KIT SCIENTIFIC REPORTS 7761

State-of-the-Art of High-Power Gyro-Devices

Update of Experimental Results 2021

Manfred Thumm

KIT Scientific Publishing

Manfred Thumm

State-of-the-Art of High-Power Gyro-Devices

Update of Experimental Results 2021

Karlsruhe Institute of Technology

KIT SCIENTIFIC REPORTS 7761

State-of-the-Art of High-Power Gyro-Devices

Update of Experimental Results 2021

by
Manfred Thumm

Institut für Hochleistungsimpuls- und Mikrowellentechnik (IHM)

KIT Scientific Publishing

Report-Nr. KIT-SR 7761

Impressum

KIT Scientific Publishing

Karlsruher Institut für Technologie (KIT)
KIT Scientific Publishing
Straße am Forum 2
D-76131 Karlsruhe

KIT Scientific Publishing is a registered trademark
of Karlsruhe Institute of Technology.
Reprint using the book cover is not allowed.

www.ksp.kit.edu

Print on Demand 2021 – Gedruckt auf FSC-zertifiziertem Papier

ISSN 1869-9669
DOI 10.5445/KSP/1000136043

Contents

Abstract

This report presents an update of the experimental achievements published in the review "State- of-the-Art of High-Power Gyro-Devices and Free Electron Masers", Journal of Infrared, Millimeter, and Terahertz Waves, **41**, No. 1, pp 1-140 (2020) related to the development of gyro-devices (Tables 2-34). Emphasis is on high-power gyrotron oscillators for long-pulse or continuous wave (CW) operation and pulsed gyrotrons for many applications. In addition, this work gives a short update on the present development status of frequency step-tunable and multi-frequency gyrotrons, coaxial-cavity multi-megawatt gyrotrons, complex two-section stepped cavity gyrotrons, gyrotrons for technological and spectroscopy applications, relativistic gyrotrons, large orbit gyrotrons (LOGs), quasi-optical gyrotrons, fast- and slow-wave cyclotron autoresonance masers (CARMs), gyroklystron-, gyro-TWT- and gyrotwystron amplifiers, gyro-harmonic converters, gyro-BWOs and dielectric vacuum windows for such high-power mm-wave sources. Gyrotron oscillators (gyromonotrons) are mainly used as high power millimeter wave sources for electron cyclotron heating (ECH), electron cyclotron current drive (ECCD), stability control and diagnostics of magnetically confined plasmas for clean generation of energy by controlled thermonuclear fusion. The maximum pulse length of commercially available 140 GHz, megawatt gyrotrons employing synthetic diamond output windows is 30 minutes (CPI and European KIT-SPC-THALES collaboration). The world record parameters of the European tube are: 0.92 MW output power at 30 min. pulse duration, 97.5% Gaussian mode purity and 44% efficiency, employing a single-stage depressed collector (SDC) for electron energy recovery. A maximum output power of 1.5 MW in 4.0 s pulses at 45% efficiency was generated with the QST-CANON 110 GHz gyrotron. The first Japan 170 GHz ITER gyrotron prototype achieved 1 MW, 800 s at 55% efficiency and holds the energy world record of 2.88 GJ (0.8 MW, 60 min., 57 %). The Russian 170 GHz ITER gyrotron obtained 0.99 (1.2) MW with a pulse duration of 1000 (100) s and 57 (53) % efficiency. The prototype tube of the KIT 2 MW, 170 GHz coaxial-cavity gyrotron achieved in short pulses the record power of 2.2 MW at 48% efficiency and 96% Gaussian mode purity. High-power CW gyrotron oscillators have also been successfully used in materials processing. Such technological applications require tubes with the following parameters: $f \geq 24$ GHz, P_{out} = 4-50 kW, CW, $\eta \geq 30\%$. Gyrotrons with pulsed magnet for various short-pulse applications deliver P_{out} = 210 kW with τ = 20 μs at frequencies up to 670 GHz ($\eta \cong 20\%$), P_{out} = 5.3 kW at 1 THz (η = 6.1%), and P_{out} = 0.5 kW at 1.3 THz (η = 0.6%). The average powers produced by 94 GHz gyroklystrons, gyrotwystrons and gyro-TWTs are 10 kW, 5 kW and 2 kW, respectively.

Keywords

Electron cyclotron maser, Gyrotron, Quasi-optical gyrotron, Gyroklystron-, Gyro-travelling-wave-, and Gyrotwystron amplifiers, Gyro-backward-wave oscillator, Cyclotron autoresonance maser, Dielectric vacuum windows

---

KIT – The Research University in the Helmholtz Association.
Please send corrections, completions and supplements to manfred.thumm@kit.edu

Zusammenfassung

Dieser Bericht bringt die im Review “State-of-the-Art of High-Power Gyro-Devices and Free Electron Masers“, Journal of Infrared, Millimeter, and Terahertz Waves, **41**, No. 1, pp. 1-140 (2020) veröffentlichten experimentellen Ergebnisse zu Gyro-Röhren (Tabellen 2-34) auf den neuesten Stand. Der Schwerpunkt liegt dabei im Bereich der Entwicklung von Hochleistungs-Gyrotron-Oszillatoren für Langpuls- und Dauerstrichbetrieb (CW) sowie von gepulsten Gyrotrons für viele Anwendungen. Außerdem wird auch kurz über den neuesten Entwicklungsstand von stufenweise frequenzdurchstimmbaren Gyrotrons, Mehrfrequenz-Gyrotrons, Multi-MW-Gyrotrons mit koaxialem Resonator, Gyrotrons mit gestuftem, zweiteiligem Resonator, Gyrotrons für technologische und spektroskopische Anwendungen, relativistischen Gyrotrons, Large-Orbit-Gyrotrons (LOGs), quasi-optischen Gyrotrons, Zyklotron-Autoresonanz-Masern (CARMs) mit schneller oder langsamer Welle, Gyroklystron-, Gyro-TWT-, und Gyrotwystron-Verstärkern, Gyro-Harmonische-Konvertern, Gyro-Rückwärtswellen-Oszillatoren (BWOs) und von dielektrischen Vakuumfenstern für solche Hochleistungsmillimeterwellenquellen berichtet. Gyrotronoszillatoren (Gyromonotrons) werden vorwiegend als Hochleistungsmillimeterwellenquellen für Elektron-Zyklotron-Heizung (ECH), Elektron-Zyklotron-Stromtrieb (ECCD), Stabilitätskontrolle und Diagnostik von magnetisch eingeschlossenen Plasmen zur Erforschung der umweltfreundlichen Energiegewinnung durch kontrollierte Kernfusion eingesetzt. Die maximale Pulslänge von kommerziell erhältlichen 140 GHz, 1 Megawatt-Gyrotrons mit Austrittsfenstern aus künstlichem Diamant ist 30 min. (CPI und Europäische KIT-SPC-THALES Zusammenarbeitsgemeinschaft). Die Weltrekordparameter des europäischen 140 GHz-Megawatt-Gyrotrons sind: 0,92 MW Ausgangsleistung bei 30 min. Pulslänge, 97,5% Gaußsche Modenreinheit und 44% Wirkungsgrad mittels eines Kollektors mit einstufiger Gegenspannung (SDC) zur Energierückgewinnung. Eine maximale Ausgangsleistung von 1,5 MW bei 4,0 s Pulslänge und 45% Wirkungsgrad wurden mit dem QST-CANON 110 GHz Gyrotron erzeugt. Das erste japanische 170 GHz ITER-Prototyp-Gyrotron erreichte 1 MW, 800 s bei 55% Wirkungsgrad und hält den Energieweltrekord mit 2,88 GJ (0,8 MW, 60 min., 57 %). Das russische 170 GHz ITER-Gyrotron lieferte 0,99 (1,2) MW bei 1000 (100) s Pulslänge und 57 (53) % Wirkungsgrad. Das KIT 2 MW, 170 GHz Prototyp-Gyrotron mit koaxialem Resonator erzielte kurzen Pulsen die Rekordleistung von 2,2 MW bei 48% Wirkungsgrad und 96% Gaußscher Modenreinheit. CW-Gyrotrons finden jedoch auch in der Materialprozeßtechnik erfolgreich Verwendung. Dabei werden Röhren mit folgenden Parametern eingesetzt: $f \geq 24$ GHz, P_{out} =4-50 kW, CW, $\eta \geq 30\%$. Gyrotrons mit gepulstem Magnet fürverschiedene Kurzpuls-Anwendungen arbeiten bei Frequenzen bis zu 670 GHz bei P_{out} = 210 kW und τ = 20 μs ($\eta \cong 4\%$), P_{out} = 5,3 kW bei 1 THz (η = 6,1%) und P_{out} = 0,5 kW bei 1,3 THz (η = 0,6%). Die höchsten von 94 GHz Gyroklystrons, Gyrotwystrons und Gyro-TWTs erzeugten mittleren Leistungen sind 10 kW, 5 kW und 2 kW.

KIT – Die Forschungsuniversität in der Helmholtz-Gemeinschaft.
Bitte schicken Sie Korrekturen, Vervollständigungen und Ergänzungen an
manfred.thumm@kit.edu

1 Introduction

The possible applications of gyrotron oscillators (gyromonotrons, or just gyrotrons) and other electron cyclotron maser (ECM) fast-wave devices (Table 1) span a wide range of technologies [1-7]. The plasma physics community has taken advantage of advances in producing high power micro- and millimeter (mm) waves in the areas of radio frequency (RF) plasma applications for magnetic confinement fusion studies, such as lower hybrid current drive (LHCD: 1-8 GHz), electron cyclotron heating and non-inductive electron cyclotron current drive (ECH&CD: 28-170 GHz), plasma production for numerous different processes and plasma diagnostic measurements, such as Collective Thomson Scattering (CTS) or heat-pulse propagation experiments. Other applications which await further development of novel high power mm-wave sources include deep-space and specialized satellite communication, high-resolution Doppler radar, radar ranging and imaging in atmospheric and planetary science, remote detection ofconcealed radioactive materials, ECR sources of highly ionized ions, submillimeter-wave and THz spectroscopy, materials processing and plasma chemistry.

Most works on ECM devices have investigated the conventional gyrotron [8-29] in which the wavevector of the radiation in an open-ended, irregular cylindrical waveguide cavity is almost transverse to the direction of the applied magnetic field, generating transverse electric (TE) electromagnetic (EM) waves near the electron cyclotron frequency or at one of its harmonics. Long-pulse and continuous wave (CW) gyrotrons delivering output powers of 0.1-1.2 MW at frequencies between 28 and 170 GHz have been used very successfully in thermonuclear fusion research for plasma ionization and start-up, ECH and local, current density profile control by non-inductive ECCD at system power levels up to 10 MW.

ECH has become a well-established heating method for both tokamaks [30-60] and stellarators [60-87]. The confining magnetic fields in present day fusion devices are in the range of B_o=1-3.6 Tesla. As fusion machines become larger and operate at higher magnetic field ($B_o \cong 5.5$T) and higher plasma densities in steady state, it is necessary to develop CW gyrotrons that operate at both higher frequencies and higher mm-wave output powers. The requirements of the new stellarator (W7-X) at the Max-Planck-Institute for Plasmaphysics in Greifswald, Germany, and the future tokamak experiment ITER (International Thermonuclear Experimental Reactor) in Cadarache, France, are between 18 and 40 MW at frequencies between 140 GHz and 170 GHz [22,25-29,37,53-57,61-81,88-109]. This suggests that mm-wave gyrotrons that generate output power of at least 1 MW, CW, per tube are required. Since efficient ECH needs axisymmetric, narrow, pencil-like mm-wave beams with well-defined polarization (linear or elliptical), single-mode gyrotron emission is necessary in order to generate a fundamental Gaussian beam mode (TEM_{00}). Single-mode 77-170 GHz gyromonotrons with conventional, cylindrical cavity, capable of 1.5 MW per tube, CW [22-29], and 2 MW coaxial-cavity gyrotrons [94-107] are currently under development. There has been continuous progress towards higher frequency and power but the main issues are still the long-pulse or CW cavity and collector operation. The availability of sources with fast frequency tunability would permit the use of a simple, non-steerable mirror antenna at the plasma torus for local current drive experiments [25-29,37,93-114]. Frequency tuning has been shown to be possible in quasi-optical Fabry-Perot cavity gyrotrons [115,116] as well as in cylindrical and coaxial cavity gyrotrons by frequency tuning in steps (different operating cavity modes) [117-152].

This report updates the present status and future prospects of gyrotrons and RF vacuum windows for ECH&CD in fusion plasmas and for ECR plasma sources for generation of multi-charged ions and soft X-rays [153-176] (Tables 2-13), the development of very high frequency gyrotrons for active plasma diagnostics [177-231], high-frequency sub-millimeter wave spectroscopy in various fields (e.g. Dynamic Nuclear Polarization (DNP) Nuclear Magnetic Resonance (NMR) spectroscopy, molecular spectroscopy, hyperfine structure of the positronium) [231-330], remote detection of concealed radioactive materials [331-334], wireless communication [335] and medical applications [336-341] (Tables 14-18) and of quasi-optical gyrotrons (Table 22). Gyrotrons also are successfully utilized in materials processing (e.g. advanced ceramic and metal-powder-compound sintering, surface hardening or dielectric coating of metals and alloys, semiconductor production, penetrating rocks) as well as in plasma chemistry [1-7,342-366]. The use of gyrotrons for such technological applications appears to be of interest if one can realize a relatively simple, low cost device, which is easy in service (such as a magnetron). Gyrotrons with low magnetic field (operated at the 2nd harmonic of the electron cyclotron frequency), low anode voltage, high efficiency and long lifetime are under development. Mitsubishi in Japan [367] and Gycom in Russia [350,358-361, 368-373] are also employing permanent magnet systems. The state-of-the-art in this area of gyrotrons for technological applications is summarized in Table 19.

The next generation of high-energy physics accelerators and the next frontier in understanding of elementary particles is based on supercolliders. For normal-conducting linear electron-positron colliders that would reach center-of-mass energies of > 1 TeV sources at 17 to 35 GHz with P_{out} = 300 MW, τ = 0.2 µs and characteristics that allow approximately 1000 pulses per second would be necessary as drivers [374-376]. These must be phase-coherent devices, which can be either amplifiers or phase-locked oscillators. Such generators are also required for super-range high-resolution radar and atmospheric sensing [377-389]. Therefore, this report also gives an overview of the present development status of relativistic gyrotrons (Tables 20 and 21), fast- and slow-wave cyclotron autoresonance masers (CARM) (Tables 23 and 24), gyro-klystrons (Tables 25-27), gyrotron travelling wave tube amplifiers (Gyro-TWT) (Tables 28 and 29), gyrotwystron amplifiers (Tables 30-32), and broadband gyrotron backward wave oscillators (Gyro-BWO) (Tables 33 and 34).

The present report updates the experimental achievements (Tables 2 - 34) in the development of gyro-devices reviewed in M. Thumm, State-of-the-Art of High-Power Gyro-Devices and Free Electron Masers, Journal of Infrared, Millimeter, and Terahertz Waves, **41**, No. 1, pp. 1-140 (2020), and in the former KfK Report 5235 (Oct 1993), FZKA Reports 5564 (Apr 1995),5728 (Mar 1996), 5877 (Feb 1997), 6060 (Feb 1998), 6224 (Jan 1999), 6418 (Feb 2000), 6588 (Mar 2001), 6708 (Feb 2002), 6815 (Feb 2003), 6957 (Feb 2004), 7097 (Feb 2005), 7198 (Feb 2006), 7289 (Feb 2007), 7392 (2008), 7467 (2009), and KIT Scientific Reports 7540 (2010), 7575 (2011), 7606 (2012), 7641 (2013), 7662 (2014), 7693 (2015), 7717 (2016), 7735 (2017) and 7750 (2018) with the same title.

The list of references includes additional information about: principle and history of gyrotrons [398-413], effective cavity length [414], internal quasi-optical mode converters as transverse Gaussian beam or HE_{11} mode output couplers [415-428], electron beam space-charge neutralization [429,430], CARMs, other gyro-amplifiers and gyro-BWOs [431-445], magnicons [446-448], gyro-harmonic converters [449-451], and free electron masers (FEMs) [390-397,452-481].

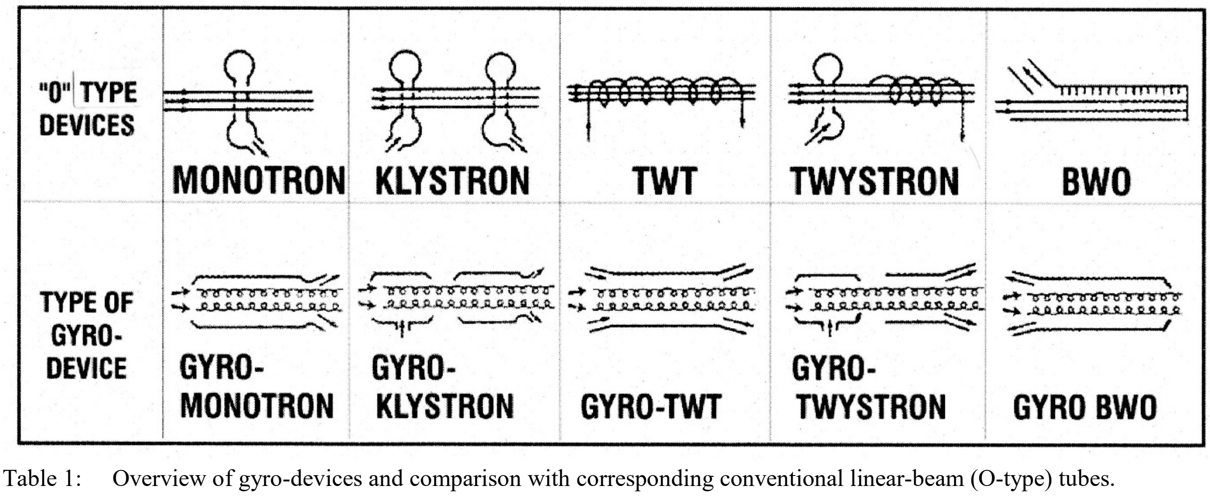

Table 1: Overview of gyro-devices and comparison with corresponding conventional linear-beam (O-type) tubes.

2 Gyrotron Oscillators and Microwave Vacuum Windows for Plasma Heating

Institution	Frequency	Mode		Power	Efficiency	Pulse length
	[GHz]	cavity	Output	[MW]	[%]	[s]
ABB, Baden [411,482]	8/39	TE_{01}/ TE_{02}	TE_{01} /TE_{02}	0.35/0.25	35/42	0.5/0.1
ARIEL UNIV., Ariel [483-487]	27,31,39,28	$TE_{11,21,01,02}$	$TE_{11,21,01,02}$	0.004-0.006	11-20	≤ 0.000011
	95/95 ($2\Omega_c$)	TE_{02}	TE_{02}/TEM_{00}	0010/0.033	14/23	10/0.1
CEERI, IPR, SAMEER, BHU, IITR,	42	TE_{03}	TE_{03}	0.126	20.4	0.0005
Pilani, Gandhinagar [488]						
CPI[1], Palo Alto	8	TE_{21}	TE_{10}	0.5 (dual output)	33	1.0
[14,19,489-507]	28,35	TE_{02}	TE_{02}	0.2	37	CW
	53.2,56,60,70	$TE_{01/02}$	TE_{02}	0.23	37	CW
	70.15/84	$TE_{10,3}$/ $TE_{15,4}$	TEM_{00}	0.6/0.56	47/44 (SDC)	2.25/2.0
	84	$TE_{15,2}$	$TE_{15,2/4}$	0.5 (0.9)	28	0.1(0.001)
	94.9	$TE_{6,2}$	TEM_{00}	0.12	50 (SDC)	CW
	95.3	$TE_{22,6}$	TEM_{00}	0.63 (1.92)	42 (40) (SDC)	15 (0.005)
CPI[1], NIFS, Palo Alto, Toki	84	$TE_{15,3}$	TEM_{00}	0.5(0.4)/0.1	29/14	2.0(10.5)/CW
[82,83,492-496,508-511]				0.59(0.25)	41(32) (SDC)	0.001(0.2)
GYCOM, IAP	5	TE_{01}	TE_{01}	0.23	26	0.1
Nizhny Novgorod	25 ($2\Omega_c$)	TE_{03}	TE_{03}	0.8/0.87	40/25(2e-beams)	0.0001
[15,118,119,137-144,512-530]	28	$TE_{4,2}$/$TE_{6,2}$	TEM_{00}	0.5	36	0.5
	37.5	TE_{62}	TEM_{00}	0.5	35	0.1
	44.8	$TE_{15,1}$	$TE_{15,1}$	1.25	35	0.0001
	53.2,54.5	TE_{83}	TEM_{00}	0.5 (0.3)	40 (36)	0.1 (1.0)
	53.5 ($3\Omega_c$)	$TE_{7,1/7,2}$	TE_{72}	0.15	10	0.00004
	68 (70)	TE_{93}	TEM_{00}	0.5 (0.68)	50 (48) (SDC)	1.0 (3.0)
	75	$TE_{9,4}$ /$TE_{11,5}$	TEM_{00}	0.5/0.8	37/70 (SDC)	0.1
	82.5	$TE_{11,3}$	$TE_{11,3}$	1.0 (1.5)	50 (36)	0.0001
	82.7/84	$TE_{10,4}$/ $TE_{12,5}$	TEM_{00}	0.65/0.88 (0.2)	54 (50) (SDC)	3.0(CW)
	82.6	$TE_{13,5}$	TEM_{00}	1.0	57 (SDC)	30
low-Q cavity tunable	64-91	echelette	Mode	80-200	11-30	0.0001
HUGHES, Torrance [408]	60	TE_{02}	TE_{02}	0.2	35	0.1
IECAS, Beijing [531-534]	24.1	TE_{01}	TE_{01}	0.15	24	0.02
	34.3($2\Omega_c$)	$TE_{02/03}$	TE_{03}	0.2	30	0.02
	94	TE_{02}	TE_{02}	0.0158	30.3	120
IECAS, NTHU [535, 536]	94	TE_{01}	TE_{01}	0.008	9.5	0.1
IAE-CAEP, Mianyang	28	TE_{02}	TEM_{00}	0.055	46 (SDC)	30
[537-539]	95	TE_{03}/TE_{62}	TE_{03}/TEM_{00}	0.02/0.03/12	20	10/600/CW
	95($2\Omega_c$)/95($3\Omega_c$)	TE_{02}/TE_{61}	TE_{02}/TE_{61}	0.012/0.006	9.9/4	0.03/0.0001
KERI, Changwon [540]	94.5	$TE_{6,2}$	TEM_{00}	0.1/0.037	33/48 (SDC)	0.00005/2
LAP/INPE, Sao Paulo [541]	24.2/30.4	TE_{12} /TE_{22}	TE_{12} /TE_{22}	0.0058/0.0063	16/18.5	0.000015
MITSUBISHI, Amagasaki	88	$TE_{8,2}$	TEM_{00}	0.35	29	0.1
KYOTO UNIV. [542]						
NEC, Kawasaki [543]	35	TE_{01}	TE_{01}	0.1	30	0.001
NRL, Washington D.C.	35	TE_{01}	TE_{01}	0.15	31	0.02
[408,544-546]	35	TE_{04}($TE_{01/04}$)	TE_{04}	0.475 (0.34)	38 (54)	0.001
	35/85	TE_{24}/TE_{13}	TE_{24}/TE_{13}	0.43 (0.3)/0.2	41 (63)/30	0.001
PHILIPS[2], Hamburg [547]	70	TE_{02}	TE_{02}	0.21(0.14)	38(30)	0.1(CW)
SPbSTU, St. Petersburg	74.2	$TE_{12,3}$	$TE_{12,3}$	0.1	44	0.00005
KIT[3] Karlsruhe [548-555]						
THALES ED[4], Velizy	8	$TE_{5,1}$	$TE_{5,1}$	1.0	45	1.0
[411,556]	35	TE_{02}	TE_{02}	0.335	43	0.15
TSUKUBA UNIV., CANON[5]	28	TE_{02}	TE_{02}	0.2	35.7	0.075
Ibaraki, Otawara [85-87,557-570]	28	$TE_{4,2}$ /$TE_{8,3}$	TEM_{00}	1.38 (0.4)	40 (31)	3 (CW)
	41(56)	TE_{02}	TE_{02}	0.2	31.3 (32.9)	0.1
	77	$TE_{18,6}$	TEM_{00}	1.9/1.6/1.2/0.22	38 (SDC)	0.1/1.8/10/4500
UESTC, Chengdu [534,571-579]	15	TE_{01}	TEM_{00}	0.1	30	0.0001
	35 ($3\Omega_c$)	TE_{51}/TE_{52}	TE_{52}	0.147	10.2	0.0001PM, 100kg
	70,94 ($2\Omega_c$)	TE_{02}/TE_{03}	TE_{03}	0.1(0.16)	20 (26.5)	0.0001
	94	TE_{61}/TE_{62}	TE_{62}/TEM_{00}	0.027 (0.02)	30 (45 (SDC))	CW
	95.3	$TE_{22,6}$	$TE_{22,6}$	0.43	34.7	0.000003
UNIV. FUKUI, TOSHIBA [543]	70	TE_{02}	TE_{02}	0.025	28.4	0.001
UNIST, Ulsan [580]	95	TE_{62}	TEM_{00}	0.062	22	0.000003

SDC: Single-stage Depressed Collector [1]) Communications & Power Industries, formerly VARIAN, [2]) formerly VALVO, [3])Karlsruhe Institute of Technology, formerly FZK, [4]) TED, formerly Thomson TE, [5]) formerly TOSHIBA

Table 2: Performance parameters of gyrotron oscillators with frequencies between 5 and 95 GHz.

Institution	**Frequency [GHz]**	**Mode**		**Power [MW]**	**Efficiency [%]**	**Pulse length [s]**
		cavity	**output**			
CPI[1], Palo Alto	106.4($2\Omega_c$)	$TE_{02/03}$	TE_{03}	0.135	21	0.1
[14,52,268,490-494,503-506, 581-606]	106.4	$TE_{12,2}$	$TE_{12,2}$	0.4	30	0.1
	110	$TE_{15,2}$	$TE_{15,2}$	0.5(0.3)	28(28)	1.0(2.0)
	110	$TE_{22,2}$	$TE_{22,2/4}$	0.5	27	2.5
	110	$TE_{22,6}$	TEM_{00}	1.28	42.3 (SDC)	0.001
				1.05	31	5.0
				0.6 (0.52)	31 (29 SDC)	10.0
				0.106	21	CW
	117.5	$TE_{20,9}$	TEM_{00}	1.67	37 (SDC)	0.001
				1.2/0.95/0.55	34 (SDC)	0.4/5.0/10.0
KIT[2], Karlsruhe	117.9	$TE_{19,5}$	TEM_{00}	1.55	31	0.007
[120-132,607-626]				1.55	49.5 (SDC)	0.007
	132.6	$TE_{9,4}$	$TE_{9,4}$	0.42	21	0.005
GYCOM-M, IAP	110	$TE_{19,5}$	TEM_{00}	1.2	40	0.0001
Moscow, N. Novgorod				1.0	65(SDC)	0.0001
[15,413,519,627-636]				0.93	36	2.0
				0.5	35	5.0
				0.35	33	10.0
GYCOM, IAP	100	$TE_{22,2}$	$TE_{22,2}$	1.1	34	0.0001
Nizhny Novgorod	104	$TE_{18,7}$	TEM_{00}	0.98	46.5 (SDC)	0.5
[15,118,119,123-152,515-520, 637-641]	105	$TE_{17,6}$	TEM_{00}	1.04/0.85	57/50 (SDC)	10/300
	106.4	$TE_{15,4}$	TEM_{00}	0.5	33	0.2
	110	$TE_{15,4}$	TEM_{00}	0.5	33	1.0
	111.5	$TE_{19,6}$	TEM_{00}	1.0	32	0.0001
	129	$TE_{17,5}$	TEM_{00}	0.5	32	0.5
QST[3], CANON[4]	110	$TE_{22,2}$	TEM_{00}	0.75	27.6	0.002
Naka, Otawara [22,569,570,642-670]				0.61	30	0.05
				0.61	50 (SDC)	0.05
				0.42	48 (SDC)	3.3
				0.35	48 (SDC)	5.0
	110	$TE_{22,6}$	TEM_{00}	1.5	45 (SDC)	4.0
				1.0	38 (SDC)	70
	110	$TE_{22,8}$	TEM_{00}	1.5/1.0	47/45 (SDC)	3.8/100
	110	$TE_{22,12}$	$TE_{22,12}$	0.7	30	0.001
	120	TE_{03}	TE_{03}	0.17	25	0.01
	120	$TE_{12,2}$	$TE_{12,2}$	0.46	24	0.1
				0.25	24	0.22
	120	$TE_{12,2}$	TEM_{00}	0.5	24	0.1
	137.6	$TE_{27,10}$	TEM_{00}	1.0	44 (SDC)	100
MITSUBISHI, Amagasaki	120	$TE_{02/03}$	TE_{03}	0.16	25	0.06
[671,672]	120	$TE_{15,2}$	$TE_{15,2}$	1.02	32.5	0.0002
				0.46(0.25)	30	0.1(0.21)
THALES ED[5], Velizy	100	TE_{34}	TE_{34}	0.19	30	0.07
[411,556]	110	TE_{93}	TE_{93}	0.42	17.5	0.002
	110	TE_{64}	TE_{64}	0.34	19	0.01
				0.39	19.5	0.21
THALES ED[5], CEA, SPC[6],	118	$TE_{22,6}$	TEM_{00}	0.7	37	0.01
KIT [673-683]				0.53(0.35)	32(23)	5.0(111)

SDC: Single-stage Depressed Collector
[1] Communications & Power Industries, formerly VARIAN, [2] formerly KfK, then FZK, [3] formerly JAERI, then JAEA, [4] formerly TOSHIBA [5] formerly Thomson TE, [6] formerly CRPP

Table 3: Present development status of high frequency gyrotron oscillators for ECH&CD and stability control in magnetic fusion devices (100 GHz ≤ f < 140 GHz, $\tau \geq 0.1$ ms).

Institution	Frequency [GHz]	Mode cavity	Mode Output	Power [MW]	Efficiency [%]	Pulse length [s]
BVERI, Beijing [684,685]	140.2	$TE_{22,6}$	$TEM_{00}(TE_{22,6})$	0.56(0.43)	24.5 (22.6)	0.001
CPI[1)], Palo Alto	140	$TE_{02/03}$	TE_{03}	0.1	27	CW
[14,19,268,490-494,503,505,506	140	$TE_{15,2}$	$TE_{15,2}$	1.04(0.32)	38 (31)	0.0005(3.6)
590-594,597-605,686-691]				0.2 (0.4)	31	avg. (peak)
	140.2	$TE_{28,7}$	TEM_{00}	0.92/0.9	36/33 (SDC)	0.003/1800
	170	$TE_{31,8}$	TEM_{00}	1.0(0.6)	35 (SDC) (26)	0.002(15)
IAE-CAEP, Mianyang [692]	140	$TE_{7,3}$	TEM_{00}	0.030/0.052	34/39.4 (SDC)	60/30
KIT[2)], PHILIPS[3)] [411,693]	140.8	TE_{03}	TE_{03}	0.12	26	0.4
KIT[2)], Karlsruhe	140.2	$TE_{10,4}$	$TE_{10,4}$	0.69	28	0.005
[120-132,412,607-626,693-709]	140.2	$TE_{10,4}$	TEM_{00}	0.6(0.5)	27 (32)	0.012(0.03)
				0.50	48 (SDC)	0.03
	140.5	$TE_{10,4}$	TEM_{00}	0.46	51 (SDC)	0.2
	140.1	$TE_{22,6}$	TEM_{00}	1.6/2.1	60/53 (SDC)	0.007/0.001
	150	TE_{03}	TE_{03}	0.12	20	0.0005
	162.3	$TE_{25,7}$	TEM_{00}	1.48	35	0.007
				1.48	50 (SDC)	0.007
KIT[2)], SPC[4)], THALES ED[5)],	139.8	$TE_{28,8}$	TEM_{00}	1.0/0.92	50/44 (SDC)	12/1800
[6,7,66-78,90-99,676,710-751]	140.3	$TE_{28,10}$	TEM_{00}	1.7/1.5	43/45 (SDC)	0.001
EGYC[6)] [752-763]	170	$TE_{32,9}$	TEM_{00}	1.2	34	0.001
				0.92/0.56/0.47	38/41 (SDC)	180/485/1570
GYCOM, IAP	140	$TE_{22,6}$	TEM_{00}	0.96	36	1.2
Nizhny Novgorod				0.54	36	3.0
[15,133-152,442,516-520,629-636,				0.26 (0.1)	36	10 (80)
641,764-803]		(dual-beam	output)	2x0.37	30	3.0
				2x0.3	29	5.5
				2x0.165	28	10.0
	140	$TE_{22,8}$	TEM_{00}	1.7	42	0.0001
				1.2	68 (SDC)	0.0001
	140	$TE_{22,8}$	TEM_{00}	1.14/0.95/0.7	59/52/49(SDC)	10/300/3000
	170	$TE_{25,10}$	TEM_{00}	1.2/0.96	53/57 (SDC)	100/1000
	170	$TE_{28,12}$	TEM_{00}	1.75/1.5/1.2	53/47 (SDC)	0.1/2.3/500
	250	$TE_{19,8}$	TEM_{00}	330/90	30	0.000045/1
GYCOM-N, IAP	140	$TE_{22,6}$	TEM_{00}	0.8	32	0.8
Nizhny Novgorod				0.88	50.5 (SDC)	1.0
[15,118,119,515-517,520,524,				0.55	33	2.0
634-637,639,640,764,779,803-807]	140	$TE_{22,10}$	TEM_{00}	0.99	47 (SDC)	0.5
	151 echelette	$TE_{0,18}$	$TE_{0,18}$	0.9	32	0.00005
	158.5	$TE_{24,7}$	TEM_{00}	0.5	30	0.7
	169.9	$TE_{7,3}$	TEM_{00}	0.03	30.5	30 (driver)
QST[7)], CANON[8)]	170	$TE_{22,6}$	TEM_{00}	0.45	19	0.05
Naka, Otawara				0.25	32 (SDC)	0.4
[22,648-663,808-851]	170.1	$TE_{31,8}$	$TE_{31,8}$	1.15	29	0.0004
	170	$TE_{31,8}$	TEM_{00}	1.3/1.2	32/57 (SDC)	0.003
				1.0/0.8	55/57 (SDC)	800/3600
	170	$TE_{31,12}$	TEM_{00}	1.56(0.94)	27	0.001(50)
	170	$TE_{31,11}$	TEM_{00}	1.23/1.05/0.6	47/51/46 (SDC)	2.0/300/1000
QST[7)], TSUKUBA UNIV., CANON[8)]	300	$TE_{32,18}$	$TE_{32,18}$	0.52/0.62	20	0.002/0.001
[569,570,852-855]						tilted SiO_2 window
NIFS, TSUKUBA UNIV.,	154	$TE_{28,8}$	TEM_{00}	1.25	37 (SDC)	0.004
CANON[8)]				0.35	39 (SDC)	1800
Toki, Ibaraki, Otawara	168	$TE_{31,8}$	TEM_{00}	0.52	19	1.0
[82-85,511,565,567-570,856-858]				0.52	30 (SDC)	1.0

SDC: Single-stage Depressed Collector [1)] Comm. & Power Industries, formerly VARIAN, [2)] formerly KfK, then FZK, [3)] formerly VALVO, [4)] formerly SPC, [5)] formerly Thomson TE, [6)] EGYC collaboration among SPC, Switzerland; KIT, Germany; HELLAS, Greece; CNR, Italy; ENEA Italy, [7)] formerly JAERI, then JAEA, [8)] formerly TOSHIBA

Table 4: Present development status of high frequency gyrotron oscillators for ECH&CD and stability control in magnetic fusion devices (f ≥ 140 GHz, τ ≥ 0.1 ms).

Institution	Frequency [GHz]	Mode cavity	Mode output	Power [MW]	Efficiency [%]	Corrug.Cavity inner	Corrug.Cavity outer
KIT[1] Karlsruhe	137.78	$TE_{27,16}$	$TE_{27,16}$	1.03	24.3	yes	no
[6,22,25-28,93-95,704-710,	139.96	$TE_{28,16}$	$TE_{28,16}$	1.17	27.2	yes	no*
726,859-878]			$TE_{76,2}$/TEM_{00}	0.95	20	yes	no
Pulse length ≤ 10 ms				0.95	29 (SDC)	yes	no
				(dual beam output)			
	142.02	$TE_{29,16}$	$TE_{29,16}$	1.04	24.4	yes	no
	138.70	$TE_{27,14}$	TEM_{00}	1.14	26.1	yes	no
	146.70	$TE_{28,15}$	TEM_{00}	1.13	25.6	yes	no
	156.90	$TE_{30,16}$	TEM_{00}	1.24	25.4	yes	no
	164.98	$TE_{31,17}$	$TE_{31,17}$	1.17	26.7	yes	no
			TEM_{00}	2.2	28	yes	no
				(single-beam output)			
				1.5	30	yes	no
				1.5	48 (SDC)	yes	no
	167.14	$TE_{32,17}$	TEM_{00}	1.22	25.6	yes	no
EGYC[2], KIT[1] [96-107,879-916]	170	$TE_{34,19}$	TEM_{00}	2.1(1ms)	48 (SDC)	yes	no
Pulse length ≤ 100 ms				2.1/1.5 (11/35ms)	47/42 (SDC)	yes	no
IAP, Nizhny Novgorod	45	$TE_{15,1}$	$TE_{15,1}$	1.25	43	no	no
[13,15,516,519,917-925]	100	$TE_{21,18}$	$TE_{21,18}$	1.0	35	yes	no
Pulse length ≤ 0.1 ms				0.5	20	no	no
	100	$TE_{20,13}$	$TE_{20,13}$	2.1	30	no	no
				1.6	38	no	no
	103	$TE_{22,13}$	$TE_{22,13}$	1.0	40	yes	yes
				0.7	30	yes	no
				0.3	14	no	no
	107	$TE_{17,7}$	$TE_{17,7}$	0.7	25	no	no
	110	$TE_{20,13}$	$TE_{20,13}$	1.15	35	yes	no
	110	$TE_{21,13}$	$TE_{21,13}$	1.0	35	yes	no
	140	$TE_{28,16}$	$TE_{28,16}$	1.5	33.5	yes	no*
				1.15	50 (SDC)	yes	no
			$TE_{76,2}$	1.17	35.2	yes	yes
			TEM_{00}	1.1	30	yes	no
				(dual-beam output)			
	224 ($2\Omega_c$)	$TE_{33,8}$	$TE_{33,8}$	0.1	11	yes	no
IAP, KIT[1] Karlsruhe [859]	133	$TE_{27,15}$	$TE_{27,15}$	1.3	29	no	no
Pulse length 30 µs	140	$TE_{28,16}$	$TE_{28,16}$	1.0	23	no	no
MIT, Cambridge [926-928]	137	$TE_{25,11}$	TEM_{00}	0.5	7.5	no	no
Pulse length 3 µs	139.6	$TE_{26,11}$	TEM_{00}	0.9	13	no	no
	142.2	$TE_{27,11}$	TEM_{00}	1.0	14.5	no	no
	140	$TE_{21,13}$	TEM_{00}	0.5	7.5	no	no
UESTC, Chengdu [929]	110/220 ($2\Omega_c$) two electron beams	TE_{02}/TE_{04}	TEM_{00}	0.02	5	no	no

[1] formerly KfK, then FZK, * very similar cavity and tube design

[2] EGYC is a collaboration among CRPP (now SPC), Switzerland; KIT, Germany; HELLAS, Greece; CNR, Italy; ENEA Italy

Table 5: Present experimental development status of short pulse (3 µs – 50 ms) coaxial cavity gyrotron oscillators.

Design studies on 4 MW, 170 GHz and 2 MW, 240 GHz coaxial-cavity gyrotrons for future fusion reactors were performed at KIT [930-933]. The 4 MW tube would operate in the $TE_{52,31}$ -mode and its q.o. output coupler would generate two 2 MW fundamental Gaussian beams which leave the tube through two CVD-diamond windows.

Institution	Frequency [GHz]	Mode cavity	Mode output	Power [MW]	Efficiency [%]	Pulse length [s]
CPI[1)], Palo Alto	8	TE_{21}	TE_{10}	0.4	26.6	0.0005
[26,29,489-507,585-594,597-606, 686-691]	(dual rectangular waveguide output)			0.4	34.2 (SDC)	0.0005
	70.15	$TE_{10,3}$	TEM_{00}	0.6	47 (SDC)	2.25
	94.9	TE_{62}	TEM_{00}	0.12	50 (SDC)	CW
	95.3	$TE_{22,6}$	TEM_{00}	0.62 (1.92)	41(40) (SDC)	15 (0.005)
	110	$TE_{22,6}$	TEM_{00}	1.28	42.3 (SDC)	0.001
				0.52	29 (SDC)	10
	140.2	$TE_{27,8}$	TEM_{00}	0.92/0.9	36/33 (SDC)	0.003/1800
IAE-CAEP, Mianyang [537-539,692]	28	$TE_{0,2}$	TEM_{00}	0.05	46 (SDC)	30
	140	$TE_{7,3}$	TEM_{00}	0.030/0.052	34/39.4 (SDC)	60/30
CPI[1)], NIFS	84	$TE_{15,3}$	TEM_{00}	0.5	29	2.0
Palo Alto, Toki [82-85,495]				0.59	41 (SDC)	0.001
				0.25	32 (SDC)	0.2
KIT[2)], Karlsruhe	117.9	$TE_{19,5}$	TEM_{00}	1.55	49.5 (SDC)	0.007
[23,120-127,607-626,699-710]	140.2	$TE_{10,4}$	TEM_{00}	0.50/0.46	48/51(SDC)	0.03/0.2
	140.1	$TE_{22,6}$	TEM_{00}	1.6/2.1	60/53 (SDC)	0.007/0.001
	162.3	$TE_{25,7}$	TEM_{00}	1.48	50 (SDC)	0.007
KIT[2)], SPC[3)], EGYC, THALES ED[4)],	139.8	$TE_{28,8}$	TEM_{00}	1.0/0.92	50/44 (SDC)	12/1800
[6,26,29,67-71,93-106,676,710-751]	140.3	$TE_{28,10}$	TEM_{00}	1.5	45 (SDC)	0.001
	170	$TE_{32,9}$	TEM_{00}	0.8	37 (SDC)	180
GYCOM, IAP	68 (70)	$TE_{9,3}$	TEM_{00}	0.5 (0.68)	50 (48) (SDC)	1.0 (3.0)
Nizhny Novgorod	75	$TE_{11,5}$	TEM_{00}	0.8	70 (SDC)	0.1
[517-519,522-525,530,630,631,636,638]	82.7	$TE_{10,4}$	TEM_{00}	0.65/0.2	38/52 (SDC)	3.0/CW
	82.6	$TE_{13,5}$	TEM_{00}	1.0	57 (SDC)	30
	84	$TE_{12,5}$	TEM_{00}	0.88 (0.2)	50 (SDC)	3.0 (CW)
	104	$TE_{18,7}$	TEM_{00}	0.98	46.5 (SDC)	0.5
	110	$TE_{19,5}$	TEM_{00}	1.0	65 (SDC)	0.0001
	140	$TE_{22,6}$	TEM_{00}	0.8	32	0.8
				0.88	50.5 (SDC)	1.0
	140	$TE_{22,10}$	TEM_{00}	0.99	47 (SDC)	0.5
GYCOM, IAP	140	$TE_{22,8}$	TEM_{00}	1.7	42	0.0001
Nizhny Novgorod				1.14/0.95/0.7	59/52/49 (SDC)	10/300/1000
[26,29,133-152,524,752-800]	170	$TE_{25,10}$	TEM_{00}	1.2	53 (SDC)	100
				0.96	57 (SDC)	1000
	170	$TE_{28,12}$	TEM_{00}	1.75/1.5/1.2	53/47 (SDC)	0.1/2.5/500
KERI, Changwon [540]]	94.5	$TE_{6,2}$	TEM_{00}	0.1/0.037	33/48 (SDC)	0.00005/2
NRL, Washington D.C.	115	QOG	TEM_{00}	0.43	12.7 (SDC)	10^{-5}
[934]				0.20	16.1 (SDC)	10^{-5}
QST[5)], CANON[6)]	110	$TE_{22,2}$	TEM_{00}	0.61	50 (SDC)	0.05
Naka, Otawara				0.35	48 (SDC)	5.0
[26,29,645-670,807-850,853,854]	110	$TE_{22,6}$	TEM_{00}	1.5	45 (SDC)	4.0
				1.0	38 (SDC)	70
	110	$TE_{22,8}$	TEM_{00}	1.5/1.0	47/45 (SDC)	3.8/100
	138	$TE_{27,10}$	TEM_{00}	1.0	43 (SDC)	100
	170	$TE_{22,6}$	TEM_{00}	0.25	19/32 (SDC)	0.4
	170.2	$TE_{31,8}$	TEM_{00}	1.2	57 (SDC)	0.003
				1.0	55 (SDC)	800
				0.8	57 (SDC)	3600
	170	$TE_{31,11}$	TEM_{00}	1.23/1.05/0.6	47/51/46 SDC	2.0/300/1000
NIFS, TSUKUBA UNIV., CANON[6)]	77	$TE_{18,6}$	TEM_{00}	1.9	38 (SDC)	0.1
Toki, Ibaraki, Otawara				1.8/1.6/1.2/0.22	38 (SDC)	0.1/1.8/10/4500
[26,29,82-87,511,560-570,855-858]	154	$TE_{28,8}$	TEM_{00}	1.25(0.35)	39 (SDC)	0.004 (1800)
	168	$TE_{31,8}$	TEM_{00}	0.52	19	1.0
				0.52	30 (SDC)	1.0

SDC: Single-stage Depressed Collector; QOG: Quasi-Optical Gyrotron, EGYC: Cons. among SPC, Swisse; KIT, Germany; HELLAS, Greece; CNR, Italy; ENEA Italy [1)] formerly VARIAN, [2)] formerly KfK, then FZK, [4)] formerly CRPP, [4)] formerly Thomson TE, [5)] formerly JAERI, then JAEA, [6)] formerly TOSHIBA

Table 6: Present development status of high frequency gyrotron oscillators with conventional cylindrical or quasi-optical cavity and single-stage depressed collector (SDC) ($\tau \geq 10$ µs).

Institution	Frequency [GHz]	Mode cavity	Mode output	Power [MW]	Efficiency [%]	Pulse length [s]	
KIT[1], Karlsruhe	114.2	$TE_{18,5}$	TEM_{00}	0.85	23	0.001	
[26-29,120-132,612,615,	117.9	$TE_{19,5}$	TEM_{00}	1.0	27	0.001	
617-626]				1.55	49.5 (SDC)	0.007	optimized
	121.6(119.5)	$TE_{20,5}$($TE_{19,7}$)	TEM_{00}	1.0(0.88)	27(23)	0.001	
	125.3(124.1)	$TE_{21,5}$($TE_{20,7}$)	TEM_{00}	1.0(1.0)	27(33.0)	0.001	
	128.9(127.5)	$TE_{22,5}$($TE_{21,7}$)	TEM_{00}	0.9(1.04)	24.5(35.0)	0.001	
	132.6(130.9)	$TE_{20,6}$($TE_{22,7}$)	TEM_{00}	0.85(0.9)	23(24)	0.001	
	136.2	$TE_{21,6}$	TEM_{00}	0.9	24.5	0.001	
	140.1(140.0)	$TE_{22,6}$($TE_{22,8}$)	TEM_{00}	1.0(1.2)	27(37.0)	0.001	
				1.6	60 (SDC)	0.007	optimized
	143.7(143.4)	$TE_{23,6}$($TE_{23,8}$)	TEM_{00}	1.1(1.2)	30(40.7)	0.001	
	147.4(146.7)	$TE_{24,6}$($TE_{24,8}$)	TEM_{00}	1.1(1.2)	30(41.8)	0.001	
	151.2	$TE_{25,6}$	TEM_{00}	1.05	28.5	0.001	
	154.9(155.9)	$TE_{23,7}$($TE_{24,9}$)	TEM_{00}	0.95(0.98)	26(26)	0.001	
	158.5(159.2)	$TE_{24,7}$($TE_{25,9}$)	TEM_{00}	1.1(1.1)	30(32.1)	0.001	
	162.3(162.5)	$TE_{25,7}$($TE_{26,9}$)	TEM_{00}	1.0(1.2)	27(36.9)	0.001	
				1.48	50 (SDC)	0.007	optimized
	166.0(165.9)	$TE_{26,7}$($TE_{27,9}$)	TEM_{00}	1.0(1.1)	26(31.9)	0.001	
	(169.2)	($TE_{28,9}$)	TEM_{00}	(1.15)	(35.7)	0.001	
GYCOM, IAP	71.5	$TE_{10,5}$	TEM_{00}	0.8	56	0.15	
Nizhny Novgorod	74.8	$TE_{11,5}$	TEM_{00}	0.8	56	0.15	
[26-29,118,119,133-152,	78.1	$TE_{12,5}$	TEM_{00}	0.8	56	0.15	.
519,521-524,636,935]	105.1	$TE_{17,6}$	TEM_{00}	1.24	41.2	0.0001	
	111.7	$TE_{19,6}$	TEM_{00}	1.37 (0.8)	42.9 (30)	0.0001(0.1)	
	124.3	$TE_{20,7}$	TEM_{00}	1.18(0.85)	37(29)	0.0001(10)	
	127.6	$TE_{21,7}$	TEM_{00}	1.33	41.6	0.0001	
	140.1	$TE_{22,8}$	TEM_{00}	1.42 (1.7)	43.3 (42)	0.0001	
	152.6	$TE_{23,9}$	TEM_{00}	1.44	44.2	0.0001	
	156.0	$TE_{24,9}$	TEM_{00}	1.01	36.1	0.0001	
	104	$TE_{18,7}$	TEM_{00}	0.98	46.5 (SDC)	0.5	
	140	$TE_{22,10}$	TEM_{00}	0.99	47 (SDC)	0.5	
QST[2], CANON[3]	166.7	$TE_{30,8}$	TEM_{00}	0.54	27	0.001	plane window
Naka, Otawara [26,29,829,936]	170	$TE_{31,8}$	TEM_{00}	0.62	32	0.001	plane window
QST[2], TSUKUBA,	225.96	$TE_{26,13}$	$TE_{26,13}$	0.274	18.1	0.002	plane window
CANON[3]	228.13	$TE_{24,14}$	$TE_{24,14}$	0.285	18.8	0.002	plane window
Naka, Ibaraki, Otawara	242.1	$TE_{25,15}$	$TE_{25,15}$	0.288	18.9	0.002	plane window
[29,853,854]	243.9	$TE_{28,14}$	$TE_{28,14}$	0.345	22.8	0.002	plane window
	250.04	$TE_{27,15}$	$TE_{27,15}$	0.292	19.3	0.002	plane window
	253.99	$TE_{28,15}$	$TE_{28,15}$	0.310	20.5	0.002	plane window
	295.65	$TE_{31,18}$	$TE_{31,18}$	0.54	19.3	0.002	plane window
	299.84	$TE_{32,18}$	$TE_{32,18}$	0.52	19.3	0.002	plane window
	301.8	$TE_{30,19}$	$TE_{30,19}$	0.52	19.3	0.002	plane window
MIT, Cambridge	107.1	$TE_{21,6}$	TEM_{00}	1.1	30	0.000003	plane window
[937-946]	110.1	$TE_{22,6}$	TEM_{00}	1.4	37	0.000003	plane window
	113.0	$TE_{23,6}$	TEM_{00}	1.1	30	0.000003	plane window
	124.5	$TE_{24,7}$	TEM_{00}	1.0	24	0.000003	plane window

SDC: Single-stage Depressed Collector; [1] formerly KfK, then FZK, [2] formerly JAERI, then JAEA, [3] formerly TOSHIBA

Table 7: Step-tunable 1 MW-class gyrotrons at KIT with Quartz, Silicon Nitride (Kyocera SN-287) or CVD-diamond Brewster window. The GYCOM 140 GHz TE22,10-mode tube was also operated in 50-150 ms pulses with a BN Brewster window (11 frequencies at 0.8 MW between 104 and 143 GHz). The QST and MIT gyrotrons used a plane single-disk output window.

Institution	Frequency [GHz]	Mode cavity	Mode output	Power [MW]	Efficiency [%]	Pulse length [s]	No. of Frequencies
CPI, Palo Alto [605]	104	TE$_{22,5}$	TEM$_{00}$	0.52	30 (SDC)	0.005	2f-Gyrotron
	140	TE$_{28,7}$	TEM$_{00}$	0.81	37 (SDC)	600	2f-Gyrotron
KIT[1)], SPC[2)] EGYC[3)], THALES ED[4)]	84	TE$_{17,5}$	TEM$_{00}$	0.97	31	1.1	2f-Gyrotron
[26-29,732,947,948]	126	TE$_{26,7}$	TEM$_{00}$	1.03	31	1.2	2f-Gyrotron
	103.8	TE$_{21,6}$	TEM$_{00}$	0.41	27 (SDC)	10	2f-Gyrotron
	140.0	TE$_{28,8}$	TEM$_{00}$	0.92	44 (SDC)	1800	2f-Gyrotron
GYCOM, IAP	121.5	TE$_{20,5}$	TEM$_{00}$	0.5	30	0.1	3f-Gyrotron
Nizhny Novgorod	140.0	TE$_{22,6}$	TEM$_{00}$	0.5	30	0.5	3f-Gyrotron
[26-29,38-51,135-152,520,	158.5	TE$_{24,7}$	TEM$_{00}$	0.5	30	0.7	3f-Gyrotron
524,636, 638-641,786-800,	105.1	TE$_{17,6}$	TEM$_{00}$	1.04/0.85	59/50 (SDC)	10/300	2f-Gyrotron
935,949]	140.1	TE$_{22,8}$	TEM$_{00}$	1.14/095	57/52 (SDC)	10/300	2f-Gyrotron
	134.7	TE$_{20,8}$	TEM$_{00}$	0.78	42.2 (SDC)	0.1	2f-Gyrotron
	170	TE$_{25,10}$	TEM$_{00}$	0.96	58 (SDC)	1000	2f-Gyrotron
QST[5)], CANON[6)]	104	TE$_{19,7}$	TEM$_{00}$	1.0/0.93/0.3	41 (SDC)	2/5/20	4f-Gyrotron
Naka, Otawara	136.8	TE$_{25,9}$	TEM$_{00}$	1.0/0.3	42 (SDC)	6/250	4f-Gyrotron
[26,29,829,832,834-849,	170	TE$_{31,11}$	TEM$_{00}$	1.2/1.0/0.6	47/49/46 SDC	5/300/2000	4f-Gyrotron
853,936,950,951]	203	TE$_{37,13}$	TEM$_{00}$	1.0/0.6	50 (SDC)	3/10	4f-Gyrotron
QST[5)], CANON[6)]	82	TE$_{17,6}$	TEM$_{00}$	1.0/0.4	35 (SDC)	1/2	3f-Gyrotron
Naka, Otawara	110	TE$_{22,8}$	TEM$_{00}$	1.9/1.5/1.0	47/45 (SDC)	1/3.8/100	3f-Gyrotron
[664-670]	137.6	TE$_{27,10}$	TEM$_{00}$	1.3/1.0	43 (SDC)	1/100	3f-Gyrotron
NIFS, TSUKUBA UNIV.,	28.04	TE$_{8,5}$	TEM$_{00}$	1.65	31	0.002	2f-Gyrotron
CANON[6)]	34.83	TE$_{10,6}$	TEM$_{00}$	1.21	27	0.002	2f-Gyrotron
Toki, Ibaraki, Otawara	115.5	TE$_{21,7}$	TEM$_{00}$				2f-Gyrotron
[569,570,670,854-857,952]	154	TE$_{28,9}$	TEM$_{00}$				2f-Gyrotron

SDC: Single-stage Depressed Collector; [1)] formerly KfK, then FZK, [2)] formerly CRPP, [3)] EGYC collaboration among SPC, Switzerland; KIT, Germany; HELLAS, Greece; CNR, Italy; ENEA Italy, [4)] formerly Thomson TE, [5)] formerly JAERI, then JAEA, [6)] formerly TOSHIBA

Table 8: Multi-frequency gyrotrons operating at different transmission maxima of a plane single-disk window.

The KIT 1 MW TE$_{22,6}$-mode gyrotron operated at frequencies between 114 and 166 GHz has been investigated with respect to fast-frequency tunability in the frequency range from 132.6 to 147.4 GHz [126]. For that purpose, the gyrotron has been equipped with a special hybrid-magnet system consisting of superconducting (sc) magnets in the cryostat and additional normal-conducting (nc) copper magnets with a fast time constant at cavity and cathode. Special problems due to the magnetic coupling between the different magnets were investigated by calculation and experiment. Making use of these investigations different current regulation schemes for the nc magnets were implemented and tested experimentally. Finally, megawatt-class step-tuning operation between the five TE$_{m,6}$-modes (m = 20 – 24) from TE$_{20,6}$ to TE$_{24,6}$ in time steps of 1 s has been achieved.

The Japan 1 MW ITER gyrotron was operated in a fast-tunable (3.5 s) sc magnet (JASTEC) at 170 GHz (TE$_{31,8}$, 615 kW, 32%) and 167 GHz (TE$_{30,8}$, 538 kW, 27%). The efficiencies are without depressed collector [936].

Institution	Frequency [GHz]	Mode cavity	Mode output	Power [MW]	Efficiency [%]	Pulse length [s]
IAP, Nizhny Novgorod [13,15]	103.8	$TE_{16,7}$	$TE_{16,7}$	0.5	17.9	0.0001
	107	$TE_{17,7}$	$TE_{17,7}$	0.7	25	0.0001
	110.2	$TE_{18,7}$	$TE_{18,7}$	0.6	21.5	0.0001
KIT[1)], Karlsruhe [125,867-870,872-874]	136.3	$TE_{26,14}$	TEM_{00}	1.02	23.5	0.001
	138.7	$TE_{27,14}$	TEM_{00}	1.14	26.1	0.001
	140.8	$TE_{28,14}$	TEM_{00}	0.92	24.0	0.001
	142.2	$TE_{26,15}$	TEM_{00}	0.90	20.6	0.001
	144.4	$TE_{27,15}$	TEM_{00}	0.96	23.1	0.001
	146.7	$TE_{28,15}$	TEM_{00}	1.13	25.6	0.001
	149.0	$TE_{29,15}$	TEM_{00}	1.08	22.9	0.001
	151.1	$TE_{30,15}$	TEM_{00}	1.00	21.3	0.001
	152.4	$TE_{28,16}$	TEM_{00}	0.75	20.8	0.001
	154.6	$TE_{29,16}$	TEM_{00}	0.94	23.4	0.001
	156.9	$TE_{30,16}$	TEM_{00}	1.24	25.4	0.001
	159.2	$TE_{31,16}$	TEM_{00}	1.04	23.9	0.001
	160.7	$TE_{29,17}$	TEM_{00}	0.99	20.7	0.001
	162.8	$TE_{30,17}$	TEM_{00}	0.98	20.7	0.001
	165.1	$TE_{31,17}$	TEM_{00}	1.24	26.3	0.001
				1.24	41 (SDC)	0.001
	167.2	$TE_{32,17}$	TEM_{00}	1.22	25.6	0.001
EGYC[2)] [898-902,905,908]	141.3	$TE_{28,16}$	TEM_{00}	1.8	26	0.001
	170.0	$TE_{34,19}$	TEM_{00}	2.2	30	0.001

SDC: Single-stage Depressed Collector;
[1)] formerly KfK, then FZK, [2)] EGYC is a collaboration among CRPP (now SPC), Switzerland; KIT, Germany; HELLAS, Greece; CNR, Italy; ENEA Italy

Table 9: Step-tunable 1 MW and 2 MW gyrotrons with coaxial cavity. IAP: Smooth inner rod and plane output window disk. KIT and EGYC: Tapered and longitudinally corrugated inner rod and broadband Silicon Nitride (Kyocera SN-287) Brewster window.

A specific feature of the coaxial gyrotron design is that it allows electron beam energy recovery and very fast frequency tuning via biasing the coaxial insert [921-924]. By biasing the inner rod of the KIT coaxial-cavity gyrotron, such very fast (within ≈ 0.1 ms) frequency tuning was demonstrated at a power level of 1 MW. In particular, fast step frequency tuning between the 165.1 GHz nominal mode and its azimuthal neighbors at 162.8 GHz and 167.2 GHz (see Table 9) was obtained. In addition, operating in the nominal $TE_{31,17}$-mode, continuous frequency pulling within 70 MHz bandwidth was achieved [874].

Material	Type	Power (kW)	Frequency (GHz)	Pulse Length (s)	Institution
water-free fused silica	single-disk inertially cooled	200	60	5.0	UKAEA/Culham
boron nitride	single-disk water edge cooled	930	110	2.0	IAP/GYCOM
		350	110	10.0	IAP/GYCOM
		960	140	1.2	IAP/GYCOM
		550	140	3.0	IAP/GYCOM
		100	140	80.0	IAP/GYCOM
		1030	170	1.0	IAP/GYCOM
		500	170	5.0	IAP/GYCOM
		270	170	10.0	IAP/GYCOM
silicon nitride	single-disk gas face and water edge cooled	130	84	30.0	NIFS/CPI
		520	168	1.0	NIFS/CANON[1)]
sapphire	single-disk LN_2 edge cooled	530	118	5.0	CEA/SPC/KIT/THALES
		350	118	100	CEA/SPC/KIT/THALES
		285*	140	3.0	IAP/INFK
		500	140	0.5	KIT/IAP/IGVP/IPP
		370	140	1.3	KIT/IAP/IGVP/IPP
sapphire	single-disk LHe edge cooled	410	110	1.0	QST/CANON[1)]
		500	110	0.5	QST/GA
sapphire	double-disk FC75 face cooled	200	28	CW	CPI
		200	35	CW	CPI
		200	60	CW	CPI
		400	84	10.5	NIFS/CPI
		350	110	5.0	QST/CANON[1)]
		200	140	CW	CPI
		500	170	0.6	QST/CANON[1)]
sapphire	distributed water cooled	65**	110	0.3	GA/QST
		200*	110	0.7	GA/CPI
Au-doped silicon	single-disk CO_2 gas edge cooled	600	140	0.8	IAP/GYCOM
diamond	single-disk water edge cooled	400	28	CW	TSUKUBA/CANON[1)]
		600	70	2.3	CPI
		1.2	77	10	NIFS/TSUKUBA/CANON[1)]
		0.3	77	CW	NIFS/TSUKUBA/CANON[1)]
		500	84	2.0	CPI
		100	94	CW	CPI
		300	104	20	QST/CANON[1)]
		300**	110	1.0	CPI/FOM
		50	110	CW	CPI/FOM
		450	110	2.0	IAP/GYCOM/GA
		1050	110	5.0	CPI/GA
		600	110	10	CPI/GA
		1500	110	4.0	QST/CANON[1)]
		1000	110	70	QST/CANON[1)]
		340	118	50	KIT/CEA/THALES
		300	118	111	KIT/CEA/THALES
		300	137	250	QST/CANON[1)]
		1000	140	12	KIT/SPC/TED
		920	140	1800	KIT/SPC/TED
		900	140	1800	CPI
		950/700	140	200/1000	IAP/GYCOM
		350	154	1800	NIFS/TSUKUBA/CANON[1)]
		1500	170	2.5	IAP/GYCOM
		1200	170	100	IAP/GYCOM
		1000	170	1000	IAP/GYCOM
		1000	170	800	QST/CANON[1)]
		800	170	3600	QST/CANON[1)]
		600	203	10	QST/CANON[1)]

Note:* and ** indicates that the power corresponds to that of a 1 MW (*) and 0.8 MW (**) HE_{11} mode. [1)] formerly TOSHIBA

Table 10: Experimental parameters of high-power millimeter-wave vacuum windows [14,15,19,22-29,137-145, 411-413, 491-507,511,519,524,525,560-570,581-691,741-854,936,947-1002].

Material	BeO p.c.	BN (CVD) p.c.	Si_3N_4 composite (SN-287)	Sapphire (Al_2O_3) s.c. orientation of E c⊥ $\vec{E}$	Silicon Au-doped s.c.	Diamond (PACVD) p.c.	Si C (6 H) p.c.
Thermal Conductivity 300 K k [W/mK] 500 K	260	55	59	40 6	150	2000 1100	330
Ultimate Bending Strength σ_B [MPa]	140	80	800	410	1000	Growth 450 Nucleation 800	440
Poissons Number ν	0.3	0.25	0.28	0.22	0.1	0.1	0.18
Density ρ [g/cm³]	2.85	2.3	3.4	4.0	2.3	3.515	3.2
Specific Heat Capacity c_p [J/g K]	1.05	0.8	0.6	0.8	0.7	0.502	0.38
Young's Modulus E [GPa]	345	70	320	385	190	1050	700
Therm. Expans. Coeff. α [10^{-6}/K]	7.2	3	2.4	5.5	2.5	1.0	4.3
Permittivity (145 GHz) ε_r'	6.7	4.7	7.84	9.4	11.7	5.67	9.92
Loss Tangent (145 GHz) tanδ [10^{-5}]	70	115	30	20	0.35	2	7
Metallizing and Brazing Bakeout Temperature	o.k.	o.k.	o.k. 550°C	o.k. 550°C	o.k 550°C	o.k. 450°C	o.k. 550°C
Possible Size ∅ [mm]	150	145	300	270	127	120	
Cost	medium	medium	high	high	low	very high	medium
Failure Resistance R' [W/mm^2] $R' = k\sigma_B (1-\nu)/E\alpha$	10.3	15.7	44.5	6.0	284	772	40
RF-Power Capacity P_T [100W^{2}s/mm^{4}K] $P_T = R'\rho\, c_P/((1+\varepsilon_r')\tan\delta)$	0.06	0.05	0.36	0.09	106	106	0.63
Radiation Sensitivity n(10^{20}-10^{21}n/m²) γ/X (0.75 Gy/s)				no no	no no	no no	

Table 11: Thermophysical, mechanical and dielectrical parameters of window materials related to thermal load-failure resistance and power transmission capacity of edge-cooled windows at room temperature (p.c. = poly-crystalline, s.c. = single-crystalline) [90,111,974,980,987,989,997-1001,1003-1007].

Material	Sapphire (Al_2O_3) s.c. orientation of E c⊥ $\vec{E}$	Silicon Au-doped s.c.	Diamond (PACVD) p.c.
Thermal Conductivity k [W/mK]	900 (20000)	1300	10000
Ultimate Bending Strength σ_B [MPa]	410	1000	450
Poissons Number ν	0.22	0.1	0.1
Density ρ [g/cm³]	4.0	2.3	3.52
Specific Heat Capacity c_p [J/g K]	0.8	0.7	0.52
Young's Modulus E [GPa]	402 (405)	190	1050
Therm. Expans. Coeff. α [10^{-6}/K]	5.5	2.5	1.2
Permittivity (145 GHz) ε_r'	9.3	11.5	5.67
Loss Tangent (145 GHz) $\tan\delta$ [10^{-5}]	0.57 (0.2)	0.35	2
Metallizing and Brazing Bakeout Temperature	o.k. 550°C	o.k 550°C	o.k. 450°C
Possible Size ∅ [mm]	270	127	160
Cost	high	low	very high
Failure Resistance R' [W/mm^2] $R' = k\sigma_B(1-\nu)/E\alpha$	130 (2871)	2463	3214
RF-Power Capacity P_T [100W^{2}s/mm^{4}K] $P_T = R'\rho c_P/((1+\varepsilon_r')\tan\delta)$	71 (4460)	907	441
Radiation Sensitivity n($0.3 \cdot 10^{21}$n/m²) γ/X (0.75 Gy/s)	no no	no no	no no

Table 12: Thermophysical, mechanical and dielectrical parameters of window materials related to thermal load-failure resistance and power transmission capacity of edge-cooled windows at LN2-temperature – 77 K (LNe-Temperature – 30 K) (p.c. = poly-crystalline, s.c. = single-crystalline) [974].

	Material	Type	RF-Profile	Cross-Section	Cooling
①	Sapphire/Metal	distributed	flattened Gaussian	rectangular (100 mm x 100 mm)	internally water cooled (300 K) $\tan\delta = 2\text{-}5 \cdot 10^{-4}$, k = 40 W/mK
②	Diamond	single-disk	Gaussian	circular (∅ = 80 mm)	water edge cooled (300 K) $\tan\delta = 2 \cdot 10^{-5}$, k = 1900 W/mK
③	Diamond	single-disk Brewster	Gaussian	elliptical (152 mm x 63.5 mm)	water edge cooled (300 K) $\tan\delta = 2 \cdot 10^{-5}$, k = 1900 W/mK
④	Silicon Au-doped	single-disk	Gaussian	circular (∅ = 80 mm)	edge cooled (230 K), refrigerator $\tan\delta = 2.5 \cdot 10^{-6}$, k = 300 W/mK
⑤	Silicon Au-doped	single-disk	Gaussian	circular (∅ = 80 mm)	LN_2 edge cooled (77 K) $\tan\delta = 4 \cdot 10^{-6}$, k = 1500 W/mK
⑥	Sapphire	single disk	flattened Gaussian	elliptical (285 mm x 35 mm)	LN_2 edge cooled (77 K) $\tan\delta = 6.7 \cdot 10^{-6}$, k = 1000 W/mK
⑦	Sapphire	single disk	Gaussian	circular (∅ = 80 mm)	LNe or LHe edge cooled (27 K) $\tan\delta = 1.9 \cdot 10^{-6}$, k = 2000 W/mK

Note that the power capability of options ②,③,⑤ and ⑦ is even 2 MW.

Table 13: Options for 1 MW, CW, 170 GHz gyrotron windows [88-93,111,974].

A wide-band CVD-diamond Brewster window in corrugated HE_{11}-waveguide with 32 mm inner diameter has been tested at 110 GHz using 0.5 s pulses with powers up to 350 kW [1008-1010]. Broadband CVD-diamond Brewster windows are also developed for use in gyro-amplifiers [1011-1012].

3 Harmonic and Very High Frequency Gyrotron Oscillators

Institution	Frequency [GHz]	Mode	Power [kW]	Efficiency [%]	Pulse length [ms]
CPI[1], Palo Alto [1013]	250	$TE_{11,1}/TE_{11,2}$	10	3.4	0.1
IAP, N. Novgorod	157	TE_{03}	2.4	9.5	CW
[177,178,1014]	250	TE_{02}/TE_{65}	4.3/1	18/5	CW
	326	TE_{23}	1.5	6.2	CW
	526	TE_{65}	0.25	2.8	CW
	1228	$TE_{58,13}$	50	10	0.03
MIT, Cambridge [1015-1017]	209	TE_{92}	15	3.5	0.001
	241	$TE_{11,2}$	25	6.5	0.001
	302	TE_{34}	4	1.5	0.0015
	339	$TE_{10,2}$	4	3	0.0015
	363	$TE_{11,2}$	7	2.5	0.0015
	417	$TE_{10,3}$	15	6	0.0015
	457/467	$TE_{15,2}/TE_{12,3}$	7/22	2/3.5	0.0015
	503	$TE_{17,2}$	10	5.5	0.0015
UESTC, Chengdu [1017-1027]	390.9	TE_{16}	1.5	2.4	0.004
	403.9/412.2	TE_{64}/TE_{93}	2.1/1.2	3.3/2.4	0.004
	416.4	TE_{45}	3	4.9	0.004/0.004
	421.65	$TE_{17,3}/TE_{17,4}$	19.3	8.6	0.004
	423.1	TE_{26}	8(1.15)	5.2	0.04
	446.1	TE_{55}	5	5.4	0.004(5)
	679	$TE_{15.2}$	3.25	9.3	0.1
UNIVERSITY, Fukui	203.4	TE_{33}	1.6	16	CW
[194-207,209-214,1028-1042]	350.3	TE_{65}	52	8.3	0.003
	384[*)]	TE_{26}	3	3.7	1
	388	$TE_{18}/TE_{17,2}$	62/83	158/13.8	0.003
	392.6	TE_{85}	60	9.6	0.004
	402[*)]	TE_{55}	2	3	1
	576[*)]	TE_{26}	1	2.5	0.5
	874[*)]	TE_{19}	0.6	2.0	0.5

[1)] Communications & Power Industries; formerly VARIAN [*)] In collaboration with TOSHIBA, Ottawara

Table 14: Performance parameters of mm- and submillimeter-wave gyrotrons operating at the 2nd harmonic of the electron cyclotron frequency, with output power > 0.6 kW.

Institution	Frequency [GHz]	Mode	Harmonic No. s	Power [kW]	Efficiency [%]	Pulse length [ms]
UNIVERSITY, Fukui	84.9	TE_{31}	3	2.5	6.3	1
IAP, Nizhny Novgorod	89.3	TE_{31}	3	1.7	3.3	1
[1043-1046]	112.7	TE_{41}	4	0.47	1	1
	138.0	TE_{51}	5	0.1	0.2	1
IAP, Nizhny Novgorod [184-193,1047-1057]	267	TE_{25}	2	0.9	4	CW
	394	TE_{37}	3	0.37	1.6	CW
	550	TE_{24}	2	0.6	2.2	0.01
			2 (sectioned klystron-type cavity)	0.5	1	0.01
	680	TE_{25}	2	1.8	3.5	0.01
	740	TE_{35}	3	0.25	0.6	0.01
			3 (sectioned klystron-type cavity)	0.2	0.55	0.01
	870	TE_{36}	3	0.3	0.9	0.01
	1000	TE_{37}	3	0.4	0.7	0.01

Table 15: Operation results of high harmonic gyrotrons with axis-encircling electron beam (LOG) and permanent magnet (Nd Fe B) at University of Fukui and pulsed magnet at IAP (THz gyrotron).

Institution	Frequency [GHz]	Mode	Power [MW]	Efficiency [%]	Pulse length [µs]	
IAP,	250	$TE_{20,2}$	0.3	31	30 - 80	pulsed magnetic field
Nizhny Novgorod	304	$TE_{22,8}$	0.3	25	25	
[177-183,185-193,318,331,332,1058-1060]	330		0.13	17	30 - 80	
	430		0.12	9	30 – 80	
	500	$TE_{28,3}$	0.1	8.2	30 – 80	
	540		0.06	5	30 – 80	
	600/650	$TE_{38,2}$	0.05/0.04	5/3.5	30 – 80	
	530/670	$TE_{31,8}$	0.20/0.21	22/20	20	
	1002	TE_{68}	0.0018	2.4	40	
	1024	$TE_{17,4}$	0.005	6.1	40	
	1300	$TE_{24,4}$	0.0005	0.6	40	
	263.2	$TE_{5,3}$	0.001	17	CW	CW operation
MIT, Cambridge	107.1	$TE_{21,6}$	0.94	24	3	
[117,927,937-946,1061-1075]	110	$TE_{22,6}$	1.67	42	3	
		TEM_{00}	1.5	48 (SDC)	3	output mode parity 96%
	113.2	$TE_{23,6}$	1.18	30	3	
	140	TE_{04}-like	0.025	7.4	3	PBG resonator, BW = 35%
	140	$TE_{15,2}$	1.33	40	3	
	148	$TE_{16,2}$	1.3	39	3	
	166.6	$TE_{27,8}$	1.50	34	3	
	170.0	$TE_{28,8}$	1.50	35	3	
	173.4	$TE_{29,8}$	0.72	29	3	
	188	$TE_{18,3}$	0.6		3	
	225	$TE_{23,3}$	0.37		3	
	231	$TE_{38,5}$	1.2	20	3	
	236	$TE_{21,4}$	0.4		3	
	267	$TE_{28,4}$	0.2		3	
	280	$TE_{25,13}$	0.78	17	3	
	287	$TE_{22,5}$	0.537	19	3	
	320	$TE_{29,5}$	0.4	20	3	
	327	$TE_{27,6}$	0.375	13	3	
UESTC, Chengdu [1020,1076-1079]	201.5	TE_{23}	0.015	6.0	4	
	216.4	TE_{23}	0.032	12.5	4	
	221	TE_{03}	0.04/0.012/0.003	17.3/4.4/5.5	4	slotted cavity/ 0.1 W with cold cathode
	228.6	TE_{52}	0.025	14.9	4	
UNIVERSITY, Fukui	202.9	TE_{33}	0.001	10	10000	
[26,212,215-230,1029-1032,1080]	278	TE_{33}	0.001	5	1000	
	290	TE_{62}	0.001	4	1000	
	294	$TE_{14,2}$	0.246	27	40	TEM_{00} output mode
	303.3	$TE_{22,2}$	0.32	32.8	100	
	314	TE_{43}	0.001	4	1000	

Table 16: Performance parameters of pulsed and CW millimeter- and submillimeter- wave gyrotron oscillators operating at the fundamental electron cyclotron resonance.

Operating at the fundamental, the 2nd harmonic or the 3rd harmonic of the electron cyclotron frequency, with one or two electron beams, enables the gyrotron to act as a medium power (several 1-100 W) step tunable, mm- and sub-mm wave source in the frequency range from 38 GHz (fundamental) to 1.014 THz ($TE_{4,12}$-mode, 2nd harmonic) [194-330,1080-1089].

A 30 W two-cavity gyrotron with frequency multiplication achieved at IAP an efficiency of 0.43 %. The first cavity operated in the TE_{01} mode near the fundamental cyclotron frequency at 95 GHz, the output cavity oscillated at the 3rd harmonic 285 GHz in the TE_{03}-mode [1090-1094]. Simultaneous generation at the 2nd (37.5 GHz) and 4th (75 GHz) harmonic (140 W at 60 kV and 6A) was obtained by a self-excited gyromultiplier with single, sectioned cavity [1095,1096]. A high-harmonic sectioned TE_{35}-mode gyrotron of IAP Nizhny Novgorod produced 0.5 kW at 740 GHz with 0.9% efficiency [1097-1099].

Institution	Frequency [GHz]	Mode	Voltage [kV]	Current [A]	Power [MW]	Efficiency [%]
MIT, Cambridge [1062,1063]	187.7	$TE_{32,4}$	94	57	0.65	12
	201.6	$TE_{35,4}$	97	54	0.92	18
	209.5	$TE_{33,5}$	98	37	0.54	15
	213.9	$TE_{34,5}$	95	51	0.89	18
	218.4	$TE_{35,5}$	90	44	0.56	14
	224.3	$TE_{33,6}$	91	60	0.90	17
	228.8	$TE_{34,6}$	92	59	0.97	18
			100	59	1.2	20
	265.7	$TE_{39,7}$	90	57	0.64	12
	283.7	$TE_{43,7}$	92	35	0.33	10
	291.6	$TE_{41,8}$	93	54	0.887	18

Table 17: Step tuning of MIT gyrotron oscillators (with large MIG [1062,1063]) operating at the fundamental electron cyclotron resonance frequency (pulse length 1.5 μs).

Institution	Frequency [GHz]	Mode	Voltage [kV]	Current [A]	Power [MW]	Efficiency [%]
MIT, Cambridge [1062,1063]	249.6	$TE_{24,11}$	71	41	0.39	14
	257.5	$TE_{23,12}$	87	41	0.33	9
	267.5	$TE_{25,12}$	85	33	0.35	12
	277.2	$TE_{27,12}$	78	42	0.45	14
	280.1	$TE_{25,13}$	92	51	0.78	17
	285.2	$TE_{26,13}$	93	41	0.42	11
	282.8	$TE_{23,14}$	94	39	0.54	15
	287.9	$TE_{24,14}$	94	51	0.64	14
	292.9	$TE_{25,14}$	95	41	0.72	18
	302.7	$TE_{27,14}$	96	43	0.27	7

Table 18: Step tuning of MIT gyrotron oscillator (with small MIG [1062,1063]) operating at the fundamental electron cyclotron resonance frequency (pulse length 1.5 μs).

4 Gyrotrons for Technological Applications

Institution	Frequency [GHz]	Mode cavity	Mode output	Power [kW]	Efficiency [%]	Voltage [kV]	Magnet
CPI[1], Palo Alto [14,19,1013]	28	TE_{02}	TE_{02}	15	38	40	room temp.
	28 ($2\Omega_c$)	TE_{02}	TE_{02}	10.8	33.6	30	room temp.
	60	TE_{02}	TE_{02}	30	38	40	cryo. mag.
CPI, NIFS [82-84,508-511] Palo Alto, Toki	84	$TE_{15,3}$	TEM_{00}	50	14	80	cryo. mag.
GYCOM/IAP, Nizhny Novgorod [1,15,119,139,172-174,344-347,350, 355-365,368-373,516,764,765,1014, 1100-1119]	12.5 (BW=4.2 %)	TE_{21}	TE_{21}	9 - 1	22.5-2.5	20	room temp.
	13(15)	TE_{01}	TE_{01}	0.3(4)	20(50)	25(15)	room temp.
	24.1 ($2\Omega_c$)	TE_{11}	TE_{11}	3.5	23	12	room temp.
	24.1 ($2\Omega_c$)	TE_{21}	TE_{11}	3.4	23	15	PM, 116kg
	24.1	TE_{32}	TE_{32}	36	50	33	room temp.
	24.1 ($2\Omega_c$)	TE_{12}	TE_{12}	13	50	25	room temp.
				28	32	25	room temp.
				6.5	60 (SDC)	17.5	room temp.
	28/30 ($2\Omega_c$)	TE_{02}	TE_{02}	10	42	26	room temp.
				30	35	26	room temp.
	28.1/28.7 ($2\Omega_c$)	TE_{03}/TE_{23}	TE_{03}/TE_{23}	10	20	23-24	2 kHz frequency switching
	28.25 ($2\Omega_c$)	TE_{12}	TE_{12}	12	20	25	PM, 68 kg[2]
	31.8-34.8	TE_{11}	TE_{11}	1.2	40	12	mech. tun.
	35.5-37.5	TE_{01}	TE_{01}	0.5	15.3	16	mech. tun.
	35.15	TE_{02}	TE_{02}	9.7	43	25	cryo. mag.
	35	TE_{02}	TEM_{00}	10-50	30-40	25-30	cryo. mag.
	37.5	TE_{62}	TEM_{00}	20	35	30	cryo. mag.
	40.5 ($3\Omega_c$)	TE_{03}	TE_{03}	3	8	20	room temp.
	45	TE_{63}	TEM_{00}	26	49	25	LF cryo.mag.
	68-72	TE_{13}	TE_{13}	1.4	22	17.5	mech. tun.
	83	TE_{93}	TEM_{00}	10-50	30-40	25-30	cryo. mag.
	150	TE_{03}	TE_{03}	22	30	40	cryo. mag.
	157 ($2\Omega_c$)	TE_{03}	TE_{03}	2.4	9.5	18	cryo. mag.
	191.5 ($2\Omega_c$)			0.55	6.2	22	cryo. mag.
	250 ($2\Omega_c$)	TE_{02}	TE_{02}	4.3	18	20	cryo. mag.
	250 ($2\Omega_c$)	TE_{65}	TE_{65}	1	5	20	cryo. mag.
	326 ($2\Omega_c$)	TE_{23}	TE_{23}	1.5	6	20	cryo. mag.
KIT, Karlsruhe [1120]	28 ($2\Omega_c$)	TE_{12}	TE_{12}	22.5	43	23.4	room temp.
MICRAMICS, San Jose [1121]	24.1 ($2\Omega_c$)	TE_{22}	TEM_{mixed}	5	25	23	room temp.
			TE_{22}	10	25	23	room temp.
MITSUBISHI, Amagasaki [367,1122-1124]	28 ($2\Omega_c$)	TE_{02}	TE_{02}	10	38.7	21	PM, 600 kg[2] tapered B
UESTC, Chengdu [1125]	37.5	TE_{13}	TE_{13}	57 (0.4 average)	9	50.5	room temp.
UNIV. Fukui, IAP Nizhny Novgorod/ GYCOM [349,1126-1133]	300	$TE_{22,8}$	TEM_{00}	2.3	16.4	14	cryo. mag.

[1] Communications & Power Industries, formerly VARIAN, [2] PM: permanent magnet

Table 19: Performance of present CW gyrotron oscillators for technological applications.

IAP Nizhny Novgorod and GYCOM have developed a dual-frequency materials processing system employing a 15 kW, 28 GHz gyrotron and a 2.5 kW, 24.1 GHz tuneable gyro-BWO (see Table 33) [350,358,359]. This system has been installed at the University of Fukui, Japan.

5 Relativistic Gyrotrons

Institution	Frequency [GHz]	Mode	Voltage [MV]	Current [kA]	Power [MW]	Efficiency [%]	Type
IAP, Nizhny Novgorod	9.23	TE_{01}	0.27 (0.28)	0.12 (0.06/0.045)	10 (8/7)	30 (45/50)	
[1134-1146]	20	TM_{01}	0.5	0.7	40	11.4	
	30	TE_{53}	0.31	0.08/0.07	12/10	50	
	30 (35)	TE_{53} (TE_{63})	0.38	0.11	20	50	
	35.2	$TE_{4,2}$	0.55	2	110	10	explos.. cath.+ kicker
		$TE_{7,3}$					injection locking
	55.7 ($2\Omega_c$)	$TE_{11,2}$	0.22	0.0325	2	28	
	79-107	TM_{1n}	0.5	2-6.5	30	3-1	slotted echelette
							cavity, n = 3-10
	94.4	$TE_{12,5}$	0.24	0.103	5.6	23	TEM_{00} output and counter rotating input for injection locking
IAP, Nizhny Novgorod	10	TE_{13}	0.3	0.4	25	20	slotted cavity
Lebedev/General Phys.	10	TE_{13}	0.3	1.0	60	15	plasma-filled
Inst. Moscow							slotted cavity
[1135,1147-1149]	40	TE_{13}	0.4	1.3	25	5	slotted cavity
KIPT, Kharkov [1150]	12	TE_{13}	0.12	8.0	60	6.3	plasma filled slotted cavity
UNIV. Michigan	2.88	TE_{01}^{r}	0.8	2 (7)	20	1.3 (0.4)	small orbit
[1151-1157]			0.8	0.35 (1.2)	6	2.1 (0.06)	large orbit
	2.15	TE_{10}^{r}	0.8	0.35 (1.2)	14	5.0 (0.15)	large orbit
	2.5	TE_{11}^{c} (coax.)	0.8	0.8 (4.0)	90	14 (2.8)	large orbit,
							slotted cavity
					40		non-slotted cavity
					20		non-slott. coax. cavity
	10	TE_{11}	0.4	0.025	0.6	6	
NRL, Washington D.C.	8.35-13	4-5 modes	3.3	80	1000	0.4	superradiant
[1158-1161]	35	TE_{62}	0.78	1.6 (3.5)	100	8 (4) *)	
			1.15	2.5	275	10	
	35	TE_{13}	0.9	0.65	35	6	slotted cavity
Tomsk Polytech. Inst.	3.1		0.75	8.0 (30)	1800	8	also vircator
[1162]							interaction
UNIV. Niigata [1163]	18.2	TE_{01}	0.08	0.5	0.2	0.55	
UNIV. Strathclyde	23	TE_{12}	0.1	0.5	5	10	
[1164-1169]	100		0.2	0.22	6.3	14	

r: rectangular waveguide
*) operation from 28 to 49 GHz by magnetically tuning through a family of TE_{m2}-modes, with the azimuthal index m ranging from 4 to 10.

Table 20: Present development status of relativistic gyrotron oscillators with MIGs.

Institution	Frequency [GHz]	Mode	Harmonic No. s	Voltage [MV]	Current [kA]	Power [MW]	Efficiency [%]
IAP, Nizhny Novgorod	21.6	TE_{11}	1	0.3	0.03 (3)	1.5	16.7 (0.17)
[444,1093,1094,1170-1178]	35.7	TE_{21}	2	0.3	0.03 (3)	1.5	16.7 (0.17)
	49.1	TE_{31}	3	0.3	0.03 (3)	0.5	6.7 (0.07)
	62.4	TE_{41}	4	0.3	0.03 (3)	0.2	2.2 (0.02)
	74.9	TE_{51}	5	0.3	0.03 (3)	0.12	1.3 (0.013)
	115.2	TE_{32}	3	0.25	0.008	0.1	5.0
	130.3	TE_{42}	4	0.25	0.008	0.1	5.0
	223	TE_{25}	2	0.25	0.003	0.045	6.0
	369	TE_{35}	3	0.25	0.003	0.019	2.5
	371	TE_{38}	3	0.25	0.002	0.010	2.0
	414	TE_{39}	3	0.25	0.002	0.008	1.7
	469	TE_{35}	3	0.25	0.003	0.020	2.5
Nagaoka Univ. Technology [1179]	98-144	TE_{n1}	n	0.325	0.045(7)	1.3	9(0.06)

Table 21: Relativistic large orbit harmonic pulse gyrotrons with axis-encircling electron beam. The 21.6-74.9 GHz experiments at IAP used an explosive-emission cathode with kicker (τ = 10 ns) and the 115-469 GHz experiments employed a quasi-Pierce type thermionic electron gun with kicker (τ = 10 µs, 1 Hz).

6 Quasi-Optical Gyrotrons

Institution	Frequency [GHz]	Mode resonator	Power [kW]	Efficiency [%]	Pulse length [ms]	Type
ABB, Baden [411,482]	92	TEM_{00q}	90	10	10	
SPC[1], Lausanne	90.8	TEM_{00q}	150	15	5	grating output
[115,116,411,1180]	100	TEM_{00q}	90	15	15	
	200 ($2\Omega_c$)	TEM_{00q}	8	3.5	15	
IAP, Nizhny Novgorod [1181]	100	TE_{061}	260	6.5	0.04	echelette cavity
MIT, Cambridge [1182-1184]	136	$HE^{()}_{061}$	83	18	0.003	confocal
	114.3	$HE^{()}_{051}$	75	16	0.003	slot-cavity
Moscow-State UNIV.	35	TEM_{00q}	1	15	CW	
[1185]	95	TEM_{00q}	1	15	CW	
NRL, Washington D.C.	110	TEM_{00q}	80	8	0.013	
[934,1186,1187]	115	TEM_{00q}	600	9	0.013	
			431	12.7 (SDC)	0.013	
			197	16.1 (SDC)	0.013	
	120	TEM_{00q}	600	9	0.013	
			200	12	0.013	
CANON[2], Otawara	112	TEM_{00q}	100	12	5	
[642]	120	TEM_{00}	26	10 (DEB)	3	
UESTC, Chengdu [1188-1191]	205.7-209.0	TE_{06}	20	11.8	0.1	confocal cavity
	395.35 ($2\Omega_c$)	$HE^{()}_{011,1}$	6.44	3.4	0.1	confocal cavity

SDC: Single-stage Depressed Collector
DEB: Dual Electron Beam (1 annular beam, 1 pencil beam), [1] Swiss Plasma Center, formerly CRPP, [2] formerly TOSHIBA

Table 22: Present development status of quasi-optical gyrotron oscillators.

7 Cyclotron Autoresonance Masers (CARMs)

Institution	Frequency [GHz]	Mode	Power [MW]	Efficiency [%]	Gain [dB]	B-Field [T]	Voltage [MV]	Current [kA]	Type
IAP	31.5-34.5	TE_{11}^*/TE_{21} ($2\Omega_c$)	3.4	17 (0.21)	-	1.05-1.2	0.40	0.05 (4)	CARM-BWO
IAP	35.7	TE_{51}	30	10	-	1.12	0.4	0.6	oscillator
IAP	36.5	TE_{11}	9	18 (0.45)	-	1.15	0.4	0.6	oscillator
IAP, IHCE	37.5	TE_{11}	10	4	30	0.5	0.5	0.5	amplifier
IAP, U. Strath., HERC	37.5	TE_{21}	0.2	0.5 (0.25)			0.15	0.25 (0.5)	superra-diance
IAP	38	TE_{11}^*/TE_{21} ($2\Omega_c$)	13	26 (0.65)	-	1.24	0.5	0.1 (4)	CARM-gyrotron
	40	TE_{11}	6	22 (0.44)	-		0.46	0.06 (0.3)	oscillator
IAP, IHCE, JINR	50	TE_{11}	30	10	-	0.7	1.0	0.3	oscillator
IAP	66.7	TE_{21}	15	3	-	0.6	0.5	1.0	oscillator
IAP, IHCE, JINR	68	TE_{11}	50	8	-	1.0	1.2	0.5	oscillator
IAP	69.8	TE_{11}	6	4	-	0.6	0.35	0.4	oscillator
IAP [1170,1171,1192-1201]	125	TE_{41}	10	2	-	0.9	0.5	1.0	oscillator
LLNL Livermore [1202]	220	TE_{11}	50	2.5	-	3.0	2.0	1.0	oscillator
MIT Cambridge [431,1203,1204]	27.8	TE_{11}	1.9	5.3	-	0.6	0.45	0.080	oscillator
	30	TE_{11}	0.1	3	-	0.64	0.3	0.012	oscillator
	32	TE_{11}	0.11	2.3	-	0.63	0.32	0.015	oscillator
	35	TE_{11}	12	6.3 (0.04)	30	0.7	1.5	0.13 (20)	amplifier
NRL, Washington DC [1205]	35,70-90	TE_{61}	0.02	0.002	-	1.0	0.6	0.2 (100)	oscillator
UNIV. Michigan [1206,1207]	15	TE_{11}	7	1.5	-	0.45	0.4	1.2	oscillator
UNIV. Strathclyde [1208-1210]	13	TE_{11}			-	0.3	0.4	0.04	oscillator
	14.3 ($2\Omega_c$)	TE_{21}	0.18	4 (0.4)	-	0.2	0.3	0.015 (0.15)	oscillator

* output mode
HERC Moscow, IAP Nizhny Novgorod, IHCE Tomsk, JINR Dubna

Table 23: State-of-the-art of fast-wave CARM experiments (short pulse).

Institution	Frequency [GHz]	Mode	Power [MW]	Efficiency [%]	Gain [dB]	B-Field [T]	Voltage [MV]	Current [kA]	Type
UNIV. Lomonosov, Moscow [432]	9.5	TM_{01}	35	3.5	-	1.15	0.4	2.5	oscillator corr.waveguide
Tomsk Polytechn. Inst. [433]	25		20	0.2	-	0.64	0.9	14	oscillator diel.waveguide
UNIV. Niigata, NIFS, UNIV. Maryland [434]	19.5	TM_{01}	0.2	3.8	-	0.9	0.035	0.15	oscillator corr.waveguide
UNIV. Yale, NRL, Washington D.C. [435]	6.2	TE_{01}	0.02	10	53	0.2	0.05	0.005	amplifier diel.waveguide

Table 24: State-of-the-art of slow-wave CARM experiments (short pulse).

8 Gyroklystrons, Gyro-TWT's, Gyrotwystrons, Gyro-BWOs and other Gyro-Devices

Weakly Relativistic Pulse Gyroklystrons

Institution	Frequency [GHz]	Mode	No. of cavities	Power [kW]	Efficiency [%]	Gain [dB]	BW [%]	Type
CPI[1)], Palo Alto [19,408]	10 ($2\Omega_c$)	TE_{01}	3	20	8.2	10	0.2	
	28	$TE_{01/02}$	2	76	9	30	0.2	
	35			65		30	0.2	
CPI, Litton, NRL, U.M.	93.8	TE_{01}	4	118	29.5	24.7	0.64	SN1
[383,594,1211-1218]			5	130	33	39.5	0.75	SN2
GYCOM-M(TORIY),	35.2	TE_{02}	2	750 (5av.)	24	20	0.6	max. power
Moscow [1219,1220]			2	350	32	19	0.9	max. efficiency
	35.0	TE_{01}	4	160	48	42	1.4	
			3	250 (1.2av.)	35	40	1.4	
IAP Nizhny Novgorod	9.25	TE_{01}	2	4	50	22	1.0	
[1221-1235]			3	16	45	22	1.0	
	15.2	TE_{01}	3	50	50	30	0.5	
	15.8	TE_{02}	3	160	40	30	0.5	max. efficiency
	32.3 ($2\Omega_c$)	TE_{02}	3	300	23	26	0.05	PM, 360 kg
			2	220	18	13	0.27	PM, 360 kg
	34	TE_{01}	4	280	32	34	0.53	
	35.12 ($2\Omega_c$)	TE_{02}	2	258	18	17	0.3	tapered B-field
	35	TE_{02}	2	300 (230)	22 (30)		0.3	2-cavity gyrotron
	93.2	TE_{01}	4	65	26	35	0.3	max. power
			4	57	34	40	0.3	max. efficiency
	93.5	TE_{02}	2	140	18	18	0.35	
			2	220	32	20	0.15	shaped B
	93.2	TE_{02}	3	340	27	23	0.41	shaped B
IECAS, Beijing [534,1236-1238]	35 ($2\Omega_c$)	TE_{02}	3	212	16	24	0.44	
Kwangwoon Univ., Seoul [1239]	27.85	TE_{01}	5	150	26	50	0.1	
NRL, Washington D.C.	4.5	TE_{10}	3	54	30	30	0.4	
[380-382,408,934,	34.95	TE_{01}	2	210	37	24	0.35	
1240-1251]	34.9	TE_{01}	3	225	31	30	0.82	
	34.9	TE_{01}	4	208	30	53	0.5	
	85	TE_{13}	2	50		20		
	85.5	TEM_{00}	2	82	19 (30SDC)	18		QOGK
	93.4	TE_{01}	4	60	25	27	0.69	max. BW
				84	34	42	0.37	max. power
			5	72	27	48	0.44	max. power x BW
UESTC, Chengdu [534,1252]	34.9 ($2\Omega_c$)	TE_{01}-TE_{02}	4	250 (5 av.)	24	36	0.4	

Table 25: Weakly relativistic pulse gyroklystron experimental results.

Weakly Relativistic CW Gyroklystrons

Institution	Frequency [GHz]	Mode	No. of cavities	Power [kW]	Efficiency [%]	Gain [dB]	BW [%]	Type
CPI, Litton, NRL, U.M. [380-383,494,1211-1218]	93.8 94.2	TE_{01} TE_{01}	4 5	10.1 10.2	33.5 31	32 33	0.45 0.75	(92 kW, 11% duty) (102 kW,10% duty)
IAP N. Novgorod [1223]	9.17	TE_{11}	2	0.7	70	22	0.3	
IAP/ISTOK Moscow [1224,1227]	91.6	TE_{01}	4	2.5	25	31	0.36	

QOGK: Quasi-Optical Gyro-Klystron;
SDC: Single-stage Depressed Collector
[1)] Communications & Power Industries, formerly VARIAN

Table 26: Weakly relativistic CW gyroklystron experimental results.

Relativistic Pulse Gyroklystron

Institution	Frequency [GHz]	Mode output	No. of cavities	Power [MW]	Efficiency [%]	Gain [dB]	BW [%]	Type
IAP, Nizhny Novgorod	30	TE_{53}	2 (TE_{52}/TE_{53})	15	40	30	0.17	triode gun
[1253-1263]		TE_{52}	3 (TE_{52}/TE_{52}/TE_{53})	12	30	38	0.17	
	35.4	TEM_{00}	2 (TE_{71}/TE_{73})	15	33	30	0.14	
UNIV. Maryland	8.57	TE_{01}	3	75	32	30	0.2	coaxial
[374-378,1264-1277]	9.875	TE_{01}	2	24	30	33	0.2	
	9.87	TE_{01}	3	27	32	36	0.2	max. power
			3	16	37	33	0.2	max. efficiency
			3	20	28	50	0.2	max. gain
	17.14 ($2\Omega_C$)	TE_{02}	3	27	13	25	0.1	coaxial
			4	18.5	7.0	23.3	0.35	coaxial
	19.76 ($2\Omega_C$)	TE_{02}	2	32	29	27	0.1	
	29.57 ($3\Omega_C$)	TE_{03}	2	1.8	2.0	14	0.1	

Table 27: Relativistic pulse gyroklystron experimental results.

Weakly Relativistic Gyro-TWTs

Institution	Frequency [GHz]	Mode	Power [kW]	Efficiency [%]	Gain [dB]	Bandwidth [%]	Type
BVERI, Beijing [534,1278-1285]	34.2	TE_{01}	290 (5 av.)	34	65	8.0	periodic SiC loading
	48	TE_{01}	150 (5 av.)	35	50	7.0	periodic SiC loading
	95	TE_{01}	120	32	39	6.3	periodic SiC loading
CPI[1], Palo Alto	5.18	TE_{11}	120	26	20	7.3	MIG
[19,383-385,408,594,1219,	5.2	TE_{11}	64	14	17.5	7.3	Pierce-helix gun
1286-1289]	93.7	TE_{11}	28	7.8	31	2	Pierce-helix gun
	95	TE_{01}	1.5 (0.6 av.)	4.2	42	7.7	
E2V, Chelmsford [1290]	10 ($2\Omega_C$)	TE_{-21}/TE_{+11}	180				gridded gun
IAP, Nizhny Novgorod [1291-1310]	36.3 ($2\Omega_C$)	TE_{-21}/TE_{+11}	180	27	25	10	cusp gun with axis-encircl. beam 3 µs
Helical Waveguide Gyro-TWTs	34.3 ($2\Omega_C$)	TE_{-21}/TE_{+11}	120	23	20	6	longpulse 110 µs
			160 (7.7)	40 (26) SDC	23 (26)	7.7 (7.5)	100 µs pulse (CW)
	96.2 ($2\Omega_C$)	TE_{-21}/TE_{+11}	3	15 (SDC)	54	2.3	CW, 2-tubes cascade
IECAS, Beijing	16.2	TE_{11}	130	17.8	41	12.3	periodic lossy
[534,1311-1313]	34.5	TE_{01}	110	15.2	33	5	periodic lossy
MIT, Cambridge [1314-1331]	140	$HE^{()}_{061}$ (q.o.)	30	12.5	29	1.6	at 0.875 kW 400 ps
			0.55	0.4	35	0.9	modulation pulse
	250	TE_{03}-like	0.045	0.4	38	3.2	PBG, 260 ps pulses
NRL, Washington D.C.	32.5	TE_{10}	6.3	10	16.7	33	1-stage tapered
[408,1332-1338]	35.5	TE_{10}	8	16	25	20	2-stage tapered
	32.3	TE_{10}	50	28	25	11	folded waveguide
							axis-encircling beam
	34.0(35.6)	TE_{01} (TE_{11})	137(70)	17 (17)	47 (60)	3.3 (17)	2-stage output
UC Los Angeles/	9.3	TE_{10}	55	11	27	11	diel. coat. waveguide
Davis [1339-1351]	10.4 ($3\Omega_C$)	TE_{31}	6	5	11	3	axis-encirl. beam
	15.7 ($2\Omega_C$)	TE_{21}	207	12.9	16	2.1	slotted waveguide
	16.2 ($8\Omega_C$)	TE_{81}	0.5	1.3	10	4.3	axis-encircling beam
	92	TE_{01}	140	22	60	2.2	heavily loaded +
							short copper stage
NTHU, Hsinchu	35.8	TE_{11}	27	16	35	7.5	2-stage severed
[437-439,1352-1358]	34.2	TE_{11}	62	21	33	12	2-stage lossy (short)
	33.6	TE_{11}	93	26.5	70	8.6	2-stage lossy (long)
UESTC, Chengdu	16	TE_{11}	200 (20 av.)	23.8	43	16.3	3-stage lossy (long)
[534,1359-1374]	16 (15.5)	TE_{11}	450 (30 CW)	25 (21)	40 (41)	12.5 (8.0)	periodic lossy circuit
	16	TE_{01}	420	23	35	10	periodic lossy circuit
	34	TE_{01}	169 (20.3 av.)	26.9	52	9.4	lossy + cutoff section
	47	TE_{01}	208	29.4	50.2	5.5	periodic lossy circuit
	92.5	TE_{01}	110	19.3	69.2	4.2	lossy circuit
UNIV. Kwangwoon [1375]	14.4	T E_{10}	14.9	18	27	7	two-stage circuit
UNIV. Strathclyde [1376-1384]	93 ($2\Omega_C$)	TE_{-21}/TE_{+11}	3.4	4.2	37	5.8	cusp gun with axis-encircling beam
UNIV. Tel Aviv [1385]	7.3	TE_{10}	0.8	12	26		3-stage output

[1] Communications & Power Industries, formerly VARIAN

Table 28: Present development status of weakly relativistic gyro-TWTs (short pulse and CW operation (IAP)).

Relativistic Gyro-TWTs

Institution	Frequency [GHz]	Mode	Power [MW]	Efficiency [%]	Gain [dB]	Bandwidth [%]	Type
IAP, Nizhny Novgorod UNIV. Strathclyde [440-442,1291-1293, 1386-1390]	9.4 ($2\Omega_C$)	TE_{-21}/TE_{+11}	1.1	29	37	21	helical waveguide with $\Delta m=3$ perturb. axis encircling e-beam
	36.5 ($2\Omega_C$)	TE_{-21}/TE_{+11}	3.0	27	33	20(ΔB)	see above
MIT, Cambridge [1391]	17.1 ($2\Omega_C$)	TE_{21}	2	4	40		Pierce-helix gun
	17.1 ($3\Omega_C$)	TE_{31}	4	6.6	51		Pierce-helix gun
NRL, Washington D.C. *) [1392,1393]	35	TE_{11}	20	11	30		explosive-emission gun, bifilar helical wiggler
UNIV. Strathclyde [1394-1399]	9.4 ($2\Omega_C$)	TE_{-21}/TE_{+11}	0.22	20	24	21	thermionic MIG, superradiance
			1.3	27	47	3	cold cathode cusp gun

*) This gyro-TWT operated near the "grazing intersection" in the dispersion diagram could also have been considered a CARM amplifier with frequency 4.4 times the relativistic cyclotron frequency.

Table 29: Present development status of relativistic gyro-TWTs (short pulse).

Weakly Relativistic Pulse Gyrotwystrons

Institution	Frequency [GHz]	Mode		Power [kW]	Efficiency [%]	Gain [dB]	BW [%]
		cavity	TW section				
CPI[1], Palo Alto [383,385,494,1218]	94	TE_{01} (4 cav.)	TE_{01}	59 (5.9 av.)	14.9	35	1.6
NRL, Washington D.C. [1400,1401]	4.5	TE_{10}	TE_{10}	73	22.5	37	1.5
	31.5	TE_{42} ($2\Omega_c$)	TE_{42}	160	25	30	1.3
	93.5	TE_{01} (3 cav.)	TE_{01}	48	17.5	30	2.0
IAP, N.Novgorod, NRL Washington D.C. [1402,1403]	9.2	TE_{01} (2 cav.)	TE_{01}	4.8	14	20	0.9
				4.4	27.5	18	1.6

[1] Communications & Power Industries, formerly VARIAN

Table 30: State-of-the-art of weakly relativistic gyrotwystron experiments (short pulse).

Weakly Relativistic Pulse Harmonic-Multiplying Inverted Gyrotwystrons/Gyro-TWT/Gyrotriotron

Institution	**Frequency [GHz]**	**Mode cavity**	**Mode TW section**	**Power [kW]**	**Efficiency [%]**	**Gain [dB]**	**BW [%]**
IECAS [1404-1411]	33.1	TE_{01}/coupled cavity ($2\Omega_c$) TE_{02}/TE_{03}	TE_{03} (Ω_c)	75	7.1	25	1.1
Seoul National UNIV. [1412]	33.9	TE_{10}	TE_{10} ($3\Omega_c$)	10^{-4}	$2 \cdot 10^{-3}$	LO-gyro-TWT	3.8
UNIV. Maryland. [443,1413-1418]	31.8	TE_{22}	TE_{42} ($2\Omega_c$)	100	20	30	1.3
	33.7	TE_{02}	TE_{03} ($2\Omega_c$)	430	35	30	0.3
	34.6	TE_{02}	TE_{03} ($2\Omega_c$)	180	32	30 phase-locked oscillator	3.0
	32.5	TE_{02}	TE_{03} ($2\Omega_c$)	200	12	36 gyro-TWT	3.0
	35	TE_{02}/TE_{03} ($2\Omega_c$)	TE_{04} ($2\Omega_c$)	110	32	53 gyro-TWT	3.0
	33.75	Gyrotriotron		126	12	27	3.2
TWT input stage (s_1=1) TE_{02} / 4-unit clustered cavities (s_2=2) TE_{03} / TWT output stage (s_3 = 2) TE_{04}							

Table 31: State-of-the-art of weakly relativistic harmonic gyro-devices (short pulse).

Relativistic Pulse Gyrotwystrons

Institution	**Frequency [GHz]**	**Mode cavity**	**Mode TW section**	**Power [MW]**	**Efficiency [%]**	**Gain [dB]**	**BW [%]**
UNIV. Maryland	9.878	TE_{01}	TE_{01}	21.6	21	25.5	
[1277,1419]	19.76	TE_{01} (9.88GHz)	TE_{02} ($2\Omega_c$)	12	11	21	

Table 32: State-of-the-art of relativistic gyrotwystron experiments (short pulse).

Weakly Relativistic Pulse Gyro-BWOs

1420-1423	Frequency [GHz]	Mode	Power [kW]	Efficiency [%]	Bandwidth [%]	Type
UNIV. Strathclyde IAP N. Novgorod [1420-1423]	8.6 ($2\Omega_C$)	TE_{+21}/TE_{-11}	65	16.5	17	quasi-Pierce gun with kicker
IAP, N. Novgorod KIT[1)], Karlsruhe [350,1109,1294-1300, 1424,1425]	24.7 ($2\Omega_C$)	TE_{+21}/TE_{-11}	7	15 23 (SDC)	5	MIG CW operation
IAP, Nizhny Novgorod [1297,1309]	35-38 ($2\Omega_C$) 35 ($2\Omega_C$) 96 ($2\Omega_C$)	TE_{+21}/TE_{-11} TE_{+21}/TE_{-11} TE_{+21}/TE_{-11}	34 10 1.3	7 7	15 15 4.2	quasi-Pierce gun with kicker cusp gun with thermal cathode cusp gun with thermal cathode two-tubes cascade
IECAS, BVERI, Beijing [1426,1427]	17.2	TE_{01}	48	10.5 21 (SDC)	5	TE_{10}^r output
MIT, Cambridge, LLNL, Livermore [1428]	140	TE_{12}^c	2	2	9	
NRL, Washington D.C. [1429]	27.8 29.2	TE_{10}^r TE_{10}^r	2 6	9 15	3 13	electric tuning magnetic tuning
NTHU, Hsinchu [1430-1438]	33.5	TE_{11}^c TE_{01}^c TE_{02}^c	20-67 115 149 154 164 123 2.8	6.5-21.7 23 30 39 41 24.5 22.6	5 8.5 4 1 1 15.8 9.5	injection locked free running electric + magnetic tuning injection locked inverse injec. locked sliced circuit sliced circuit
UNIV. Strathclyde [1439-1444]	95 ($2\Omega_C$)	TE_{+21}/TE_{-11}	12	20	15.3	magnetic tuning, casp gun
UNIV. Utah [1445]	10	TE_{10}^r	0.72	10	8	

r = rectangular waveguide; c = circular waveguide, [1)]formerly KfK, then FZK

Table 33: Experimental results on weakly relativistic pulse gyro-BWOs (short pulse and CW operation (IAP)).

Relativistic Pulse Gyro-BWOs (pulse duration = 0.02-1 µs)

Institution	Frequency [GHz]	Mode	Power [MW]	Efficiency [%]	BW [%]	Voltage [MV]	Current [kA]	Type
IAP, N. Novgorod [1446,1447]	10 35(2Ωc)	TM_{11} TE_{-21}/ TE_{+11}	200 1.15	22 10 axis	 15 (ΔB) encircling	0.45 0.35 e-beam	2 0.032	Cherenkov with cycl. mode selection helical w.g. with Δm=3 perturbation
UNIV. Kanazawa [1448,1449]	9-13	TE_{10}^r	1	0.75 (0.02)	1	0.45	0.3(10)	
UNIV. Michigan [1450,1451]	4-6 5-6 (2Ωc)	TE_{11} TE_{11}	55 (30) 1	8 (4.3) 0.15	1 4	0.7	1	
USAF Phillips Lab. Aberdeen [1452,1453]	4.2 4.4	TE_{21} TE_{01}	4 0.15	1 0.04	1 1	0.4 0.4	1 1	

r = rectangular waveguide

Table 34: Experimental results on relativistic gyro-BWOs (short pulse).

Acknowledgments

The author would like to thank M. Einat (Ariel University), J.J. Feng (BVERI, Beijing), L. Ives and M.E. Read (Calabazas Creek Research), R. Magne (CEA, Cadarache), M. Blank, M.J. Cattelino, S.R. Cauffman, K. Felch, H. Jory and R. Schumacher (CPI, Palo Alto), W.A. Bongers (DIFFER, Nieuwegein), J.R. Brandon, T. Schaich, C.W.O. Thompson and C. Wort (Element 6, Charters), F. Albajar, T. Bonicelli and P. Sánchez (F4E), J.L. Doane, R. Freeman, J. Lohr, C.P. Moeller and R.A. Olstad (General Atomics, San Diego), M.V. Agapova, V.I. Kurbatov, V.E. Myasnikov, V.B. Orlov, L.G. Popov, E.A. Solujanova, E.M. Tai and S.V. Usachev (GYCOM), V.L. Bratman, Yu. Bykov, G.G. Denisov, N. Ginzburg, M.Yu. Glyavin, V.A. Goldenberg, A.N. Kuftin, A. Litvak, V.N. Manuilov, S. Mishakin, V.V. Parshin, A. Peskov, M.I. Petelin, A.B. Pavelyev, R. Rozental, A.G. Savilov, E.V. Sokolov, V.E. Zapevalov and E.V. Zasypkin (IAP RAS, Nizhny Novgorod), J. Luo and Q. Xue (IECAS, Beijing), W. Kasparek, C. Lechte and B. Plaum (IGVP, Stuttgart), F. Leuterer, M. Münich, J. Stober, D. Wagner and H. Zohm (IPP Garching), H. Braune, V. Erckmann, H.P. Laqua, S. Marsen, T. Stange and F. Wilde (IPP, Greifswald), C. Darbos and M. Henderson (ITER, Cadarache), S.-T. Han (KERI, Changwon), K. Avramidis, E. Borie, G. Dammertz, B. Ell, G. Gantenbein, S. Illy, Z. Ioannidis, J. Jelonnek, J. Jin, P.C. Kalaria, L. Krier, W. Leonhardt, G. Link, A. Meier, D. Mellein, I. Pagonakis, B. Piosczyk, S. Ruess, T. Ruess, T. Rzesnicki, T. Scherer, M. Schmid, and C. Wu (Karlsruhe Institute of Technology), M.A. Shapiro and R.J. Temkin (MIT, Cambridge), H. Asano and T. Kikunaga (MITSUBISHI, Amagasaki), S. Kubo, M. Sato, T. Shimozuma and S. Takayama (NIFS, Toki), J.P. Calame, Y. Carmel, B. Danly, A. Fliflet, M. Garven, S.H. Gold and B. Levush (NRL, Washington D.C.), Y. Tsunawaki (Osaka Sangyo University), J. Neilson (SLAC), S. Alberti, T. Goodman, J.-P. Hogge and M.Q. Tran (SPC, Lausanne), G.G. Sominski and O.I. Louksha (State Polytechnical University, St. Petersburg), W. He (Shenzhen University), A.W. Cross, C. Donaldson, A.D.R. Phelps and K. Ronald (Strathclyde University), E. Jerbi (Tel Aviv University), F. Legrand, R. Marchesin and P. Thouvenin (THALES, Velizy), G.R. Neil (Thomas Jefferson Lab), K. Yokoo (Tohoku University Sendai), N.C. Luhmann, Jr. and D.B. McDermott (UC, Davis), L. Hongfu, Y. Liu and L. Shenggang (UESTC, Chengdu), K.R. Chu (National Taiwan University (NTU), Taipei), C.-Y. Tsai (National Tsing Hua University (NTHU), Hsinchu), T. Idehara, S. Mitsudo, I. Ogawa and T. Saito (University of Fukui), O. Dumbrajs (University of Latvia, Riga), T.M. Antonsen, V.L. Granatstein, W. Lawson, G.S. Nusinovich and A.N. Vlasov (University of Maryland), R.M. Gilgenbach and Y.Y. Lau (University of Michigan), T. Imai, T. Kariya and R. Minami (University of Tsukuba), J. Hirshfield (Yale University), K. Kajiwara, A. Kasugai, Y. Oda, K. Sakamoto and K. Takahashi (QST, Naka). This work could not have been done without their help, stimulating suggestions and useful discussions.

The author also wishes to express his deep gratitude to Mrs. M. Huber for her help in doing the layout of this report.

References

[1] Gaponov-Grekhov, A.V., Granatstein, V.L., 1994, Application of high-power microwaves. Artech House, Boston, London.

[2] Thumm, M., 1997, Applications of high-power microwave devices, in "Generation and Application of High Power Microwaves". R.A. Cairns and A.D.R. Phelps, eds., Institute of Physics Publishing, Bristol and Philadelphia, 305-323.

[3] Thumm, M., 2001, Novel applications of millimeter and submillimeter wave gyro-devices. Int. J. Infrared and Millimeter Waves, 22, 377-386.

[4] Thumm, M., 2002, Free-electron masers vs. gyrotrons: prospects for high-power sources at millimetre and submillimeter wavelengths. Nuclear Instruments & Methods in Physics Research, A483, 196-194.

[5] Thumm, M., 2005, High power gyro-devices for plasma heating and other applications. Int. J. Infrared and Millimeter Waves, 26, 483-503.

[6] Thumm, M.K.A., 2011, Recent developments on high-power gyrotrons – introduction to this special issue. J. of Infrared, Millimeter, and Terahertz Waves, 32, 241-252.

[7] Thumm, M., 2011, Gyro-devices and their applications, Proc. 12th IEEE Int. Vacuum Electronics Conference (IVEC 2011), Bangalore, India, PL-7, Plenary Talk. pp. 521-524.

[8] Hirshfield, J.L., Granatstein, V.L., 1977, The electron cyclotron maser – an historical survey. IEEE Trans. on Microwave Theory and Techniques, 25, 522-527.

[9] Flyagin, V.A., Gaponov, A.V., Petelin, M.I., Yulpatov, V.K., 1977, The gyrotron. IEEE Trans. on Microwave Theory and Techniques, 25, 514-521.

[10] Andronov, A.A., Flyagin, V.A., Gaponov, A.V., Goldenberg, A.L., Petelin, M.I., Usov, V.G., Yulpatov, V.K., 1978, The gyrotron: high power sources of millimetre and submillimetre waves. Infrared Physics, 18, 385-393.

[11] Petelin, M.I., 1993, Physics of advanced gyrotrons. Plasma Phys. and Contr. Nucl. Fusion, **35**, Supplement B, 343-351.

[12] Flyagin, V.A., Goldenberg, A.L., Nusinovich, G.S., 1984, Powerful gyrotrons, in Infrared and Millimeter Waves, Vol. 11, ed. K.J. Button, Academic Press, New York, 179-226.

[13] Flyagin, V.A., Nusinovich, G.S., 1988, Gyrotron oscillators. Proceedings of the Institute of Electrical and Electronics Engineers, 76, 644-656 and, 1985, Powerful gyrotrons for thermo nuclear research, in Infrared and Millimeter Waves, Vol. 13, ed. K.J. Button, Academic Press, New York, 1-17.

[14] Felch, K., Huey, H., Jory, H., 1990, Gyrotrons for ECH application. J. Fusion Energy, 9, No. 1, 59-75.

[15] Goldenberg, A.L., Denisov, G.G., Zapevalov, V.E., Litvak, A.G., Flyagin, V.A., 1996, Cyclotron resonance masers: state of the art. Radiophys. and Quantum Electronics, 39, 423-446.

[16] Gold, S.H., Nusinovich, G.S., 1997, Review of high-power microwave source research. Rev. Scient. Instruments, 68, 3945-3974.

[17] Granatstein, V.L., Levush, B., Danly, B.G., Parker, R.K., 1997, A quarter century of gyrotron research and development. IEEE Trans. on Plasma Science, 25, 1322-1335.

[18] Petelin, M.I., 1999, One century of cyclotron radiation. IEEE Trans. on Plasma Science, 27, 294-302 and 2015, The gyrotron: physical genealogy. Terahertz Science and Technology, 8, No. 4, 157-166.

[19] Felch, K.L., Danly, B.G., Jory, H.R., Kreischer, K.E., Lawson, W., Levush, B., Temkin, R.J., 1999, Characteristics and applications of fast-wave gyrodevices. Proc. of the IEEE, 87, No. 5, 752-781

[20] Thumm, M., 2002, Progress in gyrotron development. Fusion Engineering and Design, 66-68, 69-90.

[21] Chu, K.R., 2004, The electron cyclotron maser. Rev. Mod. Phys., 76, 489-540.

[22] Sakamoto, K., 2007, Progress of high-power-gyrotron development for fusion research. Fusion Science and Technology, 52, 145-153.

[23] Faillon, G., Kornfeld, G., Bosch, E., Thumm, M.K., 2008, Microwave Tubes, in "Vacuum Electronics – Components and Devices", J.A. Eichmeier, M.K. Thumm, eds., Springer, Berlin, Heidelberg, Germany, 1-84.

[24] Thumm, M., 2009, History, present status and future of gyrotrons, Proc. 10th IEEE Int. Vacuum Electronics Conference (IVEC 2009), Rome, Italy, pp. 37-40.

[25] Thumm, M., 2011, Progress on gyrotrons for ITER and future thermonuclear fusion reactors. IEEE Trans. on Plasma Science, 39, 971-979.

[26] Litvak, A., Sakamoto, K., Thumm, M., 2011, Innovation on high-power long-pulse gyrotrons. Plasma Physics and Controlled Fusion, 53, 12402 (14 pp).

[27] Nusinovich, G.S., Thumm, M.K.A., Petelin, M., 2014, The gyrotron at 50: Historical overview. J. Infrared, Millimeter, and Terahertz Waves, 35, No. 4, 325-381.

[28] Thumm, M., 2014, Recent advances in the worldwide fusion gyrotron development. IEEE Trans. on Plasma Science, 42**,** No. 3, 590-599.

[29] Thumm, M.K.A., Denisov, G.G., Sakamoto, K., Tran, M.Q., 2019, High-power gyrotrons for electron cyclotron heating and current drive. Nuclear Fusion, 59, 073001 (37pp).

[30] Luce, T.C., 2002, Applications of high-power millimeter waves in fusion energy research. IEEE Trans. on Plasma Science, 30, 734-754.

[31] Imai, T., Kobayashi, N., Temkin, R., Thumm, M., Tran, M.Q., Alikaev, V., 2001, ITER R&D: auxiliary systems: electron cyclotron heating and current drive system. Fusion Engineering and Design, 55, 281-289.

[32] Zohm, H., Gantenbein, G., Giruzzi, G., Günter, S., Leuterer, F., Maraschek, M., Meskat, J., Peeters, A.G., Suttrop, W., Wagner, D., Zabiégo, M., ASDEX Upgrade Team, ECRH Group, 1999, Experiments on neoclassical tearing mode stabilization by ECCD in ASDEX Upgrade. Nuclear Fusion, 39, 577-580.

[33] Gantenbein, G., Zohm, H., Giruzzi, G., Günter, S., Leuterer, F., Maraschek, M., Meskat, J., Yu, Q., ASDEX Upgrade Team, ECRH-Group (AUG), 2000, Complete suppression of neoclassical tearing modes with current drive at the electron-cyclotron-resonance frequency in ASDEX Upgrade tokamak. Phys. Rev. Lett., 85, 1242-1245.

[34] Zohm, H., Gantenbein, G., Gude, A., Günter, S., Leuterer, F., Maraschek, M., Meskat, J.P., Suttrop, W., Yu, Q., ASDEX Upgrade Team, ECRH Group (AUG), 2001, The physics of neoclassical tearing modes and their stabilization by ECCD in ASDEX Upgrade. Nuclear Fusion, 41, 197-202.

[35] Zohm, H., Gantenbein, G., Gude, A., Günter, S., Leuterer, F., Maraschek, M., Meskat, J., Suttrop, W., Yu, Q., ASDEX Upgrade Team, ECRH-Group (AUG), 2001, Neoclassical tearing modes and their stabilization by electron cyclotron current drive in ASDEX Upgrade. Physics of Plasmas, 8, 2009-2016.

[36] Prater, R., 2005, Application of electron cyclotron current drive on ITER. Journal of Physics: Conference Series, 25, 257-265.

[37] Zohm, H., Thumm, M., 2005, On the use of step-tuneable gyrotrons in ITER. Journal of Physics: Conference Series, 25, 274-282.

[38] Wagner, D., Leuterer, F., Manini, A., Monaco, F., Münich, M., Ryter, R., Schutz, H., Zohm, H., Franke, T., Heidinger, R., Thumm, M., Kasparek, W., Gantenbein, G., Litvak, A.G., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Denisov, G.G., Tai, E.M., Solyanova, E.A., Malygin,

S.A., 2006, New frequency step-tunable ECRH system for ASDEX Upgrade, Int. J. of Infrared and Millimeter Waves, 27, 173-182.

[39] Wagner, D., Leuterer, F., Manini, A., Monaco, F., Münich, M., Ryter, R., Schütz, H., Stober, J., Zohm, H., Franke, T., Danilov, I., Heidinger, R., Thumm, M., Gantenbein, G., Kasparek, W., Lechte, C., Litvak, A., Denisov, G., Tai, E., Popov, L., Nichiporenko, V., Myasnikov, V., Solyanova, E., Malygin, S., Meo, F., Woskov, P., 2007, The new multi-frequency electron cyclotron resonance heating system for ASDEX Upgrade, Fusion Science and Technology, 52, 313-320.

[40] Zohm, H., 2007, Recent experimental progress in electron cyclotron resonance heating and electron cyclotron current drive in magnetically confined fusion plasmas. Fusion Science and Technology, 52, 134-144.

[41] Zohm, H., Gantenbein, G., Leuterer, F., Manini, A., Maraschek, M., Yu, Q., and the ASDEX Upgrade Team, 2007, Control of MHD instabilities by ECCD: ASDEX Upgrade results and implications for ITER. Nuclear Fusion, 47, 228-232.

[42] Wagner, D.H., Grünwald, G., Leuterer, F., Manini, A., Monaco, F., Münich, M.J., Schütz, H., Stober, J., Zohm, H., Franke, T., Thumm, M., Heidinger, R., Gantenbein, G., Meier, A., Kasparek, W., Lechte, C., Litvak, A.G., Denisov, G.G., Chirkov, A.V., Tai, E.M., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Solyanova, E.A., Malygin, S.A., Meo, F., Woskow, P.O., 2008, Present status of the new multifrequency ECRH system for ASDEX Upgrade, IEEE Trans. on Plasma Science, 36, 324-331.

[43] Wagner, D., Stober, J., Leuterer, F., Sips, G., Grünwald, G., Monaco, F., Münich, M., Poli, E., Schütz, H., Volpe, F., Treutterer, W., Zohm, H., Franke, T., Thumm, M., Heidinger, R., Gantenbein, G., Meier, A., Kasparek, W., Lechte, C., Litvak, A., Denisov, G., Chirkov, A., Tai, E., Popov, L., Nichiporenko, V., Myasnikov, V., Solyanova, E., Malygin, S., 2008, Multi-frequency ECRH at ASDEX Upgrade, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 2, pp. 304-311.

Wagner, D., Stober, J., Bäumel, S., Franke, T., Leuterer, F., Poli, E., Monaco, F., Münich, M., Schütz, H., Zohm, H., Thumm, M., Scherer, T., Meier, A., Gantenbein, G., Flamm, J., Kasparek, W., Lechte, C., Höhnle, H., Litvak, A.G., Denisov, G.G., Cirkov, A., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Solyanova, E.A., Malygin, S.A., 2009, Multi-frequency ECRH system at ASDEX Upgrade, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R4D06.0016.

[44] Wagner, D.H., Stober, J.K., Leuterer, F., Sips, G., Grünwald, G., Monaco, F., Münich, M.J., Poli, E., Schütz, H., Volpe, F., Treutterer, W., Zohm, H., Franke, T., Thumm, M., Heidinger, R., Gantenbein, G., Meier, A., Kasparek, W., Lechte, C., Litvak, A.G., Denisov, G.G., Chirkov, A., Tai, E., Popov, L., Nichiporenko, V., Myasnikov, V., Solyanova, E., Malygin, S., 2009, Progress and first results with the new multifrequency ECRH system for ASDEX Upgrade, IEEE Transactions on Plasma Science, 37, 395-402.

Wagner, D., Stober, J., Leuterer, F., Monaco, F., Münich, M., Schmid-Lorch, D., Schütz, H., Zohm, H., Thumm, M., Scherer, T., Meier, A., Gantenbein, G., Flamm, J., Kasparek, W., Höhnle, H., Lechte, C., Litvak, A.G., Denisov, G.G., Chirkov, A., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Solyanova, E.A., Malygin, S.A., 2010, Multi-frequency ECRH at ASDEX Upgrade, status and plans, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Tu-E1.4.

[45] Wagner, D., Stober, J., Leuterer, F., Monaco, F., Münich, M., Schmid-Lorch, D., Schütz, H., Zohm, H., Thumm, M., Scherer, T., Meier, A., Gantenbein, G., Flamm, J., Kasparek, W., Höhnle, H., Lechte, C., Litvak, A.G., Denisov, G.G., Chirkov, A., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Solyanova, E.A., Malygin, S.A., 2011, Recent upgrades and extensions of the ASDEX Upgrade ECRH system. J. of Infrared, Millimeter, and Terahertz Waves, 32, 274-282.

[46] Stober, J., Bock, A., Höhnle, H., Reich, M., Sommer, F., Treutterer, W., Wagner, D., Giannone, L., Herrmann, A., Leuterer, F., Monaco, F., Maraschek, M., Mlynek, A., Müller, S., Münich, M., Poli, E., Schubert, M., Schütz, H., Zohm, H., Kasparek, W., Stroth, U., Meier, A., Scherer, T., Strauß, D., Vaccaro, A., Flamm, J., Thumm, M., Litvak, A., Denisov, G.G., Chirkov, A.V., Tai, E.M., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Soluyanova, A., Malygin, S.A., ASDEX Upgrade Team, 2012, ECRH on ASDEX Upgrade. System status, feed-back control, plasma physics results. EPJ Web of Conferences, **32**, 02011/1-8.

[47] Wagner, D., Stober, J., Leuterer, F., Monaco, F., Müller, S., Münich, M., Rapson, C., Reich, M., Ryter, F., Schubert, M., Schütz, H., Treutterer, W., Zohm, H., Thumm, M., Scherer, T., Meier, A., Gantenbein, G., Jelonnek, J., Kasparek, W., Lechte, C., Plaum, B., Litvak, A.G., Denisov, G.G., Chirkov, A., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Solyanov, E.A., Malygin, S.A., ASDEX Upgrade Team, 2014, ECRH at ASDEX Upgrade - Development of a flexible high-power millimeter wave system driven by plasma physics needs and machine safety. Proc. 9th Int. Workshop "Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, pp. 11-12.

[48] Stober, J., Sommer, F., Anigioni, C., Bock, A., Fable, E., Leuterer, F., Monaco, F., Müller, S., Münich, M., Pertzold, B., Poli, E., Schubert, M., Schütz, H., Wagner, D., Zohm, H., the ASDEX Upgrade Team, Kasparek, W., Plaum, B., Meier, A., Scherer, Th., Strauß, D., Jelonnek, J., Thumm, M., Litvak, A., Denisov, G.G., Chirkov, A.V., Tai, E.M., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Soluyanova, E.A., Malygin, V., 2015, High power ECRH and ECCD in moderately collisional ASDEX Upgrade H-modes and status of EC system upgrade. EPJ Web of Conferences, 87, 02004 (6pp).

[49] Wagner, D., Stober, J., Kircher, M., Leuterer, F., Monaco, F., Münich, M., Schubert, M., Zohm, H., Gantenbein, G., Jelonnek, J., Thumm, M., Meier, A., Scherer, T., Strauss, D., Kasparek, W., Lechte, C., Plaum, B., Zach, A., Litvak, A.G., Denisov, G.G., Chirkov, A., Malygin, V., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Solyanova, E.A., Malygin, S.A., ASDEX Upgrade Team, 2017, Extension of the multi-frequency ECRH system at ASDEX Upgrade. EPJ Web of Conferences, 149, 03004 (2pp).

[50] Wagner, D., Stober, J., Kircher, M., Leuterer, F., Monaco, F., Münich, M., Schubert, M., Zohm, H., Gantenbein, G., Jelonnek, J., Thumm, M., Meier, A., Scherer, T., Strauss, D., Kasparek, W., Lechte, C., Plaum, B., Zach, A., Litvak, A., Denisov, G., Chirkov, A., Malygin, V., Popov, L.G., Myasnikov, V.E., Tai, E.M., Solyanova, E.A., ASDEX Upgrade Team, 2018, Status of the 8 MW multi-frequency ECRH system at ASDEX. Proc. 19th Int. Vacuum Electronics Conference (IVEC 2018), Monterey, CA, USA, 13.1.

[51] Wagner, D., Stober, J., Kircher, M., Leuterer, F., Monaco, F., Münich, M., Schubert, M., Zohm, H., Gantenbein, G., Jelonnek, J., Thumm, M., Meier, A., Scherer, T., Strauss, D., Kasparek, W., Lechte, C., Plaum, B., Zach, A., Litvak, A.G., Denisov, G.G., Chirkov, A., Malygin, V., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Solyanova, E.A., ASDEX Upgrade Team, 2019, Completion of the 8 MW multi-frequency ECRH system at ASDEX. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-PM2-1-5.

Wagner, D., Stober, J., Kircher, M., Leuterer, F., Monaco, F., Münich, M. Schubert, M., Zohm, H., Gantenbein, G., Jelonnek, J., Thumm, M., Meier, A., Scherer, T., Strauss, D., Kasparek, W., Lechte, C., Plaum, B., Zach, A., Litvak, A.G., Denisov, G.G., Chirkov, A., Malygin, V., Popov, L.G., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Solyanova, E.A., ASDEX Upgrade Team: Improvement of the power handling capability of the upgraded multi-frequency ECRH system at ASDEX Upgrade, Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Light Sources 4.

[52] Cengher, M., Lohr, J., Gorelov, Y., Torrezan, A., Ponce, D., Chen, X., Moeller, C., 2016, DIII-D electron cyclotron heating system status and upgrades, IEEE Trans. on Plasma Science, 44, No. 12, 3465-3470.

[53] Darbos, C., Henderson, M., Albajar, F., Bigelow, T., Bonicelli, T., Chavan, R., Denisov, G.G., Fasel, D., Heidinger, R., Hogge, J.P., Kobayashi, N., Piosczyk, B., Rao, S.L., Rasmussen, D., Saibene, G., Sakamoto, K., Takahashi, K., Thumm, M., 2009, Progress in design and integration of the ITER electron cyclotron H&CD system. Fusion Engineering and Design, 84, 651-655.

[54] Henderson, M., Albajar, F., Alberti, S., Baruah, U., Bigelow, T., Becker, B., Bertizzolo, R., Bonicelli, T., Bruschi, A., Caughman, J., Chavan, R., Cirant, S., Collazos, A., Darbos, C., deBaar, M., Denisov, G., Farina, D., Gandini, F., Gassmann, T., Goodman, T.P., Heidinger, R., Hogge, J.P., Jean, O., Kajiwara, K., Kasparek, W., Kasugai, A., Kern, S., Kobayashi, N., Landis, J.D., Moro, A., Nazare, C., Oda, J., Paganakis, I., Platania, P., Plaum, B., Poli, E., Porte, L., Piosczyk, B., Ramponi, G., Rao, S.L., Rasmussen, D., Rouden, D., Saibene, G., Sakamoto, K., Sanchez, F., Scherer, T., Shapiro, M., Sozzi, C., P. Spaeh, Strauss, D., Sauter, O., Takahashi, K., Tanga, A., Temkin, R., Thumm, M., Tran, M.Q., Zohm, H., Zucca, C., 2009, An overview of the ITER electron cyclotron H&CD system, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, F2P101.0554.

[55] Henderson, M., Albajar, F., Alberti, S., Baruah, U., Bigelow, T., Becket, B., Bertizzolo, R., Bonicelli, T., Bruschi, A., Caughman, J., Chavan, R., Cirant, S., Darbos, C., de Baar, M., Denisov, G., Farina, D., Gandini, F., Gassmann, T., Goodman, T.P., Heidinger, R., Hogge, J.P., Kajiwara, K., Kasparek, W., Kasugai, A., Kern, S., Kobayashi, N., Landis, J.D., Li, F., Litvak, A., Moro, A., Myasnikov, V., Nazare, C., Oda, J., Omori, T., Pagonakis, I., Parmer, D., Peters, B., Platania, P., Plaum, B., Poli, E., Porte, I., Piosczyk, B., Purohit, D., Ramponi, G., Rao, S.L., Rasmussen, D., Ronden, D., Saibene, G., Sakamoto, K., Sanchez, F., Scherer, T., Schreck, S., Singh, N.P., Shapiro, M., Sozzi, C., Spaeh, P., Straus, D., Sauter, O., Tai, E., Takahasi, T., Temkin, R., Thomas, P., Thumm, M., Zohm, H., 2011, Present status of the 24 MW 170 GHz ITER EC H&CD system, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 21-22.

[56] Omori, T., Henderson, M.A., Albajar, F., Alberti, S., Baruah, U., Bigelow, T., Beckett, B., Bertizzolo, R., Bonicelli, T., Bruschi, A., Caughman, J., Chavan, R., Cirant, S., Collazos, A., Cox, D., Darbos, C., de Baar, M.R., Denisov, G., Farina, D., Gandini, F., Gassmann, T., Goodman, T.P., Heidinger, R., Hogge, J.P., Kobayashi, N., Kumric, H., Landis, J.D., Moro, A., Nazare, C., Oda, Y., Pagonakis, I., Piosczyk, B., Platania, P., Plaum, B., Poli, E., Porte, L., Purohit, D., Ramponi, G., Rao, S.L., Rasmussen, D.A., Ronden, D.M.S., Rzesnicki, T., Saibene, G., Sakamoto, K., Sanchez, F., Scherer, T., Shapiro, M., Sozzi, C., Spaeh, P., Strauss, D., Suter, O., Takahashi, K., Temkin, R., Thumm, M., Tran, M.Q., Udintsev, V., Zohm, H., 2011, Overview of the ITER EC H&CD system and its capabilities. Fusion Engineering and Design, 86, 951-954.

[57] Takahashi, K., Oda, Y., Ikeda, R., Kobayashi, T., Moriyama, S., Sakamoto, K., Terakado, M., Abe, G., Isozaki, M., 2017, Development of MW gyrotron and equatorial launcher for ITER. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), 2017, Cancun, Mexico, WC2.2.

[58] Granucci, G., Aiello, G., Avramidis, K.A., Bruschi, A., Gantenbein, G., Garavaglia, S., Grossetti, G., Jelonnek, J., Moro, A., Poli, E., Rispoli, N., Strauss, D., Thumm, M.,Tigelis, I., Tsironis, C., Franke, T., Tran, M.Q., 2017, The EC-system of EU DEMO: concepts for a reactor heating system. EPJ Web of Conferences, 149, 03003 (2pp).

[59] Garavaglia, S., Aiello, G., Alberti, S., Avramidis, K., Bruschi, A., Chelis, I., Franck, J., Gantenbein, G., Granucci, G., Grossetti, G., Hizanidis, K., Illy, S., Jelonnek, J., Kalaria, P., Latsas, G., Moro, A., Pagonakis, I., Peponis, D., Poli, E., Rispoli, N., Ruess, S., Rzesnicki, T., Scherer, T., Strauss, D., Thumm, M., Tigelis, I., Tsironis, C., Wu, C., Franke, T., Tran, M.Q., 2018, EU DEMO EC system preliminary conceptual design. Fusion Engineering and Design, 136, Part B, 1173-1177.

[60] Prater, R., 2004, Heating and current drive by electron cyclotron waves. Physics of Plasmas, 11, 2349-2376.

[61] Erckmann, V., Kasparek, W., Plaum, B., Lechte, C., Petelin, M.I., Braune, H., Gantenbein, G., Laqua, H.P., Lubiako, L., Marushchenko, N.B., Michel, G., Turkin, Y., Weissgerber, M., and the W7-X ECRH-teams at IPP Greifswald, IPF Stuttgart, and KIT, 2012, Large scale CW ECRH systems: some considerations. EPJ Web of Conferences, 32, 04009/1-6.

[62] Erckmann, V., WVII-AS Team, Kasparek, W., Müller, G.A., Schüller, P.G., and Thumm, M., 1990, Electron cyclotron resonance heating transmission line and launching system for the Wendelstein VII-AS stellarator. Fusion Technology, 17, 76-85.

[63] Erckmann, V., Dammertz, G., Dorst, D., Empacher, L., Förster, W., Gantenbein, G., Geist, T., Kasparek, W., Laqua, H.P., Müller, G.A., Thumm, M., Weissgerber, H., Wobig, H., W7-X and W7-AS Teams at IPP Garching, W7-X Team at FZK Karlsruhe, W7-X Team at IPF Stuttgart, 1999, ECRH and ECCD with high power gyrotrons at the stellarators W7-AS and W7-X. IEEE Trans. on Plasma Science, 27, 538-546.

[64] Kasparek, W., Erckmann, V., Laqua, H.P., Borie, E., Dammertz, G., Empacher, L., Förster, W., Gantenbein, G., Illy, S., Michel, G., Müller, G., Piosczyk, B., Thumm, M., Wagner, D., Weißgerber, M., Zohm, H., W7-X and W7-AS Teams at IPP Garching, W7-X Team at IPF Stuttgart, W7-X Team at FZK Karlsruhe, 1999, ECRH and ECCD for the stellarator W7-X. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 1, 185-204.

[65] Erckmann, V., Laqua, H.P., Maassberg, H., Geiger, J., Dammertz, G., Kasparek, W., Thumm, M., W7-X and W7-AS teams IPP, W7-X team FZK, W7-X team IPF, 2001, Electron cyclotron resonance heating and EC-current drive experiments at W7-AS, status at W7-X. Fusion Engineering and Design, 53, 365-375.

[66] Wanner, M., Erckmann, V., Feist, J.-H., Gardebrecht, W., Hartmann, D., Krampitz, R., Niedermeyer, H., Renner, H., Rummel, Th., Schauer, F., Wegener, L., Wesner, F., Müller, G.A., Kasparek, W., Thumm, M., Dammertz, G., 2003, Status of WENDELSTEIN 7-X construction, Nucl. Fusion, 43, 416-424.

[67] Dammertz, G., Braune, H., Erckmann, V., Gantenbein, G., Kasparek, W., Laqua, H.P., Leonhardt, W., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M.K., 2004, Progress in the 10-MW ECRH system for the stellarator W7-X. IEEE Trans. on Plasma Science, 32, 144-151.

[68] Erckmann, V., Brand, P., Braune, H., Dammertz, G., Gantenbein, G., Kasparek, W., Laqua, H.P., Maassberg, H., Marushchenko, N.B., Michel, G., Thumm, M., Turkin, Y., Weissgerber, M., Weller, A., W7-X ECRH Team at IPP Greifswald, W7-X ECRH Team at FZK Karlsruhe and W7-X ECRH Team at IPF Stuttgart, 2007, Electron cyclotron heating for W7-X: physics and technology, Fusion Science and Technology, 52, 291-312.

[69] Erckmann, V., W7-X ECRH teams at IPP, IPF and FZK, 2007, The W7-X ECRH plant: status and recent achievements, Proc. 17th Topical Conf. on Radio Frequency Power in Plasmas, Clearwater, Florida, USA, AIP Conf. Proc., Vol. 933, 421-424.

[70] Erckmann, V., Brand, P., Braune, H., Gantenbein, G., Kasparek, W., Laqua, H.P., Lechte, C., Marushchenko, N.B., Michel, G., Thumm, M., Turkin, Y., Weissgerber, M., and the W7-X ECRH-teams at IPP Greifswald, IPF Stuttgart and FZK Karlsruhe, 2008, The 10 MW, CW, ECRH-plant for W7-X: status and high power performance, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 1, pp. 60-69.

[71] Thumm, M., Brand, P., Braune, H., Dammertz, G., Erckmann, V., Gantenbein, G., Illy, S., Kasparek, W., Kern, S., Laqua, H.P., Lechte, C., Leonhardt, W., Marushchenko, N.B., Michel, G., Piosczyk, B., Schmid, M., Turkin, Y., Weisgerber, W., 2010, Status and high power performance of the 10-MW 140-GHz ECH system for the stellarator Wendelstein 7-X. Plasma and Fusion Research, 5, 1006/1-8.

[72] Geiger, J., Wolf, R.C., Beidler, C., Cardella, A., Chlechowitz, E., Erckmann, V., Gantenbein, G., Hathiramani, D., Hirsch, M., Kasparek, W., Kißlinger, J., König, R., Kornejew, P., Laqua, H.P., Lechte, C., Lore, J., Lumsdaine, A., Maaßberg, H., Marushchenko, N.B., Michel, G., Otte, M., Peacock, A., Sunn Pedersen, T., Thumm, M., Turkin, Y., Werner, A., Zhang, D., W7-X Team, 2013, Aspects of steady-state operation of the Wendelstein 7-X stellarator. Plasma Phys. Control. Fusion, 55, 014006.

[73] Thumm, M., 2014, The 1st decade of ECRH on Wendelstein Stellarators – A humorous retrospect. Proc. 9th Int. Workshop “Strong Microwaves and Terahertz Waves: Sources and Applications", July 24-30, 2014, Nizhny Novgorod, Russia, pp. 26-27.

[74] Braune, H., Laqua, H.P., Marsen, S., Moseev, D., Noke, F., Purps, F., Schneider, N., Schulz, T., Stange, T., Uhren, P., W7-X ECRH Teams at IPP, IGVP Stuttgart and KIT Karlsruhe, 2016, Gyrotron operation during the first W7-X campaign – handling and reliability. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 25-30, 2016, Copenhagen, Denmark, H4B.2.

[75] Wolf, R.C., et al., 2016, Wendelstein 7-X program – Demonstration of a stellerator option for fusion energy. IEEE Trans. on Plasma Science, 44, 1466-1471.

[76] Wolf, R.C. et al., 2017, Major results from the first plasma campaign of the Wendelstein 7-X stellarator. Nuclear Fusion, 57, 102020 (13pp).

[77] Braune, H., Brunner, K.J., Laqua, H.P., Marsen, S., Moseev, D., Noke, Purps, F., Schneider, N., Schulz, T., Stange, T., Uhren, P., Wilde, F., W7-X Team at IPP, IGVP Stuttgart, KIT Karlsruhe, 2018, Concurrent operation of 10 gyrotrons at W7-X–experience and improvement opportunities. EPJ Web of Conferences, 187, 01003 (2pp).

[78] Braune, H., Brunner, K.J., Laqua, H.P., Marsen, S., Moseev, D., Noke, F., Purps, F., Schneider, N., Schulz, T., Stange, T., Uhren, P., Wilde, W7-X Team at IPP, IGVP Stuttgart and KIT Karlsruhe, 2018, ECRH at W7-X - Concurrent operation of 10 gyrotrons. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, We-A2-4-5.

[79] Wolf, R.C. et al., 2019, Electron-cyclotron-resonance heating in Wendelstein 7-X: A versatile heating and current-drive method and a tool for in-depth physics studies. Plasma Physics and Controlled Fusion, 61, 014037 (9pp).

[80] Klinger, T. et al., 2019, Overview of first Wendelstein 7-X high-performance operation. Nuclear Fusion, 59, 112004 (11pp).

[81] Wolf, R. C. et al., 2019, Performance of Wendelstein 7-X stellarator plasmas during the first divertor operation phase. Physics of Plasmas, 26, 082504 (14pp).

[82] Ohkubo, K., Kubo, S., Shimozuma, T., Idei, H., Sato, M., Yoshimura, Y., Mizuno, Y., Ito, S., Kobayashi, S., Takita, Y., Kaneko, O., Kawahata, K., Komori, A., Ohyabu, N., Yamada, H., Ikeda, K., Oka, Y., Osakabe, M., Takeiri, K., Tsumori, K., Kumazawa, R., Mutoh, T., Saito, K., M., Seki, T., Watari, T., Ashikawa, N., Emoto, M., de Vries, P.C., Funaba, H., Goto, M., Ida, K., Inagaki, S., Isobe, M., Kado, S., Kobuchi, T., Masuzaki, S., Minami, T., Miyazawa, J., Morisaki, T., Morita, S., Murakami, S., Mutoh, S., Nagayama, Y., Nakamura, Y., Nakanishi, H., Narihara, K., Nishimura, K., Noda, N., Ohdachi, S., Ozaki, T., Pavlichenko, R.O., Peterson, B.J., Sagara, A., Sakakibara, S., Sakamoto, R., Sasao, H., Sasao, M., Sato, K., Shoji, M., Sudo, S., Suzuki, H., Takechi, M., Tanaka, K., Toi, K., Tokuzawa, T., Yamada, I., Yamaguchi, S., Yamamoto, S., Yamazaki, K., Yokoyama, M., Watanabe, K.Y., Motojima, O., Fujiwara, M., 1999, Electron cyclotron plasma production and heating on LHD: system and its application. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 1, 27-40.

[83] Idei, H., Kubo, S., Shimozuma, T., Sato, M., Ohkubo, K., Yoshimura, Y., Takita, Y., Kobayashi, S., Ito, S., Mizuno, Y., Tsumori, K., Ikeda, K., Notake, T., Watari, T., Kaneko, O., Komori, A., Yamada, H., de Vries, P.C., Goto, M., Ida, K., Inagaki, S., Kado, S., Kawahata, K., Kobuchi, T., Minami, T., Miyazawa, J., Morisaki, T., Morita, S., Murakami, S., Muto, S., Nagayama, Y., Nakanishi, H., Narihara, K., Peterson, B.J., Sakakibara, S., Sasao, H., Sato, K., Tanaka, K., Takeiri, Y., Watanabe, K.Y., Yamada, I., Motojima, O., Fujiwara, M., LHD Experimental Group, 2001, Electron cyclotron heating scenario and experimental results in LHD. Fusion Engineering and Design, 53, 329-336.

[84] Shimozuma, T., Kubo, S., Idei, H., Yoshimura, Y., Notake, T., Watari, T., Mizuno, Y., Ito, S., Kobayashi, S., Takita, Y., Sato, M., Ohkubo, K., Ida, K., Ohyabu, N., Yamada, I., Narihara, K., Inagaki, S., Nagayama, Y., Takeiri, Y., Funaba, H., Yokoyama, M., Murakami, S., and the LHD Experimental Group, 2002, Recent results of ECH experiment by an upgraded heating system in LHD. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 307-319.

[85] Igami, H., Notake, T., Yoshimura, Y., Shimozuma, T., Kubo, S., Ohkubo, K., Inagaki, S. and LHD Experimental Group, 2005, High power injection and steady state ECRH operation in LHD. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 2, 398-408.

[86] Nishiura, M., Tanaka, K., Kubo, S., Saito, T., Tatematsu, Y., Notake, T., Kawahata, K., Shimozuma, T., Mutoh, T., 2008, Design of collective Thomson scattering system using 77 GHz gyrotron for bulk and tail ion diagnostics in the large helical device, Review of Scientific Instruments, 79, 10E731-1 – 10E731-3.

[87] Igami, H., Kubo, S., Shimozuma, T., Yoshimura, Y., Takahashi, H., Tsujimura, T.I., Kobayashi, S., Mizuno, Y., Takubo, H., Tanaka, K., Yokoyama, M., Seki, R., Yamada, I., Yasuhara, R., Tsuchiya, H., Ida, K., Yoshinuma, M., Kobayashi, T., Ohdachi, S., Osakabe, M., Morisaki, T., LHD Experiment Group, 2018, Recent progress of the applications of ECRH/ECCD and the supportive technologies in the LHD. EPJ Web of Conferences, 203, 02001 (8pp).

[88] Thumm, M., 1994, Progress in the development of high-power millimeter- and submillimeter wave gyrotrons and of free electron masers. Archiv für Elektrotechnik 77, 51-55.

[89] Thumm, M., 1995, Advanced electron cyclotron heating systems for next step fusion experiments. Fusion Engineering and Design, 30, 139-170.

[90] Thumm, M., 1997, Recent development of high power gyrotrons and windows for EC wave applications. Proc. 12th Topical Conf. on Radio Frequency Power in Plasmas, Savannah, Georgia, USA, AIP Conference Proceedings 403, 183-190.

[91] Thumm, M., 1997, Present developments and status of electron sources for high power gyrotron tubes and free electron masers. Applied Surface Science, 111, 106-120.

[92] Thumm, M., 1998, State-of-the-art and recent developments of high-power gyrotron oscillators. Proc. Radio Frequency Workshop (RF 98), High Energy Density Microwaves, Pajaro Dunes, California, USA, AIP Conference Proceedings 474, 146-162.

[93] Thumm, M., 2003, MW gyrotron development for fusion plasma applications. Plasma Phys. Control. Fusion, 45, A143-A161.

[94] Thumm, M., Alberti, S., Arnold, A., Bariou, D., Dammertz, G., Darbos, C., Dumbrajs, O., Gantenbein, G., Erckmann, V., Giguet, E., Heidinger, R., Hogge, J.-P., Illy, S., Jin, J., Kasparek, W., Liévin, C., Magne, R., Michel, G., Piosczyk, B., Prinz, O., Rzesnicki, T., Schwörer, K., Tran, M.Q., Yang, X., Yovchev, I., 2005, Gyrotron development in the EU for present fusion experiments and for ITER. Proc. 7th Workshop on High Energy Density and High Power RF, AIP Conference Proceedings 807, 2006, 167-179.

[95] Dammertz, G., Alberti, A., Arnold, A., Bariou, D., Brand, P., Braune, H., Erckmann, V., Dumbrajs, O., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.-Ph., Illy, S., Jin, J., Kasparek, W., Koppenburg, K., Laqua, H.P., Legrand, F., Leonhardt, W., Liévin, Ch., Michel, G., Neffe, G., Piosczyk, B., Prinz, O., Rzesnicki, T., Schmid, M., Thumm, M., Tran, M.Q., Yang, X., Yovchev, I., 2006, High-power gyrotron development at Forschungszentrum Karlsruhe for fusion applications, IEEE Trans. on Plasma Science, 34, 173-186.

[96] Jelonnek, J., Alberti, S., Avramidis, K., Braune, H., Erckmann, V., Gantenbein, G., Hogge, J.P., Illy, S., Jin, J., Kern, S., Noke, F., Pagonakis, I., Piosczyk, B., Purps, F., Rzesnicki, T., Samartsev, A., Schlaich, A., Schmid, M., Thumm, M., 2012, High power gyrotron development at KIT for ECH&CD of fusion plasmas, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 111-112.

[97] Jelonnek, J., Alberti, S., Avramidis, K., Erckmann, V., Gantenbein, G., Hesch, K., Hogge, J.-P., Illy, S., Jin, J., Kern, S., Pagonakis, I., Piosczyk, B., Rzesnicki, T., Samartsev, A., Thumm, M., W7-X teams at KIT, IPF Stuttgart, IPP Greifswald, EGYC teams at KIT, EPFL-CRPP, HELLAS, IPF-CNR, 2013, Development of advanced gyrotrons in Europe. Fusion Science and Technology, 64, 505-512.

[98] Jelonnek, J., Avramidis, K., Franck, J., Gantenbein, G., Hesch, K., Illy, S., Jin, J., Malygin, A., Pagonakis, I., Rzesnicki, T., Samartsev, A., Scherer, T., Schlaich, A., Schmid, M., Strauss, D., Thumm, M., Zhang, J., 2013, KIT gyrotron development for future fusion applications. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo10-3.

[99] Jelonnek, J., Albajar, F., Alberti, S., Avramidis, K., Benin, P., Bonicelli, T., Cismondi, F., Erckmann, V., Gantenbein, G., Hesch, K., Hogge, J.-P., Illy, S.,.Ioannidis, Z.C., Jin, J., Laqua, H., Latsas, G.P., Legrand, F., Michel, G., Pagonakis, I.Gr., Piosczyk, B., Rozier, Y., Rzesnicki, T., Tigelis, I.G., Thumm, M., Tran, M.Q., Vomvoridis, J.L., 2014, From series production of gyrotrons for W7-X toward EU-1MW gyrotrons for ITER. IEEE Trans. on Plasma Science, 42, No. 5, 1135-1144.

[100] Jelonnek, J., Avramidis, K., Franck, J., Gantenbein, G., Hesch, K., Jin, J., Kalaria, P., Pagonakis, I.Gr., Rzesnicki, T., Schmid, M., Thumm, M., 2014, Development of advanced gyrotrons. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W3_D-25.1.

[101] Jelonnek, J., Aiello, G., Avramidis, K., Franck, J., Gantenbein, G., Grossetti, G., Hesch, K. , Illy, S., Jin, J., Kalaria, P., Pagonakis, I.Gr., Rzesnicki, T., Ruess, S., Samartsev, A., Scherer, T., Strauss, D., Wu, C., Thumm, M., Alberti, S., Braunmueller, F., Genoud, J., Hogge, J.-P., Schlatter, C., Tran, T.-M., Tran, M.Q., Chelis, I., Vomvoridi, J.L., Ioannidis, Z.C., Latsas, G., Tigelis, I.G., Bruschi, A., Lontano, M., Hermann, V., Legrand, F., Rozier, Y., Albajar, F., Bonicelli, T., Cismondi, F., 2015, From W7-X towards ITER and beyond: Status and progress in EU fusion gyrotron developments. 16th IEEE International Vacuum Electronics Conference (IVEC 2015), Beijing, P.R. China, S23.2.

[102] Jelonnek, J., Aiello, G., Alberti, S., Avramidis, K., Bertinetti, A., I.G., Bruschi, A., Chelis, J., Franke, T., Gantenbein, G., Garavaglia, S., Granucci, G., Grossetti, Illy, S., Ioannidis, Z.C., Jin, J., Kalaria, P., Latsas, G.P., Laqua, H., Leggieri, A., Legrand, F., Marek, A., Pagonakis, I.Gr., Peponis, D., Savoldi, L., Rzesnicki, Ruess, S., Ruess, T., Scherer, T., Schmid, M., Strauss, D., Tigelis, I., Thumm, M., Tran, M.Q., Wilde, F., Wu, C., Zanino, R., Zein, A., 2017, European research activities towards a future DEMO gyrotron. EPJ Web of Conferences, 149, 04007 (2pp).

[103] Jelonnek, J., Aiello, G., Avramidis, K., Gantenbein, G. Grossetti, G., Illy, S., Ioannidis, Z.C., Jin, J., Kalaria, P., Marek, A., Pagonakis, I.G., Rzesnicki, T., Ruess, S., Scherer, T., Schmid, M., Strauss, D., Thumm, M., Wilde, F., Wu, C., Zein, A., 2017, Developments of fusion gyrotrons for W7-X, ITER and EU DEMO: Ongoing activities and future plans of KIT. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, WC2.1 (Invited).

[104] Gantenbein, G., Avramidis, K., Illy, S., Ioannidis, Z.C., Jin, J. Jelonnek, J., Kalaria, P., Pagonakis, I.Gr., Ruess, S., Ruess, T. Rzesnicki, T., Thumm, M., Wu, C., 2019, New trends of gyrotron development at KIT: An overview on recent investigations. Fusion Engineering and Design, 146, Part A, 341-344.

[105] Jelonnek, J., G. Aiello, S. Alberti, K. Avramidis, A. Bruschi, I. Chelis, T. Franke, G. Gantenbein, S. Garavaglia, G. Granucci, G. Grossetti, S. Illy, Z. Ioannidis, J. Jin, P. Kalaria, G. Latsas, I. Pagonakis, D. Peponis, T. Rzesnicki, S. Ruess, T. Ruess, T. Scherer, M. Schmid, D. Strauss, C. Wu, M. Thumm, I. Tigelis, M.Q. Tran, F. Wilde, A. Zein, 2019, Towards advanced fusion gyrotrons: 2018 update on activities within EUROfusion. EPJ Web of Conferences, 203, 04007 (6pp).

[106] Jelonnek, J., Aiello, G., Albajar, F., Alberti, S., Avramidis, K.A., Bertinetti, A., Brücker, P.T., Bruschi, A., Chelis, I., Dubray, J., Fanale, F., Fasel, D., Franke, T., Gantenbein, G., Garavaglia, S., Genoud, J., Granucci, G., Hogge, J.-P., Illy, S., Ioannidis, Z.S., Jin, J., Laqua, H., Latsas, G.P., Leggieri, A., Legrand, F., Marchesin, R., Marek, A., Marlétaz, B., Obermaier, M., Pagonakis, I.Gr., Peponis, D.V., Ruess, S., Ruess, T., Rzesnicki, T., Sanchez, P., Savoldi, L., Scherer, T., Strauss, D., Thouvenin, P., Thumm, M., Tigelis, I., Tran, M.-Q., Wilde, F., Wu, C., Zisis, A., 2019, From W7-X towards ITER and beyond: 2019 Status on EU fusion gyrotron developments. Proc. 20th Int. Vacuum Electronics Conference (IVEC 2019), Busan, Southkorea, 13.2.

[107] Avramidis, K.A., G. Aiello, S. Alberti, P.T. Brücker, A. Bruschi, I. Chelis, T. Franke, G. Gantenbein, S. Garavaglia, J. Genoud, M. George, G. Granucci, G. Grossetti, J.-P. Hogge, S. Illy, Z.C. Ioannidis, J. Jelonnek, J. Jin, P.C. Kalaria, G.P. Latsas, A. Marek, I.Gr. Pagonakis, D.V. Peponis, S. Ruess, T. Ruess, T. Rzesnicki, T. Scherer, M. Schmid, D. Strauss, M. Thumm, I. Tigelis, C. Wu, A. Zein, A. Zisis, M.Q. Tran, 2019, Overview of recent gyrotron R&D towards DEMO within EUROfusion Work Package Heating and Current Drive. Nuclear Fusion, 59, 066014 (9pp).

[108] Denisov, G., Litvak, A., Sokolov, E., Chirkov, A., Eremeev, A., Tai, E., Soluyanova, E., Myasnikov, V., Popov, L., 2019, Development of megawatt gyrotrons in IAP/GYCOM. Proc. 20th Int. Vacuum Electronics Conference (IVEC 2019), Busan, Southkorea, 13.1.

[109] Litvak, A.G., Denisov, G.G., Eremeev, A.G., Glyavin, M.Yu., Kopelovich, E.A., Popov, L.G., Kuftin, A.N., Sokolov, E.V., Soluyanova, E.A., Tai, E.M., Tsvetkov, A.I., Zapevalov, V.E., 2020, The progress in the development of gyrotrons for plasma installations in Russia. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Gyrotrons 1.1.

[110] Dumbrajs, O., Nusinovich, G.S., 2004, Coaxial gyrotrons: past, present, and future (review). IEEE Trans. on Plasma Science, 32, 934-946.

[111] Thumm, M., Kasparek, W., 1995, Recent advanced technology in electron cyclotron heating systems. Fusion Engineering and Design, 26, 291-317.

[112] Thumm, M.K., Kasparek, W., 2002, Passive high-power microwave components. IEEE Trans. on Plasma Science, 30, 755-786.

[113] Henle, W., Jacobs, A., Kasparek, W., Kumric, H., Müller, G.A., Schüller, P.G., Thumm, M., Engelmann, F., Rebuffi, L., 1991, Conceptual study of multi-megawatt millimeter wave transmission and antenna systems for electron cyclotron wave applications in NET/ITER. Fusion Technology 1990, eds. B.E. Keen, M. Huguet, R. Hemsworth. Elsevier Science Publishers B.V., 238-242.

[114] Kasparek, W., Petelin, M., Erckmann, V., Shchegolkov, D., Bruschi, A., Cirant, S., Litvak, A., Thumm, M., Plaum, B., Grünert, M. Malthaner, M., ECRH Groups at IPP Greifswald, FZK Karlsruhe, IPF Stuttgart, 2007, Fast switching and power combination of high-power electron cyclotron wave beams: principles, numerical results, and experiments, Fusion Science and Technology, 52, 281-290.

[115] Alberti, S., Tran, M.Q., Hogge, J.P., Tran, T.M., Bondeson, A., Muggli, P., Perrenoud, A., Jödicke, B., Mathews, H.G., 1990, Experimental measurements on a 100 GHz frequency tunable quasi-optical gyrotron. Phys. Fluids, B2, 1654-1661.

[116] Hogge, J.P., Tran, T.M., Paris, P.J., Tran, M.Q., 1996, Operation of a quasi-optical gyrotron with a gaussian output coupler. Phys. Plasmas, 3, 3492-3500.

[117] Kreischer, K.E. Temkin, R.J., 1987, Single-mode operation of a high-power, step-tunable gyrotron. Phys. Rev. Lett., 59, 547-550.

[118] Kurbatov, V.I., Malygin, S.A., Vasilyev, E.G., 1990, Commercial gyrotrons for thermo-nuclear investigations. Proc. Int. Workshop on Strong Microwaves in Plasmas, Suzdal, Inst. of Applied Physics, Nizhny Novgorod, 1991, 765-772.

[119] Bogdanov, S.D., Kurbatov, V.I., Malygin, S.A., Orlov, V.B., Tai, E.M., 1993, Industrial gyrotrons development in Salut. Proc. 2nd Int. Workshop on Strong Microwaves in Plasmas, Moscow - Nizhny Novgorod - Moscow, ed. A.G. Litvak, Inst. of Applied Physics, Nizhny Novgorod, 1994, Vol. 2, 830-835.

Zapevalov, V.E., Malygin, S.A., Pavelyev, V.G., Tsimring, Sh.E., 1984, Coupled resonator gyrotrons with mode conversion. Radiophys. Quantum Electron., 27, 846-852.

[120] Braz, O., Dammertz, G., Kuntze, M., Thumm, M., 1997, D-band frequency step-tuning of a 1 MW gyrotron using a Brewster output window. Int. J. Infrared and Millimeter Waves, 18, 1465-1477.

[121] Braz, O., Dammertz, G., Henry, S., Kuntze, M., Sato, M., Shimozuma, T., Thumm, M., 1998, Frequency step-tuned operation of a 1 MW, D-band gyrotron using a Brewster output window. Proc. 8th ITG-Conference on Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 150, 299-304.

[122] Thumm, M., Borie, E., Braz, O., Dammertz, G., Dumbrajs, O., Koppenburg, K., Kuntze, M., Piosczyk, B., 1999, 1.6 MW frequency step-tunable D-band gyrotron. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 591-609.

[123] Dammertz, G., Dumbrajs, O., Koppenburg, K., Piosczyk, B., Thumm, M., 2000, Frequency-step-tunable high-power gyrotrons for plasma physics applications. J. Comm. Tech. and Electronics, 45, S60-S64.

[124] Dumbrajs, O., Nusinovich, G.S., 1992, Theory of a frequency-step-tunable gyrotron for optimum plasma ECRH. IEEE Trans. Plasma Science, 20, 452-457.

[125] Thumm, M., Arnold, A., Borie, E., Braz, O., Dammertz, G., Dumbrajs, O., Koppenburg, K., Kuntze, M., Michel, G., Piosczyk, B., 2001, Frequency step-tunable (114-170 GHz) megawatt gyrotrons for plasma physics applications. Fusion Eng. and Design, 53, 407-421.

[126] Koppenburg, K., Dammertz, G., Kuntze, M., Piosczyk, B., Thumm, M., 2001, Fast frequency-step-tunable high-power gyrotron with hybrid-magnet-system. IEEE Trans. on Electron Devices, 48, 101-107.

[127] Samartsev, A., Gantenbein, G., Dammertz, G., Illy, S., Kern, S., Leonhardt, W., Schlaich, A., Schmid, M., Thumm, M., 2011, Development of frequency step tunable 1 MW gyrotron at 131 to 146.5 GHz, Proc. 12th IEEE Int. Vacuum Electronics Conference (IVEC 2011), Bangalore, India, P2.22., 269-270.

[128] Gantenbein, G., Dammertz, G., Jelonnek, J., Losert, M., Samartsev, A. Schlaich, A., Scherer, T., Strauss, D., Thumm, M., Wagner, D., 2013, Operation of a step-frequency tunable gyrotron with a diamond Brewster angle output window. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 7A-2.

[129] Samartsev, A., Dammertz, G., Gantenbein, G., Jelonnek, J., Schlaich, A., Thumm, M., 2013, First operation of a D-band megawatt gyrotron with elliptically brazed diamond window. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo P1-61.

[130] Gantenbein, G., Samartsev, A., Aiello, G., Dammertz, G., Jelonnek, J., Losert, M., Schlaich, A., Scherer, T., Strauss, D., Thumm, M., Wagner, D., 2014, First operation of a step-frequency tunable 1 MW gyrotron with a diamond Brewster angle output window. IEEE Trans. on Electron Devices, 61, No. 6, 1806-1811.

[131] Samartsev, A., Avramidis, K.A., Gantenbein, G., Dammertz, G., Thumm, M., Jelonnek, J., 2015, Efficient frequency step-tunable megawatt-class D-band gyrotron. IEEE Trans. on Electron Devices, 62, No. 7, 2317-2332.

[132] Gantenbein, G., Samartsev, A., Avramidis, K.A., Dammertz, G., Thumm, M., Jelonnek, J., 2015, Efficient frequency step-tunable megawatt-class D-band gyrotron. 40th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, W2E-1.

[133] Kuftin, A.N., Bogdashov, A.A., Chirkov, A.V., Denisov, G.G., Lygin, V.K., Moiseev, M.A., Zapevalov, V.E., 2001, Development of frequency step tunable 105-170 GHz 1 MW gyrotron. Conf. Digest, 26th Int. Conf. on Infrared and Millimeter Waves, Toulouse, France, 5-230-5-233.

[134] Zapevalov, V.E., Bogdashov, A.A., Chirkov, A.V., Denisov, G.G., Kuftin, A.N., Lygin, M.A., Moiseev, M.A., 2002, Optimization of the frequency step tunable 105-170 GHz 1 MW gyrotron prototype. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 1-2.

[135] Zapevalov, V.E., Bogdashov, A.A., Denisov, G.G., Kuftin, A.N., Lygin, V.K., Moiseev, M.A., Chirkov, A.V., 2004, Development of a prototype of a 1-MW 105-156-GHz multi-frequency gyrotron. Radiophysics and Quantum Electronics, 47, 396-404.

[136] Popov, L.G., Agapova, M.V., Bogdashov, A.A., Denisov, G.G., Gnedenkov, A.Ph., Ilyin, V.I., Ilyin, V.N., Khmara, D.V., Kuftin, A.N., Litvak, A.G., Malygin, S.A., Malygin, V.I., Myasnikov, V.E., Nichiporenko, V.O., Pavelyev, A.B., Rischin, Yu.V., Shamanova, N.A., Solujanova, E.A., Tai, E.M., Usachev, S.V., Zapevalov, V.E., 2005, Status of multi-frequency 105-140 GHz/1 MW/10 s gyrotron and recent test results. Proc. 6th Int. Workshop on Strong Microwaves in

Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 119-124.

[137] Denisov, G.G., Litvak, A.G., Myasnikov, V.E., Tai, E.M., Zapevalov, V.E., Agapova, M.V., Chirkov, A.V., Kuftin, A.N., Malygin, S.A., Malygin, V.I., Nichiporenko, V.O., Pavel'ev, A.B., Parshin, V.V., Soluyanova, E.A., Ilin, V.I., Ilin, V.N., Vikharev, A.L., Usachev, S.V., Usov, V.G., 2008, Development in Russia of high power gyrotrons for plasma fusion installations, Proc. 9th IEEE Int. Vacuum Electronics Conference (IVEC 2008), Monterey, CA, USA, 26-27.

[138] Denisov, G.G., Litvak, A.G., Agapova, M.V., Myasnikov, V.E., Tai, E.M., Zapevalov, V.E., Chirkov, A.V., Kuftin, A.N., Malygin, S.A., Malygin, V.I., Nicniporenko, V.O., Kazansky, I.V., Kruglov, A.V., Rukavishikova, V.G., Knedenkov, A.F., Pavel'ev, A.B., Parsin, V.V., Popov, L.G., Sokolov, E.V., Soluyanova, E.A., Ilin, V.I., Ilin, V.N., Vikharev, A.L., Shamanova, N.A., Usachev, S.V., 2008, Multi-frequency gyrotrons for plasma fusion installations, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T2A1.1468.

[139] Litvak, A.G., 2008, High power gyrotrons: development and applications, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, R1P1.1734.

[140] Denisov, G.G., Litvak, A.G., Myasnikov, V.E., Tai, E.M., Zapevalov, V.E., 2008, Development in Russia of high-power gyrotrons for fusion. Nucl. Fusion, 48, 054007 (5pp).

[141] Denisov, G.G., Litvak, A.G., Myasnikov, V.E., Tai, E.M., Ilin, V.I., Zapevalov, E.V., 2008, Gyrotrons for fusion research. State of the art and progress trends, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Acad. of Sciences, Nizhny Novgorod, 2009, Vol. 1, pp. 15-26.

[142] Kazansky, I.V., Kruglov, A.V., Malygin, S.A., Orlov, V.B., Solujanova, E.A., Tai, E.M., Belousov, V.I., Chirkov, A.V., Denisov, G.G., Malygin, V.I., Pavelev, A.B., Sokolov, E.V., 2008, Step-tunable experimental gyrotrons at 75 GHz and 140 GHz ranges, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 1, pp. 100-102.

[143] Litvak, A.G., Denisov, G.G., Myasnikov, V.E., Tai, E.M., Azizov, E.A., Ilin, V.I., 2011, Development in Russia of megawatt power gyrotrons for fusion, J. of Infrared Milli Terahz Waves, 32, 337-342.

[144] Litvak, A.G., Denisov, G.G., Myasnikov, V.E., Tai, E.M., Sokolov, E.V., Ilin, V.I., 2012, Recent development results in Russia of megawatt power gyrotrons for plasma fusion installations. EPJ Web of Conferences, 32, 04003/1-7.

[145] Khvostenko, A.P., Denisov, G.G., Ilin, V.I., Khvostenko, P.P., Kochin, V.A., Malygin, V.I., Myasnikov, V.E., Popov, L.G., Soluyanova, E.A., Tai, E.M., Usachev, S.V., 2012, Test bench for ITER gyrotrons. Measurements of the RF power value during tests of the ITER-prototype gyrotrons. EPJ Web of Conferences, 32, 04021/1-6.

[146] Denisov, G.G., Litvak, A.G., Zapevalov, V.E., Myasnikov, V.E., Tai, E.M., Popov, L.G., Nichiporenko, V.O., Usachev, S.V., Soluyanova, E.A., Kazansky, I.V., Kruglov, A.V., Sokolov, E.V., Ilin, V.I., 2013, Recent results in development in Russia of megawatt power gyrotrons for fusion. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 6A-1.

[147] Litvak, A.G., Denisov, G.G., Myasnikov, V.E., Tai, E.M., Sokolov, E.V., Ilin, V.I., 2013, New results of megawatt power gyrotrons development. Proc. 38th Int. Conf. on Infrared, Millim. and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Tu1-4.

[148] Denisov, G.G., Litvak, A.G., Bakunin, V.L., Chirkov, A.V., Kuftin, A.N., Malygin, V.I., Novozhilova, Yu.V., Zapevalov, V.E., Tai, E.M., Myasnikov, V.E., Popov, L.G., Soluyanova, E.A., Agapova, M.V., Belov, Yu.N., Kazansky, I.V., Kruglov, A.V., Nichiporenko, V.O., Sokolov, E.V., Usachev, S.V., Roy, I.N., 2014, New results and new trends in development of

gyrotrons for fusion. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W3_D-25.4.

[149] Denisov, G.G., 2014, Development of gyrotrons for fusion – New results and new trends. Proc. 9th Int. Workshop “Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, pp. 7-8.

[150] Denisov, G.G., 2017, Development of gyro-devices at IAP/GYCOM. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, GI-1.

[151] Popov, L.G., Chirkov, A.V., Denisov, G.G., Litvak, A.G., Malygin, V.I., Zapevalov, V.E., Agapova, M.V., Belov, Yu.N., Kazansky, I.V., Kuzmin, A.V., Myasnikov, V.E., Nichiporenko, V.O., Sokolov, E.V., Soluyanova, E.A., Tai, E.M., Usachev, S.V., 2017, Super-high power gyrotrons for electron cyclotron plasma heating. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, GI-2.

[152] Denisov, G.G., 2017, New trends in gyrotron development. EPJ Web of Conferences, 149, 01001 (2pp).

[153] Golubev, S.V., Razin, S.V., Semenov, V.E., Smirnov, A.N., Vodopyanov, A.V., Zorin, V.G., 1999, Sources of soft X-rays and multicharged ions based on ECR discharge in heavy gases sustained by high-power gyrotron radiation. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 1, 347-355.

[154] Golubev, S.V., Luchin, V.I., Razin, S.V., Salaschenko, N.N., Smirnov, A.N., Vodopyanov, A.V., Zorin, V.G., 1999, Mirror-trapped plasma heated by powerful millimeter wave radiation as an ECR source of soft X-rays. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 1, 356-370.

[155] Bohanov, A.F., Golubev, S.V., Izotov, I.V., Razin, S.V., Sidorov, A.V., Skalyga, V.A., Vodopyanov, A.V., Zorin, V.G., 2005, ECR ion source with quasi-gasdynamic plasma confinement regime. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 2, 657-665.

[156] Vodopyanov, A.V., Golubev, S.V., Mansfeld, D.A., Nikolaev, A.G., Oks, E.M., Khizhnyak, V.I., Yushkov, G.Yu., 2007, Multiple ionization of vacuum-arc-generated metal ions in a magnetic trap heated by high-power microwave radiation. Techn. Phys. Letters, 33, 44-49.

[157] Ciavola, G., Gammino, S., Celona, L., 2008, ECR multicharged ion sources of new generation, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 2, pp. 442-453.

[158] Zorin, V.G., Bokhanov, A.F., Golubev, S.V., Izotov, I.V., Mansfeld, D.A., Razin, S.V., Sidorov, A.V., Skalyga, V.A., Vodopyanov, A.V., 2008, Gasdynamic ECR sources of multicharged ions, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 2, pp. 587-591.

[159] Zorin, V.G., Skalyga, V.A., Izotov, I.V., Razin, S.V., Sidorov, A.V., Lamy, T., Thuillier, T., 2011, ECR breakdown of heavy gases in open mirror trap. Transactions of Fusion Science and Technology, 59, 140-143.

[160] Yushkov, G.Yu., Savkin, K.P, Nikolaev, A.G., Oks, E.M., Vodopyanov, A.V., Izotov, I.V., Mansfeld, D.A., 2011, Formation of multicharged metal ions in vacuum arc plasma heated by gyrotron radiation. Plasma Science and Technology, 13, No. 5, 596-599.

[161] Vodopyanov, A.V., Izotov, I.V., Mansfeld, D.A., Yushkov, G. Yu., 2012, Multicharged ion source based on Penning-type discharge with electron cyclotron resonance heating by millimeter waves. Review of Scientific Instruments, 83, 02A325 (3pp).

[162] Higurashi, Y., Ohnishi, J., Nakagawa, T., Haba, H., Tamura, M., Aihara, T., Fujimaki, M., Komiyama, M., Uchiyama, A., Kamigaito, O., 2012, Production of a highly charged uranium ion beam with RIKEN superconducting electron cyclotron resonance ion source. Review of Scientific Instruments, 83, 02A333 (3 pp).

[163] Chkhalo, N.I., Golubev, S.V., Mansfeld, D., Salashchenko, N.N., Sjmaenok, L.A., Vodopyanov, A.V., 2012, Source for extreme ultraviolet lithography based on plasma sustained by millimeter-wave gyrotron radiation. J. Micro/Nanolith. MEMS MOEMS, 11, 021123 (7 pp).

[164] Yushkov, G.Yu., Vodopyanov, A.V., Nikolaev, A.G., Izotov, I.V., Savkin, K.P., Golubev, S.V., Oks, E.M., 2013, Gyrotron microwave heating of vacuum arc plasma for high-charge-state metal ion beam generation. IEEE Trans. on Plasma Science, 41, No. 8, 2081-2086.

[165] Glyavin, M.Yu., Golubev, S.V., Izotov, I.V., Litvak, A.G., Luchinin, A.G., Razin, S.V., Sidorov, A.V., Skalyga, V.A., Vodopyanov, A.V., 2014, A point-like source of extreme ultraviolet radiation based on a discharge in a non-uniform gas flow, sustained by powerful gyrotron radiation of terahertz frequency band. Applied Physics Letters, 105, 174101 (4pp).

[166] Glyavin, M.Yu., Golubev, S.V., Sidorov, A.V., Razin, S.V., Fokin, A.P., Luchinin, A.G., Litvak, A.G., Morozkin, M.V., Vodopyanov, A.V., Semenov, V.E., Rakova, E.I., Nusinovich, G.S., Tsvetkov, A.I., 2015, Experimental investigation of powerful THz gyrotrons for initiation of localized gas discharge. 40th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, WS-5.

[167] Skalyga, V., Izotov, I., Golubev, S., Vodopyanov, A., Tarvainen, O., 2016, First experiments with gasdynamic ion source in CW mode. Review of Scientific Instruments, 87, 02A715 (3pp).

[168] Skalyga, V., Izotov, I., Golubev, S., Sidorov, A., Razin, S., Vodopyanov, A., Tarvainen, O., Koivisto, H., Kalvas, T., 2016, New progress of high current gasdynamic ion source (invited). Review of Scientific Instruments, 87, 02A716 (4pp).

[169] Skalyga, V.A., Izotov, I.V., Sidorov, A.V., Golubev, S.V., Razin, S.V., 2017, Study of hydrogen ECR plasma in a simple mirror magnetic trap heated by 75 GHz pulsed gyrotron radiation. Review of Scientific Instruments, 88, 033503 (5pp).

[170] Sidorov, A.V., Zorin, V.G., Izotov, I.V., Razin, S.V., Skalyga, V.A., 2010, Generation of high-current beam of multiply charged ions from a dense plasma produced by high-power millimeter-wave gyrotron radiation under ECR conditions. Technical Physics, 55, No. 10, 1540-1542.

[171] Sun, L., Zhao, H.W., Guo, J.W., 2017, Gyrotron frequency ECRIS development and future challenges. EPJ Web of Conferences, 149, 02005 (2pp).

[172] Tsvetkov, A.I., Eremeev, A.G., Kholoptsev, V.V., Shmelev, M.Yu., Plotnikov, Yu.V., Bykov, Y.V., Kopelovich, E.A., Novikov, A.Yu., Troitskiy, M.M., Kuznetsov, M.V. Zhurin, K.A., Fokin, A.P., Morozkin, M.V., Glyavin, M.Yu., Bakulin, M.I., Denisov, G.G., Soluyanova, E.A., Tai, E.M., 2017, 45 GHz/20 kW gyrotron-based setup with automated output power control for ECR ion source. EPJ Web of Conferences, 149, 04032 (2pp).

[173] Glyavin, M., Tsvetkov, A., Eremeev, A., Kholoptsev, V., Bykov, Y., Denisov, G., Kopelovich, E., Tai, E.M., 2017, 45 GHz/20 kW gyrotron-based microwave generator for ECR ion source. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RD36.

[174] Denisov, G.G., Glyavin, M.Yu., Tsvetkov, A.I., Eremeev, A.G., Kholoptsev, V.V., Plotnikov, I.V., Bykov, Y.V., Orlov, V.B., Morozkin, M.V., Shmelev, M.Yu., Kopelovich, A.A., Troitskiy, M.M., Kuznetsov, M.V., Zhurin, K.A., Novikov, A.Yu., Bakulin, M.I., Sobolev, D.I., Tai, E.M., Soluyanova, E.A., Sokolov, E.V., 2018, A 45 GHz/20 kW gyrotron-based microwave setup for

the fourth-generation ECR ion sources. IEEE Trans. on Electron Devices, 2018, 65, No. 9, 3963-3969.

[175] Lapin, R.L., Skalyga, V.A., Izotov, I.V., Golubev, S.V., Razin, S.V., Bokhanov, A.F., Kazakov, M.Yu., Shaposhnikov, R.A., Kiseleva, S.V., Tarvainen, O., 2020, Efficiency investigation of a negative hydrogen ion beam production with the use of the gasdynamic ECR plasma. J. Phys.: Conf. Ser., 1647, 012012 (4pp).

[176] Zhao, H.W., Sun, L.T., Guo, J.W., Zhang, W.H., Lu, W., Wu, W., Wu, B.M., Sabbi, G., Juchno, M., Hafalia, A., Ravaioli, E., Xie, D.Z., 2018, Superconducting ECR ion source: From 24-28 GHz SECRAL to 45 GHz fourth generation ECR. Review of Scientific Instruments, 89, No. 5, 052301 (10pp).

[177] Flyagin, V.A., Kuftin, A.N., Luchinin, A.G., Nusinovich, G.S., Pankratova, T.B., Zapevalov, V.E., 1989, Gyrotrons for electron cyclotron heating and active plasma diagnostics. Proc. Joint IAEA Techn. Committee Meeting on ECE and ECRH (EC-7 Joint Workshop), Hefei, P.R. China, 355-372.

[178] Flyagin, V.A., Luchinin, A.G., Nusinovich, G.S., 1983, Submillimeter-wave gyrotrons: theory and experiment. Int. J. Infrared and Millimeter Waves, 4, 629-637.

[179] Glyavin, M.Yu., Luchinin, A.G., 2007, A terahertz gyrotron with pulsed magnetic field, Radiophysics and Quantum Electronics, 50, 755-761.

[180] Glyavin, M.Yu., Luchinin, A.G., Golubiatnikov, G.Yu., 2008, Generation of 1.5-kW, 1-THz coherent radiation from a gyrotron with a pulsed magnetic field, Physical Review Letters, 100, 015101(3pp).

[181] Glyavin, M.Yu., Luchinin, A.G., 2008, 1.3 THz gyrotron with a pulsed magnet, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 1, pp. 108-116.

[182] Glyavin, M.Yu., Luchinin, A.G., 2009, Powerful terahertz gyrotrons based on pulsed magnets. Terahertz Science and Technology, 2, 150-155.

[183] Bratman, V., Glyavin, M., Idehara, T., Kalynov, Y., Luchinin, A., Manuilov, V., Mitsudo, S., Ogawa, I., Saito, T., Tatematsu, Y., Zapevalov, V., 2009, Review of subterahertz and terahertz gyrodevices at IAP RAS and FIR FU, IEEE Trans. on Plasma Science, 37, 36-43.

[184] Bratman, V.L., Kalynov, Yu.K., Manuilov, V.N., 2009, Large-orbit gyrotron operation in the terahertz frequency range, Physical Review Letters, 102, No. 24, 245101 (4pp).

[185] Bratman, V.L., Glyavin, M.Yu., Kalynov, Yu.K., Litvak, A.G., Luchinin, A.G., Savilov, A.V., Zapevalov, V.E., 2011, Terahertz gyrotrons at IAP RAS: Status and new designs, J. of Infrared Milli Terahz Waves, 32, 371-379.

[186] Glyavin, M.Yu., Luchinin, A.G., 2011, High power pulsed terahertz gyrotrons, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 59-60.

[187] Bratman, V.L., Bogdashov, A.A., Denisov, G.G., Glyavin, M.Yu., Kalynov, Yu.K., Luchinin, A.G., Manuilov, V.N., Zapevalov, V.E., Zavolsky, N.A., Zorin, V.G., 2012, Gyrotron development for high power THz technologies at IAP RAS. J. Infrared Milli Terahz Waves, 33, 715-723.

[188] Glyavin, M.Yu., Denisov, G.G., Zapevalov, V.E., Kuftin, A.N., Luchinin, A.G., Manuilov, V.N., Morozkin, M.V., Sedov, A.S., Chirkov, A.V., 2014, Terahertz gyrotrons: State of the art and prospects. J. Communications Technology and Electronics, 59, No. 8, 792-797.

[189] Glyavin, M.Yu., 2017, Development and applications of THz gyrotrons. EPJ Web of Conferences, 149, 01008 (2pp).

[190] Glyavin, M., Denisov, G., 2017, Development of high power THz band gyrotrons and their applications in physical research. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RC2.1.

[191] Glyavin, M.Yu., Denisov, G.G., Khazanov, E.A., 2018, From millimeter to microns – IAP RAS powerful sources for various applications. EPJ Web of Conferences, 195, 00001 (2pp).

[192] Glyavin, M., Denisov, G., 2018, Terahertz gyrotrons with unique parameters. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, We-A2-4-1.

[193] Denisov, G.G., Glyavin, M.Y., Fedotov, A.E., Zotova, I.V., 2020, Theoretical and experimental investigations of terahertz-range gyrotrons with frequency and spectrum control. Journal of Infrared, Millimeter, and Terahertz Waves, 41, No. 9, 1131-1143.

[194] Idehara, T., Tatsukawa, T., Ogawa, I., Shimizu, Y., Nishida, N., Yoshida, K., 1996, Development and applications of submillimeter wave gyrotrons. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 634-659.

[195] Ogawa, I., Iwata, M., Idehara, T., Kawahata, K., Iguchi, H., Ejiri, A., 1997, Plasma scattering measurement using a submillimeter wave gyrotron (Gyrotron FUII) as a power source. Fusion Engineering and Design, 34-35, 455-458.

[196] Shimizu, Y., Ichikawa, K., Shibutani, K., Karuhashi, K., Tatsukawa, T., Idehara, T., Ogawa, I., Okazaki, Y., Okamoto, T., 1997, Submillimetre wave gyrotron (Gyrotron FU IV) for plasma diagnostics. Fusion Engineering and Design, 34-35, 459-462.

[197] Idehara, T., Ogawa, I., Mitsudo, S., Sabchevski, S., Kitai, A., Kitai, K., 2001, Development and applications of submillimeter wave gyrotrons (FU Series). Proc. 9th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 165, 177-182.

[198] Idehara, T., Kamada, M., Tsuchiya, H., Hayashi, T., Agusu, La, Mitsudo, S., Ogawa, I., Manuilov, V.N., Naito, K., Yuyama, T., Jiang, W., Yatsui, K., 2005, Development of THz gyrotrons in FIR FU. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 141-149.

[199] Idehara, T., Saito, T., Ogawa, I., Mitsudo, S., Tatematsu, Y., 2008, THz gyrotrons – FU CW series for high power THz technologies, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, M2A3.1267.

[200] Notake, T., Saito, T., Tatematsu, Y., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, M., Fujii, A., Agusu, L., Ogawa, I., Idehara, T., 2008, Subterahertz gyrotron developments for collective Thomson scattering in LHD. Review of Scientific Instr., 79, 10E732-1-3.

[201] Idehara, T., Ogawa, I., Mitsudo, S., Tatematsu, Y., Saito, T., 2008, Development and applications of THz gyrotrons, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 1, pp. 40-46.

[202] Idehara, T., Ogawa, I., Mitsudo, S., Tatematsu, Y., Furuya, T., Saito, T., 2009, High power THz technologies using gyrotrons as radiation sources, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, W3D01.0047.

[203] Notake, T., Saito, T., Tatematsu, Y., Fujii, A., Ogasawara, S., La Augusu, Ogawa, I., Idehara, T., 2009, Development of a novel high power sub-THz second harmonic gyrotron, Physical Review Letters, 225002-1-4.

[204] Saito, T., Notake, T., Tatematsu, Y., Fujii, A., Ogasawara, S., Agusu, L., Idehara, T., Manuilov, V.N., 2009, Generation of high power sub terahertz radiation from a gyrotron at second harmonic resonance, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R4D05.0089.

[205] Saito, T., Tatematsu, Y., Ogasawara, S., Yamada, N., Fujii, A., Idehara, T., Manuilov, V.N., 2010, Development of high power sub terahertz gyrotrons for application to CTS measurement, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Th-E1.5.

[206] Idehara, T., Horii, F., Fujii, Y., Ogawa, I., Saito, T., Fujiwara, T., Suehara, T., Dupree, R., 2011, High power THz technologies opened by high power radiation sources – Gyrotron FU CW series, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, Invited S1, pp. 61-62.

[207] Saito, T., Tatematsu, Y., Yamada, N., Ogasawara, S., Ikeda, R., Ogawa, I., Idehara, T., Manuilov, V.N., 2011, Development of high power gyrotrons in the sub terahertz region for application to CTS measurement, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 65-66.

[208] Tatematsu, Y., Yamaguchi, Y., Idehara, T., Ozeki, T., Ikeda, R., Kanemaki, T., Ogawa, I., Saito, T., 2012, Development of a kW level-200 GHz gyrotron FU CW GI with an internal quasi-optical mode converter. J. Infrared Milli Terahz Waves, 33, 292-305.

[209] Saito, T., Ogasawara, S., Yamada, N., Ikeuchi, S., Tatematsu, Y., Ikeda, R., Ogawa, I., Manuilov, V.N., 2012, New power records of sub-terahertz gyrotron with second-harmonic oscillation. Plasma and Fusion Research: Rapid Communications, 7, 126003-1 (3 pages).

[210] Saito, T., Tatematsu, Y., Yamaguchi, Y., Ikeuchi, S., Ogasawara, S., Yamada, N., Ikeda, R., Ogawa, I., Idehara, T., 2012, Observation of dynamic interactions between fundamental and second-harmonic modes in a high-power sub-terahertz gyrotron operating in regimes of soft and hard self-excitation. Physical Review Letters, 109, 155001-1 (5 pp).

[211] Saito, T., Yamada, N., Ikeuti, S., Ogasawara, S., Tatematsu, Y., Ikeda, R., Ogawa, I., Idehara, T., Manuilov, V.N., Shimozuma, T., Kubo, S., Nishiura, M., Tanaka, K., Kawahata, K., 2012, Generation of high power sub-terahertz radiation from a gyrotron with second harmonic oscillation. Physics of Plasmas, 19, 063106 (9 pp).

[212] Idehara, T., Sabchevski, S.P., 2012, Development and applications of high-frequency gyrotrons in FIR FU covering the sub-THz to THz range. J. Infrared Milli Terahz Waves, 33, 667-694.

[213] Idehara, T., Mudiganti, J.C., Agusu, L., Kanemaki, T., Ogawa, I., Fujiwara, T., Matsuki, Y., Ueda, K., 2012, Development of a compact sub-THz gyrotron FU CW CI for application to high power THz technologies. J. Infrared Milli Terahz Waves, 33, 724-744.

[214] Saito, T., Yamada, N., Ikeuchi, S., Ogasawara, S., Yamaguchi, Y., Tatetmatsu, Y., Ikeda, R., Ogawa, I., 2012, Mode competition and cooperation in high power sub-THz gyrotrons, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Tue-A-3-4.

[215] Ikeda, R., Tatematsu, Y., Idehara, T., Yamaguchi, Y., Ogawa, I., Saito, T., 2012, Development of a table-top 200 GHz gyrotron FU CW CII with an internal mode converter, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Mon-C-3-5.

[216] Yamaguchi, Y., Saito, T., Tatematsu, Y., Ikeuchi, S., Yamada, N., Ikeda, R., Ogawa, I., Idehara, T., 2012, Development of a high-power 295 GHz fundamental-harmonic gyrotron, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Tue-A-3-5.

[217] Saito, T., Yamaguchi, Y., Ikeuchi, S., Kasa, J., Tatemetsu, Y., Ikeda, R., Ogawa, I., Idehara, T., Kubo, S., Shimozuma, T., Nishiura, M., Tanaka, K., 2013, Experimant for over 200 kW oscillation of a 295 GHz pulse gyrotron. Proc. 38th Int. Conf. on Infrared, Milli-meter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo5-3.

[218] Tatematsu, Y., Yamaguchi, Y., Idehara, T., Kawase, T., Ichioka, R., Ogawa, I., Saito, T., Fujiwara, T., 2014, Development of second harmonic gyrotrons, Gyrotron FU CW GII and

Gyrotron FU CW GIII, equipped with internal mode converters. J Infrared Milli Terahz Waves, 35, No. 2, 169-178.
[219] Tatematsu, Y., Yamaguchi, Y., Idehara, T., Kawase, T., Ogawa, I., Saito, T., Fujiwara, T., 2014, Characteristics of the mode converter of Gyrotron FU CW GII radiating Gaussian beams in both the fundamental and second harmonic frequency bands. J Infrared Milli Terahz Waves, 35, No. 6-7, 517-524.
[220] Tatematsu, Y., Yamaguchi, Y., Kawase, T., Ichioka, R., Ogawa, I., Idehara, T., 2014, Analysis of oscillation characteristics and optimal conditions for high power operation of Gyrotron FU CW GIII. Physics of Plasmas, 21, 083113 (6pp).
[221] Tatematsu, Y., Yamaguchi, Y., Ichioka, R., Ogawa, I., Idehara, T., Saito, T., 2014, Development of a multiple-frequency gyrotron, Gyrotron FU CW GV. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W4_D-25.9.
[222] Saito, T., Yamaguchi, Y., Tatematsu, Y., Kasa, J., Kotera, M., Ikeuchi, S., Idehara, T., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, M., 2014, High power oscillation experiment of a prototype gyrotron for 300 GHz band collective Thomson scattering diagnostics in LHD. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W4_D-25.17.
[223] Yamaguchi, Y., Saito, T., Tatematsu, Y., Ikeuchi, S., Manuilov, V.N., Kasa, J., Kotera, M., Idehara, T., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, M., 2015, High-power pulsed gyrotron for 300 GHz-band collective Thomson scattering diagnostics in the Large Helical Device. Nucl. Fusion, 55, 013002 (10pp).
Yamaguchi, Y., Kasa, J., Saito, T., Tatematsu, Y., Kotera, M., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, 2015, High power 303 GHz gyrotron for CTS in LHD. J. Instrumentation, 10, C10002 (10pp).
[224] Tatematsu, Y., Yamaguchi, Y., Ichioka, R., Kotera, M., Saito, T., Idehara, T., 2015, Development of the multifrequency gyrotron FU CW GV with Gaussian beam output. J Infrared Milli Terahz Waves, 36, 697-708.
[225] Saito, T., Kasa, J., Yamaguchi, Y., Tatematsu, Y., Kotera, M., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, M., 2015, Development of a high power 300 GHz band gyrotron for practical use in collective Thomson scattering diagnostics in LHD. 40th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, H1E-2.
[226] Saito, T., Yamaguchi, Y., Tatematsu, Y., Hirobe, T., Fukunari, M., Kasa, J., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, M., 2016, High power oscillation of 300 GHz band gyrotron for practical use in Collective Thomson Scattering in LHD. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 25-30, 2016, Copenhagen, Denmark, H4B.1.
[227] Saito, T., Yamaguchi, Y., Fukunari, M., Tatemetsu, Y., Hirobe, T., Shinbayashi, R., Tanaka, S., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, M., 2017, Design consideration and oscillation characteristics of high-power 300 GHz gyrotron. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RA2.1.
Saito, T., Tanaka, S., Shinbayashi, R., Yamaguchi, Y., Fukunari, M., Tatemetsu, Y., Melnikova, M.M., Ryskin, N.M., 2019, Observation of multi-peak frequency spectrum in a high power sub-THz gyrotron. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Tu-PM1-1-4.
[228] Idehara, T., I. Ogawa, I., Wagner, D., Thumm, M., Kosuga, K., Sabchevski, S.P., 2018, High purity mode CW gyrotron covering the subterahertz to terahertz range using a 20 T superconducting magnet. IEEE Trans. on Electron Devices, 65, No. 8, 3486-3491.

[229] Idehara, T., Sabchevski, S.P., 2018, Development and application of gyrotrons at FIR UF. IEEE Trans. on Plasma Science, 46, No. 7, 2452-2459.

[230] Tatematsu, Y., 2018, Recent progress in development and application of sub-THz gyrotrons in University of Fukui. EPJ Web of Conferences, 195, 01018 (2pp).

[231] Tatemetsu, Y., Takayama, K., Maeda, Y., Ueyama, T., Ogura, T., Fukunari, M., Yamaguchi, Y., Saito, T., 2018, Development of a second harmonic multi-frequency gyrotron with Gaussian beam output. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, Tu-P2-R1-5.

Tatematsu, Y., Takayama, K., Maeda, Y., Ueyama, T., Ogura, T., Nakagawa, K., Kamiya, R., Fukunari, M., Yamaguchi Y., Saito, T., 2019, Development of a second harmonic multi-frequency Gaussian beam output Gyrotron FU CW GVII. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-PM2-1-1.

[232] Bajaj, V.S., Farrar, C.T., Hornstein, M.K., Mastovsky, I., Vieregg, J., Bryant, J., Eléna, B., Kreischer, K.E., Temkin, R.J., Griffin, R.G., 2003, Dynamic nuclear polarization at 9 T using a novel 250 GHz gyrotron microwave source. J. of Magnetic Resonance, 160, 85-90.

[233] Hornstein, M.K., Bajaj, V.S., Griffin, R.G., Kreischer, K.E., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2004, Harmonic results of a 460 GHz gyrotron. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 26-27.

[234] Hornstein, M.K., Bajaj, V.S., Griffin, R.G., Kreischer, K.E., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Woskov, P.P., 2004, CW results of a 460 GHz second harmonic gyrotron oscillator – for sensitivity enhanced NMR –. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 147-148.

[235] Hornstein, M.K., Bajaj, V.S., Kreischer, K.E., Griffin, R.G., Temkin, R.J., 2005, CW second harmonic results at 460 GHz of a gyrotron oscillator – for sensitivity enhanced NMR –. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 437-438.

[236] Hornstein, M.K., Bajaj, V.S., Griffin, R.G., Kreischer, K.E., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2005, Second harmonic operation at 460 GHz and broadband continuous frequency tuning of a gyrotron oscillator. IEEE Trans. on Electron Devices, 52, 798-807.

[237] Han, S.T., Joye, C.D., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Woskov, P.P., 2006, Stable operation of a 0.46 THz continuous wave gyrotron oscillator. Proc. Int. Vacuum Electronics Conference and Int. Vacuum Electron Sources (IVEC/IVESC 2006), Monterey, California, USA, 539-540.

[238] Joye, C.D., Griffin, R.G., Hornstein, M.K., Hu, K.N., Kreischer, K.E., Rosay, M., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Woskov, P.P., 2006, Operational characteristics of a 14-W 140-GHz gyrotron for dynamic nuclear polarization. IEEE Trans. on Plasma Science, 34, 518-523.

[239] Hornstein, M.K., Bajaj, V.S., Griffin, R.G., Temkin, R.J., 2006, Continuous-wave operation of a 460-GHz second harmonic gyrotron oscillator. IEEE Trans. on Plasma Science, 34, 524-533.

[240] Hornstein, M.K., Bajaj, V.S., Griffin, R.G., Temkin, R.J., 2007, Efficient low-voltage operation of a CW gyrotron oscillator at 233 GHz. IEEE Trans. on Plasma Science, 35, 27-30.

[241] Han, S.T., Griffin, R.G., Hu, K.N., Joo, C.-G., Joye, C.D., Sirigiri, J.R., Temkin, R.J., Torrezan, A.C., Woskov, P.O., 2007, Spectral characteristics of a 140 GHz long-pulsed gyrotron, IEEE Trans. on Plasma Science, 35, 559-564.

[242] Bajaj, V.S., Hornstein, M.K., Kreischer, K.E., Sirigiri, J.R., Woskov, P.O., Mark-Jurkauskas, M.L., Herzfeld, J., Temkin, R.J., Griffin, R.G., 2007, 250 GHz CW gyrotron oscillator for dynamic nuclear polarization in biological solid state NMR, J. of Magnetic Resonance, 189, 251-279.

[243] Torrezan, A.C., Han, S.T., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2008, CW operation of a tunable 330/460 GHz gyrotron for enhanced nuclear magnetic resonance, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T5D33.1271.

[244] Torrezan, A.C., Han, S.-T., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Barnes, A.B., Griffin, R.G., 2010, Continuous-wave operation of a frequency-tunable 460-GHz second-harmonic gyrotron for enhanced nuclear magnetic resonance, IEEE Trans. on Plasma Science, 38, 1150-1159.

[245] Torrezan, A.C., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2010, Operation of a tunable second-haramonic 330 GHz CW gyrotron, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 199-200.

[246] Griffin, R.G., 2011, Dynamic nuclear polarization at 9T using a novel 250 GHz gyrotron microwave source. Journal of Magnetic Resonance, 213, 410-412.

[247] Temkin, R., Barnes, A., Griffin, R., Jawla, S., Mastovsky, I., Nanni, E., Shapiro, M., Torrezan, A., Woskov, P., 2011, Recent progress at MIT on THz gyrotron oscillators for DNP/NMR, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, W3A.1.

[248] Barnes, A.B., Markhasin, E., Daviso, E., Michaelis, V.K., Nanni, E.A., Jawla, S.K., Mena, E.L., DeRocher, R., Thakkar, A., Woskov, P.P., Herzfeld., J., Temkin R.J., Griffin, R.G., 2012, Dynamic nuclear polarization at 700 MHz/460 GHz. J. of Magnetic Res., 224, 1-7.

[249] Barnes, A.B., Nanni, E.A., Herzfeld, J., Griffin, R.G., Temkin, R.J., 2012, A 250 GHz gyrotron with a 3 GHz tuning bandwidth for dynamic nuclear polarization. J. of Magnetic Resonance, 221, 147-153.

[250] Barnes, A.B., Nanni, E.A., Jawla, S., Ni, Q.Z., Herzfeld, J., Griffin, R.G., Temkin, R.J., 2012, A novel high power 3 GHz tunable 250 GHz gyrotron for dynamic nuclear polarization, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 329-330.

[251] Jawla, S., Ni, Q.Z., Barnes, A., Guss, W., Daviso, E., Herzfeld, J., Griffin, R., Temkin, R., 2013, Continuously tunable 250 GHz gyrotron with a double disk window for DNP-NMR spectroscopy. J. Infrared Milli Terahz Waves, 34, 42-52.

[252] Temkin, R., 2014, THz gyrotrons and their applications. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, P-25.1.

[253] Jawla, S.K., Guss, W.C., Shapiro, M.A., Temkin, R.J., 2014, Design and experimental results from a 527 GHz gyrotron for DNP-NMR spectroscopy. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W4_D-25.12.

[254] Jawla, S., Resse, M., George, C., Yang, C., Shapiro, M.m Griffin, R., Temkin, R., 2016, 330 GHz / 500-MHz dynamic nuclear polarization – NMR spectrometer. 17th IEEE International Vacuum Electronics Conference (IVEC 2016), April 19-21, 2016, Monterey, CA, USA, Invited Keynote, P4.10.

[255] Griffin, R.G., Swager, T.M., Temkin, R.J., 2019, High frequency dynamic nuclear polarization: New directions for the 21st century. Journal of Magnetic Resonance, 306, 128-133.

[256] Jawla, S.K., Griffin, R.G., Mastovsky, I.A., Shapiro, M.A., Temkin, R.J., 2020, Second harmonic 527-GHz gyrotron for DNP-NMR: Design and Experimental Results. IEEE Trans. on Electron Devices, 67, No. 1, 328-334.

[257] Jawla, S., Mastovsky, I., Shapiro, M.A., Temkin, R., 2019, Second Harmonic 527 GHz gyrotron for DNP-NMR. Proc. 20th Int. Vacuum Electronics Conference (IVEC 2019), Busan, Korea, 4.4.

[258] Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Felch, K., Rosay, M., Tometich, L., 2009, Demonstration of a 263 GHz gyrotron for dynamic nuclear polarization, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, W3D02.0122.

[259] Rosay, M., Tometich, L., Pawsey, S., Bader, R., Schauwecker, R., Blank, M., Borchard, P.M., Cauffman, S.R., Felch, K.L., Weber, R.T., Temkin, R.J., Griffin, R.G., Maas, W.E., 2010, Solid-state dynamic nuclear polarization at 263 GHz: Spectrometer design and experimental results, Phys. Chem. Chem. Phys., 12, 5850-5860.

[260] Blank, M., Borchard, P., Cauffman, S., Felch, K., Rosay, M., Tometich, L., 2012, High-frequency CW gyrotrons for NMR/DNP applications, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 327-328.

[261] Booske, J.H., Dobbs, R.J., Joye, C.D., Kory, C.L., Neil, G.R., Park, G.S., Park, J., Temkin, R.J., 2011, Vacuum electronic high power terahertz sources, IEEE Trans. on Terahertz Science and Technology, 1, 54-75.

[262] Nusinovich, G., 2011, Terahertz gyrotrons, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, W1.1.

[263] Felch, K., Blanck, M., Borchard, P., Cauffman, S., Rosay, M., Tometich, L., 2013, First tests of a 527 GHz gyrotron for dynamic nuclear polarization. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 1B-1.

[264] Blank, M., High-frequency gyrotrons for DNP-enhanced NMR applications. 2014, Proc. 15th IEEE Int. Vacuum Electronics Conference (IVEC 2014), Monterey, CA, USA, PL4.
Blank, M., Borchard, P., Cauffman, S., Felch, K., Rosay, M., Tometich, L., 2014, Development of high-frequency gyrotrons for DNP/NMR applications. Proc. 9th Int. Workshop “Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, pp. 13-14.

[265] Rosay, M., Blank, M., Engelke, F., 2016, Instrumentation for solid-state dynamic nuclear polarization with magic angle spinning NMR. J. of Magnetic Resonance, 262, 88-98.

[266] Blank, M., 2018, Demonstration of a 593 GHz gyrotron for DNP. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, We-A2-4-2.

[267] Blank, M., Felch, K.L., 2018, Millimeter-wave sources for DNP-NMR. eMagRes, 7, 155-166.

[268] Blank, M., Borchard, P., Cauffman, S., Felch, K., 2020, Development of high-frequency gyrotrons for spectroscopy and plasma heating applications. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Gyrotrons 2.1.

[269] Scott, F.J., Saliba, E.P., Albert, B.J., Alaniva, N., Sesti, E.L., Gao, C., Golota, N.C., Choi, E.J., Jagtap, A.P., Wittmann, J.J., Eckardt, M., Harneit, W.H., Corzilius, B., Sigurdsson, S.T., Barnes, A.B., 2018, Frequency-agile gyrotron for electron decoupling and pulsed dynamic nuclear polarization. Journal of Magnetic Resonance, 289, 45-54.

[270] Gao, C., Alaniva, N., Saliba, E.P., Sesti, E.L., Judge, P.T., Scott, F.J., Halbritter, T., Sigurdsson, S.T., Barnes, A.B., 2019, Frequency-chirped dynamic nuclear polarization with magic angle spinning using a frequency-agile gyrotron. J. of Magnetic Resonance, 308, 106586 (10pp).

[271] Judge, P.T., Sesti, E.L., Alaniva, N., Saliba, E.P., Price, L.E., Gao, C., Halbritter, T.,Sigurdsson, S.T., Kyei, G.B., Barnes, A.B., 2020, Characterization of frequency-chirped dynamic nuclear polarization in rotating solids. J. of Magnetic Resonance, 313, 57-63.

[272] Idehara, T., Ogawa, I., Agusu, La., Kanemaki, T., Mitsudo, S., Saito, T., Fujiwara, T., Takahashi, H., 2007, Development of 394.6 GHz CW gyrotron (gyrotron FU CW II) for DNP/Proton-NMR at 600 MHz. Int. J. Infrared and Millimeter Waves, 28, 433-442.

[273] Agusu, La, Idehara, T., Ogawa, I., Saito, T., Kanemaki, T., Takahashi, H., Fujiwara, T., 2007, Detailed consideration of experimental results of gyrotron FU CW II developed as a radiation source for DNP-NMR spectroscopy. Int. J. Infrared and Millimeter Waves, 28, 499-511.

[274] Idehara, T. Saito, T., Ogawa, I., Mitsudo, S., Tatematsu, Y., La Agusu, Mori, H., Kobayashi, S., 2008, Development of terahertz FU CW gyrotron series for DNP, Appl. Magn. Resonance, 34, 265-275.

[275] Idehara, T., Agusu, L., Ogawa, I., Kobayashi, S., Saito, T., Dupree, R., Smith, M.E., 2008, Development of gyrotron FU CW IIA for 600 MHz and 300 MHz DNP-NMR experiments at the University of Warwick, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T5D23.1185.

[276] Kosuga, K., Idehara, T., Ogawa, I., Saito, T., Agusu, L., Kanemaki, T., Smith, M.E., Dupree, R., 2009, Development of Gyrotron FU CW VII for 600 and 300 MHz DNP-NMR, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M5E55.0235.

[277] Ogawa, I., Idehara, T., Kobayashi, S., Changb, T.H., Horii, F., Saito, T., 2009, Development of continuously frequency tunable gyrotron and its application to 200 MHz DNP-NMR spectroscopy as a radiation source, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, W3D03.0309.

[278] Idehara, T., Kosuga, K., Agusu, La, Ikeda, R., Ogawa, I., Saito, T., Matsuki, Y., Ueda, K., Fujiwara, T., 2010, Continuously frequency tunable high power sub-THz radiation source – gyrotron FU CW VI for 600 MHz DNP-NMR spectroscopy, J. Infrared Milli Terahz Waves, 31, 775-790.

[279] Idehara, T., Kosuga, K., La Agusu, Ogawa, I., Dupree, R., Takahashi, H., Mark, M.E., 2010, Gyrotrons FU FU CW VII for 600 MHz and 300 MHz DNP-NMR spectroscopy, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, We-P13.

[280] Mitsudo, S., Nakagawa, N., Ohashi, Y., Katayama, T., Tatematsu, Y., Ogawa, I., Idehara, T., Saito, T., 2010, Development of a sub-THz CW gyrotron for the millimeter wave pulsed ESR spectrometer, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Th-P.53.

[281] Idehara, T., Saito, T., Ogawa, I., Mitsudo, S., Tatematsu, Y., Ikeda, R., Mudiganti, J., Kosuga, K., 2010, THz gyrotron FU CW series for high power THz technologies, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Th-E1.1.

[282] Ikeda, R., Idehara, T., Ogawa, I., Kosuga, K., Saito, T., Matsuki, Y., Ueda, K., Fujiwara, T., Chang, T.H., 2010, Development of continuously frequency tunable gyrotrons FU, CW VI and FU CW VI A for application to 600 MHz DNP-NMR spectroscopy, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Th-E1.3.

[283] Matsuki, Y., Takahashi, H., Ueda, K., Idehara, T., Ogawa, I., Toda, M., Akutsu, H., Fujiwara, T., 2010, Dynamic nuclear polarization experiments at 14.1 T for solid-state NMR, Phys. Chem. Chem. Phys., 12, 5799-5803.

[284] Matsuki, Y., Ueda, K., Idehara, T., Ikeda, R., Ogawa, I., Nakamura, S., Toda, M., Anai, T., Fujiwara, T., 2012, Helium-cooling and –spinning dynamic nuclear polarization for sensitivity-enhanced solid-state NMR at 14 T and 30 K. J. of Magnetic Resonance, 225, 1-9.

[285] Matsuki, Y., Ueda, K., Idehara, T., Ikeda, R., Kosuga, K., Ogawa, I., Nakamura, S., Toda, M., Anai, T., Fujiwara, T., 2012, Application of continuously frequency-tunable 0.4 THz gyrotron to dynamic nuclear polarization for 600 MHz solid-state NMR. J. Infrared Milli Terahz Waves, 33, 745-755.

[286] Ikeda, R., Idehara, T., Ogawa, I., Tatematsu, Y., Chang, T.H., Chen, N.C., Matsuki, Y., Ueda, K., Fujiwara, T., 2012, Development of a continuously frequency tunable gyrotron operating at the fundamental resonance for 600 MHz DNP-NMR spectroscopy, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Tue-Pos-29.

[287] Idehara, T., Tatematsu, Y., Yamaguchi, Y., Ikeda, R., Ogawa, I., Saito, T., Matsuki, Y., Ueda, K., Fujiwara, T., Toda, M., 2013, 460 GHz second harmonic gyrotrons for a 700 MHz DNP-NMR

spectroscopy. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo1-4.
[288] Yamaguchi, Y., Tatematsu, Y., Saito, T., Kuwahara, T., Ikeda, R., Ogawa, I., Idehara, T., Dumbrajs, O., 2013, Experimental verification of a self-consistent calculation for continuous frequency-tune with a 400 GHz band second harmonic gyro-BWO. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo P1-53.
[289] Tatematsu, Y., Kawase, T., Ichioka, R., Yamaguchi, Y., 2013, Power improvement on gyrotron FU CW GIII. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Tu1-5.
[290] Ikeda, R., Idehara, T., Tatematsu, Y., Ogawa, I., Yamaguchi, Y., Kanemaki, T., Saito, T., 2013, Development of broadband frequency tunable gyrotron operating at the fundamental resonance for 600 MHz DNP-NMR spectroscopy. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, We P2-80.
[291] Idehara, T., Tatematsu, Y., Yamaguchi, Y., Khutoryan, E., Kuleshov, A., Ueda, K., Matsuki, Y., Fujiwara, T., 2014, Sub-THz gyrotrons with special functions of frequency control for applications to DNP-NMR spectroscopy. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W4_D-25.15.
[292] Idehara, T., Tatematsu, Y., Yamaguchi, Y., Khutoryan, E.M., Luleshov, A.N., Ueda, K., Matsuki, Y., Fujiwara, T., 2015, The development of 460 GHz gyrotrons for 700 MHz DNP-NMR spectroscopy. J Infrared Milli Terahz Waves, 36, 613-627.
[293] Idehara, T., Khutoryan, E.M., Tatematsu, Y., Yamaguchi, Y., Kuleshov, A.N., Dumbrajs, O., Matsuki, Y., Fujiwara, T., 2015, High speed frequency modulation of a 460 GHz gyrotron for application to the 700 MHz DNP enhanced NMR spectroscopy. 40th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, W2E-3.
[294] Ueda, K., Matsuki, Y., Fujiwara, T., Tatematsu, Y., Ogawa, I., Idehara, T., 2016, Further characterization of 394-GHz Gyrotron FU CW GII with additional PID control system for 600-MHz DNP-SSNMR spectroscopy. J Infrared Milli Terahz Waves, 37, 825-836.
[295] Matsuki, Y., Idehara, T., Fukazawa, J., Fujiwara T., 2016, Advaned instrumentation for DNP-enhanced MAS NMR for higher magnetic fields and lower temperatures. J. of Magnetic Resonance, 262, 107-115.
[296] Dumbrajs, O., Khutoryan, E.M., Idehara, T., 2016, Hysteresis and Frequency Tunability of Gyrotrons. J Infrared Milli Terahz Waves, 37, No. 6, 531-560.
[297] Tatematsu, Y., Yamaguchi, Y., Kotera, M., Saito, T., 2016, Frequency tunability in both 200 and 400 GHz bands realized in Gyrotrons FU CW GIV and FUCW X. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 25-30, 2016, Copenhagen, Denmark, HSP.21.13.
[298] Idehara, T., Glyavin, M., Kuleshov, A., Sabchevski, S., Manuilov, V., Zaslavsky, V., Zotova, I., Sedov, A., 2017, A novel THz-band double-beam gyrotron for high-field DNP-NMR spectroscopy. Review of Scientific Instruments, 88, No.9, 094708 (5pp.).
Idehara, T., Glyavin, M., Kuleshov, A., Sabchevski, S., Manuilov, V., Zaslavsky, V., Zotova, I., Sedov, A., 2017, Experimental study of a THz double-beam gyrotron. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RB2.2.
[299] Bandurkin, I., Fokin, A., Glyavin, M., Khutoryan, Kuleshov, A., Mitsudo, S., Sabchevski, S., Tatematsu, Saito, T., Ishikawa, Y., Zotova, I., Zaslavsky, V., Idehara, T., 2019, An experimental investigation of a 0.8 THz gyrotron with improved mode selection. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Tu-PM1-1-3.
[300] Mitsudo, S., Glyavin, M., Khutoryan, E., Bandurkin, I., Saito, T., Ishikawa, Y., Manuilov, V., Zotova, I., Fedotov, A., Kuleshov, A., Sabchevski, S., Tatematsu, Y., Zaslavsky, V., Idehara, T.,

2019, An experimental investigation of a 0.8 THz double-beam gyrotron. Journal of Infrared, Millimeter, and Terahertz Waves, 40, No. 12, 1114-1128.

[301] Kuleshov, A., Khutoryan, E., Kishko, S., Ponomarenko, S., Glyavin, M., Bandurkin, I., Manuilov, V., Fedotov, A., Saito, T., Ishikawa, Y., Tatematsu, Y., Mitsudo, S., Idehara, T., 2020, Low-voltage operation of the double-beam gyrotron at 400 GHz. IEEE Trans. on Electron Devices, 67, No. 2, 673-676.

[302] Urushizaki, Y., Idehara, T., Ogawa, I., Ikeda, R., Sabchevski, S., Asai, S., Suehara, T., Miyazaki, A., Yamazaki, T., Kobayashi, T., 2010, Gyrotrons FU CW V and FU CW VIII for measurement of hyperfine structure of positronium, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Mo-P.31.

Dumbrajs, O., Idehara, T., 2010, Frequency tunable gyrotron FU CW VA for measuring hyperfine split of positronium, J. Infrared Milli Terahz Waves, 31, 1265-1270.

[303] Yamazaki, T., Miyazaki, A., Suehara, T., Namba, T., Asai, S., Kobayashi, T., Saito, H., Ogawa, I., Idehara, T., Sabchevski, S., 2012, Direct observation of the hyperfine transition of ground-state positronium. Physical Review Letters, 108, 253401, 5 (pp).

[304] Asai, S., Yamazaki, T., Miyazaki, A., Suehara, T., Namba, T., Kobayashi, T., Saito, H., Idehara, T., Ogawa, I., Sabchevski, S., 2012, Direct measurement of positronium hyperfine structure: A new horizon of precision spectroscopy using gyrotrons. J. Infrared Milli Terahz Waves, 33, 766-776.

[305] Miyazaki, A., Yamazaki, T.,·Suehara, T., Namba, T., Asai, S.,·Kobayashi, T.,·Saito, H., Idehara, T., Ogawa, I., Tatematsu, Y., 2014, The direct spectroscopy of Positronium hyperfine structure using a sub-THz gyrotron. J Infrared Milli Terahz Waves, 35, No. 1, 91-100.

[306] Miyazaki, A., Yamazaki, T., Suehara, T., Namba, T., Asai, S., Kobayashi, T., Saito, H., Tatematsu, Y., Ogawa, I., Idehara, T., 2015, First millimeter-wave spectroscopy of ground-state positronium. Prog. Theor. Exp. Phys, 2015, 011C01 (10pp).

Rogalev, A., Goulon, J., Goujon, G., Wilhelm, F., Ogawa, I., Idehara, T., 2012, X-ray detected magnetic resonance at sub-THz frequencies using a high power gyrotron source. J. Infrared Milli Terahz Waves, 33, 777-793.

[307] Idehara, T., Sabchevski, S.P., Glyavin, M., Mitsudo, S., 2020, The gyrotrons as promising radiation sources for THz sensing and imaging. Applied Sciences, 10, 980 (22pp).

[308] Yamaguchi, Y., Ogura, T., Ueyama, T., Maeda, Y., Takayama, K., Sasano, J., Fukunari, M., Tatematsu, Y., Saito, T., 2020, Super multi-frequency oscillations at fundamental harmonics with a complex cavity gyrotron. IEEE Electron Device Letters, 41, No. 8, 1241-1244.

[309] Tatematsu, Y., Yamaguchi, Y., Fukunari, M., Takayama, K., Maeda, Y., Ueyama, T., Ogura, T., Nakagawa, K., Kammiya, R., Ito, S., Okamoto, R., Saito, T., 2020, Development of Gyrotron FU CW GVII: a second harmonic, multifrequency gyrotron that radiates Gaussian beams. Journal of Infrared, Millimeter, and Terahertz Waves, 41, No. 5, 576-589.

[310] Glyavin, M., Idehara, T., Khizhnyak, V., Luchinin, A., Manuilov, V., Agusu, L., Ogawa, I., Saito, T., Takahashi, H., Fujiwara, T., 2008, Design of gyrotron FU CW VI for 600 MHz DNP-NMR experiment, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T5D28.1432.

[311] Zapevalov, V.E., Dubrov, V.V., Fix, A.Sh., Kopelovich, E.A., Kuftin, A.N., Malygin, O.V., Manuilov, V.N., Moiseev, M.A., Sedov, A.S., Venediktov, N.P., Zavolsky, N.A., 2009, Development of 260 GHz second harmonic CW gyrotron with high stability of output parameters for DNP spectroscopy, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, W3D04.0389.

[312] Glyavin, M.Yu., Luchinin, A.G., Rodin, Yu.V., 2010, Generation of 5 kW/l THz coherent radiation from pulsed magnetic field gyrotron, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, We-E1.1.

[313] Zapevalov, V.E., Fix, A.Sh., Kopelovich, E.A., Kornishin, S.Yu., Kotov, A.V., Kuftin, A.N., Malygin, O.V., Manuilov, V.N., Moiseev, M.A., Sedov, A.S., Tsalolikhin, V.I., Zavolsky, N.A., 2010, Elaboration of 260 GHz second harmonic CW gyrotron with high stability of output parameters for DNP spectroscopy, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, We-E1.4.

[314] Glyavin, M.Yu., Chirkov, A.V., Denisov, G.G., Fokin, A.P., Kholoptsev, V.V., Kuftin, A.N., Luchinin, A.G., Golubyatnikov, G.Yu., Malygin, V.I., Morozkin, M.V., Manuilov, V.N., Proyavin, M.D., Sedov, A.S., Sokolov, E.V., Tai, E.M., Tsvetkov, A.I., Zapevalov, V.E., 2015, Experimental tests of a 263 GHz gyrotron for spectroscopic applications and diagnostics of various media. Rev. Scientific Instr., 86, 054705 (3pp).

[315] Fokin, A.P., Denisov, G.G., Glyavin, M.Yu., Golubiatnikov, G.Yu., Lubyako, L.V., Morozkin, M.V., Movschevich, B.Z., Tsvetkov, A.I., 2017, High precision frequency stabilization of a 100 W/263 GHz continuous wave gyrotron. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, GII-4.

[316] Denisov, G.G., Fokin, A.P., Glyavin, M.Yu., Golubiatnikov, G.Yu., Lubyako, L.V., Morozkin, M.V., Movschevich, B.Z., Tsvetkov, A.I., 2017, High precision frequency stabilization of a 263 GHz continuous wave gyrotron. EPJ Web of Conferences, 149, 04022 (2pp).
Denisov, G.G., Morozkin, M.V., Fokin, A.P., Chirkov, A.V., Kuftin, A.N., Kornishin S.Y., Tai, E.M. Sedov, A.S., Proyavin, M.D., Tsvetkov, A.I., Glyavin, M.Y., 2019, design and test of 253/527 GHz gyrotron for spectroscopy applications. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-Po-1-55.

[317] Bratman, V.L., Fedotov, A.E., Fokin, A.P., Glyavin, M.Yu., Manuilov, V.N., Osharin,I.V., 2017, Operation of a sub-terahertz CW gyrotron with an extremely low voltage. Physics of Plasmas, 24, 113105 (5pp).

[318] Glyavin, M.Y., Denisov, G.G., Zapevalov, V.E., Koshelev, M.A., Tretyakov, M.Y., Tsvetkov, A.I., 2016, High-power terahertz sources for spectroscopy and material diagnostics. Physics – Uspekhi, 59, No. 6, 595-604.

[319] Koshelev, M.A., Tsvetkov, A.I., Morozkin, M.V., Glyavin, M.Yu., Tretyakov, M.Yu., 2017, Molecular gas spectroscopy using radioacoustc detection and high-power coherent subterahertz radiation sources. J. Molecular Spectroscopy, 331, 9-16.

[320] Golubiatnikov, G.Yu., Koshelev, M.A., Tsvetkov, A.I., Fokin, A.P., Glyavin, M.Yu., Tretyakov, M.Yu., 2018, Recent results on THz gyrotron-based molecular spectroscopy. EPJ Web of Conferences, 195, 06017 (2pp).

[321] Sintsov, S., Tabata, K., Mansfeld, D., Vodopyanov, A., Komurasaki, K., 2020, Optical emission spectroscopy of non-equilibrium microwave plasma torch sustained by focused radiation of gyrotron at 24 GHz. J. Phys. D: Appl. Phys., 53, No. 30, 305203 (11pp).

[322] Sidorov, A., Razin, S., Veselov, A., Viktorov, M., Vodopyanov, A., Luchinin, A., Glyavin, M., 2020, Dynamics of the gas discharge in noble gases sustained by the powerful radiation of 0.67 THz gyrotron. Physics of Plasmas, 27, 093509 (7pp).

[323] Golubiatnikov, G.Yu., Koshelev, M.A., Tsvetkov, A.I., Fokin, A.P., Glyavin, M.Yu., Tretyakov, M.Yu., 2020, Sub-terahertz high-sensitivity high-resolution molecular spectroscopy with a gyrotron. IEEE Trans. on Terahertz Science and Technology, 10, No. 5, 502-512.

[324] Denysenkov, V., Prandolini, M.J., Gafurov, M., Sezer, D., Endeward, B., Prisner, T.F., 2010, Liquid state DNP using a 260 GHz high power gyrotron, Phys. Chem. Chem. Phys., 12, 5786-5790.

[325] Gafurov, M., Denysenkov, V., Prandolini, M.J., Prisner, T.F., 2012, Temperature dependence of the proton Overhauser DNP enhancements on aqueous solutions of Fremy's salt measured in a magneticfield of 9.2 T. Applied Magnetic Resonance, 43, 119-128.

[326] Alberti, S., Ansermet, J.Ph., Braunmüller, F., Cuanillon, P., Dubray, J., Fasel, D., Hogge, J.Ph., Macor, A., de Rijk, E., Tran, M.Q., Tran, T.M., Vuillemin, Q., 2012, Experimental results on a modular gyrotron operating at 0.26 THz for 400 MHz DNP/NMR spectroscopy applications, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Thu-A-2-3.

[327] Alberti, S., Braunmueller, F., Tran, T.M., Genoud, J., Hogge, J.-P., Tran, M.Q., 2013, Nano-second pulses in a THz gyrotron oscillator operating in a mode-locked self-consistent Q-switch regime. Physical Review Letters, 111, No. 20, 205101 (5pp).

[328] Rozier, Y., Legrand, F., Lievin, C., Racamier, J.-R., Marchesin, R.,Alberti, S., Braunmueller, F., Hogge, J.-P., da Silva, M., Tran, T.M., Tran, M.Q., Macor, A., 2013, Manufacturing of a 263 GHz continuously tunable gyrotron. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 1B-3.

[329] Hogge, J.-P., Braunmueller, F., Alberti, S., Genoud, J., Tran, T.M., Vuillemin, Q., Tran, M.Q., Ansermet, J.-P., Cuanillon, P., Macor, A., de Rijk, E., Saraiva, P., 2013, Detailed characterization of a frequency-tunable 260 GHz gyrotron oscillator planned for DNP/NMR spectroscopy. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo P1-16.

[330] Alberti, S., Braunmueller, F., Tran, T.M., Genoud, J., Vuillemin, Q., Hogge, J.-P., Tran, M.Q., Ansermet, J.-P., Macor, A., de Rijk, E., 2013, New results on the physics of THz gyrotrons. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Tu1-1.

[331] Glyavin, M.Yu., Luchinin, A.G., Nusinovich, G.S., Rodgers, J., Kashyn, D.G., Romero-Talamas, C.A., Pu, R., 2012, A 670 GHz gyrotron with record power and efficiency. Applied Physics Letters, 101, 153503 (4 pages).

[332] Glyavin, M., Luchinin, A., Morozkin, M., Bogdashov, A., Rodin, Yu., Denisov, G., Rodgers, J., Romero-Talamas, C., Kashyn, D., Pu, R., Nusinovich, G., Shkvarunets, A., Granatsein, V., 2012, Experimental investigation of powerful 0.67 THz gyrotron with a pulsed solenoid for remote detection of concealed radioactive materials. 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Mon-A-3-4.

[333] Nusinovich, G.S., 2016, Remote detection of concealed radioactive materials by using focused powerful terahertz radiation. J. Infr. Milli Terahz Waves, 37, No. 6, 515-535.

[334] Kim, D., Yu, D., Sawant, A., Choe, M.S., Choi, E.M., 2017, First experimental observation of breakdown for detection of radioactive material using a gyrotron in real-time. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, MT-6.

[335] Tsvetkov, A.I., Fokin, A.P., Sedov, A.S., Glyavin, M.Yu., 2018, Using a gyrotron as a source of modulated radiation for data transmission systems in the terahertz range. EPJ Web of Conferences, 195, 09006 (2pp).

[336] Tatsukawa, T., Doi, A., Teranaka, M., Takashima, H., Goda, F., Watanabe, S., Idehara, T., Mitsudo, S., Kanemaki, T., Namba, T., 2005, Millimeter wave irradiation and invasion into living bodies using a gyrotron as a radiation source. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 2, 727-731.

[337] Miyoshi, N., Ito, S., Ogawa, I., Idehara, T., 2010, Combination treatment of hyperthermia and photodynamic for experimental tumor model using gyrotron (107, 203 GHz), Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Th-P.11.

[338] Sabchevski, S.P., Idehara, T., Ishiyama, S., Miyoshi, N., Tatsukawa, T., 2013, A dual-beam irradiation facility for a novel hybrid cancer therapy. J. Infr. Milli Terahz Waves, 34, 71-87.

[339] Glyavin, M.Yu., Idehara, T., Sabchevski, S.P., 2015, Development of THz gyrotrons at IAP RAS and FIR UF and their applications in physical research and high power THz technologies. IEEE Trans. on Terahertz Science and Technology, 5, No. 5, 788-797.

[340] Idehara, T., Sabchevski, S.P., 2017, Gyrotrons for high-power terahertz science and technology at FIR UF. J Infrared Milli Terahz Waves, 38, 62-86.

[341] Idehara, T., 2016, Development and applications of high power THz radiation sources – gyrotrons. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 26-30, 2016, Copenhagen, Denmark, H1.1.

[342] Bykov, Y., Goldenberg, A.F.L., Flyagin, V.A., 1991, The possibilities of material processing by intense millimeter-wave radiation. Mat. Res. Soc. Symp. Proc., 169, 41-42.

[343] Sklyarevich, V., Detkov, A., Shevelev, M., Decker, R., 1992, Interaction between gyrotron radiation and powder materials. Mat. Res. Soc. Symp. Proc., 269, 163-169.

[344] Link, G., Feher, L., Rhee, S., Thumm, M., Bauer, W., Ritzhaupt-Kleissl, H.-H., Weddigen, A., Böhme, R., Weisenburger, A., 1998, Sintering of ceramics using gyrotron radiation. Proc. 8th ITG-Conference on Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 150, 375-380.

[345] Link, G., Feher, L., Thumm, M., Ritzhaupt-Kleissl, H.-J., Böhme, R., Weisenburger, A., 1999, Sintering of advanced ceramics using a 30 GHz, 10 kW, CW industrial gyrotron. IEEE Trans. on Plasma Science, 27, 547-554.

[346] Link, G., Weisenburger, A., Thumm, M., 2004, Millimeter-wave technology for powder processing. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 311-315.

[347] Bykov, Yu., Eremeev, A., Glyavin, M., Kholoptsev, V., Luchinin, A., Plotnikov, I., Denisov, G., Bogdashev, A., Kalynova, G., Semenov, V., Zharova, N., 2004, 24-84 GHz gyrotron systems for technological microwave applications. IEEE Trans. on Plasma Science, 32, No. 1, 67-72.

[348] Mitsudo, S., Hoshizuki, H., Idehara, T., Saito, T., 2006, Development of material processing system by using a 300 GHz CW gyrotron. Journal of Physics. Conf. Series, 51, 549-552.

[349] Mitsudo, S., Sakai, K., Idehara, T., Saji, T., Saito, T., Sano, S., 2007, Millimeter and submillimeter wave sintering of ceramics. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 267-268.

[350] Denisov, G., Bykov, Yu., Eremeev, A., Glyavin, M., Kholoptsev, V., Kalynova, G., Luchinin, A., Morozkin, M., Plotnikov, I., Sobolev, D., 2007, High efficient gyrotron-based systems for materials processing, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 433-434.

[351] Vikharev, A.L., Gorbachev, A.M., Kozlov, A.V., Koldanov, V.A., Litvak, A.G., Ovechkin, N.M., Bykov, Yu.V., Denisov, G.G., Parshin, V.V., Radishev, D.B., 2005, Development of MPACVD technology for high-rate diamond production. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 2, 613-625.

[352] Vikharev, A.L., Gorbachev, A.M., Kozlov, A.V., Koldanov, V.A., Litvak, A.G., Ovechkin, N.M., Radishev, D.B., Bykov, Yu.V., Chaplan, M., 2006, Diamond films grown by millimeter wave plasma-assisted CVD reactor, Diamond and Related Materials, 15, 502-507.

[353] Sadykov, V., Usoltsev, V., Eremeev, N., Mezentseva, N., Pelipenko, V., Krieger, T., Belyaev, V., Sadovskaya, E., Muzykantov, V,. Fedorova, Yu., Ishchenko, A., Salanov, A., Okhlupin, Yu., Uvarov, N., Smorygo, O., Arzhannikov, A., Korobeinikov, M., Thumm, Ma. K.A., 2013,

Functional nanoceramics for intermediate temperature solid oxide fuel cells and oxygen separation membranes. Journal of the European Ceramic Society, 33, Issue 12, 2241–2250.

[354] Sennikov, P.G., Vodopyanov, A.V., Golubev, S.V., Mansfeld, D.A., Drozdov, M.N., Drozdov, Yu.N., Andreev, B.A., Gavrilenko, L.V., Pryakhin, D.A., Shashkin, V.I., Godisov, O.N., Glasunov, A.I., Safonov, A.Ju., Pohl, H.-J., Thewalt, M.L.W., Becker, P., Riemann, H., Abrosimov, N.V., Valkiers, S., 2012, Towards 0.99999 28Si, Solid State Communications, 152, 455-457.

[355] Bykov, Y.V., Egorov, S.V., Eremeev, A.G., Kholoptsev, V.V., Plotnikov, I.V., Rybakov, K.I., Sorokin, A.A., 2016, On the mechanism of microwave flash sintering of ceramics. Materials, 9, 684 (18pp).

[356] Egorov, S.V., Bykov, Y.V., Eremeev, A.G., Sorokin, A.A., Serov, E.A., Parshin, V.V., Balabanov, S.S., Belyaev, A.V., Novikova, A.V., Permin, D.A., 2017, Millimeter-wavelength radiation used to sinter radiotransparent MgAl2O4 ceramics. Radiophysics and Quantum Electronics, 59, No. 8-9, 690-697.

[357] Mahmoud, M., Link, G., Jelonnek, J., Thumm, M., 2017, Investigation on mm-wave sintering of metal powder compacts using in-situ dilatometry and electrical resistivity measurements. EPJ Web of Conferences, 149, 02007 (2pp).

[358] Denisov, G.G., Bykov, Y.V., Glyavin, M.Yu., Luchinin, A.G., Morozkin, M.M., Sobolev, D.I., 2008, High efficient gyrotron-based systems for technological applications, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, R4A2.1512.

[359] Denisov, G.G., Bykov, Yu.V., Eremeev, A.G., Glyavin, M.Yu., Luchinin, A.G., Morozhin, M.M., Samsonov, S.V., 2009, Prospective gyro-devices for technological applications, Proc. 10th IEEE Int. Vacuum Electronics Conf. (IVEC 2009), Rome, Italy, pp. 513-514.

[360] Bykov, Y.V., Denisov, G.G., Eremeev, A.G., Flat, F.A., Glyavin, M.Yu., Gorbachev, A.M., Kalynova, G.I., Kholoptsev, V.V., Kopelovich, E.A., Luchinin, A.G., Plotnikov, I.V., Morozkin, M.V., Samsonov, S.V., Vikharev, A.L., 2009, Efficiency enhancement of gyrotron based setups for materials processing, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R3D03.0058.

[361] Soluyanova, E.A., Bykov, Yu.V., Chirkov, A.V., Denisov, G.G., Kopelovich, E.A., Orlov, V.B., Pavelyev, A.B., Sokolov, E.V., Tai, E.M., 2011, Gyrotron complexes for technological applications, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, p. 133.

[362] Vodopyanov, A.V., Samokhin, A.V., Alexeev, N.V., Sinayskiy, M.A., Tsvetkov, A.I., Glyavin, M.Yu, Fokin, A.P., Malygin, V.I., 2017, Application of the 263 GHz/1kW gyrotron setup to produce a metal oxide nanopowder by the evaporartion-condensation technique, Vacuum, 145, 340-346.

[363] Bykov, Yu.V., Eremeev, A.G., Glyavin, M.Yu., Denisov, G.G., Kalynova, G.I., Kopelovich, E.A., Luchinin, A.G., Plotnikov, I.V., Proyavin, M.D., Troitskiy, M.M., Kholoptsev, V.V., 2019, Millimeter-wave gyrotron research system. I. Description of the facility. Radiophysics and Quantum Electronics, 61, No. 10, 752-762.

[364] Bykov, Yu.V., Egorov, S.V., Eremeev, A.G., Plotnikov, I.V., Rybakov, K.I., Sorokin, V.V., Kholoptsev, V.V., 2019, Millimeter-wave gyrotron system for research and application development. Part 2. High-temperature processes in polycrystalline dielectric materials. Radiophysics and Quantum Electronics, 61, No. 11, 787-796.

[365] Glyavin, M., Sabchevski, S., Idehara, T., Mitsudo, S., 2020, Gyrotron-based technological systems for material processing – Current status and prospects. Journal of Infrared, Millimeter, and Terahertz Waves, 41, No. 8, 1022-1037.

[366] Woskov, P.P., Einstein, H.H., Oglesby, K.D., 2014, Penetrating rock with intense millimeter-waves. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, F2_B-36.3.

[367] Kikunaga, T., Asano, H., Yasojima, Y., Sato, F., Tsukamoto, T., 1995, A 28 GHz gyrotron with a permanent magnet system. Int. J. Electronics, 79, 655-663.

[368] Bykov, Yu., Glyavin, M., Goldenberg, A., Flyagin, V., Lygin, V., Manuilov, V., Moiseev, M., Zavolsky, N., 1999, Development and experimental investigation of high power technological gyrotrons. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, TU-A7.

[369] Kuftin, A.N., Flyagin, V.A., Lygin, V.K., Luchinin, A.G., Malygin, O.V., Zapevalov, V.E., Zavolsky, N.A., 1999, 5.8-62 GHz CW gyrotrons with warm and permanent magnets for technological application. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2000, Vol. 2, 671- 676.

[370] Kuftin, A.N., Flyagin, V.A., Lygin, V.K., Malygin, O.V., Zapevalov, V.E., Zavolsky, N.A., 1999, Technological gyrotrons with permanent magnet system. Proc. Int. University Conf. "Electronics and Radiophysics of Ultra-High Frequencies" (UHF-99), 1999, St. Petersburg, Russia, 126-129.

[371] Kuftin, A.N., Flyagin, V.A., Lygin, V.K., Malygin, O.V., Zapevalov, V.E., Zavolsky, N.A., 2000, Technological gyrotrons with permanent magnet system. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 267-268.

[372] Bykov, Yu., Denisov, G., Eremeev, A., Kalynova, G., Kholoptsev, V., Kopelovich, E., Kuftin, A., Lygin, V., Pavelyev, A., Plotnikov, I., Zapevalov, V., Zavolsky, N., 2004, Microwave source based on the 24 GHz 3 kW gyrotron with permanent magnet. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 191-192.

[373] Denisov, G., Bykov, Yu., Eremeev, A., Kholoptsev, V., Glyavin, M., Luchinin, A., Kalynova, G., Plotnikov, I., 2006, 24-28 GHz gyrotron-based sources for technological applications. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 500.

[374] Granatstein, V.L., Lawson, W., Latham, P.E., 1988, Feasibility of 30 GHz gyroklystron amplifiers for driving linear supercolliders. Conf. Digest, 13th Int. Conf. on Infrared and Millimeter Waves, Honolulu, Hawaii, Proc., SPIE 1039, 230-231.

[375] Granatstein, V.L., Nusinovich, G.S., 1993, On the optimal choice of microwave systems for driving TeV linear colliders. Proc. 2nd Int. Workshop on Strong Microwaves in Plasmas, Moscow - Nizhny Novgorod - Moscow, ed. A.G. Litvak, Inst. of Applied Physics, Nizhny Novgorod, 1994, Vol. 2, 575-586.

[376] Granatstein, V.L., Lawson, W., 1996, Gyro-amplifiers as candidate RF drivers for TeV linear colliders. IEEE Trans. on Plasma Science, 24, 648-665.

[377] Manheimer, W.M., Mesyats, G.A., Petelin, M.I., 1993, Super-high-power microwave radars. Proc. 2nd Int. Workshop on Strong Microwaves in Plasmas, Moscow - Nizhny Novgorod - Moscow, ed. A.G. Litvak, Inst. of Applied Physics, Nizhny Novgorod, 1994, Vol. 2, 632-641.

[378] Manheimer, W.M., 1992, On the possibility of high power gyrotrons for super range resolution radar and atmospheric sensing. Int. J. Electronics, 72, 1165-1189.

[379] Clunie, D., Mesyats, G., Osipov, M.L., Petelin, M.I., Zagulov, P., Korovin, S.D., Clutterbuck, C.F., Wardrop, B., 1996, The design, construction and testing of an experimental high power, short-pulse radar. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol. 2, 886-902.

[380] Danly, B.G., Blank, M., Calame, J.P., Levush, B., Nguyen, K., Pershing, D., Petillo, J., Hargreaves, T.A., True, R.B., Theiss, A.J., Good, G.R., Felch, K., James, B.G., Borchard, P., Chu, T.S., Jory, H., Lawson, W.G., Antonsen, T.M., Garven, M., 1999, High average power gyro-klystrons for radar applications. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, Plenary M-3.

[381] Danly, B.G., 2002, Gyro-amplifiers for high power millimeter wave radar. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 361-362.
Ngo, M.T., Danly, B.G., Myers, R., Pershing, D.E., Gregers-Hansen, V., Linde, G., 2002, High-power millimeter-wave transmitter for the NRL WARLOC radar. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 363-364.

[382] Danly, B.G., Cheung, J., Gregers-Hansen, V., Linde, G., Ngo, M., 2002, Warloc: a high-power millimeter-wave radar. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 233-234.

[383] Blank, M., Borchard, P., Cauffman, S., Felch, K., 2007, Design and demonstration of W-band gyrotron amplifiers for radar applications. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 364-366.

[384] Linde, G.J., Ngo, M.T., Danly, B.G., Cheung, W.J., Hregers-Hansen, V., 2008, WARLOC: a high-power coherent 94 GHz radar, IEEE Trans. on Aerospace and Electronic Systems, 44, 1102-1117.

[385] MacDonald, M.E., Anderson, J.P., Lee, R.K., Gordon, D.A., McGrew, G.N., 2014, The HUSIR W-band transmitter. Lincoln Laboratory Journal, 21, No. 1, 106-114.

[386] Tolkachev, A.A., Levitan, B.A., Solovjev, G.K., Veytsel, V.V., Farber, V.E., July 2000, A megawatt power millimeter-wave phased-array radar. IEEE Aerospace and Electronic Systems Magazine, 15, No. 7, 25-31.

[387] Tolkachov, A.A., Levitan, B.A., Petelin, M.I., 2008, Prospects of high-power millimeter-wave radar, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2009, Vol. 2, pp. 489-493.

[388] van't Klooster, K., Petelin, M. Thumm, M. Aloisio, M., 2013, Ka-band groundstation antenna aspects for deep space telecommunication and radar. Proc. 7th European Conf. on Antennas and Propagation (EuCAP 2013), Gothenburg, Schweden, pp. 242-246.

[389] van't Klooster, K., Petelin, M. Thumm, M., 2013, Deep space telecom and radar in a Ka-band ground station antenna. 23rd Int. Crimean Conference "Microwave & Telecommunication Technology" (CriMiCo'2013), Sevastopol, Crimea, Ukraine, IEEE Catalog No. CFP13788, pp. 1109-1111.

[390] Bratman, V.L., Denisov, G.G., Ginzburg, N.S., and Petelin, M.I., 1983, FEL's with Bragg reflection resonators. Cyclotron autoresonance masers versus ubitrons. IEEE Journal of Quantum Electronics, 19, 282-296.

[391] Marshall, T.C., 1985, Free electron lasers, MacMillan, New York.

[392] Sprangle, P., Coffey, T., 1985, New high power coherent radiation sources, in Infrared and Millimeter Waves, Vol. 13, ed. K.J. Button, Academic Press, New York, 19-44.

[393] Stone, R.R., Jong, R.A., Orzechowski, T.J., Scharlemann, E.T., Throop, A.L., Kulke, B., Thomassen, K.I., Stallard, B.W., 1990, An FEL-based microwave system for fusion. J. Fusion Energy, 9, 77-101.

[394] Freund, H.P., Antonsen, T.M., Jr., 1992, Principles of free-electron lasers. Springer, Heidelberg, 1st edition, 1996, Chapman&Hall, London, 2nd edition, 2012, Springer, 3rd ed.

[395] Freund, H.P., Neil, G.R., 1999, Free-electron lasers: Vacuum electronic generators of coherent radiation. Proc. of the IEEE, 87, 782-803.

[396] Neil, G.R., 2014, Accelerator sources for THz science: A review. J Infrared Milli Terahz Waves, 35, No. 1, 5-16.
[397] Neil, G.R., Williams, G.P., 2015, High power terahertz production from relativistic electron beams. Terahertz Science and Technology, 8, No. 2, 41-49.
[398] Twiss, R.Q., 1958, Radiation transfer and the possibility of negative absorption in radio astronomy. Aust. J. Phys., 11, 564-579; Twiss, R.Q., Roberts, J.A., 1958, Electromagnetic radiation from electrons rotating in an ionized medium under the action of a uniform magnetic field. Aust. J. Phys., 11, 424.
[399] Schneider, J., Stimulated emission of radiation by relativistic electrons in a magnetic field. 1959, Phys. Rev. Lett., 2, 504-505.
[400] Gaponov, A.V., Addendum, 1959, Izv. VUZ Radiofiz., 2, 837, an addendum to Gapanov, A.V., 1959, Interaction between electron fluxes and electromagnetic waves and waveguides. Izv. VUZ Radiofiz., 2, 450-462.
[401] Kleinwächter, H., 1950, Zur Wanderfeldröhre. Elektrotechnik, 4, 245-246 (in German).
[402] Bott, I.B., Link, M., 1964, Radiation generator operating in the millimeter and submillimeter wavelength range, Patent GB 3,353,053, Filed Ser.No. 354,678, Claim March 1963; 12,348/63.
[403] Bott, I.B., 1964, Tunable source of millimeter and submillimeter electromagnetic radiation. Proc. of the IEEE, 52, 330.
[404] Bott, I.B., 1965, A powerful source of millimetre wavelength electromagnetic radiation. Physics Letters, 14, 293-294.
[405] Hirshfield, J.L., Wachtel, J.M., 1964, Electron cyclotron maser. Phys. Rev. Lett., 12, 533-536.
[406] Gaponov, A.V., Petelin, M.I. and Yulpatov, V.K., 1967, The induced radiation of excited classical oscillators and its use in high frequency electronics. Izv. VUZ Radiofiz. 10, 1414 (Radiophys. Quantum Electronics, 10, 794-813).
[407] Jory, H., 1968, Investigation of electronic interaction with optical resonators for microwave generation and amplification. Research and Development Techn. Report ECOM-01873-F, Varian Associates, Palo Alto, California.
[408] Granatstein, V.L., Alexeff, I., eds., 1987, High-power microwave sources. Artech House, Boston, London.
[409] Benford, J. Swegle, J., Schamiloglu, E., 2007, High-power microwaves, 2nd Ed., Taylor & Francis, New York, London.
[410] Nusinovich, G.S., 1999, Review of the theory of mode interaction in gyrodevices. IEEE Trans. on Plasma Science, 27, 313-326.
[411] Edgcombe, C.J., ed., 1993, Gyrotron oscillators-their principles and practice. Taylor & Francis, London.
[412] Kartikeyan, M.V., Borie, E., Thumm, M.K.A., 2004, Gyrotrons – High power microwave and millimeter wave technology. Springer, Berlin.
[413] Nusinovich, G., 2004, Introduction to the physics of gyrotrons. The Johns Hopkins University Press, Baltimore and London.
[414] Thumm, M., 2014, Effective cavity length of gyrotrons. J. Infrared, Millimeter, and Terahertz Waves, 35, No. 12, 1011-1017.
[415] Bogdashov, A.A., and Denisov, G.G., 2004, Asympthotic theory of high-efficiency converters of higher-order waveguide modes into eigenwaves of open mirror lines. Radiophysics and Quantum Electr., 47, 283-296.
[416] Thumm, M., Arnold, A., Dammertz, G., Michel, G., Pretterebner, J., Wagner, D., Yang, X., 2004, An advanced dimple-wall launcher for a 140 GHz 1MW continuous wave gyrotron. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 195-200.

[417] Thumm, M., Yang, X., Arnold, A., Dammertz, G., Michel, G., Pretterebner, J., Wagner, D., 2005, A high-efficiency quasi-optical mode converter for a 140-GHz 1-MW CW gyrotron. IEEE Trans. on Electron Devices, 52, 818-824.

[418] Thumm, M., Arnold, A., Drumm, O., Jin, J., Michel, G., Piosczyk, B., Rzesnicki, T., Wagner, D., Yang, X., 2005, Quasi-optical mode converters in advanced high-power gyrotrons for nuclear fusion plasma heating. In: Quasi-Optical Control of Intense Microwave Transmission, eds. J.L. Hirshfield and M.I. Petelin, Springer, 325-351.

[419] Chirkov, A.V., Denisov, G.G., Kulygin, M.L., Malygin, V.I., Malygin, S.A., Pavel'ev, A.B., Soluyanova, E.A., 2006, Use of Huygens's principle for analysis and synthesis of the fields in oversized waveguides, Radiophys. Quantum Electronics, 49, 344-353.

[420] Jin, J., Thumm, M., Piosczyk, B., Kern, S., Flamm, J., Rzesnicki, T., 2009, Novel numerical method for the analysis and synthesis of the fields in highly oversized waveguide mode converters, IEEE Transactions on Microwave Theory and Techniques, 57, 1661-1668.

[421] Jin, J., Flamm, J., Kern S., Rzesnicki, T., Thumm, M., 2010, Design of phase correcting mirror system for coaxial-cavity ITER gyrotron, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 29-30.
Jin, J., Rzesnicki, T., Kern, S., Thumm, M., 2011, High-efficiency quasi-optical mode converter for the coaxial cavity gyrotron. Fusion Science and Technology, 59, 742-748.

[422] Flamm, J.H., Jin, J., Thumm, M.K., 2011, Wave propagation in advanced gyrotron output couplers, J. Infrared Milli Terahz Waves, 32, 887-896.

[423] Jin, J., Flamm, J., Jelonnek, J., Kern, S., Pagonakis, I., Rzesnicki, T., Thumm, M., 2013, High-efficiency quasi-optical mode converter for a 1-MW TE32,9-mode gyrotron. IEEE Trans. on Plasma Science, 41, No. 10, 2748-2753.

[424] Jin, J., Gantenbein, G., Jelonnek, J., Rzesnicki, T., Thumm, M., 2015, Development of mode conversion waveguides at KIT. EPJ Web of Conferences, 87, 04003 (5pp).

[425] Jin, J., Thumm, M., Gantenbein, G., Jelonnek, J., 2017, A numerical synthesis method for hybrid-type high power gyrotron launchers. IEEE Trans. on Microwave Theory and Techniques, 65, No. 3, 699-706.

[426] Ives, L., Read, M., Bui, T., Marsden, D., Collins, G., Schaub, S., Guss, W., Temkin, R., Neilson. J., Gorelov, Y., Cengher, M., Moeller, C., LeViness, A., Lohr, J., 2017, Development of advanced output coupling structures for gyrotrons. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RB2.3.

[427] Neilson, J.M., Ives, R.L., Schaub, S.C., Guss, W.C., Rosenzweig, G., Temkin, R.J., Borchard, P., 2018, Design and high-power test of an internal coupler to HE11 mode in corrugated waveguide for high-power gyrotrons. IEEE Trans. on Electron Devices, 65, No. 6, 2316-2320.

[428] Ives, R.L., Collins, G., Neilson, J., Marsden, D., 2020, Direct coupled gyrotrons for plasma heating. Proc. 21st Int. Vacuum Electronics Conference (IVEC 2020), Monterey (Virtual Conference), CA, USA, 12.3.
Ives, R.L., Marsden, D., Collins, G., Neilson, J., Anderson, J., Zeller, K., 2021, Direct coupled gyrotrons for plasma heating. Proc. 22nd Int. Vacuum Electronics Conference (IVEC 2021), Virtual Event, The Netherlands, S7.6.

[429] Zaginaylov, G.I., Shcherbinin, V.I., Schuenemann, K., Thumm, M.K., 2006, Influence of background plasma on electromagnetic properties of "cold" gyrotron cavity. IEEE Trans. on Plasma Science, 34, 512-517.

[430] Schlaich, A., Wu, C., Pagonakis, I., Avramidis, K., Illy, S., Gantenbein, G., Jelonnek, J., Thumm, M., 2015, Frequency-based investigation of charge neutralization processes and thermal cavity expansion in gyrotrons. J Infrared Milli Terahz Waves, 36, 797-818.

[431] Pendergast, K.D., Danly, B.G., Menninger, W.L., Temkin, R.J., 1992, A long-pulse CARM oscillator experiment. Int. J. Electronics, 72, 983-1004.

[432] Galuzo, S.Yu., Kanavets, V.I., Slepkov, A.I., Pletyushkin, V.A., 1982, Relativistic cyclotron accelerator exploiting the anomalous Doppler effect. Sov. Phys. Tech. Phys., 27, 1030-1032.

[433] Didenko, A.N., Borisov, A.R., Fomenko, G.P., Shlapakovskii, A.S., Shtein, Yu.G., 1983, Cyclotron maser using the anomalous Doppler effect. Sov. Phys. Tech. Lett., 9, 572-573.

[434] Ogura, K., Amin, M.R., Minami, K., Zheng, X.D., Suzuki, Y., Kim, W.S., Watanabe, T., Carmel, Y., Granatstein, V.L., 1996, Experimental demonstration of a high-power slow-wave electron cyclotron maser based on a combined resonance of Cherenkov and anomalous Doppler interactions. Phys. Rev. Lett. E, 53, 2726-2729.

[435] Guo, H., Chen, L., Keren, H., Hirshfield, J.L., Park, S.Y., Chu, K.R., 1982, Measurements of gain for slow cyclotron waves on an annular electron beam. Phys. Rev. Lett., 49, 730-733.

[436] Granatstein, V.L., Read, M.E., Barnett, L.R., 1982, Measured performance of gyrotron oscillators and amplifiers, in Infrared and Millimeter Waves, Vol. 5, ed. K.J. Button, Academic Press, New York, 267-304.

[437] Chu, K.R., Lin, A.T., 1988, Gain and bandwidth of the gyro-TWT and CARM amplifiers. IEEE Trans. on Plasma Science, Vol. 16, 90-103.

[438] Chu, K.R., Chen, H.-Y., Hung, C.-L., Chang, T.-H., Barnett, L.R., Chen, S.-H., Yang, T.-T., Dialetis, D.J., 1999, Theory and experiment of ultrahigh-gain gyrotron traveling wave amplifier. IEEE Trans. on Plasma Science, 27, 391-404.

[439] Chu, K.R., 2002, Overview of research on the gyrotron traveling-wave amplifier. IEEE Trans. on Plasma Science, 30, 903-908.

[440] Denisov, G.G., Bratman, V.L., Phelps, A.D.R., Samsonov, S.V., 1998, Gyro-TWT with a helical operating waveguide: new possibilities to enhance efficiency and frequency bandwidth. IEEE Trans. on Plasma Science, 26, No. 3, 508-518.

[441] Bratman, V.L., Cross, A.W., Denisov, G.G., Phelps, A.D.R., Samsonov, S.V., 2005, Microwave devices with helically corrugated waveguides. In: Quasi-Optical Control of Intense Microwave Transmission, eds. J.L. Hirshfield and M.I. Petelin, Springer, 105-114.

[442] Denisov, G.G., Gylyavin, M.Yu., 2016, Development of gyro-devices at IAP/ GYCOM in the range from gigahertz to terahertz. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), Sept. 26-30, 2016, Copenhagen, Denmark, H2D.5.

[443] Guo, H., Chen, S.H., Granatstein, V.L., Rodgers, J., Nusinovich, G., Levush, B., Walter, M., Chen, W.J., 1997, A high performance, frequency doubling, inverted gyrotwystron. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 285-286.

[444] Bratman, V.L., Kalynov, Yu.K., Manuilov, V.N., Samsonov, S.V., 2005, Submillimeter-wave large-orbit gyrotron. Radiophysics and Quantum Electronics, 48, 731-736.

[445] Ganguly, A.K., Ahn, S., Park, S.Y., 1988, Three dimensional nonlinear theory of the gyro-peniotron amplifier. Int. J. Electronics, 65, 597-618.

[446] Nezhevenko, O.A., 1994, Gyrocons and magnicons: Microwave generators with circular deflection of the electron beam. IEEE Trans. on Plasma Science, 22, 756-772.

[447] Karliner, M.M., Kozyrev, E.V., Makarov, I.G., Nezhevenko, O.A., Ostreiko, G.N., Persov, B.Z., Serdobintsev, G.V., 1998, The magnicon – an advanced version of the gyrocon. Nucl. Instr. and Meth. in Phys. Res., A269, 459-473.

[448] Yakovlev, V.P., Nezhevenko, O.A., R.B. True, R.B., 1997, Electron Gun for a High-Power X-Band Magnicon Amplifier, Proc. of the 1997 Particle Accelerator Conference, Vancouver, B.C., Canada.

[449] Hirshfield, J.L., LaPointe, M.A., Yoder, R.B., Ganguly, A.K., Wang, Ch., Hafizi, B., 1996, High-power microwave production by gyroharmonic conversion and co-generation. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 730-744.

[450] Hirshfield, J.L., LaPointe, M.A., Wang, C., Ganguly, A.K., 1999, 20 GHz high-power gyro-harmonic co-generation. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2000, Vol. 2, 728-739.

[451] Wang, M., Ganguly, A.K., Hirshfield, J.L., 2002, Observation of stimulated emission at high gyroharmonics: basis for a synchrotron resonance maser. Phys. Rev. Lett., 87, 153801-1/4.

[452] Phillips, R.M., 1960, The ubitron, a high-power traveling-wave tube based on a periodic beam interaction in unloaded waveguide. IRE Trans. Electron. Dev., 7, 231-241 and, 1988, History of the ubitron. Nucl. Instr. Meth., A272, 1-9, and, 1998, private communication.

[453] Drori, R., Jerby, E., 1997, Free-electron-laser-type interaction at 1 meter wavelength range. Nucl. Instr. Meth., A393, 284.

[454] Verhoeven, A.G.A., Bongers, W.A., Best, R.W.B., van Ingen, A.M., Manintveld, P., Urbanus, W.H., van der Wiel, M.J., Bratman, V.L., Denisov, G.G., Shmelyov, M.Yu., Nickel, H.-U., Thumm, M., Müller, G., Kasparek, W., Pretterebner, J., Wagner, D., Caplan, M., 1992, The 1 MW, 200 GHz FOM-Fusion-FEM. Conf. Digest 17th Int. Conf. on Infrared and Millimeter Waves, Pasadena (Los Angeles), Proc., SPIE 1929, 126-127.

[455] Urbanus, W.H., Best, R.W.B., Bongers, W.A., van Ingen, A.M., Manintveld, P., Sterk, A.B., Verhoeven, A.G.A., van der Wiel, M.J., Caplan, M., Bratman, V.L., Denisov, G.G., Varfolomeev, A.A., Khlebnikov, A.S., 1993, Design of the 1 MW, 200 GHz, FOM fusion FEM. Nucl. Instr. Meth., A 331, 235-240.

[456] Verhoeven, A.G.A., Bongers, W.A., van der Geer, C.A.J., Manintveld, P., Schüller, F.C., Urbanus, W.H., Valentini, M., van der Wiel, M.J., 1995, A broad-tuneable free electron maser for ECW applications. Proc. 9th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating, Borrego Springs, California, 309-320.

[457] Verhoeven, A.G.A., Bongers, W.A., Bratman, V.L., Caplan, M., Denisov, G.G., van Dijk, G., van der Geer, C.A.J., Manintveld, P., Poelmann, A.J., Pluygers, J., Shmelyov, M.Yu., Smeets, P.H.M., Sterk, A.B., Urbanus, W.H., 1998, First high power experiments with the Dutch free electron maser. Physics of Plasmas, 5, 2029-2036.

[458] Verhoeven, A.G.A., Bongers, W.A., Bratman, V.L., Caplan, M., Denisov, G.G., van der Geer, C.A.J., Manintveld, P., Poelman, A.J., Pluygers, J., Shmelyov, M.Yu., Smeets, P.H.M., Sterk, A.B., Urbanus, W.H., 1998, First microwave generation in the FOM free electron maser. Plasma Phys. and Contr. Fusion, 40, Suppl. 8A, 139-156.

[459] Verhoeven, A.G.A., Bongers, W.A., Bratman, V.L., Caplan, M., Denisov, G.G., van der Geer, C.A.J., Manintveld, P., Poelman, A.J., Plomb, J., Savilov, A.V., Smeets, P.H.M., Urbanus, W.H., 1998, First generation of mm-waves in the dutch free-electron maser. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 21-23.

[460] Urbanus, W.H., Bongers, W.A., van der Geer, C.A.J., Manintveld, P., Plomb, J., Pluygers, J., Poelmann, A.J., Smeets, P.H.M., Verhoeven, A.G.A., Bratman, V.L., Denisov, G.G., Savilov, V., Shmelyov, M.Yu., Caplan, M., Varfolomeev, A.A., Tolmachev, S.V., Ivanchenkov, S.N., 1999, High-power electrostatic free-electron maser as a future source for fusion plamsa heating: Experiments in the short-pulse regime. Phys. Rev. E, 59, 6058-6063.

[461] Verhoeven, A.G.A., Bogers, W.A., Bratman, V.L., Caplan, M., Denisov, G.G., van der Geer, C.A.J., Manintveld, P., Poelmann, A.J., Plomp, J., Savilov, A.V., Smeets, P.H.M., Sterck, A.B., Urbanus W.H., 1999, First mm-wave generation in the FOM free electron maser. IEEE Trans. on Plasma Science, 27, 1084-1091.

[462] Urbanus, W.H., Bratman, V.L., Bongers, W.A., Caplan, M., Denisov, G.G., van der Geer, C.A.J., Manintveld, P., Militsyn, B., Oomens, A.A.M., Poelman, A.J., Plomp, J., Pluygers, J., Savilov, A.V., Smeets, P.H.M., Sterk, A.B., Verhoeven, A.G.A., 2001, A high power, tunable free elctron maser for fusion. Fusion Engineering and Design, 53, 423-430.

[463] Militsyn, B.L., Bongers, W.A., Bratman, V.L., Caplan, M., Denisov, G.G., van der Geer, C.A.J., Manintveld, P., Oomens, A.A.M., Plomp, J., Pluygers, J., Poelman, A.J., Riet, M., Savilov, A.V., Smeets, P.H.M., Tito, C.J., Turk, G.H.B., Varfolomeev, A.A., Urbanus, W.H., 2002, First lasing of the Dutch fusion FEM in the long-pulse configuration. Nucl. Instr. Meth., A483, 259-262.

[464] Urbanus, W.H., Bongers, W.A., Bratman, V., van der Geer, C.A.J., Graswinckel, M.F., Manintveld, P., Militsyn, B.L., Savilov, A., and FEM Team, 2002, Long-pulse operation at constant output power and single-frequency mode of a high-power electrostatic free-electron maser with depressed collector. Phys. Rev. Lett., 89, 214801-1/-4.

[465] Freund, H.P., Granatstein, V.L., 1995, Long wavelength free electron laser in 1994. Nucl. Instr. Meth., A358, 551-554 and, 1996, Nucl. Instr. Meth., A375, 665-668 and, 1997, Nucl. Instr. Meth., A393, 9-12, and, 1998, Nucl. Instr. Meth., A407, 30-33, and, 1999 Nucl. Instr. Meth., A429, 33-36, and private communication.

[466] Shaw, A., Al-Shammaá, A., Stuart, R.A., Balfour, C., Lucas, J., 1996, First results of a CW industrial FEM. Nucl. Instr. Meth., A375, 245-247.

[467] Dylla, H.F., 1999, An overview of the user program for the Jefferson Lab free electron laser. Proc. SPIE, Vol. 3618, 388-395.

[468] Neil, G.R., Bohn, C.L., Benson, S.V., Biallas, G., Douglas, D., Dylla, H.F., Evans, R., Fugitt, J., Grippo, A., Gubeli, J., Hill, R., Jordan, K., Li, R., Merminga, L., Piot, P., Preble, J., Shinn, M., Siggins, T., Walker, R., Yunn, B., 2000, Sustained kilowatt lasing in a free-electron laser with same-cell energy recovery. Phys. Rev. Lett., 84, 662-665.

[469] Benson, S.V., 2002, What have we learned from the kilowatt IR-FEL at Jefferson lab?, Nucl. Instr. Meth., A483, 1-7.

[470] Behre, C., Benson, S., Biallas, G., Boyce, J., Curtis, C., Douglas, D., Dylla, H.F., Dillon-Townes, L., Evans, R., Grippo, J., Hardy, D., Heckman, J., Hernandez-Garcia, C., Hiatt, T., Jordan, K., Merminga, L., Neil, G., Preble, J., Rutt, H., Shinn, M., Siggins, T., Toyokawa, H., Waldman, D.W., Walker, R., Wilson, N., Yunn, B., Zhang, S., 2004, First lasing of the IR upgrade FEL at Jefferson Lab. Nuclear Instruments & Methods in Physics Research, 528, No. 1-2, 19-22.

[471] Boyce, J.R., 2005, The Jefferson Lab high power light source. Proc. 7th Workshop on High Energy Density and High Power RF, AIP Conf. Proceedings 807, 2006, 348-355.

[472] Thomas, A.W., Williams, G.P., 2007, The free electron laser at Jefferson Lab: the technology and the science. Proceedings of the IEEE, 95, 1679-1682.

[473] Kulipanov, G.N., Gavrilov, N.G., Knyazev, B.A., Kolobanov, E.I., Kotenkov, V.V., Kubanov, V.V., Matveenko, A.N., Medvedev, L.E., Miginsky, S.V., Mironenko, L.A., Ovchar, V.K., Popik,V.M., Salikova, T.V., Scheglov, M.A., Serednyakov, S.S., Shevchenko, O.A., Skrinski, A.N., Tcheskidov, V.G., Vinokurov, N.A., Demyanenko, M.A., Esaev, D.G., Naumova, E.V., Prinz, V.Y., Fedin, V.P., Gonchar, A.M., Peltek, S.E., Petrov, A.K., Merzhievsky, L.A., Cherkassky, V.S., 2008, Research highlights from the Novosibirsk 400 W average power THz FEL, Int. J. of Terahertz Science and Technology, 1, 51-125.

[474] Akberdin, R.R., Chesnokov, E.N., Dem'yanenko, M.A., Esaev, D.G., Goryachevskaya, T.N., Klimov, A.E., Knyazev, B.A., Kolobanov, E.I., Kozlov, A.S., Kubarev, V.V., Kulipanov, G.N., Kuznetsov, S.A., Matveenko, A.N., Medvedev, L.E., Naumova, E.V., Okotrub, A.V., Ovchar, V.K., Palagin, K.S., Paschin, N.S., Peltek, S.G., Petrov, A.K., Prinz, V.Ya., Popik, V.M., Salikova, T.V., Serednyakov, S.S., Skrinsky, A.N., Shevchenko, O.A., Scheglov, M.A., Vinokurov, N.A., Vlasenko, M.G., Yakovlev, V.V., Zaigraeva, N.S., 2009, High power THz

applications on the NovoFEL, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, T3C01.0521.

[475] Kubarev, V.V., Kulipanov, G.N., Shevchenko, O.A., Vinokurov, N.A., 2010, Third harmonic lasing on Terahertz NovoFEL, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Mo-F2.1.

[476] Vinokurov, N., 2011, Free electron lasers as a High-power Terahertz Sources, J. Infrared Milli Terahz Waves, 32, 1123-1143.

[477] Kulipanov, G.N., Bagryanskaya, E.G., Chesnokov, E.N., Choporova, Y.Yu., Gerasimov, V.V., Getmanov, Y.V., Kiselev, S.L., Knyazev, B.A., Kubarev, V.V., Peltek, S.E., Popik, V.M., Salikova, T.V., Scheglov, M.A., Seredniakov, S.S., Shevchenko, O.A., Skrinsky, A.N., Veber, S.L., Vinokurov, N.A., 2015, Novosibirsk Free Electron Laser – facility, description and recent experiments. IEEE Trans. on Terahertz Science and Technology, 5, No. 5, 798-809.

[478] Shevchenko, O.A., Arbuzov, V.S., Vinokurov, N.A., Vobly, P.D., Volkov, V.N., Getmanov, Y.V., Davidyuk, I.V., Deychuly, O.I., Dementyev, E.N., Dovzhernko, B.A., Knyazev, B.A., Kolobanov, E.I., Kondarov, A.A., Kozak, V.R., Kozyrev, E.V., Kurbarev, V.V., Kulipanov, G.N., Kuper, E.A., Kuptsov, I.V., Kurkin, G.Y., Krutikhin, S.A., Medvedev, L.E., Motygin, S.V., Ovchar, V.K., Osipov, V.N., Petrov, V.V., Pilan, A.M., Popik, V.M., Repkov, V.V., Salikova, T.V., Sedlyarov, I.K., Serednyakov, S.S., Skinsky, A.N., Tararyshkin, S.V., Tribendis, A.G., Cheskidov, V.G., Chernov, K.N., Shcheglov, M.A., 2017, Novosibirsk Free Electron Laser: Recent achievements and future prospects. Radiophysics and Quantum Electronics, 59, No. 8-9, 605-612.

[479] Kaminsky, A.K., Perel'shtein, E.A., Sedykh, S.N., Ginzburg, N.S., Kuzikov, S.V., Peskov, N.Yu., Sergeev, A.S., 2010, Demonstrating high-power 30-GHz free-electron maser operation on a resonant load. Technical Physics Letters, 36, 211-215.

[480] Bandurkin, I.V. Kaminsky, A.K., Perelstein, E.A., Peskov, N.Y., Savilov, A.V., Sedykh, S.N., 2012, High-power free-electron maser with frequency multiplication operating in a shortwave part of the millimeter wave range. Techn. Phys. Lett., 38, No. 8, 759-763.

[481] Peskov, N.Yu., Bandurkin, I.V., Kaminsky, A.K., Kuzikov, S.V., Perlstein, E.A., Savilov, A.V., Sedykh, S.N., Vikharev, A.A., 2016, High-power free-electron maser operated in a two-mode frequency-multiplying regime. Phys. Rev. Accel. and Beams, 19, 060704 (6pp).

[482] Jödicke, B., Mathews, H.-G., Agosti, G., Alberti, S., Bondeson, A., Hogge, J.P., Isaak, B., Muggli, P., Perrenoud, A., Tran, T.M., Tran, M.Q., 1989, Entwicklung von Hochleistungs-Gyrotrons in der Schweiz. ITG-Fachbericht 108, VDE-Verlag GmbH, Berlin, 191-195.

[483] Einat, M., Pilossof, M., Ben-Moshe, R., Hirshbein, H., Borodin, D., 2012, 95 GHz gyrotron with ferroelectric cathode. Physical Review Letters, 109, 185101 (5 pp).

[484] Avraham, E., Ben-Moshe, R., Pilossof, M., Einat, M., 2016, Frequency-replaceable ferro-electric cathode gyrotron for the entire Ka-band using replaceable resonator. IEEE Trans. on Electron Devices, 63, No. 5, 2097-2103.

[485] Pilossof, M., Einat, M., 2016, Initial results of 95 GHz gyrotron with water cooled magnet. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 25-30, 2016, Copenhagen, Denmark, HSP.21.04.

[486] Pilossof, M., Einat, M., 2018, 95-GHz gyrotron with room temperature dc solenoid. IEEE Trans. on Electron Devices, 65, No. 8, 3474-3478 and, 2019, private communication.
Pilossof, M., Einat, M., 2019, 95 GHz gyrotron with water cooled magnet and high average power. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Tu-PM1-1-6.

[487] Witman, M., Avraham, E., Ben-Moshe, R., Pilossof, M. Einat, M., 2019, Long pulse uncooled copper magnet for gyrotron. IEEE Trans. on Electron Devices, 66, No. 11, 4928-4931.

Pilossof, M., Einat, M., 2020, High-average-power second harmonic W-band gyrotron with room-temperature solenoid. IEEE Trans. on Electron Devices, 67, No. 4, 1804-1807.

[488] Bera, A., Singh, N.K., Kumar, N., Rathi, D., Satynaryana, K., Singh, U., Kulkarni, S.V., Mishra, A.K., Vishant, Khatun, H., Alaria, M.K., Varia, A., Parmar, K., Kadia, B., Srinivas Y.S.S., Kevadia, M., Ranjan, O., Pareek, N., Babu, R., Das, S., Jain, P.K., Sinha, A.K., Kartikeyan, M.V., Joshi, S., 2019, Development of 42-GHz, 200-kW gyrotron for Indian tokamak system tested in the regime of short pulselength. IEEE Trans. on Plasma Science, 47, No. 10, 4658-4663.

[489] Ives, L.R., Jory, H., Neilson, J., Chodorow, M., Feinstein, J., LaRue, A.D., Zitelli, L., Martorana, R., 1993, Development and test of a 500 kW, 8-GHz gyrotron. IEEE Trans. on Electron Devices, 40, 1316-1321.

[490] Felch, K., Chu, T.S., Feinstein, J., Huey, H., Jory, H., Nielson, J., Schumacher, R., 1992, Long-pulse operation of a gyrotron with beam/rf separation. Conf. Digest 17th Inf. Conf. on Infrared and Millimeter Waves, Pasadena, Proc., SPIE 1929, 184-195.

[491] Chu, T.S., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Felch, K., Jory, H., Saraph, G., Wagner, D., 2000, Recent progress in producing megawatt gyrotrons for ECH applications. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 13-14.

[492] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Jory, H., 2002, Progress update on CPI 500 kW and 1 MW, multi-second-pulsed gyrotrons. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 332-333.

[493] Chu, T.S., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Felch, K., Jory, H., 2002, Operation of a 500 kW, 84 GHz, long pulse gyrotron with collector potential depression. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 5-6.

[494] Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Felch, K., Jory, H., 2002, Development and demonstration of gyrotron oscillators and amplifiers at CPI. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 7-15.

[495] Bae, Y.S., Lee, H.K., Jeong, J.H., Namkung, W., Cho, M.H., Chu, S., 2003, Operation of high power 84-GHz gyrotron for KSTAR ECH system. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 38-39.

[496] Bae, Y.S., Na, Y.S., Oh, Y.K., Kwon, M., Bak, J.S., Lee, G.S., Jeong, J.H., Park, S.I., Cho, M.H., Namkung, W., Ellis, R.A., Park, H., Sakamoto, K., Takahashi, K., Yamamoto, T., 2007, Status of KSTAR electron cyclotron heating system, Fusion Science and Technology, 52, 321-333.

[497] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Jory, H., 2004, Demonstration of a 95 GHz, 100 kW, CW gyrotron oscillator. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 63-64.

[498] Cauffman, S., Blank, M., Cahalan, P., Felch, K., McGhee, R.W., Coffey, M., 2006, Operation of a 95 GHz 100 kW gyrotron in a high-Tc (BSCCO) magnet. Proc. Int. Vacuum Electronics Conference and Int. Vacuum Electron Sources (IVEC/IVESC 2006), Monterey, California, USA, 537-538.

[499] Cauffman, S., Blank, M., Felch, K., Borchard, P., Cahalan, P., Jory, H., 2007, Initial testing of a 95 GHz, 2.5 MW gyrotron. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 94-95.

[500] Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Felch, K., Jory, H., 2008, Development and demonstration of a multi-megawatt 95 GHz gyrotron oscillator, Proc. 9th IEEE Int. Vacuum Electronics Conference (IVEC 2008), Monterey, CA, USA, 32-33.

[501] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Jory, H., 2008, Recent test results on a 95 GHz, 2 MW gyrotron, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T2A2.1608.

[502] Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Felch, K., 2010, Development and demonstration of a multi-megawatt 95 GHz gyrotron, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 189-190.

[503] Blank, M., Bochard, P., Cahalan, P., Cauffman, S., Felch, K., 2011, Megawatt class gyrotron development at CPI. Proc. 8th Int. Workshop on Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, p. 8.

[504] Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Felch, K., 2011, Demonstration of a multi-megawatt 95 GHz gyrotron, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, Th4A.5.

[505] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., 2012, Recent high-power gyrotron activities at 95, 110 and 170 GHz, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 109-110.

[506] Cauffman, S., Blank, M., Borchard, P., Felch, K., 2012, Recent development and testing of megawatt-class gyrotrons, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Tue-A-3-3.

[507] Felch, K., Blank, M., 2012, private communications.

[508] Shimozuma, T., Sato, M., Takita, Y., Kubo, S., Idei, H., Ohkubo, K., Kuroda, T. Tubokawa, Y., Huey, H., Jory, H., 1994, Development of a high power 84 GHz gyrotron. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Cat No.: AP 941228, 65-66.

[509] Sato, M., Shimozuma, T. Takita, Y., Kubo, S., Idei, H., Ohkubo, K., Kudora, T., Watari, T., Loring, Jr., M., Chu, S., Felch, K., Huey, H., 1995, Development of a high power 84 GHz gyrotron. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 195-196.

[510] Shimozuma, T., Sato, M., Takita, Y., Ito, S., Kubo, S., Idei, H., Ohkubo, K., Watari, T., Chu, T.S., Felch, K., Cahalan, P., Loring, Jr., C.M., 1997, The first experiments on an 84 GHz gyrotron with a single-stage depressed collector. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 194-195, and private com.

[511] Shimozuma, T., Sato, M., Kubo, S., Idei, H., Yoshimura, Y., Takita, Y., Ito, S., Kobayashi, S., Mizuno, Y., Ohkubo, K., and LHD Experimental Group G1, G2, 1999, ECRH system and initial experiments in Large Helical Device. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, TU-D6.

[512] Malygin, S.A., 1986, A high-power gyrotron operating at the third harmonic of the cyclotron frequency. Soviet J. of Communications Techn. and Electronics, 31, 106-108.

[513] Zapevalov, V.E., Malygin, S.A., Tsimring, Sh.E., 1993, High-power gyrotrons at second harmonic of cyclotron frequency. Radiophysics and Quantum Electronics, 36, No. 6, 346-353.

[514] Zapevalov, V.E., Manuilov, V.N., Malygin, O.V., Tsimring, Sh.E., 1994, High-power twin-beam gyrotrons operating at the second gyrofrequency harmonic. Radiophys. and Quantum Electronics, 37, 237-240.

[515] Bogdanov, S.D., Gyrotron Team, Solujanava, E.A., 1994, Industrial gyrotrons from GYCOM. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 351-352.

[516] Goldenberg, A.L., Litvak, A.G., 1995, Recent progress of high-power millimeter wave-length gyrodevices. Phys. Plasmas, 2, 2562-2572 and private communications.

[517] Kurbatov, V.I., Malygin, S.A., Orlov, V.B., Solujanova, E.A., Tai, E.M., 1999, 70-140 GHz 1 MW gyrotrons on their way to CW operation. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 641-650.

[518] Belousov, V.I., Bogdashov, A.A., Denisov, G.G., Kurbatov, V.I., Malygin, V.I., Malygin, S.A., Orlov, V.B., Popov, L.G., Solujanova, E.A., Tai, E.M., Usachov, S.V., 2004, Test results of the 84 GHz / 200 kW / CW gyrotron. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating, Nizhny Novgorod, Russia, May 17-20, 2004.

[519] Litvak, A.G., Agapova, M.V., Denisov, G.G., Kurbatov, V.I., Tai, E.M., Malygin, S.A., Myasnikov, V.E., Ilyin, V.I., Usachev, S., Zapevalov, V.E., 2002, New results in development of MW output power gyrotrons for fusion systems, Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 295-296, and Private Comm., 2002.

[520] Zapevalov, V.E., Belousov, V.I., Bogdashov, A.A., Bykov, Yu.V., Chirkov, A.V., Denisov, G.G., Glyavin, M.Yu., Kuftin, A.N., Litvak, A.G., Lygin, V.K., Malygin, V.I., Malygin, O.V., Moiseev, M.A., Agapova, M.V., Gnedenkov, A.Ph., Iljin, V.N., Khmara, D.V., Kostyna, A.N., Kurbatov, V.I., Myasnikov, V.E., Nichiporenko, V.O., Popov, L.G., Usachev, S.V., Malygin, S.A., Solujanova, E.A., Tai, E.M., Roschin, Yu.V., Iljin, V.I., 2004, Evolution of Russian gyrotrons for fusion and technological application. Proc. 10th Int. Conf. Displays and Vac. Electr., Garmisch-Partenkirchen, ITG-Fachbericht 183, 41-44.

[521] Zapevalov, V.E., Kalynov, Khizhnjak, V.I., Yu.K., Lygin, V.K., Malygin, O.V., Malygin, S.A., Moiseev, M.A., Manuilov, V.N., Solujanova, E.A., Tai, E.M., 2004, Low frequency gyrotrons for fusion. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating, Nizhny Novgorod, Russia, 2005, 403-408.

[522] Belousov, V.I., Bogdashov, A.A., Denisov, G.G., Kurbatov, V.I., Malygin, V.I., Malygin, S.A., Orlov, V.B., Popov, L.G., Solujanova, E.A., Tai, E.M., Usachev, S.V., 2004, Test results of the 84 GHz/200 kW/CW gyrotron. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating (EC13), ed. A. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2005, 388-392.

[523] Denisov, G.G., Belousov, V.I., Chirkov, A.V., Litvak, A.G., Malygin, V.I., Shmelyov, M.Yu., Kurbatov, V.I., Kazanskiy, I.V., Solujanova, E.A., Tai, E.M., 2005, 200 kW/CW gyrotrons and transmission line components for fusion systems. Proc. 6th IEEE Int. Vacuum Electronics Conf. (IVEC 2005), Noordwijk, The Netherlands, 119-120.

[524] Denisov, G.G., Litvak, A.G., Myasnikov, V.E., Tai, E.M., 2005, Recent results in Gycom/ IAP development of high-power gyrotrons for fusion installations. Proc. 6th IEEE Int. Vacuum Electronics Conf. (IVEC 2005), Noordwijk, The Netherlands, 497-500.

[525] Kurbatov, V.I., Malygin, S.A., Orlov, V.B., Solujanova, E.A., Tai, E.M., Bogdashov, A.A., Chirkov, A.V., Denisov, G.G., Malygin, V.I., Pavelev, A.B., 2005, CW gyrotrons and attendant components at 200 kW microwave power level. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 113-118.

[526] Zapevalov, V.E., Kalynov, Yu.K., Lygin, V.K., Malygin, O.V., Malygin, S.A., Moiseev, M.A., Manuilov, V.N., Soluyanova, E.A., Tai, E.M., Khizhnjak, V.I., 2006, Low-frequency gyrotrons for fusion studies. Radiophysics and Quantum Electronics, 49, No. 3, 185-195.

[527] Bagryansky, P.A., Demin, S.P., Gospodchikov, E.D., Kovalenko, Yu.V., Malygin, V. I., Murakhtin, S.V., Savkin, V.Ya., Shalashov, A.G., Smolyakova, O.B., Solomakhin, A.L., Thumm, M. , Yakovlev, D.V.,2013, ECR heating system for the gas dynamic trap. Fusion Science and Technology, 63, (1T), 40-45.

[528] Vlasov, S.N., Koposova, E.V., Pavel'ev, A.B., Khizhnyak, V.I., 1996, Gyrotrons with echelette resonators. Radiophysics and Quantum Electronics, 39, No. 6, 458– 462.

[529] Agapov, L.N., Bogdanov, S.D., Venedictiov, N.P., Vlasov, S.N., Koposova, E.V., Kurbatov, V.I., Soluyanova, E.A., 2013, Electronic tuning of the working frequency of a gyrotron with an echelette structure. Radiophys. and Quantum Electr., 56, No. 7, 441-445.

[530] Denisov, G.G., Malygin, V.I., Tsvetkov, A.I., Eremeev, A.G., Shmelev, M.Yu., Belousov, V.I., Baber, I.S., Karpov, N.I., Leonov, I.I., Kopelovich, E.A., Troitskiy, M.M., Kuznetsov, M.V., Varygin, I.A., Zhurin, K.A., Movshevich, B.Z., Chirkov, A.V., Glyavin, M.Yu., Tai, E.M., Soluyanova, E.A., Bakulin, M.I., Roy, I.N., Anashkin, I.O., Khvostenko, P.P., Kirneva, N.A., 2020, Microwave setup of a megawatt power level for the ECR plasma heating and current drive system of T-15MD tokamak. Radiophysics and Quantum Electronics, 63, Nos. 5-6, 332-344.

[531] Chen, Z.-G., 1992, Luo, L., 2000, private communications, Institute of Electronics, Chinese Academy of Sciences (IEAS), Beijing, P.R. China and Guo, H., Wu, D.S., Liu, G., Miao, Y.H., Qian, S.Z., Qin, W.Z., 1990, Special complex open-cavity and low-magnetic field high power gyrotron. IEEE Trans. on Plasma Science, 18, 326-333.

Yao, X., Jiang, D., Feng, C., Yang, X., Zhang, H., Qi, X., Jiang, D., Li, Z., Wang, L., Zheng, S., 2000, Electron cyclotron wave current startup for ohmic discharges on the CT-6B tokamak. IEEE Trans. on Plasma Science, 28, 323-330.

[532] Xu, S.-X., Wang, B., Geng, Z.-H., Wang, H., Gu, W., Su, Y.-N., Liu, P.-K., 2011, Study of a quasi-optical mode converter for W-band gyrotron oscillator, IEEE Trans. on Plasma Science, 39, 3345-3350.

[533] Geng, Z.H., Su, Y.N., Liu, P.K., Xu, S.X., Gu, W., Liu, G.F., Du, C.H., Wang, H., 2014, Experiment and simulation of a W-band CW 30 kW low-voltage conventional gyrotron. IEEE Trans. on Electron Devices, 61, No. 6, 1789-1794.

[534] Luo, J., Feng, J., Gong, Y., 2021, A review of microwave vacuum devices in China. IEEE Microwave Magazine, 22, No. 4, 18-33.

[535] Du, C.H., Liu, P.K., Chang, T.H., Yuan, C.P., Yu, S.J., Liu, G.F., Li, Z.D., Shi, S.H., Xue, Q.Z., Zhang, S.C., Gu, W., Su, Y.L., Geng, Z.H., Xu, S.X., 2013, Experiment study of a W-band frequency tunable gyrotron oscillator with over-length cylindrical cavity. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 3P-10.

[536] Du, C.-H., Qi, X.-B., Liu, P.-K., Chang, T.-H., Xu, S.-X., Geng, Z.-H., Hao, B.-L., Xiao, L., Liu, G.-F., Li, Z.-D., Shi, S.-H., Wang, H., 2014, Theory and experiment of a W-band tunable gyrotron oscillator. IEEE Trans. on Electron Devices, 61, No. 6, 1781-1788.

[537] Sun, D., & Chen, H., Ma, G., Lei, W., Chen, H., Meng, F., 2014, A W-band third harmonic gyrotron with an iris cavity. J Infrared Milli Terahz Waves, 35, No. 5, 458-467.

[538] Sun, D., Ma, G., Huang, Y., Zhuo, T., Chen, 2015, Experimental study on 95 GHz TE02 mode third-harmonic gyrotron, High Power Laser and Particle Beams, 27, 070101 (2pp).

[539] Ma, G., Huang, Y., Zhuo, T., Sun, D., Jiang, Y., Li, Y., Ou, B., Chen, H., Meng, F., 2015, Experimental study of a 95 GHz gyrotron. 16th IEEE International Conference on Vacuum Electronics (IVEC 2015), Beijing, P.R. China, S23.6.

Sun, D., Zhuo, T., Ma, G., Hu, L., Chen, H., Meng, F., 2019, Recent results of a CW 94 GHz second harmonic gyrotron based on a continuous operation solenoid. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-Po-1-40.

Hu, L., Ma, G., Sun, D., Huang, Q., Zhuo, T., Gong, S., Jiang, Y., Zeng, Z., Ma, Q., Lei, W., Song, R., Hu, P., Hu, X., Guo, Z., Ku, X., Tan, Z., Chen, H., Meng, F., 2021, Development of a 28-GHz/50-kW/30-s gyrotron system for fusion application. IEEE Trans. on Plasma Science, 49, No. 4, 1468-1474.

[540] Pathania, V., Khatun, H., Han, S.-T., 2019, Operational characteristics of a 30 kW W-band gyrotron development at KERI. Proc. 20th Int. Vacuum Electronics Conference (IVEC 2019), Busan, Southkorea, P2-1.12.

Han, S.T., Sirigiri, J.R., Khatun, H., Pathania, V., Kim, J., 2021, Development of a compact W-band gyrotron system with a depressed collector. IEEE Trans. on Plasma Science, 49, No. 2, 672-679.

[541] Barroso, J.J., Castro, P.J., Pimenta, A.A., Spassovsky, V.A., Corrêa, R.A., Idehara, T., Ogawa, I., 1997, Operation of a 32 GHz gyrotron. Int. J. Infrared and Millim. Waves, 18, 2147-2160 and, 1995, SBMO/IEEE MTT-S IMOC'95 Proceedings.

[542] Maekawa, T., Teremuchi, Y., Yoshimura, S., Matsunaga, K., 1996, ECH system using an 88 GHz gyrotron for the WT-3 tokamak. Proc. 11th Topical Conference on RF in Plasmas, Palm Springs, AIP Conf. Proc., 355, 437-440.

[543] Idehara, T., 1995, private communication, Fukui University Japan.

[544] Carmel, Y., Chu, K.R., Dialetis, D., Fliflet, A., Read, M.E., Kim, K.J., Arfin, B., Granatstein, V.L., 1982, Mode competition, suppression, and efficiency enhancement in overmoded gyrotron oscillators. Int. J. Infrared and Millimeter Waves, 3, No. 5, 645-665.

[545] Carmel, Y., Chu, K.R., Read, M., Ganguly, A.K., Dialetis, D., Seeley, R., Levine, J.S., Granatstein, V.L., 1983, Realization of a stable and highly efficient gyrotron for controlled fusion research. Physical Review Letters, 50, No. 2, 112-116.

[546] Rhinewine, M., Read, M.E., 1986, A TE1,3 gyrotron at 85 GHz. Int. J. Electronics, 61, 729-733.

[547] Behm, K, Jensen, E., 1986, 70 GHz gyrotron development at Valvo. Conf. Digest 11th Int. Conf. on Infrared and Millimeter Waves, Pisa, 218-220.

[548] Kas'yanenko, D.V., Louksha, O.I., Piosczyk, B., Sominski, G.G., Thumm, M., 2002, Low-frequency parasitic oscillations in the 74.2 GHz moderate-power pulse gyrotron. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Acad. of Sciences, Nizhny Novgorod, 2003, Vol. 1, 162-167.

[549] Kas'yanenko, D.V., Louksha, O.I., Sominski, G.G., Piosczyk, B., Thumm, M., 2004, Experimental investigation of electron energy spectra in the collector region of moderate-power millimeter-wave gyrotron. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 81-86.

[550] Kas'yanenko, D., Louksha, O., Piosczyk, B., Sominski, G., Thumm, M., 2004, Measurements of electron beam characteristics in the moderate-power 4-mm gyrotron. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 661-662.

[551] Kas'yanenko, D.V., Louksha, O.I., Piosczyk, B., Sominsky, G.G., Thumm, M., 2004, Low-frequency parasitic space-charge oscillations in the helical electron beam of a gyrotron. Radio-physics and Quantum Electronics, 47, Nos. 5-6, 414-420.

[552] Louksha, O.I., Piosczyk, B., Louksa, O.I., Piosczyk, B., Sominski, G.G., Thumm, M., Samsonov, D.B., 2005, Effect of electron emission inhomogeneity on electron beam characteristics and output parameters of a 4-mm gyrotron. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 135-140.

[553] Louksha, O., Piosczyk, B., Samsonov, D., Sominski, G., Thumm, M., 2006, Improvement of gyrotron beam quality by suppression of parasitic low-frequency oscillations. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 85.

[554] Louksha, O.I., Piosczyk, B., Sominski, G.G., Thumm, M.K., Samsonov, D.B., 2006, On potentials of gyrotron efficiency enhancement: measurements and simulations on a 4-mm gyrotron. IEEE Trans. on Plasma Science, 34, 502-511.

[555] Louksha, O.I., Piosczyk, B., Samsonov, D.B., Sominski, G.G., Thumm, M.K., 2007, Experimental study of gyrotron efficiency enhancement by improvement of electron beam quality, Conf. Digest Joint 32nd Int. Conf. on Infrared and Millimetre Waves and 15th Int. Conf. on TeraHertz Electronics, Cardiff, UK, 880-881.

[556] Mourier, G., 1990, Current gyrotron development at Thomson Tubes Electroniques. Proc. Int. Workshop on Strong Microwaves in Plasmas, Suzdal, Inst. of Applied Physics, Nizhny Novgorod, 1991, 751-764 and, 1993, private communication.

[557] Kariya, T., Mitsunaka, Y., Imai, T., Saito, T., Tatematsu, Y., Sakamoto, K., Minami, R., Watanabe, O., Numakura, T., Endo, Y., 2007, Optimization of 28 GHz gyrotron output performance for ECRH experiment of the GAMMA 10. Trans. of Fusion Science and Technology, 51, 397-399.

[558] Ota, M., Kariya, T., Imai, T., Sakamoto, K., Minami, R., Endo, Y., Aoki, H., Iizumi, H., Kondou, H., 2011, Development of 28 GHz – 1 MW gyrotron for GAMMA10 ECRH. Trans. of Fusion Science and Technology, 59, 238-240.

[559] Kariya, T., Minami, R., Imai, T., Kato, K., Idei, H., Hanada, K., Zushi, H., Numakura, T., Endo, Y., Ichimura, M., 2015, Development of 28 GHz gyrotron for cooperative ECH study. Fusion Science and Technology, 68, 147-151.

[560] Kariya, T., Minami, R., Imai, T., Sakamoto, K., Kubo, S., Shimozuma, T., Takahashi, H., Ito, S., Mutoh, T., Mitsunaka, Y., Endo, Y., Shidara, H., Murofushi, N., Sakagoshi, Y., Yasutake, H., Okazaki, Y., 2009, Development of 28 GHz and 77 GHz 1 MW gyrotron for ECRH of magnetically confined plasma, Trans. of Fusion Science and Techn., 55, 91-94.

[561] Kariya, T., Minami, R., Imai, T., Ota, M., Endo, Y., Kubo, S., Shimozuma, T., Takahashi, T., Yoshimura, Y., Ito, S., Mutoh, T., Sakamoto, K., Mitsunaka, Y., 2011, Development of 28 GHz and 77 GHz, mega-watt gyrotrons for fusion devices, J. Infrared Milli Terahz Waves, 32, 295-310.

[562] Kubo, S., Nishiura, M., Tanaka, K., Shimozuma, T., Tatematsu, Y., Notake, T., Saito, T., Yoshimura, Y., Igami, H., Takahashi, H., Tamura, N., 2010, Collective Thomson scattering study using gyrotron in LHD. Plasma and Fusion Res.: Regular Art., 5, S1038 (5 pp).

[563] Takahashi, H., Shimozuma, T., Ito, S., Kubo, S., Yoshimura, Y., Igami, H., Nishiura, M., Kobayashi, S., Mizuno, Y., Okada, K., Takita, Y., Yamada, I., Yokoyama, M., Ido, T., Shimizu, A., Ida, K., Matsuoka, S., Satake, S., Mutoh, T. and the LHD experiment group, 2011, Study of high Te plasma characteristics of LHD using high power 77 GHz gyrotrons, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 41-42.

[564] Shimozuma, T., Takahashi, H., Ito, S., Kobayashi, S., Kubo, S., Yoshimura, Y., Igami, H., Nishiura, M., Ogasawara, S., Makino, R., Okada, K., Takita, Y., Ito, Y., Mutoh, T., Minami, R., Kariya, T., Imai, T., 2011, Optimization of high power and high efficiency operation of 77 GHz gyrotrons for ECRH in the large helical device, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, W2A.1.

[565] Kariya, T., Minami, R., Imai, T., Kubo, S., Shimozuma, T., Takahashi, H., Yoshimura, Y., Ito, S., Mutoh, T., Ota, M., Endo, Y., Sakamoto, K., 2011, Development of mega-watt gyrotrons for fusion research. Trans. of Fusion Science and Technology, 59, 241-243.

[566] Ogasawara, S., Kubo, S., Nishiura, M., Tatematsu, Y., Saito, T., Tanaka, K., Shimozuma, T., Yoshimura, Y., Igami, H., Takahashi, H., Ito, S., Takita, Y., Kobayashi, S., Mizuno, Y., Okada, K., Minami, R., Kariya, T., Imai, T., 2012, Suppression of spurious mode oscillation in megawatt 77-GHz gyrotron as a high quality probe beam source for the collective Thomson scattering in LHD. Review of Scientific Instruments, 83, 10D731-1 (3 pages).

[567] Ito, S., Shimozuma, T., Yoshimura, Y., Igami, H., Takahashi, H., Nishiura, M., Kobayashi, S., Mizuno, Y., Okada, K., Kubo, S., 2015, Recent results of gyrotron operation in NIFS. EPJ Web of Conferences, 87, 04013 (6pp).

[568] Kariya, T., Imai, T., Minami, R., Numakura, T., Eguchi, T., Kato, T., Endo, Y., Ichimura, M., Shimozuma, T., Kubo, S., Takahashi, H., Yoshimura, Y., Igami, H., Ito, S., Mutoh, T., Sakamoto,

K., Idei, H., Zushi, H., Nagasaki, K., Sano, F., Ono, M., Mitsunaka, Y., 2015, Development of gyrotrons for fusion with power exceeding 1 MW over a wide frequency range. Nucl. Fusion, 55, 093009 (10pp).

[569] Kariya, T., Imai, T., Minami, R., Sakamoto, K., Oda, Y., Ikeda, R., Shimozuma, T., Kubo, S., Idei, H., Numakura, T., Tsumura, K., Ebashi, Y., Okada, M., Nakashima, Y., Yoshimura, Y., Takahashi, H., Ito, S., Hanada, K., Nagasaki, K., Ono, M., Eguchi, T., Mitsunaka, Y., 2017, Development of over-MW gyrotrons for fusion at 14 GHz to sub-THz frequencies. Nucl. Fusion, 57, 066001 (9pp).

[570] Kariya, T., Minami, R., Imai, T., Okada, M., Motoyoshi, F., Numakura, T., Nakashima, Y., Idei, H., Onchi, T., Hanada, K., Shimozuma, T., Yoshimura, Y., Takahashi, H., Kubo, S., Oda, Y., Ikeda, R., Sakamoto, K., Ono, M., Nagasaki, K., Eguchi, T. Mitsunaka, Y., 2019, Development of high power gyrotrons for advanced fusion devices. Nucl. Fusion 59, 066009 (10pp).

[571] Li, H., Xie, Z., Wang, W., Luo, Y., Du, P., Den, X., Wang, H., Yu, S., Niu, X., Wang, L., Liu, S., 2002, 35 GHz third-harmonic gyrotron with a permanent magnet system. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 301-302.

[572] Li, H., Xie, Z.-L., Wang, W., Luo, Y., Du, P., Den, X., Wang, H., Yu, S., Niu, X., Wang, L., Liu, S., 2003, A 35-GHz low-voltage third-harmonic gyrotron with a permanent magnet system. IEEE Trans. on Plasma Science, 31, 264-271.

[573] Niu, X.-J., Wang, L., Li, H.-F., 2009, 94 GHz second-harmonic gyrotron with complex cavity, Proc. 10th IEEE Int. Vacuum Electronics Conference (IVEC 2009), Rome, Italy, pp. 469-470.

[574] Niu, X.-J., Wang, L., Li, H.-F., 2009, Experimental investigation of 94 GHz second-harmonic gyrotrons, Proc. 10th IEEE Int. Vacuum Electronics Conference (IVEC 2009), Rome, Italy, pp. 485-486.

[575] Niu, X.J., Li, W., Yu, S., Li, H.F., 2009, 94 GHz, 90 kW, CW, low-voltage gyrotron, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M5E52.0392.

[576] Liu, Y.-H., Niu, X., Liu, H., Yao, J., Zhou, J., Lei, C., Jiang, H., Yang, Y., Sun, Y., 2012, Design and experiment demonstration of a W-band second-harmonic gyrotron with complex cavity, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 337-338.

[577] Niu, X.J., Gu, L., 2012, Experiment of 94 GHz, CW, low-voltage gyrotron, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 507-508.

[578] Niu, X.J., Lei, C.J., Liu, Y.H., Li, H.F., 2013, A study on 94 GHz low-voltage, low-current gyrotron. IEEE Trans. on Electron Devices, 65, 3907-3912.

[579] Liu, Y-H., Liu, Q., Niu, X., Wang, H., Liu, J., Guo, G., Xu, L., Wang, L., Zhang, Y., Jia, K., Li, H., 2021, Design and experiment on a 95-GHz 400 kW-level gyrotron. IEEE Trans. on Electron Devices, 68, No. 1, 434-437.

[580] Kim, S.G., Sawant, A., Lee, I., Kim, D., Choe, M., Won, J.-H., Kim, J., So, J., Jang, W., Choi, E., 2016, System development and performance testing of a W-band gyrotron. J. Infrared Milli Terahz Waves, 37, 209-229.

[581] Felch, K., Chu, T.S., DeHope, W., Huey, H., Jory, H., Nielson, J., Schumacher, R., 1994, Recent test results on a high-power gyrotron with an internal, quasi-optical converter. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 333-334.

[582] Neilson, J.M., Felch, K., Chu, T.S., Feinstein, J., Hess, C., Huey, H.E., Jory, H.R., Mizuhara, Y.M., Schumacher, R., 1995, Design and tests of a gyrotron with a radially-extracted electron beam. IEEE Trans. on Plasma Science, 23, 470-480.

[583] Felch, K., Borchard, P., Chu, T.S., Jory, H., Loring, Jr., C.M., Neilson, J., Lorbeck, J.A., Blank, M., 1995, Long-pulse tests on a high-power gyrotron with an internal, quasi-optical converter. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 191-192.

[584] Felch, K., Blank, M., Borchard, P., Chu, T.S., Feinstein, J., Jory, H.R., Lorbeck, J.A., Loring, C.M., Mizuhara, Y.M., Nielson, J.M., Schumacher, R., Temkin, R.J., 1996, Long-pulse and CW tests of a 110 GHz gyrotron with an internal, quasi-optical converter. IEEE Trans. on Plasma Science, 24, 558-569.

[585] Felch, K., Borchard, P., Cahalan, P., Chu, T.S., Jory, H., Loring Jr., C.M., Moeller, C.P., 1996, Status of 1 MW CW gyrotron development at CPI. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, AM16.

[586] Felch, R., Borchard, P., Cauffman, S., Callis, R.W., Cahalan, P., Chu, T.S., Denison, D., Jory, H., Mizuhara, M., Remsen, D., Saraph, G., Temkin, R.J., 1998, Status report on a 110 GHz, 1 MW, CW gyrotron with a CVD diamond window. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 376-368.

[587] Chu, S., Blank, M., Borchard, P., Cauffman, S., Felch, K., Jory, H., 2004, Development of a 1.5 MW gyrotron at 110 GHz. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 30-31.

[588] Chu, T.S., Blank, M., Cahalan, P., Cauffman, S., Felch, K., Jory, H., 2005, High power testing of a 110 GHz gyrotron with a single-stage depressed collector. Proc. 6th IEEE Int. Vacuum Electronics Conf. (IVEC 2005), Noordwijk, The Netherlands, 117-118.

[589] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Jory, H., Gorelov, Y., Lohr, J., 2008, Operating experience on six 110 GHz, 1 MW gyrotrons for ECH applications. Nucl. Fusion, 48, 054008 (4pp).

[590] Chu, T.S., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Felch, K., Jory, H., 2003, Development of high power gyrotrons at 110 GHz and 140 GHz. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 32-33.

[591] Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Felch, K., Jory, H., 2004, Development of long-pulse, megawatt-class gyrotron oscillators at 110 and 140 GHz. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating (EC13), ed. A. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2005, 383-387.

[592] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Jory, H., 2005, Recent advances in increasing output power and pulse duration in gyrotron oscillators. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 237-238.

[593] Jory, H., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Felch, K., 2005, CPI gyrotrons for fusion EC heating. Proc. 7th Workshop on High Energy Density and High Power RF, AIP Conference Proceedings 807, 2006, 180-190.

[594] Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Felch, K., Jory, H., 2005, High-power gyrotron oscillator and broadband gyro-amplifier development at CPI. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2006, Vol. 1, 46-57.

[595] Lohr, J., Cengher, M., Deboo, J., Gorelov, I.A., Moeller, C.P., Neilson, J., Young, D., Ponce, D., 2009, Performance of the six gyrotron system on the DIII-D tokamak, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R4D03.0203.

[596] Lohr, J., Cengher, M., Doane, J.L., Ellis, R.A., Gorelov, Y.A., Kolemen, E., Moeller, C.P., Noraky, S., Penaflor, B.G., Ponce, D.M., Prater, R., Shapiro, M., Tax, D., 2012, Performance,

diagnostics, controls and plans for the gyrotron system on the DIII-D tokamak. EPJ Web of Conferences, 32, 02009/1-6.

[597] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., 2012, Gyrotrons for magnetic fusion applications at 110 GHz and 170 GHz. EPJ Web of Conferences, 32, 04007/1-5.

[598] Cauffman, S., Blanck, M., Borchard, P., Felch, K., 2013, Overview of fusion gyrotron development programs at 110 GHz, 117.5 GHz, 140 GHz, and 170 GHz. Proc. 38th Int. Conf. Infrared, Millim. and Terahz Waves (IRMMW-THz 2013), Mainz, Germany, Mo1-1.

[599] Cauffman, S., Blank, M., Borchard, P., Felch, K., 2014, First tests of a 117.5 GHz 1.8 megawatt gyrotron for plasma heating and current drive. Proc. 15th IEEE Int. Vacuum Electronics Conference (IVEC 2014), Monterey, CA, USA, 3.1.

[600] Felch, K., Blank, M., Borchard, P., Cauffman, S., 2014, Progress in the development of 117.5 GHz and 170 GHz gyrotrons. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W4_D-25.7.

[601] Felch, K., Blank, M., Borchard, P., Cauffman, S., 2015, Recent tests on 117.5 GHz and 170 GHz gyrotrons. EPJ Web of Conferences, 87, 04006 (4pp).

[602] Lohr, J., Anderson, J., Brambila, R., Cengher, M., Chen, X., Ellis, R.A., Grosnickle, W., Moeller, C., Prater, R., Ponce, D., Riford, L., Torrezan, A.C., 2016, The multiple gyrotron system on the DIII-D tokamak. J Infrared Milli Terahz Waves, 37, No. 1, 21-44.

[603] Cauffman, S., Blank, M., Borchard, P., Felch, K., 2016, Fusion gyrotron development in the 110-170-GHz frequency range. 17th IEEE International Vacuum Electronics Conference (IVEC 2016), April 19-21, 2016, Monterey, CA, USA, Invited Keynote, P4.11.

[604] Blank, M., Borchard, P., Cauffman, S., Felch, K., 2017, High power and high frequency gyrotron development at CPI. Proc. 10th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod-Moscow, Russia, pp. 27-28.

[605] Felch, K., Blank, M., Cauffman, S., Borchard, P.: Status of testing activities on gyrotrons for magnetic fusion applications, 2017, Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, WC2.3.

[606] Cengher, M., Lohr, J., Simmerling, P., Gorelev, Y., Torrezan, A., Ponce, D., Doane, J., Su, D., Chen, X., 2020, Status and plans for the DIII-D ECH/ECCD System. IEEE Trans. on Plasma Science, 48, No. 6, 1698-1702.

[607] Borie, E., Dammertz, G., Gantenbein, G., Kuntze, M., Möbius, A., Nickel, H.-U., Piosczyk, B., Thumm, M., 1993, 0.5 MW/140 GHz TE10,4 Gyrotron with built-in highly efficient quasioptical converter. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 519-520.

[608] Geist, T., Thumm, M., Wiesbeck, W., 1991, Linewidth measurement on a 140 GHz gyrotron. Conf. Digest 16th Int. Conf. on Infrared and Millimeter Waves, Lausanne, Proc., SPIE 1576, 272-273.

[609] Thumm, M., Borie, E., Dammertz, G., Kuntze, M., Möbius, A., Nickel, H.-U., Piosczyk, B., Wien, A., 1993. Development of high-power 140 GHz gyrotrons for fusion plasma applications. Proc. 2nd Int. Workshop on Strong Microwaves in Plasma, Moscow-Nizhny Novgorod-Moscow, Inst. of Applied Physics, Nizhny Novgorod, 1994, Vol. 2, 670-689.

[610] Gantenbein, G., Borie, E., Dammertz, G., Kuntze, M., Nickel, H.-U., Piosczyk, B., Thumm, M., 1994, Experimental results and numerical simulations of a high power 140 GHz gyrotron. IEEE Trans. Plasma Science, 22, 861-870.
Dumbrajs, O., Thumm, M., Pretterebner, J., Wagner, D., 1992, A cavity with reduced mode conversion for gyrotrons. Int. J. Infrared and Millimeter Waves, 13, 825-840.

[611] Thumm, M., Borie, E., Dammertz, G., Höchtl, O., Kuntze, M., Möbius, A., Nickel, H.-U., Piosczyk, B., Semmle, C., Wien, A., 1994, Development of advanced high-power 140 GHz

gyrotrons at KfK. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 57-58.

[612] Thumm, M., Braz, O., Dammertz, G., Iatrou, C.T., Kuntze, M., Piosczyk, B., Soudeé, G., 1995, Operation of an advanced, step-tunable 1 MW gyrotron at frequencies between 118 GHz and 162 GHz. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 199-200.

[613] Dammertz, G., Braz, O., Iatrou, C.T., Kuntze, M., Möbius, A., Piosczyk, B., Thumm, M., 1995, Highly efficient long-pulse operation of an advanced 140 GHz, 0.5 MW gyrotron oscillator. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 285-286.

[614] Piosczyk, B., Iatrou, C.T., Dammertz, G., Thumm, M., 1995, Operation of gyrotrons with single-stage depressed collectors. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 491-492.

[615] Dammertz, G., Braz, O., Kuntze, M., Piosczyk B., Thumm, M., 1997, Step-tunable 1 MW broad-band gyrotron with Brewster window. Proc. 10th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating, Ameland, The Netherlands, 483-488.

[616] Dammertz, G., Braz, O., Chopra, A.K., Koppenburg, K., Kuntze, M., Piosczyk, B., Thumm, M., 1999, Recent results of the 1-MW, 140-GHz, TE22,6-mode gyrotron. IEEE Trans. on Plasma Science, 27, 330-339.

[617] Koppenburg, K., Arnold, A., Borie, E., Dammertz, G., Drumm, O., Kartikeyan, M.V., Piosczyk, B., Thumm, M., Yang, X., 2002, Design of a multifrequency high power gyrotron at FZK. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 153-154.

[618] Thumm, M., Arnold, A., Borie, E., Dammertz, G., Drumm, O., Heidinger, R., Kartikeyan, M.V., Koppenburg, K., Meier, A., Piosczyk, B., Wagner, D., Yang, X., 2003, Development of frequency step tunable 1 MW gyrotrons in D-band. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 30-31.

[619] Yang, X., Drumm, O., Arnold, A., Borie, E., Dammertz, G., Koppenburg, K., Wagner, D., Thumm, M., 2003, Design of a quasi-optical mode converter for a frequency step-tunable gyrotron. Int. J. of Infrared and Millimeter Waves, 24, 1599-1608.

[620] Koppenburg, K., Arnold, A., Borie, E., Dammertz, G., Drumm, O., Kartikeyan, M.V., Piosczyk, B., Thumm, M., Yang, X., 2003, Recent results of the multifrequency high power gyrotron development at FZK. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 125-126.

[621] Koppenburg, K., Arnold, A., Borie, E., Dammertz, G., Drumm, O., Kartikeyan, M.V., Piosczyk, B., Thumm, M., Yang, X., 2004, Design of a step-tunable 105-140 GHz, 1 MW gyrotron at FZK. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 55-59.

[622] Prinz, O., Arnold, A., Gantenbein, G., Liu, Y., Thumm, M., Wagner, D., 2009, Highly efficient quasi-optical mode converter for a multifrequency high-power gyrotron, IEEE Transactions on Electron Devices, 56, 828-834.

[623] Prinz, O., Gantenbein, G., Thumm, M., 2007, Matching the output beam of a multi-frequency gyrotron to a Brewster window with small aperture, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 49-50.

[624] Prinz, O., Arnold, A., Dammertz, G., Flamm, F., Gantenbein, G., Jin, J., Piosczyk, B., Rzesnicki, T., Thumm, M., 2007, Quasi-optical mode converter for a multi-frequency D-band gyrotron, Conf. Digest Joint 32nd Int. Conf. on Infrared and Millimetre Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 888-889.

[625] Arnold, A., Prinz, O., Wagner, D., Thumm, M. 2007, Operation of a quasi-optical multi-mode generator for 105-150 GHz, Conf. Digest Joint 32nd Int. Conf. on Infrared and Millimetre Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 434-435.

[626] Prinz, O., Gantenbein, G., Thumm, M., 2008, Advanced quasi-optical mode converter for a multi-frequency gyrotron, Proc. 9th IEEE Int. Vacuum Electronics Conference (IVEC 2008), Monterey, CA, USA, 64-65.

[627] Agapova, M.V., Alikaev, V.V., Axenova, L.A., Bogdashov, A.A., Borshchegovsky, A.S., Keyer, A.P., Denisov, G.G., Flyagin, V.A., Fix, A.Sh., Ilyin, V.I., Ilyin, V.N., Khmara, V.A., Kostyna, A.N., Kuftin, A.N., Myasnikov, V.E., Nichiporenko, V.O., Popov, L.G., Zapevalov, V.E., Zakirov, F.G., 1995, Long-pulse 110 GHz/1MW gyrotron. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 205-206.

[628] Myasnikov, V.E., Agapova, M.V., Alikaev, V.V., Bogdashov, A.A., Borshegovsky, A.A., Denisov, G.G., Flyagin, V.A., Fix, A.Sh., Ilyin, V.I., Ilyin, V.N., Khmara, V.A., Khmara, D.V., Kostyna, A.N., Nichiporenko, V.O., Popov, L.G., Zapevalov, V.E., 1997, Long-pulse operation of 110 GHz 1 MW gyrotron. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 102-103.

[629] Myasnikov, V.E., Agapova, M.V., Alikaev, V.V., Borshchegovsky, A.S., Denisov, G.G., Flyagin, V.A., Fix, A.Sh., Ilyin, V.I., Ilyin, V.N., Keyer, A.P., Khmara, V.A., Khmara, D.V., Kostyna, A.N., Nichiporenko, V.O., Popov, L.G., Zapevalov, V.E., 1996, Megawatt power level long-pulses 110 GHz and 140 GHz gyrotrons. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 577-598.

[630] Zapevalov, V.E., 1996, Achievement of stable operation of powerful gyrotrons for fusion. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 599-613 and private communications.

[631] Glyavin, M.Yu., Kuftin, A.N., Venediktov, N.P., Zapevalov, V.E., 1997, Experimental investigation of a 110 GHz/1 MW gyrotron with the one-step depressed collector. Int. J. Infrared and Millimeter Waves, 18, 2129-2136.

[632] Myasnikov, V.E., Agapova, M.V., Nichiporenko, V.O., Popov, L.G., Usachev, S.V., Iljin, V.N., Khmara, V.A., Litvak, A.G., Denisov, G.G., Zapevalov, V.E., Flyagin, V.A., Fix, A.Sh., Alikaev, V.V., Iljin, V.I., 1999, Development of 1-MW long-pulse/CW gyrotrons in 110-170 GHz frequency range. Proc. Int. University Conf. "Electronics and Radiophysics of Ultra-High Frequencies" (UHF-99), 1999, St. Petersburg, Russia, 138-141.

[633] Myasnikov, V.E., Agapova, M.V., Nichiporenko, V.O., Popov, L.G., Usachev, S.V., Iljin, V.N., Khmara, V.A., Litvak, A.G., Denisov, G.G., Zapevalov, V.E., Flyagin, V.A., Fix, A.Sh., Alikaev, V.V., Iljin, V.I., 1999, Development of 1-MW long-pulse/CW gyrotrons in 110-170 GHz frequency range. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2000, Vol. 2, 610-614.

[634] Denisov, G.G., 1999, Development of 1 MW output power level gyrotrons for fusion systems. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 967-986.

[635] Denisov, G.G., Zapevalov, V.E., Litvak, A.G., Myasnikov, V.E., 2003, Megawatt gyrotrons for ECR heating and current-drive systems in controlled-fusion facilities. Radiophysics and Quantum Electronics, 46, 757-768.

[636] Litvak, A.G., Denisov, G.G., Myasnikov, V.E., Tai, E.M, 2005, Recent results in Gycom/IAP development of high-power gyrotrons for fusion installations. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 233-234.

[637] Denisov, G.G., Kuftin, A.N., Malygin, V.I., Venediktov, N.P., Vinogradov, D.V., Zapevalov, V.E., 1992, 110 GHz gyrotron with a built-in high-efficiency converter. Int. J. Electronics, 72, 1079-1091.

[638] Venediktov, N.P., Glyavin, M.Y., Zapevalov, V.E., Kuftin, A.N., 1998, Experimental study of a 110-GHz/1-MW gyrotron with a single-stage depressed collector. Radiophysics and Quantum Electronics, 41, 449-456.

[639] Bogdashov, A.A., Chirkov, A.V., Denisov, G.G., Kuftin, A.N., Lygin, V.K., Moiseev, M.A., Zapevalov, V.E., 2000, Development of the step tunable 140/110 GHz 1 MW gyrotron for fusion. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 21-22, and, 2000, private communications.

[640] Denisov, G.G., Belousov, V.I., Pavel'ev, A.B., Chirkov, A.V., Ilin, V.N., Kurbatov, V.I., Malygin, S.A., Myasnikov, V.E., Orlov, V.B., Soluyanova, E.A., Sokolov, E.V., Tai, D.M., 2006, Multi-frequency gyrotron with BN Brewster window. Conf. Digest 31st Int. Conf. on Infrared and Millim. Waves and 14th Int. Conf. on Terahz Electron., Shanghai, China, 75.

[641] Nichiporenko, V.O., Agapova, M.V., Denisov, G.G., Ilyin, V.I., Litvak, A.G., Malygin, S.A., Myasnikov, V.E., Popov, L.G., Solujanova, E.A., Zapevalov, V.E., Tai, E.M., 2006, State of the art of 1 MW/105-140 GHz/10 sec gyrotron project in GYCOM. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 338.

[642] Nagashima, T., Sakamoto, K., Maebara, S., Tsuneoka, M., Okazaki, Y., Hayashi, K., Miyake, S., Kariya, T., Mitsunaka, Y., Itoh, Y., Sugawara, T., Okamoto, T., 1990, Test results of 0.5 MW gyrotron at 120 GHz and 1.5 MW at 2 GHz Klystron for fusion application. Proc. Int. Workshop on Strong Microwaves in Plasmas, Suzdal, Inst. of Applied Physics, Nizhny Novgorod, 1991, 739-750 and, Okazaki, Y., 1994, private communication, Toshiba, Ohtawara, Japan.

[643] Sakamoto, K, Tsuneoka, M., Maebava, S., Kasugai, A., Fujita, H., Kikuchi, M., Yamamoto, T., Nagashima, T., Kariya, T., Okazaki, Y, Shirai, N., Okamoto, T. Hayashi, K., Mitsunaka, Y., Hirata, Y., 1992, Development of a high power gyrotron for ECH of tokamak plasma. Conf. Digest 17th Int. Conf. on Infrared and Millim. Waves, Pasadena, SPIE 1929, 188-189.

[644] Sakamoto, K., Tsuneoka, M., Kasugai, A., Maebara, S., Nagashima, T., Imai, T., Kariya, T., Okazaki, Y., Shirai, N., Okamoto, T., Hayashi, K., Mitsunaka, Y., Hirata, Y., 1993, Development of a high power gyrotron for fusion application in JAERI. Proc. 2nd Int. Workshop on Strong Microwaves in Plasmas, Moscow – Nizhny Novgorod - Moscow, ed. A.G. Litvak, Inst. of Applied Physics, Nizhny Novgorod, 1994, Vol. 2, 601-615.

[645] Sakamoto, K, Tsuneoka, M., Kasugai, A. Takahashi, K., Maebara, S., Imai, T., Kariya, T., Okazaki, Y., Hayashi, K., Mitsunaka, Y., Hirata, Y., 1994, Development of 110 GHz CPD gyrotron. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 63-64.

[646] Sakamoto, K., Tsuneoka, M., Kasugai, A., Imai, T., Kariya, T., Hayashi, K., Mitsunaka, Y., 1994, Major improvement of gyrotron efficiency with beam energy recovery. Phys. Rev. Lett., 73, 3532-3535.

[647] Hayashi, K., Hirata, Y., Mitsunaka, Y., 1996, Startup analysis of a gyrotron power supply system for depressed-collector operation. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, AM11.

[648] Sakamoto, K., Kasugai, A., Tsuneoka, M., Takahashi, K., Ikeda, Y., Imai, T., Kariya, T., Mitsunaka, Y., 1998, Development of high power gyrotron with diamond window. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 363-364, and private communications.

[649] Sakamoto, K., Kasugai, A., Takahashi, K., Tsuenoka, M., Ikeda, Yu., Ikeda, Yo., Imai, T., Kariya,T., Mitsunaka, Y., 1999, Status of high power gyrotron development for fusion application in JAERI. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, TU-A1.

[650] Fujii, T., Imai, T., 1999, Development of ECRF components and system for ITER and JT-60U tokamak. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 615-628.

[651] Sakamoto, K., Kasugai, A., Shoyama, H., Hayashi, K., Takahashi, K., Tsuneoka, M., Ikeda, Yu., Ikeda, Yo., Kajiwara, K., Moriyama, S., Seki, M., Fujii, T., Kariya, T., Mitsunaka, Y., Imai, T., 2000, Development of 100 GHz band gyrotrons and its application for JT-60U and ITER. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 11-12.

[652] Kajiwara, K., Ikeda, Y., Sakamoto, K., Kasugai, A., Seki, M., Moriyama, S., Takahashi, K., Imai, T., Mitsunaka, Y., Fujii, T., 2003, High power operation of 110 GHz gyrotron at 1.2 MW on the JT-60 ECRF system. Fusion Eng. and Design, 65, 493-499.

[653] Kasugai, A., Sakamoto, K., Takahashi, K., Kajiwara, K., Shoyama, H., Ikeda, Yu., Tsuneoka, M., Ikeda, Y., Fujii, T., Kariya, T., Mitsunaka, Y., Imai, T., 2001, 1 MW and long pulse operation of Gaussian beam output gyrotron with CVD diamond window for fusion devices. Fusion Engineering and Design, 53, 399-406.

[654] Sakamoto, K., Kasugai, A., Ikeda, Y., Hayashi, K., Takahashi, K., Tsuneoka, M., Kariya, T., Mitsunaka, Y., Imai, T., 2002, Development of 170 GHz and 110 GHz gyrotron for fusion application. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 336-337, and private communications, 2002.

[655] Sakamoto, K., 2003, Development of gyrotron and application to fusion research. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 11-12.

[656] Sakamoto, K., Kasugai, A., Ikeda, Y., Hayashi, K., Takahashi, K., Moriyama, S., Seki, M., Kariya, T., Mitsunaka, Y., Fujii, T., Imai, T., 2003, Development of 170 and 110 GHz gyrotrons for fusion devices. Nucl. Fusion, 43, 729-737.

[657] Fujii, T., Seki, M., Moriyama, S., Terakado, M., Shinozaki, S., Hiranai, S., Shimono, S., Hasegawa, K., Yokokura, K., and the JT-60 team, 2005, Operational progress of the 110 GHz-4 MW ECRF heating system in JT-60U. J. of Physics: Conf. Series, 25, 45-50.

[658] Moriyama, S., Kobayashi, T., Isayama, A., and the JT-60 RF heating group, 2009, Development of linear motion antenna and 110 GHz gyrotron for 7 MW electron cyclotron range of frequency system in JT-60SA tokamak, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M5E47.0442.

[659] Kobayashi, T., Moriyama, S., Seki, M., Sawahata, M., Terakado, M., Fujii, T., 2008, Achievement of 1.5 MW, 1 s oscillation by the JT-60U gyrotron, Plasma and Fusion Research: Rapid Communications, 3, 014-1 – 014-3.

[660] Kobayashi, T., Terakado, M., Sato, F., Yokokura, K., Shimono, Hasegawa, K., Sawahata, M., Suzuki, S., Hiranai, S., Igarashi, K., Wada, K., Suzuki, T., Kajiwara, K., Kasugai, A., Sakamoto, K., Isayama, A., Motsunaga, G., Moriyama, S., 2009, Development of high power gyrotron and power modulation technique using the JT-60U ECRF system, Plasma and Fusion Res.: Regular Articles, 4, 037-1 – 037-10.

[661] Kobayashi, T., Isayama, K., Yokokura, K., Shimono, M., Hasegawa, K., Sawahata, M., Suzuki, S., Terakado, M., Hiranai, S., Sato, F., Wada, K., Hinata, J., Sato, Y., Ohzeki, M., Takahashi, K., Kajiwara, K., Oda, Y., Kasugai, A., Sakamoto, K., Hoshino, K., Moriyama, S., 2011, Progress of high-power and long-pulse ECRF system development in JT-60, Nuclear Fusion, 51, 103037 (10 pp).

[662] Sakamoto, K., Kajiwara, K., Oda, Y., Takahashi, K., Hayashi, K., 2011, Progress of gyrotron development in JAEA, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 35-36.

[663] Sakamoto, K., Kajiwara, K., Oda, Y., Takahashi, K., Hayashi, K., Kobayashi, N., 2011, Development of high power long pulse gyrotron in JAEA, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, W4A.5.

[664] Kobayashi, T., Isayama, A., Sawahata, M., Suzuki, S., Terakado, M., Hiranai, S., Wada, K., Sato, Y., Hinata, J., Yokokura, K., Hoshino, K., Kajiwara, K., Sakamoto, K., Moriyama, S., 2012, Dual frequency gyrotron development for JT-60SA, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Mon-A-3-5.

[665] Kobayashi, T., Sawahata, M., Terakado, M., Hiranai, S., Wada, K., Sato, Y., Hinata, J., Yokokura, K., Hoshino,K., Kajiwara, K., Oda, Y., Takahashi, K., Ikeda, R., Moriyama, S., Sakamoto, K., 2013, Long pulse operation of a dual frequency gyrotron for JT-60SA. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Tu1-3.

[666] Kobayashi, T., Moriyama, S., Isayama, A., Sawahata, M., Terakado, M., Hiranai, S., Wada, K., Sato, Y., Hinata, J., Yokokura, K., Hoshino, K., Sakamaoto, K., 2015, Development of a dual frequency (110/138 GHz) gyrotron for JT-60SA and its extension to an oscillation at 82 GHz. EPJ Web of Conferences, 87, 04008 (5pp).

[667] Kobayashi, T., Moriyama, S., Yokokura, K., Sawahata, M., Terakado, M., Hiranai, S., Wada, K., Sato, Y., Hinata, J., Hoshino, K., Isamaya, A., Oda, Y., Ikeda, R., Takahashi, K., Sakamoto, K., 2015, Gyrotron development for high-power long-pulse electron cyclotron heating and current drive at two frequencies in JT-60SA and its extension toward operation at three frequencies. Nucl. Fusion, 55, 063008 (8pp).

[668] Kobayashi, T., Sawahata, M., Terakado, M., Hiranai, S.,Ikeda, R., Oda, Y., Wada, K., Hinata, J., Yokokura, K., Hoshino, K., Takahashi, K., Isayama, A., Moriyama, S., Sakamoto, K., 2015, Progress and status of the gyrotron development for the JT-60SA ECH/CD system. 40th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, T1E-1.

[669] Kobayashi, T., Ikeda, R., Oda, Y., Takahashi, K., Shidara, H., Sawahata, M., Terakado, M., Hiranai, S., Sato, F., Wada, K., Hinata, J., Yokokura, K., Hoshino, K., Moriyama, S., 2016, Progress and developments of high-power, long-pulse and multi-frequency ECH/CD system for JT-60SA. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 25-30, 2016, Copenhagen, Denmark, HSP.21.27.

[670] Kobayashi, T., Sawahata, M., Terakado, M., Hiranai, S., Sato, F., Wada, K., Hinata, J., Kajiwara, K., Oda, Y., Ikeda, R., Isayama, A., Takahashi, K., Moriyama, S., 2018, Development of ECH/CD system and preparation toward first plasma of JT-60SA. 20th Joint Workshop on Electron Cyclotron Emission (ECE) and Electron Cyclotron Resonance Heating (ECRH) (EC20), May 14-17, 2018, Greifswald, Germany.

[671] Shimozuma, T., Kikunaga, T., Asano, H., Yasojima, Y., Miyamoto, K., Tsukamoto, T., 1993, A 120 GHz high-power whispering-gallery mode gyrotron. Int. J. Electronics, 74, 137-151.

[672] Asano, H., Kikunagu, T., Shimozuma, T., Yasojima, Y., Tsukamoto, T., 1994, Experimental results of a 1 Megawatt gyrotron. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 59-60.

[673] Giguet, E., Dubrovin, A., Krieg, J.M., Thouvenin, Ph., Tran, C., Garin, P., Pain, M., Alberti, S., Tran, M.Q., Whaley, D.R., Borie, E., Braz, O., Möbius, A., Piosczyk, B., Thumm, M., Wien, A., 1995, Operation of a 118 GHz - 0.5 MW gyrotron with cryogenic window: design and long pulse

experiments. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 339-340.

[674] Alberti, S., Braz, O., Garin, P., Giguet, E., Pain, M., Thouvenin, P.H., Thumm, M., Tran, C., Tran, M.Q., 1996, Long pulse operation of a 0.5 MW - 118 GHz gyrotron with cryogenic window. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, AF1.

[675] Pain, M. Garin, P., Tran, M.Q., Alberti, S., Thumm, M., Braz, O., Giguet, E., Thouvenin, P., Tran, C., 1996, Status of the 118 GHz - quasi-CW gyrotron of the Tore Supra and TCV tokamaks. Fusion Technology, 1996, eds., C. Varandas, F. Serra. Elsevier Science Publishers B.V., 1997, 533-536.

[676] Alberti, S., Arnold, A., Borie, E., Dammertz, G., Erckmann, V., Garin, P., Giguet, E., Illy, S., Le Cloarec, G., Le Goff, Y., Magne, R., Michel, G., Piosczyk, B., Thumm, M., Tran, C., Tran, M.Q., Wagner, D., 2001, European high-power CW gyrotron development for ECRH systems. Fusion Engineering and Design, 53, 387-397.

[677] Darbos, C., Magne, R., Alberti, S., Barbuti, A., Berger-By, G., Bouquey, F., Cara, P., Clary, J., Courtois, L., Dumont, R., Giguet, E., Gil, D., Giruzzi, G., Jung, M., Le Goff, Y., Legrand, F., Lennholm, M., Liévin, C., Peysson, Y., Roux, D., Thumm, M., Wagner, T., Tran, M.Q., Zou, X., 2001, The 118 GHz ECRH experiment on Tore Supra. Fusion Eng. and Design, 56-57, 605-609.

[678] Magne, R., Alberti, S., Barbuti, A., Bouquey, F., Clary, J., Darbos, C., Giguet, E., Hogge, J.Ph., Jung, M., Le Goff, Y., Lennholm, M., Liévin, Ch., Portafaix, Ch., Roux, D., Saoutic, B., Thumm, M., 2001, Very long pulse testing of the TH 1506 B 118 GHz gyrotron. Proc. 14th Top. Conf. on Radio Frequency Power in Plasmas, Oxnard, California, AIP Conference Proceedings, Vol. 595, 477-481.

[679] Magne, R., Bouquey, F., Clary, J., Darbos, C., Jung, M., Lambert, R., Lennholm, M., Roux, D., Alberti, A., Hogge, J.P., Bariou, D., Legrand, F., Liévin, C., Arnold, A., Thumm, M., 2004, Improvement of the gyrotron TH 1506B for tore supra. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 32-33.

[680] Darbos, C., Alberti, S., Arnold, A., Bariou, D., Bouquey, F., Clary, J., Hogge, J.P., Lennholm, M., Liévin, C., Magne, R., Thumm, M., 2004, New design of the gyrotron used for ECRH experiments on Tore Supra. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating (EC13), ed. A. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2005, 409-414.

[681] Darbos, C., Arnold, A., Prinz, H.O., Thumm, M., Bouquey, F., Hogge, H.P., Lambert, R., Liévin, C., Magne, R., Traisne, E., 2007, Upgrade of the TH1506B 118 GHz gyrotron using modelling tools, Proc. 17th Topical Conf. on Radio Frequency Power in Plasmas, Clearwater, Florida, USA, AIP Conf. Proc., Vol. 933, 425-428.

[682] Prinz, H.O., Arnold, A., Dammertz, G., Thumm, M., 2007, Analysis of a TE22,6 118-GHz quasi-optical mode converter, IEEE Trans. on Microwave Theory and Techniques, 55, 1697-1703.

[683] Darbos, C., Magne, R., Arnold, A., Prinz, H.O., Thumm, M., Bouguey, F., Hogge, J.P., Lambert, R., Lennholm, M., Liévin, C., Traisnel, E., 2009, The 118-GHz electron cyclotron heating system on Tore Supra, Fusion Science and Technology, 56, 1205-1218.

[684] Liu, B., Feng, J., Zhang, Ya., Zhang, Yi., Li, Z., Zeng, X., An, K., 2018, Experiments on a 140 GHz TE22,6-mode gyrotron. Proc. 19th Int. Vacuum Electronics Conference (IVEC 2018), Monterey, CA, USA, P7.12.

[685] Liu, B., Feng, J., Zhang, Yi., Zhang, Ya., Chen, B., 2019, Study of 140 GHz and 170 GHz gyrotrons for fusion plasma ECRH. Proc. 20th Int. Vacuum Electronics Conference (IVEC 2019), Busan, Southkorea, 13.3.

[686] Blank, M., Felch, K., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Jory, H., 2003, Development of a 140 GHz, 1 MW, long-pulse gyrotron oscillator. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 123-124.

[687] Jory, H., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Felch, K., 2003, Test results for a 140 GHz, 1 MW gyrotron. Proc. 6th Workshop of High Energy Density and High Power RF, Berkeley Springs, West Virginia, 224-233.

[688] Blank, M., Felch, K., Borchard, P., Cahalan, P., Cauffman, S.R., Chu, T.S., Jory, H., 2004, Demonstration of a high-power long-pulse 140-GHz gyrotron oscillator. IEEE Trans. on Plasma Science, 32, 867-876.

[689] Felch, K., Blank, M., Borchard, P., Cahalan, P., Cauffman, S., Chu, T.S., Jory, H., 2005, Recent ITER-relevant gyrotron tests. Journal of Physics: Conference Series, 25, 13-23.

[690] Blank, M., Borchard, P., Cauffman, S., Felch, K., 2015, Development and demonstration of a 900 kW, 140 GHz gyrotron. 16th IEEE International Conference on Vacuum Electronics (IVEC 2015), Beijing, P.R. China, S23.3.

[691] Cauffman, S., Blank, M., Borchard, P., Felch, K., 2015, Design and testing of a 900 kW, 140 GHz gyrotron. 40th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, M1E-5.

[692] Hu, L., Ma, G., Sun, D., Zhuo, T., Chen, H., Meng, F., 2018, Design and experiment of a 140 GHz 50 kW gyrotron. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, Th-A2-4-3.
Hu, L., Ma, G., Sun, D., Zhuo, T., Huang, Q., Chen, H., Meng, F., 2019, Development of a 140 GHz 50 kW gyrotron in IAE. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Tu-AM-1-5.

[693] Borie, E., Gantenbein, G., Jödicke, B., Dammertz, G., Dumbrajs, O., Geist, T., Hochschild, G., Kuntze, M., Nickel, H.-U., Piosczyk, B., Thumm, M., 1992, Mode competition using TE03 gyrotron cavities. Int. J. Electronics, 72, 687-720.

[694] Dammertz, G., Haubrich, G., Hochschild, G., Jödicke, B., Kitlinski, M., Kuntze, M., Möbius, A., Piosczyk, B., Stickel, H., 1988, First experimental results of the KfK 150 GHz gyrotron. Int. J. Electronics, 64, 29-36.

[695] Gantenbein, G., Borie, E., Möbius, A., Piosczyk, B., Thumm, M., 1991, Design of a high-power 140 GHz gyrotron oscillator operating in an asymmetric volume mode at KfK. Conf. Digest 16th Int. Conf. on Infrared and Milli. Waves, Lausanne, Proc., SPIE 1576, 264-265.

[696] Piosczyk, B., Kuntze, M., Borie, E., Dammertz, G., Dumbrajs, O., Gantenbein, G., Möbius, A., Nickel H.-U., Thumm, M., 1992, Development of high power 140 GHz gyrotrons at KfK for applications in fusion. Fusion Technology 1992, eds. C. Ferro, M. Gasparotto, H. Knoepfel. Elsevier Science Publishers B.V., 1993, 618-622.

[697] Gantenbein, G., Borie, E., Dumbrajs, O., Thumm, M., 1995, Design of a high order volume mode cavity for a 1 MW/140 GHz gyrotron. Int. J. Electronics, 78, 771-782.

[698] Dammertz, G., Braz, O., Iatrou, C.T., Kuntze, M., Möbius, A., Pioszyk, B., Thumm, M., 1996, Long-pulse operation of a 0.5 MW TE10,4 gyrotron at 140 GHz. IEEE Trans. on Plasma Science, 24, 570-578.

[699] Piosczyk, B., Iatrou, C.T., Dammertz, G., Thumm, M., 1996, Single-stage depressed collectors for gyrotrons. IEEE Trans. on Plasma Science, 24, 579-585.

[700] Dammertz, G., Braz, O., Kuntze, M., Piosczyk, B., Thumm, M., 1996, Design criteria for step tunable long-pulse gyrotrons. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 660-666.

[701] Dammertz, G., Braz, O., Kuntze, M., Piosczyk, B., Thumm, M., 1997, Influence of window reflections on gyrotron operation. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 150-151.

[702] Kuntze, M., Borie, E., Dammertz, G., Piosczyk, B., Thumm, M., 1999, 140 GHz gyrotron with 2.1 output power. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, W-A6.

[703] Dammertz, G., Borie, E., Iatrou, C.T., Kuntze, M., Piosczyk, B., Thumm, M.K, 2000,140-GHz gyrotron with multimegawatt output power. IEEE Trans. on Plasma Science, 28, 561-566.

[704] Piosczyk, B., Borie, E., Braz, O., Dammertz, G., Iatrou, C.T., Illy, S., Kern, S., Kuntze, M., Kartikeyan, M.V., Michel, G., Möbius, A., Thumm, M., 1996, Advanced high power gyrotrons for ECW application. Fusion Technology 1996, eds., C. Varandas, F. Serra. Elsevier Science Publishers B.V., 1997, 545-548.

[705] Kuntze, M., Borie, E., Braz, O., Dammertz, G., Illy, S., Michel, G., Möbius, A., Piosczyk, B., Thumm, M., 1998, Advanced high power gyrotrons for ECRH applications. Proc. 20th Int. Symp. on Fusion Technology (SOFT), Marseille, France, Vol. 1, 489-492.

[706] Piosczyk, B., Arnold, A., Borie, E., Dammertz, G., Drumm, O., Dumbrajs, O., Illy, S., Kuntze, M., Koppenburg, K., Schmid, M., Thumm, M., 2001, Progress in the development of advanced high power gyrotrons. Proc. 2nd IEEE Int. Vacuum Electronics Conf. (IVEC 2001), Noordwijk, Netherlands, 327-330.

[707] Piosczyk, B., Arnold, A., Borie, E., Dammertz, G., Drumm, O., Dumbrajs, O., Illy, S., Kuntze, M., Koppenburg, K., Schmid, M., Thumm, M., 2001, Advanced high power gyrotrons for fusion applications. Proc. 9th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 165, 149-152.

[708] Piosczyk, B., Arnold, A., Borie, E., Dammertz, G., Drumm, O., Dumbrajs, O., Illy, S., Kuntze, M., Koppenburg, K., Thumm, M., 2001, Development of advanced high power gyrotrons at Forschungszentrum Karlsruhe. Frequenz, 55, 242-246.

[709] Kuntze, M., Alberti, S., Dammertz, G., Giguet, E., Illy, S., Heidinger, R., Koppenburg, K., LeCloarec, G., LeGoff, Y., Leonhardt, W., Piosczyk, B., Schmid, M., Thumm, M.K., Tran, M.Q., 2003, Advanced high power gyrotrons. IEEE Trans. on Plasma Science, 31, 25-31.

[710] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H., LeCloarec, G., Legrand, F., LeGoff, Y., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Rzesnicki, T., Schmid, M., Thumm, M., Tran, M.Q., 2004, Development of multimegawatt gyrotrons for fusion plasma heating and current drive. 5th IEEE Int. Vacuum Elect. Conf. (IVEC 2004), Monterey, CA, USA, 28-29.

[711] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Förster, W., Gantenbein, G., Garin, P., Giguet, E., Illy, S., Kasparek, W., Laqua, H., Le Cloarec, G., Le Goff, Y., Leonhardt, W., Magne, R., Michel, G., Müller, G., Kuntze, M., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2001, 1 MW, 140 GHz, CW gyrotron for Wendelstein 7-X. Proc. 9th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 165, 143-147.

[712] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Hogge, J.-P., Illy, S., Kasparek, W., Koppenburg, K., Laqua, H., Le Cloarec, G., Le Goff, Y., Leonhardt, W., Liévin, Ch., Magne, R., Michel, G., Müller, G., Neffe, G., Kuntze, M., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2001, Development of a 140 GHz, 1 MW, continuous wave gyrotron for the W7-X stellarator. Frequenz, 55, 270-275.

[713] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H.P., LeCloarec, G., LeGoff, Y., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe,

G., Piosczyk, B., Schmid, M., Schwörer, K., Thumm, M.K., Tran, M.Q., 2002, Development of a 140-GHz 1-MW continuous wave gyrotron for the W7-X stellarator. IEEE Trans. on Plasma Science, 30, 808-818.

[714] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H., LeCloarec, G., Legrand, F., LeGoff, Y., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.P., 2002, 140 GHz, 1 MW, CW gyrotron for fusion plasma heating. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 330-331.

[715] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H.P., LeCloarec, G., Legrand, F., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Schwörer, K., Thumm, M., Tran, M.Q., 2002, Progress of the 1 MW, 140 GHz, CW gyrotron for W7-X. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 3-4.

[716] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H.P., LeCloarec, G., LeGoff, Y., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2002, Status of the 1 MW, 140 GHz gyrotron for W7-X. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 16-28.

[717] Dammertz, G., Alberti, S., Fasel, D., Giguet, E., Koppenburg, K., Kuntze, M., Legrand, F., Leonhardt, W., Lievin, C., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Sterk, A., Thumm, M., Tran, M.Q., Verhoeven, A.G.A., 2003, Power modulation capabilities of the 140 GHz/1MW gyrotron for the stellarator Wendelstein 7-X. Fusion Engineering and Design, 66-68, 497-502.

[718] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H., LeCloarec, G., Legrand, F., LeGoff, Y., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2003, Progress in the development of a 1-MW, CW gyrotron at 140 GHz for fusion plasma heating. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 34-35.

[719] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H.P., LeCloarec, G., Legrand, F., Leonhardt, W., Liévin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Schwoerer, K., Thumm, M., Tran, M.Q., 2003, Prototype of a 1 MW, CW gyrotron at 140 GHz for Wendelstein 7-X. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 121-122.

[720] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H.P., LeCloare, G., Legrand, F., Leonhardt, W., Liévin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Schwörer, K., Thumm, M., Tran, M.Q., 2004, The 140-GHz 1-MW CW gyrotron for the Stellarator W7-X, Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 35-39.

[721] Dammertz, G., Alberti, S., Arnold, A., Brand, P., Braune, H., Borie, E., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.-P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H., LeCloarec, G., Legrand, F., Leonhardt, W., Liévin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Schwörer, K., Thumm, M., Tran, M.Q., 2004,

Progress in the development of 1 MW CW gyrotrons for the stellarator W7-X. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating (EC13), ed. A. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2005, 371-376.

[722] Dammertz, G., Alberti, S., Arnold, A., Borie, E., Brand, P., Braune, H., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Kuntze, M., Laqua, H., LeCloarec, G., Legrand, F., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2004, Status of the 1 MW, CW gyrotrons for the stellarator W7-X. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 113-114.

[723] Dammertz, G., Alberti, S., Bariou, D., Brand, P., Braune, H., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Kasparek, W., Laqua, H.P., Liévin, C., Leonhardt, W., Michel, G., Müller, G., Neffe, G., Piosczyk, P., Schmid, M., Thumm, M., 2005, 140 GHz high-power gyrotron development for the stellarator W7-X. Fusion Eng. and Design, 74, 217-221.

[724] Dammertz, G., 2005, Development of a 1-MW, CW gyrotron at 140 GHz for electron-cyclotron-resonance-heating in fusion plasma devices. Proc. 6th IEEE Int. Vacuum Electronics Conf. (IVEC 2005), Noordwijk, The Netherlands, 113.

[725] Dammertz, G., Alberti, S., Arnold, A., Bariou, D., Borie, E., Brand, P., Braune, H., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Laqua, H., Legrand, F., Leonhardt, W., Lievin, C., Michel, G., Müller, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2005, Experimental results on the 140 GHz, 1 MW, CW gyrotrons for the stellarator W7-X. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 235-236.

[726] Dammertz, G., Alberti, S., Arnold, A., Bariou, D., Brand, P., Braune, H., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.-P., Illy, S., Jin, J., Kasparek, W., Koppenburg, K., Laqua, H.P., Legrand, F., Leonhardt, W., Lievin, C., Magne, R., Michel, G., Müller, G., Neffe, G., Piosczyk, P., Rzesnicki, T., Schmid, M., Thumm, M., Tran, M.Q., Yang, X., 2005, Development of multimegawatt gyrotrons for fusion plasma heating and current drive. IEEE Trans. on Electron Devices, 52, No. 5, 808-817.

[727] Gantenbein, G., Dammertz, G., Alberti, S., Arnold, A., Erckmann, V., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Koppenburg, K., Laqua, H., Legrand, F., Leonhardt, W., Liévin, C., Michel, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2006, Status of the 1-MW, 140-GHz, CW gyrotron for W7-X. Proc. Int. Vacuum Electronics Conference and Int. Vacuum Electron Sources (IVEC/IVESC 2006), Monterey, California, USA, 533-534.

[728] Dammertz, G., Alberti, S., Arnold, A., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Laqua, H., Legrand, F., Leonhardt, W., Liévin, C., Michel, G., Neffe, G., Piosczyk, B., Schmid, M., Thumm, M., Tran, M.Q., 2006, Status of the series production of 1-MW, 140-GHz, CW gyrotrons for W7-X. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 21.

[729] Thumm, M., Alberti, S., Arnold, A., Dammertz, G., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.-P., Illy, S., Kasparek, W., Laqua, H.P., Lievin, C., Magne, R., Michel, G., Piosczyk, B., Schwörer, K., Tran, M.Q., Yang, X., 2005, Status of 1 MW, 140 GHz, CW gyrotron for W7-X. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 33-45.

[730] Gantenbein, G., Dammertz, G., Erckmann, V., Illy, S., Kasparek, W., Lechte, C., Legrand, F., Lietaer, G., Liévin, C., Piosczyk, B., Schmid, M., Thumm, M., 2007, Experimental results on

high-power gyrotrons for the stellarator W7-X. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves & 15th Int. Conf. on Terahertz Electr., Cardiff, UK,102-103.

[731] Braune, H., Brand, P., Dammertz, G., Erckmann, V., Gantenbein, G., Kasparek, W., Laqua, H.P., Lechte, C., Leonhardt, W., Mellein, D., Michel, G., Noke, F., Purps, F., Schlüter, K.-H., Schmid, M., Thumm, M., and the W7-X ECRH Teams at IPP, IPF and FZK, 2007, Extended operation of the 1 MW, CW gyrotrons for W7-X. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves & 15th Int. Conf. on Terahertz Electr., Cardiff, UK,104-105.

[732] Thumm, M., Alberti, A., Arnold, A., Brand, P., Braune, H., Dammertz, G., Erckmann, V., Gantenbein, G., Giguet, E., Heidinger, R., Hogge, J.P., Illy, S., Kasparek, W., Laqua, H.P., Legrand, F., Leonhardt, W., Liévin, C., Michel, G., Neffe, G., Piosczyk, B., Schmid, M., Schwörer, K., Tran, M.Q., 2007, EU megawatt-class 140-GHz CW gyrotron, IEEE Trans. on Plasma Science, 35, 143-153.

[733] Schmid, M., Illy, S., Dammertz, G., Erckmann, V., Thumm, M., 2007, Transverse field collector sweep system for high power CW gyrotrons, Fus. Eng. and Design, 82, 744-750.

[734] Thumm, M., Brand, P., Braune, H., Dammertz, G., Erckmann, V., Gantenbein, G., Illy, S., Kasparek, W., Laqua, H.P., Lechte, C., Leonhardt, W., Michel, G., Neffe, G., Piosczyk, B., Schmid, M., Weissgerber, M., 2008, Progress in the 10-MW 140-GHz ECH system for the stellarator W7-X, IEEE Trans. on Plasma Science, 36, 341-355.

[735] Thumm, M., Braune, H., Dammertz, G., Erckmann, V., Gantenbein, G., Illy, S., Kern, S., Kasparek, W., Laqua, H.P., Lechte, C., Legrand, F., Leonhardt, W., Lievin, C., Michel, G., Piosczyk, B., Prinz, O., Schmid, M., 2008, 1 MW, 140 GHz series gyrotrons for the W7-X stellarator, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2009, Vol. 1, pp. 84-94.

[736] Braune, H., Erckmann, V., Illy, S., Laqua, H.P., Noke, F., Purps, F., Schmid, M., 2008, Advanced transverse field collectors sweeping for high power gyrotrons, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 1, pp. 149-153.

[737] Kern, S., Schlaich, A., Flamm, J., Gantenbein, G., Latsas, G., Rzesnicki, T., Samartsev, A., Thumm, M., Tigelis, I., 2009, Investigations on parasitic oscillations in megawatt gyrotrons, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, T4C01.0132.

[738] Gantenbein, G., Dammertz, G., Flamm, J., Illy, S., Kern, S., Latsas, G., Piosczyk, B., Rzesnicki, T., Samartsev, A., Schlaich, A., Thumm, M., Tigelis, I., 2010, Experimental investigations and analysis of parasitic RF oscillations in high-power gyrotrons, IEEE Trans. on Plasma Science, 38, 1168-1177.

[739] Schlaich, A., Flamm, J., Gantenbein, G., Kern S., Latsas, G., Rzesnicki, T., Samartsev, A., Thumm, M., Tigelis, I., 2010, Investigations on parasitic oscillations in megawatt gyrotrons, Proc. 11th IEEE Int. Vacuum Electronics Conf. (IVEC 2010), Monterey, USA, pp. 33-34.

[740] Gantenbein, G., Erckmann, V., Illy, S., Kern, S., Kasparek, W., Lechte, C., Leonhardt, W., Liévin, C., Samartsev, A., Schlaich, A., Schmid, M., Thumm, M., 2011, 140 GHz, 1 MW CW gyrotron development for fusion applications – Progress and recent results. J. of Infrared, Millimeter, and Terahertz Waves, 32, 320-328.

[741] Thumm, M., Gantenbein, G., Erckmann, V., Illy, S., Kern, S., Kasparek, W., Lechte, C., Leonhardt, W., Liévin, C., Samartsev, A., Schlaich, A., Schmid, M., 2011, 140 GHz, 1 MW, CW gyrotron development for the ECRH system of the stellarator Wendelstein7-X, Proc. 12th IEEE Int. Vacuum Electonic Conf. (IVEC 2011), Bangalore, India, pp. 105-106.

[742] Thumm, M., Braune, H., Dammertz, G., Gantenbein, G., Erckmann, V., Illy, S., Kern, S., Kasparek, W., Lechte, C., Leonhardt, W., Liévin, C., Michel, G., Noke, F., Purps, F., Samartsev,

A., Schlaich, A., Schmid, M., Schulz, T., 2011, Recent progress on the 1 MW, 140 GHz, CW series gyrotrons for W7-X, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 45-46.

[743] Gantenbein, G., Braune, H., Dammertz, G., Erckmann, V., Illy, S., Kern, S., Kasparek, W., Lechte, C., Leonhardt, W., Lievin, C., Michel, G., Noke, F., Purps, F., Samartsev, A., Schlaich, A., Schmid, M., Thumm, M., 2011, Status of 1 MW, 140 GHz series gyrotrons for W7-X, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, W4A.1.

[744] Jelonnek, J., Braune, H., Dammertz, G., Erckmann, V., Flamm, J., Gantenbein, G., Hollmann, F., Jonitz, L., Kasparek, W., Kern, S., Laqua, H.P., Lechte, C., Légrand, F., Leonhardt, W., Lietaer, G., Michel, G., Noke, F., Purps, F., Samartsev, A., Schlaich, A., Schmid, M., Thumm, M., Uhren, P., 2012, Progress on 140 GHz, 1 MW, CW series gyrotrons for W7-X, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Thu-A-2-2.

[745] Schmid, M., Roy Choudhury, A., Dammertz, G., Erckmann, V., Gantenbein, G., Illy, S., Jelonnek, J., Kern, S., Legrand, F., Rzesnicki, T., Samartsev, A., Schlaich, A., Thumm, M., 2013, Recent achievements on tests of series gyrotrons for W7-X and planned extension at the KIT gyrotron test facility. Fusion Eng. and Design, 88, 945-949.

[746] Schlaich, A., Gantenbein, G., Jelonnek, J., Thumm, M., 2013, Transient millimeter-wave signal analysis with unambiguous RF spectrum reconstruction. IEEE Trans. on Microwave Theory and Techniques, 61, 4660-4666.

[747] Schlaich, A., Jelonnek, J., Thumm, M., 2013, Millimeter-wave time-domain spectrum analysis system with unambiguous RF spectrum reconstruction. 2013 International Microwave Symposium (IMS 2013), Seattle, WA, USA, WEPN-1.
Schlaich, A., Gantenbein, G., Jelonnek, J., Thumm, M., 2013, Simulation of high power gyrotron operation during window arc. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo P1-41.

[748] Roy Choudhury, A., D'Andrea, D., Thumm, M., 2015, Study of dynamic after cavity interaction in gyrotrons – Part II: Influence of a nonuniform magnetic field. IEEE Trans. on Electron Devices, 62, No. 1, 192-199.

[749] Leggieri, A., Alberti, S., Avramidis, K.A., Dammertz, G., Erckmann, V., Gantenbein, G., Hogge, J.-P., Illy, S., Ioannidis, Z., Jelonnek, J., Jin, J., Laqua, H., Legrand, Lievin, C. Marchesin, R., Pagonakis, I.Gr., Rzesnicki, T., Thouvenin, P., Thumm, M., Wolf, R., 2019, Thales TH1507 140 GHz 1 MW CW gyrotron for W7-X stellarator. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-AM-1-1.

[750] Wilde, F., Marsen, S., Stange, T., Moseev, D., Oosterbeek, J.W., Laqua, H.P., Wolf, R.C., Avramidis, K., Gantenbein, G., Pagonakis, I.Gr., Illy, S., Jelonnek, J., Thumm, M.K., W7-X Team, 2019, Automated mode recovery for gyrotrons demonstrated at Wendelstein 7-X. Fusion Eng. and Design, 148, 111258 (6pp).

[751] Illy, S., Avramidis, K.A., Ioannidis, Z.C., Aiello, G., Benin, P., Chelis, I., Dinklage, A., Gantenbein, G., Jelonnek, J., Jin, J., Laqua, H.P., Leggieri, A., Legrand, F., Liévin, C., Marchesin, R., Marsen, S., Pagonakis, I.Gr., Ruess, T., Rzesnicki, T., Scherer, T., Strauss, D., Thumm, M., Tigelis, I., Wagner, D., Weggen, J., Wolf, R.C., Wendelstein 7-X Team. Recent development of a 1.5 MW, 140 GHz continuous-wave gyrotron for the upgraded ECRH system at W7-X. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Gyrotrons 2.2.

[752] Cismondi, F., Albajar, F., Bonicelli, T., EGYC Team (KIT), 2014, Thales Team (TED): EU development program for the 1 MW gyrotron for ITER. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, T4_E-16.15.

[753] Albajar, F., G. Aiello, S. Alberti, F. Arnol, K. Avramidis, M. Bader, R. Batista, R. Bertizzolo, T. Bonicelli, F. Braunmueller, C. Brescan, A. Bruschi, B. van Burg, K. Camino, G. Carannante, V. Casarin, A. Castillo, F. Cauvard, C. Cavalieri, M. Cavinato, R. Chavan, J. Chelis, F. Cismondi, D. Combescure, C. Darbos, D. Farina, D. Fasel, L. Figini, M. Gagliardi, F. Gandini, G. Gantenbein, T. Gassmann, R. Gessner, T.P. Goodman, V. Gracia, G. Grossetti, C. Heemskerk, M. Henderson, V. Hermann, J.P. Hogge, S. Illy, Z. Ioannidis, J. Jelonnek, J. Jin, W. Kasparek, J. Koning, A.S. Krause, J.D. Landis, G. Latsas, F.Li, F. Mazzocchi, A. Meier, A. Moro, R. Nousiainen, D. Purohit, S. Nowak, T. Omori, J. van Oosterhout, J. Pacheco, I. Pagonakis, P. Platania, E. Poli, A.K. Preis, D. Ronden, Y. Rozier, T. Rzesnicki, G. Saibene, F. Sanchez, F. Sartori, O. Sauter, T. Scherer, C. Schlatter, S. Schreck, A. Serikov, U. Siravo, C. Sozzi, P. Spaeh, A. Spichiger, D. Strauss, K. Takahashi, M. Thumm, J. Tigelis, A. Vaccaro, J. Vomvoridis, M.Q. Tran, B. Weinhorst, 2015, Status of Europe's contribution to the ITER EC system. EPJ Web of Conferences, 87, 04004 (6pp).

[754] Pagonakis, I.Gr., Albajar, F., Alberti, S., Avramidis, K., Bonicelli, T., Braunmueller, F., Bruschi, A., Chelis, J., Cismondi, F., Gantenbein, G., Hermann, V., Hesch, K., Hogge, J.-P., Jelonnek, J., Jin, J., Illy, S., Ioannidis, Z.C., Kobarg, T., Latsas, G.P., Legrand, F., Lontano, M., Piosczyk, B., Rozier, Y., Rzesnicki, T., Samartsev, A., Schlatter, C., Thumm, M., Tigelis, I.G., Tran, M.Q., Tran, T.-M., Weggen, J., Vomvoridis, J.L., 2015, Status of the development of the EU 170GHz/ 1 MW/CW gyrotron. Fusion Eng. and Design, 96-97, 149-154.

[755] Rozier, Y., Albajar, F., Alberti, S., Avramidis, K.A., Bonicelli, T., Cismondi, F., Frigot, P.-E., Gantenbein, G., Hermann, V., Hogge, J.-P., Jelonnek, J., Jin, J., Legrand, F., Lietaer, G., Pagonakis, I.Gr., Rzesnicki, T., Thumm, M., 2016, Manufacturing and tests of the European 1 MW, 170 GHz CW gyrotron prototype for ITER. 17th IEEE Int. Vacuum Electronics Conference (IVEC 2016), April 19-21, 2016, Monterey, CA, USA, S8.1.

[756] Hogge, J.-P., Alberti, S., Braunmueller, F., Schlatter, C., Tran, M.Q., Avramidis, K., Gantenbein, G., Illy, S., Ioannidis, Z.C., Jelonnek, J., Jin, J., Kobarg, T., Losert, M., Pagonakis, I.G., Rzesnicki, T., Schmid, M., Thumm, M., Hermann, V., Rozier, Y., Chelis, J., Vomvoridis, J.L., Latsas, G.P., Tigelis, I.G., Zisis, A., Bin, W., Bruschi, A., Lontano, M., Kasparek, W., Lechte, C., Albajar, F., Bonicelli, T., P.-E. Frigot, P.-E., 2016, Status and experimental results of the European 1 MW, 170 GHz industrial CW prototype gyrotron for ITER. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 25-30, 2016, Copenhagen, Denmark, H3B.1.

[757] Ioannidis, Z.C., Rzesnicki, T., Albajar, F., Alberti, S., Avramidis, K.A., Bin, W., Bonicelli, T., Bruschi, A., Chelis, I., Frigot, P.-E., Gantenbein, G., Hermann, V., Hogge, J.-P., Illy, S., Jin, J. Jelonnek, J., Kasparek, W., Latsas, G., Lechte, C., Legrand, F., Kobarg, T., Pagonakis, I.Gr., Rozier, Y., Schlatter, C., Schmid, M., Tigelis, I.G., Thumm, M., Tran, M.Q., Zein, A., Zisis, A., 2017, CW Experiments with the EU 1-MW, 170-GHz industrial prototype gyrotron for ITER at KIT. IEEE Trans. on Electron Devices, 64, No. 9, 3885-3892.

[758] Gantenbein, G., Albajar, F., Alberti, S., Avramidis, K., Bin, W., Bonicelli, T., Bruschi, A., Chelis, J., Fanale, F., Legrand, F., Hermann, V., Hogge, J.-P., Illy, S., Ioannidis, Z.C., Jin, J., Jelonnek, J., Kasparek, W., Latsas, G.P., Lechte, C., Lontano, M., Pagonakis, I.G., Rzesnicki, T., Schlatter, C., Schmid, M., Tigelis, I.G., Thumm, M., Tran, M.Q., Vomvoridis, J.L., Zein, A. Zisis, A., 2017, Experimental results of the EU ITER prototype gyrotrons. EPJ Web of Conferences, 157, 03016 (4pp).

[759] Rzesnicki, T., Albajar, F., Alberti, S., Avramidis, K., Bin, W., Bonicelli, T., Braunmueller, F., Bruschi, A., Chelis, J., Frigot, P.-E., Gantenbein, G., Hermann, V., Hogge, J.-P., Illy, S., Ioannidis, Z.C., Jelonnek, J., Jin, J., Kasparek, W., Latsas, G.P., Lechte, C., Lontano, M., Kobarg, T., Pagonakis, I.G., Rozier, Y., Schlatter, C., Schmid, M., Tigelis, I.G., Thumm, M., Tran, M.Q., Vomvoridis, J.L., Zisis, A., 2017, Experimental verification of the European 1 MW, 170 GHz industrial CW prototype gyrotron for ITER. Fusion Engineering and Design, 123, 490-494.

[760] Ioannidis, Z.C., Rzesnicki, T., Avramidis, K., Gantenbein, G., Illy, S., Jin, J., Kobarg, T., Pagonakis, I.Gr., Schmid, M., Thumm, M., Jelonnek, J., Hermann, V., Rozier, Y., Legrand, F., Alberti, S., Braunmueller, F., Hogge, J.-P., Schlatter, C., Genoud, J., Tran, M.Q., Kasparek, W., Lechte, C., Vomvoridis, J.L., Chelis, J., Latsas, G.P., Zisis, A., Tigelis, I.G., Bruschi, A., Bin, W., Lantano, M., Albajar, A., Bonicelli, T., Frigot, P.-E.: First cw experiments with the EU ITER 1 MW, 170 GHz industrial prototype gyrotron. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, GIII-1.

[761] Rzesnicki, T., Ioannidis, Z.C., Avramidis, K., Gantenbein, G., Illy, S., Jelonnek, J., Jin, J., Kobarg, T., Pagonakis, I.Gr., Schmid, M., Thumm, M., EGYC Team, 2017, Experimental study on further performance optimization of the European 1 MW, 170 GHz gyrotron prototype for ITER. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, WC2.5.

[762] Ioannidis, Z.C., Albajar, F., Alberti, S., Avramidis, K.A., Bin, W., Bonicelli, T., Bruschi, A., Chelis, J., Fanale, F., Gantenbein, G., Genoud, J., Hogge, J.-P., Hermann, V., Illy, S., Jelonnek, J., Jin, J., Kasparek, W., Latsas, G.P., Legrand, F., Lechte, C., Pagonakis, I.Gr., Rzesnicki, T., Sánchez, F., Schlatter, C., Schmid, M., Tigelis, I.G., Thumm, M., Tran, M.Q., Zisis, A. Zein, A., 2019, Recent experiments with the European 1MW, 170 GHz industrial CW and short-pulse gyrotrons for ITER. Fusion Engineering and Design, 146, Part A, 349-352.

[763] Ioannidis, Z., Rzesnicki, T., Albajar, F., Alberti, S., Avramidis, K., Bin, W., Bonicelli, T., Bruschi, A., Chelis, I., Fanale, F., Gantenbein, G., Hermann, V., Hogge, J.-P., Illy, S., Jin, J., Jelonnek, J., Kasparek, W., Latsas, G., Lechte, C., Legrand, F., Pagonakis, I., Sanchez, F., Schmid, M., Schlatter, C., Thumm, M., Tigelis, I., Tran, M.Q., Zisis, A., Zein, A., 2019, Report of recent experiments with the European 1 MW, 170 GHz CW and SP prototype gyrotrons for ITER. EPJ Web of Conferences, 203, 04006 (5pp).

[764] Myasnikov, V.E., Cayer, A.P., Bogdanov, S.D., Kurbatov, V.I., 1991, Soviet industrial gyrotrons. Conf. Digest 16th Int. Conf. on Infrared and Millimeter Waves, Lausanne, SPIE 1576, 127-128.

[765] Flyagin, V.A., Goldenberg, A.L., Zapevalov, V.E., 1993, State of the art of gyrotron investigation in Russia. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 581-584.

[766] Denisov, G.G., Flyagin, V.A., Goldenberg, A.L., Khizhnyak, V.I., Kuftin, A.N., Malygin, V.I., Pavelyev, A.B., Pylin, A.V., Zapevalov, V.E., 1991, Investigation of gyrotrons in IAP. Conf. Digest 16th Int. Conf. on Infrared and Millimeter Waves, Lausanne, SPIE 1576, 632-635.

[767] Agapova, M.V., Axenova, L.A., Alikaev, V.V., Cayer, A.P., Denisov, G.G., Flyagin, V.A., Fix, A.Sh., Iljin, V.I., Ilyin, V.N., Khmara, V.A., Kostyna, A.N., Kuftin, A.N., Mjasnikov, V.E., Popov, L.G., Zapevalov, V.E., 1994, Long-pulsed 140 GHz/0.5 MW gyrotron: problems and results. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 79-80.

[768] Mjasnikov, V.E., Agapova, M.V., Alikaev, V.V., Borshchegovsky, A.S., Denisov, G.G., Fljagin, V.A., Fix, A.Sh., Ilyin, V.I., Ilyin, V.N., Keyer, A.P., Khmara, V.A., Khmara, D.V., Kostyna, A.N., Nichiporenko, V.O., Popov, L.G., Zapevalov, V.E., 1996, Megawatt power long-pulse 140 GHz gyrotron. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, ATh1.

[769] Zapevalov, V.E., Alikaev, V.V., Denisov, G.G., Flyagin, V.A., Fix, A.Sh., Kuftin, A.N., Kurbatov, V.I., Myasnikov, V.E., 1997, Development of 1 MW ouptut power level gyrotron for ITER. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 108-109.

[770] Denisov, G.G., Flyagin, V.A., Kuftin, A.N., Lygin, V.K., Moiseev, M.A., Zapevalov, V.E., 1996, Development of the prototype 170 GHz/ 1 MW gyrotron for ITER at IAP. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, N. Novgorod, 1997, Vol.2, 717-722.

[771] Myasnikov, V.E., Agapova, M.V., Kostyna, A.N., Popov, L.G., Denisov, G.G., Bogdashov, A.A., Zapevalov, V.E., 1998, Development of 140 GHz/ 1 MW gyrotron with a dual RF beam output. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 375-376.

[772] Myasnikov, V.E., Agapova, M.V., Ilyin, V.N., Khmara, D.V., Kostyna, A.N., Nichiporenko, V.O., Popov, L.G., Zakirov, F.G., Shamanova, N.A., Alikaev, V.V., Ilyin, V.I., Denisov, G.G., Zapevalov, V.E., Bogdashov, A.A., Kuftin, A.N., Lygin, V.K., Litvak, A.G., Chirkov, A.V., Moiseev, M.A., 2001, Status of the 140 GHz/800 kW/3-10 s gyrotron for TEXTOR tokamak. Proc. 2nd IEEE Int. Vacuum Electronics Conf. (IVEC 2001), Noordwijk, Netherlands, 321-323.

[773] Myasnikov, V.E., Usachev, S.V., Agapova, M.V., Alikaev, V.V., Denisov, G.G., Fix, A.Sh., Flyagin, V.A., Gnedenkov, A. Ph., Ilyin, V.I., Kuftin, A.N., Popov, L.G., Zapevalov, V.E., 1998, Long-pulse operation of 170 GHz/1 MW gyrotron for ITER. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 24-25.

[774] Myasnikov, V.E., Litvak, A.G., Usachev, S.V., Popov, L.G., Agapova, M.V., Alikaev, V.V., Denisov, G.G., Gnedenkov, A. Ph., Ilyin, V.I., Ilyin, V.N., Khmara, D.V., Kostyna, A.N., Nichiporenko, V.O., Zapevalov, V.E., 1999, Development of 170 GHz gyrotron with depressed collector and diamond window for ITER. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, TU-A8.

[775] Zapevalov, V.E., Denisov, G.G., Flyagin, V.A., Fix, A.Sh., Kuftin, A.N., Litvak, A.G., Agapova, M.V., Iljin, V.N., Khmara, V.A., Myasnikov, V.E., Nichiporenko, V.O., Popov, L.G., Usachev, S.V., Alikaev, V.V., Iljin, V.I., 2001, Development of 170 GHz/1 MW Russian gyrotron for ITER. Fusion Eng. and Design, 53, 377-385.

[776] Myasnikov, V.E., Litvak, A.G., Usachev, S.V., Popov, L.G., Agapova, M.V., Alikaev, V.V., Denisov, G.G., Gnedenkov, A.Ph., Ilyin, V.I., Ilyin, V.N., Khmara, D.V., Kostyna, A.N., Nichiporenko, V.O., Zapevalov, V.E., 2002, Development of 170 GHz gyrotron for ITER. Proc. 3rd IEEE Int. Vacuum Electr. Conf. (IVEC 2002), Monterey, USA, 334-335.

[777] Denisov, G.G., 2002, Megawatt gyrotrons for fusion research. State of the art and trends of development. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 29-45.

[778] Litvak, A.G., Denisov, G.G., 2003, Gyrotron oscillator for fusion reactor. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 352-353.

[779] Denisov, G.G., Bogdashov, A.A., Belousov, V.I., Chirkov, A.V., Kalynova, G.I., Kuftin, A.N., Litvak, A.G., Lygin, V.K., Malygin, V.I., Moiseev, M.A., Zapevalov, V.E., Kurbatov, V.I., Malygin, S.A., Orlov, V.B., Tai, E.M., Ilyin, V.N., Popov, L.G., Myasnikov, V.E., Sokolov, E.V., Apagova, M.V., Usachev, S.V., Soluyanova, E.V., Gnedenkov, A.F., Khmara, D.V., Kostyna, A.N., Nichiporenko, V.O., Manuilov, V.N., Ilyin, V.I., 2003, New results in development of MW output power gyrotrons for fusion systems. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 28-29.

[780] Zapevalov, V.E., Belousov, V.I., Bogdashov, A.A., Chirkov, A.V., Denisov, G.G., Kuftin, A.N., Litvak, A.G., Lygin, V.K., Malygin, V.I., Moiseev, M.A., Agapova, M.V., Gnedenkov, A.Ph., Iljin, V.N., Khmara, D.V., Kostyna, A.N., Myasnikov, V.E., Nichiporenko, V.O., Popov, L.G.,

Usachev, S.V., Roschin, Yu.V., Iljin, V.I., 2003, Evolution of 170 GHz/1 MW Russian gyrotron for ITER. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 165-166.

[781] Usachev, S.V., Litvak, A.G., Myasnikov, V.E., Popov, L.G., Agapova, M.V., Nichiporenko, V.O., Denisov, G.G., Bogdashov, A.A., Gnedenkov, A.Ph., Ilyin, V.I., Ilyin, V.N., Khmara, D.V., Kostyna, A.N., Kuftin, A.N., Kurbatov, V.I., Lygin, V.K., Moiseev, M.A., Malygin, V.I., Zapevalov, V.E., Tai, E.M., 2004, Development of 170 GHz/ 1 MW/CW gyrotron for ITER. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating (EC13), ed. A. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2005, 398-402.

[782] Litvak, A.G., Myasnikov, V.E., Usachev, S.V., Popov, L.G., Agapova, M.V., Nichiporenko, V.O., Denisov, G.G., Bogdashov, A.A., Gnedenkov, A.Ph., Ilyin, V.I., Ilyin, V.N., Khmara, D.V., Kostyna, A.N., Kuftin, A.N., Lygin, V.K., Moiseev, M.A., Malygin, V.I., Solujanova, E.A., Zapevalov, V.E., Tai, E.M., 2004, Development of 170 GHz/1MW/50%/CW gyrotron for ITER. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 111-112.

[783] Denisov, G.G., Litvak, A.G., Myasnikov, V.E., Tai, E.M., Ilin, V.I., Zapevalov, V.E., 2005, Megawatt-power gyrotrons for fusion. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 62-75.

[784] Agapova, M.V., Bogdashov, A.A., Chirkov, A.V., Denisov, G.G., Gnedenko, A.Ph., Ilyin, V.I., Ilyin, V.N., Khmara, D.V., Kostyna, A.N., Kuftin, A.N., Kurbatov, V.I., Litvak, A.G., Lygin, V.K., Malygin, V.I., Malygin, S.A., Moiseev, M.A., Myasnikov, V.E., Nichiporenko, V.O., Popov, L.G., Soluyanova, E.A., Shamanova, N.A., Tai, E.M., Usachev, S.V., Zapevalov, V.E., 2005, Development status of 1 MW and 1.5-1.7 MW / 170 GHz gyrotrons for ITER. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2006, Vol. 1, 107-112.

[785] Agapova, M.V., Denisov, G.G., Ilyin, V.I., Litvak, A.G., Myasnikov, V.E., Popov, L.G., Usachev, S.V., Zapevalov, V.E., Tai, E.M., 2006, Recent results in the development of 170 GHz/CW gyrotrons for ITER. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 516.

[786] Denisov, G.G., Litvak, A.G., Myasnikov, V.E., Tai, E.M., Zapevalov, V.E., 2007, Recent results of development in Russia of high power gyrotrons, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 43-44.

[787] Litvak, A.G., Denisov, G.G., Il'in, V.N., Myasnikov, V.E., Tai, E.M., Vikharev, A.L., Zapevalov, V.E., 2007, Resent results of development in Russia of high power gyrotrons. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 41-43.

[788] Usachev, S.V., Agapova, M.V., Bogdashov, A.A., Chirkov, A.V., Denisov, G.G., Gnedenkov, A.Ph., Ilyin, V.N., Kostyna, A.N., Kuftin, A.N., Litvak, A.G., Malygin, V.I., Myasnikov, V.E., Nichiporenko, V.O., Popov, L.G., Soluyanova, E.A., Tai, E.M., Zapevalov, V.E., 2007, New test results of 170 GHz/1 MW/50%/CW gyrotron for ITER. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 44-45.

[789] Popov, L.G., Denisov, G.G., Litvak, A.G., Agapova, M. V., Gnedenkov, A.P., Kostyna, A.N., Nichiporenko, V.O., Myasnikov, V.E., Tai, E.M., Usachev, S.V., Zapevalov, V.E., Chirkov, A.V., Ilin, V.I., Ilin, V.N., Kuftin, A.N., Malygin, S.A., Malygin, V.I.., Parshin, V.V., Pavel'ev, A.B., Rukavishnikova, V.G., Roschin, Yu.V., Sokolov, E.V., Solyanova, E.A., Vikharev, A.L., 2008, Development in Russia of 170 GHz gyrotron for ITER, Proc. 33rd Int. Conf. on Infrared, Millim and Terahz Waves, Pasadena, CA, USA, W4U4.1472.

[790] Popov, L.G., Usachev, S.V., Agapova, M.V., Chirkov, A.V., Denisov, G.G., Gnedenkov, A.Ph., Ilyin, V.I., Ilyin, V.N., Kostyna, A.N., Kuftin, A.N., Litvak, A.G., Malygin, S.A., Malygin, V.I., Myasnikov, V.E., Nichiporenko, V.O., Roschin, Yu.V., Rukavishnikova, V.G., Soluyanova, E.A., Tai, E.M., Yakunin, A.N., Yashnov, Yu.M., Zapevalov, V.E., 2008, Test results of 170 GHz / 1 MW / 50% gyrotron for ITER, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2009, Vol. 1, pp. 95-99.

[791] Litvak, A.G., Denisov, G.G., Agapova, M.V., Gnedenkov, A.Ph., Kostyna, A.N., Nichiporenko, V.O., Myasnikov, V.E., Popov, L.G., Tai, E.M., Usachev, S.V., Zapevalov, V.E., Chirkov, A.V., Ilin, V.I., Ilin, V.N., Kuftin, A.N., Malygin, S.A., Malygin, V.I., Parshin, V.V., Pavel'ev, A.B., Rukavishnikova, V.G., Roschin, Yu.V., Sokolov, E.V., Soluyanova, E.A., Vikharev, A.L., 2009, Development in Russia of 170 GHz gyrotron for ITER, Proc. 10th IEEE Int. Vacuum Electron. Conf. (IVEC2009), Rome, Italy, pp. 281-282.

[792] Litvak, A.G., Denisov, G.G., Agapova, M.V., Gnedenkov, A.Ph., Kostyna, A.N., Nichiporenko, V.O., Myasnikov, V.E., Popov, L.G., Tai, E.M., Usachev, S.V., Zapevalov, V.E., Chirkov, A.V., Ilin, V.I., Ilin, V.N., Kuftin, A.N., Malygin, S.A., Malygin, V.I., Parshin, V.V., Zavolsky, N.A., Pavel’ev, A.B., Rukavishnikova, V.G., Roschin, Yu.V., Sokolov, E.V., Soluyanova, E.A., Usov, V.G., Vikharev, A.L., 2009, Development in Russia of 170 GHz gyrotron for ITER, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R4D02.0065.

[793] Litvak, A.G., Denisov, G.G., Agapova, M.V., Myasnikov, V.E., Popov, L.G., Tai, E.M., Usachev, S.V., Zapevalov, V.E., Chirkov, A.V., Ilin, V.I., Kuftin, A.N., Malygin, V.I., Sokolov, E.V., Soluyanova, E.A., 2010, Recent results of development in Russia of 170 GHz gyrotron for ITER, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Tu-E1.1.

[794] Usachev, S.V., Popov, L.G., Ilin, V.I., Agapova, M.V., Denisov, G.G., Gnedenkov, A.Ph., Ilin, V.N., Khvostenko, A.P., Kostyna, A.N., Kuftin, A.N., Litvak, A.G., Malygin, V.I., Myasnikov, V.E., Nichiporenko, V.O., Novikov, V.N., Rukavishnikova, V.G., Sokolov, E.V., Soluyanova, E.A., Tai, E.M., Usov, V.G., Yashnon, Yu.M., Zapevalov, V.E., 2011, Last test results of 170 GHz / 1 MW / 50% / CW gyrotron for ITER, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 136-137.

[795] Litvak, A., Denisov, G., Agapova, M.V., Myasnikov, V., Popov, L., Tai, E.M., Usachev, S.V., Zapevalov, V.E., Chirkov, A., Ilin, V.I., Kuftin, A.N., Malygin, V.I., Sokolov, E.V., Solyanova, E., 2011, Development in Russia of 170 GHz gyrotron for ITER, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, Th2A.1.

[796] Myasnikov, V.E., Agapova, M.V., Kuftin, A.N., Zapevalov, V.E., Denisov, G.G., Ilin, V.I., Belnova, L.M., Chirkov, A.V., Gnedenkov, A.Ph., Litvak, A.G., Malygin, V.I., Nichiporenko, V.O., Novikov, V.N., Popov, L.G., Roy, I.N., Rukavishnikova, V.G., Sokolov, E.V., Soluyanova, E.A., Tai, E.M., Usachev, S.V., 2013, Progress of 1.5-1.7 MW/170 GHz gyrotron development. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Tu1-6.

[797] Myasnikov, V.E., Agapova, M.V., Kuftin, A.N., Zapevalov, V.E., Denisov, G.G., Belnova, L.M., Chirkov, A.V., Gnedenkov, A.Ph., Litvak, A.G., Malygin, V.I., Manuilov, V.N., Nichiporenko, V.O., Novikov, V.N., Popov, L.G., Roy, I.N., Rukavishnikova, V.G., Sokolova, E.V., Soluyanova, E.A., Tai, E.M., Usachev, S.V., Yashnov, Yu.M., 2014, New results of extra-powerful 1.5MW/170GHz gyrotron development. 39th Int. Conf. on Infrared, Millimeter and Terahz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W4_D 25.8.

[798] Agapova, M.V., Myasnikov, V.E., Kuftin, A.N., Zapevalov, V.E., Denisov, G.G., Belnova, L.M., Chirkov, A.V., Gnedenkov, A.Ph., Litvak, A.G., Malygin, V.I., Manuilov, V.N., Nichiporenko,

V.O., Novikov, V.N., Popov, L.G., Roy, I.N., Rukavishnikova, V.G., Sokolov, E.V., Soluyanova, E.A., Tai, E.M., Usachev, S.V., 2014, 1.5 MW/170 GHz gyrotron: Perspective CW regime-higher voltage or higher current priority? Proc. 9th Int. Workshop "Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, pp. 145-146.

[799] Denisov, G.G., Litvak, A.G., Chirkov, A.V., Eremeev, A.G., Malygin, V.I., Tai, E.M., Myasnikov, V.E., Popov, L.G., Soluyanova, E.A., Belov, Yu.N., Kazansky, I.V., Kruglov, A.V., Nichiporenko, V.O., Sokolov, E.V., Usachev, S.V., Roy, I.N., 2015, Development status of gyrotron setup for ITER ECW system. 40th Int. Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, H1E-6.

[800] Denisov, G., 2018, Recent results in IAP/GYCOM development of megawatt gyrotrons. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, Th-A2-4-1.

[801] Denisov, G.G., Glyavin, M.Yu., Fokin, A.P., Kuftin, A.N., Tsvetkov, A.I. , Sedov, A.S., Soluyanova, E.A., Bakulin, M.I., Sokolov, E.V., Tai, E.M., Morozkin, M.V., Proyavin, M.D., Zapevalov, V.E., 2018, First experimental tests of powerful 250 GHz gyrotron for future fusion research and collective Thomson scattering diagnostics. Review of Scientific Instruments, 89, 084702 (4pp).

[802] Morozkin, M., Denisov, G., Tai, E., Soluyanova, E., Sedov, A., Fokin, A., Kuftin, A., Tsvetkov, A., Bakulin, M., Sokolov, E., Malygin, V., Proyavin, M., Zapevalov, V., Mocheneva, O., Glyavin, M., 2018, Development of the prototype of high power sub-THz gyrotron for advanced fusion power plant (DEMO). EPJ Web of Conferences, 195, 01008 (2pp).

[803] Litvak, A.G., Denisov, G.G., Glyavin, M.Y., 2021, Russian gyrotrons: achievements and trends. IEEE Journal of Microwaves, 1, No. 1, 260-268.

[804] Zapevalov, V.E., Belousov, V.I., Vlasov, S.N., Zavolsky, N.A., Koposova, E.V., Kornishin, S.Yu., Kuftin, A.N., Moiseev, M.A., Khizhnyak, V.I., 2014, Research of the gyrotron with the echelette resonator. Proc. 9th Int. Workshop "Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, pp. 166-167.

[805] Zapevalov, V.E., Vlasov, S.N., Koposova, E.V., Kuftin, A.N., Paveliev, A.B., Zavolsky, N.A., 2018, Various types of echelette resonators for gyrotrons. EPJ Web of Conferences, 195, 01022 (2pp).

[806] Denisov, G.G., Kuftin, A.N., Manuilov, V.N., Zavolsky, N.A., Chirkov, A.V., Soluyanova, E.A., Tai, E.M., Bakulin, M.I., Tsvetkov, A.I., Fokin, A.P., Novozhilova, Y.V., Movshevich, B.Z., Glyavin, M.Yu., 2020, Design of master oscillator for frequency locking of a complex of mega-watt level microwave sources, Microw Opt Technol Lett., 62, 2137–2143.

[807] Denisov, G.G., Kuftin, A.N., Glyavin, M.Yu., Tsvetkov, A.I, Golubiatnikov, G.Yu., Tai, E.M., Soluyanova, E.A., Bakulin, M.I., Fokin, A.P., Shmelev, M.Yu., Movshevich, B.Z., 2021, Experimental tests of a high-stable 170 GHz/25 kW gyrotron as a master oscillator for frequency locking of megawatt level microwave sources, 22nd IEEE Int. Vacuum Electronics Conference (IVEC 2021), Virtual Event, The Netherlands, S7.1.

[808] Sakamoto, K., Kasugai, A., Tsuneaka, M. Takahashi, K., Imai, T., Kariya, T., Okazaki, Y., Hayashi, K., Mitsunaka, Y., Hirata, Y., 1995, Development of 170 GHz gyrotron for ITER. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 269-270.

[809] Sakamoto, K., Kasugai, A., Tsuneoka, M., Takahashi, K., Imai, T., Kariya, T., Okazaki, Y., Hayashi, K., Mitsunaka, Y., Hirata, Y., 1996, Development of 170 GHz high power long pulse gyrotron for ITER. Proc. 21st Int. Conf. on Infrared and Millim. Waves, Berlin, AT1.

[810] Sakamoto, K., Kasugai, A., Takahashi, K., Tsuneoka, M., Imai, T., Kariya, T., Hayashi, K., 1996, Stable, single-mode oscillation with high-order volume mode at 1 MW, 170 GHz gyrotron. J. of Physical Society of Japan, 65, 1888-1890.

[811] Sakamoto, K., Kasugai, A., Tsuneoka, M., Takahashi, K., Ikeda, Yu., Imai, T., Nagashima, T., Ohta, M., T., Kariya, T., Hayashi, K., Mitsunaka, Y., Hirata, Y., Ito, Y., Okazaki, Y., 1997, Development of 170 GHz/500 kW gyrotrons. Int. J. of Infrared and Millimeter Waves, 18, 1637-1654.

[812] Tsuneoka, M., Fujita, H., Sakamoto, K., Kasugai, A., Imai, T., Nagashima, T., Asaka, T., Kamioka, N., Yasuda, M., Iiyama, T., Yoshida, T., Nara, H., Ishibashi, M., 1997, Development of d.c. power supply for gyrotron with energy recovery system. Fusion Eng. and Design, 36, 461-469.

[813] Sakamoto, K., Kasugai, A., Tsuneoka, M., Takahashi, K., Imai, T., 1999, High power 170 GHz gyrotron with synthetic diamond window. Rev. Sci. Instrum., 70, 208-212.

[814] Sakamoto. K., Hayashi, K., Shoyama, H., Kasugai, A., Takahashi, K., Tsuneoka, M., Ikeda, Y., Kariya, T., Mitsunaka, T., Imai, T., 2001, Development of 170 GHz long pulse gyrotron for ITER. Conf. Digest, 26th Int. Conf. on Infrared and Millimeter Waves, Toulouse, France, 5-59-5-63.

[815] Shoyama, H., Sakamoto, K., Hayashi, K., Kasugai, A., Tsuneoka, M., Tokahashi, K., Ideda, Y., Kariya, T., Mitsunaka, Y., Imai, T., 2002, High-efficiency oscillation of 170 GHz high-power gyrotron at TE31,8 mode using depressed collector. Jpn. J. Appl. Phys., 40, L906-L908.

[816] Kasugai, A., Sakamoto, K., Minami, R., Takahashi, K., Imai, T., 2004, Study of millimeter wave high-power. Nucl. Instrum. & Methods in Physics Research, A528, 110-114.

[817] Sakamoto, K., Kasugai, A., Minami, R., Takahashi, K., Kobayashi, N., Imai, T., 2004, Development of high power 170 GHz gyrotron for ITER. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 109-110.

[818] Sakamoto, K., Kasugai, A., Minami, R., Takahashi, K., Kobayashi, N., 2005, Development of long pulse and high power 170 GHz gyrotron. J. of Physics: Conf. Series, 25, 8-12.

[819] Kasugai, A., Minami, R., Takahashi, M., Kobayashi, N., Sakamoto, K., 2005, Development of a 170 GHz high-power and CW gyrotron for fusion application. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 287-288.

[820] Minami, R., Kasugai, A., Takahashi, K., Kobayashi, N., Sakamoto, K., 2005, Development of high power gyrotron for ITER. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 100-106.

[821] Kasugai, A., Takahashi, K., Kobayashi, N., Sakamoto, K., 2006, Development of 170 GHz gyrotron for ITER. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 202.

[822] Sakamoto, K., Kasugai, A., Takahashi, K., Minami, R., Kobayashi, N., Kajiwara, K., 2007, Achievement of robust high-efficiency 1 MW oscillation in the hard-self-excitation region by a 170 GHz continuous-wave gyrotron. Nature Phys., 3, 411-414.

[823] Shoyama, H., Sakamoto, K., Hayashi, K., Kasugai, A., Tsuneoka, M., Takahashi, K., Ikeda, Y., Kariya, T., Mitsunaka, Y., Imai, T., 2001, High-efficiency oscillation of 170 GHz high-power gyrotron at TE31,8 mode using depressed collector. Jpn. J. Appl. Phys., 40, L 906-908.

[824] Kasugai, A., Kajiwara, K., Takahashi, K., Kobayashi, N., Kariya, T., Mitsunaka, Y., Sakamoto, K., 2007, Steady state operation of high power gyrotron for ITER, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 37-40.

[825] Sakamoto, K., 2007, Gyrotrons and mm wave technology for ITER. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electr., Cardiff, UK, 4-7.

[826] Sakamoto, K., Kasugai, A., Kajiwara, K., Takahashi, K., Kobayashi, N., 2007, Demonstration of high efficiency 1 MW oscillation by 170 GHz CW gyrotron. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 708-709.

[827] Sakamoto, K., Kajiwara, K., Kasugai, A., Oda, Y., Kobayashi, T., Takahashi, K., Kobayashi, N., Moriyama, S., Fujii, T., 2008, High power gyrotron development for fusion application, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, R4A1.1695.

[828] Kasugai, A., Sakamoto, K., Takahashi, K., Kajiwara, K., Kobayashi, N., 2008, Steady-state operation of 170 GHz-1 MW gyrotron for ITER. Nucl. Fusion, 48, 054009 (6pp).

[829] Sakamoto, K., Kajiwara, K., Kasugai, A., Takahashi, K., Kobayashi, N., Oda, Y., 2008, High power 170 GHz gyrotron development in JAEA, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 1, 7-14.

[830] Sakamoto, K., Kasugai, A., Kajiwara, K., Oda, Y., Takahashi, K., Hayashi, K., Ideda, Y., Okazaki, Y., Kobayashi, N., 2009, Progress of high power gyrotron development in JAEA, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R4D01.0427.

[831] Sakamoto, K., Kasugai, A., Kajiwara, K., Takahashi, K., Oda, Y., Hayashi, K., Kobayashi, N., 2009, Progress of high power 170 GHz gyrotron in JAEA, Nucl. Fusion, 49, 095019 (6pp).

[832] Kajiwara, K., Kasugai, A., Oda, Y., Takahashi, K., Kobayashi, N., Sakamoto, K., 2009, Long pulse and high power repetitive operation of the 170 GHz ITER gyrotron, Plasma and Fusion Research: Letters, 4, 006-1 – 006-3.

[833] Kajiwara, K., Oda, Y., Kasugai, A., Takahashi, K., Sakamoto, K., 2010, Reliability test of the ITER 170 GHz gyrotron and development of the two-frequency gyrotron, Proc. 11th IEEE Int. Vacuum Electronics Conf. (IVEC 2010), Monterey, USA, pp. 31-32.

[834] Sakamoto, K., Kajiwara, K., Takahashi, K., Oda, Y., Kasugai, A., Kobayashi, T., Kobayashi, N., Henderson, M., Darbos, C., 2010, Development of high power gyrotron for ITER application, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Tu-E1.6.

[835] Kajiwara, K., Kasugai, A., Oda, Y., Takahashi, K., Sakamoto, K., Darbos, C., Henderson, M., 2011, Reliability test of the 170 GHz gyrotron for ITER, J. of Infrared Milli Terahz Waves, 32, 329-336.

[836] Kajiwara, K., Oda, Y., Kasugai, A., Takahashi, K., Sakamoto, K., Darbos, C., Henderson, M.A., 2011, Repetitive gyrotron operation for ITER. Fusion Eng. and Design, 86, 955-958.

[837] Kajiwara, K., Oda, Y., Kasugai, A., Takahashi, K., Sakamoto, K., 2011, Development of dual-frequency gyrotron with triode magnetron injection gun. Applied Physics Express, 4, 126001-1 (3 pages).

[838] Oda, Y., Kajiwara, K., Takahashi, K., Sakamoto, K., 2012, Development of dual frequency gyrotron and high power test of EC components. EPJ Web of Conf., 32, 04004/1-8.

[839] Kajiwara, K., Oda, Y., Kasugai, A., Takahashi, K., Sakamoto, K., 2012, Progress of the development of gyrotron and gyrotron system for ITER, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 107-108.

[840] Oda, Y., Kajiwara, K., Takahashi, K., Mitsunaka, Y., Sakamato, K, 2013, High efficiency coupling of radio frequency beams from the dual frequency gyrotron with a corrugated transmission system. Review of Scientific Instruments, 84, 013501 (6pp).

[841] Kajiwara, K., Sakamoto, K., Oda, Y., Hayashi, K., Takahashi, K., Kasugai, A., 2013, Full high-power modulation on a 170 GHz 1 MW ITER gyrotron with a triode magnetron injection gun. Nuclear Fusion, 53, 043013 (5pp).

[842] Sakamoto, K., Kajiwara, K., Oda, Y., Hayashi, K., Takahashi, K., Kobayashi, T., Moriyama, S., 2013, Status of high power gyrotron development in JAEA. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 6A-3.

[843] Sakamoto, K., Kajiwara, K., Oda, Y., Hayashi, K., Ikeda, R., Takahashi, K., Kobayashi, T., Moriyama, S., 2013, Progress of high power long pulse gyrotron for fusion applications. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo5-1.

[844] Sakamoto, K., Oda, Y., Ikeda, R., Kobayashi, T., Kajiwara, K., Hayashi, K., Takahashi, K., Moriyama, S., 2014, Progress on high power long pulse gyrotron development in JAEA. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W3_D-25.3.

[845] Sakamoto, K., Oda, Y., Ikeda, R., Kobayashi, T., Kajiwara, K., Takahashi, K., Moriyama, S., 2015, Development of high power gyrotron and related technologies. Terahertz Science and Technology, 8, No. 1, 1-18.

[846] Sakamoto, K., Ikeda, R., Oda, Y., Kobayashi, Kajiwara, K., Shidara, H., Takahashi, K., Moriyama, S., 2015, Status of high power gyrotron development in JAEA. 16th IEEE International Conference on Vacuum Electronics (IVEC 2015), Beijing, P.R. China, S23.1.

[847] Ikeda, R., Kajiwara, K., Oda, Y., Takahashi, K., Sakamoto, K., 2015, High-power and long-pulse operation of TE31,11 mode gyrotron. Fusion Eng. and Design, 96-97, 482-487.

[848] Oda, Y., Ikeda, R., Takahashi, K., Kajiwara, K., Kobayashi, T., Sakamoto, K., Moriyama, S., Darbos, C., Henderson, M., 2017, Recent activities of ITER gyrotron development in QST. EPJ Web of Conferences, 149, 01002 (2pp).

[849] Ikeda, R., Oda, Y., Kajiwara, K., Kobayashi, T., Terakado, M., Takahashi, K., Moriyama, S., Sakamoto, K., 2018, Progress on performance test of ITER gyrotron. Proc. 19th Int. Vacuum Electronics Conf. (IVEC 2018), Monterey, CA, USA, 8.1.

[850] Ikeda, R., Oda, Y., Kajiwara, K., Kobayashi, T., Nakai, T., Terakado, M., Takahashi, K., Moriyama, S., Sakamoto, K., 2018, Progress on 1 MW operation of Japan gyrotron for ITER EC system. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, Tu-P2-R1-1.

[851] Ikeda, R., Oda, Y., Kobayashi, T., Terakado, M., Kajiwara, K., Takahashi, K., Moriyama, S., Sakamoto, K., 2018, Development of 170 GHz, 1 MW gyrotron with higher order TE31,11 mode oscillation for ITER EC system. Fusion Engineering and Design, 128, 23-27.

[852] Sakamoto, K., Oda, Y., Kariya, T., Minami, R., Ikeda, R., Kajiwara, K., Takahashi, K., Hayashi, K., Imai, T., 2015, Preliminary result of 300 GHz short pulse high order mode gyrotron. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W5_P25.1.

[853] Oda, Y., Kariya, T., Minami, R., Ikeda, R., Kajiwara, K., Takahashi, K., Hayashi, K., Imai, T., Sakamoto, K., 2015, Progress of 300 GHz high order mode gyrotron development. 40th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, TS-68.

[854] Ikeda, R., Oda, Y., Kobayashi, T., Terakado, M., Kajiwara, K., Takahashi, K., Moriyama, S., Sakamoto, K., 2016, Development of multi-frequency gyrotron for ITER and DEMO at QST. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahz Waves (IRMMW-THz 2016), September 26-30, 2016, Copenhagen, Denmark, H2D.2, private communications.

[855] Sakamoto, K., Ikeda, R., Kariya, T., Oda, Y., Kobayashi, T., Kajiwara, K., Hayashi, K., Minami, R., Takahashi, K., Imai, T., Moriyama, S., 2017, Study of high power and high frequency gyrotron for fusion reactor. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RA2.3.

[856] Hayashi, K., Mitsunaka, Y., Hirata, Y., Kariya, T., Okazaki, Y., Yamazaki, C., Saito, F., 2001, Design and tests of 168-GHz, 500-kW gyrotrons and power supply system. Fusion Engineering and Design, 53, 457-464.

[857] Shimozuma, T., Kubo, S., Yoshimura, Y., Igami,H., Takahashi, H., Kobayashi, S., Ito, S., Mizumo, Y., Okada, K., Takita, Y., Mutoh, T., Idei, H., Minami, R., Kariya, T., Imai, T., 2010, Progress of a multi-megawatt gyrotron system for electron cyclotron heating on the large helical device, Proc. 35th Int. Conf. Inf Milli Terahz Waves, Rome, Italy, Tu-P.04.

[858] Shimozuma, T., Takahashi, H., Ito, S., Kubo, S., Yoshimura, Y., Igami, H., Nishiura, M., Ogasawara, S., Makino, R., Mizuno, Y., Okada, K., Kobayashi, S., Mutoh, T., Minami, R., Kariya, T., Imai, T., 2013, Installation of a 154 GHz mega-watt gyrotron and its contribution to the extension of plasma parameter regime in LHD. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, Mo1-3.

[859] Flyagin, V.A., Khishnyak, V.I., Manuilov, V.N., Pavelyev, A.B., Pavelyev, V.G., Piosczyk, B., Dammertz, G., Höchtl, O., Iatrou, C., Kern, S., Nickel, H.-U., Thumm, M., Wien, A., Dumbrajs, O., 1994, Development of a 1.5 MW coaxial gyrotron at 140 GHz. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 75-76.

[860] Piosczyk, B., Braz, O., Dammertz, G., Iatrou, C.T., Kern, S., Möbius, A., Thumm, M., Wien, A., Zhang, S.C., Flyagin, V.A., Khishnyak, V.I., Kuftin, A.N., Manuilov, V.N., Pavelyev, A.B., Pavelyev, V.G., Postnikova, A.N., Zapevalov, V.E., 1995, Development of a 1.5 MW, 140 GHz coaxial gyrotron. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 423-424.

[861] Pioscyzk, B., Braz, O., Dammertz, G., Iatrou, C.T., Kern, S., Kuntze, M., Möbius, A., Thumm, M., Flyagin, V.A., Khishnyak, V.I., Kuftin, A.N., Malygin, V.I., Pavelyev, A.B., Zapevalov, V.E., 1996, A 140 GHz, 1.5 MW, TE28,16-coaxial cavity gyrotron. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, AM2.

[862] Iatrou, C.T., Braz, O., Dammertz, G., Kern, S., Kuntze, M., Piosczyk, B., Thumm, M., 1996, Operation of a megawatt coaxial gyrotron at 165 GHz. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, ATh15.

[863] Thumm, M., Braz, O., Dammertz, G., Iatrou, C.T., Kern, S., Kuntze, M., Möbius, A., Piosczyk, B., Flyagin, V.A., Khishnyak, V.I., Malygin, V.I., Pavelyev, A.B., Zapevalov, V.E., 1996, Experimental results of 1.5 MW coaxial cavity gyrotrons in the frequency range 115-170 GHz. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 614-633.

[864] Piosczyk, B., Braz, O., Dammertz, G., Iatrou, C.T., Kern, S., Kuntze, M., Michel, G., Möbius, A., Thumm, M., Flyagin, V.A., Khishnyak, V.I., Pavelyev, A.B., Zapevalov, V.E., 1997, Operation of a coaxial gyrotron with a dual RF-beam output. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 114-115.

[865] Piosczyk, B., Braz, O., Dammertz, G., Iatrou, C.T., Kern, S., Kuntze, M., Möbius, A., Thumm, M., Flyagin, V.A., Khishnyak, V.I., Malygin, V.I., Pavelyev, A.B., Zapevalov, V.E., 1997, A 1.5-MW, 140-GHz, TE28,16-coaxial cavity gyrotron. IEEE Trans. on Plasma Science, 25, 460-469.

[866] Iatrou, C.T., Braz, O., Dammertz, G., Kern, S., Kuntze, M., Pioszyk, B., M. Thumm, 1997, Design and experimental operation of a 165-GHz, 1.5-MW, coaxial-cavity gyrotron with axial rf output. IEEE Trans. on Plasma Sciences, 25, 470-479.

[867] Piosczyk, B., Braz, O., Dammertz, G., Iatrou, C.T., Illy, S., Kuntze, M., Michel, G., Möbius, A., Thumm, M., Flyagin, V.A., Khishnyak, V.I., Pavelyev, A.B., Zapevalov, V.E., 1998, Coaxial cavity gyrotron with dual RF beam output. IEEE Trans. on Plasma Science, 26, 393-401.

[868] Piosczyk, B., Braz, O., Dammertz, G., Iatrou, C.T., Kuntze, M., Michel, G., Möbius, A., Thumm, M., 1998, 165 GHz, TE31,17 - coaxial cavity gyrotron with quasi-optical RF-output. Conf. Dig. 23rd Int. Conf. on Infrared and Millim. Waves, Colchester, UK, 168-169.

[869] Piosczyk, B., Braz, O., Dammertz, G., Iatrou, C.T., Illy, S., Kuntze, M., Michel, G., Thumm, M., 1999, 165 GHz, 1.5 MW-Coaxial cavity gyrotron with depressed collector. IEEE Trans. on Plasma Science, 27, 484-489.

[870] Pioszcyk, B., Braz, O., Dammertz, G., Kuntze, M., Michel, G., Lamba, O.S., Thumm, M., 1999, Progress report on the 165 GHz coaxial cavity gyrotron. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, TU-A9.

[871] Piosczyk, B., Braz, O., Dammertz, G., Kuntze, M., Michel, G., Thumm, M., 1999, Status of the 1.5 MW, 165 GHz coaxial cavity gyrotron. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 629-634.

[872] Piosczyk, B., Arnold, A., Dammertz, G., Dumbrajs, O., Kuntze, M., Leonhardt, W., Pavelyev, A.B., Schmid, M., Thumm, M., 2000, 2.2 MW, 165 GHz coaxial cavity gyrotron. Conf. Digest 25th Int. Conf. Infrared and Milli Waves, Beijing, P.R. China, 19-20.

[873] Piosczyk, B., Arnold, A., Dammertz, G., Kuntze, M., Michel, G., Lamba, O.S., Thumm, M.K., 2000, Step-frequency operation of a coaxial cavity from 134 to 169.5 GHz. IEEE Trans. on Plasma Science, 28, 918-923.
Dumbrajs, O., Khizhnyak, V.I., Pavelyev, A.B., Piosczyk, B., Thumm, M.K., 2000, Design of rapid-frequency step-tunable powerful coaxial-cavity harmonic gyrotrons. IEEE Trans. on Plasma Science, 28, 681-687.

[874] Piosczyk, B., Arnold, A., Dammertz, G., Dumbrajs, O., Kuntze, M., Thumm, M.K., 2002, Coaxial cavity gyrotron-recent experimental results. IEEE Trans. on Plasma Science, 30, 819-827.

[875] Ling, G., Piosczyk, B., Thumm, M.K., 2000, A new approach for a multistage depressed collector for gyrotrons. IEEE Trans. on Plasma Science, 28, 606-613.

[876] Piosczyk, B., Arnold, A., Budig, H., Dammertz, G., Dumbrajs, O., Drumm, O., Kartikeyan, M.V., Kuntze, M., Thumm, M., Yang, X., 2002, A 2 MW, CW coaxial cavity gyrotron. Experimental and technical conditions. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 104-110.

[877] Piosczyk, B., Budig, H., Dammertz, G., Dumbrajs, O., Drumm, O., Illy, S., Jin, J., Thumm, M., 2003, Coaxial cavity gyrotron – recent results and ongoing development work. Conf. Digest 28th Int. Conf. on Infrared and Millim. Waves, Otsu, Japan, 167-168.

[878] Piosczyk, B., Dammertz, G., Dumbrajs, O., Kartikeyan, M.V., Thumm, M.K., Yang, X., 2004, 165-GHz coaxial cavity gyrotron. IEEE Trans. on Plasma Science, 32, 853-860.

[879] Piosczyk, B., Arnold, A., Budig, H., Dammertz, G., Dumbrajs, O., Drumm, O., Kartikeyan, M.V., Kuntze, M., Thumm, M., Yang, X., 2003, Towards a 2 MW, CW, 170 GHz coaxial cavity gyrotron for ITER. Fusion Eng. and Design, 66-68, 481-485.

[880] Piosczyk, B., Arnold, A., Budig, H., Dammertz, G., Dumbrajs, O., Illy, S., Jin, J., Michel, G., Rzesnicki, T., Thumm, M., Wagner, D., 2004, 2 MW, CW, 170 GHz coaxial cavity gyrotron. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 45-49, Invited Paper.

[881] Piosczyk, B., Arnold, A., Borie, E., Dammertz, G., Dumbrajs, O., Heidinger, R., Illy, S., Jin, J., Koppenburg, K., Michel, G., Rzesnicki, T., Thumm, M., Yang, X., 2004, Development of advanced high power gyrotrons for EC H&CD applications in fusion plasmas. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating (EC13), ed. A. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2005, 377-382.

[882] Piosczyk, B., Rzesnicki, T., Arnold, A., Budig, H., Dammertz, G., Dumbrajs, O., Illy, S., Jin, J., Koppenburg, K., Leonhardt, W., Michel, G., Schmid, M., Thumm, M., Yang, X., 2004, Progress

in the development of the 170 GHz coaxial cavity gyrotron. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 107-108.

[883] Piosczyk, B., Dammertz, G., Dumbrajs, O., Drumm, O., Illy, S. Jin, J., Thumm, M., 2004, A 2-MW, 170-GHz coaxial cavity gyrotron. IEEE Trans. on Plasma Science, 32, 413-417.

[884] Piosczyk, B., Dammertz, G., Dumbrajs, O., Illy, S., Jin, J., Leonhardt, W., Michel, G., Prinz, O., Rzesnicki, T., Schmid, M., Thumm, M., Yang, X., 2005, A 2 MW, 170 GHz coaxial cavity gyrotron – experimental verification of the design of main components. Journal of Physics: Conference Series, 25, 24-32.

[885] Hogge, J.-P., Alberti, S., Arnold, A., Bariou, D., Beunas, A., Bonicelli, T., Chavan, R., Cirani, S., Dumbrajs, O., Drumm O., Fasel, D., Giguet, E., Goodman, T., Henderson, M., Illy, S., Jin, J., LeCloarec, G., Lievin, C., Magne, R., Mondino, P.-L., Piosczyk, B., Porte, L., Rzesnicki, T., Santinelli, M., Sterck, A.B., Thumm, M., Tran, M.Q., Verhoeven, A.G.A., Yovchev, I., 2004, Development of a 2 MW, CW, 170 GHz coaxial cavity gyrotron for ITER. Proc. 13th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Heating (EC13), ed. A. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2005, 393-397.

[886] Hogge, J.-P., Alberti, S., Arnold, A., Bariou, D., Benin, P., Bonicelli, T., Bruschi, A., Chavan, R., Cirant, S., Dumbrajs, O., Fasel, D., Gandini, F., Giguet, E., Goodman, T., Heidinger, R., Henderson, M., Illy, S., Jin, J., Lievin, C., Magne, R., Marmillod, P., Mondino, P.-L., Perez, A., Piosczyk, B., Porte, L., Rzesnicki, T., Santinelli, M., Thumm, M., Tran, M.Q., Yovchev, I., 2005, Development of a 2-MW, CW coaxial gyrotron at 170 GHz and test facility for ITER. Journal of Physics: Conference Series, 25, 33-44.

[887] Lievin, C., Alberti, S., Arnold, A., Bariou, D., Benin, P., Bonicelli, T., Dammertz, G., Dumbrajs, O., Fasel, D., Giguet, E., Goodman, T., Heidinger, R., Henderson, M., Hogge, J.P., Illy, S., Jin, J., Mondino, P.L., Piosczyk, B., Porte, L., Rzesnicki, T., Thumm, M., Tran, M.Q., Yovchev, I., 2005, Development of a 2-MW, CW coaxial gyrotron at 170 GHz for electron-cyclotron-resonance-heating in ITER. Proc. 6th IEEE Int. Vacuum Electronics Conf. (IVEC 2005), Noordwijk, The Netherlands, 21-24.

[888] Piosczyk, B., Rzesnicki, T., Dammertz, G., Dumbrajs, O., Illy, S., Jin, J., Leonhardt, W., Michel, G., Schmid, M., Thumm, M., Yang, X., 2005, 170 GHz, 2 MW, CW coaxial cavity gyrotron – experimental verification of the design. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 289-290.

[889] Piosczyk, B., Alberti, S., Bariou, D., Benin, P., Bonicelli, T., Dammertz, G., Dumbrajs, O., Fasel, D., Giguet, E., Goodman, T., Heidinger, R., Henderson, M., Hogge, J.P., Illy, S., Jin, J., Lievin, C., Michel, G., Mondino, P.L., Porte, L., Rzesnicki, T., Thumm, M., Tran, M.Q., Yang, X., Yovchev, I., 2005, Progress in the development of the 170 GHz coaxial cavity gyrotron for ITER. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Phys., RAS, Nizhny Novgorod, 2006,Vol. 1, 91-99.

[890] Piosczyk, B., Alberti, S., Benin, P., Bonicelli, T., Dammertz, G., Dumbrajs, O., Gantenbein, G., Giguet, E., Goodman, T., Hogge, J.P., Illy, S., Lievin, C., Michel, G., Porte, L., Rzesnicki, T., Schmid, M., Thumm, M., Tran, M.Q., 2006, Progress in development of the 170 GHz, 2 MW coaxial cavity gyrotron for ITER. Conf. Digest 31st Int. Conf. Infrared and Milli Waves and 14th Int. Conf. Terahertz Electronics, Shanghai, China, 197.

[891] Bonicelli, T., S. Alberti, S. Cirant, O. Dormicchi, D. Fasel, J.P. Hogge, S. Illy, J. Jin, C. Lievin, P.L. Mondino, B. Piosczyk, T. Rzesnicki, M. Santinelli, G. Taddia, M. Thumm, M.Q. Tran, 2007, EC power sources: European technological developments towards ITER, Fusion Engineering and Design, 82, 619-626.

[892] Rzesnicki, T., Piosczyk, B., Dammertz, G., Gantenbein, G., Thumm, M., Michel, G., 2007, 170 GHz, 2 MW coaxial cavity gyrotron – investigation of the parasitic oscillations and efficiency of the RF-output system -, Proc 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 45-46.

[893] Rzesnicki, T., Piosczyk, B., Flamm, J., Jin, J., Kern, S., Prinz, O., Thumm, M., 2008, 170 GHz, 2 MW coaxial cavity gyrotron - experimental investigations on the pre-prototype tube, Proc. 9th IEEE Int. Vacuum Electr. Conf. (IVEC 2008), Monterey, CA, USA, 30-31.

[894] Rzesnicki, T., Piosczyk, B., Flamm, J., Jin, J., Kern, S., Prinz, O., Thumm, M., 2008, Recent experimental results on the 170 GHz, 2 MW coaxial cavity pre-prototype gyrotron for ITER, Proc. 33rd Int. Conf. Infrared, Millim. and Terahz Waves, Pasadena, CA, USA, W4U5.1521.

[895] Alberti, S., Albajar, F., Avramides, K.A., Benin, P., Bin, W., Bonicelli, T., Bruschi, A., Cirant, S., Droz, E., Dumbrajs, O., Fasel, D., Gandini, F., Goodman, T., Hogge, J.-P., Illy, S. Jawla, S., Jin, J., Kern, S., Lievin, C., Marlétaz, B., Marmillod, Ph., Pagonakis, I., Perez, A., Piosczyk, B., Porte, L., Rzesnicki, T., Siravo, U., Thumm, M., Tran, M.Q., 2008, Status of development of the 2 MW, 170 GHz coaxial-cavity gyrotron for ITER, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, F2A1.1413.

[896] Hogge, J.-P., Goodman, T.P., Alberti, S., Albajar, F., Avramides, K.A., Benin, P., Bethuys, S., Bin, W., Bonicelli, T., Bruschi, A., Cirant, S., Droz, E., Dumbrajs, O., Fasel, D., Gandini, F., Gantenbein, G., Illy, S., Jawla, S., Jin, J., Kern, S., Lavanchy, P., Liévin, C., Marlétaz, B., Marmillod, P., Perez, A., Piosczyk, B., Pagonakis, I., Porte, L., Rzesnicki, T., Siravo, U., Thumm, M., Tran, M.Q., 2009, First experimental results from the European Union 2-MW coaxial cavity ITER gyrotron prototype, Fusion Science and Technology, 55, 204-212.

[897] Rzesnicki, T., Piosczyk, B., Gantenbein, G., Jin, J., Kern, St., Samartsev, A., Thumm, M., 2009, 170 GHz, 2 MW coaxial cavity gyrotron for ITER – recent results obtained with a short pulse tube –, Proc. 10th IEEE Int. Vacuum Electronics Conference (IVEC 2009), Rome, Italy, pp. 277-278.

[898] Rzesnicki, T., Piosczyk, B., Gantenbein, G., Jin, J., Kern, S., Samartsev, A., Thumm, M., 2009, Major progress in the development of the 2 MW coaxial-cavity gyrotron for ITER, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R4D04.0032.

[899] Rzesnicki, T., Piosczyk, B., Kern, S., Illy, S., Jin, S., Samartsev, A., Schlaich, A., Thumm, M., 2010, 2.2-MW record power of the 170-GHz European preprototype coaxial-cavity gyrotron for ITER, IEEE Trans. on Plasma Science, 38, 1141-1149.

[900] Rzesnicki, T., Piosczyk, B., Kern, S., Illy, S., Jin, J., Samartsev, A., Schlaich, A., Thumm, 2010, Experiments with the European 2 MW coaxial-cavity pre-prototype gyrotron for ITER, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 27-28.

[901] Rzesnicki, T., Piosczyk, B., Roy Choudhury, A., Illy, S., Jin, J., Kern, S., Samartsev, A., Schlaich, A., Thumm, M., 2010, Recent results with the European 2 MW coaxial-cavity pre-prototype gyrotron for ITER, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Tu-E1.2.

[902] Rzesnicki, T., Piosczyk, B., Illy, S., Jin, J., Kern S., Pagonakis, I.Gr., Samartsev, A., Schlaich, A., Thumm, M., 2011, 2 MW, 170 GHz coaxial-cavity gyrotron for ITER: Results obtained with a short pulse pre-prototype at KIT, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 121-122.

[903] Rzesnicki, T., Piosczyk, B., Illy, S., Jin, J., Kern, S., Pagonakis, I., Samartsev, A., Schlaich, A., Thumm, M., 2011, Status of experiments with the 2 MW coaxial-cavity pre-prototype gyrotron for ITER, Proc. 36th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2011), Houston, TX, USA, Th2A.3.

[904] Kern, S., Hogge, J.P., Alberti, S., Avramides, K., Gantenbein, G., Illy, S., Jelonnek, J., Jin, J., Li, F., Pagonakis, I.Gr., Piosczyk, B., Rzesnicki, T., Thumm, M.K., Tigelis, I., Tran, M.Q., and the whole EU home team of EGYC, 2012, Experimental results and recent developments on the EU 2 MW 170 GHz coaxial cavity gyrotron for ITER. EPJ Web of Conferences, 32, 04009/1-6.

[905] Rzesnicki, T., Piosczyk, B., Gantenbein, G., Illy, S., Jelonnek, J., Jin, J., Kern, S., Pagonakis, I.Gr., Samartsev, A., Schlaich, A., Thumm, M., 2012, 2 MW coaxial-cavity pre-prototype gyrotron for ITER – recent experiments with the modified gyrotron setup, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Mon-A-3-3.

[906] Rzesnicki, T., Gantenbein, G., Illy, S., Jelonnek, J., Jin, J., Pagonakis, I.G., Piosczyk, B., Schlaich, A., Thumm, M., 2013, 2 MW, 170 GHz coaxial-cavity short-pulse gyrotron – Investigations on electron beam instabilities and parasitic oscillations. Proc. 38th Int. Conf. on Infrared, Millimeter and THz Waves (IRMMW-THz2013), Mainz, Germany, We5-3.

[907] Rzesnicki, T., Piosczyk, B., Gantenbein, G., Jelonnek, J., Jin, J., Pagonakis, I.Gr., Schlaich, A., Thumm, M., 2014, 2 MW, 170 GHz coaxial-cavity short-pulse gyrotron – Single stage depressed collector operation. 39th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2014), Tucson, AZ, USA, W4_D-25.10.

[908] Rzesnicki, T., Pagonakis, I.Gr., Samartsev, A., Avramidis, K., Gantenbein, G., Illy, S., Jelonnek, J., Jin, J., Lechte, C., Losert, M., Piosczyk, B., Thumm, M., EGYC Team, 2015, Recent Experimental results of the European 1 MW, 170 GHz short-pulse gyrotron prototype for ITER. 40th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, H1E-1.

[909] Ruess, S., T. Rzesnicki, T., Pagonakis, I.Gr., Kobarg, T., Fuchs, M., Illy, S., Gantenbein, G., Thumm, M., Jelonnek, J., 2016, Experimental results and outlook of the 2 MW 170 GHz coaxial-cavity gyrotron towards long pulse operation. Proc. 10th German Microwave Conference (GeMiC 2016), March 14-16, 2016, Bochum, Germany, S11.3.

[910] Ruess, S., Avramidis, K.A., Fuchs, M., Gantenbein, G., Ioannidis, Z., Illy, S., Jin, J., Kalaria, P.C., Kobarg, T., Pagonakis, I.Gr., Ruess, T., Rzesnicki, T., Schmid, M., Thumm, M., Weggen, J., Zein, A., Jelonnek, J., 2018, KIT coaxial gyrotron development: from ITER toward DEMO. Int. J. of Microwave and Wireless Technologies, 10, 547-555.

[911] Ruess, S., Avramidis, K.A., Gantenbein, G., Ioannidis, Z., Illy, S., Kalaria, P.C., Kobarg, T., Pagonakis, I.Gr., Ruess, T., Rzesnicki, T., Thumm, M., Weggen, J., Jelonnek, J., 2018, Current status of the KIT coaxial-cavity longer-pulse gyrotron and its key components. EPJ Web of Conferences, 187, 01028 (2pp).

[912] Rzesnicki, T., Avramidis, K.A., Gantenbein, G., Illy, S., Ioannidis, Z.C., Jin, J., Pagonakis, I.Gr., Ruess, S., Ruess, T., Schmid, M., Thumm, M., Weggen, J., Jelonnek, J., 2018, Development and first operation of the 170 GHz, 2 MW longer-pulse coaxial-cavity modular gyrotron prototype at KIT. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, We-A2-4-4.

[913] Illy, S., Avramidis, K.A., Gantenbein, G., Ioannidis, Z., Jin, J., Kalaria, P.C., Pagonakis, I.Gr., Ruess, S., Ruess, T., Rzesnicki, T., Thumm, M., Jelonnek, J., 2019, Recent status and future prospects of coaxial-cavity gyrotron development at KIT. EPJ Web of Conferences, 203, 04005 (6pp).

[914] Pagonakis, I.G., Avramidis, K.A., Gantenbein, G., Illy, S., Ioannidis, Z.C., Jin, J., Kalaria, P., Piosczyk, B., Ruess, S., Ruess, T., Rzesnicki, T., Thumm, M., Jelonnek, J., 2020, Design and first experiments of a triode magnetron injection gun for the KIT 2 MW 170 GHz coaxial cavity gyrotron. Physics of Plasmas, 27, 023105 (8pp).

[915] Ioannidis, Z.C., Rzesnicki, T., Avramidis, K.A., Gantenbein, G., Illy, S., Jin, J., Krier, L., Pagonakis, I.Gr., Ruess, S., Schmid, M., Thumm, M., Jelonnek, J., 2020, Operation of the modular KIT 170 GHz – 2 MW longer-pulse coaxial-cavity gyrotron with pulses up to 50 ms. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA Gyrotrons 1.3.

[916] Ruess, T., Avramidis, K.A., Gantenbein, G., Illy, S., Thumm, M., Jelonnek, J., 2020, Theoretical study on the possibility for stepwise tuning of the frequency of the KIT 2 MW 170/204 GHz coaxial-cavity gyrotron. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Gyrotrons 1.4.

[917] Vlasov, S.N., Zagryadskaya, L.I., Orlova, I.M., 1976, Open coaxial resonators for gyrotrons. Radio Eng. Electron. Phys., 21, 96-102.

[918] Gaponov, A.V., Flyagin, V.A., Goldenberg, A.L., Nusinovich, G.S., Tsimring, Sh.E., Usov, V.G., Vlasov, S.N., 1981, Powerful millimetre-wave gyrotrons. Int. J. Electronics, 51, No. 4, 277-302.

[919] Flyagin, V.A., Khizhnyak, V.I., Kuftin, A.N., Manuilov, V.N., Pavelyev, A.B., Pavelyev, V.G., Zapevalov, V.E., 1997. Investigation of coaxial gyrotrons at IAP RAS. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 112-113.

[920] Pavelyev, A.B., Flyagin, V.A., Khizhnyak, V.I., Manuilov, V.N., Zapevalov, V.E., 1999, Investigations of advanced coaxial gyrotrons at IAP RAS. Proc. Int. University Conf. "Electronics and Radiophysics of Ultra-High Frequencies" (UHF-99), 1999, St. Petersburg, Russia, 142-145.

[921] Khizhnyak, V.I., Manuilov, V.N., Pavelyev, A.B., Zapevalov, V.E., 2000, Investigations of advanced coaxial gyrotrons at IAP RAS, Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 117-118.

[922] Zapevalov, V.E., Pavelyev, A.B., Khizhnyak, V.I., 2000, Experimental test of the natural scheme of electron beam energy recovery in a coaxial gyrotron. Radiophysics and Quantum Electronics, 43, 671-674.

[923] Khizhnyak, V.I., Manuilov, V.N., Pavelyev, A.B., Zapevalov, V.E., 2001, Natural scheme of electron beam energy recovery in coaxial gyrotron. Proc. 9th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 165, 153-157.

[924] Zapevalov, V.E., Khizhnyak, V.I., Moiseev, M.A., Pavelyev, A.B., Zavolsky, N.A., 2002, Advantages of coaxial cavity gyrotrons. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 111-115.

[925] Flyagin, V.A., Khizhnyak, V.I., Manuilov, V.N., Moiseev, M.A., Pavelyev, A.B., Zapevalov, V.E., Zavolsky, N.A., 2003, Investigations of advanced coaxial gyrotrons at IAP RAS. Int. J. of Infrared and Millimeter Waves, 24, 1-17.

[926] Hogge, J.P., Kreischer, K.E., Read, M.E., 1995, Results of testing a 3 MW, 140 GHz gyrotron with a coaxial cavity. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 417-418.

[927] Kimura, T., Hogge, J.P., Advani, R., Denison, D., Kreischer, K.E., Temkin, R.J., 1996, Investigation of megawatt power level gyrotrons for ITER. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, AM1.
Kreischer, K.E., Kimura, T., Danly, B.G., Temkin, R.J., 1997, High-power operation of a 170 GHz megawatt gyrotron. Phys. Plasmas, 4, No. 5, 1907-1914.

[928] Advani, R., Hogge, J.P., Kreischer, K.E., Pedrozzi, M., Read, M.E., Sirigiri, J.R., Temkin, R.J., 2002, Experimental investigation of a 140 GHz coaxial gyrotron oscillator. IEEE Trans. on Plasma Science, 29, 943-950.

[929] Liu, S., Liu, D., Yan, Y., Yu, S., Fu, W., 2015, Theoretical and experimental investigations on the coaxial gyrotron with two electron beams. 40th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, M1E-1.
[930] Beringer, M.H., Illy, S., Jin, J., Kern, S., Rode, J.C., Thumm, M., 2009, Further design steps towards a 4 MW 170 GHz coaxial-cavity gyrotron, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, T4C04.0154.
[931] Beringer, M.H., Illy, S., Jin, J., Kern, S., Lievin, C., Thumm, M., 2010, Design of major components for a 4 MW 170 GHz coaxial-cavity gyrotron, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 35-36.
[932] Beringer, M.H., Kern, S., Thumm, M., 2013, Mode selection and coaxial cavity design for a 4 MW 170 GHz gyrotron including thermal aspects. IEEE Trans. on Plasma Science, 41, No. 4, 853-861.
[933] Franck, J., Avramidis, K., Gantenbein, G., Illy, S., Jin, J., Thumm, M., Jelonnek, J., 2015, Ageneric mode selection strategy for high-order mode gyrotrons operating at multiple frequencies. Nuclear Fusion, 55, 013005 (6pp).
[934] Hargreaves, T.A., Fliflet, A.W., Fischer, R.P., Barsanti, M.L., 1990, Depressed collector performance on the NRL quasi-optical gyrotron. Conf. Digest 15th Int. Conf on Infrared and Millimeter Waves, Orlando, Proc., SPIE 1514, 330-332.
[935] Nichiporenko, V., Popov, L., Myasnikov, V., Agapova, M., Belov, Yu., Gnedenkov, A., Ilyin, V., Irkhin, V., Kazansky, I., Kruglov, A., Rukavishnikova, V., Shamanova, N., Soluyanova, E., Tai, E., Usachev, S., Litvak, A., Chirkov, A., Denisov, G., Kuftin, A., Malygin, V., Zapevalov, V., Zohm, H., Stober, J., Wagner, D., Leuterer, F., Monaco, F., Münich, M., Schütz, H., 2010, Multi-frequency gyrotron for ASDEX Upgrade, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Tu-P.05.
[936] Sakamoto, K., Kajiwara, K., Oda, Y., Takahashi, K., Hayashi, K., Kobayashi, N., 2012, Progress of high power multi-frequency gyrotron development, 37th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Tue-A-3-1.
[937] Anderson, J.P., Shapiro, M.A., Temkin, R.J., Mastovsky, I., 2003, Operation of a 1.5 MW, 110 GHz gyrotron experiment. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 171-172.
[938] Anderson, J.P., Shapiro, M.A., Temkin, R.J., Mastovsky, I., 2004, Recent results for the 1.5-MW, 110-GHz gyrotron experiment. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 34-35.
[939] Anderson, J.P., Shapiro, M.A., Temkin, R.J., Mastovsky, I., 2004, Operation of a 1.5-MW, 110-GHz gyrotron depressed collector experiment. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 155-156.
[940] Choi, E.M., Marchewka, C., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2005, Megawatt power level 120 GHz gyrotrons for ITER start-up. Journal of Physics: Conference Series, 25, 1-7.
[941] Anderson, J.P., Shapiro, M.A., Temkin, R.J., Mastovsky, I., Cauffman, S.R., 2004, Studies of the 1.5-MW 110 GHz gyrotron experiment. IEEE Trans. on Plasma Science, 32, 877-883.
[942] Choi, E.M., Sirigiri, J.R., Shapiro, M.A., Temkin, R.J., 2005, Recent results from the 1.5 MW, 110 GHz gyrotron experiment at MIT. Proc. 6th IEEE Int. Vacuum Electronics Conf. (IVEC 2005), Noordwijk, The Netherlands, 115-116.
[943] Choi, E.M., Marchewka, C., Sirigiri, J.R., Shapiro, M.A., Temkin, R.J., 2005, Experimental results for a 1.5 MW, 110 GHz gyrotron with an improved cavity. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 241-242.

[944] Choi, E.M., Cerfon, A.J., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2007, Efficiency enhancement of a 1.5-MW, 110-GHz gyrotron with a single-stage depressed collector. Fusion Science and Technology, 52, 334-339.

[945] Choi, E., Cerfon, A.J., Mastovsky, I., Mulligan, W., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2007, Experimental study of a 1.5 MW, 110 GHz gyrotron with a single-stage depressed collector. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 98-99.

[946] Tax, D.S., Rock, B.Y., Fox, B.J., Jawla, S.K., Schaub, S.C., Shapiro, M.A., Temkin, R.J., Vernon,R.J., 2014, Experimental results for a pulsed 110/124.5-GHz megawatt gyrotron. IEEE Trans. on Plasma Science, 42, No. 5, 1128-1134.

[947] Marchesin, R., Alberti, S., Avramidis, K.A., Bertinetti, A., Dubray, J., Fasel, D., Gantenbein, G., Genoud, J., Hogge, J.-P., Illy, S., Jelonnek, J., Jin, J., Leggieri, A., Legrand, F., Marlétaz, B., Pagonakis, I.Gr., Savoldi, L., Thouvenin, P., Thumm, M., Tran,M.-Q., 2019, Manufacturing and test of the 1 MW long-pulse 84/126 GHz dual-frequency gyrotron for TCV. Proc. 20th Int. Vacuum Electronics Conference (IVEC 2019), Busan, Southkorea, 13.4.

[948] Alberti, S., Avramidis, K.A., Bin, W., Bertinetti, A., Dubray, J., Fasel, D., Garavaglia, S., Genoud, J., Goodman, T., Hogge, J.-P., Isoz, P.-F., Lavanchy, P., Legrand, F., Marlétaz, B., Masur, J., Moro, A., Pagonakis, I.Gr., Silva, M., Siravo, U., Toussaint, M., 2019, High-efficiency, long-pulse operation of MW-level dual-frequency gyrotron, 84/126 GHz, for the TCV tokamak. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-AM-1-2.

[949] Agapova, M., Belov, Y., Chirkov, A., Denisov, G., Gnedenkov, A., Ilin, V., Kazansky, I., Khailov, I., Kuftin, A., Kuzmin, A., Litvak, A., Lyubimov, A., Malygin, V., Miasnikov, V., Morozkin, M., Nichiporenko, V., Popov, L., Sokolov, E., Soluyanova, E., Tai, E., Usachev, S., Zapevalov, V., Joung, M., NFRI group, Stober, J., MPI IPP group, 2019, Megawatt power dual-frequency gyrotrons for modern fusion facilities. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-AM-1-5.

[950] Ikeda, R., Oda, Y., Kobayashi, T., Kajiwara, K., Terakado, M., Takahashi, K., Moriyama, S., Sakamoto, K., 2017, Multi-frequency, MW-power triode gyrotron having a uniform directional beam. J Infrared Milli Terahz Waves, 38, 531-537.

[951] Ikeda, R., Kajiwara, K., Nakai, T., Kobayashi, T., Terakado, M., Takahashi, K., Sakamoto, K., 2019, Performance tests of ITER gyrotron and design study of dual-frequency ITER gyrotron. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-Po-1-71.

[952] Igami, H., Kubo, S., Shimozuma, T., Yoshimura, Y., Takahashi, H., Tsujimura, T.I., Kobayashi, S., Mizuno, Y., Takubo, H., Tanaka, K., Yokoyama, M., Seki, R., Yamada, I., Yasuhara, R., Tsuchiya, H., Ida, K., Yoshinuma, M., Kobayashi, T., Ohdachi, S., Osakabe, M., Morisaki, T., LHD Experiment Group, 2018, Recent progress of the applications of ECRH/ECCD and the supportive technologies in the LHD. 20th Joint Workshop on Electron Cyclotron Emission (ECE) and Electron Cyclotron Resonance Heating (ECRH) (EC20), May 14-17, 2018, Greifswald, Germany.

[953] Häfner, H.E., Bojarsky, E., Norajitra, P., Reiser, 1992, H. Cryocooled windows for high frequency plasma heating. Fusion Technlogy 1992, eds. C. Ferro, M. Gasparotto, H. Knoepfel (Elsevier Science Publishers B.V. 1992), 520-523.

[954] Häfner, H.E., Bojarsky, E., Heckert, K., Norajitra, P., Reiser, H., 1994, Liquid nitrogen cooled window for high frequency plasma heating. Journal of Nuclear Materials, 212-215, 1035-1038.

[955] Häfner, H.E., Heckert, K., Norajitra, P., Vouriot, R. Hofmann, A., Münch, N., Nickel, H.-U., Thumm, M., Erckmann, V., 1994, Investigations of liquid nitrogen cooled windows for high

power millimeter wave transmission. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 281-282.

[956] Heidinger, R., Link, G., 1995, The mm-wave absorption in sapphire and its description by the 2-phonon model. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 16-17.

[957] Norajitra, P., Häfner, H.E., Thumm, M., 1995, Alternatives for edge cooled single disk windows with 1 MW transmission power. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 475-476.

[958] Saitoh, Y., Itoh, K., Yoshiyuki, T., Ebisawa, K., Yokokura, K., Nagashima, T., Yamamoto, T., 1992, Cryogenic window for millimeter-wave transmission. Fusion Technology 1992, eds. C. Ferro, M. Gasparotto, H. Knoepfel (Elsevier Science Publ. B.V. 1992), 632-636.

[959] Fix, A.S., Sushilin, P.B., 1993, Calculation and experimental investigation of cryogenic window. Proc. 5th Russian-German Meeting on ECRH and Gyrotrons, Karlsruhe, 389-392 and, 1994, Proc. 6th Russian-German Meeting on ECRH and Gyrotrons, Moscow, 1994, Vol.2, 244 247.

[960] Kasugai, A., Yokokura, K., Sakamoto, K., Tsuneoka, M., Yamamoto, T., Imai, T., Saito, Y., Ito, K. Yoshiyuki, T., Ebisawa, K., 1994, High power tests of the cryogenic window for millimeter wave. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 295-296.

[961] Garin, P., Bon-Mardion, G., Pain, M., Heidinger, R., Thumm, M., Dubrovin, A., Giguet, E., Tran, C., 1995, Cryogenically cooled window: a new step toward gyrotron CW peration. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 271-272.

[962] Parshin, V.V., Heidinger, R., Andreev, B.A., Gusev, A.V., Shmagin, V.B., 1995, Silicon with extra low losses for megawatt output gyrotron windows. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 22-23, and Parshin, V.V., 1998, private communication.

[963] Shimozuma, T., Sato, M., Takita, Y., Kubo, S., Idei, H., Ohkubo, K., Watari, T., Morimoto, S., Tajima, K., 1995, Development of elongated vacuum windows for high power CW millimeter waves. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 273-274.

[964] Shimozuma, T., Morimoto, S., Sato, M., Takita, Y., Ito, S., Kubo, S., Idei, H., Okhubo, K., Watari, T., 1997, A forced gas-cooled single disk window for high power cw millimeter waves. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 146-147.

[965] Petelin, M.I., Kasparek, W., 1991, Surface corrugation for broadband matching of windows in powerful microwave generators. Int. J. Electronics, 71, 871-873.

[966] Nickel, H.-U., Ambrosy, U., Thumm, M., 1992, Vacuum windows for frequency-tunable high-power millimeter wave systems. Conf. Digest 17th Int. Conf. on Infrared and Millimeter Waves, Pasadena, Proc., SPIE 1929, 462-463.

[967] Nickel, H.-U., Massler, H., Thumm, M., 1993, Development of broadband vacuum windows for high-power millimeter wave systems. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 172-173.

[968] Shang, C.C., Caplan, M., Nickel, H.-U., Thumm, M., 1993, Electrical analysis of wideband and distributed windows using time-dependent field codes. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 178-179.

[969] Moeller, C.P., Doane, J.L., DiMartino, M., 1994, A vacuum window for a 1 MW CW 110 GHz gyrotron. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 279-280.

[970] Shapiro, M.A., Moeller, C.P., Temkin, R.J., 2002, Electromagnetic analysis and cold test of a distributed window for a high power gyrotron. Int. J. Infrared and Millimeter Waves, 20, 533-542.

[971] Heidinger, R., 1994, Dielectric property measurements on CVD diamond grades for advanced gyrotron windows. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 277-278.

[972] Heidinger, R., Schwab, R., Spörl, R., Thumm, M., 1997, Dielectric loss measurements in CVD diamond windows for gyrotrons. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 142-143.

[973] Braz, O., Kasugai, A., Sakamoto, K., Takahashi, K., Tsuneoka, M., Imai, T., Thumm, 1997, High power 170 GHz test of CVD diamond for ECH window. Int. J. Infrared and Millimeter Waves, 18, 1495-1503.

[974] Thumm, M., 1998, Development of output windows for high-power long-pulse gyrotrons and EC wave applications. Int. J. Infrared and Millimeter Waves, 19, 3-14.

[975] Heidinger, R., Spörl, R., Thumm, M., Brandon, J.R., Sussmann, R.S., Dodge, C.N., 1998, CVD diamond windows for high power gyrotrons. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, U.K., 223-225.

[976] Kasugai, A., Sakamoto, K., Takahashi, K., Tsuneoka, M., Kariya, T., Imai, T., Braz, O., Thumm, M., Brandon, J.R., Sussmann, R.S., Beale, A., Ballington, D.C., 1998, Chemical vapor deposition diamond for high-power and long-pulse millimeter wave transmission. Rev. Scientific Instruments, 69, 2160-2165.

[977] Thumm, M., Braz, O., Heidinger, R., Makowski, M., Spörl, R., 1999, Design and optimization of the ITER ECRF window unit. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, PS-5.

[978] Spörl, R., Heidinger, R., Schwab, R., 1999, Dielectric characterisation of CVD diamond windows at elevated tempertures. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, F-A9.

[979] Thumm, M., Alberti, S., Arnold, A., Borie, E., Dammertz, G., Erckmann, V., Garin, P., Giguet, E., Illy, S., Le Cloarec, G., Le Goff, Y., Magne, R., Michel, G., Piosczyk, B., Tran, M.Q., Wagner, D., 1999, 1 MW, 140 GHz, CW gyrotron for Wendelstein-7-X. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, Plenary W-2.

[980] Thumm, M., Arnold, A., Heidinger, R., Rohde, M., Schwab, R., Spoerl, R., 2001, Status report on CVD diamond window development for high power ECRH. Fusion Engineering and Design, 53, 517-524.

[981] Brandon, J.R., Coe, S.E., Sussmann, R.S., Sakamoto, K., Spoerl, R., Heidinger, R., Hanks, S., 2001, Development of CVD diamond r.f. windows for ECRH. Fusion Engineering and Design, 53, 553-559.

[982] Heidinger, R., Meier, A., Rohde, M., Spörl, R., Thumm, M., Arnold, A., 2000, Millimeter wave characterisation of large area MPACVD diamond windows. Conf. Digest 25th Int. Conf. on Infrared and Millim. Waves, Beijing, P.R. China, 389-390.

[983] Petelin, M.I., 1999, Microwave applications of gratings. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 930-941.

[984] Thumm, M., 2001, MPACVD-diamond windows for high-power and long-pulse millimeter wave transmission. Diamond and Related Materials, 10, 1692-1699.

[985] Heidinger, R., Meier, A., Thumm, M., 2001, Dielectric loss studies in diamond window components for megawatt gyrotrons. Proc. 2nd IEEE Int. Vacuum Electronics Conference (IVEC 2001), Noordwijk, Netherlands, 227-230.

[986] Heidinger, R., Meier, A., Thumm, M., Arnold, A., 2001, MPACVD diamond discs characterised as window components for megawatt gyrotrons. Proc. 9th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 165, 357-362.

[987] Heidinger, R., Dammertz, G., Meier, A., Thumm, M.K., 2002, CVD diamond windows studied with low- and high-power millimeter waves. IEEE Trans. on Plasma Science, 30, 800-807.

[988] Yang, X., Wagner, D., Piosczyk, B., Koppenburg, K., Borie, E., Heidinger, R., Leuterer, F., Dammertz, G., Thumm, M., 2003, Analysis of transmission characteristics for single and double disk windows. Int. J. of Infrared and Millimeter Waves, 24, 619-628.

[989] Yang, X., Piosczyk, B., Heidinger, R., Thumm, M., 2003, A double disk window for the JET EP ECRH system. Fusion Engineering and Design, 66-68, 633-637.

[990] Yang, X., Borie, E., Dammertz, G., Heidinger, R., Koppenburg, K., Leuterer, F., Piosczyk, B., Wagner, D., Thumm, M., 2003, The influence of window parameters on the transmission characteristics of millimeter waves. Int. J. of Infrared and Millimeter Waves, 24, 1805-1813.

[991] Yang, X., Dammertz, G., Heidinger, R., Koppenburg, K., Leuterer, F., Meier, A., Piosczyk, B., Wagner, D., Thumm, M., 2005, Design of an ultra-broadband single-disk output window for a frequency step-tunable 1 MW gyrotron. Fusion Eng. and Design, 74, 489-493.

[992] Danilov, I., Heidinger, R., Meier, A., Thumm, M., 2004, Design and thermo-mechanical analysis of a double disk window for step-tuneable gyrotrons. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 301-304.

[993] Takahashi, K., Illy, S., Heidinger, R., Kasugai, A., Minami, R., Sakamoto, K., Thumm, M., Imai, T., 2005, Development of reliable diamond window for EC launcher on fusion reactors. Fusion Eng. and Design, 74, 305-310.

[994] Danilov, I., Heidinger, R., Meier, A., Piosczyk, B., Schmid, M., Späh, P., Bongers, W., Graswinckel, M., Lamers, B., Verhoeven, A.G.A., 2007, High-power short-pulse, mechanical, and thermohydraulic tests of the window prototype for remote steering launcher. Fusion Science and Technology, 52, 250-255.

[995] Heidinger, R., Danilov, I., Meier, A., Piosczyk, B., Späh, P., Thumm, M., Bongers, W., Graswinckel, M., Henderson, M., Leuterer, F., Verhoeven, A.G.A., Wagner, D., 2007, Development of high power window prototypes or ECH&CD launchers, Fusion Engineering and Design, 82, 693-699.

[996] Heidinger, R., Danilov, I., Meier, A., Arnold, A., Flamm, J., Thumm, M., Leuterer, F., Stober, J., Wagner, D., 2007, Low power mm-wave transmission characteristics of a frequency tuneable double disk CVD-diamond, Conf. Digest Joint 32nd Int. Conf. on Infrared and Millimetre Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, pp. 877-879, Invited Paper.

[997] Flamm, J., Schlaich, A., Arnold, A., Prinz, O., Heidinger, R., Thumm, M., 2008, Characterization of windows for fusion applications using a D-band network analyzer, Proc. 33rd Int. Conf. on Infrared, Millim. and Terahertz Waves, Pasadena, CA, USA, T4A2.1535.

[998] Scherer, T.A., Heidinger, R., Meier, A., Strauss, D., Takahashi, K., Kajiwara, K., Sakamoto, K., 2008, Experimental and theoretical thermal analysis of CVD diamond window units for the ITER upper launcher, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T5D32.1206.

[999] Scherer, T.A., Aiello, G., Grossetti, G., Meier, A., Schreck, S., Spaeh, P., Strauss, D., Vaccaro, A., Siegel, M., Meckbach, J.M., Scheuring, A., 2012, Reduction of surface losses of CVD diamond by passivation methods, 37th Int. Conf. on Infrared, Millimeter and Terahz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Tue-B-22.

[1000] Aiello, G., Gagliardi, M., Meier, A., Saibene, G., Scherer, T.A., Schreck, S., Spaeh, P., Strauss, D., Vaccaro, A., 2019, ITER torus diamond window unit: FEM analyses and impact on the design. IEEE Trans. on Plasma Science, 47, No. 7, 3289-3297.

[1001] Aiello, G., Scherer, T., Avramidis, K.A., Casal, N., Franke, T., Gagliardi, M., Gantenbein, G., Henderson, M., Jelonnek, J., Meier, A., Saibene, G., Schreck, S., Strauss, D., Thumm, M., Tran, M.Q., Wild, C., Woerner, E., 2019, Diamond window technology for electron cyclotron heating and current drive: State of the art. Fusion Science and Technology, 75, 719-729.

[1002] Belousov, V.I., Denisov, G.G., Filchenkov, S.E., Kovalev, N.F., Petelin, M.I., 2009, Broad band matched windows for gyrotrons, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, R3D06.0183.

[1003] Yu, G., Dutta, J.M., Jones, C.R., 2004, Potentials of SiC as a gyrotron window material. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 299-300.

[1004] Dutta, J.M., Jones, C.R., Parshin, V.V., Garin, B., Polyakov, V.I., Rukovishnikov, A., 2008, Electrically active defects and dielectric loss in silicon carbide, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, M5D4.1629.

[1005] Jones, C.R., Dutta, J., Yu, G., Gao, Y., 2011, Measurement of dielectric properties for low-loss materials at millimeter wavelengths, J. Infrared Milli Terahz Waves, 32, 838-847.

[1006] Mocheneva, O.S., Parshin, V.V., 2006, The scattering of submm waves by microcaverns in CVD-diamond windows. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electr., Shanghai, China, 182.

[1007] Serov, E.A., Parshin, V.V., Vlasova, K.A., Makarov, A.I., 2020, Modern dielectric materials for output windows of high-power microwave and teraherz sources. Journal of Infrared, Millimeter, and Terahertz Waves, 41, No. 12, 1450-1459.

[1008] Read, M., Lawrence Ives, R., Neilson, J., Tax, D., Temkin, R., Doane, J., 2012, A wide-band window in HE1,1 guide for gyrotrons, 37th Int. Conf. on Infrared, Millimeter and Terahz Waves (IRMMW-THz 2012), Wollongong, Australia, 2012, Tue-Pos-30.

[1009] Ives, R.L., Read, M., Bui, T., Marsden, D., Collins, G., Guss, W., Temkin, R., Neilson, J., 2015, Development of a wide-band window in HE1,1 guide for gyrotrons. 40th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, W2E-5.

[1010] Read, M., Bui, T., Ives, R.L., Marsden, D., Collins, G., Guss, W., Temkin, R., Neilson, J., Yuri Gorelov, Y., Cengher, M., Moeller, C., LeViness, A., Lohr, J., 2016, Development of a wide-band window in HE1,1 guide for gyrotrons. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), Copenhagen, Denmark, W4C.1.

[1011] Zhang, Y., Zhang, L., He, W., Donaldson, C.R., McElhinney, P., Phelps, A.D.R., Cross, A.W., 2015, Design and measurement of a W-band Brewster window. IEEE Microwave and Wireless Components Letters, 25, No. 12, 826-828.

[1012] Ji, X., Du, C.-H., Liu, P.-K., 2018, Terahertz Brewster window for ultrabroadband gyrotron application. IEEE Microwave and Wireless Components Letters, 28, No. 10, 855-857.

[1013] Bohlen, H., Eisen, E., Felch, K., Jory, H., Lenci, S., Wright, E., 1998, New high-power microwave tubes for scientific industrial and broadcast applications. Proc. 8th ITG-Conference on Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 150, 248-256.
Jory, H., 1997, Communications & Power Industries, Palo Alto, CA, USA private comm.

[1014] Zaytsev, N.I., Pankratova, T.P., Petelin, M.I., Flyagin, V.A., 1974, Millimeter- and submillimeter-wave gyrotrons. Radio Eng. and Electronic Phys., 19, 103-107.
Bandurkin, I.V., Fokin, A.P., Glyavin, M.Yu., Luchinin, A.G., Osharin, I.V., Savilov, A.V., 2020, Demonstration of a selective oversized cavity in a terahertz second-harmonic gyrotron. IEEE Electron Device Letters, 41, No. 9, 1412-1415.

[1015] Spira-Hakkarainen, S.E., Kreischer, K.E., Temkin, R.J., 1990, Submillimeter-wave harmonic gyrotron experiment. IEEE Trans. on Plasma Science, 18, 334-342.

[1016] Kreischer, K.E., Grimm, T.L., Guss, W.C., Temkin, R.J., Xu, K.Y, 1990, Research at MIT on high frequency gyrotrons for ECRH. Proc. Int. Workshop on Strong Microwaves in Plasmas, Suzdal, Inst. of Applied Physics, Nizhny Novgorod, 1991, 713-725.

[1017] Kreischer, K., Farrar, C., Griffin, R., Temkin, R., Vieregg, J., 1999, The development of a 250 GHz cw gyrotron for EPR and NMR spectroscopy. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, TU-A3.

[1018] Yan, Y.Y., Fu, W.F., Li, X.L., Yuan, X.Y., Liu, S.L., 2010, Experimental results of a 0.42 THz harmonic gyrotron, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Th-P.50.

[1019] Yan, Y., Li, X., Yuan, X., Fu, W., Liu, D., 2013, A 0.423 THz second harmonic gyrotron oscillator. Chinese Journal of Electronics, 22, No. 2, 415-418.

[1020] Fu, W., Guan, X., Chen, C., Li, X., Yuan, X., Yan, Y., 2014, Design and experiment of a 220/420-GHz gyrotron for nondestructive evaluation. IEEE Trans. on Electron Devices, 61, No. 6, 2531-2537.

[1021] Zhang, T., Zhao, Q., Yu, S., Yang, Y., Zhang, Y., 2016, The nonlinear simulation, design and experiments on 0.42 THz gyrotron with gradually tapered complex cavity. Vacuum, 125, 85-92.

[1022] Zhao, A.Q., Yu, B.S., 2017, The nonlinear designs and experiments on a 0.42-THz second harmonic gyrotron with complex cavity. IEEE Trans. on Electron Devices, 64, No. 2, 564-570.

[1023] Zhao, Q., Yu, S., 2017, The influences of beam quality and Ohmic loss on the beam-wave interaction in a 420 GHz second-harmonic complex-cavity gyrotron. Europhysics Letters, 118, No. 3, 38002 (7pp).

[1024] Zhao, Q., Yu, S., 2017, Reflection influence on the operation of a 420 GHz second harmonic gyrotron with complex cavity. Vacuum, 145, 128-135.

[1025] Wang, Z., Yu, S., Zhang, T., 2019, Investigation of the effect of electron beam quality on a 0.68-THz second harmonic gyrotron. IEEE Trans. on Plasma Science, 47, No. 11, 5153-5158.

[1026] Wang, Z., Yu, S., Zhang T., 2019, Investigation of the effect of electron beam quality on a 0.68-THz second harmonic gyrotron. IEEE Trans. on Plasma Science, 47, No. 11, 5153-5158.

[1027] Wang, Z., Yu, S., 2020, The nonlinear design and experiments of a 0.68-THz second harmonic gyrotron. IEEE Trans. on Plasma Science, 48, No. 8, 2952-2957.

[1028] Idehara, T., Tatsukawa, T., Ogawa, I., Tanabe, H., Mori, T., Wada, S., Brand, G.F., Brennan, M.H., 1992, Development of a second cyclotron harmonic gyrotron operating at submillimeter wavelengths. Phys. Fluids B4, 267-273 and 1993, Phys. Fluids B5, 1377-1379.

[1029] Shimizu, Y., Makino, S., Ichikawa, K., Kanemaki, T. Tatsukawa, T., Idehara, T., Ogawa, I., 1995, Development of submillimeter wave gyrotron using 12 T superconducting magnet. Phys. Plasmas, 2, 2110-2116.

[1030] Idehara, T., Shimizu, Y., Ichikawa, K., Makino, S., Shibutani, K., Kurahashi, K., Tatsukawa, T., Ogawa, I., Okazaki, Y., Okamoto, T., 1995, Development of a medium power, submillimeter wave gyrotron using a 17 T superconducting magnet. Phys. Plasmas, 2, 3246-3248.

[1031] Idehara, T., Tatsukawa, T., Ogawa, I., Shimizu, Y., Kurahashi, K., Nishida, N., Yoshida, K., 1996, Development of terahertz gyrotron using a 17T superconducting magnet. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, AT9.

[1032] Idehara, T., Nishida, N., Yoshida, K., Ogawa, I., Tatsukawa, T., Wagner, D., Gantenbein, G., Kasparek, W., Thumm, M., 1998, High frequency and high mode purity operations of gyrotron FU IVA. Int. J. Infrared and Millimeter Waves, 19, 919-930.

[1033] Idehara, T., Ogawa, I., Mitsudo, S., Pereyaslavets, M.L., Tsuchida, T., Ui, M., 1998, Development of a submillimeter wave gyrotron (gyrotron FU V). Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 398-399.

[1034] Idehara, T., Ogawa, I., Mitsudo, S., Pereyaslavets, M., Nishida, N., Yoshida, K., 1999, Development of frequency tunable, medium power gyrotrons (Gyrotron FU Series) as submillimeter wave radiation sources. IEEE Trans. on Plasma Science, 27, 340-354.

[1035] Ogawa, I., Idehara, T., Iwata, Y., Pavlichenko, R., Mitsudo, S., Wagner, D., Thumm, M., 2002, High quality operation of high frequency gyrotron. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 293-294.
Wagner, D., Gantenbein, G., Kasparek, W., Thumm, M., 1995, Improved gyrotron cavity with high quality factor. Int. J. Infrared and Millimeter Waves, 16, 1481-1489.

[1036] Idehara, T., Mitsudo, S., Pavlichenko, R., Ogawa, I., Wagner, D., Thumm, M., 2002, Development of submillimeter wave gyrotron FU series. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 116-128.

[1037] Idehara, T., Ogawa, I., Mitsudo, S., 2003, Present status of gyrotron FU series. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 251-252.

[1038] Ogawa, I., Idehara, T., Itakura, Y., Wagner, D., Thumm, M., 2003, High purity mode operation of gyrotron FU VA and generation of intense Gaussian beam. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 289-290.

[1039] Ogawa, I., Idehara, T., Itakura, Y., Hori, T., Wagner, D., Thumm, M., 2004, Conversion of gyrotron output into Gaussian beam and its application to plasma diagnostics. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 201-204.

[1040] Ogawa, I., Idehara, T., Sasagawa, H., Kimura, A., Mitsudo, S., Hori, T., Wagner, D., Thumm, M., 2004, High quality operation of gyrotron aiming toward the convenient radiation source in the submillimeter wave length range. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 371-374.

[1041] Idehara, T., Ogawa, I., Iwata, Y., Kanemaki, T., Ohashi, K., Kobayashi, H., Yokoyama, T., Glyavin, M., Sabchevski, S., 2003, Development of a large orbit gyrotron (LOG). Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 285-286.

[1042] Idehara, T., Ogawa, I., Mitsudo, S., Watanabe, S., Sato, N., Ohashi, K., Kobayashi, H., Yokoyama, T., Zapevalov, V., Glyavin, M., Kuftin, A., Malygin, O., Sabchevski, S., 2004, A high harmonic gyrotron and a gyro-peniotron with an axis-encircling electron beam and a permanent magnet. Proc. 10th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 183, 51-54.

[1043] Idehara, T., Watanabe, O., Kamada, M., Agusu, L., Yatsui, K., Jiang, W., Manuilov, V.N., Glyavin, M.Yu., 2004, Powerful large orbit gyrotron of submillimeter wavelength range. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 625-626.

[1044] Idehara, T., Ogawa, I., Mitsudo, S., Iwata, Y., Watanabe, S., Itakura, Y., Ohashi, K., Kobayashi, H., Yokoyama, T., Zapevalov, V.E., Glyavin, M.Yu., Kuftin, A.N., Malygin, O.V., Sabchevski, S.P., 2004, A high harmonic gyrotron with an axis-encircling electron beam and a permanent magnet. IEEE Trans. on Plasma Science, 32, 903-909.

[1045] Idehara, T., Ogawa, I., Mitsudo, S., Iwata, Y., Watanabe, S., Itakura, Y., Ohashi, K., Kobayashi, H., Yokoyama, T., Zapevalov, V., Glyavin, M., Kuftin, A., Malygin, O., Sabchevski, S., 2005, Development of a high harmonic gyrotron with an axis-encircling electron beam and a permanent magnet. Vacuum, 77, 539-546.

[1046] Idehara, T., Ogawa, I., Mitsudo, S., Iwata, Y., Watanabe, S., Itakura, Y., Agusu, L., Ohashi, K., Kobayashi, H., Yokoyama, T., Zapevalov, V., Glyavin, M., Kuftin, A., Malygin, O., Sabchevski, S., 2005, Development of a large orbit gyrotron (LOG) operating at higher harmonics. Conf.

Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 525-526.

[1047] Bratman, V.L., Kalynov, Y.K., Manuilov, V.N., 2009, A 1-THz third-harmonic large-orbit gyrotron, Proc. 34th Int. Conf. Infrar, Milli and Terahz Waves, Busan, Korea, M4D01.0118.

[1048] Bandurkin, I.V., Bratman, V.L., Kalynov, Yu.K., Osharin, I.V., Savilov, A.V., 2015, High-harmonic large orbit gyrotrons in IAP RAS. 40th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, FS-58.

[1049] Bandurkin, I.V., Kalynov, Yu.K., Savilov, A.V., 2016, Experimental study of a gyrotron with a sectioned klystron-type cavity operated at higher cyclotron harmonics. Radio Phys. and Quantum Electronics, 58, No. 9, 694-700.

[1050] Savilov, A.V., Bandurkin, I.V., Bratman, V.L., Kalynov, Yu.K., Osharin, I.V., 2017, Terahertz large-orbit high-harmonic gyrotrons at IAP RAS: Recent experiments and new designs. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, GIII-5.

[1051] Bandurkin, I.V., Bratman, V.L., Kalynov, Yu.K., Osharin, I.V., Savilov, A.V., 2018, Terahertz large-orbit high-harmonic gyrotrons at IAP RAS: Recent experiments and new designs. IEEE Trans. on Electron Devices, 65, No. 6, 2287-2293.

[1052] Savilov, A., Bandurkin, I., Bratman, V., Kalynov, Yu., Manuilov, V., Osharin, I., Zavolsky, N., 2018, Terahertz large-orbit high-harmonic gyrotrons at IAP RAS: Features. Recent experiments and new designs. Proc. 43rd Int. Conf. on Infrared, Millim, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, Tu-P2-R1-7.

[1053] Savilov, A.V., Bandurkin. I.V., Glyavin, M,Yu., Kalynov, Yu.K., Oparina, Yu.S., Osharin, I.V., Zavolsky, N.A., 2018, High-harmonic gyrotrons with irregular microwave systems. EPJ Web of Conferences, 195, 01015 (2pp).

[1054] Bandurkin, I.V., Bratman, V.L., Kalynov, Yu.K., Manuilov, V.N., Osharin, I.V., Savilov, A.V., 2019, High-harmonic gyrotrons with axis-encircling electron beam at IAP RAS. Radiophysics and Quantum Electronics, 62, No. 7-8, 513-519.

[1055] Bandurkin, I., Bratman, V., Kalynov, Yu., Manuilov, V., Osharin, Savilov, A., 2019, Development of terahertz large-orbit highharmonic gyrotrons at IAP RAS. Proc. 20th Int. Vacuum Electronics Conf. (IVEC 2019), Busan, Southkorea, 4.1.

[1056] Kalynov, Y.K., Manuilov, V.N., Fiks, A.S., Zavolsky, N.A., 2019, Powerful continuous-wave sub-terahertz large-orbit gyrotron. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Mo-AM-1-4.

[1057] Kalynov, Yu.K., Manuilov, V.N., Fiks, A.Sh., Zavolskiy, N.A., 2019, Powerful continuous-wave sub-terahertz electron maser operating at the 3rd cyclotron harmonic. Applied Physics Letters, 114, No. 21, 213502 (5pp).

Kalynov, Yu.K., Manuilov, V.N., Osharin, I.V., Savilov, A.V., Fiks, A.Sh., 2020, Radio Physics and Quantum Electronics, 63, Nos. 5-6, 321-331.

[1058] Palitsin, A.V., Rodin, Y.V., Luchinin, A.G., Panin, A.N., Bakunin, V.L., Novozhilova, Y.V., Gromov, A.V., Goykhman, M.B., Zuev, A.S., Glyavin, M.Yu., 2020, Experimental study of multimode dynamics of THz-band pulsed magnetic field gyrotron. IEEE Electron Device Letters, 41, No. 10, 1576-1578.

[1059] Glyavin, M., Zotova, I., Rozental, R., Malkin, A., Sergeev, A., Fokin, A., Rumyantsev, V., Morozov, S., 2020, Investigation of the frequency double-multiplcation effect in a sub-THz gyrotron. Journal of Infrared, Millimeter, and Terahertz Waves, 41, No. 10, 1245-1251.

[1060] Glyavin, M., Zotova, I., Gashturi, A., Fokin, A., Luchinin, A., Tsvetkov, A., Rozental, R., Semenov, E., Sergeev, A., Nusinovich, G., 2020, Simultaneous gyrotron operation at several cyclotron harmonics: Theory and experiment. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Gyrotrons 2.4.

Denisov, G.G., Glyavin, M.Yu., Kuftin, A.N., Proyavin, M.D., Morozkin, M.V., Sobolev, D.I., Fokin, A.P., Tai, E.M., Rodin, Yu.V., Luchini, A.G., Manuilov, V.N., 2021, Proc. 22nd Int. Vacuum Electronics Conference (IVEC 2021), Virtual Event, The Netherlands, S8.3.

[1061] Xu, K.Y., Kreischer, K.E., Guss, W.C., Grimm, T.L., Temkin, R.J., 1990, Efficient operation of a megawatt gyrotron. Conf. Digest 15th Int. Conf. on Infrared and Millimeter Waves, Orlando, Proc., SPIE 1514, 324-326.

[1062] Grimm, T.L., Kreischer, K.E., Guss, W.C., Temkin, R.J., 1992, Experimental study of a megawatt 200-300 GHz gyrotron oscillator. Fusion Technology, 21, 1648-1657 and, 1993, Phys. Fluids, B5, 4135-4143.

[1063] Grimm, T.L., Borchard, P.M., Kreischer, K.E., Guss, W.C., Temkin, R.J., 1992, High power operation of a 200-300 GHz gyrotron oscillator and multimegawatt gyrotrons for ITER. Conf. Digest 17th Int. Conf. on Infrared and Millimeter Waves, Pasadena, Proc., SPIE 1929, 190-191 and 194-195.

[1064] Kimura, T., Danly, B.G., Kreischer, K.E., Temkin, R.J., 1995, Development of a 1 MW, 170 GHz gyrotron with internal mode converter. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 201-202.

[1065] Sirigiri, J.R., Kreischer, K.E., Machuzak, J., Mastovsky, I., Shapiro, M.A., Temkin, R.J., 2001, Photonic-band-gap resonator gyrotron. Phys. Rev. Lett., 86, 5628-5631.

[1066] Choi, E.M., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2006, Experimental study of a high efficiency 1.5 MW, 110 GHz gyrotron. Proc. Int. Vacuum Electronics Conference and Int. Vacuum Electron Sources (IVEC/IVESC 2006), Monterey, California, USA, 417-418.

[1067] Choi, E.M., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2006, Single-stage depressed collector experimental results from a 110 GHz 1.5 MW gyrotron at MIT. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 22.

[1068] Choi, E.M., Marchewka, C.D., Mastovsky, I., Sirigiri, J.R., Shapiro, M.A., Temkin, R.J., 2006, Experimental results for a 1.5 MW, 110 GHz gyrotron oscillator with reduced mode competition. Physics of Plasmas, 13, 023103-1-023103-7.

[1069] Hidaka, Y., Choi, E.M., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2008, Study of after cavity interaction in a high efficiency 1.5 MW, 110 GHz gyrotron, Proc. 9th IEEE Int. Vacuum Electronics Conference (IVEC 2008), Monterey, CA, USA, 66-67.

[1070] Hikada, Y., Choi, E.M., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2008, Effects of after cavity interaction in a 1.5 MW, 110 GHz gyrotron with a depressed collector, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T2A4.1545.

[1071] Tax, D.S., Choi, E.M., Hidaka, Y., Mastovsky, I., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Torrezan, A.C., Neilson, J., 2010, Operation of a 1.5 MW, 110 GHz gyrotron with an advanced internal mode converter, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 313-314.

[1072] Tax, D.S., Choi, E.M., Mastovsky, I., Neilson, J.M., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Torrezan, A.C., 2011, Experimental results on a 1.5 MW, 110 GHz gyrotron with a smooth mirror mode converter, J. of Infrared Milli Terahz Waves, 32, 358-370.

[1073] Tax, D.S., Sinitsyn, O.V., Guss, W.C., Nusinovich, G.S., Shapiro, M.A., Temkin, R.J., 2013, Experimental study of the start-up scenario of a 1.5-MW, 110-GHz gyrotron, IEEE Trans. on Plasma Science, 41, No. 4, 862-871.

[1074] Guss, W.C., Schaub, S.C., Tax, D.S., Jawla, S.K., Shapiro, M.A., Temkin, R.J., Neilson, J.M., Borchard, P., 2014, High power test of an internal coupler to corrugated waveguide for high power gyrotrons. Proc. 15th IEEE Int. Vacuum Electronics Conference (IVEC 2014), Monterey, CA, USA, P3.15.

[1075] Genoud, J., Picard, J., Schaub, S., Jawla, S., Shapiro, M., Temkin, R., 2020, Studies of the effect from reflection with a short-pulse high-power gyrotron. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Gyrotrons 2.3.

[1076] Fu, W., Yan, Y., Li, X., Liu, S., 2010, The experiment of a 220 GHz gyrotron with a pulse magnet, J Infrared Milli Terahz Waves, 31, 404-410.

[1077] Yuan, X., Zhu, W., Zhang, Y., Xu, N., Yan, Y., Wu, J., Shen, Y., Chen, J., She, J., Deng, S., 2016, A fully-sealed carbon-nanotube cold-cathode terahertz gyrotron, Scientific Reports, 6, 32936.

[1078] Guan, X., Fu, W., Lu, D., Yan, Y., Yang, T., Yuan, X., 2019, Experiment of a high-power sub-THz gyrotron operating in higher-order axial modes. IEEE Trans. on Electron Devices, 66, No. 6, 2752-2757.

[1079] Guan, X. Fu, W., Lu, D., Yang, T., Yuan, X., Yan, Y., 2020, 0.22-THz frequency-tunable gyrotron with transverse sliced cavity. Proc. 45th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2020), Buffalo (Virtual Conference), NY, USA, Gyrotrons 1.2.

[1080] Saito, T., Tanaka, S., Shinbayashi, R., Hirobe, T., Yamaguchi, Y., Fukunari, M., Tatemetsu, Y., Ohkubo, K., Kubo, S., Shimozuma, T., Tanaka, K., Nishiura, M., 2018, Developments of equipment for sub-THz Collective Thomson Scattering in LHD. Proc. 43rd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2018), Nagoya, Japan, Tu-P2-R1-2.

[1081] Brand, G.F., Fekete, P.W., Hong, K., Moore, K.J., Idehara, T., 1990, Operation of a tunable gyrotron at the second harmonic of the electron cyclotron frequency. Int. J. Electronics, 68, 1099-1111.

[1082] Hong, K.D., Brand, G.F., 1993, A 150-600 GHz step-tunable gyrotron. J. Appl. Phys., 74, 5250-5258.

[1083] Idehara, T., Kamada, M., Tsuchiya, H., Hayashi, T., Agusu, La, Mitsudo, S., Ogawa, I., Manuilov, V.N., Naito, K., Yuyama, T., Jiang, W., Yatsui, K., 2005, Development of an ultra high frequency gyrotron with a pulsed magnet. Proc. 7th Workshop on High Energy Density and High Power RF, AIP Conference Proceedings 807, 2006, 197-205.

Idehara, T., Tsuchiya, H., L. Agusu, Mori, H., Murase, H., Watanabe, O., Saito, T., Ogawa, I., Mitsudo, S., 2006, Development of a THz gyrotron. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 509.

[1084] Idehara, T., Tsuchiya, H., Agusu, La, Mitsudo, S., Murase, H., Mori, H., Kanemaki, T., Saito, T., 2006, Development of a THz gyrotron with 20 T pulsed magnet. Journal of Physics: Conference Series, 51, 553-556.

[1085] Idehara, T., Tsuchiya, H., Agusu, L., Mori, H., Murase, H., Saito, T., Ogawa, I., Mitsudo, S., 2007, Development of CW THz gyrotrons in FIR FU, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 341-342.

[1086] Agusu, L., Tsuchiya, H., Mori, H., Idehara, T., Saito, T., Ogawa, I., Mitsudo, S., 2007, The experimental results and theoretical analysis of a THz gyrotron using a 21 T pulse magnet at FIR FU, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 343-344.

[1087] Idehara, T., Tsuchiya, H., Agusu, L., Mori, H., Murase, H., Saito, T., Ogawa, I., Mitsudo, S., 2007, The 1 THz gyrotron at Fukui University. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 309-311.

[1088] Han, S.-T., 2020, Application of a compact sub-terahertz gyrotron for nondestructive inspections. IEEE Trans. on Plasma Science, 48, No. 9, 3238-3245.

[1089] Du, C.-H., Li, S.-Q., Li, F.-H., Liu. P.-K., Gao, Z.-C., 2021, 2nd harmonic 1-THz fourth-harmonic gyrotron. Proc. 22nd Int. Vacuum Electronics Conference (IVEC 2021), Virtual Event, The Netherlands, S8.6.

[1090] Denisov, G.G., Antakov, I.I., Gachev, I.G., Lygin, V.K., Sokolov, E.V., Zasypkin, E.V., 2005, Studying of the 95/285 GHz gyrotron with frequency multiplication. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 435-436.

[1091] Bandurkin, I.V., Bratman, V.L., Denisov, G.G., Savilov, A.V., 2005, Frequency multiplication in gyro-oscillators. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 156-161.

[1092] Antakov, I.I., Gachev, I.G., Denisov, G.G., Lygin, V.K., Zasypkin, E.V., 2005, Development and experimental study of a two-cavity 285 GHz CW gyrotron-multiplier. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2006, Vol. 1, 162-166.

[1093] Bandurkin, I.V., Bratman, V.L., Denisov, G.G., Gachev, I.G., Kalynov, Yu.K., Savilov, A.V., 2006, New schemes of high-harmonic gyro-devices with frequency multiplication. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 83.

[1094] Bandurkin, I.Y., Bratman, V.L., Kalynov, Y.K., Manuilov, V.N., Samsonov, S.V., Savilov, A.V., 2008, Terahertz high-harmonic gyrotrons and gyro-multipliers, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, M2A4.1449.

[1095] Bandurkin, I.V., Bratman, V.L., Savilov, A.V., Samsonov, S.V., Volkov, A.B., 2009, Progress in studying a self-excited gyromultiplier, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M4D02.0342.

[1096] Bandurkin, I.V., Bratman, V.L., Savilov, A.V., Samsonov, S.V., Volkov, A.B., 2009, Experimental study of a fourth-harmonic gyromultiplier, Phys. of Plasmas, 16, 070701-1-3.

[1097] Bandurkin, I.V., Kalynov, Yu.K., Savilov, A.V., 2010, High-harmonic gyrotron with sectioned cavity. Physics of Plasmas, 17, 073101 (8pp).

[1098] Bandurkin, I.V., Kalynov, Yu.K., Savilov, A.V., 2014, High-harmonic sectioned gyrotron. Proc. 9th Int. Workshop "Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, pp. 215-216.

[1099] Bandurkin, I.V., Kalynov, Yu.K., Savilov, A.V., 2015, Experimental realization of the high-harmonic gyrotron oscillator with a klystron-like sectioned cavity. IEEE Trans. on Electron Devices, 62, No. 7, 2356-2359.

[1100] Antakov, I.I., Gachev, I.G., Kurbatov, V.I., Sokolov, E.V., Solujanova, E.A., Zasypkin, E.V., 1996, A Ka-band 10 kW CW efficient compact gyrotron for materials processing. Proc. 21st Int. Conf. on Infr. and Millimeter Waves, Berlin, AM3.

[1101] Antakov, I.I., Gachev, I.G., Kurbatov, V.I., Sokolov, E.V., Solujanova, E.A., Zasypkin, E.V., 1996, Ka-band and W-band 10 kW CW high efficiency gyrotrons for materials processing. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 679-687.

[1102] Flyagin, V.A., Kuftin, A.N., Lygin, V.K., Luchinin, A.G., Malygin, O.V., Manuilov, V.N., Tsimring, Sh.E., Zapevalov, V.E., 1996, CW 10 kW technological gyrotron in the range 15-50 GHz. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 711-716.

[1103] Zasypkin, E.V., Antakov, I.I., Gachev, I.G., Vlasov, S.N., Sokolov, E.V., 1998, Continuously tunable 35-190 GHz powerful gyrotrons at GYCOM. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 323-324.

[1104] Zasypkin, E.V., Moiseev, M.A., Nemirovskaya, L.L., 1998, Expansion of a frequency tuning band in a gyrotron with coupled cavities. Int. J. Electronics, 85, 207-216.

[1105] Möbius, A., 1995, A permanent magnet system for gyrotrons. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 487-488.

[1106] Glyavin, M., Goldenberg, A., Flyagin, V., Kuftin, A., Luchinin, A., Lygin, V., Malygin, O., Manuilov, V., Moiseev, M., Zavolsky, N., Zapevalov, V., 1999, Experimental investigation of technological gyrotrons. Proc. Int. University Conf. "Electronics and Radiophysics of Ultra-High Frequencies" (UHF-99), 1999, St. Petersburg, Russia, 112.

[1107] Bykov, Yu., Glyavin, M., Goldenberg, A., Luchinin, A., Lygin, V., Zavol'skii, N., 1999, Efficient 24-30 GHz CW gyrotrons for technological applications. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2000, Vol. 2, 747-750.

[1108] Bykov, Y., Glyavin, M., Denisov, G., Holoptsev, V., Eremeev, A., Plotnikov, I., Pavlov, V., 2001, 3.5 kW 24 GHz compact gyrotron system for microwave processing of materials. Proc. 8th Int. Conf. on Microwave and High Frequency Heating, Bayreuth, 89.

[1109] Denisov, G.G., Bykov, Yu.V., Eremeev, A.G., Holoptsev, V.V., Glyavin, M.Yu., Luchinin, A.G., Kalynova, G.I., Plotnikov, I.V., Samsonov, S.V., 2005, Development of gyrotron-based technological systems at Gycom / IAP. Conf. Digest 30th Int. Conf. Infrared and Milli Waves and 13th Int. Conf. Terahertz Electronics, Williamsburg, VA, USA, 28-29.

[1110] Morozkin, M.V., Glyavin, M.Yu., Denisov, G.G., Luchinin, A.G., 2008, A high-efficiency second-harmonic gyrotron with a depressed collector. Int. J. Infrared and Millimeter Waves, 29, 1004-1010.

[1111] Bykov, Yu.V., Denisov, G.G., Glyavin, M.Yu., Goldenberg, A.L., Luchinin, A.G., Morozkin, M.V., Sobolev, D.I., 2008, The second harmonic gyrotron with record efficiency, Proc. 7th Int. Workshop on Strong Microwaves: Sources and Applications, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2009, Vol. 1, pp. 134-138.

[1112] Glyavin, M.Yu., Denisov, G.G., Luchinin, A.G., Morozkin, M.V., Sobolev, D.I., 2009, Experimental study of a gyrotron operated at the second gyrofrequency harmonic with the single-stage energy recovery, Radiophysics and Quantum Electronics, 51, 768-771.

[1113] Glyavin, M.Yu., Luchinin, A.G., Morozkin, M.V., 2011, Technological gyrotron with the wide-band fast frequency sweeping, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 107-108.

[1114] Glyavin, M., Luchinin, A., Morozkin, M., 2012, The Ka-band 10-kW continuous wave gyrotron with wide-band fast frequency sweep. Rev. Scientific Inst., 83, 074706 (3 pp).

[1115] Tsvetkov, A.I., Denisov, G.G., Bykov, Y.V., Glyavin, M.Y., Eremeev, A.G., Kholoptsev, V.V., Morozkin, M.V., Shmelev, M.Y., Sobolev, D.I., Chirkov, A.V., Tai, E.M., Soluyanova, E.A., Bakulin, M.I., 2016, 45 GHz/20 kW gyrotron-based system for ECR ion source. 43rd IEEE Int. Conf. on Plasma Science, June 19-23, Banff, Canada, 1P-24.

[1116] Glyavin, M.Yu., Fedotov, A.E., Zotova, I.V., Luchinin, A.G., Proyavin, M.D., Rozental, R.M., Tarakanov, V.P., 2019, Experimental demonstration of the possibility to expand the band of smooth tuning of frequency generation in short-cavity gyrotrons. Radiophysics and Quantum Electronics, 61, No. 11, 797-800.

[1117] Glyavin, M.Yu., Bykov, Y.V., Luchinin, A.G., Manuilov. V.N., Morozkin, M.V., Proyavin, M.D., Sobolev, D.I., Tai, E.M., 2018, Recent progress in K-band technological gyrotrons development. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Tu-AM-1-2.

[1118] Proyavin, M.D., Glyavin, M.Yu., Zavol'sky, N.A., Manuilov, V.N., Morozkin, M.V., Sobolev, D.I., Krapivnitskaya, T.O., 2019, Development of a high-power continuous-wave gyrotron for high-efficiency technological K-band microwave complexes. Radiophysics and Quantum Electronics, 62, No. 7-8, 507-512.
[1119] Fokin, A.P., Sedov, A.S., Zuev, A.S., 2020, Experimental demonstration of the third cyclotron harmonic excitation in technological gyrotron with delayed selective feedback. Review of Scientific Instruments, 91, No. 2, 024706 (5pp).
[1120] Malygin, A., Illy, S., Pagonakis, I., Avramidis, K., Thumm, M., Jelonnek, J., Ives, L., Collins, G., 2014, Experimental investigations of a 15 kW/28 GHz second harmonic CW gyrotron designed for evaluation of new emitter technologies. Proc. 9th Int. Workshop "Strong Microwaves and Terahertz Waves: Sources and Applications", July 24-30, 2014, Nizhny Novgorod, Russia, pp. 162-163.
[1121] Huey, H., 2010, Micramics, Inc., San Jose, CA, USA, private communication.
[1122] Kikunaga, T., Asano, H., Hemmi, K., Sato, F., Tsukamoto, T., 1995, A 28 GHz gyrotron with a permanent magnet system. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 485-486.
[1123] Takada, T., Ohashi, K., Honshima, M., Kikunaga, T., 1995, Nd-Te-B permanent magnet circuit for a 28 GHz CW gyrotron. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 489-490.
[1124] Asano, H., Kikunaga, K., Hemmi, K., Sato, F., Tsukamoto, T., 1996, A 28 GHz gyrotron with a permanent magnet system for industry applications. Proc. 21st Int. Conf. on Infrared and Millimeter Waves, Berlin, AM5.
[1125] Wang, W., Yu, G., Xu, M., Gong, Y., 2003, 8 mm TE13 mode gyrotron. Int. J. of Infrared and Millimeter Waves, 24, 661-668.
[1126] Zapevalov, V.E., Lygin, V.K., Malygin, O.V., Moiseev, M.A., Khizhnjak, V.I., Karpov, V.P., Tai, E.M., Idehara, T., Ogawa, I., Mitsudo, S., 2005, Development of the 300 GHz/ 4 kW/CW gyrotron. Proc. 6th IEEE Int. Vacuum Electronics Conf. (IVEC 2005), Noordwijk, The Netherlands, 121-122.
[1127] Hoshizuki, H., Matsuura, K., Mitsuso, S., Idehara, T., Malygin, O.V., Khizhnjak, V.I., Zapevalov, V.E., Ueda, T., Furuiti, M., Kitano, A., Nishi, H., Ishibashi, J., 2005, Development of the material processing system by using a 300 GHz gyrotron. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 375-376.
[1128] Zapevalov, V.E., Lygin, V.K., Malygin, O.V., Moiseev, M.A., Karpov, V.P., Khizhnjak, V.I., Tai, E.M., Idehara, T., Ogawa, I., Mitsudo, S., 2005, Development of the 300 GHz/4 kW/CW gyrotron. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 167-172.
[1129] Saito, T., Idehara, T., Mitsudo, S., Ogawa, I., Hoshizuki, H., Murase, H., Sakai, K., Zapevalov, V.E., Malygin, O.V., Khizhnjak, V.I., Karpov, V.P., Tai, E.M., 2006, Oscillation characteristics of CW 300 GHz gyrotron FU CWI. Conf. Digest 31st Int. Conf. Infrared and Millimeter Waves and 14th Int. Conf. Terahertz Electronics, Shanghai, China, 24.
[1130] Mitsudo, S., Sakai, K., Idehara, T., Saito, T., 2006, 300 GHz gyrotron material processing system. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 572.

[1131] Saito, T., Nakano, T., Hoshizuki, H., Sakai, K., Tatematsu, Y., Mitsudo, S., Ogawa, I., Idehara, T., Zapevalov, V.E., 2007, Performance test of CW 300 GHz gyrotron FU CW I. Int. J. Infrared and Millimeter Waves, 28, 1063-1078.

[1132] Saito, T., Nakamo, T., Tatematsu, Y., Mitusdo, S., Idehara, T., Zapevalov, V.E., 2008, Operation improvement of CW 300 GHz gyrotron FU CWI, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, F2A3.1207.

[1133] Zapevalov, V.E., Lygin, V.K., Malygin, O.V., Moiseev, M.A., Khizhnyak, V.I., Karpov, V.P., Tai, E.M., Idehara, T., Mitsudo, S., Ogawa, I., Saito, T., 2007, High-power oscillator of continuous electromagnetic radiation with a frequency of 300 GHz, Radiophysics and Quantum Electronics, 50, 420-428.

[1134] Bratman, V.L., Ginzburg, N.S., Nusinovich, G.S., Petelin, M.I., Strelkov, P.S., 1981, Relativistic gyrotrons and cyclotron autoresonance masers. Int. J. Electron., 51,541-567.

[1135] Bratman, V.L., Denisov, G.G., Ofitserov, M.M., Korovin, S.D., Polevin, S.D., Rostov, V.V., 1987, Millimeter-wave HF relativistic electron oscillators. IEEE Trans. on Plasma Science, 15, 2-15.

[1136] Zaitsev, N.I., Ginzburg, N.S., Zavolskii, N.A., Zapevalov, V.E., Ilyakov, E.V., Kulagin, I.S., Kuftin, A.N., Lygin, V.K., Moiseev, M.A., Novozhilova, Yu.V., Rozental, R.M., Tsalolokhin, V.I., 2001, Highly efficient relativistic SHF gyrotron with a microsecond pulse width. Tech. Phys. Lett., 27, 266-270.

[1137] Zaitsev, N.I., Ginzburg, S., Ilyakov, E.V., Kulagin, I.S., Lygin, V.K., Manuilov, V.N., Moiseev, M.A., Rosenthal, R.M., Zapevalov, V.E., Zavolsky, N.A., 2002, X-band high-efficiency relativistic gyrotron. IEEE Trans. on Plasma Science, 30, 840-845.

[1138] Ilyakov, E.V., Kulagin, I.S., Kuzikov, S.V., Lygin, V.K., Manuilov, V.N., Moiseev, M.A., Petelin, M.I., Rozental, R.M., Zaitsev, N.I., Zapevalov, V.E., Zavolsky, N.A., 2003, 10-MW, Ka-band gyrotron. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 325-326.

[1139] Ilyakov, E., Krasnykh, A., Kulagin, I., Kuzikov, S., Lygin, V., Moiseev, M., Petelin, M., Zaitsev, N., 2004, Ka band – 10 MW gyro-devices: an experiment and a project. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 61-62.

[1140] Zaitsev, N.I., Zavolsky, N.A., Zapevalov, V.E., Ilyakov, E.V., Kulagin, I.S., Lygin, V.K., Moiseev, M.A., Nechaev, V.E., Petelin, M.I., Rozental, R.M., 2003, Ten-megawatt pulsed gyrotron with a 1-cm wavelength and a 50% efficiency. Radiophysics and Quantum Electronics, 46, 816-819.

[1141] Rozental, R.M., Zaitsev, N.I., Kulagin, I.S., Ilyakov, E.V., Ginzburg, N.S., 2004, Nonstationary Processes in an X-band relativistic gyrotron with delayed feedback. IEEE Trans. on Plasma Science, 32, 418-421.

[1142] Abubakirov, E.B., Chirkov, A.V., Denisov, G.G., Guznov, Y.M., Kornishin, S.Y., Leontyev, A.N., Plankin, O.P., Rozental, R.M. Sedov, A.S., Semenov, E.S., Tarakanov, V.P., Zavolsky, N.A., Zapevalov, S.A., Zapevalov, V.E., 2017, W-band 5 MW pulsed relativistic gyrotron. IEEE Trans. on Electron Devices, 64, No. 4, 1865-1867.

[1143] Leontyev, A.N., Abubakirov, E.B., Chirkov, A.V., Denisov, G.G., Guznov, Yu.M., Kornishin, S.Yu., Plankin, O.P., Rozental R.M., Sedov, A.S., Semenov, E.S., Zavolsky N.A., Zapevalov, S.A., Zapevalov, V.E., 2017, W-band 5 MW pulse relativistic gyrotron: development and experimental implementation. EPJ Web of Conferences, 149, 04026 (2pp).

[1144] Zavolsky N.A., Ilyakov, E.V., Kalynov, Yu.K., Kulagin, I.S., Manuilov, V.N., Shevchenko, A.S., 2018, High-power relativistic millimeter-wave relativistic gyrotron operating at the second cyclotron harmonic. Radiophysics and Quantum Electronics, 61, No. 1, 40-47.

[1145] Abubakirov, E.B., Denisenko, A.N., Fedotov, A.E., Leontyev, A.N., Rozental, R.M., Tarakanov, V.P., 2019, First operation of Ka-band high-current relativistic gyrotron. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Tu-PM1-1-2.

[1146] Bakunin, V.L., Guznov, Yu.M., Denisov, G.G., Zaitsev, N.I., Zapevalov, S.A., Kuftin, A.N., Novozhilova, Yu.V., Fokin, A.P., Chirkov, A.V., Shevchenko, A.S., 2019, An experimental study of the external-signal influence on the oscillation regime of a megawatt gyrotron. Radiophysics and Quantum Electronics, 62, No. 7-8, 481-489.

[1147] Krementsov, V.I., Petelin, M.I., Rabinovich, M.S., Rukhadze, A.A., Strelkov, P.S., Shkvarunets, A.G., 1978, Plasma-filled gyrotron with a relativistic supervacuum electron beam. Sov. Phys. JETP, 48, 1084-1085.

[1148] Ginzburg, N.S., Krementsov, V.I., Petelin, M.I., Strelkov, P.S., Shkvarunets, A.G., 1979, Experimental investigation on a high-current relativistic cyclotron maser. Sov. Phys. Tech. Phys., 24, 218-222.

[1149] Voronkov, S.N., Krementsov, V.I., Strelkov, P.S., Shkvarunets, A.G., 1982, Stimulated cyclotron radiation and millimeter wavelengths from high-power relativistic electron beams. Sov. Phys. Tech. Phys., 27, 68-69.

[1150] Kolyada, Yu.E., Fainberg, Ya.B., Kornilov, E.A., Ognivenko, V.V., Kiyashko, V.A., 1976, Interaction of a high-current electron beam with a plasma in open cavity in a mirror system. Sov. Tech. Phys. Lett., 2, 348-350.

[1151] Gilgenbach, R.M., Wang, J.G., Choi, J.J., Outten, C.A., Spencer, TA, 1988, Intense electron beam cyclotron masers with microsecond pulse lengths. Conf. Digest 13th Int. Conf. on Infrared and Millimeter Waves, Honolulu, Hawaii, Proc., SPIE 1039, 362-363.

[1152] Gilgenbach, R.M., Hochman, J.M., Jaynes, R. Walter, M.T., Rintamaki, J., Lash, J.S., Luginsland, J., Lau, Y.Y., Spencer, T.A., 1995, Rectangular interaction structures in high power gyrotron devices. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 528-529.

[1153] Hochman, J.M., Gilgenbach, R.M., Jaynes, R.L., Rintamaki, J.I., Lau, Y.Y., Spencer, T.A., 1997, High power microwave emission of large and small orbit rectangular cross section gyrotrons. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 315-316.

[1154] Hochman, J.M., Gilgenbach, R.M., Jaynes, R.L., Rintamaki, J.I., Lau, Y.Y., Cohen, W.E., Peters, C.W., Spencer, T.A., 1998, Polarization control of microwave emission from high power rectangular cross-section gyrotron devices. IEEE Trans. Plasma Scien., 26, 383-392.

[1155] Jaynes, R.L., Gilgenbach, R.M., Cohen, W.E., Lopez, M.R., Peters, C.W., Hochman, J.M., Lau, J.J., Spencer, T.A., 1999, High power microwave production in a coaxial, large orbit, axis encircing gyrotron oscillator. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, TU-A4.

[1156] Jaynes, R.L., Gilgenbach, R.M., Peters, C.W., Cohen, W.E., Lopez, M.R., Lau, Y.Y., Williams, W.J., Spencer, T.A., 2000, Long-pulse, high-power, large-orbit, coaxial gyrotron oscillator experiments. IEEE Trans. on Plasma Science, 28, 945-952.

[1157] Gilgenbach, R.M., Jaynes, R.L., Cohen, W.E., Peters, C.W., Lopez, M.R., Lau, Y.Y., Williams, W.J., Spencer, T.A., 2000, Experiments on slotted, coaxial, high power gyrotrons. Conf. Digest Intense Microwave Pulses VII., Orlando, Florida, USA, SPIE-4031, 8-18.

[1158] Granatstein, V.L., Herndon, M., Sprangle, P., Carmel, Y., Nation, J.A., 1975, Gigawatt microwave emission from an intense relativstic electron beam. Plasma Physics, 17, 23-28.

[1159] Gold, S.H. Fliflet, A.W., Manheimer, W.M., McCowan, R.B., Black, W.M., Lee, R.C., Granatstein, V.L., Kinkead, A.K., Hardesty, D.L., Sucy, M., 1987, High peak power Ka-band gyrotron oscillator experiment. Phys. Fluids, 30, 2226-2238.

[1160] Gold, S.H., Fliflet, A.W., Manheimer, W.M., McCowan, R.B., Lee, R.C., Granatstein, V.L., Hardesty, D.L, Kinkead, A.K., Sucy, M., 1988, High peak power Ka-band gyrotron oscillator experiments with slotted and unslotted cavities. IEEE. Trans. Plasma Science, 16, 142, and, Gold, S.H., 1998, private communication.

[1161] Black, W.M., Gold, S.H., Fliflet, A.W., Kirkpatrick, D.A., Manheimer, W.M., Lee, R.C., Granatstein, V.L., Hardesty, D.L., Kinkead, A.K., Sucy, M., 1990, Megavolt Multikiloamp Ka-band gyrotron oscillator experiment. Phys. Fluids, B2, 193.

[1162] Didenko, A.N., Zherlitsyn, A.G., Zelentsov, V.I., Sulakshin, A.S., Fomenko, G.P., Shtein, Yu.G., Yushkov, Yu.G., 1976, Generation of gigawatt microwave pulses in the nanosecond range. Sov. J. Plasma Phys., 2, 283-285.

[1163] Minami, K., Hayatsu, Y., Sato, T., Sanmonji, M., Granatstein, V.L., 2002, Experiment on a cold cathode gyrotron. 29th IEEE Int. Conf. on Plasma Science (ICOPS 2002), Banff, Canada, May 26-30, 3P09.

[1164] Cross, A.W., Spark, S.N., Phelps, A.D.R., 1988, Gyrotron experiments using cavities of different ohmic Q. Conf. Digest 17th Int. Conf. on Infrared and Millimeter Waves, Pasadena, Proc., SPIE 1929, 392-393.

[1165] Cross, A.W., Spark, S.N., Phelps, A.D.R., 1995, Gyrotron experiments using cavities of different ohmic Q. Int. J. Electronics, 79, 481-493.

[1166] Cross, A.W., MacGregor, S.J., Phelps, A.D.R., Ronald, K., Spark, S.N., Turnbull, S.M., 1995, Megawatt, 1 kHz PRF tunable gyrotron experiments. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 530-531.

[1167] Ronald, K., Cross, A.W., Phelps, A.D.R., He, W., 2001, Observations of dynamic behaviour in an electron cyclotron maser oscillator. Appl. Phys., 34, L17-L22.

[1168] Ronald, K., Phelps, A.D.R., Cross, A.W., He, W., 2001, Observations of non-stationary behaviour in electron cyclotron masers. Proc. 9th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 165, 159-162.

[1169] Ronald, K., Cross, A.W., Phelps, A.D.R, He, W., Whyte, C.G., Thomson, R., Rafferty, E., 2003, ECM automodulation experiments. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 255-256.

[1170] Bratman, V.L., Kalynov, Yu.K., Kolganov, N.G., Manuilov, V.N., Ofitserov, M.M., Savilov, A.V., Samsonov, S.V., Volkov, A.B., 1996, Cyclotron autoresonance masers and relativistic gyrotrons. Proc. 3rd Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, 1997, Vol.2, 745-761.

[1171] Bratman, V.L., Kalynov, Yu.K., Ofitserov, M.M., Samsonov, S.V., Savilov, A.V., 1997, CARMs and relativistic gyrotrons as effective sources and millimeter and submillimeter waves. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 58-60.

[1172] Bratman, V.L., Fedotov, A.E., Kalynov, Yu.K., Manuilov, V.N., Ofitserov, M.M., Samsonov, S.V., Savilov, A.V., 1998, Gyrotron on the 5th cyclotron harmonic. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 325-326.

[1173] Bratman, V.L., Fedotov, A.E., Kalynov, Y.K., Manuilov, V.N., Ofitserov, M.M., Samsonov, V., Savilov, A.V., 1999, Moderately relativistic high-harmonic gyrotrons for millimeter/submillimeter wavelength band. IEEE Trans. on Plasma Science, 27, 456-461, and private communications, 2002.

[1174] Bratman, V.L., Dumesh, B.S., Fedotov, A.E., Manuilov, V.N., Kalynov, Yu.K., Ofitserov, M.M., Rusin, F.S., Samsonov, S.V., 2002, Powerful sources of coherent submillimeter-wave radiation. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 135-143.

[1175] Bratman, V.L., Dumesh, B.S., Fedotov, A.E., Grishin, Yu.A., Kalynov, Yu.K., Manuilov, V.N., Rusin, F.S., Samsonov, S.V., 2004, New sources of coherent submillimeter-wave radiation. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 193-194.

[1176] Bratman, V.L., Kalynov, Yu.K., Manuilov, V.N., Samsonov, S.V., 2005, Large orbit gyrotron at submillimeter waves. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 443-444.

[1177] Bratman, V.L., Kalynov, Yu.K., Manuilov, V.N., Samsonov, S.V., 2005, Large-orbit gyrotron operation at submillimeter waves. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2006, Vol. 1, 150-155.

[1178] Bratman, V.L., Bandurkin, I.V., Dumesh, B.S., Fedotov, A.E., Kalynov, Y.K., Kolganov, N.G., Manuilov, V.N., Rusin, F.S., Samsonov, S.V., Savilov, A.V., 2005, Sources of coherent terahertz radiation. Proc. 7th Workshop on High Energy Density and High Power RF, AIP Conference Proceedings 807, 2006, 356-366.

[1179] Jiang, W., 2013, High power Microwave Source Development in Nagaoka University of Technology. Proc. Int. Symp. on Development of terahertz gyrotrons and applications. Fukui, Japan, 15A-6.

[1180] Hogge, J.P., Cao, H., Kasparek, W., Tran, T.M., Tran, M.Q., Paris, P.J., 1991, Ellipsoidal diffraction grating as output coupler for quasi-optical gyrotrons. Conf. Digest 16th Int. Conf. on Infrared and Millimeter Waves, Lausanne, Proc., SPIE 1576, 540-541.

[1181] Vlasov, S.N. Koposova, E.V., Pavelyev, A.B., Khizhnyak, V.I. 1996, Gyrotrons with echelette resononators. Radiophys. and Quantum Electronics, 39, 458-462.

[1182] Kreischer, K.E., Schutkeker, J.B., Danly, B.G., Mulligan, W.J., Temkin, R.J., 1984, High efficiency operation of a 140 GHz pulsed gyrotron. Int. J. Electron. 57, No. 6, 835-850.

[1183] Hu, W., Shapiro, M.A., Kreischer, K.E., Temkin, R.J., 1997, 140 GHz confocal cavity gyrotron experiment. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 116-117.

[1184] Hu, W., Shapiro, M.A., Kreischer, K.E., Temkin, R.J., 1998, 140-GHz gyrotron experiments based on a confocal cavity. IEEE Trans. on Plasma Science, 26, 366-374.

[1185] Gapochka, M.G., Korolev, A.F., Kostienko, A.I., Sukhorukov, A.P., Sheludchenkov, A.V., Golenitski, I.I., Evtushenko, O.V., Pulino, A., 1996, Compact low-voltage quasioptical millimeter-wave generators. Proc. 25th European Microwave Conference, Prague, 144-145.

[1186] Fliflet, A.W., Hargreaves, T.A., Fischer, R.P., Manheimer, W.M., Sprangle, P., 1990, Review of quasi-optical gyrotron development. J. Fusion Energy, 9, 31-58.

[1187] Fischer, R.P., Fliflet, A.W., Manheimer, W.M., Levush, B., Antonsen Jr., T.M., 1993, Mode priming an 85 GHz quasioptical gyroklystron. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 330-331.

[1188] Guan, X., Fu, W., Yan, Y., 2017, A 0.4-THz second harmonic gyrotron with quasi-optical confocal cavity. J Infrared Milli Terahz Waves, 38, 1457-1470.

[1189] Fu, W., Guan, X., Yan, Y., Li, X., Huang, Y., Meng, L., 2017, Harmonic terahertz gyrotron with quasi-optical confocal cavity. EPJ Web of Conferences, 149, 05014 (2pp).

[1190] Fu, W., Guan, X., Yan, Y., 2017, Initial experimental results for a 400 GHz second harmonic gyrotron with quasi-optical confocal cavity. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RB2.1.

[1191] Fu, W., Guan, X., Yan, Y., 2020, Generating high-power continuous-frequency tunable sub-terahertz radiation from a quasi-optical gyrotron with confocal waveguide. IEEE Electron Devices Letters, 41, No. 4, 613-616.

[1192] Bratman, V.L., Denisov, G.G., 1992, Cyclotron autoresonance masers - recent experiments and prospects. Int. J. Electronics, 72, 969-981.

[1193] Bratman, V.L., Denisov, G.G., Ofitserov, M.M., Samsonov, S.V., Arkhipov, O.V., Kazacha, V.I., Krasnykh, A.K., Perelstein, E.A., Zamrij, A.V., 1992, Cyclotron auto-resonance maser with high Doppler frequency up-conversion. Int. J. Infrared and Millimeter Waves, 13, 1857-1873.

[1194] Bratman, V.L., Denisov, G.G., Samsonov, S.V., 1993, Cyclotron autoresonance masers: achievements and prospects of advance to the submillimeter wavelength range. Proc. 2nd Int. Workshop on Strong Microwaves in Plasmas, Moscow - Nizhny Novgorod -Moscow, Inst. of Applied Physics, Nizhny Novgorod, 1994, Vol. 2, 690-711.

[1195] Bratman, V.L., Denisov, G.G., Kol'chugin, B.D., Samsonov, S.V., Volkov, A.B., 1995, Experimental demonstration of high-efficiency cyclotron-autoresonance-maser operation. Phys. Rev. Lett., 75, 3102-3105.

[1196] Ginzburg, N.S., Zotova, I.V., Sergeev, A.S., Konoplev, I.V., 1997, Experimental observation of cyclotron superradiance under group synchronism conditions. Phys. Rev. Letters, 78, 2365-2368.

[1197] Ginzburg, N.S., Zotova, I.V., Sergeev, A.S., Phelps, A.D.R., Cross, A.W., Shapk, V.G., Yaladin, M.I., Tarakanov, V.P., 1999, Generation of ultrashort microwave pulses based on cyclotron superradiance. IEEE Trans. on Plasma Science, 27, 462-469.

[1198] Bratman, V.L., Denisov, G.G., Kalynov, Yu.K., Samsonov, S.V., Savilov, A.V., Cross, A.W., He, W., Phelps, A.D.R., Ronald, K., Whyte, C.G., Young, A.R., 1999, Novel types of cyclotron resonance devices. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2000, Vol. 2, 683-702.

[1199] Bratman, V.L., Fedotov, A.E., Kolganov, N.G., Samsonov, S.V., Savilov, A.V., 2000, Effective co-generation of opposite and forward waves in cyclotron-resonance masers. Phys. Rev. Lett., 85, 3424-3427.

[1200] Bratman, V.L., Fedotov, A.E., Savilov, A.V., 2000, A gyrodevice based on simultaneous excitation of opposite and forward waves (Gyrotron BWO-TWT). IEEE Trans. on Plasma Science, 28, 1742-1746.

[1201] Bratman, V.L., Fedotov, A.E., Kolganov, N.G., Samsonov, S.V., Savilov, A.V., 2001, Experimental study of CRM with simultaneous excitation of traveling and near-cutoff waves (CARM-Gyrotron). IEEE Trans. on Plasma Science, 29, 609-612.

[1202] Caplan, M., Kulke, B., Westenskow, G.A.; McDermott, D.B., Luhmann, Jr., N.C., 1992, Induction-linac-driven, millimeter-wave CARM oscillator. Laboratory Report UCRL-53689-80, Lawrence Livermore National Laboratory, Livermore, California.

[1203] Danly, B.G., Hartemann, F.V., Chu, T.S., Legorburn, P., Menninger, W.L, Temkin, R.J., 1992, Long-pulse millimeter-wave free-electron laser and cyclotron autoresonance maser experiments. Phys. Fluids, B4, 2307-2314.

[1204] Alberti, S., Danly, B.G., Gulotta, G., Giguet, E., Kimura, T., Menninger, W.L., Rullier, J.L., Temkin, R.J., 1993, Experimental study of a 28 GHz high-power long-pulse cyclotron autoresonance maser oscillator. Phys. Rev. Lett., 71, 2018-2021.

[1205] McCowen, R.B., Sullivan, C.A., Gold, S.H., Fliflet, A.W., 1992, Observation of harmonic gyro-backward-wave oscillation in a 100 GHz CARM oscillator experiment. Int. J. Electronics, 72, No. 5 and 6, 1033-1043.

[1206] Wang, J.G., Gilgenbach, R.M., Choi, J.J., Outten, C.A., Spencer, T.A., 1989, Frequency -tunable, high-power microwave emission from cyclotron autoresonance maser oscillation and gyrotron interactions. IEEE Trans. Plasma Science, 17, 906-908.

[1207] Choi, J.J., Gilgenbach, R.M., Spencer, T.A., 1992, Mode competition in Bragg resonator cyclotron resonance maser experiments driven by a microsecond intense electron beam. Int. J. Electronics, 72, No. 5 and 6, 1045-1066.

[1208] Cooke, S.J., Cross, A.W., He, W., Phelps, A.D.R., 1995, The operation of a second harmonic CARM oscillator. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 427-428.

[1209] Cooke, S.J., Cross, A.W., He, W., Phelps, A.D.R, 1996, Experimental operation of a cyclotron autoresonance maser oscillator at the second harmonic. Phys. Rev. Lett., 77, 4836-4839.

[1210] Young, A.R., He, W. Ronald, K., Cross, A.W., Whyte, C.G., Phelps, A.D.R., 1998, Cold and thermionic cathode CARM experiments. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 448-449.

[1211] Felch, K., James, B.G., Borchard, P., Cahalan, P., Chu, T.S., Hargreaves, T.A., Blank, M., Pershing, D.E., Calame, J.P., Nguyen, K., Danly, B.G., Levush, B., 1999, Recent test results for a 10 kW average power W-band gyroklystron amplifier. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, M-A5.

[1212] Blank, M., Danly, G., Levush, B., Calame, J.P., Nguyen, K., Pershing, D., Petillo, J., Hargreaves, T.A., True, R.B., Theiss, J., Good, G.R., Felch, K., James, B.G., Borchard, P., Cahalan, P., Chu, T.S., Jory, H., Lawson, W.G., Antonsen, Jr., T.M., 1999, Demonstration of a 10 kW average power 94 GHz gyroklystron amplifier. Phys. of Plasmas, 6, 4405-4409.

[1213] Blank, M., Felch, K., James, B.G., Borchard, P., Cahalan, P., Chu, T.S., Jory, H., Hargreaves, T.A., True, R.B., Theiss, A.J., Good, G.R., Danly, B.G., Levush, B., Calame, J.P., Nguyen, K., Pershing, D., Petillo, J., Lawson, W.G., Antonsen, T.M. jr., 1999, Experimental demonstration of a high-average power W-band gyroklystron amplifier. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2000, Vol. 2, 703-712.

[1214] Blank, M., Felch, K., James, B.G., Borchard, P., Cahalan, P., Chu, T.S., Danly, B.G., Pershing, D.E., Nguyen, K., Calame, J.P., Levush, B., 2000, Demonstration of high average power W-band gyro-amplifiers. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 113-114.

[1215] Blank, M., Danly, B.G., Levush, B., 2000, Experimental demonstration of W-band gyroklystron amplifiers with improved gain and efficiency. IEEE Trans. on Plasma Science, 28, 706-711.

[1216] Blank, M., Felch, K., James, B.G., Borchard, P., Cahalan, P., Chu, T.S., Jory, H., Danly, B.G., Levush, B., Calame, J.P., Nguyen, K.T., Pershing, D.E., 2002, Development and demonstration of high-average power W-band gyro-amplifiers for radar applications. IEEE Trans. on Plasma Science, 30, 865-875.

[1217] Danly, B.G., Blank, M., Calame, J.P., Levush, B., Nguyen, K.T., Pershing, D.E., Parker, R.K., Felch, K.L., James, B.G., Borchard, P., Cahalan, P., Chu, T.S., Jory, H.R., Hargreaves, T.A., True, R.B., Lawson, W.G., Antonsen, T.M., 2000, Development and testing of a high-average power, 94-GHz gyroklystron. IEEE Trans. on Plasma Science, 28, 713-726.

[1218] Blank, M., Borchard, P., Cauffman, S., Felch, F., 2006, Broadband W-band gyrotron amplifier development. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 198.

[1219] Antakov, I.I., Zasypkin, E.V., Sokolov, E.V., Yulpatov, V.K., Keyer, A.P., Musatov, V.S., Myasnikov, V.E., 1993, 35 GHz radar gyroklystrons. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 338-339.

[1220] Antakov, I.I., Gaponov, A.V., Zasypkin, E.V., Sokolov, E.V., Yulpatov, V.K., Aksenova, L.A., Keyer, A.P., Musatov, V.S., Myasnikov, V.E., Popov, L.G., Levitan, B.A., Tolkachev, A.A., 1993, Gyroklystrons: millimeter wave amplifiers of the highest power. Proc. 2nd Int. Workshop on Strong Microwaves in Plasmas, Moscow - Nizhny Novgorod - Moscow, ed. A.G. Litvak, Inst. of Applied Phys., Nizhny Novgorod, 1994, Vol.2, 587-596.

[1221] Antakov, I.I., Aksenova, L.A., Zasypkin, E.V., Moisseev, M.A., Popov, L.G., Sokolov, E.V., Yulpatov, V.K., 1990, Mulit-cavity phase-locked gyrotrons for lower-hybrid heating in torodial plasmas. Proc. Int. Workshop on Strong Microwaves in Plasmas, Suzdal, Inst. of Applied Physics, Nizhny Novgorod, 1991, 773-782.

[1222] Antakov, I.I., Moiseev, M.A., Sokolov, E.V., Zasypkin, E.V., 1993, Theoretical and experimental investigation of X-band two-cavity gyroklystron. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 336-337.

[1223] Antakov, I.I., Moiseev, M.A., Sokolov, E.V., Zasypkin, E.V., 1994, Theoretical and experimental investigation of X-band two-cavity gyroklystron. Int. J. of Infrared and Millimeter Waves, 15, 873-887.

[1224] Zasypkin, E.V., Moiseev, M.A., Sokolov, E.V., Yulpatov, V.K., 1995, Effect of penultimate cavity position and tuning on three-cavity gyroklystron amplifier performance. Int. J. Electronics, 78, 423-433.

[1225] Zasypkin, E.V., Moiseev, M.A., Gachev, I.G., Antakov, I.I., 1996, Study of high-power Ka-band second-harmonic gyroklystron amplifier. IEEE Trans. on Plasma Science, 24, 666-670.

[1226] Antakov, I.I., Gachev, I.G., Sokolov, E.V., 1995, Experimental study of two-cavity gyrotron with feedback between cavities. Proc. Conf.: Intense Microwave-Pulses III, San Diego, Proc. SPIE 2557, 380-385.

[1227] Anatokov, I.I., Zasypkin, E.V., Sokolov, E.V., 1993, Design and performance of 94 GHz high power multicavity gyroklystron amplifier. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 466-467 and Proc. 2nd Int. Workshop on Strong Microwaves in Plasmas, Moscow-Nizhny Novgorod-Moscow, ed. A.G. Litvak, Inst. of Applied Phys., Nizhny Novgorod, 1994, Vol.2, 754-758.

[1228] Zasypkin, E.V., Gachev, I.G., Anatkov, I.I., Moissev, M.A., Lygin, V.K., Sokolov, E.V., 1998, Development of a W-band 120 kW gyroklyston at IAP. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 183.

[1229] Zasypkin, E.V., Gachev, I.G., Antakov, I.I., Moiseev, M.A., Zavolsky, N.A., 1999, Study of a W-band pulsed 200 kW gyroklystron amplifier. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, W-A2.

[1230] Gachev, I.G., Antakov, I.I., Moiseev, M.A., Sokolov, E.V., Zavolsky, N.A., Zaspykin, E.V., 1999, 200 kW pulsed W-band gyroklystron amplifier. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 713-717.

[1231] Gachev, I.G., Antakov, I.I., Zasypkin, E.V., 2000, Status of a W-band pulsed 200 kW gyroklystron experiment. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 181-182.

[1232] Zasypkin, E.V., Gachev, I.G., Antakov, I.I., Sokolov, E.V., 2001, W-band pulsed 300 kW gyroklystron amplifier. Conf. Digest, 26th Int. Conf. on Infrared and Millimeter Waves, Toulouse, France, 5-89-5-91.

[1233] Gachev, I.G., Antakov, I.I., Lygin, V.K., Moiseev, M.A., Sokolov, E.V., Zasypkin, E.V., 2002, A Ka-Band second harmonic gyroklystron with a permanent magnet. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2003, Vol. 1, 151-155.

[1234] Antakov, I. I., E.V., Gachev, I. G., Zasypkin, 2011, Experimental studies of a gyroklystron operating in the field of a permanent magnet. Radiophysics and Quantum Electronics, 54, No. 3, 166-173.

[1235] Zasypkin, E.V., Gachev, I.G., Antakov, I.I., 2012, Experimental study of a W-band gyro-klystron amplifier operated in the high-order TE021 cavity mode. Radiophysics and Quantum Electronics, 55, No. 5, 309-317.

[1236] Liu, P.K., Zhang, S.C., Xu, S.X., Su, Y.N., Quin, W.Z., Jin, F., Gu, W., Yue, Q.Z., Geng, Z.H., 2007, Recent results in the development of a Ka-band second harmonic gyroklyston amplifier, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 237-238 and Liu, P.K., IECAS Beijing, private communication.

[1237] Liu, P.-K., Zhang, S.C., Xu, S.X., Su, Y.N., Qin, W.Z., Geng, Z.H., Gu, W., Xue, Q.Z., Jin, F., Han, B., 2010, Experimental studies of a Ka-band second harmonic gyroklystron amplifier, Proc. 35th Int. Conf. on Infrared, Millim. and THz Waves, Rome, Italy, Mo-E3.2.

[1238] Xu, S.X., Liu, P.K., Zhang, S., Su, Y., Geng, Z.H., Gu, W., Xue, Q., Han, B., 2012, A Ka-band second harmonic gyroklystron amplifier. IEEE Trans. on Plasma Science, 40, 2099-2104.

[1239] Choi, J.J., Kim, H.J., Na, Y.H., Kim, W.C., Kwon, M., Temkin, R., 2002, Initial hot-tests on a 28 GHz five-cavity gyroklystron amplifier. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 367-368.

[1240] Choi, J.J., McCurdy, A.H., Wood, F., Kyser, Calame, J., Nguyen, K., Danly, B.G., Levush, B., Parker, R.K., 1997, High power 35 GHz gyroklystron amplifiers. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 229-230.

[1241] Choi, J.J., McCurdy, A.H., Wood, F.N., Kyser, R.H., Calame, J.P, Nguyen, K.T., Danly, B.G., Antonsen, T.M., Levush, B., Parker, R.K., 1998, Experimental investigation of a high power, two-cavity, 35 GHz gyroklystron amplifier. IEEE Trans. on Plasma Science, 26, 416-425.

[1242] Garven, M., Calame, J.P., Choi, J.J., Danly, B.G., Nguyen, K.T., Wood, F., 1998, Experimental 35 GHz multi-cavity gyroklystron amplifiers. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 28-29.

[1243] Garven, M., Calame, J.P., Danly, B.G., Levush, B., Nguyen, K.T., Wood, F.N., 1999, Experimental studies of a high gain 35 GHz gyroklystron amplifier. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, M-A6.

[1244] Calame, J.P., Graven, M., Choi, J.J., Nguyen, K., Wood, F., Blank, M., Danly, B.G., Levush, B., 1999, Experimental studies of bandwidth and power production in a three-cavity 35 GHz gyroklystron amplifier. Phys. of Plasmas, 6, 285-297.

[1245] Garven, M., Calame, J.P., Nguyen, K.T., Danly, B.G., Levush, B., Wood, F.N., 2000, Experimental studies of a four-cavity, 35 GHz gyroklystron amplifier. IEEE Trans. on Plasma Science, 28, 672-680.

[1246] Blank, M., Danly, B.G., Levush, B., Latham, P.E., Pershing, D.E., 1997, Experimental demonstration of a W-band gyroklystron amplifier. Phys. Rev. Lett., 79, 4485-4488.

[1247] Blank, M., Danly, B.G., Levush, B., Pershing, D.E., 1998, Experimental investigation of W-band (93 GHz) gyroklystron amplifiers. IEEE Trans. on Plasma Science, 26, 409-415.

[1248] Blank, M., Danly, B.G., Levush, B., 1998, Experimental demonstration of W-band gyro-amplifiers with improved performance. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 26-27.

[1249] Danly, B.G., Blank, M., Calame, J.P., Levush, B., Nguyen, K., Pershing, D., Petillo, J., Hargreaves, T.A., True, R.B., Theiss, A.J., Good, G.R., Felch, K., Chu, T.S., Jory, H., Borchard, P., James, B.G., Lawson, W.G., Antonsen, T.M., 1998, Development of a W-band gyroklystron for radar applications. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 32-33.

[1250] Burke, J.M., Czarnaski, M.A., Fischer, R.P., Giangrave, M., Fliflet, A.W., Manheimer, W.M., 1991, 85 GHz TE13 phase-locked gyroklystron oscillator experiment. Conf. Dig. 13th Int. Conf. Infrared and Milli Waves, Honolulu, Hawaii, Proc., SPIE 1039, 228-229.

[1251] Fischer, R.P., Fliflet, A.W., Manheimer, W.M., 1992, The NRL 85 GHz quasioptical gyroklystron experiment. Conf. Digest 17th Int. Conf. on Infrared and Millimeter Waves, Pasadena, Proc., SPIE 1039, 254-255.

[1252] Wang, J., Luo, Y., 2014, The study of a Ka-band high power TE01-TE02 gyroklystron, Proc. 15th IEEE Int. Vacuum Electronics Conference (IVEC 2014), Monterey, CA, USA, P3.3. and Li, H., UESTC, Chengdu, China, private communication.

[1253] Ilyakov, E.V., Kulagin, I.S., Kuzikov, S.V., Moiseev, M.A., Petelin, M.I., Rozental, R.M., Zaitsev, N.I., Zavolsky, N.A., 2004, Ka-band gyroklystron operating at a combination of high-order modes. Proc. 15th Int. Conf. on High-Power Particle Beams (BEAMS' 2004), St. Petersburg, Russia, 525-527.

[1254] Ilyakov, E.V., Kulagin, I.S., Kuzikov, S.V., Moiseev, M.A., Petelin, M.I., Shevchenko, A.S., Zaitsev, N.I., 2005, Gyroklystron operating at a sequence of high-order modes. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, RAS, Nizhny Novgorod, 2006, Vol. 1, 58-61.

[1255] Zaitsev, N.I., Ilyakov, E.V., Kuzikov, S.V., Kulagin, I.S., Lygin, V.K., Moiseev, M.A., Petelin, M.I., Shevchenko, A.S., 2005, Pulsed high-order volume mode gyroklystron. Radiophysics and Quantum Electronics, 48, 737-740.

[1256] Zaitsev, N.I., Kulagin, I.S., Kuzikov, S.V., Plotkin, M.E., Syratchev, I., 2007, Microwave components for 30 GHz high-power gyroklystron. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on THz Electr., Cardiff, UK, 369-370.

[1257] Petelin, M., Danilov, Y., Pavelyev, V., Zasypkin, E., Zaitsev, N., 2010, A research to a high-order-mode gyroklystron, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 191-192.

[1258] Zaitsev, N.I., Danilov, Yu.Yu., Gvozdev, A.K., Kuzikov, S.V., Moiseev, M.A., Petelin, M.I., Plotkin, M.E., Zapevalov, S.A., 2011, A pulsed multimegawatt gyroklystron, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, p. 140.

[1259] Danilov, Yu.Yu., 2012, Input cavity of high-order asymmetric-mode gyroklystron. Technical Physics Letters, 38, No.6, 576-578.

[1260] Kuzikov, S.V., Plotkin, M.E., Zaitsev, N.I., 2014, Method of excitation of a high-order spatial mode in the input cavity of gyroklystron. Journal of Communications Technology and Electronics, 59, No. 1, 71-76.

[1261] Guznov, Yu.M., Danilov, Yu.Yu., Kuzikov, S.V., Novozhiova, Yu.V., Shevchenko, A.S., Zaitsev, N.I., Rozhnev, A.G., Ryskin, N.M., 2013, High-power Ka-band gyro-klystron oscillator with time-delayed feedback. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 7A-3.

[1262] Zaitsev, N.I., Guznov, Yu.M., Kuzikov, S.V., Moiseyev, M.A., Petelin, P.I., Plotkin, M.E., Taj, E.M., Shevchenko, A.S., 2013, High-power pulsed millimeter-wave gyro-klystron based on the TE711 – TE731 mode sequence. Proc. 23rd Int. Crimean Conference “Microwave & Telecommunication Technology” (CriMiCo’ 2013), Sevastopol, Crimea, Ukraine, IEEE Catalog No. CFP13788, pp. 912-913.

[1263] Zaitsev, N., Petelin, M., Guznov, Yu., 2014, High-order mode relativistic gyroklystrons. Proc. 9th Int. Workshop “Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, p. 174.

[1264] Tantawi, S.G., Main, W.T., Latham, P.E., Nusinovich, G.S., Lawson, W.G., Striffler, C.D., Granatstein, V.L., 1992, High-power X-band amplification from an overmoded three-cavity gyroklystron with a tunable penultimate cavity. IEEE Trans. Plasma Science, 20, 205-215.

[1265] Lawson, W., Calame, J.P., Hogan, P., Skopec, M., Striffler, C.D., Granatstein, V.L., 1992, Performance characteristics of a high-power X-band two-cavity gyroklystron. IEEE Trans. Plasma Science, 20, 216-223.
[1266] Matthews, H.W., Lawson, W., Calame, J.P., Flaherty, M.K.E., Hogan, B., Cheng, J., Latham, P.E., 1994, Experimental studies of stability and amplification in a two-cavity second harmonic gyroklystron. IEEE Trans. Plasma Science, 22, 825-833.
[1267] Lawson, W., Hogan, B., Calame, J.P., Cheng, J., Latham, P.E., Granatstein, V.L., 1994, Experimental studies of 30 MW fundamental mode and harmonic gyro-amplifiers. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.AP 941228, 421-422.
[1268] Park, G.-S., Granatstein, V.L., Park, S.Y., Armstrong, C.M., Ganguly, A.K., 1992, Experimental study of efficiency optimization in a three-cavity gyroklystron amplifier. IEEE Trans. on Plasma Science, 20, 224-231.
[1269] Lawson, W., Hogan, B., Flaherty, M.K.E., Metz, H., 1996, Design and operation of a two-cavity third harmonic Ka-band gyroklystron. Appl. Phys. Lett., 63, 1849-1851.
[1270] Lawson, W., Cheng, J., Calame, J.P., Castle, M., Hogan, B., Granatsein, V.L, Reiser, M., Saraph, G.P., 1998, High power operation of a three-cavity X-band coaxial gyro-klystron. Phys. Rev.Lett., 81, 3030-3033.
[1271] Lawson, W., Cheng, J., Hogan, B., Granatstein, V.L., Xu, X., 1998, High power operation of an 8.6 GHz coaxial gyroklystron. Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 373-374.
[1272] Cheng, J., Xu, X., Lawson, J., Calame, J.P., Castle, M., Hogan, B.P., Granatstein, V.L., Nusinovich, G.S., Reiser, M., 1999, Experimental studies of a high-power, X-band, coaxial gyroklystron. IEEE Trans. on Plasma Science, 27, 1175-1187.
[1273] Lawson, W., Hogan, B., Gouveia, S., Huebschman, B., Granatstein, V.L., 2002, Development of Ku-band frequency-doubling coaxial gyroklystrons for accelerator applications. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 1-82.
[1274] Lawson, W., Hogan, B., Gouveia, E.S., Hübschman, B., Granatstein, V.L., 2002, Improved of a frequency doubling Ku-band gyroklystron experiment. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 203-204.
[1275] Lawson, W., Gouveia, S., Hogan, B., Granatstein, V.L., 2003, Experimental results of four-cavity 17 GHz gyroklystron. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 344-345.
[1276] Gouveia, E.S., Lawson, W., Hogan, B., Bharathan, K., Granatstein, V.L., 2003, Current status of gyroklystron research at the University of Maryland. Proc. 6th Workshop of High Energy Density and High Power, Berkeley Springs, West Virginia, 79-88.
[1277] Lawson, W., Calame J.P., Nusinovich, G.S., Hogan, B., 2017, Reflections on the University of Maryland's program investigating gyro-amplifiers as potential sources for linear colliders. Terahertz Science and Technology, 10, No. 1, 1-43.
[1278] Liu, B., Wang, E., Qian, L., Li, Z., Feng, J., 2010, Experimental study of a Ka-band gyro-TWT with the mode-selective ciruits, J. Infrared Milli Terahz Waves, 31, 1463-1468.
[1279] Liu, B., Wang, E.F., Qian, L.J., Li, Z.I., Feng, J.J., 2010, Experimental study of a Ka band gyro-TWT with the mode-selective circuits, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Mo-E3.4.
[1280] Liu, B., Feng, J., Wang, E., Li, Z., Zeng, X., Qian, L., Wang, H., 2011, Design and experimental study of a Ka-band gyro-TWT with periodic dielectric loaded circuits, IEEE Trans. on Plasma Science, 39, 1665-1672.
[1281] Wang, E.F., Zeng, X., Liu, B.T., Li, Z.L., Feng, J.J., 2012, Experimental study of 290 kW Ka-band gyrotron-traveling wave-tube, Proc. 13th IEEE Int. Vacuum Electronics Conference and

9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, pp. 215-216.

[1282] Wang, E., Zeng, X., Liu, B., Qian, L., Li, Z., Feng, J., 2012, Experimental study of high-power gyrotron traveling-wave tube with periodic lossy material loading. IEEE Trans. on Electron Devices, 40, No. 7, 1846-1853.

[1283] Wang, E.F., Zeng, X., Liu, B.T., Li, Z.L., Feng, J.J., Yan, T.C., 2013, Experimental study of high-frequency and high-gain Ka-band gyrotron-traveling wave-tube. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 3P-15.

[1284] Liu, B., Li, Z., Wang, E., Zeng, X. Zhu, Y., Feng, J., Yan, T., 2013, Experimental study of a Q-band gyro-TWT. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 7A-5.

[1285] Wang, E., Xi, A., Zeng, X., Sun, H., Zhu, S., Feng, J., 2015, Preliminary experiment research on the W-band gyrotron traveling wave tube. 16th IEEE International Conference on Vacuum Electronics (IVEC 2015), Beijing, P.R. China, S7.4.

[1286] Ferguson, E., Symons, R.S., 1981, A gyro-TWT with a space-charged limited gun. Proc. Int. Electron Device Meeting, 198-201.

[1287] Eckstein, J.N., Latshaw, D.W., Stone, D.S., 1983, 95 GHz gyro traveling wave tube. VARIAN Assoc., Final Rep. Contract DASG60-79-C-005 MOD P003 (BMDACTC), and Bohlen, H.P., Felch, K., 1996, private communication, CPI, Palo Alto.

[1288] Blank, M., Borchard, P., Cauffman, S., Felch, K., 2005, Development and demonstration of a broadband W-band gyro-TWT amplifier. Conf. Digest 30th Int. Conf. on Infrared and Millimeter Waves and 13th Int. Conf. on Terahertz Electronics, Williamsburg, VA, USA, 652-653.

[1289] Blank, M., Borchard, P., Cauffman, S., Felch, K., 2006, Demonstration of a broadband W-band gyro-TWT amplifier. Proc. Int. Vacuum Electronics Conference and Int. Vacuum Electron Sources (IVEC/IVESC 2006), Monterey, California, USA, 459-460.

[1290] Duffield, M.J., North, R., 2011, Manufacture and evaluation of a GyroTWA amplifier. Proc. 12th IEEE Int. Vacuum Electronics Conf. (IVEC 2011), Bangalore, India, pp. 333.

[1291] Bratman, V.L., Cross, A.W., Denisov, G.G., He, W., Phelps, A.D.R., Ronald, K., Samsonov, S.V., Whyte, C.G., Young, A.R., 2000, Efficient wide-band gyro-TWT with a helically grooved wave-guide. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 175-176.

[1292] Denisov, G.G., 2001, Development of frequency-tunable high-power gyro-devices. Conf. Digest, 26th Int. Conf. on Infrared and Millimeter Waves, Toulouse, France, 5-42-5-47.

[1293] Denisov, G.G., Bratman, V.L., Manuilov, V.N., Kalynova, G.I., Ofitserov, M.M., Samsonov, S.V., Volkov, A.B., 2002, New test results on broad-band gyro-TWT and gyro-BWO with helically grooved operating waveguides. Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 197-198.

[1294] Bratman, V.L., Denisov, G.G., Kalynova, G.I., Manuilov, V.N., Ofitserov, M.M., Samsonov, S.V., Volkov, A.B., 2002, Broadband efficient low-relativistic gyro-TWT with helically grooved waveguide. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 359-360.

[1295] Samsonov, S.V., Bogdashov, A.A., Denisov, G.G., Eremeev, A.G., Gachev, I.G., Holoptsev, V.V., Ivanov, V.Yu., Kalynova, G.I., Kornishin, S.Yu., Kurkin, V.S., Manuilov, V.N., Maslov, V.V., Mishakin, S.V., Plotnikov, I.V., Smirnova, T.M., 2011, Development of helical-waveguide gyro-TWT at IAP, Proc. 8th Int. Workshop Strong Microwaves and Terahertz Waves: Sources and Applications, Nizhny Novgorod – St. Petersburg, Russia, July 9-16, 2011, pp. 123-124.

[1296] Bratman, V.L., Cross, A.W., Denisov, G.G., Glyavin, M.Yu., He, W., Luchinin, A.G., Lygin, V.K., Manuilov, V.N., Phelps, A.D.R., Samsonov, S.V., Thumm, M., Volkov, A.B., 2002, Broadband gyro-TWTs and gyro-BWOs with helically rippled waveguides. Proc. 5th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2003, Vol. 1, 46-57.

[1297] Denisov, G.G., Bratman, V.L., Glyavin, M.Yu., Lygin, V.K., Luchinin, A.G., Manuilov, V.N., Ofitserov, M.M., Samsonov, S.V., Thumm, M., Volkov, A.B., 2003, Recent test results on broadband gyro-TWT and gyro-BWO with helically grooved operating waveguides. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 338-339.

[1298] Bratman, V.L., Denisov, G.G., Samsonov, S.V., Cross, A.W., Phelps, A.D.R., Xe, W., 2007, High-efficiency wideband gyro-TWTs and gyro-BWOs with helically corrugated waveguides, Radiophysics and Quantum Electronics, 50, No. 2, 95-107.

[1299] Samsonov, S.V., Bratman, V.L., Denisov, G.G., Gachev, I.G., Glyavin, M.Yu., Manuilov, V.N., 2007, Gyro-TWTs and gyro-BWOs with helically corrugated waveguides. Conf. Digest 32nd Int. Conf. on Infrared and Millimeter Waves and 15th Int. Conf. on Terahertz Electronics, Cardiff, UK, 578-580.

[1300] Samsonov, S.V., Denisov, G.G., Gachev, I.G., Kalynova, G.I., Manuilov, V.N., Mishakin, S.V., Bykov, Yu.V., Eremeev, A.G., Holoptsev, V.V., 2009, Development of helical-waveguide gyro-TWT and gyro-BWO, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M3D03.0269.

[1301] Samsonov, S.V., Denisov, G.G., Gachev, I.G., Eremeev, A.G., Fiks, A.S., Kholoptsev, V.V., Kalynova, G.I., Manuilov, V.N., Mishakin, S.V., Sokolov, E.V., 2012, CW Ka-band kilowatt-level helical-waveguide Gyro-TWT. IEEE Trans. on Electron Devices, 59, 2250-2255.

[1302] Samsonov, S.V., Gachev, I.G., Denisov, G.G., Bogdashov, A.A., Mishakin, S.V., Fiks, A.S., Soluyanova, E.A., Tai, E.M., Dominyuk, Y.V., Levitan, B.A., Murzin, V.N., 2014, Ka-Band gyrotron traveling-wave tubes with the highest continuous-wave and average power. IEEE Trans. on Electron Devices, 61, No. 12, 4264-4267.

[1303] Samsonov, S.V., Denisov, G.G., Gachev, I.G., Bogdashov, A.A., Mishakin, S.V., Fiks, A.S., Soluyanova, E.A., Tai, E.M., 2014, Ka-band gyro-TWTs with high CW and average power. Proc. 9th Int. Workshop "Strong Microwaves and Terahertz Waves: Sources and Applications", Nizhny Novgorod, Russia, pp. 172-173.

[1304] Samsonov, S.V., Bogdashov, A.A., Denisov, G.G., Gachev, I.G., Mishakin, S.V., 2016, Recent experiments and simulations on gyro-TWTs with helically corrugated waveguides. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), September 25-30, 2016, Copenhagen, Denmark, H4B.5.

[1305] Samsonov, S.V., Denisov, G.G., Gachev, I.G., Bogdashov, A.A., Mishakin, S.V., Manuilov, V.N., Belousov, V.I., Sobolev, D.I., Sokolov, E.V., Soluyanova, E.A., Tai, E.M., 2017, Development of gyrotron traveling-wave tubes at IAP and Gycom. EPJ Web of Conferences, 149, 04002 (2pp).

[1306] Samsonov, S.V., Bogdashov, A.A., Denisov, G.G., Gachev, I.G., 2019, Experiments on W-band high-gain helical-waveguide gyro-TWT. Proc. 20th Int. Vacuum Electronics Conference (IVEC 2019), Busan, Southkorea, 22.2.

[1307] Denisov, G.G., Bogdashov, A.A., Gachev, I.G., Samsonov, S.V., 2019, Gyro-TWTs with helically corrugated waveguides: Overview of the main principles. Proc. 44th Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2019), Paris, France, Tu-AM-1-1.

[1308] Samsonov, S.V., Bogdashov, A.A., Gachev, I.G., Denisov, G.G., 2019, Sudies of a gyrotron traveling-wave tube with helically corrugated waveguides at IAP: Results and prospects. Radiophysics and Quantum Electronics, 62, No. 7-8, 455-466.

[1309] Samsonov, S.V., Denisov, G.G., Gachev, I.G., Bogdashov, A.A., 2020, CW operation of a W-band high-gain helical waveguide Gyro-TWT. IEEE Electron Device Letters, 41, No. 5, 773-776.
Bogdashov, A.A., Samsonov, S.V., 2021, Cold-test of transverse input-output microwave circuit components for a high-power W-band gyro-TWT. IEEE Electron Device Letters, 42, No. 1, 98-101.

[1310] Rozental, R.M., Samsonov, S.V., Gachev, I.G., Glyavin, M.Yu., Bogdashov, A.A., Mansfeld, D.A., Vodopyanov, V., 2021, CW Multifrequency K-band source based on a helical-waveguide gyro-TWT with delayed feedback. IEEE Trans. on Electron Devices, 68, No. 1, 330-335.

[1311] Xue, Q.Z., Du, C.H., Liu, P.K., Zhang, S.C., Liu, P.K., Gu, W., Su, Y.L., Xu, S.X., Geng, Z.H., Wang, S.J., 2012, Research Progress of Ka band gyro-TWTs in IECAS, Proc. 13th IEEE Int. Vacuum Electronics Conference and 9th IEEE Int. Vacuum Electron Sources Conference (IVEC-IVESC 2012), Monterey, CA, USA, p. 421.

[1312] Wang, J., Luo, Y., Xue, D., 2013, The study of a high power TE11 Ku-band gyro-TWT. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 1B-5.

[1313] Liu, G., Que, Q., Zhang, S., Gu, W., Wang, X., Zhao, G., Zhao, D., Geng, Z., Xu, S.-H., 2018, Development and demonstration of a Ka-band gyrotron traveling-wave tube, IEEE Trans. on Plasma Science, 46, No. 6, 1975-1983.

[1314] Sirigiri, J.R., Shapiro, M.A., Temkin, R.J., 2002, Initial experimental results from the MIT 140 GHz quasioptical gyro-TWT. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 83-84.
Sirigiri, J.R., Shapiro, M.A., Temkin, R.J., 2002, Experimental results from the MIT 140 GHz quasioptical Gyro-TWT, Proc. 27th Int. Conf. on Infrared and Millimeter Waves, San Diego, USA, 235-236.

[1315] Sirigiri, J.R., Shapiro, M.A., Temkin, R.J., 2003, A novel 140 GHz quasioptical gyro-TWT. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 207-208.

[1316] Joye, C.D., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Torrezan, A.C., 2008, Operation of a wide-band 140 GHz, 1 kW confocal gyro-traveling wave amplifier, Proc. 9th IEEE Int. Vacuum Electronics Conference (IVEC 2008), Monterey, CA, USA, 89-90.

[1317] Joye, C.D., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2008, A wideband 140 GHz, 1 kW, confocal gyro-traveling wave amplifier, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, F2A2.1347.

[1318] Kim, H., Joye, C.D., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Woskov, P.P., Maly, T., Griffin, R.G., 2009, An overmoded 140 GHz, 1 kW quasioptical gyro-TWT with an internal mode converter, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, T5E50.0072.

[1319] Joye, C.D., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., 2009, Demonstration of a 140-GHz 1-kW confocal gyro-traveling-wave amplifier, IEEE Trans. on Electron Devices, 56, 818-827.

[1320] Kim, H.J., Nanni, E.A., Shapiro, M.A., Sirigiri, J.R., Woskov, P.P., Temkin, R.J., 2010, Amplification of picosecond pulses in a 140-GHz gyrotron-traveling wave tube, Physical Review Letter, 105, 135101-1 135101-4.

[1321] Kim, H., Nanni, E.A., Shapiro, M.A., Sirigiri, J.R., Temkin, R.J., Woskov, P.P., 2010, Experimental measurement of picosecond pulse amplification in a 140 GHz gyro-TWT, Proc. 11th IEEE Int. Vacuum Electronics Conf. (IVEC 2010), Monterey, USA, 193-194.

[1322] Nanni, E.A., Kim, H.J., Shapiro, M.A., Woskov, P.P., Temkin, R.J., 2010, Amplification of picosecond pulses in a 140 GHz gyro-TWT, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Tu-E3.2.

[1323] Nanni; E.A., Lewis, S.M., Shapiro, M.A., Griffin, R.G., Temkin, R.J., 2013, Photonic-band-gap traveling-wave gyrotron amplifier. Physical Review Letters, 111, 235101 (5pp).

[1324] Nanni, E.A., Lewis, S.M., Shapiro, M.A., Temkin, R.J., 2013, A high gain photonic bandgap gyrotron amplifier. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 7A-1.

[1325] Soane, A., Guss, W., Jawla, S., Shapiro, M., Temkin, R., 2014, Progress of a 140 GHz gyro-amplifier using a confocal waveguide. Proc. 15th IEEE Int. Vacuum Electronics Conference (IVEC 2014), Monterey, CA, USA, 8.1.

[1326] Soane, A.V., Guss, W.C., Jawla, S., Shapiro, M.A., Temkin, R.J., 2016, A 140-GHz gyro-amplifier using a sever-less confocal waveguide. 17th IEEE Int. Vacuum Electronics Conference (IVEC 2016), April 19-21, 2016, Monterey, CA, USA, P4.12.

[1327] Nanni, E.A., Jawla, S., Lewis, S.M., Shapiro, M., Temkin, R.J., 2016, Amplification of picosecond pulses with a photonic-band-gap gyro-TWT. 17th IEEE Int. Vacuum Electronics Conference (IVEC 2016), April 19-21, 2016, Monterey, CA, USA, S8.4.

[1328] Soane, A.V., Shapiro, Jawla, S., M.A., Temkin, R.J., 2017, Operation of a 140-GHz gyro-amplifier using a dielectric-loaded, sever-less confocal waveguide. IEEE Trans. on Plasma Science, 45, No. 10, 2835-2840.

[1329] Soane, A.V., Jawla, S., Shapiro, M.A., Temkin, R.J., 2017, A 140 GHz gyro-amplifier using a dielectric-loaded, sever-less confocal waveguide. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, GIII-2.

[1330] Nanni, E.A., Jawla, S., Lewis, S.M., Shapiro, M.A., Temkin, R.J., 2017, Photonic-band-gap gyrotron amplifier with picosecond pulses. Appl. Phys. Lett., 111, 233504 (5pp).

[1331] Rosenzweig, G., Jawla, S.K., Picard, J.F., Shapiro, M.A., Temkin, R.J., 2021, Phase measurements of a 140-GHz confocal gyro-amplifier. J. Infrared, Millimeter, and Terahertz Waves, 42, 29-39.

[1332] Park, G.S., Park, S.Y., Kyser, R.H., Armstrong, C.M., Ganguly, A.K., Parker, R.K., 1994, Broadband operation of a Ka-band tapered gyro-traveling wave amplifier. IEEE Trans. on Plasma Science, 22, 536-543.

[1333] Park, G.S., Choi, J.J., Park, S.J., Armstrong, C.M., Ganguly, A.K., Kyser, R.H., Parker, R.K., 1995, Gain broadening of two-stage tapered gyrotron traveling wave tube amplifier. Phys. Rev. Lett., 74, 2399-2402.

[1334] Choi, J.J, Park, G.S., Ganguly, A.K., Armstrong, C.M., Calise, F., Wood, F., Sobocinski, B., Parker, R.K., 1995, Experimental investigation on broadband millimeter wave gyro-TWT amplifiers. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 343-344.

[1335] Garven, M., Calame, J.P., Danly, B.G., Nguyen, K.T., Levush, B., Wood, F.N., Pershing, D.E., 2002, A gyrotron-traveling-wave tube amplifier experiment with a ceramic loaded interaction region. IEEE Trans. on Plasma Science, 30, No. 3, 885-893.

[1336] Garven, M., Calame, J.P., Danly, G., Nguyen, K.T., Levush, B., Wood, F.N., 2002, Experimental studies of a Gyro-TWT amplifier with a lossy ceramic interaction region. 29th IEEE Int. Conf. on Plasma Science (ICOPS 2002), Banff, Canada, May 26-30, 2B0607.

[1337] Calame, J.P., Garven, M., Danly, B.G., Levush, B., Nguyen, K.T., 2003, Gyrotron-traveling wave-tube circuits based on lossy ceramics. IEEE Trans. on Electron Devices, 49, 1469-1477.

[1338] Pershing, D.E., Nguyen, K.T., Calame, J.P., Danly, B.G., Levush, B., Wood, F.N., Garven, M., 2004, A TE11 Ka-band gyro-TWT amplifier with high-average power compatible distributed loss. IEEE Trans. on Plasma Science, 32, No. 3, 947-956.

[1339] Leou, K.C., McDermott, D.B., Luhmann, Jr., N.C., 1992, Design of experimental dielectric loaded wideband Gyro-TWT. Conf. Digest 17th Conf. on Infrared and Millimeter Waves, Pasadena, Proc., SPIE 1929, 326-327.

[1340] Leou, K.C., Wang, Q.S., Chong, C.K., Balkcum, A.J., Fochs, S.N., Garland, E.S., Pretterebner, J., Lin, A.T., McDermott, D.B., Hartemann, F., Luhmann, Jr., N.C., 1993, Gyro-TWT amplifiers at UCLA. Conf. Digest 18th Int. Conf. on Infrared and Millimeter Waves, Colchester (Essex, UK), Proc., SPIE 2104, 531-532.

[1341] Wang, Q.S., Leou, K.C., Chong, C.K., Balkeum, A.J., McDermott, D.B., Luhmann, Jr., N.C., 1994, Gyro-TWT amplifier development at UCD. Conf. Digest 19th Int. Conf. on Infrared and Millimeter Waves, Sendai, JSAP Catalog No.: AP 941228, 415-416.

[1342] Wang, Q.S., McDermott, D.B. Luhmann, Jr., N.C., 1995, Stable operation of a 200 kW second harmonic TE21 gyro-TWT amplifier. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 347-348.

[1343] Wang, Q.S., McDermott, D.B. Luhmann, Jr., N.C., 1995, Demonstration of marginal stability by a 200 kW second-harmonic gyro-TWT amplifier. Phys. Rev. Lett., 75, 4322-4325.

[1344] Wang, Q.S., McDermott, D.B., Luhmann, Jr., N.C., 1996, Operation of a stable 200-kW second-harmonic gyro-TWT amplifier. IEEE Trans. on Plasma Science, 24, 700-706.

[1345] Leou, K.C., McDermott, D.B., Luhmann, Jr., N.C., 1996, Large-signal characteristics of a wide-band dielectric-loaded gyro-TWT amplifier. IEEE Trans. on Plasma Science, 24, 718-726.

[1346] Furano, D.S., McDermott, D.B., Kou, C.S., Luhman, Jr., N.C., Vitello, P., 1989, Theoretical and experimental investigation of a high-harmonic gyro-TWT amplifier. Phys. Rev. Lett., 62, 1314-1317.

[1347] Chong, C.K., McDermott, D.B., Luhmann, Jr., N.C., 1998, Large-signal operation of a third-harmonic slotted gyro-TWT amplifier. IEEE Trans. on Plasma Science, 26, 500-507.

[1348] Song, H.H., Barnett, L.R., McDermott, D.B., Hirata, Y., Hsu, H.I., Marandos, P.S., Lee, J.S., Chang, T.H., Chu, K.R., Luhmann, Jr., N.C., 2003, W-band heavily loaded TE01 gyrotron traveling wave amplifier. 4th IEEE Int. Vacuum Electronics Conf. (IVEC 2003), Seoul, Korea, 348-349.

[1349] Song, H.H., McDermott, D.B., Hirata, Y., Barnett, L.R., Domier, C.W., Hsu, H.L., Chang, T.H., Tsai, W.C., Chu, K.R., Luhmann, Jr., N.C., 2003, Theory and experiment of a 95 GHz gyrotron traveling wave amplifier. Conf. Digest 28th Int. Conf. on Infrared and Millimeter Waves, Otsu, Japan, 205-206.

[1350] Song, H.H., McDermott, D.B., Hirata, Y., Barnett, L.R., Domier, C.W., Hsu, H.L., Chang, T.H., Tsai, W.C., Chu, K.R., Luhmann, Jr., N.C., 2004, Theory and experiment of a 94 GHz gyrotron traveling-wave amplifier. Physics of Plasmas, 11, No. 5, 2935-2941.

[1351] Barnett, L.R., Luhmann, N.C., Jr., Chiu, C.C., Chu, K.R., Yan, Y.C., 2007, Advances in W-Band TE01 gyro-TWT amplifier design, Proc. 8th IEEE Int. Vacuum Electronics Conference (IVEC 2007), Kitakyushu, Japan, 233.

[1352] Chu, K.R., Barnett, L.R., Lau, W.K., Chang, L.H., Chen H.Y., 1990, A wide-band millimeter-wave gyrotron traveling-wave amplifier experiment. IEEE Trans. Electron Devices, 37, 1557-1560.

[1353] Chu, K.R., Barnett, L.R., Chen, H.Y., Chen, S.H., Wang, CH., Yeh, Y.S., Tsai, Y.C., Yang, T.T., Dawn, T.Y., 1995, Stabilization of absolute instabilities in the gyrotron traveling wave amplifier. Phys. Rev. Lett., 74, 1103-1106 and, 1997, priv. communication.

[1354] Chu, K.R., Chen, H.Y., Hung, C.L., Chang, T.H., Barnett, L.R., Chen, S.H., Yang, T.T., An ultra high gain gyrotron travelling wave amplifier. 1998, Conf. Digest 23rd Int. Conf. on Infrared and Millimeter Waves, Colchester, UK, 30-31.

[1355] Chu, K.R., Chen, H.Y., Hung, C.L., Chang, T.H., Barnett, L.R., Chen, S.H., Yang, T.T., 1998, Ultrahigh gain gyrotron travelling wave amplifier. Phys. Rev. Lett., 81, 4760-4763.

[1356] Chu, K.R., Chang, T.H., Chen, H.Y., Hung, C.L., Barnett, L.R., Chen, S.H., Yang, T.T., 1999, Physics and technology issues of the gyrotron traveling wave amplifier. Proc. 4th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 2000, Vol. 2, 718-727.

[1357] Barnett, L.R., Tsai, W.C., Hsu, H.L., Luhmann, Jr., N.C., Chiu, C.C., Pao, K.F., Chu, K.R., 2006, 140 kW W-band TE01 ultra high gain gyro-TWT amplifier. Proc. Int. Vacuum Electronics Conference and Int. Vacuum Electron Sources (IVEC/IVESC 2006), Monterey, California, USA, 461-462.

[1358] Chiu, C.C., Pao, K.F., Yan, Y.C., Chu, K.R., Barnett, L.R., Luhmann, N.C., 2008, Nonlinearly driven oscillations in the gyrotron traveling-wave amplifier, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, T5D23.1185.

[1359] Wang, H., Li, H., Luo, Y., Yan, R., 2011, Theoretical and experimental investigation of a Ka-band Gyro-TWT with lossy interaction structure, J. Infrared Milli Terahz Waves, 32, 172-185.

[1360] Yan, R., Luo, Y., Liu, G., Pu, Y., 2012, Design and experiment of a Q-band gyro-TWT loaded with lossy dielectric. IEEE Trans. on Electron Devices, 59, 3612-3617.

[1361] Youlei, P., Luo, Y., Jiang, W., Liu, G., 2013, Research of low frequency oscillations of Ka band TE01 gyro-TWT. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 3P-11.

[1362] Xu, Y., Luo, Y., Yan, R., Wang, J., Pu, Y., Li, H., Xiong, C., 2013, Design and experiment of a U-band TE01 gyro-TWT. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 3P-9.

[1363] Wang, J., Luo, Y., Xu, Y., Yan, R., Pu, Y., Deng, X., Wang, H., 2014, Simulation and experiment of a Ku-band gyro-TWT. IEEE Trans. on Electron Devices, 61, 1818-1823.

[1364] Yan, R., Tang, Y., Luo, Y., 2014, Design and experimental study of a high-gain W-band gyro-TWT with nonuniform periodic dielectric loaded waveguide. IEEE Trans. on Electron Devices, 61, No. 6, 2564-2569.

[1365] Xu, Y., Luo, Y., Yan, R., Wang, J.X., Liu, G., 2015, Design and experimental study of a broad-band U-band TE01 gyrotron travelling wave tube. 16th IEEE International Conference on Vacuum Electronics (IVEC 2015), Beijing, P.R. China, S7.2.

[1366] Wang, J.X., Xu, Y., Luo, Y., 2015, Theory and experimental study of a 200 kW Ku-band gyro-TWT. 16th IEEE International Conference on Vacuum Electronics (IVEC 2015), Beijing, P.R. China, S7.3.

[1367] Wang, J., Tian, Q., Li, X., Shu, G., Xu, Y., Luo, Y., 2017, Theory and experiment investigate of a 400 kW Ku-band gyro-TWT with mode selective loss loading structure. IEEE Trans. on Electron Devices, 64, 550-555.

[1368] Xu, Y., Li, Y., Wang, J., Jiang, W., Liu, G., Luo, Y., Li, H., 2018, Design and Experiment of a high power and broadband Ku-band TE11 Mode Gyro-TWT. IEEE Trans. on Electron Devices, 65, No. 5, 1962-1968.

[1369] Yan, R., Luo, Y., Zhang, Q., Shang, Y., Liao, X., 2018, Development of high average power and high stability gyro-TWT for industrial use. Proc. 19th Int. Vacuum Electronics Conference (IVEC 2018), Monterey, CA, USA, 8.4.

[1370] Yan, R., Li, H., Wang, D., Wang, J., Wang, L., Pu, Y., Xu, Y., Jiang, W., Liu, G., Luo, Y., 2018, Investigation on high average power operations of gyro-TWTs with dielectric-loaded waveguide circuits. IEEE Trans. on Electron Devices, 65, No. 7, 3012-3018.

[1371] Jiang, W., Wang, J., Shen, Y., Liu, G., Wu, Z., 2018, Curved geometry collector design for high-power gyrotraveling wave tubes. IEEE Trans. on Electron Devices, 65, No. 6, 2327-2333.

[1372] Xu, Y., Sun, M., Peng, T., Wang, J., Luo, Y., Yan, R., Jiang, W., Liu, G., Li, H., 2019, Design and Experiment of a high average power Ku-band TE01 mode gyro-TWT. IEEE Trans. on Electron Devices, 66, No. 3, 1559-1566.

[1373] Li, H., Wang, J., Yao, Y., Luo, Y., 2020, Investigation on Ku-band dual-state gyro-TWT. IEEE Trans. on Plasma Science, 48, No. 7, 2366-2371.

[1374] Xu, Y., Mao, Y., Wang, W., Luo, Y., Wang, J.X., Yan, R., Yao, Y., Jiang, W., Liu, G., Li, H., 2020, Proof-of-principle experiment of a 20 kW-average-power Ka-band gyro-traveling wave tube with a cut-off waveguide section. IEEE Electron Device Letters, 41, No. 5, 769-772.
Xu, Y., Liu, Z., Mao, Y., Zheng, Z., Luo, Y., Jiang, W. Wang, J., Li, H., 2021, Design and experiment of a 200-kW Q-band gyro-TWT. IEEE Trans. on Electron Devices, 68, No. 2, 811-817.

[1375] Jung, S.W., Lee, H.S., Jang, K.H., Choi, J.J., So, J.H., 2015, Experiments on a Ku-band gyrotron traveling-wave-tube amplifier with a tapered waveguide. J. Korean Phys. Soc., 67, No. 5, 854-859.

[1376] He, W., Donaldson, C.R., Zhang, L., McElhinney, P., Yin, H., Ronald, K., Cross, A.W., Phelps, A.D.R., 2015, Latest development of a W-band gyro-TWA based on a helically corrugated interaction region. 16th IEEE International Conference on Vacuum Electronics (IVEC 2015), Beijing, P.R. China, S7.1.

[1377] He, W., Donaldson, C.R., Zhang, L., McElhinney, P., Yin, H., Garner, J., Ronald, K., Cross, A.W., Phelps, A.D.R., 2015, Further experiments of a W-band gyro-TWA based on a helically corrugated interaction region. 40th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2015), Hong Kong, H1E-4.

[1378] He, W., Donaldson, C.R., Zhang, L., McElhinney, P., Yin, H., Garner, J., Ronald, K., Cross, A.W., Phelps, A.D.R., 2016, High pulse repetition frequency operation of a W-band gyro-TWT based on a cusp electron beam source. Proc. 41st Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2016), Copenhagen, Denmark, H4B.4.

[1379] He, W., Donaldson, C.R., Zhang, L., Ronald, K., Phelps, A.D.R., Cross, A.W., 2017, Broadband amplification of low-terahertz signals using axis-encircling electrons in a helically corrugated interaction region. Phys. Rev. Lett., 119, No. 18, 184801 (5pp).

[1380] Phelps, A.D.R., 2017, Progress in microwave to sub-THz sources at Strathclyde. EPJ Web of Conferences, 149, 04023 (2pp).

[1381] He, W., Donaldson, C.R., Zhang, L., McElhinney, P., Garner, J., Ronald, K., Cross, A.W., Phelps, A.D.R., 2017, Measurement of a W-band gyro-TWA experiment based on a helically corrugated interaction region. Proc. 18th IEEE Int. Vacuum Electronics Conference (IVEC 2017), London, UK, GIII-6.

[1382] He, W., Donaldson, C.R., Zhang, L., McElhinney, Yin, H., P., Garner, J., Ronald, K., Cross, A.W., Phelps, A.D.R., 2017, Design and experiment of a broadband W-band gyro-TWA based on a helically corrugated interaction region. Proc. 42nd Int. Conf. on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2017), Cancun, Mexico, RC2.4.

[1383] He, W., Zhang, L., Donaldson, C.R., Yin, H., Ronald, K., Cross, A.W., Phelps, A.D.R., 2020, The development of broadband millimeter-wave and terahertz gyro.TWTs. Terahertz Science and Technology, 13, No. 3, 90-111.

[1384] Donaldson, C.R., Zhang, L., Cross, A.W., Whyte, C.G., 2020, Upgrades of W-band gyro-TWA system for high-PRF operation. Proc. 21th Int. Vacuum Electronics Conference (IVEC 2020), Monterey (Virtual Conference), CA, USA, 12.2.

[1385] Kesar, A., Blank, D., Jerby, E., 2002, Amplitude locking in a gyro TWT amplifier with a delayed feedback. 29th IEEE Int. Conf. on Plasma Science (ICOPS 2002), Banff, Canada, May 26-30, 3P18.

[1386] Denisov, G.G., Bratman, V.L., Cross, A.W., He, W., Phelps, A.D.R., Ronald, K., Samsonov, S.V., Whyte, C.G., 1998, Experimental results from a helical waveguide gyro-TWT. Conf. Dig. 23rd Int. Conf. Infrared and Millimeter Waves, Colchester, UK, 170-172.

[1387] Denisov, G.G., Bratman, V.L., Cross, A.W., He, W., Phelps, A.D.R., Ronald, K., Samsonov, S.V., Whyte, C.G., 1998, Gyrotron traveling wave amplifier with a helical interaction waveguide. Phys. Rev. Letters, 81, 5680-5683.

[1388] Bratman, V.L., Cross, A.W., Denisov, G.G., He, W., Phelps, A.D.R., Ronald, K., Samsonov, S.V., Whyte, C.G., Young, A.R., 1999, Frequency-broadband gyro-travelling wave amplifier operating with eigenwaves of helically rippled waveguides. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, M-4A, and private communication.

[1389] Bratman, V.L., Cross, A.W., Denisov, G.G., He, W., Phelps, A.D.R., Ronald, K., Samsonov, S.V., Whyte, C.G., Young, A.R., 2000, High-gain wide-band gyrotron travelling wave amplifier with a helically corrugated waveguide. Phys. Rev. Lett., 84, No. 12, 2746-2749.

[1390] Phelps, A.D.R., Bratman, V.L., Cross, A.W., Denisov, G.G., He, W., Ronald, K., Samsonov, S.V., Whyte, C.G., Young, A.R., 2001, A broadband, efficient, gyrotron amplifier. Proc. 9th Int. Conf. Displays and Vacuum Electronics, Garmisch-Partenkirchen, ITG-Fachbericht 165, 193-198.

[1391] Menninger, W.L., Danly, B.G., Temkin, R.J., 1996, Multimegawatt relativistic harmonic gyrotron traveling-wave tube amplifier experiments. IEEE Trans. on Plasma Science, 24, 687-699.

[1392] Gold, S.H., Fliflet, A.W., Kirkpatrick, D.A., 1989, High-power millimeter-wave gyro-traveling-wave amplifier. Conf. Digest 14th Int. Conf. on Infrared and Millimeter Waves, Würzburg, SPIE 1240, 332-333.

[1393] Gold, S.H., Kirkpatrick, D.A., Fliflet, A.W., McCowan, R.B., Kinkaed, A.K., Hardesty, D.L., Sucy, M., 1991, High voltage millimeter-wave gyro-travelling-wave amplifier. J. Appl. Phys., 69, 6696-6698, and, Gold, S.H., 1998, private communication.

[1394] Young, A.R., Phelps, A.D.R., He, W., Whyte, C.G., Cross, A.W., Ronald, K., Robertson, C.W., Rafferty, E.G., Thomson, J., 2004, Operation of a thermionic gyro-TWT with a helical interaction waveguide. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 55-56.

[1395] Phelps, A.D.R., Ronald, K., He, W., Young, A.R., Rafferty, E.G., Cross, A.W., Whyte, C.G., Thomson, J., Robertson, C.W., 2004, Results from thermionic cathode gyro-TWA experiments. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsruhe, Germany, 273-274.

[1396] Young, A.R., Whyte, C.G., Raffety, E.G., Thomson, J., Robertson, C.W., Phelps, A.D.R., He, W., Cross, A.W., Ronald, K., 2006, Comparison of broadband gyro-TWA simulations with experiments. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 342.

[1397] Cross, A.W., He, W., Phelps, A.D.R., Ronald, K., Whyte, C.G., Young, A.R., Robertson, C.W., Rafferty, E.G., Thomson, J., 2007, Helically corrugated waveguide gyrotron traveling wave amplifier using a thermionic cathode electron gun. Applied Physics Lett., 90, 253501-1 – 253501-3.

[1398] Rowlands, D.H., Phelps, A.D.R., Young, A.R., Whyte, C.G., He, W., Cross, A.W., Robertson, C.W., Ronald, K., 2007, A cusp gun gyro-TWA with helical interaction region, Proc. 8th IEEE Int. Vacuum Electronics Conf. (IVEC 2007), Kitakyushu, Japan, 235-236.

[1399] Whyte, C.G., Young, A.R., Rowlands, D.H., Robertson, C.W., Phelps, A.D.R., He, W., Cross, A.W., Ronald, K., 2008, Broadband gyro-TWA with thermionic CUSP gun: simulations and comparison with experiment, Proc. 9th IEEE Int. Vacuum Electronics Conference (IVEC 2008), Monterey, CA, USA, 91-92.

[1400] Blank, M., Danly, B.G., Levush, B., 1999, Experimental demonstration of a W-band (94 GHz) gyrotwystron amplifier. IEEE Trans. on Plasma Science, 27, 405-411.

[1401] Malouf, P.M., Granatstein, V.L., Park, S.Y., Park, G.S., Armstrong, C.M., 1995, Performance of wideband, three-stage, mixed geometry gyrotwystron amplifier, IEEE Trans. on Electron Devices, 42, No. 9, 1681-1685.

[1402] Zasypkin, E.V., Levush, B., Blank, M., Sokolov, E.V., Antakov, I.I., 1997, Study of X-band three-stage gyrotwystron amplifier. Conf. Digest 22nd Int. Conf. on Infrared and Millimeter Waves, Wintergreen, Virginia, USA, 281-282.

[1403] Blank, M., Zasypkin, E.V., Levush, B., 1998, An investigation of X-band gyrotwystron amplifiers. IEEE Trans. on Plasma Science, 26, 577-581.

[1404] Liu, B.T., Zhang, Y.S. Zheng, L., 2006, A Ka-Band phigtron with a novel coupled ball-cavity as output. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 201.

[1405] Luo, J., Yuan, G., Luan, Y., Guo, W., Zhu, M., Jiao, C., Zhang, Y., Lou, X., Zheng, L., Wu, E., Liu, B., 2006, First experiment and design of a harmonic multiplying gyrotron traveling wave amplifier with the TE02 mode output. Conf. Dig. 31st Int. Conf. on Infrared and Millimeter Waves & 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 339.

[1406] Luo, J., Yuan, G., Zhang, Y., Liu, B., Zheng, L., Guo, W., Zhu, M., Jiao, C., Luan, Y., Lou, X., 2007, A harmonic multiplying gyrotron traveling wave amplifier with the TE02 mode output, Proc. 8th IEEE Int. Vacuum Electronics Conf. (IVEC 2007), Kitakyushu, Japan, 229-230 and Liu, P.K., IECAS Beijing, private communication.

[1407] Luo, J., Yuan, G., Zhang, Y., Guo, W., Zhu, M., Jiao, C., Li, Y., Zhang, T., Sun, H., Luan, Y., Zhang, C., Cui, J., 2008, Research progress of the harmonic multiplying gyrotron traveling wave amplifier at Ka Band in IECAS, Proc. 9th IEEE Int. Vacuum Electronics Conference (IVEC 2008), Monterey, CA, USA, 93-94.

[1408] Luo, J., Yuan, G., Zhang, Y., Guo, W., Zhu, M., Jiao, C., Li, Y., Zhang, T., Sun, H., Luan, Y., Zhang, C., Cui, J., 2008, A harmonic multiplying gyrotron traveling wave amplifier at Ka band developed in IECAS, Proc. 33rd Int. Conf. on Infrared, Millimeter and Terahertz Waves, Pasadena, CA, USA, W5D30.1232.

[1409] Luo, J., Zhang, Y., Guo, W., Zhu, M., Yuan, G., Zhou, W., Zhang, C., Cui, J., Zhang, Y., 2009, 8 mm band, 75 kW harmonic multiplying gyrotron traveling amplifier with the bandwidth of more than 1%, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M3D02.0033.

[1410] Luo, J., Jiao, C., Luan, Y., Yuan, G., Guo, W., Zhu, M., Zhang, Y., 2010, Operation of a Ka-band harmonic-multiplying gyrotron traveling-wave tube, IEEE Trans. on Electron Devices, 57, 27682773.

[1411] Luo, J., Zhang, Y., Guo, W., Zhu, M., Yuan, G., Cui, J., Zhang, Y., Ren, L., Yang, J., 2010, Operation of a Ka-band harmonic multiplying gyrotron traveling wave tube, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Mo-P.07.

[1412] Baik, Ch.W., Jeon, S.G., Kim, D.H., Sato, N., Yokoo, K., Park, G.S., 2005, Third-harmonic frequency multiplication of a two-stage tapered gyrotron TWT amplifier. IEEE Trans. on Electron Devices, 52, 829-838.

[1413] Guo, H., Chen, S.-H., Granatstein, V.L., Rodgers, J., Nusinovich, G.S., Walter, M.T., Zhao, J., Chen, W., 1998, Operation of a high performance, harmonic-multiplying, inverted gyrotwystron. IEEE Trans. on Plasma Science, 26, 451-460.

[1414] Guo, H. Chen, S.H., Granatstein, V.L., Rodgers, J., Nusinovich, G. Walter, M., Levush, B., Chen, W.J., 1997, Operation of a highly overmoded, harmonic multiplying gyrotron amplifier. Phys. Rev. Lett, 79, 515-518.

[1415] Rodgers, J., Guo, H., Granatstein, V.L., Chen, S.H., Nusinovich, G.S., Walter, M., Zhao, J., 1999, High efficiency, phase-locked operation of the harmonic-multiplying inverted gyrotwystron oscillator. IEEE Trans. on Plasma Science, 27, 412-421.

[1416] Guo, H., Rodgers, J., Zhao, J., Miao, Y.Y., Chen, W.J., Granatstein, V.L., 2000, Latest progress in studies of harmonic multiplying gyro-amplifiers. Conf. Digest 25th Int. Conf. on Infrared and Millimeter Waves, Beijing, P.R. China, 317-318.

[1417] Guo, H., Miao, Y.Y., Rodgers, J., Granatstein, V.L., Wu, R.S., Luo, J.R., Wu, D.S., Yin, Y.L., Miao, H., Zhang, Y.S. Cai, Z.P., Zheng, L., Su, Y.N., Guo, W., Luan, Y.T., Ding, Y.G., 2002, A new triplet gyrotron amplifier, the gyrotriotron. Proc. 3rd IEEE Int. Vacuum Electronics Conf. (IVEC 2002), Monterey, USA, 119-120.

[1418] Guo, H., Miao, Y.Y., Rodgers, F., Granatstein, V.L., Wu, R.S., Luo, J.R., Wu, D.S., Yin, Y.L., Miao, Y.H., Zhang, Y.S., Cai, Z.P., Zheng, L., Su, Y.N., Guo, W., Luan, Y.T., Ding, Y.G., 2002, Initial experimental results of a new triplet harmonic-multiplying gyrotron amplifier (gyrotriotron). Proc. 27th Int. Conf. on Infrared and Millim. Waves, San Diego, USA, 205-206.

[1419] Lawson, W., Latham, P.E., Calame, J.P., Cheng, J., Hogan, B., Nusinovich, G.S., Irwin, V., Granatstein, V.L., Reiser, M., 1995, High power operation of first and second harmonic gyrotwystrons. J. Appl. Phys., 78, 550-559.

[1420] He, W., Cross, A.W., Whyte, C.G., Young, A.R., Phelps, A.D.R., Ronald, K., Rafferty, E.G., Thomson, J., Robertson, C.W., Speirs, D.C., Samsonov, S.V., Bratman, V.L., Denisov, G..G., 2004, Gyro-BWO experiment using a helical interaction waveguide. 5th IEEE Int. Vacuum Electronics Conf. (IVEC 2004), Monterey, CA, USA, 206-207.

[1421] He, W., Cross, A.W., Whyte, C.G., Young, A.R., Phelps, A.D.R., Ronald, K., Rafferty, E.G., Thomson, J., Robertson, C.W., Speirs, D.C., 2004, Thermionic gyro-BWO experiment using a helical interaction waveguide. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahz Electr., Karlsruhe, Germany, 233-234.

[1422] He, W., Ronald, K., Young, A.R., Cross, A.W., Phelps, A.D.R., Whyte, C.G., Rafferty, E.G., Thomson, J., Robertson, C.W., Speirs, D.V., Samsonov, S.V., Bratman, V.L., Denisov, G.G., 2005, Gyro-BWO experiments using a helical interaction waveguide. IEEE Trans. on Electron Devices, 52, 839-844.

[1423] He, W., Whyte, C.G., Cross, A.W., Young, A.R., Phelps, A.D.R., Ronald, K., Rafferty, E.G., Thomson, J., Robertson, C.W., Samsonov, S.V., Bratman, V.L., Denisov, G.G., 2005, Experiments and simulations of a gyro-BWO using a helical interaction waveguide. Proc. 6th Int. Workshop on Strong Microwaves in Plasmas, Nizhny Novgorod, ed. A.G. Litvak, Inst. of Appl. Phys., Russian Acad. of Sciences, N. Novgorod, 2006, Vol.1, 125-134.

[1424] Denisov, G.G., Samsonov, S.V., Bratman, V.L., Bogdashov, A.A., Glyavin, M.Yu., Luchinin, A.G., Lygin, V.K., Thumm, M., 2004, Frequency-tunable CW gyro-BWO with a helically rippled operating waveguide. Conf. Digest 29th Int. Conf. on Infrared and Millimeter Waves and 12th Int. Conf. on Terahertz Electr., Karlsruhe, Germany, 235-236.

[1425] Samsonov, S.V., Denisov, G.G., Bratman, V.L., Bogdashov, A.A., Glyavin, M.Yu., Luchinin, A.G., Lygin, V.K., Thumm, M.K., 2004, Frequency-tunable CW gyro-BWO with a helically rippled operating waveguide. IEEE Trans. on Plasma Science, 32, 884-889.

[1426] Liu, B.-T., Jiao, C.-Q., Zhang, Y.S., Yuan, G.-J., Guo, W., Zheng, L., 2007, Experimental study of a Ku-Band gyrotron backward-wave oscillator with a single stage depressed collector. IEEE Trans. on Plasma Science, 35, 1065-1069.

[1427] Liu, B., 2006, Experimental study of a Ku-Band gyrotron backward-wave oscillator with a single stage depressed collector and linear-mode output. Conf. Dig. 31st Int. Conf. Infrared and Millimeter Waves and 14th Int. Conf. Terahertz Electronics, Shanghai, China, 80.

[1428] Basten, M.A., Guss, W.C., Kreischer, K.E., Temkin, R.T., Caplan, M., 1995, Experimental investigation of a 140 GHz gyrotron-backward wave oscillator. Int. J. Infrared and Millimeter Waves, 16, 880-905.

[1429] Park, S.Y., Kyser, R.H., Armstrong, C.M., Parker, R.K., Granatstein, V.L., 1990, Experimental Study of a Ka-band gyrotron backward-wave oscillator. IEEE Trans. on Plasma Science, 18, 321-325.

[1430] Kou, C.S., Chen, S.H., Barnett, L.R., Chu, K.R., 1993, Experimental study of an injection locked gyrotron backward wave oscillator. Phys. Rev. Lett., 70, 924-927.

[1431] Chang, T.H., Chen, S.H., Cheng, F.H., Kou, C.S., Chu, K.R., 1999, Experimental study of an injection locked gyro-BWO. Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, California, USA, M-A2.

[1432] Chu, K.R., Chen, S.H., Chang, T.H., 2000, Review of the gyrotron backward wave oscillator. Conf. Dig. 25th Int. Conf. Infrared and Milli Waves, Beijing, P.R. China, 9-10.

[1433] Fan, C.T., Chang, T.H., Pao, K.F., Chen, S.H., Chu, K.R., 2006, Stability and tunability of a gyrotron backward-wave oscillator. Conf. Digest 31st Int. Conf. on Infrared and Millimeter Waves and 14th Int. Conf. on Terahertz Electronics, Shanghai, China, 517.

[1434] Chang, T.H., Fan, C.T., Pao, K.F., Chu, K.R., Chen, S.H., 2007, Stability and tunability of the gyrotron backward-wave oscillator. Applied Physics Letters, 90, 19150-1-3.

[1435] Fan, C.T., Chang, T.H., Pao, K.F., Chu, K.R., Chen, S.H., 2007, Stable, high efficiency gyrotron backward-wave oscillator, Phys. of Plasmas, 14, 093102 – 093102-8.

[1436] Pao, K.F., Tan, C.T., Chang, T.H., Chiu, C.C., Chu, K.R., 2007, Selective suppression of high order axial modes of the gyrotron backward-wave oscillator, Phys. of Plasmas, 14, 093301-1-7.

[1437] Chen, N.C., Yu. C.F., Yuan, C.P., Chang, T.H., 2009, A mode-selective circuit for TE01 gyrotron backward-wave oscillator with wide-tuning range, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M3D01.0369.

[1438] Chen, N.C., Yu, C.F., Yuan, C.P., Chang, T.H., 2009, A mode-selective circuit for TE01 gyrotron backward-wave oscillator with wide-tuning range, Applied Physics Letters, 94, 101501-1-3.

[1439] He, W., Donaldson, C.R., Cross, A.W., Li, F., Phelps, A.D.R., Zhang, L., Ronald, K., Robertson, C.W., Whyte, C.G., Young, A.R., 2009, Experiment of a high power W-band gyro-BWO using a helically corrugated waveguide, Proc. 34th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Busan, Korea, M5E60.0363.

[1440] Donaldson, C.R., He, W., Cross, A.W., Li, F., Phelps, A.D.R., Zhang, L., Ronald, K., Robertson, C.W., Whyte, C.G., McElhinney, P., 2010, Experimental demonstration of a W-band gyro-BWO using a helically corrugated waveguide, Proc. 11th IEEE Int. Vacuum Electronics Conference (IVEC 2010), Monterey, USA, pp. 195-196.

[1441] Donaldson, C.R., He, W., Phelps, A.D.R., Li, F., Zhang, L., Cross, A.W., Ronald, K., Robertson, C.W., Whyte, C.G., Young, A.R., 2010, Experimental demonstration of a W-band gyro-BWO using a helically corrugated waveguide, Proc. 35th Int. Conf. on Infrared, Millimeter and Terahertz Waves, Rome, Italy, Mo-E3.1.

[1442] He, W., Donaldson, C.R., Zhang, L., Ronald, K., McElhinney, P., Cross, A.W., 2013, High power wideband gyrotron backward wave oscillator operating towards the terahertz region. Physical Review Letters, 110, 165101 (5pp).

[1443] He, W., Donaldson, C.R., Zhang, L., McElhinney, P., Ronald, K., Cross, A.W., 2013, W-band gyro-TWT uing a cusp electron gun and a helically corrugated interaction circuit. Proc. 14th IEEE Int. Vacuum Electronics Conference (IVEC 2013), Paris, France, 7A-4.

[1444] He, W., Donaldson, C.R., Zhang, L., McElhinney, P., Phelps, A.D.R., Ronald, K., Cross, A.W., 2013, Latest experiments of W-band gyro-BWO using helically corrugated waveguides. Proc. 38th Int. Conf. on Infrared, Millimeter and Terahertz Waves (IRMMW-THz 2013), Mainz, Germany, We1-3.

[1445] Schriever, R.L., Johnson, C.C., 1966, A rotating beam waveguide oscillator. Proc. of the IEEE, 2029-2030.

[1446] Bratman, V.L., Denisov, G.G., Phelps, A.D.R., Samsonov, S.V., 1998, Gyro-TWTs and gyro-BWOs with helical waveguides. Proc. Research Workshop of the Israel Science Foundation on Cyclotron Resonance Masers and Gyrotrons, Kibbutz Ma'ale Hachamisha, Israel, 252-264.

[1447] Bratman, V.L., Fedotov, A.E., Savilov, A.V., 1999, A new type of gyro-BWO (gyro-BWT-TWT). Conf. Digest 24th Int. Conf. on Infrared and Millimeter Waves, Monterey, CA, USA, TH-E6.

[1448] Kamada, K., Nawashiro, K., Tamagawa, F., Igarashi, H., Kizu, S., Lee, C.-Y., Kawasaki, S., Ando, R., Masuzaki, M., 1998, Backward wave oscillator experiments with a relativistic electron beam using an X-band rectangular waveguide. Int. J. of Infrared and Millimeter Waves, 19, 1317-1324.

[1449] Kamada, K., Nawashiro, K., Tamagawa, F., Lee, C.-Y., Yoshida, H., Kawasaki, S., Ando, R., Masuzaki, M., 2000, Dependence of output power on cavity length in a gyrotron backward wave oscillator. Int. J. of Infrared and Millimeter Waves, 21, 1441-1449.

[1450] Walter, M.T., Gilgenbach, R.M., Menge, P.R., Spencer, T.A., 1994, Effects of tapered tubes on long-pulse microwave emission from intense e-beam gyrotron-backward-wave oscillators. IEEE Trans. Plasma Sciences, 22, 578-584.

[1451] Walter, M.T., Gilgenbach, R.M., Luginsland, J.W., Hochman, J.M., Rintamaki, J.I., Jaynes, R.L., Lau, Y.Y., Spencer, T.A., 1996, Effects of tapering on gyrotron backward-wave oscillators. IEEE Trans. on Plasma Science, 24, 636-647.

[1452] Spencer, T.A., Arman, M.J., Hendricks, K.J., Hackett, K.E., Stump, M., Gilgenbach, R.M., 1995, Non-axisymmetric mode competition in a high current, high voltage TE01 gyrotron-backward-wave oscillator experiment. Conf. Digest 20th Int. Conf. on Infrared and Millimeter Waves, Lake Buena Vista (Orlando), Florida, 536-537.

[1453] Spencer, T.A., Davis, C.E., Hendricks, K.J., Agee, F.J., Gilgenbach, R.M., 1996, Results from gyrotron backward wave oscillator experiments utilizing a high-current high-voltage annular electron beam. IEEE Trans. on Plasma Science, 24, 630-635.

Gyrotrons are mainly used as high power millimeter wave sources for electron cyclotron heating and current drive (ECH&CD), stability control and diagnostics of magnetically confined plasmas for generation of energy by controlled thermonuclear fusion. The maximum pulse length of commercially available 140 GHz, megawatt-class gyrotrons employing synthetic diamond output windows is 30 minutes (CPI and European KIT-SPC-THALES collaboration). The world record parameters of the European tube are: 0.92 MW output power at 30 min. pulse duration, 97.5% Gaussian mode purity and 44% efficiency, employing a single-stage depressed collector (SDC) for electron energy recovery. A maximum output power of 1.5 MW in 4.0 s pulses at 45 % efficiency was generated with the QST-CANON 110 GHz gyrotron. The first Japan 170 GHz ITER gyrotron prototype achieved 1 MW, 800 s at 55% efficiency and holds the energy world record of 2.88 GJ (0.8 MW, 60 min., 57 %). The Russian 170 GHz ITER gyrotron obtained 0.99 (1.2) MW with a pulse duration of 1000 (100) s and 57 (53) % efficiency. The prototype tube of the KIT 2 MW, 170 GHz coaxial-cavity gyrotron achieved in short pulses the record power of 2.2 MW at 48 % efficiency and 96 % Gaussian mode purity. High-power CW gyrotron oscillators also have been successfully used in materials processing. Such technological applications require tubes with the following parameters: $f > 24$ GHz, $P_{out} = 4$-50 kW, CW, $\eta > 30$ %. Gyrotrons with pulsed magnet for various short-pulse applications deliver $P_{out} = 210$ kW with $\tau = 20$ ms at frequencies up to 670 GHz ($\eta \cong 20$ %), $P_{out} = 5.3$ kW at 1 THz ($\eta = 6.1$%), and $P_{out} = 0.5$ kW at 1.3 THz ($\eta = 0.6$%). In addition, this work gives a short update on the present status of frequency step-tunable and multi-frequency gyrotrons, coaxial-cavity multi-megawatt gyrotrons, complex two-section stepped cavity gyrotrons, gyrotrons for technological and spectroscopy applications, relativistic gyrotrons, large orbit gyrotrons (LOGs), quasi-optical gyrotrons, cyclotron autoresonance masers (CARMs), gyroklystron-, gyro-TWT- and gyrotwystron amplifiers, gyro-BWOs and dielectric vacuum windows for such high-power mm-wave sources. The average powers produced by 94 GHz gyroklystrons, gyrotwystrons and gyro-TWTs are 10 kW, 5 kW and 2 kW, respectively.

ISSN 1869-9669