

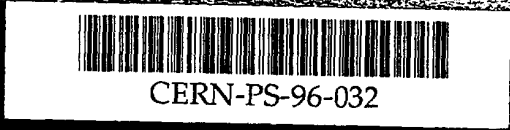
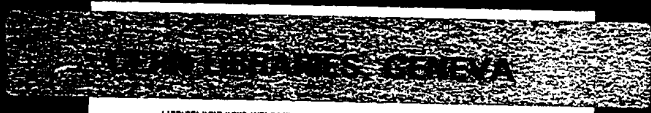


XVIII International Linac Conference

Geneva, Switzerland

26-30 August, 1996

CERN/PS 96-32 (DI)



Compendium of Scientific Linacs

J. Clendenin*, L. Rinolfi, K. Takata**, D.J. Warner

*SLAC, Stanford, USA

**KEK, Tsukuba, Japan

CERN – PS Division
European Organization for Nuclear Research
Switzerland
November 1996



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Foreword

The International Committee supported the proposal of the Chairman of the XVIII International Linac Conference to issue a new Compendium of linear accelerators. The last one was published in 1976. The Local Organizing Committee of Linac96 decided to set up a sub-committee for this purpose.

Contrary to the catalogues of the High Energy Accelerators which compile accelerators with energies above 1 GeV, we have not defined a specific limit in energy. Microtrons and cyclotrons are not in this compendium. Also data from thousands of medical and industrial linacs has not been collected. Therefore, only scientific linacs are listed in the present compendium.

Each linac found in our research and involved in a physics context was considered. It could be used, for example, either as an injector for high energy accelerators, or in nuclear physics, material physics, free electron lasers or synchrotron light machines.

Linear accelerators are developed in three continents only : America, Asia, Europe. This geographical distribution is kept as a basis.

The compendium contains the parameters and status of scientific linacs. Most of these linacs are operational. However, many facilities under construction or design studies are also included. A special mention has been made at the end for the studies of future linear colliders.

In spite of all the care we took to compile all world linacs existing or under development, some are probably missing. The reason is either a lack of information or the fact that no answer was received from the institute.

Many thanks to all persons in the various laboratories who supplied the data about their linacs. We hope that this Compendium will be a useful tool for the Linac community.

L. Rinolfi

Committee and Contributors for the 1996 Compendium

The members of the sub-committee who produced this Compendium are the following :

J. Clendenin (SLAC)
L. Rinolfi (CERN) - Chairman
K. Takata (KEK)
D.J. Warner (CERN)

Y. Yamazaki (KEK) contributed by collecting data from Asian linacs and made useful comments.

S.L. Neboux provided great help using the WWW to obtain information about various linacs and organizing the secretariat. Last but not least, she installed and updated the Compendium on the World-Wide Web.

E. Bryant, T. Kehrer and A. Rogerson have handled the secretarial work in an efficient and enthusiastic way. The clarity of the typing and the efficiency to correct the mistakes have been appreciated. During the elaboration of the Compendium, they kept smiling and that participated to its success.

H. Haseroth, Chairman of the International Committee, proposed the compilation of a Compendium of linacs for this conference.

D. Dekkers, Chairman of the Local Organizing Committee and B. Allardyce made useful comments to finalize the catalogue.

Summary

This compendium comprises 176 scientific linacs distributed over 3 continents :

Americas	:	61
Asia	:	37
Europe	:	78

Altogether the breakdown for the types of particles is the following :

Electrons	:	111
Positrons	:	12
Protons/H ⁻	:	23
Ions	:	30

The lists, without technical details, are published on the World-Wide Web. The address is the following :

<http://www.cern.ch/Linac96/Linacs.html>

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São José dos Campos	CTA	e- : 30 MeV	Neutron production and research	5
CANADA				
Saskatoon	University of Saskatchewan	e- : 310 MeV	Subatomic physics research	6
Vancouver	TRIUMF	ions : 1.5 MeV/u (ISAC)	Ion accelerator	7
USA				
CALIFORNIA				
Berkeley	LBNL	e- : 50 MeV	ALS Injector	8
		e- : 4 MeV (RTA)	Power source for LC	9
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		e- : 5 MeV (AXF-0)	Inj. for FEL + Laser Acc. Exp.	13
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		e- : 15 GeV (LCLS)	X-ray FEL	18
		e- : 630 MeV (NLCTA)	Test facility for LC	19
	SSRL	e- : 120 MeV	Injector for SPEAR	20
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College Park	University of Maryland	e- : 9 MeV	Research	36
Galthersburg	NIST	e- : 32 MeV (MIRF)	Physics research	37
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Middleton	MIT/Bates	e- : 1 GeV	Research	38
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Albuquerque	Sandia National Laboratories	ions : 1.9 MeV/u	Post accelerator	40
Los Alamos	LANL	e- : 30 MeV (PHERMEX)	Flash radiography	41
		e- : 20 MeV (AFEL)	FEL experiments	42
		e- : 20 MeV (DARHT)	X-ray pulse for radiography	43
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		p : 1.25 MeV (CRITS)	Test CW RFQ	49

LOCATION	INSTITUTION	LINACS	FUNCTION	Page
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Troy	RPI	e- : 90 MeV	Research experiments	53
Upton	BNL	e- : 120 MeV	NSLS injector	54
		e- : 70 MeV (ATF)	Accelerator physics	55
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		e- : 45 MeV	MKIII FEL Injector	58
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ASIA

LOCATION	INSTITUTION	LINACS	FUNCTION	Page
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		p : 35 MeV	Proton beam application	70
Hefei	HLS	e- : 225 MeV	Injector for Light Source	71
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Ibaraki, Osaka	ISIR, Osaka University	e- : 150 MeV (S-Band)	Scientific research	73
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	RLNR	ions : 3.4 MeV/u (TIT-IH-2)	Booster Linac Heavy Ion Acc.	89
		ions : 2.4 MeV/u (TIT-IH)	Main Linac Heavy Ion Acc.	90
		ions : 1.7 MeV/u (Deuteron IH Linac)	Radio-isotope Prod. for PET	91
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		e- : 0.5 GeV (TELL)	Injector for 3 SR rings	98
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	ICR, Kyoto University	p : 7 MeV	Accel. development	100
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EUROPE

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		e- : 0.075 GeV	Injector for YerPHI Synchrotron	109
		e- : 0.008 GeV (LAE-8)	Irr. of material + rad. techn.	110
		e- : 0.005 GeV (U-003)	Applied Research	111
		e- : 0.004 GeV (LAE-4)	Irr. of material + sterilization	112
BELGIUM Geel Gent	IRMM Gent University	e- : 200 MeV (GELINA)	Neutron and radiation physics	113
		e- : 15 MeV	Interdisciplinary research	114
FRANCE Le Barp Bruyères-le-Châtel Grenoble Orsay Saclay	CEA-CESTA	e- : 8 MeV (PIVAIR)	X-ray radiography	115
		e- : 3 MeV (LELIA)	FEL	116
	CEA ESRF	e- : 20 MeV (ELSA)	FEL, R&D	117
		e- : 200 MeV	Injector for Synch. Rad. Fac.	118
	CNRS-LURE	e- : 2.3 GeV	Physics experiments	119
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GERMANY Berlin Bonn Darmstadt Dortmund Hamburg Heidelberg Mainz Munich	HMI	e- : 15 MeV	Radiography	129
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		ions : 1.4 MeV/u (Linac II)	Heavy ion injector for UNILAC	134
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	IKP University of Dortmund	e- : 130 MeV (S-DALINAC)	Nuclear physics + FEL driver	136
		e- : 100 MeV (DELTA)	Inj. for 1.5 GeV SR	137
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Kernphysik Institut Technical University	e- : 3.5 MeV	Injector for RTM (MAMI)	145	
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	FOM Twente University	e- : 7 MeV (TEUFEL)	FEL	154
POLAND Swierk	Soltan Inst. Nucl. Studies	e- : 22 MeV (S-20)	Accelerator technology	155

LOCATION	INSTITUTION	LINACS	FUNCTION	Page		
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		INR	p : 600 MeV (MMFL)	Nuclear physics	158	
		ITEP	p : 36 MeV (ISTRA-36)	Test facility	159	
			ions : 24.6 MeV (I-2)	Injector for PS	160	
	Novosibirsk	Kurchatov Institute	ions : 0.036 MeV/u (TIPr-1)	Ion fusion	161	
			e- : 60 MeV (FAKEL)	Research	162	
		BINP	e-/e+ : 510 MeV (VEPP-5)	Injector for Fi-factory	163/164	
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AMERICA (North & South)

AMERICA (North & South)

ELECTRON LINAC

Name of Linac : *Linac*
Function : *Electron Linac - Pulsed Source of Neutrons*
Institution and address : *Centro Atómico Bariloche - Bariloche - Argentina*
Person in charge : *Dr. Rolando Granada*
Name of person supplying these data : *Dr. Rolando Granada*
e-mail : *granada@cab.cnea.edu.ar*
tel. : *+54 944 45223* fax : *+54 944 45299*

HISTORY AND STATUS

Const. started : *1964* ; first beam : *1969*
Present status : *Operating*
Cost of facility :
Present linac staff : *2 man-years*
Present yearly operation time : *900* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *0.15* A
Normalized emittance (1σ) : *π mm-mrad*

Injector

Longitudinal matching : *Pre-Buncher*
Output : MeV; intensity : A
Pulse width, spacing : *1.2 μ s, 10 ms*
Normalized emittance (1σ) : *π mm-mrad*

Acceleration System

Total linac length : *6* m
No. sections : *1* ; lengths : *3* m
Field mode : *$2\pi/3$* ; frequency : *2856* GHz
Wave type : *TW* ; filling time : *0.83* μ s
 v_g/c range : *(1)* ; Q : *15000*
Shunt impedance : *53-60* M Ω /m
Iris : aperture : diameter : *19.2-26.7* mm
thickness : *5.8* mm
Attenuation/section : *0.57* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *12* MW; mean : *2.6* kW

Focusing System

Type, No. of elements, and spacing :
On the injector and on the beam transport system.
None on the WG

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.025</i>		GeV
Accel gradient	: <i>8.3</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>5</i>		%
Rep. rate	: <i>100</i>		Hz
Pulse length	: <i>1.2</i>		μ s
Beam intensity	: <i>0.020</i>		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

(1) $v_g/c = 0.02 - 0.0065$

ELECTRON LINAC

Name of Linac : *LNLS **
Function : *Storage ring injector*
Institution and address : *LNLS - CX Postal 6192, Campinas, Brazil*
Person in charge : *Lucia C. Jahnel*
Name of person supplying these data : *Lucia C. Jahnel*
e-mail : *Lucia@LNLS.ANSP.BR*
tel. : *+55 19 257 4520* fax : *+55 19 257 4632*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *12/1987*
Present status : *(1) Commissioning*
Cost of facility : *35 MUSD*
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : *40* π mm-mrad

Injector

Longitudinal matching : *Pre buncher (no buncher)*
Output : *0.08* MeV; intensity : *2* A
Pulse width, spacing : *100 ns; 66 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *20.5* m
No. sections : *4* ; lengths : *3.07* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μ s
 v_p/c range : *(2)* ; Q : *13000*
Shunt impedance : *52 - 60* M Ω /m
Iris : aperture : diameter : *26.2 - 19.2* mm
thickness : *5.8* mm
Attenuation/section : *0.57* Np
Power units, Number : *2* type : *(3) Klystron*
RF power peak : *25* MW; mean : *(4)* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids at the first acc. struc., a triplet between the second and the third acc. struc., two quadrupoles and a spectrometer at the end.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	<i>> 0.1</i>	<i>0.10</i>	GeV
Accel gradient	<i>10</i>	<i>10</i>	MeV/m
$\Delta E/E$ (FWHM)		<i>1</i>	%
Rep. rate	<i>15</i>	<i>15</i>	Hz
Pulse length	<i>0.1</i>	<i>0.1</i>	μ s
Beam intensity		<i>0.100</i>	A
Norm. emit. (1σ)		<i>77×10^{-4}</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *LNLS - Laboratório Nacional de Luz Sincrotron (100 MeV Linac)*

(1) *The first two structures (50 MeV) have been in operation since 1987. During July 1995, the machine was transferred to the definitive LNLS site where the two remaining accelerating structures were installed. The first beam with energy above 100 MeV was obtained on December 22nd 1995.*

(2) *0.0204 - 0.0065*

(3) *Divided for 2 structures.*

(4) *3.8×10^{-3}*

ELECTRON LINAC

Name of Linac : IEAv * electron linac
Function : Neutron production and radiation dosimetry research
Institution and address : CTA/IEAv - Rod, Tamoios km 5.5 São José dos Campos - SP - Brasil
Person in charge : C.R.S. Stopa (laboratory) - C. Fuhrmann (linac)
Name of person supplying these data : C.R.S. Stopa
e-mail : stopa@ieav.cta.br
tel. : +55 123 413033 (ext. 278) fax : +55 123 414277

HISTORY AND STATUS

Const. started : (1) 1986 ; first beam :
Present status : Under construction
Cost of facility : 5 MUSD (1995)
Present linac staff : 12 man-years
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : Triode ; energy : 100 keV
Beam intensity (peak) : 4 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : (2)
Output : MeV; intensity : 2 A
Pulse width, spacing : 200 ns - 1.25 ms
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 4 m
No. sections : (3) 2 ; lengths : 2.0 m
Field mode : $2\pi/3$; frequency : 1.3 GHz
Wave type : TW ; filling time : 1.0 μ s
 v_g/c range : (4) ; Q : 19000
Shunt impedance : (eff) 32 M Ω /m
Iris : aperture : diameter : 44.94 - 39.40 mm
thickness : 12.00 mm
Attenuation/section : 0.23 Np
Power units, Number : 1 type : Klystron
RF power peak : 20 MW; mean : 60 kW

Focusing System

Type, No. of elements, and spacing :
Eight solenoids up to 30 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy		0.030	GeV
Accel gradient		9.0	MeV/m
$\Delta E/E$ (FWHM)		15	%
Rep. rate		800	Hz
Pulse length		0.200	μ s
Beam intensity		2.0	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* Instituto de Estudos Avançados

- (1) The linac construction was interrupted during the 90-94 period due to fund shortage.
- (2) L-band prebuncher and buncher.
- (3) The first accelerating structure includes a 0.57 m long bunching region.
- (4) 0.0076 - 0.0047

ELECTRON LINAC

Name of Linac : *Saskatchewan Accelerator Laboratory*
Function : *Provide c.w. beams for subatomic physics research*
Institution and address : *University of Saskatchewan, 107 North Road, Saskatoon, Sask S7N 5C6 Canada*
Person in charge : *Dr Dennis M. Skopik*
Name of person supplying these data : *Dr J.J. Murphy*
e-mail : *jjm@skatter.usask.ca*
tel. : *+1 306 966 6071* fax : *+1 306 966 6058*

HISTORY AND STATUS

Const. started : *1961* ; first beam : *1965*
Present status : *Operational*
Cost of facility :
Present linac staff : *48*
Present yearly operation time : *5000* h

LINAC PARAMETERS

Electron Sources

Types : *Haimson* ; energy : *220* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : *23* π mm-mrad

Injector

Longitudinal matching :
Output : *12* MeV; intensity : *1.3* A
Pulse width, spacing : *1.5* μ s, *2.8* ms
Normalized emittance (1σ) : *0.43* π mm-mrad

Acceleration System

Total linac length : *28* m
No. sections : *6* ; lengths : *3.3 - 4.83* m
Field mode : *(1) 2\pi/3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.78* μ s
 v/c range : *(2)* ; Q : *15000*
Shunt impedance : *53-60* M Ω /m
Iris : aperture : diameter : *0.75-1.0* mm
thickness : *5.8* mm
Attenuation/section : *5.7* Np
Power units, Number : *6* type : *ITT*
RF power peak : *21* MW; mean : *21* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.110-0.295</i>	<i>0.310</i>	GeV
Accel gradient	:		MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>		%
Rep. rate	: <i>180</i>	<i>360</i>	Hz
Pulse length	: <i>0.36</i>	<i>2</i>	μ s
Beam intensity	: <i>0.016-0.060</i>	<i>0.220</i>	A
Norm. emit. (1σ)	: <i>0.3</i>	<i>0.3</i>	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *TM010*
- (2) *0.020 - 0.0065*

ION LINAC

Name of Linac : *ISAC **
 Function : *Accelerator of Light Radioactive Ions*
 Institution and address : *TRIUMF, 4004 Wesbrook Mall, Vancouver, B.C., Canada, V6T 2A3*
 Person in charge : *P.W. Schmor*
 Name of person supplying these data : *G. Dutto*
 e-mail : *dutto@triumf.ca*
 tel. : *+1 604 222 7419* fax : *+1 604 222 1074*

HISTORY AND STATUS

Const. started : *1995* ; first beam : *2000*
 Present status : *Design, prototyping*
 Cost of facility : *34 MCDN*
 Present linac staff :
 Present yearly operat. time : *na* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3*
 Types of source : *CUSP, SURFACE, ECR...*
 Species of ions : *A ≤ 30*
 Range of currents : *≤ 1* μAe
 Range of output energies : *2* keV/u
 Pulse length : *dc* μs ; rep. rate : *dc* Hz
 Normalized emittance (1σ) : *0.026* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *RFQ (split ring, 4 rod) / 8* m
 Output currents : *≤ 1* μAe
 Output energies : *150* keV/u
 Frequency : *35* MHz; peak RF power : *150* kW
 Pulse length : *cw* μs ; rep. rate : *cw* Hz
 Normalized emittance (1σ) : *0.026* π mm-mrad

Longitudinal Matching

Type : *4 Harmonic single gap buncher*
 Mod. *0.2* keV; drift *5700* mm at *11.5* MHz
0.1 keV; drift *3000* mm at *35* MHz

Accelerating System

Total linac length : *5.6* m; N^o. of tanks : *5*
 Tank diameters : *1* m
 Number of drift-tubes : *9, 13, 15, 14, 13*
 Drift-tube lengths : *25.7 - 80.0* mm
 Drift-tube diam (range) : *20 - 26* mm
 Gap/cell length (range) : *0.43 - 0.55*
 Aperture diameter : *10* mm to *16* mm
 RF frequency(ies) : *105* MHz
 Field modes :
 Eff. shunt impedance : *(1)* $\text{M}\Omega/\text{m}$
 Q : *(2)*
 Filling time : μs
 Equil. phases : *0°* ; accel. rate *0 - 0.24* MeV/u-m
 RF rep. rate : *cw* Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : *0.08* MW; mean : *0.08* MW

Focusing System

No. elements : *5*
 type : *Quad. triplet* order :
 Gradients : *44* to *66* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Carbon Foil*
 Charge states : *1* to *6* at *150* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species :		<i>A ≤ 30</i>
Energy :		<i>(3)</i> MeV/u
$\Delta E/E$ (FWHM) :		<i>≤ 1</i> %
Mean acc. rate :		MeV/u-m
Beam current :		<i>1</i> μAe peak
Norm. emit. (1σ) :		<i>0.026</i> π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *Isotope Separator and ACcelerator*

- (1) *(MAFIA) 350, 530, 570, 470, 390 MΩ/m*
- (2) *(MAFIA) 10500, 14000, 19000, 22000, 23000*
- (3) *0.150 - 1.5 MeV/u*

LINAC

- *Double Gap Spiral Resonators before IH tanks*

RFQ

- *4 rod, split ring, cw*

ELECTRON LINAC

Name of Linac : *ALS Injector*
Function : *Electron Injector for the Advanced Light Source*
Institution and address : *LBL, 1 Cyclotron Road, Berkeley, CA 94720, USA*
Person in charge : *Charles Kim*
Name of person supplying these data : *Charles Kim*
e-mail : *chkim@lbl.gov*
tel. : *+1 510 486 7218* fax : *+1 510 486 4960*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *02/1991*
Present status : *Operational*
Cost of facility : *(1) 3.75 MUSD*
Present linac staff : *NA*
Present yearly operation time : *~ 7000* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic triode* ; energy : *120* keV
Beam intensity (peak) : *1* A
Normalized emittance (1σ) : *10* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *0.5* MeV; intensity : *0.2* A
Pulse width, spacing : *(3)*
Normalized emittance (1σ) : *30* π mm-mrad

Acceleration System

Total linac length : *4* m
No. sections : *2* ; lengths : *2* m
Field mode : *$2\pi/3$* ; frequency : *2.9979* GHz
Wave type : *TW* ; filling time : *0.4* μ s
 v_p/c range : *0.017* ; Q : *13620*
Shunt impedance : *56.1* M Ω /m
Iris : aperture : diameter : *23.82* mm
thickness : *5.0* mm
Attenuation/section : *0.267* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *(4) MW*; mean : *0.054* kW

Focusing System

Type, No. of elements, and spacing :
7 solenoids for < 25 MeV
2 quad triplets at 25 MeV and at 50 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *4 ~ 12*
No. of particles/bunch : *2 nC / bunch*
Bunch separation : *8 ns, 1 Hz*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.050</i>	<i>0.050</i>	GeV
Accel gradient	: <i>13</i>	<i>13</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>	<i>1</i>	%
Rep. rate	: <i>1</i>	<i>1</i>	Hz
Pulse length	: <i>0.024</i>	<i>0.08</i>	μ s
Beam intensity	: <i>125</i>	<i>125</i>	A
Norm. emit. (1σ)	: <i>40</i>	<i>40</i>	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Actual US Dollar spent over 1987 - 1991.*
- (2) S Band buncher, 125 MHz Buncher, 500 MHz Buncher.*
- (3) 100ps FWHM, 8ns, 4~10 microbunches, 8 ns spacing.*
- (4) S Band buncher, section 1, section 2.*

ELECTRON LINAC

Name of Linac : 100 MeV Electron-Positron Linac
Function : Positron production; materials science and particle research
Institution and address : LLNL *, Bldg. 194, L-280 Livermore CA94550 USA
Person in charge : Thomas E. Cowan
Name of person supplying these data : Thomas E. Cowan
e-mail : tcowan@llnl.gov
tel. : +1 510 422 9678 fax : +1 510 422 0883

HISTORY AND STATUS

Const. started : 1967 ; first beam : 1969
Present status : *Operating*
Cost of facility : 4.6 MUSD (1969)
Present linac staff : 3
Present yearly operation time : ~ 500 h

LINAC PARAMETERS

Electron Sources

Types : (1) ; energy : 105 keV
Beam intensity (peak) : (2) 15 / 1 A
Normalized emittance (1 σ) : π mm-mrad

Injector

Longitudinal matching : (3)
Output : 2.5 MeV; intensity : (2) 10 / 0.8 A
Pulse width, spacing : 20ns-0.69ms / 3 μ s-3.3ms
Normalized emittance (1 σ) : π mm-mrad

Acceleration System

Total linac length : (4) 17 m
No. sections : 5 ; lengths : 2.42 m
Field mode : $2\pi/3$; frequency : 2.856 GHz
Wave type : TW ; filling time : 0.65 μ s
 v_g/c range : 0.019 ; Q : 13200
Shunt impedance : 53 M Ω /m
Iris : aperture : diameter : 26 - 19 mm
thickness : 6.1 mm
Attenuation/section : 0.29 (0.12 Np/m) Np
Power units, Number : 5 type : *Klystrons*
RF power peak : 15 MW; mean : 16.2 kW

Focusing System

Type, No. of elements, and spacing :
Solenoids for buncher and each TW section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.11 / 0.08	0.165	GeV
Accel gradient	: 9.1 / 6.6	13.1	MeV/m
$\Delta E/E$ (FWHM)	: 2 - 5	< 2	%
Rep. rate	: 720 / 300	1440 / 300	Hz
Pulse length	: 0.020 / 2.8	0.1 / 3	μ s
Beam intensity	: (5) 6 / 0.7	(5) 10 / 0.8	A
Norm. emit. (1 σ):			π mm-mrad

OTHER RELEVANT INFORMATION

* *Lawrence Livermore National Laboratory*

- (1) *Thermionic (BaO in W matrix), modified Pierce geometry.*
- (2) *The LLNL 100 MeV Linac is designed to operate in both a short and a long pulse mode depending on whether the application requires a narrow pulse width (eg. for time-of-flight applications) or high average flux. Typical applications include materials irradiation and generation of secondary positron and neutron beams. Typical short-pulse mode parameters are 1-20 ns pulse width, 10 A peak current, and variable repetition rate from single pulse up to 1440 Hz. Long pulse parameters are 1-3 μ s, 0.7 A peak, and variable rep rate from single pulse to 300 Hz. Parameters are listed by short-pulse mode / long-pulse mode.*
- (3) *S-band tapered phase velocity buncher.*
- (4) *Measured to end of TW section # 5.*
- (5) *Maximum beam intensity values are given for operation at 75 MeV. For 165 MeV operation design beam intensity values are 2 A / 0.1 A for short / long pulse modes.*

ELECTRON LINAC

Name of Linac : *ETA II*
Function : *Advanced Radiography Development*
Institution and address : *LLNL, PO Box 808, Livermore CA 94551, USA*
Person in charge : *George Caporaso*
Name of person supplying these data : *Glen Westenskow, Yu-Jui'an Chen*
e-mail : *gw@llnl.gov*
tel. : *+1 510 423 6936* fax : *+1 510 423 2664*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1989*
Present status : *(1)*
Cost of facility :
Present linac staff : *10*
Present yearly operation time : *NA* h

LINAC PARAMETERS

Electron Sources

Types : *Dispenser* ; energy : *1000* keV
Beam intensity (peak) : *2200* A
Normalized emittance (1σ) : *NA* π mm-mrad

Injector

Longitudinal matching : *NA*
Output : *1* MeV; intensity : *2200* A
Pulse width, spacing : *70 ns*
Normalized emittance (1σ) : *350* π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *60* ; lengths : m
Field mode : *NA* ; frequency : *NA* GHz
Wave type : *NA* ; filling time : *NA* μ s
 v_g/c range : *NA* ; Q : *NA*
Shunt impedance : *NA* M Ω /m
Iris : aperture : diameter : *NA* mm
thickness : *NA* mm
Attenuation/section : *NA* Np
Power units, Number : *4* type : *(2)*
RF power peak : *NA* MW; mean : *NA* kW

Focusing System

Type, No. of elements, and spacing :
82 Solenoids
23.5 cm long, 4 cm separation

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.006</i>		GeV
Accel gradient	:		MeV/m
$\Delta E/E$ (FWHM)	: <i>2</i>		%
Rep. rate	:	<i>1000</i>	Hz
Pulse length	: <i>0.07</i>		μ s
Beam intensity	: <i>2000</i>		A
Norm. emit. (1σ)	: <i>350</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Preparing for new set of experiments*
- (2) Magnetic Pulse Compressors*

ETA II is a linear induction accelerator

- 60 induction cells*
- 6.6 cm pipe radius*

Nominal beam parameters

- 6.3 MeV plus or minus 2 % beam energy spread*
- 2 to 3 kA beam current*
- 70 ns pulse width with 30 ns flat top*
- 350 π mm-mrad for 1σ normalized emittance*
- plus or minus 1 mm transverse sweep*

ELECTRON LINAC

Name of Linac : AXF-0
Function : Injector for FEL and Laser Acceleration experiments
Institution and address : UC Davis Dept. of App. Science / Lawrence Livermore National Laboratory*
Person in charge : F.V. Hartemann
Name of person supplying these data : Greg Le Sage
e-mail : lesage@wente.llnl.gov
tel. : +1 510 423 6776 fax : +1 510 422 2514

HISTORY AND STATUS

Const. started : 1994 ; first beam : NA
Present status : (1)
Cost of facility :
Present linac staff : 6
Present yearly operation time : NA h

LINAC PARAMETERS

Electron Sources

Types : Photocathode ; energy : NA keV
Beam intensity (peak) : (2) A
Normalized emittance (1σ) : NA π mm-mrad

Injector

Longitudinal matching : NA
Output : 5 MeV; intensity : 1000 A
Pulse width, spacing : 2 μ s, 0.1 s
Normalized emittance (1σ) : < 1 π mm-mrad

Acceleration System

Total linac length : 0.037 m
No. sections : 1 ; lengths : m
Field mode : π ; frequency : 8.548 GHz
Wave type : Standing ; filling time : 0.16 μ s
 v_p/c range : NA ; Q : 8600
Shunt impedance : 93 M Ω /m
Iris : aperture : diameter : 6.66 mm
thickness : 6.66 mm
Attenuation/section : NA Np
Power units, Number : 1 type : Klystron
RF power peak : 20 MW; mean : (3) 0.4 kW

Focusing System

Type, No. of elements, and spacing :
Solenoid bucking pair

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 100
No. of particles/bunch : 6.241×10^9 (1 nc / bunch)
Bunch separation : 467 ps (every 4th rf cycle)

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		0.005	GeV
Accel gradient :		135	MeV/m
$\Delta E/E$ (FWHM) :		0.3	%
Rep. rate :		10	Hz
Pulse length :		2	μ s
Beam intensity :			A
Norm. emit. (1σ) :		< 1	π mm-mrad

OTHER RELEVANT INFORMATION

* PO Box 808, L-402, Livermore, CA 94550, USA

(1) Accelerator cavity hot RF testing

(2) 1 kA (1 nC / 1 psec)

(3) 2 μ s / pulse * 10 pulses / sec * 20 MW

Drive laser based on AlGaAs semiconductor rf modelocked oscillator, locked to rf drive master oscillator. Repetition rate is fourth subharmonic of rf drive.

References

- [1] "Laser ring photocathode RF linac", F.V. Hartemann, G.P. Le Sage, S. Fochs, D.B. McDermott and N.C. Luhmann Jr., Bull. APS 38, 1941 (October 1993).
- [2] "Photoinjector-Driven Chirped-Pulse Free Electron Maser", G.P. Le Sage, F.V. Hartemann, H.X.C. Feng, S.N. Fochs, J.P. Heritage, N.C. Luhmann Jr., M.D. Perry, and G.A. Westenskow. AGARD conference proceedings 564, High Power Microwaves, NATO Symposium, Ottawa, Canada (May 1994).
- [3] "Gigahertz Repetition Rate AlGaAs / Ti: Sapphire (LiSAF) Modelocked Oscillator / Power Amplifier Laser System for Advanced Photoinjectors", P.J. Delfyett, S.N. Fochs, J.P. Heritage, G.P. Le Sage, J.D. McNally, F.V. Hartemann, N.C. Luhmann Jr., and M.D. Perry, Lasers for RF Guns Proceedings, Brookhaven National Laboratory Publication 52435, 41 (May 1994).

ELECTRON LINAC

Name of Linac : *Saturnus*
Function : *Beam Physics Studies*
Institution and address : *UCLA, Phys. Dep., 405 Hilgard Ave., LA, CA 90095-1547, USA*
Person in charge : *Claudio Pellegrini*
Name of person supplying these data : *Claudio Pellegrini*
e-mail : *pellegrini@physics.ucla.edu*
tel. : fax : *+ 1 310 206 1091*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *3 man-years*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Photoinjector* ; energy : *4000* keV
Beam intensity (peak) : *150* A
Normalized emittance (1σ) : *5* π mm-mrad

Injector

Longitudinal matching :
Output : *4* MeV; intensity : *150* A
Pulse width, spacing : *4 ps*
Normalized emittance (1σ) : *5* π mm-mrad

Acceleration System

Total linac length : *1.5* m
No. sections : *1* ; lengths : *0.4* m
Field mode : π ; frequency : *2.856* GHz
Wave type : *SW* ; filling time : *0.9* μ s
 v_g/c range : ; Q : *10000*
Shunt impedance : *50* M Ω /m
Iris : aperture : diameter : *10* mm
thickness : *10* mm
Attenuation/section : Np
Power units, Number : *1* type : *RK5*
RF power peak : *22* MW; mean : *0.200* kW

Focusing System

Type, No. of elements, and spacing :
1 Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : *6×10^9*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.015</i>	<i>0.015</i>	GeV
Accel gradient	: <i>25</i>	<i>25</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.2</i>	<i>0.2</i>	%
Rep. rate	: <i>5</i>	<i>5</i>	Hz
Pulse length	: <i>2.5</i>	<i>2.5</i>	μ s
Beam intensity	:		A
Norm. emit. (1σ)	: <i>5</i>	<i>5</i>	π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *Naval Postgraduate School Linac*
Function : *Education and Research*
Institution and address : *Dept. of Physics, Naval Postgraduate School, Monterey, CA 93943, USA*
Person in charge : *Professor Xavier K. Maruyama*
Name of person supplying these data : *Professor Xavier K. Maruyama*
e-mail : *maruyama@physics.nps.navy.mil*
tel. : *+1 408 656 2431* fax : *+1 408 656 2834*

HISTORY AND STATUS

Const. started : *12/1966* ; first beam : *02/1967*
Present status : *Operational*
Cost of facility :
Present linac staff : *Part time*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.13* MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *3* ; lengths : *3.3* m
Field mode : ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *1* μ s
 v_p/c range : ; Q :
Shunt impedance : $M\Omega/m$
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : *22* MW; mean : *0.1* kW

Focusing System

Type, No. of elements, and spacing :
Moveable pole tips on two deflection magnet
Quadrupole Doublet

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.1</i>		GeV
Accel gradient	: <i>10</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>0.3</i>		%
Rep. rate	: <i>60</i>		Hz
Pulse length	: <i>1</i>		μ s
Beam intensity	: 3×10^7		A
Norm. emit. (1σ)	: <i>300</i>		π mm-mrad

OTHER RELEVANT INFORMATION

Many of the parameters are equivalent to the original Stanford HEPL Mark III Accelerator.

(1) Dispenser Cathode

POSITRON LINAC

Name of Linac : SLAC 3-km Linac
 Function : e^+ / e^- Collider, Injector for B Factory
 Institution and address : SLAC, PO Box 4349, Stanford, CA 94309, USA
 Person in charge : Franz-Josef Decker (Linac), Jym Clendenin (Sources)
 Name of person supplying these data : F-J. Decker
 e-mail : DECKER@STANFORD.EDU
 tel. : +1 415 926 3606 fax : +1 415 926 2407

HISTORY AND STATUS

Differences with respect to corresponding e^- linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy :	30000	MeV	
Radius (1σ) :	0.6	mm	
Beam intensity :	$4 \times 10^{10} e^- / \text{bunch}$	A	

LINAC PARAMETERS

Conversion Target and Capture

Material :	W- (^{26}Re)		
Type :	Trolling wheel		
Thickness (rad.length) :	6	χ	
Diameter :	63 / 89	mm	
Mean deposited power :	9	kW	
Solenoidal field ^{a)} :	Flux concentrator: 5.5 T Tapered solenoid: 0.12 T		
Matching device :	Flux concentrator		
RF sections ^{a)} :	$1 \times 1.5 \text{ m } 55 \text{ MV/m}$, then $3 \times 3 \text{ m } 20 \text{ MV/m}$		

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e^- linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	(13)	(13)	GeV
Accel gradient :	19		MeV/m
$\Delta E/E$ (FWHM) :	0.25		%
Rep. rate :	120		Hz
Pulse length :	(7)		μs
Yield (fin.en) :	0.8 - 1.2		$e^+ / e^- \times \text{GeV}$
Beam intensity :	(14)		$\mu\text{A peak}$
Norm. emit. (1σ):	(15)		$\pi \text{ mm-mrad}$

OTHER RELEVANT INFORMATION

(Continued from Electron Linac form)

- (5) (cont.) An e^+ bunch from the Positron Source is injected at the 200 MeV point of the injector. For C, the 2 e^- bunches and the single e^+ bunch are then co-accelerated by a single rf pulse, separated by sign of charge into the 2 Damping Rings, then 2 damped e^- bunches and a single damped e^+ bunch are reassembled in the linac and co-accelerated to high energy. (One e^- bunch is separated at the 2/3rd point (30 GeV) for positron production.)
- (6) Intensity: $\sim 70\%$ of Source (note 2.)
- (7) Pulse width, repetition rate: 120 ns (3 bunches) before 2/3rd point (note 5) and 60 ns (2 bunches) after with a repetition rate of 120 Hz for C; 5 ps (1 bunch) with a repetition rate up to 120 (60) Hz for I for e^- (e^+) respectively; and 200 ns to 2 μs with a repetition rate of 120 Hz for FT.
- (8) Wave type: TW, constant gradient
- (9) v_g / c range: 0.0204 - 0.0065
- (10) RF power peak: 163 MW effective with SLED.
- (11) No. of bunches/pulse: 3 (including e^+ bunch) in linac before 2/3rd point (note 5) and 2 after for C; 1 (either e^- or e^+) in linac for I; up to 7000 for FT at up to 30 GeV; up to 700 for FT at up to 50 GeV.
- (12) No. of particles/bunch: $\sim 70\%$ of Source (note 2) except e^+ in linac is about 0.9 of e^- in linac.
- (13) Final energy: 46.6 GeV is the normal energy of the linac for producing Z's at C. The maximum (no-load) energy is 52 GeV. For FT experiments, the linac runs between 30 and 52 GeV. For I, the energies of the extracted beams will be in the range 2.5 - 12 GeV.
- (14) Beam intensity: about 4×10^{10} particles for each of the colliding bunches for C; similar intensity per bunch for I, and up to $4 \times 10^{11} e^- / \text{pulse}$ for FT.
- (15) Norm. emit. (1σ): For round beams for C or I, $\sim 25\pi \text{ mm-mrad}$ each plane; for flat beams for C only, 40/6 for x(y) plane.

ELECTRON LINAC

Name of Linac : *NLCTA **
Function : *Test Facility for Linear Collider*
Institution and address : *Stanford Linear Accelerator Center, PO Box 4349, Stanford, CA 94309, USA*
Person in charge : *Ron Ruth*
Name of person supplying these data : *Ron Ruth*
e-mail : *RRUTH@SLAC.STANFORD.EDU*
tel. : *+1 415 926 5390* fax : *+1 415 926 5368*

HISTORY AND STATUS

Const. started : *05/1992* ; first beam : *07/1996*
Present status : *Nearing Completion*
Cost of facility : *20 MUSD*
Present linac staff : *Under Construction*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *150* keV
Beam intensity (peak) : *4* A
Normalized emittance (1σ) : *6* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *90* MeV; intensity : *2* A
Pulse width, spacing : *140 ns, 88 ps*
Normalized emittance (1σ) : *30* π mm-mrad

Acceleration System

Total linac length : *(2)* m
No. sections : *6* ; lengths : *1.8* m
Field mode : *$2\pi/3$* ; frequency : *11.424* GHz
Wave type : *TW* ; filling time : *0.1* μ s
 v_e/c range : *0.12 - 0.03* ; Q : *6500*
Shunt impedance : *87 - 67* M Ω /m
Iris : aperture : diameter : *11.4 - 7.8* mm
thickness : *1 - 2* mm
Attenuation/section : *0.54* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *(3)* MW; mean : *0.24* kW

Focusing System

Type, No. of elements, and spacing :
Lens, 31 solenoids
32 quadrupoles
Main linac, FODO 2m spacing

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1600*
No. of particles/bunch : *4×10^8*
Bunch separation : *88 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	<i>0.63</i>		GeV
Accel gradient :	<i>50</i>		MeV/m
$\Delta E/E$ (FWHM) :	<i>0.5</i>		%
Rep. rate :	<i>10</i>		Hz
Pulse length :	<i>0.140</i>		μ s
Beam intensity :	<i>0.75</i>		A
Norm. emit. (1σ) :	<i>30</i>		π mm-mrad

OTHER RELEVANT INFORMATION

* *NLCTA - Next Linear Collider Test Accelerator*

- (1) 2 prebuncher cavities, 3 low β cells*
- (2) $1.8 \times 6 = 10.8$*
- (3) Klystron 50 MW - 1.5 μ s with pulse compressor
90 MW - 250 ns at the section*

ELECTRON LINAC

Name of Linac : *SSRL Injector Linac* *
Function : *Electron Linac for e⁻ injection to the Booster*
Institution and address : *SLAC/SSRL MS 69, PO Box 4349, Stanford, CA 94309, USA*
Person in charge : *M. Cornacchia*
Name of person supplying these data : *S. Park*
e-mail : *spark@slac.stanford.edu*
tel. : *+1 415 926 2526* fax : *+1 415 926 4100*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1990*
Present status : *Operating*
Cost of facility : *2 MUSD (1990)*
Present linac staff : *3 man-years*
Present yearly operation time : *6000* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *2900* keV
Beam intensity (peak) : *0.64* A
Normalized emittance (1 σ) : *> 5* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *2.9* MeV; intensity : *0.24* A
Pulse width, spacing : *0.3-3 ps, 350 ps*
Normalized emittance (1 σ) : *80* π mm-mrad

Acceleration System

Total linac length : *9* m
No. sections : *(3) 3* ; lengths : *3* m
Field mode : *2 π /3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μ s
 v_g/c range : *(4)* ; Q : *13000*
Shunt impedance : *53-60* M Ω /m
Iris : aperture : *19.1 - 26.2* mm
thickness : *5.84* mm
Attenuation/section : *0.57* Np
Power units, Number : *2* type : *(5) Klystron*
RF power peak : *40* MW; mean : *1* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles, two, 3m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *3*
No. of particles/bunch : *5 \times 10⁸*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.11</i>	<i>0.12</i>	GeV
Accel gradient	: <i>12.2</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>0.17</i>		%
Rep. rate	: <i>10</i>		Hz
Pulse length	: <i>2.5</i>	<i>2.5</i>	μ s
Beam intensity	: <i>(6) 0.24</i>		A
Norm. emit. (1 σ)	: <i>20</i>		π mm-mrad

OTHER RELEVANT INFORMATION

* *SSRL - Stanford Synchrotron Radiation Laboratory*

- (1) 1.5-cell thermionic RF gun*
- (2) quadrupole triplet, alpha magnet, quadrupole doublet, correctors, and chopper*
- (3) Next to the injector, there is one additional section powered by a separate klystron, to be used as a test stand for rf gun with photo/thermionic cathode.*
- (4) 0.0065 - 0.0204*
- (5) One klystron (SLAC 5045) powers the rf gun and the first two sections. The last section and the test stand are powered by SLAC XK-5 klystrons*
- (6) The intensity is averaged over one RF cycle.*

ELECTRON LINAC

Name of Linac : SCA *
Function : Driver for Free Electron Lasers
Institution and address : HEPL, Stanford University, Stanford, CA 94305-4085, USA
Person in charge : Todd I. Smith
Name of person supplying these data : Todd I. Smith
e-mail : Todd.Smith@Stanford.edu
tel. : +1 415 723 1906 fax : +1 415 725 8311

HISTORY AND STATUS

Const. started : ~ 1968 ; first beam : ~ 1971
Present status : Operating
Cost of facility : ?
Present linac staff : 5 man-years
Present yearly operation time : 3000 h

LINAC PARAMETERS

Electron Sources

Types : Triode ; energy : 120 keV
Beam intensity (peak) : 0.001 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : 260 MHz SHB
Output : 5 MeV; intensity : 10 A
Pulse width, spacing : 2 ps, 85.6 ns
Normalized emittance (1σ) : 5 π mm-mrad

Acceleration System

Total linac length : 25 m
No. sections : 4 ; lengths : 6.5 m
Field mode : π ; frequency : 1.3 GHz
Wave type : SW ; filling time : 1000 μ s
 v_g/c range : ; Q : 2×10^6
Shunt impedance : M Ω /m
Iris : aperture : diameter : ~ 50 mm
thickness : ~ 10 mm
Attenuation/section : Np
Power units, Number : 4 type : Klystron
RF power peak : 0.010 MW; mean : 10 kW

Focusing System

Type, No. of elements, and spacing :
Random solenoids and quads.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : NA
No. of particles/bunch : NA
Bunch separation : 84.6 ns

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.04	0.05	GeV
Accel gradient	1.5	2	MeV/m
$\Delta E/E$ (FWHM)	0.1	0.1	%
Rep. rate	20	20	Hz
Pulse length	10000	CW	μ s
Beam intensity	200	500	A
Norm. emit. (1σ)	5	5	π mm-mrad

OTHER RELEVANT INFORMATION

* SCA - Superconducting Linear Accelerator

This is a superconducting linac using 55 cell cavities. We are beginning an upgrade to use TESLA 9 cell cavities, operating at 10 MeV/metre. The machine energy range will remain the same, but the output current will increase to 1 mA. The peak current (in a 2 ps micropulse) will increase to 40 A. The emittance will remain at 5 π mm-mrad.

ELECTRON LINAC

Name of Linac : *SUNSHINE*
Function : *Research/educational facility, sub picosecond electron bunches*
Institution and address : *SSRL, P.O. Box 4349, Stanford, CA 94309, USA*
Person in charge : *H. Wiedemann*
Name of person supplying these data : *H. Wiedemann*
e-mail : *WIEDEMANN@slac.stanford.edu*
tel. : fax :

HISTORY AND STATUS

Const. started : *1992* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *Graduate students*
Present yearly operation time : *Daily as desired* h

LINAC PARAMETERS

Electron Sources

Types : *RF-gun* ; energy : *2600* keV
Beam intensity (peak) : *1.3* A
Normalized emittance (1σ) : *~ 10* π mm-mrad

Injector

Longitudinal matching : *None required*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *3.0* m
No. sections : *1* ; lengths : *3.0* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *(1)* ; filling time : *0.83* μ s
 v_g/c range : *(2)* ; Q : *14000*
Shunt impedance : *53 - 60* M Ω /m
Iris : aperture : diameter : *26.2 - 19.1* mm
thickness : *5.84* mm
Attenuation/section : *0.57* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *25* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
None required

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *~ 3000*
No. of particles/bunch : *2 - 5 $\times 10^8$*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.033</i>		GeV
Accel gradient	: <i>10</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>~ 10</i>		%
Rep. rate	: <i>10</i>		Hz
Pulse length	: <i>1.5</i>		μ s
Beam intensity	: <i>≤ 0.4</i>		A
Norm. emit. (1σ)	: <i>< 1</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *TW const G*
- (2) *0.02 - 0.007*

Facility is used to generate sub picosecond electron bunches, coherent far infrared radiation, measure sub picosecond pulses, coherent transition radiation, coherent undulator radiation, single pass FEL experiments.

References

- [1] *Phys. Rev. Lett. vol. 73, Aug. 1994, p. 967.*

ION LINAC

Name of Linac : *Florida State University Superconducting Linac*
 Function : *Heavy ion booster linac for a tandem Van de Graaff*
 Institution and address : *Florida State University, Physics Dept. Tallahassee, FL 32306 USA*
 Person in charge : *Prof. K. Kemper*
 Name of person supplying these data : *E.G. Myers*
 e-mail : *MYERS@NUCMAR.PHYSICS.FSU.EDU*
 tel. : *+1 904 644 4040* fax : *+1 904 644 9848*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *03/1987*
 Present status : *Operational*
 Cost of facility : *2.75 USD (1984)*
 Present linac staff : *1.5*
 Present yearly operat. time : *3700* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3*
 Types of source : *Cs Sputter, He⁺, Pol. Li⁺*
 Species of ions : *all ions except noble gases*
 Range of currents : *20* μ Ae
 Range of output energies : *(1)* keV/u
 Pulse length : *cw* μ s; rep. rate : *cw* Hz
 Normalized emittance (1σ) : *12* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Tandem Van de Graaff* m
 Output currents : *4* μ Ae
 Output energies : *10 000* keV/u
 Frequency : *cw* MHz; peak RF power : *kW*
 Pulse length : μ s; rep. rate : Hz
 Normalized emittance (1σ) : *1.5* π mm-mrad

Longitudinal Matching

Type : *(2)*
 Mod. keV; drift mm at *48.5* MHz
 keV; drift mm at *97* MHz

Accelerating System

Total linac length : *8* m; N^o. of tanks : *3*
 Tank diameters : *not circular* m
 Number of drift-tubes : *12 cavities, 2 tubes/cavity*
 Drift-tube lengths : *Atlas, high beta* mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : *25* mm to mm
 RF frequency(ies) : *97* MHz
 Field modes : *split loop resonator*
 Eff. shunt impedance : *2 $\times 10^5$* M Ω /m
 Q : *(3)*
 Filling time : *cw* μ s
 Equil. phases : *0-15* ; accel. rate *(4)* MeV/u-m
 RF rep. rate : *cw* Hz; pulse : μ s
 Beam rate : *cw* Hz; pulse : μ s
 RF power peak : *cw* MW; mean : *6 $\times 10^{-4}$* MW

Focusing System

No. elements : *6*
 type : *superconducting solenoid* order :
 Gradients : *2* to *4 Tesla* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Foils in VdG terminal and before linac*
 Charge states : *-1* to *+8* at *0.33* MeV/u
 Charge states : *+8* to *+12* at *2.8* MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	: <i>(5)</i>	
Energy	: <i>10</i>	MeV/u
$\Delta E/E$ (FWHM)	: <i>0.1</i>	%
Mean acc. rate	: <i>0.56</i>	MeV/u-m
Beam current	: <i>(6)</i>	μ Ae peak
Norm. emit. (1σ)	: <i>1.0</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

- (1) 120 keV*
- (2) Gridded pretandem & superconducting posttandem*
- (3) 5×10^8 loaded to 10^7 by vcx*
- (4) variable*
- (5) $^{28}\text{Si}^{8+/12+}$*
- (6) Beam current : 0.025 μ Ae*

Linac consists of 12, independently phased, superconducting cavities, optimized for beta = 0.105. There is also a superconducting buncher resonator before the linac, and a superconducting rebuncher after the linac. Resonators made by Argonne National Laboratory.

Reference

- [1] E.G. Myers et al., Nucl. Instrum. and Meth. B40/41, (1989) 904.*

ELECTRON LINAC

Name of Linac : *Advanced Photon Source Injector Linac*
Function : *e⁺ and e⁻ injector for the APS Storage Ring*
Institution and address : *Argonne National Laboratory, Argonne, IL 60439, USA*
Person in charge : *Linac Manager, Marion M. White*
Name of person supplying these data : *Marion M. White*
e-mail : *mwhite@aps.anl.gov*
tel. : *+1 630 252 5552* fax : *+1 630 252 4732*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1993*
Present status : *Operational*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Cathode* ; energy : *110* keV
Beam intensity (peak) : *2.6* A
Normalized emittance (1 σ) : *π* mm-mrad

Injector

Longitudinal matching : *Prebuncher / buncher*
Output : *4.5* MeV; intensity : A
Pulse width, spacing : *30 ns, 60 Hz rf rate*
Normalized emittance (1 σ) : *1.2* π mm-mrad

Acceleration System

Total linac length : *(1) 50* m
No. sections : *5+9=14* ; lengths : *3* m
Field mode : *2 π /3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : μ s
 v_p/c range : ; Q :
Shunt impedance : M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *(2)* type : *Klystrons*
RF power peak : *35* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
Solenoids, quadrupoles, triplets.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *86 microbunches per pulse*
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.220</i>	<i>0.650</i>	GeV
Accel gradient	: <i>17</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>+/- 8</i>	<i>+/- 8</i>	%
Rep. rate	: <i>(3)</i>		Hz
Pulse length	: <i>0.030</i>		μ s
Beam intensity	: <i>2</i>		A
Norm. emit. (1 σ)			π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Standard SLAC-type accelerating structures and SLED cavities*
- (2) 2 + 3 = 5*
- (3) 48 pps @ 60 Hz*

*e⁻ linac has 5 accelerating structures and 1 SLED;
2 Klystrons*
*e⁺ linac has 9 accelerating structures and 2 SLEDs;
3 Klystrons*

POSITRON LINAC

Name of Linac : *Advanced Photon Source Injector Linac*
Function : *e⁺ and e⁻ injector for the APS Storage Ring*
Institution and address : *Argonne National Laboratory, Argonne, IL 60439, USA*
Person in charge : *Linac Manager, Marion M. White*
Name of person supplying these data : *Marion M. White*
e-mail : *mwhite@aps.anl.gov*
tel. : *+1 630 252 5552* fax : *+1 630 252 4732*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e⁻) at Conversion Target

Energy : 200 - 220 MeV
Radius (1 σ) : 3 - 5 mm
Beam intensity : 1.7 A

LINAC PARAMETERS

Conversion Target and Capture

Material : *Tungsten*
Type : *disk*
Thickness (rad.length) : 2 χ
Diameter : 12 mm
Mean deposited power : 0.48 kW
Solenoidal field^{a)} : *5000 A 1.5 T*

Matching device :
RF sections^{a)} : *1 SLAC-type accelerating structure 3 m long*

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.40	0.45	GeV
Accel gradient			MeV/m
$\Delta E/E$ (FWHM)	0.1 to 1.5	1.0	%
Rep. rate	30	(1)	Hz
Pulse length	0.030	0.030	μ s
Yield (fin.en)	1-200 400		e ⁺ /e ⁻ x GeV
Beam intensity	12000	8000	μ A peak
Norm. emit. (1 σ):			π mm-mrad

OTHER RELEVANT INFORMATION

(1) 48 pps @ 60 Hz. \Rightarrow 24 pulses at a 60 Hz rate each 0.5 s.

ELECTRON LINAC

Name of Linac : 22 MeV Chemistry
Function : Pulse Radiolysis - Beam diagnostics
Institution and address : Chemistry Division, Argonne National Laboratory, Argonne, IL 60439, USA
Person in charge : Charles Jonah
Name of person supplying these data : Charles Jonah
e-mail : jonah@anlchm.chm.anl.gov
tel. : +1 630 252 3471 fax : +1 630 252 4993

HISTORY AND STATUS

Const. started : 1965 ; first beam : 1968
Present status : Operating
Cost of facility : ~ 750 kUSD (1968)
Present linac staff : (1)
Present yearly operation time : 1300 h

LINAC PARAMETERS

Electron Sources

Types : Hot cathode ; energy : 135 keV
Beam intensity (peak) : 30 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : 4 MeV; intensity : 20 A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : m
No. sections : 2 ; lengths : 0.845 m
Field mode : TM01 ; frequency : 1.307 GHz
Wave type : TW ; filling time : 0.6 μ s
 v_e/c range : 0.005 ; Q : 19400
Shunt impedance : M Ω /m
Iris : aperture : diameter : 50 mm
thickness : 12 mm
Attenuation/section : 0.228 Np
Power units, Number : type :
RF power peak : 16 MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
Lots of quadrupoles

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.022		GeV
Accel gradient	:		MeV/m
$\Delta E/E$ (FWHM)	: 1		%
Rep. rate	: 1	800	Hz
Pulse length	: $5 \times 10^{-6} - 3$		μ s
Beam intensity	: (2)		A
Norm. emit. (1σ)	: 200		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) 1 operator, 20% supervisor
- (2) This machine was built for radiation chemistry and therefore has a wide range of pulse widths.
5 ps to 30 ps with 1000 A peak

4 ns - 40 ns, 15 A peak: transient mode
100 ns - 3 μ s, 1.5 - 3 A peak: steady state mode

PROTON AND/OR H- LINAC

Name of Linac : *ANL Linac**
 Function : *H⁻ Injector for IPNS ***
 Institution and address : *Argonne National Laboratory, Argonne, IL 60439, USA*
 Person in charge : *V. Stipp*
 Name of person supplying these data: *V. Stipp*
 e-mail : *vstipp@anl.gov*
 tel. : *+1 630 252 6604* fax : *+1 630 252 9987*

HISTORY AND STATUS

Const. started : *1959* ; first beam : *1962*
 Present status : *Operational*
 Cost of facility : *5 MUSD (1962)*
 Present linac staff : *5*
 Present yearly operat. time : *4500* h

Focusing System

No. elements : *124*
 type : *DC* order : *+-+*
 Gradients : *45* to *8* T/m
 Other :

LINAC PARAMETERS

Ion Source

Type : *H⁻ Magnetron*
 Output : *50* mA at *20* keV
 Pulse length : *60 - 90* μ s; rep. rate : *30* Hz
 Normalized emittance (1σ) : *1.8* π mm-mrad

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Energy :	<i>50</i>	MeV
Mean acc. rate :	<i>1.89</i>	MeV/m
$\Delta E/E$ (FWHM) :	<i>± 0.25</i>	%
Beam current :	<i>12</i>	mA peak
Norm. emit. (1σ) :		π mm-mrad

Pre-accelerator (including RFQ)

Types : *Cockcroft-Walton* ; lengths : m
 Output : *45* mA at *750* keV
 Pulse length: *60 - 90* μ s; rep. rate : *30* Hz
 Normalized emittance (1σ) : π mm-mrad

OTHER RELEVANT INFORMATION

- * *ANL - Argonne National Laboratory IPNS 50 MeV H⁻ Linac*
- ** *IPNS - Intense Pulsed Neutron Source*

Longitudinal Matching

Type : *One buncher*
 Mod. *25* keV; drift *890* mm at *200.06* MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *33.5* m; No. of tanks : *1*
 Tank diameters : *0.95* m
 Number of drift-tubes : *124*
 Drift-tube lengths : *49 - 354* mm
 Drift-tube diam (range): *250 - 147* mm
 Gap/cell length (range): *0.22 - 0.25*
 Aperture diameter : *12.7* mm to *31.75* mm
 RF frequency(ies) : *200.06* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *30* M Ω /m
 Q : *80000*
 Filling time : *125* μ s
 Equilibrium phases : *26 $^\circ$*
 RF rep. rate : *30* Hz; pulse : *220* μ s
 Beam rate : *30* Hz; pulse : *60 - 90* μ s
 RF power peak : *3.5* MW; mean : *0.022* MW

PROTON AND/OR H⁻ LINAC

Name of Linac Fermilab 400 MeV H⁻ Linac
 Functions 400 MeV Injector for 8 GeV Booster Synchrotron and
 66 MeV for Neutron Cancer Therapy
 Institution and address Fermi National Accelerator Laboratory
 P.O. Box 500, Batavia IL, USA
 Person in charge C. W. Schmidt
 E-mail, phone and fax cschmidt@fnal.gov , 630-840-4414 , (fax)630-840-8590
 WWW Linac information http://fnnews.fnal.gov/acc_tour_linac.html or http://garlic.fnal.gov/
 Data supplied by, date L. Allen, E. McCrory, A. Moretti, M. Popovic ; March 11, 1996

HISTORY AND STATUS

0.75-116 MeV Linac

Const. started: 12/1968 ; first beam: 11/30/1970
 Present status: Operational, originally 200 MeV
 Cost of facility: \$12.7M / 1968 currency/date

116-401 MeV Linac

Const. started: 8/1989 ; first beam: 8/28/1993
 Present status: Operational
 Cost of facility: \$22M / 1992 currency/date
 Present linac staff: 12 (5 staff, 7 techs)
 Present yearly operating time: 8,000+ h

LINAC PARAMETERS

Ion Source

Type: H⁻ Magnetron source
 Output: 60-100 mA at 18 keV
 Pulse length: 80 μ s ; rep. rate: 15 Hz

Pre-Accelerator

Type: Cockcroft-Walton (two)
 Accelerating column length: 0.23 and 0.30 m
 Output: 60-70 mA at 750 keV
 Pulse length: 80 μ s ; rep. rate: 15 Hz
 1- σ normalized emittance: (out) 0.1 π mm-mrad

Low Energy Linac -

0.75-116 MeV Alvarez Linac

Longitudinal Matching

Type: one single-gap buncher
 Mod.: 35 keV ; drift: 750 mm at 201.25 MHz

Accelerating System

Total length: 78 m ; no. tanks: 5 for 116 MeV
originally 144.8 m ; 9 tanks ; (200) MeV
 Tank diameters: 0.94-0.84 m
 No. drift tubes: 209 (277)
 Drift-tube lengths: 47.4-410.0 (450) mm
 Drift-tube diameter: 160 mm
 Gap/cell length (range): 0.20-0.41 (0.47)
 RF frequency: 201.25 MHz ; field modes: TM010
 Eff. shunt impedance: 27-15 M Ω /m
 Q: 50,000-60,000 ; filling time: 100 μ s
 Equilibrium phase: -32^o
 RF rep. rate: 15 Hz ; pulse: 150 (flat top) μ s
 Beam rate: 15 (max) Hz ; pulse: 60 μ s
 RF power peak: 21 MW ; mean: 0.045 MW

Focusing System

No. elements: 219 ; type: pulsed magnetic
 (No. elements: 295 for 200 MeV)
 Order: FD ; gradient: 70 to 7 T/m
 1- σ normalized emittance: (in) 0.2 π mm-mrad

High Energy Linac -

116-401 MeV side-coupled-structure Linac

Longitudinal Matching

Type: multi-cell SCS buncher and vernier
 Mod.: 1600 keV ; drift: 2675 mm at 805 MHz
 Mod.: 220 keV ; drift: 1128 mm at 805 MHz

Accelerating System

Total linac length: 64 m ; no. modules: 7
 Cell diameters: 269 mm ; no. cells: 448
 Cell lengths: 86.3-132.3 mm
 Cell bore diameter: 30 mm
 RF frequency: 805 MHz ; field modes: TM01
 Eff. shunt impedance: 41-56 M Ω /m
 Q: 24,000-28,000 ; filling time: 6 μ s
 Equilibrium phase: -32^o
 RF rep. rate: 15 Hz ; pulse: 120 (flat top - max) μ s
 Beam rate: 15 (max) Hz ; pulse: 60 μ s
 RF power peak: 75 MW ; mean: 0.14 MW

Focusing System

No. elements: 28 ; type: pulsed magnetic
 Order: FODO ; gradient: 25 T/m

LINAC PERFORMANCE

Normal operation

Energy: 0.75-116 MeV
 Mean acc. rate: 1.5 MeV/m
 Energy: 116-401 MeV
 Mean acc. rate: 4.4 MeV/m
 $\Delta E/E$ (%) : 0.2 FWHM
 Beam current: 50 mA peak
 1- σ normalized emittance: (out) 1.5 π mm-mrad

OTHER RELEVANT PARAMS., REFS., ETC.

The original Linac had achieved 300 mA of protons. The Linac now delivers H⁻ beams which are time shared between injection into the Booster for the high energy and accelerator physics programs, and for neutron cancer therapy.

The Linac was recently increased in energy by removing the last four tanks of the original Linac and replacing them with seven accelerating side-coupled structure modules to achieve 400 MeV in the same enclosure.

Reference publications:

1. *Particle Accelerators* 1, 93 (1970).
2. "Commissioning and First Operation of the 400 MeV Linac at Fermilab" 1994 European Part. Acc. Conf.

PROTON AND/OR H- LINAC

Name of Linac : *AccSys Technology Model PL-7 Linac*
 Function : *Booster Synchrotron H⁻ Pre-injector Accelerator*
 Institution and address : *Indiana Univ. Cyclotron Facility, Bloomington, IN 47408, USA*
 Person in charge : *Dennis FRIESEL*
 Name of person supplying these data : *Dennis FRIESEL*
 e-mail : *friesel@iucf.indiana.edu*
 tel. : *+1 812 855 2944* fax : *+1 812 855 6645*

HISTORY AND STATUS

Const. started : *05/1995* ; first beam : *~ 07/1996*
 Present status : *Under construction*
 Cost of facility : *1.2 MUSD*
 Present linac staff : *85 tech staff @ IUCF*
 Present yearly operat. time : *4000 (projected) h*

LINAC PARAMETERS

Ion Source

Type : *(1)*
 Output : *≤ 1.0 mA at 25.0 keV*
 Pulse length : *≤ 400 μs; rep. rate : 1 - 5 Hz*
 Normalized emittance (1σ) : *0.30 π mm-mrad*

Pre-accelerator (including RFQ)

Types : *RFQ* ; lengths : *2.3 m*
 Output : *≤ 1.0 mA at 3000 keV*
 Pulse length : *≤ 400 μs; rep. rate : 1 - 5 Hz*
 Normalized emittance (1σ) : *≤ 1.0 π mm-mrad*

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *1.54 m; No. of tanks :*
 Tank diameters : *0.57 m*
 Number of drift-tubes : *22*
 Drift-tube lengths : *25.4 mm*
 Drift-tube diam (range): *mm*
 Gap/cell length (range):
 Aperture diameter : *mm to mm*
 RF frequency(ies) : *425 MHz*
 Field modes :
 Eff. shunt impedance : *MΩ/m*
 Q : *30000*
 Filling time : *μs*
 Equilibrium phases :
 RF rep. rate : *1 - 5 Hz; pulse : ≤ 400 μs*
 Beam rate : *1 - 5 Hz; pulse : ≤ 400 μs*
 RF power peak : *0.360 MW; mean : 0.300 MW*

Focusing System

No. elements :
 type : *Quadrupole* order :
 Gradients : to T/m
 Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	7.0	7.0	MeV
Mean acc. rate	1.75	1.75	MeV/m
ΔE/E (FWHM)	1.0	1.0	%
Beam current	≤ 1.0	10.0	mA peak
Norm. emit. (1σ)	≤ 1.0	≤ 1.0	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) i) *Duoplasmatron H⁻*;
- ii) *Atomic Beam Polarized H⁻*

This linac is a commercially available system manufactured by AccSys. Technology Inc, Pleasanton, CA. It is a 7 MeV H⁻ linac, a model PL-7. The RFQ (3 MeV H⁻) and DTL (4 MeV H⁻) are coupled directly together to form a single 4 m long accelerator which produces 7 MeV H⁻ for injection into a 2.24 Tm Synchrotron. The linac and synchrotron are now under construction, with first beam operation scheduled for mid-1998.

References

- [1] *CIS, A Low Energy Injector for IUCF Cooler, IEEE 0-7083-3 (1996) 336.*

ELECTRON LINAC

Name of Linac : *Notre Dame Radiation Laboratory Linac Facility*
Function : *Pulse Radiolysis for Chemical Kinetics*
Institution and address : *Notre Dame Radiation Laboratory, Notre Dame, IN 46556-0579, USA*
Person in charge : *K.-D. Asmus*
Name of person supplying these data : *John Bentley*
e-mail : *bentley.1@nd.edu*
tel. : *+1 219 631 6117* fax : *+1 219 631 8068*

HISTORY AND STATUS

Const. started : *10/1993* ; first beam : *10/1994*
Present status : *Operational*
Cost of facility : *2 MUSD (1993)*
Present linac staff : *1 man-year*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *130* keV
Beam intensity (peak) : *8* A
Normalized emittance (1σ) : *π* mm-mrad

Injector *(2)*

Longitudinal matching :
Output : *MeV*; intensity : *A*
Pulse width, spacing :
Normalized emittance (1σ) : *π* mm-mrad

Acceleration System

Total linac length : *0.7* m
No. sections : *1* ; lengths : *0.7* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.35* μ s
 v_g/c range : ; Q : *13500*
Shunt impedance : *55* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *0.07* Np
Power units, Number : *1* type : *XKS Klystron*
RF power peak : *16* MW; mean : *4* kW

Focusing System

Type, No. of elements, and spacing :
Bucking coil, focus lens, eight air core focus coils in Helmholtz geometry.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *~ 7 per 2 ns pulse*
No. of particles/bunch : *$\sim 10^{10}$*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.008</i>	<i>0.0095</i>	GeV
Accel gradient	: <i>11.4</i>	<i>12.5</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>2</i>	<i>2.5</i>	%
Rep. rate	: <i>1</i>	<i>60</i>	Hz
Pulse length	: <i>0.002</i>	<i>0.002 to 1.5</i>	μ s
Beam intensity	: <i>4</i>	<i>4</i>	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Thermionic cathode*
- (2) Prebuncher is integral with accelerator section*

Linac was built by Titan Beta, Dublin, CA.

Beam intensity is 4 A @ 10 ns, 2 A @ 1.5 μ s.

ION LINAC

Name of Linac : *Superconducting Linac*
 Function : *Booster Accelerator & Decelerator for heavy ions*
 Institution and address : *James R. Macdonald Lab., Kansas State Univ. Manhattan, KS, USA*
 Person in charge : *Tom J. Gray*
 Name of person supplying these data : *Tom J. Gray*
 e-mail : *tgray@phys.KSU.edu*
 tel. : *+1 913 5326782* fax : *+1 913 532 6806*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1989*
 Present status : *Operational*
 Cost of facility : *$\sim 2 \times 10^6$ USD (1987)*
 Present linac staff : *7*
 Present yearly operat. time : *≤ 1000 h*

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *Cs sputter & diode neg. ion*
 Species of ions : *H-U*
 Range of currents : *1 - 20 μ Ae*
 Range of output energies : *≤ 60 keV/u*
 Pulse length : *2 μ s; rep. rate : 12 M Hz*
 Normalized emittance (1σ) : *? π mm-mrad*

Pre-accelerators (including RFQ)

Types (lengths) : *EN Tandem m*
 Output currents : *≤ 10 μ Ae*
 Output energies : *≤ 3000 keV/u*
 Frequency : *MHz; peak RF power : kW*
 Pulse length : *μ s; rep. rate : Hz*
 Normalized emittance (1σ) : *π mm-mrad*

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *15 m; N^o. of tanks : 3*
 Tank diameters : *(1) 1.5 (not full circle) m*
 Number of drift-tubes : *(2)*
 Drift-tube lengths : *(3) mm*
 Drift-tube diam (range): *(3) mm*
 Gap/cell length (range): *(3)*
 Aperture diameter : *(3) mm to (3) mm*
 RF frequency(ies) : *97 MHz*
 Field modes : *(3)*
 Eff. shunt impedance : *(3) M Ω /m*
 Q : *$\leq 2 \times 10^7$ loaded*
 Filling time : *μ s*
 Equil. phases : ; accel. rate MeV/u-m
 RF rep. rate : Hz; pulse : *μ s*
 Beam rate : *12×10^6 Hz; pulse : (4) 0.1 μ s*
 RF power peak : *(5) MW; mean : MW*

Focusing System

No. elements : *3*
 type : *Solenoid triplets* order :
 Gradients : to T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Carbon foils - post stripping mode*
 Charge states : *+1 to bare* at *2* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	<i>F⁹⁺</i>	<i>Cu</i>	
Energy	<i>5</i>	<i>3</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>0.1</i>	<i>0.1</i>	%
Mean acc. rate	<i>2.8</i>	<i>3.0</i>	MeV/u-m
Beam current	<i>0.1</i>	<i>~ 0.1</i>	μ Ae peak
Norm. emit. (1σ)	<i>?</i>	<i>?</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>C₂O₂Si₇Cl</i>	<i>E \leq 130 MeV</i>	
<i>T_i</i>	<i>depending on ion species</i>	

OTHER RELEVANT INFORMATION

Our Linac is superconducting like ATLAS. We used their technology. We have the Argonne Split ring Nb resonator.

- (1) "bath tub" cryostats*
- (2) 2 per resonator - 14 resonators*
- (3) See Argonne National Laboratory*
- (4) Same as ATLAS using split ring resonators: see I. Sheppard, ANL*
- (5) 200×10^6*

ELECTRON LINAC

Name of Linac : *Dept. of Materials and Nuclear Engineering*
Function : *Research*
Institution and address : *Univ. of Maryland, College Park, Maryland, USA*
Person in charge : *Vince Adams*
Name of person supplying these data : *Vince Adams*
e-mail : *vja@eng.umd.edu*
tel. : *1 301 405 7355* fax : *1 301 314 9467*

HISTORY AND STATUS

Const. started : *1985* ; first beam : *1985*
Present status : *Operational*
Cost of facility : *400 000 USD*
Present linac staff : *1/3 technician*
Present yearly operation time : *200* h

LINAC PARAMETERS

Electron Sources

Types : *Electron* ; energy : *1000-9000 keV*
Beam intensity (peak) : *0.25 A*
Normalized emittance (1σ) : *π mm-mrad*

Injector

Longitudinal matching :
Output : *MeV*; intensity : *A*
Pulse width, spacing : *3 μ s, variable*
Normalized emittance (1σ) : *π mm-mrad*

Acceleration System

Total linac length : *1.5* m
No. sections : *1* ; lengths : *1.5* m
Field mode : ; frequency : *GHz*
Wave type : *S* ; filling time : *μ s*
 v_{ϕ}/c range : ; Q :
Shunt impedance : *M Ω /m*
Iris : aperture : diameter : *mm*
thickness : *mm*
Attenuation/section : *Np*
Power units, Number : type :
RF power peak : *2.0 MW*; mean : *kW*

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.007</i>	<i>0.009</i>	GeV
Accel gradient	:		MeV/m
$\Delta E/E$ (FWHM)	: <i>10</i>		%
Rep. rate	: <i>300</i>		Hz
Pulse length	: <i>3</i>		μ s
Beam intensity	:		A
Norm. emit. (1σ)	:		π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *MIRF* *
Function : *Physics and Dosimetry Research*
Institution and address : *NIST, Gaithersburg, MD 20899, USA*
Person in charge : *Dr. Charles E. Dick*
Name of person supplying these data : *C.E. Dick*
e-mail : *cedick@enh.nist.gov*
tel. : fax :

HISTORY AND STATUS

Const. started : *1973* ; first beam : *1974*
Present status : *Operating*
Cost of facility :
Present linac staff : *1.5 man-years*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *40* keV
Beam intensity (peak) : *<0.300* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *7-32* MeV; intensity : *0.1* A
Pulse width, spacing : *7 μ s, 10 msec*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *2* ; lengths : *2.29/3.32* m
Field mode : *$\pi/2$* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *0.5* μ s
 v_g/c range : ; Q :
Shunt impedance : M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *25* MW; mean : *10* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.025</i>	<i>0.032</i>	GeV
Accel gradient	: <i>6</i>	<i>6</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>5</i>	<i>5</i>	%
Rep. rate	: <i>100</i>	<i>100</i>	Hz
Pulse length	: <i>7</i>	<i>7</i>	μ s
Beam intensity	: <i>10^5</i>	<i>10^5</i>	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* *Medical Industrial Radiation Facility*

(1) S-band Prebuncher and Buncher

This machine was originally built as a therapy machine for use at Yale New Haven hospital. In 1992 it was dismantled and setup at NIST as a Medical and Industrial Radiation Facility.

ELECTRON LINAC

Name of Linac : *MIT Linac **
Function : *Research*
Institution and address : *PO Box 846, Middleton, MA 01949, USA*
Person in charge : *Prof. Stanley Kowalski*
Name of person supplying these data : *Prof. Stanley Kowalski*
e-mail : *sk@mitlns.mit.edu*
tel. : *+1 617 253 9200* fax :

HISTORY AND STATUS

Const. started : *1967* ; first beam : *1971*
Present status : *Operating*
Cost of facility : *6 MUSD (1967)*
Present linac staff : *83 FTE (1)*
Present yearly operation time : *4000* h

LINAC PARAMETERS

Electron Sources

Types : *(2)* ; energy : *370* keV
Beam intensity (peak) : *0.04* A
Normalized emittance (1σ) : *10* π mm-mrad

Injector

Longitudinal matching : *120°*
Output : *20* MeV; intensity : *0.04* A
Pulse width, spacing : *16 μ s, 1-6 ms*
Normalized emittance (1σ) : *10* π mm-mrad

Acceleration System

Total linac length : *150* m
No. sections : *22* ; lengths : *(3)* m
Field mode : *2 π /3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *1.27* μ s
 v_g/c range : *(4)* ; Q : *13750*
Shunt impedance : *53* M Ω /m
Iris : aperture : diameter : *24 - 29* mm
thickness : *5.84* mm
Attenuation/section : *0.825* Np
Power units, Number : *12* type : *Klystrons*
RF power peak : *5* MW; mean : *100* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids over first four sections; six quad doublets spaced 17 & 34 m in remainder of linac

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *46000*
No. of particles/bunch : *9 $\times 10^6$*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	<i>:(5) 0.1 - 1.0</i>	<i>1.06</i>	GeV
Accel gradient	<i>: 3</i>	<i>9</i>	MeV/m
$\Delta E/E$ (FWHM)	<i>: 0.3</i>	<i>0.3</i>	%
Rep. rate	<i>: 600</i>	<i>1000</i>	Hz
Pulse length	<i>: 16</i>	<i>16</i>	μ s
Beam intensity	<i>: 0.004</i>	<i>0.04</i>	A
Norm. emit. (1σ)	<i>: 10</i>	<i>10</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *MIT-Bates Linac - Massachusetts Institute of Technology-Bates Linear Accelerator Centre*

- (1) Full Time Equivalent*
- (2) Thermionic & polarized sources*
- (3) 4 sections at 3.7 m and 18 sections at 7.35 m*
- (4) 0.0389 - 0.0093*
- (5) Energies above 0.5 GeV achieved using a recirculator to send the beam through the linac a second time.*

ION LINAC

Name of Linac : MIT/FAA AccSys DL-1
 Function : Neutron radiography, fast neutron analysis
 Institution and address : Massachusetts Institute of Technology, Cambridge MA, USA
 Person in charge : Richard Lanza
 Name of person supplying these data : Richard Lanza
 e-mail : lanza@mit.edu
 tel. : +1 617 253 2399 fax : +1 617 253 2343

HISTORY AND STATUS

Const. started : 1989 ; first beam : 1989
 Present status : *Running*
 Cost of facility : USD 400 000 (1989)
 Present linac staff : 3
 Present yearly operat. time : 1000 h

LINAC PARAMETERS

Ion Sources

No. of sources : 1
 Types of source : *Duoplasmatron*
 Species of ions : D^+
 Range of currents : (peak) 8000 μAe
 Range of output energies : 25 keV/u
 Pulse length : ≤ 100 μs ; rep. rate : ≤ 640 Hz
 Normalized emittance (1σ) : 0.15 π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : 0.7 m
 Output currents : (peak) 6000 μAe
 Output energies : 900 keV/u
 Frequency : 425 MHz; peak RF power : 60 kW
 Pulse length : ≤ 100 μs ; rep. rate : ≤ 640 Hz
 Normalized emittance (1σ) : 0.2 π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : m; N^o. of tanks :
 Tank diameters : m
 Number of drift-tubes :
 Drift-tube lengths : mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : mm to mm
 RF frequency(ies) : MHz
 Field modes :
 Eff. shunt impedance : M Ω /m
 Q :
 Filling time : μs
 Equil. phases : ; accel. rate MeV/u-m
 RF rep. rate : Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : MW; mean : MW

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other :

Charge Stripping (Typical)

Type(s) :
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species :		
Energy :		MeV/u
$\Delta E/E$ (FWHM) :		%
Mean acc. rate :		MeV/u-m
Beam current :		μAe peak
Norm. emit. (1σ) :		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

Manufactured by: *AccSys Technology*
Pleasanton, CA

ION LINAC

Name of Linac : *Sandia Tandem Booster*
Function : *Heavy Ion Post Accelerator*
Institution and address : *Sandia National Labs, PO Box 5800, ABQ, NM 87185 USA*
Person in charge : *Harald Schone*
Name of person supplying these data : *Harald Schone*
e-mail : *hschon@somnet.sandia.gov*
tel. : *+1 505 844 2598* fax : *+1 505 844 7775*

HISTORY AND STATUS

Const. started : *1/1994* ; first beam : *10/1995*
Present status : *Development*
Cost of facility : *1.6 MUSD (1995)*
Present linac staff : *1/2 man-year*
Present yearly operat. time : *400* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3*
Types of source : *(1)*
Species of ions : *most elements Au*
Range of currents : *0.1 - 10* μAe
Range of output energies : *0.3 - 60* keV/u
Pulse length : *DC* μs ; rep. rate : *DC* Hz
Normalized emittance (1σ) : *π mm-mrad*

Pre-accelerators (including RFQ)

Types (lengths) : *EN-TANDEM* *20* m
Output currents : *10* μAe
Output energies : *$50 - 12 \times 10^3$* keV/u
Frequency : *DC* MHz; peak RF power : *n.a.* kW
Pulse length : *n.a.* μs ; rep. rate : *n.a.* Hz
Normalized emittance (1σ) : *0.2* π mm-mrad

Longitudinal Matching

Type : *none*
Mod. *n.a.* keV; drift *n.a.* mm at *n.a.* MHz
n.a. keV; drift *n.a.* mm at *n.a.* MHz

Accelerating System

Total linac length : *6.2* m; N^o. of tanks : *2*
Tank diameters : *0.5* m
Number of drift-tubes : *n.a.*
Drift-tube lengths : *n.a.* mm
Drift-tube diam (range): *n.a.* mm
Gap/cell length (range): *- 16 mm - 45 mm*
Aperture diameter : *1.5* mm to mm
RF frequency(ies) : *425* MHz
Field modes : *TE210*
Eff. shunt impedance : *2* M Ω /m
Q : *7000*
Filling time : *10* μs
Equil. phases : ; accel. rate *0.276* MeV/u-m
RF rep. rate : *1-1000* Hz; pulse : *10-110* μs
Beam rate : *1-1000* Hz; pulse : *10-110* μs
RF power peak : *0.76* MW; mean : *8×10^{-3}* MW

Focusing System

No. elements : *7*
type : *dc doublet triplet* order : *-*
Gradients : *2* to *3.5* T/m
Other :

Charge Stripping (Typical)

Type(s) : *carbon foil*
Charge states : *7+* to *28+* at *0.25* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	: <i>Au²⁸⁺</i>	
Energy	: <i>1.91</i>	MeV/u
$\Delta E/E$ (FWHM)	: <i>0.4</i>	%
Mean acc. rate	: <i>8×10^{-3}</i>	MeV/u-m
Beam current		: <i>3×10^{-5}</i> μAe peak
Norm. emit. (1σ)	: <i>0.2</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
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OTHER RELEVANT INFORMATION

(1) *Li-exch., Sputter, Duo-plasmatron*

ELECTRON LINAC

Name of Linac : *PHERMEX* *
Function : *Flash Radiography - Intense e^- beam Study*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *Scott A. Watson*
Name of person supplying these data : *Scott A. Watson*
e-mail : *scottw@lanl.gov*
tel. : *+1 505 665 6233* fax : *+1 505 665 4396*

HISTORY AND STATUS

Const. started : *1957* ; first beam : *1963*
Present status : *Operational*
Cost of facility : *~ 5 MUSD (year)*
Present linac staff : *6*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types *Thermionic cathode*; energy : *500* keV
Beam intensity (peak) : *20* A
Normalized emittance (1σ) : *500* π mm-mrad

Injector

Longitudinal matching :
Output : *0.5* MeV; intensity : *1000* A
Pulse width, spacing : *200 ns, 10 s*
Normalized emittance (1σ) : *500* π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *3* ; lengths : *2.6* m
Field mode : ; frequency : *0.05* GHz
Wave type : ; filling time : *1000* μ s
 v_g/c range : *Beta = 1* ; Q : *100000*
Shunt impedance : M Ω /m
Iris : aperture : diameter : *150* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *8* type :
RF power peak : *5* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
9 Solenoids

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *10*
No. of particles/bunch : *~ 10¹⁵*
Bunch separation : *20 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.03</i>		GeV
Accel gradient	: <i>5.0</i>	<i>6.5</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>50</i>	<i>80</i>	%
Rep. rate	: <i>0.1</i>	<i>1</i>	Hz
Pulse length	: <i>0.2</i>	<i>0.2</i>	μ s
Beam intensity	: <i>(1)</i>		A
Norm. emit. (1σ)	: <i>500</i>	<i>500</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Pulsed High Energy Machine Emitting X Rays*

(1) *1000 A e^- beam at 30 MeV focused to a 3 mm spot size.*

ELECTRON LINAC

Name of Linac : *AFEL **
Function : *Electron Accelerator and FEL*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *R. Sheffield*
Name of person supplying these data : *R. Sheffield*
e-mail : *Sheff@lanl.gov*
tel. : *+1 505 667 1237* fax : *+1 505 667 8207*

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1992*
Present status : *Operating*
Cost of facility : *6 MUSD (1992)*
Present linac staff : *2*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Photocathode* ; energy : *0.0004* keV
Beam intensity (peak) : *200* A
Normalized emittance (1σ) : *0.5* π mm-mrad

Injector

Longitudinal matching : *none*
Output : *1.5* MeV; intensity : *200* A
Pulse width, spacing : *5-20 ps, 10 ns*
Normalized emittance (1σ) : *(1)* π mm-mrad

Acceleration System

Total linac length : *1.2* m
No. sections : *1* ; lengths : *1.2* m
Field mode : *$\pi/2$* ; frequency : *1.3* GHz
Wave type : *SW* ; filling time : *2* μ s
 v_{ϕ}/c range : ; Q : *8000*
Shunt impedance : *45* M Ω /m
Iris : aperture : diameter : *24* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *50* kW

Focusing System

Type, No. of elements, and spacing :
One solenoid around first several cells of accelerator

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *2000*
No. of particles/bunch : *6 - 40 $\times 10^9$*
Bunch separation : *10 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.017</i>	<i>0.02</i>	GeV
Accel gradient	: <i>19</i>	<i>22</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.3</i>	<i>0.3</i>	%
Rep. rate	: <i>1</i>	<i>60</i>	Hz
Pulse length	: <i>20</i>	<i>20</i>	μ s
Beam intensity	:		A
Norm. emit. (1σ)	: <i>2</i>	<i>10</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Advanced Free-Electron Laser*

(1) *For 1 nC*

References

- [1] *Sheffield, R.V. et al., (1992) Nucl. Inst. and Methods in Phys. Res. A318, 282 - 289.*
[2] *Nguyen, D.C. et al., (1995) Nucl. Inst. and Methods in Phys. Res. A 358, 27 - 30.*

ELECTRON LINAC

Name of Linac : *DARHT ITS **
 Function : *Engineering prototype for DARHT ***
 Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
 Person in charge :
 Name of person supplying these data : *Michael J. Burns*
 e-mail : *burns_michael_j@lanl.gov*
 tel. : *+1 505 667 5069* fax : *+1 505 667 8316*

HISTORY AND STATUS

Const. started : *11/1990* ; first beam : *05/1991*
 Present status : *(1) Operational*
 Cost of facility : *(2) 10 MUSD*
 Present linac staff : *~ 8*
 Present yearly operation time : *~ 1000* h

LINAC PARAMETERS

Electron Sources

Types : *(3)* ; energy : *N/A* keV
 Beam intensity (peak) : *(4)* A
 Normalized emittance (1σ) : *(5)* π mm-mrad

Injector

Longitudinal matching : *N/A*
 Output : *3.75* MeV; intensity : *4000* A
 Pulse width, spacing : *(6)*
 Normalized emittance (1σ) : *(5)* π mm-mrad

Acceleration System (7)

Total linac length : *3.65* m
 No. sections : *1* ; lengths : *3.65* m
 Field mode : *N/A* ; frequency : *N/A* GHz
 Wave type : *N/A* ; filling time : *5* μ s
 v_p/c range : *N/A* ; Q : *< 5*
 Shunt impedance : *(9) ~ 0.001* M Ω /m
 Iris : aperture : diameter : *none* mm
 thickness : *N/A* mm
 Attenuation/section : *N/A* Np
 Power units, Number : *4* type : *(10)*
 RF power peak : *N/A* MW; mean : *N/A* kW

Focusing System

Type, No. of elements, and spacing :
(11)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
 No. of particles/bunch : *1.5 $\times 10^{15}$ (4 kA, 60 ns)*
 Bunch separation : *single pulse*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.0055</i>	<i>0.006</i>	GeV
Accel gradient	: <i>0.5</i>	<i>0.5</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>(12)</i>	<i>(12)</i>	%
Rep. rate	: <i>single shot</i>	<i>single shot</i>	Hz
Pulse length	: <i>0.062</i>	<i>0.06</i>	μ s
Beam intensity	: <i>3000-4000</i>	<i>3000</i>	A
Norm. emit. (1σ)	: <i>(5)</i>	<i>(5)</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Integrated Test Strand*

** *Dual-Axis Radiographic Hydrodynamic Test Facility*

- (1) See comment on original*
- (2) include 3.5 MUSD building*
- (3) cold-cathode field emitter or ArF eximer-laser driven photocathode*
- (4) ~ 60-65 A/cm²*
- (5) Normalized 4 \times rms 700-1000 π mm-mrad (Lapostolle)*
- (6) 60 ns flattop, single square-wave pulse*
- (7) Linear Induction Accelerator*
- (8) Pulsed power charging time*
- (9) (peak ~ 800 MHz)*
- (10) Water Blumlein PFLs*
- (11) quadrifilar-wound, square-hollow Cu tube solenoids with iron homogenizer rings at injector anode, within 8 accelerating cells, and within HEBT. Peak field about 1.2 kGauss.*
- (12) 0.05 % (rms) Operation
< 1 % (rms) Design*

ELECTRON LINAC

Name of Linac : *Subpicosecond High-Brightness Accelerator Facility*
Function : *Short bunch compression / plasma interaction experiments*
Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
Person in charge : *B. Carlsten*
Name of person supplying these data : *B. Carlsten*
e-mail : *bcarlsten@lanl.gov*
tel. : *+1 505 667 5657* fax : *+1 505 667 8207*

HISTORY AND STATUS

Const. started : *10/1994* ; first beam : *04/1995*
Present status : *Operating*
Cost of facility : *0.5 MUSD (1995)*
Present linac staff : *1 man-year*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Photoinjector* ; energy : keV
Beam intensity (peak) : *1000* A
Normalized emittance (1σ) : *5* π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *0.5* m
No. sections : *1* ; lengths : *0.5* m
Field mode : $\pi/2$; frequency : *1.3* GHz
Wave type : *SW* ; filling time : *2* μ s
 v_g/c range : ; Q : *10000*
Shunt impedance : *~20* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *5* MW; mean : *0.050* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles 8 (all electromagnets)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *10 - 20*
No. of particles/bunch : *~10¹¹*
Bunch separation : *9 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.008</i>		GeV
Accel gradient	: <i>20</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>		%
Rep. rate	: <i>1</i>		Hz
Pulse length	: <i>10</i>		μ s
Beam intensity	: <i>(1) 1000</i>		A
Norm. emit. (1σ)	: <i>5</i>		π mm-mrad

OTHER RELEVANT INFORMATION

Uses a chicane to compress an initial 10 - 20 ps bunch to ~ 1 ps.

(1) peak

PROTON AND/OR H⁻ LINAC

Name of Linac "Los Alamos Neutron Science Center" (LANSCE) Linac
 Function(s) High intensity proton beams and H⁻ for Proton Storage Ring
 Institution and address Los Alamos National Laboratory, Los Alamos, NM 87545
 Person in charge Stanley O. Schriber
 Name, e-mail, telephone and fax no. of person supplying these data
 Frank E. Merrill fmerrill@lanl.gov 505-665-1396 505-665-0046 date 5/1/96
 Earl W. Hoffman earl@lanl.gov 505-667-7816 505-665-8604 date 5/1/96

HISTORY AND STATUS

Const. started...2/68...first beam....6/72...(dates)
 Present status.....Operational.....
 Cost of facility..US.\$57M(1968)...currency/date
 Present linac staff....100.....(incl. beam delivery)
 Present yearly operat. time.....3600...h

LINAC PARAMETERS

H⁻ Ion Source

Type..H⁻ Converter type surface Plasma Source
 Output.....17...mA at.....80...keV
 Pulse length.....825...μs; rep. rate.....120...Hz

H⁻ Pre-accelerator (including RFQ)

Type.....CW.....; length.....m
 Output.....17...mA at.....750...keV
 1-σ normalized emit.0.2...πmm-mrad

H⁻ Longitudinal Matching

Type.....2 Bunchers.....
 Mod. ...3...keV; drift...4714...mm..at...201...MHz
 ...16...keV; drift...1795...mm..at...201...MHz

H⁺ Ion Source

Type.....duo-Plasmatron.....
 Output...30...mA...at.....30...keV
 Pulse length...825...μs; rep. rate.....120...Hz

H⁺ Pre-accelerator (including RFQ)

Type.....CW.....; length.....m
 Output.....30...mA at.....750...keV
 1-σ normalized emit.....0.03...πmm-mrad

H⁺ Longitudinal Matching

Type....2 Bunchers.....
 Mod. ...5 keV; drift 5853 mm at 201.25 MHz
 ...16 keV; drift 1795 mm at 201.25 MHz

DTL Focusing System

No. Elements...135...type....Quad....order.....FODO.....
 Gradients.....74.0...to.....5.0...T/m

SCL Focusing System

No. Elements...104...type....Quad....order.....FDO.....
 Gradients.....20.0...to.....30.0...T/m

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	800	800	MeV
Mean Acc. rate	1.0	1.0	MeV/m
ΔE/E (%)	0.1	0.1	FWHM
H ⁺ Beam current	17 mA		mA peak
H ⁺ 1-σ norm emit.	0.3		π mm-mrad
H ⁻ Beam current	11 mA		mA peak
H ⁻ 1-σ norm emit.	0.3		π mm-mrad

	DTL	SCL
Total linac length (m)	62	731
No. tanks	4	104
Tank diameters (m)	0.9	0.26
No. drift-tubes/cells	165	4960
Drift-tube lengths (mm)	48-373	n/a
Drift-tube dias (mm)	160-180	n/a
Gap/cell length	0.16-0.4	n/a
Aperture dias. (mm)	15 to 30.0	31.8 to 44.5
RF frequencies (MHz)	201.25	805
Field modes	TM010	TM010
Eff. shuntimps. (MΩm)	50-70	25-38
Q	60-75x10 ³	18-25x10 ³
Filling time (μs)	150	15
Equil. phases	26°	31° - 42°
RF rep. rate (Hz)	120	120
RF pulse (μs)	1035	985
Beam rate (Hz)	120	120
Beam pulse (μs)	825	825
RF power peak (MW)	3.0	1.25
RF mean power (MW)	0.26	0.09

OTHER RELEVANT PARAMS., REFS. ETC.

R. E. O. Ericson, V. W. Hughes and D. E. Nagle, *The Meson Factories*, (University of California Press, Los Angeles, 1991).

M. Stanley Livingston, "LAMPF A Nuclear Research Facility," LA-6878-MS, September 1977.

M. Stanley Livingston, "Origins and History of the Los Alamos Meson Physics Facility," LA-5000.

PROTON AND/OR H- LINAC

Name of Linac : *PL-2 RFQ*
 Function : *Proton, Deuteron acceleration*
 Institution and address : *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
 Person in charge : *Richard Morgado*
 Name of person supplying these data : *Charlene Cappiello*
 e-mail : *ccappiello@lanl.gov*
 tel. : *+1 505 667 7728* fax : *+1 505 665 3457*

HISTORY AND STATUS

Const. started : ; first beam : *1994*
 Present status : *(1)*
 Cost of facility : *USD 750 000 (1994)*
 Present linac staff : *None*
 Present yearly operat. time : *200* h

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other :

LINAC PARAMETERS

Ion Source

Type : *Duoplasmatron*
 Output : *> 30* mA at *30* keV
 Pulse length : μ s; rep. rate : Hz
 Normalized emittance (1σ) : *< 50* π mm-mrad

Pre-accelerator (including RFQ)

Types : *RFQ* ; lengths : *1.92* m
 Output : *0.5* mA at *1750* keV
 Pulse length: *5 - 50* μ s; rep. rate : *(2)* Hz
 Normalized emittance (1σ) : *< 50* π mm-mrad

Longitudinal Matching NA

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System NA

Total linac length : m; No. of tanks :
 Tank diameters : m
 Number of drift-tubes :
 Drift-tube lengths : mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : mm to mm
 RF frequency(ies) : MHz
 Field modes :
 Eff. shunt impedance : $M\Omega/m$
 Q :
 Filling time : μ s
 Equilibrium phases :
 RF rep. rate : Hz; pulse : μ s
 Beam rate : Hz; pulse : μ s
 RF power peak : MW; mean : MW

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Energy	: <i>1.75</i>	MeV
Mean acc. rate	:	MeV/m
$\Delta E/E$ (FWHM)	: <i>2.790</i>	%
Beam current	: <i>25</i>	mA peak
Norm. emit. (1σ)	: <i>< 50</i>	π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Currently on loan to Oak Ridge National Laboratory, located at Western Kentucky University.*

(2) *150 - 1500*

Also capable of deuteron acceleration. Coupled with a beryllium target, it produces neutrons.

ELECTRON LINAC

Name of Linac : *CESR Linac*
Function : *Electron filling of CESR Storage Ring*
Institution and address : *Cornell University, Wilson Laboratory, Ithaca, NY 14853*
Person in charge : *Roy Cutler (of Linac)*
Name of person supplying these data : *Roy Cutler*
e-mail : *RIC@LNS62.LNS.CORNELL.EDU*
tel. : *+1 607 255 4882* fax : *+1 607 255 8061*

HISTORY AND STATUS

Const. started : *1965* ; first beam : *(1)*
Present status : *Operating*
Cost of facility : *1.9 MUSD (1966)*
Present linac staff : *~ 1 man-year*
Present yearly operation time : *6000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *150* keV
Beam intensity (peak) : *(2)* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *0.15* MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *45* m
No. sections : *8* ; lengths : *3x3m*; m
Field mode : *2 π /3* ; frequency : *2856* GHz
Wave type : *TW* ; filling time : *(4)* μ s
 v_g/c range : *(5)* ; Q : *(5)*
Shunt impedance : *(5)* M Ω /m
Iris : aperture : diameter : *(5)* mm
thickness : *(5)* mm
Attenuation/section : *(5)* Np
Power units, Number : *8* type : *Klystron*
RF power peak : *21* MW; mean : *6* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid coils for injector and section 1.
Quad doublets or triplets between other sections.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *7 - 21*
No. of particles/bunch : *2 x 10⁹*
Bunch separation : *14 - 220 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.34</i>	<i>0.35</i>	GeV
Accel gradient	: <i>10</i>	<i>10</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.25</i>		%
Rep. rate	: <i>60</i>		Hz
Pulse length	: <i>(6)</i>		μ s
Beam intensity	:		A
Norm. emit. (1σ)	:		π mm-mrad

OTHER RELEVANT INFORMATION

All eight sections used to accelerate electrons for CESR filling. For positrons, W target is inserted after section 4 (150 MeV). Positrons accelerated by sections 5 - 8 to 200 MeV. 7 - 21 μ bunch / pulse for either electron or positron operation.

- (1) 1966 electrons, 1976 positrons*
- (2) 5×10^{10} (pos.), 3×10^9 (elec.)*
- (3) Two 214 MHz subharmonic Bunchers*
- (4) 0.55 - 0.82 μ s*
- (5) Linac consists of 4 different types of sections - all constant gradient (average 10 MeV/m).
Section 1 - SLAC type
Sections 2 - 8 and energy compressor - Varian*
- (6) RF pulse length 2.2 μ s on the flat-top*

ION LINAC

Name of Linac : *Stony Brook Superconducting Heavy-Ion Linac*
 Function : *Heavy-Ion Accelerator for Basic Research in Nuclear & Atomic Physics*
 Institution and address : *University of Stony Brook, Stony Brook, NY 11794-3800 USA*
 Person in charge : *Prof. Gene D. Sprouse*
 Name of person supplying these data : *John W. Noé*
 e-mail : *John.noe@sunysb.edu*
 tel. : *+1 516 632 8156* fax : *+1 516 632 8573*

HISTORY AND STATUS

Const. started : *1980* ; first beam : *1983*
 Present status : *Full-time Operation*
 Cost of facility : *4 MUSD (1982)*
 Present linac staff : *About 5 (FTE)*
 Present yearly operat. time : *About 4000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *Negative-ion sputter*
 Species of ions : *Protons to Bismuth*
 Range of currents : *0.1 - 10* μAe
 Range of output energies : *(1) 200 - 400* keV/u
 Pulse length : *cw* μs ; rep. rate : Hz
 Normalized emittance (1σ) : *5 - 10* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *FN tandem Van de Graaff / 14* m
 Output currents : ≤ 10 μAe
 Output energies : keV/u
 Frequency : *cw* MHz; peak RF power : kW
 Pulse length : μs ; rep. rate : Hz
 Normalized emittance (1σ) : ~ 1.0 π mm-mrad

Longitudinal Matching

Type : (2)
 Mod. *500* keV; drift *8000* mm at *150* MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *16* m; N^o. of tanks : (3)
 Tank diameters : m
 Number of drift-tubes : *Resonators = 16 + 24*
 Drift-tube lengths : mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : *19* mm to mm
 RF frequency(ies) : *150.4* MHz
 Field modes : $\beta\lambda / 2$
 Eff. shunt impedance : $\text{M}\Omega/\text{m}$
 Q : $\sim 10^8$
 Filling time : μs
 Equil. phases : -15° ; accel. rate $\text{MeV}/\text{u}\cdot\text{m}$
 RF rep. rate : *cw* Hz; pulse : μs
 Beam rate : *cw* Hz; pulse : μs
 RF power peak : (4) MW; mean : MW

Focusing System

No. elements : *12*
 type : (5) order :
 Gradients : to T/m
 Other :

Charge Stripping (Typical)

Type(s) : *5 $\mu\text{g}/\text{cm}^2$ carbon after tandem*
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	: <i>Li6 - Zr90</i>		
Energy	: ≤ 12		MeV/u
$\Delta E/E$ (FWHM)	: <i>0.1</i>		%
Mean acc. rate	: ~ 0.4		MeV/u-m
Beam current	: <i>0.01 - 1.0</i>	(6) 3	μAe peak
Norm. emit. (1σ)	: ~ 0.5		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>Protons</i>	<i>1 - 20 MeV</i>	<i>Tandem only</i>
<i>Gold</i>	<i>50 - 100 MeV</i>	<i>without linac</i>

OTHER RELEVANT INFORMATION

- (1) *Unit = keV*
- (2) *Double-drift harmonic buncher & s/c resonator*
- (3) *Cryostats = 12*
- (4) *cw = 7 kW total*
- (5) *Room temperature quadrupole doublet*
- (6) *μAe cw*

Linac has 16 superconducting QUARTER-WAVE RESONATORS with $\beta_{opt} = 0.07$ c and 24 s/c split-loop resonators with $\beta_{opt} = 0.10$ c. Energy gain per resonator is approx. 500 keV per unit charge. Superconductor is lead-tin on copper.

References

- [1] *J.W. Noé, Rev. Sci. Instr. 57, 757 (May 1986)*

ELECTRON LINAC

Name of Linac : *Gaerttner*
Function : *Electron LINAC for Various Research Experiments (1)*
Institution and address : *Rensselaer Polytechnic Institute, Tibbits Ave., Troy, NY 12180, USA*
Person in charge : *Dr Robert C. Block, Director*
Name of person supplying these data : *Peter J. Brand*
e-mail : *brandp@rpi.edu*
tel. : *+1 518 276 6406* fax : *+1 518 276 4007*

HISTORY AND STATUS

Const. started : *1958* ; first beam : *1960*
Present status : *Operating*
Cost of facility :
Present linac staff : *4 man-years*
Present yearly operation time : *700* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *75* keV
Beam intensity (peak) : *0 - 40* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *20.1* m
No. sections : *8* ; lengths : *1* m
Field mode : $\pi/4$; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *1.25* μ s
 v_g/c range : ; Q :
Shunt impedance : *12.0* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *0.36* Np
Power units, Number : *8* type : *Klystron*
RF power peak : *10* MW; mean : *15* kW

Focusing System

Type, No. of elements, and spacing :
Axial magnetic field incorporated in accelerator section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>(2)</i>	<i>0.090</i>	GeV
Accel gradient	: <i>7.5</i>	<i>11</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>10</i>	<i>10</i>	%
Rep. rate	: <i>(3)</i>	<i>720</i>	Hz
Pulse length	: <i>0.015 - 5</i>	<i>5</i>	μ s
Beam intensity	: ≤ 3		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Neutron cross-section, isotope generation, electronic testing, gemstone coloration and other research needs, as required.*
- (2) Two extraction ports are available. One provides energy from 5 to 25 MeV, the second from 25 to > 60 MeV.*
- (3) Single to 720*

ELECTRON LINAC

Name of Linac : NSLS *
Function : Electron Injector for NSLS Booster Synchrotron
Institution and address : Brookhaven National Laboratory, Upton, NY 11973-5000, USA
Person in charge : Eric Blum
Name of person supplying these data : Eric Blum
e-mail : BLUM@BNLLS1.BNL.GOV
tel. : +1 516 344 2438 fax : +1 516 244 3029

HISTORY AND STATUS

Const. started : 1978 ; first beam : 1980
Present status : Operating
Cost of facility : Unknown
Present linac staff : 2
Present yearly operation time : 7100 h

LINAC PARAMETERS

Electron Sources

Types : Triode ; energy : 100 keV
Beam intensity (peak) : ~1 A
Normalized emittance (1σ) : ~100 π mm-mrad

Injector

Longitudinal matching : S-Band Prebuncher
Output : 0.2 MeV; intensity : A
Pulse width, spacing : 2.5 μ sec, 1.2 sec
Normalized emittance (1σ) : ~100 π mm-mrad

Acceleration System

Total linac length : 9.5 m
No. sections : 3 ; lengths : 4.5, 3, 3 m
Field mode : $2\pi/3$; frequency : 2.856 GHz
Wave type : TW ; filling time : 1.2, 0.8 μ s
 v/c range : ; Q : 13000
Shunt impedance : 53 M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : 3 type : Klystrons
RF power peak : 21 MW; mean : 0.044 kW

Focusing System

Type, No. of elements, and spacing :
None

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 7
No. of particles/bunch : 3×10^{10}
Bunch separation : 95 ns

LINAC PERFORMANCE

	Normal Operation	Max. or Design	
Final energy	: 0.12	0.12	GeV
Accel gradient	: 12.6	12.6	MeV/m
$\Delta E/E$ (FWHM)	: 1	1	%
Rep. rate	: 0.83	2	Hz
Pulse length	: 2.5	2.5	μ s
Beam intensity	:		A
Norm. emit. (1σ)	: 1	1	π mm-mrad

OTHER RELEVANT INFORMATION

* National Synchrotron Light Source injector Linac

The linac was built from a Varian buncher section that was originally installed at Cornell University and two SLAC sections.

ELECTRON LINAC

Name of Linac : ATF *
Function : Users's Facility for Accelerator and Beam Physics
Institution and address : Brookhaven National Laboratory, Upton, NY 11973-5000, USA
Person in charge : Ilan Ben-Zvi
Name of person supplying these data : Ilan Ben-Zvi
e-mail : ILAN@BNL.GOV
tel. : +1 516 3445143 fax : +1 516 3443029

HISTORY AND STATUS

Const. started : 1987 ; first beam : 1991
Present status : *Operating*
Cost of facility : 5 MUSD (1993)
Present linac staff : 8 man-years
Present yearly operation time : 1100 (1995) h

LINAC PARAMETERS

Electron Sources

Types : *Photoinjector* ; energy : 4500 keV
Beam intensity (peak) : 100 A
Normalized emittance (1σ) : 2 π mm-mrad

Injector

Longitudinal matching : *Injector \equiv Source*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 6 m
No. sections : 2 ; lengths : 3.05 m
Field mode : $2\pi/3$; frequency : 2.856 GHz
Wave type : *TW* ; filling time : 0.83 μ s
 v_g/c range : (1) ; Q : 13000
Shunt impedance : 52 M Ω /m
Iris : aperture : diameter : 19.2 mm
thickness : 5.842 mm
Attenuation/section : 0.57 Np
Power units, Number : 1 type : *Klystron*
RF power peak : 25 MW; mean : 0.25 kW

Focusing System

Type, No. of elements, and spacing :
1 Solenoid following photoinjector. Nothing in linac.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *Variable 1-200*
No. of particles/bunch : *Variable up to 3×10^9*
Bunch separation : *12.5 ns or 25 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.05	0.07	GeV
Accel gradient	8	11	MeV/m
$\Delta E/E$ (FWHM)	0.5	0.2	%
Rep. rate	1-3	6	Hz
Pulse length	2.5	4	μ s
Beam intensity	100	300	A
Norm. emit. (1σ)	2	1	π mm-mrad

OTHER RELEVANT INFORMATION

* *Accelerator Test Facility*

(1) 0.0204 - 0.0065

The ATF has 3 beam lines and 15 User Experiments approved by a peer review committee.

High power (multi GW) laser beams, synchronized with the e^- beam are provided.

More information is on the World Wide Web from <http://www.BNL.GOV>. Select the Accelerator Test Facility link.

PROTON AND/OR H- LINAC

Name of Linac : *Brookhaven 200 MeV H⁻ Linac*
 Function : *H⁻ injector for the AGS Booster*
 Institution and address : *Brookhaven National Laboratory, Upton, NY 11973-5000, USA*
 Person in charge : *D.I. Lowenstein / T. Roser*
 Name of person supplying these data : *J. Alessi*
 e-mail : *ALESSI@BNL.GOV*
 tel. : *+1 516 344 7563* fax : *+1 516 344 5011*

HISTORY AND STATUS

Const. started : *04/1967* ; first beam : *11/1970*
 Present status : *Operational*
 Cost of facility : *22.4 MUSD (1970)*
 Present linac staff : *9*
 Present yearly operat. time : *4000* h

Focusing System

No. elements : *286*
 type : *Pulsed* order : *FODO*
 Gradients : *80* to *7* T/m
 Other : *Pulsed flat-top ~ 650 μs*

LINAC PARAMETERS

Ion Source

Type : *Magnetron H⁻*
 Output : *80 - 100* mA at *35* keV
 Pulse length : *500* μs; rep. rate : *7.5* Hz
 Normalized emittance (1σ) : *0.37* π mm-mrad

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Energy	: <i>200</i>	MeV
Mean acc. rate	: <i>1.45</i>	MeV/m
ΔE/E (FWHM)	: <i>± 0.2</i>	%
Beam current	: <i>35 - 40</i>	mA peak
Norm. emit. (1σ)	: <i>1.9</i>	π mm-mrad

Pre-accelerator (including RFQ)

Types : *4-vane RFQ* ; lengths : *1.6* m
 Output : *65* mA at *750* keV
 Pulse length : *500* μs; rep. rate : *7.5* Hz
 Normalized emittance (1σ) : *0.4* π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Mod. 28 keV; drift : 2986 mm at 201.25 MHz*
Mod. 12 keV; drift : 1454 mm at 201.25 MHz
Mod. 24 keV; drift : 729 mm at 201.25 MHz

Longitudinal Matching

Type : *Three buncher (5.9 m transport)*
 Mod. (1) keV; drift mm at MHz
 keV; drift mm at MHz

Original machine described in Part. Accel. 9 (1979), 1-156.

Accelerating System

Total linac length : *144.* m; No. of tanks : *9*
 Tank diameters : *0.94 - 0.84* m
 Number of drift-tubes : *277*
 Drift-tube lengths : *47 - 446* mm
 Drift-tube diam (range): *180 - 160* mm
 Gap/cell length (range): *0.20 - 0.47*
 Aperture diameter : *20* mm to *40* mm
 RF frequency(ies) : *201.25* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *50.15* MΩ/m
 Q : *53000 - 40000*
 Filling time : *< 100μs* μs
 Equilibrium phases : *-32°*
 RF rep. rate : *7.5* Hz; pulse : *600* μs
 Beam rate : *7.5* Hz; pulse : *300* μs
 RF power peak : *30.0* MW; mean : *0.14* MW

Converted to H⁻ acceleration in 1982.

Converted from Cockcroft-Walton to RFQ in 1989.

AGS Booster accepts approx. 4 pulses/3 sec; all remaining pulses go to Brookhaven Linac Isotope Producer (BLIP).

Beam Pulse width will be increased to 500μs during 1996 running period.

ELECTRON LINAC

Name of Linac : *Duke Linac*
 Function : *Storage Ring Injection, Beam Transport Experiments, Free-Electron*
 Institution and address : *Duke University, PO Box 90305, Durham, NC 27708-0319, USA*
 Person in charge : *Patrick O'Shea*
 Name of person supplying these data : *Patrick O'Shea*
 e-mail : *oshea@fel.duke.edu*
 tel. : *+1 919 660 2652* fax : *+1 919 660 2671*

HISTORY AND STATUS

Const. started : (1) ; first beam : *10/1994*
 Present status : *Operational*
 Cost of facility : (1)
 Present linac staff :
 Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : (2) ; energy : keV
 Beam intensity (peak) : A
 Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : (2)
 Output : MeV; intensity : A
 Pulse width, spacing :
 Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 44 m
 No. sections : 11 ; lengths : 3.05 m
 Field mode : $2\pi/3$; frequency : 2.856 GHz
 Wave type : *TW* ; filling time : 0.8 μ s
 v_g/c range : (3) ; Q : 13000
 Shunt impedance : 58 M Ω /m
 Iris : aperture : diameter : 26.22 - 19.23 mm
 thickness : 5.84 mm
 Attenuation/section : 0.57 Np
 Power units, Number : 3 type : *Klystron*
 RF power peak : 32 MW; mean : 0.32 kW

Focusing System

Type, No. of elements, and spacing :
Quad doublets spaced every 4 accelerator sections

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *100 - 3000*
 No. of particles/bunch : *$10^8 - 10^9$*
 Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	(4) 0.280	(4) 0.295	GeV
Accel gradient	6.4	6.7	MeV/m
$\Delta E/E$ (FWHM)	0.1	0.1	%
Rep. rate	2	5	Hz
Pulse length	0.03	1	μ s
Beam intensity	0.04	0.2	A
Norm. emit. (1σ)		10	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *The linac began its life as the MkIII linac at Stanford University in the early 1960s. The accelerator sections are from some of the early production runs of the SLAC constant gradient structures. New rf, vacuum and magnet systems were added at Duke. Therefore, a construction cost is difficult to estimate. Installation of the linac at Duke began in 1993.*
- (2) *The electron source/injector is a single-cell rf thermionic gun with α -magnet for longitudinal matching. The cathode material is LaB₆. The gun operates at a nominal energy of 1 MeV.*
- (3) *0.0204 - 0.0065*
- (4) *The linac sits in a 150m long tunnel, and will be extended to reach 1.2 GeV. An upgrade to 500 MeV is currently underway. A description of the linac can be found in a paper by P.G. O'Shea et al., to appear in the Proceedings of the 1995 IEEE Particle Accelerator Conference, Dallas, May 1995.*

ELECTRON LINAC

Name of Linac : *MKIII FEL Linac-Driver*
Function : *Driver for mid-infrared MKIII FEL*
Institution and address : *Duke University, FEL Lab., PO Box 90305, Durham, NC 27708-0319, USA*
Person in charge : *Prof. John M.J. Madey, Director*
Name of person supplying these data : *John M.J. Madey*
e-mail :
tel. : *+1 919 660 2643* fax : *+1 919 660 2671*

HISTORY AND STATUS

Const. started : *1982* ; first beam : *1984*
Present status : *Operational*
Cost of facility : *(1) 250 KUSD*
Present linac staff : *4*
Present yearly operation time : *2500* h

LINAC PARAMETERS

Electron Sources

Types : *Microwave Gun* ; energy : *860* keV
Beam intensity (peak) : *0.6* A
Normalized emittance (1σ) : *2 \times 8* π mm-mrad

Injector (2)

Longitudinal matching : (3)
Output : MeV; intensity : (4) *40* A
Pulse width, spacing :
Normalized emittance (1σ) : *2 \times 8* π mm-mrad

Acceleration System (5)

Total linac length : m
No. sections : *1* ; lengths : *3* m
Field mode : ; frequency : GHz
Wave type : ; filling time : μ s
 v_g/c range : ; Q :
Shunt impedance : M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *30* MW; mean : *9* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupole, triplet at input to linac, doublet pair to match into FEL

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *2 \times 10^4*
No. of particles/bunch : *5 \times 10^8*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.043</i>	<i>0.045</i>	GeV
Accel gradient	: <i>14</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>0.3</i>		%
Rep. rate	: <i>30</i>		Hz
Pulse length	: <i>8</i>		μ s
Beam intensity	: <i>0.25</i>		A
Norm. emit. (1σ)	: <i>(6)</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *Linac only*
- (2) *Integrated microwave thermionic gun*
- (3) *α -magnet momentum analyzer/bunch compressor*
- (4) *Peak*
- (5) *Acceleration system = SLAC-type*
- (6) *Vertical : 2*
Horizontal : 8

ELECTRON LINAC

Name of Linac : ORELA*
Function : Electron Linac for Production of Neutrons and Slow Positrons
Institution and address : Oak Ridge National Lab, Bldg. 6010, MS-6354, Oak Ridge, TN 37831, USA
Person in charge : D.C. Larson
Name of person supplying these data : T.A. Lewis
e-mail : lewista@ornl.gov
tel. : +1 423 574 4594 fax : +1 423 576 8746

HISTORY AND STATUS

Const. started : 1966 ; first beam : 1969
Present status : Operating
Cost of facility : 4.8 MUSD (1969)
Present linac staff : 2
Present yearly operation time : 1600 h

LINAC PARAMETERS

Electron Sources

Types : Triode ; energy : 150 keV
Beam intensity (peak) : 60 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : (1)
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 16.4 m
No. sections : 4 ; lengths : 4.1 m
Field mode : $2\pi/3$; frequency : 1.3 GHz
Wave type : TW ; filling time : 1.85 μ s
 v_g/c range : 0.007 ; Q :
Shunt impedance : M Ω /m
Iris : aperture : diameter : Variable mm
thickness : mm
Attenuation/section : 0.41 Np
Power units, Number : 4 type : Klystron
RF power peak : 24 MW; mean : 65 kW

Focusing System

Type, No. of elements, and spacing :
Solenoid over LINAC length.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : NA
No. of particles/bunch : NA
Bunch separation : NA

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.140	0.178	GeV
Accel gradient	: 10	10	MeV/m
$\Delta E/E$ (FWHM)	:		%
Rep. rate	: to 1000	to 1000	Hz
Pulse length	: 0.002-0.05	0.002-0.05	μ s
Beam intensity	: 15	25	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* Oak Ridge Electron Linear Accelerator

(1) Buncher part of first section

Linac used to produce intense, pulsed bunches of neutrons at repetition rates from 15-1000 Hz. Burst widths from 4-30 ns. Flight tube lengths from 8-200 m. Intensity 10^{14} n/sec. Has attached an intense pulsed source of slow positrons.

Home Page : <http://www.phy.ornl.gov/orela/orela.html>

ELECTRON LINAC

Name of Linac : *Boeing Linac*
Function : *FEL Driver**
Institution and address : *FEL Program, Boeing D&SG, PO Box 3999 M/S 2T-50, Seattle, WA 98124, USA*
Person in charge : *John L. Adamski*
Name of person supplying these data : *A.M Vetter*
e-mail : *vetamx00@ccmail.ca.boeing.com*
tel. : *+1 206 544 5922* fax :

HISTORY AND STATUS

Const. started : *03/1996* ; first beam : *03/1997*
Present status : *Under construction*
Cost of facility :
Present linac staff : *10*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : (1) ; energy : *NA* keV
Beam intensity (peak) : (2) *0.10* A
Normalized emittance (1σ) : *7 @ 3.6 nC* π mm-mrad

Injector

Longitudinal matching : (3)
Output : *20* MeV; intensity : (2) *0.10* A
Pulse width, spacing : *800 μ s, 33.3 ms*
Normalized emittance (1σ) : *7* π mm-mrad

Acceleration System

Total linac length : (4) *20* m
No. sections : *6* ; lengths : *1.5* m
Field mode : *3 π /4* ; frequency : *1.3* GHz
Wave type : (5) ; filling time : *5* μ s
 v_p/c range : *0.003* ; Q : *20000*
Shunt impedance : (6) *16.6* M Ω /m
Iris : aperture : diameter : *55* mm
thickness : *14.5* mm
Attenuation/section : *2.6 dB (power)* Np
Power units, Number : *4* type : *Klystron*
RF power peak : *10* MW; mean : *60* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupole triplets between section pairs

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *3.6 nC*
Bunch separation : *36.9 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		<i>0.100</i>	GeV
Accel gradient :		<i>6.7</i>	MeV/m
$\Delta E/E$ (FWHM) :		<i>0.5</i>	%
Rep. rate :		<i>30</i>	Hz
Pulse length :		<i>200</i>	μ s
Beam intensity :		<i>0.10</i>	A
Norm. emit. (1σ):		<i>10</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *FEL - Free Electron Laser*

- (1) *RF photocathode (K_2CsSb)*
- (2) *During RF macropulse.*
- (3) *Injector is 20 MeV linac described on separate sheet, interfaced to main linac by a 1.3 GHz linac section and chicane buncher to compress 60 ps bunch to 7 ps.*
- (4) *Excluding injector described on separate sheet.*
- (5) *TW const. Z*
- (6) $R = V_a^2/2P_c$

References

- [1] *J.L. Adamski, et al., "A Kilowatt Class Visible Free Electron Laser Facility," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.*
- [2] *D. Dowell and A. Vetter, "Magnetic Pulse Compression using a Third Harmonic RF Linearizer," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.*

ELECTRON LINAC

Name of Linac : *Boeing Linac*
Function : *FEL Driver Injector**
Institution and address : *FEL Program, Boeing D&SG, PO Box 3999 M/S 2T-50, Seattle, WA 98124, USA*
Person in charge : *John L. Adamski*
Name of person supplying these data : *A.M. Vetter*
e-mail : *vetamx00@ccmail.ca.boeing.com*
tel. : *+1 206 544 5922* fax :

HISTORY AND STATUS

Const. started : *06/1994* ; first beam : *06/1995*
Present status : *Operational*
Cost of facility :
Present linac staff : *10*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *NA* keV
Beam intensity (peak) : *(2) 0.25* A
Normalized emittance (1σ) : *7 @ 3.6 nC* π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *2* MeV; intensity : *(2) 0.25* A
Pulse width, spacing : *800 μ s, 33.3 ms*
Normalized emittance (1σ) : *7* π mm-mrad

Acceleration System

Total linac length : *8.5* m
No. sections : *4* ; lengths : *(4)* m
Field mode : π ; frequency : *0.433* GHz
Wave type : *SW* ; filling time : *5* μ s
 v_e/c range : ; Q : *27000*
Shunt impedance : *(5) 13* M Ω /m
Iris : aperture : diameter : *50* mm
thickness : *166* mm
Attenuation/section : *NA* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *4* MW; mean : *(6) 100* kW

Focusing System

Type, No. of elements, and spacing :
Axial field coils between cavities

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *3.6 nC*
Bunch separation : *36.9 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.02</i>	<i>0.025</i>	GeV
Accel gradient	: <i>3</i>	<i>3</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>	<i>1</i>	%
Rep. rate	: <i>30</i>	<i>30</i>	Hz
Pulse length	: <i>800</i>	<i>8300</i>	μ s
Beam intensity	: <i>0.1</i>	<i>0.23</i>	A
Norm. emit. (1σ)	: <i>9</i>	<i>7</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *FEL - Free Electron Laser*

- (1) RF photocathode (K_2CsSb)*
- (2) During RF macropulse.*
- (3) Photocathode is in side wall of a 433 MHz single cell cavity with 3 cm gap; following is a second single cell cavity with a 4.5 cm gap.*
- (4) 2 sections of 1 m, 2 sections of 1.7 m.*
- (5) $R = V_a^2/2P_c$*
- (6) Quantity given is for operation as injector for 100 MeV linac. RF duty factor up to 25% is possible.*

References

- [1] T.D. Hayward et al., "A High Duty Factor Electron Linac for FEL," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.*
- [2] J.L. Adamski, et al., "A Kilowatt Class Visible Free Electron Laser Facility," Proc. 1995 Particle Acc. Conf., Dallas TX, May 1-5, 1995.*

ION LINAC

Name of Linac : *University of Washington Superconducting Booster*
Function : *Post-accelerator for heavy ions*
Institution and address : *Nuclear Physics Lab, Box 354290, Univ of Washington, Seattle WA 98195 USA*
Person in charge : *Derek W. Storm*
Name of person supplying these data : *D.W. Storm*
e-mail : *storm@npl.washington.edu*
tel. : *+1 206 543 4085* fax : *+1 206 685 4634*

HISTORY AND STATUS

Const. started : *11/1983* ; first beam : *10/1987*
Present status : *Operational*
Cost of facility : *9.6 MUSD (1985)*
Present linac staff : *7 people, 3 FTE (1)*
Present yearly operat. time : *3000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *3 (all negative)*
Types of source : *(2)*
Species of ions : *any mass up to 64*
Range of currents : *1 - 20* μAe
Range of output energies : *5 - 35* keV/u
Pulse length : *CW* μs ; rep. rate : Hz
Normalized emittance (1σ) : *0.15* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *FN tandem van de Graaff* m
Output currents : *1 - 10* μAe
Output energies : *16000 - 1500* keV/u
Frequency : *12.5* MHz; peak RF power : kW
Pulse length : *CW* μs ; rep. rate : Hz
Normalized emittance (1σ) : *0.4 - 3* π mm-mrad

Longitudinal Matching

Type : *Single superconducting resonator*
Mod. < 500 keV; drift *4m* mm at *162.5* MHz
keV; drift mm at MHz

Accelerating System

Total linac length : *18* m; N^o. of tanks : *12*
Tank diameters : m
Number of drift-tubes : *(3)*
Drift-tube lengths : mm
Drift-tube diam (range): mm
Gap/cell length (range):
Aperture diameter : *20* mm to mm
RF frequency(ies) : *150* MHz
Field modes : *TEM ($\lambda/4$)*
Eff. shunt impedance : *2×10^5* M Ω /m
Q : *$5 \times 10^7 - 2 \times 10^8$*
Filling time : μs
Equil. phases : *-20°*; accel. rate MeV/u-m
RF rep. rate : *CW* Hz; pulse : μs
Beam rate : *CW* Hz; pulse : μs
RF power peak : < *500* MW; mean : < *500* MW

Focusing System

No. elements : *13*
type : *dc doublets* order :
Gradients : *47* to T/m
Other :

Charge Stripping (Typical)

Type(s) : *c foil following FN tandem injector*
Charge states : to *19* at *> 1.5* MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	: <i>$A \leq 64$</i>	
Energy	: <i>5 - 15</i>	MeV/u
$\Delta E/E$ (FWHM)	: <i>0.1</i>	%
Mean acc. rate	:	MeV/u-m
Beam current	: <i>0.01 - 1</i>	μAe peak
Norm. emit. (1σ)	:	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
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OTHER RELEVANT INFORMATION

- Full Time Equivalent*
- Sputter, DEIS, Duoplasmatron w/exchange*
- No drift-tubes, number of resonators: 24; 12*

24 Superconducting quarter wave resonators of 0.18m diameter, optimum velocity 0.1 c.
Lead plated copper construction.
Independently phased.
Accelerating fields 3.0 MV/m in resonators.

References

- [1] *Project described in D.W. Storm et al., IEEE Trans. Nucl. Sci. NS-32 (1985) 3262.*



ASIA

192A

POSITRON LINAC

Name of Linac : *Beijing Electron / Positron Linac*
Function : *Injector of Beijing Electron - Positron Collider*
Institution and address : *Institute of High Energy Physics, P.O. Box 918, Beijing, China*
Person in charge : *WANG, Jin*
Name of person supplying these data : *J. Wang*
e-mail : *wangj@BEPC2.IHEP.AC.CN*
tel. : *+86 10 6821 3344 * fax : +86 10 6821 3374*

HISTORY AND STATUS

Differences with respect to corresponding e^- linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy : 150 MeV
Radius (1σ) : mm
Beam intensity : 2.4 A

OTHER RELEVANT INFORMATION

* Ext. 2268

- (1) 5 mm
(2) Taped solenoid :
2.7 T max. ; 0.35 T min. ; 12 cm long

LINAC PARAMETERS

Conversion Target and Capture

Material : Tungsten
Type :
Thickness (rad.length) : (1) λ
Diameter : 10 mm
Mean deposited power : kW
Solenoidal field^{a)} : 0.35 T 9 m long
Matching device : (2)
RF sections^{a)} :

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e^- linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	1.3	1.6	GeV
Accel gradient :	10	10	MeV/m
$\Delta E/E$ (FWHM) :	1		%
Rep. rate :	12.5	25	Hz
Pulse length :	3	3	μ s
Yield (fin.en) :	0.025		$e^+e^- \times$ GeV
Beam intensity :	3000	9000	μ A peak
Norm. emit. (1σ):			π mm-mrad

ELECTRON LINAC

Name of Linac : *Beijing FEL Facility Linac*
Function : *FEL-driver*
Institution and address : *Institute of High Energy Physics, P.O. Box 918, Beijing, China*
Person in charge : *Jialin Xie*
Name of person supplying these data : *Jialin Xie*
e-mail : *XIEJL@BEPC3.IHEP.AC.CN*
tel. : fax : *+86 10 8213374*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1991*
Present status : *Operating*
Cost of facility : *1 MRMB (1990)*
Present linac staff : *6*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *RF-gun* ; energy : *1200* keV
Beam intensity (peak) : *0.200* A
Normalized emittance (1σ) : *20* π mm-mrad

Injector

Longitudinal matching :
Output : *1.2* MeV; intensity : *0.200* A
Pulse width, spacing : *4.5 μ s* , *100* ms
Normalized emittance (1σ) : *20* π mm-mrad

Acceleration System

Total linac length : *3.05* m
No. sections : *1* ; lengths : *3.05* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μ s
 v_g/c range : *(1)* ; Q : *(2)*
Shunt impedance : *53* M Ω /m
Iris : aperture : diameter : *26.231/19.243* mm
thickness : *5.844* mm
Attenuation/section : *0.57* Np
Power units, Number : *1* type : *XK-5*
RF power peak : *20* MW; mean : *10* kW

Focusing System

Type, No. of elements, and spacing :
No

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *12852*
No. of particles/bunch : *9.7×10^8*
Bunch separation : *350* ns

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.03</i>		GeV
Accel gradient	: <i>10</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>		%
Rep. rate	: <i>10</i>		Hz
Pulse length	: <i>4.5</i>		μ s
Beam intensity	: <i>0.200</i>		A
Norm. emit. (1σ)	: <i>30</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *0.0208/0.007*
- (2) *13800/13900*

PROTON AND/OR H- LINAC

Name of Linac : *Beijing 35 MeV Proton Linac*
Function : *Proton Beam Application*
Institution and address : *Institute of High Energy Physics, P.O. Box 918, Beijing, China*
Person in charge : *S.H. Wang*
Name of person supplying these data : *Z.H. Luo*
e-mail : *luozh@bepc3.ihep.ac.cn*
tel. : fax : *+86 10 8213374*

HISTORY AND STATUS

Const. started : *1982* ; first beam : *08/1985*
Present status : *Operating*
Cost of facility : *4 MUSD (1982)*
Present linac staff : *40*
Present yearly operat. time : *~ 4000* h

Focusing System

No. elements : *105*
type : *Pulsed* order : *FODO*
Gradients : *92* to *20* T/m
Other : *Pulsed flat top $\approx 250 \mu\text{s}$*

LINAC PARAMETERS

Ion Source

Type : *Duoplasmatron*
Output : *250* mA at *750* keV
Pulse length : *150* μs ; rep. rate : *12.5* Hz
Normalized emittance (1σ) : *3.0* $\pi\text{mm-mrad}$

Pre-accelerator (including RFQ)

Types : *Cockcroft-Walton* ; lengths : m
Output : *180* mA at *750* keV
Pulse length : *150* μs ; rep. rate : *12.5* Hz
Normalized emittance (1σ) : *3.0* $\pi\text{mm-mrad}$

Longitudinal Matching

Type : *Double Bunchers*
Mod. *55* keV; drift *950* mm at *201.25* MHz
25 keV; drift *800* mm at *402.5* MHz

Accelerating System

Total linac length : *21.8* m; No. of tanks : *1*
Tank diameters : *0.94 ~ 0.90* m
Number of drift-tubes : *105*
Drift-tube lengths : *48 ~ 274* mm
Drift-tube diam (range): *180 ~ 160* mm
Gap/cell length (range): *0.21 ~ 0.31*
Aperture diameter : *20* mm to *30* mm
RF frequency(ies) : *201.25* MHz
Field modes : *TM 010*
Eff. shunt impedance : *30 ~ 55* M Ω /m
Q : *45000*
Filling time : *150* μs
Equilibrium phases : *-40 $^\circ$ ~ -25 $^\circ$*
RF rep. rate : *12.5* Hz; pulse : *450* μs
Beam rate : *12.5* Hz; pulse : *150* μs
RF power peak : *5.0* MW; mean : *0.03* MW

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	: <i>35.5</i>	<i>35.5</i>	MeV
Mean acc. rate	: <i>1.59</i>	<i>1.59</i>	MeV/m
$\Delta E/E$ (FWHM)	: \pm <i>0.6</i>	\pm <i>0.8</i>	%
Beam current	: <i>40</i>	<i>60</i>	mA peak
Norm. emit. (1σ)	: <i>6</i>	<i>8</i>	$\pi\text{mm-mrad}$

OTHER RELEVANT INFORMATION

- *Post coupled Alvarez Structure*
- *Used for Nuclear Physics Experiment, Radio-isotope production and Neutron Therapy for Cancer.*
- *Original one was 10 MeV proton Linac, constructed during 1978 - 1982, then up-graded to 35 MeV.*

ELECTRON LINAC

Name of Linac : *HIL* *
Function : *Electron Injector Linac for HLS* **
Institution and address : *USTC NSRL, Hefei, Anhui 230026 P.R. China*
Person in charge : *Xiaofeng Shen*
Name of person supplying these data : *Sai Dong*
e-mail : *sdong@mail.nsrl.ustc.edu.cn*
tel. : *+86 551 3602011* fax : *+86 551 5561078*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1987*
Present status : *Operating*
Cost of facility : *7.6 MYuan (1987)*
Present linac staff : *14 man-years*
Present yearly operation time : *5500* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *0.5* A
Normalized emittance (1σ) : *21* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *26* MeV; intensity : *> 0.1* A
Pulse width, spacing : *1 μ s, 20 ms*
Normalized emittance (1σ) : *1.8* π mm-mrad

Acceleration System

Total linac length : *35.128* m
No. sections : *8* ; lengths : *3* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μ s
 v_g/c range : *0.012* ; Q : *13500*
Shunt impedance : *57.6* M Ω /m
Iris : aperture : diameter : *21.977* mm
thickness : *5.0* mm
Attenuation/section : *0.54* Np
Power units, Number : *4* type : *Klystrons*
RF power peak : *15* MW; mean : *1.875* kW

Focusing System

Type, No. of elements, and spacing :
2 magnetic lenses at between the gun and the buncher; solenoids up to 10 MeV; 3 quadrupole lenses pair between sections to 200 MeV.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *2856*
No. of particles/bunch : *3.1×10^{11}*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.20</i>	<i>0.225</i>	GeV
Accel gradient	: <i>12</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>1.0</i>	<i>0.8</i>	%
Rep. rate	: <i>50</i>	<i>300</i>	Hz
Pulse length	: <i>1.0</i>	<i>0.2 - 1.0</i>	μ s
Beam intensity	: <i>0.07</i>	<i>0.05</i>	A
Norm. emit. (1σ):		<i>0.45</i>	π mm-mrad

OTHER RELEVANT INFORMATION

- * *HIL - HLS Injector Linac*
- ** *HLS - Hefei Light Source*

(1) S-band pre-buncher, buncher and pre-accelerator

References

- [1] Yuan Ji Pei, An injector 200 MeV electron LINAC for HESYRL storage ring, R.S.I. Vol. 60, No. 7, 1701 (1991).*
- [2] Yuan Ji Pei, "The Design of a 200 MeV linear Accelerator", Proceedings of '80 National Conference on Particle Accelerators, 1984, 10.*
- [3] De-Fa Wang, Yuanji Pei, Duohui He, "The 200 MeV LINAC at HESYRL", Proc. of International Conference on Linac Accelerator, 1986, SLAC.*

ELECTRON LINAC

Name of Linac : *ISIR S-Band Linac*
Function : *Scientific Research*
Institution and address : *ISIR, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567, Japan*
Person in charge : *Seiichi Tagawa*
Name of person supplying these data : *S. Okuda*
e-mail : *s-okuda@sanken.osaka-u.ac.jp*
tel. : fax :

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1989*
Present status : *Operational*
Cost of facility :
Present linac staff : *3*
Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *100* keV
Beam intensity (peak) : *0.65* A
Normalized emittance (1σ) : *50* π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *3* ; lengths : *3* m
Field mode : *$2/3 \pi$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.68* μ s
 v/c range : *0.0147* ; Q : *12600*
Shunt impedance : *53* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *0.459* Np
Power units, Number : type :
RF power peak : *35* MW; mean : *12* kW

Focusing System

Type, No. of elements, and spacing :
Triplet Q magnet - 4

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *4300*
No. of particles/bunch : *1.4×10^9*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.10</i>	<i>0.15</i>	GeV
Accel gradient	: <i>19.3</i>	<i>20</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>2</i>		%
Rep. rate	: <i>60</i>		Hz
Pulse length	: <i>1.5</i>		μ s
Beam intensity	: <i>0.65</i>		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *ISIR L-Band Linac*
Function : *Scientific Research*
Institution and address : *ISIR, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567, Japan*
Person in charge : *Seiichi Tagawa*
Name of person supplying these data : *S. Okuda*
e-mail : *S-okuda@sanken.osaka-u.ac.jp*
tel. : fax :

HISTORY AND STATUS

Const. started : *1975* ; first beam : *1978*
Present status : *Operational*
Cost of facility :
Present linac staff : *4*
Present yearly operation time : *2300* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *110* keV
Beam intensity (peak) : *30* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *3* m
No. sections : *1* ; lengths : *3* m
Field mode : *$2/3 \pi$* ; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *1.96* μ s
 v_e/c range : *0.0075* ; Q : *19000*
Shunt impedance : *40* M Ω /m
Iris : aperture : diameter : *36 - 43* mm
thickness : *13* mm
Attenuation/section : *0.2832* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *20* MW; mean : *50* kW

Focusing System

Type, No. of elements, and spacing :
Triplet Q Magnet - 4

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : *4.2×10^{11}*
Bunch separation : *9.2 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.03</i>	<i>0.038</i>	GeV
Accel gradient	: <i>10</i>	<i>13</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>	<i>1</i>	%
Rep. rate	: <i>120</i>	<i>720</i>	Hz
Pulse length	: <i>0.020</i>	<i>0.020</i>	μ s
Beam intensity	: <i>(1)</i>		A
Norm. emit. (1σ)	: <i>400</i>		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 67 nC bunch

ION LINAC

Name of Linac : *HIMAC Injector*
 Function : *Injector for HIMAC*
 Institution and address : *NIRS, 4-9-1 Anagawa, Inage-ku, Chiba 263, Japan*
 Person in charge : *S. Yamada*
 Name of person supplying these data : *S. Yamada*
 e-mail : *yamada_s@nirs.go.jp*
 tel. : *+81 43 256 0122* fax : *+81 43 251 1840*

HISTORY AND STATUS

Const. started : *03/1987* ; first beam : *03/1993*
 Present status : *Operational*
 Cost of facility : *3 BJPY (1987)*
 Present linac staff : *13*
 Present yearly operat. time : *4000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *16 GHz ECR & PIG*
 Species of ions : *He to Ar*
 Range of currents : *100 to 1000* μAe
 Range of output energies : *8* keV/u
 Pulse length : *3000* μs ; rep. rate : *3* Hz
 Normalized emittance (1σ) : *0.6* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *4 vane RFQ, 7.3* m
 Output currents : *60 to 600* μAe
 Output energies : *800* keV/u
 Frequency : *100* MHz; peak RF power : *260* kW
 Pulse length : *700* μs ; rep. rate : *3* Hz
 Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *23.9* m; N°. of tanks : *3*
 Tank diameters : *2.20 / 2.18 / 2.16* m
 Number of drift-tubes : *107*
 Drift-tube lengths : *98.5 - 257.3* mm
 Drift-tube diam (range): *160* mm
 Gap/cell length (range): *0.21 - 0.26*
 Aperture diameter : *20* mm to *30* mm
 RF frequency(ies) : *100* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *25 - 36* M Ω /m
 Q : *96 000 / 99 200 / 100 800*
 Filling time : *250* μs
 Equil. phases : *(1)* ; accel. rate *0.22* MeV/u-m
 RF rep. rate : *3* Hz; pulse : *1,200* μs
 Beam rate : *3* Hz; pulse : *500* μs
 RF power peak : *(2)* MW; mean : *0.0043* MW

Focusing System

No. elements : *55*
 type : *pulsed* order : *FODO*
 Gradients : *60* to *24* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *C foil*
 Charge states : *Ar6+* to *18+* at *6* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	<i>C</i>	<i>Ar</i>	
Energy	<i>6.0</i>	<i>6.0</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>± 0.2</i>	<i>± 0.2</i>	%
Mean acc. rate	<i>0.22</i>	<i>0.22</i>	MeV/u-m
Beam current	<i>250</i>	<i>200</i>	μAe peak
Norm. emit. (1σ)			π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>Ne</i>	<i>6.0</i>	
<i>Si</i>	<i>6.0</i>	

OTHER RELEVANT INFORMATION

- (1) *-30°, -25°*
- (2) *1.2 (max)*

ELECTRON LINAC

Name of Linac : *SPring - 8 Linac*
Function : *Injector for SPring - 8*
Institution and address : *SPring - 8, Kamigori, Hyogo, 678-12 Japan*
Person in charge : *Hideaki YOKOMIZO*
Name of person supplying these data : *Hideaki YOKOMIZO*
e-mail : *yokomizo@haru01.spring8.or.jp*
tel. : +81 7915 8 0885 fax : +81 7915 8 0850

HISTORY AND STATUS

Const. started : *1991* ; first beam : *(1)*
Present status : *Under construction*
Cost of facility : *5 BJPY (1996)*
Present linac staff : *12*
Present yearly operation time : *5500 (plan)* h

LINAC PARAMETERS

Electron Sources (2)

Types : *Triode* ; energy : *200* keV
Beam intensity (peak) : *20* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(3)*
Output : *9* MeV; intensity : *0.1 - 100* A
Pulse width, spacing : *1 ns - 1 μ s, 16.6 ms*
Normalized emittance (1σ) : *50* π mm-mrad

Acceleration System

Total linac length : *140* m
No. sections : *26* ; lengths : *3* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.6* μ s
 v_p/c range : *0.016* ; Q : *13500*
Shunt impedance : *52* M Ω /m
Iris : aperture : diameter : *20 - 26* mm
thickness : *5* mm
Attenuation/section : *0.4* Np
Power units, Number : *14* type : *Klystron*
RF power peak : *80* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 9 MeV and triplets up to final energy

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		<i>1.15</i>	GeV
Accel gradient :		<i>17</i>	MeV/m
$\Delta E/E$ (FWHM) :		<i>1</i>	%
Rep. rate :		<i>60</i>	Hz
Pulse length :		<i>1</i>	μ s
Beam intensity :		<i>0.100</i>	A
Norm. emit. (1σ):			π mm-mrad

OTHER RELEVANT INFORMATION

- (1) 1996 (Expected)*
- (2) The electron gun has three modes of pulse length :
1ns, 10 - 40 ns and 1 - 2 μ s.*
- (3) S-band pre-buncher and buncher*

References

- [1] *H. Yoshikawa et al., Proc. of 1996 Int. Linac Conf.,
to be published.*

POSITRON LINAC

Name of Linac : *S*Pring-8 Linac
Function : *I*njector for *S*Pring-8
Institution and address : *S*Pring-8, Kamigori, Hyogo, 678-12, Japan
Person in charge : Hideaki Yokomizo
Name of person supplying these data : Hideaki Yokomizo
e-mail : yokomizo@haru01.spring8.or.jp
tel. : +81 7915 8 08855 fax : +81 7915 8 0850

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e⁻) at Conversion Target

Energy :	250	MeV
Radius (1 σ) :	< 1.0	mm
Beam intensity :	10	A

LINAC PARAMETERS

Conversion Target and Capture

Material :	90% W 10% Cu	
Type :	Stationary	
Thickness (rad.length) :	2.0	χ
Diameter :	10	mm
Mean deposited power :	1.0	kW
Solenoidal field ^{a)} :	0.4 T over 2.5 m; DC	
Matching device :	2 T pulsed solenoid	
RF sections ^{a)} :	19 \times 3 m	

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		0.9	GeV
Accel gradient :		17	MeV/m
$\Delta E/E$ (FWHM) :		1.0	%
Rep. rate :		8	Hz
Pulse length :		0.040	μ s
Yield (fin.en) :		1.2	e ⁺ /e ⁻ x GeV
Beam intensity :		30000	μ A peak
Norm. emit. (1 σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

In order to avoid ion trapping in the storage ring, SPring-8 Linac is able to provide positron beam. In the electron mode, the tungsten target is pulled out from the beam line.

The pulsed solenoid coil has adjustable mechanism for tilting and parallel movement to search the best position to have maximum positron yield.

ELECTRON LINAC

Name of Linac :
Function : *Electron Injector Linac for NIJI-III and FEL*
Institution and address : *Sumitomo Electric**
Person in charge : *Dr. H. Takada*
Name of person supplying these data : *K. Emura*
e-mail : *emura@okk.sumiden.co.jp*
tel. : *+81 7915 8 0659* fax : *+81 7915 8 0670*

HISTORY AND STATUS

Const. started : *1993* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *2 man-years*
Present yearly operation time : *800* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *200* keV
Beam intensity (peak) : *5* A
Normalized emittance (1σ) : *7* π mm-mrad

Injector

Longitudinal matching : *S-band, SHPB / PB / B*
Output : *4* MeV; intensity : *2* A
Pulse width, spacing : *10 ps, 2.1 ns*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *2* ; lengths : *3* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.6* μ s
 v/c range : ; Q : *13500*
Shunt impedance : *50* M Ω /m
Iris : aperture : diameter : *20* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *2* type : *Klystron*
RF power peak : *45* MW; mean : *6* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 4 MeV.
2 Triplets

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.10</i>	<i>0.12</i>	GeV
Accel gradient	: <i>18</i>	<i>22</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1.0</i>	<i>1.0</i>	%
Rep. rate	: <i>2</i>	<i>2</i>	Hz
Pulse length	: <i>1 and 10</i>	<i>1 and 10</i>	μ s
Beam intensity	:		A
Norm. emit. (1σ)	: <i>60</i>	<i>60</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Harima Science Garden City, Kamigori, Hyogo, 678-12 Japan*

References

[1] *K. Emura, K. Tsumori, M. Moriguchi and H. Takada, "Development of a Compact Linear Accelerator for SR Injection", Sumitomo Electric Technical Review, No. 39 (1995).*

ELECTRON LINAC

Name of Linac : 45 MeV Electron Linear Accelerator Laboratory
Function : Electron Linac for the study of atomic science and nuclear engineering
Institution and address : Hokkaido Univ., N-13 W-8, Kita-ku, Sapporo 060, Japan
Person in charge : T. Enoto
Name of person supplying these data : T. Enoto
e-mail : tem@hune.hokudai.ac.jp
tel. : +81 11 706 7128 fax : +81 11 706 7128

HISTORY AND STATUS

Const. started : 1971 ; first beam : 1974
Present status : *Operating*
Cost of facility : 250 MJPY (1971)
Present linac staff : 3 men
Present yearly operation time : 2000 h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : 100 keV
Beam intensity (peak) : 2.0 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *S-band buncher*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 23 m
No. sections : 3 ; lengths : 2 m
Field mode : $2\pi/3$; frequency : 2.856 GHz
Wave type : *TW* ; filling time : 0.56 μ s
 v_g/c range : 0.00783 ; Q : 12200
Shunt impedance : 60 M Ω /m
Iris : aperture : diameter : 19.0 - 20.0 mm
thickness : mm
Attenuation/section : 0.628 Np
Power units, Number : 3 type : *Klystron*
RF power peak : 5 MW; mean : 3 kW

Focusing System

Type, No. of elements, and spacing :
Q-magnet, 10 section
steering magnet, 4 section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 30-10000
No. of particles/bunch : 1.5×10^{11} - 4.4×10^8
Bunch separation : 350 ps

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.045	0.045	GeV
Accel gradient	7.5	7.5	MeV/m
$\Delta E/E$ (FWHM)	15	15	%
Rep. rate	100	200	Hz
Pulse length	0.01 - 3	0.01 - 3	μ s
Beam intensity	1.5	2	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

ELECTRON LINAC

Name of Linac : *PNC Linac*
 Function : *Electron Linac for Transmutation*
 Institution and address : *PNC-OEC * 4002 Oarai-machi, Ibaraki-ken 311-13, Japan*
 Person in charge : *Takashi Emoto*
 Name of person supplying these data : *Takashi Emoto*
 e-mail : *emoto@oec.pnc.go.jp*
 tel. : *+81 29 267 4141 ext.3130* fax : *+81 29 266 3868*

HISTORY AND STATUS

Const. started : *1994* ; first beam : *1996*
 Present status : *Under the commissioning*
 Cost of facility : *5000 MJPY*
 Present linac staff : *17 man-years*
 Present yearly operation time : *NA* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *200* keV
 Beam intensity (peak) : *0.400* A
 Normalized emittance (1σ) : *NA* π mm-mrad

Injector

Longitudinal matching : *(1)*
 Output : *2.0* MeV; intensity : *0.100* A
 Pulse width, spacing : *4 ms, 16 ms*
 Normalized emittance (1σ) : *NA* π mm-mrad

Acceleration System

Total linac length : *18* m
 No. sections : *8* ; lengths : *1.2* m
 Field mode : *$2\pi/3$* ; frequency : *(2)* GHz
 Wave type : *TW* ; filling time : *(3)* 13 μ s
 v_g/c range : *(4)* ; Q : *(5)*
 Shunt impedance : *16.2 - 39.1* M Ω /m
 Iris : aperture : diameter : *24.5 - 32.4* mm
 thickness : *12* mm
 Attenuation/section : *0.04076 - 0.06082* Np
 Power units, Number : *2* type : *Klystron*
 RF power peak : *1.2* MW; mean : *(6)* 240 kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 3.5MeV; a doublet at 3.5MeV and between sections to 10 MeV; a triplet at 10 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
 No. of particles/bunch : *NA*
 Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.01</i>	<i>NA</i>	GeV
Accel gradient	: <i>1.0 - 1.4</i>	<i>NA</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.2</i>	<i>NA</i>	%
Rep. rate	: <i>0 - 50</i>	<i>NA</i>	Hz
Pulse length	: <i>10 - 4000</i>	<i>NA</i>	μ s
Beam intensity	: <i>0.100</i>	<i>NA</i>	A
Norm. emit. (1σ)	: <i>N/A</i>	<i>NA</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Power Reactor & Nuclear Fuel Development Co. Oarai Engineering Centre*

- (1) L-band pre-buncher and buncher*
- (2) 1.249135*
- (3) Resonant Ring filling time*
- (4) 0.011-0.025*
- (5) 20130-15392*
- (6) 1.2MW klystron only*

ELECTRON LINAC

Name of Linac : *KURRI*-LINAC*
Function : **
Institution and address : *KURRI, Kumatori-cho, Sennan-gun, Osaka, 590-04, Japan*
Person in charge : *Y. Fujita*
Name of person supplying these data : *K. Takami*
e-mail : *takami@rri.kyoto-u.ac.jp*
tel. : *+81 724 52 0901 ext. 2278* fax : *+81 724 53 0488*

HISTORY AND STATUS

Const. started : *1965* ; first beam : *1967*
Present status : *Operating*
Cost of facility : *1.1 MUSD (1965)*
Present linac staff : *3*
Present yearly operation time : *1900* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *85* keV
Beam intensity (peak) : *~ 20* A
Normalized emittance (1σ) : *π mm-mrad*

Injector

Longitudinal matching : *L-band pre-buncher*
Output : *MeV*; intensity : *A*
Pulse width, spacing : *10 ns ~ 4 μ s, 2 ms*
Normalized emittance (1σ) : *π mm-mrad*

Acceleration System

Total linac length : *5* m
No. sections : *2* ; lengths : *2 & 2.5* m
Field mode : *$2\pi/3$* ; frequency : *1.3* GHz
Wave type : *TW* ; filling time : *2* μ s
 v_p/c range : ; Q :
Shunt impedance : *M Ω /m*
Iris : aperture : diameter : *mm*
thickness : *mm*
Attenuation/section : *Np*
Power units, Number : *2* type : *Klystrons*
RF power peak : *20* MW; mean : *30* kW

Focusing System

Type, No. of elements, and spacing :
Not installed

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *13 - 5200*
No. of particles/bunch : *$\sim 2.5 \times 10^{10}$*
Bunch separation : *770 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.030</i>	<i>0.046</i>	GeV
Accel gradient	: <i>6.7</i>	<i>10</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>10</i>	<i>3</i>	%
Rep. rate	: <i>360</i>	<i>480</i>	Hz
Pulse length	: <i>0.01 ~ 4</i>	<i>0.01 ~ 4</i>	μ s
Beam intensity	: <i>6</i>		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

- * *KURRI - Kyoto University Research Reactor Institute*
- ** *Neutron source, X-ray source, light source, electron irradiation, γ -ray irradiation, positron production*

ELECTRON LINAC

Name of Linac : *Tohoku 300 MeV Electron Linac*
Function : *Electron Linac for nuclear physics and other applications*
Institution and address : *Lab. of Nucl. Sci. Tohoku Univ., Sendai 982, Japan*
Person in charge : *M. Oyamada*
Name of person supplying these data : *M. Oyamada*
e-mail : *oyamada@thkln1.lns.tohoku.ac.jp*
tel. : +81 22 743 3423 fax : +81 22 743 3401

HISTORY AND STATUS

Const. started : 1963 ; first beam : 1967
Present status : *Operating*
Cost of facility : *500 MJPY (1963)*
Present linac staff : *8 man-years*
Present yearly operation time : *4000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *2.0* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : (1)
Output : *0.4* MeV; intensity : *1.0* A
Pulse width, spacing : *4 μ s, 3.3ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *52* m
No. sections : *8+12* ; lengths : *1.05, 2.1* m
Field mode : *2 π /3* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.4, 0.8* μ s
 v_p/c range : *0.0088* ; Q : *14000*
Shunt impedance : *54* M Ω /m
Iris : aperture : diameter : *20.9* mm
thickness : *5.842* mm
Attenuation/section : *0.275, 0.55* Np
Power units, Number : *2+3* type : *Klystron*
RF power peak : *25* MW; mean : *30* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids, 20 sets, each acc. structure
quadrupole doublets, 3 pairs, 8m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.25</i>	<i>0.3</i>	GeV
Accel gradient	: <i>7.8</i>	<i>9.4</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1.5</i>	<i>1.0</i>	%
Rep. rate	: <i>300</i>	<i>300</i>	Hz
Pulse length	: <i>3</i>	<i>3</i>	μ s
Beam intensity	: <i>0.1</i>	<i>0.1</i>	A
Norm. emit. (1σ)	: <i>60</i>		π mm-mrad

OTHER RELEVANT INFORMATION

(1) *S-band pre-buncher and buncher*

References

- [1] *Performance of an Energy Compressing System for the Tohoku 300-MeV linac. M. Sugawara et al.; Nucl. Instr. & Meth. 153, 343-346 (1978).*
- [2] *SSTR - The 150 MeV pulse stretcher of Tohoku University. T. Tamae et al.; Nucl. Instr. & Meth. A264, 173-185 (1988).*
- [3] *The Tohoku University Stretcher-Booster Ring. M. Oyamada et al.; Proc. the 10th Symp. on Acc. Sci. and Tech. Hitachinaka, Japan, 463-465 (1995).*

ELECTRON LINAC

Name of Linac : *INS-ES * 15 MeV Linac*
Function : *Electron Injector Linac for INS-ES*
Institution and address : *INS **, University of Tokyo, Midoricho, Tanashi, Tokyo 188, Japan*
Person in charge : *M. Muto*
Name of person supplying these data : *M. Muto*
e-mail : *muto@ins.u-tokyo.ac.jp*
tel. : *+81 424 69 9552* fax : *+81 424 62 0775*

HISTORY AND STATUS

Const. started : *1972* ; first beam : *1974*
Present status : *Operating*
Cost of facility :
Present linac staff :
Present yearly operation time : *~ 3000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *0.5* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2.1* m
No. sections : *7* ; lengths : m
Field mode : *$2\pi/3$* ; frequency : *2.758* GHz
Wave type : *TW* ; filling time : *0.54* μ s
 v_g/c range : *(1)* ; Q : *11700*
Shunt impedance : *64* M Ω /m
Iris : aperture : diameter : *29.795 ~ 19.893* mm
thickness : *5.0* mm
Attenuation/section : *0.44* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *6* MW; mean : *0.52* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 15 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.015</i>	<i>0.015</i>	GeV
Accel gradient	: <i>7.5</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>~ 5</i>		%
Rep. rate	: <i>21.5</i>	<i>21.5</i>	Hz
Pulse length	: <i>1.2</i>		μ s
Beam intensity	: <i>0.150</i>		A
Norm. emit. (1σ)	: <i>~ 30</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- * *INS 1.3 GeV Electron Synchrotron*
- ** *Institute for Nuclear Study*

(1) *0.008 - 0.0309*

References

- [1] *"The Construction of 15 MeV Linear Accelerator as Injector for INS Electron Synchrotron", T. Katayama et al., INS-Report 240 (1975).*

ION LINAC

Name of Linac :
 Function : *ISOL * post accelerator*
 Institution and address : *Institute for Nuclear Study***
 Person in charge : *S. Arai*
 Name of person supplying these data : *S. Arai*
 e-mail : *arai@ins.u-tokyo.ac.jp*
 tel. : +81 424 69 9558 fax : +81 424 62 0775

HISTORY AND STATUS

Const. started : *04/1992* ; first beam : *03/1996*
 Present status : *Tuning*
 Cost of facility : *520 MJPY over 5 years*
 Present linac staff : *8 man-years*
 Present yearly operat. time : h

LINAC PARAMETERS

Ion Sources

No. of sources : 4
 Types of source : (1)
 Species of ions : *Ions up to Ni²⁺ Z/A - 1/30*
 Range of currents : (2) μAe
 Range of output energies : 2 keV/u
 Pulse length : *Variable* μs ; rep. rate : *10 ~ 1000* Hz
 Normalized emittance (1σ) : (3) π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Split coaxial RFQ (8.6)* m
 Output currents : (2) μAe
 Output energies : 170 keV/u
 Frequency : 25.5 MHz; peak RF power : (4) kW
 Pulse length : (5) μs ; rep. rate : *1 ~ 999* Hz
 Normalized emittance (1σ) : (3) π mm-mrad

Longitudinal Matching

Type : *6-Gap Double Coaxial $\lambda/4$ cavity*
 Mod. 200 keV; drift 3760 mm at 25.5 MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : 5.6 m; N^o. of tanks : 4
 Tank diameters : 1.49, 1.34 m
 Number of drift-tubes : 7 ~ 10 + 2 (1/2)
 Drift-tube lengths : 29 ~ 53 mm
 Drift-tube diam (range): 38 ~ 52 mm
 Gap/cell length (range): 0.5
 Aperture diameter : 20 mm to 32 mm
 RF frequency(ies) : 51 MHz
 Field modes : *TE110 like (IH)*
 Eff. shunt impedance : 218 ~ 289 $\text{M}\Omega/\text{m}$
 Q : 10681 ~ 18490
 Filling time : 33 ~ 58 μs
 Equil. phases : -25° ; accel. rate 0.15 MeV/u-m
 RF rep. rate : 1 ~ 999 Hz; pulse : (5) μs
 Beam rate : 1 ~ 999 Hz; pulse : (5) μs
 RF power peak : (6) MW; mean : (6) cw MW

Focusing System

No. elements : 9
 type : DC order : Triplet
 Gradients : 38 to 45 T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Carbon foil (10 $\mu\text{g}/\text{cm}^2$)*
 Charge states : *Ni²⁺ to Ni⁹⁺* at 0.17 MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species :			
Energy :	1.05	1.05	MeV/u
$\Delta E/E$ (FWHM) :		0.5 ~ 2	%
Mean acc. rate :	0.15	0.15	MeV/u-m
Beam current :		(7)	μAe peak
Norm. emit. (1σ) :		0.1	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *ISOL - Isotope Separator On-Line*
 ** *University of Tokyo, Midari-cho, Tanashi-shi, Tokyo 188, Japan*

- (1) *ECR, SURFACE IONIZ., FEBIAD for unstable nuclei
ECR for stable nuclei*
- (2) *< 10¹⁰ pps for unstable nuclei
200 μA for ¹⁴N⁺*
- (3) *0.03 ~ 0.1 for unstable nuclei
0.1 for stable nuclei*
- (4) *max 250 kW*
- (5) *50 ~ 3000*
- (6) *0.015 ~ 0.039 (max)*
- (7) *6000 for Z/A - 1/30*

ELECTRON LINAC

Name of Linac : SCARLET*
 Function : Superconducting RF Linac Driver for FEL
 Institution and address : Tokai Research Establishment, JAERI **
 Person in charge : Eisuke J. Minehara
 Name of person supplying these data : E.J. Minehara
 e-mail : minehara@felwu0.tokai.jaeri.go.jp
 tel. : +81 29 282 5464 fax : +81 29 270 5923

HISTORY AND STATUS

Const. started : 1988 ; first beam : 12/1993
 Present status : Operating
 Cost of facility : 13.5 MUSD (1995)
 Present linac staff : 5 man-years
 Present yearly operation time : (1) h

LINAC PARAMETERS

Electron Sources

Types : Triode ; energy : 250 keV
 Beam intensity (peak) : 0.1 - 0.2 A
 Normalized emittance (1 σ) : 20 π mm-mrad

Injector

Longitudinal matching : (2)
 Output : 2 MeV; intensity : 10 - 20 A
 Pulse width, spacing : 1 ms, 100 ms
 Normalized emittance (1 σ) : > 20 π mm-mrad

Acceleration System

Total linac length : 25 m
 No. sections : 2 ; lengths : 1.5 m
 Field mode : π ; frequency : 0.4998 GHz
 Wave type : SW ; filling time : 500-1000 μ s
 v_p/c range : 0.7 - 0.9 ; Q : 2×10^9
 Shunt impedance : M Ω /m
 Iris : aperture : diameter : mm
 thickness : mm
 Attenuation/section : Np
 Power units, Number : 2 type : MMIC
 RF power peak : 0.050 MW; mean : 1.5 kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
 No. of particles/bunch :
 Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.015	0.023	GeV
Accel gradient	6.5	> 7	MeV/m
$\Delta E/E$ (FWHM)	< 0.8	0.75	%
Rep. rate	10	10	Hz
Pulse length	50 - 400	1000	μ s
Beam intensity	3.5 - 7	14 (10)	A
Norm. emit. (1 σ)	> 20	10	π mm-mrad

OTHER RELEVANT INFORMATION

- * SCARLET - Super Conducting Accelerator for Research of Light Emission at Tokai
- ** Japan Atomic Energy Research Institute , 2 - 4 Shirakata-Shirane, Tokai, Naka, Ibaraki 319-11 Japan

- (1) About 2000 hrs on beam, 8400 hrs of refrigerator on duty.
- (2) A pair of 0.3 m single cell 500 MHz preaccelerator 83.3 MHz 1/6th SubHarmonic Buncher

PROTON AND/OR H- LINAC

Name of Linac : *JAERI 2 MeV RFQ*
 Function : *Beam Test*
 Institution and address : *JAERI, Tokai-mura, Naka-gun, Ibaraki-ken, 319-11, Japan*
 Person in charge : *Motoharu Mizumoto*
 Name of person supplying these data : *Motoharu Mizumoto*
 e-mail : *mizumoto@linac.tokai.jaeri.go.jp*
 tel. : *+81 29 282 6451* fax : *+81 29 282 5663*

HISTORY AND STATUS

Const. started : *03/1992* ; first beam : *02/1994*
 Present status : *Operating*
 Cost of facility :
 Present linac staff : *11*
 Present yearly operat. time : h

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other :

LINAC PARAMETERS

Ion Source

Type : *Multi-cusp*
 Output : *140* mA at *100* keV
 Pulse length : *100* μ s; rep. rate : *100* Hz
 Normalized emittance (1σ) : *0.08* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 vane* ; lengths : *335* m
 Output : *70* mA at *2000* keV
 Pulse length : *700* μ s; rep. rate : *100* Hz
 Normalized emittance (1σ) : *0.7* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : m; No. of tanks :
 Tank diameters : m
 Number of drift-tubes :
 Drift-tube lengths : mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : mm to mm
 RF frequency(ies) : MHz
 Field modes :
 Eff. shunt impedance : M Ω /m
 Q :
 Filling time : μ s
 Equilibrium phases :
 RF rep. rate : Hz; pulse : μ s
 Beam rate : Hz; pulse : μ s
 RF power peak : MW; mean : MW

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy :		<i>2</i>	MeV
Mean acc. rate :		<i>0.6</i>	MeV/m
$\Delta E/E$ (FWHM) :		<i>< 5</i>	%
Beam current :		<i>70</i>	mA peak
Norm. emit. (1σ) :		<i>0.7</i>	π mm-mrad

OTHER RELEVANT INFORMATION

RFQ only.

ELECTRON LINAC

Name of Linac : *Subpicosecond Twin Linac*
Function : *Picosecond Time-resolved Measurement for Radiation Physics and Chemistry*
Institution and address : *NERL *, University of Tokyo, Tokai, Ibaraki, Japan*
Person in charge : *Mitsuru Uesaka*
Name of person supplying these data : *Mitsuru Uesaka*
e-mail : *uesaka@utnl.gen.u-tokyo.ac.jp*
tel. : *+81 29 287 8421* fax : *+81 29 287 8488*

HISTORY AND STATUS

Const. started : *1975* ; first beam : *1977*
Present status : *Operating*
Cost of facility : *5 MUSD*
Present linac staff : *4 persons*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic* ; energy : *90* keV
Beam intensity (peak) : *10* A
Normalized emittance (1σ) : *100* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : *100* π mm-mrad

Acceleration System

Total linac length : *10* m
No. sections : *2* ; lengths : *2* m
Field mode : *$2/3\pi$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.6* μ s
 v_{ϕ}/c range : *0.0085* ; Q : *1931*
Shunt impedance : *56* M Ω /m
Iris : aperture : diameter : *20* mm
thickness : *4* mm
Attenuation/section : *0.39* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *7* MW; mean : *1.8* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1 - 14300*
No. of particles/bunch : *≤ 3 nC*
Bunch separation : *350 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>(2)</i>		GeV
Accel gradient	: <i>10</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>0.3</i>		%
Rep. rate	: <i>50</i>		Hz
Pulse length	: <i>(3)</i>		μ s
Beam intensity	: <i>≤ 1000</i>		A
Norm. emit. (1σ)	: <i>100</i>		π mm-mrad

OTHER RELEVANT INFORMATION

* *Nuclear Engineering Research Laboratory*

- (1) *476 MHz SHB, 2.856 GHz Prebuncher*
(2) *0.028, 0.018, 0.035*
(3) *700 fs to 5 μ s*

ION LINAC

Name of Linac : *TIT-IH-2-Linac*
 Function : *Booster Linac of Heavy Ion Accelerator*
 Institution and address : *RLNR, Tokyo Institute of Technology, Tokyo, Japan*
 Person in charge : *Director of RLNR*
 Name of person supplying these data : *T. Hattori*
 e-mail : *thattori@nr.titech.ac.jp*
 tel. : *+81 3 5734 3055* fax : *+81 3 5734 2959*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1987*
 Present status : *Operational*
 Cost of facility : *0.5 MUSD (1984)*
 Present linac staff : *1 man-year*
 Present yearly operat. time : *100* h

LINAC PARAMETERS

Ion Sources

No. of sources :
 Types of source :
 Species of ions :
 Range of currents : μAe
 Range of output energies : keV/u
 Pulse length : μs ; rep. rate : Hz
 Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *TIT-IH-Linac* 7 m
 Output currents : *0.1* μAe
 Output energies : *2.4* keV/u
 Frequency : *48* MHz; peak RF power : *80* kW
 Pulse length : μs ; rep. rate : *DC* Hz
 Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : 3 m; N^o. of tanks : 1
 Tank diameters : 0.76 m
 Number of drift-tubes : 21+2 (1/2)
 Drift-tube lengths : 56.0 ~ 66.6 mm
 Drift-tube diam (range): 60 mm
 Gap/cell length (range): 1/2
 Aperture diameter : 30 mm to mm
 RF frequency(ies) : 96 MHz
 Field modes : *TE111*
 Eff. shunt impedance : 132 $\text{M}\Omega/\text{m}$
 Q :
 Filling time : *DC* μs
 Equil. phases : 0 ; accel. rate 1.33 MeV/u-m
 RF rep. rate : *DC* Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : (1) MW; mean : 0.001 MW

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other : *No*

Charge Stripping (Typical)

Type(s) : *Carbon foil*
 Charge states : C^{3+} to C^{6+} at 2.4 MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	<i>P</i>	<i>Cl</i>	
Energy	<i>3.4</i>	<i>3.4</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>5</i>	<i>5</i>	%
Mean acc. rate	<i>0.36</i>	<i>1.33</i>	MeV/u-m
Beam current	<i>0.03</i>	<i>0.1</i>	$\mu\text{Ae peak}$
Norm. emit. (1σ)	<i>0.6</i>	<i>0.6</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>P</i>	<i>3.4 MeV/u</i>	
<i>O⁶⁺</i>	<i>3.0 MeV/u</i>	<i>at 10 kW</i>

OTHER RELEVANT INFORMATION

(1) *10 kW (50 kW)*

ION LINAC

Name of Linac : *TIT-IH-Linac*
 Function : *Main Linac of Heavy Ion Accelerator*
 Institution and address : *RLNR, Tokyo Institute of Technology, Tokyo, Japan*
 Person in charge : *Director of RLNR*
 Name of person supplying these data : *T. Hattori*
 e-mail : *thattori@nr.titech.ac.jp*
 tel. : *+81 3 5734 3055* fax : *+81 + 5734 2959*

HISTORY AND STATUS

Const. started : *1983* ; first beam : *10/1984*
 Present status : *Operational*
 Cost of facility : *3.5 MUSD (1983)*
 Present linac staff : *1 man-year*
 Present yearly operat. time : *200* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *PIG and SNICS-II*
 Species of ions : *He ~ Cl* $\epsilon \geq 1/4$
 Range of currents : *30* μAe
 Range of output energies : *20* keV/u
 Pulse length : *DC* μs ; rep. rate : *Hz*
 Normalized emittance (1σ) : *π mm-mrad*

Pre-accelerators (including RFQ)

Types (lengths) : *5SDH-2* m
 Output currents : *10* μAe
 Output energies : *240* keV/u
 Frequency : *DC* MHz; peak RF power : *kW*
 Pulse length : μs ; rep. rate : *Hz*
 Normalized emittance (1σ) : *π mm-mrad*

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *7* m; N^o. of tanks : *1*
 Tank diameters : *1.4* m
 Number of drift-tubes : *43+2 (1/2)*
 Drift-tube lengths : *43.5 ~ 134.2* mm
 Drift-tube diam (range): *50/100* mm
 Gap/cell length (range): *1/3*
 Aperture diameter : *23* mm to *1.0* mm
 RF frequency(ies) : *47* MHz
 Field modes : *TE111*
 Eff. shunt impedance : *179* M Ω /m
 Q : *21500*
 Filling time : *DC* μs
 Equil. phases : *-30* ; accel. rate *1.23* MeV/u-m
 RF rep. rate : *DC* Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : *0.08* MW; mean : *0.08* MW

Focusing System

No. elements : *DC*
 type : *QM* order : *FODO*
 Gradients : *20* to *50* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Carbon foil*
 Charge states : *Cl⁴⁺* to *Cl⁹⁺* at *0.24* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	<i>Cl</i>	<i>Cl</i>	
Energy	<i>2.4</i>	<i>2.4</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>0.5</i>	<i>0.5</i>	%
Mean acc. rate	<i>1.23</i>	<i>1.23</i>	MeV/u-m
Beam current	<i>0.1</i>	<i>0.1</i>	μAe peak
Norm. emit. (1σ)	<i>0.6</i>	<i>0.6</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>P</i>	<i>2.4 MeV/u</i>	<i>PIG</i>
<i>Cl</i>	<i>2.4 MeV/u</i>	<i>SNICS-II</i>

OTHER RELEVANT INFORMATION

ION LINAC

Name of Linac : *Deuteron IH Linac*
 Function : *Radio-Isotope Production for PET*
 Institution and address : *RLNR, Tokyo Institute of Technology, Tokyo, Japan*
 Person in charge : *T. Hattori*
 Name of person supplying these data : *T. Hattori*
 e-mail : *thattori@nr.titech.ac.jp*
 tel. : *+81 3 5734 3055* fax : *+81 3 5734 2959*

HISTORY AND STATUS

Const. started : *1993* ; first beam : *06/1996*
 Present status : *Operational*
 Cost of facility : *0.1 MUSD*
 Present linac staff : *1 man-year*
 Present yearly operat. time : *100* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *Compact ECR*
 Species of ions : *P, d*
 Range of currents : *100* μAe
 Range of output energies : *100* keV/u
 Pulse length : *DC* μs ; rep. rate : Hz
 Normalized emittance (1σ) : *0.6* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *HVPS (0.5)* m
 Output currents : *100* μAe
 Output energies : *100* keV/u
 Frequency : *DC* MHz; peak RF power : kW
 Pulse length : μs ; rep. rate : Hz
 Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *1.9* m; N^o. of tanks : *1*
 Tank diameters : *0.56 - 0.64 - 0.7* m
 Number of drift-tubes : *28+2 (1/2)*
 Drift-tube lengths : *13.1 ~ 21.1* mm
 Drift-tube diam (range): *30 - 60* mm
 Gap/cell length (range): *~ 0.5*
 Aperture diameter : *24* mm to *44* mm
 RF frequency(ies) : *103* MHz
 Field modes : *TE111*
 Eff. shunt impedance : *420* M Ω /m
 Q : *16000*
 Filling time : *DC* μs
 Equil. phases : ; accel. rate *1.7* MeV/u-m
 RF rep. rate : *DC* Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : *DC* MW; mean : *0.012* MW

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other : *APF (-90^o ~ +15^o)*

Charge Stripping (Typical)

Type(s) : *No*
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	<i>P</i>	<i>D</i>	
Energy	<i>1.7</i>	<i>1.7</i>	MeV/u
$\Delta E/E$ (FWHM)			%
Mean acc. rate			MeV/u-m
Beam current	<i>1</i>	<i>1000</i>	μAe peak
Norm. emit. (1σ)	<i>0.6</i>	<i>0.6</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>P</i>	<i>1.7 MeV/u</i>	
<i>D</i>	<i>1.7 MeV/u</i>	

OTHER RELEVANT INFORMATION

ION LINAC

Name of Linac : *TIT-RFQ*
 Function : *Heavy Ion Linac for plasma experiment*
 Institution and address : *RLNR Tokyo, Institute of Technology, Tokyo, Japan*
 Person in charge : *T. Hattori*
 Name of person supplying these data : *T. Hattori*
 e-mail : *thattori@nr.titech.ac.jp*
 tel. : *+81 3 5734 3055* fax : *+81 3 5734 2959*

HISTORY AND STATUS

Const. started : *1992* ; first beam : *11/1993*
 Present status : *Operational*
 Cost of facility : *0.75 MUSD (1992)*
 Present linac staff : *1 man-year*
 Present yearly operat. time : *600* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *ECR*
 Species of ions : *(1)*
 Range of currents : *1600 (7000)* μAe
 Range of output energies : *0.22* keV/u
 Pulse length : *DC* μs ; rep. rate : *Hz*
 Normalized emittance (1σ) : *0.5* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *HVPS (0.2)* m
 Output currents : μAe
 Output energies : keV/u
 Frequency : MHz; peak RF power : kW
 Pulse length : μs ; rep. rate : *DC* Hz
 Normalized emittance (1σ) : *0.6* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *4.4* m; N^o. of tanks :
 Tank diameters : *725* m
 Number of drift-tubes : *242*
 Drift-tube lengths : *413* mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : *0.8* mm to *1.0* mm
 RF frequency(ies) : *81* MHz
 Field modes : *TE210*
 Eff. shunt impedance : *28* M Ω /m
 Q : *12000*
 Filling time : *150* μs
 Equil. phases : *(2)* ; accel. rate *0.78* MeV/u-m
 RF rep. rate : *30* Hz; pulse : *3000* μs
 Beam rate : *30* Hz; pulse : *3000* μs
 RF power peak : *0.115* MW; mean : *0.012* MW

Focusing System

No. elements : *242*
 type : *FD* order :
 Gradients : to T/m
 Other : *RFQ*

Charge Stripping (Typical)

Type(s) : *No*
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	<i>He</i>	<i>Xe¹⁰⁺</i>	
Energy	<i>0.22</i>	<i>0.22</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>0.5</i>	<i>0.5</i>	%
Mean acc. rate	<i>0.3</i>	<i>0.78</i>	MeV/u-m
Beam current	<i>1.6</i>	<i>6.8</i>	μAe peak
Norm. emit. (1σ)	<i>0.5</i>	<i>0.5</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>He ~ Xe¹⁰⁺, Pb³⁺</i>	<i>0.22 MeV/u</i>	<i>ECR IS</i>

OTHER RELEVANT INFORMATION

- (1) *He⁺, ¹⁶O⁺, Xe¹⁰⁺ $\epsilon \geq 1/16$*
- (2) *-90, -30, -20*

ELECTRON LINAC

Name of Linac : *KEK PF* 2.5 GeV Linac*
Function : *Injector Linac for 2.5 GeV PF Storage Ring and AR***
Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken, 305, Japan*
Person in charge : *Kazuo Nakahara*
Name of person supplying these data : *H. Kobayashi*
e-mail : *hitoshik@kekvox.kek.jp*
tel. : *0298 64 5585* fax : *0298 64 2801*

HISTORY AND STATUS

Const. started : *1978* ; first beam : *1982*
Present status : *Operating*
Cost of facility : *7000 MJPY (1982)*
Present linac staff : *29*
Present yearly operation time : *5300* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *200* keV
Beam intensity (peak) : *>10* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *43* MeV; intensity : *10* A
Pulse width, spacing : *10 ns, 40 ms*
Normalized emittance (1σ) : *70* π mm-mrad

Acceleration System

Total linac length : *415* m
No. sections : *160* ; lengths : *1.9* m
Field mode : *$2\pi/3$* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.45-0.56* μ s
 v_p/c range : *(1)* ; Q : *> 13000*
Shunt impedance : *55.4 - 60.3* M Ω /m
Iris : aperture : diameter : *24 - 19.5* mm
thickness : *5* mm
Attenuation/section : *0.23 - 0.55* Np
Power units, Number : *40* type : *Klystron*
RF power peak : *30* MW; mean : *5.3* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupole triplets, 28 triplets
~ 10 m interval in the first fifth part
~ 20 m interval in the remainder of accelerator

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>2.5</i>	<i>3.0</i>	GeV
Accel gradient	: <i>8</i>	<i>20</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.4</i>		%
Rep. rate	: <i>25</i>	<i>50</i>	Hz
Pulse length	: <i>0.001</i>	<i>1</i>	μ s
Beam intensity	: <i>0.4</i>	<i>10</i>	A
Norm. emit. (1σ)	: <i>180</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- * *PF - Photon Factory*
- ** *AR - Accumulator Ring*

(1) *0.019 - 0.0083*

The linac is being upgraded from 2.5 GeV to 8 GeV.

References

[1] *J. Tanaka, Nucl. Instr. Meth. 177 (1980) 101.*

POSITRON LINAC

Name of Linac : *KEK PF 2.5 GeV Linac*
Function : *Positron Injector Linac for 2.5 GeV PF Storage Ring and AR*
Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken, 305, Japan*
Person in charge : *Kazuo Nakahara*
Name of person supplying these data : *H. Kobayashi*
e-mail : *hitoshik@kekvox.kek.jp*
tel. : *+81 0298 64 5585* fax : *+81 0298 64 2801*

HISTORY AND STATUS

Differences with respect to corresponding e^- linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy :	250	MeV
Radius (1σ) :	~ 1	mm
Beam intensity :	10	A

LINAC PARAMETERS

Conversion Target and Capture

Material :	<i>Ta</i>	
Type :	<i>Stationary</i>	
Thickness (rad.length) :	2.0	χ
Diameter :	20	mm
Mean deposited power :	2	kW
Solenoidal field ^{a)} :	<i>(1) QWT</i>	

Matching device :
RF sections^{a)} :

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e^- linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	2.5	3	GeV
Accel gradient :	8	20	MeV/m
$\Delta E/E$ (FWHM) :	0.44		%
Rep. rate :	25	50	Hz
Pulse length :	0.001	0.04	μ s
Yield (fin.en) :	1.8×10^{-2}	1.8×10^{-2}	$e^+/e^- \times$ GeV
Beam intensity :	32000	50000	μ A peak
Norm. emit. (1σ):	2000		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *QWT - Quarter Wave Transformer*
2 T pulsed solenoid (50 mm)
0.4 T DC solenoid (8 m)

References

- [1] *A. Enomoto et al., Nucl. Instr. Meth. A281 (1989)1.*

PROTON AND/OR H- LINAC

Name of Linac : *KEK 5 MeV H⁻ Linac Test Stand*
 Function : *Accelerator Study for JHP*
 Institution and address : *KEK, 1-1 Oho, Tsukuba-shi, Ibaraki-ken 305, Japan*
 Person in charge : *Y. Yamazaki*
 Name of person supplying these data : *Y. Yamazaki*
 e-mail : *yoshishi@kekvox.kek.jp*
 tel. : *+81 298 64 5202* fax : *+81 298 64 3182*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1994*
 Present status : *Partly operational*
 Cost of facility : *700 MJPY (1995)*
 Present linac staff : *6*
 Present yearly operat. time : *h*

Focusing System

No. elements : *19*
 type : *(5) PQM* order : *FODO*
 Gradients : *175* to *168* T/m
 Other :

LINAC PARAMETERS

Ion Source

Type : *Volume-production Type H⁻ Ion Source*
 Output : *16* mA at *50* keV
 Pulse length : *350* μ s; rep. rate : *50* Hz
 Normalized emittance (1σ) : *0.13* π mm-mrad

Pre-accelerator (including RFQ)

Types : *(1) 4 vane RFQ* ; lengths : *2.7* m
 Output : *(2) 13.2* mA at *3000* keV
 Pulse length: *(3) 200* μ s; rep. rate : *(4) 20* Hz
 Normalized emittance (1σ) : *0.15* π mm-mrad

Longitudinal Matching

Type : *One buncher system*
 Mod. *115* keV; drift *784* mm at *432* MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *1.17* m; No. of tanks : *1*
 Tank diameters : *0.44* m
 Number of drift-tubes : *17*
 Drift-tube lengths : *43 to 54* mm
 Drift-tube diam (range): *80* mm
 Gap/cell length (range): *0.24 to 0.26*
 Aperture diameter : *10* mm to mm
 RF frequency(ies) : *432* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *62* M Ω /m
 Q : *44000*
 Filling time : *16* μ s
 Equilibrium phases : *-30 $^\circ$*
 RF rep. rate : *50* Hz; pulse : *600* μ s
 Beam rate : Hz; pulse : μ s
 RF power peak : *0.095* MW; mean : *0.003* MW

LINAC PERFORMANCE

	Normal Operation	Max, or Design
--	---------------------	-------------------

Energy	3	5.4	MeV
Mean acc. rate		2.1	MeV/m
$\Delta E/E$ (FWHM)			%
Beam current	6	20	mA peak
Norm. emit. (1σ)		0.3	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) With PISL's 432 MHz.*
- (2) The H⁻ beam test with LEBT.*
- (3) High power test up to 600 μ s.*
- (4) High power test up to 50 Hz.*
- (5) Permanent quadrupole magnet.*
 - a) One quarter structure of the 10 MeV drift-tube linac. Post-coupled structure.*
 - b) The full beam test will be done in 1997.*

ELECTRON LINAC

Name of Linac : *ICR 100 MeV Electron Linac*
Function : *Electron Linac for KSR injection*
Institution and address : *ICR, Kyoto University, Gokano-sho, Uji-city, Kyoto 611, Japan*
Person in charge : *M. Inoue*
Name of person supplying these data : *A. Noda*
e-mail : *noda@kyticr.kuicr.kyoto-u.ac.jp*
tel. : *+81 774 32 5806* fax : *+81 774 33 5509*

HISTORY AND STATUS

Const. started : *10/1994* ; first beam : *10/1995*
Present status : *Operating*
Cost of facility :
Present linac staff : *5 man-years*
Present yearly operation time : *300 (1995)* h

LINAC PARAMETERS

Electron Sources

Types : *(1)* ; energy : *100* keV
Beam intensity (peak) : *0.12* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Prebuncher, Buncher*
Output : *5* MeV; intensity : *0.1* A
Pulse width, spacing : *1 μ s, 50 ms*
Normalized emittance (1σ) : *100* π mm-mrad

Acceleration System

Total linac length : *10.5* m
No. sections : *3* ; lengths : *3* m
Field mode : *$2\pi/3$* ; frequency : *2.857* GHz
Wave type : *TW* ; filling time : *0.58* μ s
 v_g/c range : *0.0172* ; Q : *13500*
Shunt impedance : *53* M Ω /m
Iris : aperture : diameter : *26.8 - 23.48* mm
thickness : *5.84* mm
Attenuation/section : *0.383* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *21* MW; mean : *1* kW

Focusing System

Type, No. of elements, and spacing :
FD.
FD Lattice, 5 elements, 3.5m spacing

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.1</i>		GeV
Accel gradient	: <i>12</i>		MeV/m
$\Delta E/E$ (FWHM)	:		%
Rep. rate	: <i>20 (max)</i>		Hz
Pulse length	: <i>1</i>		μ s
Beam intensity	: <i>0.100</i>		A
Norm. emit. (1σ)	:		π mm-mrad

OTHER RELEVANT INFORMATION

(1) Pierce type thermal gun

The duty factor is 2×10^{-3} %

PROTON AND/OR H- LINAC

Name of Linac : *ICR 7MeV Proton Linac*
 Function : *Proton Linac for Accelerator Development and Material Irradiation*
 Institution and address : *ICR, Kyoto University, Gokano-sho, Uji-city, Kyoto 611, Japan*
 Person in charge : *M. Inoue*
 Name of person supplying these data : *A. Noda*
 e-mail : *noda@kyticr.kuicr.kyoto-u.ac.jp*
 tel. : *+81 774 32 5806* fax : *+81 774 32 5509*

HISTORY AND STATUS

Const. started : *04/1986* ; first beam : *01/1992*
 Present status : *Operating*
 Cost of facility : *300 MYEN (1986)*
 Present linac staff : *5 man-years*
 Present yearly operat. time : *1500 (1995)* h

Focusing System

No. elements : *29*
 type : *PMQ (NdFeB)* order : *FODO*
 Gradients : *175* to T/m
 Other :

LINAC PARAMETERS

Ion Source

Type : *Multi-cusp Field Type*
 Output : *10* mA at *50* keV
 Pulse length : *500* μ s; rep. rate : *max 180* Hz
 Normalized emittance (1σ) : *1* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 vane RFQ* ; lengths : *2.195* m
 Output : *1.2* mA at *2000* keV
 Pulse length : *50* μ s; rep. rate : *max 180* Hz
 Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type : *(1)*
 Mod. *190* keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *(2)* m; No. of tanks : *1*
 Tank diameters : *0.451* m
 Number of drift-tubes : *28*
 Drift-tube lengths : *38.8 - 65.3* mm
 Drift-tube diam (range): *55* mm
 Gap/cell length (range):
 Aperture diameter : mm to mm
 RF frequency(ies) : *433* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *100* M Ω /m
 Q : *(3) 40000*
 Filling time : *10* μ s
 Equilibrium phases :
 RF rep. rate : *max 180* Hz; pulse : *60* μ s
 Beam rate : *max 180* Hz; pulse : *50* μ s
 RF power peak : *0.33* MW; mean : *0.003* MW

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Energy	: <i>7</i>	MeV
Mean acc. rate	: <i>1.7</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>± 3</i>	%
Beam current	: <i>0.6</i>	mA peak
Norm. emit. (1σ)		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Longitudinal Matching Type : Single rebuncher with double gap resonator between RFQ and DTL.*
- (2) 1.868*
- (3) Unloaded*

ION LINAC

Name of Linac : *RILAC* *
 Function : *Basic Research, Injector for the Ring Cyclotron*
 Institution and address : *The Institute of Physical and Chemical Research (RIKEN)***
 Person in charge : *Y. Miyazawa*
 Name of person supplying these data : *A. Goto*
 e-mail : *goto@ringps.riken.go.jp*
 tel. : *+81 48 462 1111* fax : *+81 48 461 5301*

HISTORY AND STATUS

Const. started : *1974* ; first beam : *1981*
 Present status : *Operational*
 Cost of facility : *(1) 10 MUSD*
 Present linac staff : *10*
 Present yearly operat. time : *4000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *ECR source (Neomafios)*
 Species of ions : *(2) Heavy Ions*
 Range of currents : μAe
 Range of output energies : *(3)* keV/u
 Pulse length : μs ; rep. rate : *CW* Hz
 Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Cockcroft-Walton* m
 Output currents : 10×10^3 μAe
 Output energies : *(4)* keV/u
 Frequency : *CW* MHz; peak RF power : kW
 Pulse length : μs ; rep. rate : Hz
 Normalized emittance (1σ) : π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *30* m; N^o. of tanks : *6*
 Tank diameters : $3^{(L)} \times 2^{(D)} \times 3.5^{(H)}$ m
 Number of drift-tubes : *87*
 Drift-tube lengths : *18 ~ 220* mm
 Drift-tube diam (range): *100 ~ 160* mm
 Gap/cell length (range): *(40 ~ 90) / (60 ~ 310)*
 Aperture diameter : *20* mm to *30* mm
 RF frequency(ies) : *17 ~ 40* MHz
 Field modes : $\lambda / 4$ coaxial / Wideröe
 Eff. shunt impedance : *20 ~ 100* M Ω /m
 Q : *18500 ~ 12000*
 Filling time : μs
 Equil. phases : ; accel. rate MeV/u-m
 RF rep. rate : Hz; pulse : *CW* μs
 Beam rate : Hz; pulse : *CW* μs
 RF power peak : MW; mean : *2.0* MW

Focusing System

No. elements : *36*
 type : *Quadupole magnet* order :
 Gradients : *10* to *60* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *C - Foil Stripper*
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

Species	Normal Operation	Max, or Design	
Species	<i>He ~ Bi</i>		
Energy	<i>(5)</i>		MeV/u
$\Delta E/E$ (FWHM)		<i>0.5</i>	%
Mean acc. rate			MeV/u-m
Beam current			μAe peak
Norm. emit. (1σ)			π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *Riken Linear Accelerator*
 ** *Wako-shi, Saitama, 351-01, Japan*

- (1) Machine only*
- (2) 52 species ever accelerated*
- (3) 16 MV*
- (4) 0.5 MV*
- (5)* 3 MeV/u for $m/q < 5$*

References

[1] *M. Odera et al., N.I.M. 227, 187 (1984)*

ELECTRON LINAC

Name of Linac : *PLS 2-GeV Linac*
Function : *Injector to Pohang Light Source*
Institution and address : *Pohang Accelerator Laboratory, Pohang 790-784, Korea*
Person in charge : *Won Namkung*
Name of person supplying these data : *Won Namkung*
e-mail : *namkung@vision.postech.ac.kr*
tel. : *+82 562 279 1006* fax : *+82 562 279 1099*

HISTORY AND STATUS

Const. started : *4/1/1991* ; first beam : *5/10/1994*
Present status : *Normal Operation*
Cost of facility : *(1)*
Present linac staff : *34*
Present yearly operation time : *5000* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic Gun* ; energy : *80* keV
Beam intensity (peak) : *2* A
Normalized emittance (1σ) : *10* π mm-mrad

Injector

Longitudinal matching : *(2)*
Output : *(3) 0.27 MeV*; intensity : *A*
Pulse width, spacing : *1 ns, 100 ms*
Normalized emittance (1σ) : *π mm-mrad*

Acceleration System

Total linac length : *150* m
No. sections : *(4) 42* ; lengths : *3.072* m
Field mode : *TM01* ; frequency : *2.856* GHz
Wave type : *TW* ; filling time : *0.83* μ s
 v/c range : *(5)* ; Q : *13000*
Shunt impedance : *53 ~ 60* M Ω /m
Iris : aperture : diameter : *19.093 ~ 26.220* mm
thickness : *5.842* mm
Attenuation/section : *1.751* Np
Power units, Number : *11* type : *(6) Klystron*
RF power peak : *80* MW; mean : *(7) 3.2* kW

Focusing System

Type, No. of elements, and spacing :

Quadrupoles

#1, #2, #3, #4, #5, #6 : ϕ 44 mm
#1:8m, #2, #3:16m, #4, #5, #6:27m

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 2	2.34	GeV
Accel gradient	: 15.5	20	MeV/m
$\Delta E/E$ (FWHM)	: 0.3	0.3	%
Rep. rate	: 10	60	Hz
Pulse length	: 10^{-3}	0.04	μ s
Beam intensity	: 2	2	A
Norm. emit. (1σ)	: 0.32	0.075	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) 16 BKRW (20 MUSD), (1994)*
- (2) S-band prebuncher and buncher*
- (3) Estimated by PARMELA*
- (4) Accelerating section: HEM11 suppressor included*
- (5) 0.0204 ~ 0.0065'*
- (6) Toshiba E-3712*
10 detunable pulse compressors used
200 MW modulator using SCR gate control
- (7) 4 μ s pulse with 10 Hz operation*

3 beam exits: 100 MeV, 1 GeV, 2 GeV

References

- [1] W. Namkung, et al., "Commissioning of PLS 2-GeV Electron Linac", Proc. 1994 EPAC, p742 (1994), and references therein.*
- [2] I. Ko, et al., "Control System of PLS 2-GeV Electron Linac", Proc. 1995 IEEE Real-Time Computer Applications, p 271 (1995), and references therein.*

ELECTRON LINAC

Name of Linac : *SRRC **
 Function : *Preinjector linac for SRRC 1.3 GeV Booster Synchrotron*
 Institution and address : *No 1 R&D Road VI Hsinchu Science-Based Industrial Park, Hsinchu 300, Taiwan*
 Person in charge : *Tzong-Shyan Ueng (Linac) Prof. Y.C. Liu (Director)*
 Name of person supplying these data : *Tzong-Shyan Ueng*
 e-mail : *UENG@SRRC01.SRRC.GOV.TW*
 tel. : *+886 35 780281 ext. 6315* fax : *+886 35 783892*

HISTORY AND STATUS

Const. started : *1991* ; first beam : *1992*
 Present status : *Operating*
 Cost of facility : *1 MUSD*
 Present linac staff : *5 man-years*
 Present yearly operation time : *4500* h

LINAC PARAMETERS

Electron Sources

Types *Dispenser cathode* ; energy : *150* keV
 Beam intensity (peak) : *< 2.5* A
 Normalized emittance (1σ) : *< 40* π mm-mrad

Injector

Longitudinal matching : *(1)*
 Output : *NA* MeV; intensity : *NA* A
 Pulse width, spacing : *NA*
 Normalized emittance (1σ) : *NA* π mm-mrad

Acceleration System

Total linac length : *3.08* m
 No. sections : *1* ; lengths : *3.08* m
 Field mode : *$2\pi/3$* ; frequency : *2.9979* GHz
 Wave type : *TW* ; filling time : *0.78* μ s
 v_g/c range : *0.012* ; Q : *13025*
 Shunt impedance : *NA* M Ω /m
 Iris : aperture : diameter : *NA* mm
 thickness : *NA* mm
 Attenuation/section : *0.564* Np
 Power units, Number : *2* type : *Klystron*
 RF power peak : *30* MW; mean : *0.9* kW

Focusing System

Type, No. of elements, and spacing :
Along the beam centerline: lens 1, drift space steering, lens 2, chopper bras, lens 3, waveguide steering, solenoids 1, 2, 3 and 4.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
 No. of particles/bunch : *NA*
 Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.05	0.05	GeV
Accel gradient	: 16.8	16.8	MeV/m
$\Delta E/E$ (FWHM)	: 0.4	0.4	%
Rep. rate	: 10	10	Hz
Pulse length	: 0.2 - 2	0.2 - 2	μ s
Beam intensity	: 0.024	0.024	A
Norm. emit. (1σ)	: 100	100	π mm-mrad

OTHER RELEVANT INFORMATION

* *Synchrotron Radiation Research Centre*

(1) *Dual cavity 3GHz chopper/prebuncher*

References

[1] *See Instruction Manual HRC - 780 50 MeV Linac for SRRC preinjector*

EUROPE

EUROPE

ELECTRON LINAC

Name of Linac : *ELECTRONICA U-006*
 Function : *Applied Researches*
 Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
 Person in charge : *Kh. Harutyunyan*
 Name of person supplying these data : *Kh. Harutyunyan*
 e-mail :
 tel. : +7 8852 3742 340083 fax : (3742) 350030 /151695

HISTORY AND STATUS

Const. started : *1990* ; first beam : *1990*
 Present status : *Operational*
 Cost of facility : *300 kUSD*
 Present linac staff : *3*
 Present yearly operation time : *500* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *30* keV
 Beam intensity (peak) : *1.5* A
 Normalized emittance (1σ) : *1* π mm-mrad

Injector

Longitudinal matching :
 Output : *10* MeV; intensity : *0.75* A
 Pulse width, spacing : *5* μ s, *1 - 200* Hz
 Normalized emittance (1σ) : *80* π mm-mrad

Acceleration System

Total linac length : *4.5* m
 No. sections : *1* ; lengths : *2.2* m
 Field mode : *$\pi/2$* ; frequency : *1890* GHz
 Wave type : *TM01* ; filling time : *0.2* μ s
 v_g/c range : *0.03* ; Q : ≥ 8000
 Shunt impedance : *25* M Ω /m
 Iris : aperture : diameter : mm
 thickness : mm
 Attenuation/section : *4* Np
 Power units, Number : *1* type : *Magnetron*
 RF power peak : *10* MW; mean : *1 - 10* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units, placed along section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *9500*
 No. of particles/bunch : *2.5×10^9*
 Bunch separation : *16cm bunch length ≤ 53 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>10</i>	<i>10</i>	GeV
Accel gradient	: <i>4.5</i>	<i>4.5</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>5</i>	<i>5</i>	%
Rep. rate	: <i>1 - 200</i>	<i>1 - 200</i>	Hz
Pulse length	: <i>5</i>	<i>5</i>	μ s
Beam intensity	: <i>0.00075</i>	<i>0.00075 (1)</i>	A
Norm. emit. (1σ)	: <i>80</i>	<i>80</i>	π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Mean*

ELECTRON LINAC

Name of Linac : *High Current Injector for YerPhI Synchrotron*
Function :
Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
Person in charge : *V. Nikogossian*
Name of person supplying these data : *G. Oksuzian*
e-mail : *Oksuzian@vx1.yerphi.am*
tel. : +7 8852 3742 344066 fax : (3742) 350030 /151695

HISTORY AND STATUS

Const. started : ; first beam :
Present status : *(1) Installation and Tuning*
Cost of facility : *8 MUSD*
Present linac staff : *9*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *150* keV
Beam intensity (peak) : *5 - 10* A
Normalized emittance (1σ) : *0.7* π mm-mrad

Injector

Longitudinal matching :
Output : *20* MeV; intensity : *1.2* A
Pulse width, spacing : *(2)*
Normalized emittance (1σ) : *1.2* π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *2* ; lengths : *2 x 2* m
Field mode : *$\pi/2$* ; frequency : *2.856* GHz
Wave type : *TM01* ; filling time : *5 - 10* μ s
 v_g/c range : *0.03* ; Q : ≥ 8000
Shunt impedance : ~ 50 M Ω /m
Iris : aperture : diameter : *29* mm
thickness : *4* mm
Attenuation/section : *7* Np
Power units, Number : *(3)* type : *Klystron*
RF power peak : *20* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units, placed in the injector section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *28000*
No. of particles/bunch : *1×10^9*
Bunch separation : *(4)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.020</i>	<i>0.120</i>	GeV
Accel gradient	: <i>5</i>	<i>5</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1.5</i>	<i>1.5</i>	%
Rep. rate	: <i>50 - 100</i>	<i>50 - 100</i>	Hz
Pulse length	: <i>5 - 10</i>	<i>5 - 10</i>	μ s
Beam intensity	: <i>(5) 0.001</i>	<i>0.001</i>	A
Norm. emit. (1σ)	: <i>0.8</i>	<i>0.8</i>	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) High-current electron source*
- (2) (5-10) μ s, (50-100) Hz*
- (3) 2 (18)*
- (4) 10.5 cm, bunch length ≤ 35 ps*
- (5) Mean current*

ELECTRON LINAC

Name of Linac : *Injector for YerPhi Synchrotron*
Function : *Generation 75 MeV electrons*
Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
Person in charge : *V. Nikogossian*
Name of person supplying these data : *G. Oksuzian*
e-mail : *Oksuzian@vx1.yerphi.am*
tel. : +7 8852 3742 344066 fax : (3742) 350030 /151695

HISTORY AND STATUS

Const. started : *1961* ; first beam : *1965*
Present status : *Operational*
Cost of facility : *4 MUSD*
Present linac staff : *6*
Present yearly operation time : *6000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *50 + 80* keV
Beam intensity (peak) : *0.5* A
Normalized emittance (1σ) : *0.7* π mm-mrad

Injector

Longitudinal matching :
Output : *15 + 75* MeV; intensity : *0.2* A
Pulse width, spacing : *1 μ s, 50* Hz
Normalized emittance (1σ) : *1* π mm-mrad

Acceleration System

Total linac length : *25* m
No. sections : *4* ; lengths : *4.5 \times 4* m
Field mode : *$\pi/2$* ; frequency : *2.7973* GHz
Wave type : *TM01* ; filling time : *~ 0.4* μ s
 v_p/c range : *~ 0.03* ; Q : *≥ 8000*
Shunt impedance : *~ 50* M Ω /m
Iris : aperture : diameter : *29* mm
thickness : *4* mm
Attenuation/section : *7* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *20* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units placed in the injector section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *2800*
No. of particles/bunch : *5×10^7*
Bunch separation : *(1)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.075</i>	<i>0.050</i>	GeV
Accel gradient	: <i>4.5</i>	<i>4.2</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>2.0</i>	<i>2.5</i>	%
Rep. rate	: <i>50</i>	<i>50</i>	Hz
Pulse length	: <i>0.5 - 1</i>	<i>0.5 - 1</i>	μ s
Beam intensity	: <i>0.000010</i>	<i>0.000010</i>	A
Norm. emit. (1σ)	: <i>0.9</i>	<i>0.9</i>	π mm-mrad

OTHER RELEVANT INFORMATION

(1) *10.7 cm, bunch length ≤ 35 ps*

ELECTRON LINAC

Name of Linac : *LAE-8 Electronics*
Function : *Irradiation of materials and radiation technology*
Institution and address : *Yerevan Physics Institute, 375036, Yerevan, Armenia*
Person in charge : *A. Oganessian*
Name of person supplying these data : *G.N. Yeritsian*
e-mail : *Yeritsian@vxc.yerphi.am*
tel. : +7 8852 3742 350030 fax :

HISTORY AND STATUS

Const. started : *1986* ; first beam : *1986*
Present status : *Irradiation source*
Cost of facility : *430000 RUR (1986)*
Present linac staff : *3 persons*
Present yearly operation time : *800* h

LINAC PARAMETERS

Electron Sources

Types : *Oxide* ; energy : *40* keV
Beam intensity (peak) : *5* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.05* MeV; intensity : *5* A
Pulse width, spacing : *1 - 5* μ s
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2* m
No. sections : *1* ; lengths : *2* m
Field mode : ; frequency : *1.86* GHz
Wave type : *TW* ; filling time : *5* μ s
 v_g/c range : ; Q : *1000*
Shunt impedance : *2* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *18* MW; mean : *18* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.008</i>	<i>0.008</i>	GeV
Accel gradient	: <i>4</i>	<i>4</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>20 - 25</i>	<i>15 - 25</i>	%
Rep. rate	: <i>150 - 250</i>	<i>150 - 250</i>	Hz
Pulse length	: <i>4</i>	<i>4</i>	μ s
Beam intensity	: 2×10^5	4×10^5 (1)	A
Norm. emit. (1σ)	: <i>20</i>	<i>10</i>	π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Mean current*

ELECTRON LINAC

Name of Linac : *ELECTRONICA U-003*
Function : *Applied Researches*
Institution and address : *Yerevan Physics Institute, 375036 Yerevan, Armenia*
Person in charge : *Kh. Harutyunyan*
Name of person supplying these data : *Kh. Harutyunyan*
e-mail :
tel. : +7 8852 3742 340083 fax : (3742) 350030 /151695

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1989*
Present status : *Operational*
Cost of facility : *200 kUSD*
Present linac staff : *3*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *30* keV
Beam intensity (peak) : *1.5* A
Normalized emittance (1σ) : *1* π mm-mrad

Injector

Longitudinal matching :
Output : *5* MeV; intensity : *0.75* A
Pulse width, spacing : *5 μ s, 1 - 200 Hz*
Normalized emittance (1σ) : *80* π mm-mrad

Acceleration System

Total linac length : *4* m
No. sections : *1* ; lengths : *2* m
Field mode : *$\pi/2$* ; frequency : *1.890* GHz
Wave type : *TM01* ; filling time : *0.2* μ s
 v_ϕ/c range : *0.03* ; Q : ≥ 8000
Shunt impedance : *25* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : *4* Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *10* MW; mean : *1 - 10* kW

Focusing System

Type, No. of elements, and spacing :
Electromagnetic lens, 3 units placed along section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *9500*
No. of particles/bunch : *2.5×10^9*
Bunch separation : *16cm, bunch length $\leq 53ps$*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.005</i>	<i>0.005</i>	GeV
Accel gradient	: <i>2.5</i>	<i>2.5</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>5</i>	<i>5</i>	%
Rep. rate	: <i>1 - 200</i>	<i>1 - 200</i>	Hz
Pulse length	: <i>5</i>	<i>5</i>	μ s
Beam intensity	: <i>0.00075</i>	<i>0.00075 (1)</i>	A
Norm. emit. (1σ)	: <i>80</i>	<i>80</i>	π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Mean*

ELECTRON LINAC

Name of Linac : *LAE-4 Electronics*
Function : *Irradiation of materials and sterilization*
Institution and address : *Yerevan Physics Institute, 375036, Yerevan, Armenia*
Person in charge : *A. Oganessian*
Name of person supplying these data : *G.N. Yeritsian*
e-mail : *Yeritsian@vxc.yerphi.am*
tel. : +7 8852 3742 350030 fax :

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1984*
Present status : *Irradiation Source*
Cost of facility : *160000 RUR (1984)*
Present linac staff : *3 persons*
Present yearly operation time : *800* h

LINAC PARAMETERS

Electron Sources

Types : *Oxide cathode* ; energy : *30* keV
Beam intensity (peak) : *5* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.05* MeV; intensity : *3* A
Pulse width, spacing : *1 - 4* μ s
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *2* m
No. sections : *1* ; lengths : *2* m
Field mode : ; frequency : *1.86* GHz
Wave type : *Mobile* ; filling time : *5* μ s
 v_g/c range : ; Q : *1000*
Shunt impedance : *2* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Magnetron*
RF power peak : *18* MW; mean : *18* kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.004</i>	<i>0.004</i>	GeV
Accel gradient	: <i>2</i>	<i>2</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>20 - 25</i>	<i>15 - 20</i>	%
Rep. rate	: <i>150 - 250</i>	<i>150 - 250</i>	Hz
Pulse length	: <i>4</i>	<i>4</i>	μ s
Beam intensity	: <i>0.4×10^3</i>	<i>$0.8 \times$</i>	A
Norm. emit. (1σ)	: <i>15</i>	<i>10</i>	π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Mean current*

ELECTRON LINAC

Name of Linac : *Gent University Electron Linac*
Function : *Electron Linac for Interdisciplinary Research*
Institution and address : *Subatomic and Radiation Physics, Proeftuinstraat 86, B-9000 Gent, Belgium*
Person in charge : *W. Mondelaers*
Name of person supplying these data : *W. Mondelaers*
e-mail : *Wim.Mondelaers@Rug.Ac.Be*
tel. : +32 9 264 65 33 fax : +32 9 264 66 99

HISTORY AND STATUS

Const. started : *1981* ; first beam : *1984*
Present status : *Operating*
Cost of facility : *85 MBF (1984)*
Present linac staff : *4 man-years*
Present yearly operation time : *5000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *40.0* keV
Beam intensity (peak) : *0.25* A
Normalized emittance (1σ) : *π* mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *1.75* MeV; intensity : *0.150* A
Pulse width, spacing : *10 μ s, 500 μ s*
Normalized emittance (1σ) : *180* π mm-mrad

Acceleration System

Total linac length : *7* m
No. sections : *1* ; lengths : *4.5* m
Field mode : *$2\pi/3$* ; frequency : *2.9985* GHz
Wave type : *TW* ; filling time : *1* μ s
 v_g/c range : *0.008 -* ; Q : *15000*
Shunt impedance : *65* M Ω /m
Iris : aperture : diameter : *25 - 18* mm
thickness : *5.0* mm
Attenuation/section : *7* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *4* MW; mean : *60* kW

Focusing System

Type, No. of elements, and spacing :

Solenoids

A triplet at 1.75 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *$3 \cdot 10^4$*
No. of particles/bunch : *$2 \cdot 10^8$*
Bunch separation : *300 psec*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.010</i>	<i>0.015</i>	GeV
Accel gradient	: <i>2</i>	<i>3</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>	<i>1</i>	%
Rep. rate	: <i>2000</i>	<i>5000</i>	Hz
Pulse length	: <i>10</i>	<i>14</i>	μ s
Beam intensity	: <i>0.100</i>	<i>0.100</i>	A
Norm. emit. (1σ)	: <i>200</i>	<i>200</i>	π mm-mrad

OTHER RELEVANT INFORMATION

(1) S-band prebuncher and buncher

References

[1] "The Gent University 15 MeV high-current linear electron accelerator facility" *W. Mondelaers et al. Nucl. Instr. & Meth. A368 (1996) 278.*

ELECTRON LINAC

Name of Linac : *ELSA*
Function : *FEL and e-beam applications*
Institution and address : *C.E.A. - 91680 Bruyeres-le-Chatel, France*
Person in charge : *Serge Joly*
Name of person supplying these data : *Serge Joly*
e-mail : *joly@bruyeres.cea.fr*
tel. : *+33 1 69 26 47 27* fax : *+33 1 69 26 70 24*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *11/1991*
Present status : *Operating*
Cost of facility :
Present linac staff : *5*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Photo-injector*
Output : *2* MeV; intensity : A
Pulse width, spacing : *20-60 ps*
Normalized emittance (1σ) : *2* π mm-mrad

Acceleration System

Total linac length : *4.5* m
No. sections : *3* ; lengths : *1.04* m
Field mode : π ; frequency : *0.433* GHz
Wave type : *SW* ; filling time : μ s
 v/c range : ; Q : *3000*
Shunt impedance : *11.25* M Ω /m
Iris : aperture : diameter : *60* mm
thickness : *26* mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *6* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *30-10800*
No. of particles/bunch : *3.10^{10}*
Bunch separation : *13.8 ns - 5 μ s*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.016</i>	<i>0.020</i>	GeV
Accel gradient	: <i>5.3</i>	<i>7</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.1</i>	<i>0.1</i>	%
Rep. rate	: <i>1</i>	<i>20</i>	Hz
Pulse length	: <i>100</i>	<i>150</i>	μ s
Beam intensity	: <i>(1) 100</i>	<i>(1) 500</i>	A
Norm. emit. (1σ)	: <i>2</i>		π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Beam Intensity (peak)*

ELECTRON LINAC

Name of Linac : *ESRF Preinjector*
Function : *Electron linac*
Institution and address : *ESRF, Ave des Martyrs, BP 220 - F 38043 Grenoble, France*
Person in charge : *Jean Paul PERRINE*
Name of person supplying these data : *JP Perrine*
e-mail :
tel. : +33 76 88 24 14 fax : +33 76 88 20 54

HISTORY AND STATUS

Const. started : *02/1988* ; first beam : *06/1991*
Present status : *Operating*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *80* keV
Beam intensity (peak) : *< 0.05* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Buncher*
Output : *4* MeV; intensity : *0.03* A
Pulse width, spacing : *1.2 μ s/2 ns* *100 ms/1 s*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *20* m
No. sections : *2* ; lengths : *6* m
Field mode : *$2\pi/3$* ; frequency : *2.9988* GHz
Wave type : *TW* ; filling time : *1.8* μ s
 v_g/c range : *(1)* ; Q : *15000*
Shunt impedance : *74* M Ω /m
Iris : aperture : diameter : *25 - 18* mm
thickness : *5* mm
Attenuation/section : *8.30* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *35* MW; mean : *14* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 4 MeV (Around bunchers)
(2)

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.160</i>	<i>0.200</i>	GeV
Accel gradient	: <i>13</i>	<i>16</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>	<i>1</i>	%
Rep. rate	: <i>10/1</i>	<i>10/1</i>	Hz
Pulse length	: <i>1.22/0.002</i>	<i>1.2/0.002</i>	μ s
Beam intensity	: <i>0.02</i>	<i>2.5</i>	A
Norm. emit. (1σ)	: <i>< 100</i>	<i>< 100</i>	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *0.0075 - 0.022*
- (2) *Focusing triplets:*
 - *one after the buncher*
 - *one between the 2 accelerating sections*
 - *solenoids around each section*

These data are values in standard operation. Initially, the gun and the buncher were designed to produce high current (> 2.5 A) allowing the optional production of e^+ . As this option has been completely abandoned, the linac is running as a low current electron injector.

Gun's running mode

- *Long pulse : 1.2 μ s 25 mA*
- *Long pulse modulated by the 352 MHz of the ring. In this case, the gun emits current only during the positive part of the sinewave of 352 MHz.*
- *Short pulse : 2 ns pulse lengths from 1 to 4 pulses each 100 ms.*

ELECTRON LINAC

Name of Linac : Orsay Linac
Function : Electron Linac for e^+ Production
Institution and address : LURE, Centre Universitaire, Bât. 209 D, 01405 Orsay, France
Person in charge : L. Melard
Name of person supplying these data : M-A. Tordeux
e-mail : Tordeux@LALCLS.IN2P3.FR
tel. : +33 1 64 46 81 80 fax : +33 1 69 85 39 97

HISTORY AND STATUS

Const. started : 1965 ; first beam : 1968
Present status : Operating
Cost of facility :
Present linac staff : 26 man-years
Present yearly operation time : 760 h

LINAC PARAMETERS

Electron Sources (1)

Types : Diode ; energy : 100 keV
Beam intensity (peak) : 3 A
Normalized emittance (1σ) : π mm-mrad

Injector (1)

Longitudinal matching : (2)
Output : 20 MeV; intensity : 1.4 A
Pulse width, spacing : 20 ns, 40 ms
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 130 m
No. sections : 17 ; lengths : 6 m
Field mode : $\pi/2$; frequency : 2.9986 GHz
Wave type : TW ; filling time : 1 μ s
 v_g/c range : 0.011 - ; Q : (3)
Shunt impedance : 10 - 18.3 M Ω /m
Iris : aperture : diameter : 30 - 18 mm
thickness : 3 mm
Attenuation/section : 0.54 - 0.92 Np
Power units, Number : 17 type : (4)
RF power peak : 25 MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
(5)

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	1	1	GeV
Accel gradient	10	13	MeV/m
$\Delta E/E$ (FWHM)			%
Rep. rate	25	50	Hz
Pulse length	0.005/0.020	id	μ s
Beam intensity	2.5/3.5	id	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

(1) A second injector "NIL" provides short pulses which are bent at 16 MeV to the main Linac through an achromatic transport line. It allows "single bunch" injection into Super-ACO.

Electron Source

Type : Triode; Energy : 100 keV; Beam Intensity : 7 A

Injector

Long. matching : S-band Prebuncher and Buncher
Output k.e.: 16 MeV; Intensity : 3.5 A
Pulse width, spacing : 5 ns, 40 ms

(2) Deflecting plates and S-band Buncher

(3) 10000 to 11800

(4) Klystron / F2040E

(5) Solenoids upto 20 MeV, a triplet at 80 MeV, doublet at 200 MeV / 440 MeV / 680 MeV, a triplet before target

References

[1] "NIL, the New Injector of the Orsay Linac".
M-A. Tordeux et al., EPAC 94 p. 170

POSITRON LINAC

Name of Linac : Orsay Linac
 Function : Positron Injector for Storage Rings (Super-ACO and DCI)
 Institution and address : LURE, Centre Universitaire, Bât. 209 D, 91405 Orsay, France
 Person in charge : L. Melard
 Name of person supplying these data : M-A. Tordeux, A. Pichot
 e-mail : Tordeux@LALCLS.IN2P3.FR
 tel. : +33 1 64 46 81 80 fax : +33 1 69 85 39 97

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right. (1)

Primary Beam (e⁻) at Conversion Target

Energy	: 1000	MeV
Radius (1σ)	:	mm
Beam intensity	: 1 or 3	A

LINAC PARAMETERS

Conversion Target and Capture

Material	: 96% W 2% Cu 2% Ni	
Type	: Removable	
Thickness (rad.length)	: 7	χ
Diameter	:	mm
Mean deposited power	: 0.5 / 0.4	kW
Solenoidal field ^{a)}	: 1600 G over 6 × 6 m; DC	

Matching device	: (2) Adiabatic lens
RF sections ^{a)}	: 23 × 6 m with Klystron 2043

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right. (3)

LINAC PERFORMANCE (4)

	Normal Operation	Max, or Design	
Final energy	: 0.8 / 1.1	1.4	GeV
Accel gradient	: 8 / 10	10	MeV/m
ΔE/E (FWHM)	: 1.4 / 1		%
Rep. rate	: 25	50	Hz
Pulse length	: 0.005 / 0.020		μs
Yield (fin.en)	: 0.7 / 0.45		e ⁺ /e ⁻ × GeV
Beam intensity	: 21000 / 4500		μA peak
Norm. emit. (1σ):			π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Two primary beams are available. See Electron Linac for narrative description
- (2) 1.25 T peak field
- (3) After the DC solenoid on the first 6 sections, 6 triplets between sections and 2 doublets.
- (4) Two types of operation are provided: injection of short bunches (5 ns) for single bunch mode, and long bunches (20 ns) for multibunch operation in the storage ring Super-ACO (800MeV), and injection of long bunches (20 ns) in the storage ring DCI (1.1 GeV).

References

- [1] R. Chehab et al. "An adiabatic matching device for the Orsay Linear Positron Accelerator", PAC83, Santa Fe, 1983.

ELECTRON LINAC

Name of Linac : *EPLUS* *
Function : *Electron Linac for e⁺ production (for SOLEIL ** SR Ring)*
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 91405 Orsay, France*
Person in charge : *R. Chaput*
Name of person supplying these data : *R. Chaput*
e-mail : *chaput@lure.u-psud.fr*
tel. : +33 1 64 46 81 58 fax : +33 1 69 85 39 97

HISTORY AND STATUS

Const. started : ; first beam :
Present status : *Project*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *2* A
Normalized emittance (1 σ) : π mm-mrad

Injector

Longitudinal matching : (1)
Output : *15* MeV; intensity : *1* A
Pulse width, spacing : (2)
Normalized emittance (1 σ) : π mm-mrad

Acceleration System

Total linac length : ~ 24 m
No. sections : *3* ; lengths : *6* m
Field mode : $2\pi/3$; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *1.5* μ s
 v_g/c range : ; Q : *13500*
Shunt impedance : *72 - 60* M Ω /m
Iris : aperture : diameter : *26.8 - 16* mm
thickness : *3* mm
Attenuation/section : *0.83* Np
Power units, Number : *3* type : *Klystron*
RF power peak : *45* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid then triplet of quadrupoles

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy		<i>0.34</i>	GeV
Accel gradient		<i>18</i>	MeV/m
$\Delta E/E$ (FWHM)		<i>10</i>	%
Rep. rate		<i>10</i>	Hz
Pulse length		<i>0.005 or 0.3</i>	μ s
Beam intensity		<i>0.7</i>	A
Norm. emit. (1 σ)			π mm-mrad

OTHER RELEVANT INFORMATION

- * *Electron Positron Linac Ulterior for SOLEIL*
- ** *SOLEIL - Source optimisée de Lumière d'Énergie Intermédiaire de Lure*

- (1) *S-band prebuncher and buncher*
- (2) *5 ns or 300 ns at 10 Hz*

References

- [1] *"Linac Injector for SOLEIL", R.. Chaput, M.A. Tordeux, EPAC '96.*

POSITRON LINAC

Name of Linac : *EPLUS **
 Function : *Positron Injector for SOLEIL ** (SR Ring)*
 Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 01405 Orsay, France*
 Person in charge : *R. Chaput*
 Name of person supplying these data : *R. Chaput*
 e-mail : *chaput@lure.u-psud.fr*
 tel. : *+33 1 64 46 81 58* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e⁻) at Conversion Target

Energy	: 340	MeV
Radius (1 σ)	:	mm
Beam intensity	: 0.7	A

LINAC PARAMETERS

Conversion Target and Capture

Material	: <i>W in Cu Matrix</i>	
Type	: <i>Removable</i>	
Thickness (rad.length)	: 2.0	χ
Diameter	:	mm
Mean deposited power	: 0.14	kW
Solenoidal field ¹⁾	: <i>0.4 T over 6.1 m DC</i>	

Matching device	: <i>$\lambda/4$ 1.8 T pulsed Solenoid</i>	
RF sections ¹⁾	: <i>(1) 4 x 6 m</i>	

¹⁾ key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.35		GeV
Accel gradient	: 15		MeV/m
$\Delta E/E$ (FWHM)	: 3		%
Rep. rate	: 10		Hz
Pulse length	: (2)		μ s
Yield (fin.en)	: 2%		e ⁺ /e ⁻ x GeV
Beam intensity	: 2000		μ A peak
Norm. emit. (1 σ):	1500		π mm-mrad

OTHER RELEVANT INFORMATION

* *Electron Positron Linac Ulterior for SOLEIL*

** *SOLEIL - Source Optimisée de Lumière d'Energie Intermédiaire de Lure*

(1) *The first and second sections have some wider iris aperture (30.4 - 24 mm) and smaller efficiency 13.9 MV / (MW)^{1/2}. The 3rd and 4th are General Electric standard sections.*

(2) *0.005 or 0.3*

ELECTRON LINAC

Name of Linac : *ELIOS **
 Function : *Electron Injector Linac for SOLEIL** (SR Ring)*
 Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 91405 Orsay, France*
 Person in charge : *R. Chaput*
 Name of person supplying these data : *R. Chaput*
 e-mail : *chaput@lure.u-psud.fr*
 tel. : *+33 1 64 46 81 58* fax : *+33 1 69 853997*

HISTORY AND STATUS

Const. started : ; first beam : *2002*
 Present status : *Project*
 Cost of facility :
 Present linac staff :
 Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
 Beam intensity (peak) : *0.250* A
 Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
 Output : *15* MeV; intensity : *0.110* A
 Pulse width, spacing : *(1)*
 Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : ~ 10 m
 No. sections : *(2) 1* ; lengths : *6* m
 Field mode : *$2\pi/3$* ; frequency : *2.998* GHz
 Wave type : *TW* ; filling time : *1.5* μ s
 v_g/c range : *(3)* ; Q : *13500*
 Shunt impedance : *72 - 60* M Ω /m
 Iris : aperture : diameter : *26.8 - 16* mm
 thickness : *3* mm
 Attenuation/section : *0.83* Np
 Power units, Number : *1* type : *Klystron*
 RF power peak : *35* MW; mean : *1.5* kW

Focusing System

Type, No. of elements, and spacing :
Two lens, between gun and prebuncher, solenoid on buncher and quadrupoles before and after section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
 No. of particles/bunch :
 Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :	<i>0.10</i>		GeV
Accel gradient :	<i>14</i>		MeV/m
$\Delta E/E$ (FWHM) :	<i>1</i>		%
Rep. rate :	<i>10</i>		Hz
Pulse length :	<i>(4)</i>		μ s
Beam intensity :	<i>0.011</i>		A
Norm. emit. (1σ) :			π mm-mrad

OTHER RELEVANT INFORMATION

* *ELIOS - Electron Linac Injector of SOLEIL*
 ** *SOLEIL - Source Optimisée de Lumière d'Energie Intermédiaire de Lure*

- (1) 5 ns or 300 ns, 100 ms*
(2) General Electric, standard accelerating structure, 6m long. Efficiency 18.5 MV/ \sqrt{MW}
(3) 0.035 - 0.0067
(4) 0.005 or 0.3

Electron production at 100 MeV for the booster (2.15 GeV) of the ring.

Two operating modes:
- 3 pulses of 5 ns, 120 ns apart at 10 Hz. Total charge 1 nC
- 30 pulses of 5 ns at 100 MHz and 10 Hz. Total charge 3.3 nC

ELECTRON LINAC

Name of Linac : *CLIO* *
Function : *Electron and Linac for Infrared FEL*
Institution and address : *LURE, Centre Universitaire, Bât. 209 D, 91405 ORSAY, France*
Person in charge : *R. Chaput*
Name of person supplying these data : *R. Chaput*
e-mail : *chaput@lure.u-psud.fr*
tel. : *+33 1 64 46 81 58* fax : *+33 1 69 85 39 97*

HISTORY AND STATUS

Const. started : *1987* ; first beam : *1991*
Present status : *Operating*
Cost of facility : *25 MFRF (1987)*
Present linac staff : *5 man-years*
Present yearly operation time : *2400* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *1.2* A
Normalized emittance (1σ) : *15* π mm-mrad

Injector

Longitudinal matching : *(1) S-band buncher*
Output : *5* MeV; intensity : *0.7* A
Pulse width, spacing : *12 μ s, 20 ms*
Normalized emittance (1σ) : *150* π mm-mrad

Acceleration System

Total linac length : *18* m
No. sections : *1* ; lengths : *4.5* m
Field mode : *$2\pi/3$* ; frequency : *2998.6* GHz
Wave type : *TW* ; filling time : *1.35* μ s
 v_g/c range : *(2)* ; Q : *14000*
Shunt impedance : *63 - 74* M Ω /m
Iris : aperture : diameter : *24 - 18* mm
thickness : *5.0* mm
Attenuation/section : *0.844* Np
Power units, Number : *1* type : *(3) Klystron*
RF power peak : *(4) MW*; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Air-coils and solenoid up to 5 MeV, two lens, and solenoid on the section. Transport: 9 quadrupoles 3 bending magnets

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *400 - 3000*
No. of particles/bunch : *4×10^9*
Bunch separation : *(5) 32 ns or 16, 8, 4*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.050</i>	<i>0.07</i>	GeV
Accel gradient	: <i>12.6</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>< 0.75</i>	<i>0.25</i>	%
Rep. rate	: <i>50</i>	<i>50</i>	Hz
Pulse length	: <i>12</i>	<i>12</i>	μ s
Beam intensity	: <i>55</i>	<i>20</i>	A
Norm. emit. (1σ)	: <i>150</i>	<i>200</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *CLIO - Centre Laser Infra-rouge Orsay*

- (1) Sub-harmonic prebuncher (500 MHz) and S-band buncher.*
- (2) 0.0067-0.02*
- (3) Klystron TH 2130 V great HF pulse width ~ 20 μ s with 20 MW.*
- (4) 20. For a 19 μ s pulse*
- (5) Wide range of bunch separation able to fill the optical cavity by 1, 2, 4, 8 light pulses.*

References

- [1] LAL/RT-89/04, February 1989 . Rapport d'étude du projet de laser à électrons libres CLIO. J.C. Bourdon et al.*
- [2] 14th International FEL Conf., August 1992. Operation of the CLIO Accelerator. R. Chaput et al.*
- [3] 17th International FEL Conf, August 1995. Activities of the CLIO Infrared Facility. JM. Ortéga et al.*

ELECTRON LINAC

Name of Linac : *CANDELA* *
 Function : *Photo-injector R & D for linear colliders*
 Institution and address : *LAL - Université d'Orsay - Bât. 200 - F 91405*
 Person in charge : *Chris Travier*
 Name of person supplying these data : *Chris Travier*
 e-mail : *travier@lalcls.in2p3.fr*
 tel. : *+33 1 64 46 83 68* fax : *+33 1 69 07 14 99*

HISTORY AND STATUS

Const. started : *1991* ; first beam : *09/1993*
 Present status : *Operating*
 Cost of facility : *6 MFRF (1995)*
 Present linac staff : *3 man-years*
 Present yearly operation time : *300* h

LINAC PARAMETERS

Electron Sources (1)

Types : *(2)* ; energy : *0* keV
 Beam intensity (peak) : *A*
 Normalized emittance (1 σ) : *π mm-mrad*

Injector (1)

Longitudinal matching :
 Output : *MeV*; intensity : *A*
 Pulse width, spacing :
 Normalized emittance (1 σ) : *π mm-mrad*

Acceleration System

Total linac length : *0.085* m
 No. sections : *1* ; lengths : *0.085* m
 Field mode : *π* ; frequency : *2.9985* GHz
 Wave type : *SW* ; filling time : *0.6* μ s
 v_{ϕ}/c range : ; Q : *10000*
 Shunt impedance : *65* M Ω /m
 Iris : aperture : diameter : *10* mm
 thickness : *16* mm
 Attenuation/section : *Np*
 Power units, Number : *1* type : *Klystron*
 RF power peak : *3.5* MW; mean : *0.25* kW

Focusing System

Type, No. of elements, and spacing :
1 solenoid at gun exit
max field 2400 Gauss

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
 No. of particles/bunch : *$< 1.25 \times 10^{10}$*
 Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.0025</i>	<i>0.0035</i>	GeV
Accel gradient	: <i>70</i>	<i>106</i>	MeV/m
$\Delta E/E$ (FWHM)	:		%
Rep. rate	: <i>12.5</i>	<i>12.5</i>	Hz
Pulse length	: <i>$< 50 \times 10^{-6}$</i>	<i>$< 50 \times 10^{-6}$</i>	μ s
Beam intensity	: <i>< 40</i>	<i>1000</i>	A
Norm. emit. (1 σ):			π mm-mrad

OTHER RELEVANT INFORMATION

* *CANon..DEclenché par LAsEr*

(1) *CANDELA is an RF gun and thus the electron source (photocathode) is directly located at the beginning of acceleration system.*

(2) *Dispenser Cathode.*

Characteristics of laser system used to illuminate the photocathode.

Type : *Ti: sapphire*
 useful wavelength : *266 nm*
 Energy maximum : *200 μ J*
 Bunch length : *0.5 - 15 ps*
 Repetition rate : *12.5 Hz*

ELECTRON LINAC

Name of Linac : *MACSE**
Function : *Study of superconducting RF accelerator techniques*
Institution and address : *CEA DSM/DAPNIA, CEA/Saclay, 91191 Gif-sur-Yvette, France*
Person in charge : *Jean Gastebois*
Name of person supplying these data : *Marcel Jablonka*
e-mail : *JABLONKA@hep.saclay.cea.fr*
tel. : +33 (1)69087323 fax : +33 (1)69087408

HISTORY AND STATUS

Const. started : *02/1989* ; first beam : *01/1991*
Present status : *Operated for experiments*
Cost of facility : *50 MFRF (1989)*
Present linac staff : *6*
Present yearly operation time : *300* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *0.003* A
Normalized emittance (1σ) : *0.5* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *2* MeV; intensity : *0.0005* A
Pulse width, spacing : *DC*
Normalized emittance (1σ) : *1* π mm-mrad

Acceleration System

Total linac length : *12* m
No. sections : *(2) 5* ; lengths : *0.5* m
Field mode : *π* ; frequency : *1.497* GHz
Wave type : *SW* ; filling time : μ s
 v_g/c range : ; Q : *(3) 1.10⁷*
Shunt impedance : $M\Omega/m$
Iris : aperture : diameter : *70* mm
thickness : mm
Attenuation/section : Np
Power units, Number : *(5)* type : *Klystron*
RF power peak : *(6)* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
Solenoidal lenses at 2 MeV
Triplets at 20 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *DC*
No. of particles/bunch : *4×10^5*
Bunch separation : *668 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.015</i>	<i>0.025</i>	GeV
Accel gradient	: <i>7</i>	<i>10</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.1</i>	<i>0.1</i>	%
Rep. rate	: <i>DC</i>	<i>DC</i>	Hz
Pulse length	:		μ s
Beam intensity	: <i>10^4</i>	<i>10^4</i>	A
Norm. emit. (1σ)	: <i>1</i>	<i>1</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Module Accelérateur à Cavité Supraconductrice pour Electrons (Electron Accelerator Module using Super-conducting Cavities)*

- (1) 60° chopper, NC pre-buncher 0.84c 5 cell SC cavity*
- (2) Superconducting 5 cell cavities.*
- (4) loaded*
- (5) TH2466*
- (6) 5×10^{-3}*

References

- [1] First description in proceedings of 1990 Linear Acc. Conf. p.141.*
- [2] Detailed description in report DAPNIA/SEA 92-09, Juin 1992.*

ELECTRON LINAC

Name of Linac : *Linac*
Function : *Science of First Electrons for Pulse Radiography*
Institution and address : *Hahn-Meitner Institut, 14109 Berlin, Germany*
Person in charge : *Dr. E. Janata*
Name of person supplying these data : *Dr. E. Janata*
e-mail : *janata@hmi.de*
tel. : *+49 30 806 22853* fax : *+49 30 806 22434*

HISTORY AND STATUS

Const. started : *1968* ; first beam : *1969*
Present status : *Operational*
Cost of facility :
Present linac staff :
Present yearly operation time : *Low* h

LINAC PARAMETERS

Electron Sources

Types : *Cathode* ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : *0.08* MeV; intensity : A
Pulse width, spacing : *2 ns - 2 μ s , 20 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : ~ 5 m
No. sections : *1* ; lengths : ~ 2 m
Field mode : ; frequency : *1.3* GHz
Wave type : ; filling time : μ s
 v/c range : ; Q :
Shunt impedance : M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : *10* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *min. 3*
No. of particles/bunch :
Bunch separation : ~ 0.8 ns

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.015</i>		GeV
Accel gradient	:		MeV/m
$\Delta E/E$ (FWHM)	:		%
Rep. rate	: <i>50</i>		Hz
Pulse length	: <i>2 ns - 2 μs</i>		μ s
Beam intensity	: <i>6</i>		A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

ION LINAC

Name of Linac : *RQ13*
 Function : *Ion Injector for Separated Sector Cyclotron*
 Institution and address : *Hahn-Meitner Institut, 14109 Berlin, Germany*
 Person in charge : *H. Homeyer*
 Name of person supplying these data : *A. Schempp*
 e-mail : *A.Schempp@em.uni-frankfurt.de*
 tel. : *+49 69 79822802* fax : *+49 69 79828510*

HISTORY AND STATUS

Const. started : *01/1994* ; first beam : *1997*
 Present status : *Construction*
 Cost of facility : *2 MDEM*
 Present linac staff : *2*
 Present yearly operat. time : *h*

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *14 GHz ECR*
 Species of ions : *1/5 > z/A > 1/8*
 Range of currents : *50* μAe
 Range of output energies : *15 to 30* keV/u
 Pulse length : *cw* μs ; rep. rate : *Hz*
 Normalized emittance (1σ) : *0.22* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *4 rod RFQ* m
 Output currents : *25* μAe
 Output energies : *90 to 360* keV/u
 Frequency : *(1) MHz*; peak RF power : *20 kW*
 Pulse length : *cw* μs ; rep. rate : *Hz*
 Normalized emittance (1σ) : *0.22* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : m; N°. of tanks :
 Tank diameters : m
 Number of drift-tubes :
 Drift-tube lengths : mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : mm to mm
 RF frequency(ies) : MHz
 Field modes :
 Eff. shunt impedance : M Ω /m
 Q :
 Filling time : μs
 Equil. phases : ; accel. rate MeV/u-m
 RF rep. rate : Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : MW; mean : MW

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other :

Charge Stripping (Typical)

Type(s) :
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species :		
Energy :		MeV/u
$\Delta E/E$ (FWHM) :		%
Mean acc. rate :		MeV/u-m
Beam current :		μAe peak
Norm. emit. (1σ) :		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

(1) 85 to 120 MHz

ELECTRON LINAC

Name of Linac : *Linac 2 **
 Function : *Electron Injector for Synchrotron*
 Institution and address : *Bonn University, Physics Inst., Nussallee 12, D-53115 Bonn*
 Person in charge : *D. Husmann*
 Name of person supplying these data : *D. Husmann*
 e-mail : *Husmann@AXPIB.PHYSIK.UNI-BONN.DE*
 tel. : *+49 228 73 3617* fax : *+49 228 73 3620*

HISTORY AND STATUS

Const. started : (1) *1992* ; first beam : *1995*
 Present status : *Operating*
 Cost of facility : *NA*
 Present linac staff : (2) *ELSA Staff*
 Present yearly operation time : (3) h

LINAC PARAMETERS

Electron Sources

Types : (4) *Triode* ; energy : *50* keV
 Beam intensity (peak) : *1* A
 Normalized emittance (1 σ) : π mm-mrad

Injector

Longitudinal matching : (5)
 Output : MeV; intensity : A
 Pulse width, spacing : *1 μ s, 20 ms*
 Normalized emittance (1 σ) : π mm-mrad

Acceleration System

Total linac length : *5.00* m
 No. sections : *1* ; lengths : *3.00* m
 Field mode : $\pi/2$; frequency : *2.9985* GHz
 Wave type : *TW* ; filling time : *0.5* μ s
 v_g/c range : ; Q : *12000*
 Shunt impedance : *50* M Ω /m
 Iris : aperture : diameter : *2.85 - 1.95* mm
 thickness : *0.3* mm
 Attenuation/section : Np
 Power units, Number : *1* type : *Klystron*
 RF power peak : *20* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids covering section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
 No. of particles/bunch : *NA*
 Bunch separation : *NA*

LINAC PERFORMANCE (6)

	Normal Operation	Max, or Design	
Final energy :		<i>0.030</i>	GeV
Accel gradient :		<i>10</i>	MeV/m
$\Delta E/E$ (FWHM) :			%
Rep. rate :	<i>50</i>	<i>50</i>	Hz
Pulse length :	<i>1</i>	<i>1</i>	μ s
Beam intensity :		<i>0.6</i>	A
Norm. emit. (1 σ):		<i>120</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* (*1 Section of former Mainz Linac "Muell"*)

- (1) *Linac has been constructed using parts of the former Mainz Linac "MUELL"*
- (2) *ELSA - Electron Stretcher Accelerator*
- (3) *No routine operation*
- (4) *A second source is used to provide polarized electron beams with a Ga As photocathode*
- (5) *S-band prebuncher and buncher*
- (6) *Normal operation data are not yet well known.*

ION LINAC

Name of Linac : GSI Heavy Ion Linac Wideröe (Linac I)
Function : Heavy Ion Injector for UNILAC Postaccelerator
Institution and address : GSI, 64220 Darmstadt, PO 11 05 52, Germany
Person in charge : J. Klabunde
Name of person supplying these data : J. Klabunde
e-mail : j.klabunde@GSI.de
tel. : +49 6159 712344 fax : +49 6159 712987

HISTORY AND STATUS

Const. started : 1972 ; first beam : 1975
Present status : Operational
Cost of facility : 8 MDEM (1972)
Present linac staff : 6/2 = 3 man-years
Present yearly operat. time : 6000 h

LINAC PARAMETERS

Ion Sources

No. of sources : 2
Types of source : PIG, CHORDIS, MEVVA
Species of ions : All ions up to uranium
Range of currents : 500 μ Ae
Range of output energies : 0.5 - 1.0 keV/u
Pulse length : 5000 μ s; rep. rate : 50 Hz
Normalized emittance (1σ) : 0.5 π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : 320 kV DC Preaccelerator m
Output currents : 500 μ Ae
Output energies : 11.7 keV/u
Frequency : MHz; peak RF power : kW
Pulse length : 5000 μ s; rep. rate : 50 Hz
Normalized emittance (1σ) : 0.5 π mm-mrad

Longitudinal Matching

Type : 2-gap double drift buncher
Mod. 4 keV; drift 1000 mm at 27 MHz
4 keV; drift 1500 mm at 27 MHz

Accelerating System

Total linac length : 26 m; N^o. of tanks : 4
Tank diameters : 1.2 m
Number of drift-tubes : 35, 35, 29, 25
Drift-tube lengths : 10 - 290 mm
Drift-tube diam (range): 34 - 40 mm
Gap/cell length (range): 0.33 - 0.65
Aperture diameter : 20 mm to 30 mm
RF frequency(ies) : 27.1 MHz
Field modes : Coaxial $\beta\lambda$ / 2 Structure
Eff. shunt impedance : 45.4, 50.6, 46, 34.7 M Ω /m
Q : 4400, 5100, 7200, 7000
Filling time : 100 μ s
Equil. phases : -30^o; accel. rate 0.054 MeV/u-m
RF rep. rate : 50 Hz; pulse : 5500 μ s
Beam rate : 50 Hz; pulse : 5000 μ s
RF power peak : 1.0 MW; mean : 0.28 MW

Focusing System

No. elements : 60
type : Singlet order : FFDD
Gradients : 30 to 100 T/m
Other :

Charge Stripping (Typical)

Type(s) : Gas
Charge states : 23 to 31 at 1.4 MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation (1)	Max, or Design	
Species	All ions	U^{10+}	
Energy	1.4	1.4	MeV/u
$\Delta E/E$ (FWHM)	1	1	%
Mean acc. rate	0.054	0.054	MeV/u-m
Beam current	3000	70	μ Ae peak
Norm. emit. (1σ)	0.5	0.5	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
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OTHER RELEVANT INFORMATION

(1) All ions with $q/m \geq 0.04$ can be accelerated, parameters given for U^{10+} .

ION LINAC

Name of Linac : *GSI Heavy Ion Linac HLI (Linac II)*
 Function : *Heavy Ion Injector for UNILAC Postaccelerator*
 Institution and address : *GSI, 64220 Darmstadt, PO 11 05 52, Germany*
 Person in charge : *J. Klabunde*
 Name of person supplying these data : *J. Klabunde*
 e-mail : *j.klabunde@gsi.de*
 tel. : *+49 6159 712344* fax : *+49 6159 712987*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1991*
 Present status : *Operational*
 Cost of facility : *6 MDEM (1990)*
 Present linac staff : *4 / 2 = 2 man-years*
 Present yearly operat. time : *6000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *14 GHz ECR*
 Species of ions : *All ions up to uranium*
 Range of currents : *6* μAe
 Range of output energies : *2.5* keV/u
 Pulse length : *CW* μs ; rep. rate : *CW* Hz
 Normalized emittance (1σ) : *0.5* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *4-rod RFQ/3* m
 Output currents : *6* μAe
 Output energies : *300* keV/u
 Frequency : *108.4 MHz*; peak RF power : *130* kW
 Pulse length : *- 5000* μs ; rep. rate : *100* Hz
 Normalized emittance (1σ) : *0.5* π mm-mrad

Longitudinal Matching

Type : *$\lambda/4 - 4$ gap resonator*
 Mod. *160* keV; drift *500* mm at *108.4* MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *3.3* m; N^o. of tanks : *1*
 Tank diameters : *0.6* m
 Number of drift-tubes : *43*
 Drift-tube lengths : *19 - 58, 369.9, 374.7* mm
 Drift-tube diam (range): *24 - 27* mm
 Gap/cell length (range): *0.2 - 0.5*
 Aperture diameter : *18* mm to *20* mm
 RF frequency(ies) : *108.4* MHz
 Field modes : *TE111 (1)*
 Eff. shunt impedance : *300* M Ω /m
 Q : *20000*
 Filling time : *< 100* μs
 Equil. phases : *0, - 30 $^\circ$* ; accel. rate *0.33* MeV/u-m
 RF rep. rate : *100* Hz; pulse : *5500* μs
 Beam rate : *100* Hz; pulse : *5000* μs
 RF power peak : *0.11* MW; mean : *0.6* MW

Focusing System

No. elements : *2*
 type : *Triplet* order : *FDF*
 Gradients : *50* to *70* T/m
 Other :

Charge Stripping (Typical)

Type(s) :
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation (2)	Max, or Design	
Species	<i>All ions</i>	<i>U^{28+}</i>	
Energy	<i>1.4</i>	<i>1.4</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>1.0</i>	<i>1.0</i>	%
Mean acc. rate	<i>0.33</i>	<i>0.33</i>	MeV/u-m
Beam current	<i>- 1000</i>	<i>6</i>	μAe peak
Norm. emit. (1σ)	<i>0.5</i>	<i>0.5</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

- (1) *(IH $\beta\lambda/2$ operation)*
- (2) *All ions with $q/m \geq 0.11$ can be accelerated, parameters given for U^{28+} .*

References

- [1] *Linac described in Linac Conf. Proc. 1988, 1990, 1992.*

ION LINAC

Name of Linac : *GSI Heavy Ion Postaccelerator (Linac III)*
 Function : *Synchrotron Injector, Physics Experiments*
 Institution and address : *GSI, 64220 Darmstadt, PO 11 05 52, Germany*
 Person in charge : *J. Klabunde*
 Name of person supplying these data : *J. Klabunde*
 e-mail : *j.klabunde@gsi.de*
 tel. : *+49 6159 712344* fax : *+49 6159 712987*

HISTORY AND STATUS

Const. started : *1972* ; first beam : *1975*
 Present status : *Operational*
 Cost of facility : *12 MDEM (1972)*
 Present linac staff : *6 / 2 = 3 man-years*
 Present yearly operat. time : *6000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *see GSI Linac I, II*
 Types of source :
 Species of ions :
 Range of currents : μAe
 Range of output energies : keV/u
 Pulse length : μs ; rep. rate : Hz
 Normalized emittance (1σ) : $\pi \text{ mm-mrad}$

Pre-accelerators (including RFQ)

Types (lengths) : *see GSI Linac I, II* m
 Output currents : μAe
 Output energies : keV/u
 Frequency : MHz ; peak RF power : kW
 Pulse length : μs ; rep. rate : Hz
 Normalized emittance (1σ) : $\pi \text{ mm-mrad}$

Longitudinal Matching

Type :
 Mod. keV ; drift mm at MHz
 keV ; drift mm at MHz

Accelerating System

Total linac length : *70* m; N^o. of tanks : *5*
 Tank diameters : *2.0* m
 Number of drift-tubes : *62, 24, 20, 36, 31*
 Drift-tube lengths : *114 - 230* mm
 Drift-tube diam (range): *200* mm
 Gap/cell length (range): *0.25*
 Aperture diameter : *30* mm to *35* mm
 RF frequency(ies) : *108.4* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *50, 55, 57, 58, 60* M Ω /m
 Q : *(1)*
 Filling time : *5000* μs
 Equil. phases : *30; 25*; accel. rate *0.2* MeV/u-m
 RF rep. rate : *50* Hz; pulse : *5500* μs
 Beam rate : *50* Hz; pulse : *5000* μs
 RF power peak : *5.0* MW; mean : *1.4* MW

Focusing System

No. elements : *173*
 type : *Singlet* order : *FFDD*
 Gradients : *20* to *40* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Carbon foil*
 Charge states : *71* to *75* at *11.4* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation (2)	Max, or Design	
Species	<i>All ions</i>	<i>U²⁸⁺</i>	
Energy	<i>(3) 1.4 - 15</i>	<i>1.4 - 15</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>0.5</i>	<i>0.5</i>	%
Mean acc. rate	<i>0.2</i>	<i>0.2</i>	MeV/u-m
Beam current	<i>3000</i>	<i>5 - 30</i>	μAe peak
Norm. emit. (1σ)	<i>0.5</i>	<i>0.5</i>	$\pi \text{ mm-mrad}$

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

- (1) *112, 108, 107, 105, 104* $\times 10^3$
- (2) *The linac has the capability to accelerate on a pulse-to-pulse basis beams of differing ion species to individual energies.*
- (3) *Energy variation between 1.4 and 15 MeV/u by additional 15 single gap cavities.*

ELECTRON LINAC

Name of Linac : *S-DALINAC*
Function : *Nuclear and Radiation Physics, FEL Driver*
Institution and address : *Institut für Kernphysik, TH Darmstadt, Germany*
Person in charge : *A. Richter*
Name of person supplying these data : *H-D. Gräf*
e-mail : *Graef@linac.ikp.physik.th-darmstadt.de*
tel. : *+49 6151 163323* fax : *+49 6151 164321*

HISTORY AND STATUS

Const. started : *1983* ; first beam : *1987*
Present status : *Operating*
Cost of facility : *20 MDEM*
Present linac staff : *6*
Present yearly operation time : *2500* h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic Gun* ; energy : *250* keV
Beam intensity (peak) : *≤ 0.03* A
Normalized emittance (1σ) : *≤ 2* π mm-mrad

Injector

Longitudinal matching : *Chopper + Prebuncher*
Output : *10* MeV; intensity : *≤ 0.00006* A
Pulse width, spacing : *CW*
Normalized emittance (1σ) : *≤ 2* π mm-mrad

Acceleration System

Total linac length : *17* m
No. sections : *8* ; lengths : *8 × 1* m
Field mode : *π* ; frequency : *3* GHz
Wave type : *TM 010* ; filling time : *1590* μ s
 v_g/c range : *Stan.wave* ; Q : *1 · 10⁹*
Shunt impedance : *1.25 × 10⁶* M Ω /m
Iris : aperture : diameter : *35* mm
thickness : *6.4* mm
Attenuation/section : *Standing wave* Np
Power units, Number : *12* type : *Klystron*
RF power peak : *(1)* MW; mean : *0.5* kW

Focusing System

Type, No. of elements, and spacing :
Quadrupoles, 4, 3.8 m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *CW*
No. of particles/bunch : *1.25 × 10⁵*
Bunch separation : *333 ps*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.03 - 0.12</i>	<i>0.130</i>	GeV
Accel gradient	: <i>≤ 7</i>	<i>10</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.05</i>		%
Rep. rate	: <i>CW</i>		Hz
Pulse length	: <i>NA</i>		μ s
Beam intensity	: <i>≤ 60 × 10⁶</i>		A
Norm. emit. (1σ)	: <i>≤ 2</i>		π mm-mrad

OTHER RELEVANT INFORMATION

(1) 5 × 10⁻⁴

Superconducting recirculating electron linac.

Superconducting cavities:

2 cells, $\beta = 0.85$

5 cells, $\beta = 1.00$

10 × 20 cells, $\beta = 1.00$

Two recirculations (three passes through linac).

ELECTRON LINAC

Name of Linac : *DELTA Injector Linac*
Function : *Electron Injector Linac for 1.5 GeV Synchrotron Radiation Light Source DELTA*
Institution and address : *University of Dortmund, D-44221 Dortmund, Germany*
Person in charge : *Th. Weis*
Name of person supplying these data : *Th. Weis*
e-mail : *weis@marvin.physik.uni-dortmund.de*
tel. : +49 231 755 5370 fax : +49 231 755 5383

HISTORY AND STATUS

Const. started : (1) 1992 ; first beam : 1994
Present status : *Operating*
Cost of facility : *NA*
Present linac staff : *1 man-year*
Present yearly operation time : 1100 h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : 50 keV
Beam intensity (peak) : A
Normalized emittance (1σ) : < 80 π mm-mrad

Injector

Longitudinal matching : (2)
Output : 3.8 MeV; intensity : 1 A
Pulse width, spacing : 2-20 ns, 10-100 ms
Normalized emittance (1σ) : < 200 π mm-mrad

Acceleration System

Total linac length : 12 m
No. sections : 2 ; lengths : 4.2 m
Field mode : $2\pi/3$; frequency : 2.9986 GHz
Wave type : *TW* ; filling time : 0.7 μ s
 v_g/c range : (3) ; Q : 10000
Shunt impedance : 42 M Ω /m
Iris : aperture : diameter : 30 - 20 mm
thickness : *Not known* mm
Attenuation/section : 0.62 Np
Power units, Number : 2 type : *Klystron*
RF power peak : 20 MW; mean : 1-10 kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 3.8 MeV; a triplet at 3.8 MeV and a triplet between sections at 40 - 50 MeV.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 6 - 60
No. of particles/bunch : 1.2×10^9
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.07	0.1	GeV
Accel gradient	8.33	11.9	MeV/m
$\Delta E/E$ (FWHM)	10	10	%
Rep. rate	10	100	Hz
Pulse length	0.002	0.020	μ s
Beam intensity	0.6	0.6	A
Norm. emit. (1σ)	140	140	π mm-mrad

OTHER RELEVANT INFORMATION

(1) *Linac has been constructed using old system parts of the Mainz university 400 MeV electron linac (first operation 1966, shut down 1989).*

Mainz components: - 2 linac sections (age 20 years)
- 20 MW klystrons, pilot klystron
- substantial part of the modulators
- gun body and prebuncher

New installed components: - 3.8 MeV buncher
- gun
- complete focusing system
- monitoring
- rf-network

(2) *S-band prebuncher and buncher*

(3) *0.011-0.036*

References

[1] *DELTA, a Status Report, DELTA Group, University of Dortmund.*

[2] *G. Blokesch, J. Friedl, A. Jankowiak, C. Piel, T. Weis, K. Wille and DELTA Group, The Injector Linac of the DELTA-Facility, Proc. 1996 European Particle Accelerator Conference, Sitges.*

ELECTRON LINAC

Name of Linac : *Linac 2*
Function : *Electron Injector for PIA (DORIS, HERA)*
Institution and address : *DESY, Notkestr. 85, 22603 Hamburg, Germany*
Person in charge : *D. Trines*
Name of person supplying these data : *M. Nagl*
e-mail :
tel. : +49 40 8998 3796 fax : +49 40 8998 4364

HISTORY AND STATUS

Const. started : *1966* ; first beam : *01/1971*
Present status : *Operating*
Cost of facility :
Present linac staff : *6*
Present yearly operation time : *6700 (1995)* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *150* keV
Beam intensity (peak) : *4.0* A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : MeV; intensity : A
Pulse width, spacing : *20 ns; 20 ms*
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *70* m
No. sections : *(2) 6* ; lengths : *5.2* m
Field mode : *$2\pi/3$* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *0.74* μ s
 v_{ph}/c range : *(3)* ; Q : *14000*
Shunt impedance : *51.5* M Ω /m
Iris : aperture : diameter : *29.5 - 22.5* mm
thickness : *5.56* mm
Attenuation/section : *0.50* Np
Power units, Number : *(2) 6* type : *(4) Klystrons*
RF power peak : *25* MW; mean : *5* kW

Focusing System

Type, No. of elements, and spacing :
0.08 T solenoids on the first 3 sections; quadrupoles on the last 5 sections

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *NA*
No. of particles/bunch : *NA*
Bunch separation : *NA*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.45</i>	<i>0.90</i>	GeV
Accel gradient	: <i>14.4</i>	<i>17.7</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.27</i>		%
Rep. rate	: <i>50</i>	<i>50</i>	Hz
Pulse length	: <i>0.020</i>		μ s
Beam intensity	: <i>0.030-0.060</i>		A
Norm. emit. (1σ)	: <i>60</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- (1) S-band prebuncher and buncher*
- (2) See Positron Linac for e^+ operation.*
- (3) 0.012-0.0043*
- (4) 11 klystrons are equipped with RF pulse compression.*

POSITRON LINAC

Name of Linac : *Linac 2*
 Function : *Positron Injector for PLA (DORIS, HERA)*
 Institution and address : *DESY, Notkestr. 85, 22603, Hamburg, Germany*
 Person in charge : *D. Trines*
 Name of person supplying these data : *M. Nagl*
 e-mail :
 tel. : +49 40 8998 3796 fax : +49 40 8998 4364

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

Primary Beam (e⁻) at Conversion Target

Energy	:	400	MeV
Radius (1 σ)	:	0.3	mm
Beam intensity	:	1.5	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	<i>Tungsten</i>	
Type	:	<i>Stationary</i>	
Thickness (rad.length)	:	2.0	χ
Diameter	:	10	mm
Mean deposited power	:	2	kW
Solenoidal field ^{a)}	:	<i>0.4 T DC over 2 RF sections</i>	
		<i>(10.4 m)</i>	
Matching device	:	<i>$\lambda/4$; 1.8 T pulsed solenoid</i>	
RF sections ^{a)}	:	<i>6 (7) \times 5.2 m</i>	

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.45	0.55	GeV
Accel gradient	: 14.4	17.7	MeV/m
$\Delta E/E$ (FWHM)	: 1.0	1.0	%
Rep. rate	: 50	50	Hz
Pulse length	: 0.060	0.1	μ s
Yield (fin.en)	: 0.025	0.03	e ⁺ /e ⁻ x GeV
Beam intensity	: 10000	15000	μ A peak
Norm. emit. (1 σ):	3000		π mm-mrad

OTHER RELEVANT INFORMATION

The electrons are accelerated in five accelerator sections, which are powered by five klystrons. Each klystron is equipped with RF pulse compression.

The electron beam is focused by a quadrupole doublet onto the target.

Behind the converter, comprising the target and the small 1.8 T positron lens, there are two RF sections with 0.4 T solenoids, followed by a matching quadrupole doublet and 5 RF sections equipped with 25 quadrupoles in a FODO channel lattice. Six of these seven klystrons are equipped with RF pulse compression.

ELECTRON LINAC

Name of Linac : TTF *
Function : Test Facility for a Superconducting Linear Collider
Institution and address : DESY, Notkestr. 85, 22603 Hamburg, Germany
Person in charge : Bernard Aune
Name of person supplying these data : Hans Weise
e-mail : Weise@desy.de
tel. : +49 40 8998 3950 fax : +49 40 8998 3094

HISTORY AND STATUS

Const. started : 1995 ; first beam :
Present status : Under construction
Cost of facility : 44 MDEM (1995)
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : (1) ; energy : (2) keV
Beam intensity (peak) : (3) 0.010 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : (4)
Output : 10 (20) MeV; intensity : (3) 0.008 A
Pulse width, spacing : see beam pulse structure
Normalized emittance (1σ) : (5) $< 5 \pi$ mm-mrad

Acceleration System

Total linac length : 50 m
No. sections : 3×8 ; lengths : 1.0 m
Field mode : π ; frequency : 1.3 GHz
Wave type : Standing ; filling time : $\approx 500 \mu\text{s}$
 v_{ϕ}/c range : 1 ; Q : 3×10^9
Shunt impedance : 0.001 M Ω /m
Iris : aperture : diameter : 78 mm
thickness : (6) mm
Attenuation/section : Np
Power units, Number : 2 type : Klystron
RF power peak : (7) MW; mean : (8) kW

Focusing System

Type, No. of elements, and spacing :
Solenoids at 250 keV, 2 triplets at 10 MeV (matching section), quadrupole doublets every 12.2m

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 216×800 (1×800)
No. of particles/bunch : 2.3×10^8 (5×10^{10})
Bunch separation : $1/216 \mu\text{s}$ ($1 \mu\text{s}$)

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy :		0.4 - 0.6	GeV
Accel gradient :		15 - 25	MeV/m
$\Delta E/E$ (FWHM) :		0.1	%
Rep. rate :		10	Hz
Pulse length :		800	μs
Beam intensity :	(3)	0.008	A
Norm. emit. (1σ) :		< 5	π mm-mrad

OTHER RELEVANT INFORMATION

* TESLA Test Facility Linac

- (1) Two different injectors are under construction; Injector I (Triode) will be used for commissioning, Injector II (RF Gun) for cavity studies.
- (2) Triode gun: 250 keV
RF gun : 3500 keV
- (3) Average current for the 800 μs long macro pulse.
- (4) Injector I : 216 MHz Buncher
Injector II : magnetic bunch compressor
- (5) For the RF gun, $E = 20 \pi$ mm.mrad
- (6) Special shape
- (7) 24×0.2
- (8) peak $\times 0.8/100$

ELECTRON LINAC

Name of Linac : *SBTF* *
Function : *Linear Collider Test Facility*
Institution and address : *DESY, Notkestr. 85, 22603 Hamburg, Germany*
Person in charge : *Norbert Holtkamp*
Name of person supplying these data : *Norbert Holtkamp*
e-mail : *MPYHOL@mint2.desy.de*
tel. : fax :

HISTORY AND STATUS

Const. started : *1992* ; first beam : *1995*
Present status : *Under construction*
Cost of facility : *10 MUSD*
Present linac staff : *~ 10 man-years*
Present yearly operation time : *1000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *90* keV
Beam intensity (peak) : *6* A
Normalized emittance (1σ) : *5* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *6* MeV; intensity : *(2)* A
Pulse width, spacing : *2 μ s, 16 ns, 50 Hz*
Normalized emittance (1σ) : *~ 500* π mm-mrad

Acceleration System

Total linac length : *30* m
No. sections : *4* ; lengths : *6* m
Field mode : *$2\pi/3$* ; frequency : *2.998* GHz
Wave type : *TW* ; filling time : *0.8* μ s
 v_p/c range : *4.1 - 1.4* ; Q : *13800*
Shunt impedance : *~ 55* M Ω /m
Iris : aperture : diameter : *27 - 13* mm
thickness : *5* mm
Attenuation/section : *0.55* Np
Power units, Number : *2* type : *Klystron*
RF power peak : *150* MW; mean : *25* kW

Focusing System

Type, No. of elements, and spacing :
Triples, solenoids

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *74 / 125 / 250*
No. of particles/bunch : *$\geq 5 \times 10^{10}$*
Bunch separation : *8 / 16 / 24 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.400</i>	<i>0.45</i>	GeV
Accel gradient	: <i>17</i>	<i>22</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>	<i>1</i>	%
Rep. rate	: <i>50</i>	<i>50</i>	Hz
Pulse length	: <i>2</i>	<i>2</i>	μ s
Beam intensity	: <i>0.300</i>	<i>0.400</i>	A
Norm. emit. (1σ)	: <i>500</i>	<i>400</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *SBTF - S - Band Test Facility*

- (1) *S-band, 500 MHz & 125 MHz buncher*
(2) *1 kA peak, 300 mA average*

PROTON AND/OR H- LINAC

Name of Linac : *Linac 3*
 Function : *Proton Injector for DESY Accelerator Complex*
 Institution and address : *DESY, Notkestr. 85, 22603 Hamburg, Germany*
 Person in charge : *D. Trines*
 Name of person supplying these data: *M. Nagl*
 e-mail :
 tel. : *+49 40 8998 3796* fax : *+49 40 8998 4364*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *11/1988*
 Present status : *Operating*
 Cost of facility :
 Present linac staff : *4*
 Present yearly operat. time : *6900 (1995)* h

Focusing System

No. elements : *131*
 type : *Pulsed* order : *FODO*
 Gradients : *100* to *20* T/m
 Other : *Pulsed flat-top (100 μs)*

LINAC PARAMETERS

Ion Source

Type : *H⁻ magnetron ion source*
 Output : *60* mA at *18* keV
 Pulse length : *75* μs; rep. rate : *6* Hz
 Normalized emittance (1σ) : *0.6* πmm-mrad

Pre-accelerator (including RFQ)

Types : *4 rod RFQ* ; lengths : *1.2* m
 Output : *20* mA at *750* keV
 Pulse length: *30* μs; rep. rate : *0.25 (1)* Hz
 Normalized emittance (1σ) : *0.8* πmm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System (2)

Total linac length : *33.6* m; No. of tanks : *3*
 Tank diameters : *0.94; 0.90; 0.86* m
 Number of drift-tubes : *(3)*
 Drift-tube lengths : *(4)* mm
 Drift-tube diam (range): *180; 160; 160* mm
 Gap/cell length (range): *22-31%; 20-29%; 26-31%*
 Aperture diameter : *20* mm to *30* mm
 RF frequency(ies) : *202.56* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *36* MΩ/m
 Q : *60000*
 Filling time : *(5)* μs
 Equilibrium phases : *-35° to -25°; -25°; -25°*
 RF rep. rate : *0.25 (1)* Hz; pulse : *250* μs
 Beam rate : *0.25 (1)* Hz; pulse : *30* μs
 RF power peak : *3.6* MW; mean : *0.0002* MW

LINAC PERFORMANCE

	Normal	Max, or	
	Operation	Design	

Energy	:	<i>50</i>	<i>50</i>	MeV
Mean acc. rate	:	<i>1.48</i>	<i>1.48</i>	MeV/m
ΔE/E (FWHM)	:	<i>0.28</i>	<i>0.28</i>	%
Beam current	:	<i>12</i>	<i>20</i>	mA peak
Norm. emit. (1σ)	:	<i>1.0</i>	<i>2.0</i>	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) *Maximum 1 Hz*
- (2) *Post coupled Alvarez linac structure.*
- (3) *51+2/2; 43+2/2; 31+2/2*
- (4) *48-147; 177-258; 274-316*
- (5) *Determined by feedback; < 100 μs*

ION LINAC

Name of Linac : *Heidelberg Postaccelerator*
 Function : *Heavy Ion Booster for Tandem-Accelerator Nuclear and Atomic Physics*
 Institution and address : *Max-Planck-Institut für Kernphysik, POBox 103980, D69029 Heidelberg*
 Person in charge : *Roland Repnow*
 Name of person supplying these data : *Roland Repnow*
 e-mail : *REP@HERING.MPI-HD.MPG.DE*
 tel. : *+49 6221 516 277* fax : *+49 6221 516234*

HISTORY AND STATUS

Const. started : *1974* ; first beam : *1979*
 Present status : *Operating*
 Cost of facility : *10 MDEM (1980)*
 Present linac staff : *6 persons*
 Present yearly operat. time : *1500-2500* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *(1)*
 Species of ions : *all ions from p to U*
 Range of currents : *0.1 - 200* μAe
 Range of output energies : *190* keV/u
 Pulse length : *DC/200* μs ; rep. rate : *55* Hz
 Normalized emittance (1σ) : *1.5* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *(2) 25* m
 Output currents : *0.1 - 10.0* μAe
 Output energies : *1000 - 24000* keV/u
 Frequency : *0* MHz; peak RF power : *na* kW
 Pulse length : *(3)* μs ; rep. rate : *55* Hz
 Normalized emittance (1σ) : *1.5* π mm-mrad

Longitudinal Matching

Type : *a) Harmonic buncher b) Spiral resonator (4)*
 Mod. *a) 1.2* keV; drift *5000* mm at *13.56* MHz
b) 300 keV; drift *3200* mm at *108.48* MHz

Accelerating System

Total linac length : *16* m; N^o. of tanks : *40*
 Tank diameters : *0.35-0.5* m
 Number of drift-tubes : *48*
 Drift-tube lengths : *35 - 146* mm
 Drift-tube diam (range): *32* mm
 Gap/cell length (range): *180 - 215*
 Aperture diameter : *20* mm to mm
 RF frequency(ies) : *108.48* MHz
 Field modes : *na*
 Eff. shunt impedance : *30* M Ω /m
 Q : *3500*
 Filling time : *na* μs
 Equil. phases : *-20°*; accel. rate *0.5* MeV/u-m
 RF rep. rate : *55* Hz; pulse : *2000* μs
 Beam rate : *55* Hz; pulse : *2000* μs
 RF power peak : *3.6* MW; mean : *0.9* MW

Focusing System

No. elements : *10*
 type : *Quad. Dupl.* order : *FD*
 Gradients : *8* to *30* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Gas / Foil*
 Charge states : *-1* to *6 12* at *0.1* MeV/u
 Charge states : *6 12* to *15 30* at *1* MeV/u

LINAC PERFORMANCE

	Normal Operation (5)	Max, or Design (6)	
Species	: ^{12}C	^{120}Sn	
Energy	: <i>11 / 15</i>	<i>5.5</i>	MeV/u
$\Delta E/E$ (FWHM)	: <i>0.04</i>	<i>0.1</i>	%
Mean acc. rate	: <i>0.25 / 0.5</i>	<i>0.12/0.25</i>	MeV/u-m
Beam current	: <i>1.0</i>	<i>0.080</i>	μAe peak
Norm. emit. (1σ)	: <i>2.0</i>	<i>2.0</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range (7)	Other info.
<i>32 S</i>	<i>8 / 13</i> MeV/u	<i>(25% DF)</i>
<i>58 Ni</i>	<i>5.3 / 10</i> MeV/u	<i>(25% DF)</i>
<i>197 Au</i>	<i>3.6</i> MeV/u	<i>(25% DF)</i>

OTHER RELEVANT INFORMATION

- (1) *CE x Duopl., Cs-Sputter-Source (neg)*
- (2) *12MV Electrostatic Tandem*
- (3) *200 - 2000 μs*
- (4) *c) rf-chopper 13.56 MHz 150 kV*
- (5) *light ions : cw / pulsed*
- (6) *heavy ions : cw / pulsed*
- (7) *cw / pulsed*

Beams can be further accelerated by TSR-storage ring in synchrotron acceleration mode.

Second linac-injector for high particle currents under construction.

References

- [1] *IEEE Trans. Nucl. Sci. Vol. NS-28, No. 2, April 1981 p. 1441: Heavy Ion Acceleration at the Heidelberg Tandem Postaccelerator Combination, B. Huck, H. Ingwersen, E. Jaeschke, B. Kolb, R. Repnow, Th. Walcher.*

ION LINAC

Name of Linac : *Heidelberg High Current Injector*
Function : *Heavy Ion High Current Injector, Nuclear and Atomic Physics*
Institution and address : *Max-Planck-Institut für Kernphysik, PO Box 103980, D 69029 Heidelberg*
Person in charge : *Robert von Hahn*
Name of person supplying these data : *Robert von Hahn*
e-mail : *vonhahn@zoohey.mpi-hd.mpg.de*
tel. : *+49 6221 516 396* fax : *+49 6221 516 234*

HISTORY AND STATUS

Const. started : *1991* ; first beam :
Present status : *Under construction*
Cost of facility : *5 MDEM*
Present linac staff : *5*
Present yearly operat. time : *h*

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
Types of source : *(1)*
Species of ions : *(1) Be, Li / all ions from p to U*
Range of currents : *(1) 4000 / 10-400 μ Ae*
Range of output energies : *4 keV/u*
Pulse length : *2000 μ s*; rep. rate : *ca 60 Hz*
Normalized emittance (1σ) : *na π mm-mrad*

Pre-accelerators (including RFQ)

Types (lengths) : *2 RFQ resonators, 3m each m*
Output currents : *T=90 % calculated μ Ae*
Output energies : *480 keV/u*
Frequency : *(2) MHz*; peak RF power : *80 kW*
Pulse length : *4000 μ s*; rep. rate : *60 Hz*
Normalized emittance (1σ) : *na π mm-mrad*

Longitudinal Matching

Type : *Spiral Resonator*
Mod. *200 keV*; drift *1500 mm* at *108.48 MHz*
keV; drift *mm* at *MHz*

Accelerating System

Total linac length : *10 m*; N°. of tanks : *8*
Tank diameters : *0.5 m*
Number of drift-tubes : *48*
Drift-tube lengths : *36 - 59 mm*
Drift-tube diam (range): *32 mm*
Gap/cell length (range): *51 - 78*
Aperture diameter : *20 mm* to *mm*
RF frequency(ies) : *108.48 MHz*
Field modes : *na*
Eff. shunt impedance : *100 M Ω /m*
Q : *5500*
Filling time : *na μ s*
Equil. phases : *-20°*; accel. rate *0.18 MeV/u-m*
RF rep. rate : *60 Hz*; pulse : *4000 μ s*
Beam rate : *60 Hz*; pulse : *4000 μ s*
RF power peak : *0.72 MW*; mean : *0.18 MW*

Focusing System

No. elements : *4*
type : *quad.dupl.* order : *FD*
Gradients : *8* to *30 T/m*
Other :

Charge Stripping (Typical)

Type(s) :
Charge states : to at MeV/u
Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	:	<i>p to U</i>
Energy	:	<i>2 MeV/u</i>
$\Delta E/E$ (FWHM)	:	<i>0.5 %</i>
Mean acc. rate	:	<i>0.2 MeV/u-m</i>
Beam current	:	<i>10 - 4000 μAe peak</i>
Norm. emit. (1σ)	:	<i>na π mm-mrad</i>

OTHER ION BEAMS

Particle	Energy range	Other info.
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OTHER RELEVANT INFORMATION

(1) *1st phase: CHORDIS / 2nd phase: ECR*
(2) *108.48 MHz*

Beams can be further accelerated by the postaccelerator and the storage ring in synchrotron mode.

ION LINAC

Name of Linac : *SchweIN : IH type*
 Function : *Heavy ion postaccelerator*
 Institution and address : *Beschleunigerlabor der LMU und TUM; D-85747 Garching, Germany*
 Person in charge : *Eckehart Nolte*
 Name of person supplying these data : *Eckehart Nolte*
 e-mail : *nolte@physik.tu-muenchen.de*
 tel. : *+49 89 289 12554* fax : *+49 89 289 14280*

HISTORY AND STATUS

Const. started : *1971* ; first beam : *1976*
 Present status : *Operating*
 Cost of facility : *2 MDEM*
 Present linac staff : *1 operator*
 Present yearly operat. time : *1440* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *CS sputter source*
 Species of ions : *(1)*
 Range of currents : *1* μAe
 Range of output energies : *4300 - 6400* keV/u
 Pulse length : μs ; rep. rate : *d.c.* Hz
 Normalized emittance (1σ) : *(2) 80* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *MP Tandem, 24* m
 Output currents : *1* μAe
 Output energies : *≈ 2400* keV/u
 Frequency : *MHz*; peak RF power : *dc* kW
 Pulse length : μs ; rep. rate : *Hz*
 Normalized emittance (1σ) : *3* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *8* m; N^o. of tanks : *2*
 Tank diameters : *1; 0.5* m
 Number of drift-tubes : *50*
 Drift-tube lengths : *≈ 100 ; ≈ 50* mm
 Drift-tube diam (range): *8000* mm
 Gap/cell length (range): *0.5*
 Aperture diameter : *30* mm to *20* mm
 RF frequency(ies) : *78; 156* MHz
 Field modes : *TE111; IH*
 Eff. shunt impedance : *150; 170* M Ω /m
 Q : *30000; 20000*
 Filling time : *d.c.* μs
 Equil. phases : *(3)* ; accel. rate *0.5* MeV/u-m
 RF rep. rate : *d.c.* Hz; pulse : μs
 Beam rate : *Hz*; pulse : μs
 RF power peak : *90* MW; mean : *90* MW

Focusing System

No. elements : *3 outside tanks*
 type : *QD* order :
 Gradients : to *30* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *Ni*
 Charge states : *11* to *22* at *2.4* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	<i>Ni</i>	
Energy	<i>6</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>1</i>	%
Mean acc. rate	<i>0.5</i>	MeV/u-m
Beam current	<i>1</i>	μAe peak
Norm. emit. (1σ)	<i>3</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
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OTHER RELEVANT INFORMATION

- (1) *S⁻, Cl⁻, Ca⁻, T⁻, MnO⁻, Fe⁻, Ni⁻, Ge⁻*
- (2) *After preaccelerator (170 kV)*
- (3) *+ 5 to - 10°*
- (4) *3 (outside tanks)*

First IH structure in operation.

First postaccelerator after Tandem accelerator.

References

- [1] *E. Nolte et al. NIM 158 (1979) 311*
- [2] *E. Nolte et al. NIM 201 (1982) 281*
- [3] *U. Ratzinger et al. NIM A263 (1988) 261*

POSITRON LINAC

Name of Linac : DAΦNE - LINAC
 Function : Positron Injector Linac per DAΦNE and for the DAΦNE BTF*
 Institution and address : INFN LNF via E. Fermi 40 CP 13 00044 Frascati Italy
 Person in charge : F. Sannibale
 Name of person supplying these data : F. Sannibale
 e-mail : sannibale@lnf.infn.it
 tel. : +39 6 94032213 fax : +39 6 94032256

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right. (1)

Primary Beam (e⁻) at Conversion Target

Energy : MeV
 Radius (1σ) : mm
 Beam intensity : A

LINAC PARAMETERS

Conversion Target and Capture

Material : Tungsten with ~25% Rhenium
 Type : Removable
 Thickness (rad.length) : χ
 Diameter : 8 mm mm
 Mean deposited power : ~ 150 W kW
 Solenoidal field¹⁾ : (2)

Matching device : (3) 5 T Flux Concentrator
 RF sections¹⁾ : (4) 10 × 3 m

¹⁾ key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.510	0.550	GeV
Accel gradient	18	25	MeV/m
ΔE/E (FWHM)	2.0	2.0	%
Rep. rate	50	50	Hz
Pulse length	0.010	0.010	μs
Yield (fin.en)			e ⁺ /e ⁻ × GeV
Beam intensity	0.036	0.036	μA peak
Norm. emit. (1σ)	< 3000	< 3000	π mm-mrad

OTHER RELEVANT INFORMATION

* BTF: Beam Test Facility. It is a branch line designed to work also in single electron mode.

- (1) Const. started : 1992
 Present status : Starting commissioning
 Cost of facility : 12 MUSD (1992)
 Present linac staff : 10 man-years
 Present yearly operation time : 0 h
 (2) 1.2 T tapered field DC solenoid, 0.5 T DC solenoid over 7 m
 (3) SLAC type.
 (4) The first section downstream the positron converter has an operating gradient of 25 MeV / m. This section will work in a decelerating mode in order to increase the positron capture.

Between the second and the third accelerating section downstream the positron converter there is a magnetic separator where the electron beam is stopped.

ION LINAC

Name of Linac : *ALPI**
 Function : *Heavy Ion Linac*
 Institution and address : *INFN - LNL via Romea 4-35020 Legnaro Italy*
 Person in charge : *G. Fortuna*
 Name of person supplying these data : *G. Fortuna*
 e-mail : *fortuna@lnl.infn.it*
 tel. : *+39 49 829 2442* fax : *+39 49 64 19 25*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *05/1994*
 Present status : *Operational*
 Cost of facility : *30 GITL*
 Present linac staff : *10 man-years*
 Present yearly operat. time : *2000* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *Sputtering source*
 Species of ions : *Stable isotopes $28 \leq A \leq 100$*
 Range of currents : *Up to $3 + 5$* μAe
 Range of output energies : *2 + 7* keV/u
 Pulse length : *dc* μs ; rep. rate : Hz
 Normalized emittance (1σ) : *0.2(estimated)* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *16 MV XTU - Tandem* m
 Output currents : *Up to 1* μAe
 Output energies : *Up to 7000* keV/u
 Frequency : *dc* MHz; peak RF power : kW
 Pulse length : μs ; rep. rate : Hz
 Normalized emittance (1σ) : *0.5(estimated)* π mm-mrad

Longitudinal Matching

Type : *(1) 5-10 MHz DD Buncher, n^2 choppers*
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *(2)* m; N^o. of tanks :
 Tank diameters : m
 Number of drift-tubes :
 Drift-tube lengths : mm
 Drift-tube diam (range) : mm
 Gap/cell length (range) :
 Aperture diameter : mm to mm
 RF frequency(ies) : MHz
 Field modes :
 Eff. shunt impedance : M Ω /m
 Q :
 Filling time : μs
 Equil. phases : ; accel. rate MeV/u-m
 RF rep. rate : Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : MW; mean : MW

Focusing System

No. elements : *29*
 type : *Singlets-Triplets* order : *FDF*
 Gradients : to *12* T/m
 Other : *8 dipoles 3.2 T·m*

Charge Stripping (Typical)

Type(s) : *c foils $5 + 10 \mu\text{g}/\text{cm}^2$*
 Charge states : *14* to *30* at *0.8-7* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	: $^{28}\text{Si}/\text{Zr}^{90}$	$^{28}\text{Si}/\text{U}^{238}$	
Energy	: <i>20/10</i>	<i>20/6</i>	MeV/u
$\Delta E/E$ (FWHM)	: <i>0.5</i>	<i>0.1</i>	%
Mean acc. rate			MeV/u-m
Beam current	: <i>5 pA</i>	<i>30 pA</i>	μAe peak
Norm. emit. (1σ)	: <i>0.5% (est.)</i>	<i>0.5</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *Acceleratore Lineare Per Ioni Superconducting Linac*

(1) n^2 ScQWRS Bunchers

(2) Accelerating System

Number and type of resonators : 52, QWR
RF frequency : 80 160 MHz ; Field mode : TEM
Q : $10^8 + 10^9$; Stored Energy : 64 - 110 mJ/(MV/m)²
 $E_{\text{peak}} / E_{\text{acc}} : 4.5 + 5$; $H_p/E_q : 100$ Gauss/MV/m
Active length : 18cm ; $\beta_{\text{opt}} : 0.11, 0.14, 0.055$
TTF (β_{opt}) : 0.92 ; Number of gaps : 2
Operating RF power per resonator at 4.5 K : 7 W
Average accelerating field : 2.5 - 5 MV/m
Phasing : all resonators independently phased
Number and type of cryostats : 13, vertical
Cryogenic plants : 1300 W at 4.5 K, 3900 W at 80K. Duty cycle : CW

Notes: we use three types of resonators namely, lead plated, Nb sheets, Nb sputtered based cavities

ELECTRON LINAC

Name of Linac : *ELETTRA INJECTOR LINAC **
Function : *Electron injector for ELETTRA*
Institution and address : *SINCROTRONE Trieste - Padriciano 34012 Trieste, Italy*
Person in charge : *G. D'Auria*
Name of person supplying these data : *C. Rossi* *G. D'Auria*
e-mail : *Carlo.Rossi@Elettra.Trieste.it* *Gerardo.Dauria@Elettra.Trieste.it*
tel. : *+39 40 375 8654* fax : *+39 40 375 8565*

HISTORY AND STATUS

Const. started : *1989* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *7 man-years*
Present yearly operation time : *4000* h

LINAC PARAMETERS

Electron Sources

Types : ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *67* m
No. sections : *7* ; lengths : *6.15* m
Field mode : *$3\pi/4$* ; frequency : *2.998* GHz
Wave type : *BTW* ; filling time : *0.760* μ s
 v_g/c range : *0.026* ; Q : *11600*
Shunt impedance : *> 71* M Ω /m
Iris : aperture : diameter : *10* mm
thickness : *9.5 +10* mm
Attenuation/section : *0.61* Np
Power units, Number : *7* type : *(1) Klystron*
RF power peak : *45* MW; mean : *2* kW

Focusing System

Type, No. of elements, and spacing :
Same as ELETTRA 100 MeV up to 100 MeV, then solenoids on section 1 and triplets at the end of each section

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *5 + 75*
No. of particles/bunch : *$0.25 \cdot 10^9$*
Bunch separation : *2 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>1.0</i>	<i>1.2</i>	GeV
Accel gradient	: <i>25</i>	<i>27</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>± 0.5</i>	<i>± 0.5</i>	%
Rep. rate	: <i>10</i>	<i>10</i>	Hz
Pulse length	: <i>$0.03 + 0.1$</i>	<i>$0.01 + 0.15$</i>	μ s
Beam intensity	: <i>0.020</i>	<i>0.020</i>	A
Norm. emit. (1σ)		<i>< 200</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *The ELETTRA Injector Linac is fed by the ELETTRA 100 MeV. A small bending magnet, located between the ELETTRA 100 MeV and the ELETTRA Injector Linac, allows to transfer the low energy beam to the FEL experimental hall. The operation modes of Injector Linac are the single bunch mode and the multibunch mode (see ELETTRA 100 MeV for more details).*

(1) *Equipped with RF pulse compression.*

ELECTRON LINAC

Name of Linac : MEA*
Function : Electron Injector Linac for AmPS
Institution and address : NIKHEF, Kruislaan 409, 1098 SJ Amsterdam, Netherlands
Person in charge : L.H. Kuyser
Name of person supplying these data : F.B. Kroes
e-mail : Frans@nikhef.nikhef.nl
tel. : +31 20 5922055 fax : +31 20 5922165

HISTORY AND STATUS

Const. started : 1975 ; first beam : 1978
Present status : Operating
Cost of facility : 30 MFL (1975)
Present linac staff : 15 man-years
Present yearly operation time : 5500 h

LINAC PARAMETERS

Electron Sources

Types : Diode ; energy : 400 keV
Beam intensity (peak) : 0.300 A
Normalized emittance (1σ) : 8 π mm-mrad

Injector

Longitudinal matching : (1)
Output : 6 MeV; intensity : 0.060 A
Pulse width, spacing : 3.5 μ s, 4 ms
Normalized emittance (1σ) : 16 π mm-mrad

Acceleration System

Total linac length : 200 m
No. sections : 23 ; lengths : 7.35 m
Field mode : $2\pi/3$; frequency : 2.856 GHz
Wave type : TW ; filling time : 1.3 μ s
 v_g/c range : (2) ; Q : 13750
Shunt impedance : 56.5 - 48 M Ω /m
Iris : aperture : diameter : 32 - 17 mm
thickness : 5.84 mm
Attenuation/section : 0.825 Np
Power units, Number : 13 type : Klystron
RF power peak : 10 MW; mean : 20 kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 100 MeV
Quadruplet/2 sections up to 750 MeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : NA
No. of particles/bunch : NA
Bunch separation : NA

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.7	0.8	GeV
Accel gradient	: 5	7	MeV/m
$\Delta E/E$ (FWHM)	: (3) < 0.1	(3) < 0.1	%
Rep. rate	: 150	250	Hz
Pulse length	: 2	3.5	μ s
Beam intensity	: 0.040	0.060	A
Norm. emit. (1σ)	: 25		π mm-mrad

OTHER RELEVANT INFORMATION

* Medium Energy Electron Accelerator

- (1) S-band chopper, pre-buncher and buncher
- (2) 0.0093 - 0.0389
- (3) Energy Spectrum Compressor

Around 1990 the 500 MeV high duty factor (1%) electron linac MEA was upgraded to a 700 MeV low duty (0.1%) factor injector linac for AmPS (Amsterdam Pulse Stretcher).

References

- [1] "High Duty Factor Electron Linear Accelerators"; J.Haimson, Lapostolle & Septier, Linear Accelerators, 1970. North Holland publishing Comp. Amsterdam.
- [2] "Modification of MEA Modulator-klystron units enabling short pulse injection into a Pulse Stretcher Ring"; F.B. Kroes, E. Heine, IEEE Proc. of the Part. Acc.Conf., Chicago, March 20-23, 1989.
- [3] "An Energy Compressor System (ECS) for AmPS"; J.G. Noomen, R.Maas, IEEE Proc. of the Part.Acc.Conf., Chicago, March 20-23, 1989.
- [4] "Improvement of the 400 keV Linac Electron Source", F.B. Kroes et al., Proc. of the 3rd European Part. Acc. Conf., Berlin, March 24-28, 1992.

ELECTRON LINAC

Name of Linac : *FELIX**
Function : *FEL-driver*
Institution and address : *FOM-"RYNHUIZEN", Edisonbaan 14, 3439 MN Nieuwegein, Netherlands*
Person in charge : *Dr. A. F. G. van der Meer*
Name of person supplying these data : *Dr. A. F. G. van der Meer*
e-mail : *meer@rijnh.nl*
tel. : *+31 306096999* fax : *+31 306031204*

HISTORY AND STATUS

Const. started : *06/1990* ; first beam : *05/1991*
Present status : *Operational*
Cost of facility : *8 MNLG (1990)*
Present linac staff : *3 man-years*
Present yearly operation time : *3000* h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : *100* keV
Beam intensity (peak) : *0.2* A
Normalized emittance (1σ) : *15* π mm-mrad

Injector

Longitudinal matching : *(1)*
Output : *4.5* MeV; intensity : *0.2* A
Pulse width, spacing : *10 μ s, 100 ms*
Normalized emittance (1σ) : *25* π mm-mrad

Acceleration System

Total linac length : *15* m
No. sections : *2* ; lengths : *3.15* m
Field mode : *$2\pi/3$* ; frequency : *2.9985* GHz
Wave type : *TW* ; filling time : *0.6* μ s
 v/c range : *0.01-0.02* ; Q : *12000*
Shunt impedance : *57* M Ω /m
Iris : aperture : diameter : *18-23* mm
thickness : mm
Attenuation/section : *0.41* Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : *4* kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to end of 1st linac (25 MeV), triplet, solenoid around 2nd linac.

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch : *10^9*
Bunch separation : *1 ns or 40 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.012-0.050</i>	<i>0.015-0.045</i>	GeV
Accel gradient	: <i>10</i>	<i>10</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>0.3-0.6</i>	<i>0.6</i>	%
Rep. rate	: <i>5</i>	<i>10</i>	Hz
Pulse length	: <i>9</i>	<i>20</i>	μ s
Beam intensity	: <i>0.17</i>	<i>0.2</i>	A
Norm. emit. (1σ)	: <i>30</i>	<i>25</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *FELIX - Free Electron Laser for Infrared Experiments*

(1) 1 GHz pre-buncher, S-band buncher

References

[1] "*A Low-Energy-Spread RF Accelerator for a Far-Infrared Free-Electron Laser*", C.A.J. van der Geer et al., NIMA 334 (1993) 607-616.

ELECTRON LINAC

Name of Linac : *TEUFEL* *
Function : *Driver for Free-Electron-Laser* **
Institution and address : *University of Twente: Drienerlolaan 5; 7522 NB Enschede; the Netherlands*
Person in charge : *G.J. Ernst, J.W.J. Verschuur*
Name of person supplying these data : *J.W.J. Verschuur*
e-mail : *J.W.J.Verschuur@tm.utwente.nl*
tel. : *+31 53 489 3971* fax : *+31 53 489 1102*

HISTORY AND STATUS

Const. started : *1988* ; first beam : *1993*
Present status : *Operating*
Cost of facility :
Present linac staff : *2 man-years*
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *(1) RF gun* ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : *0.65* m
No. sections : *1* ; lengths : *0.65* m
Field mode : *$\pi/2$* ; frequency : *1.3* GHz
Wave type : *SW* ; filling time : *4* μ s
 v_p/c range : ; Q : *16885*
Shunt impedance : *47.0* M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : *1* type : *Klystron*
RF power peak : *20* MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
1 solenoid at position of cathode and first 2.5 cells with bucking coil to zero field at cathode

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *< 1200*
No. of particles/bunch : *< 4.4 \times 10^{10}*
Bunch separation : *12.31 ns*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.006</i>	<i>0.007</i>	GeV
Accel gradient	: <i>10 - 30</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>0.5</i>		%
Rep. rate	: <i>< 10</i>		Hz
Pulse length	:		μ s
Beam intensity	: <i>(2)</i>	<i>(2)</i>	A
Norm. emit. (1σ)	: <i>5</i>		π mm-mrad

OTHER RELEVANT INFORMATION

- * *Twente Eindhoven Urenco Free Electron Laser*
- ** *Injector for 25 MeV racetrack microtron*

- (1) *Photocathode*
- (2) *5 nC / bunch with a maximum of 7 nC / bunch*

ELECTRON LINAC

Name of Linac : S-20*
Function : Research in Accelerator Technology, Testing of Accelerating structures
Institution and address : SINS **, 05-400 Otwock-Swierk, Poland
Person in charge : W. Maciszewski
Name of person supplying these data : W. Maciszewski
e-mail : sinsp10@cx1.cyf.gov.pl
tel. : + 48 2 779 8632 fax : + 48 2 779 3481

HISTORY AND STATUS

Const. started : 1995 ; first beam : 1996
Present status : *under construction*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Triode* ; energy : 30 keV
Beam intensity (peak) : 0.200 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 2.50 m
No. sections : 1 ; lengths : 2.20 m
Field mode : $2\pi/3$; frequency : 2.995 GHz
Wave type : *TW* ; filling time : 0.9 μ s
 v_p/c range : ; Q :
Shunt impedance : 18 M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : 1 type : *Klystron*
RF power peak : 5 MW; mean : 3.5 kW

Focusing System

Type, No. of elements, and spacing :
Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.022		GeV
Accel gradient	: 10		MeV/m
$\Delta E/E$ (FWHM)	:		%
Rep. rate	: 100		Hz
Pulse length	: 7		μ s
Beam intensity	:		A
Norm. emit. (1σ)	:		π mm-mrad

OTHER RELEVANT INFORMATION

- * *Laboratory set-up*
- ** *SINS - Soltan Institute for Nuclear Studies*

More detailed data will be given after running up.

ION LINAC

Name of Linac : *LU-20 **
 Function : *Ion Injector for Nuclotron*
 Institution and address : *JINR LHE. 141980 Dubna, Moscow Region, Russia*
 Person in charge : *V.A. Monchinsky*
 Name of person supplying these data : *A.I. Govorov*
 e-mail : *edik@sunhe.JINR.Dubna.SU.*
 tel. : fax : *+7 7096 2165889*

HISTORY AND STATUS

Const. started : *02/1966* ; first beam : *11/1973*
 Present status : *Operational*
 Cost of facility : *15 MUSD (1995)*
 Present linac staff : *10 man-years*
 Present yearly operat. time : *2000 (1995)* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *LIS, EBIS*
 Species of ions : *Ions up to Kr²⁹⁺ Z/A > 1/3*
 Range of currents : *(1)* μ Ae
 Range of output energies : *3* keV/u
 Pulse length : *5 - 150* μ s; rep. rate : *0.2* Hz
 Normalized emittance (1 σ) : *0.2* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Accelerating tube 2.2* m
 Output currents : *(2)* μ Ae
 Output energies : *150* keV/u
 Frequency : MHz; peak RF power : kW
 Pulse length : *600* μ s; rep. rate : *0.2* Hz
 Normalized emittance (1 σ) : *0.3* π mm-mrad

Longitudinal Matching

Type : *1 gap buncher*
 Mod. *50* keV; drift *800* mm at *145* MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *14.38* m; N^o. of tanks : *1*
 Tank diameters : *1.4* m
 Number of drift-tubes : *57 + 2 (1/2)*
 Drift-tube lengths : *56 - 316* mm
 Drift-tube diam (range): *133.5 to 110* mm
 Gap/cell length (range): *0.25; g/2 $\beta\lambda$*
 Aperture diameter : *17* mm to *25* mm
 RF frequency(ies) : *145* MHz
 Field modes : *TM010*
 Eff. shunt impedance : *16* M Ω /m
 Q : *40000*
 Filling time : *< 150* μ s
 Equil. phases : *-10^o-25^o*; accel. rate *0.34* MeV/u-m
 RF rep. rate : *0.5* Hz; pulse : *500* μ s
 Beam rate : *0.2* Hz; pulse : *5 - 400* μ s
 RF power peak : *5.0* MW; mean : *0.0005* MW

Focusing System

No. elements : *58*
 type : *DC* order : *FODO*
 Gradients : *65* to *9* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *C foil*
 Charge states : *equil.* to *charge* at *5.0* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	<i>(3)</i>	<i>(4)</i>
Energy	<i>5.0</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>+ 0.25</i>	%
Mean acc. rate	<i>0.34</i>	MeV/u-m
Beam current	<i>(3)</i>	<i>(4)</i> μ Ae peak
Norm. emit. (1 σ)	<i>3.5</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>p</i>	<i>20 MeV</i>	<i>duoplas.</i>
<i>d, α</i>	<i>5 MeV/u</i>	<i>duoplas.</i>

OTHER RELEVANT INFORMATION

* *LHE JINR Ion Linac (LU-20)*

(1) for LIS : 200 $\times 10^3$ μ Ae
for EBIS : 10 μ Ae

(2) for LIS : 40 $\times 10^3$ μ Ae
for EBIS : 5 μ Ae

(3) for LIS : Species C⁴⁺, Mg¹⁰⁺
Beam Current 3 $\times 10^3$

(4) for EBIS : Species Kr²⁹⁺
Beam Current 2

PROTON AND/OR H- LINAC

Name of Linac : *MMFL **
 Function : *Nuclear physics, Isotope production*
 Institution and address : *INR, 117312 Moscow 60th Anniversary pr. 7A, Russia*
 Person in charge : *S.K. Esin*
 Name of person supplying these data : *P.N. Ostroumov*
 e-mail : *OSTROUMOV@AL20.INR.TROITSK,RU*
 tel. : fax : *+7 095 135 22 68*

HISTORY AND STATUS

Const. started : *1977* ; first beam : *1990*
 Present status : *Operational*
 Cost of facility : *130 MRUR (1989)*
 Present linac staff : *170*
 Present yearly operat. time : *3000* h

LINAC PARAMETERS

Ion Source

Type : *H⁺ Duoplasmatron, H⁻ Dudnikov - type*
 Output : *250H⁺, 100 H⁻ mA at 40H⁺, 20H⁻ keV*
 Pulse length : *100 μs*; rep. rate : *100 Hz*
 Normalized emittance (1σ) : *0.5 π mm-mrad*

Pre-accelerator (including RFQ)

Types : *Accelerating tube* ; lengths : *1.3 m*
 Output : *(1) mA at 750 keV*
 Pulse length : *100 μs*; rep. rate : *100 Hz*
 Normalized emittance (1σ) : *0.7 π mm-mrad*

Longitudinal Matching

Type : *2 bunching cavities*
 Mod. *12.5 keV*; drift *1270 mm* at *198.2 MHz*
50.0 keV; drift *500 mm* at *198.2 MHz*

Accelerating System

Total linac length : *430 m*; No. of tanks : *33*
 Tank diameters : *1.05-0.89 0.46 - 0.40 m*
 Number of drift-tubes : *186 + 10 × 0.5*
 Drift-tube lengths : *47.8 - 390.5 mm*
 Drift-tube diam (range): *150 mm*
 Gap/cell length (range): *0.242 - 0.3976*
 Aperture diameter : *15 - 28 mm to 38 mm*
 RF frequency(ies) : *198.2 991.0 MHz*
 Field modes : *TM010 TM020*
 Eff. shunt impedance : *33-20 22-40 MΩ/m*
 Q : *64000-50000 17000-29000*
 Filling time : *100 10 μs*
 Equilibrium phases : *37-26 33*
 RF rep. rate : Hz; pulse : μs
 Beam rate : *100 Hz*; pulse : *80 μs*
 RF power peak : *110.0 MW*; mean : *1.2 MW*

Focusing System

No. elements : *434*
 type : *Quadrupoles* order : *FODO/FDO*
 Gradients : *60* to *20 T/m*
 Other :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	<i>423</i>	<i>600</i>	MeV
Mean acc. rate	<i>1.4</i>	<i>1.4</i>	MeV/m
ΔE/E (FWHM)	<i>0.9</i>	<i>0.8</i>	%
Beam current	<i>20.0</i>	<i>50.0</i>	mA peak
Norm. emit. (1σ)	<i>0.8</i>	<i>1.5</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Moscow Meson Factory Linac*

(1) *90H⁺, 20H⁻*

Part I - post coupled Alvarez linac structure.
Part II - disc and washer linac structure.

Proton stretcher - compressor ring is under construction (Energy - 600 MeV, circulating current - 11 A, orbit circumference - 106.7 m, duty factor - max 98 %, min 10⁻³ %, rep. rate 100 Hz).

References

[1] *V.D. Burlakov et al, Proc. of the 1984 Linac Conf. Seeheim, Germany, p 9-13.*

PROTON AND/OR H- LINAC

Name of Linac : *ISTRA-36 **
 Function : *Driver for Subcritical Test Facility; Production of Radionuclides*
 Institution and address : *Inst. for Theoretical and Experimental Physics, 117259, Moscow, Russia*
 Person in charge : *A. Kozodaev*
 Name of person supplying these data : *A. Kozodaev*
 e-mail : *kozodaev@r02vax.itep.ru*
 tel. : +7 095 123 0292 fax : +7 095 123 6584

HISTORY AND STATUS

Const. started : 1982 ; first beam : 19/09/1989
 Present status : *Assembled*
 Cost of facility : 2 MUSD (1992)
 Present linac staff : 6
 Present yearly operat. time : h

Focusing System

No. elements : 91
 type : *Quadrupole* order : *FODO*
 Gradients : 60 to 23.6 T/m
 Other : *SmCo₃ quadrupoles*

LINAC PARAMETERS

Ion Source

Type : *Cold cathode duoplasmatron*
 Output : 300 - 400 mA at 82 keV
 Pulse length : 5-150 μ s; rep. rate : 0.5-25 Hz
 Normalized emittance (1σ) : 0.5 π mm-mrad

Pre-accelerator (including RFQ)

Types : *4-vane RFQ* ; lengths : 4.6 m
 Output : 150 mA at 3000 keV
 Pulse length : 5-150 μ s; rep. rate : 0.5-25 Hz
 Normalized emittance (1σ) : 0.8 π mm-mrad

Longitudinal Matching

Type : *It is not necessary*
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : 16 m; No. of tanks : 2
 Tank diameters : 0.65; 0.63 m
 Number of drift-tubes : 33 + 2 (1/2); 54 + 2 (1/2)
 Drift-tube lengths : 68-100; 123-193 mm
 Drift-tube diam (range): 100; 85 mm
 Gap/cell length (range): 0.18-0.25; 0.18-0.29
 Aperture diameter : 18 mm to 18 mm
 RF frequency(ies) : 297 MHz
 Field modes : *TM010*
 Eff. shunt impedance : 28; 38 M Ω /m
 Q : 35000; 36000
 Filling time : μ s
 Equilibrium phases : -50° to -37°; -37° to -30°
 RF rep. rate : 0.5 - 25 Hz; pulse : 230 μ s
 Beam rate : 0.5 - 25 Hz; pulse : 5 - 150 μ s
 RF power peak : 7.3 MW; mean : MW

LINAC PERFORMANCE

Normal Max, or
 Operation Design

Energy : 36 MeV
 Mean acc. rate : 2 MeV/m
 $\Delta E/E$ (FWHM) : 1.2 %
 Beam current : 150 200 mA peak
 Norm. emit. (1σ) : 1.5 π mm-mrad

OTHER RELEVANT INFORMATION

* *ISTRA-36 (ITEP Proton Linac)*

RFQ RF frequency 148.5 MHz

Drift-tubes are open to vacuum

Ion channel will be between DTL tanks

RFQ and tank No.1 (DTL-10MeV) have launched at 150mA, 5 μ s, 1 Hz

References

[1] *Description of the ISTRA-36 see in Proc. of 1990 Linac Conf., p.776 and Proc. of 1994 Linac Conf., p.128.*

ION LINAC

Name of Linac : I-2 *
 Function : *Injector of 10 GeV PS*
 Institution and address : *Inst. for Theoretical and Experimental Physics, 117259, Moscow, Russia*
 Person in charge : *N.V. Lazarev*
 Name of person supplying these data : *N.V. Lazarev*
 e-mail : *Skachkov_v@cl.itep.ru*
 tel. : fax : +7 95 123 6584

HISTORY AND STATUS

Const. started : 1962 ; first beam : 1966
 Present status : *Injector of 10 GeV PS*
 Cost of facility : 4 MUSD
 Present linac staff : 8 for shifts + 6 for service
 Present yearly operat. time : 5500 h

LINAC PARAMETERS

Ion Sources

No. of sources : 1
 Types of source : *Cold cathode duoplasmatron*
 Species of ions : *p*
 Range of currents : 2×10^6 μ Ae
 Range of output energies : 15 keV/u
 Pulse length : 20 - 25 μ s; rep. rate : 2 Hz
 Normalized emittance (1σ) : π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : 750 kV acc. column 2.3 m
 Output currents : 1.2×10^6 μ Ae
 Output energies : 703 keV/u
 Frequency : MHz; peak RF power : kW
 Pulse length : 20 - 25 μ s; rep. rate : 2 Hz
 Normalized emittance (1σ) : 8 π mm-mrad

Longitudinal Matching

Type : *One-gap buncher*
 Mod. 30 keV; drift 850 mm at 148.5 MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : 6+ m; N^o. of tanks : 2
 Tank diameters : 1.37 m
 Number of drift-tubes : 1/2+18+1/2 1/2+33+1/2
 Drift-tube lengths : 137 - 313, 190 - 314 mm
 Drift-tube diam (range): 190 - 150, 150 mm
 Gap/cell length (range): 0.2 - 0.3; 0.16 - 0.3
 Aperture diameter : 20 mm to 25 mm
 RF frequency(ies) : 148.5 MHz
 Field modes : E010
 Eff. shunt impedance : 22 M Ω /m
 Q : 65000 - 70000
 Filling time : 150 μ s
 Equil. phases : 37^o; accel. rate 1.35 MeV/u-m
 RF rep. rate : 2 Hz; pulse : 300 μ s
 Beam rate : 2 Hz; pulse : 15 - 20 μ s
 RF power peak : 1.0+2.0 MW; mean : 0.002 MW

Focusing System

No. elements : 37 + 68
 type : *dc* order : *FOD, FOFDOD*
 Gradients : 55 to 18 T/m
 Other : *Each drift tube contains 2 lenses of opp. signs*

Charge Stripping (Typical)

Type(s) :
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	<i>p</i>		
Energy	24.6	24.6	MeV/u
$\Delta E/E$ (FWHM)	1.0	0.8	%
Mean acc. rate	1.3	1.3	MeV/u-m
Beam current	$0.18-0.2 \times 10^6$	0.23×10^6	μ Ae peak
Norm. emit. (1σ)	10	8	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>He_A²⁺</i>	<i>24.6 MeV/n</i>	

OTHER RELEVANT INFORMATION

* I-2 (*Injector the 2nd*)

- (1) *Cold cathode duoplasmatron ion source with pulse exhaust valve.*
- (2) *Used 750 kV pulse (1ms) transformer.*
- (3) *Acc. period is $2\beta\lambda$ in the 1st cavity and $\beta\lambda$ in the 2nd cavity.*

References

- [1] *"Pribory i Technika Eksperimenta" N5, p. 9-70, 1967*
- [2] *Proc. of the 6th Int. Conf. on High Energy Accelerators, 1967 p. A₁-A₃, A₃₀-A₃₁*

ION LINAC

Name of Linac : *ITEP **
 Function : *Prototype of Driver for Heavy Ion Fusion*
 Institution and address : *Inst. for Theoretical and Experimental Physics, 117259, Moscow, Russia*
 Person in charge : *Kulevoy T.V.*
 Name of person supplying these data : *Kulevoy T.V.*
 e-mail : *Kulevoj@mvax3.itep.ru*
 tel. : fax : *+7 125 65 84*

HISTORY AND STATUS

Const. started : *1984* ; first beam : *1986*
 Present status : *Operational*
 Cost of facility :
 Present linac staff : *4 man-years*
 Present yearly operat. time : *500 (1995)* h

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *MEVVA*
 Species of ions : *Cu⁺, Mo³⁺, Ta³⁺, W³⁺, U⁴⁺*
 Range of currents : *Up to 100000* μ Ae
 Range of output energies : *1.3* keV/u
 Pulse length : *400* μ s; rep. rate : *1* Hz
 Normalized emittance (1σ) : *0.2* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *RFQ, 12* m
 Output currents : *15000* μ Ae
 Output energies : *36* keV/u
 Frequency : *6.19* MHz; peak RF power : *3000* kW
 Pulse length : *600* μ s; rep. rate : *0.25* Hz
 Normalized emittance (1σ) : *0.3* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : m; N^o. of tanks :
 Tank diameters : m
 Number of drift-tubes :
 Drift-tube lengths : mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : mm to mm
 RF frequency(ies) : MHz
 Field modes :
 Eff. shunt impedance : M Ω /m
 Q :
 Filling time : μ s
 Equil. phases : ; accel. rate MeV/u-m
 RF rep. rate : Hz; pulse : μ s
 Beam rate : Hz; pulse : μ s
 RF power peak : MW; mean : MW

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other :

Charge Stripping (Typical)

Type(s) :
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	<i>(1)</i>	
Energy	<i>0.036</i>	MeV/u
$\Delta E/E$ (FWHM)	<i>4</i>	%
Mean acc. rate	<i>0.003</i>	MeV/u-m
Beam current	<i><15 000</i>	μ Ae peak
Norm. emit. (1σ)	<i>0.3</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.

OTHER RELEVANT INFORMATION

* *ITEP Heavy Ion Linac (TIPr-1)*

(1) *Any metal ions with mass-to-charge rate about 60.*

ELECTRON LINAC

Name of Linac : *Linac-60 RRC (FAKEL)*
 Function : *Electron and neutron source for physical research*
 Institution and address : *RRC Kurchatov Institute 123182 Moscow Russia*
 Person in charge : *V.V. Petrenko*
 Name of person supplying these data : *V.V. Kalachnikov*
 e-mail : *kalach@fakel.ssspi.msk.ru*
 tel. : +7 095 196 77 42 fax : +7 095 196 59 73

HISTORY AND STATUS

Const. started : *1963* ; first beam : *12/1973*
 Present status : *Operating*
 Cost of facility : *10 MRUR (1973)*
 Present linac staff : *22 man-years*
 Present yearly operation time : *3200* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *100* keV
 Beam intensity (peak) : *3* A
 Normalized emittance (1σ) : *π* mm-mrad

Injector

Longitudinal matching : *Inflector and buncher (2m)*
 Output : *4* MeV; intensity : *1.5* A
 Pulse width, spacing : *1-5 μ s*
 Normalized emittance (1σ) : *π* mm-mrad

Acceleration System

Total linac length : *20* m
 No. sections : *5* ; lengths : *2* m
 Field mode : *$2\pi/3$* ; frequency : *1.818* GHz
 Wave type : *TW* ; filling time : *0.3* μ s
 v_g/c range : *0.03 - 0.01* ; Q :
 Shunt impedance : *50 - 40* M Ω /m
 Iris : aperture : diameter : *47 - 33* mm
 thickness : *6* mm
 Attenuation/section : *0.13* Np
 Power units, Number : *6* type : *Klystron*
 RF power peak : *30* MW; mean : *20* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid up to 4 MeV, 3 doublets after 1, 3 and 5 sections

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
 No. of particles/bunch :
 Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.054	0.060	GeV
Accel gradient	: 5	6	MeV/m
$\Delta E/E$ (FWHM)	: 8	6	%
Rep. rate	: 150	150	Hz
Pulse length	: 4.2	5.5	μ s
Beam intensity	: 0.8	1	A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

In particular, one of targets (breeding target) is used with neutron multiplication coefficient of 5. The target can operate with electron beam up to 100 kW. The target is equipped with path lengths with length of several metres.

ELECTRON LINAC

Name of Linac : *VEPP-5 Pre-injector*
Function : *Pre-injector*
Institution and address : *Budker INP *, Novosibirsk 630090, Russia*
Person in charge : *A.V. Novokhatski*
Name of person supplying these data : *P.V. Logatchev*
e-mail : *logatchov@inp.nsk.su*
tel. : +7 3832 359583 fax : +7 3832 352163

HISTORY AND STATUS

Const. started : *1988* ; first beam :
Present status : *Under construction*
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : *Thermionic gun* ; energy : *200* keV
Beam intensity (peak) : *10* A
Normalized emittance (1σ) : *100* π mm-mrad

Injector

Longitudinal matching :
Output : *510* MeV; intensity : *1000* A
Pulse width, spacing : *20 ps, 20 ms*
Normalized emittance (1σ) : *15* π mm-mrad

Acceleration System

Total linac length : *70* m
No. sections : *14* ; lengths : *3* m
Field mode : *TM01* ; frequency : *2.856* GHz
Wave type : *(1) TW* ; filling time : *0.5* μ s
 v_p/c range : *0.02* ; Q : *1.3×10^4*
Shunt impedance : *53* M Ω /m
Iris : aperture : diameter : *25.9 : 83.8* mm
thickness : *6* mm
Attenuation/section : *(2)* Np
Power units, Number : *4* type : *5045 Klystron*
RF power peak : *63* MW; mean : *45* kW

Focusing System

Type, No. of elements, and spacing :
2 solenoids
FODO 31 el., spacing 1700 mm

Beam Pulse Structure (if applicable)

No. of bunches/pulse : *1*
No. of particles/bunch : *10^{11}*
Bunch separation : *20 ms*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.510</i>	<i>0.510</i>	GeV
Accel gradient	: <i>18</i>	<i>18</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>1</i>	<i>1</i>	%
Rep. rate	: <i>50</i>	<i>50</i>	Hz
Pulse length	: <i>2×10^{-5}</i>	<i>2×10^{-5}</i>	μ s
Beam intensity	: <i>1000</i>	<i>1000</i>	A
Norm. emit. (1σ)		<i>15</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *Institute for Nuclear Physics*

- (1) *$2\pi/3$*
- (2) *0.11 Np/m*

POSITRON LINAC

Name of Linac : *VEPP-5 pre-injector*
Function : *Pre-injector*
Institution and address : *Budker INP *, Novosibirsk 630090, Russia*
Person in charge : *A.V. Novokhatski*
Name of person supplying these data : *P.V. Logatchev*
e-mail : *logatchov@inp.nsk.su*
tel. : +7 3832 359583 fax : +7 3832 352163

HISTORY AND STATUS

Differences with respect to corresponding e⁻ linac, are given in space to right.

OTHER RELEVANT INFORMATION

(1) 25 π mm-mrad

Primary Beam (e⁻) at Conversion Target

Energy : 300 MeV
Radius (1 σ) : 0.5 mm
Beam intensity : 1000 A

LINAC PARAMETERS

Conversion Target and Capture

Material : *Tungsten (W)*
Type : *Solid*
Thickness (rad.length) : 2.5 χ
Diameter : 3 mm
Mean deposited power : 0.016 kW
Solenoidal field^{a)} : 0.5

Matching device : *AD*
RF sections^{a)} : *25 MeV/m*

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e⁻ linac, are given in space to right.

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.510	0.510	GeV
Accel gradient	: 18	18	MeV/m
$\Delta E/E$ (FWHM)	: 3	3	%
Rep. rate	: 50	50	Hz
Pulse length	: 2×10^{-5}	2×10^{-5}	μ s
Yield (fin.en)	: 0.05	0.05	e ⁺ /e ⁻ x GeV
Beam intensity	: 5×10^7	5×10^7	μ A peak
Norm. emit. (1 σ):	(1)	(1)	π mm-mrad

PROTON AND/OR H- LINAC

Name of Linac : I-100
Function : Fixed target
Institution and address : IHEP, 142284, Protvino, Moscow Region, Russia
Person in charge : V.A. Teplyakov
Name of person supplying these data : Maltsev A.P.
e-mail : zherebtsov@vx.olu.decnnet.ihep.su
tel. : fax : +95 230 23 37

HISTORY AND STATUS

Const. started : 1961 ; first beam : 11/1966
Present status : Operational
Cost of facility :
Present linac staff : 8 man-years
Present yearly operat. time : 1000 (1994) h

LINAC PARAMETERS

Ion Source

Type : Plasma accelerator
Output : 300 mA at 700 keV
Pulse length : 300 μ s; rep. rate : 1 Hz
Normalized emittance (1σ) : 0.2 π mm-mrad

Pre-accelerator (including RFQ)

Types : Pulse transf. ; lengths : 2.2 m
Output : 300 mA at 700 keV
Pulse length : 300 μ s; rep. rate : 1 Hz
Normalized emittance (1σ) : 0.2 π mm-mrad

Longitudinal Matching

Type : One buncher system
Mod. 25.4 keV; drift 995 mm at 148.5 MHz
keV; drift mm at MHz

Accelerating System

Total linac length : 80 m; No. of tanks : 3
Tank diameters : 1.32; 1.22; 1.08 m
Number of drift-tubes : (1)
Drift-tube lengths : (2) mm
Drift-tube diam (range): 232 - 100 mm
Gap/cell length (range): 0.185 - 0.277
Aperture diameter : 20 mm to 40 mm
RF frequency(ies) : 148.5 MHz
Field modes : E010
Eff. shunt impedance : 25 - 15 M Ω /m
Q : 72000; 50000; 36000
Filling time : < 100 μ s
Equilibrium phases : -37° to 50°
RF rep. rate : 1 Hz; pulse : 400 μ s
Beam rate : 1 Hz; pulse : 100 μ s
RF power peak : 10 MW; mean : 0.004 MW

Focusing System

No. elements : 163
type : Pulsed order : FODO
Gradients : 60 to 4 T/m
Other : Pulsed flat top (250 μ s)

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Energy	: 38;74;103	MeV
Mean acc. rate	: 1.25	MeV/m
$\Delta E/E$ (FWHM)	: 0.45	%
Beam current	: ≤ 100	mA peak
Norm. emit. (1σ)	: 2	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) 93+2 (1/2); 41+2 (1/2); 26+2 (1/2)
- (2) 62 - 413; 456 - 537; 586 - 624

Alvarez linac structure.

Proton injector for IHEP Accelerator complex in 1967-1983.

PROTON AND/OR H- LINAC

Name of Linac : URAL-30
 Function : Proton Injector for IHEP Accelerator Complex
 Institution and address : IHEP, 142284, Protvino, Moscow region, Russia
 Person in charge : V.A. Teplyakov
 Name of person supplying these data : A.P. Maltsev
 e-mail : ZKEREBTSOV@VX.OLU.DECNET.IHEP.SU
 tel. : fax : +7 095 230 23 37

HISTORY AND STATUS

Const. started : 07/1973 ; first beam : 11/1983
 Present status : Operational
 Cost of facility :
 Present linac staff : 7 man-years
 Present yearly operat. time : 1080 (1995) h

LINAC PARAMETERS

Ion Source

Type : Plasma accelerator
 Output : 200-250 mA at 100 keV
 Pulse length : 5-10 μ s; rep. rate : 16.6 Hz
 Normalized emittance (1σ) : 0.1 - 0.15 π mm-mrad

Pre-accelerator (including RFQ)

Types : 2H RFQ ; lengths : 4.1 m
 Output : 100 mA at 1980 keV
 Pulse length : 5-10 μ s; rep. rate : 16.6 Hz
 Normalized emittance (1σ) : 0.8 π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : 21.3 m; No. of tanks : 2
 Tank diameters : 0.42 ; 0.42 m
 Number of drift-tubes : 65 ; 57
 Drift-tube lengths : 9.7 - 97.5 ; 50.8 - 89.6 mm
 Drift-tube diam (range): 34.4 ; 37.4 mm
 Gap/cell length (range):
 Aperture diameter : 19 mm to 22 mm
 RF frequency(ies) : 148.5 MHz
 Field modes : Longitudinal magnetic field
 Eff. shunt impedance : 120 - 10 $M\Omega$ /m
 Q : 15000
 Filling time : < 30 μ s
 Equilibrium phases : -30° ; -30°
 RF rep. rate : 16.6 Hz; pulse : 5-10 μ s
 Beam rate : 16.6 Hz; pulse : 5-10 μ s
 RF power peak : 10 MW; mean : 0.004 MW

Focusing System

No. elements : 122
 type : RFQ order : FFDD T/m
 Gradients : 337 kV/cm² to
 Other : Space-periodic RFQ focusing system

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	30		MeV
Mean acc. rate	1.3		MeV/m
$\Delta E/E$ (FWHM)	± 0.35		%
Beam current	50 - 70	100	mA peak
Norm. emit. (1σ)	2.5		π mm-mrad

OTHER RELEVANT INFORMATION

Space-periodic radio-frequency quadrupole focusing system.

H^- resonator; RFQ : 2H⁻ resonator.

Linac parameters described at EPAC 1988.

ELECTRON LINAC

Name of Linac : *Electron Linear Accelerator LU-50*
Function : *
Institution and address : *Russian Federal Nuclear Center ***
Person in charge : *Yu.A. Khokhlov*
Name of person supplying these data : *N.V. Zavyalov*
e-mail : *zavyalov@expd.rfnc.nnov.su*
tel. : +7 83 130 17072 fax : +7 83 130 58269

HISTORY AND STATUS

Const. started : 1976 ; first beam : 1981
Present status : *Operating*
Cost of facility : 3 MUSD (1996)
Present linac staff : 6 man-years
Present yearly operation time : 1500 h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : 50 keV
Beam intensity (peak) : 0.0024 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 29 m
No. sections : 1-2 ; lengths : 3.795 m
Field mode : $2\pi/3$; frequency : 1.818 GHz
Wave type : *TW* ; filling time : 0.9 μ s
 v_p/c range : 0.013 ; Q : (1) 12000
Shunt impedance : 80 M Ω /m
Iris : aperture : diameter : 38.082 - 33.00 mm
thickness : 5 mm
Attenuation/section : 0.32 Np
Power units, Number : 1 type : *Magnetron*
RF power peak : 30 MW; mean : 100 kW

Focusing System

Type, No. of elements, and spacing :
Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.065	0.075	GeV
Accel gradient	8.6	10	MeV/m
$\Delta E/E$ (FWHM)	20	20	%
Rep. rate	2400	2400	Hz
Pulse length	0.01	0.01	μ s
Beam intensity	0.00024	0.00024	A
Norm. emit. (1σ)	6.5	6.5	π mm-mrad

OTHER RELEVANT INFORMATION

* *Electron Linac for neutron spectrometry with time-of-flight method in an energy range from few hundreds keV to few tens MeV.*

** *All Russia Scientific Research Institute of Experimental Physics (RFNC-VNIIEF), 607190 Sarov (Arzamas-16), Nizhnii Novgorod Region, Russia.*

(1) *Maximum value*

At the present time the linac Lu-50 is widely used for investigation of nuclear reactions which are induced by fast neutrons.

References

[1] *Yu.A. Khokhlov, N.V. Zavyalov, I.A. Ivanin et al., "Linear accelerator of All-Union Scientific Research Institute of Experimental Physics for neutron spectrometry". Nuclear Data for Science Technology. Proceedings of an International Conference, held at the Forschungszentrum Jülich, Fed. Rep. of Germany, 13-17 May 1991, p.487-489.*

[2] *Report on Linac96 "Electron Linear Accelerators of RFNC-VNIIEF", N.V. Zavyalov and etc.*

ELECTRON LINAC

Name of Linac : *Electron Linear Accelerator LU-10-20*
Function : *Electron Linac for support and development of new radiation technologies*
Institution and address : *Russian Federal Nuclear Center **
Person in charge : *N.V. Zavyalov*
Name of person supplying these data : *N.V. Zavyalov*
e-mail : *zavyalov@expd.rfnc.nnov.su*
tel. : *+7 83 130 17072* fax : *+7 83 130 58269*

HISTORY AND STATUS

Const. started : *1992* ; first beam : *1994*
Present status : *Operating*
Cost of facility : *750 000 USD (1996)*
Present linac staff : *4 man-years*
Present yearly operation time : *2000* h

LINAC PARAMETERS

Electron Sources

Types : *Diode* ; energy : *40* keV
Beam intensity (peak) : *0.005* A
Normalized emittance (1σ) : *π* mm-mrad

Injector

Longitudinal matching :
Output : *MeV*; intensity : *A*
Pulse width, spacing :
Normalized emittance (1σ) : *π* mm-mrad

Acceleration System

Total linac length : *3* m
No. sections : *1* ; lengths : *1.65* m
Field mode : *$2\pi/3$* ; frequency : *1.818* GHz
Wave type : *TW* ; filling time : *0.54* μ s
 v_g/c range : *(1)* ; Q : *(2) 12000*
Shunt impedance : *6 - 58.3* M Ω /m
Iris : aperture : diameter : *27.53 - 47.5* mm
thickness : *6.23* mm
Attenuation/section : *Np*
Power units, Number : *1* type : *Magnetron*
RF power peak : *6* MW; mean : *22* kW

Focusing System

Type, No. of elements, and spacing :
Solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: <i>0.008</i>	<i>0.009</i>	GeV
Accel gradient	: <i>7</i>	<i>8</i>	MeV/m
$\Delta E/E$ (FWHM)	: <i>10</i>	<i>10</i>	%
Rep. rate	: <i>1000</i>	<i>1000</i>	Hz
Pulse length	: <i>0.002-0.005</i>	<i>0.004</i>	μ s
Beam intensity	: <i>1.5</i>	<i>0.0015</i>	A
Norm. emit. (1σ)	: <i>10</i>	<i>10</i>	π mm-mrad

OTHER RELEVANT INFORMATION

* *All Russia Scientific Research Institute of Experimental Physics (RFNC-VNIIEF), 607190 Sarov (Arzamas-16), Nizhnii Novgorod Region, Russia*

- (1) *0.0065 - 0.027*
(2) *Maximum value*

At the present time the linac Lu-50 is widely used for investigation of nuclear reactions which are induced by fast neutrons.

References

- [1] *Report on Linac96 "Electron Linear Accelerators of RFNC-VNIIEF", N.V. Zavyalov and etc.*

ELECTRON LINAC

Name of Linac :
Function : *Electron Injector Linac for Synchrotron Radiation Source*
Institution and address : *Laboratori del Sincrotrò de Barcelona, **
Person in charge :
Name of person supplying these data : *M. Pont*
e-mail : *mpont@ifae.es*
tel. : *+34 3 581 2832* fax : *+34 3 581 7302*

HISTORY AND STATUS

Const. started : ; first beam :
Present status :
Cost of facility :
Present linac staff :
Present yearly operation time : h

LINAC PARAMETERS

Electron Sources

Types : ; energy : keV
Beam intensity (peak) : A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching :
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : m
No. sections : ; lengths : m
Field mode : ; frequency : GHz
Wave type : ; filling time : μ s
 v/c range : ; Q :
Shunt impedance : M Ω /m
Iris : aperture : diameter : mm
thickness : mm
Attenuation/section : Np
Power units, Number : type :
RF power peak : MW; mean : kW

Focusing System

Type, No. of elements, and spacing :

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy			GeV
Accel gradient			MeV/m
$\Delta E/E$ (FWHM)			%
Rep. rate			Hz
Pulse length			μ s
Beam intensity			A
Norm. emit. (1σ)			π mm-mrad

OTHER RELEVANT INFORMATION

* *Vila Universitària G-002, 06193 Bellaterra, Spain*

We are in the design stage of the future Synchrotron Radiation Source in Barcelona (Spain), but right now we cannot produce specific data on the Linac that will be used at LSB.

POSITRON LINAC

Name of Linac : LIL*
 Function : Positron Injector Linac for LEP**
 Institution and address : CERN, 1211 Geneva 23, Switzerland
 Person in charge : L. Rinolfi
 Name of person supplying these data : J.P. Potier
 e-mail : potier@cernvm.cern.ch
 tel. : +41 22 767 2584 fax : +41 22 767 8510

HISTORY AND STATUS

Differences with respect to corresponding e^- linac, are given in space to right.

Primary Beam (e^-) at Conversion Target

Energy	:	200	MeV
Radius (1σ)	:	0.4	mm
Beam intensity	:	1.4	A

LINAC PARAMETERS

Conversion Target and Capture

Material	:	W in Cu matrix	
Type	:	Stationary	
Thickness (rad.length)	:	2.0	χ
Diameter	:	5	mm
Mean deposited power	:	0.6	kW
Solenoidal field ^{a)}	:	0.36 T over 9 m ; DC field	

Matching device	:	(1)
RF sections ^{a)}	:	(2)

^{a)} key parameters

Accelerating System, Focusing System and Beam Pulse Structure

Differences with respect to corresponding e^- linac, are given in space to right. (3)

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.5	0.65	GeV
Accel gradient	: 9.2	12.0	MeV/m
$\Delta E/E$ (FWHM)	: 1.0	1.0	%
Rep. rate	: 100	100	Hz
Pulse length	: 0.025	0.025	μ s
Yield (fin.en)	: (4)	3.0×10^{-2}	e^+e^- x GeV
Beam intensity	: 5000	11000	μ A peak
Norm. emit. (1σ):	2800	2300	π mm-mrad

OTHER RELEVANT INFORMATION

* LIL - LEP Injector Linac
 ** LEP - Large Electron Positron Collider

- Quarter Wave Transformer; $\lambda/4$, 0.85 T pulsed solenoid
- Decelerating mode at the capture.
Gradient : 9.5 MV/m
- 12 sections powered by 4 klystrons, 2 of which are equipped with RF pulse compression.

Two solenoids, 0.36 T, on the first 2 accelerator sections, 1 quadrupole doublet, 4 independent matching quadrupoles, followed by a 32-quadrupole FODO lattice.

- 2.5×10^{-2} . The yield is given within an energy spread of $\pm 1\%$.

References

- [1] "New Optics of the LEP Injector Linac for e^+ Production". C. Bourat, H. Braun, L. Rinolfi, EPAC94 (London) and CERN/PS 94-18 (LP).

ELECTRON LINAC

Name of Linac : CTF *
Function : Test facility for a linear collider (CLIC **)
Institution and address : CERN, 1211 Geneva 23, Switzerland
Person in charge : J. Madsen
Name of person supplying these data : L. Rinolfi
e-mail : rinolfi@ps.msm.cern.ch
tel. : +41 22 767 20 07 fax : +41 22 767 85 10

HISTORY AND STATUS

Const. started : 07/1989 ; first beam : 12/1990
Present status : (1)
Cost of facility :
Present linac staff : 4
Present yearly operation time : 1000 h

LINAC PARAMETERS

Electron Sources

Types : RF gun ; energy : 4500 keV
Beam intensity (peak) : 100 A
Normalized emittance (1σ) : 20 π mm-mrad

Injector

Longitudinal matching : No
Output : 50 MeV; intensity : 100 A
Pulse width, spacing : 10 ps, 100 ms
Normalized emittance (1σ) : 20 π mm-mrad

Acceleration System

Total linac length : 20 m
No. sections : (2) 2 ; lengths : 0.28 m
Field mode : $2\pi/3$; frequency : 30 GHz
Wave type : TW ; filling time : 0.011 μ s
 v_p/c range : 0.082 ; Q : 4220
Shunt impedance : 110 M Ω /m
Iris : aperture : diameter : 4 mm
thickness : 0.5 mm
Attenuation/section : 0.25 Np
Power units, Number : (3) 1 type : RF sections
RF power peak : 80 MW; mean : (4) kW

Focusing System

Type, No. of elements, and spacing :
Solenoid at 4 MeV.
Doublet structure between 45 MeV and the end of linac.

Beam Pulse Structure (if applicable)

No. of bunches/pulse : (5) 1 - 2
No. of particles/bunch : 8×10^9
Bunch separation : 0.33 - 10 ns

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	: 0.095	0.320 (2)	GeV
Accel gradient	: 80	80	MeV/m
$\Delta E/E$ (FWHM)	: 1	1	%
Rep. rate	: 10	10	Hz
Pulse length	: 10×10^{-6}	10×10^{-6}	μ s
Beam intensity	: 100	100	A
Norm. emit. (1σ)	: 20	20	π mm-mrad

OTHER RELEVANT INFORMATION

* CLIC Test Facility

** CLIC - Compact Linear Collider

- (1) CTF1 ran from 1990 until 1995
CTF2 will start in July 1996
- (2) It is foreseen to install later on 10 more 30 GHz sections in order to achieve 320 MeV
- (3) The power units consist of one RF decelerating structure where a drive beam (high charge, short pulses) generates the 30 GHz. This structure feeds 2 accelerating structures.
- (4) 9.6×10^3
- (5) Figures are given for the Main beam. For the drive beam, they will be:
Nb of bunches/pulse : 48
Nb of particles/bunch : 1.3×10^{11}
Bunch separation : 333 ps

Reference

- [1] "CTF2 Design Report", The CLIC Study Group, CLIC Note 304 - CERN PS 96-14 (LP).

PROTON AND/OR H- LINAC

Name of Linac : CERN 50 MeV Proton Linac (Linac 2)
Function : Proton Injector for CERN Accelerator Complex
Institution and address : CERN, 1211 Geneva 23, Switzerland
Person in charge : H. Haseroth
Name of person supplying these data : C.E. Hill
e-mail : CEH@PS.MSM.CERN.CH
tel. : +41 22 7673659 fax : +41 22 7679145

HISTORY AND STATUS

Const. started : 11/1973 ; first beam : 09/1978
Present status : Operational
Cost of facility : 23 MCHF (1978)
Present linac staff : 16/2 = 8 man-years
Present yearly operat. time : 6700 (1995) h

LINAC PARAMETERS

Ion Source

Type : Duoplasmatron with polarized expansion cup
Output : 250-300 mA at 92 keV
Pulse length : 20-150 μ s; rep. rate : 1 (max Hz
Normalized emittance (1σ) : 0.8 π mm-mrad

Pre-accelerator (including RFQ)

Types : (1) 4 vane RFQ ; lengths : 1.8 m
Output : 165 mA at 750 keV
Pulse length : 500 μ s; rep. rate : 1 (max Hz
Normalized emittance (1σ) : 1.2 π mm-mrad

Longitudinal Matching

Type : Two buncher system
Mod. 150 keV; drift 285 mm at 202.56 MHz
120 keV; drift 146 mm at 202.56 MHz

Accelerating System (2)

Total linac length : 33.6 m; No. of tanks : 3
Tank diameters : 0.94; 0.90; 0.86 m
Number of drift-tubes : (3)
Drift-tube lengths : (4) mm
Drift-tube diam (range): 180; 160; 160 mm
Gap/cell length (range): (5)
Aperture diameter : 20 mm to 30 mm
RF frequency(ies) : 202.56 MHz
Field modes : TM010
Eff. shunt impedance : 36 $M\Omega/m$
Q : 60000
Filling time : (6) μ s
Equilibrium phases : -25° to -35°; -25°; -25°
RF rep. rate : 1 (max 2) Hz; pulse : 500 μ s
Beam rate : 1 (max 2) Hz; pulse : 20-150 μ s
RF power peak : 10 MW; mean : 0.002 MW

Focusing System

No. elements : 131
type : pulsed order : FODO
Gradients : 100 to 20 T/m
Other : Pulsed flat top ($\approx 200 \mu$ s)

LINAC PERFORMANCE (7)

	Normal Operation	Max, or Design (8)
Energy	: 50	MeV
Mean acc. rate	: 1.48	MeV/m
$\Delta E/E$ (FWHM)	: ± 0.25	%
Beam current	: 150	180 mA peak
Norm. emit. (1σ)	: 5	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) Converted from Cockcroft-Walton injector to RFQ in 1993.
- (2) Post coupled Alvarez Linac structure.
- (3) 51+2(1/2); 43+2(1/2); 31+2(1/2)
- (4) 48-147; 177-258; 274-316
- (5) 0.22-0.31; 0.2-0.29; 0.26-0.31
- (6) determined by feedback < 100 μ s
- (7) Beam length modulated at source according to beam user. Users are SPS fixed target physics, Antiproton production, Test beams, ISOLDE, LEAR.
- (8) Maximum performance obtained in tests for LHC beams.

References

- [1] Original machine described at Linac Conference 1979 (Montauk) and PAC 1979.
RFQ modifications described at Linac 1994 (Tsukuba).

PROTON AND/OR H- LINAC

Name of Linac : *PL2 RFQ Linac*
 Function : *Calibration of L3 E.M. Calorimeter*
 Institution and address : *CERN, 1211 Geneva 23, Switzerland*
 Person in charge : *H. Newman*
 Name of person supplying these data : *H. Newman*
 e-mail : *newman@vxcern.cern.ch*
 tel. : *+41 22 767 6366* fax : *+41 22 767 8530*

HISTORY AND STATUS

Const. started : *05/1989* ; first beam : *(1)*
 Present status : *Operating*
 Cost of facility : *USD 940 000*
 Present linac staff : *3 (part-time)*
 Present yearly operat. time : *≈ 240* h

Focusing System

No. elements : *4 quads*
 type : *Electromagnets* order : *FDFD*
 Gradients : *0* to *20.5* T/m
 Other : *2 bends for horizontal and vertical steering*

LINAC PARAMETERS

Ion Source

Type : *Multi-cusp, RF driven, H⁻ volume*
 Output : *12* mA at *29* keV
 Pulse length : *50* μs; rep. rate : *60 (2)* Hz
 Normalized emittance (1σ) : *~ 0.3 (3)* π mm-mrad

Pre-accelerator (including RFQ)

Types : *4 vane* ; lengths : *1.626* m
 Output : *7* mA at *1850* keV
 Pulse length : *5* μs; rep. rate : *(2) 60* Hz
 Normalized emittance (1σ) : *(3) 0.4* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : m; No. of tanks :
 Tank diameters : m
 Number of drift-tubes :
 Drift-tube lengths : mm
 Drift-tube diam (range): mm
 Gap/cell length (range):
 Aperture diameter : mm to mm
 RF frequency(ies) : MHz
 Field modes :
 Eff. shunt impedance : MΩ/m
 Q :
 Filling time : μs
 Equilibrium phases :
 RF rep. rate : Hz; pulse : μs
 Beam rate : Hz; pulse : μs
 RF power peak : MW; mean : MW

LINAC PERFORMANCE

	Normal Operation	Max, or Design
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Energy	: <i>1.85</i>	MeV
Mean acc. rate	: <i>1.14</i>	MeV/m
ΔE/E (FWHM)	: <i>(3) 1</i>	%
Beam current	: <i>7</i>	mA peak
Norm. emit. (1σ)	: <i>(3) 0.4</i>	π mm-mrad

OTHER RELEVANT INFORMATION

- (1) First proton beam at factory; 08/1990*
First H⁻ beam at factory: 08/1991;
First normal operation in L3 at CERN: 11/1992
- (2) Maximum repetition rate 150 Hz, normally run at*
about 60 Hz, rate limited by L3 DAQ.
- (3) Estimated value*

Mfg: AccSys Technology Inc.
Pleasanton CA 94566
USA

ION LINAC

Name of Linac : CERN Heavy Ion Linac (Linac 3)
 Function : (Heavy) Ion Injector for CERN Accelerator Complex
 Institution and address : CERN, 1211 Geneva 23, Switzerland
 Person in charge : H. Haseroth
 Name of person supplying these data : C.E.Hill
 e-mail : CEH@PS.MSM.CERN.CH
 tel. : +41 22 767 3659 fax : +41 22 767 9145

HISTORY AND STATUS

Const. started : 06/1991 ; first beam : 06/1994
 Present status : Operational
 Cost of facility : 15 MCHF (1994)
 Present linac staff : 16/2 = 8 man-years
 Present yearly operat. time : 2500 (1995) h

LINAC PARAMETERS

Ion Sources

No. of sources : 1
 Types of source : 14 GHz ECR (afterglow mode)
 Species of ions : Lead 27+
 Range of currents : 120 μ Ae
 Range of output energies : 2.5 keV/u
 Pulse length : 100-1500 μ s; rep. rate : 10 /5 Hz
 Normalized emittance (1σ) : 0.28 π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : 4 rod RFQ, 2.66 m
 Output currents : 80 μ Ae
 Output energies : 250 keV/u
 Frequency : 101.3 MHz; peak RF power : 200 kW
 Pulse length : 1000 μ s; rep. rate : 1 (max 10) Hz
 Normalized emittance (1σ) : 0,4 π mm-mrad

Longitudinal Matching

Type : 4 gap buncher
 Mod. 100 keV; drift 530 mm at 101.3 MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : 8.1 m; N^o. of tanks : 3
 Tank diameters : Not circular section m
 Number of drift-tubes : 41; 28; 30
 Drift-tube lengths : 18 - 72 (triplet 430) mm
 Drift-tube diam (range): 28 to 32 mm
 Gap/cell length (range): 0.29 to 0.54; g/0.5 $\beta\lambda$
 Aperture diameter : 18 mm to 22 mm
 RF frequency(ies) : 101.28, 202.56, 202.56MHz
 Field modes : TE110 (IH $\beta\lambda/2$ operation)
 Eff. shunt impedance : 270; 250; 285 M Ω /m
 Q : 21200; 12500; 1440
 Filling time : (1) μ s
 Equil. phases : 0 - 30 $^\circ$; accel. rate 0.52 MeV/u-m
 RF rep. rate : 1 (max 10) Hz; pulse : 1000 μ s
 Beam rate : 1 - 10 max Hz; pulse : (2) μ s
 RF power peak : 1.1 MW; mean : 0.55/11 MW

Focusing System

No. elements : 4 \times 3
 type : DC triplet order : FDF
 Gradients : 69 to 56.5 T/m
 Other : 2 triplets in tank 1, 2 between tanks

Charge Stripping (Typical)

Type(s) : C foil ($\approx 100 \mu\text{g cm}^{-2}$)
 Charge states : 27+ to (3) at 4.2 MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Species	: Lead 53+	Lead 55+	
Energy	: 4.2		MeV/u
$\Delta E/E$ (FWHM)	: 0.5 - 0.6		%
Mean acc. rate	: 0.52		MeV/u-m
Beam current	: 25		μ Ae peak
Norm. emit. (1σ)	: 0.95		π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
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OTHER RELEVANT INFORMATION

- (1) determined by feedback; <10
- (2) 40, 600, 1000 max
- (3) (52+) 53+ (55+)

Constructed by international collaboration between CERN, France, Germany, Italy, India, Czech Republic, Sweden and Switzerland.

Parameters given for 208Pb, ions with $q/m > 0.12$ can also be accelerated provided source extraction for 2.5 keV/u is between 13 and 25 kV. Linac was designed for Pb25+.

Beams length modulated at source. Users are SPS ion physics, test beams and LEAR.

References

- [1] Project described in "CERN Heavy-Ion Facility Design Report", CERN 93-01 (1993).

ELECTRON LINAC

Name of Linac : LUE 2000*
Function : Electron Linac for Fixed Target Experiments
Institution and address : NSC-KPTI "Accelerator" R&D&P Est., 310108 Kharkov, Ukraine
Person in charge : A. Dovbnya
Name of person supplying these data : Y. Tur
e-mail : tur@nik.kharkov.ua
tel. : +380 57 235 6533 fax : +380 57 235 3731

HISTORY AND STATUS

Const. started : 1958 ; first beam : 1964
Present status : Since 1992 - idle
Cost of facility : NA
Present linac staff : 112 man-years
Present yearly operation time : 4000 (1991) h

LINAC PARAMETERS

Electron Sources

Types : Diode ; energy : 80 keV
Beam intensity (peak) : 3 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : (1)
Output : 20 MeV; intensity : 1 A
Pulse width, spacing : 2.0 μ s; 10 - 80 ms
Normalized emittance (1σ) : <200 π mm-mrad

Acceleration System

Total linac length : 240 m
No. sections : 49 ; lengths : 4.3 m
Field mode : $\pi/2$; frequency : 2.797 GHz
Wave type : TW ; filling time : 0.4 μ s
 v_g/c range : 0.04 ; Q : 10000
Shunt impedance : 43 M Ω /m
Iris : aperture : diameter : 30.0 mm
thickness : 4.0 mm
Attenuation/section : 0.3375 Np
Power units, Number : 50 type : Klystron
RF power peak : 20 MW; mean : 2.6 kW

Focusing System

Type, No. of elements, and spacing :
Solenoids up to 20 MeV, triplets at 20 MeV and between sections up to 300 MeV; 5 quadruplets at 0.4, 0.8, 1.2, 1.6, 2.0 GeV

Beam Pulse Structure (if applicable)

No. of bunches/pulse : NA
No. of particles/bunch : NA
Bunch separation : NA

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	1.8	2.0	GeV
Accel gradient	8.4	10	MeV/m
$\Delta E/E$ (FWHM)	0.3	0.1	%
Rep. rate	50	100	Hz
Pulse length	2.5	2.5	μ s
Beam intensity	0.0005	0.001	A
Norm. emit. (1σ)	480	200	π mm-mrad

OTHER RELEVANT INFORMATION

* LUE 2000 (2 GeV Kharkov Linac)

(1) S-band pre-buncher, buncher

Ten new quasi-constant gradient accelerating structures (4 subsections) have been designed, constructed and installed in acceleration system [1].

Characteristics are following :

Filling time : 0.94 μ s; v_g/c : 0.015; Q : 11000

Shunt impedance : 56 M Ω /m

Iris diameter : 25-19 mm

Attenuation/section : 0.952 Np

With the new 40 MW klystron [2] :

Normal gradient : 14 MeV/m

Max gradient : 20 MeV/m

References

[1] "Development of Components for Multisection Electron Accelerators" - Proceedings of the Workshop on JINR C-tau Factory, Dubna, 1992, pp. 365-374.

[2] "Development of Linear Electron Accelerators for Basic Scientific Researches and Advancement of Technologies in Ukraine" - Ukrainian Physical Journal, vol. 40 (1995), No. 9, pp. 909-912, (in Ukrainian).

ELECTRON LINAC

Name of Linac : LUE 40*
Function : Electron Linac for Fixed Target Experiments
Institution and address : NSC-KPTI "Accelerator" R&D&P Est., 310108 Kharkov, Ukraine
Person in charge : A. Zykov
Name of person supplying these data : Y. Tur
e-mail : tur@nik.kharkov.ua
tel. : +380 57 235 6533 fax : +380 57 235 3731

HISTORY AND STATUS

Const. started : 1958 ; first beam : 1964
Present status : Since 1992 - idle
Cost of facility : NA
Present linac staff : 10 man-years
Present yearly operation time : 1500 (1991) h

LINAC PARAMETERS

Electron Sources

Types : Diode ; energy : 80 keV
Beam intensity (peak) : 4 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : (1)
Output : 19 - 8 MeV; intensity : 0.05 - 1 A
Pulse width, spacing : 10 μ s; 20 - 80 ms
Normalized emittance (1σ) : 200 π mm-mrad

Acceleration System

Total linac length : 8.5 m
No. sections : 1 ; lengths : 4.3 m
Field mode : $\pi/2$; frequency : 2.797 GHz
Wave type : TW ; filling time : 0.38 μ s
 v_p/c range : 0.04 ; Q : 10000
Shunt impedance : 43 M Ω /m
Iris : aperture : diameter : 30.0 mm
thickness : 4.0 mm
Attenuation/section : 0.3375 Np
Power units, Number : 1 type : Klystron
RF power peak : 10 MW; mean : 5 kW

Focusing System

Type, No. of elements, and spacing :
2 axial symmetric lenses between gun and injector,
solenoid

Beam Pulse Structure (if applicable)

No. of bunches/pulse : NA
No. of particles/bunch : NA
Bunch separation : NA

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.02	0.04	GeV
Accel gradient	2.9	5.8	MeV/m
$\Delta E/E$ (FWHM)	3	3	%
Rep. rate	50	100	Hz
Pulse length	10	10	μ s
Beam intensity	0.8	1.0	A
Norm. emit. (1σ)	-	200	π mm-mrad

OTHER RELEVANT INFORMATION

* LUE 40 (40 MeV Kharkov Linac)

(1) Pre-buncher; TW buncher 3 m

References

[1] Described in "Atomnaya energiya" 1979, v.46, No. 3, pp. 336 - 340 (in Russian).

ELECTRON LINAC

Name of Linac : LIC *
Function : Multipurpose scientific experimental facility
Institution and address : NSC - KPTI "Accelerator" R&D&P Est., 310108 Kharkov, Ukraine
Person in charge : V.A. Kushmir
Name of person supplying these data : V.A. Kushmir
e-mail : kushmir@nik.kharkov.ua
tel. : +380 57 235 6286 fax : +380 57 235 3731

HISTORY AND STATUS

Const. started : 1991 ; first beam : 1993
Present status : Operating
Cost of facility :
Present linac staff : 3 man-years
Present yearly operation time : (1995) 1000 h

LINAC PARAMETERS

Electron Sources

Types : RF-gun ; energy : 700 - 1100 keV
Beam intensity (peak) : 1.7 A
Normalized emittance (1σ) : 12 π mm-mrad

Injector

Longitudinal matching : RF-gun
Output : 0.7 - 1.1 MeV; intensity : 1.5 A
Pulse width, spacing : 2 μ s, 160 - 1000 ms
Normalized emittance (1σ) : 12 π mm-mrad

Acceleration System

Total linac length : 4.0 m
No. sections : 1 ; lengths : 2.3 m
Field mode : $4\pi/3$; frequency : 2.797 GHz
Wave type : TW ; filling time : 0.9 μ s
 v/c range : 0.01 ; Q : 13000
Shunt impedance : 12 M Ω /m
Iris : aperture : diameter : 50 mm
thickness : 50 mm
Attenuation/section : 0.6 Np
Power units, Number : 1 type : Klystron
RF power peak : 22 MW; mean : kW

Focusing System

Type, No. of elements, and spacing :
One axial. symmetric lens between RF-gun and section

Beam Pulse Structure (if applicable)

No. of bunches/pulse :
No. of particles/bunch :
Bunch separation :

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.015	0.02	GeV
Accel gradient	6.5	8.7	MeV/m
$\Delta E/E$ (FWHM)	3	< 8	%
Rep. rate	1 - 6.25	6.25	Hz
Pulse length	0.3 - 1.5	2.5	μ s
Beam intensity	1.0	1.3	A
Norm. emit. (1σ)	14	< 20	π mm-mrad

OTHER RELEVANT INFORMATION

* (Laser Injector Complex)

a) Microsecond pulses

This facility produces pulses in the microsecond range

b) Nanosecond pulses

It can be used also in the nanosecond range.

Pulse width : 7 ns
Spacing : 320 - 1000 ms
Final Energy : 0.018 GeV
Acc. gradient : 7.8 MeV/m
 $\Delta E/E$ (%) : 2
Beam intensity : 1.5 A
Beam Pulse Structure:
No. of bunches/pulse : 20
No. of particles/bunch : 3×10^9
Bunch separation : 358.2 ps

References

[1] Project described in "Proceeding of the 13 Conference on Charge Particles Accelerators, Dubna, 1992" (in Russian). Present-day status described in report that submitted to EPAC '96.

PROTON AND/OR H- LINAC

Name of Linac : *KMTA **
 Function : *Nuclear and Irradiation Physics*
 Institution and address : *NNC KFTI Academicheskaja str.1, 310108 Kharkov, Ukraine*
 Person in charge : *Ye.V. Gussev*
 Name of person supplying these data : *N.A. Khizhnyak*
 e-mail : *kfti@rocket.kharcov.ua*
 tel. : *+38 057 235 6414* fax : *+38 057 235 3564*

HISTORY AND STATUS

Const. started : *1985* ; first beam :
 Present status : *Under construction*
 Cost of facility : *2.5 MUSD*
 Present linac staff :
 Present yearly operat. time : *h*

LINAC PARAMETERS

Ion Source

Type : *Duoplasmatron*
 Output : *500* mA at *150* keV
 Pulse length : *1000* μ s; rep. rate : *1 - 20* Hz
 Normalized emittance (1σ) : *2* π mm-mrad

Pre-accelerator (including RFQ)

Types : *Pulse transformer* ; lengths : *m*
 Output : *500* mA at *150* keV
 Pulse length: *1000* μ s; rep. rate : *1 - 20* Hz
 Normalized emittance (1σ) : *2* π mm-mrad

Longitudinal Matching

Type : *H₁₁ cavity: 152.5 MHz: 6.0 kV/cm: 26 - gaps*
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *10.9* m; No. of tanks : *3*
 Tank diameters : *0.4* m
 Number of drift-tubes : *22: 24: 22*
 Drift-tube lengths : *9 - 180* mm
 Drift-tube diam (range): *10.26 - 200.0* mm
 Gap/cell length (range): *0.39 - 0.67*
 Aperture diameter : *12.5* mm to *100.0* mm
 RF frequency(ies) : *152.5* MHz
 Field modes : *H_{11N}*
 Eff. shunt impedance : *45.0: 52.5: 50.3* M Ω /m
 Q : *5000: 7200: 9500*
 Filling time : *20.0 - 30.0* μ s
 Equilibrium phases : *-90° + +50°*
 RF rep. rate : *1 - 20* Hz; pulse : *1000* μ s
 Beam rate : *1 - 20* Hz; pulse : *1000* μ s
 RF power peak : *7.56* MW; mean : *0.15* MW

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other : *Modify Alternating-phase Focusing (MAPF)*

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Energy	: <i>(1) 22.5</i>		MeV
Mean acc. rate	: <i>2.0</i>		MeV/m
$\Delta E/E$ (FWHM)	: <i>± 1.5</i>		%
Beam current	: <i>50.0</i>	<i>100.0</i>	mA peak
Norm. emit. (1σ)	: <i>4</i>		π mm-mrad

OTHER RELEVANT INFORMATION

* *Kharkov Material Test Accelerator*

(1) *The first turn*

It is built:

- *RF frequency system to 35.0 MW peak power, 0.8 MW - mean;*
- *injector;*
- *water cooling system; and other.*

ION LINAC

Name of Linac : *Kharkov Heavy Ion Linac **
 Function : *Heavy Ion Accelerator*
 Institution and address : *NNC KFTI Akademicheskaja str.1, 310108 Kharkov, Ukraine*
 Person in charge : *B.I. Rudvak*
 Name of person supplying these data : *V.A. Bomko*
 e-mail : *kfti@rocket.kharkov.ua*
 tel. : *+38 057 235 3564* fax : *+38 057 235 3564*

HISTORY AND STATUS

Const. started : *1955* ; first beam : *1958*
 Present status : *Operational*
 Cost of facility :
 Present linac staff : *20 man-years*
 Present yearly operat. time : *1500 (1994)* h

LINAC PARAMETERS

Ion Sources

No. of sources : *2*
 Types of source : *Duoplasmatron and MEVVA*
 Species of ions : *Argon 3+, Titanium 3+*
 Range of currents : *2500* μ Ae
 Range of output energies : *3* keV/u
 Pulse length : *300* μ s; rep. rate : *2-5* Hz
 Normalized emittance (1σ) : *0.2* π mm-mrad

Pre-accelerators (including RFQ)

Types (lengths) : *Pulse Transformer KG-800* m
 Output currents : *500* μ Ae
 Output energies : *33* keV/u
 Frequency : *MHz*; peak RF power : *kW*
 Pulse length : *500* μ s; rep. rate : *10* Hz
 Normalized emittance (1σ) : *0.3* π mm-mrad

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *15.4* m; N^o. of tanks : *2*
 Tank diameters : *(1)* m
 Number of drift-tubes : *47; 40*
 Drift-tube lengths : *14 to 72; 72 to 210* mm
 Drift-tube diam (range): *56 to 129; 72 to 210* mm
 Gap/cell length (range): *0.5; g/0.25 $\beta\lambda$*
 Aperture diameter : *24* mm to *30* mm
 RF frequency(ies) : *47.2; 47.2* MHz
 Field modes : *TE110 (1H $\beta\lambda$ /2 operation)*
 Eff. shunt impedance : *150; 50* M Ω /m
 Q : *14000; 15000*
 Filling time : *10; 10* μ s
 Equil. phases : *-20 $^\circ$ -30 $^\circ$* ; accel. rate (2) MeV/u-m
 RF rep. rate : *2-5* Hz; pulse : *500* μ s
 Beam rate : *2-5* Hz; pulse : *500* μ s
 RF power peak : *0.4; 2.3* MW; mean : *(3)* MW

Focusing System

No. elements : *20*
 type : *Quadrupole* order : *FODO*
 Gradients : to *30* T/m
 Other :

Charge Stripping (Typical)

Type(s) : *C foil*
 Charge states : *3+* to *12+* at *1* MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	: <i>Argon 12+</i>	
Energy	: <i>8.5</i>	MeV/u
$\Delta E/E$ (FWHM)	: <i>0.5</i>	%
Mean acc. rate	: <i>0.658</i>	MeV/u-m
Beam current	: <i>2</i>	μ Ae peak
Norm. emit. (1σ)	: <i>1</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>Nitrogen,</i>	<i>8.5 MeV/u</i>	
<i>Aluminium</i>	<i>8.5 MeV/u</i>	

OTHER RELEVANT INFORMATION

* *Kharkov Heavy Ion Linac (Multi Charged Ion Linac MILAC)*

- (1) *0.9 \times 1.16 (not circular); 1.5 m*
- (2) *0.235; 0.658 MeV/u-m*
- (3) *7 \times 10 $^{-4}$; 4 \times 10 $^{-3}$ MW*

ION LINAC

Name of Linac : *MLUD-3*
 Function : *Neutron generator*
 Institution and address : *NNC KFTI Akademicheskaja str.1, 310108 Kharkov, Ukraine*
 Person in charge : *N.G. Shulika*
 Name of person supplying these data : *N.A. Khizhnyak*
 e-mail : *kfti@rocket.kharkov.ua*
 tel. : *+38 057 235 6414* fax : *+38 057 235 3564*

HISTORY AND STATUS

Const. started : *1972* ; first beam : *1975*
 Present status : *Operational*
 Cost of facility : *300000 USD*
 Present linac staff : *2 man-year*
 Present yearly operat. time : *h*

LINAC PARAMETERS

Ion Sources

No. of sources : *1*
 Types of source : *Duoplasmatron*
 Species of ions : *Deuteron 1+*
 Range of currents : *300 × 10³ μAe*
 Range of output energies : *75 keV/u*
 Pulse length : *250 μs*; rep. rate : *1.10 Hz*
 Normalized emittance (1σ) : *10 π mm-mrad*

Pre-accelerators (including RFQ)

Types (lengths) : *m*
 Output currents : *μAe*
 Output energies : *keV/u*
 Frequency : *MHz*; peak RF power : *kW*
 Pulse length : *μs*; rep. rate : *Hz*
 Normalized emittance (1σ) : *π mm-mrad*

Longitudinal Matching

Type :
 Mod. keV; drift mm at MHz
 keV; drift mm at MHz

Accelerating System

Total linac length : *1.2 m*; N^o. of tanks : *1*
 Tank diameters : *0.5 m*
 Number of drift-tubes : *16*
 Drift-tube lengths : *7 to 135 mm*
 Drift-tube diam (range): *20 to 120 mm*
 Gap/cell length (range): *0.33 to 0.75*
 Aperture diameter : *9 mm to 40 mm*
 RF frequency(ies) : *97.8 MHz*
 Field modes : *TE_{11N}*
 Eff. shunt impedance : *35 MΩ/m*
 Q : *5000*
 Filling time : *20 μs*
 Equil. phases : *(1)* ; accel. rate *1.65 MeV/u-m*
 RF rep. rate : *1-10 Hz*; pulse : *300 μs*
 Beam rate : *1-10 Hz*; pulse : *250 μs*
 RF power peak : *0.6 MW*; mean : *0.01-0.15 MW*

Focusing System

No. elements :
 type : order :
 Gradients : to T/m
 Other : *Modified Alternating-phase Focusing (MAPF)*

Charge Stripping (Typical)

Type(s) :
 Charge states : to at MeV/u
 Charge states : to at MeV/u

LINAC PERFORMANCE

	Normal Operation	Max, or Design
Species	: <i>Deuteron 1+</i>	
Energy	: <i>1.65</i>	MeV/u
ΔE/E (FWHM)	: <i>+2.5</i>	%
Mean acc. rate	: <i>1.4</i>	MeV/u-m
Beam current	: <i>65 × 10³</i>	μAe peak
Norm. emit. (1σ)	: <i>4</i>	π mm-mrad

OTHER ION BEAMS

Particle	Energy range	Other info.
<i>Proton</i>	<i>1.65 MeV</i>	<i>~40 mA peak</i>
<i>H₃⁺</i>	<i>3.3 MeV</i>	<i>~75 mA peak</i>

OTHER RELEVANT INFORMATION

* *Small-size deuterium Linac (MLUD-3)*

(1) *-90° + +50°*

ELECTRON LINAC

Name of Linac : SRS *
Function : *Electron Injector for SRS Booster*
Institution and address : *CLRC, Daresbury Laboratory, Warrington, WA4 4AD, UK*
Person in charge : *D M Dykes*
Name of person supplying these data : *D M Dykes*
e-mail : *d.m.dykes@dl.ac.uk*
tel. : +44 1925 603142 fax : +44 1925 603192

HISTORY AND STATUS

Const. started : 1976 ; first beam : 1978
Present status : *Operational*
Cost of facility : *284 MGBP (1978)*
Present linac staff : *4 part time*
Present yearly operation time : < 500 h

LINAC PARAMETERS

Electron Sources

Types : (1) *Triode* ; energy : 80 keV
Beam intensity (peak) : > 0.350 A
Normalized emittance (1σ) : π mm-mrad

Injector

Longitudinal matching : *Integral S-band buncher*
Output : MeV; intensity : A
Pulse width, spacing :
Normalized emittance (1σ) : π mm-mrad

Acceleration System

Total linac length : 2 m
No. sections : 1 ; lengths : 2 m
Field mode : $2\pi/3$; frequency : 2.998 GHz
Wave type : *TW* ; filling time : < 1 μ s
 v_g/c range : 0.16 - 0.1 ; Q : 17600
Shunt impedance : 56 - 64 M Ω /m
Iris : aperture : diameter : 23.36 - 20.0 mm
thickness : 5.95 mm
Attenuation/section : 0.236 Np
Power units, Number : 1 type : *Klystron*
RF power peak : 6 MW; mean : 1.2 kW

Focusing System

Type, No. of elements, and spacing :
Solenoids: 2 for source and
2 distributed for accelerator

Beam Pulse Structure (if applicable)

No. of bunches/pulse : 500
No. of particles/bunch : 2.5×10^{10}
Bunch separation : 2 ns

LINAC PERFORMANCE

	Normal Operation	Max, or Design	
Final energy	0.012	0.015	GeV
Accel gradient	6	7.5	MeV/m
$\Delta E/E$ (FWHM)	1	1	%
Rep. rate	10	10	Hz
Pulse length	1	2	μ s
Beam intensity	0.020	0.030	A
Norm. emit. (1σ)	-	10	π mm-mrad

OTHER RELEVANT INFORMATION

* *SRS - Synchrotron Radiation Source*

(1) *Electron source uses an Eimac planar triode, 8755, fitted to the gun assembly. The anode is broken off, cathode/grid assembly is then reconditioned.*

The source is modulated via the grid at 500 MHz.

LINEAR COLLIDERS

LINEAR CONDENSERS

Linear Collider Studies

Within the framework of an international collaboration, different approaches for Linear Colliders in the TeV range are under study. It is worth mentioning the main laboratories who contribute to this research, in the 1996 compendium of linacs.

An "International Linear Collider Technical Review Committee Report" was published by G. Loew (SLAC) in December 1995.

At EPAC96, J.P. Delahaye (CERN) presented a review on "Design Issues of TeV Linear Colliders".

The two following tables were presented at the Linac96 Conference by G. Loew. They show an updating of the parameters and they provide the reader with an overview of e^-/e^+ linear colliders under consideration at 500 GeV.

Table 1

Linear Colliders: Overall and Final Focus Parameters -- 500 GeV (c.m.)

	TESLA		SBLC		JLC(S)		JLC(C)		JLC(X)		NLC		VLEPP		CLIC	
	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated
	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96
Initial energy (c.o.f.m.) (GeV)	500		500		500		500		500		500		500		500	
RF frequency of main linac (GHz)	1.3		3		2.8		5.7	4.2	11.4		11.4		14		30	
Nominal Luminosity ($10^{33} \text{ cm}^{-2} \text{ s}^{-1}$) [*]	2.6		2.2		5.2		7.3		5.1		5.3		12.3		0.7-3.4	3.9
Actual luminosity ($10^{33} \text{ cm}^{-2} \text{ s}^{-1}$) [†]	6.1	6.0	3.75	5.0	4.3		6.1	9.1	5.2		7.1	5.5	9.3		1.07-4.8	7.5
Linac repetition rate (Hz)	10	5	50		50		100		150		180		300		2530-1210	280
No. of particles/bunch at IP (10^{10})	5.15	3.63	2.9	1.1	1.44		1.0	1.1	.63		.65	.75	20		.8	
No. of bunches/pulse	800	1130	125	333	50		72		85		90		1		1-10	50
Bunch separation (nsec)	1000	708	16.0	6	5.6		2.8		1.4		1.4		-		.67	1
Beam power/beam (MW)	16.5	8.2	7.26	7.25	1.3		2.9	3.2	4.2		4.2	4.8	2.4		.8-3.9	4.47
Damping ring energy (GeV)	4.0		3.15		2.0		2.0		2.0		2.0		3.0		2.15	
Unloaded/loaded gradient (MV/m) ^{**}	25/25		21/17		31/-		40/32	40/29.3	73/58		50/37	50/35	100/91		80/78	100/95
Total two-linac length (km)	29	32	33	32	22.1		18.8	20.2	10.4		15.6	17.6	7		8.8	7.4
Total beam delivery length (km)	3		3		3.6		3.6		3.6		4.4	10.4	3		2.4	
$\gamma_e \gamma_p \epsilon_x$ (m-rad x 10^6)	20/1	14/25	10/5		3.3/05		3.3/05		3.3/05		5/05	4/09	20/08		3/15	4.9/08
β_x^*/β_y^* (mm)	25/2	25/7	22/8	11/45	10/1		10/1	15/2	10/1		10/1	10/15	100/1		10/18	10/13
σ_x^*/σ_y^* (nm) before pinch	1000/64	845/19	670/28	335/15	260/3.0		260/3.0	318/4	260/3.0		320/3.2	285/6.8	2000/4		2477/4	315/3
σ_x^* (μm)	1000	700	500	300	120		120	200	90		100	125	750		200	100
Crossing Angle at IP (mrad)	0		3	2.5	6.4		6.0	8	6.1		20		6		1	20
Disruptions D_x/D_y	.56/8.7	.28/17	.36/8.5	.32/7.1	.29/25		.20/18	.23/17	.09/8.3		.07/7.3		.4/215		.29/9.8	.21/9.9
H_p	2.3		1.8		1.6		1.4	1.82	1.4		1.34	1.4	2.0		1.42	1.25
Upsilon sub-zero	.02		.037		.20		.14		.12		.089	.09	.059		.07	
Upsilon effective	.03		.042		.22		.144	.079	.12		.090		.074		.075	.084
S_B (%)	3.3	2.9	3.2	3.1	12.7		6.5	3.9	3.5		2.4	3.2	13.3		3.6	3.5
n_x (no. of γ 's per e)	2.7		1.9		2.2		1.5	1.4	.94		.8	1.0	5.0		1.35	1.38
N_{beam} ($pT^{\text{min}}=20 \text{ MeV}/c; \Theta_{\text{max}}=0.15$)	19.0		8.8		31.6		10.3		2.9		2.0		1700		3.0	
$N_{\text{beam}}/\text{crossing}$.17		.10		.98		.23		.05		.03		45.9		.05	
$N_{\text{beam}} \times 10^2$ ($pT^{\text{min}}=3.2 \text{ GeV}/c$)	.16		.14		3.4		.66		.14		.08		56.4		.10	

* For the sake of uniformity, the nominal luminosity is simply defined as $N^2/4\pi \sigma_x^* \sigma_y^*$ times the number of crossings per second, and in all cases assumes head-on collisions, no hour-glass effect and no pinch. The actual luminosity incorporates all these effects, including crossing angle where applicable. NLC calculations assume crab-crossing.

** The main linac loaded gradient includes the effect of single-bunch (all modes) and multibunch beam loading, assuming that the bunches ride on crest. Beam loading is based on bunch charges in the linacs, which are slightly higher than at the IP.

Table 2
Pre-linacs, Damping Rings and Main Linac Parameters -- 500 GeV (c.m.)

	TESLA		SBLC		JLC(S)		JLC(C)		JLC(X)		NLC		VLEPP		CLIC		
	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	TRC	Updated	
	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	12/95	7/96	
Pre-linacs																	
First stage e ⁺ energy (GeV)	4		3.15		1.98		1.98		1.98		2		3		2.15		2.15
Second stage e ⁺ energy (GeV)	-		-		-		20		10-20		10		-		9		9
Beam energy to make e ⁺ (GeV)	250		250		10		10		10		3-6		150		2.15		2.15
Damping Rings																	
e ⁺ pre-damping ring energy (GeV)	-		-		1.98		1.98		1.98		2		-		2.15		2.15
e ⁺ damping ring energy (GeV)	4		3.15		1.98		1.98		1.98		2		3		2.15		2.15
Ring circumference (m)	20,000		650		222		321		277		223		160		283		283
Damping times (ms) (τ _x /τ _y)	20/20		3.8/3.8		6.1/8		3.5/4.3		4.0/5.2		4.1/4.6		1.8/2.9		10.5/10.5		48x50
Number of bunches per ring	800		1130		100		288		340		360		3		48x10		48x50
Bunch length (mm)	10		3.6		4.8		5		5		4.1		9.8		1.8		1.8
Extr. beam emittance, (πE _x ² /h _x , 10 ⁻⁶)	20/1		14/25		10/5		5/2.5		3.3/0.5		2.5/0.3		3.6/0.4		45.5/4.5		2.5/0.4
Main Linacs																	
RF frequency (GHz)	1.3		3		2.8		5.7		11.4		11.4		14		30		80/78
Unloaded/loaded gradient (MV/m) ^{††}	25/25		21/17		31/-		40/32		73/58		50/37		50/35		100/91		100/
Active two-linac length (km)	20		30.2		19.8		15.7		8.7		14.2		16.3		5.8		5.3
Total two-linac length (km)	29		33		32		32		10.4		15.6		17.6		7		8.8
Total number of klystrons	604		2517		2560		43561		3320		3936		4528		1400		2
Total number of modulators	604		2517		2560		2178		3320		1970		2264		140		10
Klystron peak power (MW)	8		150		135		48		135		50		150		150		NA
Klystron repetition rate (Hz)	10		50		50		100		150		180		300		300		2530/1210
Klystron pulse length (μsec)	1315		2.8		4.5		2.4		.5		1.2		.5		.5		.0116/0.00176
Pulse compression ratio	-		-		3.75		5		2		5		4.55		3.2		-
Pulse compression gain	-		-		-2		3.5		1.96		3.83		3.6		3.2		-
RF pulse length at linac (μsec)	1315		2.8		1.2		480		.23		.24		.11		.11		.0116/0.00176
Number of sections	19328		5034		5120		8712		6640		7872		9056		5600		22466
Section length (m)	1.04		6		3.6		1.8		1.31		1.8		1		1		.280
a/λ (range if applicable)	.15		.16/1.1		.14/1		.16/1.2		.20/1.4		.22/1.5		.14		.14		.2
Total AC power to make rf (MW)	164		139		118		139		114		103		121		57		100
Wall plug → beam efficiency (%)	20		10.7		3.0		4.6		5.6		8.2		7.9		8.4		1.6/7.8

^{††} The main linac loaded gradient includes the effect of single-bunch (all modes) and multibunch beam loading, assuming that the bunches ride on crest. Beam loading is based on bunch charges in the linacs, which are slightly higher than at the IP.

