Technofusion: new Spanish singular scientific-technical facility for fusion research

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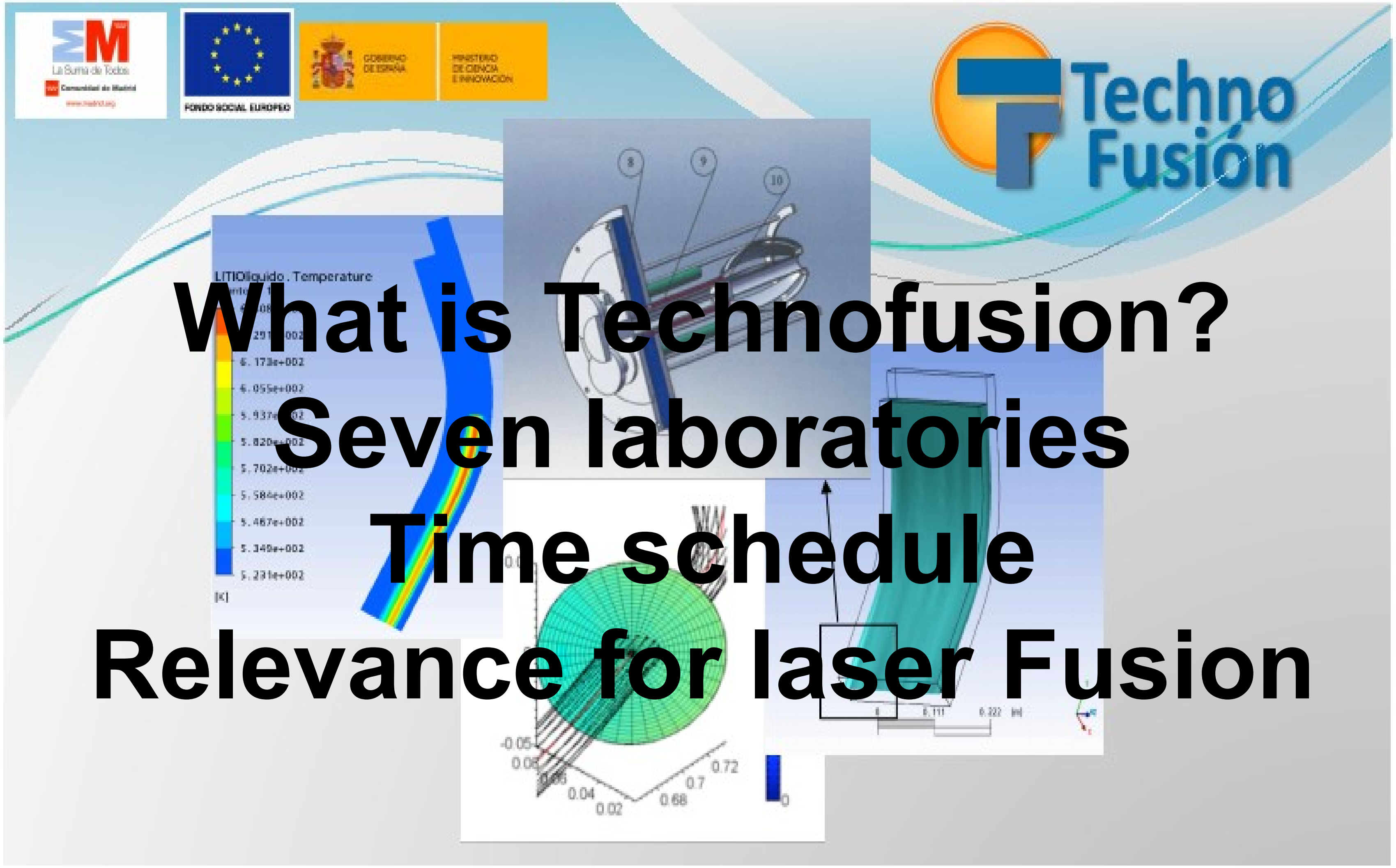
INDEX



What is Technofusion?

Seven laboratories

Time schedule

Relevance for laser Fusion

What is Technofusion?

Technofusion is the scientific&technical installation for fusion research in Spain, based on three pillars:

- It is an open facility to European users.
- It is a facility with instrumentation not accesible to small research groups.
- It is designed to be closely coordiated with the European Fusion Program.

With a budget of 80-100 M€ over five years, several top laboratories will be constructed.

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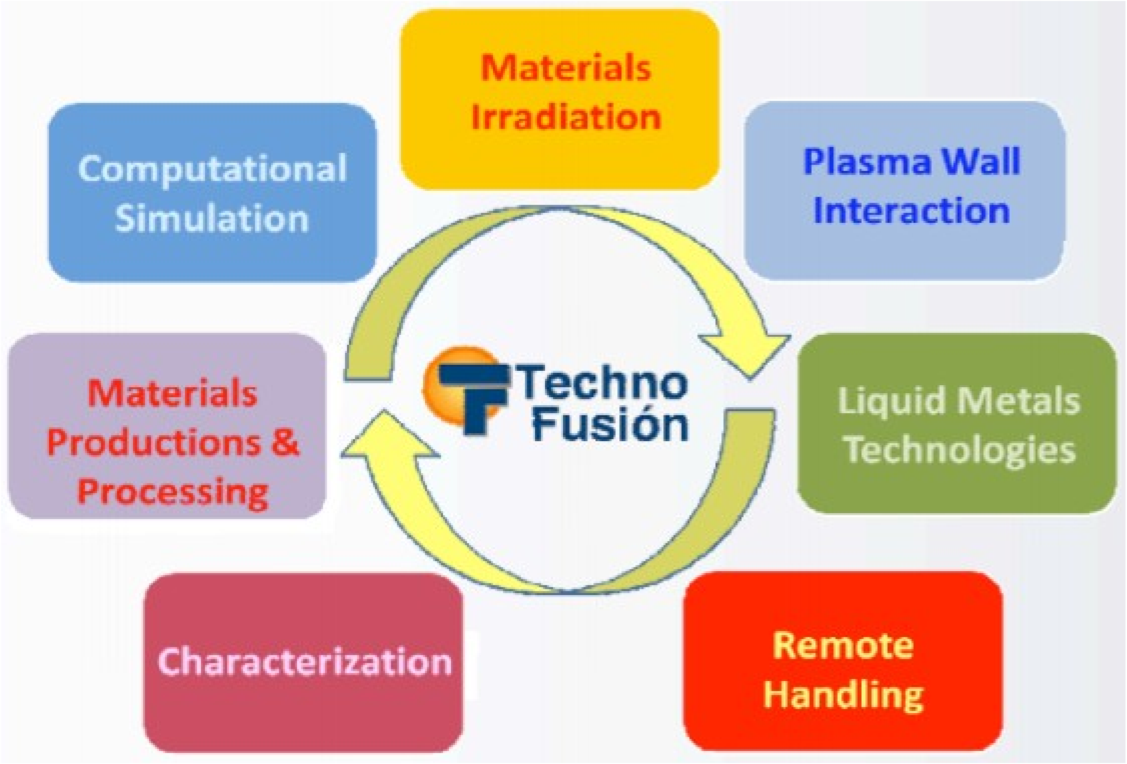
The main technological areas which have been identified are: materials and remote handling, with special stress on the radiation effects.



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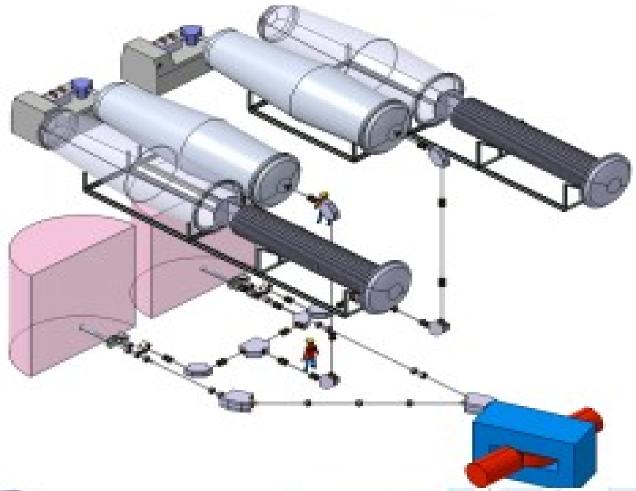
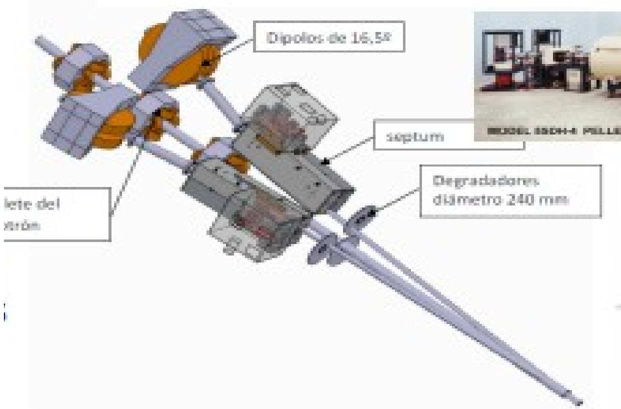
TechnoFusión – Material Irradiation

GOAL: Simulate neutron damage produced in different components of a reactor

- The effect is simulated by ion implantation from 3 accelerators
  - 2 accelerators for H and He
  - 1 accelerator for heavy ions
- Tests will be carrie out in different materials, evaluating the raditation damage, effects in magnetic fields...





Thanks to A. Ibarra

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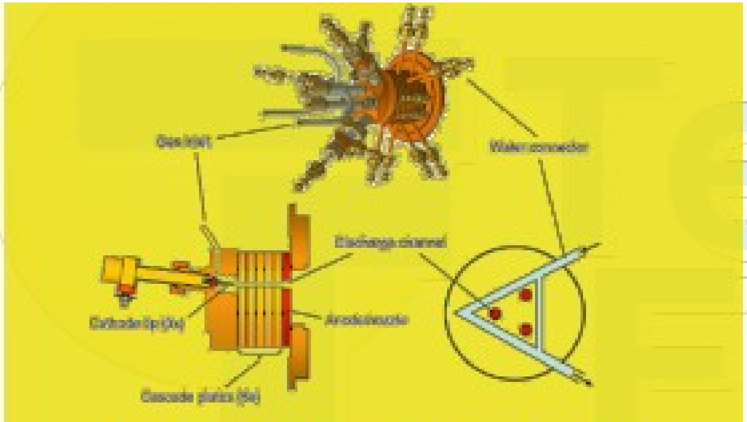
PLASMA WALL INTERACTION

GOAL: Reproduce the high thermal loads to which plasma facing materials will be exposed.

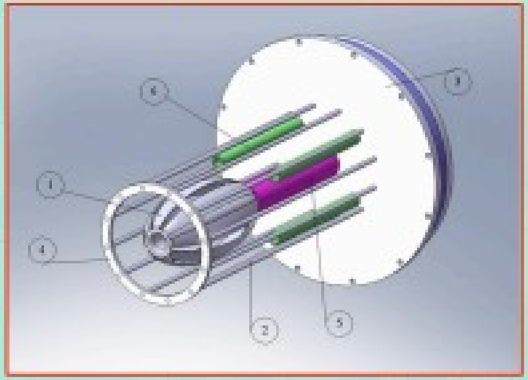
Two plasma conditions could be used separately or simultaneously.

To irradiate samples at high powers (>10 MW/m2) and high particle fluxes (10^24/m2/s) in stationary state.



Fuente de arco en cascada+alto campo (1-2 T)

To irradiate samples using high power pulses of short duration (to simulate ELM's and disruptions)



Dispositivo QSPA

Thanks to A. Ibarra

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CHARACTERIZATION TECHNIQUES

GOAL: Characterization of fusion materials before, during and after radiation and high thermal load expositions

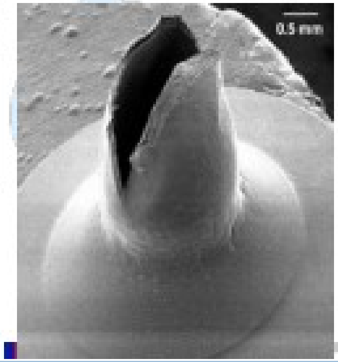
In-situ, ex-situ analisys of physical properties (stress, nanoindentation, fluence, fatigue, hardness, luminiscence, optical absorption, thermal conductivity, difusion, etc...)

Chemical, micro/macro structural analysis: IBA, SIMS, APT, TEM+EELS, DRX...

Material processing techniques (FIB, FIB-SEM)

Technical support to other Technofusion laboratories

General view of several creep test machines in paralel



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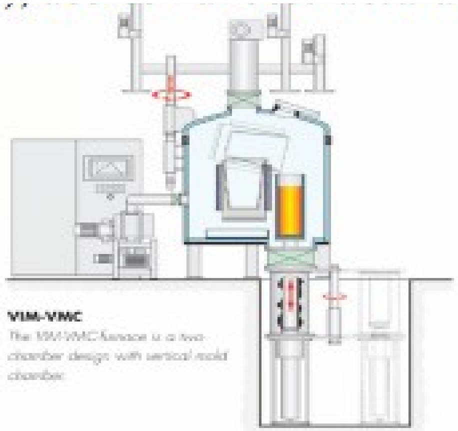
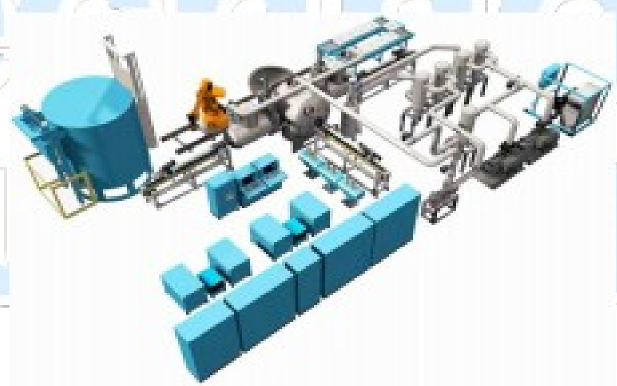
MATERIAL PRODUCTION &PROCESSING

GOAL: Fabrication of new materials for fusion in semi-industrial scale and prototiping level

Advanced processing (mechanical milling, VIM, HIP, SPS, VPS,..) and production techniques (welding, joining,...)
Mostly metallic materials (ODS stainless steels, nanostructured steels, W alloys,...)



Sketch of VIM-VMC-furnace with vertical mold chamber



Vacuum Plasma Spraying system

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LIQUID METAL TECHNOLOGY

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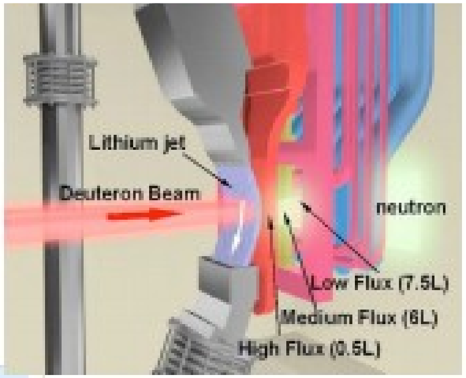
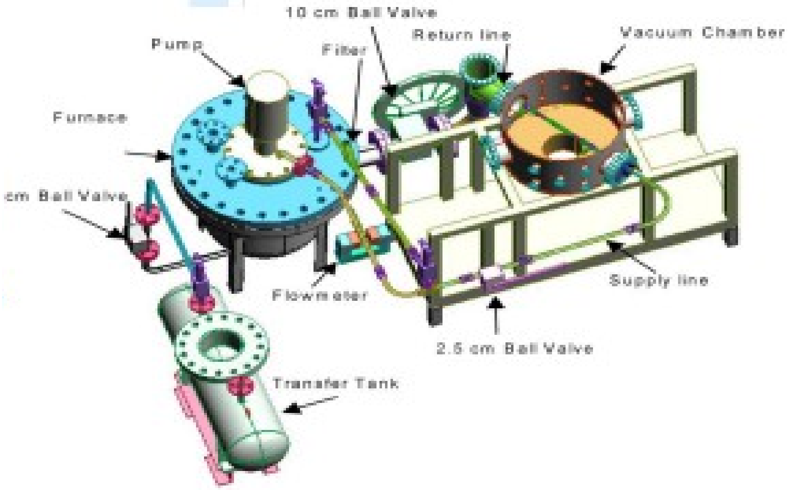
GOAL: Analysis of Technologies associated to Liquid Metals used in fusion reactors (Li)



- Liquid Li loop for fusion applications
  VL=4-20 m/s, T= 250-300 ºC
- Free surface experiments, using an electron accelerator @ 10 MeV
- Studies of material corrosion under Li flow w/o Gamma ray irradiation
- Magneto-hydrodynamic studies of Liquid Li
- Purification and impurity control experiments in the Li loop
- Permeation studies, including coatings



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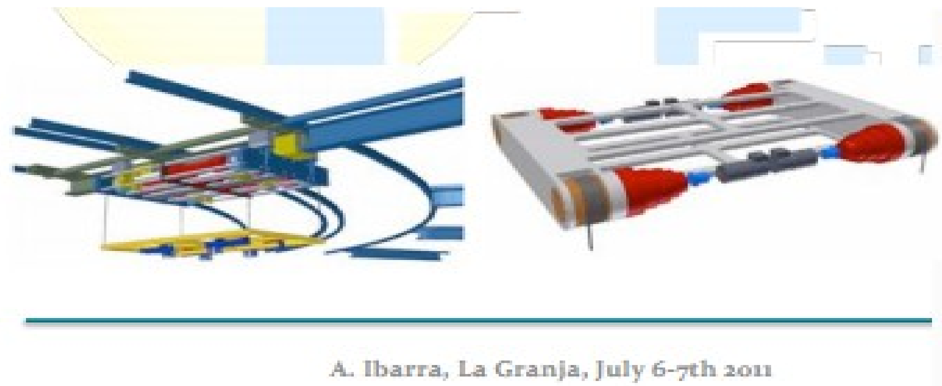
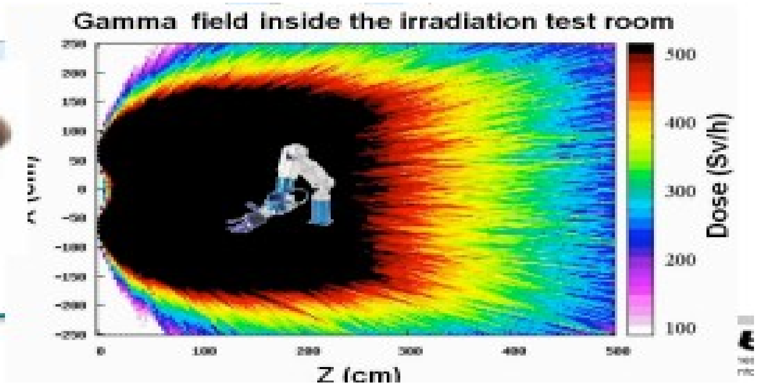
Techno Fusión REMOTE HANDLING TECHNOLOGY

GOAL: Development of new robitic techniques compatible with the harsh conditions found inside the reactor and validation of the current available systems for ITER or IFMIF

Facility for the manipulation of large prototipes (PPD and TBM in ITER and irradiation modules in IFMIF)
Room for tests under irradiaction conditions, coupled to an electron accelerator to validate, certify and characterization of remote handling tools and instrumentation in an uniform ionizing field equivalent to that of ITER and DEMO and other fusion reactors.





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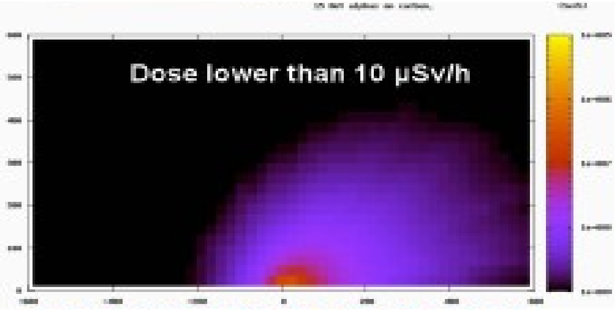
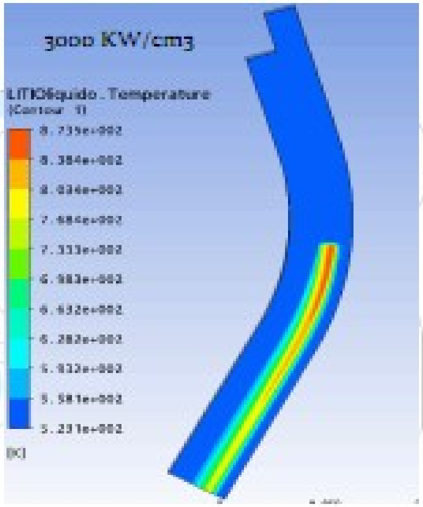
COMPUTATIONAL SIMULATIONS

GOAL: Computational simulations to support and verify experimental results obtained in other Technofusion Laboratories.



Spatial distribution of dose rates. Implantation of H and He in Fe and C samples.

- Computational simulations of components for different Technofusion Laboratories and ITER, DEMO and IFMIF facilities having into account radiation effects.
- Engineering simulations related to fusion reactors
- Use of national computational clusters Mare Nostrum (Barcelona) and Magerit (UPM)



Rise in temperature (ΔT : 350ºC) under irradiation of 1 MeV in the Free Surface Experiment

TIME SCHEDULE

TechnoFusion: Time schedule

• Conceptual design	*2009-2010*
• Detailed design and prototyping	*2011-2013*
• Buildings and Commercial Hardware	*2012-2014*
• Complex Hardware	*2011-2015*
• Installation and Commissioning	*2012-2016*

Priorities

(To be agreed with the EU Programme,
taking into account availability of equipments, complexity, possible users,...)

First phase

- Some characterization techniques (SIMS, Atomic probe), low energy accelerators, Remote Handling Lab, Materials Processing Lab

Second phase

- Other characterization techniques, high energy accelerator, liquid metal loop, PWI Facility

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RELEVANCE FOR LASER FUSION

TECHNOFUSION was initially conceived for magnetic confinement fusion needs (ITER, DEMO, IFMIF).

However, can be also used for Inertial Confinement Fusion?

THE ANSWER IS YES!

Most of the laboratories are valid for both fusion approaches, but for the "plasma wall interaction" laboratory since plasmas are fairly different.

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RELEVANCE FOR LASER FUSION

		Time (s)	Deposited energy (MJm^{-2})	Power (MWm^{-2})	Heat flux parameter (MJm^{-2}s$^{-1/2}$)	Particle energy (eV)	Particle flux (m^{-2}s^{-1})
Divertor	steady state	1000	-	15	-	1-30	$<10^{24}$
	ELM's	0.2×10^{-3}	1	5×10^{3}	70	1-30	$<10^{24}$
	disruptions	1×10^{-3}	20	2×10^{4}	600	1-30	$<10^{24}$
Direct target	α-particles	200×10^{-9}	0.03	1.5×10^{5}	70	2.1×10^{6} avg.	$<10^{25}$
	DT debris	1.5×10^{-6}	0.06	4×10^{4}	50	1.5×10^{5} avg.	$<10^{24}$

Alvarez et al.Fus. Eng. & Des.

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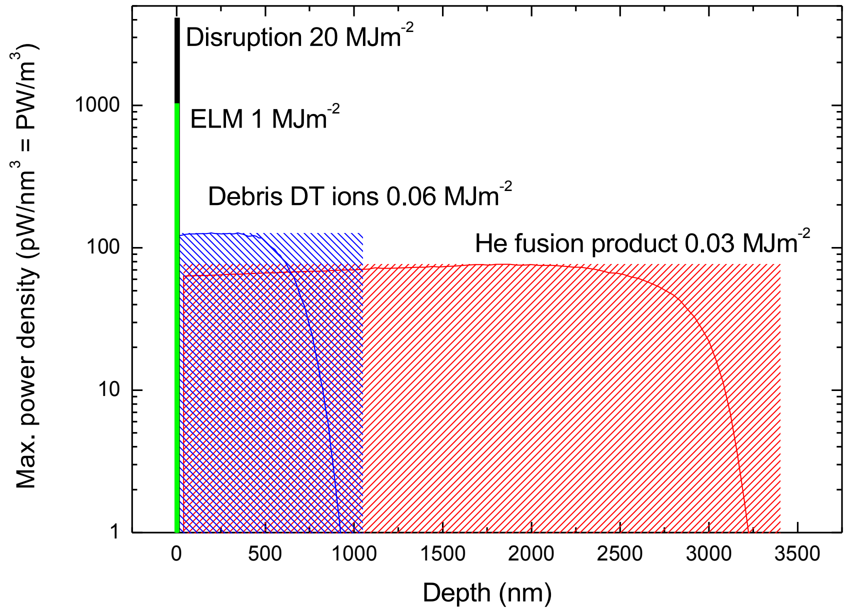
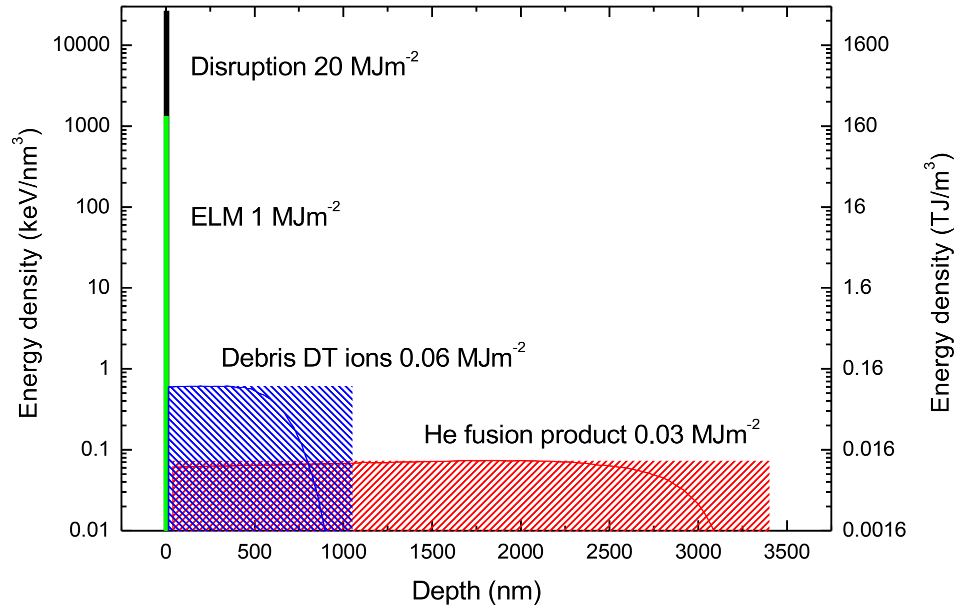
RELEVANCE FOR LASER FUSION





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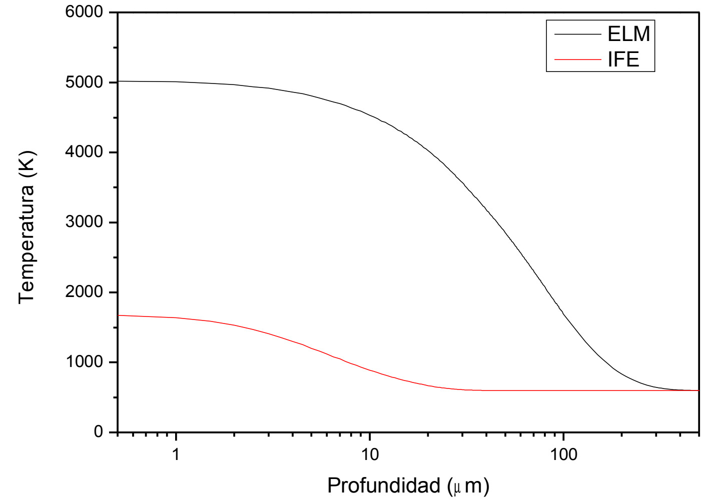

- High energy particle
-Broad spectrum
- Short pulses and high fluxes

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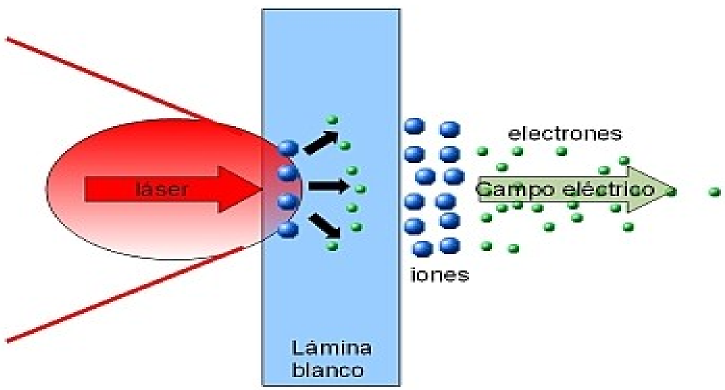
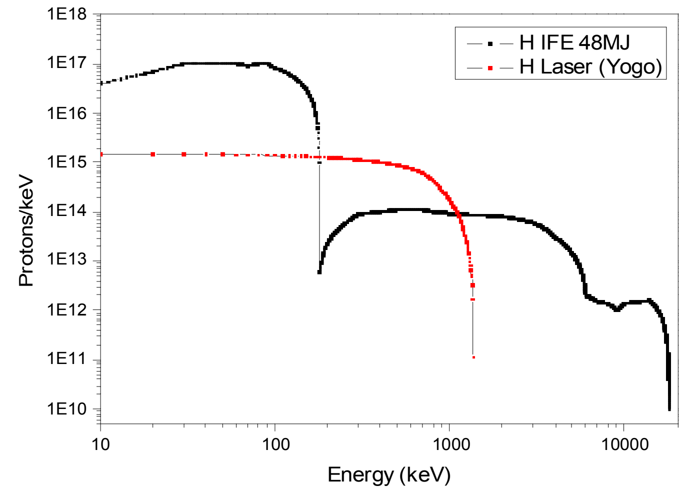
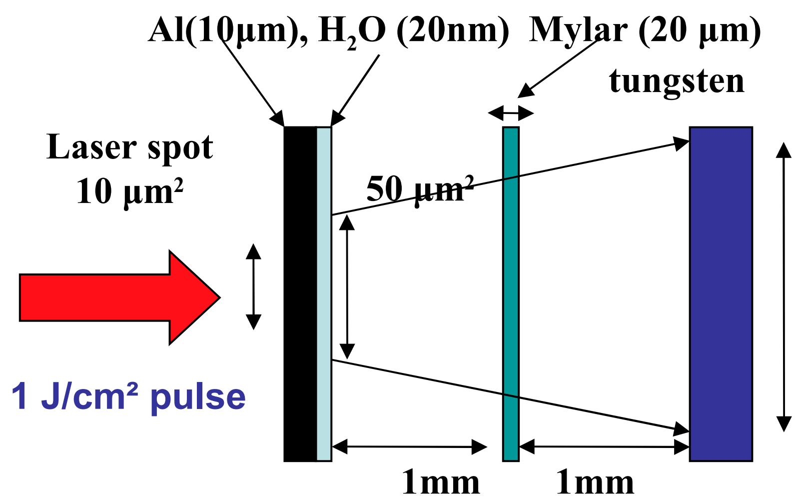
LASER DRIVEN ION BEAMS

We are proposing the construction of an ultraintense laser system for ion beam generation







With properties similar to LF ion bursts:

- short beam pulses

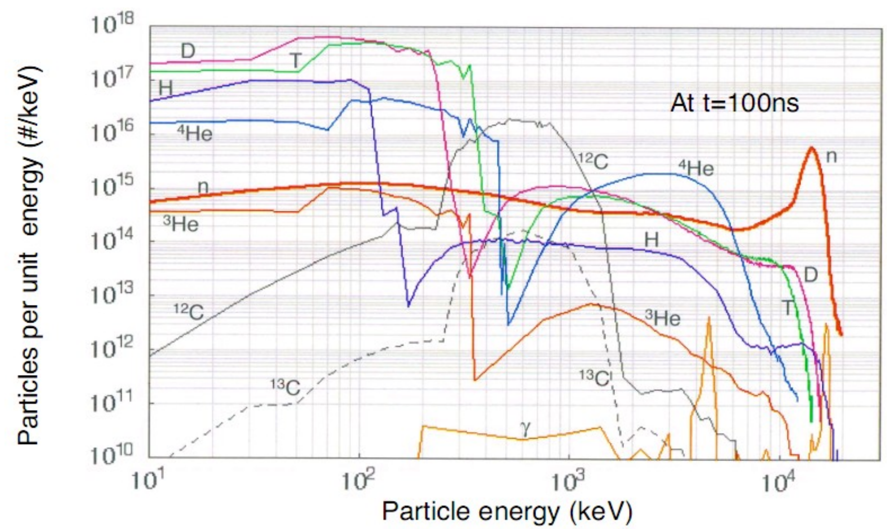
- Intensities >TW/m^2

- Fluxes 1e^{29}p/m^2/s

In collaboration with Prof. KTanaka

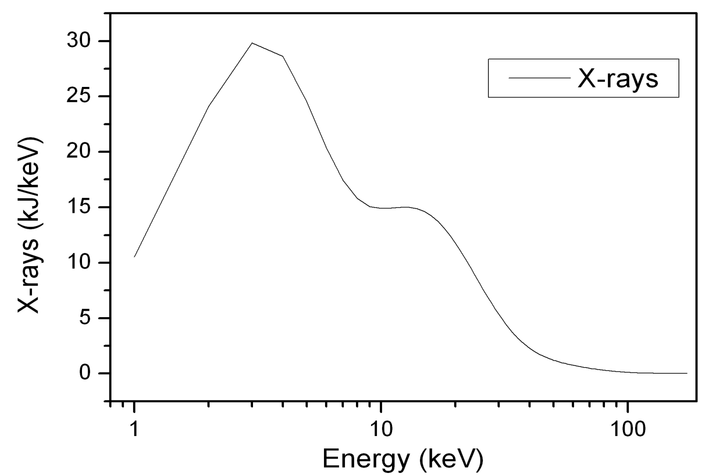
LASER DRIVEN X RAYS BEAMS

Other particles are expected to be created by Ultra Intense lasers which can simulate inertial fusion environments.
X rays
Neutrons?



GOAL

Complete experiment with simultaneous irradiation of all particles present in laser fusion plasma.
Repetitive mode.



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Thanks for your attention

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