

A laser-driven source to reproduce the space radiation environment

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Spanish Center for Pulsed Lasers (CLPU by its Spanish initials)



Unique Research and Technology Infrastructures (ICTS by its Spanish initials).

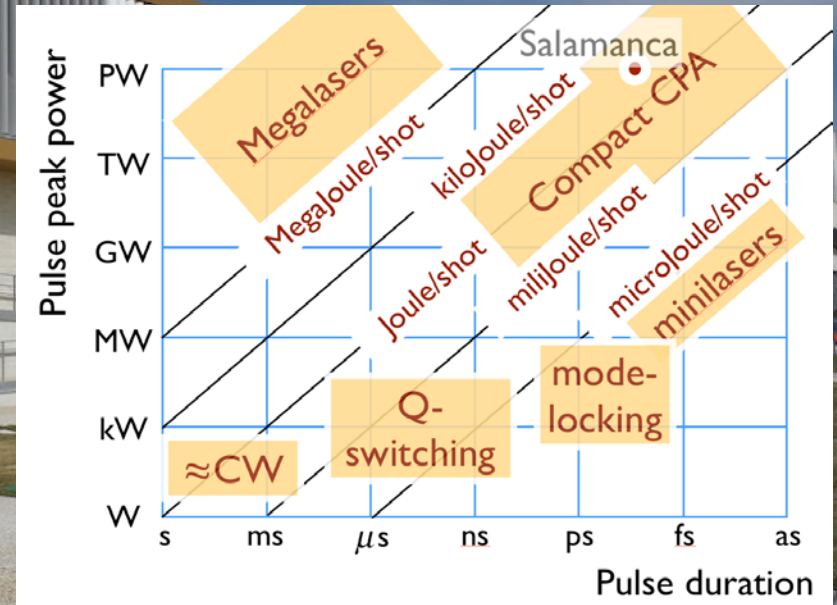
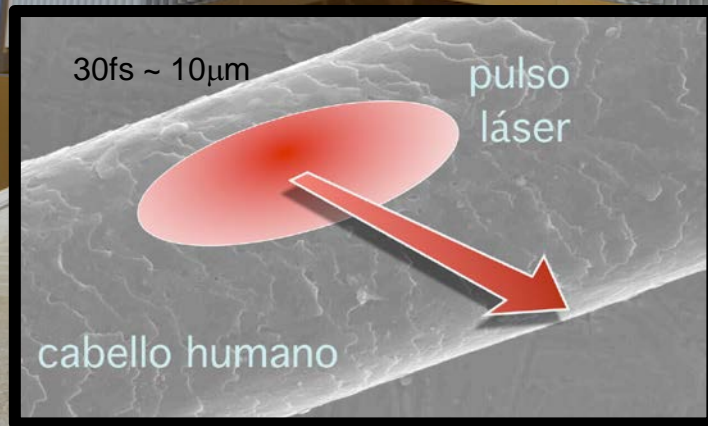


For more information visit the ICTS webpage: www.idi.mineco.gob.es/portal/site/MICINN/ICTS

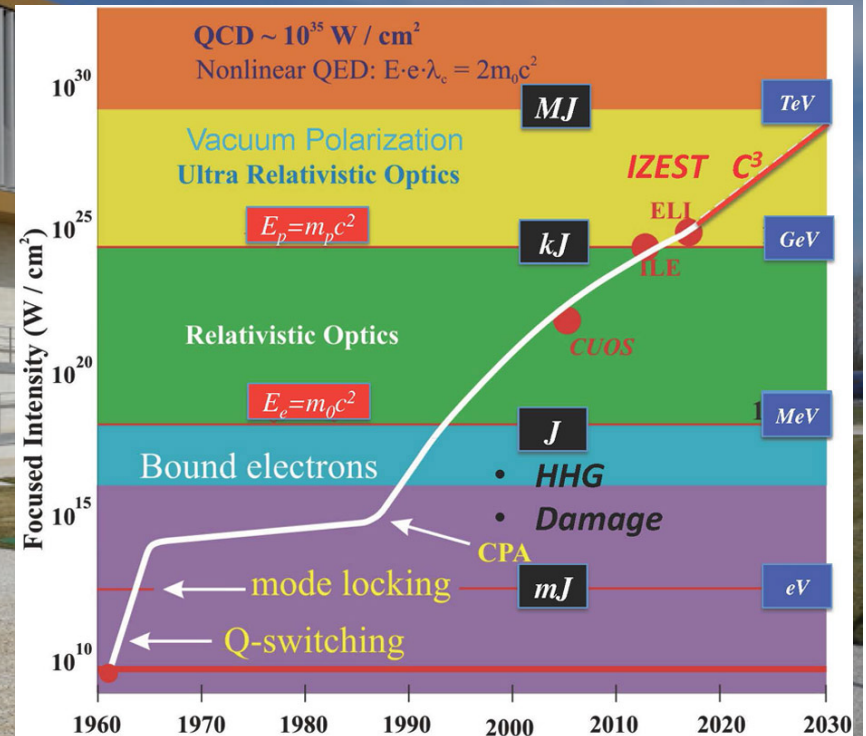
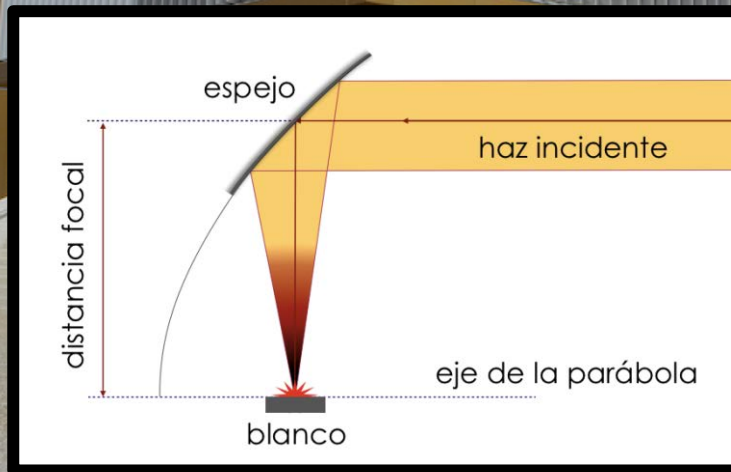
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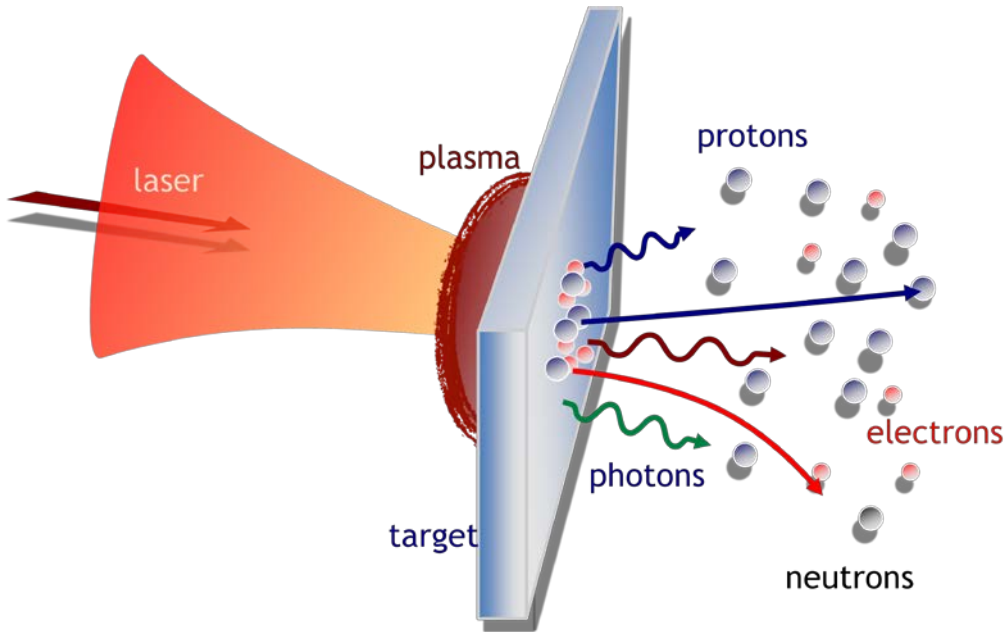
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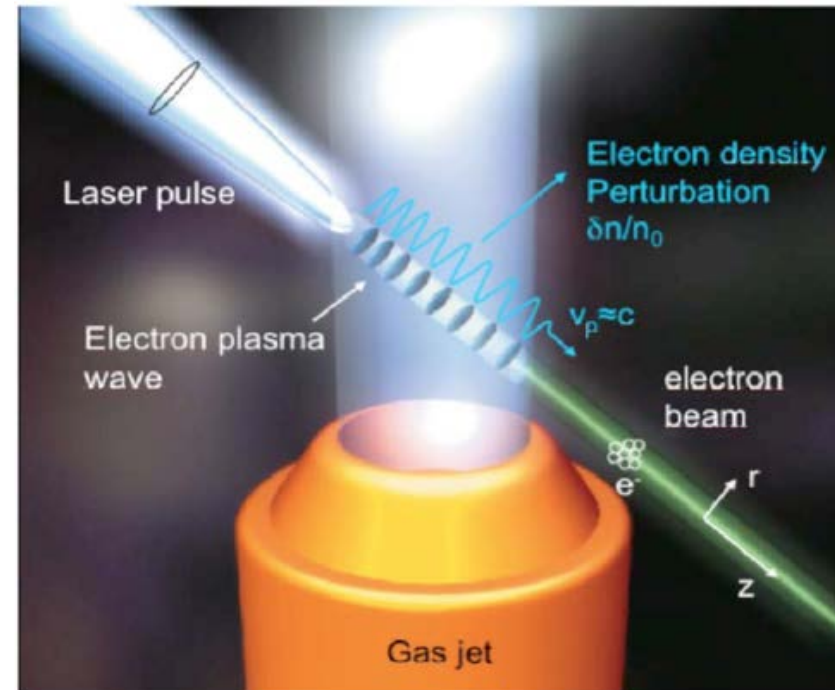


Solid target configuration



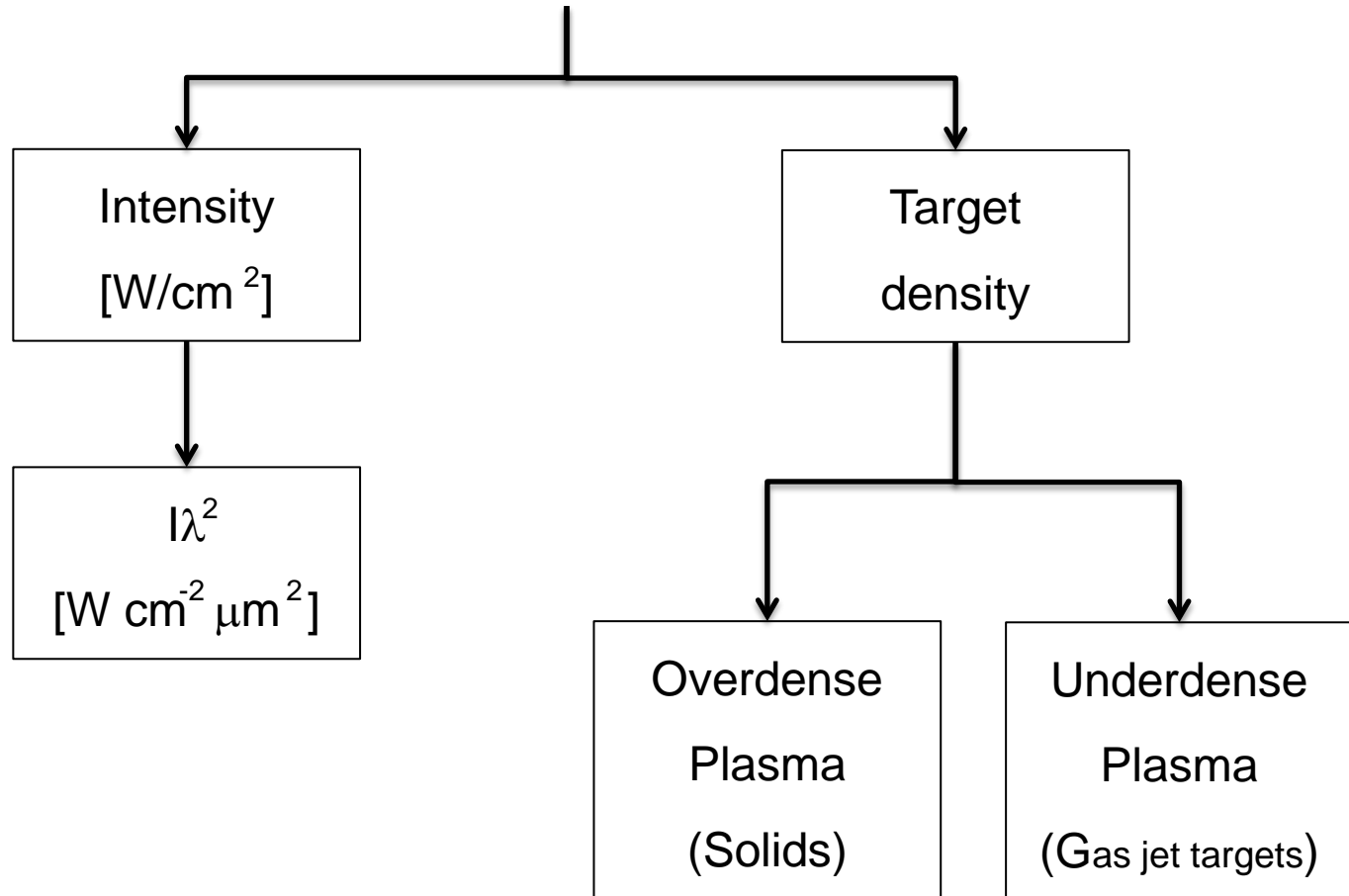
10^{22} W/cm^2

Gas jet configuration

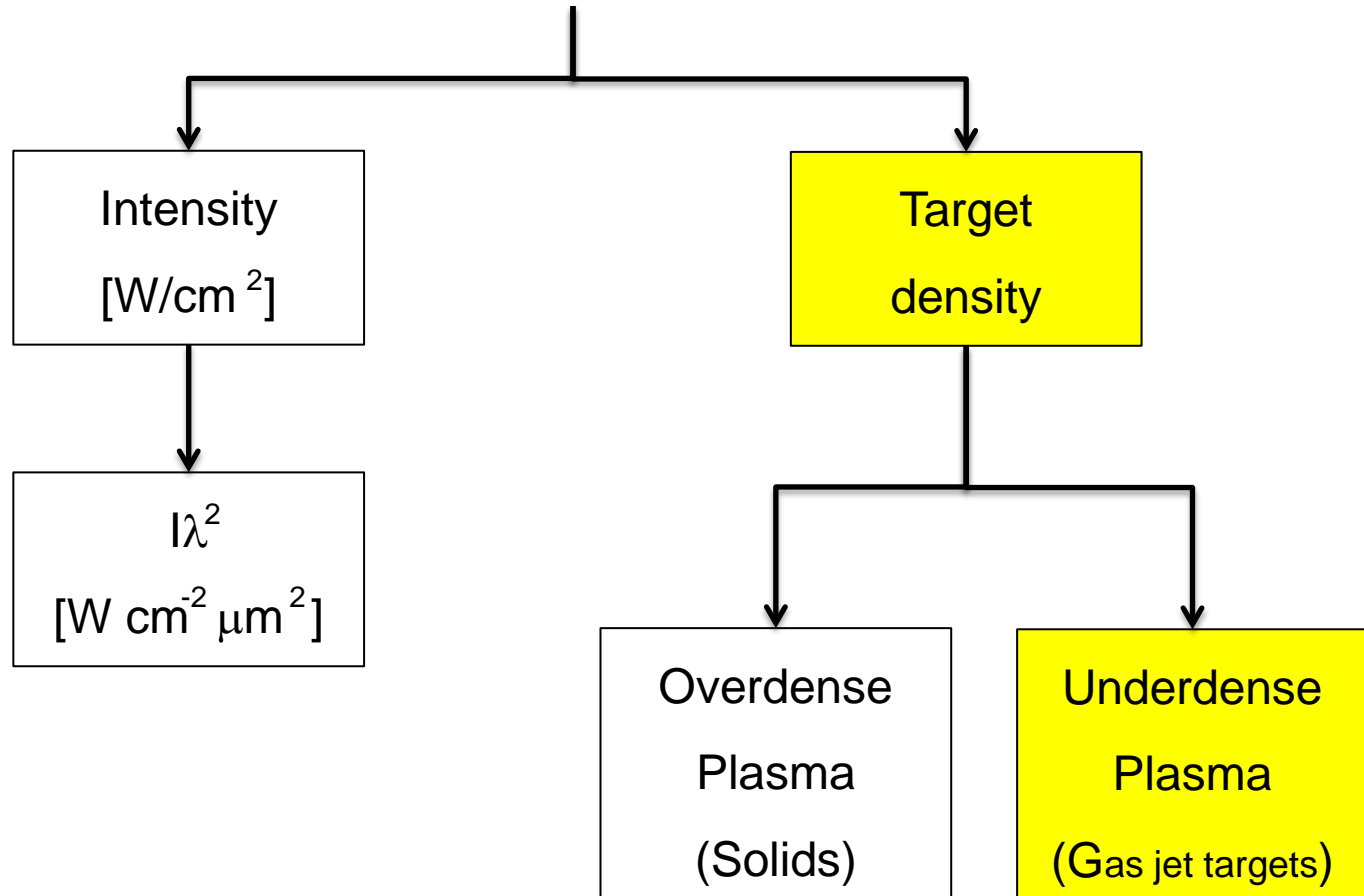


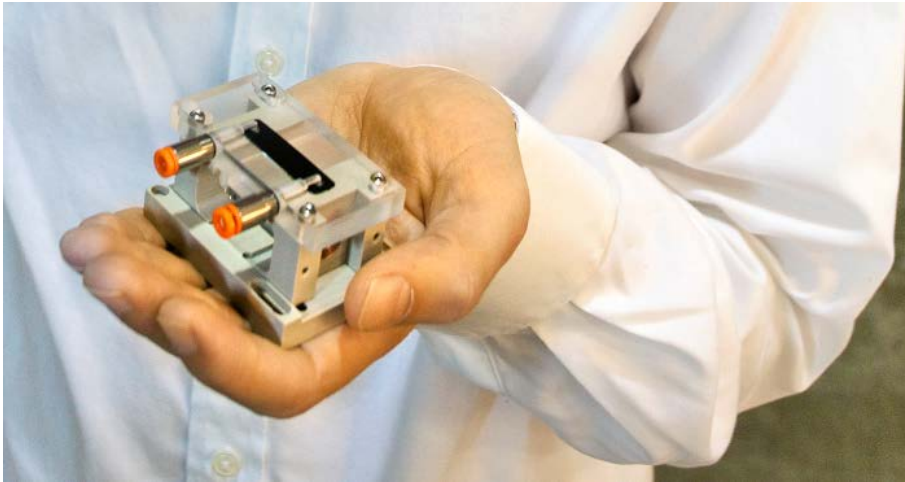
Particle accelerators based on laser-produced plasmas can operate in many different regimes depending on the characteristics of the plasma.

Parameters of relevance for particle acceleration



Parameters of relevance for particle acceleration





A **9 cm-long** capillary discharge waveguide used at the BELLA (laser) Center at the Lawrence Berkeley National Laboratory to **produce an electron beam up to 4.25 GeV** (Leemans 2014).

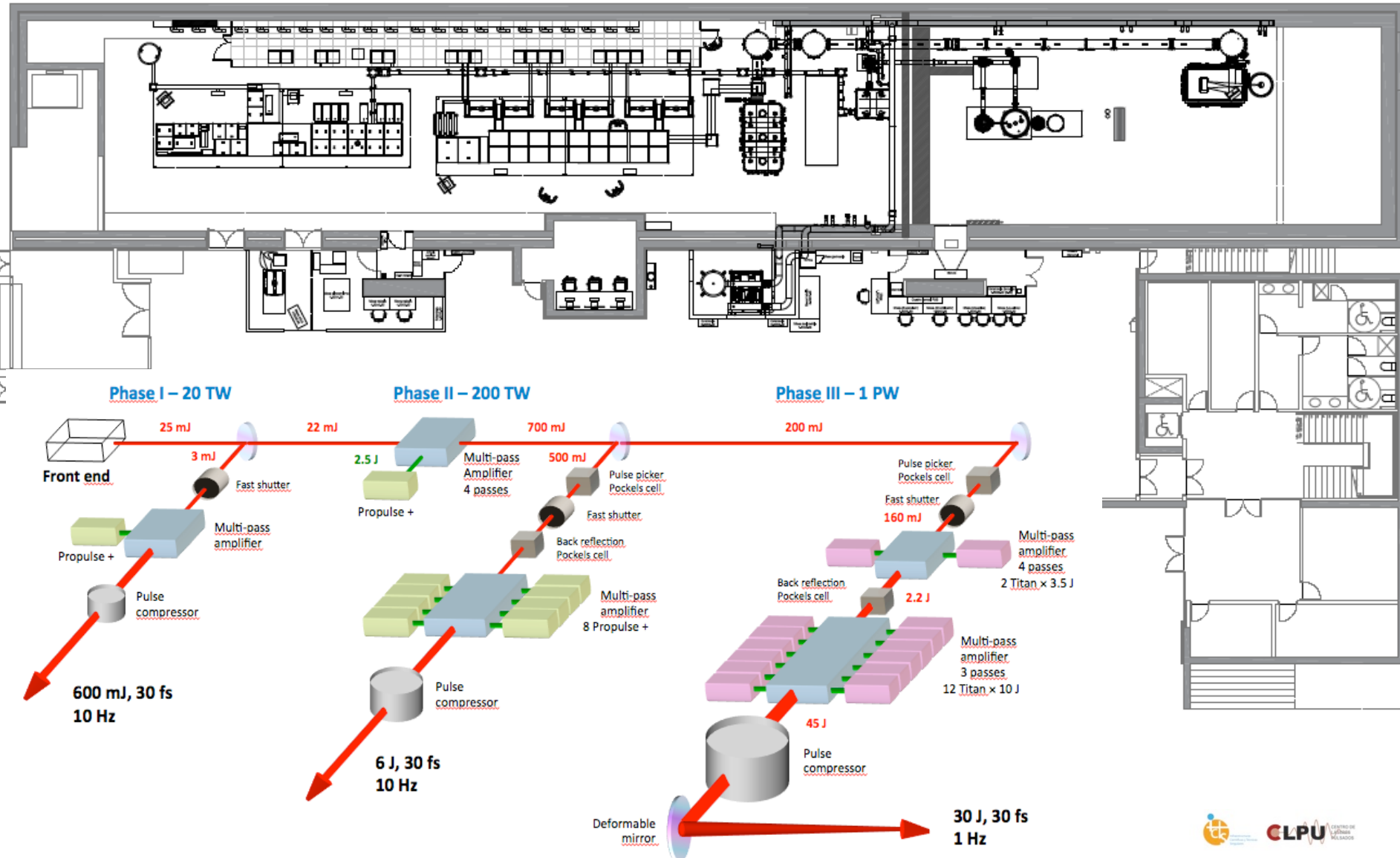
The so-called **laser plasma accelerators** promise for innovation of affordable and compact accelerators for various applications ranging from high energy physics to medical and industrial applications among which stands the **space industry**.

Intense Laser Labs World Wide



From the “International Committee of Ultra-High Intensity Lasers”
(ICUIL, www.icuil.org)

VEGA laser : Ti:Sapphire custom made laser built by Amplitude Technologies.



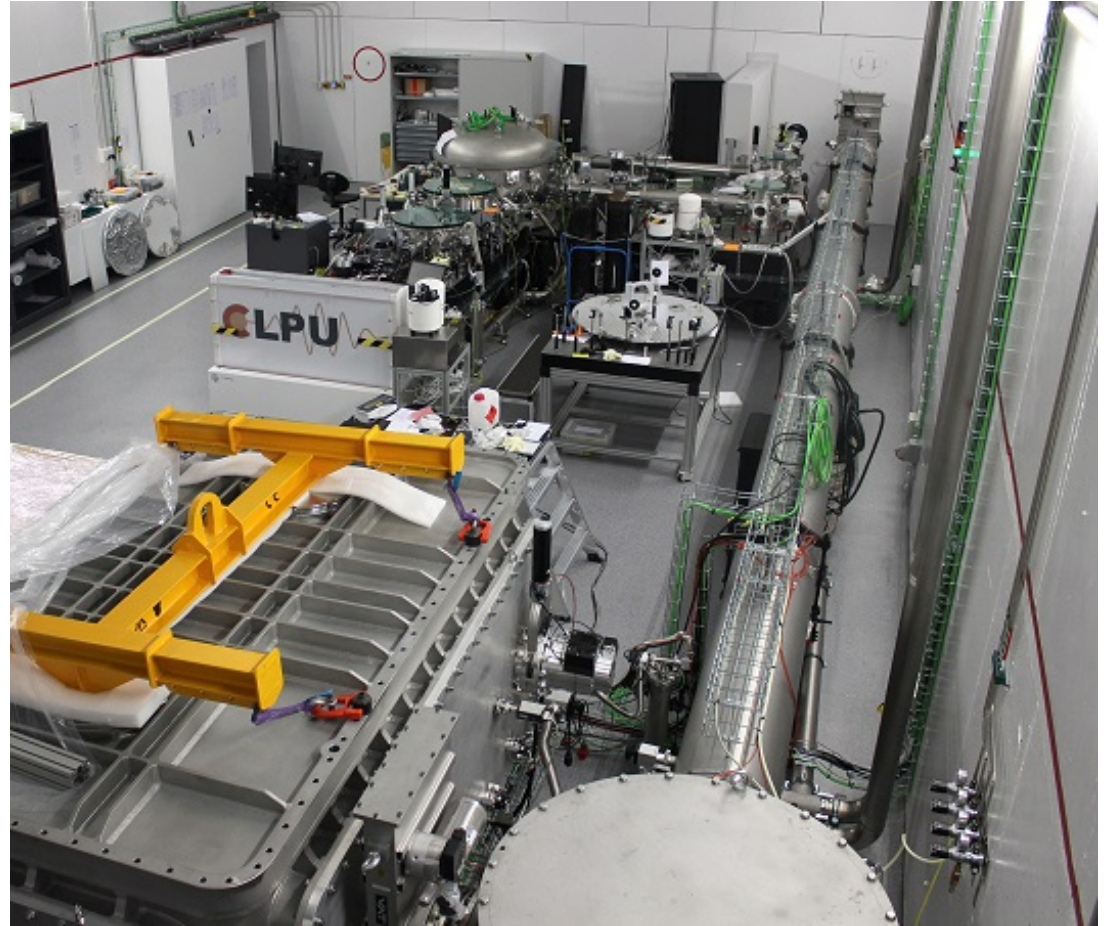
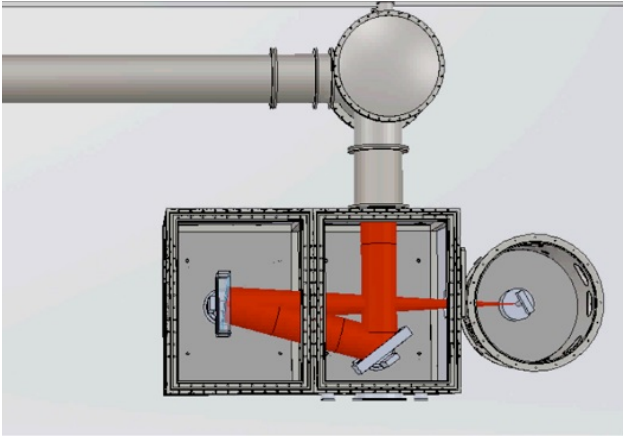
A laser-driven source to reproduce the space radiation environment

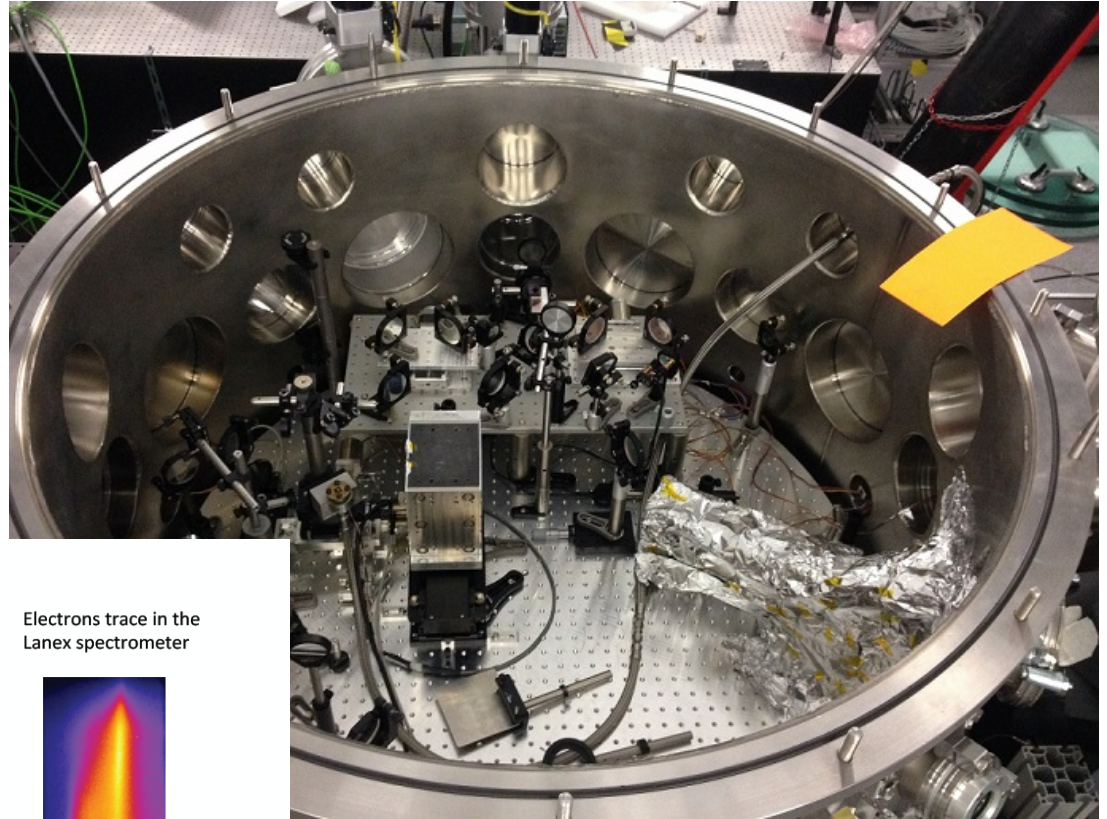


A laser-driven source to reproduce the space radiation environment

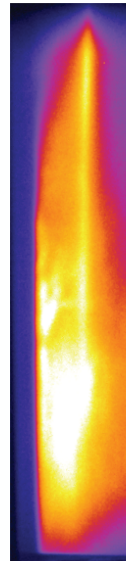
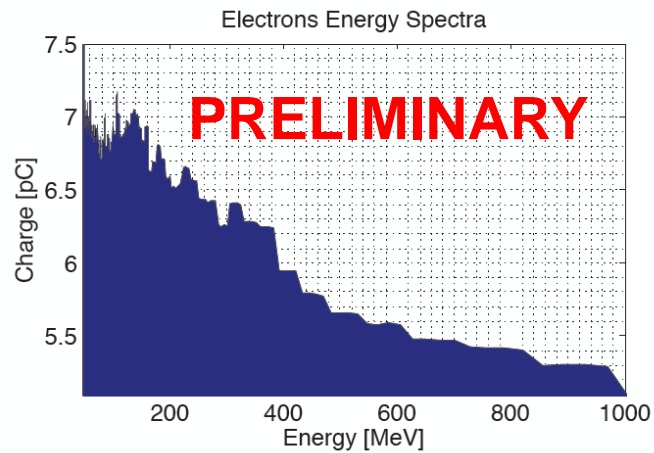


A laser-driven source to reproduce the space radiation environment

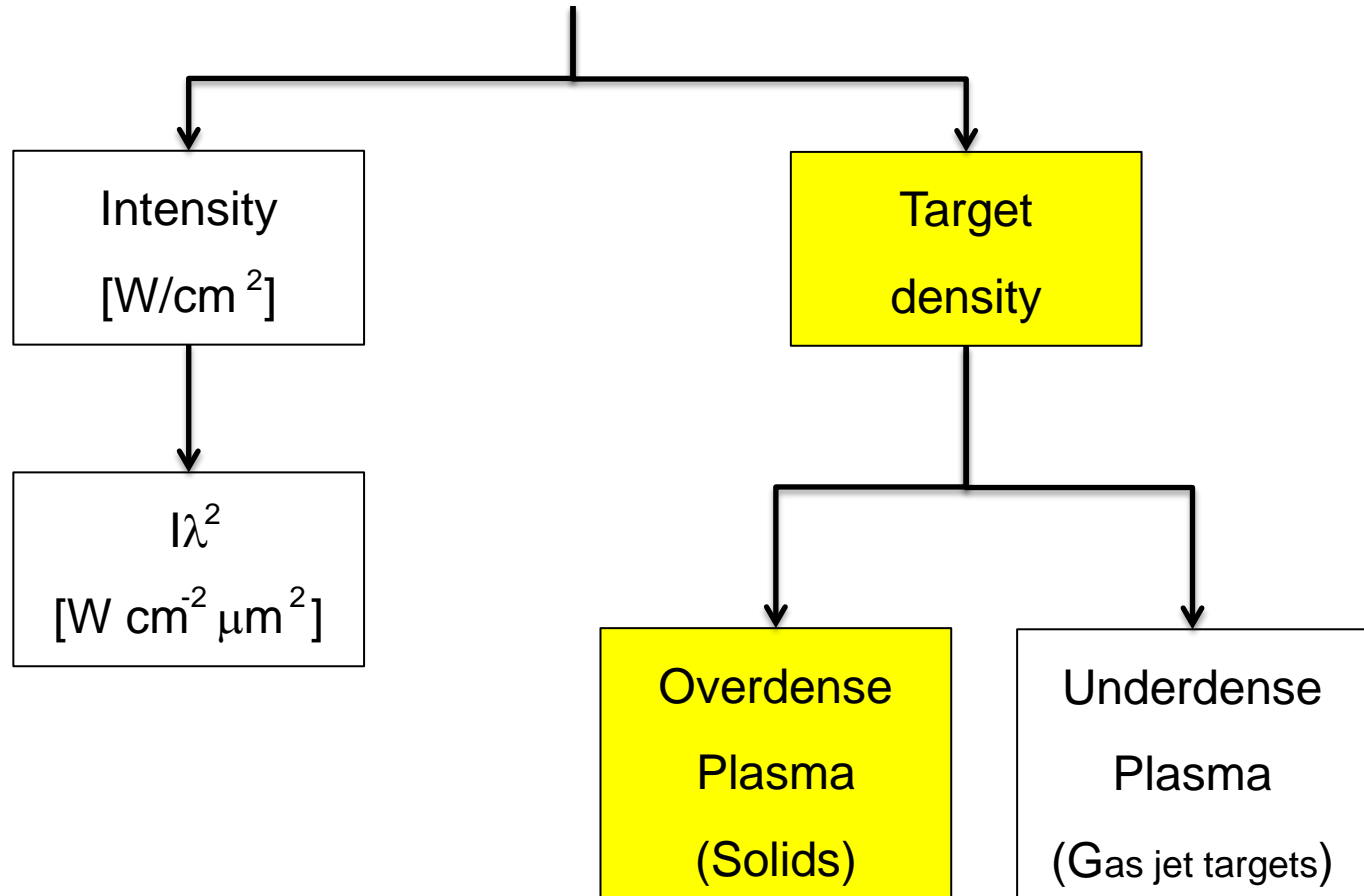




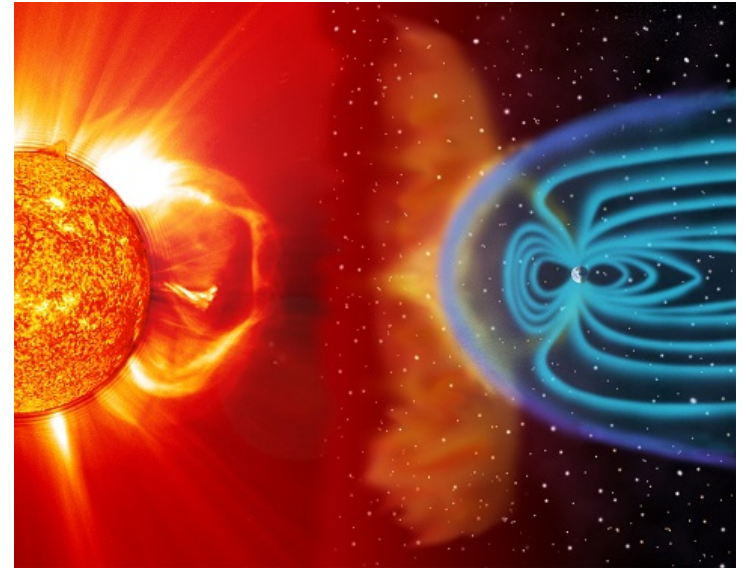
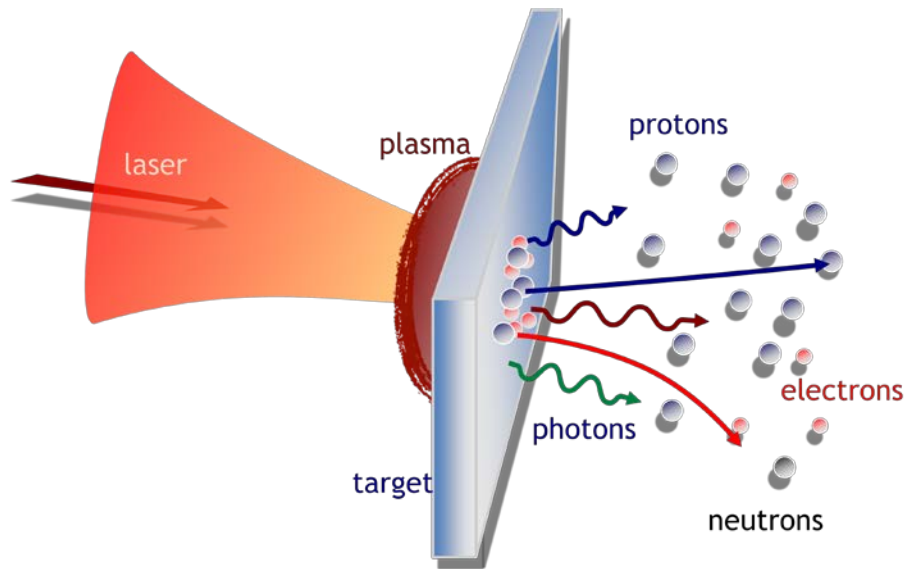
Electrons trace in the
Lanex spectrometer



Parameters of relevance for particle acceleration



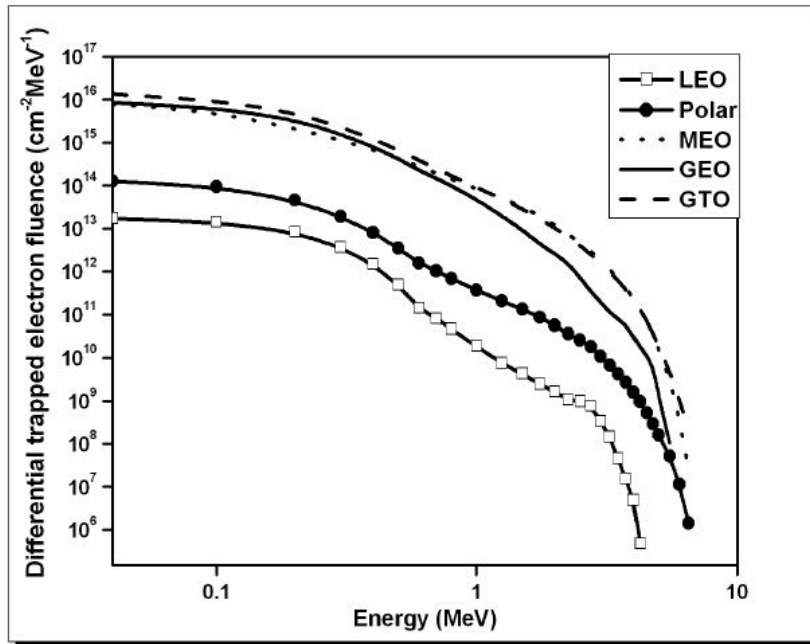
How **similar** would be the particle beams to those from space?



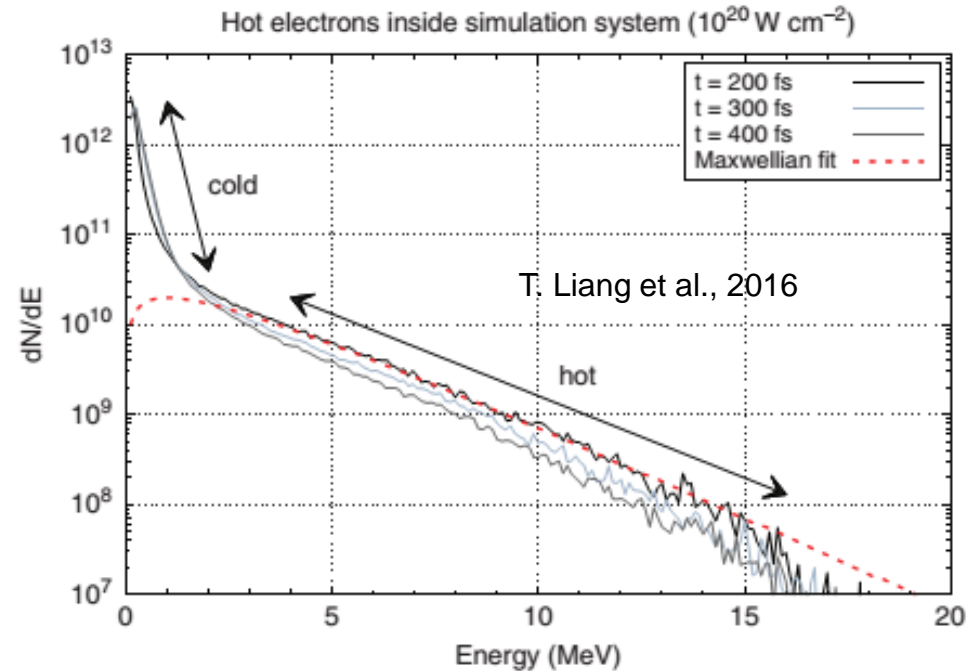
- ❖ Mixed radiation fields: **electron**, **proton/ion**, photons and neutrons.

Today, we are going to speak about trapped particles environment.

Trapped Particles Environment : Electron

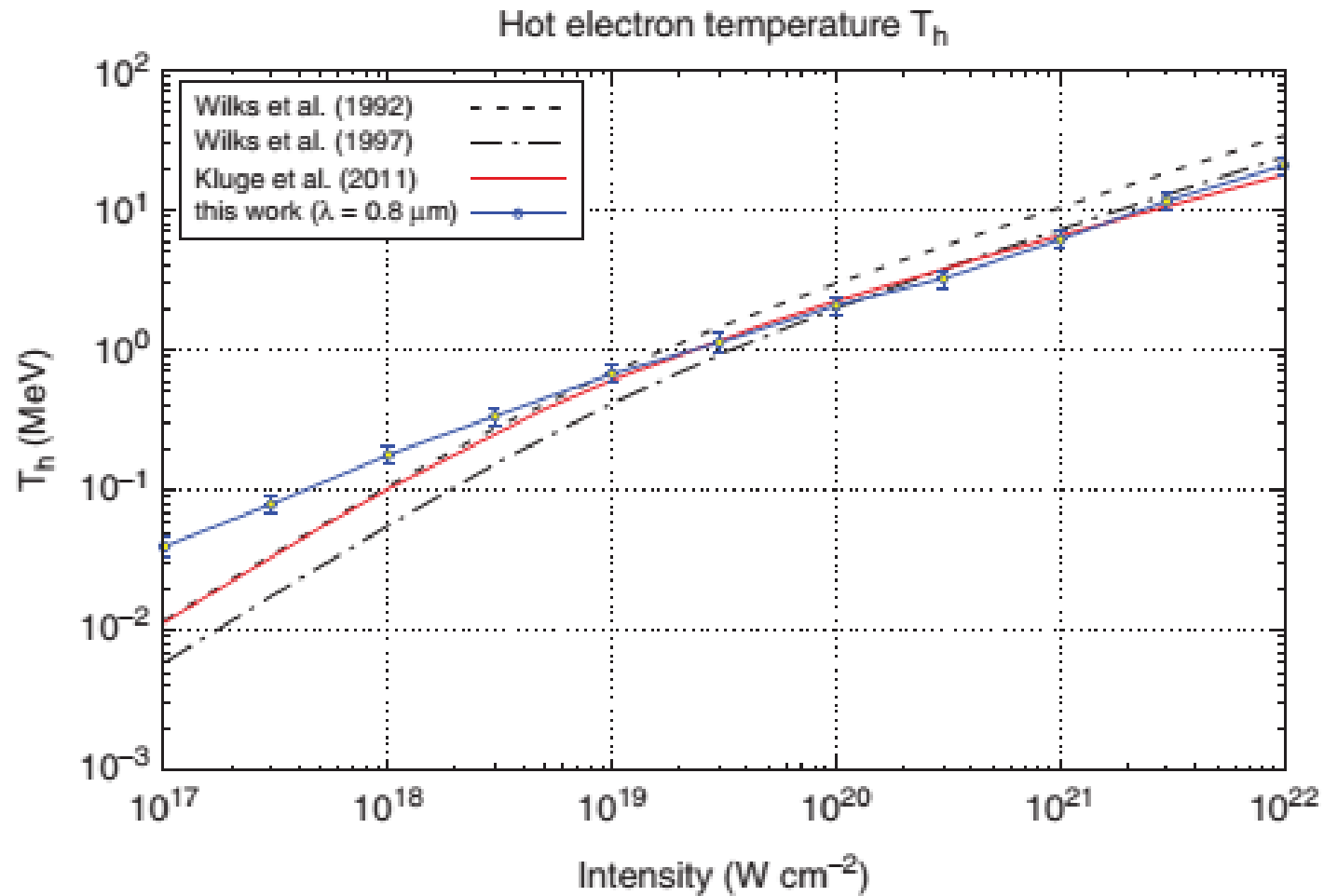


S. Samwel et al., International Journal of Astronomy and Astrophysics 01, 2006.



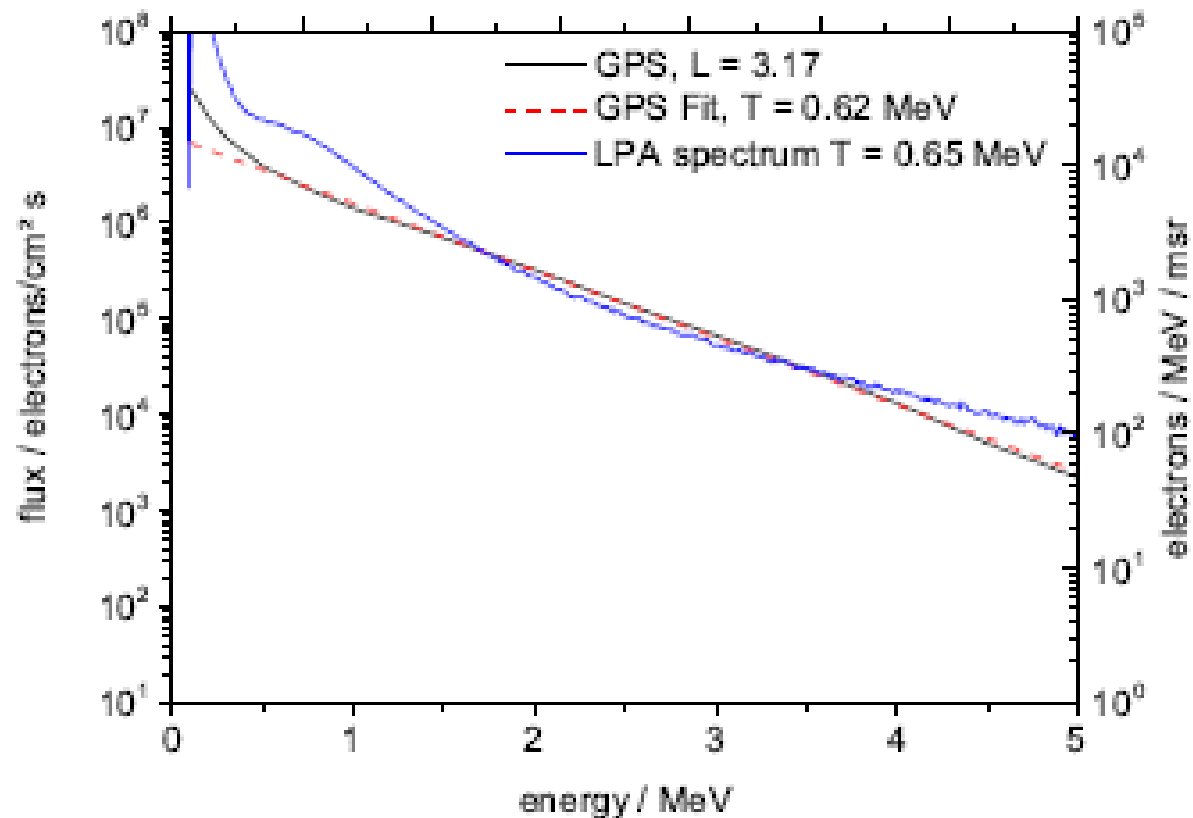
A Maxwellian fit yields a characteristic slope of $T=2.1$ MeV

❖ Large energy broadband spectra.



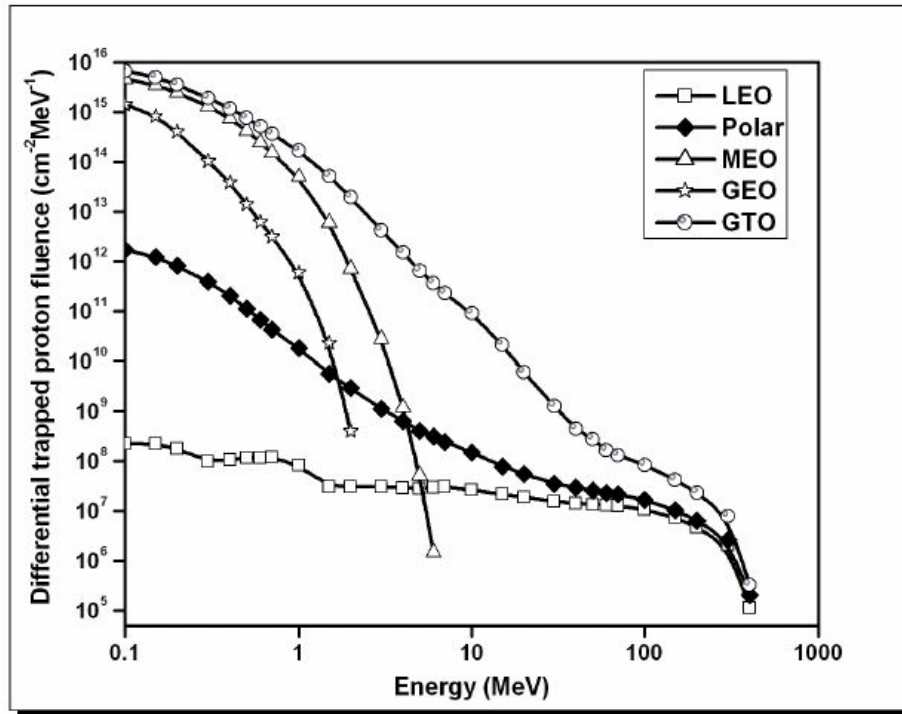
The hot electron temperature scales with laser intensity.

How **similar** would be the electron beam to those from space?

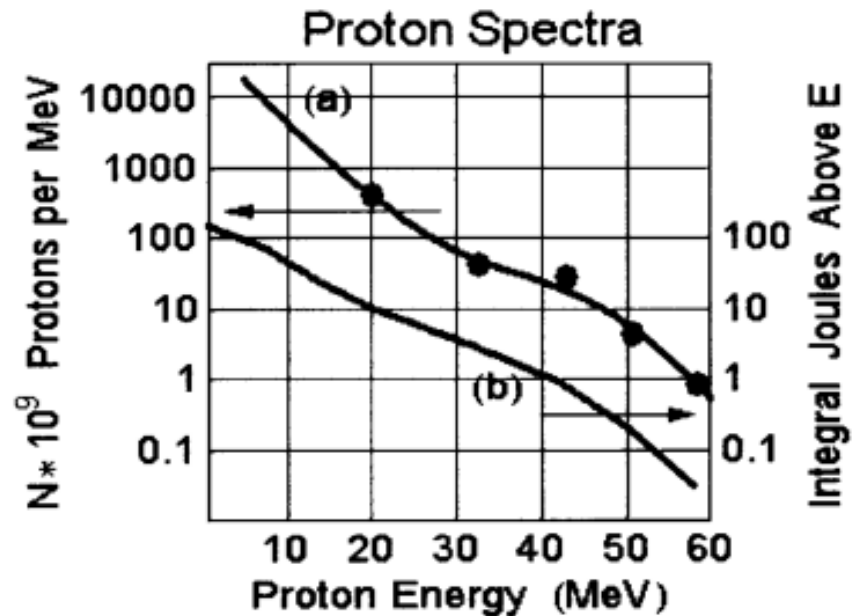


Reproduction of electron fluxes in the GPS orbit with laser-plasma-generated electron flux with $T=0.65\text{MeV}$. Hidding et al. (2013), ESA NPI Activity 4000102854

Trapped Particles Environment : Proton

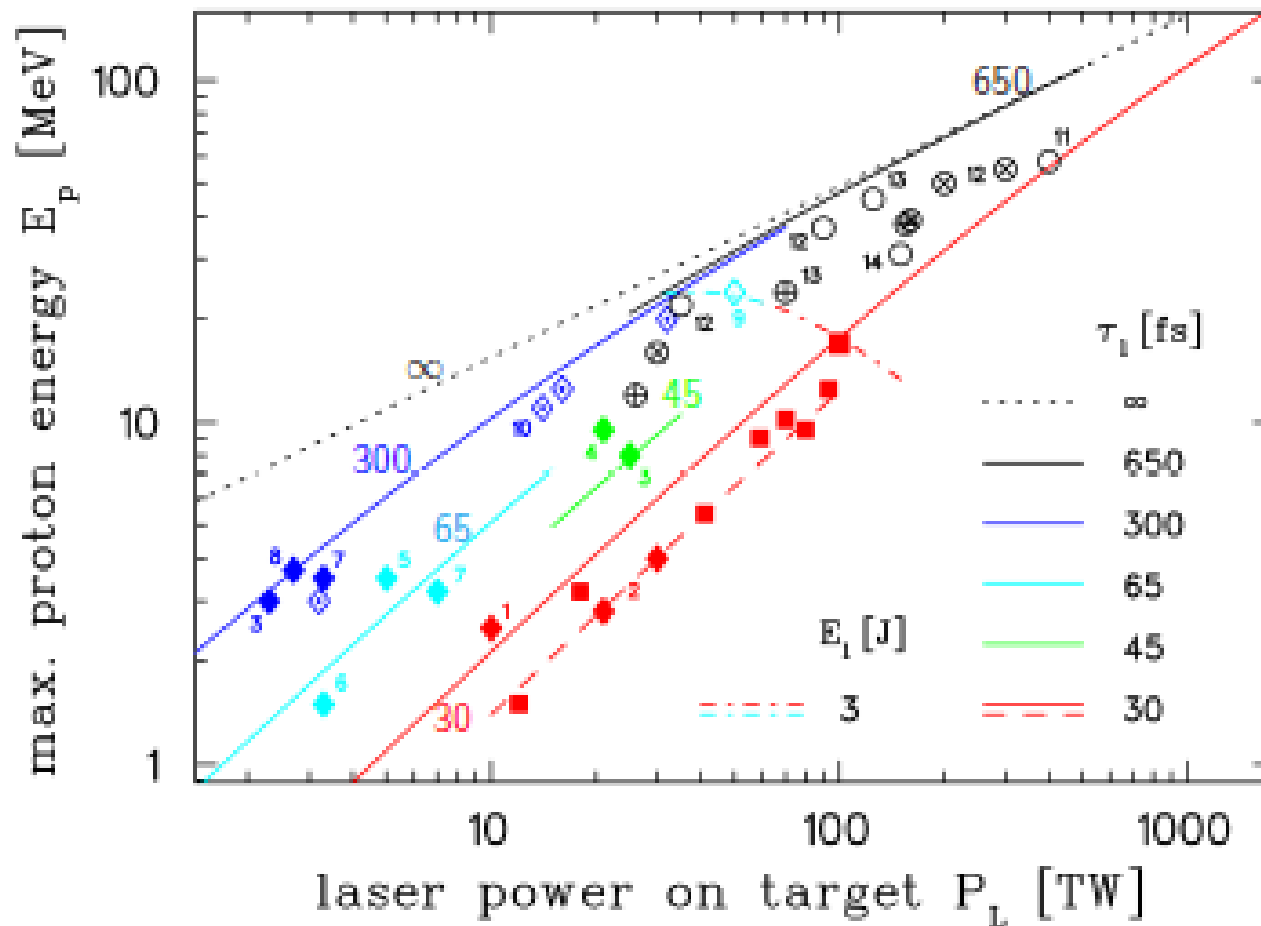


S. Samwel et al., International Journal of Astronomy and Astrophysics 01, (2006).



Snaveley et al. (2000)

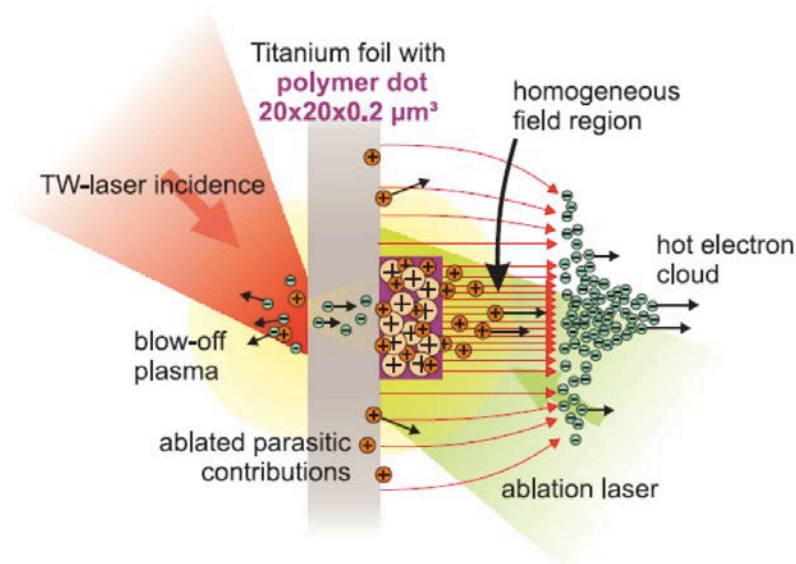
❖ Large energy broadband



Experimental scaling of proton energy cut-off with laser power and pulse duration.

Zeil et al. (2010), New J. Phys. 12, 045015.

How **different** would be the particle beams to those from space?



- ❖ The radiation field is pulsed, since it is generated during the laser pulse interaction.
- ❖ Bunch of particles (scale of 100's fs).
- ❖ Very high particle flux.

Is this (+) or (-) ?

Image taken from S.M. Pfotenhauer et al, New J. Phys. (2008) 033034

How **different** would be the particle beams to those from space?

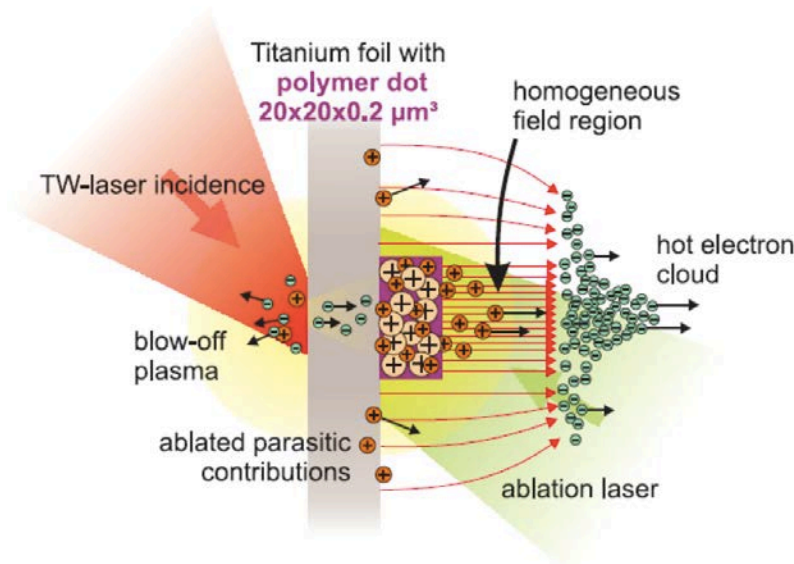


Image taken from S.M. Pfotenhauer et al, New J. Phys. (2008) 033034

- ❖ The radiation field is pulsed, since it is generated during the laser pulse interaction.
- ❖ Bunch of particles (scale of 100's fs).
- ❖ Very high particle flux.

Is this (+) or (-) ?

- (+) We will have enough particle flux to reproduce an space exposition in a short time.
- (-) Nonlinear effects might occur at very high fluxes (the flux can be lowered easily but with the penalty of increasing the exposition time).
- (-) The experimental characterization of the radiation beam is not trivial.

Conclusion

- Laser-driven source might cover the need of affordable and compact accelerators for space applications.
- First studies are very promising (Hidding et al. 2013).
- There is a lack of knowledge about the effects that a bunch of particles in the time scale of the laser pulse might produce.
- Further studies are needed in order to validate that laser-driven source meets the criteria required in this field.
- The Spanish Laser Center (CLPU) is a high intensity laser facility with capability to contribute in this field together with the community.

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ACCESS REQUEST

FIRST CALL FOR VEGA-2 ACCESS

200TW PLASMA LASER POWER VEGA PULSED ULTRAFAST PHYSICS ULTRASHORT 200TW
ACCESS CALL RESEARCH INNOVATION VEGA PLASMA PHOTON OPTICS POWER

VEGA-2 (200TW class laser) did last year successful commissioning experiments, and so CLPU offers 100 shifts (working days) of access during the period October 2017 to October 2018. CLPU invites groups working in the fields of plasma physics, extreme matter physics, laser-particle acceleration, atomic physics, ... to submit research proposals for beam time at the VEGA-2 laser.

Proposals can be submitted from **April 1st, 2017**, and the first selection of the Access Committee will be made with the proposals received until **June 30th**. Those proposals will be scientifically evaluated by an Access Committee, with participation of highly recognized experts external to CLPU.

Details on the call are available here [\[ENGLISH\]](#) [\[SPANISH\]](#)

Thank you!

