IMPULSE PROJECT

Working Package 3
Standardization and Metrology in Task 3.2

2022 Spanish Workshop on HEDP Opportunities at FAIR

Centro de Láseres Pulsados

Dated Friday November 18th 2022

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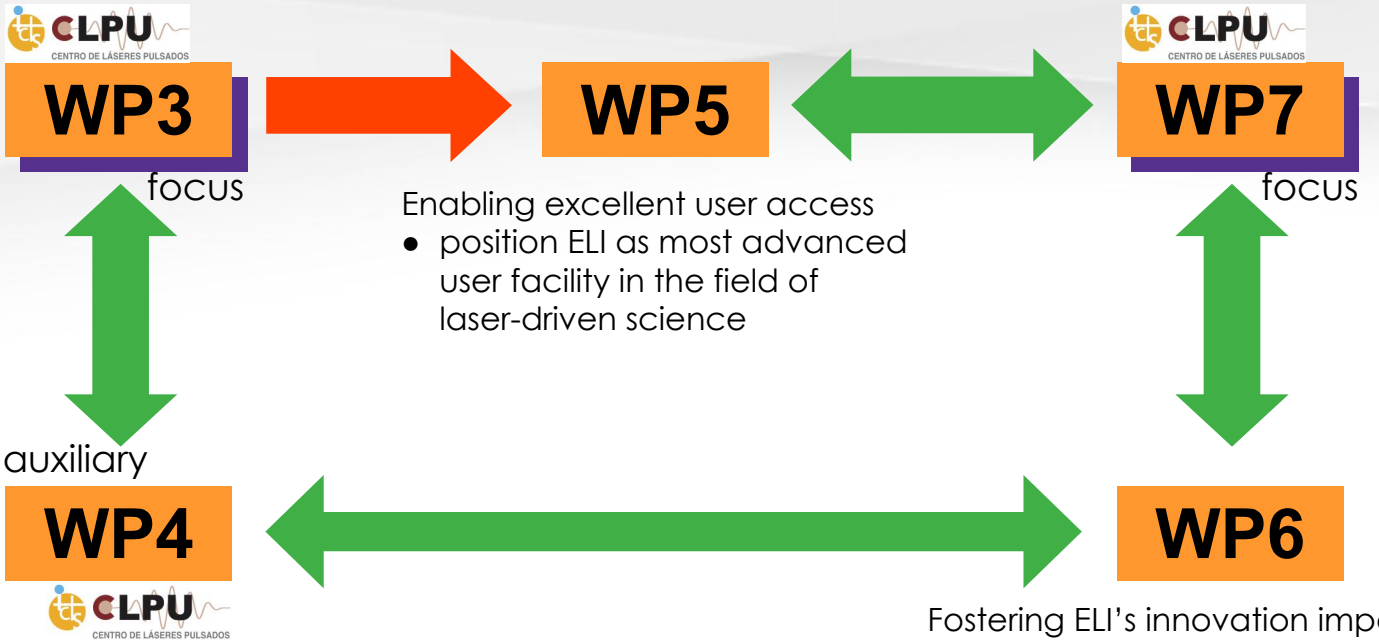
CLPU Tasks in Working Package 3

WP3 (ELI, STFC, CLPU, LMU, HZDR)

- ★ 3.1 :: joint definition, review and optimisation of operational modes
- ★ **3.2 :: standardization of metrology procedures for laser and secondary sources**
- ★ 3.3 :: optimize management of spare parts: maximize efficiency, safety & reliability
- ★ 3.4 :: capacity building through training and operating teams

- **expanded user base**
  - non-scientific objective
- **innovation impact**
  - scientific objective
- **explicit goals**
  - excellent performance of routine operations
  - joint approach to critical challenges
  - standardization + standardization requirements

Framework



Enabling excellent user access
- position ELI as most advanced user facility in the field of laser-driven science

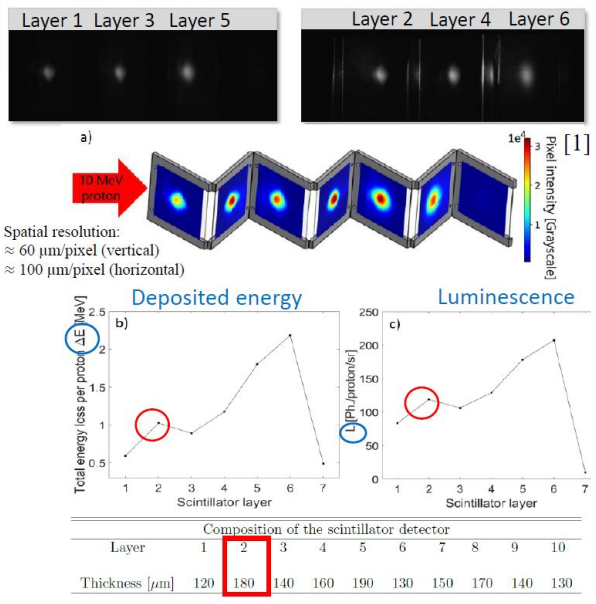
Key technologies and enhanced experiments
- understanding and control of key technologies
- enhancing the experimental capabilities of ELI
- **EMP**

Fostering ELI's innovation impact
- maximize ELI's impact on innovation through the development of a shared approach to knowledge transfer and industrial access

Standardization and Standardization Requirements

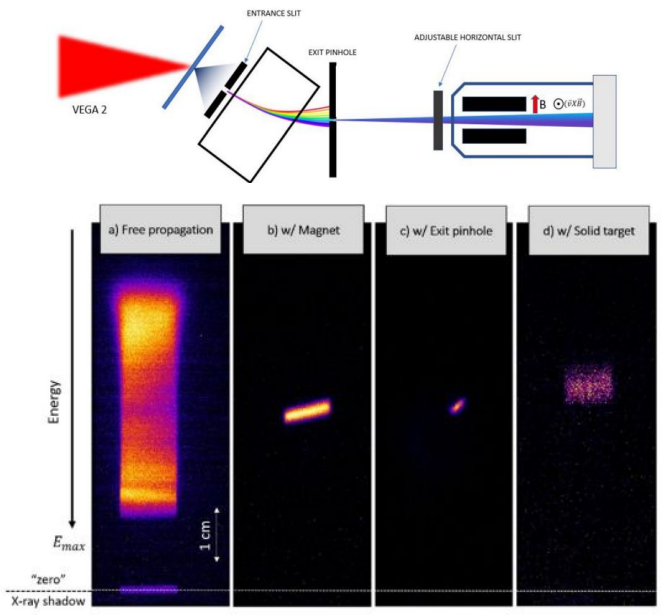
Detector Highlights

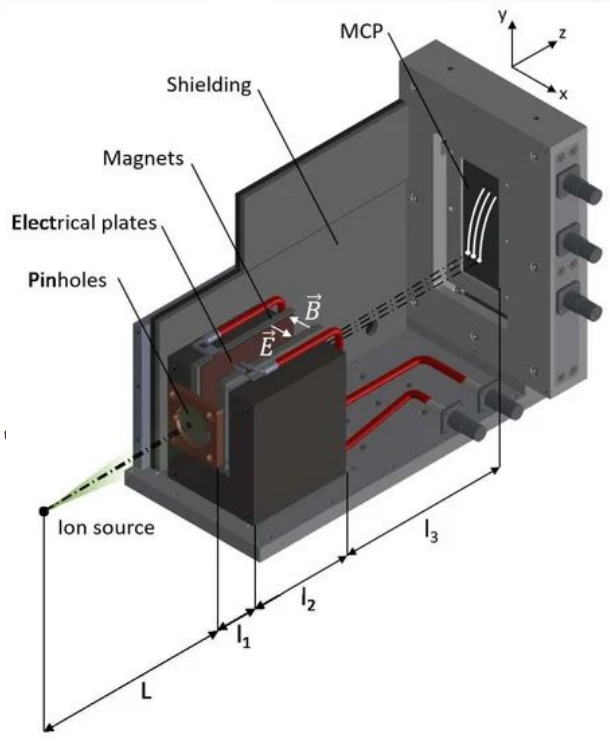
- ★ M. Huault et al., High Power Laser Science and Engineering 7, e60 (2019)
- ★ J.I. Apiñaniz et al., Scientific Reports 11, 6881 (2021)
- ★ C. Salgado-López et al., Sensors 22(9) 3239 (2022)



Composition of the scintillator detector

Layer	1	2	3	4	5	6	7	8	9	10
Thickness [µm]	120	180	140	160	190	130	150	170	140	130





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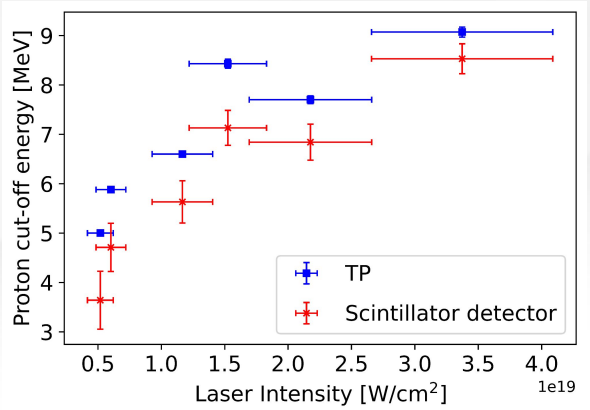
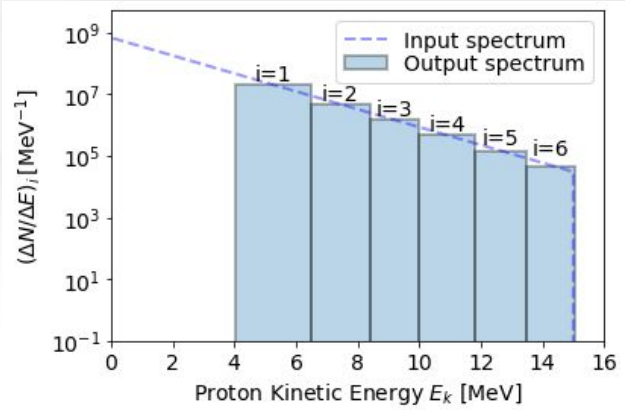
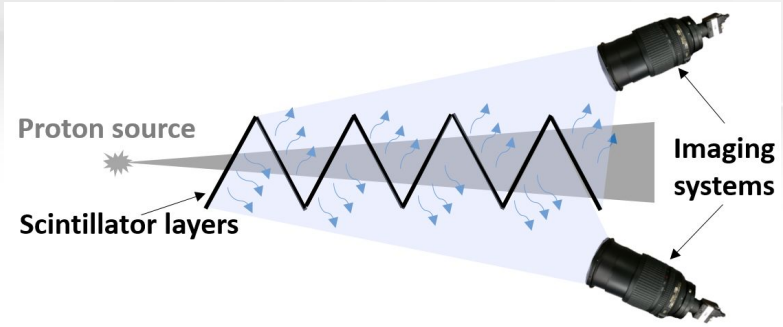
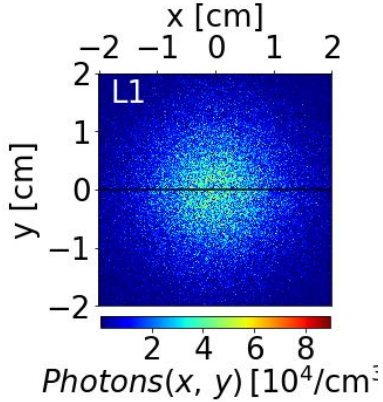
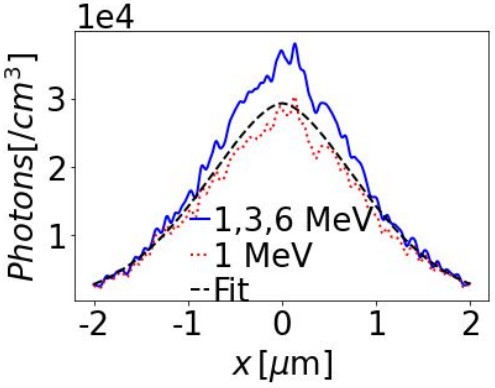
Spatiospectral Ion Beam Diag: Scintillator Accordeon

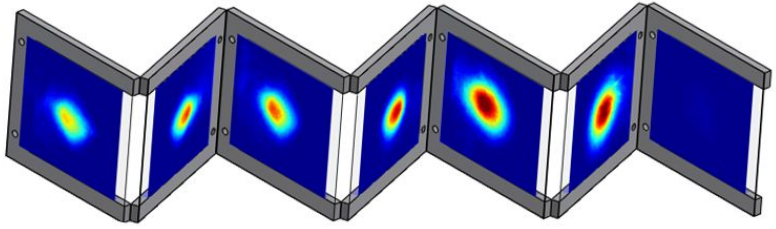






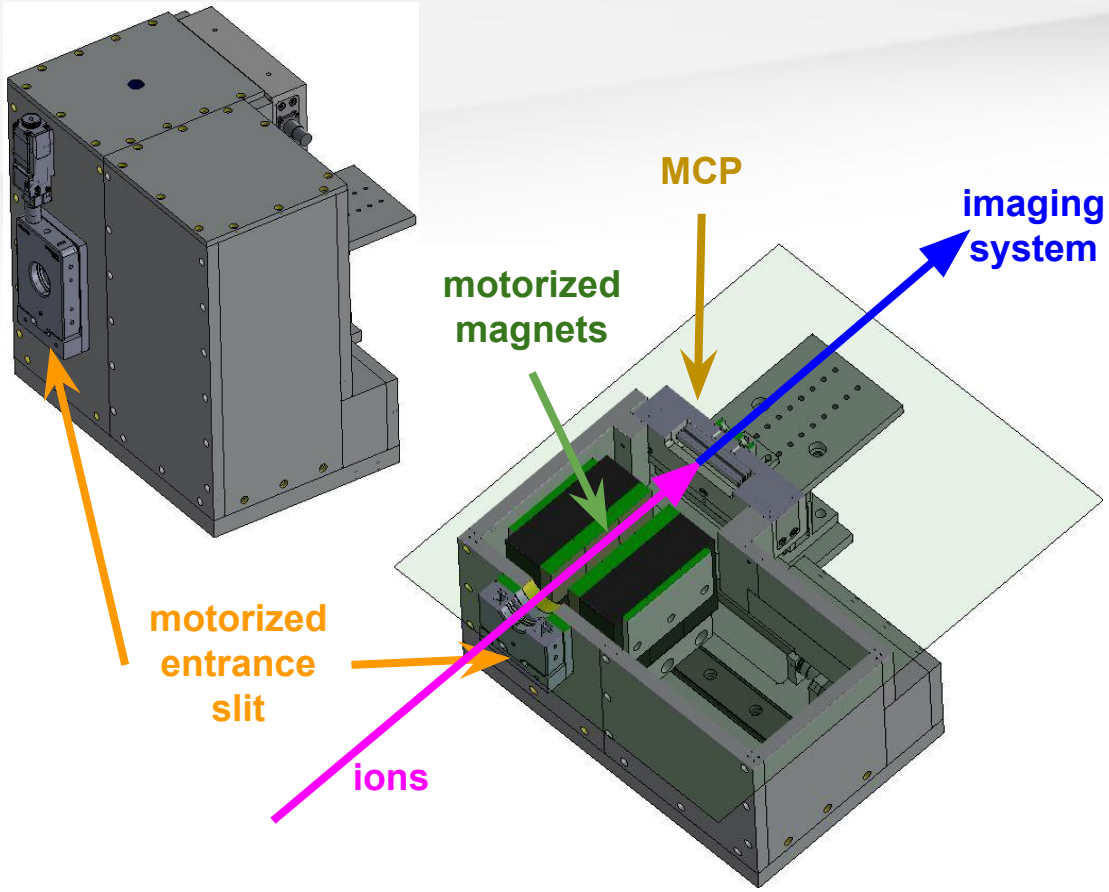


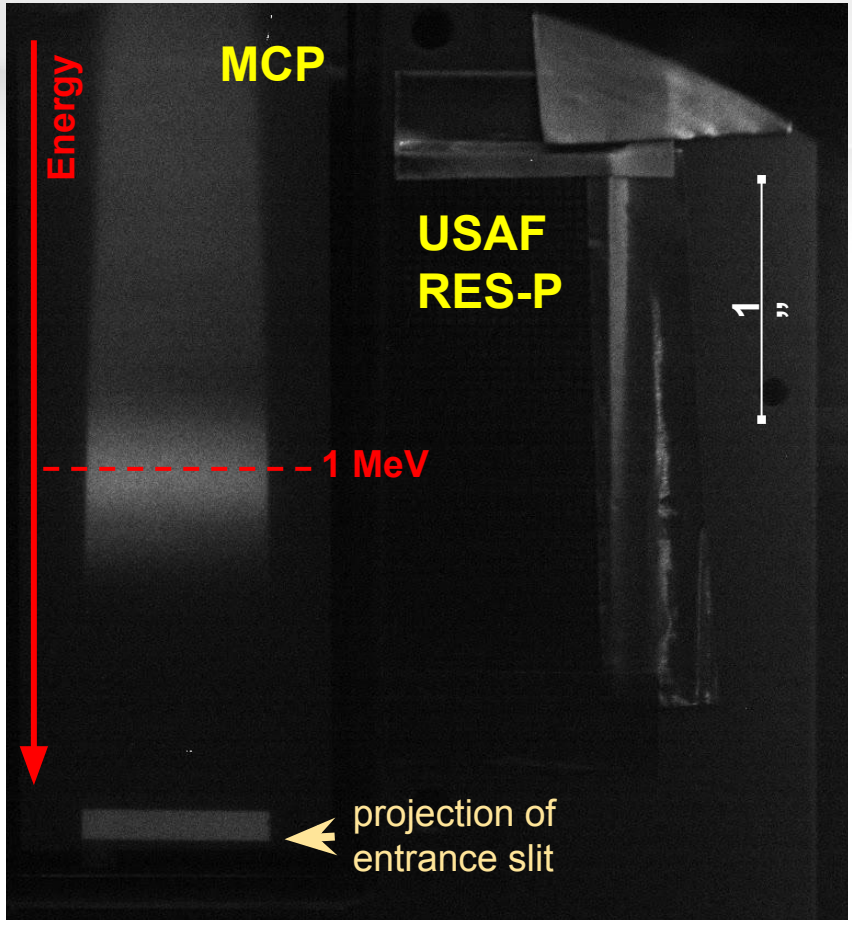




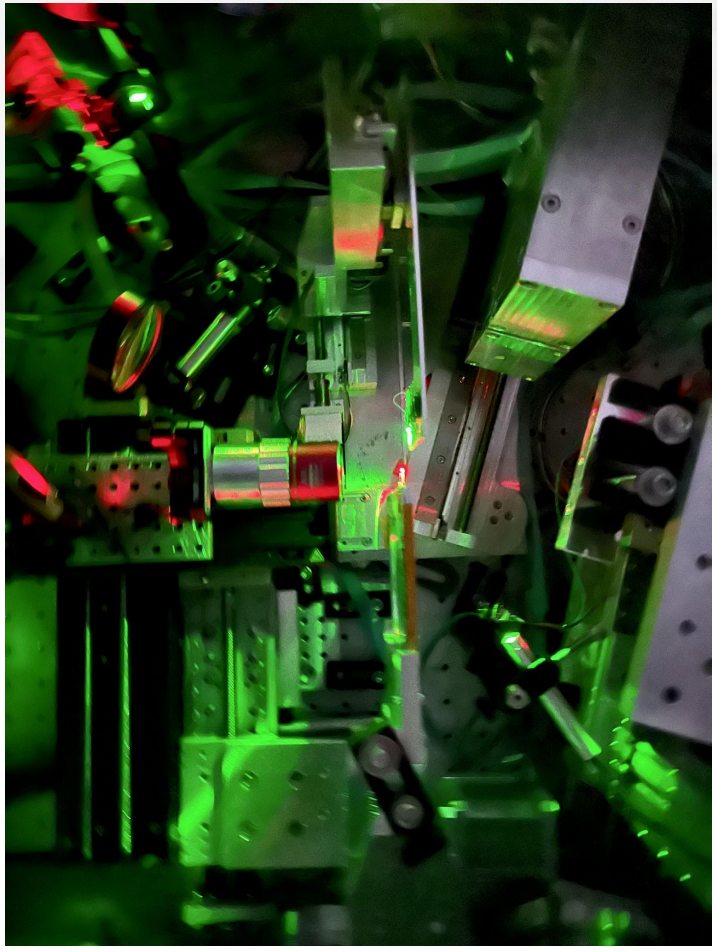
M. Huault et al., *in preparation* (2022)

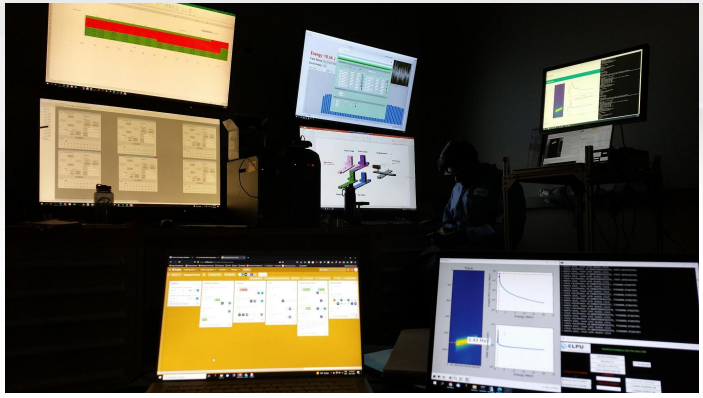
Fully motorized charged particle beam spectrometer

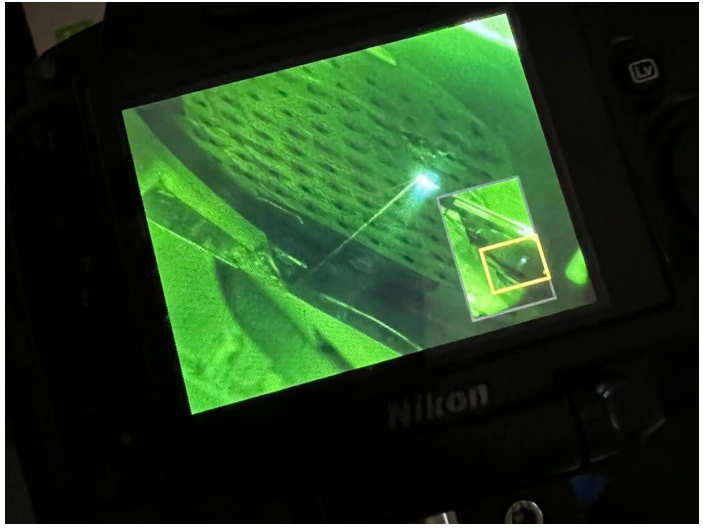




Fully Motorized Charged Particle Beam Spectrometer

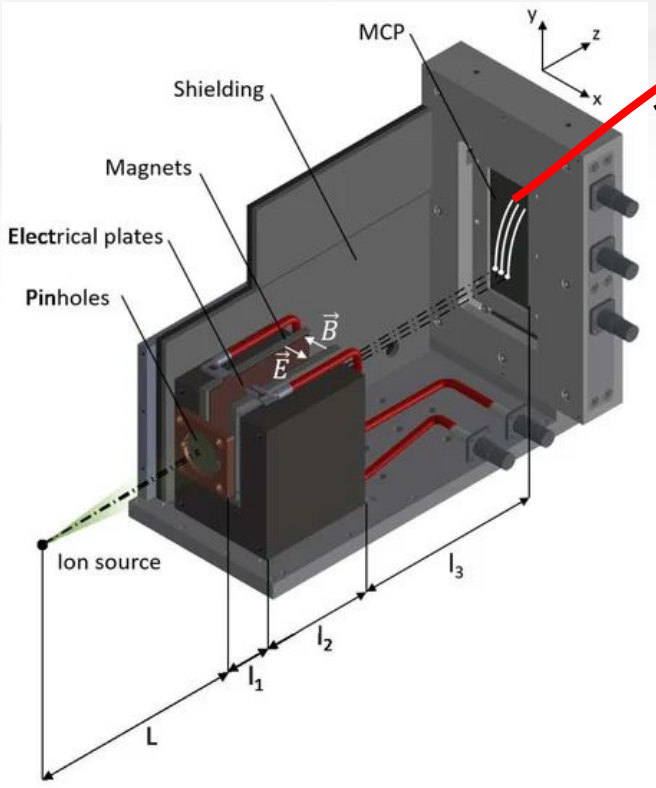






Set-up, maintenance, measurement and analysis service at CSU, Colorado

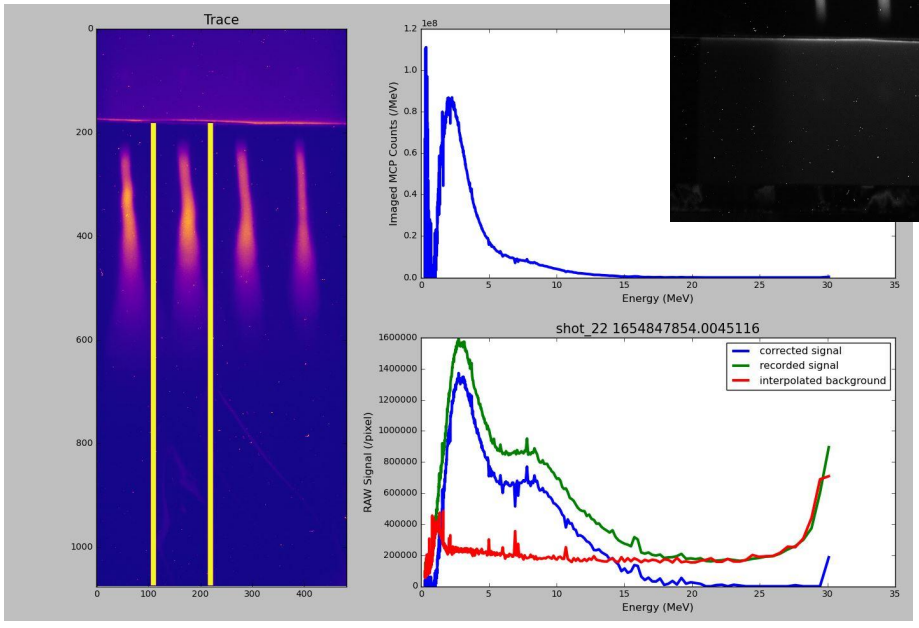
HRR Thomson Parabola

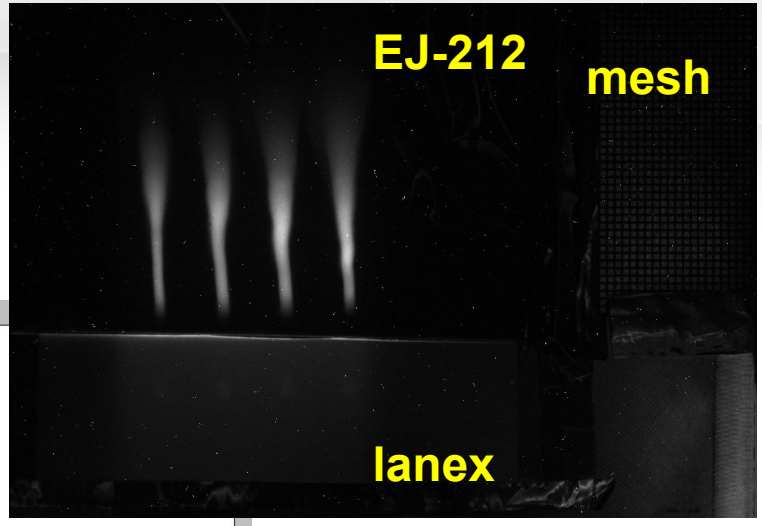


Imaging outside chamber: Nikkor + CMOS

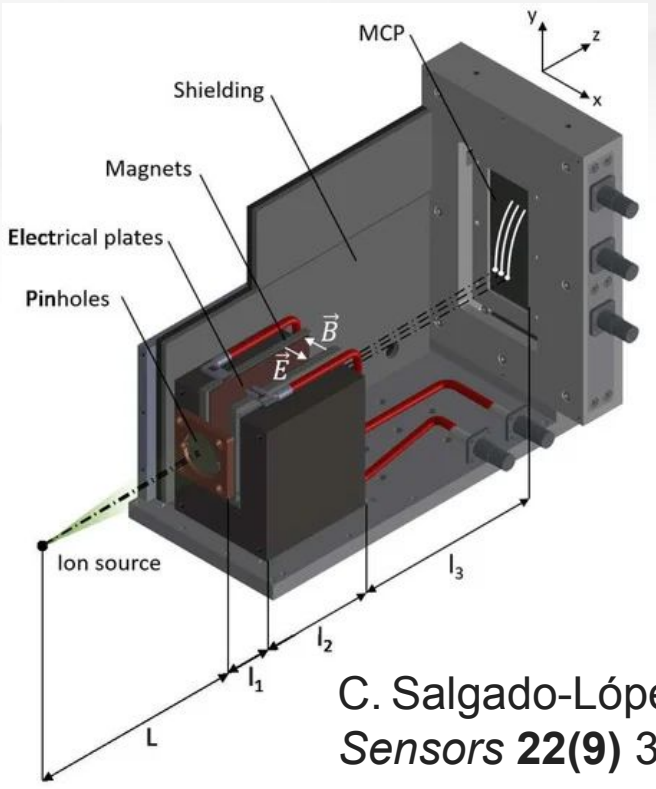
light-tight channel

spectrum

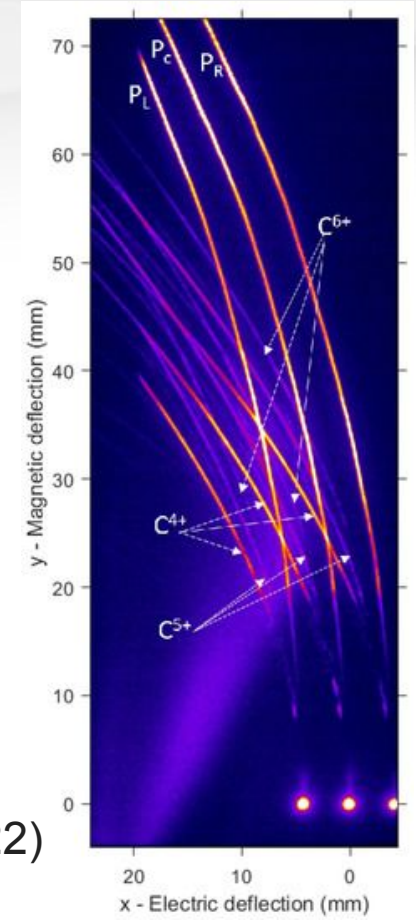


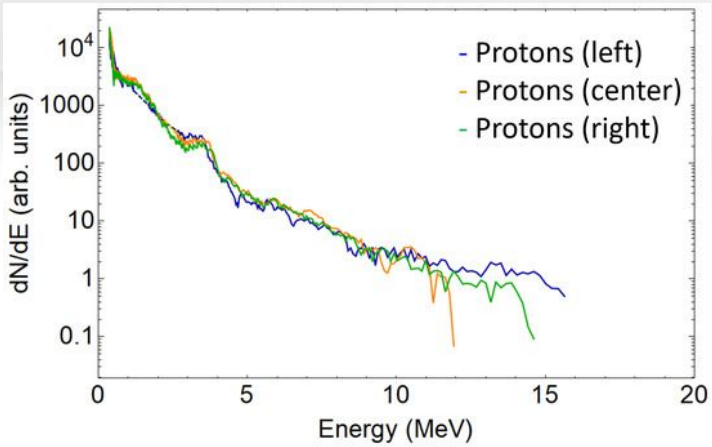


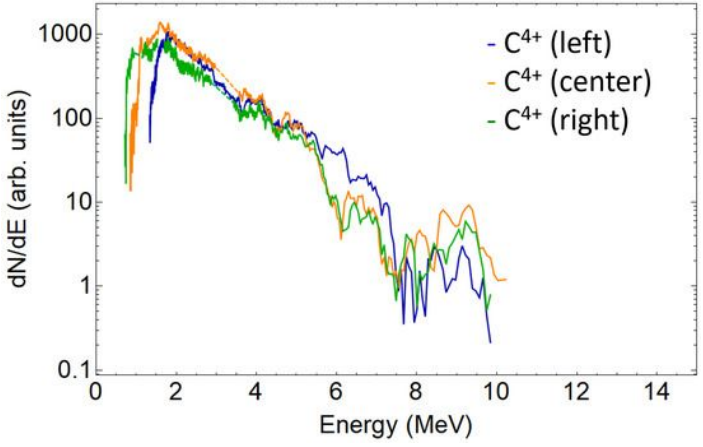
Multi-pinhole Thomson Parabola



C. Salgado-López et al.,
Sensors **22(9)** 3239 (2022)



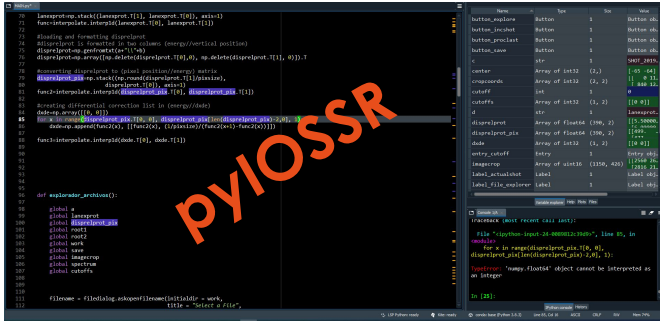


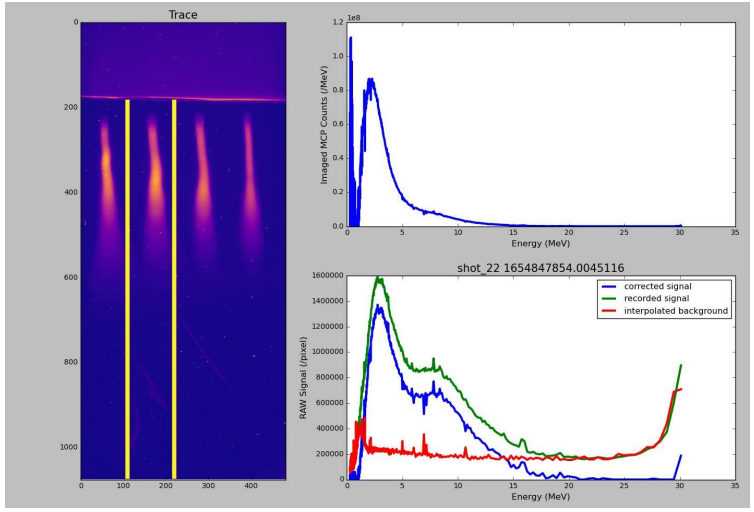


Automatized Spectrum Analysis: Software

From manual operation to High Repetition Rate!

- diagnostic front ends with online interfaced user control for first-view live analysis
- future work on enhanced methods for fast data processing
  - ⏩ eventually towards machine learning
- **developed routine pyIOSSR**
  - ⏭ ESPEC
  - ⏭ Thomson Parabola





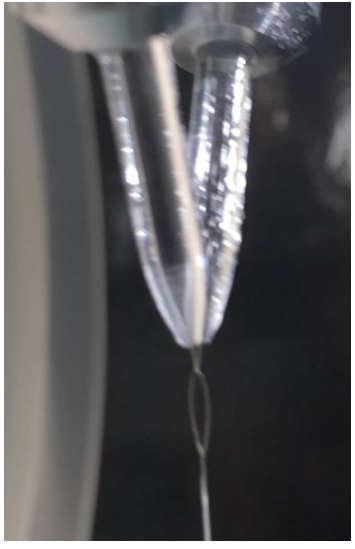
GIT version control, python, TKinter GUI, Browser-interface, Anaconda

Joint Approach to Critical Challenges

R&D of HRR Targetry!

- in parallel with user access, if possible collaborative
  ⏩ eventually towards own target fab
- **ongoing activity:**

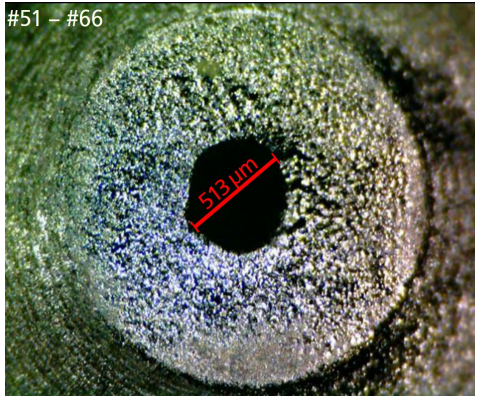
⏭ liquid jets



P. Puyuelo-Valdes et al., submitted to Plasma Physics and Controlled Fusion (2021)

⏭ gas jets

M. Ehret et al., in preparation arXiv:2012.09455



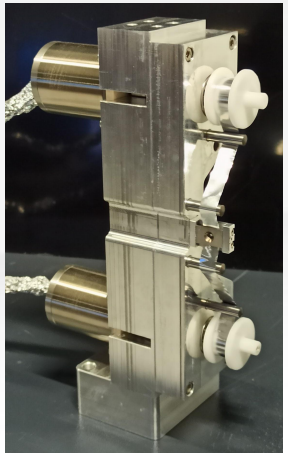
⏭ solid targets

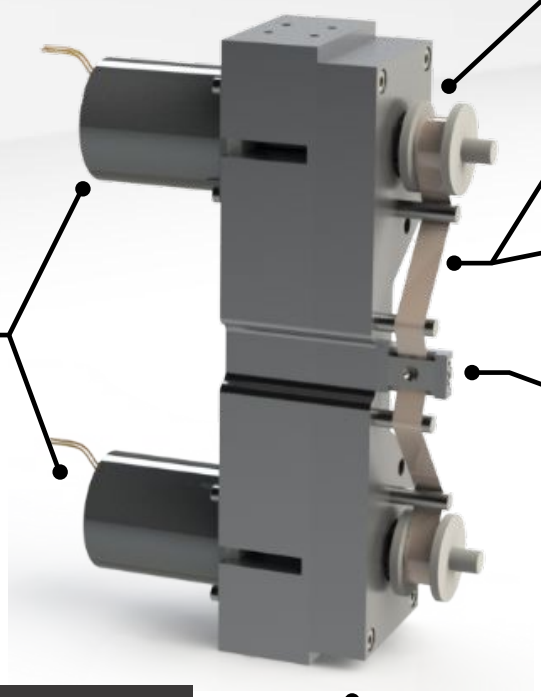
successful experiment with 256 shots for a Stopping Power campaign

EMP Studies

★ **K. Nelissen et al., Scientific Reports 10, 3108 (2020)**

HRR Targetry: CLPU Tape Target System TaTaS-1

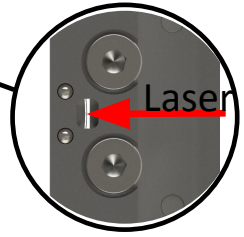




+ 1000 shots per cassette
Quick interchangeable cassettes

Stable interaction area
Constant tension

Broad range of materials
and thickness



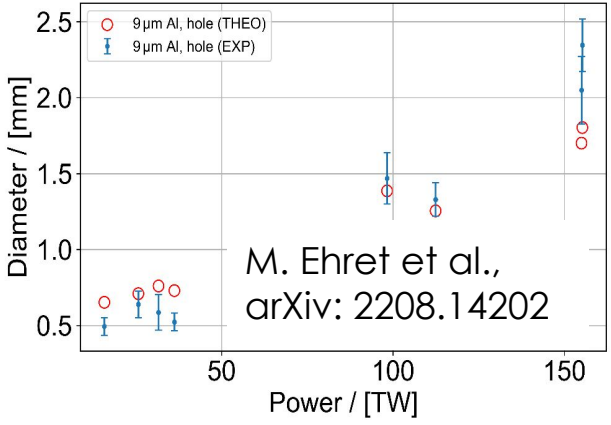
Access to laser interaction
Through aperture hole

Attachment of secondary geometries to aperture

Synchronous movement
Single shot up to 10Hz

EMP protection
Through target isolation

Model of ablation holes to design suitable apertures



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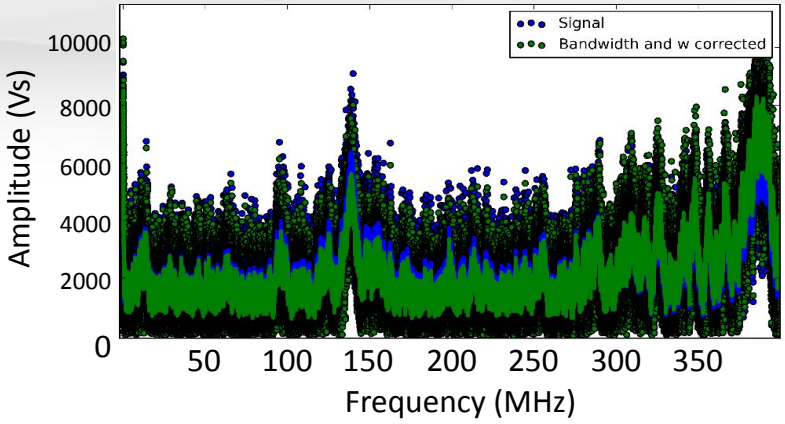
Measurement of Electromagnetic Pulses

Cavity Modes 9 kHz — 400 MHz

- ★ in any laser laser-target interaction that yields charging effects (gas targets / solid targets)
- ★ **geometry determines strongly the excited modes**
- ★ 10s to 100s of µT B-field amplitude

M. Ehret et al., *arXiv:2207.06082* (2022)

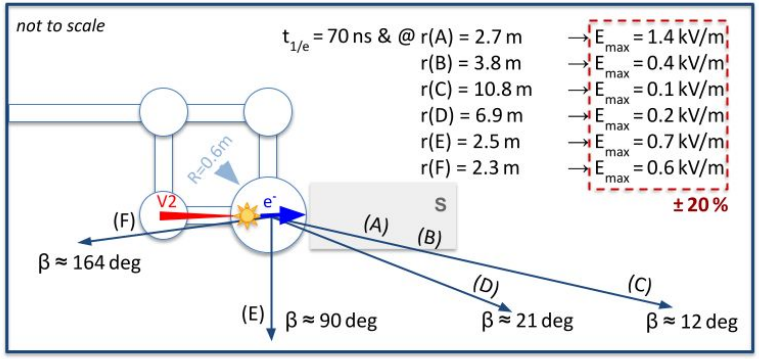


Radiation Field 300 MHz — 2 GHz

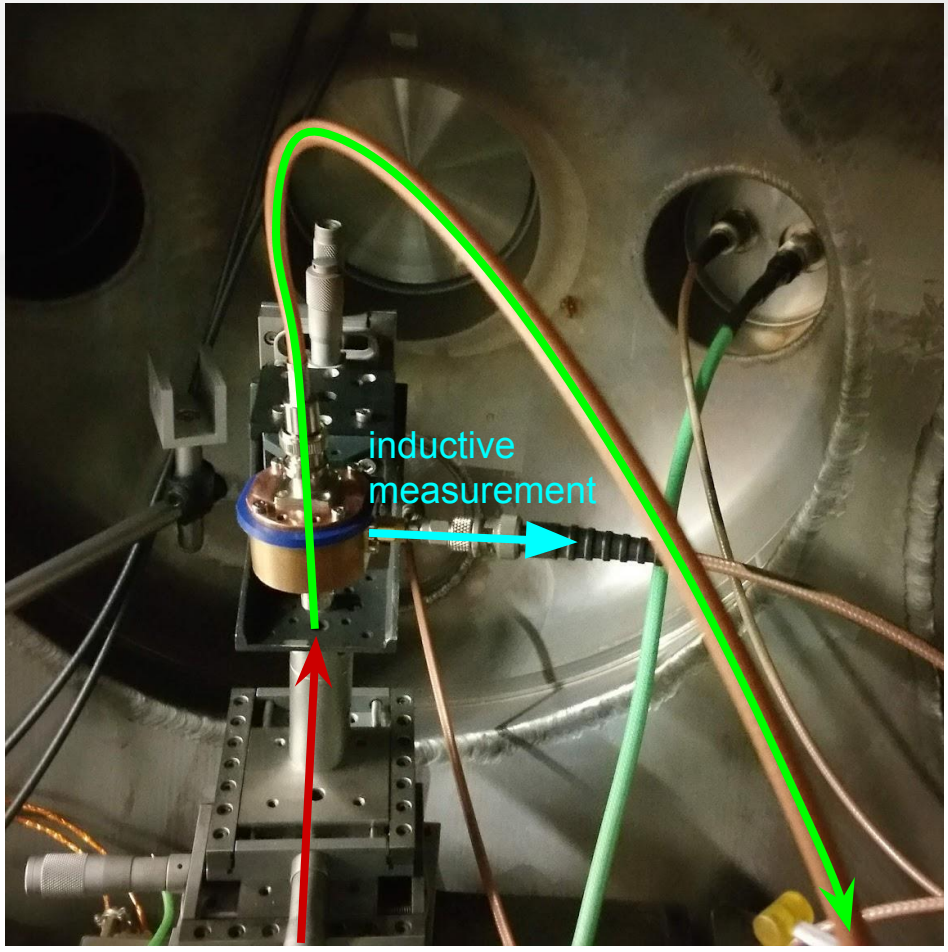
- ★ interaction chamber is imperfect Faraday Cage
- ★ **indication for dipole-like fields in experimental hall**
- ★ 100s of V/m E-field amplitude

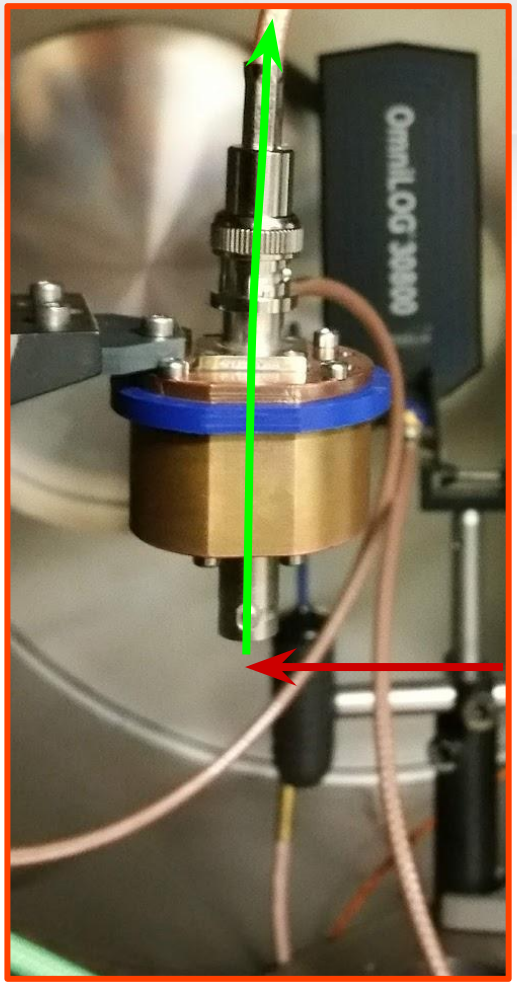
M. Ehret et al., *in preparation* (2022)

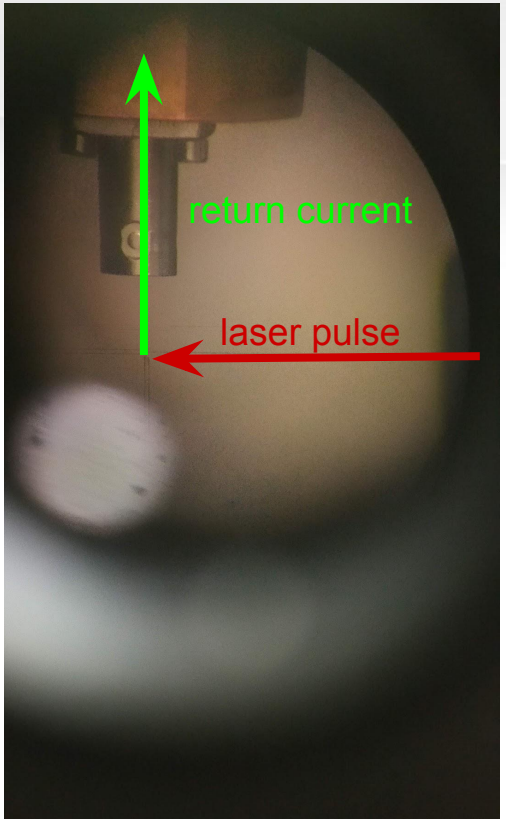
EMP in the Experimental Hall (E-Field Antenna)



Direct Measurement of Return Currents







J. Cikhardt et al.,
in preparation (2022)

Joint Calibrations with Secondary Sources at CLPU?

Laser source	Central wavelength	Minimum duration	Maximum energy on target	Focusing optics	Contrast ratio	Repetition rate
VEGA 1	800 nm	30 fs	600 mJ			10 Hz
VEGA 2	800 nm	30 fs	6 J	F/4	8e-9 @ -10ps 1e-5 @ -1ps	10 Hz
VEGA 3	800 nm	30 fs	30 J	F/10.5	8e-9 @ -10ps 2e-5 @ -1ps	1 Hz

Ion source	Max. energy	Spectrum C.	Beam charge	Opening angle
TNSA protons (solids)	10 MeV - 20MeV	broad	16 pC	20 - 25 deg
TNSA protons (liquids)	< 10MeV	broad		

Electron source	Max. energy	Spectral shape	Beam charge	Opening angle
Wakefield electrons	500 MeV	2 temperature	pC/MeV	mrad

Key events at CLPU

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VEGA

TROC workshop: Technology & Research Opportunities @ CLPU

Salamanca – 17-19 April 2023

Network on Extreme Intensity Laser – NEILS @ LASERLAB

Salamanca – 20-21 April 2023

Laserlab Europe

by CLPU LaPlaSS Laser Plasma Summer

Laser Plasma Summer School - LaPlaSS

Salamanca –11-15 September 2023

50th EPS Plasma Physics Conference

Salamanca- June/July 2024

EPS Plasma Physics Conferences

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IMPULSE

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

UKRI Science and Technology Facilities Council

IST TÉCNICO LISBOA

QUEEN'S UNIVERSITY BELFAST

TECHNISCHE UNIVERSITÄT DARMSTADT

HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

CNR IFN Istituto di Fotonica e Nanotecnologie

FORTH FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS

CLPU CENTRO DE LÁSERES PULSADOS

INFN LNS Istituto Nazionale di Fisica Nucleare Laboratori Nazionali del Sud

Elettra Sincrotrone Trieste

eli

eli attosecond

eli nuclear physics

FZU Institute of Physics of the Czech Academy of Sciences

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