

# Opportunities for users & collaborators @ ELI facilities

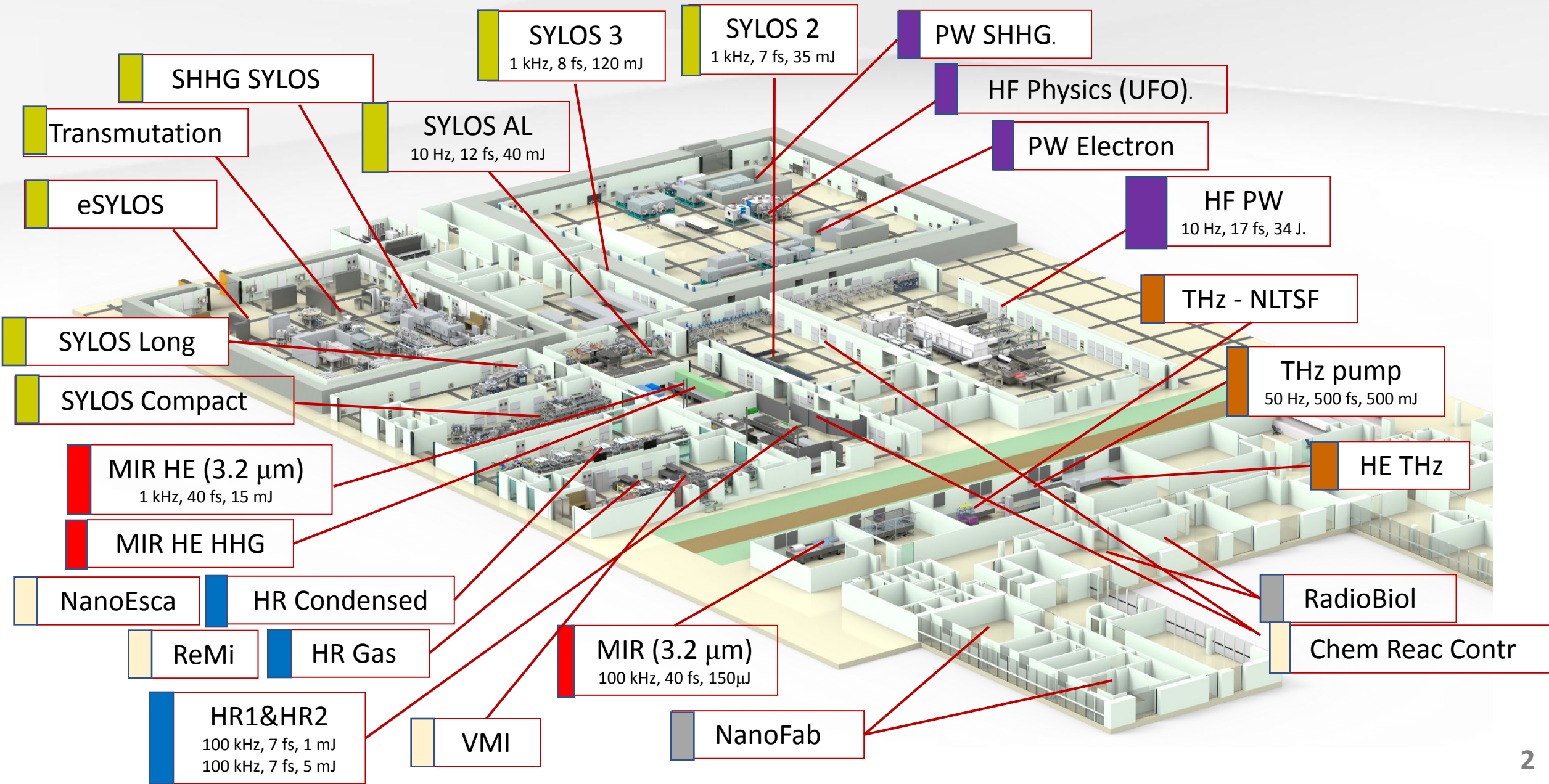
**Dimitris Charalambidis**  
Chief Scientific Advisor, ELI ALPS

**ELI ERIC Iberian Information Day**  
**Madrid, 1 June 2022**



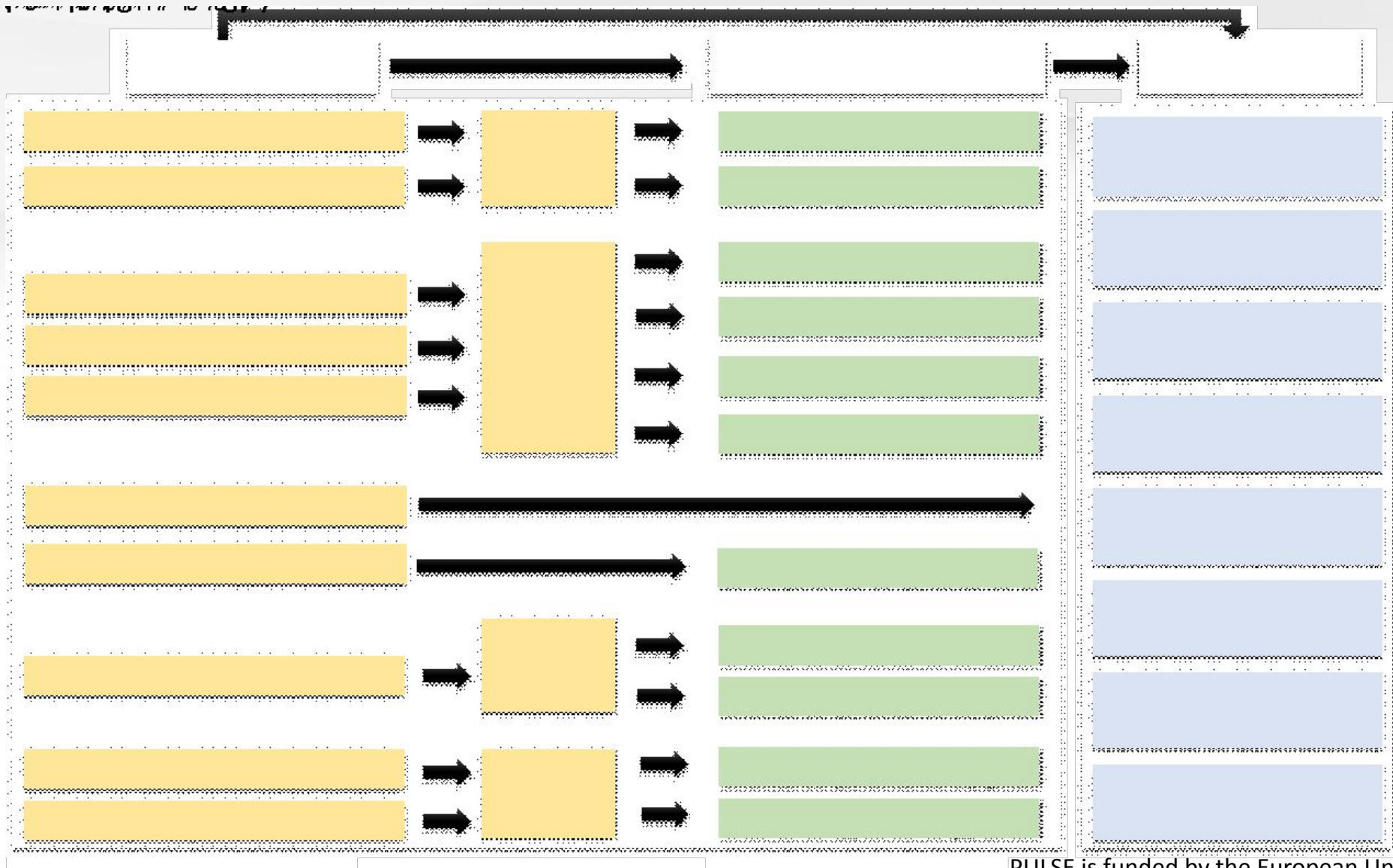
IMPULSE is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871161

# Facility overview





# Research potential offered @ ELI ALPS



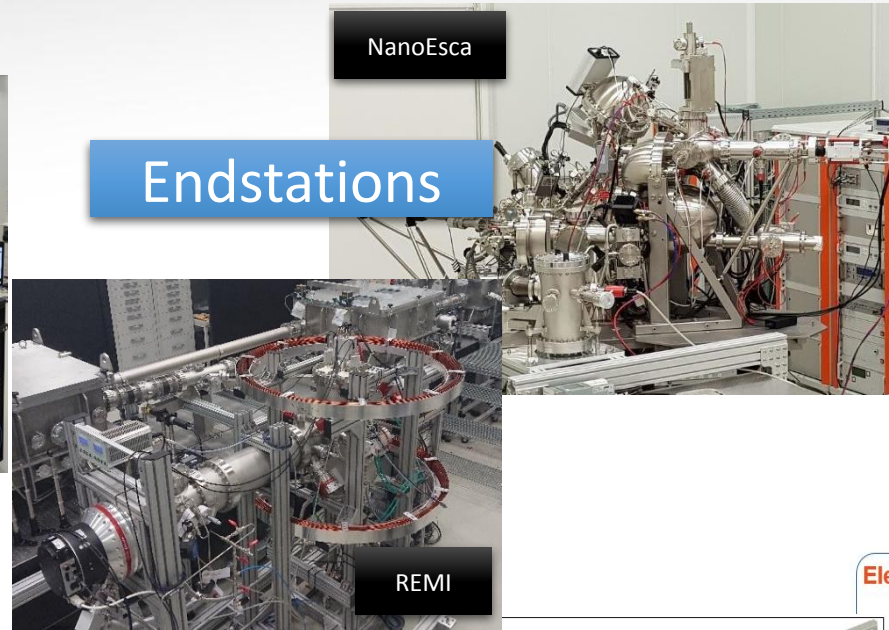
...PULSE is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871161

# Portfolio of research opportunities Capacity, Capability and Uniqueness

## Lasers



## Endstations



## Simulation tools

Simulation tools in intense laser matter interaction

$10^{12-16}$   $10^{16-17}$   $10^{17-23}$

### Hydrodynamic codes

ESTHER  
MULTI-fs  
CHIC  
CRASH

Ionisation, Pre-Plasma  
formation, Plasma fluid  
expansion

### Particle In Cell (PIC)

WARPX  
OSIRIS  
EPOCH  
LPIC  
PConGPU

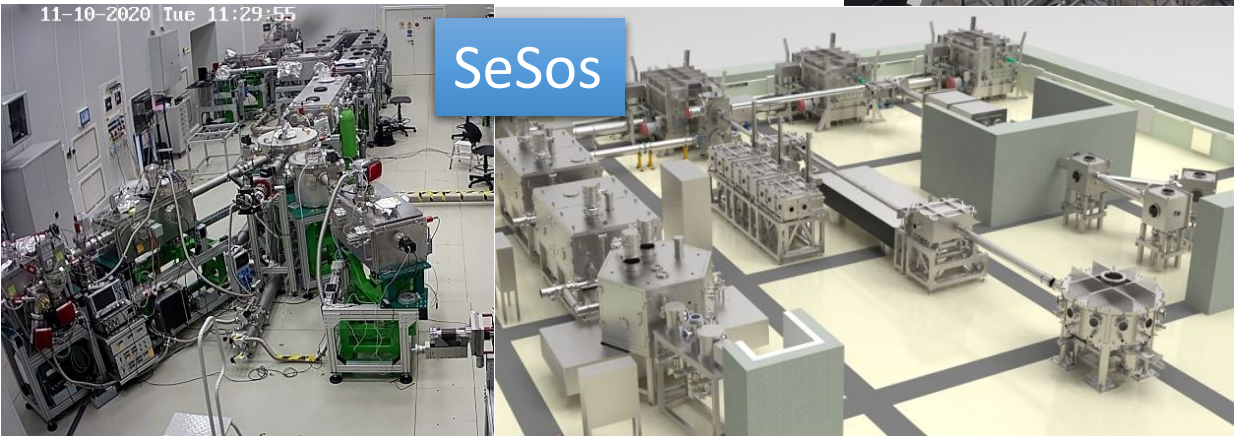
Charge dynamics (particle acceleration),  
Plasma field dynamics (absorption, HHG)

### Simplified PIC

WAKE  
CALDER-CIRC

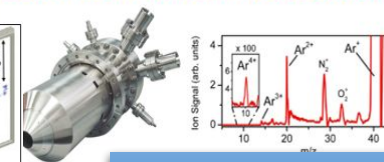
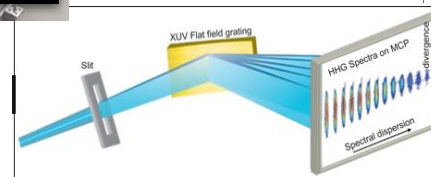
Featured in p19-20 [https://hpc.kifu.hu/sites/default/files/2021-06/HPC\\_Echo\\_2021.pdf](https://hpc.kifu.hu/sites/default/files/2021-06/HPC_Echo_2021.pdf)

## SeSos

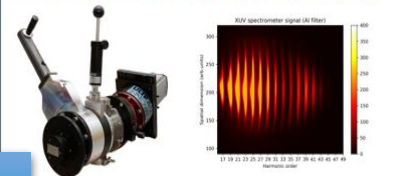


## Metrology

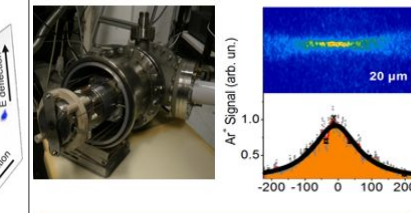
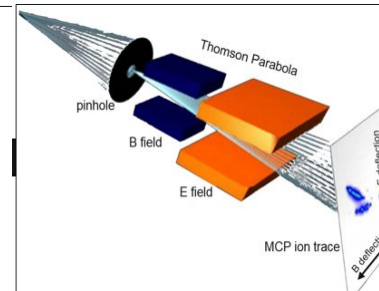
### Electron/Ion TOF (5x + high resolution)



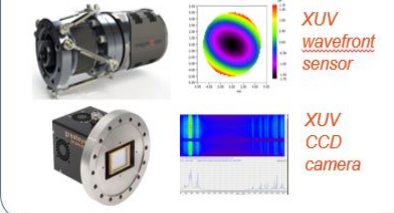
### XUV/VUV Photon spectrometer (5x)



### Ion Microscope (2x)



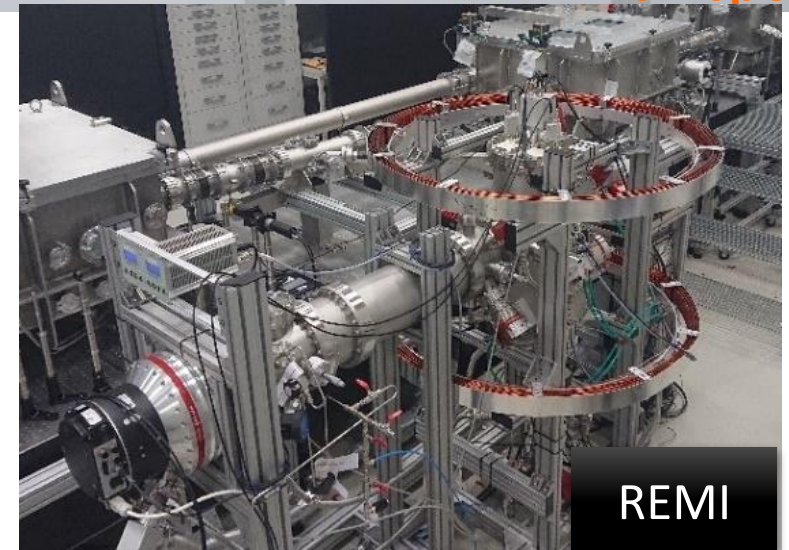
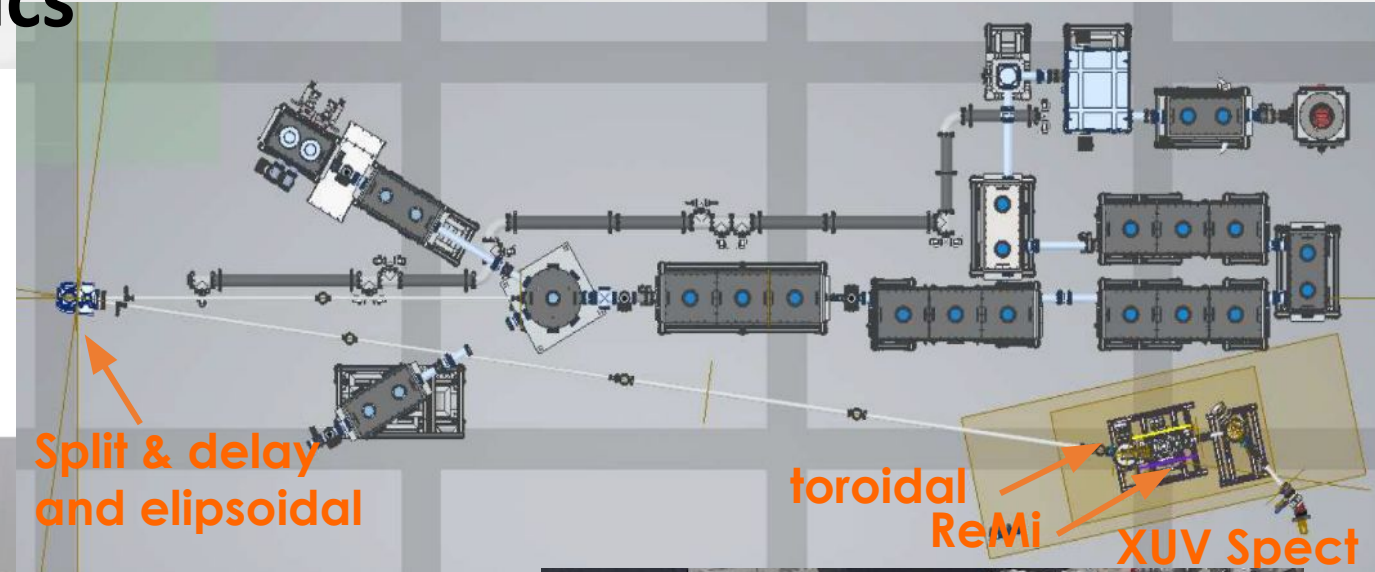
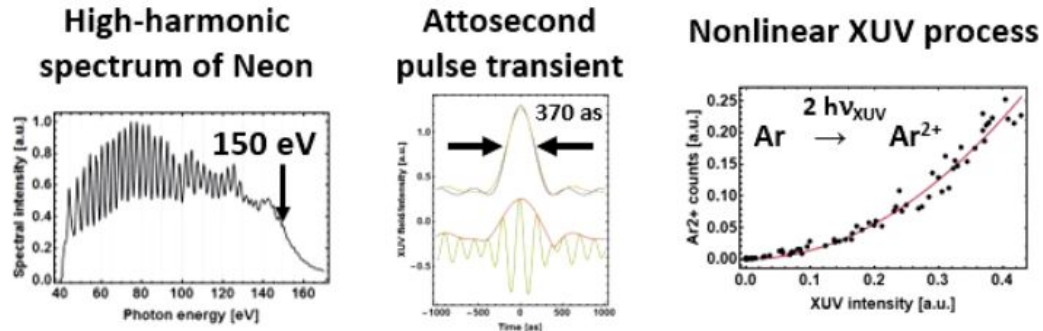
### Beam diagnostics





# Examples of research opportunities

## 1kHz atto + ReMi. Kinematically complete experiments of ultrafast dynamics

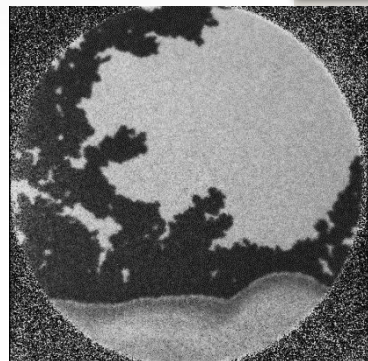




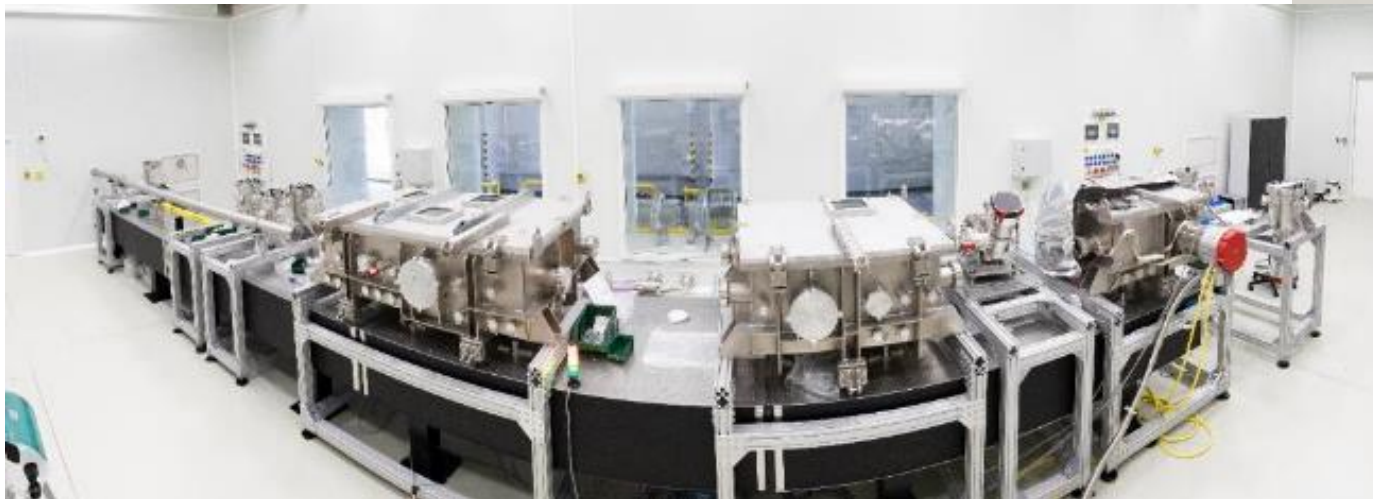
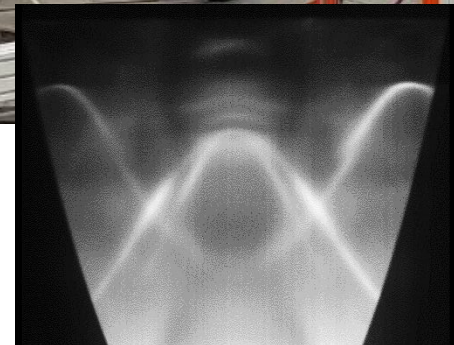
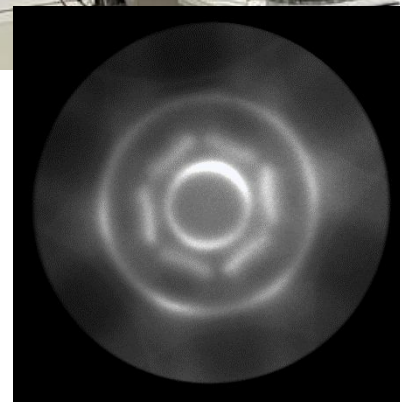
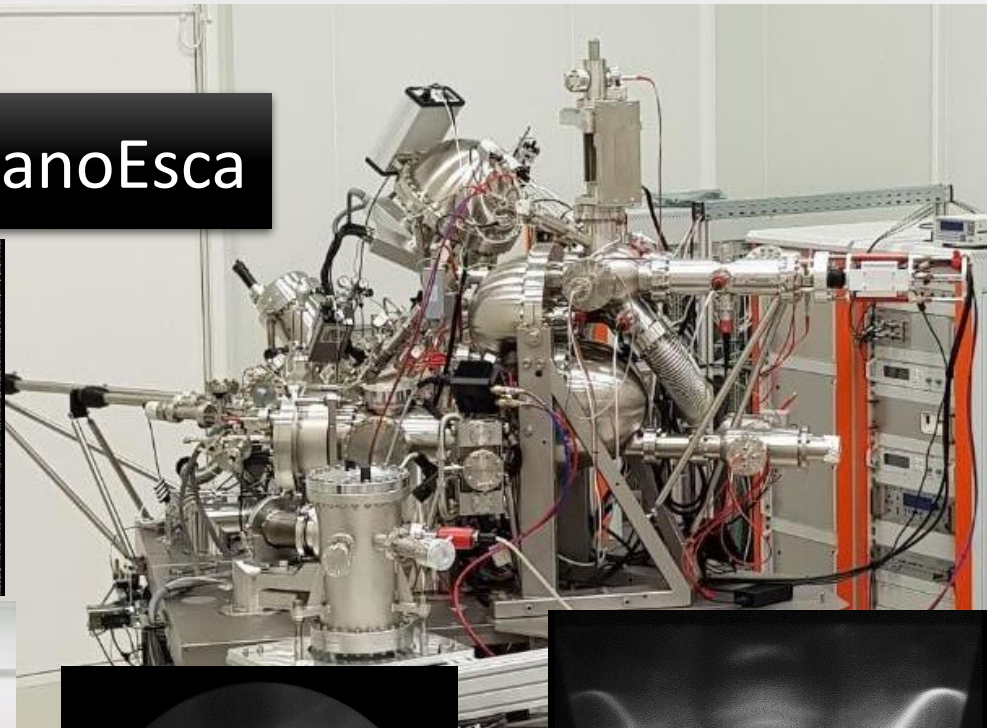
# Examples of research opportunities:

**100kHz atto + NanoEsca**  
**Band structure dynamics during**  
**phase transitions.**

**Energy & spin resolved real &**  
**k-space measurements**



NanoEsca



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# Mid IR: Coupling strong field physics with quantum optics

1<sup>st</sup> User paper from ELI-ALPS

PHYSICAL REVIEW LETTERS **122**, 193602 (2019)

## Quantum Optical Signatures in a Strong Laser Pulse after Interaction with Semiconductors

N. Tsatrafyllis,<sup>1</sup> S. Kühn,<sup>2</sup> M. Dumergue,<sup>2</sup> P. Foldi,<sup>2,3</sup> S. Kahaly,<sup>2</sup> E. Cormier,<sup>2,4</sup> I. A. Gonoskov,<sup>5</sup>  
B. Kiss,<sup>2</sup> K. Varju,<sup>2,6</sup> S. Varro,<sup>2,7</sup> and P. Tzallas<sup>1,2,\*</sup>

<sup>1</sup>Foundation for Research and Technology-Hellas, Institute of Electronic Structure and Laser,  
PO Box 1527, GR-71110 Heraklion, Greece

<sup>2</sup>ELI-ALPS, ELI-Hu Non-Profit Ltd., Dugonics tér 13, H-6720 Szeged, Hungary

<sup>3</sup>Department of Theoretical Physics, University of Szeged, Dom ter 9, 6720 Szeged, Hungary

<sup>4</sup>Univ Bordeaux, CNRS, CELIA, CEA, F-33405 Talence, France

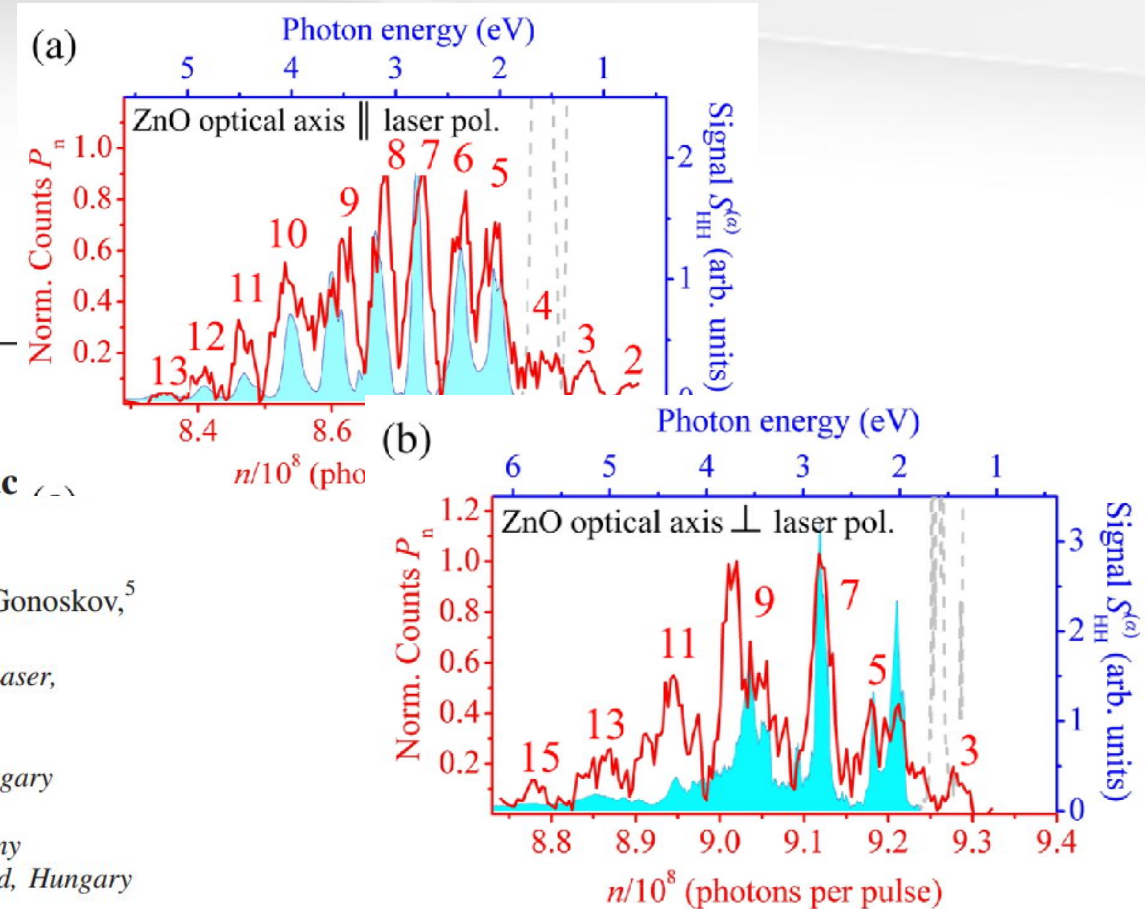
<sup>5</sup>Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle, Germany

<sup>6</sup>Department of Optics and Quantum Electronics, University of Szeged, Dom ter 9, 6720 Szeged, Hungary

<sup>7</sup>Wigner Research Center for Physics, 1121 Budapest, Hungary



(Received 28 September 2018; published 14 May 2019)



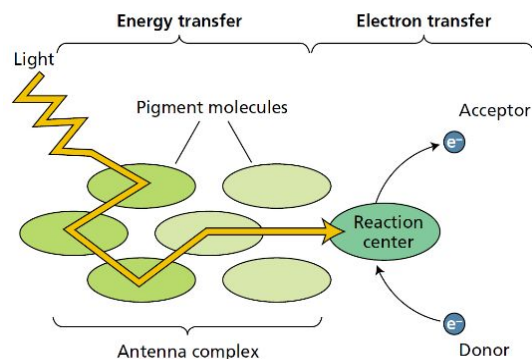
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## Tackling biological challenges using THz radiation

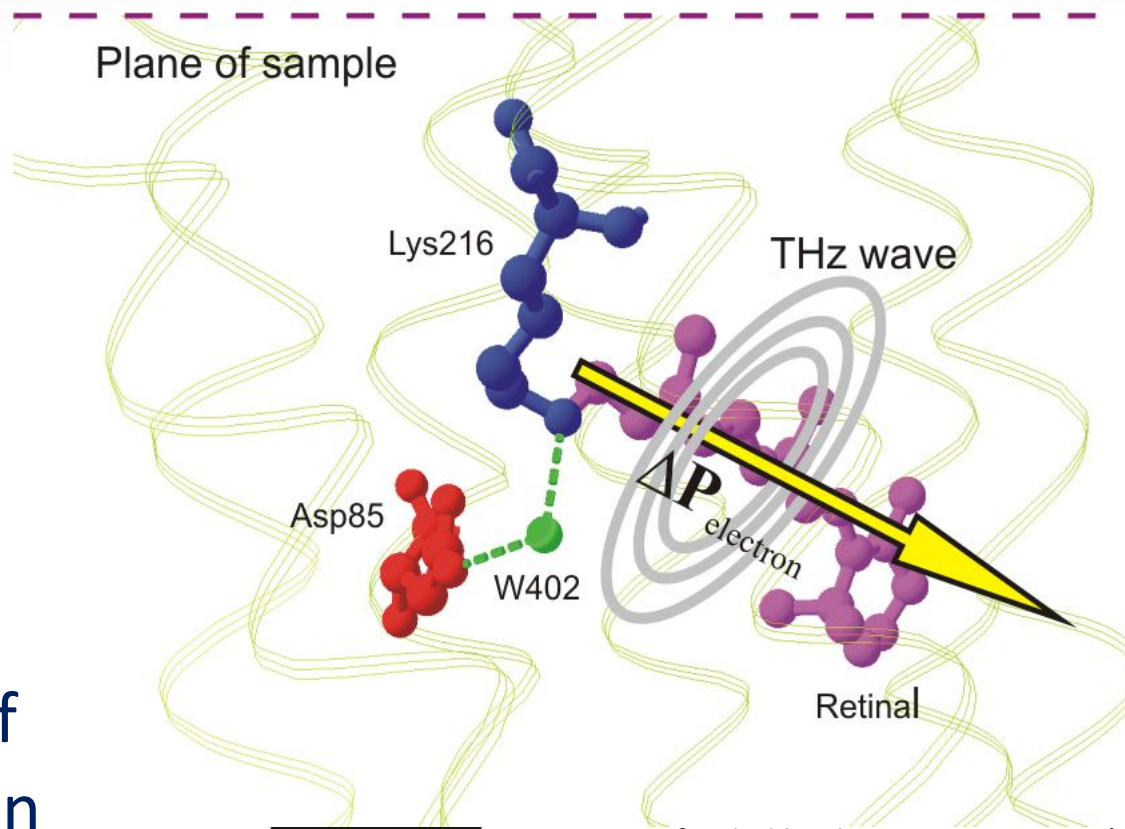
BRC-Szeged research plans @ ELI-ALPS

### Photosynthetic Light Reactions



□ Direct observation & control of charge separation by EM radiation

Ultrafast charge separation generates EM radiation



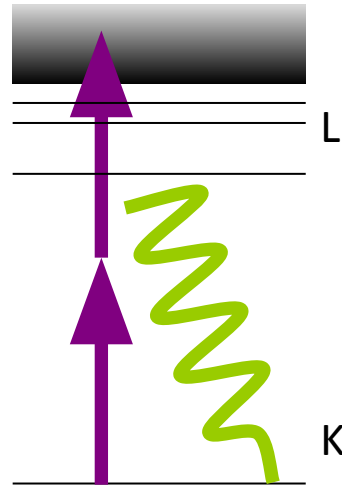
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# Examples of research opportunities

PW SHHG: intense x-ray attosecond pulses

Inaugurating the era of MP inner-shell processes or just a dream?



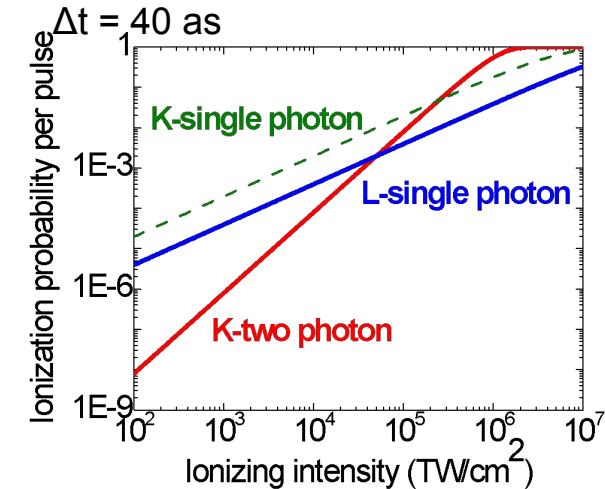
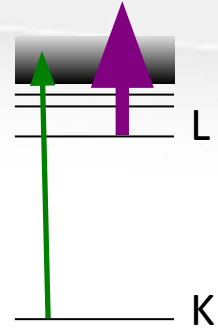
2-photon ionization of inner-shells in solid targets  
 → high atomic density → higher signal  
 Spatial selectivity

□  $\omega = 110\text{eV}$  (e.g.  $\text{Be}^{3+}$ )

$$\sigma_K^{(2)} = 5 \cdot 10^{-54} \text{ cm}^4 \cdot \text{s}$$

$$\sigma_L^{(1)} \sim 10 \text{ kb} (10^{-20} \text{ cm}^2)$$

$$\sigma_K^{(1)} \sim 10^{-19} \text{ cm}^2 (220\text{eV})$$



@  $\sim 5 \cdot 10^{16} \text{ W/cm}^2$  the TPI becomes the dominant ionization process!!



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# Opportunities in education

- Several PhD students participate user campaigns at ELI-ALPS receiving training and producing outstanding results for their dissertation
- Several post-doctoral fellows participate in user campaigns at ELI-ALPS receiving training and producing high quality publications
- ELI is organizing an annual Summer School (ELISS)

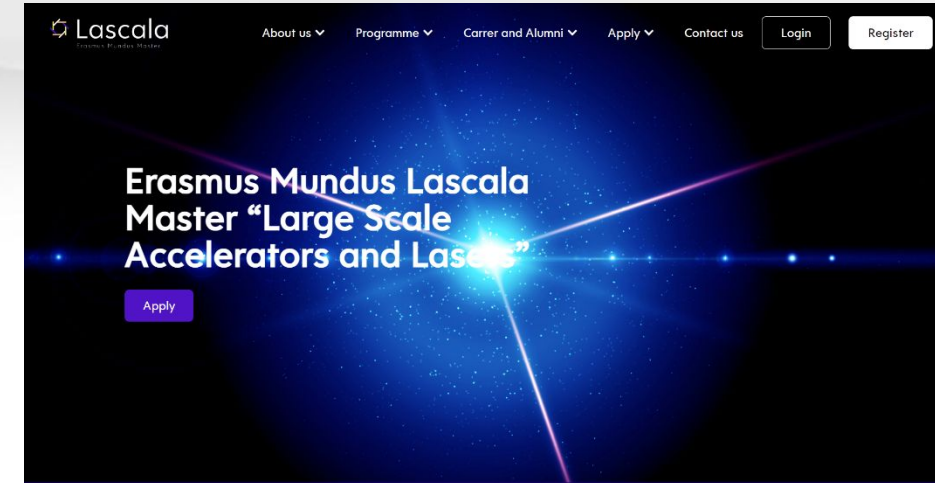


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# Opportunities in education

□ ELI-ALPS is offering courses in the LASCALA masters program of ERASMUS MUNDUS. LASCALA aims at training experts in the most advanced experimental and theoretical tools and concepts of high power lasers and associated advanced sources, as well as in their applications for science and society.



□ ELI-ALPS is offering 2-6 months internships for training in specific laser related research and technology topics and participation in exciting projects

## STUDENT PROGRAM @ ELI ALPS

Internship / MSc projects offered

**What we offer?**

- Unique opportunity to turn theory into practice within an international research institution in the field of laser technology
- Specific topic scope - possibility to work on existing projects within a team
- Dedicated mentor
- Completion certificate
- Chance to meet fellow students and make new friends
- Participation in ELI Summer School
- Weekly meal cover accommodation and/or travel and entertainment expenses
- Duration of internship: from 2 to 6 months, based on agreement
- Don't hes! apply!

We provide unique opportunities to work within an international research environment on a state of the art topic with dedicated mentors. We expect potential to be part of a publication at the end of the internship.

Applications containing your Resumé/CV and the topic you are applying for with a short motivation letter should be sent to the HR and communication department.



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## Opportunities for the industry

- Exploit the large variety of the laser systems of ELI in evaluating which system/parameters would better serve their needs
- Testing new methods and/or materials candidates for being adopted in a production line
- Use of the analytical facilities offered
- In the area of ELI-ALPS a science park is planned to be built, companies of which will have immediate access to the facilities of the RI
- Museums and galleries can exploit laser based analytical and treatment techniques in the sector of cultural heritage



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## Instead of an epilogue

- be creative
- work out new ideas
- turn them to reality at ELI
- and return successful and happy to the Iberian Peninsula

We, ELI, will provide the means and host you with pleasure



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# Thank you !



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