

# ELI Beamlines

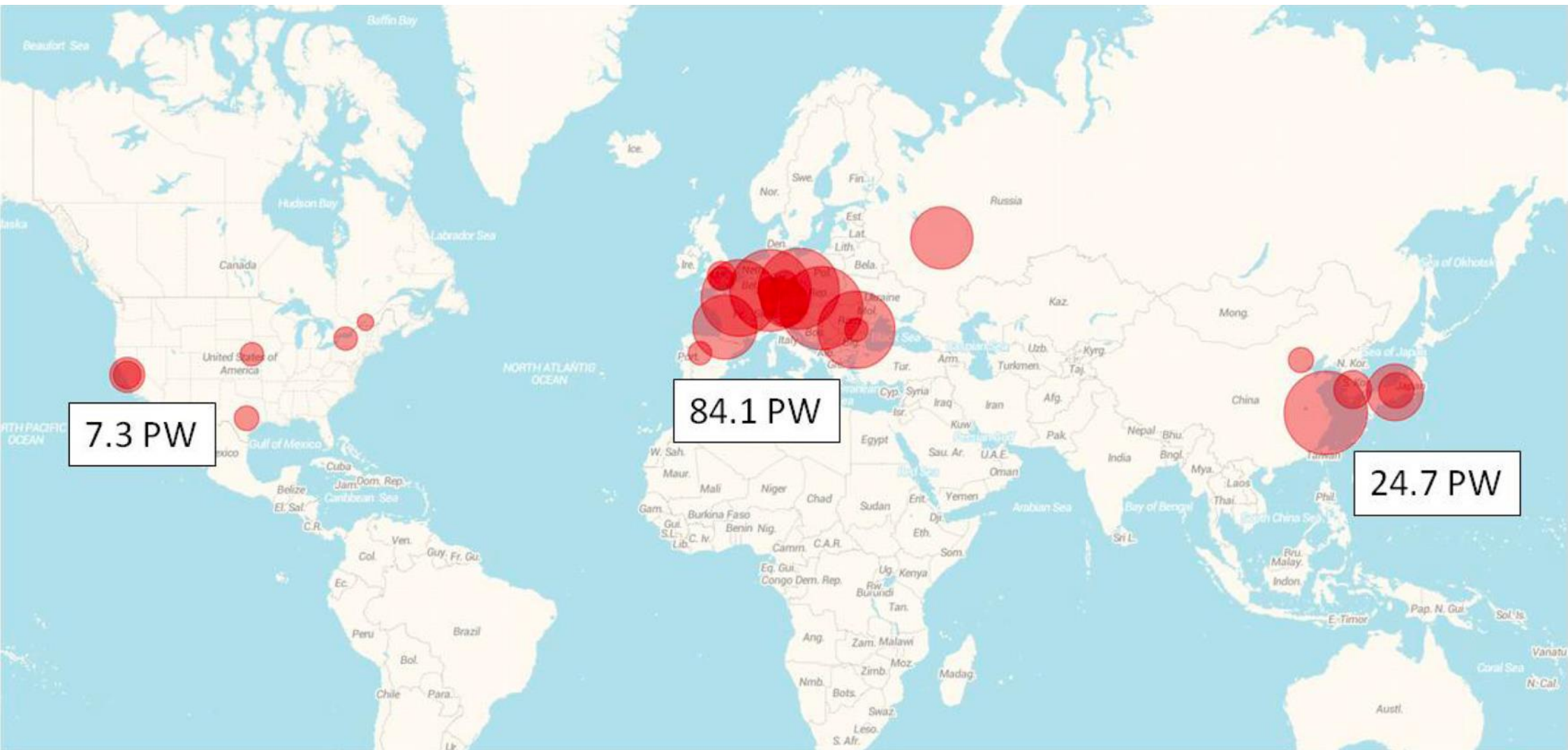
High-Energy Beam Pillar of the pan-European Research Infrastructure ELI

## Projects and challenges to the technology transfer & industry partnership





- Part of the Czech Academy of Sciences
- FZU is the largest one of 53 institutes of the CAS – over 1300 employees
- More than 60 years of history
- World-leading and internationally excellent scientific results



SOURCE: Courtesy of J.L. Collier

# ELI facilities: unique research opportunities

**Attosecond Laser Science**, which will capitalize on new regimes of time resolution (**ELI-ALPS, Szeged, HU**)

**High-Energy Beam Facility**, responsible for development and application of ultra-short pulses of high-energy particles and radiation stemming from relativistic and later ultrarelativistic interaction (**ELI-Beamlines, Prague, CZ**)

**Nuclear Physics Facility** with ultra-intense lasers and brilliant gamma beams (up to 19 MeV) enabling also brilliant neutron beam generation with a largely controlled variety of energies (**ELI-NP, Magurele, RO**)

**Ultra-High-Field Science** centred on direct physics of the unprecedented laser field strength (**ELI 4, to be decided**)



# *ELI-ALPS*

## *Szeged, Hungary*

### *May 2017*



- *5 Laser Sources: 2 PW, 5mJ 100kHz, 100mJ 1kHz, MIR 3.1 $\mu$ m100kHz, THz 5J*
- *10 Secondary Sources: GHHG HR, MIR, THz, SHHG, e, ion accelerator*
- *8 experimental stations: Atto, CMF, nano mat., Plasma Phys, Radiobio, HRI, THz SCR*
- *24, 500 m<sup>2</sup>*

# *ELI-Beamlines*

## *Dolní Břežany, Czech Republic*

### *December 2015*



- *5 Laser Sources: 10 PW, 1 PW 10Hz, 100mJ 1kHz lasers fs synchronization*
- *7 Secondary Sources: X-rays 1-150 keV, e 3 GeV, p 50-200 MeV accelerators*
- *9 experimental stations: MAC, ELIps, TREX, SRS, Plasma Physics Platform*
- *31,000 m<sup>2</sup>*

**ELI-NP**  
**Măgurele, Romania**  
**September 2016**

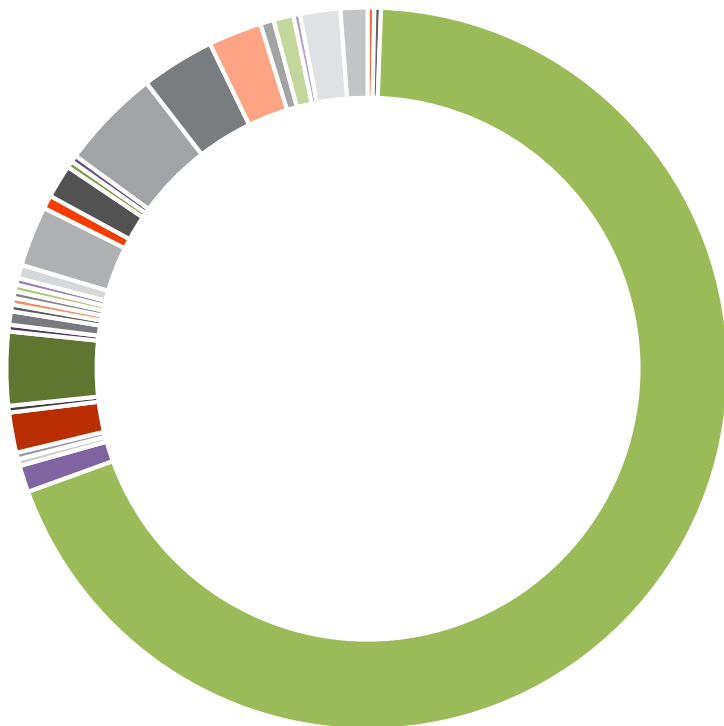


- **Laser Sources:** *2x10 PW lasers synchronizable on the fs scale*
- **Gamma Beam System:** *Tunable, narrow band, 0.2-20 MeV gamma beam*
- **8 experimental areas:** *Laser + Laser, Gamma, Laser + Gamma*
- **33,000 m<sup>2</sup> + guest house**



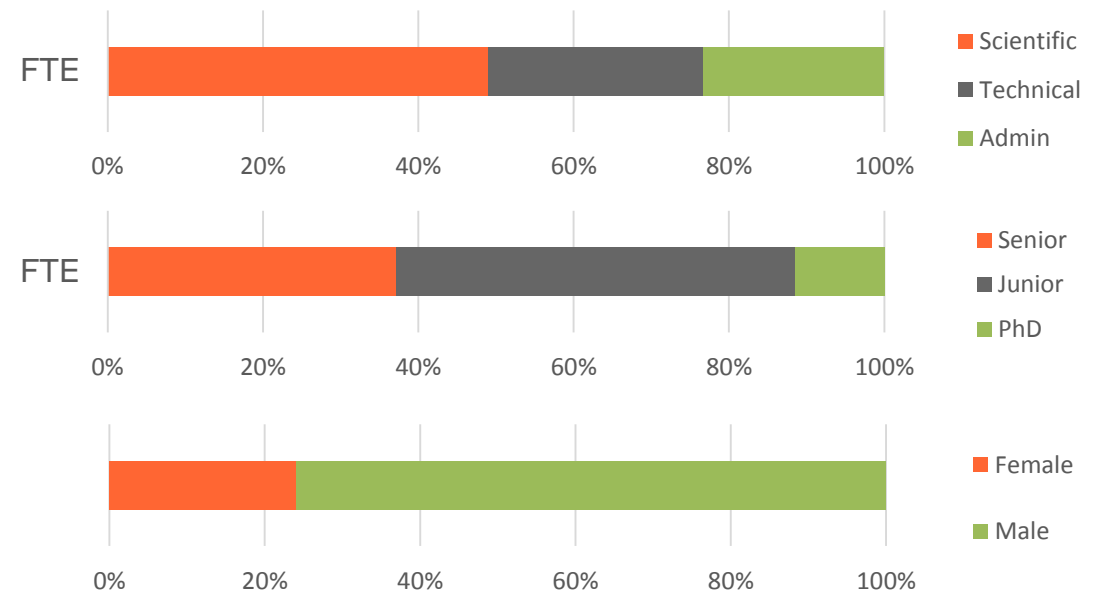
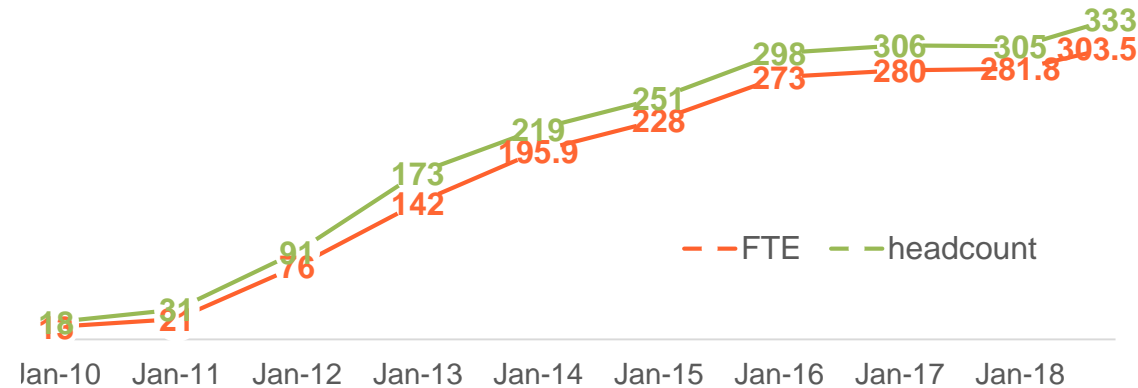


- Australia
- Bulgaria
- Czech
- China
- France
- Croatia
- India
- Ireland
- Italy
- Japan
- South Africa
- Columbia
- South Korea
- Costa Rica
- Lithuania
- Hungary
- Moldavia
- Germany
- Nepal
- Poland
- Portugal
- Austria
- Russia
- Slovakia
- USA
- Spain
- Sweden
- Turkey
- Ukraine
- UK



# Human resources

## STAFF PROFILE FTE



- ELI Beamlines, HiLASE, Institute of Physics AS CR
- Prague Innovation Center
- Central Bohemian Innovation Centre
- Institutes of Academy of Sciences, Czech Technical University, Charles University, Biocev, ...)
- Industrial partners



## Laser Building

### Support Rooms First Floor

Cryogenic systems, power supply cooling, auxiliary systems

**L1** 100 mJ / 1 kHz

**L2** 1 PW / 20 J / 10 Hz

**L3** PW / 30 J / 10 Hz

**L4** 10 PW / 1.5 kJ

### Lasers Ground Floor

**E1** Material & Bio-molecular Applications

**E2** X-ray Sources

**E3** Plasma Physics

**L4c** Compressor

**E4** ELIMAIA Ion Acceleration

### Experimental Halls Basement

**E5** Electron Acceleration & Laser Undulator X-ray Source

**E6**

## H2020 projects

- **ELI-TRANS**
- **EUCALL**
- ***IMPULSE (from Jan 2020)***

## National funded

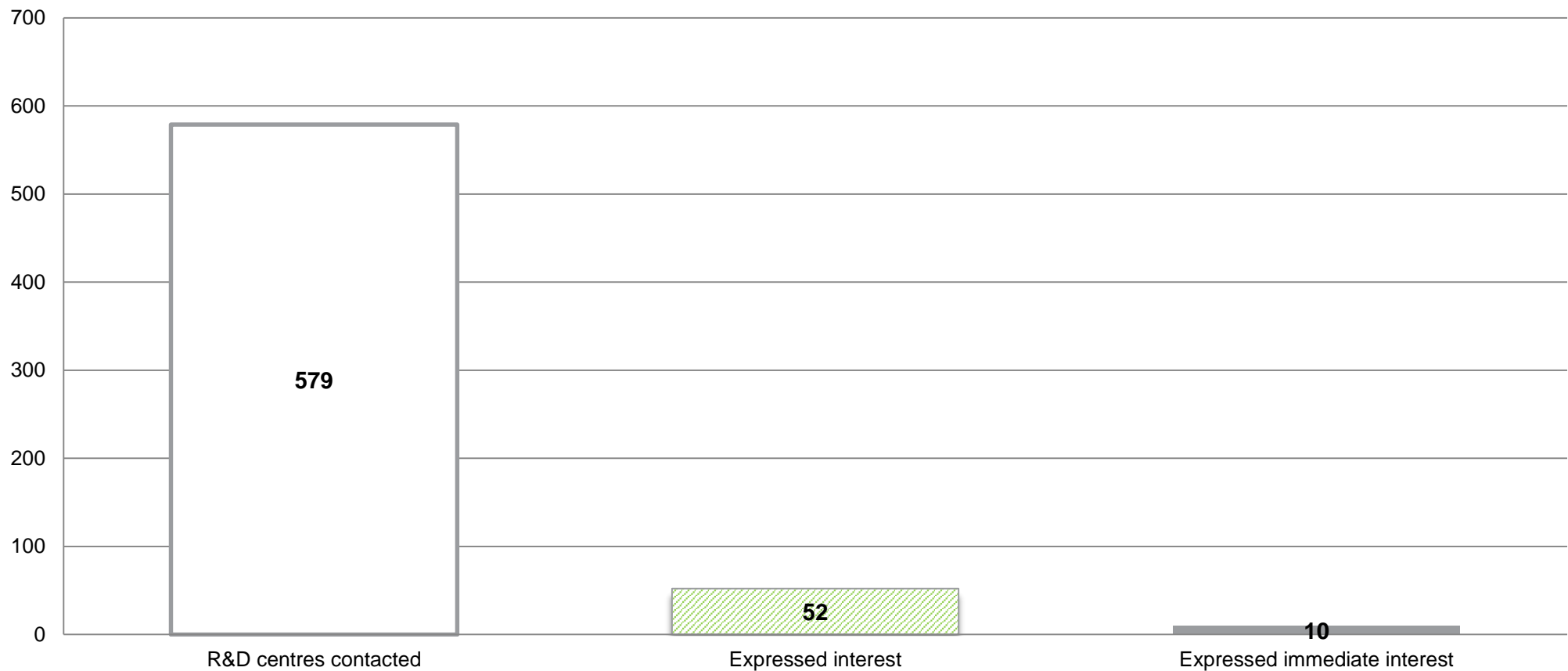
- Institute of Physics – internal Commercialisation Fund
- GAMA 1, GAMA 2 (Technology Agency of the Czech Republic)
- Prague – pole of excellence

## Knowledge and Technology Transfer for ELI-ERIC (WP 6)

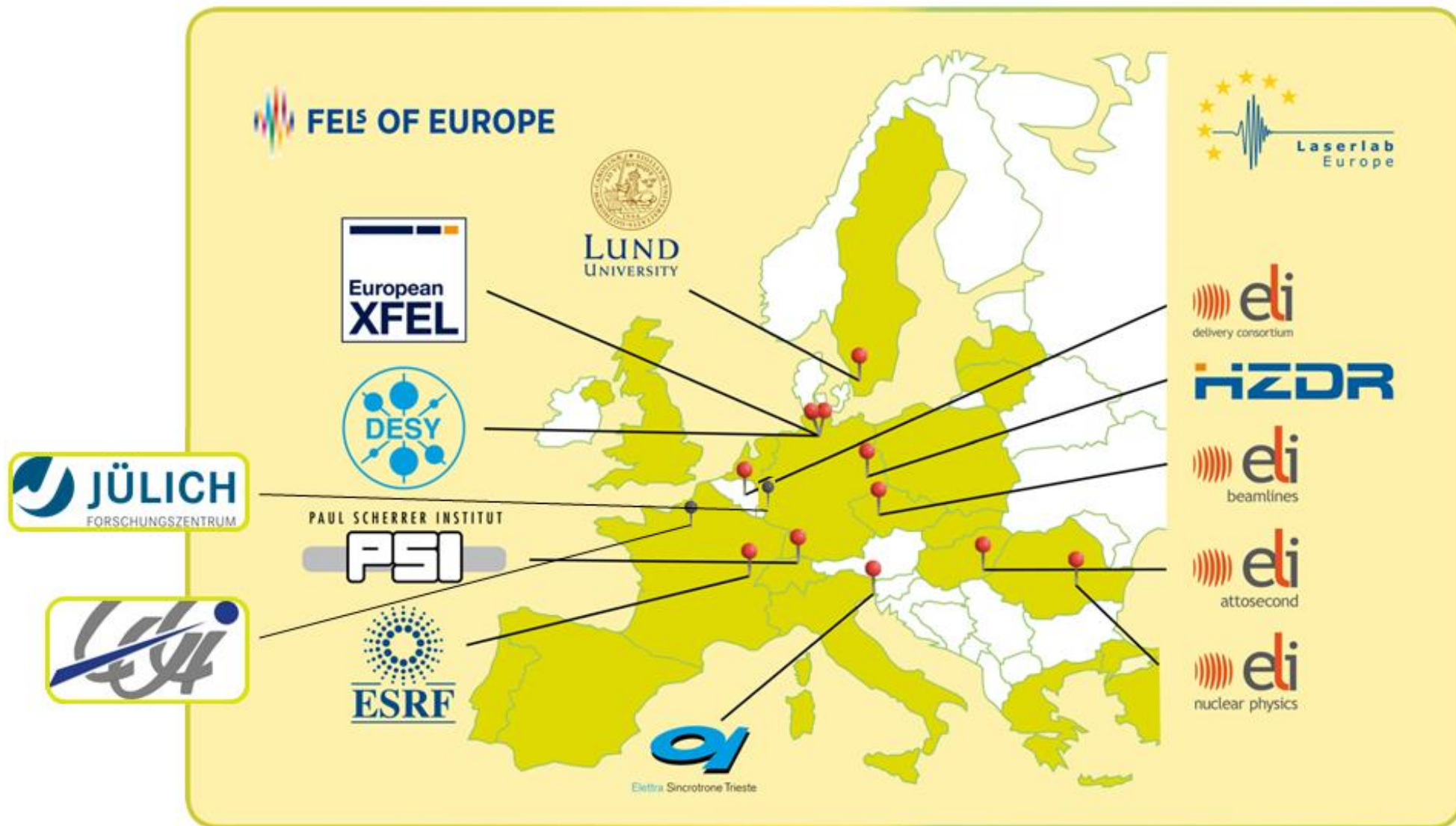
- Report current key KTT activities within ELI pillars
- Develop a collaboration plan with selected international RIs
- Develop an IP policy for ELI-ERIC
- Investigate industrial users and develop an industrial user analysis
- Develop an access and collaboration strategy of ELI ERIC to industry

 eli attosecond	 eli nuclear physics	 eli beamlines	 DESY	<a href="#"><u>Deutsches Elektronen-Synchrotron</u></a>
ELI-ALPS	ELI-NP	ELI Beamlines		<a href="#"><u>ELETTRA</u></a>
 PRACE	 KIT Karlsruhe Institute of Technology	 EGI		<a href="#"><u>Science and Technology Facilities Council</u></a>

## Target group: companies with R&D in Europe in pharmacy, biotech, chemistry, nanotech



# European Cluster of Advanced Laser Light Sources



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654220

- 7M€ from Horizon 2020 for project period Oct 2015 - Oct 2018
- 11 partners from nine countries, two further clusters, two associate partners





Highlights from the “Innovation Potential of Advanced Light Sources” report from the EUCALL project:

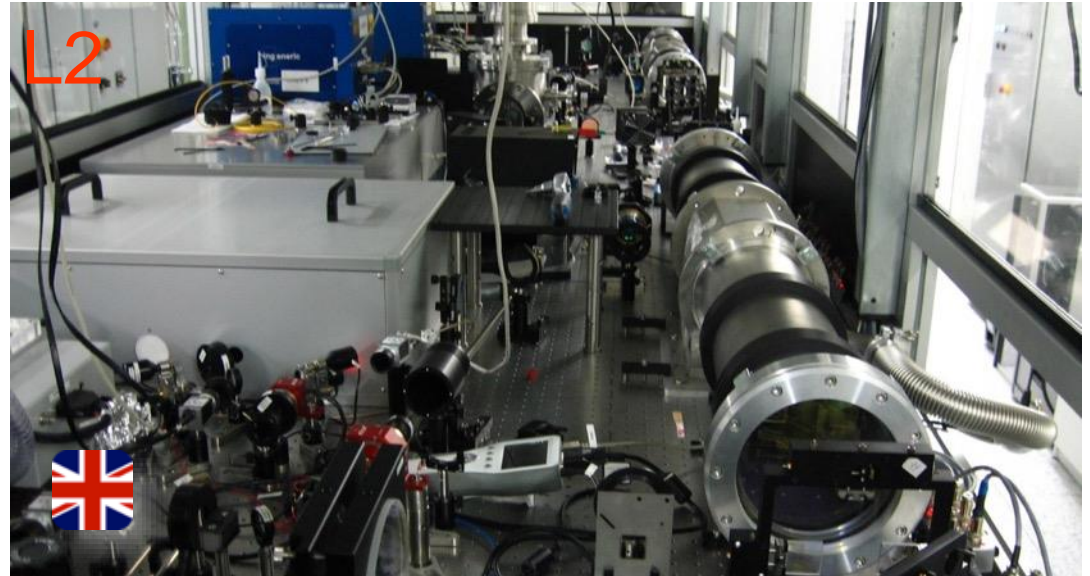
- Industry’s awareness of potential for collaboration with RIs
- Joint development of technology (Models of Joint Development)
- Protection and commercialization of intellectual property
- Commercial access policies
- Introduction to the panel discussion

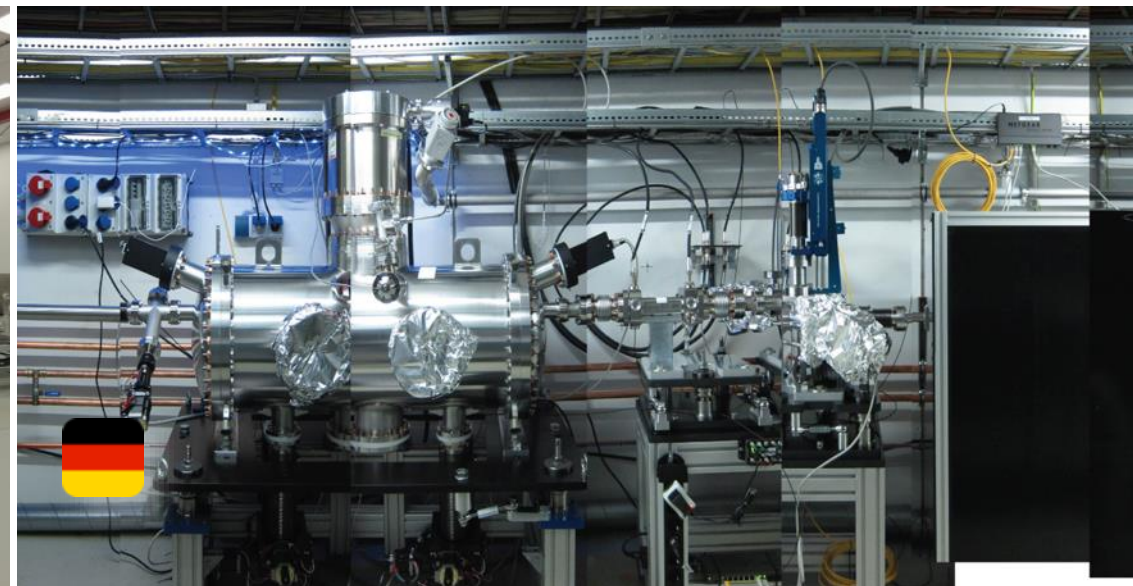
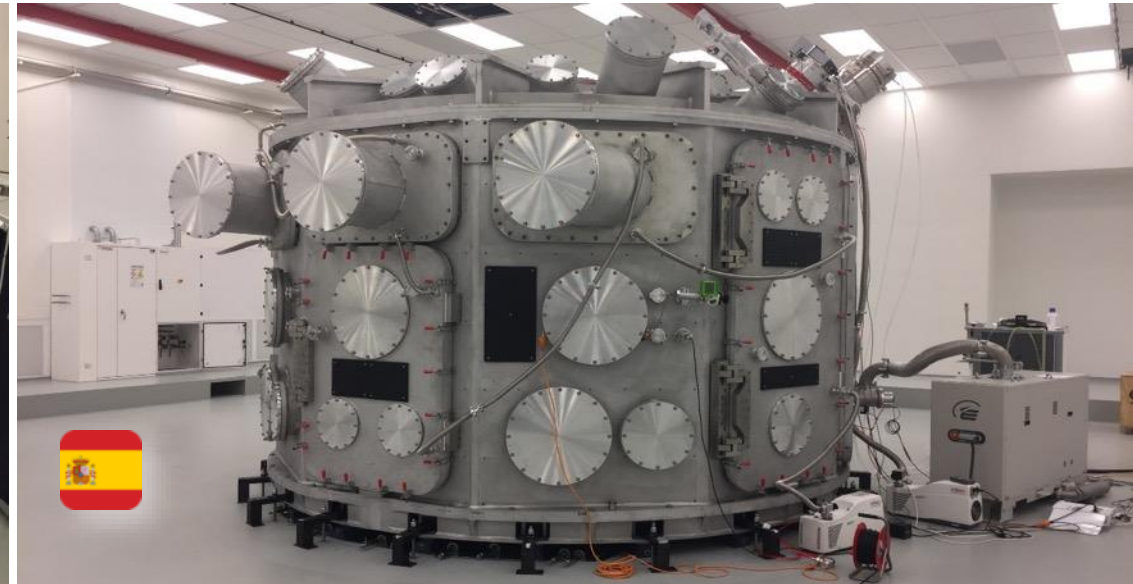
EUCALL report “Innovation Potential of Advanced Light Sources” was prepared to **analyze the combined innovation potential** of the advanced laser light source research infrastructures (RIs).

- An extensive survey has been performed among the TTOs of light source RIs
- A further survey was performed at the Hannover Messe 2018

- **In-house R&D (high-tech instrumentation, technologies, software)**
- **User time (available soon...)**





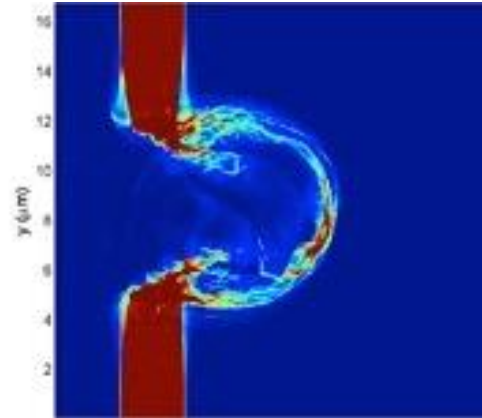


Beamline	Laser 1 Allegra	Laser 2 Amos	Laser 3 HAPLS	Laser 4 Aton
Peak power	15 TW	> 0.1 PW	≥ 1 PW	10 PW
Energy in pulse	200 mJ	> 3 J	≥ 30 J	≥ 1.5 kJ
Pulse duration	< 12 fs	25 fs	≤ 30 fs	≤ 150 fs
Rep rate	kHz	20 Hz	10 Hz	1 per min
Pump laser technology	Diode Pumped Solid State Lasers (DPSSL)	Diode Pumped Solid State Lasers (DPSSL)	Flashlamp-pumped Nd:glass amplifiers	Flashlamp-pumped Nd:glass amplifiers
Designed, developed & tested by	ELI Beamlines (CZ) Trumpf (Germany)	Science and Technology Facilities Council (UK) ELI Beamlines (CZ)	Lawrence Livermore National Laboratory (USA) ELI Beamlines (CZ)	National Energetics (USA) EKSPLA (Lithuania) ELI Beamlines (CZ)
Investment (mil. EUR)	7.5	12.5	39	37
<b>ELI Beamlines involvement</b>	<ul style="list-style-type: none"> <li>Optical parametric chirped-pulse amplification (OPCPA) pulse chain</li> <li>Pulse compressors</li> <li>Control &amp; timing systems</li> </ul>	<ul style="list-style-type: none"> <li>Pump laser sub-systems</li> <li>Optical parametric chirped-pulse amplification (OPCPA)</li> <li>Control &amp; timing systems</li> </ul>	<ul style="list-style-type: none"> <li>Pulse compressor</li> <li>Short pulse diagnostics</li> <li>Control &amp; timing systems</li> </ul>	<ul style="list-style-type: none"> <li>Pulse compressor</li> <li>Optical parametric chirped-pulse amplification (OPCPA) design</li> <li>Short pulse diagnostics</li> <li>Timing system</li> </ul>

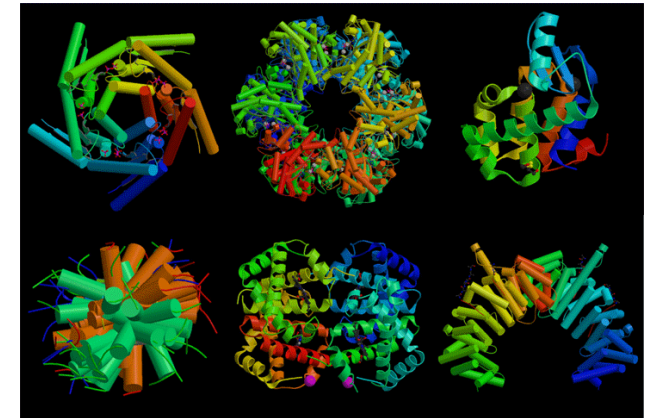
# Research applications



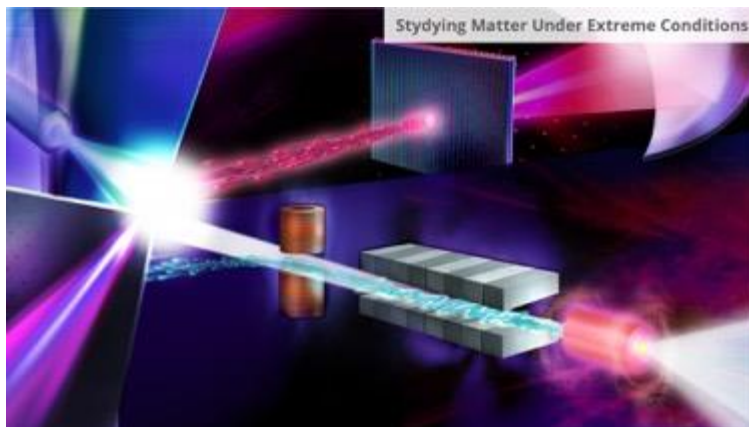
X-ray and gamma sources,  
laboratory astrophysics



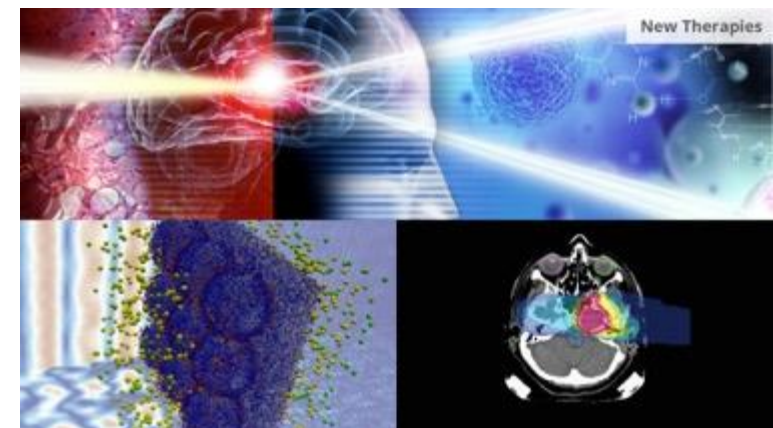
Particle acceleration



Biology and biochemistry



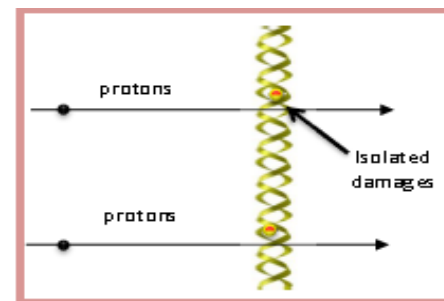
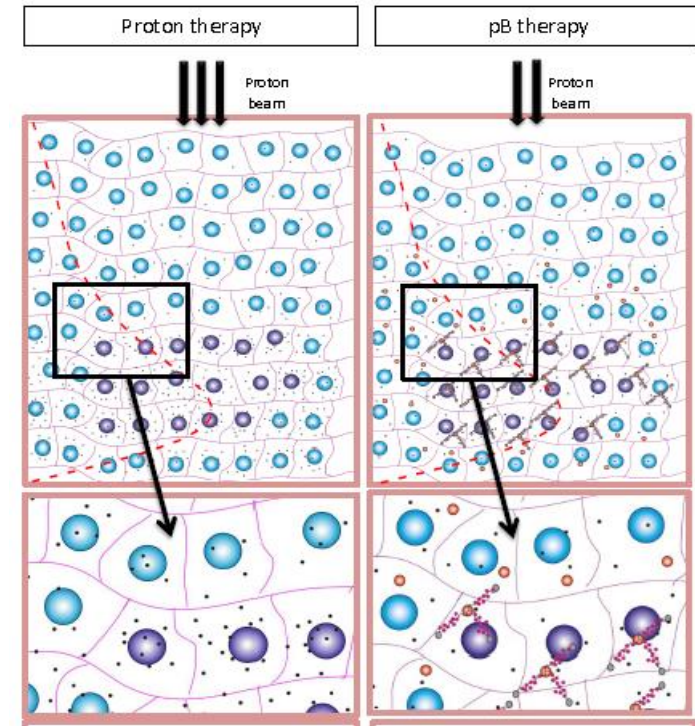
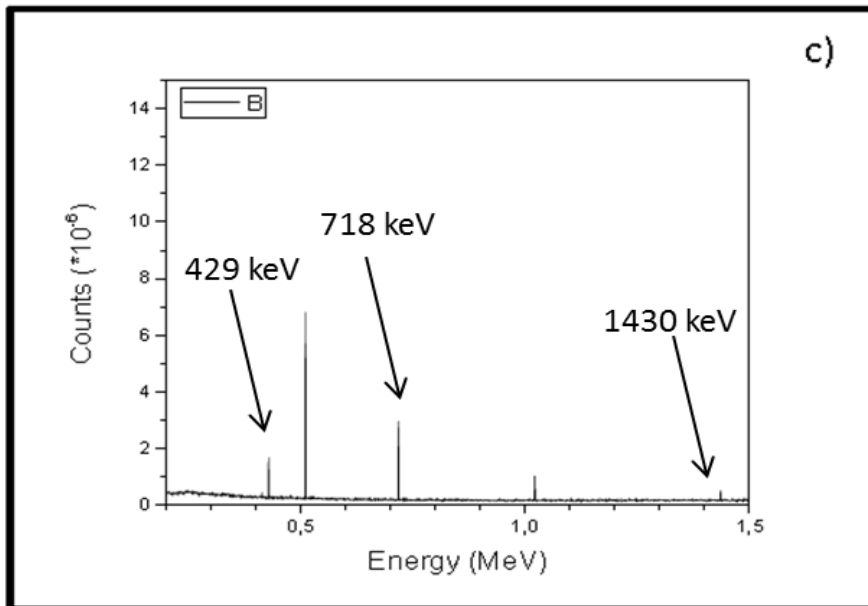
Advanced materials  
and nanotechnology



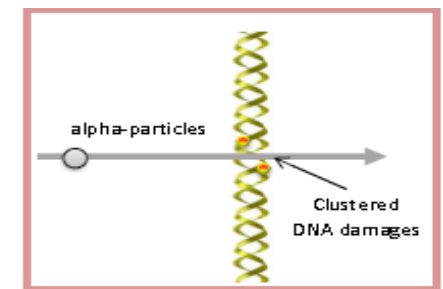
Medical diagnostics  
and treatment technology

Device and method for **enhanced proton therapy** and simultaneous **prompt gamma-ray imaging** irradiating an object (e.g. cancer) that contains a **mixture of  $^{11}\text{B}$  and  $^{10}\text{B}$** :

- EPO Application (E16002)
- Institute of Physics (80%), INFN (20%)



**Biological effect**



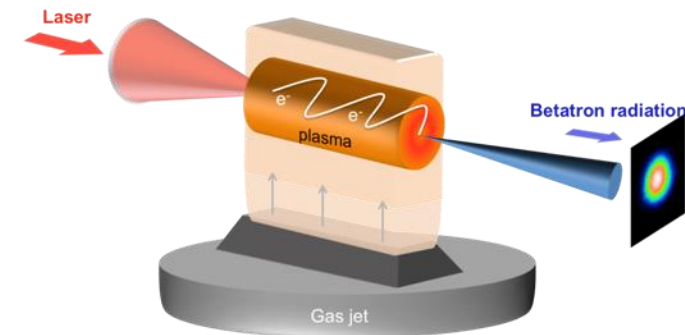


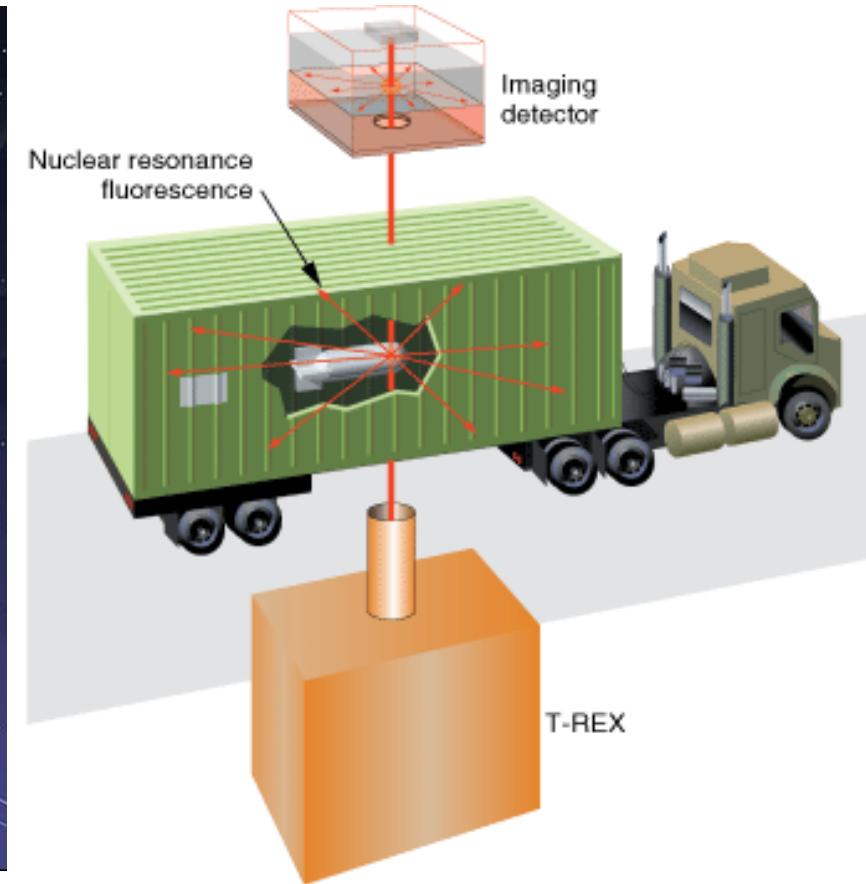
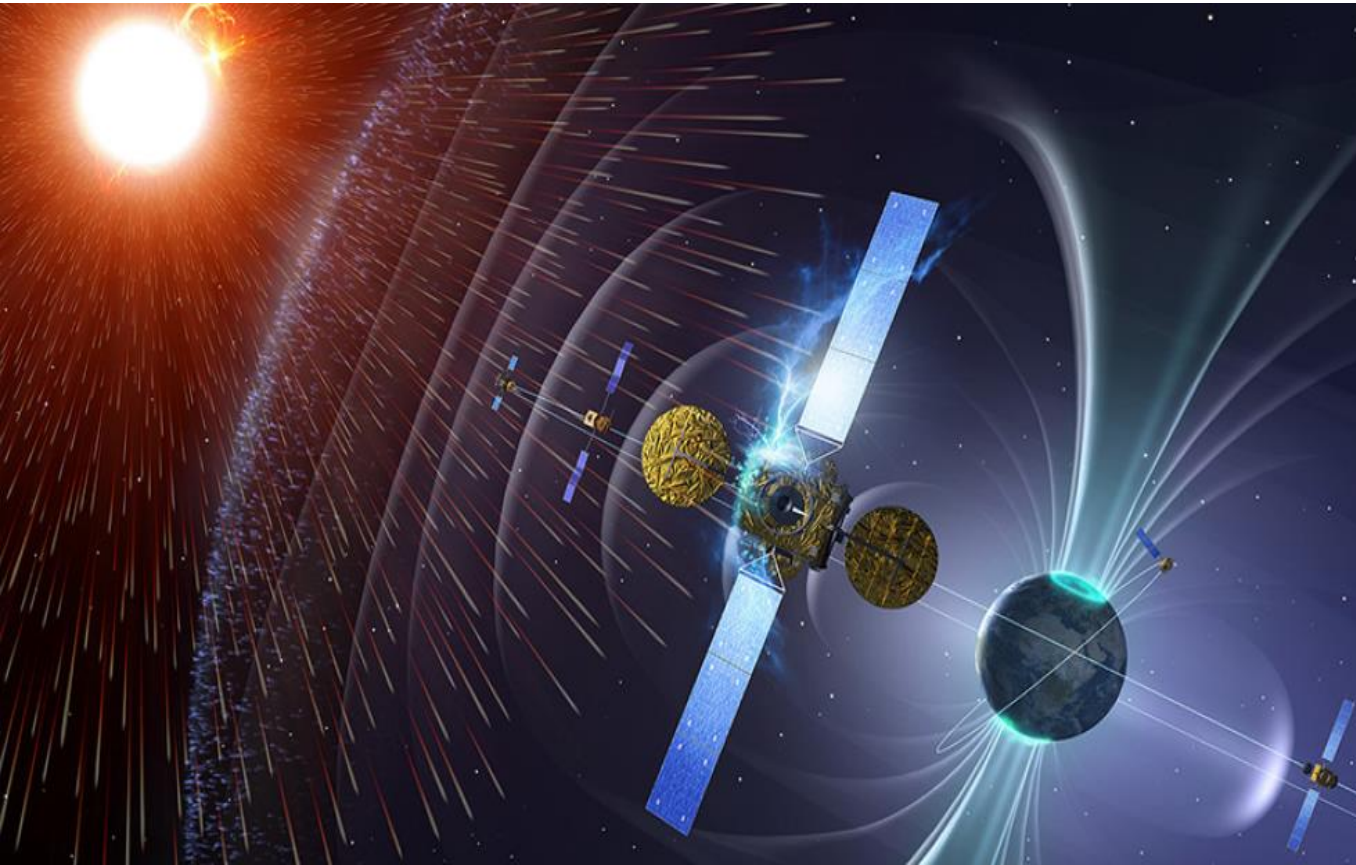
# 3D imaging applications



$\mu$ CT of mouse embryo taken with a laser driven x-ray beam

X-rays from relativistic e-beams, Betatron and Compton





Testing of components for space environment

Testing components exposed to extreme radiation levels (space application) for radiation hardness

Nuclear interrogation and national security

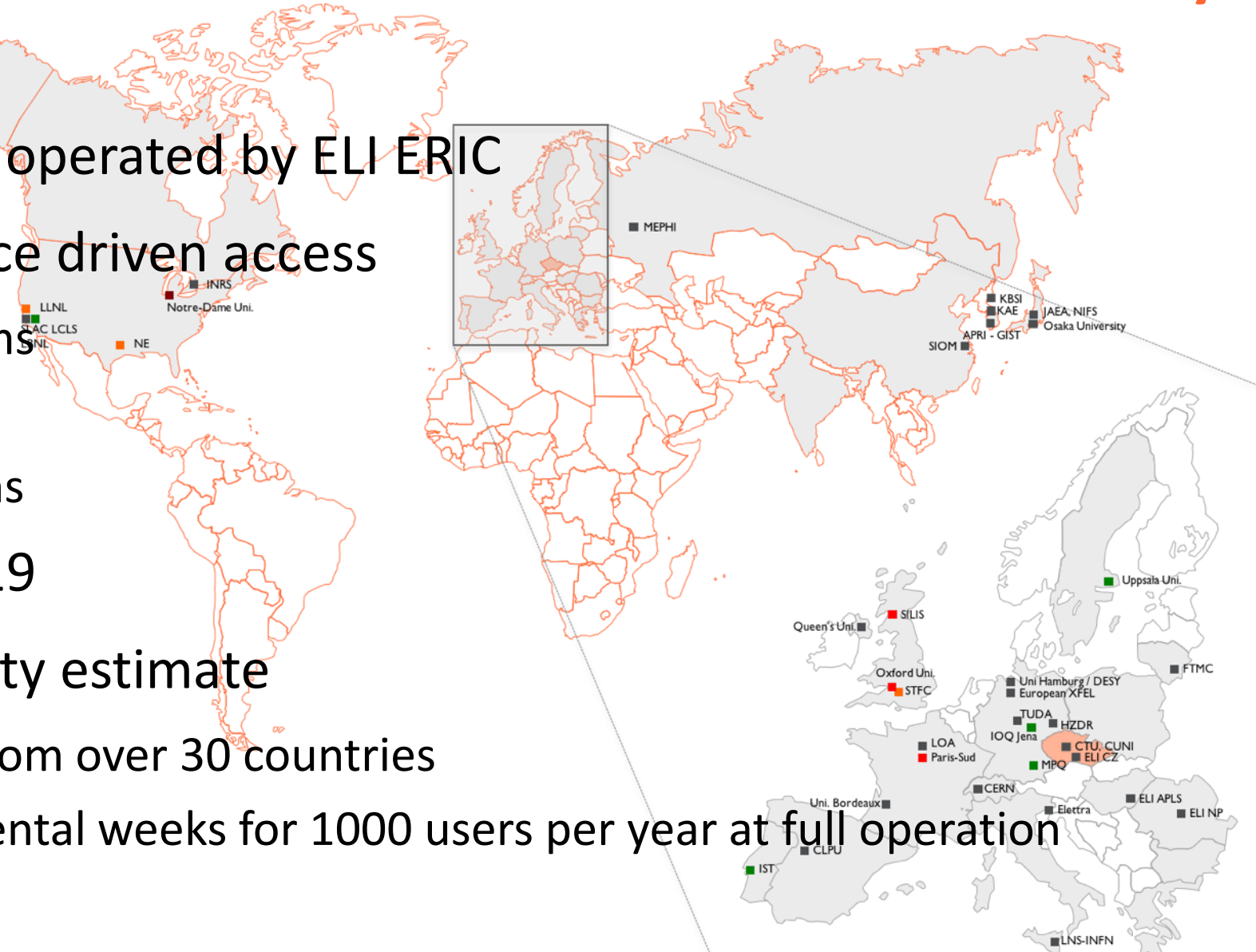
Narrowband x-ray or neutron induced gamma emission  
Element/isotope mapping of samples via nuclear activation



- Mathematical simulations
- Advanced material development
- Safety and security systems

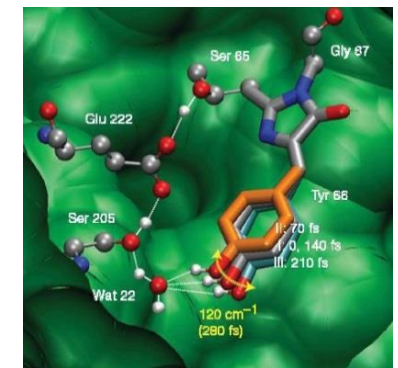
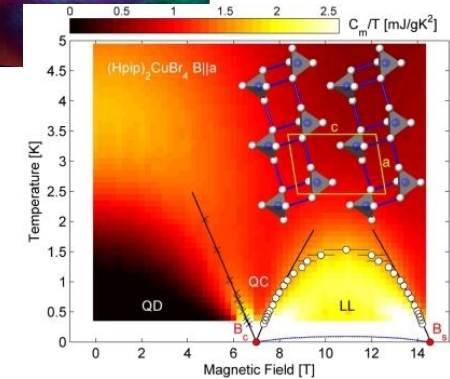
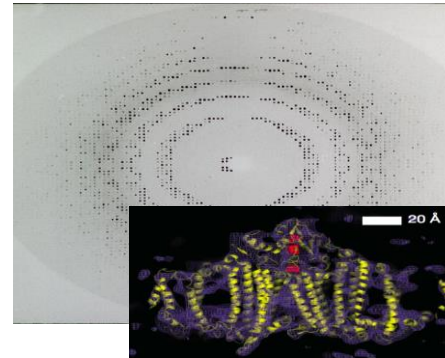


- 100% capacity operated by ELI ERIC
- Open excellence driven access
  - 6 laser systems
  - 7 beamlines
  - 9 user stations
- First call in 2019
- User community estimate
  - Originating from over 30 countries
  - 300 experimental weeks for 1000 users per year at full operation

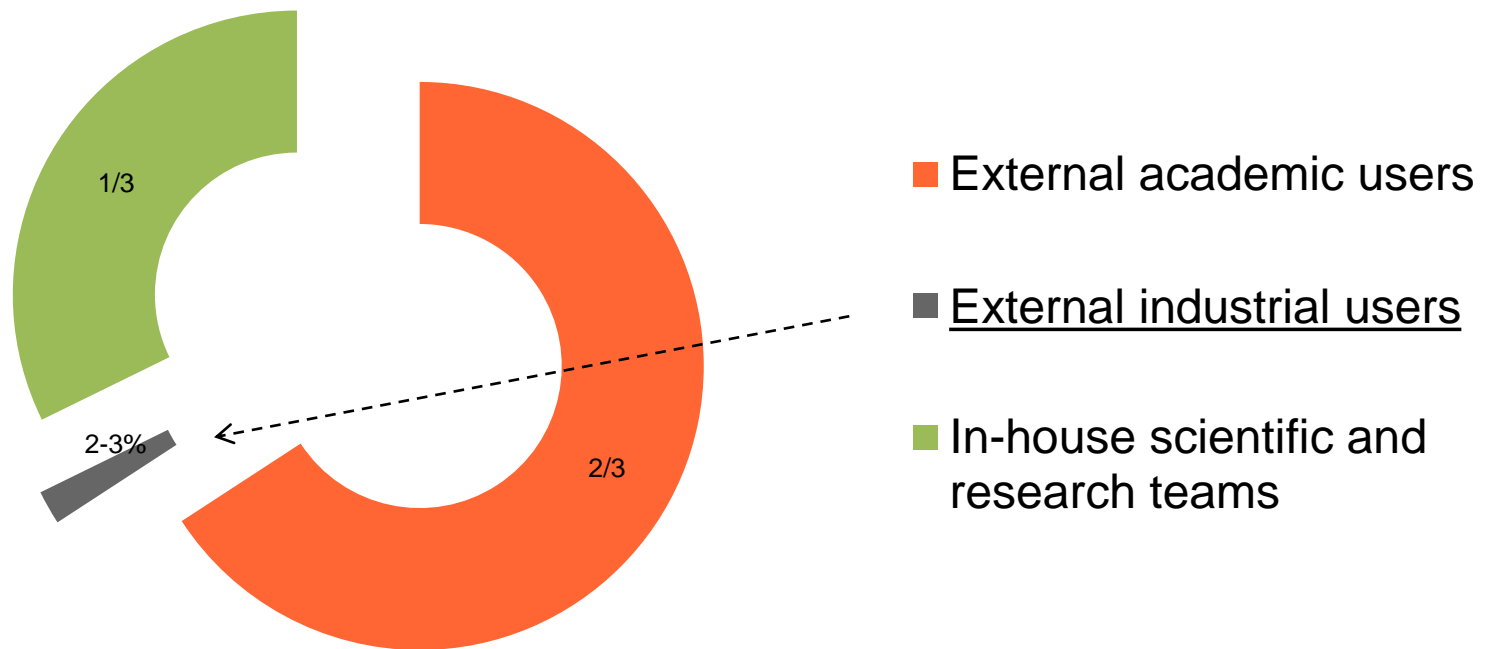


## Atomic, Molecular and Optical Science and Coherent Diffractive Imaging

- Studying liquids being mixed in-situ and tracking chemical reactions
- Characterising materials at atomic-, nano-, and micro-scopic lengthscales
- Studying dynamic phenomena from milli- to femto-second time resolutions (time-resolved studies)



**Lasers and all beamlines will be available for international users to accomplish their own research projects, development of technologies and know-how, and use or test their equipment**



## USER OFFICE

- Receiving proposals via Electronic project office (remote registration, submitting, experiment results, feedback, etc.), distribution to relevant pillars



### Academic users

- Open Access Policy: open to all researchers, based on open competition and selection of the proposals, evaluated by on the sole criterion of scientific excellence
- Non-proprietary access
- ELI Peer-review panel: evaluation and assessment of scientific/technological quality
- General non-discrimination principles



### Industrial users

- Proprietary access
- NO Peer-review evaluation, but ELI Proprietary Project Approval Panel



## ***Non-proprietary research***

- Scientific excellence
- Peer-review assessment
- Dissemination of results via publications and scientific journals
- Access is funded from public sources, grants, projects, etc.

## ***Proprietary research***

- Industry-related research, return on investment expected
- Assessed only by technical feasibility, legality, safety and ethics (Proprietary Project Approval Panel)
- Confidential, no requirement to publish results
- A fee would be charged to cover operational costs of the ELI facilities (time used and services provided)

## ***Individual and group access***

- Individual researchers, research teams or research consortia

## ***Call for access***

- Calls published for available beamlines (non-proprietary access)
- On-going for proprietary access

## ***Time slots for access***

- Beam-day: 8 hours
- Beam-week: 40 hours

## ***Fast track access***

- Standard will be a beam-time waiting list scheduled on an operational plan
- Fast track access for short expiration date (bio projects)

## ***Long term access***

- Projects requiring long installation / assembling of equipment
- Equipment could be used by other users
- This user will not be required to re-submit proposals to access the infrastructure

## *Legal conditions*

- Reflect national legislation of each pillar
- Experiment performed under contract guaranteeing complete confidentiality, the results are available only to the customer
- Non-disclosure agreement (NDA) signed

## *Ownership of Intellectual Property (IP)*

- Standard IP policy principles for research infrastructures apply
- Ownership of IP is split in a ration that reflects financial and human contribution
- Always based on a written agreement
- **Proprietary research** – full IP rights belong to the user

## *Protection of created Intellectual Property*

- Patent costs are divided in a ratio reflecting the ownership rights
- Patent exploitation is priority for technology transfer activities

## ***Infrastructure***

- User office – planning visits to ELI pillars, administrative support, travel arrangements, etc.
- Available laboratories for experiment (sample) preparation
- Grant office – assistance with preparing new joint collaboration projects with industry

## ***Personnel***

- **Industrial Liaison Scientist** – assistance to industrial users with no prior experience with research infrastructures / laser facilities
- Clear explanation of available techniques to industrial user
- Support to experiment preparation, data collection and data analysis
- Reporting and data sending

**Thank you for your attention!**

**ANY QUESTIONS???**

**Aleš Hála**

Head of technology transfer unit

26 November 2019

