Extreme-Light-Infrastructure
Project overview
Data management needs and challenges

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EGI Technical Forum – 20 September 2012 - Prague

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Akademie věd ČR, v. v. i.

project supported by:

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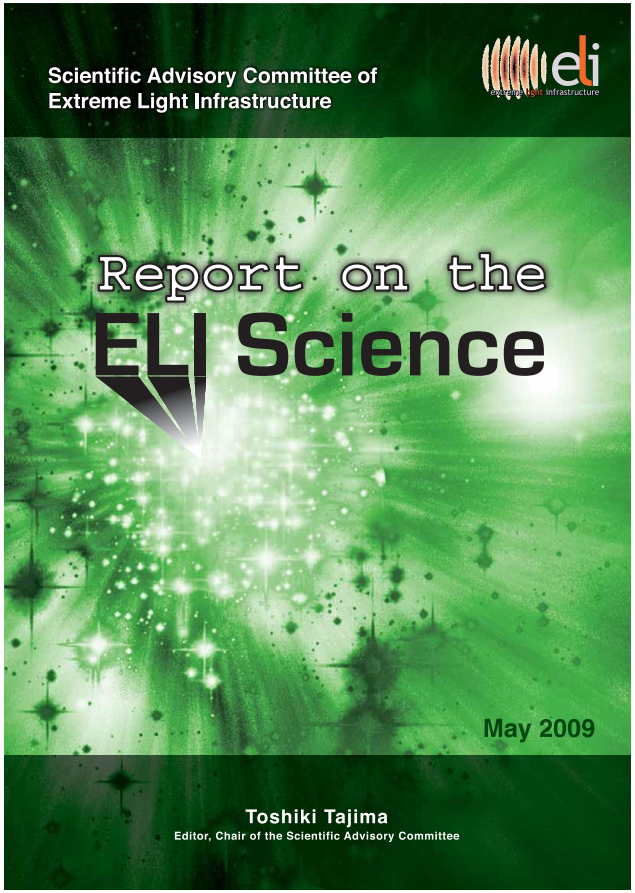
What is ELI?

- One of the 48 EU priority projects listed on the roadmap of the European Strategic Forum on Research Infrastructures (since 2006)
- Four pillars of unprecedented scientific and research applications of ultra-intense and ultra-short laser pulses
- 1st ESFRI project to be fully implemented in the newer EU Member States (CZ, HU, RO) through strong pan-European and international collaboration
- In brief, ELI's mission is to be become:
  - 1st general purpose international laser research infrastructure
  - Best laser center in the world for user-based research – with performance and approach following the example of synchrotrons (e.g. ESRF in Grenoble)

4 scientific "pillars"

Four "Grand Challenges" in the scientific case of ELI:

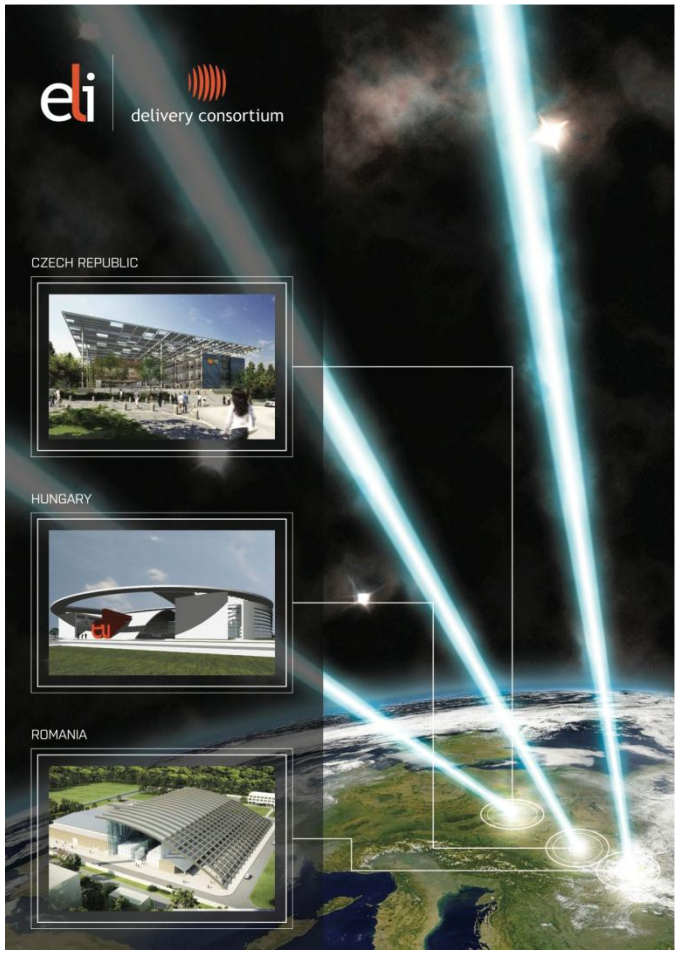
- **Attosecond Laser Science:** temporal investigation of electron dynamics in atoms, molecules, plasmas and solids at attosecond scale
- **High Energy Beam Science:** development and usage of dedicated beam lines with ultra short pulses of high energy radiation and particles reaching almost the speed of light
- **Laser-Induced Nuclear Physics**: nuclear physics methods to study laser-target interactions, new nuclear spectroscopy, new photonuclear physics, etc.
- **Ultra High Field Science**: investigation of laser-matter interaction in an energy range where relativistic laws could stop to be valid



From past to present

2006	November	ELI is among the 35 RI projects listed as priority initiatives for Europe within the first ESFRI Roadmap
2007	October	Launch of the ELI Preparatory Phase (project funded by DG Research, 13 countries)
2008	November	The Czech Republic, France, Hungary, Romania and the UK submit their bid for hosting the Extreme-Light-Infrastructure
2009	October	The Czech Republic, Hungary and Romania receive the mandate to implement ELI as a distributed research infrastructure
2010	December	End of the Preparatory Phase of ELI
2011	June	The funding of the ELI Beamlines facility is approved by the EC
2012	September	The funding of the ELI Nuclear Physics facility (RO) is approved by the EC; the grant application of the Attosecond facility (HU) is being finalised
	October	The ELI Delivery Consortium is established as a legal entity granted with a permanent management and administrative team

Implementation of ELI



- ELI will be implemented as **a distributed research infrastructure** based initially on 3 **specialised and complementary facilities** located in the Czech Republic, Hungary and Romania (structural funds)
- The three facilities should be delivered by end 2015 and jointly **operated by an inclusive European RI Consortium (ELI-ERIC)**
- The conditions of implementation of the so-called **"fourth pillar" of ELI will be decided at a later stage** on the basis of a review of the results of the technological solutions currently under development in Europe
- The three hosts have the responsibility of establishing an **ELI Delivery Consortium**

eli delivery consortium

4 complementary sites

Szeged

Attosecond facility

Dolní Břežany

Beamlines facility

Magurele

Photonuclear facility

Site to be determined after 2012

High-intensity development

Attosecond XUV/X-ray physics

Applications in material sciences and biology

High-brightness sources of X-rays & particles

Molecular & biomedical sciences, particle acceleration, dense plasma physics, exotic physics

Laser-induced nuclear physics

Photonuclear science and applications

Exawatt-class laser technology

High-intensity laser technologies for frontier physical research

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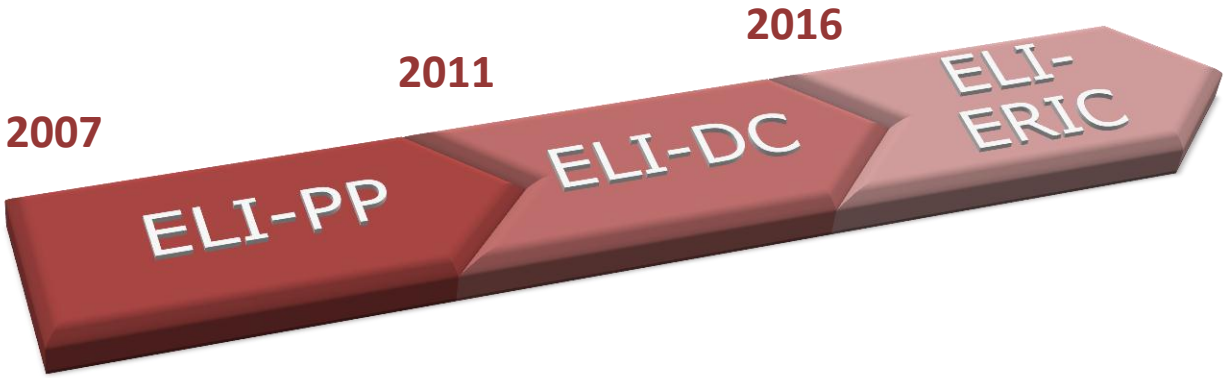
ELI institutional phasing



About ELI and ELI Beamlines

Ana Arana Antelo
former Deputy Head of Cabinet of Commissioner for Science and Research

"A recent good example of the use of Structural Funds for Research Infrastructures include the Czech Republic, where the national Operational Programme "R&D for Innovation" has allocated almost 70% of the total funding to priorities such as European Centres of Excellence and Regional R&D centres. New research infrastructures financed from these resources are closely connected to the ESFRI Roadmap projects, notably the massive Extreme Light Infrastructure (ELI) project, the first large scale infrastructure based in the eastern part of the EU, investing over € 700 million Euro in laser science and its applications." – June 2011, WIRE Conference

"A good example is the research infrastructure of ELI in the Czech Republic, where the complementary resources from cohesion policy, national resources and from the 7. Framework Programme are used" – February 2012, Competitiveness Council

"This is exactly the type of project we want to see more of in the future. It is aimed at boosting research and innovation with a clear EU added value, to ensure that each and every euro is wisely spent" – September 2012, about the approval of ELI-NP

Johannes Hahn
European Commissionner for Regional Policy

David Cameron
British Prime Minister

"Britain has been and remains at the forefront of innovation in the science and technology sectors. I'm pleased to see the Rutherford Appleton Laboratory and other UK organisations play such an important role in the development of these sectors in the Czech Republic, especially ELI Beamlines" – June 2011, Official visit in the Czech Republic

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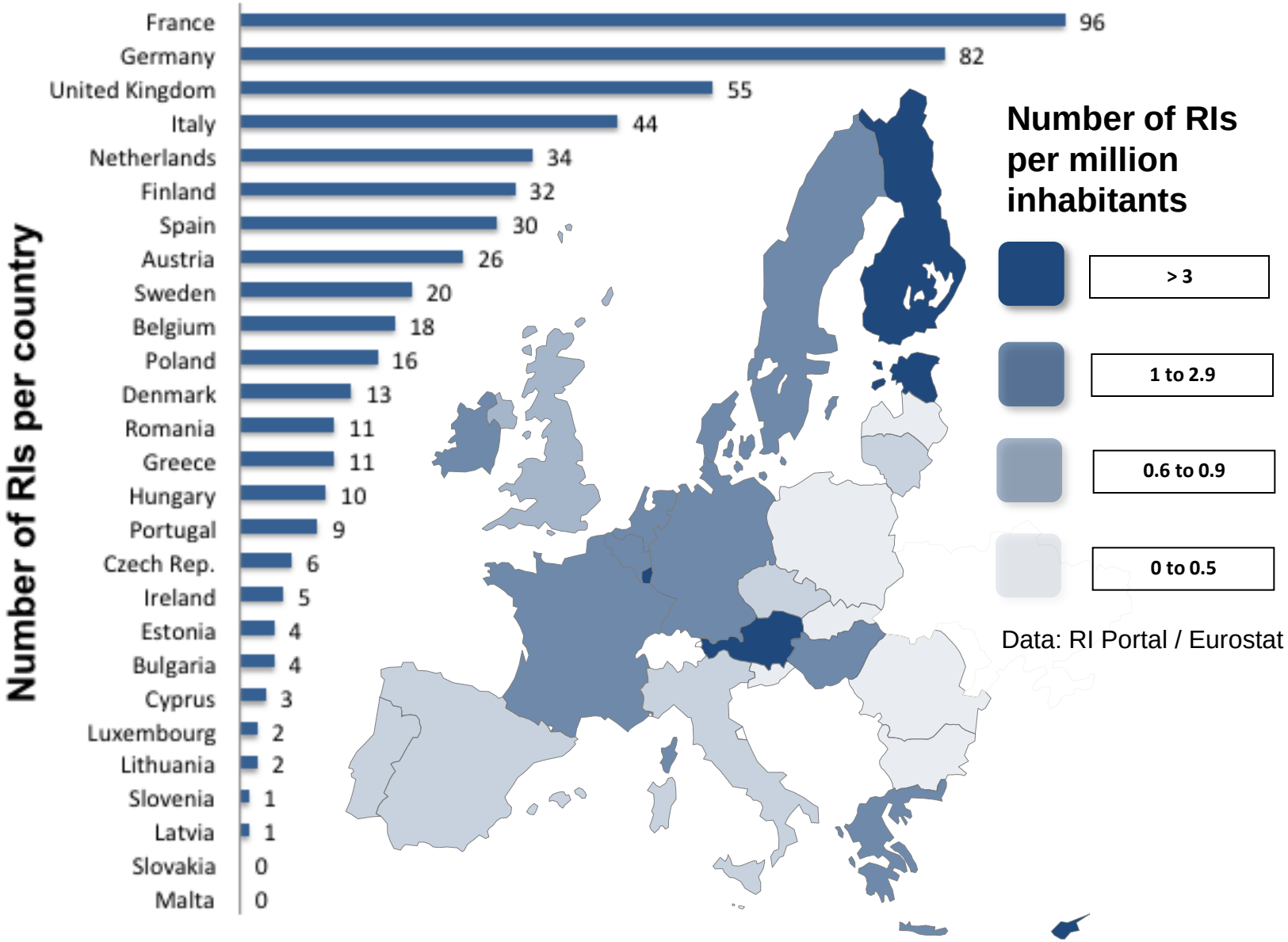
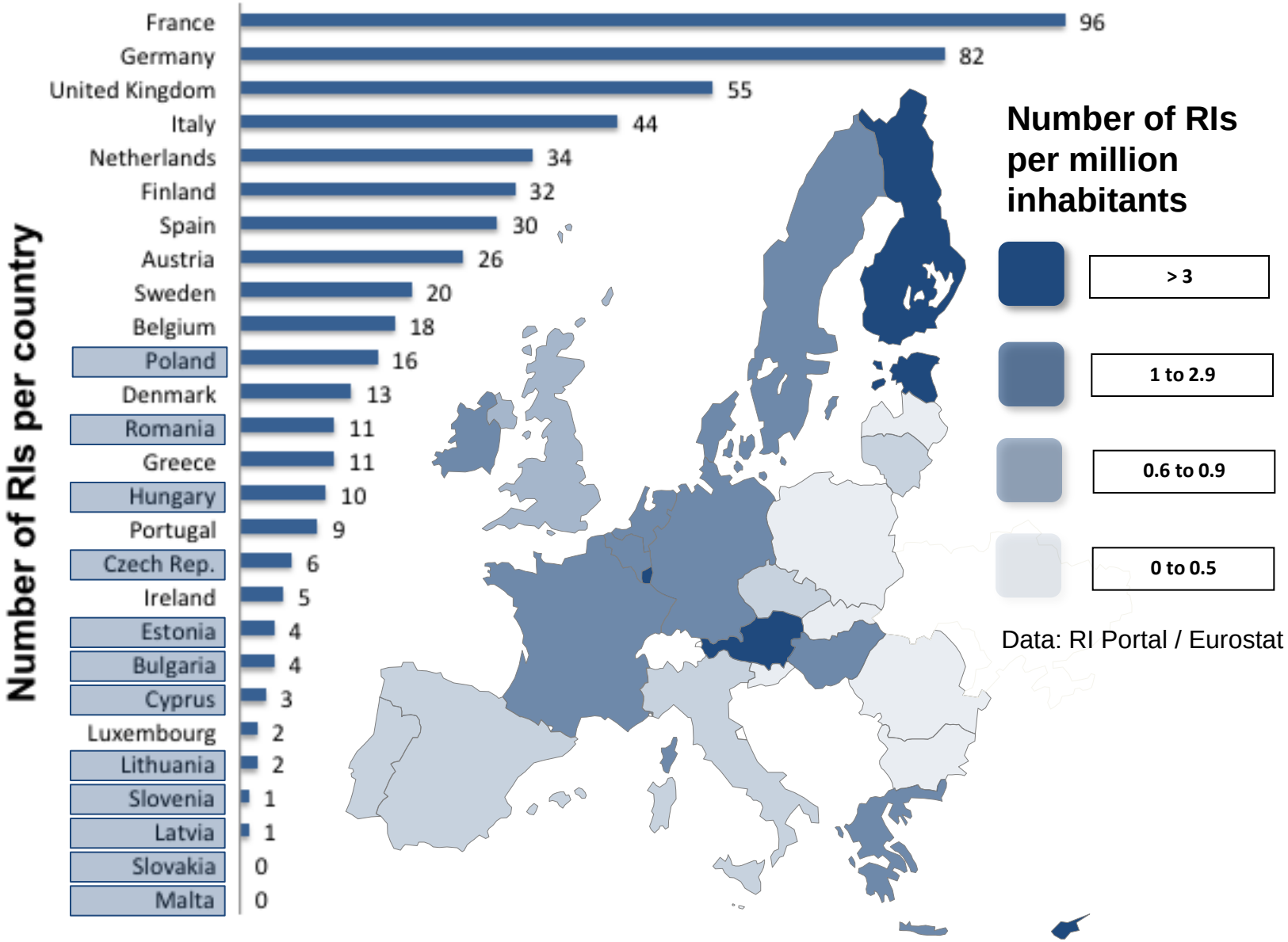
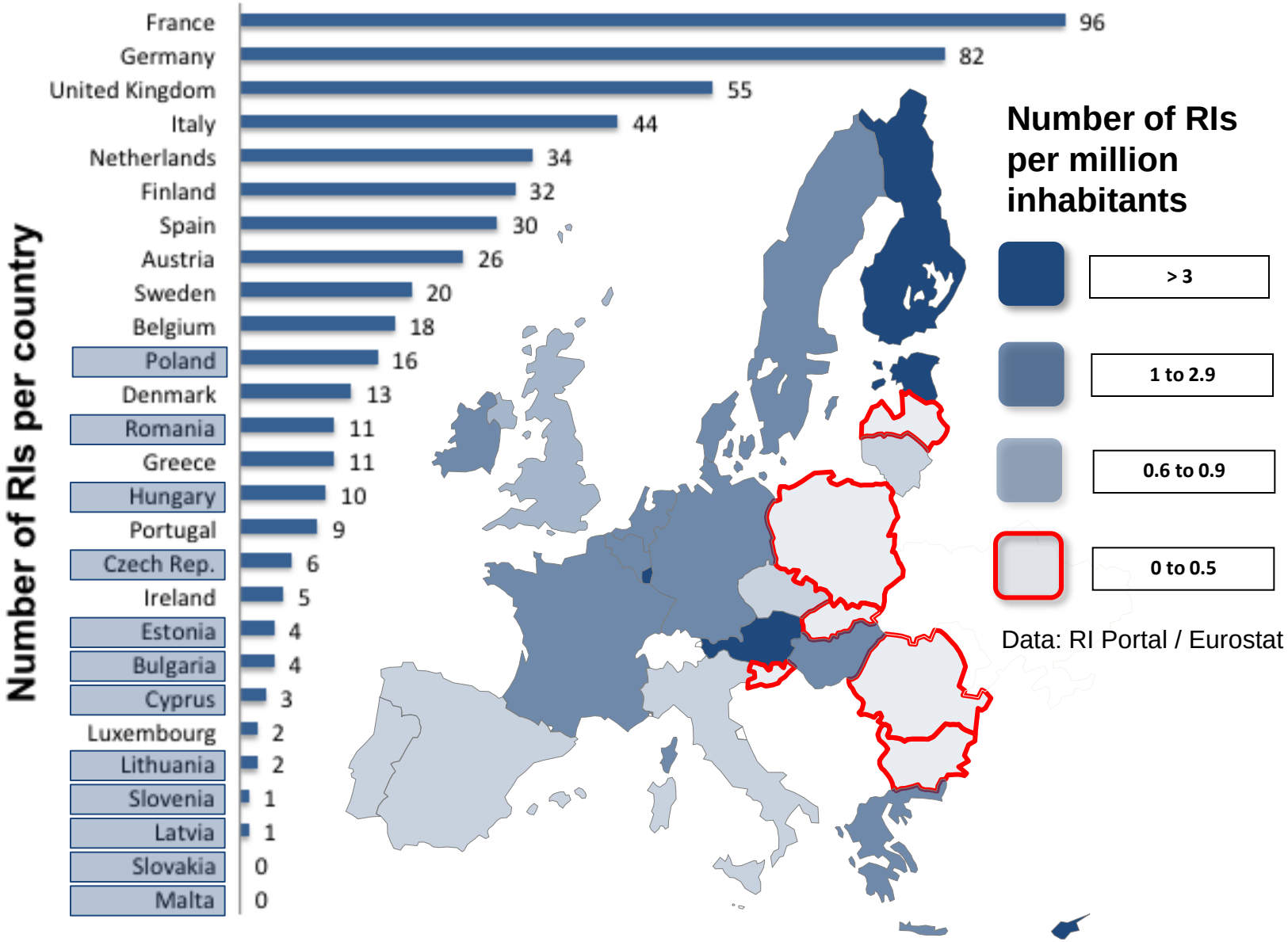
Imbalanced distribution of RIs



Imbalanced distribution of RIs



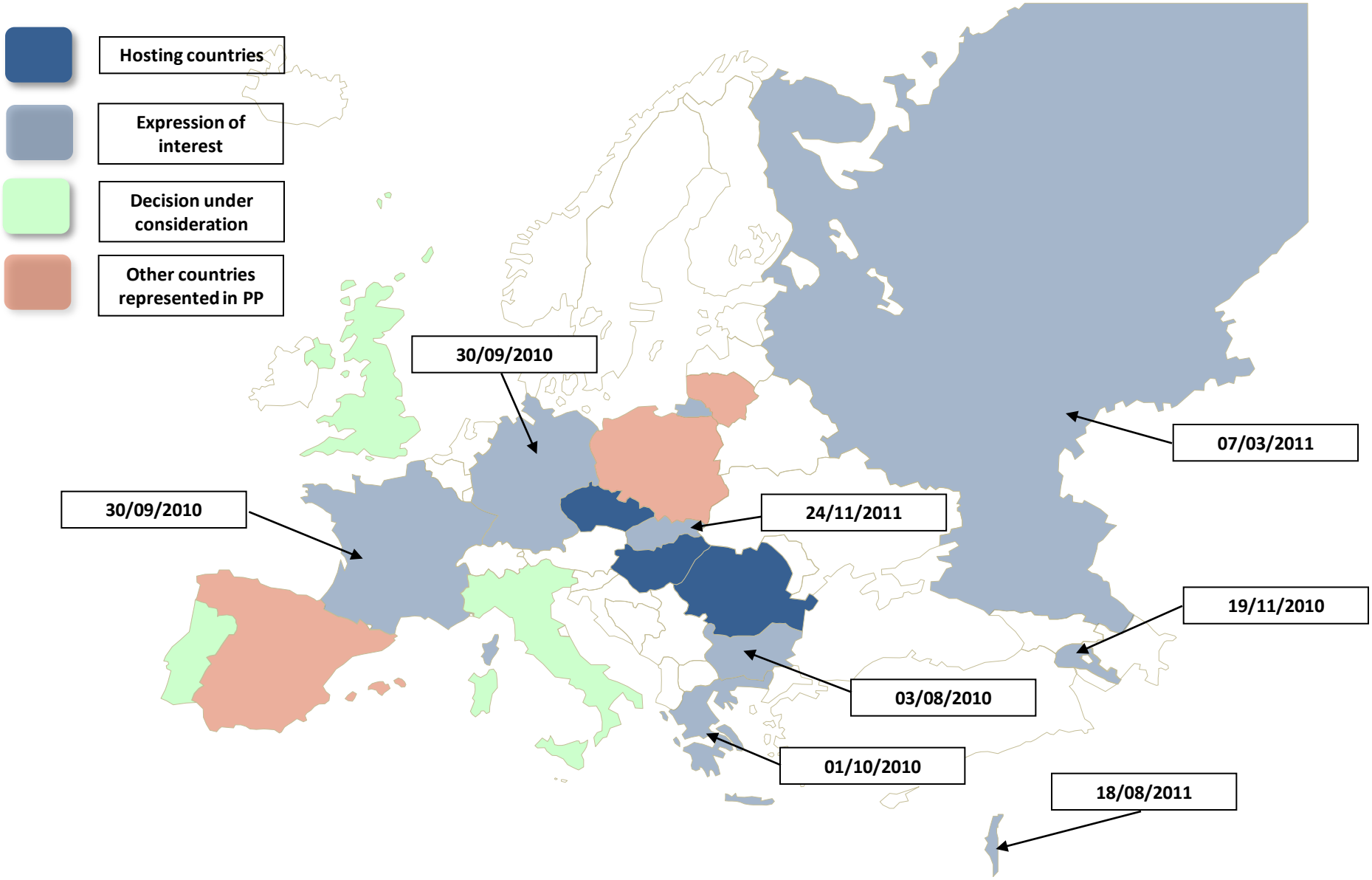
Imbalanced distribution of RIs



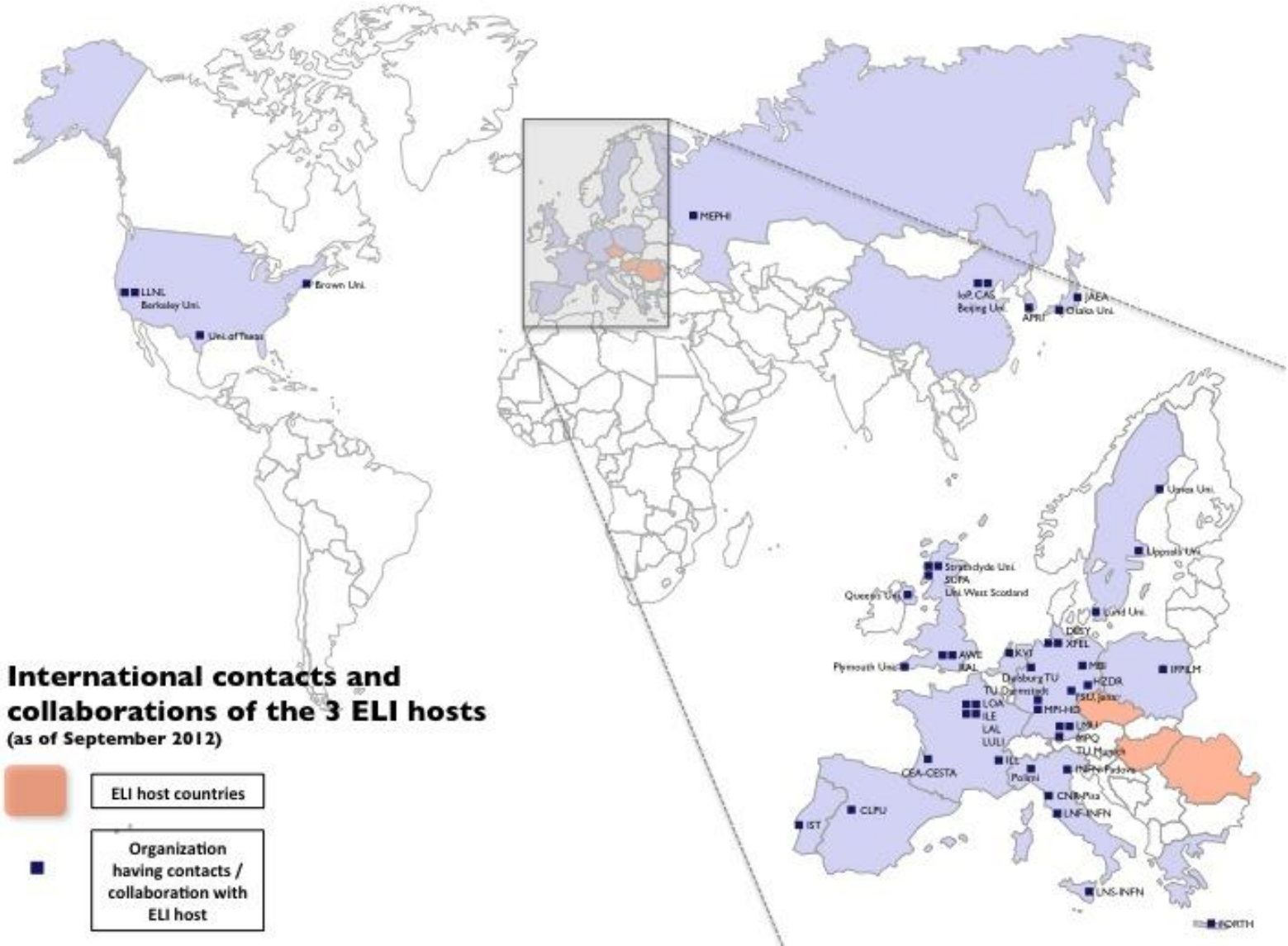
An innovative funding model

- The first three ELI facilities represent a total investment cost of about €850 million, with up to 85% co-funding coming from structural funds (ERDF)
- Structural funds aim at supporting the socio-economic development of the less-developed regions of the EU to promote regional cohesion in Europe
- In the current programming period (2007-2013), €10 billion are dedicated to the funding of research infrastructures and centres of excellence (75% of which is reserved for convergence regions). This is likely to increase in the next programming period.
- Challenges connected to the use of structural funds: time constraint, non-synchronisation between operational programmes of the three countries, public procurement rules, tough rules imposed by OP´s managing authority

Current political interest



International involvement

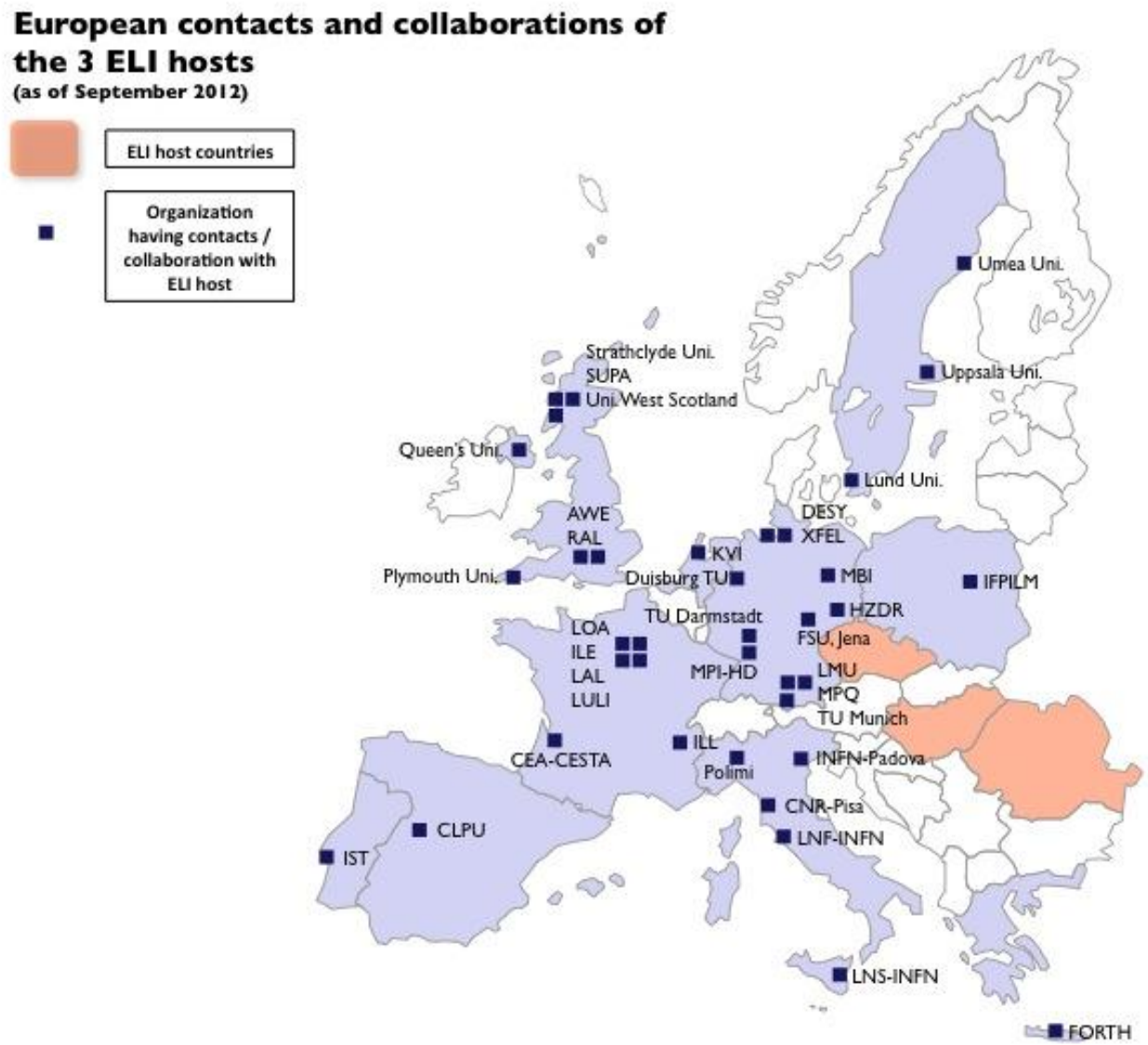


International contacts and collaborations of the 3 ELI hosts
(as of September 2012)

ELI host countries

Organization having contacts / collaboration with ELI host

European involvement



ELI Attosecond (HU)

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ELI Nuclear Physics (RO)

eli delivery consortium

ELI Beamlines (CZ)

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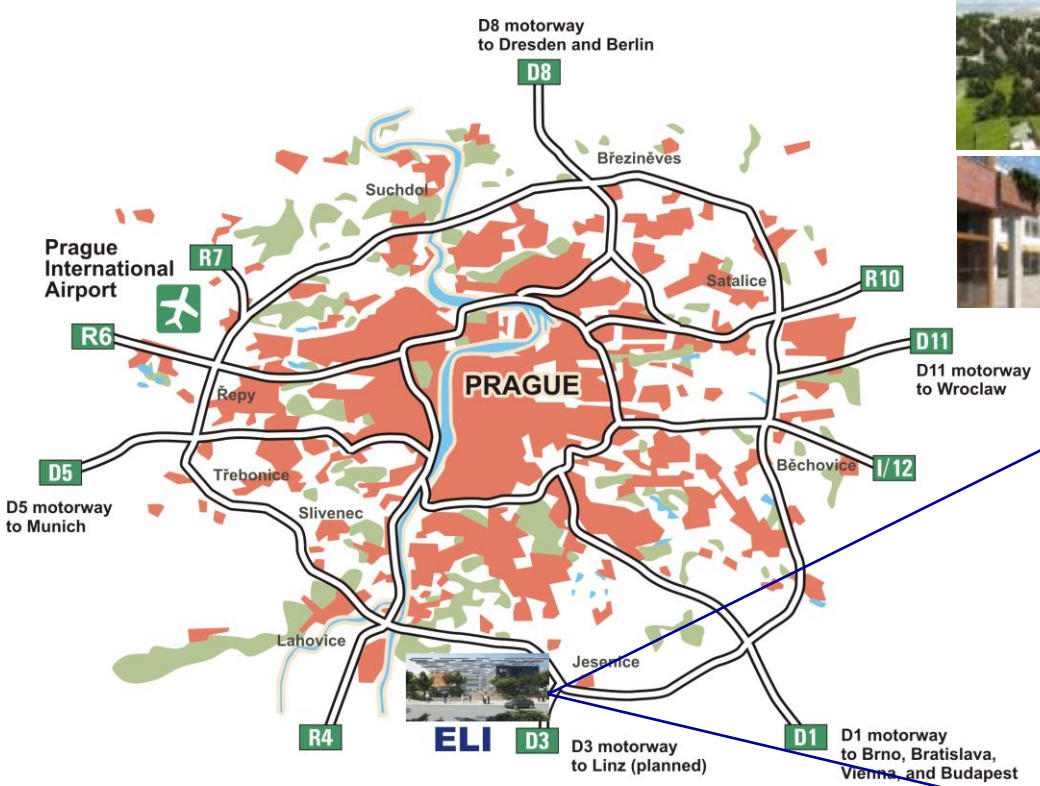
Site of ELI Beamlines



Research programmes

Research Program 1
Lasers generating rep-rate ultrashort pulses & multi-petawatt peak powers

Research Program 2
X-ray sources driven by rep-rate ultrashort laser pulses

Research Program 3
Particle acceleration by lasers

Research Program 4
Applications in molecular, biomedical, and material sciences

Research Program 5
Laser plasma and high-energy-density physics

Research Program 6
High-field physics and theory

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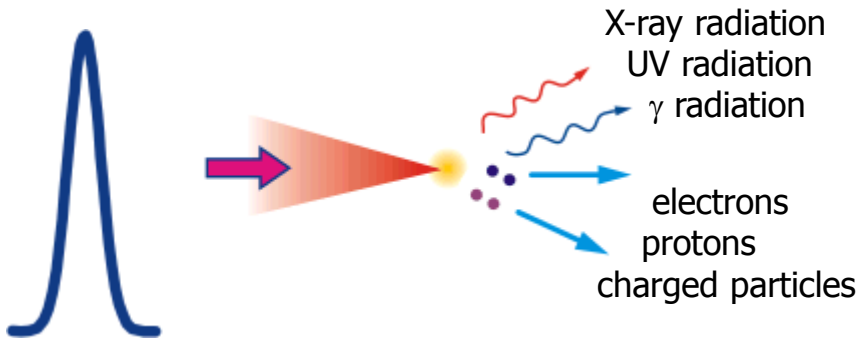
ELI Beamlines' philosophy and mission

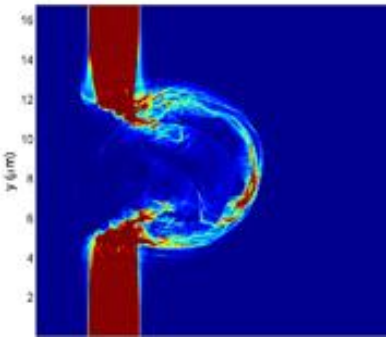
Laser systems
RP1
Ultrashort laser pulses

Secondary sources
RP2 – RP6
Research / fundamental science / applications

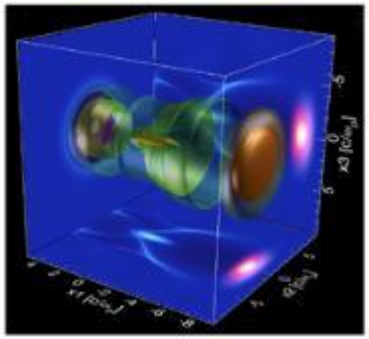


Basic research at ELI

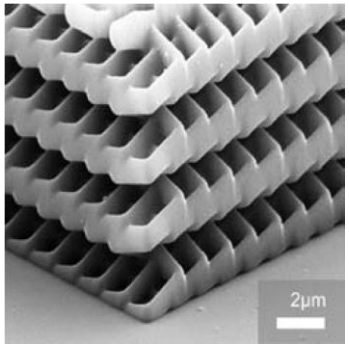
Roentgen and gamma sources, laboratory astrophysics



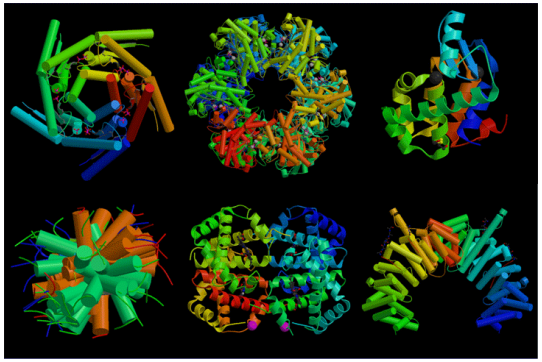
Proton acceleration



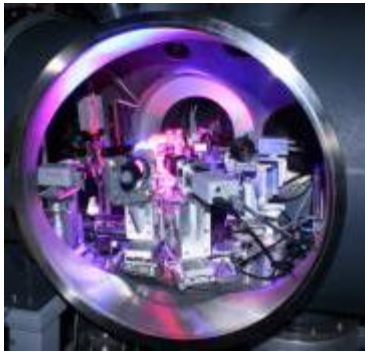
Electron acceleration



Nanotechnology and advanced materials



Biology and biochemistry



Medical diagnostics and treatment technology

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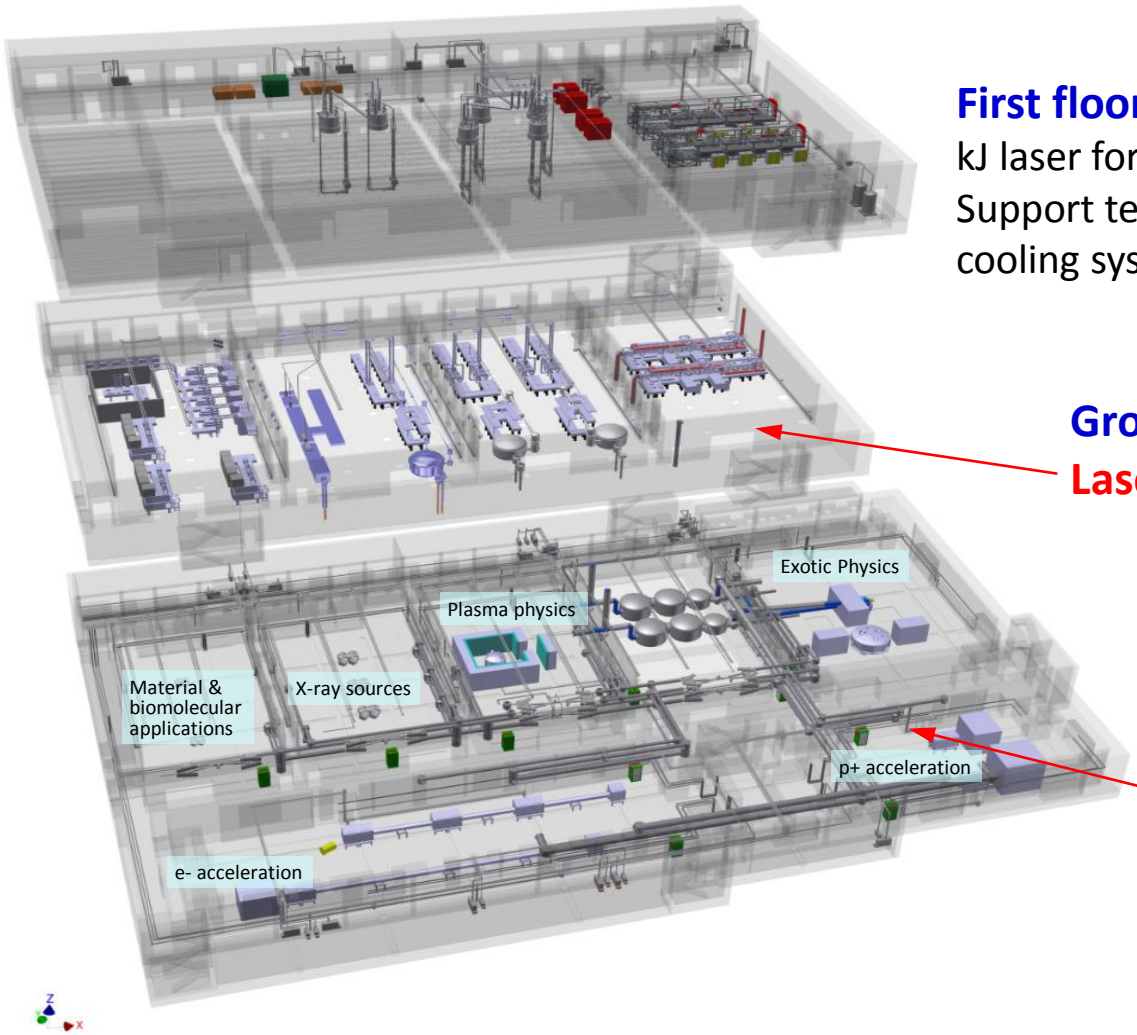
Building layout



First floor

kJ laser for L4

Support technologies, cryogenic systems, cooling systems

Ground floor (80 x 40 m)

Laser halls L1 – L4

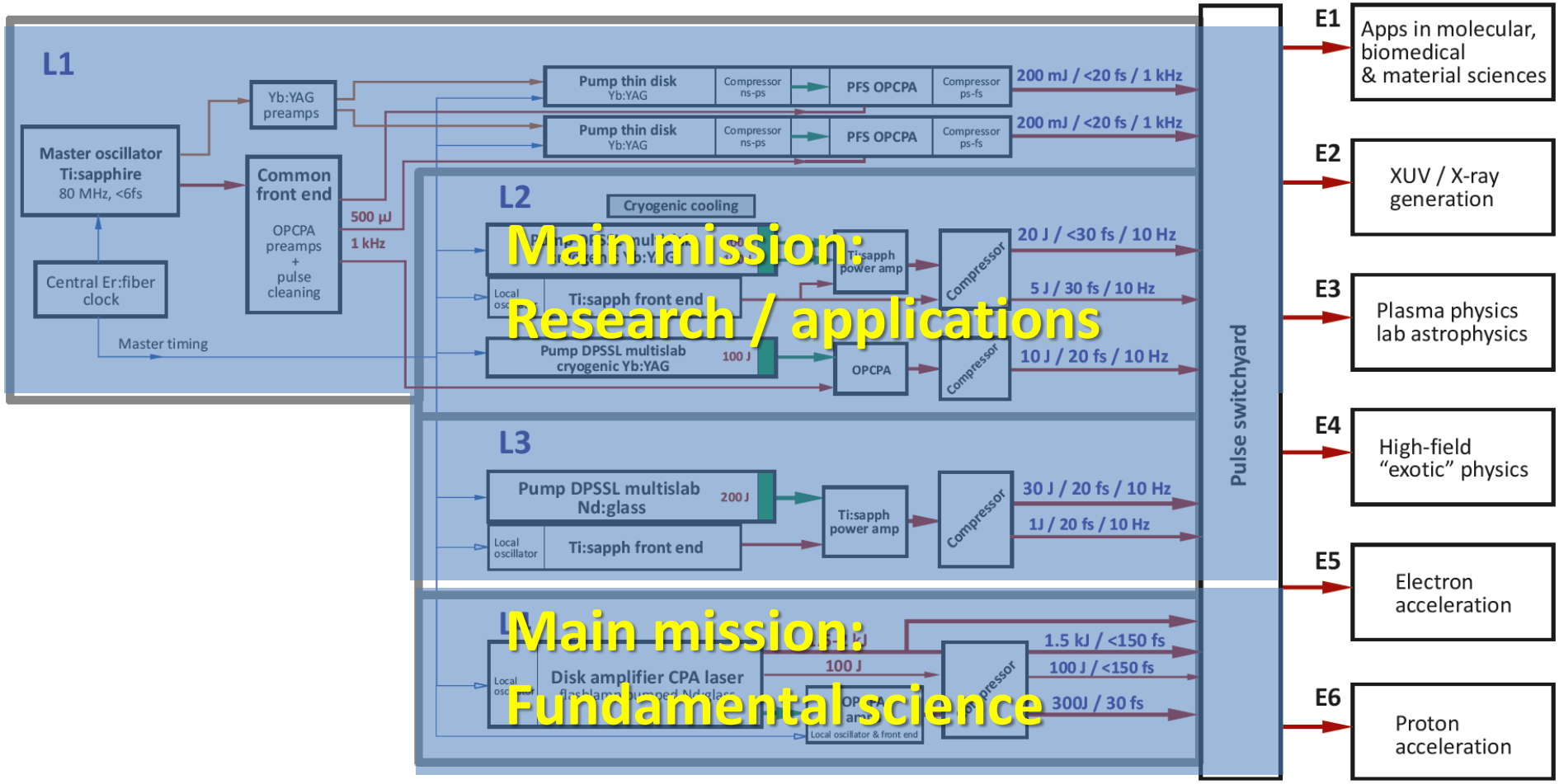
Basement (110 x 60 m)

Compressor(s) of L4 10-PW laser(s)

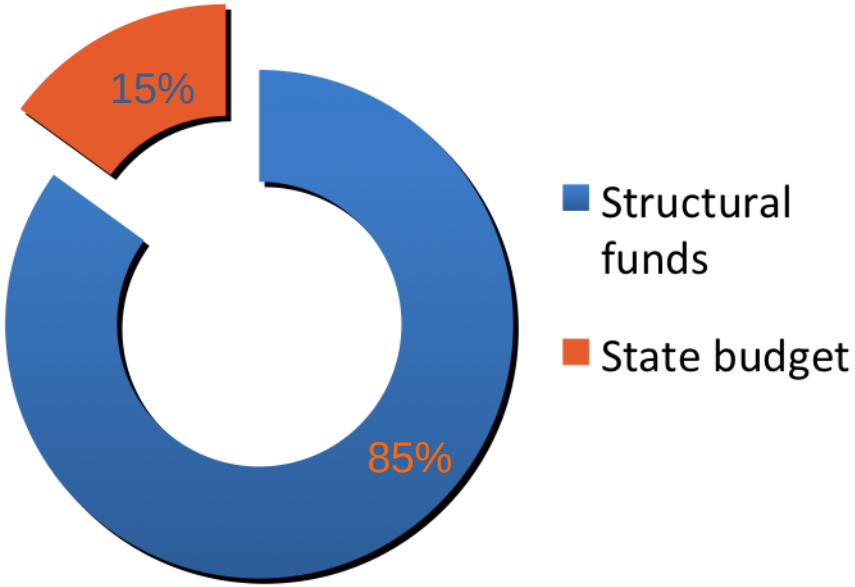
Vacuum pulse distribution

6 specialized Experimental halls

ELI Beamlines laser scheme

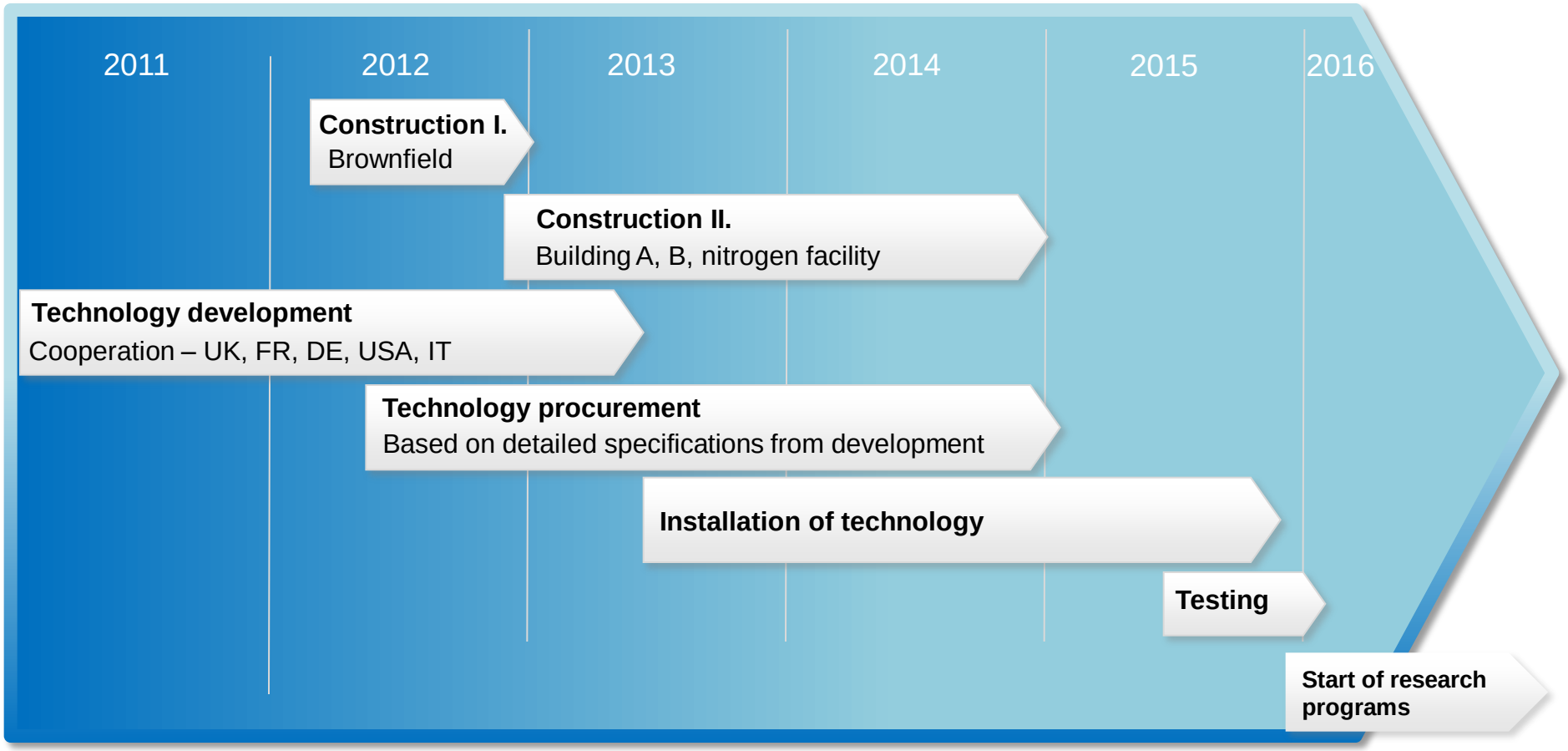


Construction budget



Budget of construction	mil. EUR
Lasers	144
Experiments	12
Supporting technology	8
Building	72
Others	36
TOTAL	**272**

Milestones



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Data challenges

Characteristics of most laser facilities today (e.g. PALS)

- Most users are from the laser plasma community (i.e. they have some technical and technological understanding of the laser system)
- Laser runs on a single-shot basis (for PALS, 1 shot every 30 minutes)
- Centralised control of the operation of the laser system and diagnostics
- Collection of data necessary for controlling the performance of the system (beam control, reliability of the system in general)
- Some of the laser parameters have to be stored during experiments and made available to the users (e.g. laser energy, laser pulse duration) in order to analyse the correlation between the results and the system itself
- Data from experiment: "visualisations" + data file containing numeric measurements or binary information (overall, typically a few tens of GB for a two-week experimental campaign with a shot every 30 minutes)
- Local acquisition system within the experimental hall nearby each detector and storage directly on the computer's hard drive.
- Issue of property: if the user is controlling the local acquisition system, the operator has no real control over the system

Data challenges

A brand new approach is necessary for ELI

- ELI will be a multidisciplinary RI open to users from other research fields than the only laser plasma community
- ELI will rely on high-repetition rate lasers (from 10 Hz to 1 kHz in the case of ELI Beamlines)
- Central server for the storage of data and the management of data access for users
- Computing model for data processing and analysis and data management system not yet defined: **exchange of best practices with RIs having experienced in this field**
- 5 dimensions:
  - Laser system control and monitoring (maximum reliability needed)
  - Computer simulation (user web interface available to users even at the stage of proposal)
  - Data acquisition (data rate needed currently under estimation, but may go up to 3 Gb/s in the case of ELI-ALPS) and real-time data processing
  - Data backup
  - Authentication and Authorisation Architecture (AAI): web-based access, remote login, data and database access.

ELI as an e-infrastructure?

Challenges of the distributed character of ELI:

- Need for strong interaction between the three implementation teams during construction (teleconference, common projects and developments, shared data, etc.)
- ELI Delivery Consortium will rely as much as possible on virtual coordination
- Need for a unified virtual research environment to organise collaboration with international partners
- The three ELI facilities will be operated jointly under a single legal umbrella: single access policy and data management system for the three facilities

Ambition to develop ELI as a physical infrastructure using the most innovative solutions developed in the world of the e-infrastructures for its staff, its partners and future users.

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