EUROPEAN
PLASMA RESEARCH
ACCELERATOR WITH
EXCELLENCE IN
APPLICATIONS

EuPRAXIA
Preparatory Phase

LPA-FEL: ELI-Beamlines vision

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for WP6 / EuPRAXIA workshop / September 23, 2024

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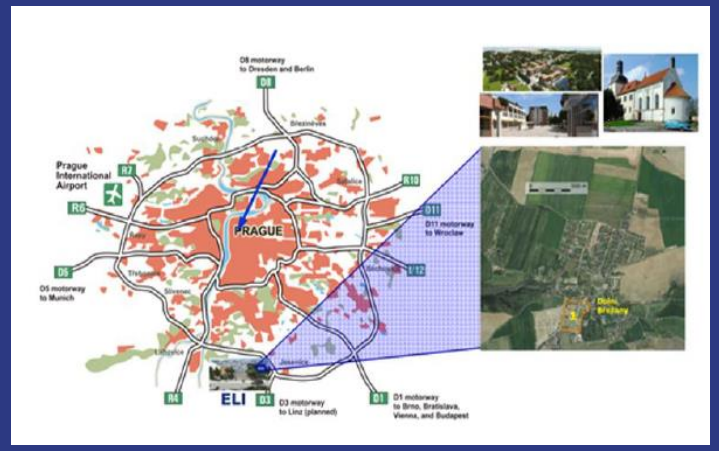
ELI-Beamlines: LPA-FEL vision

Funded by the European Union

Overview of existing facility

Location: near Prague (CZ)



eli beamlines

ELI Beamlines explores the interaction of light with matter at intensities 10 times higher than previously achievable.

4 PW class laser systems, 4 support lasers
7 Secondary sources – EUV - X-rays, Electron and Ion Accelerators
10 User stations

- 350 international staff
- Area 31,000 m2

- Structural Dynamics
- Particle Acceleration and Applications
- HED Physics and ICF
- High Field Physics

PRE-INVESTED BUDGET

… wo personal cost

ELI-beamlines building (offices, labs, halls)	Total: ~ 100 MEur
L2-LUIS technology	
L2-laser hall (including relevant technology)	~ 5 MEur
L2-DUHA laser	~ 5.5 MEur
L2-to-E5 laser beam transport	~ 1.5 MEur
E5 experimental hall @ Local Control Room (including vacuum, cooling, cabling, gases, compressed air, CS, MSI, PSS, Radiation-MS)	~ 10 MEur
E5 LUIS technology	~ 2.5 MEur
(L2-Hall) + (E5-Hall) + (L2-Laser) + (L2-BT) + LUIS	**~ 25 MEur**

L2-hall and DUHA-Laser

E5-hall and LUIS

Presented: EuPRAXIA CoE workshop / June 5-7, 2023

ELI-Beamlines: vision

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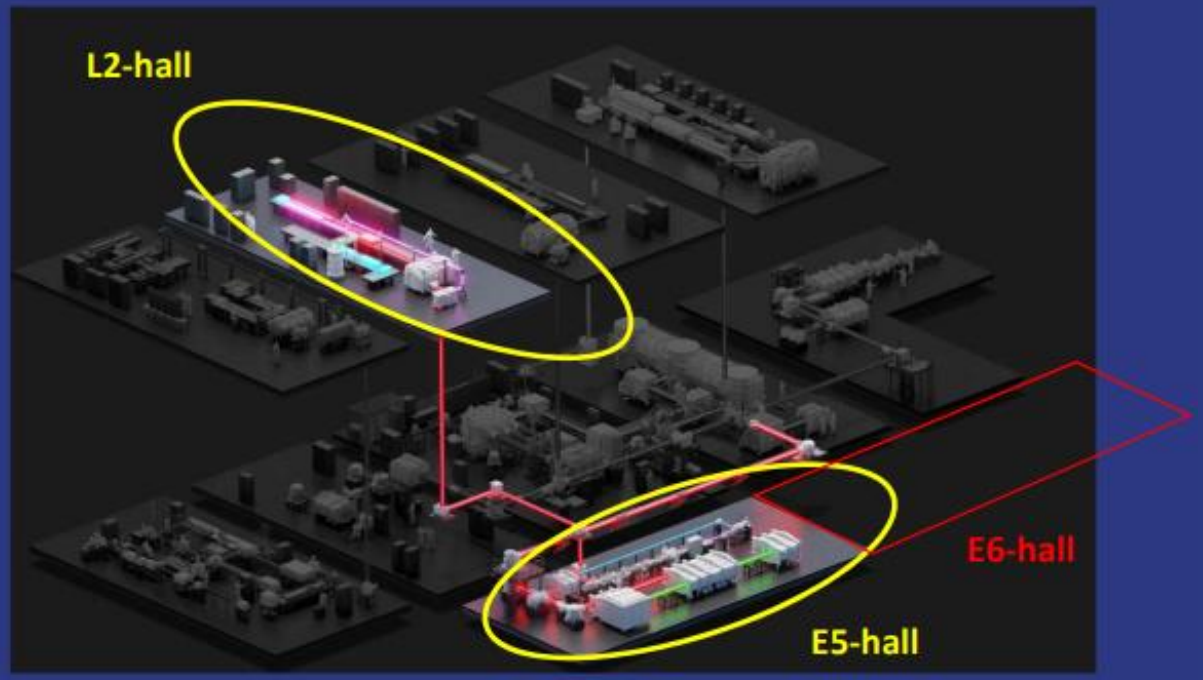
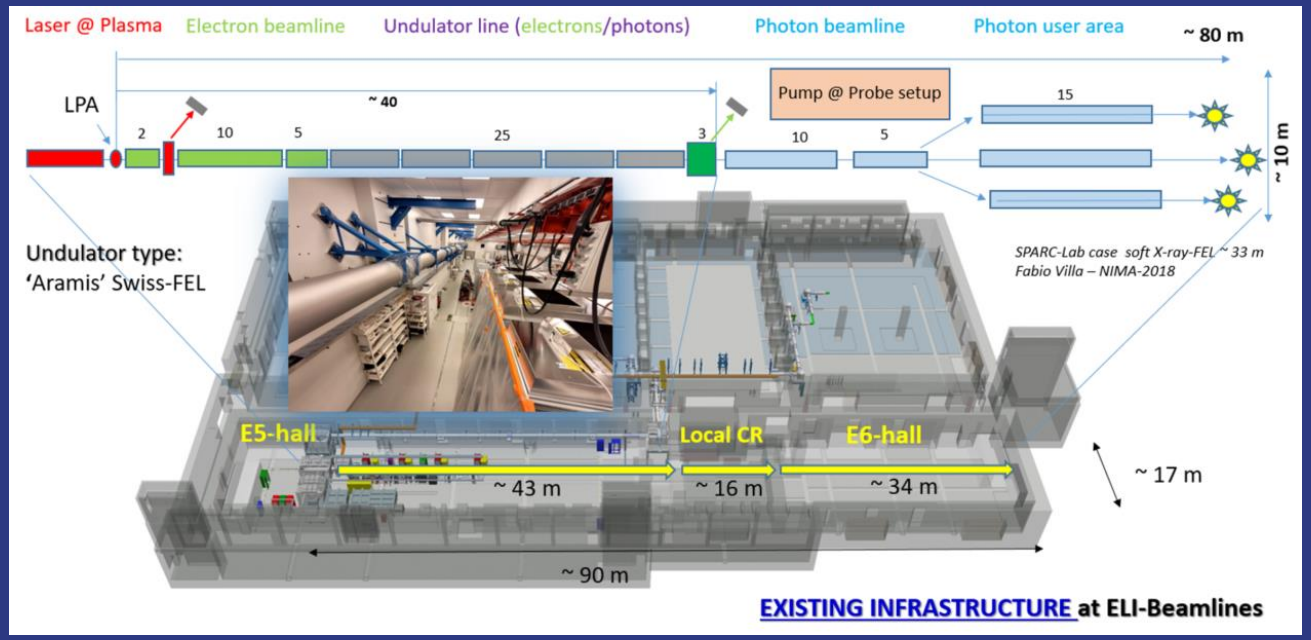
Possible usage of the existing ELI-Beamlines infrastructure for LPA-based FEL (EuPRAXIA/Phase#1 – 1GeV)



Integration of the L2-DUHA laser with the E5-LUIS experimental setup



1GeV LPA-based FEL (vision)

Presented: EuPRAXIA CoE workshop / June 5-7, 2023

ELI-Beamlines: vision

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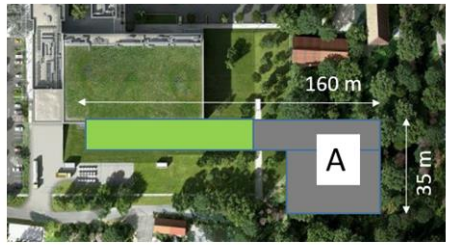
Possible usage of the existing ELI-Beamlines infrastructure for LPA-based FEL (EuPRAXIA/Phase#2 – 5 GeV)

Option-A (using existing facility)



Extension of E6 hall → extra 60 meters length

→ **Budget estimation for E6 extension**
permission @ TDR ~ 10% (NON-inv) of total budget → 1.5 year
underground work ~ **11 MEur** (INV) → + 2 years

→ **Finalization of extended infrastructure (shielding, engineering) ~ 20 MEur**

→ **Budget for other key components → TBD**

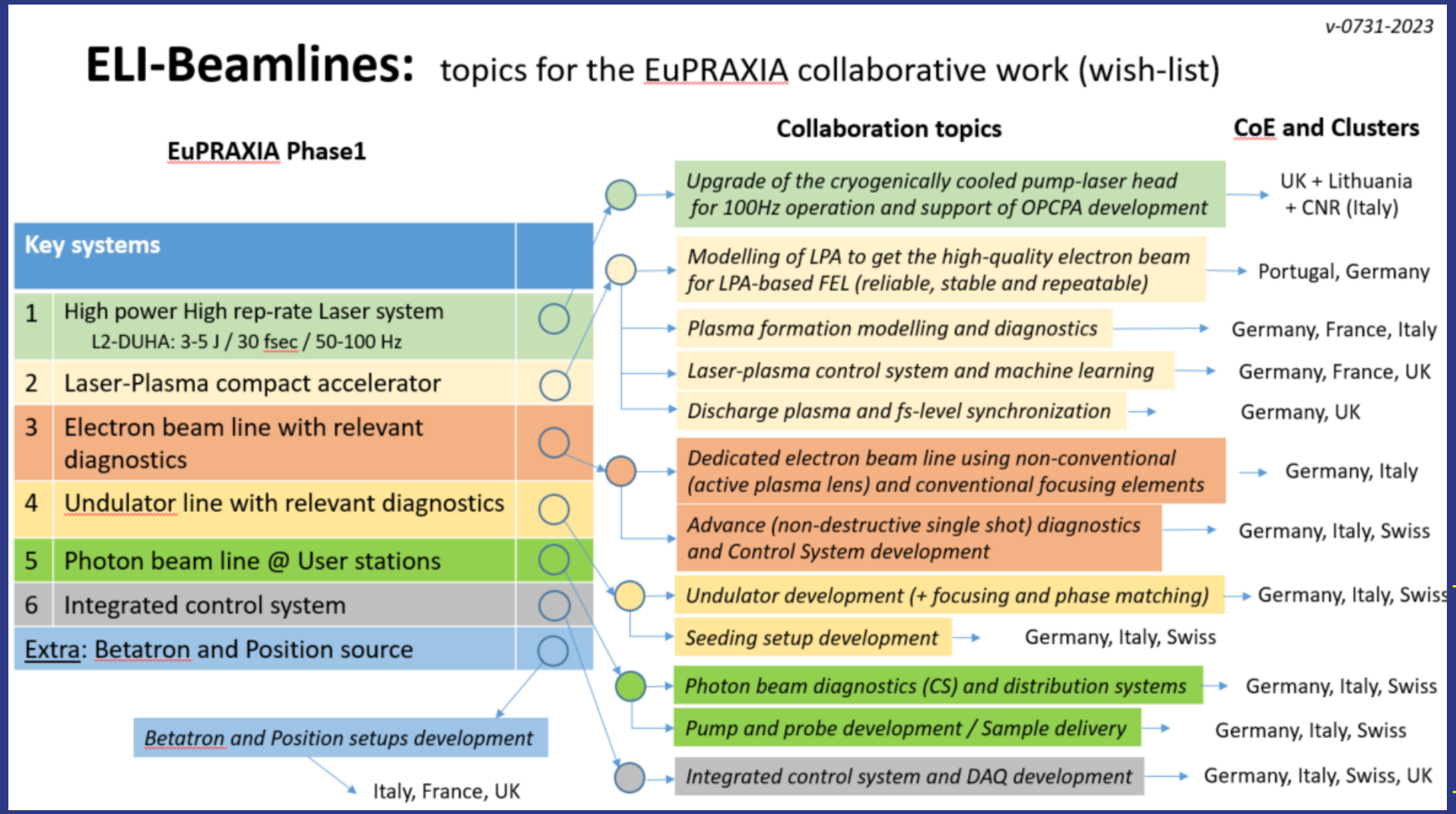
Presented: EuPRAXIA CoE workshop / June 5-7, 2023

Collaboration efforts: EuPRAXIA Consortium
Financial support from all member states
+ Contribution from Outside community

Possible time schedule:

Phase#1 … Commissioning of the setup: after 4-5 years from beginning of financing
Phase#2 … Infrastructure preparation ~ 3 years from beginning of financing

ELI-Beamlines: vision



Presented to EuPRAXIA community: July 31, 2023

ELI-Beamlines: vision

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Topics for the EuPRAXIA collaborative work (extraction from the full-list)

(4) Undulator line with relevant diagnostics

- **(4.1) Modelling Activity:** SASE and seeded FEL regimes based on the LPA-setup → start-to-end simulations with realistic imperfections (laser jitter, short-to-shot variation of the plasma parameters, alignment and field errors of conventional magnets)
- **(4.2) Design of the undulator line and procurement of all components, including focusing phase-matching elements in the inter-section areas and relevant diagnostics**
- **(4.3) 'Seeded-FEL' setup development** (from main conceptual solution to realization)

(5) Photon beam line @ User stations

- **(5.1)** Design of the **photon beam line** from the undulator line up to user stations, including the photon beam diagnostic with relevant control system and distribution setup (3 user stations at the end of the photon beam line)
- (5.2) **"Pump and probe" setup** development, including the **sample delivery systems** for each user station

(6) Integrated control system and DAQ → Development of the **integrated control system** and **DAQ**

ELI-Beamlines: vision

Funded by the European Union

Thank you for your attention

ELI-Beamlines: vision / machine operation

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Laser operation for users: example – L3-HAPLS sharing between different experimental halls

Requirements: stable, controllable, flexible including PSI/MSS systems

L3-HAPLS team