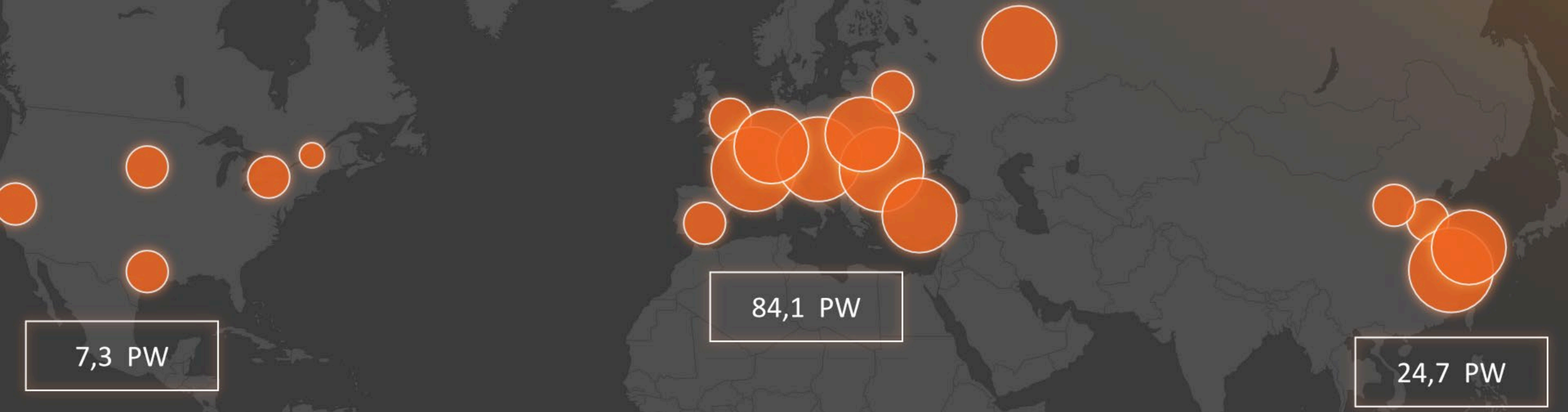
Big Science Partner & Industry Day

Cracow, 12 January 2024

Aleš Hála, Head of Innovation office

A European Research Infrastructure Consortium

Investment in high-power laser systems is connected to a strong and relatively consolidated community in Laserlab Europe beginning in 2001.

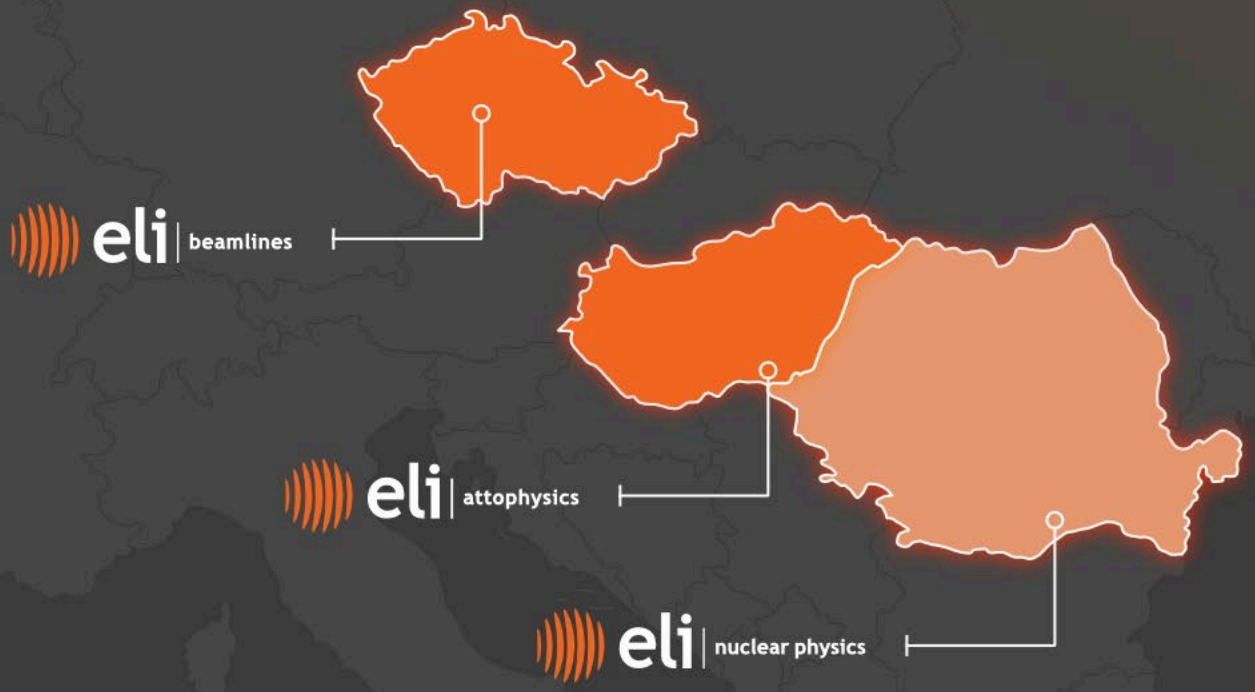


Europe leads the world in laser production and installation, especially state-of-the-art systems.

Courtesy of J.L.Collier

ELI ERIC - Multisite Infrastructure

- ELI is on the European ESFRI Roadmap since 2006!
- Investment has driven leadership in laser and photonics
- Projected total peak power for high power laser systems operational and under construction is by far world-leading
- ELI Facilities are introducing 3 @10PW and 6 @PW-class lasers,
- Total investment ca 1 Billion EUR
- ELI ERIC organization mandated to operate ELI Facilities



eli beamlines

- Secondary sources – beamlines of high energy photons, electrons, protons, neutrons, muons
- Medical imaging and diagnostics, radiotherapy
- New materials
- X-ray optics
- Plasma Physics, High Energy Density and High-field Physics
- Fusion

eli attophysics

- Ultrafast physical processes
- Chemical, medical and materials science analysis
- Attosecond measurement techniques
- Biological imaging technologies
- Artificial photosynthesis
- Nanoscience

eli nuclear physics

- Photonuclear Physics
- High power laser system
- Brilliant energy tunable gamma-ray beam system

Laser parameters – ELI Beamlines (CZ)

Synchronization within <100 fs by master facility clock

L1 – ALLEGRA

Technology
- OPCPA
- Circular
- Gaussian
- Synchronized probe beam

Parameters

Nominal	Current
100 mJ	55 mJ
1 kHz	1 kHz
15 fs	15 fs

L2 – DUHA

Technology
- OPCPA
- Circular
- Flat-top
- Synchronized mid-IR pulse

Parameters

Nominal	Current
2 J	WORK
3 Hz	IN
<40 fs	PROGRESS

L3 – HAPLS

Technology
- Ti:Sapphire, DPSSL
- Square, 250x250 mm^2
- Flat-top

Parameters

Nominal	Current
30 J	13 J
10 Hz	3.3 Hz
30 fs	30 fs

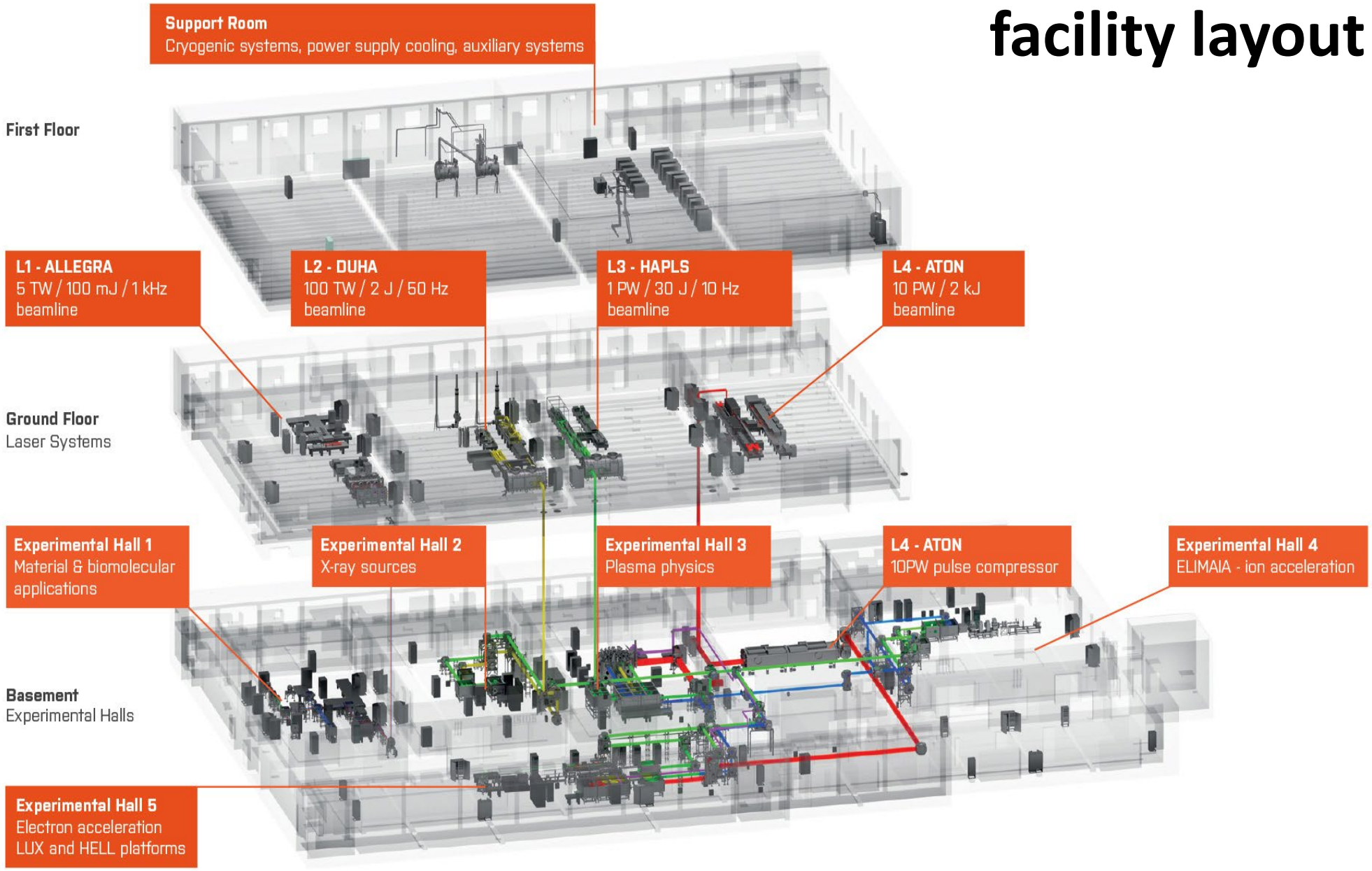
L4 – ATON

Technology
- Nd:glass
- Square, 550x550 mm^2
- Flat-top
- Longer beams (ns and ps)

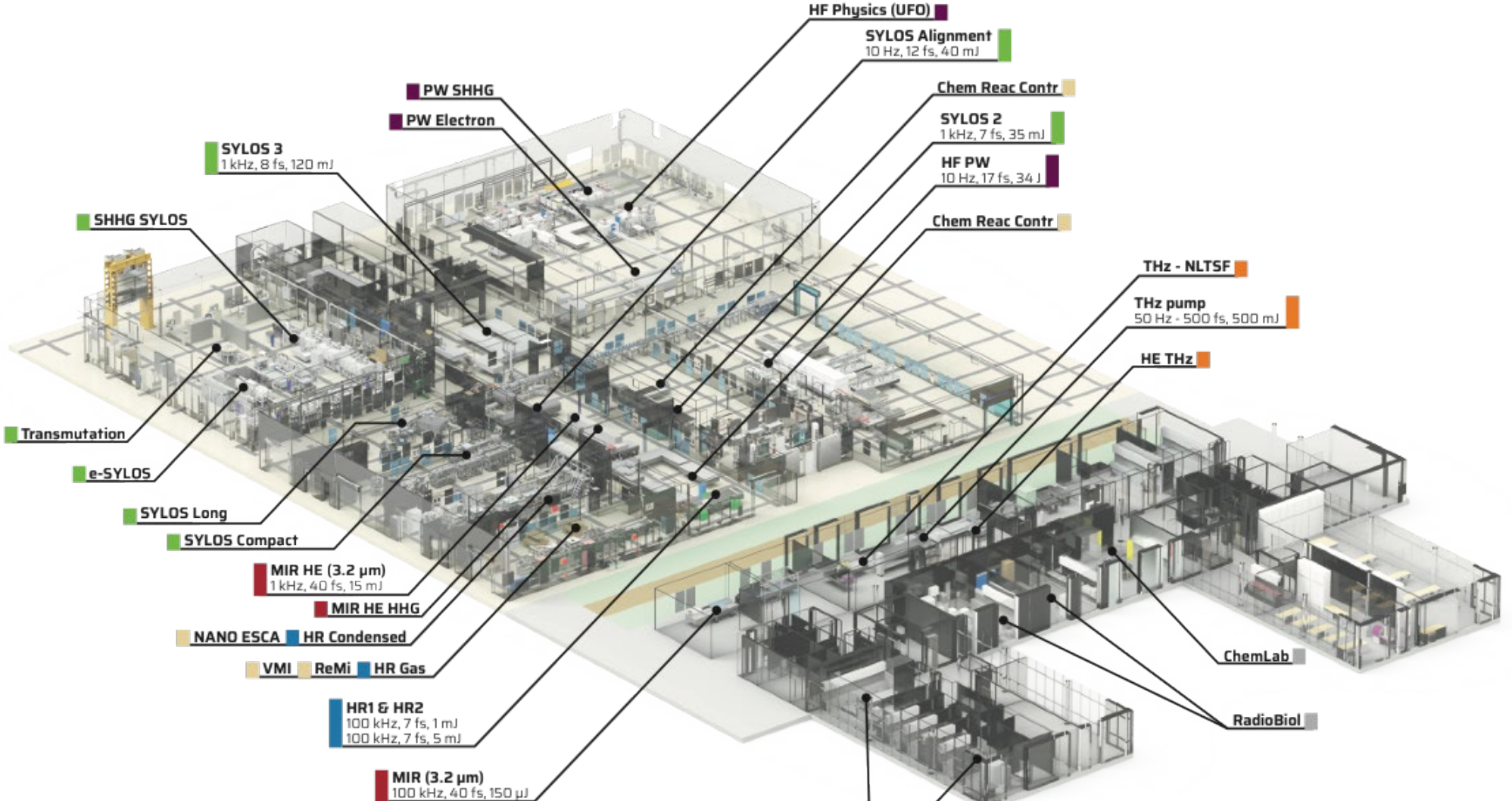
Parameters

Nominal	Current
1.5 kJ	1.5kJ
1/min	1/5min
150 fs	

ELI Beamlines (CZ) facility layout



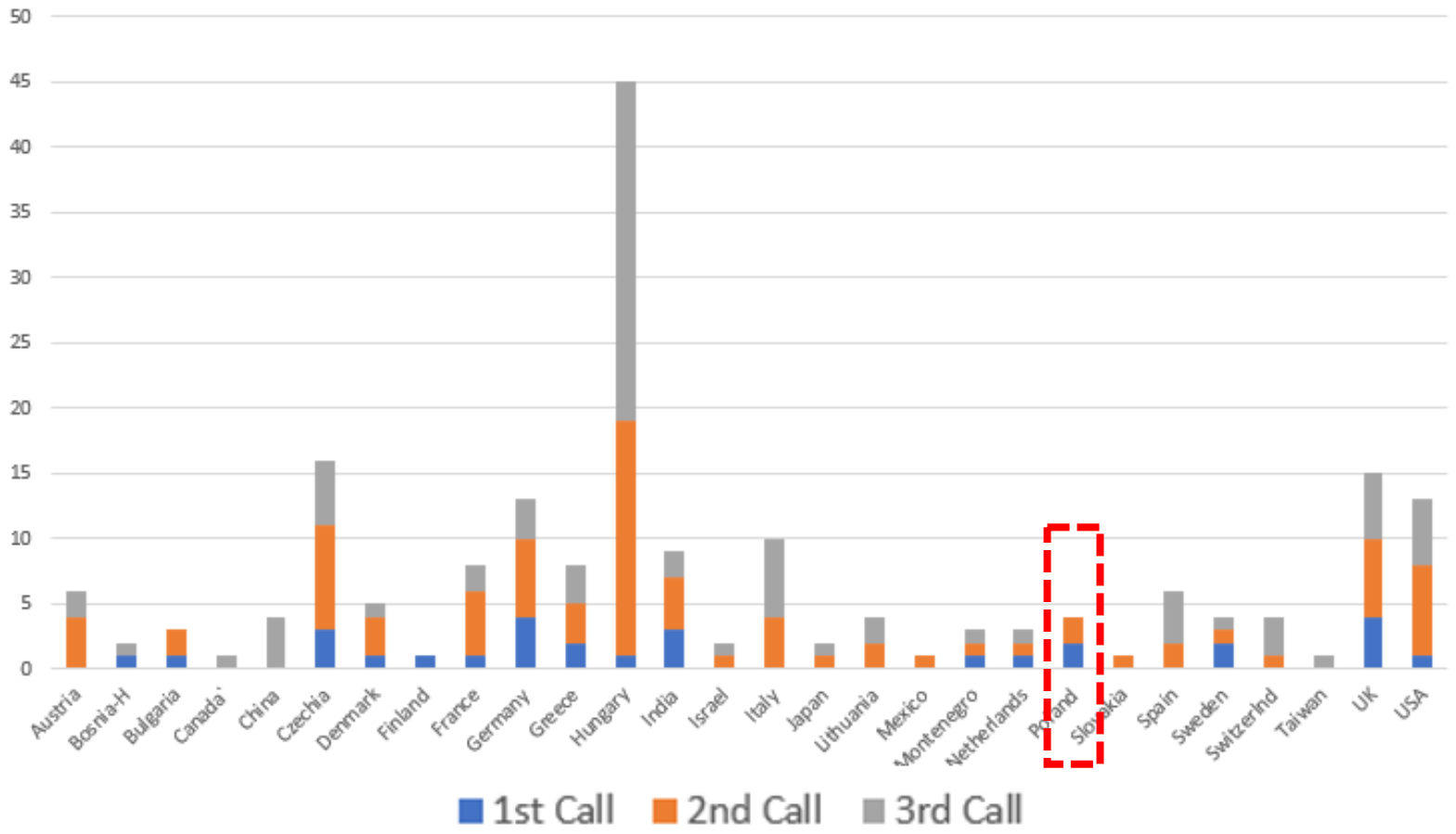
ELI ALPS (HU)
Facility layout and laser parameters



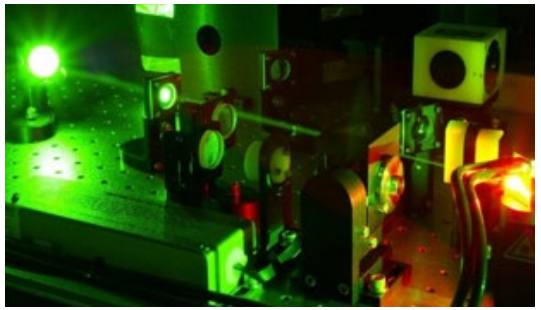
User access

The first 3 ELI user calls received 227 proposals from 28 countries

	1st Call	2nd Call	3rd Call
ALPS	11	35	38
BL	17	49	33
NP	16	18	10



ELI science case

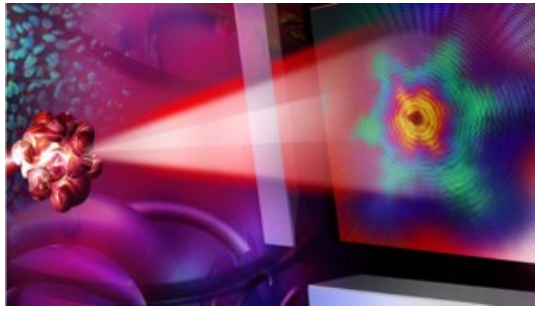


Laser research

Soft to hard x-rays

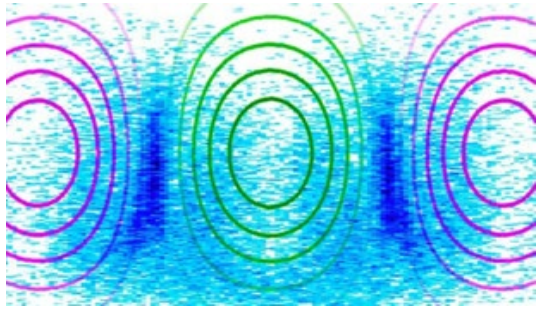
Particle Acceleration
250 MeV Ions, 10 GeV e^-

Nuclear Physics and Photonics

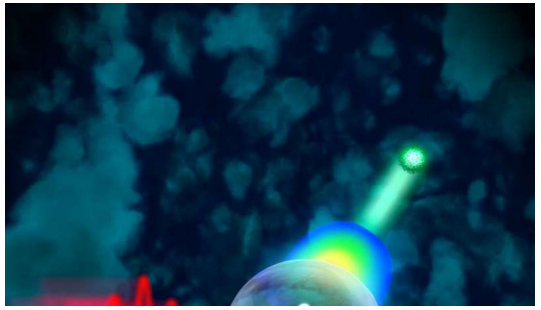


Material Science and Biology

Plasma Physics and High
Energy Density, Astrophysics



Ultra High Intensity Interactions
High-field physics and theory



Ultrafast, attosecond dynamics

Training a new generation of scientists and experts

- ELI welcomes doctoral and master level students from diverse fields
- There are over 40 students currently working at ELI and doing their research
- Internship Program 30+ students annually

Collaboration with Poland

- **ELI-Polska Consortium** established in 2019 with 11 institutes
- Education and training activities: **24 Polish students trained** at the ELI facilities resulting in 2 bachelor, 1 master and 2 PhD theses defended
- **ELI Summer School** participation
- **4 Polish user experiments** proposed in ELI user calls

SOLARIS
NATIONAL SYNCHROTRON
RADIATION CENTRE

Activities in Poland

- 28 Sep 2021 – **Round table meeting** in Warsaw with Polish stakeholders
- 7 – 8 March 2023 – **ELI–Poland Information day** organised at IFJPan (Cracow) incl. visit to synchrotron Solaris (60+ participants representing ELI-Polska Consortium)
- June 2023, support to the Polish Conference in Zakopane

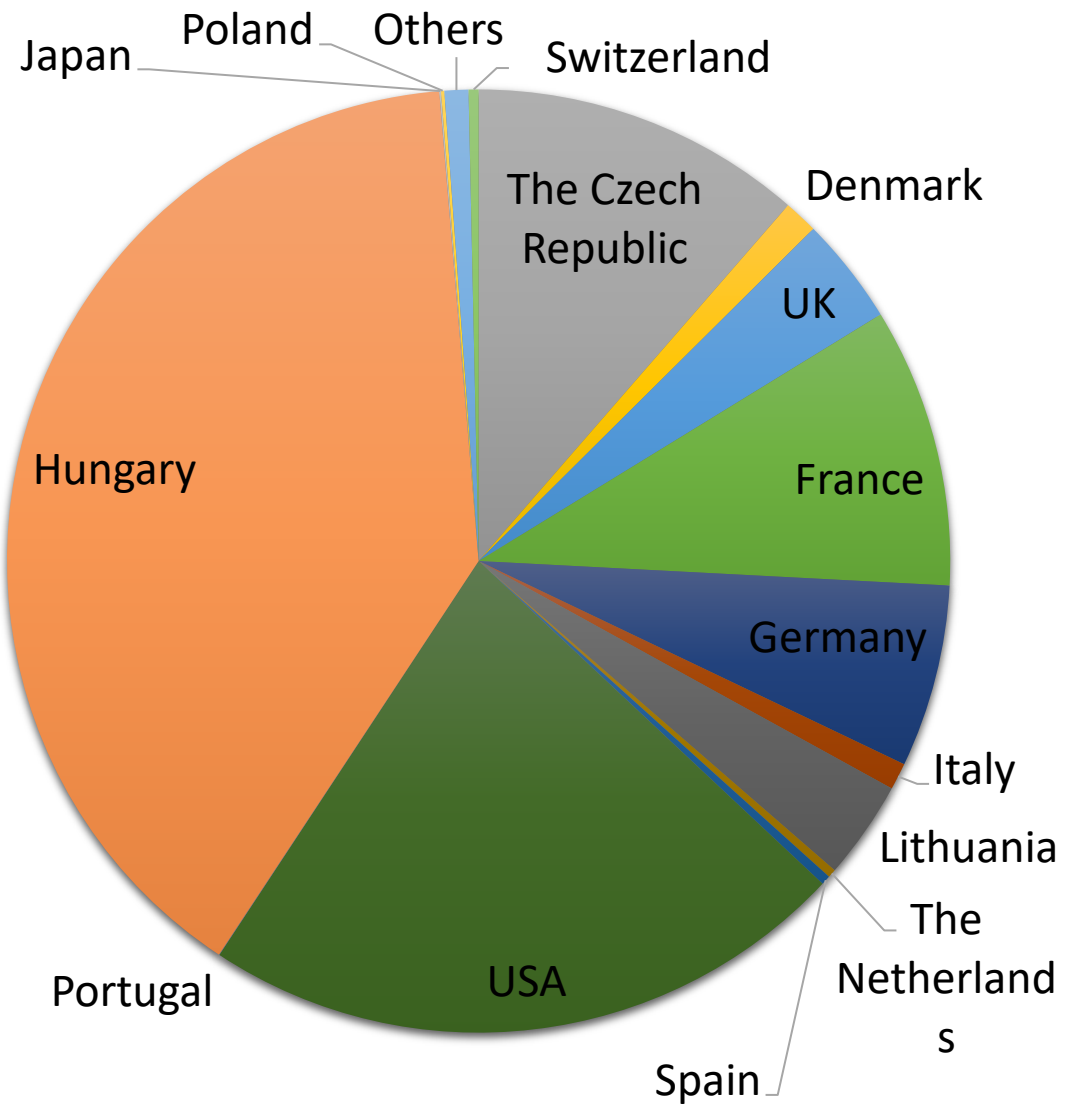
Key conclusions and next steps

- Aim to build on existing collaborations
- Identify and expand on synergies between the facilities
- Promote cooperation on education and training
- Targeted outreach to users about ELI's scientific offer for access
- Outreach to broader research community in Poland

Business opportunities – overwiev

Technology suppliers to ELI

Country	Contracted value million EUR
Czech Republic	42.7
Denmark	4.8
United Kingdom	15.3
France	39.8
Germany	26
Italy	3.8
Lithuania	14
The Netherlands	1.2
Spain	1.4
Portugal	0.06
USA	92.4
Poland	**0.8**
Hungary	163.5
Japan	0.2
Romania	0.5
Switzerland	1.4
Others	3.4
TOTAL in HU and CZ (w/o RO)	**415**



eli

Poland

Optics & Photonics

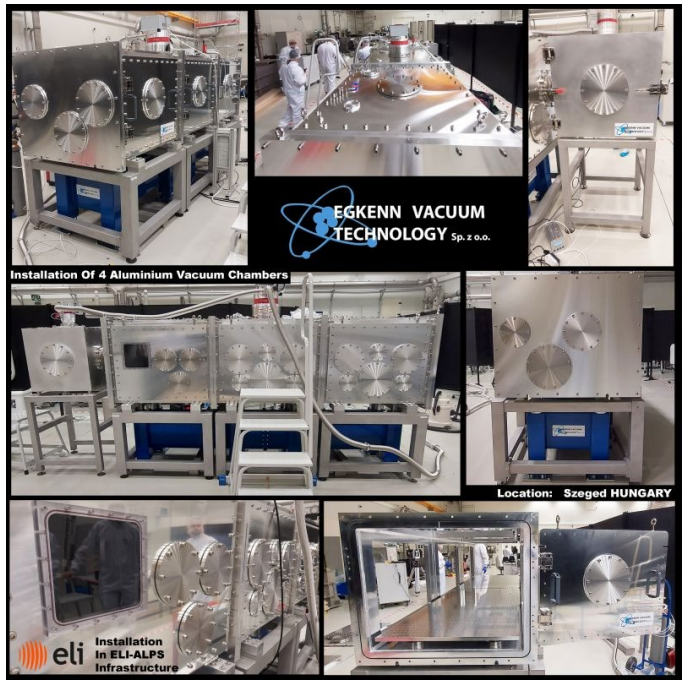
VIGO PHOTONICS

LAMBDA SYSTEM

Vacuum systems & Components

PREVAC

X-RAY PROTECT



Electronics, Detectors & Others

ANIMA LAB

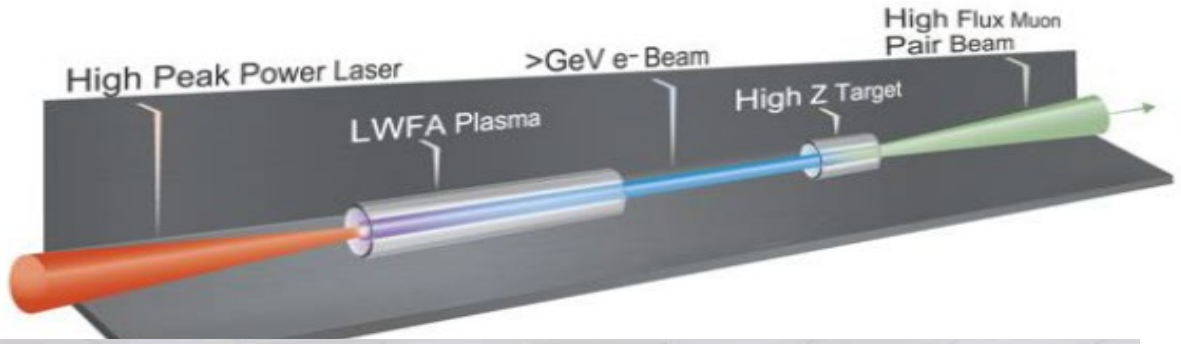
creotech

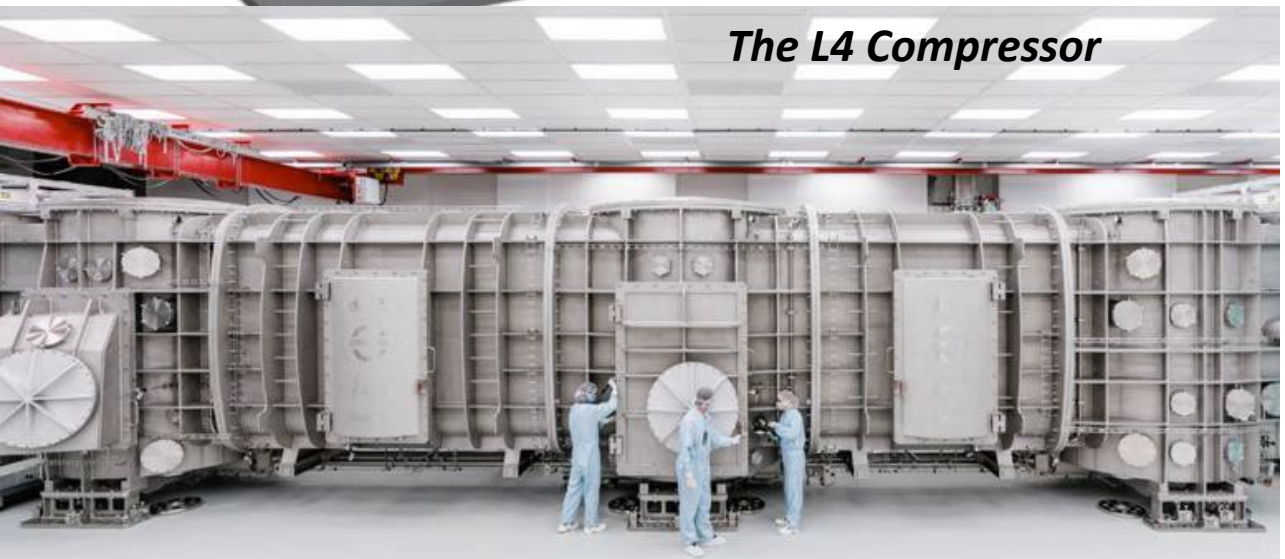
CRI JOLANTA COMPUTERS & ROBOTICS INSTITUTE

Intense and Compact Muon Sources for Science and Security

Lawrence Livermore National Laboratory · Colorado State University · University of Maryland · Berkeley Lab · XUV LASERS · Lockheed Martin

7.3m USD for ELI / ELI provides 4m matching fund to develop the beam transport to E5 experimental hall





DARPA USD 27 m / 4 years / 2 phases

Unique capabilities for LWFA

- L4 ATON laser system: energy 1.5kJ, peak power 10 PW, 1 shot 1 per min
- Ideal opportunity for realizing LWFA of electrons to >10 GeV energies and muon production

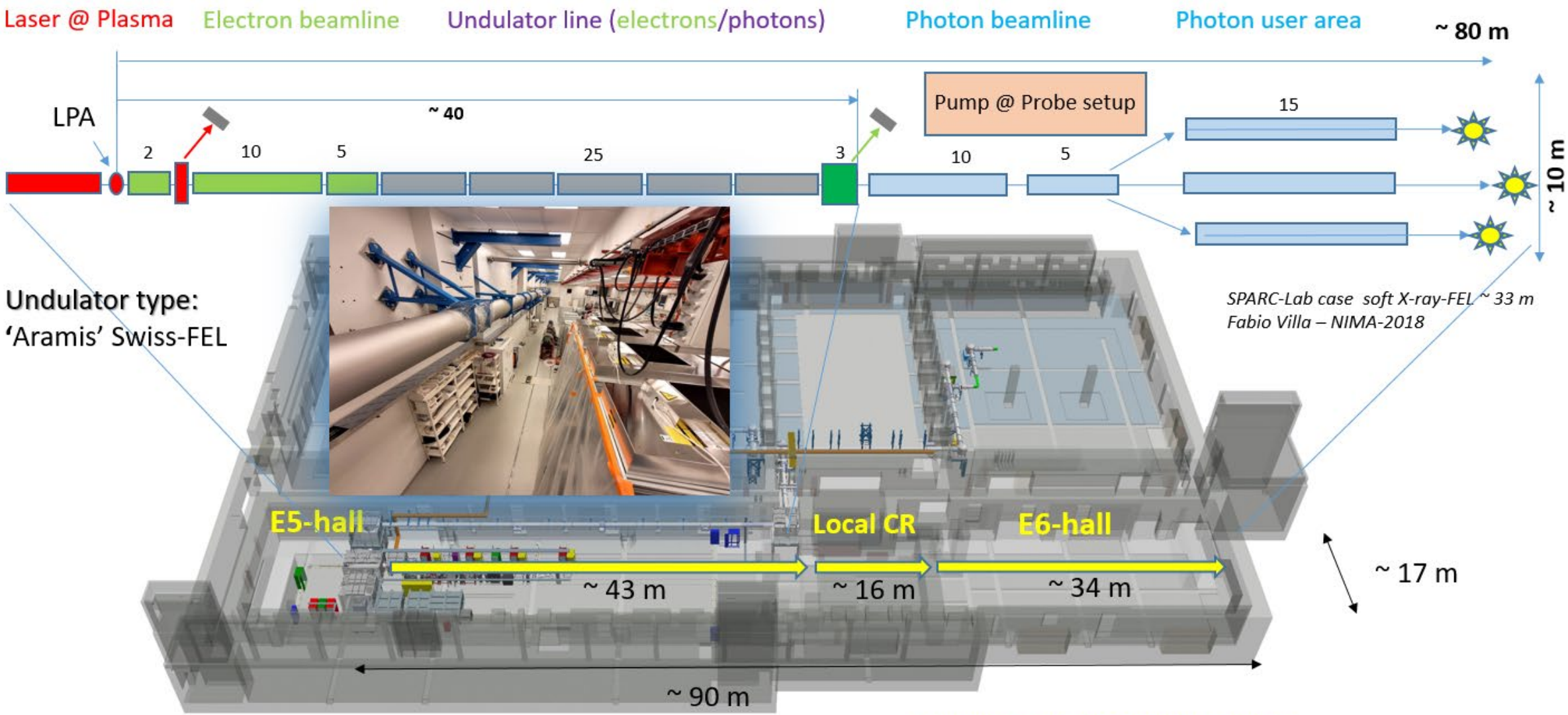
Strong competence

- Modeling and simulations to 100 GeV
- Monte-Carlo simulations for muon detection and radiation shielding

Attracting leading users

- Extend on-going collaboration with US

ELI Beamlines: infrastructure – 1st phase – 1 GeV case

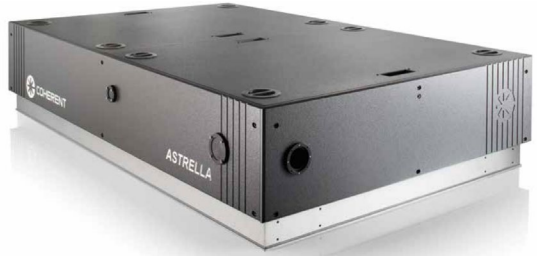


EXISTING INFRASTRUCTURE at ELI-Beamlines

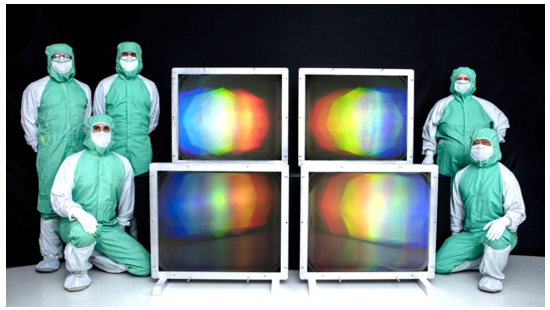
Strategic procurement areas

Priority procurement areas

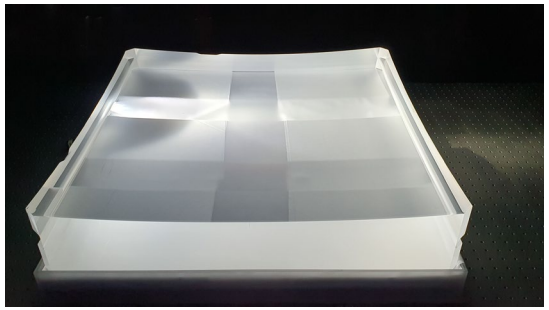
- Optical and opto-mechanical components
- Optics coating
- Detectors
- Electronics
- Data infrastructure
- Cyber security infrastructure
- Vacuum infrastructure
  - Vessels, valves, bellows



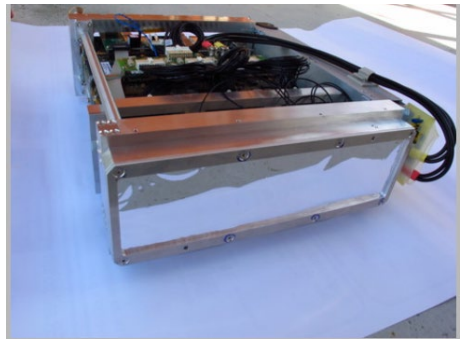
Spare parts/maintenance needs in 2023/2024



L4f gratings – 800k EUR/2pcs (5 years cycle)

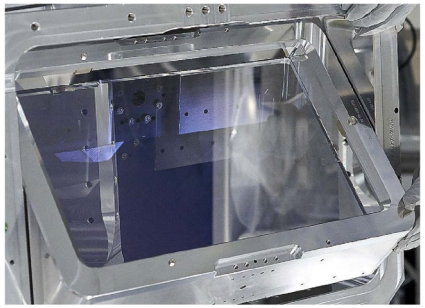


L4f OAP – 500k EUR/pcs (4 years cycle)



Eiger Detector – 200k EUR (4 years cycle)

L4f mirrors – 400k EUR/pcs (4 years cycle)



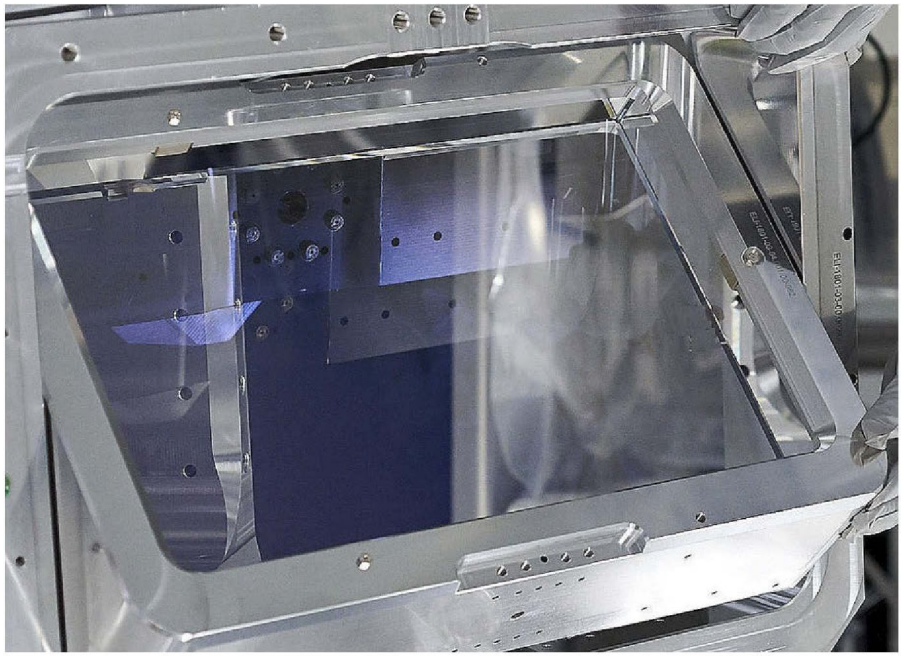
L3 mirrors – 15k EUR/pcs (4 years cycle)

Diode pulsers – 20k EUR/pcs (4 years cycle)

Tender areas in 2024 (I)

Laser systems

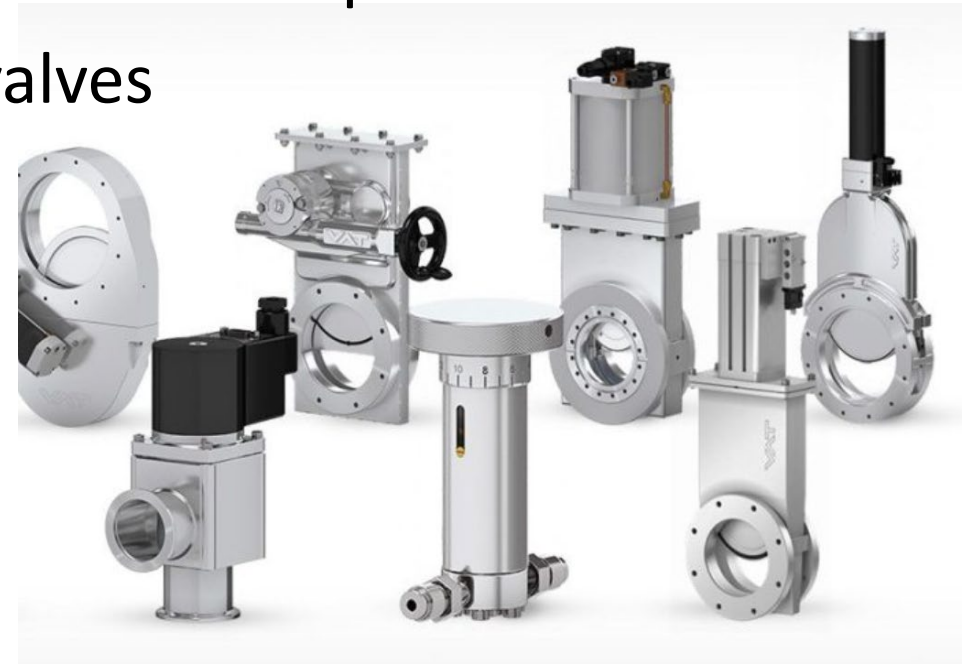
- **Expected expenditure of 1.8M EUR**
- mirrors, crystals, laser windows, actuators
- oscillators, servers

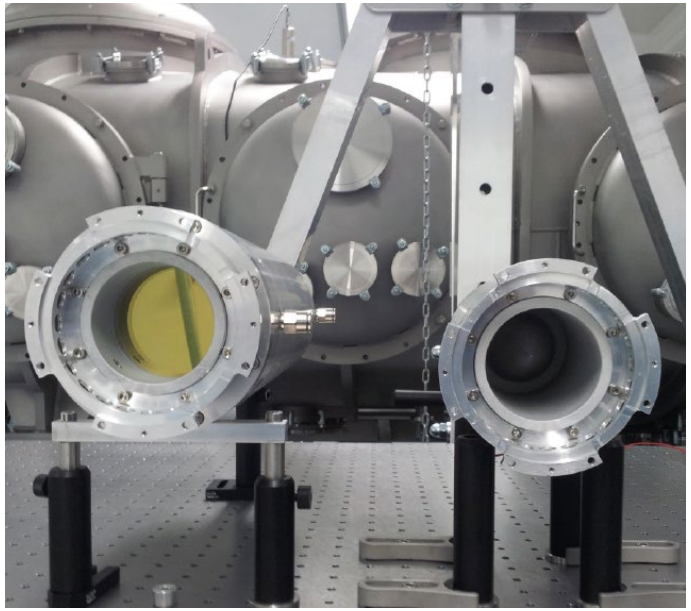


Tender areas in 2024 (II)

Laser beam transport

- **Expected expenditure of 850K EUR**
- mirror substrates coating, mounts and breadboards
- actuator controls, beam dumps
- vacuum motors, valves





Tender areas in 2024 (III)

Research programmes

- **Expected expenditure of 520K EUR**
- data acquisition, master electronics, VUV optics
- opto-mechanics and motion stages, sample delivery systems, imaging cameras and photon spectrometers
- off-axis parabolic and flat mirrors incl. coating

Tender areas in 2024 (IV)

Coating lab

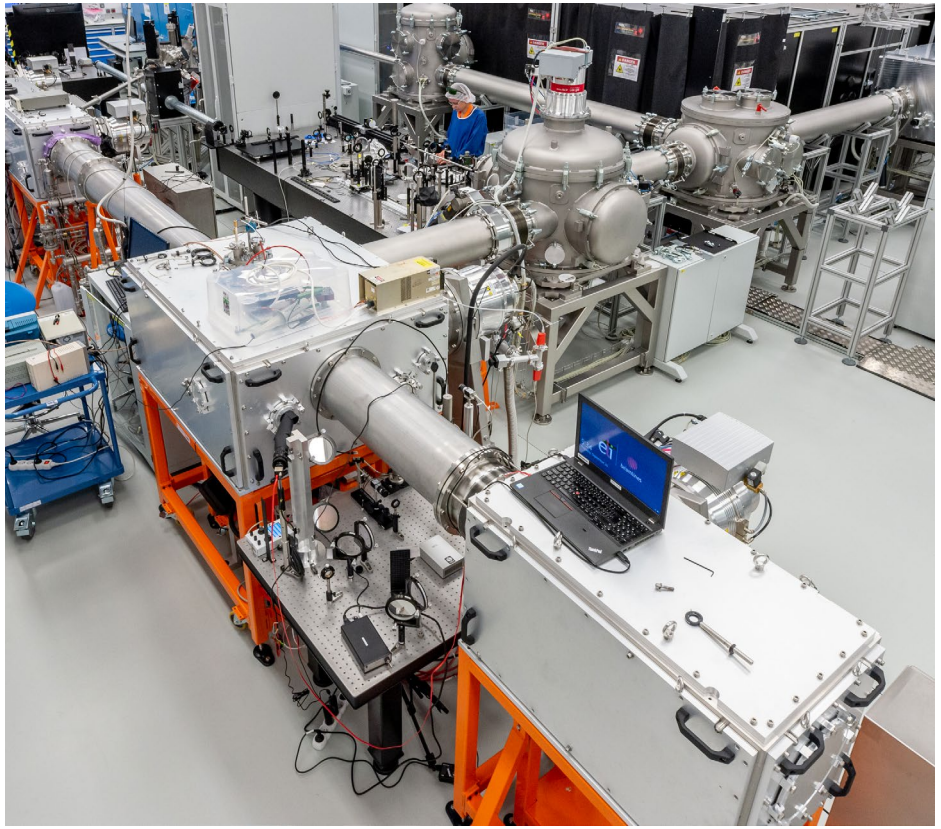
- **Expected expenditure of 125K EUR**
- ion sources

Safety

- **Expected expenditure of 120K EUR**
- radiation shielding, passive dosimetry

Workshops, labs

- **Expected expenditure of 112K EUR**
- total productive maintenance, vacuum pumps



Detailed procurement plan 2024 (I)

System	Tender	Estimated cost (EUR w/o VAT)	SPECIFICATION
Beam Transport L3	Vacuum motors / actuators	44,000 EUR	High-precision high-load vacuum compatible electrical actuators driven by stepper motors including motor controllers. Actuators are required to be compatible with vacuum pressures of 10^{-6} mbar or lower. A single-axis linear motion driven by the stepper motor is considered as well as an axial load capacity of at least 10 kg (100 N). Minimum step, i.e., minimum incremental motion, of the actuators in full step shall be 0.1 µm or less with a maximum speed of 0.2 mm per second or higher.
Beam Transport L3	Spare mirror substrates	128,000 EUR	A set of spare mirror substrates to transport 1 PW, 30 J, 30 fs, 10Hz, 820 nm beam of L3 laser. Mirror substrates are of rectangular shape with approx. dimensions 440 x 300 x 75 mm. Material Corning HPFS 7980 mirror fused silica without open bubbles on the front reflecting surface. Substrates shall be biased (wavefront prefigured) to meet wavefront, gradient distortion specification after coating.
Beam Transport L3	Turbomolecular pumps	68,000 EUR	DN250 oil-free, i.e. equipped with magnetic levitation at the high-vacuum vacuum side and acceptable with vacuum compatible lubricants at the exit side. Pumping speed over 2000 l/s, ISO F inlet connection; water cooled.
Beam Transport L4f	High vacuum compatible actuators with controls	50,000 EUR	Actuators will be installed into the optomechanical system of beam transport delivering the L4's 10PW beam. Actuators are required to be compatible with vacuum pressures of 10-6 mbar or lower. A single-axis linear motion driven by the stepper motor is considered as well as an axial load capacity of at least 40 kg (400 N).
Beam Transport L4f	Beam dump	48,000 EUR	Cooled hollow metal construction with multiple glass slab inserts to ensure maximum beam scatter to "shell" walls.
Beam Transport L4f	Mounts OMx	105,000 EUR	Mechanical fixation of large L4 mirrors with nominal dimensions 1000 x 800 mm, mass of mount approx. 300kg – 400 kg (mirror itself about 200kg); the mount should ensure min. two rotations around axis passing through the center of mirror's optical surface; the mount will operate in ISO 7 to ISO 5 environments
Laser 1	Replacement of main laser oscillator	260,000 EUR	Broadband femtosecond ytterbium doped oscillator with frequency 80 MHz and with integrated OPA module. Required are two synchronized outputs: one broadband pulse compressible to 15 fs with a central wavelength of 800 nm, and one pulse with central wavelength of 1030 nm and pulse duration max 6 ps. A possibility of synchronization with external reference is required as well.

Detailed procurement plan 2024 (II)

System	Tender	Estimated cost (EUR w/o VAT)	SPECIFICATION
Laser 3	SBM8, SBM9, SBM10 large mirrors	50,000 EUR	Mirrors for transport of the beam between Beta amplifier and Compressor. SBM8 and SBM9 have rectangular shape of approx. 280x280x80 mm, SBM10 has rectangular shape of approx. 400x280x80 mm. Material is Corning HPFS 7980 or similar. The SBM8 mirror front face is spherical with radius of curvature 14552 mm +/-5%. The other two mirrors are flat. The front faces of the SBM8 and SBM9 mirrors have HR coating for 720-880 nm @ 4.5° AOI, p-pol., The front face of the SBM10 mirror has HR coating for 720-880 nm @ 45° AOI, p-pol.
Laser 3	Wavefront correction phase plate	90,000 EUR	Transmissive window polished to a specific shape that corrects for the aberration from the main L3 beam collimating mirror SBM8. Rectangular shape with 210x210x15 mm dimensions, made from Heraeus Suprasil 312 or similar. The substrate has 0.05° wedge. The input and output face is AR coated for 740-870 nm.
Laser 3	Alpha Ti:sapphire crystal	60,000 EUR	Ti:sapphire crystal for the Alpha amplifier - gain medium in which the pulse is amplified. Rod of 3 cm diameter and 3 cm length. AR coating for 532 nm and 760-860 nm. Absorption coefficient 1 cm-1 @ 532 nm.
Laser 4	Actuators for PA1 and PA2 mirrors	50,000 EUR	. Actuators are required to be compatible with vacuum pressures of 10-6 mbar or lower. A single-axis linear motion driven by the stepper motor is considered as well as an axial load capacity of at least 50 kg (500 N). Minimum step, i.e., minimum incremental motion, of the actuators in full step shall be 50 nm or less with a maximum speed of 50 µm per second or higher.
Laser 4	Control Servers	75,000 EUR	1U rack-mount form factor PC with temperature resistance to 50 degrees Celsius ambient temperature and an expansion slot supporting PCIe graphics card (up to 75Watts).
Laser 4	PA1/PA2 5K chiller	48,000 EUR	Chillers to cool down the L4's Power Amplifiers. High-capacity thermoelectric chiller providing up to 5500 Watts of cooling capacity with ± 0.05°C stability at constant load. The chiller should provide precise temperature control.
HED / P3 Plasma	Hi-speed detector (camera)	100,000 EUR	Hybrid pixel detector for free-electron laser (FEL) applications, operating at 120 Hz frame rate, providing an ultrahigh dynamic range (245 eV to 88 MeV) through gain auto-ranging. High dynamic range x-ray imaging spanning more than 4 orders of magnitude dynamic range (from a single photon to 11000 photons/pixel/pulse at 8 keV). The low noise levels allowing usage with long integration times at non-FEL sources.
LUIS	Photon-beam diagnostic chamber	120,000 EUR	A compact rectangular vacuum chamber (800 x 1400 x 1200 mm) for diagnostics technology dedicated to diagnostic of incoherent photon radiation generated by electrons passing through a compact undulator, and focusing of the photon beam. The chamber shall be designed and manufactured for operation at a vacuum level better than 10-6 mbar. It will consist of stainless-steel body with removable aluminium walls and an internal breadboard on support mechanically separated from the chamber support.

https://eli-laser.eu/procurement/

Procurement rules

Open procurements

Thank you for your attention

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