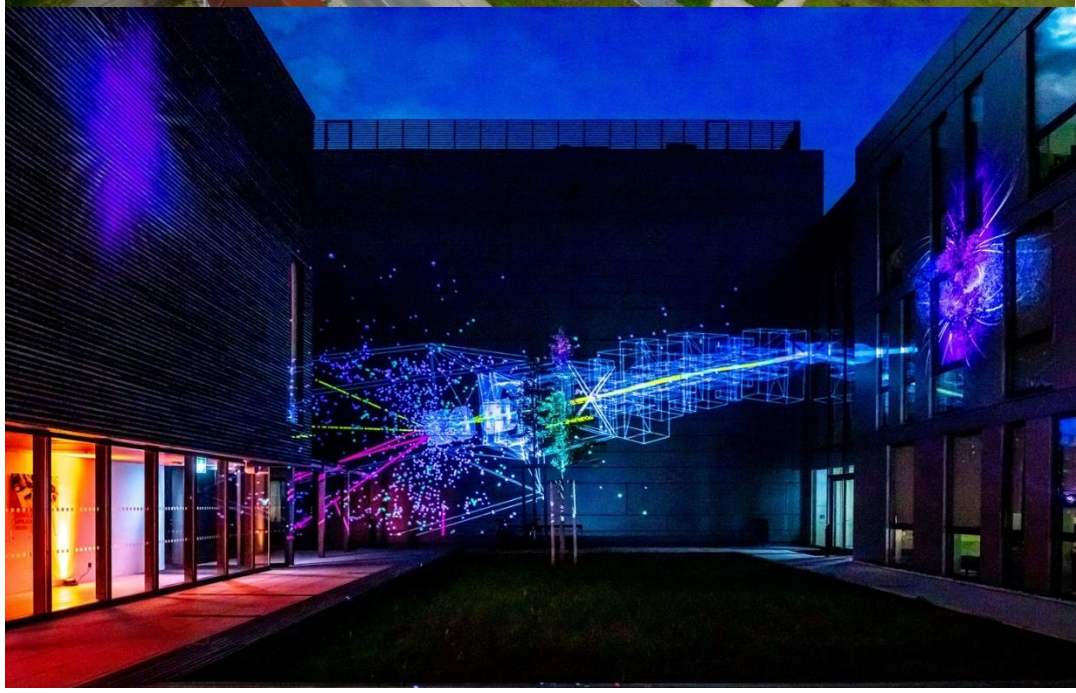
ELI Beamlines:
Laser Infrastructure of the Czech Republic



S. Weber

ELI-Beamlines, Czech Republic

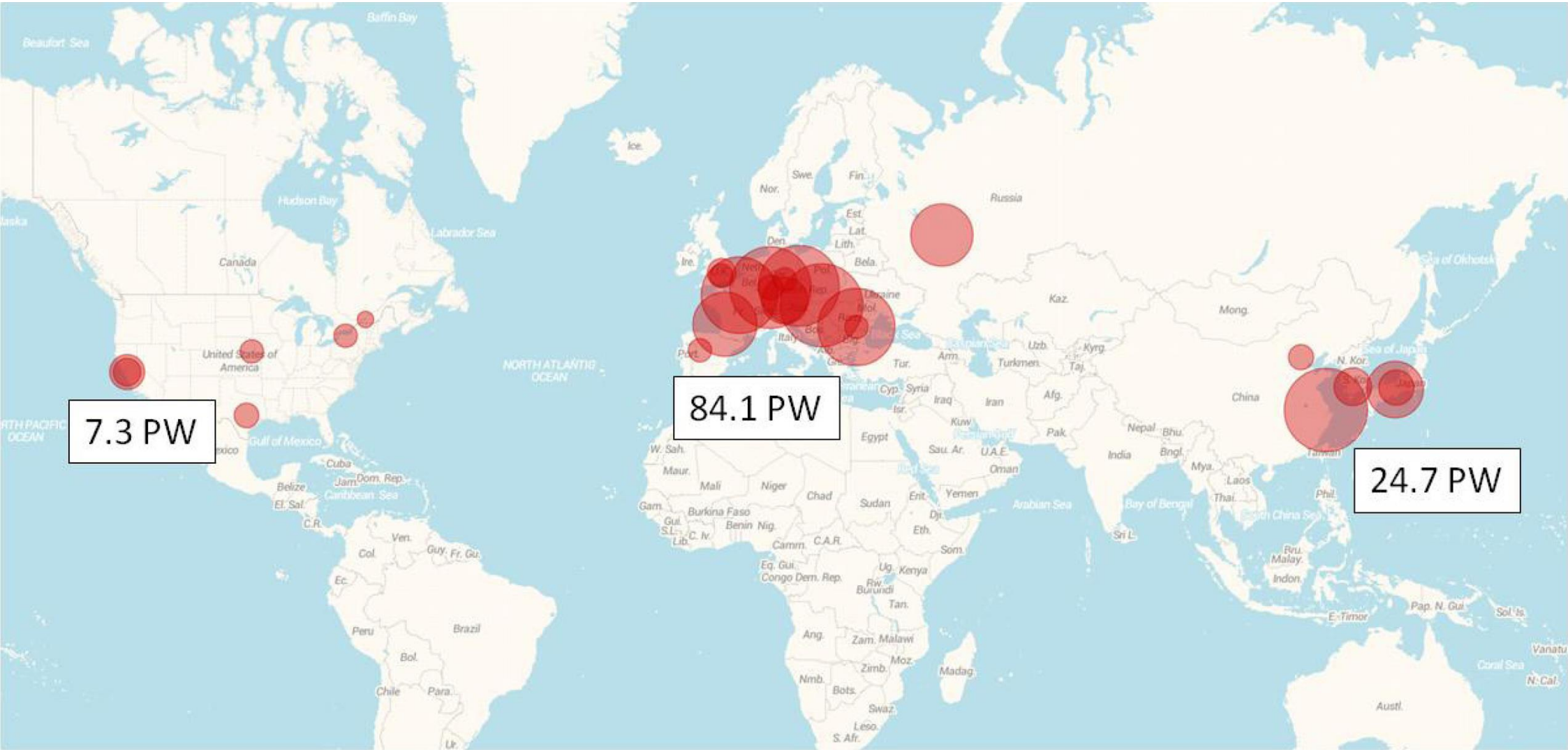
Ungarischer Tag der Wissenschaft & Berlin Science Week 12/11/2020

FZÚ

EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

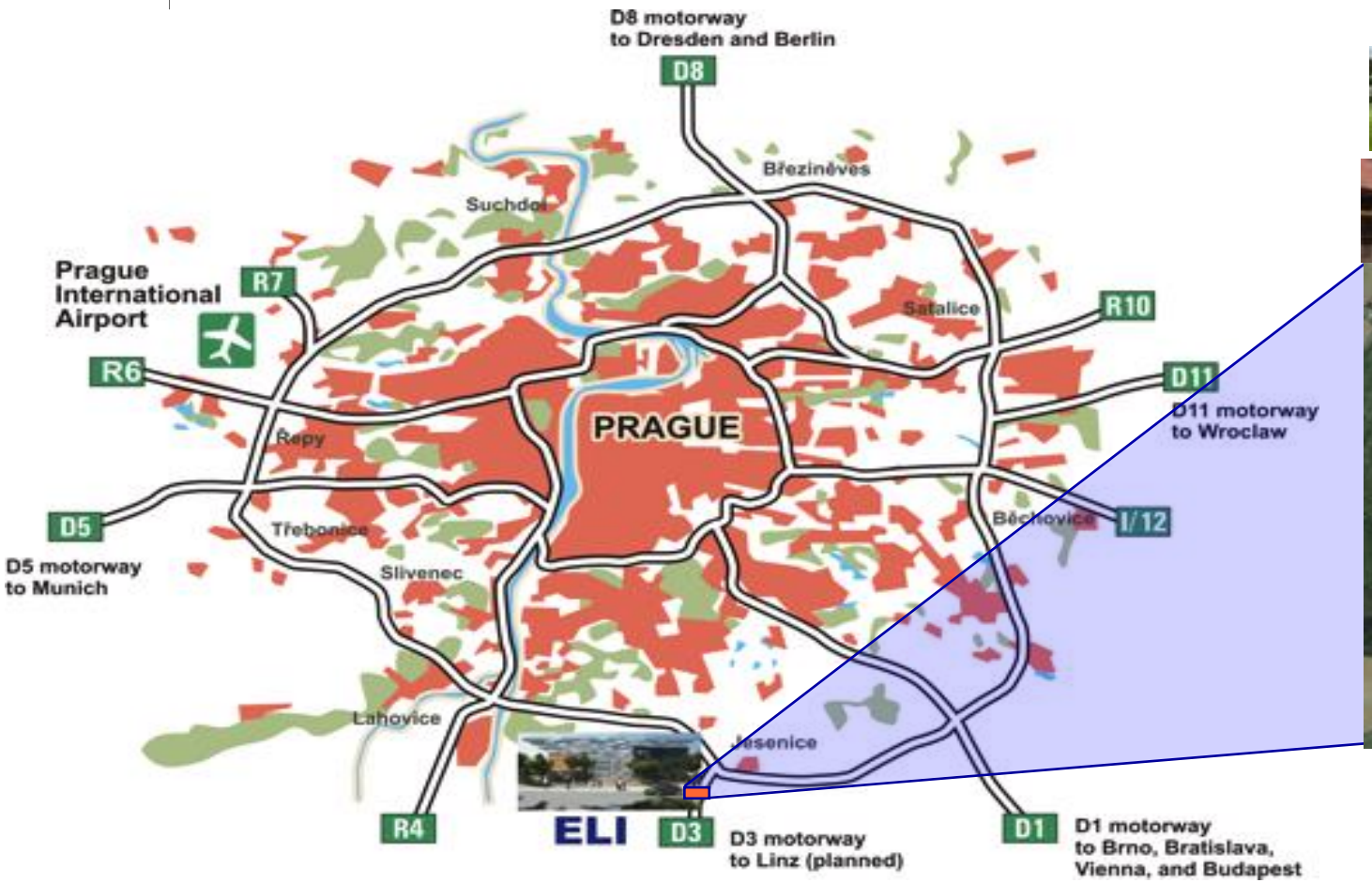
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

PW Laser World:
Europe tries to keep the lead



SOURCE: Courtesy of J.L. Collier

Location of ELI-Beamlines

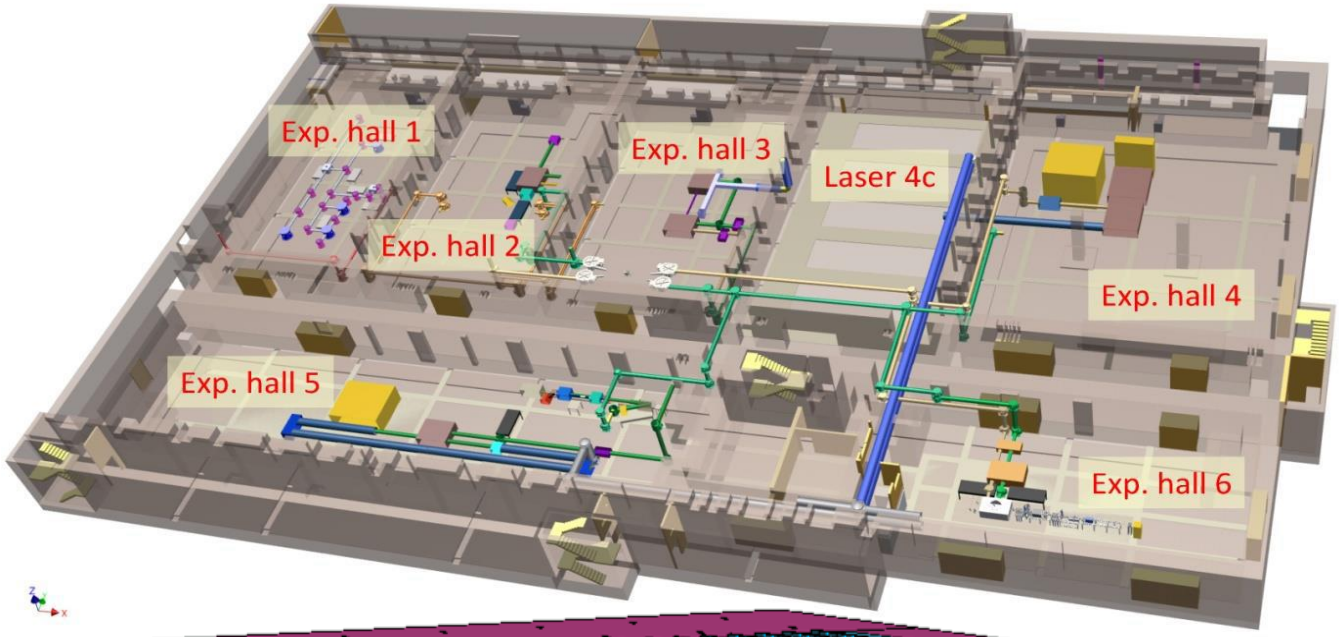


Dolní Břežany

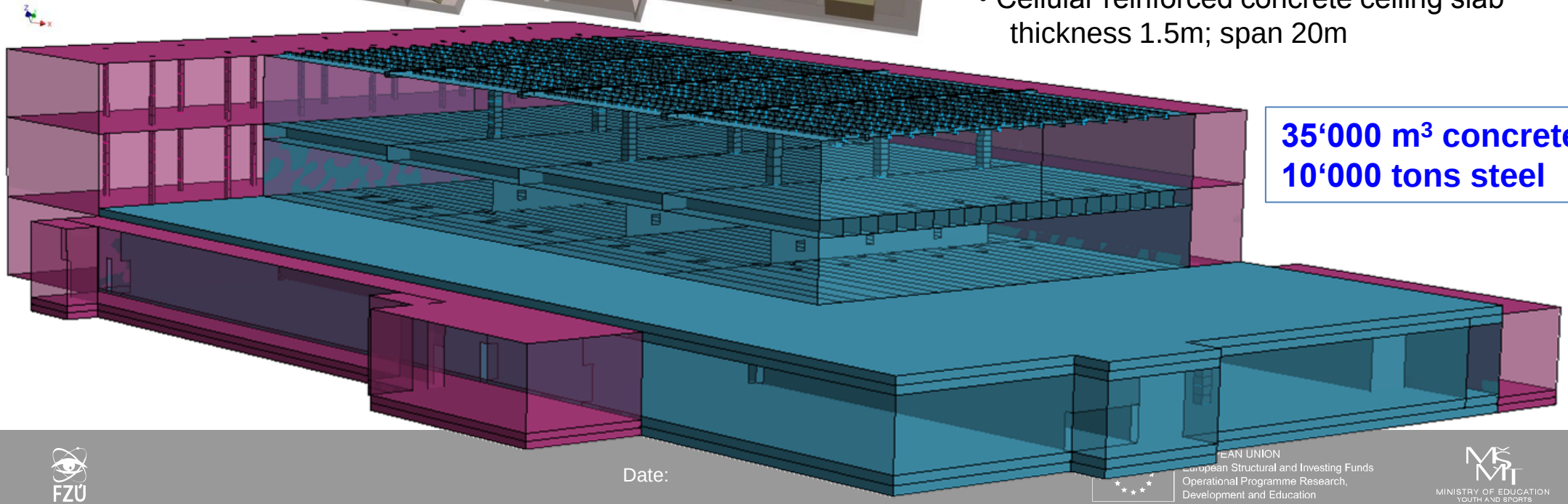
- **HiLASE: New lasers for industry and research**
  - High average power pulsed lasers
  - Development high-rep lasers and laser systems that will find use in industry
- **Biocev**
  - European Centre of Excellence in biomedicine and biotechnology
  - Universities + CAS

Laser Research Campus

ELI-BL experimental & laser halls



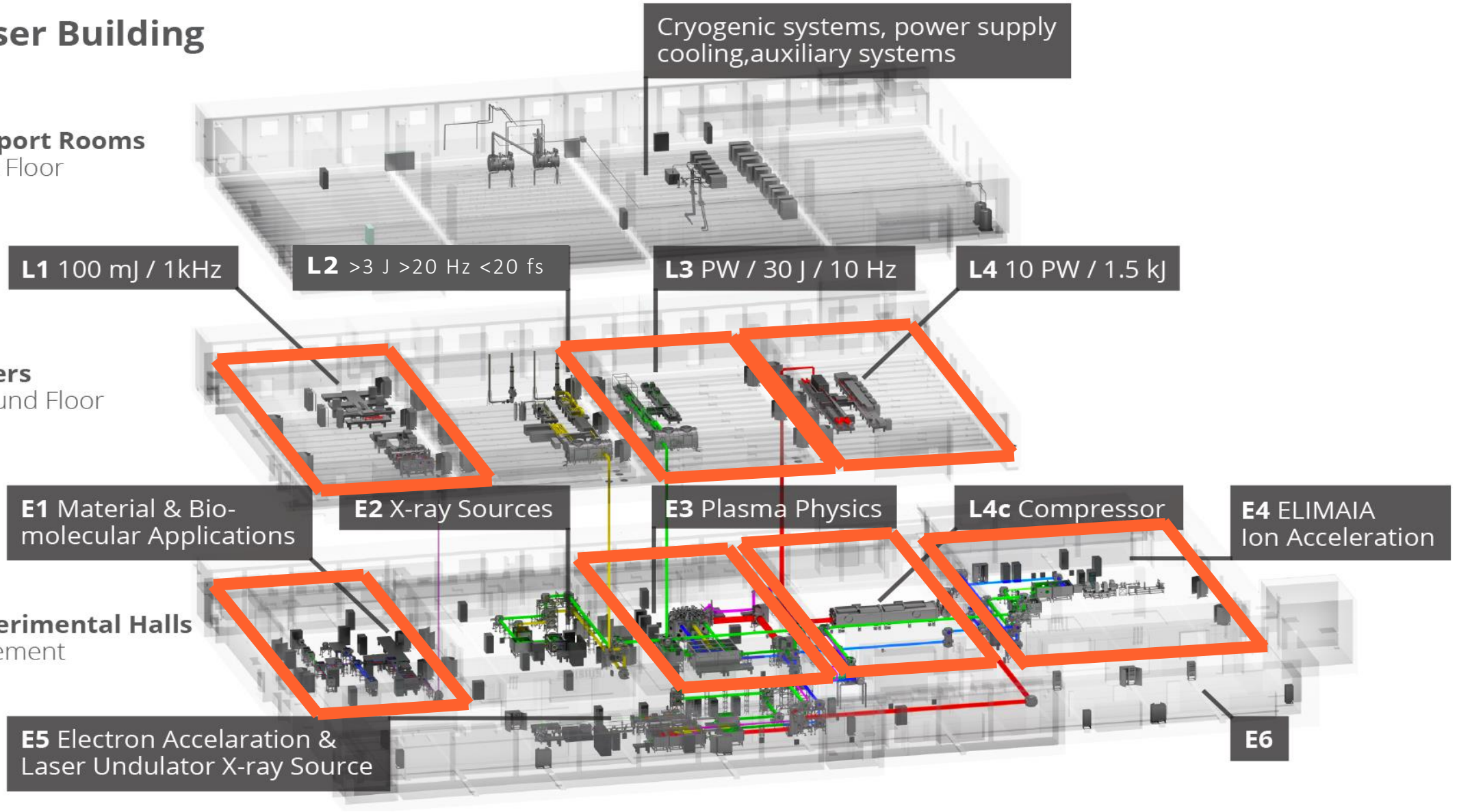
- Site area 65,000 m^2
- Building(s) 28,645 m^2
- Building volume 170,000 m^3
- Experimental building 16,500 m^2
- Laboratories 4,500 m^2
- Offices 4,400 m^2
- Multifunction areas 2,300 m^2
- Total estimated construction costs of €65M
- Foundation raft slab thickness 1 m
- 1.6 m shielded reinforced concrete walls in the underground
- Cellular reinforced concrete ceiling slab thickness 1.5m; span 20m



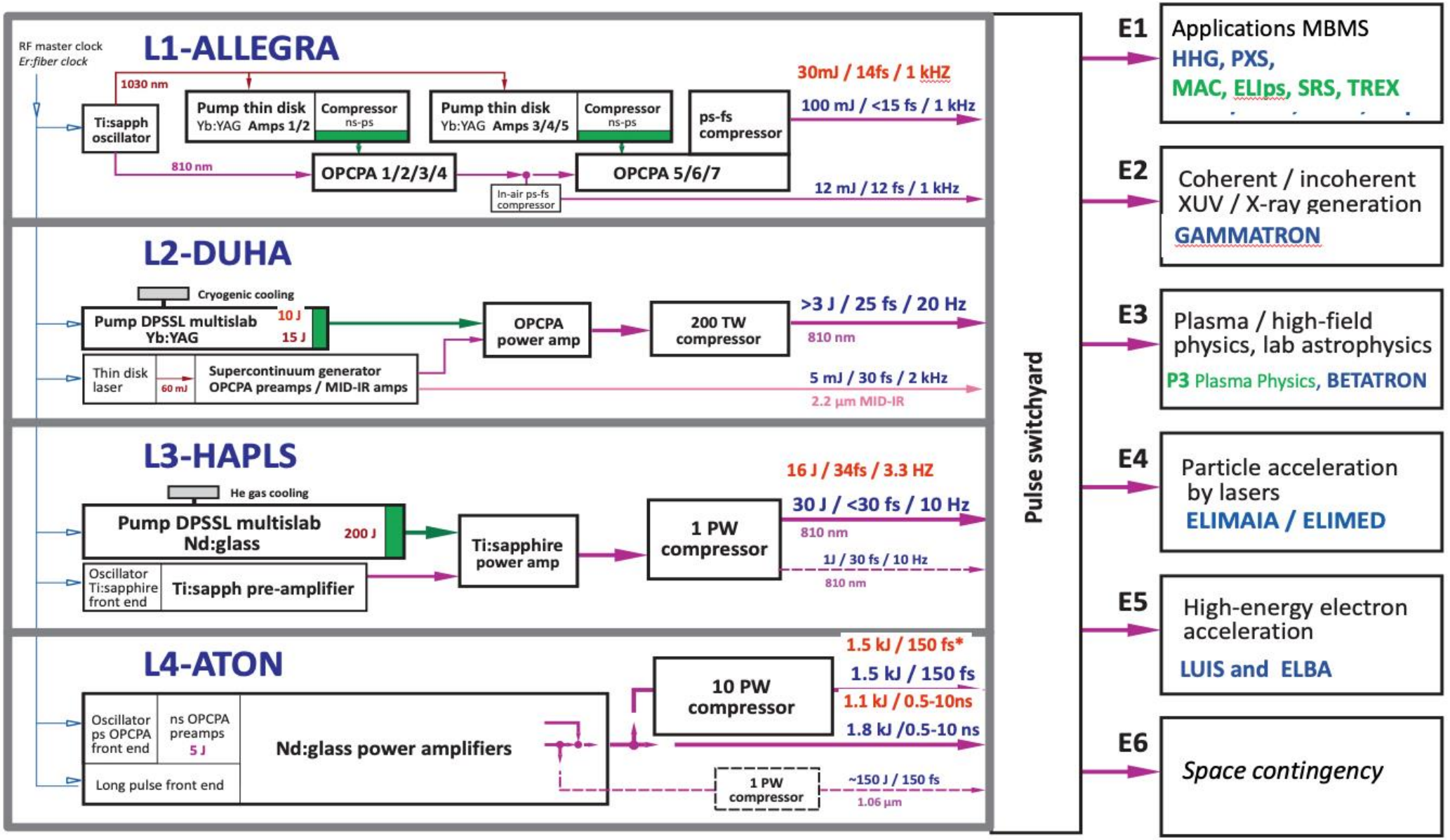
35‘000 m^3 concrete
10‘000 tons steel

Building layout

Laser Building



Facility Technology Scheme



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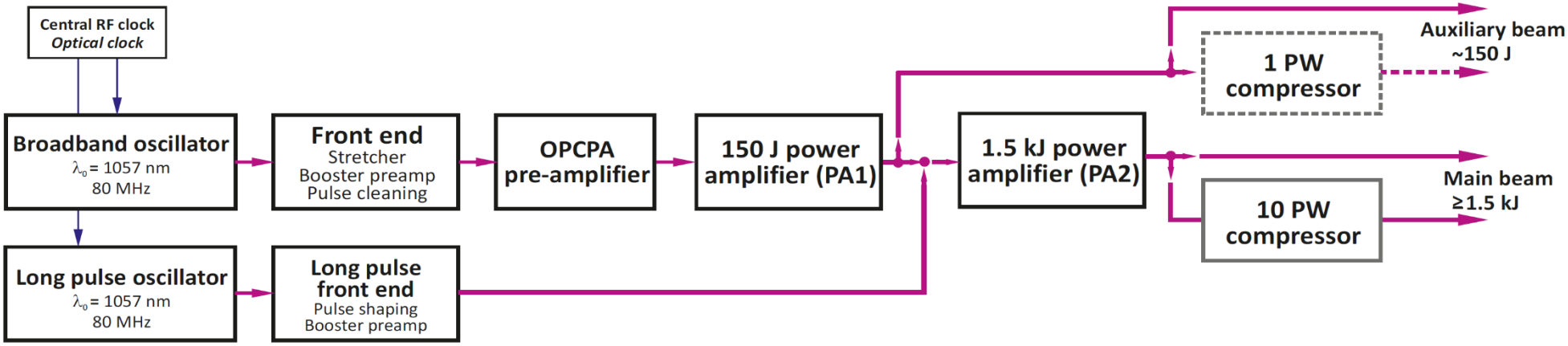
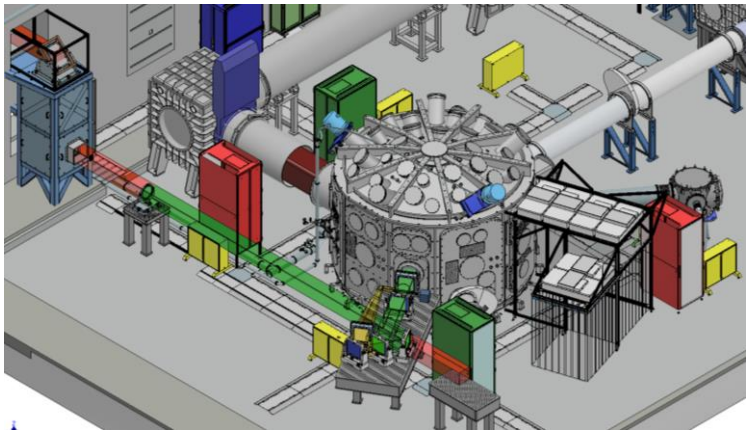
The L4 laser

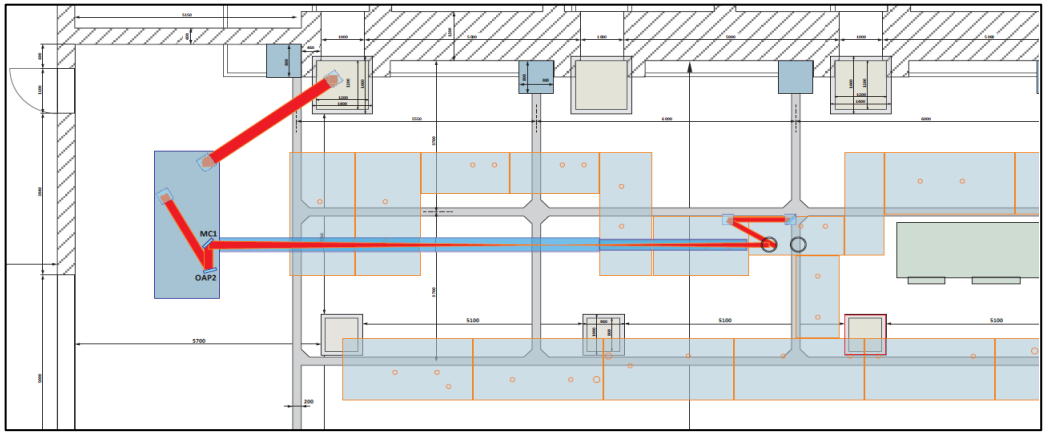
➔ **Uniqueness of this 10 PW laser is the long pulse length of 150 fs, therefore more energy: 1.5 kJ can deliver femtosecond, picosecond & nanosecond pulses**



high-energy density physics (HEDPS) capabilities at high repetition rate in addition to UHI interaction

➔ has given rise to the L4n and L4p projects (fully funded)





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L4 10 PW optical compressor

10 PW peak power late 2021

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Initial experimental chains L1-E1, L3-E3, L3-E4, L4-E3 valid till 2022

User operation

Commissioning phase

Commissioning phase

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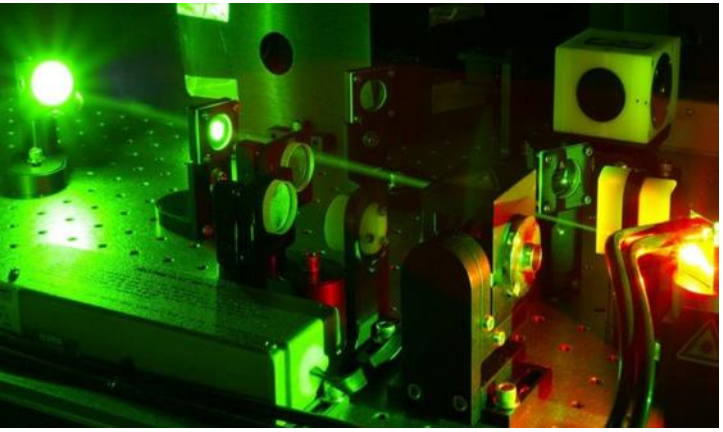
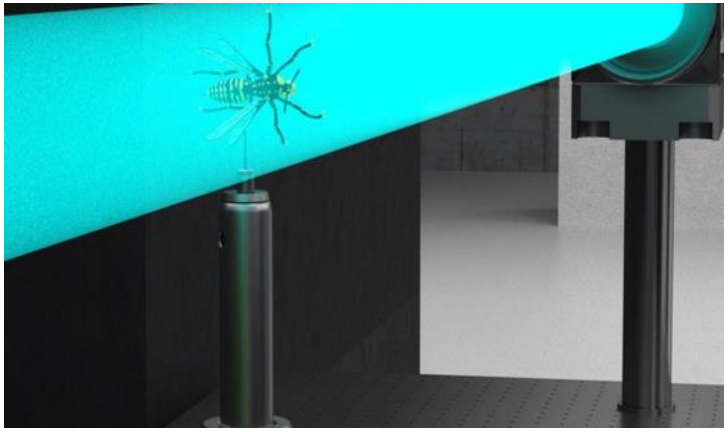
Science Case @ ELI Beamlines

Scientific Director – Georg Korn

Scientific strategy and coordination of Research programs



Department of Laser Systems
B. Rus



Department of Radiation Physics and Electron Acceleration & HiFI, S. Bulanov

Department of Ion Acceleration and Applications of High Energy Particles, D. Margarone

Department of Structural Dynamics, J. Andreasson & ELIBIO, J. Hajdu

Department of Plasma Physics and Ultra-High Intensity Interaction, S. Weber

← includes former theory/simulation & HPC/VBL activities

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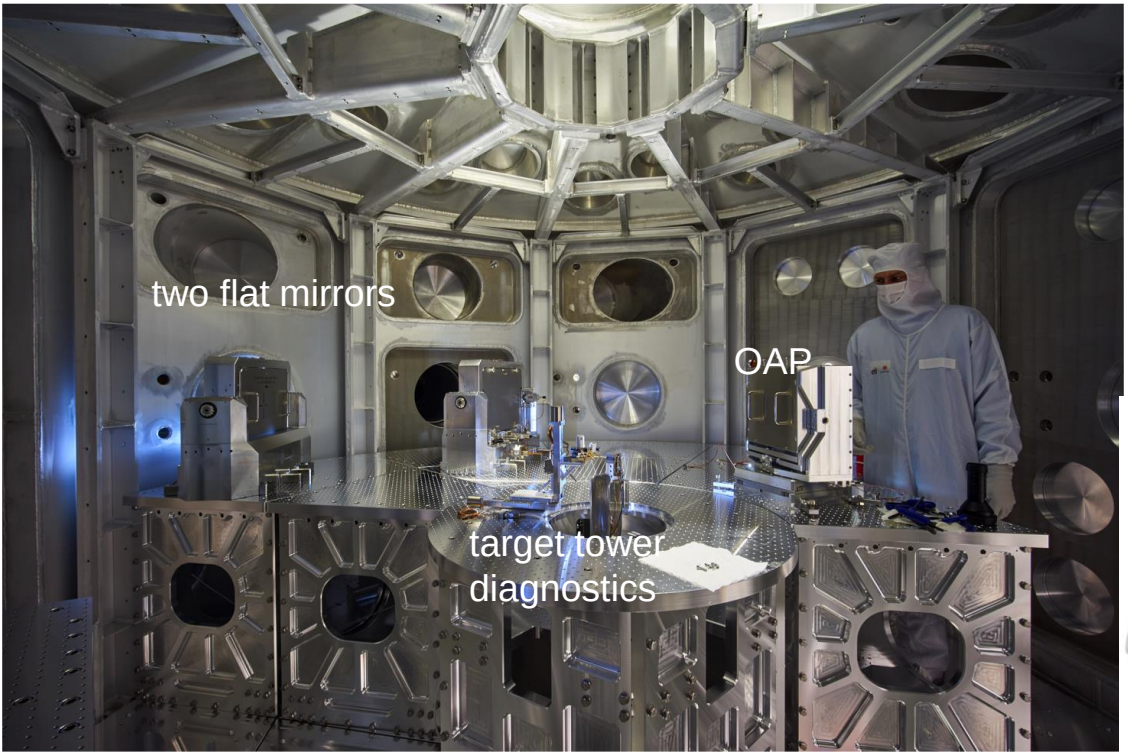
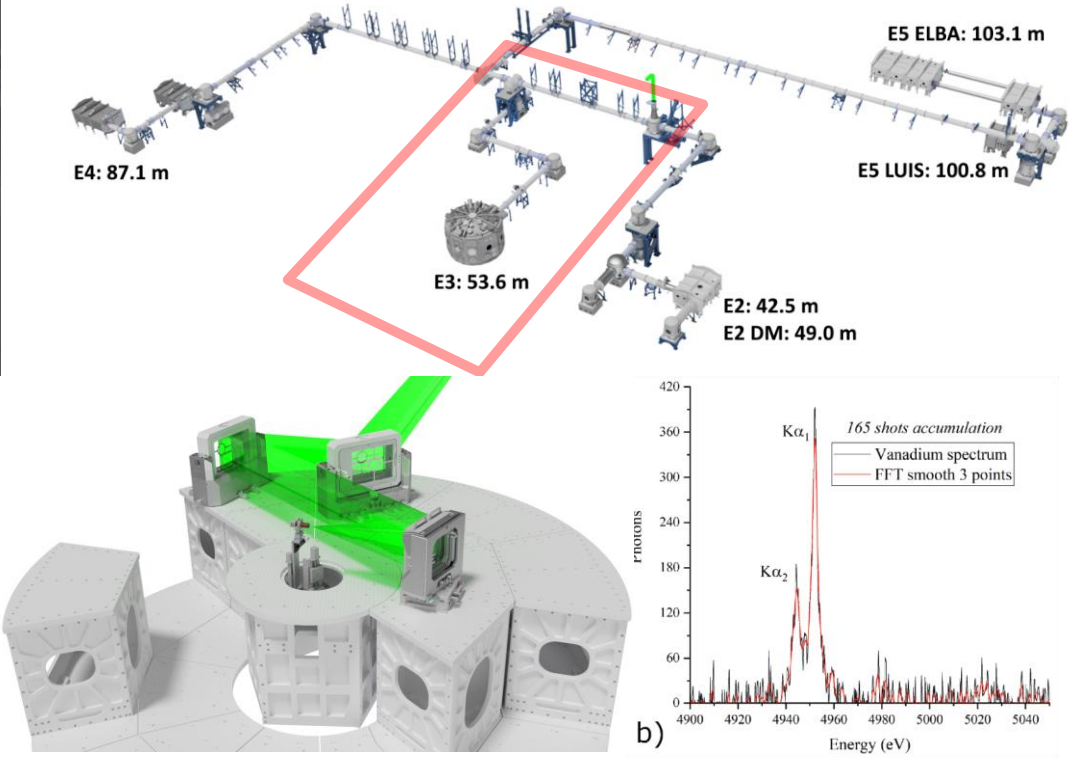
HAPLS-P3 laser commissioning

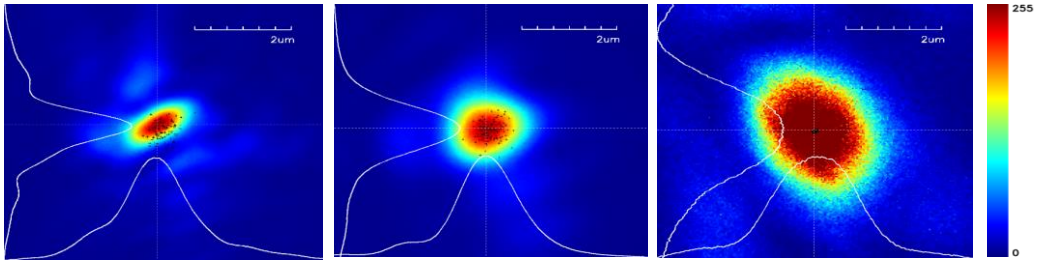




Full aperture HAPLS

80 mm HAPLS

1” blue alignment beam

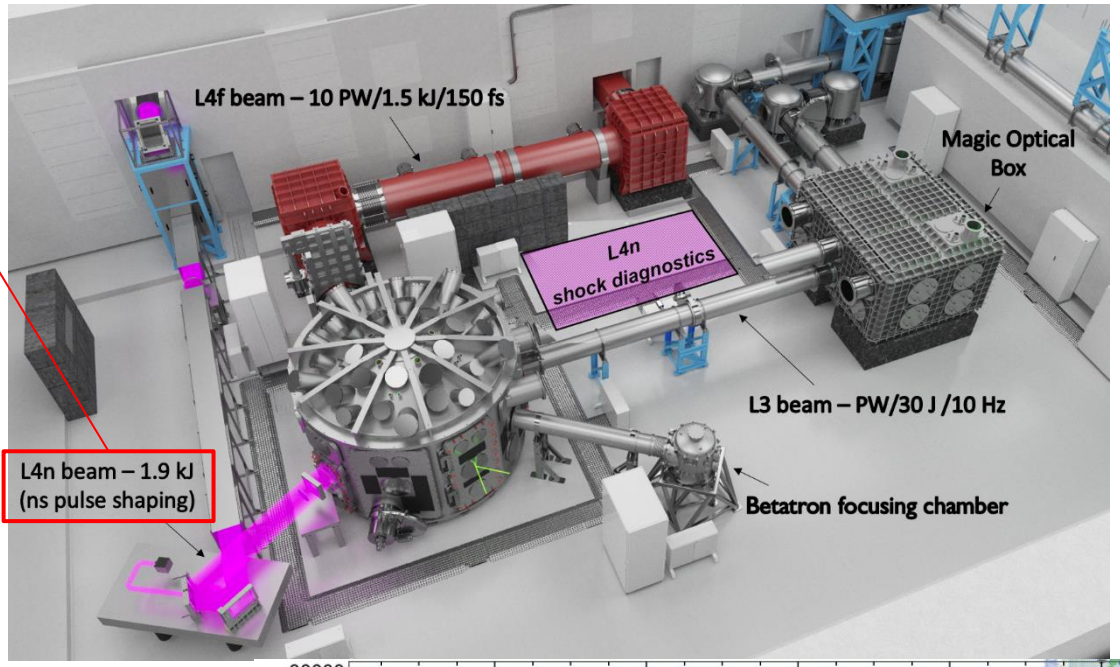


Configuration/Sample	Pointing RMS [μrad]		
	Radial	X	Y
HAPLS beam full aperture	2.444 ± 0.169	1.524 ± 0.105	1.911 ± 0.132
HAPLS beam 80 mm aperture	2.514 ± 0.177	1.597 ± 0.113	1.942 ± 0.137
Blue laser 1	1.372 ± 0.068	0.999 ± 0.049	0.940 ± 0.046
Blue laser 2	1.492 ± 0.113	0.974 ± 0.074	1.131 ± 0.085
Blue laser 2 (P3 pumps OFF)	0.286 ± 0.020	0.218 ± 0.016	0.185 ± 0.013
HAPLS uncompressed (low power)	≈ 1.8		
HAPLS uncompressed (high power)	≈ 3.1		

L4n beam to pave the way to HEDP in the high-repetition rate regime

L4n beam will soon become operational and is relevant for High Pressure Physics at ELI Beamlines.

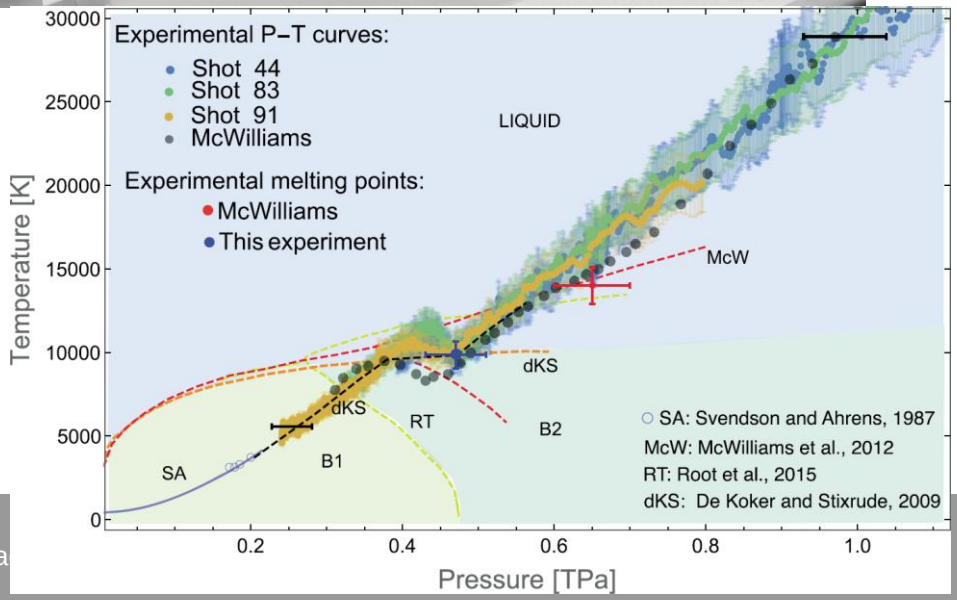
32x32 cm² (square beam)
λ = 1053 nm
E = 1.9 kJ
τ = 0.1 – 10 ns



Requirements for ns HED experiment:

- Reliable high energy laser driver
- Uniform pressure distribution
- Steady pressure pulse (precise pulse shape control)
- High precision measurement diagnostics

1 to 5-10 shots a day → 1 shot / ~minute



User Operation in E1 (Structural Dynamics)

2019 Users

Institute of Chemical Process Fundamentals
Charles University, Dept. of Phys. & Macromolecular Chemistry
J. Heyrovský Institute of Physical Chemistry
Institute of Physics, Division of Optics
Masaryk University - Brno
Institute of Biotechnology - Vestec
University of South Bohemia - České Budějovice
Leipzig University
Technical University Ilmenau
Otto von Guericke University Magdeburg
Technical University Berlin
University of Hamburg
Paderborn University
Queen Mary University in London
University of Southampton
Wigner Research Centre Budapest
University of Genoa, Istituto Nazionale di Fisica Nucleare
CNR-IFN Padova
IPC PAS Warsaw
INP PAS Krakow
PNPI RAS Sankt Petersburg
IGIC RAS Moscow
Chalmers University of Technology Gothenburg
Lund University
Uppsala University
University of Oulu
Element Aero
New Mexico State University

2020

- Fast track Access for Coronavirus-related Research

- Second Open Call
  Instrumentation:
  MAC
  TREX
  ELIps
  SRS

  8-12/2020
  16 proposals scheduled

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User Calls Schedule 2020-21

Call	2020				2021	
	Q1	Q2	Q3	Q4	Q1	Q2
E1 Peer MAC, ELIps, TREX, SRS		Call	EXPs	EXPs	Call	EXPs
E3 SFL and LFL Commissioning with L3 HAPLS				Call SFL	EXPs SFL	EXPs LFL
E3 L4n Commissioning					Call L4n	EXPs
E4 Commissioning with L3 HAPLS					Call IA/ELIMED	EXPs

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Facility Perspective

2020

User operation
E1, calls for E3, E4, **Performance ramp-up**
L1 50+mJ
L3 laser sources,
HPC commissioning

2021

User operation
E1, E3, E4,
calls for E2, E5
Performance ramp-up
L3 1PW
L4 10 PW, L4n
commissioning

2022

User operation
E1, E2, E3, E4, E5
Ramp-ups
L1 -100mJ
L3 PW/Hz
L4 10PW/min

Upgrades
L2 DUHA laser,
LUIS beamline,
ELBA multi GeV,
Gammatron

2023

User operation
Reaching Steady state
Ramp-ups
L3 PW/10Hz

Upgrades
L1 second arm
Combining L3 and L4n in E3
L4 in E4

ELI Beamlines Strategic Development Plan

Average power kW class short pulses
Peak power multi 10 PW
Ultra-intense interaction, collision of laser-produced electrons with high-intensity laser pulses
Compact table top particle accelerators, FEL
Optical material (HD coatings) development and production
Combined experiments with different lasers

R&D and Upgrade projects – additional 70 mil. EUR

ELIBIO – Biolab facility, new technology, R&D activities
HIFI – High-field science and computing capabilities
ADONIS – Multiple-enhancements for parallel operation

User base & collaborators: open door...

eli beamlines

Imperial College London
University of Oxford
University of Strathclyde Glasgow
University of Potsdam
Technische Universität Berlin
DESY
CFEL GSI SCIENCE
Universität Leipzig
MEPhI
SIOM
Queen's University Belfast
European XFEL
HZDR
Helmholtz Zentrum Dresden Rossendorf
FLASH. Free-Electron Laser FLASH
TUM
UHH Universität Hamburg DER FORSCHUNG | DER LEHRE | DER BILDUNG
Science & Technology Facilities Council Rutherford Appleton Laboratory
Colorado State University
LMU Ludwig-Maximilians-Universität München
BERKELEY LAB
Fermilab
TEXAS
Friedrich-Schiller-Universität
LAOLA Laboratory for Laser- and beam-driven plasma Acceleration
MBI
PAN Polish Academy of Sciences
Lawrence Livermore National Laboratory
CHALMERS
INFN LNS
TU WIEN Photonics
University of Potsdam
TEL AVIV UNIVERSITY אוניברסיטת תל אביב
cea
ESRF
cnrs
VU VRIJE UNIVERSITEIT AMSTERDAM
UNIVERSITY OF GOTHENBURG
UPPSALA UNIVERSITET
LUND UNIVERSITY
IFPiLM Instytut Fizyki Plazmy i Laserowej Mikrosyntezy
UK Uniwersytet Jana Kochanowskiego w Kielcach
université de BORDEAUX
CELIA
laboratoire d'optique appliquée
i3M Instituto de Instrumentación para Imagen Molecular
WEIZMANN INSTITUTE OF SCIENCE
האוניברסיטה העברית בירושלים THE HEBREW UNIVERSITY OF JERUSALEM
Lund Laser Centre
CEITEC Central European Institute of Technology BRNO | CZECH REPUBLIC
BIOCEV
eli Nuclear Physics
eli attosecond
Rigaku
TÉCNICO LISBOA
大阪大学 OSAKA UNIVERSITY
Jihočeská univerzita v Českých Budějovicích University of South Bohemia in České Budějovice
ČVUT České vysoké učení technické v Praze
PROTON THERAPY CENTER
SIGMAPHI Accelerator Technologies
INRS Institut national de la recherche scientifique
apri ADVANCED PHOTONICS RESEARCH INSTITUTE
OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
LRC 激光聚变研究中心 LASER FUSION RESEARCH CENTER

ELI-Beamlines
a world class laser research infrastructure with high impact for society