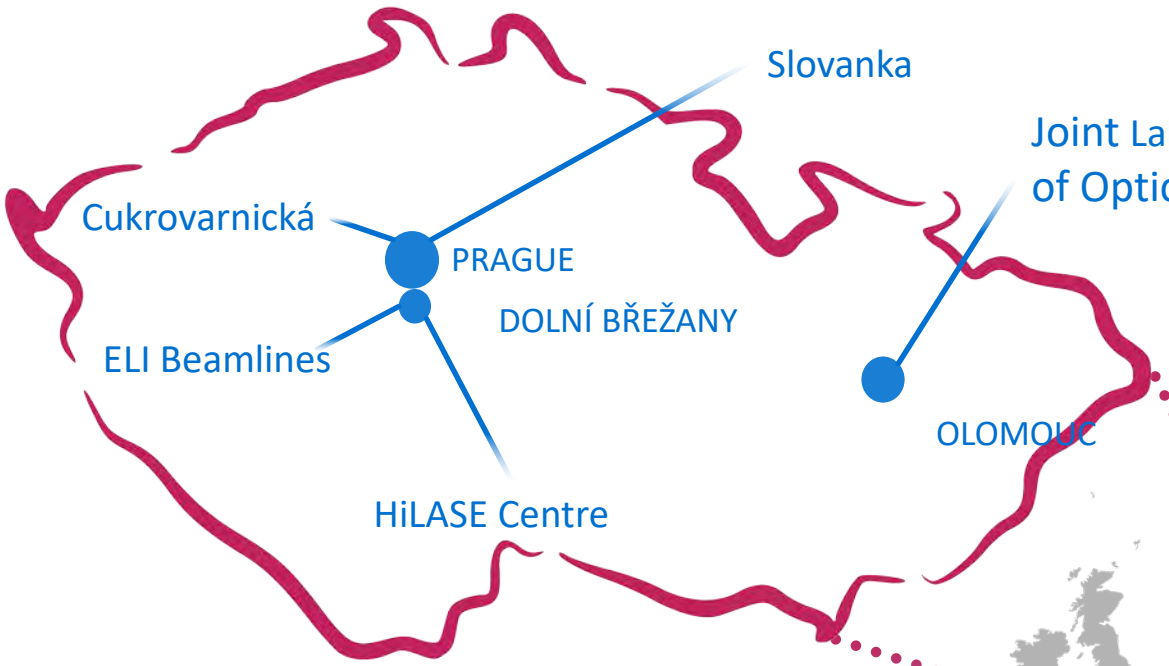
eli beamlines

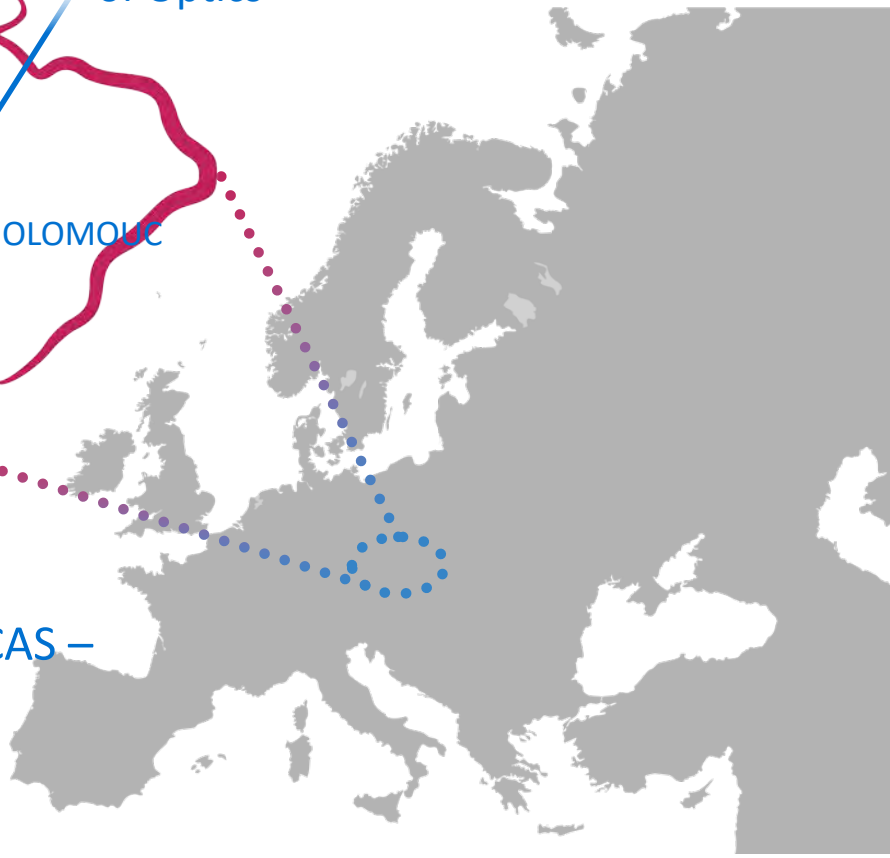
FZU Institute of Physics of the Czech Academy of Sciences

The Czech Academy of Sciences

ELI Beamlines

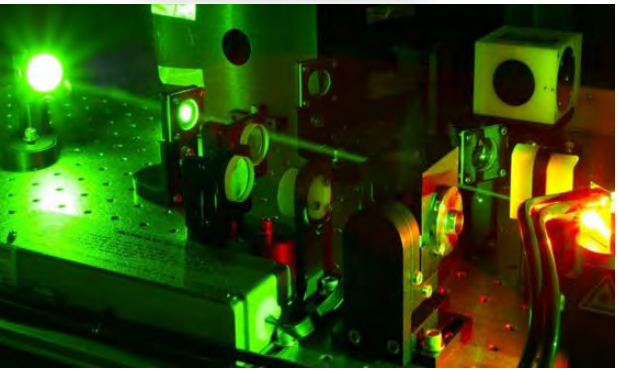
High-Energy Beam Pillar





- 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

Science Case @ ELI Beamlines



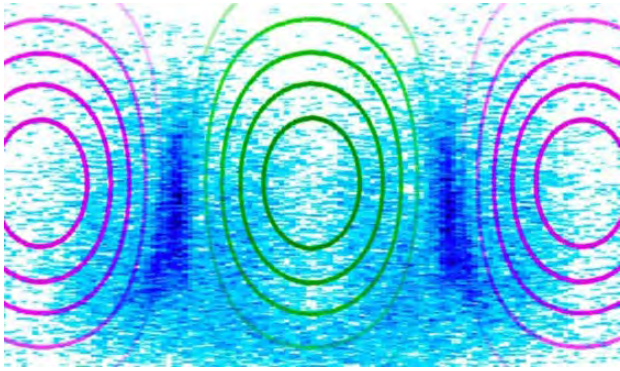
RP1 – Laser Development, B. Rus
Lasers generating rep-rate ultrashort pulses & multi-petawatt peak powers

RP2 – Radiation Physics and Electron Acceleration, S. Bulanov
Soft to hard x-rays, GeV electrons

RP3 – Ion Acceleration, D. Margarone
250 MeV Ions Acceleration by lasers

RP4 – Applications in MBMS S, J. Andreasson & ELIBIO, J. Hajdu

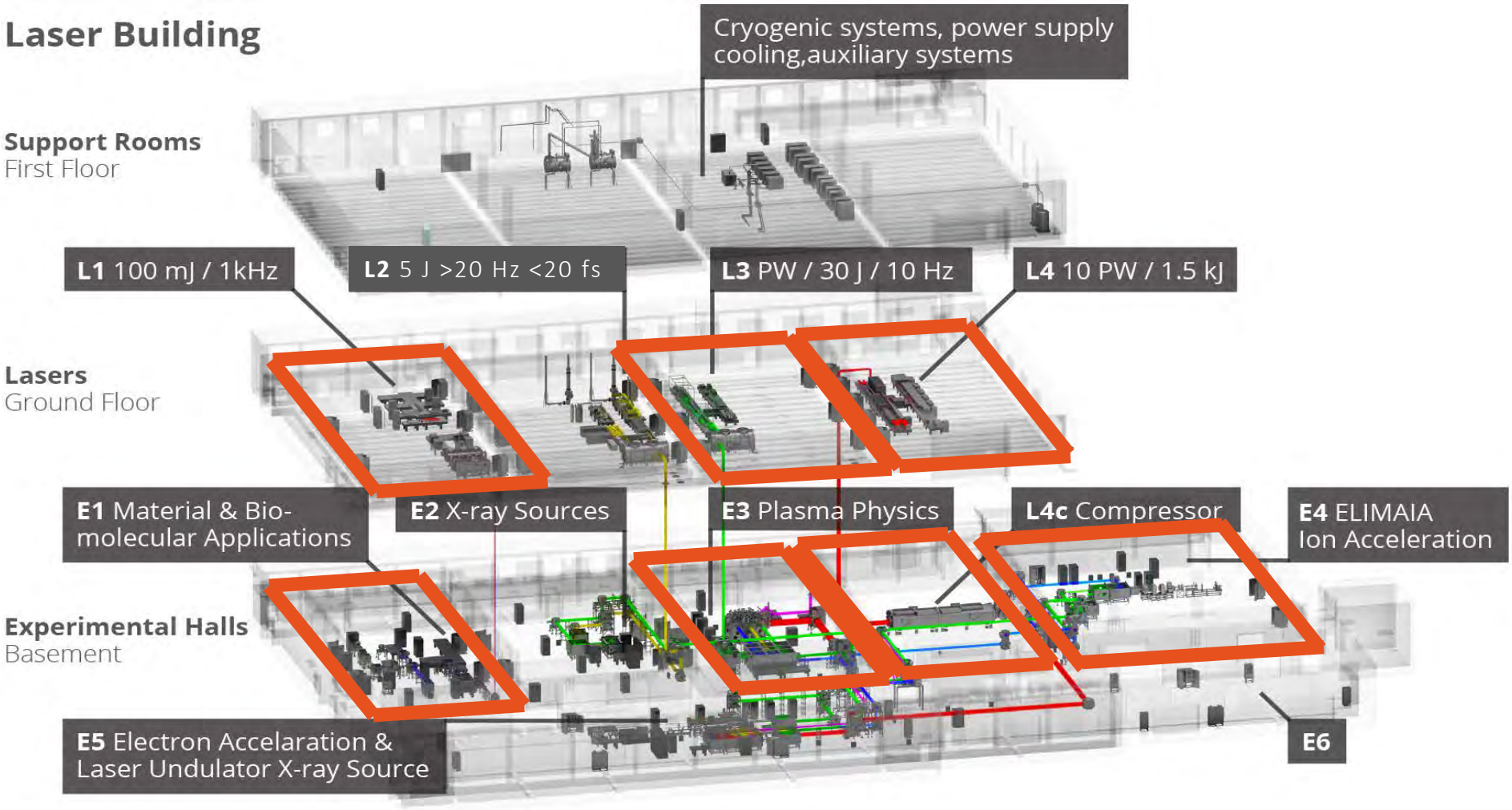
RP5 – Plasma Physics, S. Weber
Laser plasma and HED physics, astrophysics



RP6 – UHI Interactions, S. Weber
High-field physics and theory

Laser Research Campus

Facility Layout – Priority Action



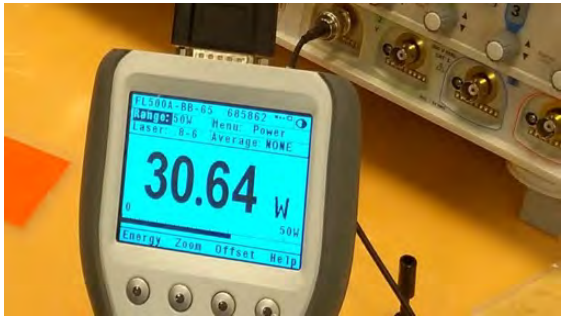
Sources overview

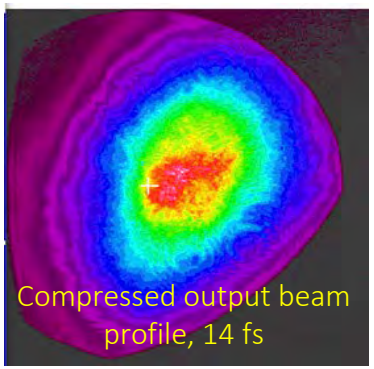
	8/2019	Technology	Design
L1	30mJ kHz 14fs	DPSSL, OPCPA pumped by thin disk	100 mJ kHz <20fs
L2	10J 10Hz ns	DPSSL, OPCPA	5J >20Hz <20fs
L3	16J 34fs 3.3Hz	DPSSL, Ti:Sa	>30J 10Hz <30fs
L4	1.5kJ 1/5min	OPCPA FE, mixed Nd:glass	1.5kJ 1/min 120 fs
HHG	5-120nm 30nJ		5-120nm, 1E10 ph
PXS	Comm. 4–30 keV		4–30 keV, 1E13 ph
LUIS	Installation	FEL Development	0.4 to 5 nm, 1E6 ph
Betatron	development		keV – MeV, 1E8 ph
ELIMAIA	commissioning		3/60-300MeV
ELBA	installation		10GeV

Our Big Laser Sources

L1 ALLEGRA laser
user experiments since June 2019

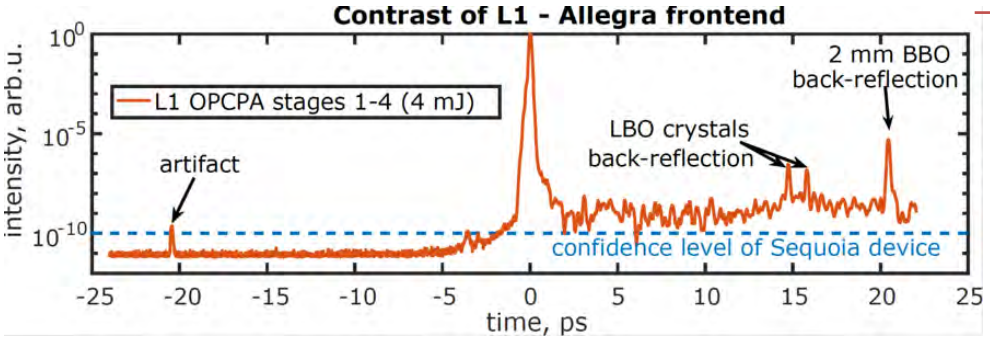
Parameter	Demonstrated 04/2019	Expected 12/2019
Broadband output energy	*30 mJ@ 1kHz*	*50 mJ @1 kHz*
Compressed output (to E1 beam distribution)	*25 mJ@ 1 kHz*	*>40 mJ @ 1 kHz*
Pulse duration	*14 fs*	*14 fs*
Temporal contrast (pre-pulses to -5 ps)	*$>10^{-10}$*	*$>10^{-11}$*





ALLEGRA operation hours July – Sept 2019

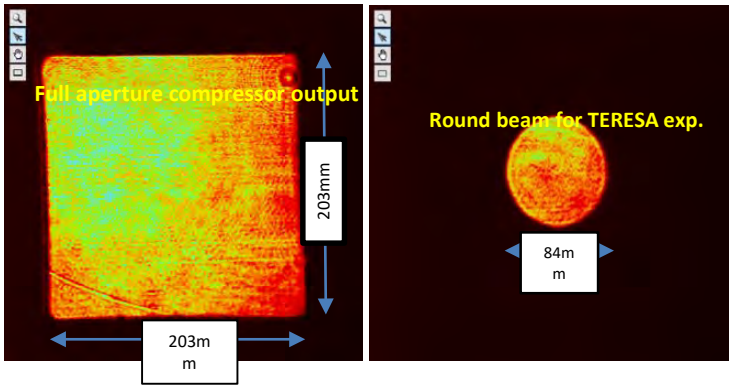
	TOTAL
DAYS	32
HOURS (with standby)	235
NET HOURS	184
STANDBY HOURS	51

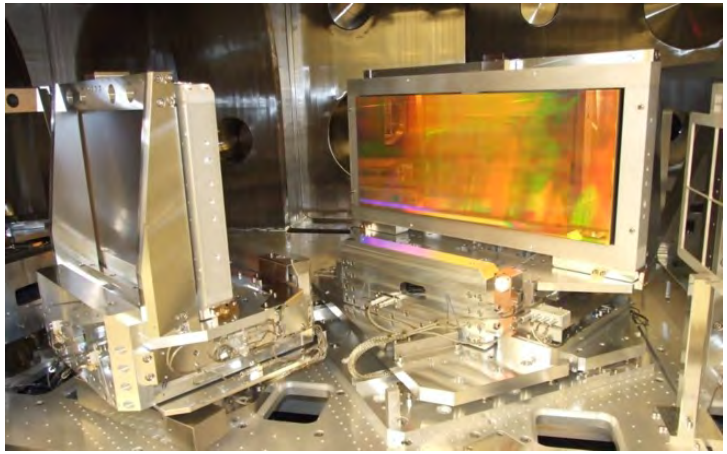


Driving synchronized soft and hard-ray sources
Enables electron and ion acceleration with kHz
Surface harmonics at kHz can be tested
… proposals up to you!

L3 HALPS laser status

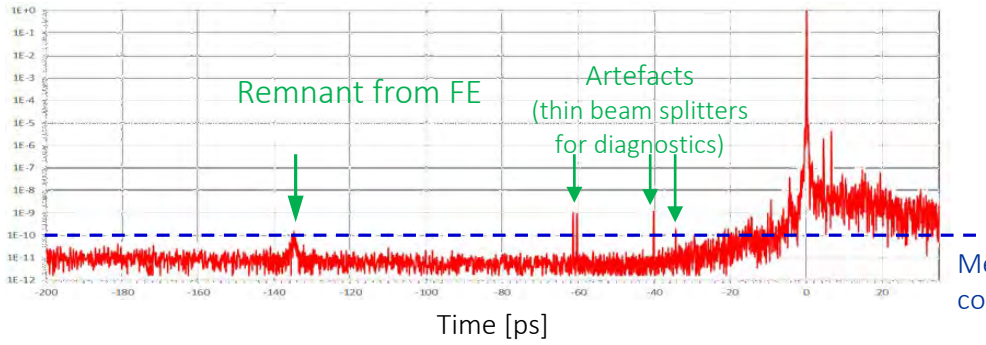
Item	6/2019
L3-HAPLS pump laser	100 J / 3.33 Hz 60 J / 3.33 Hz for experiments
Pulse compressor, pulse and beam diagnostics	Fully integrated with the laser, energy 0.5J, output pulse duration 34 fs
L3-HAPLS for TERESA experiments	1st experimental run (100 mJ), 2nd exp. campaign starting
Output beam shape	Round beam 84-mm-in-diam. for TERESA generated
Output pulse temporal contrast	Near 10^{11} @ 100 ps measured by Sequoia





Compressor output pulse temporal contrast

Data from SPDP (Short Pulse Diagnostic Package) – Sequoia scan

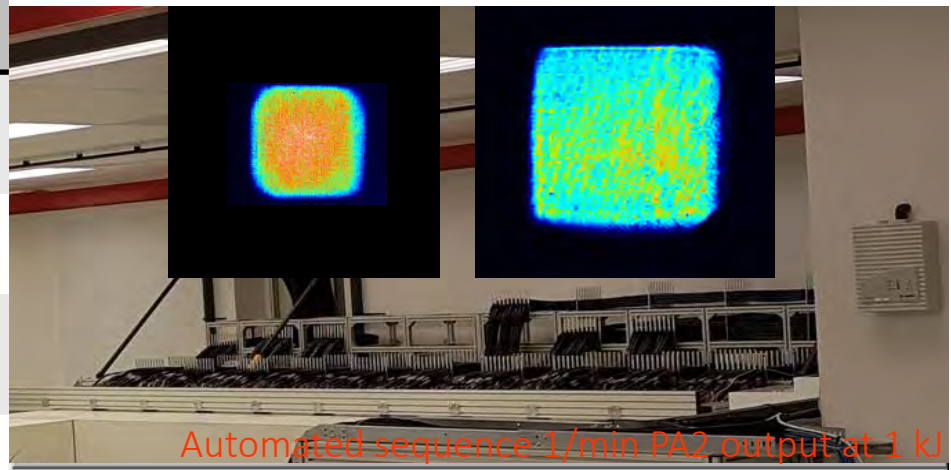


L4 ATON laser status

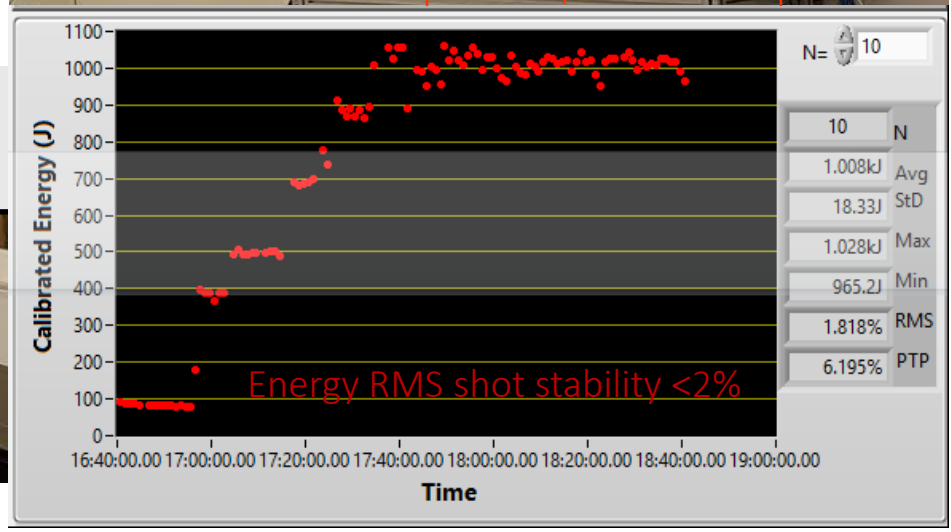
Parameter	Measured value
CPA pulse energy	1512 J significant headroom, higher energy possible
Bandwidth FWHM	~14 nm Gaussian fit compressibility 150 fs
Long pulse energy	1180 J significant headroom, higher energy possible
Pulse width / temporal shaping	<0.5-10 ns 125 ps with 60 ps rise time
Current shot rate	1 per minute (>1 hour sessions) 1 per 5 minutes for quality beam

Power Amp PA1
18 cm clear aperture

Power Amp PA2
30 cm clear aperture



Automated sequence 1/min PA2 output at 1 kJ



L4 10 PW optical compressor

10 PW peak power late 2020

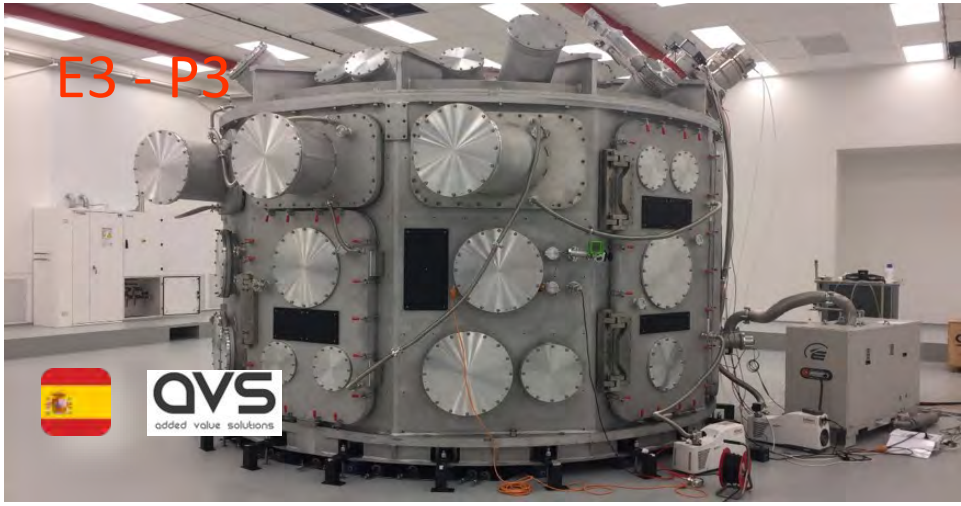
L3 Beam Transport to P3

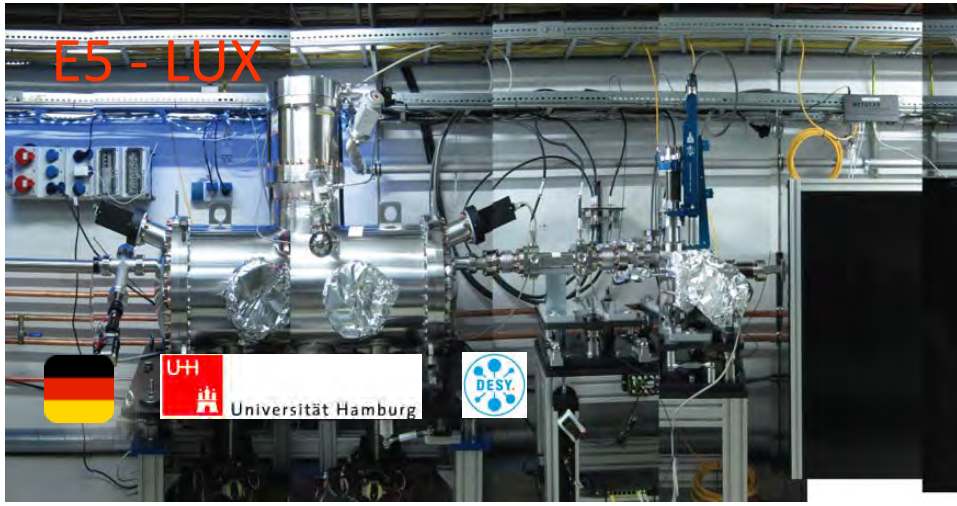
setup with mirror inside the turning mirror box

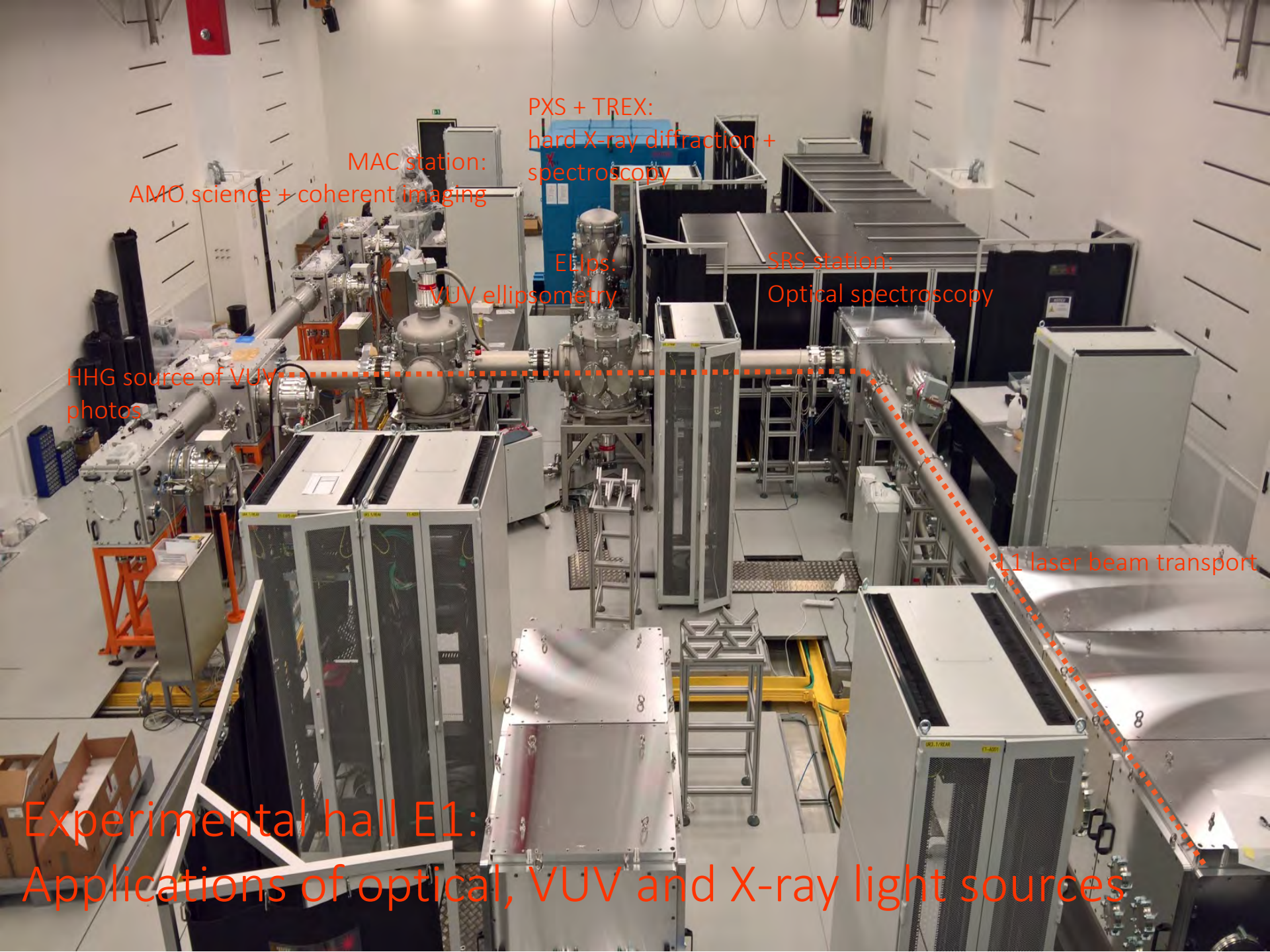
Main features:

- Versatility
- Vibration stability
- Cleanliness

Experimental Areas







Experimental hall E1: Applications of optical, VUV and X-ray light sources

Initial User Operation @ ELI Beamlines

- First open call for user assisted commissioning and early use experiments
- Published February 15, 2019, closed June 20
- 20 experiments scheduled between June to Sept. 2019

	w24	w25	w26	w27	w28	w29	w30	w31	w32	w33	w34	w35	w36	w37	w38	w39
	user week 1	user week 2	user week 3	partial shutdown	shutdown	partial shutdown	user week 4	user week 5	user week 6	user week 7	user week 8	user week 9	user week 10 contingency	user week 11 contingency	user week 12 contingency	user week 13 contingency
	Jun 10 to 14	Jun 17 to 21	Jun 24 to 28	jul 1 to 5	jul 8 to 12	jul 15 to 19	jul 22 to 26	jul 29 to aug 2	Aug 5 to 9	Aug 12 to 16	Aug 19 to 23	Aug 26 to 30	Sept 2 to 6	Sept 9 to 14	Sept 16 to 20	Sept 23 to 27
MAC	Luca Poletto (IT)	Filipe Maia (SE)				Tim Oelze (GE) Pamir Nag (CZ)**	Russel Minns (UK)/ Katharine Reid (UK) / Pamir Nag (CZ)	Russel Minns (UK) / Katharine Reid (UK)	Pamir Nag (CZ)**	Russel Minns (UK)/ Katharine Reid (UK)	Russel Minns (UK) / Katharine Reid (UK)	Russel Minns (UK) / Katharine Reid (UK)				
ELIps			Stefan Zollenr (US)/ Luca Poletto (IT)	Stefan Zollenr (US)/ Luca Poletto (IT)*											Stefan Zollenr (US)/ Luca Poletto (IT)***	
Optical spectroscopy	Carola Emminger (US)	Tamas Kreszthelyi (HU)	Adam Dubroka (CZ)				Jaroslav Zadny (CZ)	Blanka Vlckova (CZ) prel.	Marina Tjunina (FI/CZ) prel.	in house	in house	in house	Oliver Herrfurth (GE)	in house	Michele Magnozzi (IT)	Jacinto Sa (SE/PL) prel.
TREX (with continuous X-ray source)											Aleksandr Baranchikov (RU)		Gennady Kopitsa (RU) prel.	Anna Kulminskaya (RU) prel.		

E1 End-stations

*Not a full week of experiments

**Users assisting with experiment preparations (No laser)

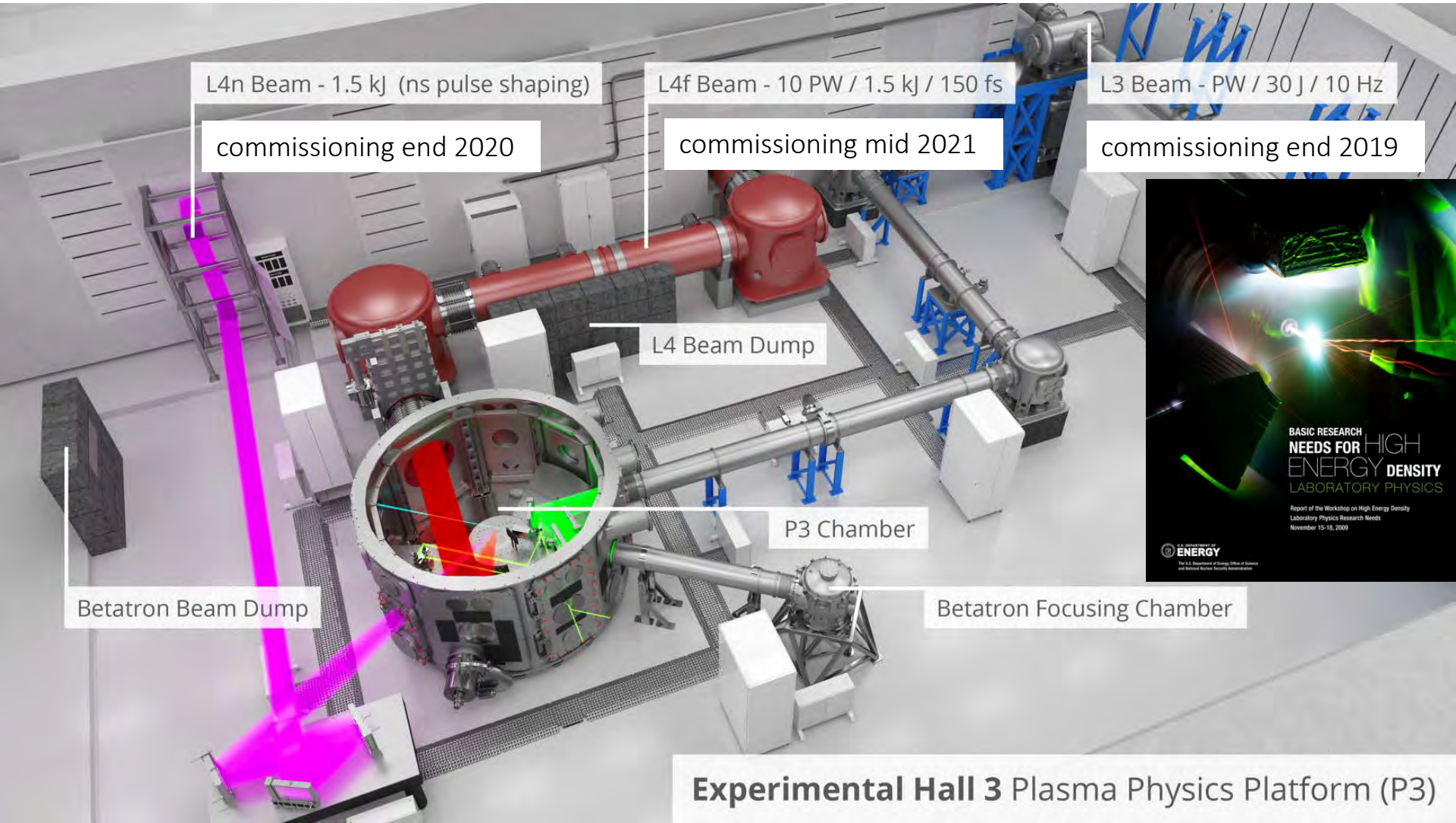
***Follow up experiments

Posponed in agreement with applicants

Maths Karlsson (SE)	Gustavo Fuertes Vives (CZ)

- 1200 hours supporting external experimenters
- “Users” from 7 countries (Germany, Finland, Czech Republic, Sweden, USA and Russia)
- Join us for user workshops
  - Science with coherent XUV sources, May 6 and 7, Workshop on optical spectroscopy, Sept 16 to 18,
  - Ultrafast X-ray science, Oct 24 and 25, ELIps workshop on pump-probe and VUV ellipsometry, Nov 11 and 12, 2019

E3 hall layout - HEDP

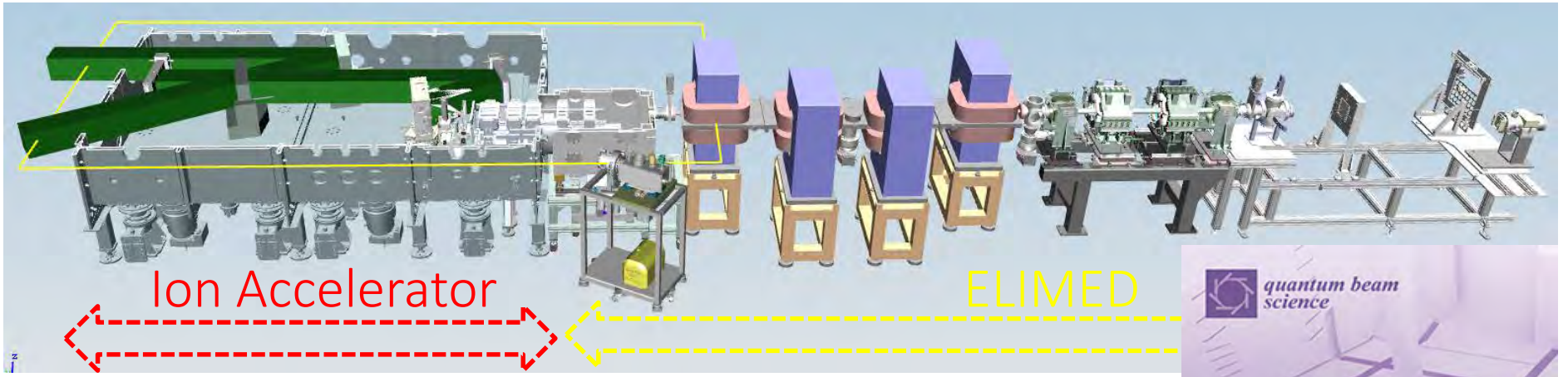


E4 Experimental hall: ELIMAIA

Acceleration, Collimation & Diagnostics

Selection, Transport & Diagnostics

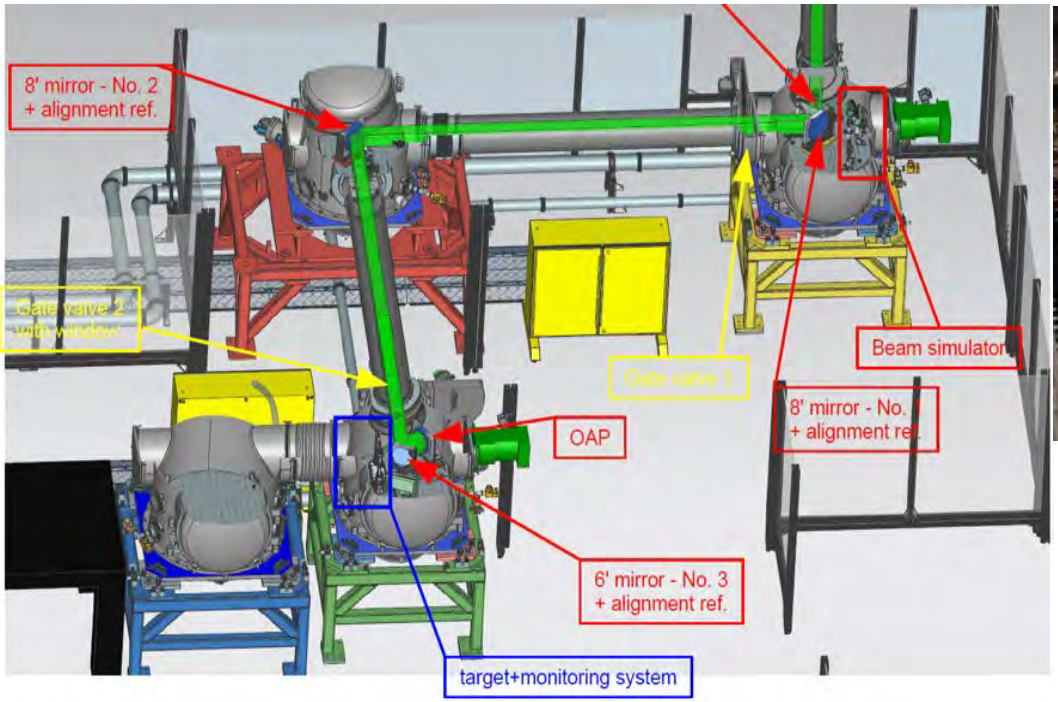
Dosimetry & Sample Irradiation

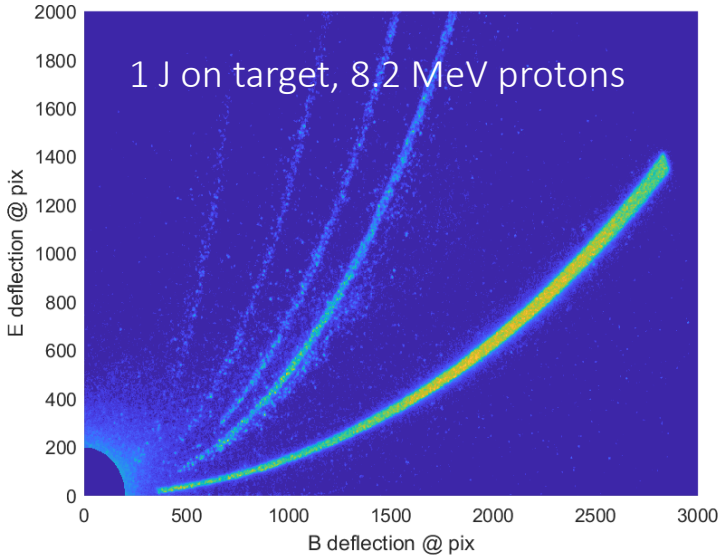


D. Margarone et al., “ELIMAIA: A Laser-Driven Ion Accelerator for Multidisciplinary Applications”, Quantum Beam Sci. 2 (2018) 8

TERESA testbed

first acceleration experiments with L3-HAPLS





Coolaboration

Collaboration between
ELI-Beamlines (FZU CAS, Czech Republic), BELLA Center (LBNL, CA, USA),
Keldysh Institute of Applied Mathematics (RAS, Moscow, Russia)
has resulted in the world highest charged particle energy (7.8 GeV) achieved with high power laser-plasma interaction in the LWFA regime

PHYSICAL REVIEW LETTERS 122, 084801 (2019)

Editors' Suggestion | Featured in Physics

Petawatt Laser Guiding and Electron Beam Acceleration to 8 GeV in a Laser-Heated Capillary Discharge Waveguide

A. J. Gonsalves,[1,*] K. Nakamura,[1] J. Daniels,[1] C. Benedetti,[1] C. Pieronek,[1,2] T. C. H. de Raadt,[1] S. Steinke,[1] J. H. Bin,[1] S. S. Bulanov,[1] J. van Tilborg,[1] C. G. R. Geddes,[1] C. B. Schroeder,[1,2] Cs. Tóth,[1] E. Esarey,[1] K. Swanson,[1,2] L. Fan-Chiang,[1,2] G. Bagdasarov,[3,4] N. Bobrova,[3,5] V. Gasilov,[3,4] G. Korn,[6] P. Sasorov,[3,6] and W. P. Leemans[1,2,†]

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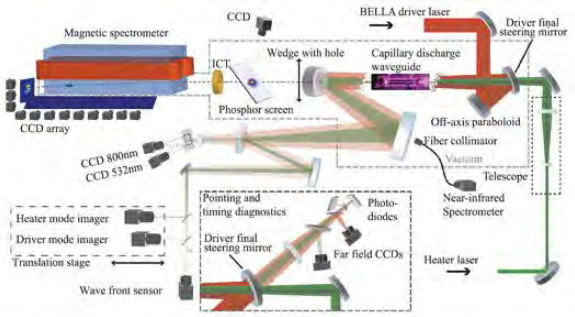
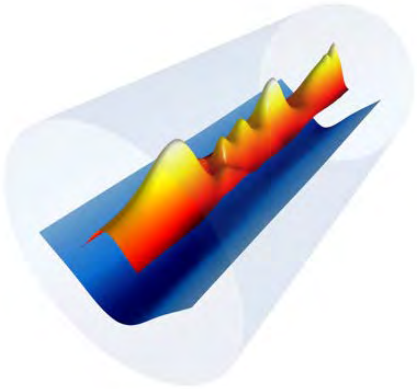
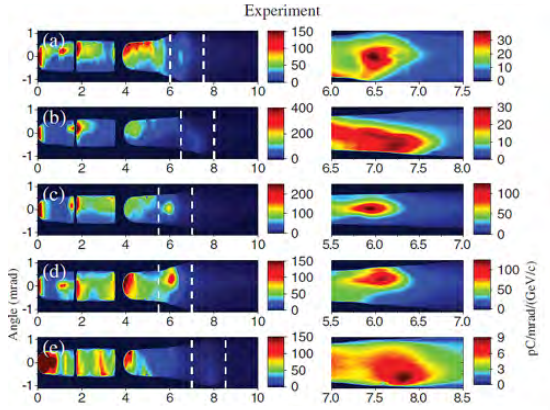
[2]*University of California, Berkeley, California 94720, USA*
[3]*Keldysh Institute of Applied Mathematics RAS, Moscow 125047, Russia*
[4]*National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow 115409, Russia*
[5]*Faculty of Nuclear Science and Physical Engineering, CTU in Prague, Brehova 7, Prague 1, Czech Republic*
[6]*Institute of Physics ASCR, v.v.i. (FZU), ELI-Beamlines Project, 182 21 Prague, Czech Republic*



Layout of the BELLA LPA with laser heater for enhancing the capillary discharge waveguide



Plasma channel's electron density profile (blue) formed by discharge inside a capillary (gray) with an 8-nanosecond laser pulse heater (red, orange, and yellow). The plasma channel was used to guide femtoseconds-long "driver" laser pulses from the BELLA petawatt laser system, which generated plasma wake waves accelerating electrons to 8 GeV over the distance of 20 centimeters.



Electron beam energy-angle distribution

https://newscenter.lbl.gov/2019/02/25/laser-drill-sets-a-new-world-record-in-laser-driven-electron-acceleration/

User Calls Schedule

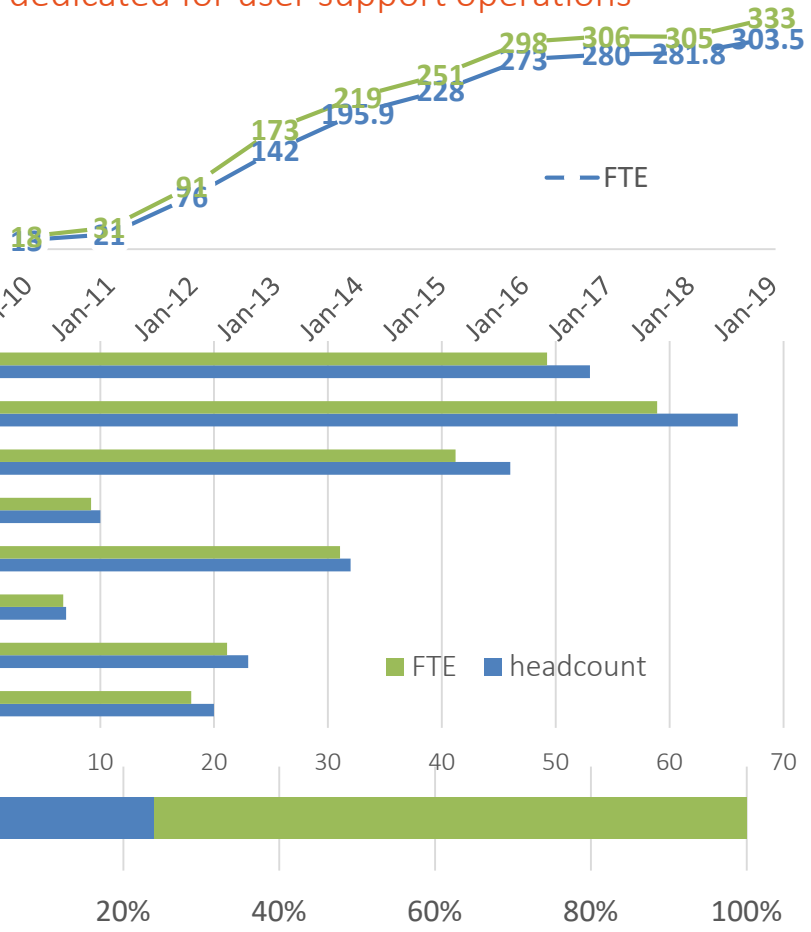
Call	Q1/2019	Q2	Q3	Q4	Q1/2020	Q2
E1 Commissioning						
E1 Peer Reviewed						
E3 Commissioning						
E4 Commissioning						

Note: Before ERIC establishment, calls shall be opened and administrated by IoP

ELI BL Staff

STAFF PROFILE FTE

2/3 dedicated for user support operations



Facility 5-year Perspective

2017
Installation and commissioning, first experiments

2019

First user call - E1, Availability of L1 and L3 laser sources,

User calls - E1, E3, E4.

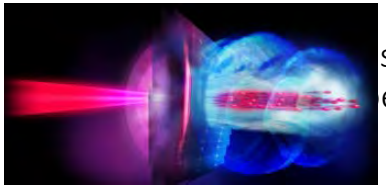
Performance ramp-up

2021-2
Completion of upgrades, L2 laser source, ELBA and LUIS/FEL beamline and Gammatron source

2018

Facility completion, Start of biolab operation,

First users



2020

ser operations and erformance ramp-up,

L4 10 PW, L4n commissioning

R&D and Upgrade projects – additional 100 mi. EUR
ELISus – core support for the R&D activities
ELIBIO – Biolab facility, new technology, R&D activities
HIFI – High-field science and computing capabilities
ADONIS – Multiple-enhancements for parallel operation

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