

Laserové centrum ELI Beamlines

Ing. Ladislav Půst, PhD.

30. října 2018



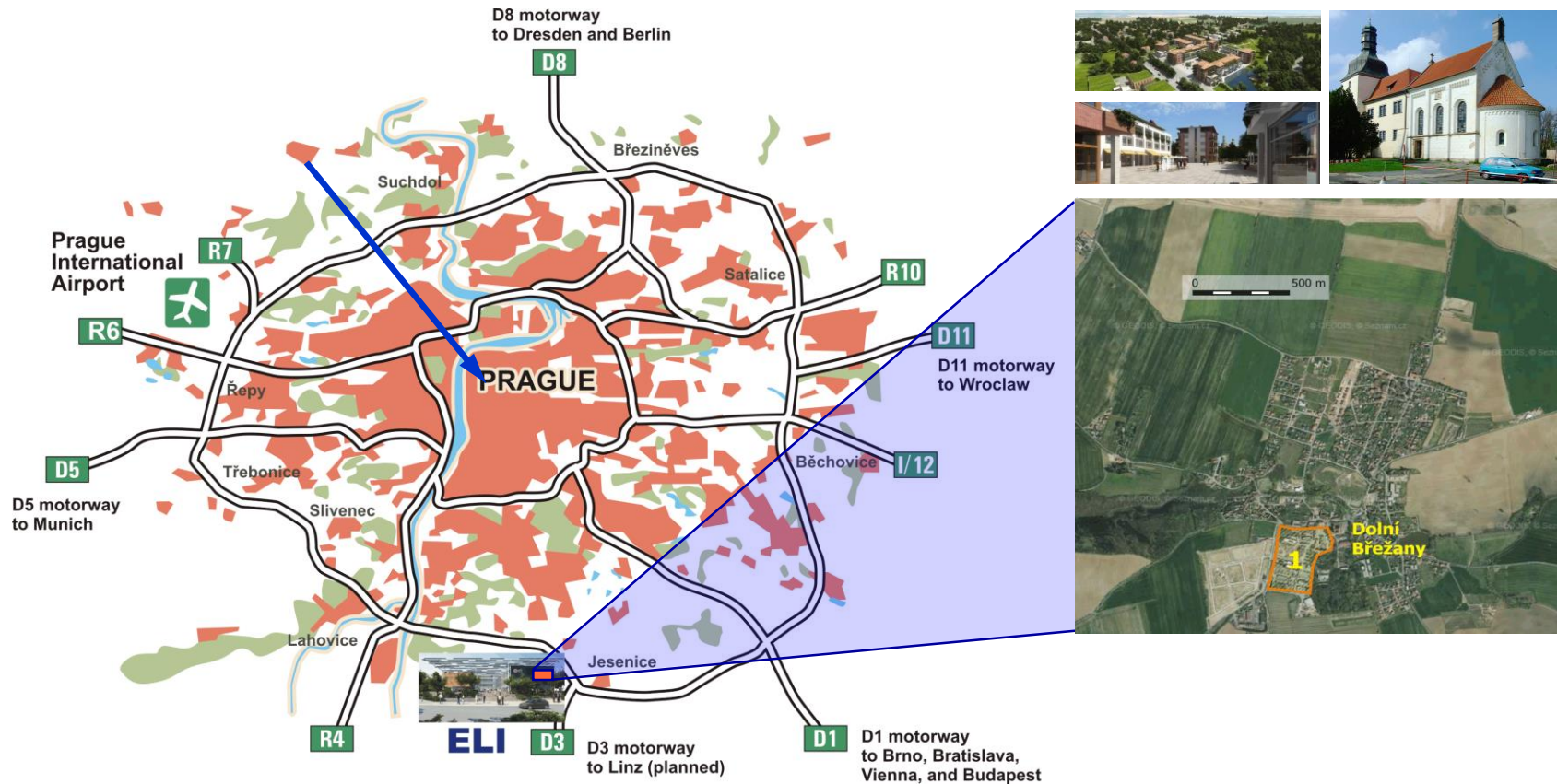
ELI Beamlines
Fyzikální ústav Akademie věd ČR, v.v.i.
Za Radnicí 835
252 41 Dolní Břežany
Ladislav.Pust@eli-beams.eu
+420-775-620-803

ELI = Extreme Light Infrastructure

- **ELI Beamlines, Dolní Břežany**
Development and application of ultra-short femtosecond pulses of high-energy particles and radiation.
- **ELI ALPS, Szeged, HU**
Extremely short attosecond laser pulses.
- **ELI Nuclear Physics, Magurele, RO**
Facility with ultra-intense lasers and brilliant gamma and neutron beams.



ELI Beamlines location



- Proximity of international airport (15 min drive), enjoyable surroundings, behind the border of Prague (funding issues)
- Synergy with planned large biotechnology center BIOCEV (2 km distance)
- Direct connection to Prague outer ring and the European motorway network



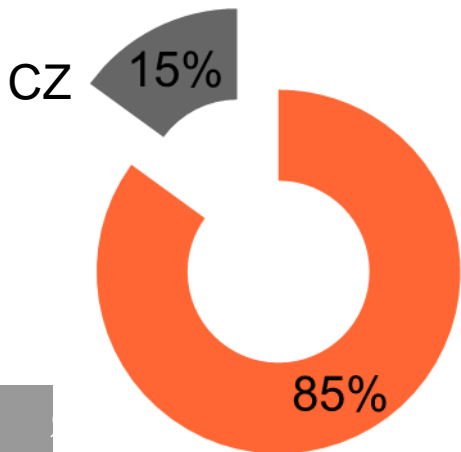
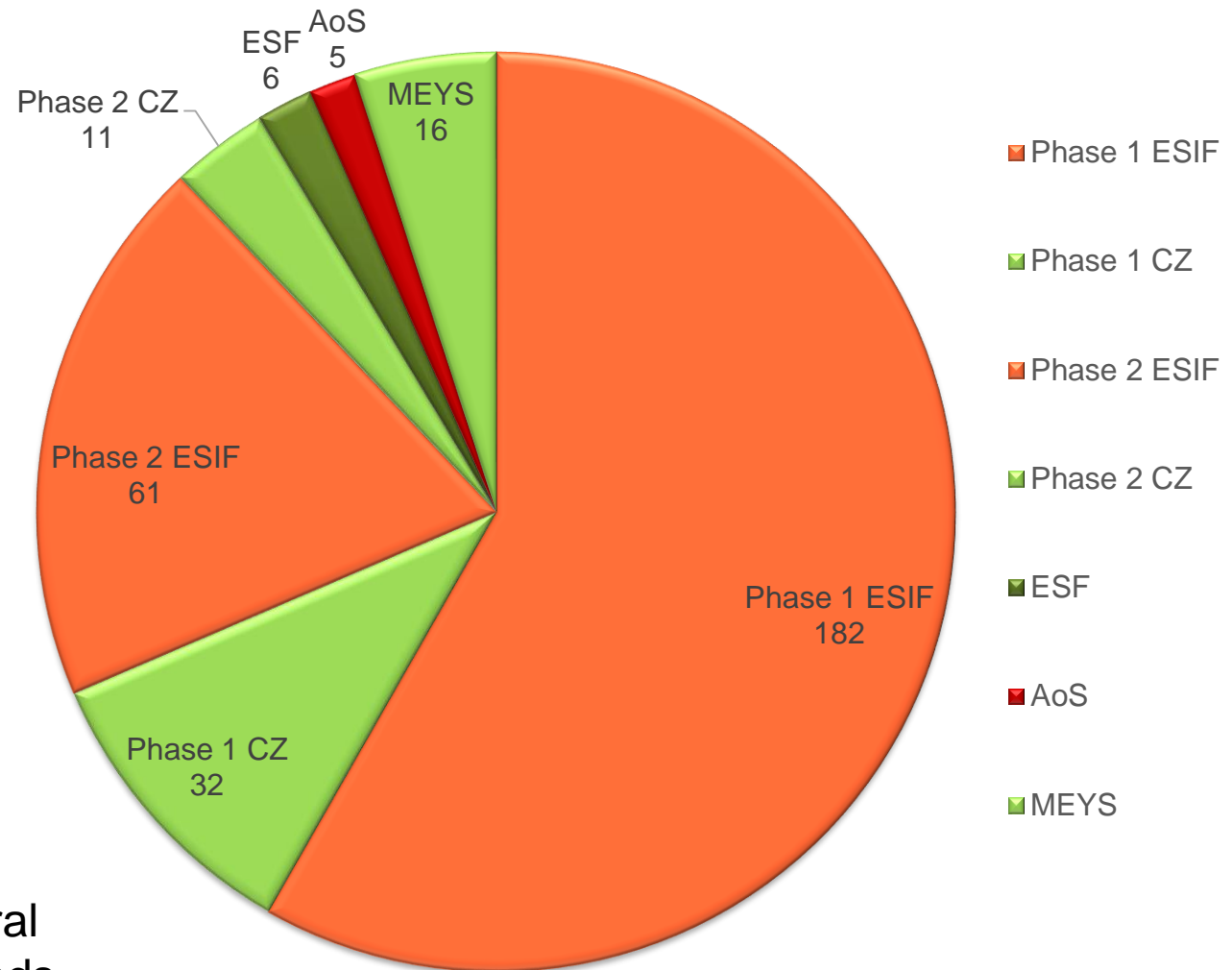
Author:

Bogle Architects

ELI Beamlines Cost 2008 - 2017

ESIF Investment	
EUR	
Building + Land	84 913 000
Technology	161 876 341
Services	8 029 091
Personal Costs	23 090 909
TOTAL	277 909 341

Funding ELI BL 2008 - 2017



ESIF = EU structural and investment funds

Date:

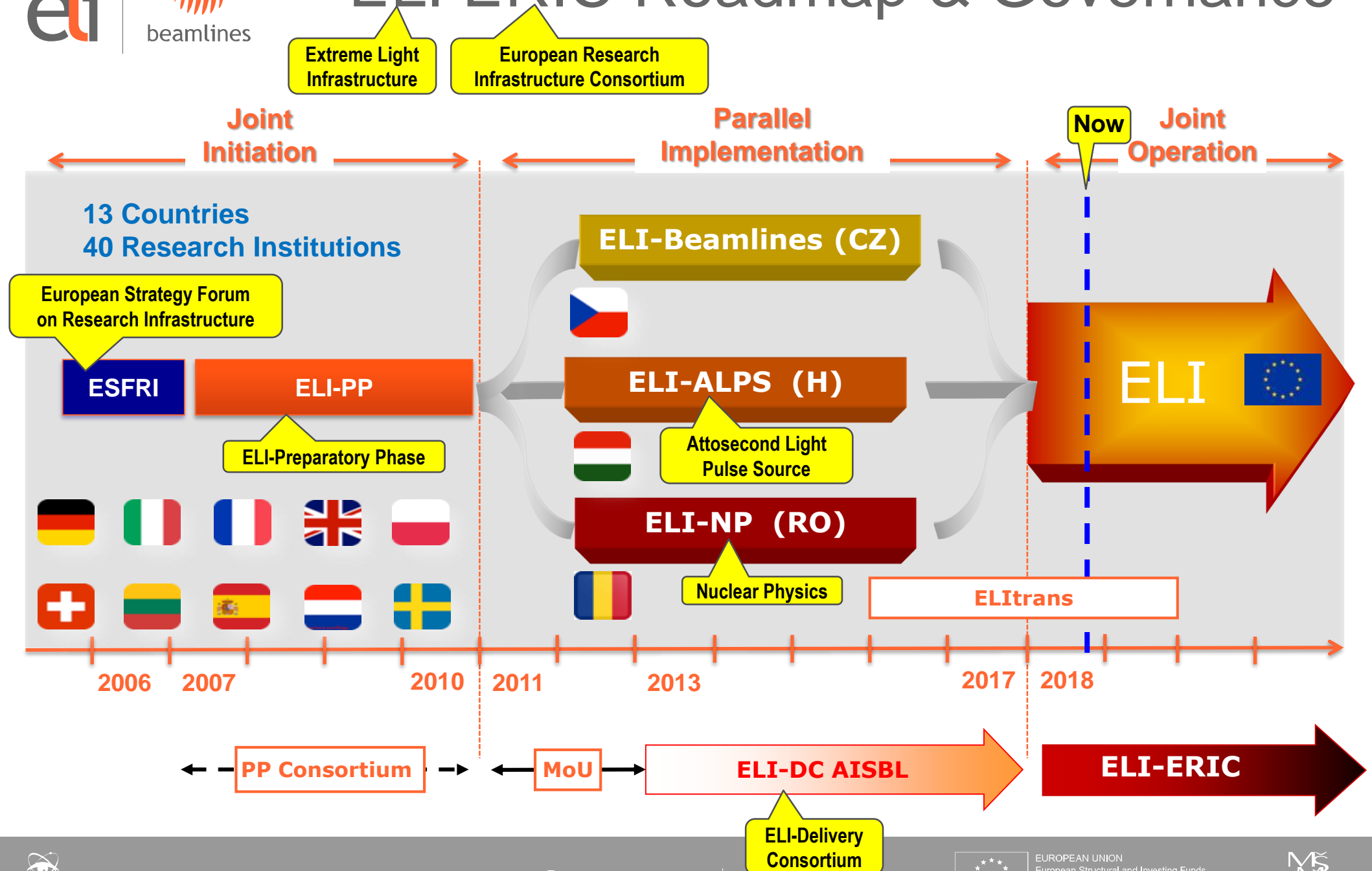


EUROPEAN UNION
European Structural and Investing Funds
Operational Programme Research,
Development and Education



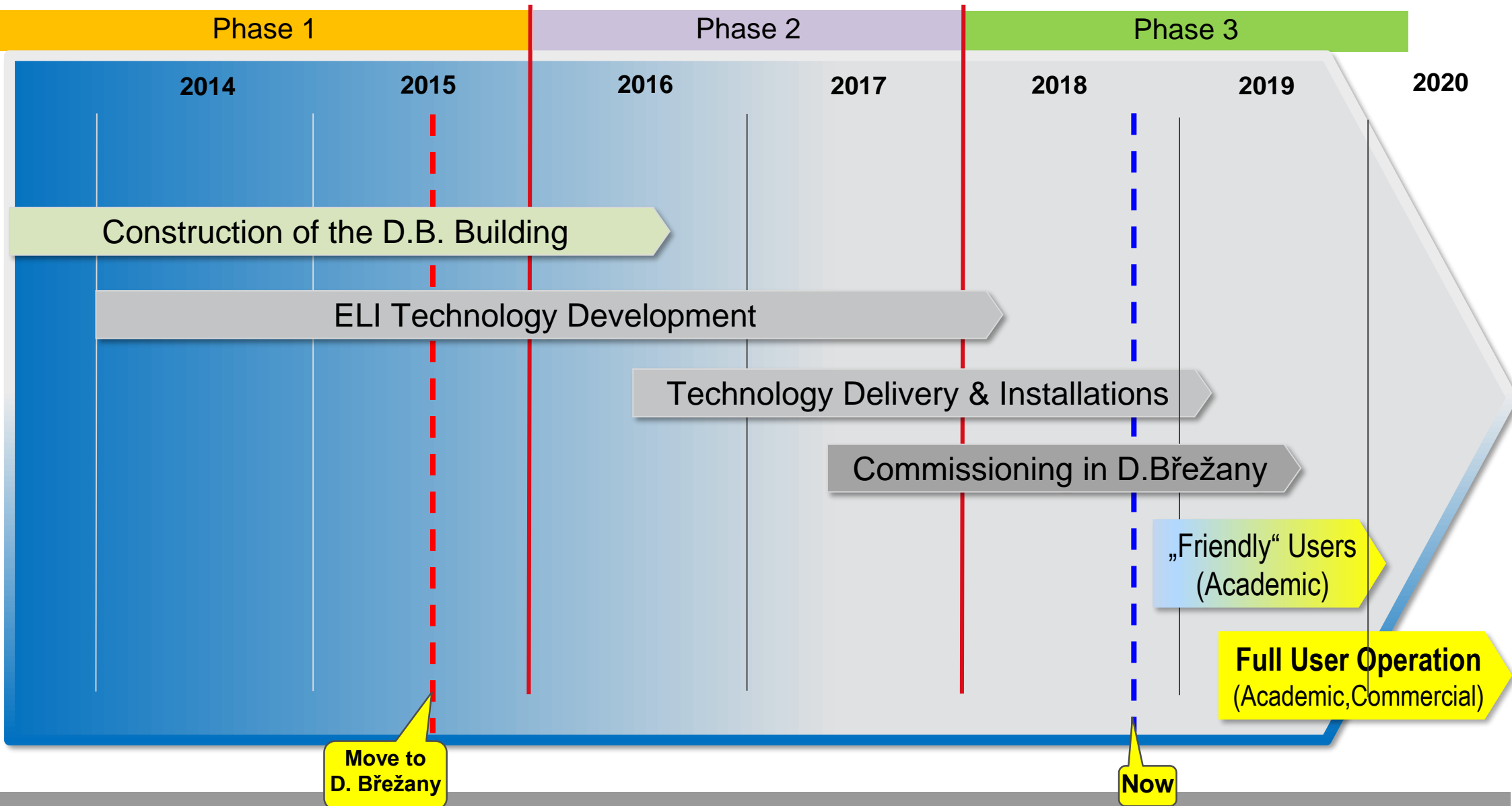
MINISTRY OF EDUCATION
YOUTH AND SPORTS

ELI ERIC Roadmap & Governance



Date:

Timeline for ELI Beamlines Operation



LASER = Light Amplification by Stimulated Emission of Radiation

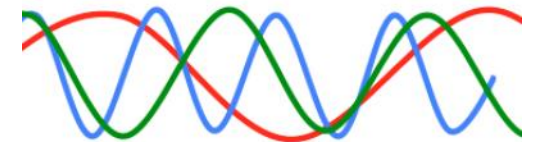
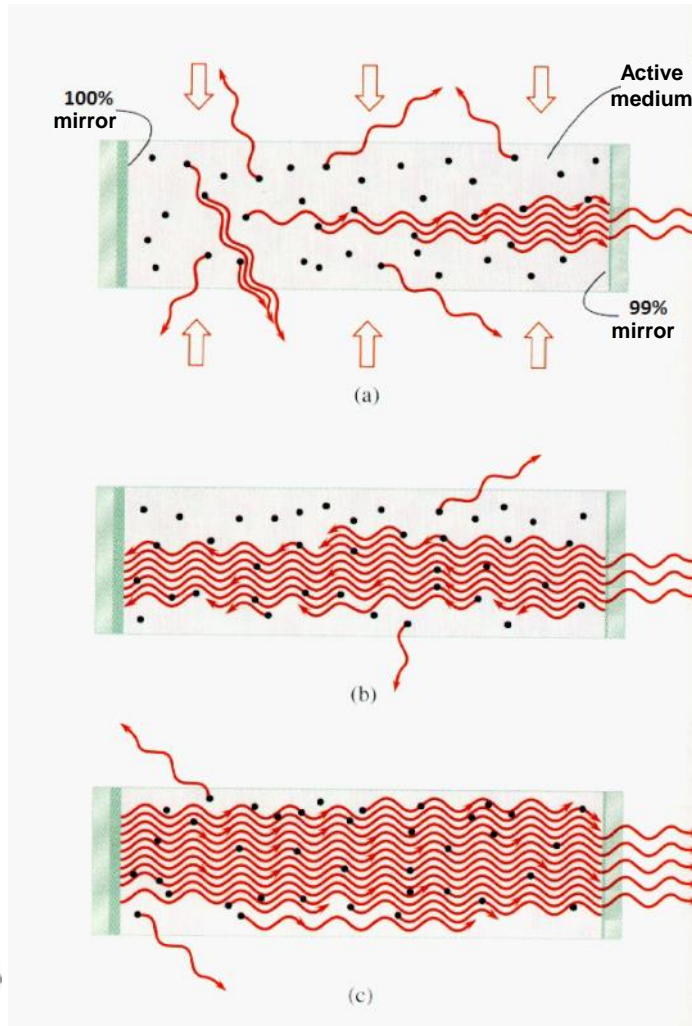
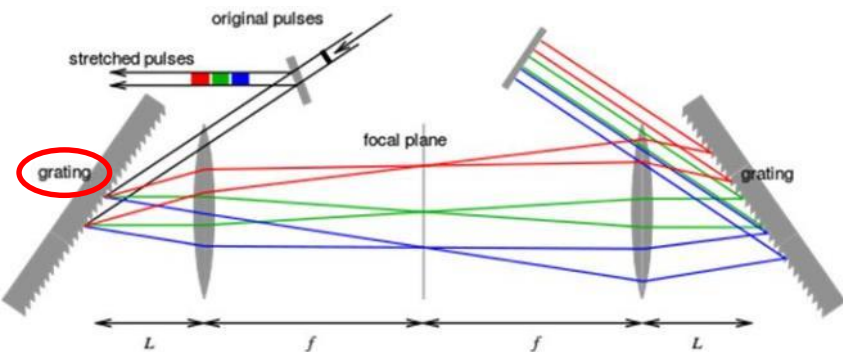
1917 – Einstein predicts stimulated emission

1960 – The first laser built

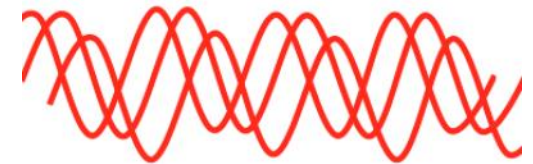
1964 – The first laser in ČR (FJFI ČVUT)

1985 – CPA amplification for pulse lasers

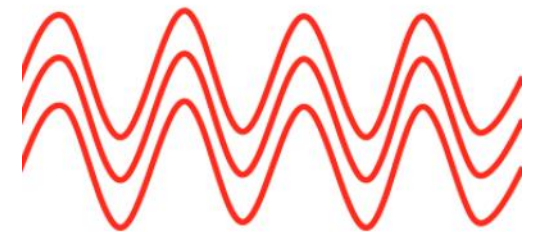
Chirped Pulse Amplification



Bulb



LED

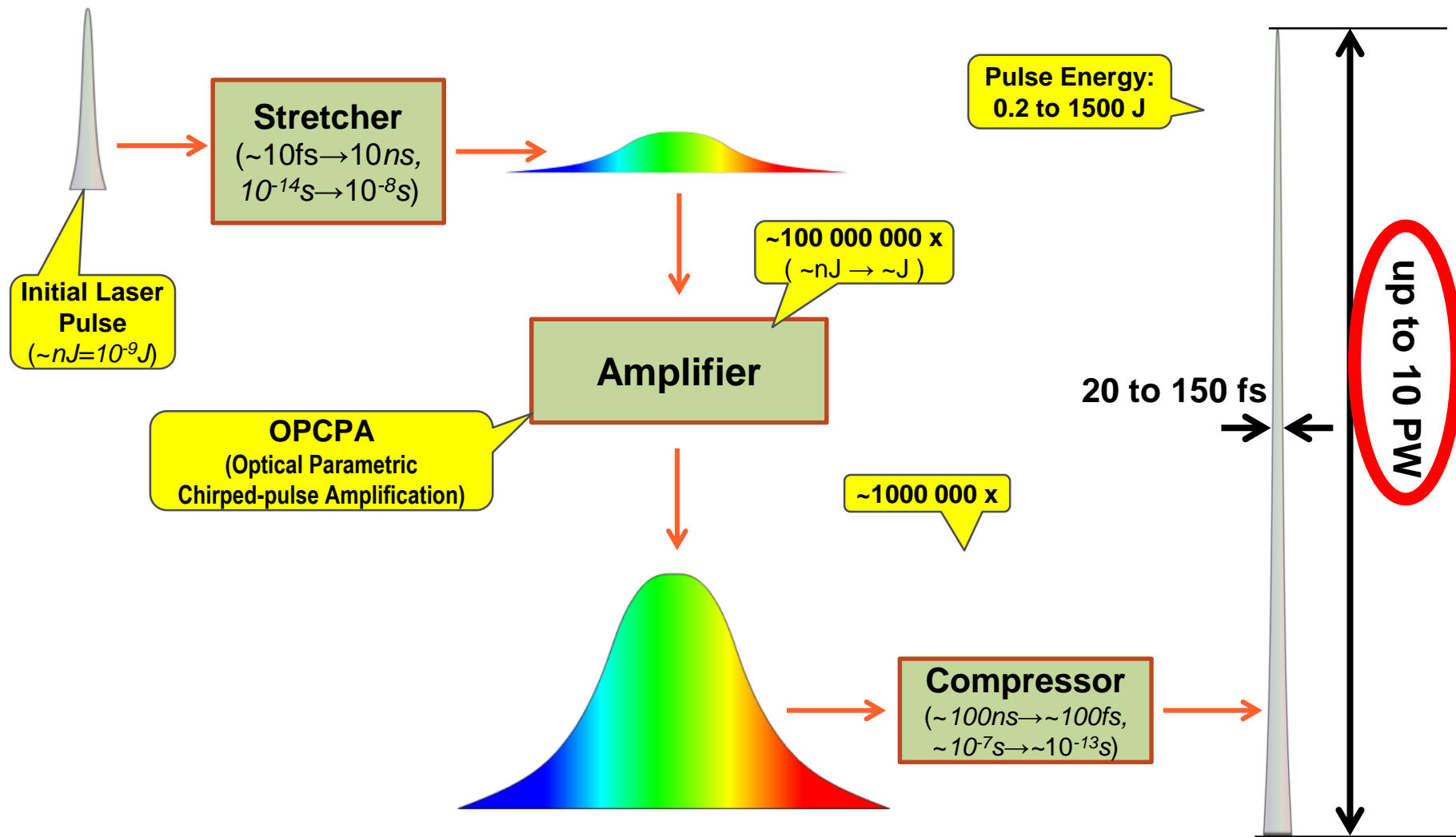


laser

Chirped Pulse Amplification (CPA)

The Nobel Prize in Physics for 2018 was awarded to **G rard Mourou and Donna Strickland**

“for their method of generating high-intensity, ultra-short optical pulses”



G rard Mourou



Donna Strickland



What is 10 PW (PetaWatt)?

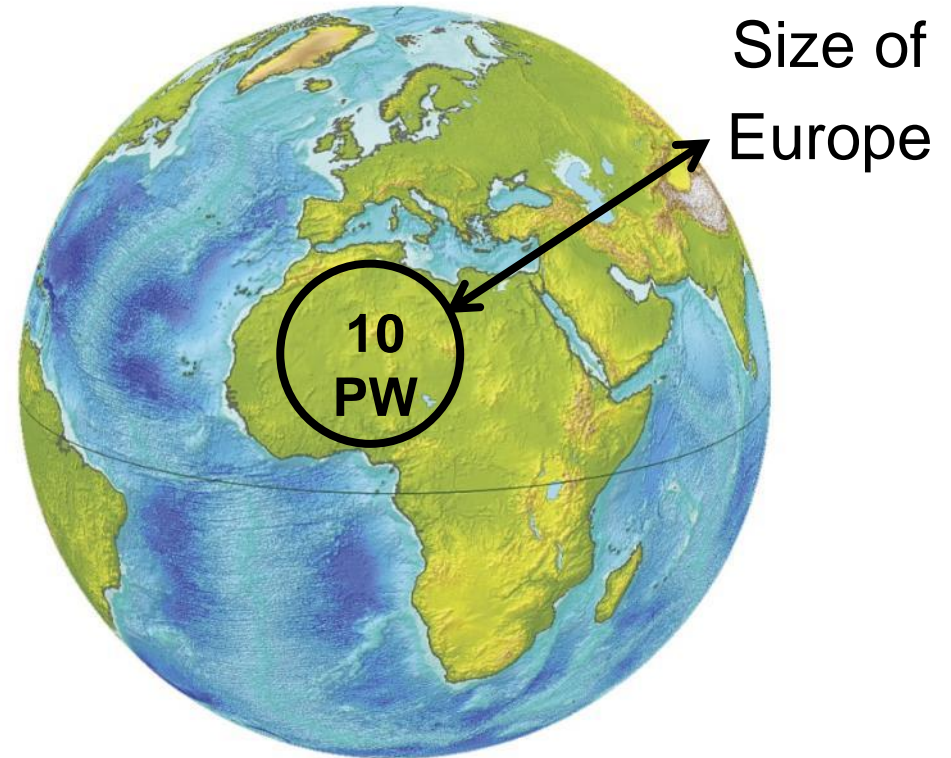
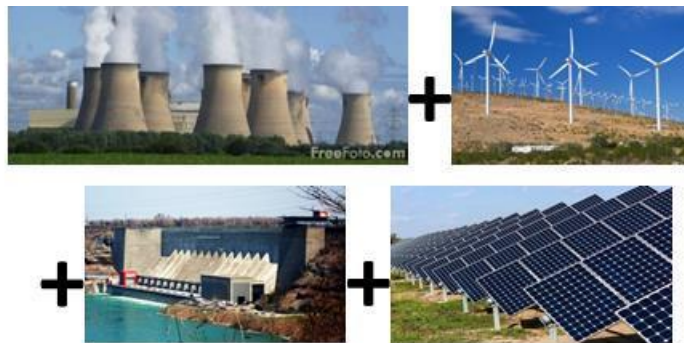
$$10 \text{ PW} = 10^{16} \text{ W} = 10 \text{ 000 000 000 000 000 W}$$

Sun power shining on Earth:
174 PW

Total electricity generating capacity:

All World: 0.0053 PW

U.S. + EU: 0.0019 PW

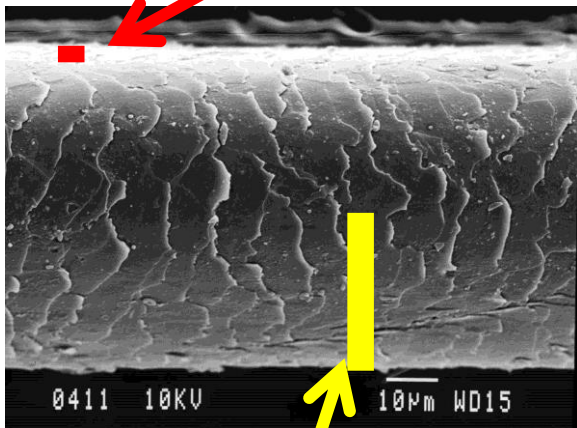


What does it mean „10 - 100 fs“?

10 fs = 10 femtoseconds =
 10^{-14} s = 0.000 000 000 000 01 s

How „long“ is 10 fs pulse of laser light?

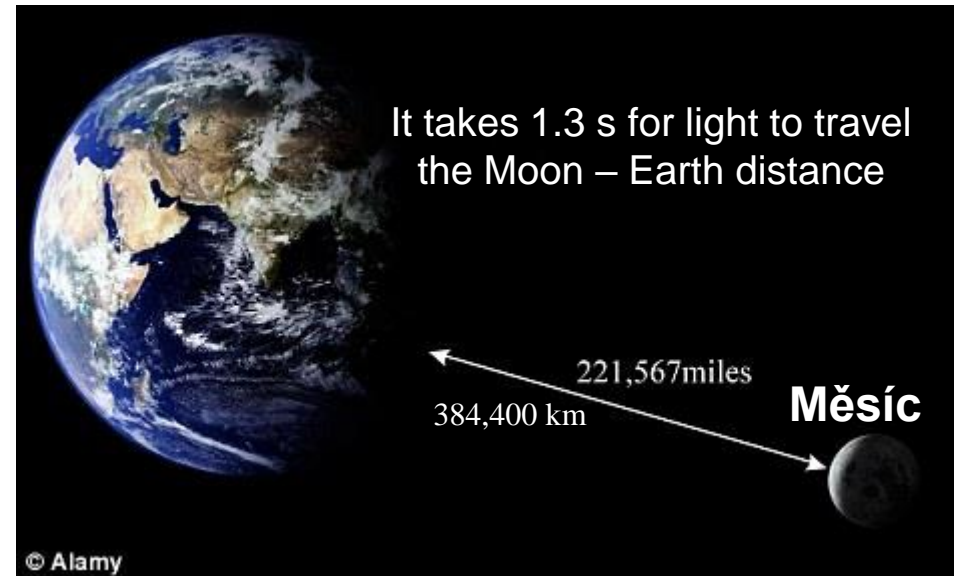
$3 \mu\text{m} = 0.003 \text{ mm}$



More powerful and longer 100 fs pulse:

$30 \mu\text{m} = 0.03 \text{ mm}$

Light speed: 300 000 km/s



**ELI laser beams will travel over 50 m to targets.
 In some setups, beams from 2 (or even 3) lasers
 have to hit the target simultaneously.**





Trasa D

CzechBio

EXBIO
Antibodies

APRONEX
BIOTECHNOLOGIES

VESTEC

Top-Bio

BIOCEV

INNOCRYSTAL

KNIGHTS
Transfer of Technologies

HODKOVICE

SIC

DOLNÍ BŘEŽANY

CITT ELI

hilase

eli | **beamlines**

Rigaku




From Dream to Reality



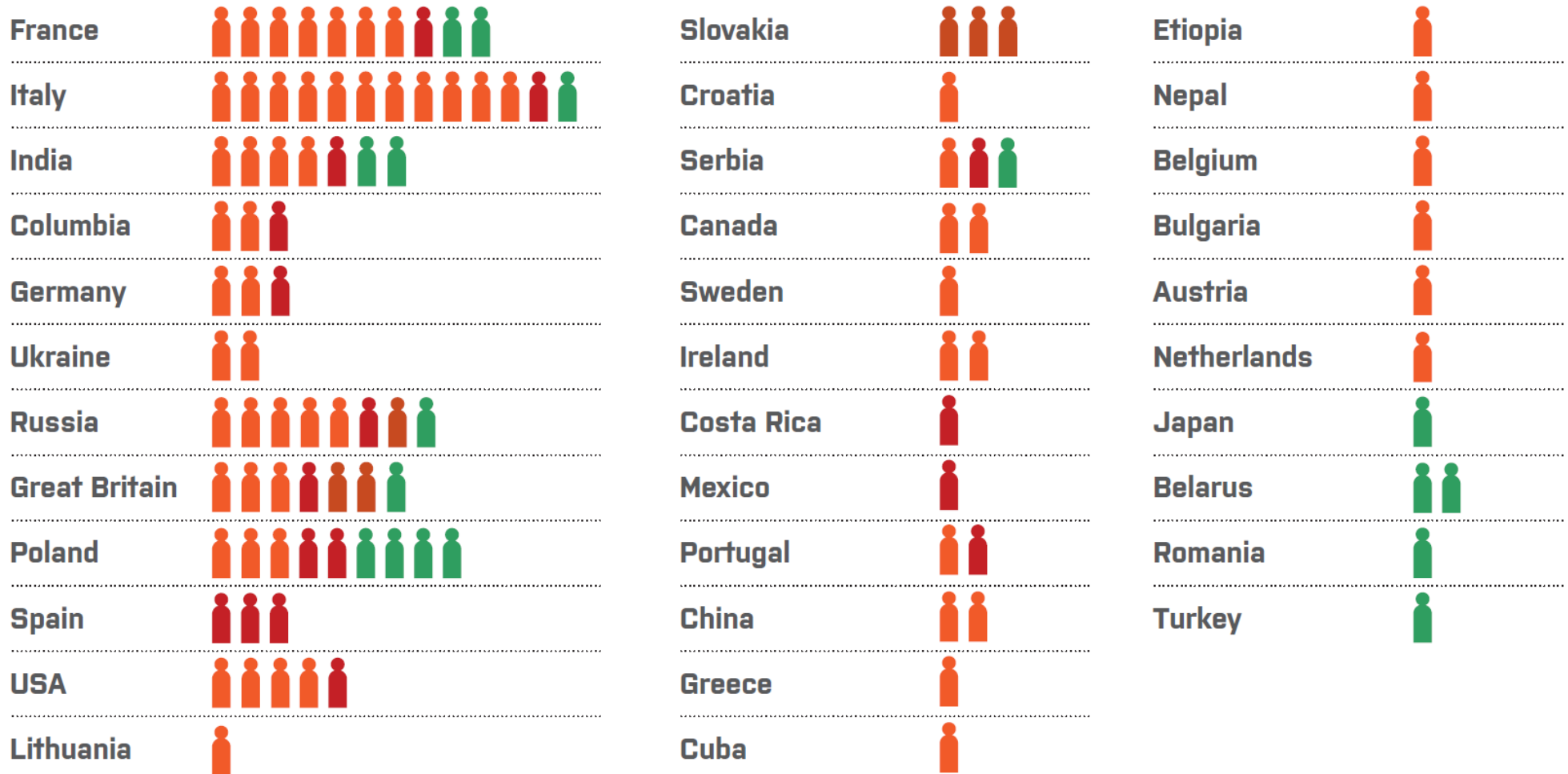
GRAND OPENING

of ELI Beamlines International Laser
Research Centre in Dolní Břežany

19th of October 2015 at 2:30 PM

Employees by Country

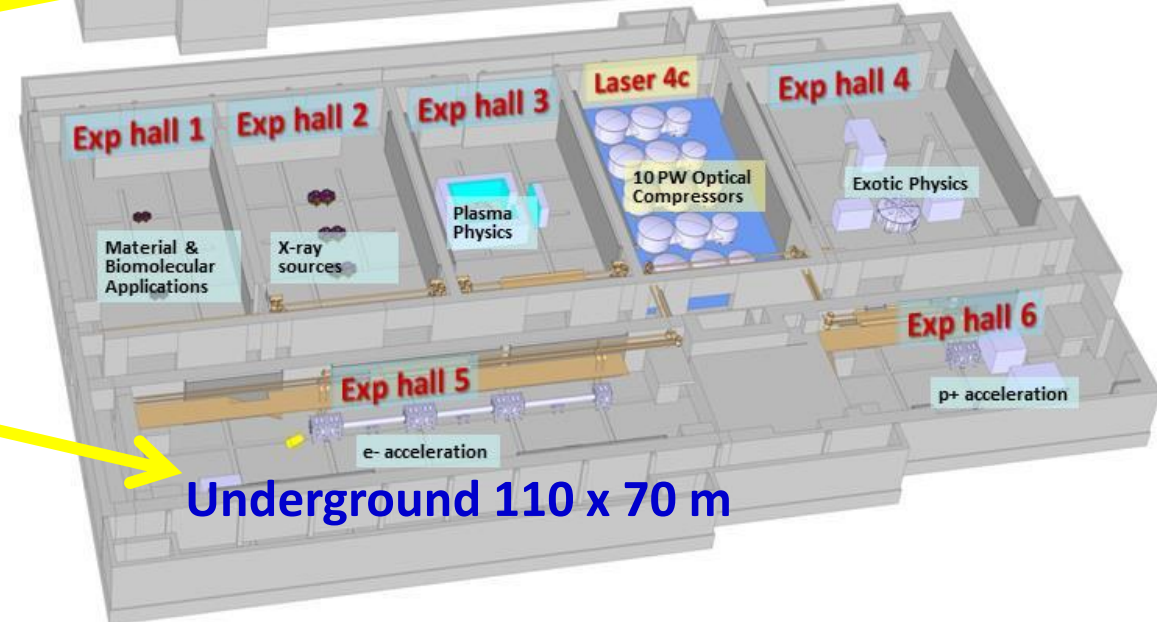
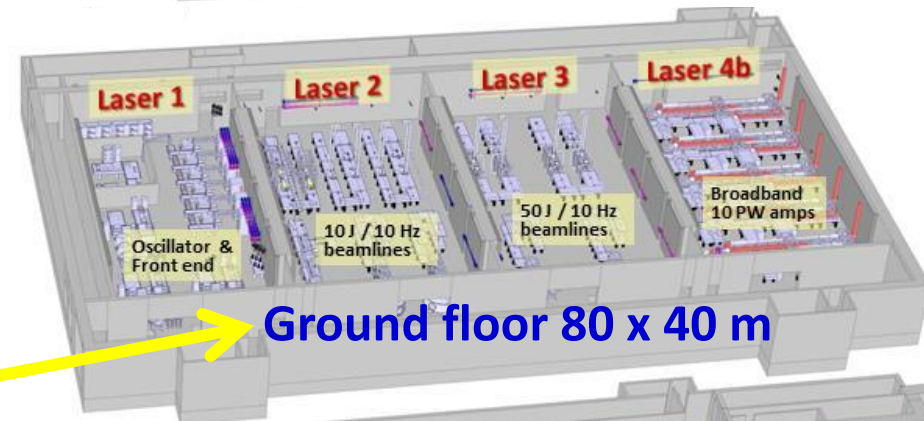
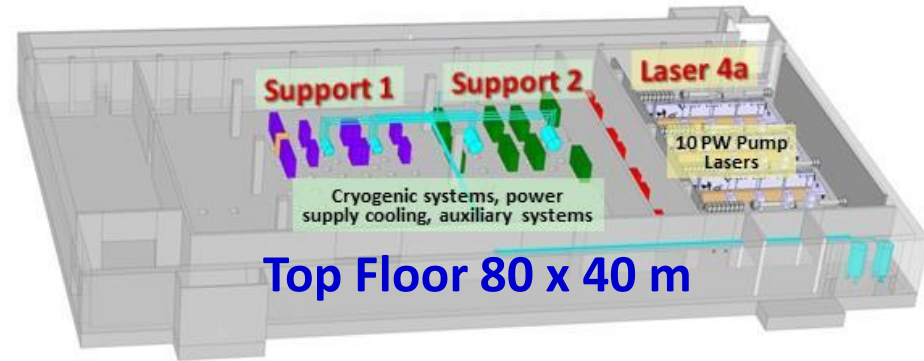
Employees and Countries



ELI Beamlines Campus



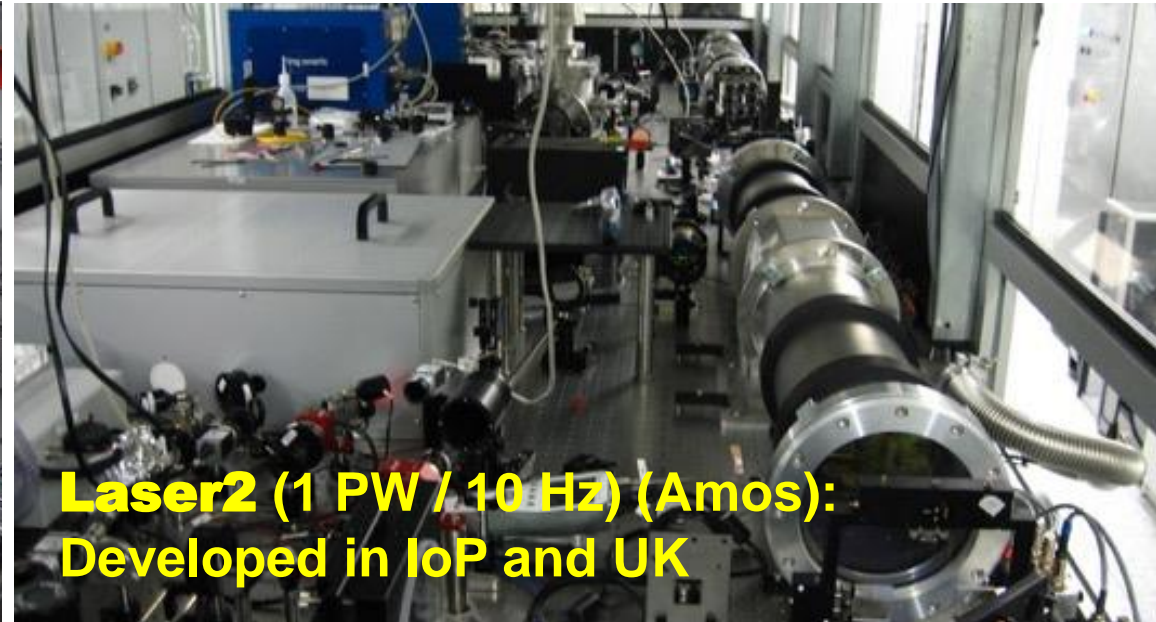
Laser Building



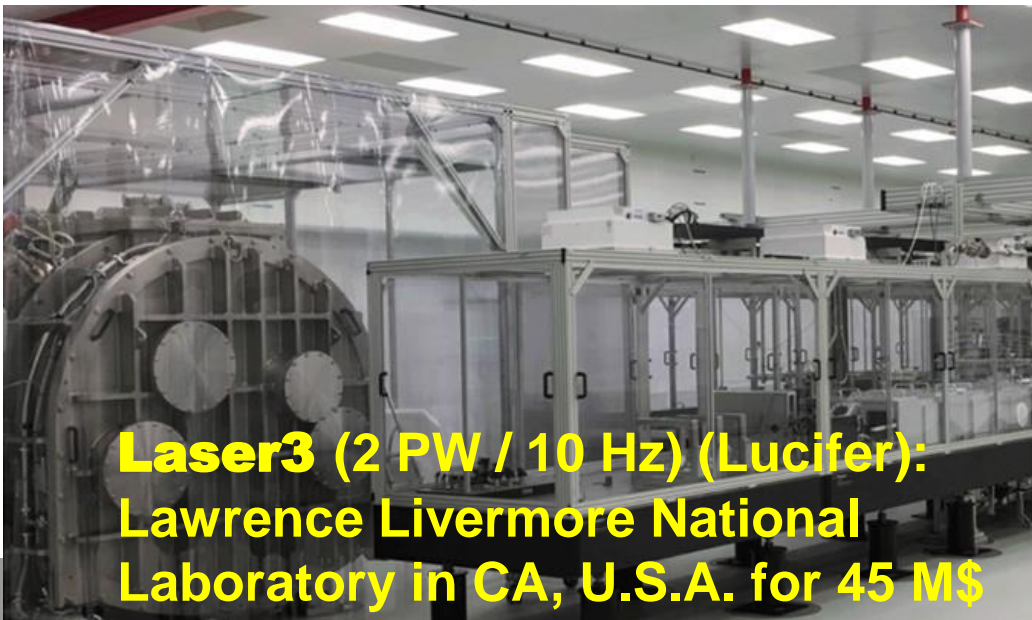
Four Laser Systems



Laser1 (0.02 PW / 1000 Hz) (Avoja):
Developed in the IoP, Prague



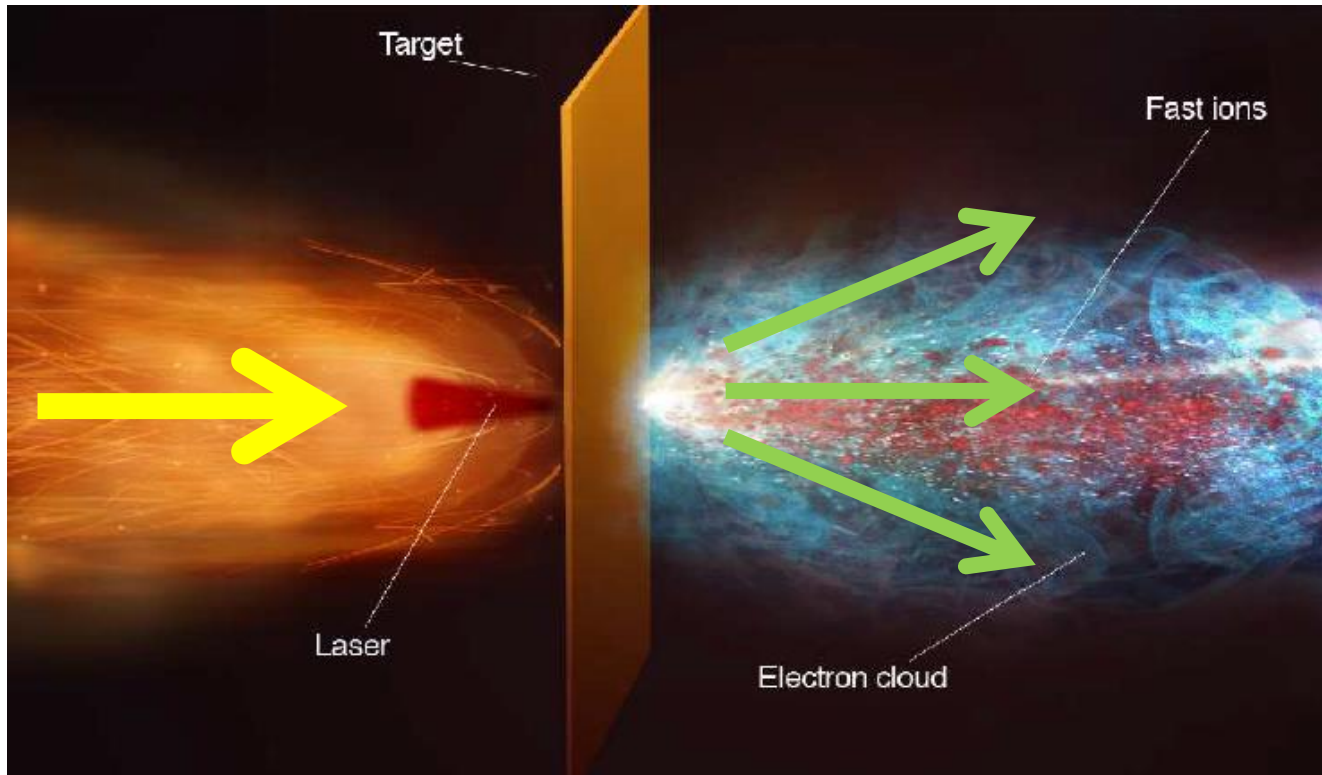
Laser2 (1 PW / 10 Hz) (Amos):
Developed in IoP and UK



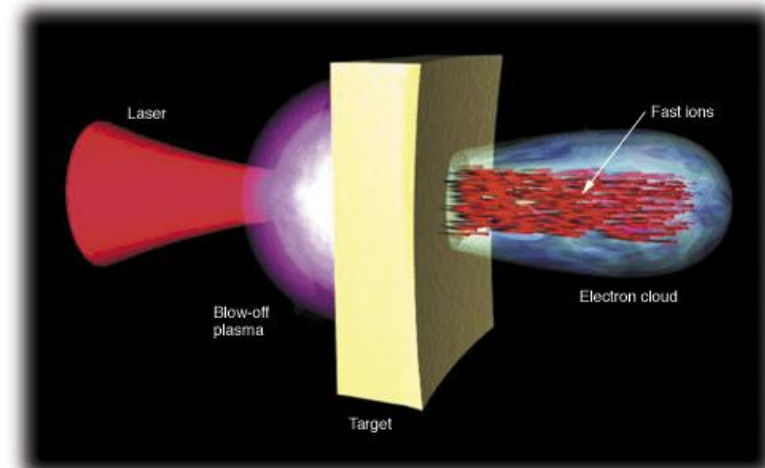
Laser3 (2 PW / 10 Hz) (Lucifer):
Lawrence Livermore National
Laboratory in CA, U.S.A. for 45 M\$



Laser4 (10 PW / single shots) (Krakati):
Made by U.S.-EU Consortium (National
Energetics, EKSPLA, LLNL, Schott) for 40 M\$



- X-Rays
- Electrons
- Protons
- Ions
- γ -Rays
- ...



In laboratory experiments, the Petawatt laser's tremendous power produced intense beams of protons, proving the laser to be a powerful ion accelerator.

Application & Research Programs

ELI-Beamlines will be international user facility
Balance between applications and fundamental science

Research Program 1

Lasers generating ultrashort pulses & multi-PW powers

Underground Floor
of the Laser building

Research Program 2

X-ray sources driven by ultrashort laser pulses

Research Program 3

Particle acceleration by lasers

Research Program 4

Molecular, biomedical, material science applications

Research Program 5

Laser plasma and high-energy-density physics

Research Program 6

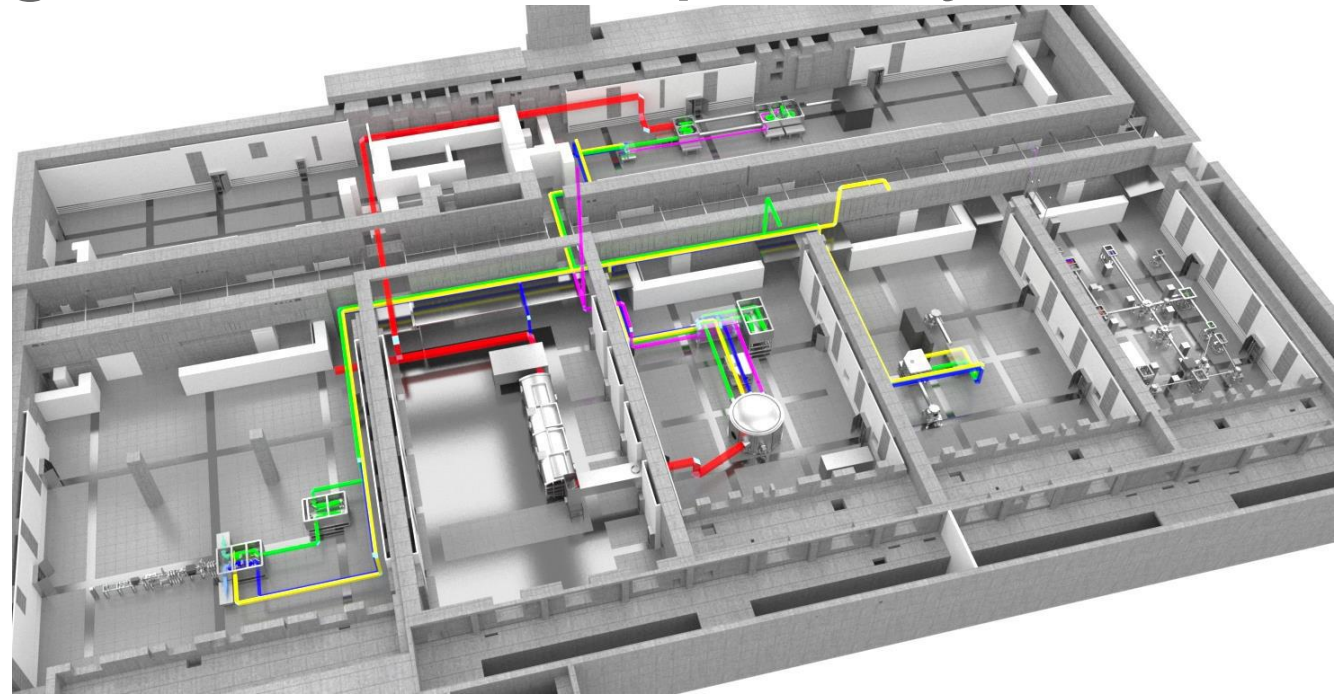
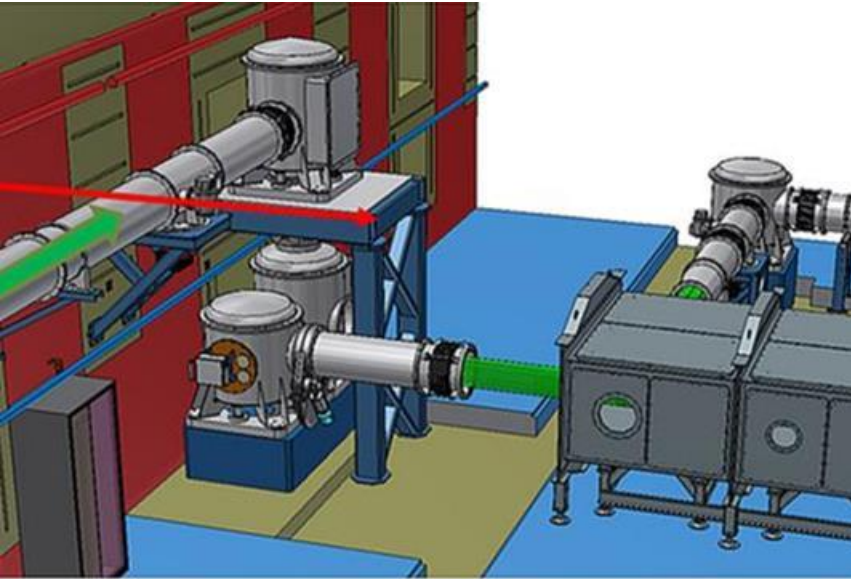
Exotic physics and theory

The „money-making“ projects

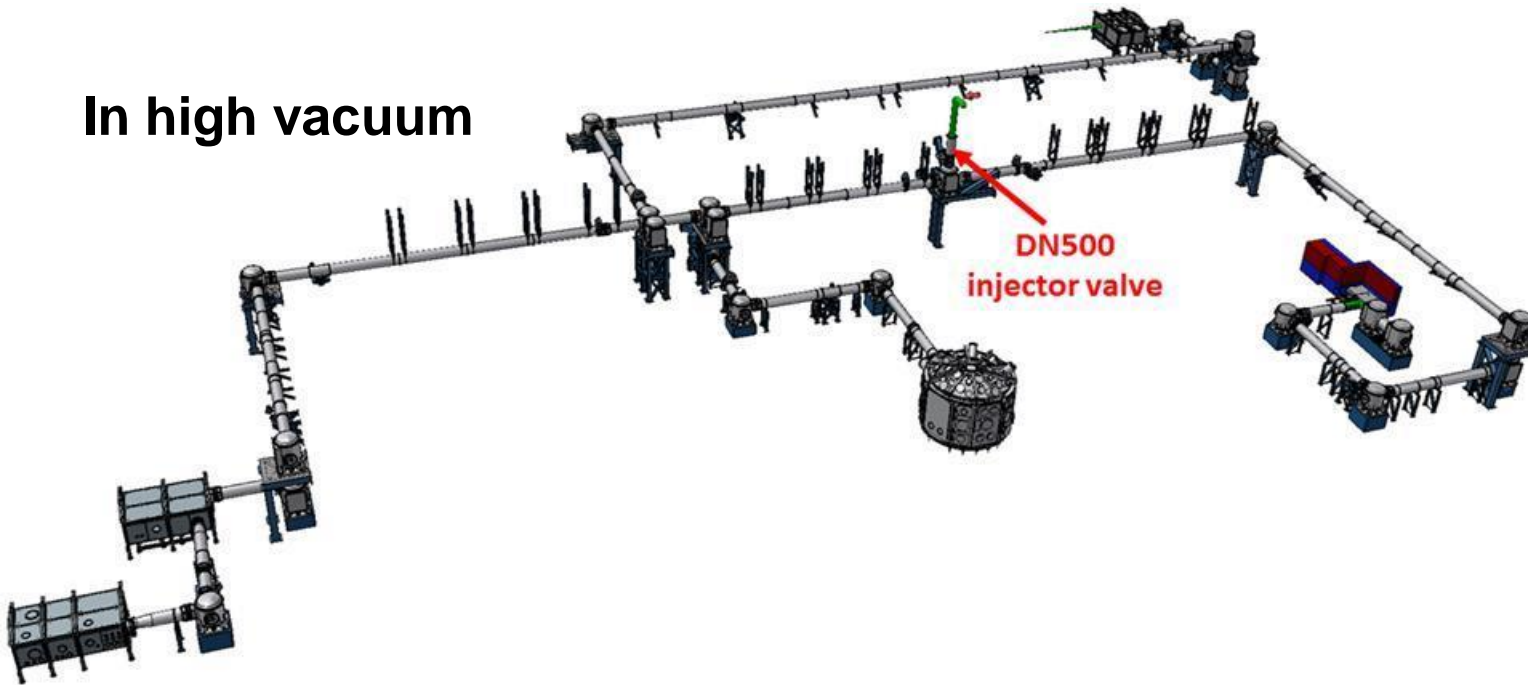


110 x 60 m

Huge Beam Transport System



In high vacuum



Laser beams:

L1: 100x100 mm

L2,L3: 250x250 mm

L4: 400x400 mm

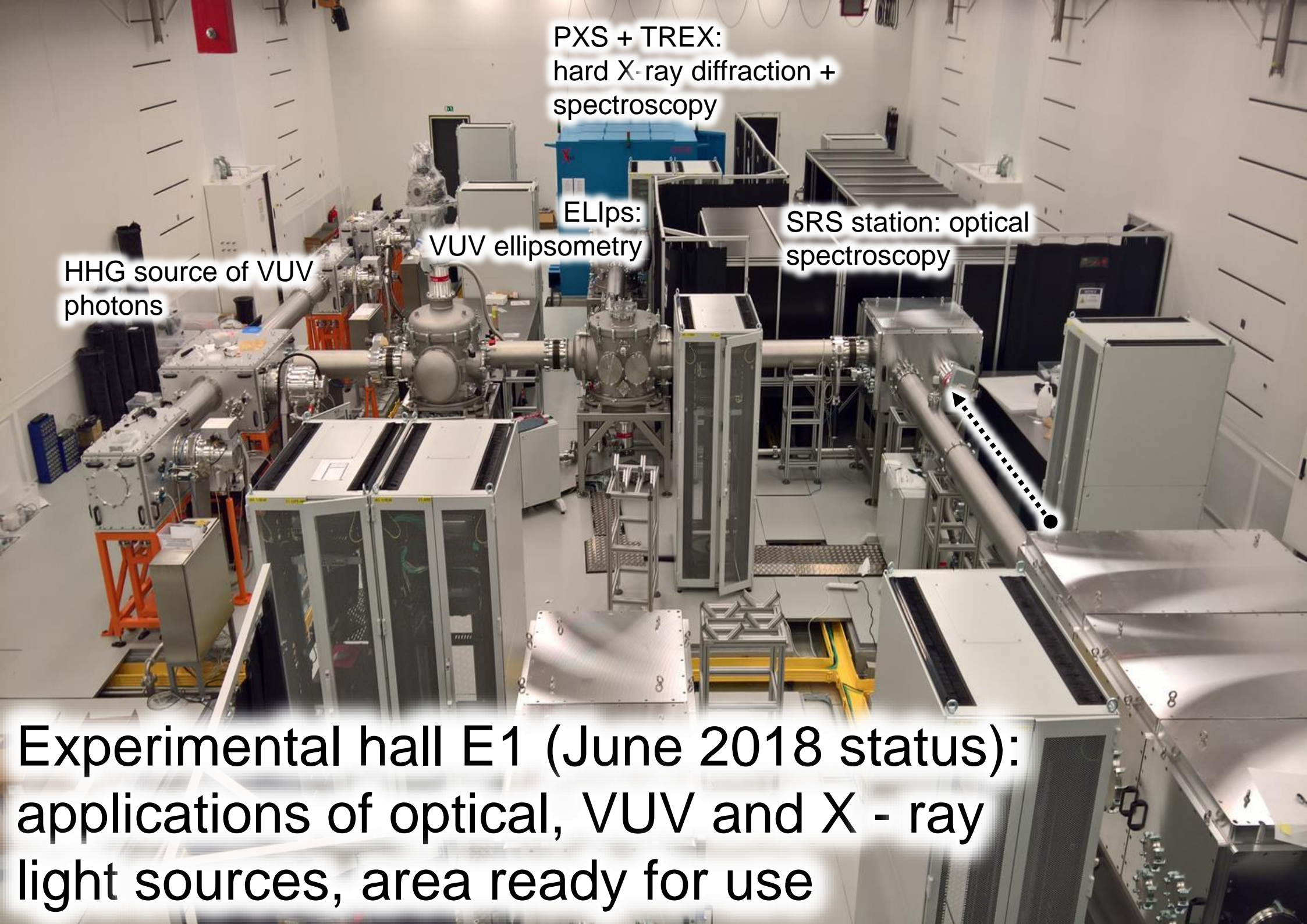
PXS + TREX:
hard X-ray diffraction +
spectroscopy

ELIps:
VUV ellipsometry

SRS station: optical
spectroscopy

HHG source of VUV
photons

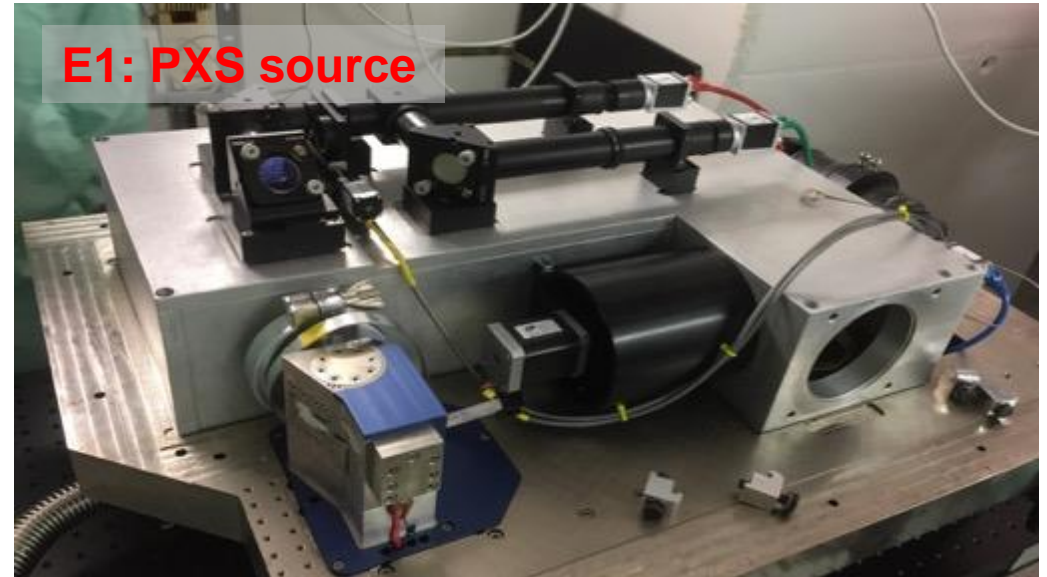
Experimental hall E1 (June 2018 status):
applications of optical, VUV and X - ray
light sources, area ready for use



E3: Plasma Physics Platform (P3)



E1: PXS source

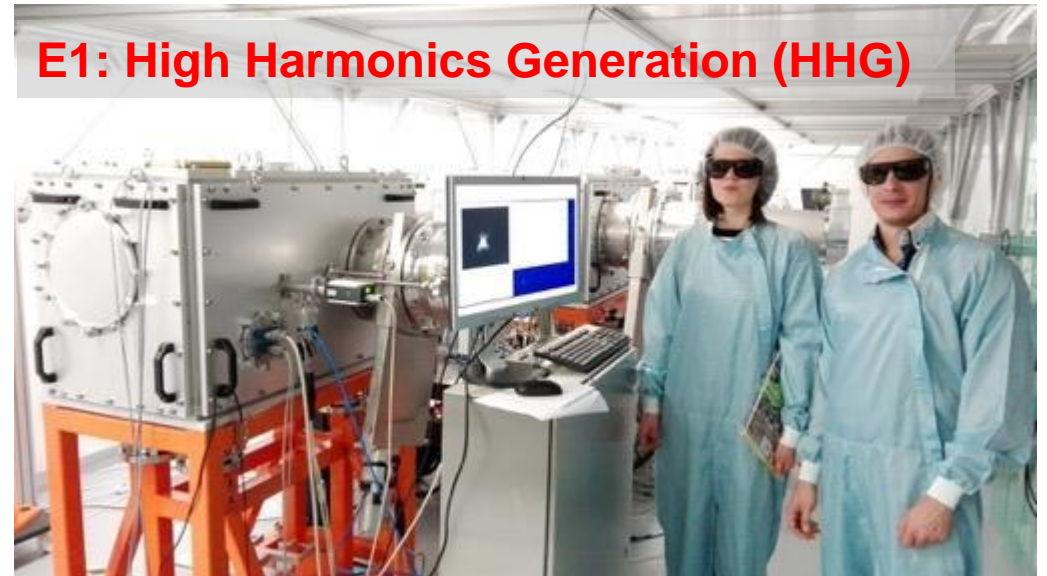


E4: ELIMAIA

ELI Multidisciplinary Applications of laser-Ion Acceleration



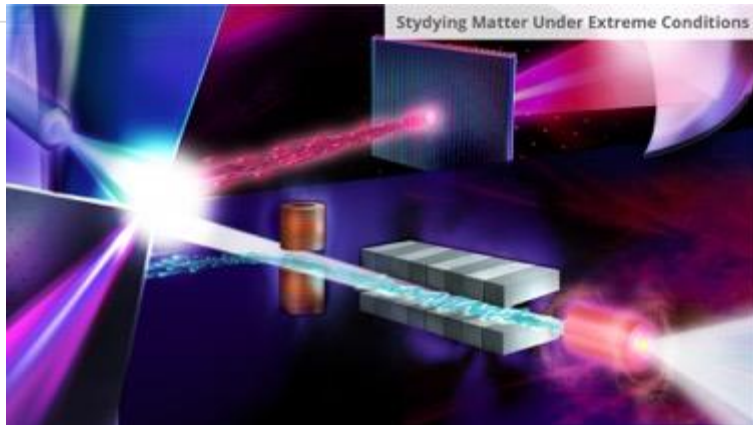
E1: High Harmonics Generation (HHG)



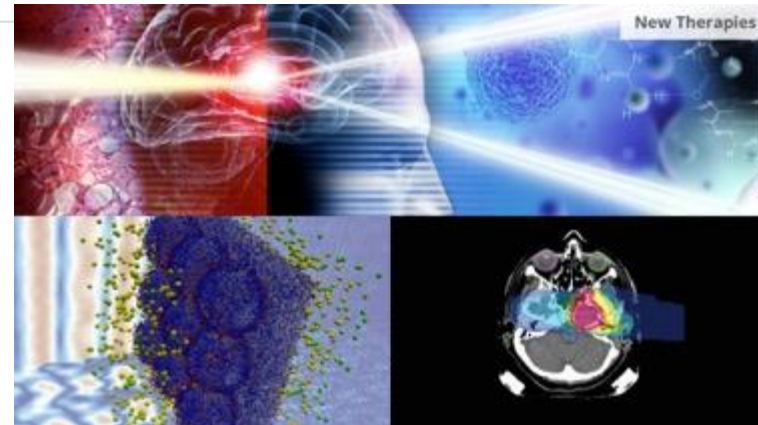
L1 Compressor Installation



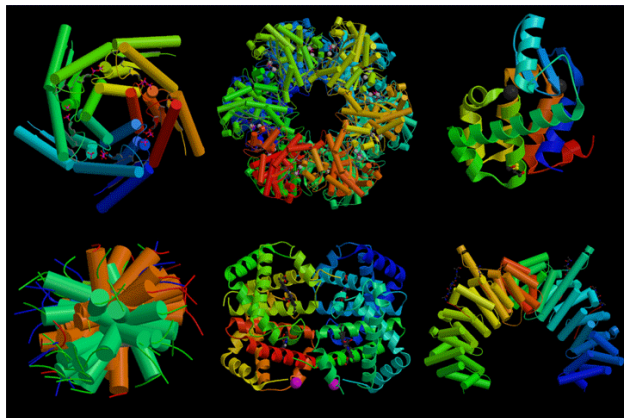
Bringing new values for society



Advanced materials, nanotechnology, satellite material testing (ESA, NASA)



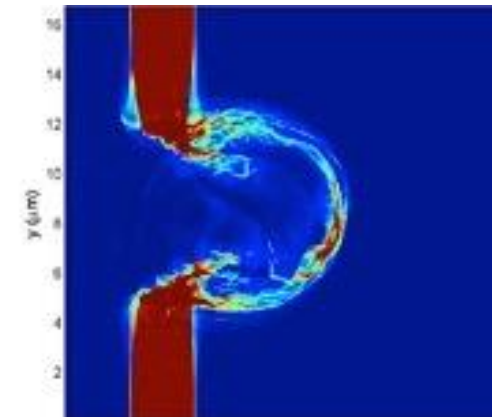
Medical diagnostics, cancer treatment technology



Biology, biochemistry, 3D imaging, drugs development, new chemicals



X-ray, γ -sources, lab astrophysics



Particle acceleration

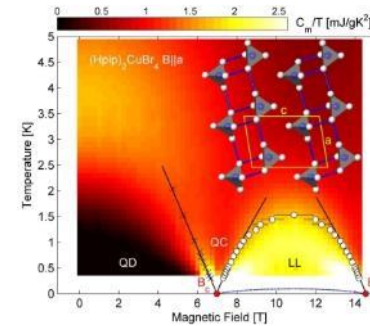
1: Coherent Diffractive Imaging (CDI) and Atomic, Molecular and Optical (AMO) Science

**Structure of non-reproducible biological particles
Like a living cell or a large virus**



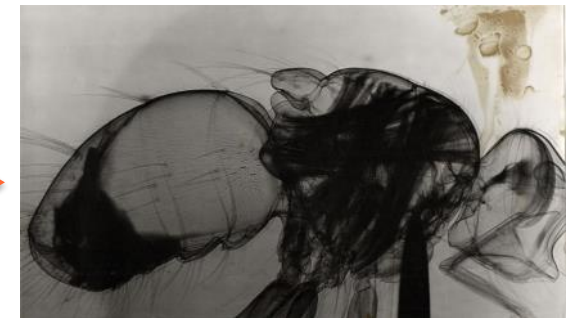
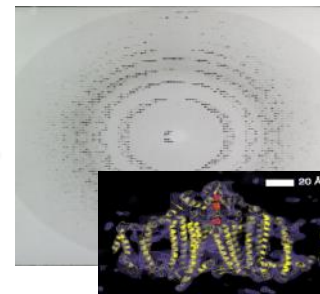
2: Soft X-ray Materials Science

Properties in new surfaces and interfaces, charge and spin dynamics (electronic and magnetic properties)



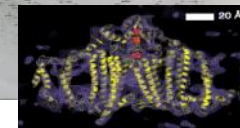
3: time-resolved X-ray phase contrast imaging

Movie of transient effects in large specimens (up to meter size)



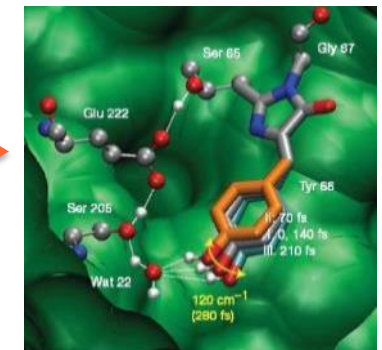
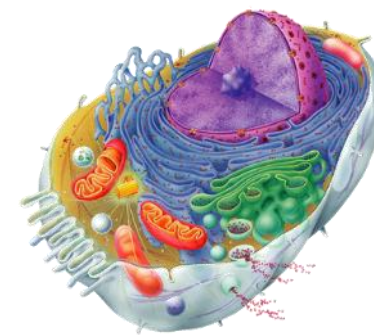
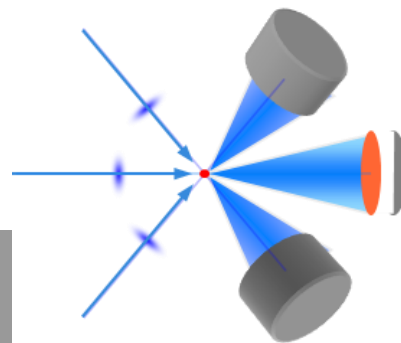
4: X-ray Diffraction and spectroscopy

Sub-ps resolution of atomic scale structural dynamics (time resolved protein crystallography)

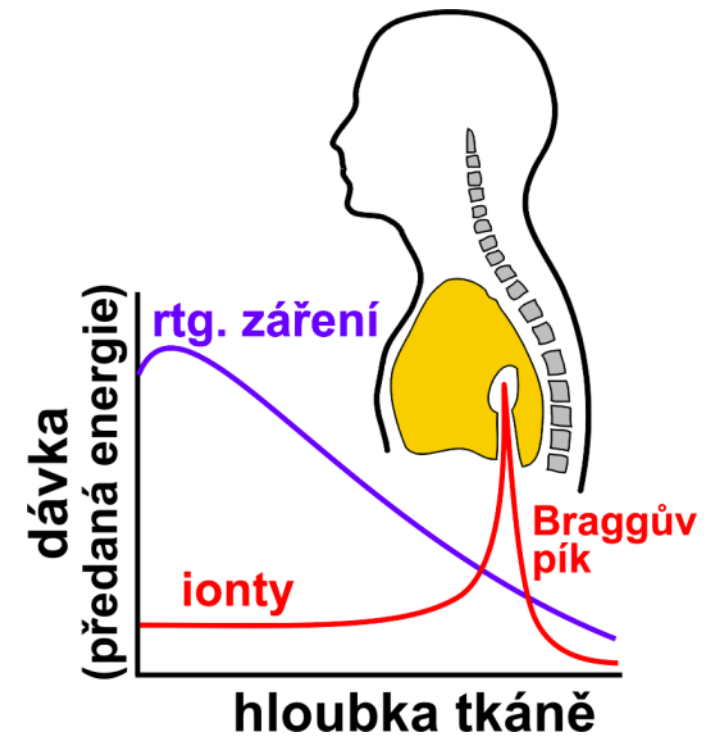
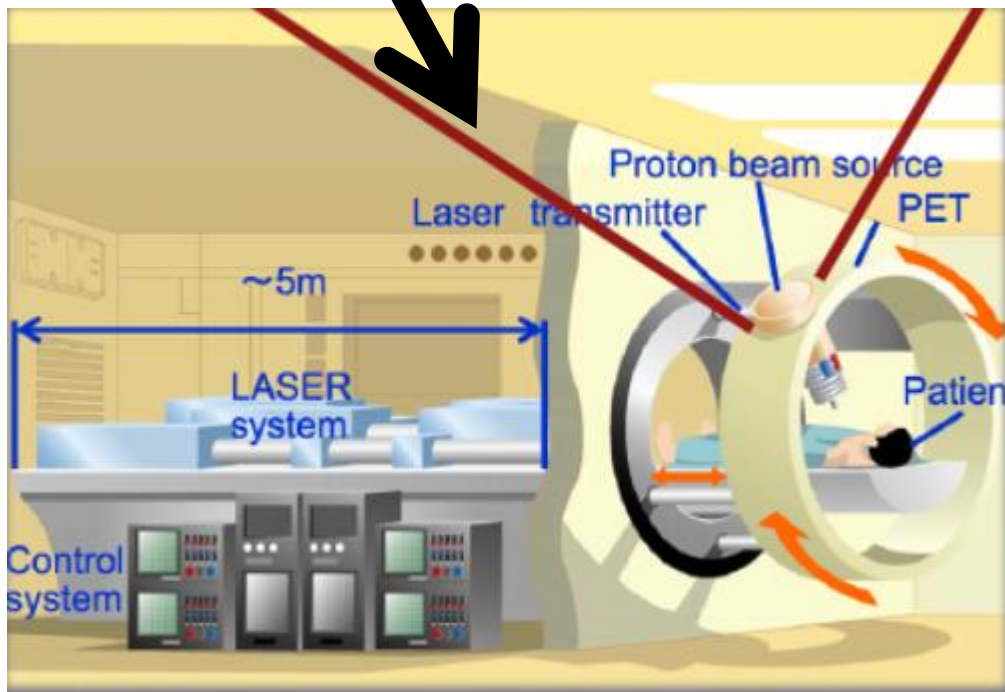


5: Pump beams + optical probe

Initiate and study transient processes in molecular dynamics and material sciences




Hadron Therapy – Proton Cancer Treatment



ELI: a World Class Laser Facility

W: www.eli-beams.eu

 ELI Beamlines

 ELI Beamlines (@ELIBeamlines)

Ladislav.Pust@eli-beams.eu
+420-775-620-803