Laser-driven acceleration at ELI Beamlines – radioprotection aspects

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Outline

• Project status

• Radiation Protection topics
ELI Beamlines facility - architecture
Implementation structure

- **Beamlines facility, ALPS**
  - Prague
  - High-brightness sources of X-ray radiation & particles
  - Attosecond XUV/X-ray physics

- **Photonuclear facility, NP**
  - Szeged
  - Laser-induced nuclear physics

- **200 PW facility (?)**
  - Magurele
  - Frontier physics by exawatt lasers
Research Programs

ELI-Beamlines bid: balance between fundamental science and applications
ELI-Beamlines will be international user facility within the ELI-DC consortium

Research Program 1
Lasers generating rep-rate ultrashort pulses & multi-petawatt peak powers

Research Program 2
X-ray sources driven by rep-rate ultrashort laser pulses

Research Program 3
Particle acceleration by lasers

Research Program 4
Applications in molecular, biomedical, and material sciences

Research Program 5
Laser plasma and high-energy-density physics

Research Program 6
High field physics and theory
4 laser beamlines: L1, L2, L3 and L4

- **L1**: 10TW-class @ kHz
- **L2** and **L3**: PW @ 10 Hz
- **L4**: 10 PW (1shot/min) and high energy “kJ” beam

**Beamlines based either on existing or newly developed technologies**

- DPSSL and flashlamp pumped
- OPCPA, Ti: Sapphire and mixed glass technologies
- Thin disk (MPQ, MBI and Trumpf)
- Multi slabs (Dipole – STFC, Mercury- LIFE- LLNL)
- Mixed glass (Texas PW laser, Apollon pump laser)
- Czech program for High Power Laser development “HiLASE”
Schematic layout of laser building

First floor (80 x 40 m)
kJ laser for L4
Support technologies, cooling systems, cryogenic systems

Ground floor (80 x 40 m)
4 laser halls (L1 to L4)

Basement (110 x 60 m)
Compressor of L4 10-PW laser
Vacuum pulse distribution
6 dedicated experimental halls (E1 to E6)
<table>
<thead>
<tr>
<th>Year</th>
<th>Phase 1</th>
<th>Phase 2</th>
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<tbody>
<tr>
<td>2014</td>
<td></td>
<td>L1</td>
</tr>
<tr>
<td>2015</td>
<td>L2</td>
<td>L4</td>
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<tr>
<td>2016</td>
<td>L3</td>
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<td>2017</td>
<td></td>
<td>E1/HHG</td>
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<tr>
<td></td>
<td>E2 Betatron</td>
<td>E3 ELIMAIA</td>
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<tr>
<td></td>
<td>E3 LUX</td>
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</tbody>
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**Timeline**

- **Beamlines**
  - E1/HHG
  - E2 Betatron
  - E3
  - E4 ELIMAIA
  - E5 LUX

- **Installation of laser systems**
  - L1
  - L2
  - L3
  - L4

**Project completed**

**Laser bldg complete**
Radioprotection challenges
Radioprotection challenges

- Low awareness of radiation protection
  - Laser community not familiar with RP principles
  - Frightened x reckless
Radioprotection challenges

- Low awareness of radiation protection
- **Source term not known**
  - Subject of research
  - Subject to change
  - Experiment dependent
  - Geometry dependent
- All calculations for a best estimate of the max
Source term in general

- beams of ionizing radiation generated
  - by interaction of the laser beam with a target
  - mechanisms dependant on the beamline
- pulsed fields
  - primary pulse length $\sim 20$ fs
  - repetition frequency $0.1\text{Hz} - 1 \text{kHz}$
- mixed fields
  - photons, neutrons, muons, protons, electrons, heavy ions
- energy
  - electrons $500 \text{MeV} \rightarrow 50 \text{GeV}$
  - protons $200 \text{MeV} \rightarrow 3 \text{GeV}$
- strong electromagnetic pulse $10-100\text{kV/m}^2$
Radioprotection challenges

- Low awareness of radiation protection
- Source term not known
- Shielding
  - Penetrations
    - Large, straight
Penetrations
Radioprotection challenges

- Low awareness of radiation protection
- Source term not known
- **Shielding**
  - Penetrations
    - Large, straight
- Dumps
  - Versatile – to accommodate wide range of energies
  - Cheap & Low long-term activation probability
Radioprotection challenges

- Low awareness of radiation protection
- Source term not known
- Shielding
- **Monitoring**
  - Requirements on devices:
    - Mixed field
    - Wide range of energies
    - Not susceptible to saturation (high dose rate)
    - Resistance to EMP
    - Ability to provide on-line data
  - Personal monitoring
    - Active vs. Passive systems
  - SIL classification
  - Calibration and certification
Radioprotection challenges

- Low awareness of radiation protection
- Source term not known
- Shielding
- Monitoring
- **Operation**
  - Full independence of the experimental halls
    - shooting in hall XY should not influence work in the adjacent halls.
  - Combined hazards (laser, gases, vacuum, IR, biohazard, EMP...)
  - Unification of warning systems and alarms
  - Radiation to electronics
Radioprotection challenges

- Low awareness of radiation protection
- Source term not known
- Shielding
- Monitoring
- Operation
- **Administrative**
  - Differences in national legislations
  - Radiation workers from all over the world
  - Bilingualism
  - Legislative update (new Atomic law)
Conclusions

http://www.eli-beams.eu/about/building/

My job is not boring!

😊
www.eli-beams.eu

Thanks for your attention!
Experimental Area

- **Experimental Hall 1**: Material & Biomolecular Applications
- **Experimental Hall 2**: X-ray sources
- **Experimental Hall 3**: Plasma Physics
- **Laser 4c**: 10 PW pulse compressors
- **Experimental Hall 4**: Proton acceleration
- **Experimental Hall 5**: Electron acceleration
- **Experimental Hall 6**:
Sources of IR in 2017