IRRADIATION OF LUMINESCENCE DOSIMETERS IN STRAY RADIATION FIELD IN LASER-DRIVEN ACCELERATORS

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## Faculty Disclosure

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<tr>
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<th>No, nothing to disclose</th>
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• UHDpulse project:
  • Work Package 4 – Activity 4.2.1: *Testing of luminescence dosimeters in stray radiation fields.*

• Stray radiation fields:
  • Are inevitably associated with all therapeutic beams
  • May cause damage to healthy tissue and organs outside the targeted area → need to characterized and understood
  • Have the same pulsed time structure of the primary beams → same metrological issues as primary field
  • Are mixed fields, i.e. composed of different types of particles with different energies → The various field components need to be identified.

Optically Stimulated Luminescence Detectors (OSLD)

• Optically Stimulated Luminescence:
  • is the emission of light from a previously irradiated material when stimulated with photons of a specific energy.

  • The intensity of the emitted light is proportional to the absorbed energy

• BeO - OSLDs have good dosimetric properties:
  • High sensitivity to ionizing radiation
  • Wide linear response (≈1µGy – few Gy)
  • Tissue equivalent ($Z_{\text{eff}} = 7.2$)
  • Sensitive to artificial and natural light
ELI Beamlines – International

ELI (Extreme Light Infrastructure) Beamlines

<table>
<thead>
<tr>
<th>Laser</th>
<th>Energy [J]</th>
<th>Power [TW]</th>
<th>Rate [Hz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 (ALLEGRA) (present)</td>
<td>0.03</td>
<td>1.5</td>
<td>10³</td>
</tr>
<tr>
<td>L1 (ALLEGRA) (target)</td>
<td>0.1</td>
<td>5</td>
<td>10³</td>
</tr>
<tr>
<td>L2 (AMOS)</td>
<td>2</td>
<td>10³</td>
<td>50</td>
</tr>
<tr>
<td>L3 (HAPLS) (present)</td>
<td>30</td>
<td>333</td>
<td>3.3</td>
</tr>
<tr>
<td>L3 (HAPLS) (target)</td>
<td>30</td>
<td>10³</td>
<td>10</td>
</tr>
<tr>
<td>L4 (ATON)</td>
<td>2×10³</td>
<td>10⁴</td>
<td>0.1</td>
</tr>
</tbody>
</table>

- The ALLEGRA laser (design performance)
  - Developed in house by the ELI Beamlines laser team.
  - The laser system is designed to generate <20 fs pulses with
  - energy exceeding 100 mJ per pulse
  - high repetition rate (1 kHz).
ALFA (Allegra Laser For Acceleration)

- Electron beam of energy up to 50 MeV with nominal laser parameters

ALFA commissioning in Feb. 2021

- Laser is working at 1 kHz, but pulses were done by operating a mechanical shutter (minimum 2 sec)
- Plasma generation and acceleration was triggered at 1Hz
- Pulse burst were in: single, 20 msec and 100 msec mode
- ~8000 pulses at low energy (6 mJ) with very weak signal
- ~500 pulses at high energy (22 mJ)
- 2 minutes of continuous operation
- Beam characteristics:
  - Few pulses >5-10 MeV
  - Energy > 0.5 MeV beam
  - Ang Distr. 90 mrad,
  - Charge 1 pC/pulse

Courtesy of Dr. G.M Grittani & the ALFA Team
**PARTICLE TYPE**

- No of primaries/charge: 1 pC / shot electrons
- Source size: pointlike
- Angular distribution: 250 mrad divergence, gaussian angular distribution
- Energy spectrum: Maxwelian distribution with 300 keV temperature

**Courtesy of D. Horvath (ELI Beamlines RP Group)**

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BeO- OSLDs: Results

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Conclusions

• **UHDPulse - Work Package 4 - Activity 4.2.1: Testing of luminescence dosimeters in stray radiation fields:**
  - BeO – OSLDs were irradiated in a stray radiation field, using a laser-driven electron beam @ ELI Beamlines.
  - Preliminary results were presented.
  - Laser-driven radiation fields are complex and not well characterized as those produced in conventional accelerators.
  - The discrepancy data/Monte Carlo can be attributed to unknown geometrical features of the beam and uncertainties of the source term.

• **Future plans :**
  - Repeat measurements using laser driven proton beams
  - Add different detector technologies with different sensitivities to different particles
    - Thermoluminescence dosimeters:
    - Electron and proton laser-driven beams

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