OMEGA EP: Status and Use Planning

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Summary

OMEGA EP is on track for completion in Q3 FY08

- Completed activation of all long-pulse and short-pulse frontends
- Completed integration and initial activation of all IR beamlines
- Successfully operating key enabling technologies
- Compressor integration and activation is the critical path for OMEGA EP
- The OMEGA EP Use Planning process is ongoing
- The initial ~100 shots have been laid out
OMEGA EP will be completed in Q3 FY08

- There are five primary missions.
  
  1. Extend HED research capabilities with high-energy and high-brightness backlighting

  2. Perform integrated advanced-ignition experiments

  3. Develop advanced backlighter techniques for HED physics

  4. Staging facility for the NIF to improve its effectiveness

  5. Conduct ultrahigh-intensity laser–matter interactions research
Short-pulse OMEGA EP beams can be directed either to OMEGA or to the new OMEGA EP target chamber.

<table>
<thead>
<tr>
<th>Short pulse combined</th>
<th>Beam 1</th>
<th>Beam 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR energy (kJ)</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Pulse duration at full energy (ps)</td>
<td>10 to 100</td>
<td>80 to 100</td>
</tr>
<tr>
<td>Focusing (diam)</td>
<td>&gt;80% in 20 µm</td>
<td>&gt;80% in 40 µm</td>
</tr>
<tr>
<td>Intensity (W/cm²)</td>
<td>$3 \times 10^{20}$</td>
<td>$2 \times 10^{18}$</td>
</tr>
</tbody>
</table>

- Each beam duration can be as short as 1 ps at reduced energy (grating damage and B-integral)
- Beam 2 can produce 2.6 kJ in 10 ps when propagating on a separate path
The OMEGA EP architecture is based on multi-configurable beam paths.
Recovery from amplifier thermal distortion supports 1-h repetition rate

- Nonuniform heating of amplifier disks causes an S-bend, leading to an astigmatic defocusing of the beam.

- Water cooling allows rapid recovery of wavefront.
IR beamlines meet initial-activation performance requirements

- >600-J stretched-pulse energy
- >3-kJ long-pulse energy
- 3.5-nm bandwidth to support picosecond pulses
The grating compressor chamber (GCC) is being integrated and is the critical path for OMEGA EP activation.

**GCC**
- $4.6 \times 4.6 \times 21.3$ m internal dimensions
- Dual-level optical tables
- Four-grating compressor layout

**Integration**
- All gratings loaded
- Tiling hardware and controls
- Both vacuum-compatible DM’s
Three OMEGA EP full-aperture gratings have been tiled using the near-field tiling method.

Wavefront of three tiled OMEGA EP full-sized gratings
Aperture size: 90 cm × 38 cm on TGA

Calculated far field

Strehl ratio: 0.92
The OMEGA EP target chamber infrastructure is being deployed.

- The beam path into the OMEGA target chamber has been cleared and structures are being integrated.
The second OMEGA EP Use Planning Workshop (30 May 2007) defined experimental plans in various areas

- OMEGA EP will be completed in Q3 FY08.
- The remainder of FY08 will be for laser system science and to learn how to carry out experiments.
  - shot opportunities will exist on short notice
- Scheduled User shots will begin in FY09.
- A series of working groups has been set up.
  - chair to provide a written summary after the workshop
  - continued discussions among working groups in advance of third workshop—February 2008
- A proposal for the first ∼100 shots (FY08) was generated.

The goal of this process is to understand and prioritize capabilities needed to most effectively use the facility.
A set of working groups has been created

- **Working Groups**
  - Hard-x-ray backlighting
  - High-brightness ~keV sources and diagnostics
  - Ion-source development and diagnostics
  - Fast ignition
  - ICF
  - Warm dense-matter physics
  - HED materials
  - Complex hydrodynamics
  - High-intensity physics, etc.

- Each working group should develop a plan for its initial shots, including
  - laser capabilities
  - target requirements
  - diagnostic capabilities
The first ~100 OMEGA EP shots for FY08 have been laid out

<table>
<thead>
<tr>
<th>Target</th>
<th>Goal</th>
<th>Diagnostics</th>
<th>Number of Shots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Ignition: Sandwich planar targets Al/Cu/Al, Al, free study</td>
<td>Electron/proton production temperature with 10-ps pulses</td>
<td>$K_\alpha$ spectroscopy</td>
<td>15</td>
</tr>
<tr>
<td>CH foil with witness layer</td>
<td>Initial channeling</td>
<td>X-ray imaging, transmitted light</td>
<td>5</td>
</tr>
<tr>
<td>Hard x-ray, WDM: Ag and Sm foil/flag/wire, resolution grid</td>
<td>Hard x-ray and keV broadband</td>
<td>50~100 mic spots, x-ray spectrometers, imagers</td>
<td>15</td>
</tr>
<tr>
<td>High brightness keV sources: F~Si materials, foams, colloidal targets</td>
<td>High brightness for ICF backlighting</td>
<td>keV x-ray spectrometer, x-ray streak camera with spectrometer</td>
<td>10</td>
</tr>
<tr>
<td>Long-pulse backlighting: Thick foil (pinhole for PPB)</td>
<td>Develop capability</td>
<td>X-ray streak</td>
<td>5</td>
</tr>
<tr>
<td>Low and high Z-ions: Thin foil</td>
<td>Develop capability</td>
<td>Optical pyrometer, heating source, RCF</td>
<td>5</td>
</tr>
<tr>
<td>HED materials: Thin Al/SiO₂ foil</td>
<td>Initial shock velocity</td>
<td>ASBO/VISAR</td>
<td>10</td>
</tr>
<tr>
<td>Al foil</td>
<td>Direct measure of Al EOS</td>
<td>Hard-x-ray source and detector</td>
<td>5</td>
</tr>
<tr>
<td>WDM: Planar foil</td>
<td>Double/colliding shock</td>
<td>SOP</td>
<td>5</td>
</tr>
<tr>
<td>ICF: Planar foil</td>
<td>Initial scale-length</td>
<td>FABS, HXRD 4ω probe</td>
<td>5</td>
</tr>
<tr>
<td>Complex Hydro: Washers/foam</td>
<td>Initial episodic jet</td>
<td>X-ray image</td>
<td>5</td>
</tr>
<tr>
<td>D³He proton source: Exploding pusher</td>
<td>Monoenergetic proton source</td>
<td>WRF</td>
<td>2</td>
</tr>
<tr>
<td>High-intensity physics: Planar foil, gas jet</td>
<td>Magnetic-field + MeV proton generation</td>
<td>Proton diagnostic, proton beam, nuclear activation</td>
<td>10</td>
</tr>
</tbody>
</table>
Summary/Conclusions

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