Laser Operations Update
LCLS Virtual Town Hall Meeting, January 2018

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Optical Lasers in all LCLS Experimental End Stations

http://lcls.slac.stanford.edu/lasers
Capabilities available in each hutch

- Current overview of laser capabilities that can be deployed in each hutch
- Continuous improvements underway; contact your POC with questions

<table>
<thead>
<tr>
<th>AMO</th>
<th>SXR</th>
<th>XPP</th>
<th>XCS</th>
<th>MFX</th>
<th>CXI</th>
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MEC capabilities discussed in MEC instrument update by Gilliss Dyer

In standard configuration experiments, a subset of laser capabilities are offered; review standard configuration documents or contact your POC
Femtosecond laser wavelength usage at LCLS

Significant diversity in optical laser requirements
THz single-cycle pulses from optical rectification in LiNbO$_3$ and nonlinear organic crystals

Present state-of the art at LCLS, LN tilted pulse front, room temperature:

- Single-cycle pulse, Peak spectrum <1 THz
- >10 $\mu$J THz pulse energies at 15 mJ, 800 nm fs-laser pump, 120 Hz repetition rate
- Up to 1 MV/cm demonstrated through better focusing
- Low frequencies <1 THz, large ponderomotive force
- THz polarization is fixed (usually vertical)

Present state-of the art at LCLS, nonlinear organic crystals:

- High fields >1 MV/cm for DSTMS (pump at 1350 nm with 1.5 mJ, 50 fs pulses)
- Shorter duration pulses and higher frequency content up to 6 THz
- Small spot size <300 um
- THz polarization can easily be controlled

LiNbO$_3$

DSTMS

OH-1
CEO phase stable MIR pulses (3-17 um)

- Phase stable Mid-Infrared pulses from difference frequency generation in GaSe
- Wavelength range from 3 um to 17 um (17 THz to 100 THz)
- OPA system has two beam paths, seeded by common white light source
- DFG process eliminates random phase, leading to CEP stable pulses

- LCLS proof of concept beam time December 2016 and October 2017
  Goal: excitation of phonon mode at 17 THz
- demonstrated CEP stable pulses
- Improvements under development
Developed **portable high-energy MIR setup** delivering >10 mJ/cm² at the interaction point, covering the wavelength range 4-17 µm

- Designed and implemented a new **single-shot spectrometer** for fast and reliable spectrum characterization
Delivery of <10fs laser pulses

- Mobile platform: self-phase modulation in gas-filled hollow fiber, 40-45fs duration input pulses with 1.5mJ pulse energy
- >0.3mJ output pulse energy at ~7.5fs

- Delivered to multiple experiments in XPP
- Scheduled delivery to experiments in XCS and SXR
Nanosecond OPO: IR, visible, UV

- Primarily used in MFX and CXI for photo-excitation of biological samples

We have supported some experiments that required CW lasers; contact your POC
Development of high rep rate pump-probe laser for LCLS-II

A robust high rep-rate high power pump laser system is essential for nearly all time-resolved experiments at LCLS-II.

Target performance: 800 nm, 1mJ, 100kHz, 100W

Current performance: 800 nm, >85W

FY18 R&D program: Wavelength extensions for early LCLS-II experiments

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<tr>
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<th>Basic</th>
<th>Upgrades</th>
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<tr>
<td>Repetition rate [MHz]</td>
<td>0.1</td>
<td>single-shot to 1(MHz)</td>
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<td>Wavelength [µm]</td>
<td>0.8</td>
<td>IR/mid-IR range (1.5 and 3.2 µm)</td>
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<tr>
<td>Pulse duration [fs]</td>
<td>15</td>
<td>&lt;10 and 50 (THz, UV to mid-IR)</td>
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<tr>
<td>Pulse energy [mJ]</td>
<td>1</td>
<td>several</td>
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<tr>
<td>Average power [W]</td>
<td>100</td>
<td>R&amp;D</td>
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Laser Science & Technology (LST) Division supports LCLS experiments and accelerator ops