

Summary of breakout session 4

Science in Extreme States (XQO&HEDS)

“Frontier of Quantum Beam Sciences in Extreme Conditions”

Chairs:

K. Tamasaku, Y. Inubushi

Presenters:

H. Yoneda *XFEL excited $K\alpha$ laser with cavity*

Y. Tange *Shock compression in Al_2O_3 @long-pulse laser*

K. Shigemori *HED state creation in nano-wires @short-pulse laser*

T. Namba *Vacuum nonlinearity*

Attendees:

Inoue, Matsuoka, Sakawa, Seino, Kohmura, Koenig

Ishino, Kon, Kodama, Yabuuchi, Miyanishi, Yabashi

Current status

XQO(XNLO)

- ✓ Many unique experiments were performed at SACLA.
- ✓ SACLA's advantage: nano-focusing for intense X-rays, two-color, maybe self-seeding...
- ✓ LCLS: 100-nm focusing w live feedback at CXI@LCLS

High-power lasers

- ✓ @SACLA Long-pulse laser: ~10 J, ns / Short-pulse laser: 500 TW, fs
- ✓ SACLA laser system has many options, and is competitive, but may need more laser scientists.
- ✓ EuXFEL: planning kJ long-pulse laser, and 1 PW short-pulse laser, in addition, strong magnetic (B) field.
- ✓ Shanghai: 5 PW (now) -> 10 PW -> 200 PW
planning vacuum birefringence (not x-rays, but may compete)

User requests with regard to XFEL beam & facility

- ✓ Acc. tuning to optimize peak power, wavefront, ... for stable 100-nm focusing, or stabilize photon energy.... (Currently, maximizing power.)
 - cf. LCLS uses two-photon absorption for peak power.
- ✓ Higher-harmonics (>8 keV) rejection in EH6 of BL2 for X-ray shadowgraph imaging.
- ✓ Higher photon energy (>30 keV) for thick diamond window.
- ✓ On-demand XFEL pulse switching, which may allow longer beamtime for 1-Hz laser users.
- ✓ Atto-second pulses for XNLO
- ✓ For X-ray photon-photon scattering:
 - SACLA BL2-BL1 simultaneous use
 - SACLA-SPring-8 timing synchronization
 - One more SACLA for head-on collision

User requests about long-pulse (ns) laser system

- ✓ MPCCD ($\sim 150 \times 200 \text{ mm}^2$) inside vacuum chamber for high-resolution XRD.
- ✓ Random phase plate for uniform beam w/o hot spots.
- ✓ **>200-J (hopefully kJ) pulse and tighter focusing to produce TPa (currently $\sim 10 \text{ J}$, 50 GPa).**
- ✓ **Ramp compression (pulse shaping) of kJ-pulse in future (to access different points in P-T space).**

User requests about short-pulse (fs) laser system (500 TW)

- ✓ Better pointing stability to guarantee spatial overlap with XFEL.
- ✓ Arrival timing monitor (ps/fs).
- ✓ **Shot-by-shot monitoring of pre-pulse shape (contrast).**
- ✓ **Thomson-scattering spectrometer to measure temperature.**
- ✓ Flexible laser path setting for head-on collision with XFEL.
- ✓ ~ 1 -micron focusing (deformable mirror), and focus spot monitor.

Some more requests and comments on short-pulse laser

- ✓ Preparation time for setup new diagnostics, apparatus,... in EH6 before XFEL beamtime.
- ✓ Radiation shield is insufficient for laser intensities $>10^{20}$ W/cm².
- ✓ Simultaneous use of long- and short-pulse lasers would be unique
 - short: proton beam, long: high pressure