Breakout session B1: hard X-ray beamlines (BL2/BL3)

"Short- and long-term requirements from users for hard X-ray beamlines"

Chairs: Y. Nishino (Hokkaido U) & I. Inoue (SACLA)

Facility talk (I. Inoue & T. Inagaki):

- Machine-learning based tuning & tailor-made XFELs (under development)
- Ideas for future machine upgrades
  (THz acceleration, short pulse option, dielectric RF cavity etc.)

Inputs from user communities

Chemistry:	S. Nozawa (KEK)
Biological imaging:	A. Suzuki (Hokkaido U)
Protein crystallography:	S. Iwata (Kyoto U)
High energy density science:	N. Ozaki (Osaka U)
Solid-state physics:	R. Fukaya (KEK)
Nonlinear optics:	K. Tamasaku (RIKEN)

Round table discussion

- Urgent requests from users -> facility plan for meeting the requests
- Photon parameters that should be included for tailor-made XFELs
- Requests from users for long-term facility developments

Slides of the facility talk and the round table discussion will be uploaded website soon after the meeting.

Urgent requests pointed by speakers

- **Improve BL2 performance (Bio imaging)**
  - Decoupling operations of BL2 and BL3 by new Q-magnets. -> ~2022
  - (Tentative solution): matching photon energies of BL2 and BL3 by careful scheduling of the beam time.
- **Reproducible beam performance (Bio imaging, NL), Stable two-color operation (NL)**
  - Machine learning-based accelerator tuning -> ~2021.
- **Improve pulse energy after mono (Condensed matter)**
  - Self-seeding (applicable to 8 keV or more) can increase spectral brightness by a factor of 4-8.
    -> Expanding photon energy range to lower side is on-going.
- **Stable direct beam profile for imaging (HEDS)**
  - Machine learning-based accelerator tuning -> within 2021.
  - (Other solution): reducing number of operating undulators can suppress contaminations of higher order transverse modes -> please ask beamline staffs for the details.
- **Broadband beam (HEDS, Ultrafast Chem)**
  - Technically possible by detuning undulators. FYI, we have an experience of generating XFELs with bandwidth of 150 eV.
- **60-Hz operation (PX), 12-hour shift (NL)**
  - Possible. Please specify your requests in the proposal.
- **Higher pulse energy @high photon energy (13-15 keV) at BL2 (PX)**
  - Please consider the use of BL3 for the experiments that requires high photon energy with high pulse energy (> 300 uJ).
- **Idea from Tamasaku-san for 120 Hz-operation at the cost of decrease in electron beam energy (~4 GeV, i.e. photon energy of ~5 keV)**
  - SACLA team will start discussions for checking the feasibility.

Photon parameters for tailor-made XFELs

Tunable Parameters

1. Pulse energy
2. Spectral width
3. Beam size
4. Pointing stability
5. Output of beamline instruments (e.g. Photo diode signal, MPCCD signal)
6. Functions using 1-5
 e.g. spectral density=(1)÷(2)

Questions from facility

- Any other parameters we should optimize?
- Are there critical photon parameters in each science case?

critical photon parameters

- 500 μJ@BL2 (Bio imaging)
- Stability of central beam position (HEDS)

Other parameters should be included

- Intensity ratio between two-colors (Nonlinear)
- Bandwidth of seeded beam (without mono)
- Shot-by-shot fluctuation of pulse energy

Requests for long-term developments

	Photon energy	Pulse energy	Duration (FWHM)	Rep. rate	Comments
Biological imaging (CDI)	- (satisfied with the present parameter)	1st priority 2.5 mJ for demo experiment 7.5 mJ for single-shot imaging	longer durations (~10 fs) are acceptable	2 nd ~300 Hz	
PX	-	1st Comparable to the LCLS (~4 mJ)	-	2nd 1 kHz 1 MHz (mix and inject SFX)	
Ultrafast chemistry	2.8 keV (L-edge) -25.5 keV (K-edge) (resonance of period 5 elements)	2nd present value ×10		1st photon flux ×100-1000	Need to improve instrumentation resolution before shortening pulse duration
High energy density science	1st priority 30-40 keV	-	-	-	
Solid state physics (pump-probe)	-	2nd increase pulse energy after mono	-	1st ~1 kHz	Radiation damage to the sample might be an issue
Nonlinear optics	-	-	2nd Availability of shorter pulse (FT-limited pulse)	1st High rep. rate	1. What is the counter part to XFELO/XRAFEL options at other facilities?? 2. Advanced two-color XFELs (seeded+seeded)