Summary of Break-Out Session 1: Applications of advanced capabilities of BL3

I. Inoue (SACLA)
Introduction to unique XFEL operation modes

T. Osaka (SACLA)
Operation status & future directions of nm focusing

K. Togawa (SACLA)
Future perspectives of attosecond XFEL

U. Bergman (SLAC)
Nonlinear X-ray emission spectroscopy using hard X-ray FEL pulses

D. Reis (SLAC)
Two-photon excitation of iron, single high energy photon emission near 2ω

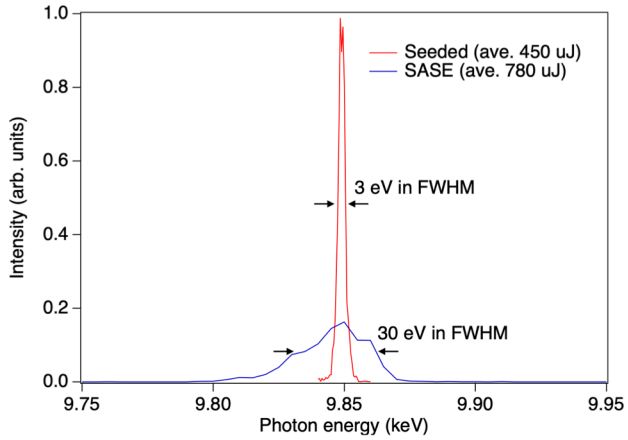
T. Driver (SLAC)
Isolated attosecond XFEL pulses: first soft X-ray experiments at the LCLS

Round table discussion
Discussion leader: H. Yoneda

Advanced XFEL operation modes and beyond

Introduction to unique XFEL operation modes, I. Inoue (SACLA)

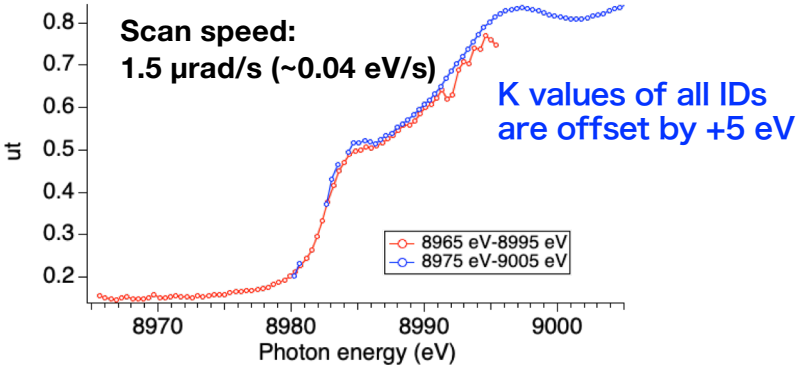
☑ Seeded-XFEL



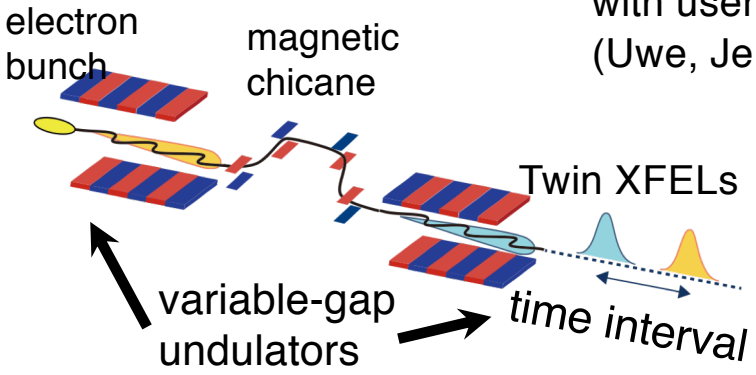
I. Inoue, Nat. Photon. (2019).

Motivated by comments from users at last users' meeting

On-the-fly photon energy scan



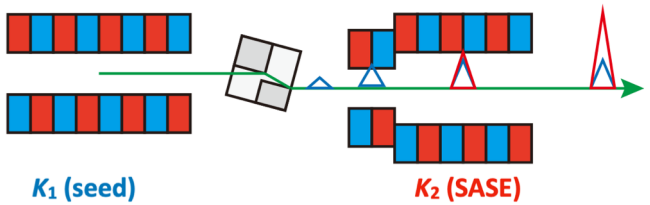
☑ Two-color XFEL



T. Hara, Nat. Commun. (2015).

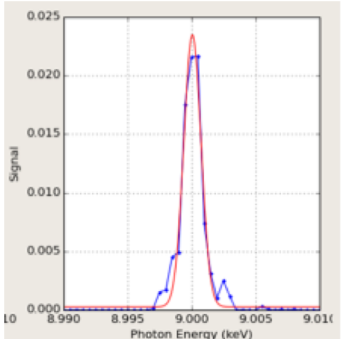
Motivated by private communications with users (Uwe, Jerry, Vittal, Kenji etc…)

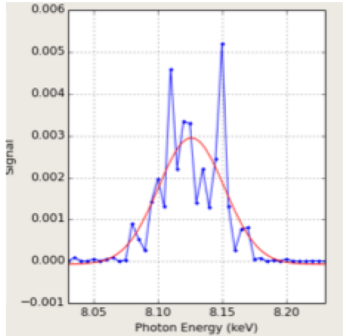
mono+pink beam



9 keV (seed)
Bandwidth: 1.5 eV (FWHM)

8.13 keV (SASE)
Bandwidth: 60 eV



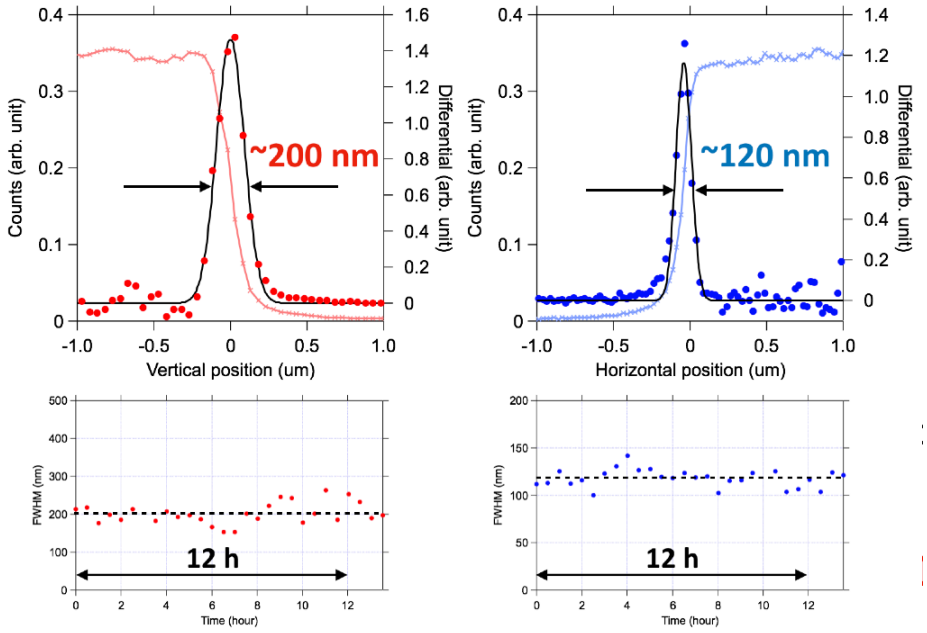


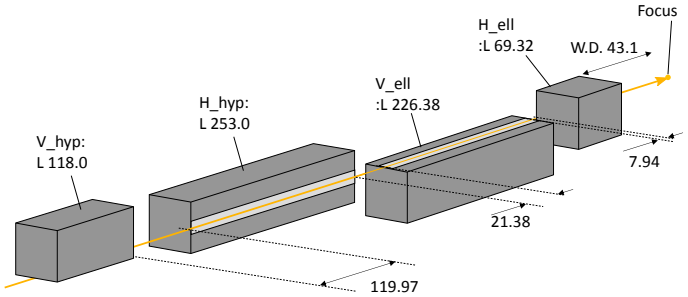
Operation status & future directions of nm focusing

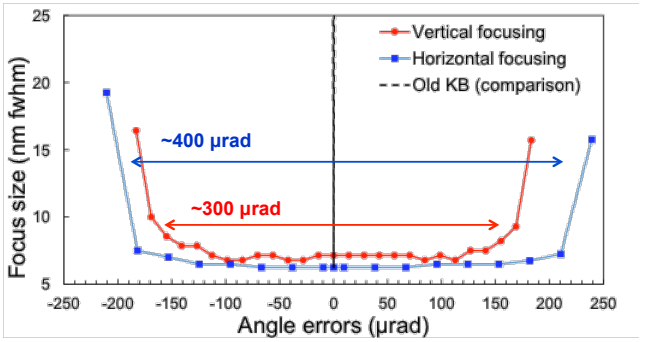
Taito Osaka, SACLA

☑ **100 nm focusing system for achieving an x-ray intensity of 10^{20} W/cm^2 is available at BL3 EH5 with flexible sample equipments.**
Typical focal size is 200 x 120 nm^2, which can be maintained over half day.

☑ **Highly stable sub-10 nm focusing system based on 'Wolter-III' geometry for reaching an extreme intensity of 10^{22} W/cm^2 is under development.**



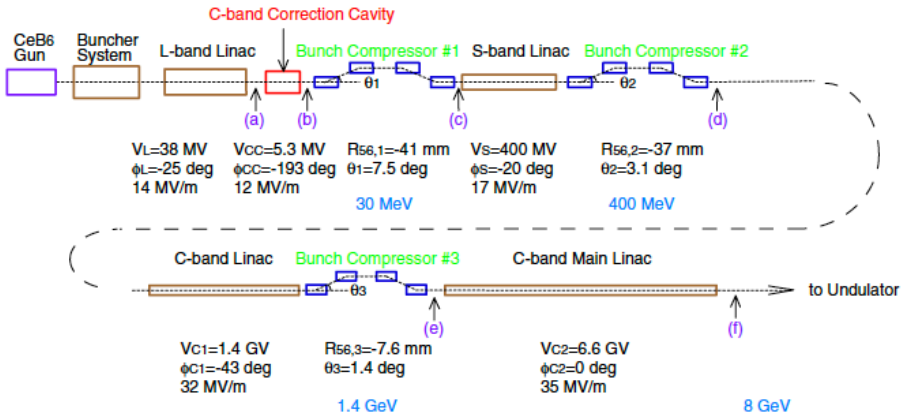


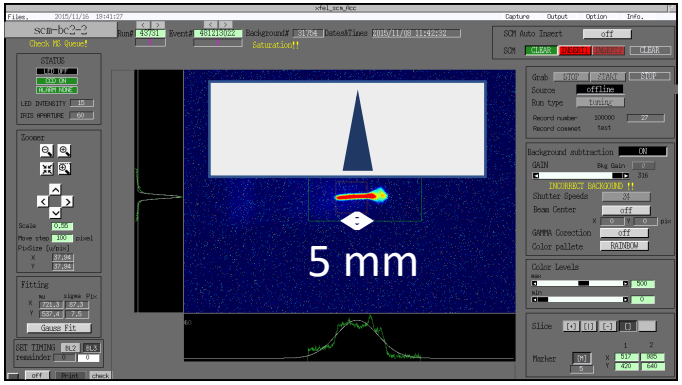


Future perspectives of attosecond XFEL (SACLA)

Kazuaki Togawa (RIKEN)

- Present bunch lengths at SACLA are ~10 fs (e-) and ~5 fs (γ).
- To shorten the bunch length down to sub-fs or attosecond, perspective study using a slotted foil technique (emittance spoiling excluding attosecond time window) has started.
- Insertion point will be the dispersive section of 2nd or 3rd bunch compressor.





- Study items: Foil material? Manufacturing? Particle tracking simulation? Schedule?

Discussion Summary:

1. Any concern about the present Advanced Capabilities?

- Two-pulse X-rays are great. But, how to confirm the time gap? It may change, if different parts of e-beam are lasing. ⇒A spoiler foil can limit the lasing part to fix the time gap.
- Need for standard intensity monitor for >10^{20} W/cm^2 ⇒calibrated nonlinear phenomena? Spoiler to define the pulse duration?

2. What kind of further Advanced Capabilities you need?

- Attosecond double pulse/attosecond optical laser for attosecond P&P
- Diagnostics for attosecond pulses

3. What is new science opportunities with Advanced Capabilities?

- Nonlinear spectroscopy with stimulated emission
- Atto-chemistry with attosecond XFEL
- High-intensity science, which is currently done by optical lasers, becomes possible with 10^{22} W/cm^2 XFEL

Needs/desires

- Intensity diagnostics
  - pulse length
  - spot size and distribution (3D)
  - pulse Energy
  - absolute intensity?
- large solid angle, good energy resolution detectors. w/background suppression
- Stable, seeded beam transform limited
- Broad-band attoseconds
- Two-color, with delay
- Highest intensities
- (sufficient) beamtime

- Need to know as much as possible about incoming pulse
- Monochromatic seed beam ideally with self-seeding
- Shot-by-shot upstream spectrometers for seed pulse (and eventually for pump pulse)
- Intensity monitor to know photon # after KB mirror (non-destructive)
- Shot-by-shot beam profile, wave front sensor for focus , temporal diagnostics
- Angular streaking to measure both spectral and temporal pulse ('cookie box' for soft x-rays)
- 'Fast' switching from seeding to non-seeding (minutes instead of hours)
- Chamber suited for a standard von Hamos setup (maybe He box, more flexibility)