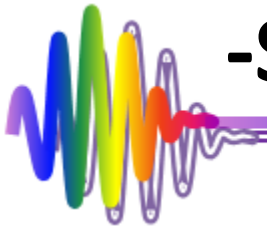
SACLA Users' Meeting 2023
Technical update
-Synchronized Optical Laser Systems-

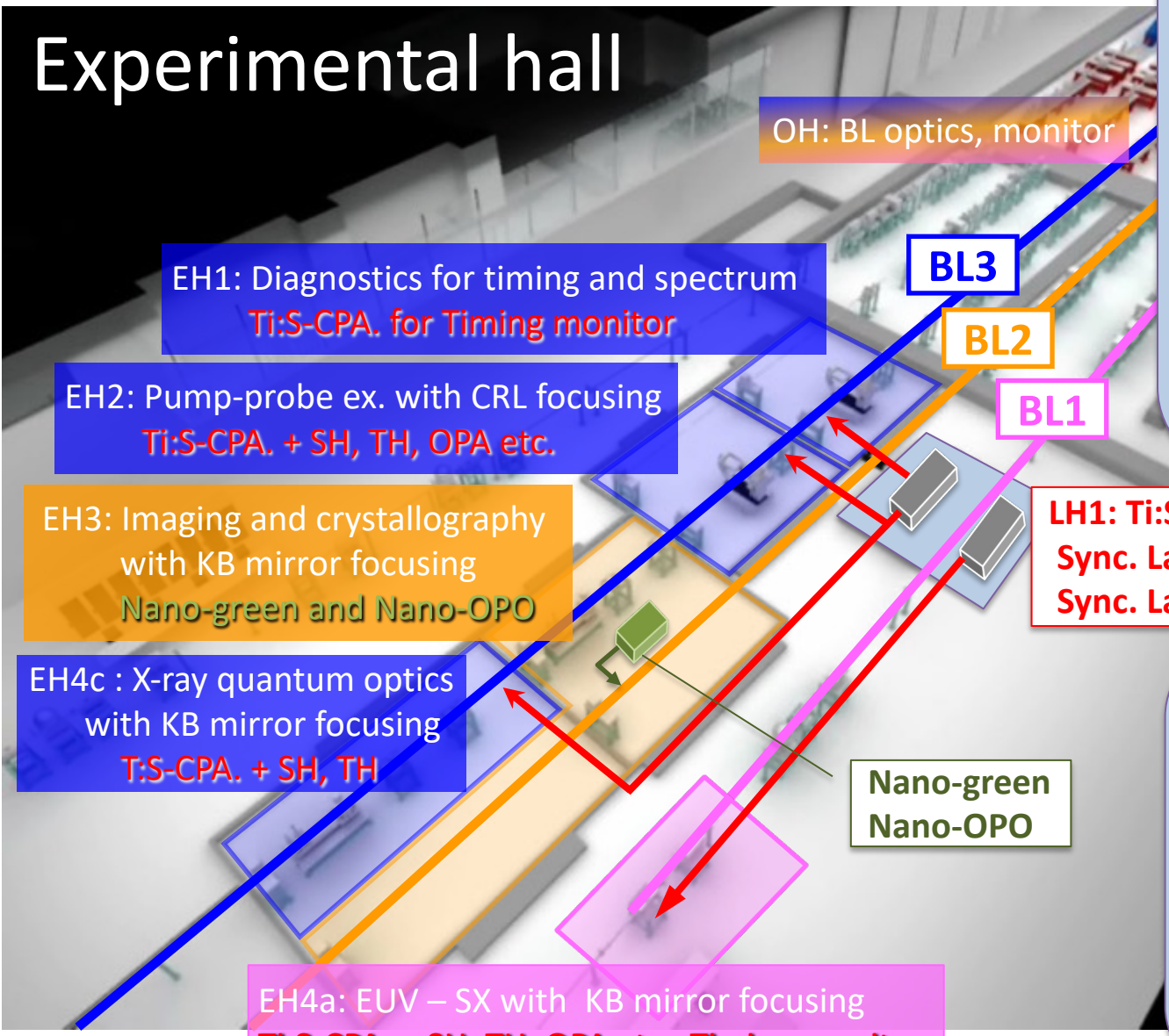


Tadashi Togashi (SACLA)

Outline

- Overview of sync. laser systems
- Femtosecond laser update
  - Timing stabilization
  - Mid-IR and THz generation
- Plan for tunable “pump” platform in regions of femto- and nano-second at EH3
- New laser hutch “LH2”
- Summary

Overview of Sync. Laser system



Femto. Sync. Laser

Ti:S-CPA.

- Wavelength: 800 nm
- Rep. rate: 60 Hz
- Output: ~12 mJ
- Pulse width: ~40 fs

SH: ~0.5 mJ, ~30 fs

TH: ~0.3 mJ, ~50 fs

FH: ~0.02 mJ,

OPA (+ SFG)

- Wavelength: 0.25 - 2.6 μm
- Output: 1 mJ (Max. S+I)

LH1: Ti:S-CPA

Sync. Laser 1 → (EH1), EH2, EH4

Sync. Laser 2 → EH4a

Nano. Sync. Laser

Nano green –Minilite-

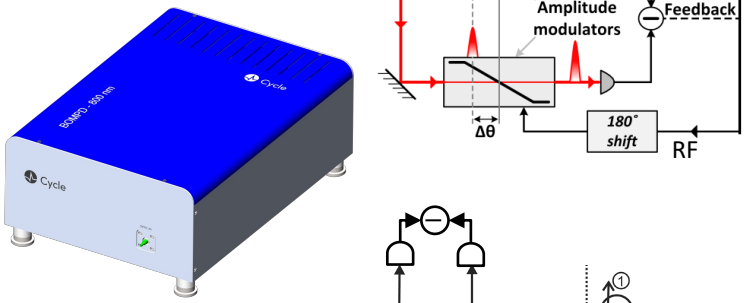
- Wavelength: 532 nm
- Rep. rate: <10 Hz
- Output: <20 mJ

Nano OPO -NT232-

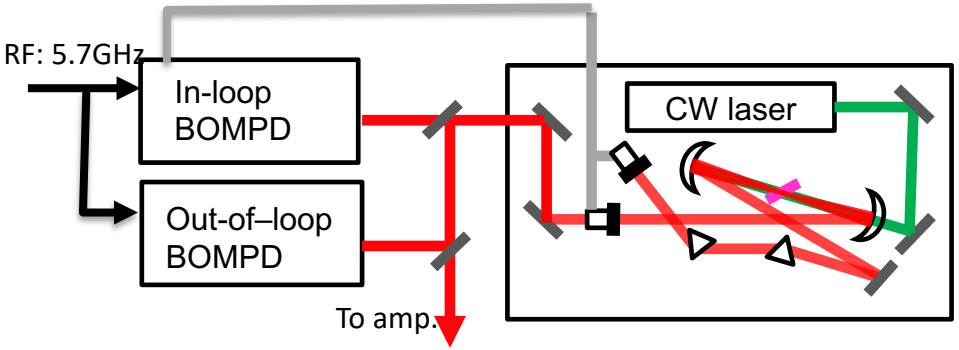
- Wavelength: 0.2-2.6 μm
- Rep. rate: < 30Hz
- Output: Max. 20 mJ

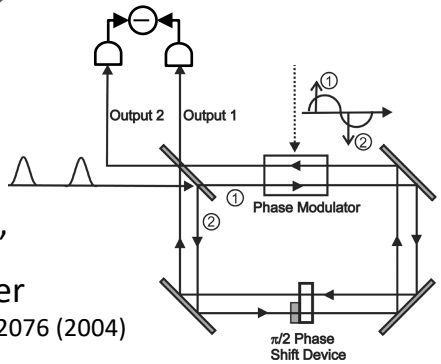
New sync. system with BOMPD

*BOMPD: balanced optical-microwave phase detector(Cycle GmbH)



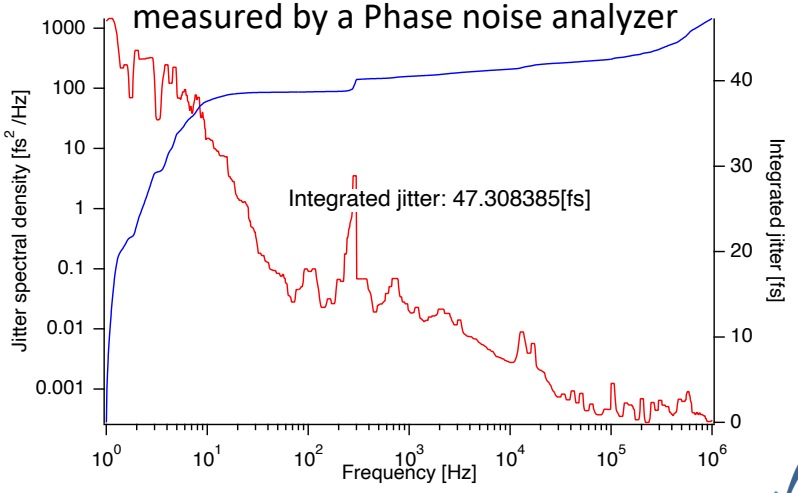
T. Togashi et al.
Appl. Sci. **10**, 7934 (2020)



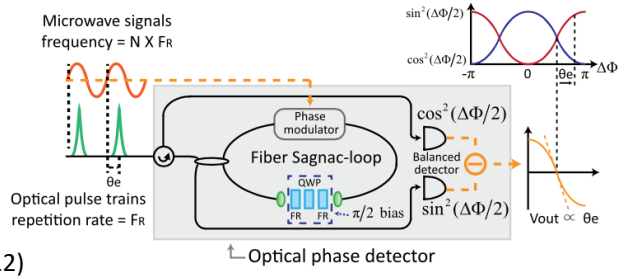


"Sagnac-loop" interferometer
J. Kim et al. OL 29, 2076 (2004)

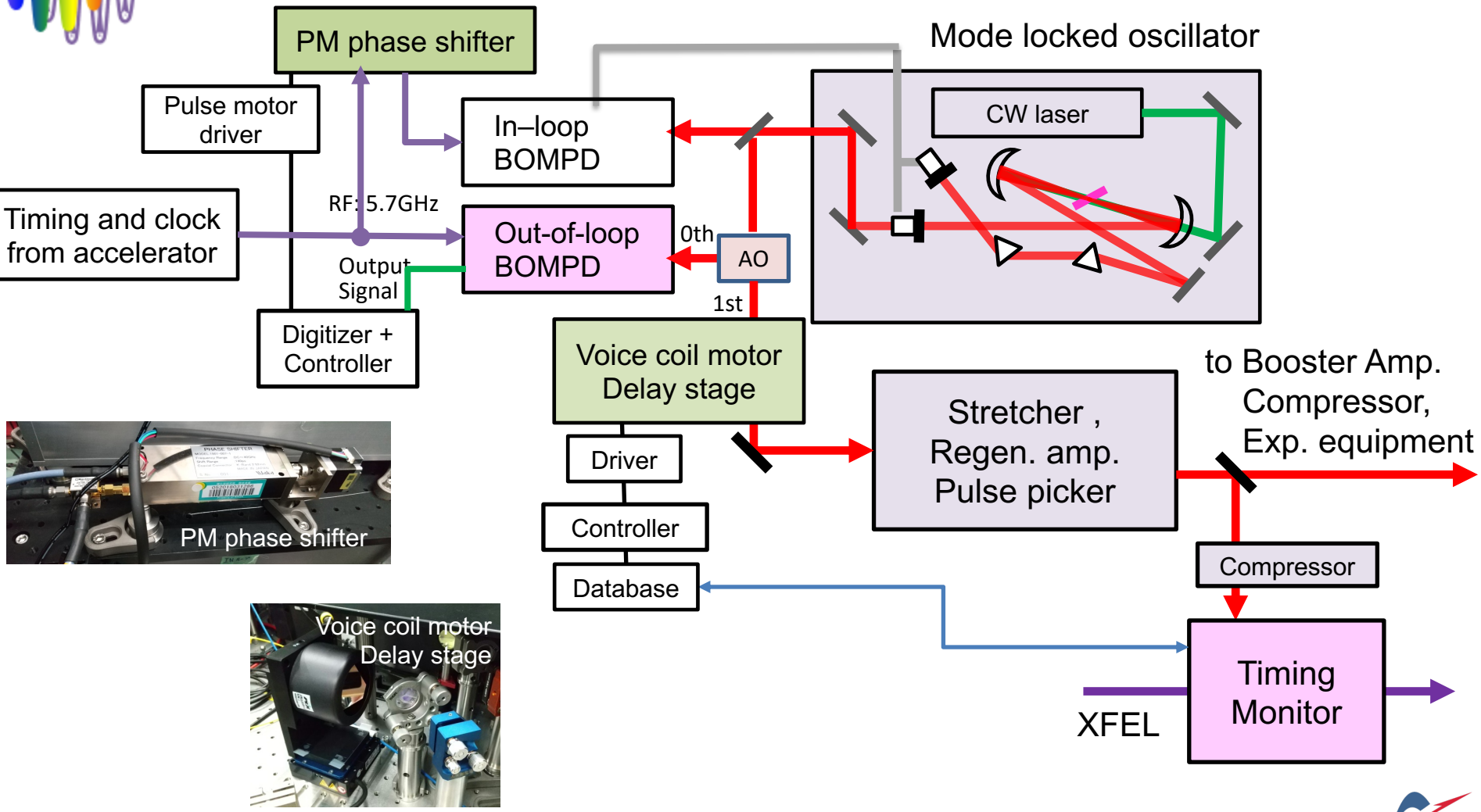
Jitter spectral density of Out-of-loop BOMPD measured by a Phase noise analyzer



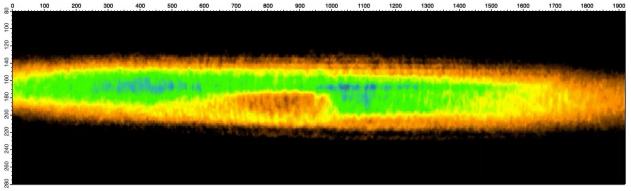
Fiber based BOMPD
K. Jung et al.
OL 37, 2958 (2012)

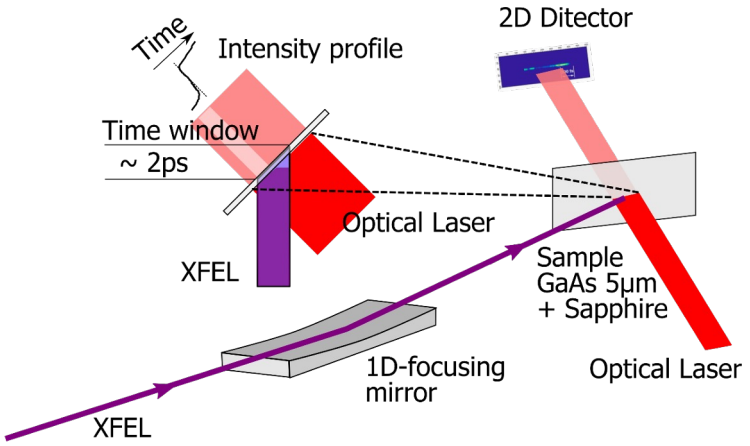


Timing drift feedback control



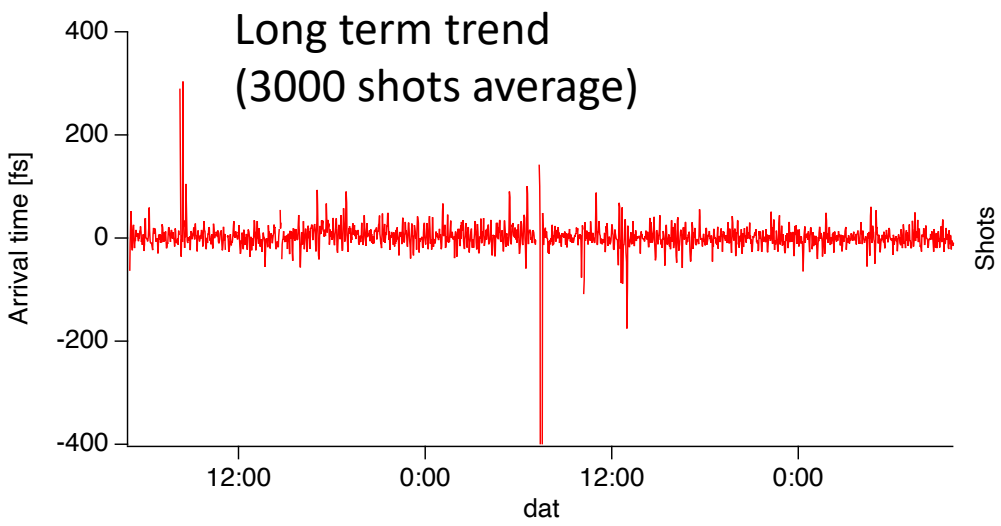
Timing stabilization result

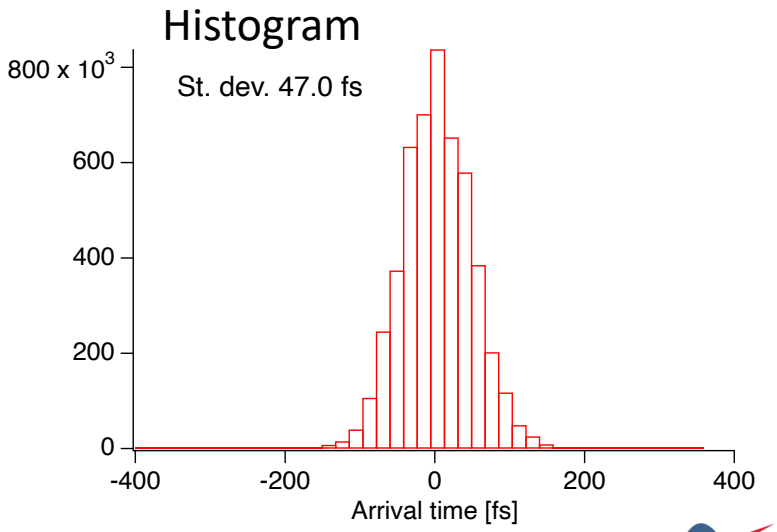




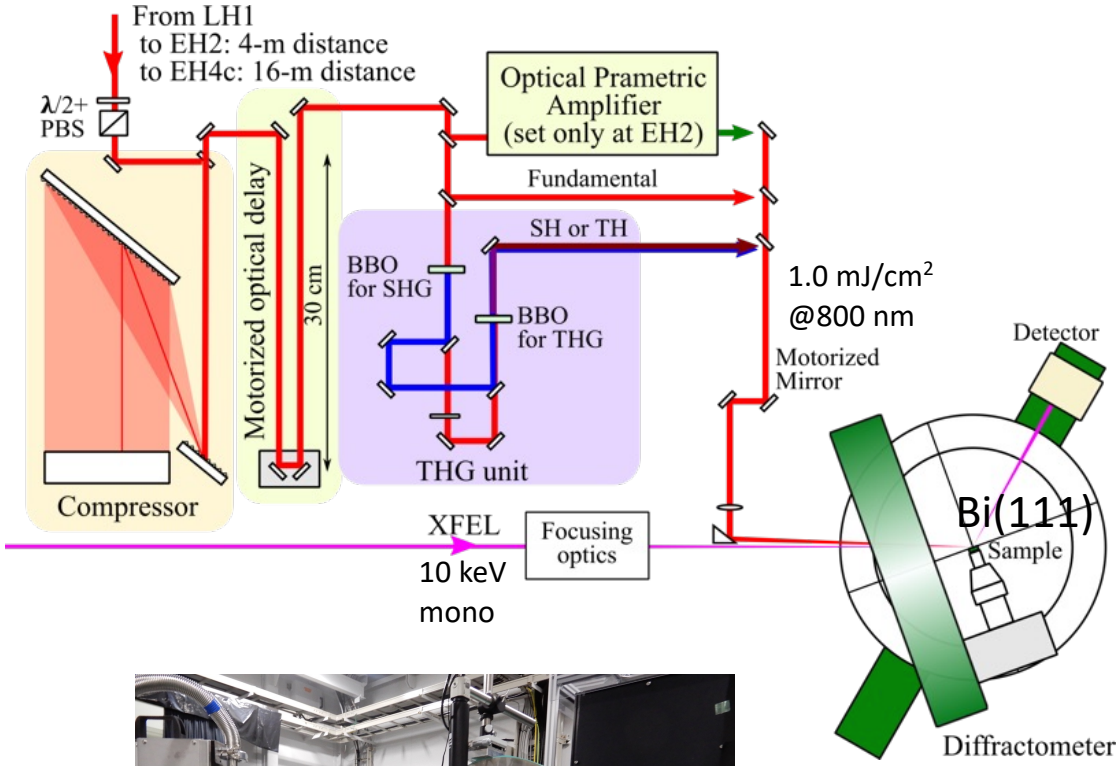
Trend of arrival time in 53 hours

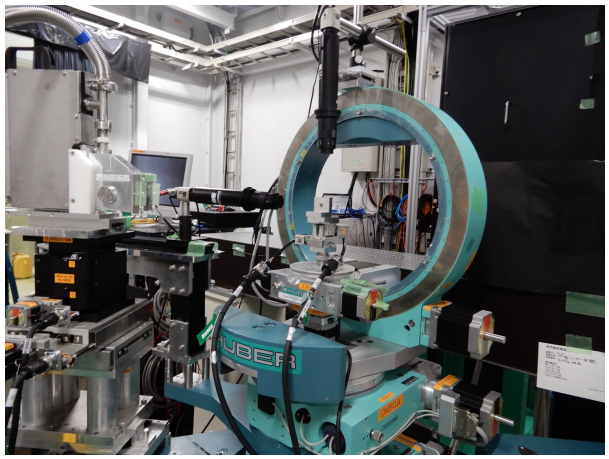
Standard deviation: 47.0 fs





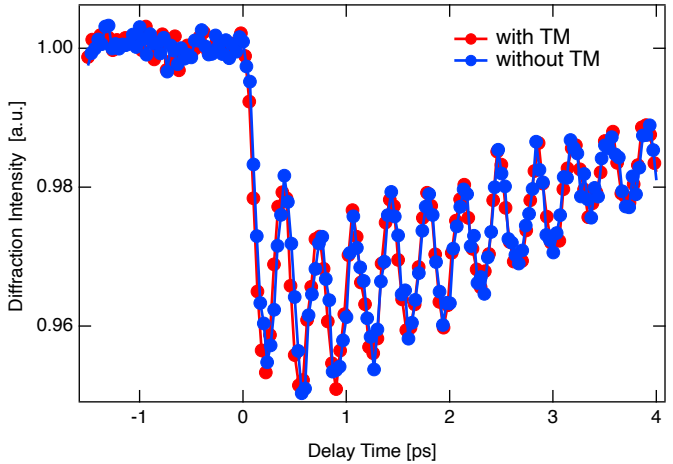
Time-resolved XRD of Bi



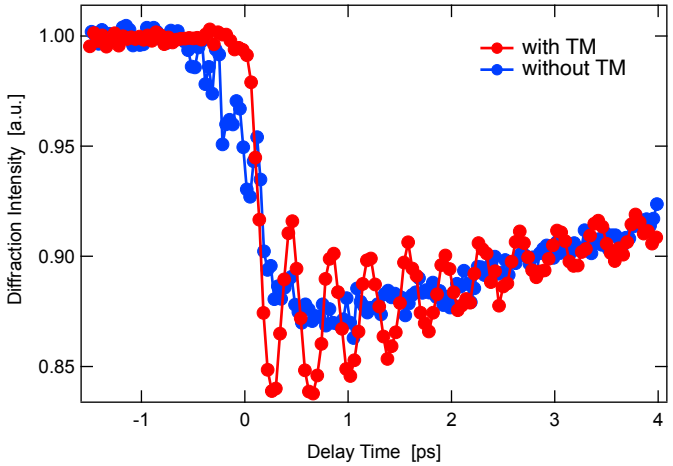


T. Togashi et al.
Appl. Sci. **10**, 7934 (2020)
Y. Kubota et al.
APL **122**, 092201 (2023)

Diffracted X-ray intensity
Coherent phonon was observed



Synchronization with BOMPD

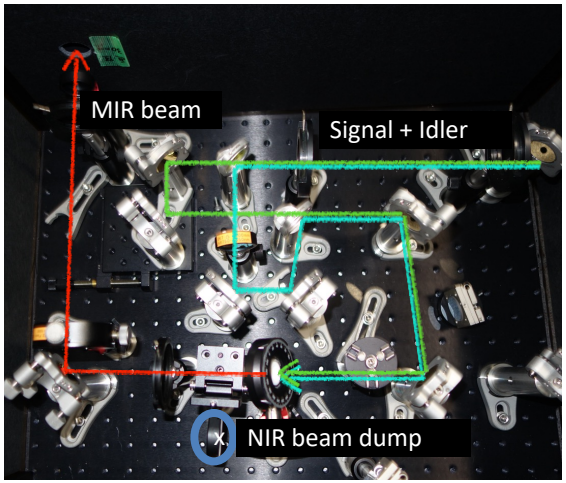


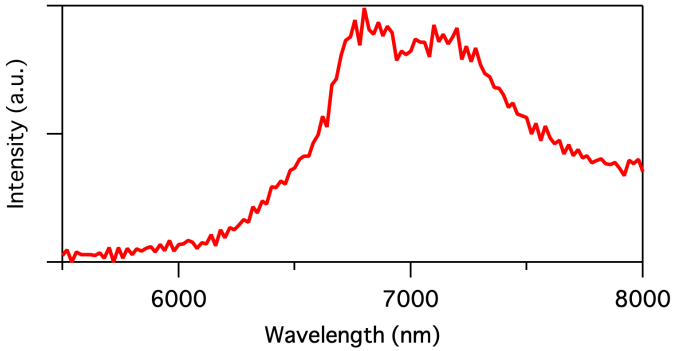
c.f. Synchronization with the old system

Mid-IR & THz generation

Mid-IR

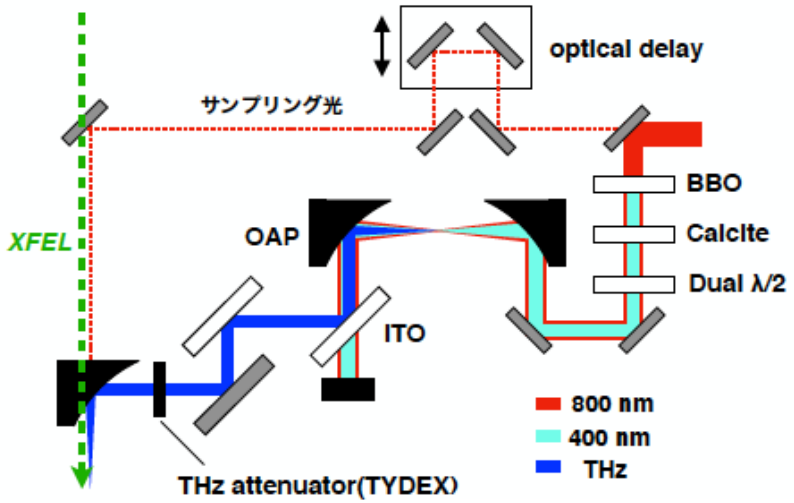
- Method: DFG of Signal and Idler from OPA
- Wavelength:
  - 2 – 11 μm ($AgGaS_2$)
  - 3 – 18 μm (GaSe)
- Pulse energy: <20 μJ @15 μm
- Focusing size: ~0.4 mm (FWHM)

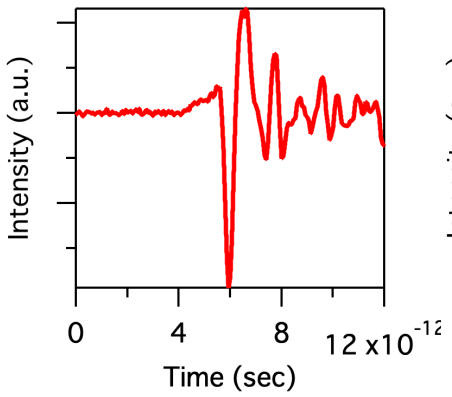


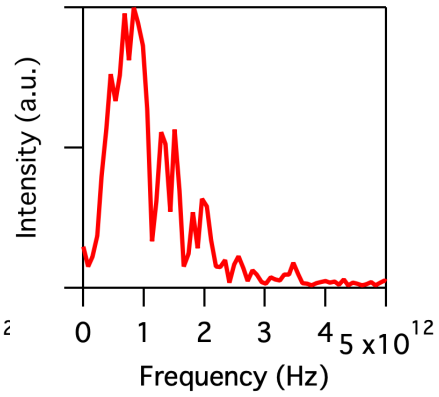


THz (preliminarily)

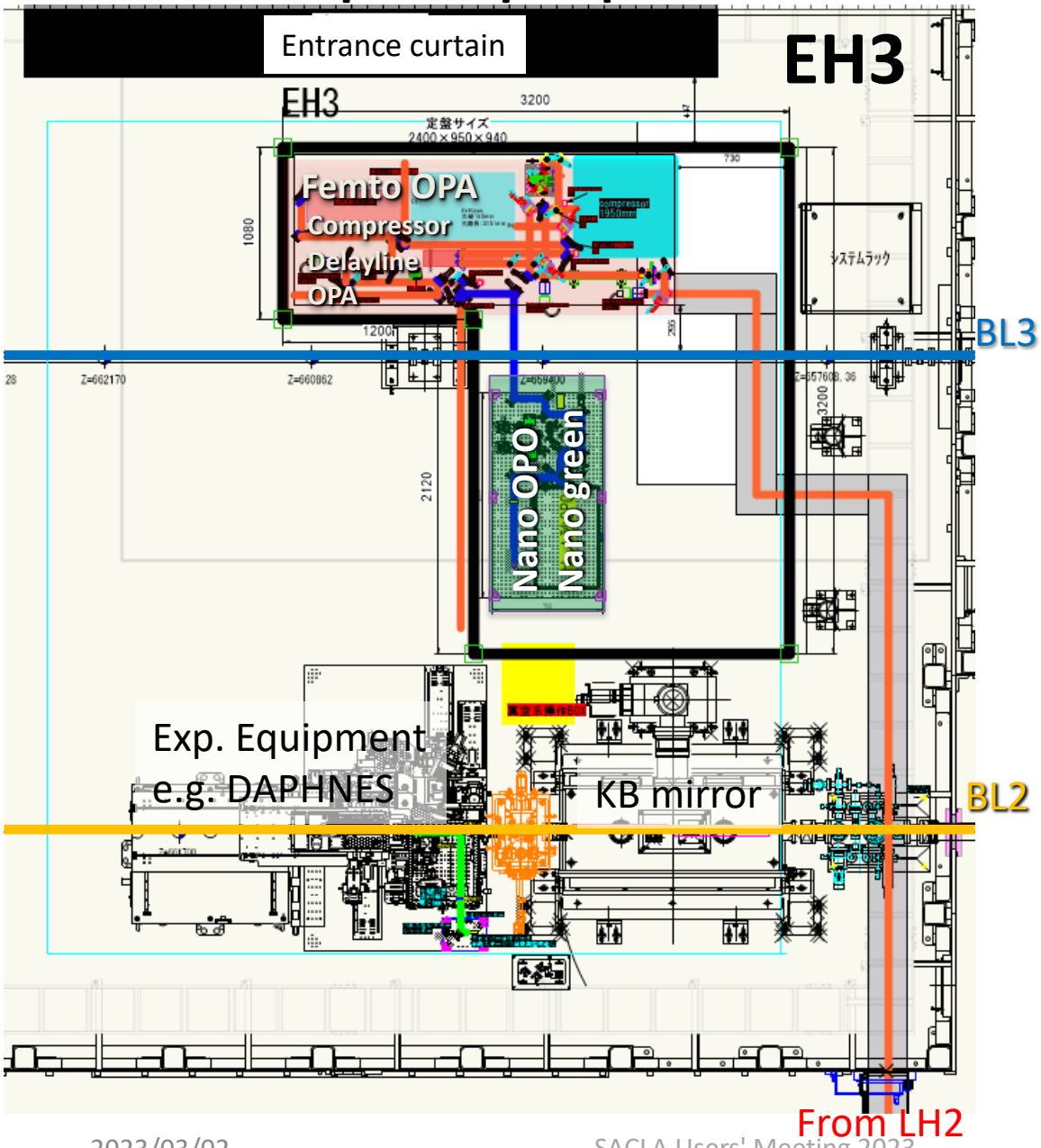
- Method: Air plasma induced by two-color pulses
- Spot size: ~ϕ1mm
- Field intensity: 1 MV/cm







Tunable “pump” platform at EH3



Specification

Nano green -Minilite- (existing)

- Wavelength: 532 nm
- Rep. rate: 10 Hz
- Output: <20 mJ
- Pulse width: ~3 ns

Nano OPO –NT232- (existing)

- Wavelength: 0.2-2.6 μm
- Rep. rate: 30Hz
- Output: Max. 20 mJ
- Pulse width: 1 - 4 ns

Femto OPA (established)

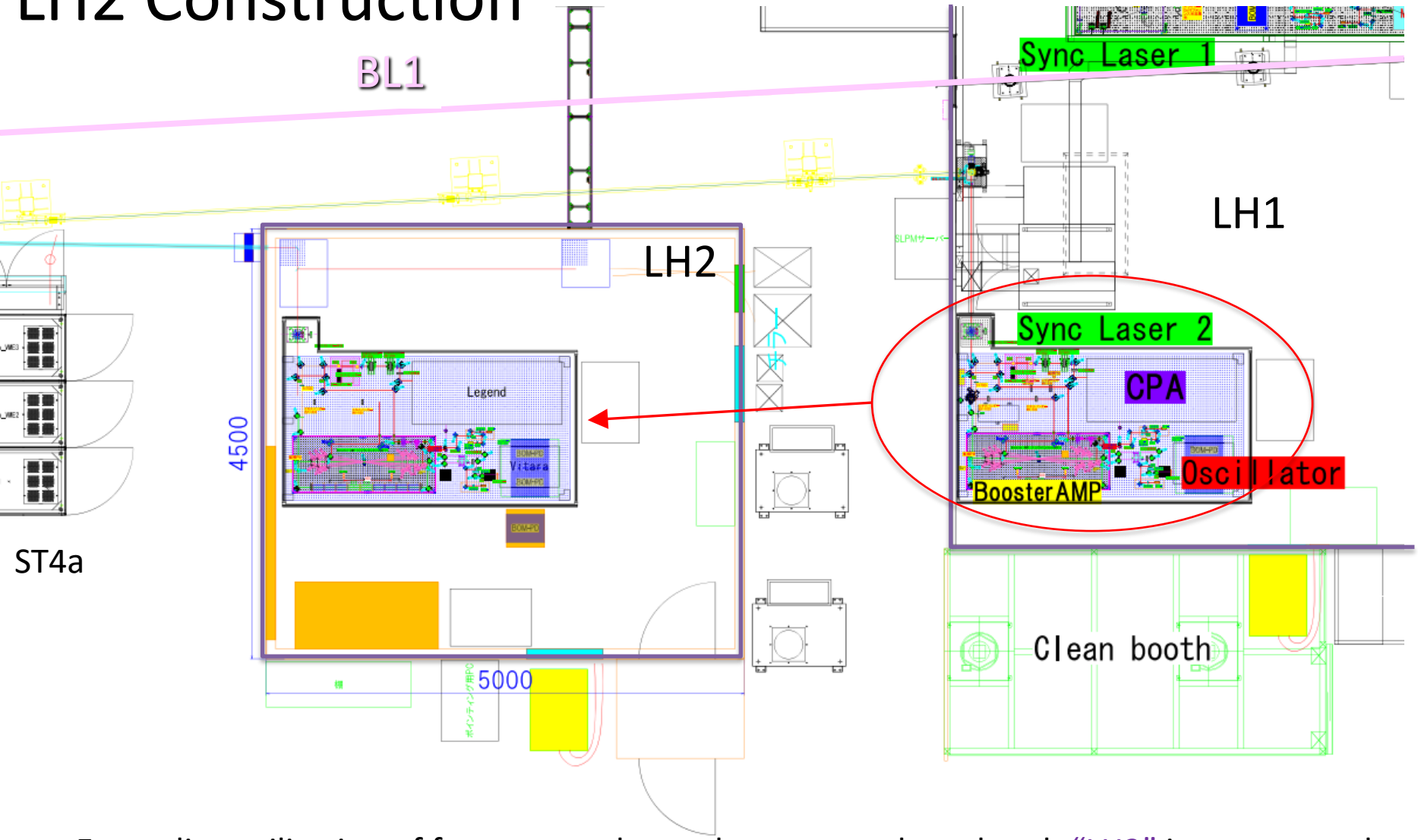
- Wavelength: 0.25 -2.6 μm
- Rep. rate: 60Hz
- Output: Max. 1 mJ (S+I)

Schedule

Construction:
Summer and winter shutdown in FY2023

Commissioning and user operation:
2024A ~

LH2 Construction



Expanding utilization of femtosecond sync. laser, a new laser hutch "LH2" is constructed.
Sync. Laser 2 will move to LH2 and operate independently.

Summery

- The high-precision synchronized laser system using BOMPD succeeded to reduce the timing fluctuation in terms of jitter and long-term drift down to 50 fs. We are now constructing the same system in Sync. Laser 2 for BL1 and BL2.
- The mid-IR and THz pulses produced by the femtosecond sync. laser are available for pump-probe experiments.
- The femtosecond OPA is installed in EH3, serving as a tunable “pump” platform for biological and chemical samples.
- A new laser hutch “LH2” is constructed for the independent operation of the femtosecond sync. lasers.