

Status and Performance Updates of Pump-probe Laser System

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On behalf of Pump-probe Laser Group

Oct. 20, 2026

SHINE Pump-probe Laser System

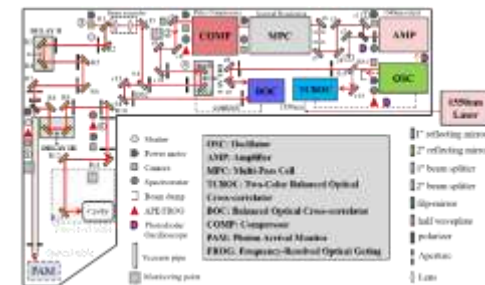
- ❑ Ultrafast optical laser required for pump-probe experiments
- ❑ Final laser implementation plan finalized
 - Commercial / Self-developed high-rep-rate laser: 1030 nm/30~40 W/<50 fs @100 kHz
- ❑ Laser transportation and synchronization between XFEL and laser
 - Environmental upgrade of SES laser clean room and optimization of optical layout
 - Installation and on-site test of time synchronization devices



Self-developed
high-rep-rate laser



Laser transportation



Time synchronization

Outlines

- **Status of Laser Systems**
- **Progress of Time Synchronization**
- **Summary**

Status of Laser Systems

□ Status of lasers for all end-stations

- **On-site test** of self-developed high-rep-rate laser for SES end-station
- Contracts of commercial laser systems for AMO/SSS/HSS/CDS end-stations has been signed, which will be delivered before the end of Dec. 2026 (LC CB3-29W-1030nm/100kHz/29W+MPC, <50fs + OPA)



Self-developed high-rep-rate laser

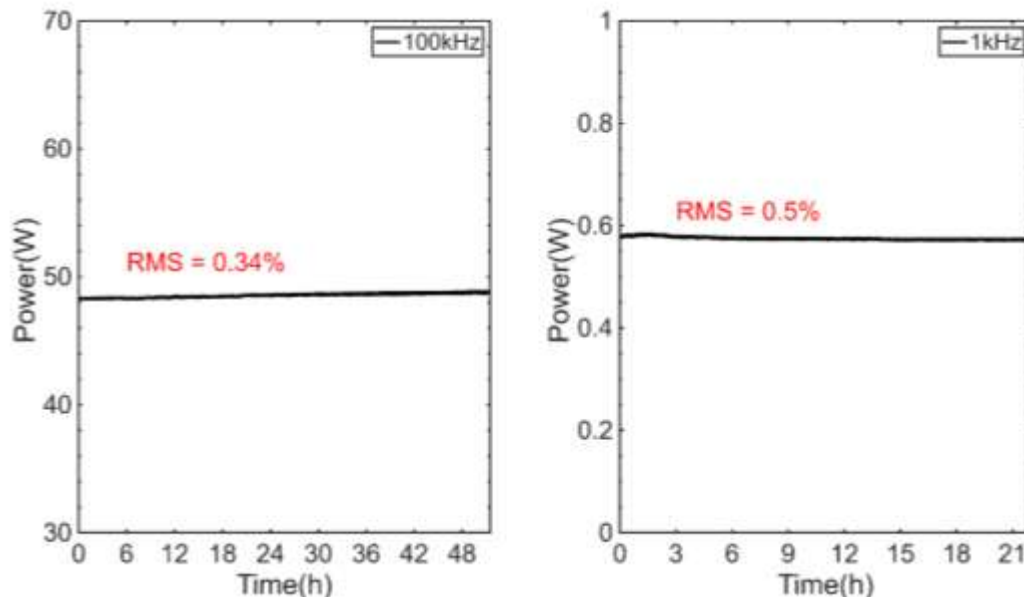


Light Conversion CB3-29W

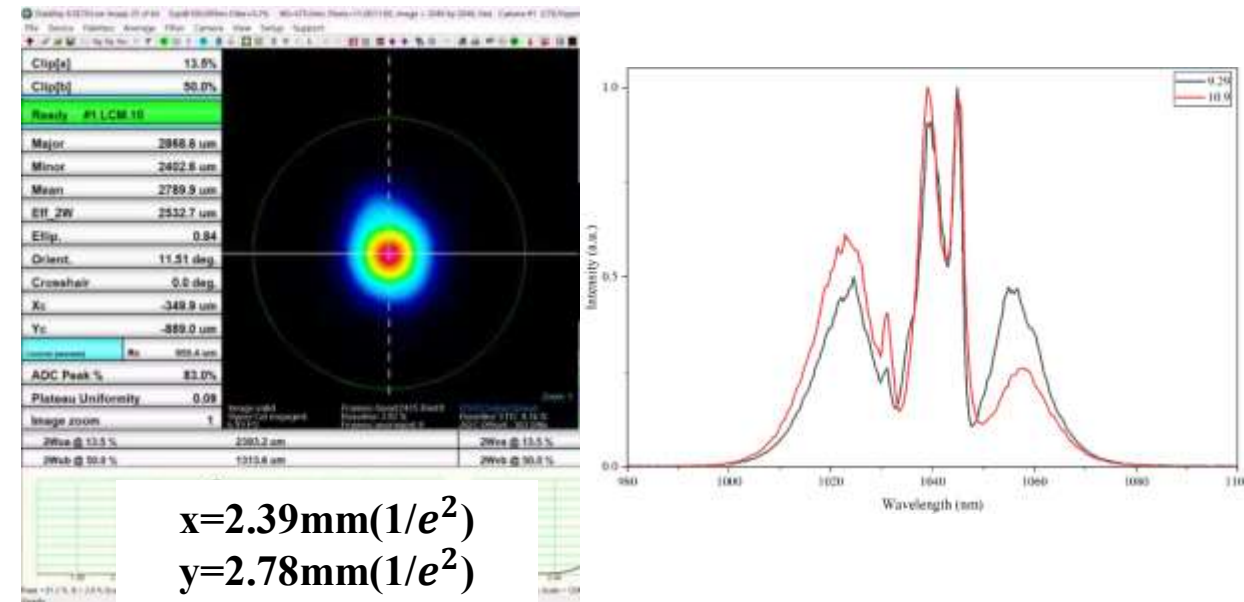
Status of Laser Systems

□ On-site test of self-developed laser system for SES

- Upgraded lab environmental control to meet strict stability requirements: $\pm 0.2\text{ }^{\circ}\text{C}$
- Optimized repetition rate tuning function and evaluated output power stability of amplifier
- Optimized MPC pulse compression and conducted beam quality testing



Average power stability @100kHz, 1kHz

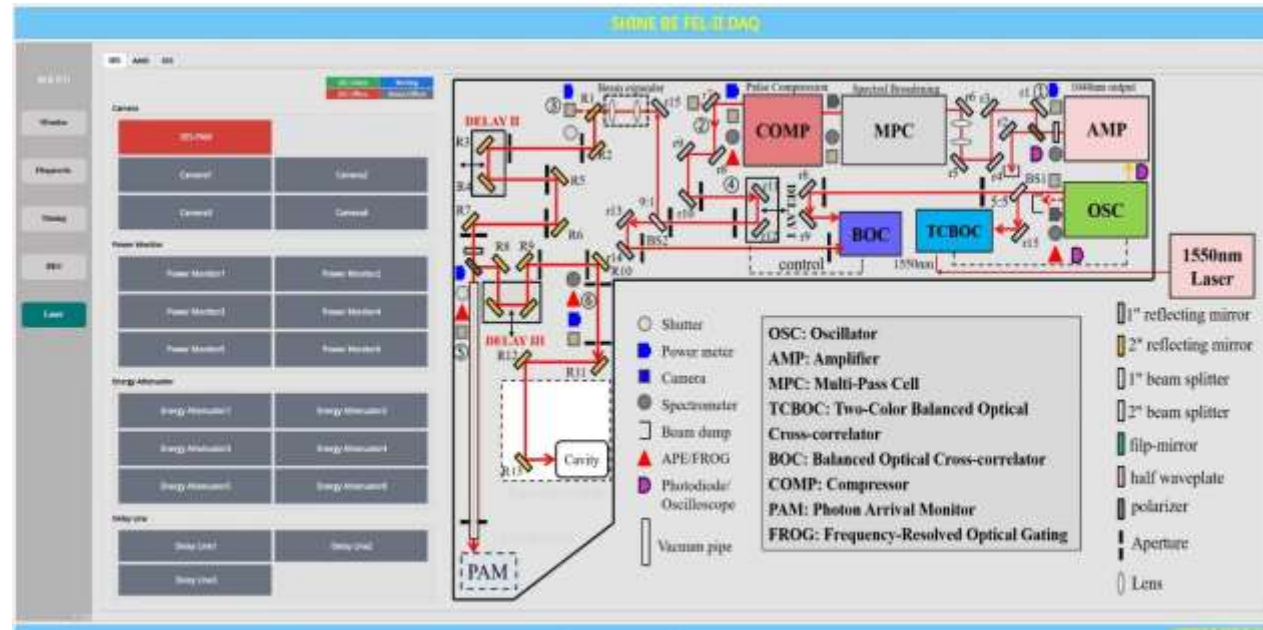


Beam profile and spectrum after MPC

Status of Laser Systems

□ Online monitor and remote control of laser parameters

- **Optimized optical path** and finalized the layout for online diagnostics and parameter monitoring
- **Laser diagnostics:** Beam profile, Pulse energy
- **Control:** Delay line, Pulse energy attenuator, Shutter

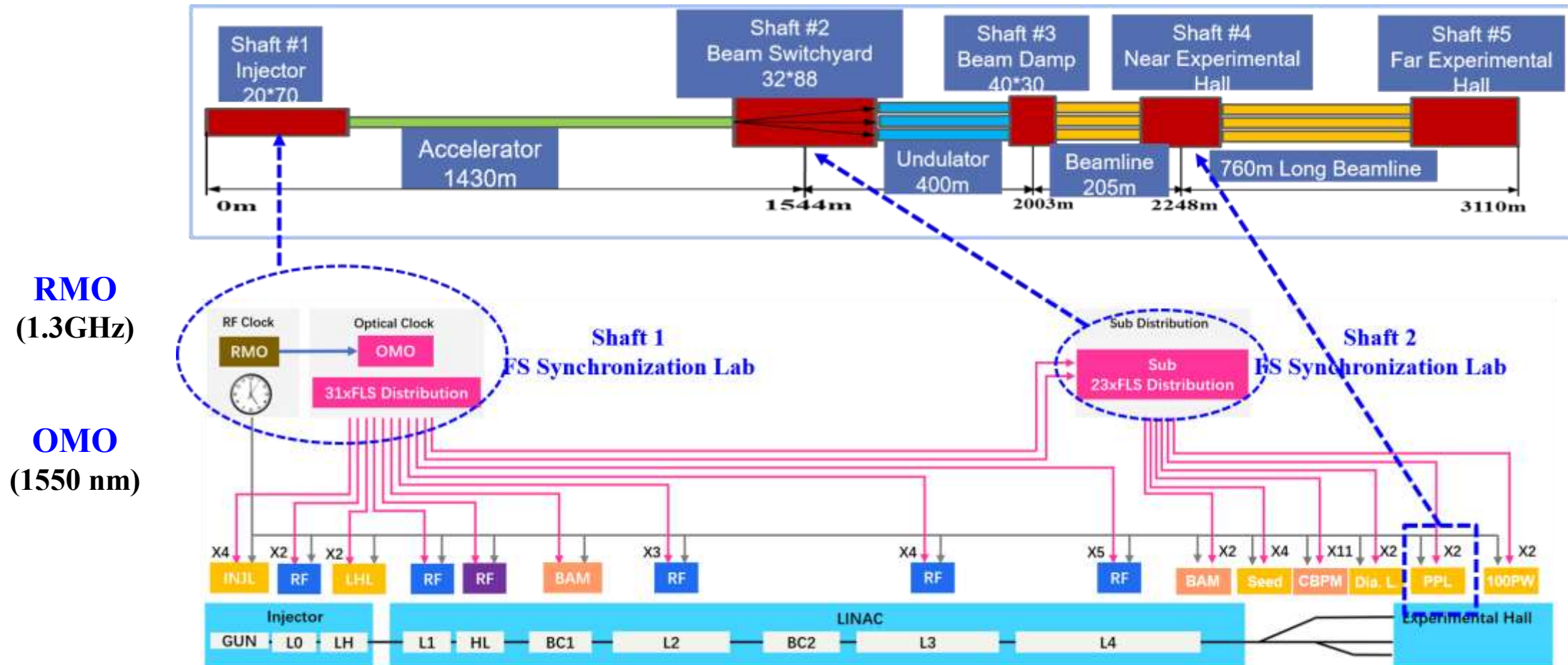


User interface of laser control

Progress of Time Synchronization

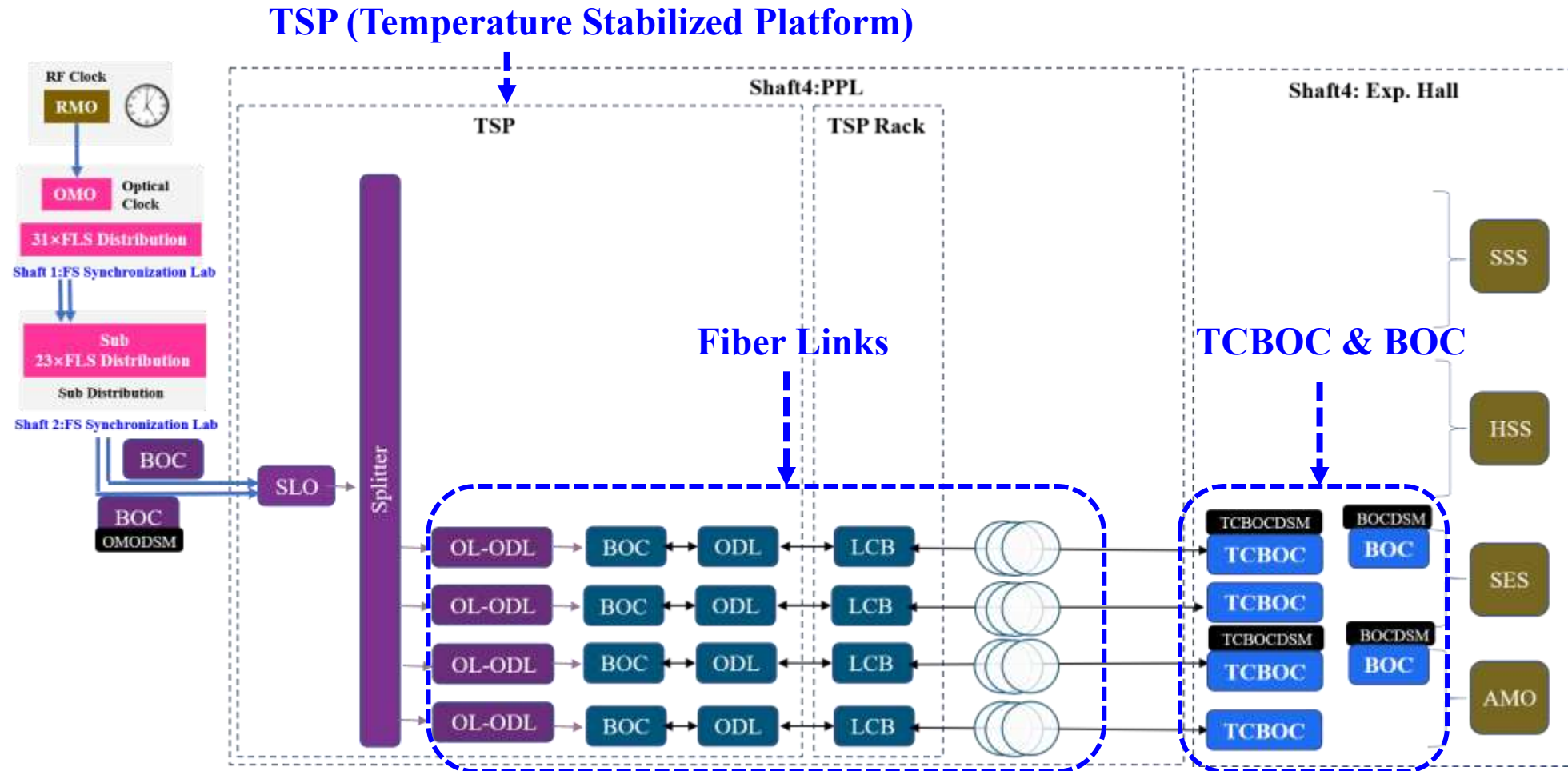
□ Femtosecond synchronization system (Responsible: Accelerator Syn. Group)

- **Technical roadmap:** The time reference distribution scheme based on **pulse link + RF link**



Progress of Time Synchronization

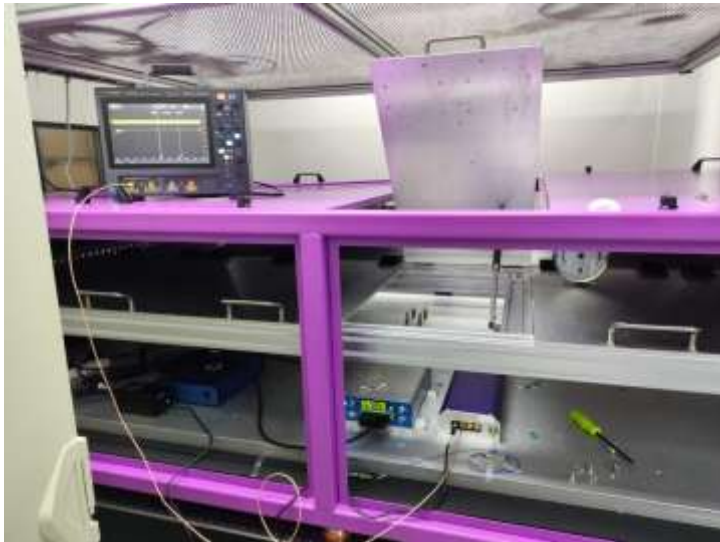
□ Sync. sub-system in Shaft #4



Progress of Time Synchronization

□ Latest installation progress of synchronization devices

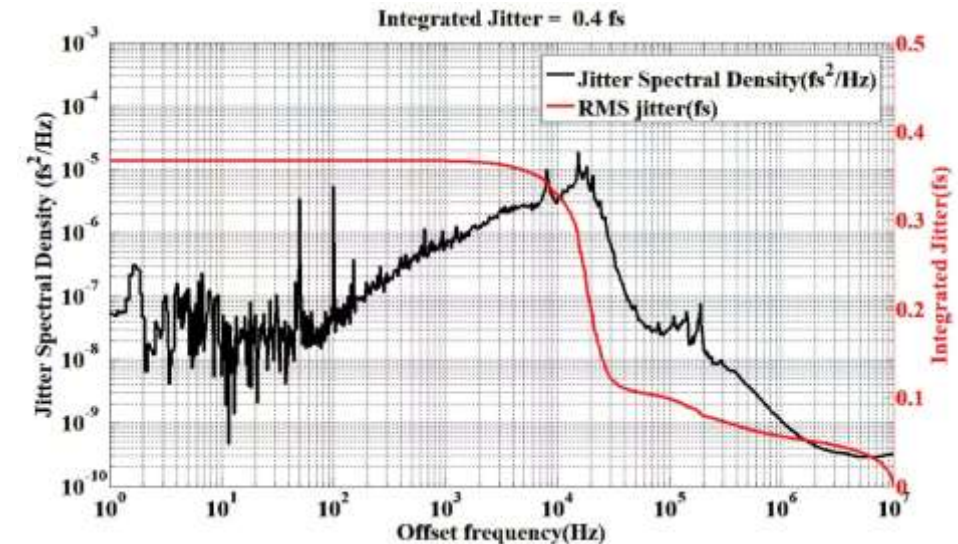
- Completed TSP design, fabrication, on-site installation, and commissioning
- Installed and commissioned the fiber phase-stabilized link between Shaft #2 and Shaft #4
- OMO in Shaft #4 synchronized with OMO in Shaft #2: Integrated jitter~**0.4fs RMS** [1Hz, 10MHz]
- On-site installation of fiber phase-stabilized links to the AMO and SES end-stations have been underway



TSP for synchronization devices



Electronics



Result of integrated jitter

Summary

- The self-developed laser has completed detailed on-site testing and partial functional optimization at the SES end-station; optical layout is currently being assembled according to the design.
- The synchronization subsystem at Shaft #4 has achieved local synchronization signal distribution; installation of the remaining local synchronization devices at Shaft #4 is currently underway.

Acknowledgement

□ Members of Pump Laser group

- Yuneng Shen, Ruixue Zhu, Ting Hai, Kang Wang

□ Colleagues from Laser group of Accelerator Division

- Bo Liu, Zhi Zhao
- Xingtao Wang, Jinguo Wang, Wenyan Zhang, Lie Feng, Chen Li, Weiyi Yin, etc.



Thank you for your attention!

