SUB-FEMTOSECOND PRECISION SYNCHRONIZATION AND FREQUENCY & TIMING DISTRIBUTION IN LARGE FACILITIES

EPIC Online Technology Meeting on Photonics Technologies for Advanced Light Sources 2024

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Online

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Cycle

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Cycle

Cycle in brief

- DESY spin-off, Hamburg-based
- Funded 2014 by Prof. F. Kärtner
- 33 people
  from 13 countries
- Delivering sub-fs precision synchronization solutions worldwide
- Growing for ever-precise and integrated systems, from FEL to deep space antenna facilities

Most challenging F&T requirements arise from state-of-the art laser facilities and telescope networks & arrays

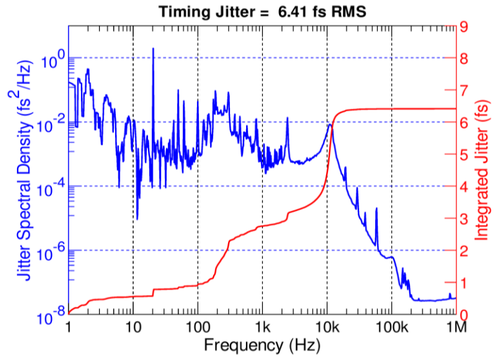
LCLS @SLAC

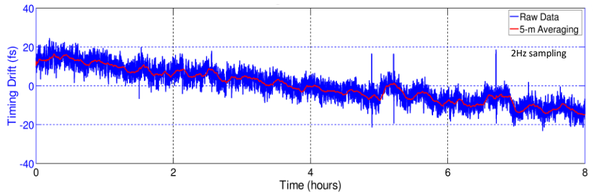
Cycle timing synchronization modules: laser oscillators and RF fs synchronization

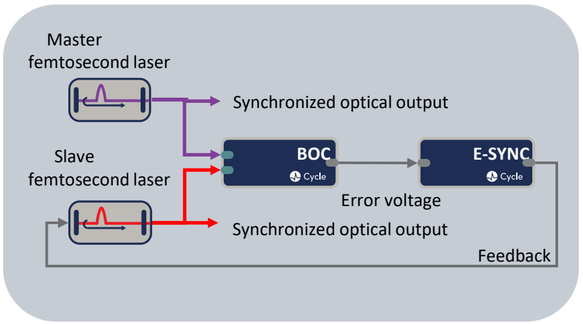
Balanced Optical Cross Correlator

- Less than 15 fs RMS timing jitter and timing drift
- RMS noise floor lower than 0.5 fs
- Attosecond-level timing jitter resolution

Ti:Sa laser locked to a 1550-nm laser:



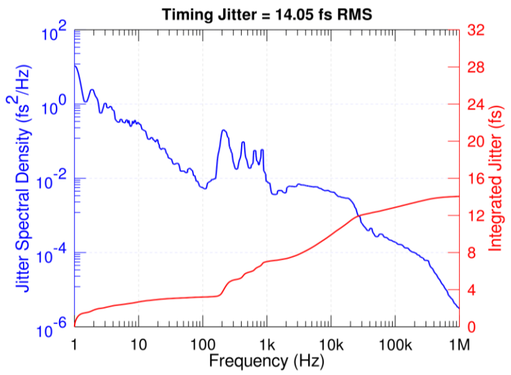


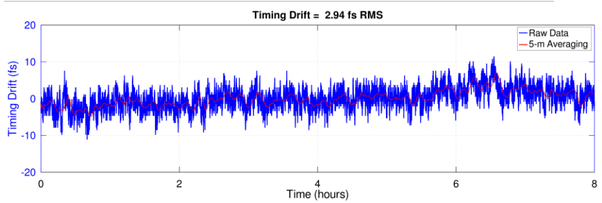


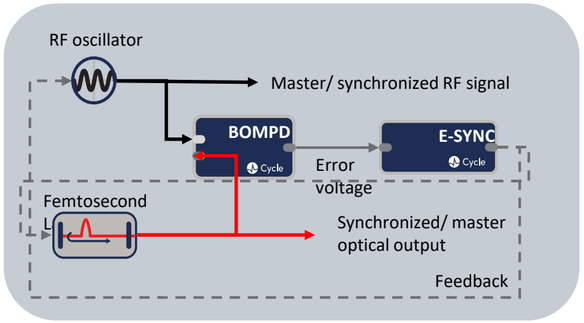
Balanced Optical Microwave Phase Detector

- Less than 20 fs RMS timing jitter and timing drift
- RMS noise floor lower than 5 fs
- Attosecond-level timing jitter resolution

Ti:Sa laser locked to a RF at 5712 MHz



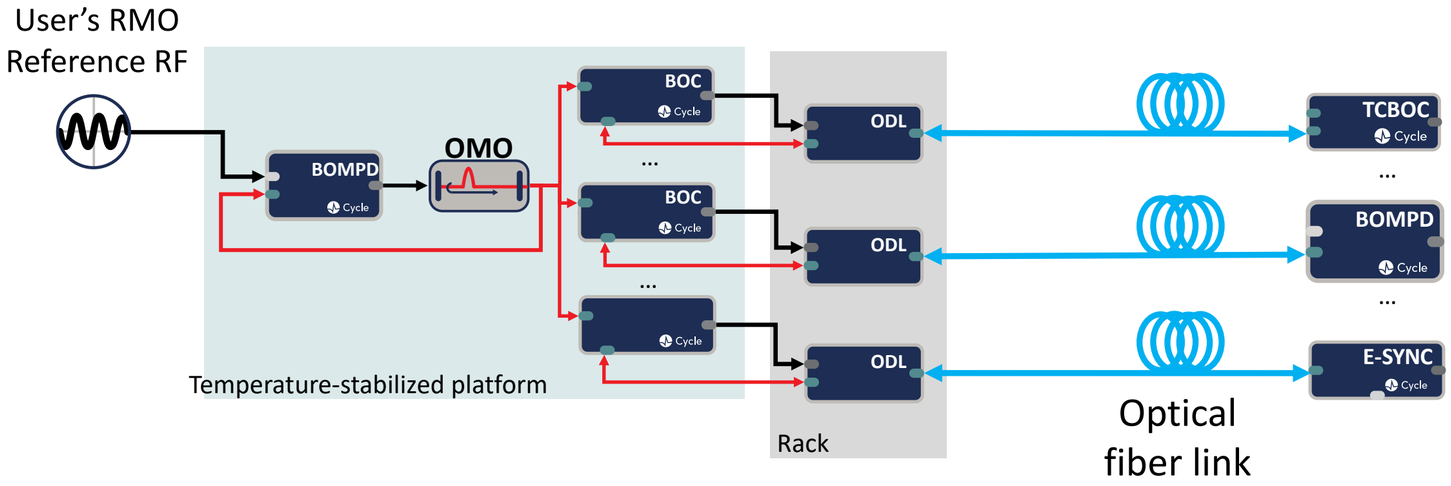




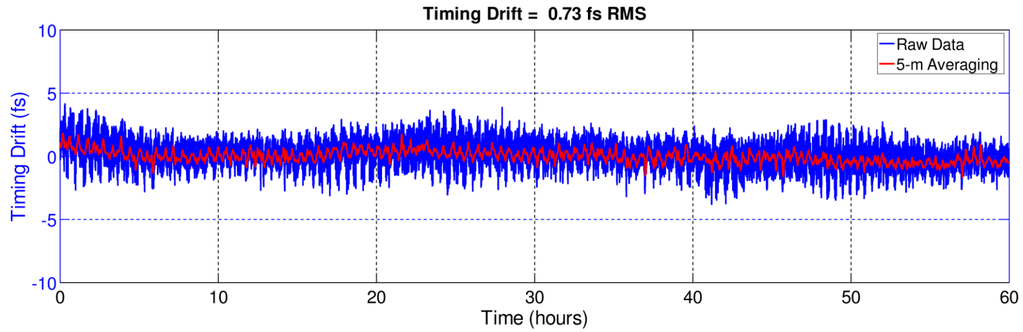
PULSE – Optical synchronization

Timing Distribution System

Lowest noise optical timing distribution & synchronization



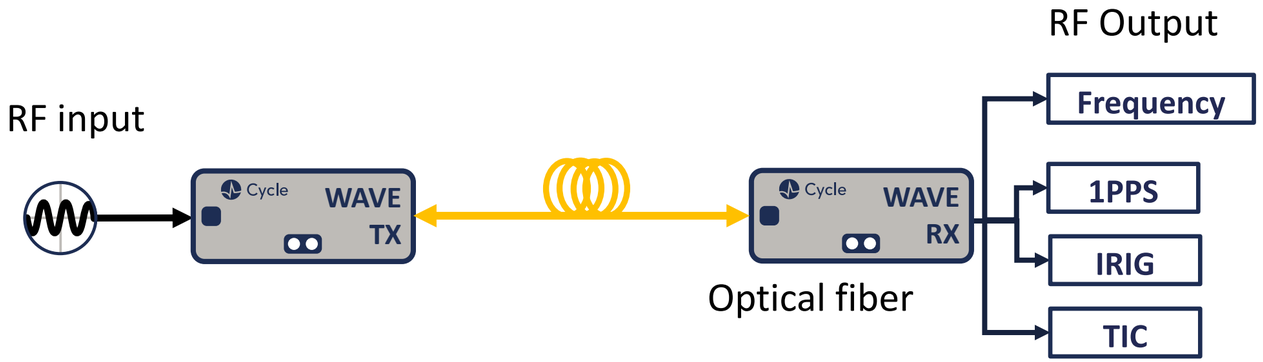
- Less than 5 fs RMS timing jitter and timing drift
- Modular and expandable system (standard up to 16 fiber links and 10-km length)
- Remote or local control via EPICS
- Automated search and lock mechanism via GUI



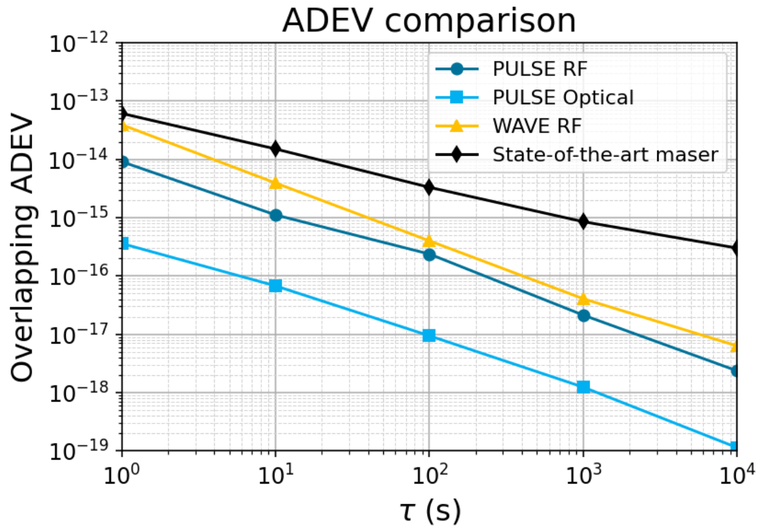
WAVE- RF over fiber F&T distribution

Timing Links

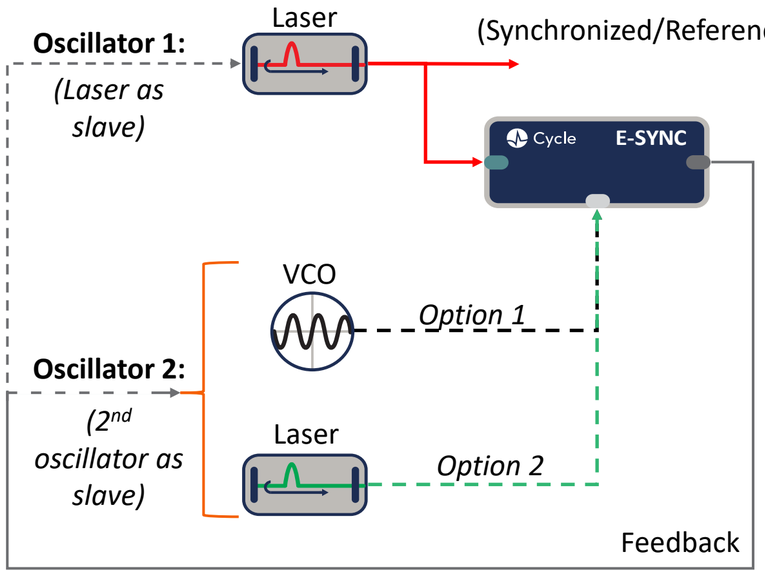
Precision frequency and time distribution over fiber



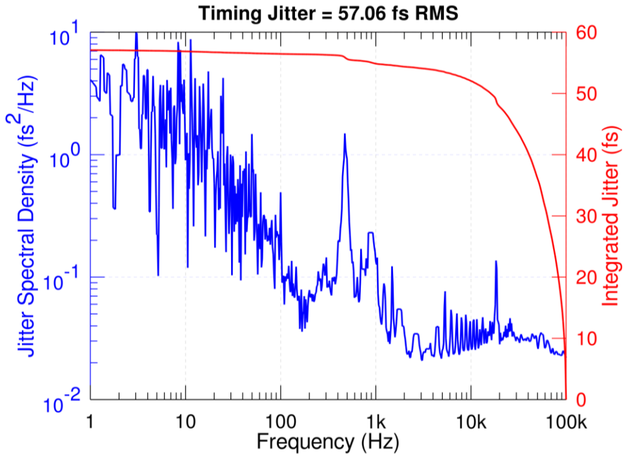
- Less than 100 fs RMS jitter, 500fs RMS drift
- Wide range RF transfer (10 MHz – 10 GHz)
- **Stability better than state-of-the-art masers**
- Modular & configurable
- Synchronous time signals (1PPS, IRIG & NTP)
- Optional: Station-time generator & Phase-Frequency-Meter

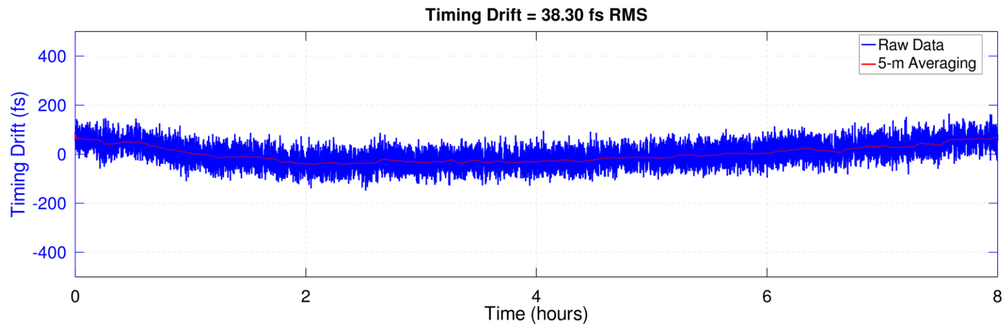


ESYNC – Synchronization



Out-of-loop timing jitter and drift a laser locked to a RF master oscillator at 2856 MHz





- Less than 100 fs RMS timing jitter
- Advanced fundamental and harmonic frequency lock functionality
- User adjustable delay between locked oscillators
- Automated search and lock mechanism via GUI

Our F&T distribution and synchronization solutions worldwide