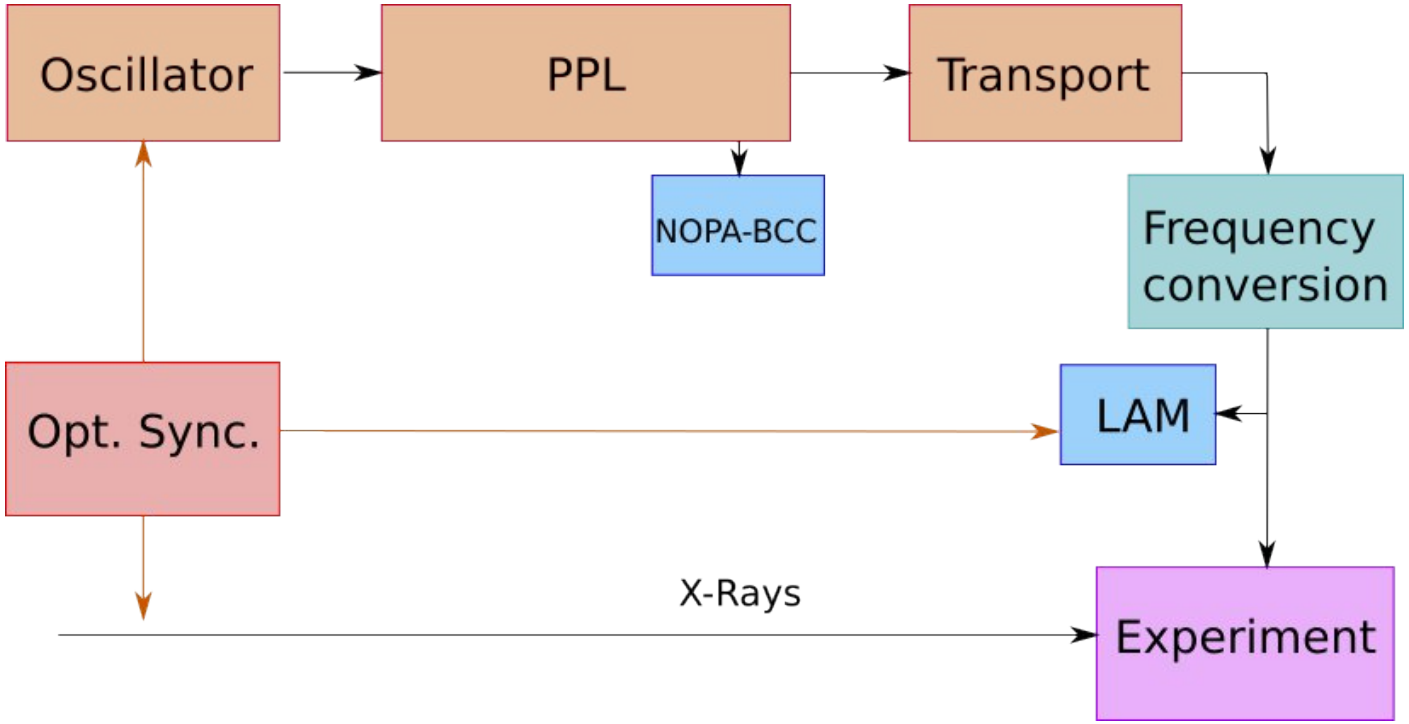
Update on Laser Pulse Arrival Time Measurements for XFEL Experiments

Nick Kschuev, on behalf of LbSync and LAS Teams
ARD ST3 Meeting, 06.07.23

Laser Pulse Arrival Time Monitor (LAM): Integration

Goal: improvement of laser arrival time below 5 fs



- Optical-to-optical synchronization
- Fiber link for reference

- Implementation in stages:
  - measurements with single-pulse resolution (up to 4.5 MHz)
  - feedbacks to compensate for drifts (10 Hz rate)
  - possible upgrade: feedbacks over the burst

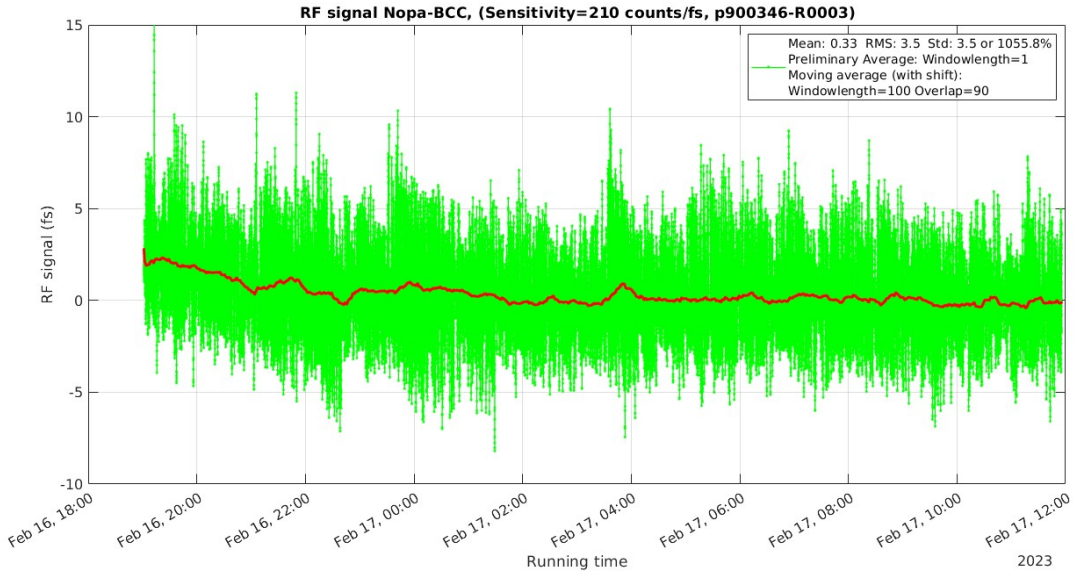
Optical laser against photon (X-ray) arrival time stability: <15 fs rms uncorrected or <10 fs corrected
Electron bunch arrival time stability against optical reference: 5-10 fs rms
(Short term measurements)

System split between different rooms: communication between MTCA crates with low-latency links

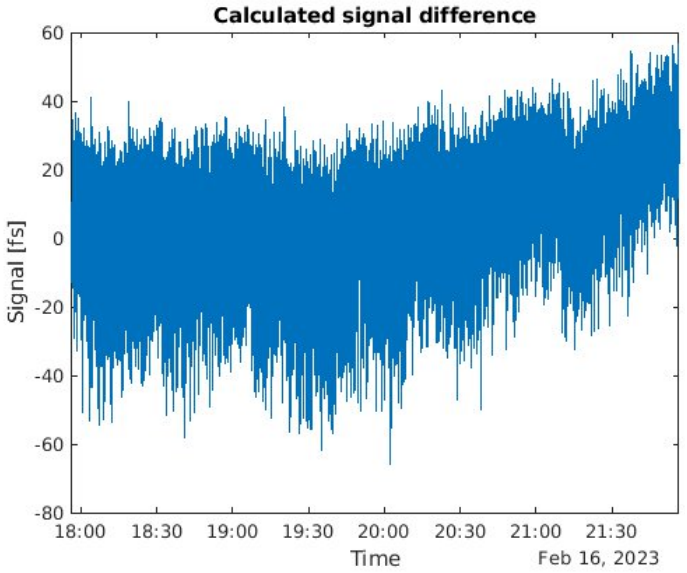
Measurements at EuXFEL End-station: MID (SASE2)

Stable arrival time in the PPL hutch, but drifts added during transport

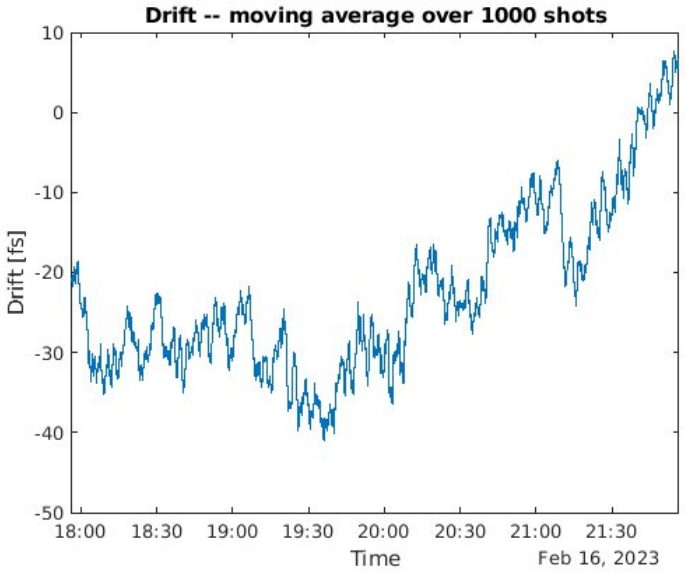
NOPA-BCC



LAM: drift + jitter



LAM: drift



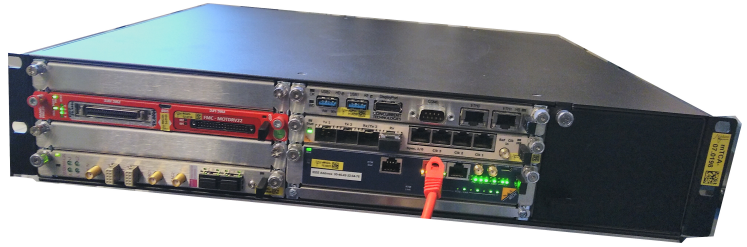
- Laser timing stable over 18 h

- Large jitter probably driven by large pointing fluctuations
- ~50fs drifts over 4 h
- Measurement duration limited by dynamic range

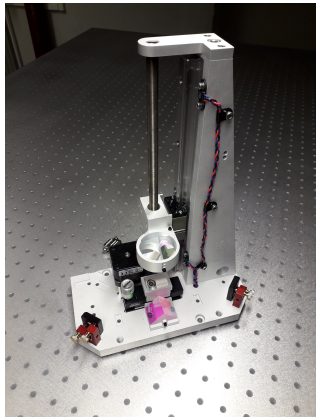
Timing drifts are added during beam transportation!

System Design and Current Investigations

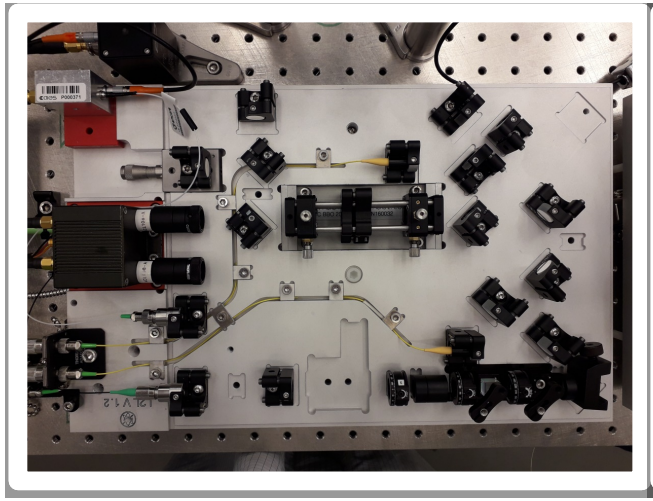
- Detectors
- Detection bandwidth

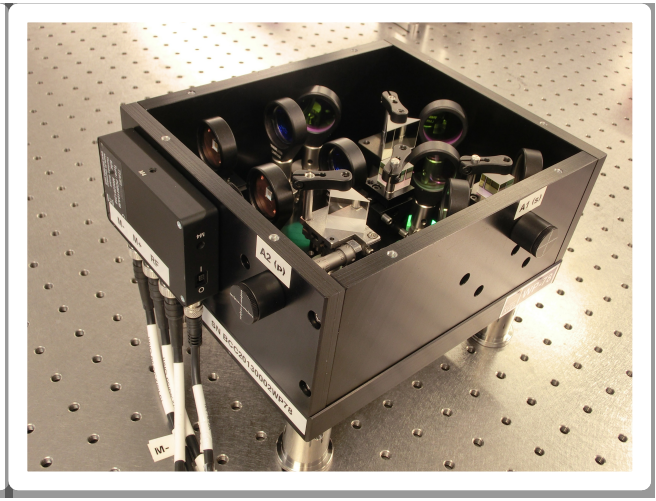


- Delay line concept
- Actuator concept



- Optical implementation over large spectral range





- Measurement at MID experiment: origin of jitter

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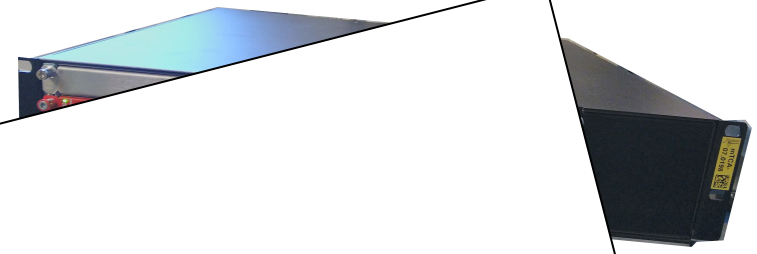

See you at the poster!