Sub-10 Femtosecond Stabilization of a Fiber-Link Using a Balanced Optical Cross-Correlator

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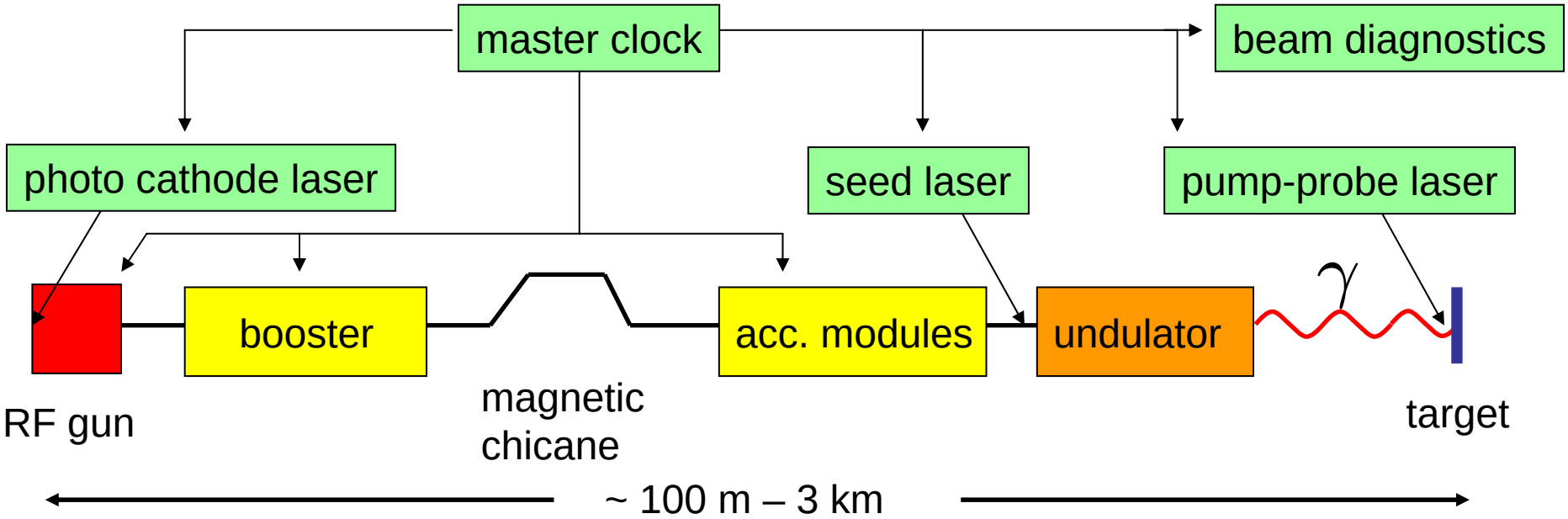
Synchronization needs in a FEL facility



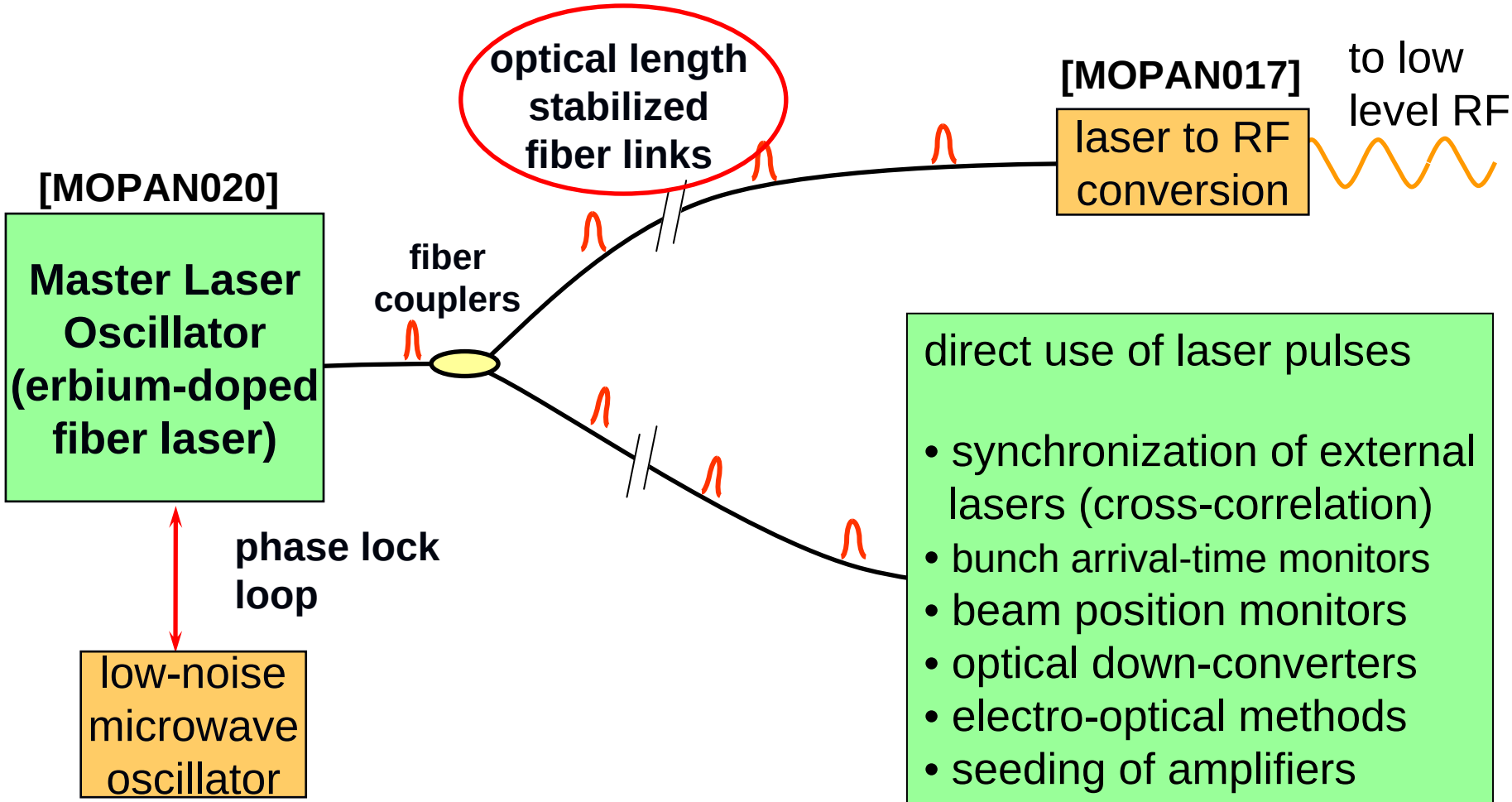
Goal:

- low timing jitter + drift between FEL and pump-probe laser (max. ~10 – 50 fs)

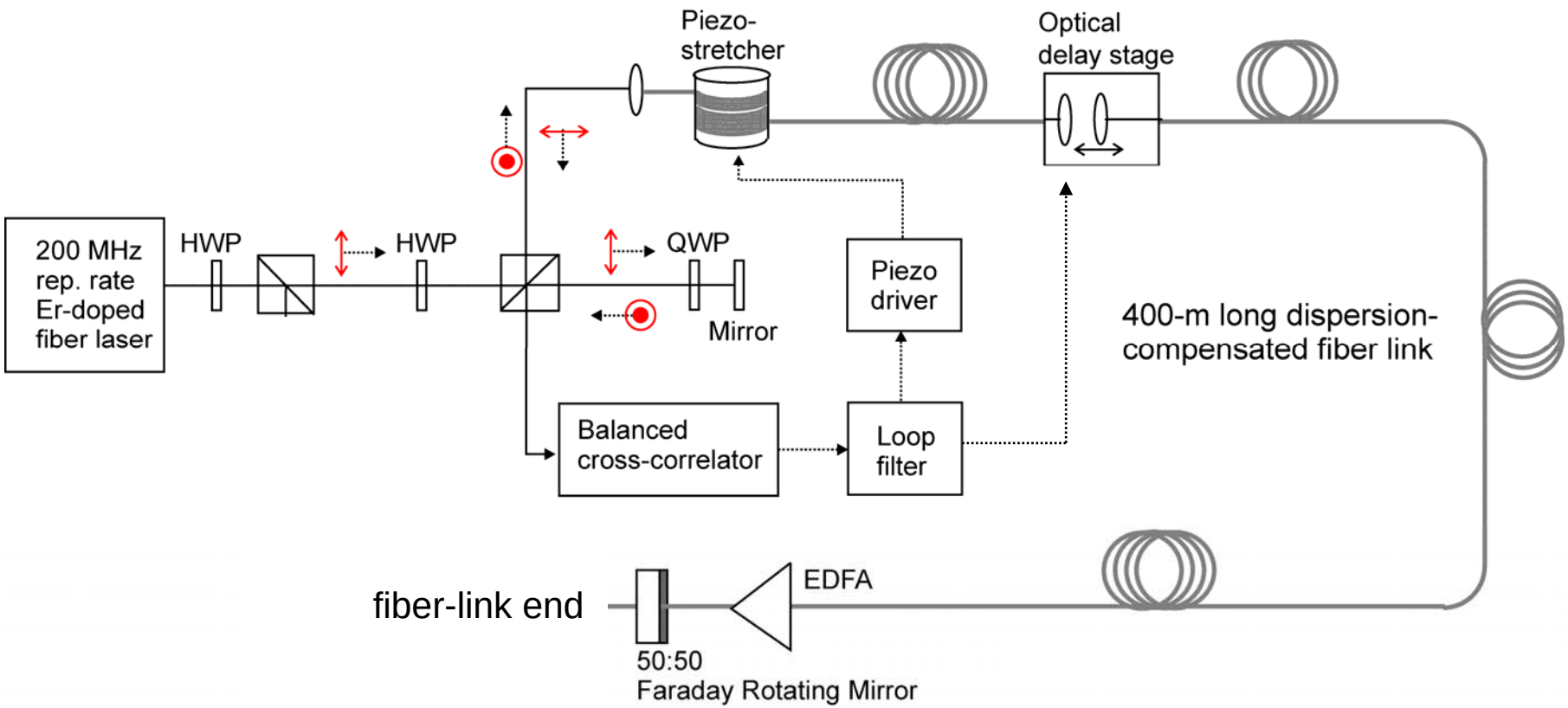
Main sources for arrival-time changes of the FEL radiation

- arrival-time of the photo cathode laser pulses
- phase of the RF gun
- amplitude and phase of booster module
- arrival-time of potential seed lasers

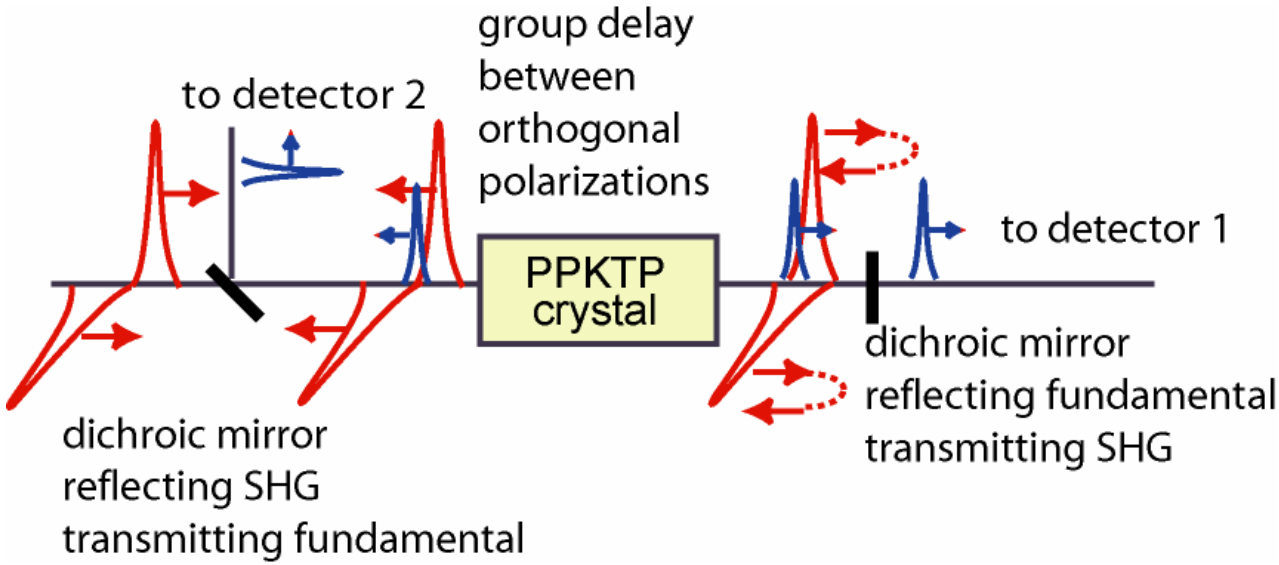
Layout of the optical synchronization system

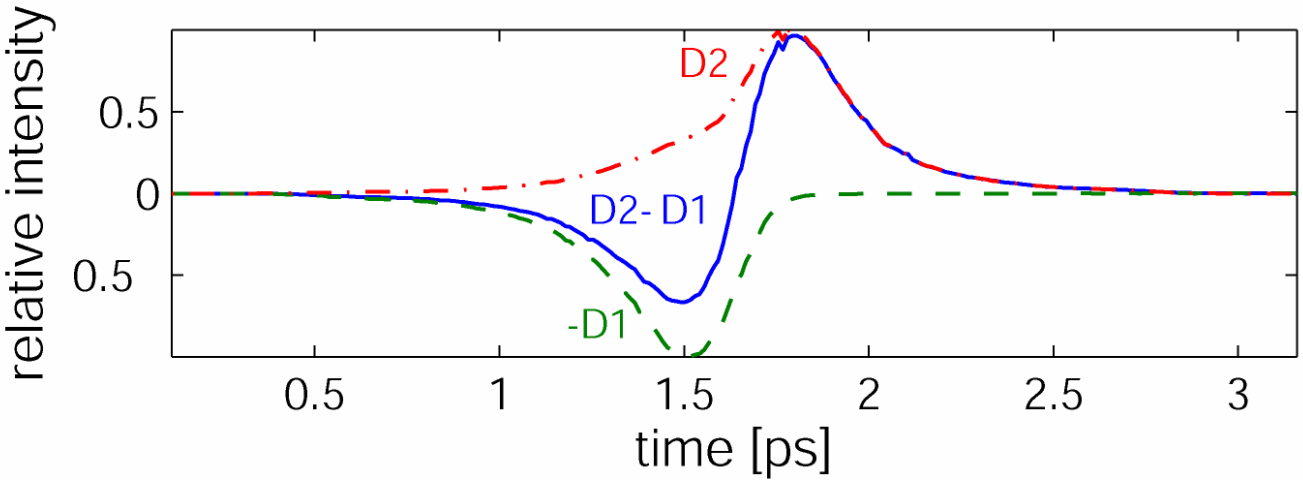


Schematic setup of the fiber-link stabilization



Balanced optical cross-correlator





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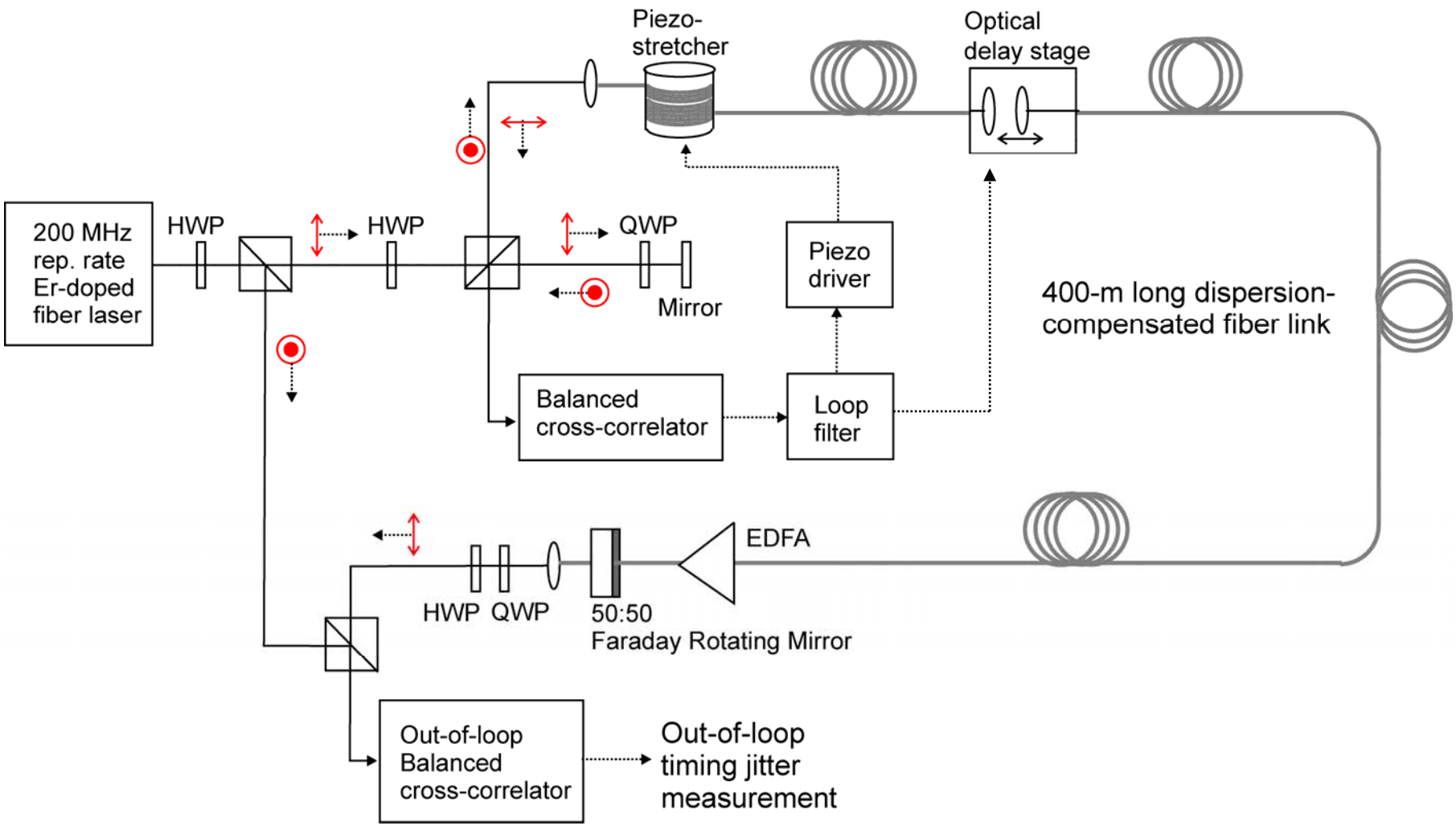
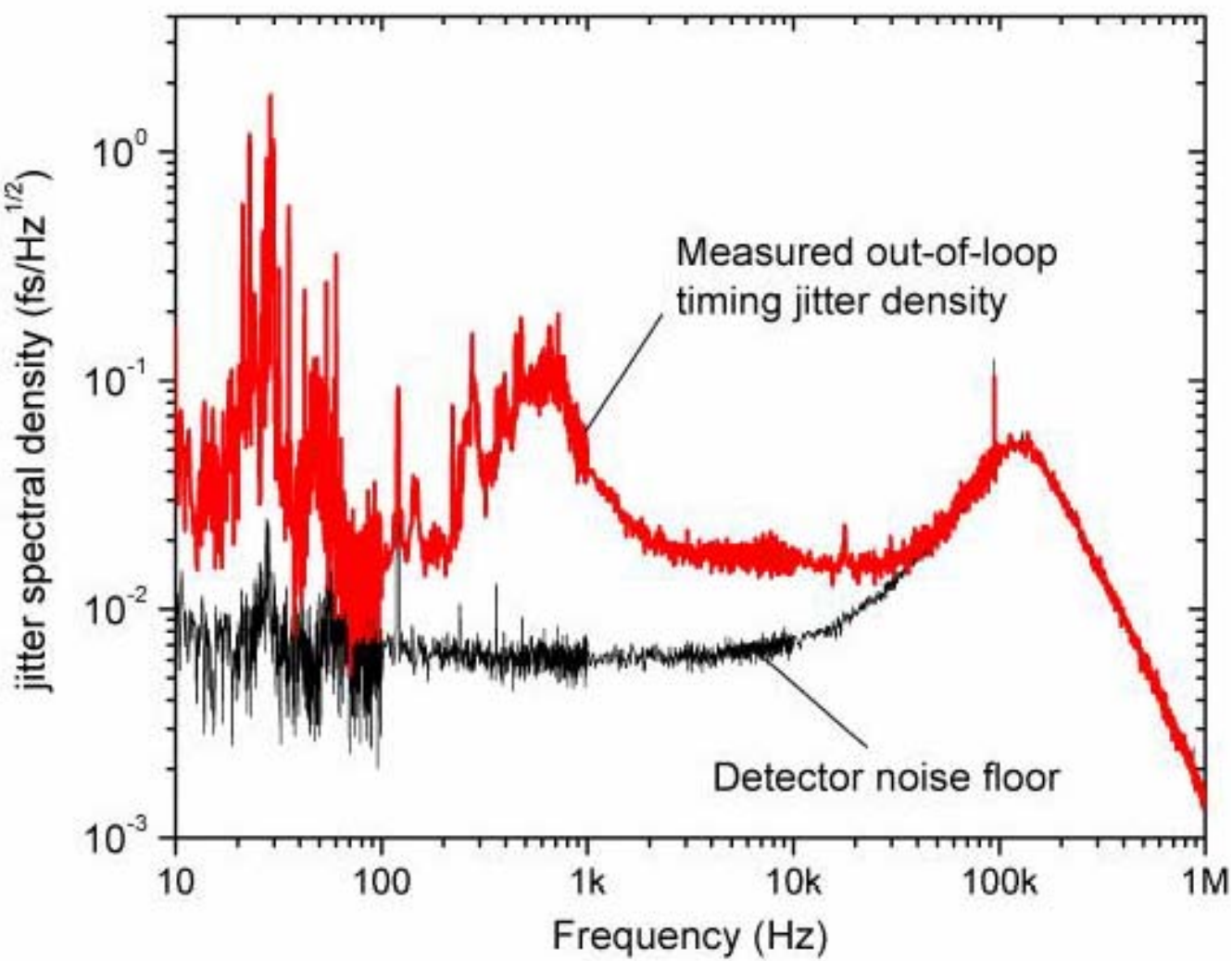
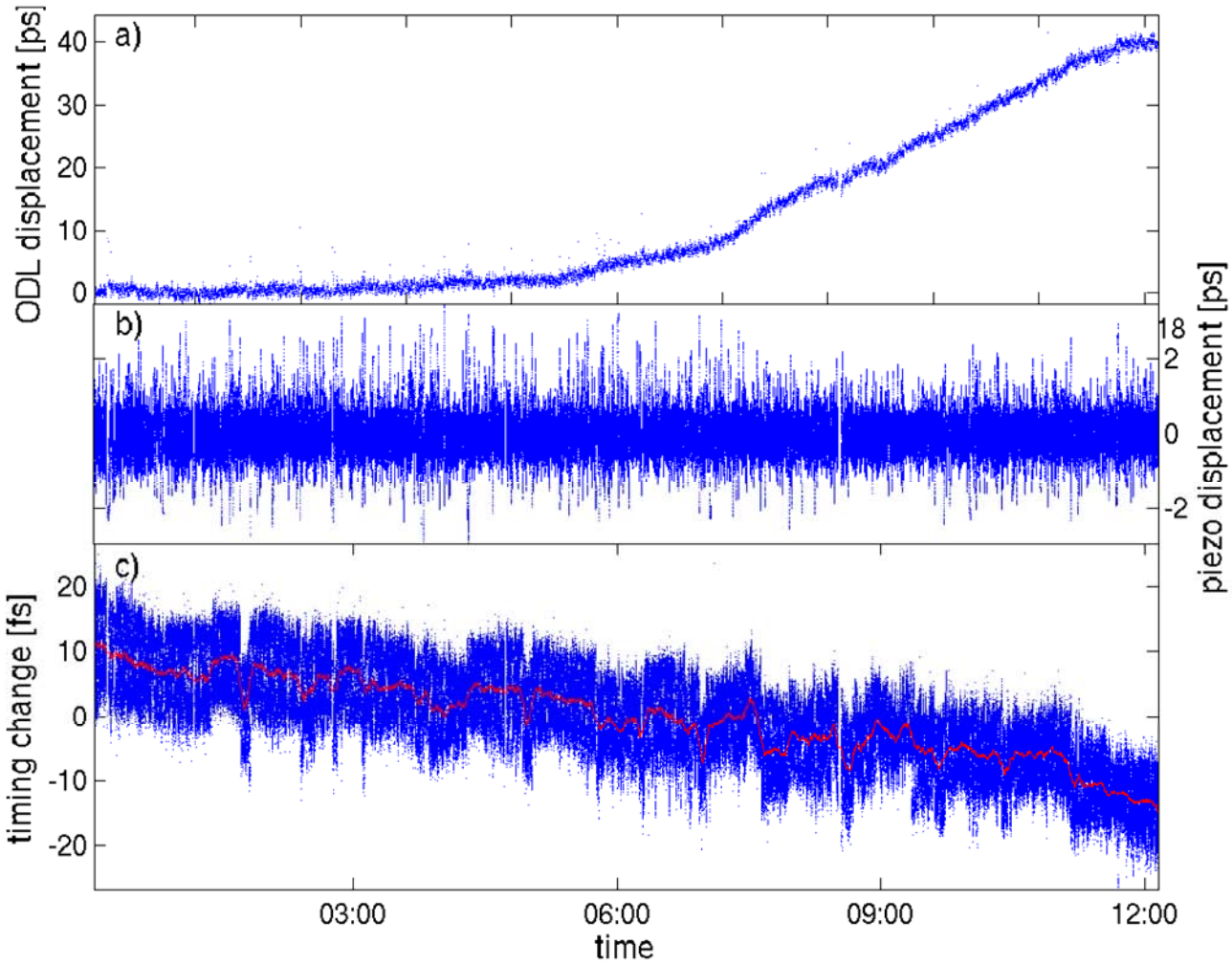


Frequency distribution of fiber-link timing changes

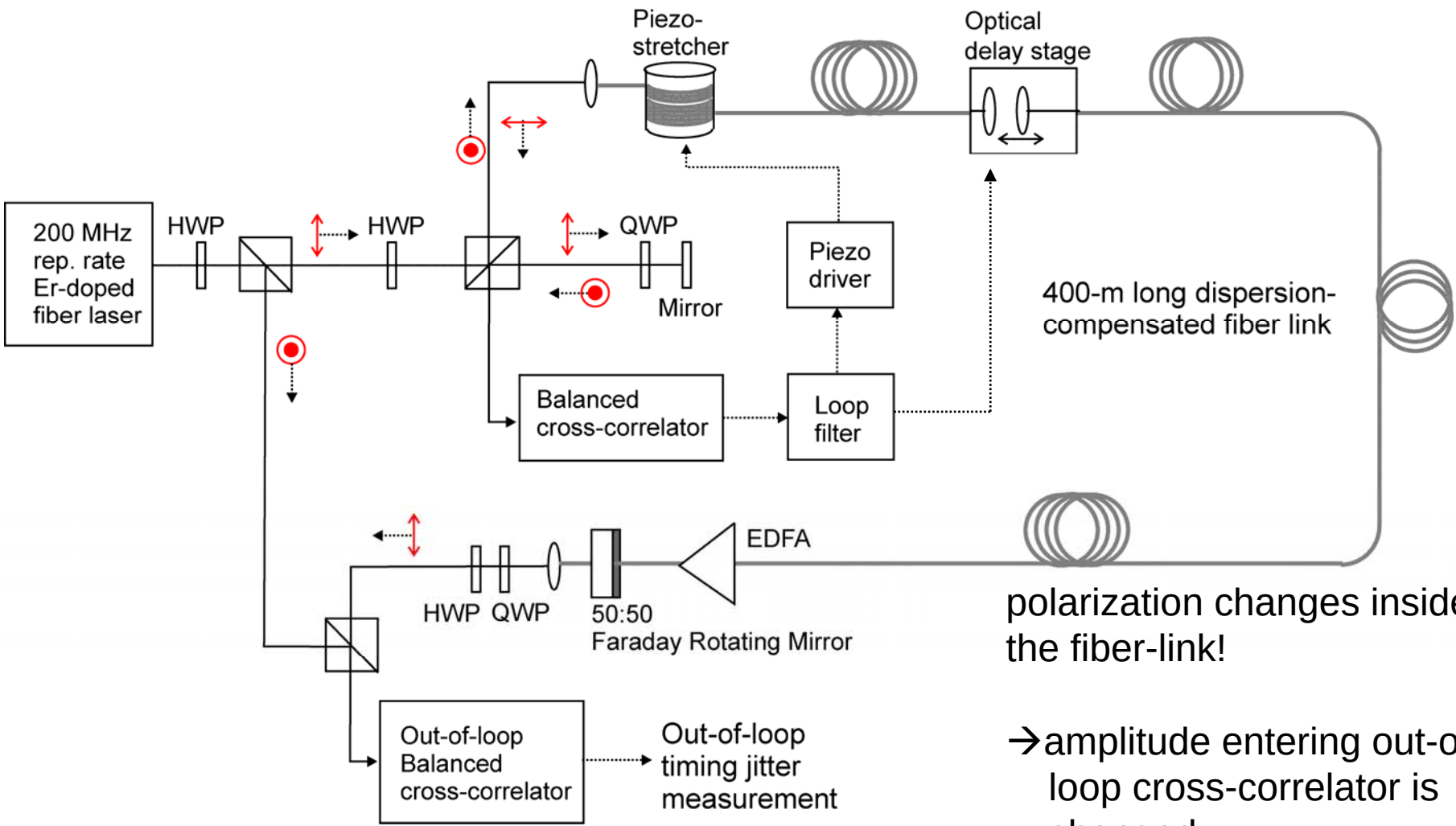


Long-term fiber-link stability



rms timing jitter over 2 minutes: (4.4 ± 1.1) fs
timing drift over 12 hours: 25 fs
measurement bandwidth: 200 kHz

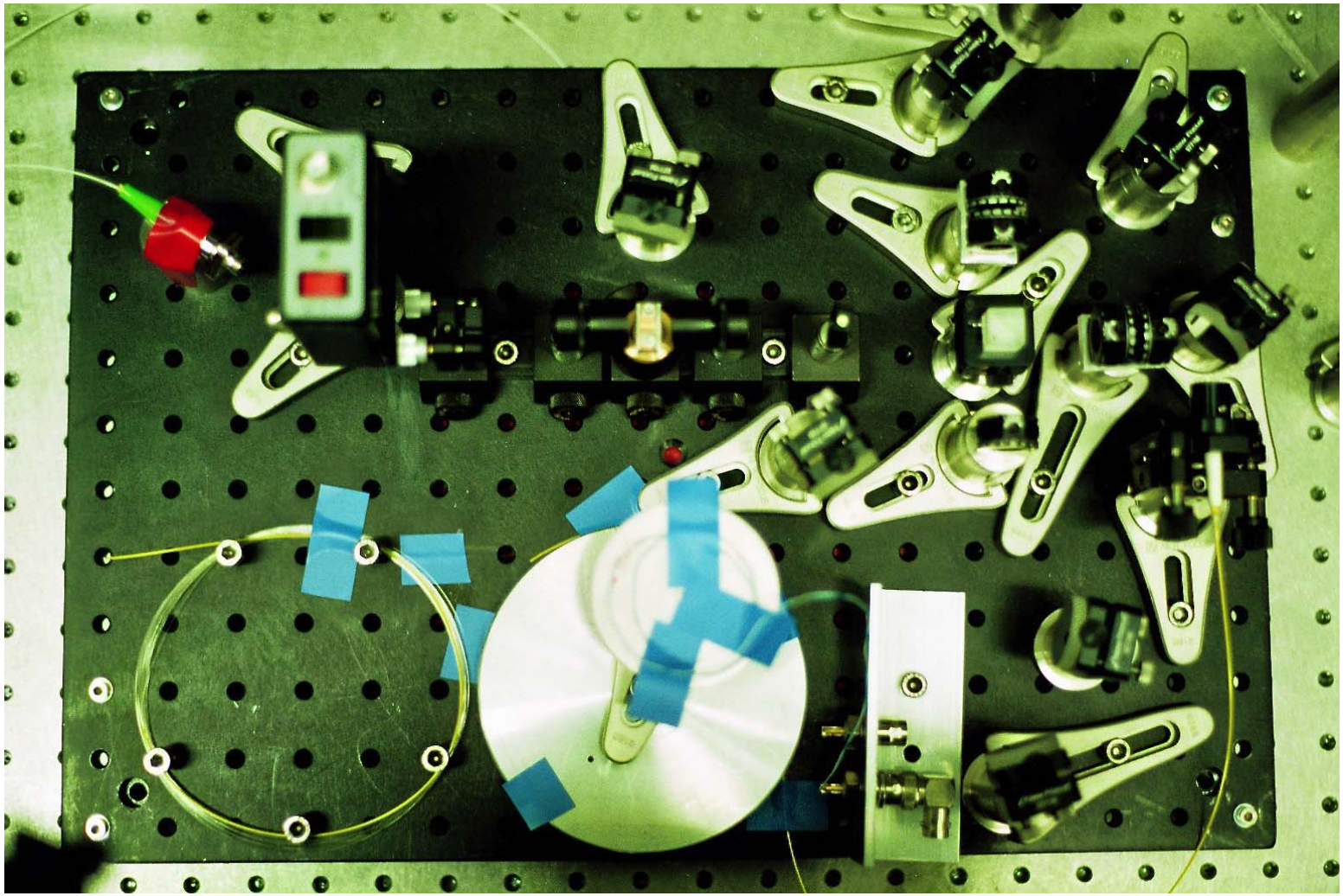
Timing drift a measurement artefact?



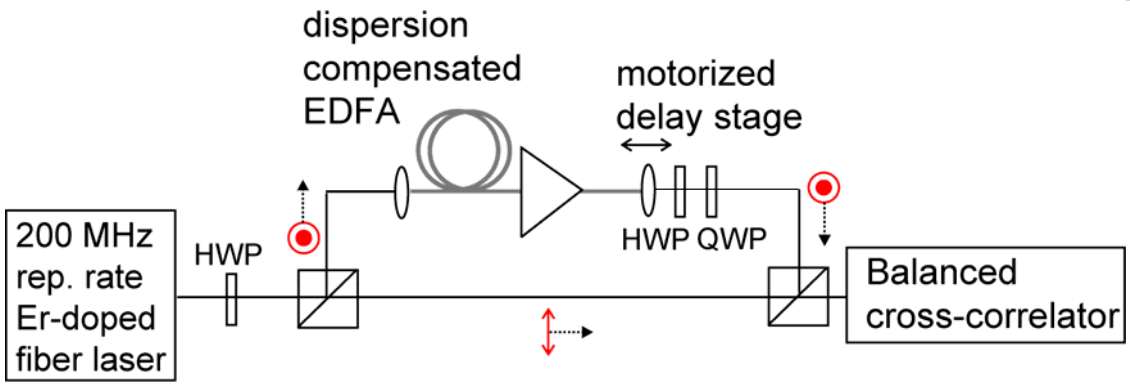
polarization changes inside the fiber-link!

→amplitude entering out-of-loop cross-correlator is changed

Fiber-link setup



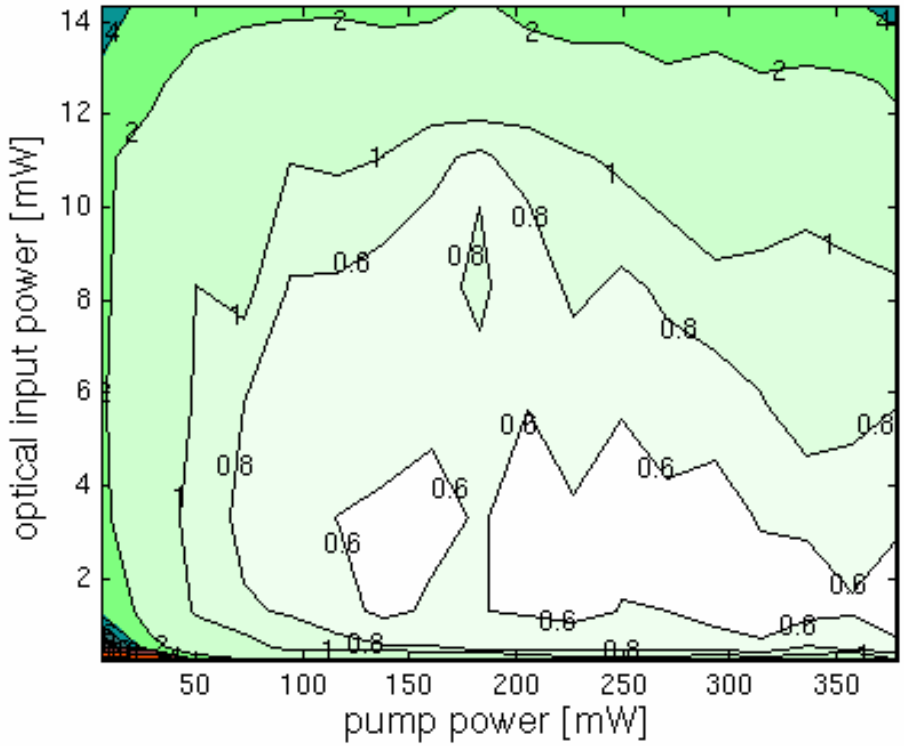
Timing jitter added by erbium-doped fiber amplifiers



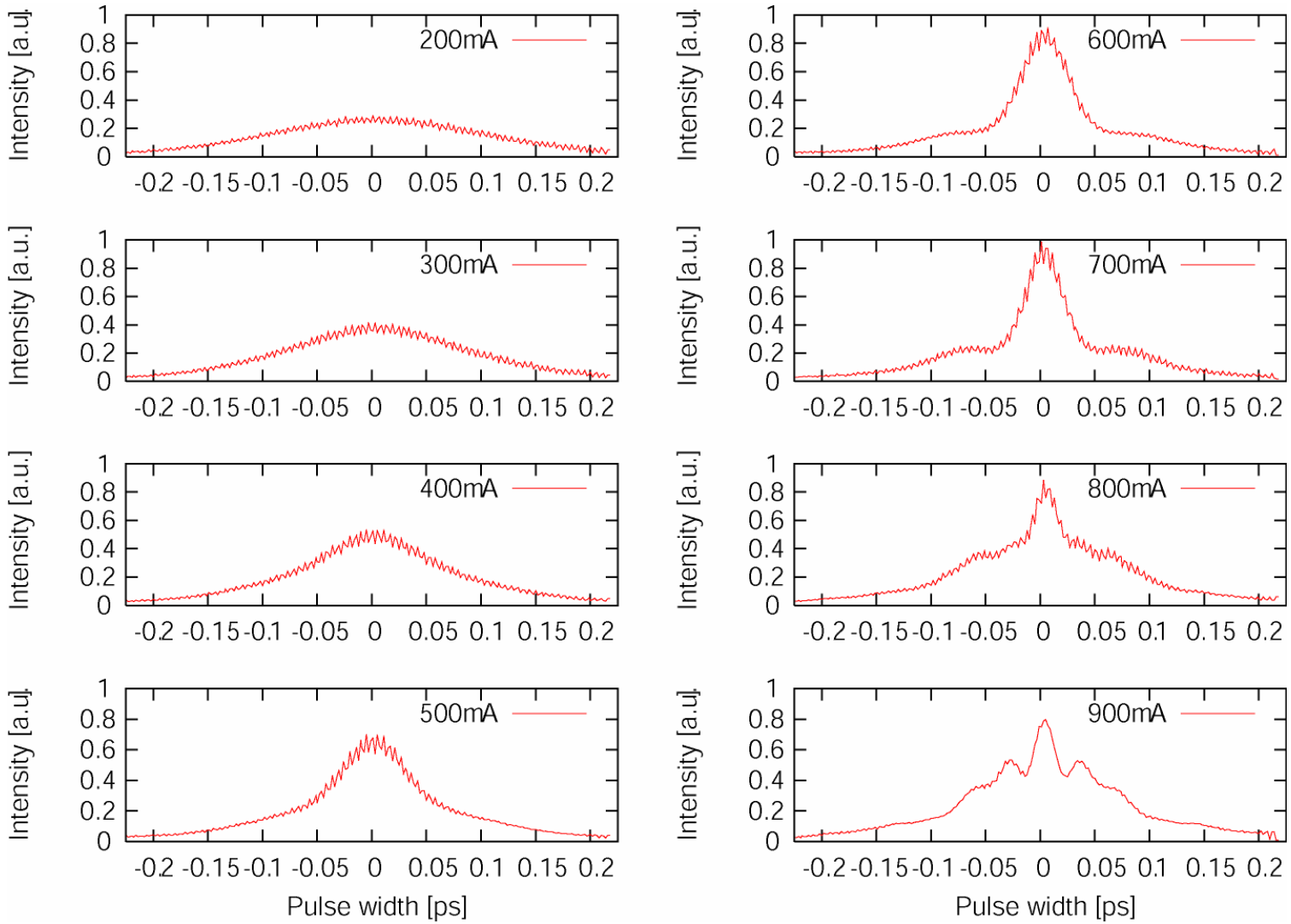
The balanced cross-correlator can be used to measure the timing jitter added by an EDFA with sub-fs resolution.

Added timing jitter in femtoseconds (500 Hz – 4.5 MHz)

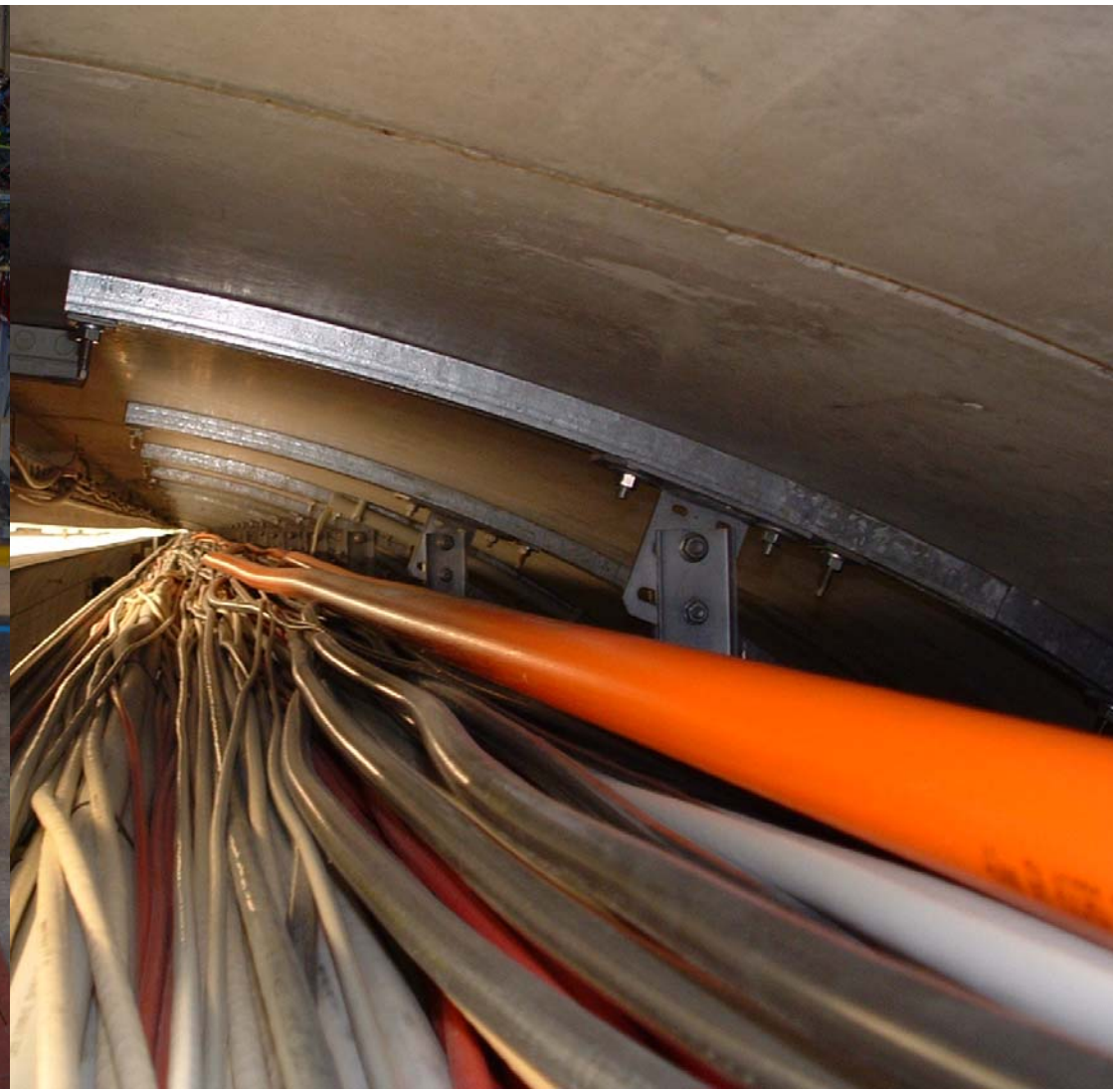
An optimized EDFA adds less than 500 as!



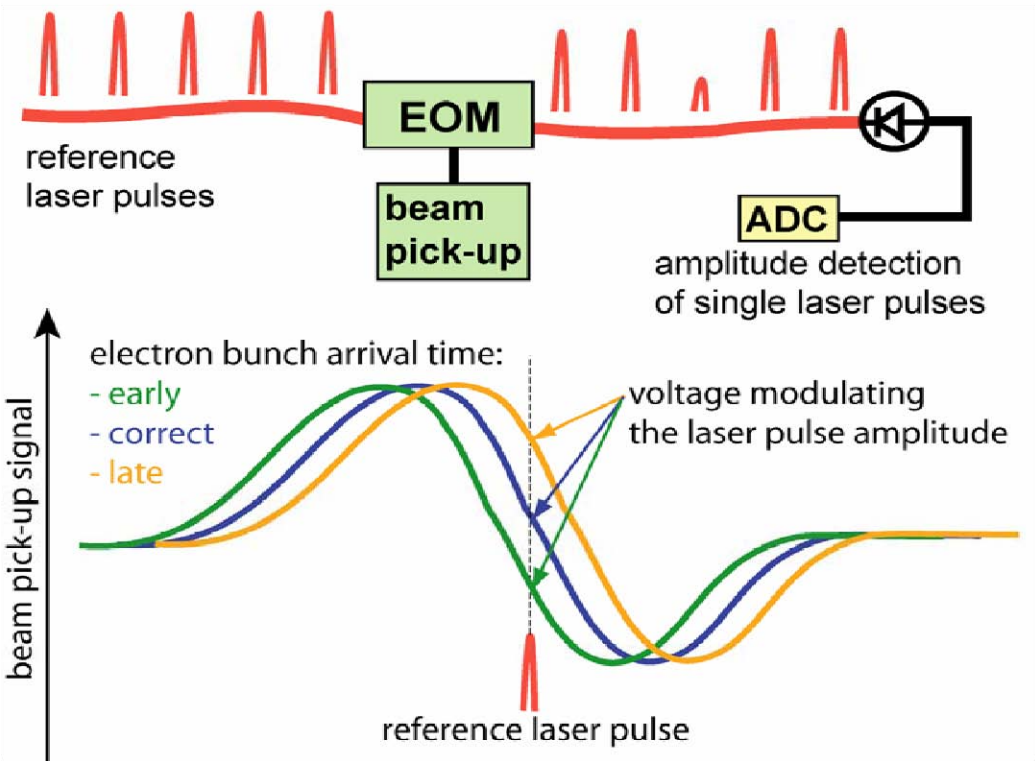
Auto-correlation of amplified laser pulses for different pump powers

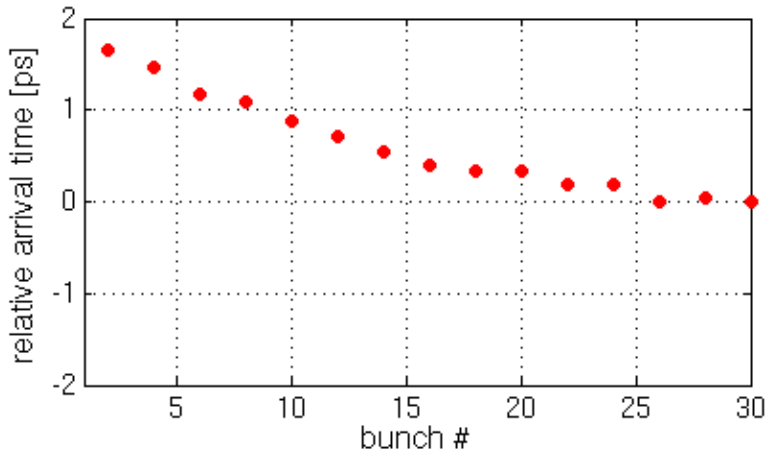


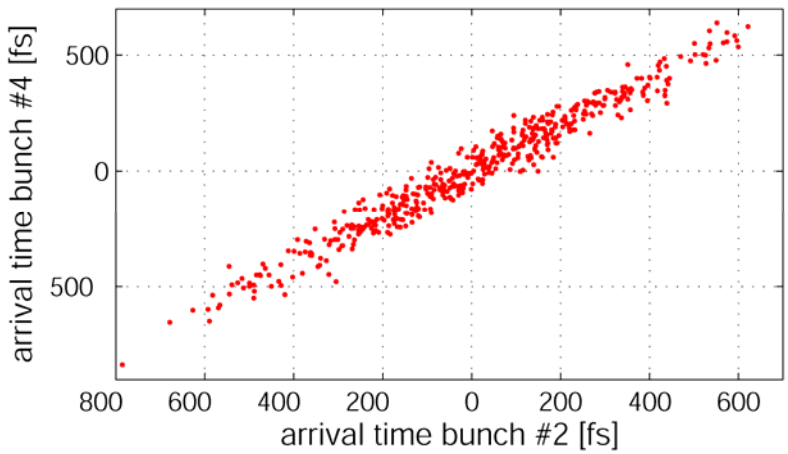
Installation of fiber-links in the FLASH linac



Bunch arrival time monitor (BAM)

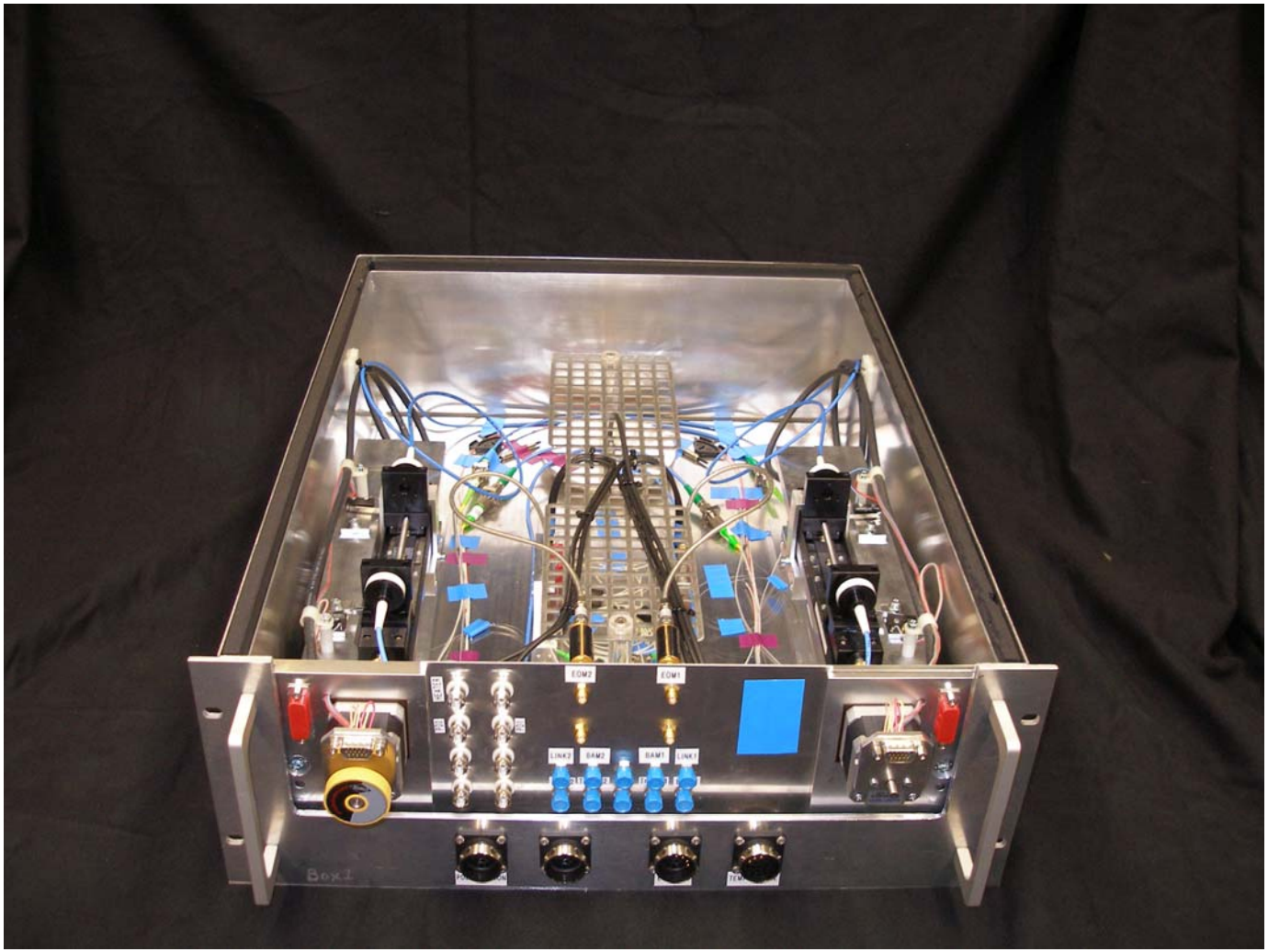






Single bunch resolution better than 30 fs.

BAM



BAM

BO-PEEP
BRAND
2" 8s
CAUTION EXPLOSIVE
BAM-PII-0157
KLASSE II
KNALLKÖRPER PYRO CRACKER 440
Gegenstand auf den Boden legen, am äußersten Ende der Zündschnur anzünden und sich rasch entfernen. Nach dem Anzünden nicht in der Hand halten! Nur im Freien verwenden!
Abgabe an Personen unter 18 Jahren verboten!
Abgabe nur in ungeöffneter Originalpackung erlaubt!
Import: JECO 27502 Brhv. Tel.0471/393-0 Hersteller: YLH
Herstellungsstätte: KWANGCHOW/VR CHINA
Bruttogewicht : 40 g
112
www.Feuerwerk-Fanpage.de
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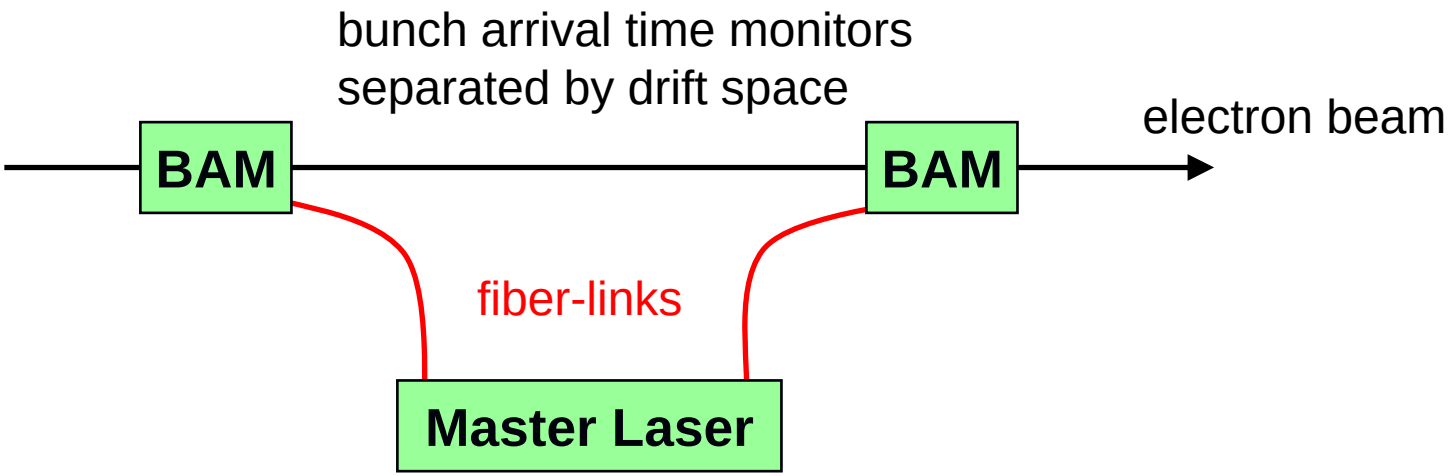
Outlook

First benchmarking of the system in the FLASH linac is planned for autumn this year:



The two BAMs measure the same arrival time changes within the resolution of the BAMs and the link stability.