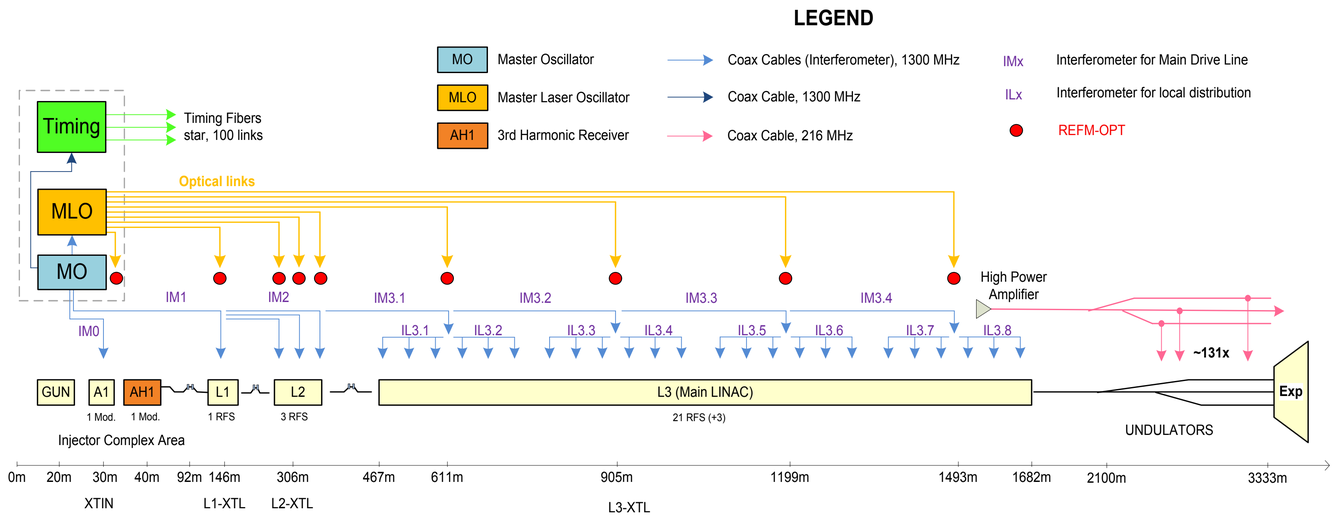
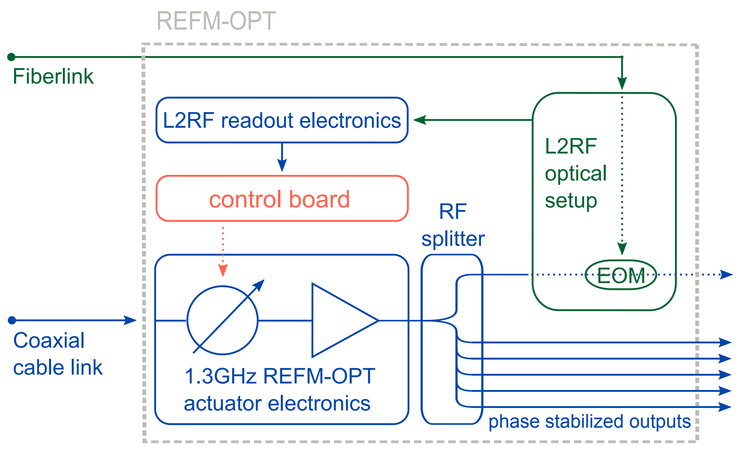
OPTICAL REFERENCE MODULE FOR FLASH AND THE EUROPEAN XFEL.

MTCA.4 BASED LASER SYNCHRONIZATION.

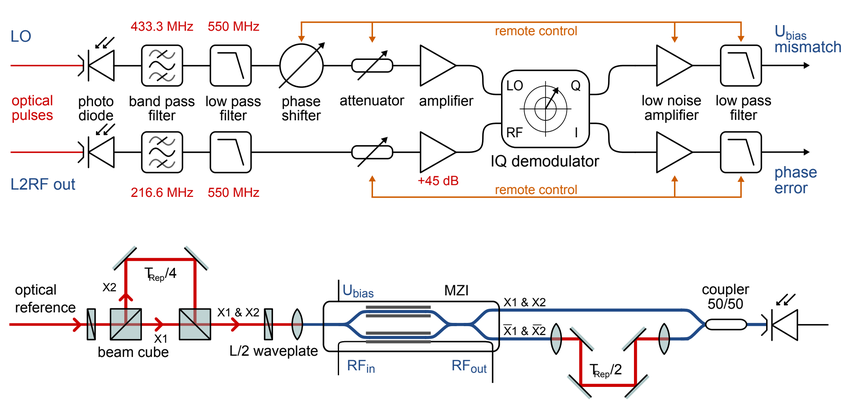
REFM-OPT: optical reference module

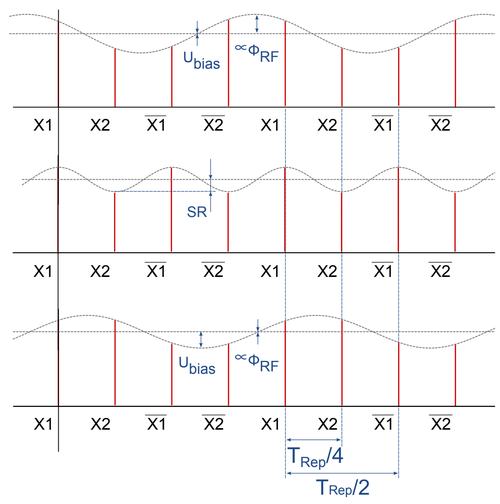
For the European XFEL, the optical synchronization system has become an invaluable support for the 1.3 GHz coaxial cable based timing distribution. High phase stability requirements have made the design of the RF-based reference system a challenging task. By using phase-stabilized fiber links it is possible to deliver highly stable optical signals to the locations of different LLRF stations without being affected by losses and drifts arising in RF cables over the huge distance of the main linac.
The REFM-OPT is an interface between the reference signal from the optical synchronization system and the RF system directly supplying the LLRF stations. It allows to resynchronize the RF reference at these locations to the laser reference on a femtosecond level.
The REFM-OPT comprises a number of electrical units supporting the L2RF phase detector, for which was shown till now unmatched stability of 3.6 fs peak-to-peak over 24 hours for a 1.3 GHz signal (see T. Lamb, et al., “Femtosecond stable laser-to-RF phase detection for optical synchronization systems”, Proceedings of IBIC2013, Oxford, UK, 2013,TUPC33).



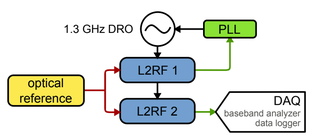


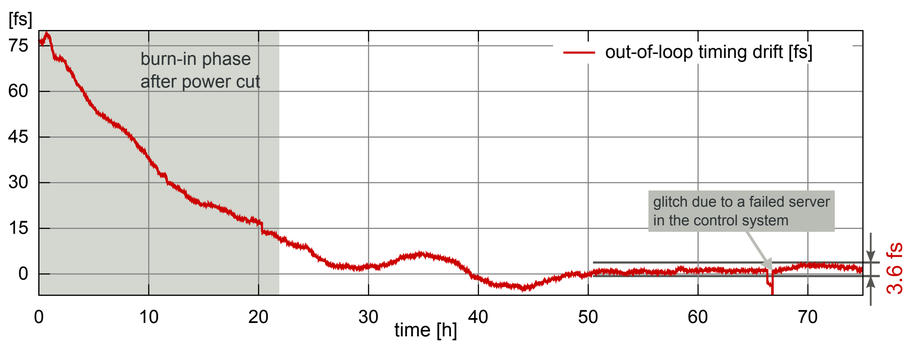
L2RF phase detector





Long-term drift measurement



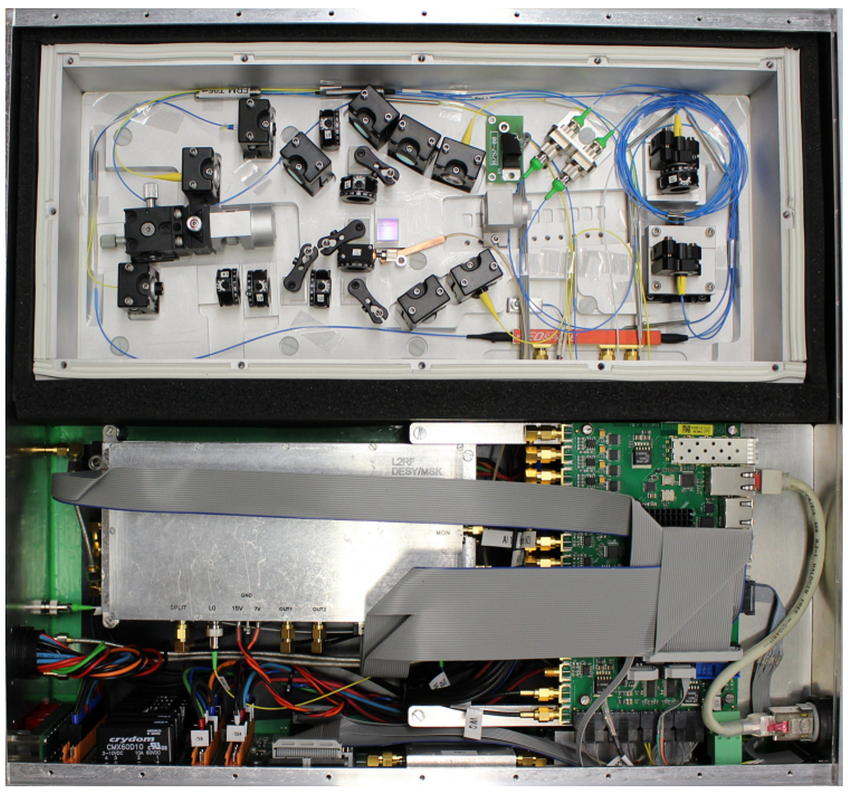


Laser synchronization

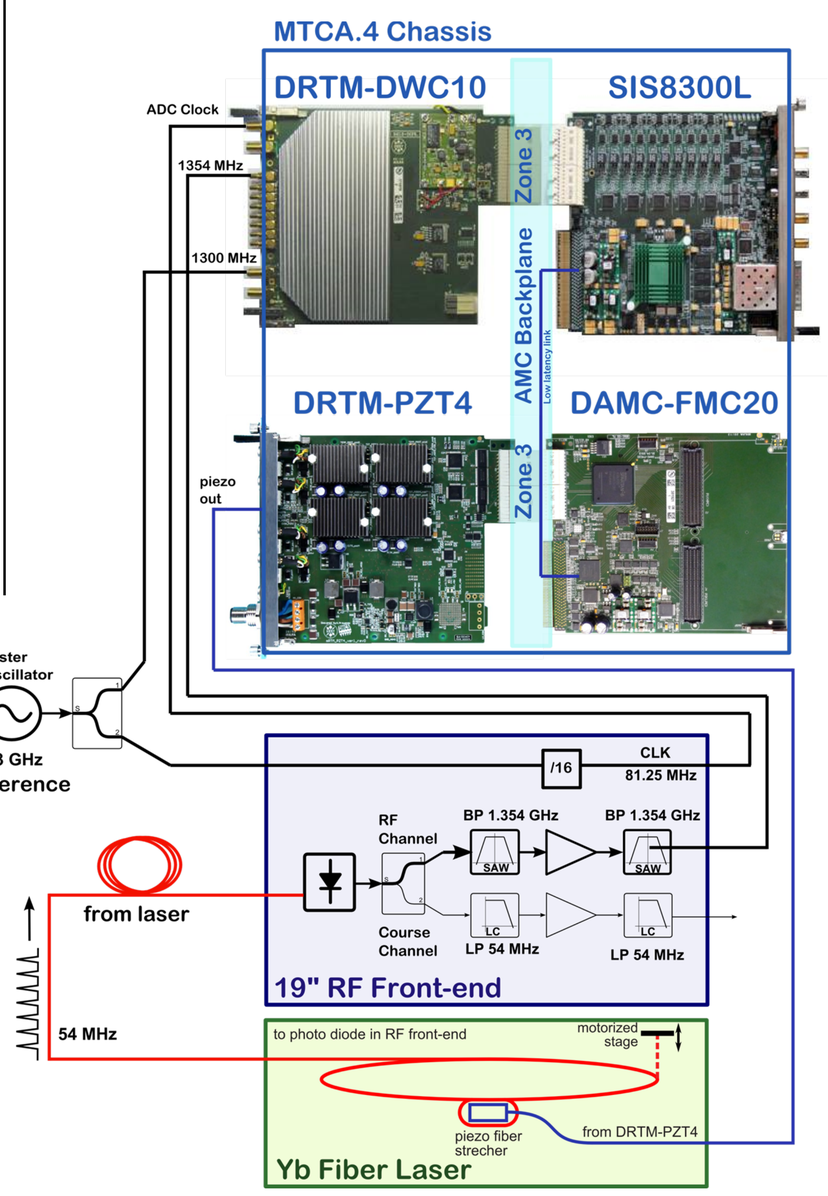
In accelerator facilities, especially free-electron lasers (FEL), the use of mode locked lasers is very common, e.g. as photo-cathode laser,for electro-optical diagnostics, seeding and pump-probe experiments. At DESY, we use an approach for laser synchronization based on MTCA.4 platform.

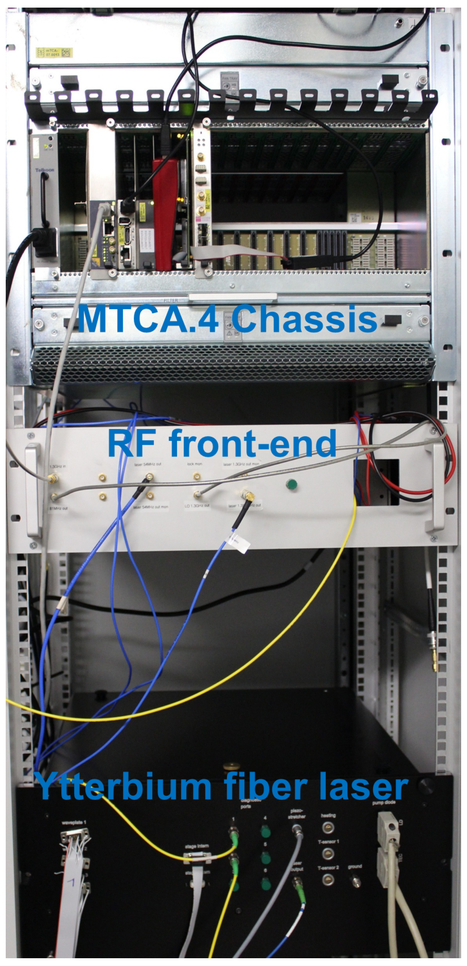
- laser pulses are converted to RF signals using a photo-diode detector
- an RF section performs filtering, amplification and down-conversion of a narrowband, CW signal
- the resulting IF signal is sampled by a high resolution digitizer on an AMC (Advanced Mezzanine Card)
- the digital controller output is transported via point-to-point links to an adjacent AMC board, on which the processing electronics drives a DAC on the rear side
- the analog signal is filtered and amplified by a high voltage power amplifier which drives the piezo stretcher in the laser

REFM-OPT realization for FLASH



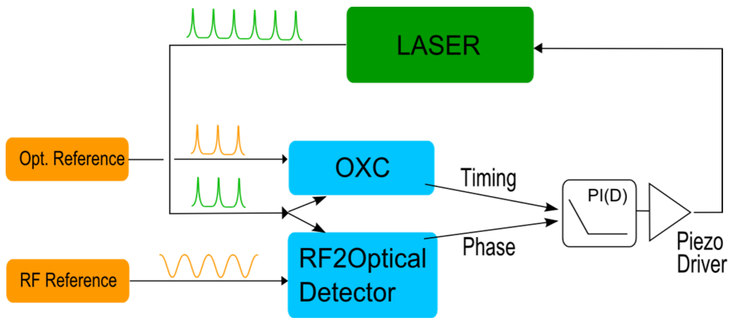
System components





Basic concept for laser synchronization

- PLL based, RF or optical reference
- different phase detection methods



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