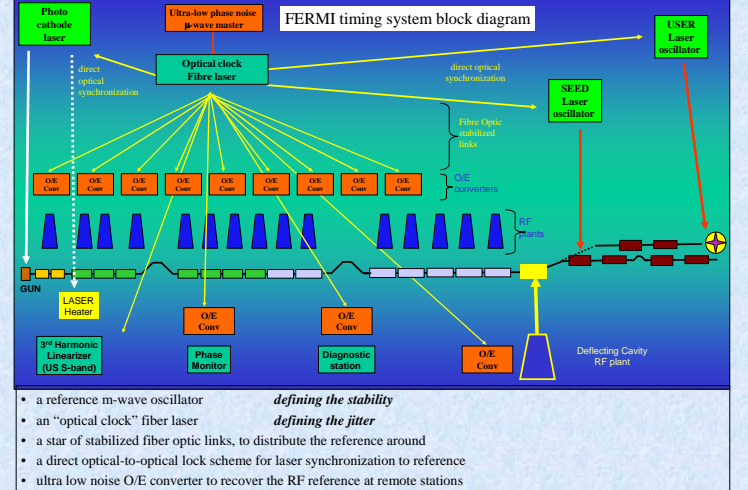
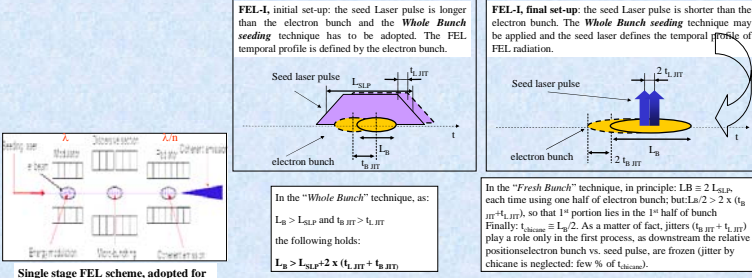


PRELIMINARY PHASE NOISE MEASUREMENTS ON THE PICOSOURCE FIBER LASER

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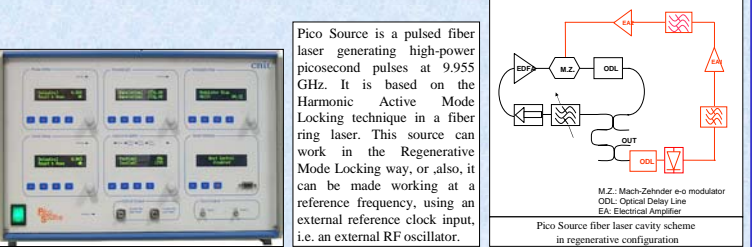
Abstract: Fermi is the fourth generation Light Source that is currently being designed at ELETRA. The timing system will play a crucial role in achieving the expected performance in Linac based FELs due to the sub-ps electron bunch length and to the expanded use of fs-lasers as key components in future light sources. Furthermore, the requirements of the timing system are also tightly linked to the applications of the generated ultra fast x-ray pulses. Optical timing systems currently seem to be the only technique to enable an RMS jitter at the 10fs level. A fundamental component of the system here analyzed is the optical reference oscillator. Therefore we are deepening our knowledge in this field. **PICOSOURCE** is a fiber laser, based on Active Mode Locking (AML), developed by CNIT (Consorzio Nazionale Interuniversitario per le Telecomunicazioni) in Pisa. The *PicoSource* can operate in two different work conditions: Regenerative ML, or Harmonic ML. Prior to start the collaboration with CNIT, we carried out a joint measurement session to investigate the PicoSource SSB Phase Noise, when operated in the Harmonic ML to a low phase noise RF oscillator (Rohde&Schwarz SML03). Using the Agilent E5052A Signal Source Analyzer we measured the RMS Timing Jitter of the PicoSource available at CNIT site. During this measurements an RMS timing jitter about 151.5fsec in the frequency range 100Hz-10MHz has been observed; by limiting the measurement bandwidth to the frequency range 10kHz-10MHz, the same value decreased to 73.6fsec. Within **EUROFEL DS3** design study, CNIT Pisa will develop an "ad hoc" fiber laser source: this source will work in regenerative mode at 3GHz. At ELETRA, an optical PLL will be developed to lower the PICOSOURCE phase Noise to the 10s fs level.

Fermi will generate coherent radiation either in a single harmonic cascade, FEL-I, or in a double cascade scheme, FEL-II, at different wavelengths ($\lambda_{FEL-I}=100-40\text{nm}$ and $\lambda_{FEL-II}=40-10\text{nm}$). Pulse durations are: Short Bunch=200fs, Long Bunch 800fs. Furthermore, both the *Whole Bunch* (WB) and *Fresh Bunch* (FB) seeding techniques have been adopted; to relax jitter requirements an initial set-up with longer laser / shorter bunch is foreseen.

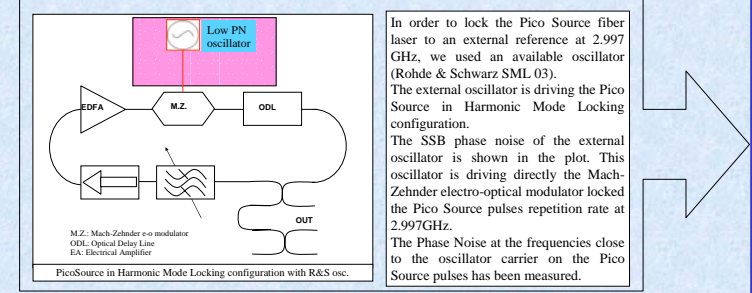


Pico Source fiber laser

The CNIT (Consorzio Nazionale Interuniversitario per le Telecomunicazioni) in Pisa, developed an ultra-fast pulses source. This source is called *Pico Source* and it can generate pulses with high repetition rate (10Gbit/sec) and short time-width (FWHM<4ps). In EUROFEL DS3 work group we start from this source to obtain an optical clock suitable to synchronize a X-FEL experiment. The timing-jitter has to be reduced compared to current measurable values, improving both the Phase Noise (PN) and the pulses high repetition rate stability.

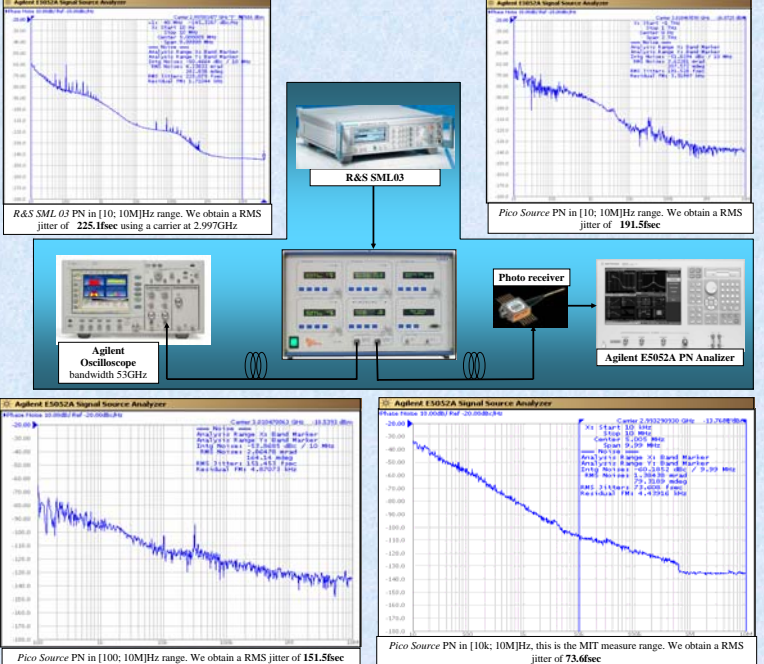


Measurement Setup

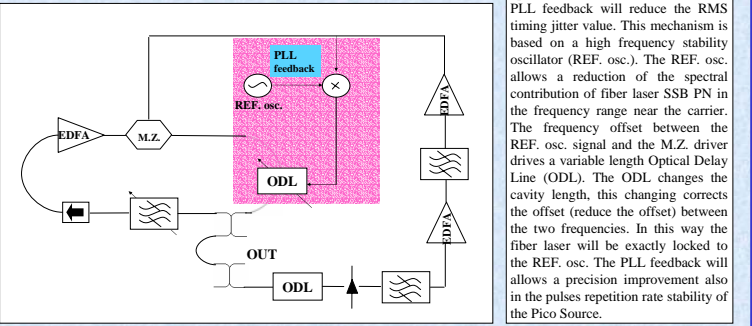


Phase noise measurement results

Using Agilent E5052A PN analyzer, we measured the SSB PN and the relative RMS timing-jitter when the Pico Source works in regenerative condition, and when it is locked with a R&S SML 03 as reference oscillator (harmonic condition). With the Agilent oscilloscope we monitored the shape of the PicoSource pulses to control the PicoSource locking.



Future upgrade



We observed the fluctuations of *Pico Source's* RMS Timing jitter in 5 min.

