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Fully synchronized high repetition rate Petawatt laser driver for betatron beamline on EuPRAXIA@SparcLab machine

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Precise synchronization plays a major role in the stability of an accelerator-based light source, or for ultrafast dynamics studies. We will present our strategy and recent achievements applied to synchronize a kHz Ti:Sa ultrafast laser to a Terawatt Yb ultrafast laser. We report on the synchronization at few fs rms level, both on short-term and long-term.
We first synchronize the slave oscillator (Yb) to the master oscillator (TiSa) using an optical cross-correlator. The fast actuator in the slave oscillator compensates for the fast and slow timing fluctuations, leading to 5fs rms relative timing jitter.
Additionally, we implement a second optical cross-correlator placed at the outputs of both amplifiers, measuring the relative jitter and drift between the 2 amplification. A motorized fibered optical delay line is used to compensate for the slow drift between both amplifiers, with a long-term stability of 16fs rms over 8 hours.
We will discuss on the limitations and improvement perspectives of such solution, and identify how this technique can be applied to a high repetition rate Petawatt laser driver of the betatron beamline installed on Eupraxia@SparcLab machine.

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