A tender X-ray delay line for high repetition rate FEL

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High rep-rate hard X-ray Free Electron Lasers (FEL) such as European XFEL and Linac Coherent Light Source upgrade (LCLS-II) enables a broad range of high-resolution, coherent pump/probe experiments over a large photon energy range, from 0.2 to 5 keV. FEL X-ray pump and X-ray probe techniques, as proposed by LCLS Tender X-ray Instrument (TXI), offers unique capability for nonlinear & multi-dimensional X-ray spectroscopy. An ultrafast kicker is used to separate electron bunches spaced tens of nanoseconds apart after exiting the superconducting LINAC. One bunch would go to the Soft X-ray (SXR) undulator and the other to the Hard X-ray (HXR) undulator. The SXR and HXR FELs will be used to do X-ray pump/X-ray probe experiments. A tender X-ray FEL delay line is necessary to compensate 10.8 or 5.4 ns delay time to synchronize the HXR and SXR brunches. The photon energy of tender X-ray FEL delay-line is between 2 and 5 keV. The average FEL X-ray power supported by the delay-line is 20 W. The exact delay time can vary ± 1 ns. A 10 ps scan range is needed with an accuracy of ± 2.5 fs. In this paper we propose a delay-line design using 4 or 6 silicon single crystals. We will discuss the cooling of the silicon crystals, the crystal motion trajectories, and design layouts with motion stages, alignment method.