Options for HXR & SXR X-ray Beam Interaction

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LCLS-II will have two separate FEL undulators (HXU and SXU) for the simultaneous production of hard x-rays (1-5 keV) and soft x-rays (0.2-1.3 keV) when fed by the 4-GeV, 1-MHz superconducting linac (SC-linac). As a second option, the HXR FEL can be fed with the 15-GeV, 120-Hz copper linac (Cu-linac) as well (1-25 keV). In addition, it may be useful to provide for the interaction of these two separate x-ray beams in each of these operating modes. Synchronization and beam transport are the issues in each case, with a concept described in the following, including order-of-magnitude cost bracket.

SC-linac Feeds Both HXR & SXR

The case where both electron beams are generated in one linac (the SC-linac) is the most challenging. The two bunches might be produced within one gun-bucket timing separation (1/186 MHz ≈ 5.4 ns) and a 5.4-ns crystal-based x-ray delay used to achieve temporal overlap. This x-ray transport and delay system (as sketched in **Fig. 1**, where the HXR beam is transported to the SXR-line) will generate some x-ray power loss which can be minimized in self-seeded mode. The existing kicker design in the beam spreader system can only comfortably switch beams within a 1-μs spacing, so a new, much faster kicker with <5 ns response would be needed, or an RF deflector system. Note also that the diagnostic systems (*e.g.*, BPMs) are not being designed to measure such closely spaced bunches. If this capability is not designed-in from the start, a substantial amount of diagnostics hardware may need to be replaced. The very fast timing control needed for the bunch-to-bunch deflection, and the diagnostics upgrade will be high-cost modifications with a rough total estimate at 25M$, including the transport and delay system of **Fig. 1**.

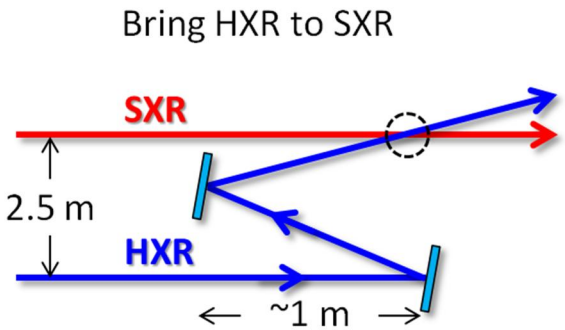

Figure 1. Crystals are used to transport and delay (5.4 ns) the HXR beam over to the SXR line.

SC-linac Feeds SXR & Cu-Linac Feeds HXR

The case where one electron beam is generated in the SC-linac and the second bunch in the Cu-linac is simpler, but only crosses the beams at the low Cu-linac bunch rate of 120 Hz. The Cu-linac timing can be

adjusted, with respect to the SC-linac, so that the two pulses overlap in time, and the mirror-based transport system shown in **Figure 2** can be used for spatial overlap. This scheme might also work with a reversed configuration, where the Cu-linac feeds the SXR FEL and the SC-linac feeds the HXR FEL. The transport and delay system of **Fig. 2** (or possibly using that of **Fig. 1** instead) will be a medium-cost modification with an estimate at 5M$ per transport system (**Fig. 1** or **Fig. 2**).

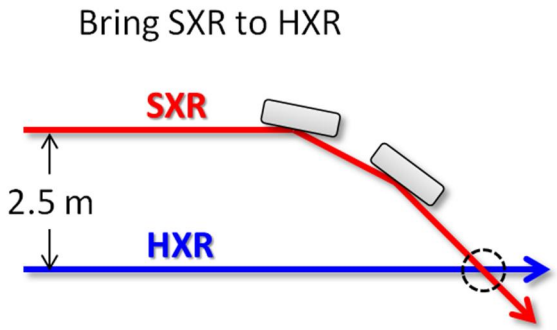

Figure 2. Mirrors are used to transport the SXR beam to the HXR line.