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<th>X-Ray Transport and Diagnostics</th>
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**Physics Requirements for the LCLS X-Ray Transport and Diagnostics**

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**Brief Summary:** This document presents the physics requirements for the portion of the LCLS described by WBS section 1.05, the X-Ray Transport and Diagnostics.

**Keywords:** X-ray optics, x-ray diagnostics, x-ray transport

**Key WBS##'s:** 1.05
Physics Requirements for the LCLS X-Ray Transport and Diagnostics

Introduction
The X-Ray Transport and Diagnostics section (XTD) begins in the electron dump area, at the point where the electron and photon beamlines diverge. It includes the x-ray beamline from this point all the way to the end of the Far Experimental Hall. Key elements include the x-ray beam containment vacuum chamber, x-ray optics such as slits, attenuators, mirrors, and monochromators, and a suite of x-ray diagnostics.

Beam transport requirements
The vacuum flight path must be sized to exclude the possibility of being struck by the x-ray beam. The average pressure throughout the system should be less than $10^{-5}$ T. In addition, the pressure at the ion pumps must be low enough to ensure long pump life (>10 years). Vacuum components that are highly susceptible to radiation damage, such as elastomer o-rings, are discouraged. In general, SLAC standard procedures for cleaning and handling of UHV components must be followed.

X-ray optics requirements

X-ray attenuators: the system of attenuators must be able to reduce the FEL beam intensity by up to 4 orders of magnitude at any energy within the design range. The attenuator system must provide stable, reproducible (to within 1%) attenuation for repeated FEL shots.

X-ray slits: the slits are not expected to be placed in the FEL beam, but should survive occasional FEL beam hits. The slit adjustment range should extend to 8 times the rms beam size for the lowest FEL design energy. Adjustment precision of 1 µm is required.

Order-sorting mirrors: these mirrors are intended to reduce contamination from the 3rd FEL harmonic. The mirror system should have adjustable cutoff energy, and should be able to reduce 3rd harmonic contamination to less than $10^{-5}$ of the transmitted FEL beam intensity, throughout the FEL design range.

Beam-directing mirrors: these mirrors will direct the FEL beam into the side stations in the FEH. Each mirror system should have a transmission of >80% between 800 eV and 18000 eV. A maximum of 3 reflections should be used in a mirror system. The mechanical stability must be such that scattered beam position jitter is less than 10% of the beam size.

X-ray monochromator: the crystal monochromator should have a useable range of 2 keV to 25 keV, with a resolution of better than $10^4$. The grating monochromator should have a useable range of 500 eV to >2000 eV, with a resolution of better than $10^3$. The monochromators must not be damaged by the FEL beam in the FEH.

X-ray pulse split/delay: the pulse split/delay system should provide a time delay range of 0-200 ps, with a resolution of 50 fs. Operation at 8 keV and 18 keV are desired.

Controls: all control systems must be EPICS compatible. EPICS-based systems are preferred.
**X-ray diagnostics requirements**

A complete set of diagnostic devices will be provided, for characterization of the x-ray beam. Measurement requirements are:

- Position of centroid    5% of the beam size
- Transverse dimensions  10% of beam size
- Divergence              10% of the beam divergence
- Photon energy          0.02% of the beam energy
- Photon energy spread   20% of the energy spread