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Ultra-high-resolution monochromators for XFEL applications at LCLS-II-HE: a 4f Optical approach with channel-cut crystals

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Traditional synchrotron monochromators cannot handle the extreme thermal loads and stability demands of XFELs, especially for seeded X-rays. To overcome this, LCLS-II-HE has developed a multi-stage monochromator system integrating two double channel-cut (DCCMs) and two consecutive channel-cut monochromators (CCMs) in a 4f optical configuration. This ensures precise beam collimation, spectral filtering, and wavefront preservation while achieving ultra-high energy resolution. Asymmetrically cut silicon crystals distribute thermal loads over a larger beam footprint, reducing distortions and enhancing stability—critical for RIXS experiments probing low-energy excitations in quantum materials. The 4f alignment minimizes spectral drift and enhances reproducibility, ensuring the sensitivity needed for resolving subtle electronic and phononic interactions. This presentation details the design, implementation, and impact of this system, providing a scalable solution for next-generation RIXS studies at LCLS.

Footnotes

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