Reflection self-seeding at SACLA

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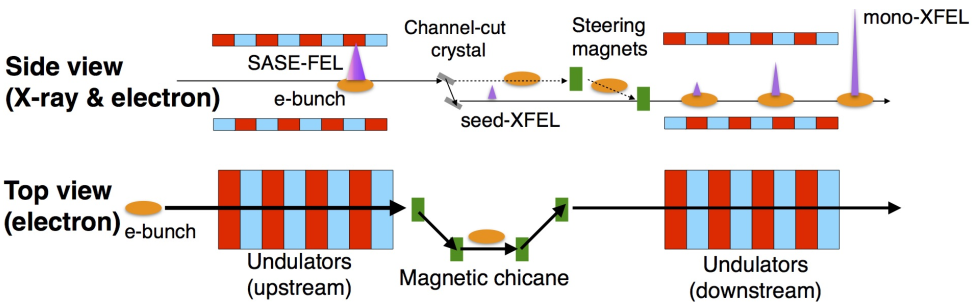
Current X-ray free-electron lasers are operated mostly based on the self-amplified spontaneous emission (SASE) scheme. In the SASE process, spontaneous radiation originating from density modulations in the electron beam is exponentially amplified along periodic magnetic fields in undulators. Although the SASE scheme is effective to produce intense X-ray beams, the stochastic starting-up processes cause poor temporal coherence and a broad spectrum.

To overcome these problems, a self-seeding scheme using a diamond crystal was proposed [1] and demonstrated at LCLS [2] and SACLA [3]. In this scheme, the thin diamond crystal is placed in the middle of the undulators. The SASE radiation from the upstream undulator is monochromatized with the crystal in the Bragg forward diffraction geometry, which produces delayed X-ray beam with a narrow bandwidth. By achieving the spatio-temporal overlap between the monochromatized X-ray beam and the electron bunch in the downstream undulator section, one can increase the intensity of the monochromatic component, though we could not achieve stable operation at SACLA, possibly due to an insufficient signal to noise ratio for the seeding intensity.

As an alternative approach, we are developing a self-seeding scheme using a silicon channel-cut crystal monochromator with a gap of a few hundreds of micrometers in the reflection geometry (Fig.1). The X-ray beam coming to the downstream undulators is purely monochromatic in this case. Thus, one could produce brilliant X-ray beam with a narrow bandwidth by amplifying the seed pulse in the downstream undulator section,

In this presentation, I will talk about the concept of the reflection self-seeding and technical details. Also, I will report on the first commissioning result of the reflection self-seeding at SACLA.



Schematic illustration of the reflection self-seeding at SACLA.

References

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