

The LCLS-II and the CW X-ray Free Electron Laser: Advancing Operational SRF Technology

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The LCLS-II X-ray Free Electron Laser (FEL) is CW X-ray FEL that will cover the spectral range from 250 eV through 20 keV with MHz rates. The FEL is being constructed in two parts: the first portion (LCLS-II) will use with a 4 GeV SRF linac to cover the soft and tender X-ray regimes from 250 eV to 5 keV and then an upgrade (LCLS-II-HE) will expand the linac energy to 8 GeV and increase the X-ray spectral range to 20 keV using a novel SRF gun to further increase the beam brightness. The LCLS-II SRF linac will be able to accelerate 30 microamps and generate up to 250 kW of electron beam which will have the potential to generate kW-scale X-ray powers. The SRF linac is based on 1.3 GHz 9-cell SRF cavities similar to those for the EuXFEL in Hamburg or the International Linear Collider however the LCLS-II cavities will operate CW at gradients between 16 and 21 MV/m and have Q_0 s of roughly 3×10^{10} . The very high Q_0 is achieved using tuned N₂ doping techniques, careful magnetic field control, and a 'fast' cool-down technique that reduces the remnant magnetic field. The linac will be cooled to cryogenic temperatures with two new 4kW 2K liquid helium cryoplants. Finally, to have flexible control over the spectral range, the facility will use two variable gap undulator systems, one optimised for hard X-rays and one for soft X-rays. The talk will describe the basics of a Free Electron Laser and the LCLS-II and LCLS-II-HE designs as well as the technological innovations pioneered by the facility. It will also describe recent commissioning results from the two new undulator systems and the LCLS-II SRF linac.

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