Power Meters and Fluorescence Intensity Monitors as Intensity Diagnostics for X-ray Free Electron Lasers

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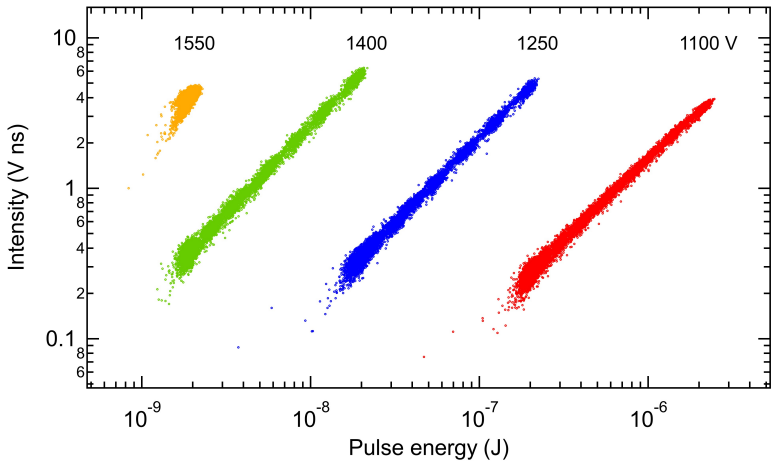
For the LCLS-II X-ray instruments, we have developed laser power meters as compact X-ray power diagnostics to operate at soft and tender X-ray photon energies. [1] We have evaluated thermopile power meters, which measure average power, and have been chosen primarily for their compatibility with the high repetition rates at LCLS-II. A number of characteristics in the soft x-ray range are presented including the linearity, calibrations conducted with a photodiode and a gas monitor detector as well as ultra-high vacuum compatibility tests. These diagnostics can be installed at various locations along an X-ray FEL beamline in order to monitor the transmission of X-ray optics, and can be used to determine the absolute X-ray power at the endstations.

In addition for LCLS-II, we have developed a fluorescence intensity monitor for the non-invasive, pulse-by-pulse normalization of experiments. A prototype diagnostic was constructed with a microchannel plate assembly and two photodiodes. The diagnostic was then installed in the LCLS SXR instrument vertical Kirkpatrick Baez mirror chamber with the detectors located above the mirror surface. The linearity, dynamic range and noise of the detectors have been characterized. The figure shows the linear response of the microchannel plate detector over a wide range of pulse energies. Here, a positive bias was used and both X-rays and electrons detected. The fluorescence intensity monitor provides intensity normalization while being compatible with high incident power, 1 MHz repetition rate and ultra-high vacuum.



The responsivity of the MCP detector compared with the LCLS upstream gas detector. The anode voltage was varied from 1100 to 1550 V.

References

[1] P. Heimann *et al.*, J Synchrotron Radiat **25**, 72 (2018).