Evaluation of Laser Stabilization and Imaging Systems for LCLS-II*

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By combining the top performing commercial laser beam stabilization system with the most ideal optical imaging configuration, the beamline for the Linear Accelerator Coherent Light Source II (LCLS-II) will deliver the highest quality and most stable beam to the cathode. To determine the optimal combination, LCLS-II beamline conditions were replicated and the systems tested with a He-Ne laser. The Guidestar-II and MRC active laser beam stabilization systems were evaluated for their ideal positioning and stability. Both a two and four lens optical imaging configuration was then evaluated for beam imaging quality, magnification properties, and natural stability. In their best performances when tested over fifteen hours, Guidestar-II kept the beam stable over ~ 70-110um while the MRC system kept it stable over ~ 90-100um. During short periods of time, Guidestar-II kept the beam stable between 10-20um, but was more susceptible to drift over time, while the MRC system maintained the beam between 30-50um with less overall drift. The best optical imaging configuration proved to be a four lens system that images to the iris located in the cathode room and from there, imaged to the cathode. The magnification from the iris to the cathode was 2:1, within an acceptable tolerance to the expected 2.1:1 magnification. The two lens configuration was slightly more stable in small periods of time (<10 minutes) without the assistance of a stability system, ~ 55um compared to ~ 70um, but the four lens configuration's beam image had a significantly flatter intensity distribution compared to the two lens configuration which had a Gaussian distribution. A final test still needs to be run with both stability systems running at the same time through the four lens system. With this data, the optimal laser beam stabilization system can be determined for the beamline of LCLS-II.

* General Audience Abstract

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