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Transverse Momentum Measuring Systems: The Cryogenic Momentatron and TESS

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The performance of photocathodes is essential for the operation of X-ray Free Electron Laser (FEL) facilities, such as the LCLS-II and the UK XFEL currently under development. This is because the initial phase-space distribution of electrons emitted by the photocathode directly impacts the final phase-space distribution at the undulator, which in turn determines the amount of radiation produced. Key performance metrics, including photocathode quantum efficiency (QE) and intrinsic emittance, are monitored to optimize facility performance. Several factors can influence these metrics, such as the photocathode material, operating temperature, vacuum and RF environmental conditions, and the characteristics of laser illumination (e.g., wavelength, pulse energy, pulse duration, and repetition rate).

To better understand the effects that these factors have on photocathode performance, SLAC has developed a laboratory-based cryogenic momentatron system designed to measure the QE and intrinsic emittance of photocathodes across a temperature range of 30 K to 300 K, using wavelength-selectable light from 200 nm to 800 nm. The system's design and initial commissioning performance have been validated through simulations and error analysis, confirming its reliability for photocathode characterization. In this presentation, we present measurements taken at SLAC, along with complementary data for Cs-Te obtained using the TESS system at Daresbury Laboratory - a similar photocathode characterization tool. These results provide valuable insights into the photoemission process and highlight how this new type of diagnostic system can contribute to optimizing photocathode performance, ultimately enhancing X-ray FELs such as the LCLS-II.

Footnotes

Funding Agency

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Author: Dr ADHIKARI, Gowri (SLAC National Accelerator Laboratory)

Co-authors: SHAN, Ir-Jene (University of Illinois Chicago); Dr JONES, Lee (Science and Technology Facilities Council); VECCHIONE, Theodore (SLAC National Accelerator Laboratory); SCHROEDER, W. Andreas (University of Illinois Chicago); CHURN, Hugh (Science and Technology Facilities Council)

Presenter: Dr JONES, Lee (Science and Technology Facilities Council)

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