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Machine learning assisted control and data analysis for an MeV ultrafast electron diffraction beamline and photocathode laser system

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An MeV ultrafast electron diffraction (MUED) instrument system is a unique characterization technique used to study ultrafast processes in a variety of materials by a pump-probe method. This technology can be advanced further into a turnkey instrument by using data science and artificial intelligence (AI) mechanisms in conjunction with high-performance computing. This can facilitate automated operation, data acquisition, and real-time or near-real-time data processing with minimal intervention by a beamline scientist. Real-time optimization and virtual beamline diagnostics combined with deep learning can be applied to the MUED diffraction patterns to recover valuable information on subtle lattice variations that can lead to a greater understanding of a wide range of material systems. Additionally, understanding the laser beam that drives photocathode electron production helps to further optimize the system. A data-science-enabled MUED facility will open this technique to a wider user base and provide a state-of-the-art instrument. Updates on research and development efforts for the MUED instrument in the Accelerator Test Facility of Brookhaven National Laboratory are presented.

Footnotes

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North America

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