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Data analysis and control of an MeV ultrafast electron diffraction system and a photocathode laser and gun system using machine learning

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An MeV ultrafast electron diffraction (MUED) instrument system, such as is located at the Accelerator Test Facility (ATF) of Brookhaven National Laboratory, is a structural characterization technique suited to investigate dynamics in the ultrashort range in a variety of materials via a laser pump method. It is a unique characterization technique especially suitable for highly correlated materials. 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 processing. The AI-based system controls can provide real-time feedback on the electron beam or provide virtual diagnostics of the beam. 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. A data-science-enabled MUED facility will also facilitate the application of this technique, expand its user base, and provide a fully automated state-of-the-art instrument. Another beamline enhancement planned is the extension of the beamline sample area to include additional instrumentation for simultaneous measurement of a standard baseline sample. EM modeling of the beamline components facilitates this. Updates on research and development for the MUED instrument are presented.

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Footnotes

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Yes

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