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FULFILLING THE MISSION OF BROOKHAVEN ATF AS A DOE'S FLAGSHIP USER FACILITY IN ACCELERATOR STEWARDSHIP

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Over last three decades, BNL Accelerator Test Facility (ATF) pioneered the concept of a proposal-based user facility for lasers and electron beam-driven advanced accelerator research (AAR). This has made ATF, operating as an Office of Science National User Facility and a flagship DOE facility in Accelerator R&D Stewardship, an internationally recognized destination for researchers who benefit from access to unique experimental capabilities not otherwise available to individual institutions and businesses. The high-peak-power long-wave infrared (LWIR) laser is a unique tool available at ATF for experimental study of wavelength scaling of strong-field phenomena and testing of laser driven acceleration regimes that are more difficult to achieve at shorter wavelengths. Other ATF capabilities include high-brightness electron linac and a facility for ultra-fast electron diffraction and microscopy experiments. ATF pursues an ambitious upgrade plan for its lasers and electron beam infrastructure. The scope of the ATF upgrade is designed to enable advances in three key areas:

Laser R&D program: CO₂ laser power upgrade to 20 TW peak power with pulse-width <500 fs will enable a world-leading program in AAR. Completing in-vacuum NIR and LWIR laser beam transport to ensure the best beam quality delivered to user experiments.

Electron Beam: Continue to move towards providing more highly compressed beams (~10 fs bunch) together with exploiting and expanding short bunch diagnostic capabilities.

UED/UEM: Improve system performance with wavelength-flexible OPA pump laser; Apply AI/ML techniques to both beam line tuning and real-time structural analysis.

A combination of these upgrades will pave the way for a range of scientific initiatives – from ion acceleration, which is relevant for future radiotherapy methodologies, to novel opportunities for investigating LWFA of electrons. This includes integrated multi-beam research in laser wakefield accelerators, such as the two-color ionization injection, with the promise of an all-optical scheme for generating collider-quality electrons beams. This will ensure that the ATF user community will continue successful R&D in accelerator technology and conducting experiments at the forefront of AAR, which are key elements of the Accelerator Stewardship mission.

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