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Progress in Plasma Accelerator R&D at the BELLA Center: From Early Applications to Collider-Relevant Studies

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The BELLA Center at LBNL facilitates four independent laser-plasma accelerator systems and a high-repetition rate fiber laser laboratory, enabling a comprehensive research program spanning critical system development, early applications and collider-relevant studies. Recent advancements in ancillary components, including active stabilization systems and plasma sources, have enabled significant milestone experiments, such as robust free-electron laser operation [1] and high-quality 10 GeV-level electron beam generation in a single stage [2] as well as early application experiments in nuclear science [3] and muon production [4]. This contribution provides an overview of the BELLA Center's cutting-edge infrastructure with its diverse scientific capabilities, outlining future research directions and highlighting recent scientific results.

[1] S. Barber et al. (accepted in PRL)

[2] A. Picksley et al. PRL 133 (25), 255001 (2024)

[3] R. Jacob et al. PRL 134 (5), 052504 (2025)

[4] D. Terzani et al. PRAB (in review with PRAB)

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