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Experimental investigation of longitudinal scraping of H- bunches via photo-detachment

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Longitudinal emittance growth is a significant challenge in RF linacs, especially for poorly bunched beams. This stems from particles occupying outer synchrotron oscillation orbits in the LBET, causing unwanted bunch-bunch interactions and degraded beam quality. To address this, we proposed using temporally spaced laser pulses to selectively photo-detach electrons from the longitudinal head and tail regions of H- ion bunches. This approach aims to reduce particle density in extreme orbits, enhancing beam uniformity and limiting emittance growth. Our experiments employed Fermilab's 'LaserNotcher' system at the font end of the linac, delivering 1.6 MW peak power with sub-nanosecond precision. By neutralizing the first and last half-nanosecond of several H- bunches, we measured their propagation injection into the booster. Measurements of pulse width, average height, and temporal spacing over booster cycles were compared between the scraped and unscraped bunches. Statistical analysis evaluated the results'significance, highlighting the feasibility of laser-based scraping for future linac designs to achieve higher beam energies with improved emittance control.

Footnotes

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Author: LANDON, Parker (Boston University)

Co-authors: RUAN, Jinhao (Fermi National Accelerator Laboratory); KEARNS, Ed (Boston University); BHAT, Chandra (Fermi National Accelerator Laboratory); JOHNSON, David (Fermi National Accelerator Laboratory); JOHNSON, Todd (Fermi National Accelerator Laboratory)

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