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Demonstration of cascaded pre-bunching for enhanced particle trapping in an Inverse Free Electron Laser accelerator

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We present results of an experiment performed at Brookhaven National Lab's Accelerator Test Facility showing the first successful demonstration of a cascaded pre-bunching scheme. Two modulator-chicane pre-bunchers arranged in series and a high power CO₂ laser seed tailor the longitudinal phase space of a 52 MeV electron beam creating a series of dense micro-bunches. Injecting this bunched beam in the stable accelerating potential of a seeded, strongly tapered undulator interaction increases the trapping fraction from 25% to 95%, accelerating up to 80% of the particles to the final design energy. These results represent an important step in the development of high efficiency tapered undulator interactions, both as advanced accelerators and as high peak and average power coherent radiation sources.

Primary author: Mr SUDAR, Nicholas (University of California, Los Angeles)

Co-authors: Dr SWINSON, Christina (Brookhaven National Lab); Dr POGORELSKY, Igor (BNL); GADJEV, Ivan (UCLA PBPL); Dr FEDURIN, Mikhail (Brookhaven National Laboratory Accelerator Test Facility); Dr POLYANSKIY, Mikhail (Brookhaven National Lab); Prof. MUSUMECI, Pietro (UCLA); Dr SAKAI, Yusuke (University of California, Los Angeles)

Presenter: Mr SUDAR, Nicholas (University of California, Los Angeles)

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