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Progress towards BELLA Center's Laser-Plasma Accelerator based Free Electron Laser

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At the BELLA Center at LBNL, we are pursuing the demonstration of a high gain free electron laser (FEL) using an electron beam generated by a laser plasma accelerator (LPA) with an ultimate goal of developing a compact, high brightness VUV/x-ray source. A new dedicated 100TW-class laser system now delivers pulses of 2.5J and 40 fs duration (at 5 Hz repetition). After an upgrade with a deformable mirror, we are now routinely producing electron beams at the 100-200 MeV level. In this presentation we will describe our LPA FEL facility, including the advanced electron beam transport line to the 4-meter-long strong-focusing VISA undulator. Transport and manipulation devices include a permanent quadrupole triplet, several steering magnets, an electro-magnetic triplet, a magnetic chicane to decompress the electron beam, a mid-line magnetic spectrometer, and a diagnostic chamber. Our simulations indicate that FEL gain should be observed by decompressing the few-femtesecond few-% energy spread beams with the chicane. Diagnostics and recent results towards FEL research will be presented, including phase-space optimization of the electron beams.

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