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Updates and Commissioning results of the Second Beamline Upgrade to BELLA PW

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The petawatt (PW) facility at Berkeley Lab Laser Accelerator (BELLA Center) has successfully performed several experiments since its installation in 2012 [1], primarily focusing on optimization of single stage, high energy gain laser-plasma accelerators (LPAs) [2,3]. Recently, the facility has undergone two significant upgrades: i) a new second beamline (2BL) delivered into the existing experimental chamber, and ii) a new experimental chamber providing capabilities for experiments in tightly focused geometries [4]. This talk focuses on the installation of the new second beamline. To form this, the PW laser pulse is split before compression, and passed through a new compressor chamber, making it capable of delivering up to 500 TW at 1 Hz, synchronous with the existing beamline (1BL). Currently installed is a f=13.5m off-axis parabola, matching the existing beamline, although focusing optics ranging from f=18.5m to short focal length geometries are possible. We show results from low- and high-power commissioning of 2BL, demonstrating temporal compression to 37 fs, high quality focal mode (measured Strehl ratio ⏀ 0.8), and good shot-to-shot timing stability between 1BL and 2BL (RMS jitter of 8 fs). We outline plans for three upcoming dual-beam campaigns made possible by this upgrade: staging of 2 LPAs; PW guiding in optically formed plasma channels; and two-color ionization injection.

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[2] Leemans, W. P., et al., Physical Review Letters 113.24 (2014): 245002. (https://doi.org/10.1103/PhysRevLett.113.245002)

[3] Gonsalves, A. J., et al., Physical Review Letters 122.8 (2019): 084801. (https://doi.org/10.1103/PhysRevLett.122.084801)

[4] Hakimi, Sahel, et al., Physics of Plasmas 29.8 (2022): 083102. (https://doi.org/10.1063/5.0089331)

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Primary authors: PICKSLEY, Alex (Lawrence Berkeley National Laboratory); Dr GONSALVES, Anthony (Lawrence Berkeley National Laboratory); TURNER, Marlene (LBNL); Dr NAKAMURA, Kei (Lawrence Berkeley National Lab); Dr OBST-HUEBL, Lieselotte (Lawrence Berkeley National Lab); TOTH, Csaba (Lawrence Berkeley National Laboratory); STACKHOUSE, Joshua (UC Berkeley); FAN-CHIANG, Liona (UC Berkeley); BULANOV, Stepan (LBNL); BENEDETTI, Carlo (LBNL); TERZANI, Davide (LBNL); HAKIMI, Sahel (Lawrence Berkeley National Laboratory); Dr BARBER, Samuel (Lawrence Berkeley National Laboratory); BERGER, Curtis (Lawrence Berkeley National Laboratory); CHEN, Qiang (Lawrence Berkeley National Laboratory); VAN TILBORG, Jeroen (LBNL); Dr SCHROEDER, Carl (Lawrence Berkeley National Laboratory); GEDDES, Cameron (Lawrence Berkeley National Laboratory); Dr ESAREY, Eric (Lawrence Berkeley National Laboratory)

Presenter: PICKSLEY, Alex (Lawrence Berkeley National Laboratory)

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