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Progress on Petawatt level experiments at BELLA Center for electron and ion acceleration

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In 2014, electron beams up to 4.3 GeV were obtained from 9 cm long capillary discharge based plasma waveguides, using 310 TW of peak power [1]. Higher beam energies were not obtained despite having more peak power available. To guide all the laser power required higher plasma density than optimal for higher beam energy. Results at full PW power will be shown from a new concept [2] on the BELLA beamline to deepen the channels (i.e., lower the on-axis density). Active plasma lenses [3] were tested on BELLA and successfully focused 1.4 GeV beams with a 6 cm long lens. This is a precursor for staging [4] at BELLA and an ionization based charge density monitor [5]. In a first ion acceleration campaign high charge, low divergence multi-MeV proton beams have been obtained. The 3 D temporal and spatial structure of the laser pulses has been measured at PW peak power level using both the INSIGHT and TERMITES techniques. The work was supported by the Office of Science, US DOE under Contract DE-AC02-05CH11231 and the NSF. [1] W. P. Leemans et al., Phys. Rev. Lett. 113, 245002 (2014). [2] N.A. Bobrova et al., Phys. Plasmas 20, 020703 (2013). [3] J. van Tilborg et al. Physical Review Letters 115, 184802 (2015). [4] S. Steinke et al., Nature 530, 190-193 (2016). [5] R. Tarkeshian et al., to be submitted.

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