Self-Waveguided Laser Wakefield Acceleration at ELBA Producing Multi-GeV Electron Beams

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Abstract:
We report recent high-power guiding and laser wakefield acceleration results from the ELBA beamline at ELI Beamlines, utilizing the L3 laser system, which delivers 13 J, 30 fs pulses at 0.2 Hz. In these experiments, self-waveguiding was used to create 20 cm plasma channels in helium above a supersonic gas jet developed at ELI. The channel-forming beam was split from the drive beam after compression and focused with an off-axis reflective axicon—implemented for the first time in self-waveguiding experiments—to establish the plasma/neutral index structure for the ~2–3 ns delayed, 11 J self-waveguiding LWFA drive pulse. This fully reflective optical configuration enabled efficient guiding and stable acceleration of electron beams to energies approaching 5 GeV, and guiding was also demonstrated at 3.3 Hz. This novel implementation of self-waveguided LWFA represents a robust, compact approach compatible with single-laser, single-compressor platforms. ELBA is now a fully operational user beamline capable of delivering multi-GeV electron beams to support a broad range of experiments in advanced laser-plasma acceleration and secondary source development.