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High-energy generation of arbitrary cylindrical vector vortex beams using a modified Mach–Zehnder interferometer

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In this paper, we demonstrate the interferometric generation of high-energy pulsed vector vortex beams at arbitrary points on the higher-order Poincaré sphere. Scalar vortex beams with topological charges ℓ=1 and ℓ=2 were produced using fused silica spiral phase plates and a 1064 nm wavelength Gaussian laser source, delivering a pulse energy of 2.75 mJ at a frequency of 1 kHz with a pulse duration of 15.5 ns. A novel, to our knowledge, modified Mach-Zehnder interferometer was constructed to allow for arbitrary inter-modal phase and amplitude control of the vector vortex states across the surface of the Poincaré sphere, achieving pulse energies of 2.5 mJ and peak powers exceeding 160 kW. This marks the highest, to the best of our knowledge, pulse energy achieved for arbitrary higher-order vector vortex beams on the HOPS.