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Correlating post-wakefield acceleration laser spectra with electron beam spectra to bulid an indirect electron diagnostic

The driving laser's spectrum evolves during laser-wakefield acceleration due to the density and intensity gradients in the driven plasma wave. These density gradients also determine the accelerating fields experienced by injected electrons, and so the post-acceleration laser spectrum may be correlated with the electron spectrum, potentially allowing for its use as a non-disruptive diagnostic of the electron beam spectrum. This would be useful in any application that uses the electron beam in a disruptive way, including several methods of light generation and, of particular interest to the authors, radiation reaction studies.

The relationship is highly non-linear however, and so we make use of machine learning approaches and train a model using not only the laser and electron spectra, but also additional diagnostics measuring the post-acceleration laser energy and spot size. This approach is validated using idealised PIC simulation and then tested on real data from an inverse-Compton scattering experiment carried out at ELI-NP in April 2024. I will present on the method, its quality as an indirect diagnostic, and plans to improve it.

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