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Data-driven modelling of laser-plasma experiments enabled by large datasets

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Laser Wakefield Acceleration (LWFA) is a process by which high gradient plasma waves are excited by a laser leading to the acceleration of electrons. The process is highly nonlinear leading to difficulties in developing 3 dimensional models for a priori, and/or ab initio prediction.

Recent experiments at the Rutherford Appleton Laboratory's (RAL) Central Laser Facility (CLF) in the United Kingdom using the 5Hz repetition rate Astra-Gemini laser have produced new results in LWFA research, inviting analysis of data with unprecedented resolution. Additionally, data driven modeling, scaling laws and models can be extended into new ranges or refined with less bias.
We will present results of training deep neural networks to learn latent representations of experimental diagnostic data and validate the latent space by comparing the distribution of beam divergences and other metrics of randomly generated spectra against the distribution in the training data. We will discuss the ability of the model to generalize results to different conditions. This work will use architectures which rely on reparameterization using a small dense network connected to a larger, convolutional neural network.

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