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Applications of machine learning and active feedback in laser-plasma wakefield accelerators

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Performing high intensity laser-plasma interactions at high repetition rate (>1 Hz) allows for a fundamental change in the way these phenomena are explored. The large quantity of data collected allows for statistical modelling and fine scans of parameter space. In addition, multi-dimensional optimisation becomes possible, which is of great importance when individual parameters are coupled in a complex manner. In this talk, I will describe how machine learning techniques can be applied to improve experimental outcomes and physical understanding in laser wakefield experiments. A series of experiments will be discussed, in which the laser and plasma parameters were autonomously controlled by an algorithm designed to optimise a user defined goal function, such as the charge of the electron beam in a particular energy band. I will also report on experiments aiming to combine feedback algorithms with controlled injection techniques. Combining these techniques with a new generation of high-power high-rep rate facilities promises to vastly accelerate progress in the field of the laser-plasma accelerators.

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