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Modelling of laser distribution as input for simulations of Laser wakefield acceleration

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The optimisation of electron beams accelerated by laser driven wakefield in plasma relies on the identification of the optimum plasma and laser properties for a specific regime of acceleration. The influence of laser symmetry around focus on the electron properties was investigated to understand recent experimental results in the case of ionisation injection in gas cells.

In order to simulate accurately laser plasma coupling for 100 TW to 1 PW class lasers drivers such as Apollon F2 beam, we implemented a Gerchberg-Saxton-like Algorithm (GSA) to efficiently fit measured asymmetric laser fluences using bases of orthogonal functions (Hermite-Gauss & Laguerre-Gauss). This GSA process allows us to retrieve a 2D phase-map associated to a collection of fluence images measured in vacuum through laser focus by minimising the integrated error on the fit. Due to the high dimensionality of the fit parameters space used within the algorithm, we employed a Bayesian Optimisation method to retrieve the optimal set of inputs for our fit functions.

We discuss the major steps, the numerical constraints and the overall accuracy of this best-fit algorithm and how it is implemented in PIC simulations using the quasi-3D cylindrical FBPIC code.

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