

Surrogate model for laser-plasma injector development

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Plasma targetry design for PALLAS experiment relies on numerical PIC parametric studies, computational fluid dynamic studies and an experimental test bench equipped with plasma density profile diagnostics, density measurement and plasma species spatial distribution for target characterisation.

We discuss construction of surrogate model of PALLAS, based on 15000 simulations performed for sparsely spaced input parameters for laser-plasma injector (laser, target density profile and species distribution). Parametric studies were performed with Smilei PIC code [1] using the azimuthal mode and envelop approximation with a low number of particles per cell [2]. Based on these simulation data we constructed ML models with KFold validation [3] to limit the overfitting (GP, Neuronal Network and decision trees). The surrogate model is then used to quickly probe parameter set of interest, predict the optimum and interpret relation between parameters. Goal of these studies is to assist the plasma target cell design and determined working points of the laser-plasma injector for a specified energy, charge, beam emittance and beam divergence.

[1] P. Drobnik et al., arxiv (2023)

[2] SMILEI: smileipic.github.io/Smilei/

[3] Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. “ O’Reilly Media, Inc.”, 2022.

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