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Optimization of a multichannel solid state plasma for laser wakefield acceleration with realistic laser parameters using a Bayesian algorithm

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Nanostructures based on carbon nanotube arrays are emerging as promising media for achieving ultra-high acceleration gradients in laser wakefield acceleration (LWFA). In this study, we design and optimize plasmas with hexagonal lattice structures, where the lattice parameters directly define the nanostructure's properties. Using WarpX, a state-of-the-art particle-in-cell (PIC) simulation framework, we conduct fully three-dimensional simulations to model the interaction between these advanced plasmas and laser pulses. To refine the lattice parameters, we apply Bayesian optimization through the Python library BoTorch, identifying optimal configurations for generating effective wakefields. These results are intended to guide preliminary simulations for future experiments at leading laser facilities, such as ELI and VEGA3, advancing the exploration of LWFA with nanostructured plasmas.

Footnotes

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Author: RODRÍGUEZ PÉREZ, Juan (Instituto Universitario de Ciencia de los Materiales)

Co-authors: BONATTO, Alexandre (Universidade Federal de Ciências da Saúde de Porto Alegre); Dr SYTOV, Alexei (Istituto Nazionale di Fisica Nucleare); HIGUERA GONZALEZ, Beatriz (University of Manchester); BONTOIU, Cristian (University of Liverpool); GATTI, Giancarlo (Istituto Nazionale di Fisica Nucleare); CAVOTO, Gianluca (Istituto Nazionale di Fisica Nucleare); XIA, Guoxing (Cockcroft Institute); DREBOT, Illya (Istituto Nazionale di Fisica Nucleare); RESTA-LOPEZ, Javier (Instituto Universitario de Ciencia de los Materiales); BANDIERA, Laura (Istituto Nazionale di Fisica Nucleare); MARTÍN-LUNA, Pablo (Instituto de Física Corpuscular)

Presenter: HIGUERA GONZALEZ, Beatriz (University of Manchester)

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