Contribution ID: **16**

Type: **not specified**

Gradient based beam line optimization for laser-accelerated ions using surrogate models

Friday, 1 November 2024 10:45 (25 minutes)

In recent decades, the development of high-power lasers has increased interest in the use and research of laser-accelerated ions. While offering excellent characteristics, such as high brightness, high energies, and very short pulse duration, laser-accelerated ions also pose significant challenges regarding their capture and transport due to high initial divergence and a wide energy spectrum. These challenges necessitate more accurate, high-fidelity simulations compared to reduced-physics models.

Leveraging the accuracy of high-fidelity simulations to train machine learning-based surrogate models offers the advantage of using gradient-based optimization methods, as neural networks are inherently backpropagable. This study demonstrates that such an optimization scheme provides accurate predictions for maximizing the transmission of a beam line handling laser-accelerated ion beams. Using transported particle distributions generated by a Runge-Kutta field tracking algorithm, a solenoid surrogate model was trained and incorporated into a toy model consisting of two solenoids and a radio frequency cavity. This toy model, a simulated counterpart of the LIGHT experiment at GSI Helmholtzzentrum für Schwerionenforschung, was subsequently optimized using the gradient-based optimizer Adam, which computed the optimal parameters such as solenoid currents and drift spaces to minimize the loss function. The resulting parameters were then implemented into the initial field tracking simulation to analyze the accuracy and robustness of the provided operating point with regard to transmission.

Primary author: DEWITT, Daniel (Technische Universität Darmstadt)

Co-author: Prof. BOINE-FRANKENHEIM, Oliver (Technische Universität Darmstadt)

Presenter: DEWITT, Daniel (Technische Universität Darmstadt)

Session Classification: Oral contributions IX