Contribution ID: **2245** Contribution code: **TUPA113** Type: **Poster Presentation**

Optimizing AWAKE Run2 Simulations Using Invertible Neural Networks

Tuesday 9 May 2023 16:30 (2 hours)

Particle-in-cell simulation plays an important role in optimization of today's plasma-based acceleration research and experiments. Due to many variables involved, the computational cost is usually very high, especially when the experiment includes several different beams, e.g., the AWAKE experiment. AWAKE Run2 uses the proton bunch to drive plasma wakefield and accelerate electron bunch in 10 m plasma. AWAKE50 experiment accelerates electron bunch to about 50 GeV for searching dark photons and other phenomena beyond the standard model. We have successfully applied the forward and inverse neural network models in the simulation of AWAKE Run2 (4 variables and 6 objectives) and AWAKE50 (9 variables and 6 objectives) experiment, which can replace computationally expensive simulation software for the optimization. Our study shows that the forward neural network provides a more efficient way to find optimal solution by Bayesian optimization algorithm. On the other hand, with an inverse neural network, it is possible to find suitable variable settings according to the desired targets. In the models we trained, the coefficients of determination (R2) of both types of models reaches > 0.90 and most of which are > 0.95. In addition, for reducing the computational cost of training dataset, we have successfully trained a forward neural network using the dataset of 10 m to 60 m accelerated distance to predict the parameters of electron bunch at 80 m, the averaged R2 value reaches 0.95.

Funding Agency

Footnotes

I have read and accept the Privacy Policy Statement

Yes

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Session Classification: Tuesday Poster Session

Track Classification: MC3: Novel Particle Sources and Acceleration Techniques: MC3.A22: Plasma Wakefield Acceleration