Contribution ID: **217** Contribution code: **MOP097** Type: **Poster Presentation**

Machine learning-driven computations of 3D Coherent Synchrotron Radiation

Monday 11 August 2025 16:00 (2 hours)

Calculating the effects of Coherent Synchrotron Radiation (CSR) is one of the most computationally expensive tasks in accelerator physics. Here, we use convolutional neural networks (CNN's), along with a latent conditional diffusion (LCD) model, trained on physics-based simulations to speed up calculations. Specifically, we produce the 3D CSR wakefields generated by electron bunches in circular orbit in the steady-state condition. Two datasets are used for training and testing the models: wakefields generated by three-dimensional Gaussian electron distributions and wakefields from a sum of up to 25 three-dimensional Gaussian distributions. The CNN's are able to accurately produce the 3D wakefields ∼250-1000 times faster than the numerical calculations, while the LCD has a gain of a factor of ∼34. We also test the extrapolation and out-of-distribution generalization ability of the models. They generalize well on distributions with larger spreads than what they were trained on, but struggle with smaller spreads.

Please consider my poster for contributed oral presentation

Yes

Would you like to submit this poster in student poster session on Sunday (August 10th)

No

Footnotes

Funding Agency

This work was supported by the Los Alamos National Laboratory LDRD Program Directed Research (DR) project 20220074DR.

I have read and accept the Privacy Policy Statement

Yes

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Session Classification: Monday Poster Session

Track Classification: MC6 - Beam Instrumentation, Controls, AI/ML, and Operational Aspects