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Facility-scale differentiable virtual accelerator at Fermilab

Monday 11 August 2025 16:00 (2 hours)

As the design complexity of modern accelerators grows, there is more interest in using advanced simulations and algorithms that have fast execution time or yield additional insights. One notable example are the gradients of physical observables with respect to design parameters, which are broadly useful in optimization and uncertainty analysis. The IOTA/FAST facility has been working on implementing and experimentally validating an end-to-end virtual accelerator test stand that is both fast and gradient-aware, allowing for rapid prototyping of new software and experiments with minimal beam time costs. We describe the selection and benchmarking of both physics and ML codes for linac and ring simulation, including obtaining parameter gradients with autodiff. We will also show the development of generic interfaces between surrogate and physics-based sections, and how the control interface is exposed as either a deterministic discrete event simulator or a fully asynchronous EPICS/ACNET soft IOC. We will also discuss challenges in model calibration and uncertainty quantification, as well as future plans to extend modelling to other Fermilab accelerators like PIP-II and Booster.

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

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Yes

Author: KUKLEV, Nikita (Fermi National Accelerator Laboratory)

Co-authors: ROMANOV, Alexander (Fermi National Accelerator Laboratory); JARVIS, Jonathan (Fermi National Accelerator Laboratory); WALLBANK, Michael (Fermi National Accelerator Laboratory); BANERJEE, Nilanjan (Fermi National Accelerator Laboratory)

Presenter: KUKLEV, Nikita (Fermi National Accelerator Laboratory)

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