



Contribution ID: **182** Contribution code: **TUCN01**

Type: **Contributed Oral Presentation**

## **Experience Integrating Online Modeling / Adaptive Digital Twin Infrastructure and ML-based Tuning for Accelerator Control at SLAC**

*Tuesday 12 August 2025 14:30 (20 minutes)*

SLAC and collaborators are developing infrastructure and algorithms for deploying online physics models and combining them with machine learning (ML) models and ML-based feedback from its running accelerators. These models predict details of the beam phase space distribution, include nonlinear collective effects, and leverage high performance computing and ML-based acceleration of simulations to enable execution in reasonable times for control room use. By enabling accelerator system models to be adapted over time and increasing the speed of model execution, these system models can provide useful information for both human-driven and automated tuning. System models such as these are sometimes called “digital twins”, which are distinguished from offline models by the bi-directional flow of information with the real system. We have also been leveraging these system models to speed up accelerator tuning, by providing initial guesses of settings (i.e. “warm starts”) and physics information to speed up ML-based tuning. For example, we have used these models to provide priors for Bayesian optimization and training platforms for reinforcement learning. Here, we give an overview of these developments (both research and infrastructure), our deployment experience, and applications at LCLS, LCLS-II, and FACET-II, with a focus on emittance tuning, FEL pulse intensity tuning, and phase space shaping. We also discuss ongoing collaborations with LBNL, JLAB, FNAL, and BNL in this space.

**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**

**I have read and accept the Privacy Policy Statement**

Yes

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**Session Classification:** Beam Instrumentation, Controls, AI/ML, and Operational Aspects (Contributed)

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