



Old Dominion University

Department of Physics

Colloquium

Monday, May 16, 2022

"High-Fidelity Simulations and Machine Learning for Accelerator Design and Optimization"

Dr. Daniel Winklehner
MIT

Abstract:

Computation has become a critically important tool for particle accelerator design and optimization. Thanks to massively parallel codes running on high-performance clusters, as a community, we can now accurately predict emergent properties of particle ensembles and non-linear collective effects. We employ Machine Learning to analyze image data, predict beam loss, and forecast accelerator interruptions. We are performing pilot studies creating “virtual twins” of entire particle accelerator systems, executing orders of magnitude faster than particle-in-cell codes. And we are only scratching the surface. Here, I will present the IsoDAR experiment in neutrino physics as an example. For it, we have developed a compact and cost-effective cyclotron-based driver to produce very high-intensity beams. The system will be able to deliver continuous wave (cw) proton currents of 10 mA on target in the energy regime around 60 MeV. 10 mA is a factor of 4 higher than the current state-of-the-art for cyclotrons and a factor of 10 compared to what is commercially available. The applications of such a driver are in particle physics, medicine, and materials- and energy research. This increase in beam current is possible due to longitudinal-radial coupling through space charge, an effect dubbed “vortex motion.” I will discuss the high-fidelity simulations performed to simulate this effect in the IsoDAR cyclotron and predict beam losses due to halo formation. Furthermore, I will show our study to optimize the IsoDAR injector (a short RFQ linear accelerator) using machine learning and discuss next steps for computation in accelerator physics.

Dr. Daniel Winklehner
May 16, 2022
3:00 PM

Join Zoom Meeting

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