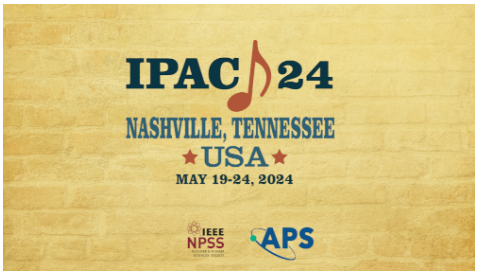

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First operational experience with data-driven hysteresis compensation for the main dipole magnets of the CERN SPS

Monday, 20 May 2024 16:00 (2 hours)

Magnetic hysteresis, eddy currents, and manufacturing imperfections pose significant challenges for beam operation in multi-cycling synchrotrons. Addressing the dynamic dependency of magnetic fields on cycling history is a current limitation for control room tools using existing models. This paper outlines recent advancements to address this, presenting the outcome of operational tests utilizing data-driven approaches and an overview of the next steps. Notably, artificial neural networks, including LSTMs and transformers, are employed to model static and dynamic effects in the main dipole magnets of the CERN SPS. Cycle-by-cycle feed-forward corrections are implemented through the CERN accelerator controls infrastructure. Utilizing physics-bound loss functions, these networks capture hysteresis and eddy currents based on measured magnetic field and current data from the B-Train, the real-time magnetic measurement system of the SPS main dipoles. The developed models interface with the CERN accelerator settings management system, propagating computed corrections of magnetic fields to corresponding adjustments in the current of the power converters feeding the magnets.

Footnotes

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