

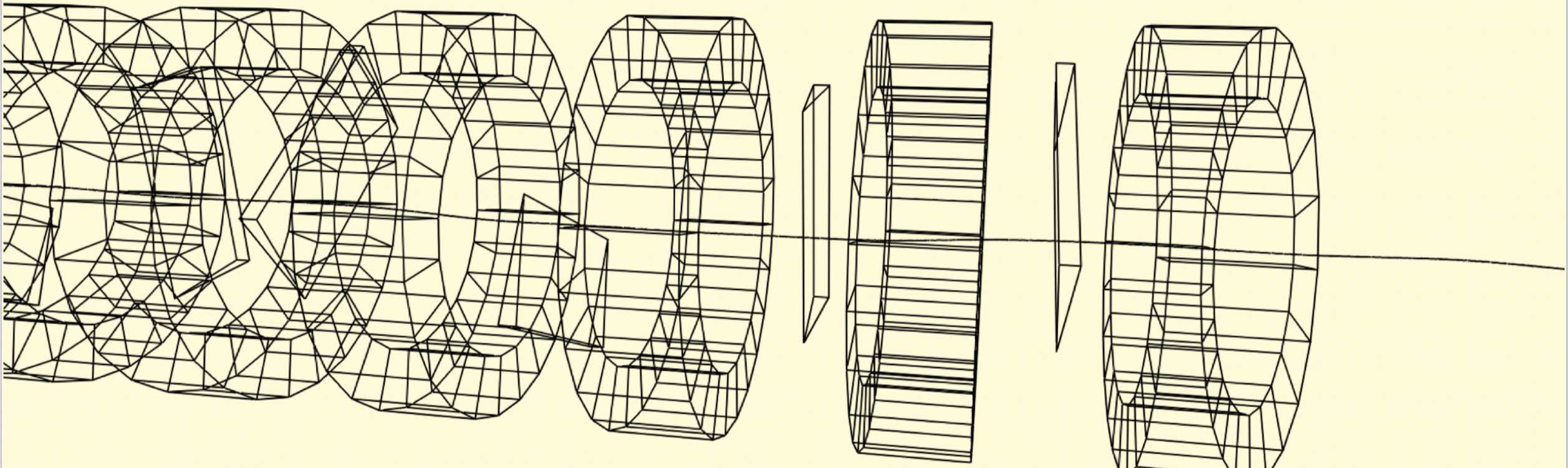
Updates on the HF0FO Project

Last two weeks

Gave a talk @ FNAL New Perspectives

SOLENOID-BASED LATTICES FOR MUON IONIZATION COOLING

A CASE STUDY OF THE HFOFO SNAKE



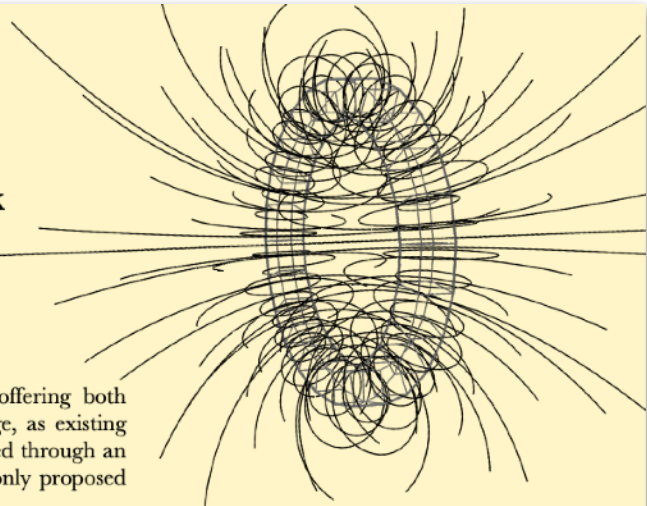
New Perspectives | July 16, 2026

Caroline Riggall, L. Lee, T. Holmes, R. Ganesan, D. Kalra @ UTK;
K. Yonehara, D. Neuffer, D. Stratakis @ FNAL

Presented a poster
@ DPF Annual Meeting

SOLENOID-BASED LATTICES FOR MUON IONIZATION COOLING

Caroline Riggall, Lawrence Lee, Tova Holmes, Rithika Ganesan, Daisy Kalra @ UTK
Katsuya Yonehara, David Neuffer, Diktys Stratakis @ FNAL

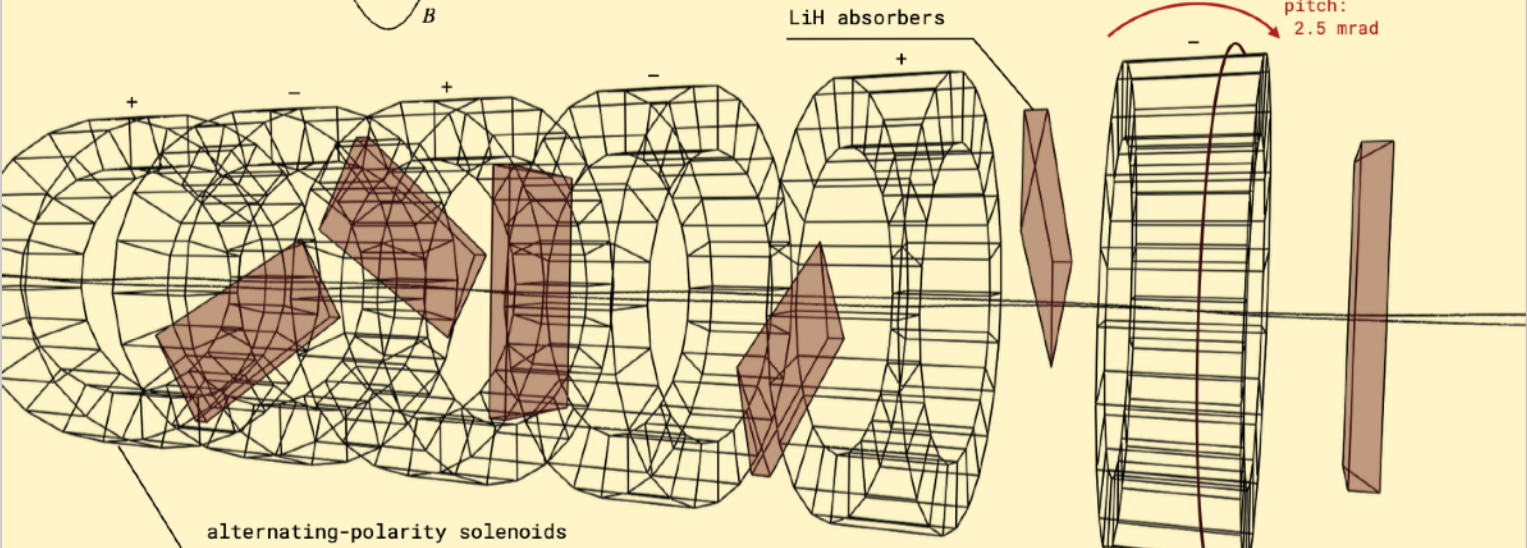
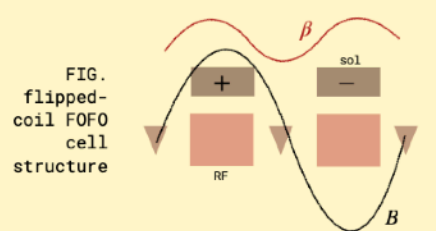


MUON IONIZATION COOLING.

A **muon collider** presents a compelling path forward for high-energy physics, offering both precision and discovery potential. Beam cooling presents a principal R&D challenge, as existing methods are not fast enough for muons. Ionization cooling—whereby a beam is passed through an absorbing material and the emittance is reduced via ionization energy loss—is the only proposed method to meet this requirement.

SOLENOID LATTICES.

Solenoid-based (FOFO) lattices are ideal for ionization cooling channels, with large acceptances and minima of the beta function conveniently located between solenoids, enabling absorber placement where multiple scattering heating effects can be minimized. Flipped-polarity cell configurations allow for restoration of angular momentum, generating closed reference orbits. By rotating solenoids, **fringe fields can be leveraged to produce effective multipoles.**



THE HELICAL FOFO SNAKE.

The Helical FOFO Snake (HFOFO) is a unique lattice that exploits periodic solenoid rotations to **cool both signs of muon in a single channel**. Traditional 6D cooling lattices use dipoles to generate dispersion, enforcing charge-selectivity in the design. Via two sets of rotations applied about the x- and z-axes, the effective rotating dipole field generated in the HFOFO lattice facilitates dispersion in-phase with absorbers placed alternately to cool μ^+ and μ^- beams. **Several versions of the lattice have been developed** to operate at different momenta, enabling resilience to up- and down-stream changes to the muon collider accelerator design and supporting ongoing optimization studies.

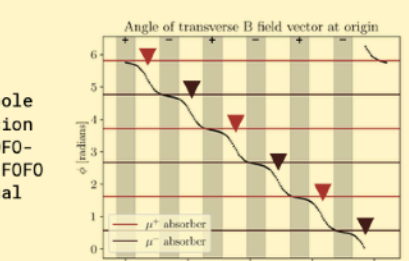
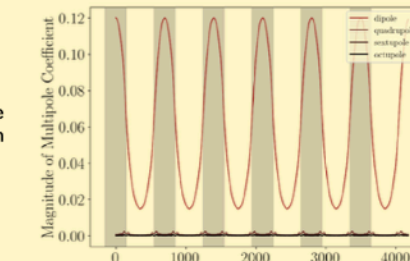
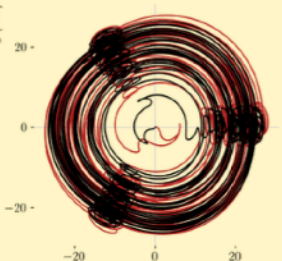


FIG. μ^+ and μ^- reference orbits in baseline HFOFO channel

FIG. multipole expansion of HFOFO-minus-FOFO residual field

FIG. orientations of rotating dipole field and absorbers

ACKNOWLEDGEMENTS.

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Fermilab
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Updates on the HF0F0 Project

Next two weeks

- Finally out of conference mode
==> Returning to RF studies!
- Working on an orbit-finding script:
 - Add some absorber —> change phase to compensate E loss —> adjust initial conditions to find orbit —> turn up gradient when orbit-finding fails to converge
 - Step through this until reaching full gradient
 - Plot amount of absorber vs. gradient required to study correlation (might tell us something interesting about how to optimize cooling performance)

