Initial 6D Cooling in a Charge-Agnostic Design

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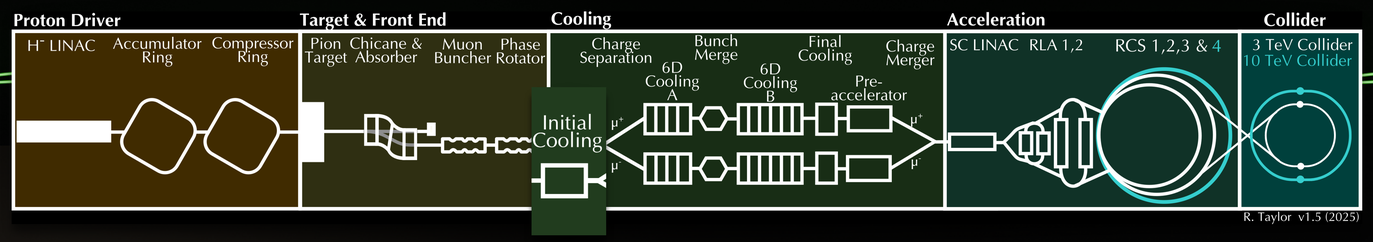
Scan this QR code to see a 3D model of HFOFO!

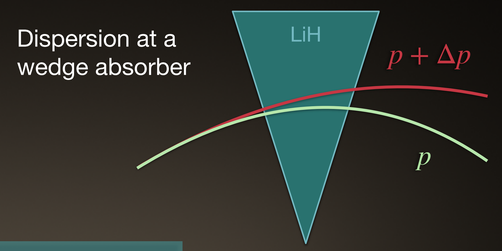


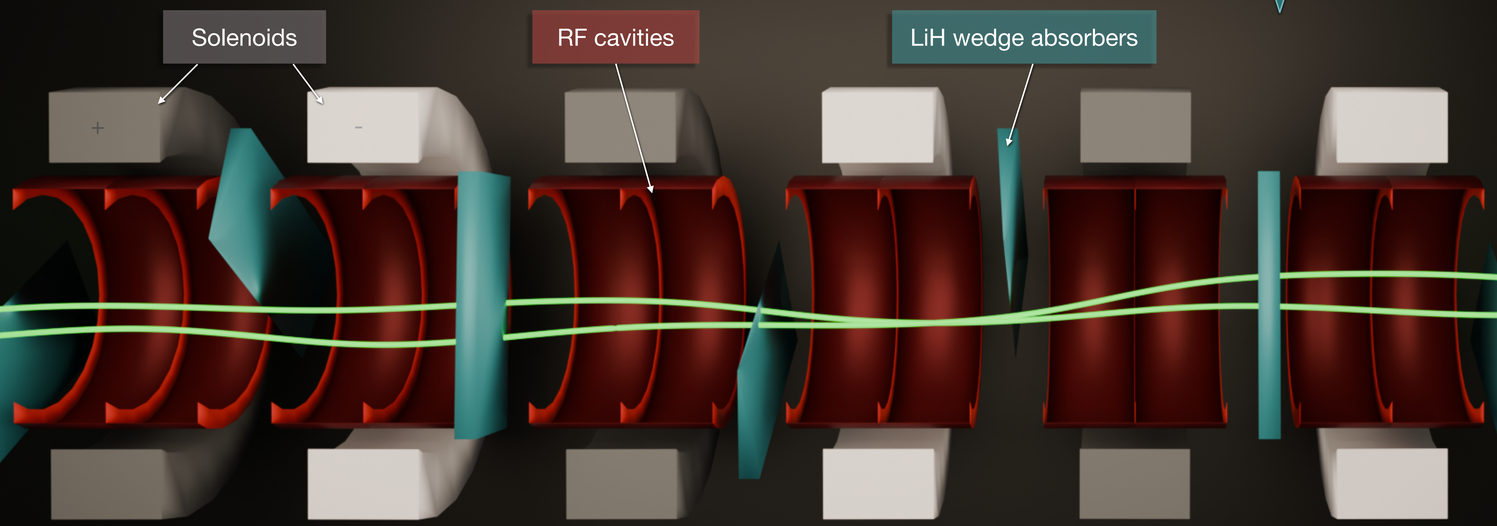
Location of HFOFO in the nominal muon collider complex.

Muon Cooling

The nominal muon production scheme for a collider begins with an intense proton beam striking a target, forming pions; these subsequently decay to muons with an initial phase space too large to achieve the necessary collider **luminosity**.

- Thus, "cooling" is necessary — or six-dimensional phase space volume (**emittance**) reduction. To meet the target luminosity for the muon collider, six orders of magnitude in emittance reduction will be required.
- Complicating this, muons have a finite lifetime and thus require a fast cooling scheme. Presented here is a design for an initial cooling channel that utilizes **ionization cooling** — the process whereby particles are passed through a material, depositing ionization and facilitating reduction in phase space density.





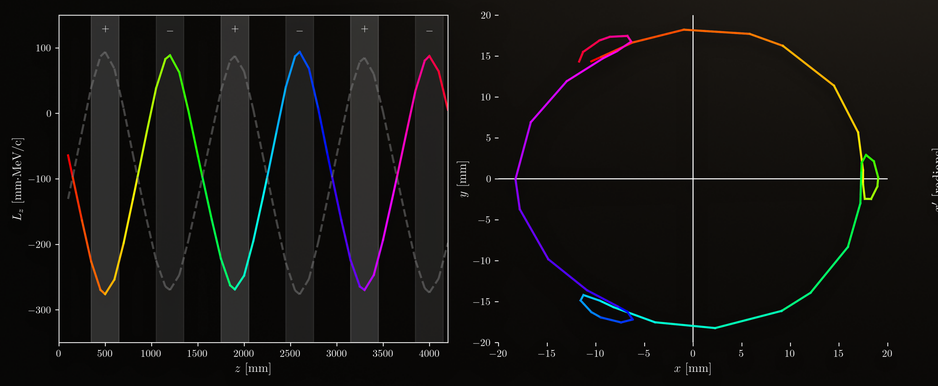
HFOFO Snake

The Helical FOFO (HFOFO) Snake is a novel approach to cooling **both signs of muon simultaneously**.

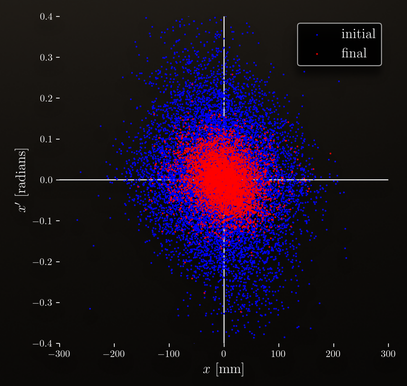
- Focusing is achieved via alternating-polarity **solenoids** with periodic inclinations applied to generate a rotating dipole field. Resultantly, μ^+ and μ^- execute identical helical orbits with a half-period longitudinal offset.
- Lithium hydride (LiH) **wedge absorbers** are placed in the gaps between solenoids to facilitate ionization cooling. Absorbers are placed such that higher-momentum muons pass through more material via dispersion and thus experience more cooling.
- **RF cavities** fit inside the solenoids provide restoration of longitudinal momentum.

Each period in the lattice is composed of six of these elements, with the total channel comprising 30 periods.

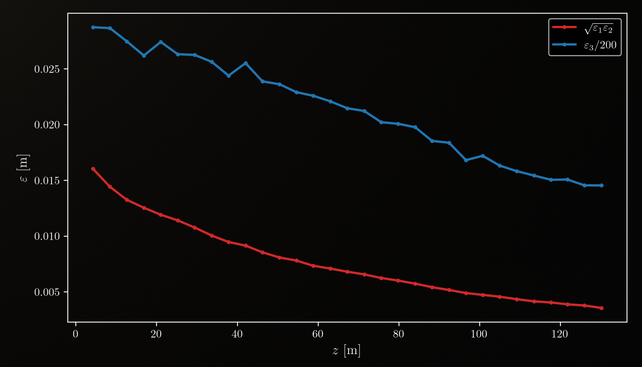
G4beamline simulations of the HFOFO design have yielded around **two orders of magnitude in 6D emittance reduction**. Current efforts are focused on optimization to achieve further cooling and minimization of particle loss.



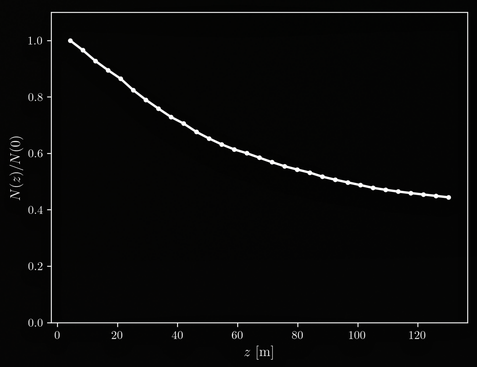
Angular momentum (left) and reference orbit (right) for one period. Colored line indicates μ^+ and dashed line μ^-.



Phase space distributions (μ^+) at the start and end of the channel.



Eigenmode emittances from ICOOL's *emitcalc.* ε_1 and ε_2 are transverse and ε_3 is the longitudinal mode.



Muon survival rate along the channel.

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