Future neutrino factories will need methods to reduce large emittance of muon beams.
MICE studies the change of emittance of a muon beam via ionization through lithium hydride and liquid hydrogen absorbers.
Single muons selected upstream of absorber and formed into ensembles to represent a muon beam.

Beam cooling causes migration of particles (in beam phase space) towards beam core.
Emittance Evolution at MICE

Beam size represented by 4-D transverse, normalised emittance
\[ \epsilon_{4D}^\perp = \frac{1}{m_\mu} \left( \frac{4}{\sqrt{\det \Sigma_\perp}} \right) \]
\[ \Sigma_\perp = \text{covariance matrix of muon ensemble in (x,y,p_x,p_y) space} \]

Amplitude: \[ A_\perp = \epsilon N \Delta_\mu \Sigma_\perp^{-1} \Delta_\mu \]
Distance of muon from beam center

Ratio of cumulative amplitude after absorber to that before absorber
\[ R_{\text{amp}}(A_\perp^0) = \frac{N(A_\perp < A_\perp^0 | \text{After})}{N(A_\perp < A_\perp^0 | \text{Before})} \]

Cooling \( \Rightarrow \) movement of muons to low amplitudes after absorber

\[ R_{\text{amp}}(A_\perp^0) > 1 \text{ at low } A_\perp^0 \]
implies cooling in LH2/LiH