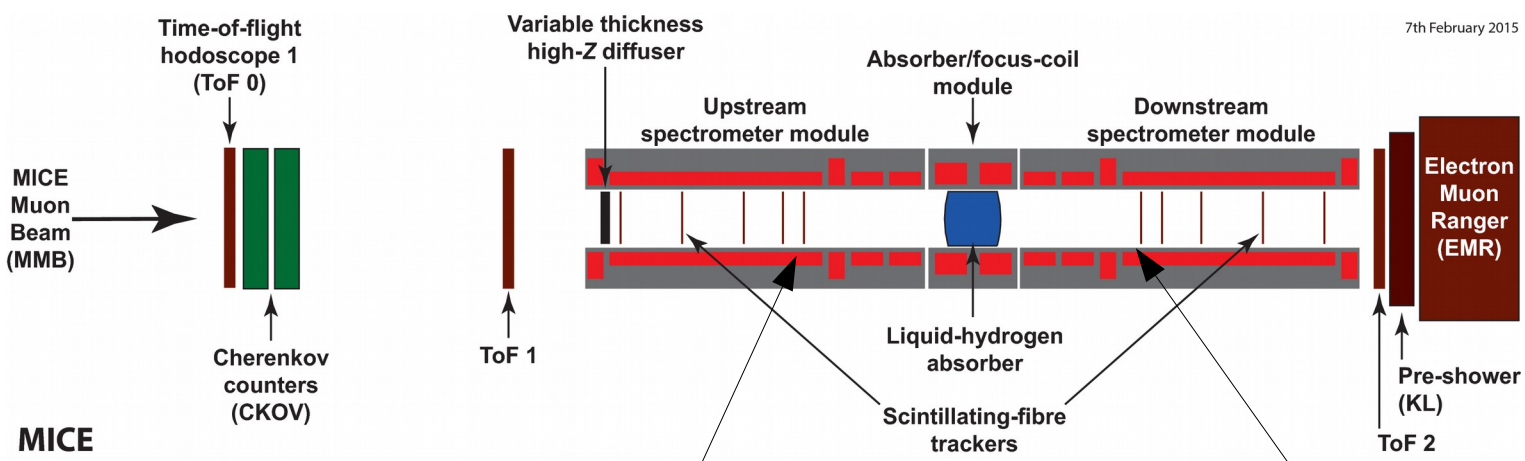
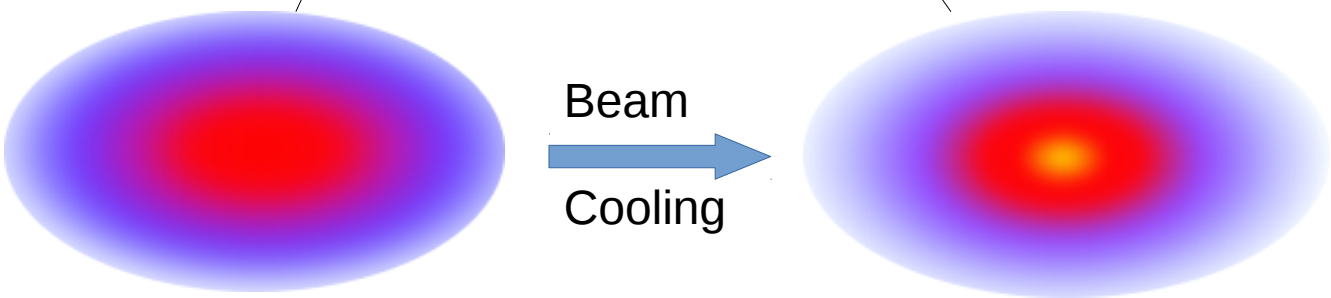
Emittance Evolution at MICE

- 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



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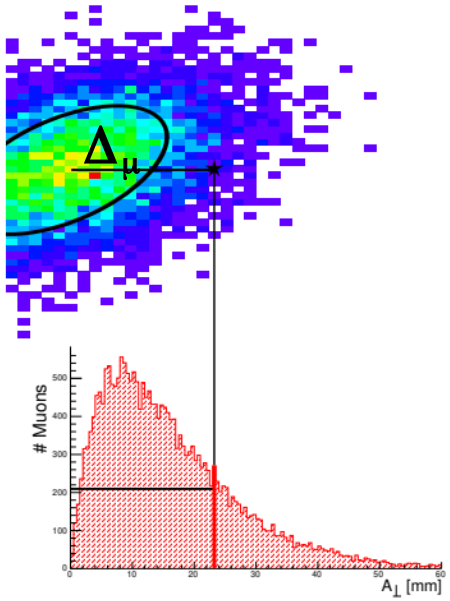

- Beam size represented by 4-D transverse, normalised emittance

$$\epsilon_\perp^{4D} = \frac{1}{m_\mu}\sqrt[4]{|det\,\Sigma_\perp|}$$

$\Sigma_\perp$ = covariance matrix of muon ensemble in (x,y,p_x,p_y) space

- Amplitude : $A_\perp = \epsilon_N \boldsymbol{\Delta}_\mu{}^T \Sigma_\perp^{-1} \boldsymbol{\Delta}_\mu$; $\boldsymbol{\Delta}_\mu = (\boldsymbol{v} - \langle \boldsymbol{v} \rangle)$
  Distance of muon from beam center

- Ratio of cumulative amplitude after absorber to that before absorber

$$R_{amp}(A_\perp^0) = \frac{N(A_\perp < A_\perp^0 | After)}{N(A_\perp < A_\perp^0 | Before)}$$

- **Cooling** $\Rightarrow$ movement of muons to low amplitudes after absorber

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