Particle Yields from the MICE Luminosity Monitor

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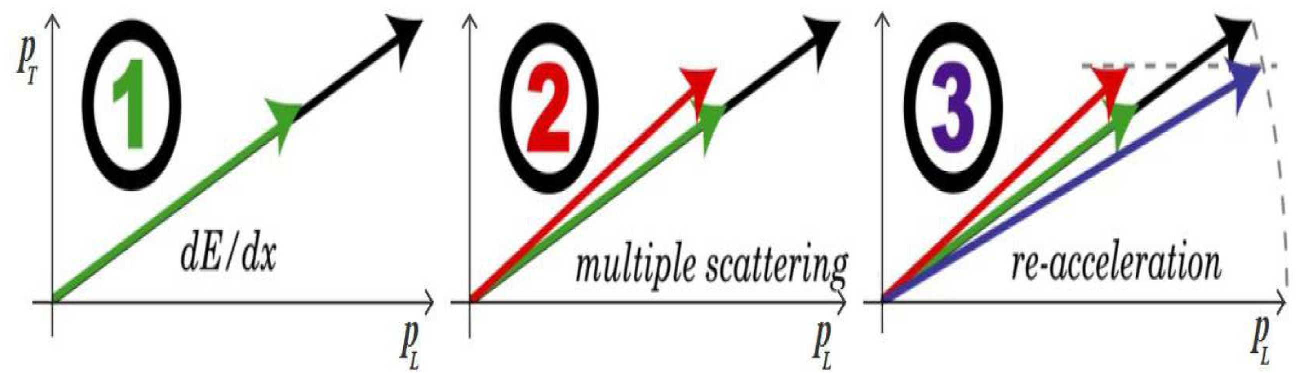
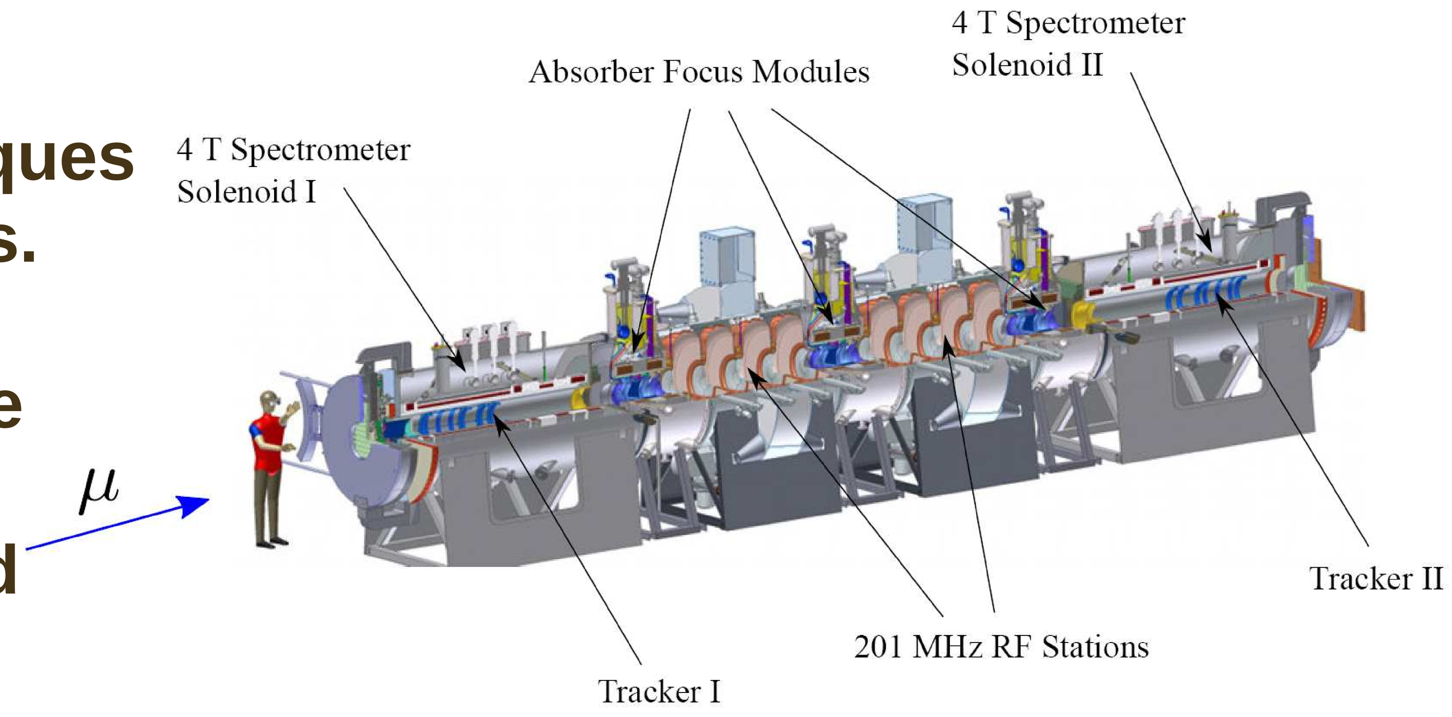
- Neutrino Factory: best facility to study neutrino oscillations and CP violation
- Muon beam generated from pion decay so has large initial emittance and must be cooled within acceptance of muon accelerator to deliver required intensity

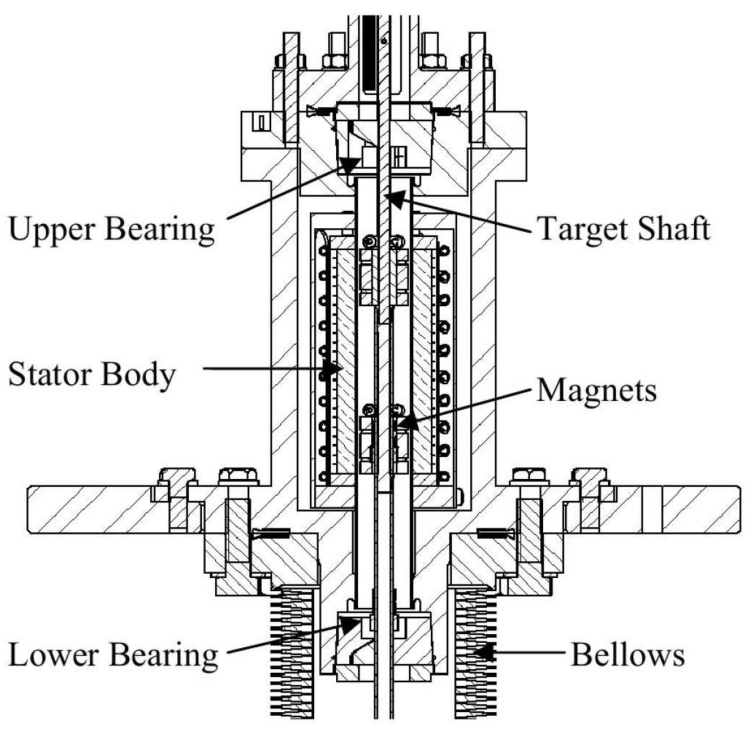
MICE:

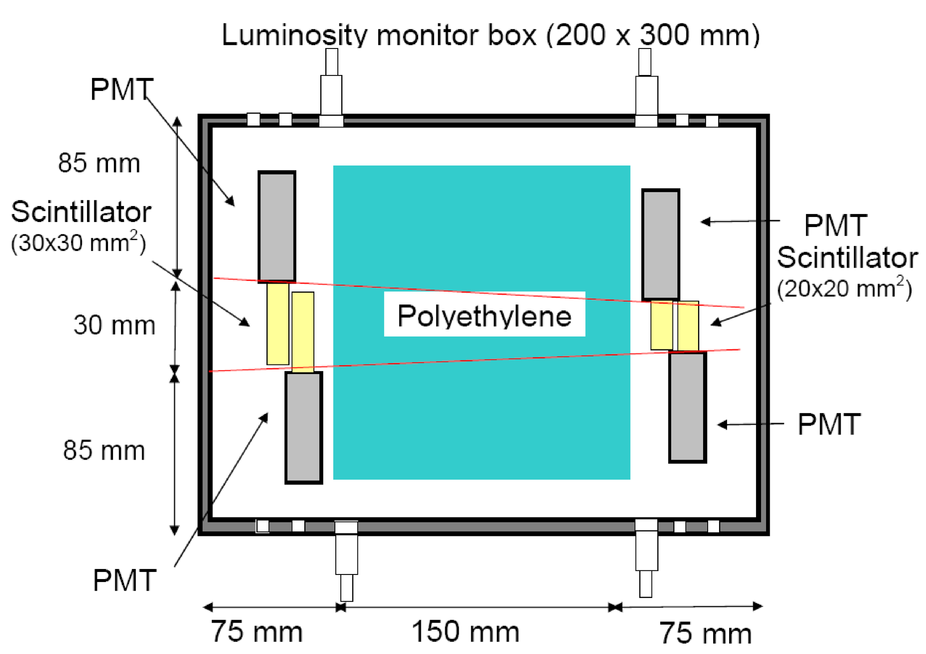
- Muon Ionisation Cooling Experiment
- Muons: 2.2 μs lifetime excludes conventional cooling techniques
- Ionisation Cooling: momentum is reduced in low Z absorbers.
- Accelerating cavities restore longitudinal momentum only.
- Net reduction in transverse momentum and consequently the phase space volume occupied by the beam
- MICE will demonstrate muon ionisation cooling at Rutherford Appleton Laboratory, Oxfordshire
- MICE beamline is fully functional





MICE Target and Luminosity Monitor

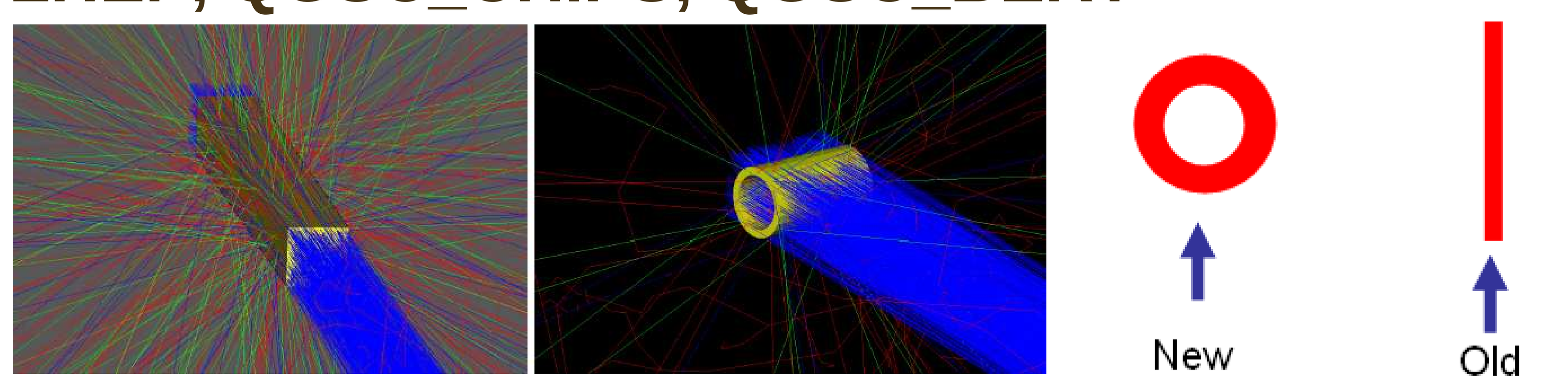




- **Target:** 24 coil stator drives titanium shaft and hollow cylindrical target (6 mm diam.) at 1 Hz into ISIS beam
- **Luminosity monitor:** two 2×2 cm^2 and two 3×3 cm^2 scintillators with 15 cm plastic filter to cut protons ~500 MeV/c and pions ~150 MeV/c placed 10 m from target at 25^o angle to MICE beamline for particle rate studies

Simulations

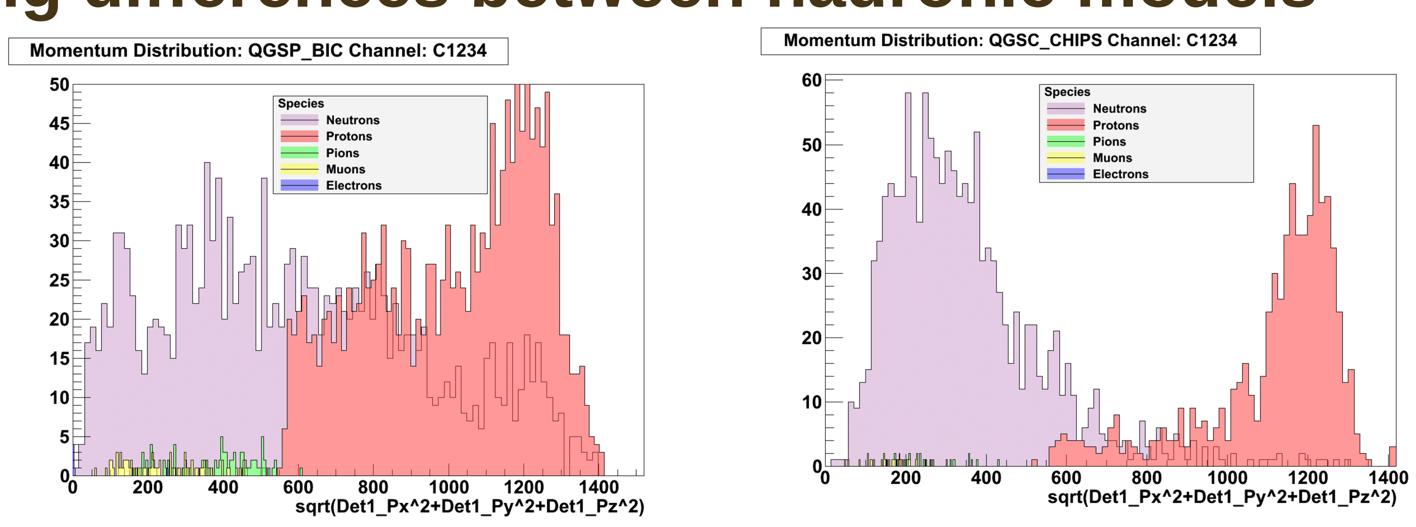
- Studied a range of hadronic physics models, using G4Beamline: QGSP_BIC, QGSP_BERT, LHEP, QGSC_CHIPS, QGSC_BERT



- Old rectangular target (1x1x10) mm
- MICE target (inner rad. 2.3 mm, outer rad. 3 mm)
- Protons interacting target induce ISIS beam loss
- Number of protons lost depends on amount of material and geometry of target
- Efficiency of cylndrical target compared to rectangular target: η =0.169±0.001 (beam lost more efficiently for thick target)

Particle Yields in the MICE Target

- Big differences between hadronic models



- Calculated yields of particles:

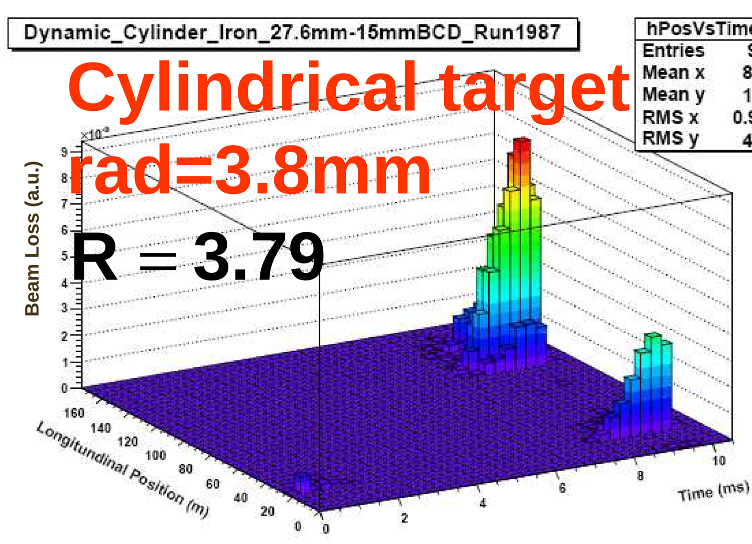
$$Y = \frac{\text{Rate}}{\text{POT} \times A(\text{cm}^2)}\frac{1}{\eta}$$

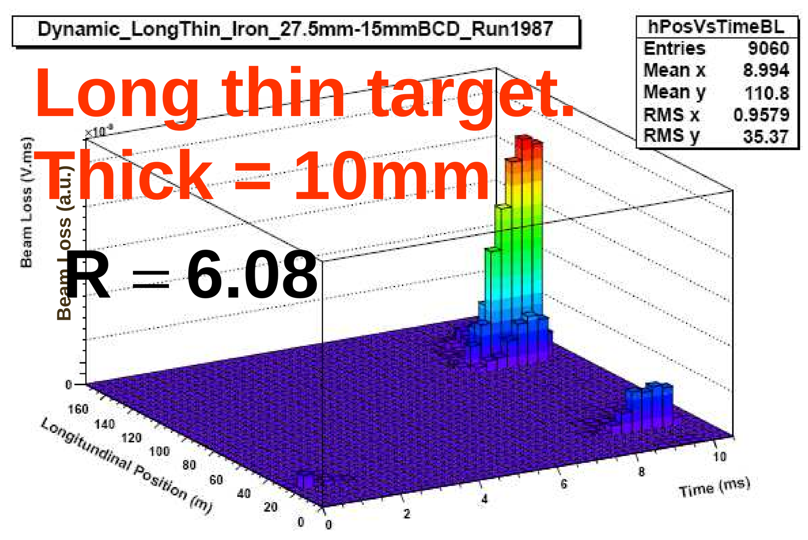
- Comparison MICE data and simulations:

Model	Yield $\left(10^{-8}\frac{counts}{POT\ cm^2}\right)$ C12	C34	C1234
Data	1.72 ± 0.52	0.82 ± 0.25	0.79 ± 0.24
QGSP_BIC	1.67 ± 0.01	0.84 ± 0.03	1.06 ± 0.04
QGSP_BERT	1.80 ± 0.02	0.81 ± 0.03	1.05 ± 0.04
LHEP	1.03 ± 0.01	0.25 ± 0.01	0.29 ± 0.02
QGSC_CHIPS	0.74 ± 0.01	0.37 ± 0.02	0.49 ± 0.03
QGSC_BERT	1.80 ± 0.02	0.84 ± 0.03	1.06 ± 0.04

ORBIT

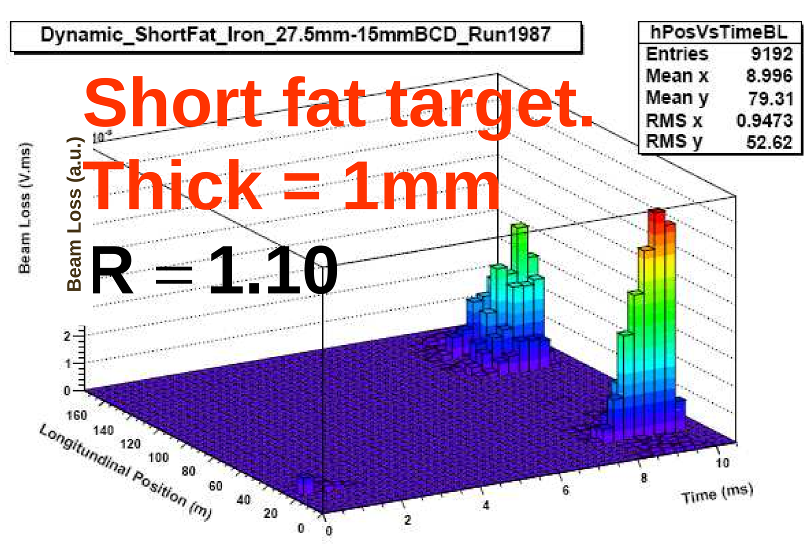
- ORBIT simulations targets dipping into ISIS
- Studies of beam loss in ISIS ring
- Protons lost nearer to target when target thicker





- Ratio beam loss target/collimator:

$$R = \frac{BL(\text{target})}{BL(\text{collimator})}$$



Status:

- MICE beam including target and Luminosity Monitor installed and performing well
- Simulations using QGSP_BIC, QGSP_BERT or QGSC_BERT models agree with data
- ORBIT simulations demonstrate beam loss close to target for thick targets