Meson Production Simulations

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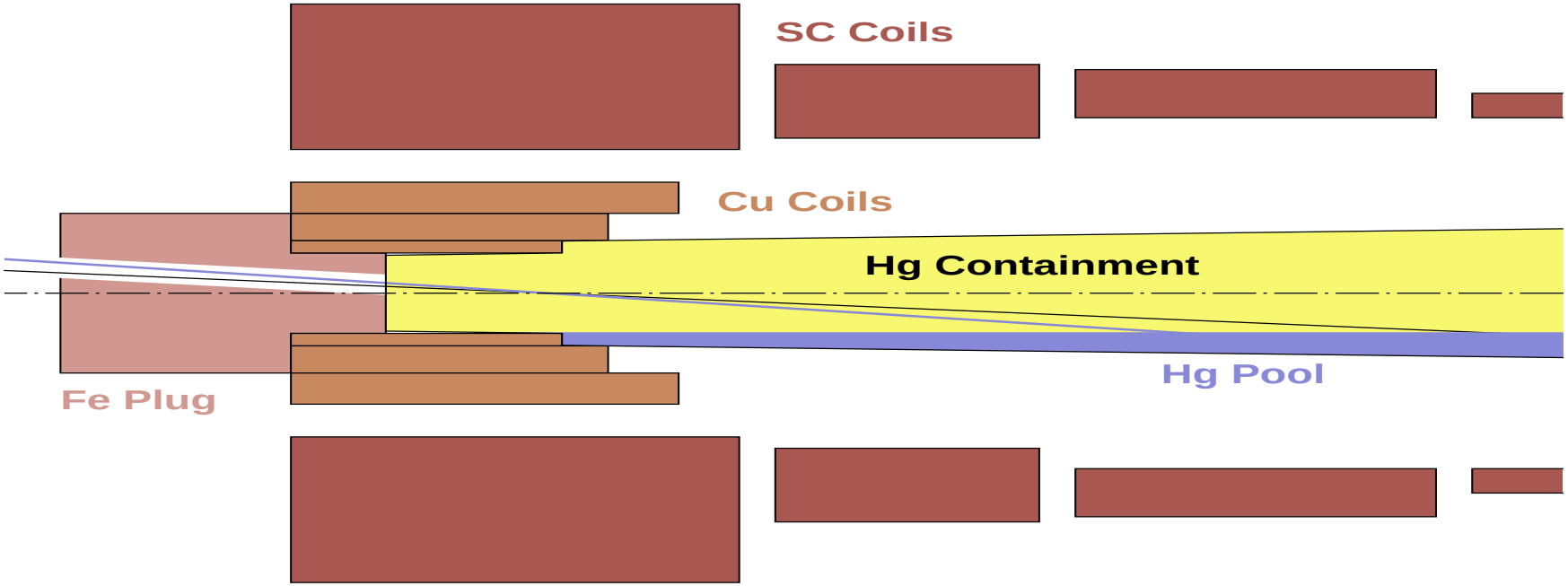
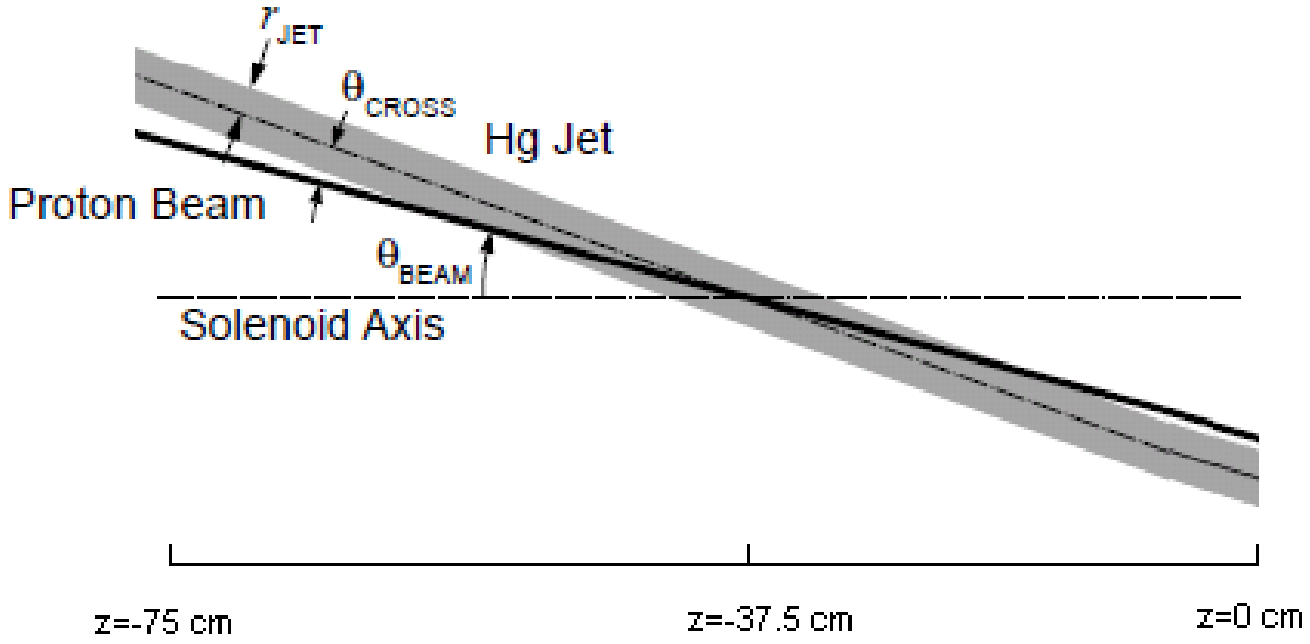
Outline

- Mercury Target Geometry and Optimized Target Parameters (Beam below Mercury Jet)
- Beam Initial Position, Beam/Jet Crossing Angle and Beam Path Length inside the Hg Jet (Beam below Mercury Jet)
- Multiple Proton Beam Entry Directions (Beam around Mercury Jet)
- Meson Production
- Summary

Neutrino Factory Target Concept

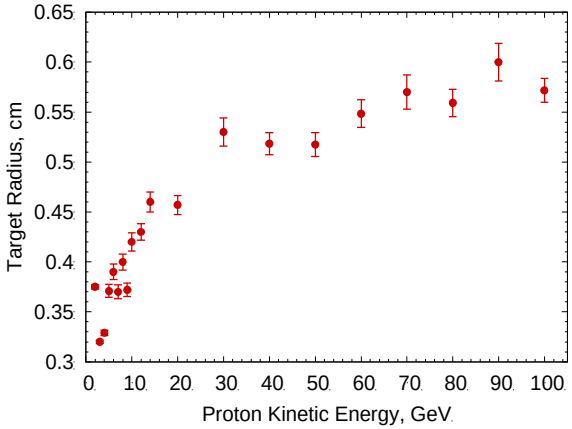


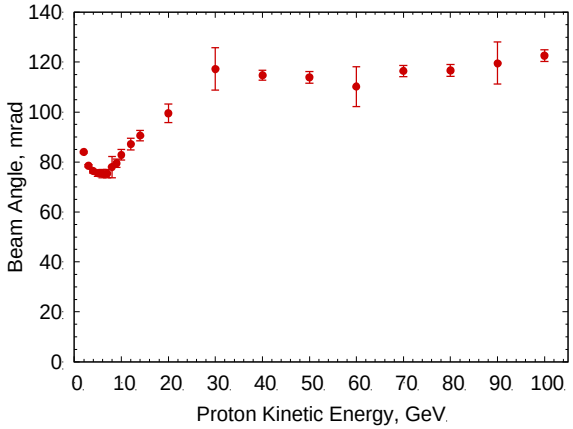
Mercury Target Geometry

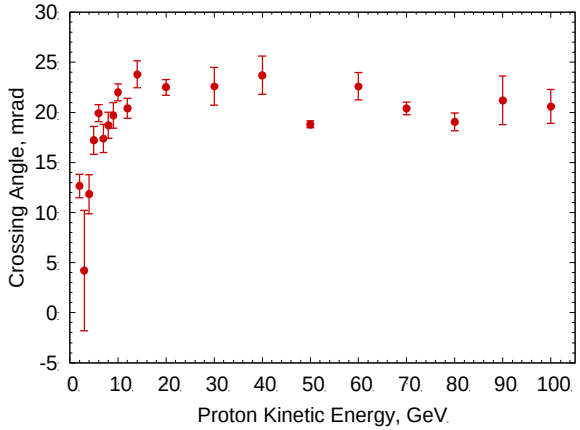


1. The proton beam is below the Hg jet at z=-75cm.
2. Count all the pions and muons of positives and negatives that cross the transverse plane at z=50m.
3. For this analysis we select all pions and muons with 40MeV<KE<180MeV.

Optimized Target Parameters at z=-75cm

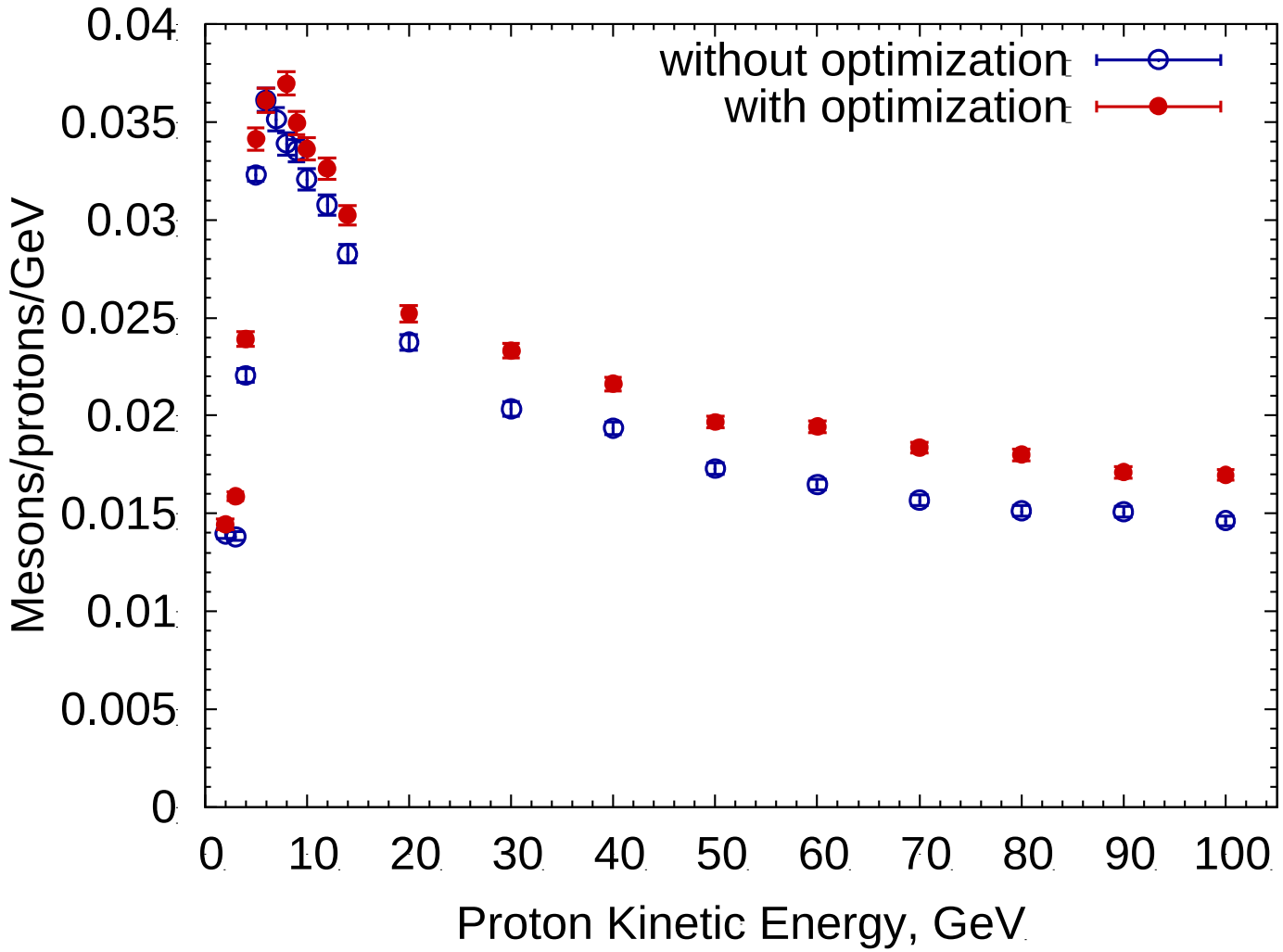




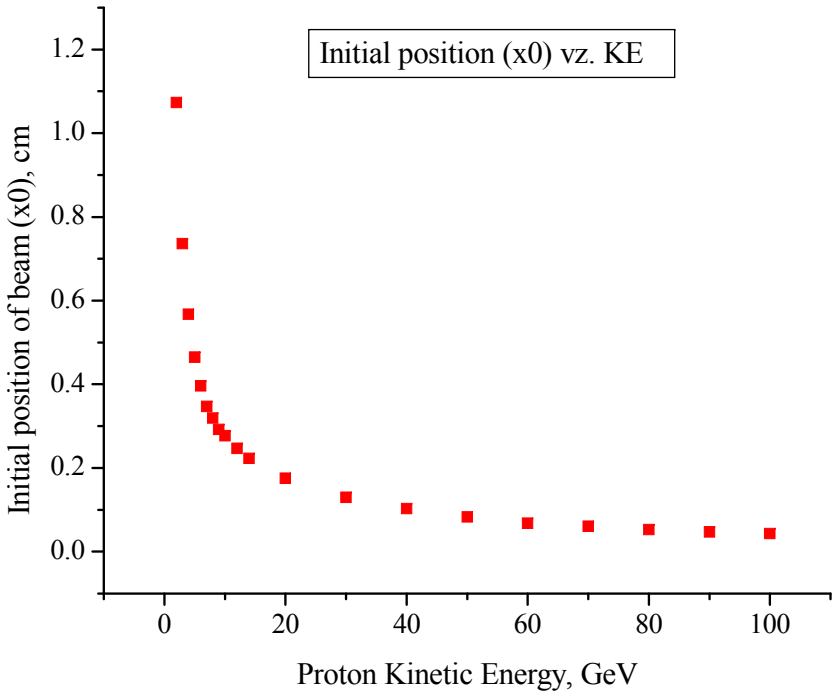


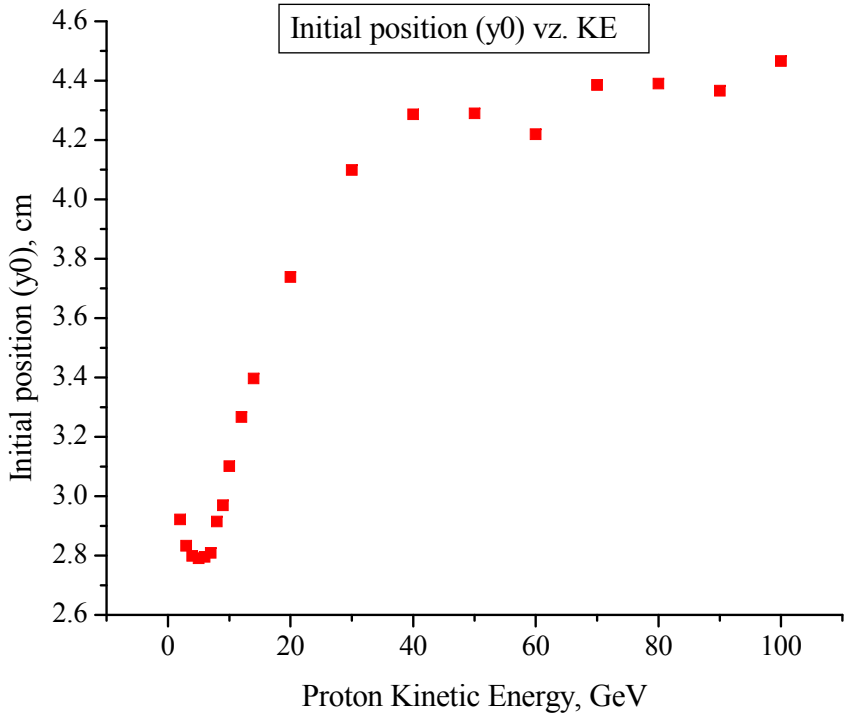
1. Beam and Jet cross only at z=-37.5cm. Beam angles also vary at different z. So the crossing angle at z=-75cm actually means the angle between beam moving direction and jet.
2. Previous Baseline: radius of 0.5cm,beam angle of 67mrad and beam/jet crossing angle of 33mrad.

Meson Production w/wt Optimization

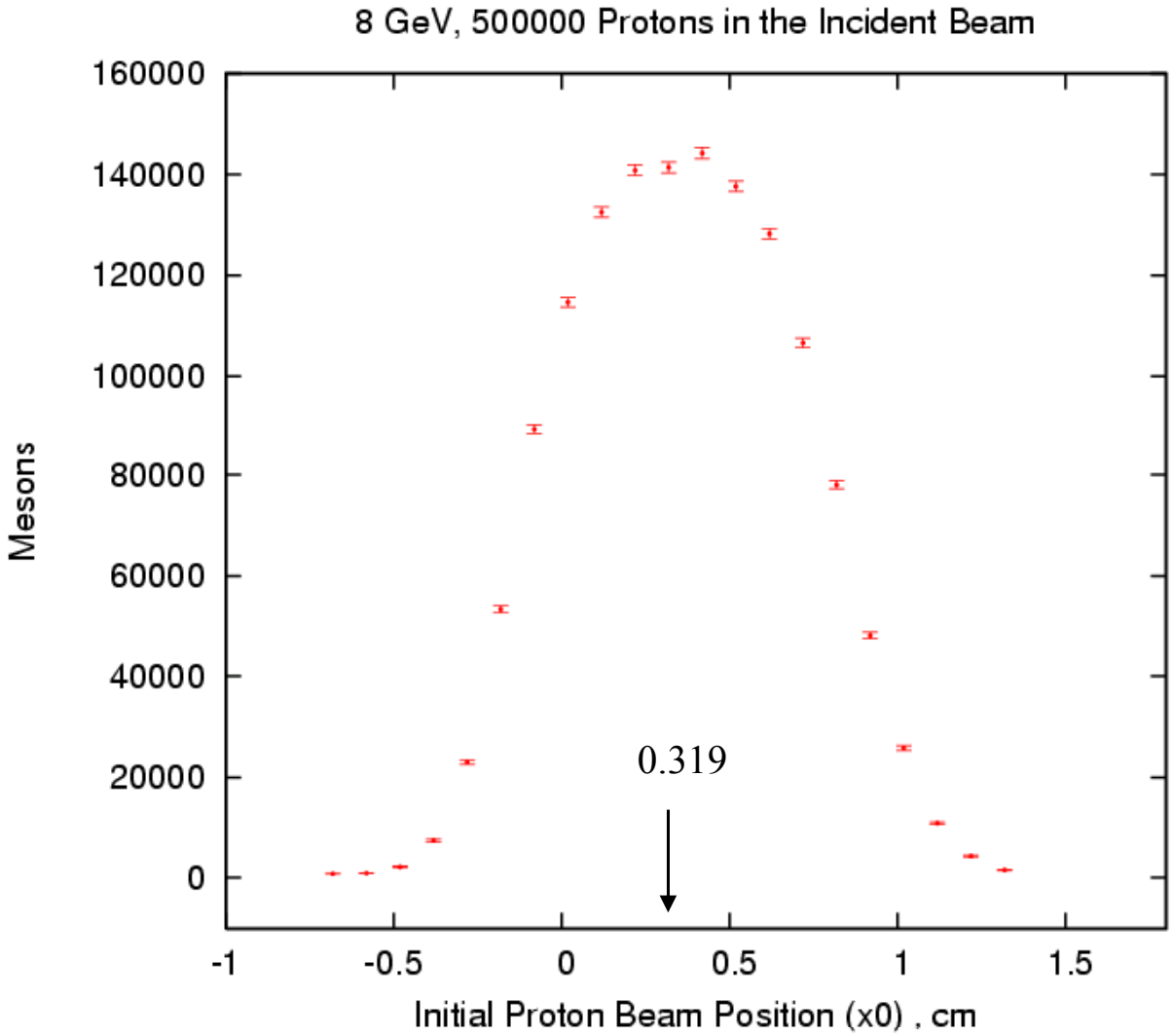


Required Beam Initial Position at z=-75cm to Achieve x=y=0 at z=-37.5cm)

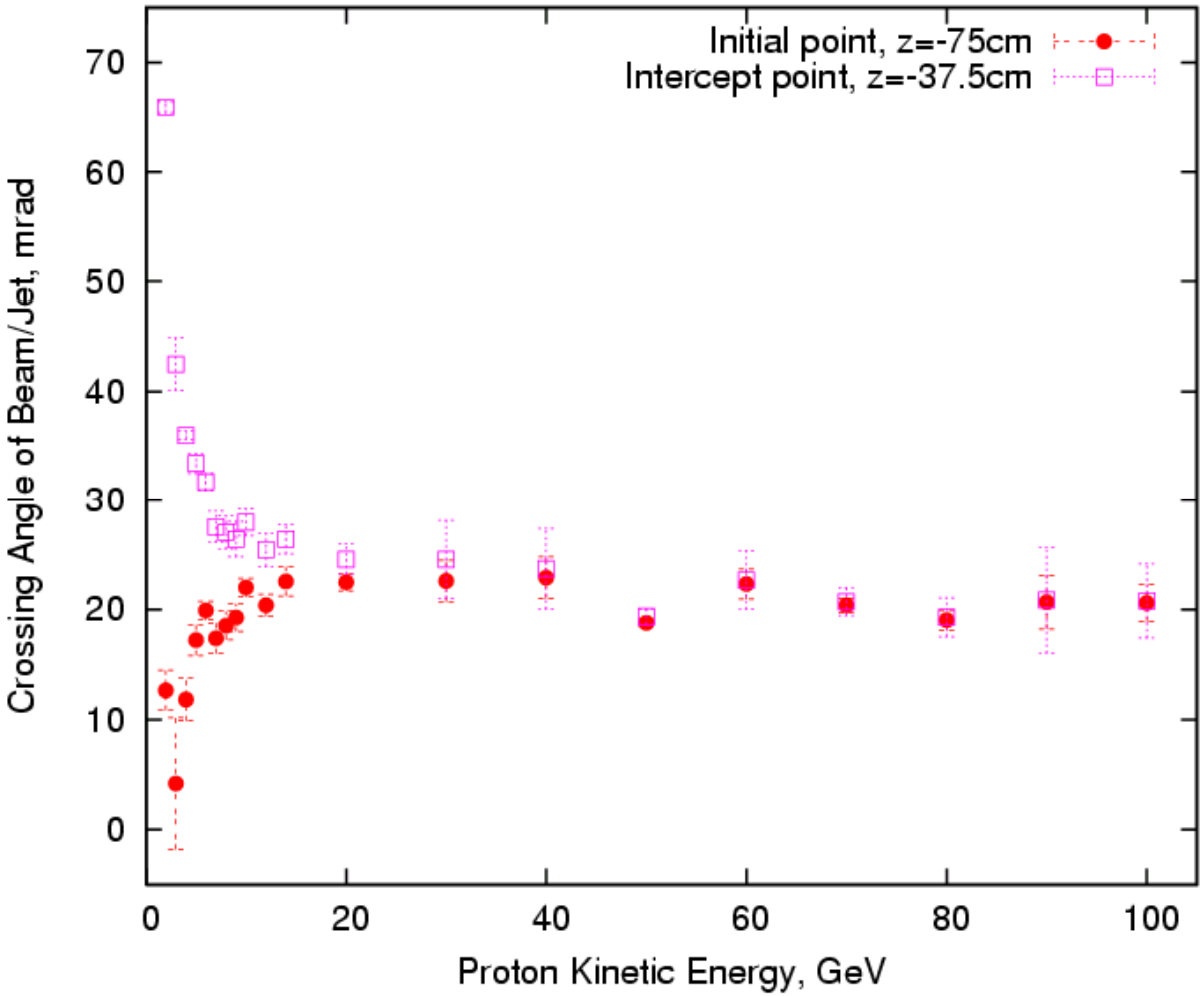




Effect of Different Beam Initial Position

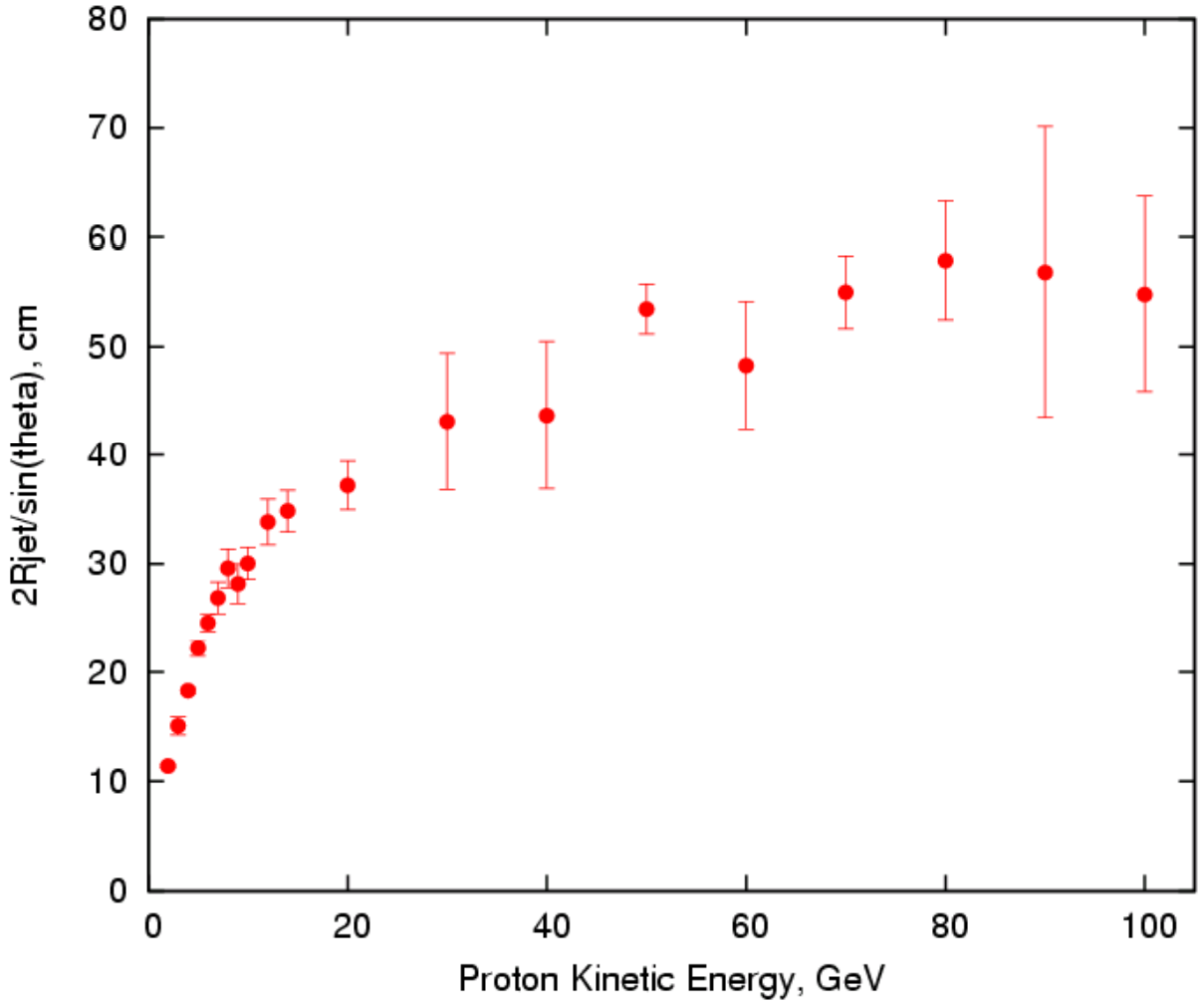


Beam/Jet Crossing Angle at z=-75cm and z=-37.5cm



8GeV, 18.55mrad at z=-75cm and 27.05mrad at z=-37.5cm

Beam Path Length inside the Mercury Jet



Nuclear interaction length for Hg is 14.58cm

Multiple Proton Beam Entry Directions

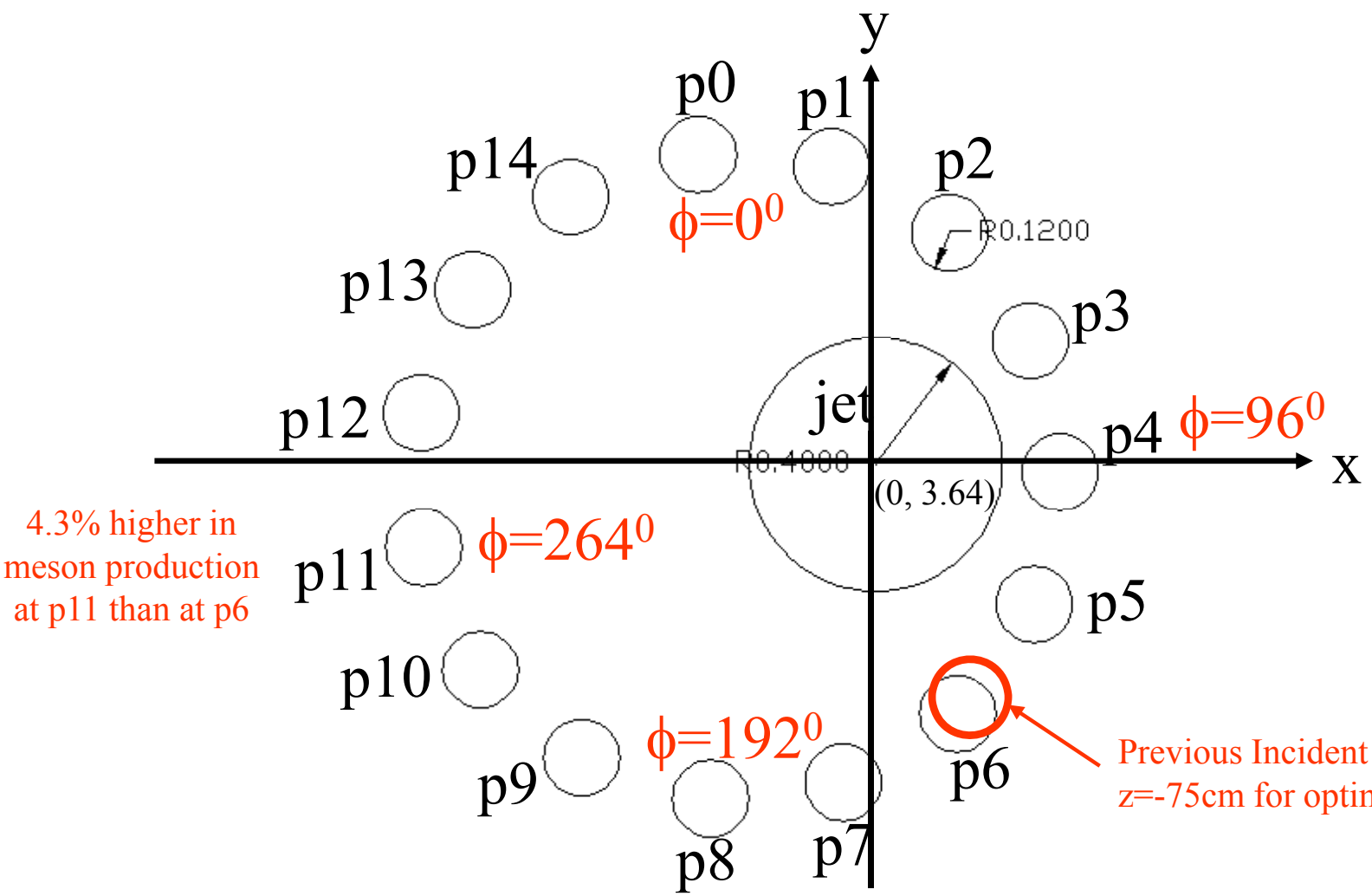
- 8GeV, $\theta_j = 96.68 mrad, r_j = 0.4 cm, \sigma_b = 0.3 r_j$
- Roll angle(Φ): Telling us what side of the jet the beam is on. (below: Φ=π, up: Φ=0, left: Φ= π/2, right: Φ=3π/2)
- Clearance: Telling us the extent of proton beam away from the Hg jet at z=-75cm.

$$C = \frac{\sqrt{(x_0 - x_j)^2 + (y_0 - y_j)^2} - r_j}{\sigma_b}$$

x_j=0, y_j=3.64cm. (x_0, y_0) is beam initial position.

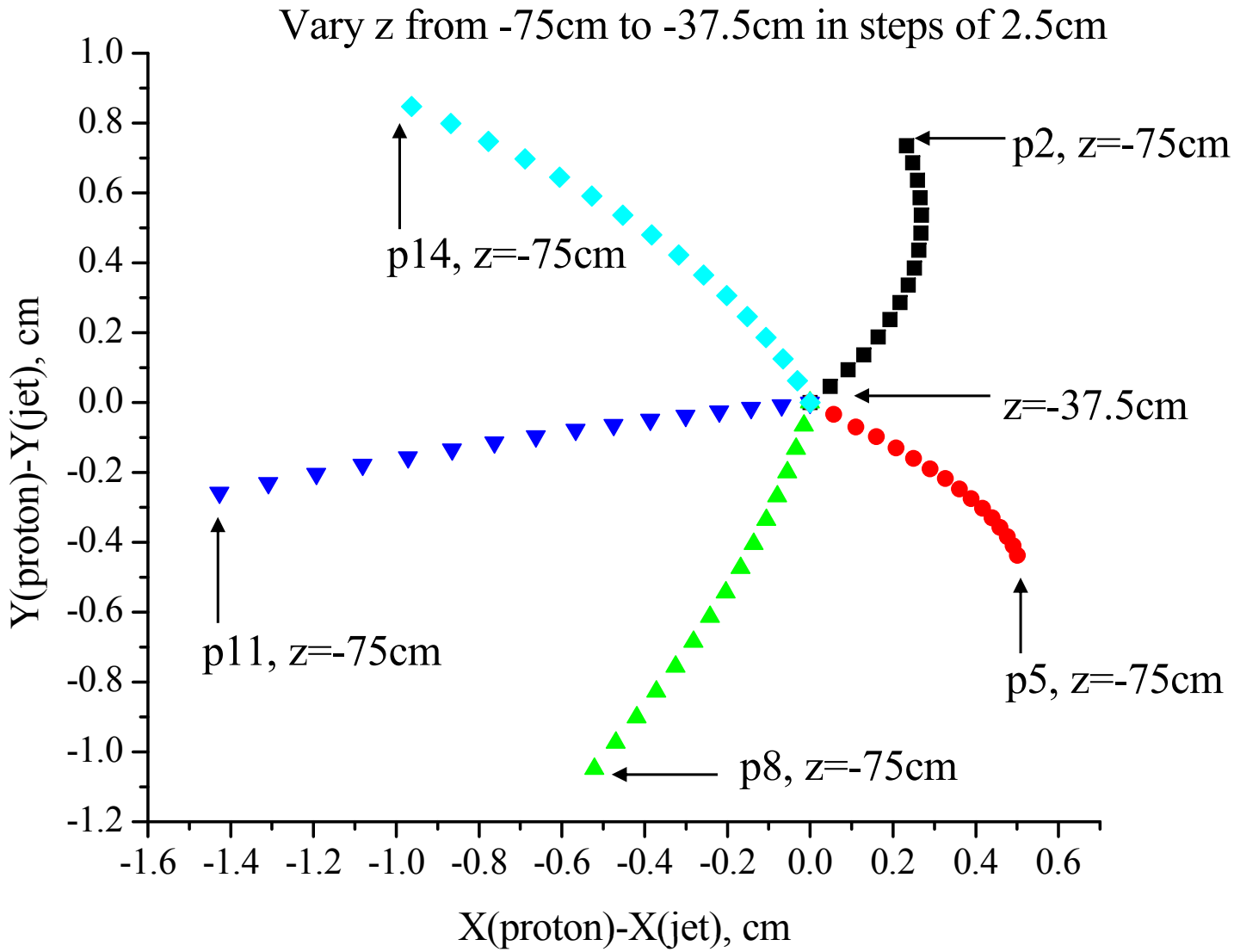
Multiple Proton Beam Entry Directions

The Required Beam Position at z=-75cm to Keep Same Crossing Angle and 24^0 Roll Angle Apart at z=-37.5cm

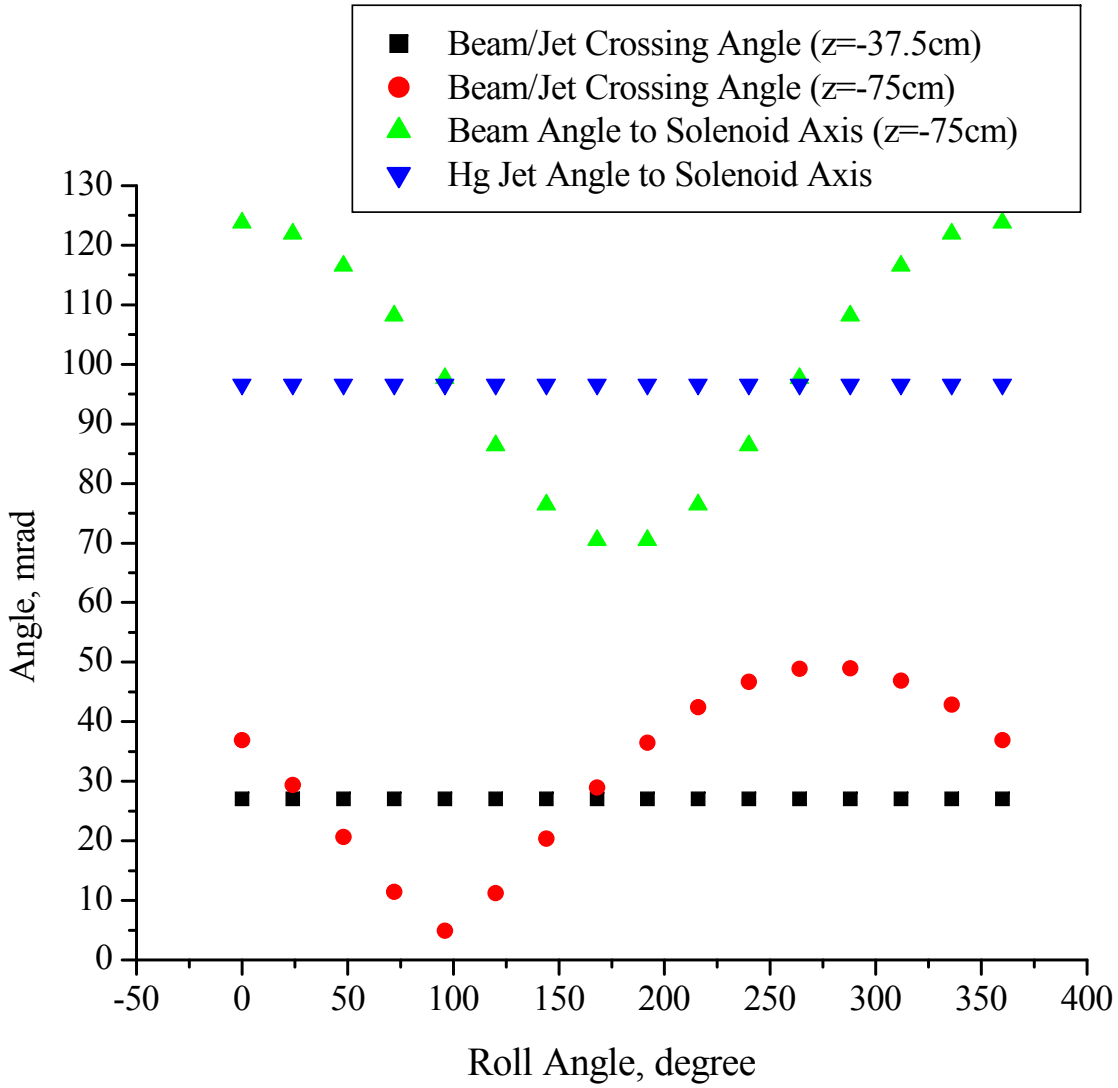


Multiple Proton Beam Entry Directions

x-y plot of proton relative to jet at different z

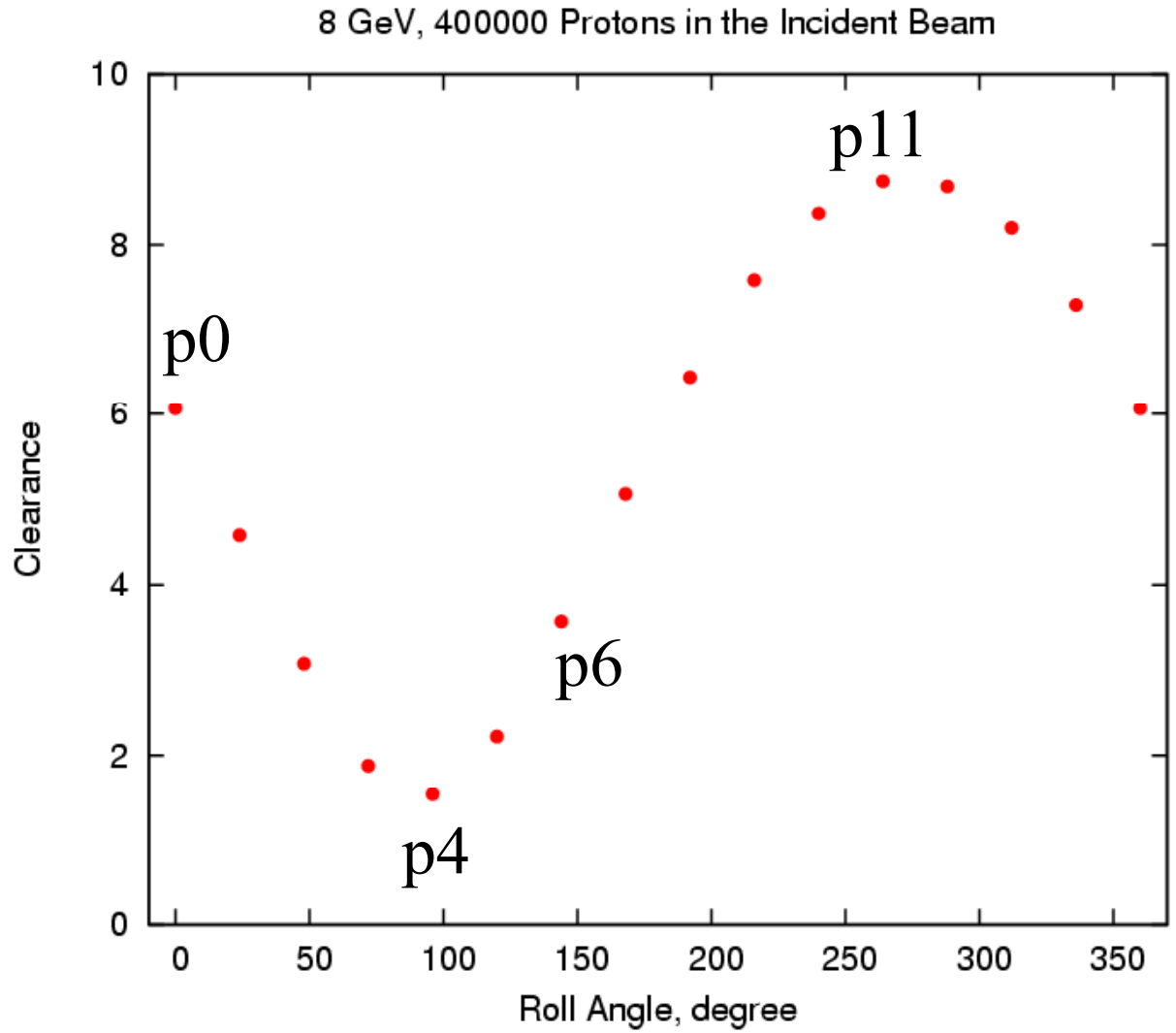


Multiple Proton Beam Entry Directions



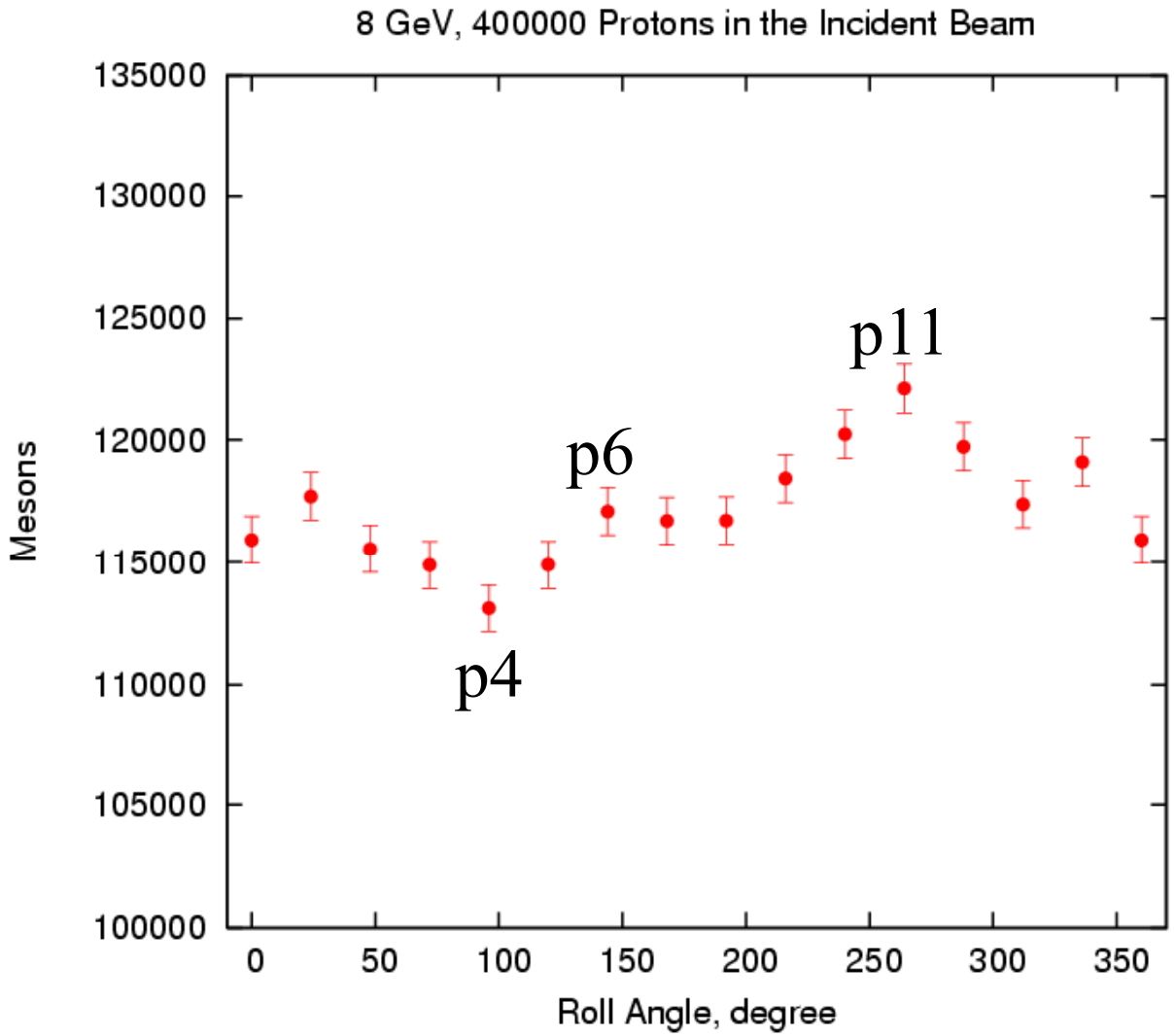
Multiple Proton Beam Entry Directions

Clearance at z=-75cm for Same Crossing Angle and 24^0 Roll Angle apart at z=-37.5cm

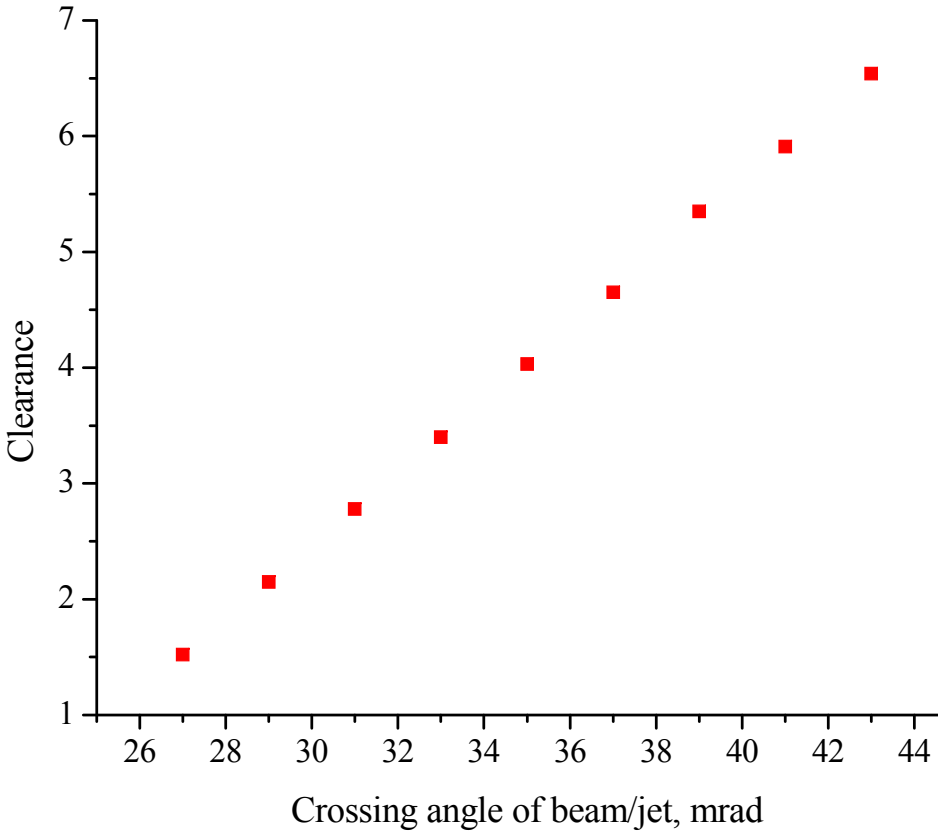


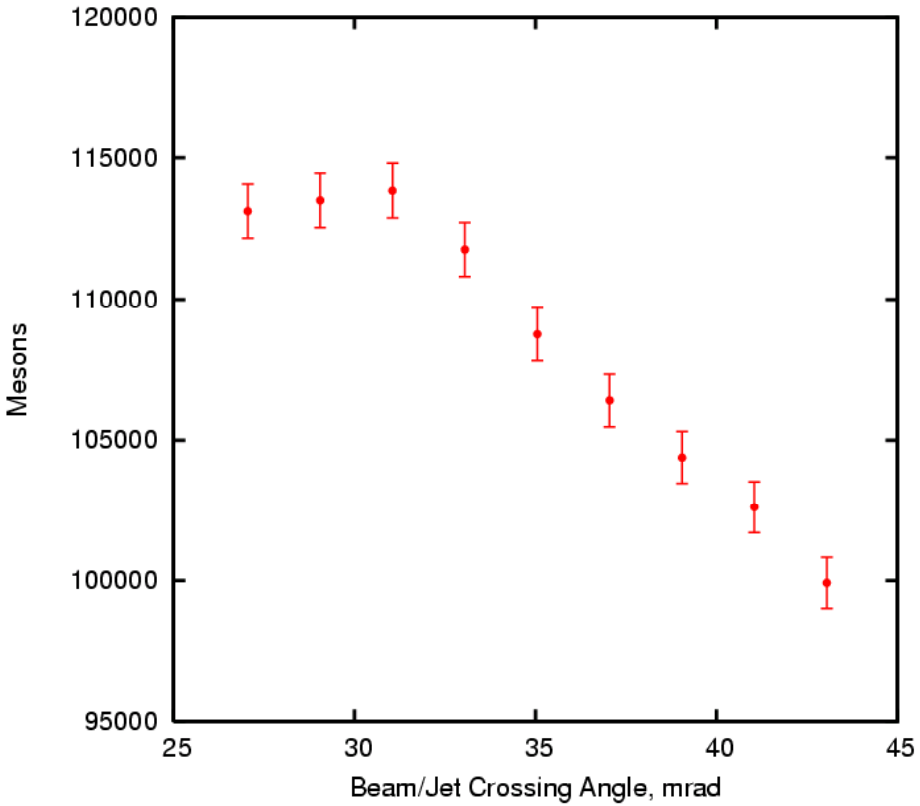
Multiple Proton Beam Entry Directions

Meson 40MeV<KE<180 MeV at 50m for Same Crossing Angle and 24^0 Roll Angle apart at z=-37.5cm

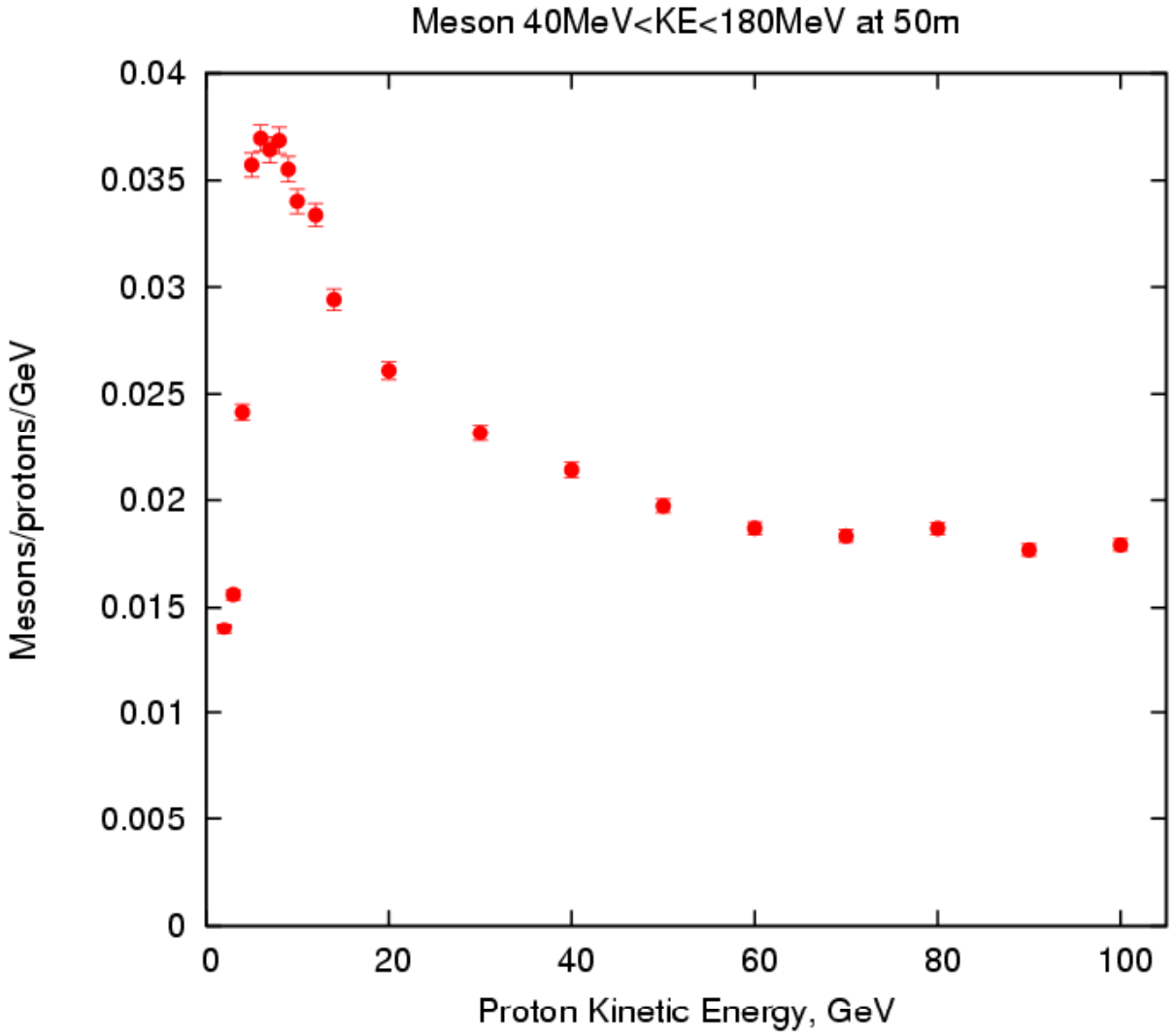


Increasing Clearance of p4

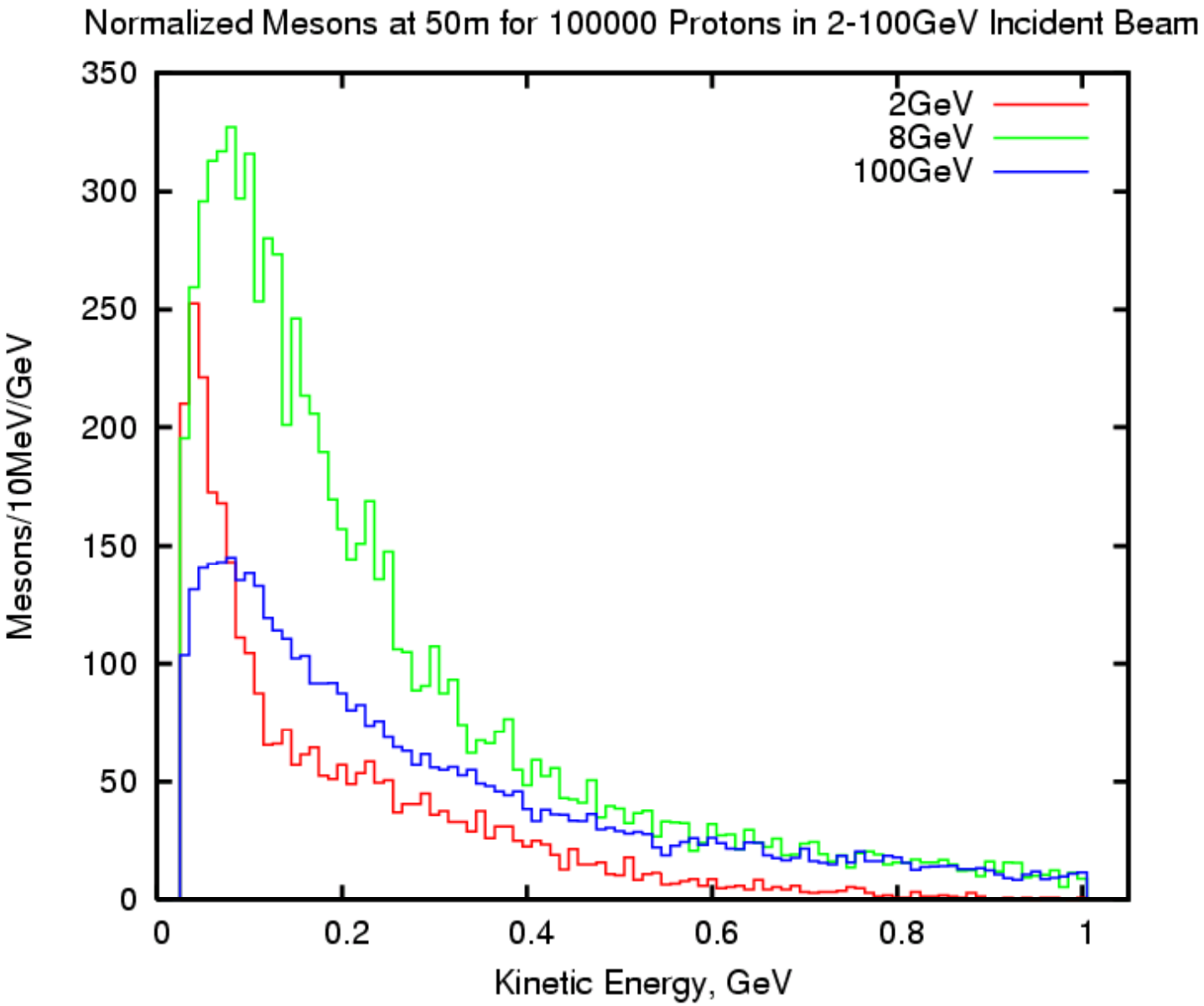




Normalized Meson Production (beam below jet)



Normalized Mesons at 50m
(beam below jet)



Summary

- Target parameters of incident beam below Hg target and KE from 2 to 100GeV are optimized.
- Beam angles and beam/jet crossing angles vary at low KE due to magnet field.
- The beam path length inside the jet is less than 2 times of the Hg interaction length at low KE.
- Layouts of multiple proton beam entry directions relative to the Hg jet at z=-75cm are determined to achieve the same crossing angle at z=-37.5cm.
- There is about 4% increase in meson production at p11 compared to p6.