Study of Proton Absorber in the MICE Beamline

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- Aim to check that the proton absorber works

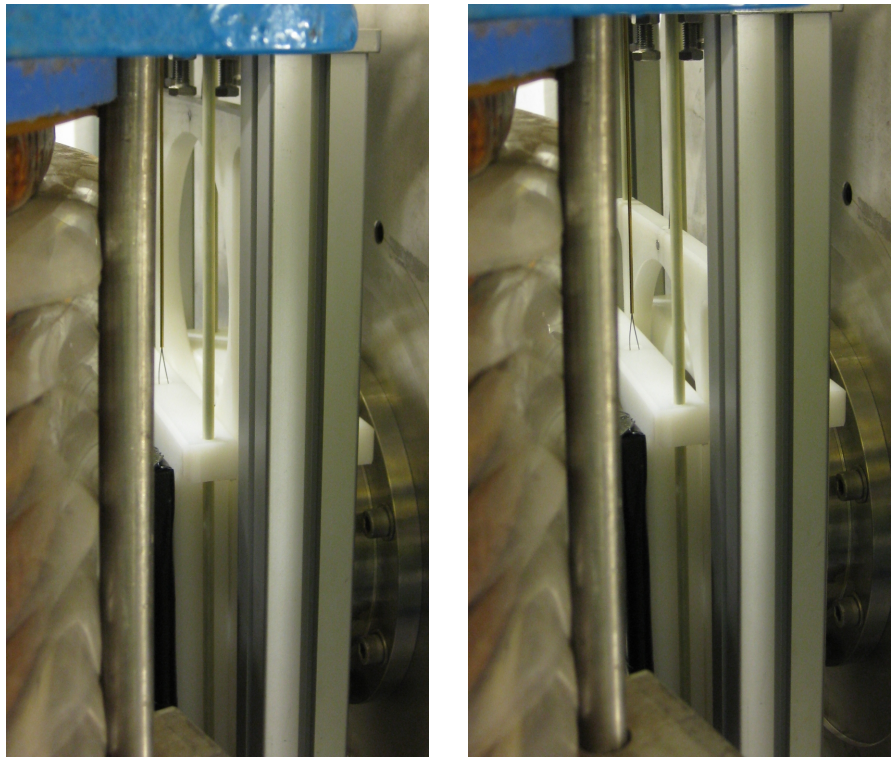


Figure: Proton absorber in action; D2 to left, DS to right; in "out" position, hole is in beamline; in "in" position, plastic is in beamline. Worked by cable pull

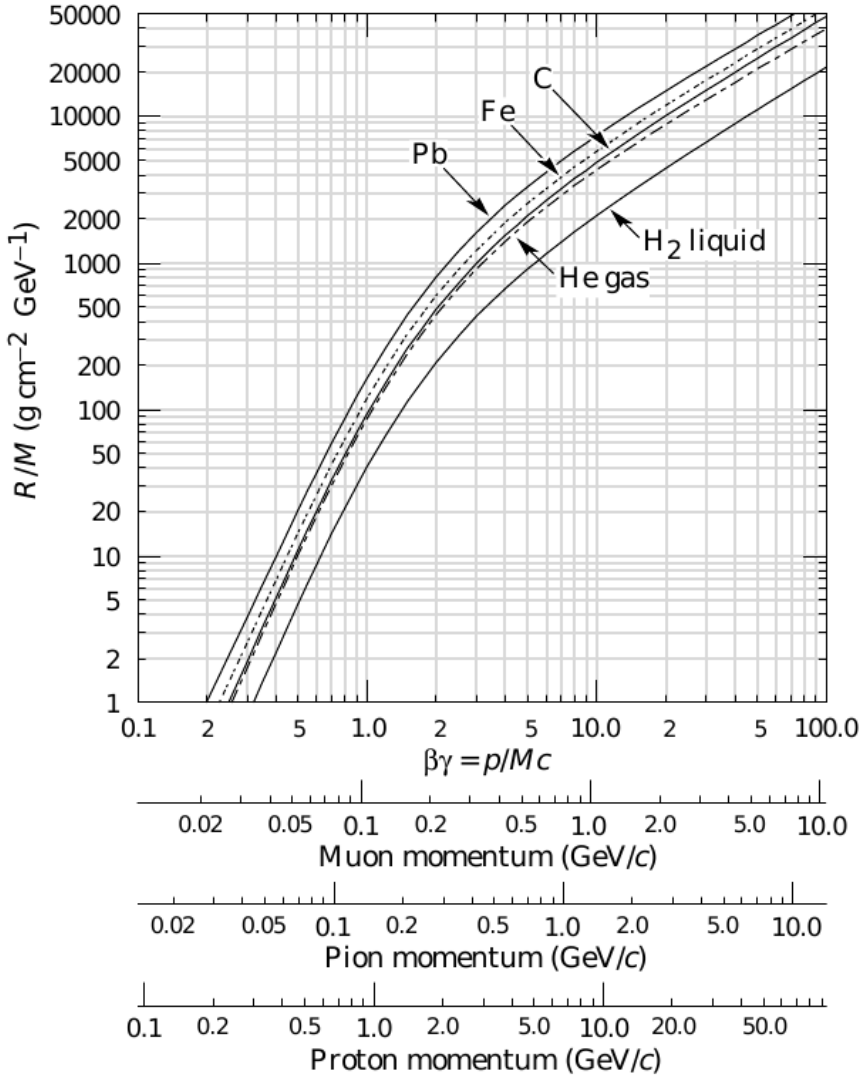


Figure: Stopping range of particles in material; plastic has a density of 0.89 g/cm^3 [PDG].

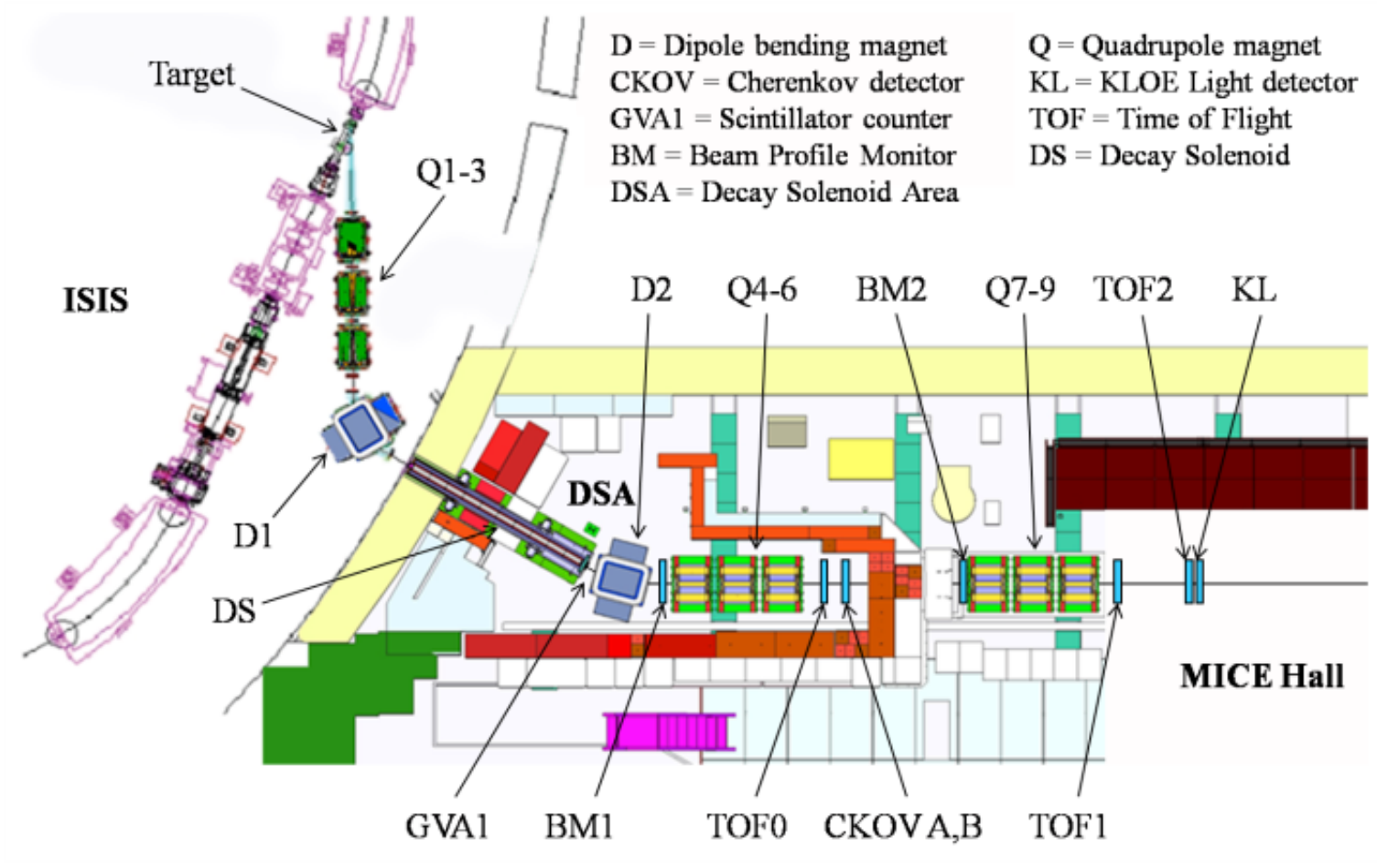


Figure: The proton absorber was installed between the decay solenoid and GVA1

Magnet	140 MeV/c Beamline Momenta	200 MeV/c Beamline Momenta	240 MeV/c Beamline Momenta
Q1	361.28	451.37	507.39
Q2	361.05	451.16	507.18
Q3	360.83	450.94	506.96
D1	360.60	450.72	506.75
DS	360.37	450.49	506.52
D2	202.86	255.87	296.88
Q4	201.20	254.35	295.41
Q5	201.19	254.35	295.41
Q6	200.68	253.88	294.95

- Studied 3 beamline magnet settings designed to cover full range of beamlines for MICE
- Jargon: "140 MeV/c beamline" means beamline to deliver muons with 140 MeV/c at MICE central absorber
- In fact material and pion decay means particle momentum is very different at different points in beamline

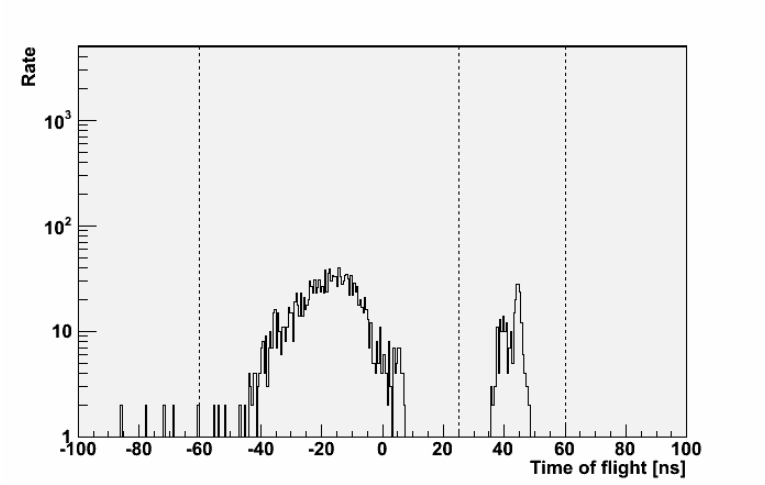
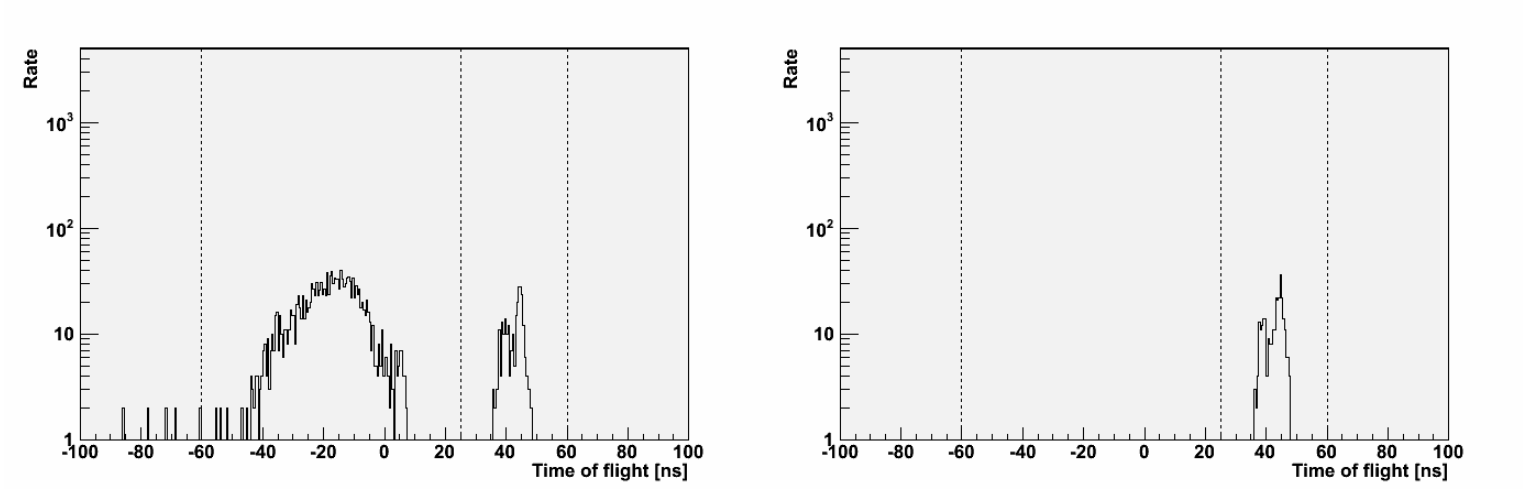


Figure: Time of flight histogram between GVA1 and TOF0.

Two peaks in time-of-flight between GVA1 and TOF0

- Associated with protons and pions.
- Some TOFs negative due to cable length
- Dual peak in "pion" peak - could be PID, could be a detector effect (don't use calibrated TOF0).
- Note cuts (dashed lines) - used for PID.



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Proton peak disappears when I include absorber (right).

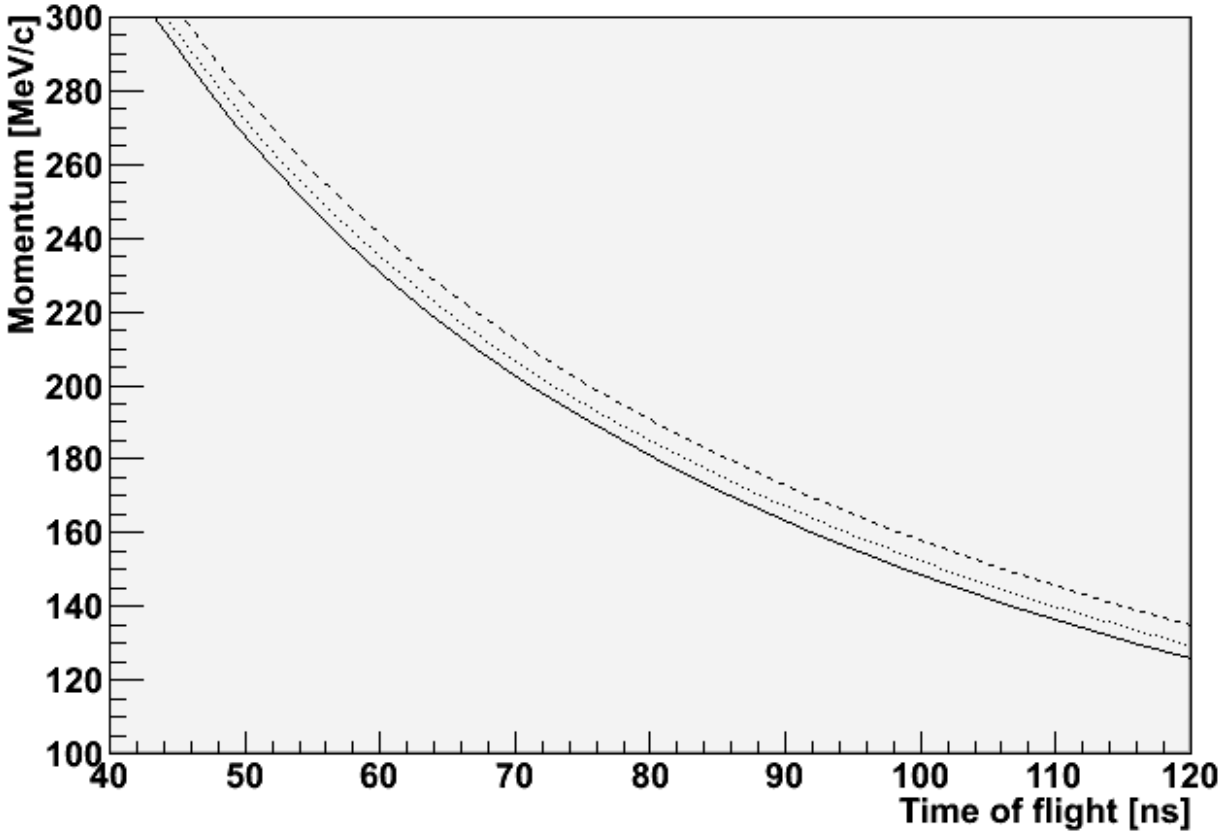


Figure: Time of flight difference between protons and pions/muons/electrons as a function of p.

- Time of flight between two peaks is $\sim$ what one expects for pion peak and proton peak.
- Assuming D2 selects momentum.

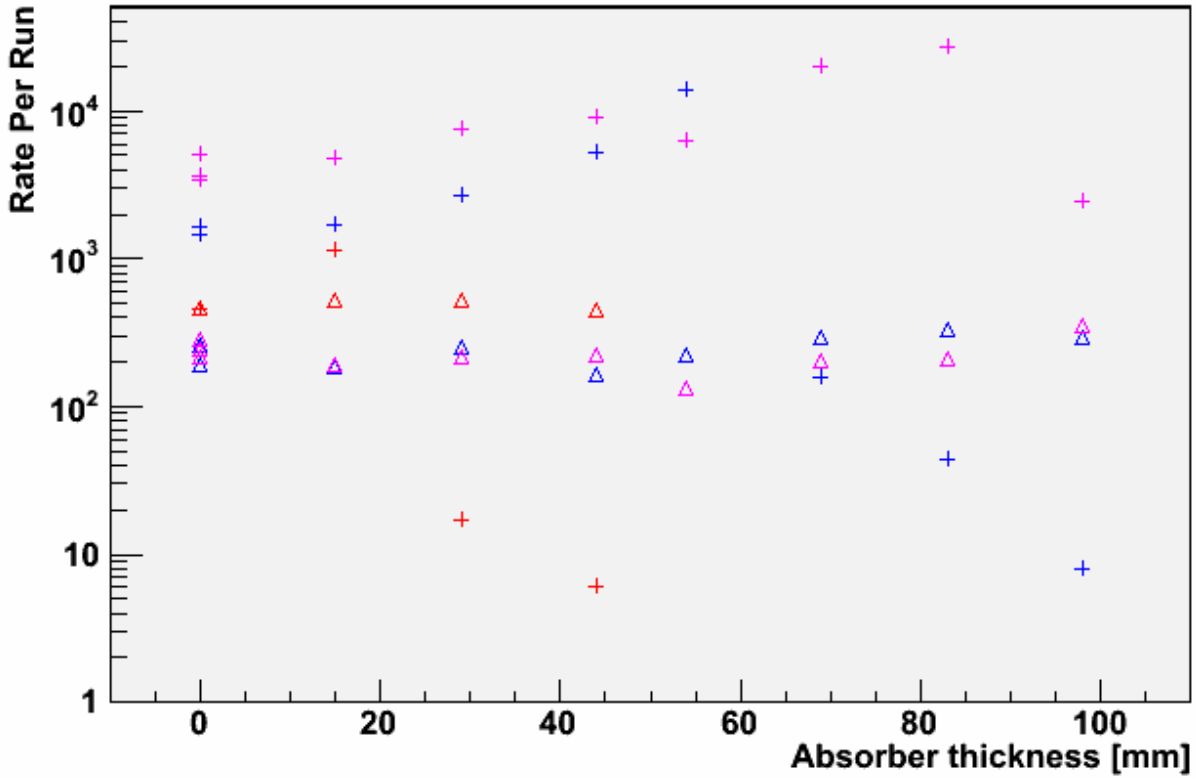
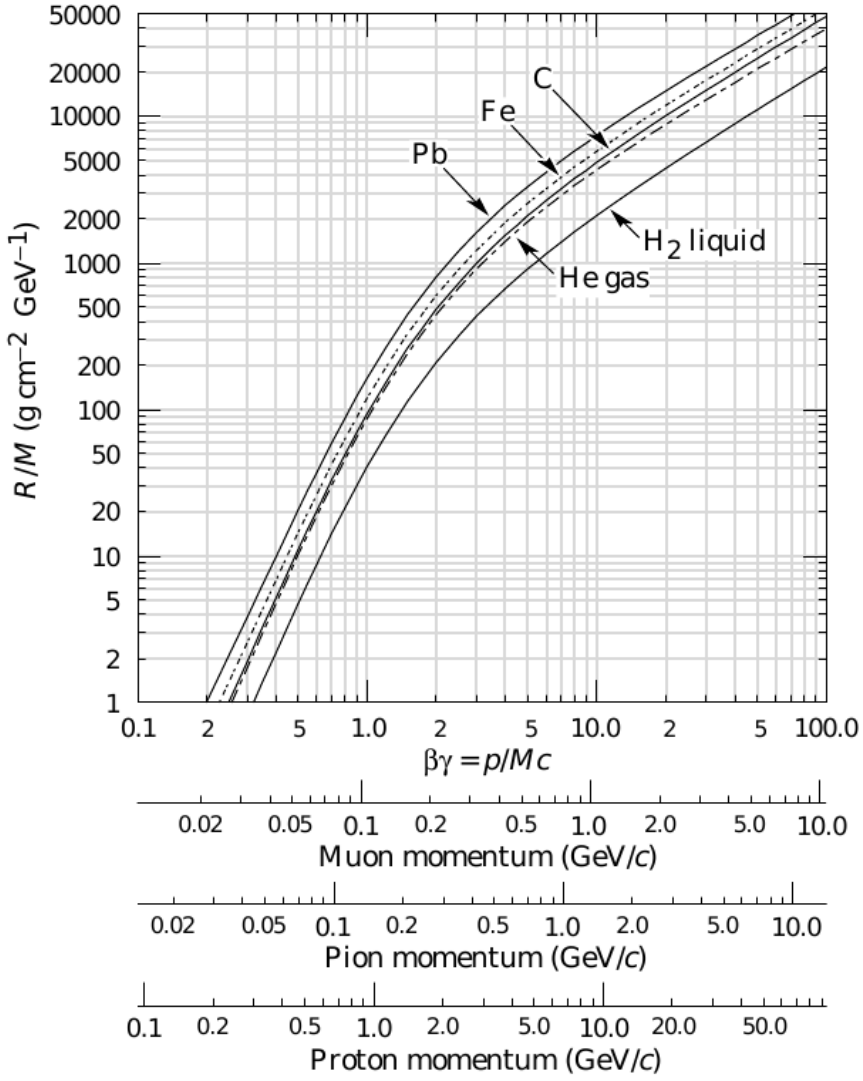


Figure: Number of particles in time of flight cuts as a function of proton absorber thickness (log scale). Crosses are number of protons, triangles are number of pions; red is data for 140 MeV/c, blue is 200 MeV/c, pink is 240 MeV/c.

- Protons visible for over a range of absorber thicknesses.
- Means proton spectrum has long low energy tail.



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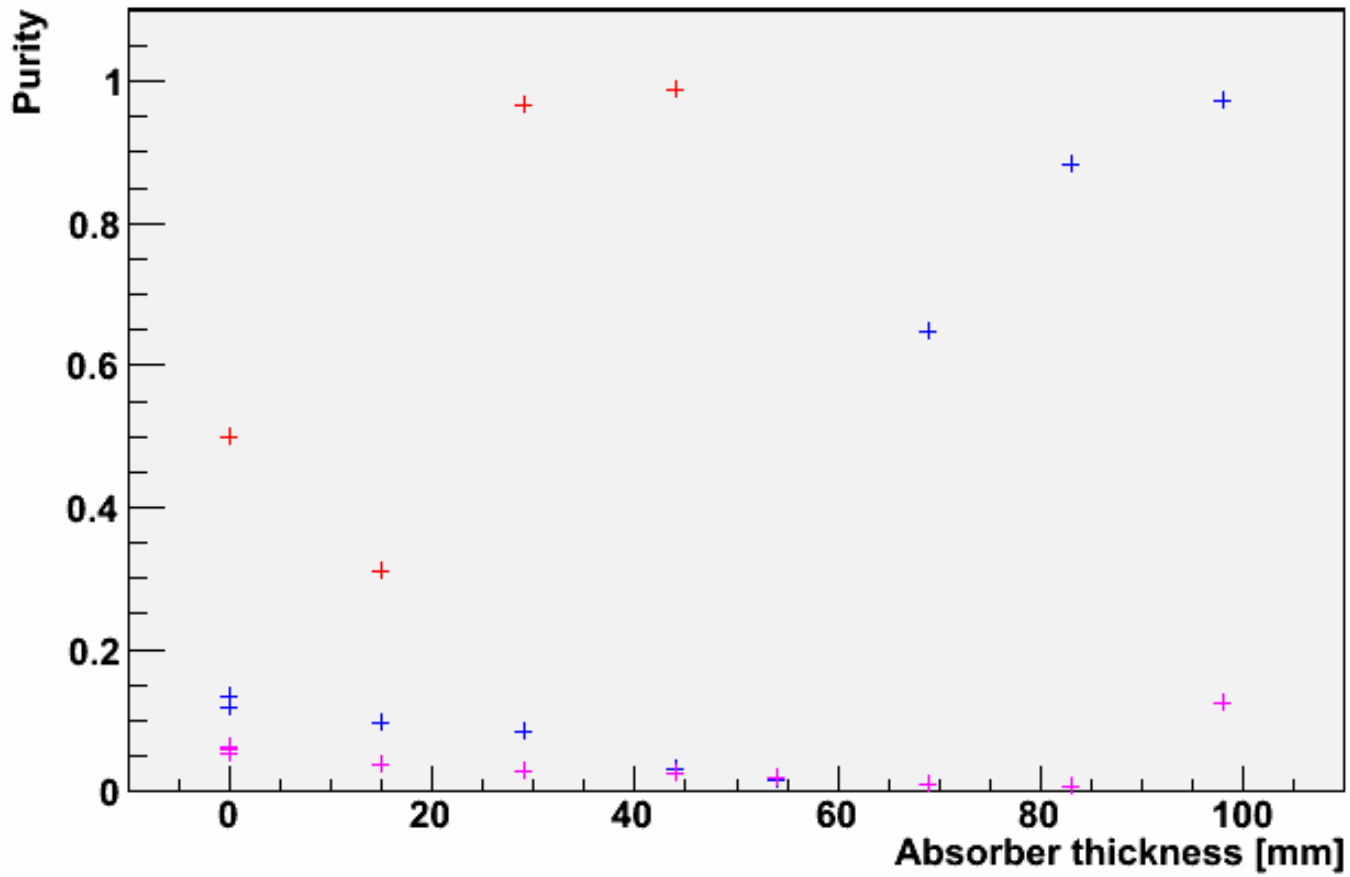

Figure: Beam purity (number of pions)/(number of protons+number of pions) as a function of total plastic thickness; red is data for 140 MeV/c, blue is 200 MeV/c, pink is 240 MeV/c.

Conclusions:

- For 140 MeV/c beamline use 29 mm of plastic.
- For 200 MeV/c beamline use 83 mm of plastic.
- For 240 MeV/c, 100 mm of plastic is not enough.
- Adding extra 50 mm block during this shutdown.
- Need to re-optimise beamline?
- Consider using forward-going muons from pion decay (lower D1 current)?