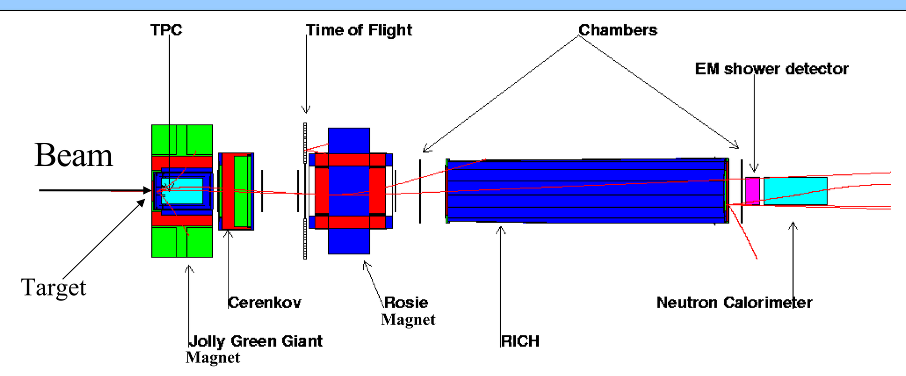
Preliminary Elastic Scattering Data from the MIPP Experiment

Gural Aydin, Univ. of Iowa (for the MIPP collaboration)

R.L. Abrams, U. Akgun, G. Aydin, W. Baker, P.D. Barnes Jr., T. Bergfeld, A. Bujak, D. Carey, C. Dukes, F. Duru, G. Feldman, Y. Fisyak, N. Graf, A. Godley, E. Gulmez, Y. Gunaydin, H.R. Gustafson, L. Gutay, E. Hartouni, P. Hanlet, M. Heffner, J. Hylen, C. Johnstone, D. Kaplan, O. Kamaev, J. Klay, M. Kostin, D. Lange, A. Lebedev, M. Longo, L.C. Lu, C. Maternick, M. Messier, H. Meyer, D.E. Miller, S.R. Mishra, N. Mokhov, K. Nelson, T. Nigmanov, A. Norman, Y. Onel, J. Paley, A. Para, H.K. Park, A. Penzo, R.J. Peterson, R. Raja, D. Rajaram, D. Ratnikov, C. Rosenfeld, H. Rubin, S. Seun, N. Solomey, R. Soltz, S. Striganov, E. Swallow, Y. Torun, R Winston, D. Wright and K. Wu

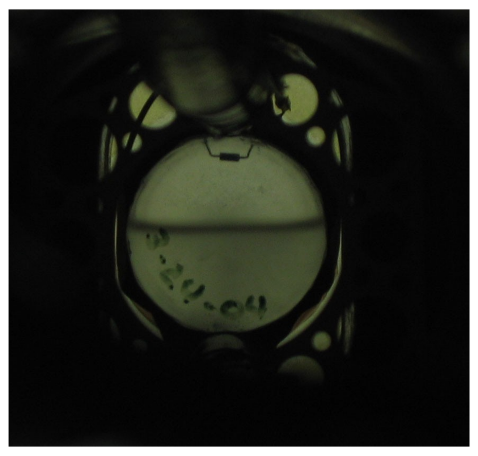
Detector Performance:

Detectors are performing well in various stages of calibration, which we expect to finish in July. Plots shown use data from the 2005 run without selection. Beam particle ID for various momenta and targets were used in this analysis. Secondary particles were only identified by RICH, and momentum measured by tracking chambers.

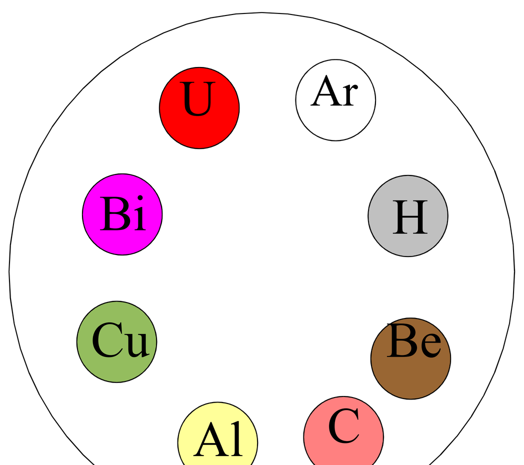


Targets and Events:

MIPP collected 2 M events on the composite NuMI target and 10 M events on 6 thin Nuclear targets of 1% λ.



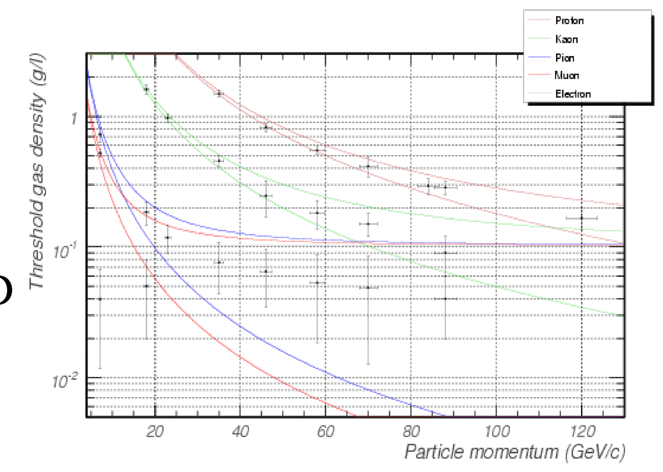
MIPP used a cryogenic Liquid Hydrogen target for 5 M events. Shown here while it is being filled.

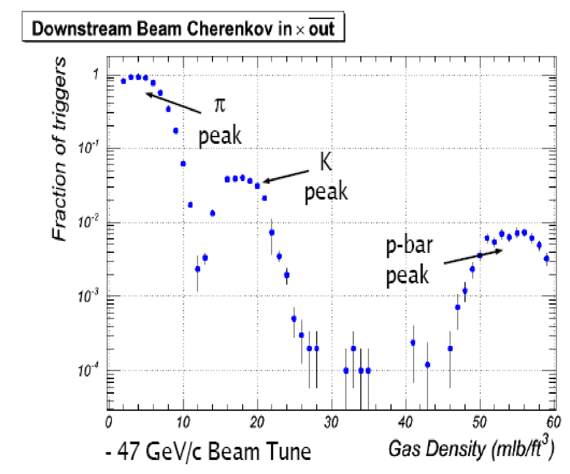


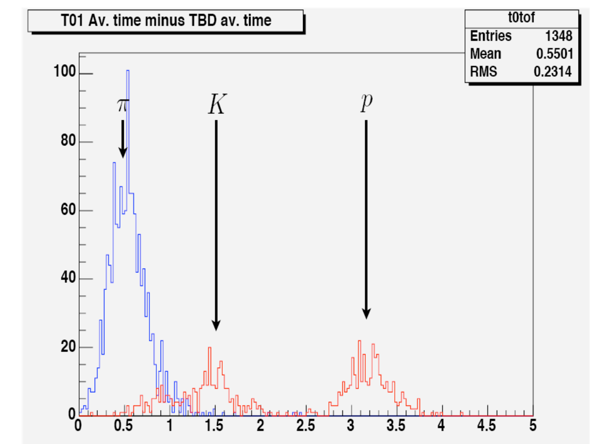
In addition we have a Argon gas target in the TPC and empty target runs for background subtraction.

Beam Particle Identification:

Six beam species: π^+, K^+, p and antiparticles are triggered with 98% tagging efficiency by the two differential beamline Cherenkov detectors. They work over a wide beam momentum range from 10 to 120 GeV/c. Scintillators in the beamline tag the beam particles and provide PID from ToF at low momentum.



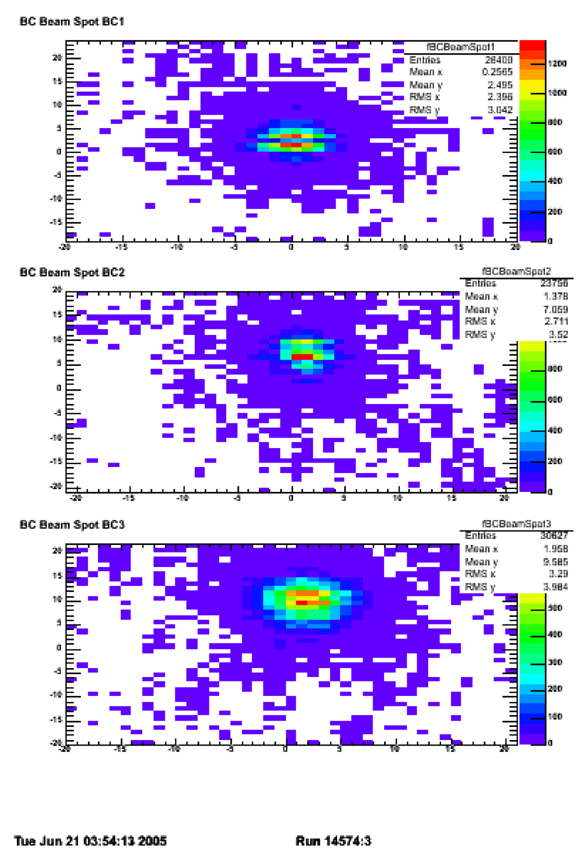




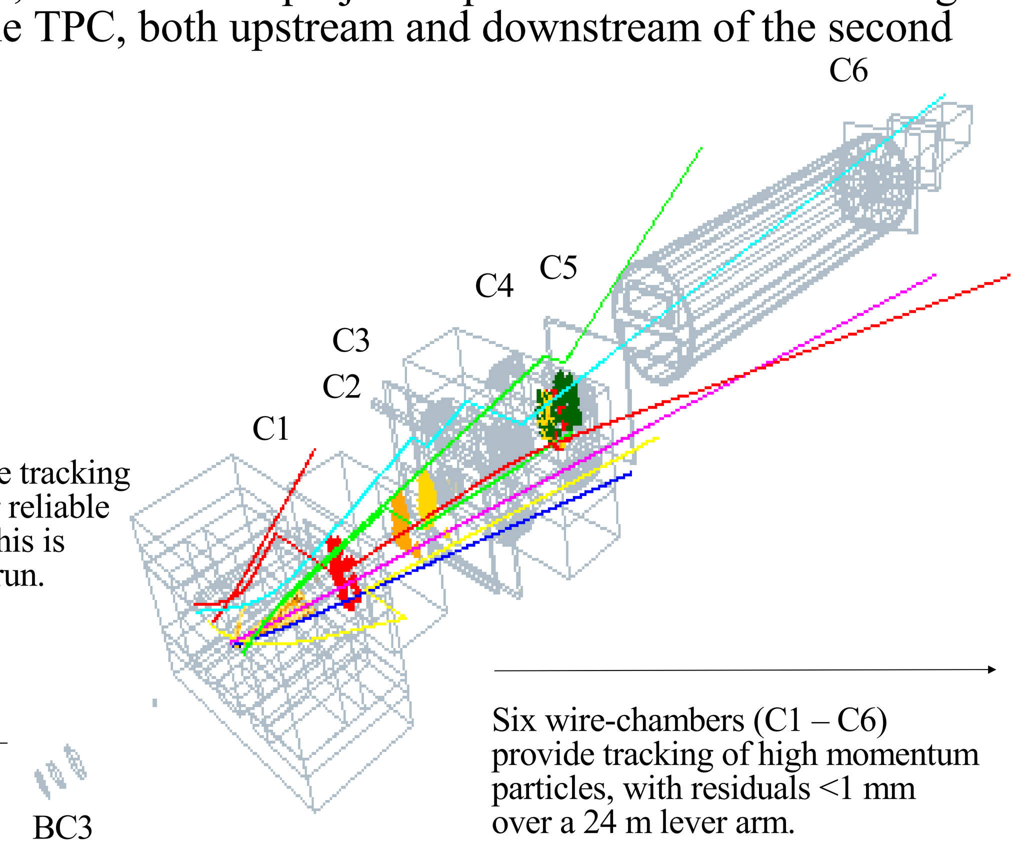
Preliminary, 5 GeV/c beam, ToF[ns]

Tracking Chambers:

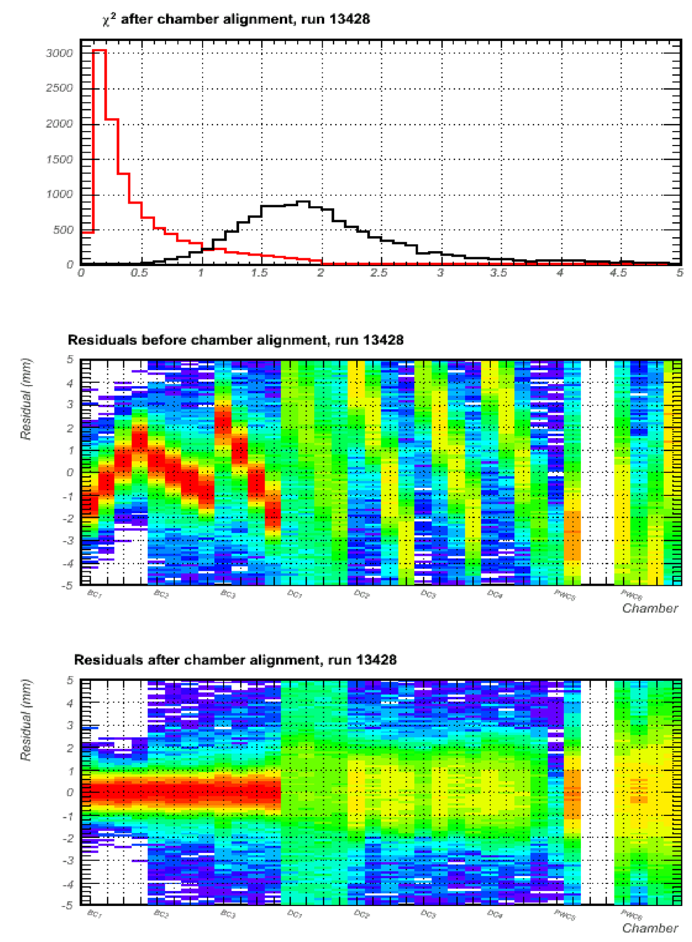
There are 9 wire chambers, 3 to track the projectile particle incident on the target and six downstream of the TPC, both upstream and downstream of the second analysis magnet



Three beam chambers provide tracking of projectile to the target. For reliable cross section measurements this is constantly monitored run by run.

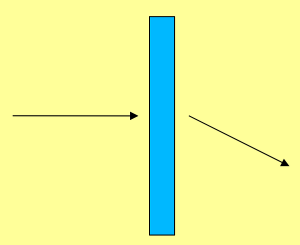


Six wire-chambers (C1 – C6) provide tracking of high momentum particles, with residuals <1 mm over a 24 m lever arm.

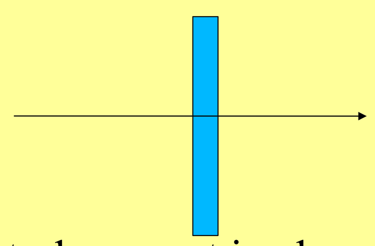


How to select interaction type:

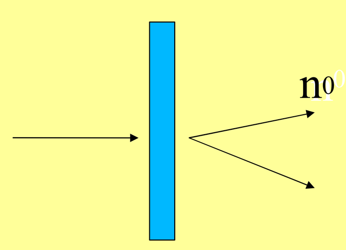
elastic: no interactions is just scattering:



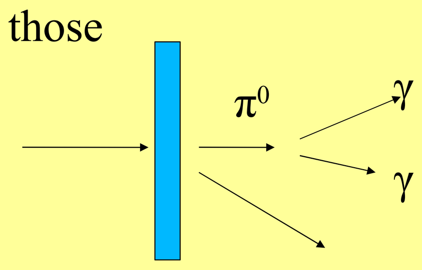
straight track is a good sign of no interaction



There are some elastic that will look like inelastic:



Neutrals are not in charged tracking system so we will get help from calorimeters to detect those



inelastic: a hard interaction, our trigger enhances this so we will have a lot

Just like elastic reactions have backgrounds from inelastic so do inelastics have background from elastic scattering events.

Theory Behind Cross Section:

The elastic scattering amplitude F(q,s), where s is total hadron-nucleon center of mass energy squared and q is the momentum transfer vector, gives us a possibility to calculate total cross section through the optical theorem.

$$\sigma(s) = (4\pi/k)\,\mathrm{Im}F(0,s)$$

where k is the hadron projectile momentum in the target-nucleus rest frame. Using this amplitude we are also able to calculate differential elastic cross section.

$$d\sigma_{elast.}(s)/d\Omega = |F(q,s)|^2 \qquad d\sigma_{elast.}(s)/dt = \pi/k^2|F(q,s)|^2$$

and total elastic cross section is: $\sigma_{elast.}(s) = \int d\Omega\,|F(q,s)|^2 = 1/k^2\int dq|F(q,s)|^2$

The elastic scattering amplitude can be expressed through the profile function:

$$\Gamma(B,s) = 1 - S(B,s) \qquad F(q,s) = ik/2\pi\int d^2B e^{iq}\Gamma(B,s)$$

where S(B,s) is the S-matrix and B is the impact parameter vector perpendicular to the incident momentum k. The total and elastic cross sections can be obtained from the profile function Γ(B,s):

$$\sigma_{tot}(s) = 2\int d^2B\,\mathrm{Re}|\Gamma(B,s)| \qquad \sigma_{elast.}(s) = \int d^2B|\Gamma(B,s)|^2$$

Thus to calculate the total, elastic and differential cross sections we need to know S-matrix S(B,s).

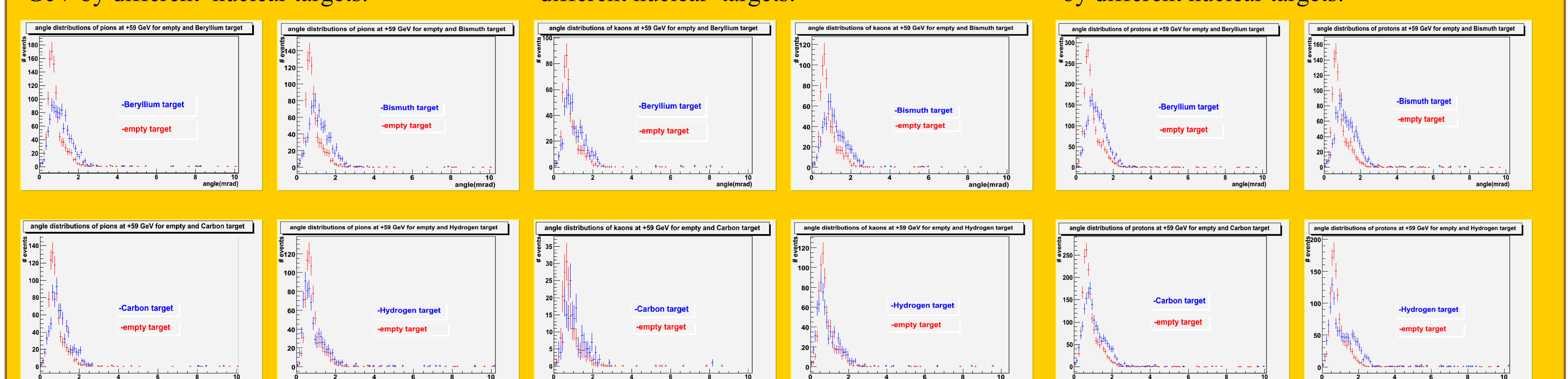
Preliminary Elastic Scattering Results:

Empty target data is only approximately scaled to the same number of beam particles as for the nuclear targets

Elastic scattering of pions at +59 GeV by different nuclear targets:

Elastic scattering of kaons at +59 GeV by different nuclear targets:

Elastic scattering of protons at +59 GeV by different nuclear targets:



-We are searching for elastically scattered pions, kaons and protons from different nuclear targets at +59 GeV.

-Up to now we only used particle ID from RICH, so we are limited in acceptance angle. We do not see substantial number of tracks scattered in this angle.

-With increased particle ID from Time of Flight and Cherenkov counter we will have more elastically scattered particles.