First Results from the MIPP Experiment

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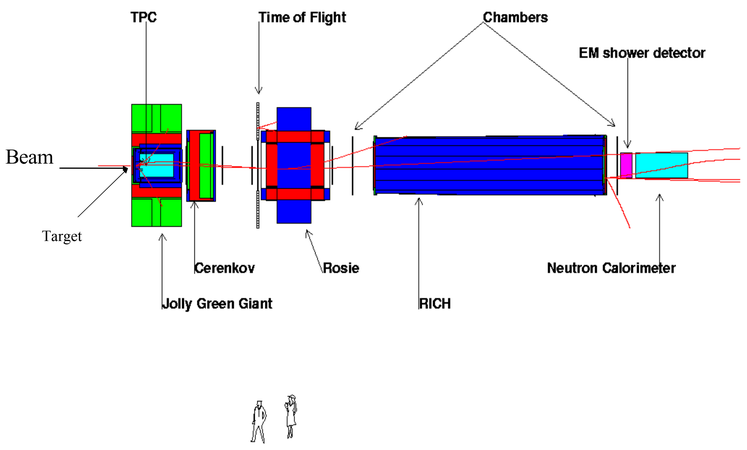
MIPP – The Main Injector Particle Production Experiment

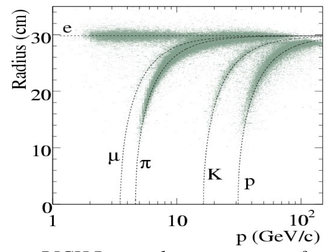
Beams and Targets
- six secondary beams of π^+, K^+, p and antiparticles from 5 to 85 GeV/c and primary 120 GeV/c proton beams
- cryogenic and solid nuclear targets, NuMI target
- Analyses shown here use 120 GeV/c proton beams on Carbon and Bismuth targets

Spectrometer
- full acceptance spectrometer
- tracking with TPC and six wire chambers, 0.7 T magnetic field
- particle ID with TPC dE/dx, ToF, Ckov and RICH
- Analyses shown here use TPC and RICH pid

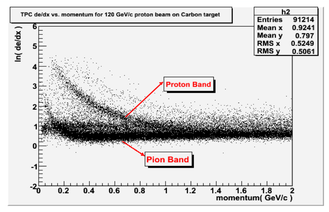


Particle Identification:

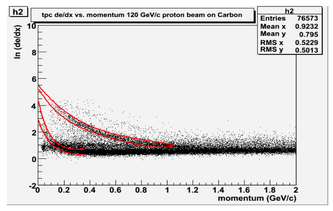
The RICH detector separates pions, kaons, and protons above 20 GeV/c and up to 90 GeV/c. The TPC identifies particles below 1 GeV/c. A preliminary PID algorithm was used in the TPC. Bethe-Bloch fits will improve the TPC particle ID.



RICH Ring radii vs momentum for positive tracks on NuMI target



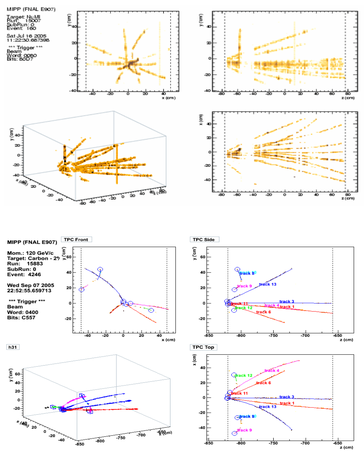
TPC ln(dE/dx) vs. momentum for secondary particles coming from primary vertex



Pion and kaon bands were fitted as polynomial in tpc dE/dx vs. momentum plot

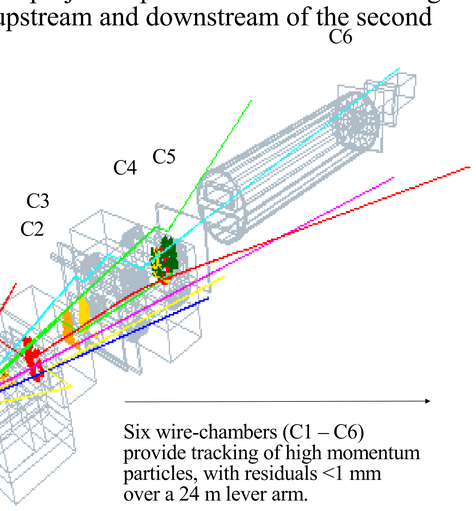
Tracking Detectors:

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

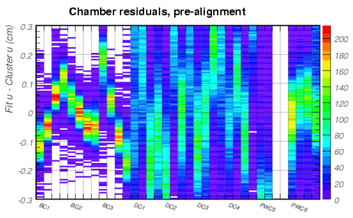


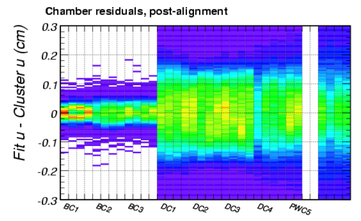
Event display showing the raw data in TPC for an interaction event proton (120 GeV/c) + NuMI target

Reconstructed interaction event in TPC with distortion correction applied. Data was taken from 120 GeV/c proton+Carbon interaction



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

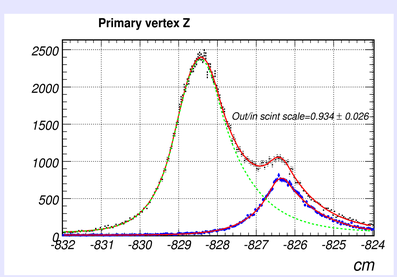




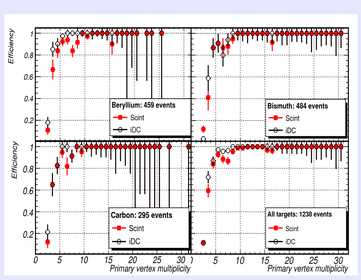
Chamber residuals before and after alignments. These residuals come from 120 GeV/c proton + Carbon runs.

Empty Target Subtraction and Interaction Trigger Efficiency for 120 GeV/c proton beam on Carbon target

Carbon target at -828.5 cm, interaction trigger scintillator at -826.5 cm



Vertex resolution is ~6 mm sigma with long tails. Z spectrum was fit to Gaussian with exponential tails

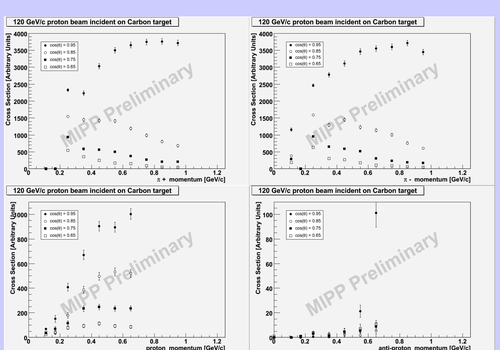


Interaction trigger efficiency was measured from minimum bias triggers

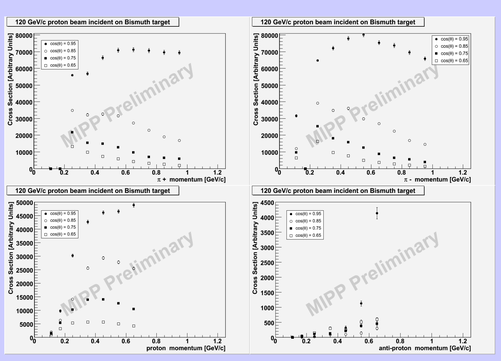
Preliminary results on pion and proton production at low momenta using 120 GeV/c protons on Carbon and Bismuth targets

TPC dE/dx vs. momentum histograms were used to separate pions and protons at low momentum up to 1 GeV/c and double differential cross sections were calculated based on momentum and polar angle of produced particles.

Cross Sections for Carbon target
(Only statistical errors are shown)



Cross Sections for Bismuth target



Formula for double differential cross section:

$$\frac{d^2\sigma}{dpd\Omega}(p,\cos\theta) = \frac{A}{2\pi N_A \rho}\,\frac{1}{a(p,\cos\theta)}\,\frac{N_{tgt}(p,\cos\theta) - N_{empty}(p,\cos\theta)}{N_b(\Delta p)(\Delta\cos\theta)}$$

- A is atomic weight of target material
- ρ is target areal density
- a is detector acceptance correction
- N_{tgt} = Reaction yield from Carbon or Bismuth
- N_{empty} =Empty target yield N_b=Incident beam flux

Limitations of this analysis:
- Detector acceptance approximated as 1. Final correction will come from Monte Carlo study.
- TPC pid algorithm based on simple cuts in dE/dx vs momentum plot. Final pid algorithm will give log-likelihood pid.
- beam flux and trigger efficiency corrections need to be applied to get absolute normalization
- all these improvements are being worked on!

First Results for the Pion to Kaon Production Ratio from 20 to 90 GeV/c in proton-carbon interactions using 120 GeV/c beam

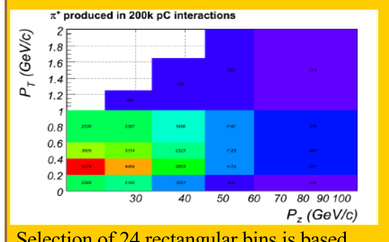
(Andre Lebedev, PhD thesis, MIPP-doc-218)

-Pion and Kaon production was measured on 2% interaction length carbon target in 24 bins in p_t and p_z

-Particle ID from the RICH

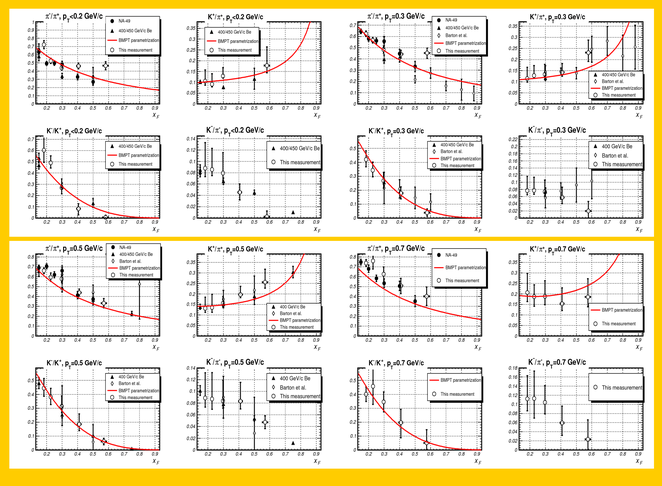
-Minimum p_z was 20 GeV/c as kaon threshold is at ~17 GeV/c

-Results are ratios of like charges and like species

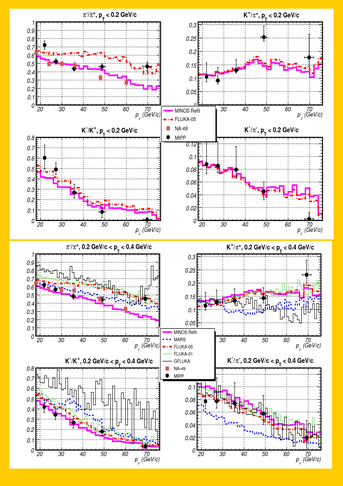


Selection of 24 rectangular bins is based pion distribution of 200K interactions in 2% Carbon using FLUKA

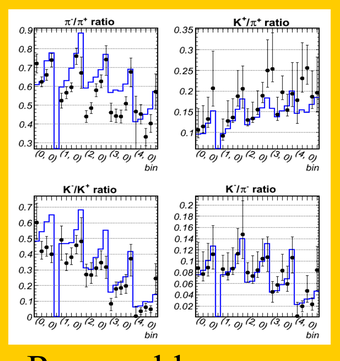
Comparison to Existing Data



Comparison to MINOS Fits



Comparison to FLUKA



-Reasonable agreement with FLUKA on like charges
-Not so good on like species

- Total statistical and systematic error is dominated by statistics

- Better tuned modeling of the RICH and better understanding of backgrounds can reduce systematic errors