Two-pion interference studies with the MIPP Experiment

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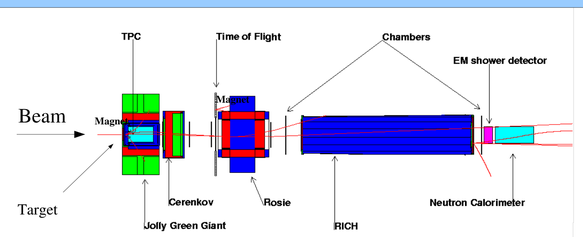
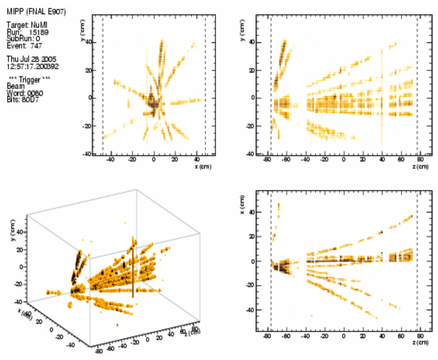
TPC Detector and Performance

This analysis uses the TPC Detector in the MIPP experiment. The detector preforms well in various stages of calibration, which we expect to finish in July. Current momentum determination techniques is not using the true B-field map. However, that and improved tracking will be implemented in June.

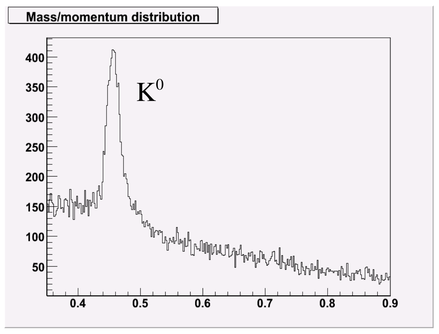


Time Projection Chamber:

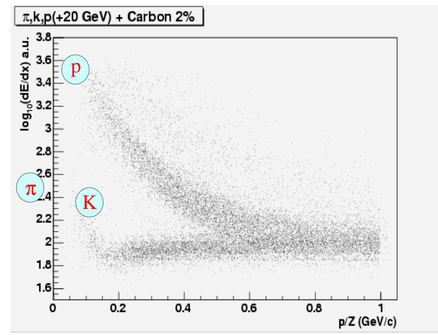
TPC Event



Invariant mass reconstruction



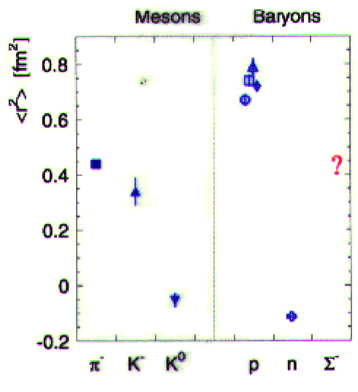
Particle Identification by dE/dx



Goal

This analysis studies the various kaon – proton interaction radii. In 1983 the NA22 experiment at CERN has already measured these quantities. However, due to lack of data, the measurement for the K^- has large large uncertainty. The measurements suggest different interaction radii for the π^- and K^-. The goal of this analysis is to update the measurements as well as provide clarity whether there indeed exists discrepancy between π^- and K^- radius.

Previous Results



The summary shows clear measurements for the pi- as well as proton interaction radii, while allowing for a 1fm^2 uncertainty for the K^-measurement.

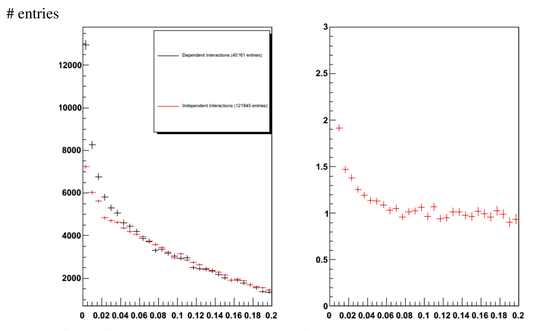
By improving the precision of the K^- interaction radius measurement, it will be possible to support or overrule the discrepancy between the $K^-$and π^-radii, suggested by the graph.

Analysis

The heart of the interferometry analysis is the correlation function, which is built by measuring the distribution of pairs of events normalized to the background of a non-interfering distribution.

To compute the distribution of interfering (dependent) tracks, for each permutation of negatively charged tracks within an event, we compute Q and store it in a histogram.

To compute the distribution of non-interfering (independent) tracks, we use particles from separate (neighbouring) events and stores the distribution of those Qs in a separate histogram.



Plot of interacting particles (black) relative to non-interacting ones (red)

Final distribution of dependent events normalized by the background

Since the interference effect occurs only at low values of Q, the two histograms have similar tails for Q > 0.3GeV/c. This region is used to scale the dependent histogram against the independent one. Finally, to receive the normalized distribution of the correlation function, we divide the scaled histogram by the independent one.

To derive the interaction radius, we can fit the Gaussian source parametrization to the resulting distribution:

$$C_{1,2}^{gaussian}(Q) = 1 + \lambda e^{-\frac{1}{2}(Q^2 R^2)}$$

Conclusion

The MIPP experiment has successfully concluded taking data in early year of 2006. Besides creating an abundance of information for the interferometry analysis, MIPP will supplement neutrino oscillation experiments (such as MINOS) with the pion and kaon productions.

The plots presented are generated from about 500,000 events. They show strong evidence for the interference effect.

In future, we will increase the efficiency of track reconstruction and will be able to provide measurements of the interaction radius of kaon beam with a liquid hydrogen target. Since the proton radius of interaction is well known, we will use the proton beam data to verify the accuracy of this technique.

References

N. Solomey Development and Utilization of a Light Chamber Tracking System in a Heavy Ion Experiment Performing To Pion Interferometry

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