MIPP Physics Analysis Topics

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Some additional data analysis topics, why they are interesting and the detector components needed for each of these to get first results.

Physics Analysis Topics

1) NuMI target ratio of pion to kaon production

2) Scaling law, fundamental physics stuides

3) Nitrogen target, ratio of pion to kaon at low energies

4) π^0 inclusive cross section

5) Antiproton cross section

6) HBT (i.e. two boson interferometry)

7) s-quark and charge exchange of Kaons

8) Nuclear target studies

9) Diffractive physics (pomerons)

10) anti-Lambda polarization studies by anti-proton production

11) K^+ mass measurment

.... and more ....

Will not cover all these topics

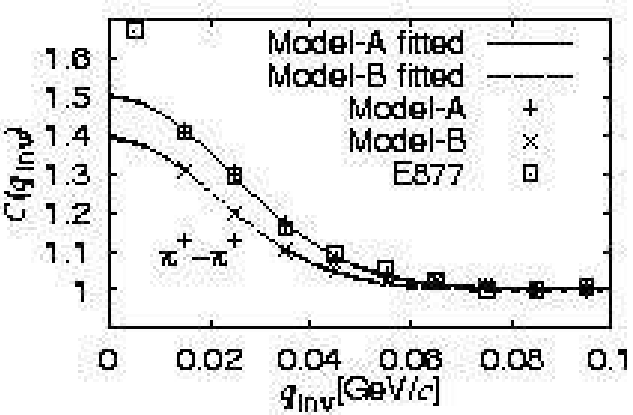
The first few of these physics topics have been extensively discussed in MIPP before by others more knowledgable than I.

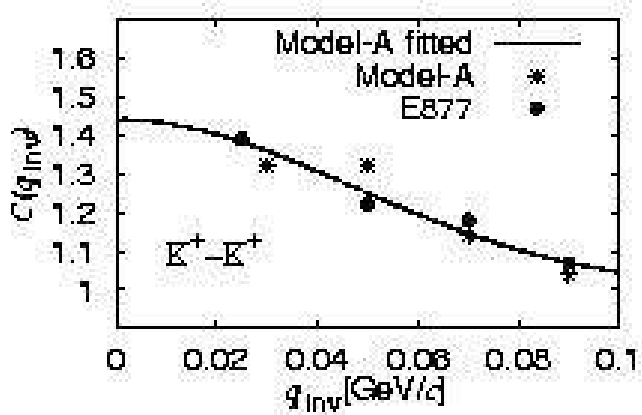
However,

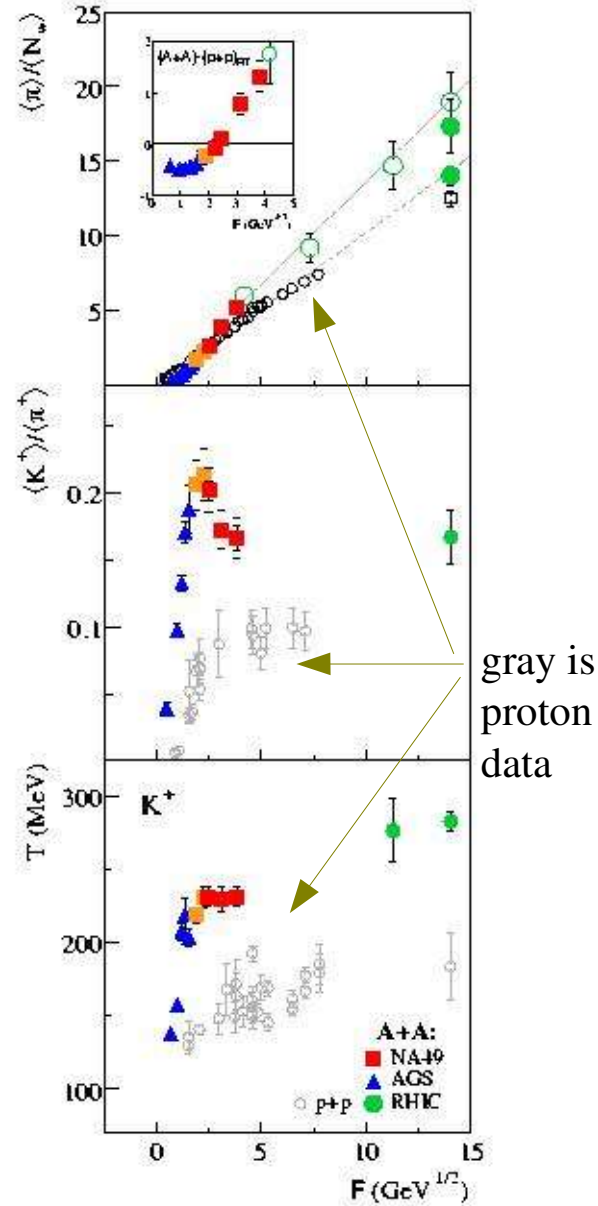
so let me summarize a few that are less well known or have not yet been considered. Plus some of these are simpler and can produce a fast result, one does not even need a MC simulation, while others only need some of the detector components.

2 identical boson interferometry:

- Measures fire-ball of the interaction in size and life-time. Useful to measure the diameter of the primary particle and nuclei.
- Very little data exists with charged Kaon beam. Plus, a detailed study of charged K production by proton on nuclear targets can help the heavy ion stuides to see if their anomolous productions are real.
- The Heavy Ion community sees a different result depending upon if they are using pion or Kaon particles for the interferometery. However; this might be due to Kaon secondard interactions as it rescatters out of the target. MIPP can directly use the Kaon beam to see if the fire ball is the same as with pions or protons on protons (LH2 target) and nuclear targets. Also a sample of K-shorts if we get enough events with two could be possible.







G. 2: Energy dependence of the mean pion multiplicity wounded nucleon, the $\langle K^+\rangle/\langle\pi^+\rangle$ ratio and the inverse pe parameter T of the transverse mass spectra of K^+ sons measured in central Pb+Pb (Au+Au) collisions (solid ubols) compared to results from p+p($\bar{p}$) reactions (open s). The changes in the SPS energy range (solid squares) gest the onset of the deconfinement phase transition.

An HBT analysis is perfect for a student who has done a lot of the hardware work and wants to finish off an analysis.

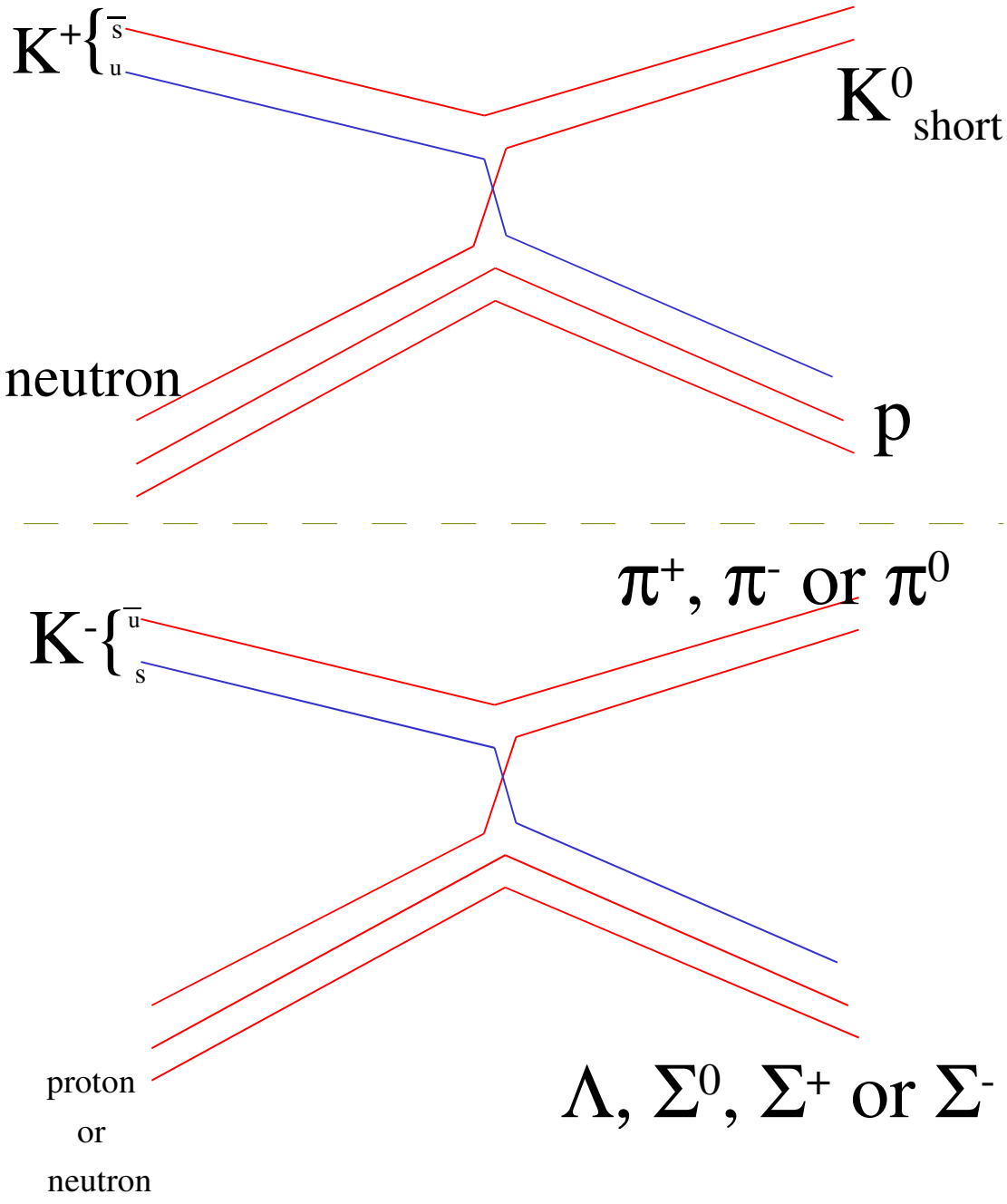
- **Does <u>not</u> need MC,** because it uses tracks from different events to get the non-interference term.
- **Can do something <u>unique,</u>** because $K^{\pm}$ data projectiles are rare.
- **Only needs the TPC working with:**

  Momentum

  Vertex

  dE/dx to identify pions or Kaons

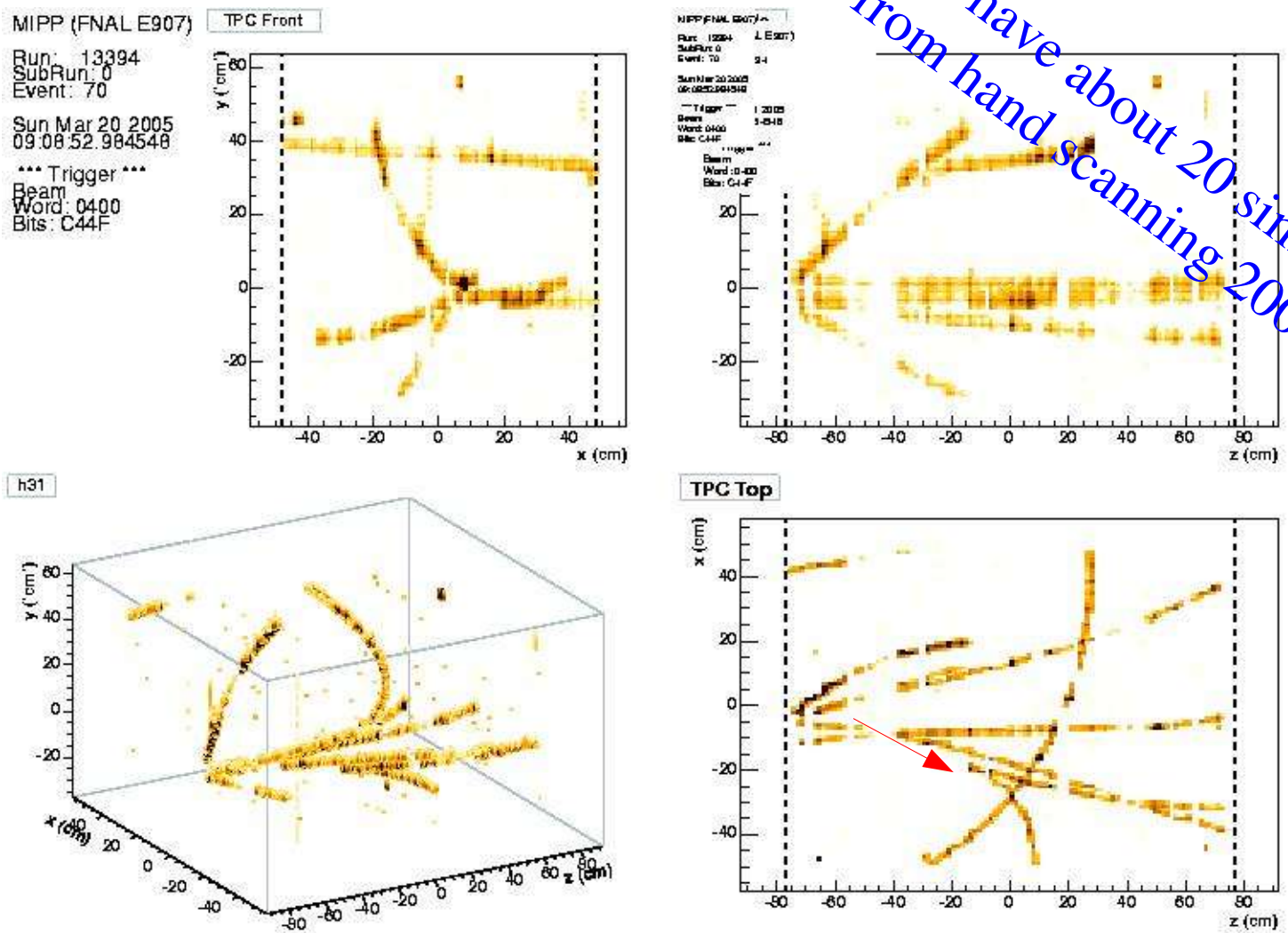
s-quark and charge exchange with a $K^{\pm}$ beam, looking for Λ or K_s^0 production



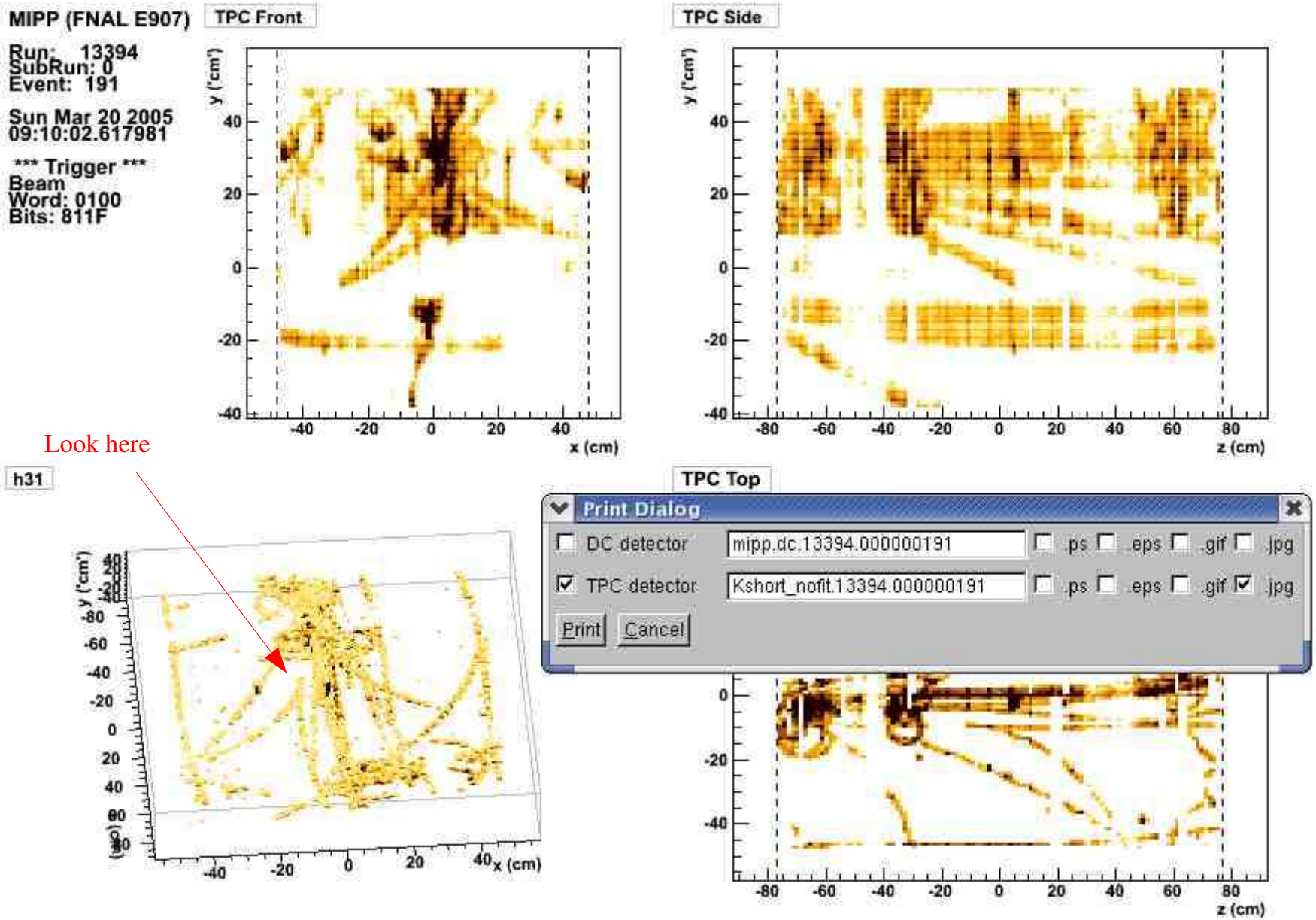
- Study of strange quark exchange process is of relavance to the Kaon CP violation groups since this mechanisum is a process in the regeneration of K short that could produce an extra pion.
- MIPP has a well tagged charged Kaon beam and the TPC has the nice ability to see the ”V” associated with Lambda or neutral Ks particles produced. The outgoing primary particle can be uniqely identified with the RICH.
- Also of interest to the nuclear community.
- These cross sections only exist from bubble chamber experiments.

Real MIPP data of Λ or K^0_s candidate:

Like Sloan Digital Skysurvey we have added a red arrow to help you find it



We have about 20 similar events from hand scanning 2000 events.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SubRun: 0
Event: 191
Sun Mar 20 2005
09:10:02.617981
*** Trigger ***
Beam
Word: 0100
Bits: 811F
TPC Front
y ('cm')
x (cm)
TPC Side
y ('cm')
z (cm)
Look here
h31
y ('cm')
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DC detector
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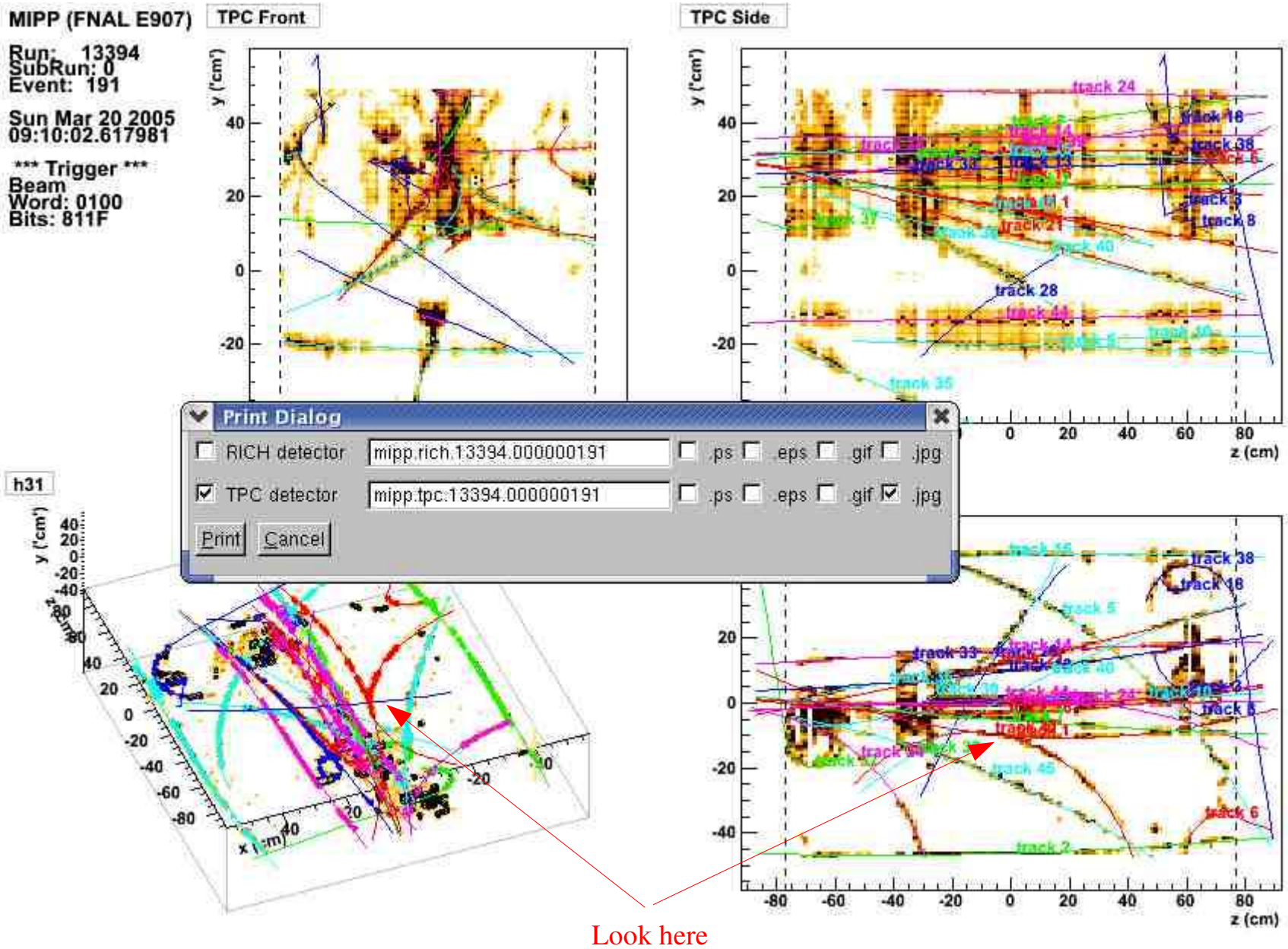
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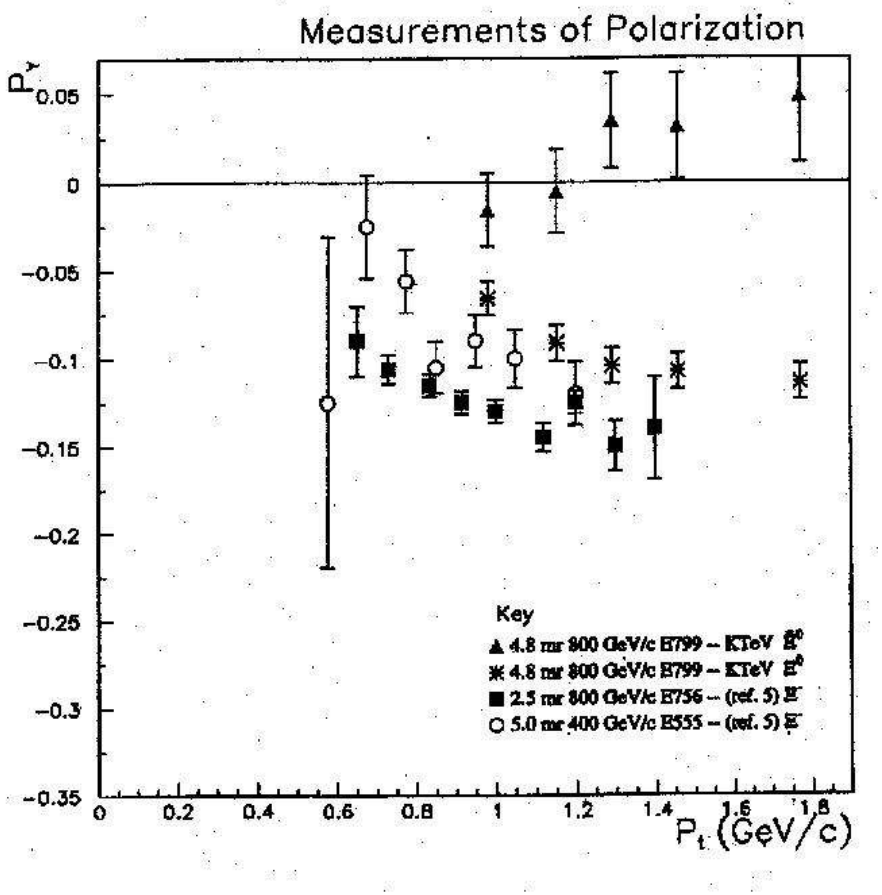
Anti Lambda Polarization by anti-proton production



- Hyperon polarization is a mystery. With proton beam producing hyperons there is polarization, with anti hyperons produced by proton beams there is not.
- Is the projectile particle influencing this?
- MIPP can study anti-protons producing anti-Lambda, and see if the situation is reversed and compare to our own proton data producing Lambda and anti-Lambda

K^+ mass measurement:

- **Kaon mass has a contraversy because it is double peaked and PDG forces PRL papers to use a value that is wrong with an inflated error bar.**
- **RICH ring diameter averaged over a large number of events and compared to the proton and charge pion RICH ring diameter can resolve this contravery.**
- **Needs to have momentum, particle tracking through RICH and RICH working**

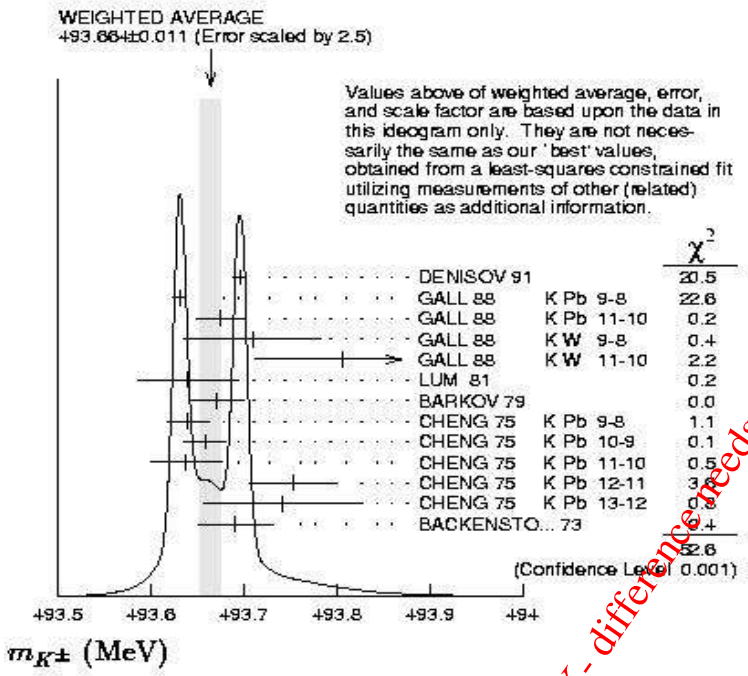
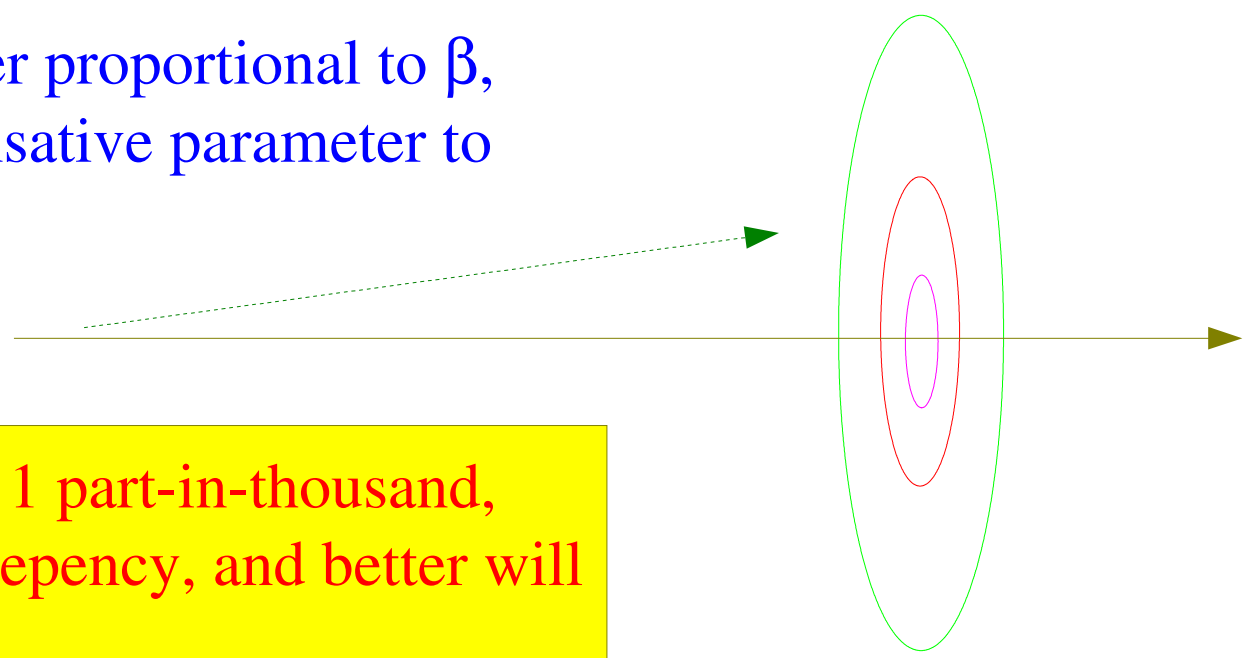


Figure 1: Ideogram of $m_{K^\pm}$ mass measurements. GALL 88 and CHENG 75 measurements are shown separately for each transition they measured.

also K+ and K- difference needs improving

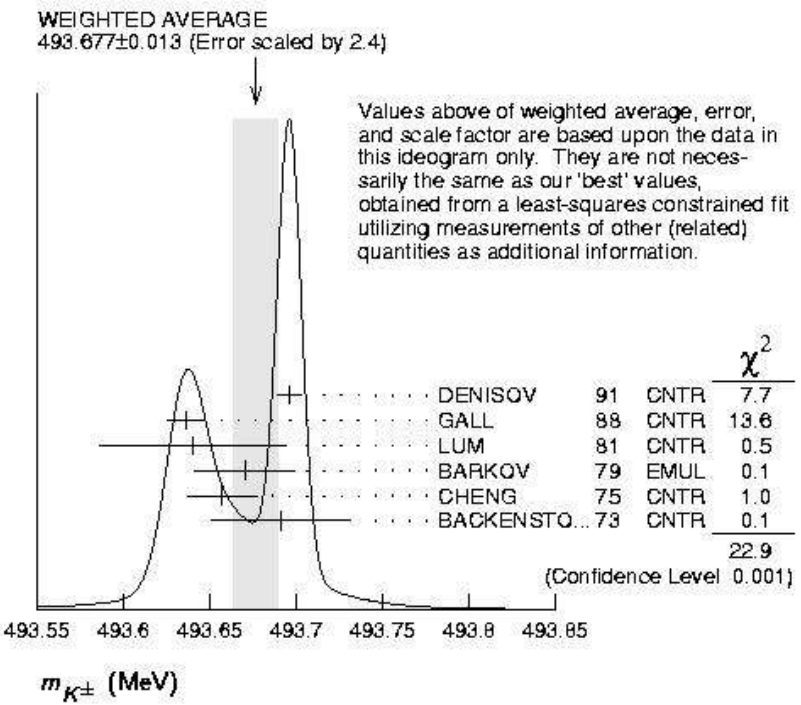
RICH ring diameter proportional to β, and is the most sensative parameter to measure mass.



Current mass error is 1 part-in-thousand, will resolve the descrepency, and better will make improvements.

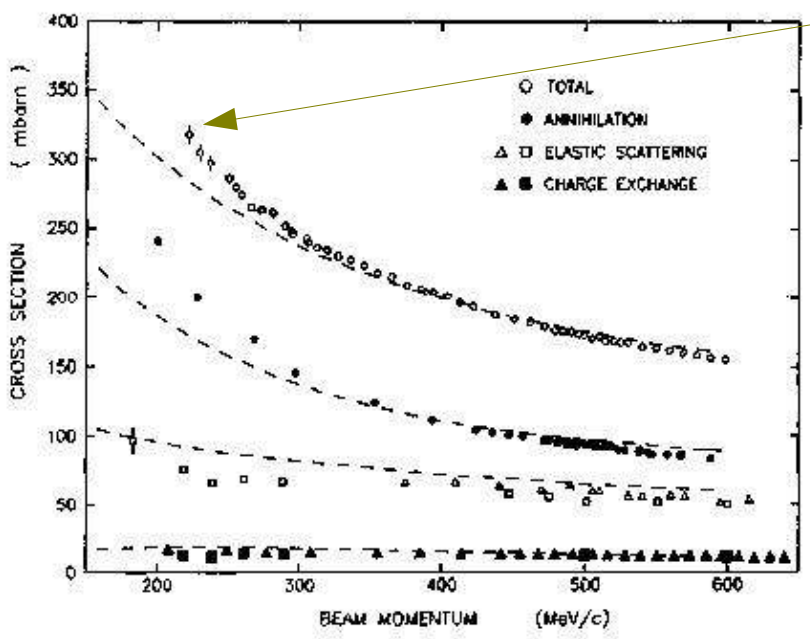
K^+ and K^- mass difference also has a discrepency

- With both polarities of charged Kaon we will be in a position to resolve the discrepency between both the positive and negative $K^{\pm}$ mass.



Anti-proton cross sections and ionization measurements

- antiproton cross sections in the range of 5 GeV to 75 GeV are badly measured.
- Ionization in Argon by antiprotons can be done with the TPC.
- Low momentum antiproton has a discrepency with theory.



Low Momentum from:

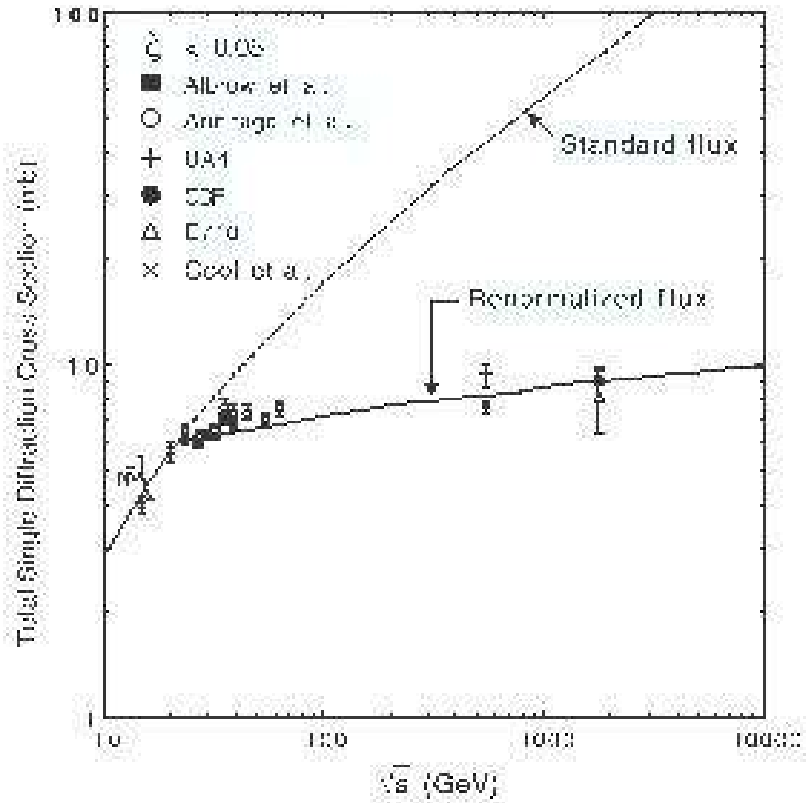
Antiprotons produced off any target interacting with the TPC Ar gas

or

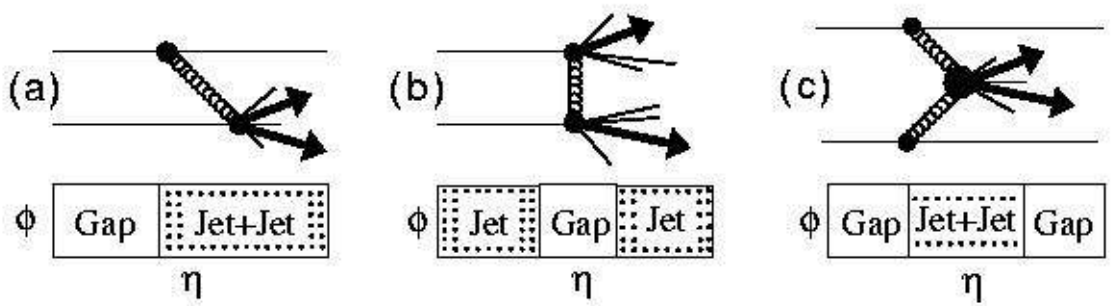
High Momentum from:

Antiprotons from beam interacting with target or TPC Ar gas.

Diffractive Pomeron cross section:



- Single Diffractive Pomeron, Double Diffractive Pomeron and Pomeron-Pomeron interaction cross sections are of interest..
- The Momentum range for this study in MIPP can be large from 5 GeV to 120 GeV beams.
- Can we distinuish single pomeron from double pomeron or pomeron-pomeron interactions?
- The old data from E710 to UA1 has a need for improvment.
- MIPP can also study meson beam processes and compare to proton beam, is it different?



We can do:

antiproton proton

proton proton

pion proton

Kaon proton

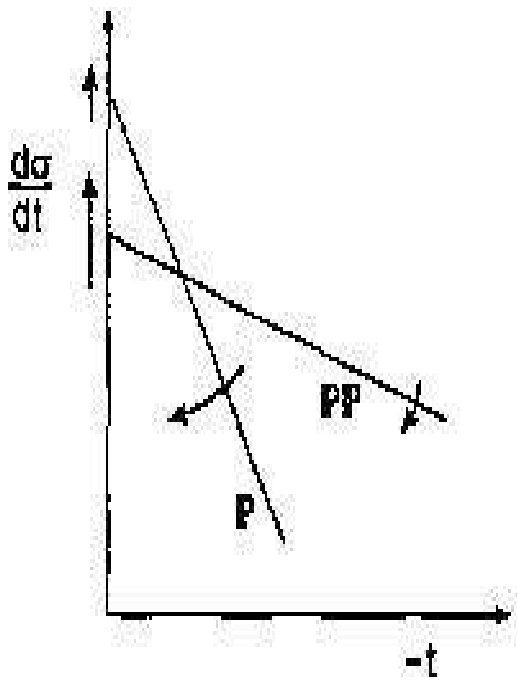


Figure 4. Contributions of single and double Pomeron exchange to the differential cross section of elastic scattering (Donnachie and Landshoff 1986). The arrows indicate how they change as the energy increases.

Advantages of starting with simple analysis:

Only need a fraction of experiment

TPC dE/dx:

Anti-proton and charged Kaon dE/dx ionization in the TPC is a number that can be improved and only needs the TPC working.

K+ mass:

Charged Kaon mass needs to be resolved and this only needs the RICH and momentum from the 6 wire chambers.

After these seperate analysis which can produce a paper in 6 months then the more complied analysis such as NuMI target or scaling law studies with Liquid Hydrogen targets can benifit from the work.

Learning approch to analysis

- Start with the simplest approch to the cross section calculation, no corrections just counting.
- Add the next primary effects such as geometric acceptance, trigger dead times .....
- Refine the cross section measurment further with other runs and empty targets to correct for backgrounds.
- Finally put in everything that goes into the cross section measrument for publication.

This learning approch to an analysis is far better for students and new comers to cross section measruments and only an advanced scientiests would be able to do everything to produce only one final number, and even then they too usually use this stepped approch.