MIPP

Main Injector Particle Production

Mark Messier
Indiana University
NO-VE 2006

Main Injector Particle Production Experiment

Goal is to measure particle production from ($\pi Kp^{+/-}$)-nucleus interactions ranging from 5 to 85 GeV/c and p-nucleus interactions at 120 GeV/c. Targets range from hydrogen to uranium.

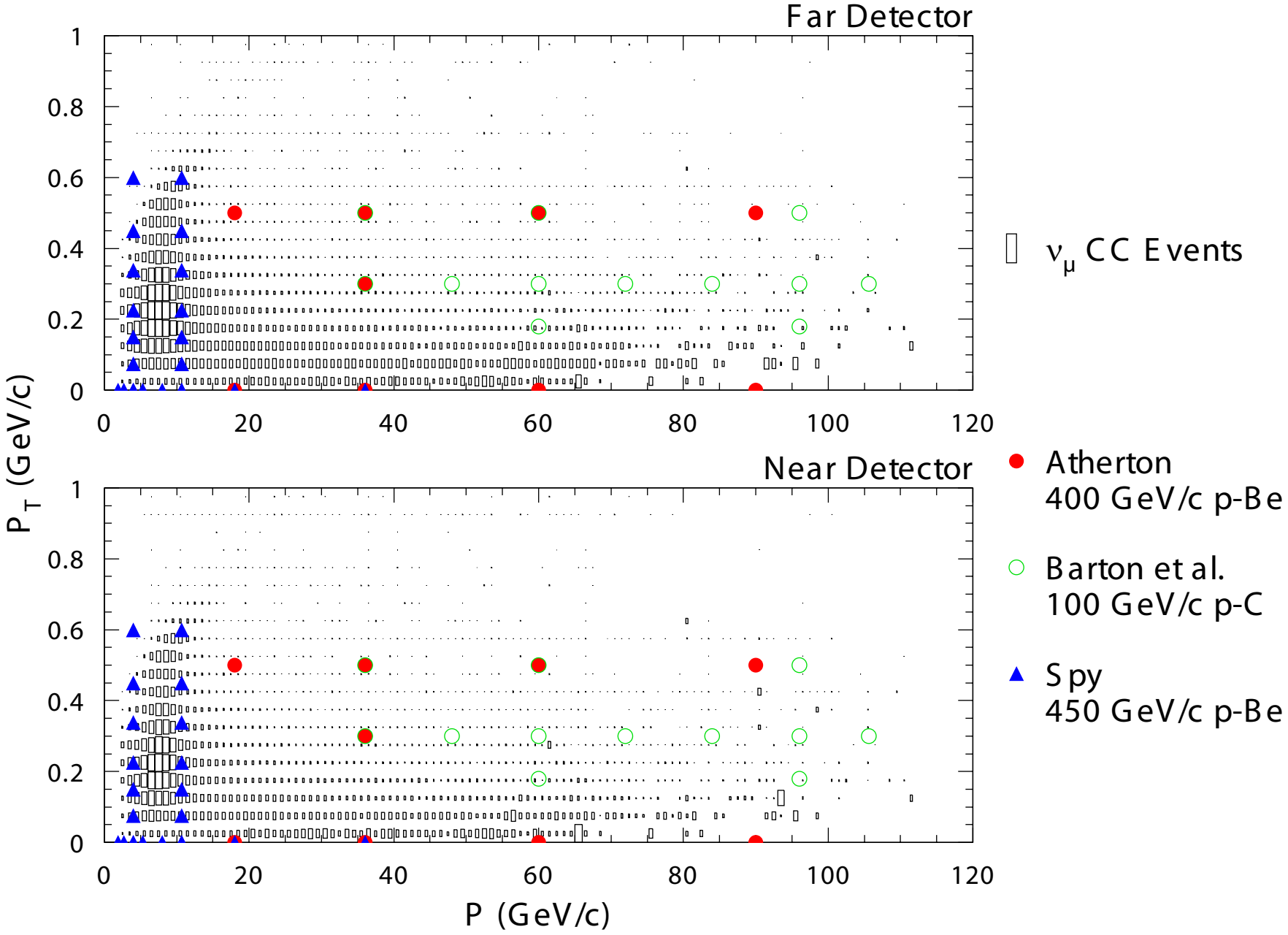
Applications to QCD, nuclear physics, and neutrino physics

Measurements include production on NuMI Target

MIPP collaboration list

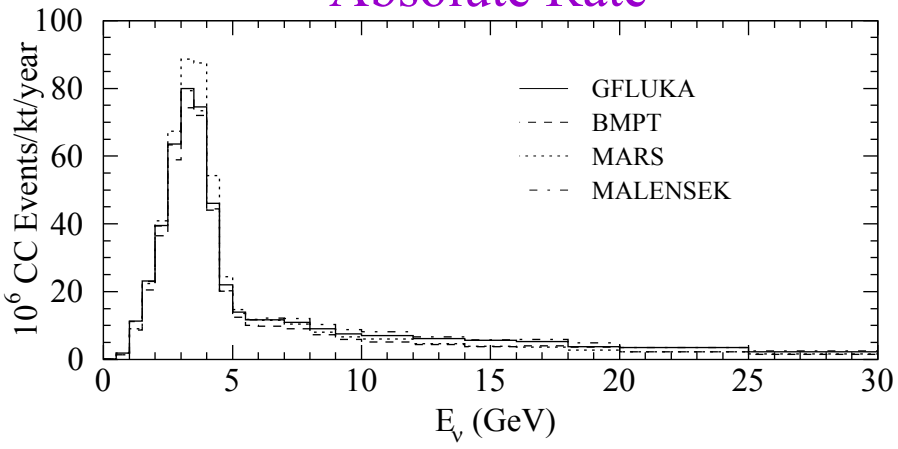
Y. Fisyak
Brookhaven National Laboratory
R. Winston
EFI, University of Chicago
M.Austin,R.J.Peterson
University of Colorado, Boulder,
E.Swallow
Elmhurst College and EFI
W.Baker,D.Carey,J.Hylen, C.Johnstone,M.Kostin, H.Meyer, N.Mokhov
A.Para, R.Raja,S. Striganov
Fermi National Accelerator Laboratory
G. Feldman, A.Lebedev, S.Seun
Harvard University
P.Hanlet, O.Kamaev,D.Kaplan, H.Rubin,N.Solomey
Illinois Institute of Technology
U.Akgun,G.Aydin,F.Duru,E.Gülmez,Y.Gunyadin,Y.Onel, A.Penzo
University of Iowa
N.Graf, M. Messier,J.Paley
Indiana University
P.D.BarnesJr.,E.Hartouni,M.Heffner,J.Klay,D.Lange,R.Soltz, D.Wright
Lawrence Livermore Laboratory
R.L.Abrams,H.R.Gustafson,M.Longo, H-K.Park, D.Rajaram
University of Michigan
A.Bujak, L.Gutay,D.E.Miller
Purdue University
T.Bergfeld,A.Godley,S.R.Mishra,C.Rosenfeld,K.Wu
University of South Carolina
C.Dukes, H.Lane,L.C.Lu,C.Maternick,K.Nelson,A.Norman
University of Virginia

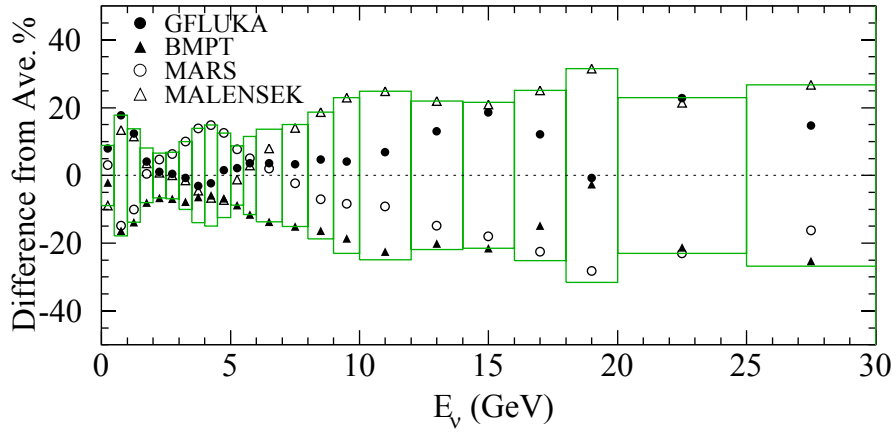
Low Energy Beam π+



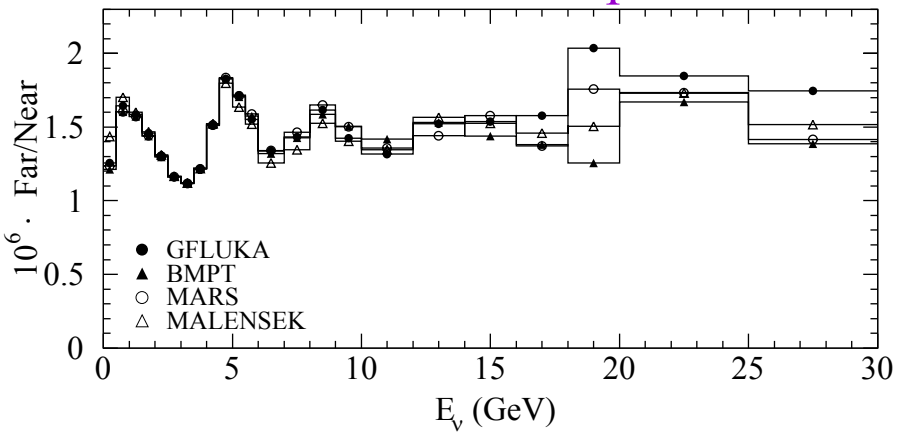
Uncertainties Due To Hadron Production

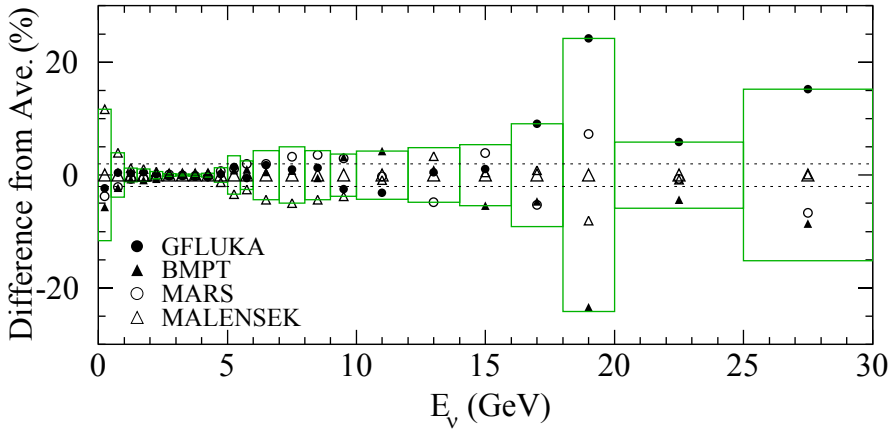
Absolute Rate





Far to Near Comparison

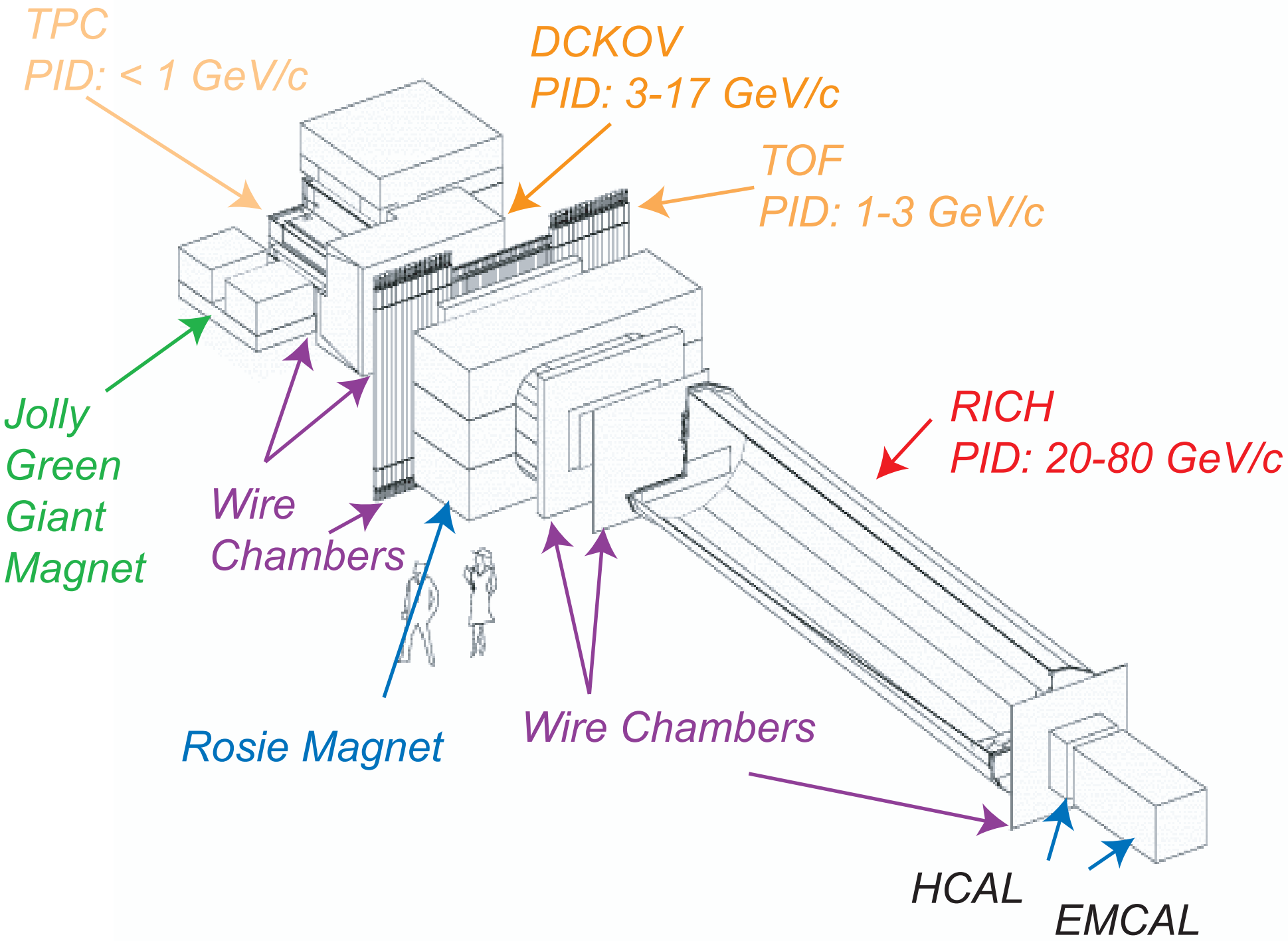


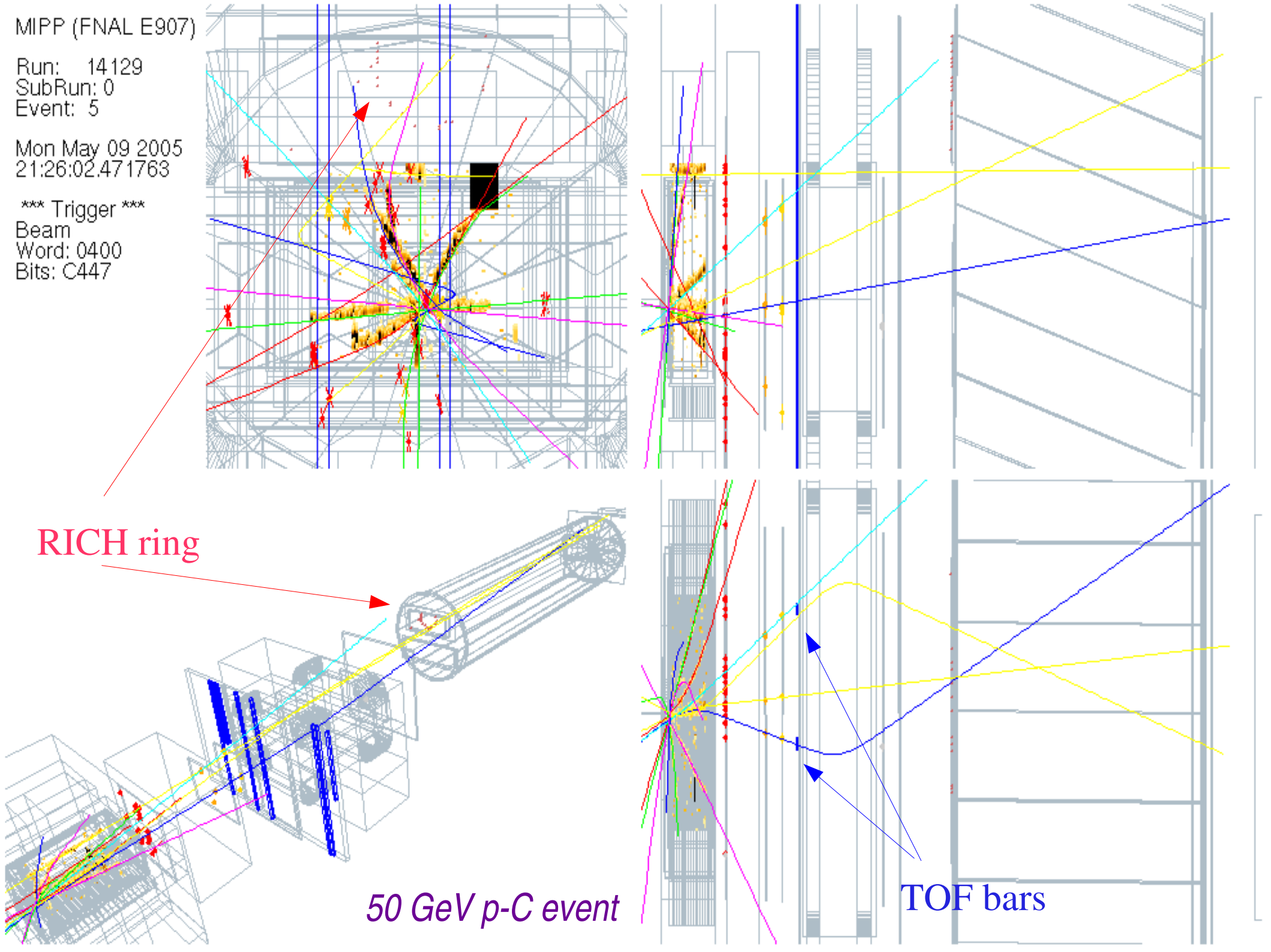


10 to 30% uncertainties in absolute rate

2-10% uncertainties in far to near comparison

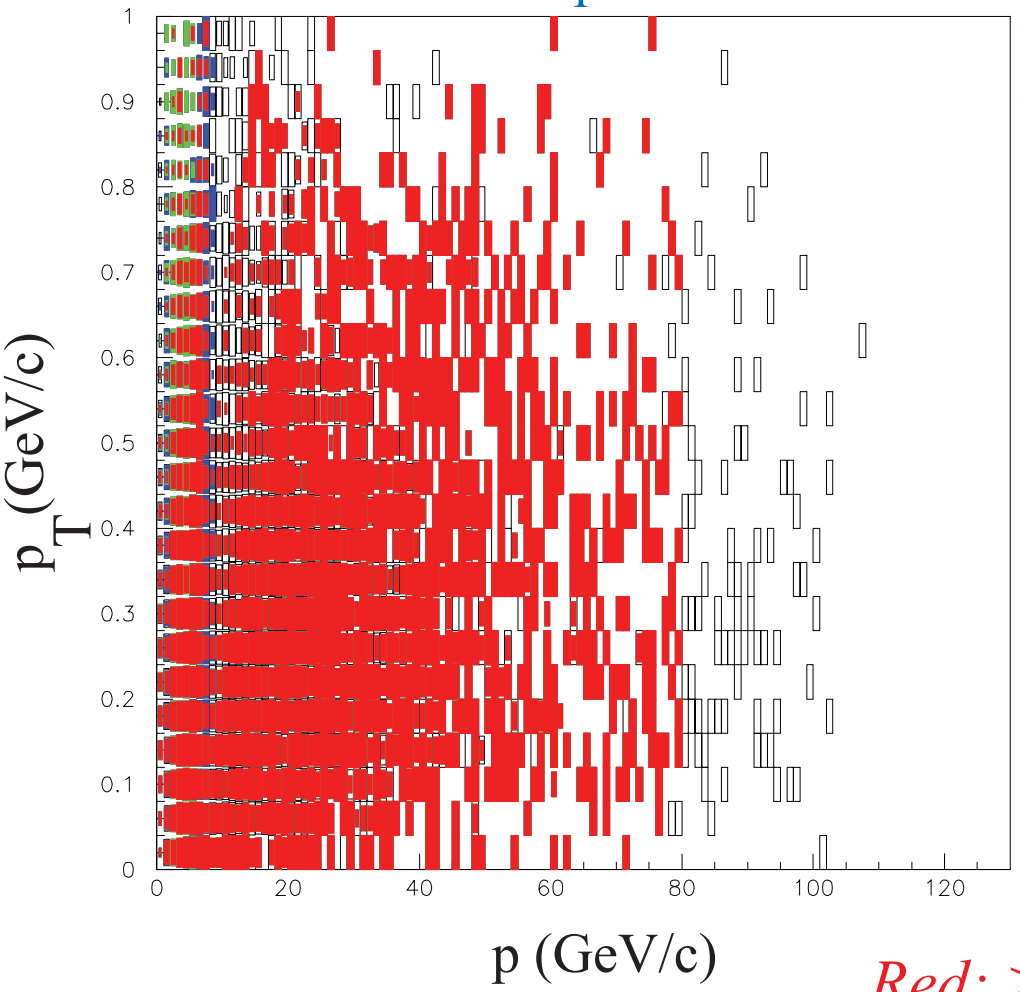
MIPP Detector Overview



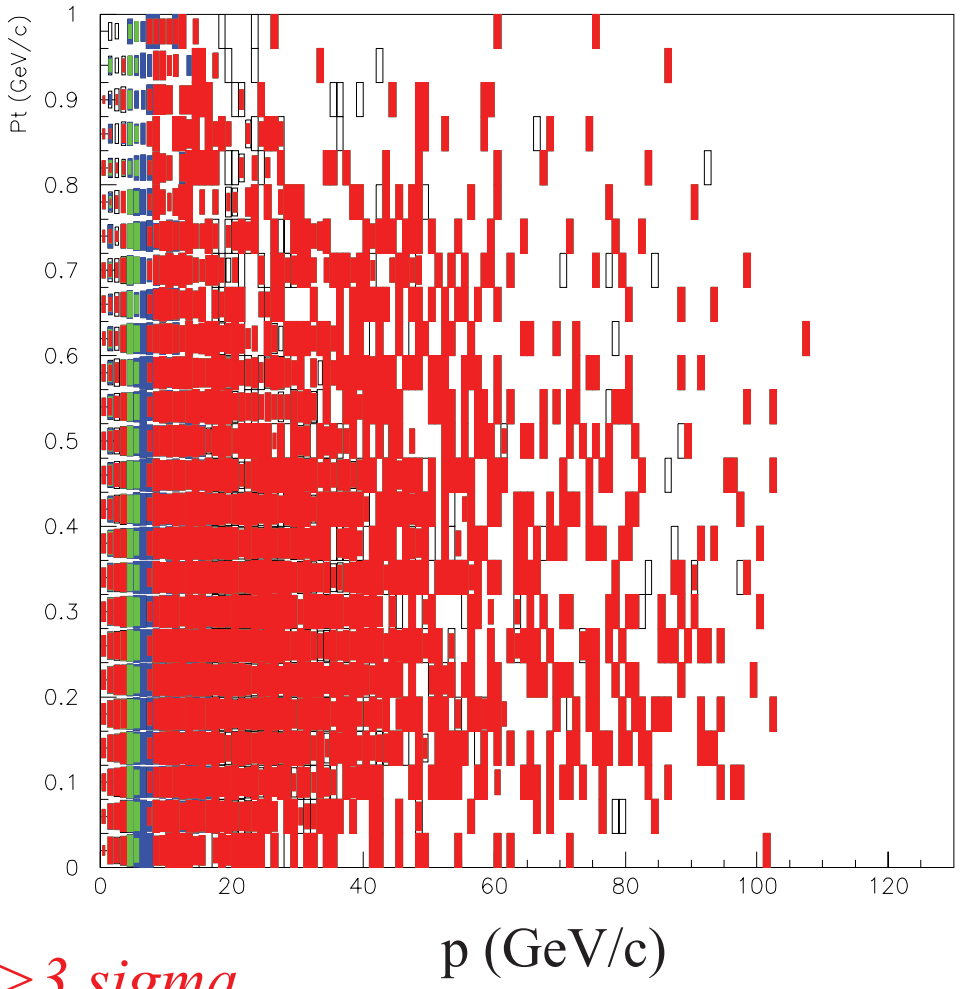

MIPP (FNAL E907)
Run: 14129
SubRun: 0
Event: 5
Mon May 09 2005
21:26:02.471763
*** Trigger ***
Beam
Word: 0400
Bits: C447
RICH ring
50 GeV p-C event
TOF bars

Particle ID Performance

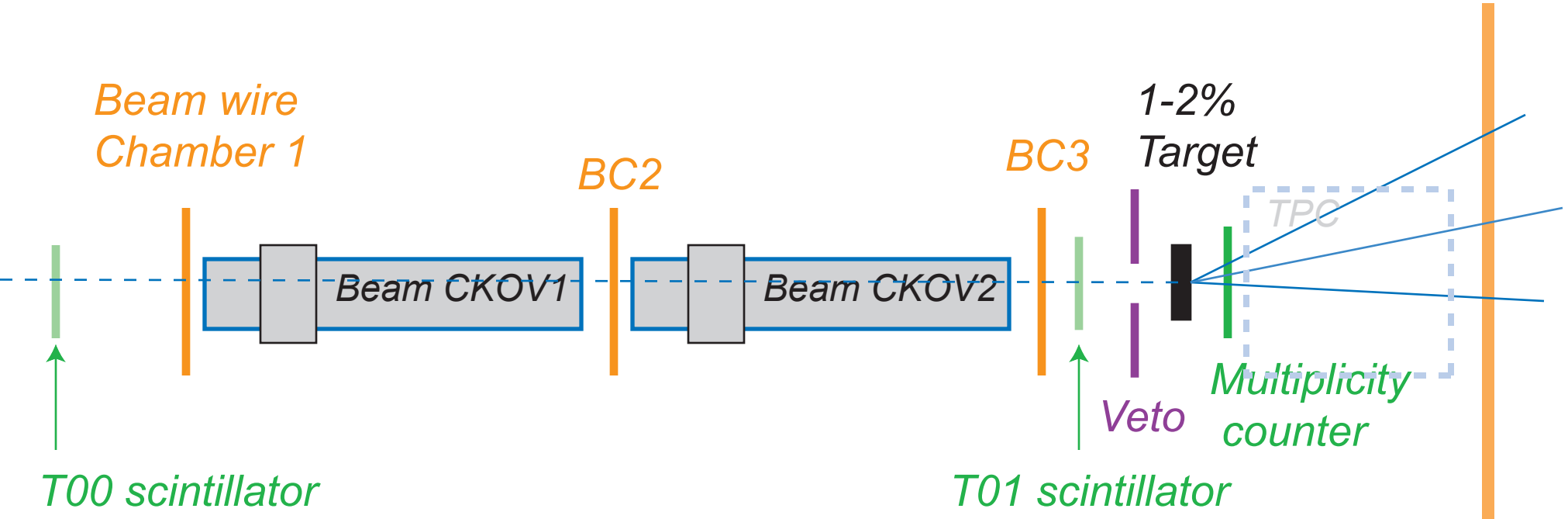
π/K separation



K/p separation



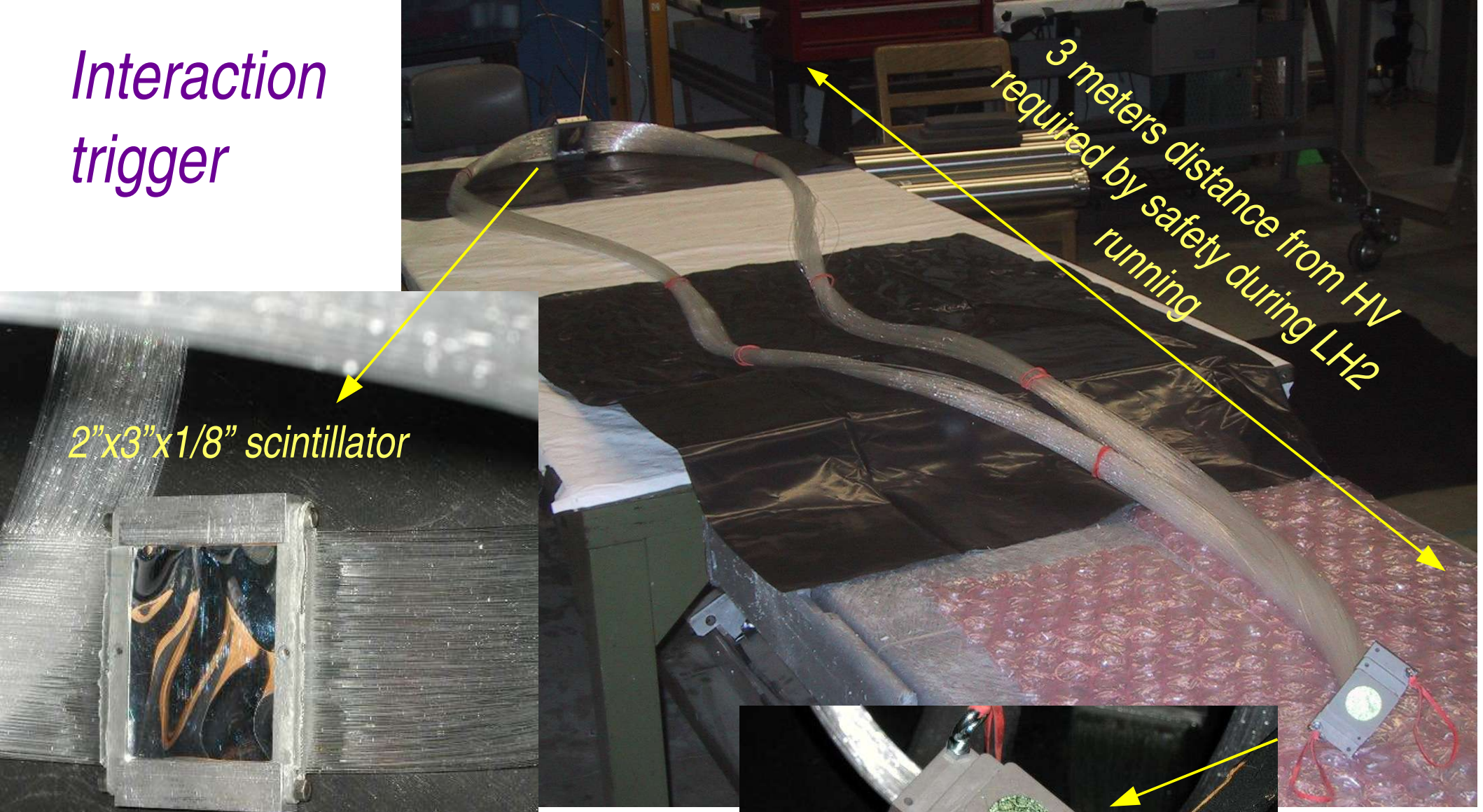
Red: >3 sigma
Green: 2-3 sigma
Blue: 1-2 sigma
White: <1 sigma

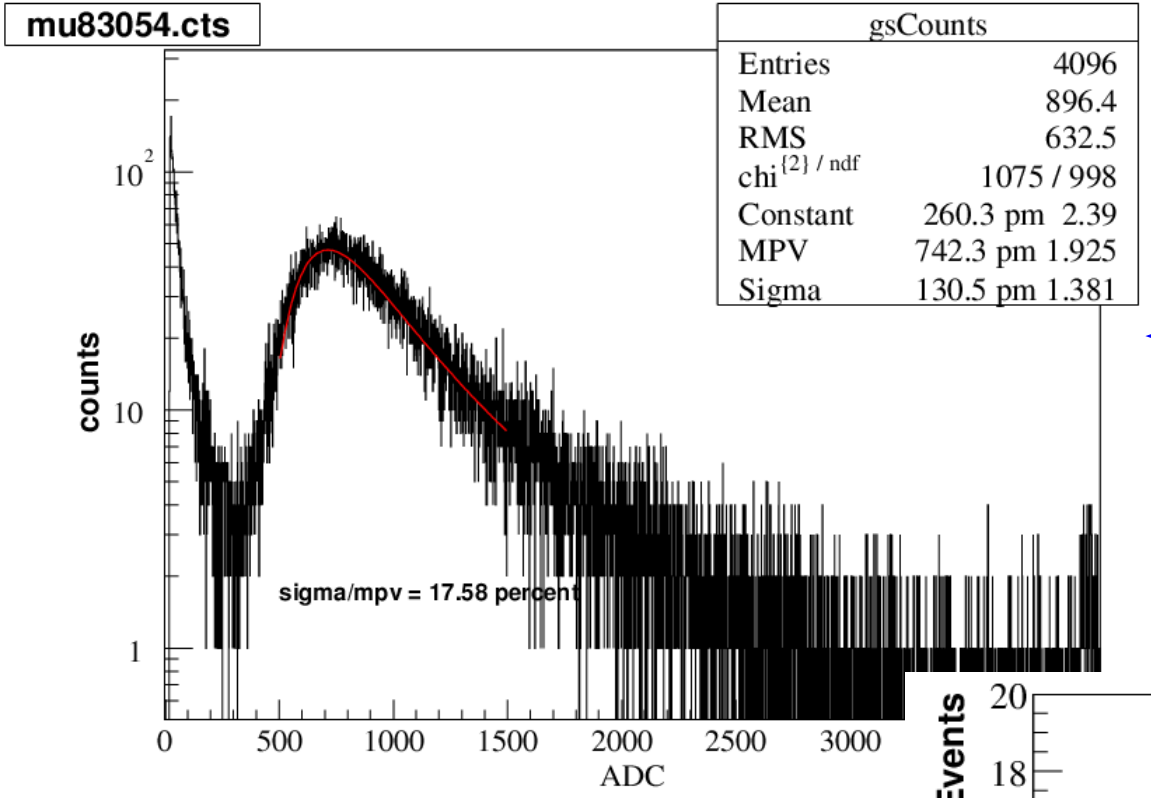


MIPP uses secondary beams ranging from 5 to 80 GeV and primary beam at 120 GeV. Secondary beams are mixtures of π/K/p. Primary beam is p only.

- *Trigger requires beam (T00 & T01 & !Veto)*
- *Thresholds in CKOV1 and CKOV2 set to get fast π/K/p tag for trigger prescale. More accurate tag is possible using combination of BCKOV information (ADC/TDC) and time of flight.*
- *Interactions in target tagged by combination of scintillator multiplicity counter and counts of hit roads in first wire chamber*
- *~5% of all data is minimum bias*

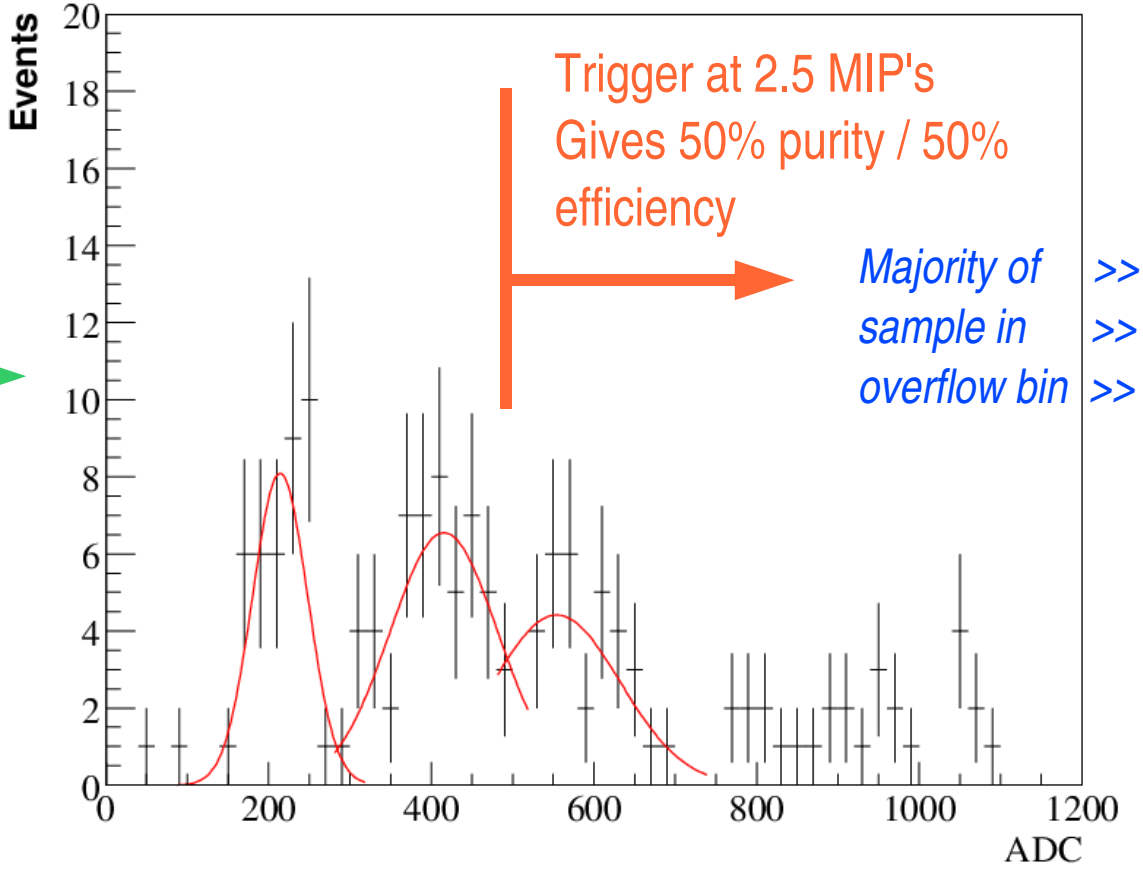
Interaction trigger

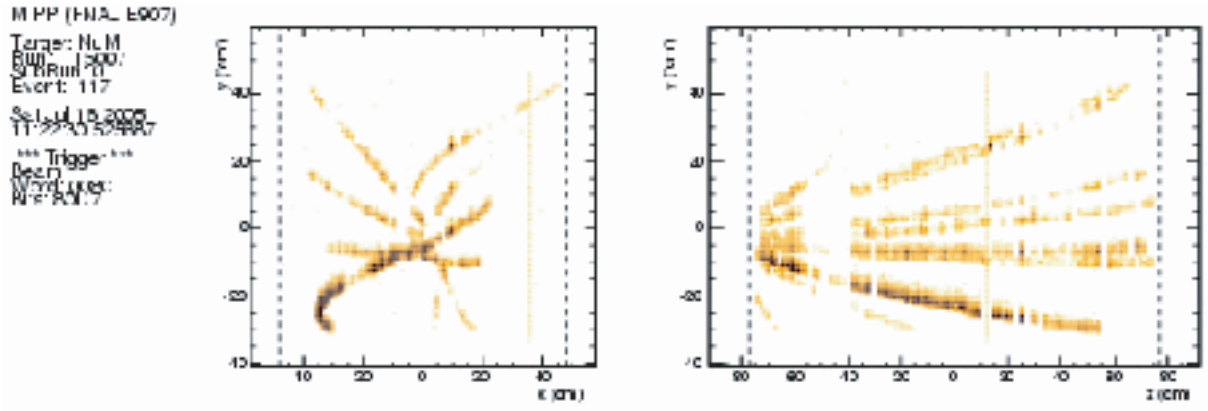




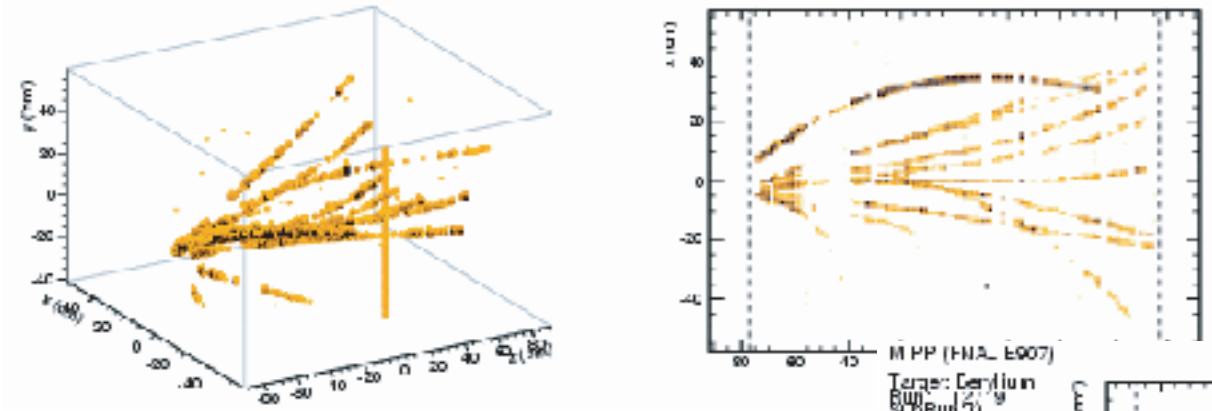
Response to cosmic rays, ~1.4 MIP equivalent at peak >> 70 pe's / MIP. Tail is convolution of cosmic ray spectrum, path length distribtion, and Landau tail

Minimum bias beam data. Interactions selected by hand scan of events



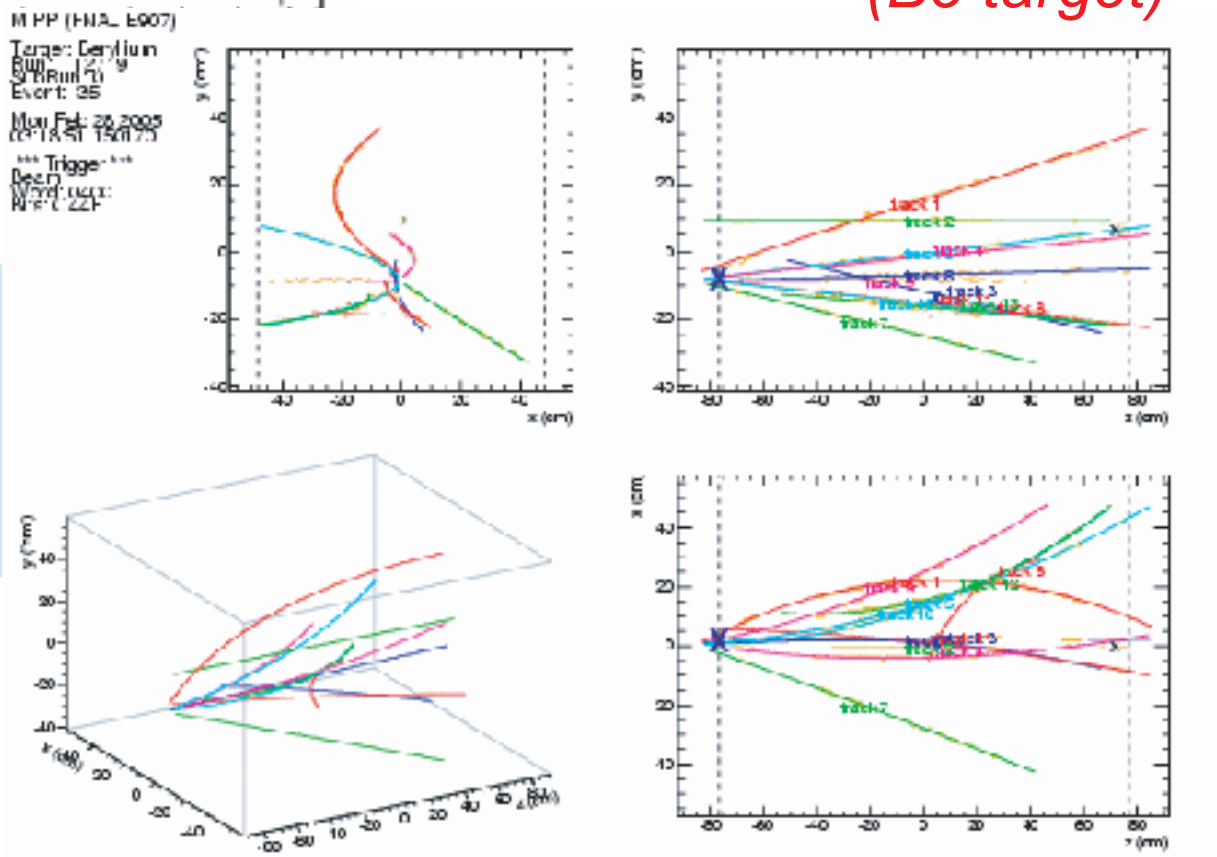


RAW TPC Data
(NuMI Target)

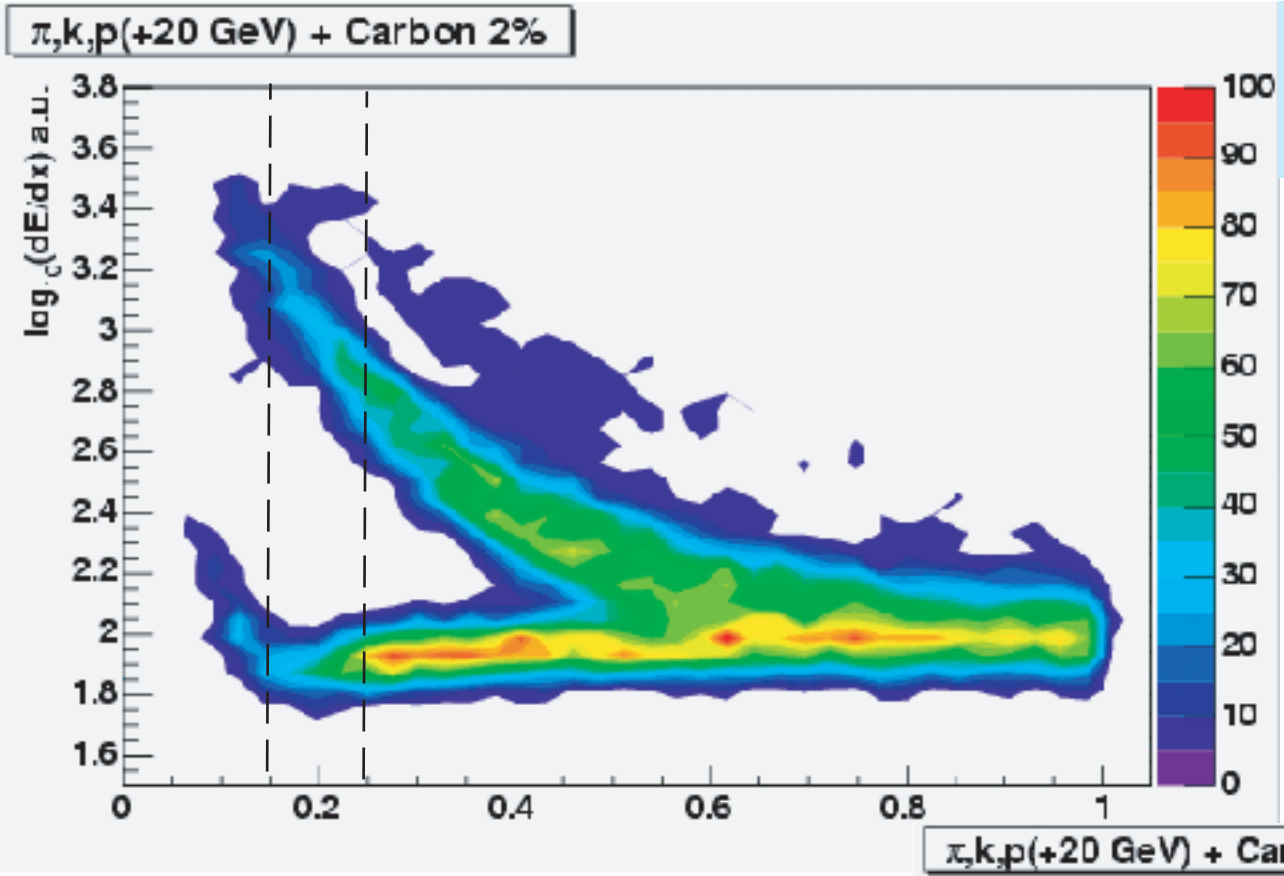


Reconstructed TPC Data
(Be target)

TPC Event Reconstruction

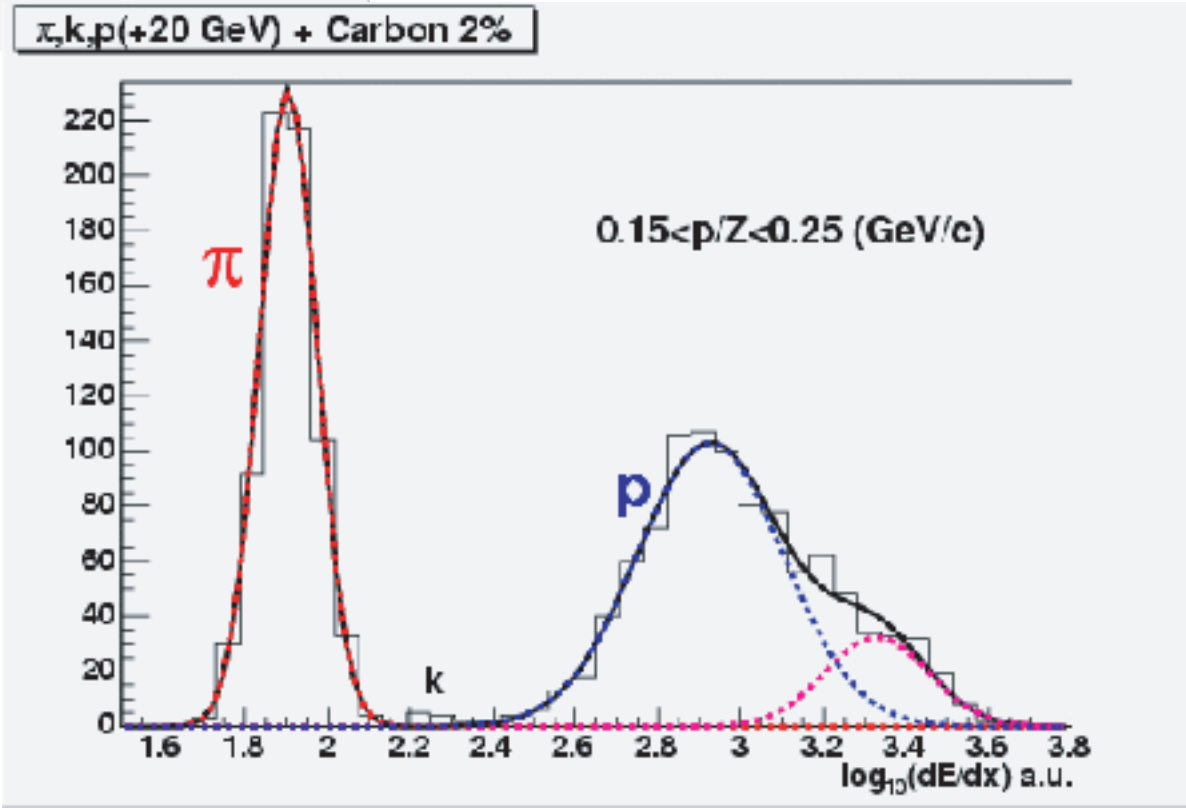


TPC dE/dx



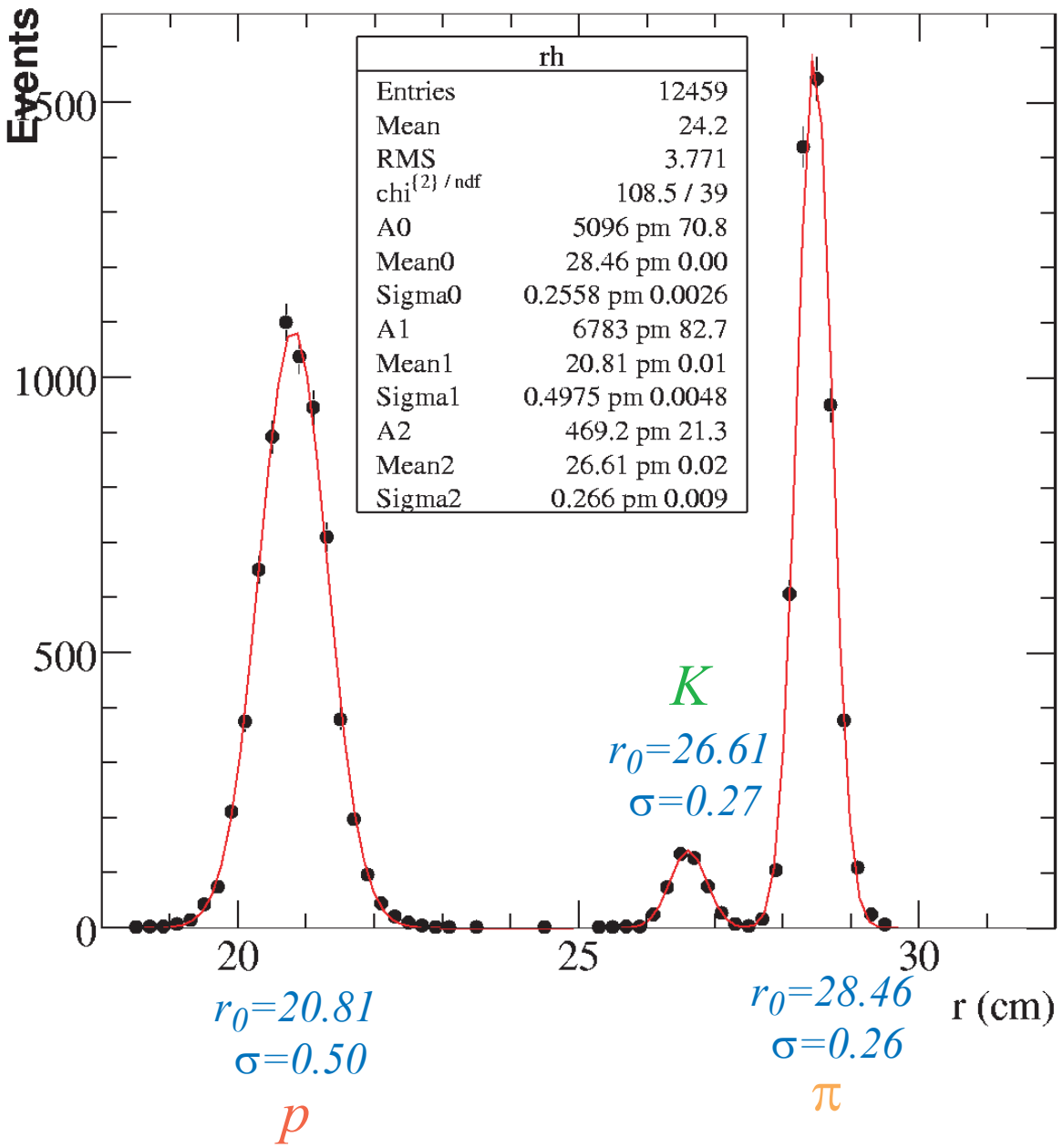
- Coarse HV and gating grid calibrations complete
- Need pad-to-pad corrections

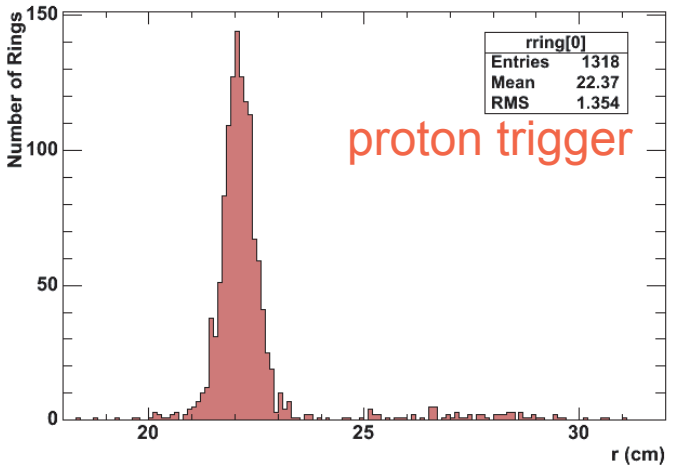
Look at this slice in momentum

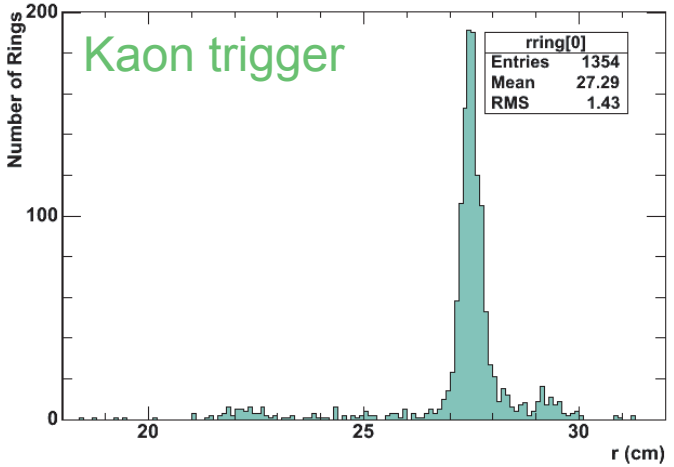


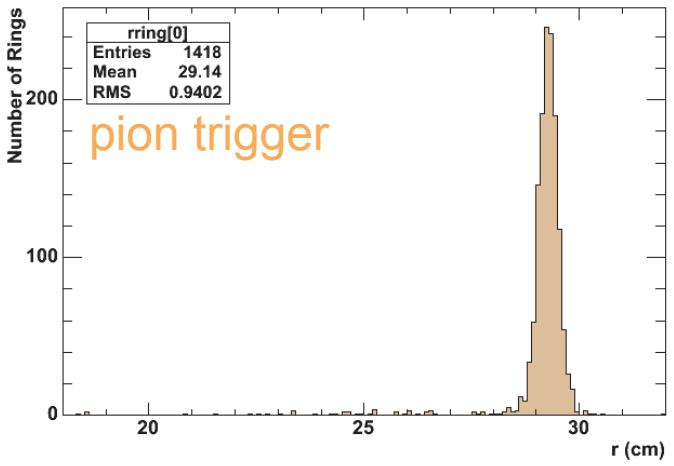
RICH Ring Radii

80 GeV - Target out (Run 8836)

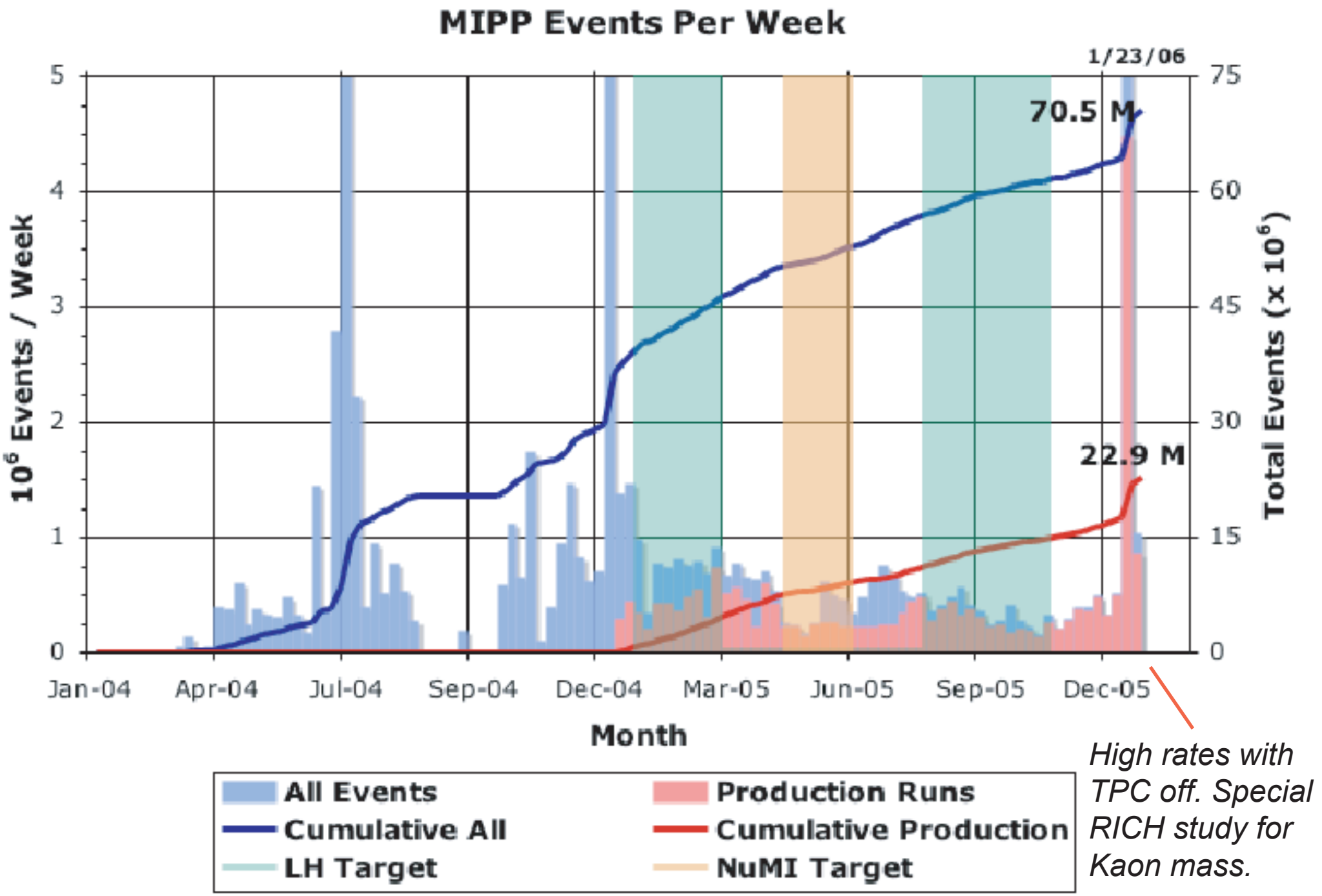








Runs 9099-9103 40 GeV target out



High rates with TPC off. Special RICH study for Kaon mass.

Entries in **bold red** meet or exceed the run plan.
Entries in *italics* are *not* in the run plan.

Data Summary 23 January 2006			Acquired Data by Target and Beam Energy Number of events, x 10^6								
Target			E								Total
Z	Element	Trigger Mix	0	5	20	35	45	60	85	120	
0	Empty[1]				*0.10*	*0.14*	*0.03*	*4.39*		*0.25*	***4.91***
	K Mass							1.76		1.76	**1.76**
0	Empty LH[1]		0.01		*0.30*			*0.61*	*0.31*		**7.12**
1	LH	Normal	0.03	0.21	**1.94**			**1.98**	**1.73**		
4	Be	*p* only								1.08	**1.75**
		Normal				0.10		0.56			
6	C	Mixed				*0.08*	0.08	**0.21**		**0.02**	**1.50**
	C 2%	Mixed			**0.39**			**0.26**		**0.47**	
	NuMI	*p* only								**1.78**	**1.78**
13	Al	Normal				*0.10*	*0.01*	*0.02*			***0.13***
29	Cu	Normal					*0.01*	*0.08*			***0.09***
47	Ag	Normal					*0.07*				***0.07***
83	Bi	*p* only								1.05	**2.82**
		Normal				0.52	0.02	1.23			
92	U	Normal	0.01					0.75			**0.75**
Total			**1.81**	**0.21**	**2.73**	**0.98**	**0.20**	**10.11**	**2.04**	**4.76**	**22.85**

Analysis Status

MIPP has been taking data for ~1+ year and is still running. While operating the detector, we have been writing our reconstruction software.

The basics all work:

- → TPC track finding and fitting
- → Track fitting with chambers
- → Used these to make preliminary alignment
- → TPC dE/dx
- → RICH ring finding + fitting

We are just now completing our first major pass through all our data. This will allow us to complete calibrations that require lots of data:

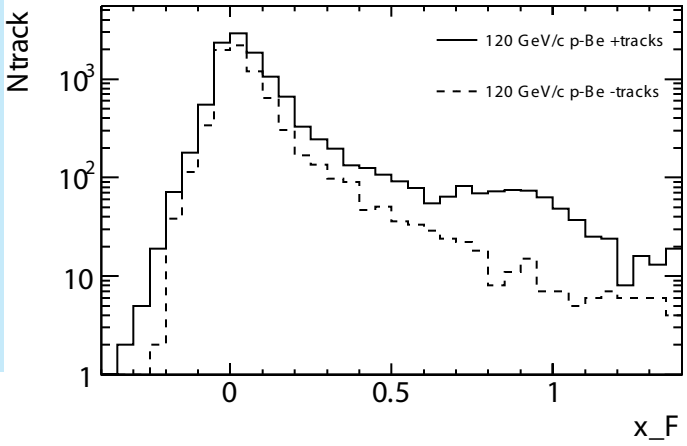
- → wire-by-wire timing calibration in chambers
- → mirror-by-mirror calibration of DCKOV
- → bar-by-bar calibration of TOF wall

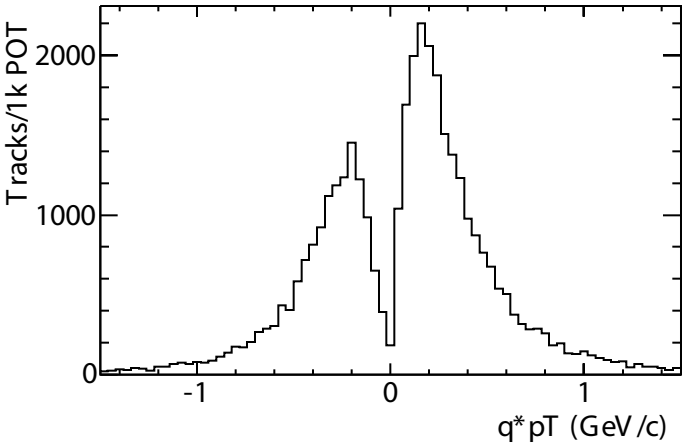
Enough of the reconstruction is working so that we can take preliminary looks at the data

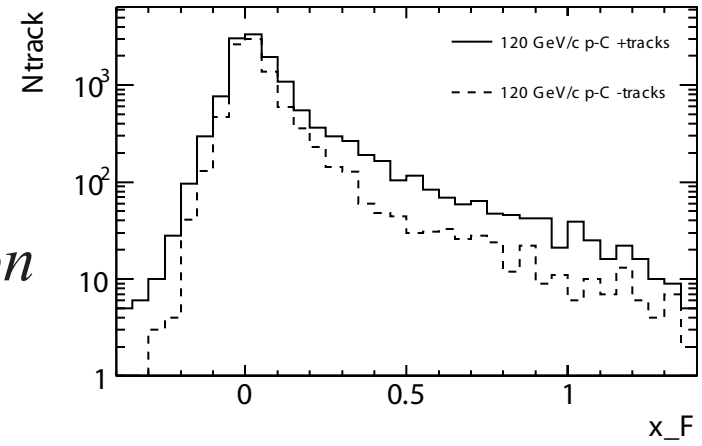
Some sample distributions for thin targets at 120 GeV

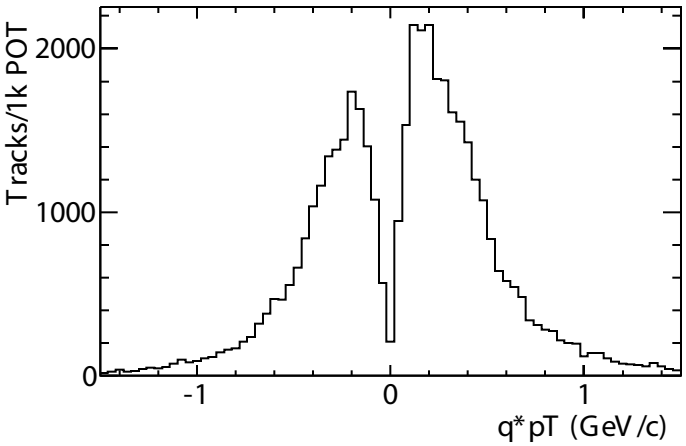
PRELIMINARY

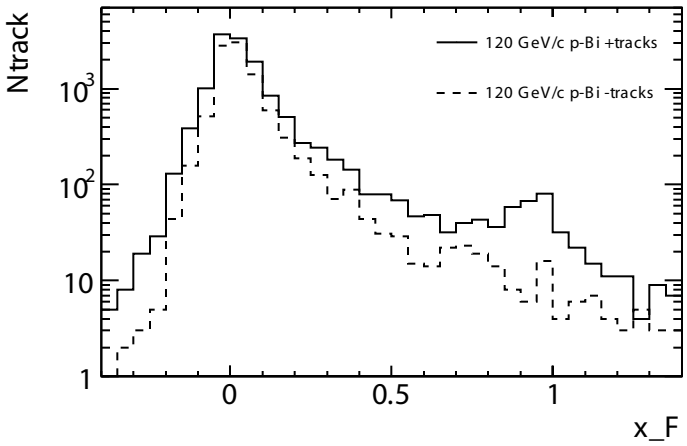
120 GeV p on Be (top), C (middle), and Bi (bottom). Feynman x distribution for all tracks shown at left, qp_T shown at right. Dotted lines show negative tracks.*

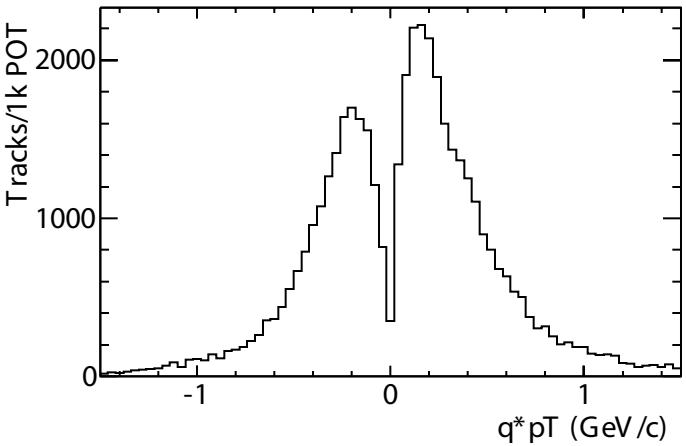




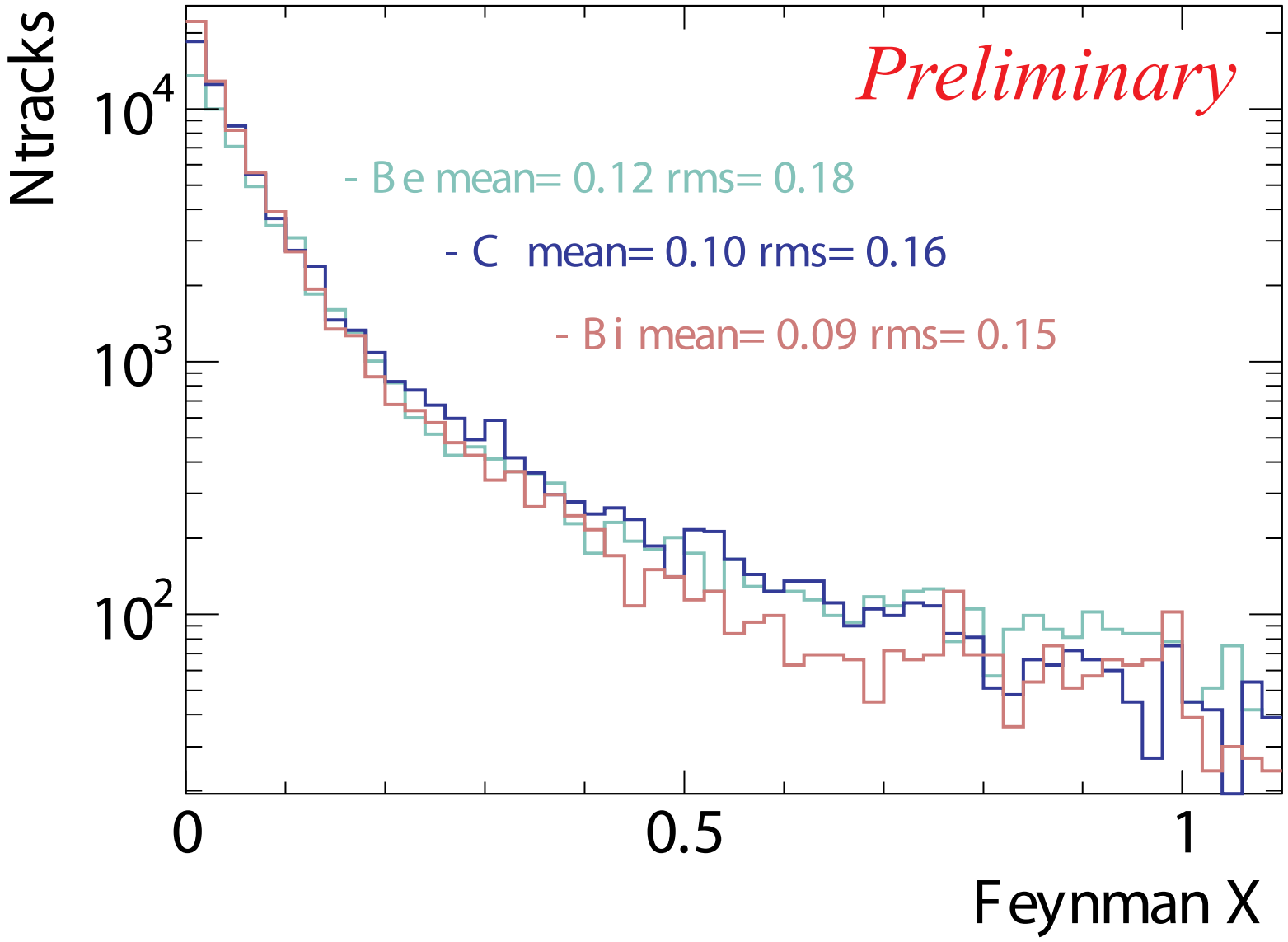


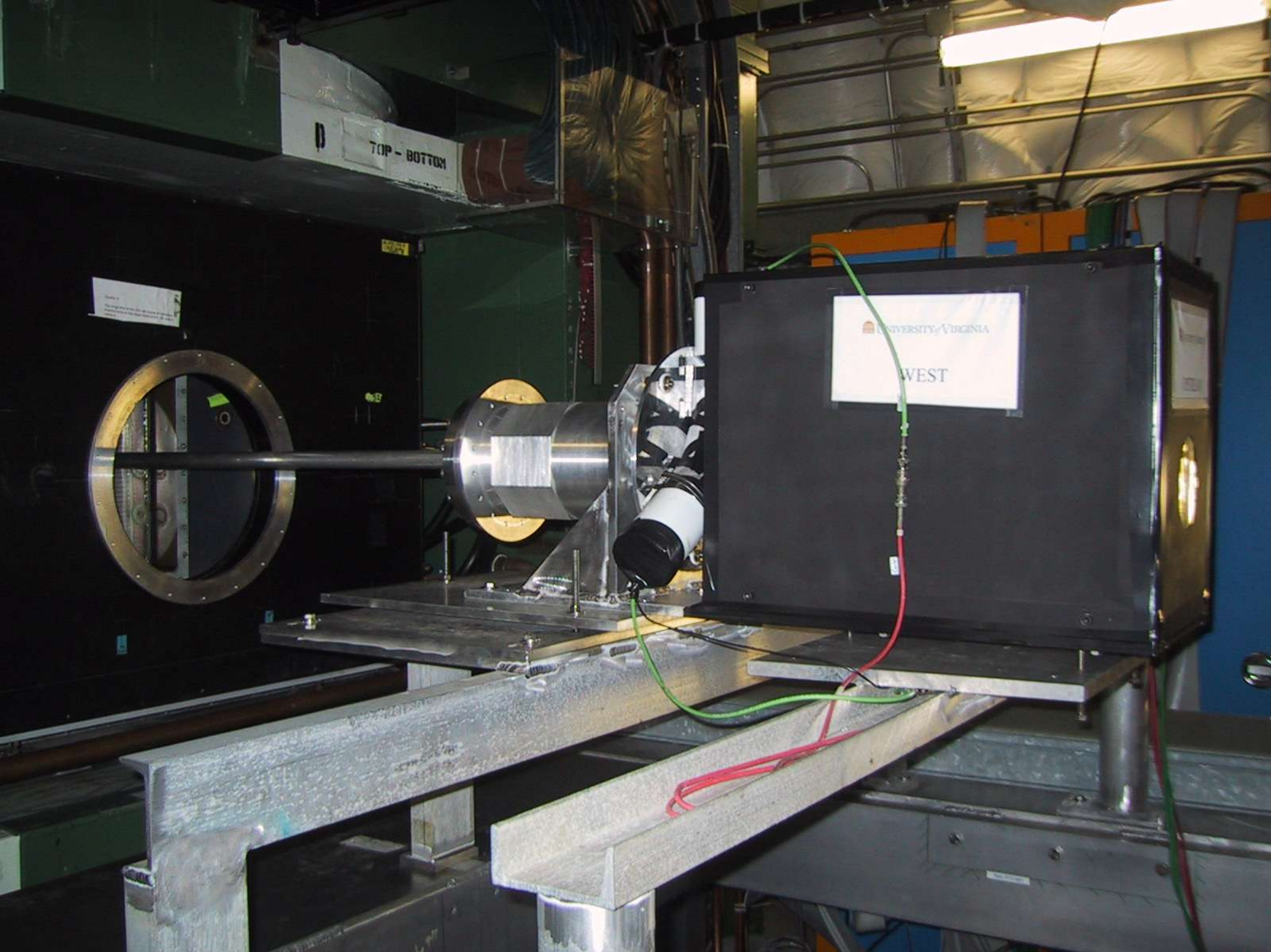




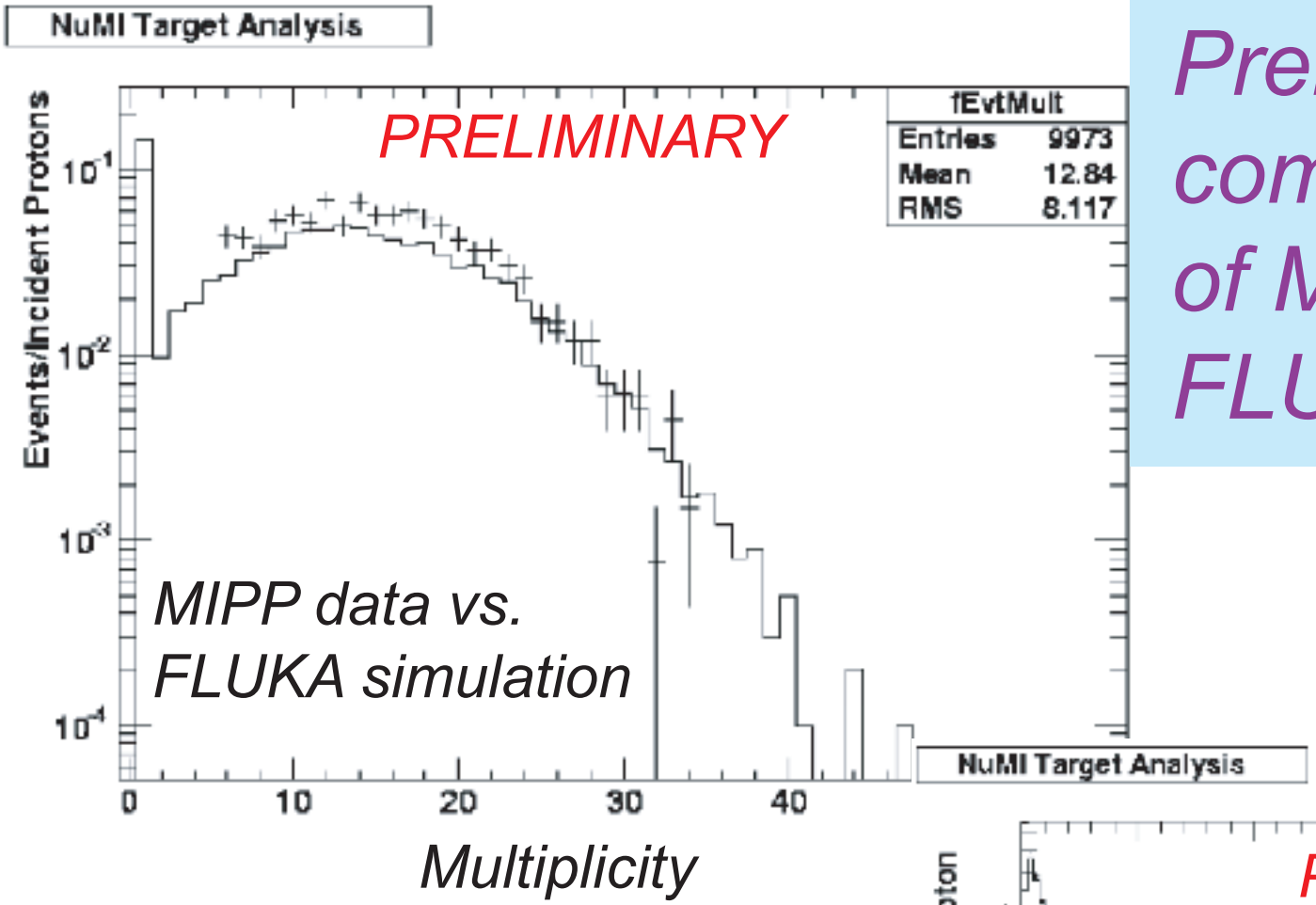


Comparison of Feynman x distributions

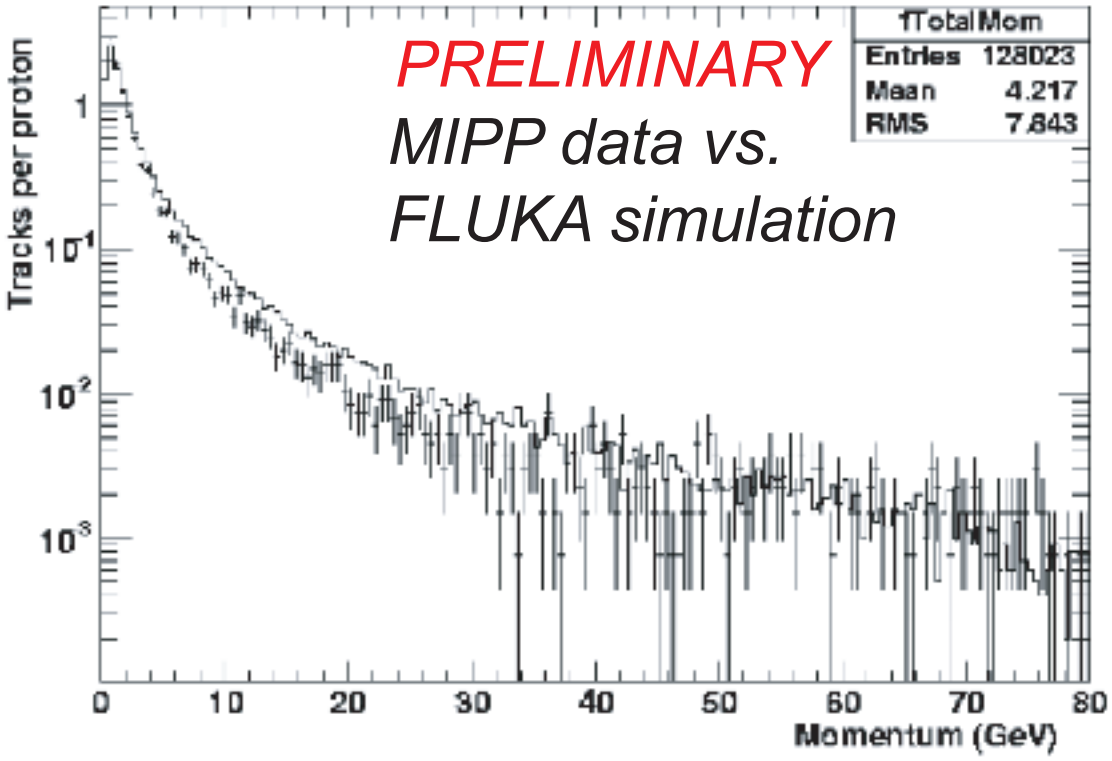



TOP - BOTTOM
UNIVERSITY of VIRGINIA
WEST

Preliminary comparisons of MIPP data to FLUKA simulations



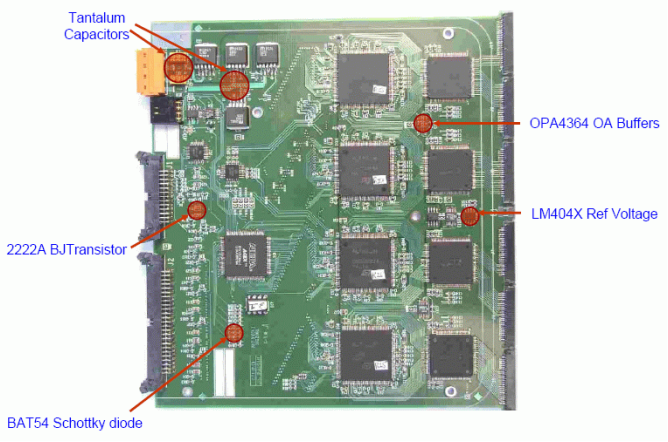
Small fraction of NuMI target data. Top shows comparison of multiplicity distribution to FLUKA simulation. Right shows comparison of total momentum spectrum to FLUKA simulation.



MIPP Upgrade

The EOS TPC used by MIPP is a great device, but its old (1980's vintage) and its electronics are limited to 30 Hz readout speed. Much faster TPC's exist today. HARP TPC runs at 3 kHz and experiment recorded total of 420M events during its run

Proposal is to use the ALICE electronics design (3 kHz) and modify the physical layout to match the EOS (MIPP) TPC



Assuming the rest of the experiment can be made to run at similar rates, MIPP could acquire data at rate of ~30M events per week of running assuming current beam conditions (3.6 second spill every 2 minutes 50% duty cycle ~= 10k spill seconds/week)

This would allow for great flexibility to measure a wide variety of nuclear targets at several momenta, do neutrino target R&D and engineering measurements, hadron calorimeter R&D (CALICE), exotic searches...

MIPP Upgrade

Proposal made to Fermilab PAC in May was not accepted, however...

There is a run of the chips scheduled for STAR and ALICE, Fermilab expected to spend ~$75k to purchase chips in this run (save startup costs)

Costs: TPC electronics upgrade ~$200k. Rest of experiment ~$200k

Upgrade proposal likely to be reconsidered in fall when current run ends

Limiting factor is manpower: Upgrade is no small task and the MIPP collaboration must grow if the upgrade is to succeed.

Neutrino experiments are gaining interest in MIPP data and have been very supportive. If MIPP upgrade is to go forward interest must be expressed as willingness to participate. There would be lots to do: *new collaborators welcome!*