The MIPP Upgrade Proposal (P-960)

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Fermilab

Format of the Talk

- Status of MIPP
- Upgrade Proposal in a Nutshell
- Physics Justification--
  - » Service Measurements
    - Neutrino Physics (MINOS, NOvA,MINERvA)
    - Improve Hadronic Shower Simulators (Geant4, Fluka, Mars…)
    - Cosmic ray experiments(ICE Cube, Pierre Auger, Hi Res..)
    - Tagged Neutral beams for the ILC
  - » MIPP Physics
    - Non perturbative QCD-(scaling laws of fragmentation)
    - Anti-proton physics
    - High multiplicity enhancements
    - Missing Baryon resonances
- Run Plan
- Conclusions

MIPP Upgrade collaboration list

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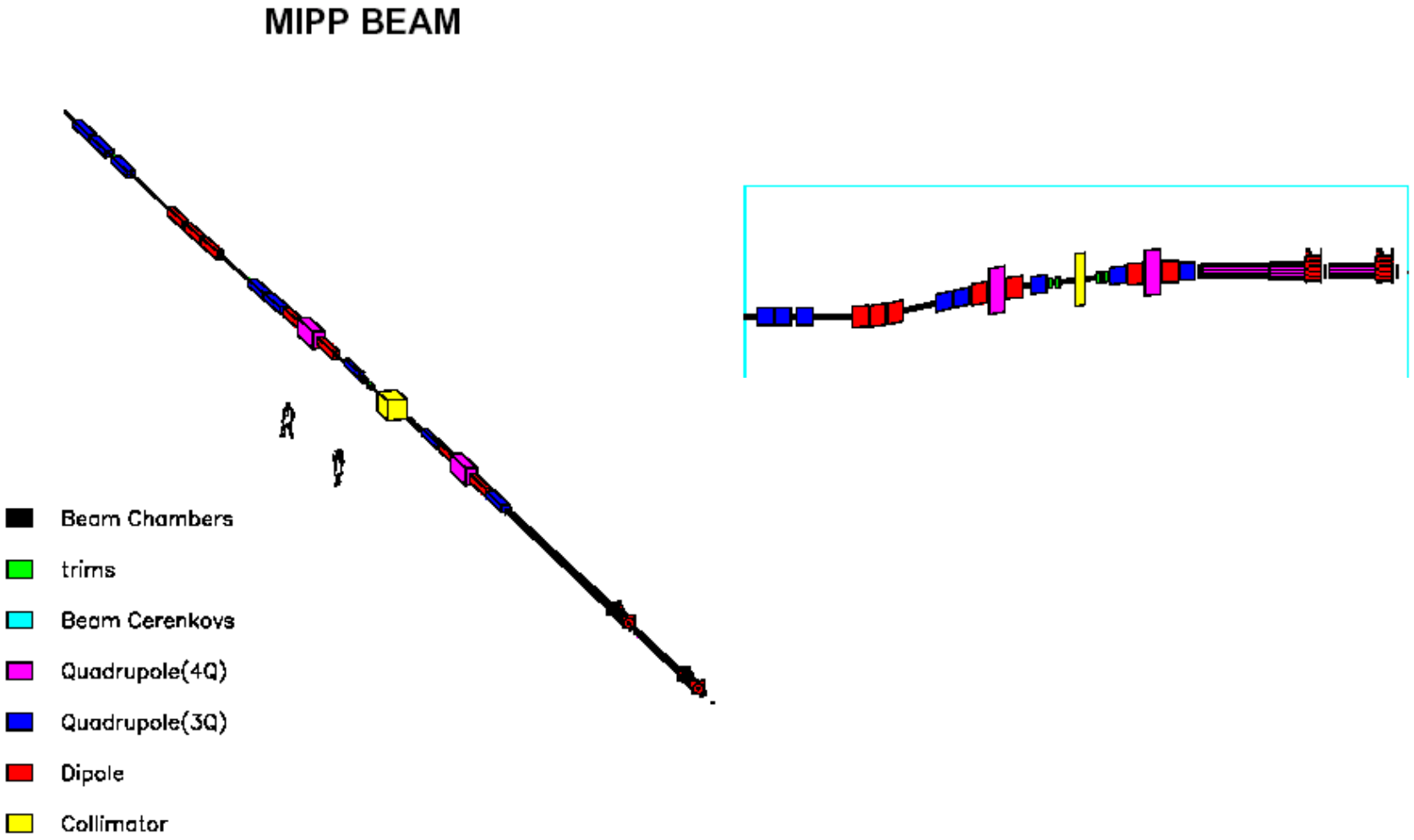
Livermore dropped out. Rest still on proposal. 10 new institutions have joined. More inegotiaitions. Previous collaboration built MIPP up from ground level. Less to do this time round. More data.

Brief Description of Experiment

- Approved November 2001
- Situated in Meson Center 7
- Uses 120GeV Main Injector Primary protons to produce secondary beams of $\pi^{\pm}$ $K^{\pm}$ $p^{\pm}$ from 5 GeV/c to 85 GeV/c to measure particle production cross sections of various nuclei including hydrogen.
- Using a TPC we measure momenta of ~all charged particles produced in the interaction and identify the charged particles in the final state using a combination of dE/dx, ToF, differential Cherenkov and RICH technologies.
- Open Geometry- Lower systematics. TPC gives high statistics. Existing data poor quality.
- First Physics run- 18 million events 2005. Ended Feb 2006

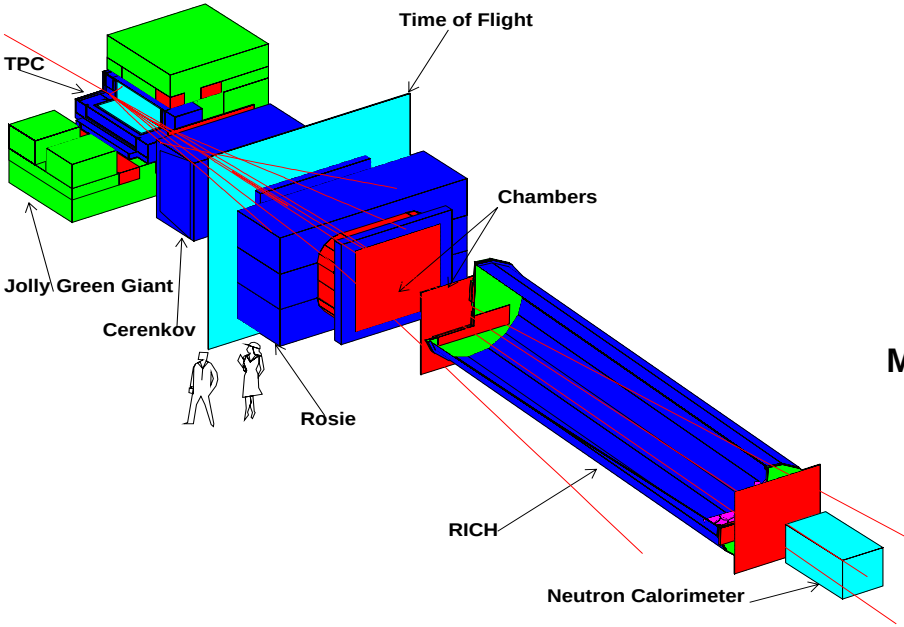
MIPP Secondary Beam

Installed in 2003. Excellent performance. Ran it successfully in MIPP from 5-85 GeV/c secondaries and 120 GeV/c primary protons. Excellent particle ID capabilities using 2 Beam Cerenkovs. For low momenta (<~10 GeV/c) ToF is used for pid. Design principles and lessons learned used in M-test upgrade.



MIPP

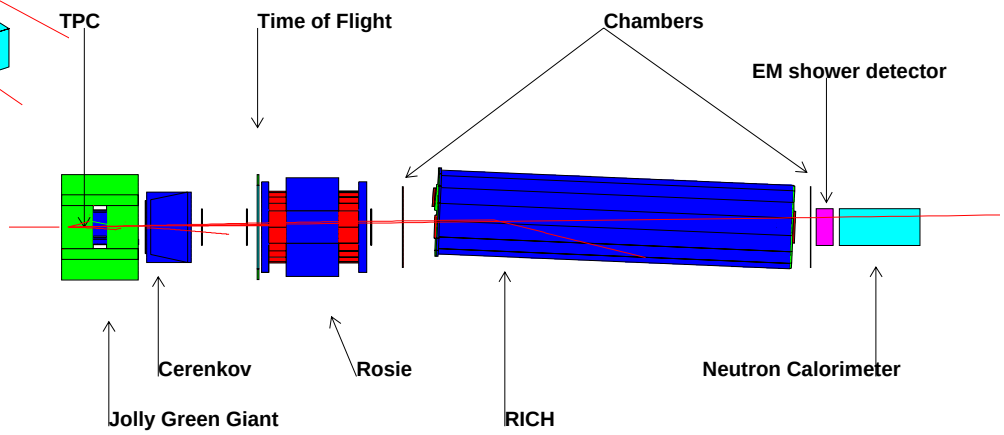
Main Injector Particle Production Experiment (FNAL-E907)



MIPP

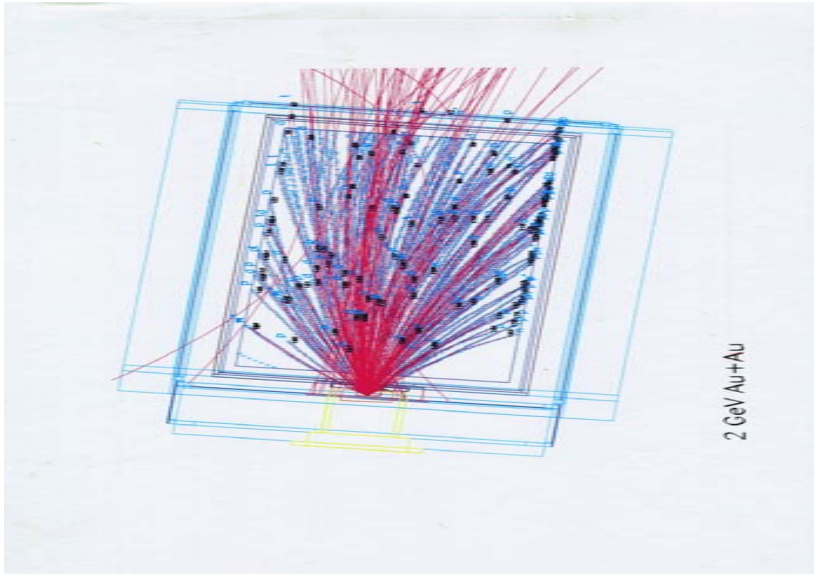
Main Injector Particle Production Experiment (FNAL-E907)

Vertical cut plane

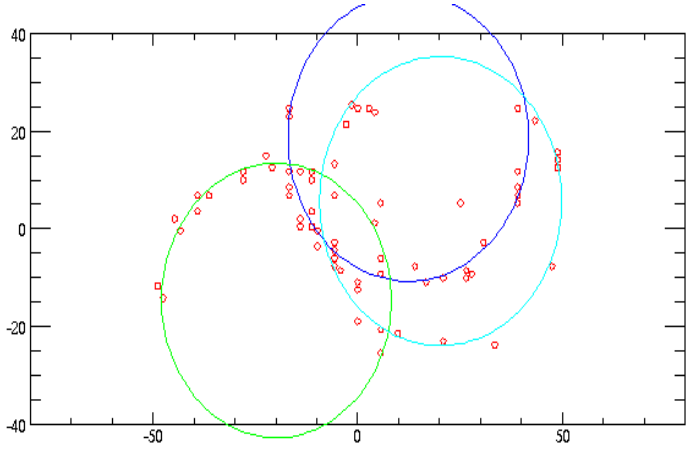


Installation in progress- Collision Hall

TPC



RICH rings pattern recognized

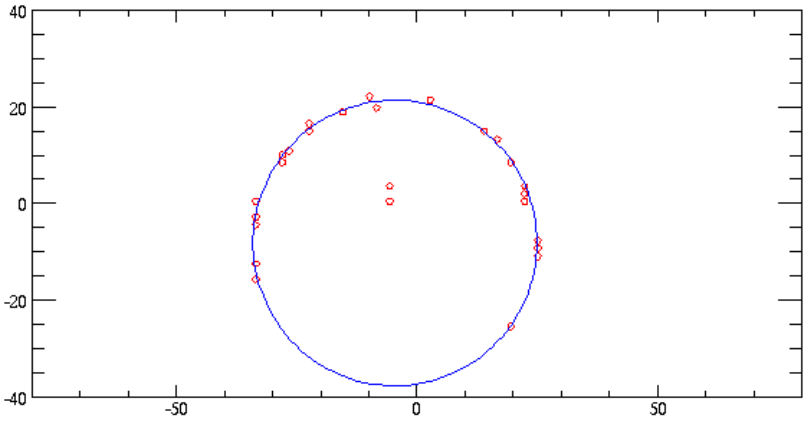


MIPP (FNAL E907)

Run: 9121
SubRun: 0
Event: 92

Wed Aug 11 2004
13:53:56.884750

Version: 0
Trigger: 10000008



MIPP (FNAL E907)

Run: 9121
SubRun: 0
Event: 100

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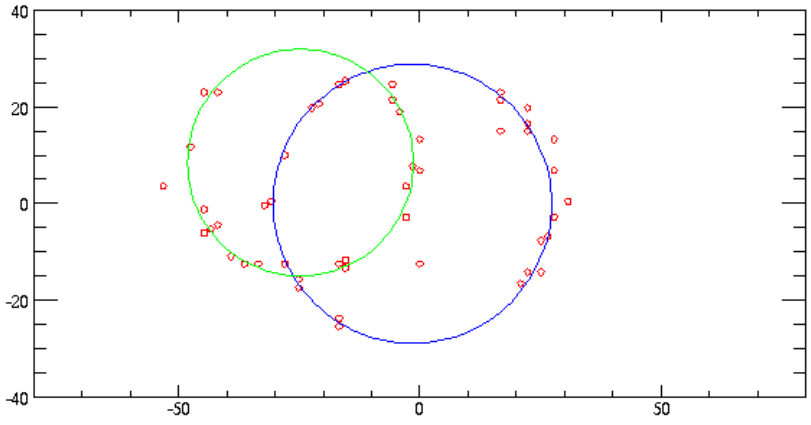
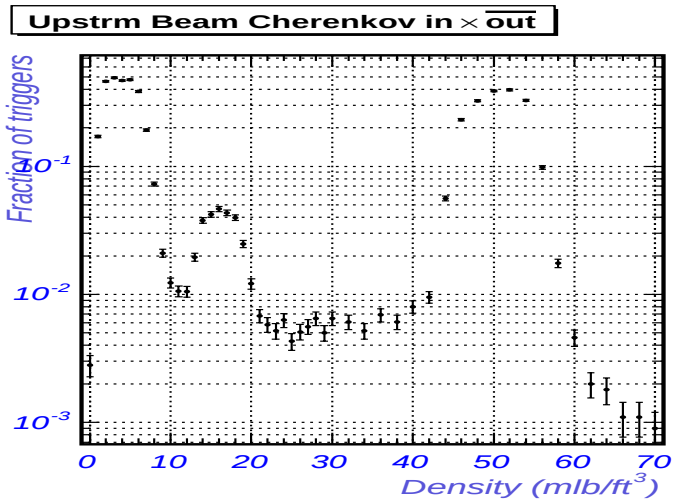
13:54:06.823879

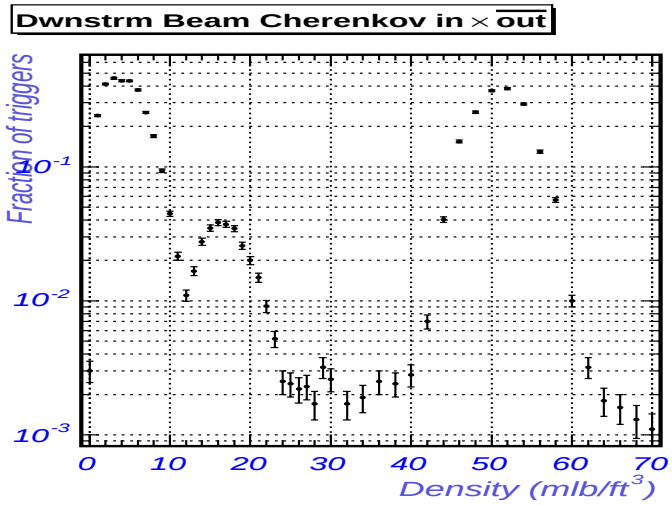
Version: 0
Trigger: 10000008



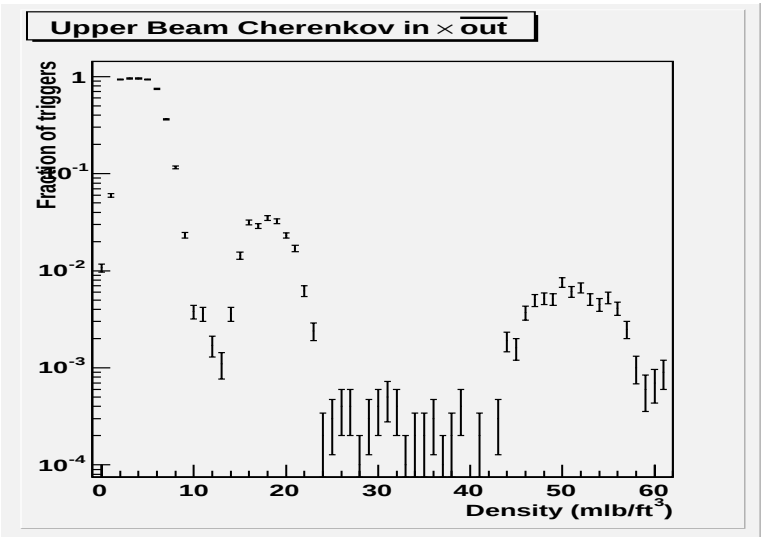
Beam Cherenkovs

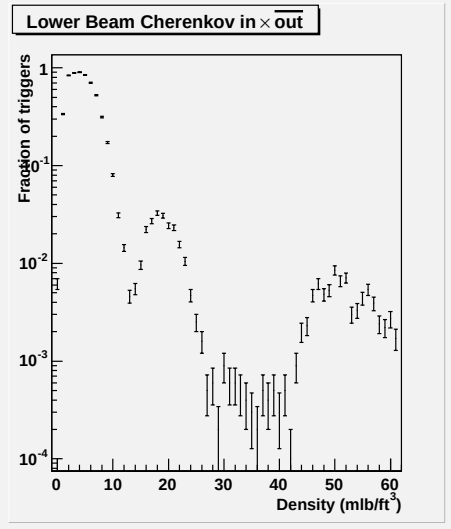
+40 GeV/c



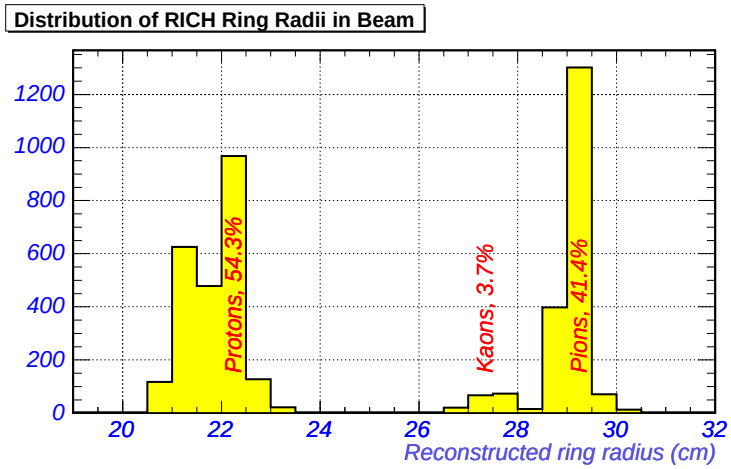


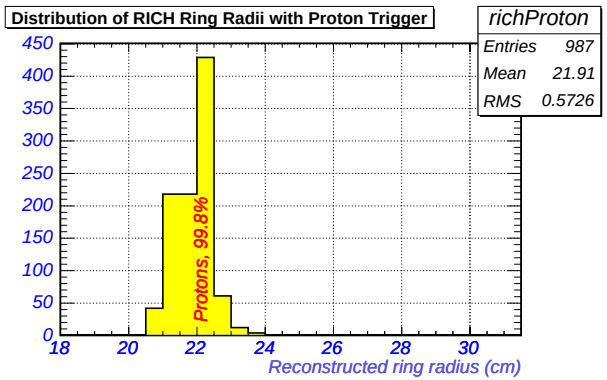
-40 GeV/c

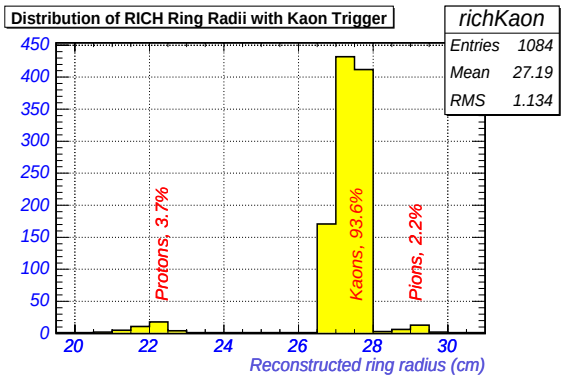


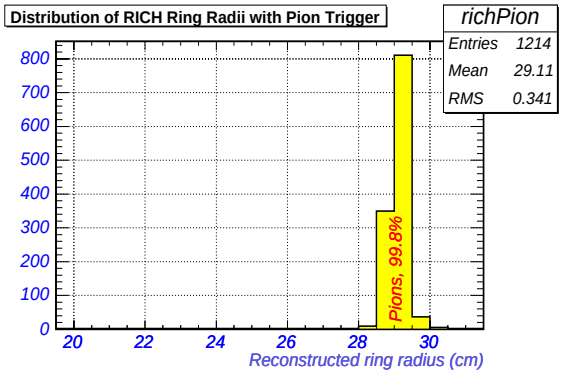


Comparing Beam Cherenkov to RICH for +40 GeV beam triggers-No additional cuts!



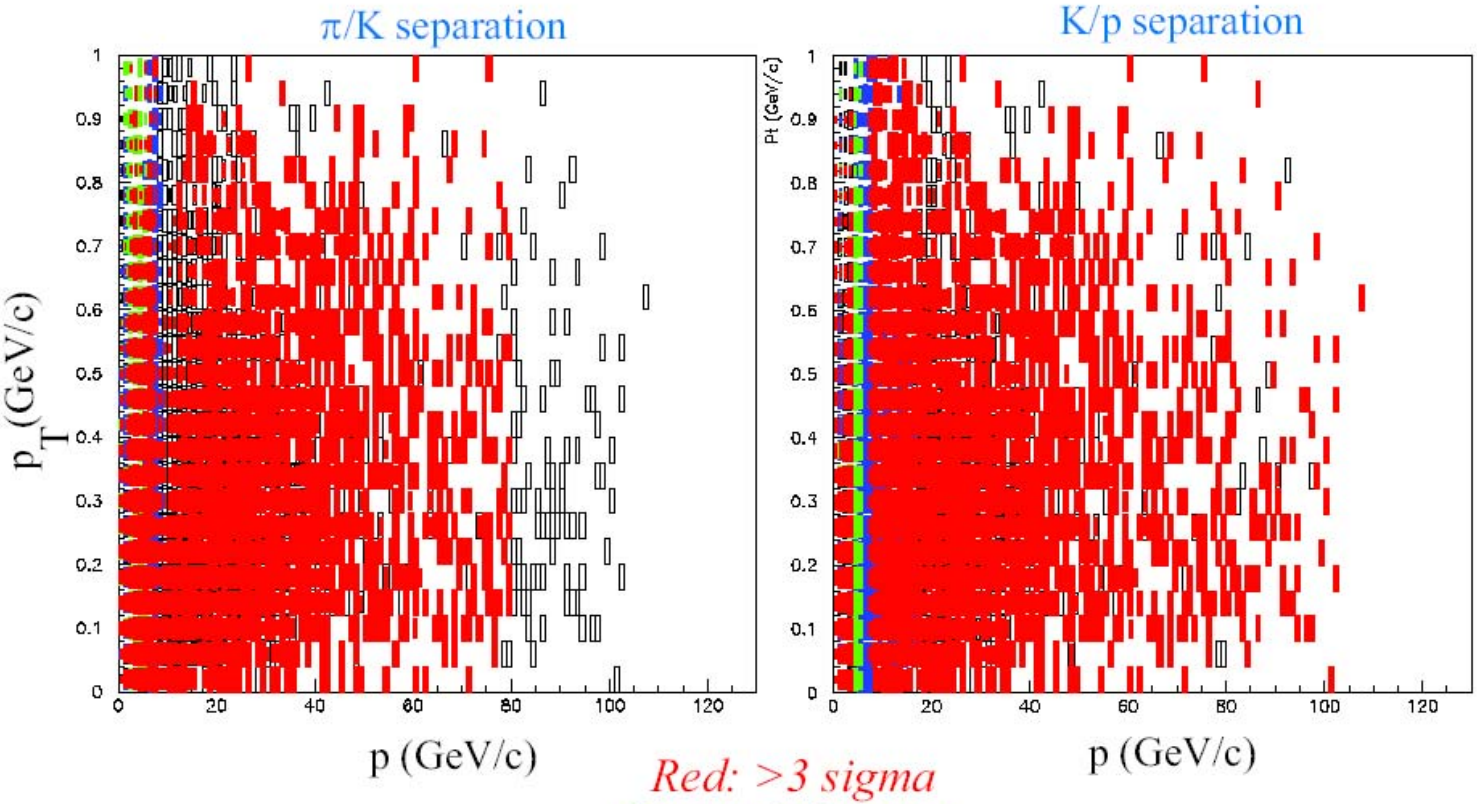




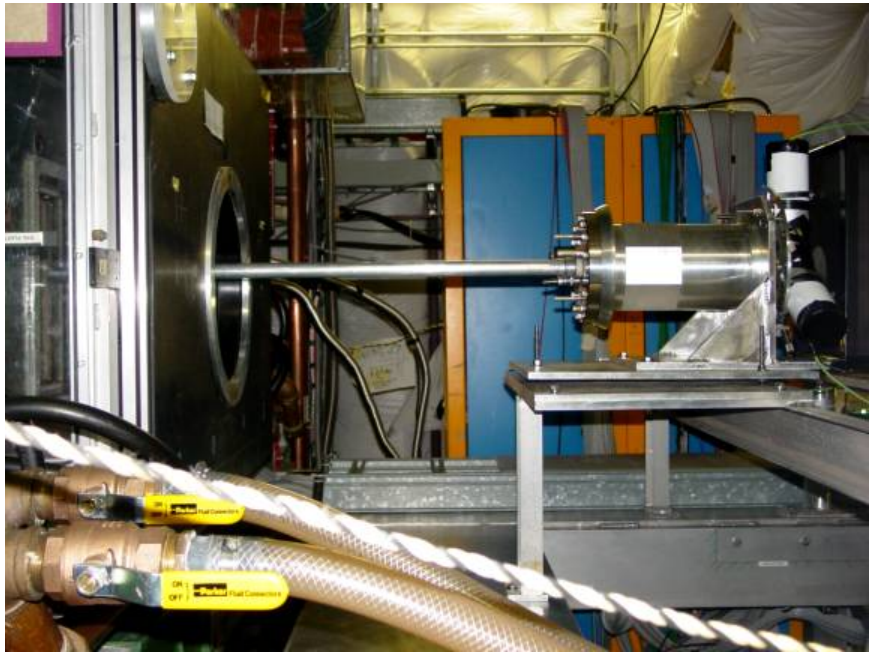


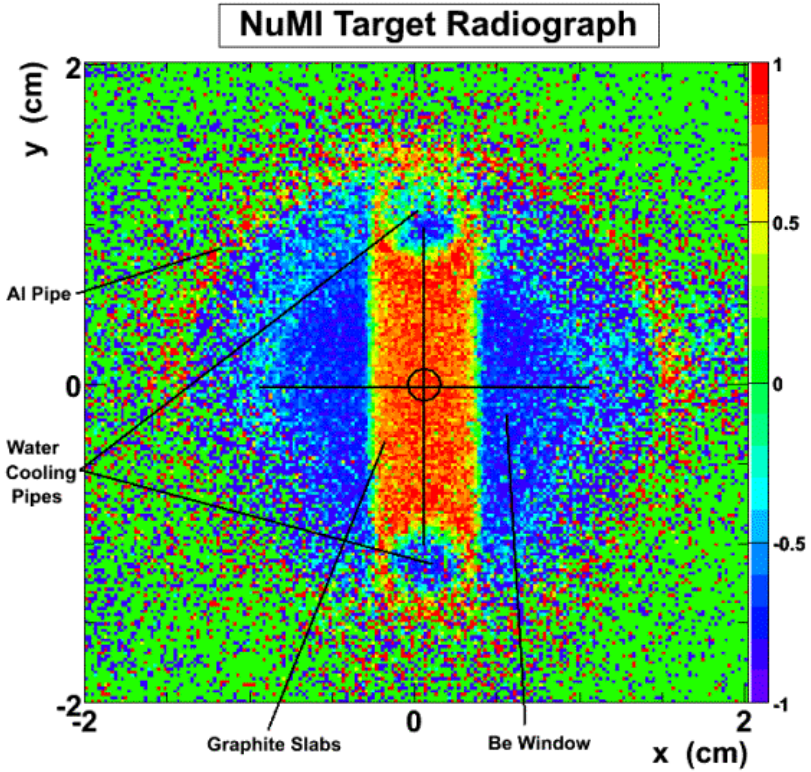
Expected MIPP Particle ID

Particle ID Performance



NUMI target pix



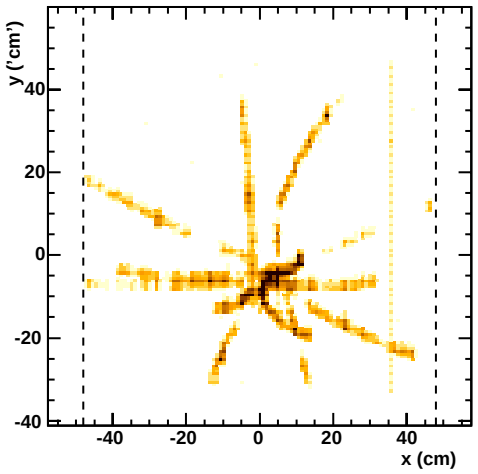


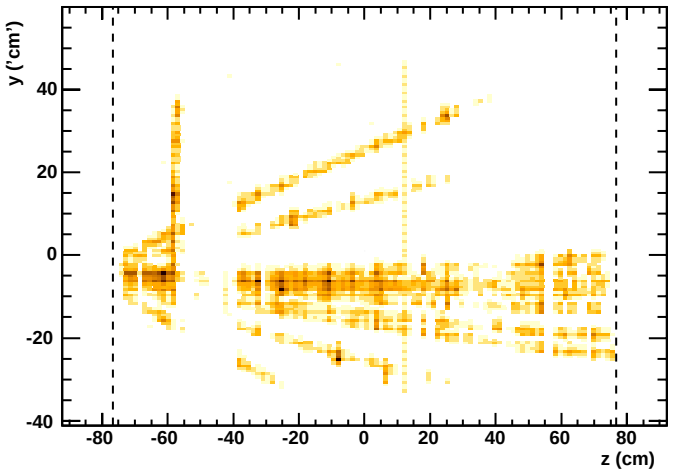
MIPP (FNAL E907)

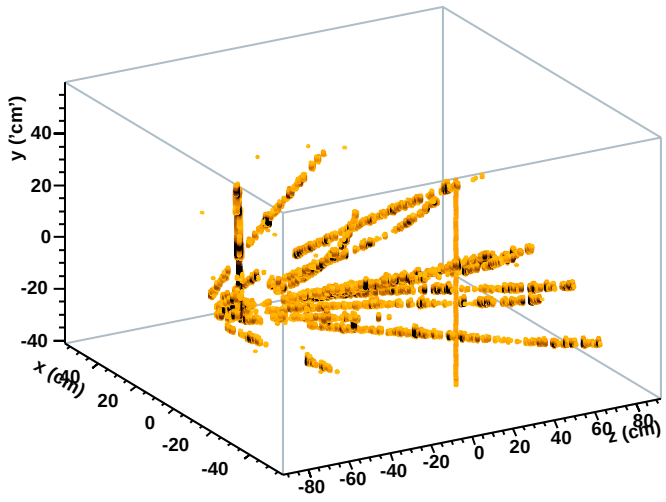
Target: NuMI
Run: 15007
SubRun: 0
Event: 160

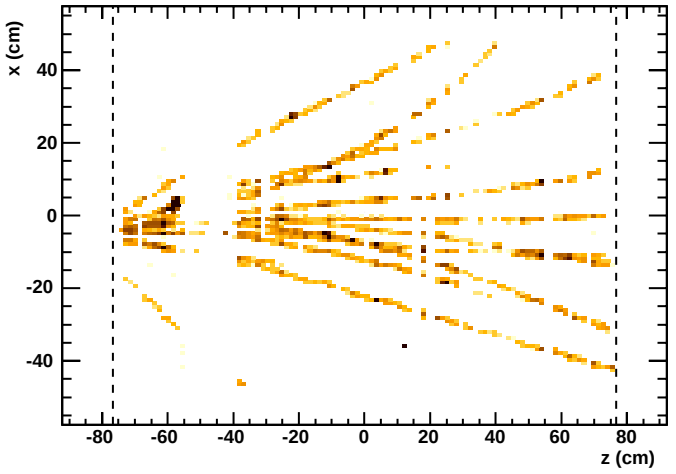
Sat Jul 16 2005
11:22:30.687398

*** Trigger ***
Beam
Word: 0080
Bits: 80D7









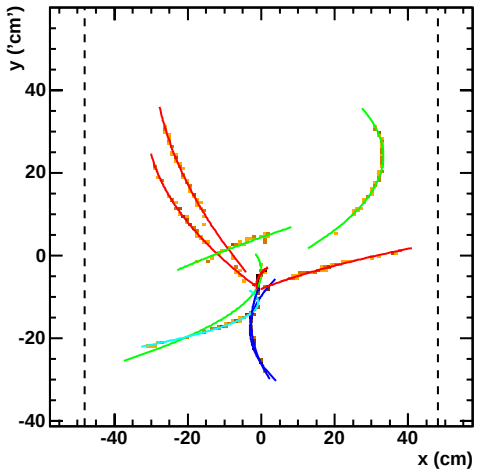
TPC Reconstructed tracks

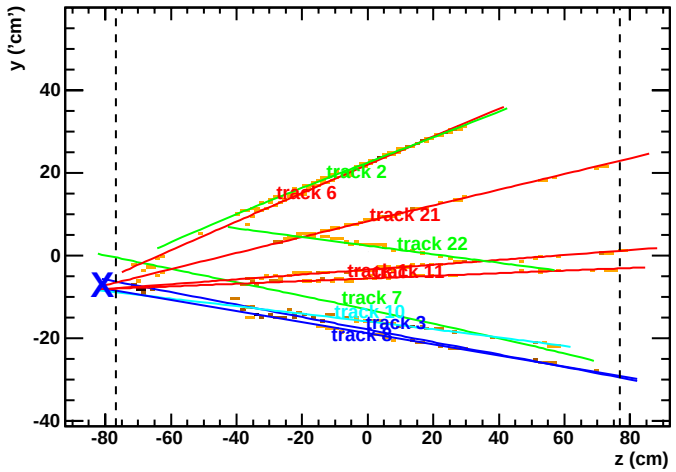
MIPP (FNAL E907)

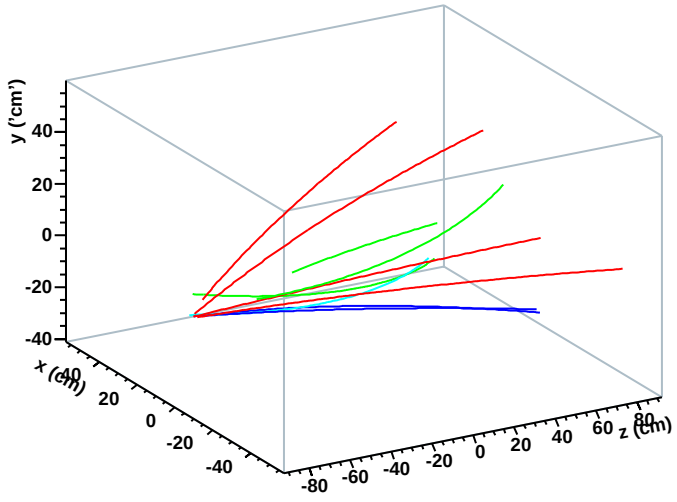
Target: Beryllium
Run: 12719
SubRun: 0
Event: 9

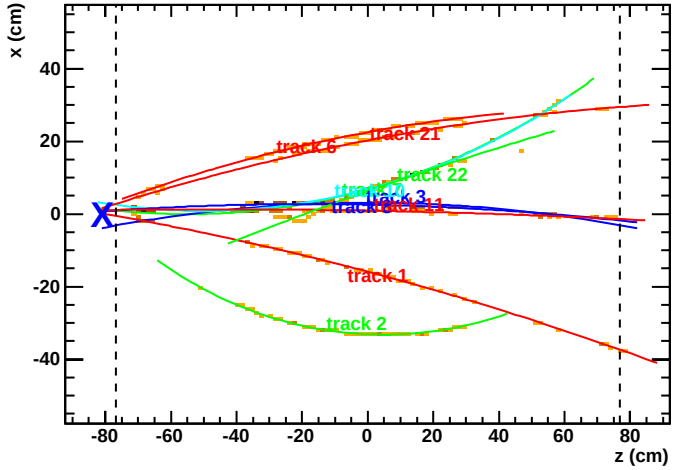
Mon Feb 28 2005
03:18:40.377278

*** Trigger ***
Beam
Word: 0400
Bits: C44F

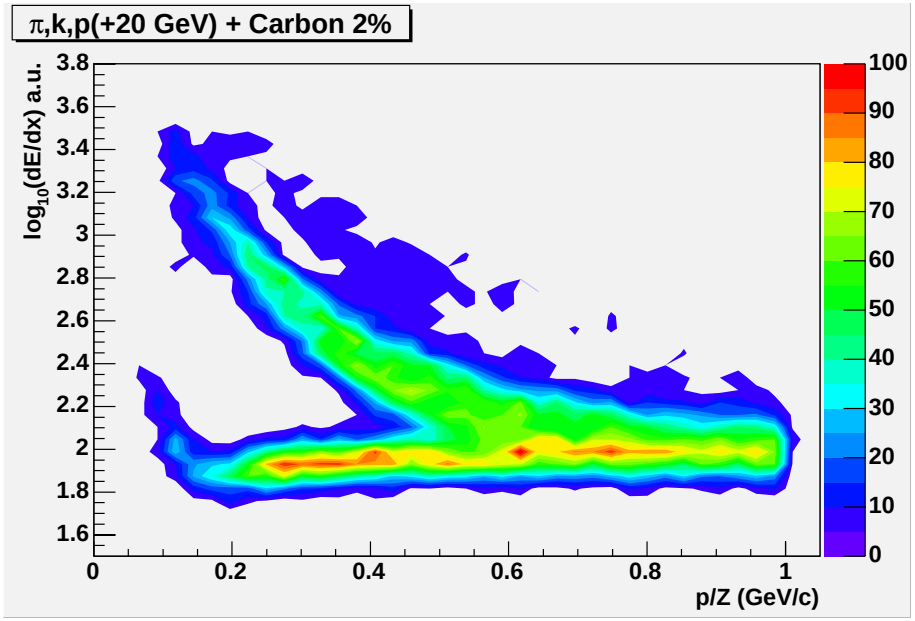


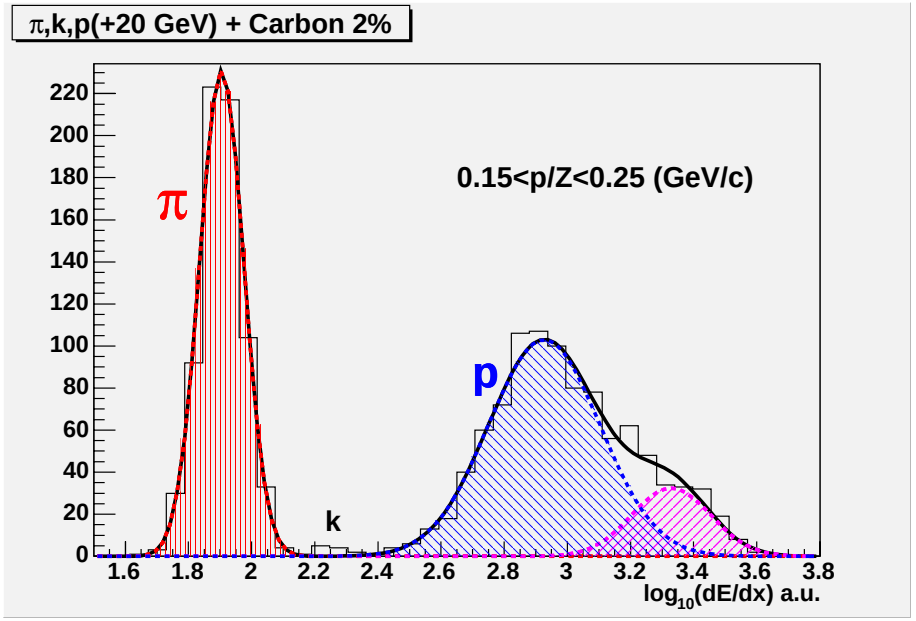


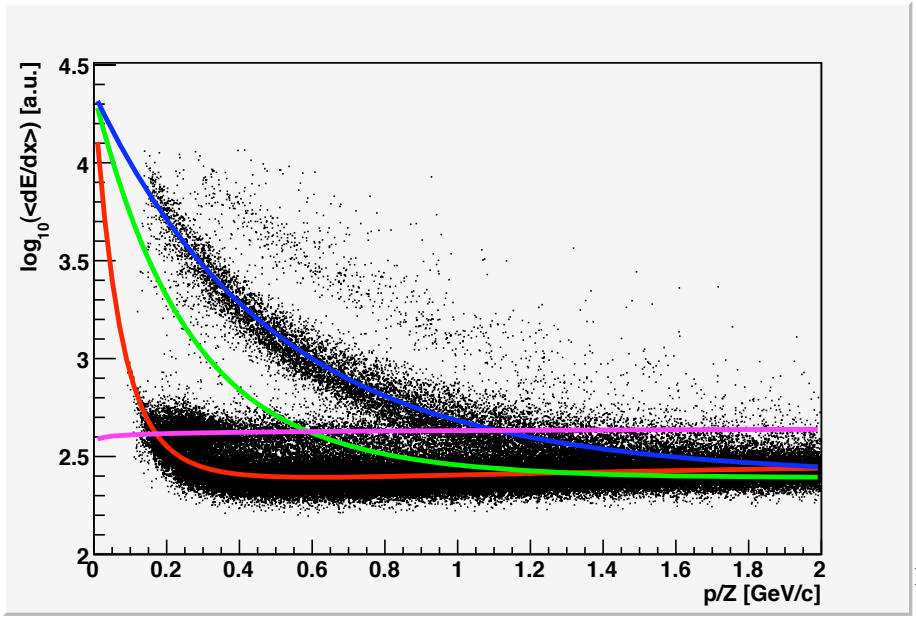




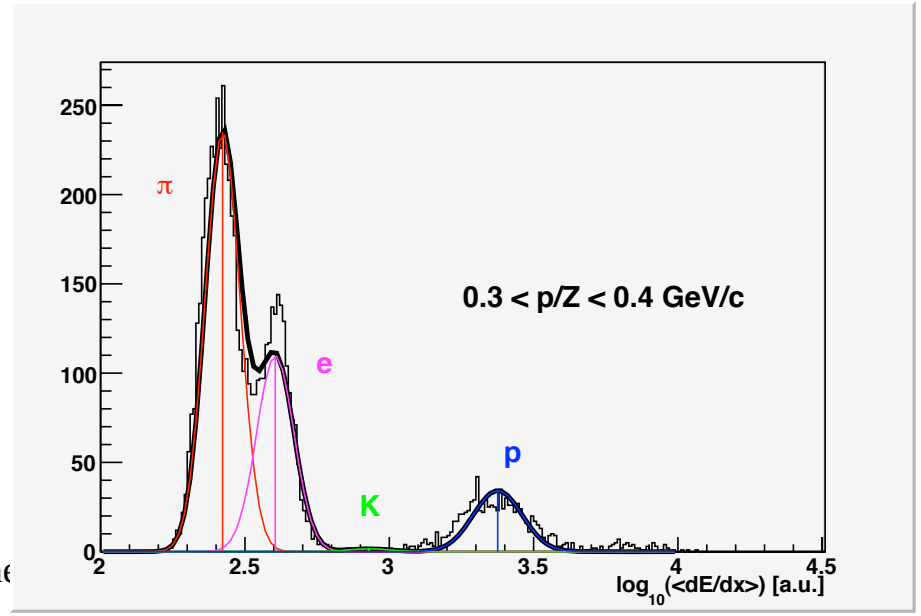
dE/dx in the TPC



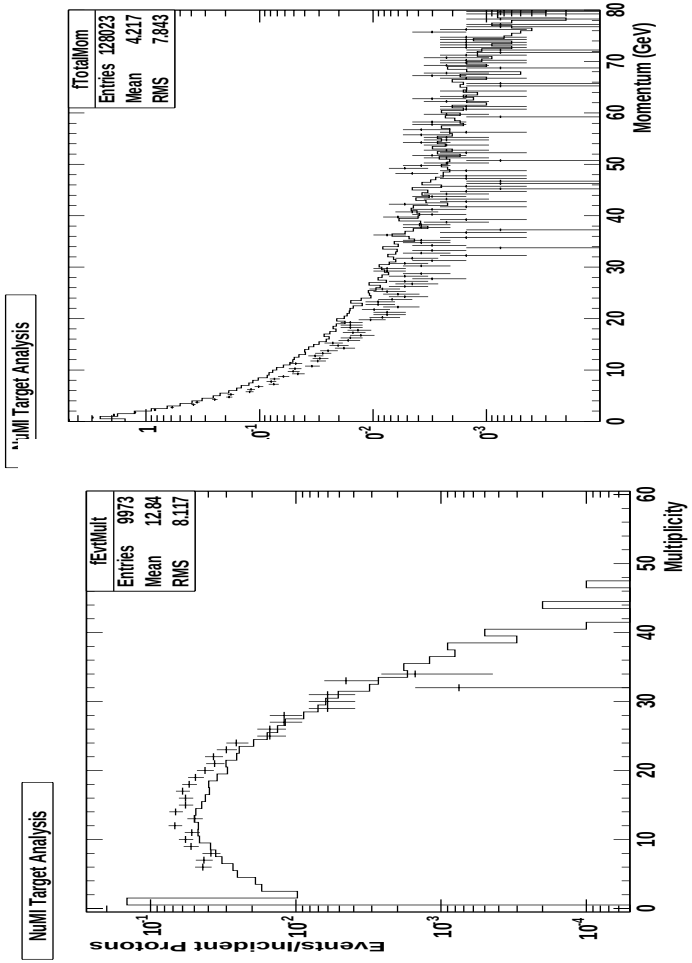




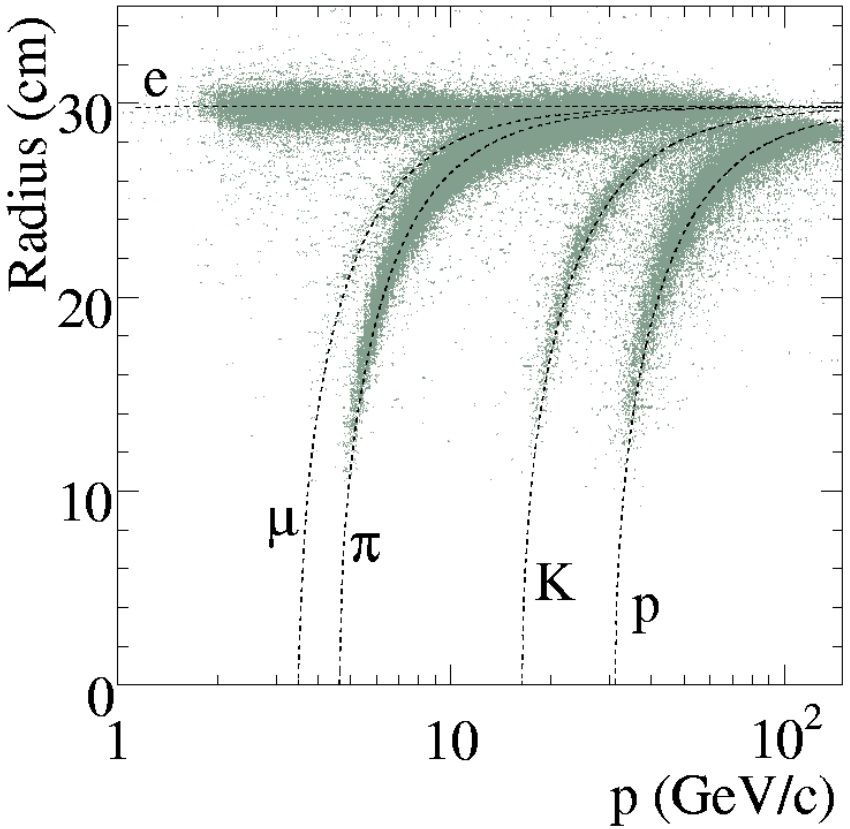
n to the



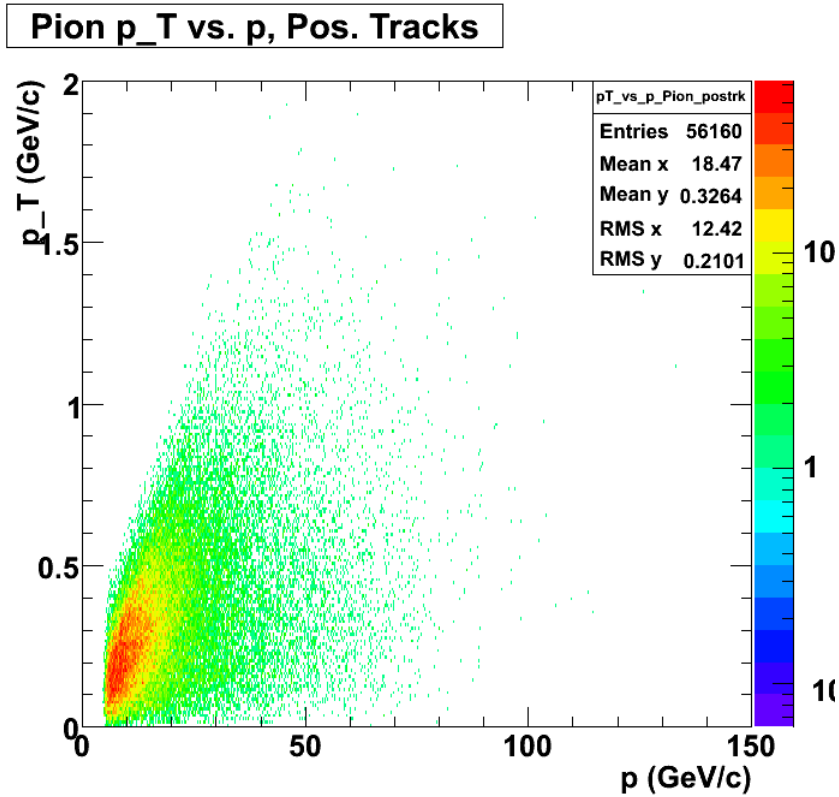
Preliminary Comparison of NUMI target to FLUKA predictions

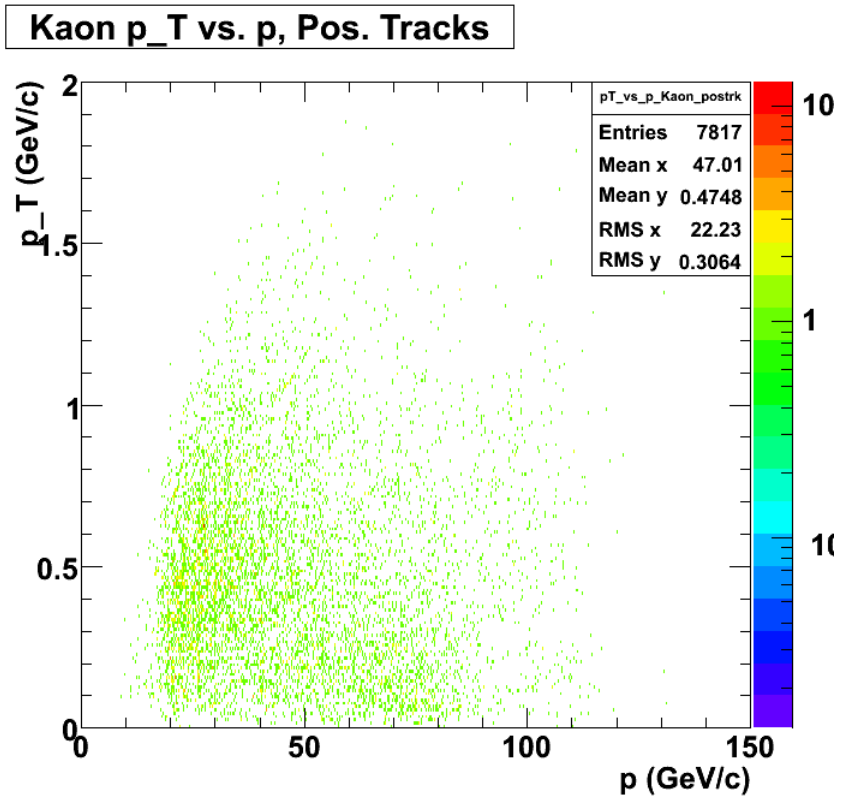


RICH Rings from NUMI target

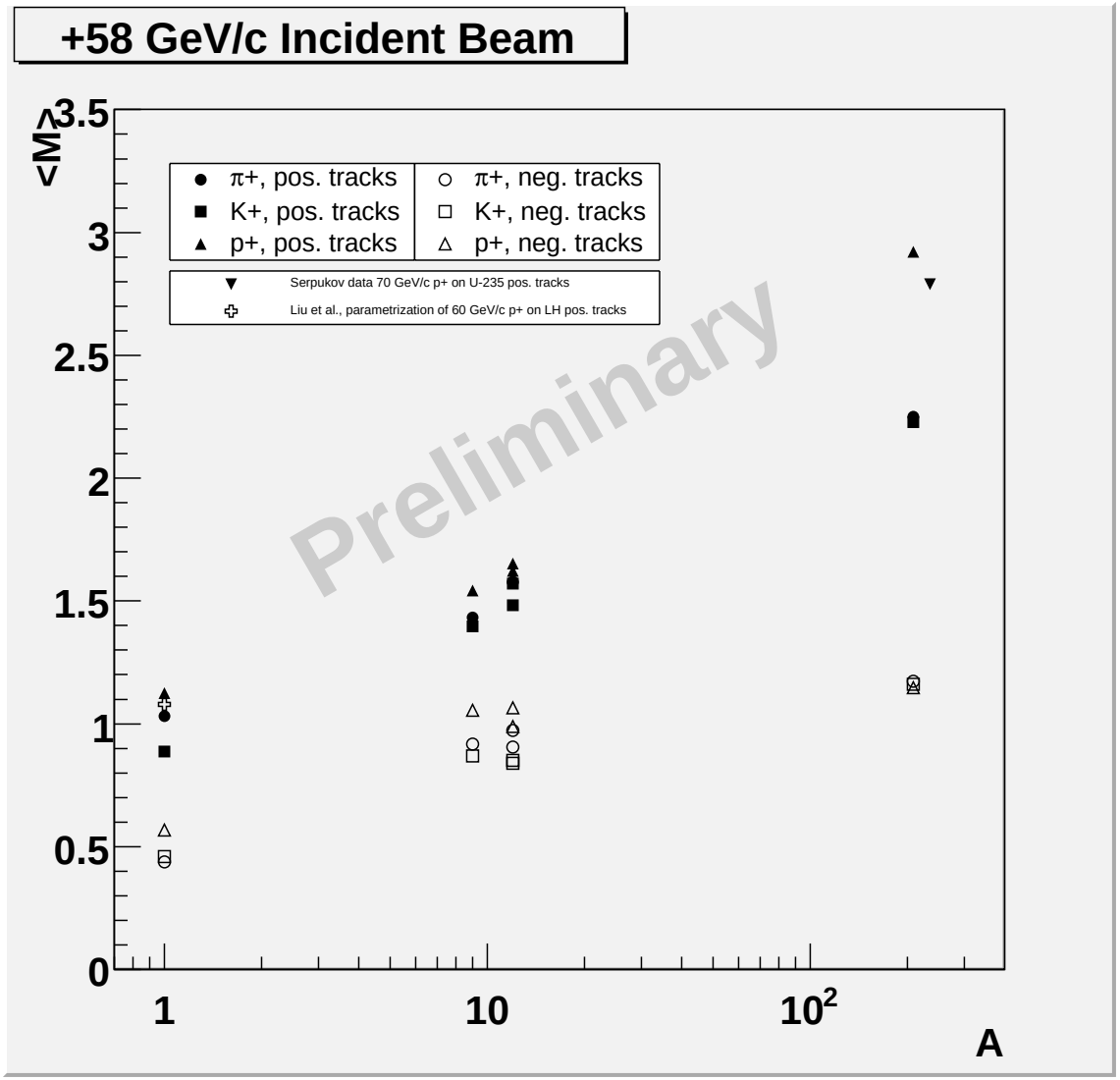


Particle ID on NUMI target





Target fragmentation multiplicities



Data Taken In current run

Data Summary 27 February 2006			Acquired Data by Target and Beam Energy Number of events, x 10^6									
Target			E									Total
Z	Element	Trigger Mix	5	20	35	40	55	60	65	85	120	
0	Empty[1]	Normal		*0.10*	*0.14*			*0.52*			*0.25*	***1.01***
	***K* Mass**[2]	**No Int.**				*5.48*	*0.50*	*7.39*	*0.96*			***14.33***
	Empty LH[1]	Normal		*0.30*				*0.61*		*0.31*		**7.08**
1	LH	Normal	0.21	**1.94**				**1.98**		**1.73**		
4	Be	***p* only**									1.08	**1.75**
		Normal			0.10			0.56				
6	C	Mixed						**0.21**				**1.33**
	C 2%	Mixed		**0.39**				**0.26**			**0.47**	
	NuMI	***p* only**									**1.78**	**1.78**
13	Al	Normal			*0.10*							***0.10***
83	Bi	***p* only**									1.05	**2.83**
		Normal			0.52			1.26				
92	U	Normal						1.18				**1.18**
Total			**0.21**	**2.73**	**0.86**	**5.48**	**0.50**	**13.97**	**0.96**	**2.04**	**4.63**	**31.38**

Status of MIPP Analysis

- Our Offline analysis software consists of 3 passes.
  - » Pass 1 Calculates pedestals, hot and dead channels, adc to charge and tdc to time conversions and an alignment pass determines the chamber alignments (done)
  - » Pass 2 fits track segments, does TPC Anode gain calibration, determines drift chamber efficiencies, RICH rings etc
  - » Pass 3 is the full reconstruction, vertex finding, and particle ID. Use Kalman filter for tracking.
- We just finished a final iteration of pass 2 and are about to embark on Pass 3 reco. Need 8 weeks on FNAL/LLNL Farms. Still developing algorithms for CKOV and ToF. Anticipate one more iteration at Pass3 to get out final distortions in TPC..
- We have a fully developed Monte Carlo (Geant3 based) that uses the same Geometry database as the Offline.
- We have a 15GB database that contains all the temperatures, HV's, pedestals etc of the data taken during the run. It is interfaced to the reconstruction.

The Proposal in a nutshell

- MIPP one can take data at ~30Hz. The limitation is the TPC electronics which are 1990's vintage. We plan to speed this rate up to 3000Hz using ALTRO/PASA chips developed for the ALICE collaboration.
- Beam delivery rate– We assume the delivery of a single 4 second spill every two minutes from the Main Injector. We assume a 42% downtime of the Main Injector for beam manipulation etc. This is conservative. Using these figures, we can acquire 5 million events per day.
- Jolly Green Giant Coil Replacement- Towards the end of our run, the bottom two coils of the JGG burned out. We have decided to replace both the top and bottom coils with newly designed aluminum coils that have better field characteristics for the TPC drift. The coil order has been placed ($200K).
- Beamline upgrade- The MIPP secondary beamline ran satisfactorily from 5 5GeV/c-85GeV/c. We plan to run it from ~1 GeV/c to 85 GeV/c. The low momentum running will be performed using low current power supplies that regulate better. Hall probes in magnets will eliminate hysteresis effects.
- TPC Readout Upgrade-We have ordered 1100 ALTRO/PASA chips from CERN ($80K). The order had to go in with a bigger STAR collaboration order to reduce overhead. We expect delivery in the new year of tested chipsets.

The Proposal in a nutshell

- MIPP- Recoil detector- GSI- Darmstadt / KVI Groningen have joined us. They will bring the plastic ball detector (a hemisphere of it) which will serve to identify recoil (wide angle) neutrons, protons and gammas from our targets.
- Triggering system- We propose to replace the MIPP interaction trigger (scintillator/wire chamber) with 3 planes of silicon pixels based on the B-TeV design. Will enable us to trigger more efficiently on low multiplicity events.
- Drift Chamber/ PWC electronics- These electronics (E690/RMH) worked well for the first run. They are old (1990's). RMH will not do 3kHz. We will replace both systems with a new design that utilizes some of the infrastructure we developed for the RICH readout.
- ToF/CKOV readout-Plan to build new readout based on TripT chip (Used by Minerva) and a high resolution TDC chip. Will use the VME readout cards in common with RICH, TPC
- RICH detector and the Beam Cerenkovs will work as is.
- Calorimeter Readout- Switch to FERA ADC's (PREP).
- DAQ software upgrade- Front end DAQ software needs to be developed. The MIPP DAQ control software+ Data base can be kept as is.
- Plan is to store one spill's worth of data on each detector and read out the whole lot at end of spill.

Nuclei of interest- 1st pass list

- The A-List
- H_2,D_2,Li,Be,B,C,N_2,O_2,Mg,Al,Si,P,S,Ar,K,Ca,,Fe,Ni,Cu,Zn,Nb,Ag,Sn,W,Pt,Au,Hg,Pb,Bi,U
- The B-List
- Na, Ti,V, Cr,Mn,Mo,I, Cd, Cs, Ba
- On each nucleus, we can acquire 5 million events/day with one 4sec beam spill every 2 mins and a 42% downtime.
- We plan to run several different momenta and both charges.
- The libraries of events thus produced will be fed into shower generator programs which currently have 30 year old single arm spectrometer data with high systematics

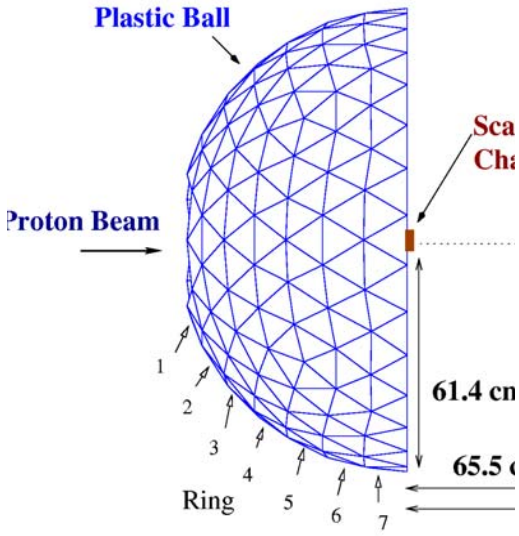
Spallation products

- Such a recoil detector coupled with the TPC can detect spallation products such as "grey" and "Black" protons, and neutrons as well as nuclear fragments.
- Table from Textbook on Calorimetry by Wigmans

	Binding Energy	Evaportion n (# neutrons)	Cascade n (# neutrons)	Ionization (#cascade p)	Target recoil
Before first reaction				(250)(π_{in})	
First reaction	126	27(9)	519 (4.2)	350(2.8)	28
Generation 2	187	63(21)	161(1.7)	105(1.1)	3
Generation 3	77	24(8)	36(1.1)	23 (0.7)	1
Generation 4	24	12(3)			
Total	414	126(41)		478(4.6)	32

TABLE I: Destination of 1.3 GeV total energy carried by an average pion produced in hadronic shower development in lead. Energies are in MeV.

The recoil detector



3.3. Plastic Ball 31

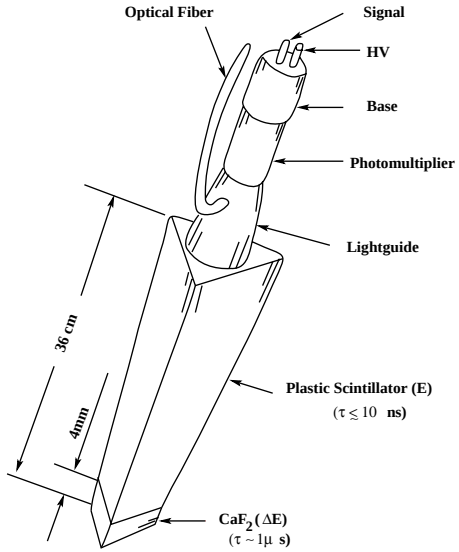
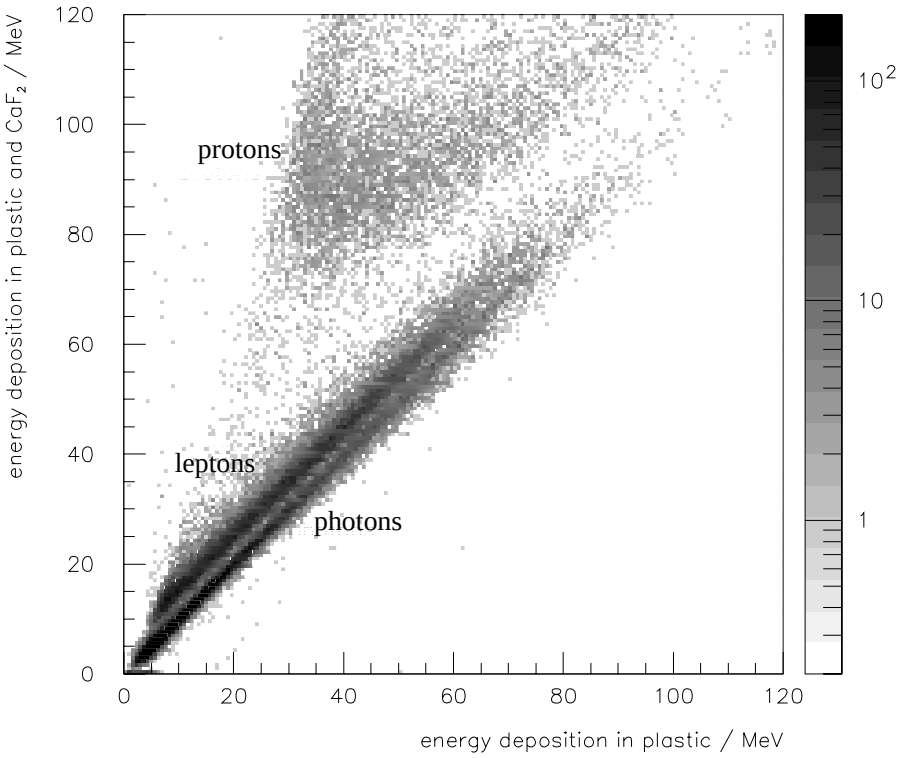


Figure 3.5: Schematic drawing of a plastic and a CaF2 detector.



Detect recoil protons, neutrons, pizeros and charged pions,kaons

Random Access Data Libraries

- Typical storage needed

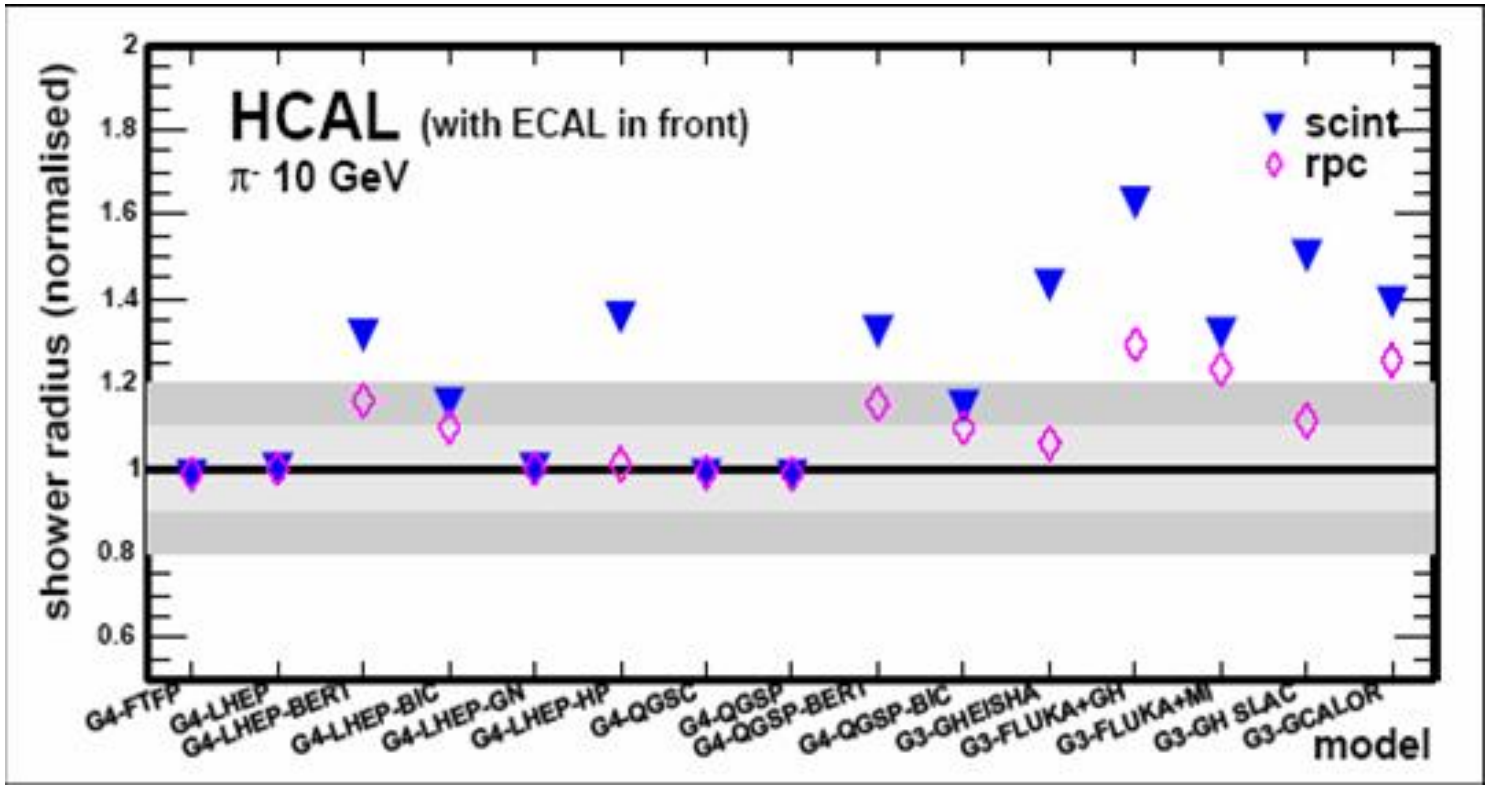
Nuclei	beam species	momentum bins	events/bin	tracks/event	words/track
30	6	10	100000	10	5

Number of events	1.80E+08	Number of days	36
Total number of words	9.00E+09	to take data	
Bytes	3.60E+10		

- Mean multiplicities and total and elastic cross section curves are parametrised as a function of s.
-

ILC needs

- Particle flow algorithm needs to distinguish neutral and charged energy deposits in the calorimeter. Depending on simulator used, the shower radius of a charged pion shower varies by as much as 60% in a calorimeter.



Tagged neutron and K-long beams in MIPP- For ILC Particle flow algorithm studies

- MIPP Spectrometer permits a high statistics neutron and K-long beams generated on the LH2 target that can be tagged by constrained fitting. The neutron and K-long momenta can be known to better than 2%. The energy of the neutron (K-long) can be varied by changing the incoming proton(K^+) momentum. The reactions involved are

$$pp \rightarrow pn\pi^+$$

$$K^+ p \rightarrow pK_L^0\pi^+$$

$$K^- p \rightarrow pK_L^0\pi^-$$

$$\bar{p}p \rightarrow \bar{n}\pi^- p$$

See R.Raja-MIPP Note 130

~50K tagged neutrons per day

Expected tagged neutral beam rates

Beam Momentum GeV/c	Proton Beam n/day	K+ beam K-Long/day	K- beam K-Long/day	Antiproton beam anti-n/day
10	20532	4400	4425	6650
20	52581	9000	9400	11450
30	66511	12375	14175	13500
60	47069	15750	14125	13550
90	37600			

General scaling law of particle fragmentation

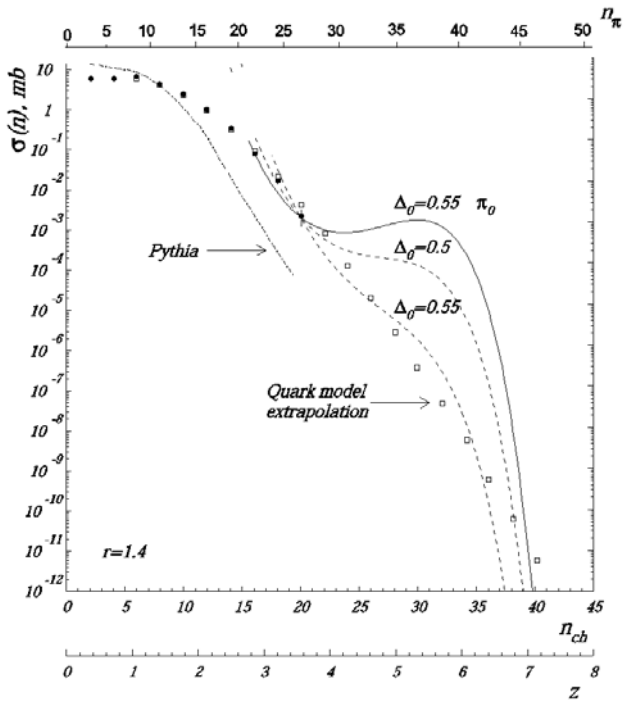
- States that the ratio of a semi-inclusive cross section to an inclusive cross section

$$\frac{f(a+b\rightarrow c+X_{subset})}{f(a+b\rightarrow c+X)} \equiv \frac{f_{subset}(M^2,s,t)}{f(M^2,s,t)} = \beta_{subset}(M^2)$$

- where M^2,s and t are the Mandelstam variables for the missing mass squared, CMS energy squared and the momentum transfer squared between the particles a and c. PRD18(1978)204.
- Using EHS data, we have tested and verified the law in 12 reactions (DPF92) but only at fixed s.
- MIPP will test this in 36 reactions. MIPP upgrade can extend these scaling relation tests to two particle inclusive reactions which requires more statistics.

Other physics interests

High Multiplicity excess due to Bose- Einstein effects in pion emission?



GSI Darmstadt/ KVI are interested in measuring anti-proton cross sections for helping them design the PANDA detector better.

Nuclear physics- y scaling, propagation of strangeness through nuclei. Measure spallation products.

Missing baryon Resonances

- Partial wave analyses of πN scattering have yielded some of the most reliable information of masses, total widths and πN branching fractions. In order to determine couplings to other channels, it is necessary to study in elastics such as

$$\pi^- p \to \eta n; \pi^- p \to \pi^+ \pi^- n; \pi^- p \to K^0 \Lambda$$

$$\gamma p \to \pi^0 p; \gamma p \to K^+ \Lambda; \gamma p \to \pi^+ \pi^- p$$

- All of the known baryon resonances can be described by quark-diquark states. Quark models predict a much richer spectrum. Where are the missing resonances? F.Wilczek, A. Selem
- "..this could form the quantitative foundation for an effective theory of hadrons based on flux tubes"- F.Wilczek

TPC Electronics Upgrade

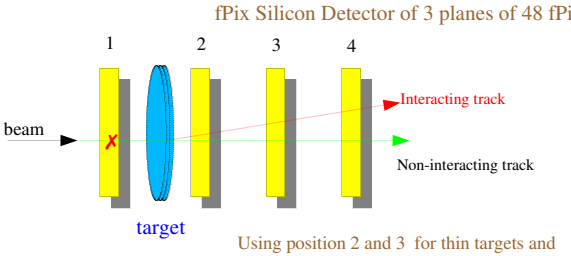
15,360 pads in TPC. 16μs to drift from top to bottom. IN principle, there are 3,800,000 individual data points possible. Each data point is a time bucket and a dE/dx ADC value. A MIPP event sparsely populates this space and is ~ 110kBytes in size. The old readout is 1990's vintage and the readout system is heavily multiplexed and limited to 60Hz maximum. For our events, we were able to achieve ~30Hz.

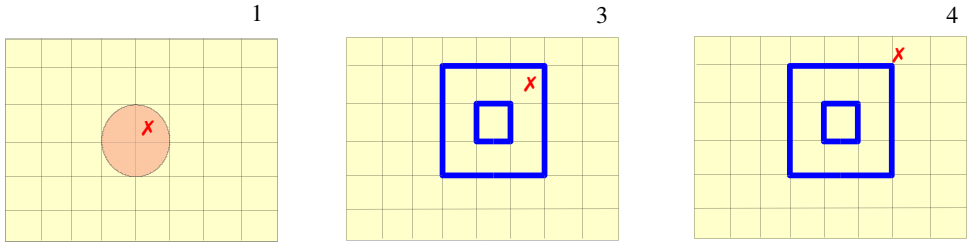
Redesign with ALICE ALTRO/PASA chips with inbuilt zero suppression can produce a readout working at 3kHz. A factor of 100 in speed.

10 times more data using 10 times less beam time!

MIPP Trigger Upgrade

- Beam sizes are large in MIPP due to the "low divergence" condition needed for beam CKOV's.
- Previous trigger of SCINT counter + 1st drift chamber wire signals performed satisfactorily for MIPP –I physics but needs improvement at low multiplicities—Landau tails.
- We propose to use silicon pixel counters (B-TEV, Phenix).
- Use a "Bull's Eye" system to detect absence of beam particle in final state to signal interactions. Also use the multiplicity in the final state as an additional piece of information.



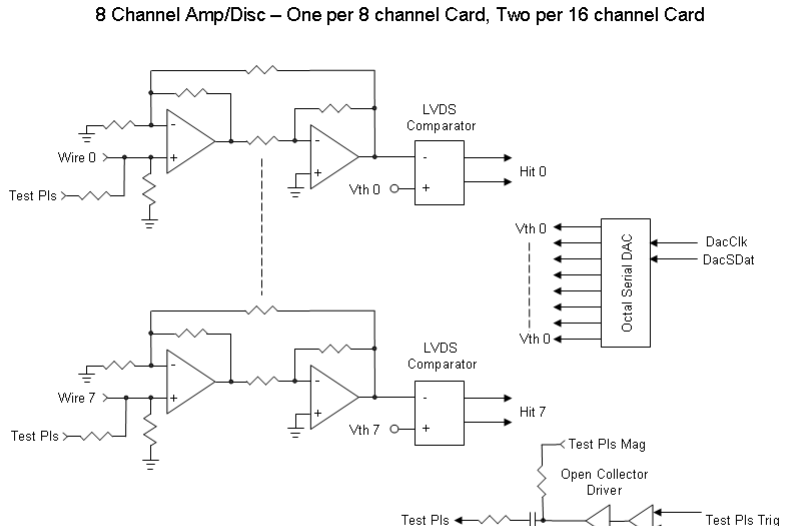


First layer before target tags where beam is and that there was only 1 hit cell. Brown circle represents where 86% of the beam hits the 4 cells in the center.

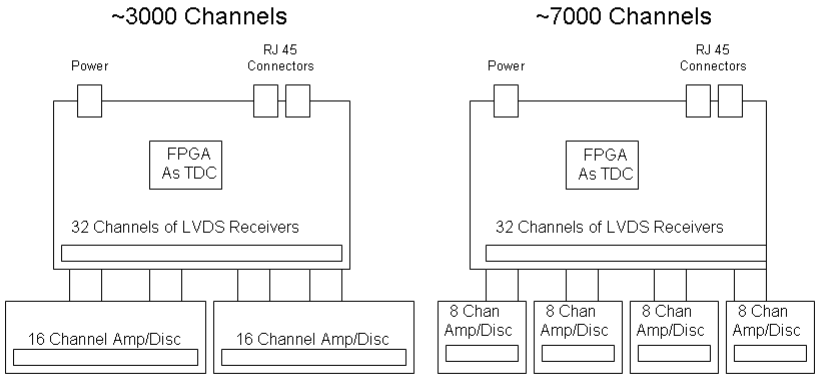
A bulls eye target, shown in blue, is made around the one cell hit location of plane1.

Drift Chamber/ PWC readout Upgrade

- Large PWC's use old CERN RMH electronics- Needs replacement.
- E690 electronics will work at these speed, if CAMAC DMA is implemented. The electronics are also aging and also put out a lot of heat.
- MIPP proposes a unified scheme for reading out both sets of chambers using a system that modifies the MIPP RICH readout cards by changing the latch to a TDC.
- Preamp cards being replaced Preamp/Discriminator front end cards.
- The RICH cards will store an entire spill's worth of events, which are readout in between spills.
- WBS task 4.2 M&S $121.2K, Labor $28.7K. Newest of the design efforts. Probably need to add 50% contingency.

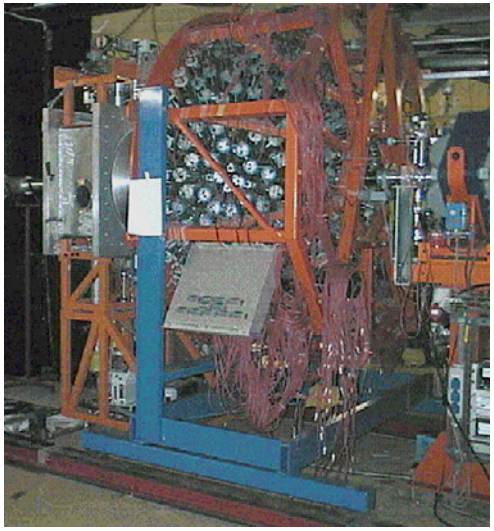


High-Speed Differential Interfaces
"Cyclone II devices can transmit and receive data through LVDS signals at a data rate of up to 640 Mbps and 805 Mbps, respectively. For the LVDS transmitter and receiver, the Cyclone II device's input and output pins support serialization and deserialization through internal logic."



Plastic Ball Recoil detector

- Plastic ball detector is avaliable. GSI/KVI have joined MIPP. We will install a hemisphere in MIPP. Mounting details to be worked out. Need the ability to remove the detector to repair it and the TPC.
- Transportation to Fermilab.
- GSI/KVI will play a lead role in making this happen
- Detector will help in all aspects of MIPP data including tagged neutral beams, missing baryon resonances and hadronic shower simulation data.



Picture of the full plastic ball at KVI

WBS task 10 Fermi M&s $0

Labor $25.9K, In Kind $55K

ToF, CkOV, Calorimeter readouts

- ToF/CkOV readout
  - » Front end boards—TripT chip used by Minerva(ADC) and a high end TDC chip (TDC-GPX from ACAM, also used by LHC-b 30 ps timing resolution). Will buffer an entire spill. Delay cables will be eliminated.
  - » Backend will use RICH VME readout card for ToF/CkoV.
  - » WBS Task 4.3 M&S $16K Labor $18K
- Calorimeter Readout
  - » Propose 4 crates of FERA ADC's (K-TeV + PREP)
  - » Read out by 2 Hytec1365 CAMAC readout controllers.
  - » WBS Task 4.4 M&S $15K

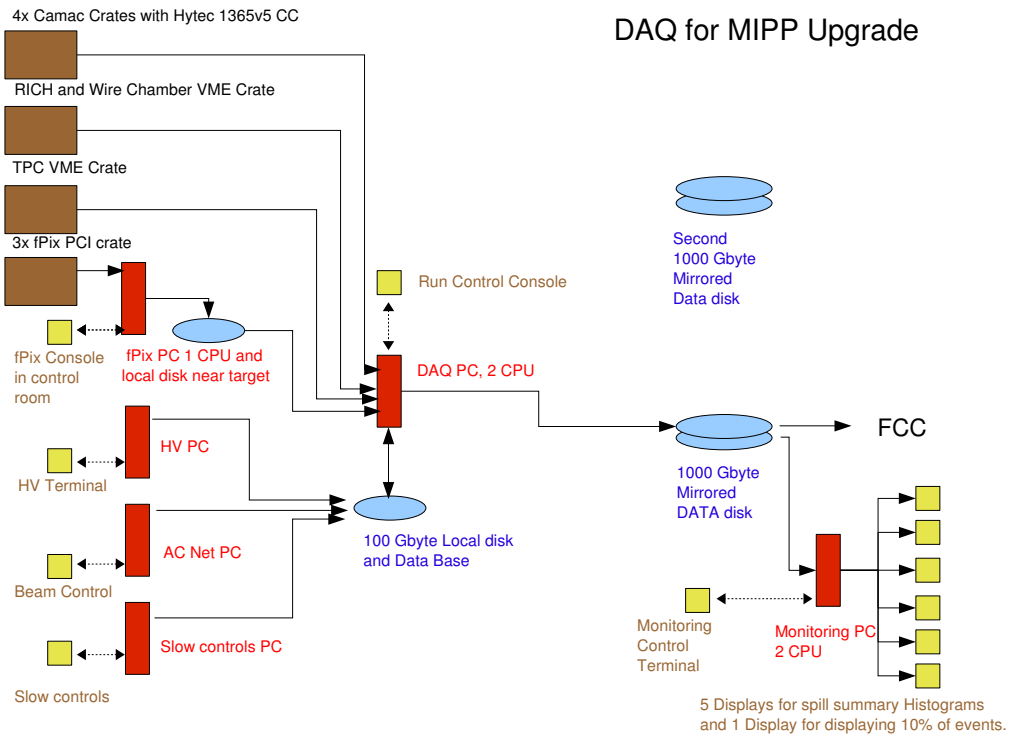
Beam Line Upgrade

Add low current power supplies and hall probes to facilitate low momentum running

WBS task 8 M&S $56K

MIPP DAQ System upgrade

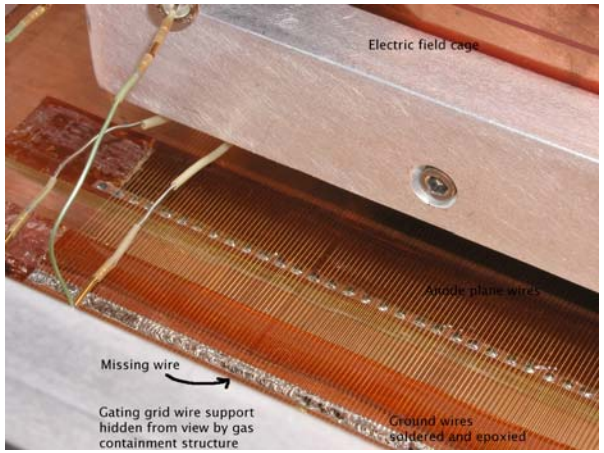
- Most of the DAQ upper layer software (Run control, Book keeping, plots) can be kept as is.
- New Power PC 5500's replace 6 existing ones.
- Linux kernel to migrate to it.(10 person weeks)
- Camac Hytec 1365V5 Module software(2 weeks)
- Update Event builder(6 weeks)
- FERA ADC readout (5 weeks)
- Modify event monitor(2 weeks)
- New fPix readout PC, DAQ PC with 1TB disk storage. All PC's will have GBit and 100MBit fast ethernet ports.
- 100 kbytes/event. 1.2 Gbyte of data per spill.
- 200Mbits/sec transfer from MC7 to Ptkmp.
- 6 Mbytes/second transfer rate into ENSTORE is needed to transfer 5 million events/day. CDF/D0 do 30-60 Mbytes/sec routinely.



WBS Task 6 M&S $47K, Labor $39K

Miscellaneous upgrades

- Beam Veto wall upgrade- Increase veto counter area
  - WBS task 9 M&S $20.1K Labor $1.5K
- Cryogenic target upgrade
  - Increase diameter of transfer pipe to cut interactions due to beam tails.
  - Spare cryo-cooler
  - Operate with Liquid N2 flask.
  - WBS Task 3.2 M&S $68K Labor$ 76K
- Gas system and slow control upgrades
  - Methylal refrigerator filling to be automated
  - Automate RICH vessel topping up with CO_2
  - Upgrade P10 gas system-to be supplied semi trailer rather than bottles.
  - Upgrade Beam CKOV vacuum instrumentation (failure detection)
  - More temperature probes in hall.
  - CKOV pressure sensors to be replaced
  - Additional slow control infra-structure – APACS system
  - WBS task 3.1 M&S $40.5K, Labor $29.9K
- RICH and CKOV phototubes
  - 7 CKOV PMT's need replacement (total 96)
  - WBS task 3.5 M&S $10K
  - 912 PMT's in RICH were lost due to fire. RICH works without them. But upgrading it by more PMT's will help with efficiency near threshold.
  - WBS task 3.6 FNAL M&S $0K In kind $150K

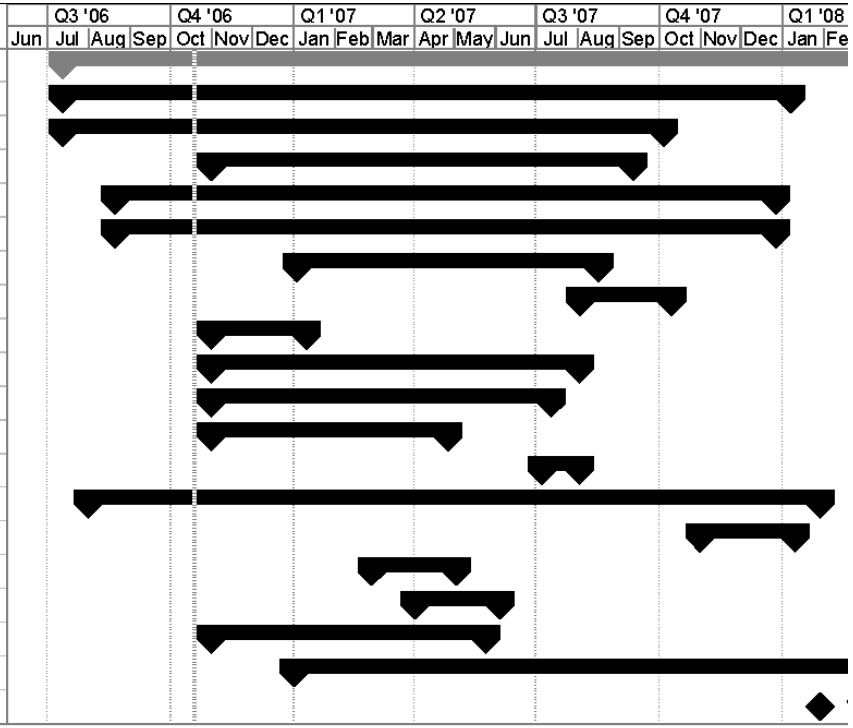


TPC rewind- Optional

WBS task 3.3 M&S $9K

MIPP Upgrade Timeline

WBS	Name	Duration	Start	Finish
0	MIPP	127.8 wks	Thu 7/13/06	Tue 12/23/08
1	Project Management	74.2 wks	Thu 7/13/06	Mon 1/7/08
2	Jolly Green Giant Repair	62 wks	Thu 7/13/06	Thu 10/4/07
3	Improvements on detector hardware	43 wks	Wed 11/1/06	Tue 9/11/07
4	Detector Readout Upgrades	67.8 wks	Mon 8/21/06	Thu 12/27/07
4.1	TPC Electronics	67.8 wks	Mon 8/21/06	Thu 12/27/07
4.2	Drift Chamber/Wire Chamber electronics	31.7 wks	Thu 1/4/07	Fri 8/17/07
4.3	ToF + CKOV electronics board design	9.5 wks	Fri 8/3/07	Wed 10/10/07
4.4	Calorimeter migration to Fera electronics	9 wks	Wed 11/1/06	Wed 1/10/07
5	Trigger System Upgrade	37.6 wks	Wed 11/1/06	Thu 8/2/07
5.1	Interaction Trigger Fpix	34.6 wks	Wed 11/1/06	Thu 7/12/07
5.2	Interaction Trigger Board	25.4 wks	Wed 11/1/06	Thu 4/26/07
5.3	Other Trigger Upgrades	4 wks	Fri 7/6/07	Thu 8/2/07
6	DAQ Software and Hardware Upgrade	74.6 wks	Tue 8/1/06	Tue 1/29/08
7	Offline farm Upgrade	9 wks	Thu 11/1/07	Thu 1/10/08
8	Beam Line Upgrade	9 wks	Thu 3/1/07	Wed 5/2/07
9	Enhanced Veto Wall	9 wks	Mon 4/2/07	Mon 6/4/07
10	Recoil Detector	28 wks	Wed 11/1/06	Thu 5/24/07
11	Visitor Support for Russian collaborators	103.2 wks	Tue 1/2/07	Tue 12/23/08
12	Commissioning Run Start	0 wks	Tue 1/29/08	Tue 1/29/08



- Detailed schedule to be found in
  - » http://ppd.fnal.gov/experiments/e907/notes/MIPPnotes/public/pdf/MIPP0139/MIPP0139.pdf

WBS	Task Name	Fermi M&S Cost	Fermi Labor Cost	Base Cost in FY06 $	In Kind	Total Project Cost
0	MIPP Upgrade Totals	$1,214,456	$566,628	$1,781,084	$205,000	$2,003,844
1	Project Management	$55,000	$0	$55,000	$0	$55,000
2	Jolly Green Giant Repair	$279,000	$141,884	$420,884	$0	$438,644
2.1	Jolly Green Giant disassembly/assembly	$80,000	$94,380	$174,380	$0	$192,140
2.2	JGG coil design and fabrication	$199,000	$25,524	$224,524	$0	$224,524
2.3	Ziptrack JGG magnet	$0	$21,980	$21,980	$0	$21,980
3	Improvements on detector hardware	$128,600	$109,114	$237,714	$150,000	$387,714
3.1	Gas System and Slow Controls Upgrade	$40,500	$29,868	$70,368	$0	$70,368
3.1.1	RICH vessel fill automation	$2,500	$5,610	$8,110	$0	$8,110
3.1.2	Methylal bath fill automation	$5,000	$7,228	$12,228	$0	$12,228
3.1.3	P10 supply upgrade	$5,000	$6,664	$11,664	$0	$11,664
3.1.4	TOF wall thermal instrumentation	$2,000	$4,232	$6,232	$0	$6,232
3.1.5	Replacement of CKOV pressure sensors	$2,000	$412	$2,412	$0	$2,412
3.1.6	Beam Ckov vacuum system	$3,000	$1,340	$4,340	$0	$4,340
3.1.7	Calibration and maintenance	$0	$2,952	$2,952	$0	$2,952
3.1.8	Slow Controls infrastructure upgrade	$21,000	$1,430	$22,430	$0	$22,430
3.2	Cryogenic System Upgrade	$68,000	$75,598	$143,598	$0	$143,598
3.2.1	Hydrogen Target transfer line	$13,000	$38,120	$51,120	$0	$51,120
3.2.2	Nitrogen Target	$10,000	$23,260	$33,260	$0	$33,260
3.2.3	Spare Cryocooler	$45,000	$14,218	$59,218	$0	$59,218
3.3	TPC rewind	$9,000	$0	$9,000	$0	$9,000
3.4	Chamber wire repairs	$1,100	$3,648	$4,748	$0	$4,748
3.5	Ckov Photomultiplier tubes	$10,000	$0	$10,000	$0	$10,000
3.6	RICH Photomultiplier tubes	$0	$0	$0	$150,000	$150,000
4	Detector Readout Upgrades	$362,920	$197,918	$560,838	$0	$568,513
4.1	TPC Electronics	$225,920	$150,847	$376,767	$0	$384,442
4.2	Drift Chamber/Wire Chamber electronics	$121,250	$28,718	$149,968	$0	$149,968
4.3	ToF + CKOV electronics board design	$15,750	$18,352	$34,102	$0	$34,102
4.4	Calorimeter migration to Fera electronics	$15,000	$0	$15,000	$0	$15,000
5	Trigger System Upgrade	$145,900	$51,400	$197,300	$0	$208,300
5.1	Interaction Trigger Fpix	$137,100	$38,800	$175,900	$0	$186,900
5.2	Interaction Trigger Board	$8,800	$12,600	$21,400	$0	$21,400
5.3	Other Trigger Upgrades	$0	$0	$0	$0	$0
6	DAQ Software and Hardware Upgrade	$46,686	$38,952	$85,638	$0	$85,638
7	Offline farm Upgrade	$0	$0	$0	$0	$0
8	Beam Line Upgrade	$56,000	$0	$56,000	$0	$56,000
9	Enhanced Veto Wall	$20,110	$1,440	$21,550	$0	$21,550
10	Recoil Detector	$0	$25,920	$25,920	$55,000	$80,920
11	Visitor Support for Russian collaborators	$105,240	$0	$105,240	$0	$105,240

Run Plan

Phase 1 Run Plan			
Target	Number of Events (Millions)	Running Time (Days)	Physics Need Group
NuMI Low Energy target	10	2	MINOS MINERVA
NuMI Medium Energy Target	10	2	MINERVA NOVA
Liquid Hydrogen	20	4	QCD PANDA DUBNA
Liquid Nitrogen	10	2	ICE CUBE
12 Nuclei			Nuclear Physics
D2 Be C Al Si Hg Fe Ni Cu Zn W Pb	60	12	Hadronic Showers
Total Events	110	22	
Raw Storage	11 TBytes		
Processed Storage	55 TBytes		

Phase 2 Run Plan			
Target	Number of Events (Millions)	Running Time (Days)	Physics Need Group
18 Nuclei			
Li B O2 Mg P S Ar K Ca			Nuclear Physics
Ni Nb Ag Sn Pt Au Pb Bi U	90	18	Hadronic Showers
10 Nuclei B-list			Nuclear Physics
Na Ti V Cr Mn Mo I Cd Cs Ba	50	10	Hadronic Showers
Total Events	140	28	
Raw Storage	14 TBytes		
Processed Storage	70 TBytes		

Phase 3 – Tagged Neutral beams for ILC 5 million events/day LH2 target

Missing baryon resonance search may request additional running depending on what is found.

Conclusions

- The MIPP Upgrade Collaboration has proposed a cost effective way to upgrade the experiment to speed up the DAQ by a factor of 100.
- We propose to add a recoil detector that will enhance the physics reach of the experiment.
- We propose to measure the NUMI LE/ ME targets.
- As well as 30 nuclei to benefit hadron shower simulators and the cosmic ray community.
- This and the tagged neutral beams will benefit the ILC PFA algorithm studies.
- We propose to increase the momentum range of the beams (down to 1 GeV/c) that will benefit the hadron shower simulators and permit the search for missing baryon resonances.
- Timely approval will benefit us on all fronts including speeding up the analysis of the data in hand.

Fermilab

November 6, 2006

Rajendran Raja
MS 122

Dear Raja,

Thank you for your presentations on P-960 to the Physics Advisory Committee (PAC) at the open and executive sessions. The Committee discussed at some length both the proposed upgrades to the MIPP spectrometer and the expanded physics measurement goals of the proposed experiment. The PAC noted that the proposed measurements can be very valuable, but felt that it is necessary to have more detailed quantitative information about what the impact of the proposed measurements would be. For that reason, and to allow more time to strengthen the collaboration commitments to the experiment, the Committee recommended deferral of a decision on the MIPP proposal. The full, detailed recommendation from the PAC is attached.

I accept the recommendation of the PAC and will defer a decision on the MIPP P-960 proposal at this time. I, and the Committee, also feel that it would be desirable to see the power of the spectrometer through presentation of more final results from the existing dataset. When the questions and concerns expressed in the PAC recommendation can be addressed, I would be pleased to further consider the MIPP P-960 proposal.

Sincerely,

Piermaria Oddone

Attachment

cc:
Y. Kim
H. Montgomery
S. Holmes
J. Appel
J. Strait
R. Dixon
V. White
M. Ross
D. Marlow
A. Lankford
A. Byon-Wagner
M. Procario
J. Whitmore
J. Stone
F. Bernthal