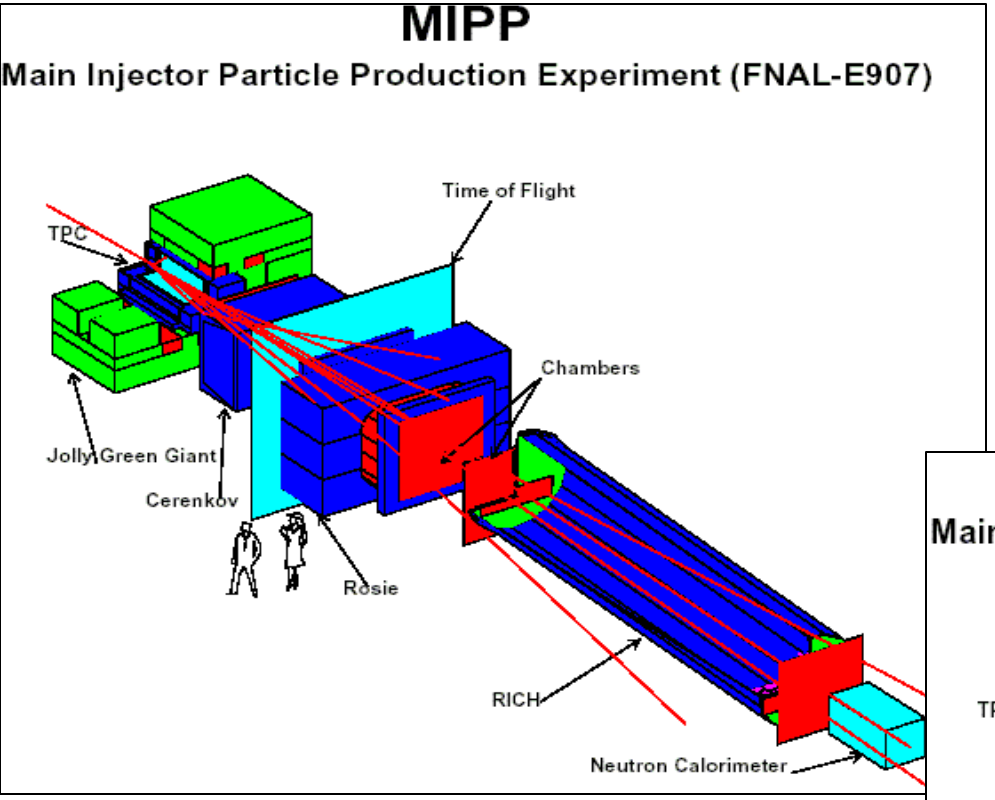
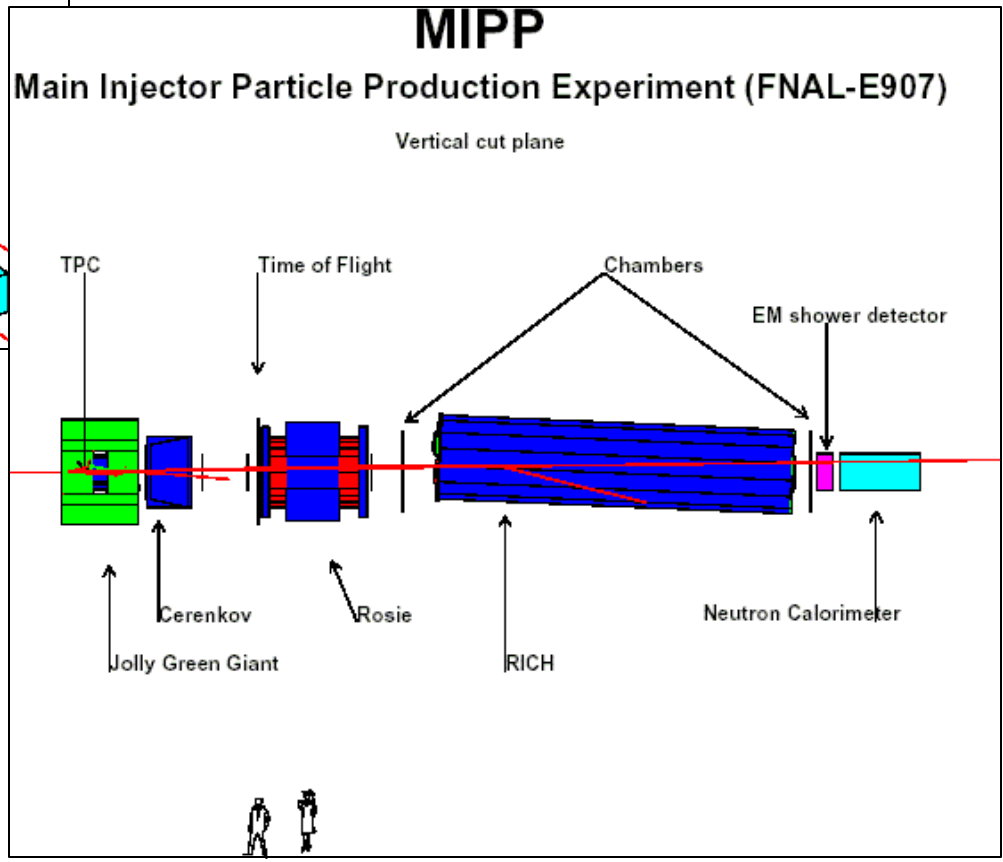
MIPP Secondary beam

Rajendran Raja
Fermilab

- Beam
- Optics
- Results
- Upgrade plans


MIPP
Main Injector Particle Production Experiment (FNAL-E907)
Time of Flight
TPC
Chambers
Jolly Green Giant
Cerenkov
Rosie
RICH
Neutron Calorimeter

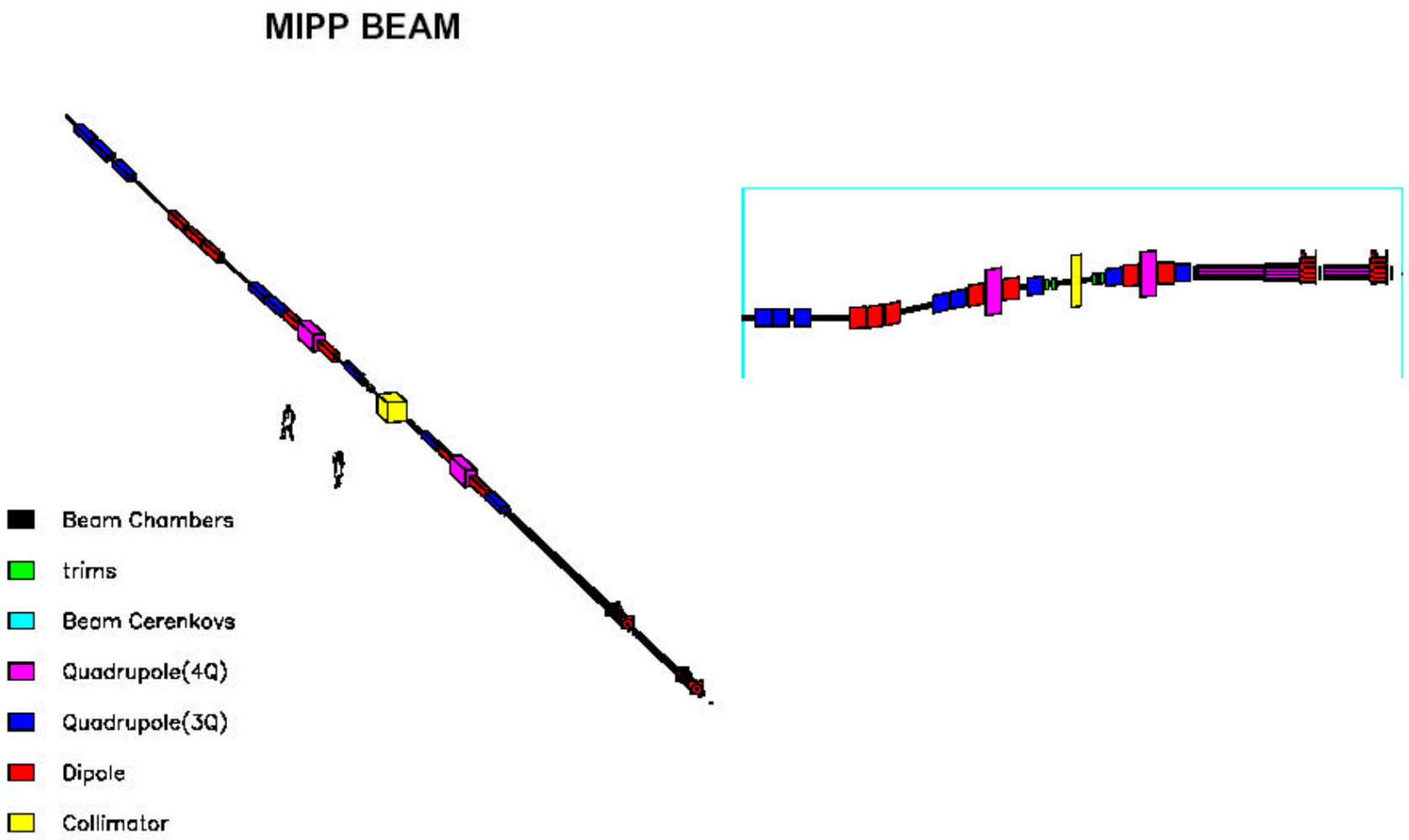

MIPP
Main Injector Particle Production Experiment (FNAL-E907)
Vertical cut plane
TPC
Time of Flight
Chambers
EM shower detector
Cerenkov
Rosie
Neutron Calorimeter
Jolly Green Giant
RICH

Beam Design

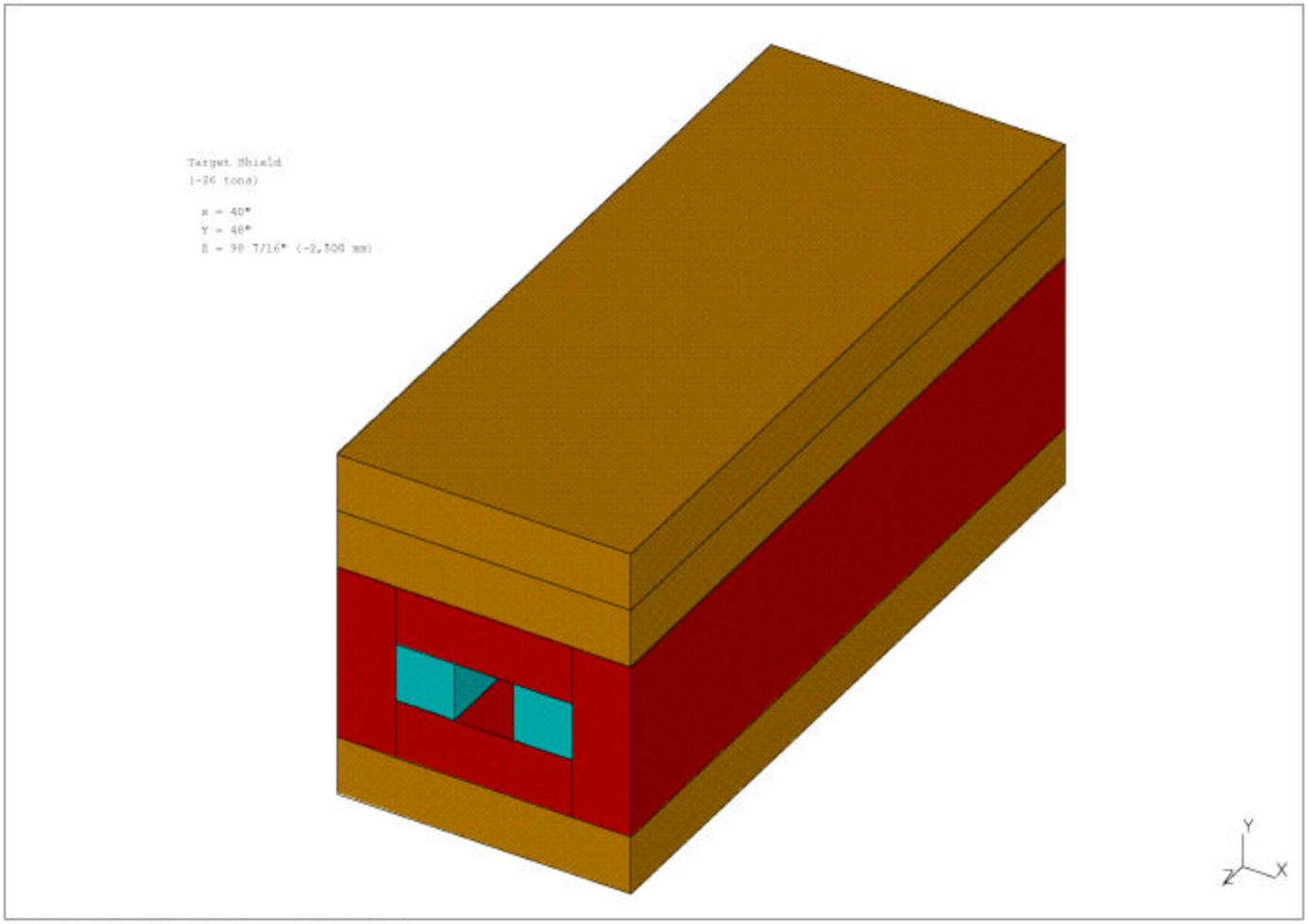
- Tricky since there are no bends in M-center
- Short secondary line needed to preserve Kaons.
- Long Beam Cerenkov´s needed to particle Id the beams.
- Need dispersion at the momentum bite selction collimator to control momentum bite t experimental target
- Need low divergence at the collimator
- 5 beamline designs fully analyzed before settling on the winner.

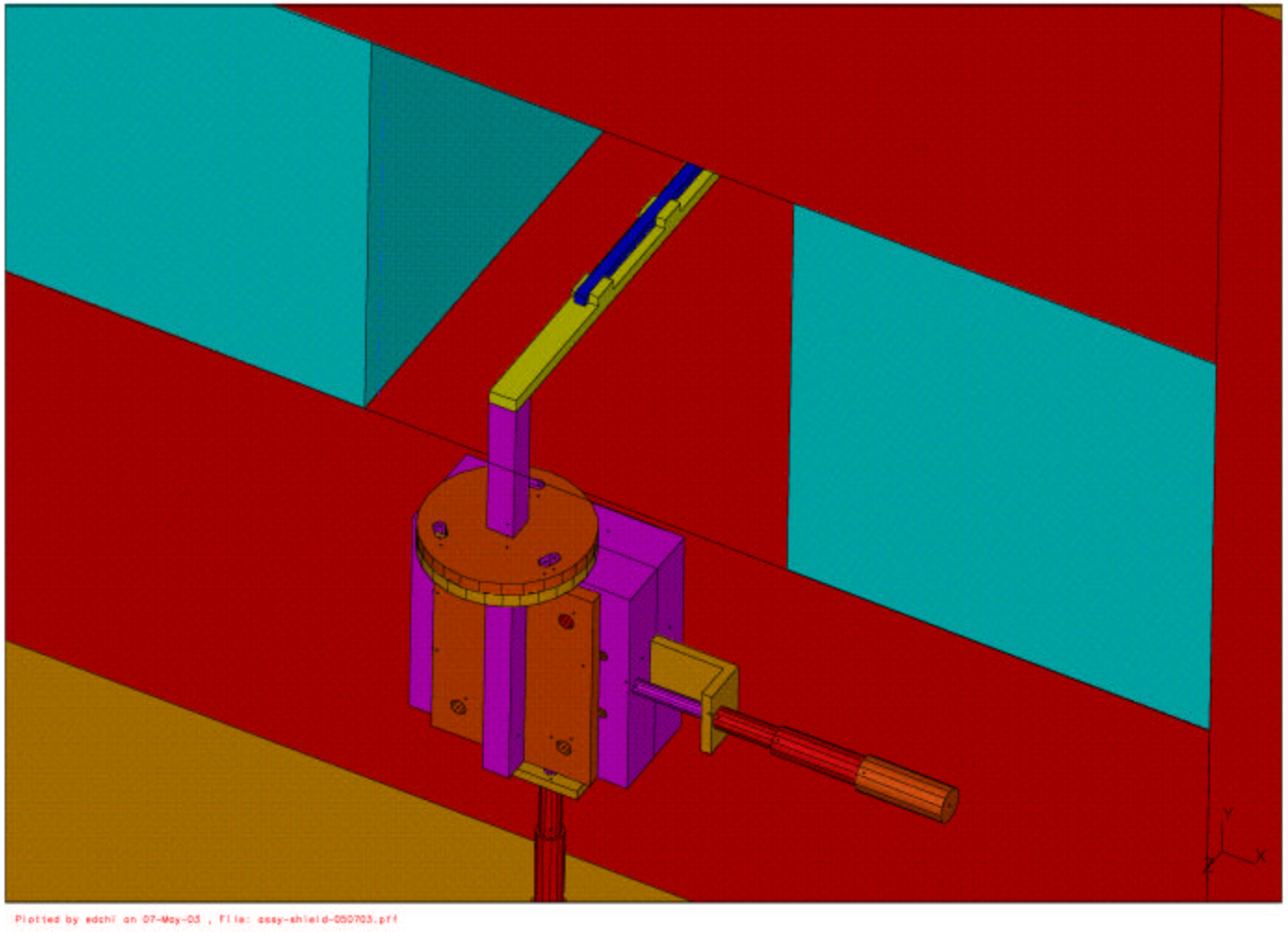
MIPP Secondary Beam

Installed in 2003. Delivering slow spill commissioning beam (40GeV/c positives since February 2004). Finished Engineering run in Aug 2004.

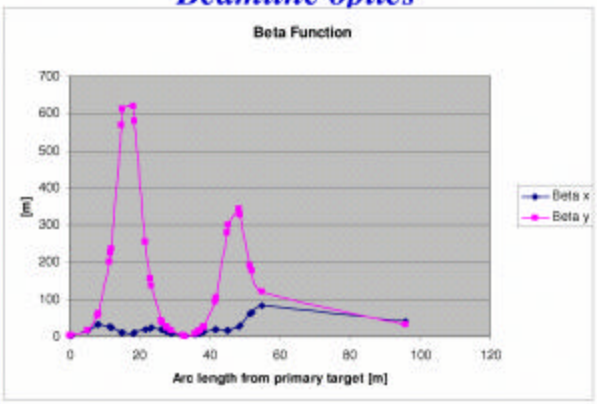


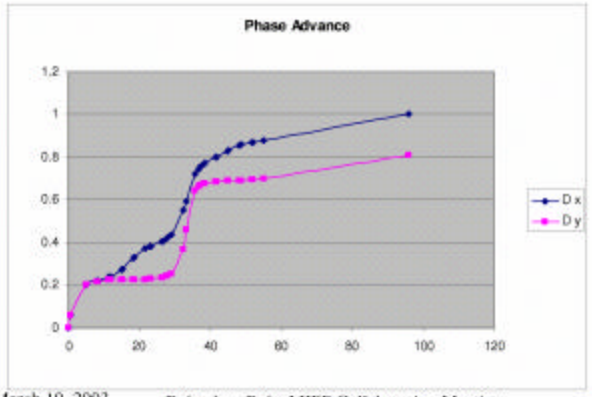
Beam Status


Target Shield
(~26 tons)
X = 40°
Y = 40°
Z = 90 T/16° (~2,500 mm)
Y
Z
X
Plotted by edchl on 30-Apr-03 , File: assy-shield-043003.prf


Plotted by edchi on 07-May-03 , File: assy-shield-050703.prf

Beamline optics





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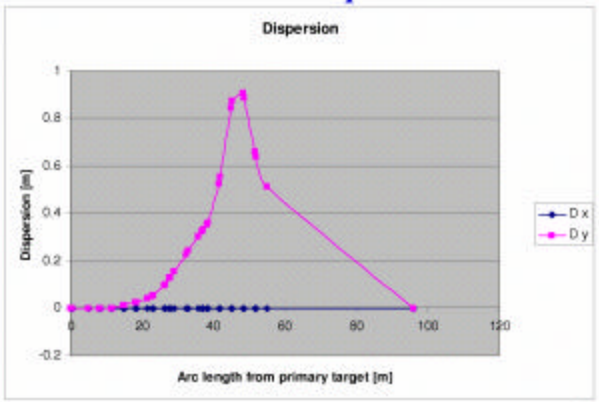
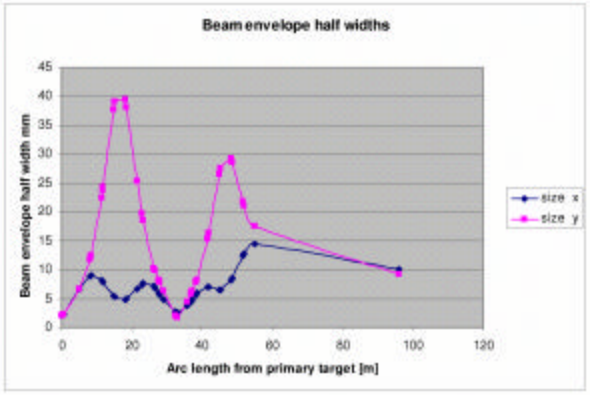
Beamline optics





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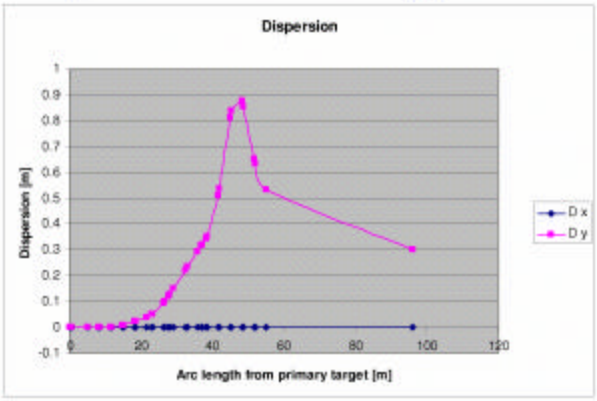
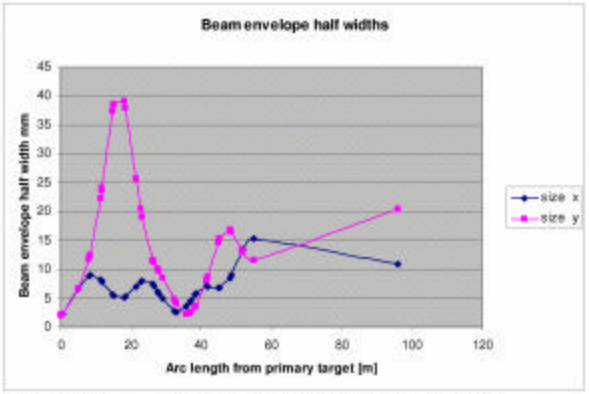
Optics Non linearities dp/p=+0.02





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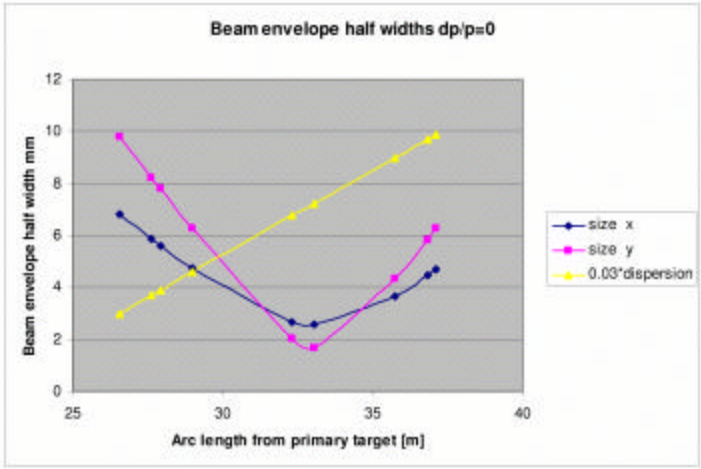
Dispersion and beam spotsize at momentum slit/



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Beam sheet

Beam Sheet For MIPP Beamline-- Carol J design 8 4-May-03

Z CENT. [ft]	X CENT. [ft]	Y CENT. [ft]	Position Code	Element Code	Power Supply	100 GeV B/G KG or KG/in	Amps
1224.921	0.000	3.939	MC5WC1				
1225.421	0.000	3.939	MC5LM1				
1232.980	0.000	3.939	MC5Q1				
1243.980	0.000	3.939	OFF				
1257.917	0.000	3.939	MC5Q2				
1263.348	0.000	3.939	MC5HT1				
1293.214	0.000	3.958	MC5U-1			7.848	838.450
1304.214	0.000	4.042	MC5U-2			7.848	838.450
1315.212	0.000	4.210	MC5U-3			7.848	838.450
1323.389	0.000	4.379	MC6IC1				
1323.881	0.000	4.390	MC6WC1				
1324.819	0.000	4.411	MC6T1				
1328.428	0.000	4.404	MC6TC				
1337.924	0.000	4.620	MC6ABS				
1345.922	0.000	4.895	MC6Q1-1			3.390	65.000
1356.919	0.000	5.147	MC6Q1-2			3.390	65.000
1368.322	0.000	5.394	MC6D-1			5.886	628.789
1379.320	0.000	5.598	MC6Q2			-5.760	1230.000
1390.319	0.000	5.772	MC6D-2			5.886	628.689
1405.599	0.000	5.962	MC6Q3			5.560	106.000
1413.337	0.000	6.051	MC6VT1			0.000	0.000
1417.814	0.000	6.102	MC6HT1			0.000	0.000
1427.911	0.000	6.215	MC6WC2				
1431.692	0.000	6.261	MC6CY				
1443.536	0.000	6.397	MC6VT2			0.000	0.000
1448.013	0.000	6.448	MC6HT2			0.000	0.000
1455.752	0.000	6.537	MC6Q4-1			4.660	89.000
1466.751	0.000	6.648	MC6D-3			5.886	628.789
1477.751	0.000	6.726	MC6Q5			5.160	1102.000
1488.751	0.000	6.775	MC6D-4			5.886	628.789
1499.751	0.000	6.789	MC6Q4-2			2.880	55.000
1506.001	0.000	6.789	MC7HD1				
1506.917	0.000	6.789	MC7BC1				
1546.921	0.000	6.789	MC7CR1				
1586.924	0.000	6.789	MC7BC2				
1607.742	0.000	6.789	MC7CR2				
1636.098	0.000	6.789	MC7BC3				
1637.182	0.000	6.789	MC7HD2				
1638.015	0.000	6.789	MC7WC1				
1639.265	0.000	6.789	MC7T1				

Survey sheet

MIPP Secondary Beam line Survey Sheet Carol 8 design R.Raja 5-May-03

Element	Upsteam y [ft]	Downstream y [ft]	Upstream Z [ft]	Downstream Z [ft]	Element
MC5WC1	3.939	3.939	1224.671	1225.171	Swic
MC5LM1	3.939	3.939	1225.171	1225.671	Loss Monitor
MC5Q1	3.939	3.939	1226.863	1236.863	3Q
OFF	3.939	3.939	1237.843	1247.843	3Q
MC5Q2	3.939	3.939	1248.848	1256.848	3Q
MC5HT1	3.939	3.939	1260.848	1265.848	Horizontal trim
MC5U-1	3.939	3.977	1288.214	1296.214	EPB dipole
MC5U-2	3.985	4.099	1299.214	1309.213	EPB dipole
MC5U-3	4.115	4.306	1310.213	1320.211	EPB dipole
MC6IC1	4.379	4.379	1323.389	1323.389	Ionization Chamber
MC6WC1	4.390	4.390	1323.881	1323.881	Swic
MC6T1	4.404	4.419	1324.491	1325.147	Copper Target
MC6TC	4.404	4.404	1324.327	1332.529	Steel Target cage
MC6ABS	4.574	4.666	1335.924	1339.924	Copper absorber
MC6Q1-1	4.781	5.010	1340.924	1350.921	3Q
MC6Q1-2	5.033	5.262	1351.921	1361.918	3Q
MC6D-1	5.294	5.495	1363.323	1373.321	EPB dipole
MC6Q2	5.512	5.684	1374.321	1384.320	4Q
MC6D-2	5.701	5.844	1385.320	1395.318	EPB dipole
MC6Q3	5.905	6.019	1400.599	1410.596	3Q
MC6VT1	6.031	6.071	1411.596	1415.076	Vertical Trim
MC6HT1	6.082	6.122	1416.076	1419.553	Horizontal trim
MC6WC2	6.215	6.215	1427.661	1428.161	Swic
MC6CY	6.223	6.299	1428.411	1434.973	Collimator
MC6VT2	6.377	6.417	1441.797	1445.275	Vertical trim
MC6HT2	6.428	6.468	1446.274	1449.752	Horizontal trim
MC6Q4-1	6.479	6.594	1450.752	1460.751	3Q
MC6D-3	6.605	6.691	1461.751	1471.751	EPB dipole
MC6Q5	6.697	6.754	1472.751	1482.751	4Q
MC6D-4	6.760	6.789	1483.751	1493.751	EPB dipole
MC6Q4-2	6.789	6.789	1494.751	1504.751	3Q
MC7HD1	6.789	6.789	1505.751	1506.251	Mipp beam hodoscope
MC7BC1	6.789	6.789	1506.417	1507.417	Mipp beam chamber
MC7CR1	6.789	6.789	1507.751	1586.091	Mipp long cerenkov
MC7BC2	6.789	6.789	1586.424	1587.424	Mipp beam chamber
MC7CR2	6.789	6.789	1587.757	1627.727	Mipp short cerenkov
MC7BC3	6.789	6.789	1635.596	1636.596	Mipp beam chamber
MC7HD2	6.789	6.789	1636.932	1637.432	Mipp beam hodoscope
MC7WC1	6.789	6.789	1637.765	1638.265	Swic
MC7T1	6.789	6.789	1639.265	1639.265	Mipp target

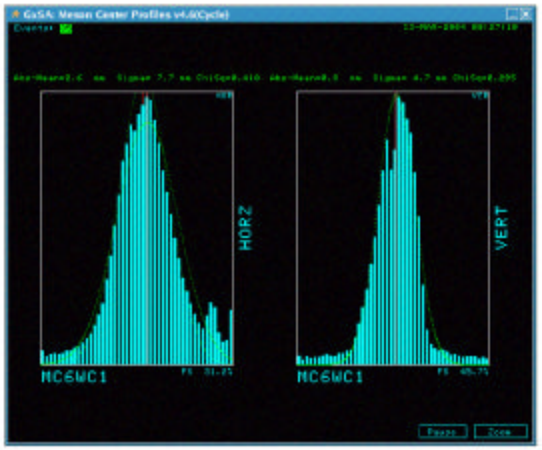
From all exp meeting. Comments valid at time of meeting!

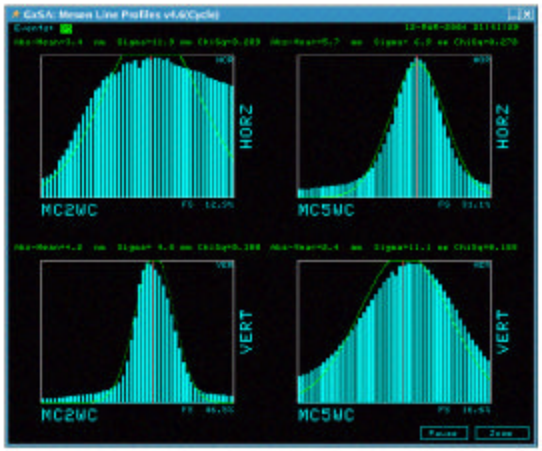
Beam Status

- Beam being delivered at 1 shot per minute or sometimes at 1 shot per 30 secs.

Beam upstream of primary target

Beam in MC2

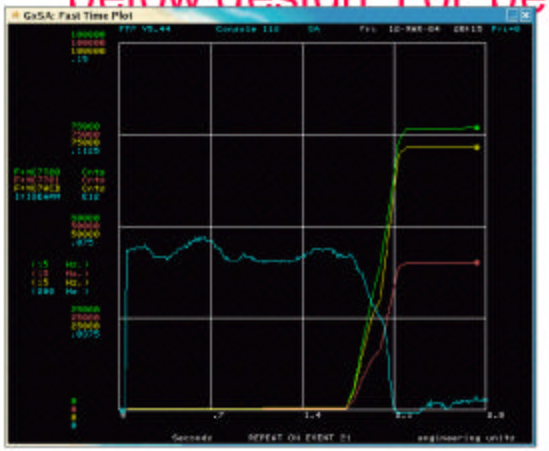


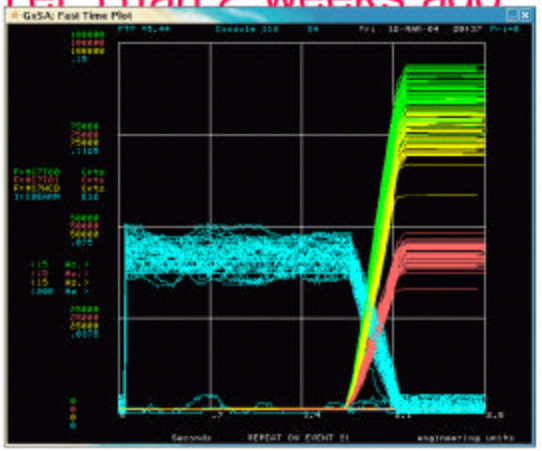


15-Mar-2004 Rajendran Raja, All Experimenters Meeting, Fermilab 2

Beam

- Beam emittance on primary target too high. Perhaps RPOS control in MI to blame?40 Gev/c positive tune. The number of secondaries/proton is a factor of 150 below design. Lot better than 2 weeks ago

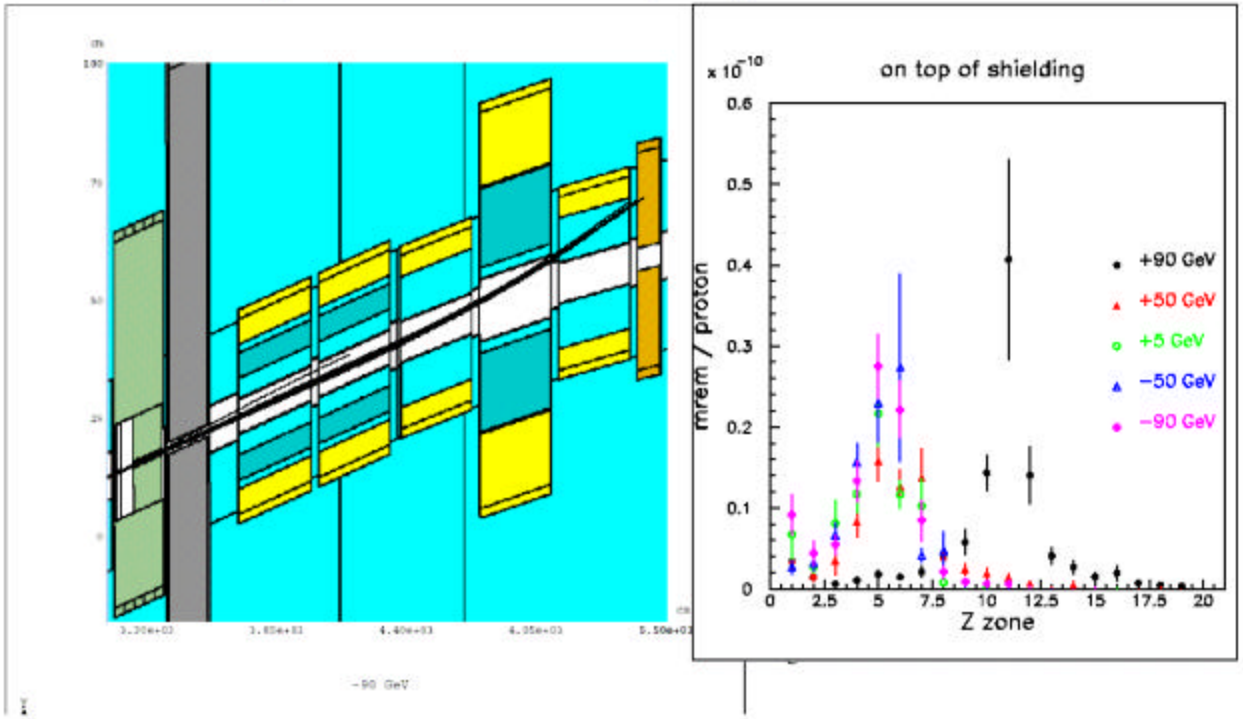




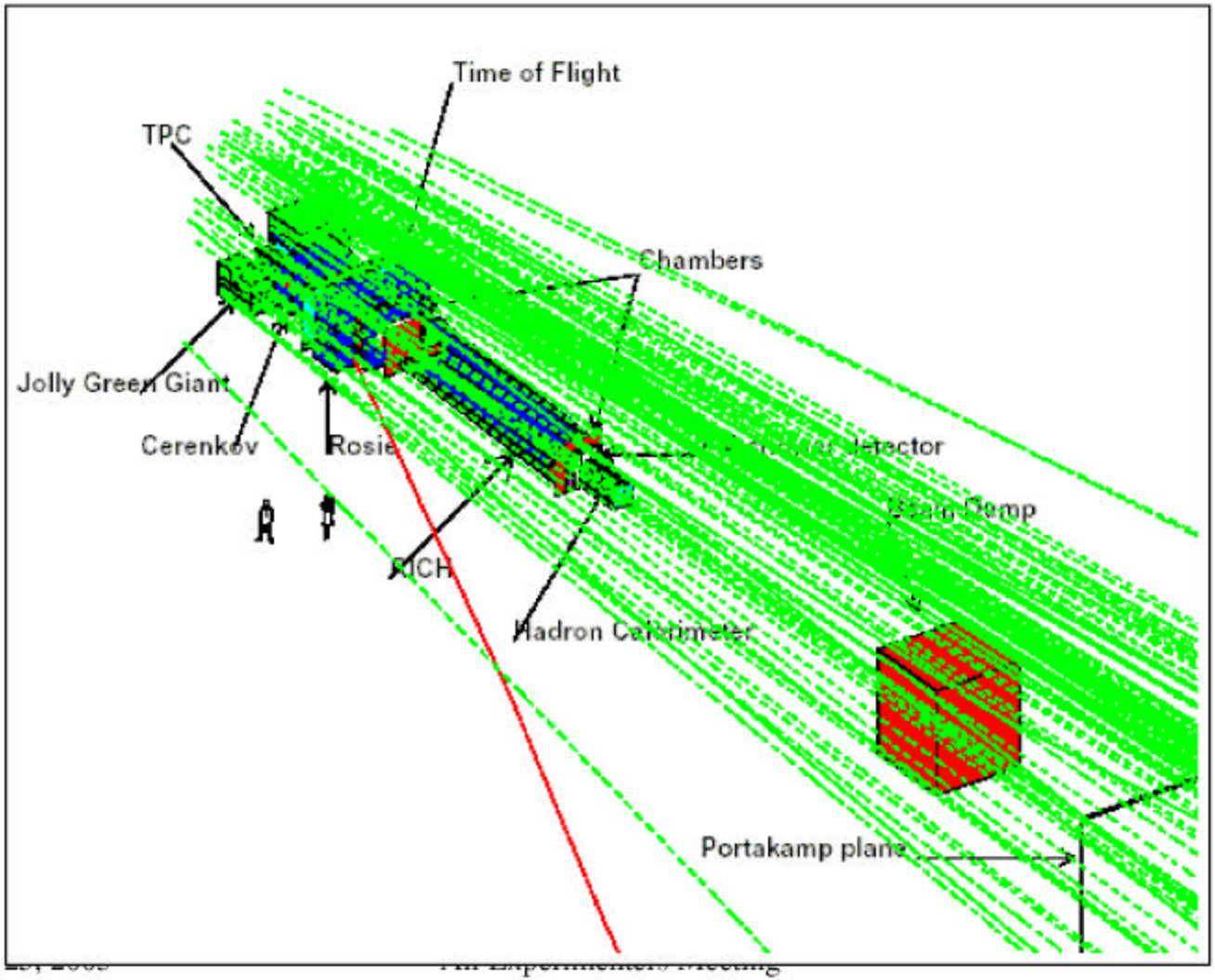
15-Mar-2004 Rajendran Raja, All Experimenters Meeting, Fermilab 3

Beam radiation studies

- Full MARS / Geant simulation. Shielding added in strategic areas to minimize prompt radiation doses.



Muons in Portakamp



Muon doses in portakamp

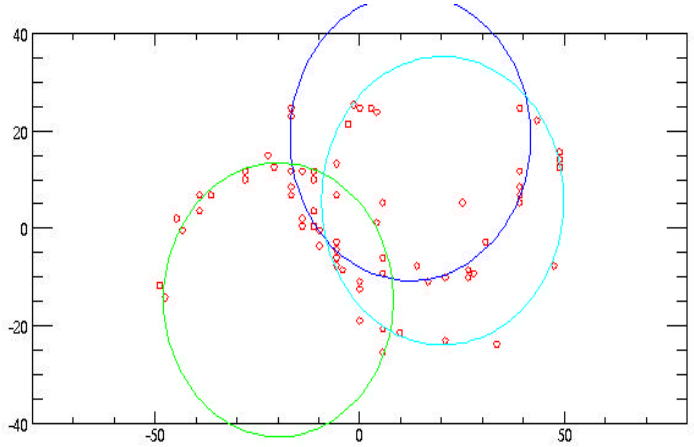
Beam Momentum GeV/c	Proton Intensity /spill	Muons in Portakamp /spill	Radiation Mrem /hour	Average Muon Momentum in portkamp GeV/c
5	9.66E+09	8.01E+04	2.02E-02	4.84
50	5.76E+08	8.81E+03	2.22E-03	6.38
90	2.67E+08	7.98E+03	2.01E-03	5.73
-5	1.49E+10	1.26E+05	3.19E-02	5.41
-50	5.73E+09	3.91E+04	9.88E-03	5.09
-90	7.62E+10	4.23E+05	1.07E-01	5.41

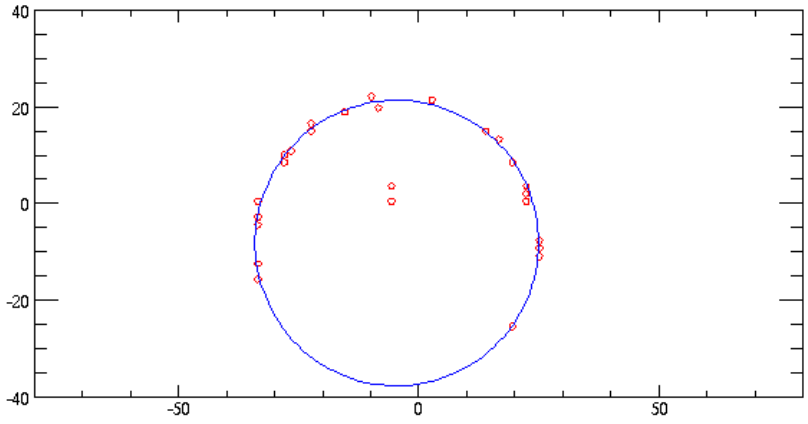
Aug 25, 2003 All Experimenters Meeting 9

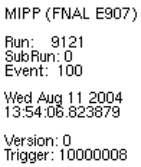
CALCULATED SECONDARY RATES FOR 2E9 protons on target

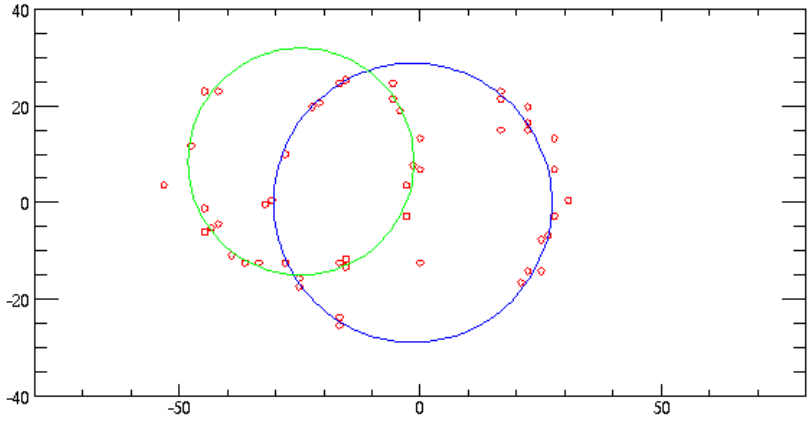
		Secondary Rates		total	fraction of	primary rate	
p GeV/c	p	K+	pi+	positives rate	maxium	at max 2ndry rate	
5	1.53E+03	3.28E+02	2.40E+04	2.59E+04	2.07E-01	9.66E+09	
15	1.62E+04	4.44E+03	7.14E+04	9.20E+04	7.36E-01	2.72E+09	
25	5.26E+04	8.59E+03	1.13E+05	1.74E+05	1.39E+00	1.44E+09	
30	8.16E+04	1.04E+04	1.28E+05	2.20E+05	1.76E+00	1.14E+09	
40	1.67E+05	1.29E+04	1.39E+05	3.19E+05	2.55E+00	7.84E+08	
50	2.93E+05	1.34E+04	1.28E+05	4.34E+05	3.47E+00	5.76E+08	
60	4.60E+05	1.19E+04	1.01E+05	5.73E+05	4.58E+00	4.37E+08	
70	6.52E+05	9.19E+03	6.83E+04	7.30E+05	5.84E+00	3.43E+08	
80	8.30E+05	6.02E+03	3.85E+04	8.74E+05	6.99E+00	2.86E+08	
90	9.17E+05	3.16E+03	1.67E+04	9.37E+05	7.50E+00	2.67E+08	
100	8.10E+05	1.15E+03	4.63E+03	8.16E+05	6.52E+00	3.07E+08	
110	4.29E+05	1.76E+02	4.48E+02	4.30E+05	3.44E+00	5.82E+08	
		Secondary Rates		total	fraction of	primary rate	
p GeV/c	p-bar	K-	pi-	negative rate	maximum	at max 2ndary rate	
5	1.04E+03	2.32E+02	1.55E+04	1.68E+04	1.34E-01	1.49E+10	
15	2.22E+03	2.46E+03	5.25E+04	5.72E+04	4.57E-01	4.37E+09	
25	1.89E+03	3.36E+03	5.97E+04	6.49E+04	5.19E-01	3.85E+09	
30	1.60E+03	3.40E+03	5.84E+04	6.34E+04	5.07E-01	3.94E+09	
40	1.02E+03	2.89E+03	5.16E+04	5.55E+04	4.44E-01	4.51E+09	
50	5.31E+02	1.96E+03	4.11E+04	4.36E+04	3.49E-01	5.73E+09	
60	2.21E+02	1.08E+03	2.91E+04	3.04E+04	2.43E-01	8.24E+09	
70	6.99E+01	4.71E+02	1.76E+04	1.82E+04	1.45E-01	1.38E+10	
80	1.53E+01	1.53E+02	8.75E+03	8.92E+03	7.14E-02	2.80E+10	
90	1.95E+00	3.25E+01	3.25E+03	3.28E+03	2.63E-02	7.62E+10	
100	9.42E-02	3.27E+00	7.26E+02	7.29E+02	5.83E-03	3.43E+11	
110	4.48E-04	5.58E-02	4.87E+01	4.87E+01	3.90E-04	5.13E+12	

RICH rings pattern recognized

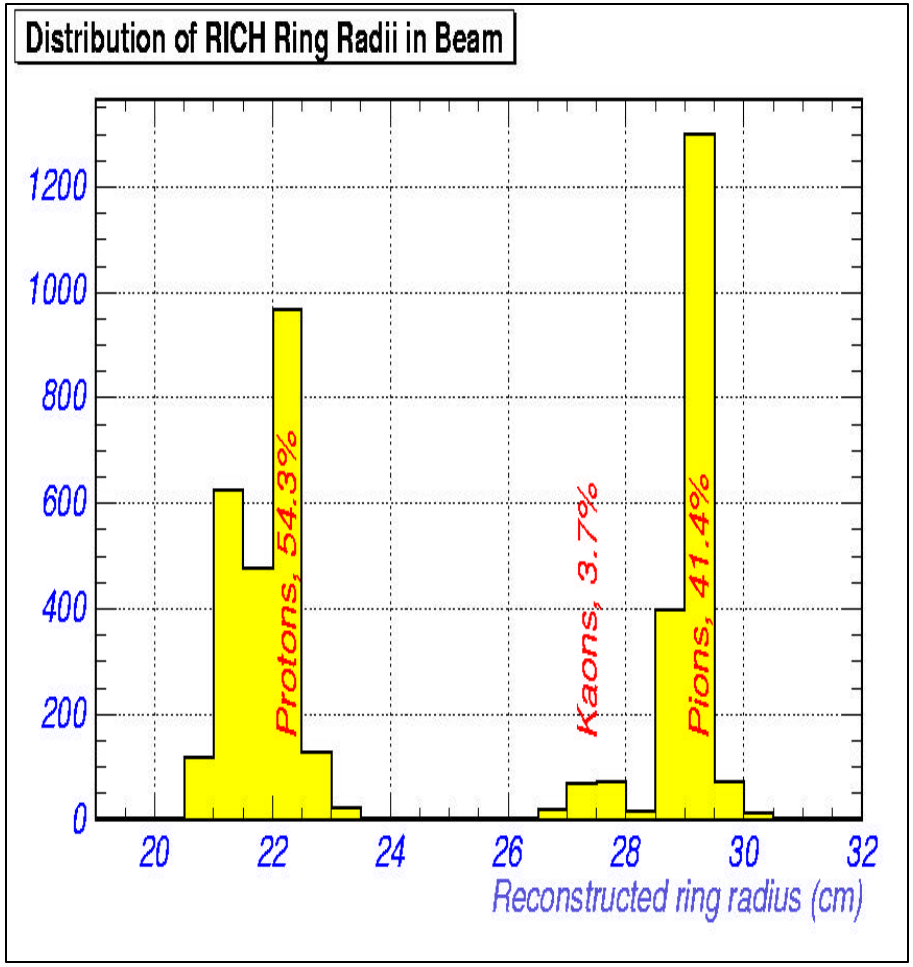






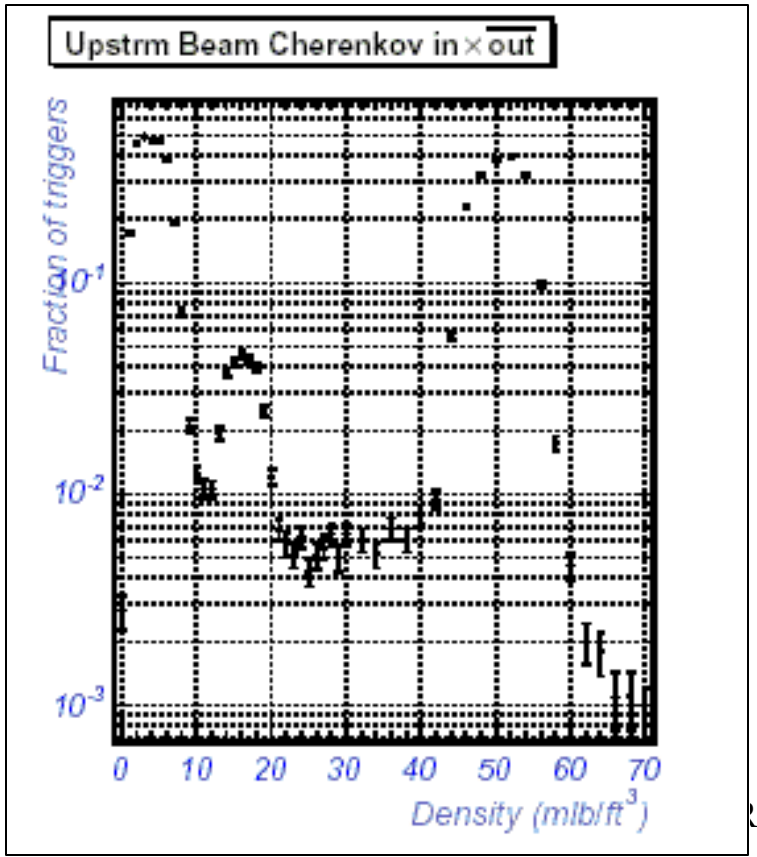


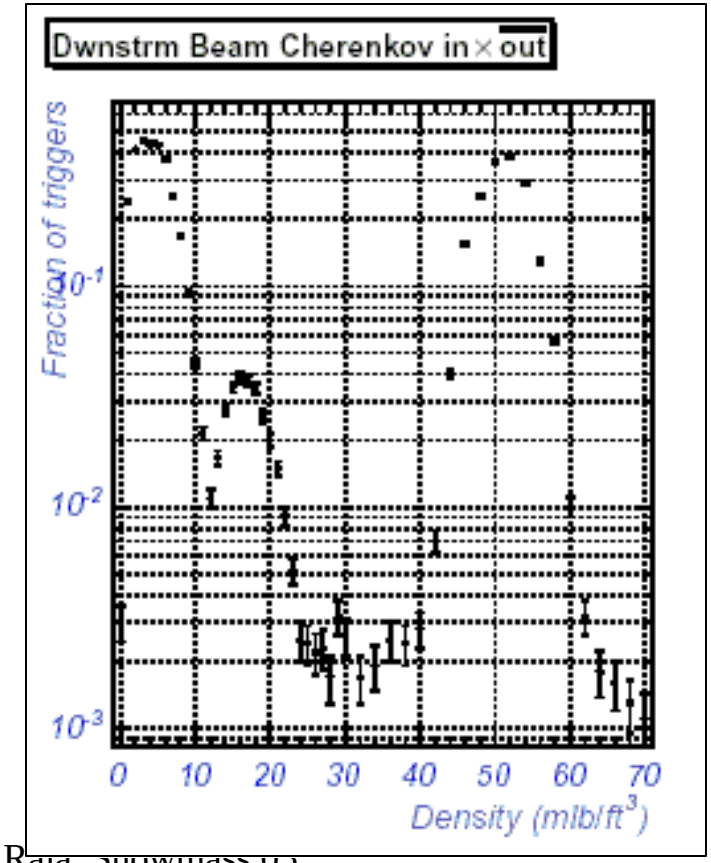
RICH radii for + 40 GeV beam triggers



Beam Cherenkovs

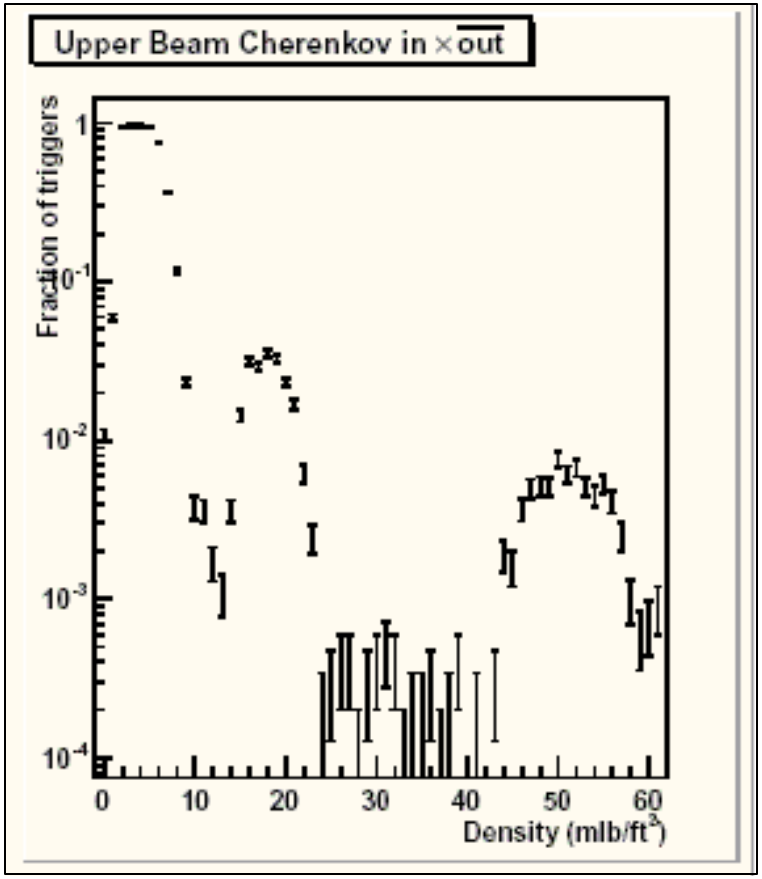
- Pressure curve Automated- Mini-Daq-APACS 30 minutes per pressure curve.+40GeV/c beam.

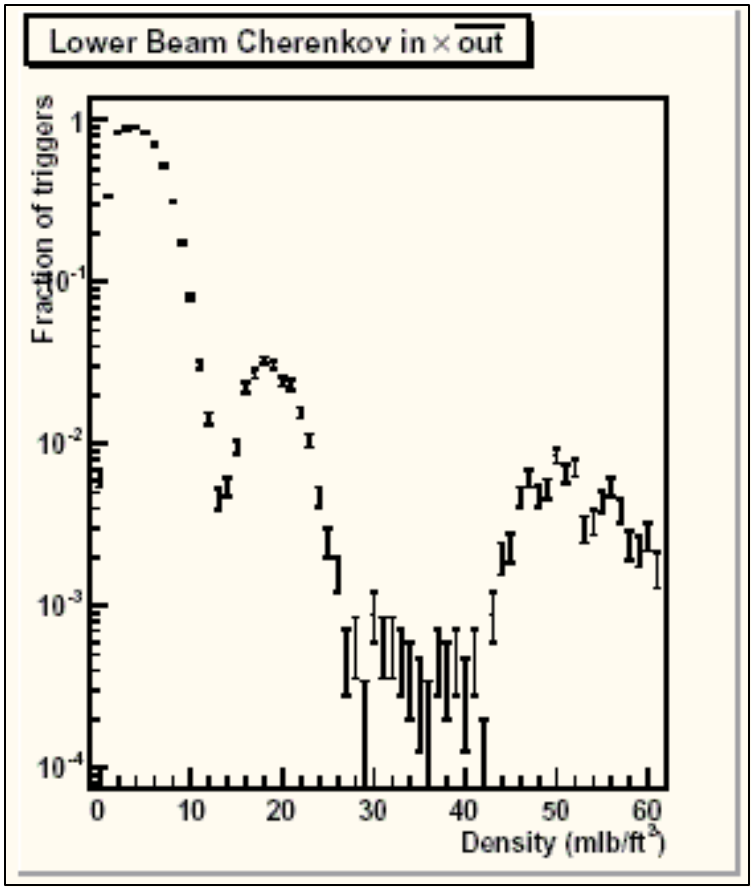




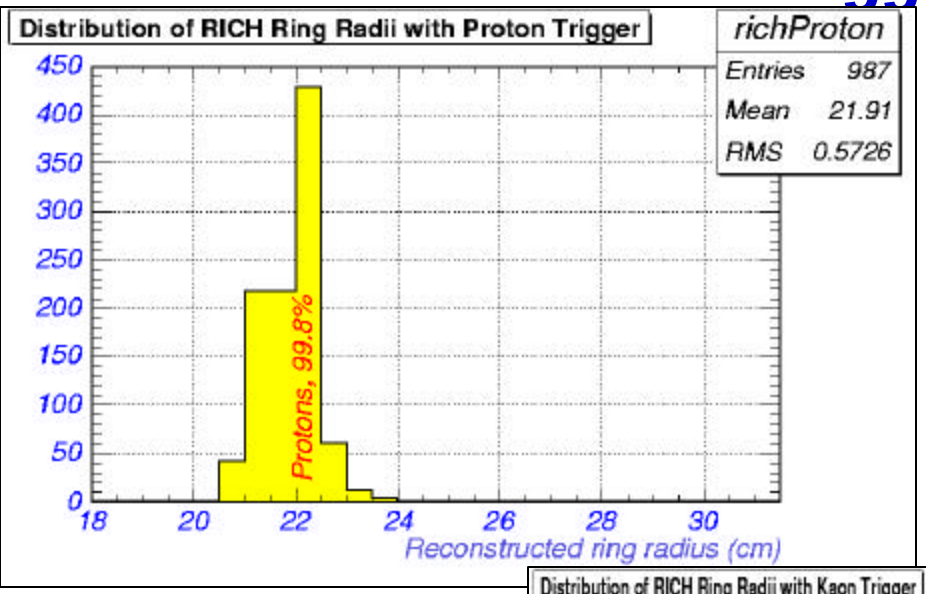
Beam Cherenkovs

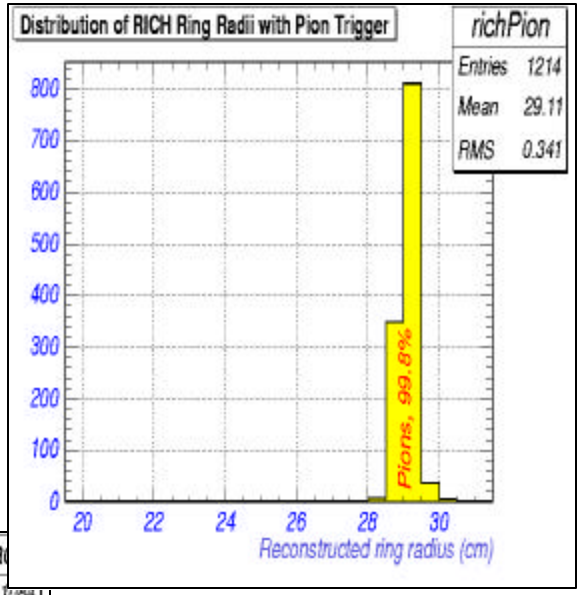
- 40 GeV/c negative beam

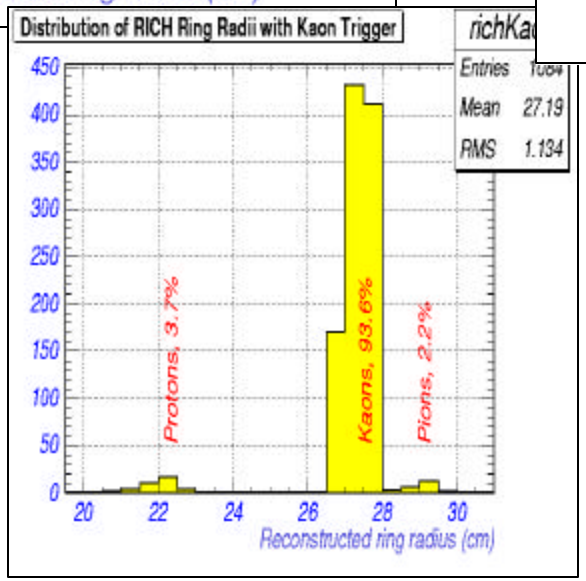




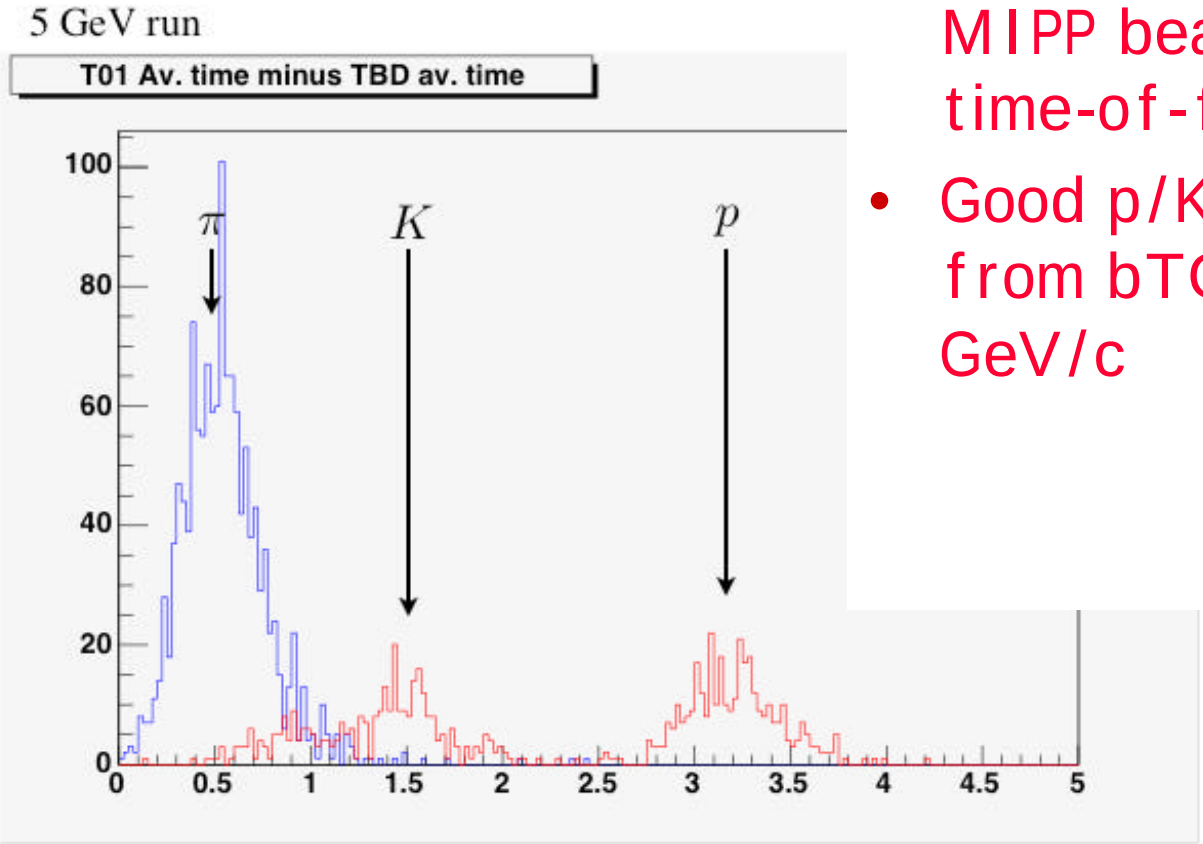
Comparing Beam Cherenkov to RICH for +40 GeV beam triggers - No additional cuts!





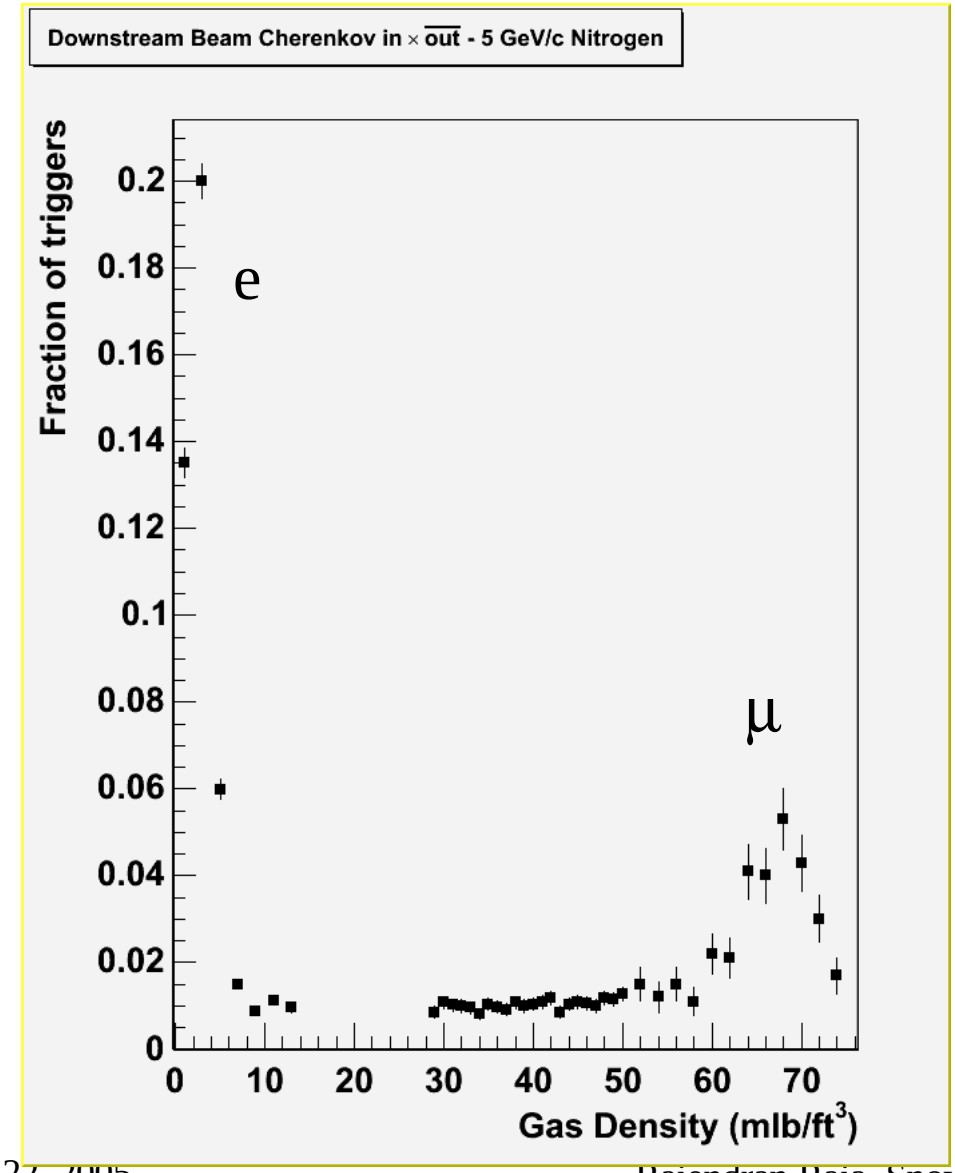


MIPP Beam PID from bTOF



- 3 scintillators in the MIPP beam line give beam time-of-flight measure
- Good p/K separation from bTOF up to 10 GeV/c

MIPP Beam PID - Electrons



- At low momentum electrons (β=1, at 4 mlb/cft in N_2) are well separated from muons and heavier particles
- π, K, and p can be tagged in C_4F_8O or similar gas with large n

PLANS TO UPGRADE BEAM

- We need to go down to 1GeV/c beams to do missing baryon resonance search.
- We believe that by changing the power supplies to trim dipole supplies (plentiful at lab) we can accurately control themagnet currents. Remnant iron fileds becom important. The measurements made at MTF seem to indict ha he remant higher order multipole effects are under control. However, to control hysteresis effects, we propose instrumenting every secondary magnet with two Hall probes.
- We may need to replace the beam cerenkovs with something smarter (short RICH with GEM readout?) to reduce multiple scattering of beam.
- However, the MIPP expertise can be helpful for improving M-TEST beamline.

Low momentum fluxes

Momentum GeV/c	p	K^+	π^+	$\bar{p}$	K^-	π^-
1	5752	0	64798	7907	0	30425
2	23373	194	459718	26863	142	236494
3	53431	3060	1069523	51424	2221	598742
5	153220	32763	2400799	103996	23164	1550810
10	663916	223210	5006708	195767	142777	3862225
15	1618120	443557	7141481	221602	245868	5248463
20	3113387	655426	9290219	212171	306685	5841030
30	8158054	1043430	12770579	160329	340144	5837467
40	16664431	1294189	13944272	101617	288728	5156862
50	29288928	1338452	12788523	53056	196400	4114582
60	45985629	1191744	10094311	22092	108032	2905091
70	65227010	919279	6834097	6987	47093	1762060

TABLE II: Secondary beam fluxes as a function of beam momentum and species for 2E11 primary protons on target