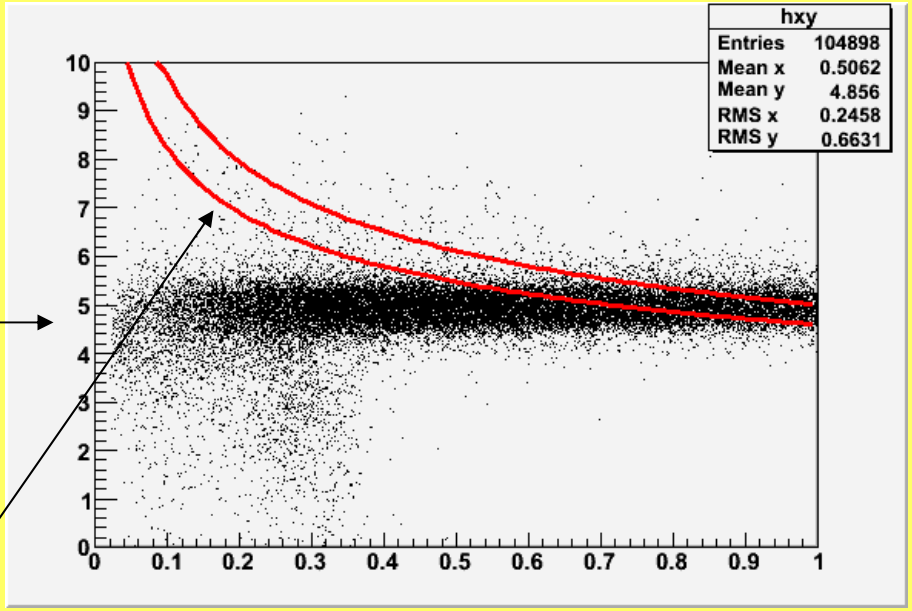
Preliminary MIPP Cross-Section on the Production of Proton from 0.1 to 0.55 GeV/c

Yusuf Gunaydin, Gural Aydin, and Yasar Onel
University of Iowa

Dmitry Ratnikov, **Illinois Institute of Technology**

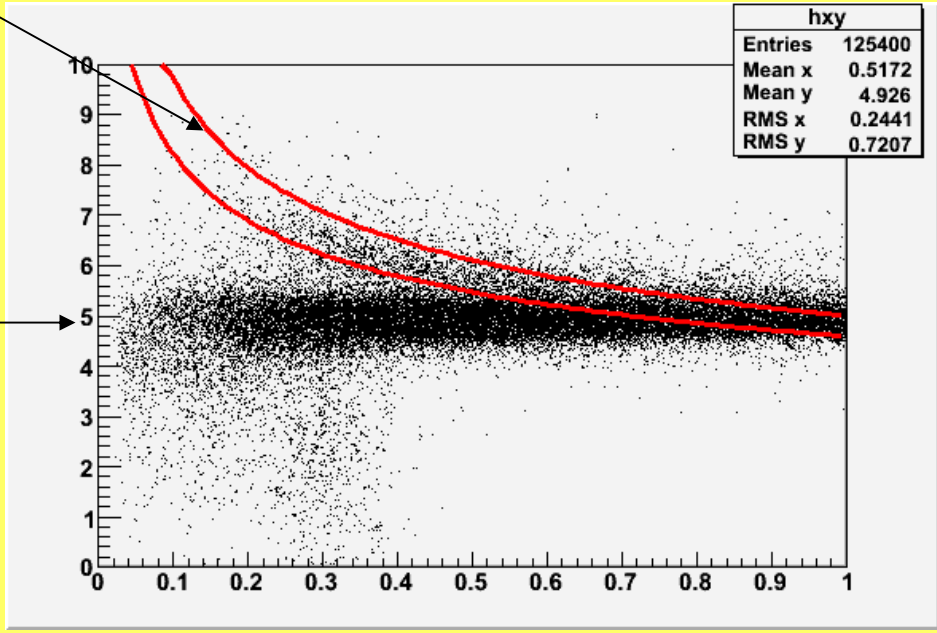
Nickolas Solomey, **FNAL**

Momentum (GeV/c) versus ln(de/dx) for anti-proton

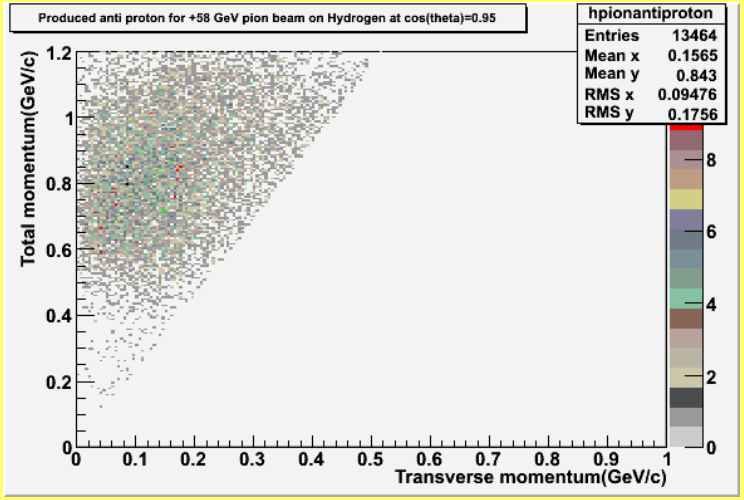


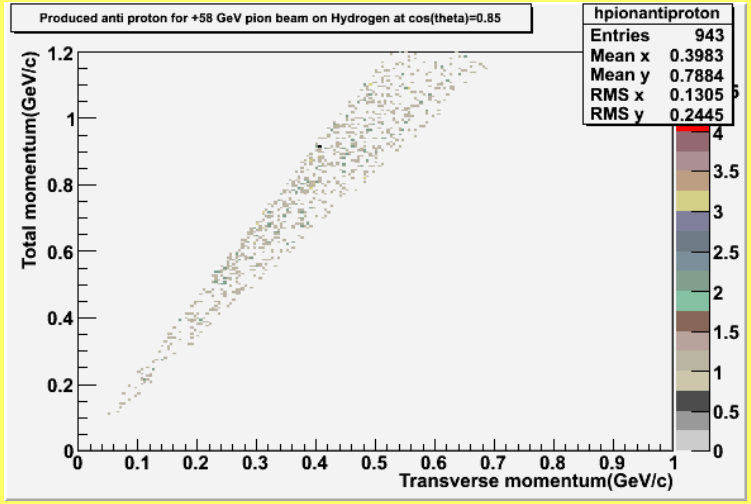
We used those red lines to identify the proton bands.

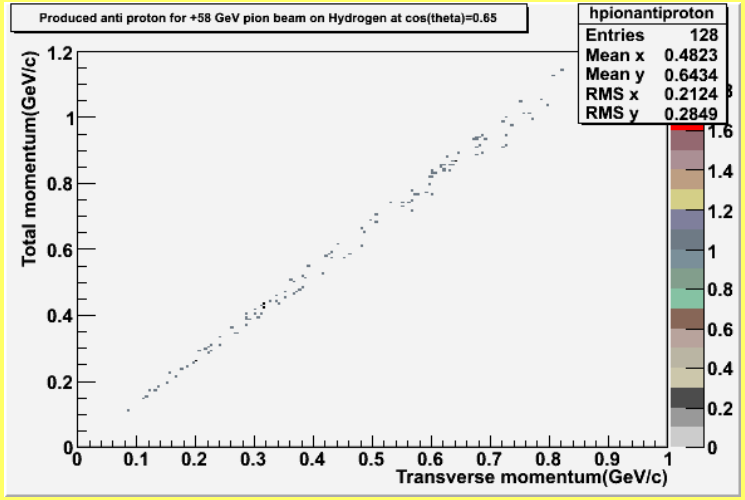
Momentum (GeV/c) versus ln(de/dx) for proton



Produced **Anti-Proton** for +58 GeV **Pion Beam** on LH2 Target , Transverse Momentum vs. Total Momentum Plots







Example of calculation

$$\frac{d^2\sigma_p}{dpd\Omega}(p,\cos\theta) = \frac{A}{2\pi N_A \rho}\frac{1}{a(p,\cos\theta)}\frac{N_p(p,\cos\theta)}{N_b \Delta p \Delta\cos\theta}$$

For Cosθ=0.95 and p=0.45

N_p=327 N_b=39,469 Δp=0.05(GeV/c)

Δcos(θ)=0.1(str) a=1 ρ=1 g/cm^2 A=2 g

1200 is correction factor for interaction trigger and prescale..

$d^2\sigma_p$ / dpdΩ=(2*327)/(6,28*6.02*10^{23}*39,469*1,200*0.05)

=0.0730*10^{-27} cm^2 =0.0730 mbarn

Proton

Proton Beam

	Angles											
d^2σ/dpdΩ	Cos(0.95)=	0.0013	0.0031	0.0096	0.0250	0.0483	0.0588	0.0730	0.0889	0.1233	0.1883	0.2475
	Cos(0.85)=	0.0018	0.0034	0.0096	0.0181	0.0246	0.0273	0.0348	0.0369	0.0322	0.0353	0.0319
	Cos(0.75)=	0.0011	0.0031	0.0107	0.0109	0.0147	0.0165	0.0152	0.0168	0.0139	0.0114	0.0107
	Cos(0.65)=	0.0016	0.0027	0.0078	0.0094	0.0063	0.0060	0.0054	0.0040	0.0036	0.0020	0.0022
		Track Proton0	Track Proton1	Track Proton2	Track Proton3	Track Proton4	Track Proton5	Track Proton6	Track Proton7	Track Proton8	Track Proton9	Track Proton10
Track Numbers:	Cos(0.95)=	6	14	43	112	216	263	327	398	552	843	1108
	Cos(0.85)=	8	15	43	81	110	122	156	165	144	158	143
	Cos(0.75)=	5	14	48	49	66	74	68	75	62	51	48
	Cos(0.65)=	7	12	35	42	28	27	24	18	16	9	10
Error Bars:	Cos(0.95)=	0.0005	0.0008	0.0015	0.0024	0.0033	0.0036	0.0040	0.0045	0.0052	0.0065	0.0074
	Cos(0.85)=	0.0006	0.0009	0.0015	0.0020	0.0023	0.0025	0.0028	0.0029	0.0027	0.0028	0.0027
	Cos(0.75)=	0.0005	0.0008	0.0015	0.0016	0.0018	0.0019	0.0018	0.0019	0.0018	0.0016	0.0015
	Cos(0.65)=	0.0006	0.0008	0.0013	0.0014	0.0012	0.0012	0.0011	0.0009	0.0009	0.0007	0.0007

Pion Beam

d^2σ/dpdΩ	Cos(0.95)=	0.0038	0.0043	0.0095	0.0259	0.0475	0.0659	0.0695	0.1049	0.1431	0.1848	0.2444
	Cos(0.85)=	0.0025	0.0038	0.0122	0.0155	0.0207	0.0187	0.0272	0.0297	0.0340	0.0342	0.0344
	Cos(0.75)=	0.0018	0.0045	0.0081	0.0092	0.0189	0.0160	0.0176	0.0151	0.0128	0.0101	0.0117
	Cos(0.65)=	0.0020	0.0036	0.0038	0.0077	0.0079	0.0043	0.0047	0.0047	0.0038	0.0032	0.0032
		Track Proton0	Track Proton1	Track Proton2	Track Proton3	Track Proton4	Track Proton5	Track Proton6	Track Proton7	Track Proton8	Track Proton9	Track Proton10
Track Numbers:	Cos(0.95)=	17	19	42	115	211	293	309	466	636	821	1086
	Cos(0.85)=	11	17	54	69	92	83	121	132	151	152	153
	Cos(0.75)=	8	20	36	41	84	71	78	67	57	45	52
	Cos(0.65)=	9	16	17	34	35	19	21	21	17	14	14
Error Bars:	Cos(0.95)=	0.0009	0.0010	0.0015	0.0024	0.0033	0.0039	0.0040	0.0049	0.0057	0.0064	0.0074
	Cos(0.85)=	0.0007	0.0009	0.0017	0.0019	0.0022	0.0021	0.0025	0.0026	0.0028	0.0028	0.0028
	Cos(0.75)=	0.0006	0.0010	0.0014	0.0014	0.0021	0.0019	0.0020	0.0018	0.0017	0.0015	0.0016
	Cos(0.65)=	0.0007	0.0009	0.0009	0.0013	0.0013	0.0010	0.0010	0.0010	0.0009	0.0008	0.0008

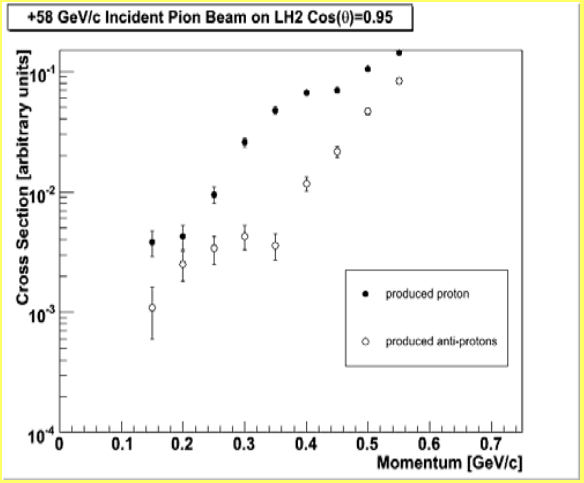
Anti Proton

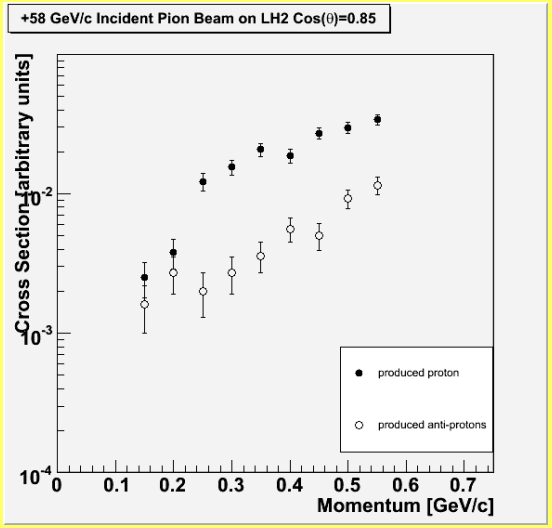
	Angles											
Proton Beam	d^2σ/dpdΩ	Cos(0.95)=	0.0011	0.0045	0.0040	0.0040	0.0092	0.0114	0.0183	0.0431	0.0844	0.1548	0.2174
		Cos(0.85)=	0.0016	0.0016	0.0029	0.0045	0.0031	0.0054	0.0069	0.0089	0.0087	0.0107	0.0145
		Cos(0.75)=	0.0007	0.0011	0.0018	0.0027	0.0029	0.0025	0.0029	0.0025	0.0020	0.0038	0.0036
		Cos(0.65)=	0.0004	0.0013	0.0009	0.0013	0.0016	0.0007	0.0011	0.0016	0.0011	0.0007	0.0018
			Track Proton0	Track Proton1	Track Proton2	Track Proton3	Track Proton4	Track Proton5	Track Proton6	Track Proton7	Track Proton8	Track Proton9	Track Proton10
	Track Numbers:	Cos(0.95)=	5	20	18	18	41	51	82	193	378	693	973
		Cos(0.85)=	7	7	13	20	14	24	31	40	39	48	65
		Cos(0.75)=	3	5	8	12	13	11	13	11	9	17	16
		Cos(0.65)=	2	6	4	6	7	3	5	7	5	3	8
	Error Bars:	Cos(0.95)=	0.0005	0.0010	0.0009	0.0009	0.0014	0.0016	0.0020	0.0031	0.0043	0.0059	0.0070
		Cos(0.85)=	0.0006	0.0006	0.0008	0.0010	0.0008	0.0011	0.0012	0.0014	0.0014	0.0015	0.0018
		Cos(0.75)=	0.0004	0.0005	0.0006	0.0008	0.0008	0.0007	0.0008	0.0007	0.0007	0.0009	0.0009
		Cos(0.65)=	0.0003	0.0005	0.0004	0.0005	0.0006	0.0004	0.0005	0.0006	0.0005	0.0004	0.0006
Pion Beam	d^2σ/dpdΩ	Cos(0.95)=	0.0011	0.0025	0.0034	0.0043	0.0036	0.0117	0.0216	0.0466	0.0839	0.1548	0.2237
		Cos(0.85)=	0.0016	0.0027	0.0020	0.0027	0.0036	0.0056	0.0050	0.0092	0.0115	0.0099	0.0140
		Cos(0.75)=	0.0005	0.0009	0.0009	0.0023	0.0025	0.0027	0.0014	0.0009	0.0032	0.0032	0.0018
		Cos(0.65)=	0.0009	0.0009	0.0011	0.0016	0.0011	0.0023	0.0025	0.0014	0.0007	0.0016	0.0005
			Track Proton0	Track Proton1	Track Proton2	Track Proton3	Track Proton4	Track Proton5	Track Proton6	Track Proton7	Track Proton8	Track Proton9	Track Proton10
	Track Numbers:	Cos(0.95)=	5	11	15	19	16	52	96	207	373	688	994
		Cos(0.85)=	7	12	9	12	16	25	22	41	51	44	62
		Cos(0.75)=	2	4	4	10	11	12	6	4	14	14	8
		Cos(0.65)=	4	4	5	7	5	10	11	6	3	7	2
	Error Bars:	Cos(0.95)=	0.0005	0.0007	0.0009	0.0010	0.0009	0.0016	0.0022	0.0032	0.0043	0.0059	0.0071
		Cos(0.85)=	0.0006	0.0008	0.0007	0.0008	0.0009	0.0011	0.0011	0.0014	0.0016	0.0015	0.0018
		Cos(0.75)=	0.0003	0.0005	0.0005	0.0007	0.0007	0.0008	0.0006	0.0005	0.0008	0.0008	0.0006
		Cos(0.65)=	0.0005	0.0005	0.0005	0.0006	0.0005	0.0007	0.0007	0.0006	0.0004	0.0006	0.0003

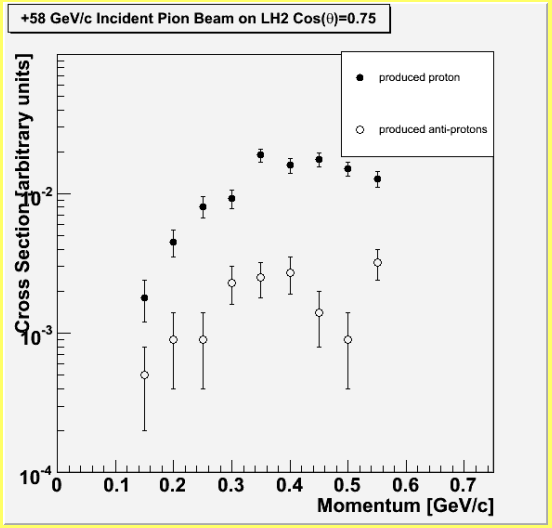
Produced Proton and Anti-Proton Cross Section for +58 GeV Pion Beam on LH2 Target

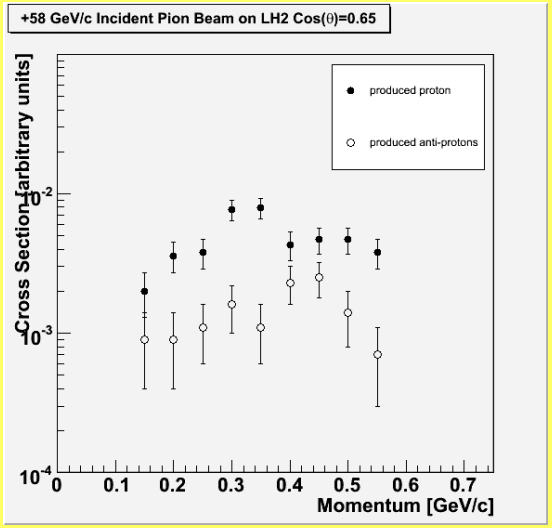
Calculation of error bars:

$$\frac{\sqrt{Number\ of\ Tracks}}{Number\ of\ Tracks} * \frac{d^2\sigma}{dpd\Omega}$$

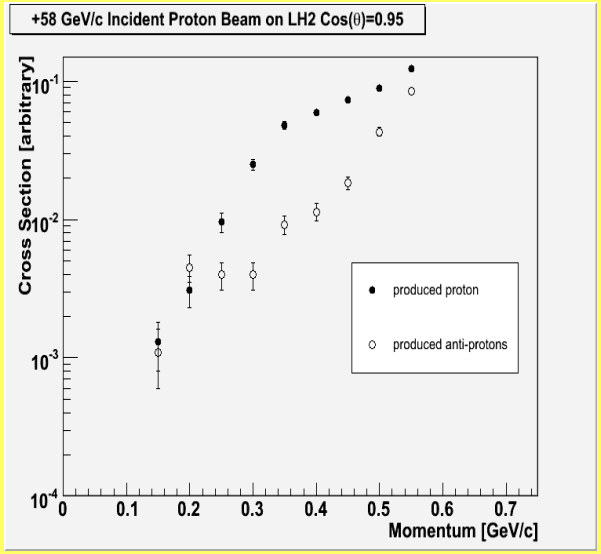


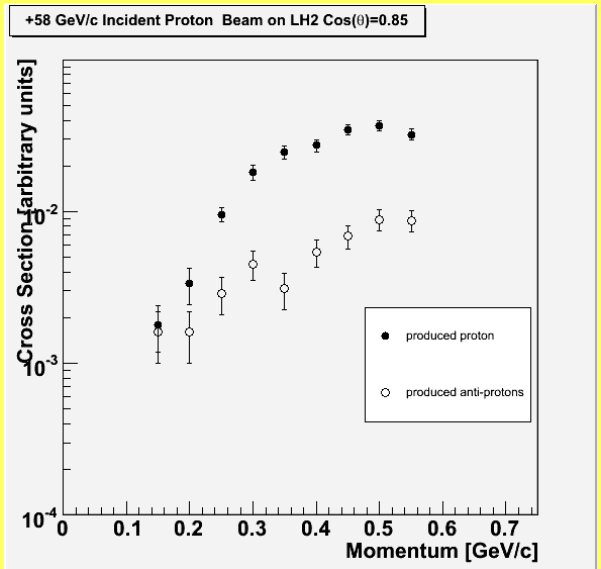


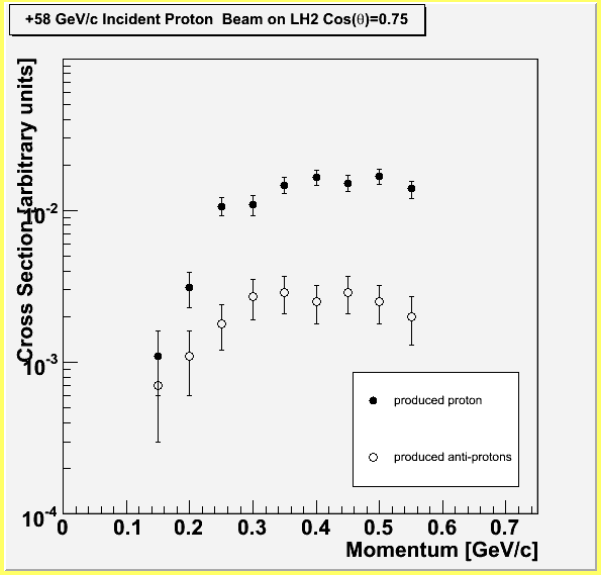


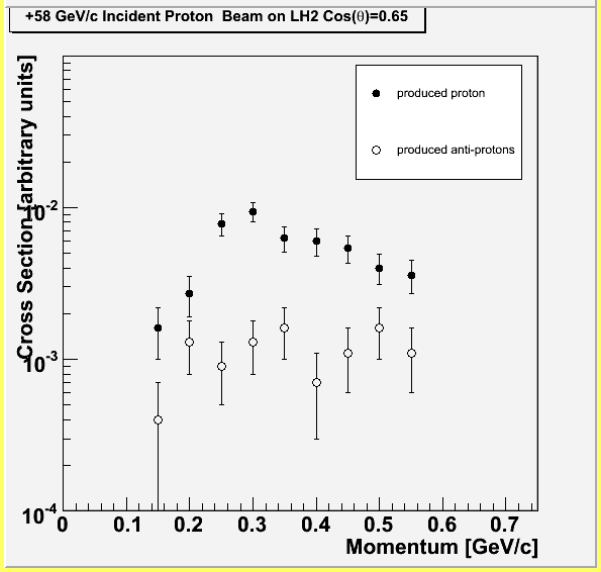


Produced Proton and Anti-Proton Cross Section for +58 GeV Proton Beam on LH2 Target







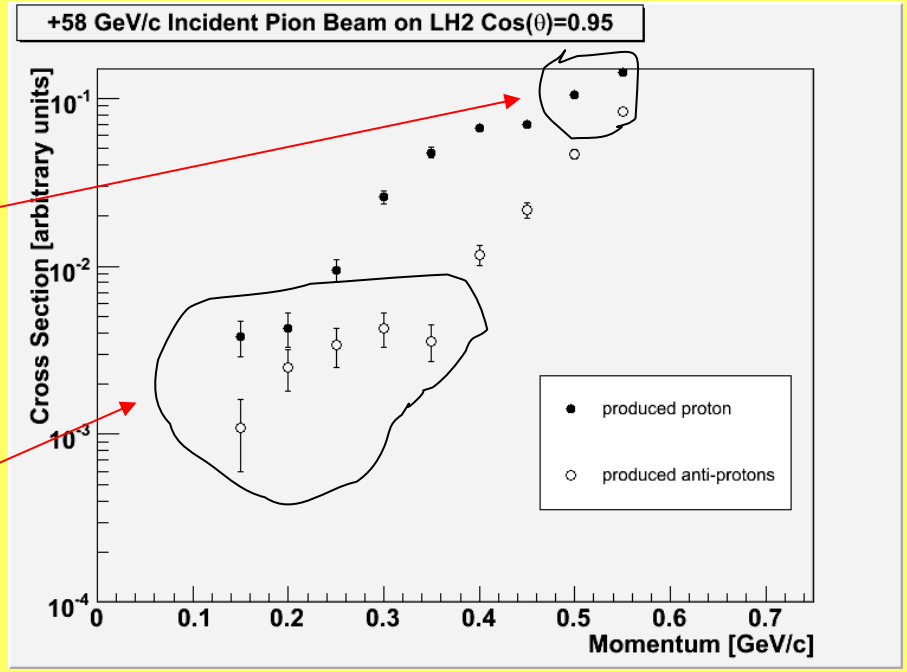


Conclusion

- There is two parts consistency with our expectations
  - Anti-Proton cross section suppressed by order of magnitude from proton cross section
  - Seeing both proton and anti-proton peak approximately at the same momentum.
- Our error bars are statistical only but quite good.

Conclusion

Discrepancy with expectation are

Proton selection band starts to merge pion forward angle

This one is because of low statistics.