A Very-Preliminary MIPP cross-section on the production of soft pions from 0.1 to 0.7 GeV/c

Gural Aydin, Yusuf Gunaydin and Yasar Onel
Univ. of Iowa

Dmitry Ratnikov, Illinois Inst. of Technology

Nickolas Solomey, Fermilab

We used numbers from a MIPP data analysis to try and produce a tentative cross-section. All numbers are preliminary as is the results, but we can compare their values favorably to a similar previous publication.

Double differential cross-section:

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

Using +58 GeV/c beams of tagged protons on Liquid Hydrogen and events that produce pions identified only by the limited acceptance of the TPC using dE/dx PID.

ρ for LH target we used 1 gm/cm^2

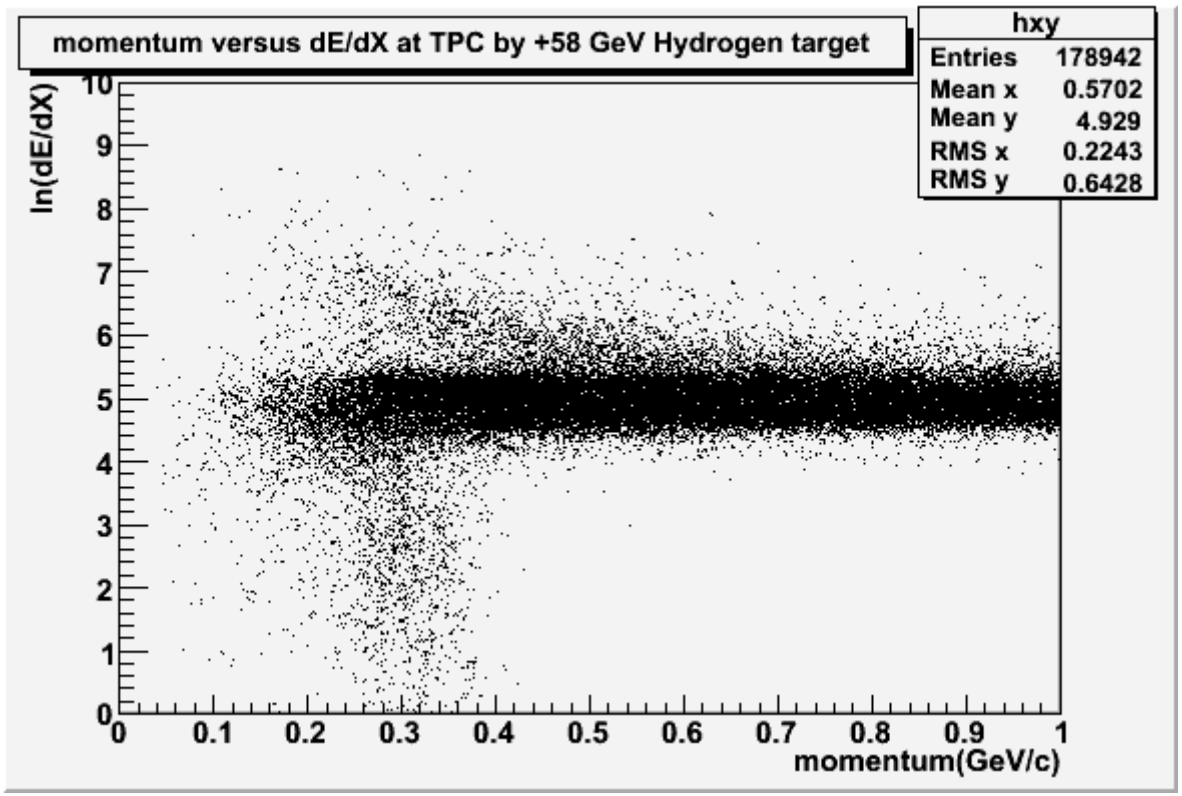
A = 2 gm

$N_A = 6.02\text{x}10^{23}$

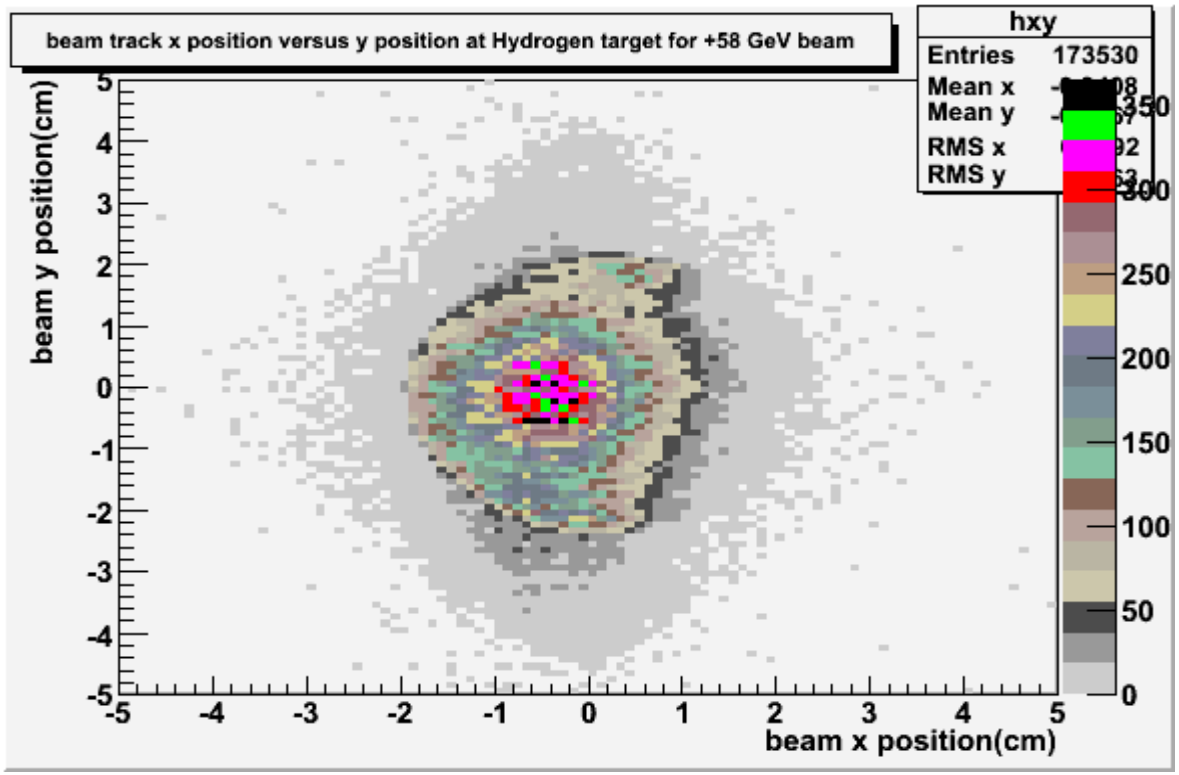
A(p,cosθ) == 1 MC acceptance needs to be changed

Using the TPC dE/dx data shown below, cuts were put applied to select pions by requiring ln(dE/dx) to be between 4.3 and 5.3.

Events which have only one beam track was selected and number of TPC hits used for dE/dx plot was above 10 for each track.



Shown here is the reconstructed vertex location at z of LH target of the tracks used.



Selection cuts were applied to data: only one beam track, PID of beam particle is a proton, etc.

The number of observed pions $N_{\pi-}$ in our analysis is shown below:

	Cosθ=0.95	Cosθ=0.85	Cosθ=0.75	Cosθ=0.65
p=0.15	816	364	264	175
P=0.25	2405	1174	791	427
P=0.35	4811	1533	792	326
P=0.45	5155	1305	460	144
P=0.55	5167	957	270	81
P=0.65	5035	642	162	54

The number of observed pions $N_{\pi+}$ in our analysis:

	Cosθ=0.95	Cosθ=0.85	Cosθ=0.75	Cosθ=0.65
P=0.15	739	380	261	192
P=0.25	2279	1197	854	528
P=0.35	4629	1560	918	382
P=0.45	5318	1410	620	225
P=0.55	5543	1133	471	130
P=0.65	5539	820	338	85

Example of calculation

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

For cos(θ) = 0.95 and p= 0.45 GeV/c

N_{π^-} = 5155 events N_b = 39469 beam particles and Δp = 0.1 GeV/c

Δcos(θ) = 0.1 str, acceptance a(p,cosθ) ≡ 1, ρ = 1 g/cm^2 and A = 2g

1200 is correction factor for interaction trigger and prescale.

$d^2\sigma_\pi/dpd\Omega = (2*5115)/(628*6.02x10^{23}*39469*1200*0.01)$

$= 5.7579x10^{-27}$ cm2 = 5.7559 mbarn

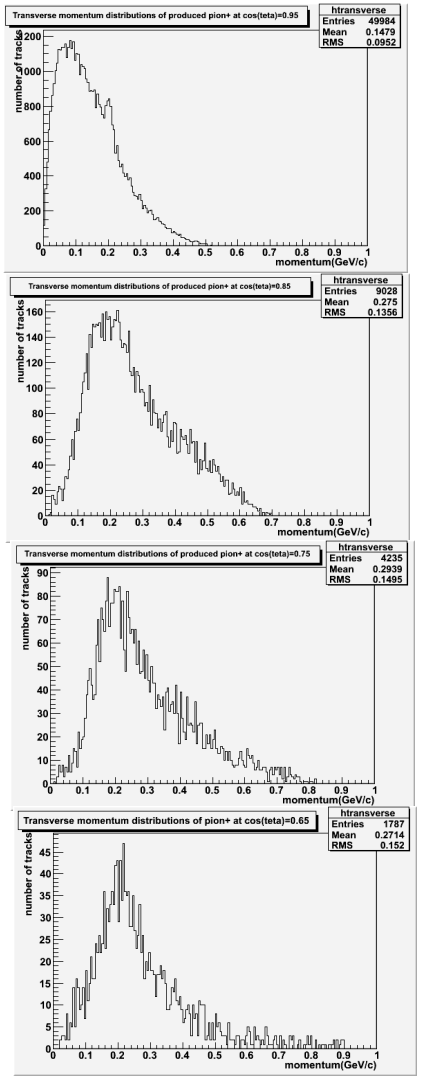
The number of incident protons on target N_p is a combination of the triggers seen, the pre-scale and interaction trigger enhancement.

There were 39,469 triggers

The Interaction trigger enhanced our 1% interaction length target by a factor of ~50, this needs to be studied with min-bias triggers.

The proton on target with interaction triggers was prescaled by a factor of 24.

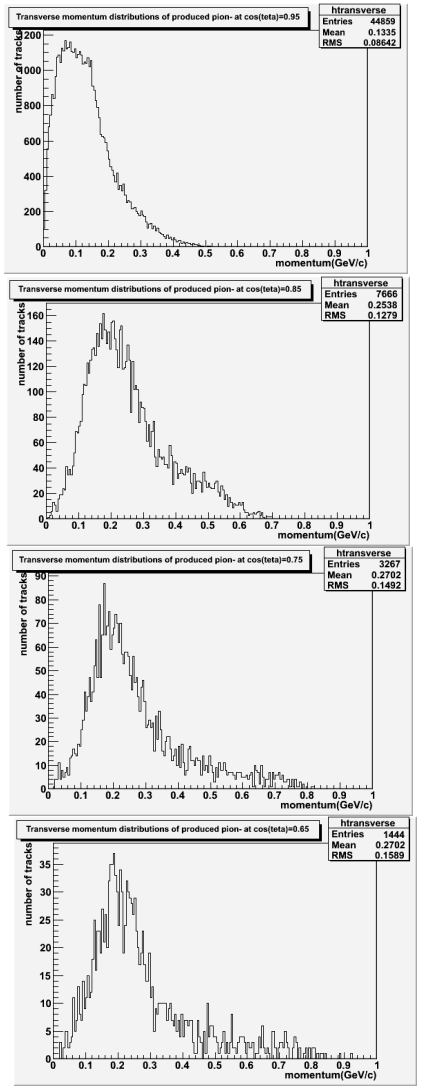
Np = 39,469 x 50 x 24 = 48,000,000



These are actually events observed in an angle and momentum bite Δp= 0.1 GeV/c, and $\Delta\cos\theta$=0.1 str., for 0.95 to 0.65 mrad. from top to bottom.

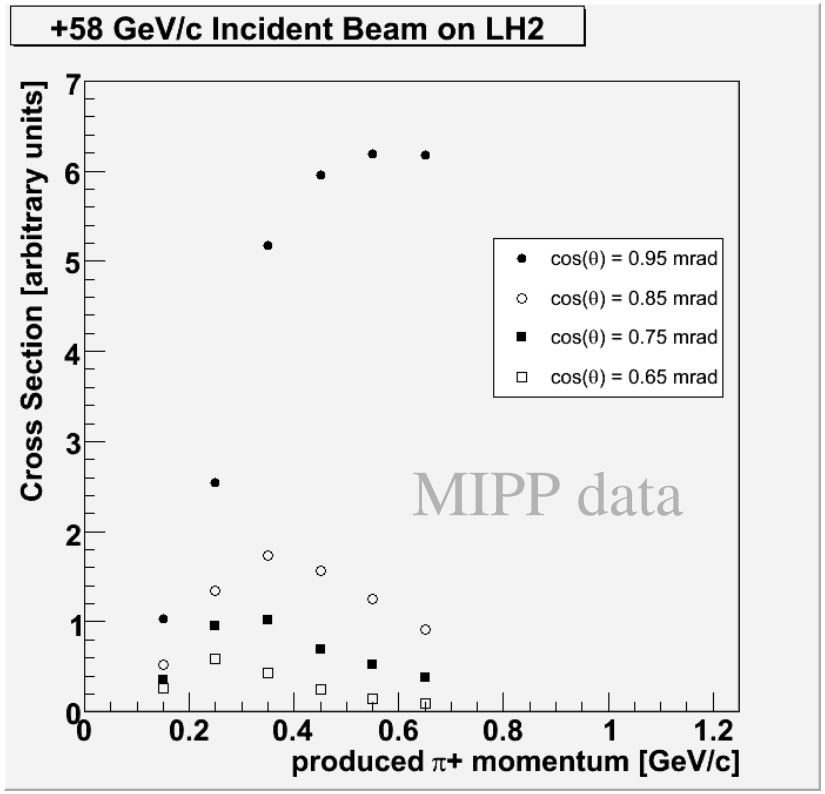
On the right is the produced negative pions and on the left the produced positive pions.

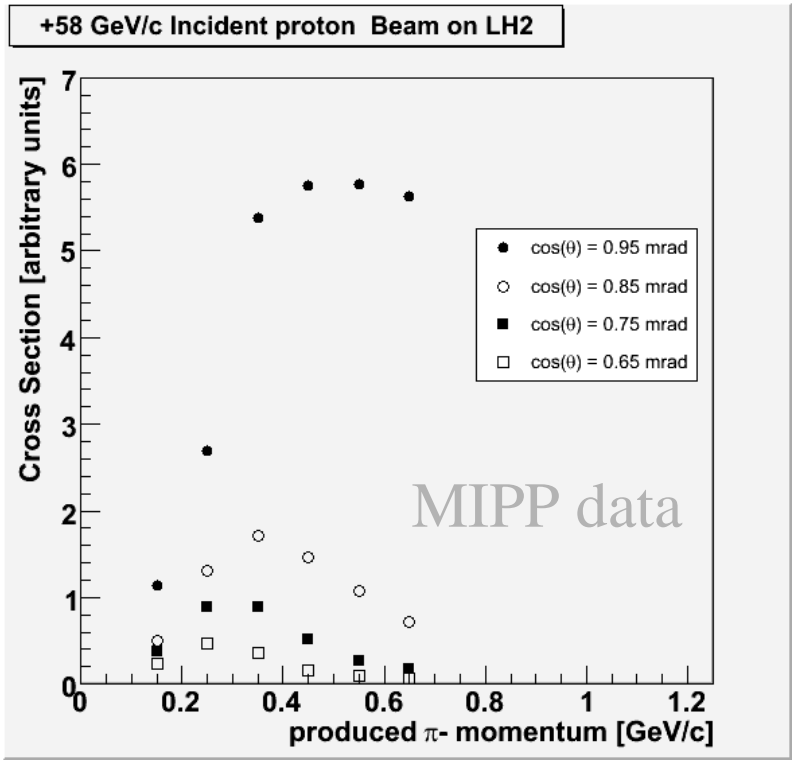
Plotted is the frequency histogram for $p_{\perp}$



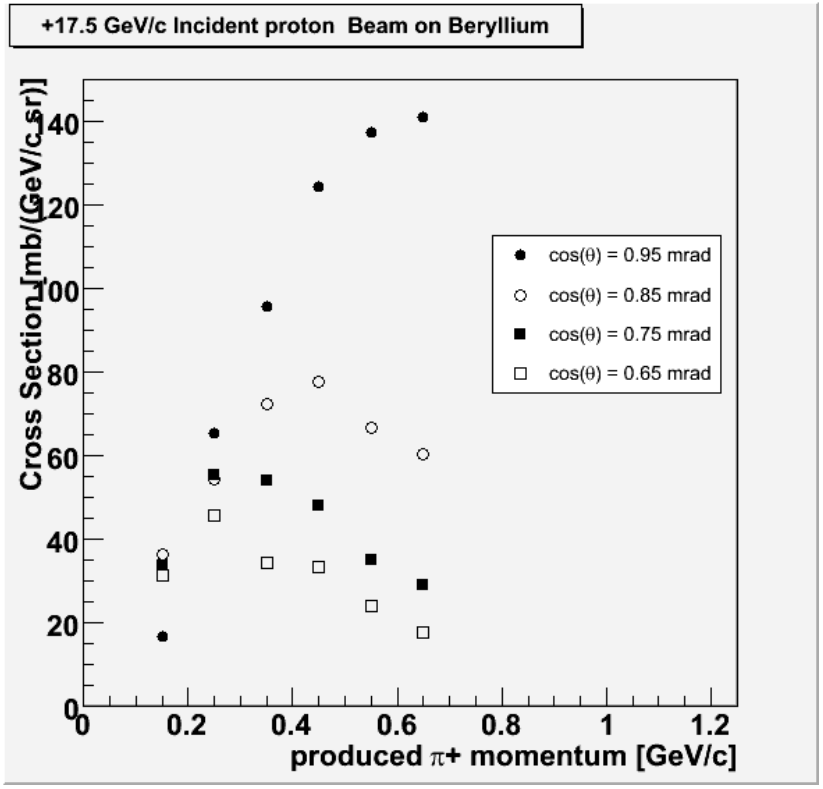
We plot all the momentum and angle bins. The dependency follows the expected pattern as angle and momentum bins change.

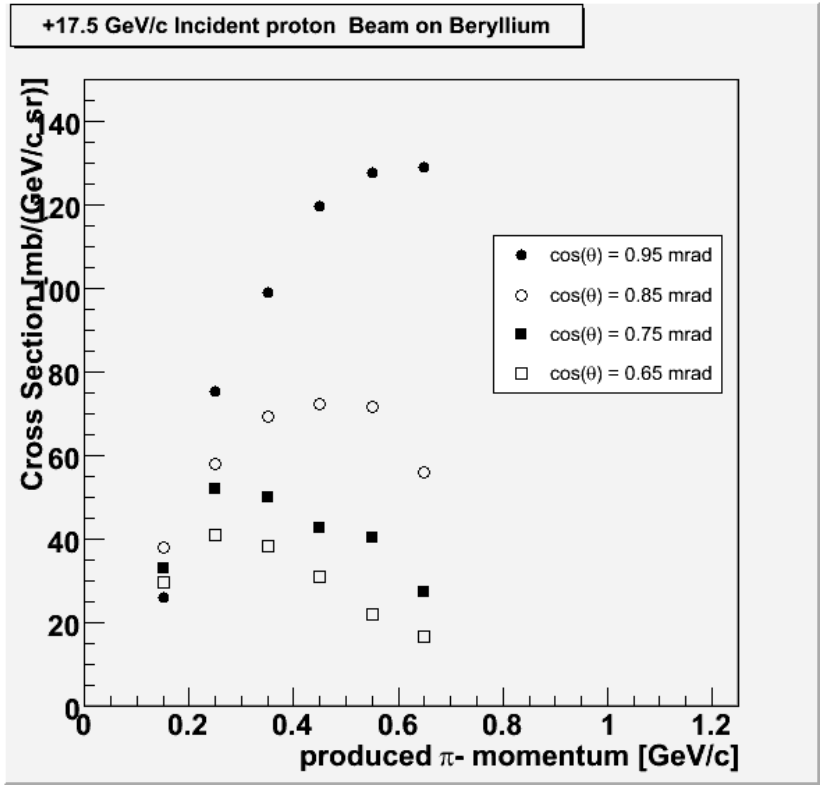
Since a lot of the values that went into these cross sections are preliminary and need detailed calculations we label them arbitrary units.





These are published plots from E910 for 17.5 GeV/c proton beam on Beryllium target



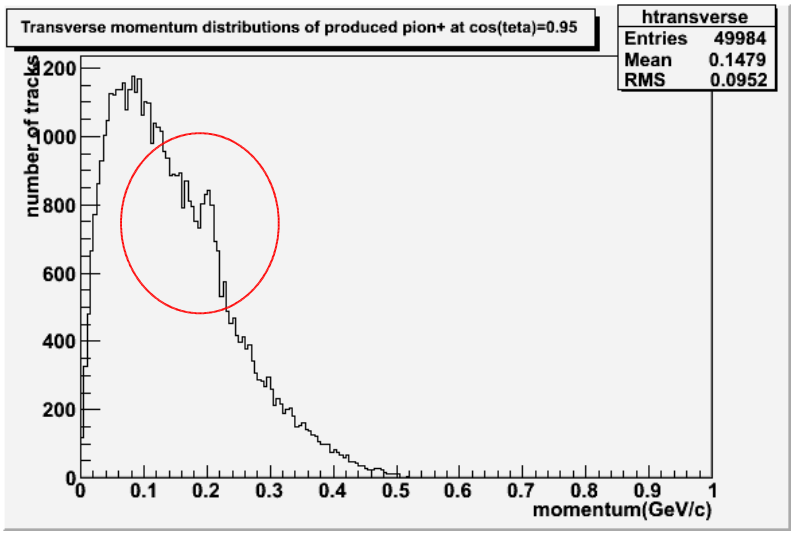


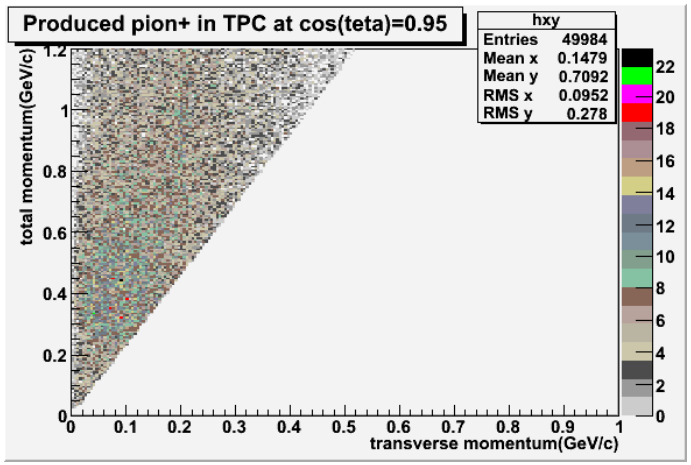
What comparison says about MIPP data

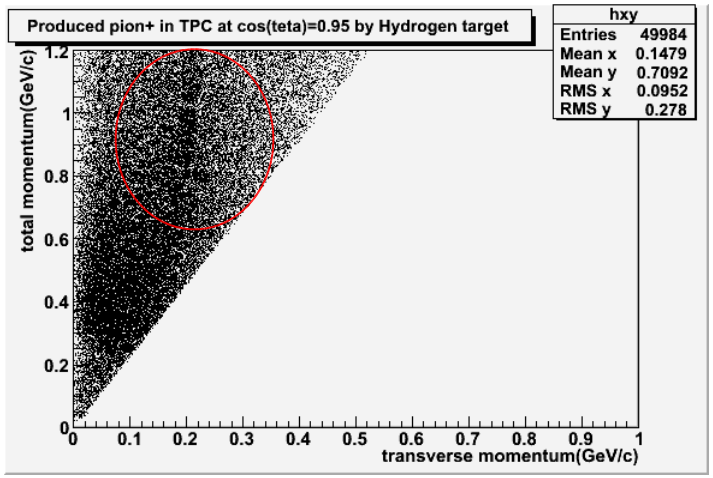
- The MIPP data like the E910 data has the π^+ peaking at higher momentum than the π^-.
- After peak momentum the cross-sections drop as expected
- The dependence on cos(θ) are at consistent ratios to each other with some improvements expected.

All of this says very favorable comparison with our data to published data, but we have to refine the numbers.

Some features in the $p_\perp$ plots have extra peaks, see red circle. When we look in the scatter plot of p vs $p_\perp$ we see an unexpected vertical line. This might be due to tracks not associated with the event.







Conclusion:

- Very preliminary MIPP data on soft pion production seem to follow expected dependency upon momentum and cos(θ) binning.
- Some problems exist.
- Future work is to start to refine each number that went into the calculation to make it a true cross-section results.
- We also plan at Univ. of Iowa with Yusuf to start to study produced proton and anti-proton in TPC PID, and add TOF PID to extend this up to 2 GeV/c.