

Nucleon Structure Functions at Large Bjorken X from 12 GeV Commissioning Experiment E12-10-002 in Hall C , JLab

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Overview

- Physics
- Hall C overview
- Kinematics
- Calibrations
- First Data to MC comparison
- Cross sections
- Summary

APS April Meeting 2018

April 14-17, 2018

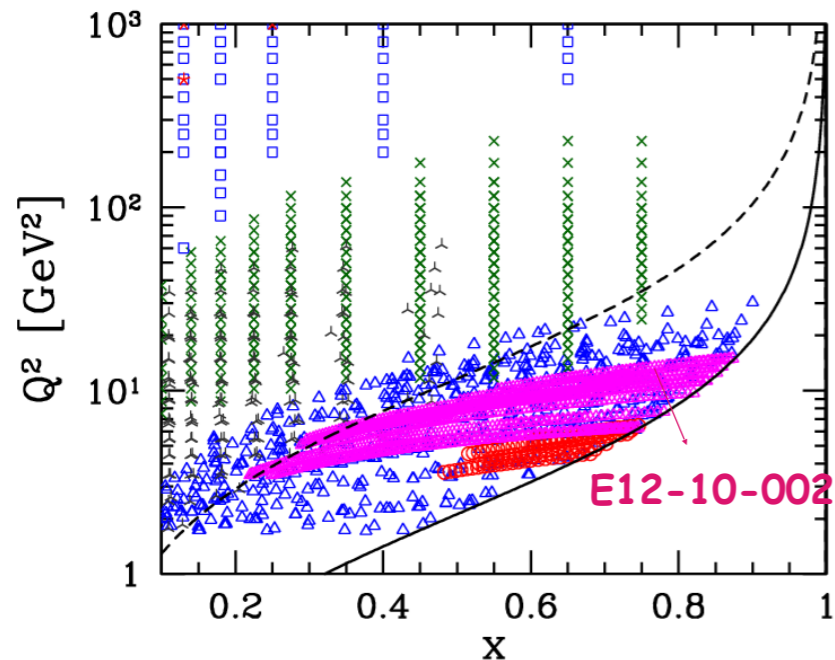
Columbus , Ohio, USA

Physics

Goal : Better knowledge of F2 structure function specially at Large x

Physics

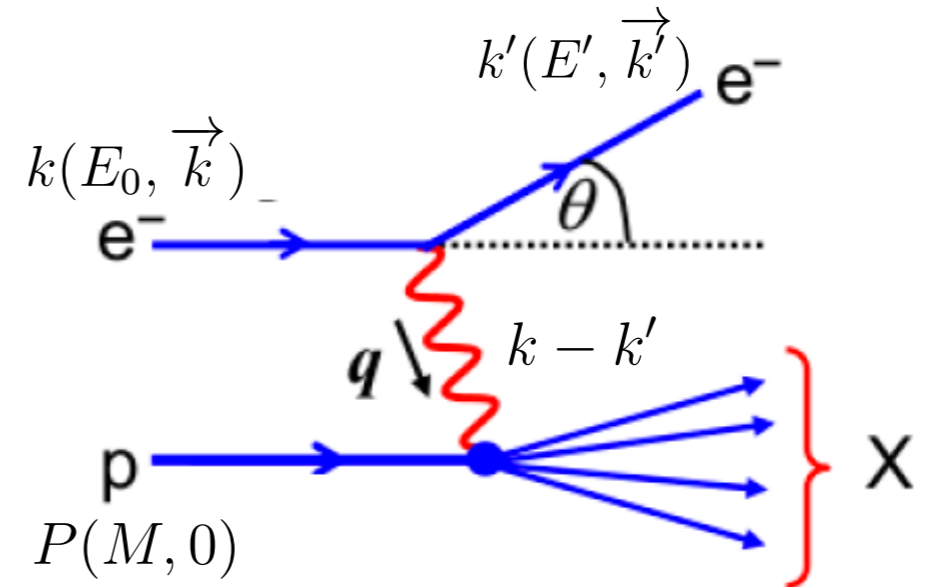
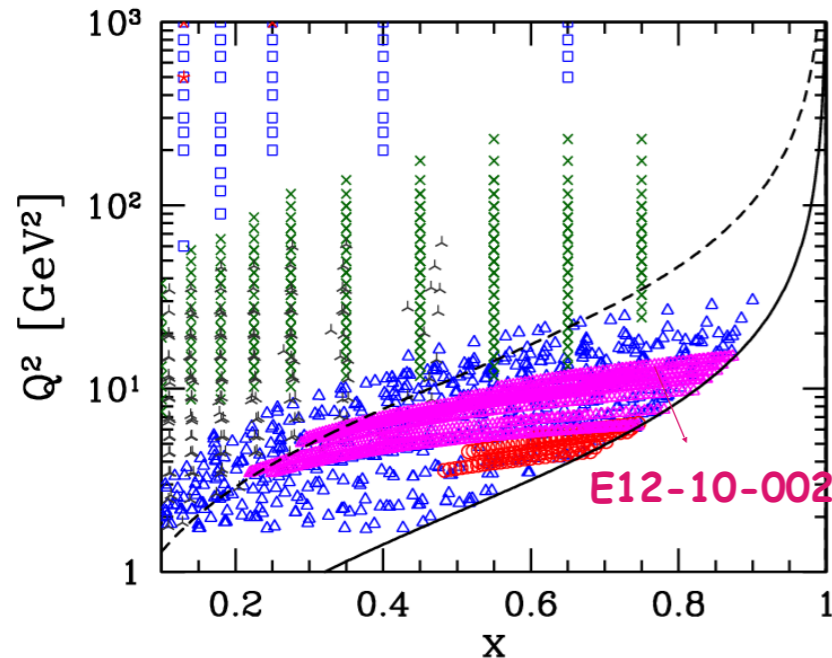
Goal : Better knowledge of F2 structure function specially at Large x



- Will provide us better understanding of the nucleon structure in terms of Parton Distribution function (PDF)
- Typical PDF's extraction still lacking in required precision at low and large X
- Relevant for studies of the non-perturbative dynamics of the nucleus : d/u ratio at $x = 1$ can give hints about quark confinements
- Important for the other experiments (e.g. at LHC) to subtract the QCD background

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$$\frac{d^2\sigma}{d\Omega dE'} = \frac{\alpha^2}{4E_0 \sin^4 \frac{\theta}{2}} \left[\frac{1}{\nu} F_2(x, Q^2) \cos^2 \frac{\theta}{2} + \frac{2}{M} F_1(x, Q^2) \sin^2 \frac{\theta}{2} \right]$$

$$\frac{d^2\sigma}{d\Omega dE'} = (N_{measured} - BG) \frac{1}{N_e N_t} \frac{1}{d\Omega dE'} \frac{1}{A} \frac{1}{\varepsilon}$$

Absolute cross-section
with radiative effect

Electrons

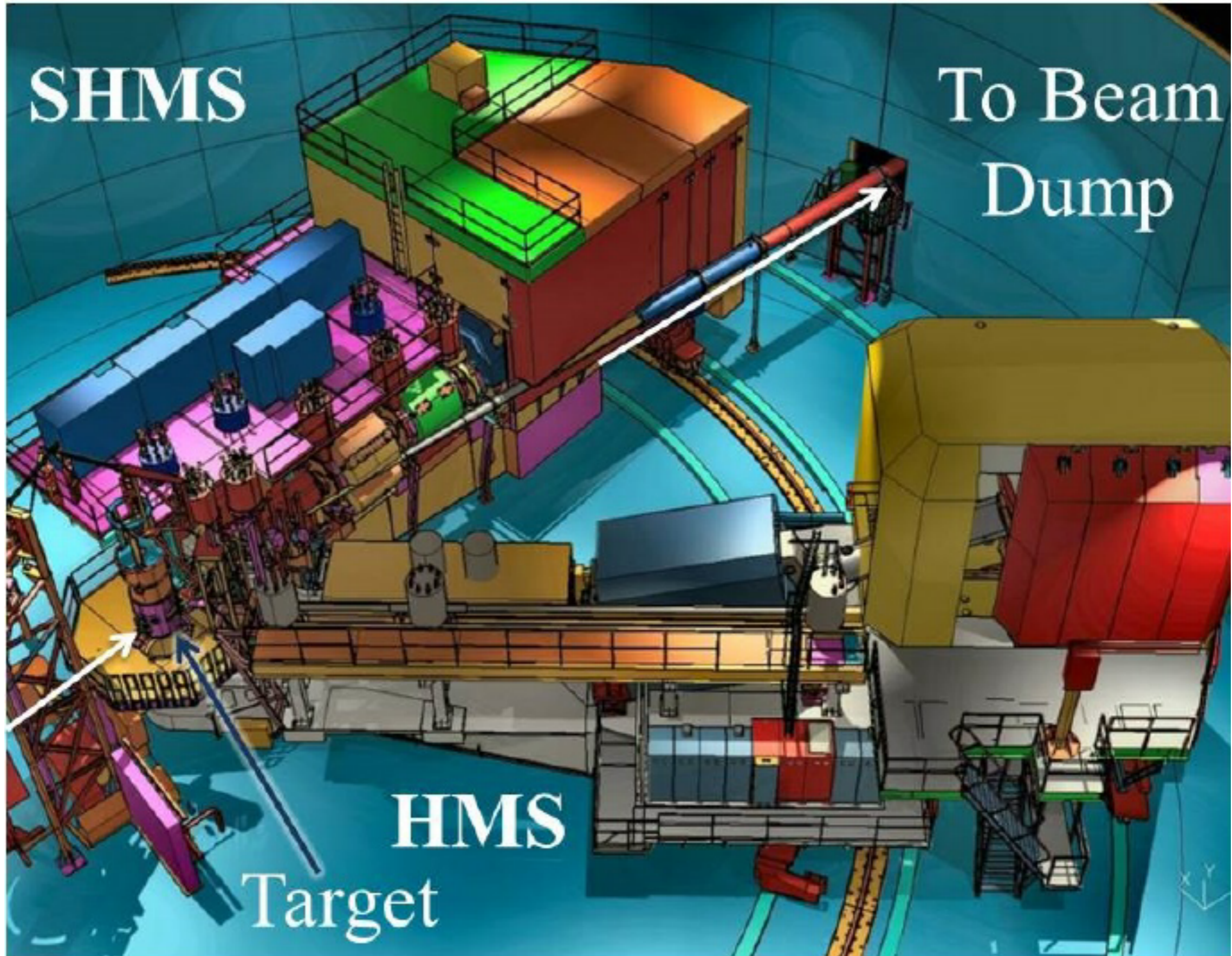
Background

acceptance

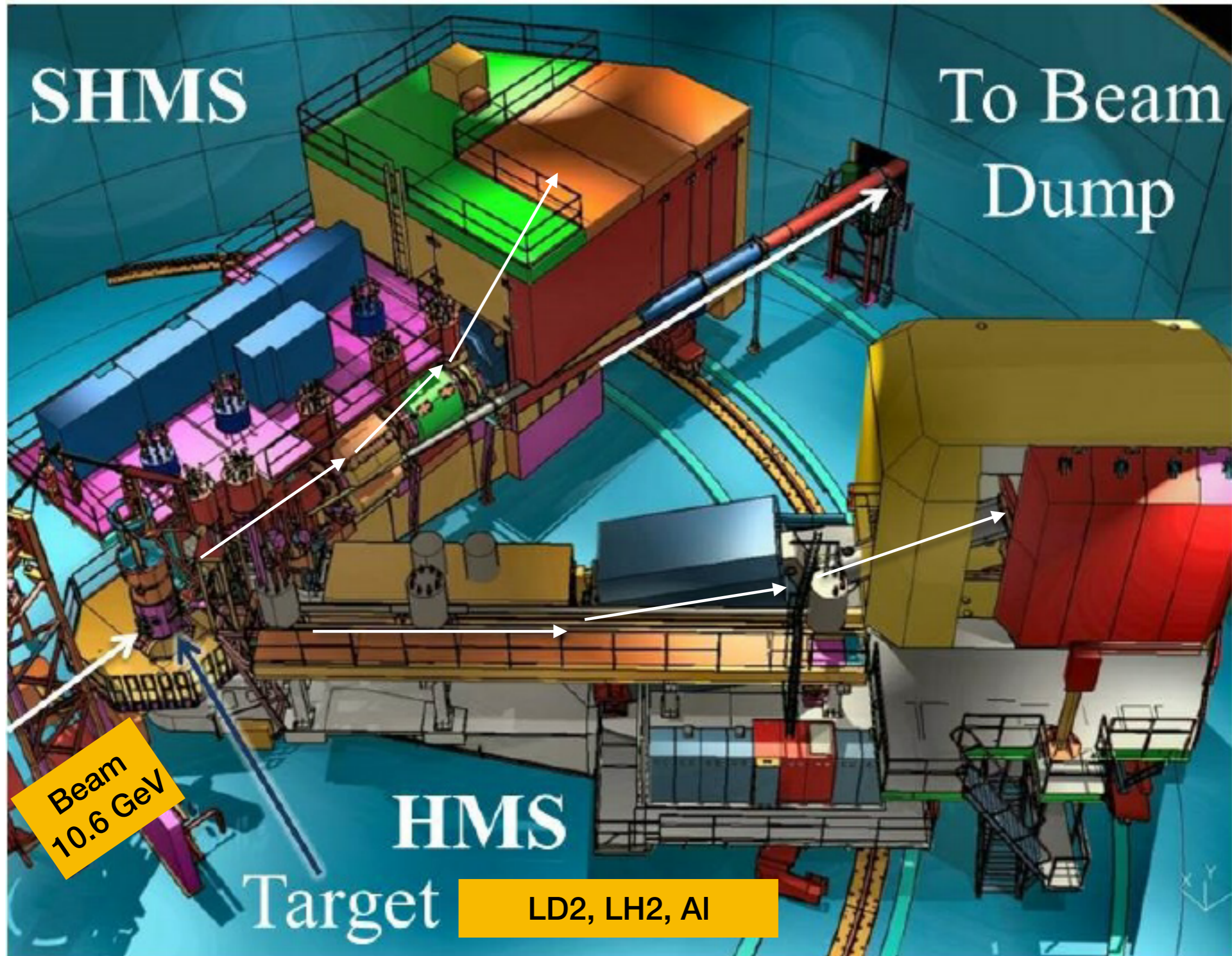
Experimental
Efficiency

- cryogenic target endcaps
- e- from decay of π^0 produced in the target
- contamination from pion response in PID

Jefferson Lab Hall C 12 GeV setup

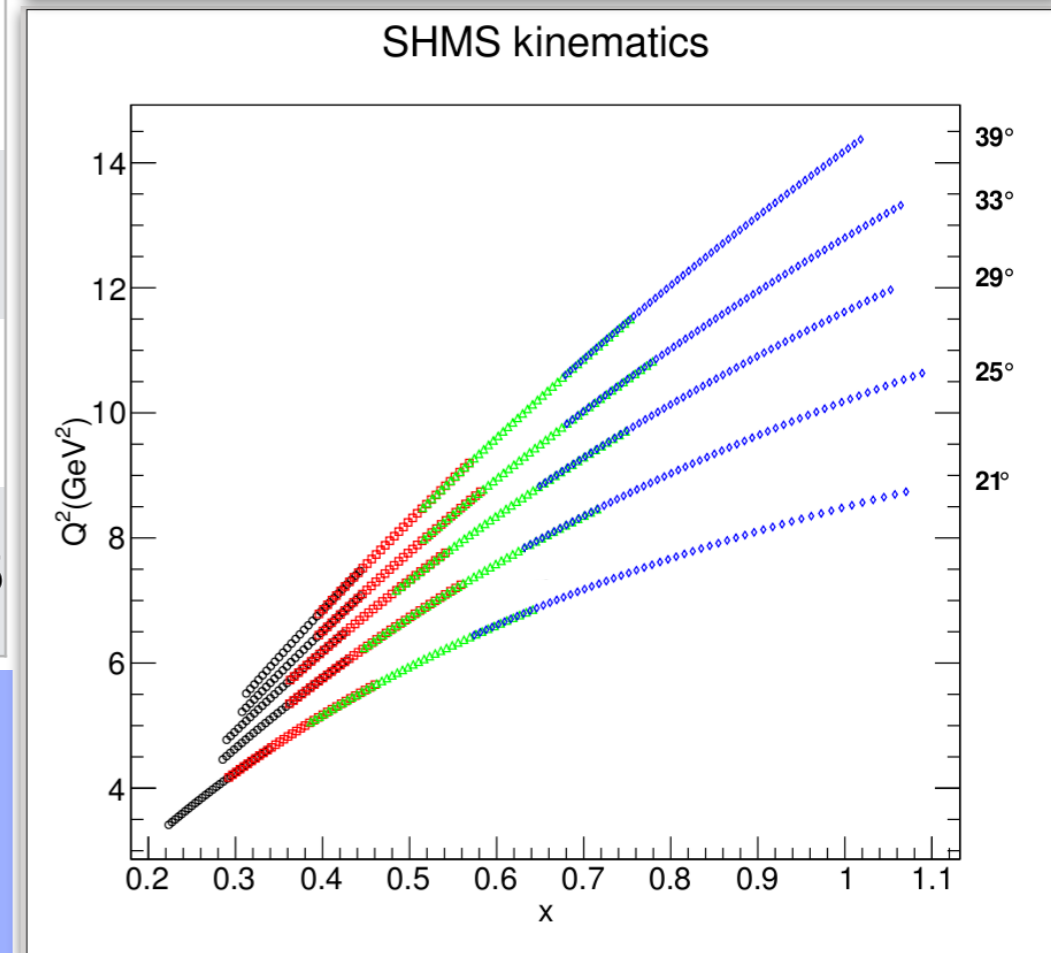
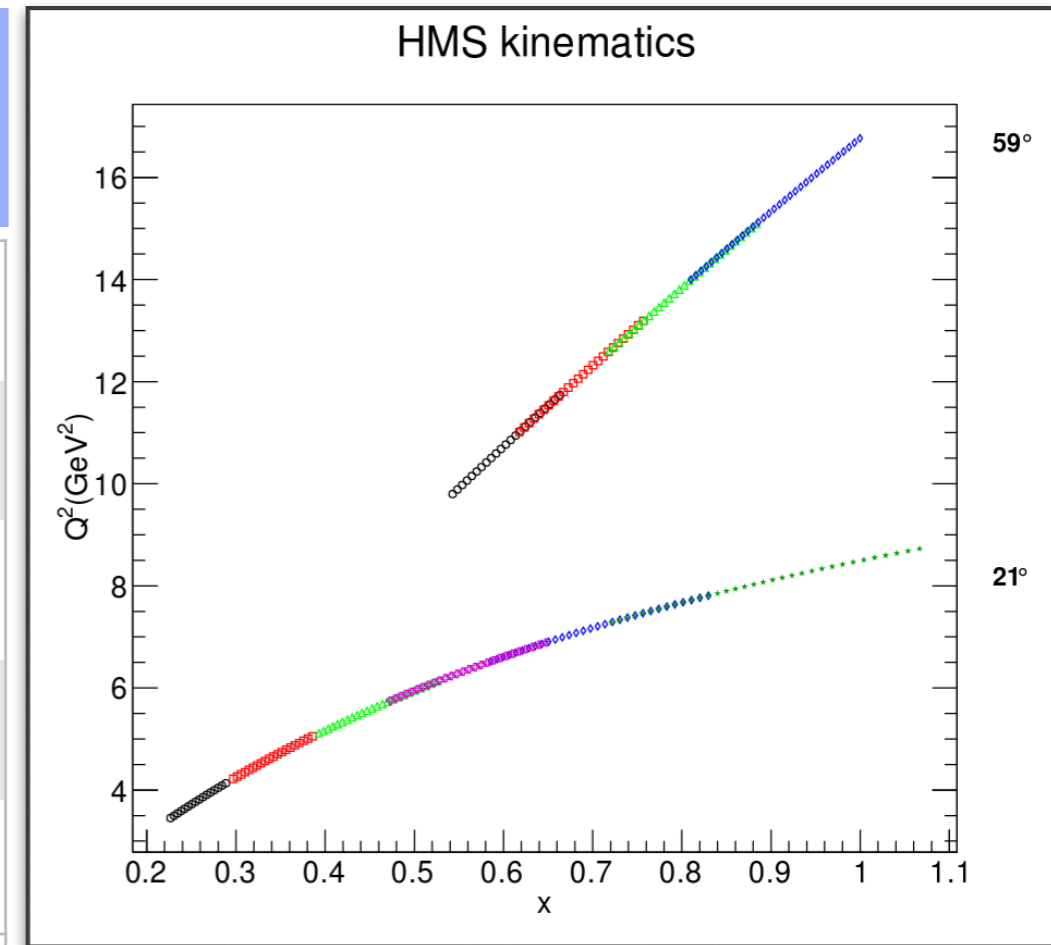


Jefferson Lab Hall C 12 GeV setup



Kinematics

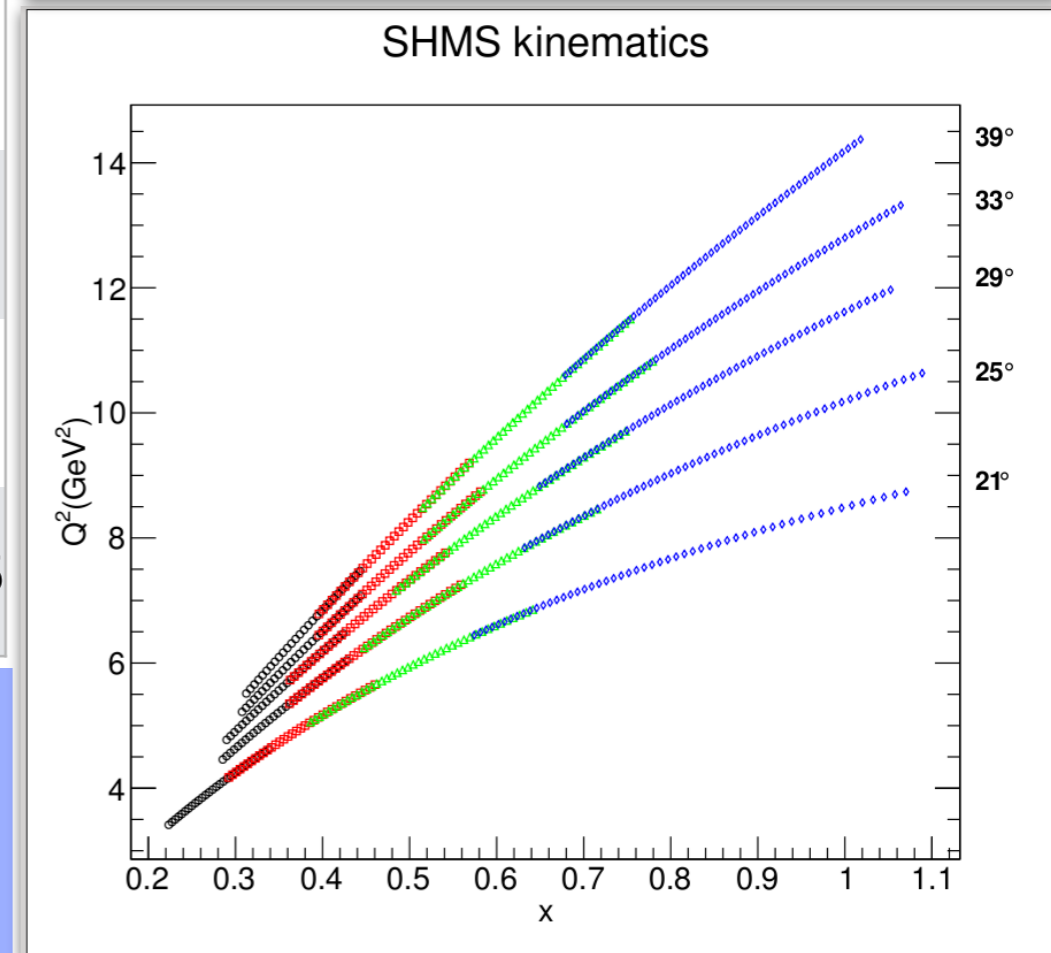
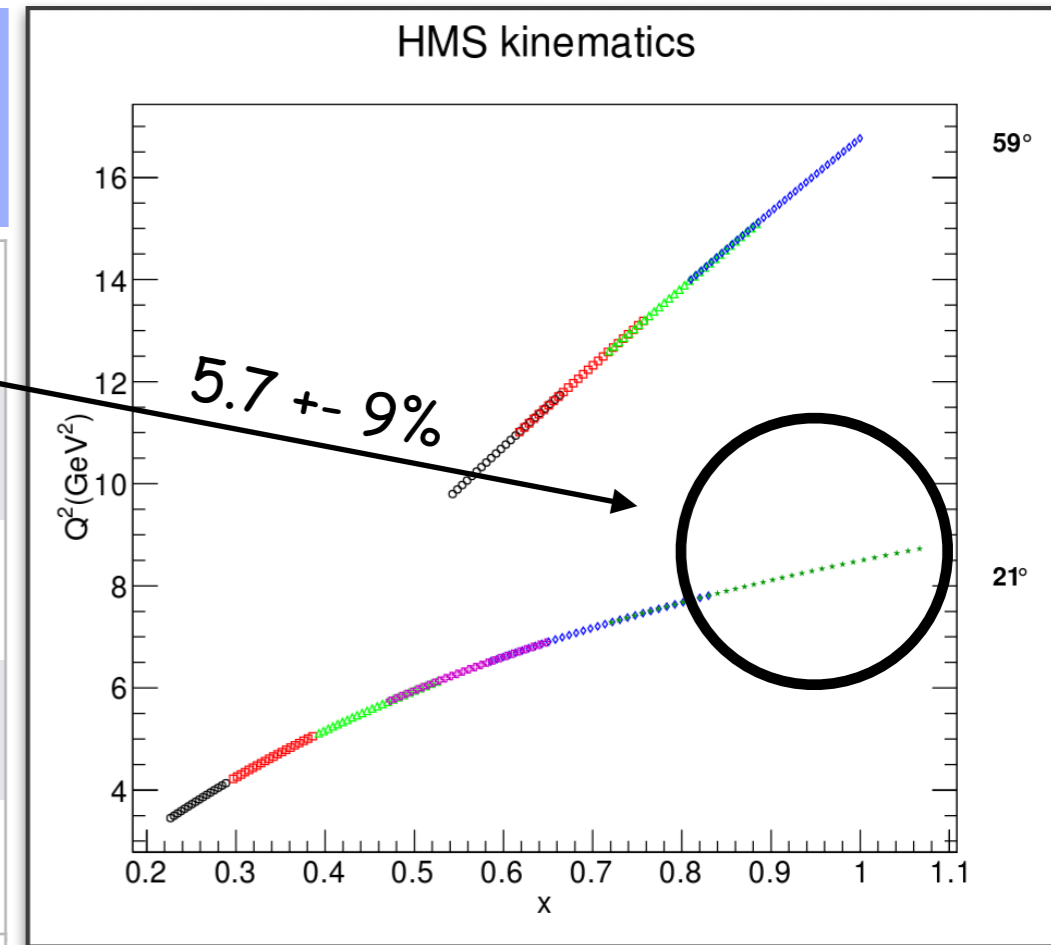
SHMS		HMS	
angle (deg)	momentum (GeV/C)	angle (deg)	momentum (GeV/C)
21	-5.1	21	-5.7
	-4.0		-5.1
	-3.3		-4.5
	-2.7		-4
24.98	-4.4	21	-3.3
	-3.5		-1.5
	-3.0		-1.35
	-2.5		-1.18
28.99	-3.7	59	-1.05
	-3		-1.18
	-2.4		-1.35
	-2		-1.5
32.985	-4.4	59	-1.5
	-3.5		-1.35
	-3.0		-1.18
	-2.5		-1.05
39	-3.7	59	-1.5
	-3		-1.35
	-2.4		-1.18
	-2		-1.05



Achieved 100% statistics goal for the all kinematic setting : LH2, LD2, Al

Kinematics

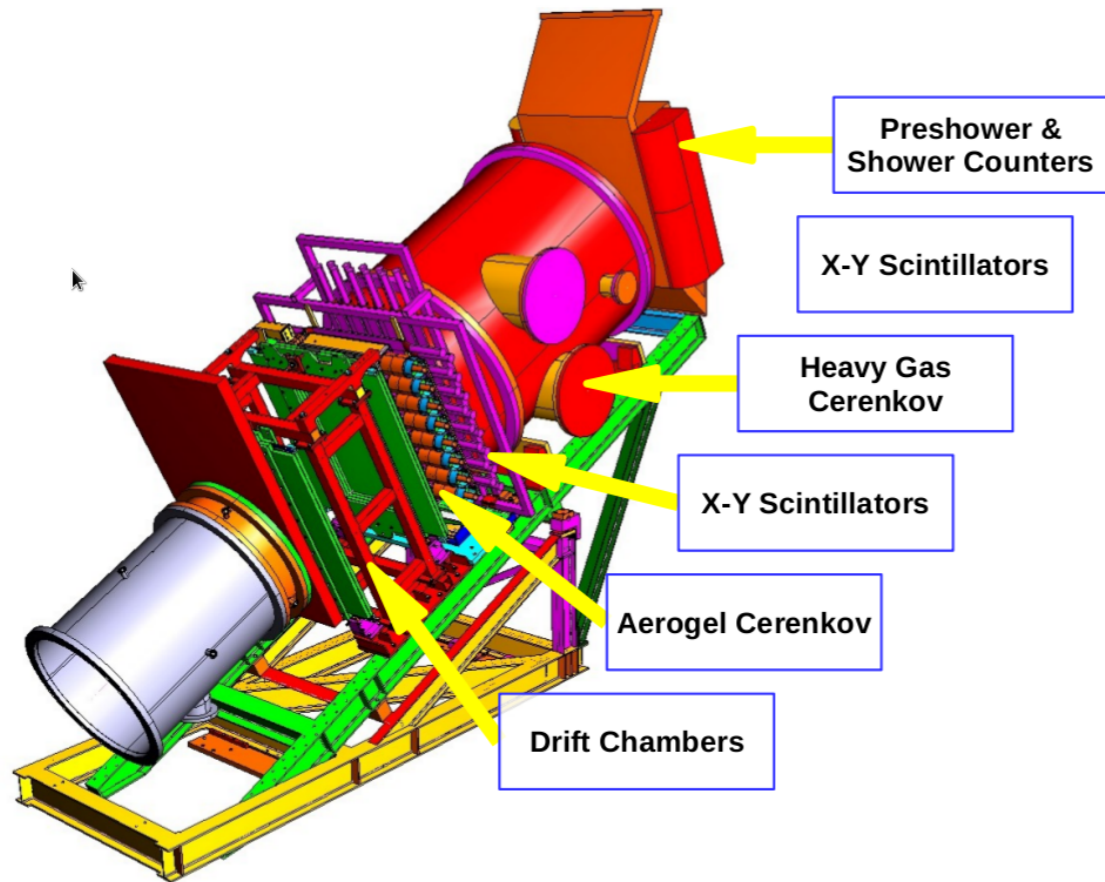
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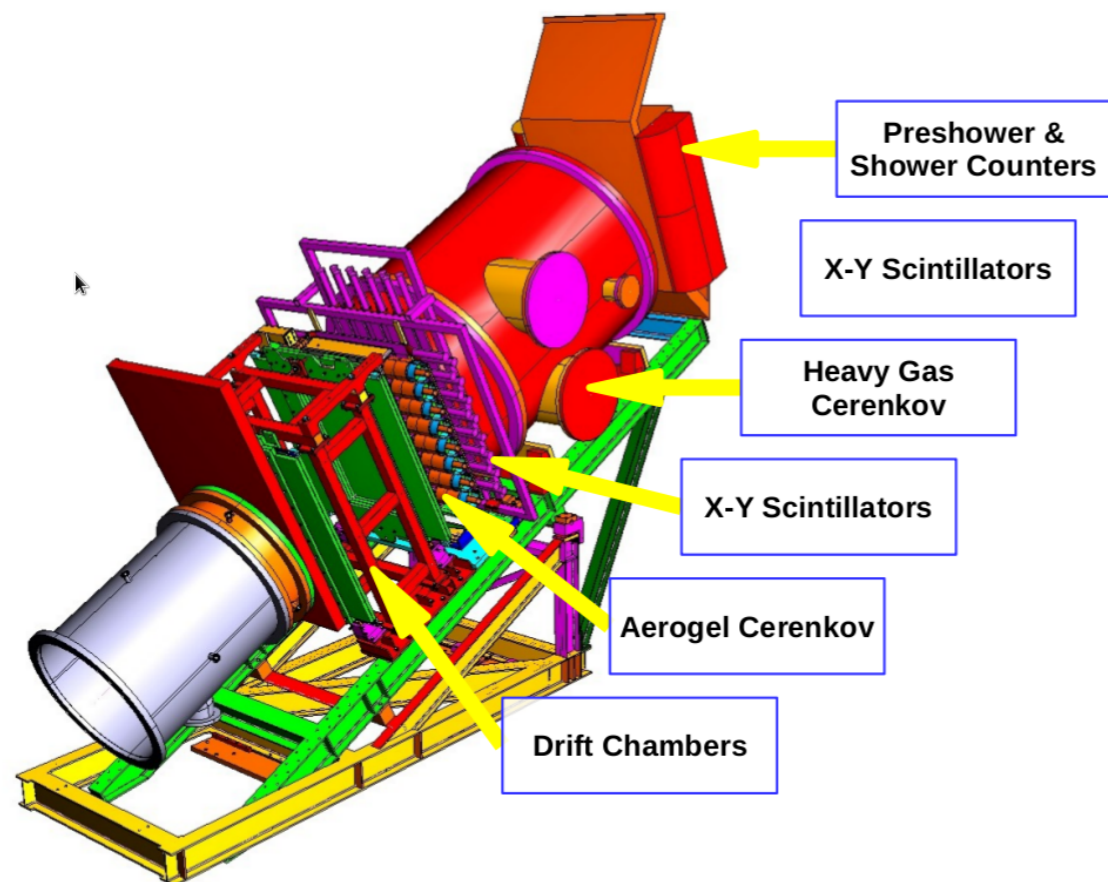
HMS Detector Package

Particle Detectors inside the HMS

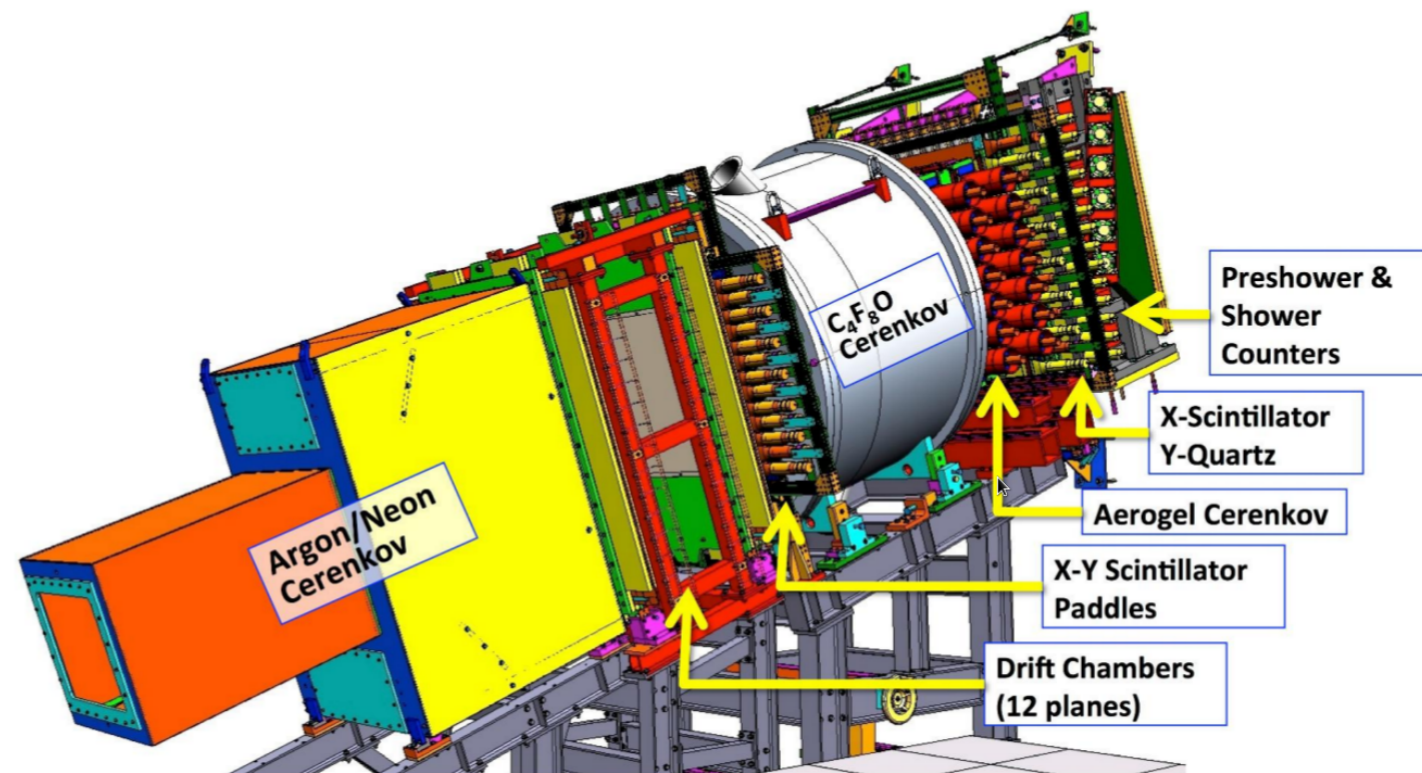


HMS & SHMS Detector Package

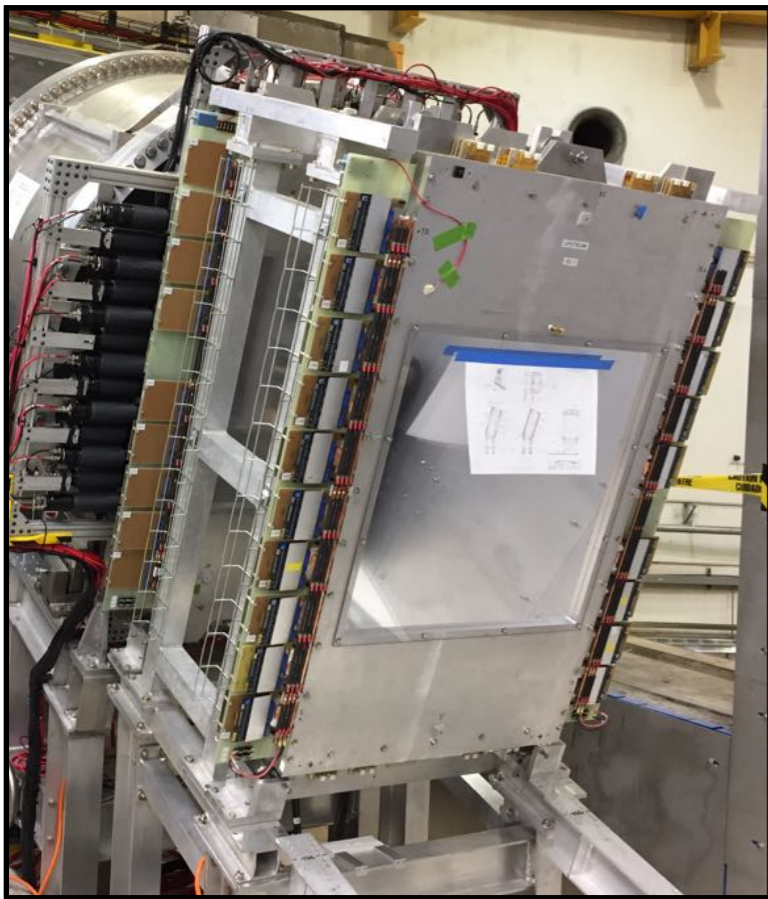
Particle Detectors inside the HMS



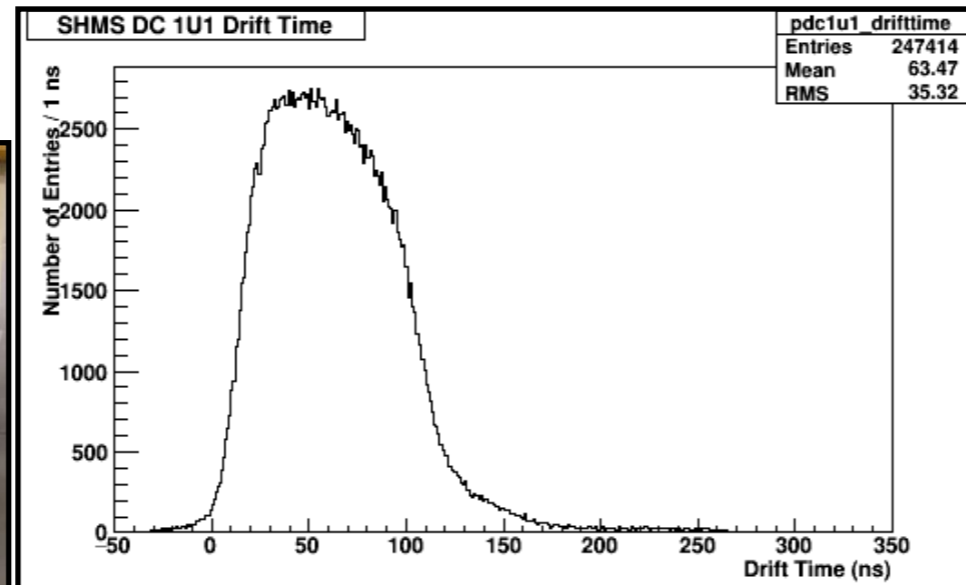
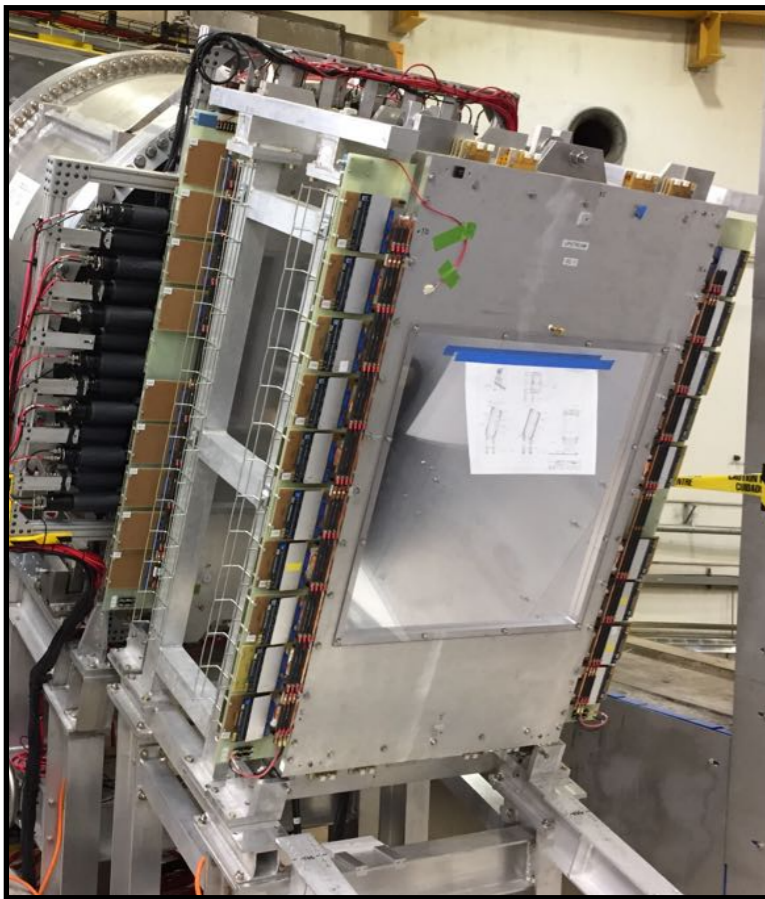
Particle Detectors inside the SHMS



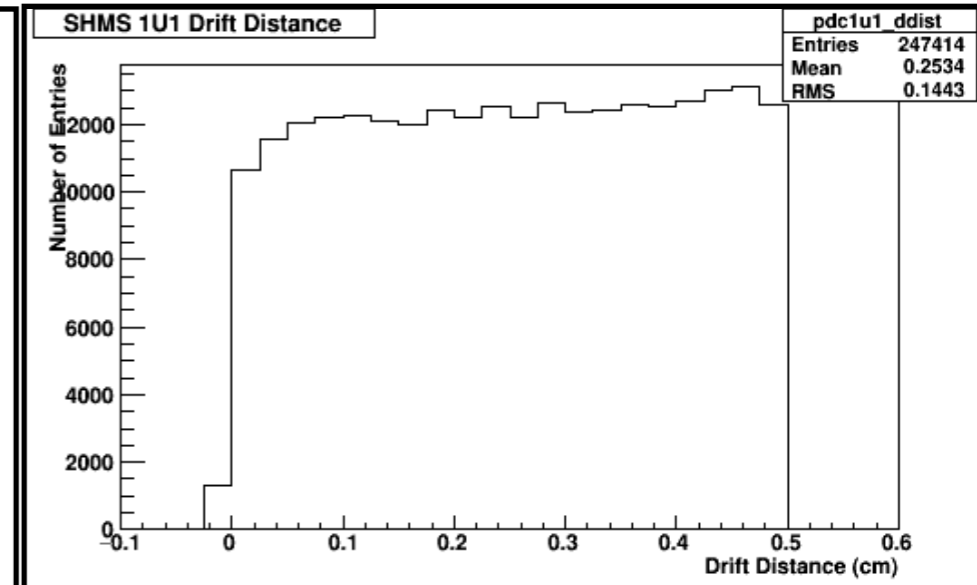
SHMS Drift Chambers Performance



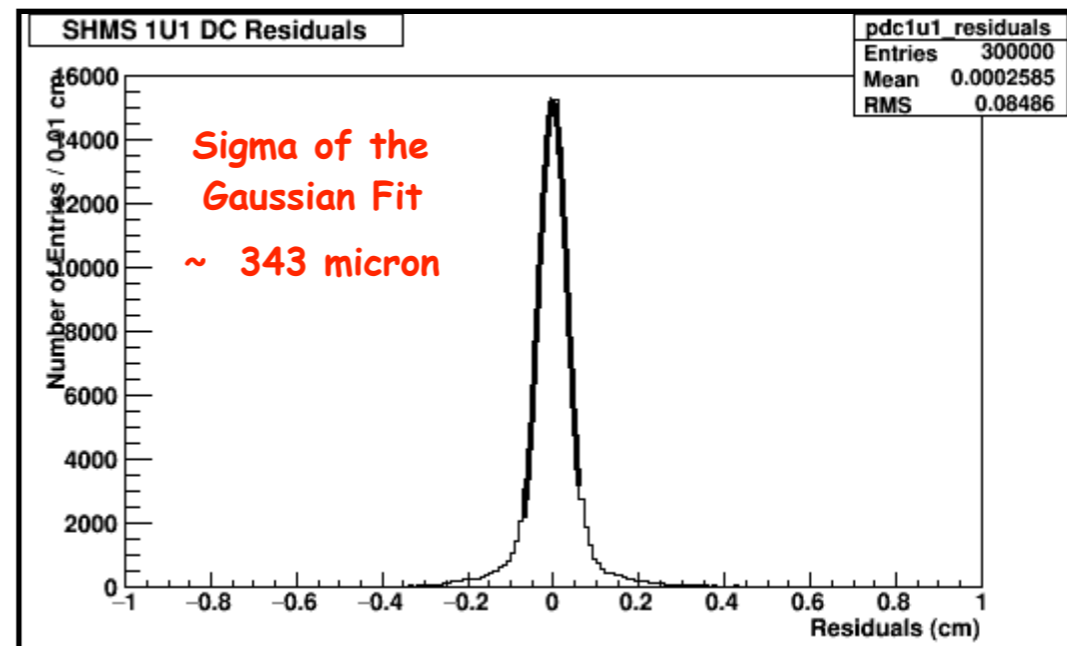
SHMS Drift Chambers Performance



Drift time for ionized electrons

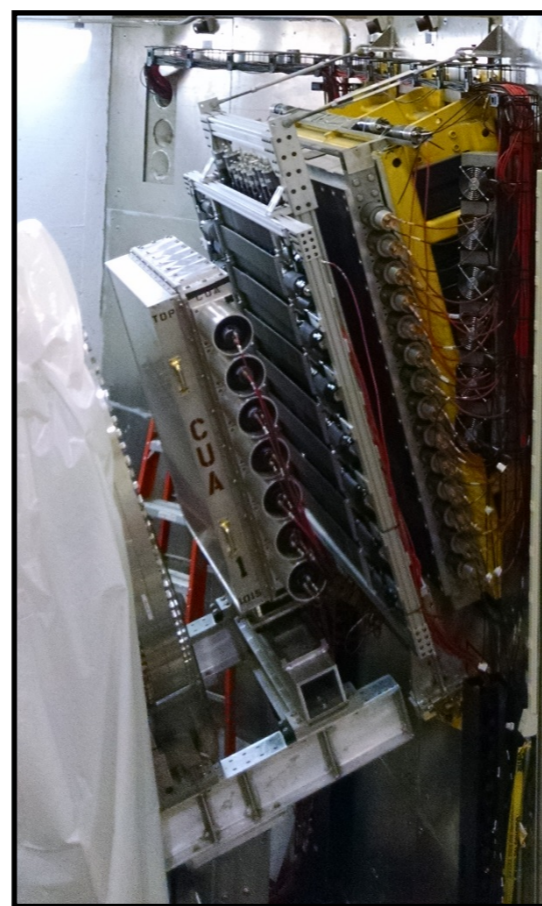
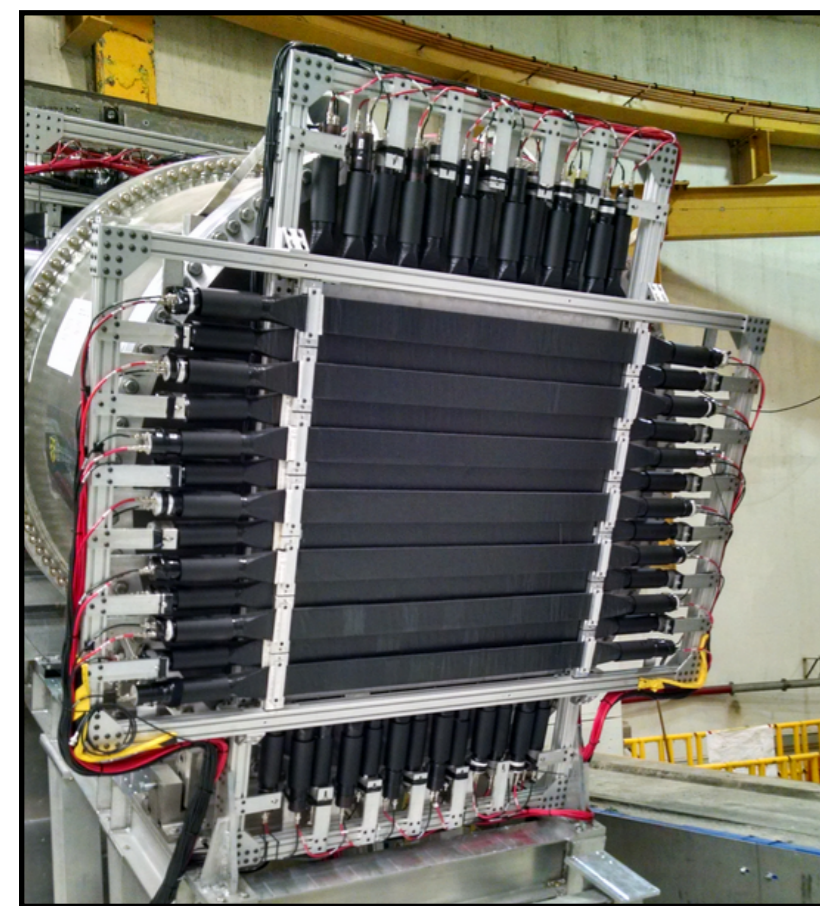


Converted to drift distance from wire

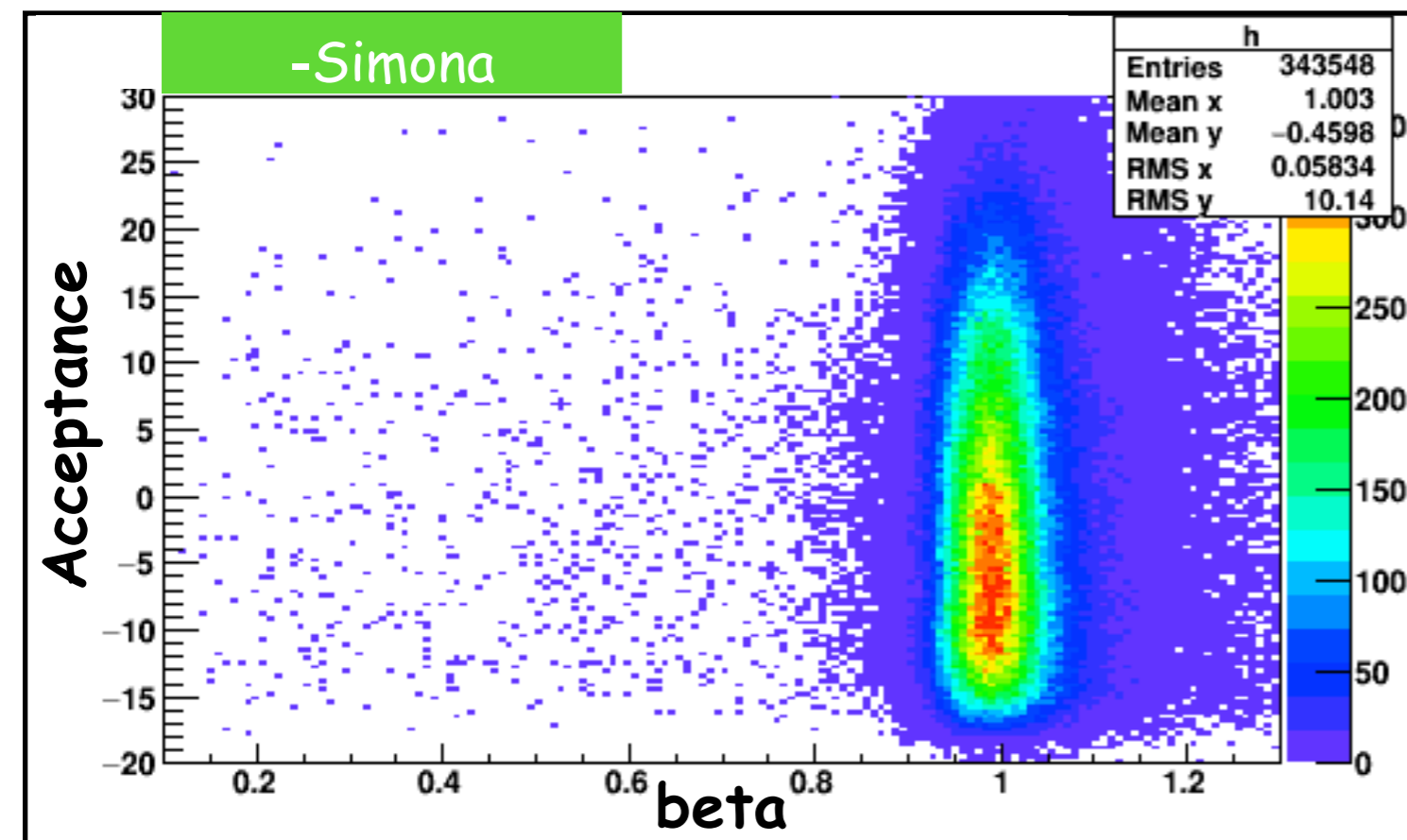


Residual = track - wire position

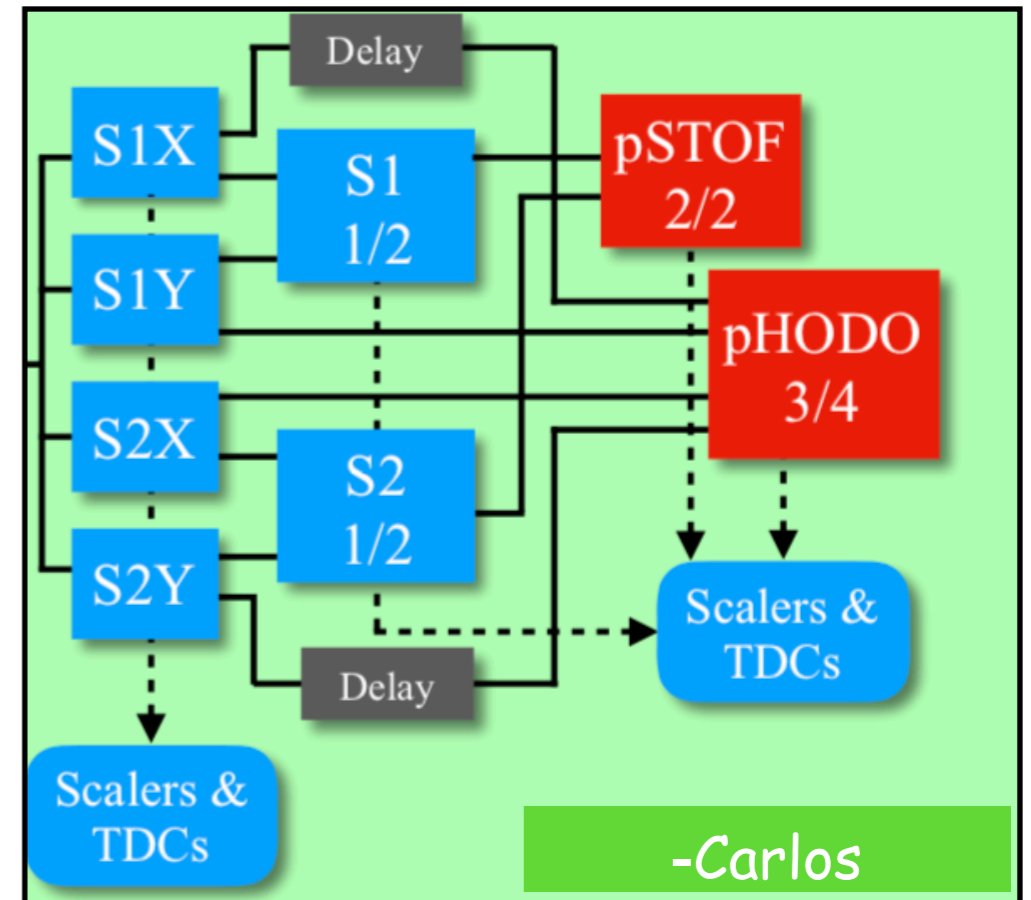
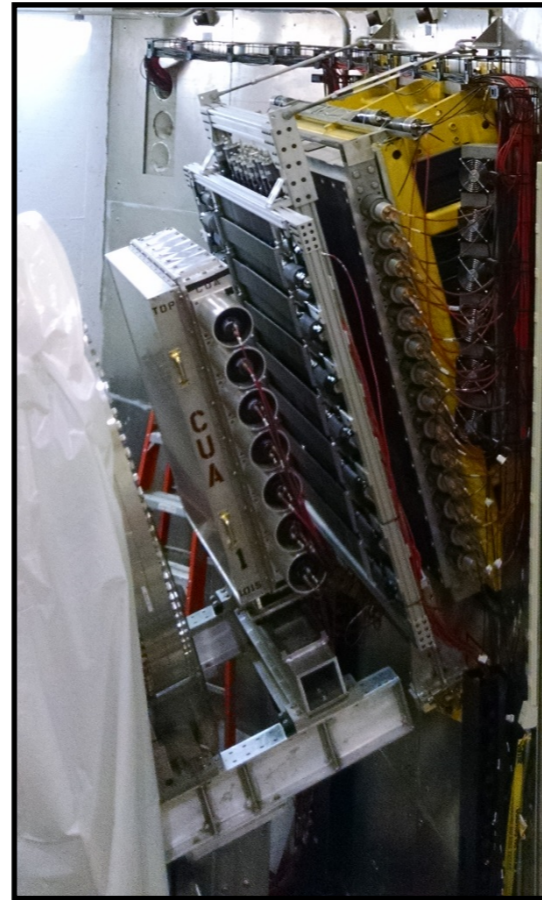
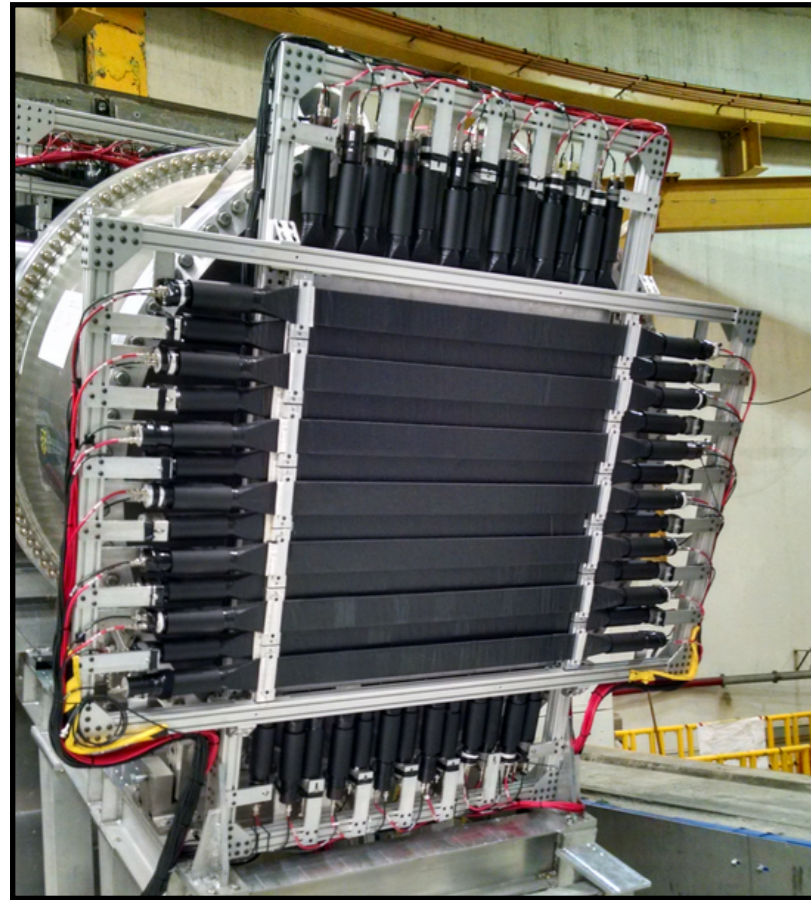
Hodoscope & Trigger



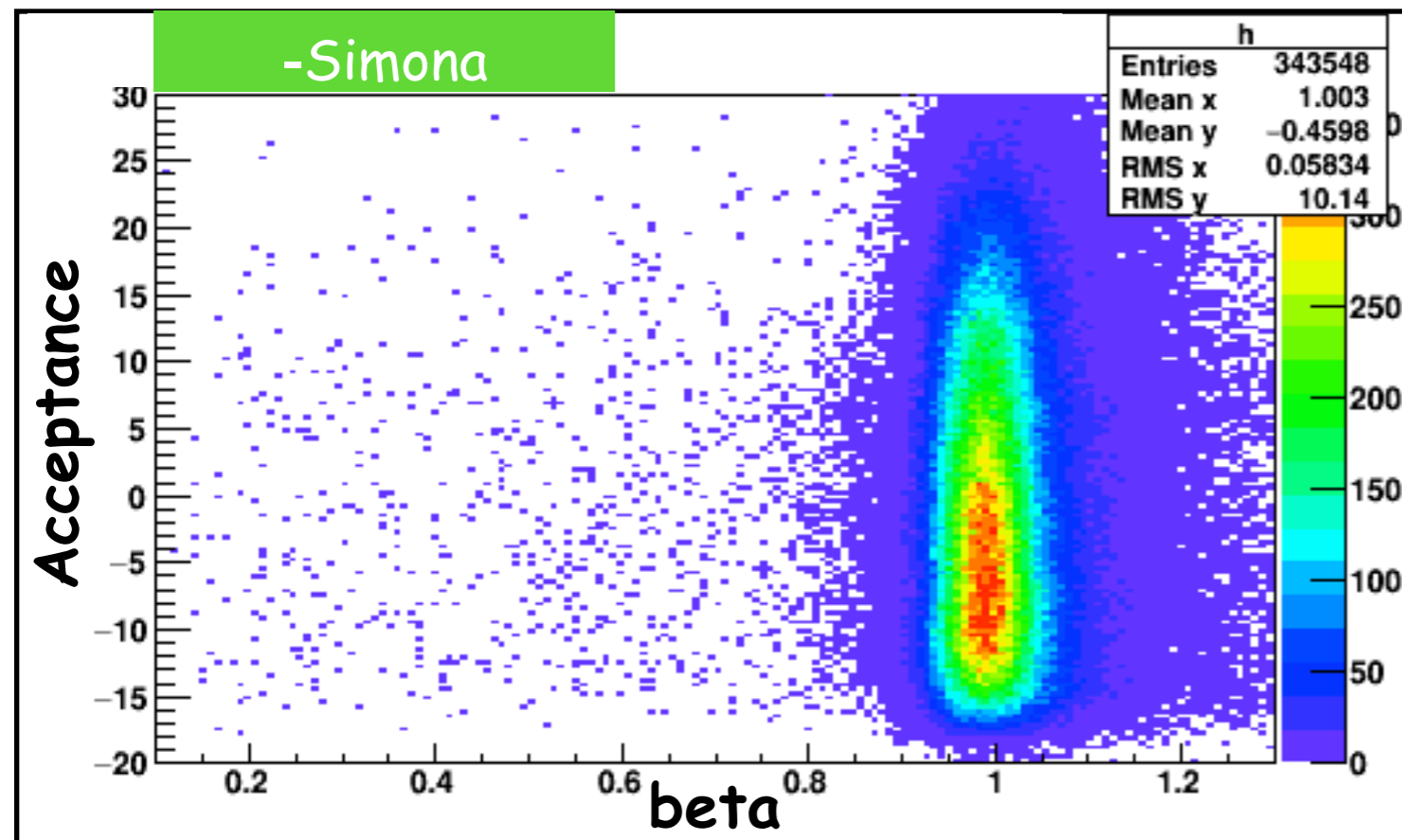
Good timing resolution from Hodoscopes better than 0.4 ns



Hodoscope & Trigger



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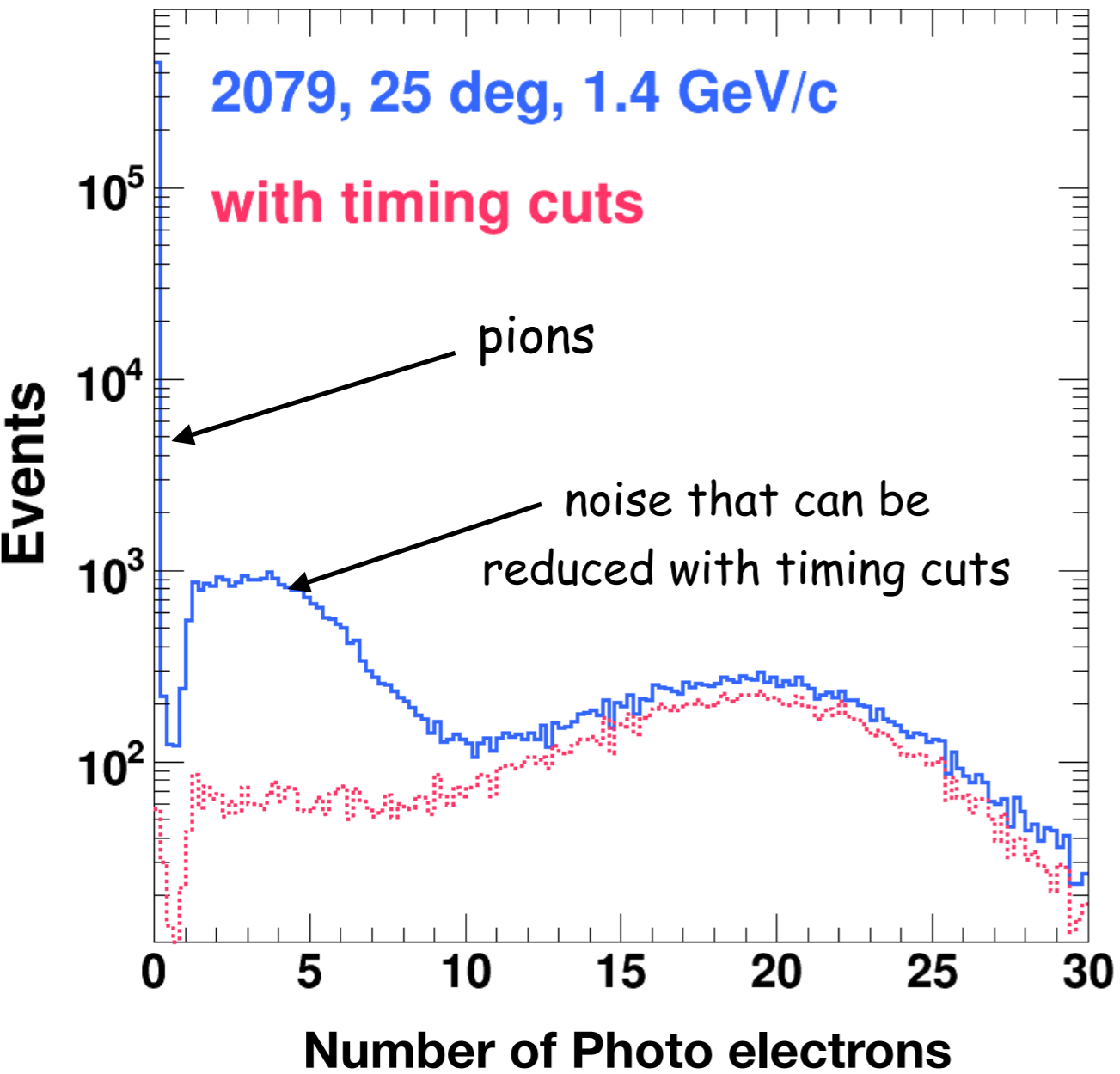
Electron Trigger

- Coincidence of multiple scintillator planes (plus PID elements)
- High efficiency of electrons (>99%)

Particle identification detectors

Nobel Gas Cherenkov

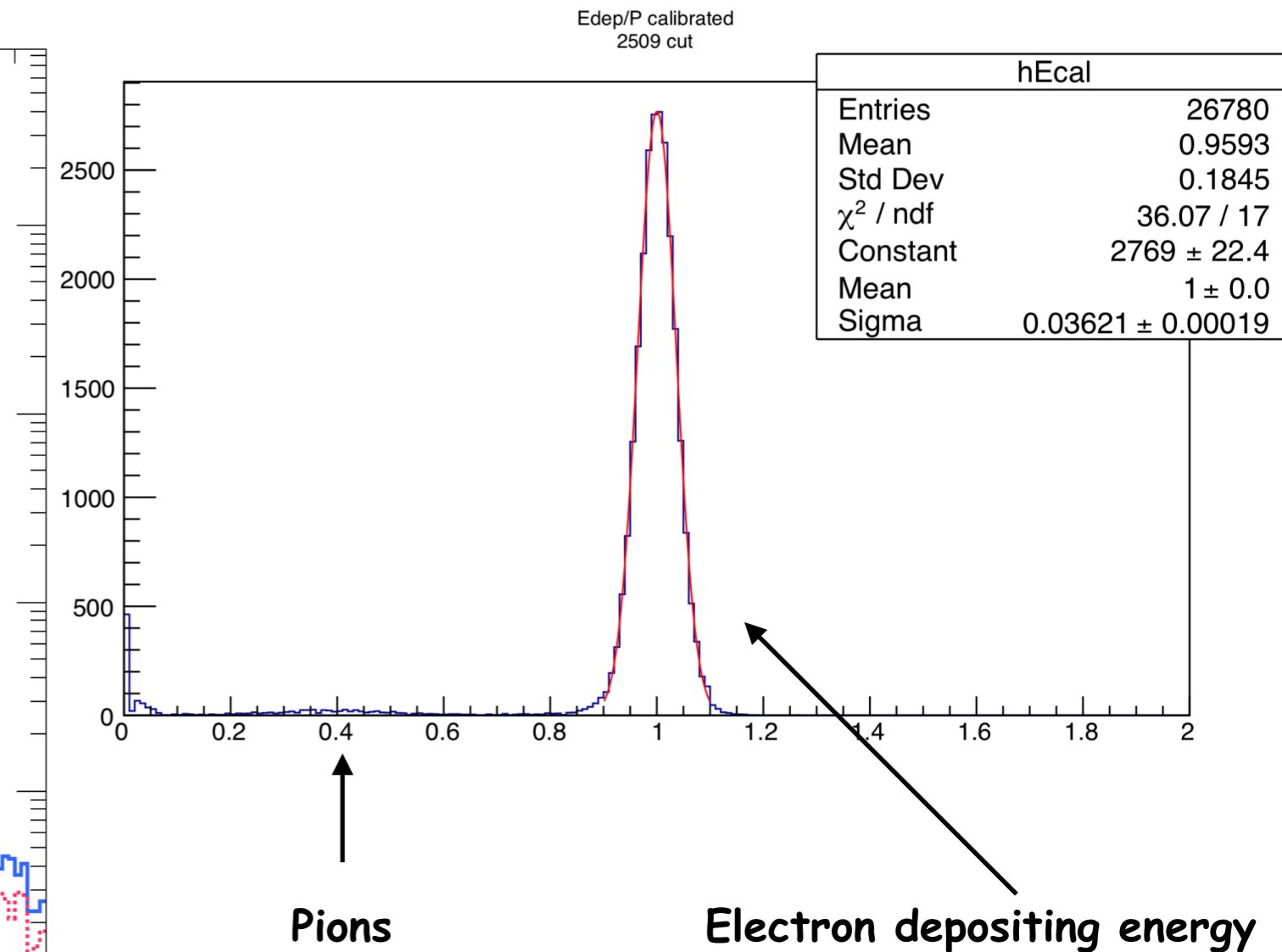
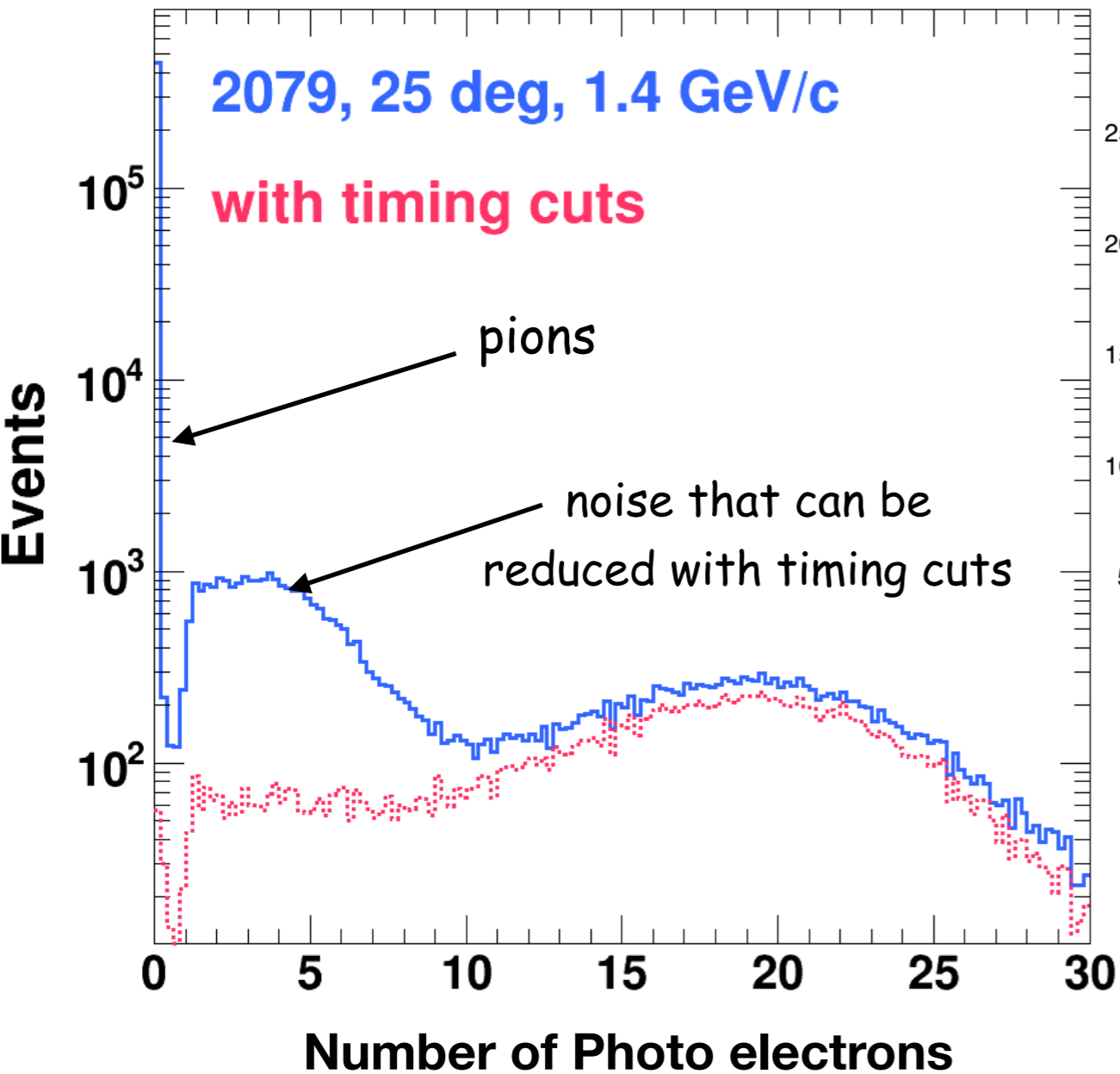
-simona



Particle identification detectors

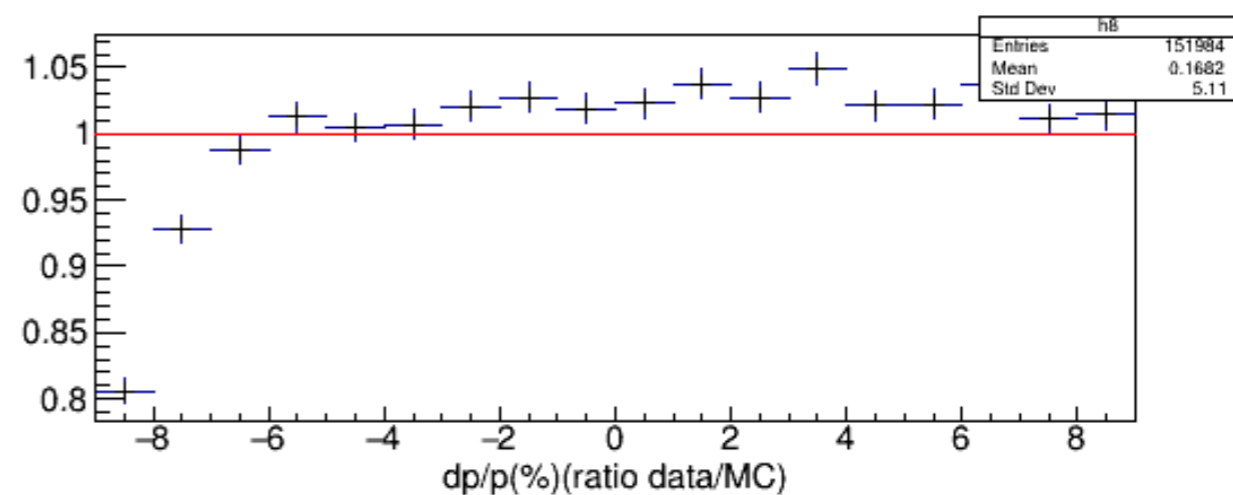
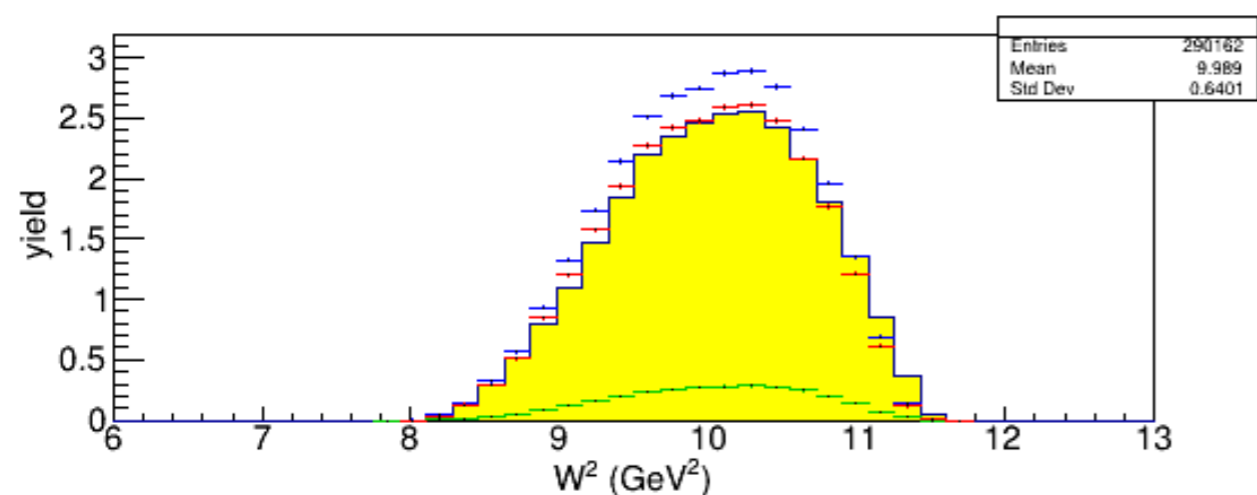
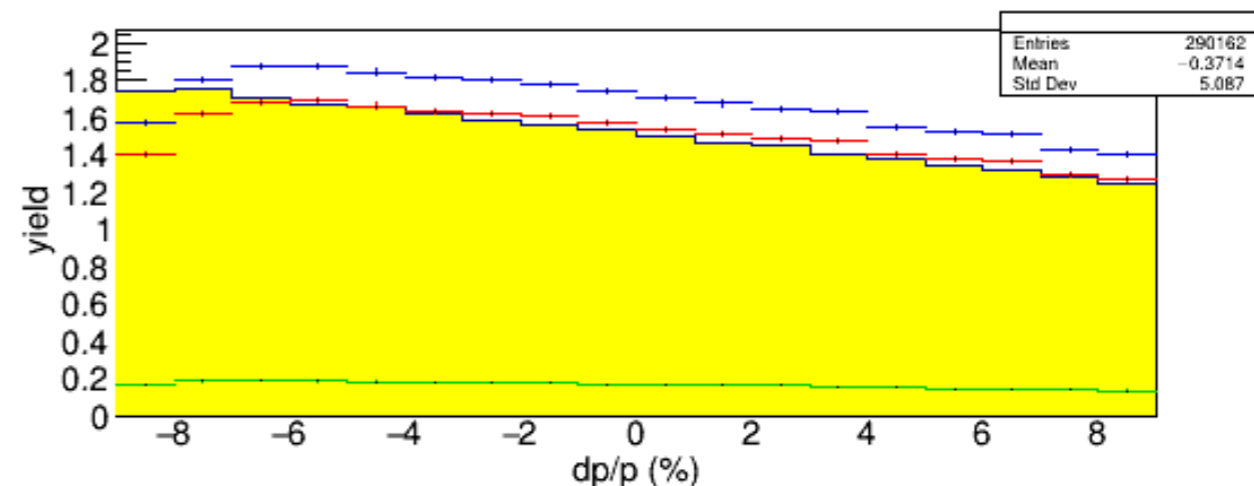
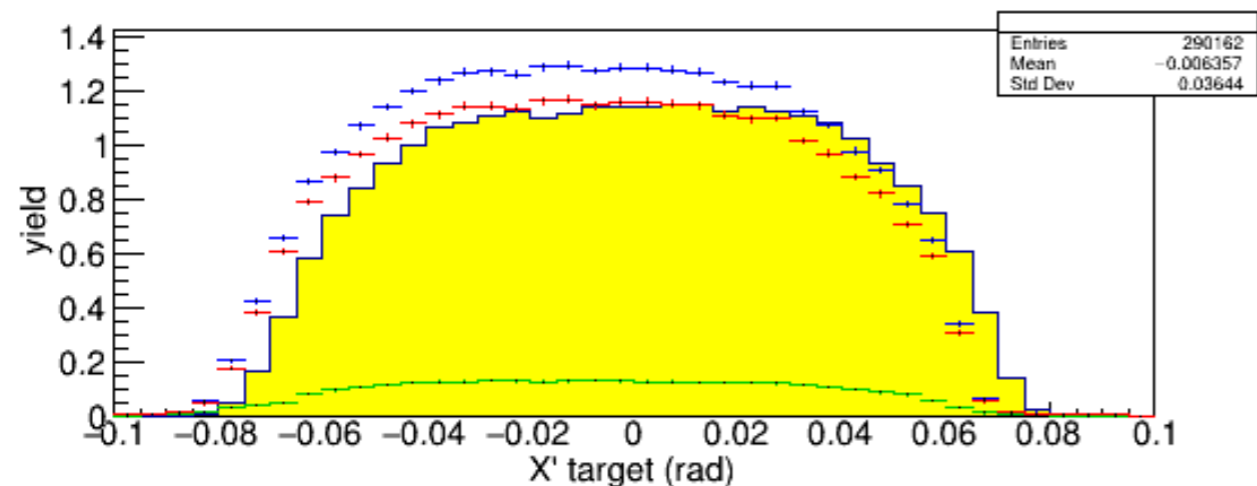
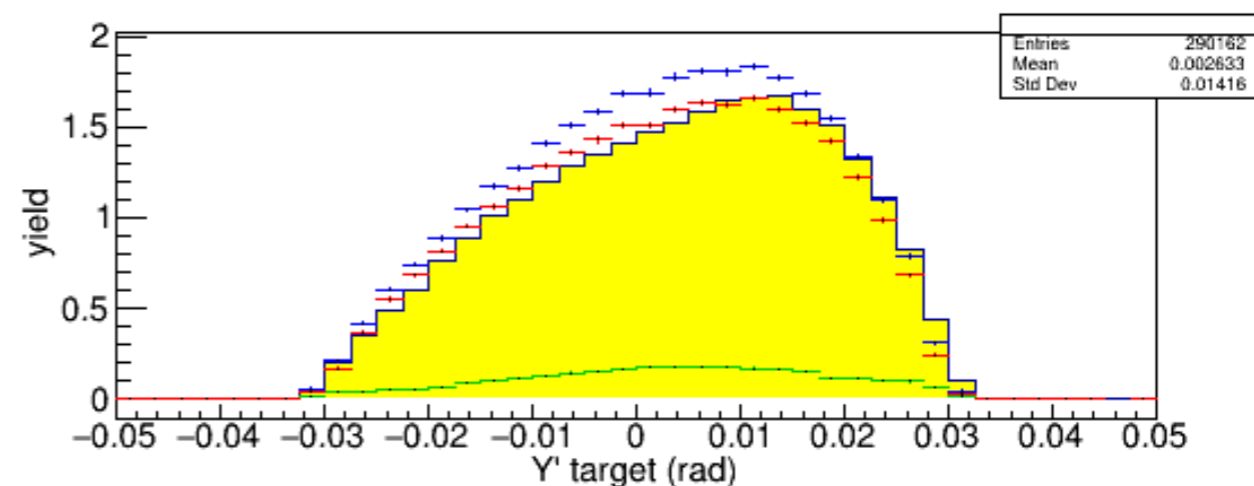
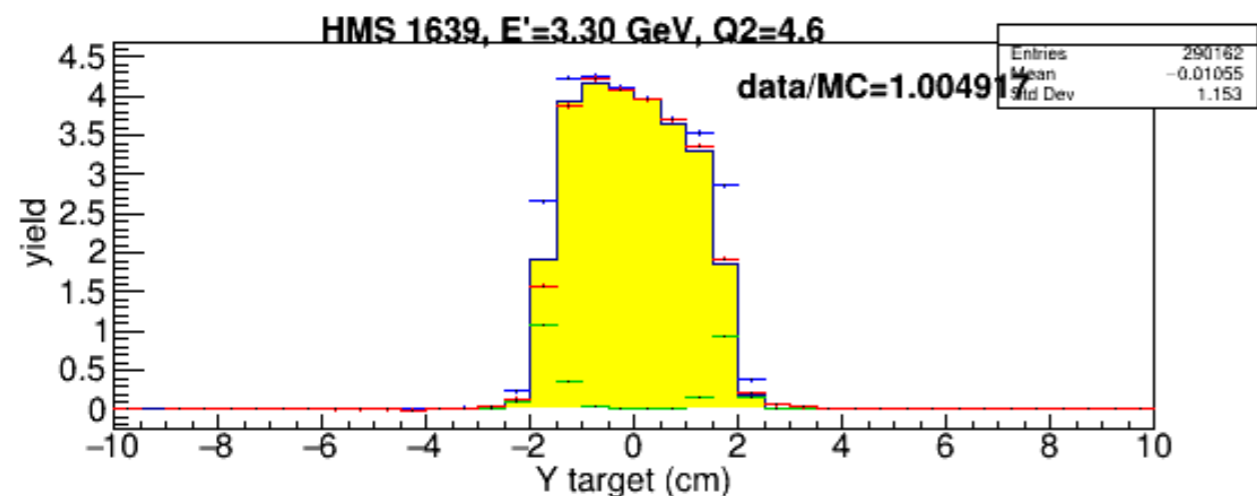
Nobel Gas Cherenkov
-simona

Calorimeter
-Fernando



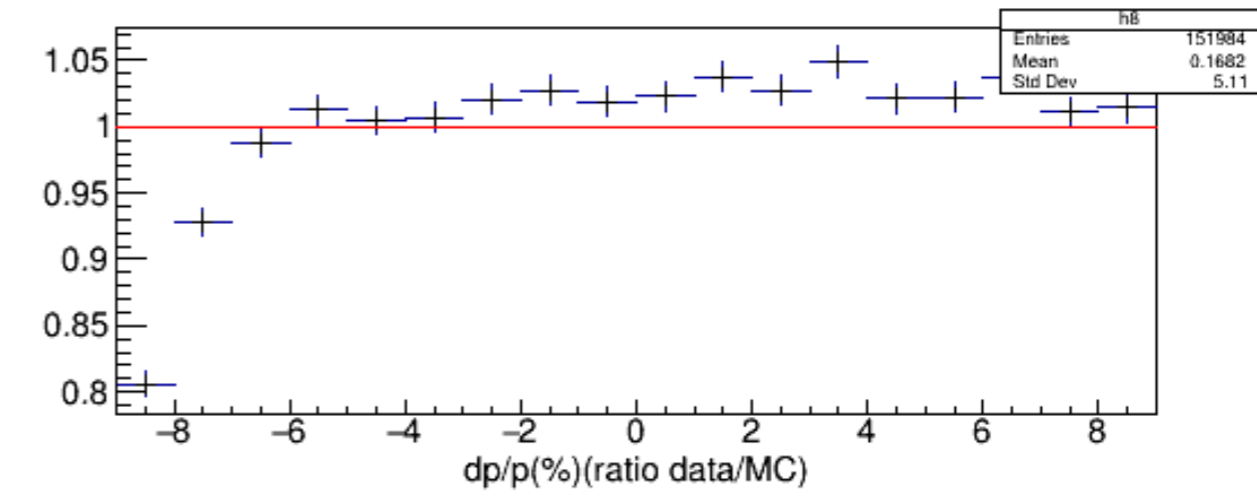
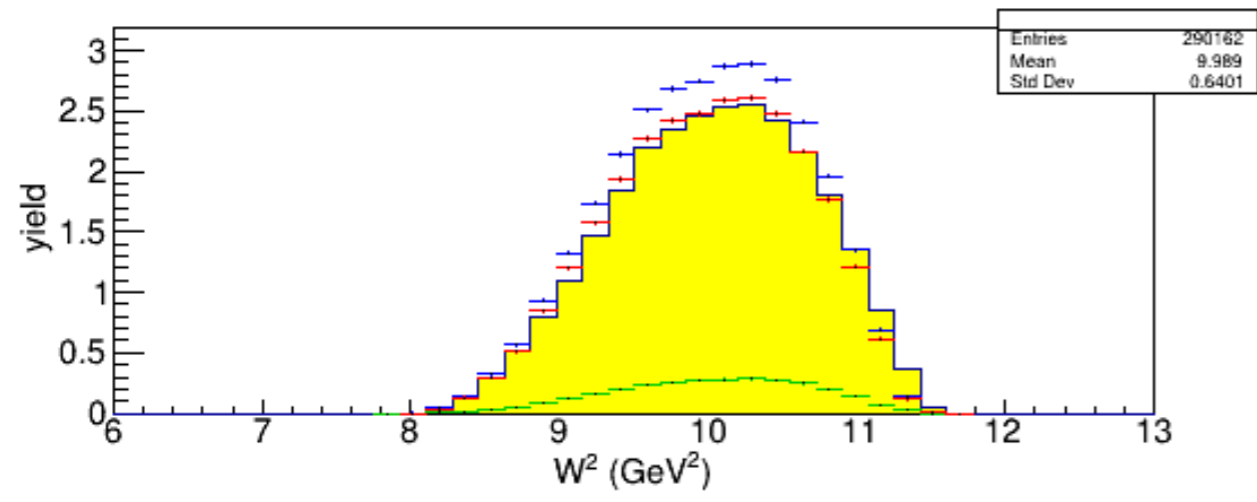
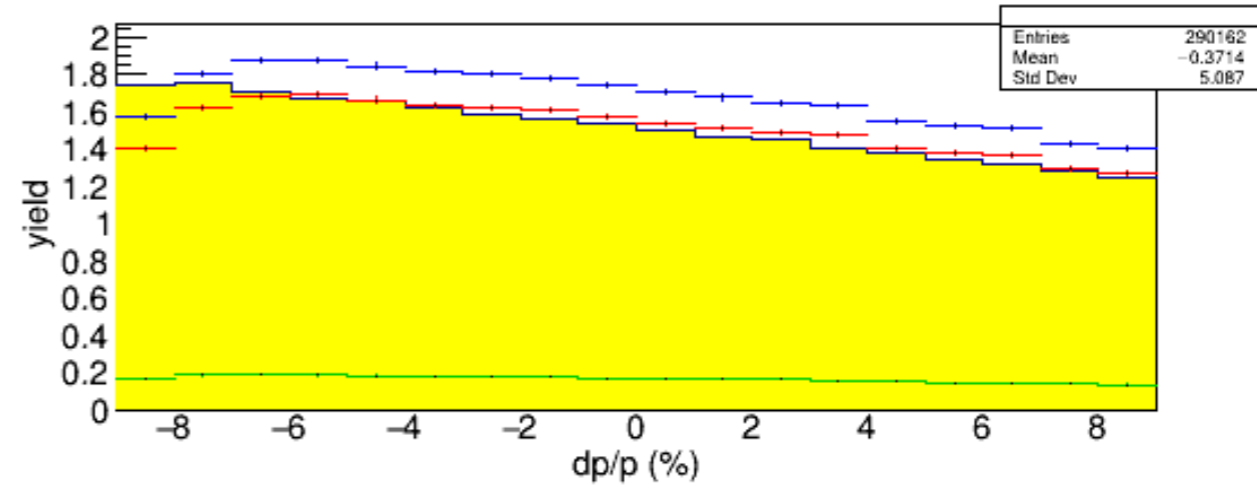
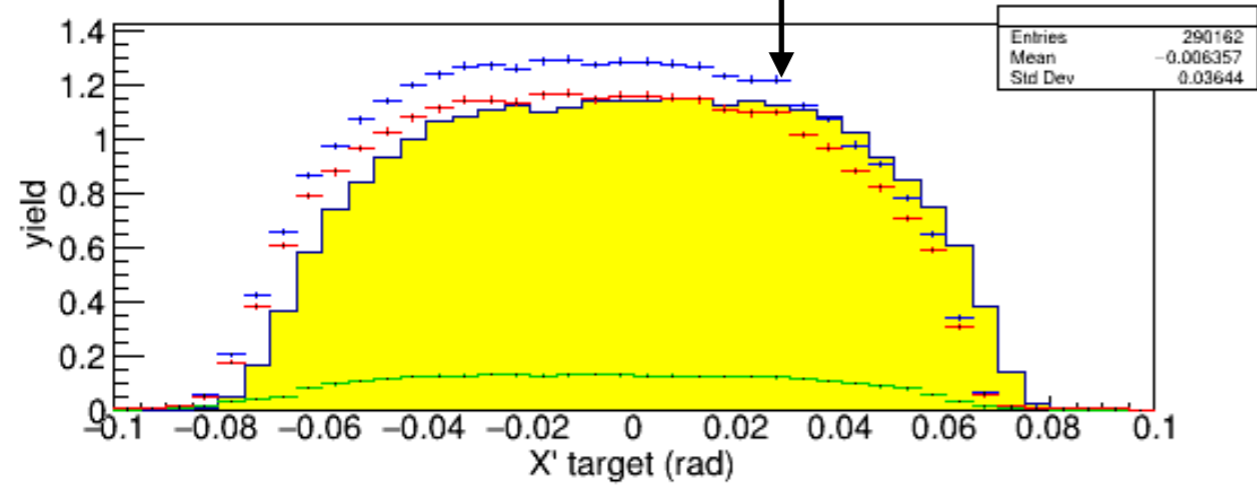
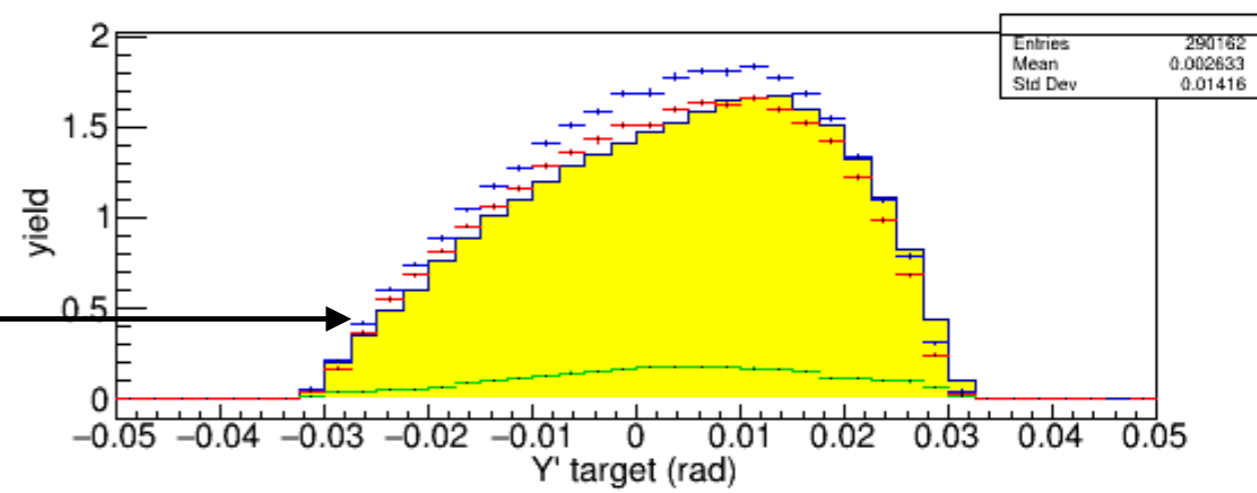
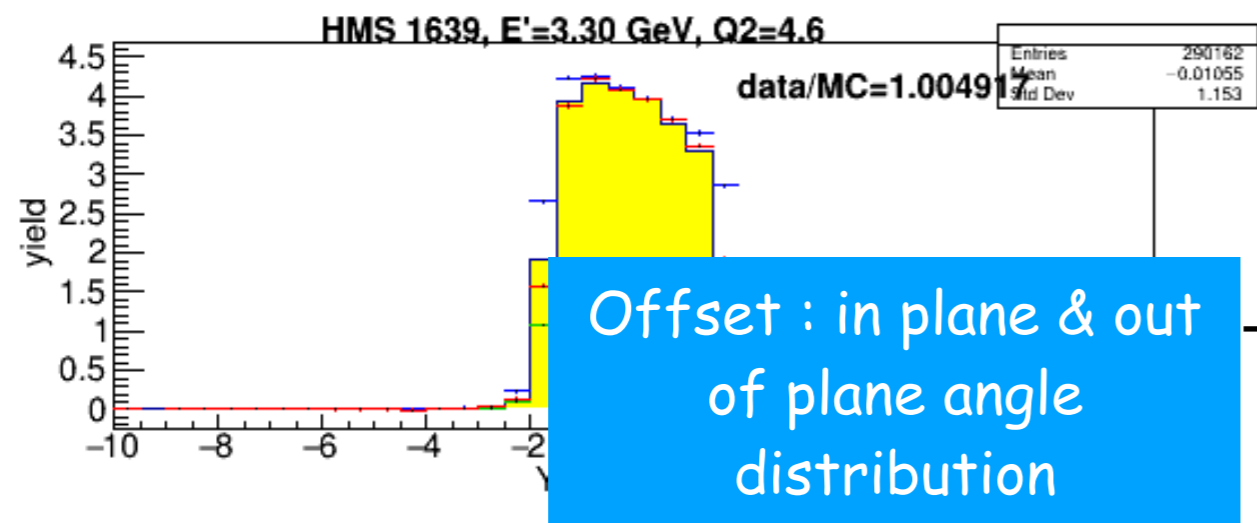
Data-MC comparison : HMS

-Abel



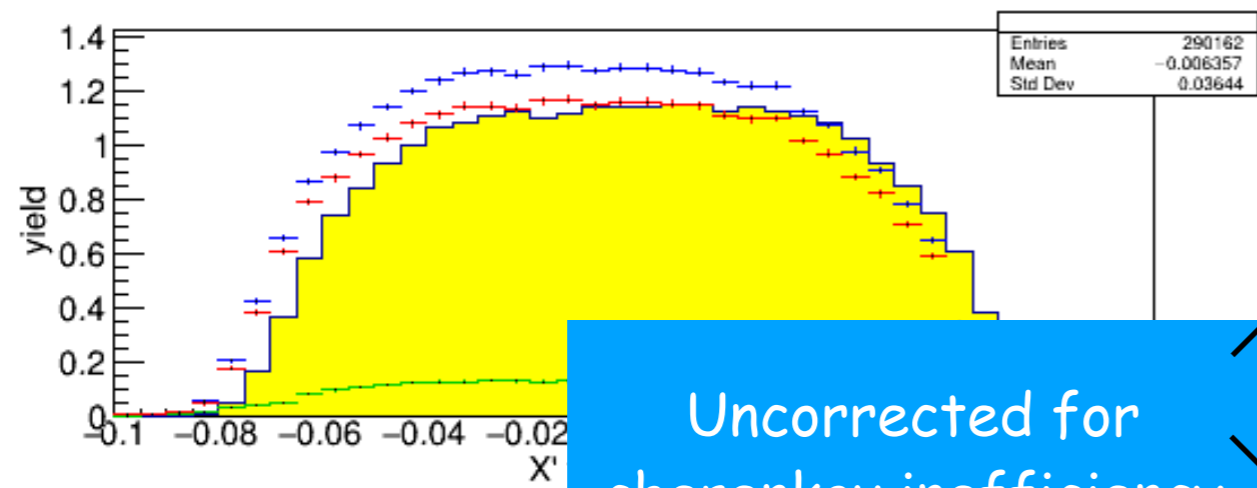
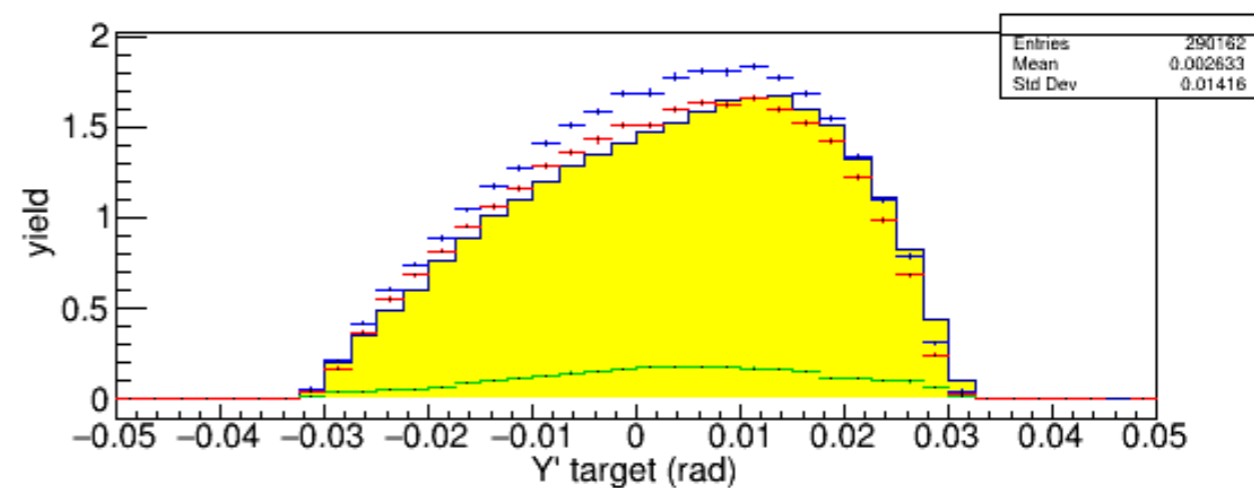
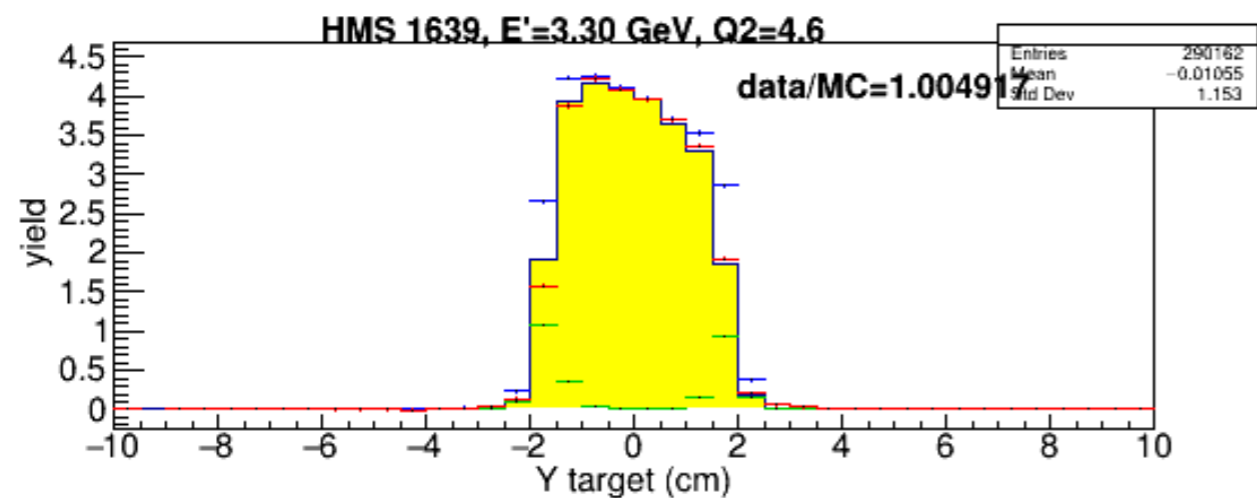
Data-MC comparison : HMS

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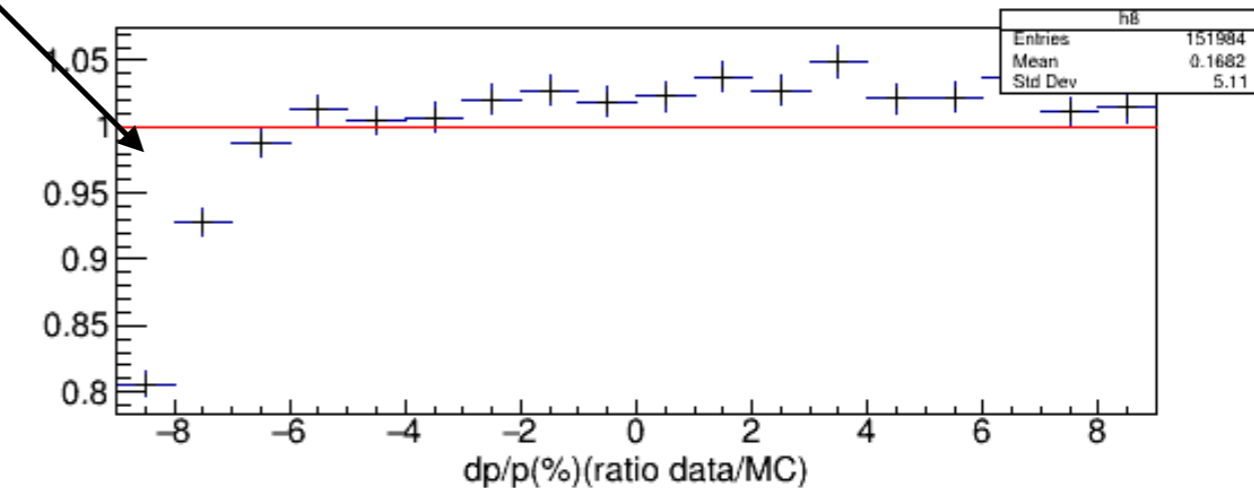
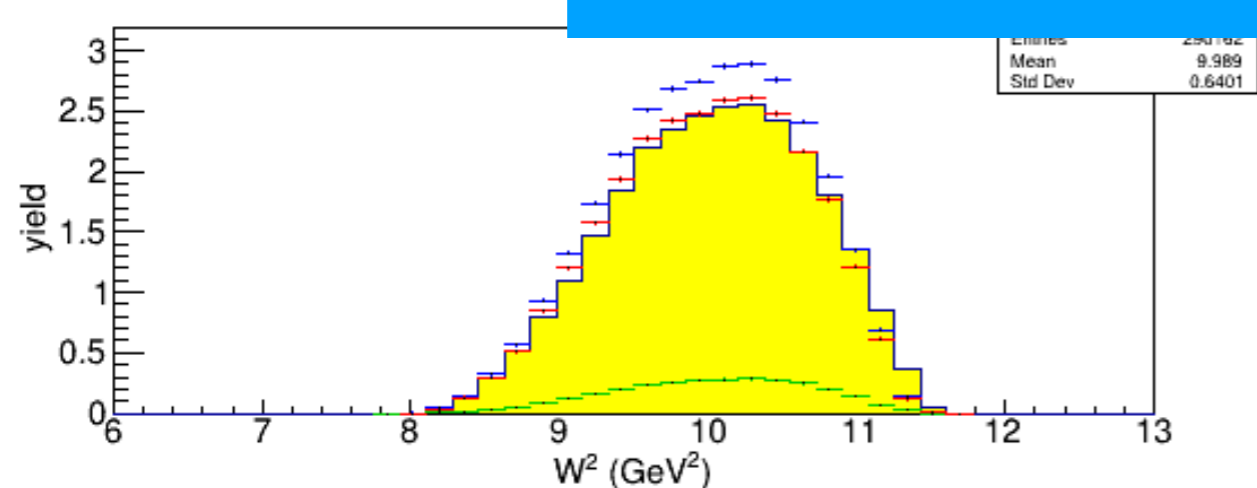
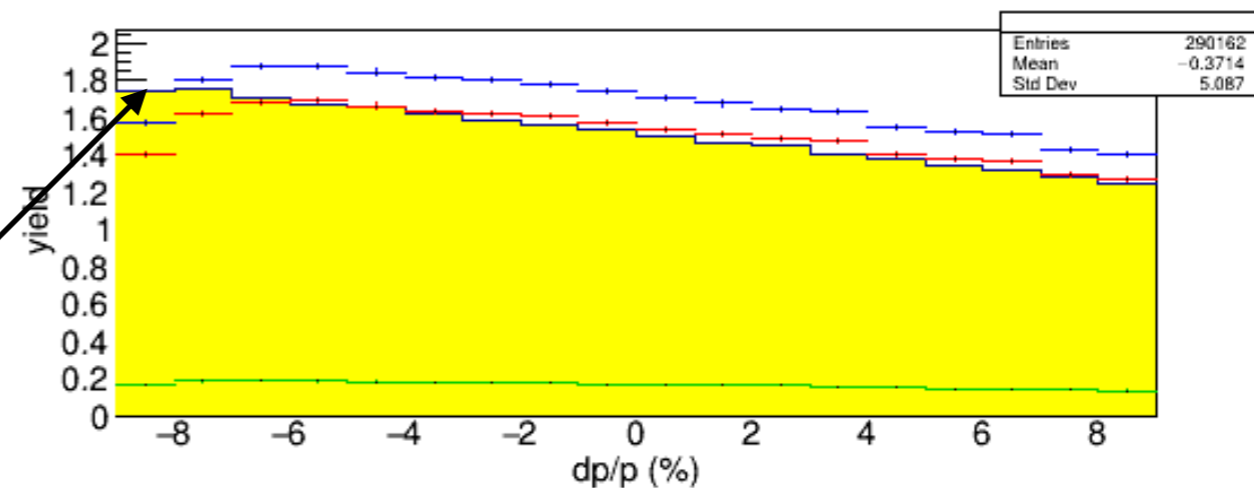


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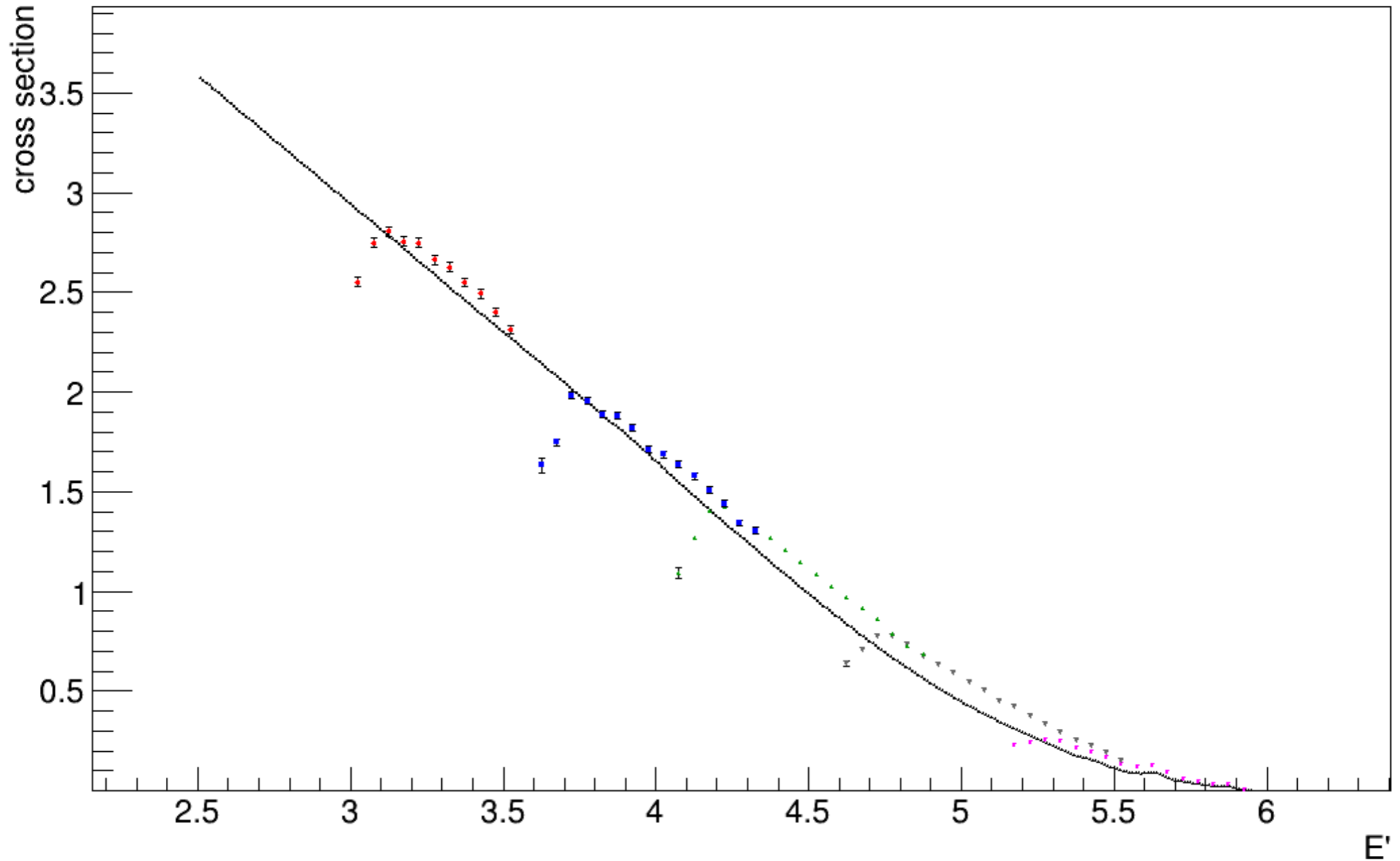


Uncorrected for
cherenkov inefficiency



First 12 GeV Cross sections in Hall C

beam energy : 10.6 GeV
angle : 21 deg



Summary

- These measurements will provide constraints for Parton Distribution Functions and for the transition from quark to nucleon degrees of freedom (quark-hadron duality)
- We achieved 100% of our statistical goal
- Detector calibrations and studies of their efficiencies are in progress
- First cross sections from 12 GeV era in Hall C

Collaboration List:

**Spokespersons : Cynthia Keppel (Jlab), Simona Malace (Jlab),
Eric Christy (Hampton University), Ioana Niculescu (JMU)**

Post Doc : Sanghwa Park (Stony Brook University)

**Grad Students : Debaditya Biswas (Hampton University),
Abel Sun (Carnegie Mellon University), Fernando Araiza
Gonzalez (Stony Brook University)**

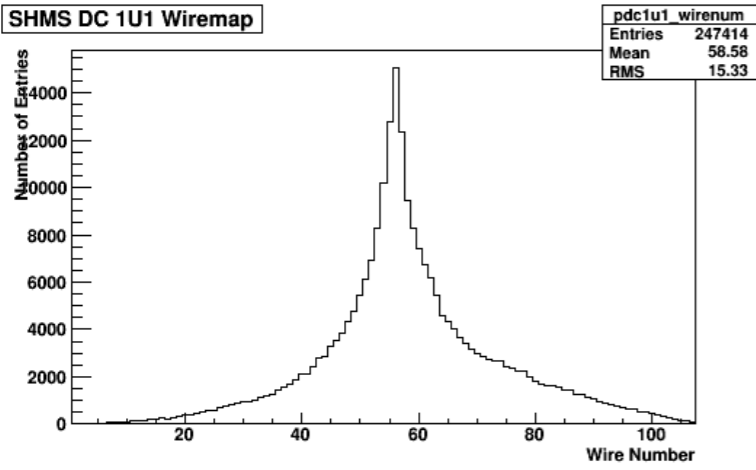
Thank you !

*This work is supported by National Science Foundation grant PHY-1508272 and Jefferson Science Associates

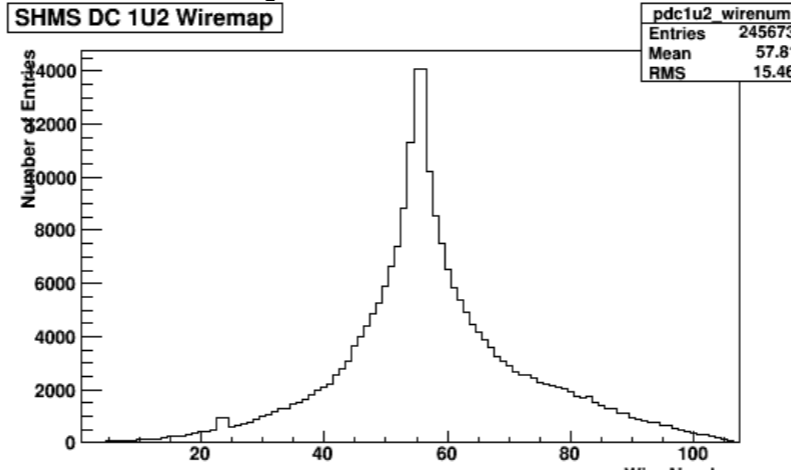
Back up *slides*

Wire maps : SHMS DC

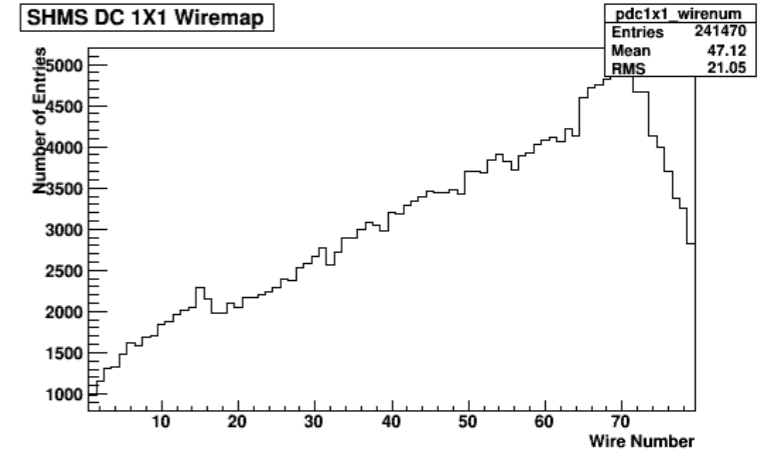
SHMS DC 1U1 Wiremap



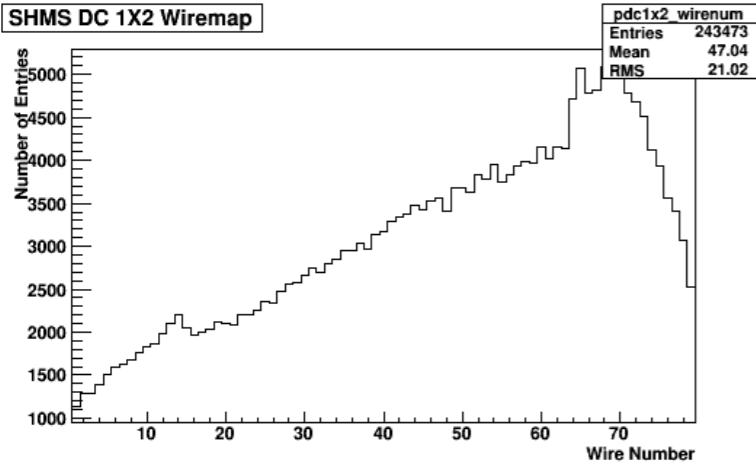
SHMS DC 1U2 Wiremap



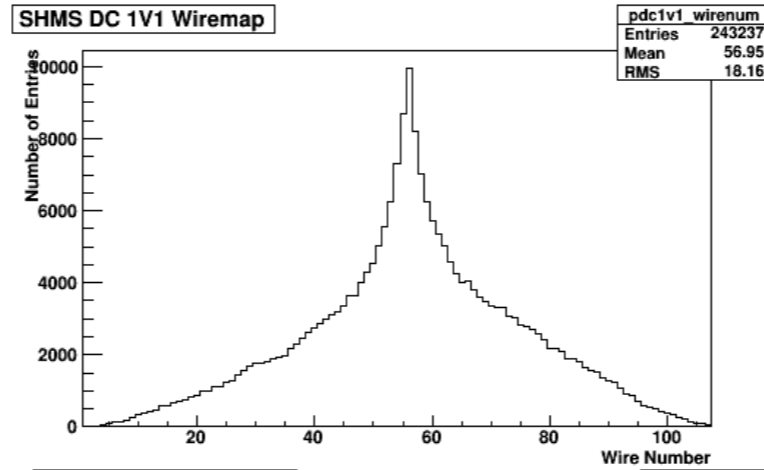
SHMS DC 1X1 Wiremap



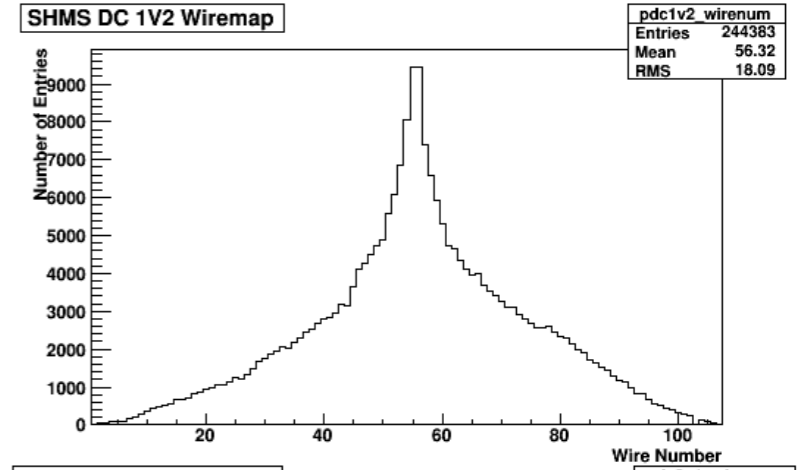
SHMS DC 1X2 Wiremap



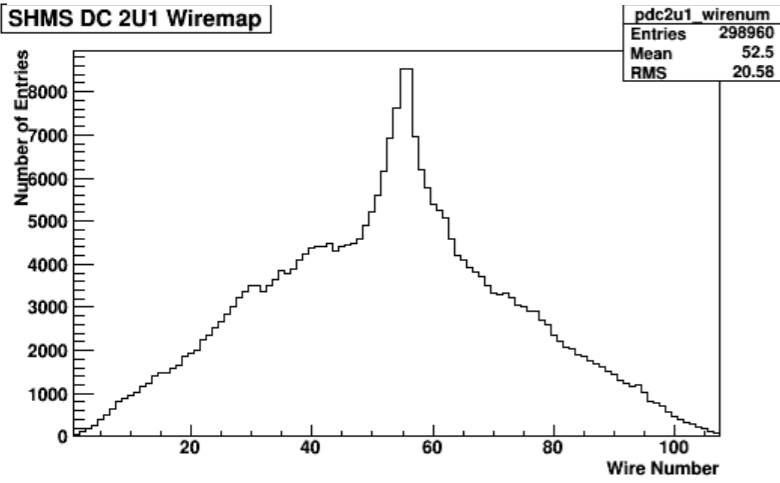
SHMS DC 1V1 Wiremap



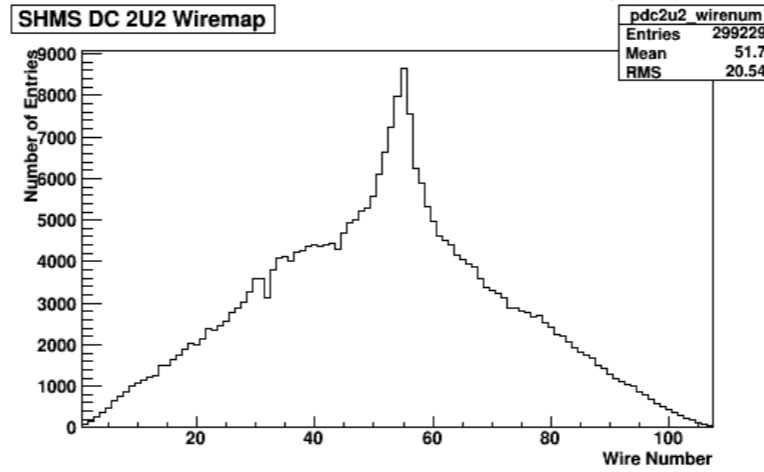
SHMS DC 1V2 Wiremap



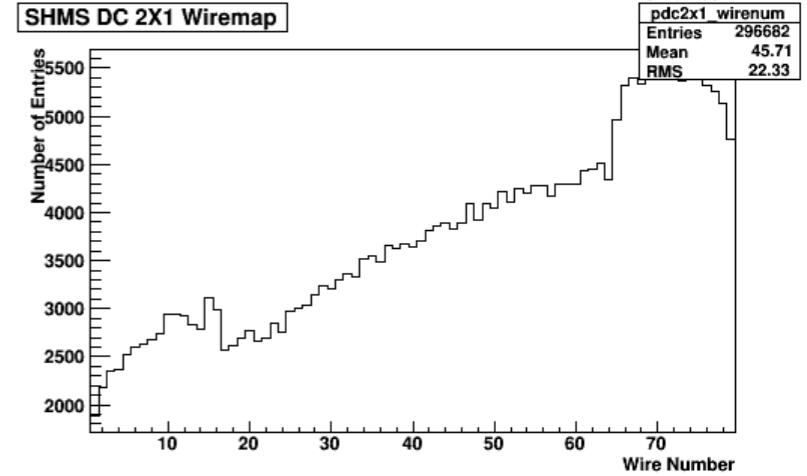
SHMS DC 2U1 Wiremap



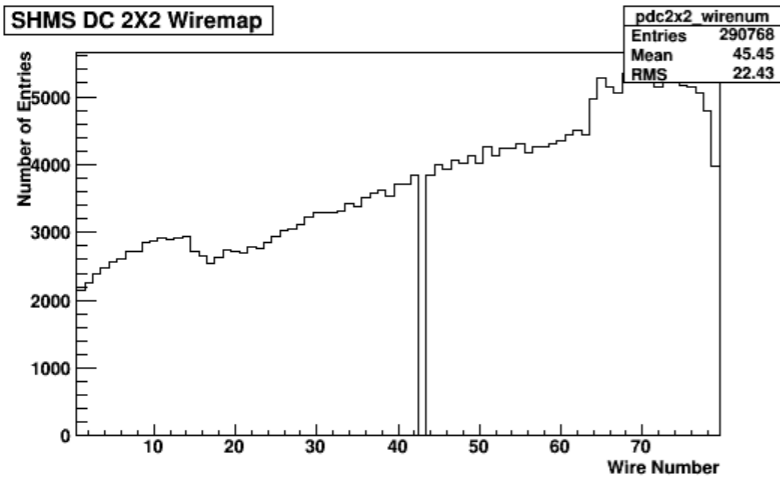
SHMS DC 2U2 Wiremap



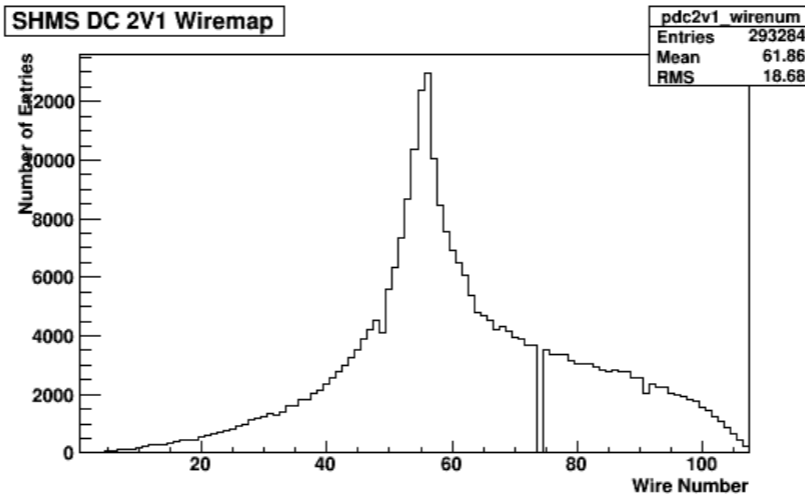
SHMS DC 2X1 Wiremap



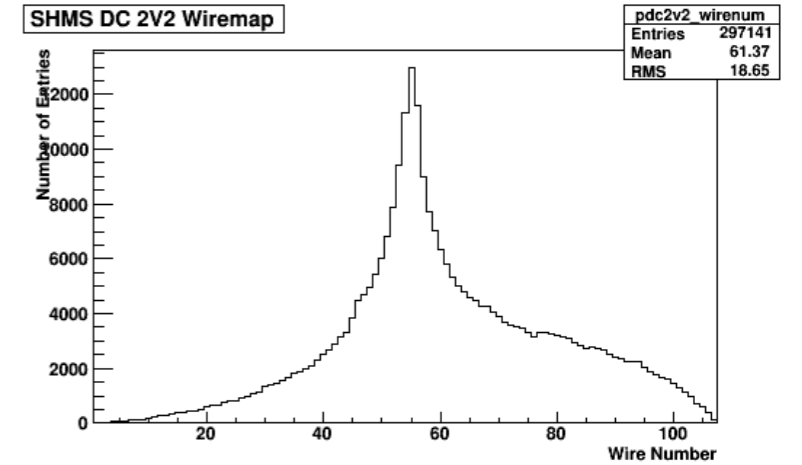
SHMS DC 2X2 Wiremap



SHMS DC 2V1 Wiremap

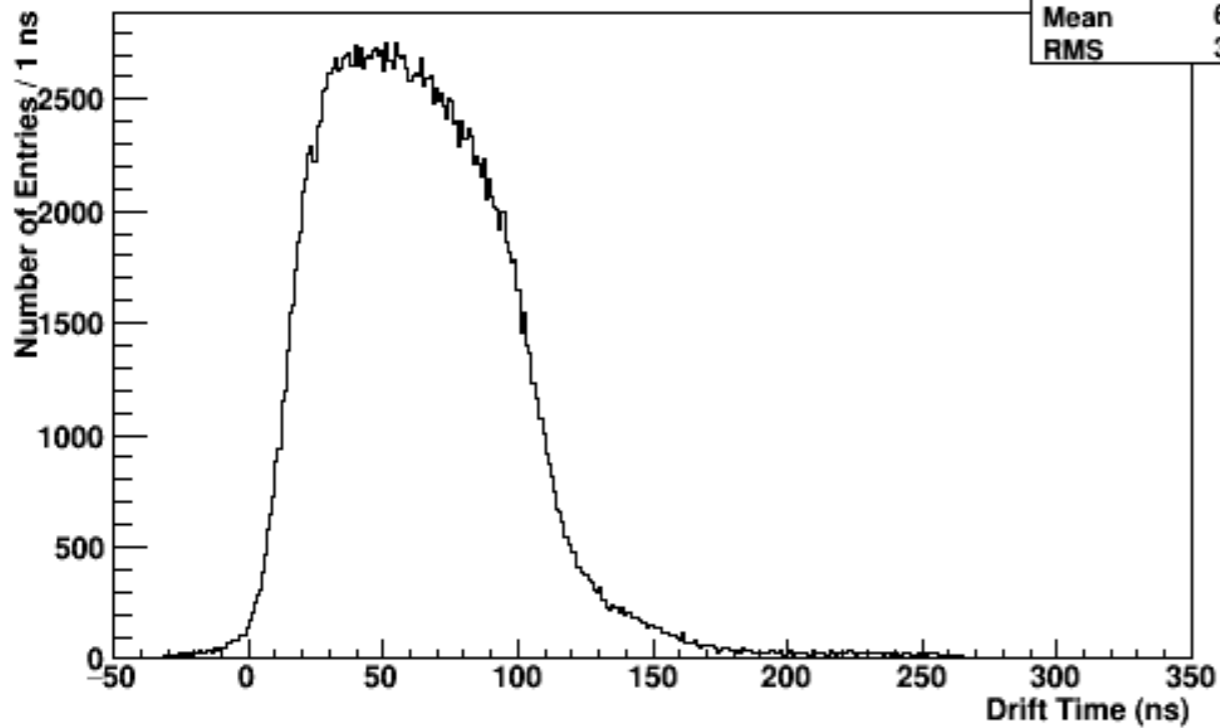


SHMS DC 2V2 Wiremap

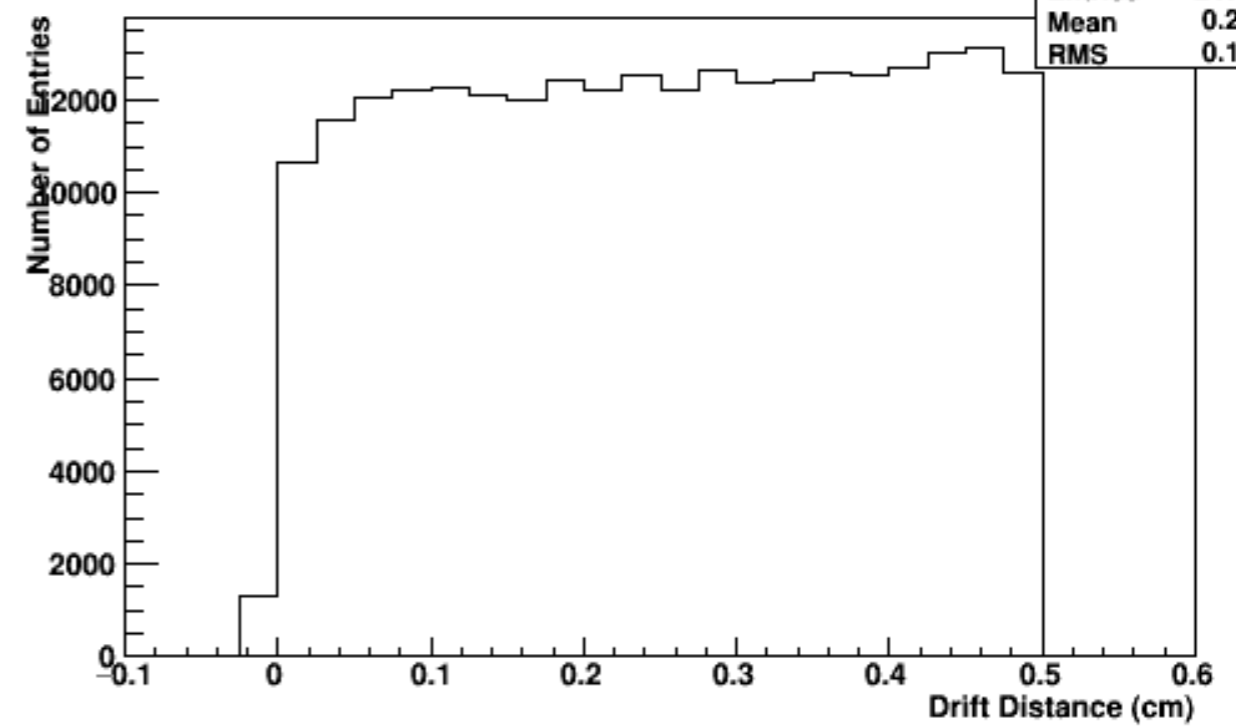


1U1 Plane Details

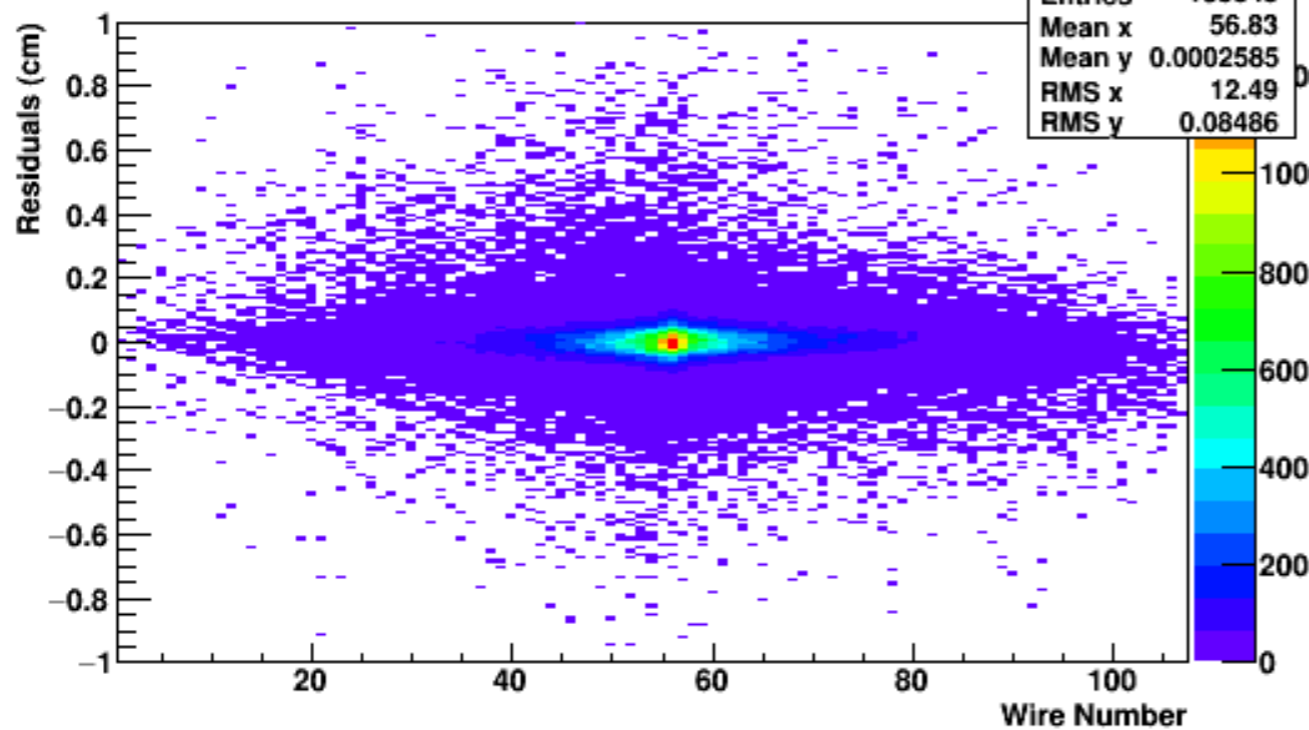
SHMS DC 1U1 Drift Time



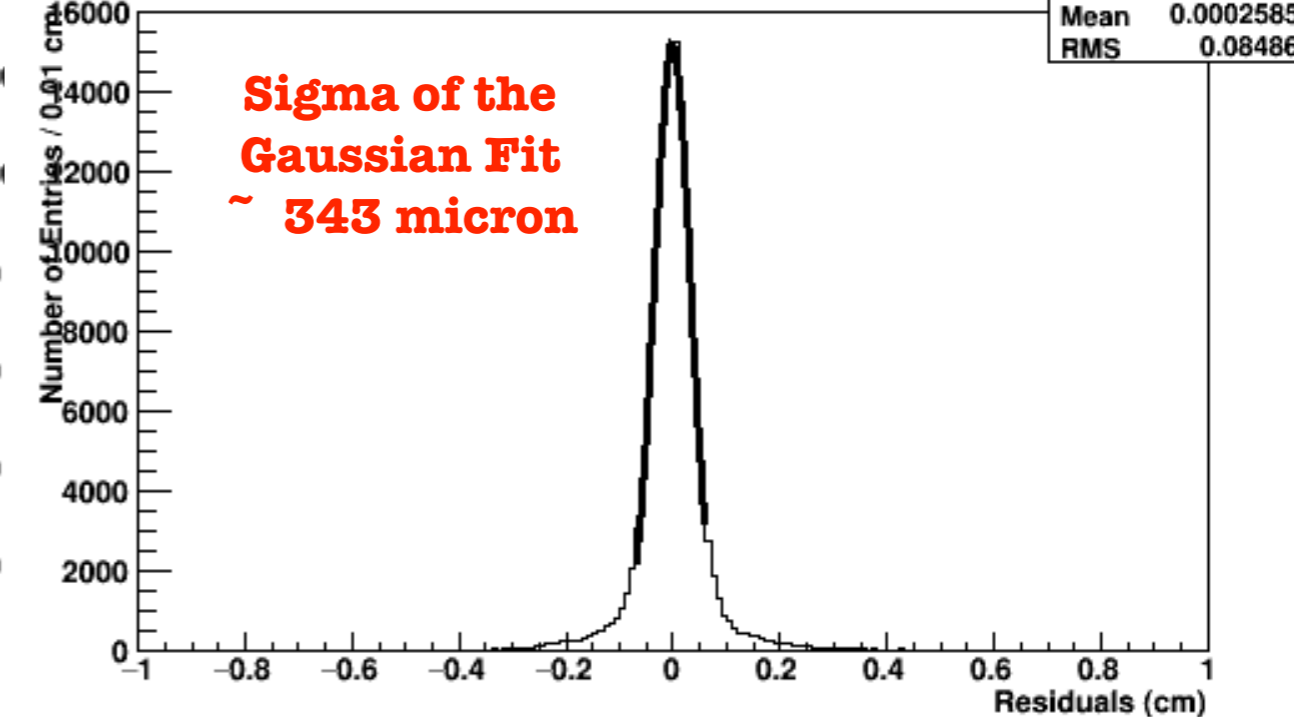
SHMS 1U1 Drift Distance



SHMS 1U1 DC Residuals vs. Wire Number



SHMS 1U1 DC Residuals



BCM Calibration

