JLab E12-10-002: Cross Section Extractions from H(e,e′) and D(e,e′)

Debaditya Biswas (Hampton University)

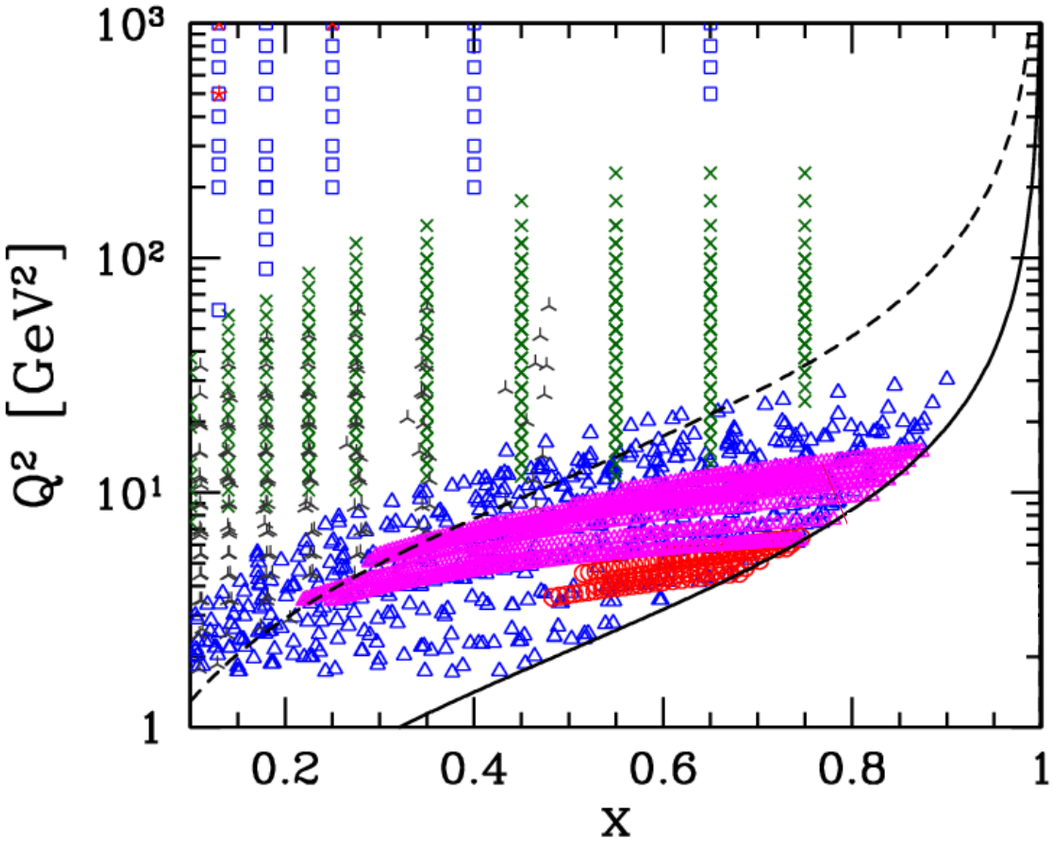
Outline :

- **Physics Motivations**
  - **Constrain PDFs**
  - **Resonance / DIS Modelling**
  - **Moments**
  - **Quark Hadron Duality**
- **Timing Cuts**
- **Detectors Calibration**
- **Detectors Efficiencies**
- **Charge Symmetric Background**
- **Acceptance Study**
- **Radiative Correction**
- **Cross-section calculation**

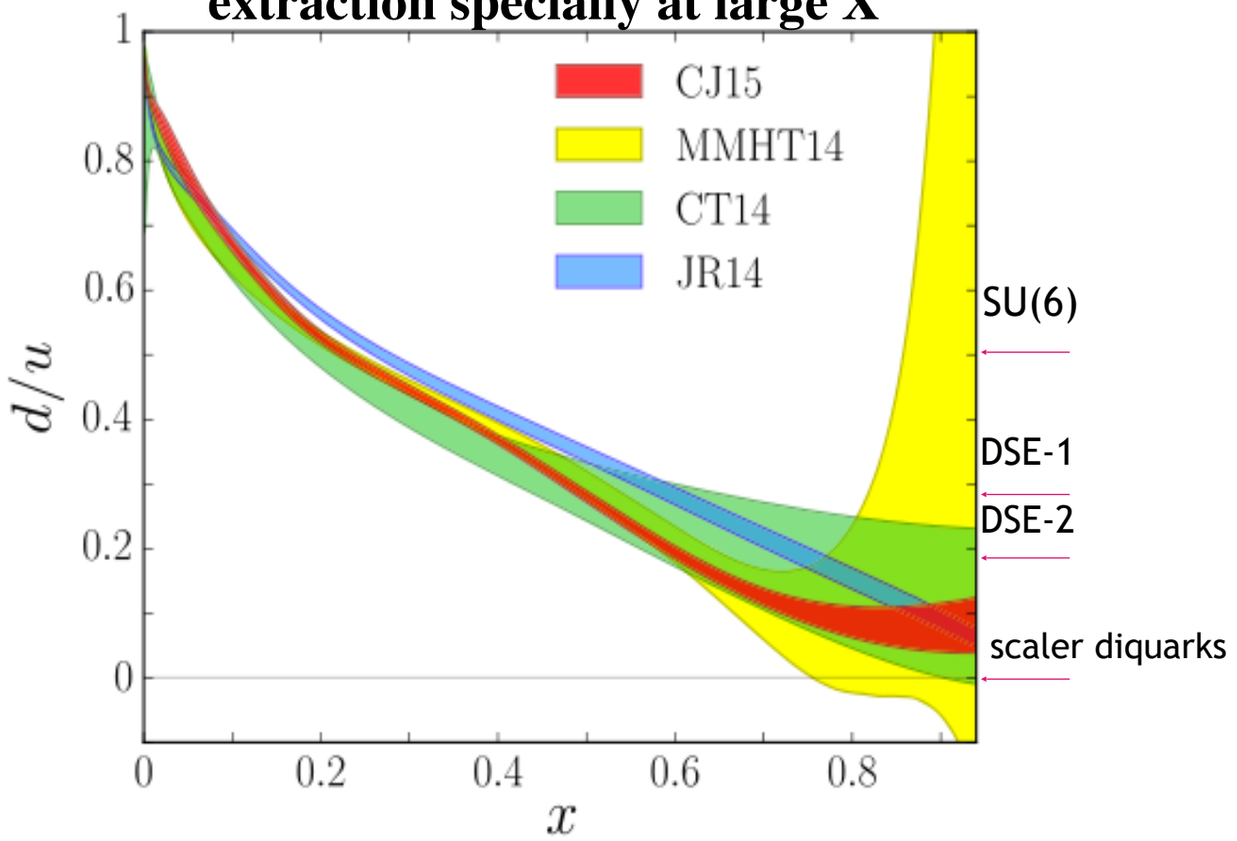
APS April Meeting, 13-16 April 2019, Denver, Colorado

Physics Motivation: Constraints for PDFs

- CTEQ-JLab (CJ) performs global QCD fits of PDFs from data including deep-inelastic lepton-nucleon scattering, proton-proton collisions (lepton pair creation, W-boson and jet production), etc., **with particular focus on the large-x region**



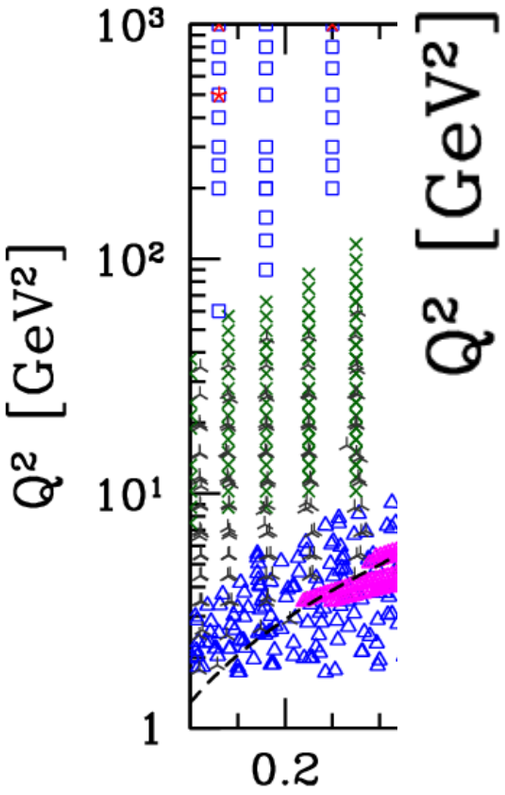
To improve uncertainty in d/u extraction specially at large X

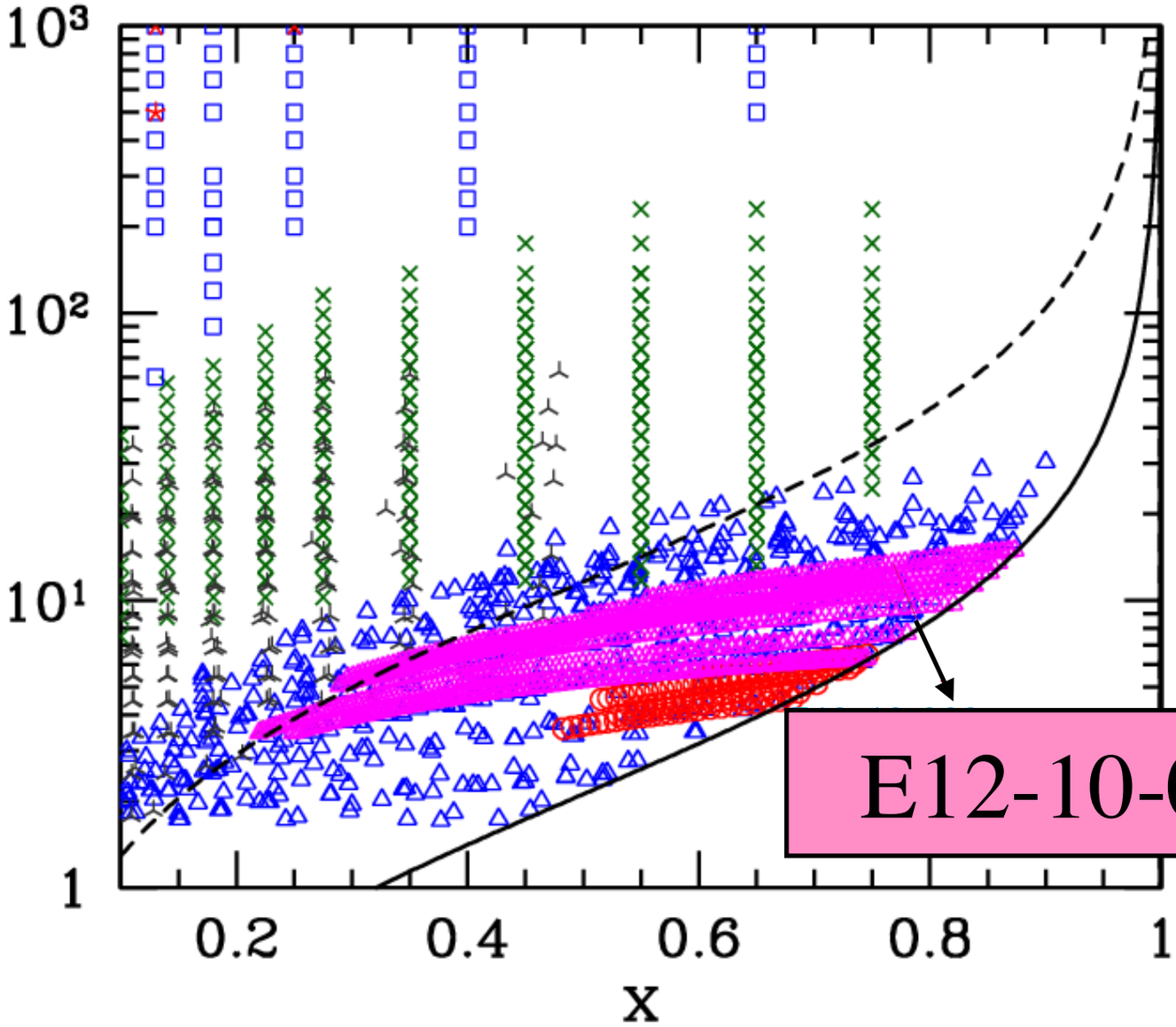


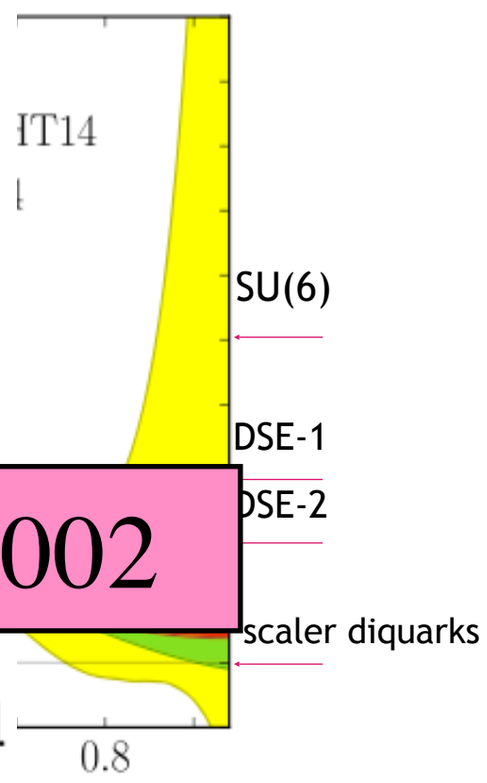
Physics Motivation: Constraints for PDFs

- CTEQ-JLab (C
  lepton-nucleo
  production), e

deep-inelastic
W-boson and jet





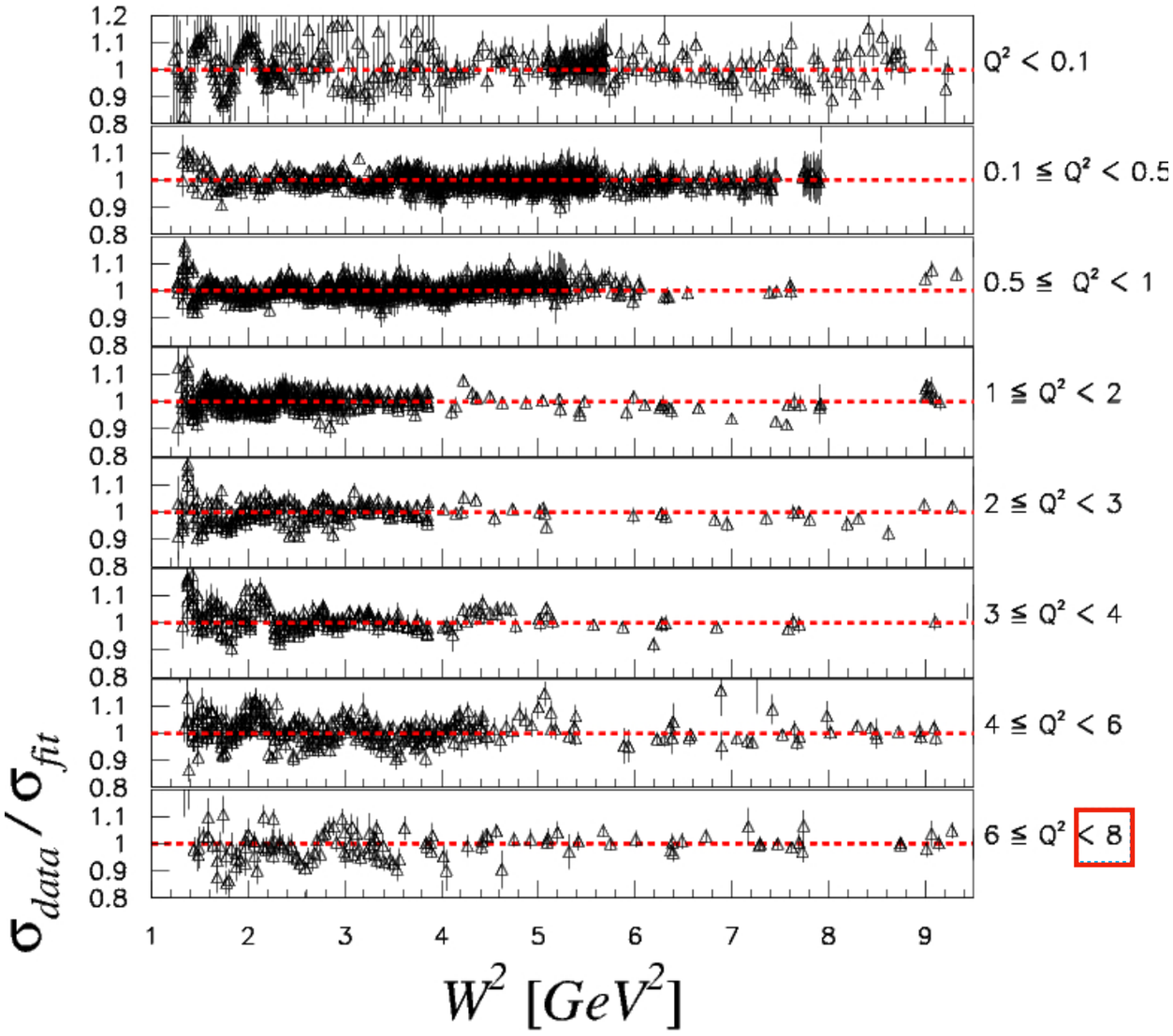


- We measured both H and D cross sections (free protons and bound neutrons)
- We not only push to larger x but we also cover the low x kinematic region
  - this should help with constraining the nuclear corrections and the d-quark at the same time

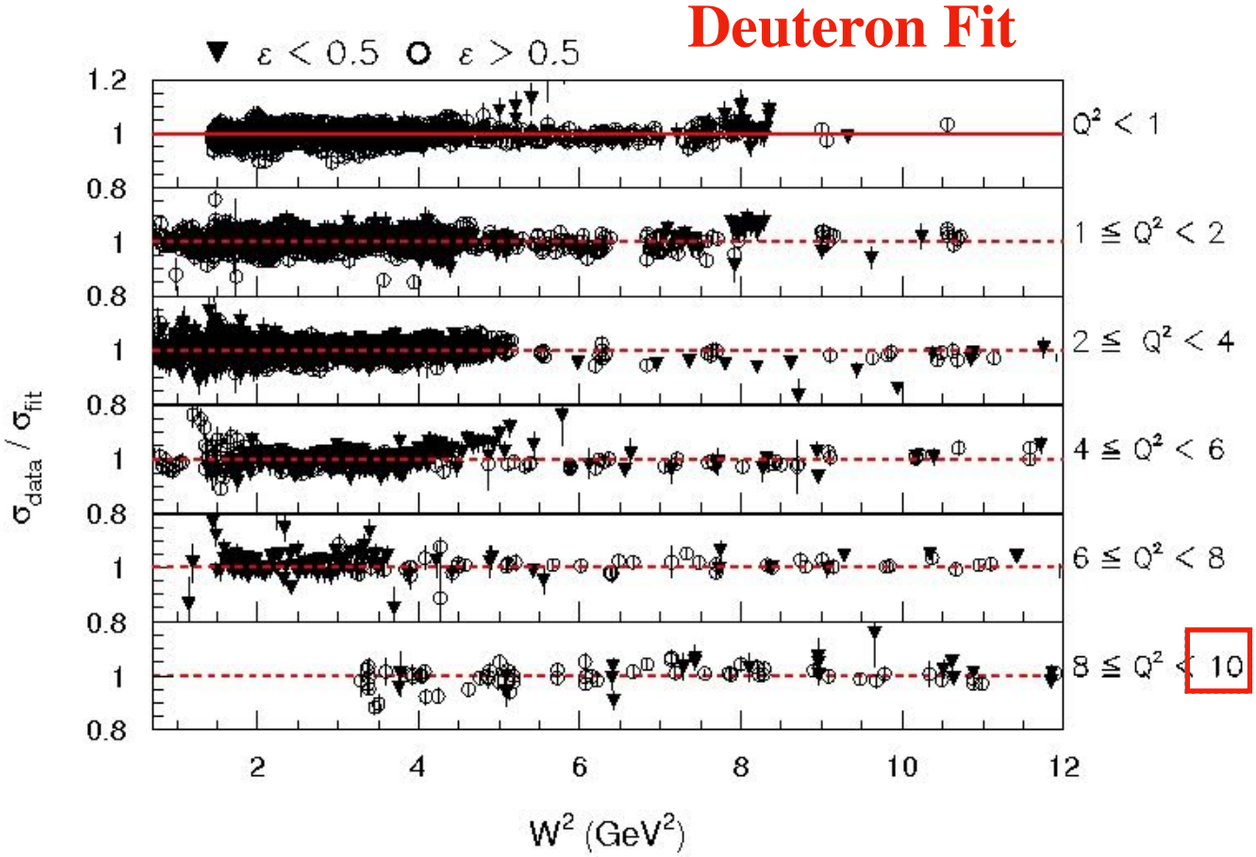
Physics Motivation: Resonance / DIS Modelling

- Provides constraints to larger Q^2 – up to 16 GeV^2 for both proton and deuteron fit
- Provides a complete data set (proton and deuteron) for a precise neutron extraction

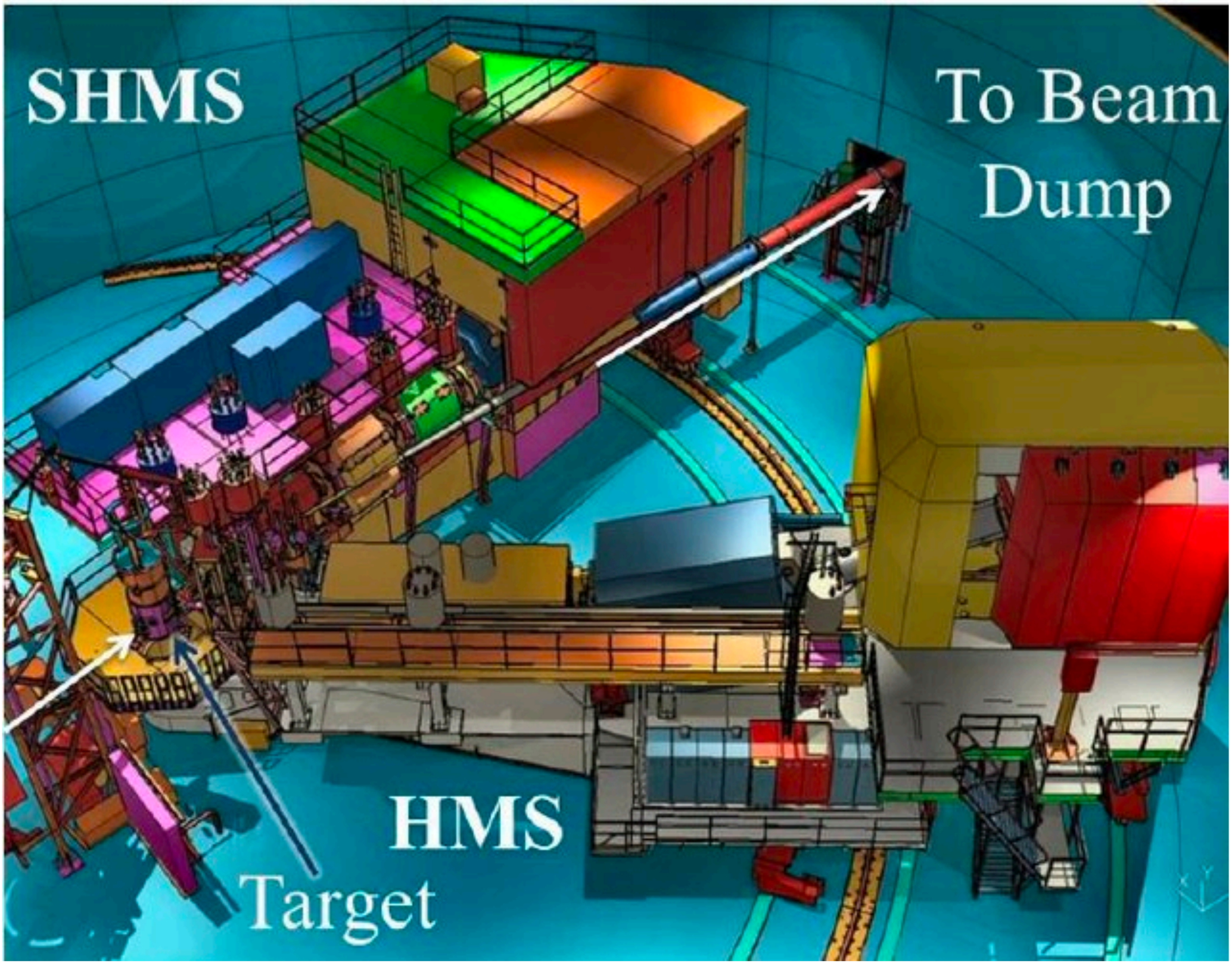
Proton Fit



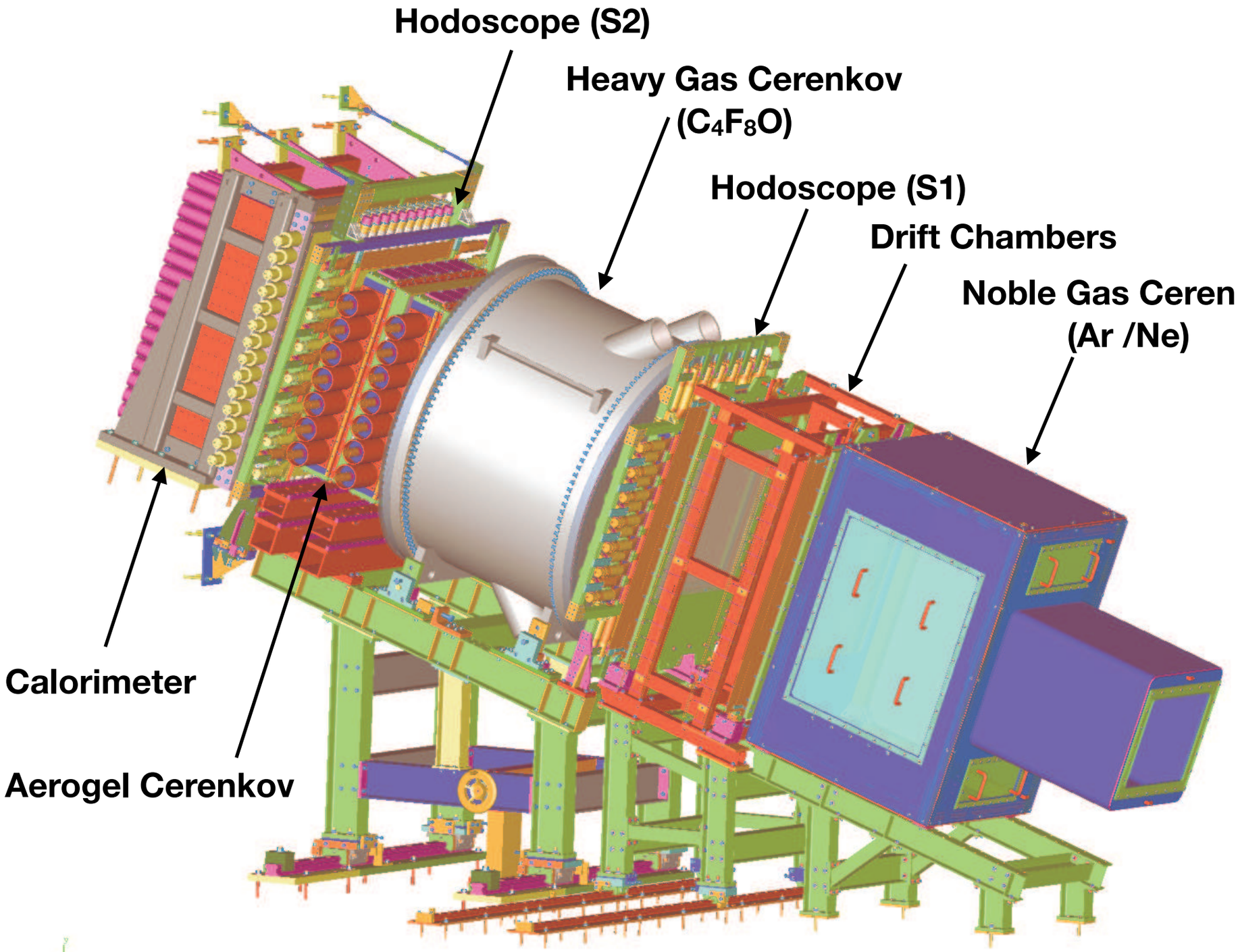
Deuteron Fit



Hall C Spectrometers



SHMS : Super High Momentum Spectrometer

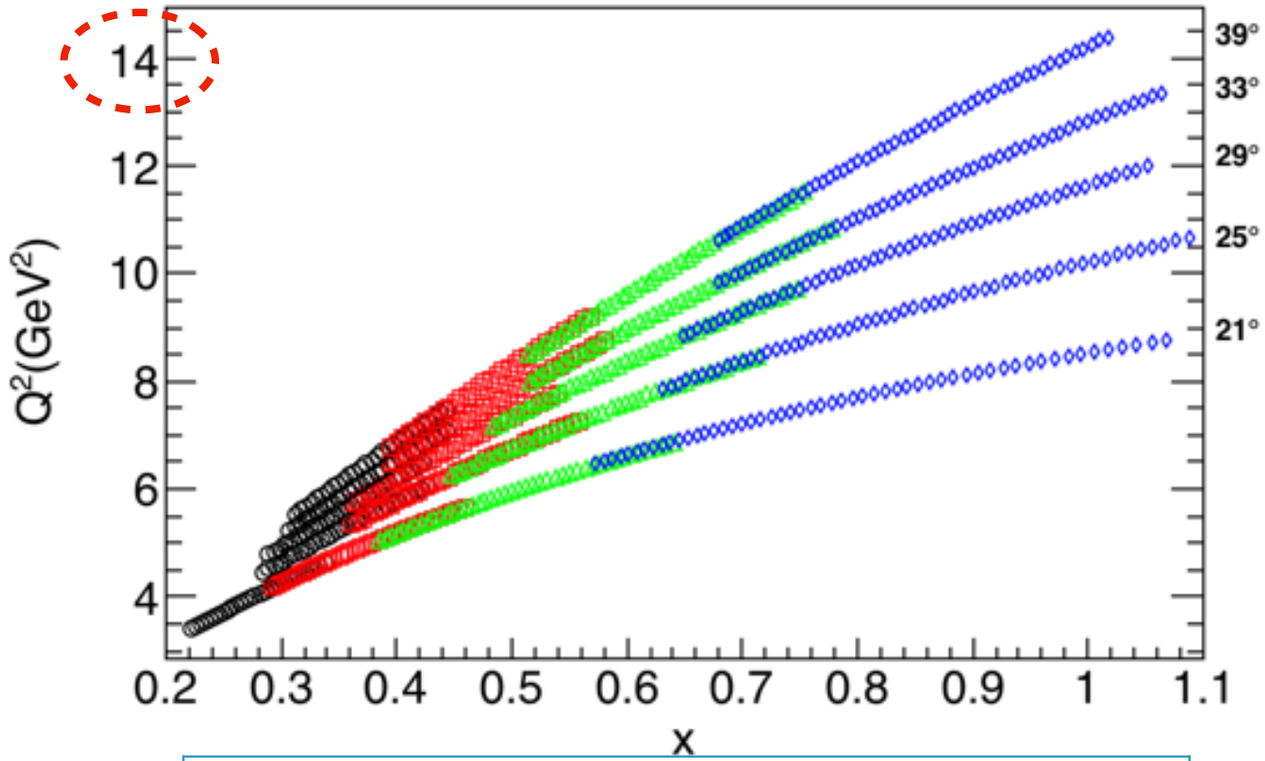


- **HMS has a very similar kind of set of Detectors**

E12-10-002 : Measurements

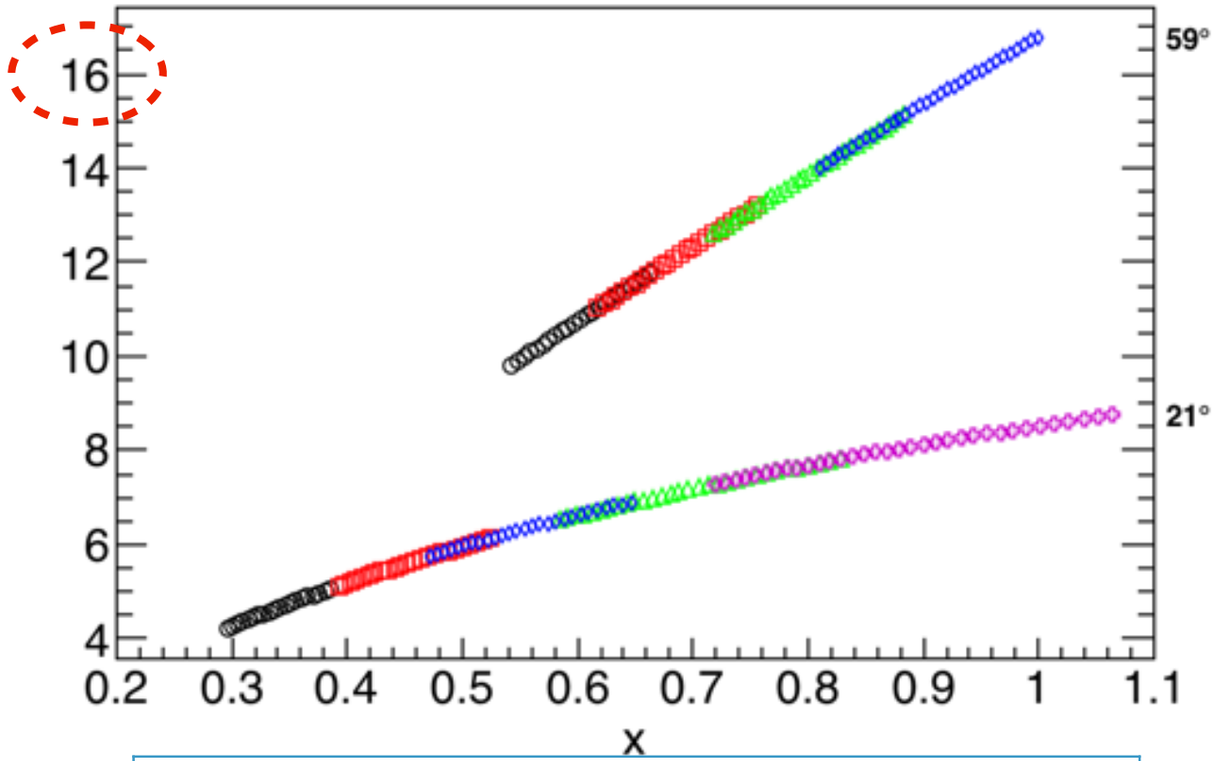
- Run in Spring 2018
- Beam Energy: 10.6 GeV
- Targets: LH2, LD2, Al

SHMS



Angle	Momentum (GeV/c)
21	2.7, 3.3, 4.0, 5.1
25	2.5, 3.0, 3.5, 4.4
29	2.0, 2.4, 3.0, 3.7
33	1.7, 2.1, 2.6, 3.2
39	1.3, 1.6, 2.0, 2.5

HMS



Angle	Momentum (GeV/c)
21	3.3, 4.0, 4.5, 5.1, 5.7
59	1.05, 1.18, 1.35, 1.50

We will extract H,D(e,e′) cross sections.

Analysis Flow

- Timing Cuts
- Calibration
  - BCM
  - Hodoscope
  - Drift Chamber
  - Calorimeter
  - Cerenkov
- Efficiency Study
  - Trigger Efficiency
  - Computer dead time
  - Calorimeter and Cerenkov Cut Efficiency
  - Pion Contamination
  - Tracking Efficiency Study
- Charge Symmetric Background
- Acceptance Study
- Radiation Correction
- Cross Section Calculation

Analysis status :

- Set timing cuts (✓)
- Calibrated detectors (✓)
- Efficiency studies - in progress
- Spectrometers acceptance - generated via Monte Carlo
- Radiative effects - calculated using existing model
- Preliminary cross section - extracted

Analysis Flow

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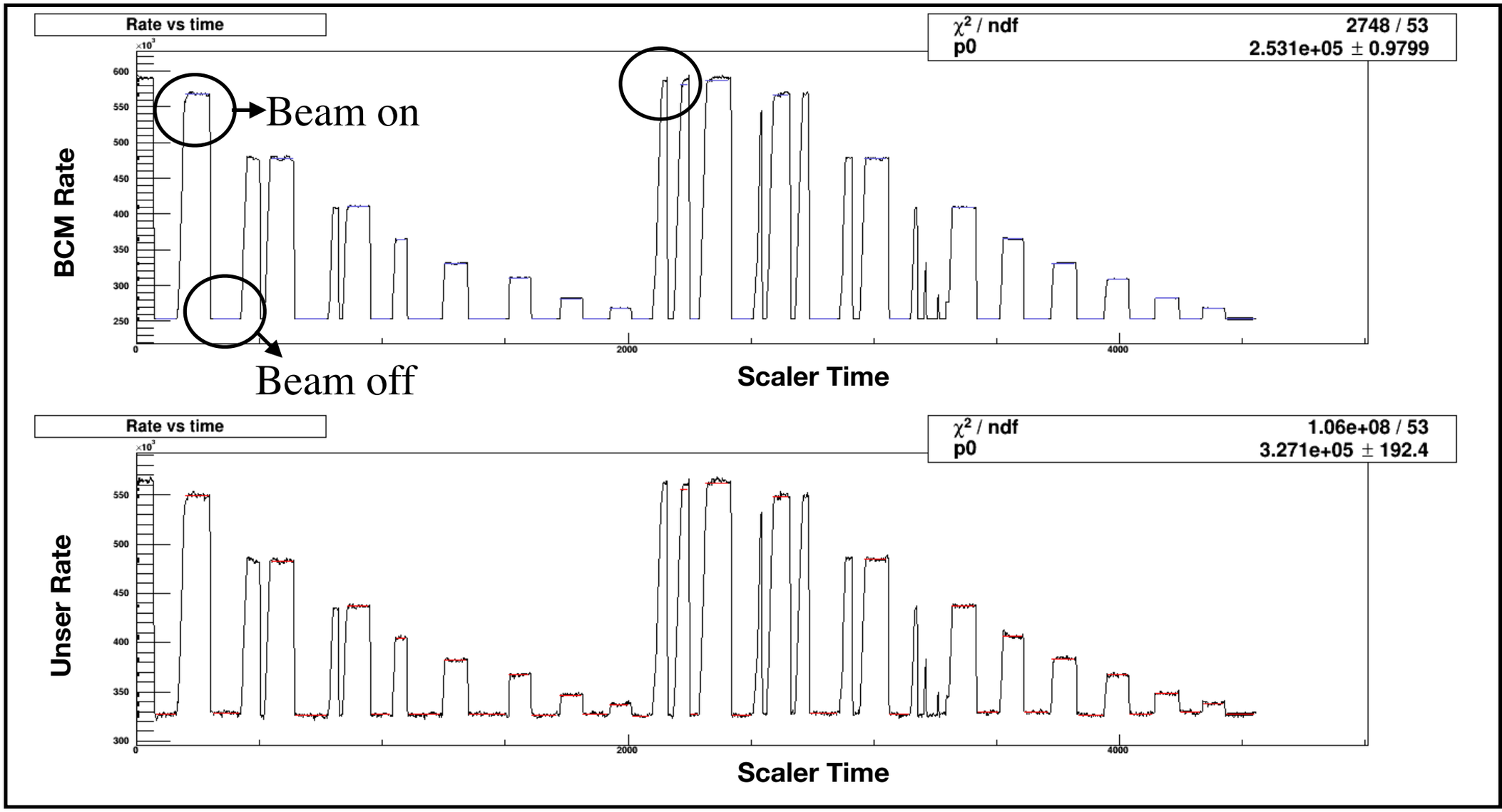
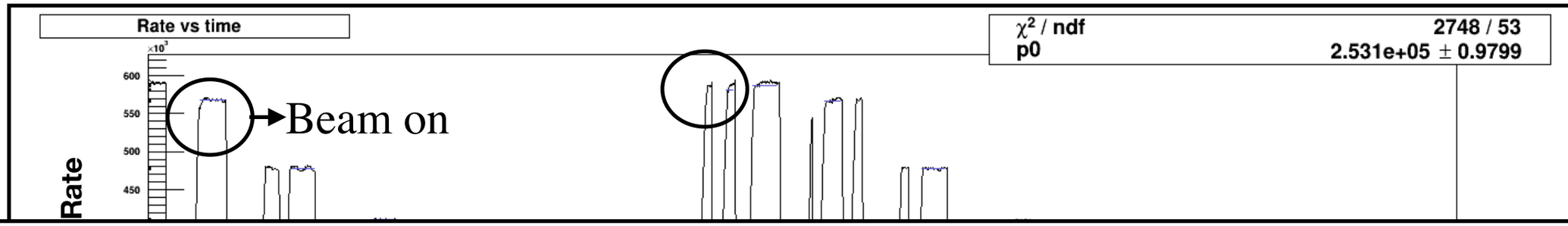
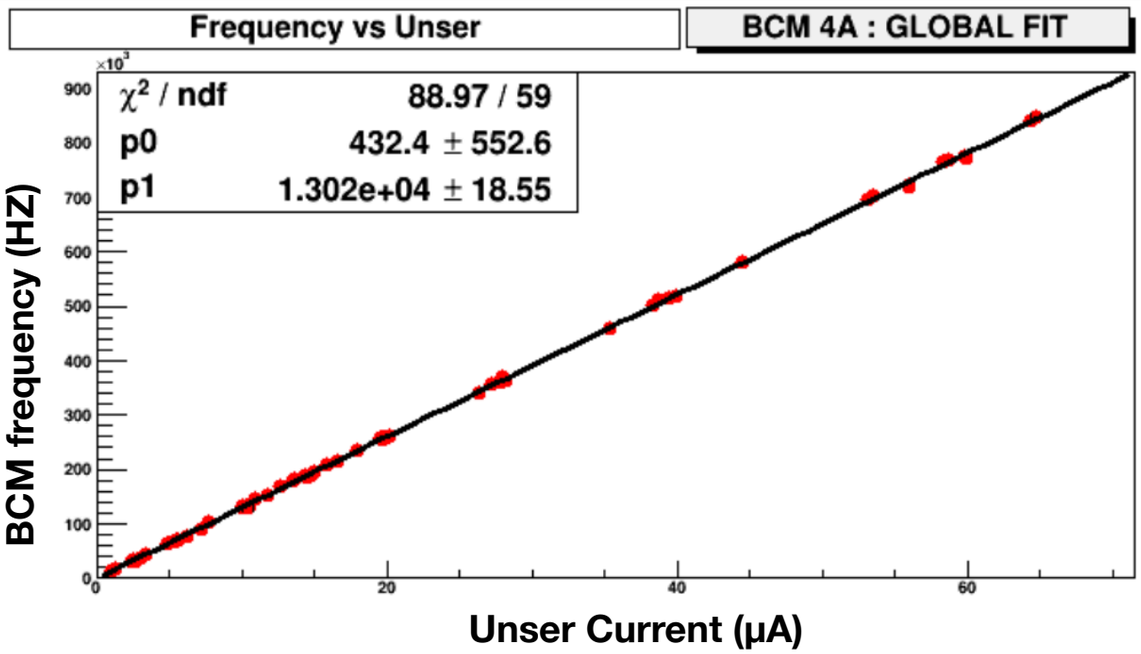
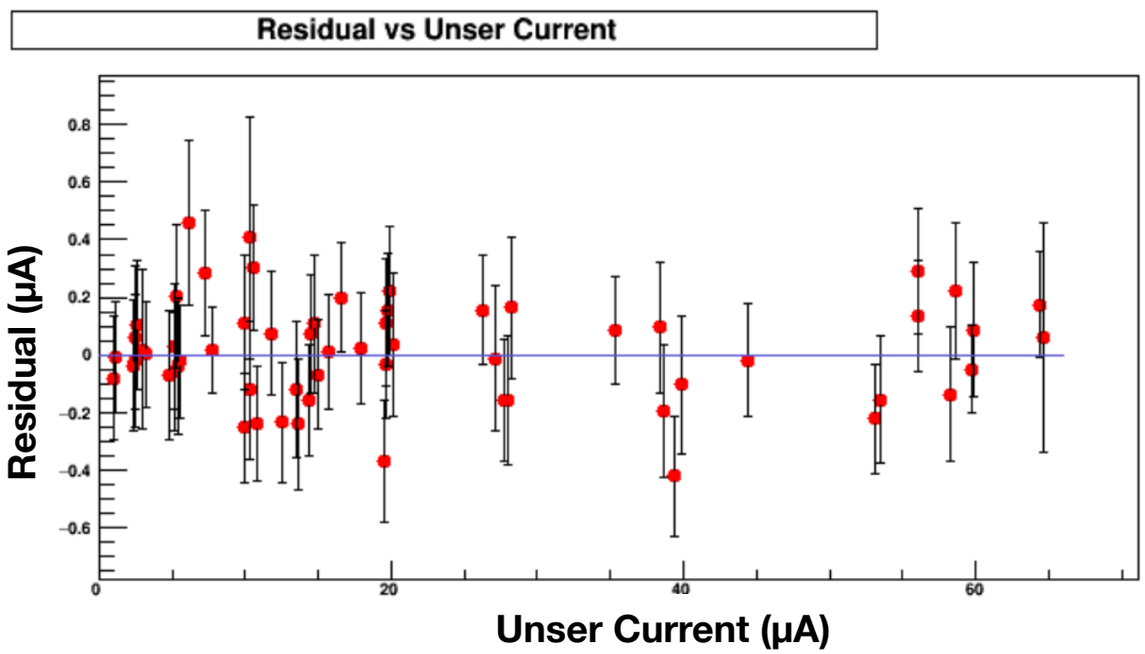
Beam Current Monitors Calibration

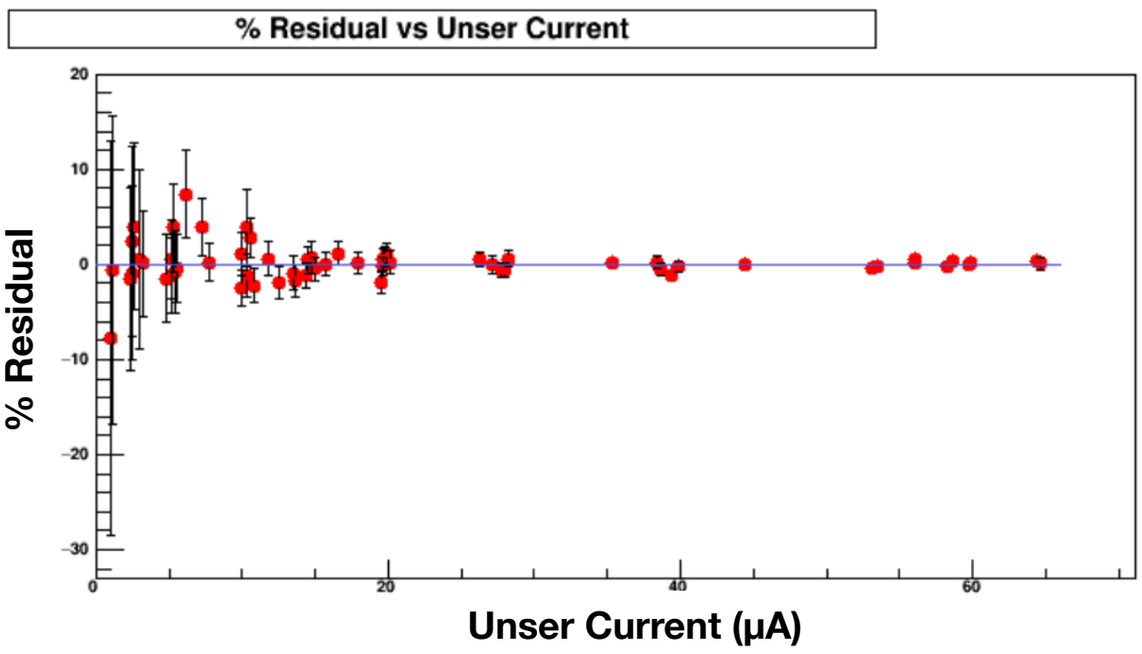


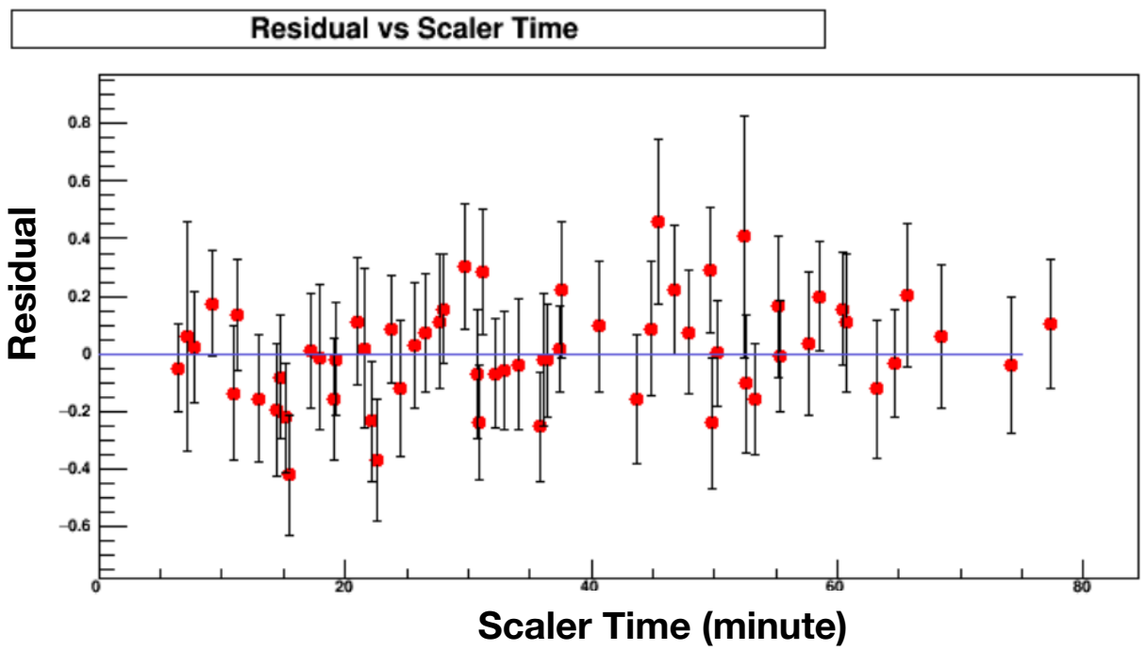
Beam Current Monitors Calibration











Analysis Flow

- Timing Cuts
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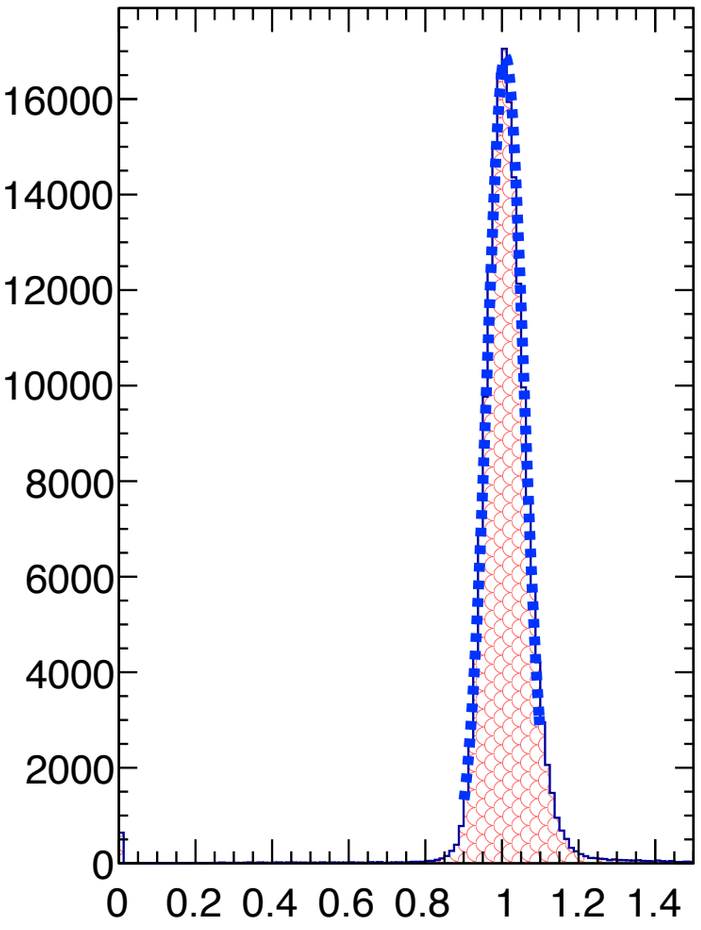
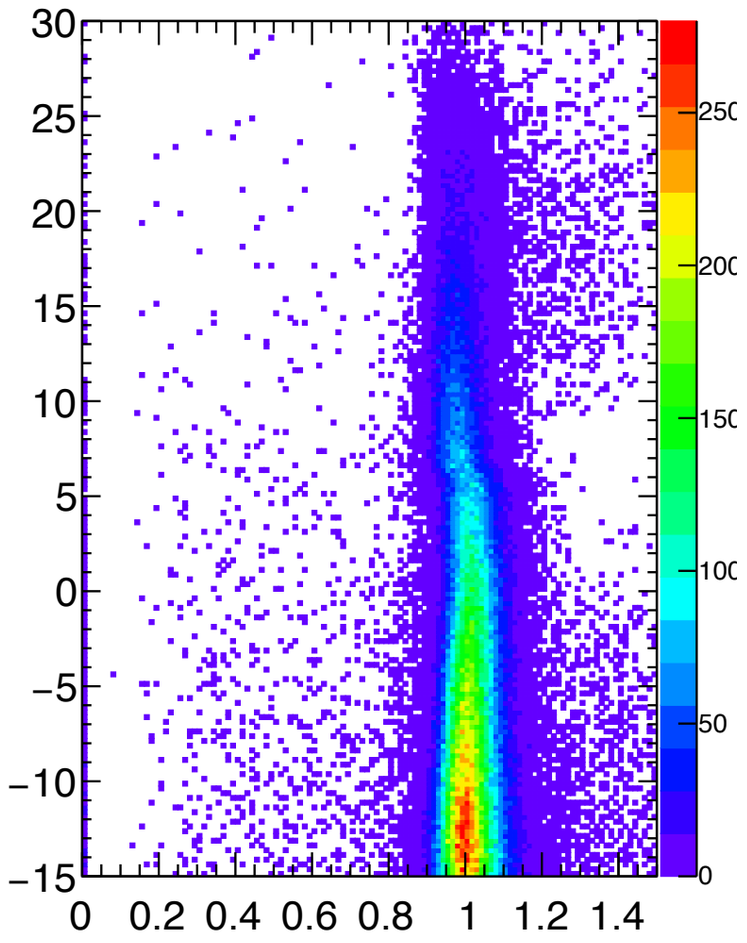
SHMS Hodoscope





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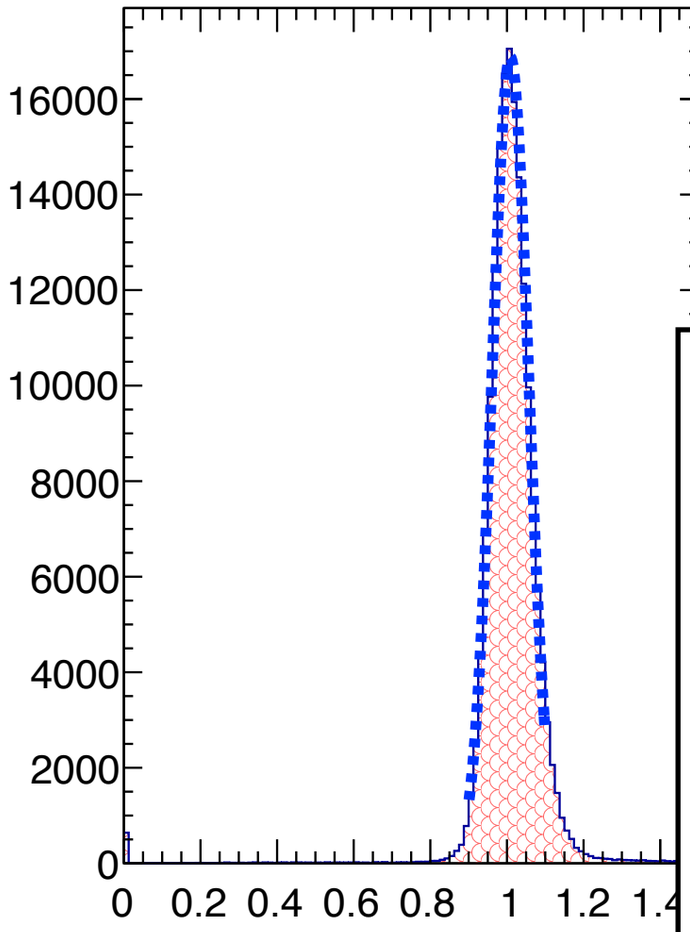

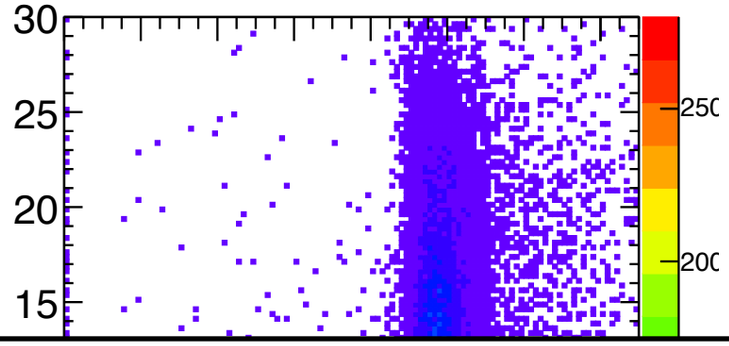

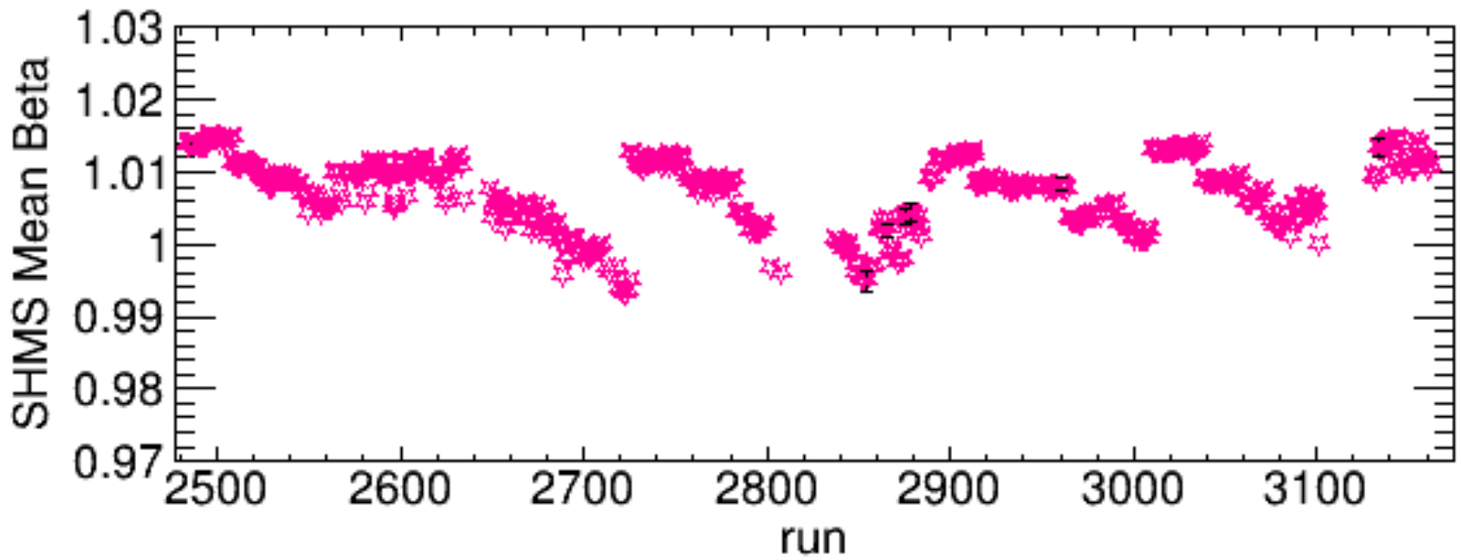

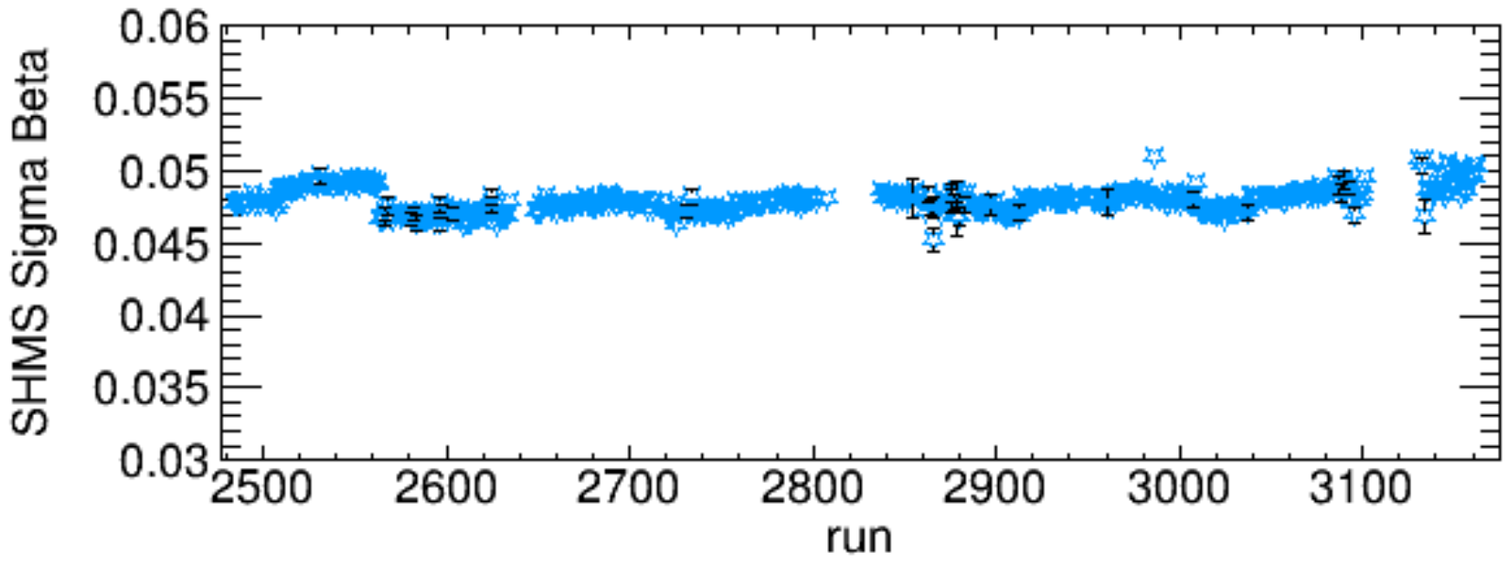

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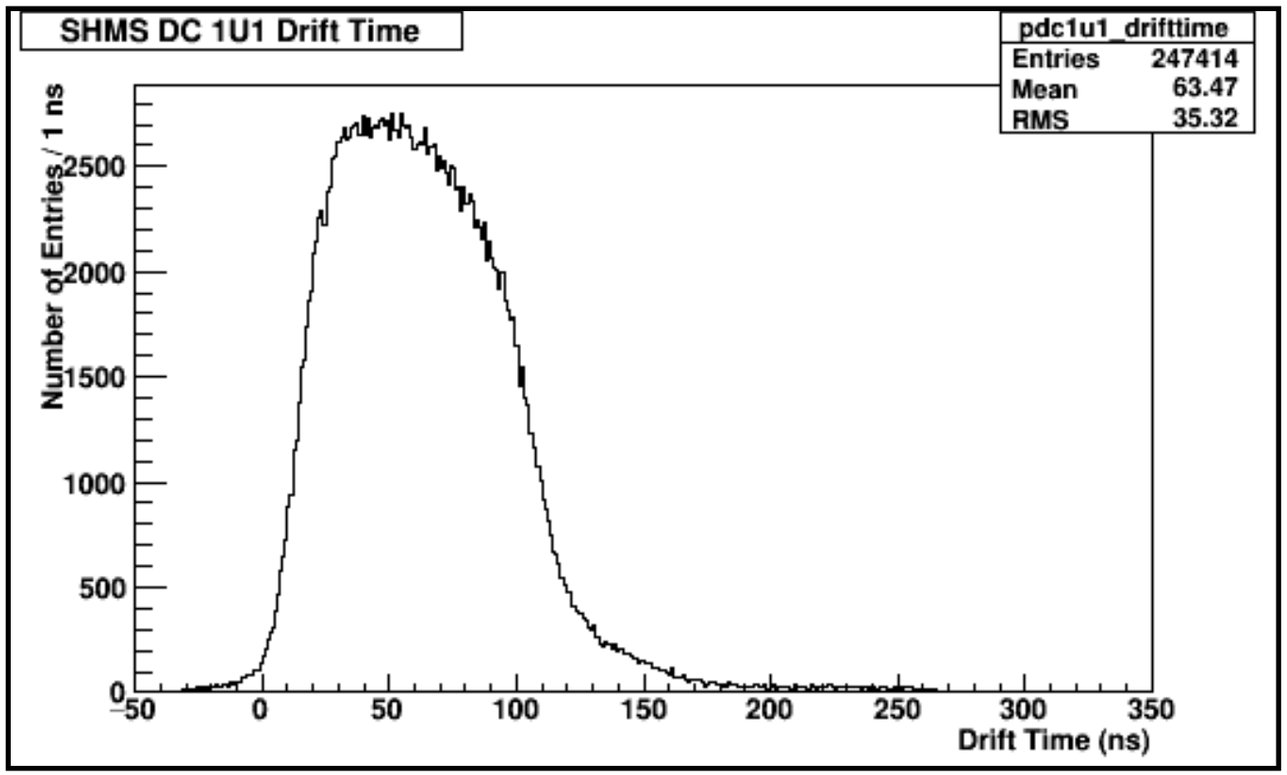
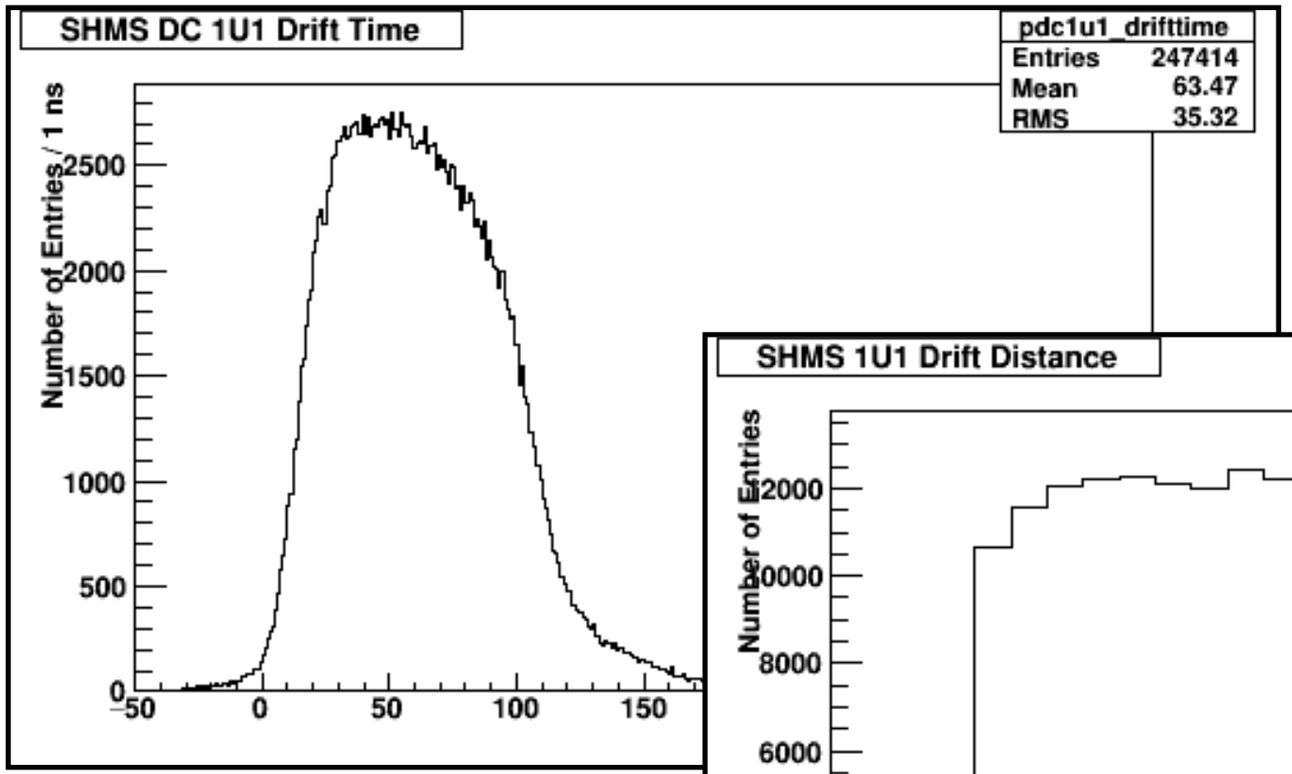
Drift Chamber Calibration

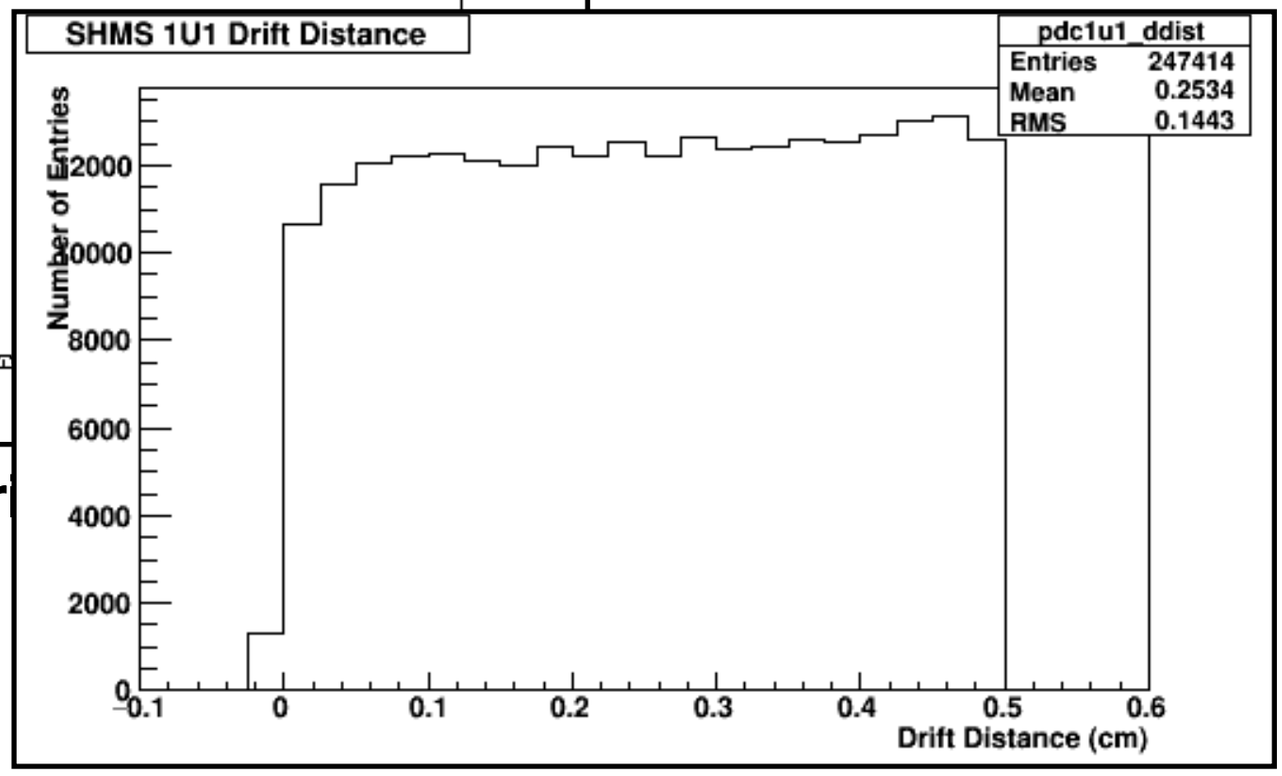


Drift Time Distribution

Drift Chamber Calibration

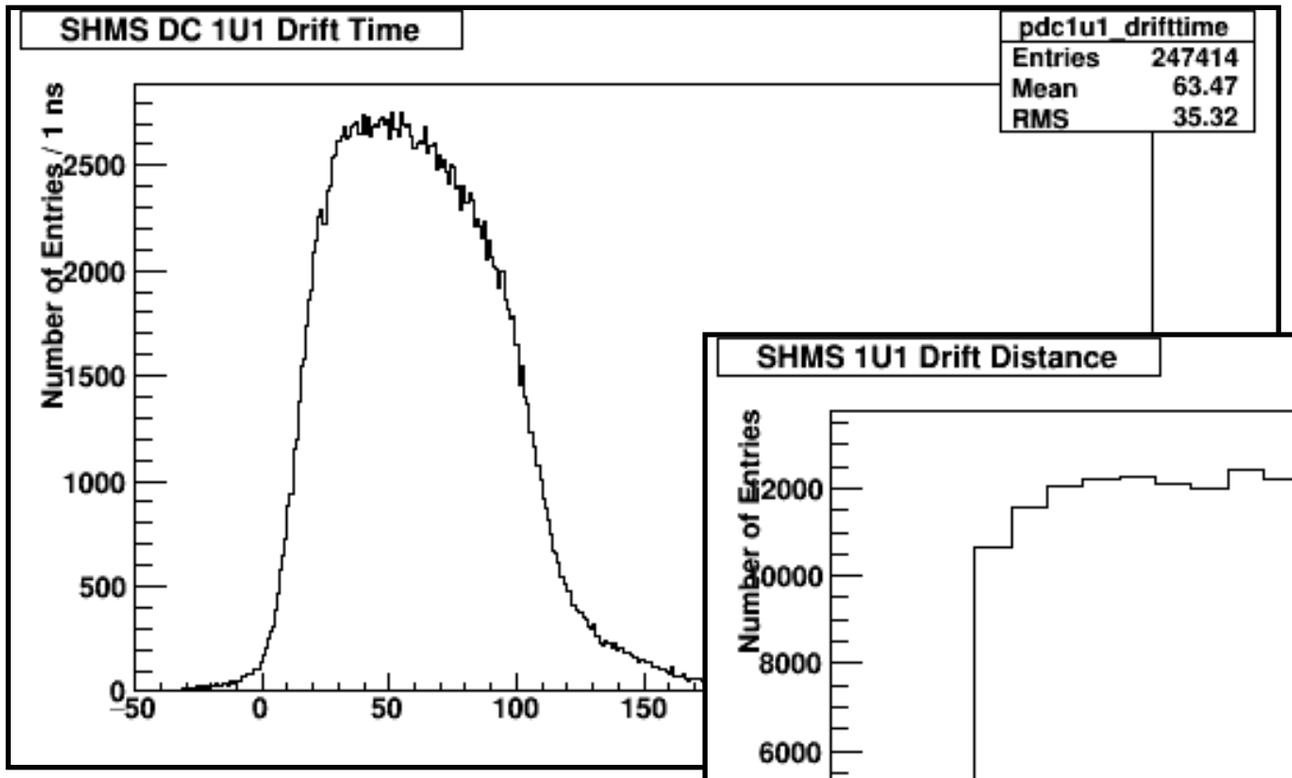


Drift Time Distri

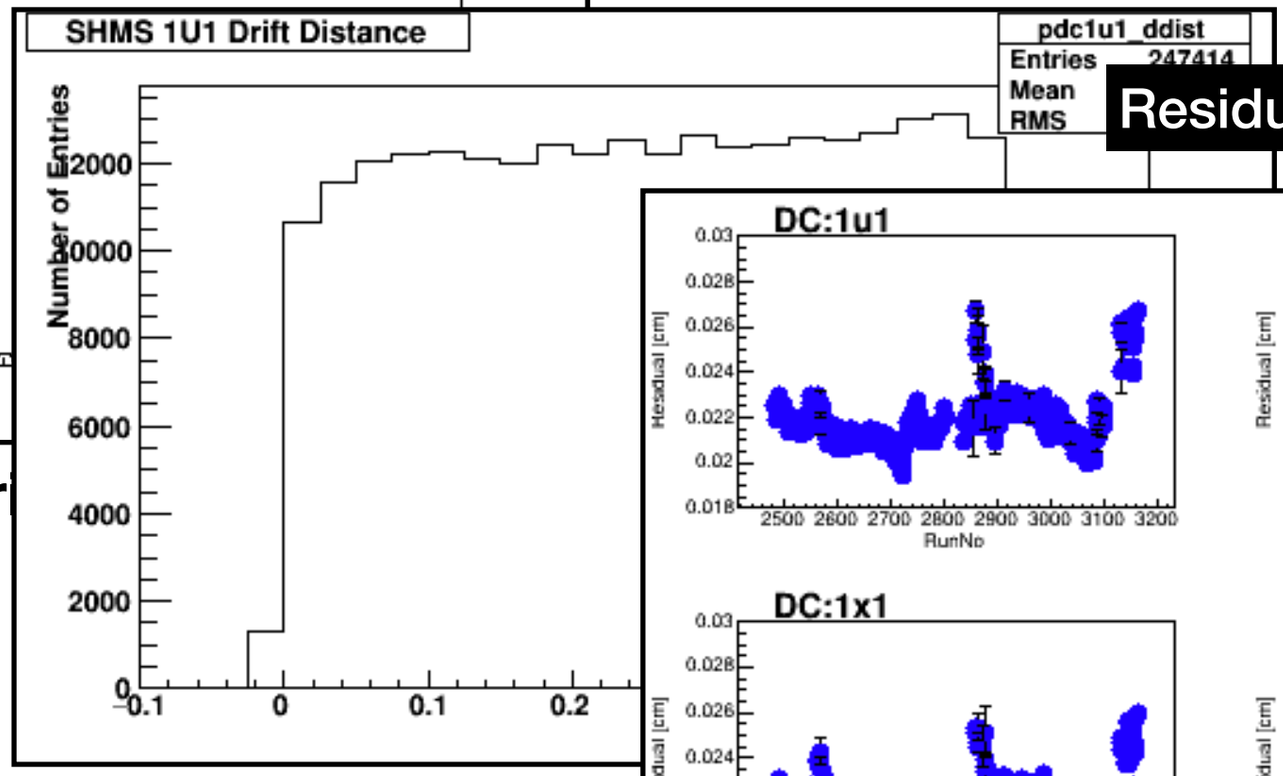


Drift Distance Distribution

Drift Chamber Calibration

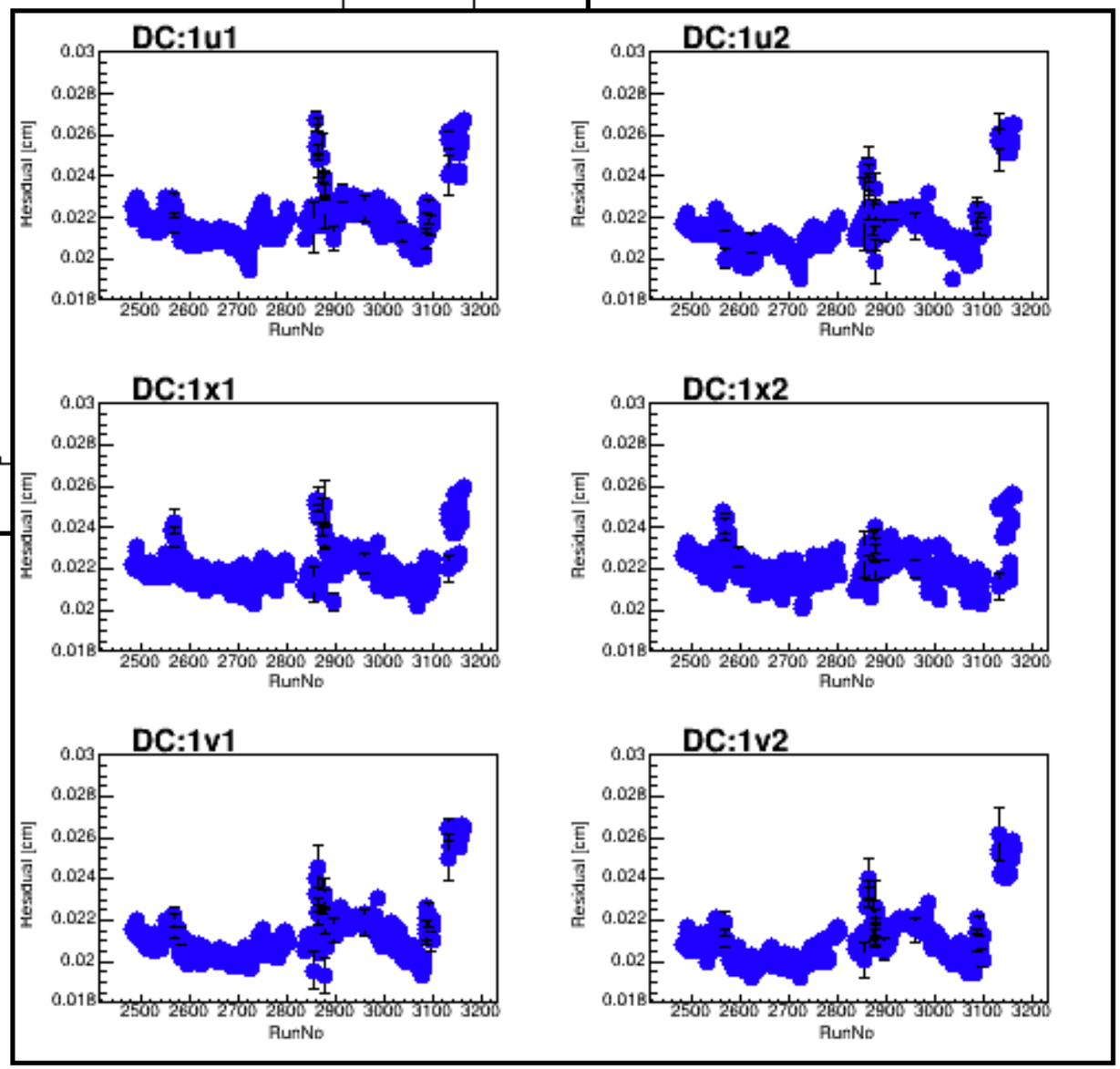


Drift Time Distri



Drift Distance

Residual



Resolution per plane ~ 220 micron

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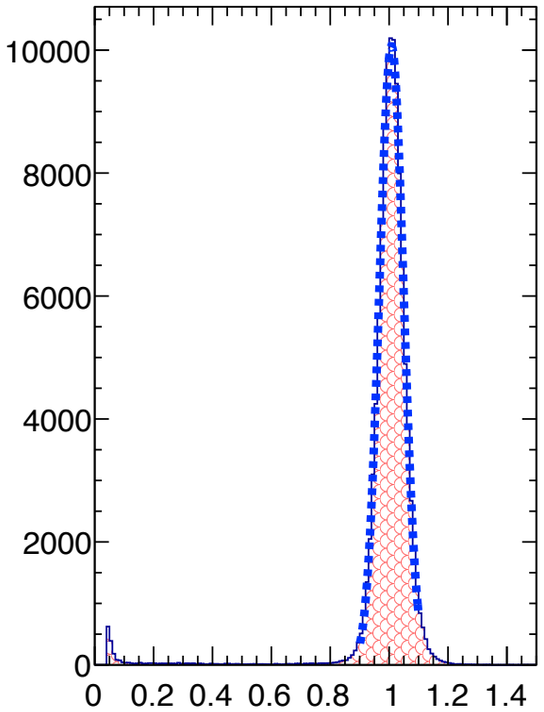
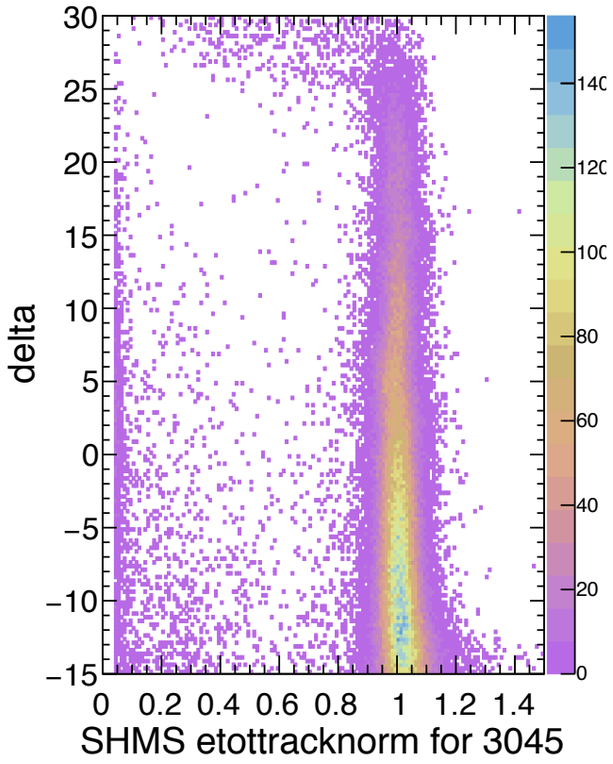
Calorimeter Calibration





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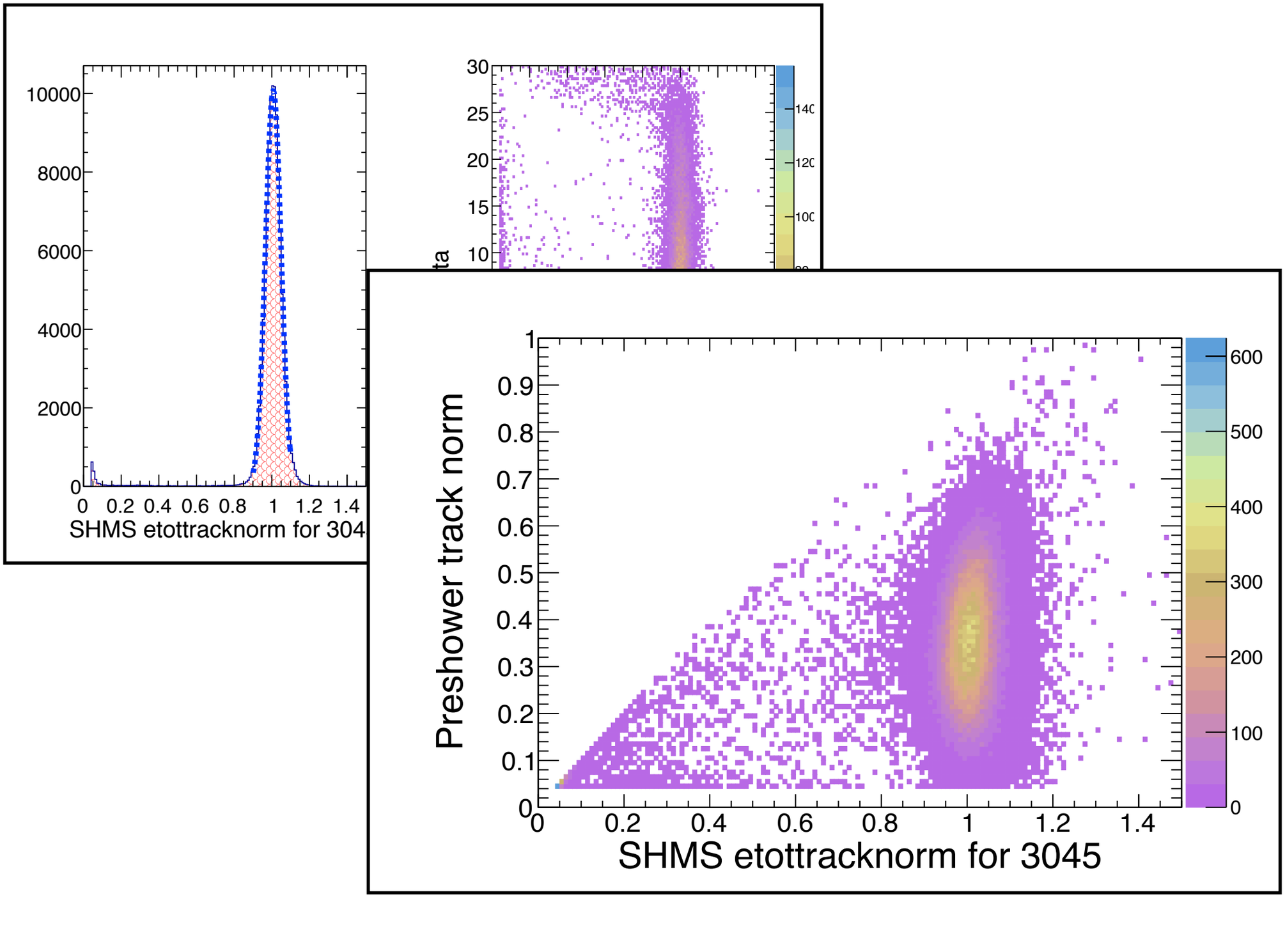

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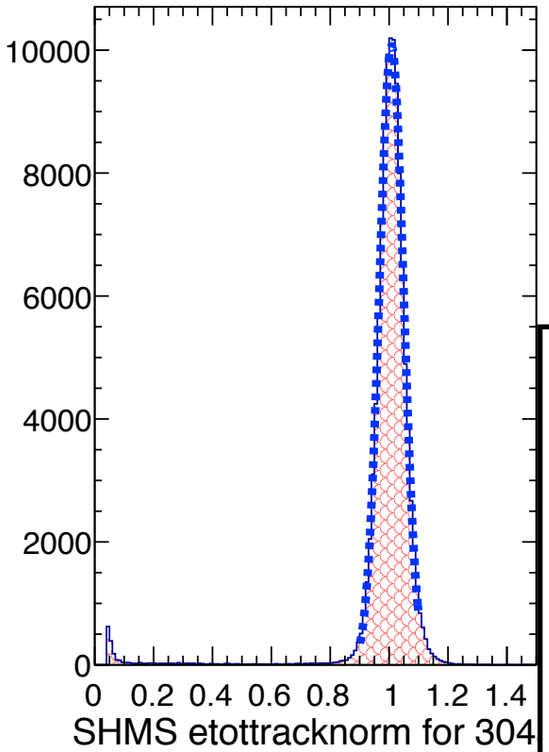

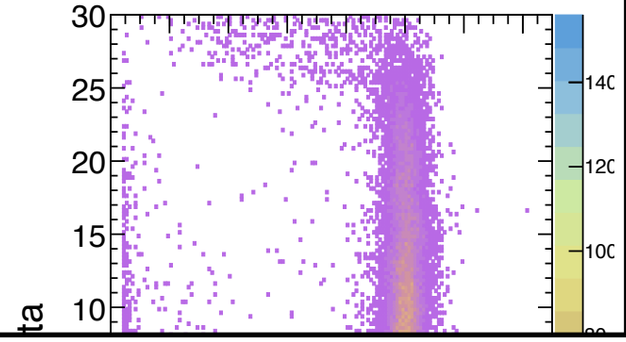

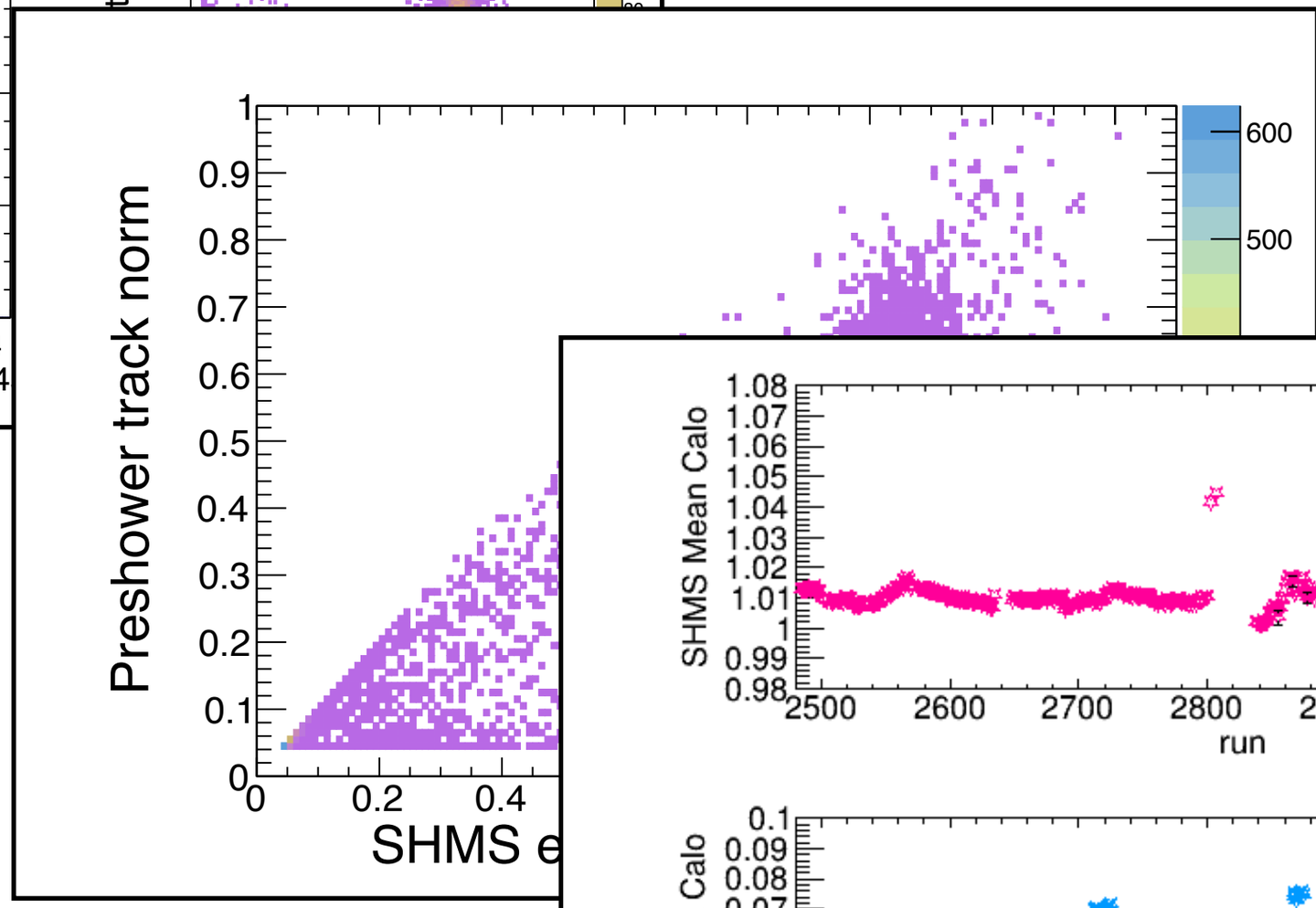

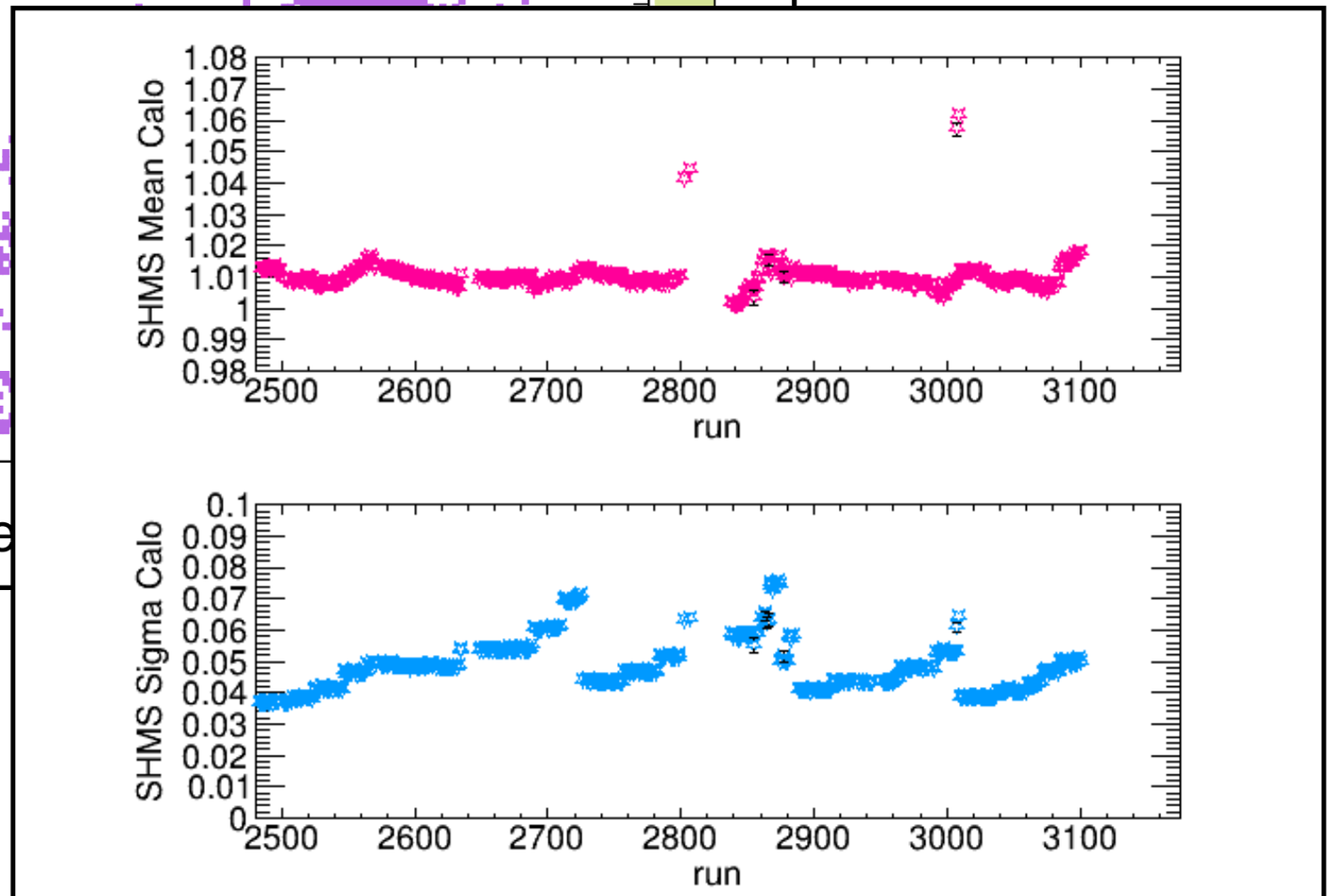

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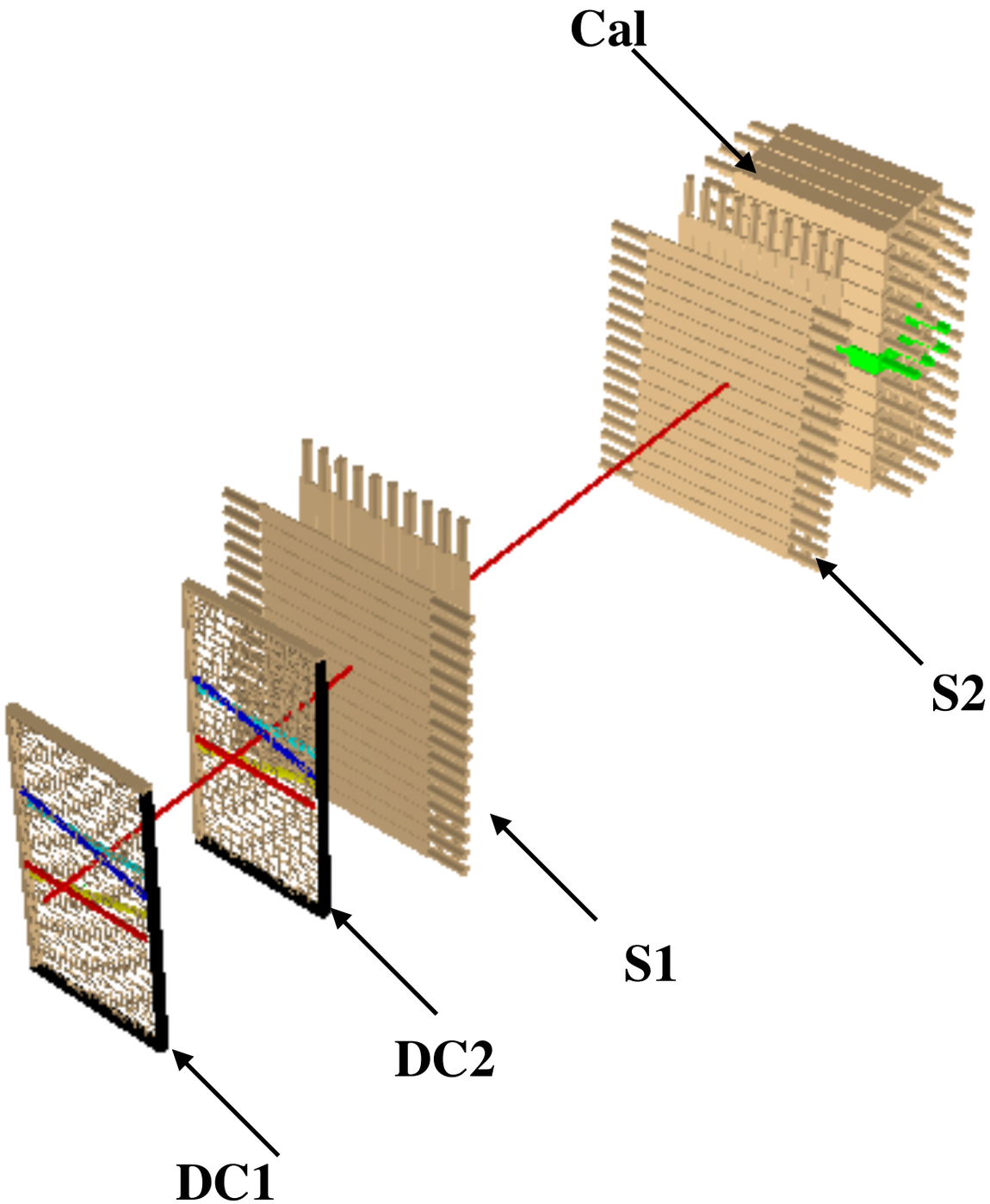
Efficiency Study : Tracking



Event Display :
Typical single track trough the detectors

Important tracking parameters

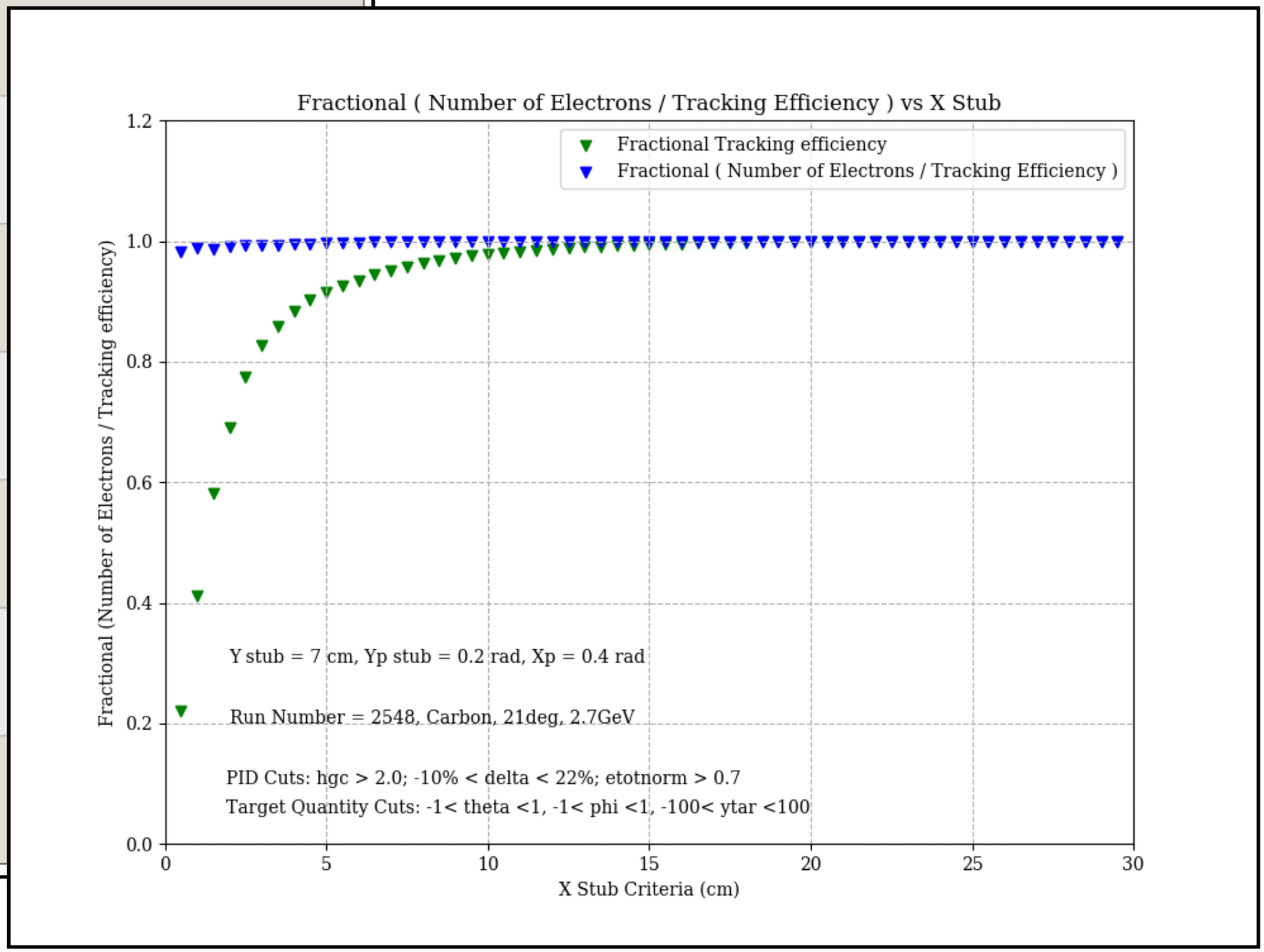
X stub	25 (cm)
Xp stub	0.7 (rad)
Y stub	7 (cm)
Yp stub	0.2 (rad)
pmax_pr_hits	25,25
pmin_combos	4,4
Space point criterion	1.2, 1.2 (cm)
pmin_hit	5,5

Efficiency Study : Tracking

Important tracking parameters

X stub	25 (cm)
Xp stub	
Y stub	
Yp stub	
pmax_pr_hits	
pmin_combos	
Space point criterion	
pmin_hit	

X Stub

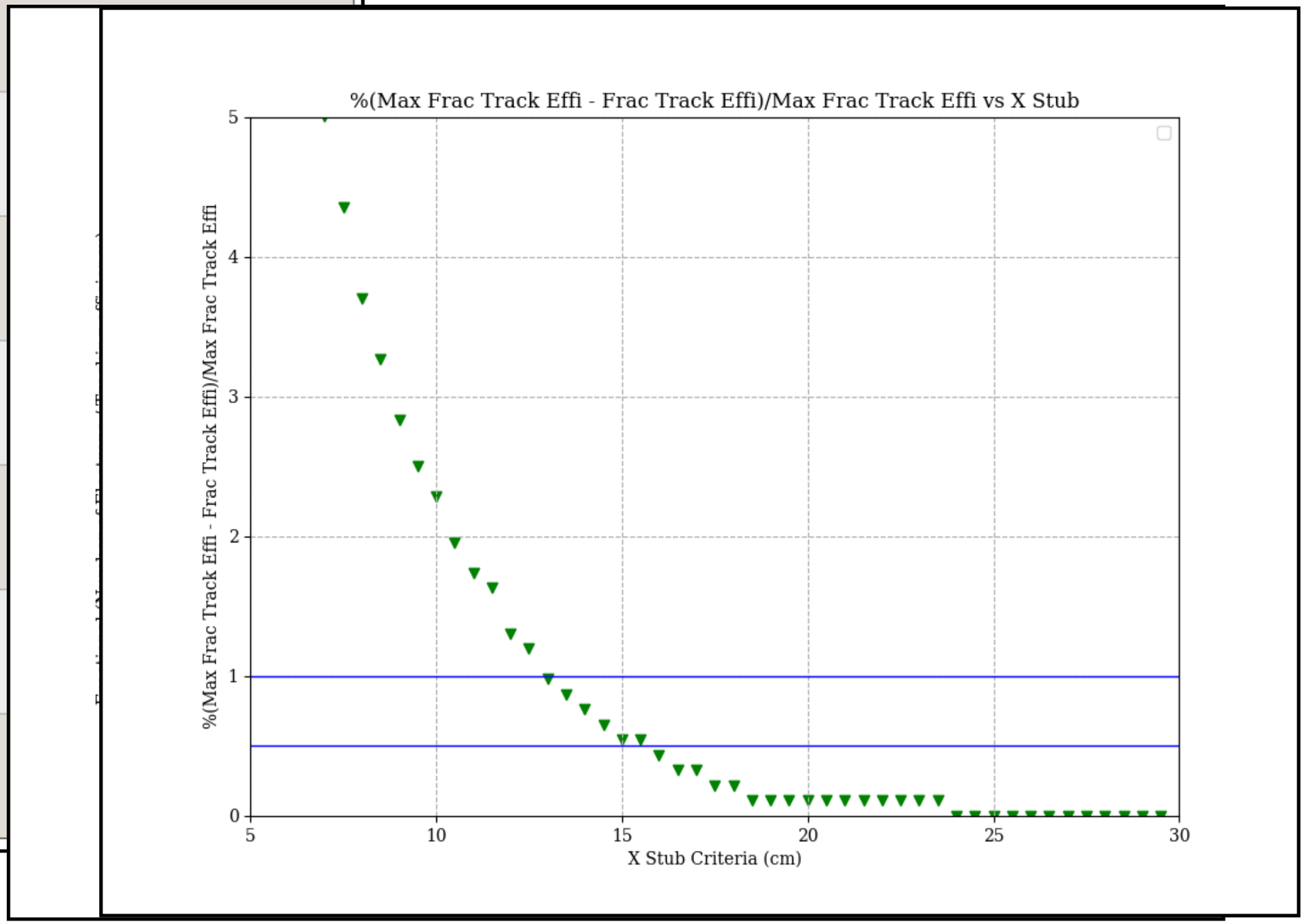


Efficiency Study : Tracking

Important tracking parameters

X stub	25 (cm)
Xp stub	
Y stub	
Yp stub	
pmax_pr_hits	
pmin_combos	
Space point criterion	
pmin_hit	

X Stub residual



Summary

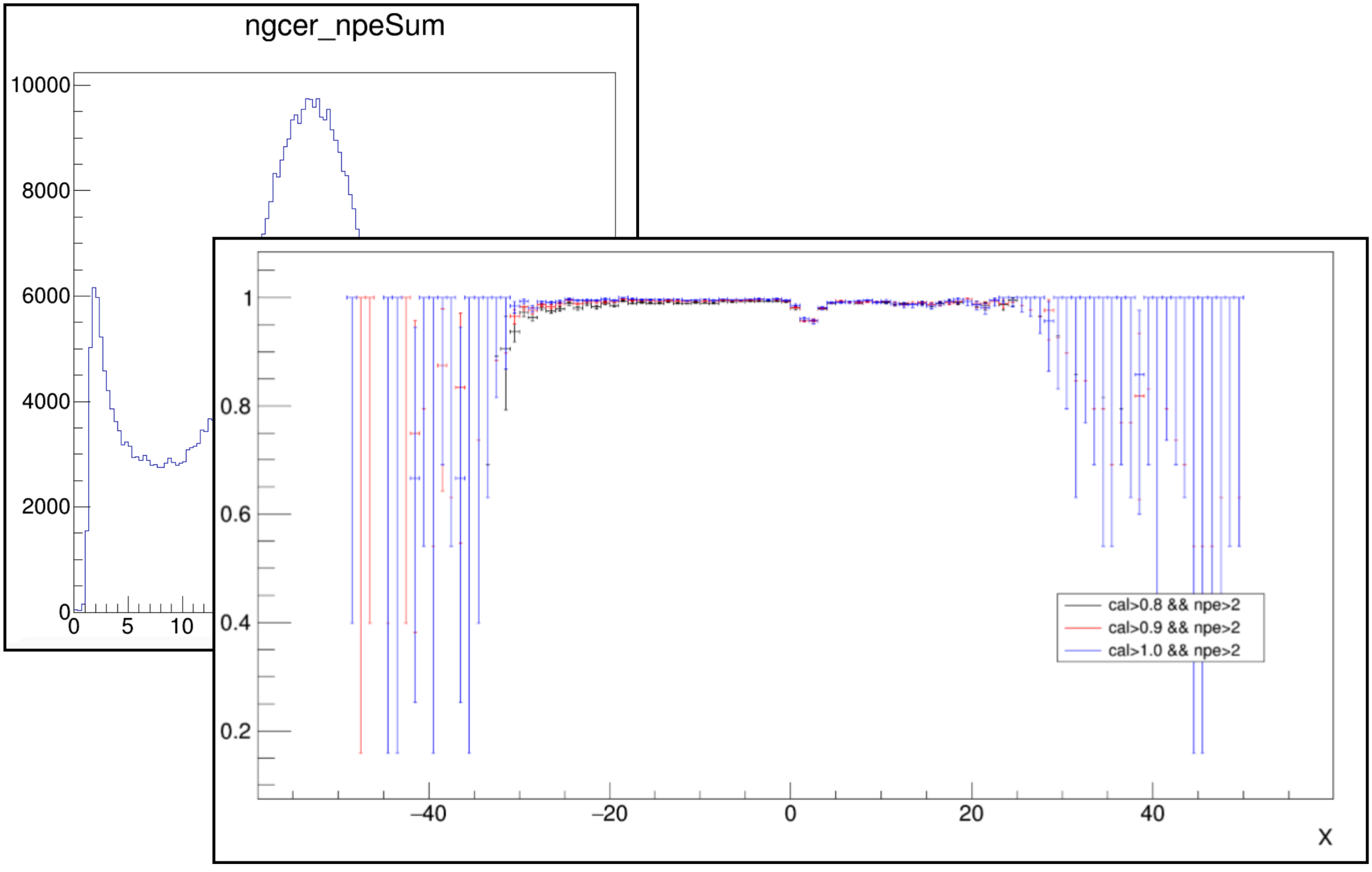
- Reached 100% statistical goal in data collection
- Good progress with the analysis over the past year
- We are at the point where we can extract the prelim cross sections and D/H ratios
- See Next Talk For more results and Cross Section !

Thank You !

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

Backup Slides

Noble Gas Cerenkov efficiency



Calorimeter Efficiency