

# Emittance Analysis Solenoid Mode

T. Lord

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12/03/2020 / MICE CM56 / RAL

## Where Things Are

- All solenoid mode datasets (excl. wedge) have had preliminary analysis completed ( *data-selection with cuts* ). In process of checking for problems
- Amplitude evolution analysis exists for cooling channel tag 2017-02-6
- Checking problem areas before escalating to all datasets

## Run Selection

Cooling Channel tag : 2017-02-6

3,4,6,10-140 LH2-full, LH2-empty, empty + LiH

MC + Data

### 3-140 LH2

9883, 9888, 9893, 9897,  
9903, 9906

### 3-140 LH2-EMPTY

10243, 10248, 10253,  
10254, 10255, 10256

### 3-140 No Absorber

10313, 10314, 10323, 10327,  
10333

### 3-140 LiH

10508, 10511

### 4-140 LH2

### 4-140 LH2-EMPTY

### 4-140 No Absorber

### 4-140 LiH

10315, 10317, 10322, 10328,  
10334

10504, 10505, 10506, 10507

### 6-140 LH2

9884, 9885, 9889, 9894,  
9898, 9904, 9905

### 6-140 LH2-EMPTY

10245, 10247, 10249

### 6-140 No Absorber

10318, 10324, 10329, 10335

### 6-140 LiH

10509, 10510

### 10-140 LH2

9886, 9887, 9890, 9891,  
9892, 9895, 9896, 9899,  
9900, 9901, 9902

### 10-140 LH2-EMPTY

10246, 10250, 10251,  
10252, 10257, 10258,  
10259, 10260

### 10-140 No Absorber

10319, 10321, 10325, 10326,  
10330, 10331, 10332

### 10-140 LiH

## Note

Only 10-140 LiH solenoid mode data is for cooling channel settings with :

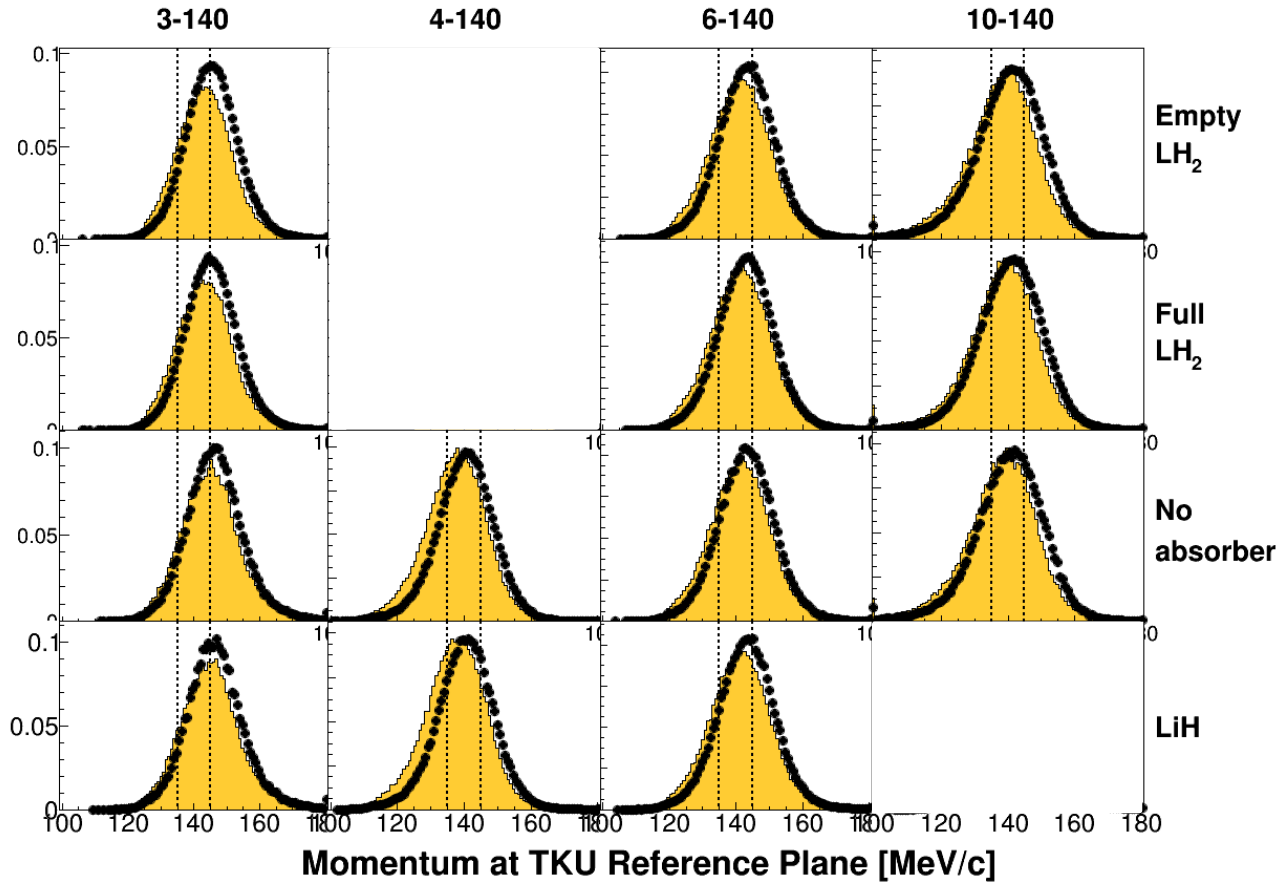
LiH vs no absorber

&

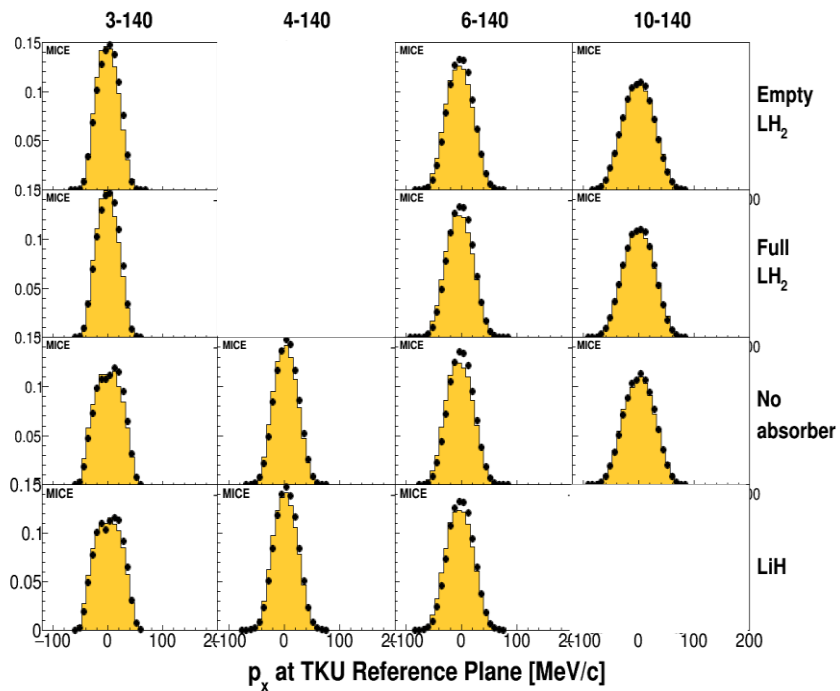
LiH 3,6,10 – 140, 3-170,200,240

LiH systematics amplitude analysis is crashing during rebinning.. Under investigation

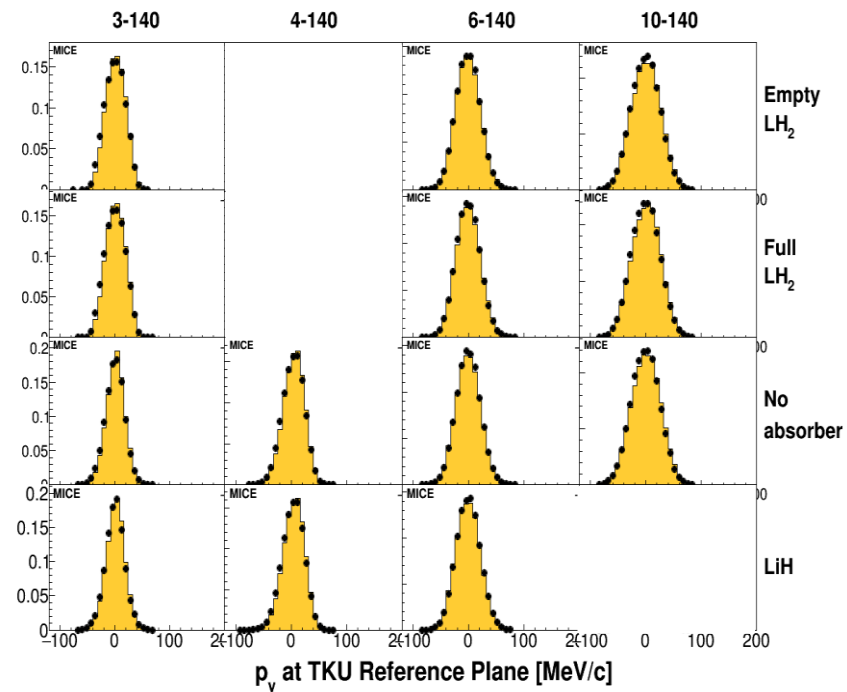
Further MC tuning needed for tku momentum agreement for 4-140



## Px

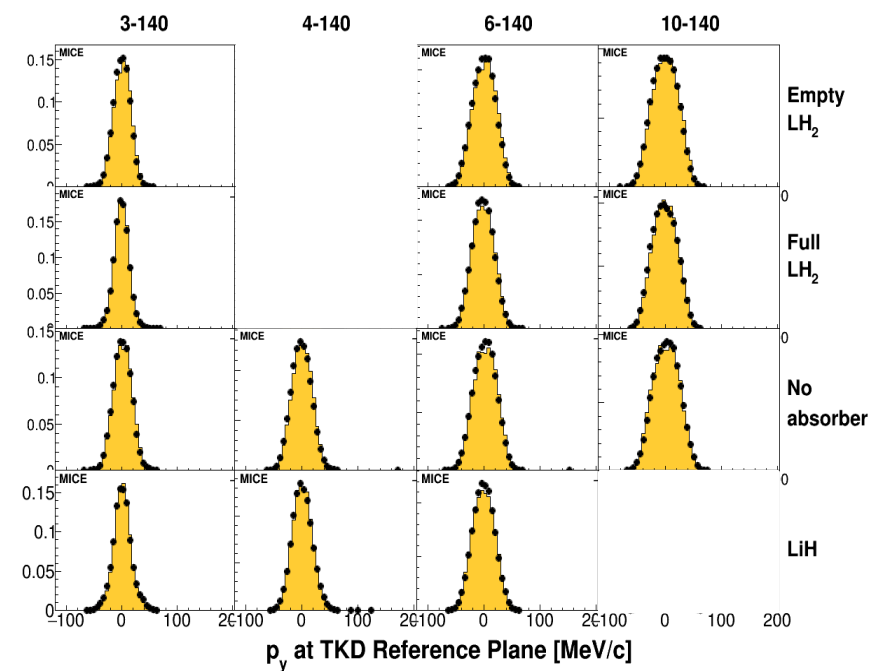
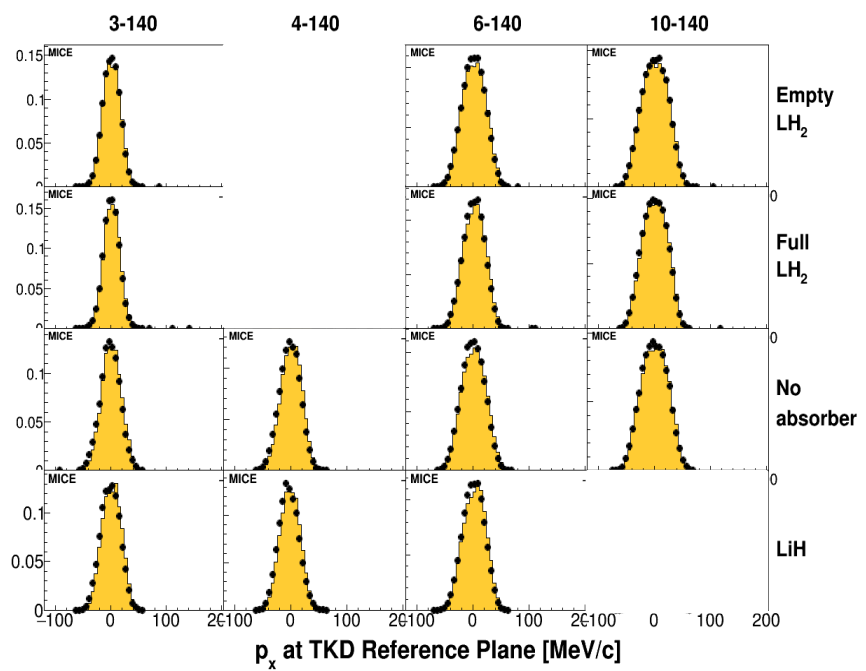


## Py



## Px

## Py

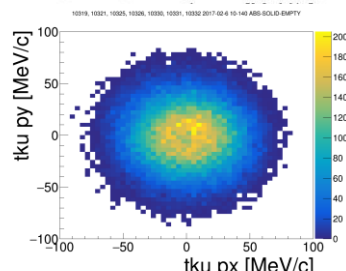
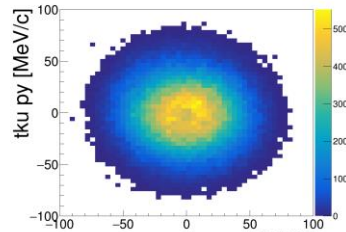
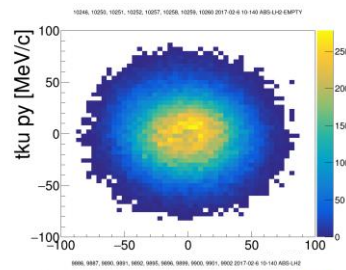
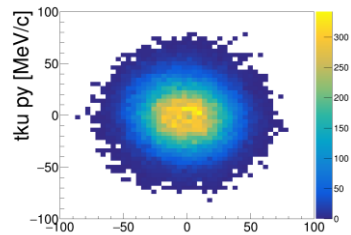
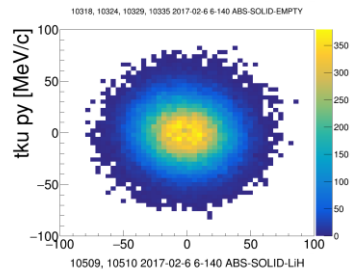
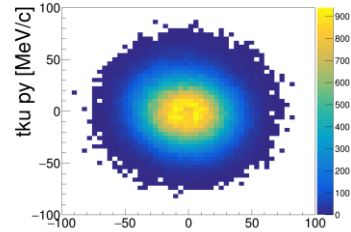
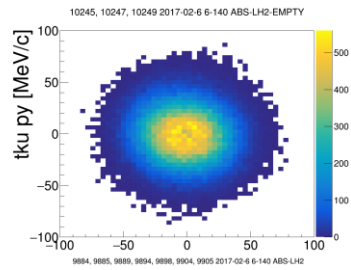
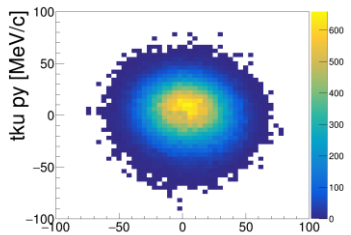
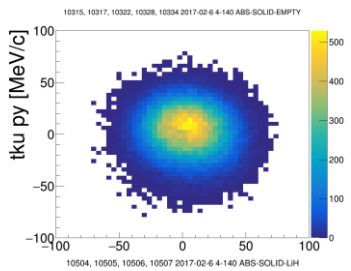
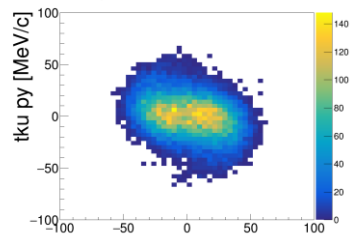
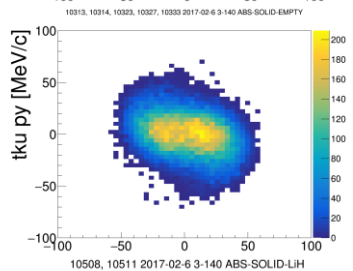
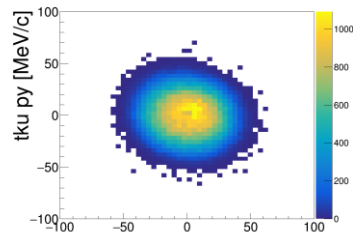
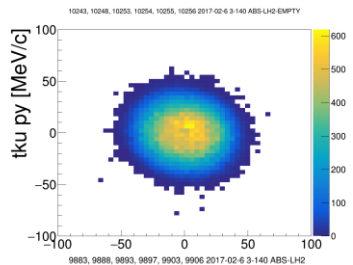


3

4

6

10



LH2-Empty

LH2

Beam – PX,  
PY US

Empty

LiH

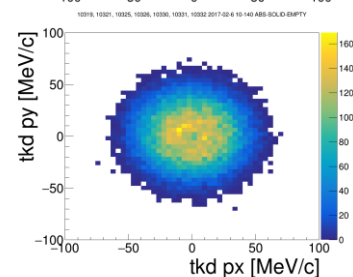
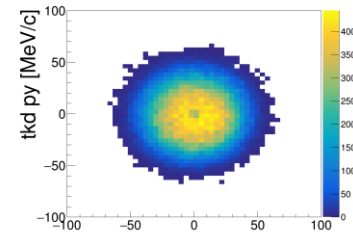
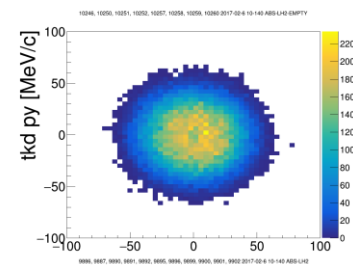
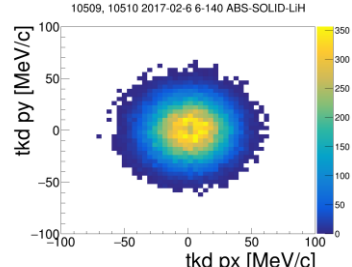
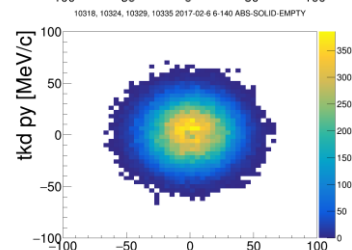
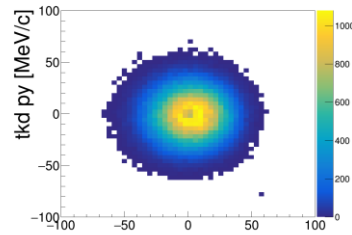
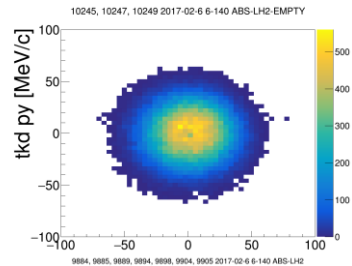
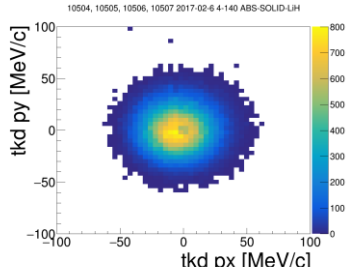
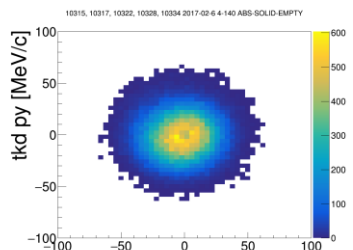
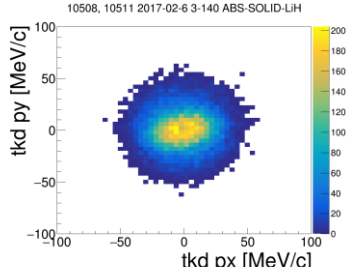
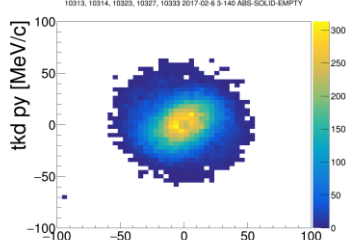
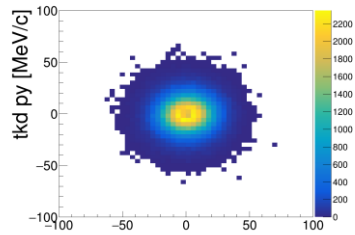
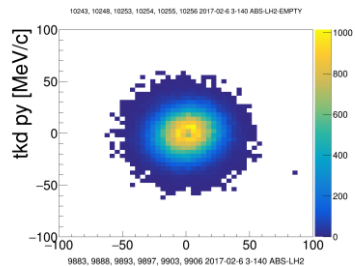


3

4

6

10



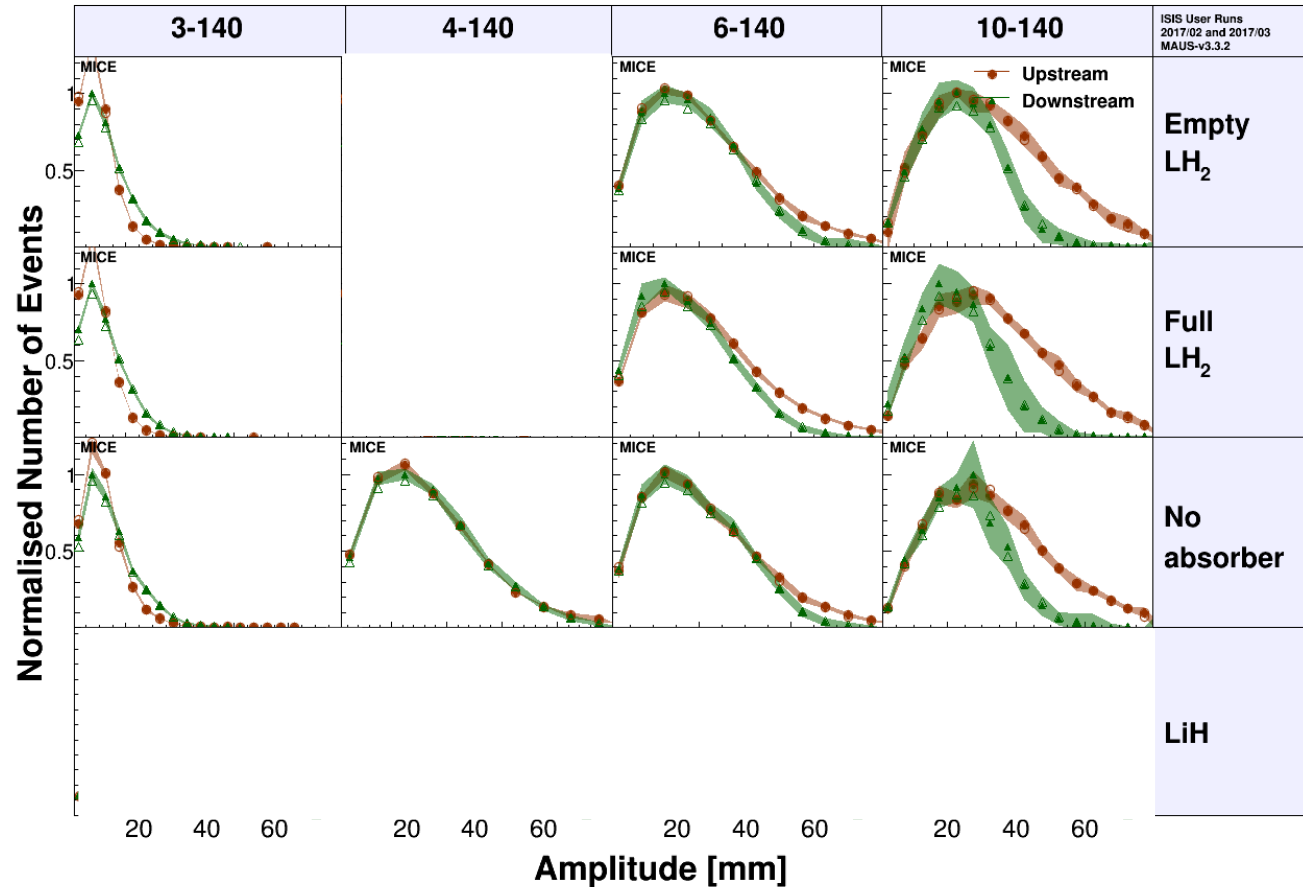
LH2-Empty

LH2

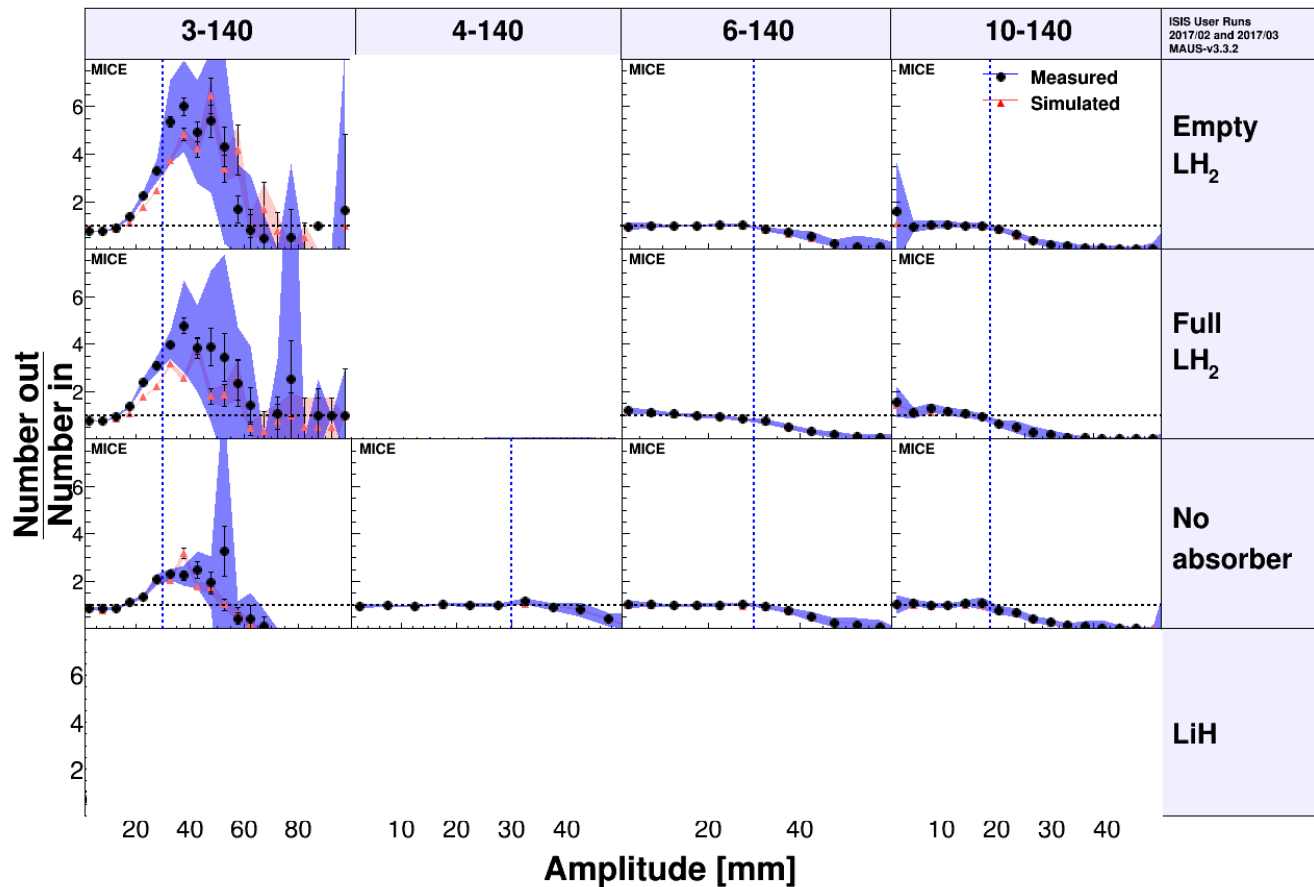
Beam - PX,  
PY DS

Empty

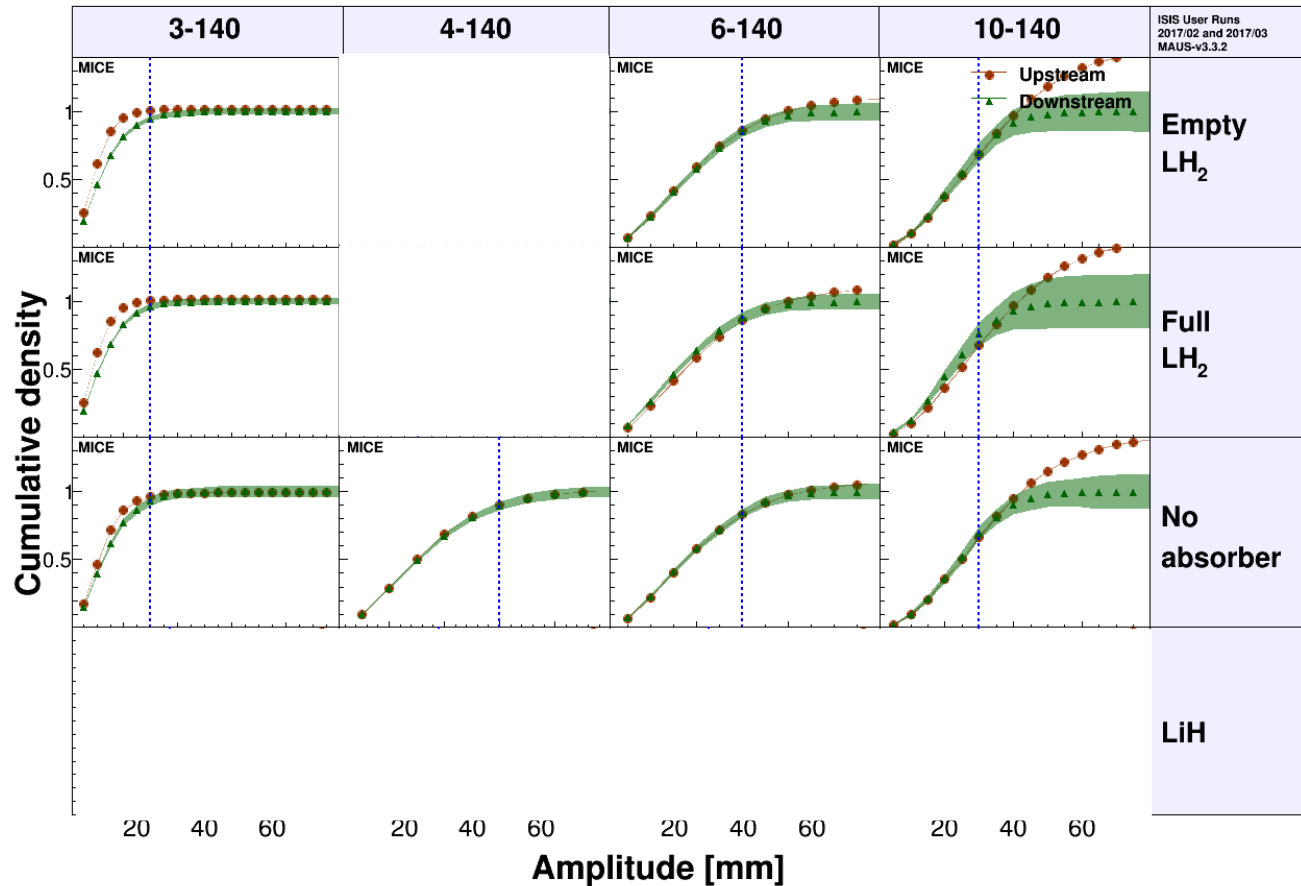
LiH



# Amplitude PDF Ratios – Data vs MC

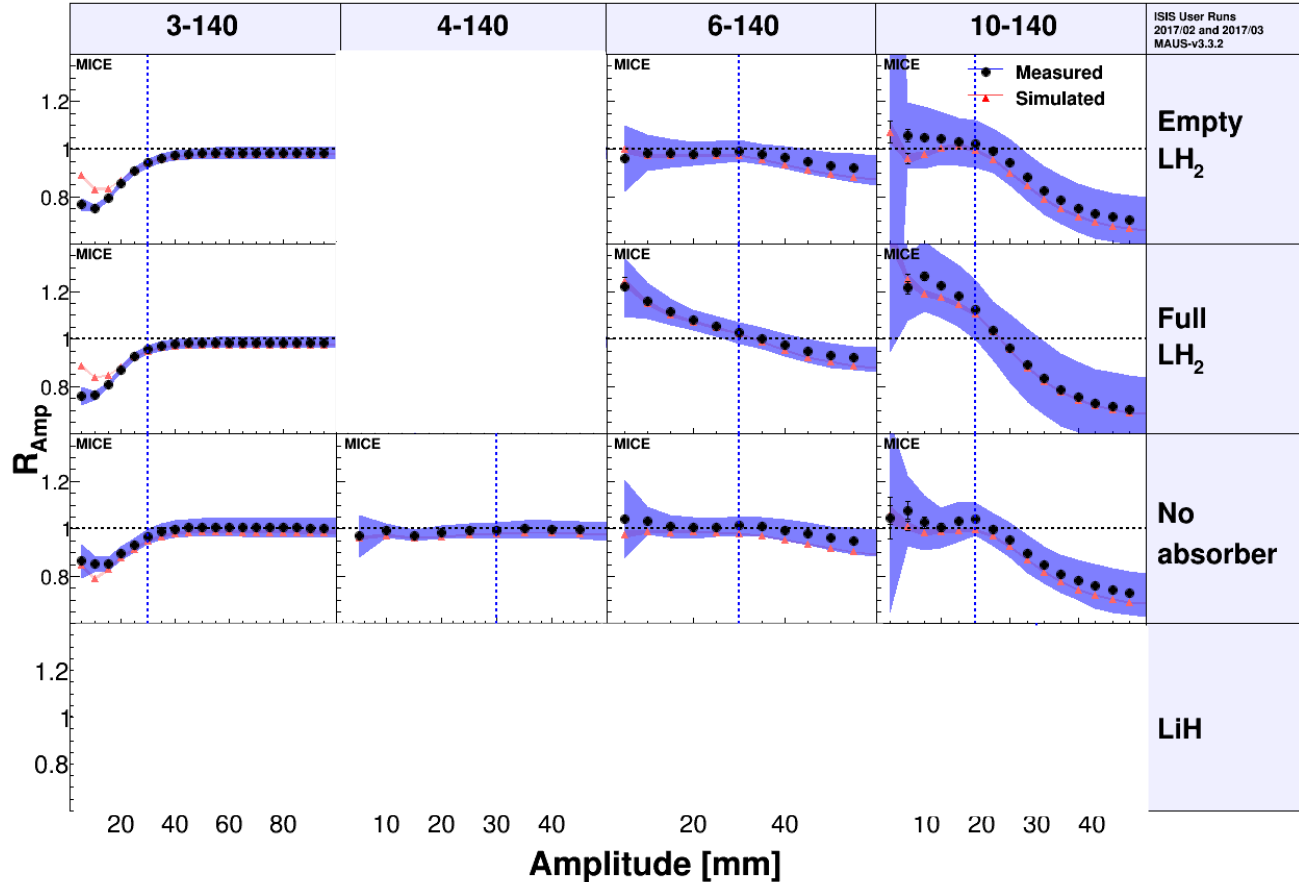


# Amplitude CDFs



ISIS User Runs  
2017/02 and 2017/03  
MAUS-v3.3.2

# Amplitude CDF Ratios – Data vs MC





## Higher momentum runs

Field tuning for momentum agreement at tku

Running iterations of maus reco with/without TOFTracker

Shown :

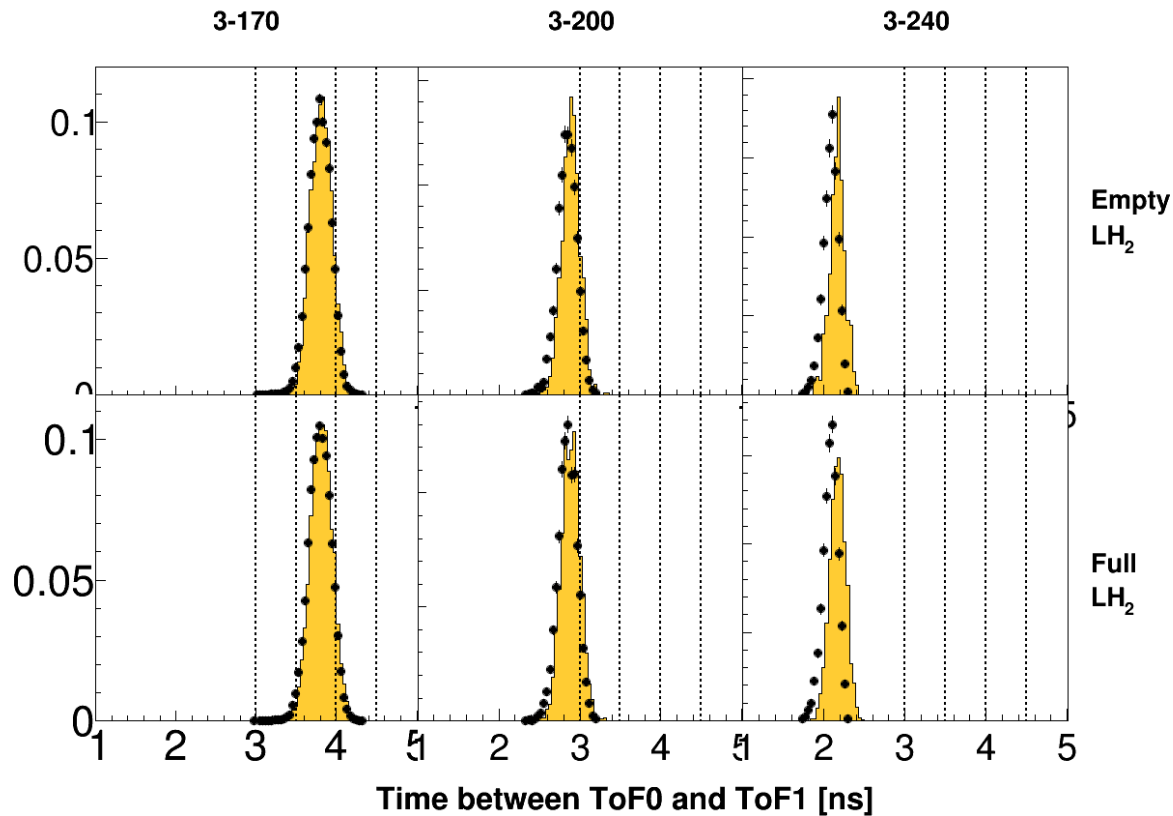
Cooling Channel tag : 2017-02-6

3 – 170, 200, 240

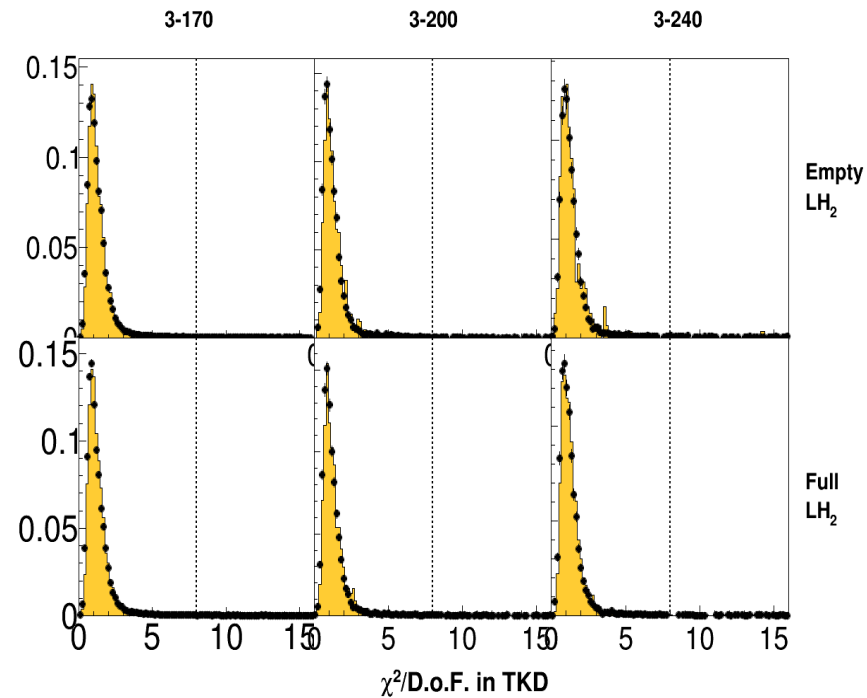
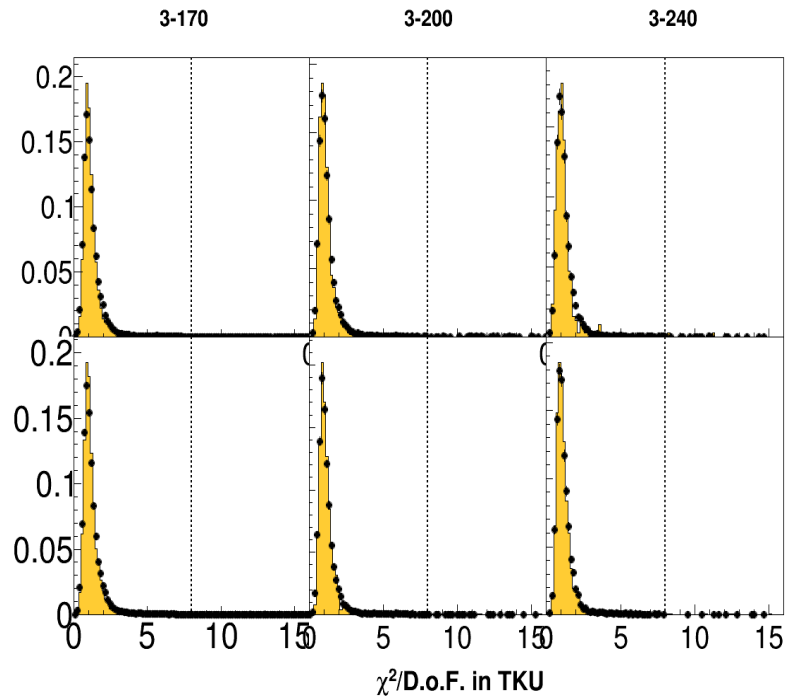
LH2, LH2-empty



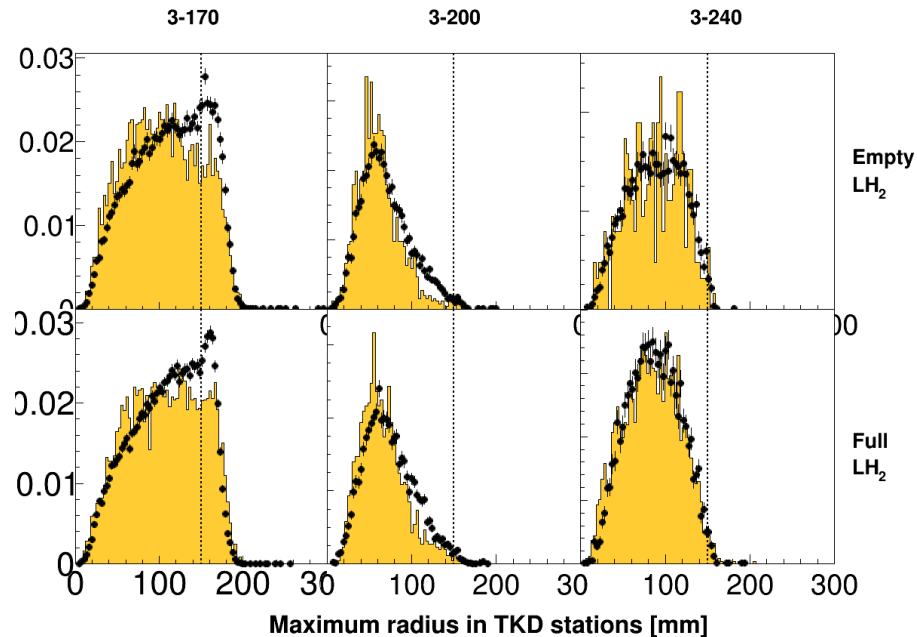
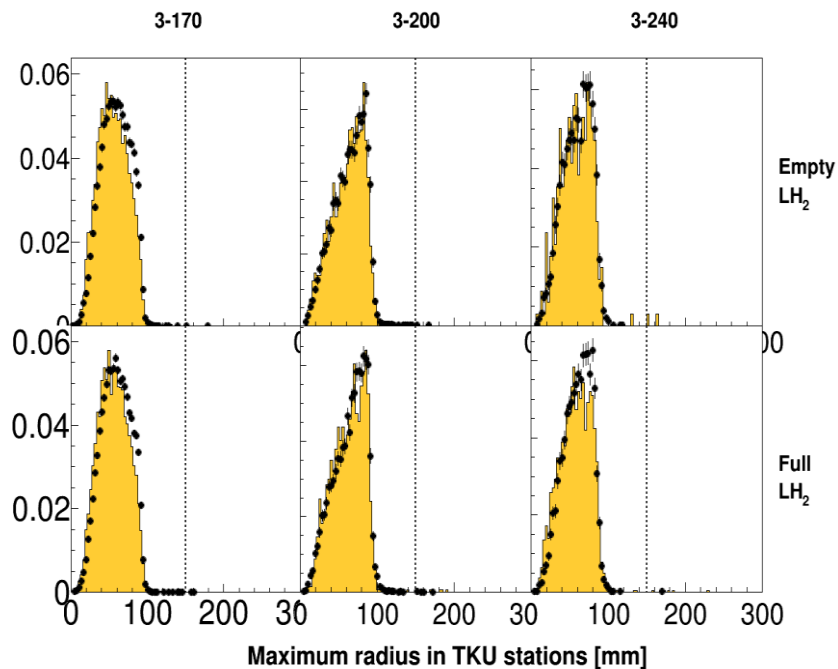
# Higher momentum runs, solenoid mode



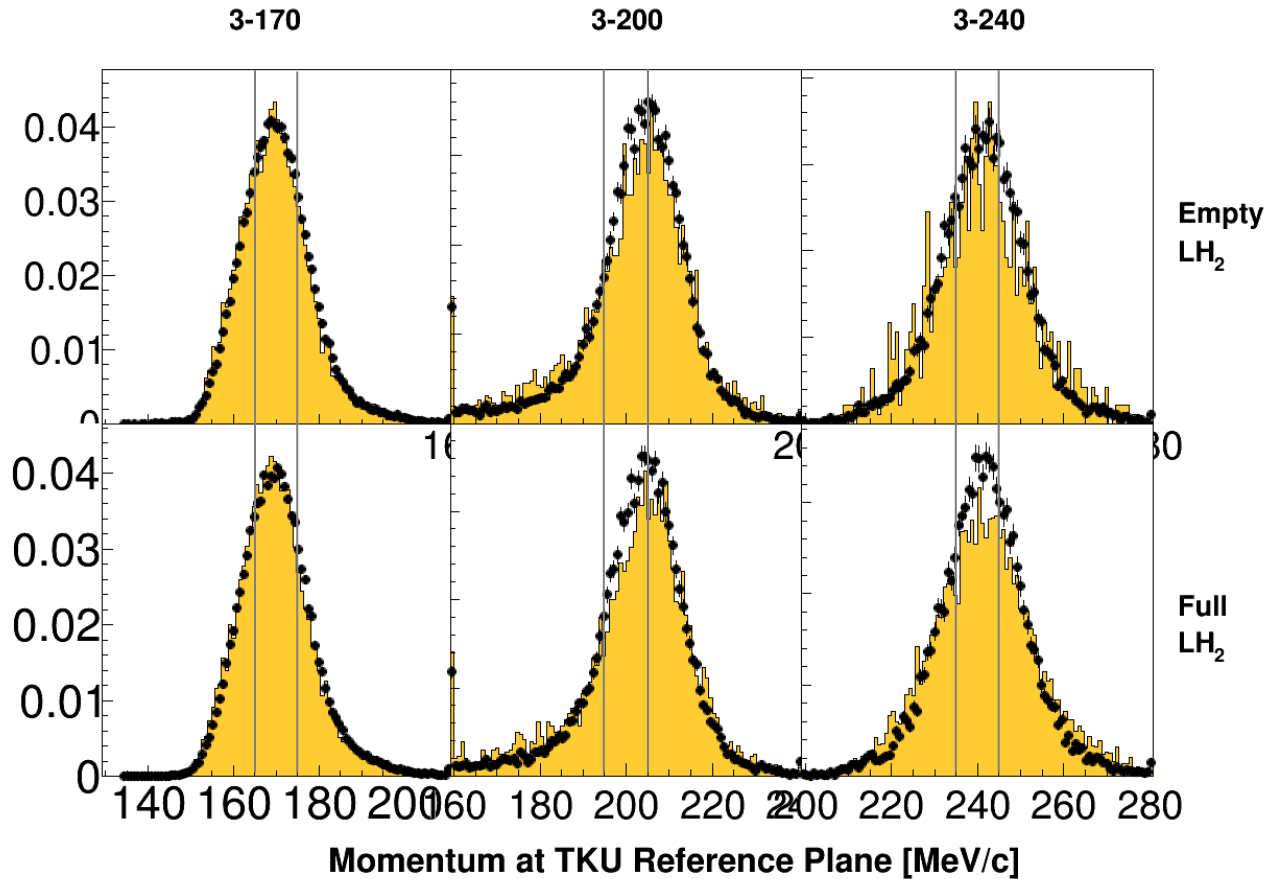
# Higher momentum runs, solenoid mode



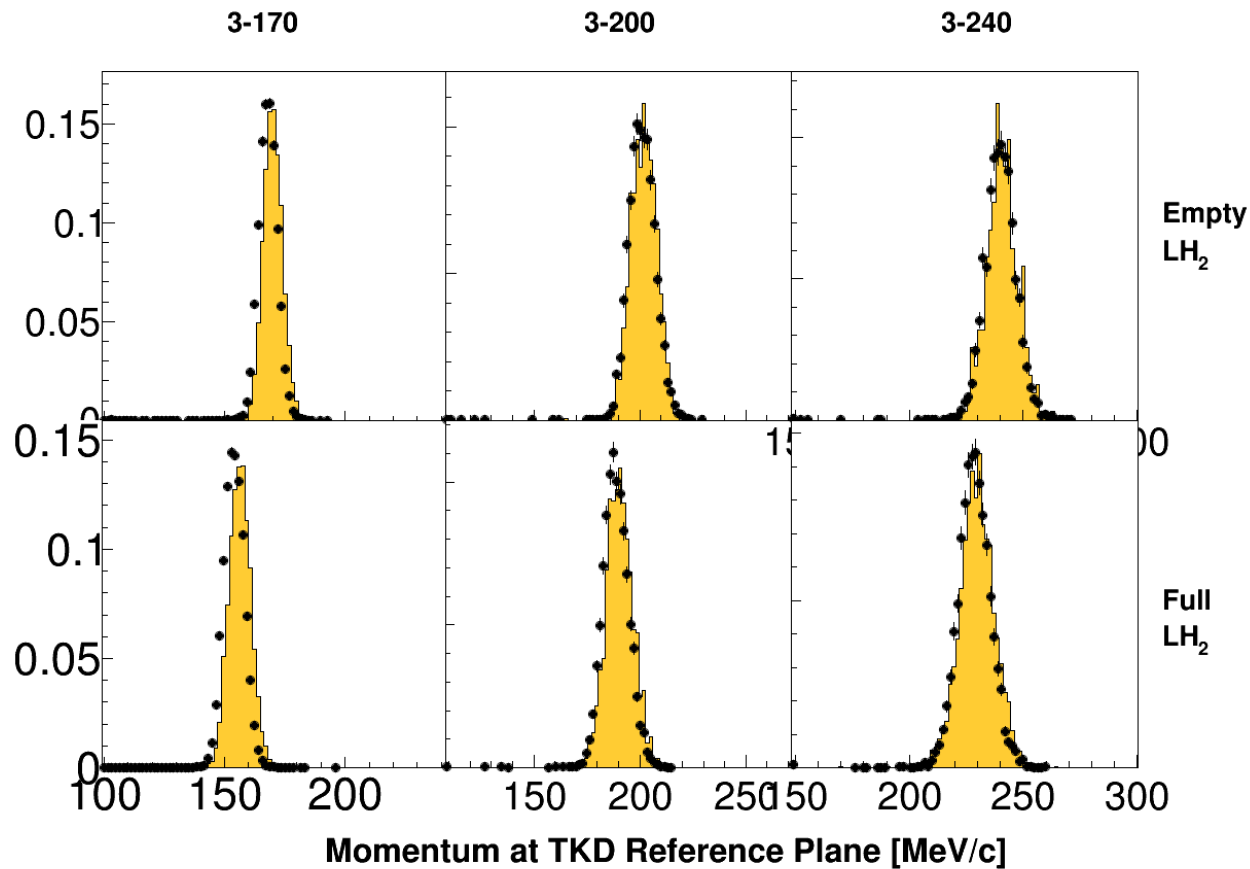
# Higher momentum runs, solenoid mode



# Higher momentum runs, solenoid mode



# Higher momentum runs, solenoid mode

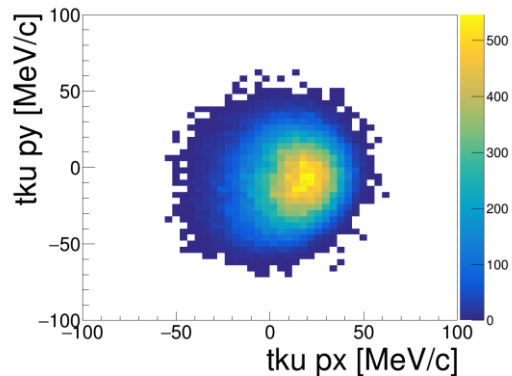


# Higher momentum runs, solenoid mode

Strong bias in p<sub>x</sub>p<sub>y</sub> plots for higher mom beamline. Suggestion is this could be from refitting of momentum based on TOF01 + TRACKER combined refit – Testing without TrackerTOFCombinedFit to see if this changes

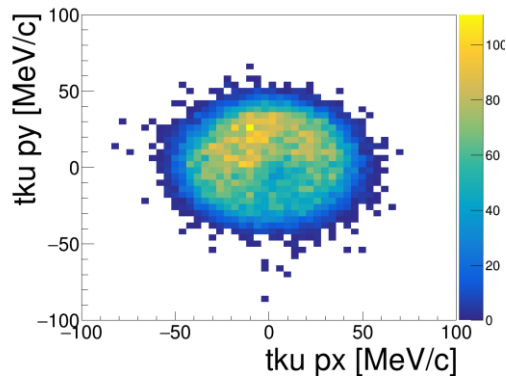
## 3-170

10268, 10269 2017-02-6 3-170 ABS-LH2-EMPTY



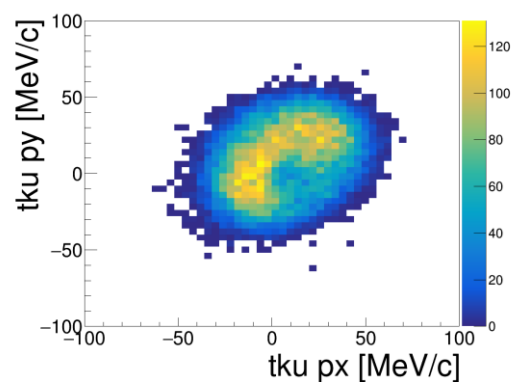
## 3-200

10262, 10266, 10267, 10275 2017-02-6 3-200 ABS-LH2-EMPTY



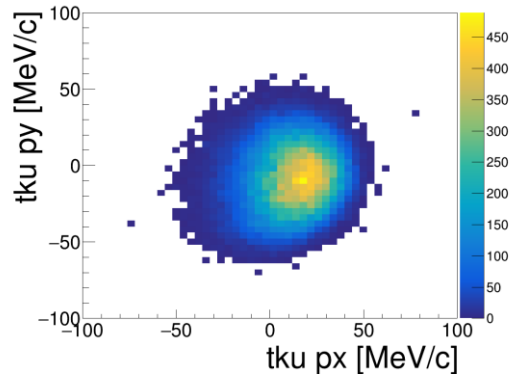
## 3-240

10261, 10264, 10265, 10270, 10271, 10272, 10273, 10274 2017-02-6 3-240 ABS-LH2-EMPTY

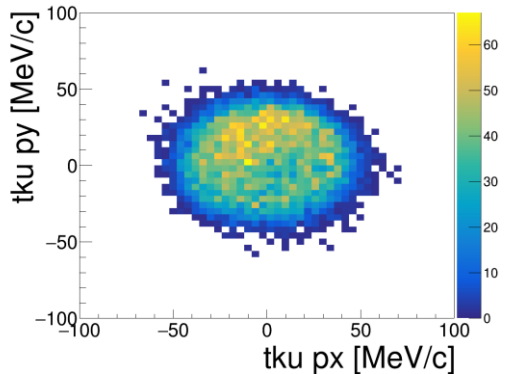


LH2-Empty

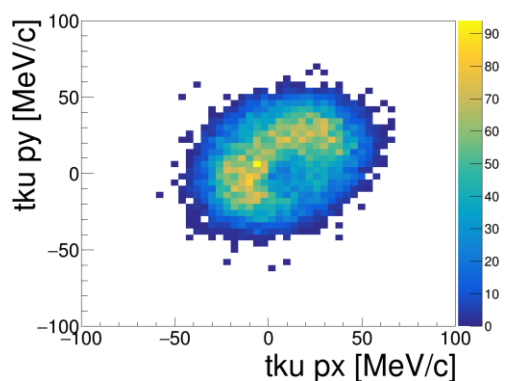
9911 2017-02-6 3-170 ABS-LH2



9910, 9915 2017-02-6 3-200 ABS-LH2



9907, 9908, 9909, 9912, 9913, 9914 2017-02-6 3-240 ABS-LH2



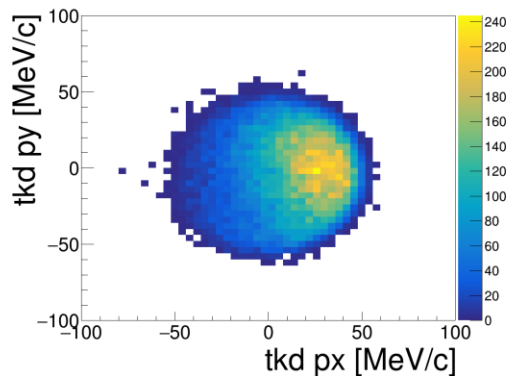
LH2

# Higher momentum runs, solenoid mode

Strong bias in p<sub>x</sub>p<sub>y</sub> plots for higher mom beamline. Suggestion is this could be from refitting of momentum based on TOF01 + TRACKER combined refit – Testing without TrackerTOFCombinedFit to see if this changes

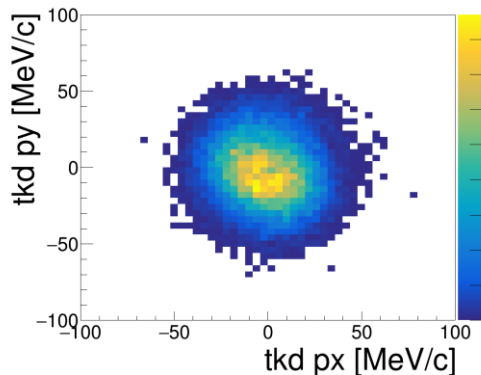
## 3-170

10268, 10269 2017-02-6 3-170 ABS-LH2-EMPTY



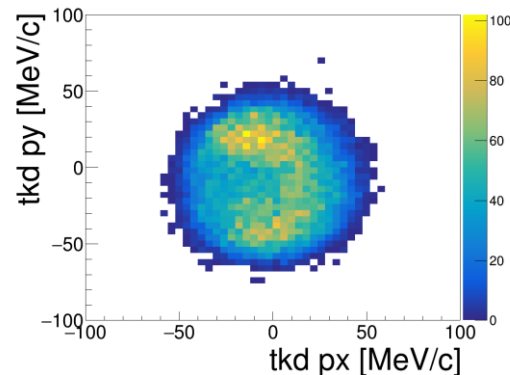
## 3-200

10262, 10266, 10267, 10275 2017-02-6 3-200 ABS-LH2-EMPTY



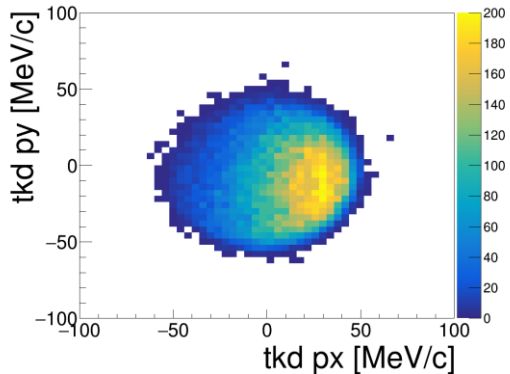
## 3-240

10261, 10264, 10265, 10270, 10271, 10272, 10273, 10274 2017-02-6 3-240 ABS-LH2-EMPTY

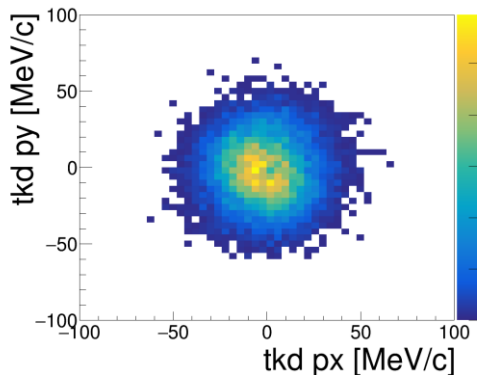


LH2-Empty

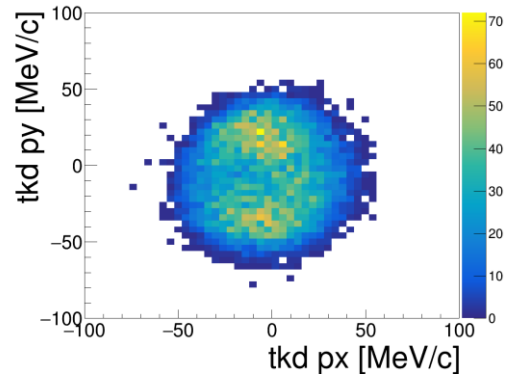
9911 2017-02-6 3-170 ABS-LH2



9910, 9915 2017-02-6 3-200 ABS-LH2



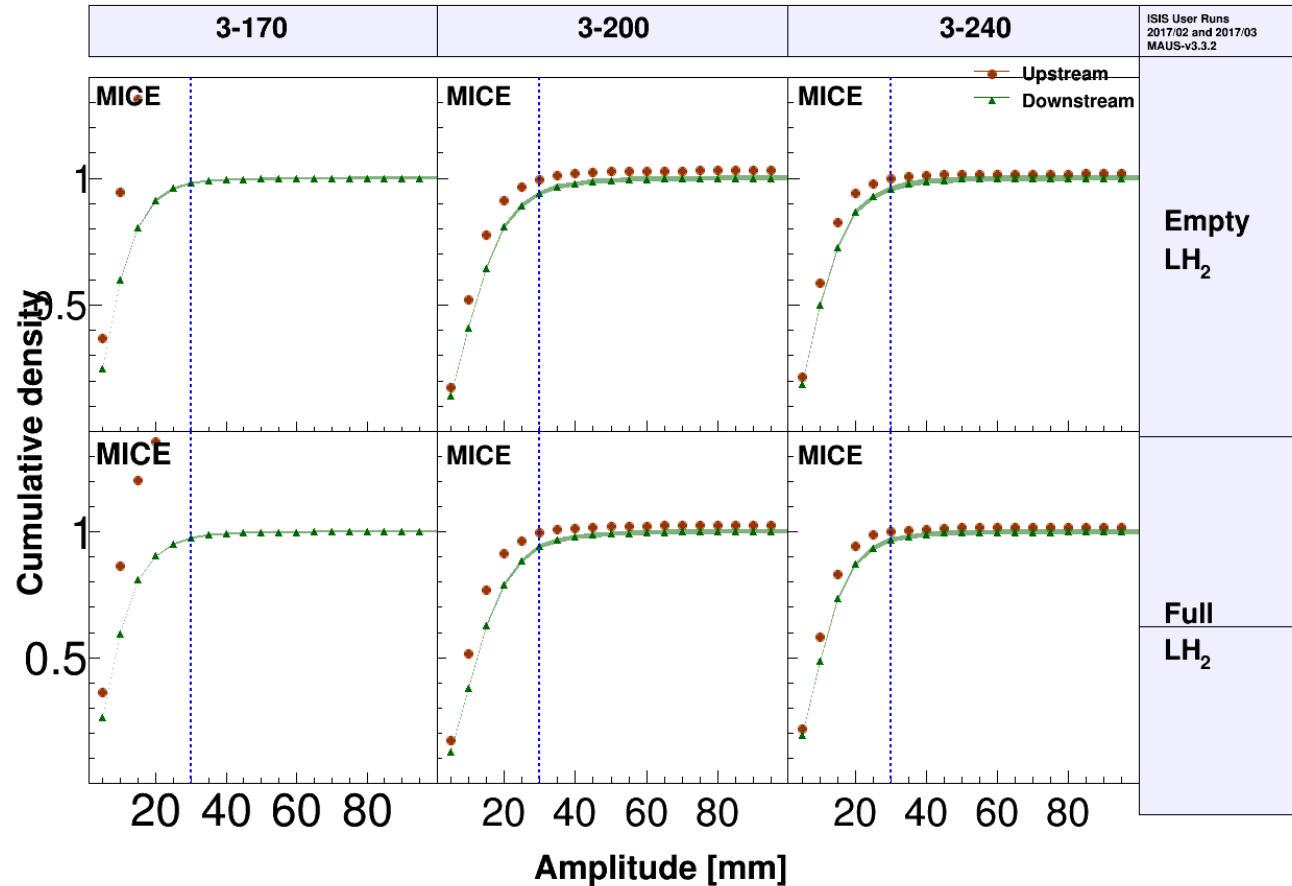
9907, 9908, 9909, 9912, 9913, 9914 2017-02-6 3-240 ABS-LH2



LH2

# Higher momentum runs, solenoid mode

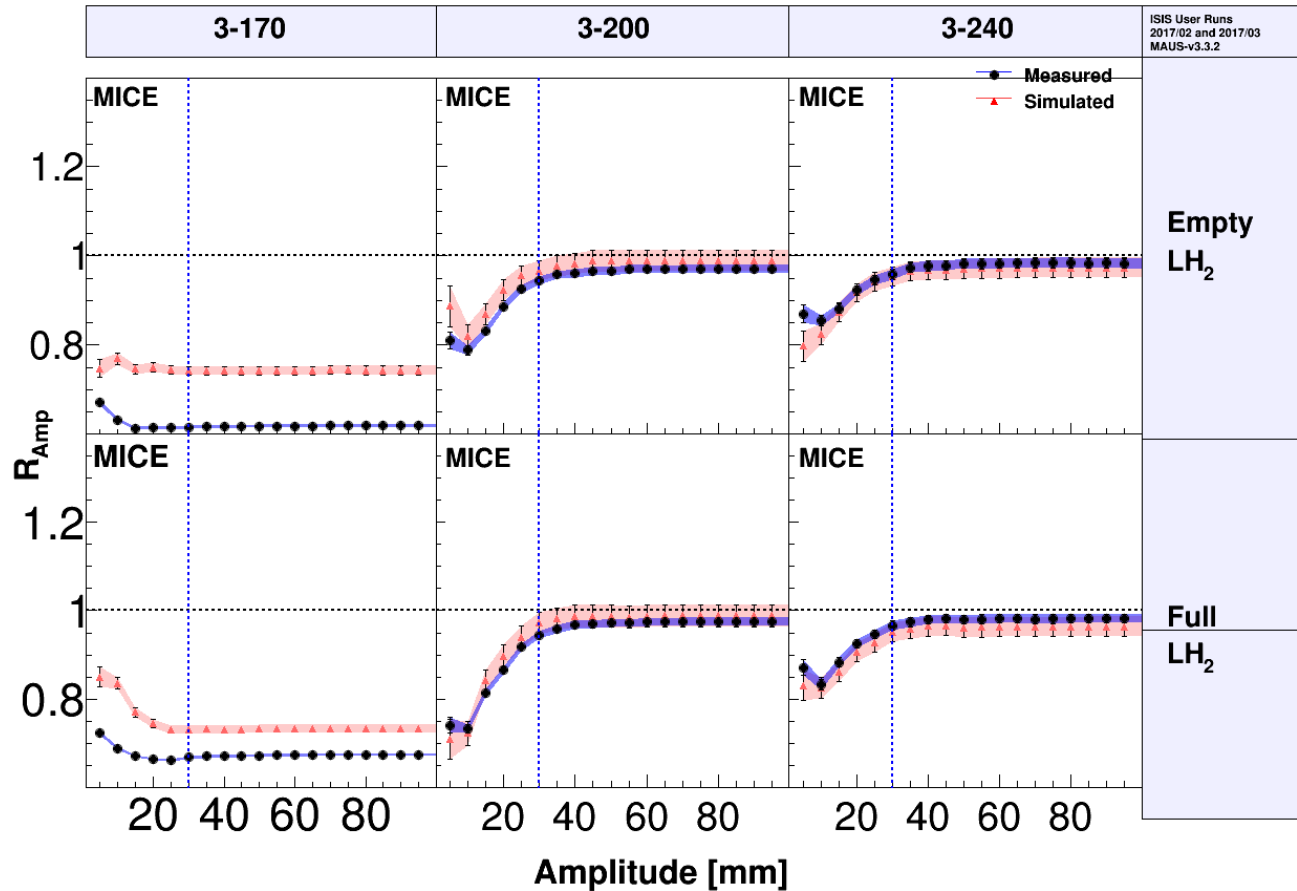
## CDF





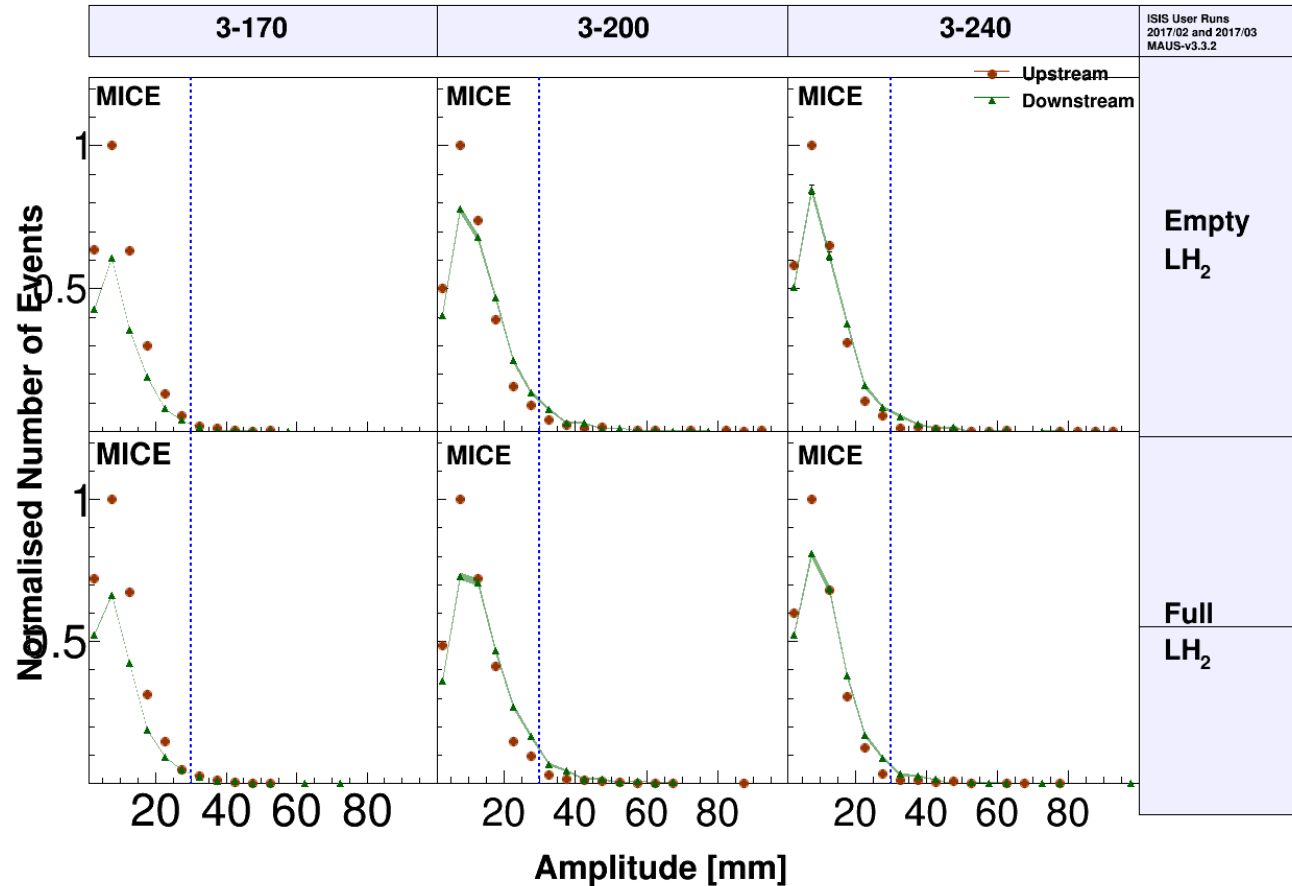
# Higher momentum runs, solenoid mode

## CDF ratios



# Higher momentum runs, solenoid mode

## PDF



ISIS User Runs  
2017/02 and 2017/03  
MAUS-v3.3.2

Empty  
LH<sub>2</sub>

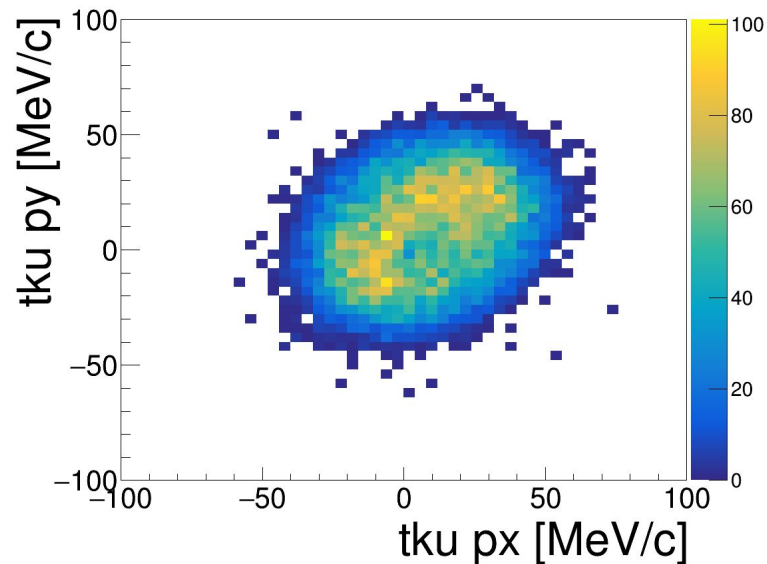
Full  
LH<sub>2</sub>

# Solenoid Mode Emittance Evolution - Low Pt hole in data selection

# Low Pt Hole US : Data plots

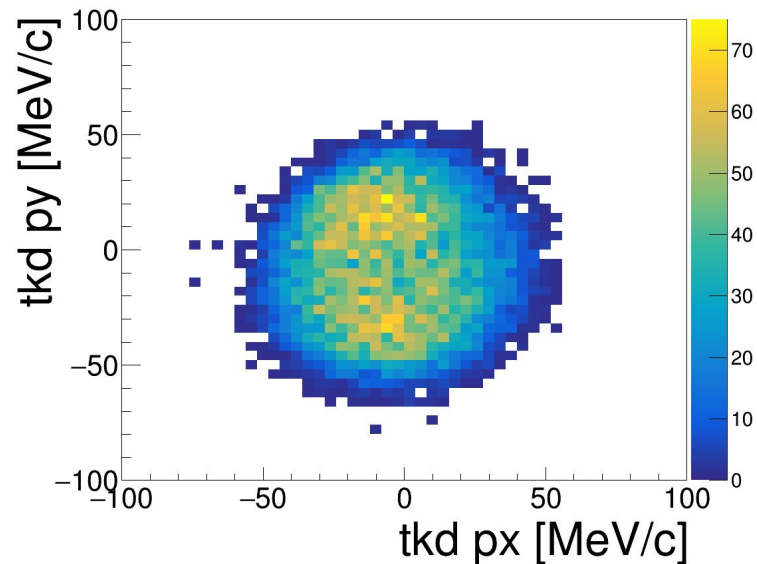
## tku

9907, 9908, 9909, 9912, 9913, 9914 2017-02-6 3-240 ABS-LH2



## tkd

9907, 9908, 9909, 9912, 9913, 9914 2017-02-6 3-240 ABS-LH2

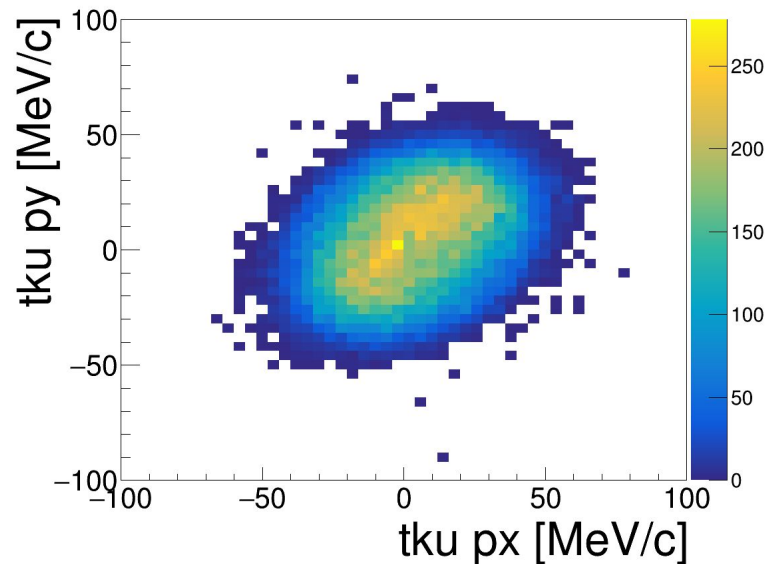


Limited by low event statistics / large track rejection rate in cuts

# Low Pt Hole US : MC plots

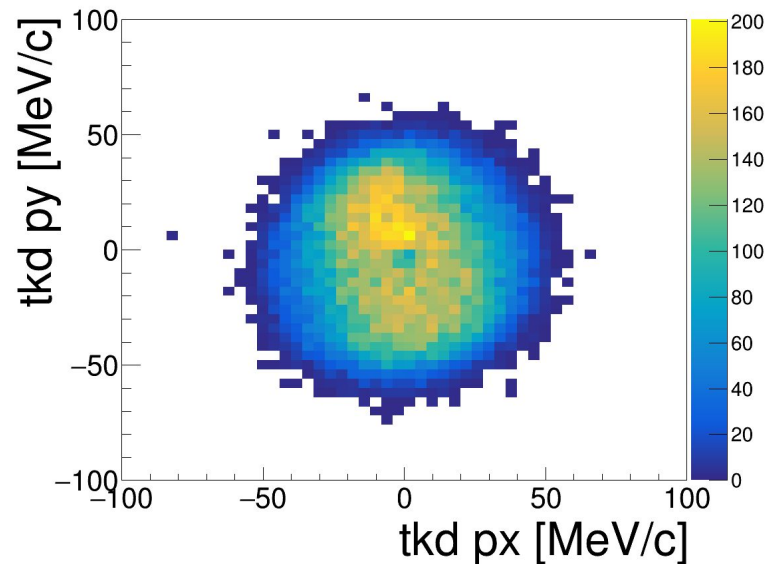
## tku

9909 2017-02-6 3-240 ABS-LH2



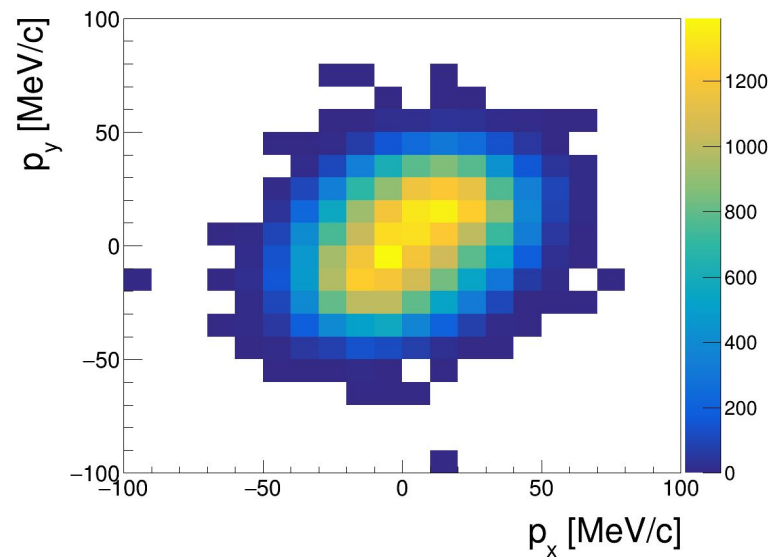
## tkd

9909 2017-02-6 3-240 ABS-LH2

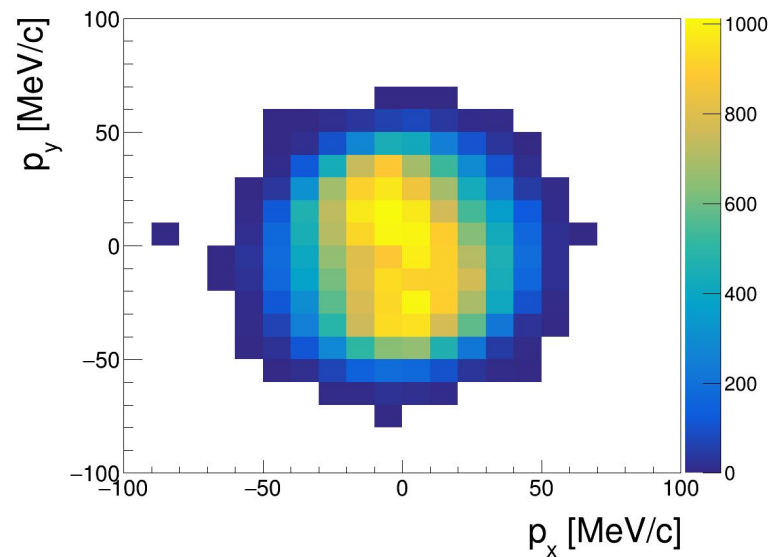


# Truth distributions

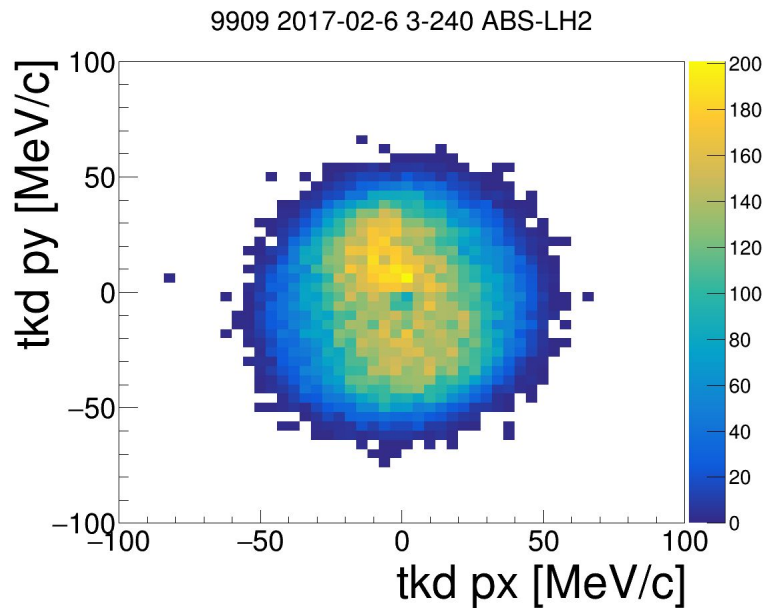
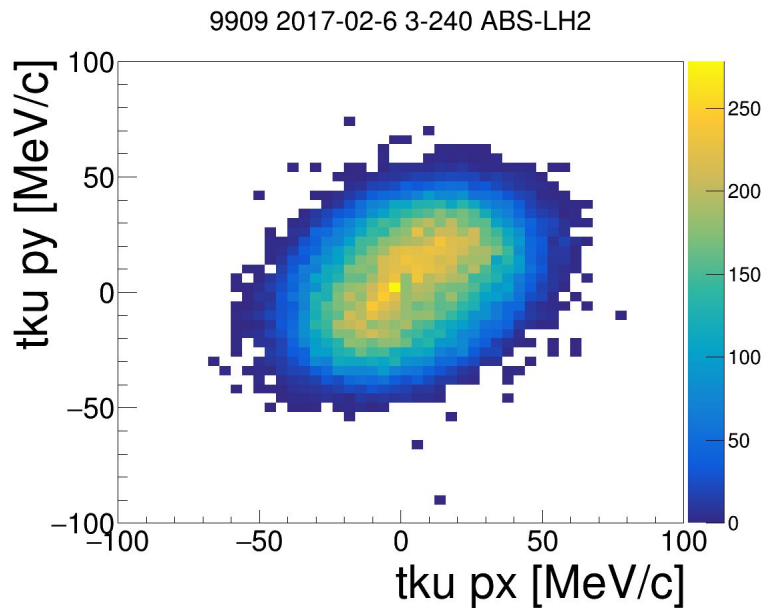
tku



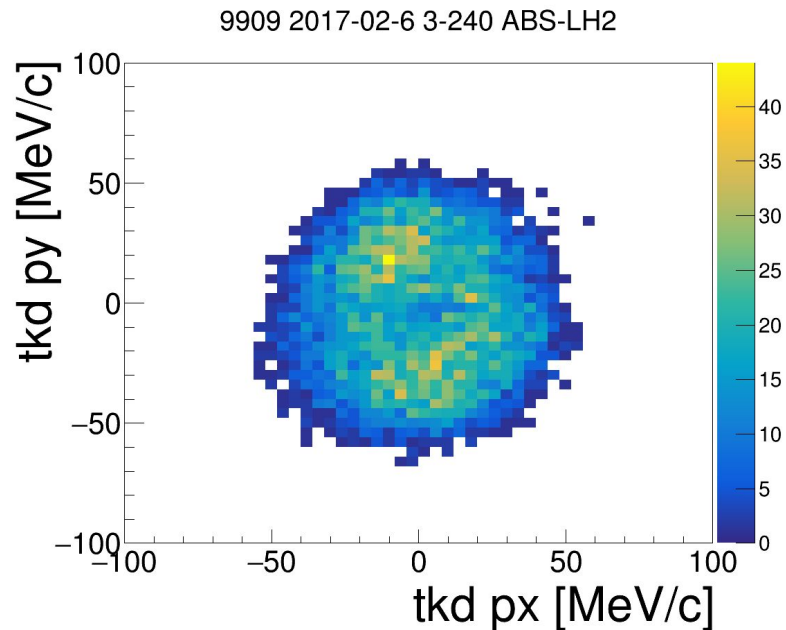
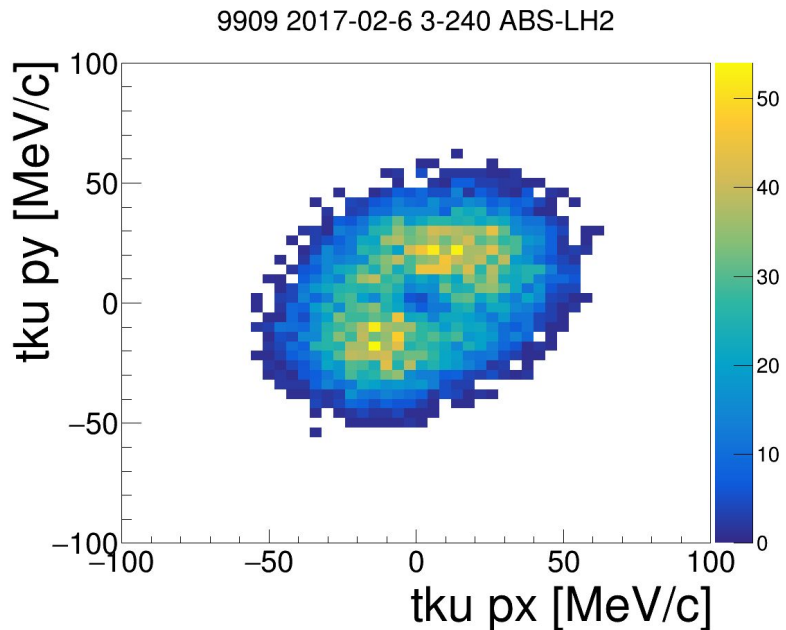
tkd



# Low Pt Hole US : Official MC plots

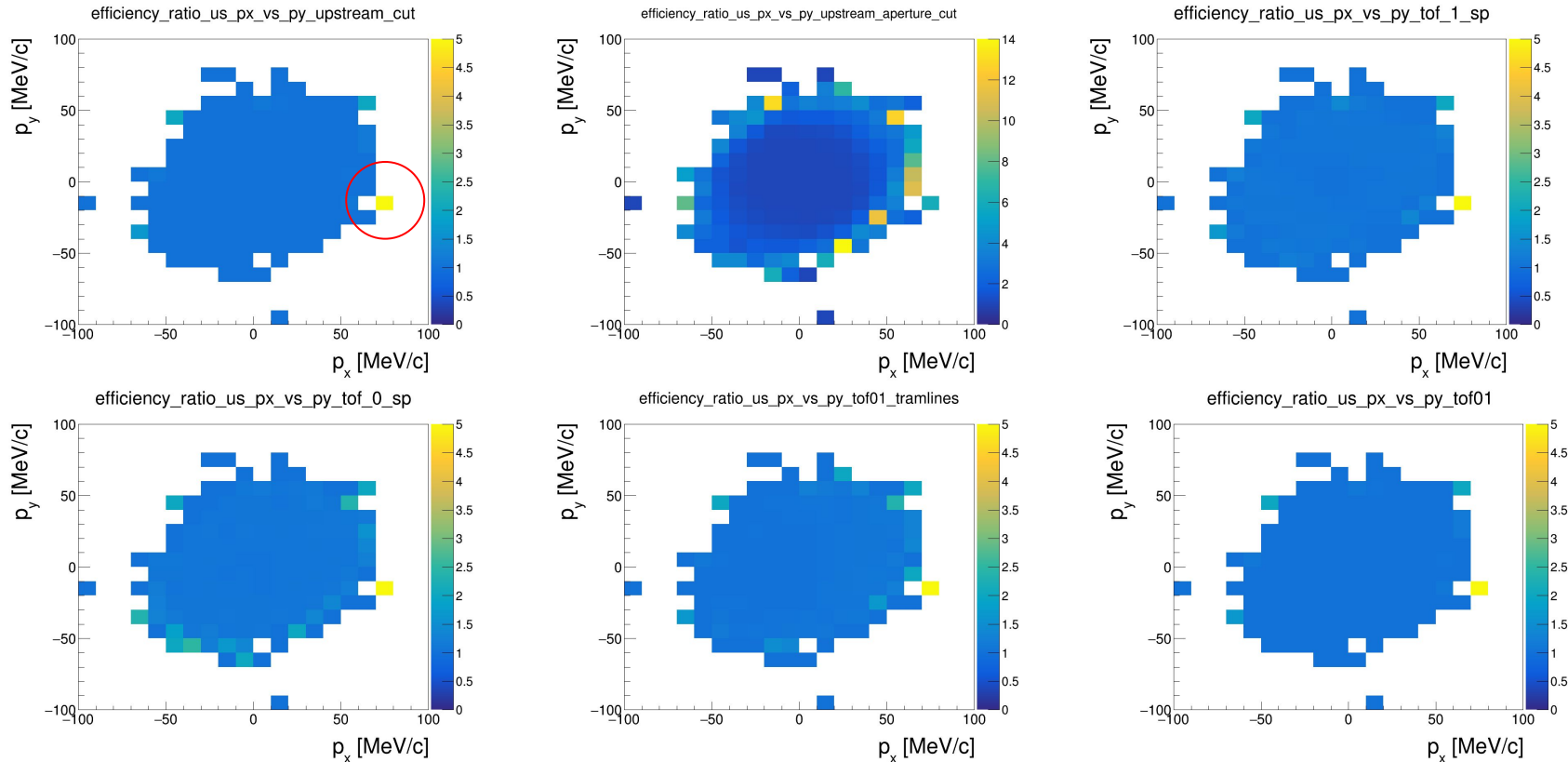


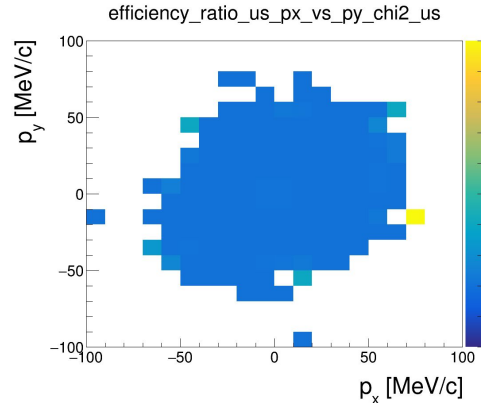
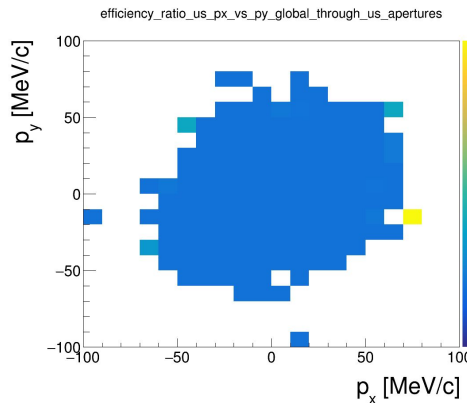
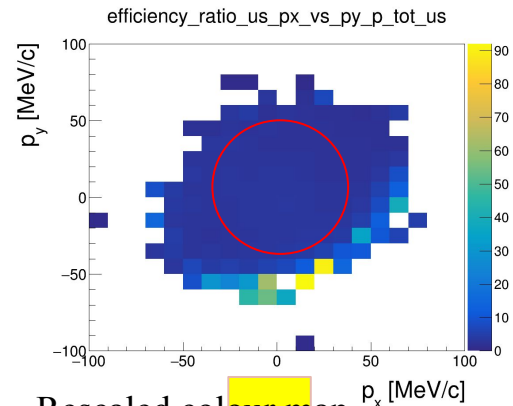
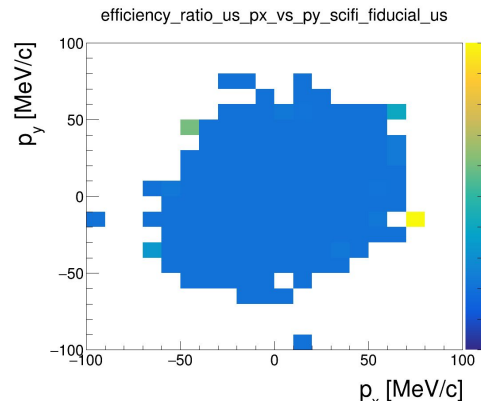
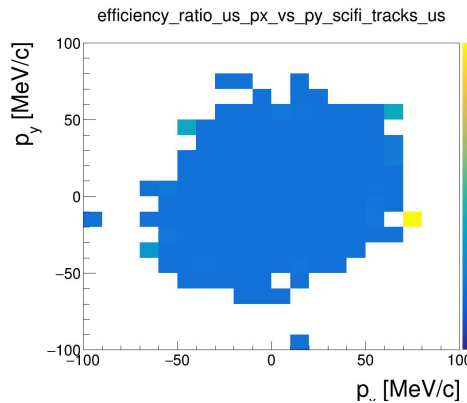
# Low Pt Hole US : OWN MC plots - No ToFTrackerCombined



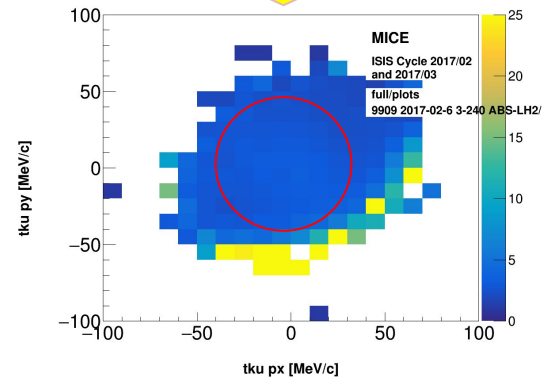


# “Efficiencies” - Cut impact in PxPy



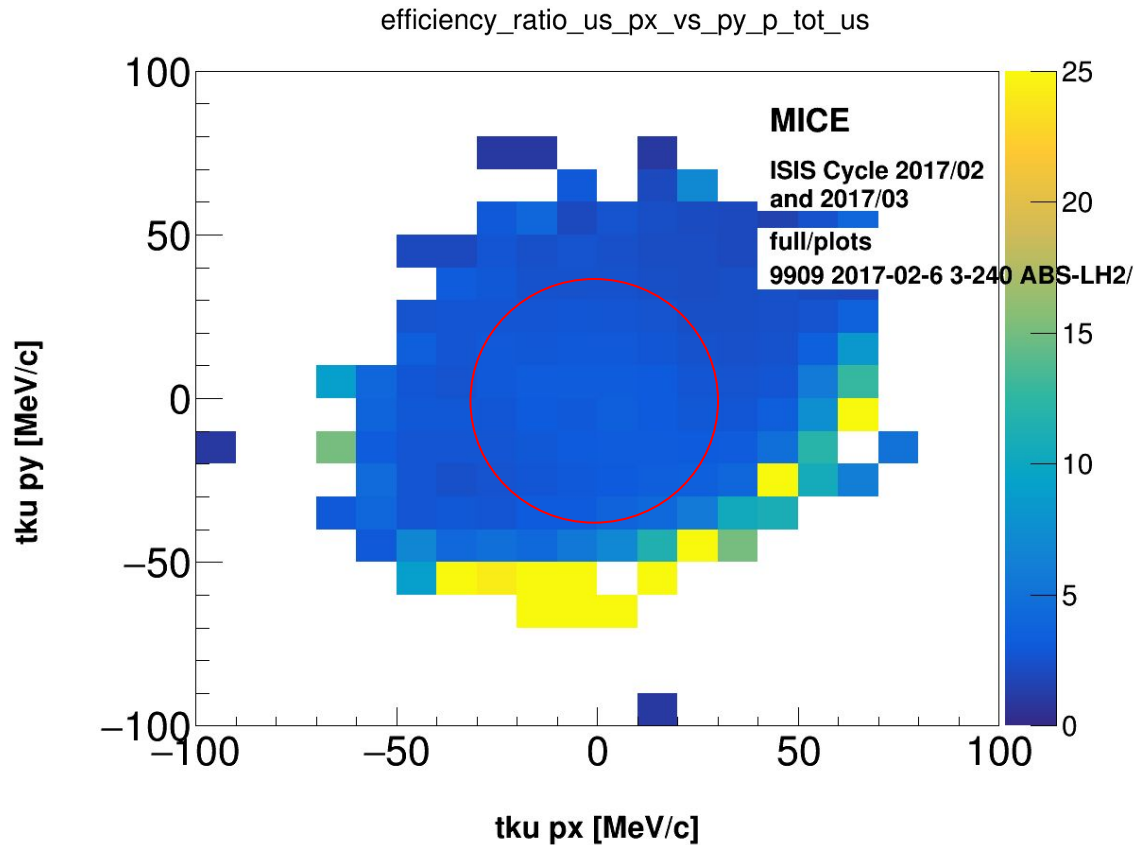


Rescaled colour map



# “Efficiencies”

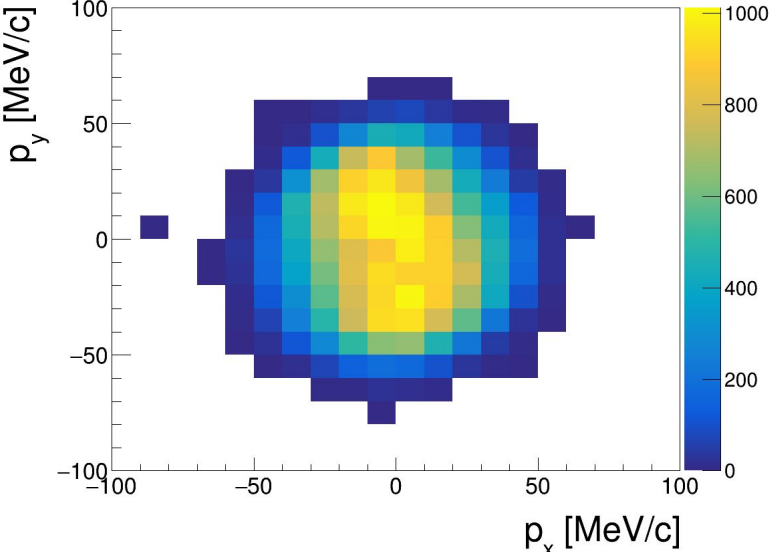
Slight increase in ratio  
over low pt region?



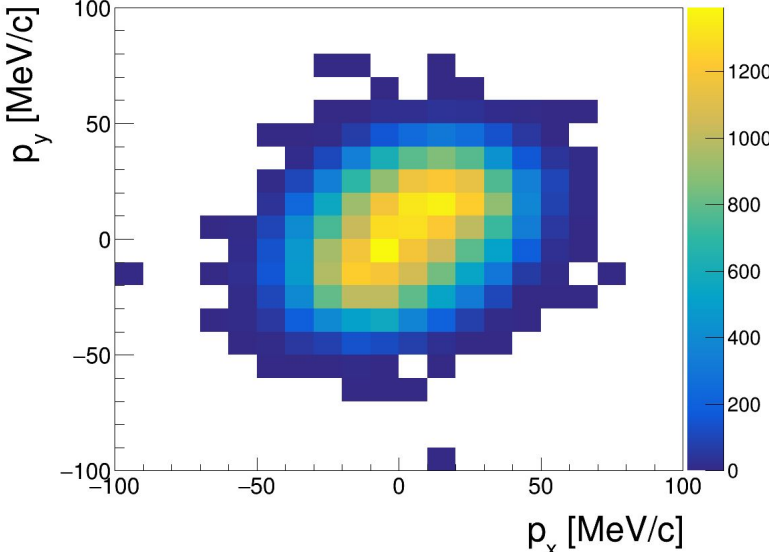


# Efficiencies : Truth distributions

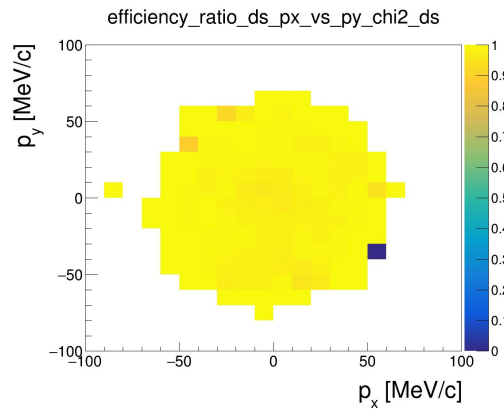
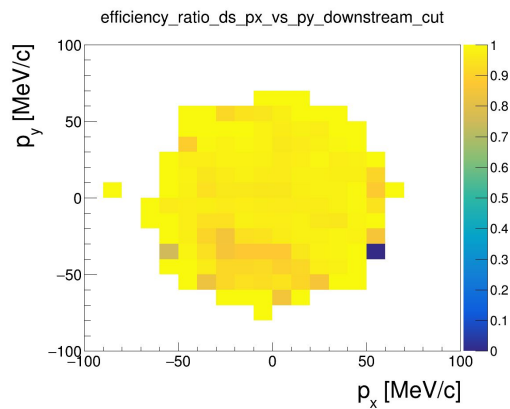
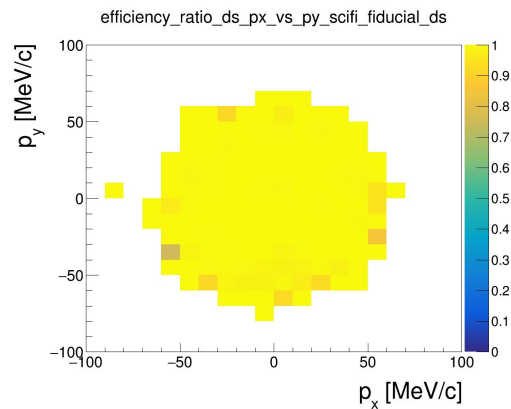
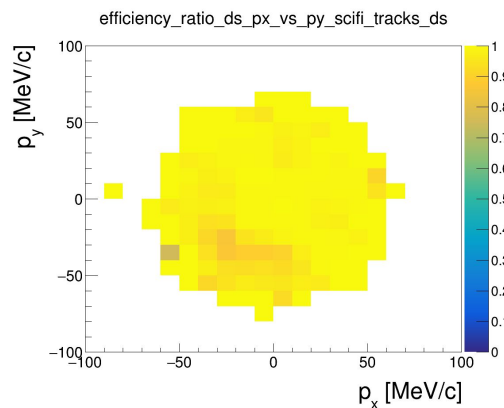
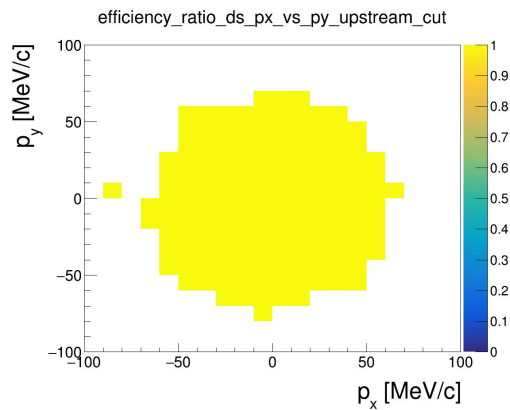
## tkd



## tku

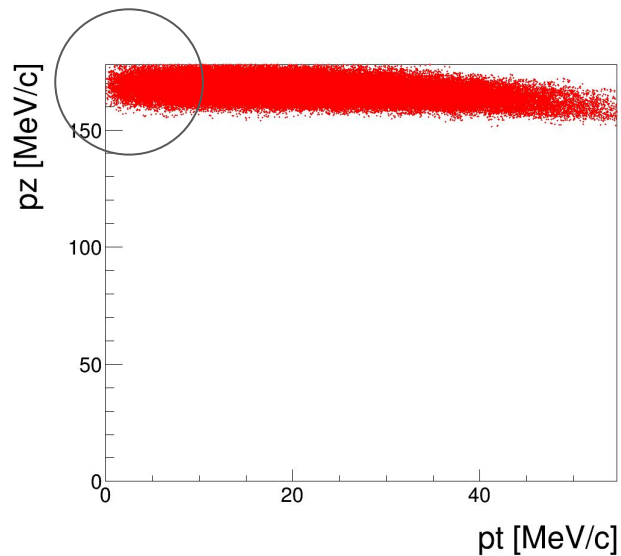


# DS



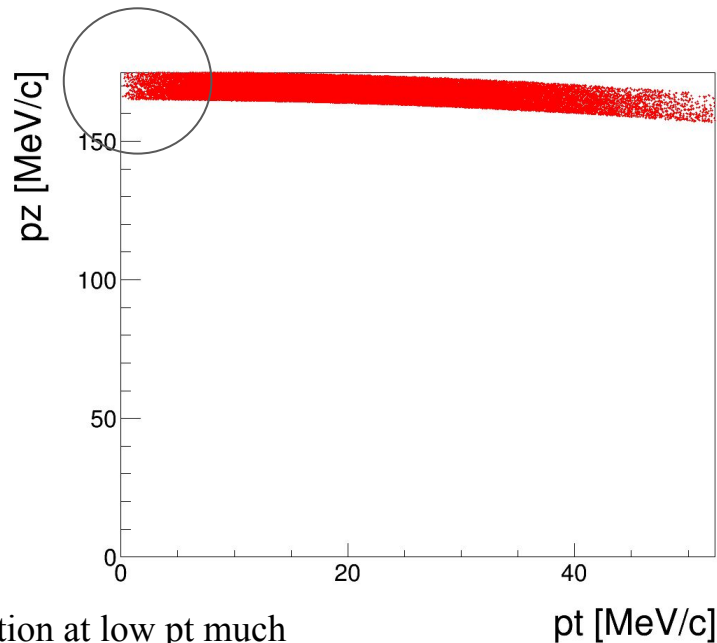
# Pt vs Pz - all cuts

## Truth



Events passing reco sample cuts

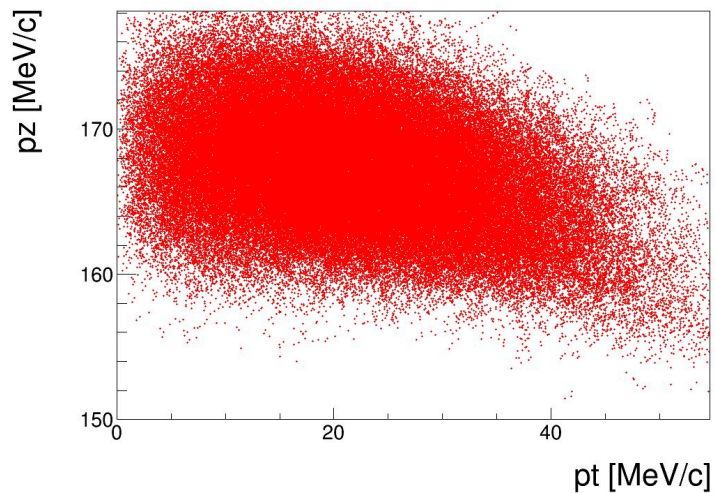
## Reco



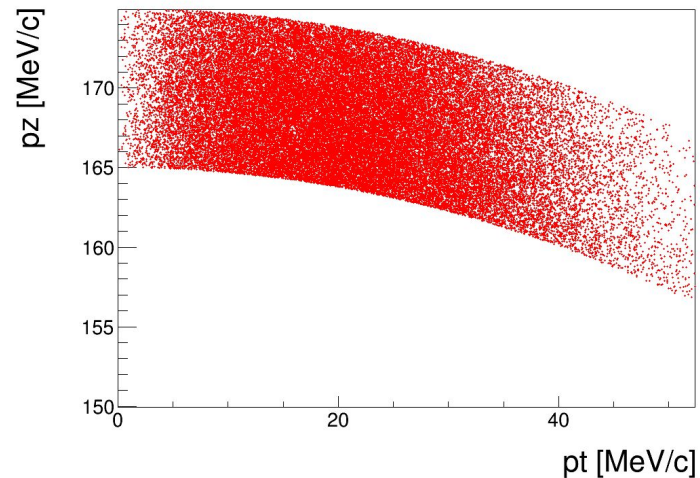
Population at low pt much denser in truth

# Pt vs Pz - all cuts

## Truth



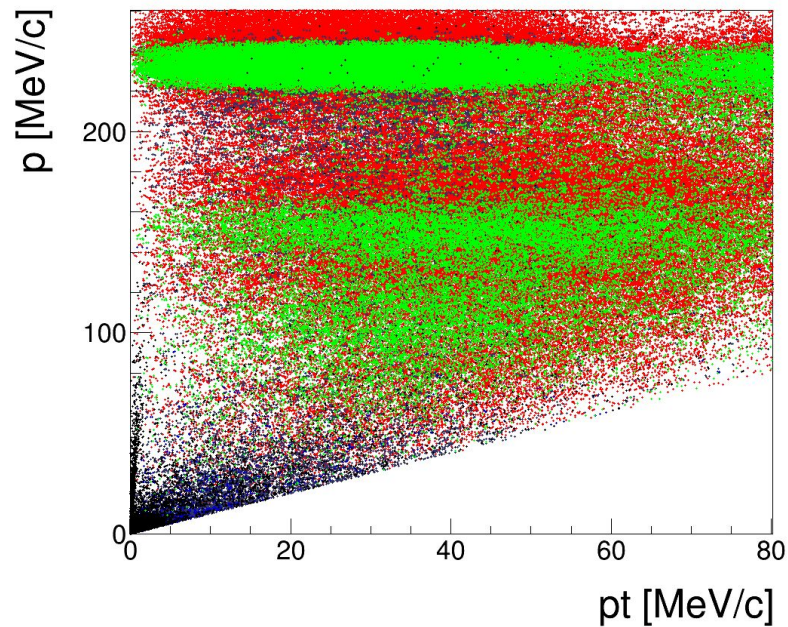
## Reco



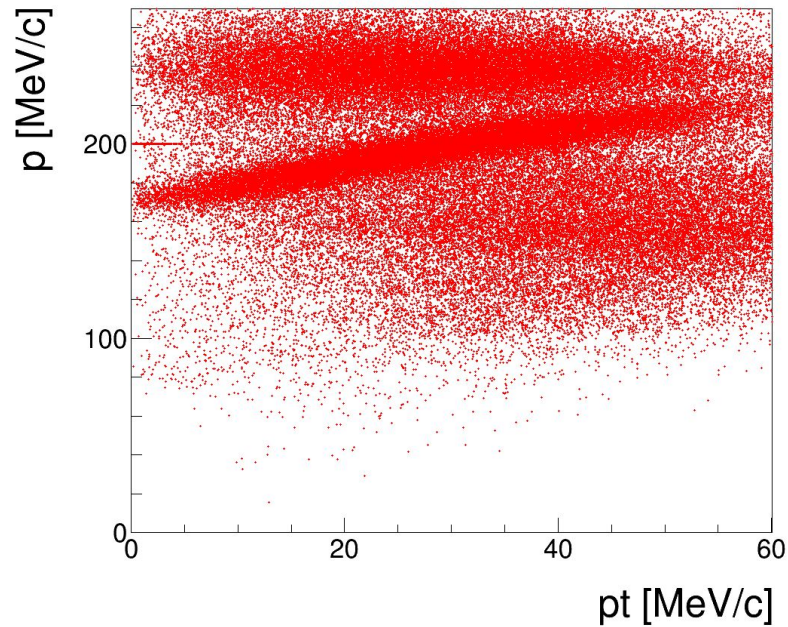


# Pt vs Pz - No cuts

## Truth

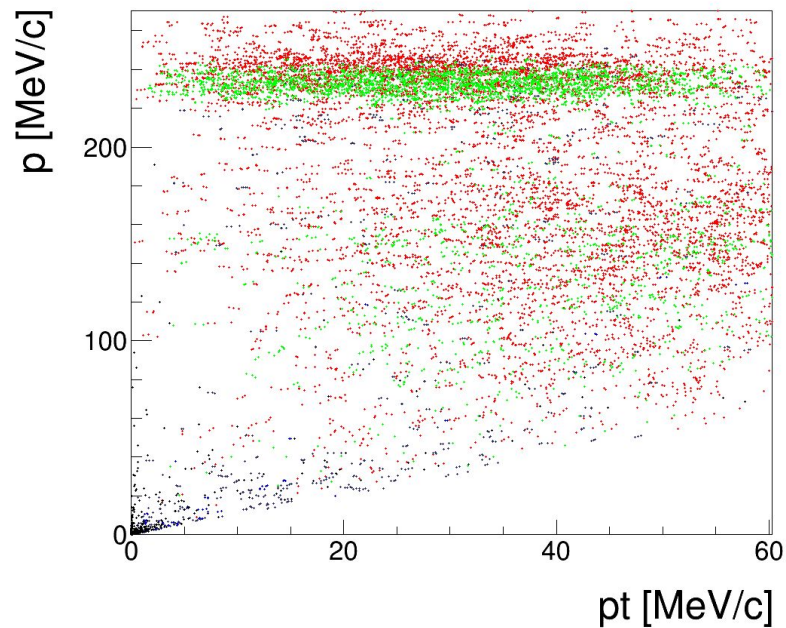


## Reco

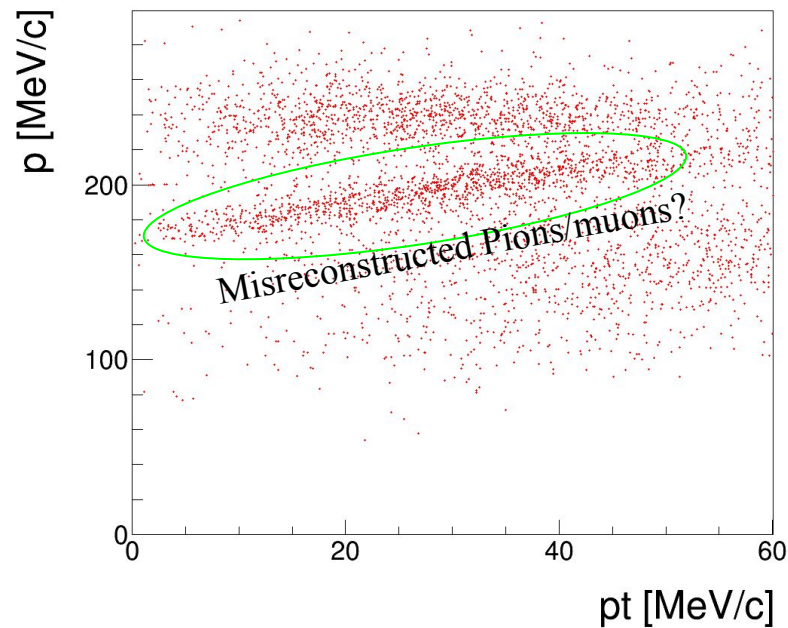


# Pt vs Pz - No cuts - Fewer Spills

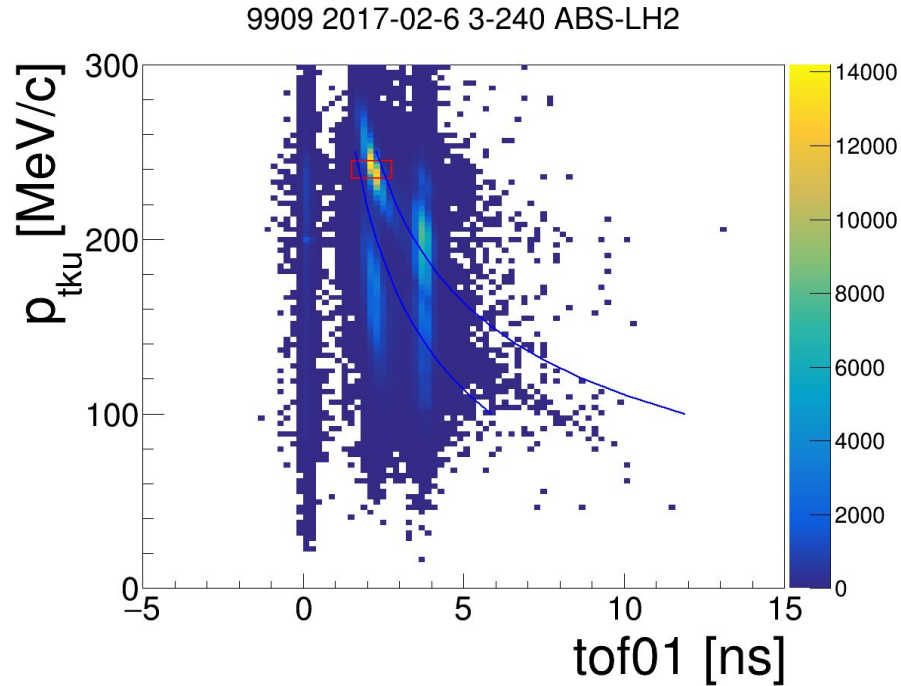
## Truth



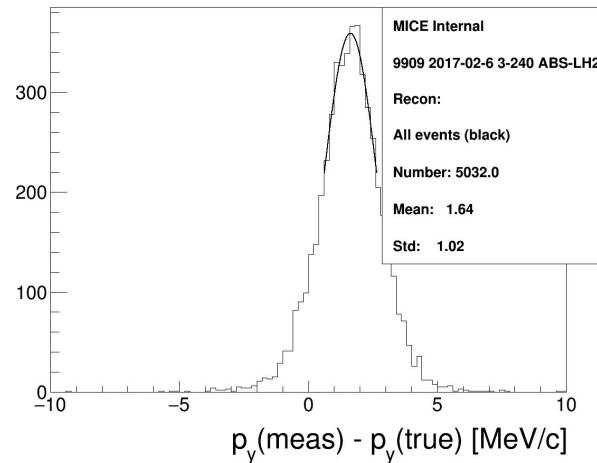
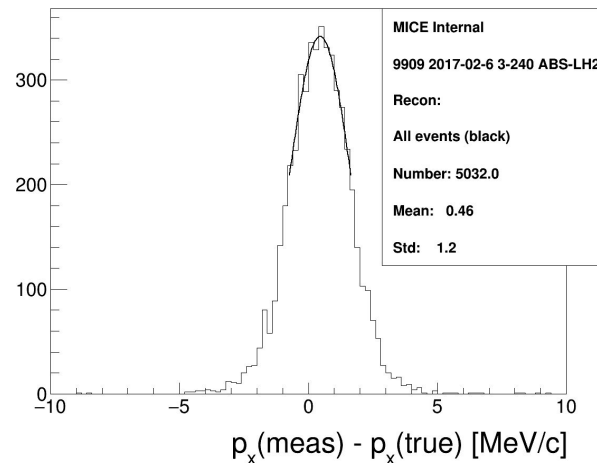
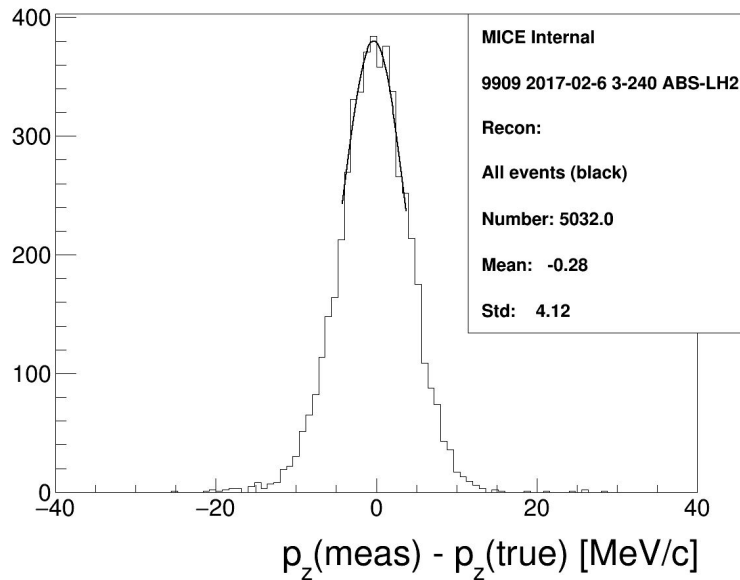
## Reco



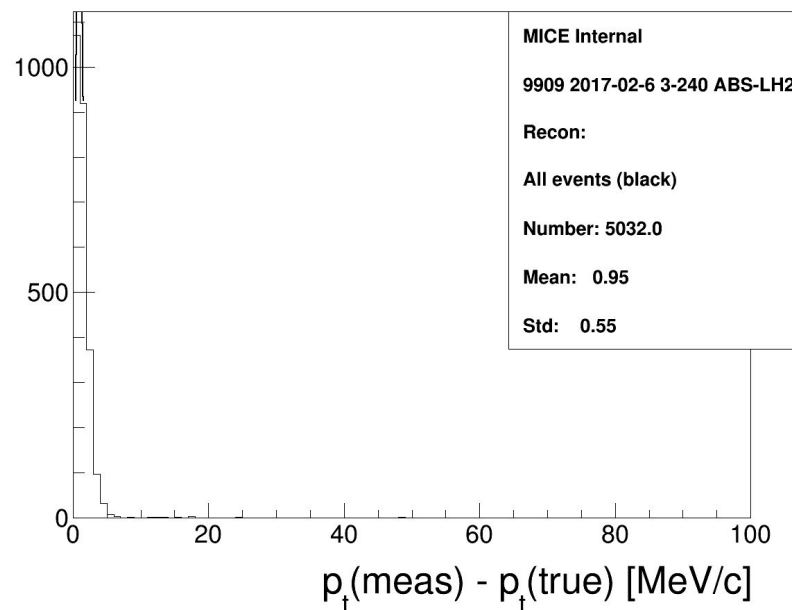
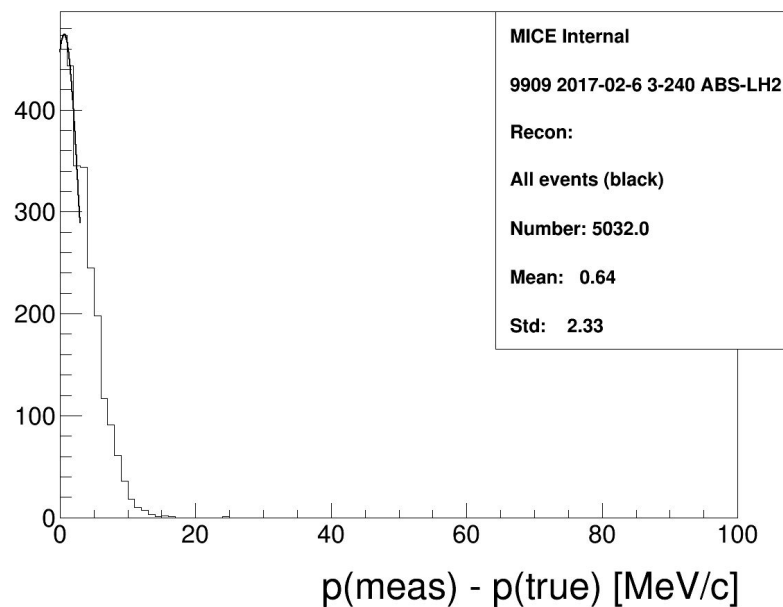
# P tku vs TOF01 - Official MC - No cuts



# Momentum Residuals

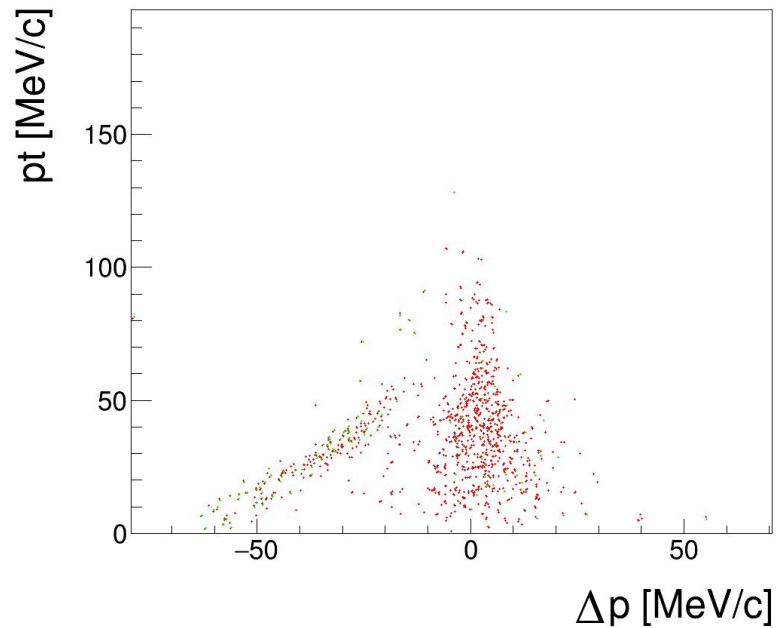


# Momentum Residuals

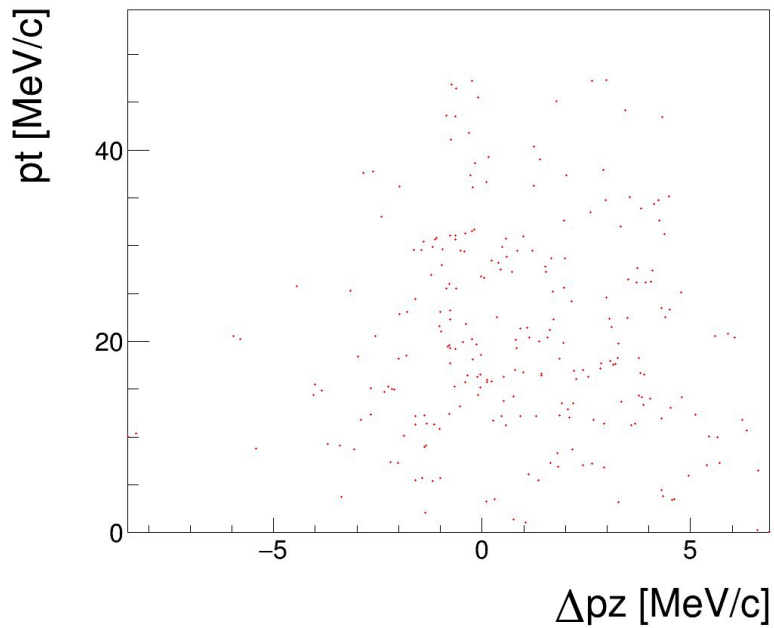


# TKU P residual vs true Pt

## No cuts

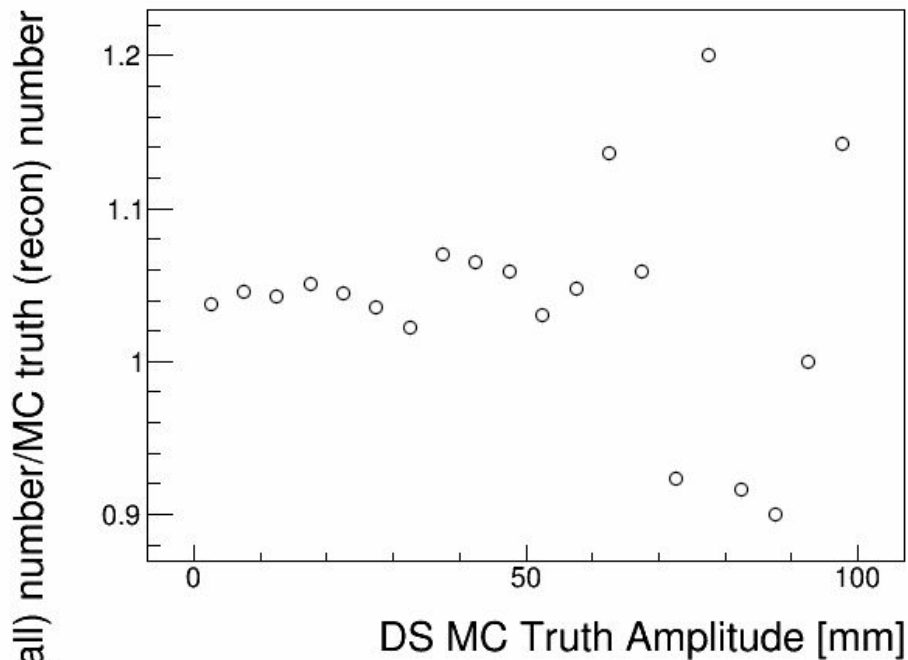


## With cuts

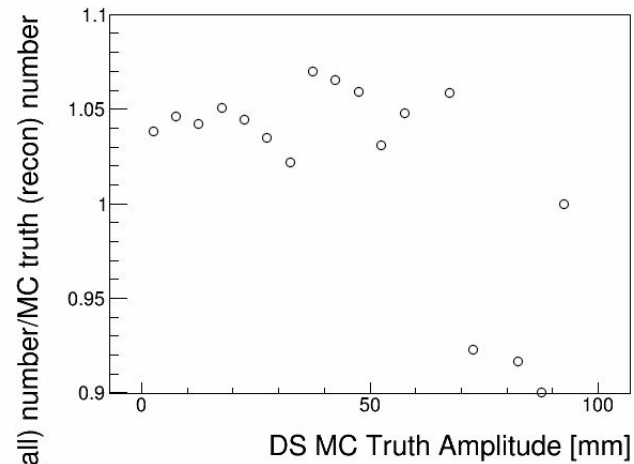


# Amplitude Inefficiency

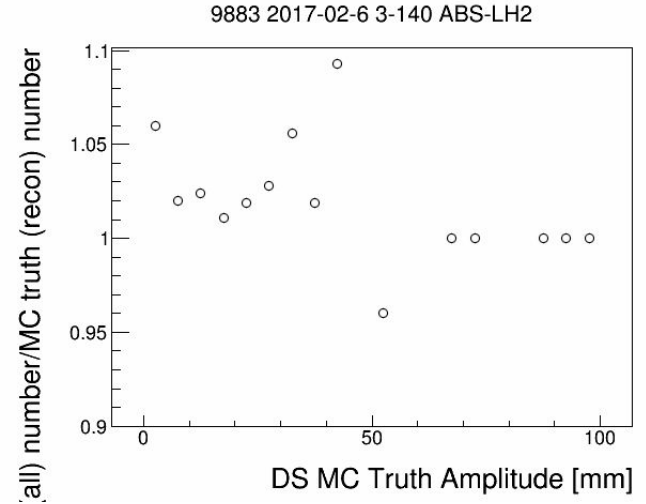
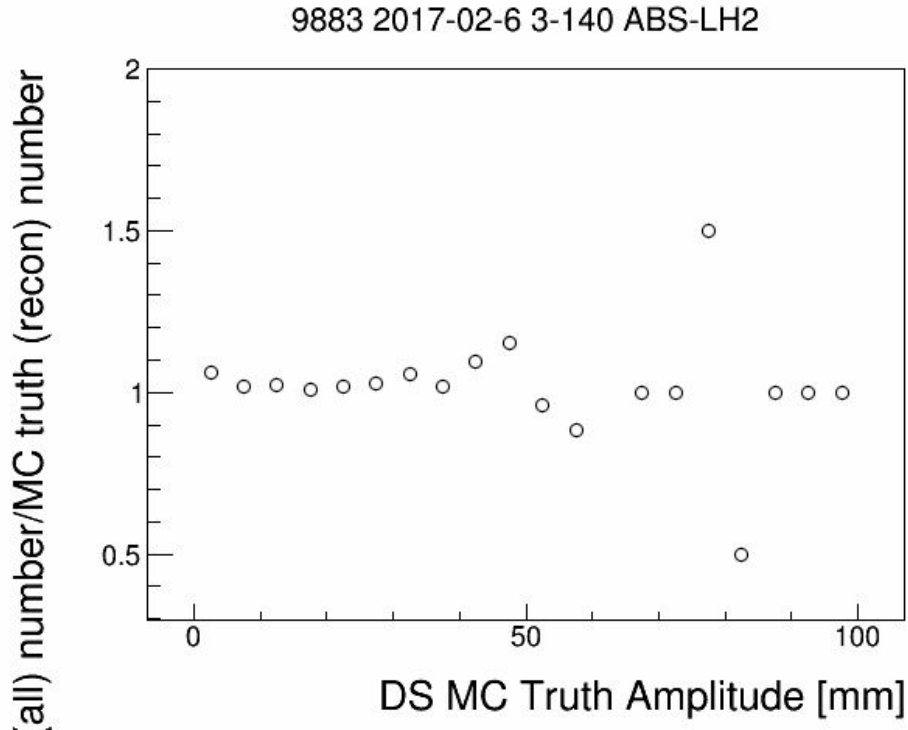
9909 2017-02-6 3-240 ABS-LH2



9909 2017-02-6 3-240 ABS-LH2



# Amplitude Inefficiency





# To Do

## Working through all datasets

Run momentum tunes with own MC & update official MC beamline for all solenoid datasets

Commission official MC for all solenoid datasets

Update analysis from MC with appropriate amplitude inefficiencies / corrections

Prod hybrid Systematics MC

## Problem Fixing

Low Pt hole persistent through analysed data-sets - check larger high mom datasets, establish MC vs data for higher statistics

Dig into 3-170 alignment-dependent amplitude behaviour

# Backup

# Backup Slides



# Cuts

## US :

1 TOF0 & TOF1 SP

TOF01 (rescaled wrt electron peak)

1 Scifi track US

Scifi fiducial US ;  $r < 150\text{mm}$

Chi2 US  $< 8$

TOF01 vs P – banana cut

P tot US +/- 5

US aperture ;  $r < 90\text{mm}$

## DS :

1 Scifi track DS

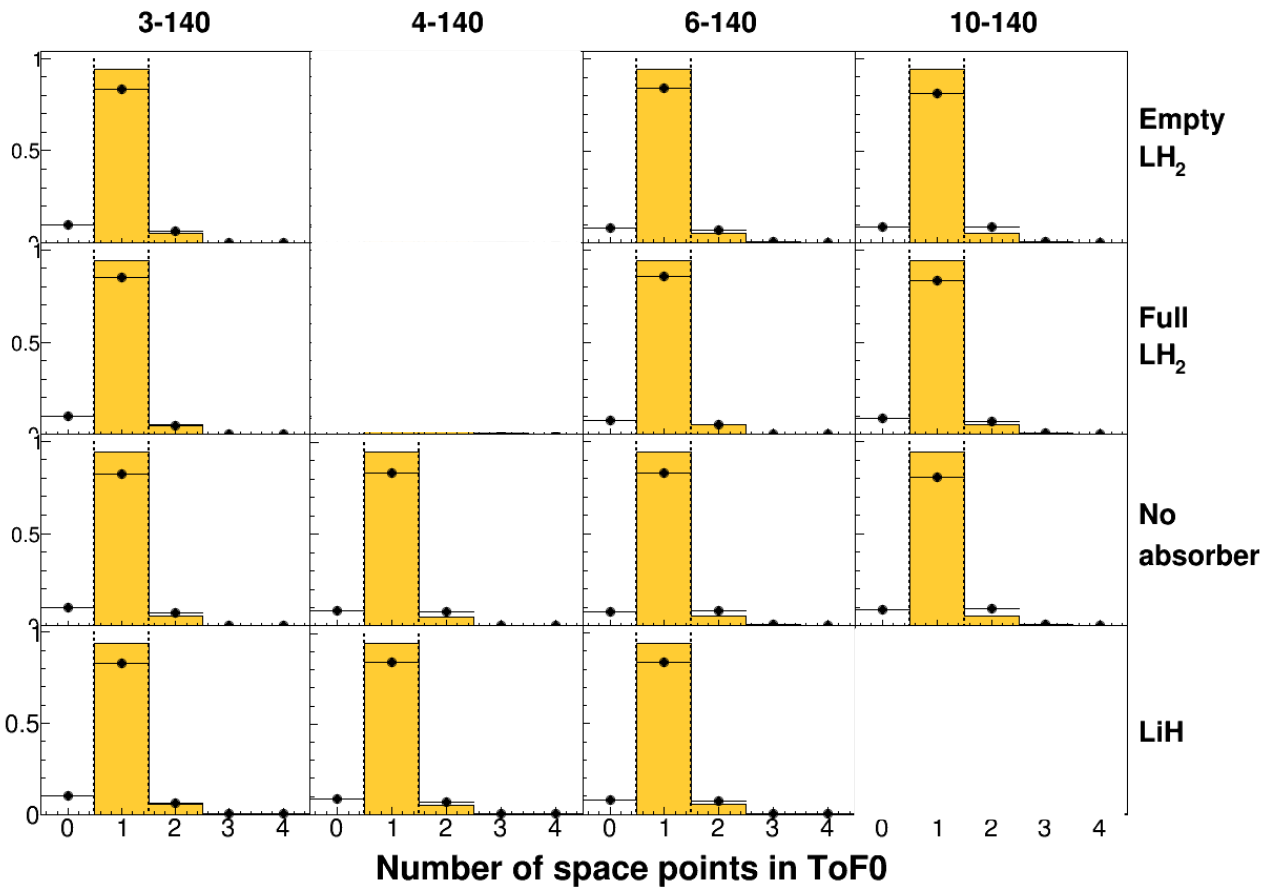
Chi2 DS  $< 8$

Scifi fiducial DS ;  $r < 150\text{mm}$

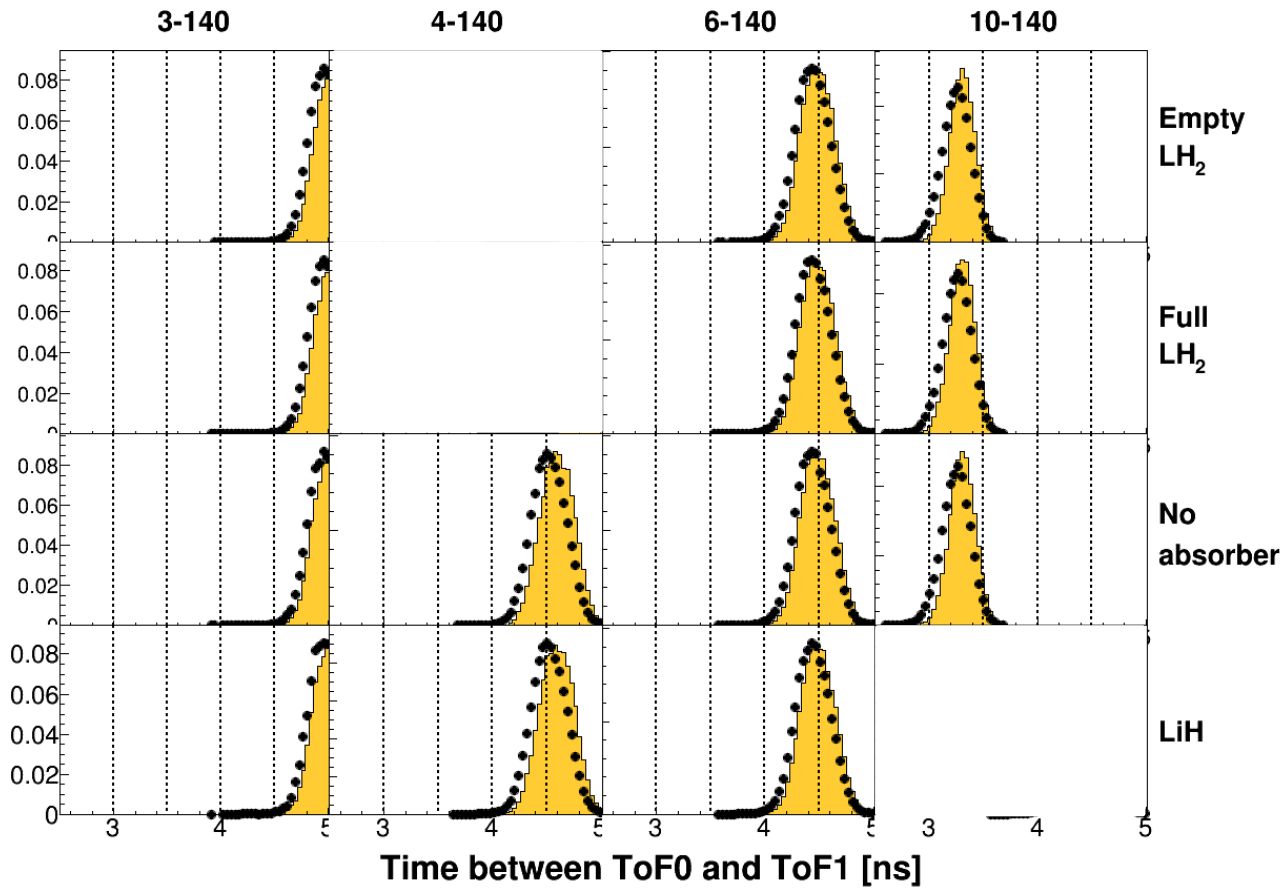
$90 < P \text{ tot DS} < 170$

DS aperture ;  $r < 90\text{mm}$

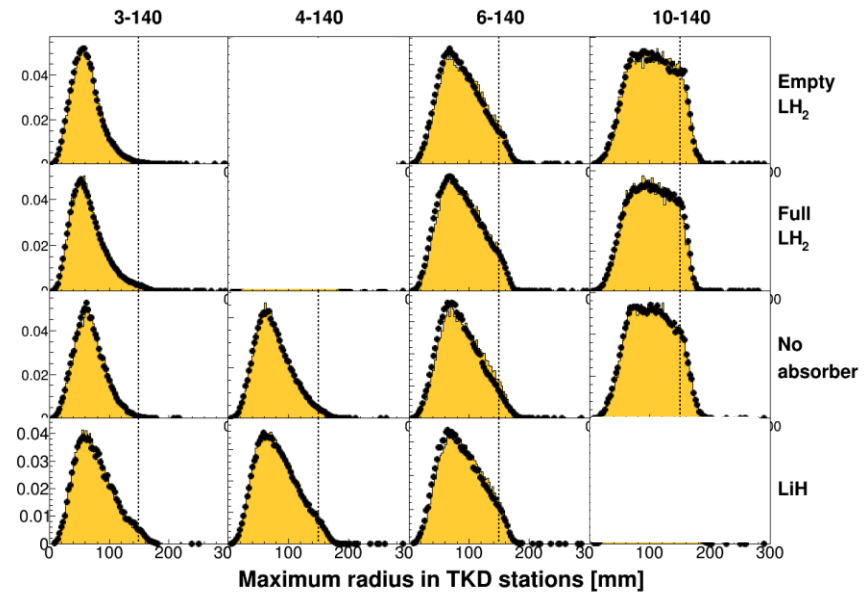
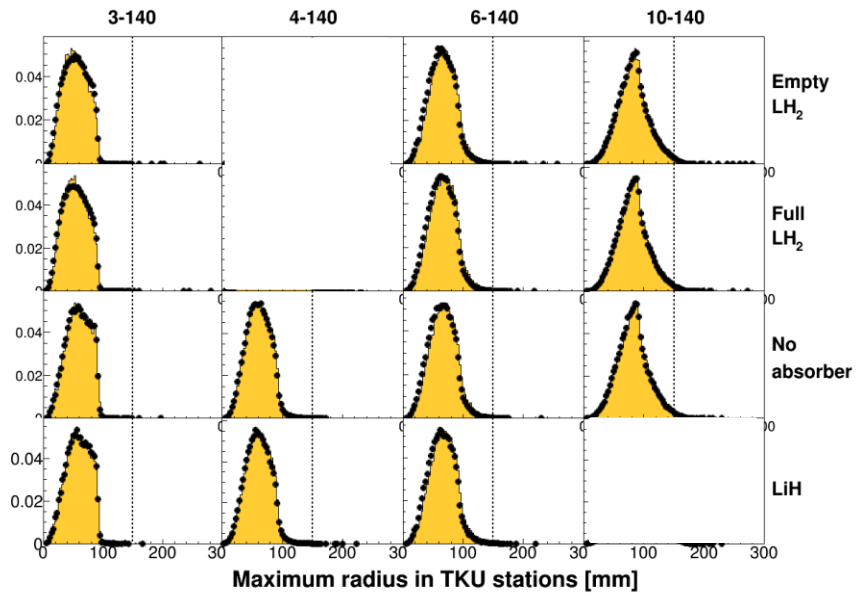
# Sample Selection



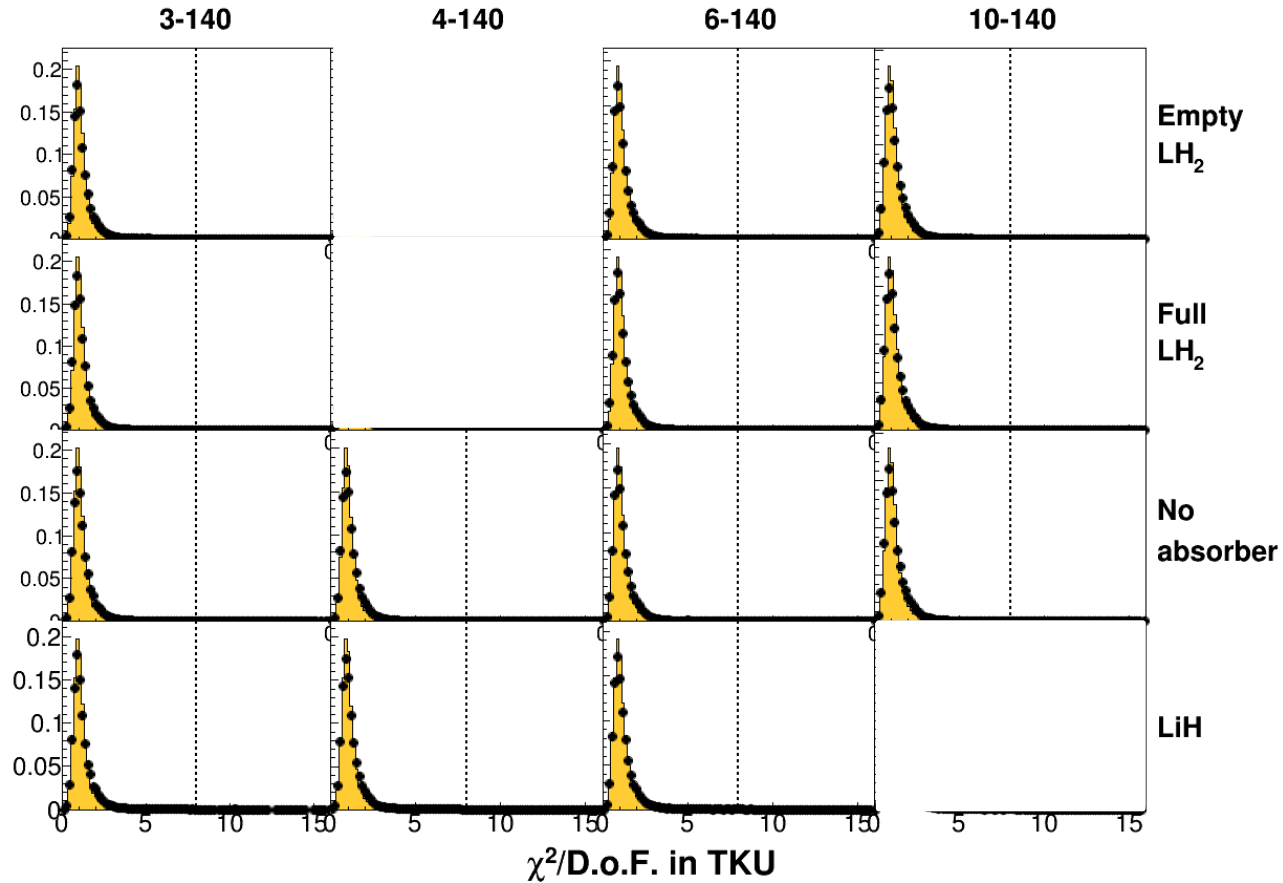
# Sample Selection

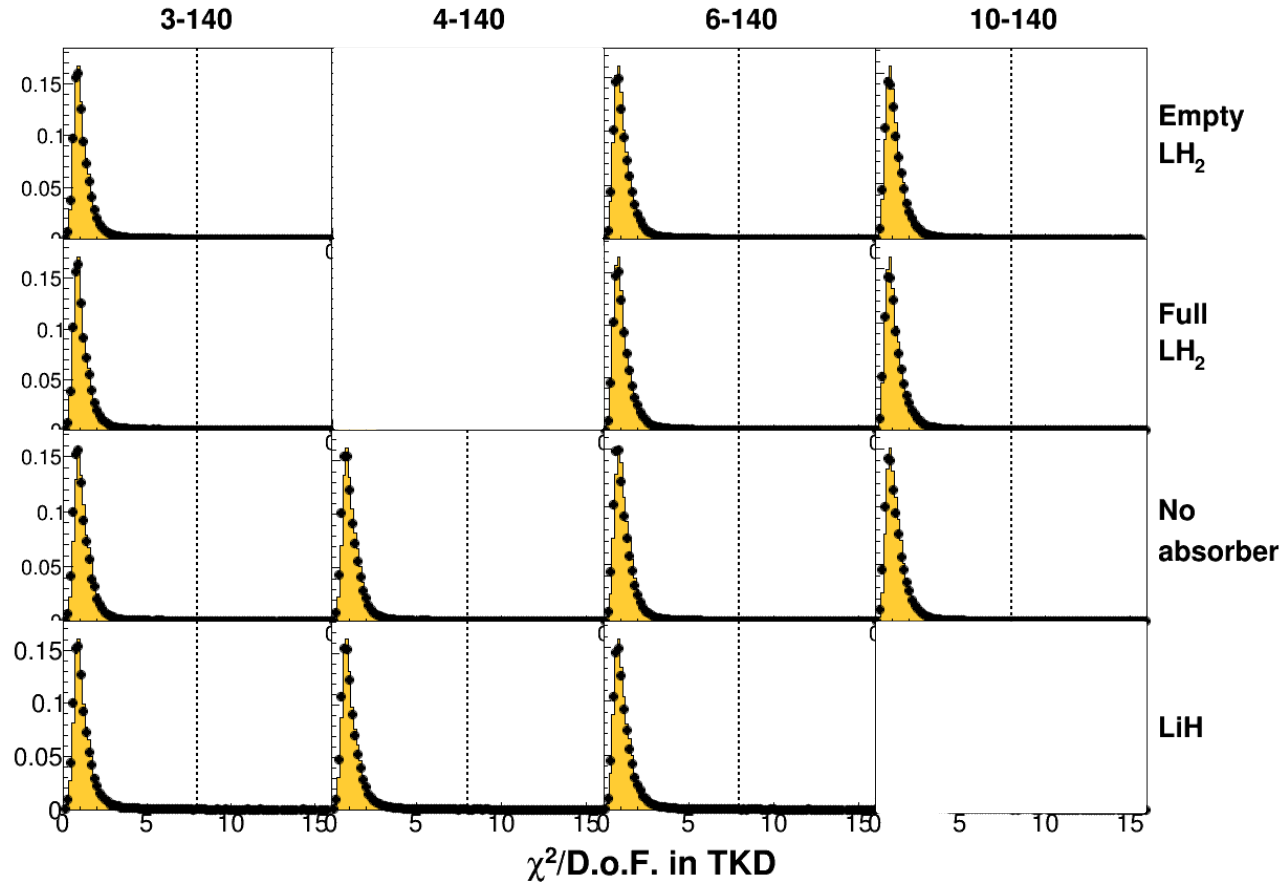


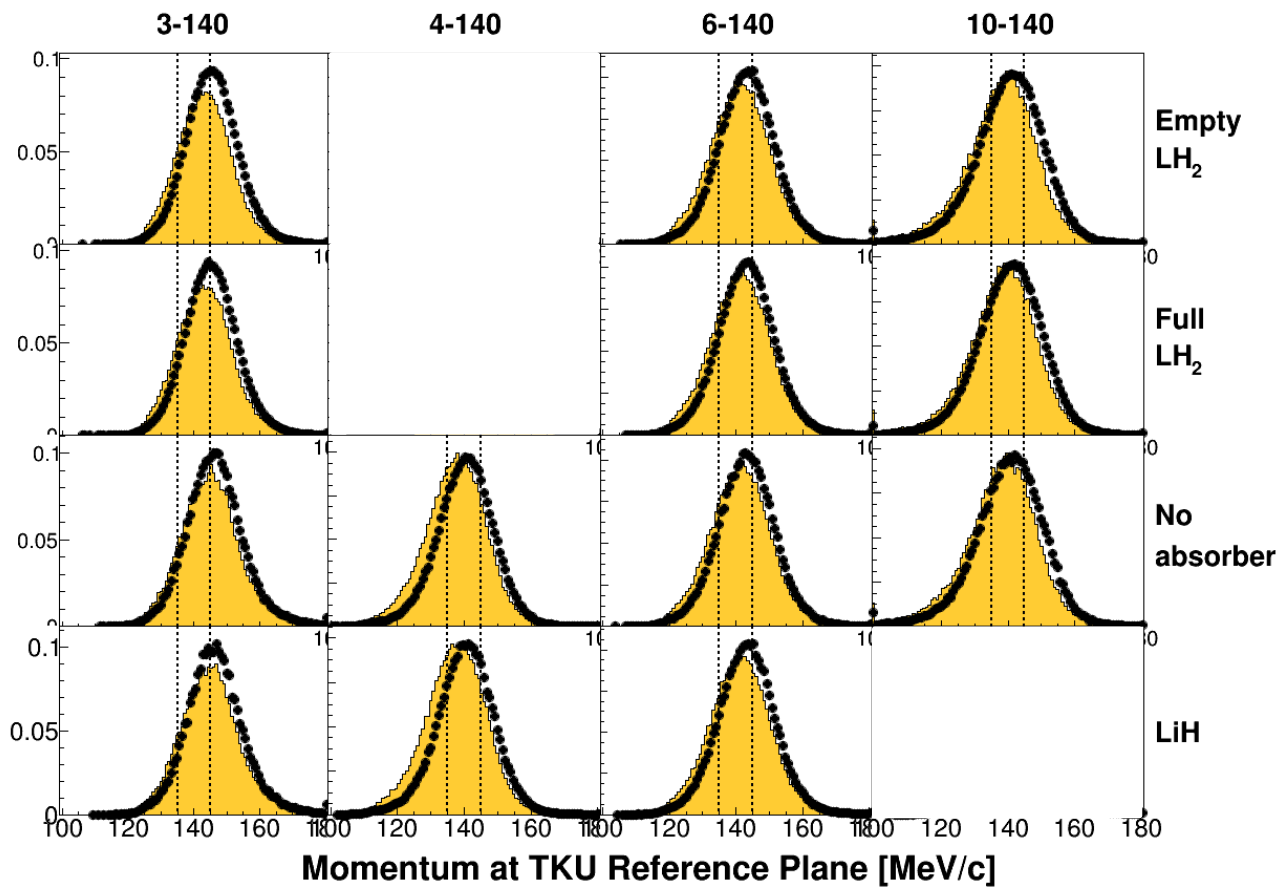
# Sample Selection



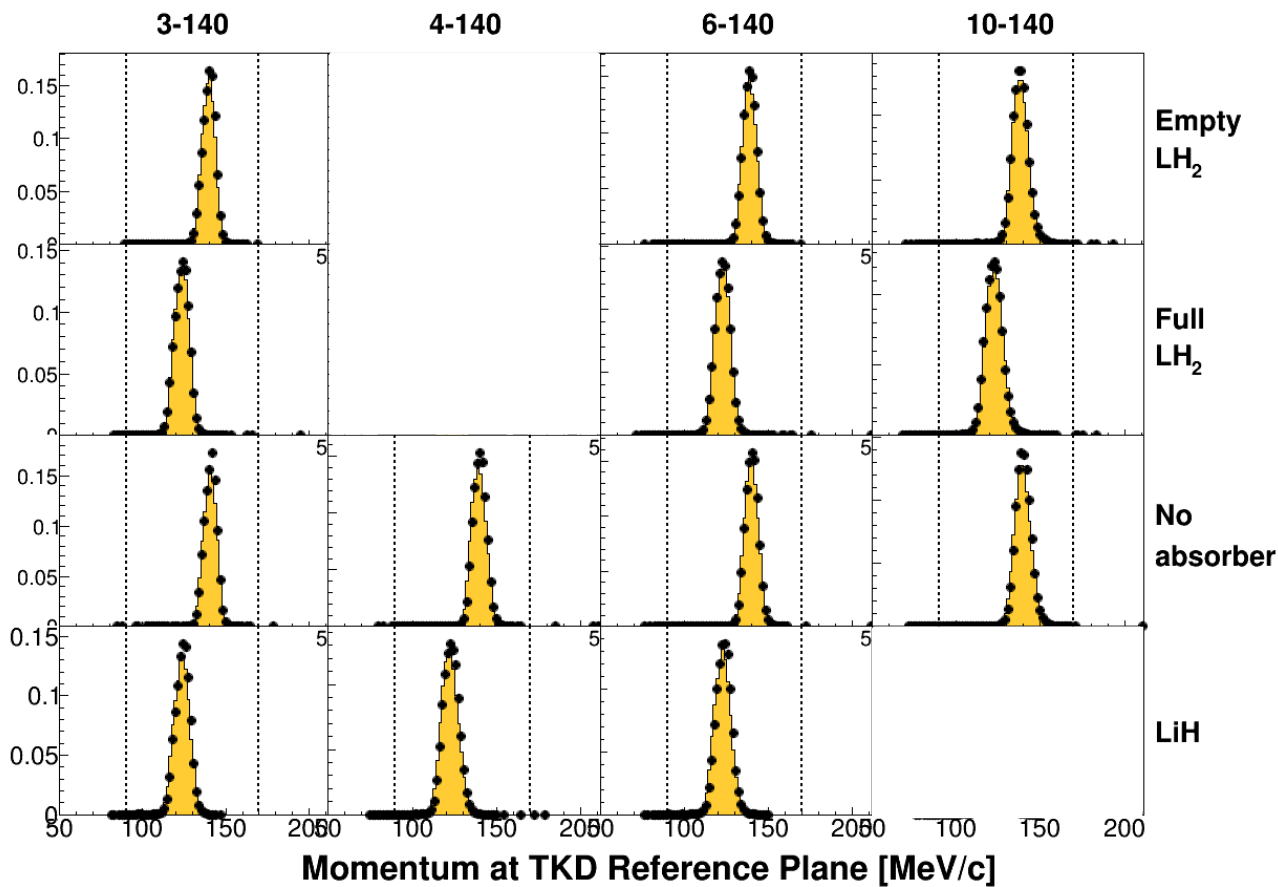




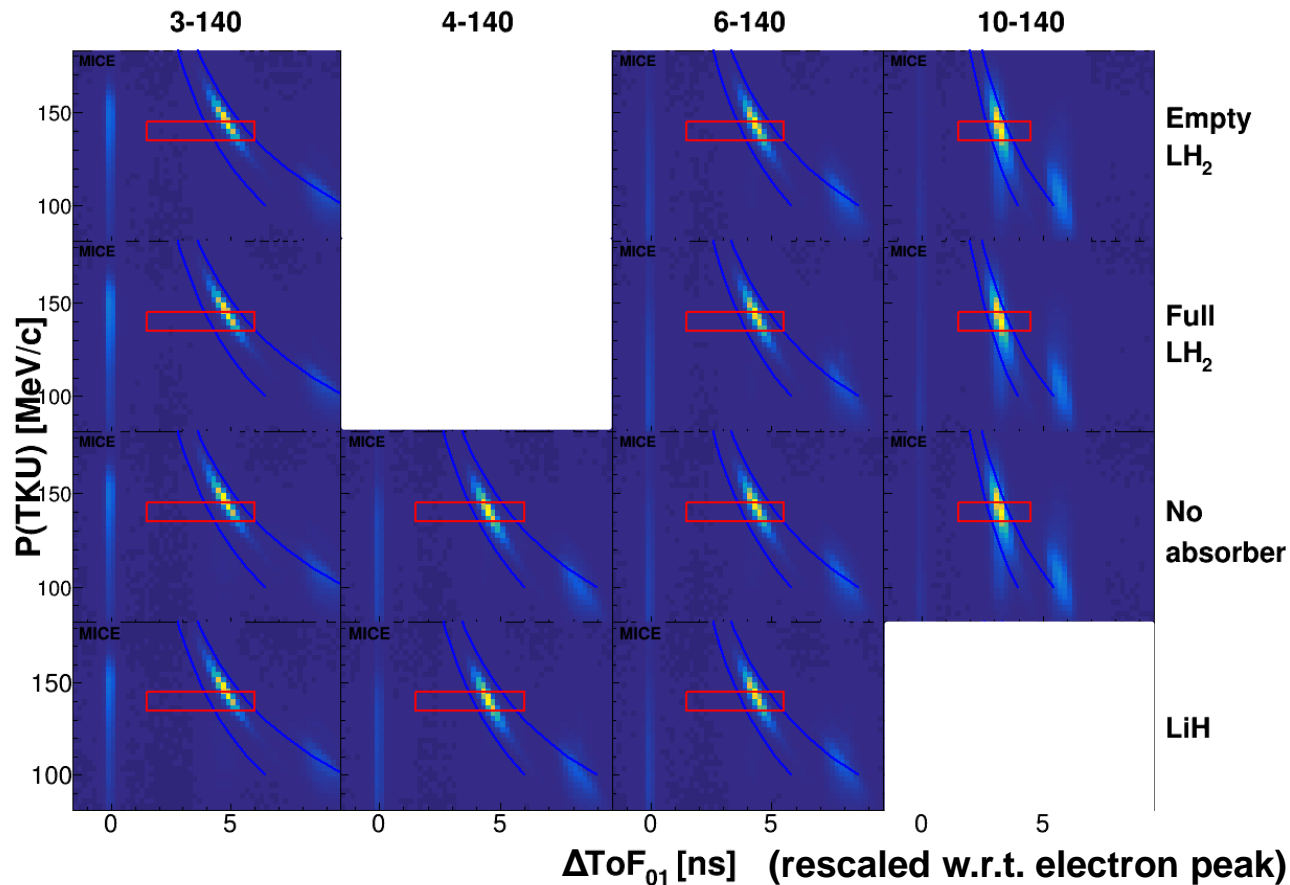




Further MC tuning  
needed for tku  
momentum  
agreement for 4-140

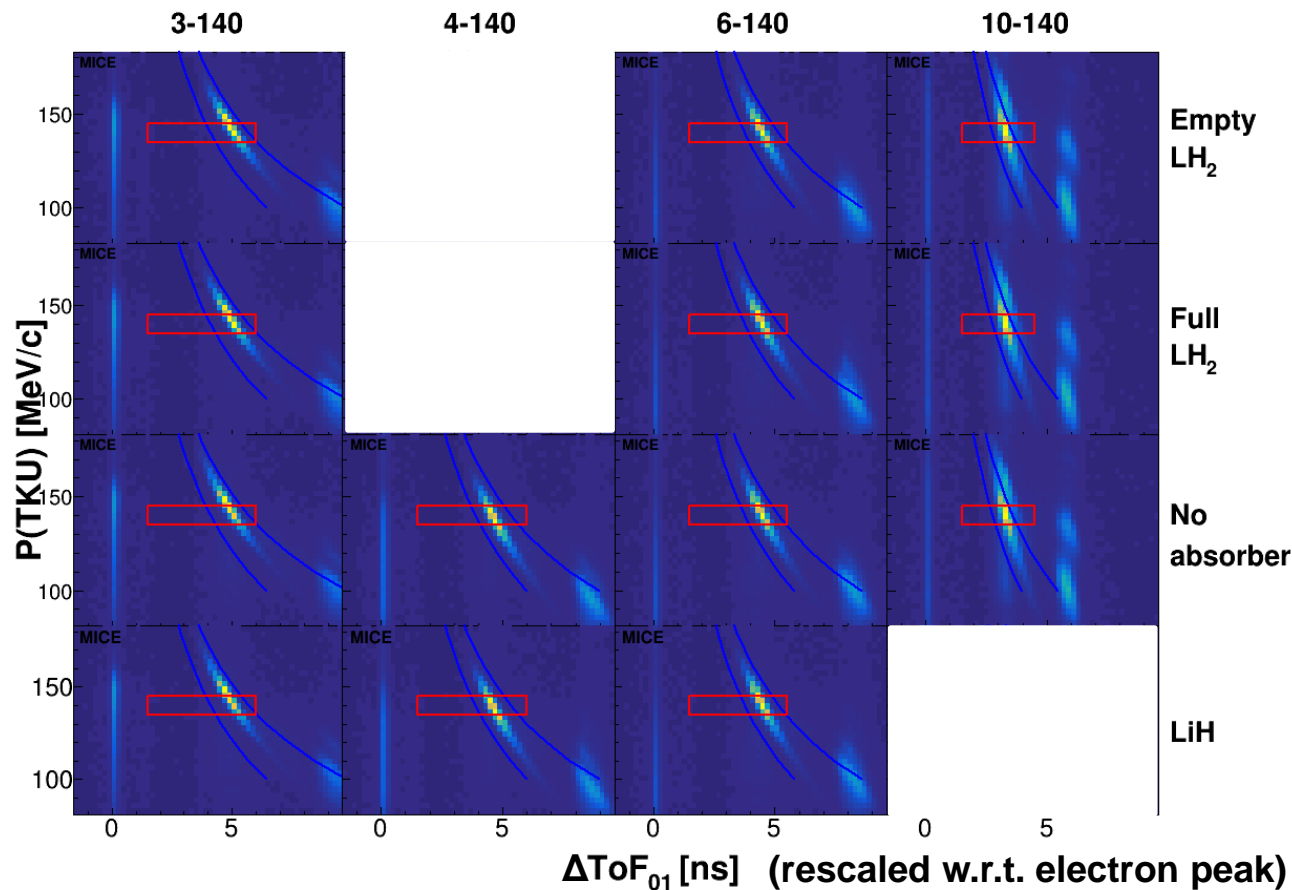


# Sample Selection



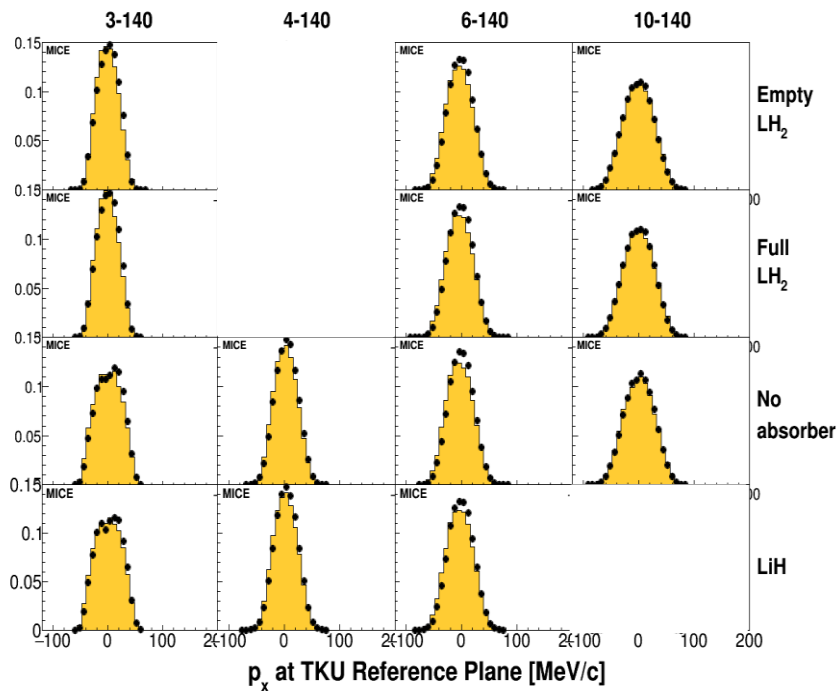
**DATA**  
No cuts

# Sample Selection

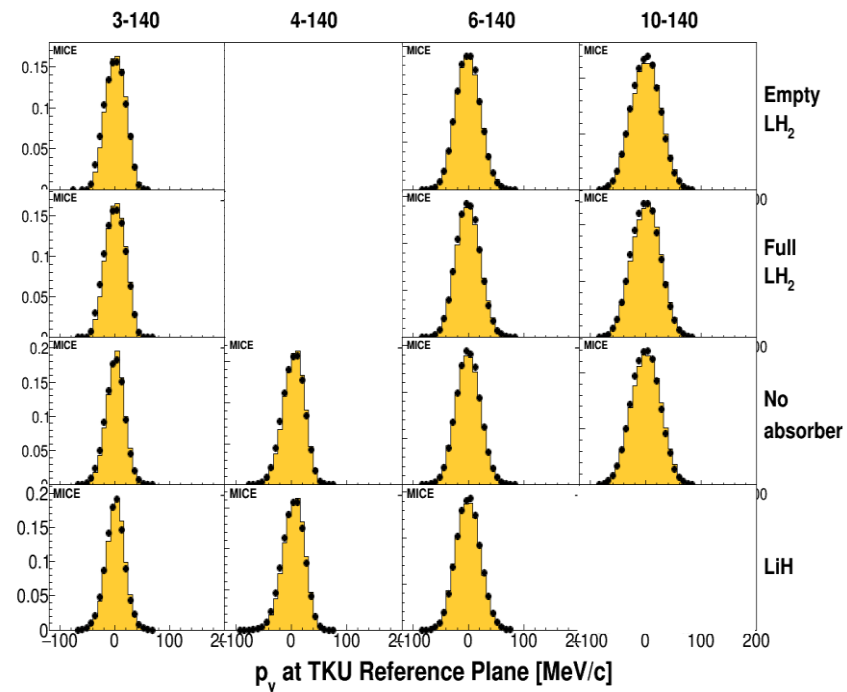


MC  
No cuts

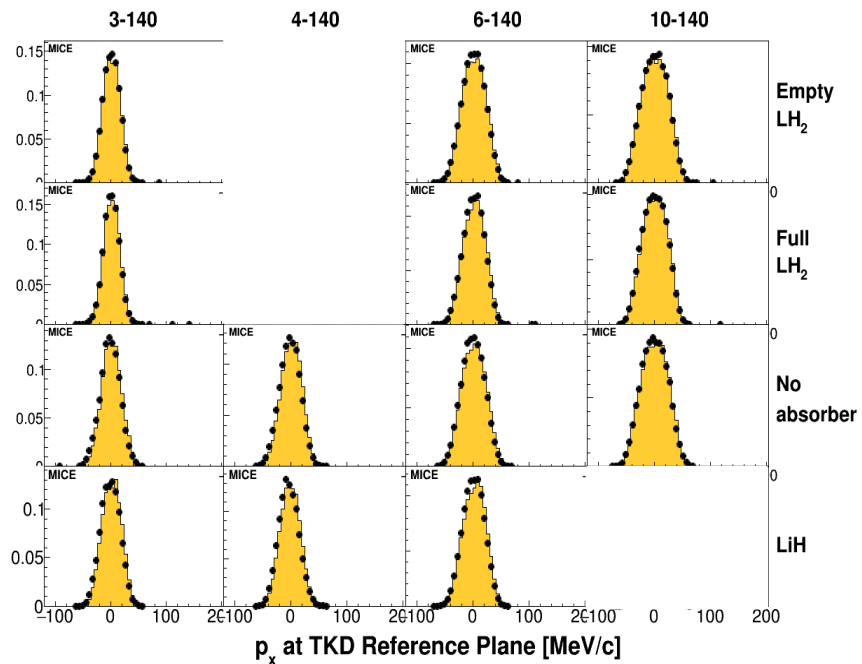
## Px



## P<sub>y</sub>



## Px



## P<sub>y</sub>

