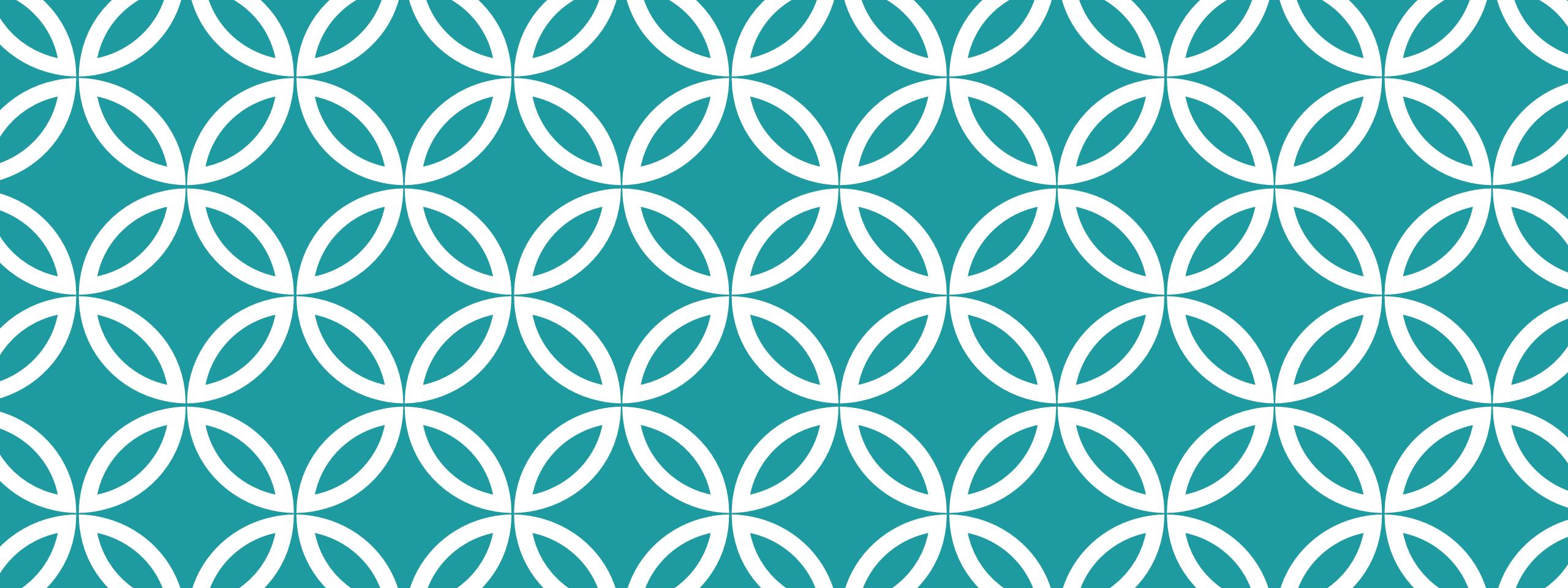


# TKU EMITTANCE PAPER

AKA Run 7469 Analysis  
V. Blackmore  
CM46

# CONTENTS

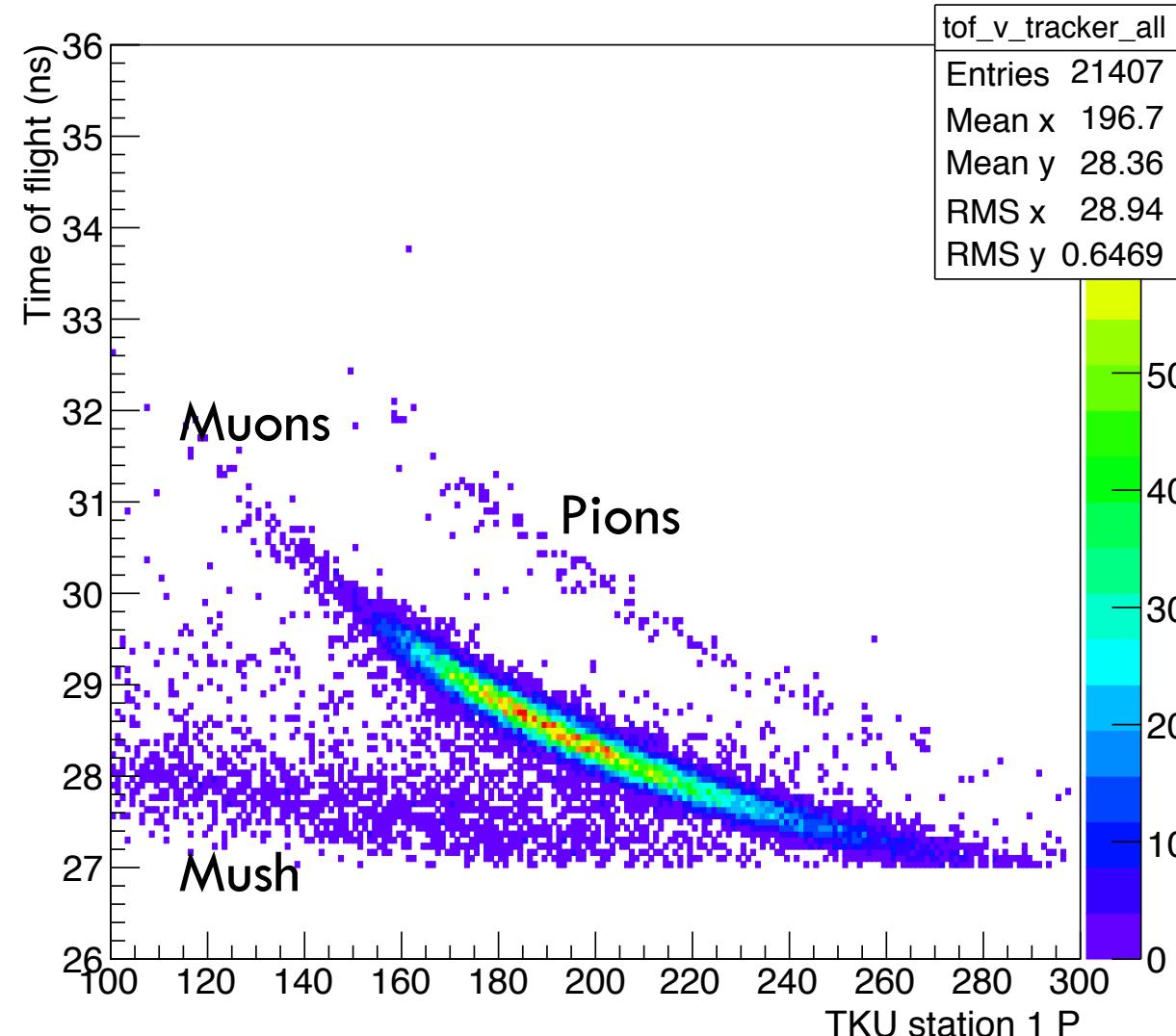
- No new plots to show
  - Preliminary plots are those approved at CM45
- Improved “simple” ROOT file extractor so it’s useable on runs **other than 7469**
  - Reads quad currents from reconstruction geometry file, etc...
- The run 7469 analysis “to do” list
  - Canonical momentum calculation – done.
  - Muon charge? Was wrong, but should now be correct
  - Improve cuts – remove “momentum loss” cut, replace with diffuser aperture cut
  - Investigate field placement
  - Origin of excess momentum loss between TOF1 and Tracker?



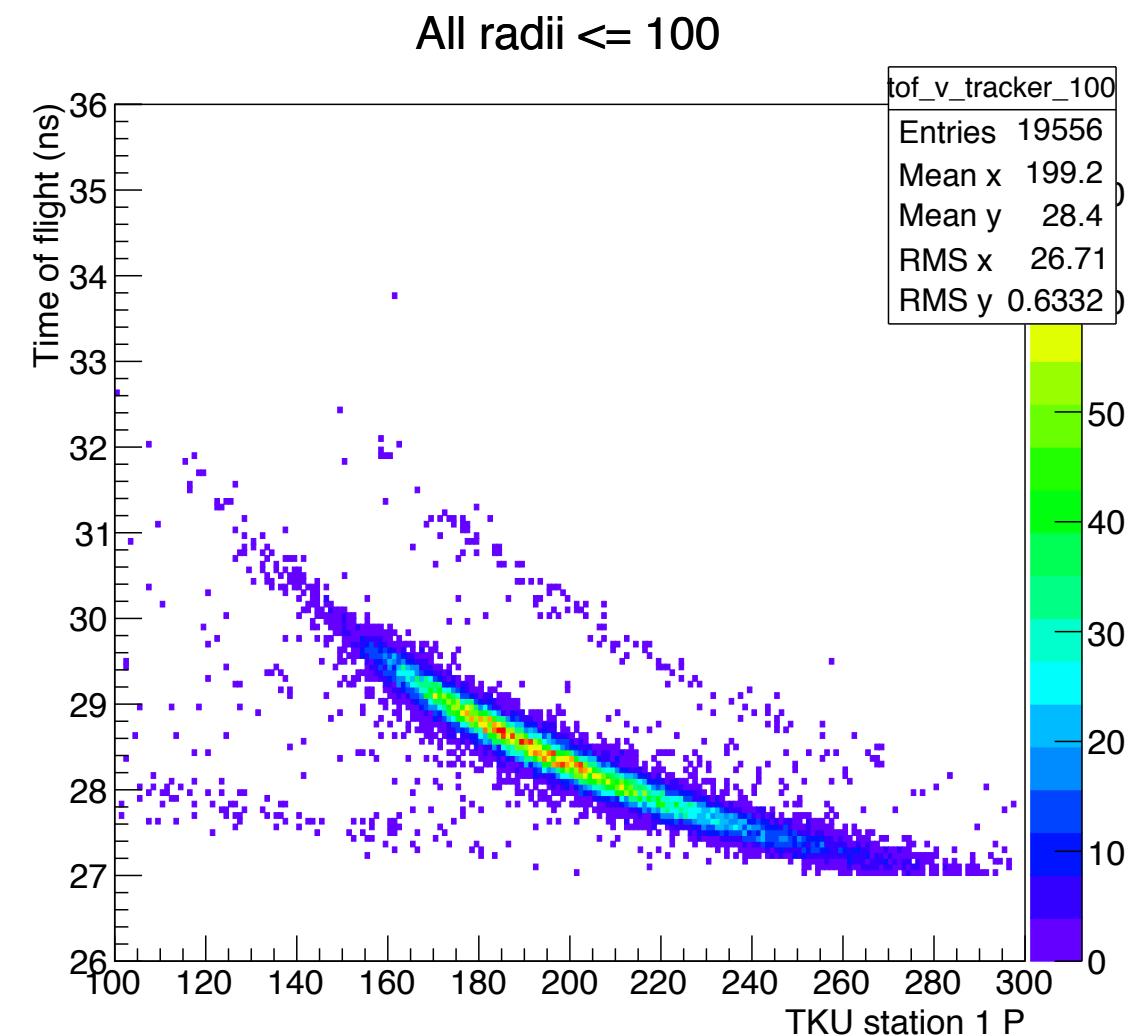
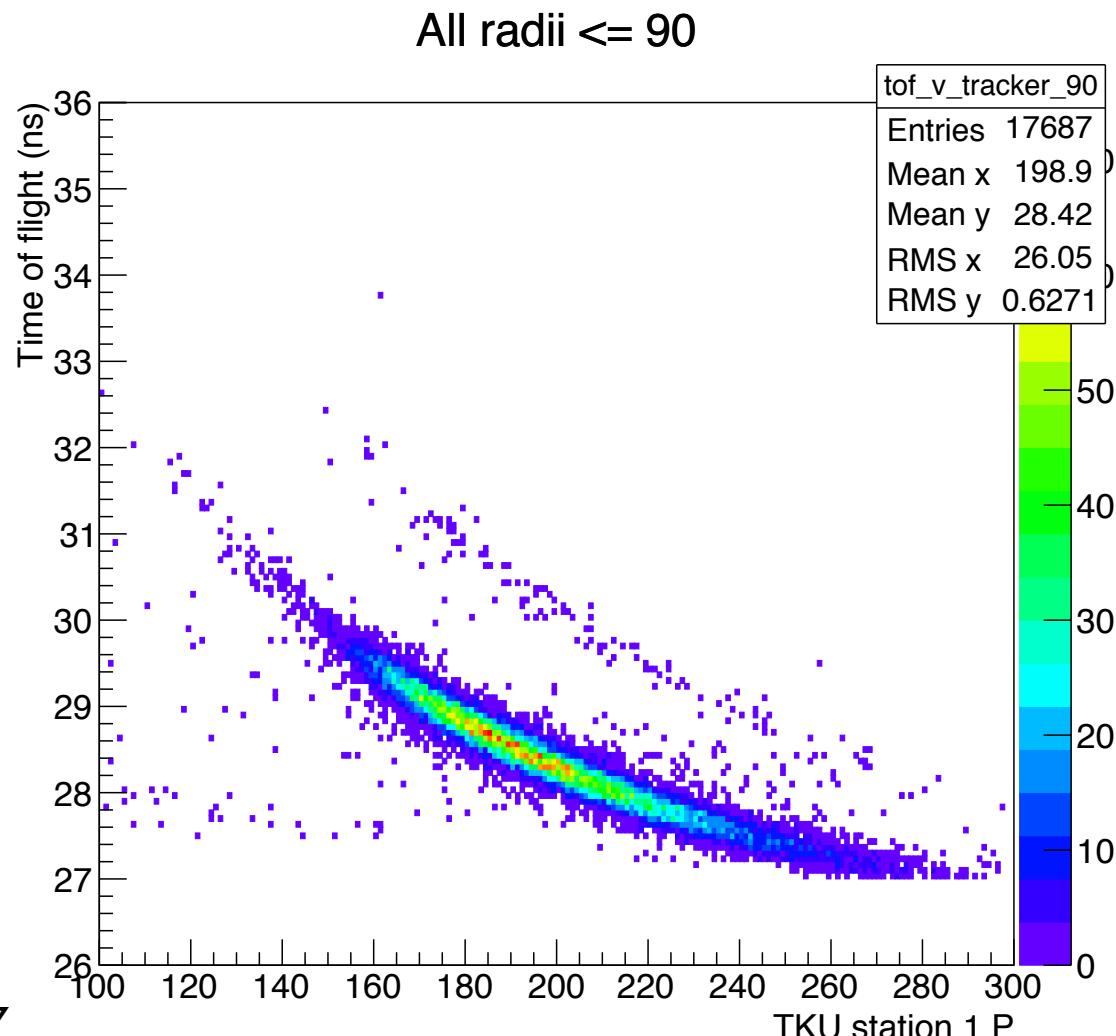
# DIFFUSER APERTURE CUT |

# DIFFUSER APERTURE CUT

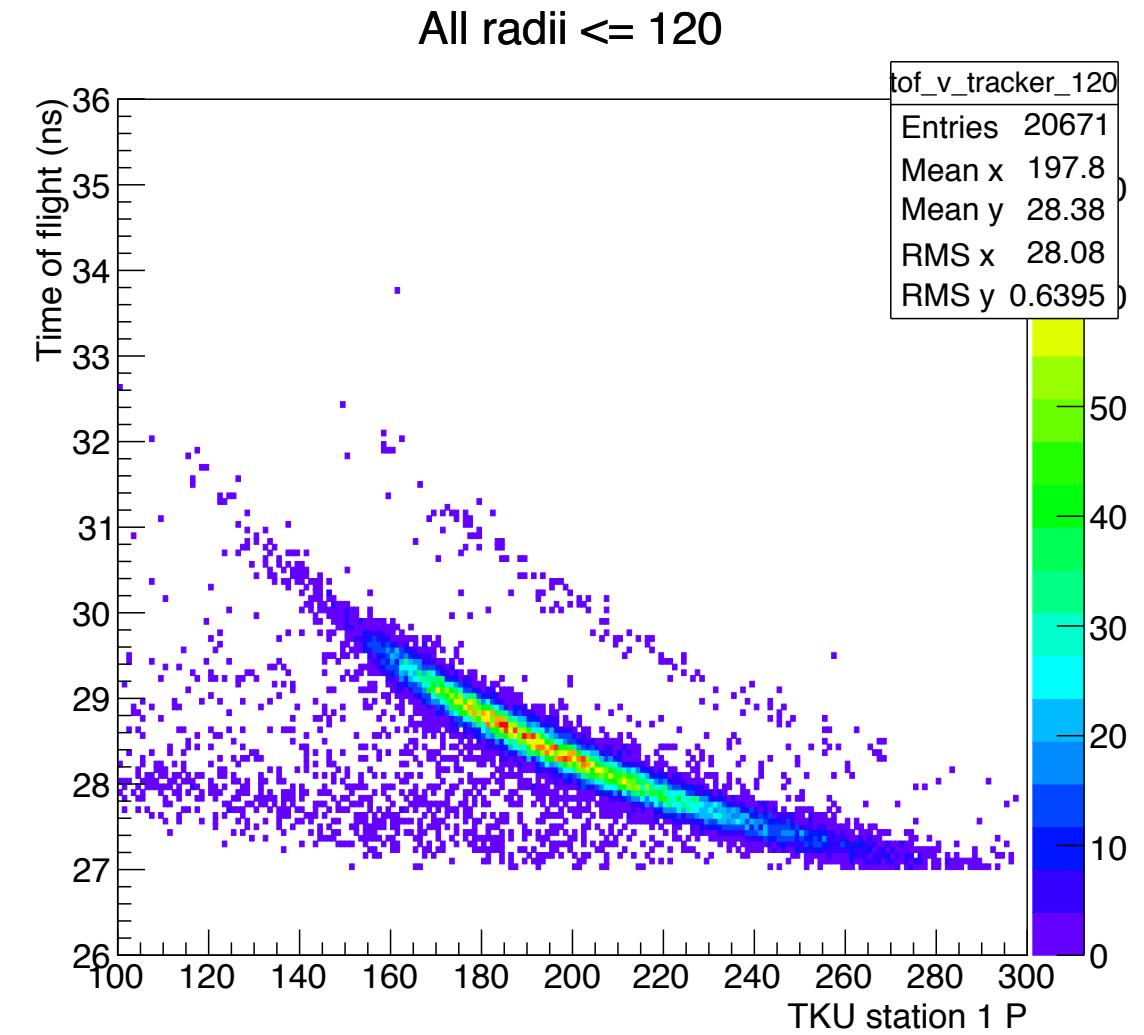
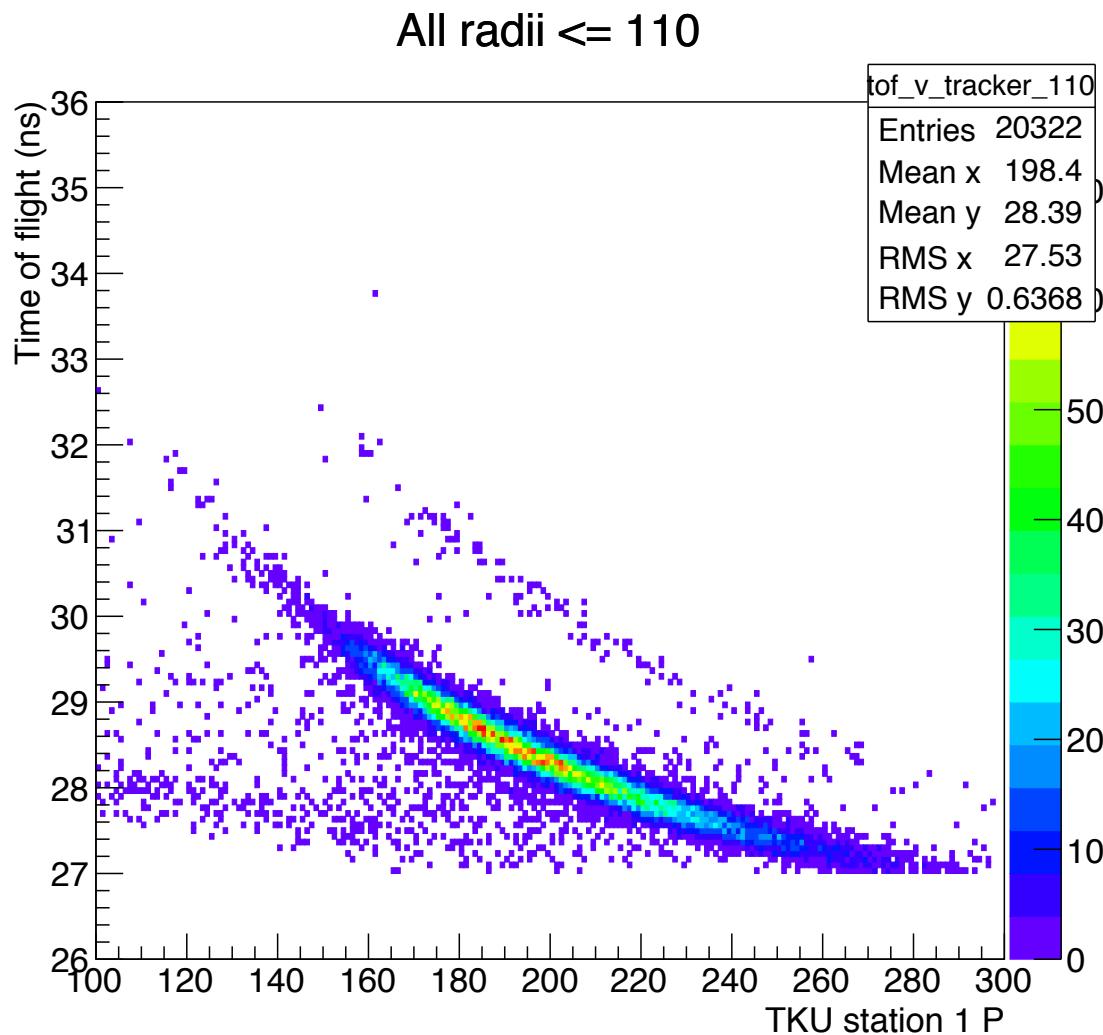
- Used to tidy up TOF vs Tracker distribution
- Claim: Particles in the lower “mush” have lost more momentum than expected from passing through the outside of the (open) diffuser
- At last CM, cut on  $\Delta P$  between TOF1 and TKU
- Prefer to replace with a radial cut on muon position near diffuser
- Chris Rogers has done some tracking from TKU station 5 to TOF1, noting where they cross the diffuser (data only so far)



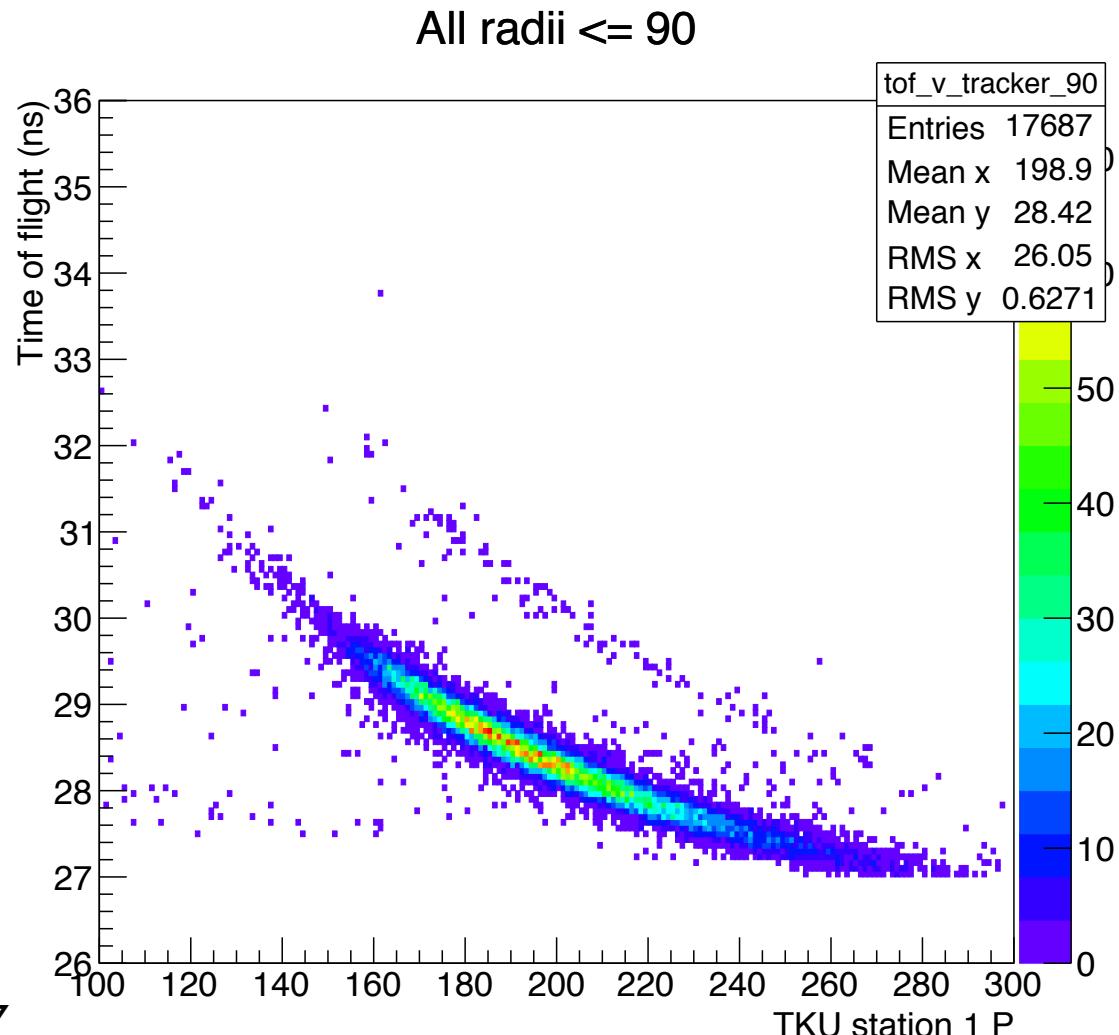
# DIFFUSER APERTURE CUT



# DIFFUSER APERTURE CUT



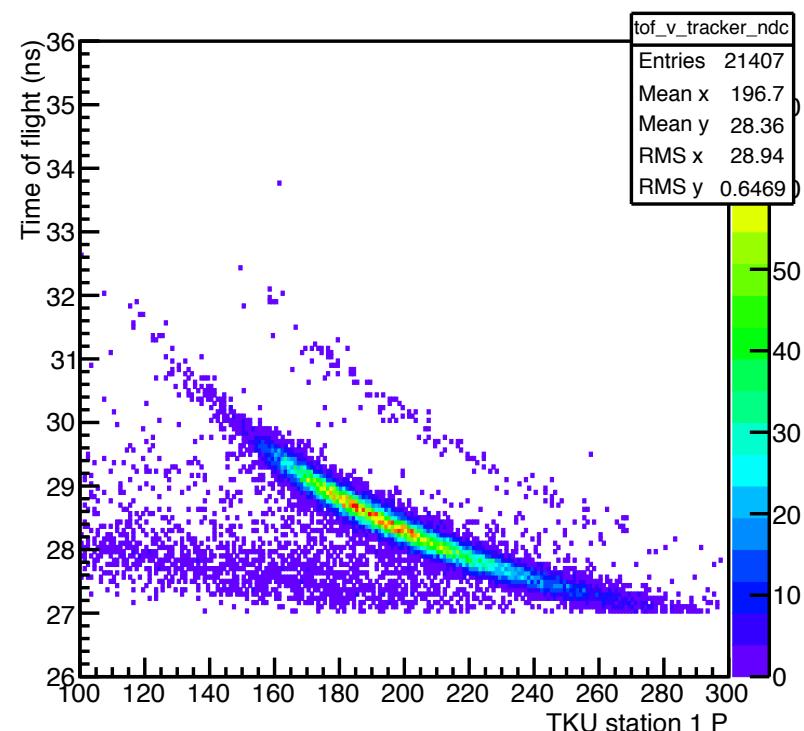
# DIFFUSER APERTURE CUT



- Accept muons that cross the diffuser at a radius  $< 90\text{mm}$
- What happens to plots of interest:
  - Without this cut, but with all “good detector” cuts
  - With good detector + good diffuser cut
  - With good detector + bad diffuser cut

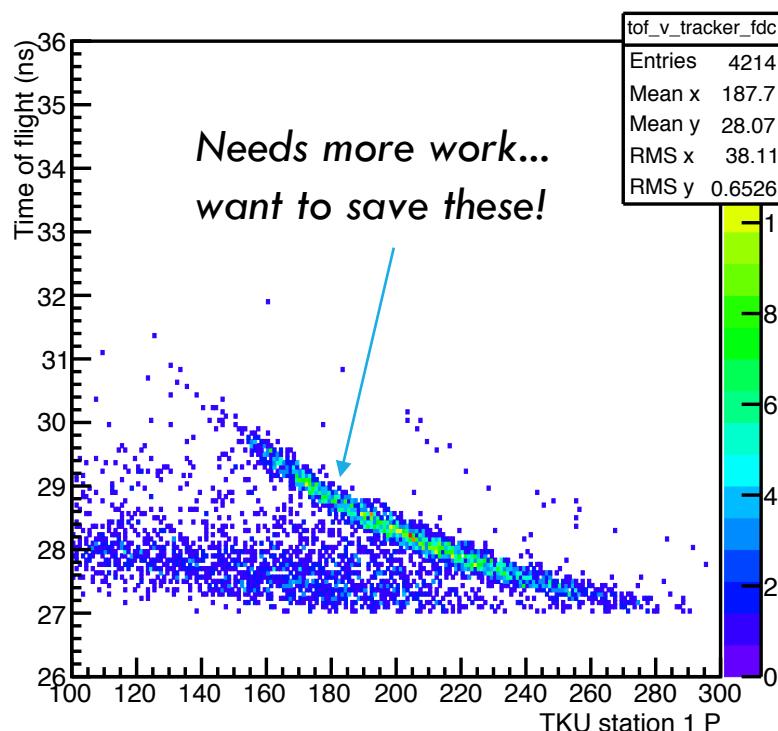
# DIFFUSER APERTURE CUT

No diffuser cut



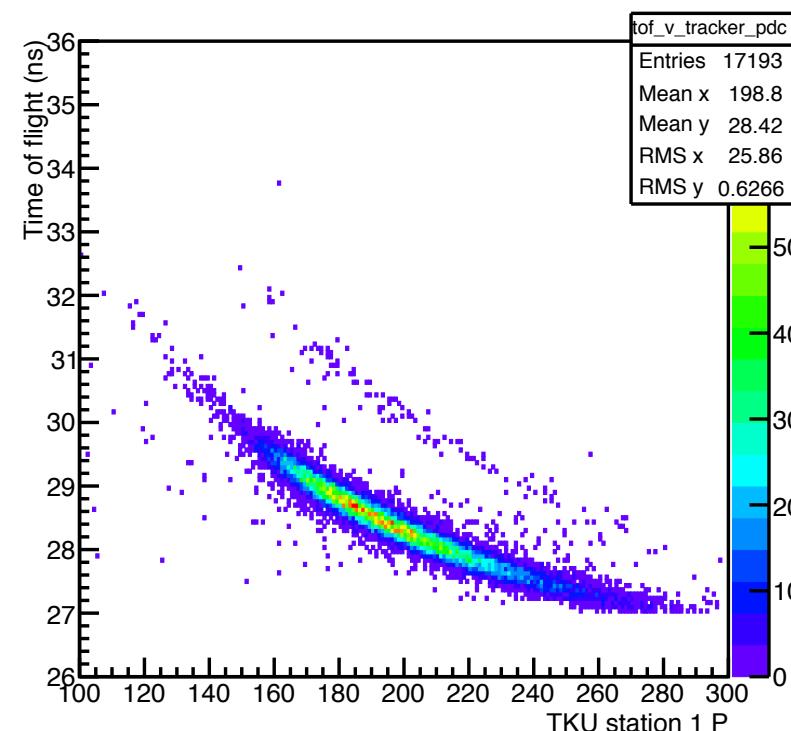
'Good detectors' only

Fail diffuser cut



'Good detectors'  
&  
Bad diffuser

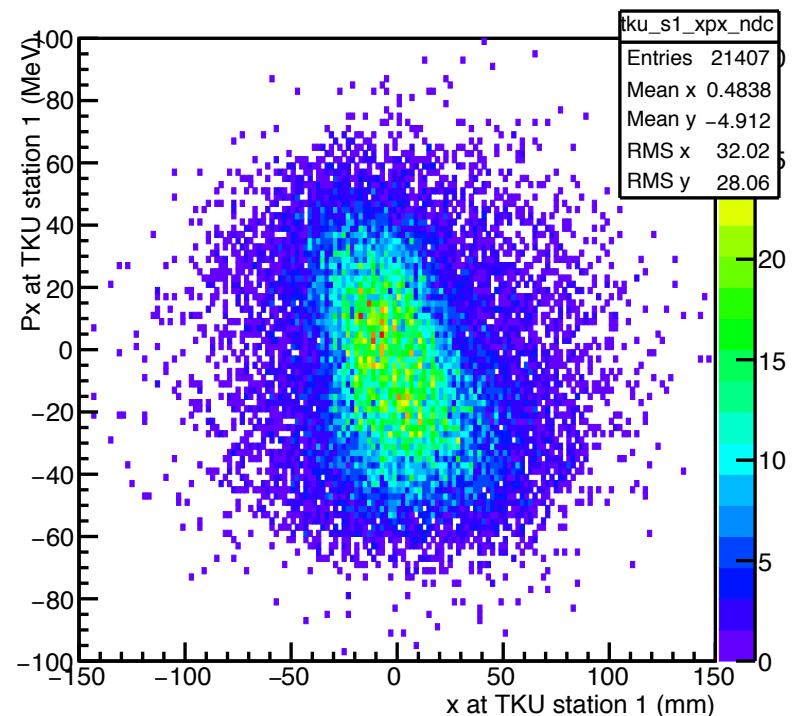
Pass diffuser cut



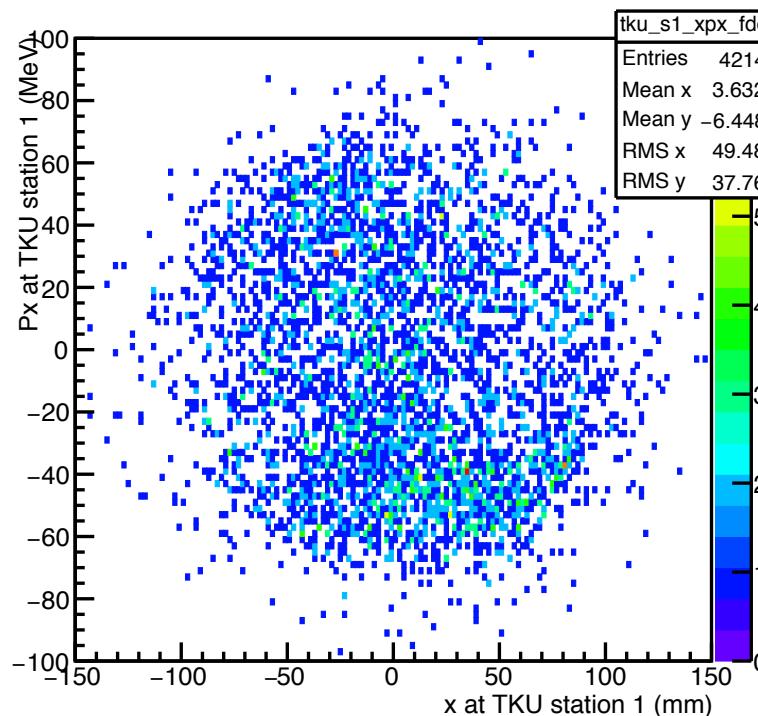
'Good detectors'  
&  
Good diffuser

# DIFFUSER APERTURE CUT (X, Px)

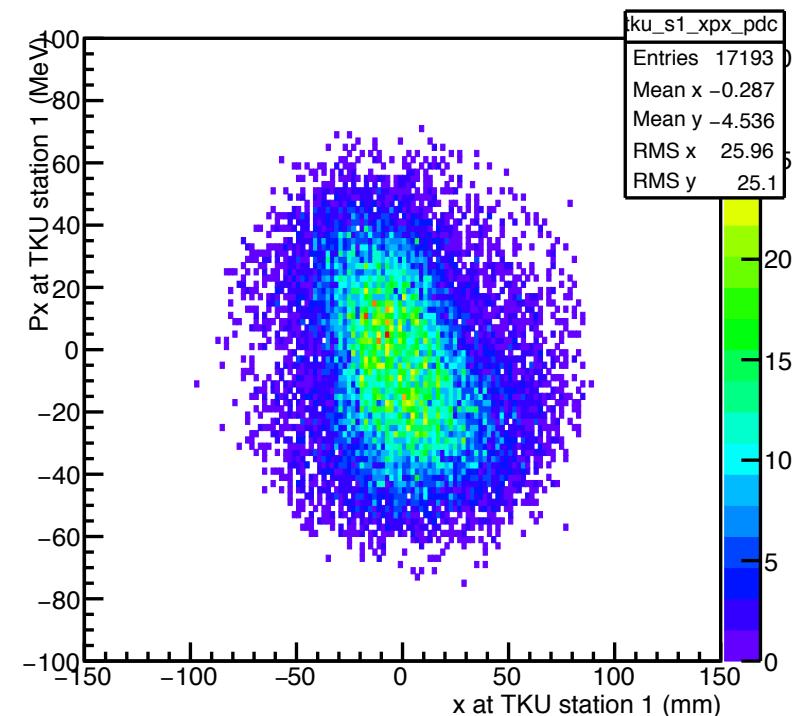
No diffuser cut



Fail diffuser cut



Pass diffuser cut

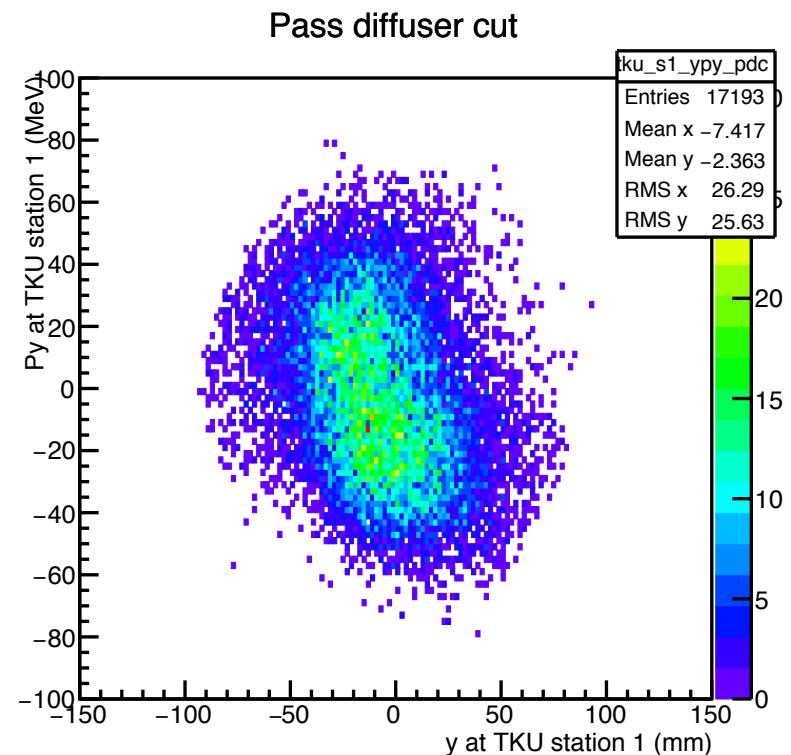
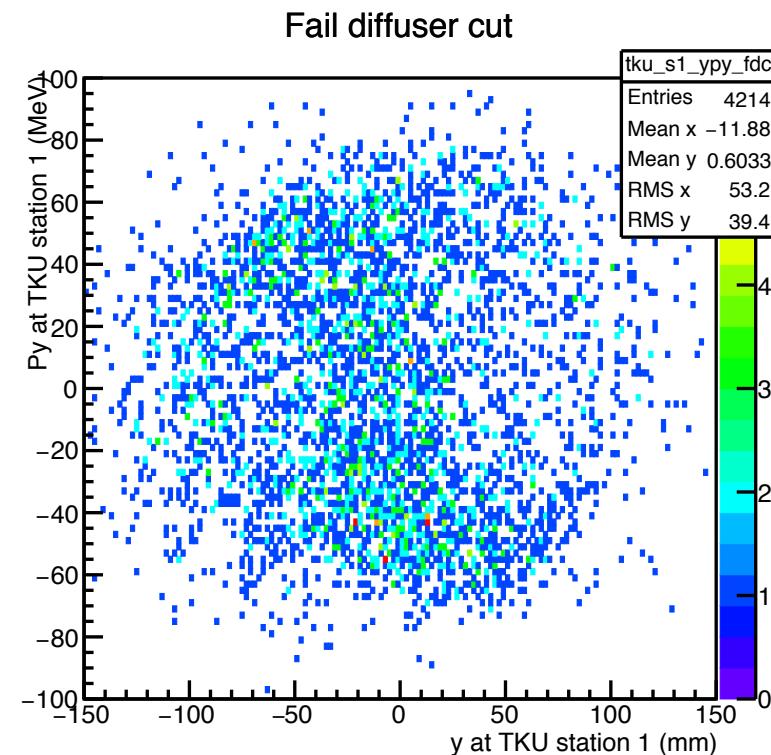
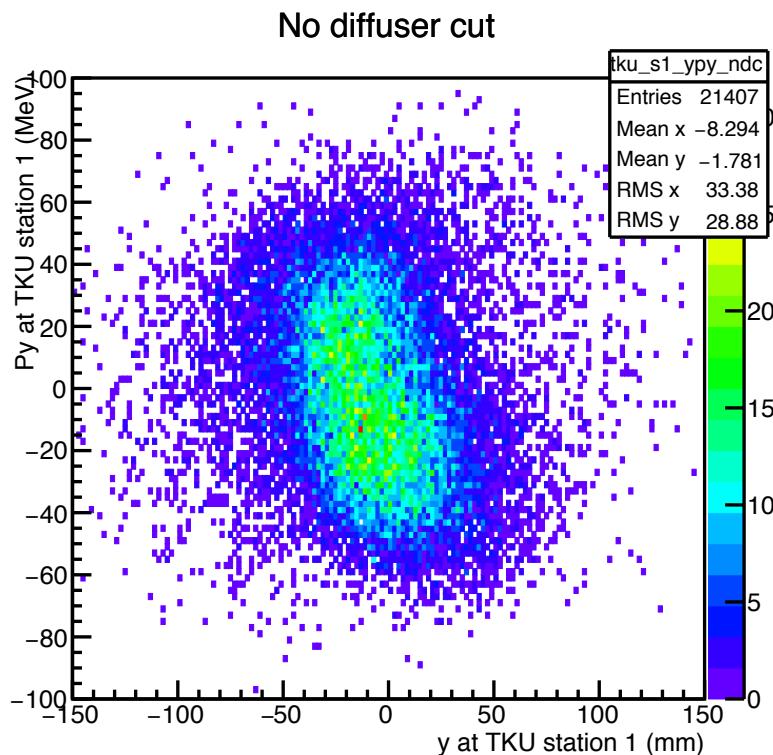


'Good detectors' only

'Good detectors'  
&  
Bad diffuser

'Good detectors'  
&  
Good diffuser

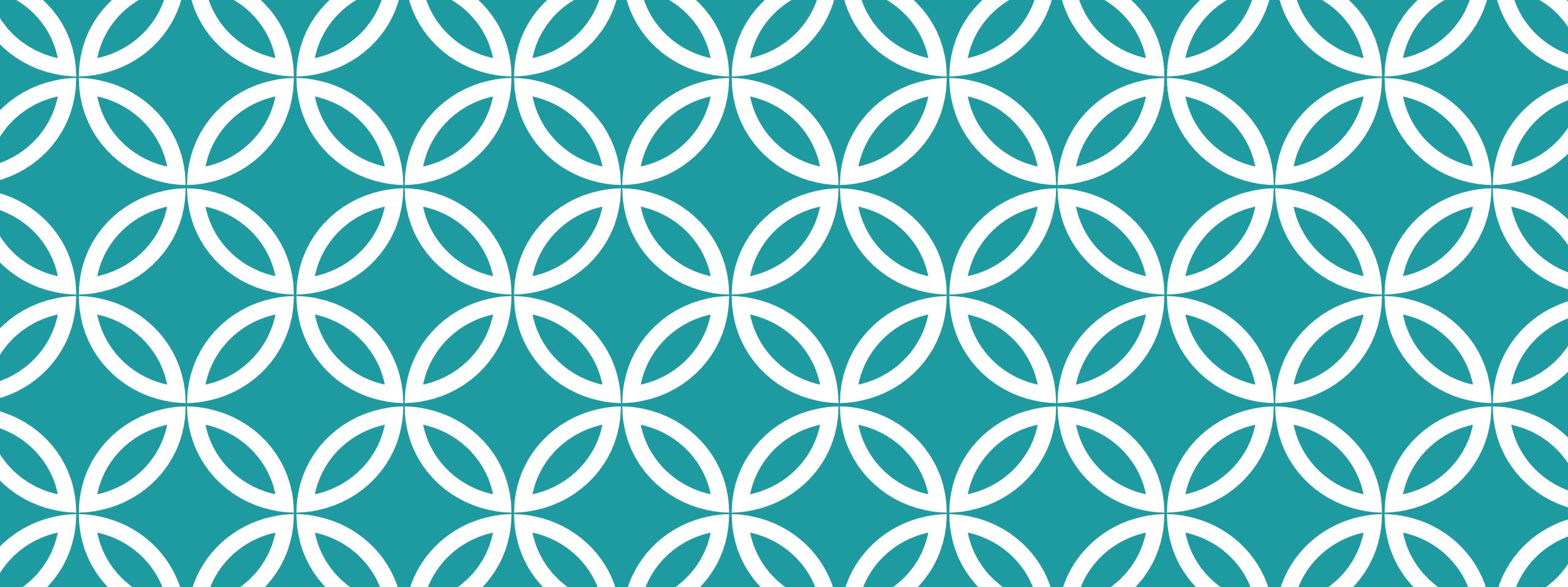
# DIFFUSER APERTURE CUT (Y, PY)



'Good detectors' only

'Good detectors'  
&  
Bad diffuser

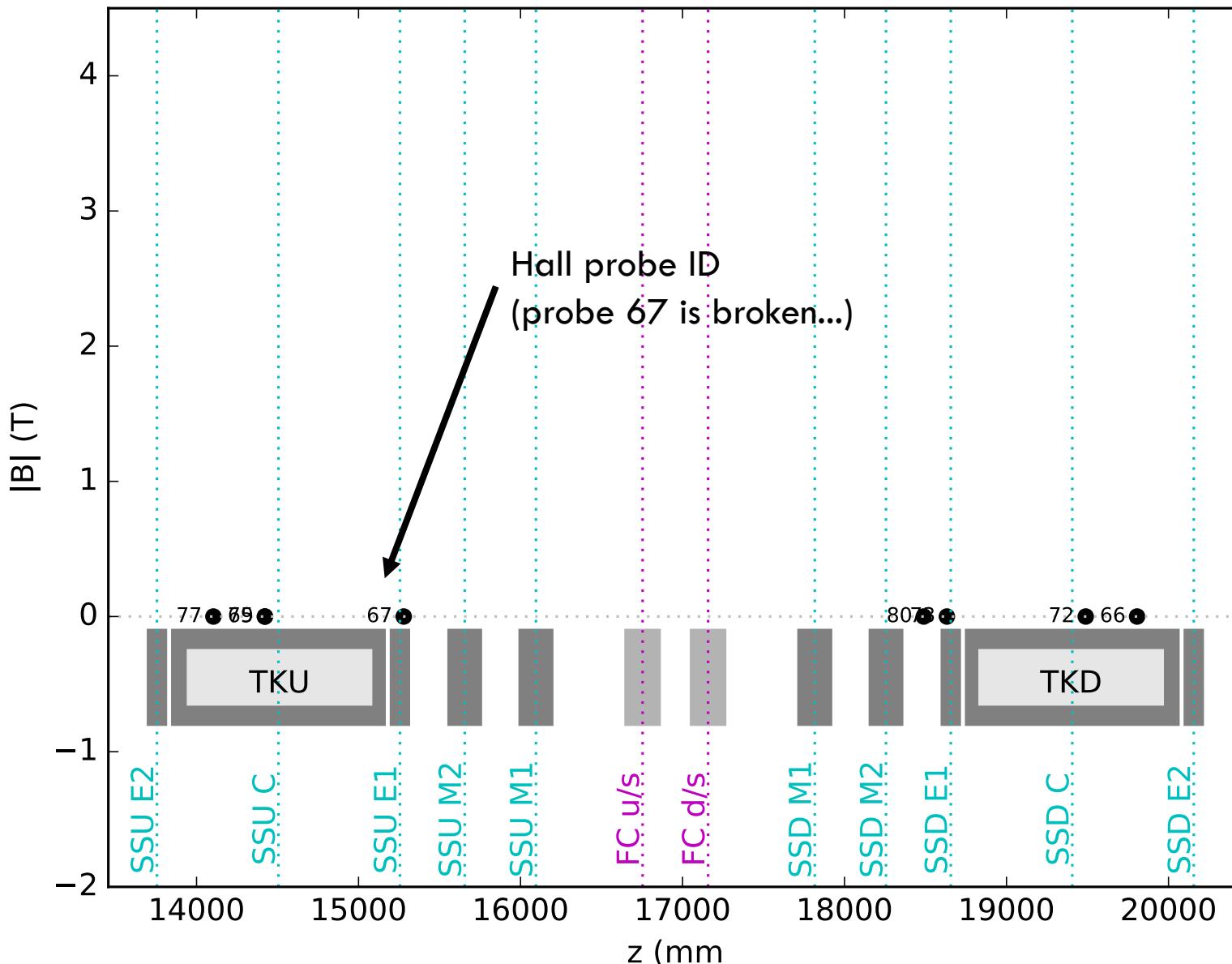
'Good detectors'  
&  
Good diffuser



# FIELDS & HALL PROBES

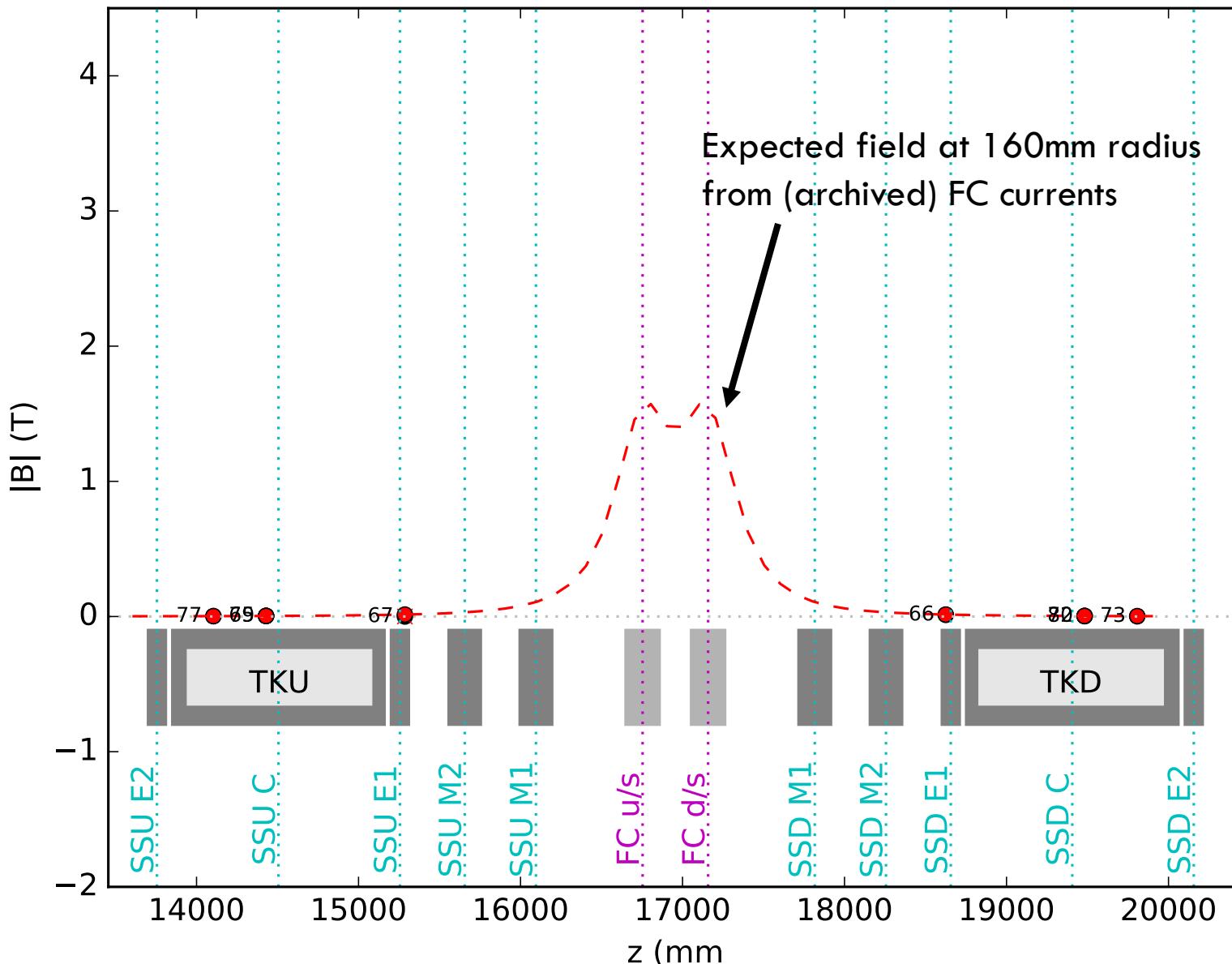
---

Following plots will look something like this:



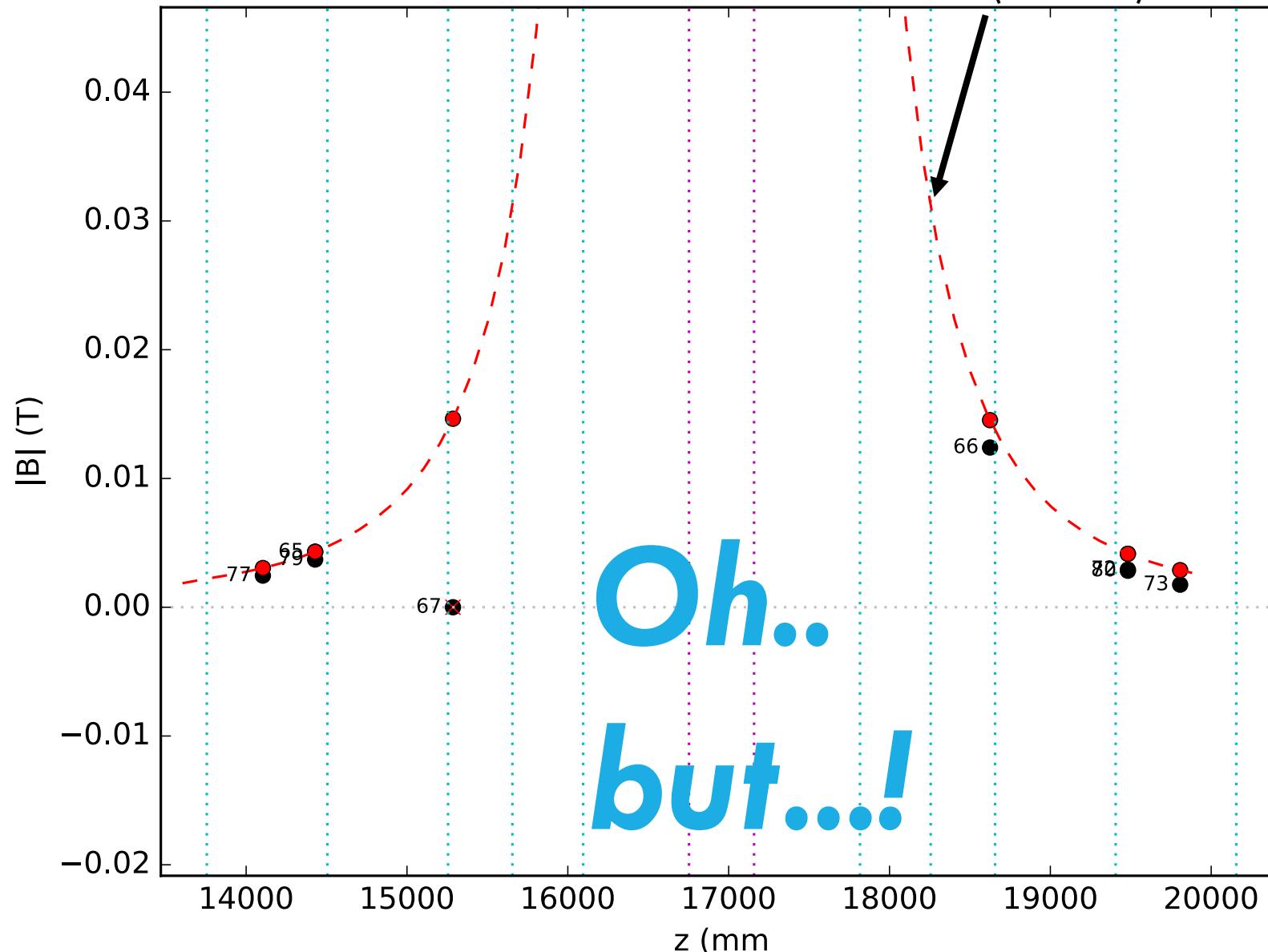
- Grey boxes = coils positioned according to geometry. Lengths are Holger's cold dimensions
- Dotted cyan/magenta lines indicate coil centres
- TKU & TKD bounding boxes according to geometry
- Black dots = Hall probes at given position. All probes are at a radius of 160mm
- Red dots = expected field at given position
- Vertical axis: Total field measured by probes, or expected field at that position

Following plots will look something like this:

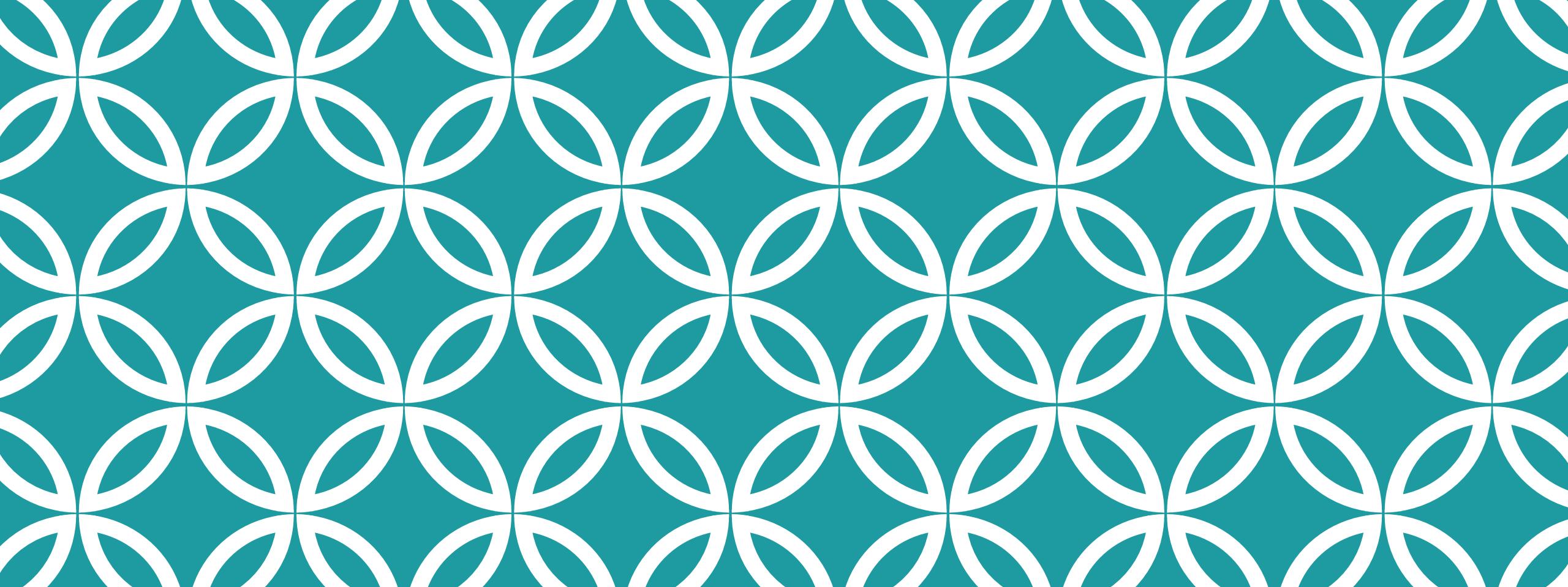


- Grey boxes = coils positioned according to geometry. Lengths are Holger's cold dimensions
- Dotted cyan/magenta lines indicate coil centres
- TKU & TKD bounding boxes according to geometry
- Black dots = Hall probes at given position. All probes are at a radius of 160mm
- Red dots = expected field at given position
- Vertical axis: Total field measured by probes, or expected field at that position

Expected field at 160mm radius  
from (archived) FC currents



- Hall probe positions here are a simple  $(r, \theta, z)$
- Hall probes sit on the tracker frame
- Tracker frame sits in the magnet bores
- Bores  $\neq$  parallel with beam axis
- Calculate field isn't *really* at the same position as the probes are measuring
  - Some rotation & offset to apply
  - Started, but not finished...



# TOF-TRACKER MOMENTUM LOSS |

# TOF-TRACKER MOMENTUM LOSS

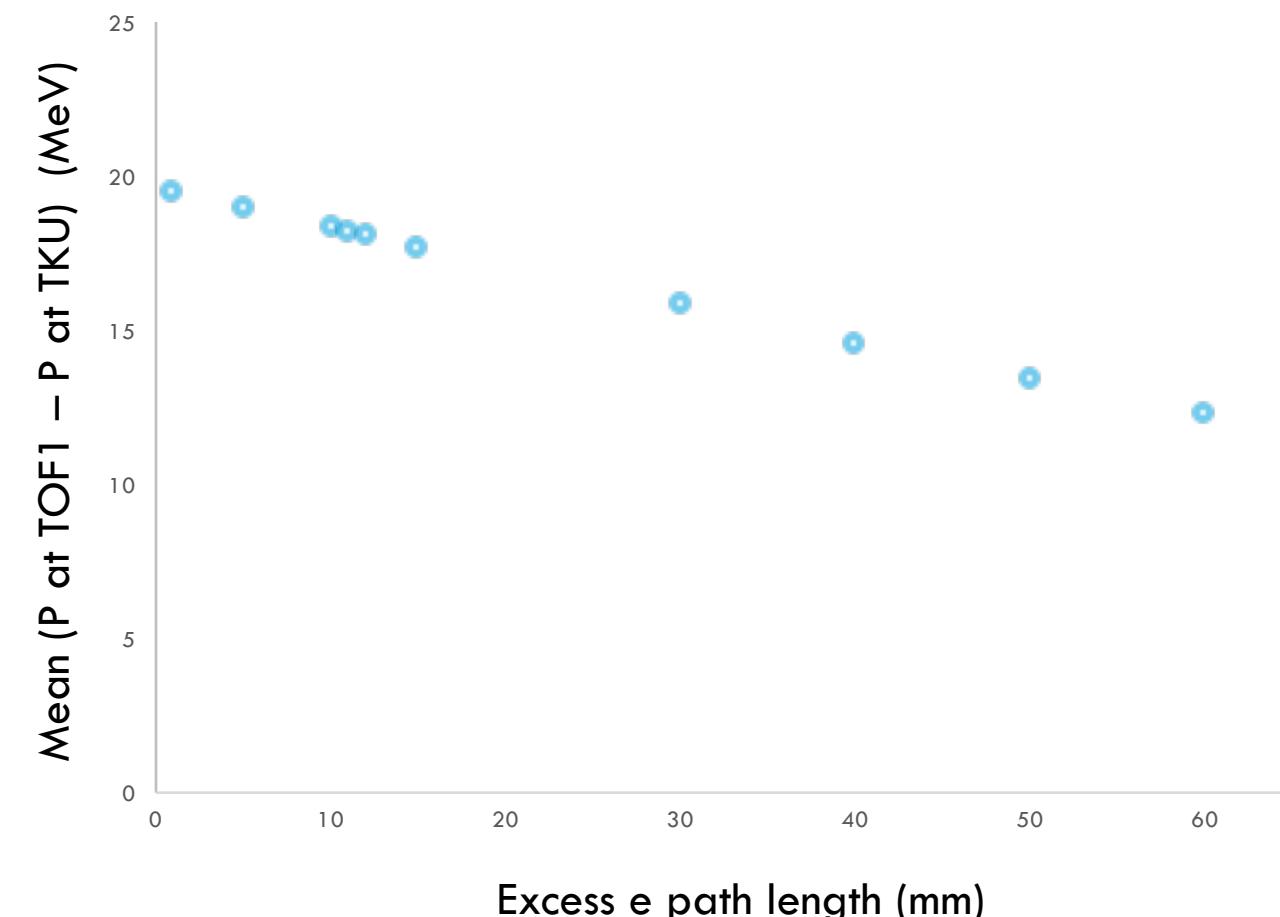
- Lose more momentum than expected between TOF1 and TKU
- Two possible causes:
  - TKU momentum correction not included in SciFi Track::mom() function?
    - Need to talk to Adam
  - Incorrect “excess electron path length” used in TOF momentum reconstruction?
    - These come from studies from Mark Rayner
    - Old G4BL simulation
    - Mean deviation from a straight line of electrons passing through Q789
    - An old (6, 200) mu+ simulation gives an 11mm excess
    - But this was a (3, 200) beam, and the excess is momentum dependent
    - **Look at more recent G4BL?**
    - **(Ultimately, doesn't affect emittance measurement at TKU... )**

*Yesterday, in a moment of clarity, I realised that I'd auto-filled the RMS rather than the mean here! Now it makes more sense.*

Excess path length (mm)	Mean (P at TOF1 – P at TKU)
1	19.5
5	18.97
10	18.32
11	18.20
12	18.08
15	17.70
30	15.81
40	14.59
50	13.44
60	12.26

# TOF-TRACKER MOMENTUM LOSS

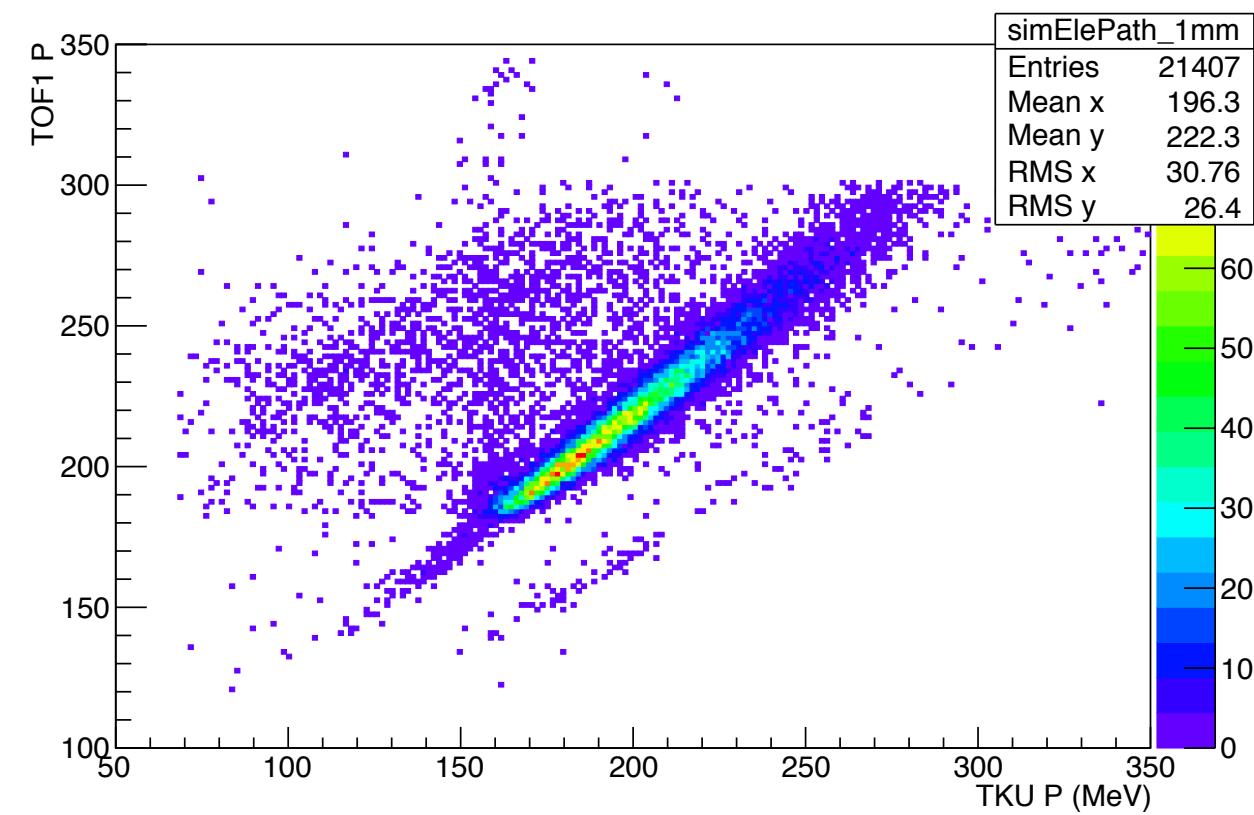
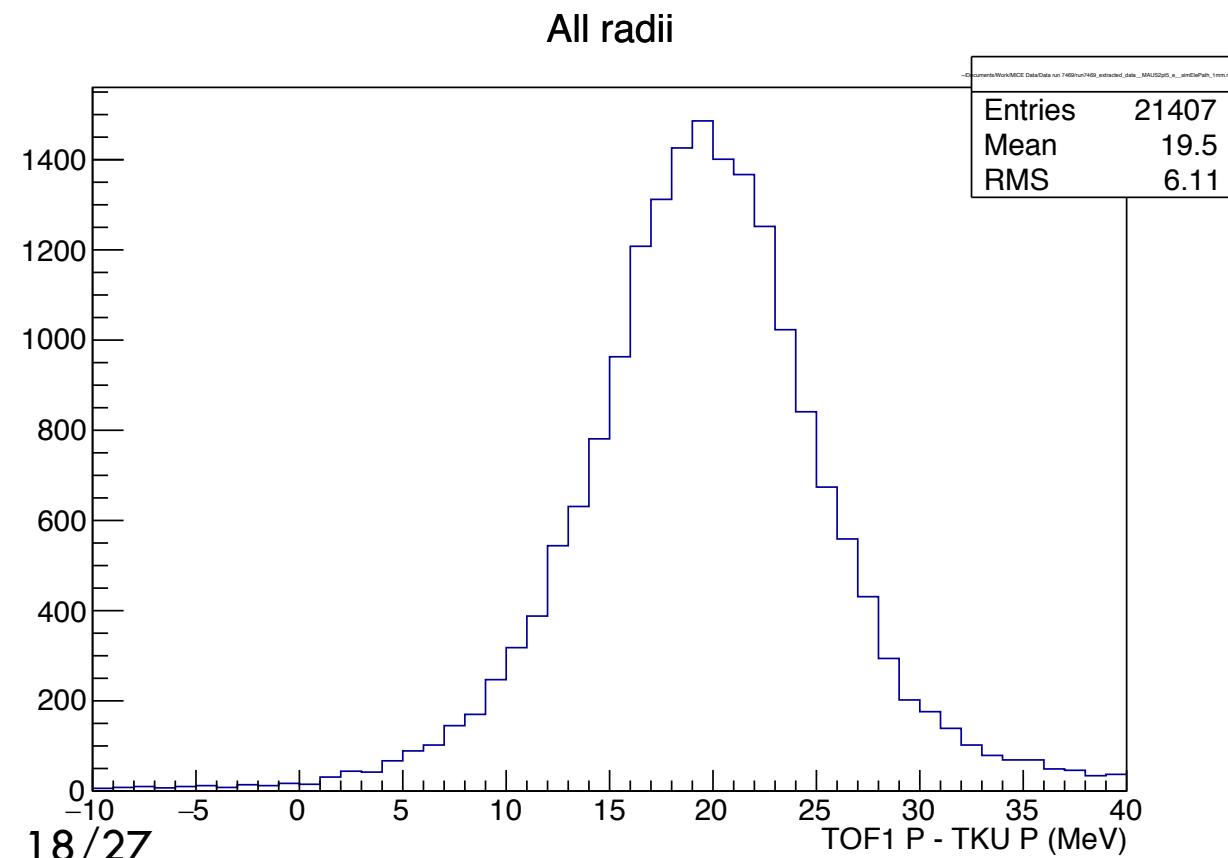
Excess path length (mm)	Mean (P at TOF1 – P at TKU)
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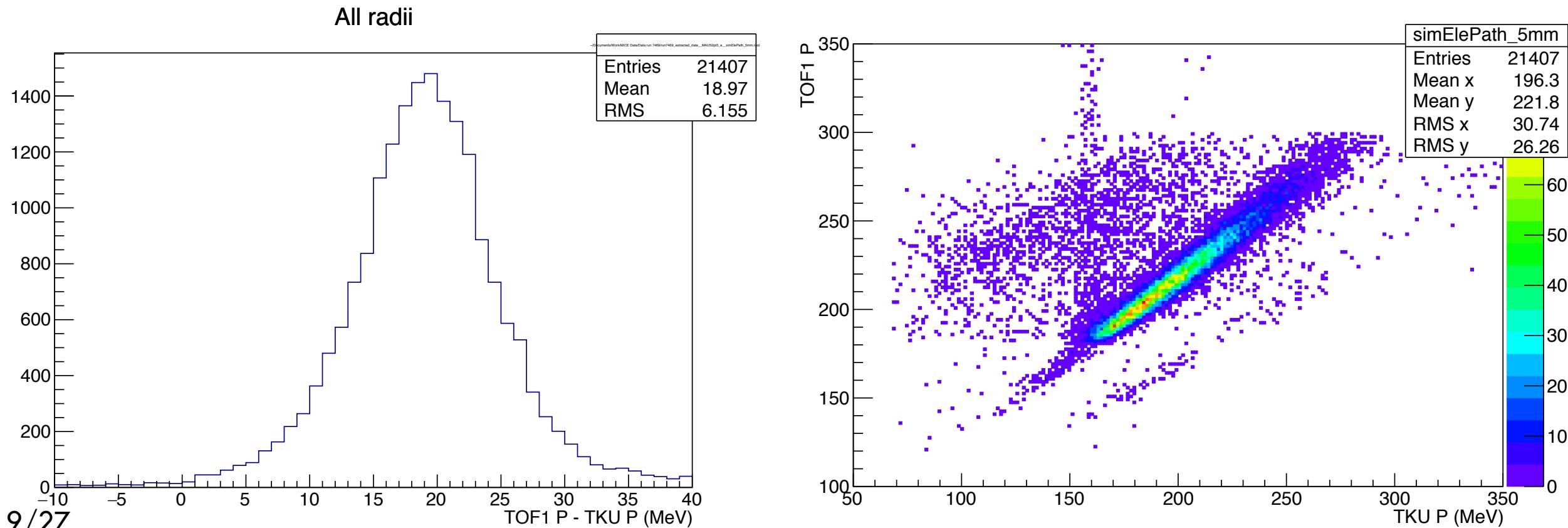
$$\frac{p_z c}{E} = \frac{L + \delta}{(L + \langle \delta_e^{\text{sim}} \rangle) + k c (t - \langle t_e^{\text{data}} \rangle)}. \quad (5.8)$$

See Eq. 5.8 in Mark's thesis, variable introduced to reduce bias on  $P_z$

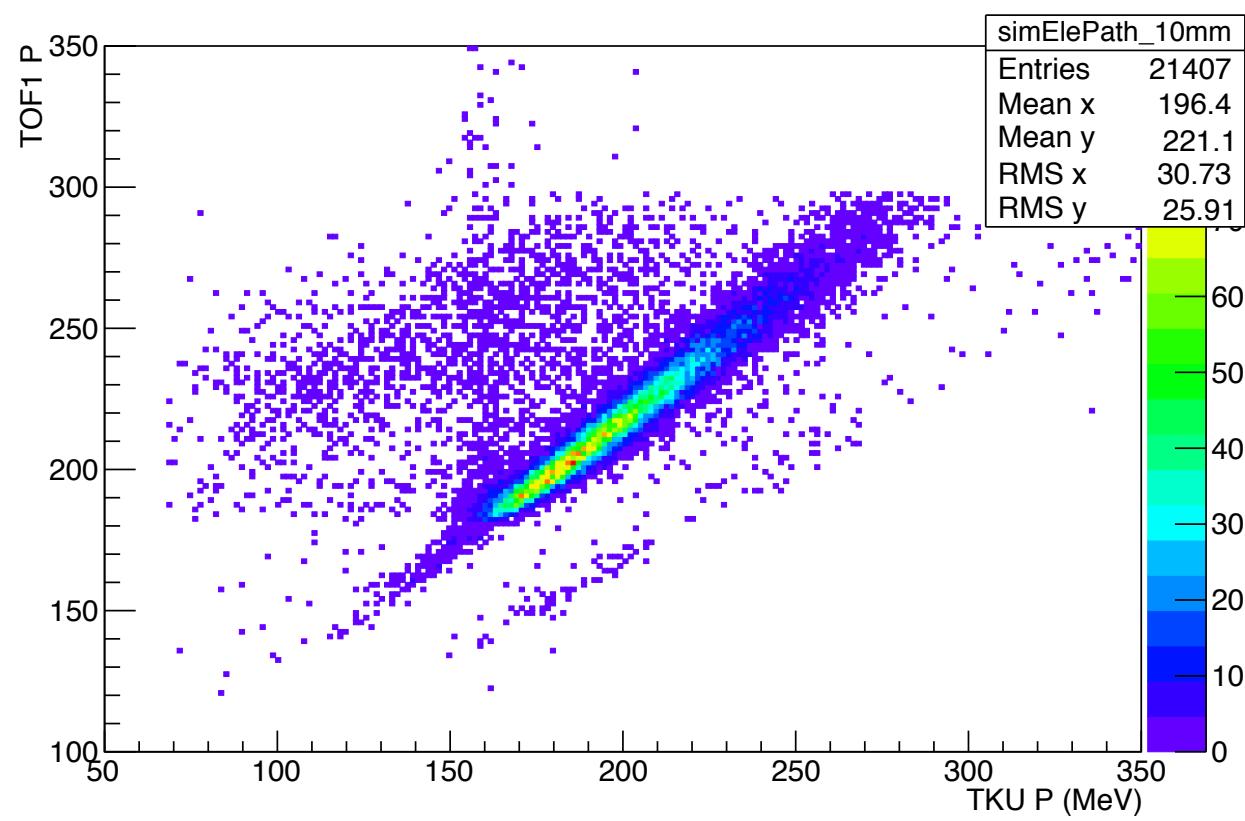
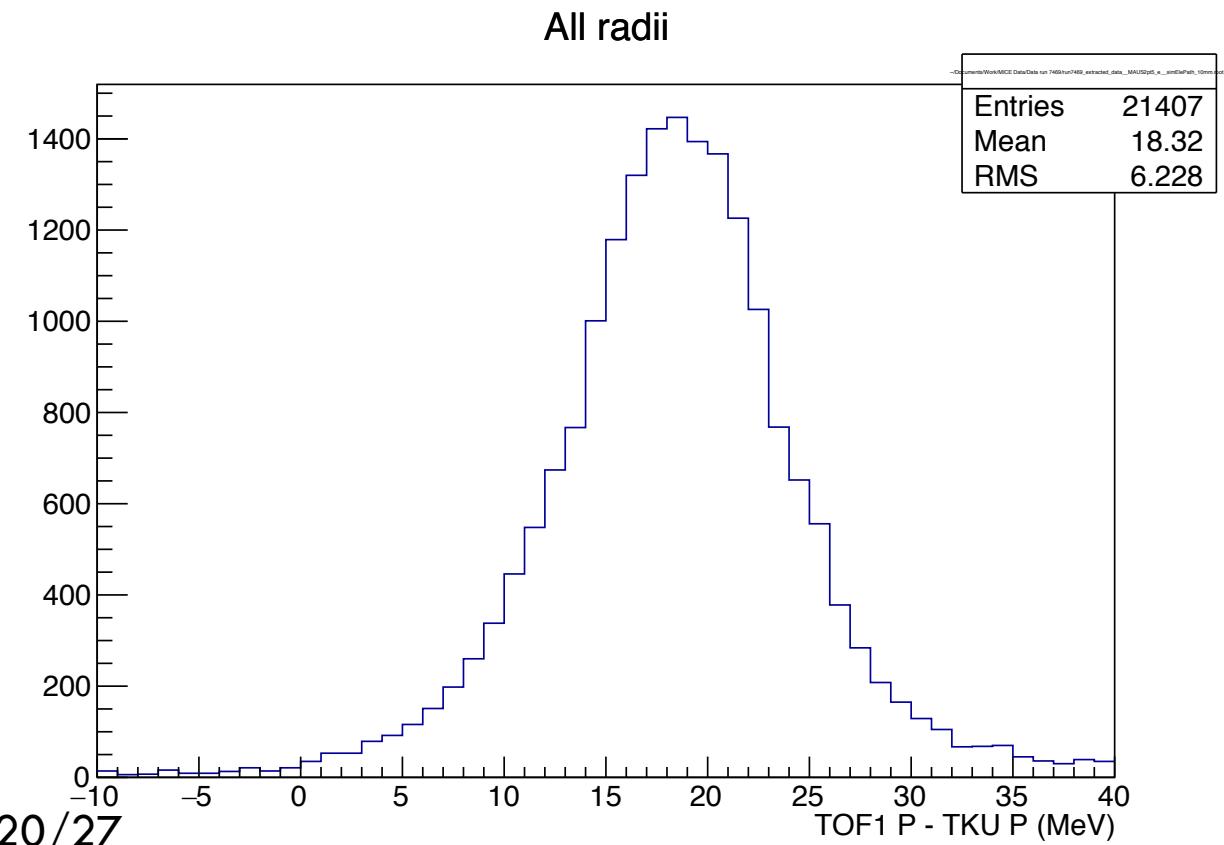
# EXCESS E PATH = 1MM



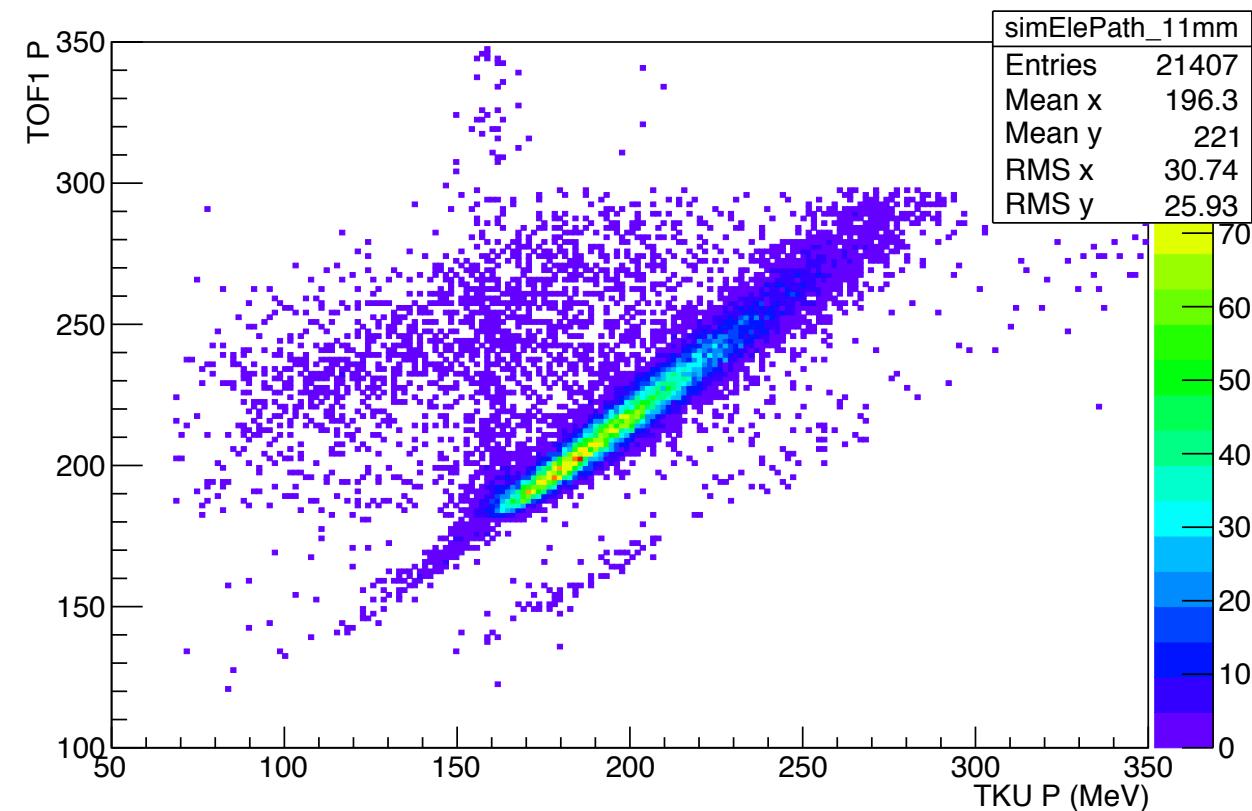
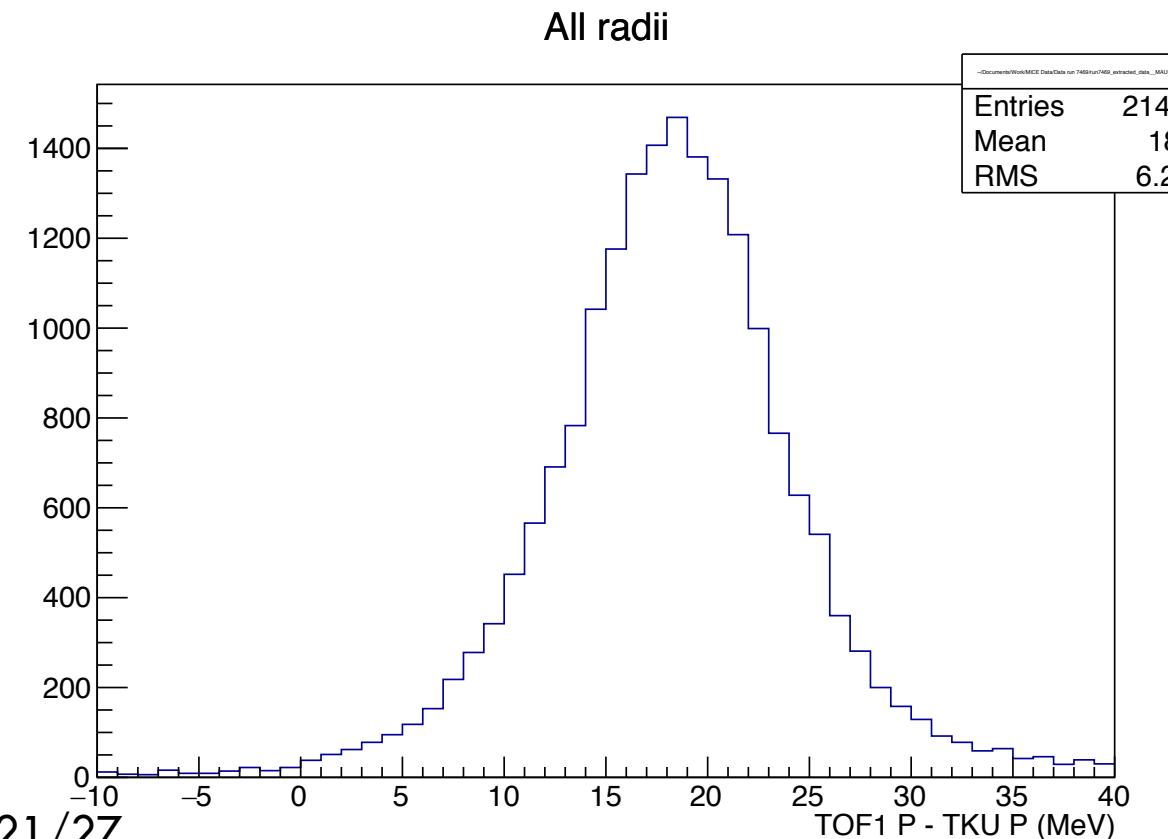
# EXCESS E PATH = 5MM



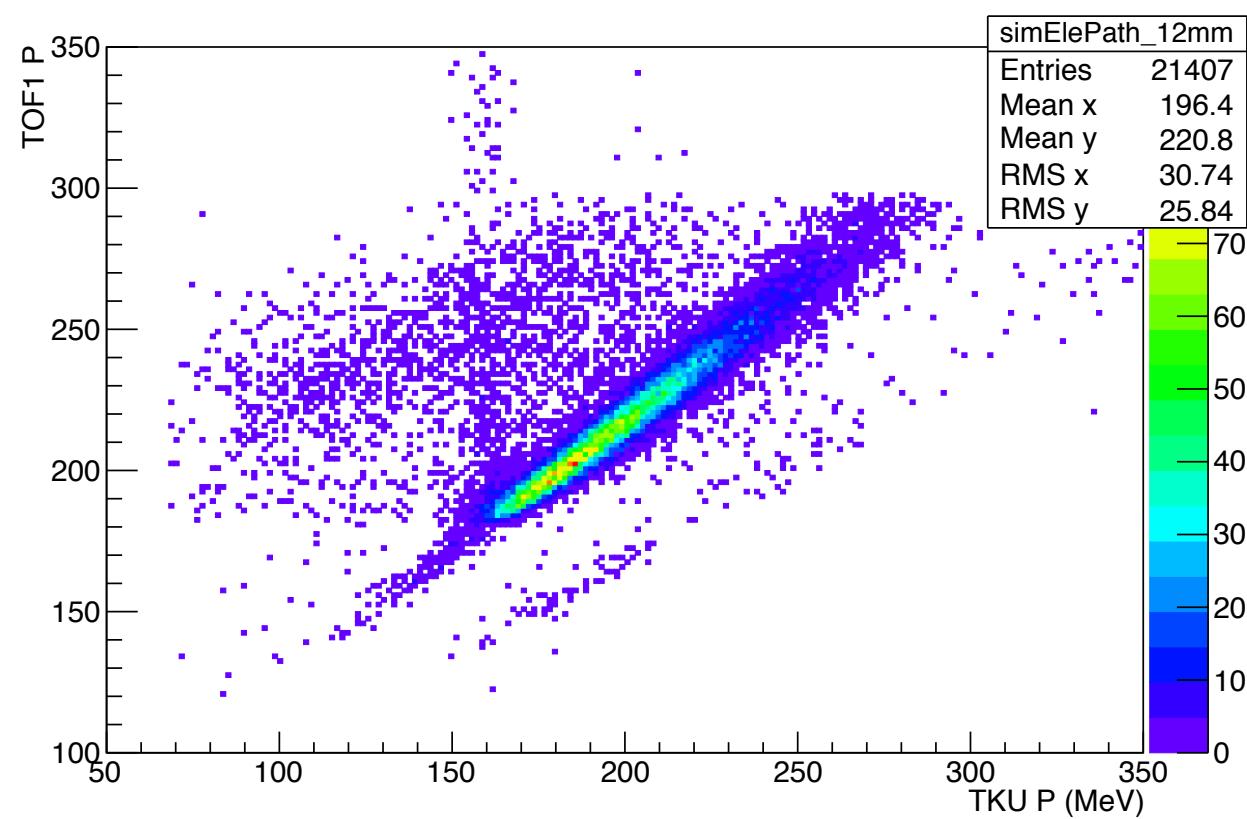
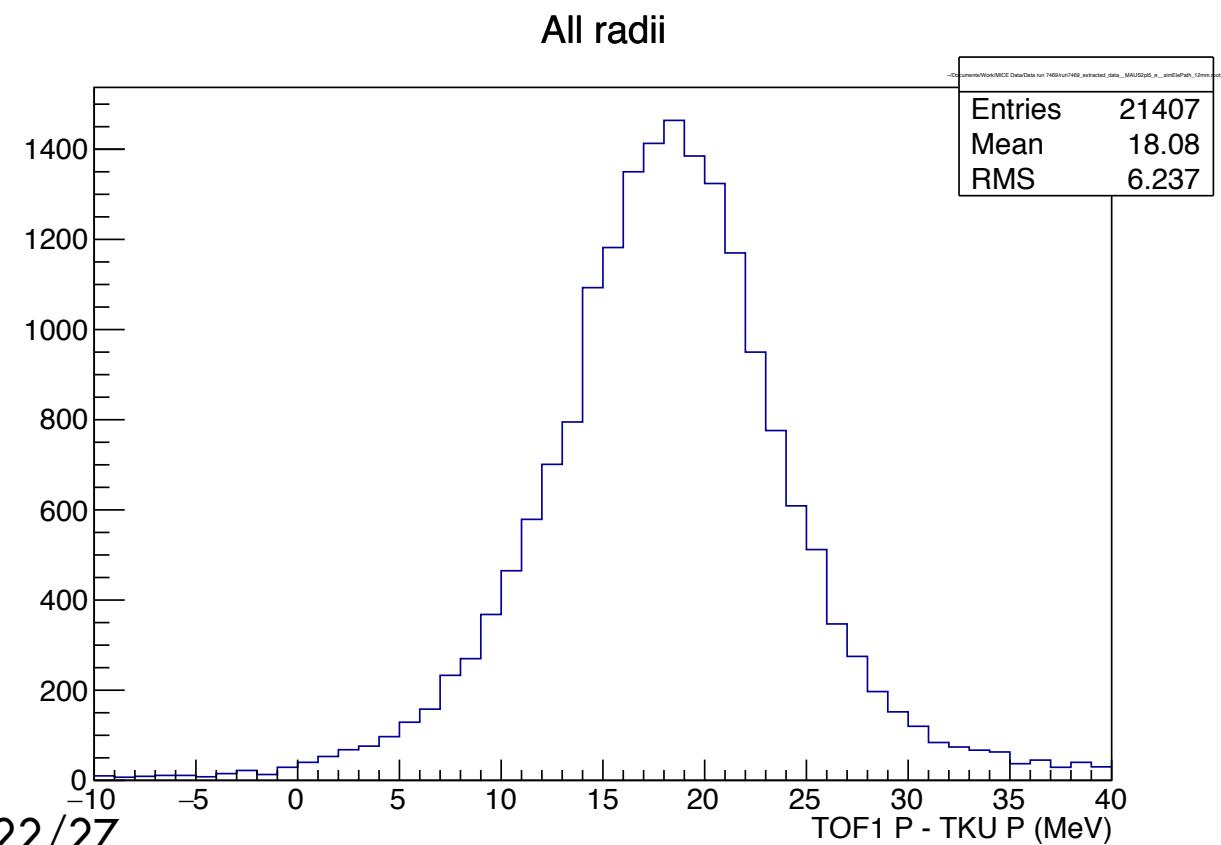
# EXCESS E PATH = 10MM



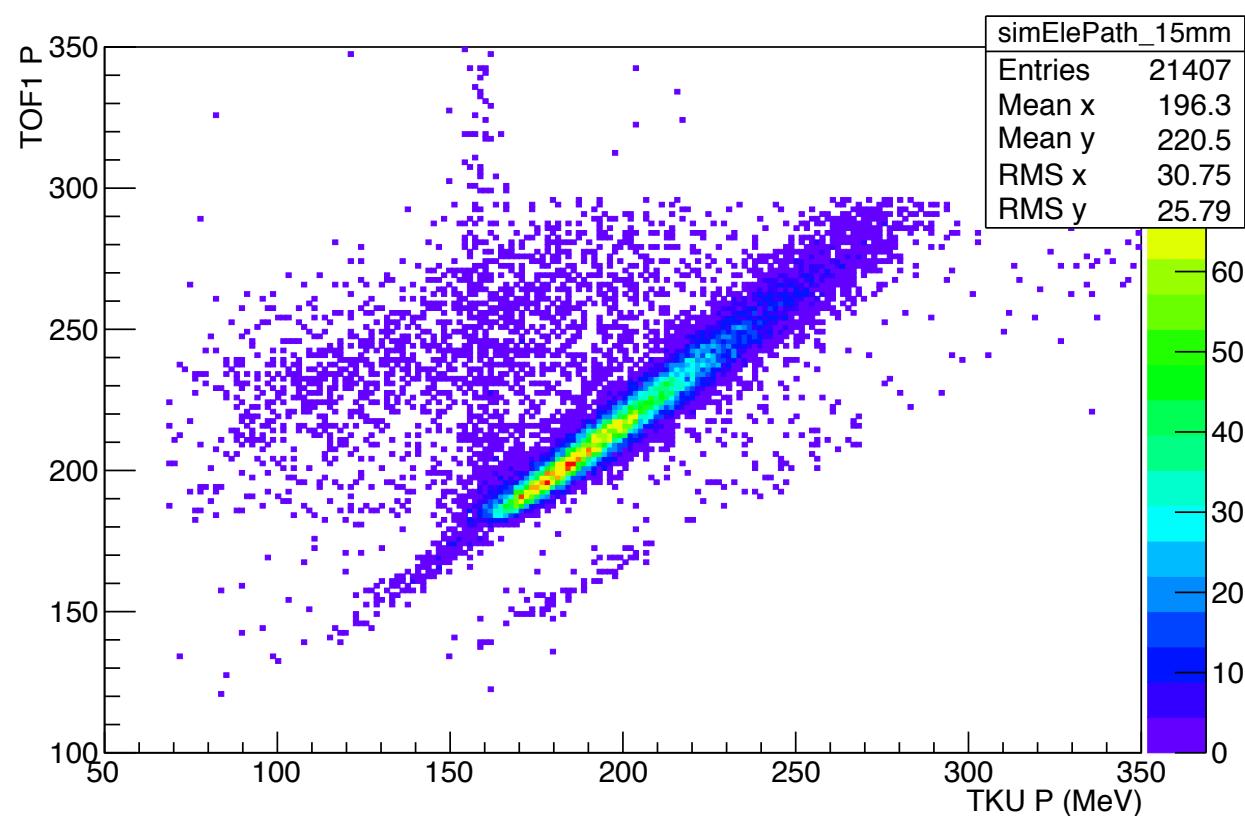
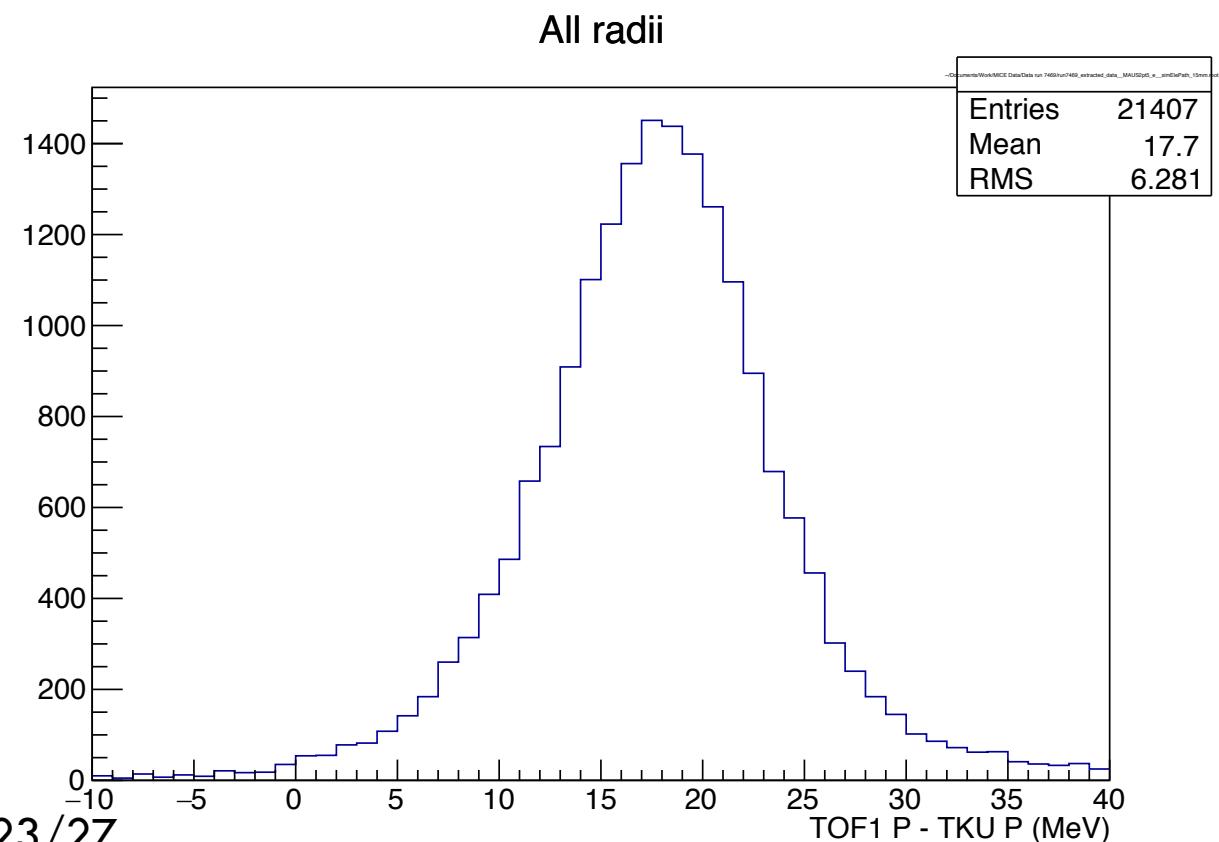
# EXCESS E PATH = 11MM (NOMINAL)



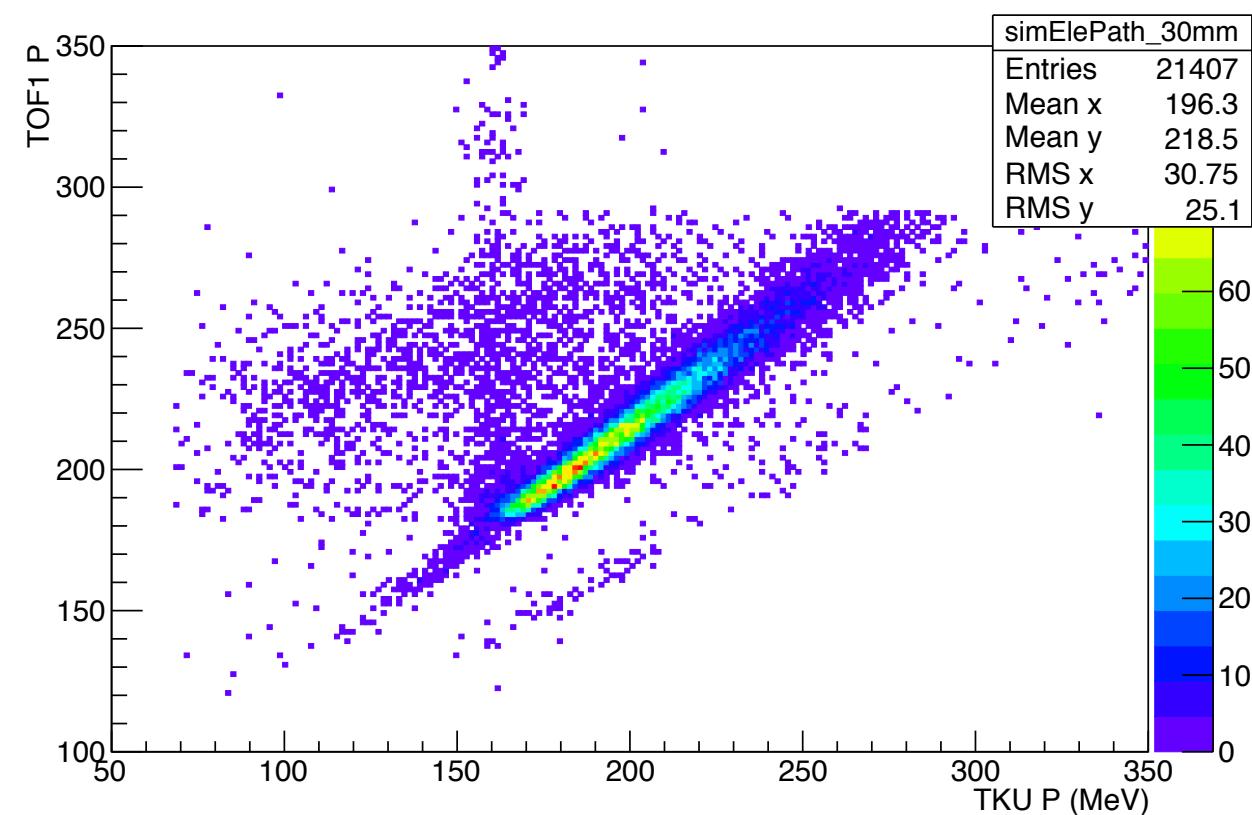
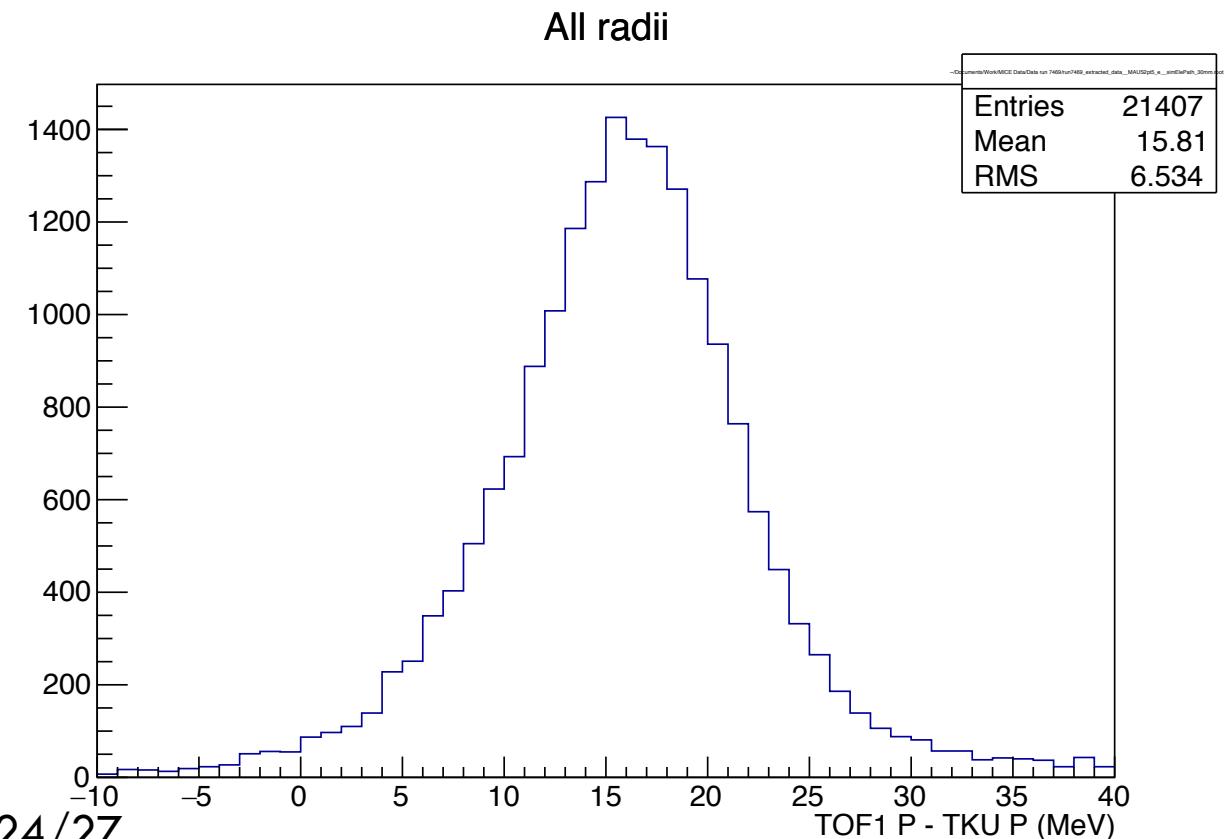
# EXCESS E PATH = 12MM



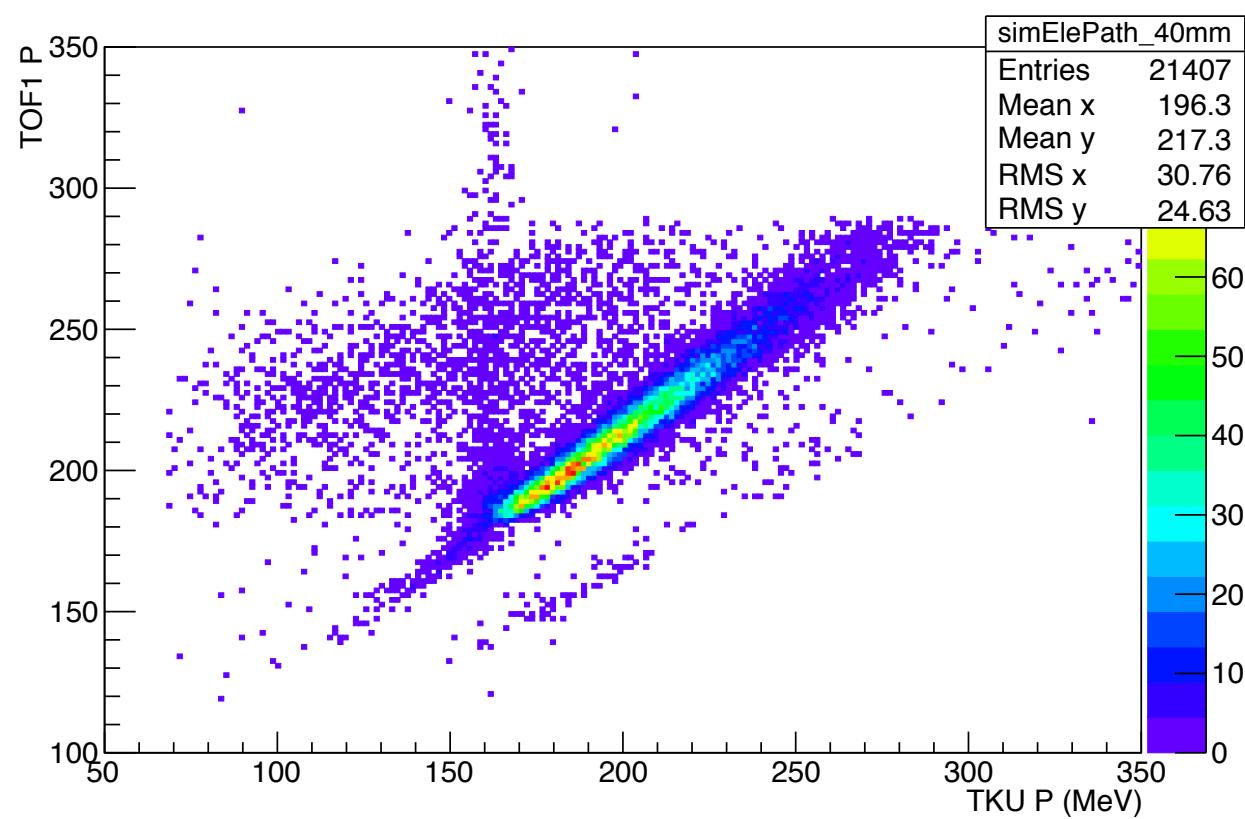
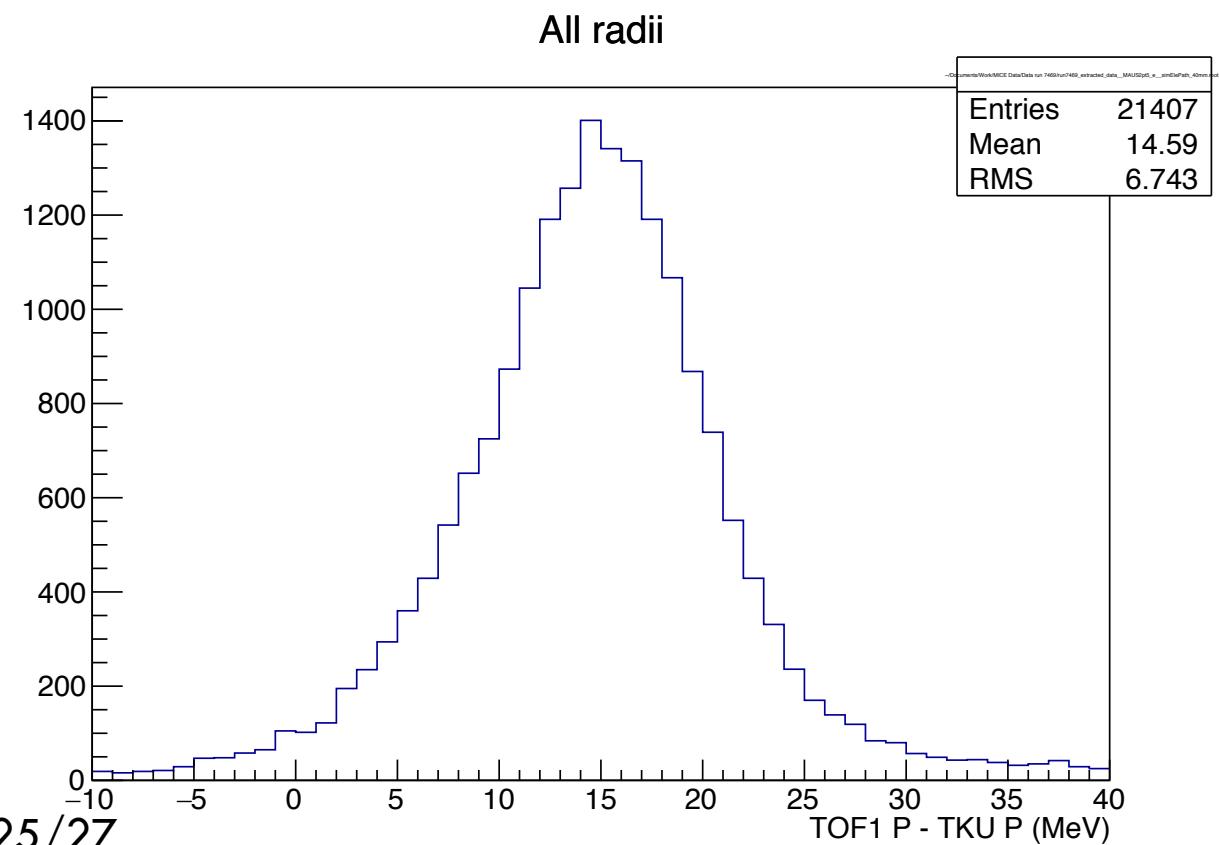
# EXCESS E PATH = 15MM



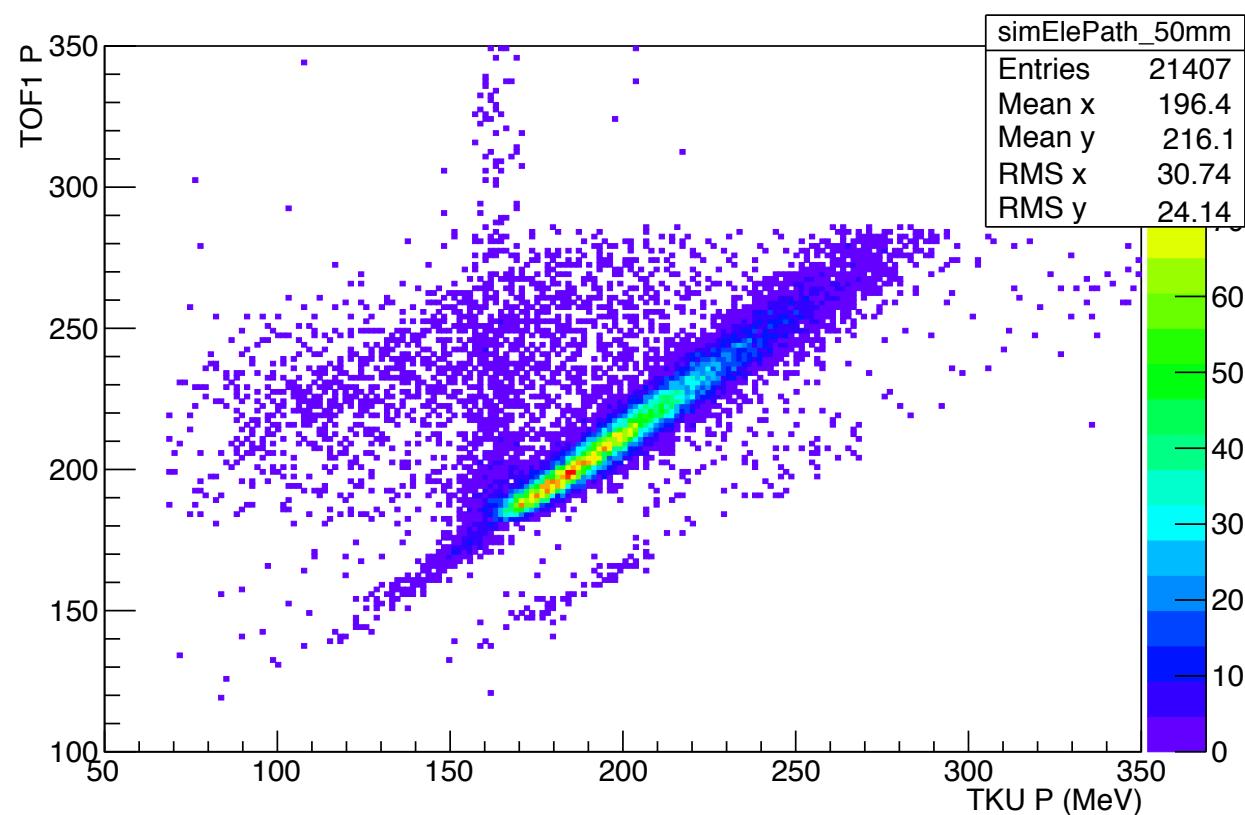
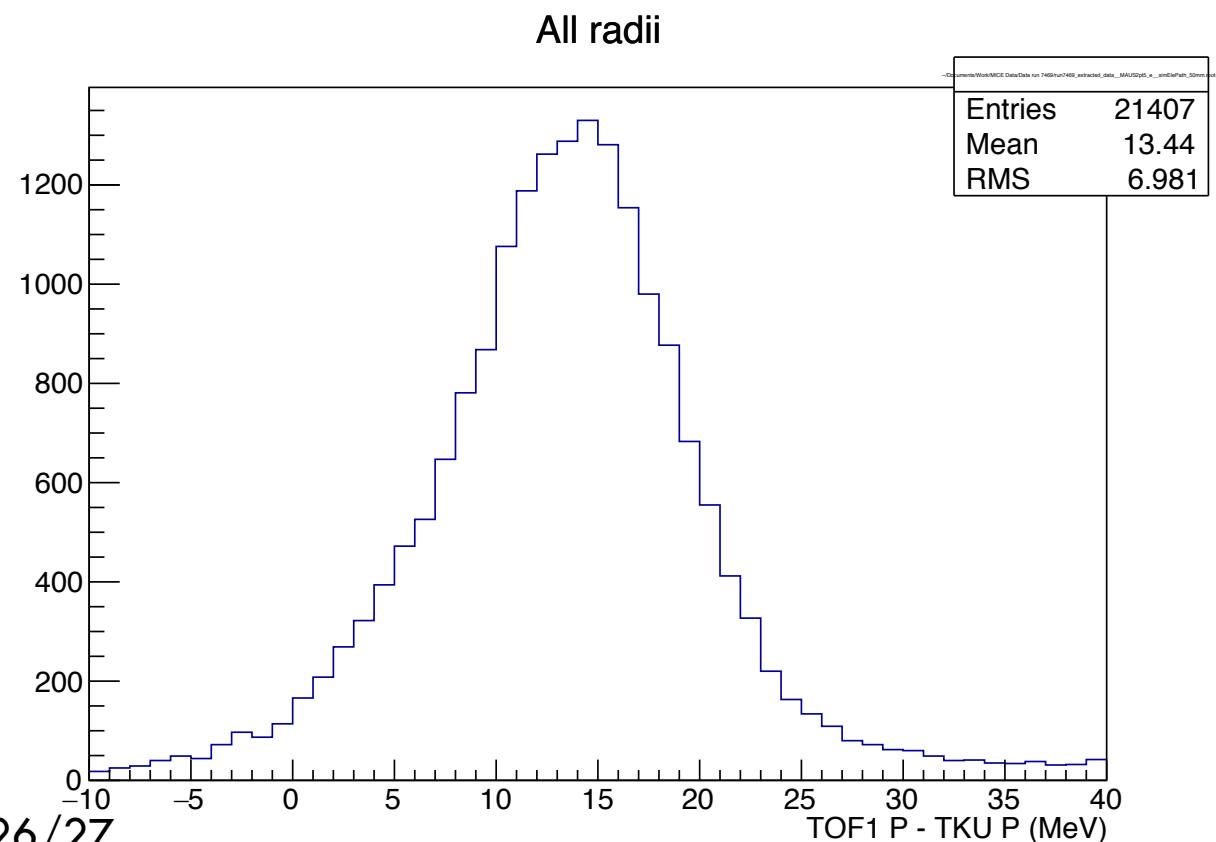
# EXCESS E PATH = 30MM



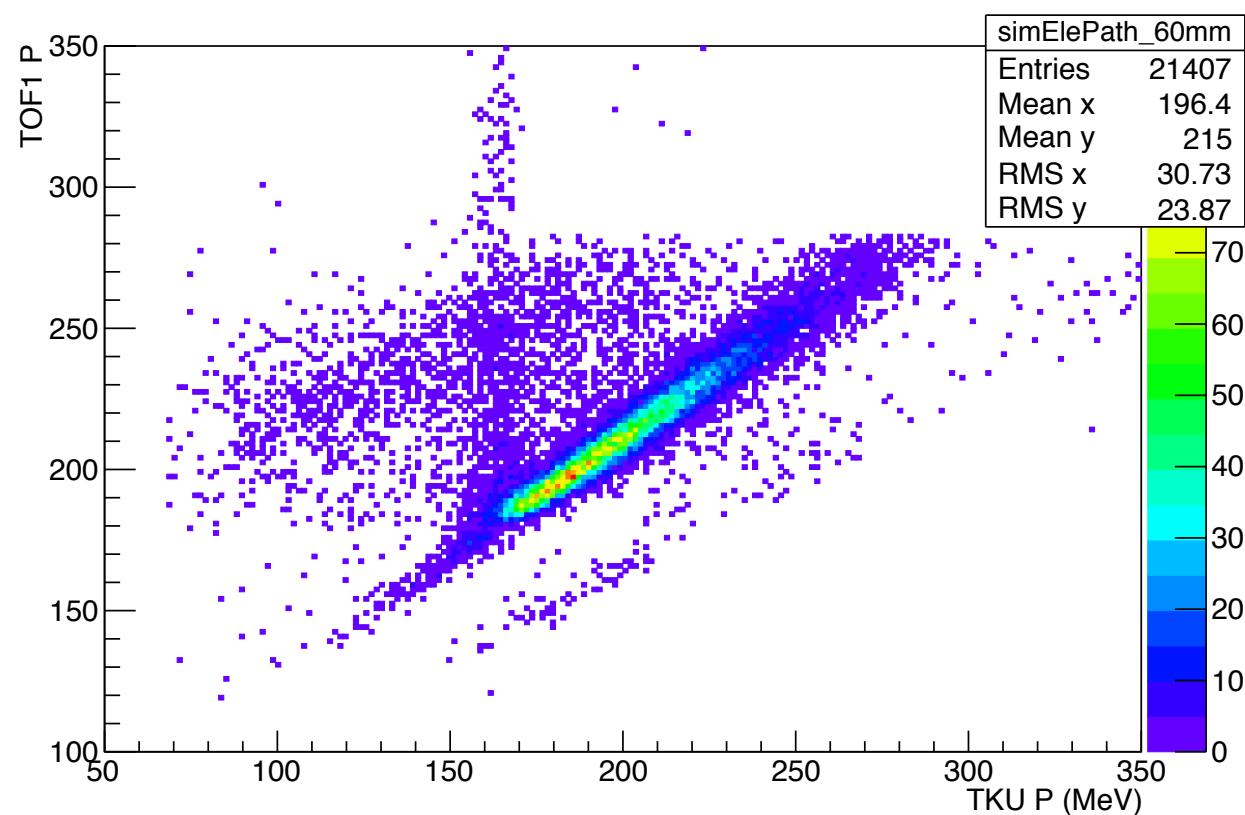
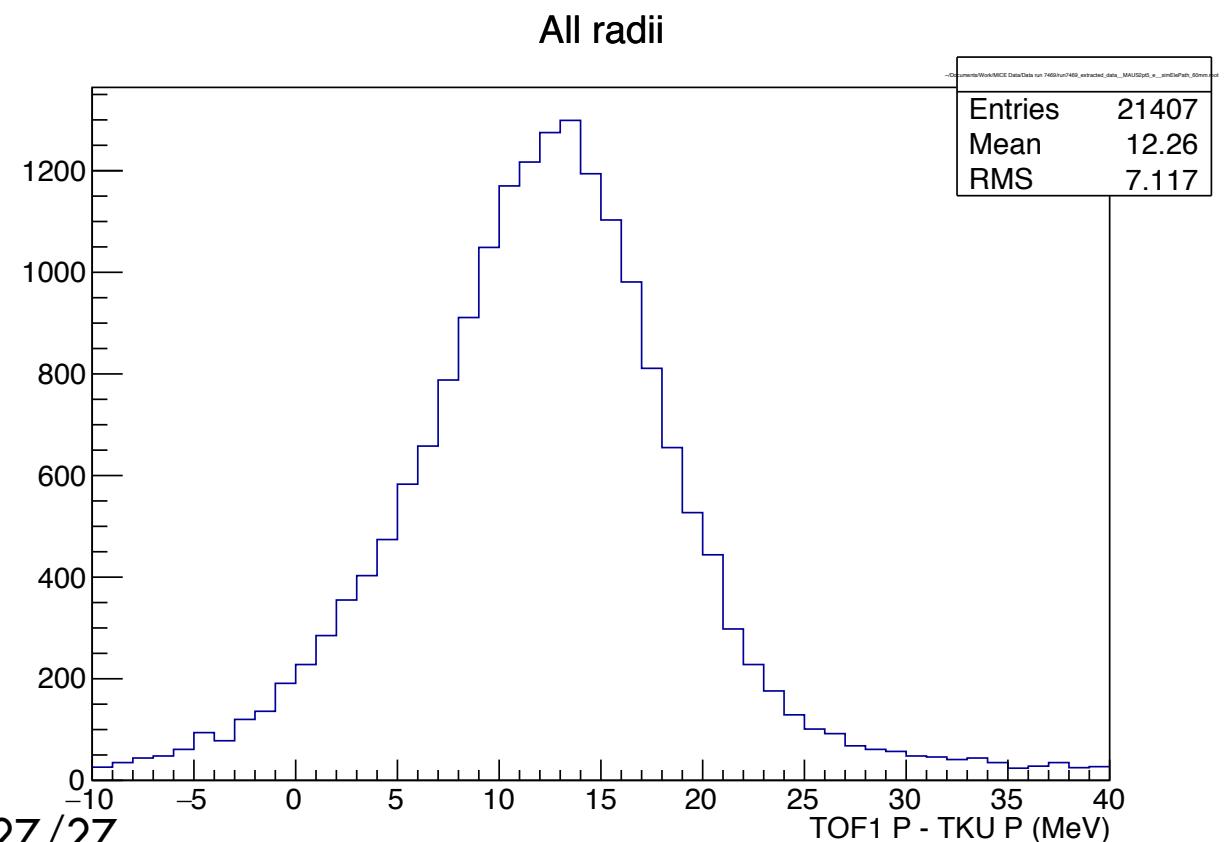
# EXCESS E PATH = 40MM



# EXCESS E PATH = 50MM



# EXCESS E PATH = 60MM



# SUMMARY

- Diffuser cut requires:
  - Tracked MC, comparison with true particle positions at diffuser
  - Investigate why particles in the muon region might fail the cut (assume too tight)
- Field placement requires:
  - Understanding where probes are w.r.t. co-ordinates for calculating fields
  - Reading out fields assumed at tracker stations for extra cross-check (requested)
- TOF-TKU momentum loss requires:
  - Looking at a G4BL simulation to check excess electron path used
  - Apply TKU momentum correction if it's not included in SciFi Tracks – ideally, analysis user shouldn't have to apply corrections as they won't know enough to know **what** correction needs applying
- Tabulate final errors