

  
**ÖAW**  


AUSTRIAN  
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SCIENCES



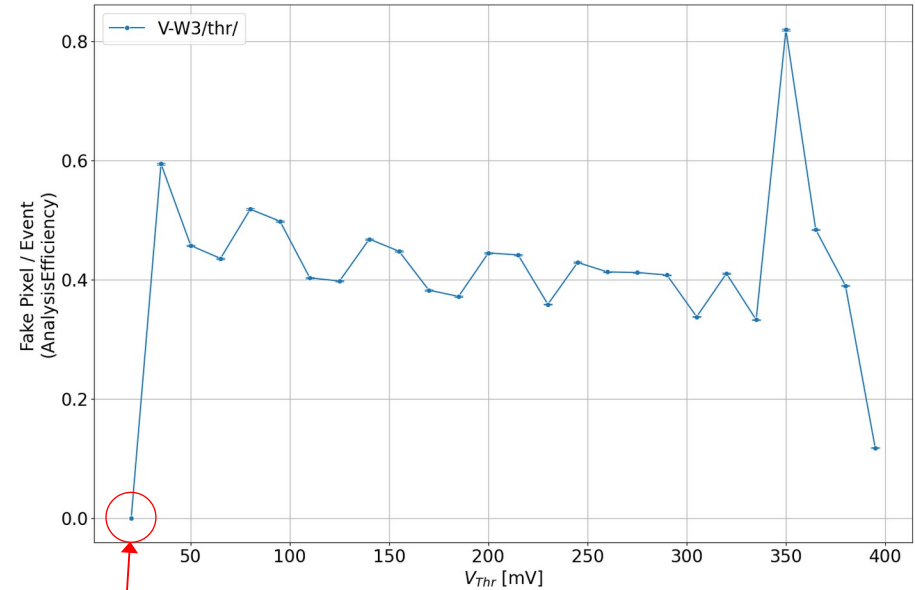
RD50 HV-CMOS Meeting

# Open Questions from Test-Beams

Bernhard Pilsl

# 1) Fake Hits

- Corry Module *AnalysisEfficiency* produces „fake\_rate“ plots
  - In events with hit(s) in our DUT, but no track (intercept) → pixels / clusters considered „fake / noise“
- Earlier there was a bug in Corry code (logic was inverted)
  - Fixed by merge request from me, now in main repo
- Problem: Telescope inefficiencies
  - We require all 6 telescope planes to have hits for track reconstruction
  - If  $\geq 1$  planes do not detect particle (due to inefficiencies or scattering) → no track → DUT hit considered fake, even though **there was a particle** causing the hit.
  - Fake rate **far too high**
  - We can't conclude noise rate in [Hz]



Histogram in Overflow  
Actually “pretty” noisy

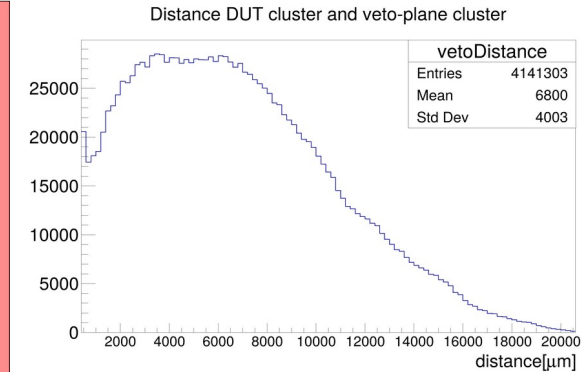
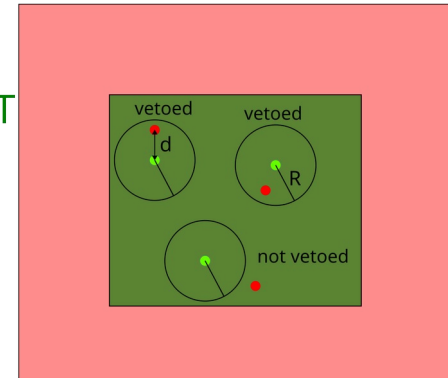
# AnalysisNoise

- Implemented Corry module *AnalysisNoise*
- Not using tracks but using correlations
  - Initially all DUT clusters considered noise
    - Telescope planes have to „veto“ hit at DUT to not be considered noise / fake
  - Is there a hit on **any** telescope plane in a distance  $d < \text{radius } R$  from the 2D projection of the hit on the DUT
  - Problem: Susceptible to noisy telescope planes (noisy plane could veto everything)
- Data from testbeam spring 2024, backside biased (W3) Vienna sample at  $V_{\text{Bias}} = 190\text{V}$  and  $V_{\text{Thr}} = 50\text{mV}$

Telescope  
plane

• Hits

DUT

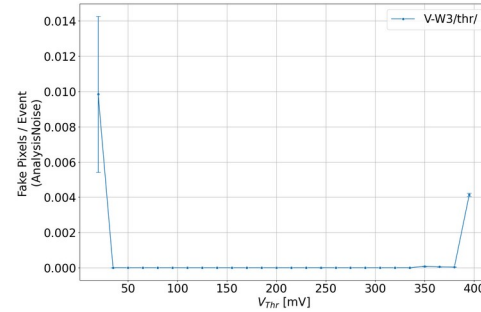


Telescope plane	#Veto
Adenium_0	616397
Adenium_1	599547
Adenium_2	596332
Adenium_3	619348
Adenium_4	655894
Adenium_5	592310
Telepix	461475

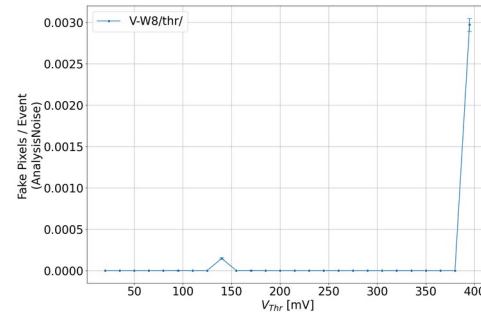
## AnalysisNoise results

- Allowing a radius of 10cm (every hit, no matter how far off, at any telescope plane can veto noise)
- Analyzed 300k tracks each
- Basically results in no noise at all

V-W3

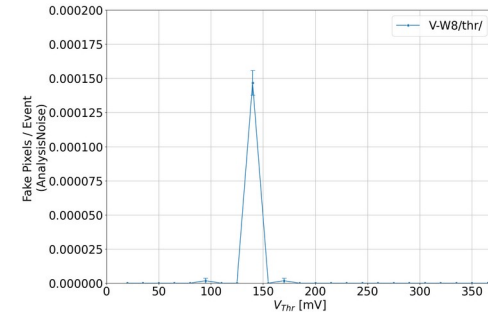
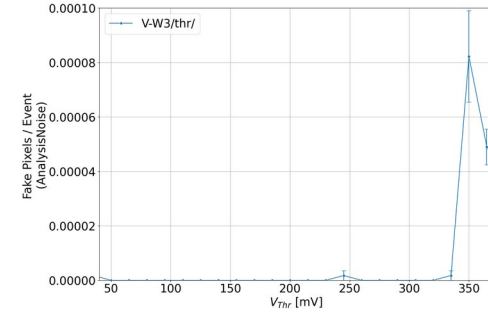


V-W8



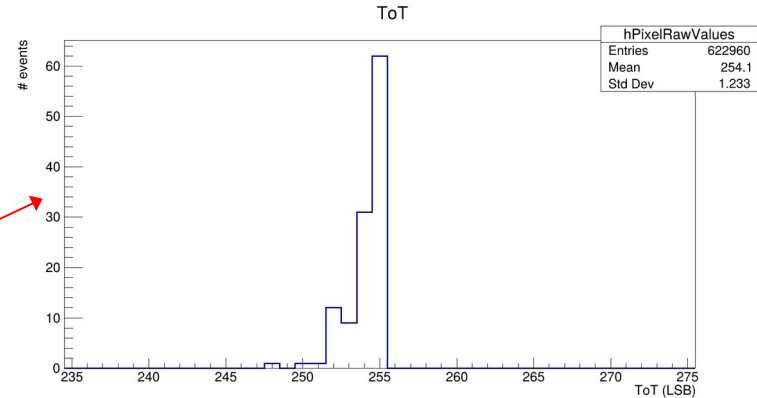
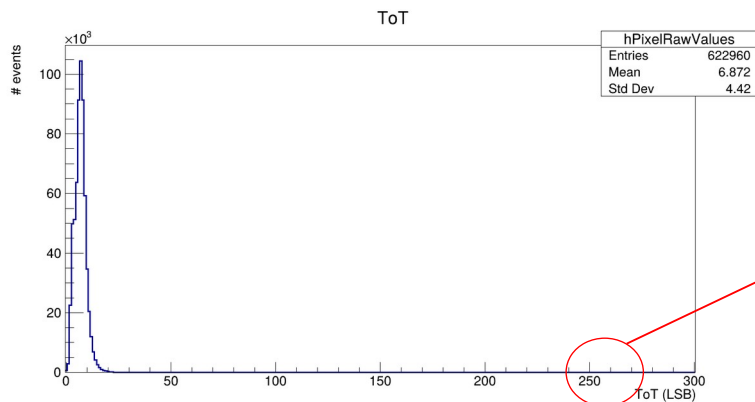
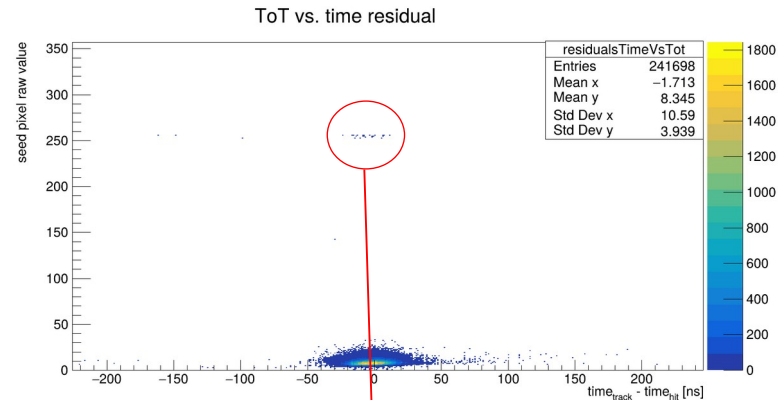
Full range

Zoomed

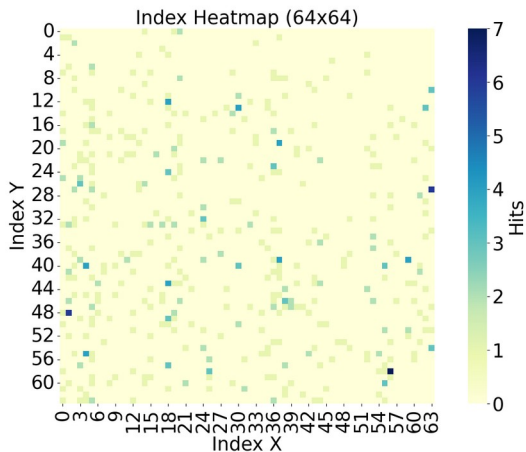


## 2) Large ToT values

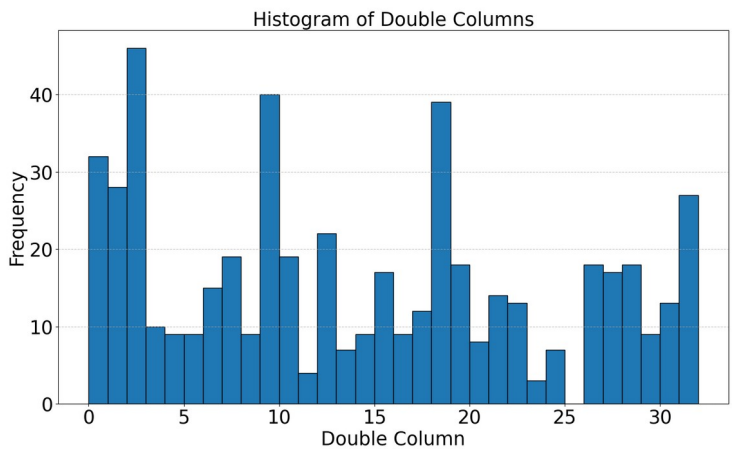
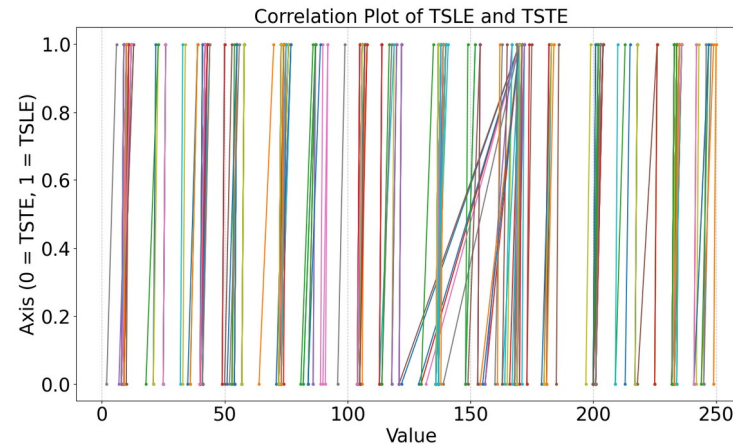
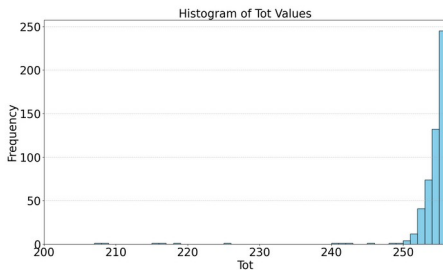
- ToT histograms show feature at ~256 LSBs
- Found when looking for timewalk
- What is it, where is it coming from?
- Do we care?



# Large ToTs (just plot everything #1)

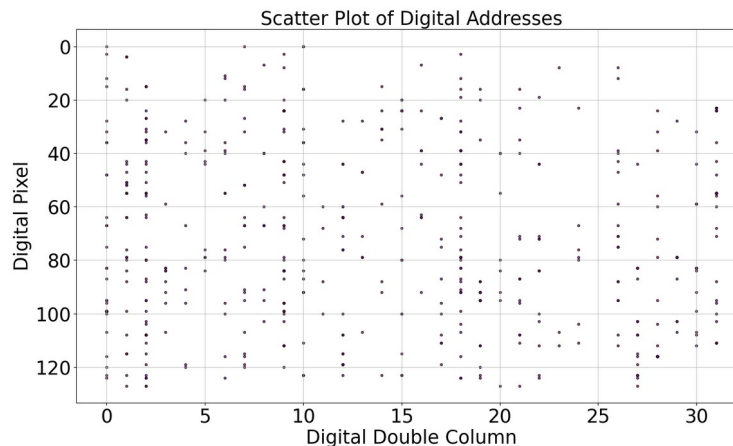


Only looking at hits from  
ToT > 200

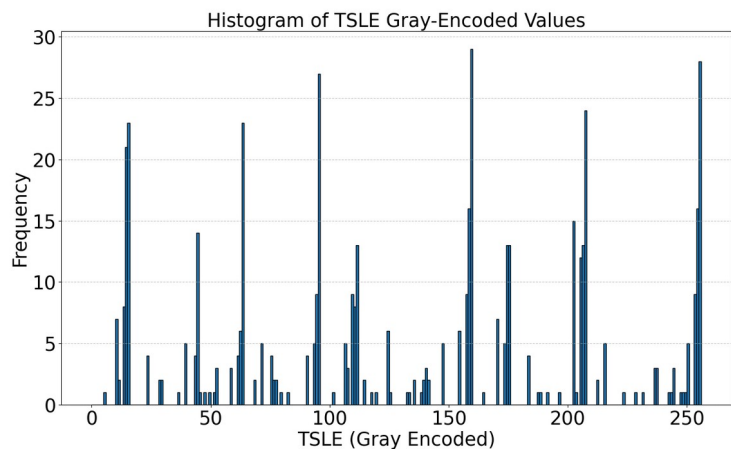
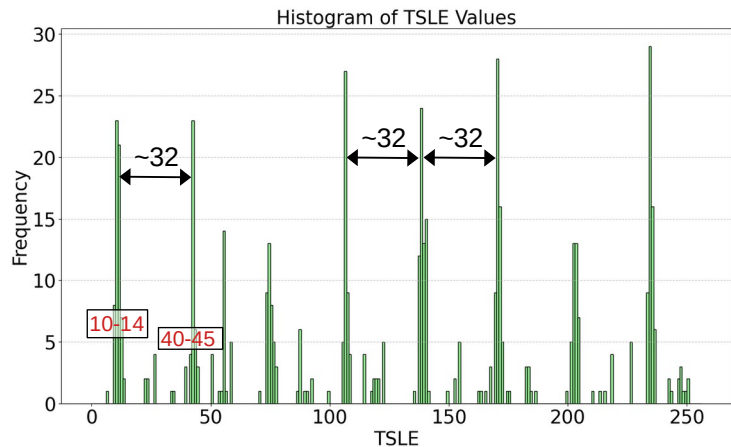


Reason for large ToTs  
 $ToT = TSTE - TSLE$

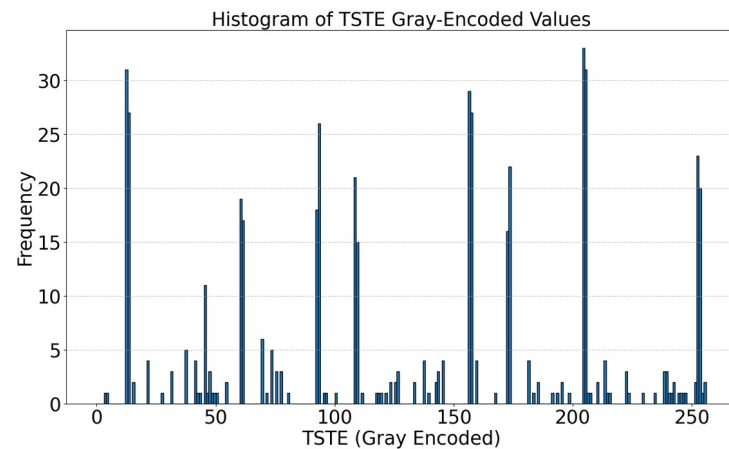
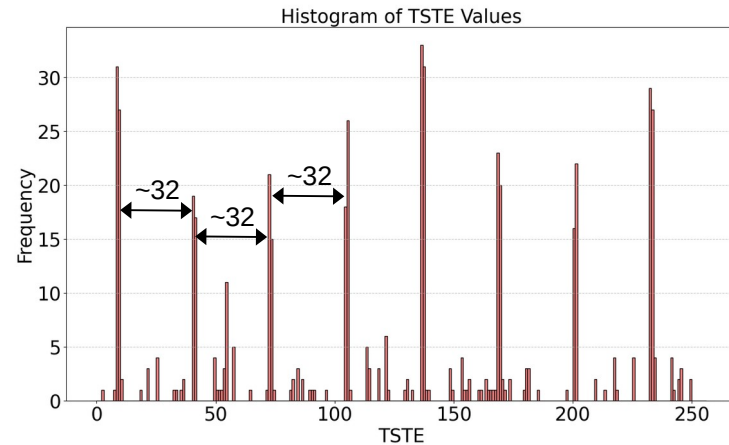
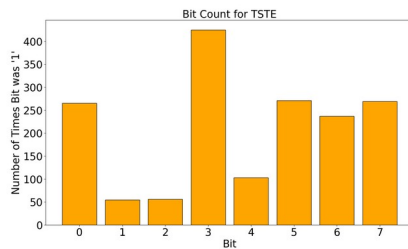
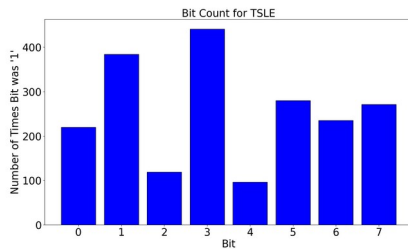
see Correlation plot:  
 $TSLE > TSTE \rightarrow ToT < 0$   
 $\rightarrow$  looks like overflow  $\rightarrow$   
we add 256



# Large ToTs (just plot everything #2)

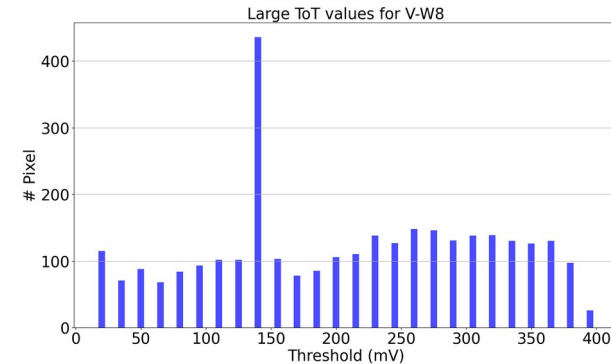
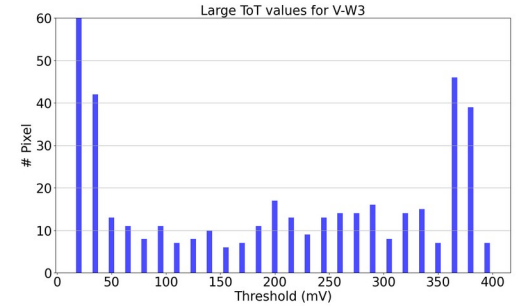
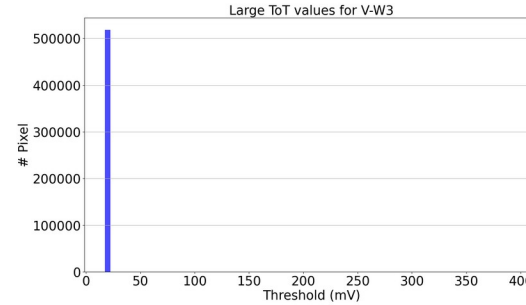


Decoded  
("normal")  
timestamps show  
pattern with  
distance of ~32  
LSBs



# Large ToTs (Threshold)

- Plotting #Pixel in which ToT > 250 vs.  $V_{Thr}$
- Comparison with noise plots earlier
  - Noisy pixels seem to be reason for large ToT values

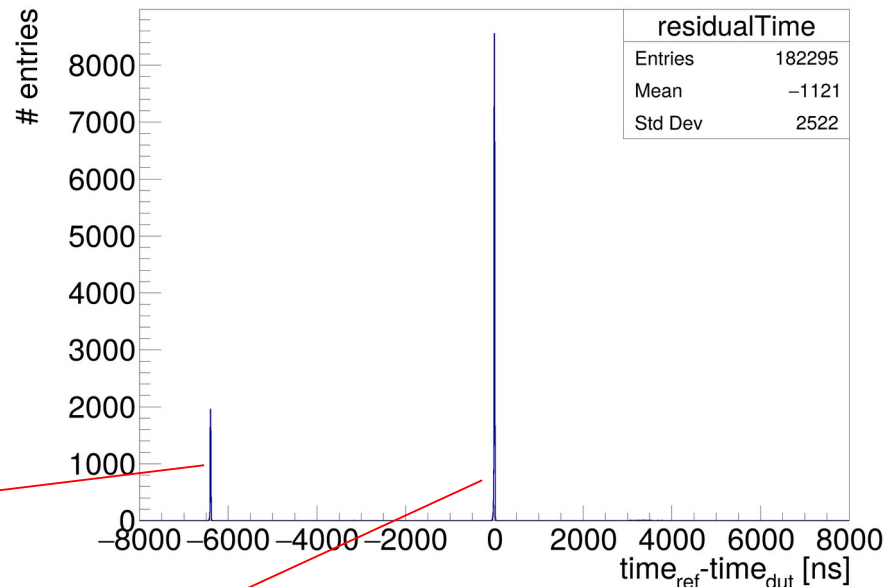




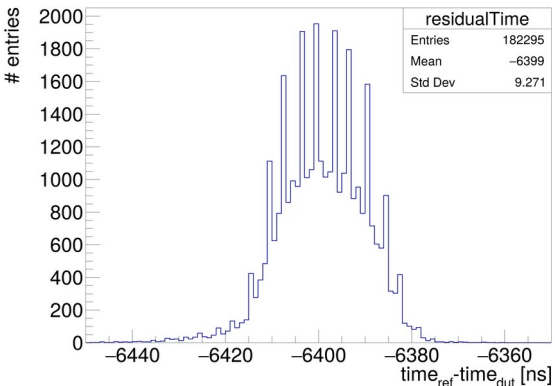
### 3) Time Residuals

- Comparing track time (**from TLU** or Telepix) with RD50-MPW4 time allows to depict timing resolution
- Secondary peak at -6400ns arises from falsely assigned overflow counter:  $256 * 25\text{ns} = 6.4\mu\text{s}$  (Hits remain in FIFO while TS overflow occurs)
- Main peak shows timing resolution of  $\sim 9.5\text{ns}$

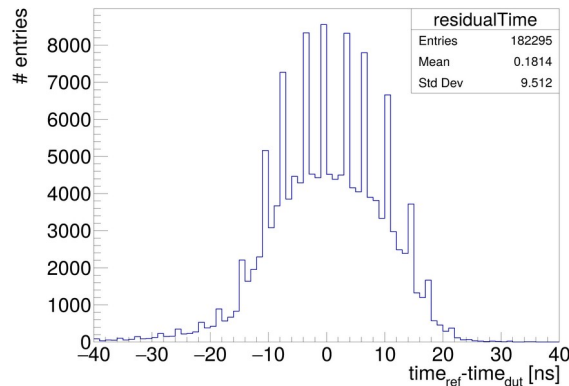
Time residual



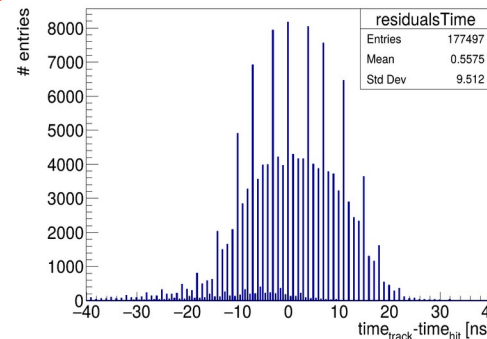
Time residual



Time residual



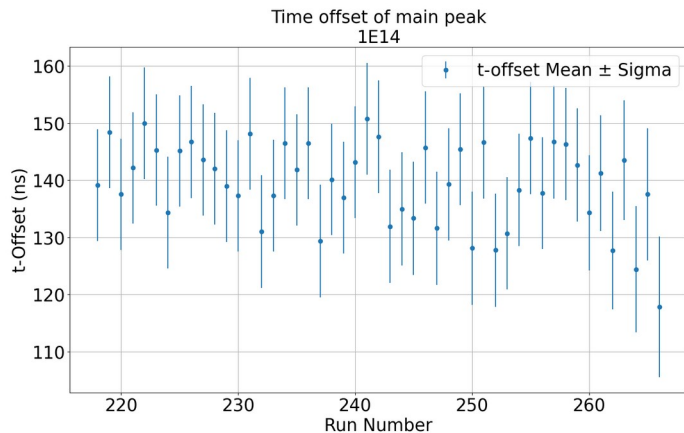
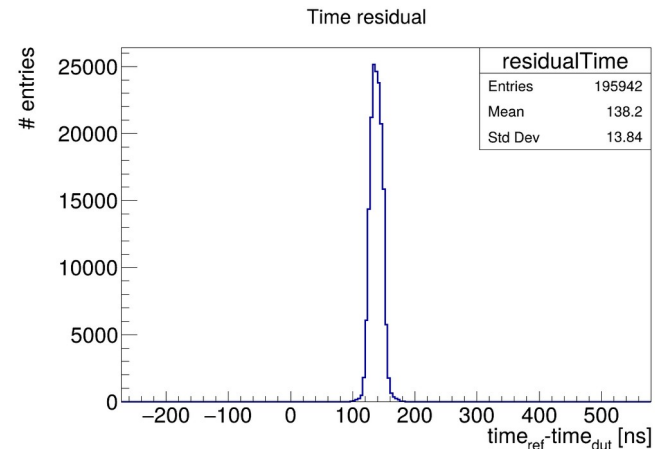
Time residual



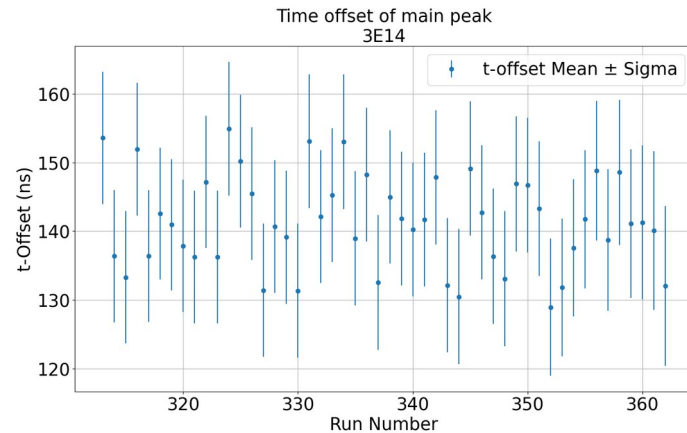
- More bins
- Structure (3 / 1 ns) from Telepix hitor (?)

# Time Residuals (t-Offset)

- Peaks in Time Residuals shows offset
  - $t_{\text{Offset}} > 0$ ;  $t_{\text{Offset}} < 200\text{ns}$
- Was much more pronounced in spring 2024 TB (up to  $6.4\mu\text{s}$  seen there (wrong `CONF_REG_TS_CTRL` value used))
- Varies from run to run
- $\approx 8$  clock cycles (25ns clock) needed for T0 signal of TLU to reset TS of MPW4



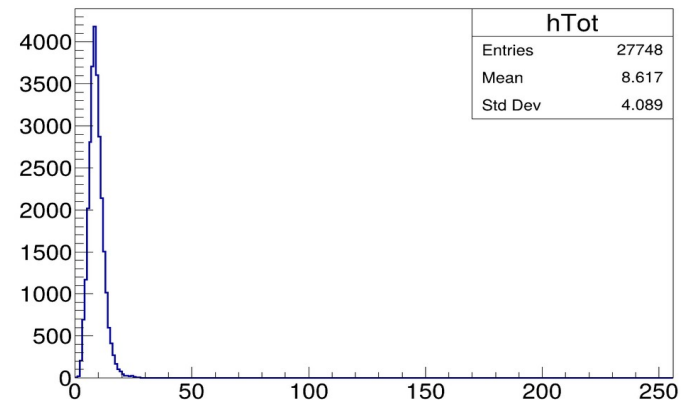
HV-scan runs  
from Oct. 24 TB



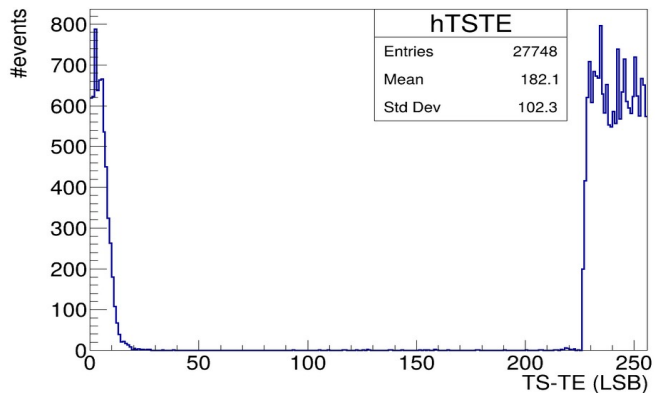
# Time Residuals (Wrong overflow)

- Shifting time by  $-6.4\mu\text{s}$ 
  - Only look into hits associated to track (only secondary peak at  $-6.4\mu\text{s}$  evaluated)
- ToT looks pretty „normal“
- TSLE and TSTE at edges of 8 bit TS region
- Could be „normal“ overflow
- Is this somehow correctable?
  - I would not know how

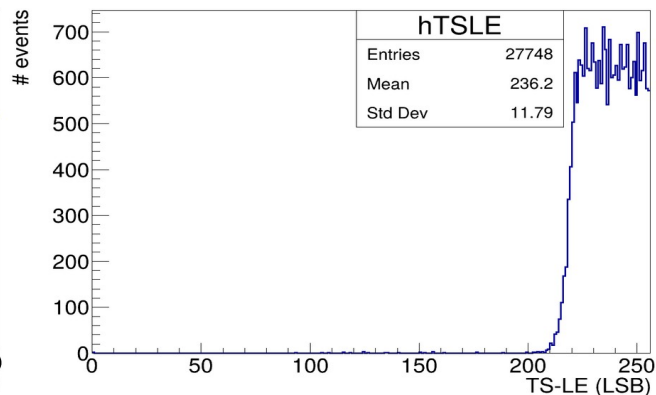
ToT



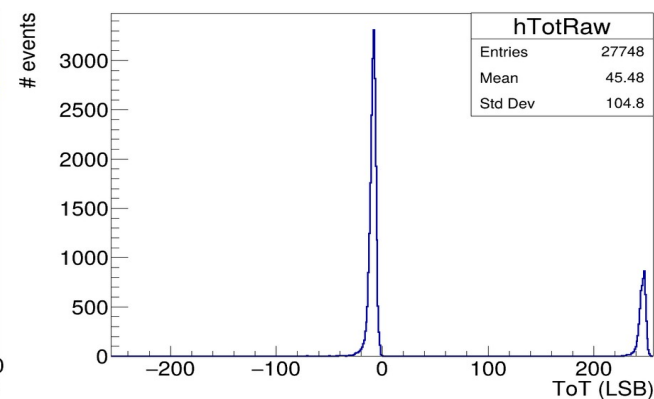
TS-TE



TS-LE

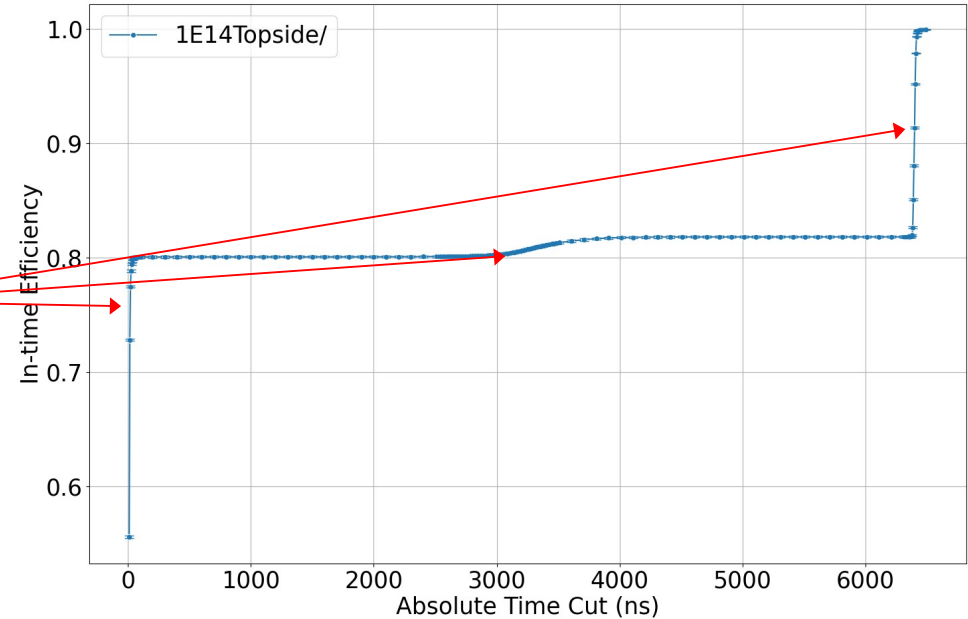


ToT no overflow

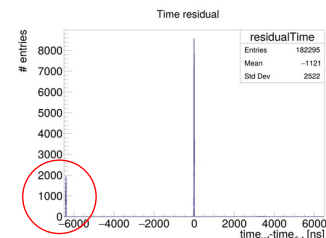
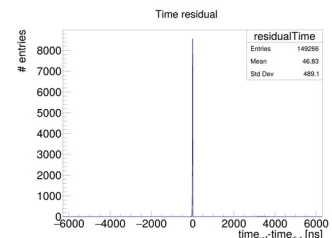
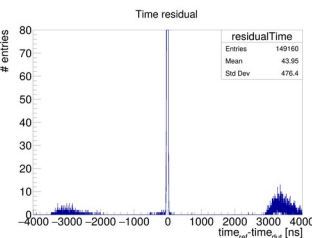
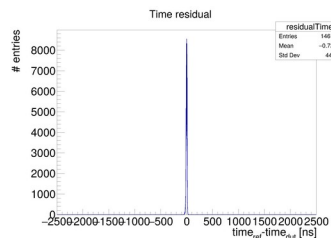
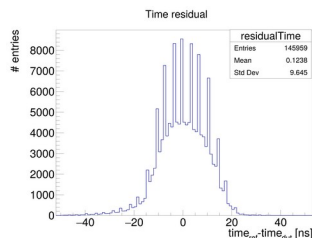
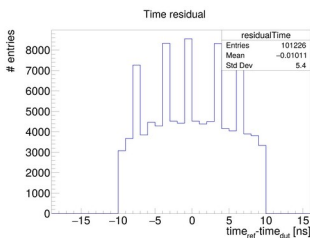
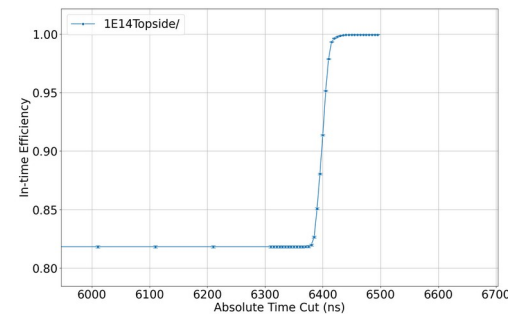
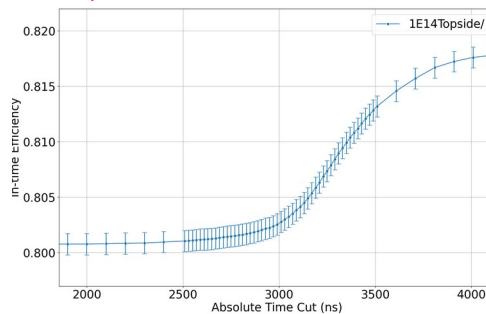
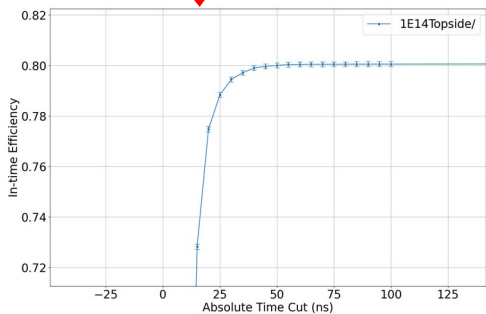
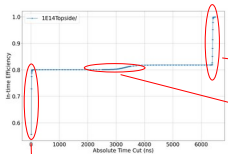


## In-time Efficiency

- Scanning in-time efficiency by cutting on time diff between track time and DUT
- Done via “timecut\_abs” parameter of *DUTAssociation* module
- Done exemplary for 1E14 topside biased sample from Oct. testbeam
- 3 efficiency increase regions observed
- At time-cut of 25ns  $\epsilon \sim 78.8\%$



# In-time Efficiency (Increase regions)

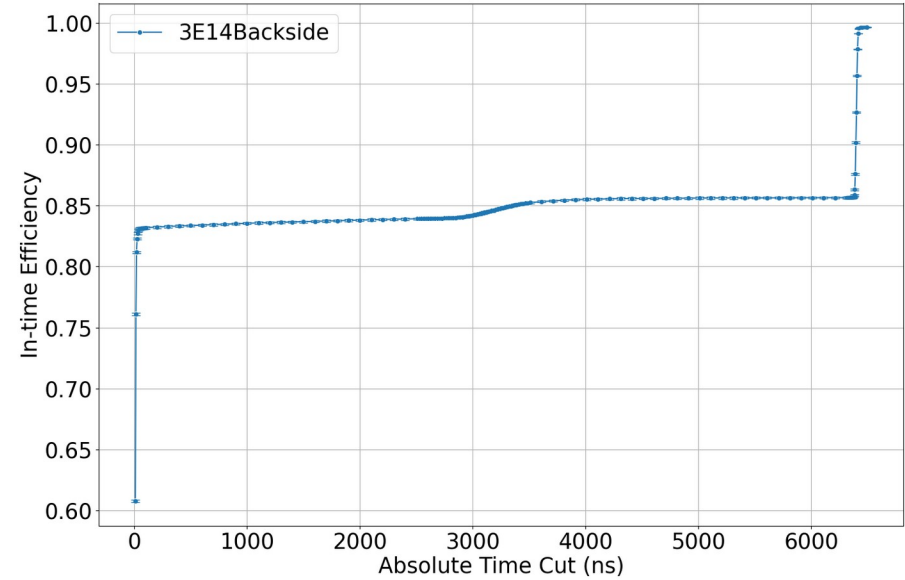
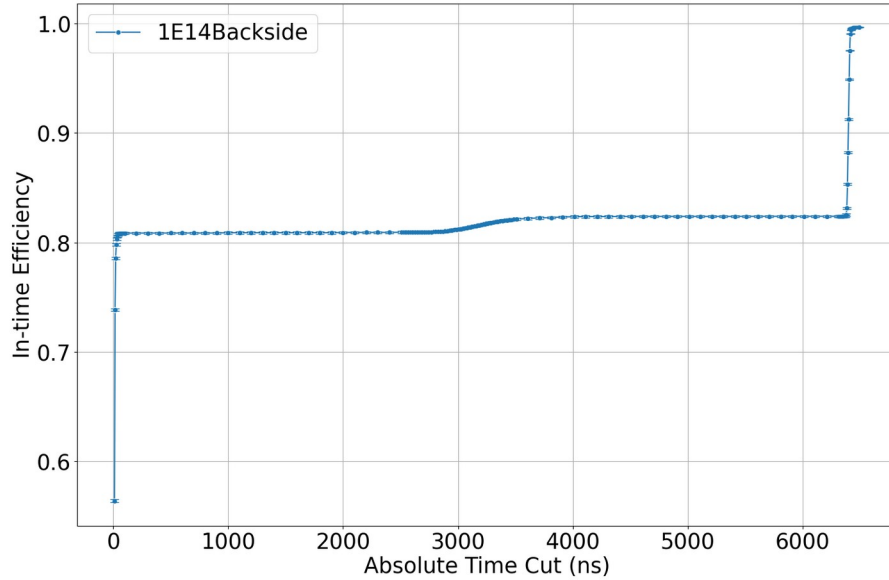


Cutting on main peak

Few hits show time offset  $O(3\mu s)$   
Why?

Including *overflow peak*

## In-time Efficiency (other samples)



1E15 not possible as only no Ovflw-Cnt based timestamp available