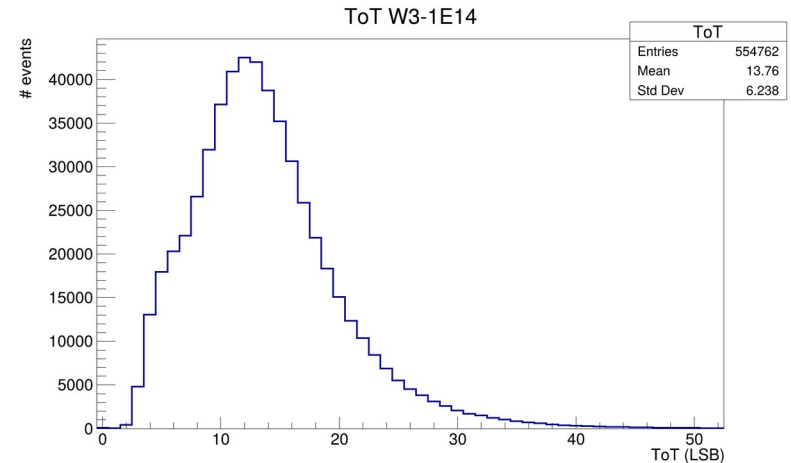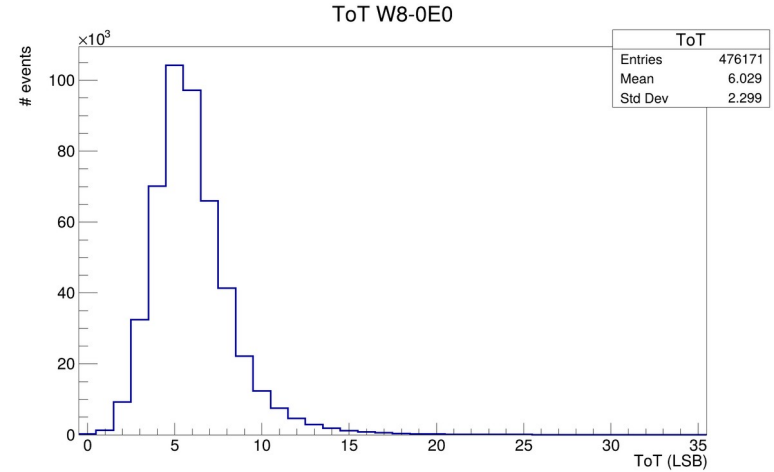# DESY Test Beam Oct. 2024

ToT and Calibration

**Bernhard Pilsl**

# Reminder

- Irradiated samples (1E14 and 3E14) showed larger ToT values than non-irradiated samples
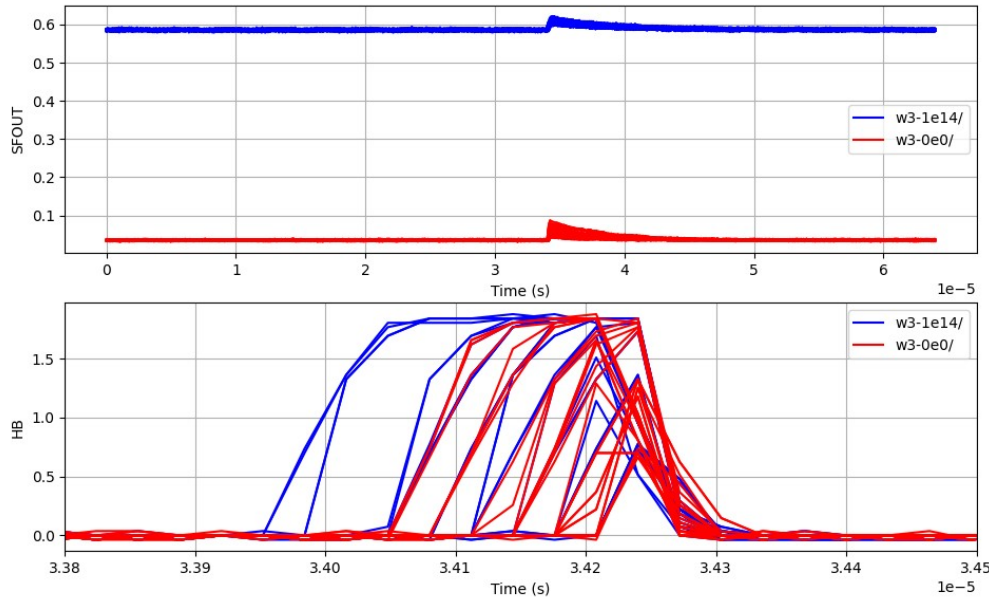
- At same bias (-190V) and same threshold (1.1V)

# Reproduce in Lab

- $^{90}$Sr source used

- Same bias and threshold settings

- Same samples (but at room temperature)

- Digital data taking via EUDAQ

- Looking at SFOUT and HB of pixel 39:07

- Digital results:
  - Slightly smaller ToT compared to TB but also ToT(1E14) > ToT(0E0)





3
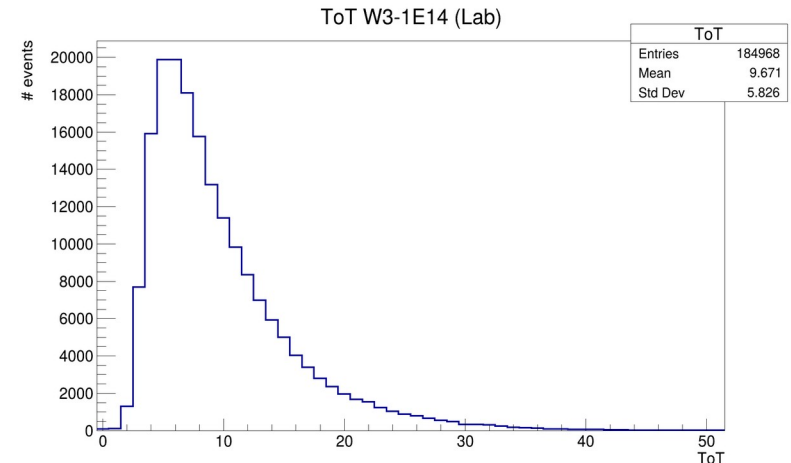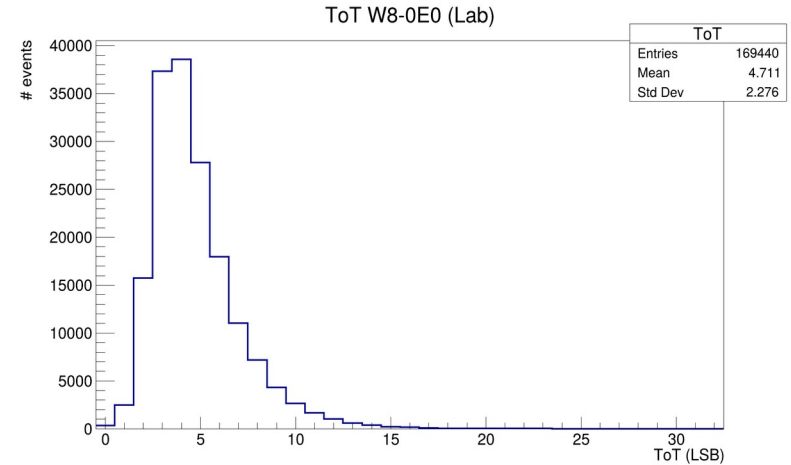
# Analog Results



- HB signals of 1E14 longer than signals from 0E0 → digital behavior ovserved analog too

- SFOUT of 1E14 shows ~600 mV offset
  - Why?
  - Is radiation changing characteristics of transistors / bias voltages (VN could be off) ?

# Calibration of injection capacitors

- MIP deposits ~22ke$^-$ in 280µm Si

- In fully depleted sensor full charge gets collected

- ToT of individual pixels at TB correspond to charge of MIP

  – Not quite right (more later)

- Evaluate injection capacitance for individual pixels by
  $$Q_{MIP} = V_{inj, best} * C_{inj, calib}$$



raw pixel charge

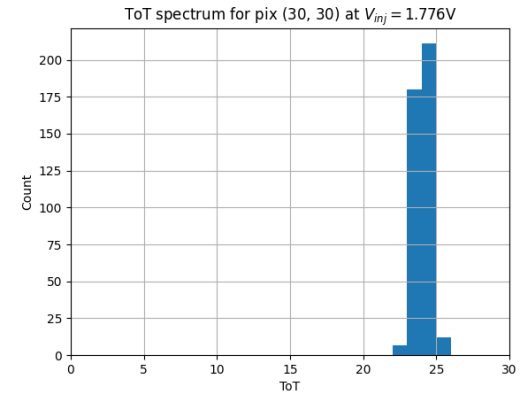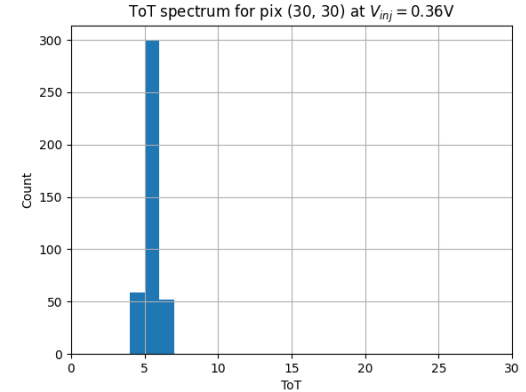| pixelcharge | |
|---|---|
| Entries | 572313 |
| Mean | 22.19 |
| Std Dev | 3.72 |
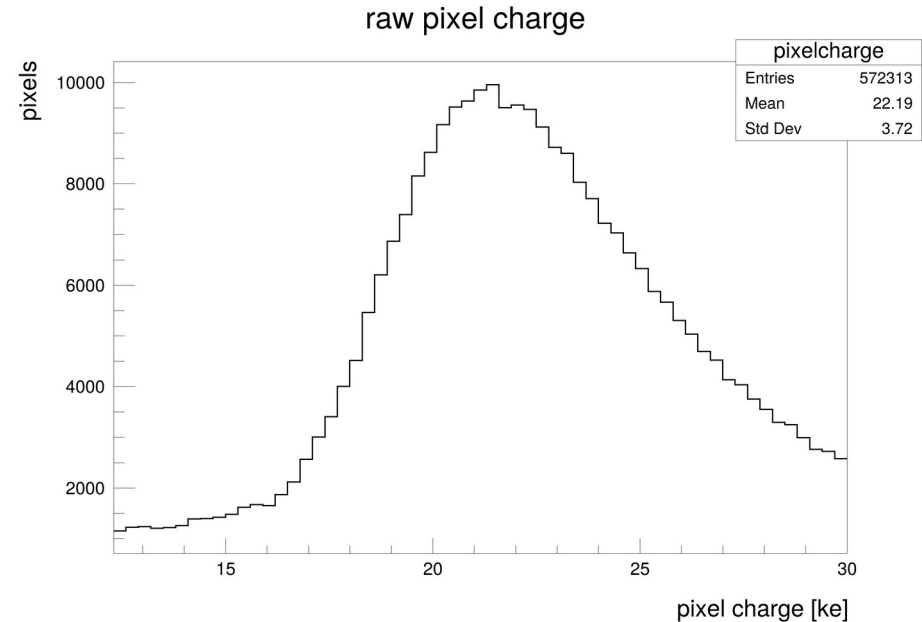
# ToT for individual pixels

- Getting proper statistics requires really long run

- Custom Corryvreckan extension to plot ToT histograms for individual pixels
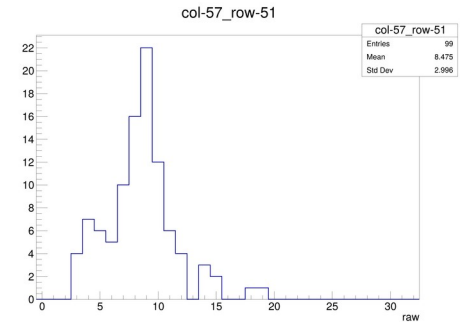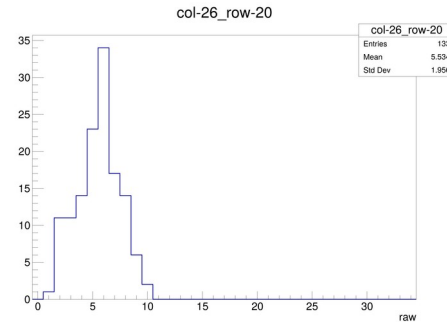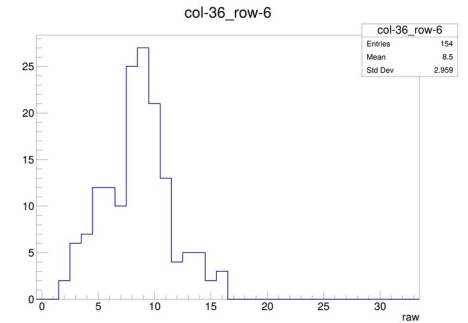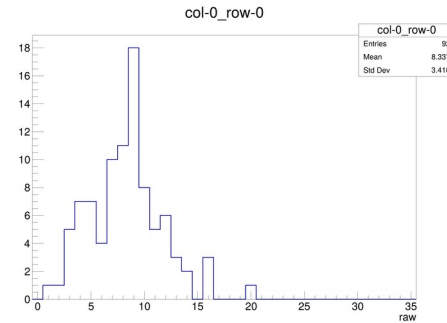
# ToT from injections

- Inject 500 times into all pixels for 75 steps in (0V, 1.8V)

- Try to find best match between ToT from testbeam and injections

  - $\rightarrow V_{inj,\ best}$ for best match

  - $C_{inj,\ calib} = Q_{MIP} / V_{inj,\ best}$



ToT spectrum for pix (30, 30) at $V_{inj} = 0.36V$



ToT spectrum for pix (30, 30) at $V_{inj} = 1.776V$



Pixel (48, 28) at $V_{inj} = 0.384V$

7
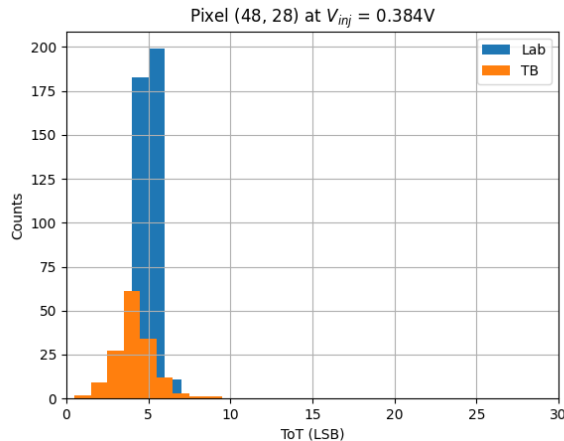
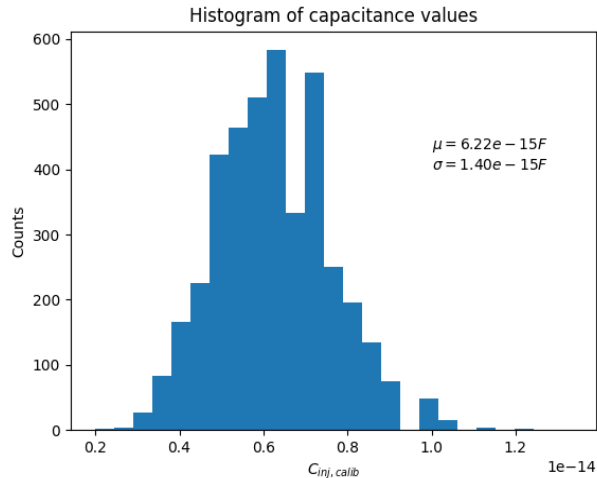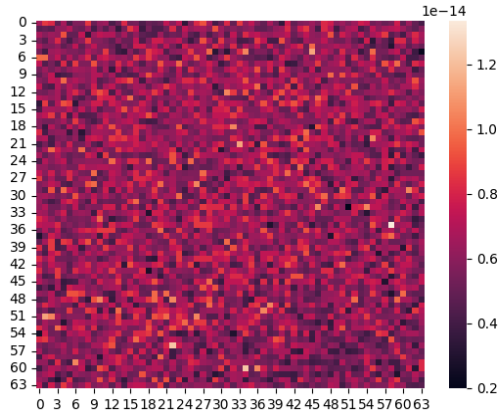# Cap calibration for individual pixels





Histogram of capacitance values

- **Mean** of **6.2fF** with **Std. dev.** of **1.4fF** evaluated

- Value in manual 2.8fF

- Problem:
  - In testbeam there is charge sharing:
  - Full MIP charge / ToT not only at one pixel but in cluster

# Cap calibration for clusters

- Can't be done for individual pixels

- Only possible for average capacitance

- Due to cluster size of ~1.3: Cluster charge ~ charge for individual pixels

- Procedure:
  - Sum histograms for all pixels at the various $V_{inj}$ steps
  - Again look for best match between cluster charge ToT and the injection ToT
  - Leads to $V_{inj} = 0.60V \rightarrow C_{inj, calib} \sim 5.9fF$

- Remaining problem: Not detected charge sharing ($Q < Q_{Thr}$)



RD50_MPWx_0 Cluster Charge

| clusterCharge | |
|---|---|
| Entries | 517851 |
| Mean | 8.013 |
| Std Dev | 3.533 |



$V_{inj} = 0.6V$