


ÖAW


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RD50 HV-CMOS Meeting

RD50-MIPW4

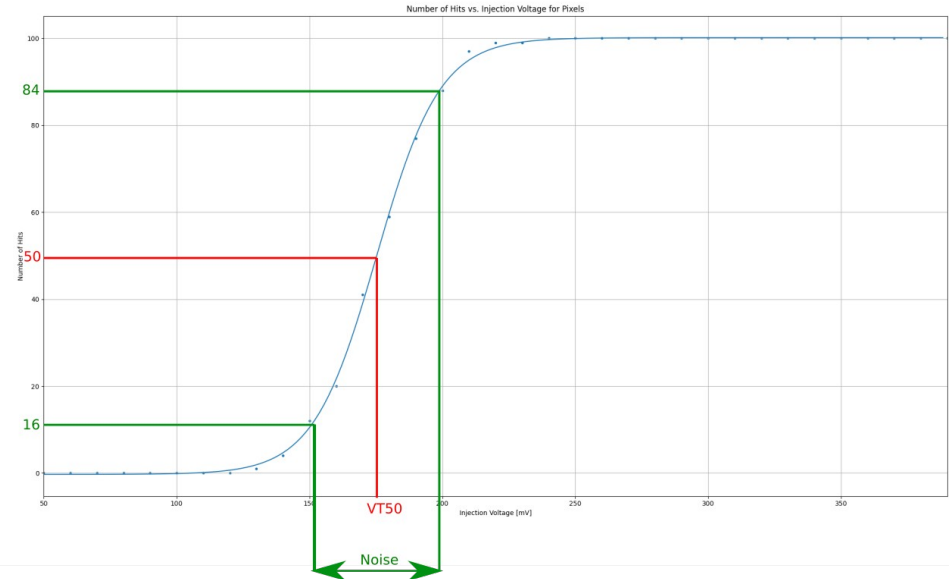
Lab measurements #2

Bias and ToT

Bernhard Pils

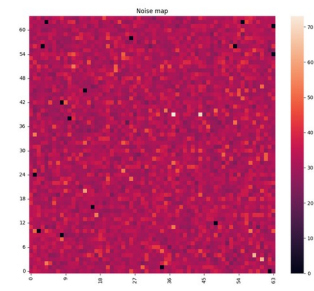
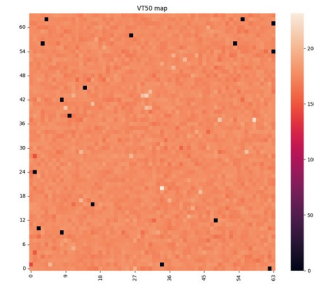
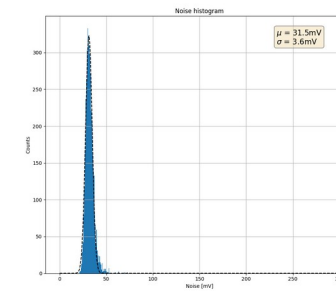
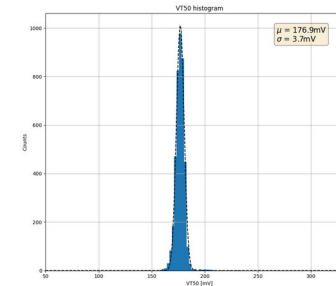
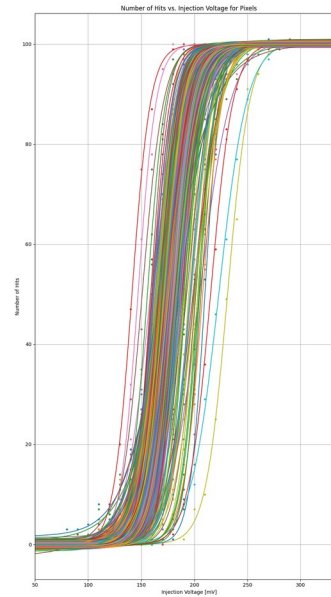
Methods

- Recorded S-Curves
- Scan injection voltage in 5mV steps
- 100 injections per step
- Fit data (to “logistic function”) $\rightarrow y_{Fit}(x)$
- From $y_{Fit}(x) = 50$ evaluate $x \dots VT50$
- From $y_{Fit}(x_1) = 16, y_{Fit}(x_2) = 84 \rightarrow \text{Noise} = x_2 - x_1$
- Chip not biased
- For conversion from voltage to charge injection capacity of 2.8fF used



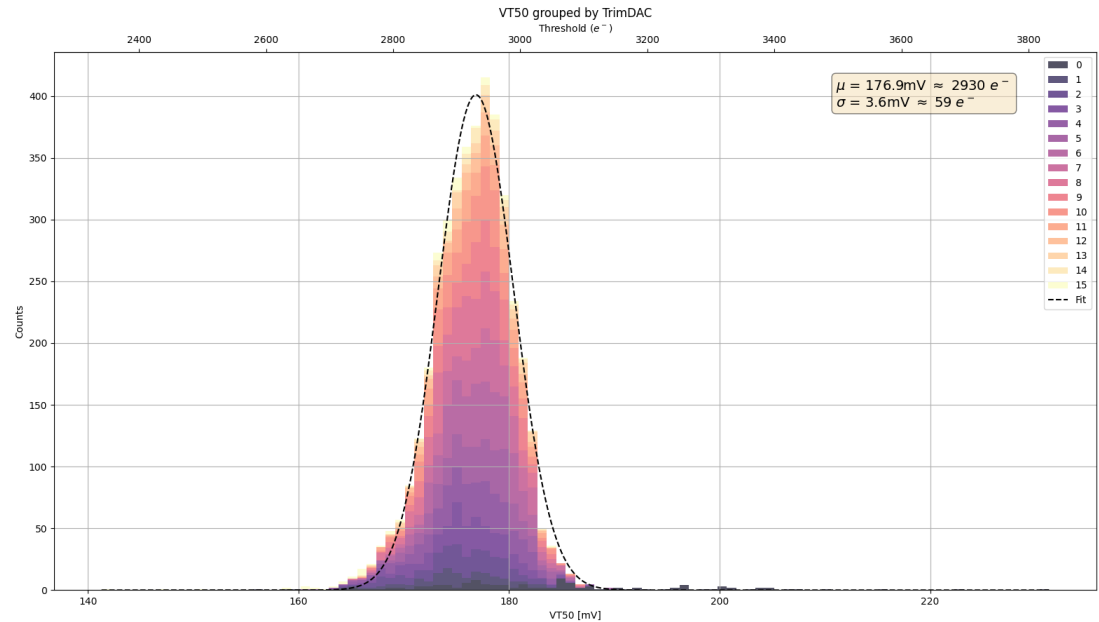
S-Curves with bias

- Biased to 200V
- Biasing allows $V_{thr} = 930\text{mV}$
 - Noise $\mu \sim 31.5\text{mV}$
 - At $V_{thr} = 950\text{mV}$ and
 - VT50 $\sigma \sim 3.7\text{mV}$
- With $V_{thr} = 950\text{mV}$
 - Noise $\mu \sim 30.3\text{mV}$
 - Without bias $\mu \sim 30.9\text{mV}$
 - Slightly better
 - VT50 $\sigma \sim 3.1\text{mV}$
 - Without bias $\sigma \sim 3.2\text{mV}$



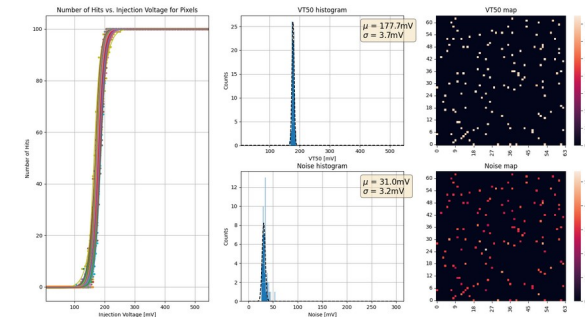
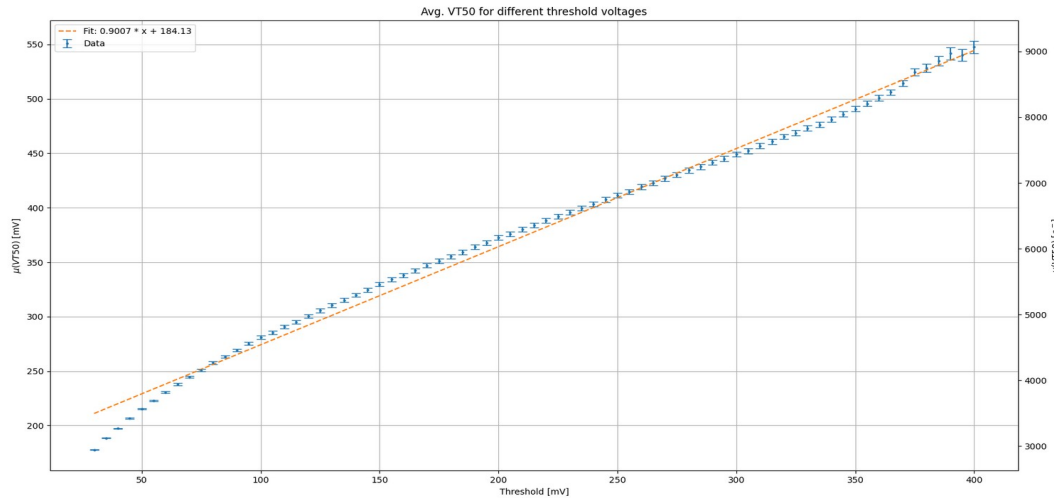
VT50 response summary

- Smallest possible threshold with 200V bias corresponds to 930mV ~ 2930e⁻
 - Still a large threshold



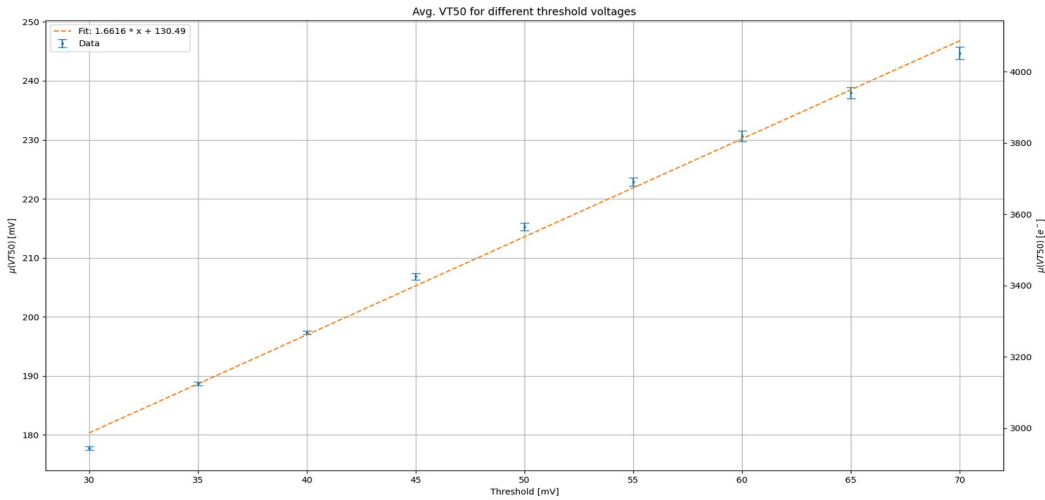
Response vs. Threshold

- Performed 2D scan
 - V_{thr} from 930mV \rightarrow 1300mV in 5mV steps
 - Injections in 5 mV steps
 - Only 1 double column (128 random pixels, to save time) evaluated
 - Justifiable by homogeneity of pixel response



Sample “behind the scenes” at $V_{thr} = 930\text{mV}$

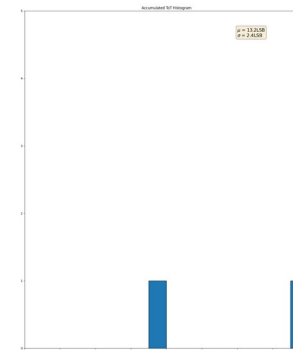
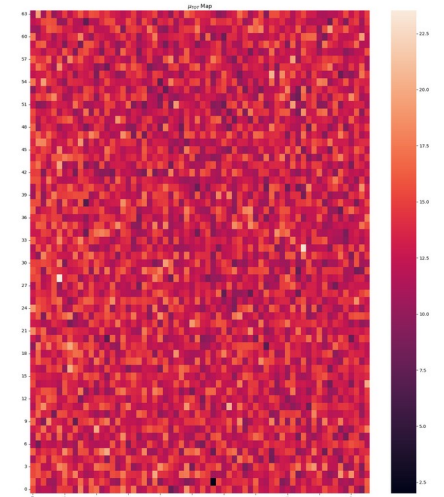
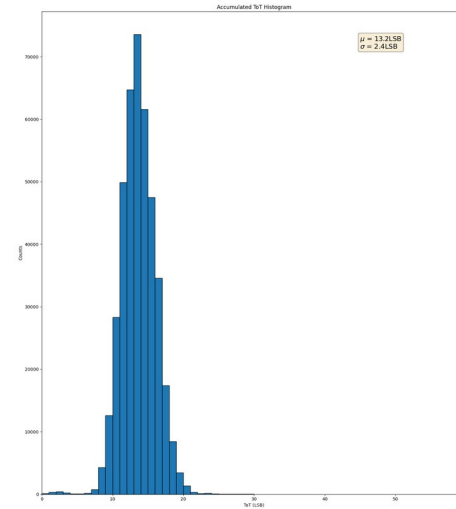
Response vs. Threshold (Low V_{th})



- In range 930mV, 970mV linear fit parameters:
 - Offset smaller
 - Slope steeper
- Non linear effects in threshold behavior observed

ToT spectrum

- $V_{thr} = 930\text{mV}$, tuned trimDAC, 200V bias, injection voltage = 1.0V
- 100 injection pulses for full matrix
- ToT values ranging from $\sim(10, 20)$ LSB
 - Huge difference of $\Delta t \sim 10 * 25\text{ns} = 250\text{ns}$
- With $fei3_read = 3$ still 2 hits with ToT values $O(250 \text{ LSB})$
 - Disappear with $fei3_read = 4$
 - *Corresponds to $5 * 25\text{ns} = 125\text{ns}$ read duration*
 - *Slow*

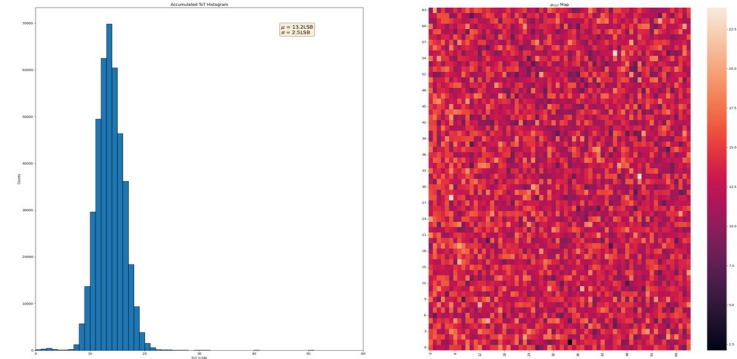


Further ToT observations

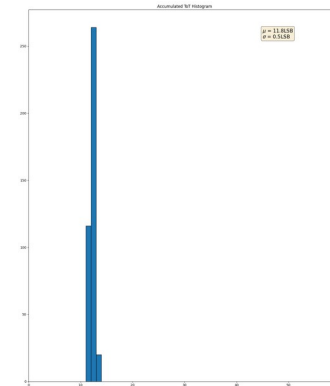
- TrimDAC set to 7 for full matrix
- Tuning seems not to have an effect on ToT distribution

- Single pixel shows 3 LSB spread
 - „Ideal“ scenario for full matrix

TrimDAC = 7

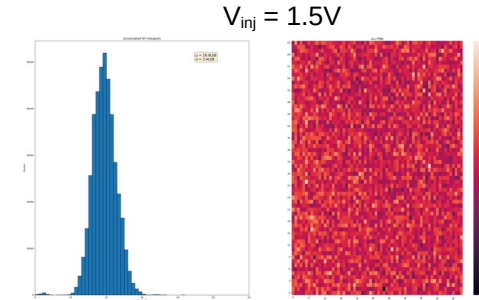
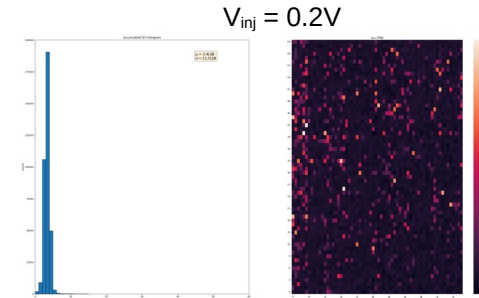
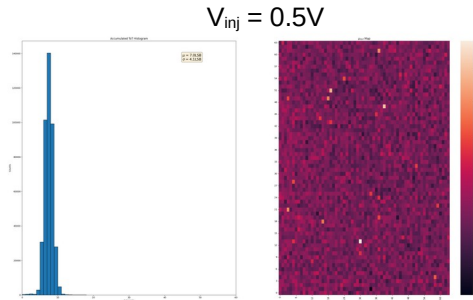


Single Pixel



ToT spectrum: Effects of V_{inj}

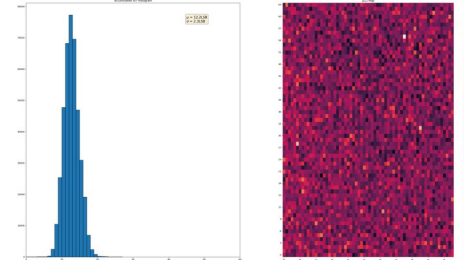
- Investigated effects of V_{inj} amplitude
- Injections to full matrix
- μ_{ToT} smaller at lower V_{inj}
- Distribution narrower at lower V_{inj}
- At $V_{inj} = 0.2V$ ($\sim VT_{50}$) almost ideal distribution



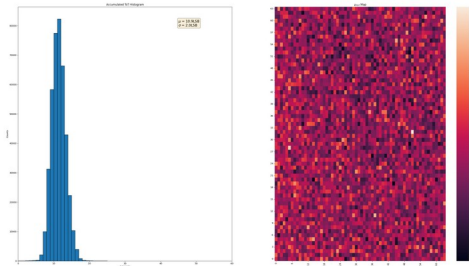
ToT spectrum: Effects of V_{thr}

- Investigated effects of V_{thr}
- $V_{inj} = 1.0V$
- μ_{ToT} smaller at higher V_{thr}
- Width of distribution “constant” at different V_{inj}

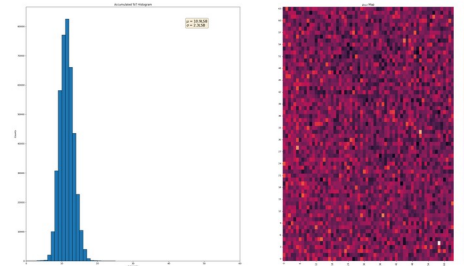
$V_{thr} = 1.0V$



$V_{thr} = 1.15V$

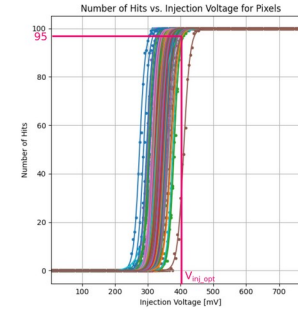


$V_{thr} = 1.25V$

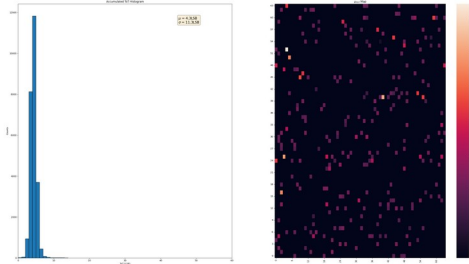


Optimize ToT Spectra

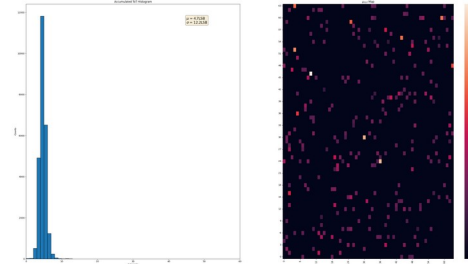
- Procedure:
 - Choose V_{thr}
 - Tune to $V_{inj} = \mu(VT50)$
 - Extract V_{inj_opt} from 95% point of tuned S-curve
 - Record injection spectra with V_{inj_opt}
- → Narrow distribution



$V_{thr} = 1.05V, V_{inj} = 400mV$



$V_{thr} = 1.15V, V_{inj} = 490mV$



Conclusion / Outlook / Questions

- Biasing allows to reduce V_{thr}
- Biasing reduces noise minimally

- Non linear behavior of V_{T50} vs V_{thr} still a mystery
 - Ideas?

- V_{inj} far off from V_{T50} at given V_{thr} leads to broad ToT distribution
 - Why?

- Measuring ToT spectrum with ^{90}Sr source
- Different bias voltages
- Investigate baseline voltage effects on response curve
- Stay tuned :)