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Topix 2.0 threshold measurement

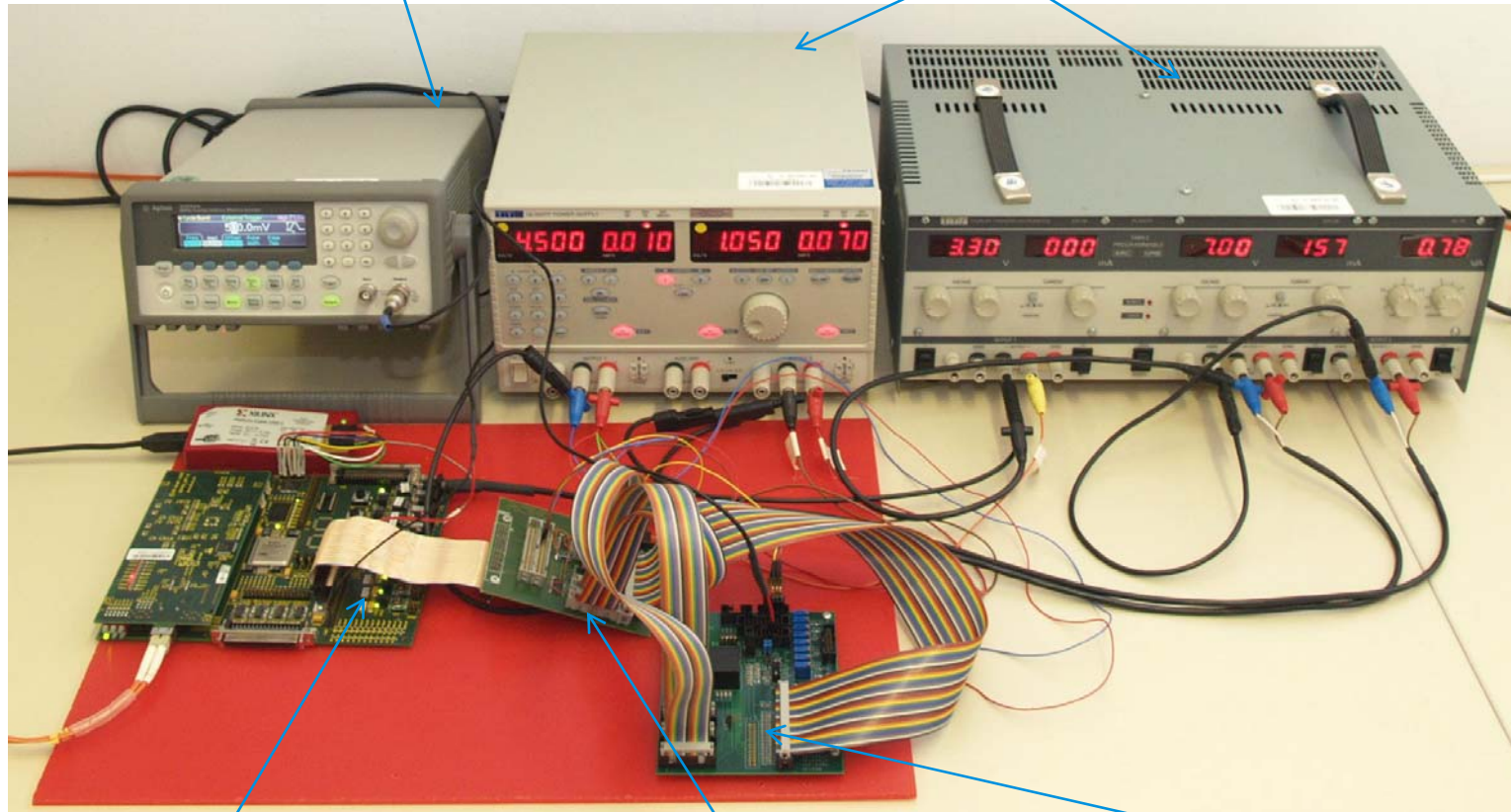
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Experimental setup

signal generator
(Agilent 33250A)

two power supplies
(TTi QI355TP, TTi PL330TP)

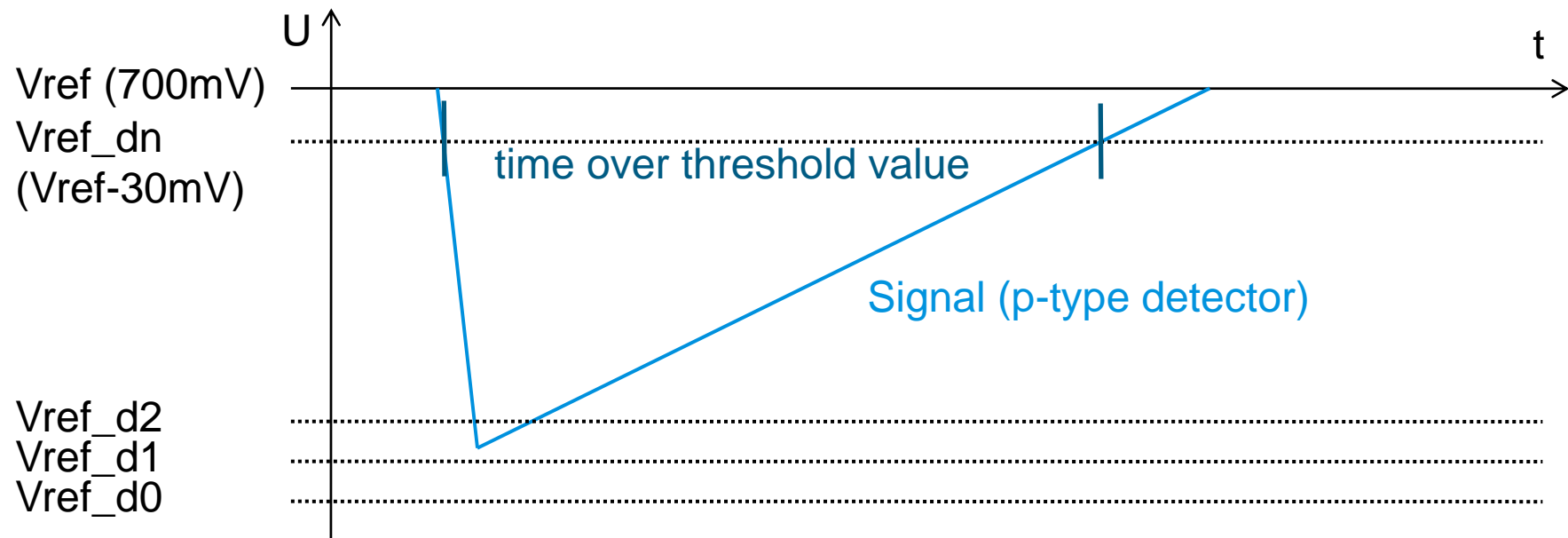


digital readout board
(with FPGA Virtex 4)

adapter board
(with three bus transceiver)

ToPix 2.0 test board
(with 12-bit DAC LTC2620)

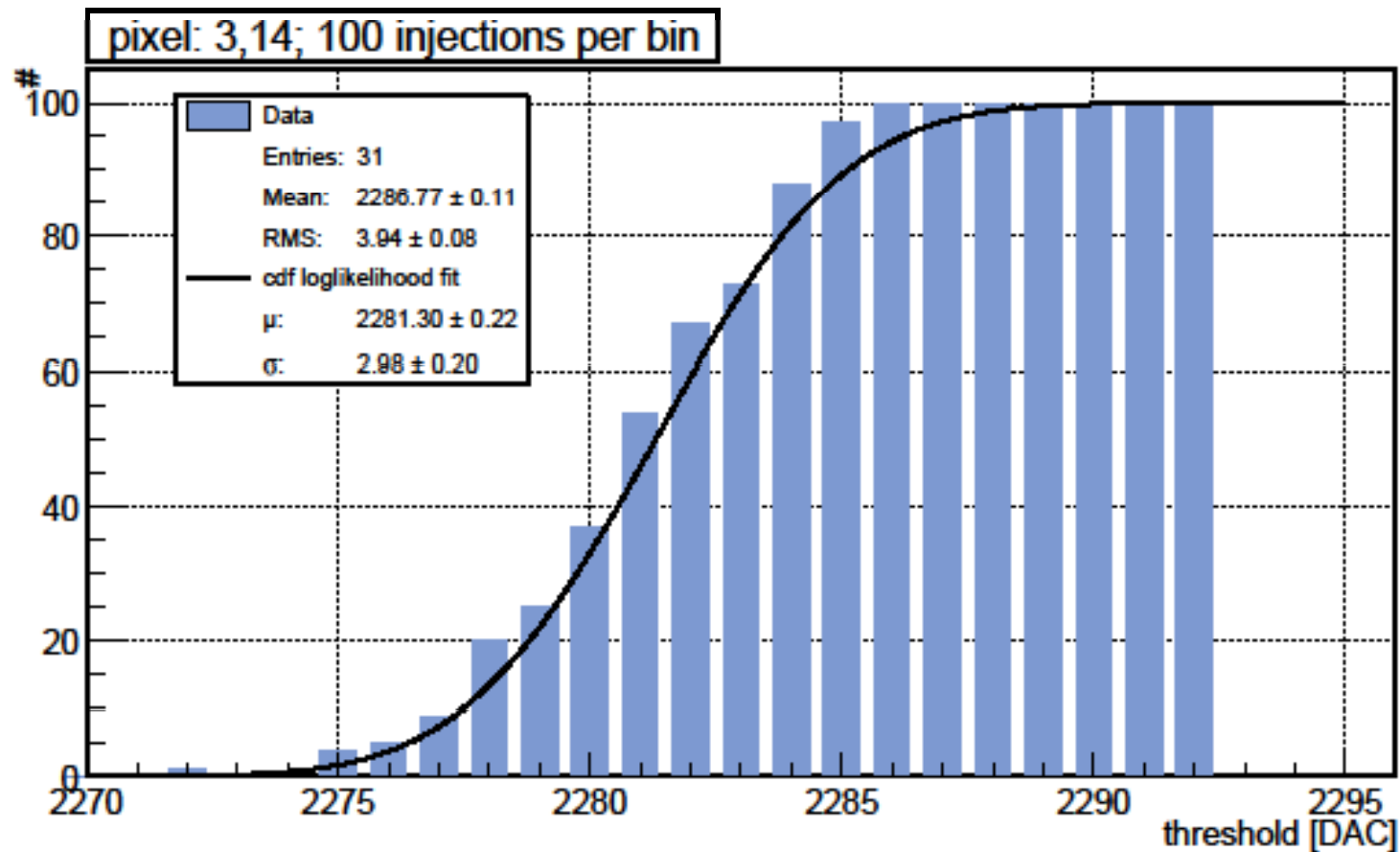
Threshold scan: method



idea: change the threshold instead of the signal

- inject same charge (rectangular signal with signal generator)
- change the 12-bit DAC value of the discriminator stepwise to higher values ($\Delta V = 0.3\text{mV}$)

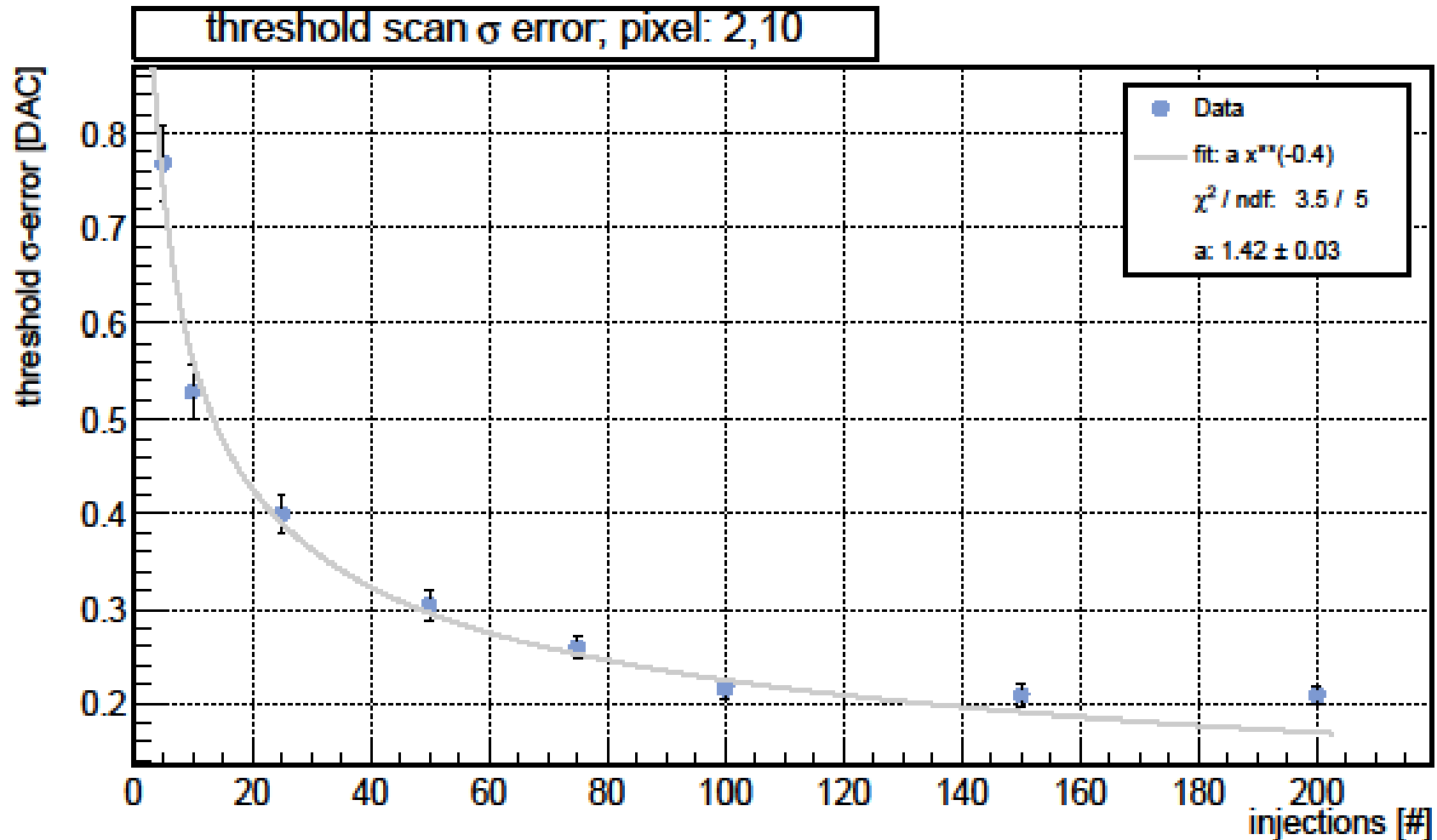
- measure ratio:
$$\frac{\text{pixel answers}}{\text{number of injection}}$$



Fit: cumulative distribution function (cdf) of Gaussian distribution:

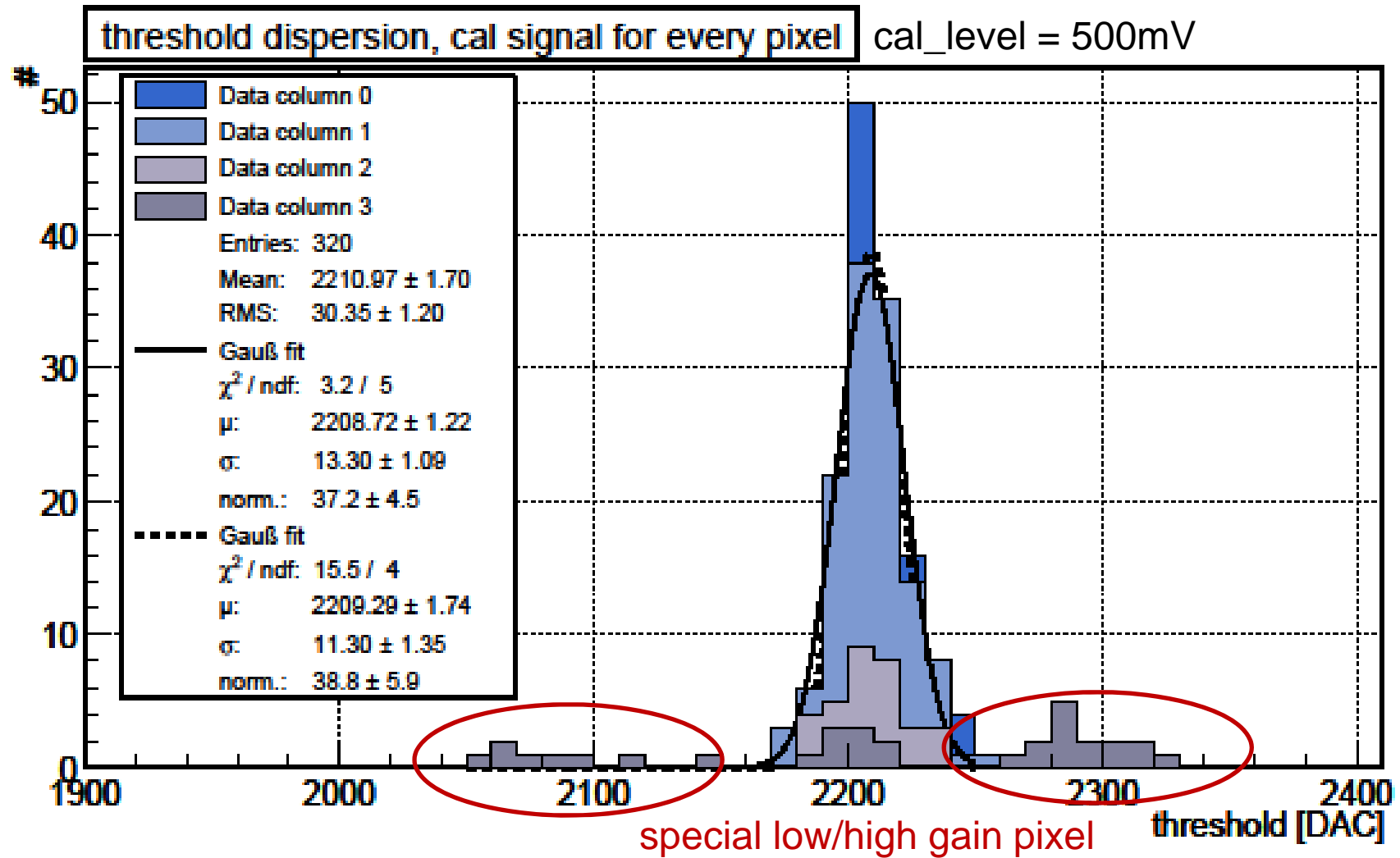
$$cdf(x) = \frac{N_{inj}}{2} \left(1 + erf \left(\frac{x - \mu}{\sqrt{2\sigma^2}} \right) \right) \rightarrow \begin{array}{l} \mu : \text{threshold} \\ \sigma : \text{noise} \end{array}$$

Threshold scan: measurement error



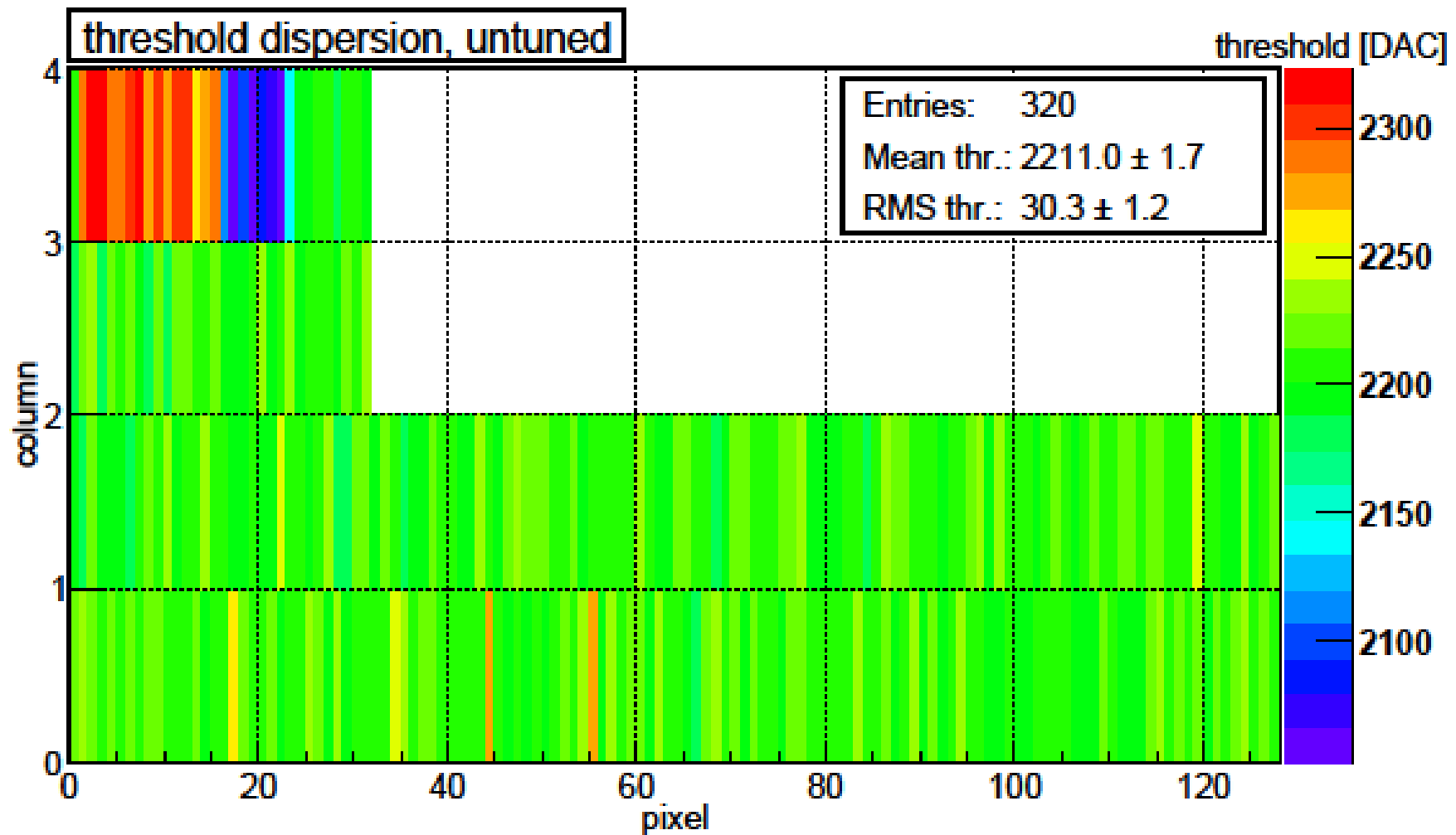
more injections per DAC setting:
→ threshold determination with smaller error
→ slower measurement

Threshold scan: results



threshold dispersion: $\sigma \approx 12\text{DAC} \approx 3.5\text{mV}$

Threshold scan: results



- **goal:** tune these pixels to one threshold level
- **motivation:** pixels with smaller threshold \rightarrow higher resolution
not too close to zero level \rightarrow avoid fake hits due to noise

Threshold tuning: method

- every pixel has a 5bit DAC to change its threshold level

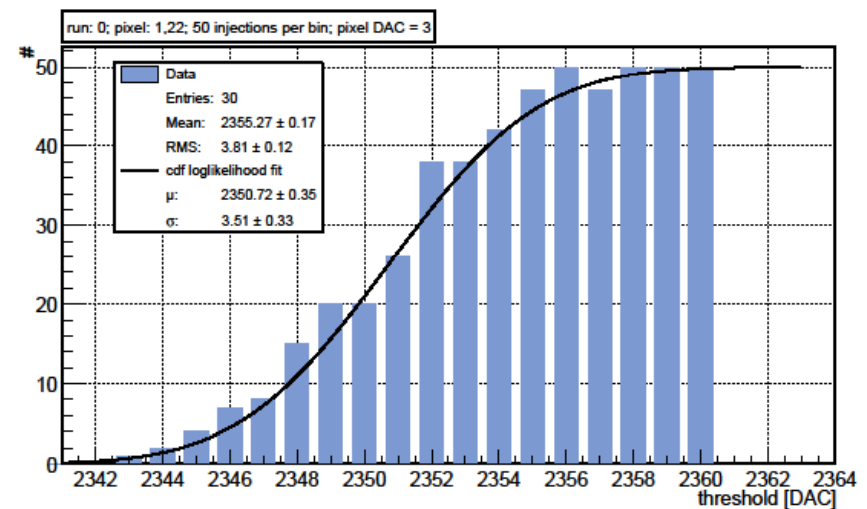
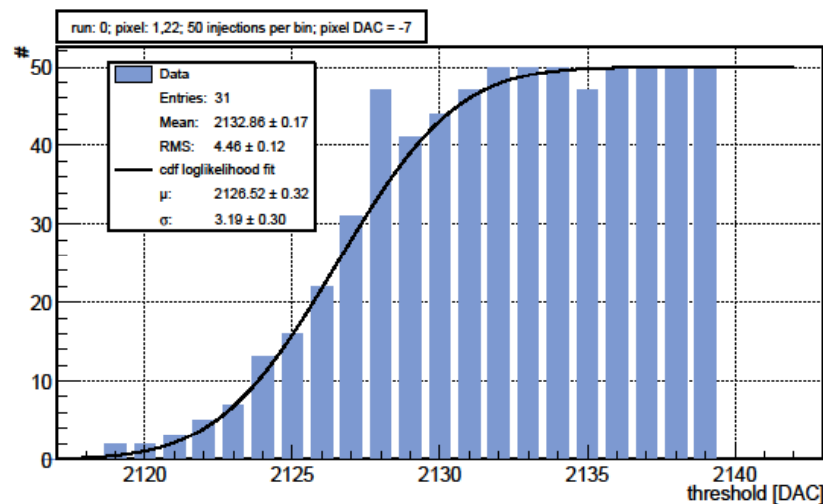


change direction

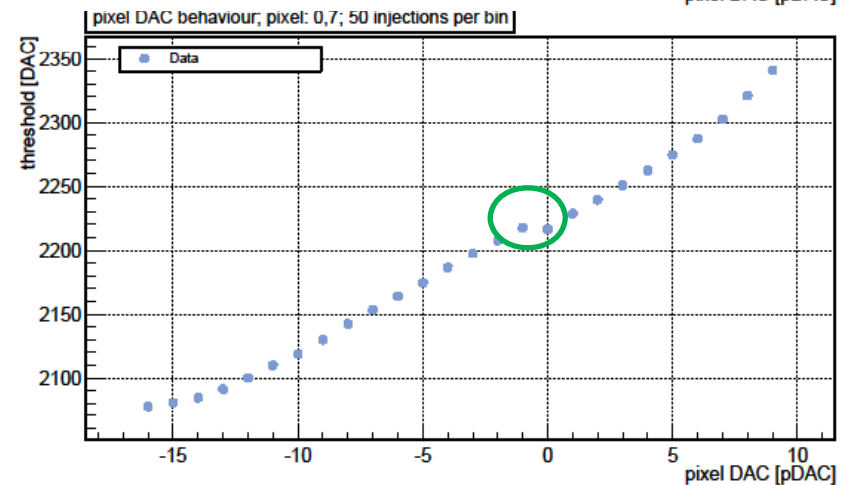
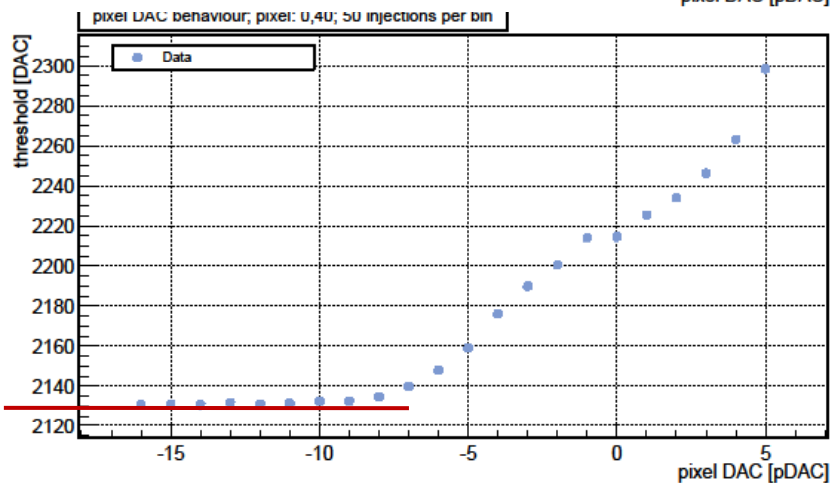
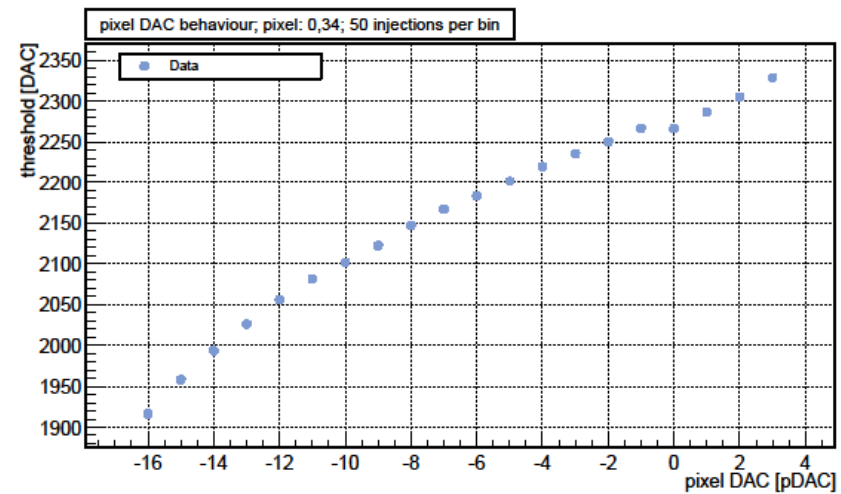
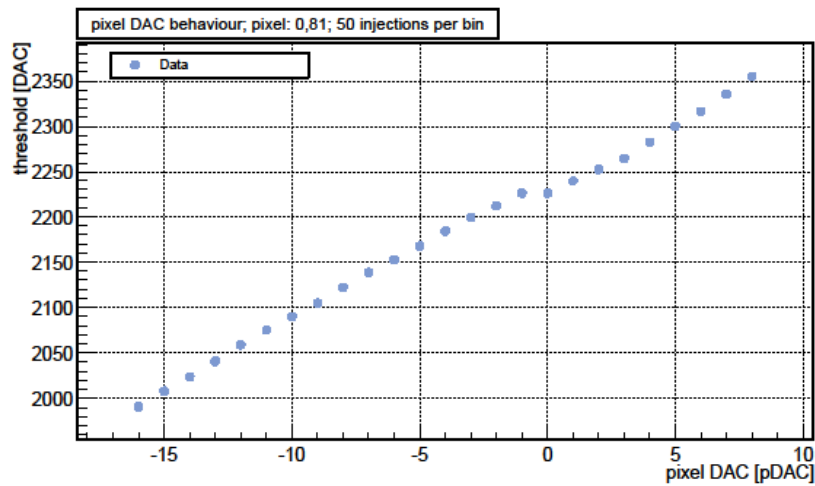


change amount

- here:
 - 16..-2 lower threshold
 - 1..0 direction bit change
 - 1..15 higher threshold
- determine the threshold for every pixel and pixel DAC setting (>7000 scans)

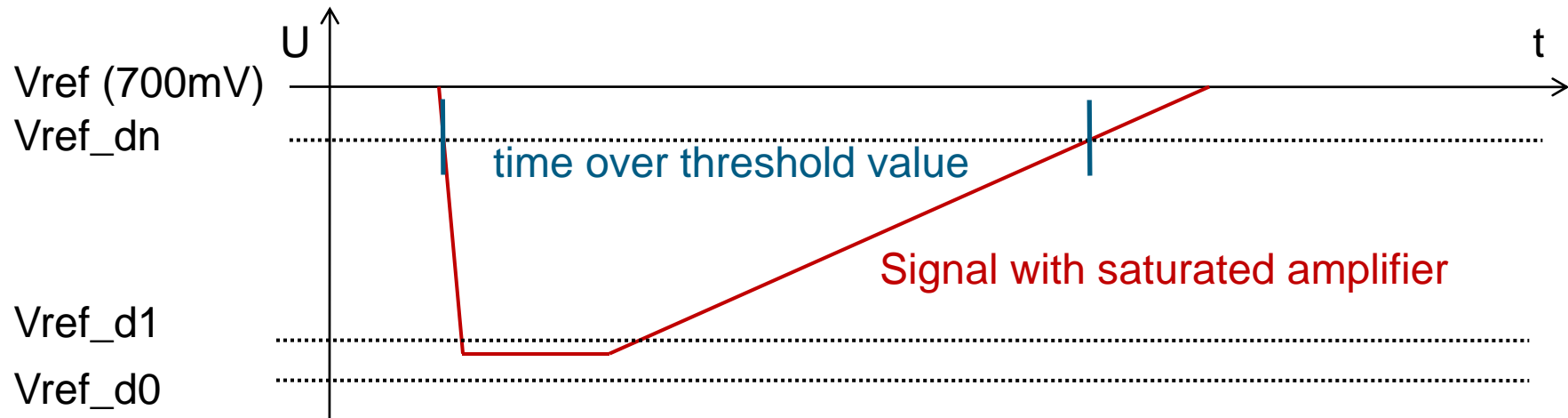


Threshold tuning: lookup tables



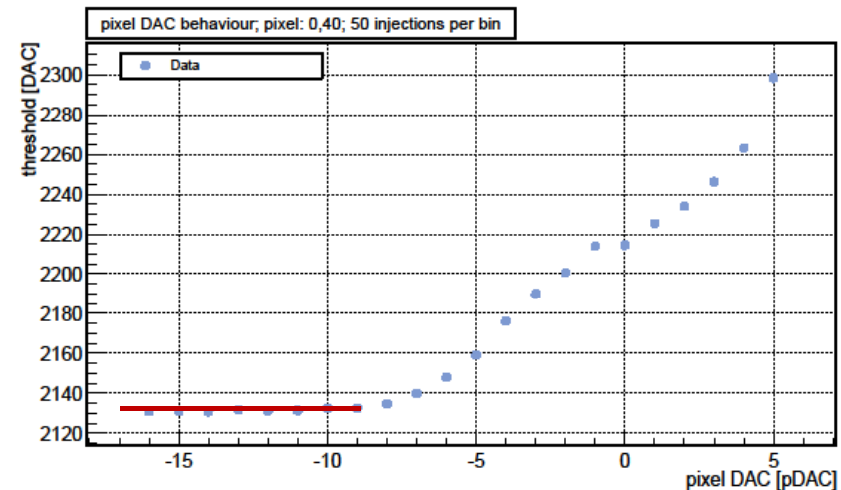
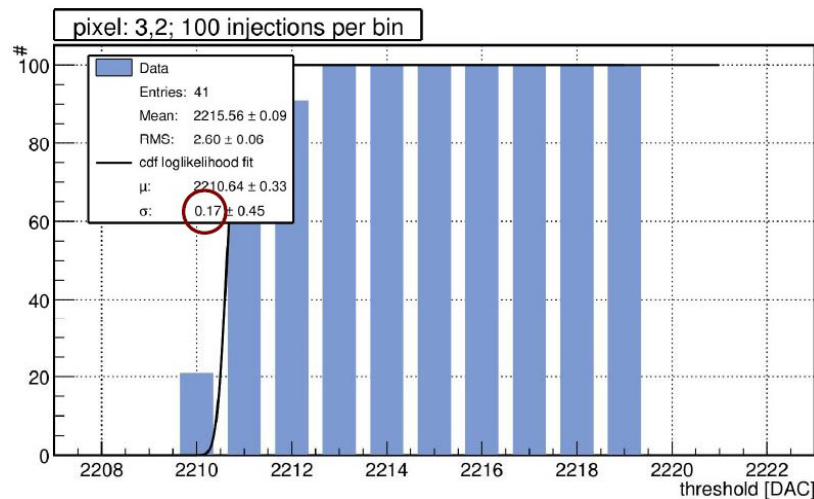
- quite different but reproducible behavior
- pixel threshold added/subtracted bit change
- amplifier saturated

Threshold tuning: systematic error



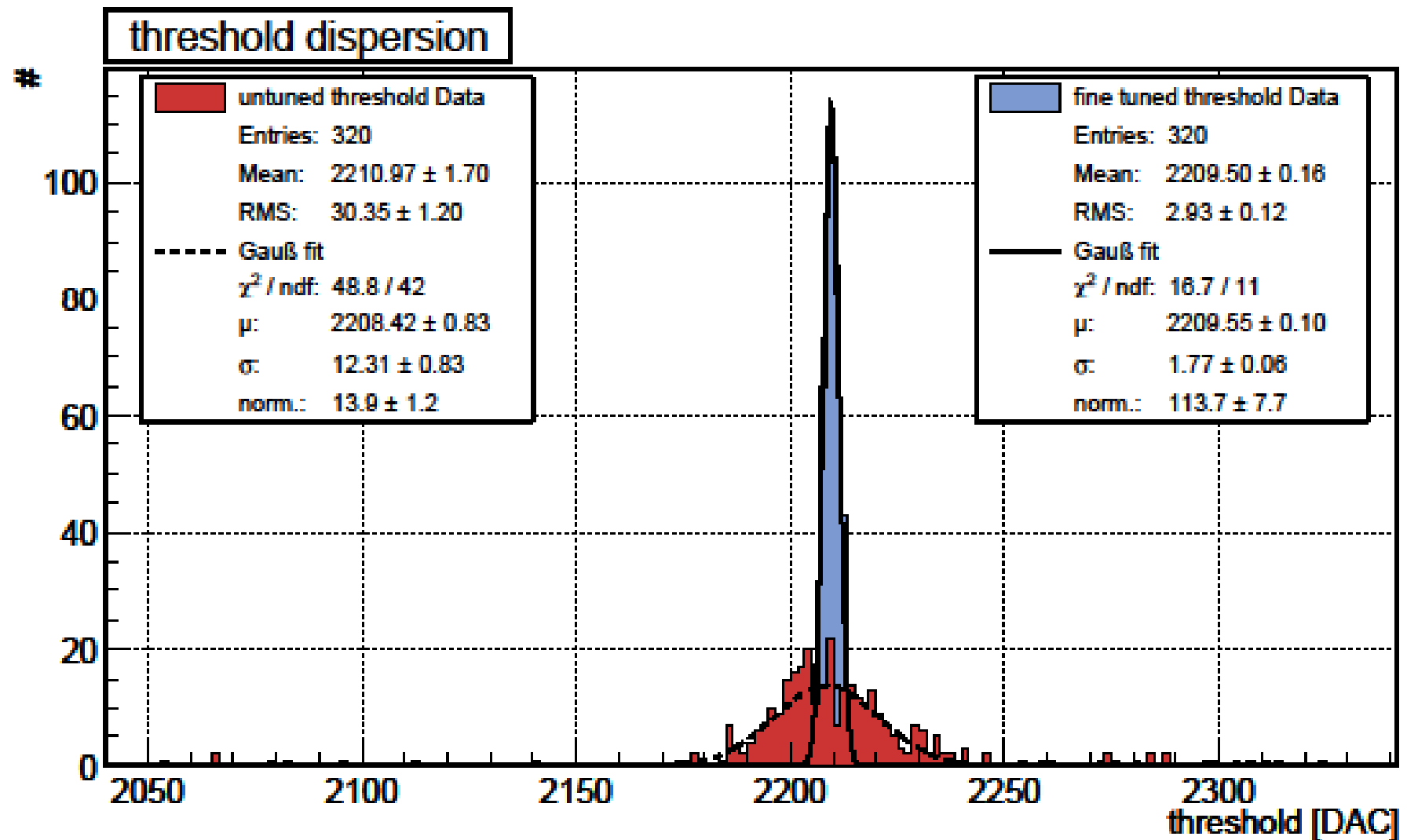
impact?? (has to be quantified):
one measures a too small noise

the threshold stays at the same level



→ proof if noise is measured correctly: measure it at different signal levels

Threshold tuning results: threshold



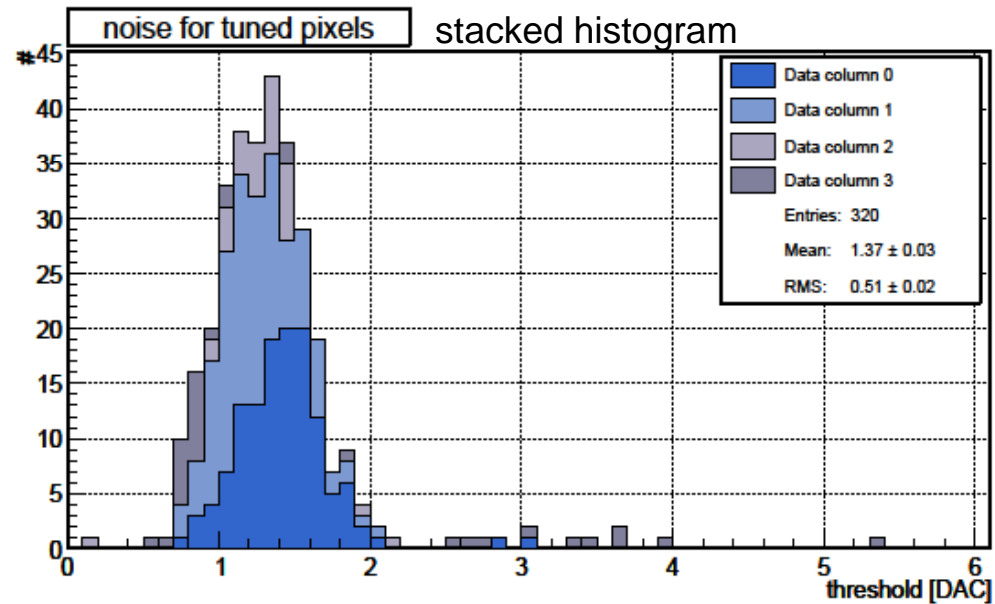
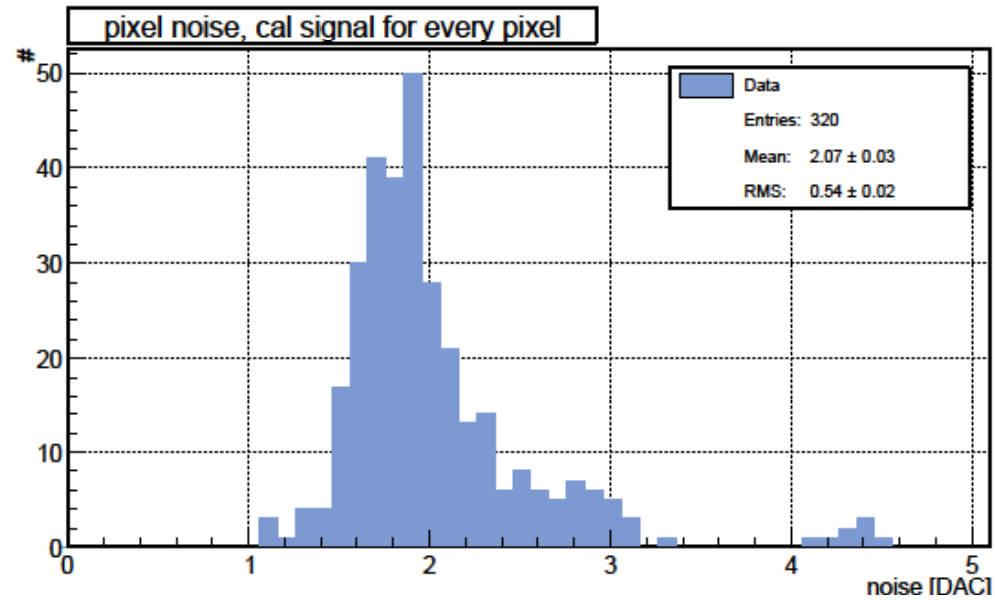
tuned threshold dispersion: $\sigma = 1.77\text{DAC} \approx 0.5\text{mV}$

Threshold tuning results: noise

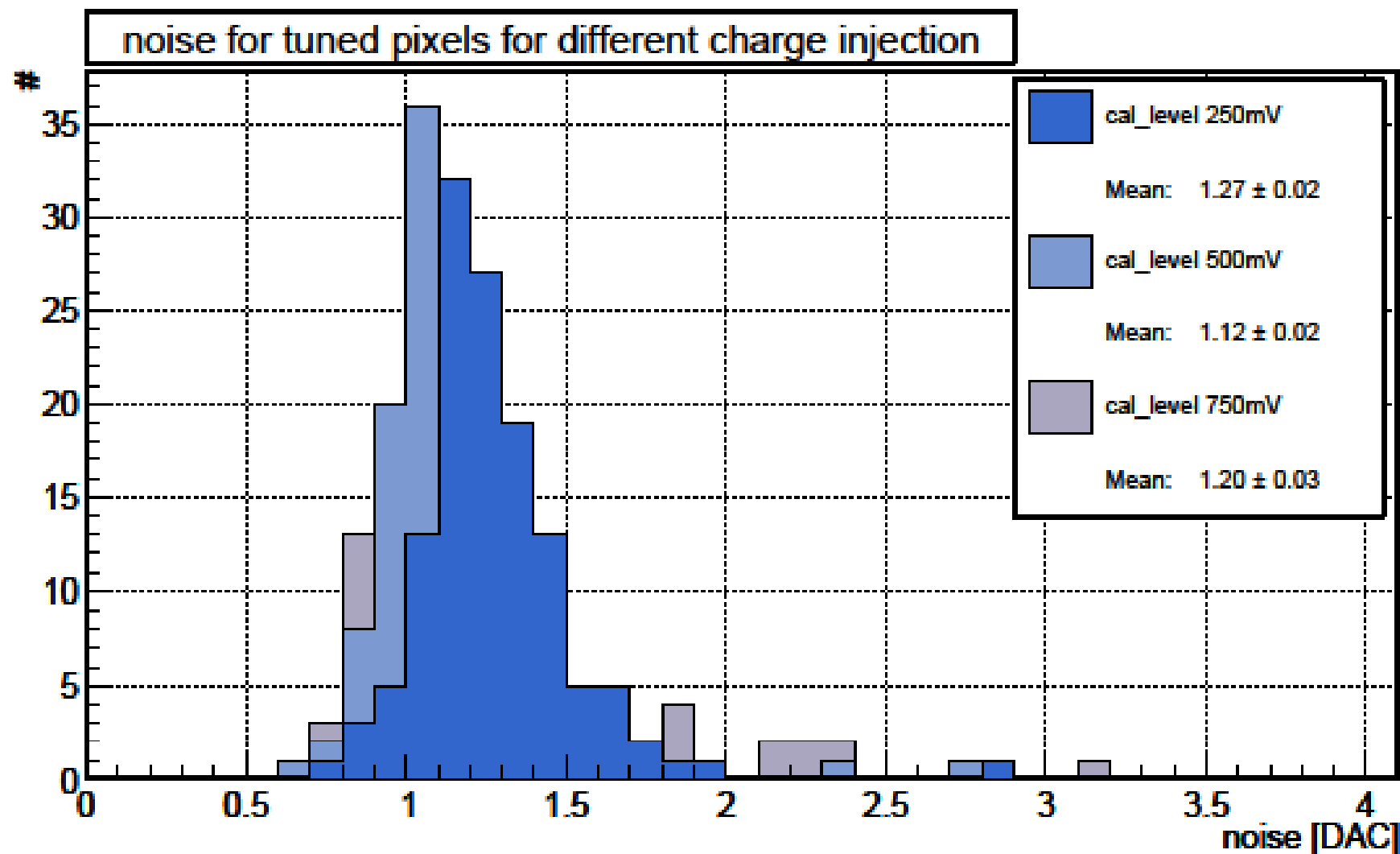
$$\sigma = 2DAC$$



$$\sigma = 1.4DAC$$

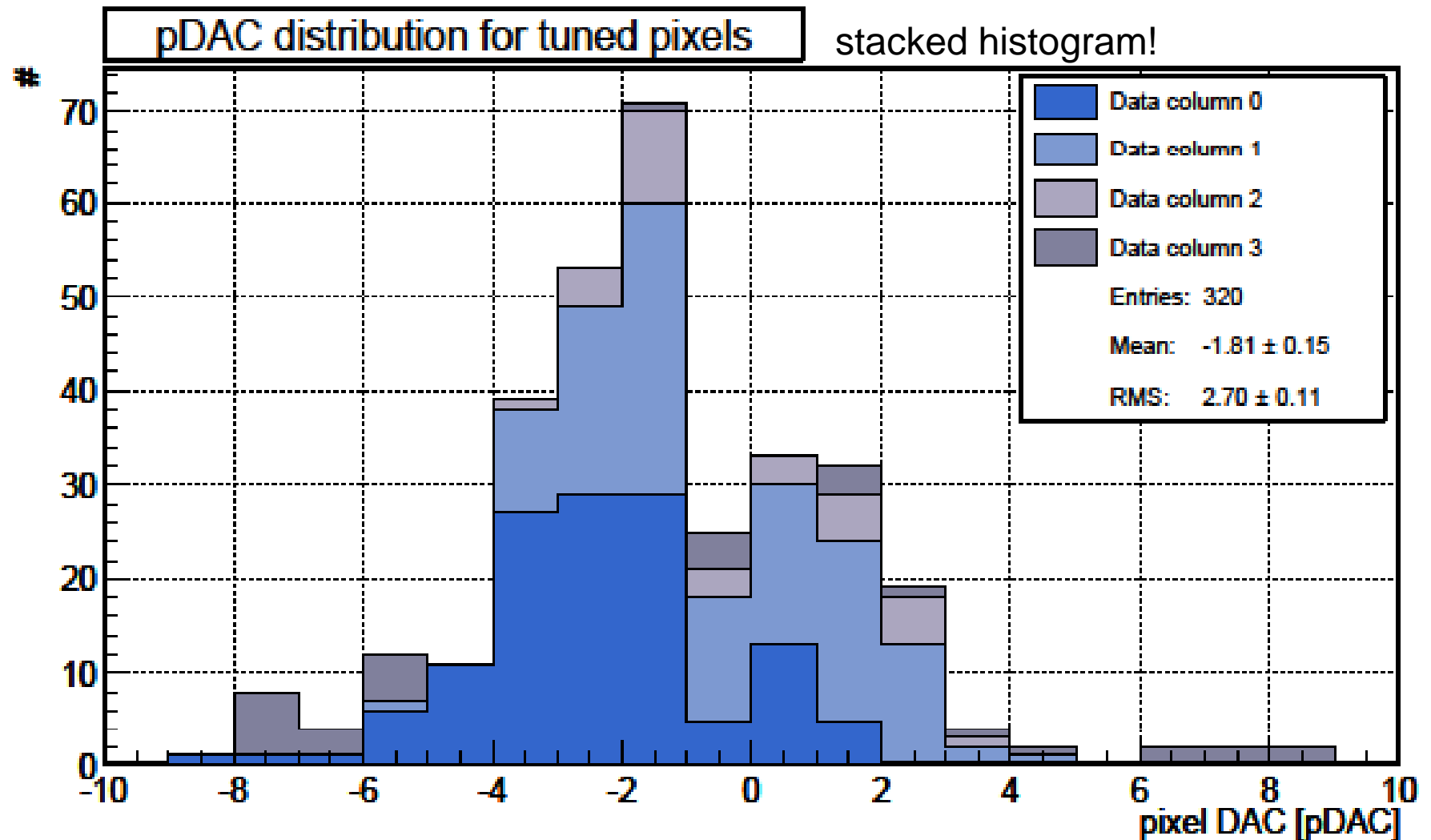


Threshold tuning: proof of results



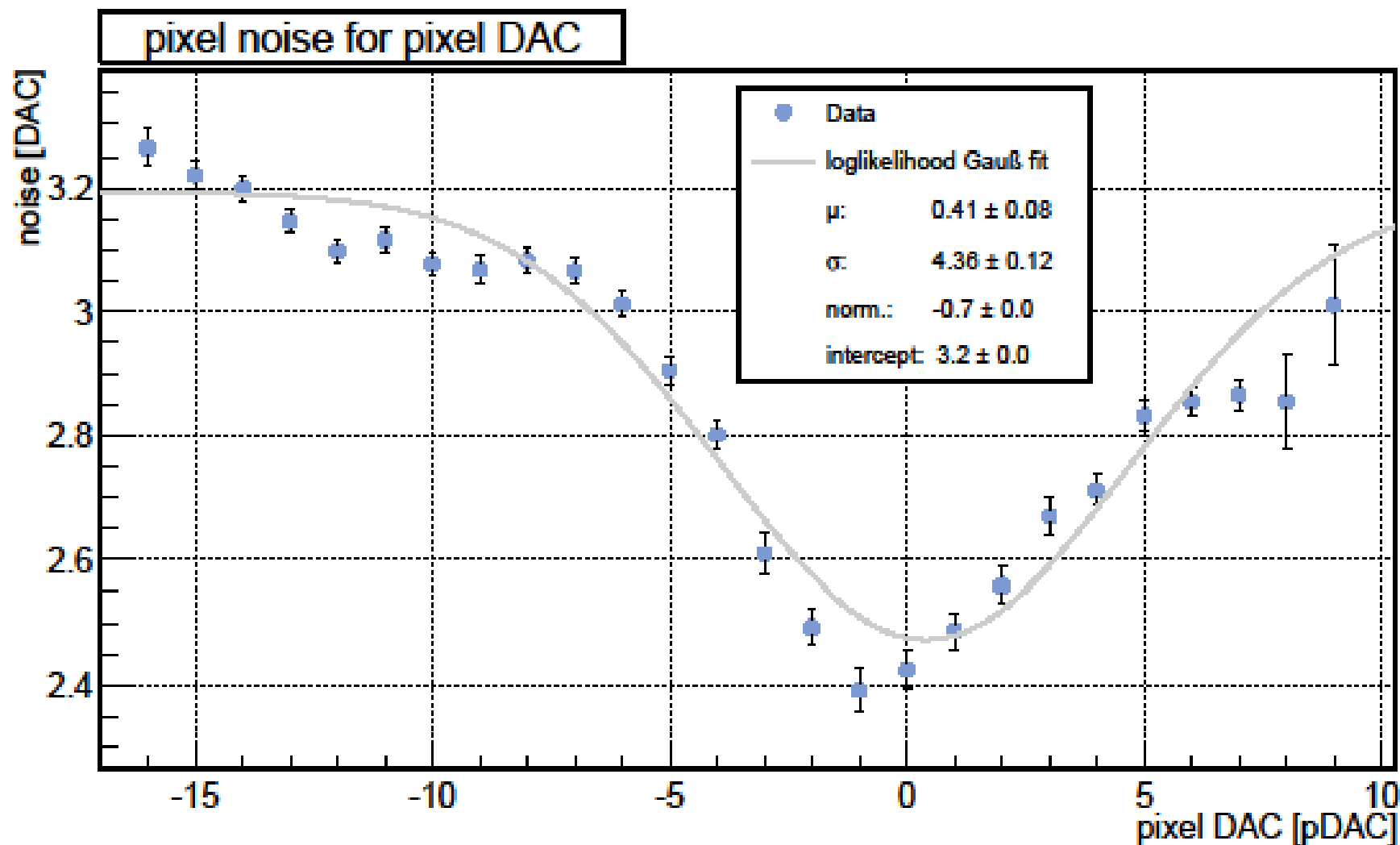
noise does not decrease for higher signal level → amplifier not saturated

Threshold tuning: improvement possibility



- pixel DAC range not fully used!
- Idea: change the pixel DAC step width

Threshold tuning: noise dependency



higher pixel DAC setting \rightarrow more noise

Summary:

- threshold tuning has been done:
 - dispersion decreases: $\sigma_{untuned} = 12.3DAC \rightarrow \sigma_{tuned} = 1.8DAC$
 - also noise decreases
- higher pixel DAC value lets the noise to increase
- A better threshold tuning can be done by using the hole pixel DAC range

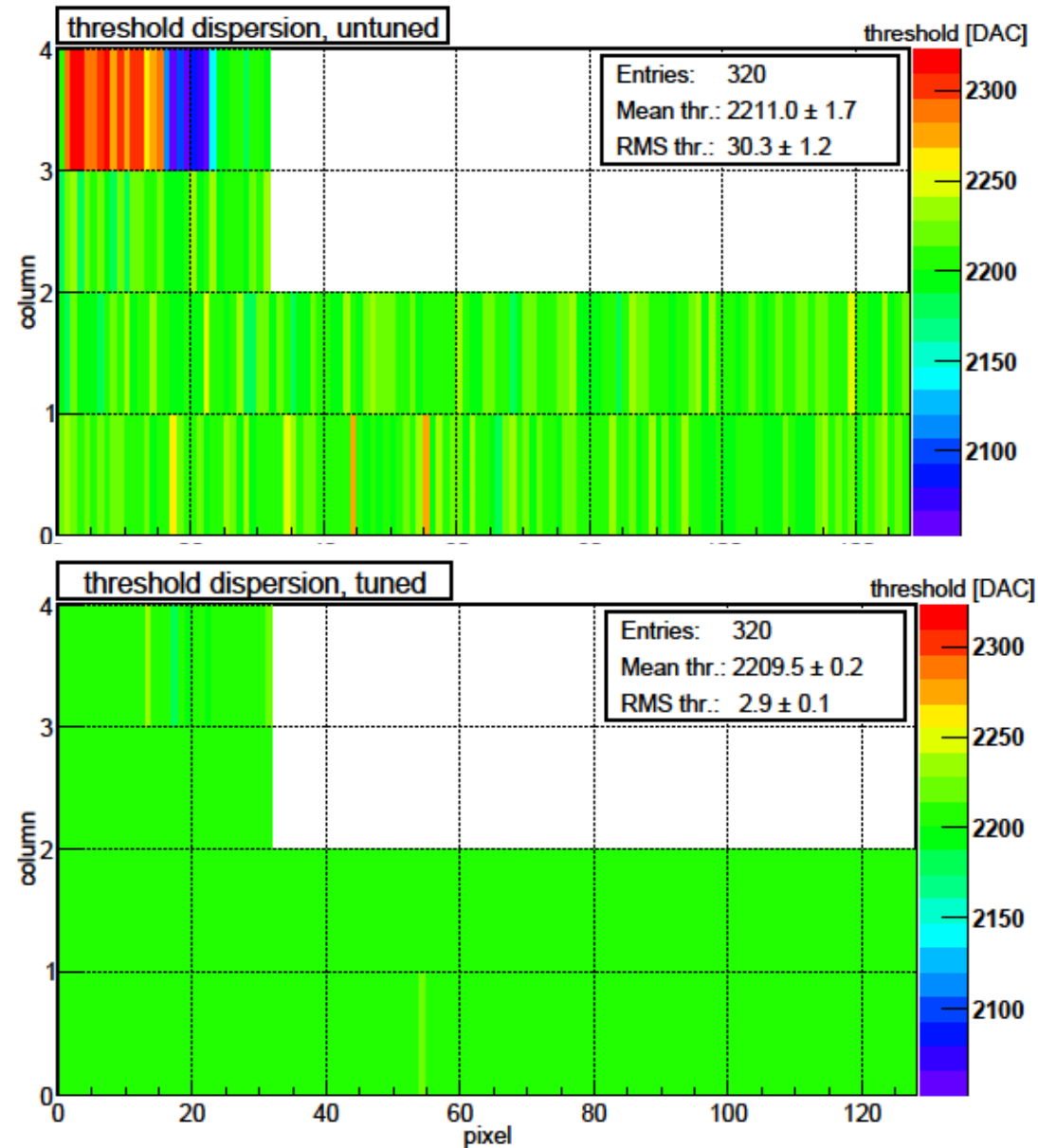
Outlook:

- do a improved threshold tuning

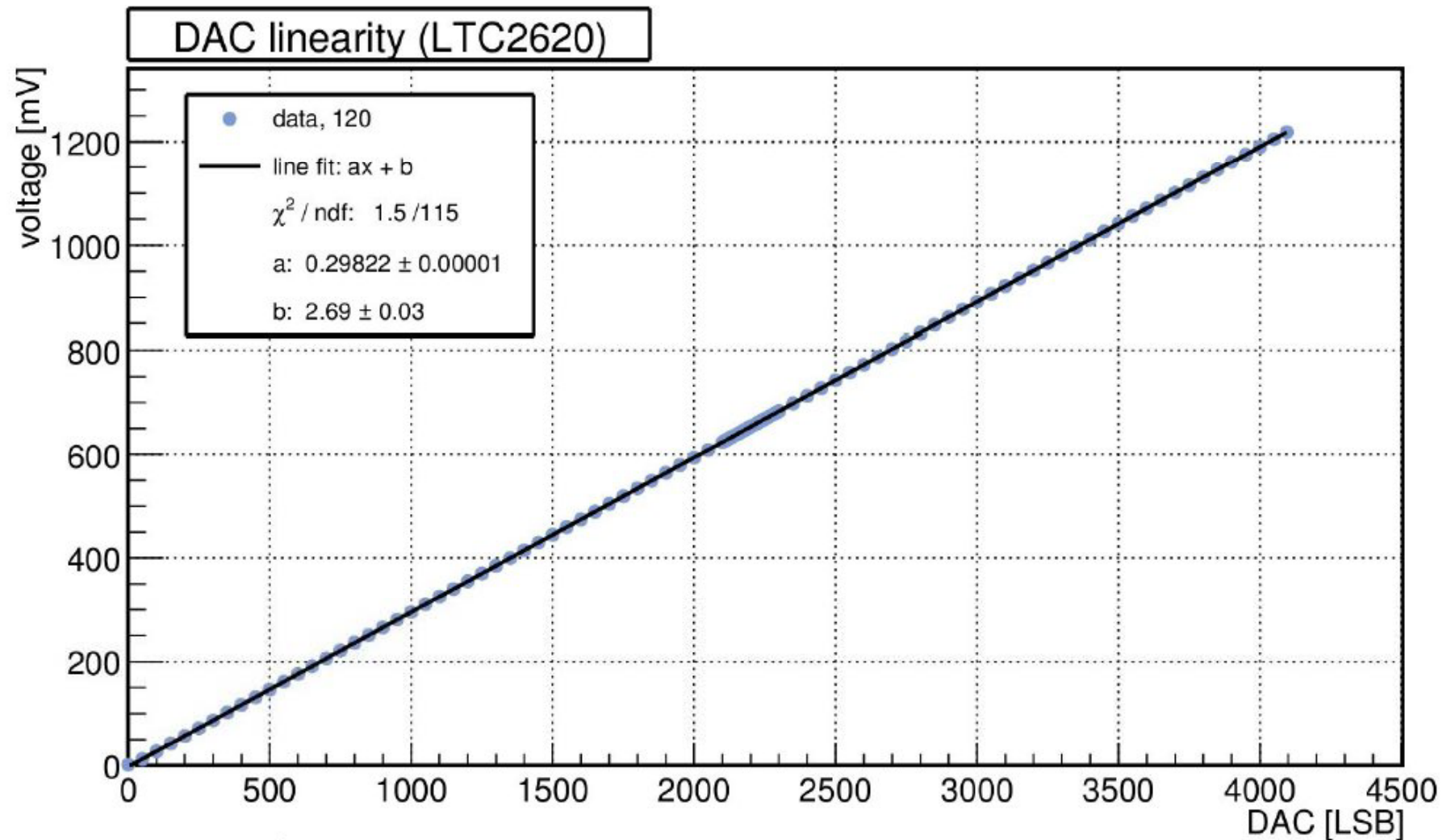
Thank you for your attention!

- **Parameter**
 - Clock frequency: 40 Mhz
 - High level voltage: 1.050 V
 - Cal_level: 500 mV
 - V_in for voltage regulators: 4.5V
 - P-type detector pixel configuration
- **Analog test points voltages:**
 - DAC_BIAS2_MON: 266mV
 - IFB_CAS_MON: 142mV
 - ILC_CAS_MON: 497mV
 - IBIAS2_MON: 200mV
 - VCASP_EXT_MON: 150mV
 - IBIAS_MON: 850mV

Appendix II: threshold tuning results (2D)

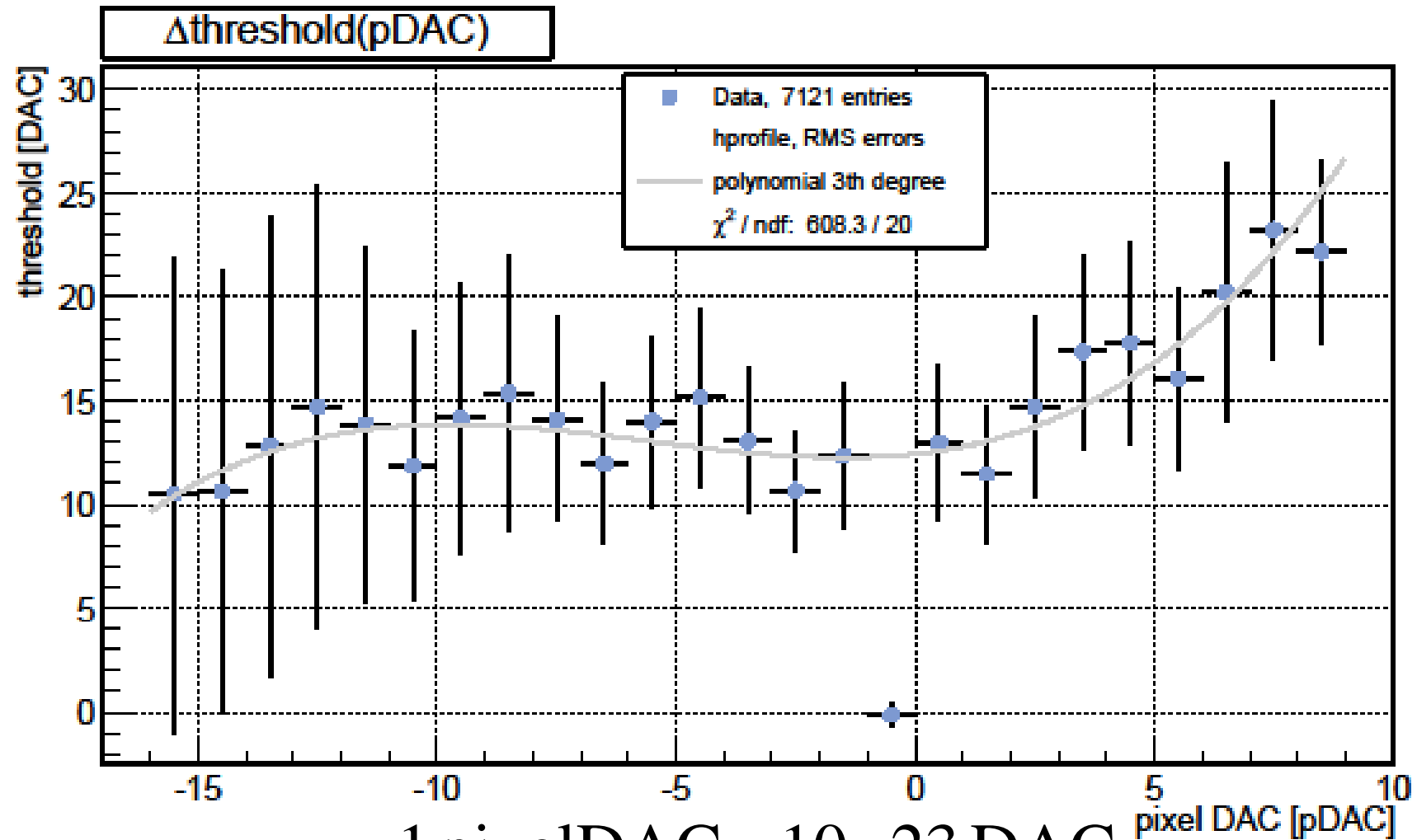


Appendix III: DAC gain



$$1\text{DAC} \equiv 298.2 \mu\text{V}$$

Appendix IV: threshold change per pixel DAC



- this can be changed to smaller values to improve the threshold tuning