S-curve noise measurements with VMM3a/SRS

Work in progress

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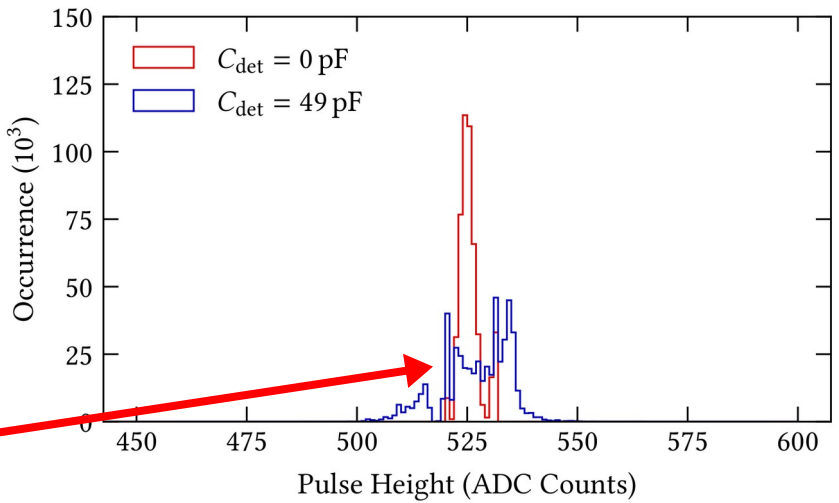
Motivation

- Goal: develop a procedure to measure the noise at working conditions and to support the noise optimization process
- VMM has an analogue part that allows access to the noise
- Can we measure the noise of our set-up, using VMM3a/SRS data?

How to measure the noise with VMM?

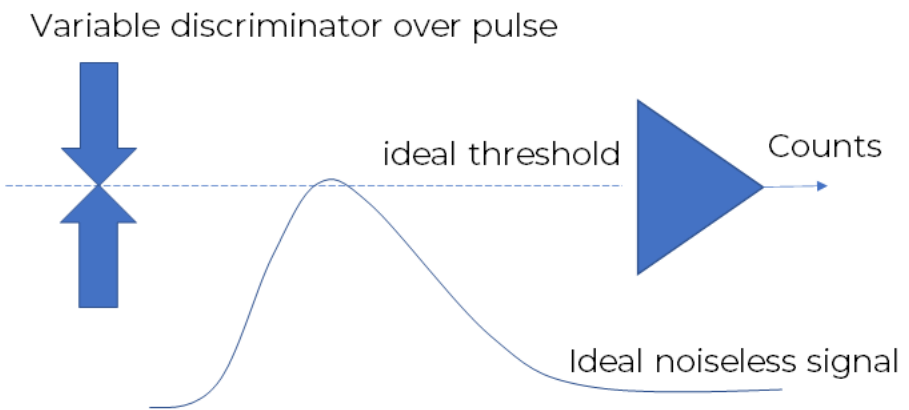
- The VMM has an analogue part → access to the noise on each channel
- How to easy access the analogue part channel by channel → only via digital part with ADC
- Can we measure the width of the pulse and get so access to the noise?
- Answer: not exactly…
- Problem: equivalent number of bits ~8 for 10-bit ADC → affects the outcome of the measurement
- Is there an alternative? → Yes, the S-curve

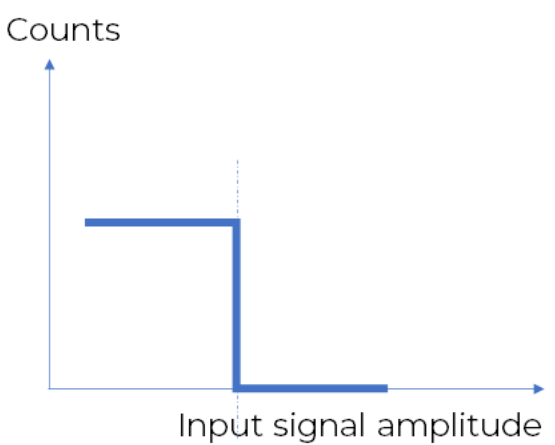
→ Gain = 9.0 mV/fC
→ 200 ns peaking time



S-curve with VMM

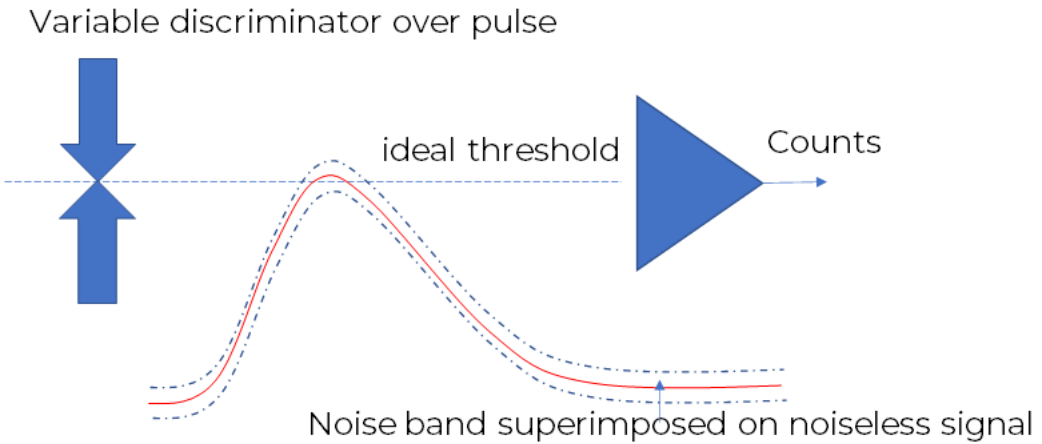
- Why S-curve? → counting based
- Uses analogue part with discriminator → when data are processed by the digital part, the ADC effect is not relevant
- Either take a constant discriminator and change the pulse height, or keep a constant pulse and change the discriminator. We do the latter.

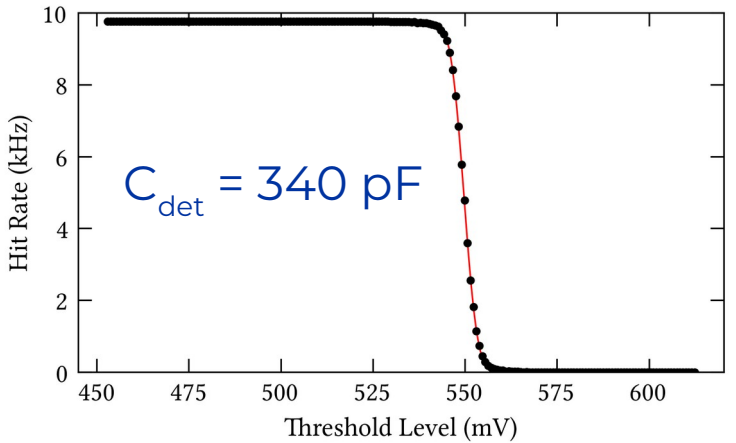




Getting the noise

- With the noise included the situation looks like this:

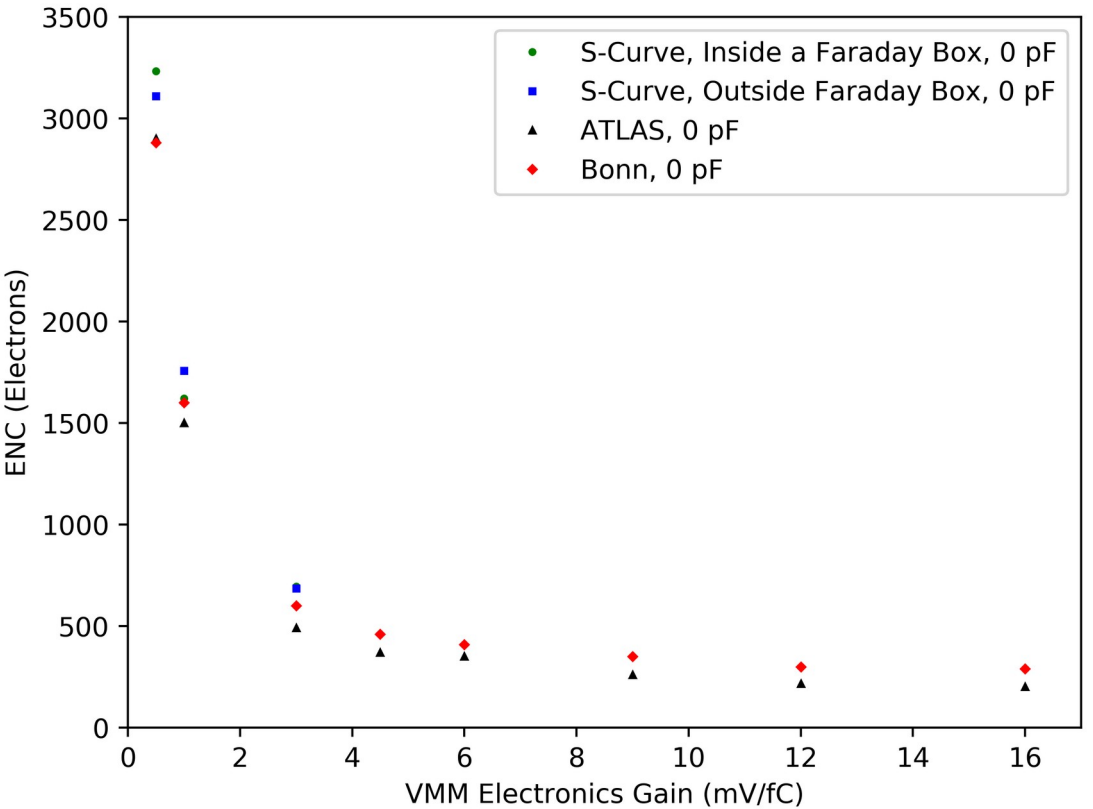




- We assume Gaussian noise → fit $N(x) = \frac{N_{\max}}{2}\operatorname{erfc}\left(\frac{x-\mu}{\sqrt{2}\sigma}\right)$ to our data
- σ gives us the noise in mV
- Conversion to electrons/ENC via VMM electronics gain, given in mV/fC

Tests on the floating hybrid

- We took a hybrid, inside and outside of a Faraday box and performed some measurements
- 0 pF connected, only intrinsic noise
- Currently only 0.5, 1.0 and 3.0 mV/fC as electronics gain
- At these gains, the results are compatible with the Bonn and ATLAS measurements (taken from Emorfili's WG5.1 presentation)

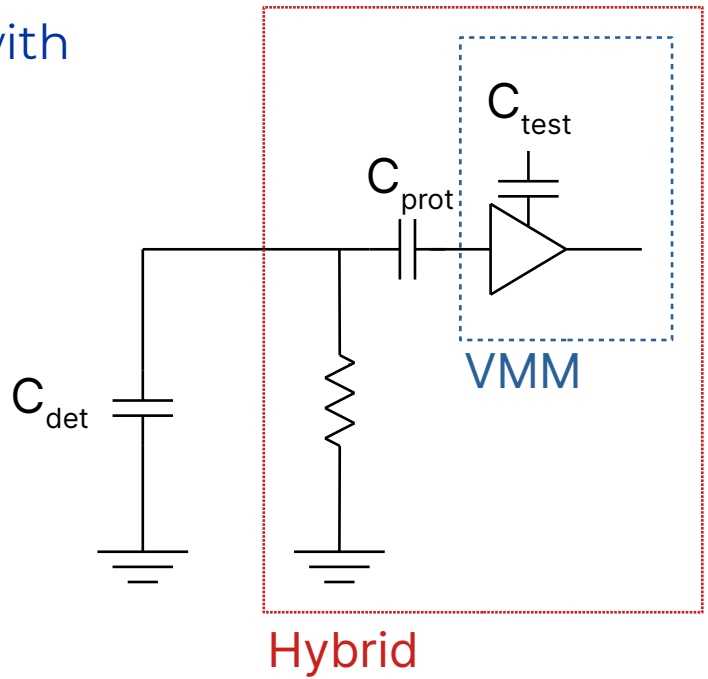


Some other tests

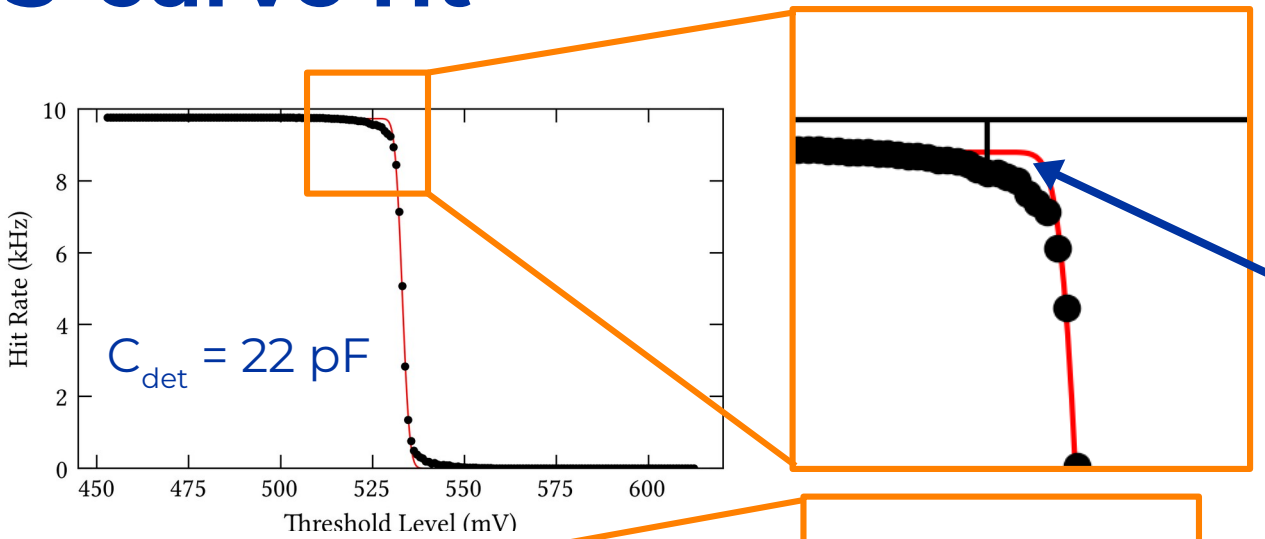
Preliminary

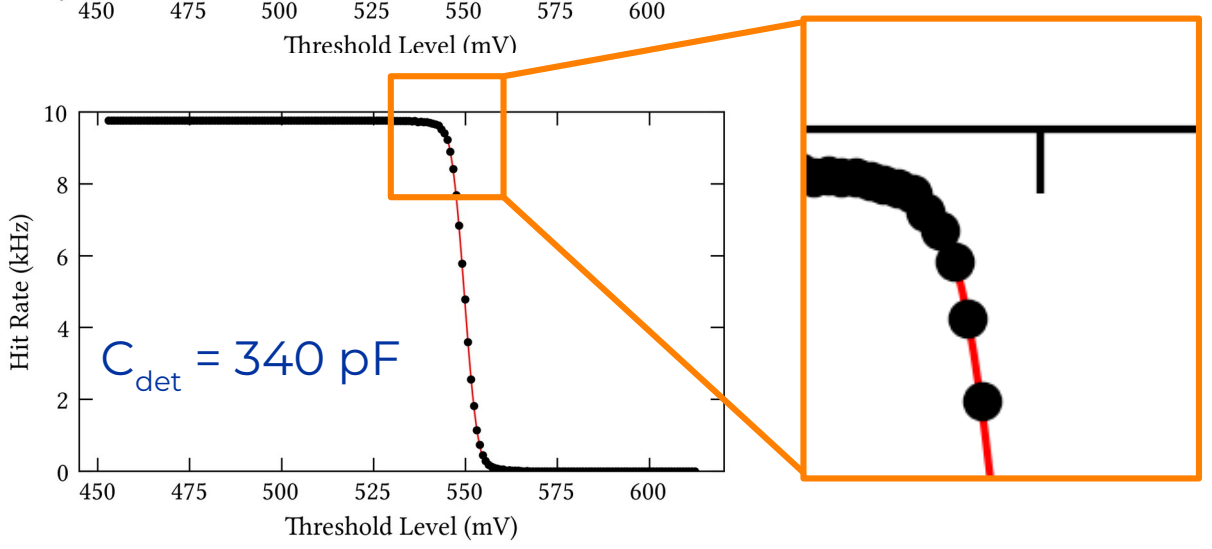
- We performed also other measurements with **external capacitance**
- Electrical scheme on the right
- Capacitor values in pF:

  0, 14, 22, 47, 65, 112, 230, 340
- Gain: 3.0 mV/fC
- 200 ns peaking time



S-curve fit



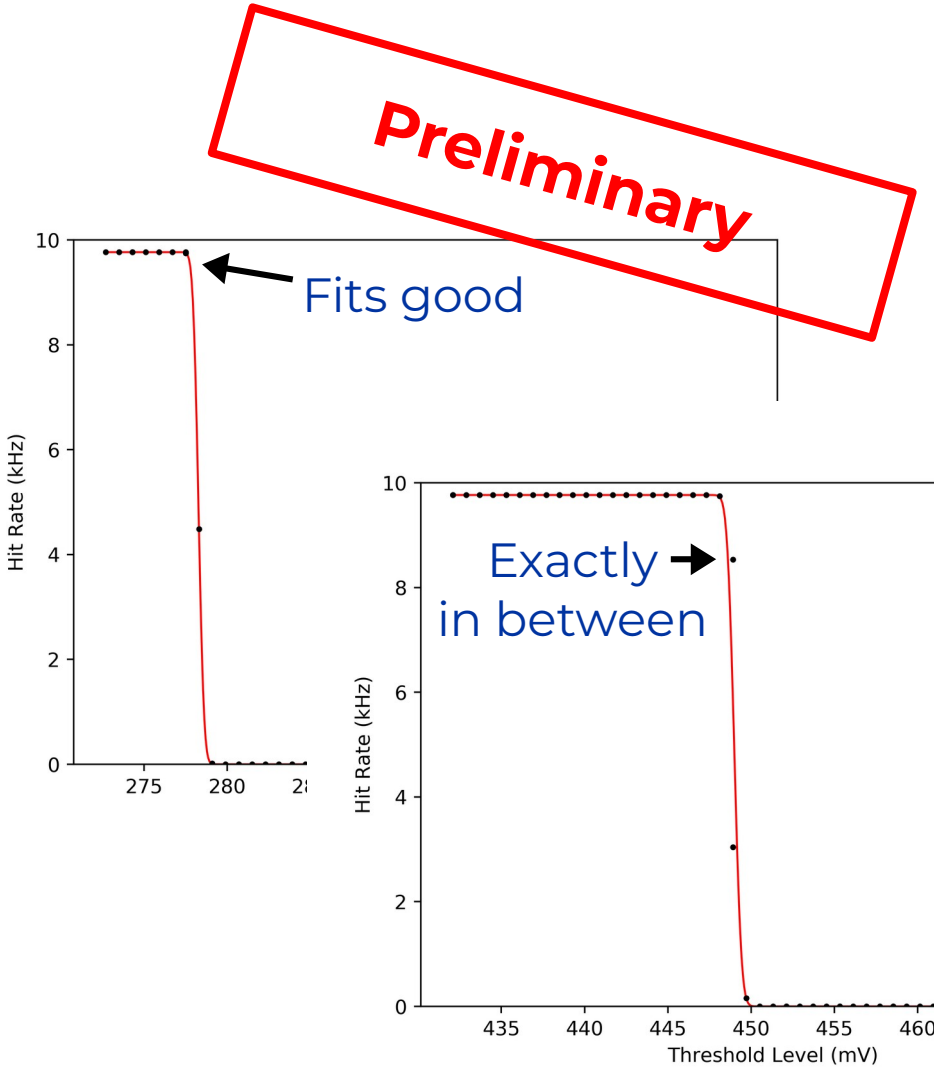


Preliminary

- Seems like erf-fit does not describe the noise completely (data are not completely Gaussian)
- Sensitive at low noise (only observed with external capacitances)

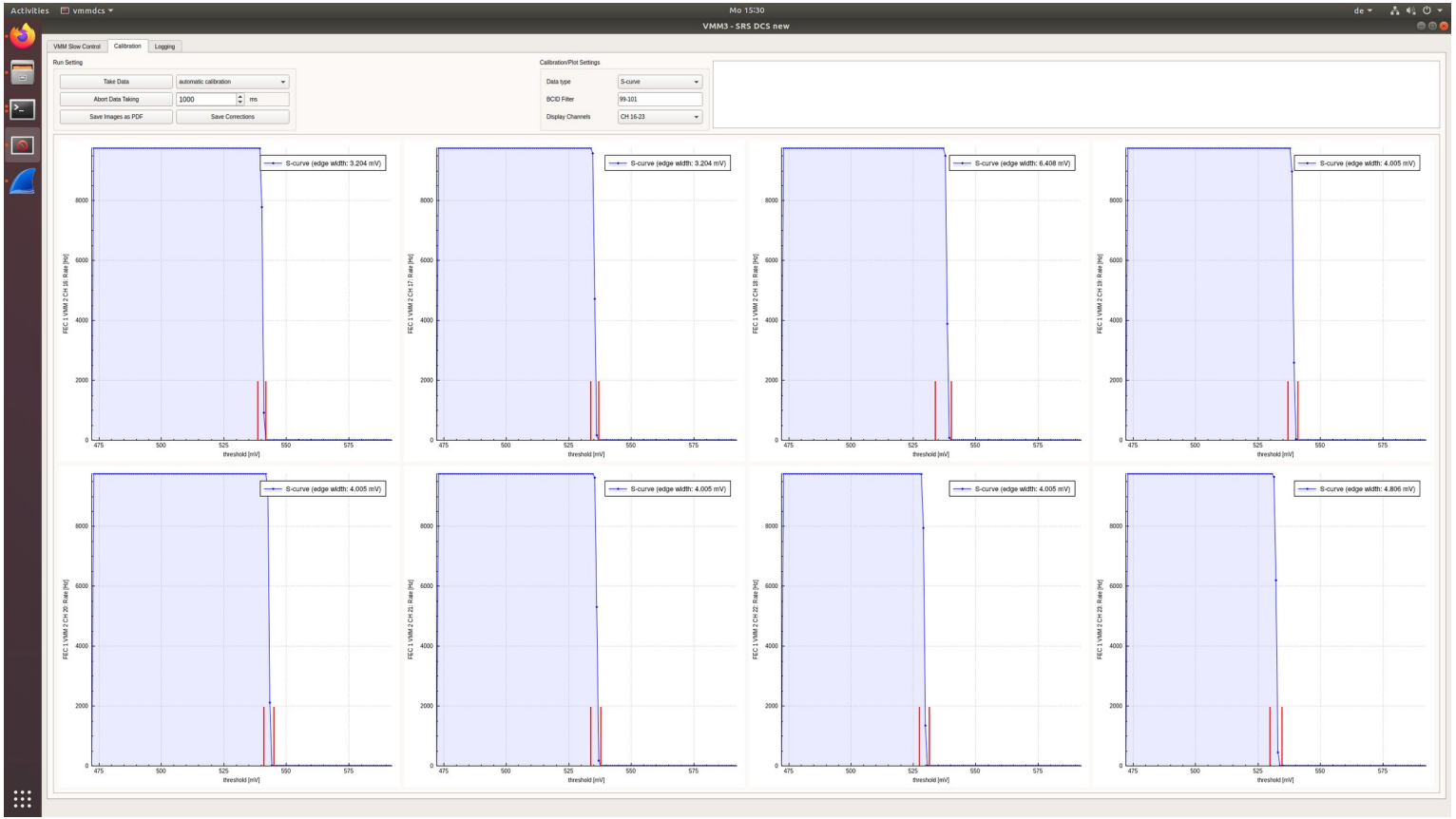
Noise contributions by the S-curve method

- There are a some things that should be considered
  - Fluctuations of the pulse
  - Fluctuations of the discriminator level
  - Hysteresis (width) of the discriminator level
  - Pulse frequency → will you be sensitive to all kinds of external periodic noise?
- Threshold DAC steps for low noise are wide



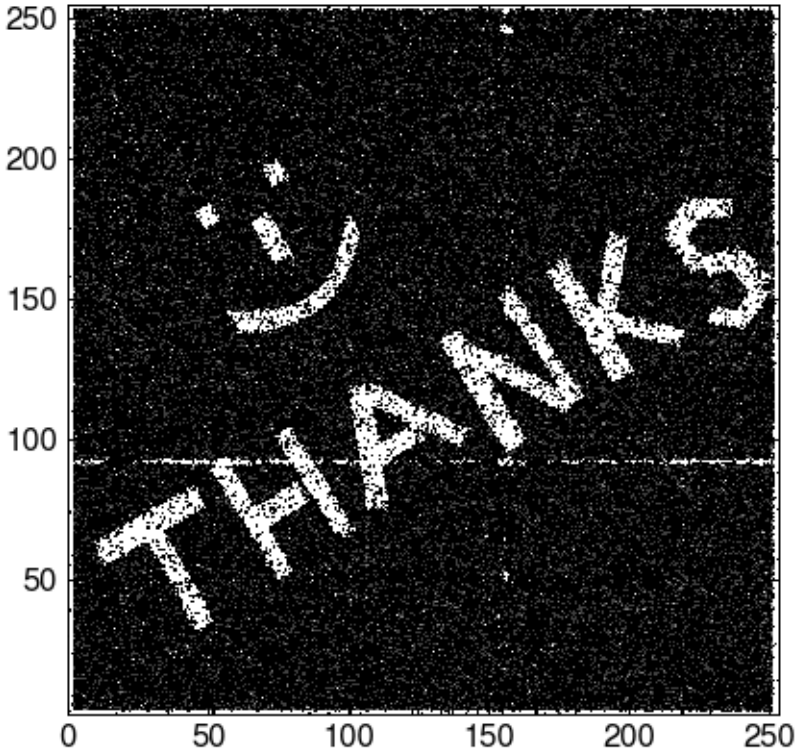
S-curve implemented in slow control

- Automated procedure, 64 channels of one ASIC at the same time
- Online monitoring + option to save results as CSV file for further analysis



Final remarks

- We are exploring the S-curve method to measure the noise of an experimental set-up with VMM3a/SRS
- Measurements on hybrids (no external capacitance) are compatible with reference measurements
- Future steps:
  - Test on different input capacitances and different VMM settings (preliminary measurements are reasonably good but with some unexpected behaviour). Has to be investigated.
  - Validate the implementation of the scan in the slow control. Some instabilities were observed, when changing the measurement conditions. No intrinsic showstopper, just some debugging that has to be done.
  - Get hands on a better error estimation



for your Attention