AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

FEB noise measurements

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in collaboration with UJ group**

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FEB overview

Front-end Electronics Board (FEB) is used to read straw tubes in STT and FT detectors. It contains:

- 2 PASTTREC ASICs with 8 channels per ASIC (16 channels per FEB). Each ASIC includes:
  - One global threshold set for all channels,
  - 5-bit baseline DAC for each channel (from -30 mV to 30 mV, with 2mV step)
  - Gain setup (0.67,1,2,4 [mV/fC]),
  - Peaking-time setup (10,15,20,35 [ns])
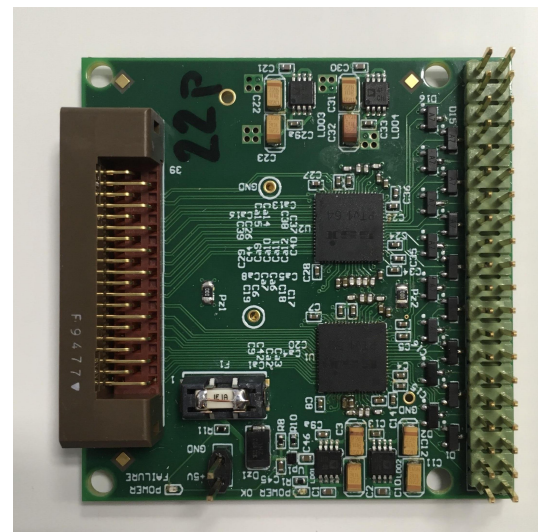
Noise units at gain set to 4 mV/fC

In front-end electronics read-out systems noise is usually presented in e⁻ (1 e⁻ = 1.602·10⁻¹⁹ C)
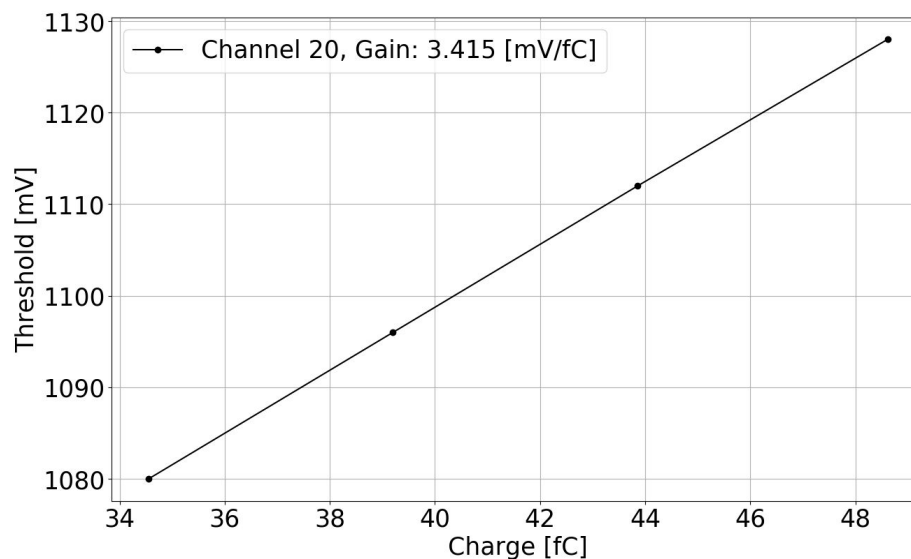
[e⁻]	[mV]
1000	0,55
2000	1,09
3000	1,64
4000	2,19

| [mV]	[e⁻]
0,5	915,18
1	1830,35
2 (DAC step)	3660,71
3	5491,06

Measurement setup

Most of the measurements were done for:

● Gain 4 mV/fC

● Peaking time 20 ns,

● Threshold 1.128 V (Vref = 1 V, threshold_cfg = 64)

● FEB with Cout = 12 pF (needed for PASTTREC stability),

● The signal of 300 kHz frequency was injected from generator (from 0.1 to 1 V with step 1 mV).
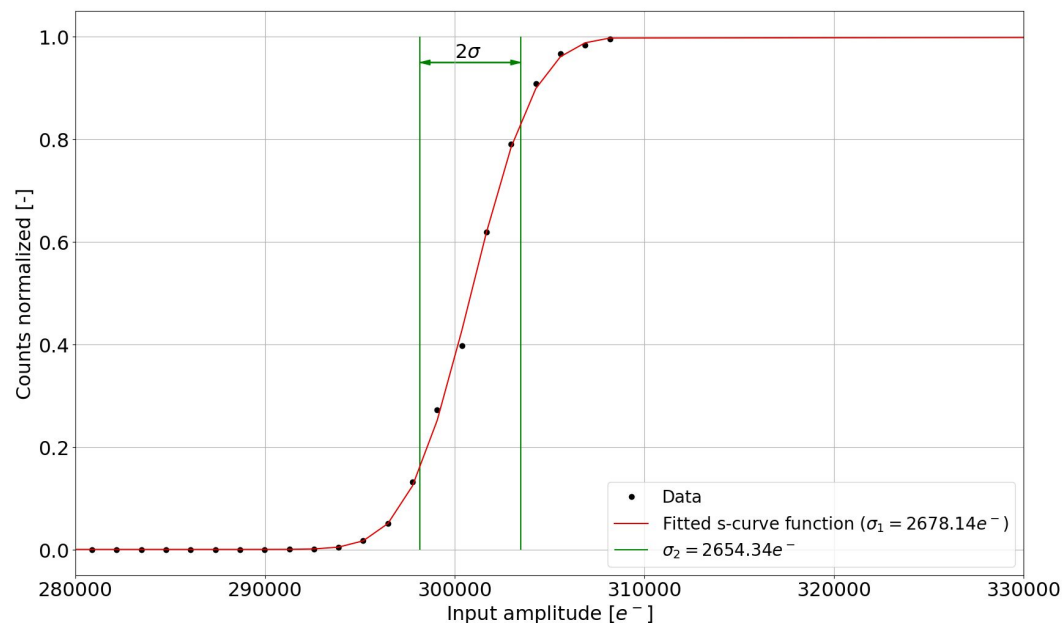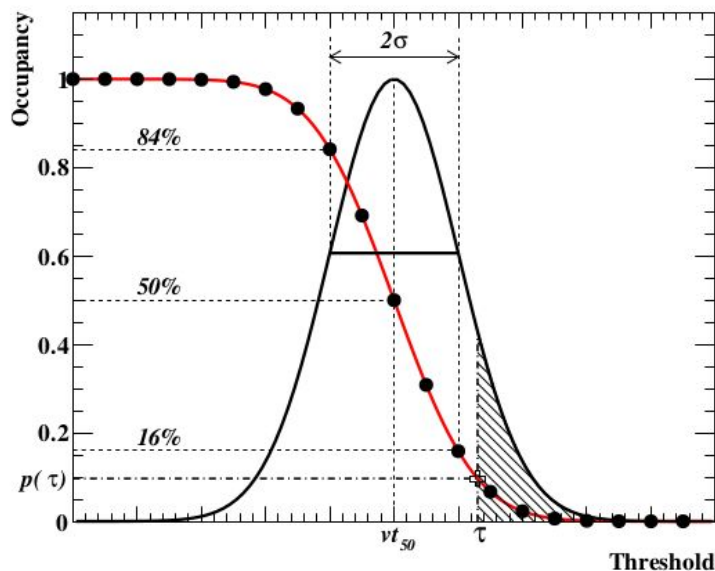
Injection boards:

● Voltage divider (47 + 1 Ω resistors)

● Injection through 10 pF capacitor

● Injection to only one channel.

In case different setting are used, it is shown in description.
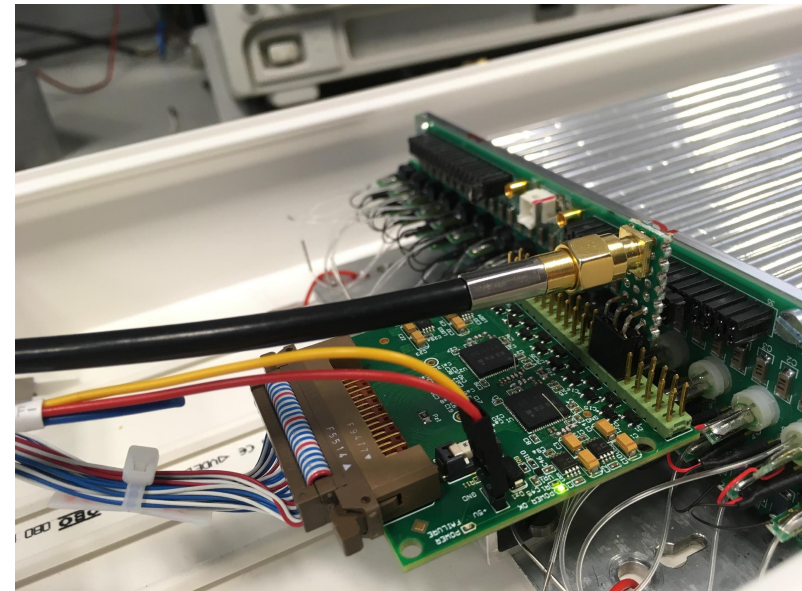
Noise calculations from s-curve

Noise is calculated assuming that number of counts vs signal amplitude (s-curve) behaves as erfc complementary error function.

[1] Gonzalez-Sevilla, S. and others,*Electrical results of double-sided silicon strip modules for the ATLAS Upgrade Strip Tracker*,ATL-UPGRADE-PUB-2012-002, ATL-COM-UPGRADE-2012-008", May 2012

For standard analysis the input amplitude difference between the 84% and 16% is taken as 2σ.
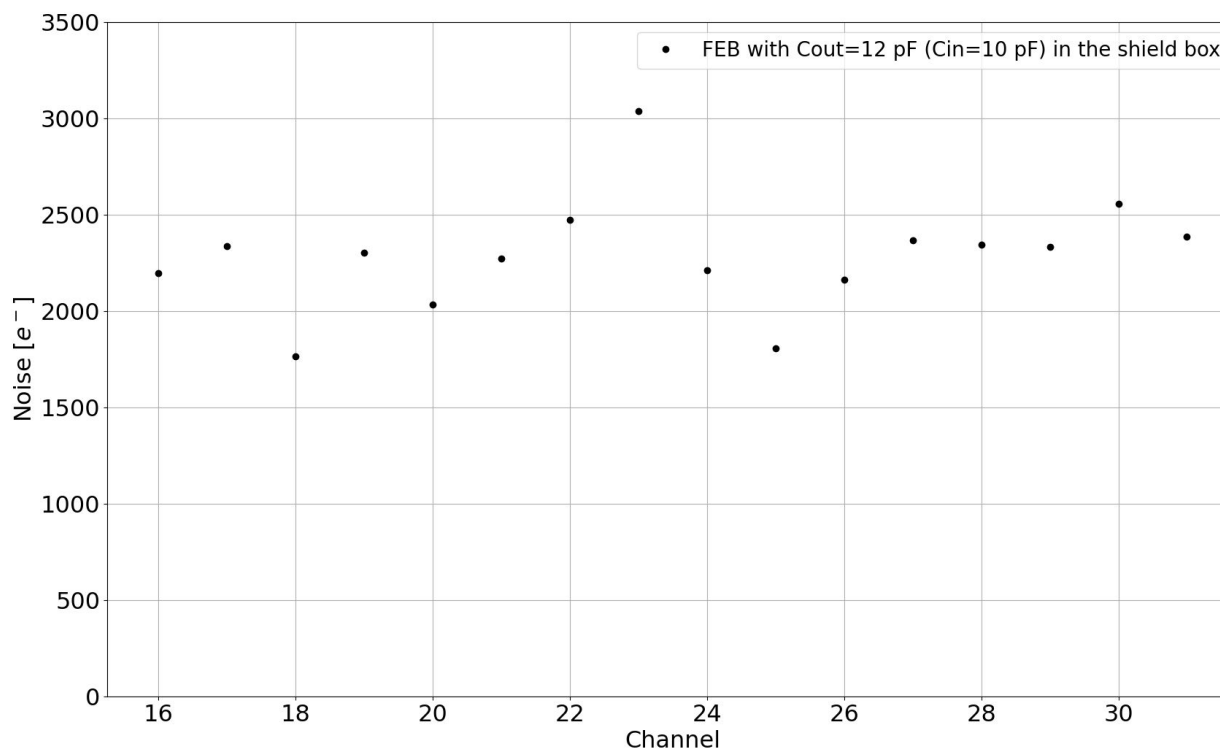
Packed and unpacked ASIC comparison

Comparison of packed and unpacked ASIC was done during first measurements when the setup was not very stable yet.
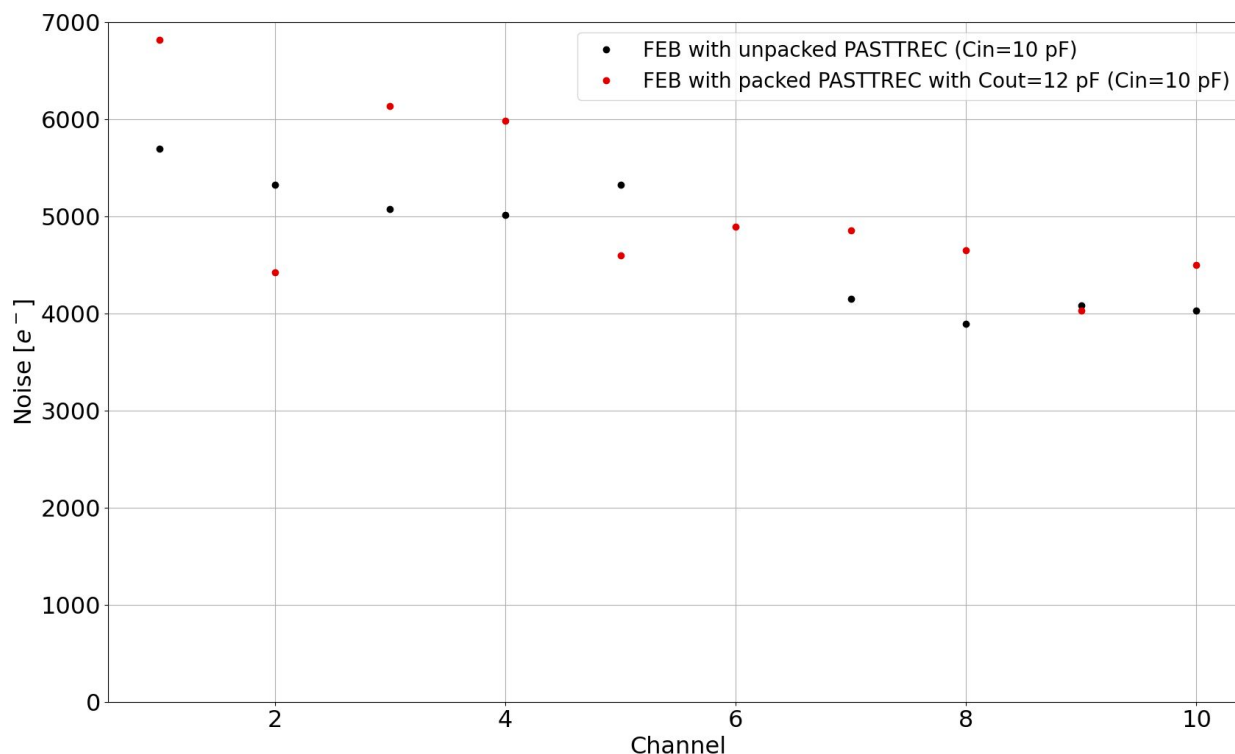
- No significant difference between packed and unpacked ASIC is observed.

FEB in the shield box

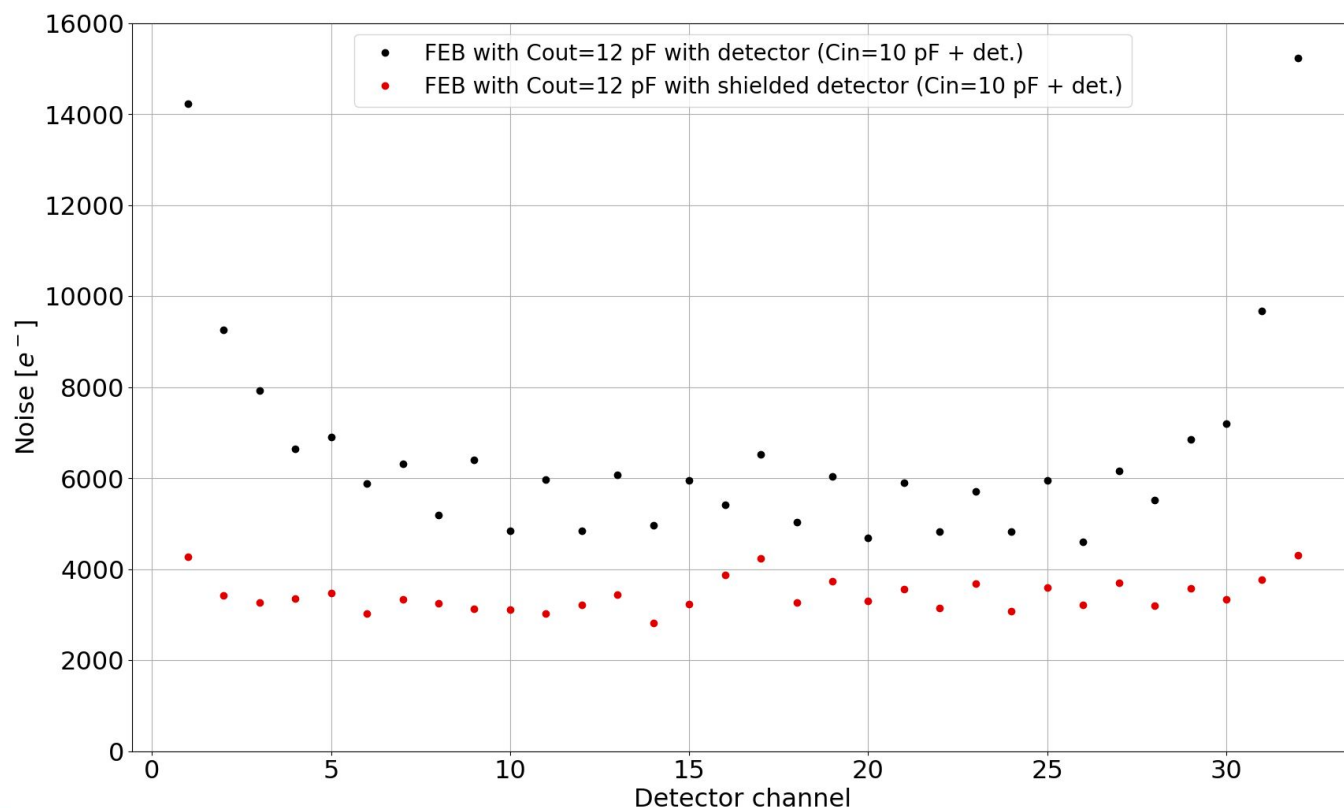First measurements were done for FEB without connected detector in the shield box.

- Noise about 2300 e⁻,

Measurements with detector

Detector without a shield measurement:
- bigger noise for edge channel,
- difference between bottom and top channels (bottom with bigger noise),
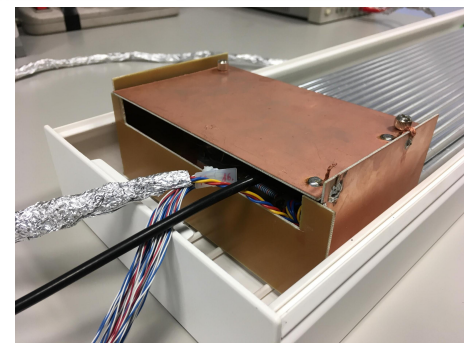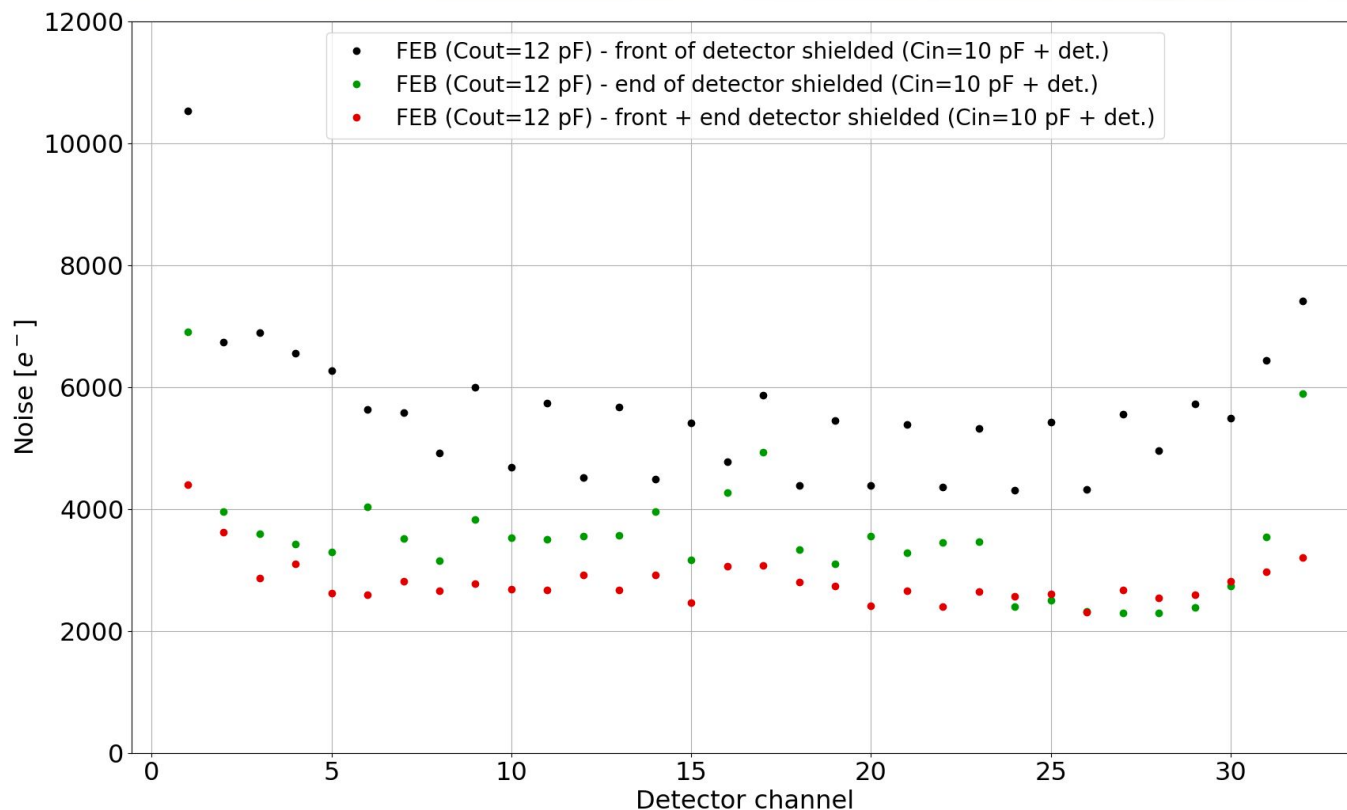- noise about 5700 e$^-$ for middle channels,

Shielded detector measurement:
- slightly bigger noise for edge channels,
- no difference between top and bottom straws,
- noise about 3500 e$^-$

Even channels – bottom straws, odd channels – top straws.

Legend:
- FEB with Cout=12 pF with detector (Cin=10 pF + det.)
- FEB with Cout=12 pF with shielded detector (Cin=10 pF + det.)

Y-axis: Noise [e$^-$]
X-axis: Detector channel

# Measurements with detector + input capacitance
Shielding of detector tests

- Only front shielded: noise about 5500 e^-, still big noise for edge channels and difference between top (odd) and bottom (even) straws (bottom ones have bigger noise),

- Only end shielded: noise about 3500 e^-,

- Both sides shielded: noise about 2600 e^- for middle channels, slightly bigger values for edge channels

- Using conductive glue: more homogeneous channels

Measurements with shielded detector + input capacitance

Both sides of detector shielded, straws with conductive glue. Measurement for different peaking time and output capacitance.
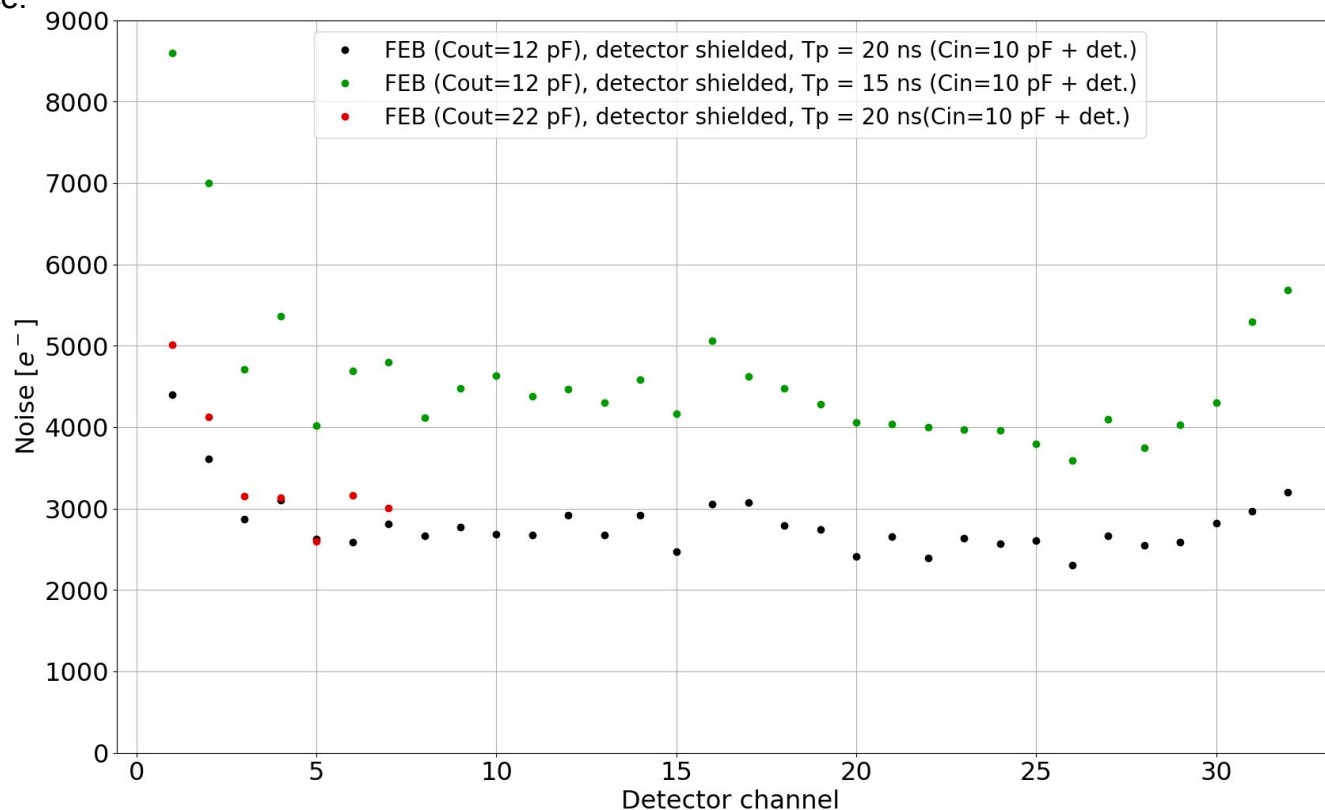
- Noise about 2600 e^- for FEB with Cout=12 pF, bigger values for edge channels,
- Bigger noise for 15 ns peaking time about 4200 e^- (about 1600 e^- bigger)
- Slightly bigger noise for some channels for FEB with Cout=22 pF.

Conclusions

Summary:

- The best results of noise level when both sides of detector are shielded (about 2600 e$^-$) - develop of the shield part,
- Larger noise with 15 ns peaking time but still on the reasonable level.

Future measurement plans:

- Optimization of the baseline setup,
- Homogeneity of channels.