Test for noise optimization with TIGER

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Activity outline

Tests have been performed in Ferrara to **find a configuration which reduces the noise of TIGER ASIC**.

We tested:

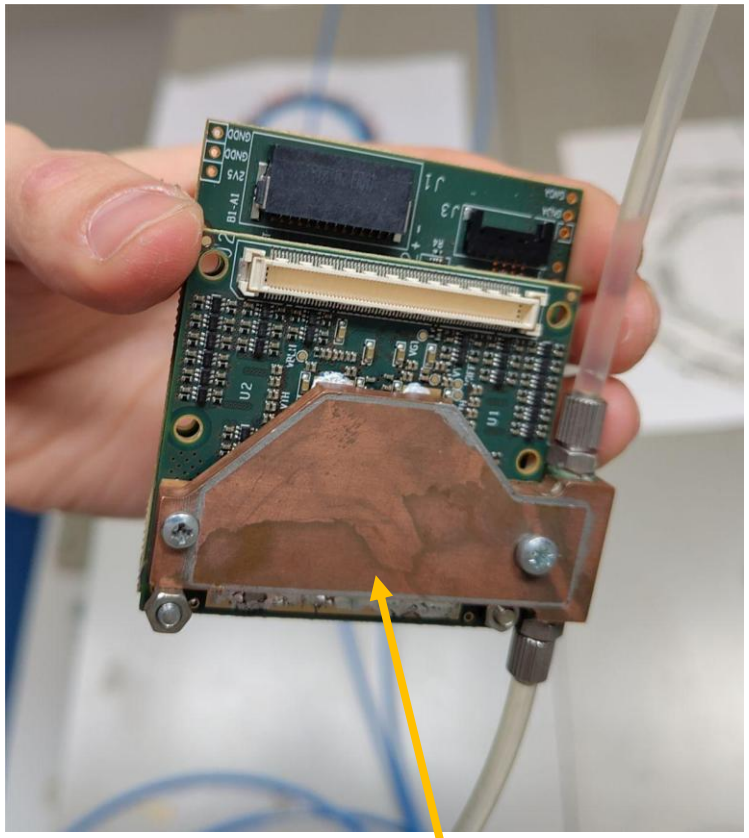
- FEB alone
- FEB connected to the 5x40cm^2 μRwell (0.4 mm pitch)

In both cases we tried **different grounding and shielding configurations**.

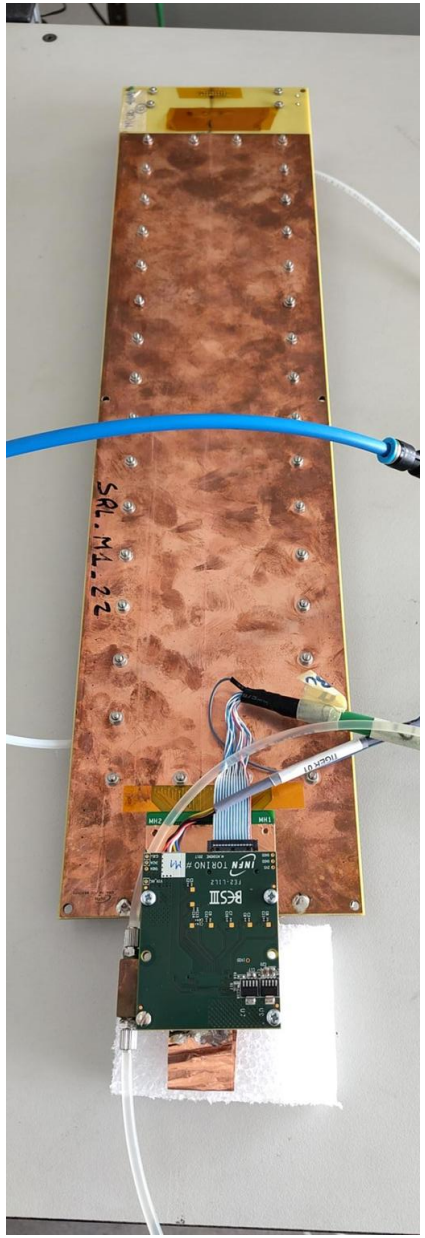
The noise was investigated with **noise scan** and **acquisition in random trigger**.

The setup

- μRwell with 0.4 mm pitch
- TIGER FEB
- FEB cooling system
- DLVPC
- 1 GEMROC module
- fanout module
- SY5527LC mainframe
- Dual Timer NIM module



Heat exchanger



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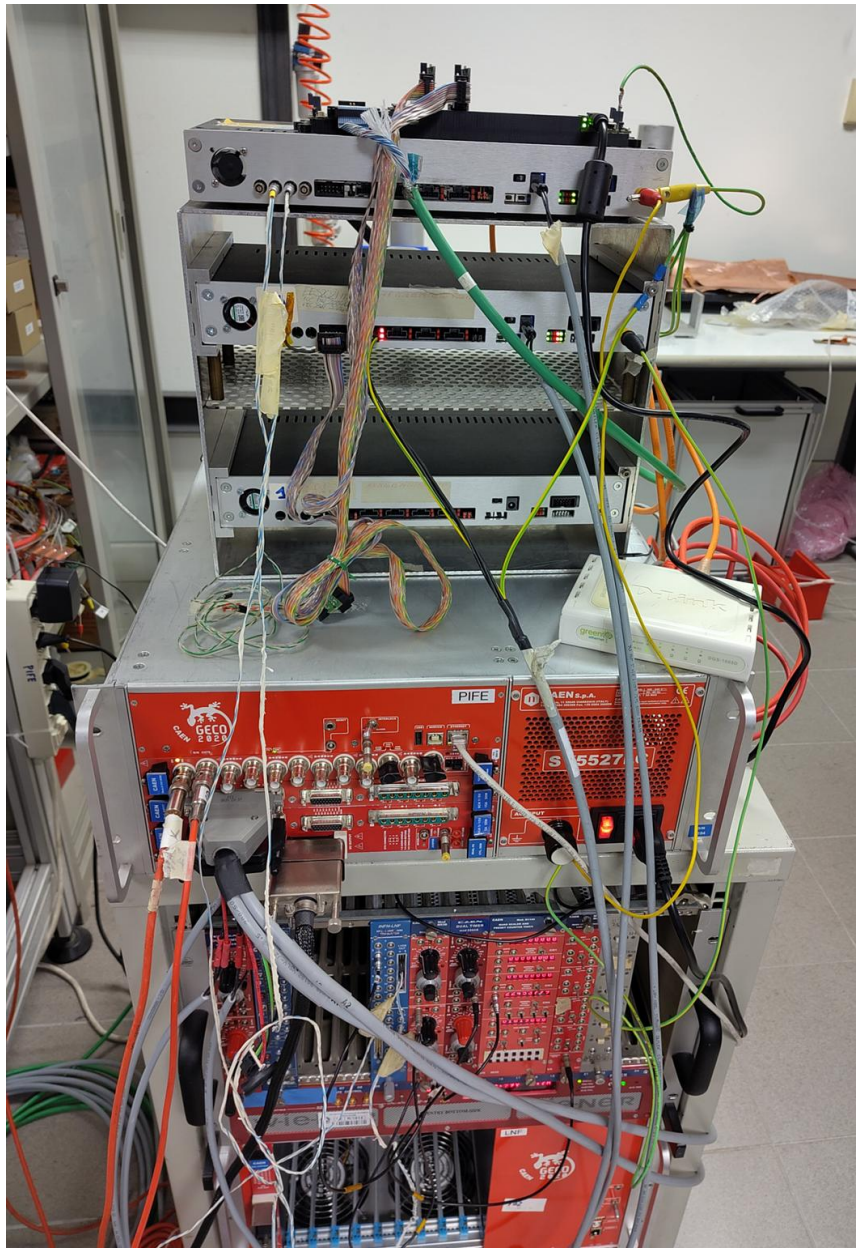

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Noise Scan

To measure the noise amplitude:

- one test pulse at a time is sent to each TIGER channel.
- While the test pulse is sent at a fixed rate, the threshold is swept across all possible DAC values.
- Standard deviation of the noise distribution estimated by fitting the threshold scan data with an error function

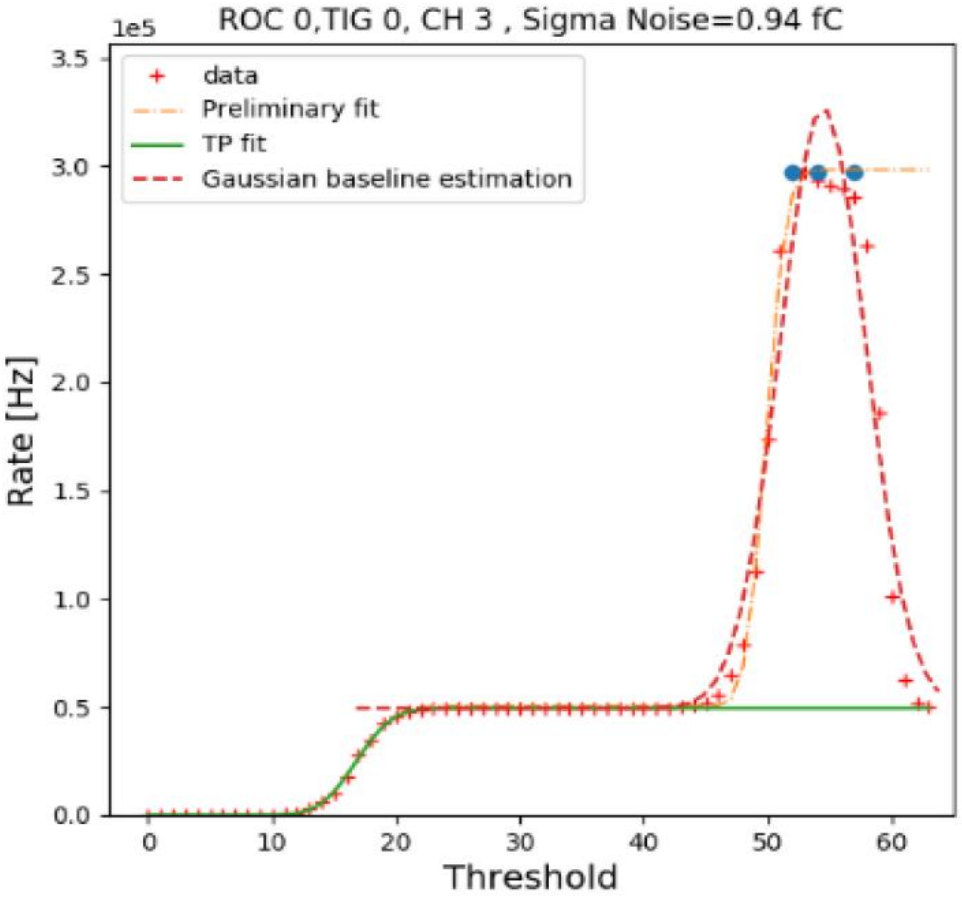
threshold in digits

test pulse amplitude

$$\eta(T) = \left[erf\left(\frac{T-\mu}{\sqrt{2}\sigma}\right) + \frac{1}{2} \right]$$

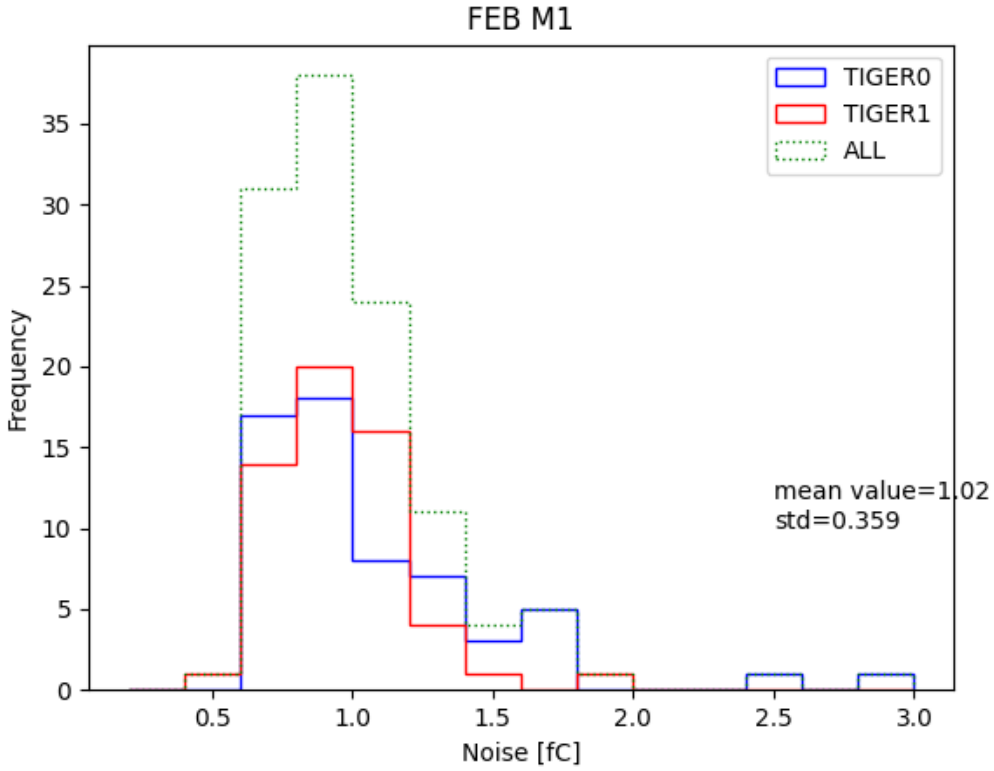
$\frac{\text{Rate detected}}{\text{Rate injected}}$

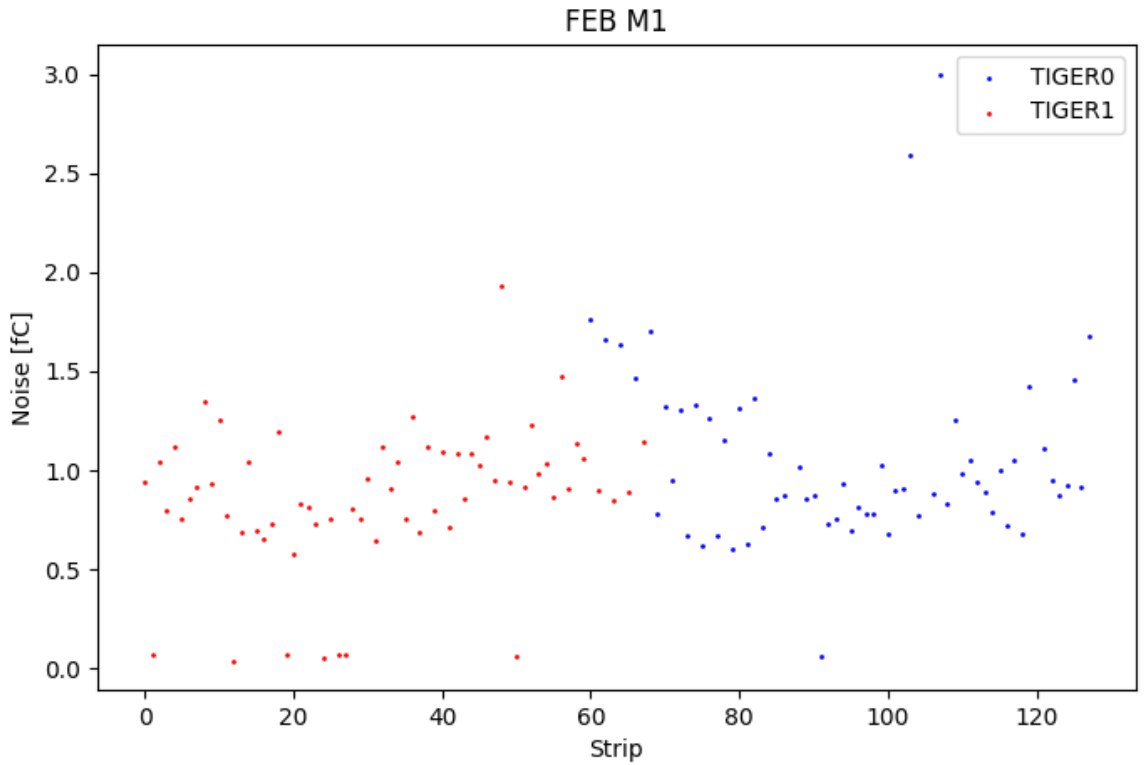
noise standard deviation



Noise Scan

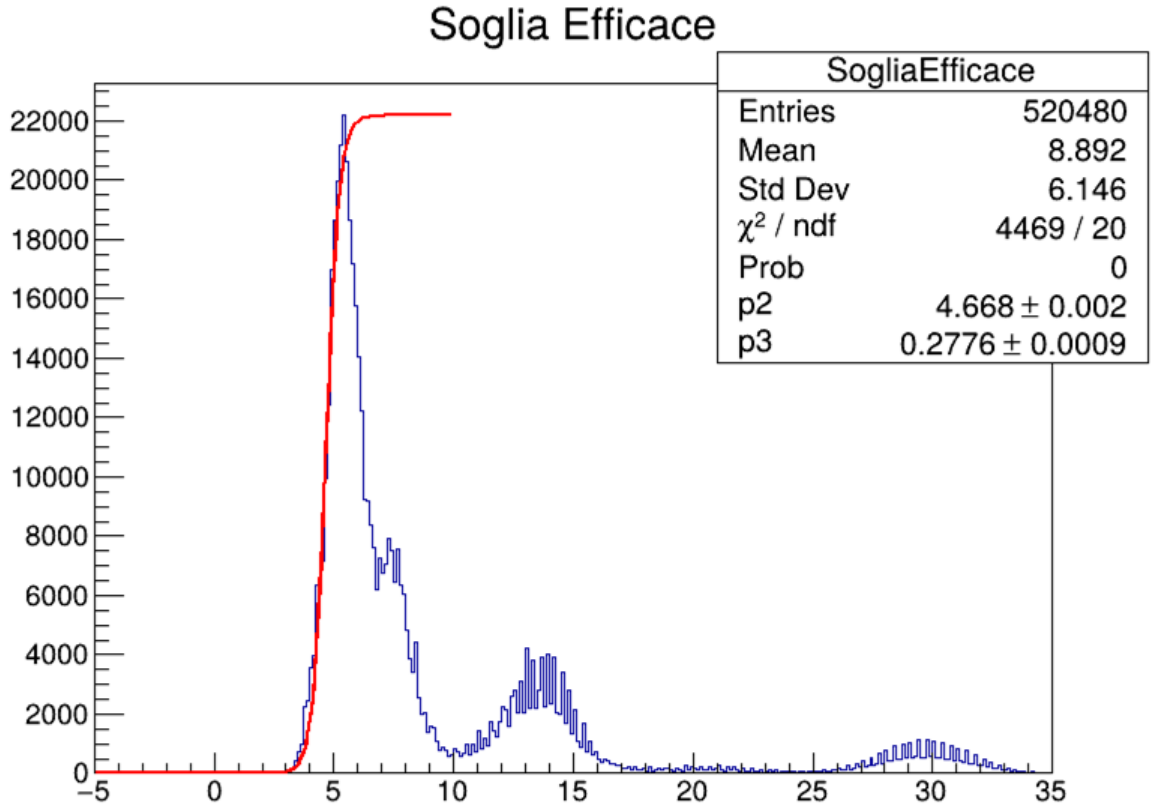
For each configuration we looked at the noise distribution of the FEB, extracting mean value and standard deviation.





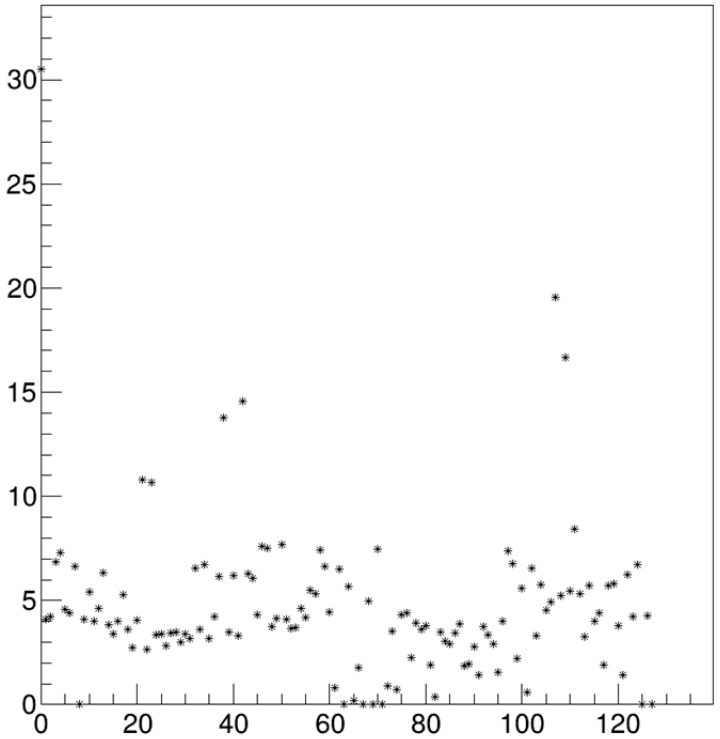
Acquisition with random trigger

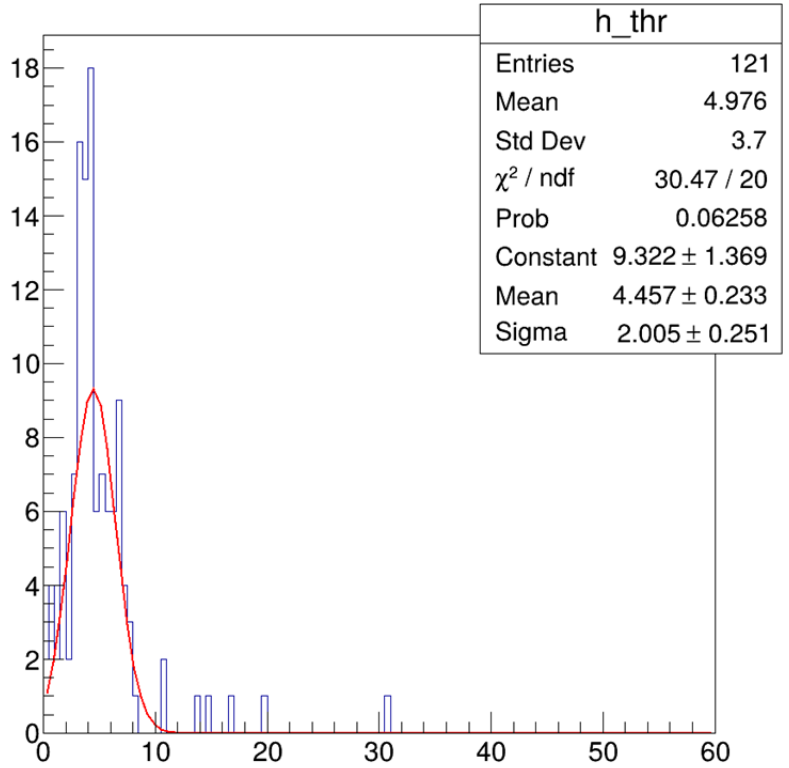
- Acquisition with an **external random trigger** provided by a Dual Timer
- Charge distribution of **single channels** fitted with *erf* to **find effective thresholds**



Acquisition with random trigger

- Acquisition with an **external random trigger** provided by a Dual Timer
- Charge distribution of **single channels** fitted with *erf* to **find effective thresholds**
- FEB noise evaluated **fitting the distribution of effective thresholds with a Gaussian**
- Mean value and standard deviation extracted from the fit





A significant discrepancy

During the tests, **discrepancies** were found **between the results of noise scan and acquisitions in random trigger**:

1. Noise scan results are always ~8 times **smaller** than that of acquisitions.
2. The two measurements can show conflicting behaviours

To solve this problem, Alberto Bortone suggested to **reduce the step of the threshold scale.**

→ Solution not yet tested

Noise studies - FEB alone

We started studying the noise a single **FEB not connected** to the detector.

Noise scan: 0.3 ± 0.3
Acquisition: 2.5. ± 0.6

Different grounding configurations tested:

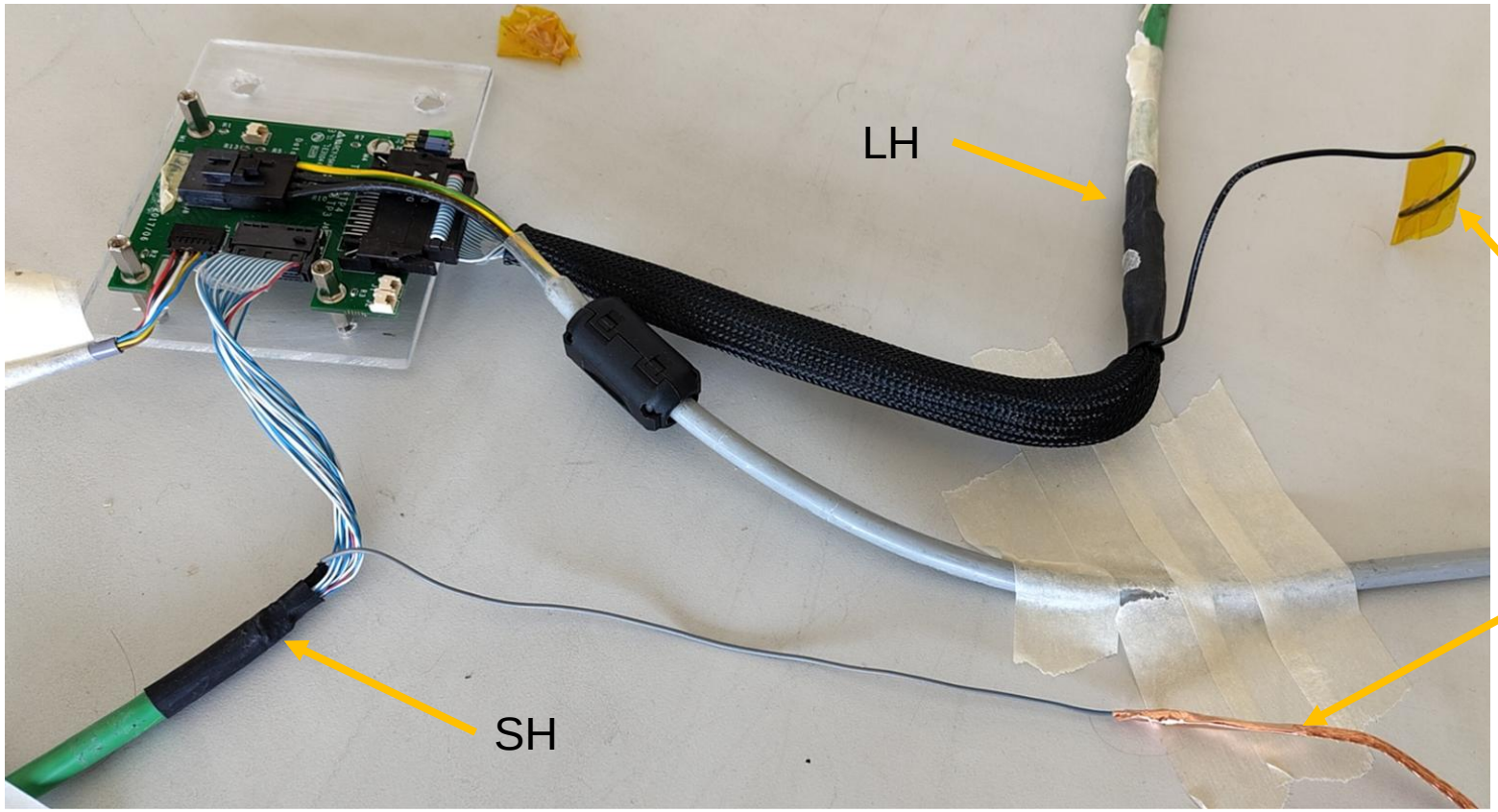
- shield of Long Haul (LH) and Short Haul (SH)
- AGND, DGND and GND of the chassis
- Faraday cage (FC) around FEB
- FC around DLVPC

Noise studies - FEB alone

variation wrt previous configuration

- shield of Long Haul (LH) and Short Haul (SH)

Noise scan: 0.3 ± 0.3 =
Acquisition: 2.5 ± 0.6 =



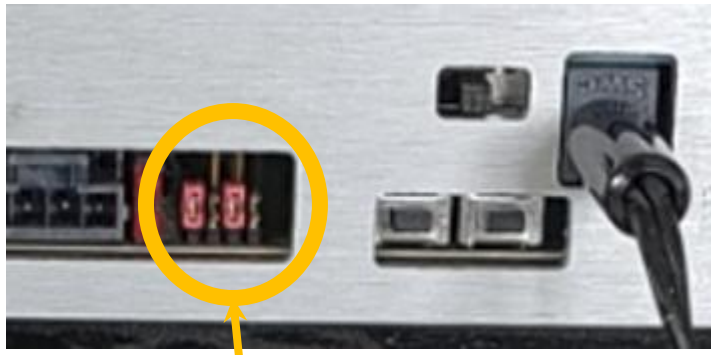
cable shield connected only at one end

SH ground connection to mainframe (main ground)

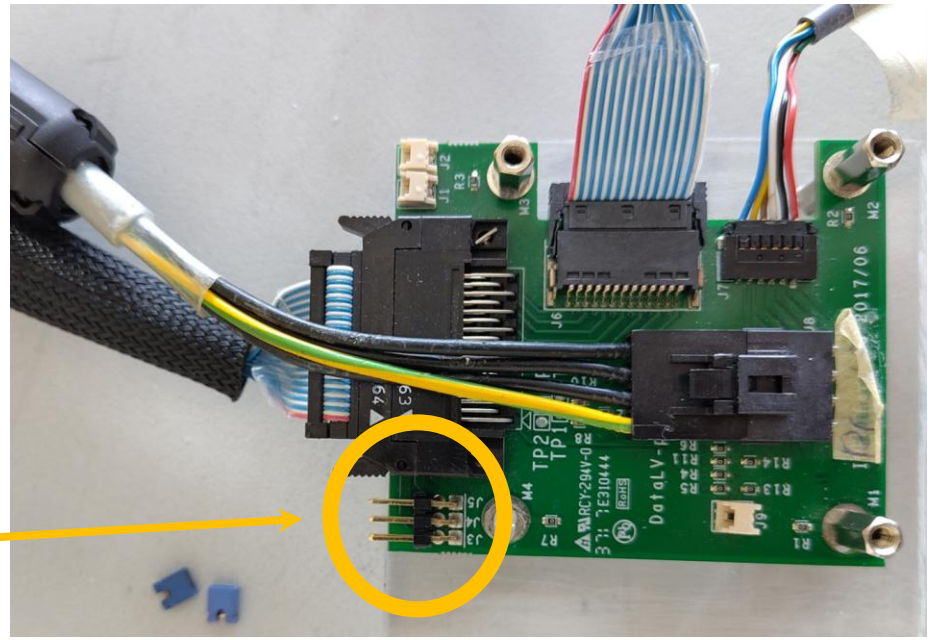
Noise studies - FEB alone

- AGND, DGND and GND of the chassis. Jumpers allow to short-circuit all of them, or a chosen combination

Noise scan: 0.3 ± 0.3 =
Acquisition: 2.9 ± 0.6 ↑



Jumpers to short-circuit different GNDs



Noise studies - FEB alone

- FC around DLVPC

Noise scan: 0.3 ± 0.3 =
Acquisition: 2.9 ± 0.5 =

- Faraday cage (FC) around FEB + DLVPC

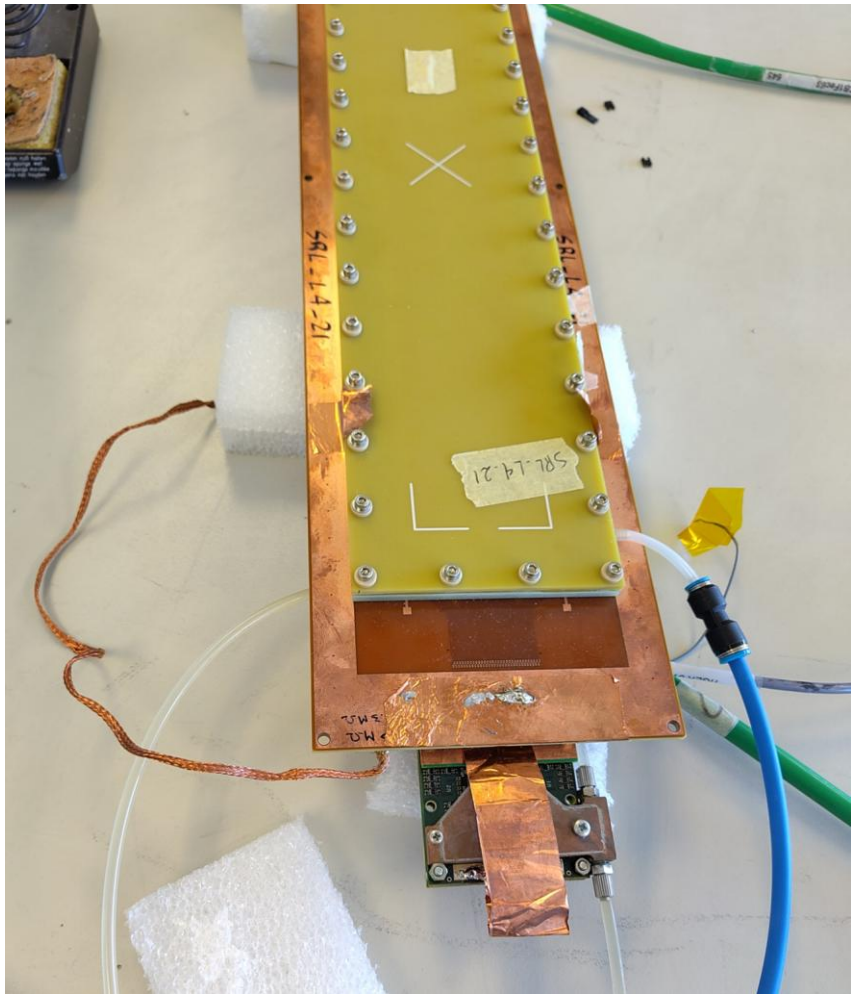
Noise scan: 0.3 ± 0.3 =
Acquisition: 3.3 ± 0.5 ↑

Noise studies - FEB & μRwell

We connected the FEB to the μRwell.

- No FC around FEB or DLVPC
- Shield of LH and SH connected to main ground

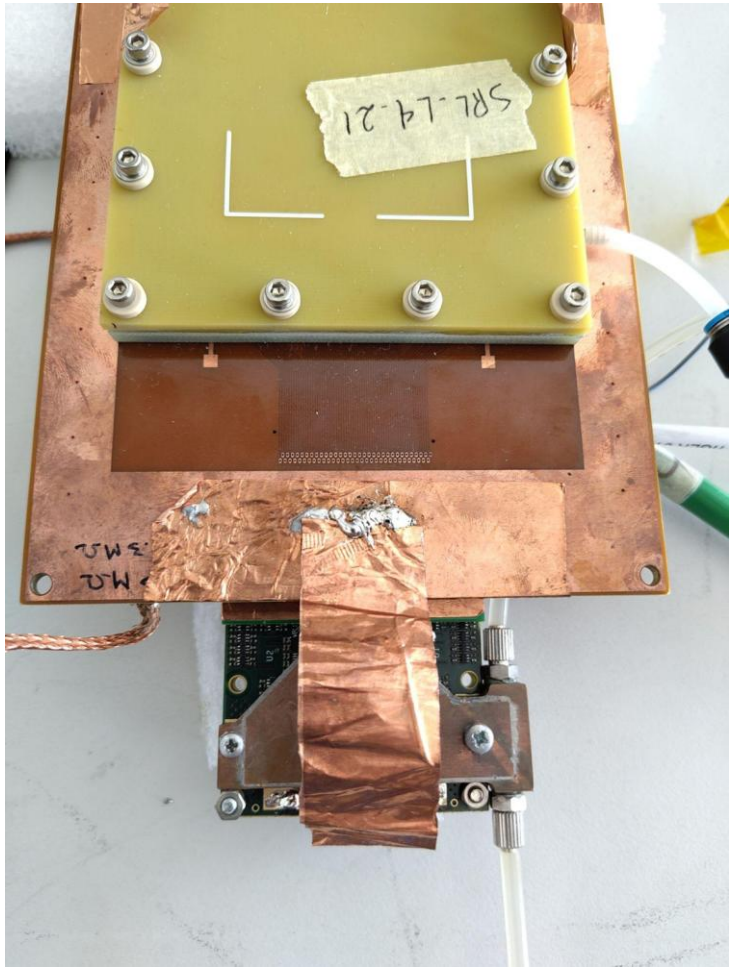
Starting from this configuration, different setups were studied.



Noise studies - FEB & μRwell

Setups under study :

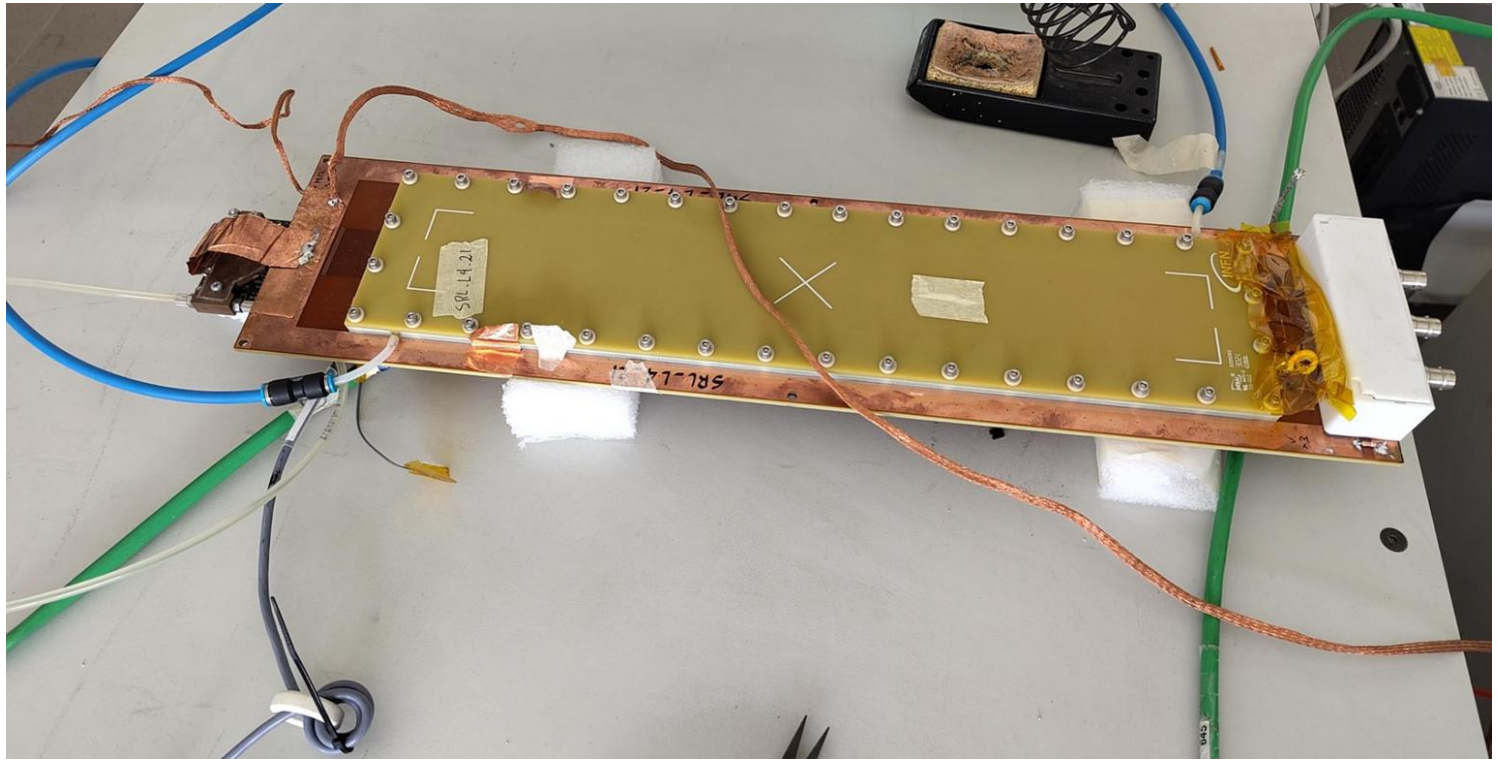
- μRwell with SHV cables **not connected**
- SHV cables **connected**, HV **off**
- SHV cables **connected**, HV **on**
- μRwell **ground plane short-circuited** with **HV return**
- **DLC short-circuited** with μRwell **ground plane**
- **FC** around μRwell
- **UPS**



Noise studies - FEB & μRwell

- μRwell with SHV cables **not connected**

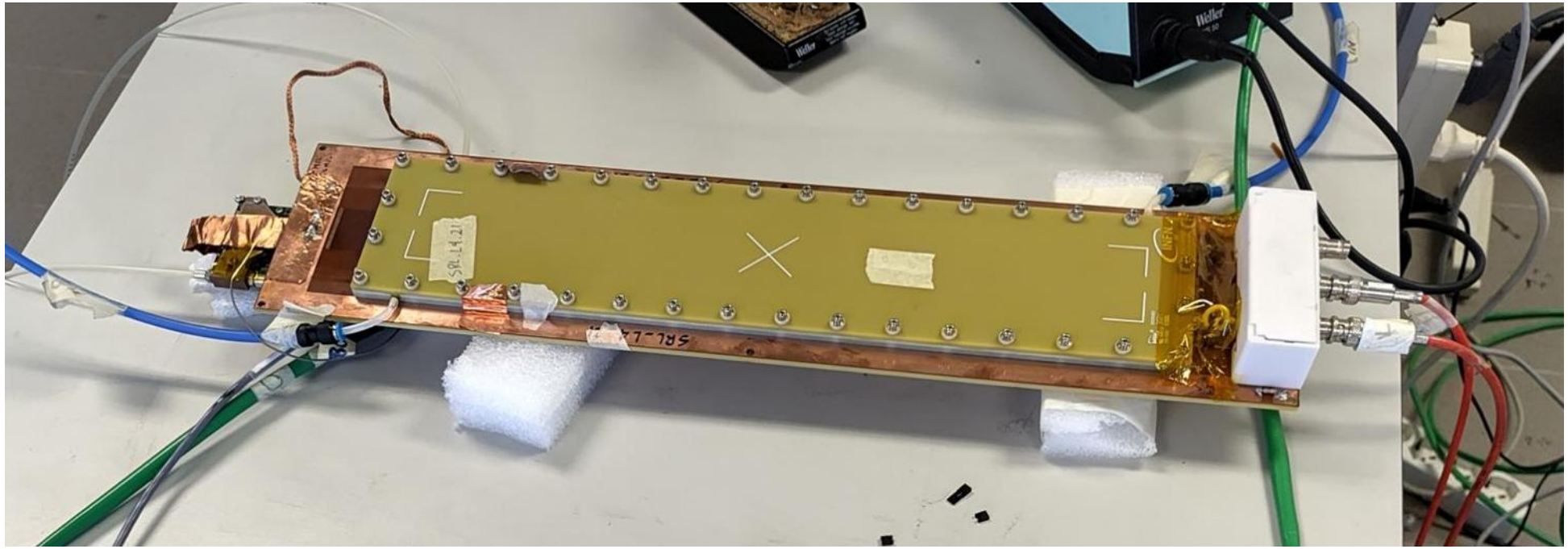
Noise scan: 0.9 ± 0.4
Acquisition: 4.6 ± 0.6



Noise studies - FEB & μRwell

- SHV cables **connected**, HV **off**

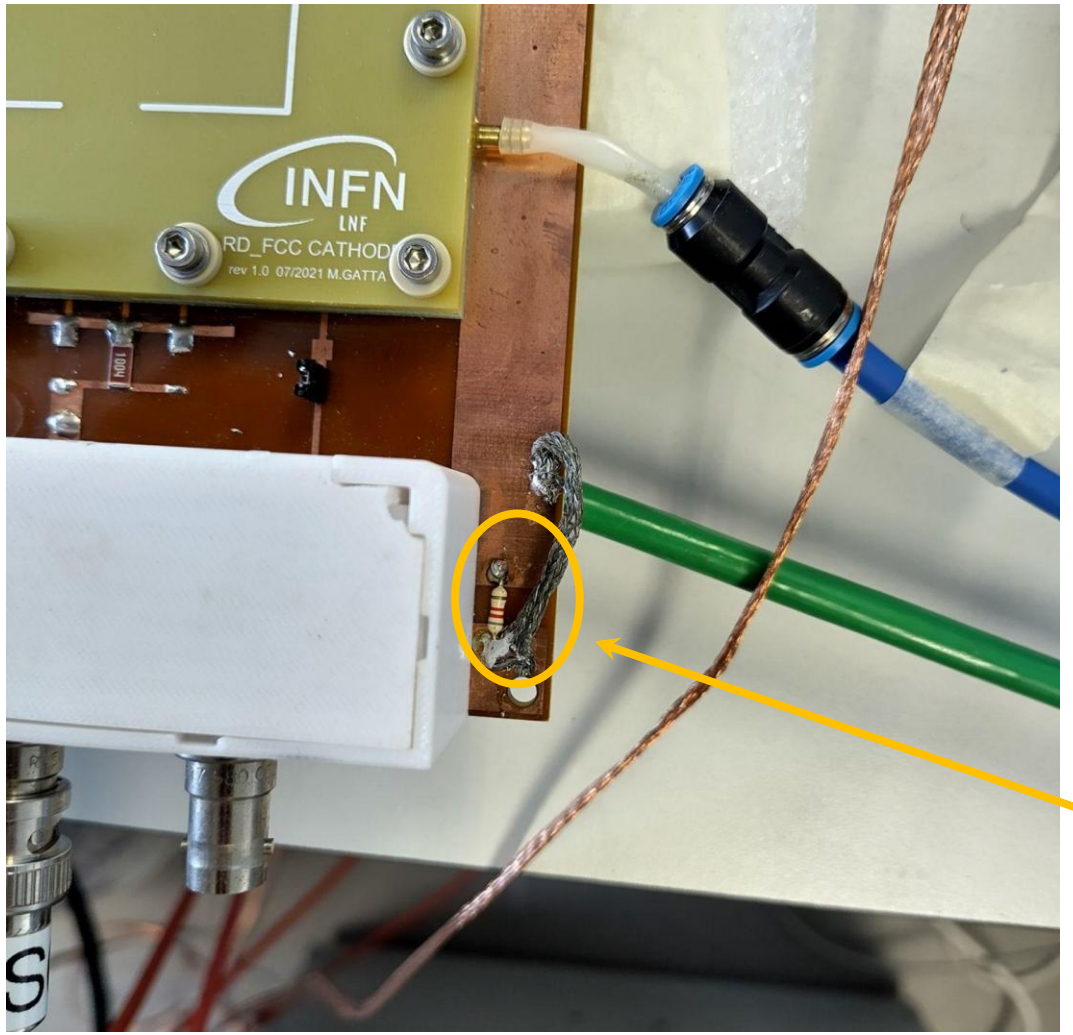
Noise scan: 1.1 ± 0.5 ↑
Acquisition: 5.2 ± 0.6 ↑



Noise studies - FEB & μRwell

- μRwell **ground plane short-circuited** with **HV return**

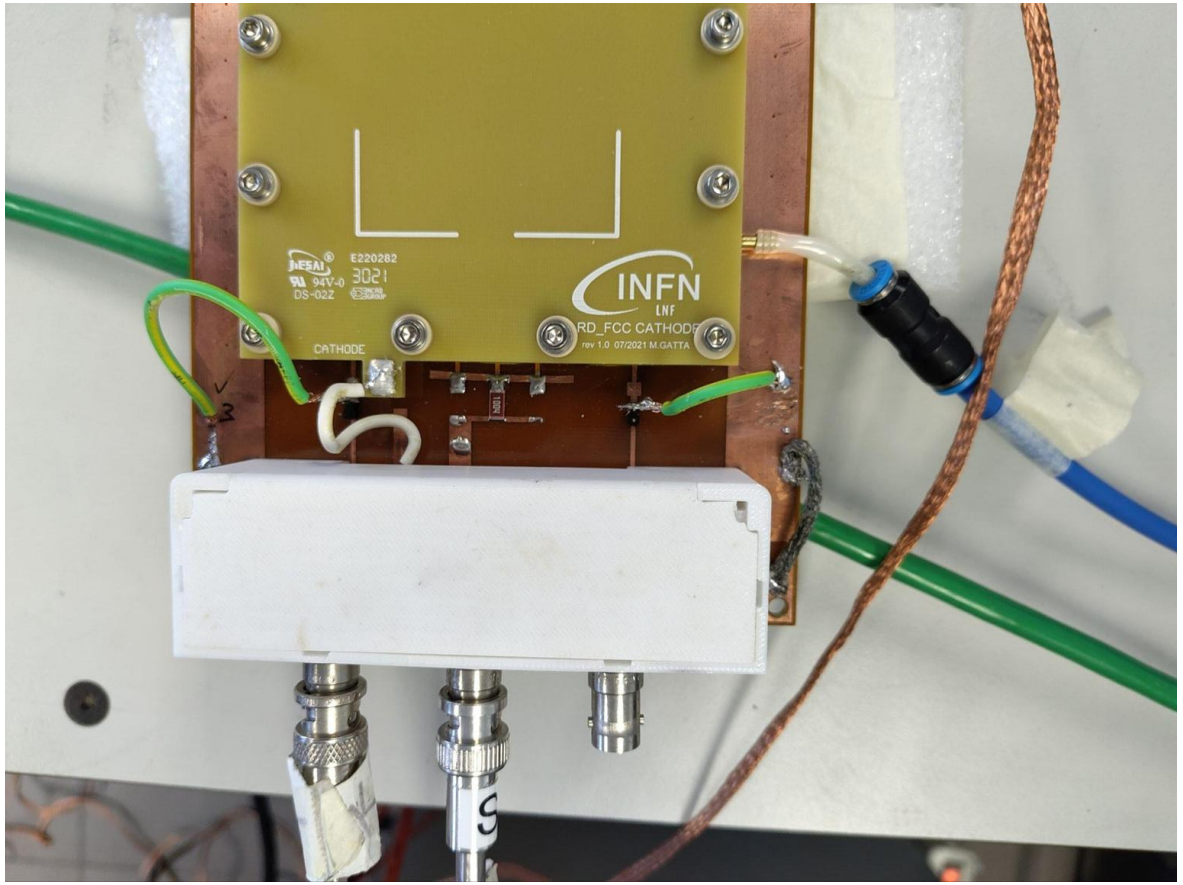
Noise scan: 1.1 ± 0.5 ↑
Acquisition: 4.7 ± 0.6 ↓



Bypassed 10MOhm resistance

Noise studies - FEB & μRwell

- **DLC short-circuited** with μRwell **ground plane**

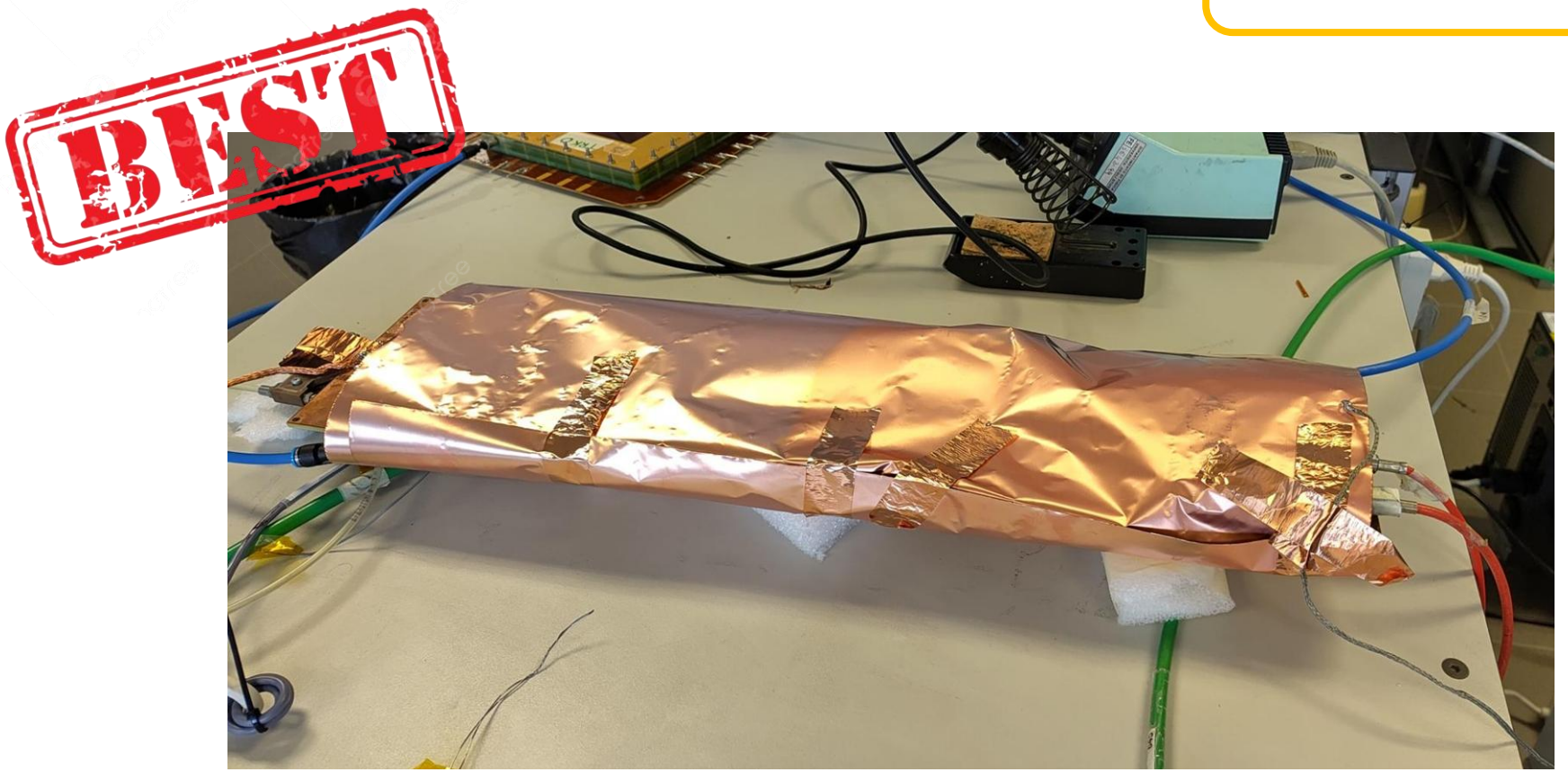


Noise scan: 1.1 ± 0.5 =
Acquisition: 4.9 ± 0.7 ↑

Noise studies - FEB & μRwell

- **FC** around μRwell

Noise scan: 0.9 ± 0.4 ↓
Acquisition: 5.1 ± 0.6 ↑



Noise studies - FEB & μRwell

- **FC** around μRwell
- HV **on**

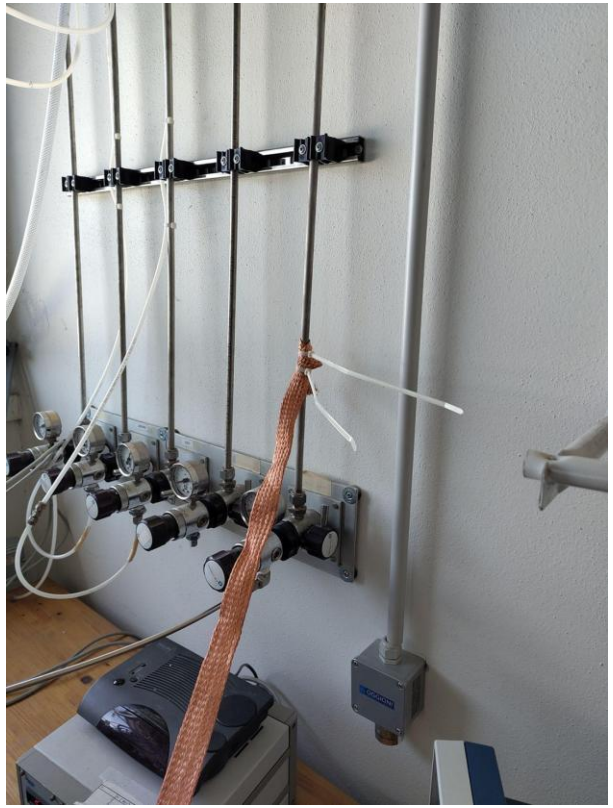
Noise scan: 1.0 ± 0.4 ↑
Acquisition: 5.2 ± 0.6 ↑

Noise studies - FEB & μRwell

- **UPS,** with the whole setup (the mainframe too) **kept floating** and connected to the ground of the building

Noise scan: 0.9 ± 0.4 ↓
Acquisition: 6.9 ± 1.8 ↑

This configuration should be investigated with a better ground



What did we learn?

- FC around DLVPC has no relevant effect
- FC around FEB increases noise
- Jumpers do not have any relevant effect
- UPS is not useful

- A better shielding of the cables reduces significantly the noise
- μRwell ground plane and HV return should be separated
- FC around μRwell helps to reduce the noise

Further tests are needed, to find a **reproducible configuration** which minimises the noise.

Thank You

Useful links

Logbook pt.1

Logbook pt.2