TOB system test - status report

Reminder on the TOB electronics architecture

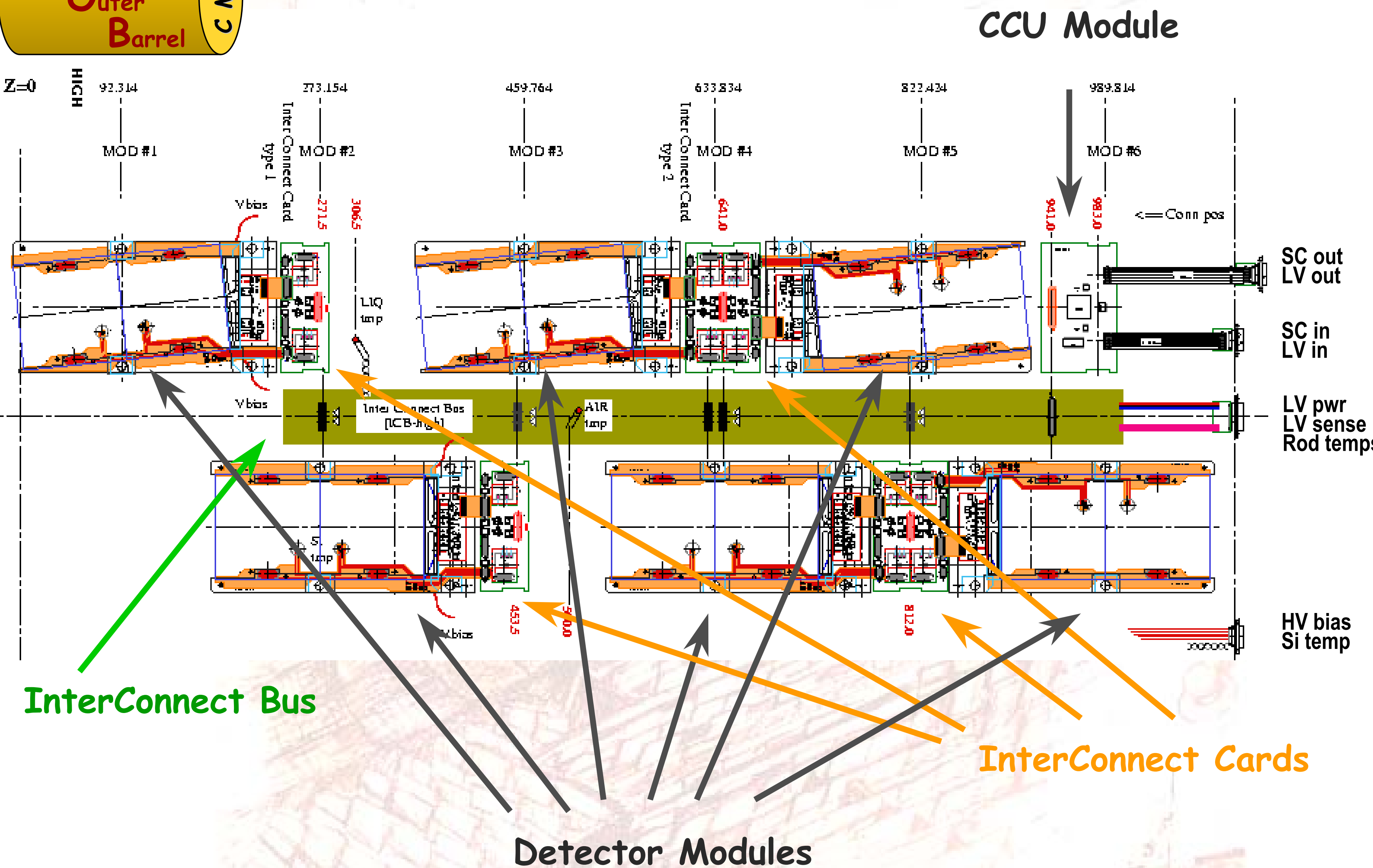
Test of the first SS rod prototype

⇒ Results

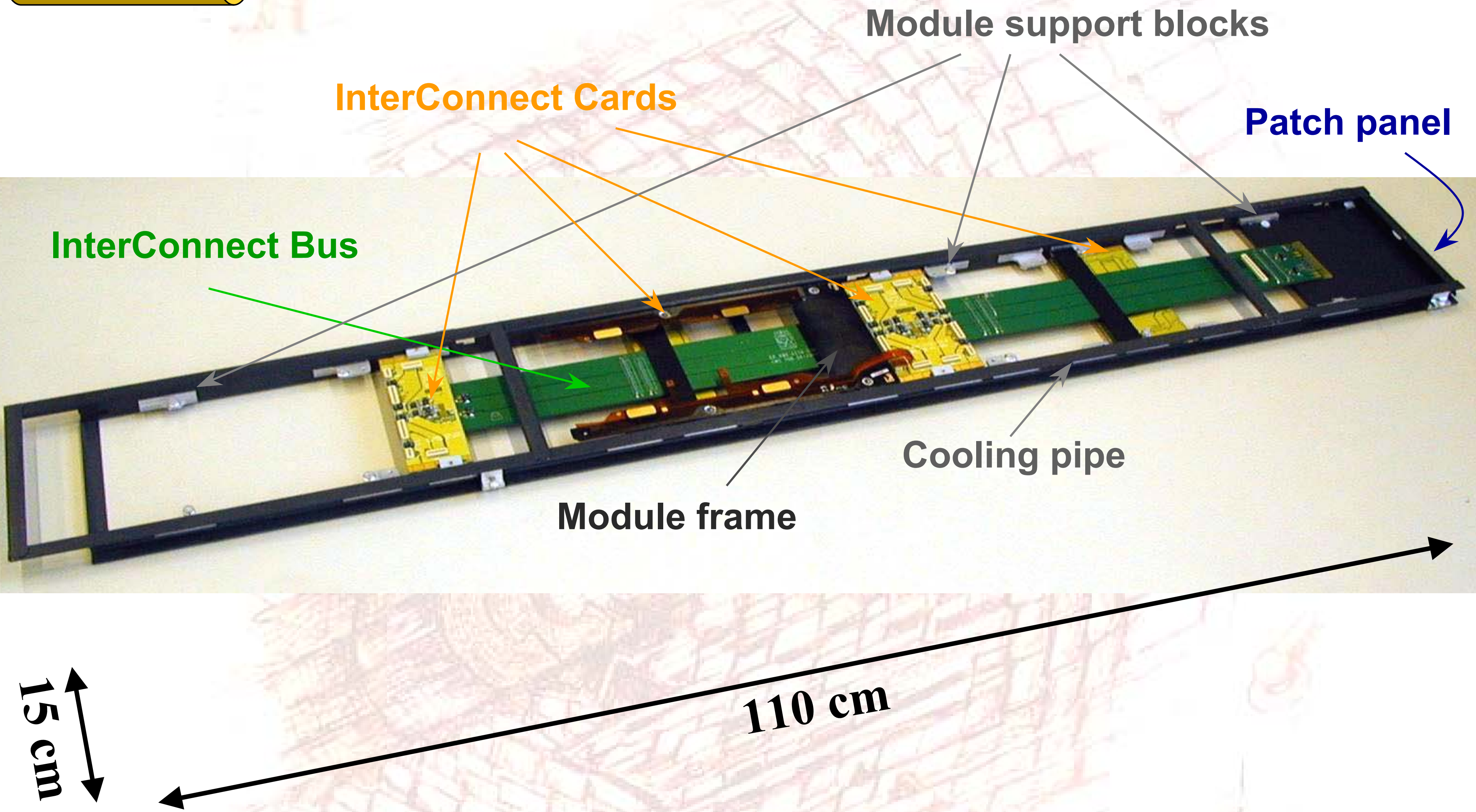
Further steps

Tracker Outer Barrel CMS

The rod



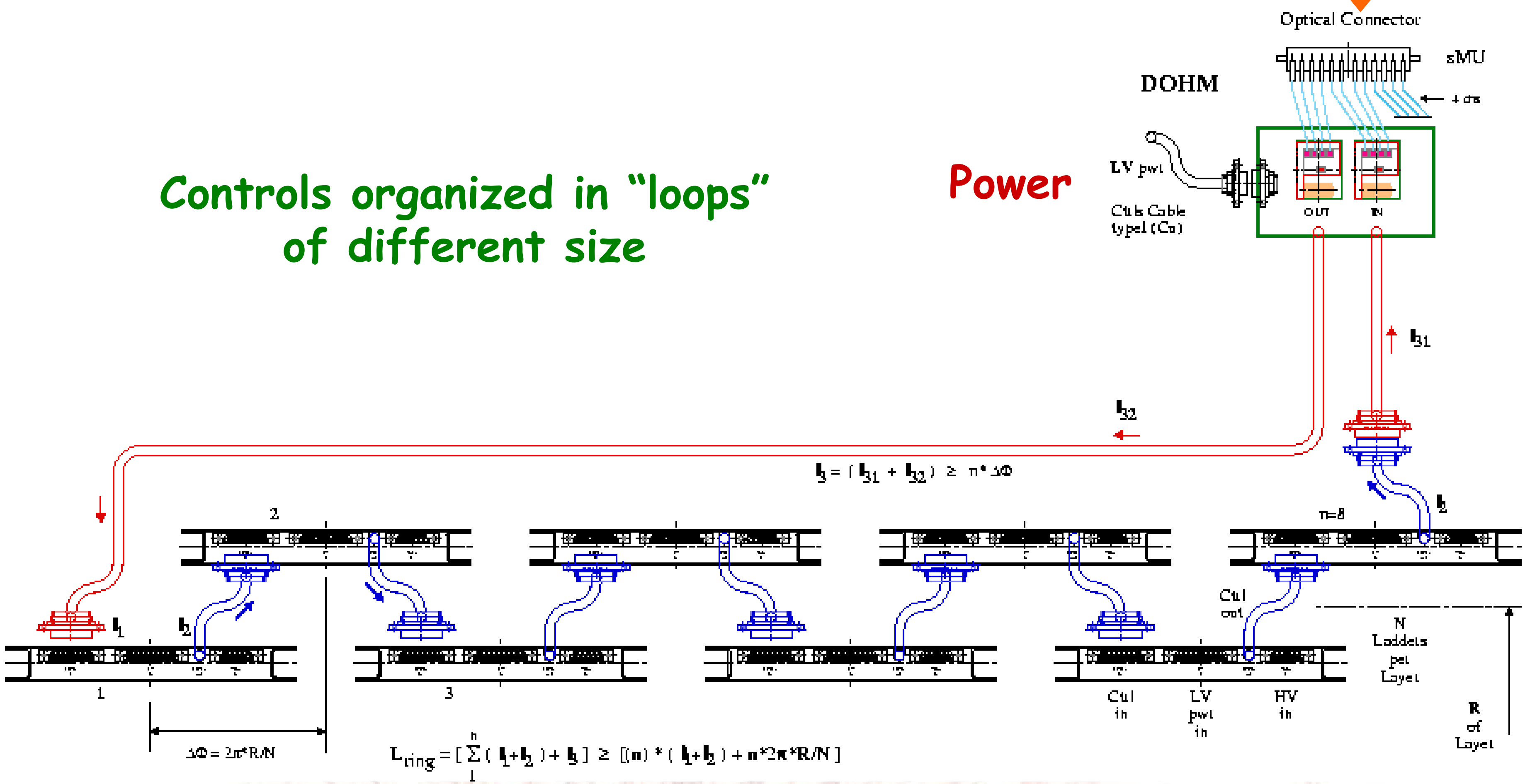
The rod components



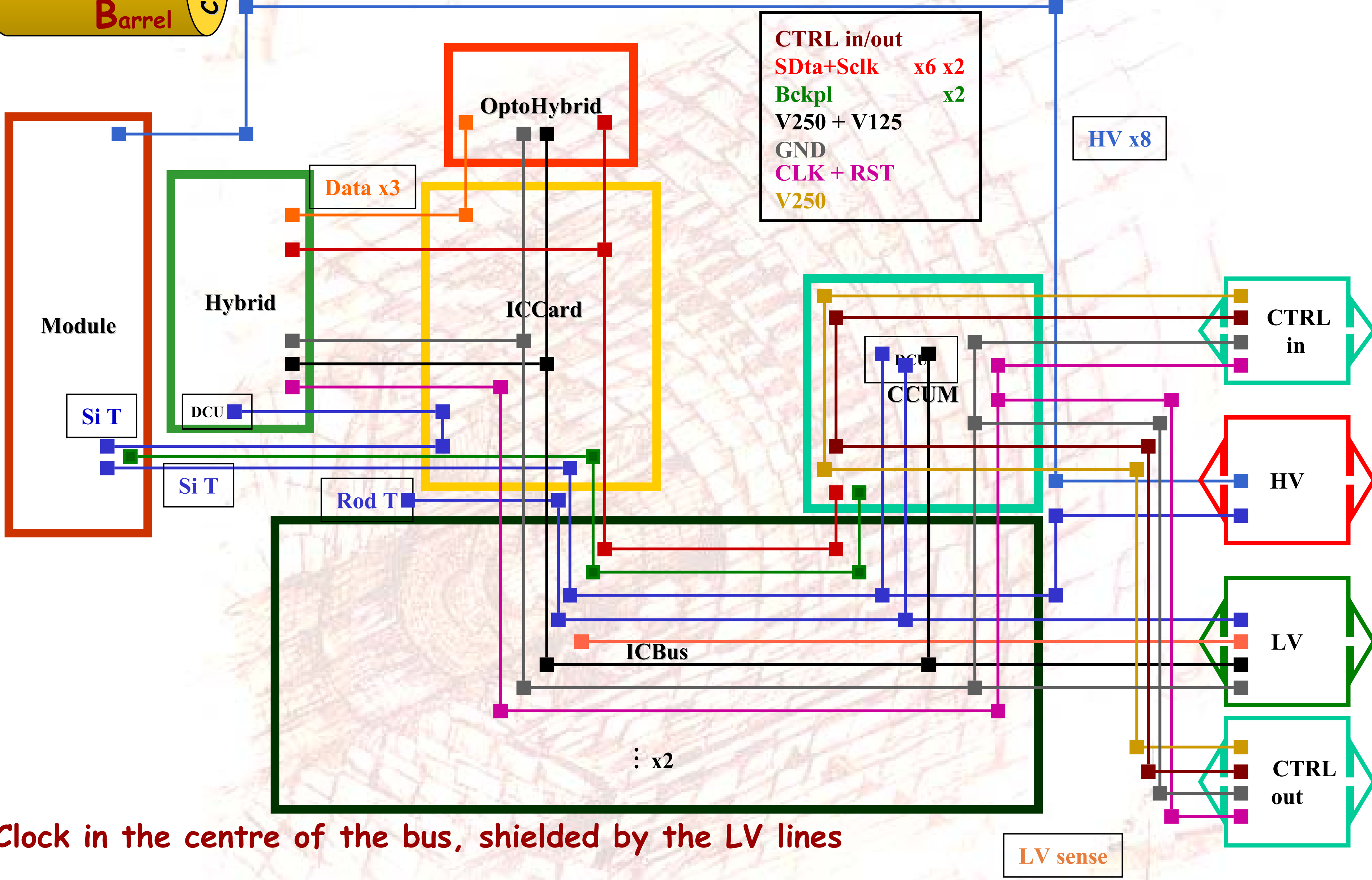
All components "final" except for the CCUM

Fibres from FEC

Controls organized in “loops” of different size

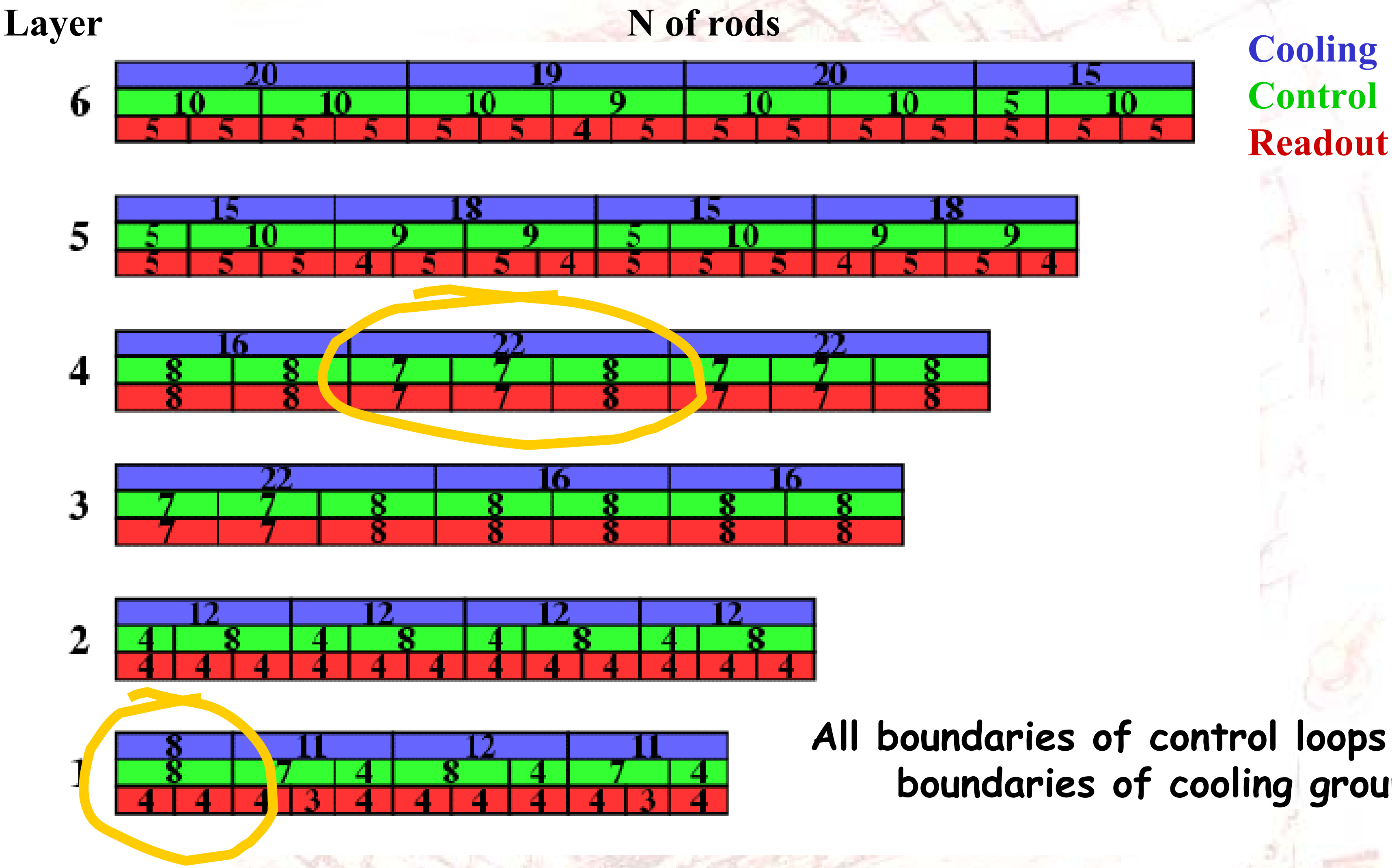


Scheme of the ROD electronics

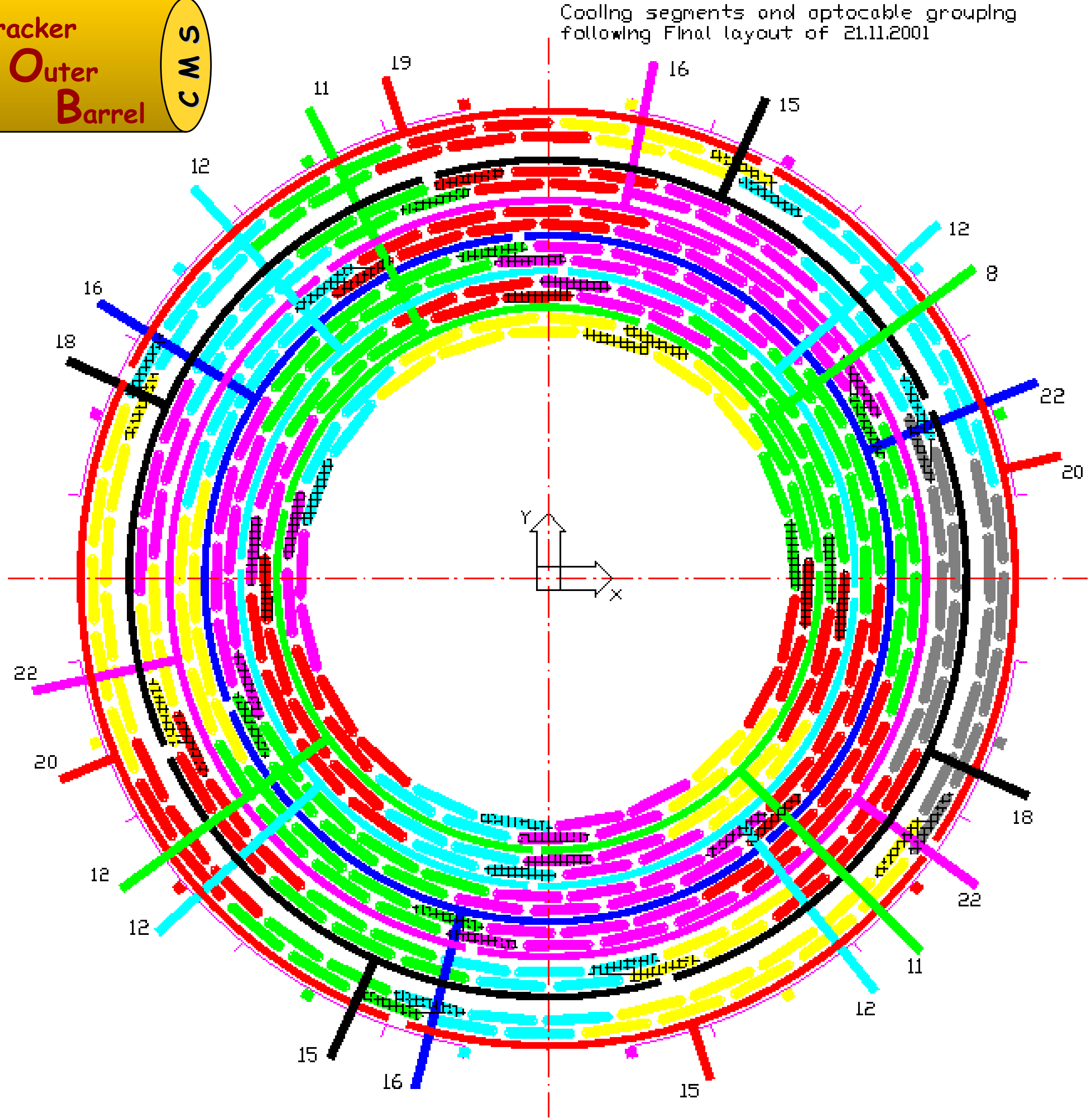


Clock in the centre of the bus, shielded by the LV lines

Cooling, control and readout grouping



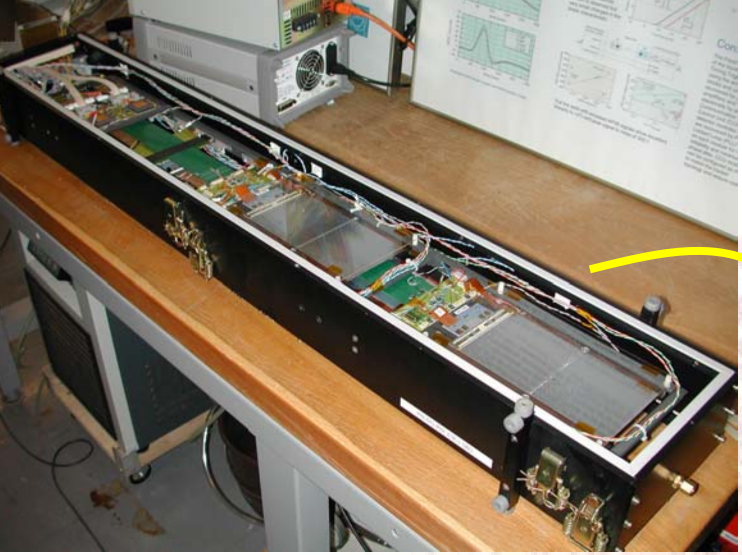
All boundaries of control loops match boundaries of cooling groups



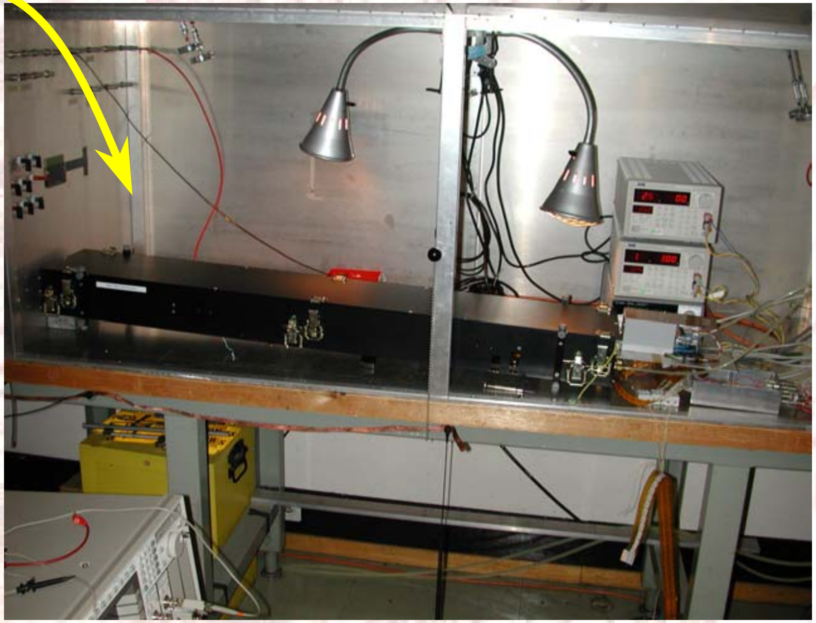
Manifolds will be used to put to ground each control loop

↓

Electrical ground ≡ Mechanical ground



Alu box, gas tight, with patch panel for cables, fibres and pipes (cooling and dry air)
(It can house 2 rods)



C_6F_{14}
Cooling plant

External temperature and humidity probes

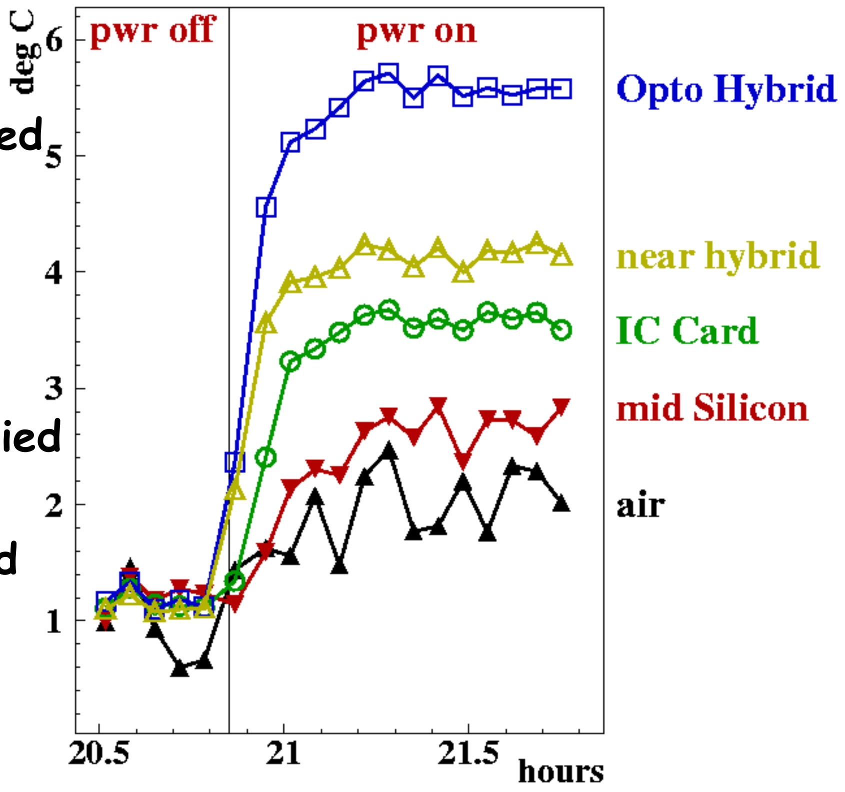
Modules, optohybrids*, CCUM*, high voltage

DAQ PC with 1 TSC, 1 FEC** and 3 FED cards, XDAQ Software, Monitoring.

(*) not yet the final versions
(**) electrical control link

Temperature measurements with all real components

- Temperature measurements performed with real thermal loads
  (electronics in operating conditions)
- Temperature of all the rod components measured with external probes
- Internal temperature probes commissioned
- Time constants to reach stable conditions verified
- Effect of the ambient temperature investigated

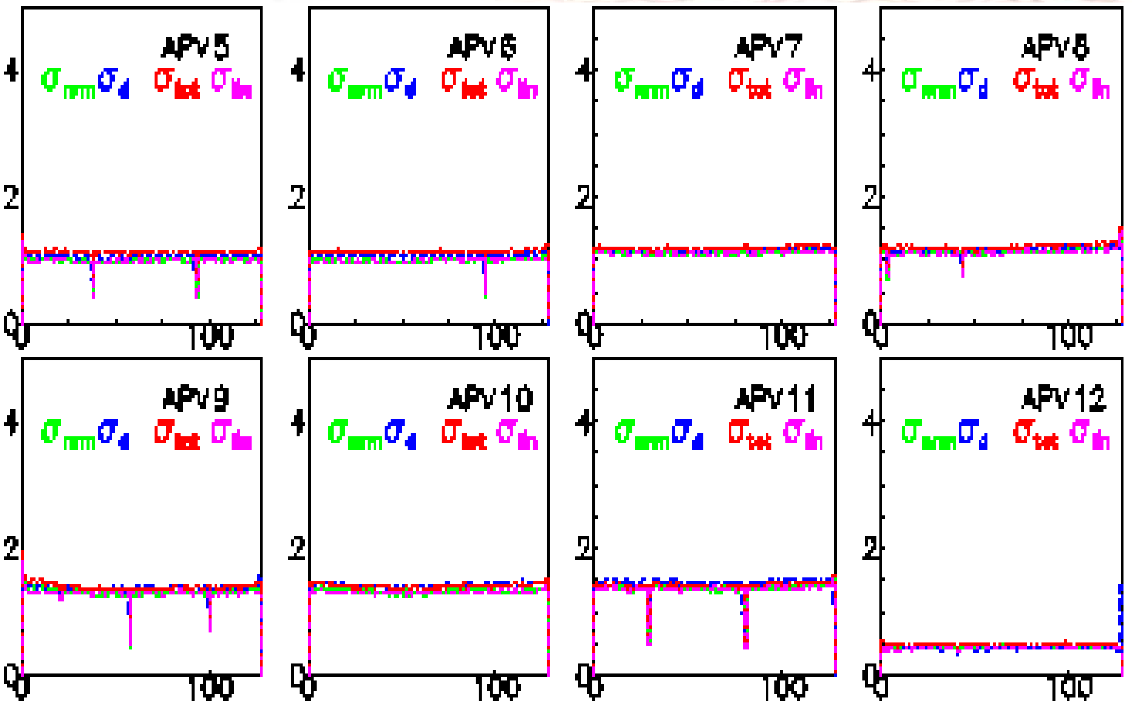


Results perfectly consistent with expectations for a SS, non-irradiated rod

Measurements summarized in a CMS Internal note

Noise profiles

Good noise profile for random triggers or low/high frequency triggers



(deconvolution)

$ped_i = \langle ADC_i \rangle_{ev}$

σ_{tot}: RMS of $ADC_i - ped_i$

$CMN_0 = \langle ADC_i - ped_i \rangle_{strip}$

σ_{nrm}: RMS of $ADC_i - ped_i - CMN_0$

σ_d: RMS of $0.5(ADC_i - ADC_{i+1})$

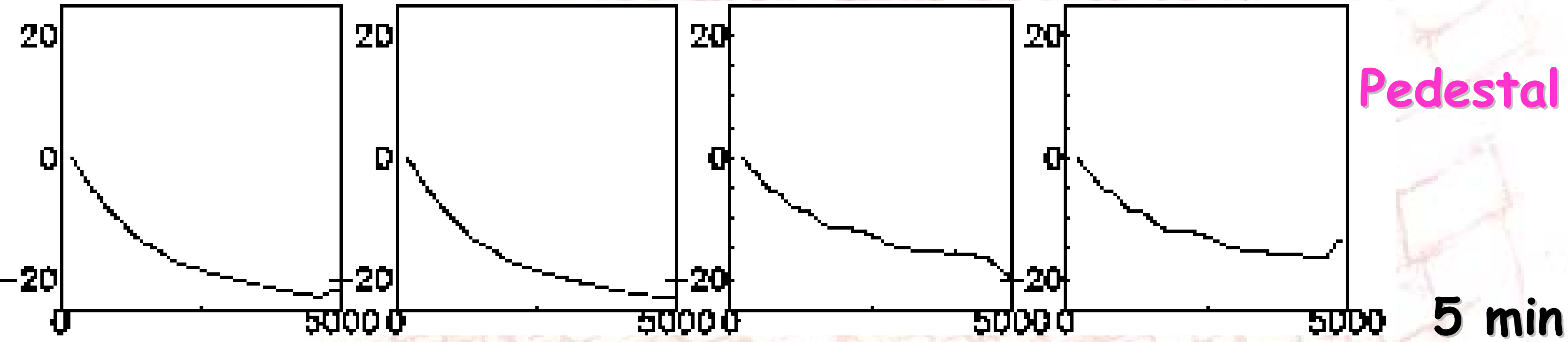
$CMN_i = b + a\,i$

σ_{lin}: RMS of $ADC_i - ped_i - CMN_i$

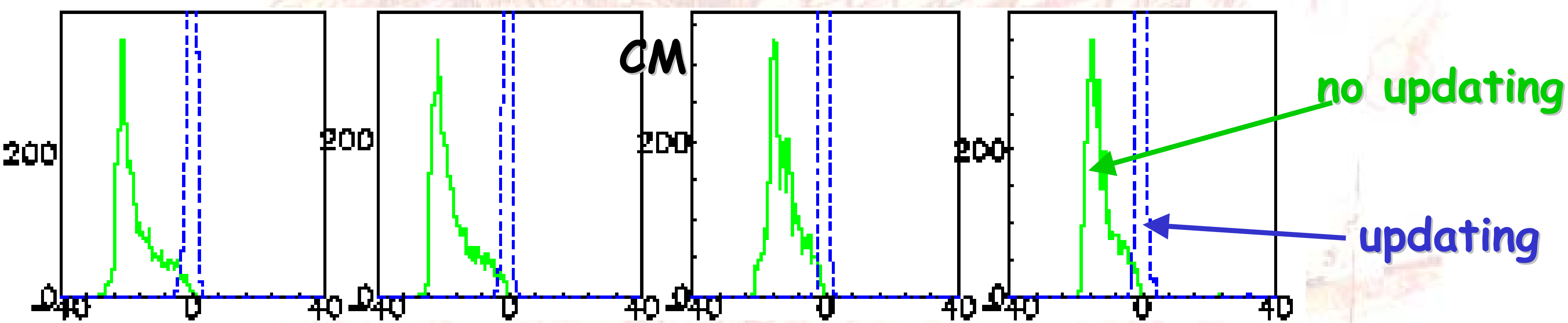
No large contribution from CMN ($\sigma_{tot} = \sigma_d$), noise is flat and gaussian (both in peak and deconvolution mode)

Pedestal drift

Drift of the pedestals in time at the beginning of a run:



Temperature increases at the beginning due to the start of run
⇒ change in the threshold of the laser
⇒ appears as a CM shifts if pedestals are not updated



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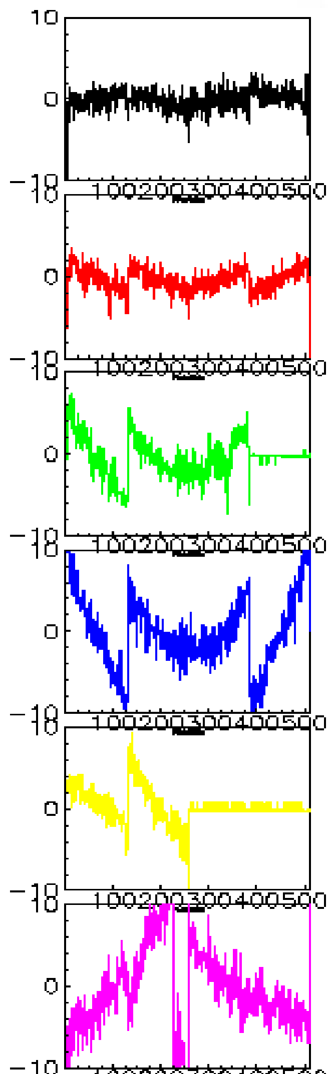
Noisy events: deconvolution @ 2KHz trigger rate

Example of bad event (Raw-Ped is shown)

- ⇒ large <u>non-flat</u> CM noise
- ⇒ well described by a linear fit
- ⇒ larger effect in detectors facing the IC Bus

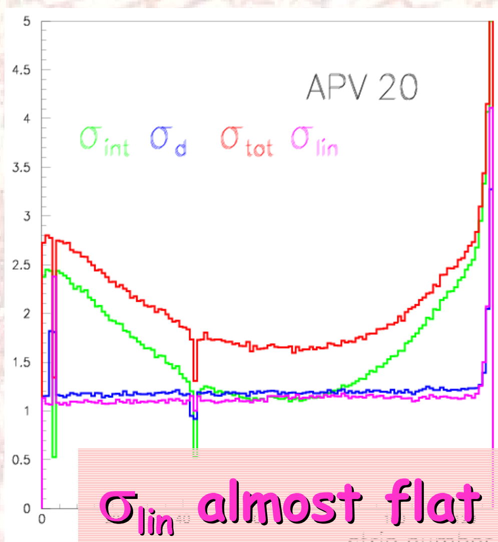


Mod. 1

IC Bus

Mod. 6

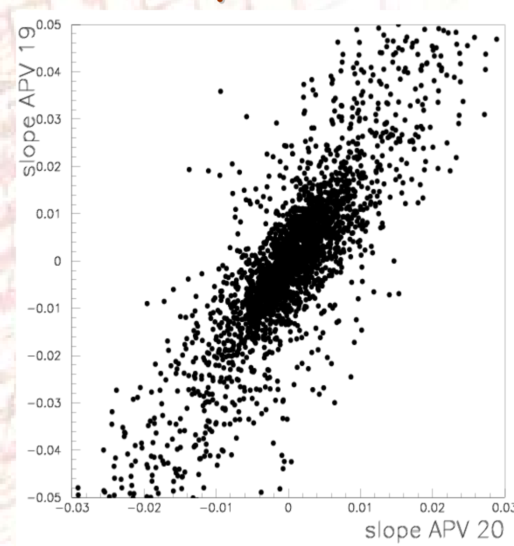
Large variation of the normal noise at the edges of the chip



σ_{lin} almost flat

Correlations among chips on the same module and on different modules

CM Slope fully correlated or fully anticorrelated



RMS(CM slope) used as noise estimator in the following

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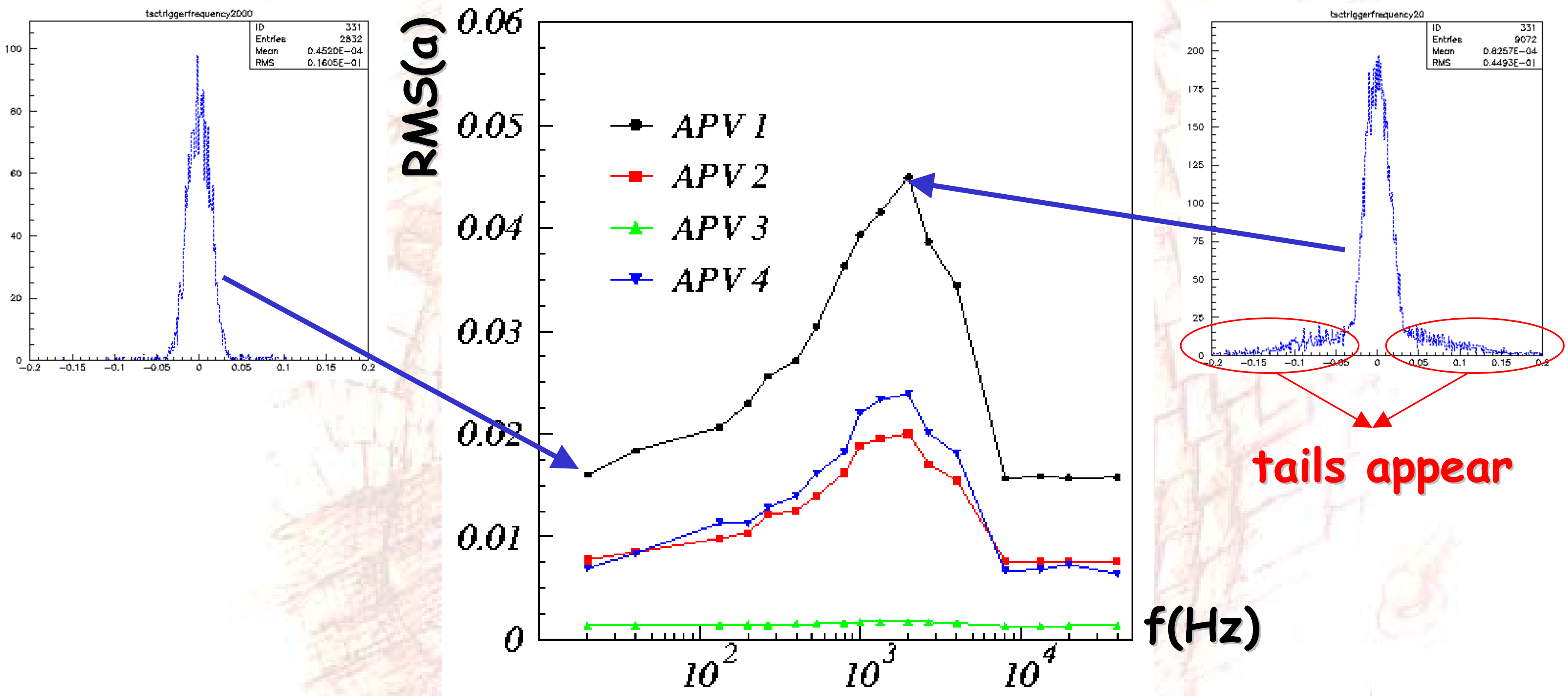
Dependence of noise on trigger frequency

Dispersion of the slope vs frequency of the internal triggers



Worst conditions at about 2KHz

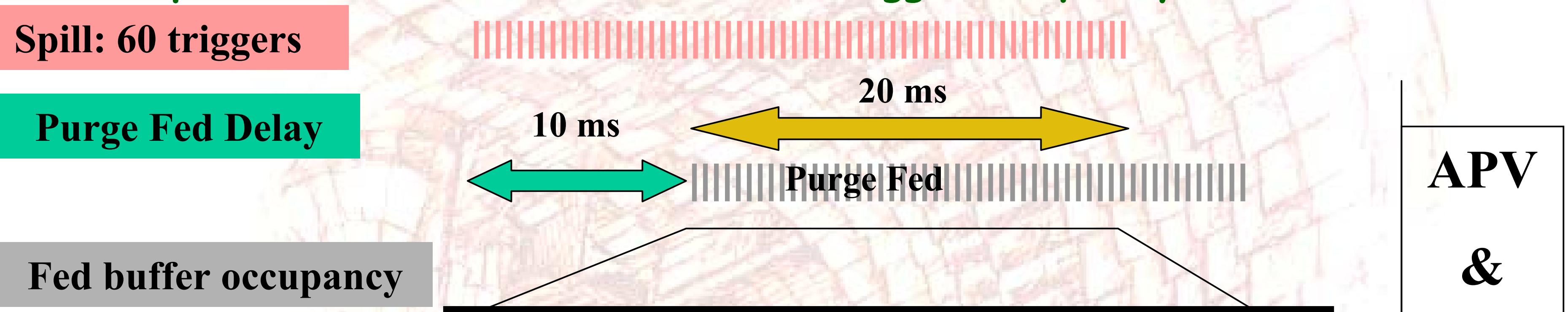
Only in deconvolution mode: no striking effect in peak

The data taking scheme (XDAQ)

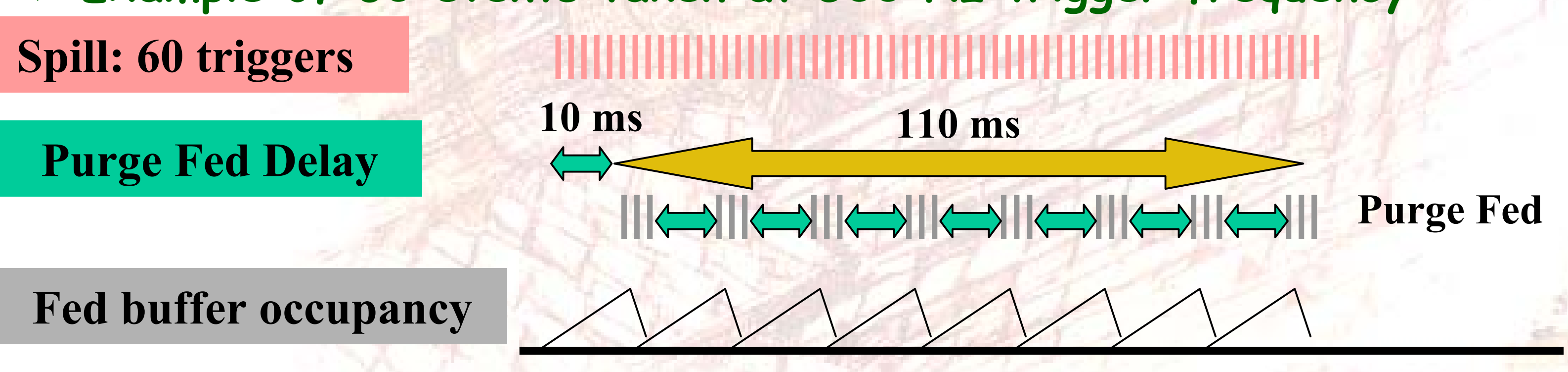
Tunable Number of events between two consecutive APV & FED resets

→ Definition of Spill

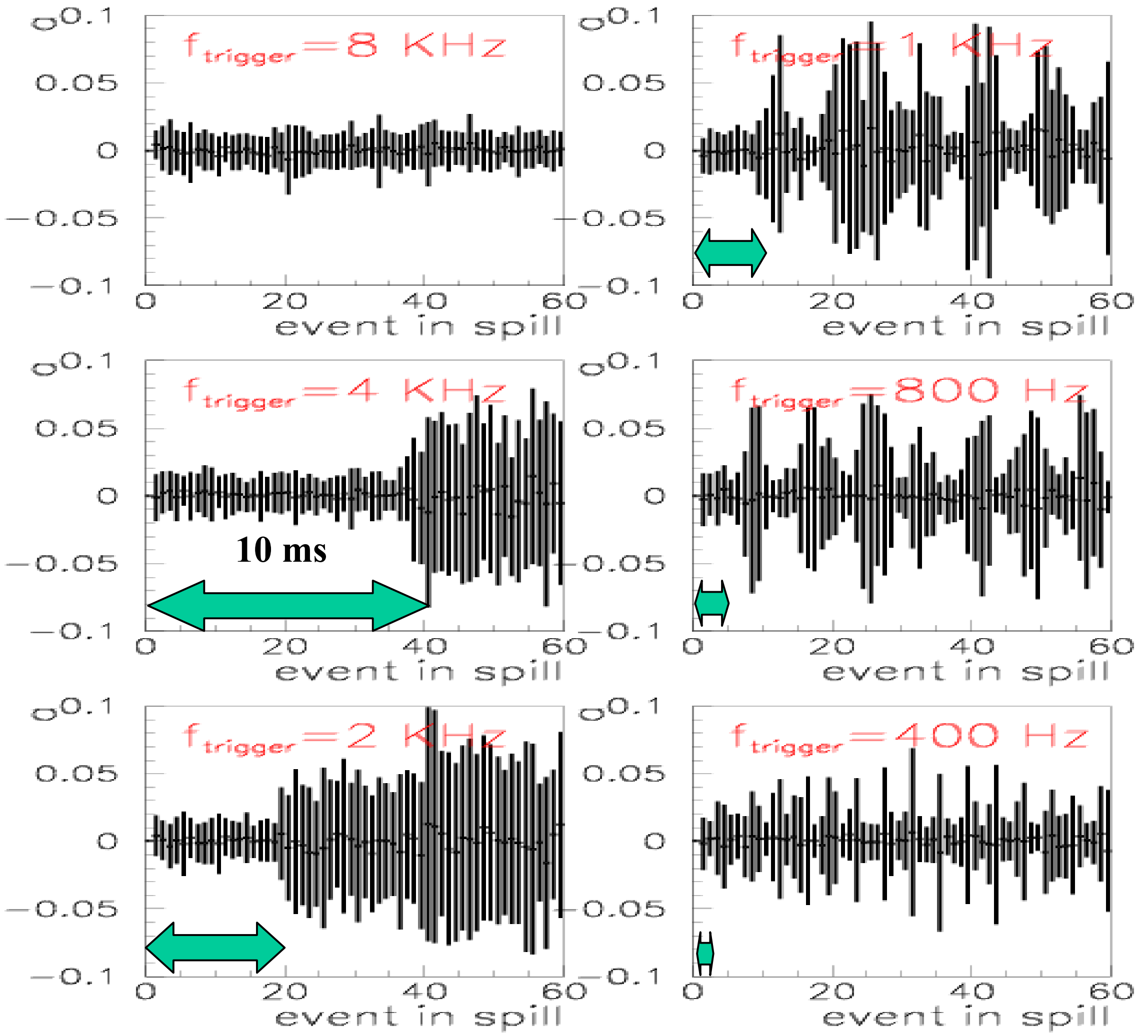
- Example of 60 events taken at 2 KHz trigger frequency



- Example of 60 events taken at 500 Hz trigger frequency



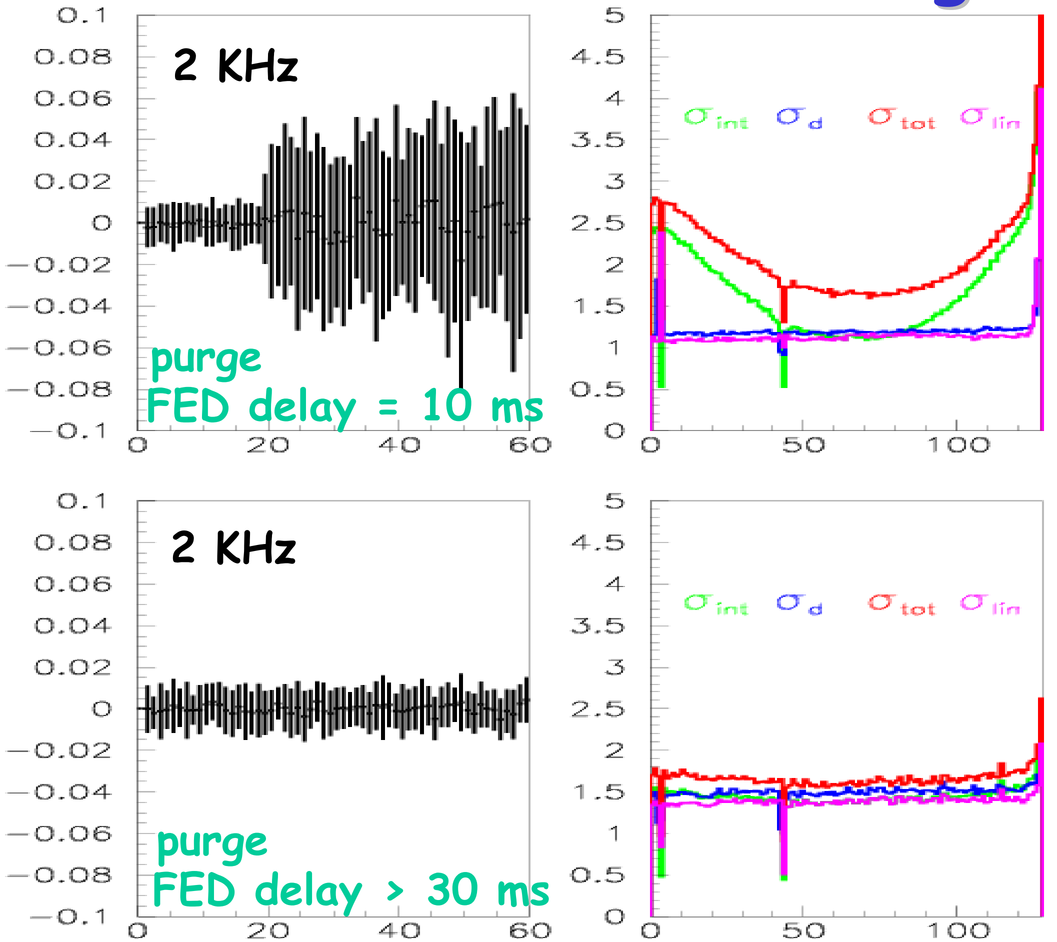
In spill analysis (frequency scan)



No large spread of CM Slope in the first 10 ms of data taking at any trigger frequency

Clear indication for a periodic variation of RMS(CM Slope)

Understanding the noise



Increase the purge FED delay so that the purge FED process starts after all the events in a spill have been collected

↓

The noise arises from the purge FED process

Noise propagation:

purge FED

→ CTRL ground line (the FEC is sitting in the same PC as the DAQ)

→ LV return line in the IC Bus

→ picked up by the modules

} Confirmed with several other tests

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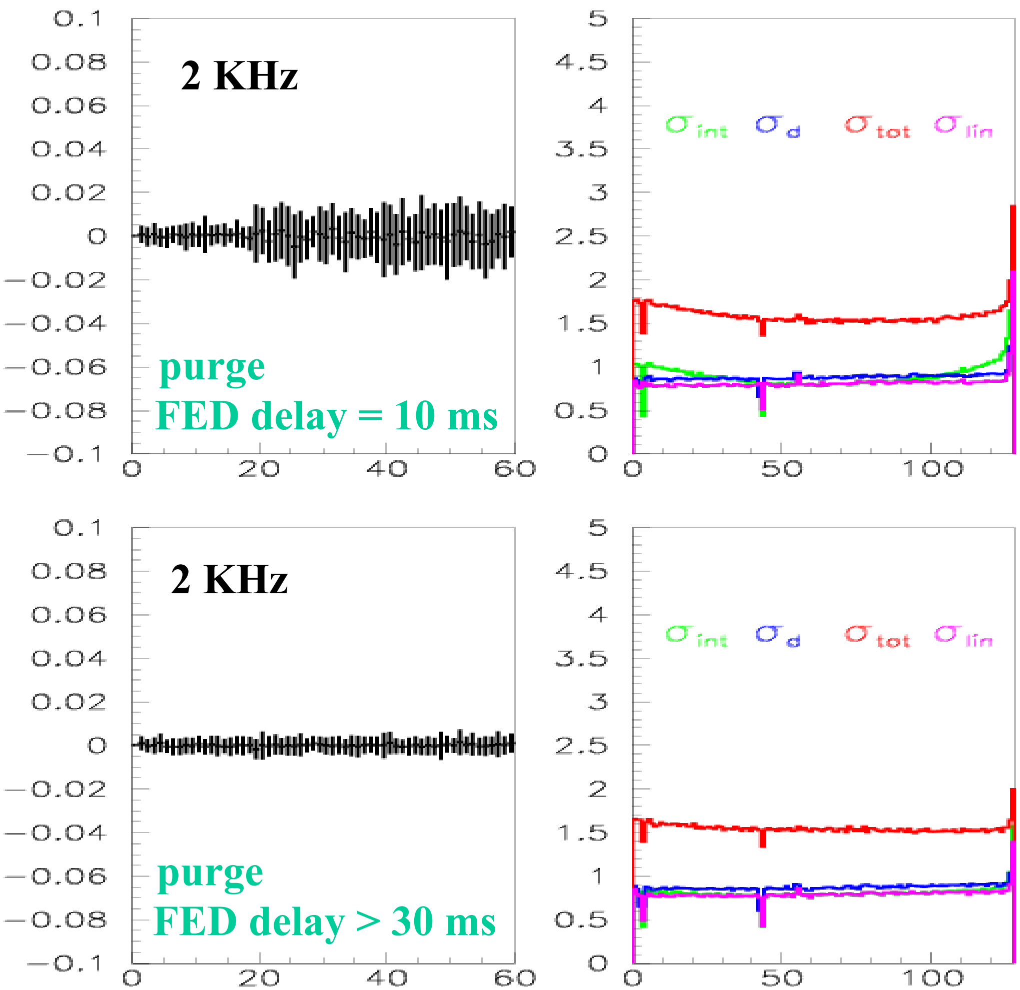
Is the peak mode really clean?



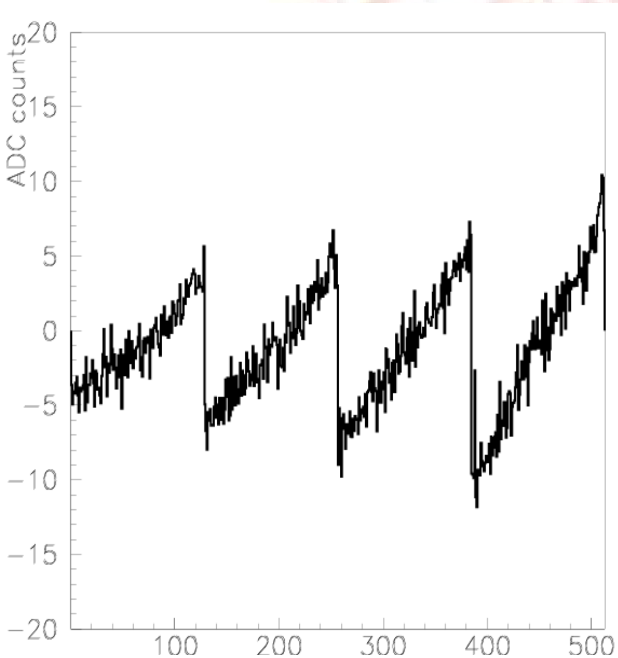
Small variation of the normal noise at the edges of the chip

σ_{lin} flat

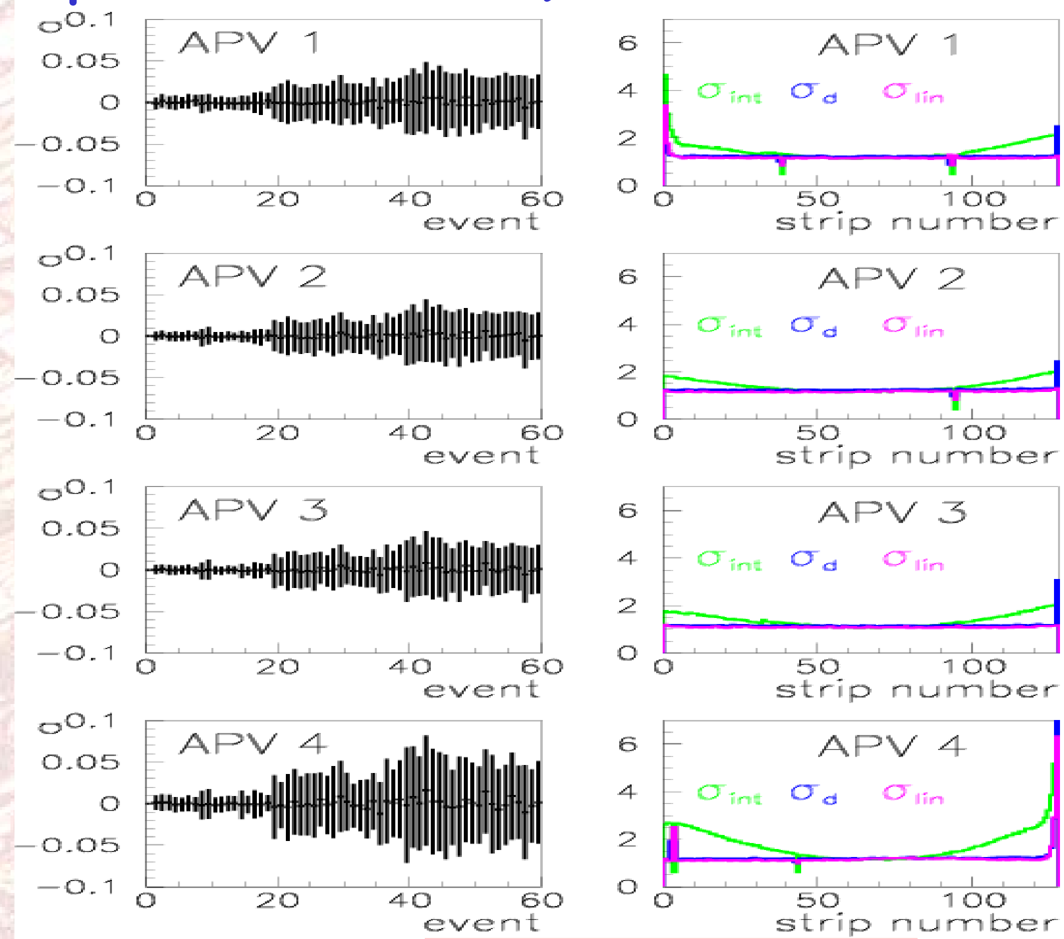
Increasing the purge FED delay the normal noise gets flat

Further tests: IC Bus alone

One module mounted on a spare Bus + CCUM + ICC + AOH
(no Cooling Pipe, no ROD frame)



Corrected raw data

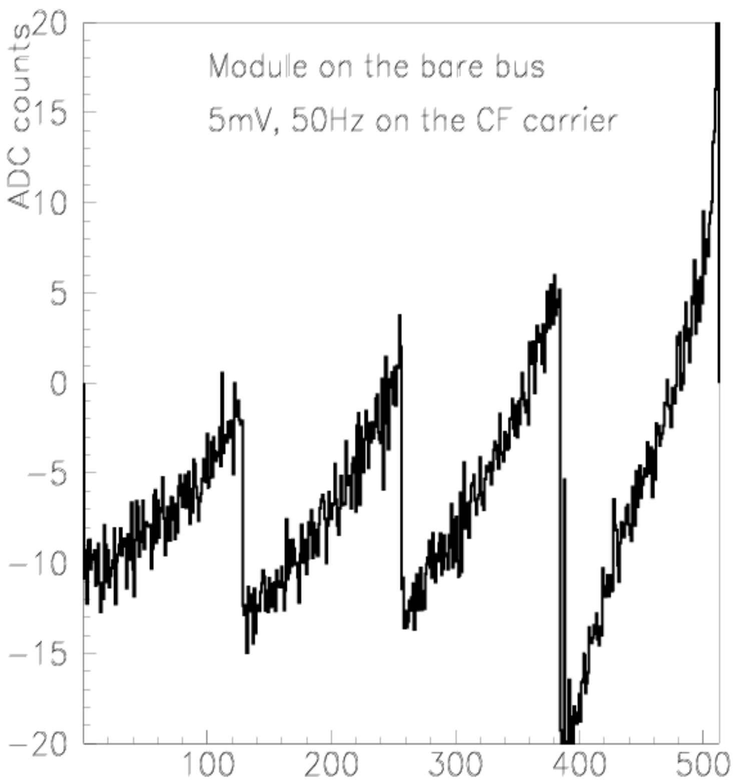


➡ **CM Slope fully correlated**

σ_{lin} almost flat

Injection of LF noise

❖ 5mV 50Hz (monochromatic) on module carrier



Corrected raw data

➡ CM Slope fully correlated

(σ_{lin} almost flat)

Effect more relevant for the APV closest to the probe

Tests repeated at different trigger frequencies

Effect observed up to 5 KHz

(sensitivity at low frequencies)

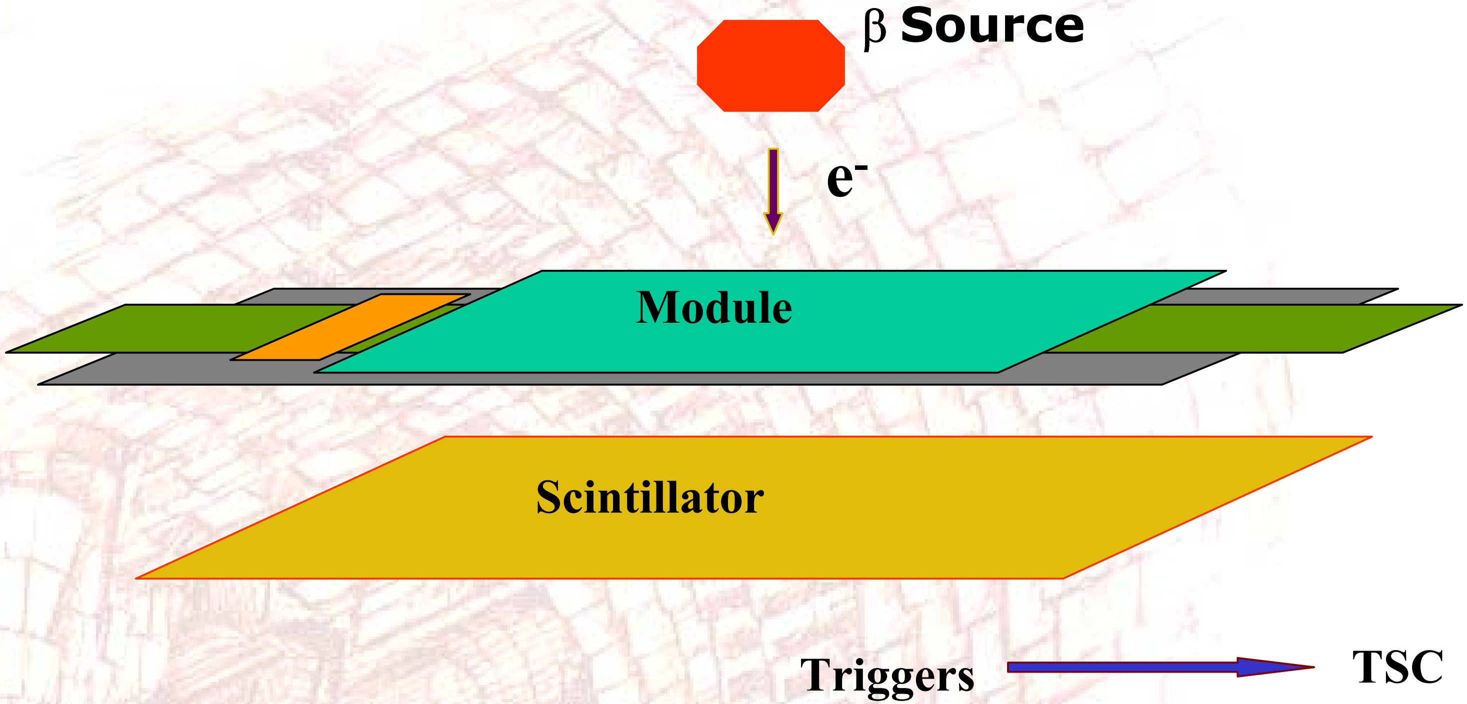
Injection of HF noise

- ❖ 4V on antenna 1 cm from module

- Linear CM induced also in this case
- Sensitivity at high frequencies
  - From frequencies as low as 500 KHz
- Evidence of local effects
  - Highest sensitivity close to pitch adapter and bonds

Special module with pitch adapter mounted on a kapton foil:
effect not confirmed

Measurements of physics signals



Peak	inverted mode	S/N ≈ 21
Deconvolution	inverted mode	S/N ≈ 15

Conclusions

- A SS rod prototype has been tested thoroughly
- No problem has been identified in the electrical design
- The grounding seems to be valid
- Clock signals are well shielded in the IC Bus
- Modules are sensitive to noise on the LV lines
  (hint that the sensitivity comes from the pitch adapter was not confirmed)
- The system reacts to noise sources with a non flat correlated noise
- Such correlated noise is (typically) perfectly described by a linear fit

The robustness of the system would be greatly increased by a calculation of the common mode with a nonzero slope

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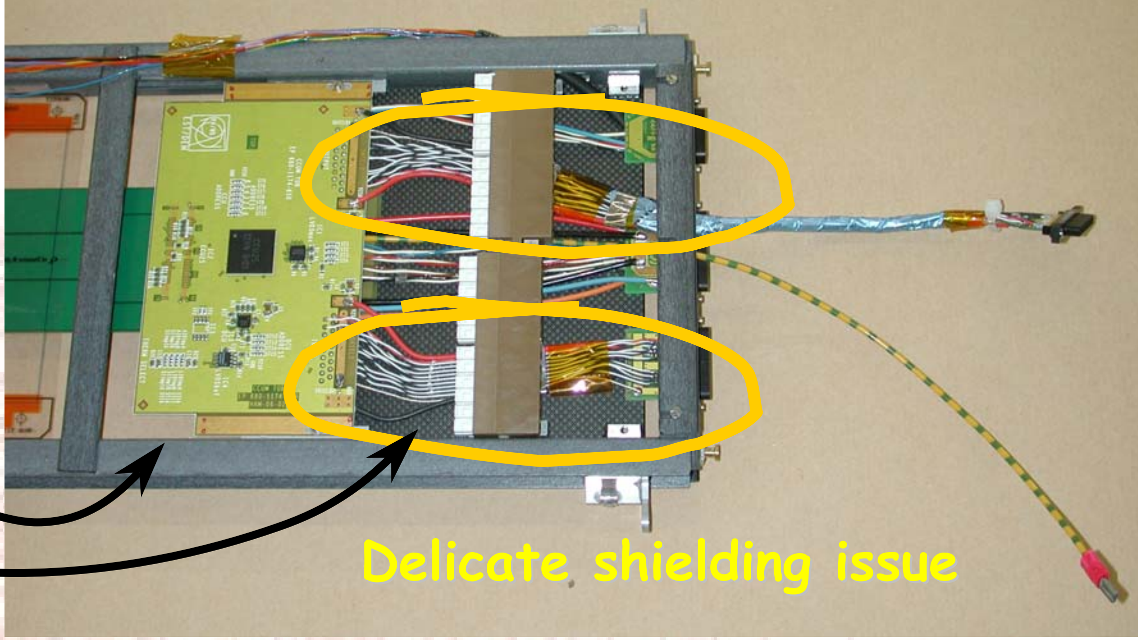
Outlook

A DS rod prototype is now being integrated

Final CCUM

Final cabling

Final optohybrids



Will be tested with optical control (finish by Xmas?)

Further steps:

Integrate a SS rod with final components and test two rods together

Test a rod @ operating temperature