

Front Tracker Status & HDMI cable noise issue

E. Cisbani / RM / R

SBS Weekly Meeting

2015 June 10

BA=Bari
CT=Catania
GE=Genova
LE=Lecce
RM=Roma-ISS

E=Engineer
P=PhD Student
R=Researcher
S=Student
T=Technician

E. Bellini / CT / R
S. Colilli / RM / T
F. Giuliani / RM / T
A. Grimaldi / CT / T
F. Librizzi / CT / R+T
M. Lucentini / RM / T
G. Mini / GE / T
P. Musico / GE / E
R. Perrino / BA+LE / R
L. Re / CT / S
F. Santavenere / RM / T
D. Sciliberto / CT / T
C. Sutera / CT / R

(all part time involvement)

Delta from previous report

Module assembling

- Three additional GEM modules under finalization (work in parallel to optimize material and schedule conflict)
- New GEM and readout foils expected from CERN in June

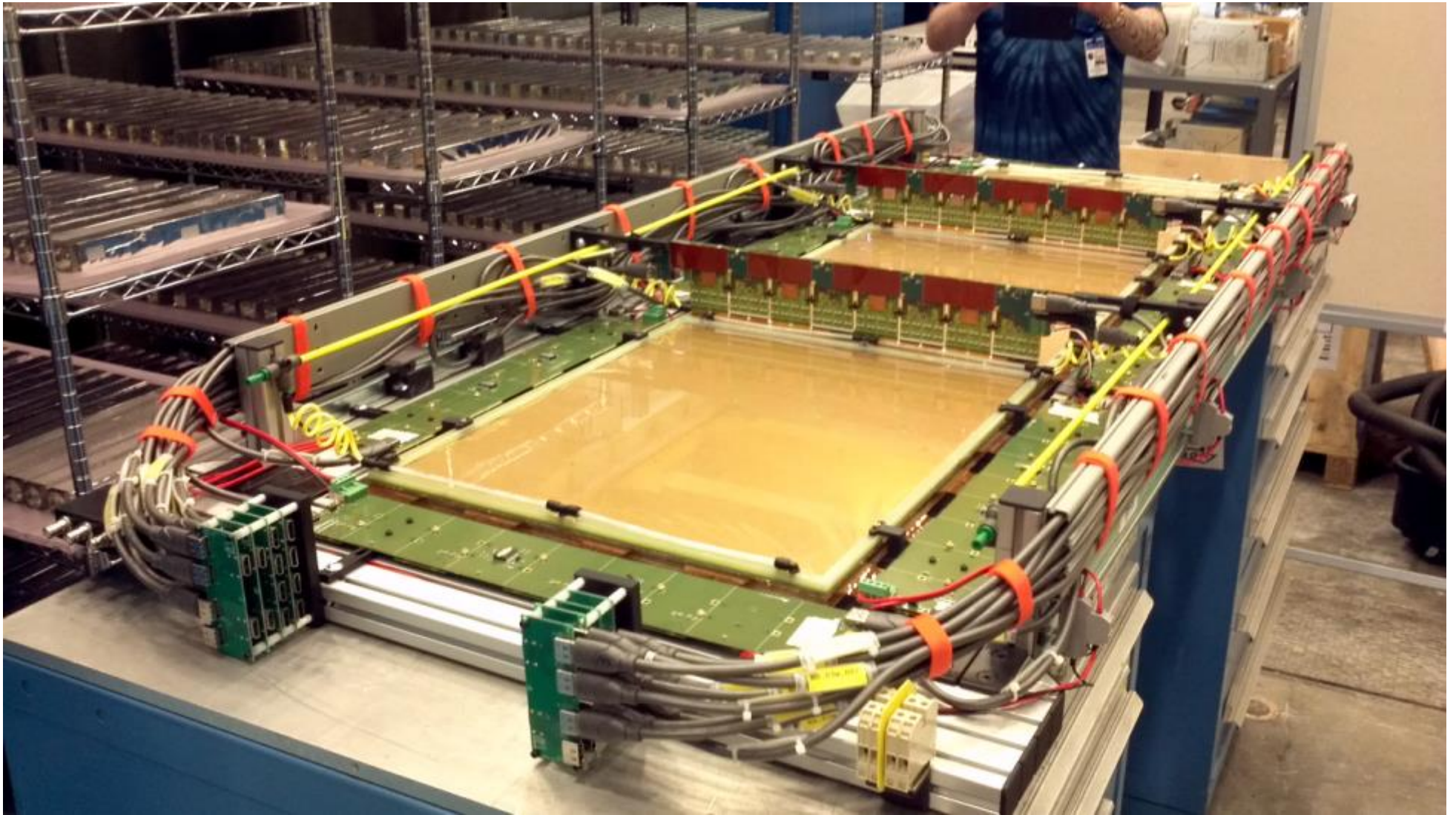
Chamber integration

- First «pilot» chamber integrated and now in JLab
- Work on carbon fiber frame in Rome

Electronics

- Progress on HDMI noise issue, triggered by Chris Cuevas
- Finalizing electronics for UVa

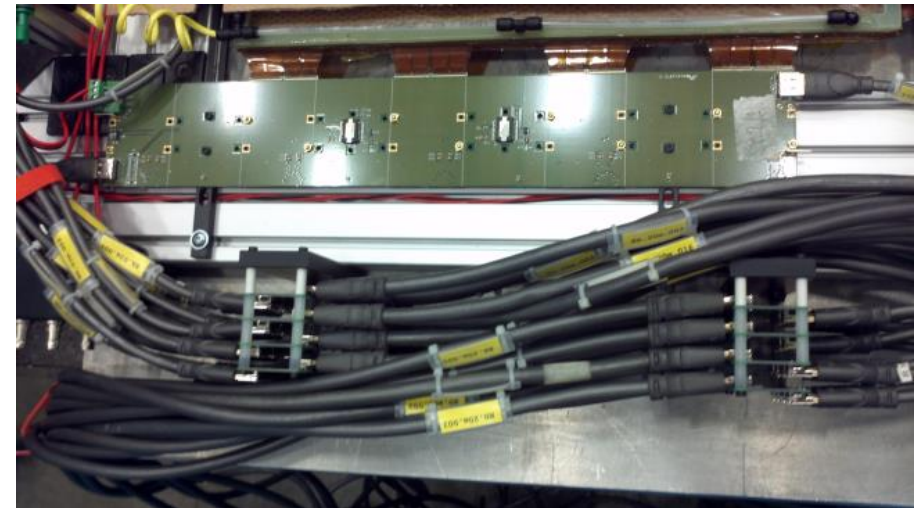
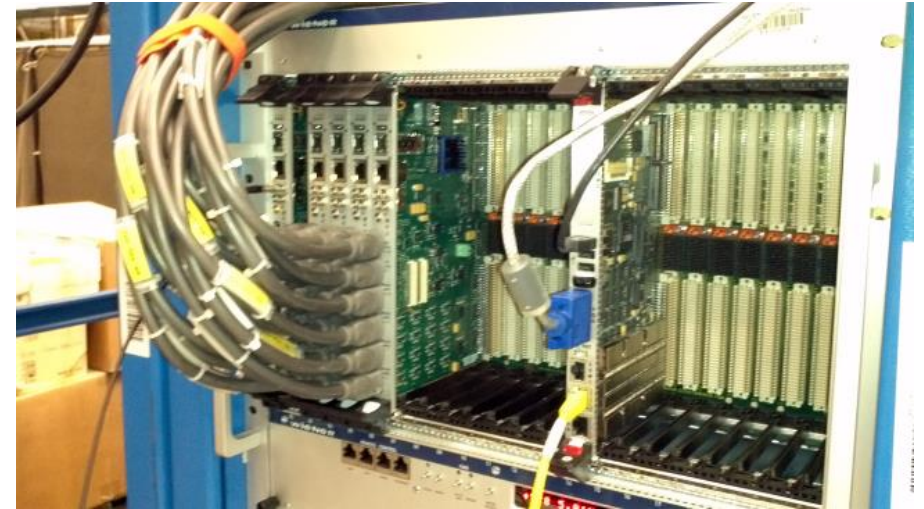
First GEM chamber in JLab (Test Lab)



Please visit, suggestions welcome

First GEM chamber in JLab

- ✓ Electronics available and connected
- ✓ Gas pipes connected
- ✓ HV ready (HV module in INFN office)
- ✓ Chamber is ready for testing
- Need gas mixture (with flow regulator) and trigger



HDMI cable issue

Electronics topology:

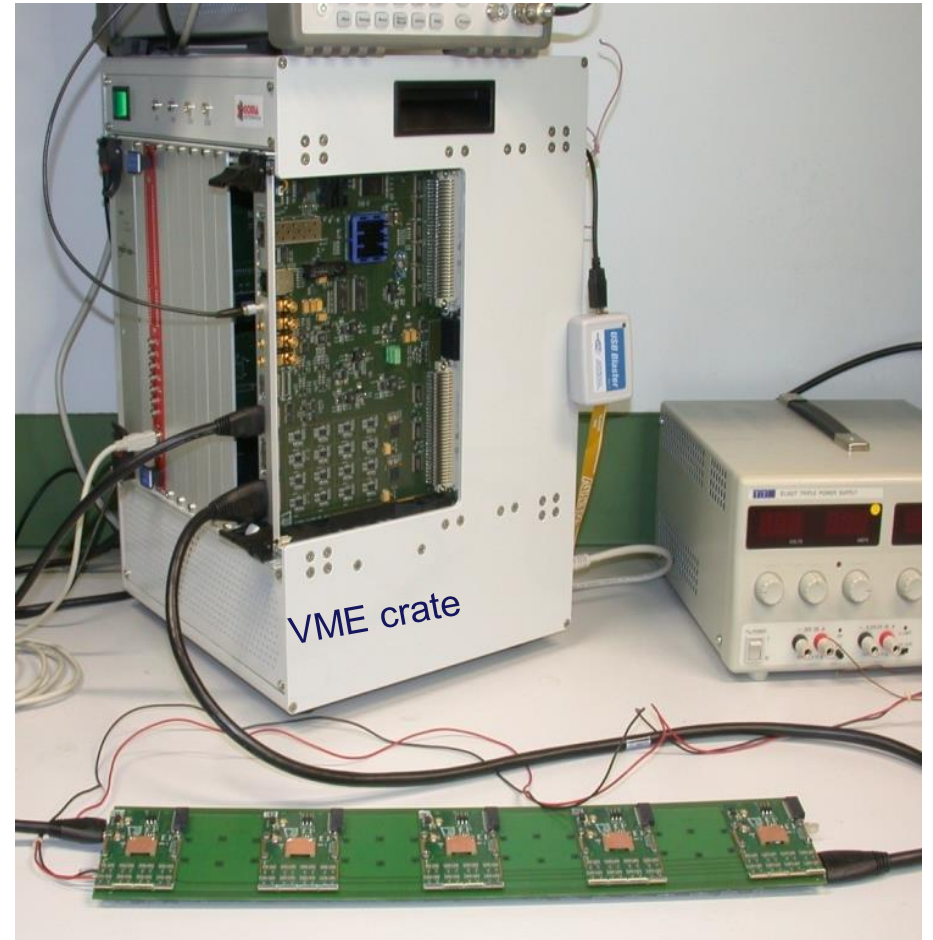
Front_end_cards

↓ HDMI cable 3 m

Patch panel

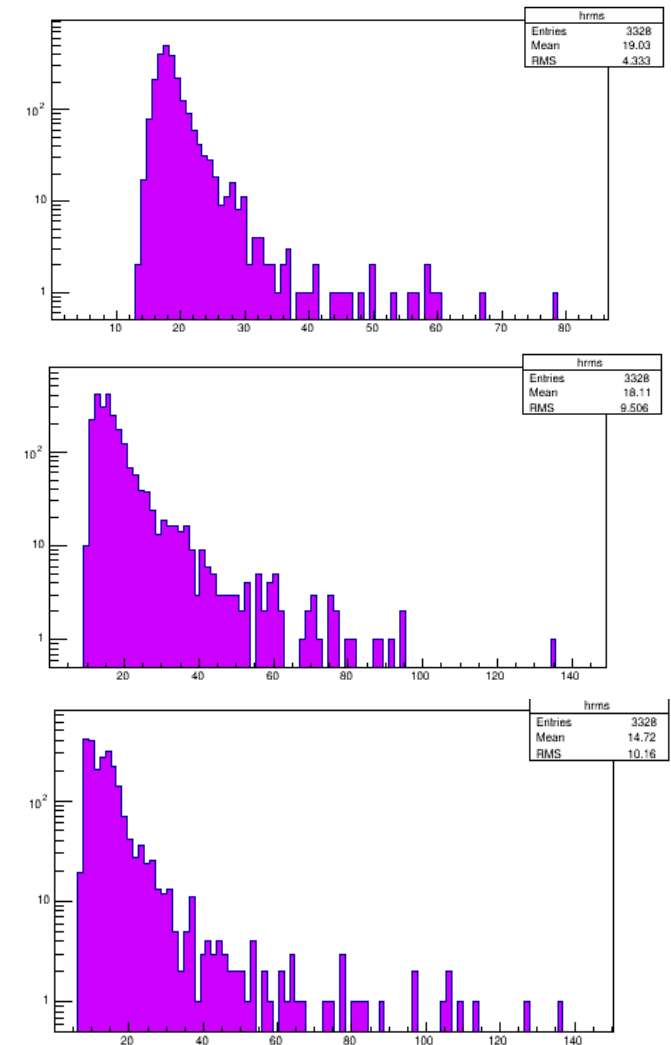
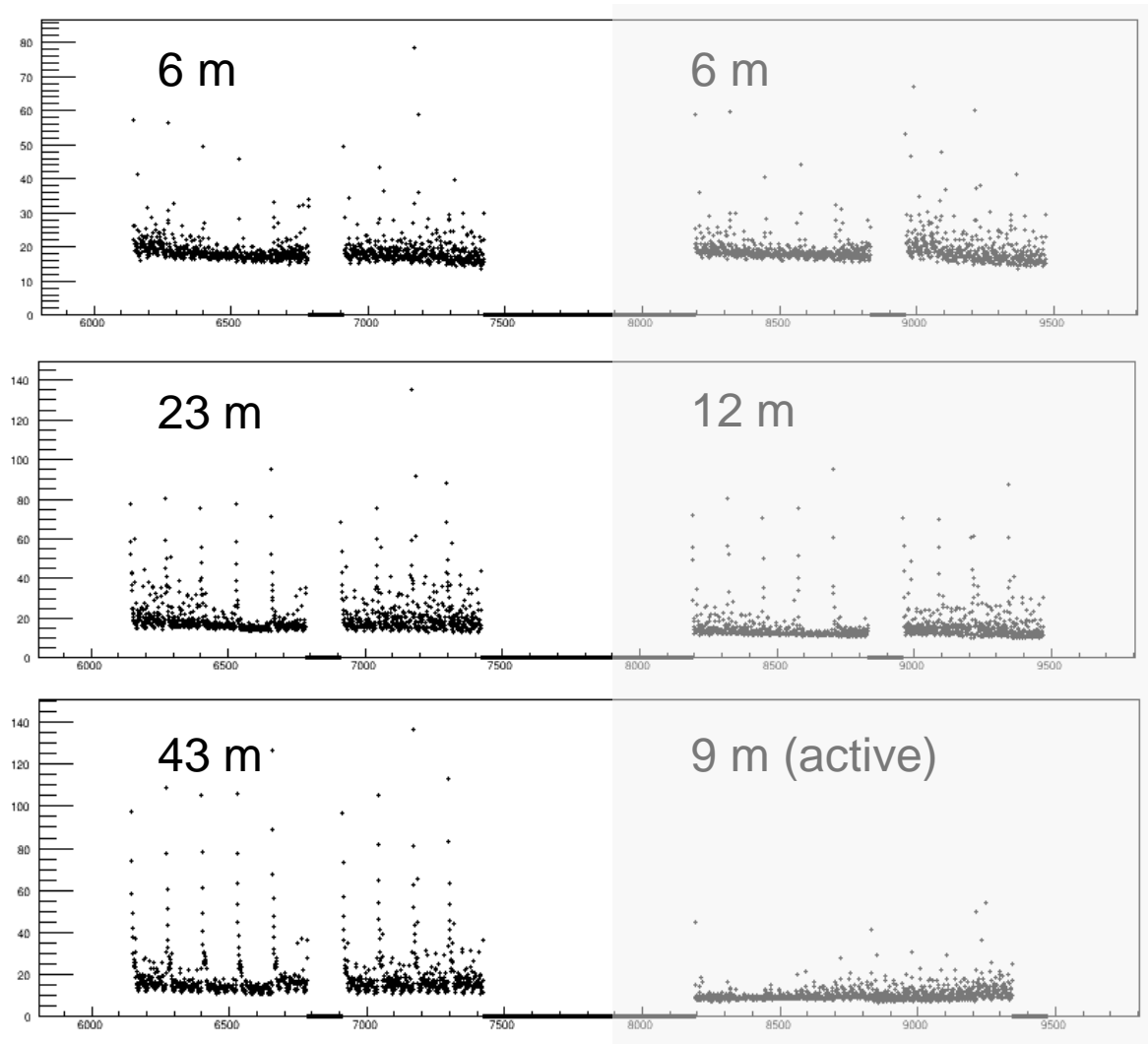
↓ HDMI cable up to 20 m

VME-MPD (ADC and control logic)



HDMI long cable noise

Pedestal RMS

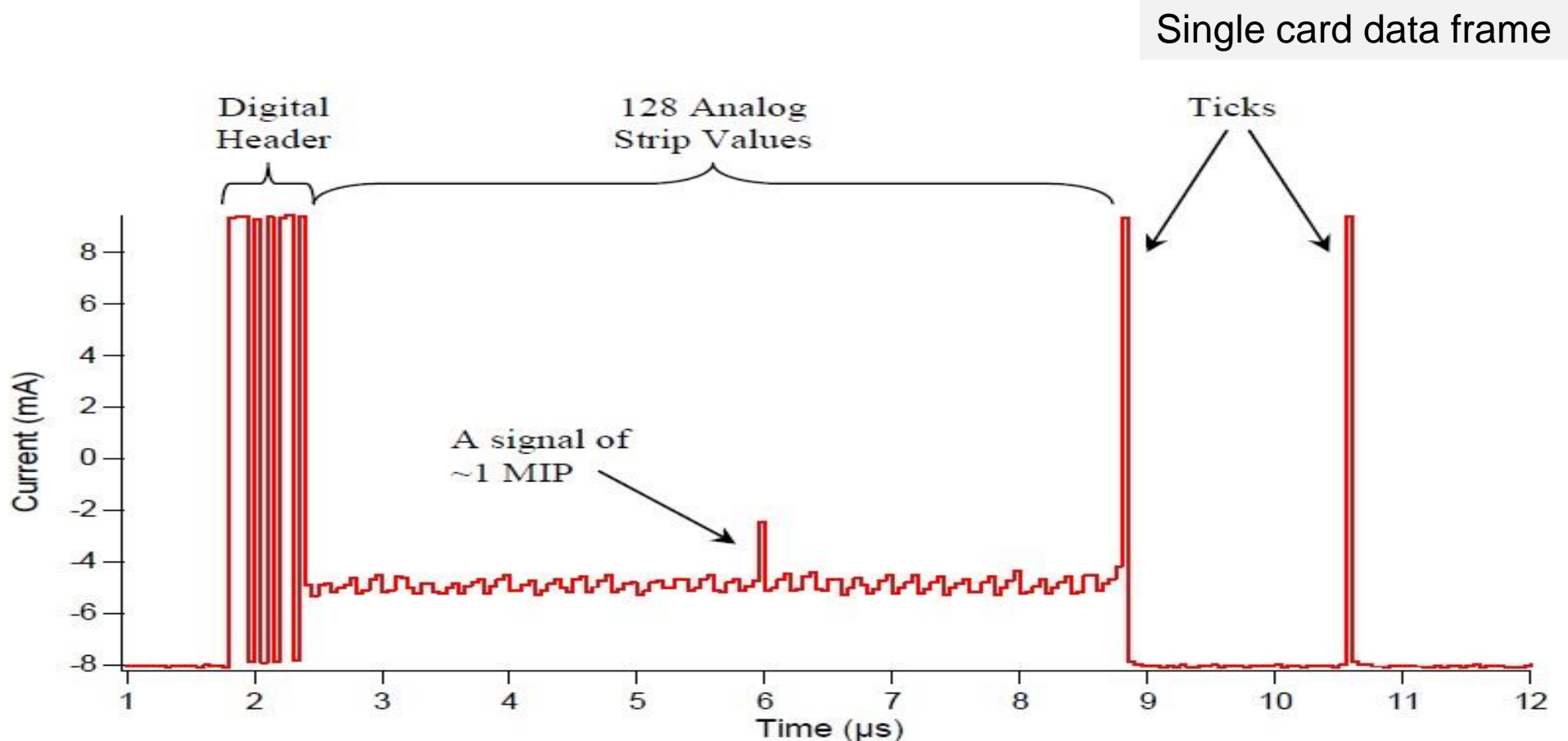


- ⇒ «peak» noise on the first 8-12 transferred channels levels for each front-end card
- ⇒ «peak» noise increases with cable length
- ⇒ noise baseline decreases with cable length (due to cable attenuation)

Belle Experience

Thanks to Chris Cuevas analysis:

the noise is related to HDMI matching impedance and presence of «digital» signal before the analog data frame

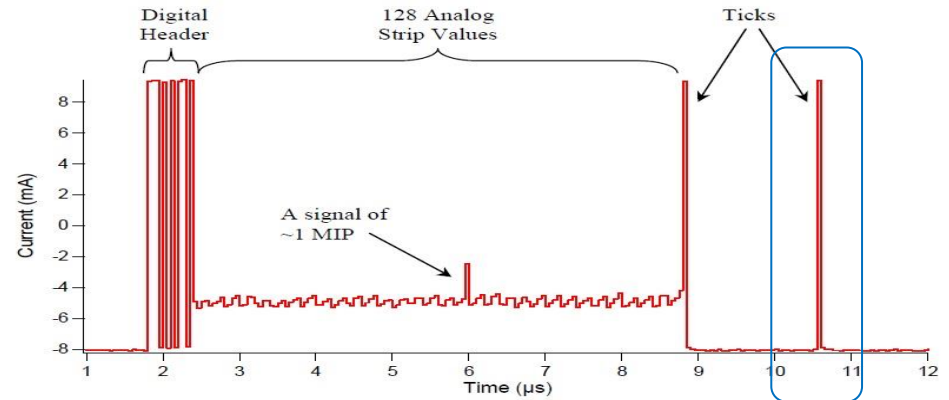


Digital Header format = 111aaaaaaaaaE; aaaaaaaaaa=memory address (change), E=1 (no error)

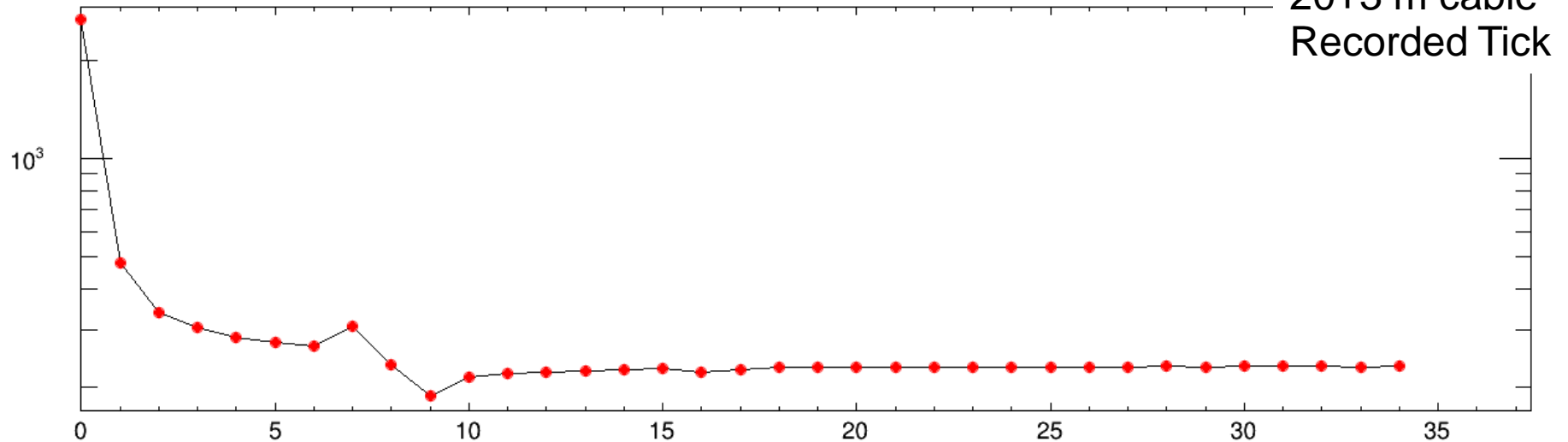
Impulse response

Tick is a reference
«square» pulse

Its distortion is an
indication of impedence
matching and other
cable issues



Impulse vs sample, phase=23



Belle Experience

Chris discovered a Belle paper (2012 JINST 7 C01082) where the problem is solved by a FIR filter implemented in firmware:

$$V(n) = \sum_{k=0}^M h(k)S(n - k)$$

Inversion provide the «original» signal

n: channel

V: distorted measured signal

S: original «unperturbed» signal

h: impulse response

Channels values are sent on serial line: $S(n-k)=0$ for $n < k$

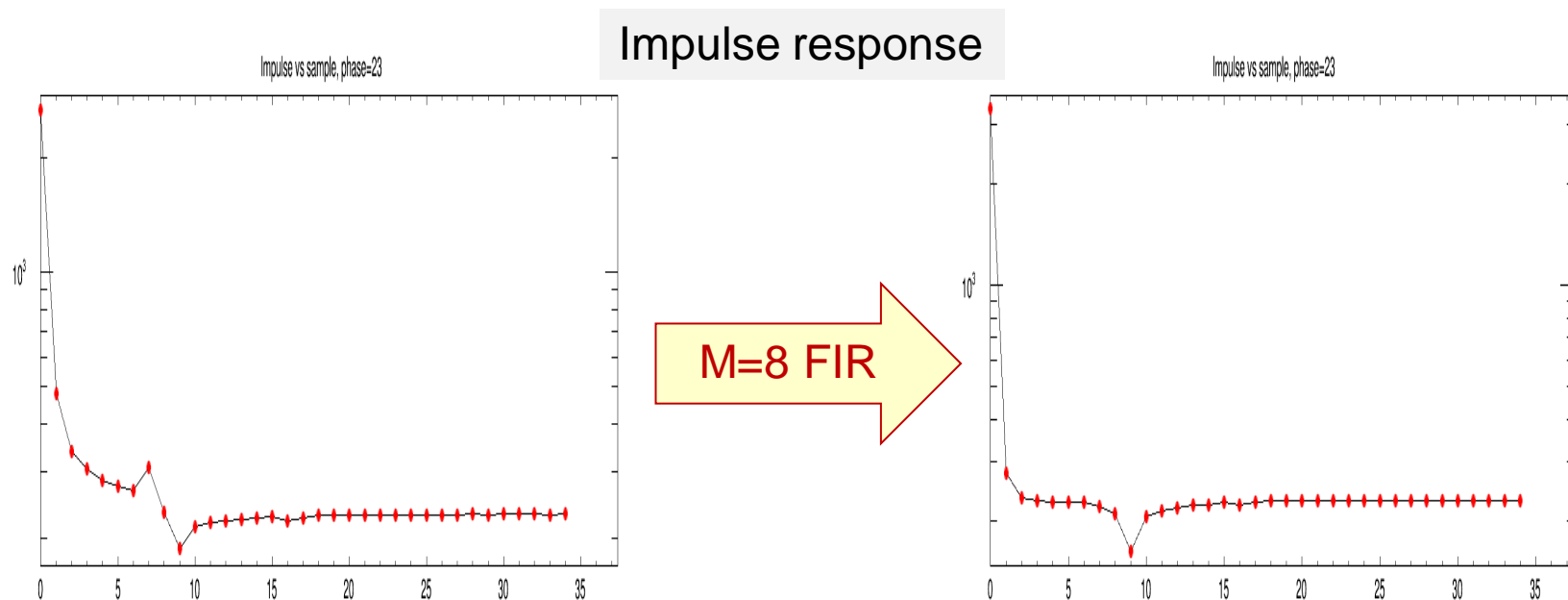
Belle used M=8 to solve their 12 m cable issue

FIR implemented

Paolo Musico implemented the FIR on the MPD firmware with $M=8$ (40% FPGA resources left) and $M=12$ (20% FPGA resources left!)

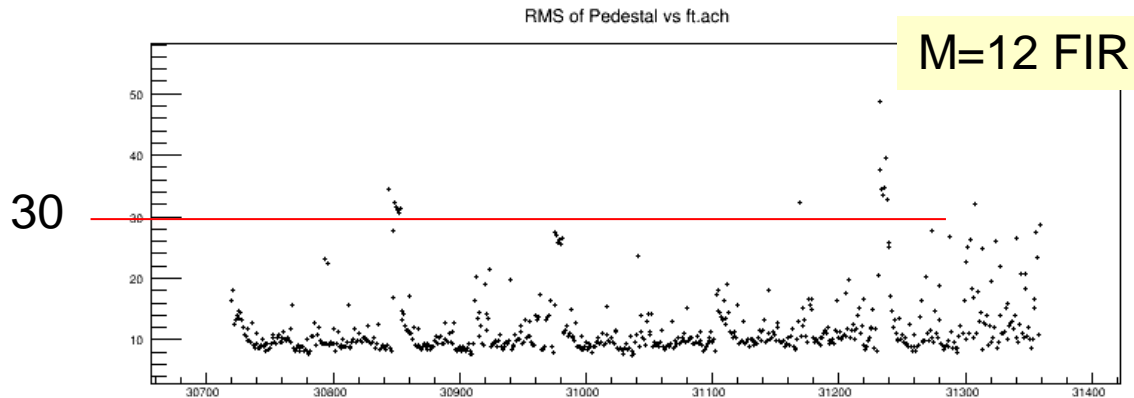
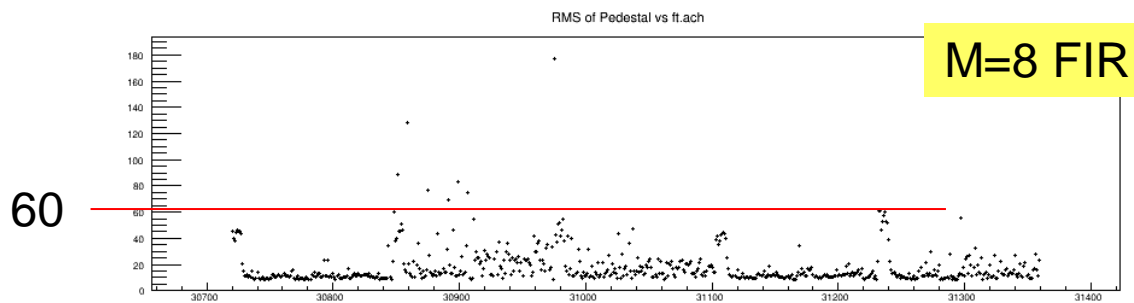
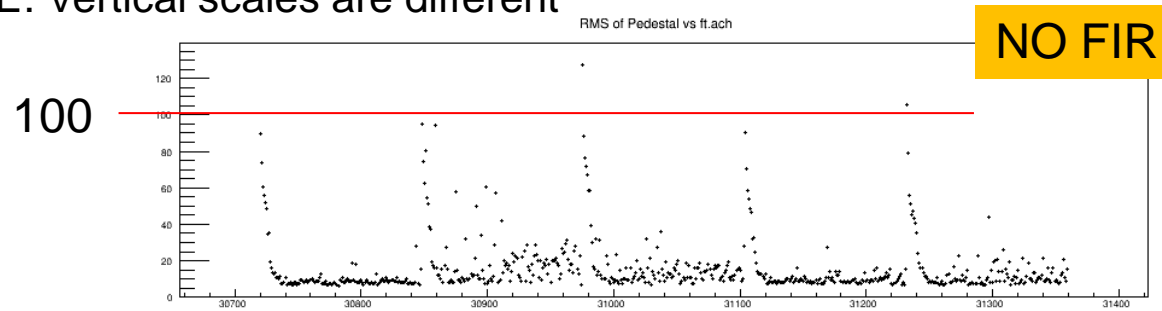
DAQ software aligned to new firmware

New piece of software to estimate $h(k)$ and then invert it to get the proper coefficients for the FIR



Pedestal RMS (20+3 m cable)

NOTE: Vertical scales are different

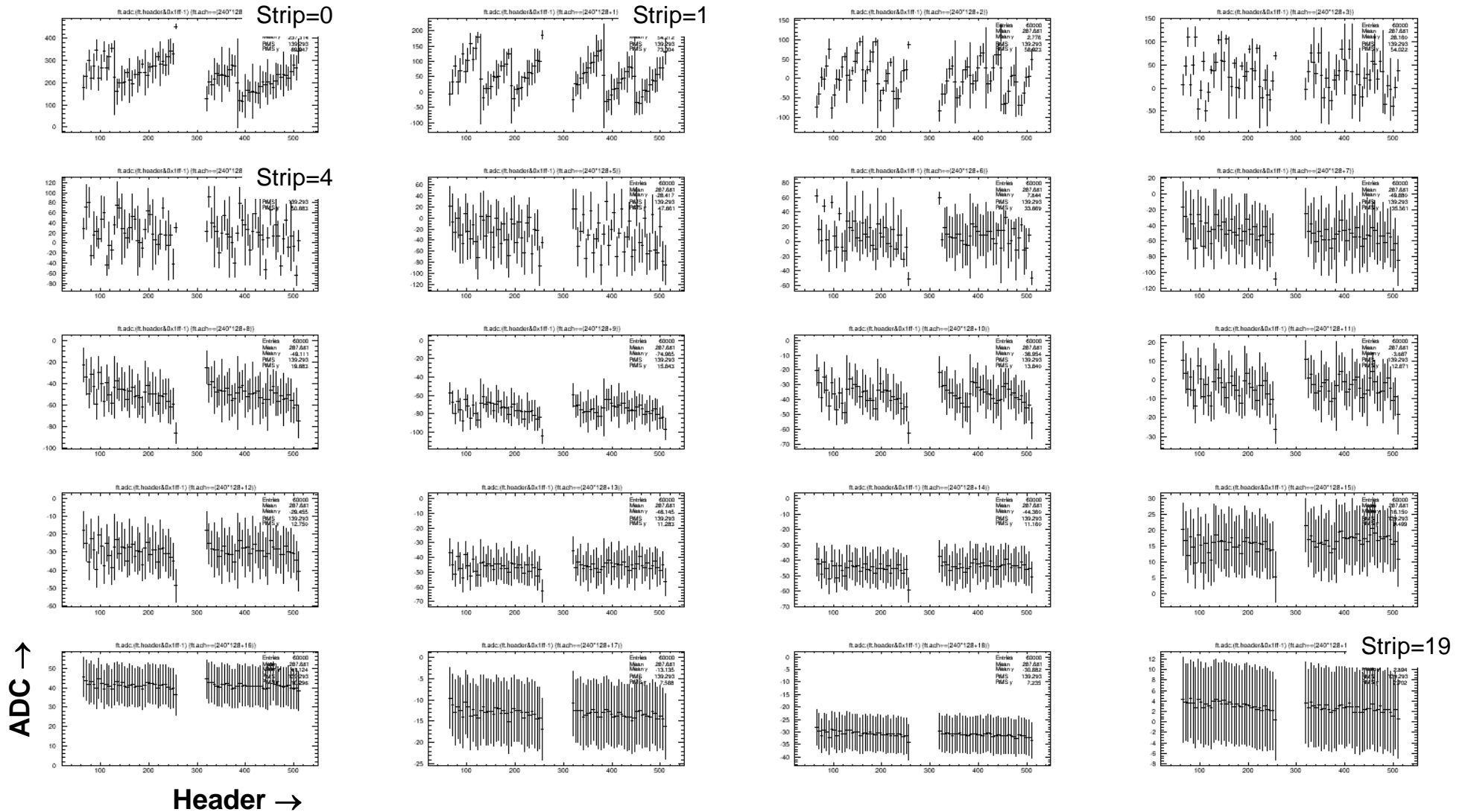


- Filter reduces the noise level of the first channels and the number of noisy channels.
- Larger M (number of parameters of the FIR) better results.
- M=12 still not completely satisfactory

Parameters optimized on first card

Single strip ADC vs Digital Header values

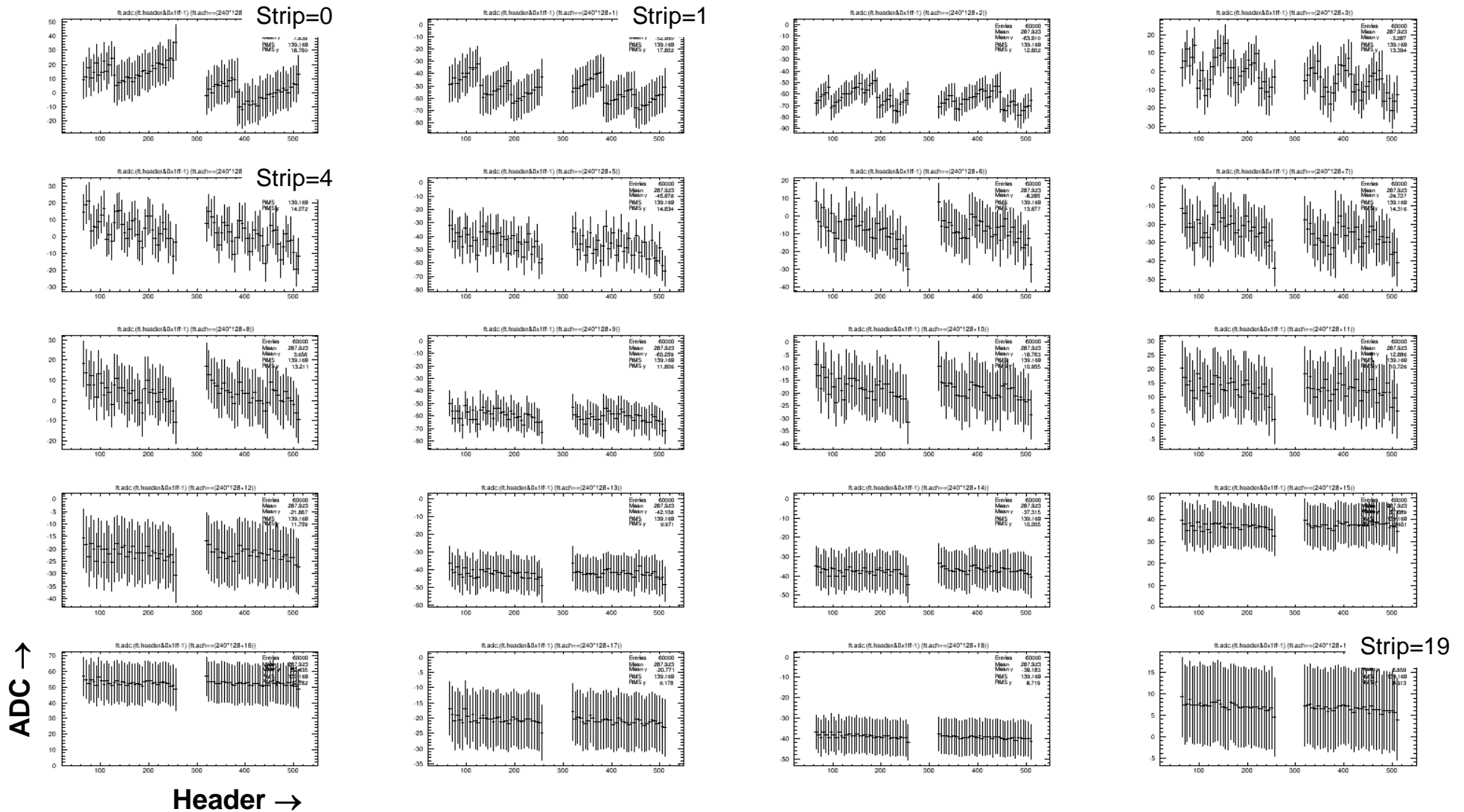
NO FIR, first 20 channels of the frame (right after the digital header)



First strips ADCs are strongly correlated to the header values (as expected)

Single strip ADC vs Digital Header values

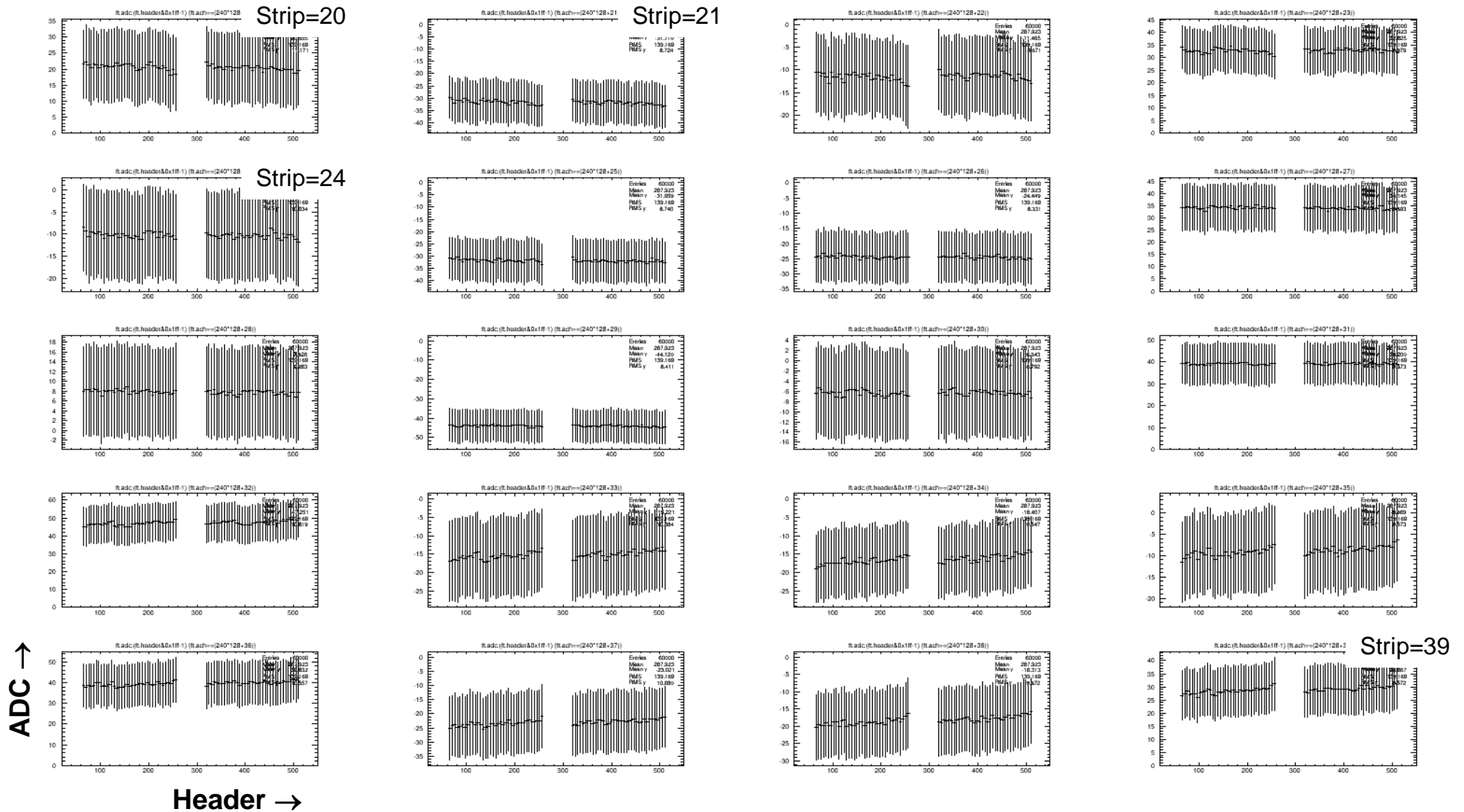
M=12 FIR, first 20 channels as previous slide



ADC and Header still correlated but variation much smaller; can be compensated offline

Single strip ADC vs Digital Header values

M=12 FIR, 20 channels after the first 20 of the previous slide



Marginal correlation on some strips; can be compensated offline

Noise issue identified and largely mitigated for 20 +3 m cables; offline processing can in principle suppress the residual noise

To do:

Verify that SNR is improved after FIR

Evaluate if 20 m long cable is really required