Performance of SPIROC chips in SKIROC mode

Michele Faucci Giannelli, Jérémy Rouene,
Vincent Vandenbussche

Outline

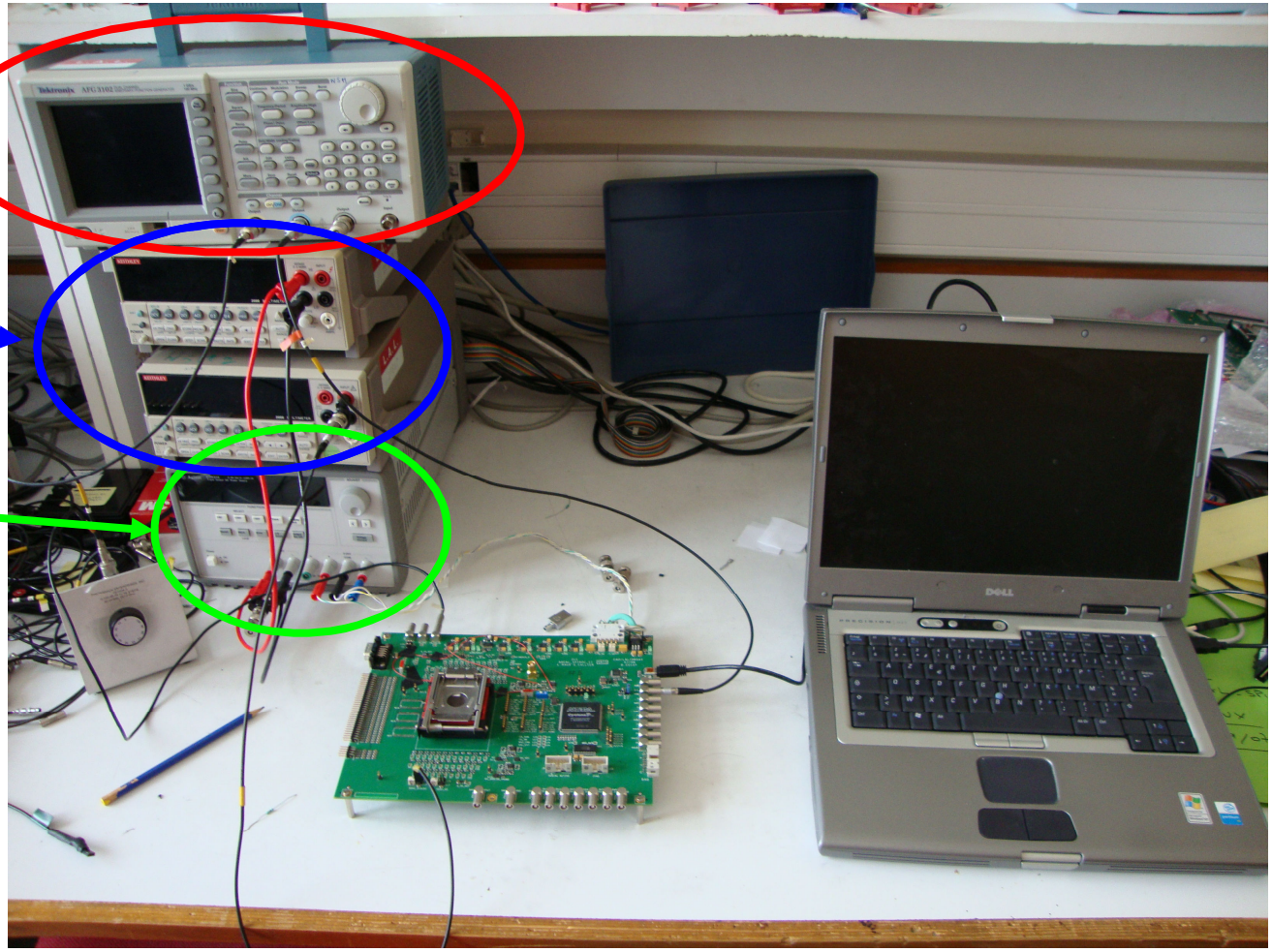
- Test bench description
- Tests on two SPIROC2 chips:
  - ADC Gaussian response
  - ADC linearity and stability tests
  - Bond gap measurement and correction
  - Noise level and stability
- Tests on SPIROC1 chips:
  - Preamplifier linearity
  - Fast shaper linearity
- Conclusions

Test bench setup

Power pulse generator

Voltmeters

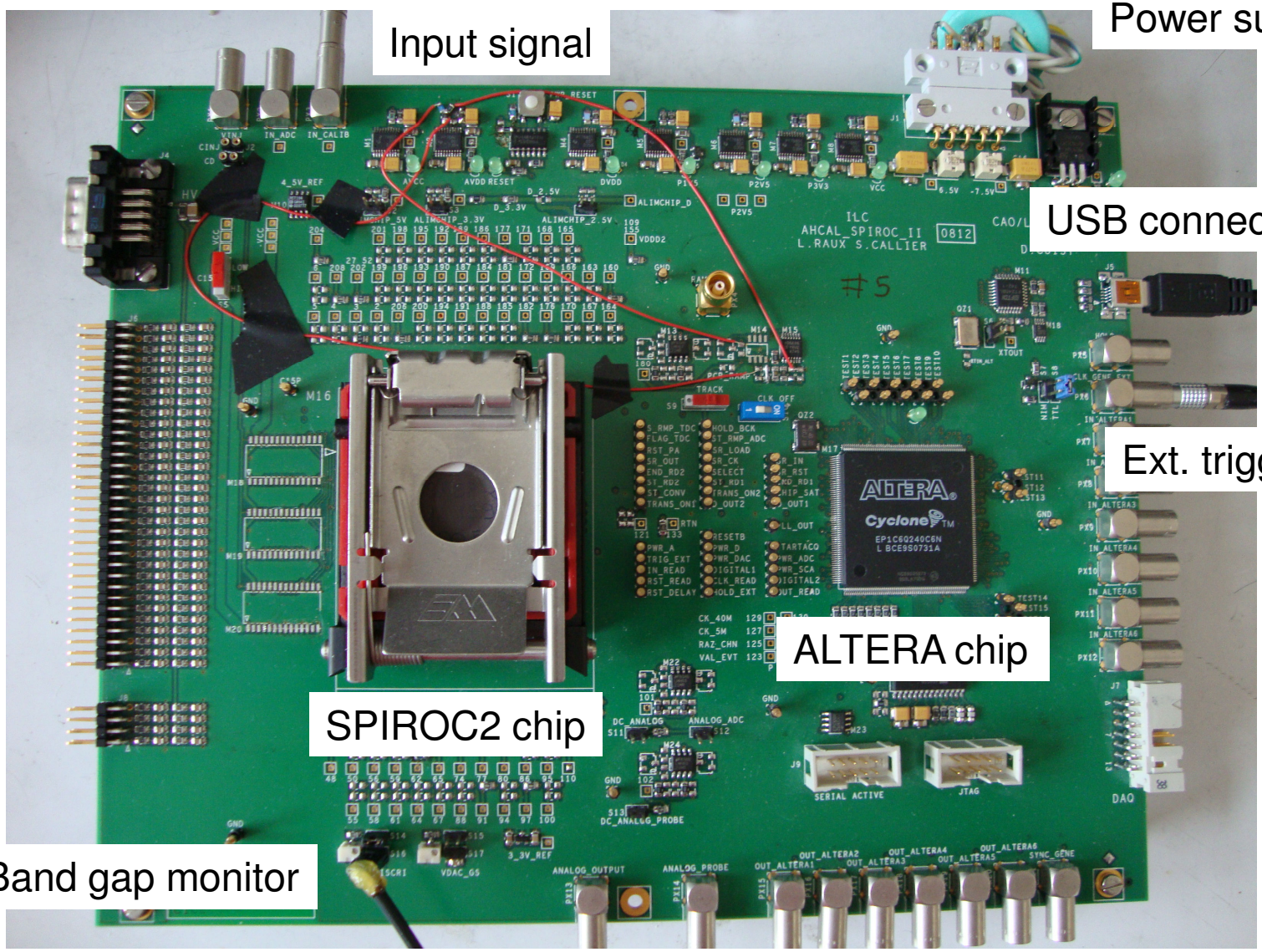
Power supply



Test board with SPIROC2 chip

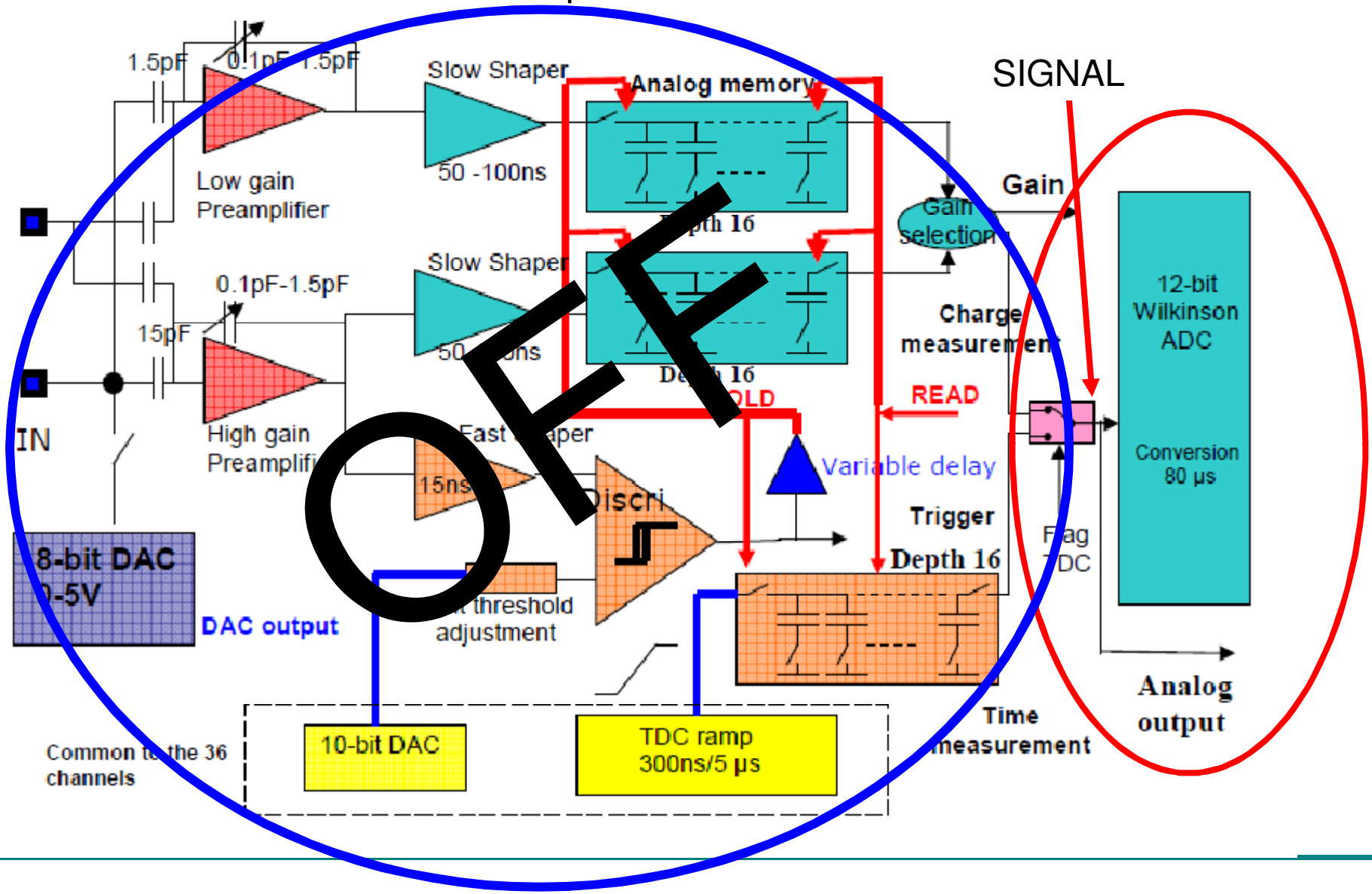
Laptop with LabView

Test bench setup



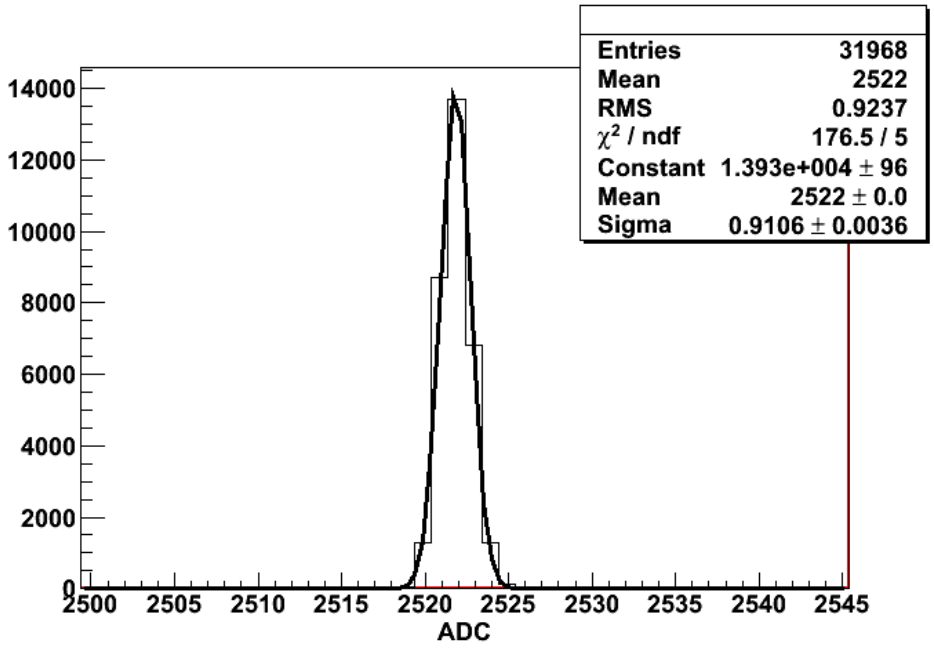
ADC test

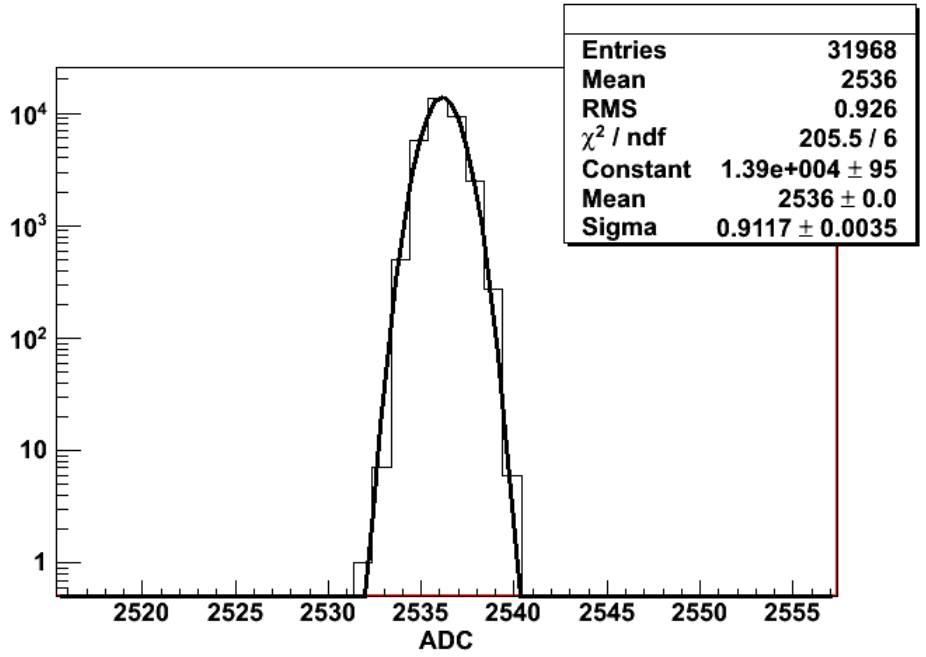
This scheme is repeated for 16 channels



Gaussian form

- Generator from 1.2V to 2.4V with 0.2V steps
- 32000 entries per step per channel



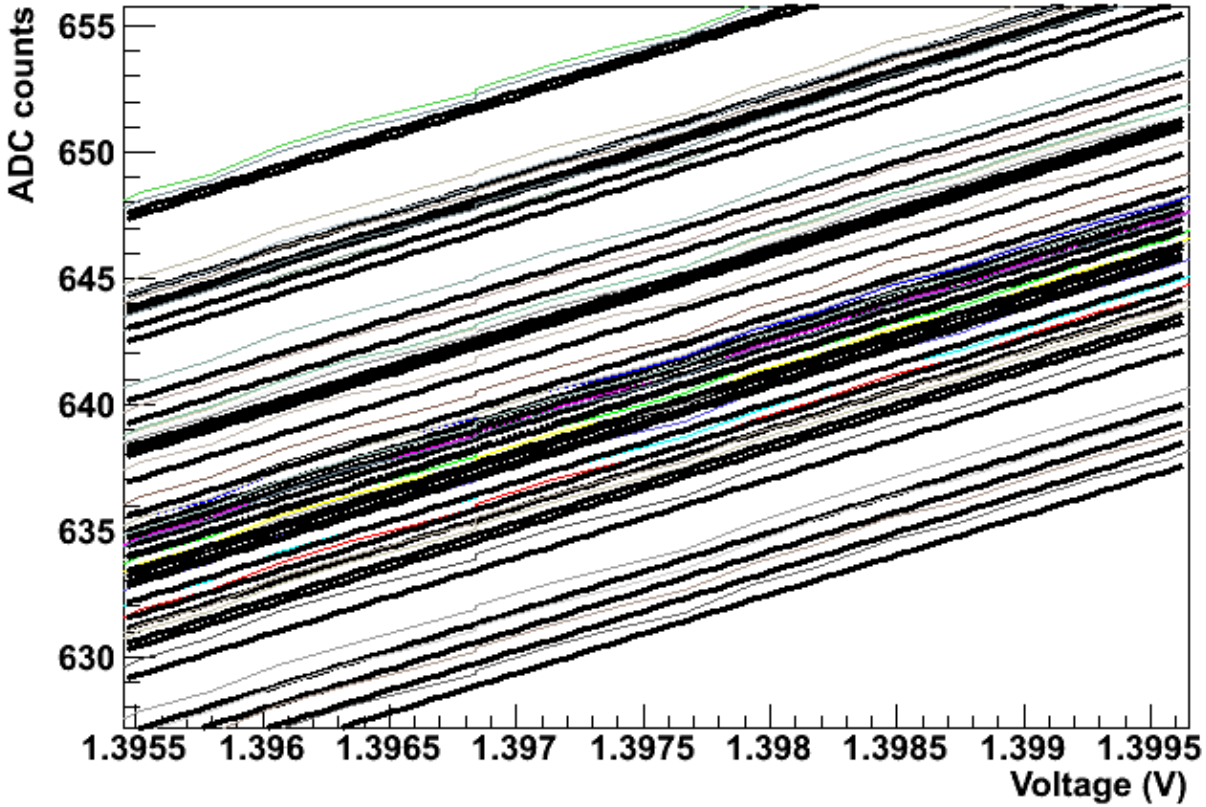


The response is not perfectly Gaussian (χ^2/ndf = 200/6) due to a small asymmetry

Linearity test

- Generator parameters:
  - from 1.2V to 2.5V
  - 250 μV steps
- 10 runs per step
- 16 measurement (depth of memory) per run
- All 36 channels received the same input
- Long time measurement
  - may be affected by instability of the chip
- Automated routine
- Analysis in ROOT

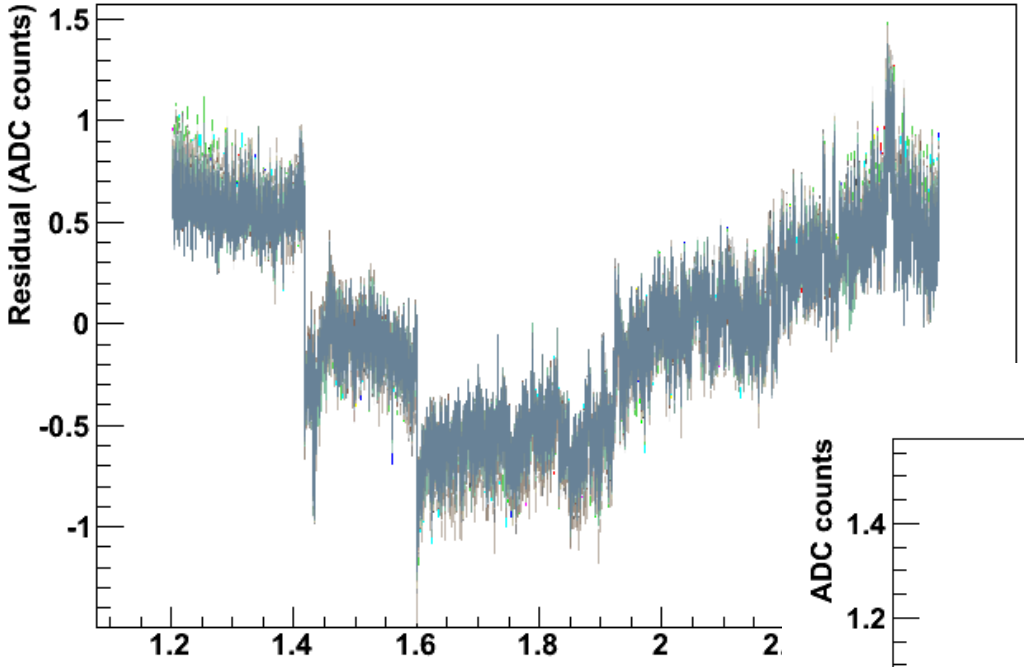
Result and fit



All 36 channels are plotted and fitted

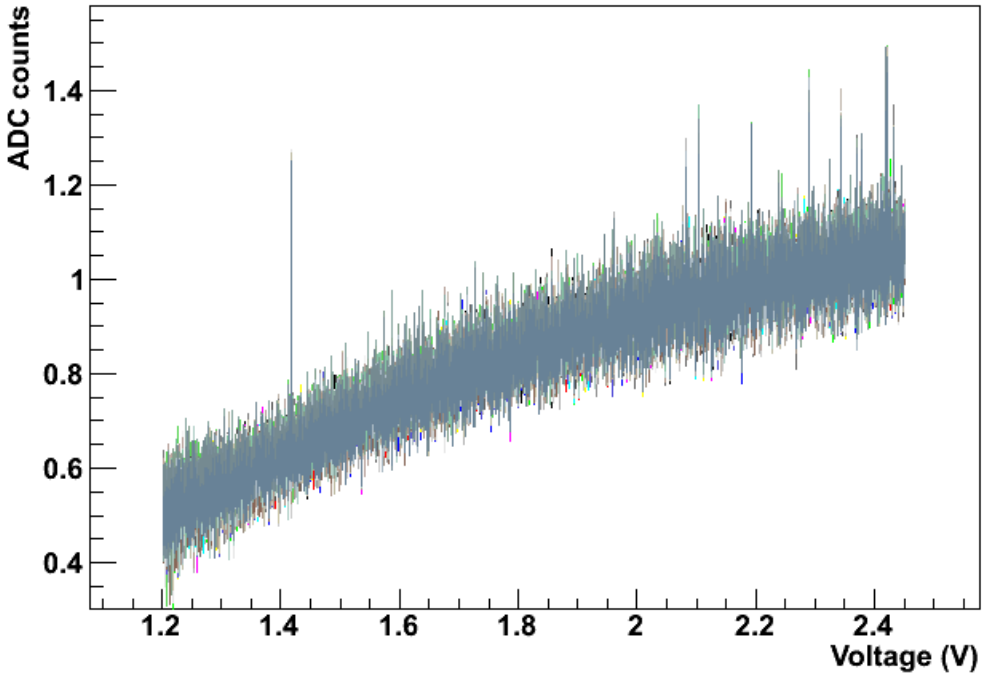
Residuals and RMS

Residuals



No major problems
Some instabilities in the residuals
Range +-1 ADC counts

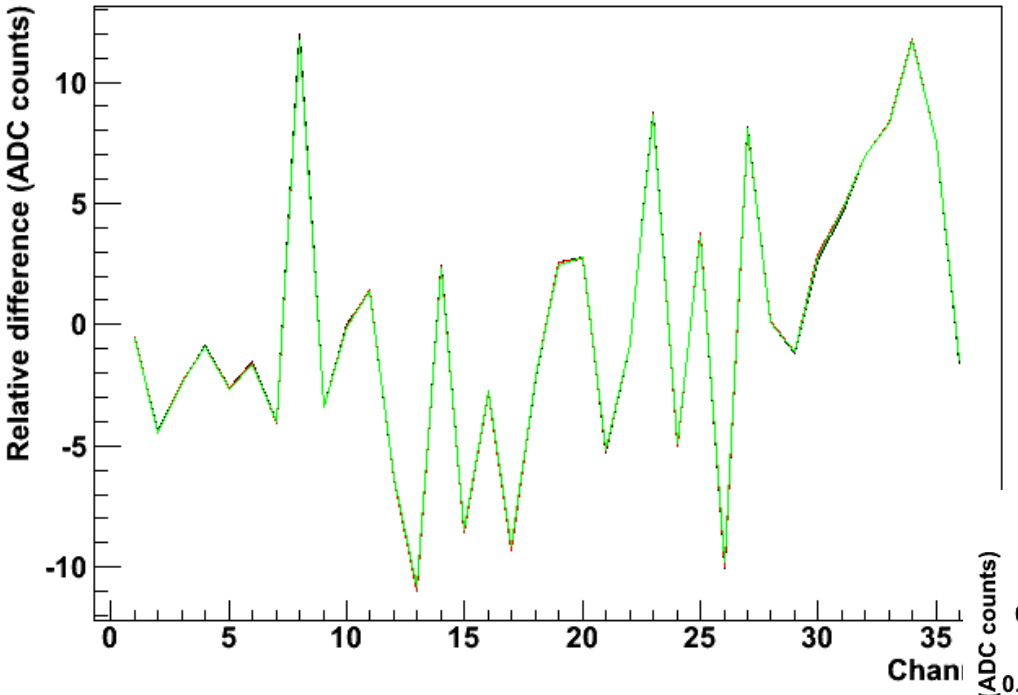
RMS



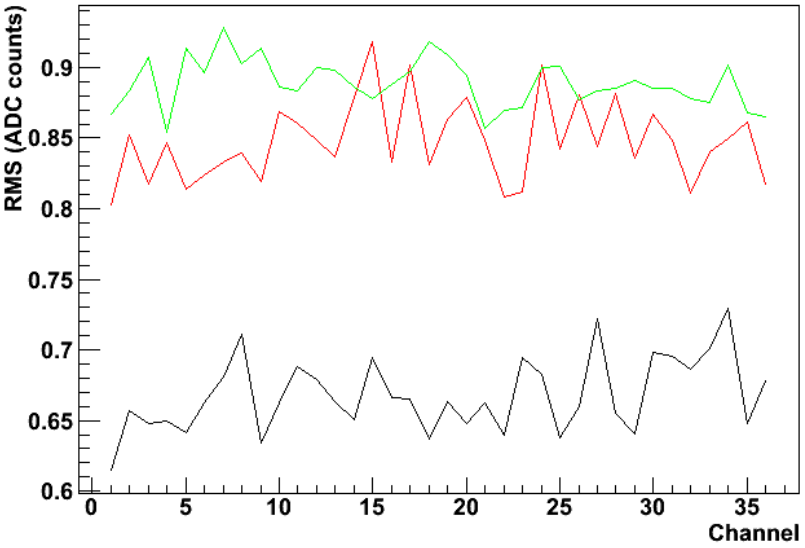
Spikes are due to known issues with the acquisition (see later)

Problem not present when using faster computer.

Comparison of 3 voltages



1.70V
1.95V
2.45V



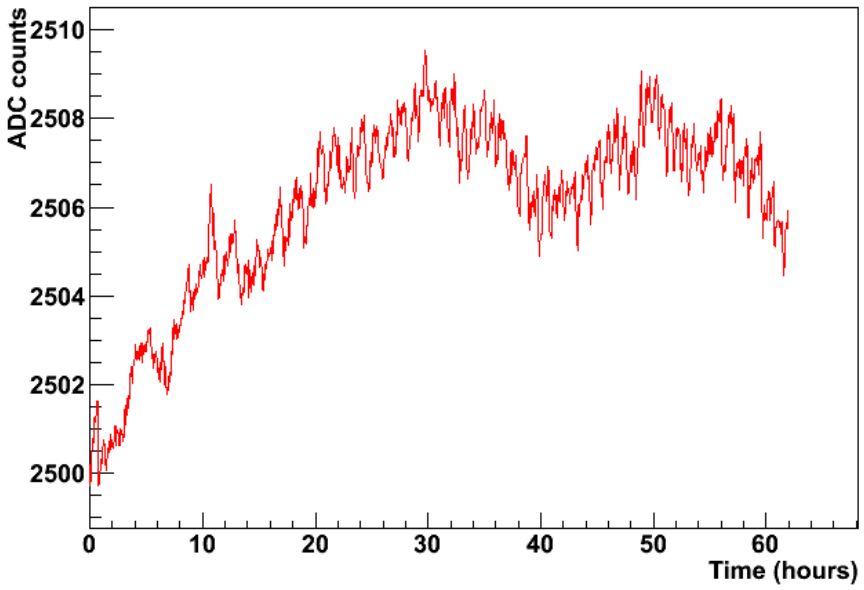
The shift between channels is constant as function of the voltage

The RMS are not correlated in the same channel at different voltages

Stability measurement

- Preliminary 50h measurement without control on band gap
- Then a 20h measurement
  - two voltages
  - Monitored both the generator voltages and the band gap value
- Measured performed during weekend (no people in the room) and with air conditioning to stabilize the temperature
- Band gap correlated with ADC output in order to characterize its effect

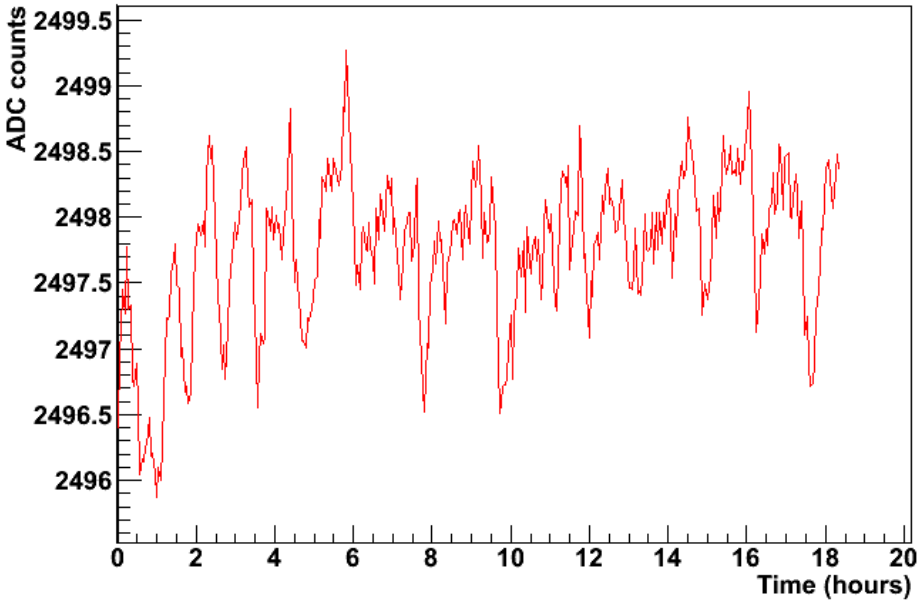
Stability



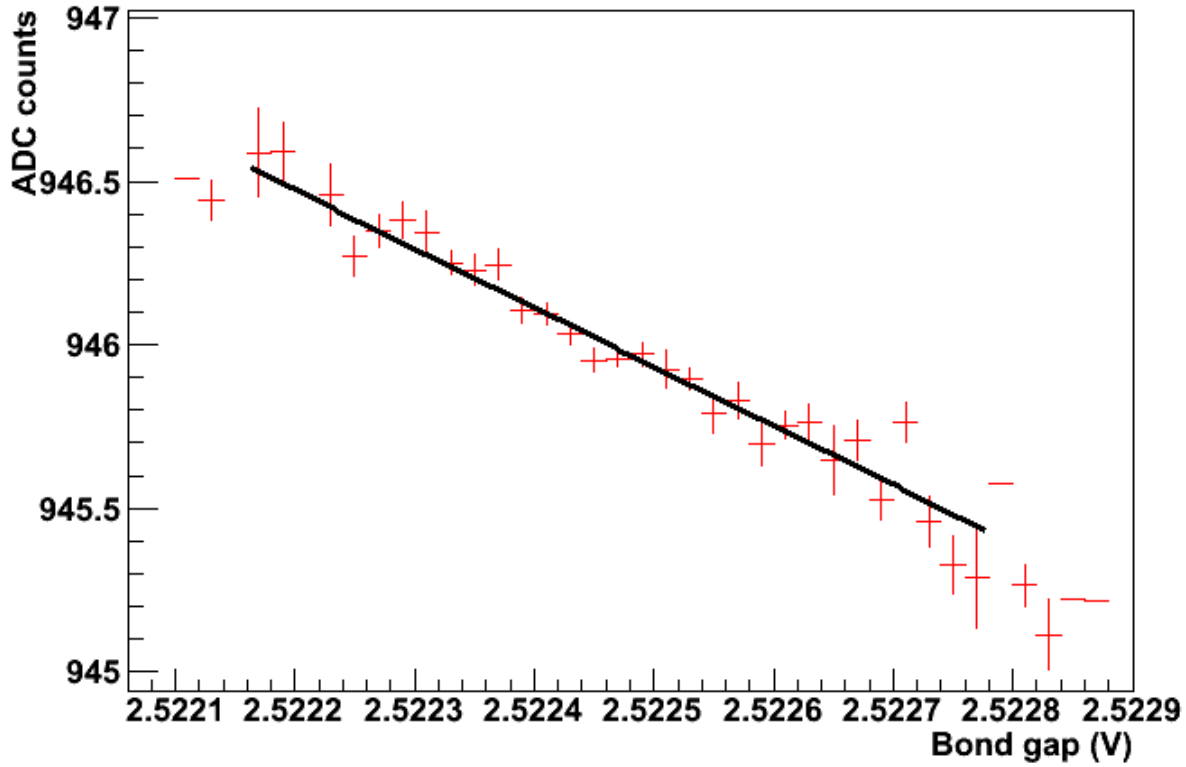
Problem with band gap caused an drift of 8 ADC counts

Once the band gap was fixed the drift was reduced to 3 ADC counts in 20 hours

Periodicity observed in both ADC and generator output, maybe due to air conditioning turning on and off



Band gap correlation

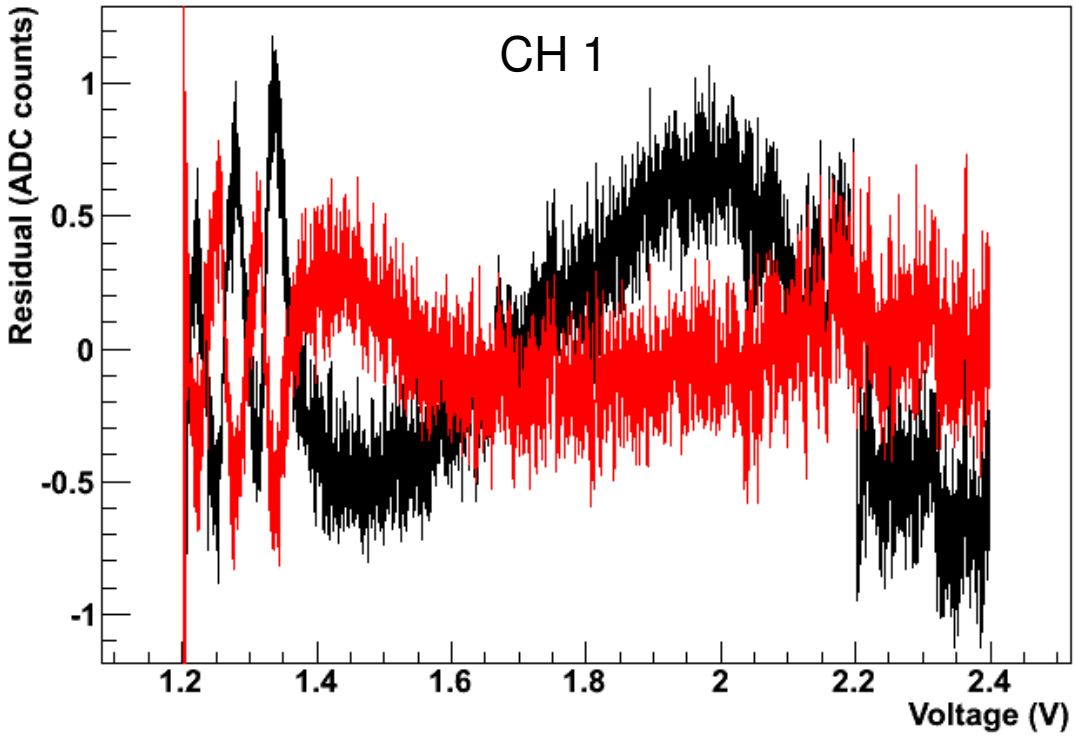


Band gap correlated with ADC output

The points were fitted with a linear function to correct the linearity measurement

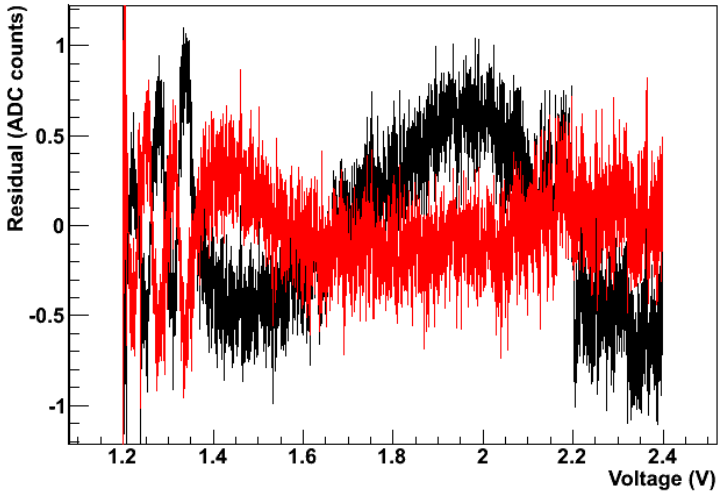
Corrected linearity

- Correcting the points using the BG information and the function obtained before
- The residual reduced from ±1 to ±0.5 ADC counts



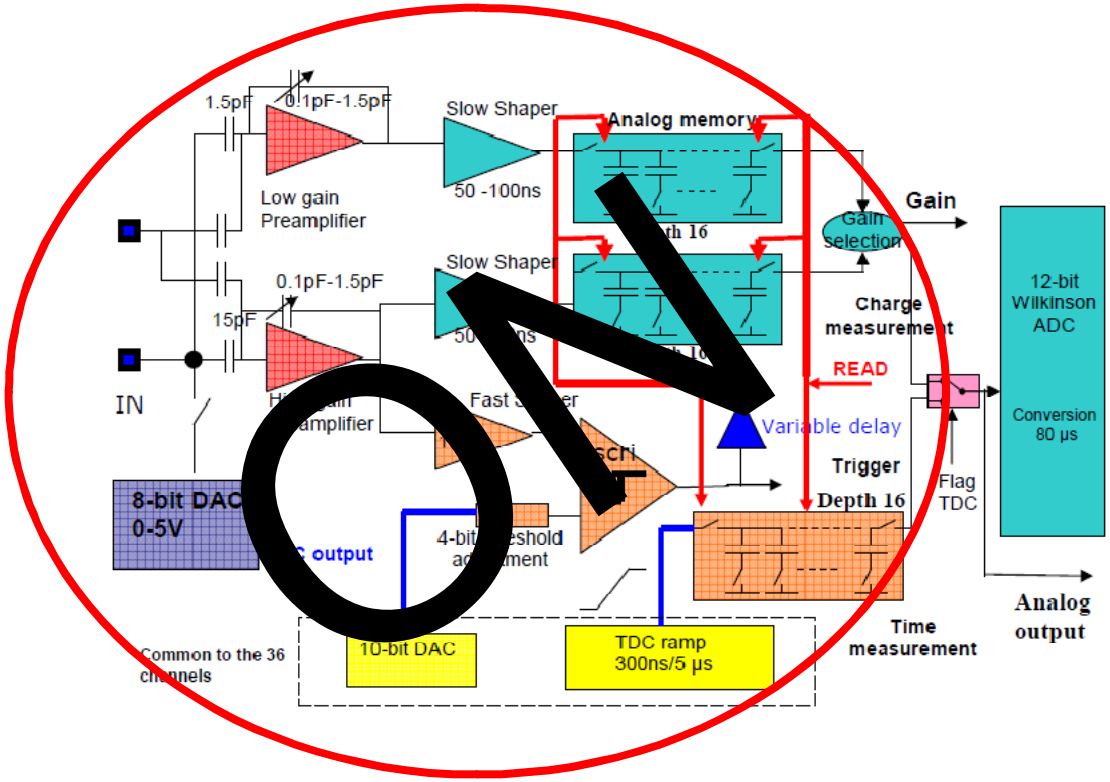
Non corrected

Band gap corrected

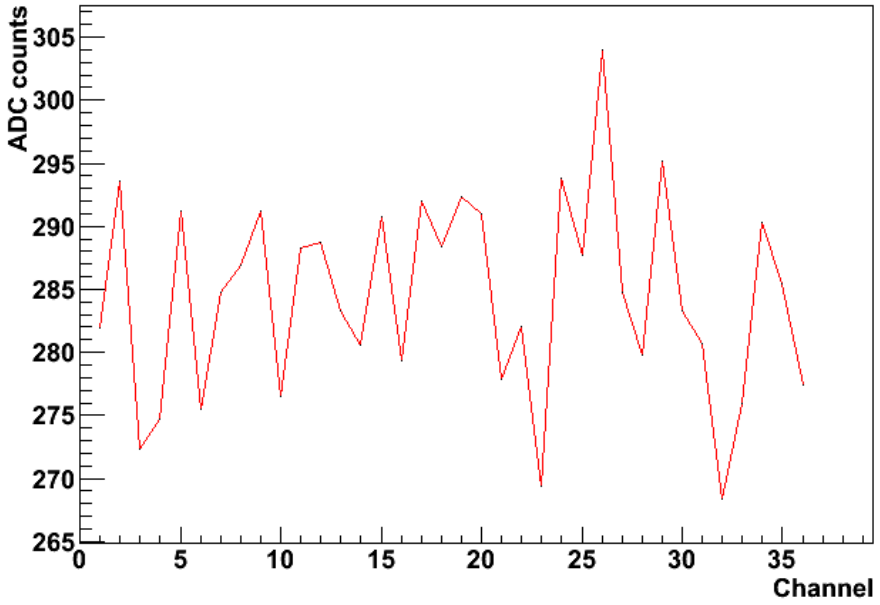


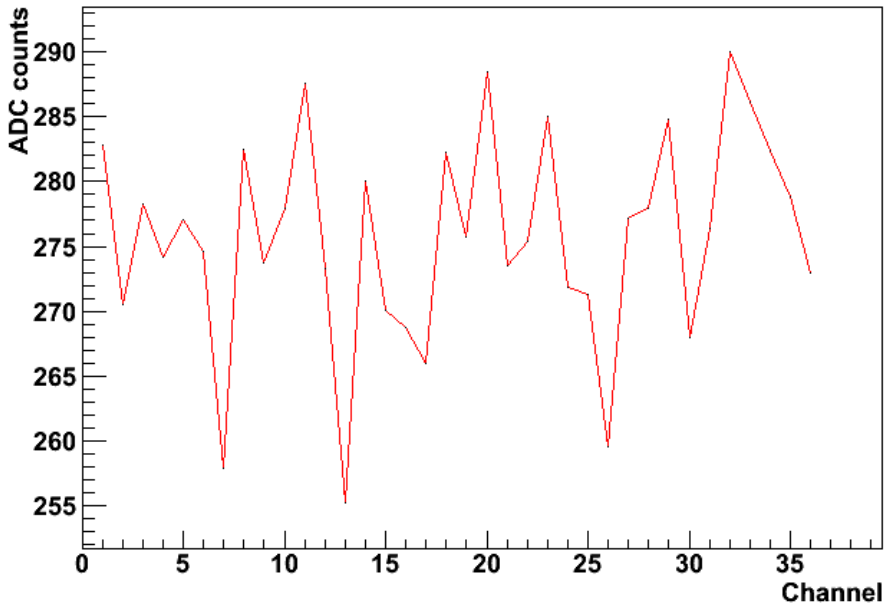
Noise measurement

- Electronics in front of ADC is activated and ADC output measured
- Similar to noise measurement



Noise level



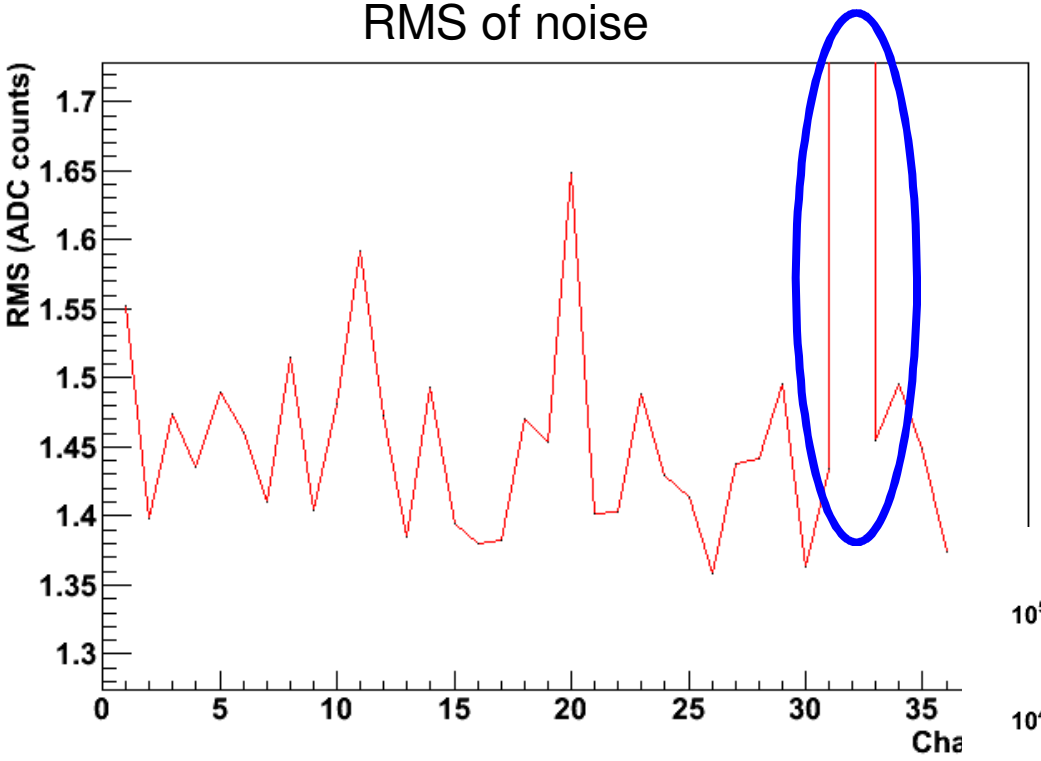


Similar level of noise in the two chips

No correlation between the two chips, hence the noise is not correlated to the chip design

Noise level

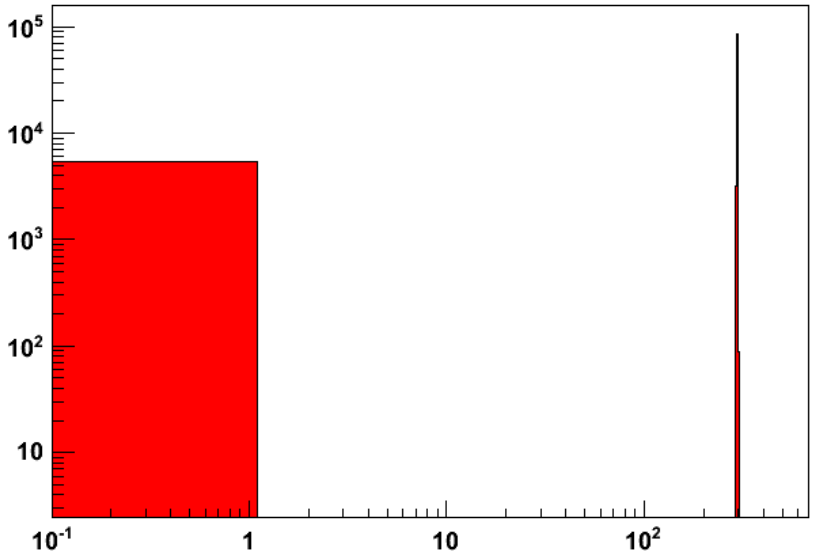
RMS of noise



Clear problem in channel 32

High number of 0s increase the RMS dramatically, the problem is due to lag in communication with laptop

The RMS is normal once the 0s are removed

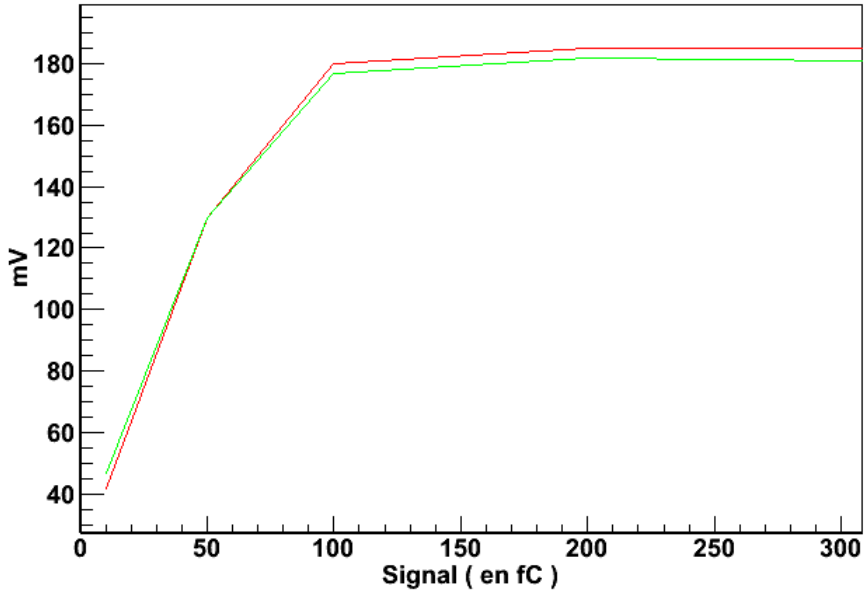


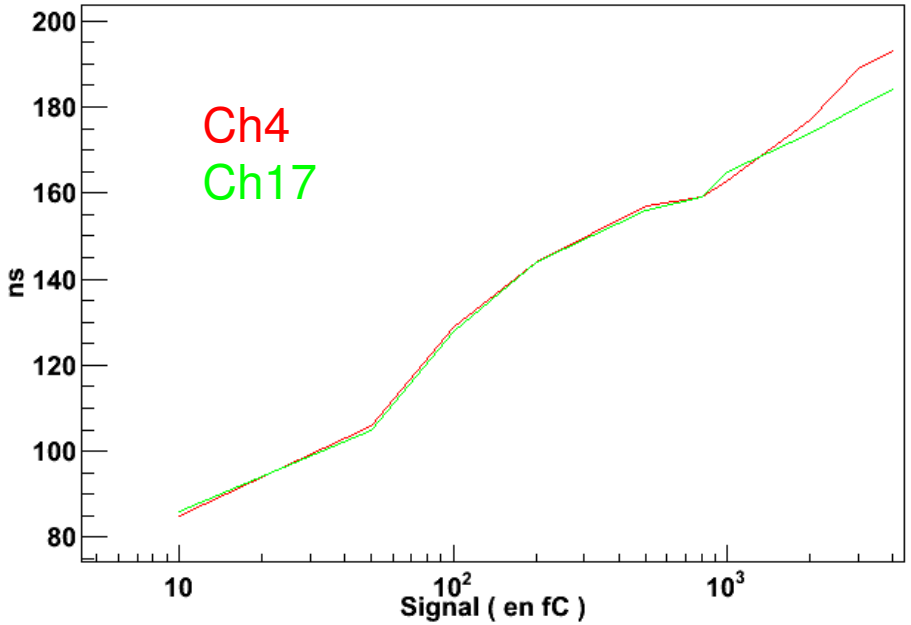
Measurements on SPIROC1

- Simpler setup than before
  - no automated measurement
- Signal injected manually varying input charge or internal gain
- On SPIROC1 it is possible to probe internal points in the chip
  - the signal after each component is measured at the oscilloscope
- Study of pre-amplifier, fast shaper and slow shaper
  - raise time, length, value of maximum
  - focus on fast shaper

Linearity of fast shaper

- Gain is fixed (200fF)
- Value and time of maximum of the output from FS as function of injected charge



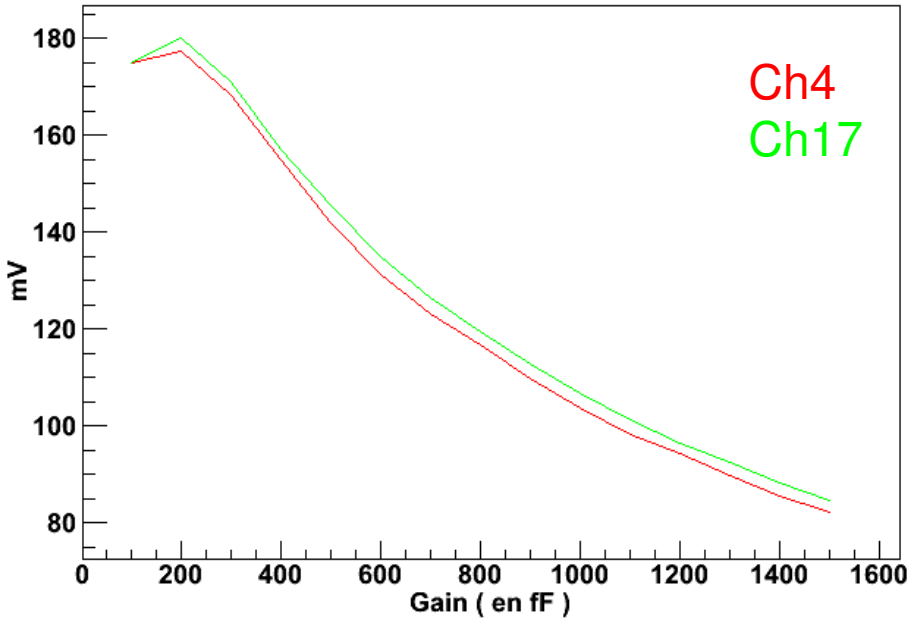


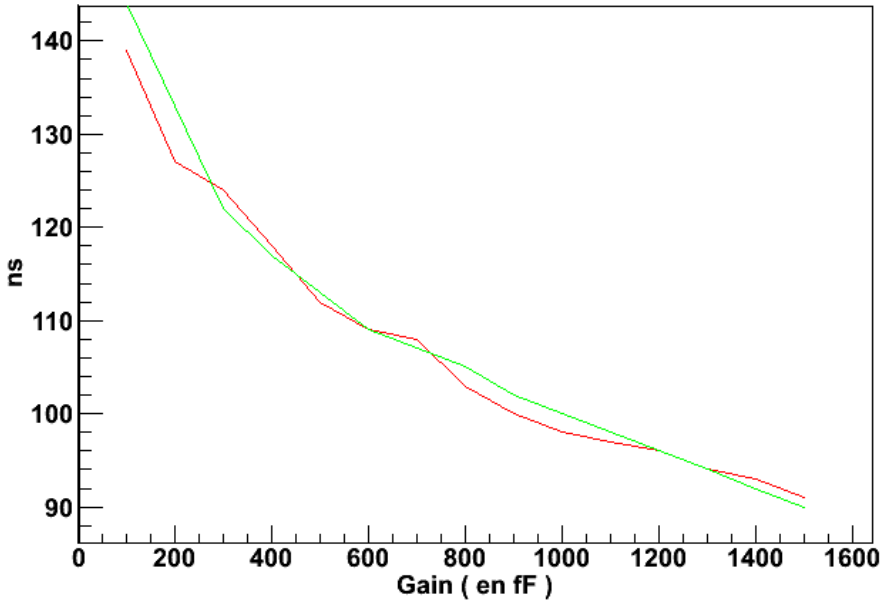
The FS is linear up to 100 fC

The time response is logarithmic for a larger range

Fast shaper

- Now fixed charge (100fC)
- Same measurements changing internal gain





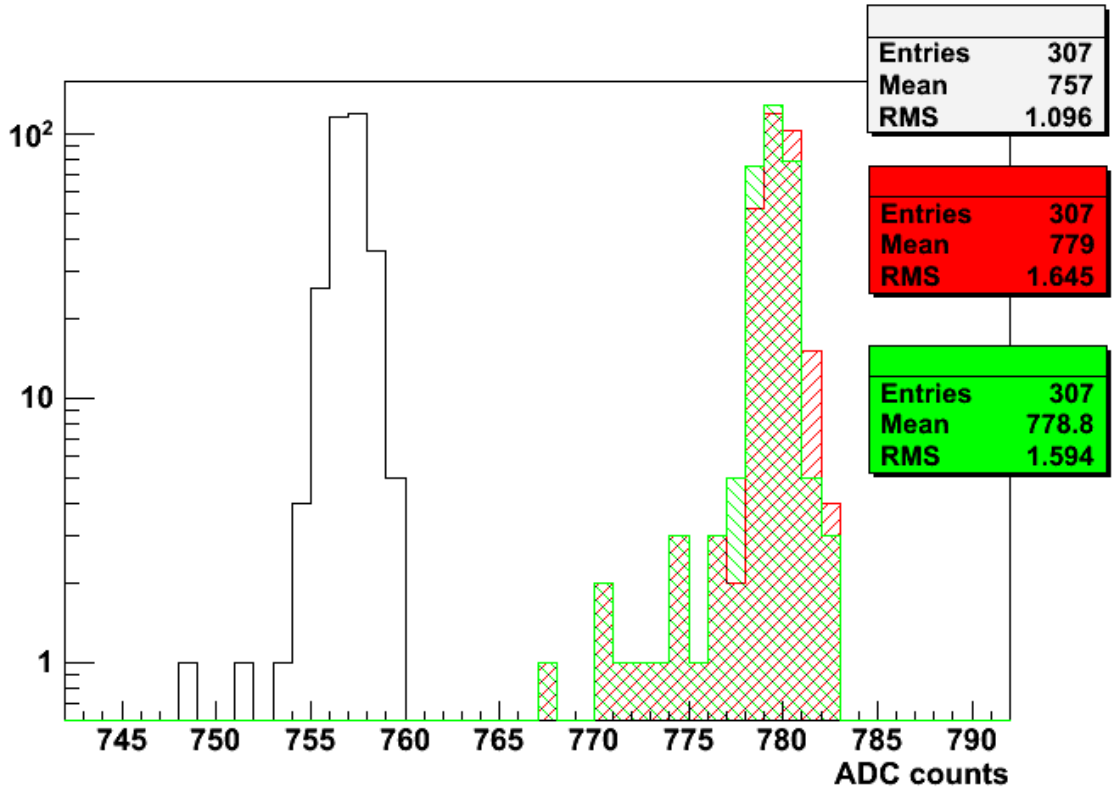
Expected 1/gain behavior in both for both maximum and the time at which it is reached

Conclusion and outlook

- Important experience for future performance studies
- ADC is working correctly once connected to fast pc and BG is monitored
  - Need to test in power pulsing mode
- Band gap need to be stabilised
- The full acquisition with SPIROC2 chip still need some debugging
  - difficult due to lack of internal probe
- More test will be performed on analog part of the chip to fully characterise all components

Backup Slides

Gaussianess of signal



Ch 12

Ch 33

Ch 8

- When changing voltage, a small tail appears
  - Larger for channels with higher mean
  - Identical for both channels!!!
  - Not at all voltages