First results of calibration of HVStripV1 chips

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CMOS Group Meeting

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Work done so far...

→ Calibration done on every pixel of the chip
  ↪ thanks to an automatized procedure

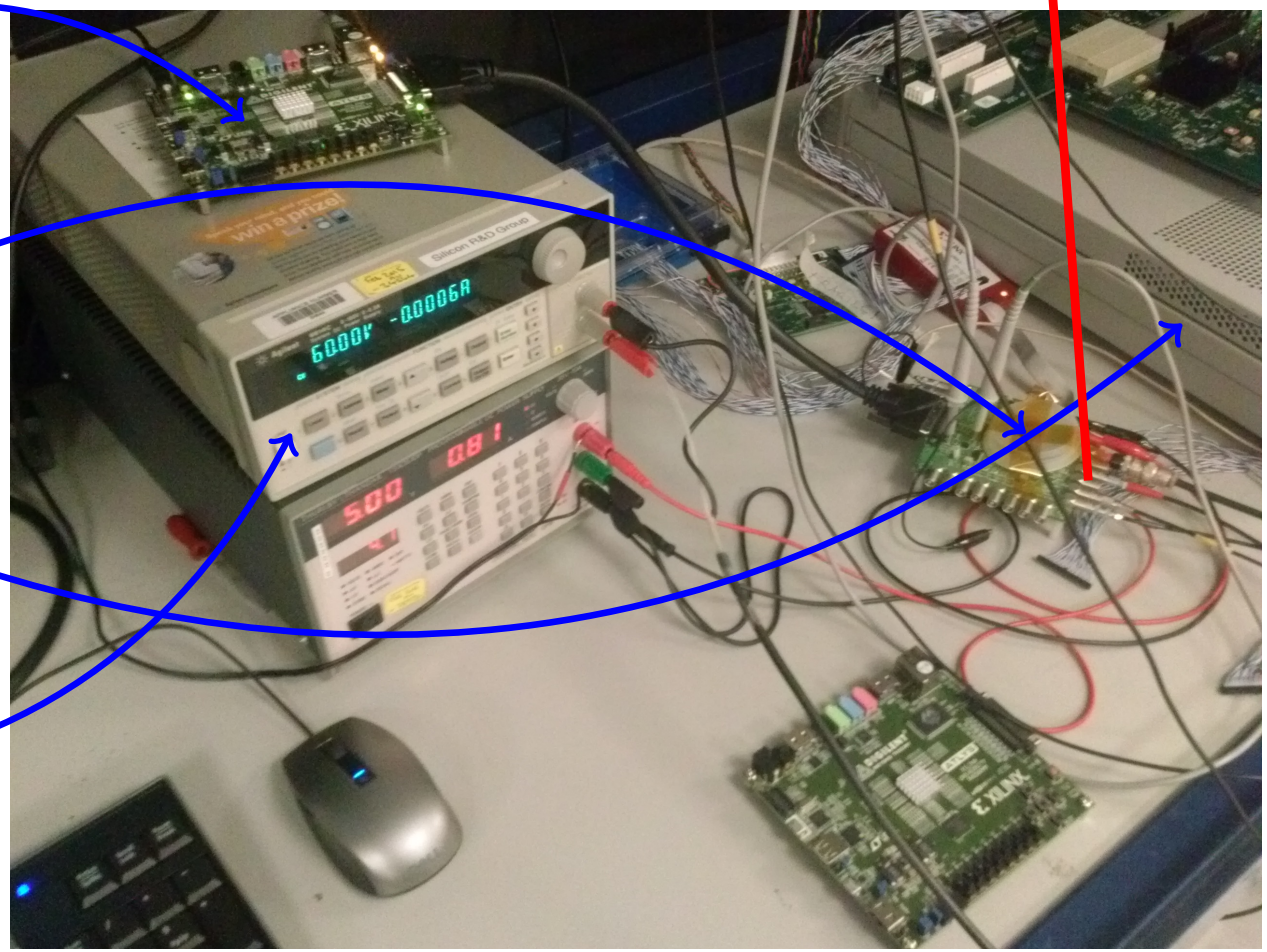
→ Gain map produced

→ Noise map produced

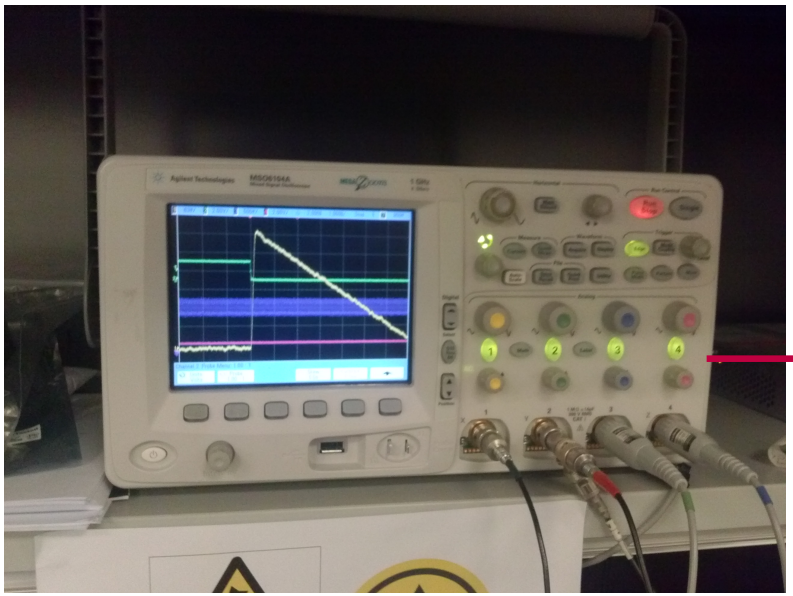
Physical set-up

Analogue output to oscilloscope

- Atlys board
- Sensor and chip
- Wave generator
- HV supply

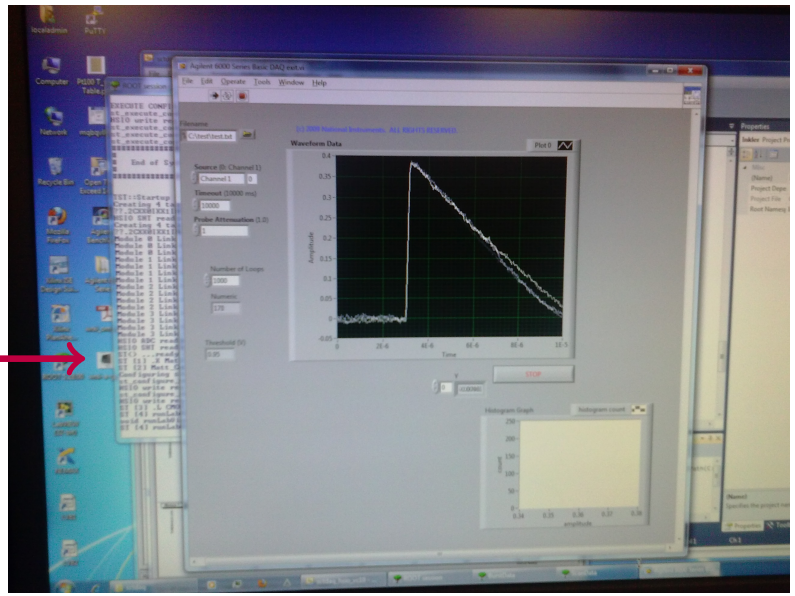


The oscilloscope:



Agilent oscilloscope

USB connection



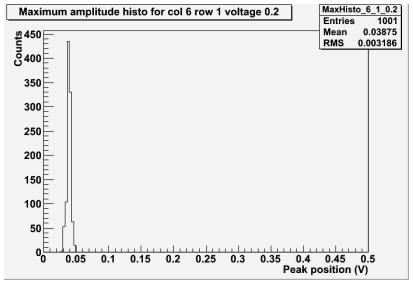
LabView program on computer

The procedure:

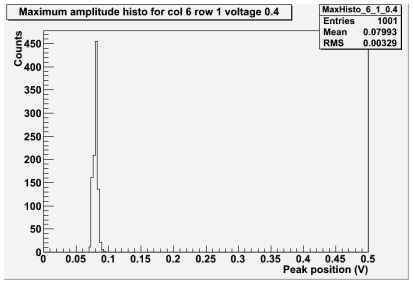
- → Loop on every pixel
  - → Loop on injection voltage from $0.2V$ to $2V$ at step of $0.1V$
    - → Inject
    - → Run LabView Program
      - → Takes 1000 waves samples
      - → Stores them in a txt file
    - → Collect all the peak maxima for each pixel and injection voltage
  - → Plot the mean peak maximum as function of the injection voltage

A ROOT macro has been developed for this.

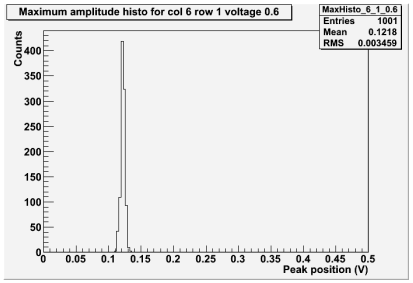
Peak distributions



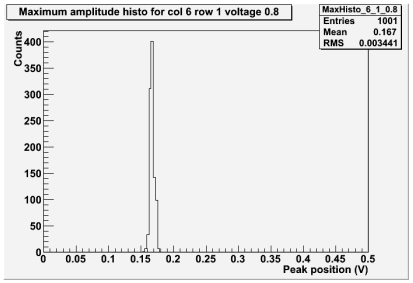
Injected V 200 mV



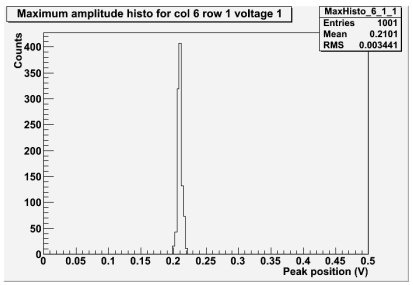
Injected V 400 mV



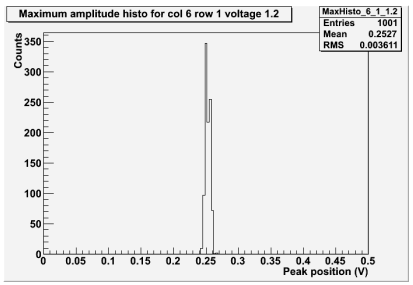
Injected V 600 mV



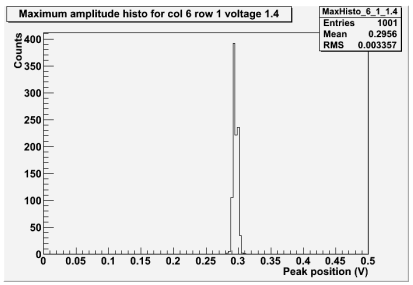
Injected V 800 mV



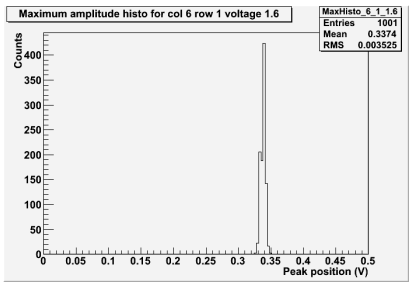
Injected V 1000 mV



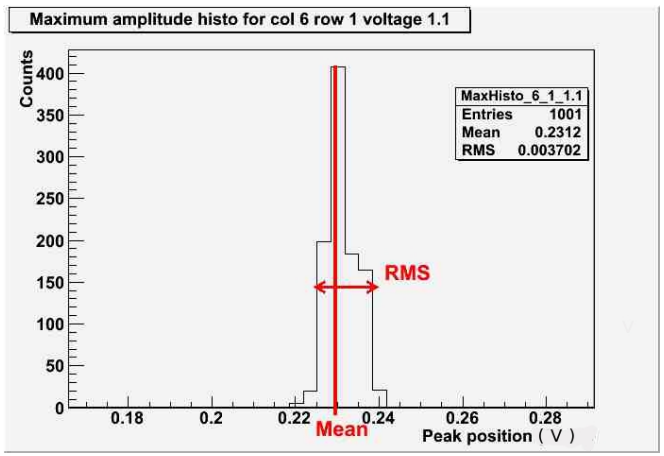
Injected V 1200 mV



Injected V 1400 mV



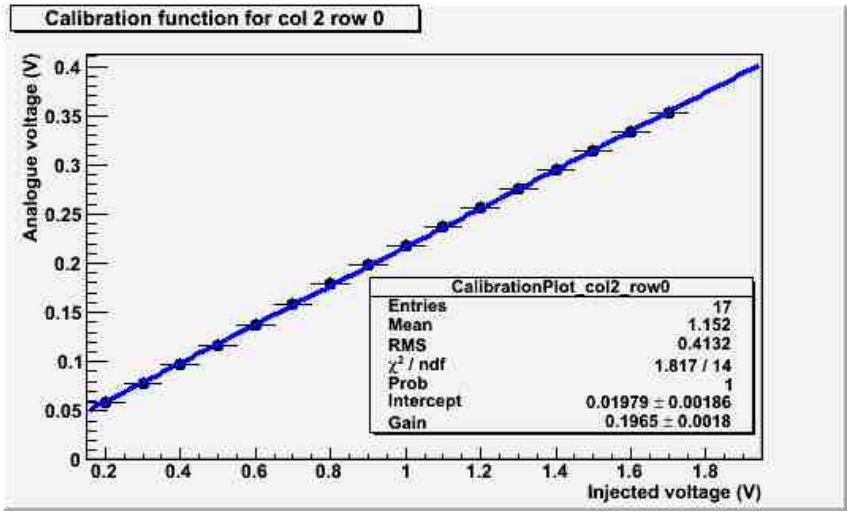
Injected V 1600 mV

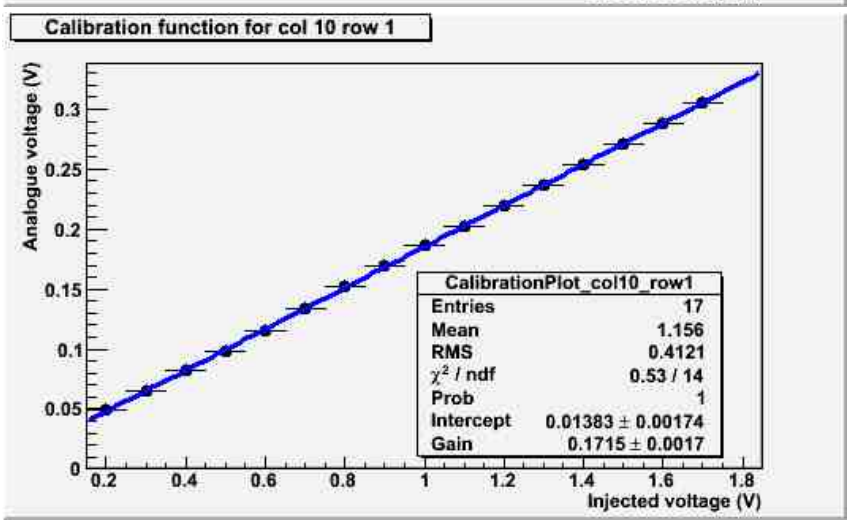


In detail:

- Gain point is set at the mean value of the distribution
- Noise is considered as the RMS
- Conversion to e^- is applied assuming the injection capacitance of $0.5fF$ (nominal)

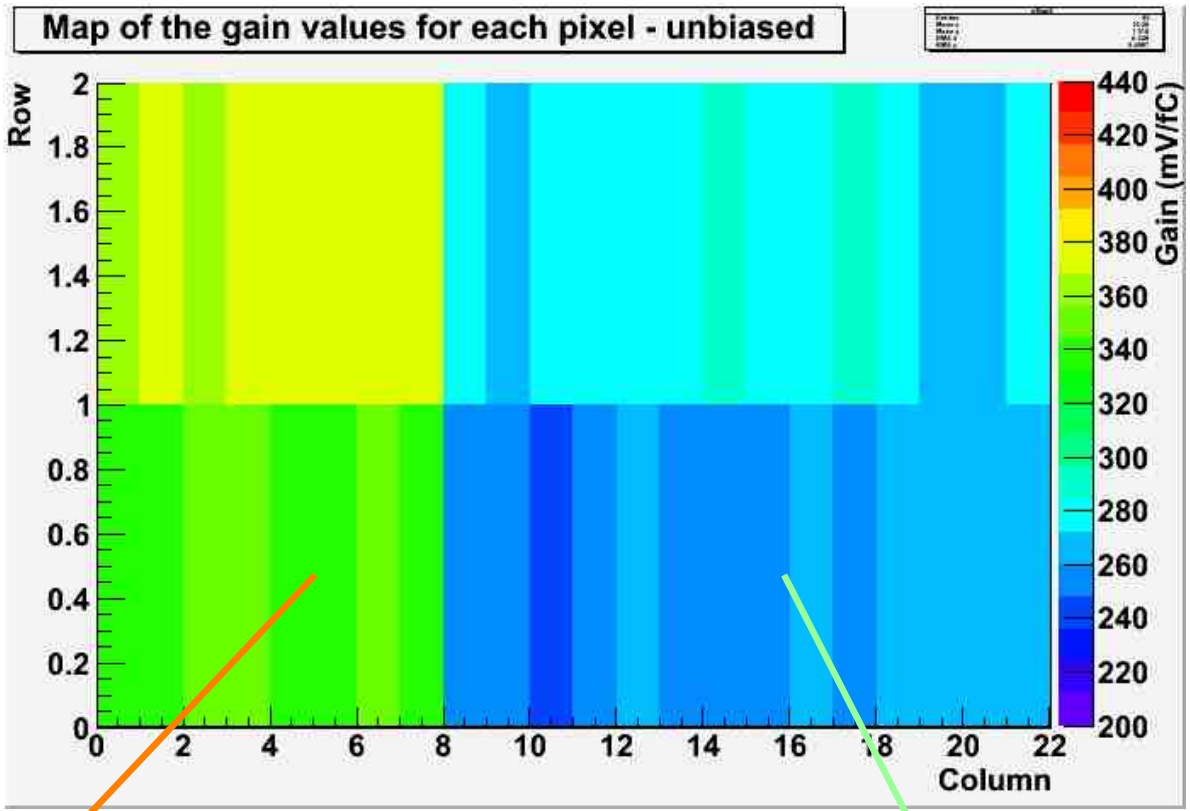
Some examples of calibrations (before biasinig):





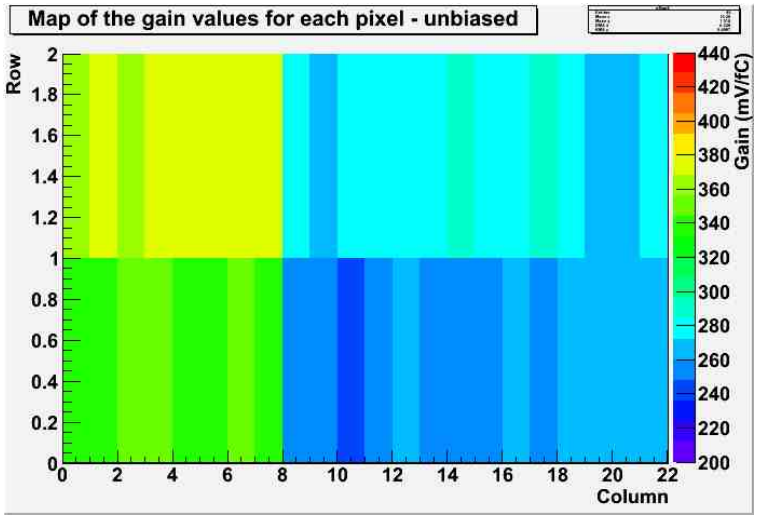
Found a generally good agreement with a straight line fit.

The gain map

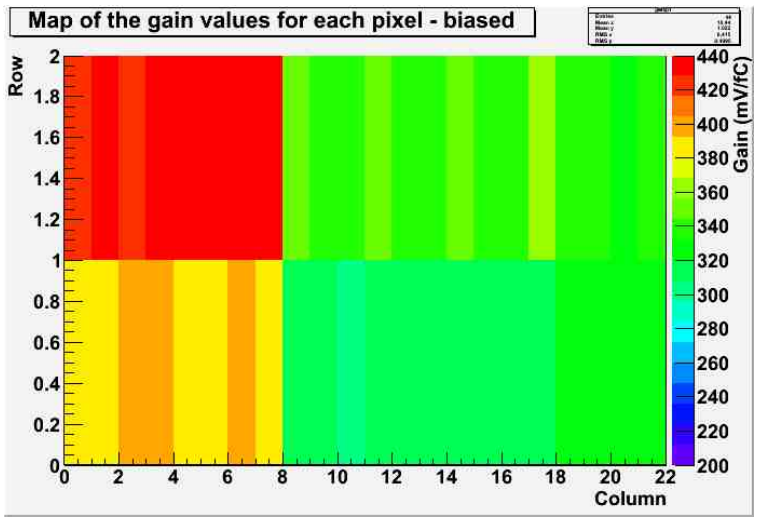


Pixel area with higher gain

Pixel area with lower gain

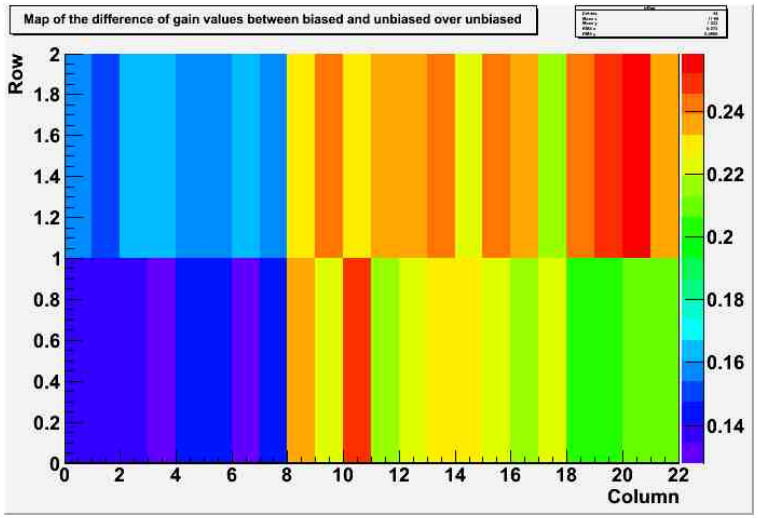


Before biasing the chip



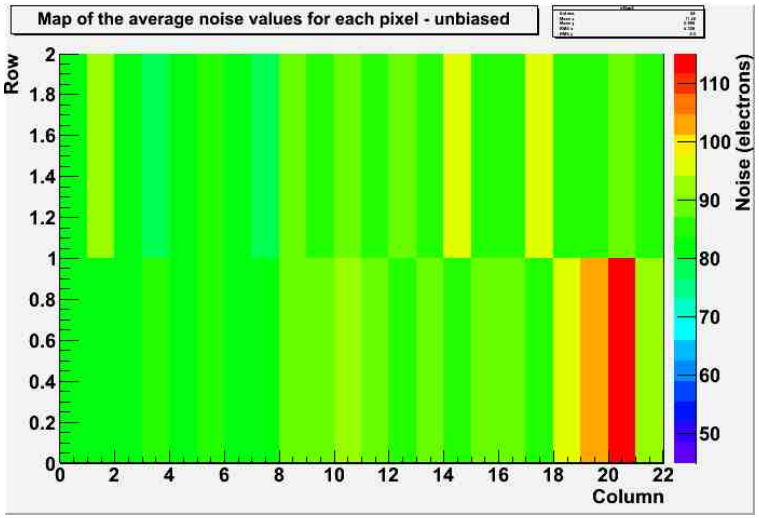
After biasing the chip

Before and after biasing (-60V)

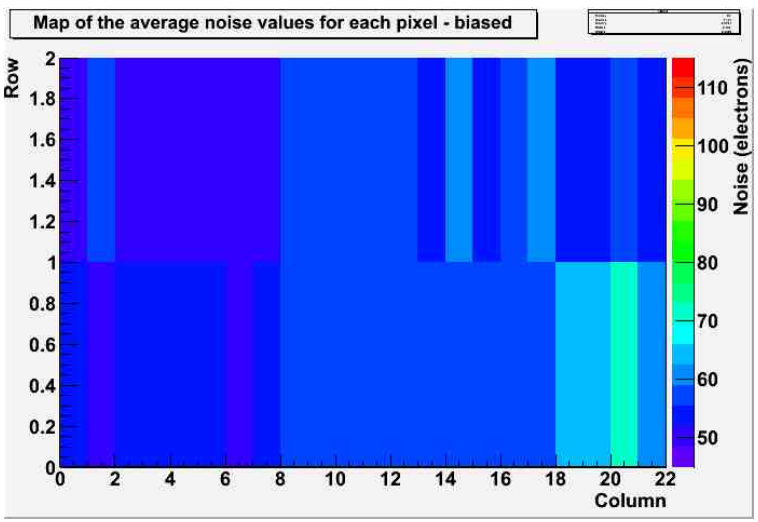


$$\frac{gain_{biased} - gain_{unbiased}}{gain_{unbiased}}$$

Significative difference: the gain has increased of about 15÷20%, with some peaks at 25%



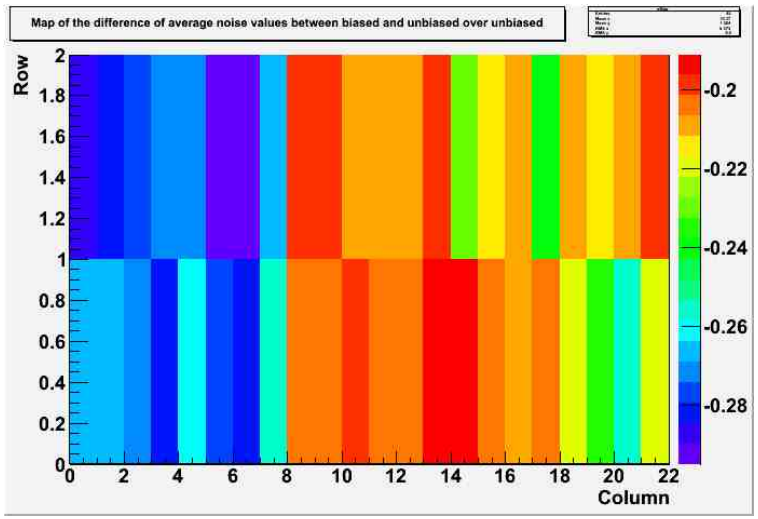
Before biasing the chip



After biasing the chip

Noise before and after biasing

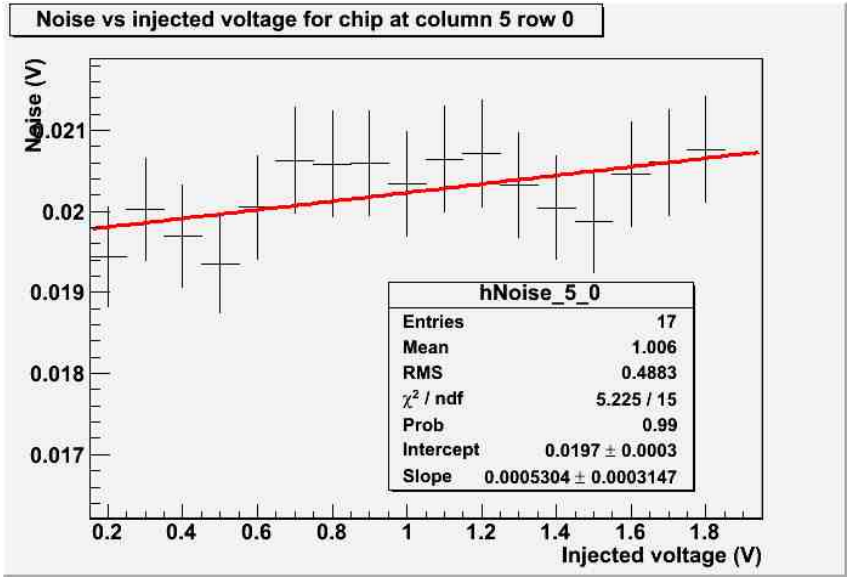
The value of gain has been used to convert the RMS of the peak maxima distribution to the noise wrt the injected charge.

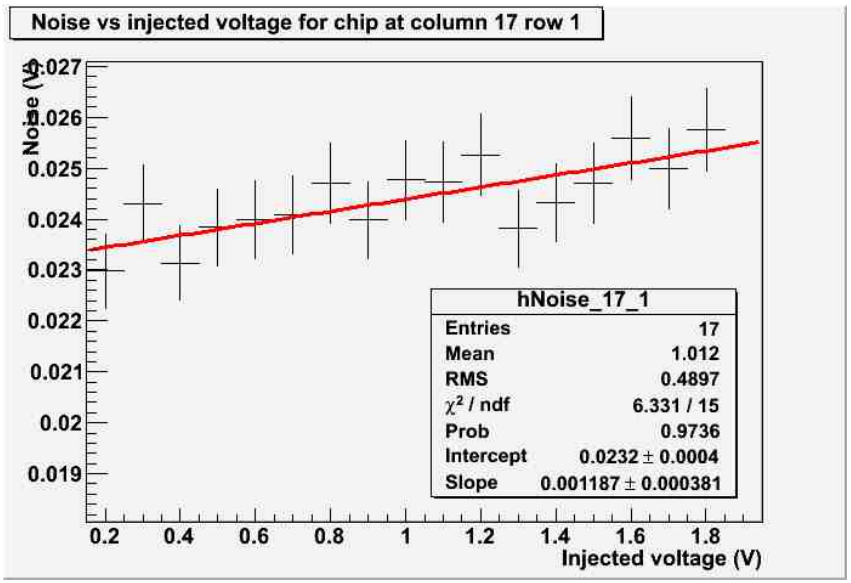


$$\frac{noise_{biased} - noise_{unbiased}}{noise_{unbiased}}$$

A general decrease of the noise after biasing is observed, as expected. The difference seems vary in the 2 sections...

Some examples of noise vs injected voltage (biased):

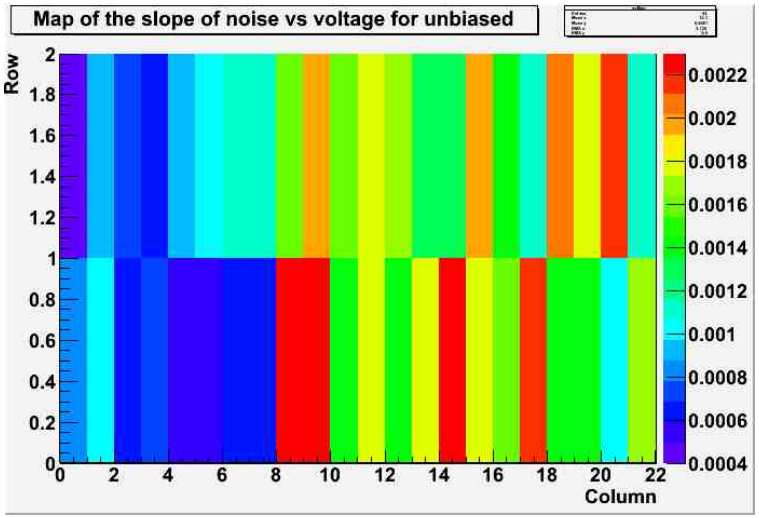




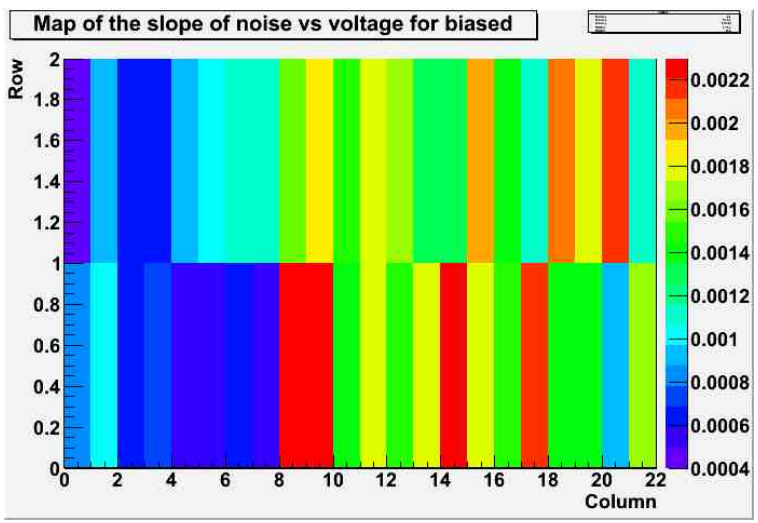
Very tiny variation, almost flat.

Note: both injection voltage and noise are in Volts, noise has been inverted wrt the gain, so the slope can be actually the increment of noise in electrons wrt the charge injected.

A map of the slope value for each pixel can be produced...

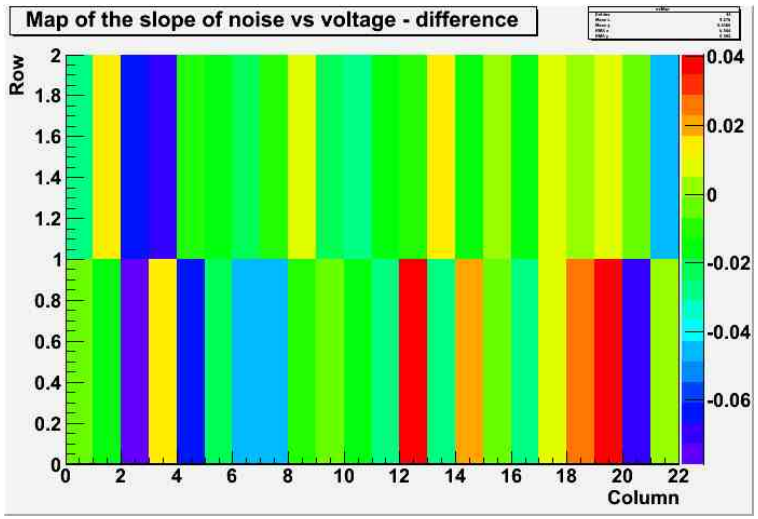


Before biasing the chip



After biasing the chip

Noise dependence on injection before and after biasing



$$\frac{slope_{biased} - slope_{unbiased}}{slope_{unbiased}}$$

The noise increases with increasing injection by a very small value. No big variation after biasing.

Conclusions

- √ Calibration procedure implemented and authomatized
- √ Gain values different in 2 portions of the chip, as expected
- √ Unexpected variation in gain after biasing
- √ Noise values different in the 2 portions as well
- √ Noise decreases after biasing

Next steps:

- → Test with Fe^{55} source
  - ↪ helps us calibrate the sensor with precision.
- → S-curves
- → Beam tests
- → Complete pre-irradiation characterisation
- → Begin irradiation campaign