Iron 55 Calibration and Relative Efficiency on HVStripV1

CMOS Group Meeting

Luigi Vigani

University of Oxford

9 December 2014

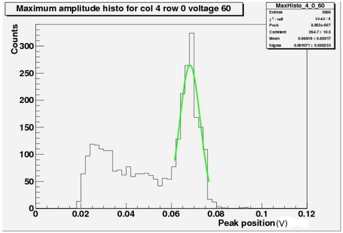
Update on the latest work on HVStripV1 pixels at Oxford:

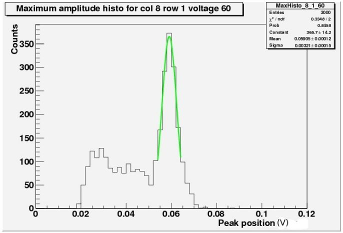
→ Calibration performed with Iron 55 source.
(with such an automated procedure as the one used previously)

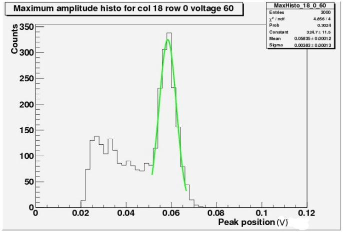
→ Relative efficiency extrapolated from decay time.

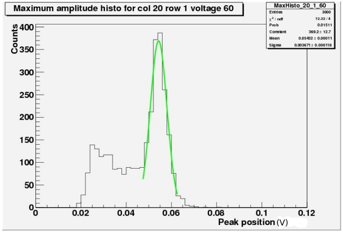
Some examples of Iron 55 peaks

Note: bias voltage 60 V.







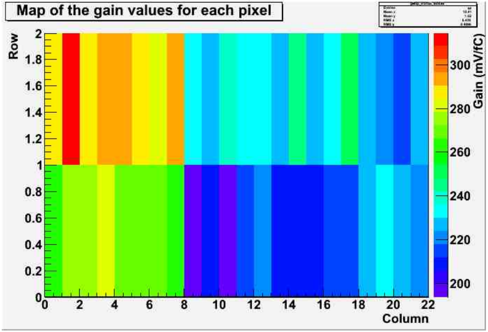


Gain Map

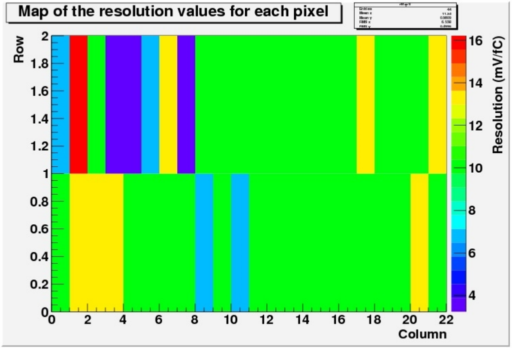
Assuming X-rays from Iron 55 are $5.9keV$ and the pair production energy in Silicon to be $3.6eV$, we have

$$Gain[\frac{mV}{fC}] = [V]_{read} \times 1000[\frac{mV}{V}] \times \left(\frac{5900eV}{3.6eV/e} \times (1.602 \times 10^{-4}[\frac{fC}{e}])\right)^{-1}$$

We obtain this:

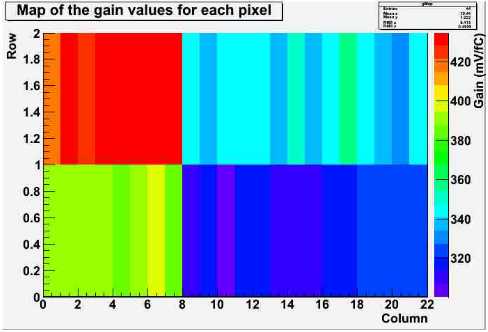


The RMS of the peak, instead, can give us an hint about the energy resolution and noise of the pixels:

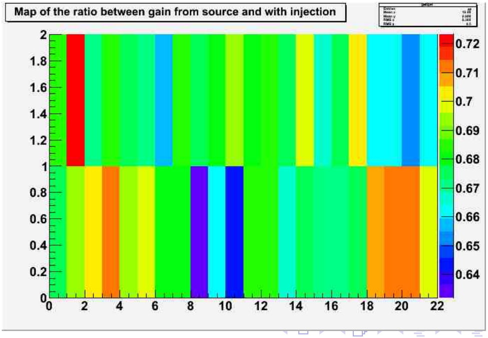


It seems to be fairly flat, apart from some fluctuations in the higher gain part.

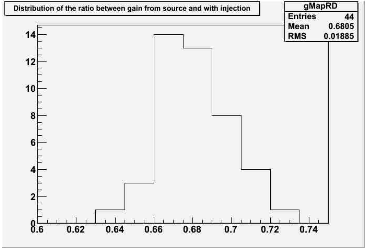
Recalling that the gain map we obtained with the injection procedure was:



We can plot the ratio between the gain map obtained with the source over the first one:



The distribution of this ratio for the pixels previously shown is:



Given this we can estimate the real value of the injection capacitance as:

$$C_{real} = \frac{C_{before}}{0.681} = (0.734 \pm 0.02) fF$$

The uncertainty is given by the RMS of the distribution: this can be a fluctuation on that value.

Relative Efficiency Map

In this run we were able to plot the time of arrival of the signal. The distribution of the time difference between two successive decays goes as an exponential with decay parameter

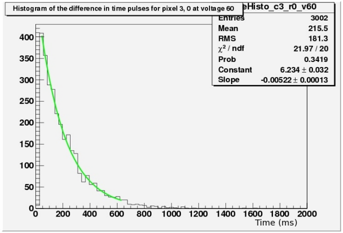
$$f(t) = Ae^{-\alpha t}, \; \alpha = \frac{N}{\tau} \cdot g \cdot e$$

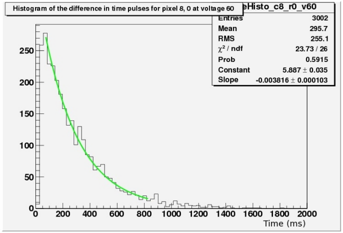
(Marsden-Barratt law, see H. Lindeman, N.Rosen: Physica 23(1957) p. 436)

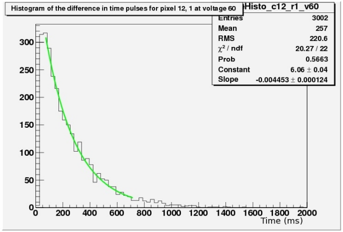
where N is the total number of atoms, τ is the decay time of the source, g is a geometrical factor and e is the efficiency of the pixel.
Therefore, assuming N, τ and g to be the same for all pixels, we can plot a relative efficiency map...

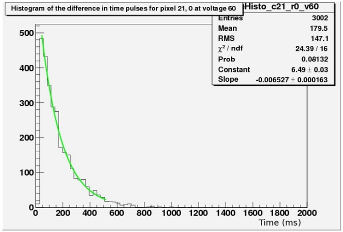
Some examples.

Note: bias voltage 60 V.

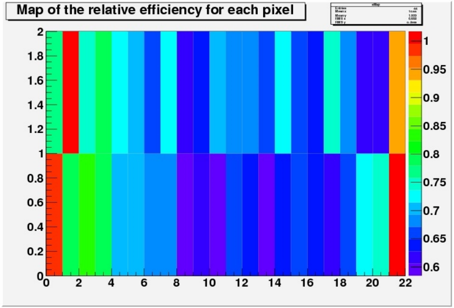








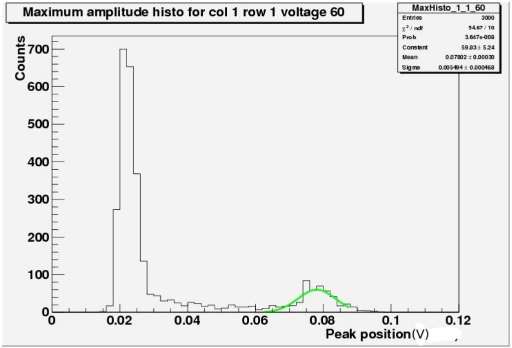
Taking the values of α and dividing by the greatest of them:



Notes:

- The pixels on the border are effectively wider than the others, their geometrical factor is higher, therefore the efficiency calculated here is higher.
- Geometrical factor is liklely to be important.
- Some hints that the higher gain pixels are more efficient can be observed.

One final note: pixel (1,1) has a strange spectrum (see image below), therefore, though it has the highest efficiency of all, we didn't consider it in the normalization of the relative efficiencies.



Conclusions

- √ Performed complete calibration with Iron 55 at 60 V bias
  - ↪ To be done at different bias to check the variations we already encountered.
- √ Result comparable with the previous one
- √ Implemented method to find relative pixel efficiency
  - ↪ Some more work must be done to reduce errors
  - ↪ Probably not very precise, but a quick and easy way to have some hints

What remains to complete pre-irradiation characterisation:

- → S-curves
- → Beam tests