Irradiation Studies on HVStripV1

CMOS Group Meeting

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Irradiation campaign

- Birmingham cyclotrone provides a 27 *MeV* proton beam
- 2 chips (named MB03 and MB04) were placed in a cold box to be exposed
- The procedure was the following:
  - $\rightarrow$ Expose MB03 for 15 mins
  - $\rightarrow$ Expose MB04 for 15 mins
  - $\rightarrow$ Stop the beam for 30 mins while taking data (injecting pulses of $\sim 2000 e^-$ and recording the analogue output with an oscilloscope)
- Repeated for 4 times, but no data recorded the second time

$\rightarrow$ The beam was tuned to obtain a final fluence of $\sim 10^{15} n_{eq}$, so $\sim 2.5 \times 10^{14} n_{eq}$ per step.

$\rightarrow$ From direct measurement it seems that not all the protons came to target, and the total fluence is estimated to be $8.77 \times 10^{14} n_{eq}$ for MB03 and $7.64 \times 10^{14} n_{eq}$ for MB04 ($\sim 2.1/1.9 \times 10^{14} n_{eq}$ per step for MB03/04).

After a couple of days from irradiation the activities were:

|	on MB03 ($\mu Si/hr$)	on MB04 ($\mu Si/hr$)
Ni foils	11	13
Al plate	11	13
pcb	15	

Nothing remarkable but still significant activity.

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- M. Baca and J. Wilson from University of Birmingham

for their support during the irradiation campaign.

The signals we observed are highly contaminated, very likely by sorrounding material that was activated by the proton beam.
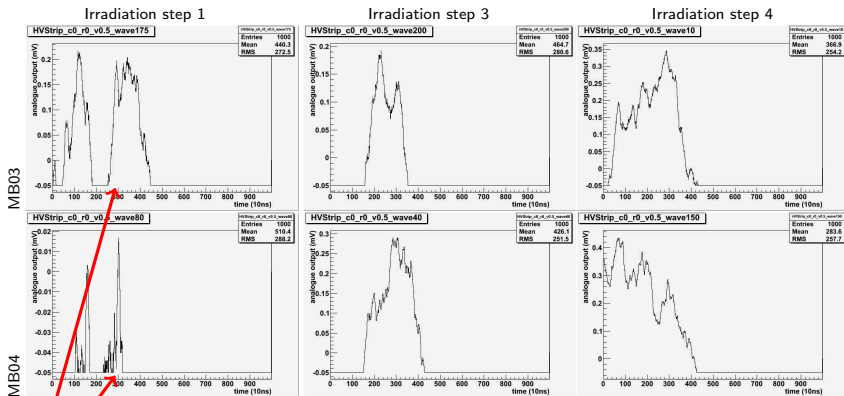
But we know that, since the signal is triggered by the injected pulse, the position of the signal should always be the same (at about channel 300).

Another fact is that the scope range was not set properly, and the baseline seems to be below threshold. Nevertheless, by averaging 300 oscilloscope signals for irradiation step 1 and 3, and 150 for step 4 (step 2 not available), we obtain this output:
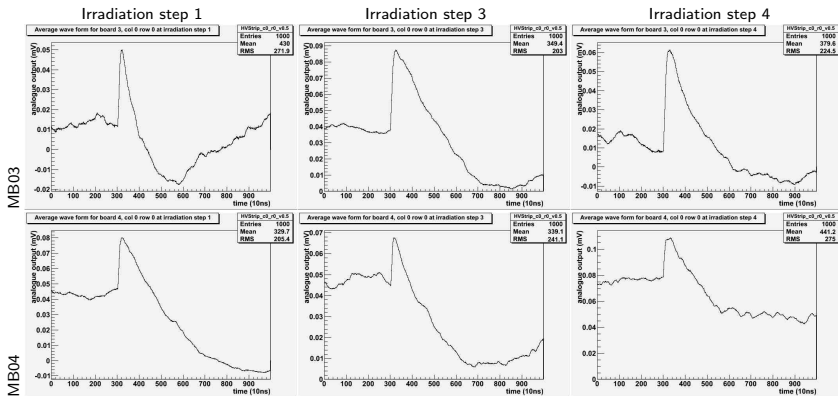
It looks that some signal can be extracted: likely the noisy events are flat distributed and shift the signal up.

Conclusions

$\sqrt{}$ HVStripV1 chips succesfully irradiated

$\sqrt{}$ Sensors seem to be still operating up to almost $10^{15} n_{eq}$

Next steps:

$\rightarrow$ Get the sensors back (within one month)

$\rightarrow$ Warm them up to favour some annealing

$\rightarrow$ Analyze their behaviour with charge injection and radiation sources for a comparison with the pre-irradiation analysis.

Backup Slides

Map of signal values at different irradiation steps for MB03

To estimate the signal, we just take the mean of the values before it starts, then we compute the signal height as the maximum value minus the baseline value. This brings some uncertainty, as the number of events is not very high and the baseline fluctuates significantly.
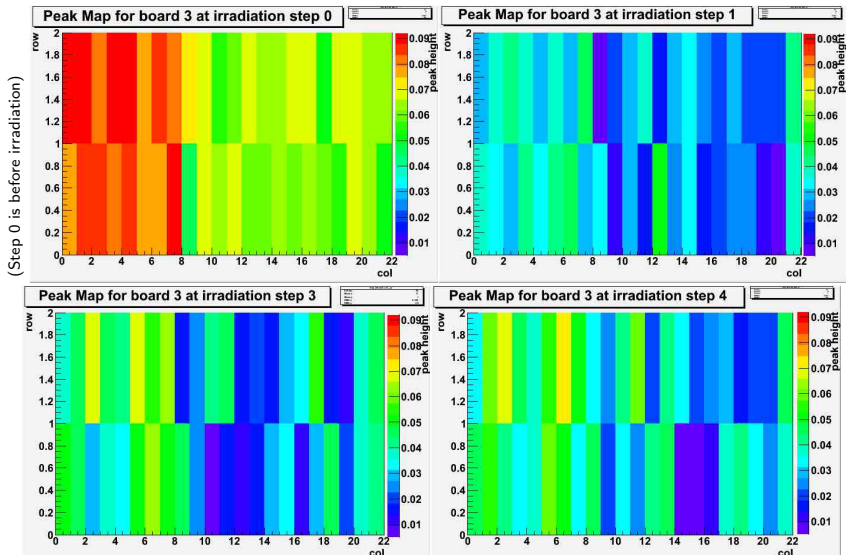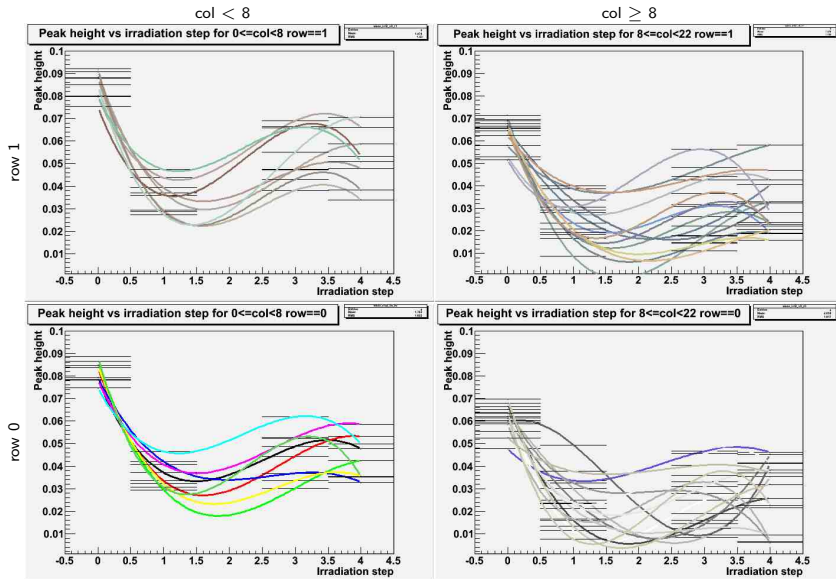
Signal vs fluence for MB03

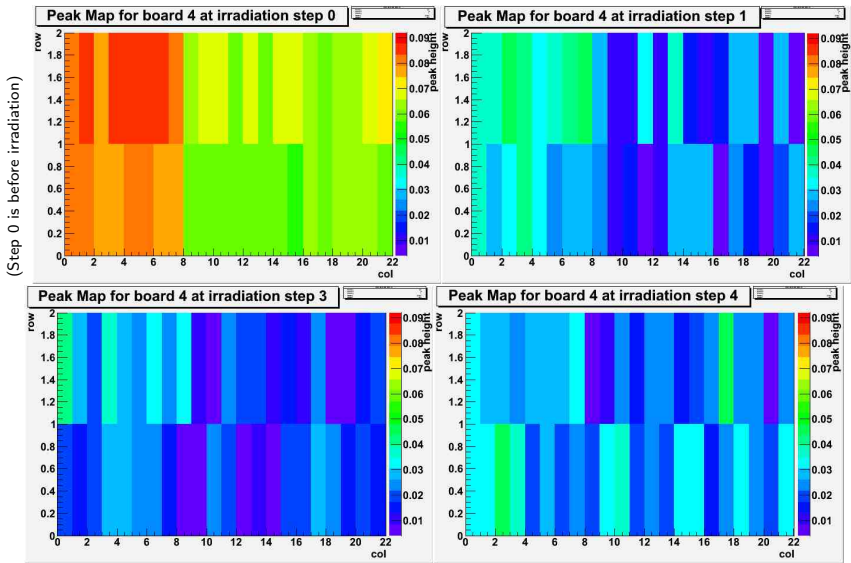The behaviour of the signal height as a function of the fluence step for each channel is the following:
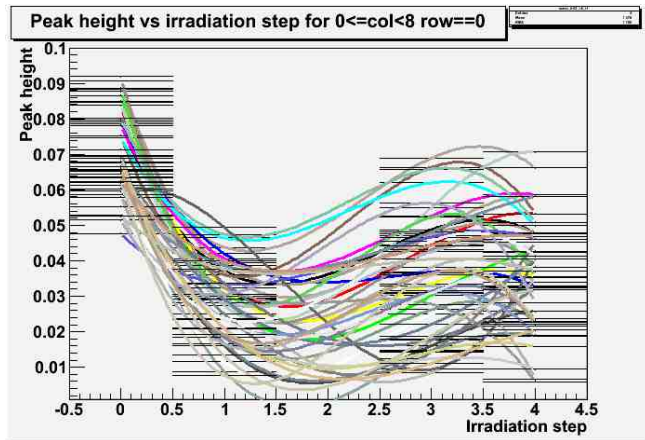
As expected, the values drop down after irradiation, altough they seem to recover a bit between step one and three, after which they drop down again.

The 4 regions in detail (on the left the ones with higher gain):
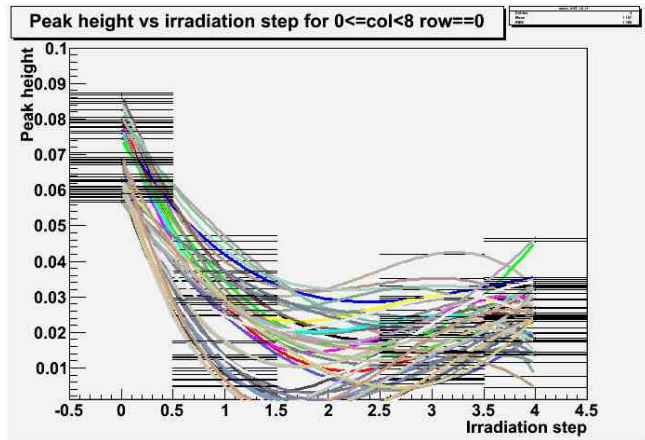
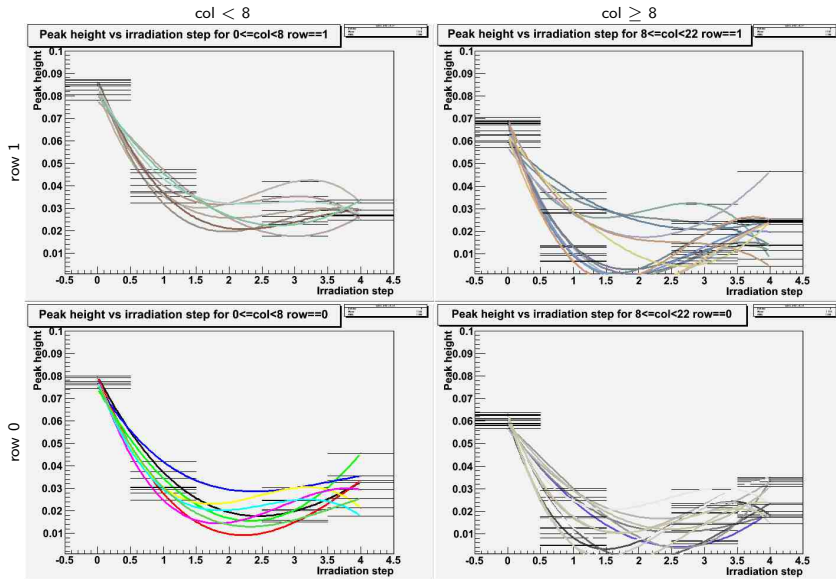# Map of signal values at different irradiation steps for MB04

Signal vs fluence for MB04

The behaviour of the signal height as a function of the fluence step for each channel is the following:

The behaviour looks similar to MB03, even though the recovery mostly happens after step 3 (see better in next slide).

The 4 regions in detail (on the left the ones with higher gain):

Leakage current during irradiation

While irradiating the sensors, the leakage current was monitored. As we had only one HV supplier, we could only monitor the total current.