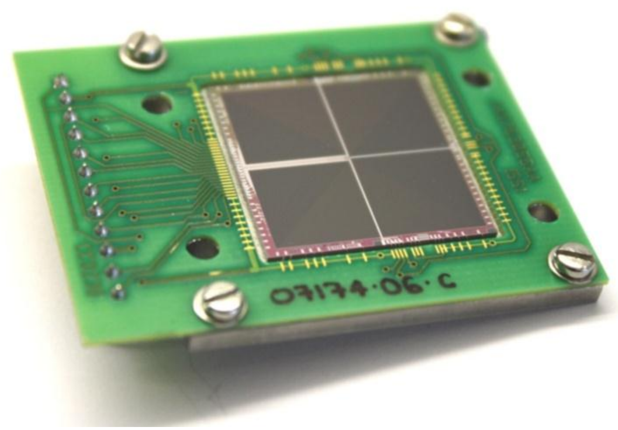
e2v centre for electronic Imaging

Responsivity Mapping Pre- and Post-Irradiation in the Swept Charge Device CCD236

Phillipa Smith

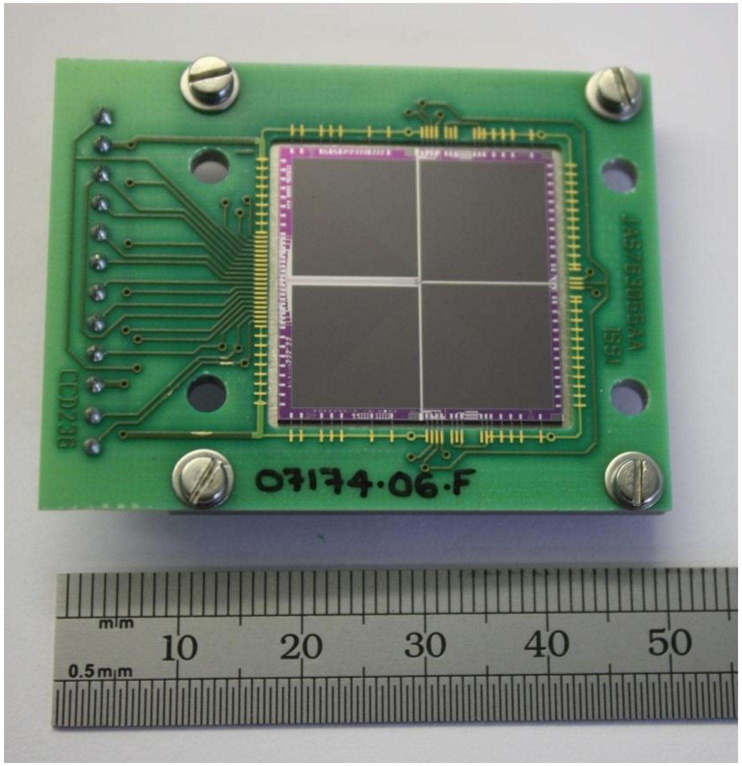
Overview

- Swept Charge Device (SCD) structure
- Experimental arrangement
- Responsivity mapping pre-irradiation
- Responsivity mapping post-irradiation
- CTI in the CCD236



The swept charge device

- Designed by e2v technologies as a soft X-ray detector for spectroscopy
- Optimal energy range 0.8 keV to 10 keV
- Second generation has:
  - increased detector area (~4cm^2)
  - reduction in split X-ray events
  - improvements to radiation hardness
- 100 μm sample (pixel) size
- Two phase clocking
- ~120 transfers to readout image area
- Good performance at -30 °C



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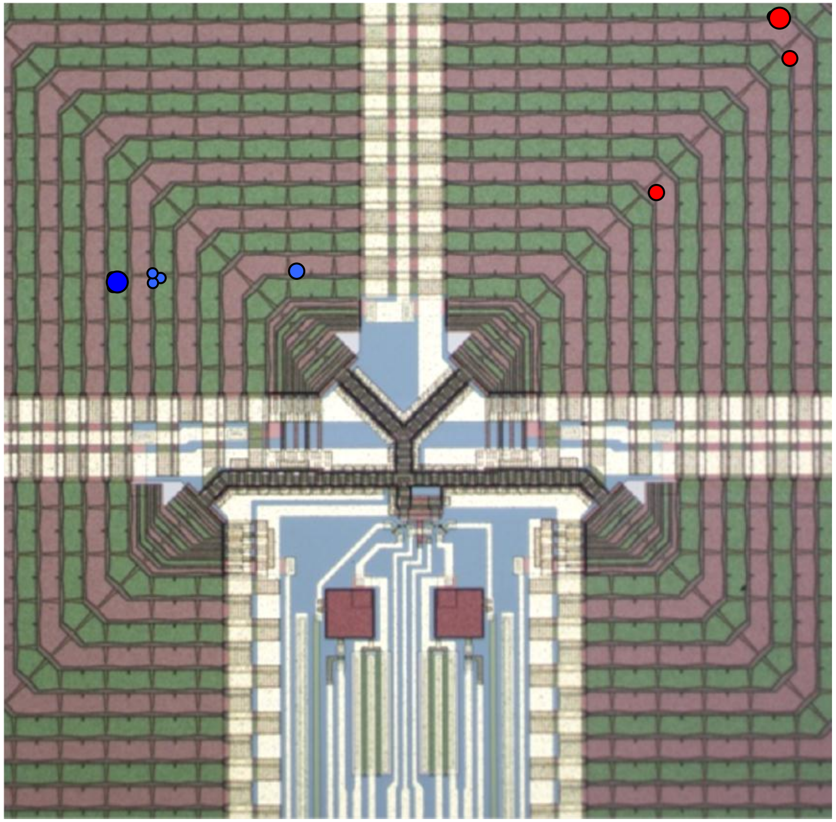
Swept charge device CCD236

- Continuously clocked device:
- High readout speed (>175 kHz)
- Good energy resolution (<150eV @5898eV)
- Low noise (<8 e$^-$ r.m.s. @ 100kHz)

- Charge is collected in each triangular area and transferred to the central channel. This is then combined before the readout node.

- Only one central transport channel

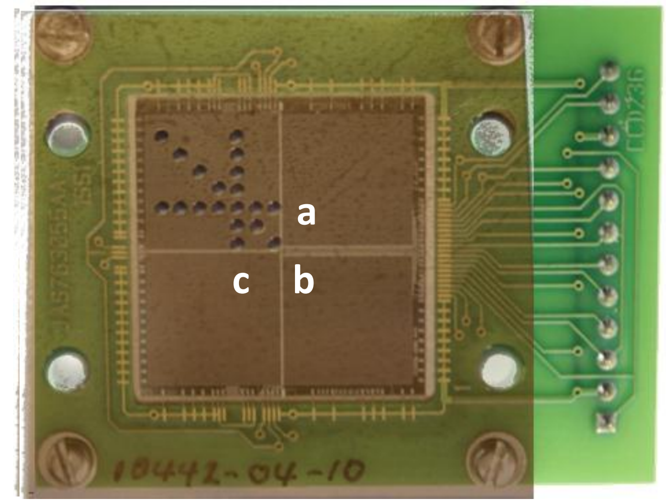


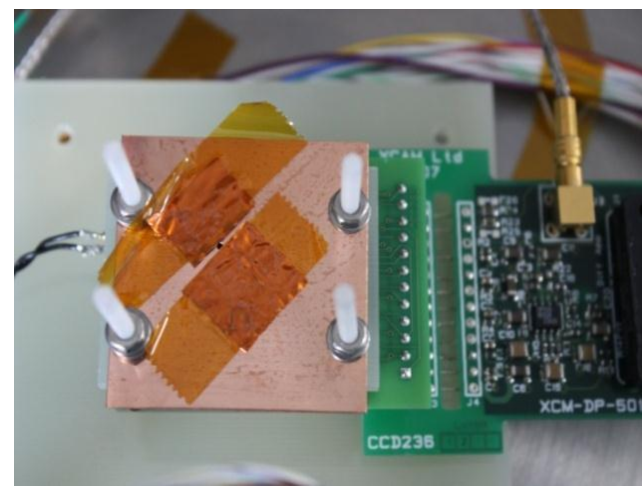
Linear output

Measured X-ray charge

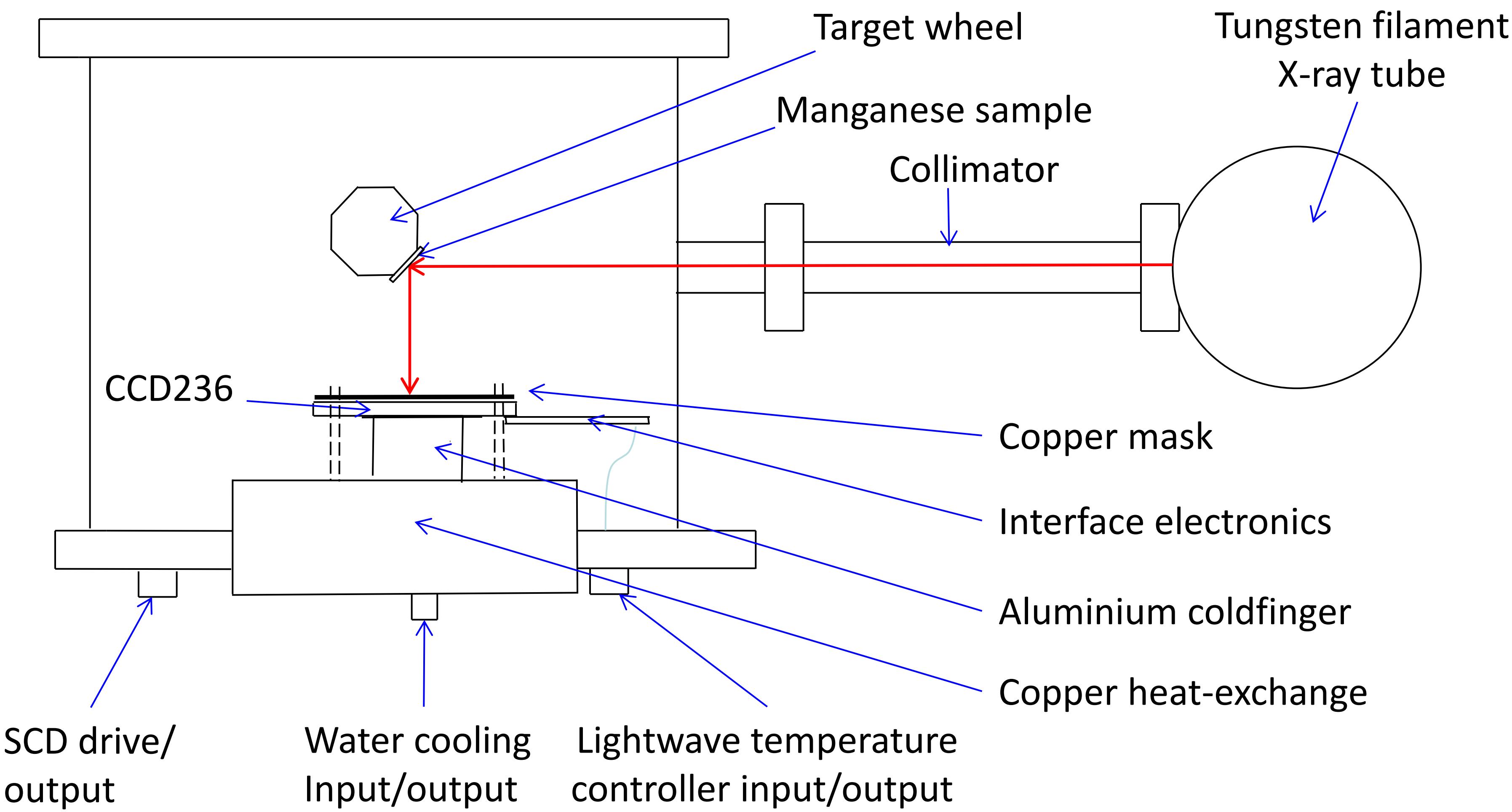
Pin-point illumination

- Array of 1 mm holes was placed over the CCD236 with lines of holes in one quadrant of the device
- Investigating vertical, horizontal and diagonal
- Surplus holes were masked using copper foil to ensure the X-rays were only hitting the designated area
- As the copper mask was mounted above the CCD236 on top of Tufnol 10G an amount of diffusion occurred.





Experimental setup



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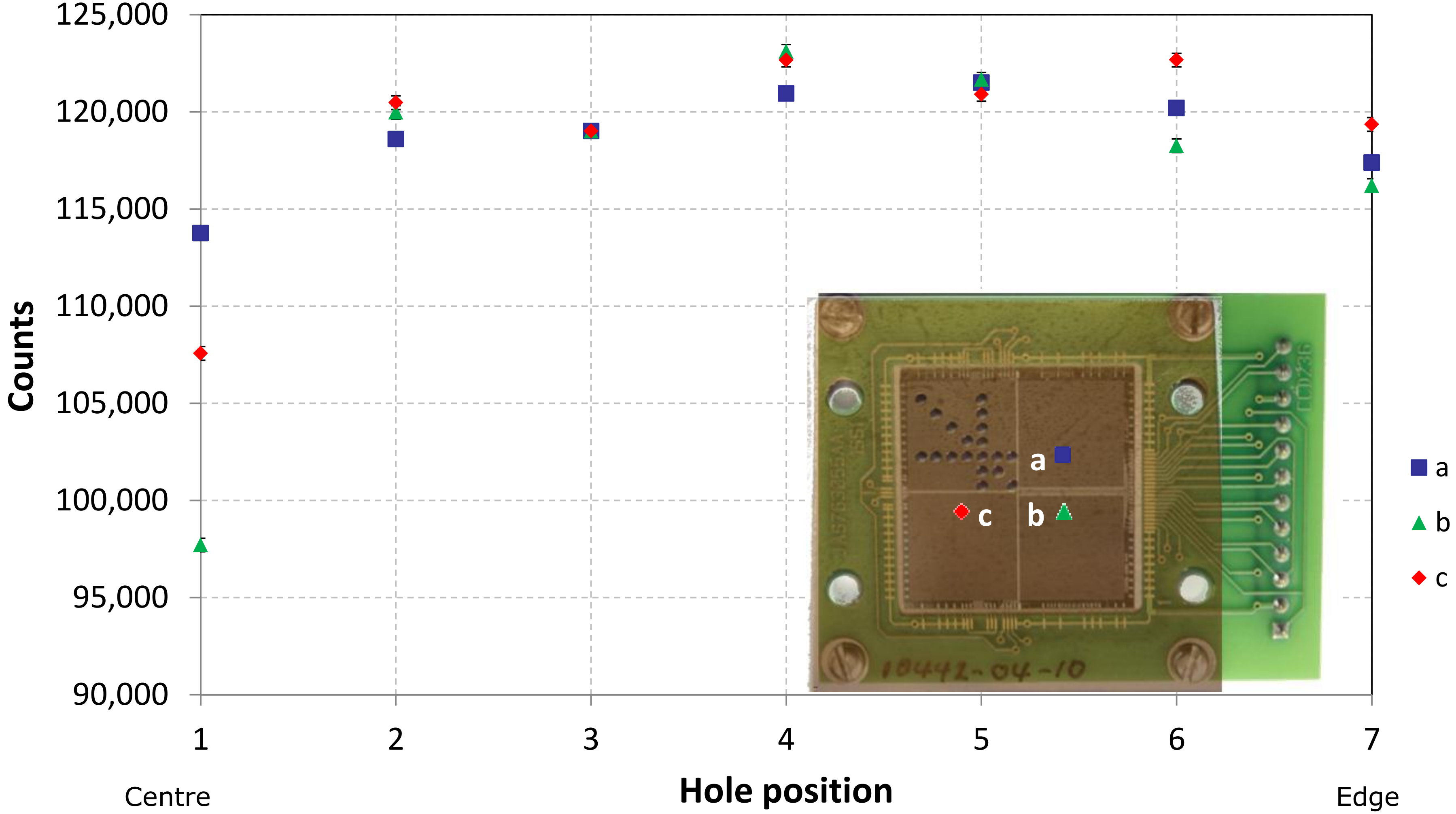
Uniformity of counts across device



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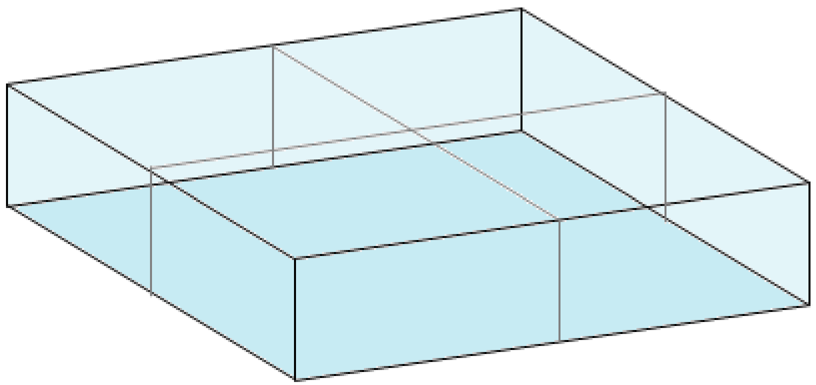
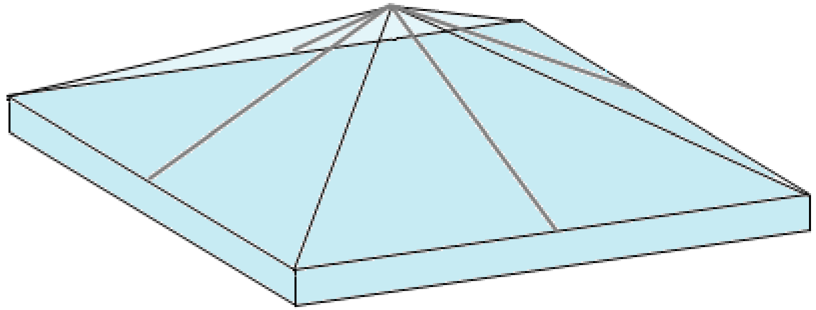
Regional radiation damage effects

- Change in spectral energy expected across the CCD236

Non-irradiated shows flat/uniform responsivity over the device



Irradiated profile should drop off as a triangle/pyramid



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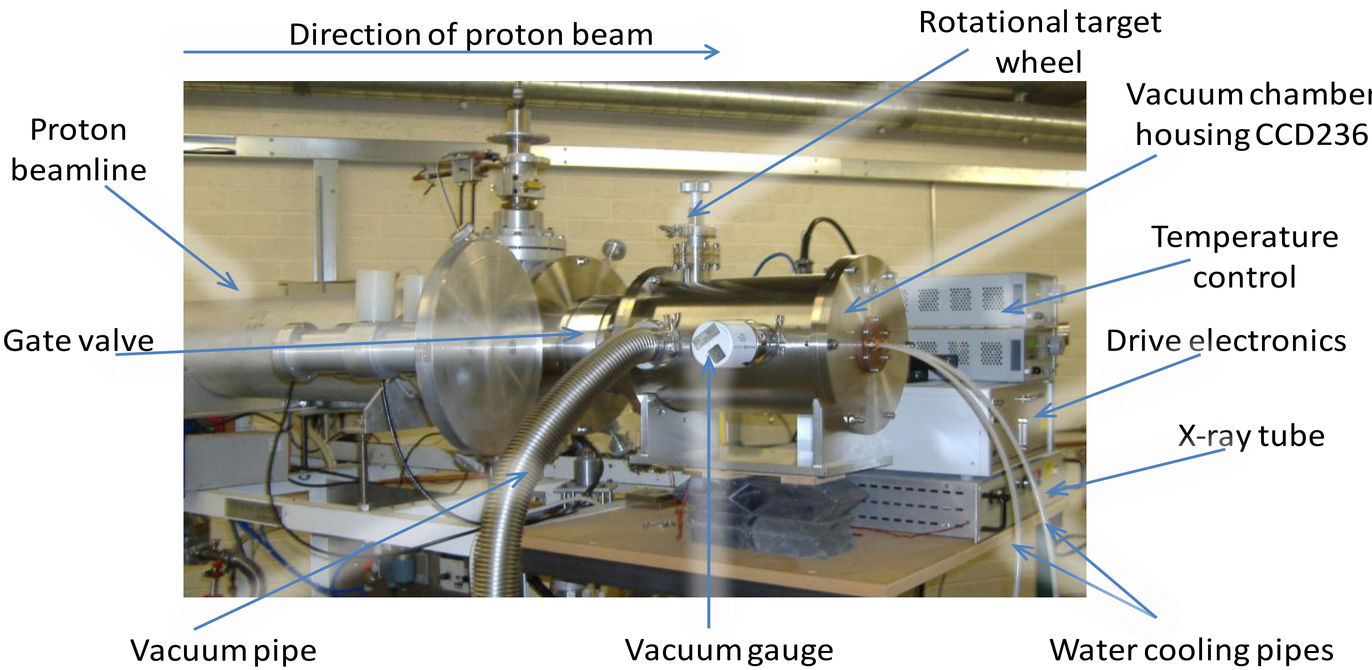
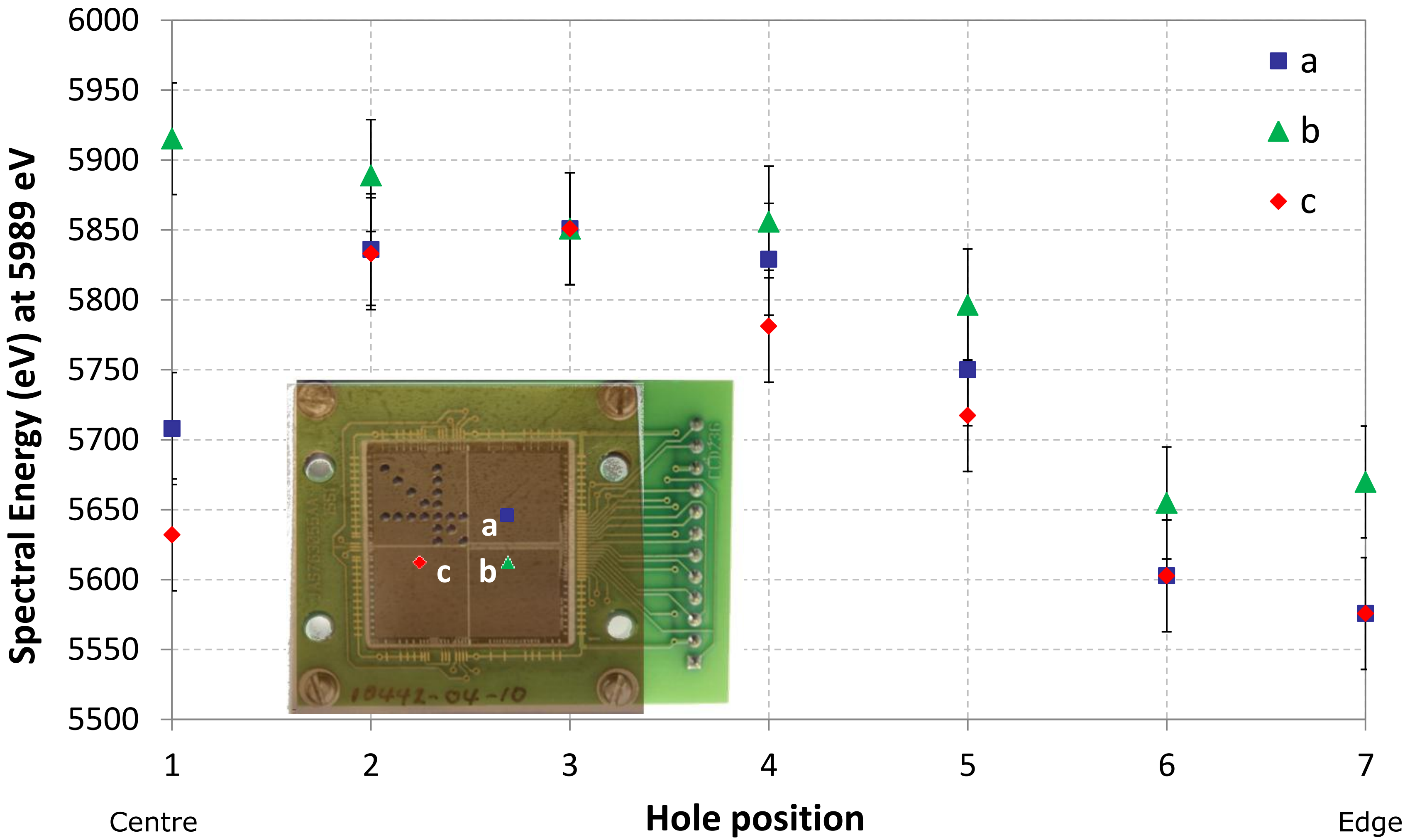
Irradiation facility

- Irradiated to a 10 MeV equivalent proton fluence of **5.0×10^8 protons.cm^{-2}**
- Cold irradiation (-35 ˚C) conducted at Harwell (UK) using TEC and water cooling
- Responsivity tests conducted after the annealing showed it was stable (within error)

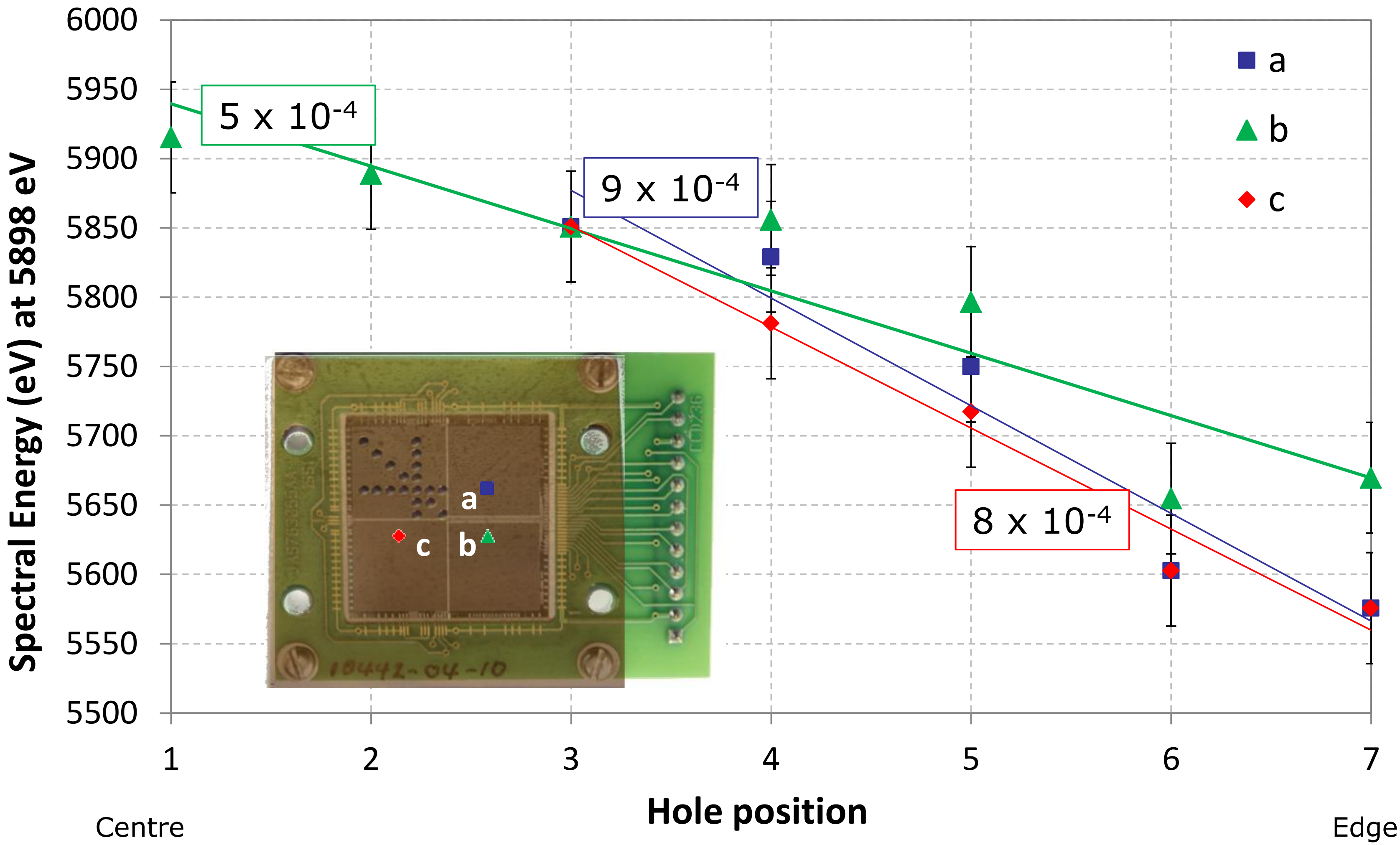


Poster session 1: Presented by **Dr. Jason GOW** on **10/9/2014** at **15:00**
"Cryogenic Proton Irradiation of a Sensor and the Subsequent Annealing"

Post- irradiation profiles



Post- irradiation CTI



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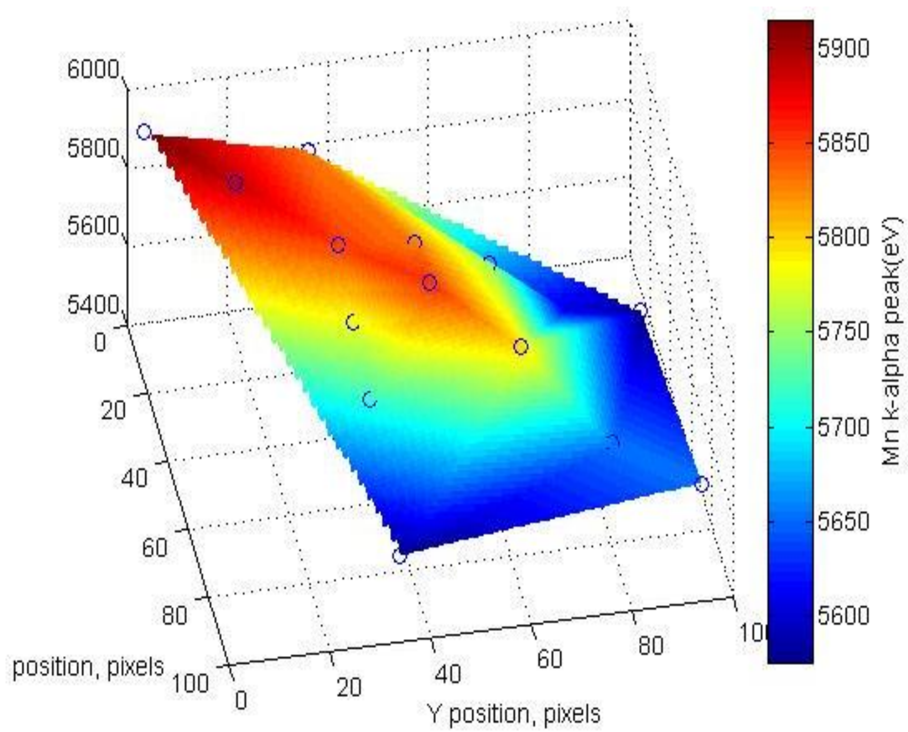
Post- irradiation CTI

- Using this quarter, the whole device performance has been suggested, comparable with the prediction



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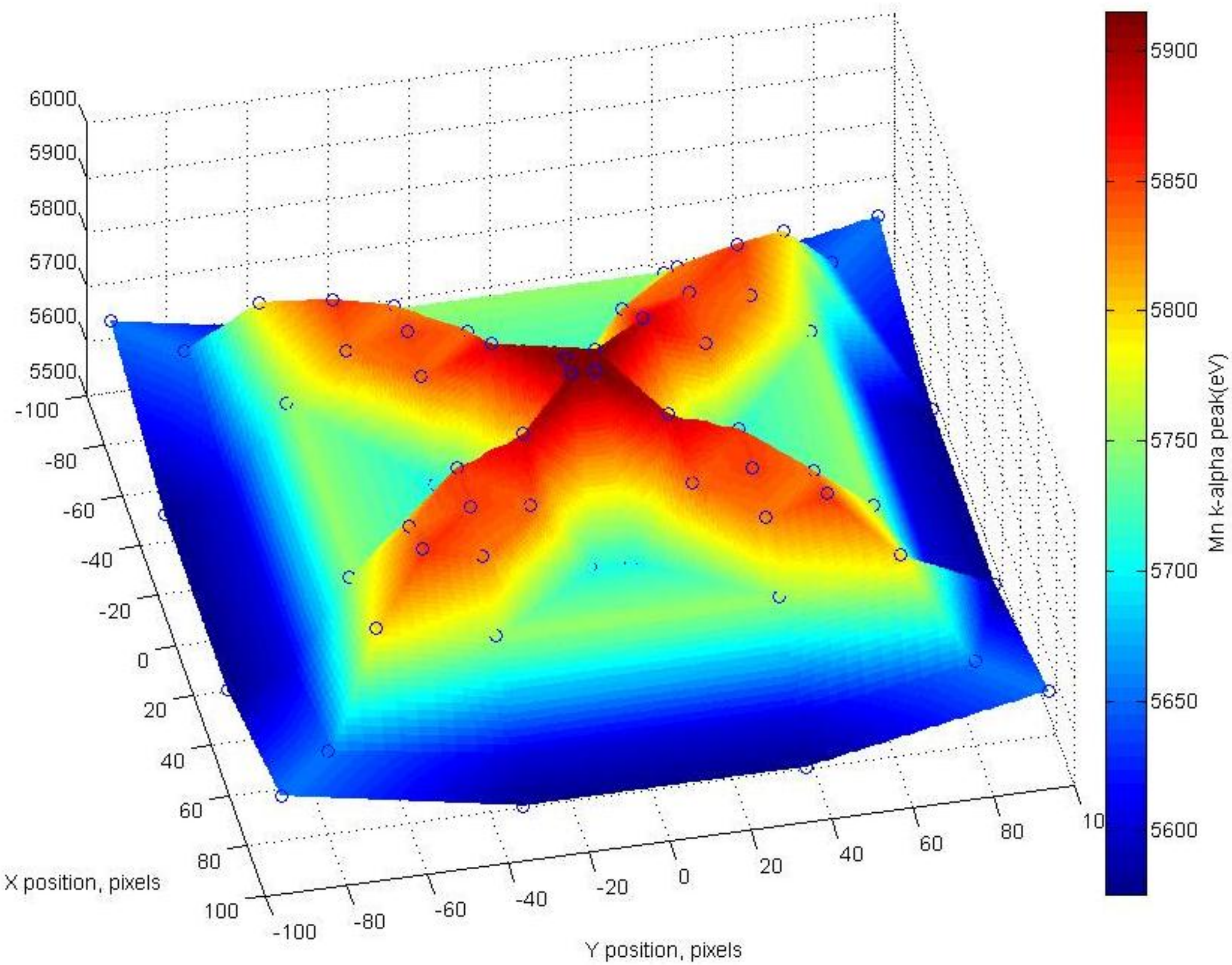
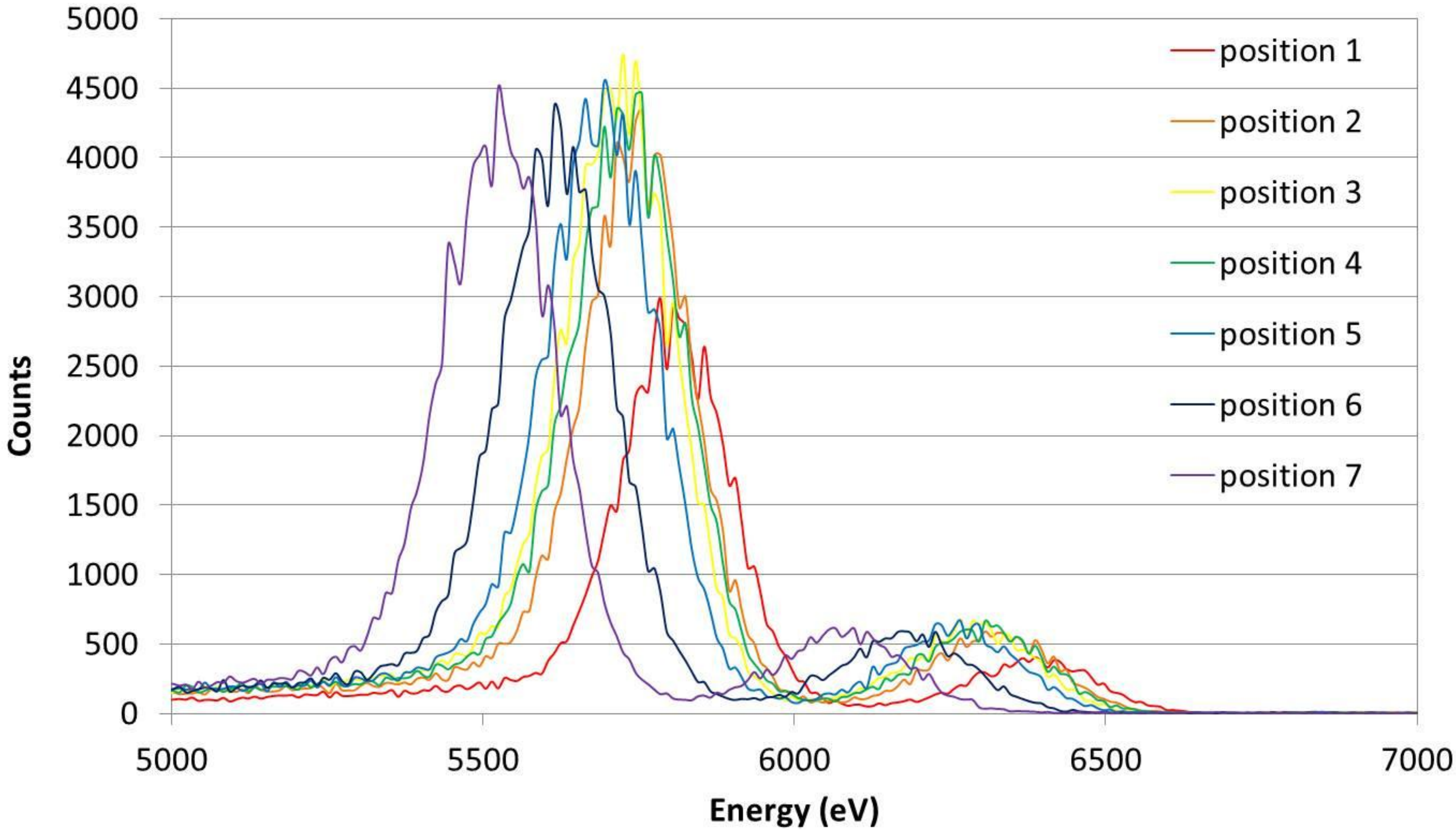
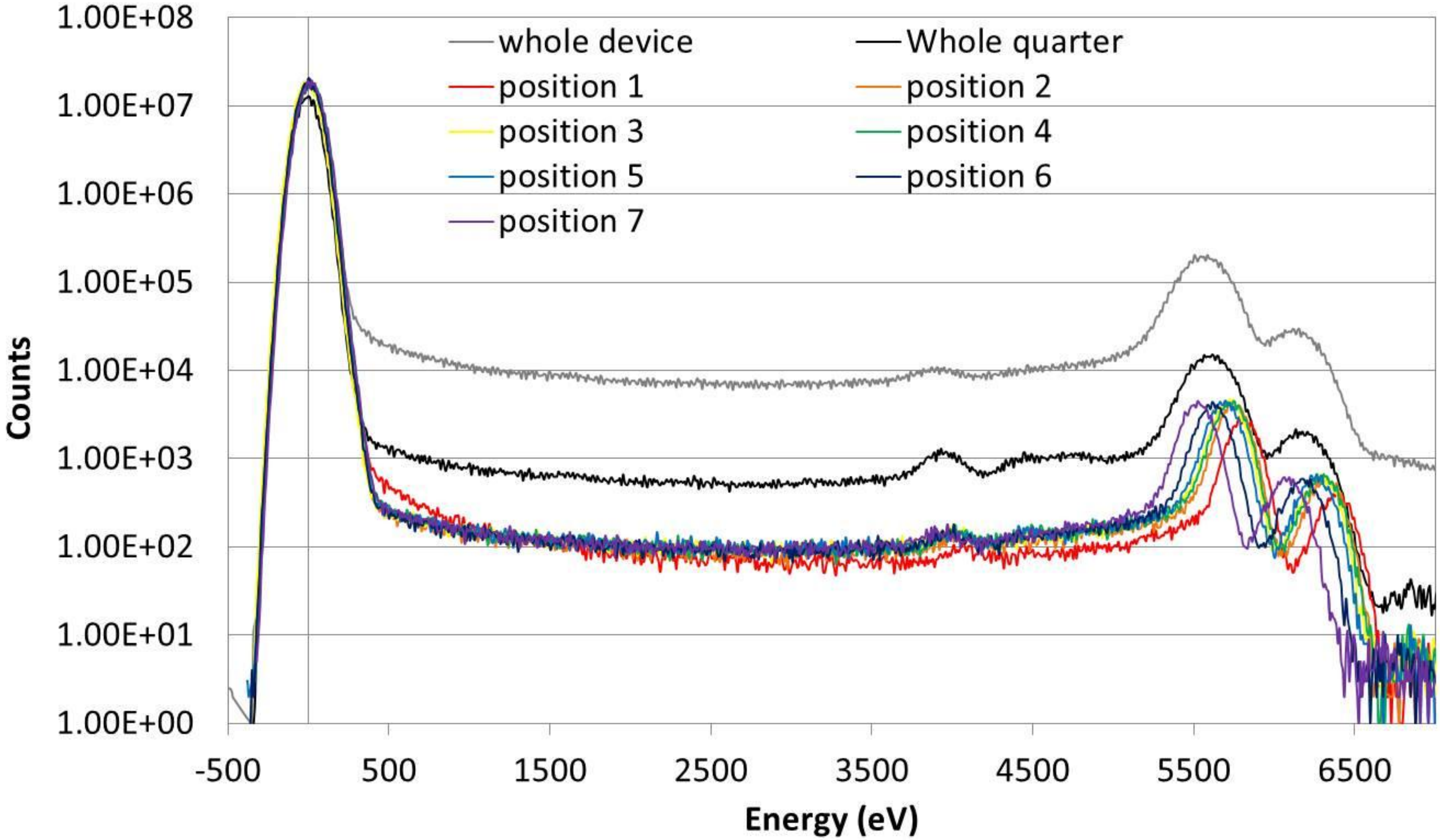
Post- irradiation CTI



Post- irradiation results

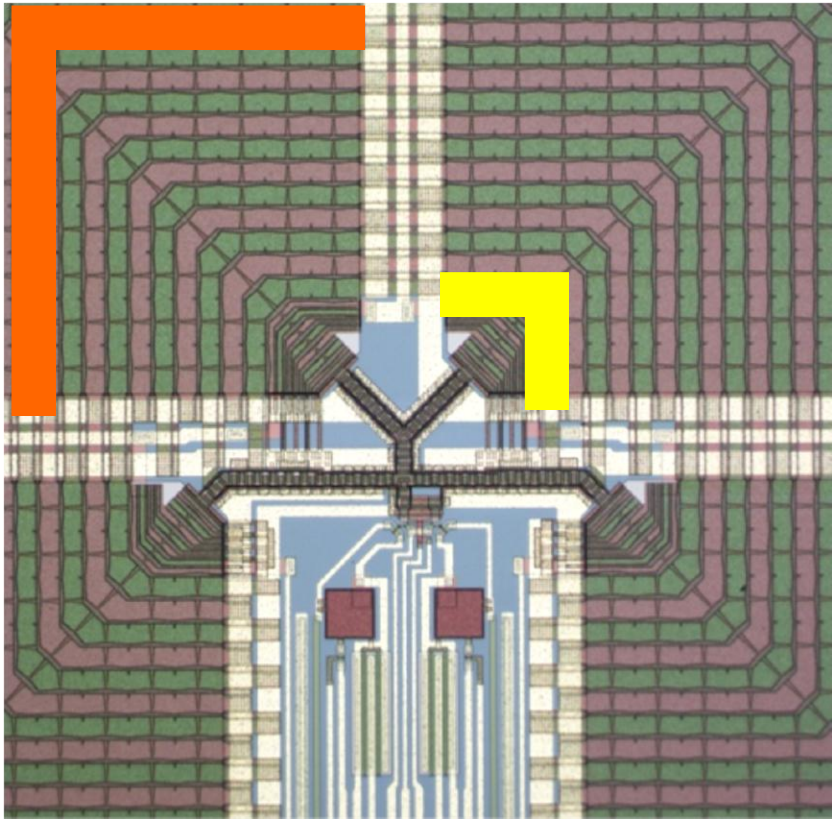


Post-irradiation Results



Location, area, and traps encountered

Large area has multiple transfers, encountering a larger number of traps



Smaller area less transfers, encountering a smaller number of traps

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Summary

- By masking various areas across an irradiated CCD236, an estimation of the CTI has been measured.
- The energy peak for each masked area has been mapped to the total energy peak, and as such it is possible to assess how different areas contribute to the increase in FWHM in an irradiated CCD236.
- As predicted, the spectral energy degrades towards the edges of the device as the signal has travelled through more radiation damaged silicon and therefore encountered more traps.
- CCD236 shows improvement in CTI post-irradiation compared with previous gen.

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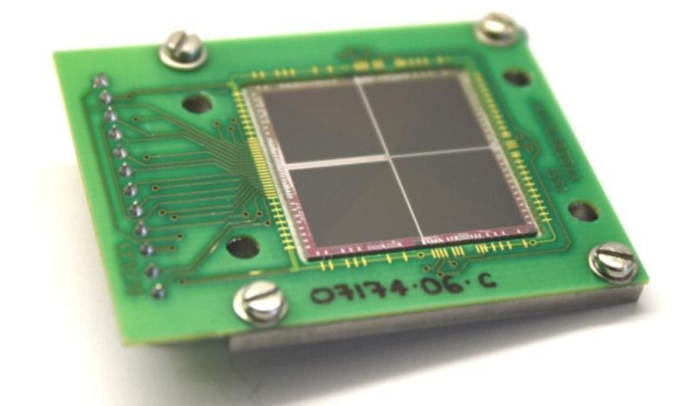

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