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ESR 15

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Attended Conferences

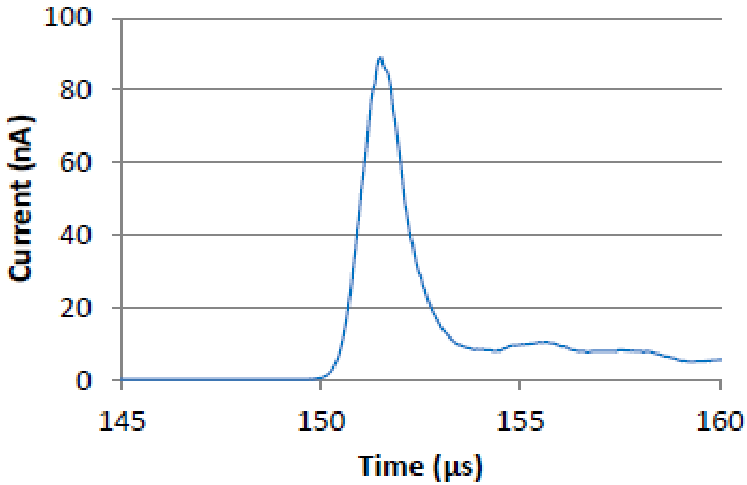
20-22 October, 2014: Mini- Micro- and Nano-dosimetry conference, Port Douglass, Australia

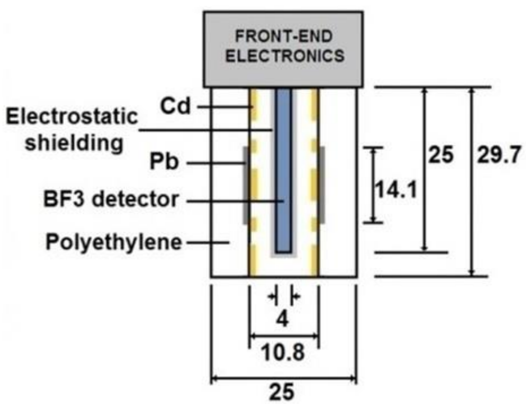
- Update on recent developments in MMND, with a session dedicated to ARDENT
- I gave presentation on space charge correction method in the LUPIN-II

3-5 June, 2015: Radsynch 2015, Hamburg, Germany

- Conference dedicated to radiation safety in synchrotron facilities
- Both through machine design and radiation protection (detectors)
- I gave an overview talk on the LUPIN-II

Experimental Campaigns





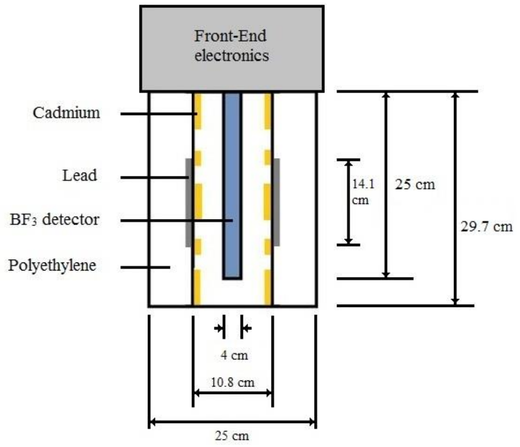
- Neutron REM counter developed in collaboration between ELSE Nuclear and Politecnico di Milano
- Uses a fast LOGAMP and unique acquisition method to allow it to cope with intense Pulsed Neutron Fields
- An ADC samples the current through the counter at 10MHz, then acquires for a user set time window (most commonly 2 or 4 ms) during a neutron burst
- The current is integrated over the time window to find the total charge of the window. This is then divided by a Charge Calibration Factor (CCF) to find the number of interacting neutrons. From this the dose is determined using an Ambient dose Equivalent (H*(10)) calibration factor.

$$H^*(10) = \frac{Total\ Integrated\ Charge}{CCF} \cdot C_{H^*(10)}$$

Experimental Campaigns

- Testing and Calibration of the LUPIN-II

- Measurements at RCNP, Japan



Testing and Calibration

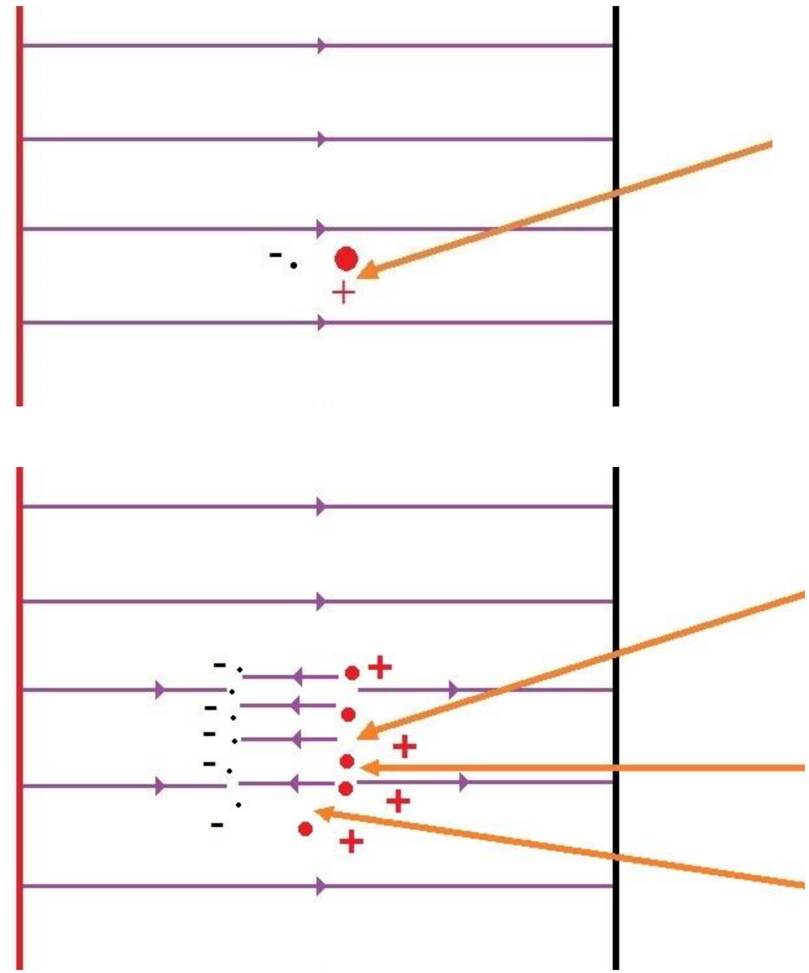
- CERN calibration laboratory was used to test the LUPIN-II FPGA
  - Problems were found when using both implemented Acquisition modes (Streaming and Derivative trigger)
  - One problem was a rounding error: the FPGA was rounding down below 0.7 instead of 0.5, meaning that the H*(10) was being underestimated
  - The other problem was in the software (Labview): one mode was not activated correctly, and therefore one the streaming mode was working

RCNP Measurements

- Measurement campaign took place from 23 November to 1 December 2014
  - Neutrons of 100 and 300 MeV were measured with the LUPIN-II system
  - The 100 MeV neutrons were measured using the FPGA and the Picoscope acquisition methods to compare
  - Due to the structure of the beam, it was not possible to see the die-away of the signal as the repetition rate was too high
  - Data under analysis for verification of detector response simulation

Space Charge Effect

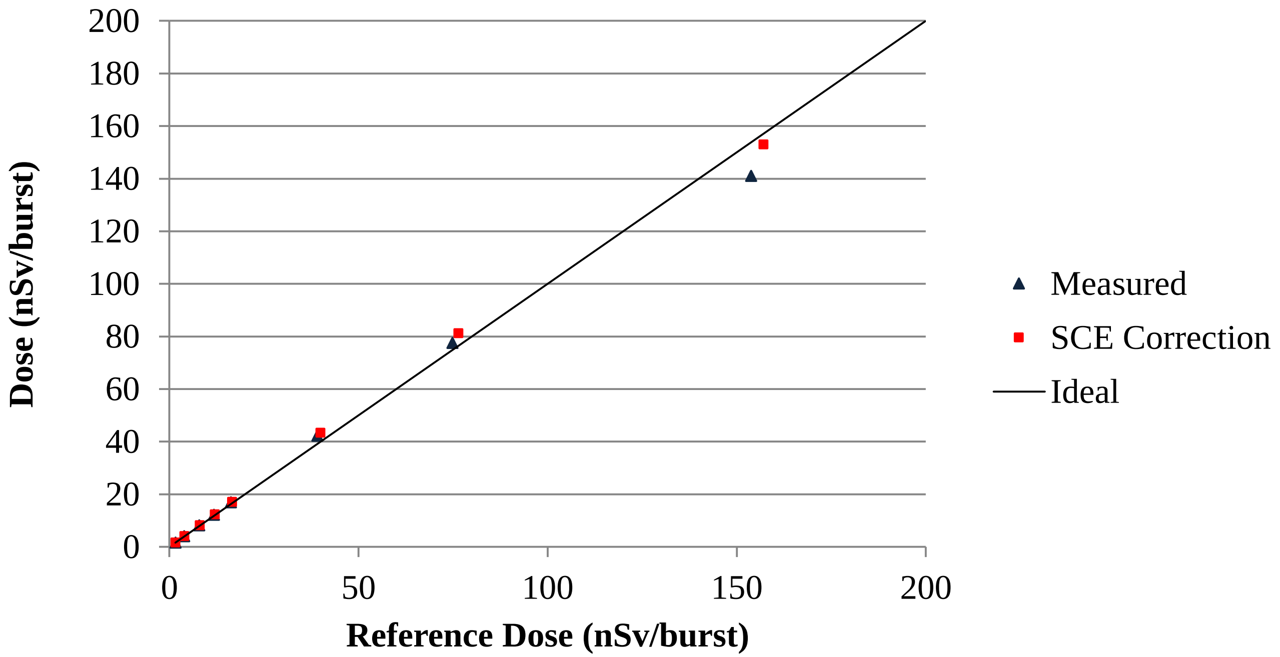
- When measuring a high-intensity burst of radiation, large amounts of localised charge is generated inside the proportional counter within a REM counter
- The charge generated may cause subsequent interacting particles to be partially shielded from the electric field, reducing the multiplication factor
- This ‘Space Charge Effect’ can be accounted for using the analytical method described in [2]
- Analytical method describes the change in the multiplication factor as a function of the number of interacting neutrons



[1] Rios, I., González, J., Mayer, R.E., “Total Fluence Influence on the Detected Magnitude of Neutron Burst using Proportional Detectors”, Radiation Measurements (2013), doi: 10.1016/j.radmeas.2013.01.007.

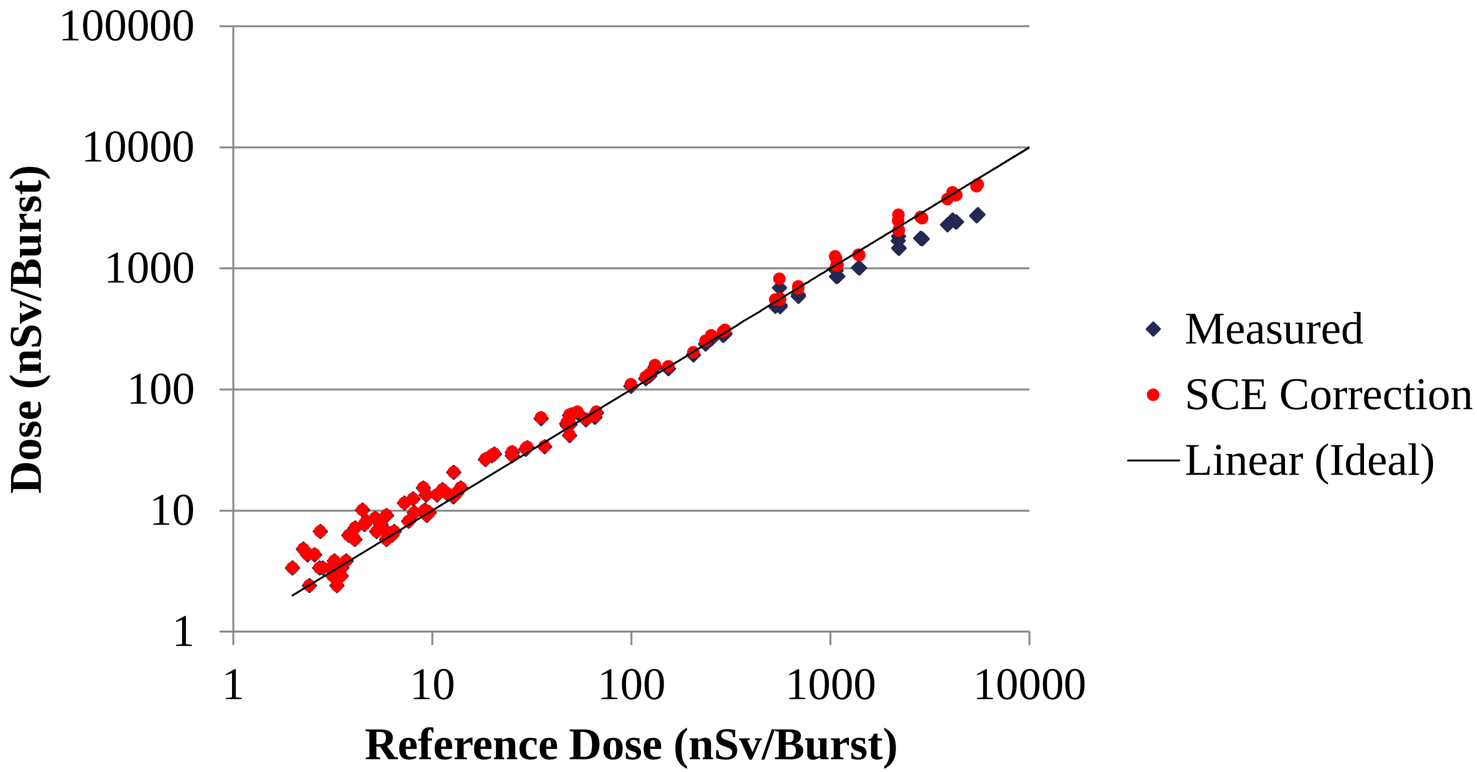
Space Charge Effect

- The analytical method was applied to data taken at Helmholtz-Zentrum Berlin (shown below), HiRadMat and in Trieste



Space Charge Effect

- HiRadMat



Space Charge Effect

- For the data from Trieste, a different approach had to be applied to show the improvement of the SCE compensation
- The χ^2 value was used
- This is a measure of the adherence of the data to a Poisson distribution; if the data follows this distribution the expectation value is 1
- Due to the fact that the accelerator at Trieste is extremely stable, the number of primary particles in the beam could be considered constant

$$\chi^2 = \frac{Varience}{Mean}$$

Space Charge Effect

- The following table shows the χ^2 values before and after the correction method was applied, as well as the upper and lower limits of acceptance of the value
- Although the data does fall within the limits before the correction, it is systematically in the lower part of the range
- With the correction, the value is improved to be much closer to 1

Charge (pC)	Measurement χ^2	Corrected χ^2	χ^2 Lower limit	χ^2 Upper limit
200	0.91	1.08	0.62	1.46
350	0.71	0.92	0.54	1.57
500	0.67	0.96	0.52	1.6
700	0.58	0.92	0.42	1.79

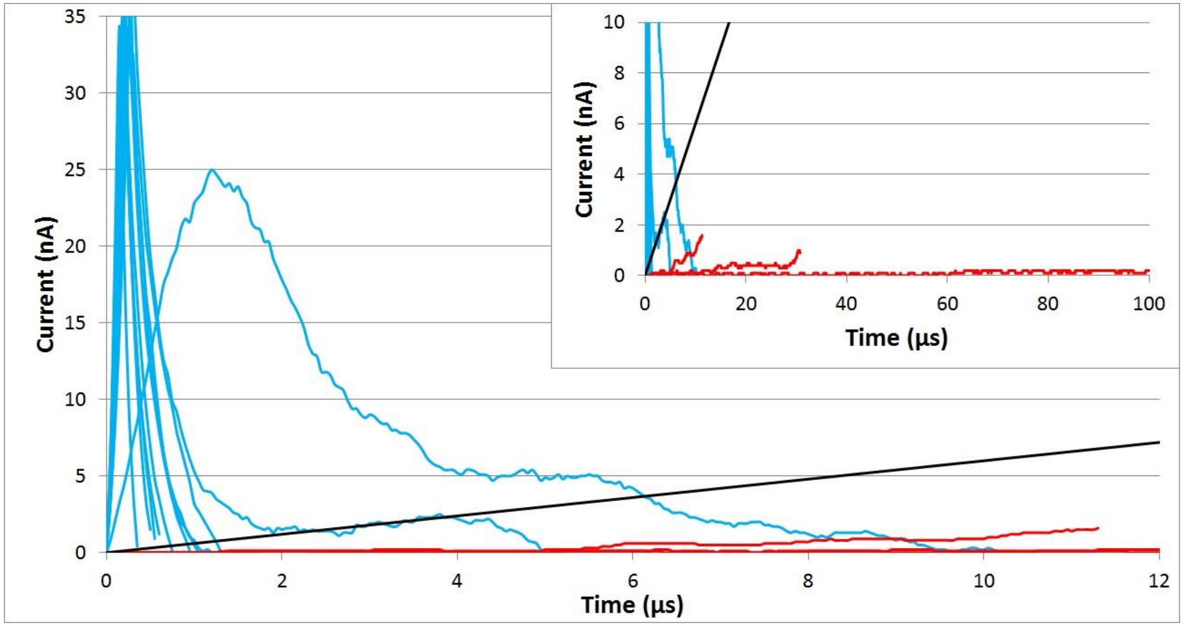
Update: Photon discrimination

- In order to discriminate between neutron and a steady photon signal, a second operational mode was introduced
- LUPIN-II reverts to a counting mode, but uses a trigger threshold on the pseudo-derivative of the signal
- For sample number N:

$$D = \frac{X_{N+1} - X_{N-1}}{2}$$

where X_N is the current sample N

- Works due to the large difference in the rate of change of the signal comparing a neutron burst to a photon background



LUPIN-II signals from neutron bursts (blue) and steady photon field (red), with proposed derivative threshold in black

Update: Photon discrimination

- Tests conducted at the Secondary Standards calibration lab at PoliMi
- The neutron count rate was measured with a Am-Be source alone, and with the Am-Be source and a gamma source together
- Both acquisition modes used
- Gamma source was set to give a 40 mSv/h H*(10) rate, neutron source placed so that only single neutrons detected per window
- While Current Integration mode showed overestimation due to gamma signal, Derivative mode did not

	NEUTRONS ONLY	NEUTRONS AND PHOTONS
	Count rate (Hz)	Count rate (Hz)
Current Integration mode	3.27	604.05
Derivative mode	3.28	3.42

Secondments

Planned:

19th July, 2015: Jablotron, Czech Republic

- Secondment to learn about administration

Thank you!