RCU2 testing and design

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1 Abstract

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3 Introduction

4 Testing at Oslo Cyclotron Lab(OCL)

4.1 About OCL

OCL was opened in 1978, the cyclotron was made by Scanditronix AB from Sweden. This is the only accelerator in Norway for ionized atoms in basic research. The cyclotron can accelerate protons,^3He and ^4He, with energies and intensities as seen in the table 1 bellow. There is vacuum inside the cyclotron and the pipes that leads to the test area so that you should not suffer energy loss from collision with air molecules. A drawing of the lab can be seen bellow in figure 1. The laboratory is divided between the inner experimental hall and the outer experimental hall. As you can see the cyclotron is put in the inner hall, and a beam is sent through pipes to the outer hall. with some magnet you are able to regulate the beam, so that you are able to get the beam to your experimental area. There are also several cups put on the pipeline, that you are able to block the beam if you want. These can be used to stop the beam during an experiment, so you are able to go into the experimental area and do changes on your setup. When the beam is on, you are not allowed to enter the inner experimental area.

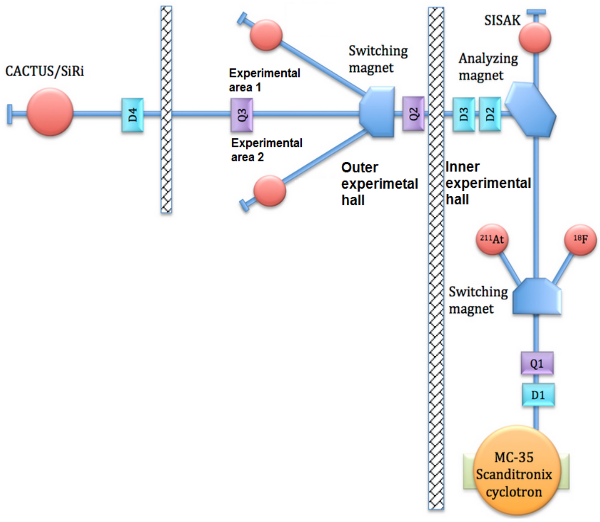

Figure 1: Out-lay of the OCL

Ionized beam particle type	Energy(MeV)	Intensity(A)
Proton	2-35	100
Deuteron	4-18	100
^3He	6-47	50
^4He	8-35	50

Table 1: Ionized beam particle data table

4.2 Experiment setup and equipment

The experiment setup was placed in the outer experimental hall in "experimental area 2". The setup that was used as well as the equipment used can be found in the figure and table bellow: The equipment was kept in close to the same height around 140-150cm. Beam exit was in a height of 141.5cm.

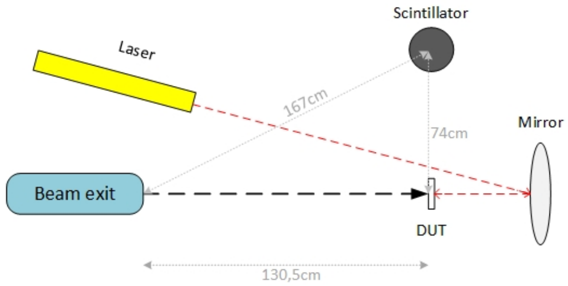

Figure 2: Experimental setup seen from above

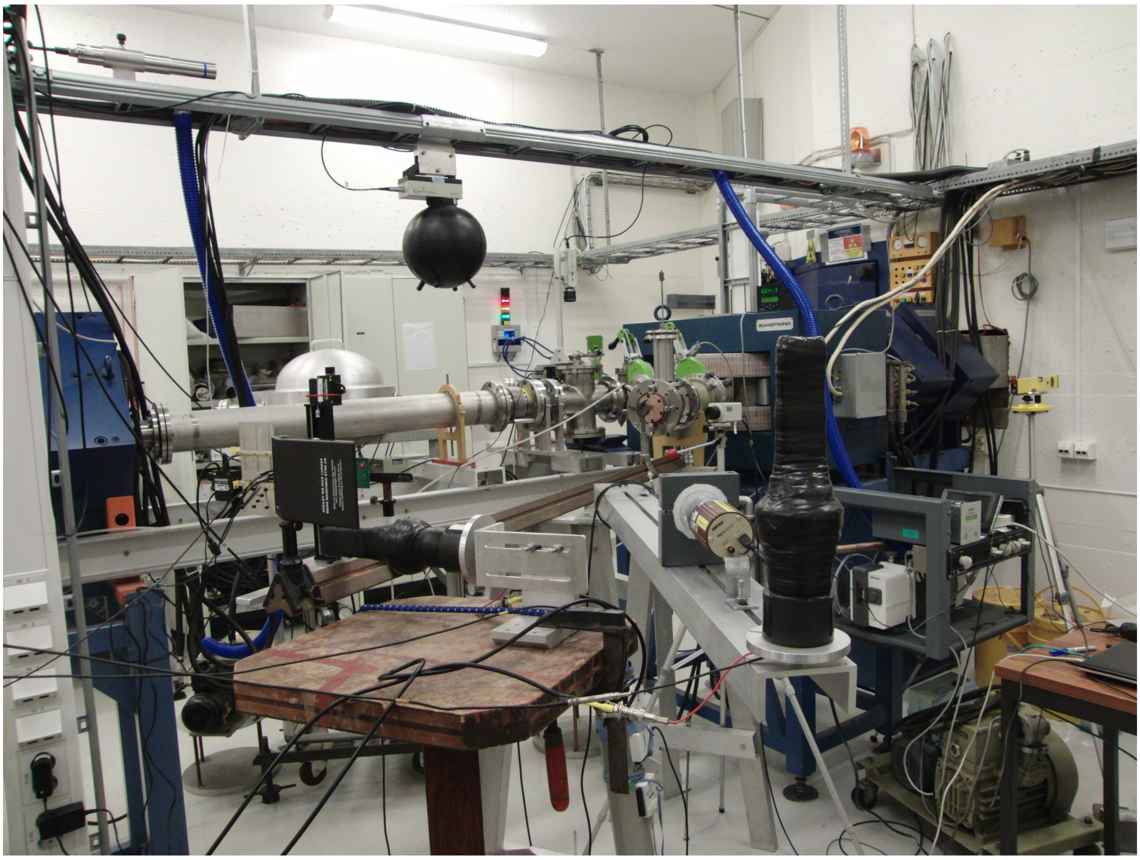

Figure 3: Picture of the experimental area

Equipment	Explanation
Scintillator	A plastic scintillator with photomultiplier, that was used to measure relative radiation. We had two of these, one that was placed right under DUT and one that was placed 75cm away from DUT. We only used one during the experiment.
High voltage regulator	Voltage for the photomultiplier. 800V was used
8 test boards	TPS51200, MIC69302WU, SN74AVCB16245, SN74AVC2T245, QS3VH257, SY89831U, ADN2814 and MAX3748
SRAM-board	A PCB board with 4 SRAM cells, that was used to characterise the beam and to measure scintillator counts
Computer	A VPN connection was set on a computer inside the experimental hall, so we where able to control the experiment outside the experimental hall. The computer was running LabView to control the experiment, data was also saved on the computer
USB DAQ	Used to get analog and digital connection to the test boards and send data to the computer.
Radiation film	A film that reacts when radiated with protons. Used to identify the beam.
Counting controller	a device that counts rising or falling edges
leveled laser	This was used to pinpoint the center of the beam.
Mirror	Reflecting the laser beam to the backside of the test boards.
XY-controller	Connected to the computer so we can do minor changes to the placement of the test boards outside the experimental area

Table 2: Equipment used in the experiment

4.3 Measurement equipment

4.3.1 SRAM

The SRAM board consist of several SRAM chips and a flash based FPGA and some connections and supporting electronics. When a SRAM chip is exposed to radiation a Single Event Upset(SEU) can occur. The method of detecting an Single Event Upset (SEU) in a SRAM is rather straight forward, as can be seen in the flow diagram of figure 4. There is an initial startup phase where a known pattern is written to all the addresses in the SRAM. When the startup phase is done, the value from the first address is read back and compared to a known value by xoring the known value with the read. If they are not alike a SEU has occurred, and a 1 will return from the xor and be added to a SEU counter. The correct value is then written back to the address and the system moves on to the next address.

A checkerboard pattern, a pattern of alternating ones and zeros, is used when writing to the SRAM. To check for stuck bits, the bit pattern in the whole address space is inverted after each read. The cross section for SEU and particles is known through earlier experiment with the SRAM-board, and is found to be 1.14×10^{-6} cm^2/

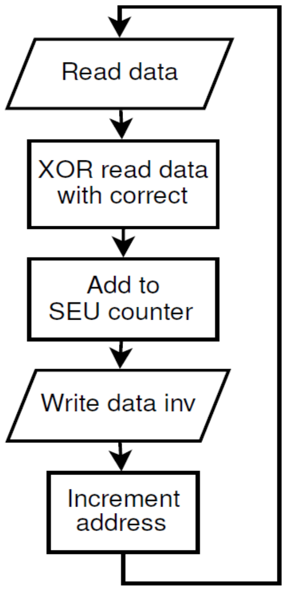

Figure 4: Flowchart for SEU detection

4.3.2 Scintillator

The detection of ionizing radiation by the scintillation light produced in certain materials is one of the oldest techniques on record. In Geiger and Marsdens famous scattering experiment of a-particles off Gold nuclei, the scattered as were observed via the scintillation light they produced when they hit a ZnS-screen. ZnS produced light flashes, called scintillation light, when hit by an α. The scintillation process remains one of the most useful methods available for the detection and spectroscopy of a wide assortment of radiation.

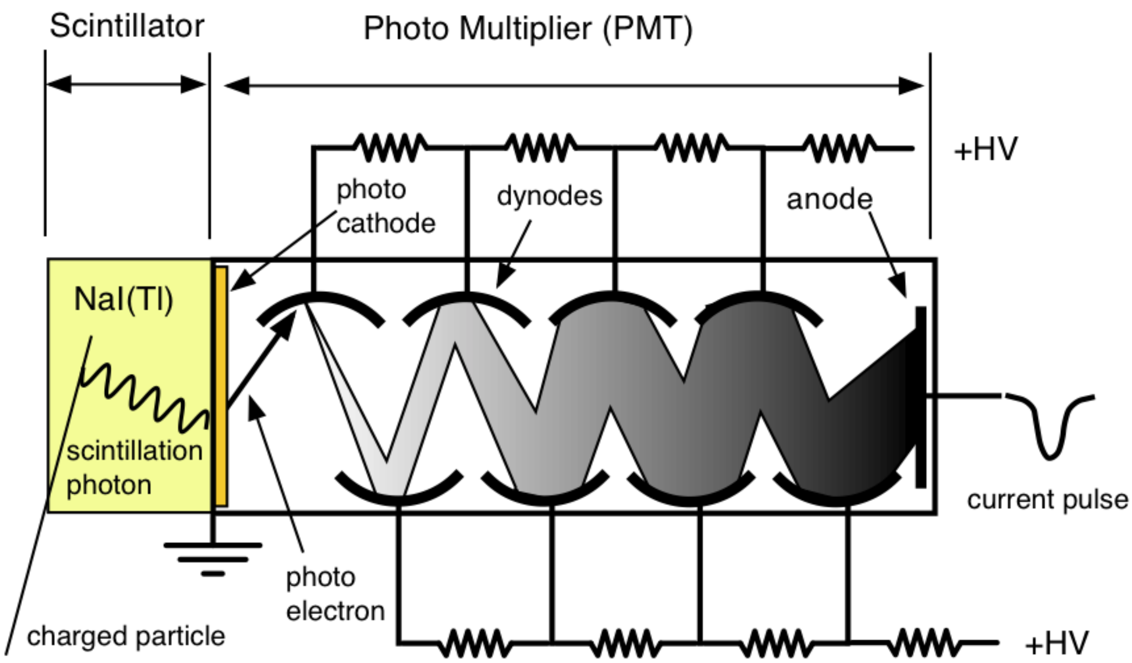

Figure 5: Concept drawing of scintillator