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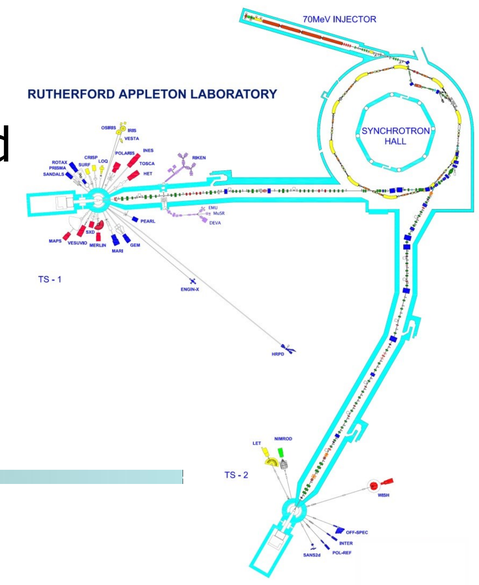
Online Total Ionisation Dosimeter (TID) monitoring using semiconductor based radiation sensors in the ISIS Proton Synchrotron

Daniel Harryman, Alex Pertica
ISIS, STFC, Rutherford Appleton Laboratory, Oxfordshire, OX11 0QX, UK.

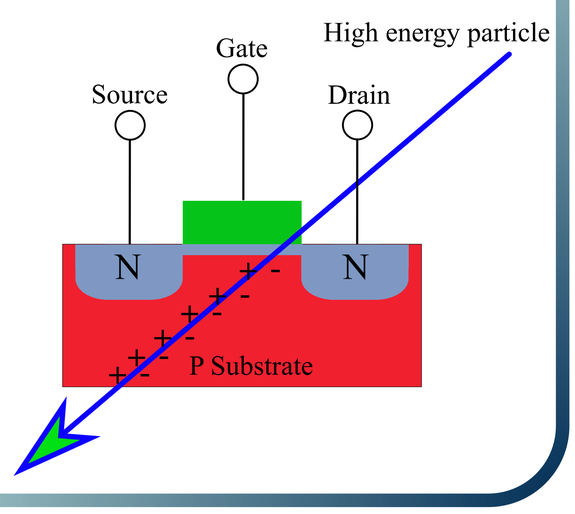
Introduction

ISIS is a pulsed spallation neutron and muon source facility, the neutrons and muons are created by colliding protons into a tungsten or graphite target. The protons are accelerated by a 70 MeV Linac and a 800 MeV synchrotron before being kicked down the Extracted Proton Beamlines. Components in the accelerator can fail due to radiation caused by the accelerator. To monitor the levels of ionising dose components receive, a Total Ionising Dosimeter has been developed using pin diodes and Radiation sensing Field Effect Transistors (RadFETs).

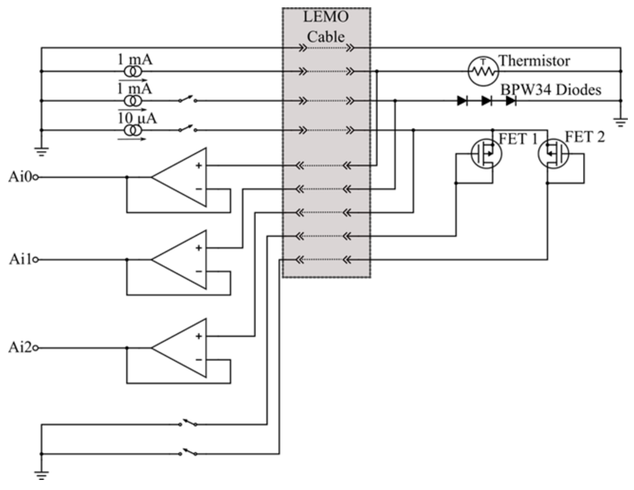


Radiation Effects on FETs

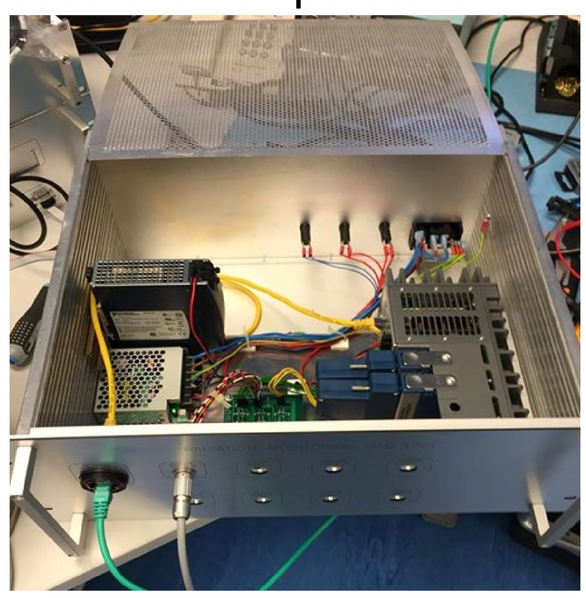
As high energy particles travel through the gate of a FET, the radiation induced charges get trapped and create electron hole pairs.



Measurement System



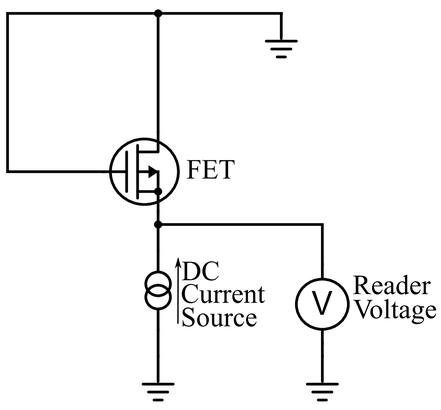
RadFETs, pin diodes and a thermistor are used in the measurement system to log dose and temperature.



The data acquisition is done by a National Instruments cRIO that is cabled to the sensor board from a shielded area.

Preliminary Experiments

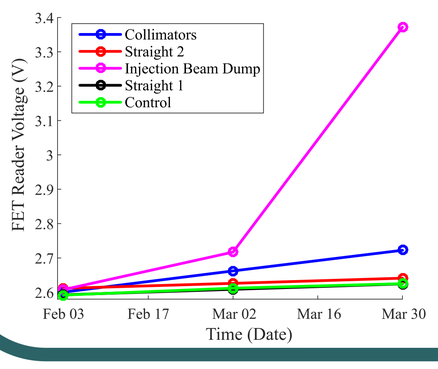
In theory biasing FETs and diodes with a constant current will output a voltage that is positively correlated to dose absorbed.

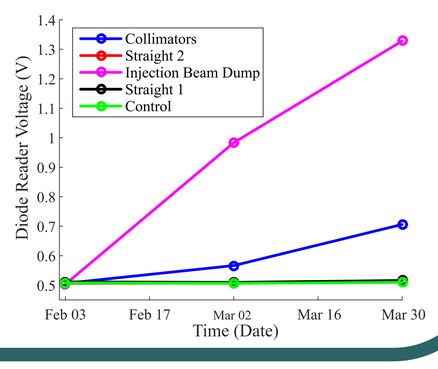


To test this diodes and FETs were placed around the ISIS synchrotron and exposed to radiation for one user run.

The measured diode and FET voltage increased more in areas that have more beam losses and radioactivity.

Areas with low activity and the control stayed the same.

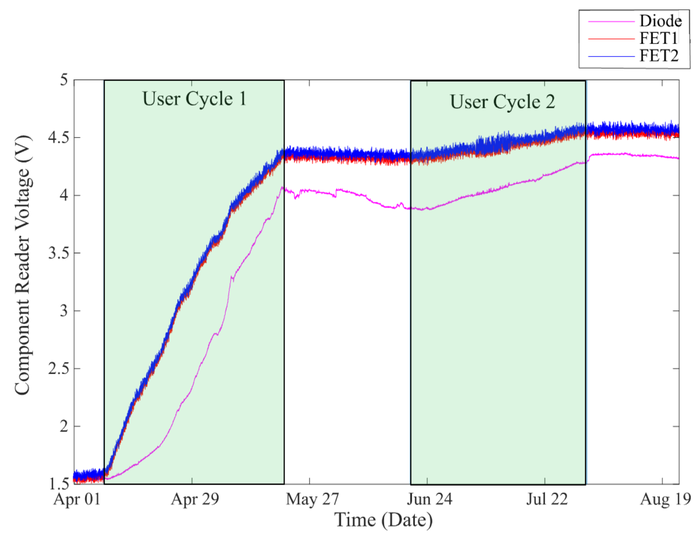




Results

The readings from sensors next to the injection beam dump were logged over two user runs.

The accelerator repetition rate was dropped from 50 Hz to 10 Hz for the second user run.



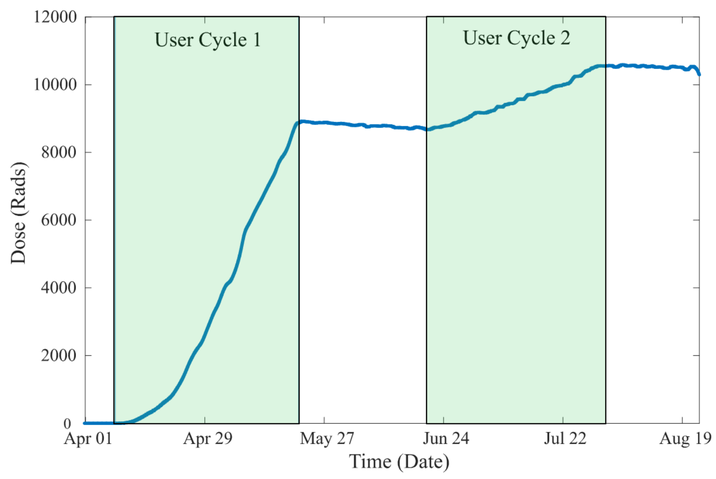
The dose from the RadFETs can be obtained using:

$$Dose = (a\Delta V)^{\frac{1}{b}} \quad \text{Rads}$$

$$a = 0.06594$$

$$b = 0.41169$$

The measured dose scales almost linearly with accelerator intensity.



daniel.harryman@stfc.ac.uk