# SC-ODIN Radiation Sensing Payload

## Secondary Payload Description

SC-ODIN's secondary payload are two Varadis VT01 dual-RADFETs. SC-ODIN will have one VT01 device located inside the electrical control unit (ECU) and one VT01 device located outside the bus, allowing total ionizing dose (TID) data to be collected throughout the mission.

## Purpose of the Experiment

Space is hostile. Besides the challenges of launch, spacecrafts are exposed to hard vacuum and to extreme temperatures. Another aspect of the space environment is radiation. On Earth, we enjoy noticeable shielding from the atmosphere and the magnetosphere. The average yearly radiation dosage for an individual is 2.4 mSv/yr (Gratsky et al. 2004, UNSCEAR 2008, NCRP 160 2009). Meanwhile, in space, SC-ODIN will be exposed to approximately 100 Gy/yr, which can be approximated to 100Sv/yr.

Radiation can affect the satellite in several different ways. One of these ways is the degradation of the performance of electronic components. For example, after being exposed to enough radiation, a transistor could no longer be capable of conducting, or would not be able to stop conducting. Or again, it could still work, but not as well. The problem is that determining the quantity of radiation required to affect the performance of a circuit is hard to determine. Normally, resistance to radiation effects, or radiation hardness, is determined by exposing the circuit to radiation. This testing is expensive, however.

Fortunately, by being careful with electronic component selection, by researching parts that have either been tested or that have been flown in space before, and by designing redundancy into systems, an acceptable radiation hardness for the satellite as a whole can be theoretically achieved. Additionally, the TID can be reduced by employing radiation shielding as seen in Figure 1, which was generated using SPENVIS.

The data collected from this secondary payload can be used in several ways. First, it can be used to compare the radiation dosages experienced by the outside of the spacecraft and by the inside of the spacecraft. Since SC-ODIN's outer shell is composed of 1/16th inch (~1.5mm) aluminium, we can expect the dosage to be reduced by about half. Second, we can monitor the time and position variance of Earth's radiation environment in the ISS orbit. Third, in the event of a failure aboard the spacecraft, a log of its approximate radiation dosage performance can be kept. Lastly, the data collected can further Space Concordia's understanding of Earth's radiation environment and its effects on components.

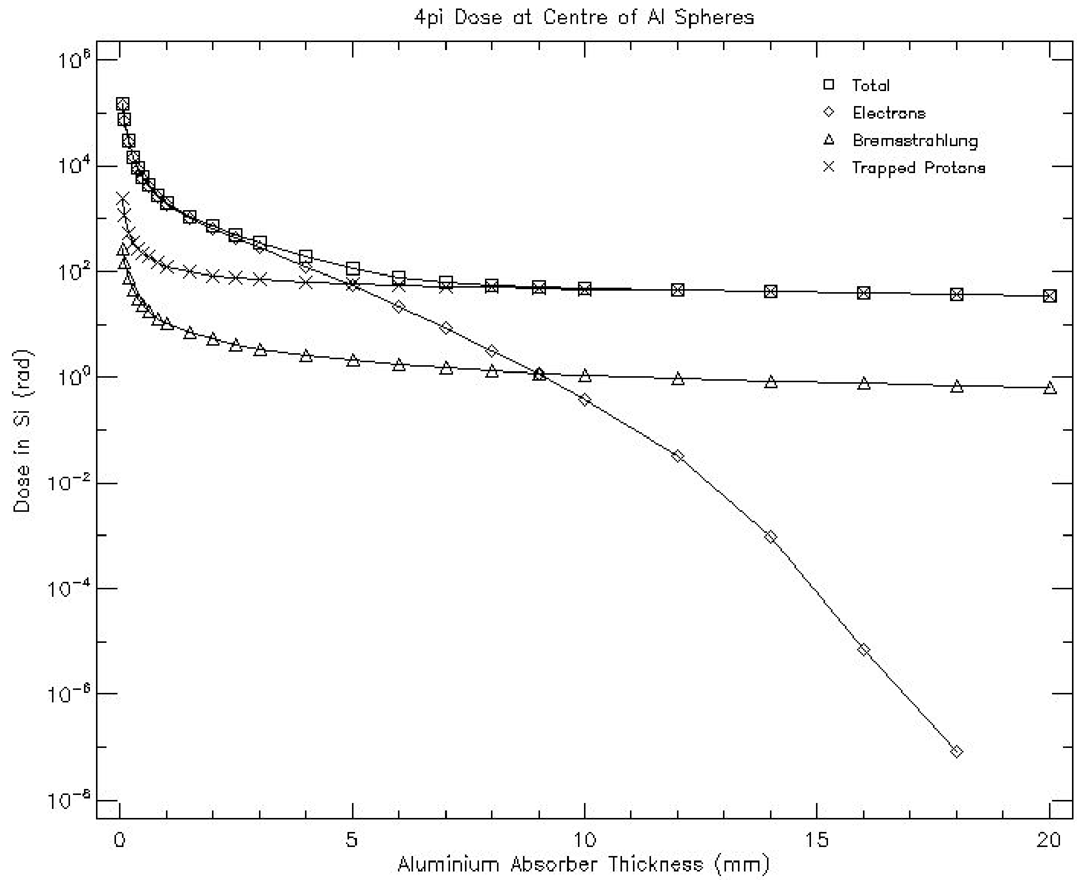


Figure 1: The effect of shielding on radiation dosage

# The VT01 Device

The Varadis VT01 devices, shown in Figure 2, are composed of two RADFETs in a SOT-23-3 package. Each RADFET is sensitive to radiation levels between 0.01 Gy (1 rad(Si)) and 1000 Gy (100 krad(Si)). RADFETs are passive sensors. Ionizing radiation charges the gate oxide of the FETs, degrading the FET's threshold voltage.

By forcing a current from source to drain, $V_{SD}$ can be measured as shown in Figure 3. The voltage reading does not directly translate to a radiation dosage. Instead, the shift in voltage indicates the TID, as shown in Figure 4. When the devices are not being read, all pins should be grounded in order for the TID readings to be more accurate.

The specifics of the relationship curve shown in Figure 4 vary from batch to batch. Purchase of VT01 devices (90€ per VT01) also includes calibration data for the devices.

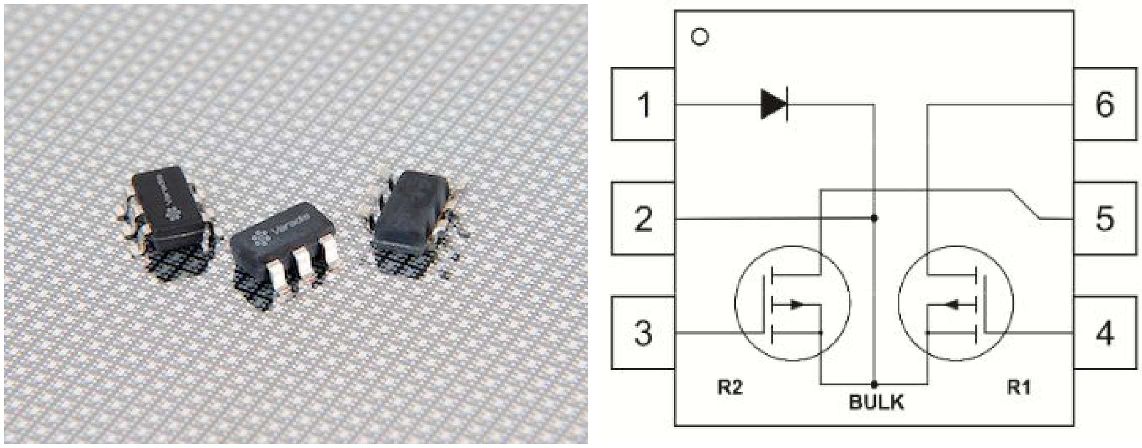


Figure 2: Varadis VT01 dual-RADFETs

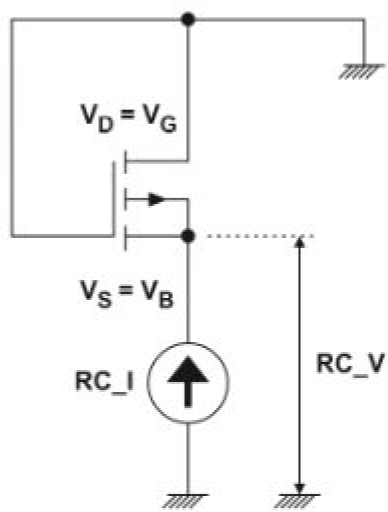


Figure 3: Biasing of a RADFET during measurement

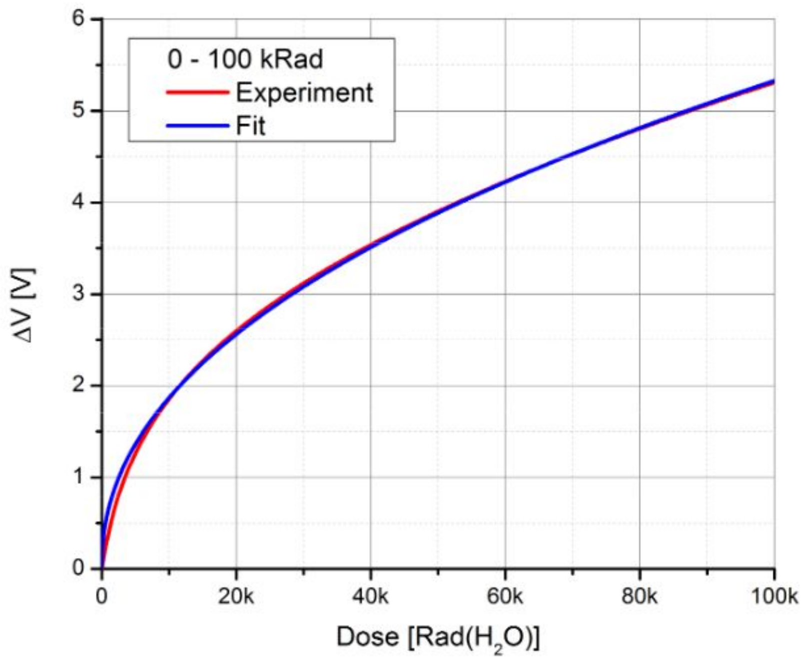


Figure 4: The shift in $V_{DS}$ indicates the device's dosage