# FEASIBILITY STUDY OF A NOVEL MULTI-STRIP SILICON DETECTOR FOR USE IN PROTON THERAPY RANGE VERIFICATION QUALITY ASSURANCE

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**Introduction:** This abstract presents the characterisation of a novel multi-strip silicon detector, the serial Dose Magnifying Glass (sDMG), for use in proton therapy range verification Quality Assurance (QA). Developed by the Centre for Medical Radiation Physics (CMRP) at the University of Wollongong, characterisation of the detector was performed using Geant4 simulations, which were then compared with experimental measurements performed at the international proton research facility, CATANA, INFN.

**Materials and Methods:** The sDMG is comprised of two linear silicon diode arrays mounted on a PCB board to provide a total of 256 individual channels, with the entire ensemble housed in a solid water phantom.

Geant4 (10.01) based simulations were developed to initially verify the applicability of the sDMG for range verification in ocular proton therapy, and later implemented to provide an understanding of the detector response obtained via experimental measurements at CATANA, INFN. To understand the impact of the air gaps surrounding the device on proton path length, additional simulations were performed modelling the air recess with increasing height from 0.5 mm to 1 mm.

Detector response to incident mono-energetic proton beams was experimentally characterised at the INFN CATANA proton therapy beam line to confirm the Monte Carlo feasibility tests. Capable of delivering 60MeV protons at the beam isocenter, the sDMG response was obtained for field size diameters of 5 mm, 13 mm, 25 mm and 36mm in addition to the detector response when PMMA slabs of 5 mm, 7 mm, 10 mm and 15 mm are positioned between the phantom and beam nozzle. These scenarios are reflected in the implemented Geant4 simulations.

**Results**: Experimental and simulated detector responses are presented in Figures 1 and 2. Figure 2 depicts a comparison between the simulated and experimental detector response for a 13 mm diameter beam incident the detector with a 10 mm PMMA slab set in front of the device.

Based on the position of the Bragg peak due to silicon, the entrance energy at the face of the sDMG phantom was reconstructed as 60 ± 0.8 MeV, 60 ± 0.2 MeV, 60 ± 0.2 MeV and 60 ± 0.4 MeV for the case without a PMMA slab and for PMMA slab thicknesses of 5, 10 and 15 mm, respectively.

Geant4 simulations show good agreement in the position of both the first and second Bragg peaks, with slight mismatching due to small geometrical differences in the implemented model of the sDMG.

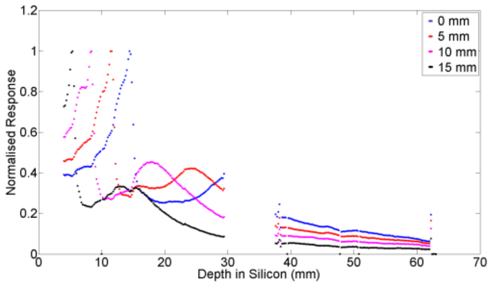


Figure 1. sDMG response to incident 60 MeV proton beam 13 mm diameter. The results are shown for different PMMA slab thicknesses in front of the device as indicated by the legend.

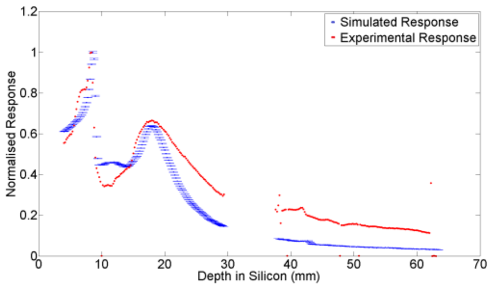


Figure 2. Comparison of simulated and experimental sDMG response to incident 60MeV, 13 mm diameter proton beam. A 10 mm PMMA slab in set in front of the device.

**Conclusion**: This study indicates that the sDMG is feasible for use in clinical proton therapy range QA, with experimental measurements confirming this. Experimental detector response achieves a high spatial resolution (0.2 mm) at energies applicable to ocular proton therapy. Geant4 simulations indicate good agreement with the experimental sDMG response and were critical to understanding the impact of the device geometry. Further, these simulation studies have provided guidelines for optimisation and improvement of the next generation of the sDMG.

**References:**

1. A.H. Merchant, et al., *Rad Meas.* doi:10.1016/j.radmeas.2017.03.017 (2017)