Development of Geant4 DICOM based dose calculation for Synchrotron Microbeam Radiation Therapy

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Background: Synchrotron generated Microbeam Radiation Therapy (MRT) utilizes high intensity, kilovoltage energy, photon beams with extremely steep dose gradients. As such, MRT is not well suited to calculations using conventional treatment planning systems. To facilitate ongoing *in vivo* studies and a convergence on clinical best practice, a dedicated Geant4 simulation needs to be developed and experimentally validated.

Material and Methods: We use Geant4 simulations to model MRT from synchrotron X-ray photon creation, transportation and filtration, through to dose delivery in increasingly complex anatomical phantoms. The Geant4 ICRP110_HumanPhantoms advanced example, with imported DICOM studies, ensures high accuracy and patient specific results. These simulations are further used to calculate changes to the photon beam spectrum unique to microbeam peaks and valleys (ensuring detector correction factors are correctly applied), optimize treatment parameters (dose uniformity with bolus layers), and prescribe dose within target volumes.

Preliminary results:
We demonstrate a robust Geant4 dose simulation tool to support ongoing *in vivo* experiments at the Australian Synchrotron. Voxelized 3D phantoms created directly from patient CT DICOM studies allow for high accuracy simulations of dose deposition to target volumes and organs of interest. Simulation run times of under 20 minutes fit well into a realistic treatment planning protocol.

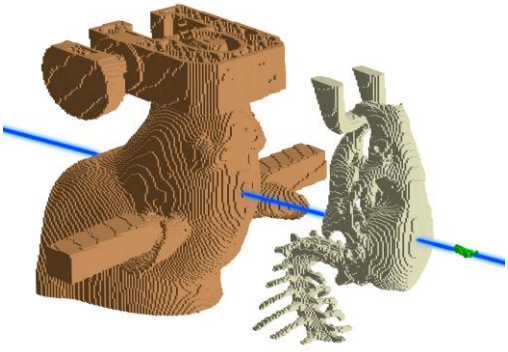

Figure 1: Visualization of geometry imported into Geant4 for treatment simulation.