

## End to end simulations of the Clatterbridge **Eye Proton Therapy Beamline**



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Jacinta Yap<sup>1,2</sup>, Matthieu Hentz<sup>3</sup>, Jordan Silverman<sup>3</sup>, Simon Jolly<sup>3</sup>, Stewart Boogert<sup>4</sup>, Andrzej Kacperek<sup>5</sup>, Roland Schnuerer<sup>1,2</sup>, Javier Resta-Lopez<sup>1,2</sup> and Carsten Welsch<sup>1,2</sup>

- <sup>1</sup> University of Liverpool, Liverpool, UK
- <sup>2</sup> Cockcroft Institute, Warrington, UK
- <sup>3</sup> University College London, London, UK
- <sup>4</sup> John Adams Institute at Royal Holloway University of London, Surrey, UK
- <sup>5</sup> The Clatterbridge Cancer Centre, NHS Foundation Trust, Wirral, UK

The Clatterbridge Cancer Centre **NHS Foundation Trust** 

The world's first hospital proton beam therapy facility, the Clatterbridge Cancer Centre (CCC), UK has successfully provided treatment for ocular cancers over the past 30 years. As the facility supports a wide range of experimental work including cell biology studies, there is a need for an accurate and reliable simulation model for full characterisation of the beam. We present recent developments of a complete end-to-end simulation model of the Clatterbridge beamline, from the extraction point of the cyclotron all the way to the treatment nozzle, developed using the Monte Carlo simulation toolkit Geant4 and expanded to include precise CAD models of the treatment beamline. Upstream of the treatment room, an extensive beam dynamics study was performed to determine beam parameters utilised with the accelerator design code **Beam Delivery Simulation (BDSIM).** Experimental measurements were carried out to validate the accuracy of the simulated beams of both codes and findings were implemented in the combined model.







As indicated by the distinct differences between the simulated and measured profiles, there are still improvements to be made to the model. It is noted that there are errors with the calculated film FWHMs due to saturation effects and positioning misalignments. The plotted points along the vertical axis are of arbitrary units, as dependent on the number of simulated primaries. The simulated pristine Bragg Peak varies slightly and other issues stem from uncertainties with parameters of the primary input beam which will be verified with experimental validation of the (BDSIM) beam optics model.



http://www.quasar-group.org http:// oma-project.eu jacinta.yap@cockcroft.ac.uk

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model will be available for wide use as a verified, standard simulation model for all related with the work performed **Clatterbridge** proton therapy beamline. The beam optics model will be experimentally validated and the inclusion of information, LET this calculations, SOBP and a parallel model in TOPAS are anticipated.