
Contribution ID: **116** Contribution code: **S3 Accelerators and Synchrotron Radiations** Type: **Oral Presentation**

# 3D Range-Modulators: Near field simulations with FLUKA and comparison with film measurements

*Thursday 23 June 2022 11:45 (15 minutes)*

The 3D range-modulator is an innovation used in particle delivery systems that can create a highly conformal and homogeneous dose distribution in the target volume with mono-energetic beam, providing an option for high dose rate FLASH therapy (exploiting the Bragg peak) [1,2].
In the normal case, the modulators are positioned far away from the target in order to avoid the fluence ripples resulting from the periodic structure of the modulators [1]. To understand the fluence structure of protons induced by the 3D range-modulators and determine the minimum distance at which the fluence is homogeneous enough for the treatment, FLUKA Monte Carlo simulation package was used to observe the fluence distributions in the air or water after protons undergoing the modulators. The highest fluence ripple was spotted at a few centimeters from the modulators and then faded away as the distance increased, which can be described by the edge scattering effect and later by the blur-out of the overlapping contributions from the pins. Moreover, the dose distribution in water was investigated, particularly for small distances between the modulators and the water phantom.
Furthermore, the Monte Carlo results were compared with *Gafchromic EBT-3* film measurements irradiated with a 3D-printed range modulator prototype and show a good qualitative agreement.
Prospectively, the strong dose inhomogeneity's which appears in the proximal part of the target, could introduce a kind of 'mini beam'normal-tissue sparing by the 3D range-modulators.

Keywords: Proton therapy, 3D range-modulators, FLUKA Monte Carlo simulation, Edge scattering, Fluence and dose ripple
Ref.: [1] Yuri Simeonov et al 2017 Phys. Med. Biol. 62 7075, [2] Yuri Simeonov et al 2022 Biomed. Phys. Eng. Express 8 035006

**Author:** CHARUCHINDA, Warisara (Chulalongkorn University, Bangkok)

**Co-authors:** Dr HORST, Felix (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany); Dr SIMEONOV, Yuri (Institut für Medizinische Physik und Strahlenschutz, Technische Hochschule Mittelhessen, Giessen, Germany); Dr SCHUY, Christoph (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany); Dr PENCHEV, Petar (Institut für Medizinische Physik und Strahlenschutz, Technische Hochschule Mittelhessen, Giessen, Germany); Dr POULSEN, Per (Danish Center for Particle Therapy (DCPT), Aarhus, Denmark); Dr SITARZ, Mateusz (Danish Center for Particle Therapy (DCPT), Aarhus, Denmark); Dr BUSOLD, Simon (Varian Medical Systems Particle Therapy, Troisdorf, Germany); Dr REIDEL, Claire-Anne (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany); Dr FOLKERTS, Michael (Varian Medical Systems, Inc., Palo Alto, California, US); Dr KRIEGER, Miriam (Varian Medical Systems Particle Therapy, Troisdorf, Germany); Prof. SUWONJANDEE, Narumon (Chulalongkorn University, Bangkok); Prof. ASAVAPIBHOP, Burin (Chulalongkorn University, Bangkok); Prof. DURANTE, Marco (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany); Prof. ZINK, Klemens (Institut für Medizinische Physik und Strahlenschutz, Technische Hochschule Mittelhessen, Giessen, Germany); Dr WEBER, Uli (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany)

**Presenter:** CHARUCHINDA, Warisara (Chulalongkorn University, Bangkok)

**Session Classification:** S3 Accelerators and Synchrotron Radiations

**Track Classification:** Accelerators and Synchrotron Radiations