EV122 / #422

REALPATH: DEVELOPMENT OF A REAL-TIME RANGE VERIFICATION SYSTEM IN HADRONTHERAPY BASED ON PROMPT GAMMA IMAGING

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Background and Aims: In hadrontherapy, range verification using the Prompt Gamma Imaging (PGI) technique has demonstrated precision within few millimeters. However, no clinical-grade system exists yet, in particular with the capability to meet the rate specifications of a wide range of accelerators. The RealPath project aims to develop a compact system with high count rate capabilities that can be seamlessly integrated within a variety of treatment environments.

Methods: The system employs a pixelated knife-edge slit camera optimized for high prompt-gamma emission rates, aiming to address the challenge of tight event clustering in the time frame given by the beam structure of synchrocyclotrons. It is designed with the ambitious aim to provide real-time feedback for each delivered spot or, at a minimum, for each treatment fraction, while showing potential for applications also in FLASH therapy. The gamma camera features a modular design (Figure 1), comprising a base unit of 64 pixelated scintillator crystals one-to-one coupled to a SiPM matrix, with a count rate capability of 1 Mcps per channel. The electronic platform, designed to prioritize simplicity and ease of use, performs data processing onboard and provides a direct 10 Gbit/s Ethernet link for real-time feedback. The architecture enables flexible configurations, where modules can be either stacked transversely to the beam direction to increase statistics, or extended along the beam direction to expand the field of view, or duplicated, enhancing detection efficiency (Figure 2). This design also supports precise timing synchronization for multi-camera setups in the treatment room. The system's compactness enables in room integration with a robotic platform for mm-precision positioning near the patient.

Results: The electronic platform is being developed concurrently with the mechanical design, aiming to achieve a finalized prototype. The experimental measurements with a first prototype unit are planned for Spring 2025 at CNAO (Pavia, IT), utilizing both protons and carbon ions.

Conclusions: The RealPath project aims to introduce a new range monitoring instrument in hadrontherapy, prioritizing the integration of the detection system within the treatment room and ensuring compatibility with different treatment irradiation fields.

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A UNIQUE MULTIPURPOSE PROTON BEAM COMMISIONING AND QA DEVICE

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Background and Aims: This study aims to develop a novel device designed for increasing efficiency in commissioning and regular QA for proton therapy. The device integrates accurate spot charateriszation and multiple QA functionalities into a single apparatus, supporting QA for CT, IGRT, surface guidance, and daily machine QA.

Methods: The unique device's design was driven by the need to accurately measure and evaluate key beam parameters. The device is completely radiotranslucent allowing for artifact free CT or CBCT scans. The device utilizes a scintillating screen and optical camera positioned outside the radiation area. Planar beams are delivered onto plastic wedges that vary in size and are utilized to quantify the range of the protons. Spots of varying energy are delivered onto the screen to quantify beam spot charateristics and positional accuracy and device misalignment. By use of a Gaussian fit, the centroid of the spot beams can be found and verified for misalignment or spot position errors.

Results: The prototype QA device was successfully used to measure dosimetric beam parameters. The proton range was determined by identifying the start of the Bragg curve profile and ending at the half-value of the distal edge. These values were obtained for both an 'open' beam and for beams with varying thicknesses of solid water inserted in their path. A linear fit applied to the data revealed a range detection sensitivity (2 pixels) on the order of 0.25 mm.

Conclusions: The prototype QA device demonstrates significant promise for enhancing daily QA in proton therapy through measurement of daily dosimetric parameters.

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EVALUATING THE USABILITY OF MACHINE LOG FILES FOR QA IN PROTON THERAPY AT MEDAUSTRON ION THERAPY CENTER

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Background and Aims: This study evaluates the usability of machine log files for beam delivery and patient-specific QA (PSQA) in proton therapy at MedAustron Ion Therapy Center. The goal was to extract key metrics and assess the reliability of log file data.

Methods: Log files were analyzed for routine QA and patient treatment plans. For QA, logged number of particles (NP) and spot positions were evaluated against dose measurements using Roos chamber in radiation-equivalent solid water phantom slabs and spot map measurements at isocenter using Lynx (IBA-Dosimetry). For treatment plans, log-files were compared to plan files. Real-time beam monitor position correction (FBL) was considered in the evaluation.

Results: For QA measured dose, NP deviations ranged up to 2%, indicating systematic underestimations of the NP contributing to the dose at the isocenter (Figure 1). Logged measured spot position