

## Multi-layer ionization chamber for quality assurance and stopping power measurements

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The Center for Proton Therapy (CPT) of the Paul Scherrer Institute has a long history of technical innovation and development in the field of proton therapy and related quality assurance (QA). The second proton pencil beam scanning gantry built at the CPT, Gantry2, is a state-of-the-art system. The unique integration of QA equipment and detectors within the control system of the gantry allows for fast and detailed measurements. Here we present our latest developments in detection systems, their performance for QA and research capabilities in comparison with their commercial equivalent.

The QA equipment developed for proton range measurement at Gantry2 consists of a multi-layer ionization chamber (MLIC). We compare three unique MLIC systems, including a commercially available device, against a water-based range measurement device as reference. The range measurement with the MLIC shows a deviation of less than 0.5 mm water equivalent thickness for 115 energies between 70 MeV and 230 MeV on a daily basis, since November 2013. The extensive integration of our detectors with the control system allows fast spot-based measurement. Including the energy change, we can achieve a proton range evaluation within 125ms. Consequently, our device can measure the proton range alteration caused by material samples for hundreds of energies within less than a minute. This method provides a fast and direct way to measure the stopping power of compounds with a  $\sigma < 0.1\text{mm}$ .

The results show the strong points of the equipment developed in-house, such as the consistency, the reliability and the innovation possibilities.

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