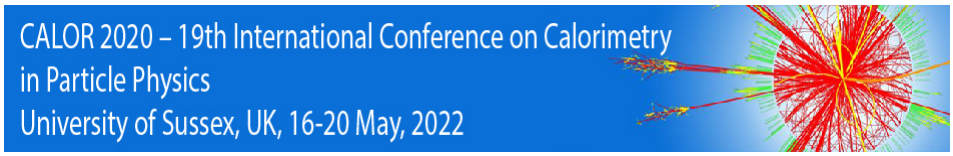

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QuARC: A Quality Assurance Range Calorimeter for Proton Therapy

Proton therapy offers highly localised dose distribution and better healthy tissue sparing over conventional radiotherapy. Crucial in optimising patient safety is the proton range: this is the largest source of uncertainty in proton therapy and prevents full advantage being taken of the superior dose conformality. In the clinic, daily Quality Assurance (QA) is performed each morning before patient treatment, including verification of the proton range in water (a proxy for human tissue) for specific beam energies. This process however, often compromises between speed and accuracy. Recently, there has been increased interest in FLASH: a high dose rate form of radiotherapy offering even greater healthy tissue sparing. However, standard detectors used in QA become unusable at FLASH dose rates.

The Quality Assurance Range Calorimeter (QuARC) is currently under development at UCL with our industrial partners Cosylab to provide fast, accurate, water-equivalent proton range measurements for daily QA, with the capability to operate at FLASH dose rates. Based on plastic scintillator developed for the SuperNEMO experiment, the detector is a series of optically isolated scintillator sheets that sample the proton energy deposition along its path. Light from each sheet is measured by a series of photodiodes: this light output is proportional to the deposited energy. An analytical depth-light model is used to fit the data and measure the proton range to sub-mm precision.

Two preliminary beam tests at UCLH with proton pencil beams between 70-110 MeV found that the QuARC is able to consistently recover proton ranges with good accuracy, even at low light levels. Fast curve fitting enables stable real-time range reconstruction at 40 Hz, as protons are delivered to the detector. Due to large dynamic range, the detector can be scaled up to FLASH dose rates. Further measurements are required to fully characterise detector performance and light output with FLASH.

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