values), beam position, spot size, and intensity within a single beam delivery. Monte Carlo dose reconstruction using independently measured beam parameters showed good agreement with reference simulations for longitudinal profiles, validating the fundamental approach.

However, clinical implementation requires resolution of identified limitations including energy calibration offsets, CMOS detector saturation at higher intensities, acquisition synchronisation challenges, and lateral profile reconstruction accuracy (77% gamma pass rate at 2%/2mm for the box field). Ongoing detector development, including improved photodiode readout electronics, scintillating fibre profile monitors, and integrated data acquisition systems, will address these challenges. Once refined, this approach offers significant advantages over current PSQA methods by enabling independent verification of beam delivery parameters while maintaining patient geometry and reducing clinical resource requirements.

CONFLICT OF INTEREST STATEMENT

The Transmission Calorimeter design has been protected under a priority patent application filed in May 2022 (https://worldwide.espacenet.com/patent/search/family/082324167/publication/WO2023227909A1?q=WO2023227909).

FUNDING

This work was funded by UKRI STFC IPS Award No. ST/V001183/1 and CLASP Award No. ST/W002175/1. This work was also partially funded by an Explorer's Award from the National Physical Laboratory's Directors' Science and Engineering Fund.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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