

Technical note

# Evaluations of a flat-panel based compact daily quality assurance device for proton pencil beam scanning (PBS) system

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## Highlights

- Investigated the flat-panel detector for quenching effect and range accuracy.
- PBS daily QA test performance of x-ray/proton coincidence and spot characteristics.
- Low, mid, high proton energy checks and its detection sensitivities.
- Transformed profiles of proton spread-out Bragg peaks.

## Abstract

### Purpose

To evaluate the flat-panel detector quenching effect and clinical usability of a flat-panel based compact QA device for PBS daily constancy measurements.

### Materials & Method

The QA device, named **Sphinx Compact**, is composed of a 20x20 cm<sup>2</sup> flat-panel imager mounted on a portable frame with removable plastic modules for constancy checks of proton energy (100 MeV, 150 MeV, 200 MeV), Spread-Out-Bragg-Peak (SOBP) profile, and machine output. The potential quenching effect of the flat-panel detector was evaluated. Daily PBS QA tests of X-ray/proton isocenter coincidence, the constancy of proton spot position and sigma as well as the energy of pristine proton beam, and the flatness of SOBP proton beam through the 'transformed' profile were performed and analyzed. Furthermore, the sensitivity of detecting energy changes of pristine proton beam was also evaluated.

### Results

The quenching effect was observed at depths near the pristine peak regions. The flat-panel measured range of the distal 80% is within 0.9 mm to the defined ranges of the delivered proton beams. X-ray/proton isocenter coincidence tests demonstrated maximum mismatch of 0.3 mm between the two isocenters. The device can detect 0.1 mm change of spot position and 0.1 MeV energy changes of pristine proton beams. The measured transformed SOBP beam profile through the wedge module rendered as flat.

## Conclusions

Even though the flat-panel detector exhibited quenching effect at the Bragg peak region, the proton range can still be accurately measured. The device can fulfill the requirements of the daily QA tests recommended by the AAPM TG224 Report.

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