Feasibility of a High-Resolution CMOS 2D Detector Array as a Film Alternative for IMRT Commissioning

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INTRODUCTION

Radiochromic film (RCF) is widely used for treatment planning system (TPS) and IMRT commissioning because of its high spatial resolution, which supports detailed evaluation of dose distributions and beam model refinement. However, film-based dosimetry is labor-intensive and requires careful handling, calibration, scanning, and post-processing. A high-resolution CMOS 2D detector array may provide a more efficient alternative while preserving the spatial resolution needed for commissioning measurements. This study evaluates the feasibility of using myQA SRS (IBA Dosimetry, Schwarzenbruck, Germany) as an alternative to RCF for IMRT commissioning measurements in solid water.

METHODS AND MATERIALS

- **Plan selection:** 5 IMRT plans were selected from the institution's commissioning plan set for a MSKCC in-house optimization algorithm ECHO in ARIA/Eclipse, including paraspinal SBRT, conventional lung, and head and neck quadshot cases. A total of 16 fields were chosen to represent a range of field sizes, modulation complexity, and dose gradients.
- **Delivery:** Fields were delivered on Varian TrueBeam and Ethos linear accelerators (Varian, Palo Alto, CA) using 6X and 6FFF photon beams.
- **Measurement setup:** Dose measurements were performed in a solid water phantom setup with the detector/film plane **at 5 cm depth using gantry 0° and SAD 100 cm. (Figure 1)**
  - **myQA SRS: 12 × 14 cm² active area with 0.4 mm resolution**. Angular correction was not applied **for gantry 0° measurements**. Large fields were measured with shifted acquisitions and stitched for analysis.
  - **Film: EBT4 radiochromic films** (Ashland, Wilmington, DE) were scanned at **72 dpi resolution (0.35 mm/pixel).** A calibration curve extending to at least 20% above the maximum measured dose was generated in FilmQA Pro v8 (Ashland). All films were processed using **triple-channel dosimetry with lateral scanner correction.**
- **Reference comparison:** For each field, myQA SRS measurements were compared with **films**, used as the commissioning benchmark in a MSKCC in-house software, Contour Overlay.
  - **Gamma Analysis (γ):** Global γ analysis was performed using **2%/1 mm and 1%/1 mm** criteria with a **10% low-dose threshold**.
  - **Dose difference:** Mean percent dose difference was calculated as **myQA SRS − film**, normalized to the **mean film dose within the ≥10% dose region.**
  - **Spatial evaluation:** Isodose overlays, dose-difference maps, and gamma index maps were reviewed. Two long fields were evaluated using stitched acquisitions to assess extended-field feasibility. Dose-difference isolines were displayed at **2% intervals** relative to the same mean film dose.

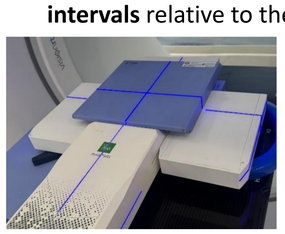


Figure 1. myQA SRS setup at 5 cm depth on a Varian Ethos linac with phantom inserts surrounding the detector, 3 cm solid water buildup above (plus ~2 cm inherent), and solid water beneath for full backscatter.

RESULTS

- Across all 16 evaluated fields, myQA SRS showed strong agreement with EBT4 film.
- Mean global gamma passing rates were **(Figure 2 (a)):**
  - **99.43% ± 0.62% using 2%/1 mm**
  - **97.33% ± 2.30% using 1%/1 mm**
- The mean dose difference was **−0.13% ± 0.81%,** normalized to the **mean film dose within the ≥10% dose region (Figure 2 (b)).**
- Gamma and dose-difference maps demonstrated good spatial agreement between myQA SRS and film. **(Figures 3-5)**
- Representative dose-difference maps showed local differences mostly within **±4% (relative to mean dose),** with larger deviations primarily localized to steep penumbra regions. **(Figures 3-5 (b))**
- Stitched acquisitions were feasible for long-field measurements, supporting potential use beyond the detector's native 12 × 14 cm² active area. **(Figure 5)**

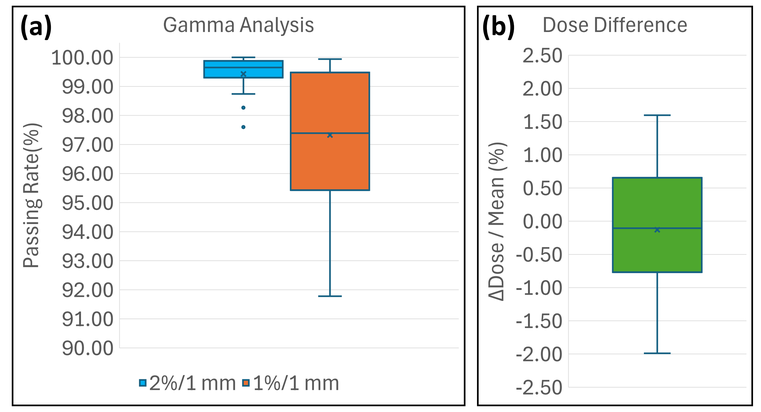
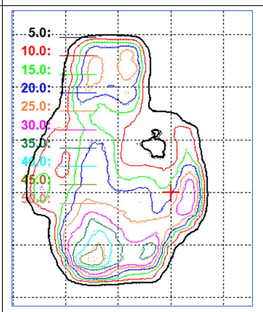
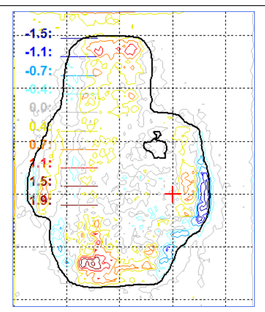
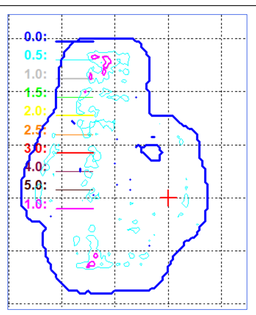
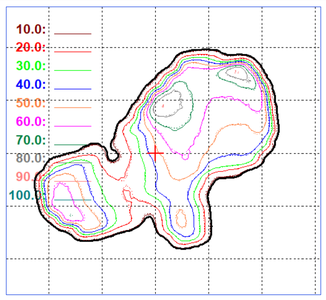
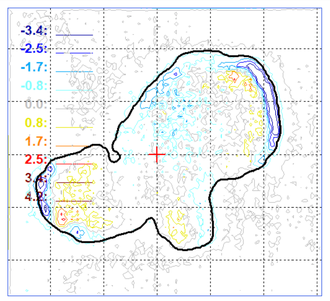
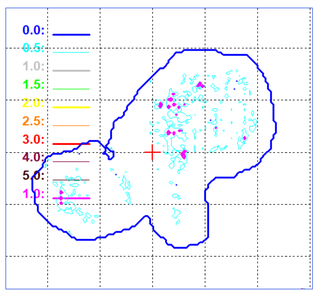
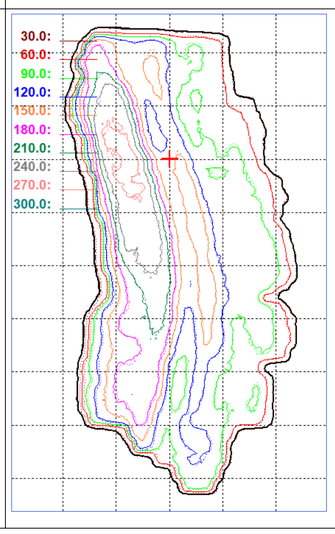
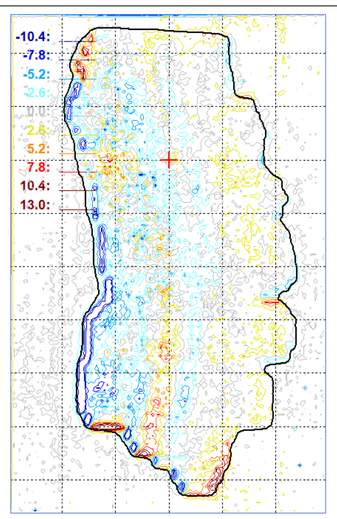
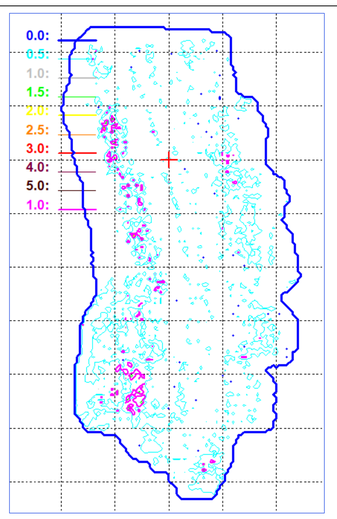


Figure 2. (a) Global γ passing rates. (b) Mean dose difference (myQA SRS − film) normalized to the mean film dose within the 10% dose ROI for each field; mean normalization (vs. maximum) increases the reported differences but better represent clinically relevant doses.

Grid spacing: 2 cm. Thick black contour = 10% threshold.	**(a)** Film (solid) vs myQA SRS (dotted) **isodose overlays** (cGy).	**(b) Dose-difference maps** (myQA SRS − film) with 2% (of mean) increments in cGy.	**(c) γ maps** using 1% /1 mm; purple contour indicates γ = 1.01.
Figure 3. A field of a lung plan on Truebeam (gamma passing rate: 99.5%).			
Figure 4. A field of a head and neck quadshot plan on Ethos (gamma passing rate: 99.4%)			
Figure 5. A stitched field of a paraspinal plan on Truebeam (gamma passing rate: 96.7%)			

DISCUSSION

myQA SRS demonstrated film-like dosimetric performance for representative IMRT commissioning fields, with high gamma passing rates and small mean dose differences across treatment sites and modulation levels, including steep-gradient paraspinal SBRT fields. Compared with RCF, myQA SRS reduces workflow burden by eliminating film handling, calibration, scanning, and post-processing, while providing near-immediate results. The detector's limited active area can be addressed with stitched acquisitions for larger fields. This study focused on gantry 0° measurements because angular correction accuracy remains important for commissioning-level validation of VMAT, virtual cone, and DCA techniques, particularly for beams near 90° or 270°. Future work will focus on improving angular correction and extending validation to arc-based commissioning.

CONCLUSIONS

The high-resolution CMOS 2D detector array demonstrated dosimetric performance comparable to EBT4 radiochromic film for IMRT commissioning measurements. Strong agreement under stringent gamma criteria, small dose differences, and reduced processing burden support the use of myQA SRS as a practical and efficient alternative to film for IMRT commissioning.

CONTACT INFORATION

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