Patient-Specific QA for External Beam Radiotherapy Using the HYPERSCINT Plastic Scintillation Detector

M. GOULET
Centre régional intégré de cancérologie (CRIC), Centre intégré de santé et de services sociaux (CISSS) - Chaudière-Appalaches, Lévis, QC, Canada

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INTRODUCTION

Plastic scintillation detectors (PSDs) have interesting dosimetric properties, including small size and energy independence. These advantages make them well suited for VMAT patient-specific QA, either alone or in conjunction with a detector matrix.

AIM

This work aims to determine if the HYPERSCINT scintillation dosimetry research platform (Medscint inc., Quebec City, Canada) can replace the classic ion chamber in a clinical patient-specific QA workflow.

METHOD

A custom-made, 3D-printed detector holder for the Delta4 Phantom+ diode matrix (Scandidos, Uppsala, Sweden) was designed to house both a A1SL ionization chamber (Standard Imaging, Middleton, WI) and a HYPERSCINT PSD probe (**Fig. 1**). The center of the chamber and PSD was placed on the same transverse plane, at a center-to-center distance of 6.5 mm from one another. The insert was 3D printed in PLA using an S5 3D printer (Ultimaker, Utrecht, Netherlands) and matches the density of the acrylic contained in the Delta4 Phantom+.

A total of 36 prostate plans (without pelvic nodes) and 47 palliative plans were selected for the study. Plans were delivered on the Phantom+ using a VersaHD linear accelerator (Elekta)(**Fig 2**) and measured simultaneously on both detectors. Difference between planned and measured dose (corrected for daily linac output) were computed for both the chamber and the PSD and the results from both detectors were compared for consistency.

RESULTS

As seen in **Fig. 3**, differences between VMAT planned and measured dose for both detectors are within 1.5% of the planned values, as expected from simple cases such as prostate and palliative sites. Dose difference between the measured and planned dose for the ionization chamber was (0.3±0.2)% (average ±1 standard deviation) for the prostate cases and (0.0±0.5)% for the palliative cases. For the HYPERSCINT alone these values stand as (0.9±0.3)% for the prostate cases and (0.5±0.7)% for the palliative cases.

A 0.5% offset on average between the HYPERSCINT and the ionization chamber can be seen from the measurements, as shown in **Fig. 4.** When comparing pairs of measurements (ion chamber vs PSD), the PSD overestimated the ion chamber dose by (0.6±0.2)% for the prostates cases and (0.5±0.4) % for the palliative cases. The source of this offset is still to be investigated, but are nevertheless deemed small enough to judge the HYPERSCINT a valid candidate to replace the chamber in future QA measurements using this setup.

***Figure 1**: Sectional view of the custom-made insert for the Delta4 Phantom+.*

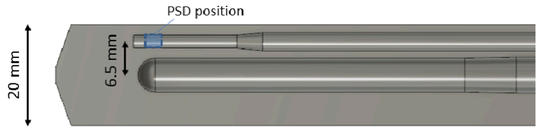


***Figure 2**: Delta4 measurement setup at the linear accelerator.*

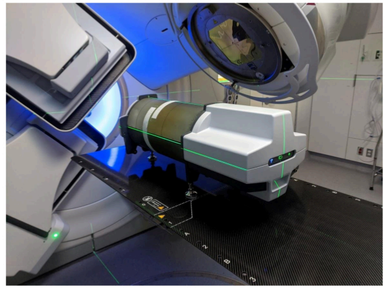


***Figure 3**: Difference between QA planned dose and measured dose, for both detectors under investigation. Deviations typically range from -1.5% to 1.5% for both detectors.*

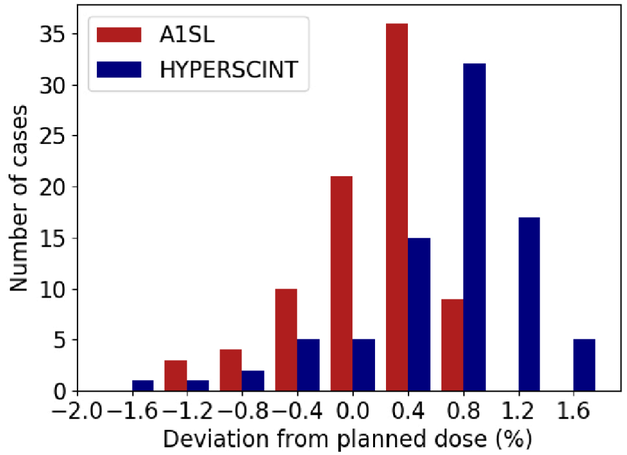
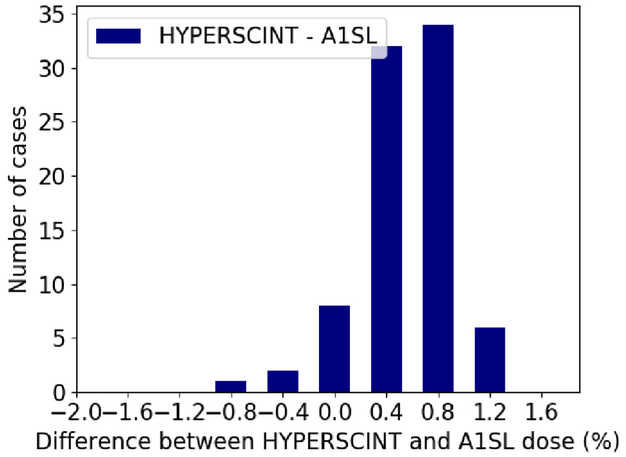


***Figure 4**: Difference between HYPERSCINT and A1SL measured dose difference. On average a 0.5% overestimate in dose is observed for the HYPERSCINT compared to the A1SL.*



CONCLUSIONS

Albeit a systematic offset of about 0.5% between the ion chamber and the PSD measured doses, the HYPERSCINT plastic scintillation dosimetry research platform shows enough accuracy to be used as a surrogate for an ion chamber in the measurement of VMAT patient-specific QA plans.

ACKNOWLEDGEMENTS

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REFERENCES

To learn more about plastic scintillation detector dosimetry :

- **Klein et al.**. In-phantom Dose Verification of Prostate IMRT and VMAT Deliveries Using Plastic Scintillation Detectors. *Radiat Meas. 2012; 10; 912-929.*
- **Guillot et al.**. Spectral Method for the Correction of the Cerenkov Light Effect in Plastic Scintillation Detectors: A Comparison Study of Calibration Procedures and Validation in Cerenkov Light-Dominated Situations. *Med Phys*. 2011; 4; 2140-50
- **Therriault-Proulx el al**. Development of a Novel Multi-Point Plastic Scintillation Detector With a Single Optical Transmission Line for Radiation Dose Measurement. *Phys Med Biol*. 2012; 21; 7147-59

See also : poster #PO-GeP-T-161, HDR Brachytherapy Technique Commissioning Using the HYPERSCINT Plastic Scintillation Detector

CONTACT INFORMATION

Mathieu Goulet, MCCPM, medical physicist
Mathieu_goulet@ssss.gouv.qc.ca