HIGH-RESOLUTION DETECTOR–DERIVED DLG IMPROVES PATIENT-SPECIFIC QA FOR SRS AND SABR

Seonghee Kang, Jegal Jin, In-bum Lee, Jung-in Kim

1Department of Radiation Oncology, Seoul National University Hospital, Seoul, 03080, Republic of Korea

SNUH SEOUL NATIONAL UNIVERSITY HOSPITAL

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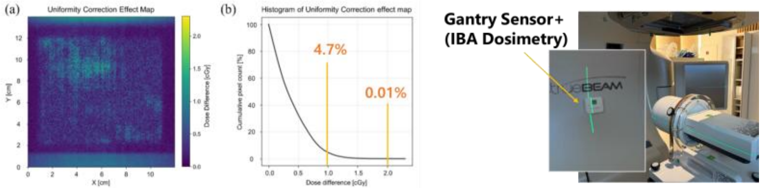
Background and Purpose

This study optimizes the DLG measurement workflow using the high-resolution CMOS-based IBA myQA SRS detector. The optimization process incorporates detector-specific corrections, including output calibration, uniformity, and angular response, to maximize dosimetric precision. The research ultimately evaluates the impact of this optimized DLG on PSQA agreement and its sensitivity to delivery errors for clinical SRS and SABR cohorts.

Methods and materials

Detector optimization

Although the manufacturer provides a factory-generated uniformity correction file and recommends performing a user uniformity calibration only when noticeable drift is observed, an additional uniformity calibration was performed to minimize non-uniformity.

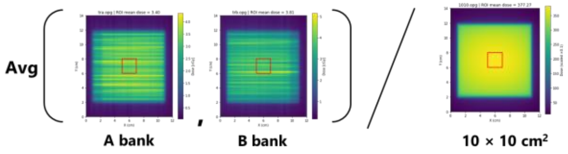


Absolute dose difference between the cases with and without uniformity correction for a 10 × 10 cm² field

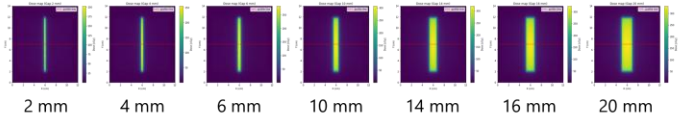
Angular correction was performed sequentially from 0° to 355°. Since the patient-right (PR) sector (180°–360°) was acquired later than the patient-left sector, it was more susceptible to the accumulated ghosting effect caused by repeated high-MU irradiations. This effect appeared immediately in the subsequent acquisition as a non-zero baseline signal, was visible as central brightening before beam-on, and did not noticeably diminish within a measurement session unless the background was manually re-acquired.

DLG Measurement and TPS Verification

- **Transmission factor**



- **Dosimetric leaf gap using SRS detector**



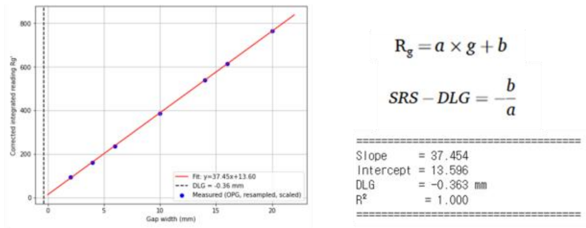
$$R_g = M(g) - M_{tr}$$

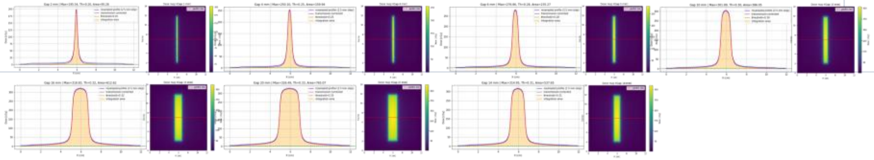
The SRS detector-based DLG (SRS-DLG) was determined by delivering static MLC gap fields at predefined gap widths and analyzing the transmission-corrected response as a function of gap. For each nominal gap width g (mm), the detector signal $M(g)$ was measured under identical MU and geometry. A separate MLC transmission measurement M_{tr}, was acquired using a closed-MLC field under the same conditions. The relative gap response R_g was defined as the measured signal with the transmission component removed:

$$R_g = M(g) - M_{tr}$$

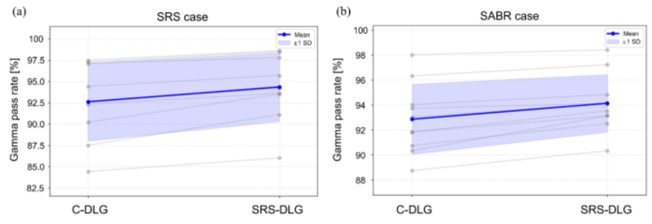
The relationship between R_g and g was modeled using a linear regression:

$$R_g = a \times g + b$$





Results



Gamma passing rate under 1%/1 mm criteria

GPR	C-DLG			SRS-DLG		
	Mean	SD		Mean	SD	P-value
SRS	92.6%	4.56%	**+1.74%**	94.3%	4.01%	< 0.001
SABR	92.8%	2.81%	**+1.28%**	94.1%	2.31%	< 0.001

Mean gamma passing rates and paired comparison

In the clinical QA impact assessment, applying SRS-DLG in the TPS produced a statistically significant increase in GPR compared with C-DLG, with mean improvements of 1.74% for SRS and 1.28% for SABR. Similar observations that optimizing DLG can improve agreement between calculated and delivered dose and increase gamma passing rates have been reported in a study, with reported GPR improvements reaching up to 36.3% in clinical stereotactic VMAT fields

Conclusion

A high-resolution CMOS detector enables robust DLG commissioning under stereotactic small-field conditions. Although the DLG difference from conventional commissioning was small, applying SRS-DLG produced statistically significant PSQA improvement. Detector optimization should be interpreted with routine QA, periodic recalibration, and complementary dose metrics beyond gamma analysis.

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