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Evaluation of Delta^4 phantom's spatial sensitivity

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Introduction

The aim of this study is to evaluate the spatial sensitivity of the Delta^4 diode array phantom – Fig.1 - (Scandidos, Uppsala, Sweden) investigating how set up errors affect the measurement's results during head and neck treatment plan verification.

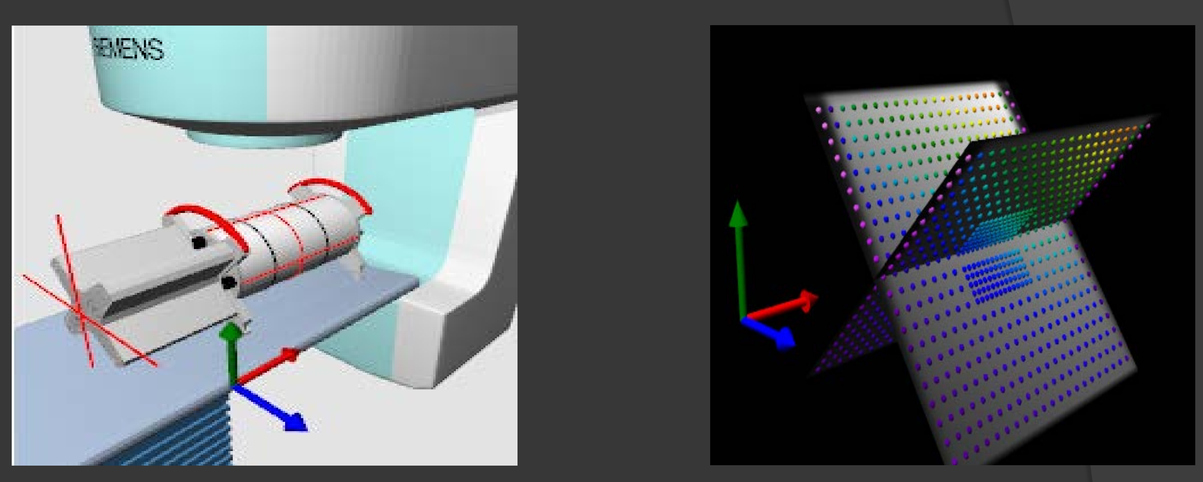
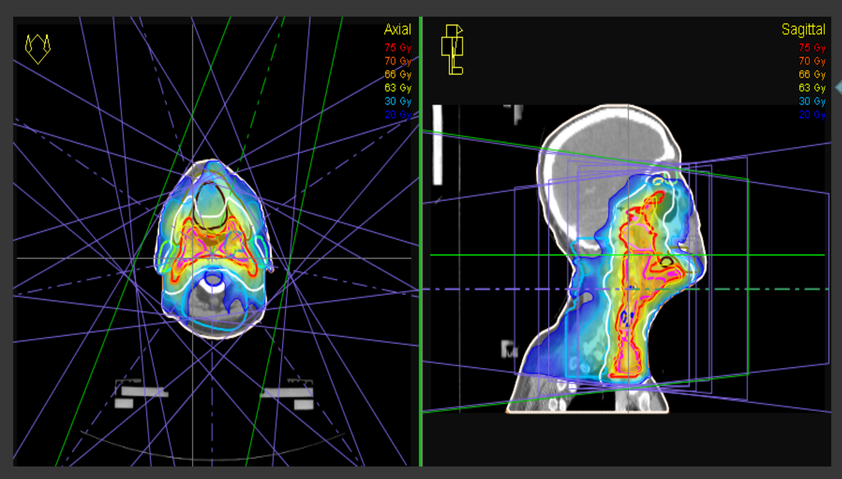


Figure 1: *The Delta^4 Phantom*

Patients and Methods

The Delta^4 phantom is used to verify ten IMRT head and neck plans, created on Oncentra v4.5.2 (Nucletron, Elekta) treatment planning system. Patient plans were transferred to the Delta^4 geometry and were delivered on a 6MV photon beam SIEMENS Oncor Impression linac. Each reference (no-shift) plan was then delivered on the linac with a ±3 mm shift of the phantom at lateral, longitudinal and vertical direction. The measurements' results for all delivered plans were evaluated using the gamma index criteria (3%/3 mm). The application of the treatment plan is considered successful with an over 90% gamma index passing rate



Dose distribution in the Axial and the Sagittal plane of a head & neck case.

A screen capture of the Delta^4 software results for the statistical variables. Statistics are shown for all measurements points and refer to dose deviation, distance to agreement and gamma index.

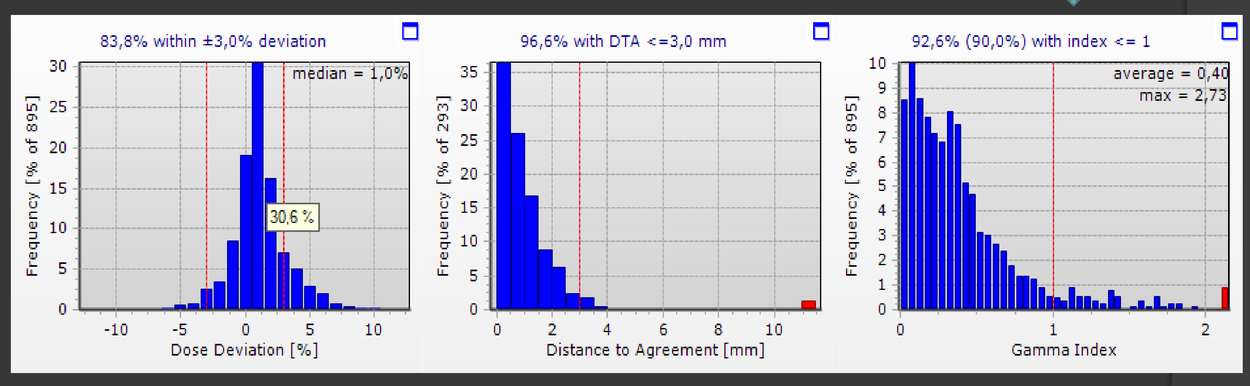


Figure 2: *IMRT head and neck treatment planning and verification with Delta^4 phantom*

Results

The gamma index passing rate was measured at no-shift position (96.1±0.7) %. Mean gamma index for each direction (lateral, longitudinal, vertical) was measured as 85.5% (SD=2.6), 85.7% (SD=4.5) and 85.2% (SD=4.5) respectively. For all shifts, in all directions, the mean gamma index passing rate was found enough below the passing rate limit of 90% and more specifically 10.6% less than the no-shift measured gamma index.

Delta ^{4} results	No shift	Lateral shift (±3mm)	Vertical shift (±3mm)	Longitudinal shift (±3mm)
Mean γ-index	96.1%	85.5%	85.2%	85.7%
SD	0.7	2.6	4.5	4.5

Figure 3: *Results for mean gamma index for each position (no shift and shift in all directions). For all shifts, in all directions, the mean gamma index passing rate was found enough below the passing rate limit of 90% and more specifically 10.6% less than the no-shift measured gamma index.*

Conclusions

Delta^4 is an efficient QA tool for individual patient treatment plan verification exhibiting high reproducibility of results for γ-index. Shifts of 3mm reveal significant deviation of measured 3%/3 mm gamma index passing rates, indicating high spatial sensitivity and efficiency of this QA tool. Future work with 3DVH software analysis is needed to report more statistics apart from γ-index values.