Clinical Evaluation of an Innovative Ionization Chamber Technology for Patient Quality Assurance

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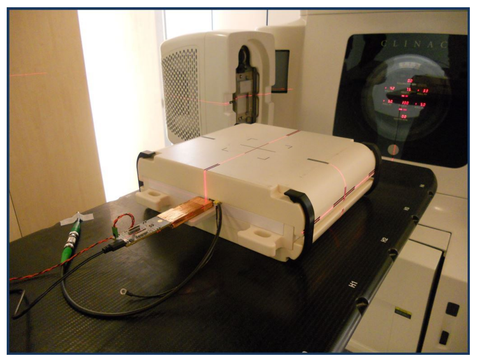
PURPOSE

To prove the feasibility of a new ionization chamber technology with high spatial resolution for patient plan quality assurance in complex MV x-rays radiotherapy techniques such as IMRT, SBRT and VMAT.

MATERIALS AND METHODS

Prototype under test: a linear array of air vented ionization chambers developed by IBA Dosimetry GmbH, consisting of 80 pixels with 3.5 mm spatial resolution and 4 mm^3 sensitive volume.



Main technological features are:

- sensitivity independence on dose per pulse;
- high long term stability;
- low energy dependence.

Performed study: a comparative clinical evaluation of treatment plans for a variety of clinical localizations and techniques.

Delivery facilities (both equipped with a 120HD MLC) :

- Varian Trilogy (Klinikum rechts der Isar, Dept. of Radiation Oncology, Munich);
- Varian TrueBeam (UCSF, Dept. of Radiation Oncology, San Francisco, CA, US).

The measured distributions were compared with Varian Eclipse TPS, EBT3 gafchromic films and a commercial diode array with 7mm spatial resolution.

RESULTS

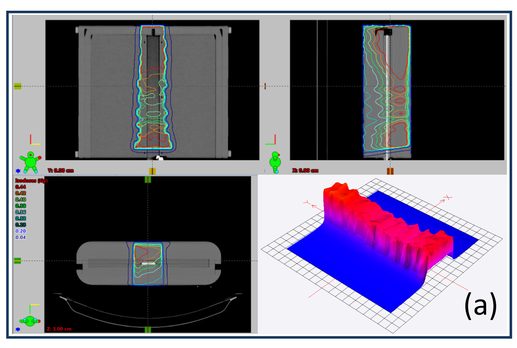
1. IMRT & VMAT plans: comparison with TPS

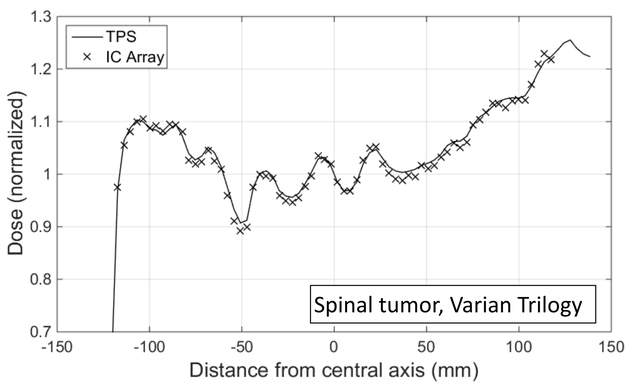
Two IMRT cases and one VMAT case are presented. The absolute average difference between TPS predicted dose and dose measured with the IC array was always found to be less than 1% (Table 1).

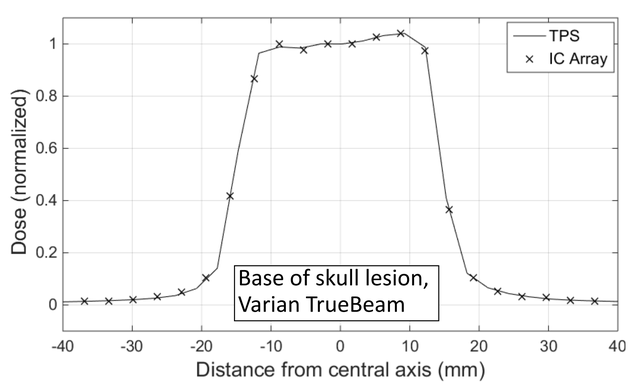
Table 1

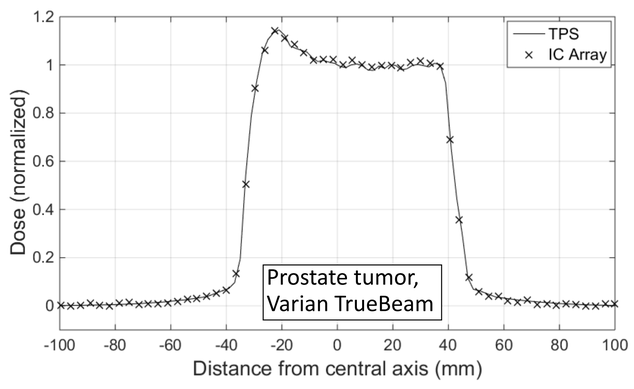
Case	Technique	Energy (MV)	Max dose (cGy)	IC Array-TPS (%)
Spinal tumor	IMRT	6	58	0.79
Prostate tumor	IMRT	6	464	0.99
Base of skull lesion	VMAT	6	450	0.75

For the spinal tumor case (sliding window IMRT) isodose curves in the phantom CT are shown below. The detector was placed along the y axis (a).







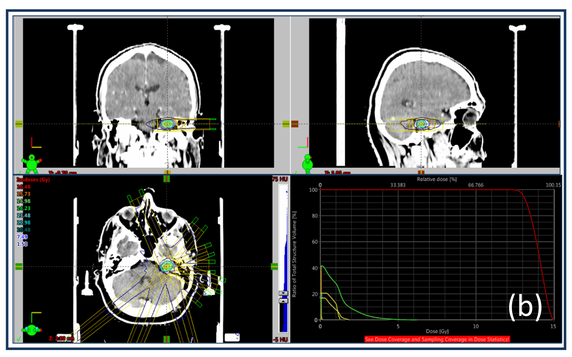


2. VMAT & SBRT plans: comparison with TPS, film & diode array

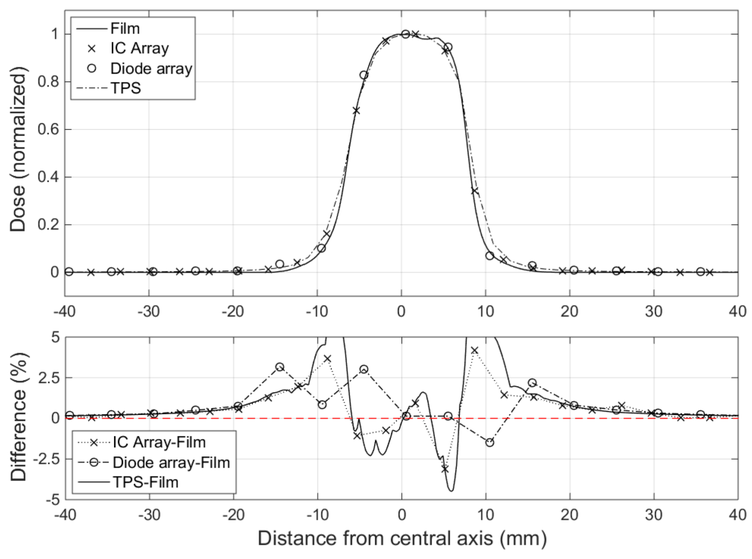
Two cases are presented in this section: a SBRT with high dose rate and a complex VMAT. The IC Array shows good performances when compared with EBT3 films (Table 2). Small fields and steep dose gradients are very well resolved.

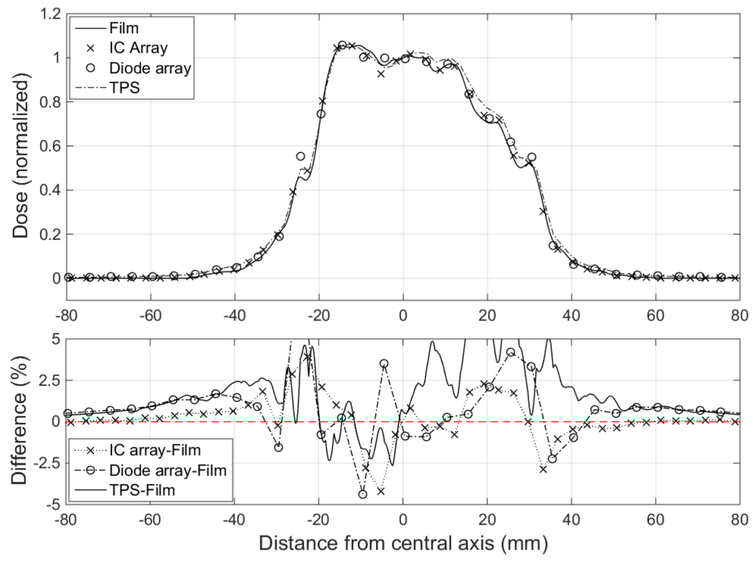
Table 2

Case	Technique	Energy (MV)	Max dose (cGy)	IC Array-TPS (%)	IC Array-film (%)	Diode array-TPS (%)	Diode array-film (%)
Brain tumor	SBRT	6	671	0.77	1.19	1.49	1.10
Lung tumor	VMAT	15	539	2.01	1.13	2.08	1.78



For the brain tumor case (SBRT, 9 fields, 1000MU/min dose rate) planned beams in TPS and DVH graph are shown above (b).





CONCLUSIONS

The technology has been proven to be valuable for patient plan quality assurance of complex fields through an extensive clinical investigation. The comparison with other reference detectors shows always a good agreement. High dosimetric performance was achieved due to high spatial resolution, insensitivity on dose per pulse and energy independence. These encouraging results suggest the extension of the technology to 2D detectors.

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