Development and characterisation of a new miniaturised detector for *in vivo* dosimetry in HDR brachytherapy.

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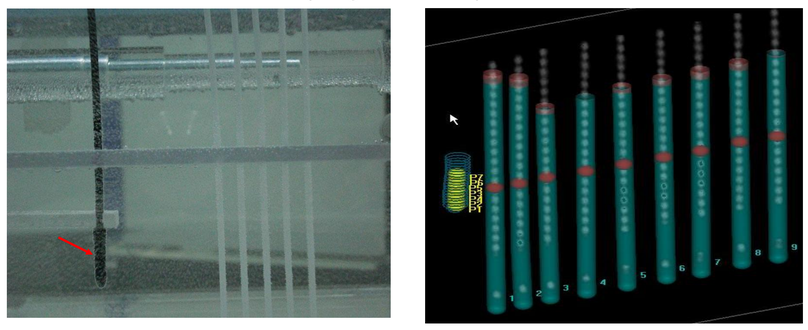
BACKGROUND / OBJECTIVE

Due to the complexity of the steps involved in a **high dose rate (HDR) brachytherapy** process, radiation dose delivered to the patient during the treatment is suscetible to many inaccuracies if compared to the treatment planned dose. Therefore, the interest in *in vivo* measurements of the dose delivered to the target and/or to the neighbouring healthy organs is increasing.

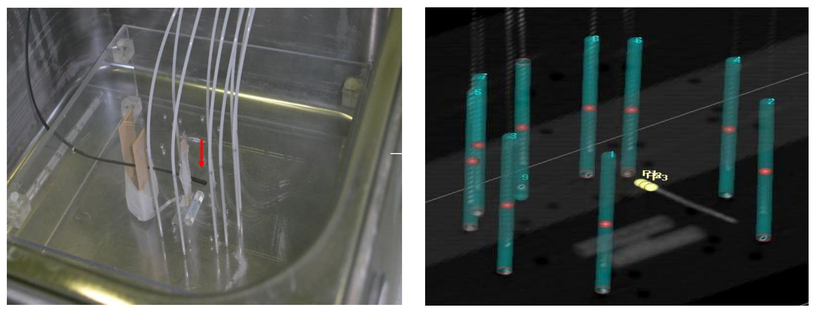
In this work, a new miniaturized detector for *in vivo* dosimetry in HDR brachytherapy was studied at the Università degli studi di Milano Statale and at IRCCS Istituto Nazionale dei Tumori, in cooperation with the Università degli studi di Milano Bicocca, EL.SE s.r.l. and Starlite s.r.l.

MATERIALS AND METHODS

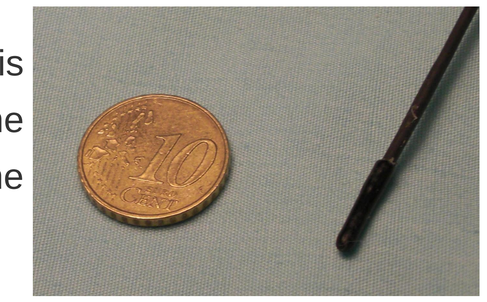
Irradiation configuration for **(a)**,**(b)**,**(c)**,**(d)**,**(e)**. Applicators are placed at different distances from the detector (range 3-60 mm).



Irradiation configuration for **(f)**. Applicators are placed at different angles on a circumference (2 cm distance) around the detector.



The detector, a 1 cm long **Ce^{3+} doped SiO_2 optical fiber,** is connected by a commercial SiO_2 fiber to an electrometer. The electrometer sends the information to a computer which records the detected number of counts at selectable time intervals.



In this study, **(a) reproducibility**, **(b) linearity**, **(c) energy dependence**, **(d) dose-rate dependence**, **(e) temperature dependence**, **(f) angular dependence** of the detector response with ^{192}Ir HDR brachytherapy fields (Nucletron Microselectron-HDR) were investigated. To this aim, two *ad hoc* phantoms with specific source applicators and a detector housing were designed to perform these measurements.

CT images (slices of 0,8 mm thickness) of the phantoms were acquired, and source dwell positions with respect to the detector were established by means of a treatment planning system (TPS) before irradiation. The dose delivered to the detector was calculated by means of the TPS in 7 equally spaced points on the detector and the resulting average dose was cosidered.

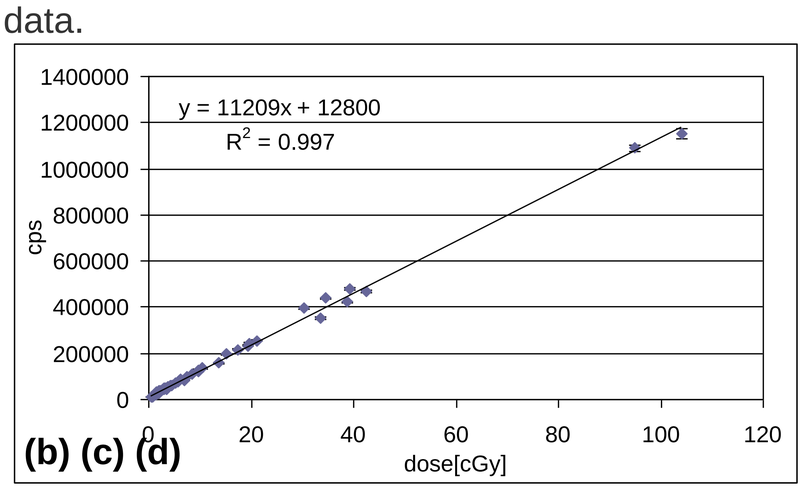
RESULTS

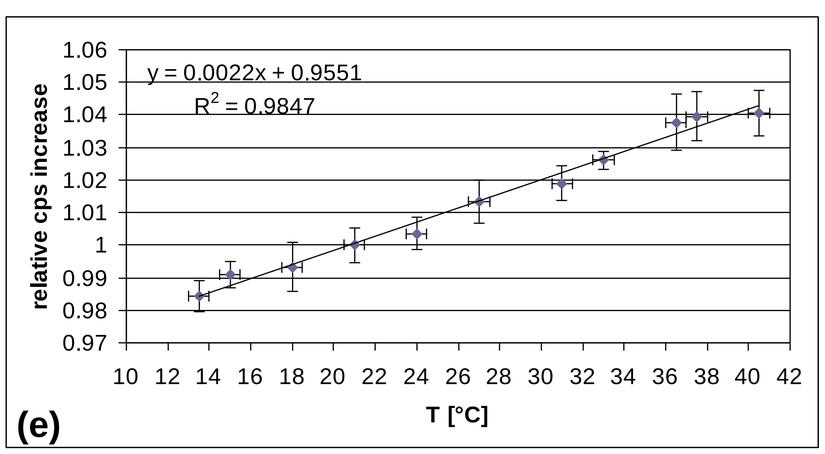
(a) Intra-session counts per second (cps) reproducibility is very high, however inter-session reproducibility is not. The detector needs therefore calibration before starting a new session of measurements.

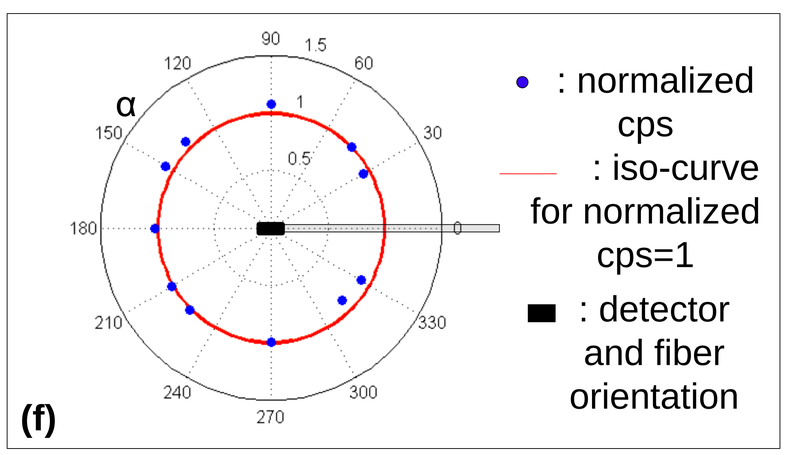
(b),**(c)**,**(d)** The average cps recorded for every source dwell position vs the corresponding average dose calculated by TPS are shown in chart. Measurements were performed at different dose-rates. No evidence of energy and dose-rate dependence results from this data.

(e) The cps increase linearly with temperature. The equation reported in chart was established to correct cps for temperature.

(f) Figure shows normalized cps at different source positions with respect to the detector. No evidence of a high angular dependence result from this data.







CONCLUSIONS

The obtained results show that the proposed detector might be promising for *in vivo* dosimetry in HDR brachytherapy (e.g. rectal dose during gynaecological or prostatic treatments). A thinner detector (ø: 0,9 mm) that might be adopted for measurements of the dose delivered to urethra during prostate treatment is under study.