Preliminary evaluation of **ArcCHECK®** detector's usefulness for **treatment plan verification** in **brachytherapy**

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Introduction

In brachytherapy treatment plan verification is problematic, because irradiation from an internally implanted source limits the possibility of trial irradiation and accurate reproduction of the dose distribution in the treated area. A new technology, called ArcCHECK® (fig. 1), could open new ways to verify treatment plans in brachytherapy. The ArcCHECK® device enables dosimetric measurements through the introduction of a phantom that allows the irradiation to be carried out in accordance with the treatment plan, i.e. reproducing the distribution of sources and the time of stopping.

Aim of work: to check if the dose distributions measured by the ArcCHECK device are consistent with the dose distributions obtained by TPS.

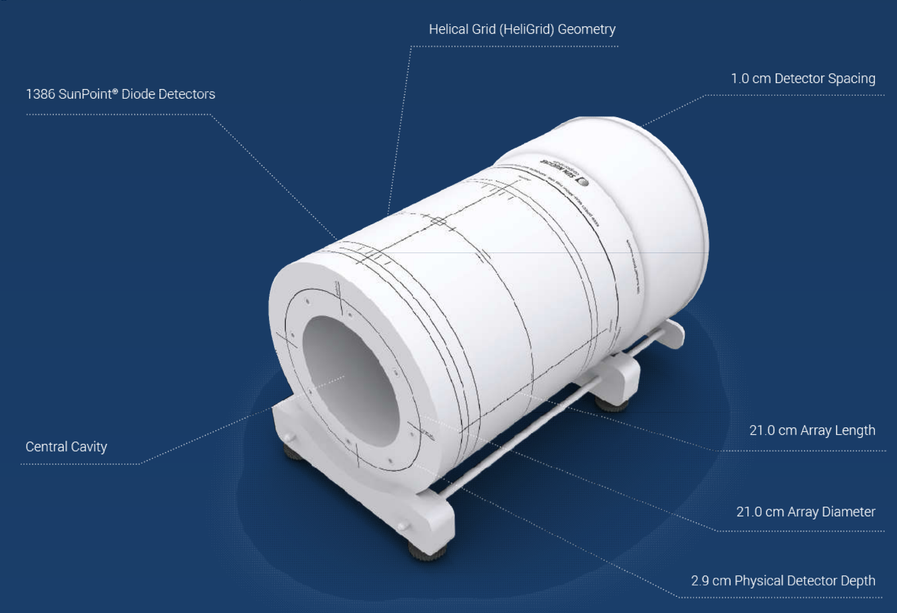

Fig. 1 Sun Nuclear ArcCHECK® 3D detector array

Methods

To verify dose distributions in brachytherapy, an additional part of the measurement system, a BrachyPlug phantom, was developed at COI in Warsaw. In this study, the dose distribution obtained from Treatment Planning System (TPS) was used to evaluation of it's accordance with dose distribution measured by ArcCHECK® device.
Inside the phantom, six brachytherapy seeds were placed in parallel canals along the edge of phantom's cylinder (fig. 2). Each seed was set in 20 positions with step size 0.25 cm and stopping time 2.7 s. Seeds used in measurement were Ir-192 microSelectron-v3.

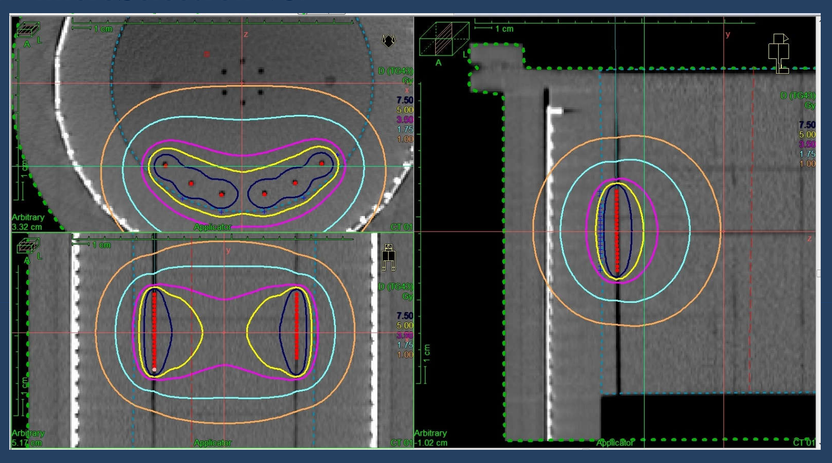

Fig. 2 Screen from TPS Elekta ® Oncentra Brachy with marked seed positions. This plan was realized in experimental measurement.

Experimental realisation of measurement is shown on figure 3. Phantom BrachyPlug is placed inside the ArcCHECK® detector. The catheters introduced to phantom are connected with afterloading machine, which contains Ir-192 HDR seeds. Next, seeds was introduced to catheters, one by one, and dose distribution on the phantom's surface was measured by ArcCHECK®. Dose distribution map is shown in section Results & Conclusions (fig. 4).

Direct quantity measured by ArcCHECK is dose distibution on the internal surface of its cylindrical cavity. Seeds arrangement along the phantom's edge is justified by proximity of detectors, which allow to use rather low doses inside the phantom and relative short source stopping times (the total irradiation time of one catheter was 54 seconds).
Ir-192 HDR seeds activity at the day of experiment was equal 10.995 Ci (406.815 GBq).

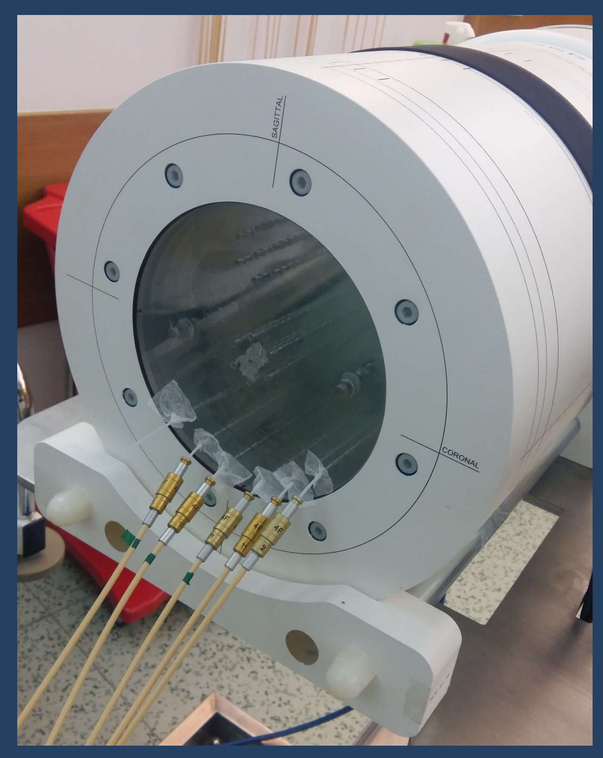

Fig. 3 Experimental realisation of dose distribution measurement in ArcCHECK® detector.

Results & Conclusions

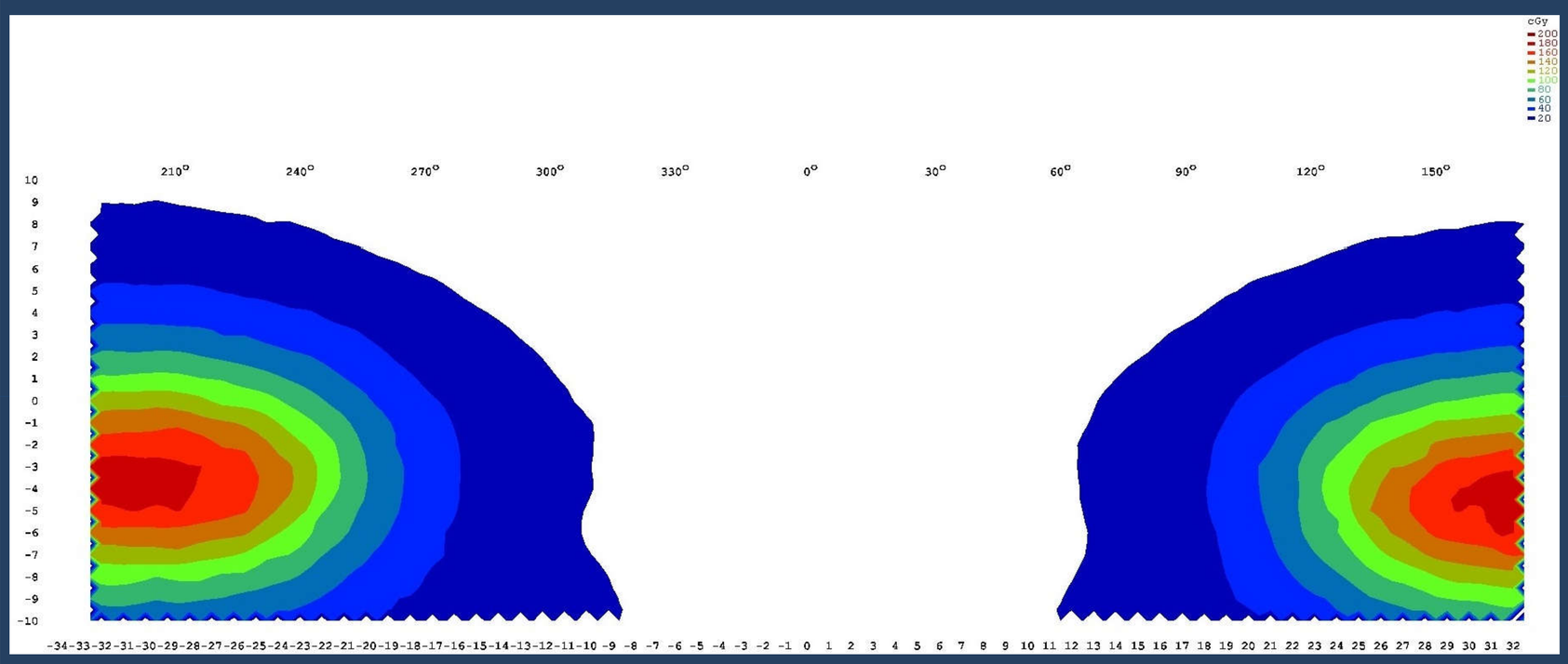

Fig. 4 Dose distibution measurement results for treatment plan shown on fig. 2. Coordinate system is 2D cylindrical (z and θ, r is fixed). Vertical axis describes detector's length in central axis (in cm), while horizontal axis shows angle (up) or distance (down in cm) from point on the top of detector's array.

Figure 4 shows measurement results received from ArcCHECK, the 2D map of dose on the phantom's surface. The map is quite analogous to the world maps in Merkator projection, with „meridian" zero at the center.
Qualitatively, measured dose distribution is close to planned one, which is good indication for future studies. However, quantitatively agreement of measured dose distribution with planned is unsatisfactory. To compare dose distributions we used DTA parameter (**D**istance **T**o **A**greement) with 3 mm and 3% of dose treshold. Only 50.8% points satisfied this condition. Because ArcCHECK® was designed for external beam dosimetric measurements, a lot of additional work is necessary to adjust it for brachytherapy applications. Brachytherapy treatment plans are essential different with EBRT so more complicated plan preparation before the comparison is necessary.