LOMONOSOV MOSCOW STATE UNIVERSITY

FACULTY OF PHYSICS

PHYSICS OF ACCELERATORS AND RADIATION MEDICINE

«STUDY OF DOSE TRANSMISSION IN A MULTILEAF COLLIMATOR ON A VARIAN HALCYON ACCELERATOR»

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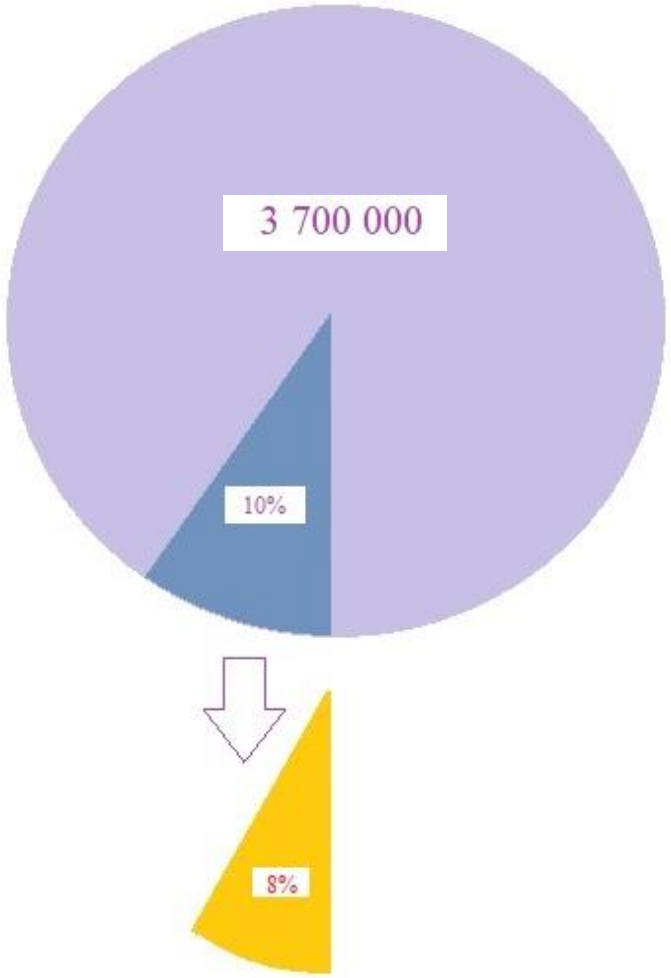
The relevance of research



- The number of patients who show late radiation reactions is increasing every year. This trend can be traced, as, thanks to modern methods of treatment, a number of patients live long enough to show long-term reactions to radiation exposure.
- In 10% of the occurrence of secondary cancer, 8% is due to the actual radiation exposure during radiation therapy.
- That is, slightly less than 1% of those who survived for a long period of time developed secondary cancer as a result of radiation therapy, however, this number may increase with longer follow-up.
- The single most important parameter that affects the overall leakage rate is the distance from the edge of the field.

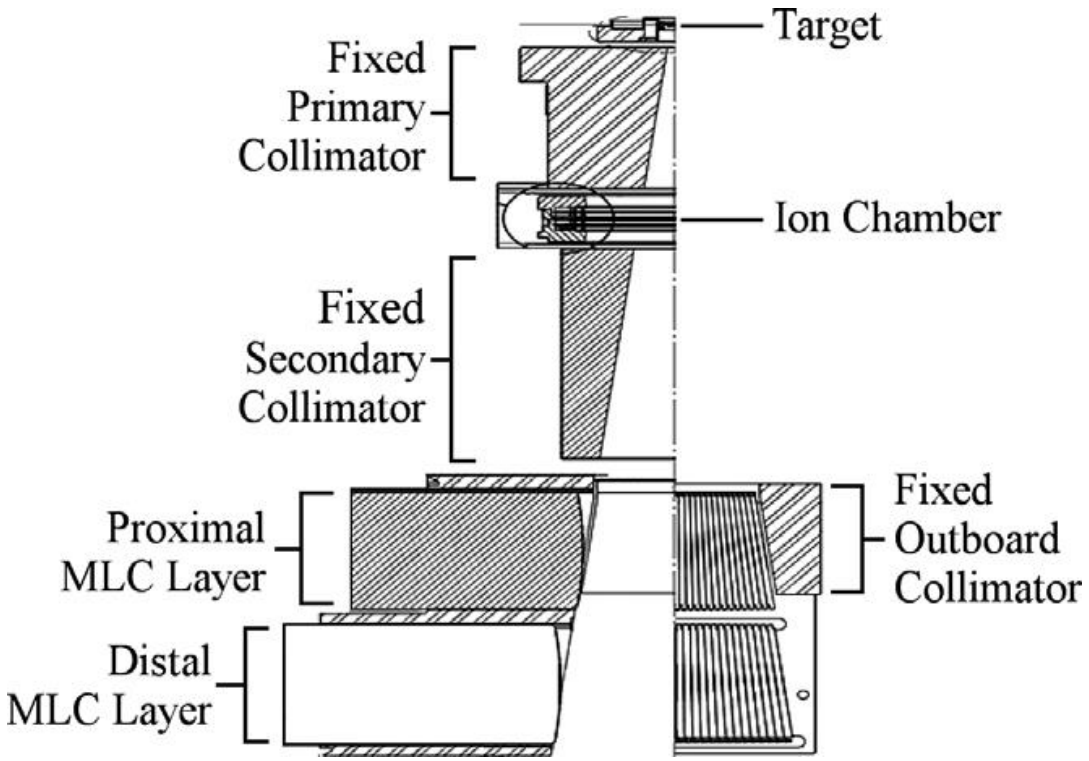
Purpose of the study

Varian Halcyon

- Experimental study of dose leakage from the SX1 multi-leaf collimator at the Varian Halcyon medical linear accelerator.
- Assessment of the dose outside the irradiated volume.

MATERIALS AND METHODS

Design features of the MLC Varian Halcyon

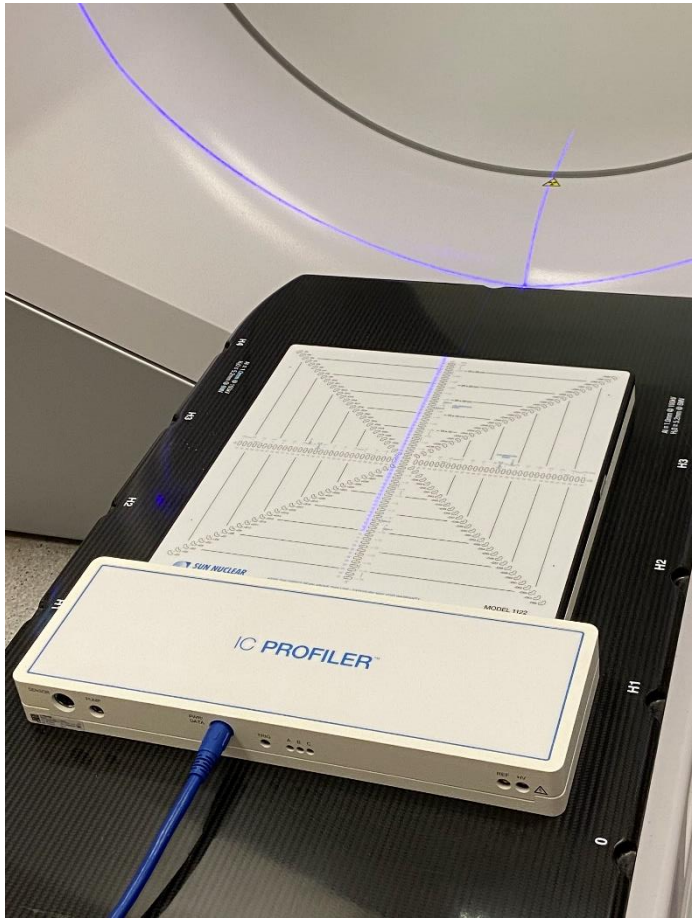


Accelerator head Halcyon

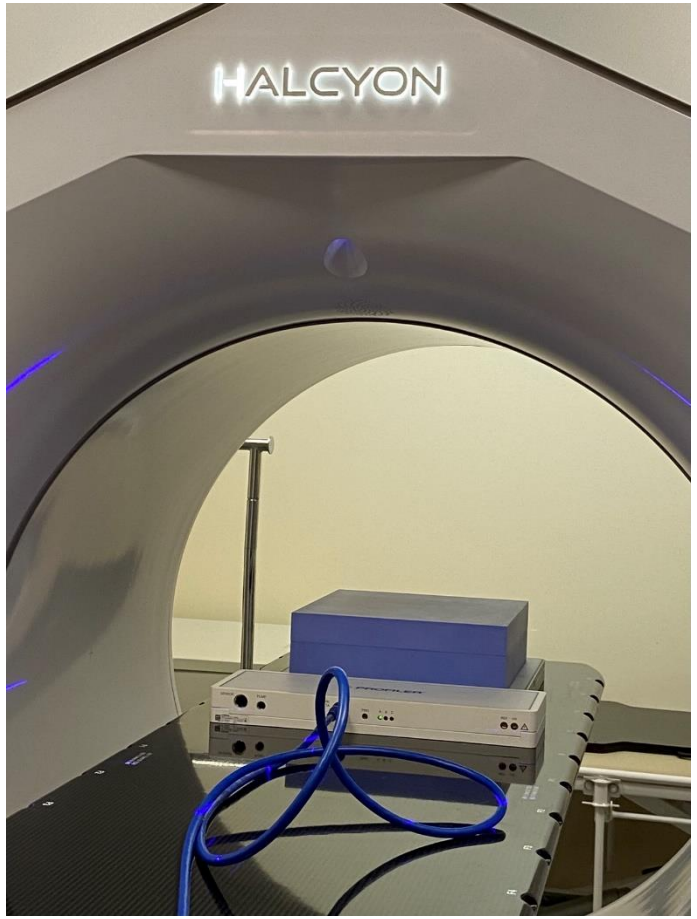
- The Halcyon MLC System features a unique stepped two-layer construction consisting of a distal and a proximal layer.
- The primary and secondary collimators are fixed, there is no smoothing filter.
- The petals are made from a natural mixture of tungsten and are staggered.
- The MLC petals on Halcyon travel in a straight line and have rounded ends.
- Halcyon delivers MLC speeds of up to 5.0 cm per second and a dose rate of 800 monitor units per minute.

MATERIALS AND METHODS

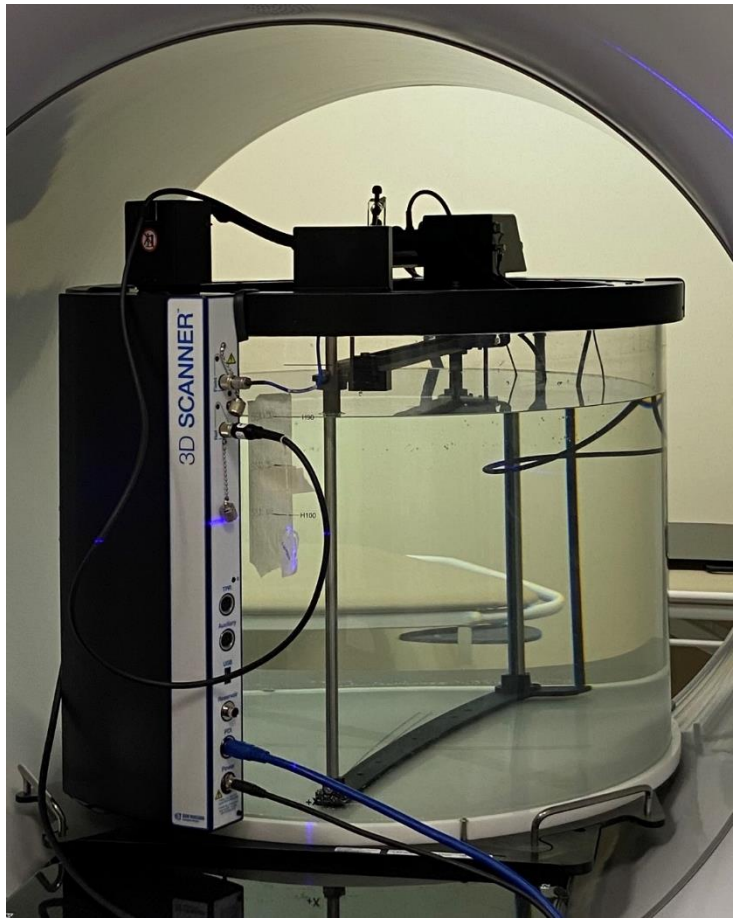
Equipment



Matrix detector IC PROFILER Sun Nuclear



General view of the experiment with the Solid Water Gammex phantom

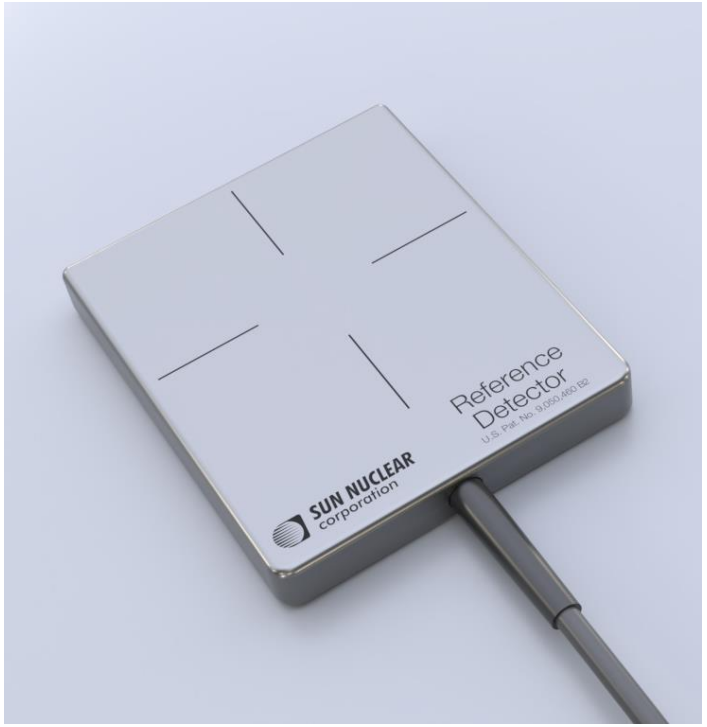


Water Phantom 3D Scanner Sun Nuclear

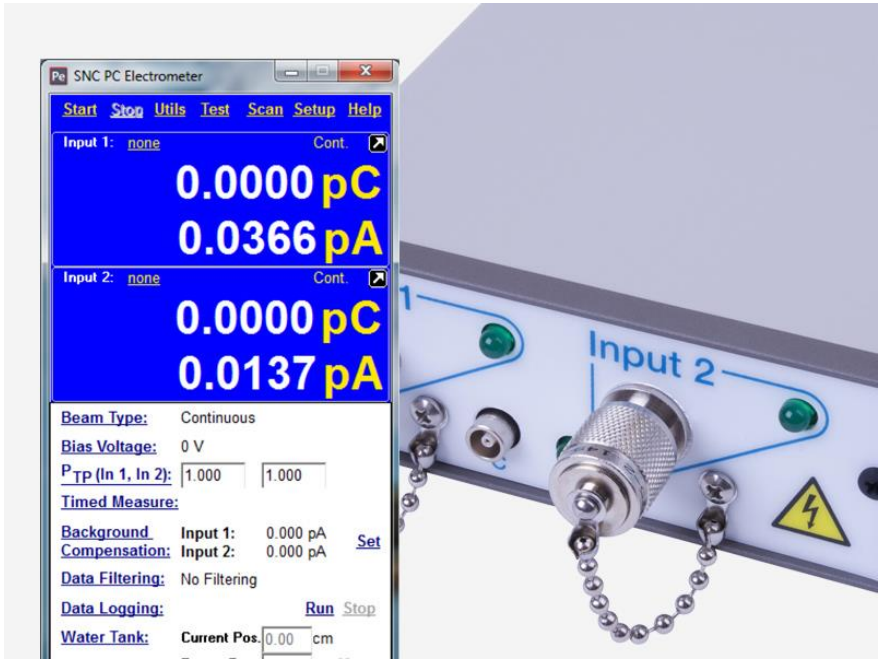
MATERIALS AND METHODS

Equipment

Ionization chamber SNC 125c



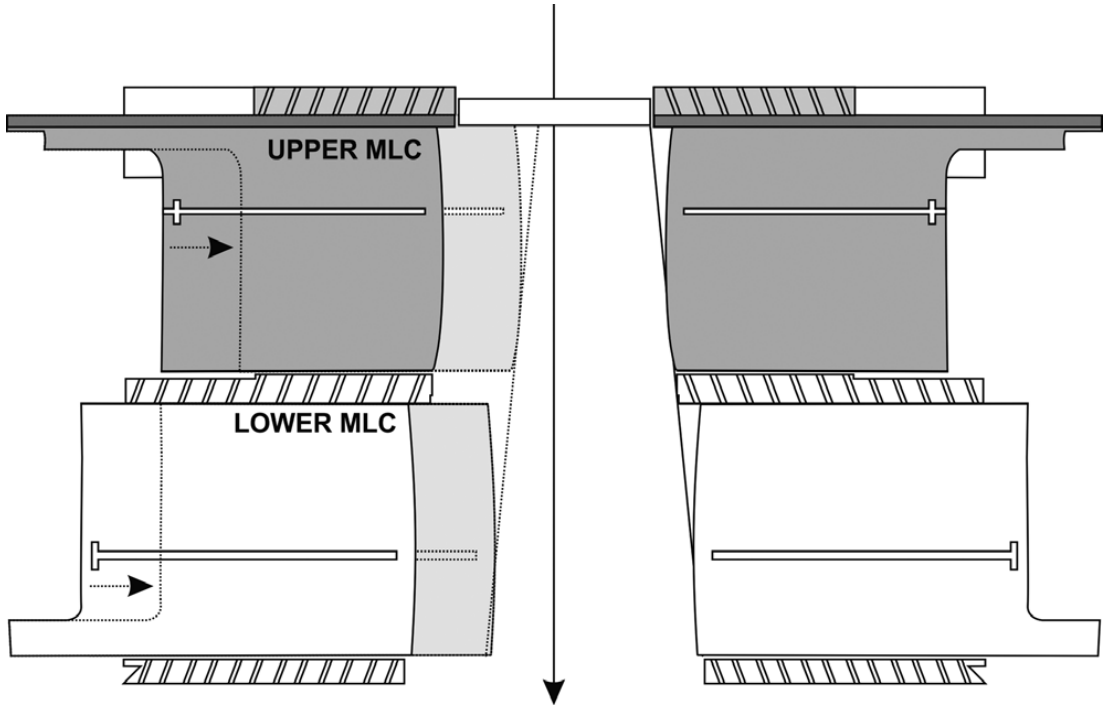
Sun Nuclear Reference Detector



PC Electrometer SNC Dosimetry

MATERIALS AND METHODS

Experimental data with different field sizes



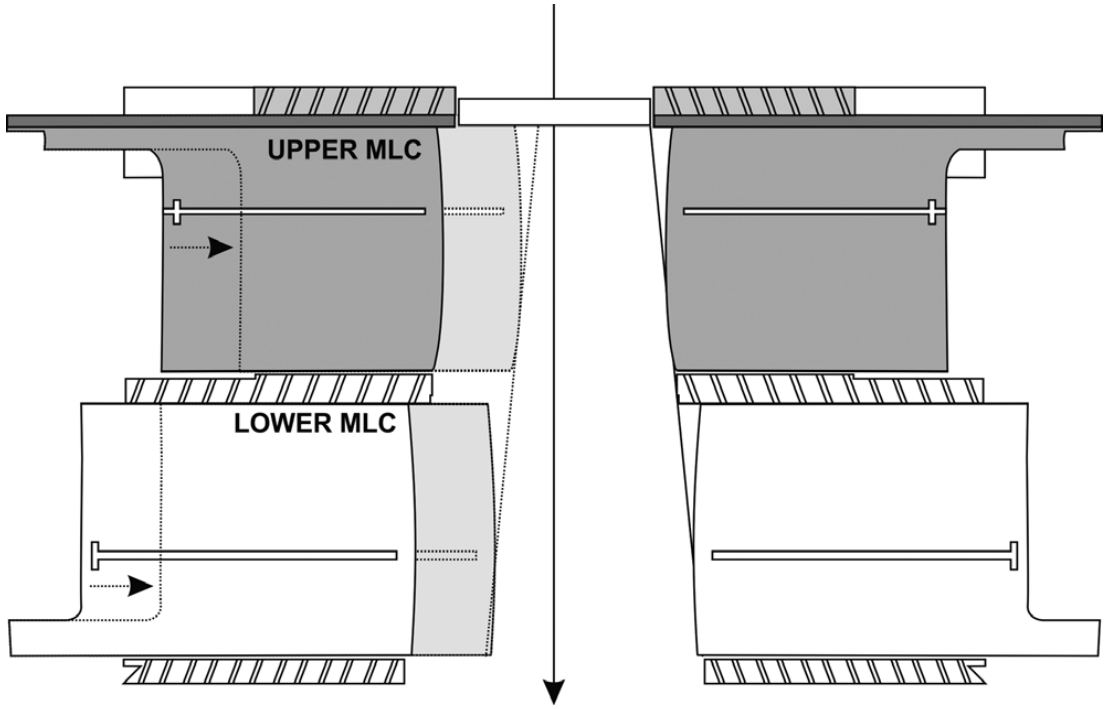
Halcyon multilayer collimation system in cross section

Analysis of doses measured on the array detector and ionization chamber. The data obtained were compared with the dose received during the planning in the Eclipse system.

- MLC positioning: 5×5 10×10, 15×15 cm^2.
- Boundary energy of bremsstrahlung photons – 6MeV.
- Gantry position – 0°.
- Dose – 200 MU.
- Height of water-equivalent phantom GAMMEX – 9,1 см.
- Matrix detector height – 0,9 cm.
- SSD – 90 cm.
- Sensitive volume of the ionization chamber SNC 125c – 0,125 cm^3.
- Depth – 10 cm.

MATERIALS AND METHODS

Small field experiment data



Halcyon multilayer collimation system in cross section

The dose was measured at reference points and compared with the dose received during planning in the Eclipse system.

- MLC positioning: $1 \times 2\ cm^2$.
- Boundary energy of bremsstrahlung photons – 6MeV.
- Gantry position – 0°.
- Dose – 200 MU.
- Sensitive volume of the ionization chamber SNC 125c – 0,125 cm^3.
- Depth – 10 cm.
- The measurements were carried out at distances from 0.5 - 6 cm with a step of 0.5 cm and at 7, 8, 10, 12, 14, 15 cm from the central axis.

RESULTS

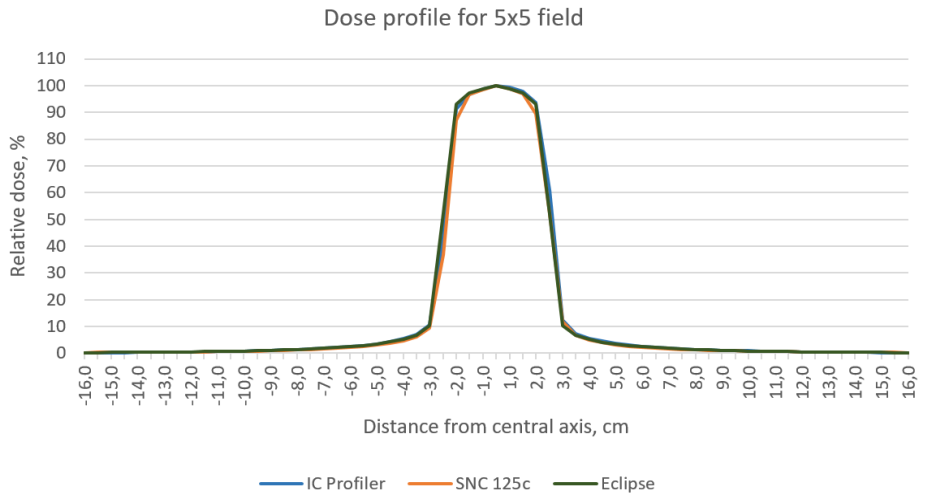
Measurements taken with closed MLC SX1

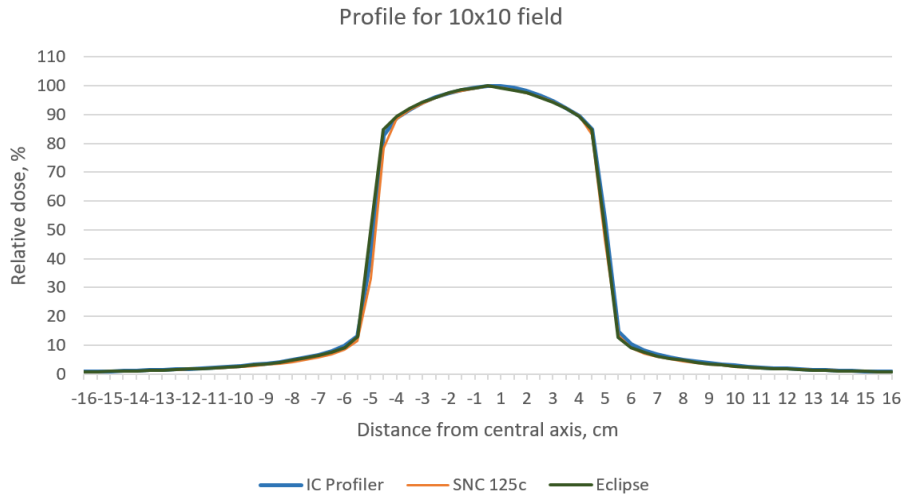
	Charge, open field, nC	Average charge value, nC	Closed field, nC	The average value of the charge of the closed field , nC	Dose leakage, %
1	431,9511±5,6153	431,9368±5,6150	0,5125±0,0067	0,5126±0,0067	0,0119±1,705E-05
2	431,8129±5,6135		0,5131±0,0067		
3	432,0245±5,6163		0,5121±0,0067		

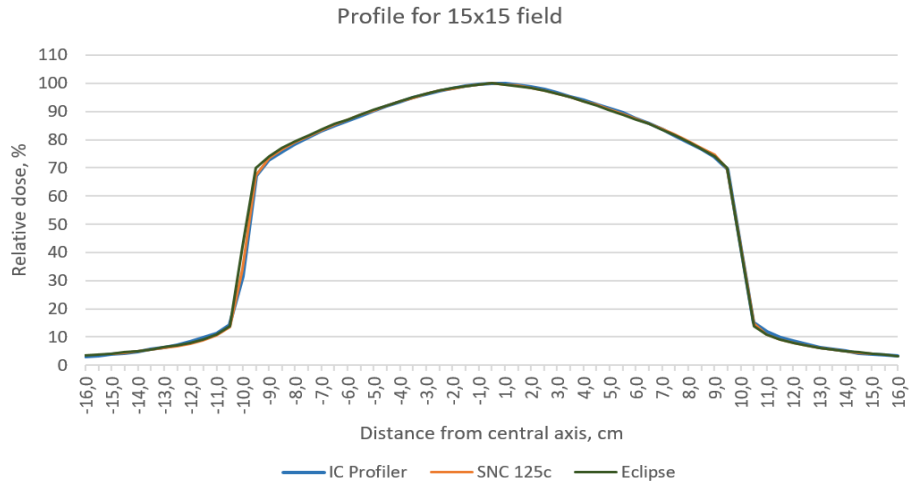
- Measurements were carried out using an SNC 600c ionization chamber, in a 3D Scanner water phantom, at a depth of 10 cm.
- Positioning the MLC for an open field: $10 \times 10\ cm^2$.
- Closing the proximal layer MLC SX1 bank A.
- Boundary energy of bremsstrahlung photons - 6 MeV .
- The gantry position is 0 °.
- Dose – 5000 MU.

RESULTS

Obtained beam profiles for different field sizes

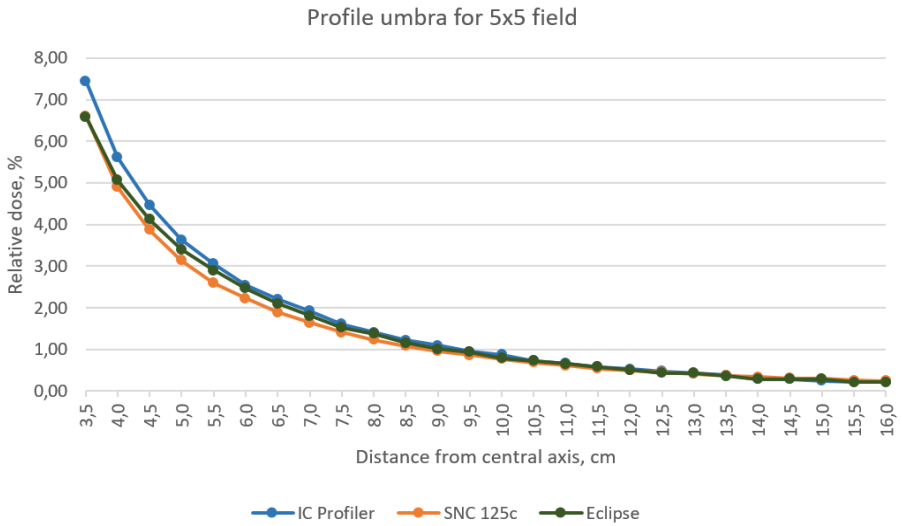


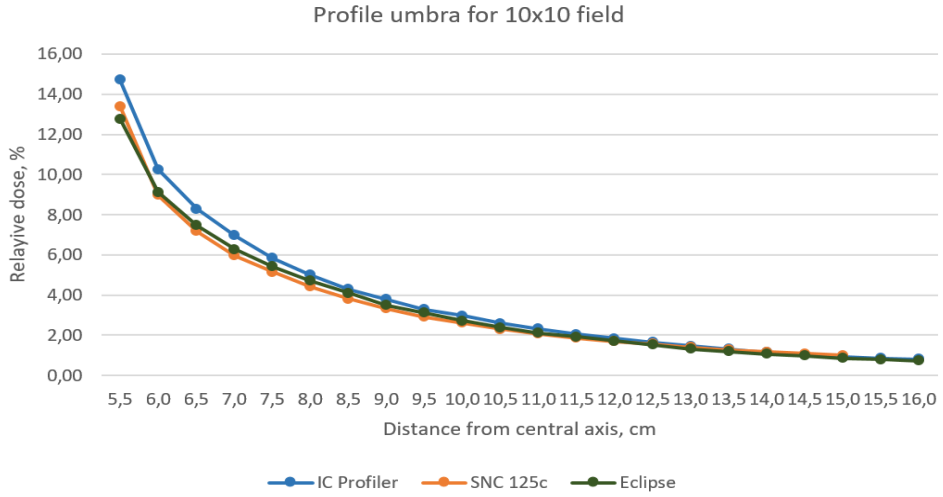


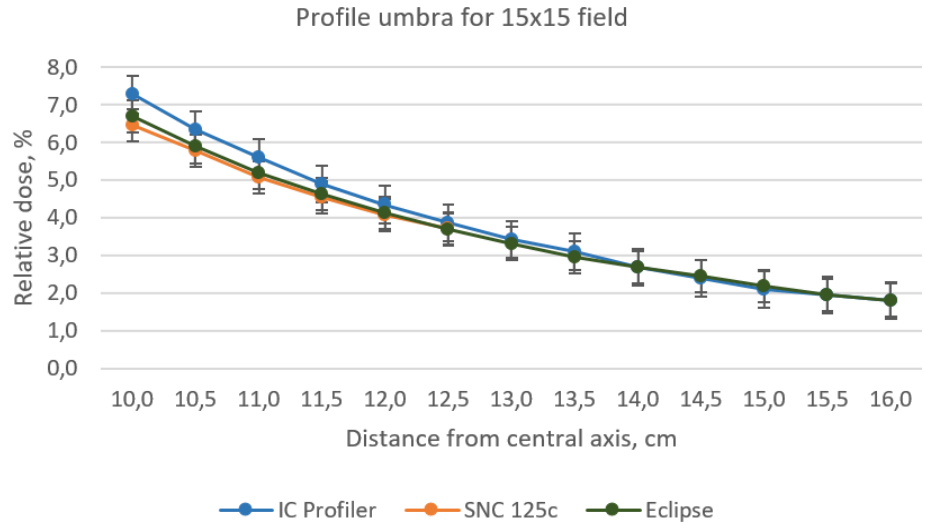


RESULTS

Shadow area plots for different field sizes

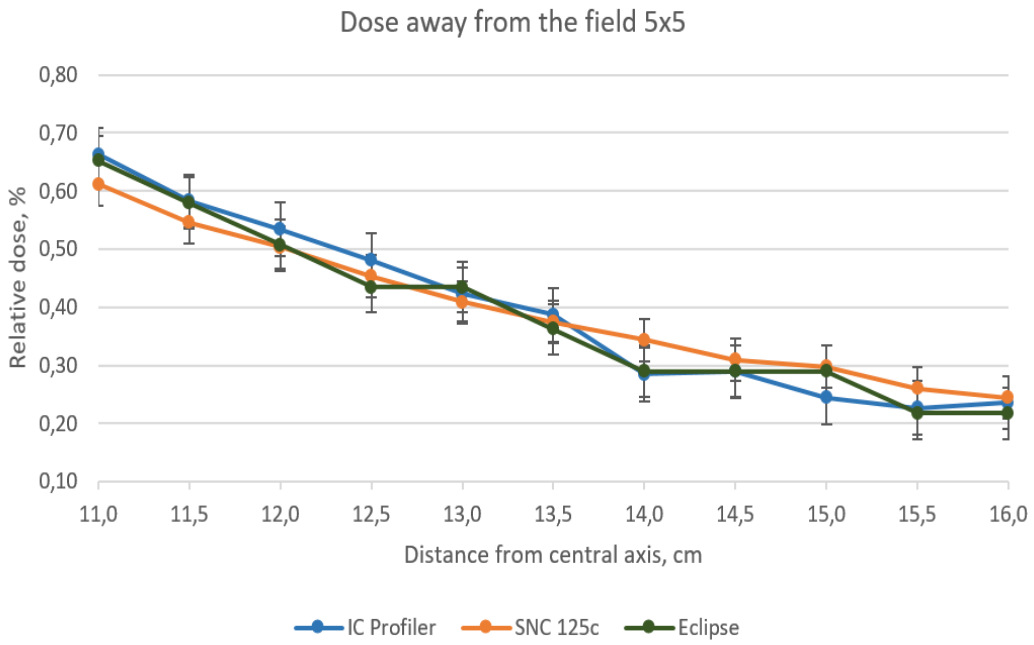


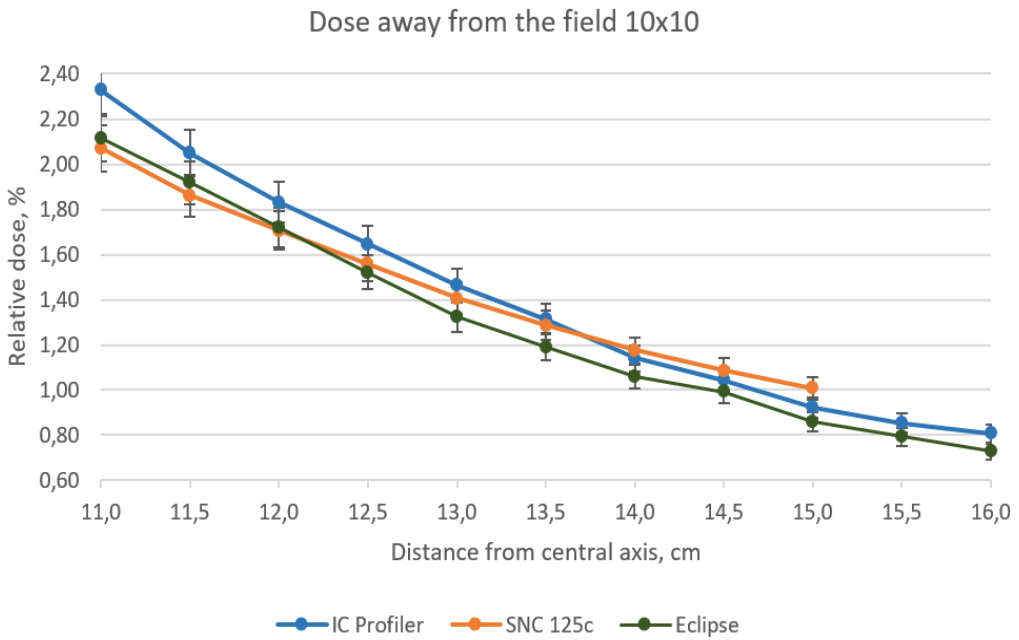




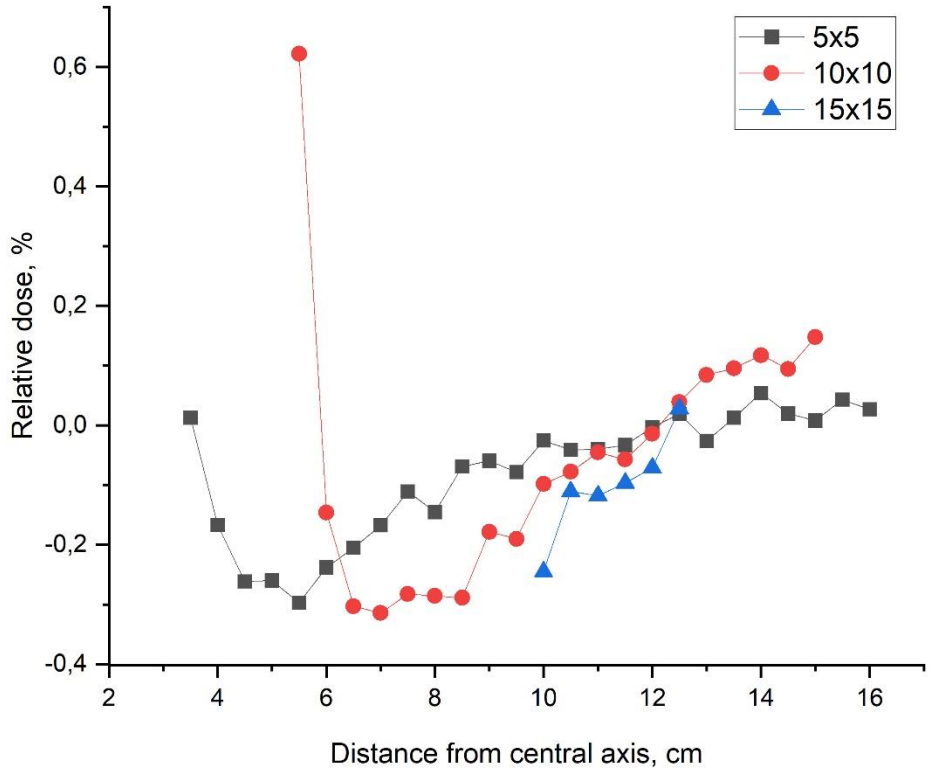
RESULTS

Profile plots away from the central axis

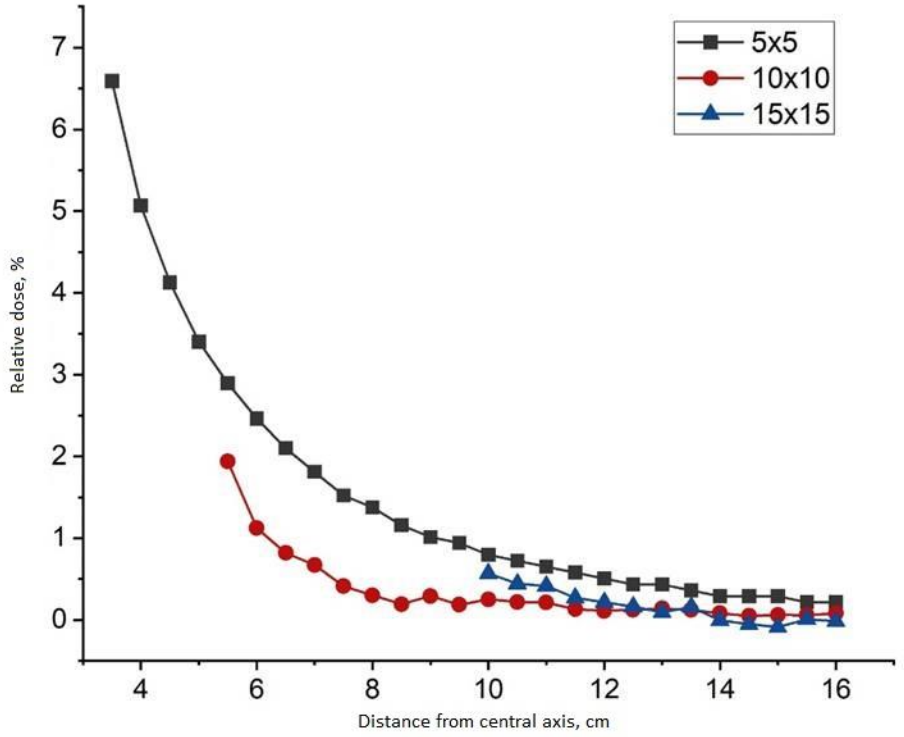




RESULTS



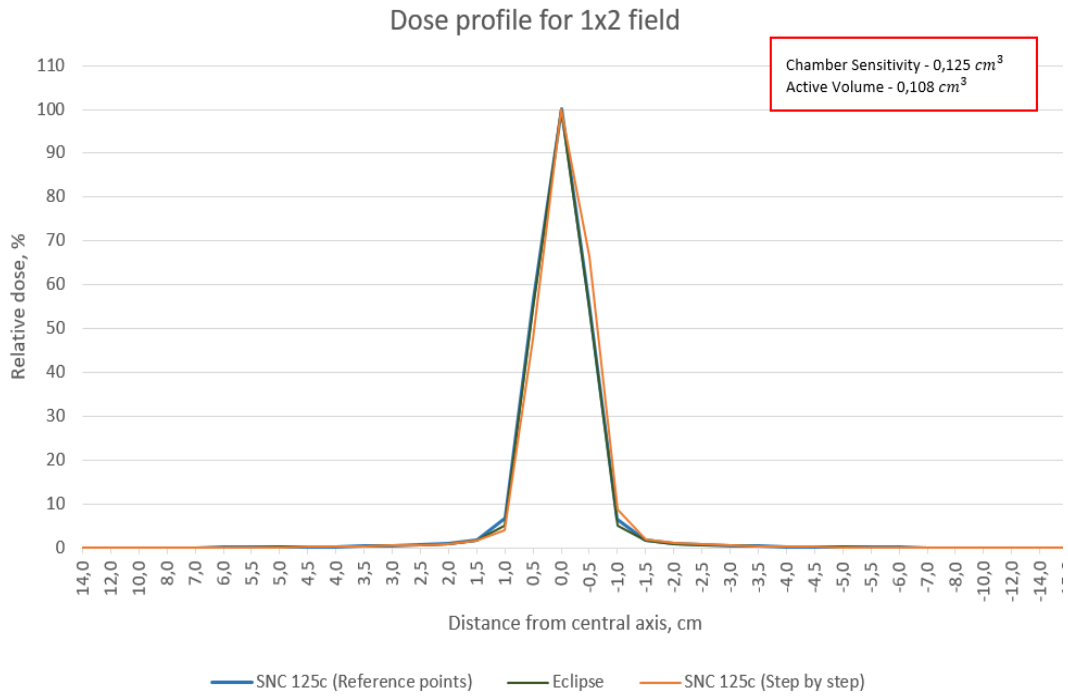
Difference between measured doses of SNC 125c and calculated doses in Eclipse

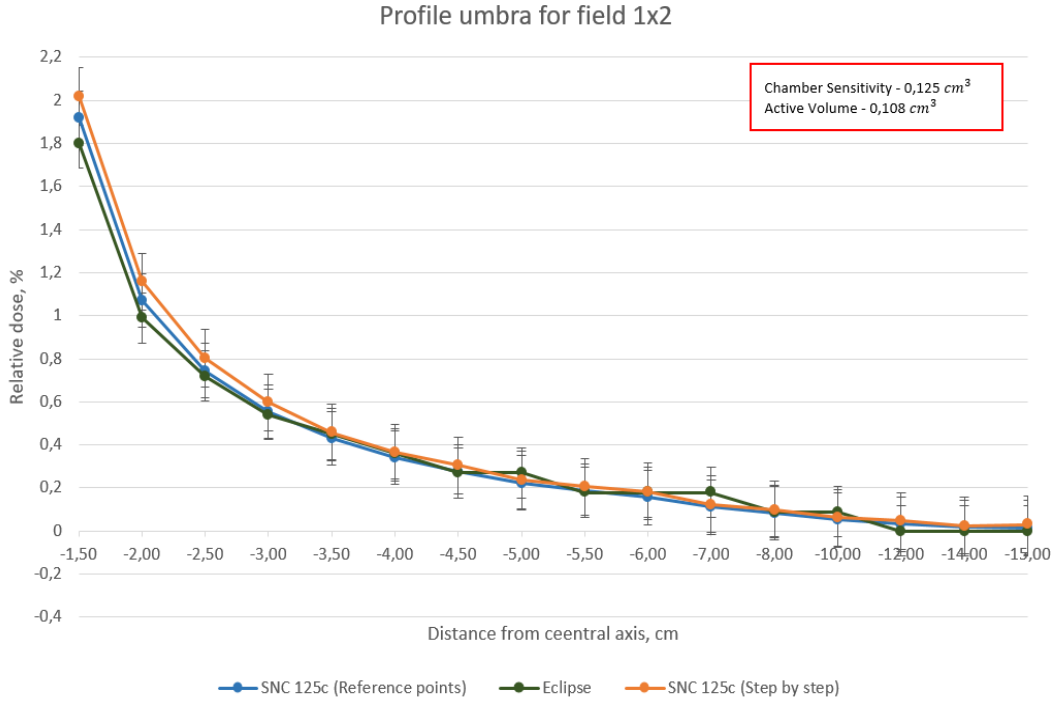


Dose difference between measured IC Profiler and calculated doses in Eclipse

RESULTS

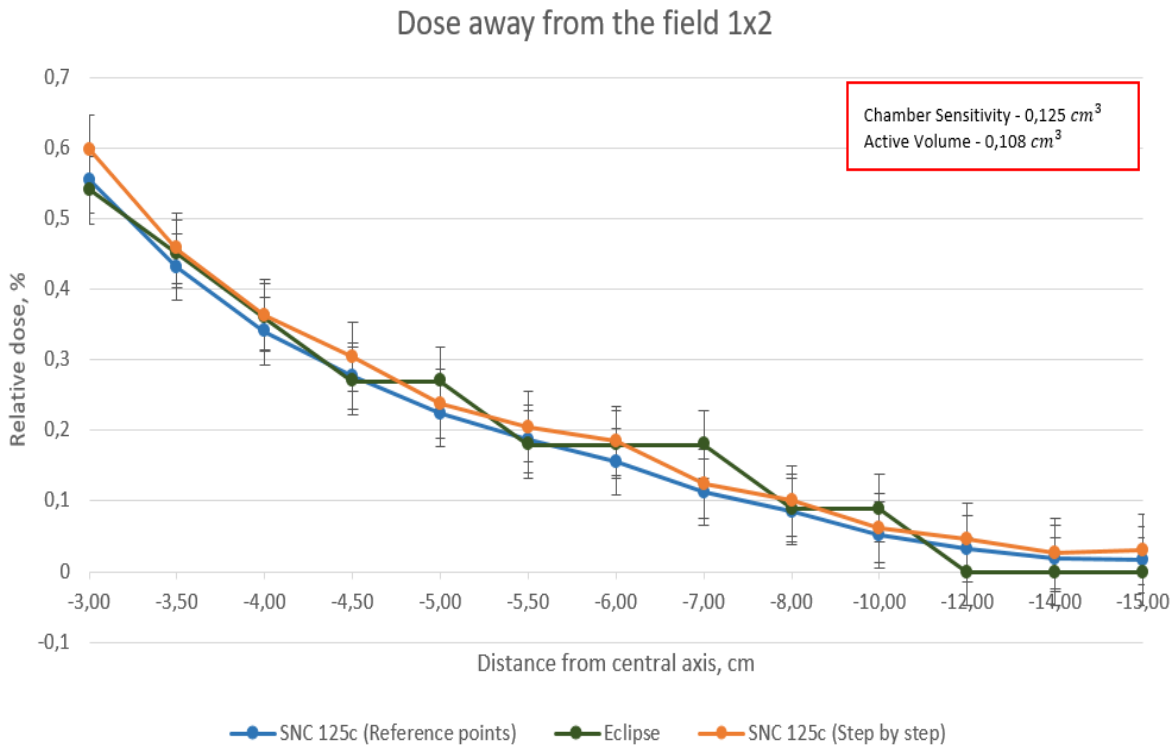
The data obtained in the experiment with a small field size





RESULTS

Data obtained for the experiment with a small field size



cm	Dose at reference points	Calculated dose	Dose measured in step by step mode
14	0,0213±0,0003	0,00	0,0374±0,0005
12	0,0341±0,0004	0,00	0,0527±0,0007
10	0,0524±0,0007	0,09	0,0639±0,0008
8	0,0886±0,0011	0,09	0,0994±0,0013
7	0,1174±0,0015	0,18	0,1258±0,0016
6	0,1593±0,0021	0,18	0,1780±0,0023
5,5	0,1896±0,0025	0,18	0,1873±0,0024
5	0,2258±0,0029	0,27	0,2462±0,0032
4,5	0,2780±0,0036	0,27	0,2755±0,0036
4	0,3445±0,0045	0,36	0,3579±0,0047
3,5	0,4343±0,0056	0,45	0,4372±0,0057
3	0,5579±0,0072	0,54	0,5371±0,0071

Conclusions

- The dose leakage with the closed MLC SX1 was - 0,0119±1,705E-05%.
- Experiments have shown that despite the fact that the same dose of 200 monitor units was guided in all experiments, the dose leakage increases with increasing field size. At a distance of 16 cm from the central axis, doses of 0.217, 0.727, 1.815% are observed for fields of 5 × 5, 10 × 10, 15 × 15, respectively.
- For a field size of 1x2 at a distance of 14 cm from the central axis, a dose of 0.02% is observed, while the planning system sets 0% of the relative dose at the same distance.
- The results of the current study are important for understanding how field size affects dose leakage.

THANKS FOR YOUR ATTENTION!