Radiation oncology ophthalmic center based on the C-80 accelerator at the NRC "Kurchatov Institute" – PNPI

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**NRC "Kurchatov Institute" - ITEP

Content

- history and statistics;
- proton oncophthalmology technology – treatment stages;
- the main achievements;
- radiation oncology ophthalmic center based on the C-80 accelerator at the NRC "Kurchatov Institute" – PNPI.

Proton oncophthalmology

Start – 1976 in USA, MGH/MEEI, Harvard Cyclotron;

since 1977 - in Russia, ITEP;

since 1984 – in Europe, PSI;

Currently, 65 centers of PRT are operating, 7 of them are specialized oncophthalmological centers;

In Russia today:

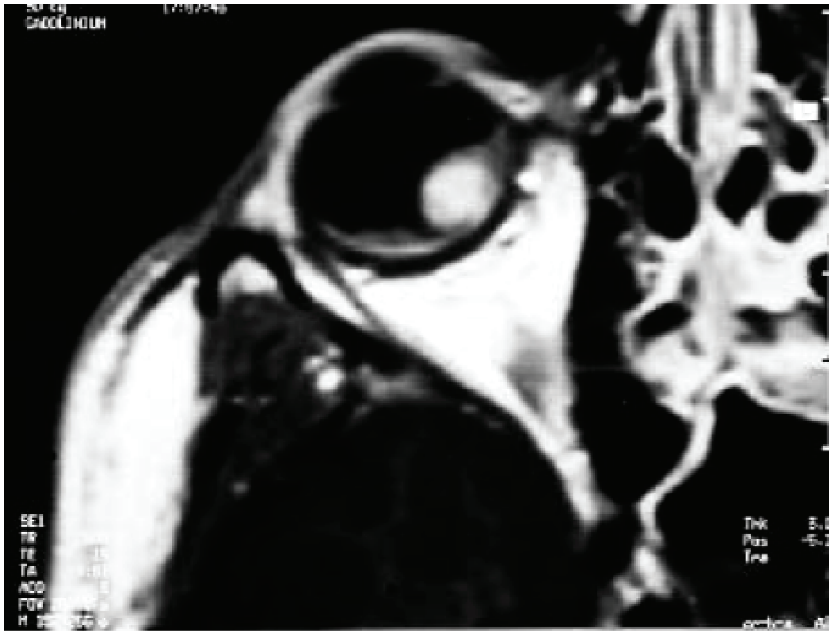
- more than 1200 patients treated at ITEP
- since 2016 in Obninsk there is a single-cabin facility of PRT (made in Protome), on which individual exposures of intraocular neoplasms are performed

Proton Radiation Therapy for Ocular Tumors

- Diagnosis;
- Surgery to document tumor extension and placement of fiducial markers;
- Simulation and radiographic measurements of markers;
- Treatment planning;
- Fabrication of individual collimators and bolus;
- Positioning;
- Radiotherapy (4-5 fractions);
- Follow-up.

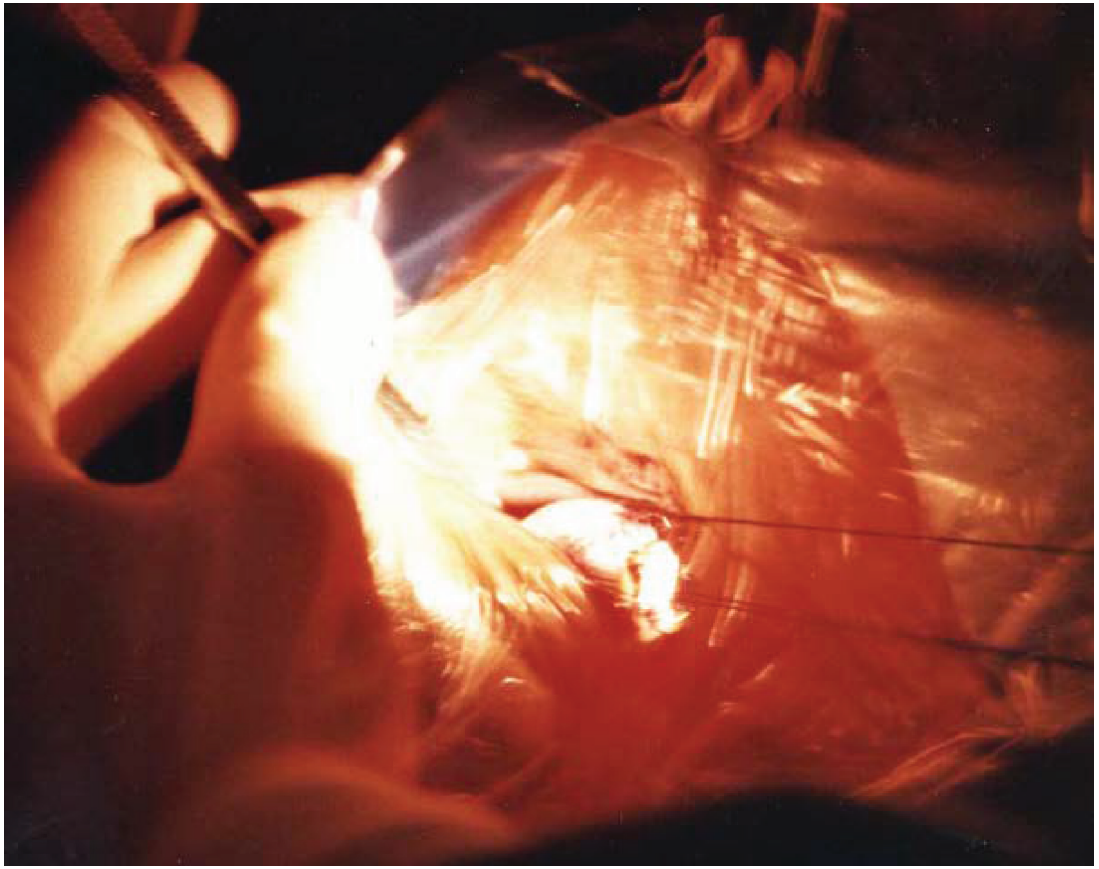
Diagnosis

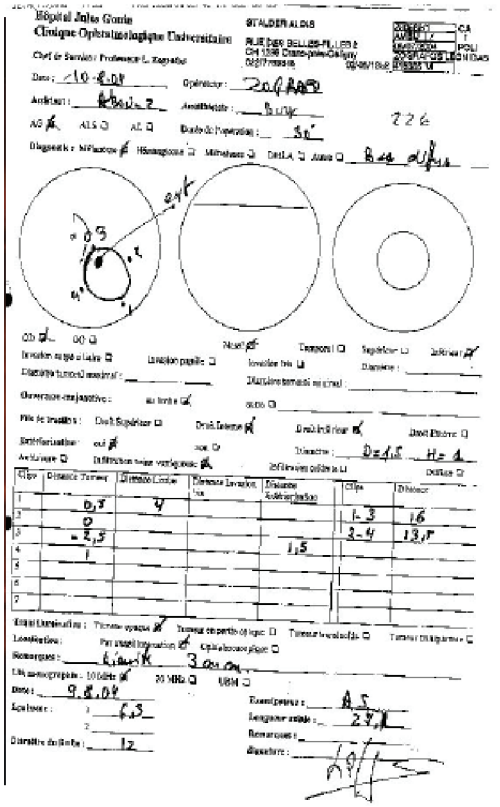
Primary symptom: reduced/disturbed vision



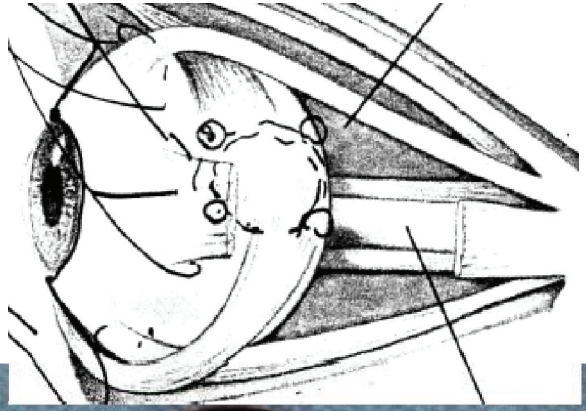
Surgery to document tumor extension and placement of fiducial markers

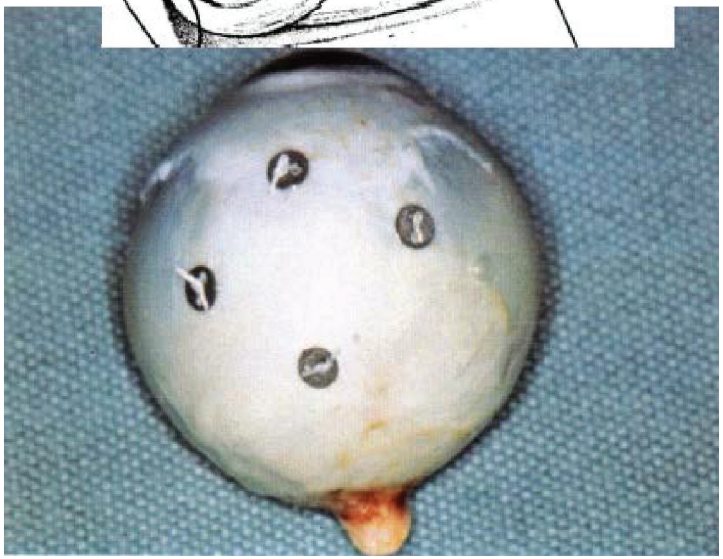
With trans-illumination the tumor throws a shadow on the sclera: the tumor base

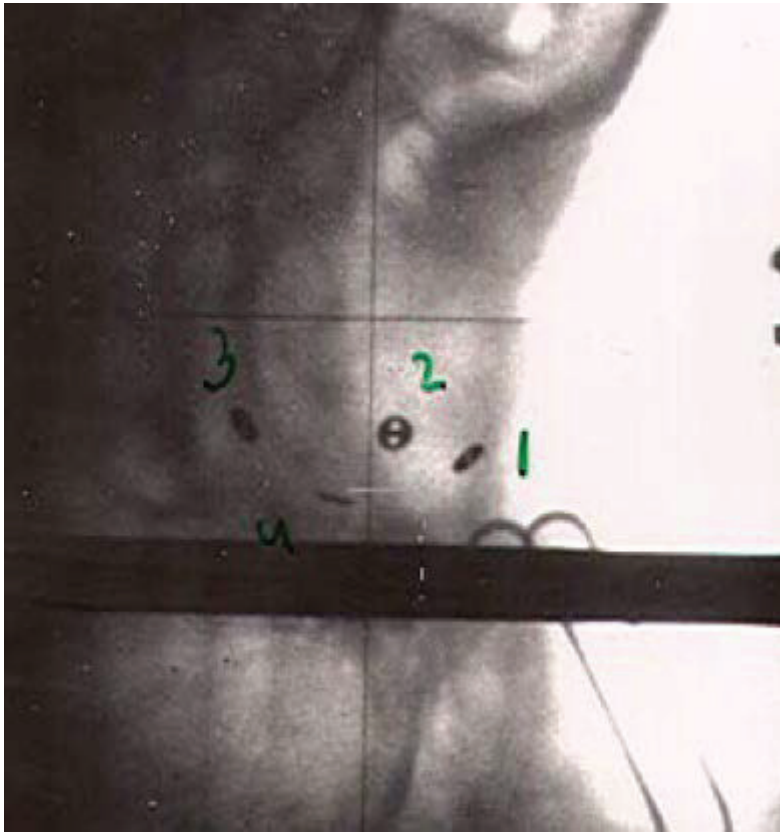




Tumor base is delineated with tantalum clips

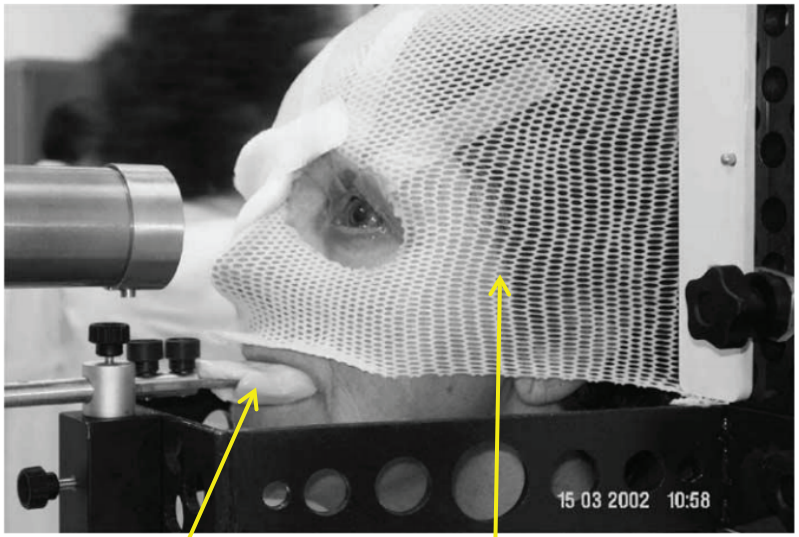






Simulation

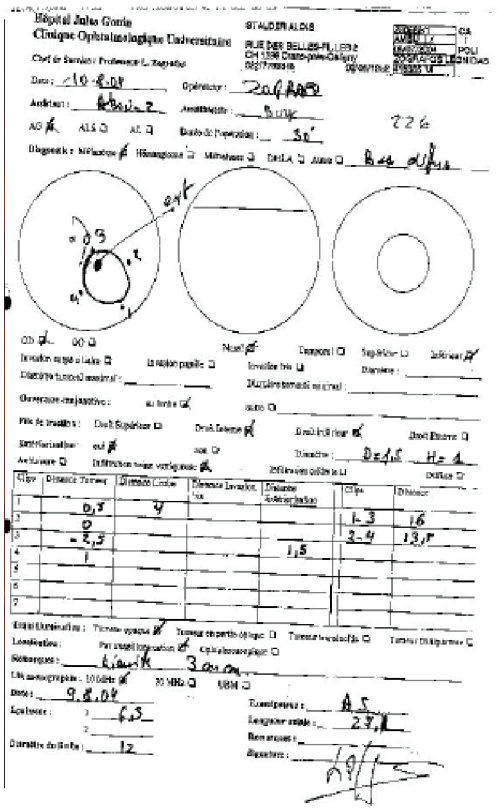
Positioning in front of the beam



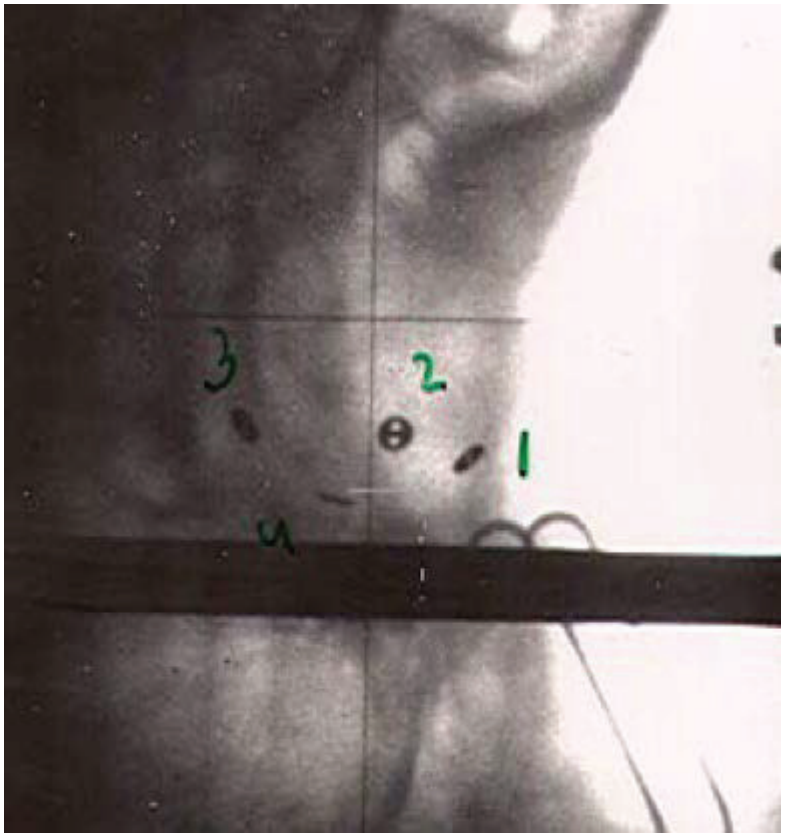
Bite block

Face mask

Radiographic verification of clip position with other clinical documentation



OP –report
Clip position

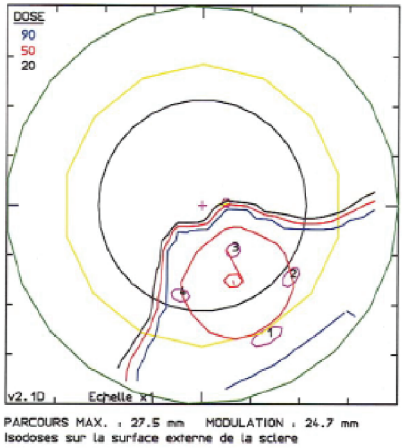


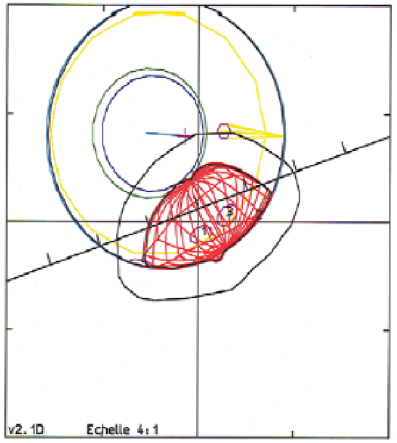
Clip position on X-ray
with coordinates

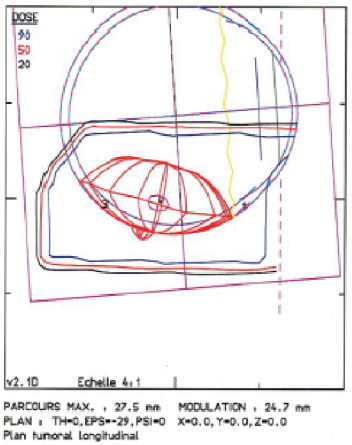
Treatment planning

- Tumor drawn based on clinical date;
- Determine optimal eye position;

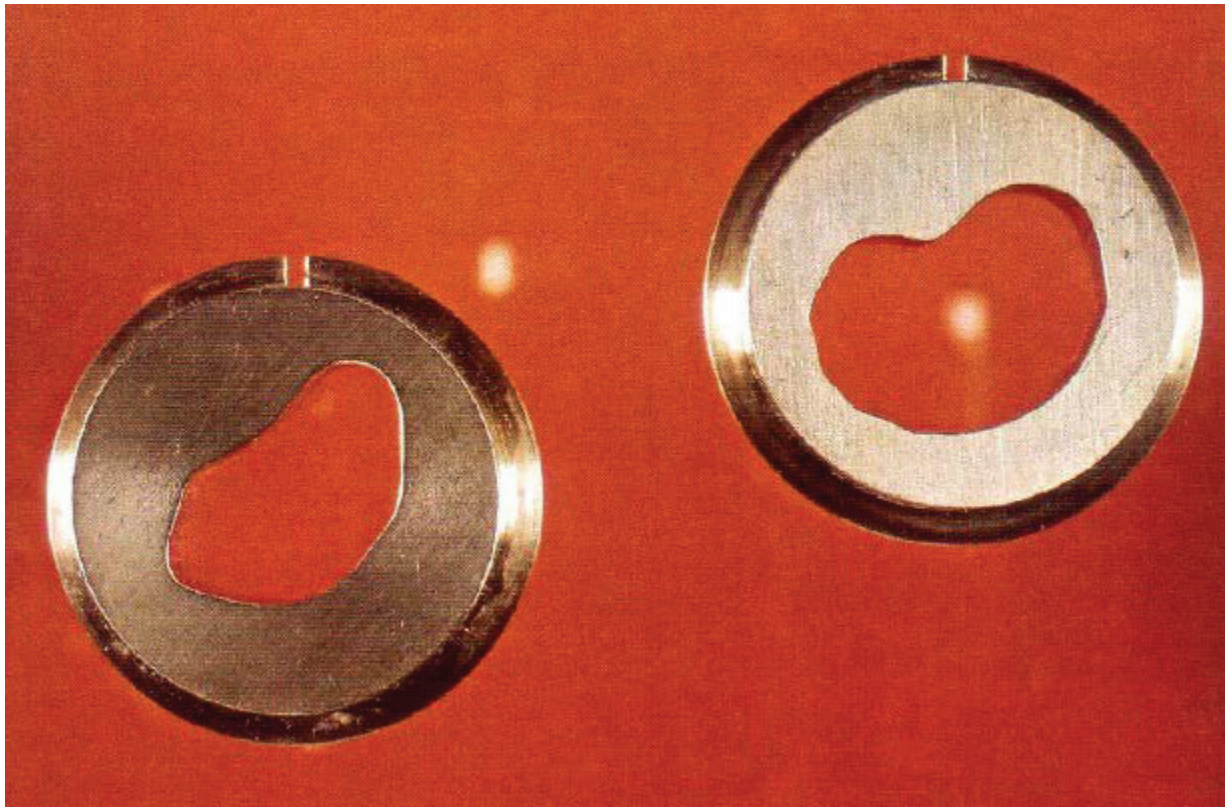
Main planning conditions: lateral margin 2 mm, distal margin 2.5 mm and maximum distance between the macula and the optical disk.







Fabrication of individual collimators

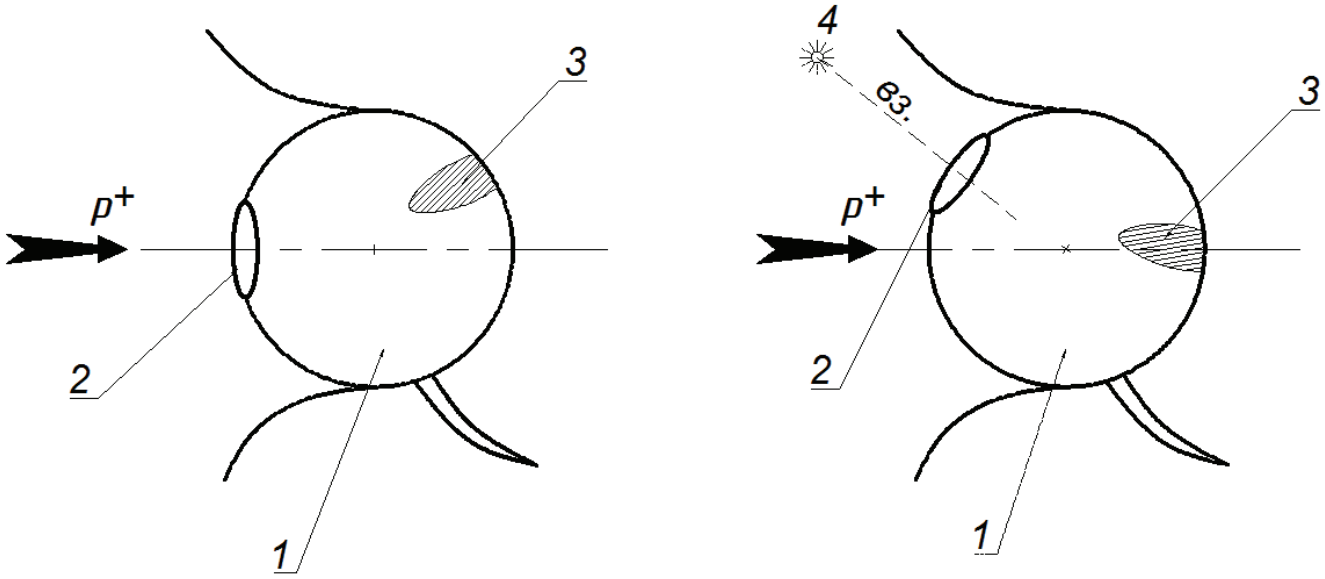


Positioning

The composition of the positioning system:

- laser positioning system;
- fixation point;
- X-ray positioning system.

Fixation point

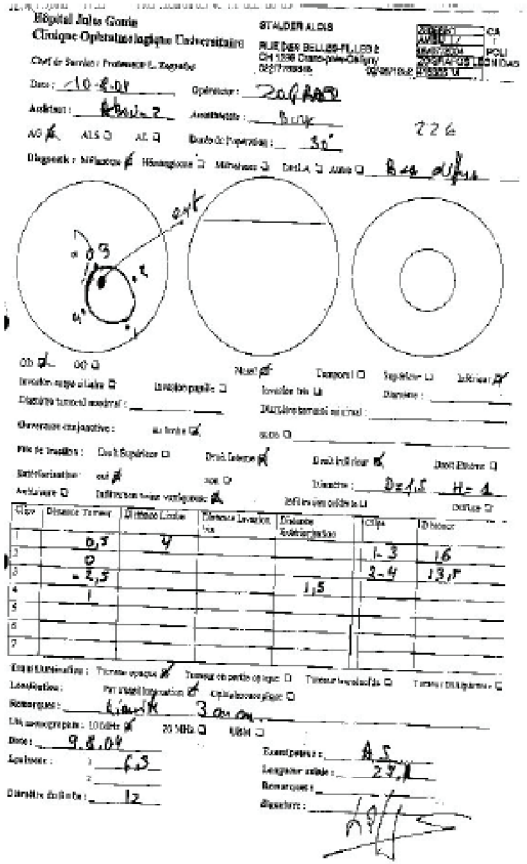


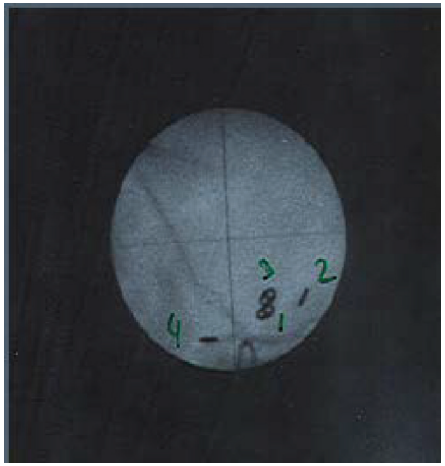
1. eyeball;
2. pupil;
3. Intraocular tumor;
4. Fixation point;

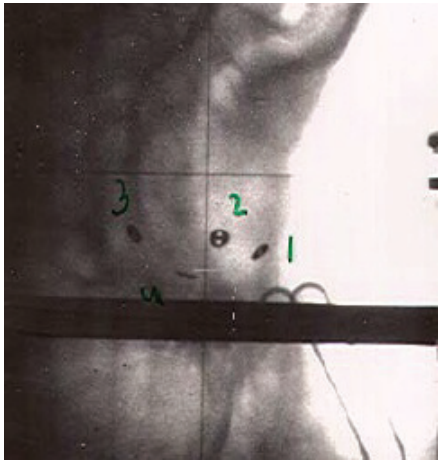
p+ – axis of the proton beam;

вз – direction of gaze.

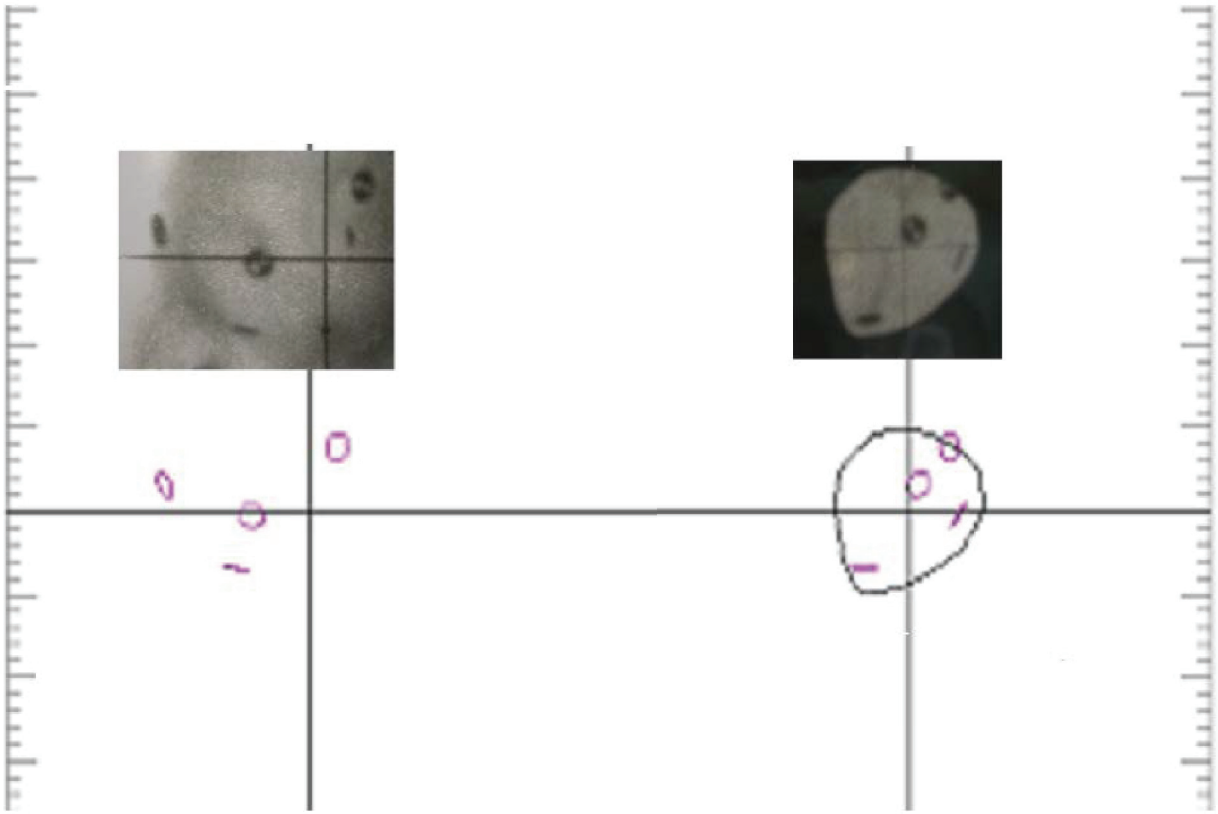
X-ray positioning system







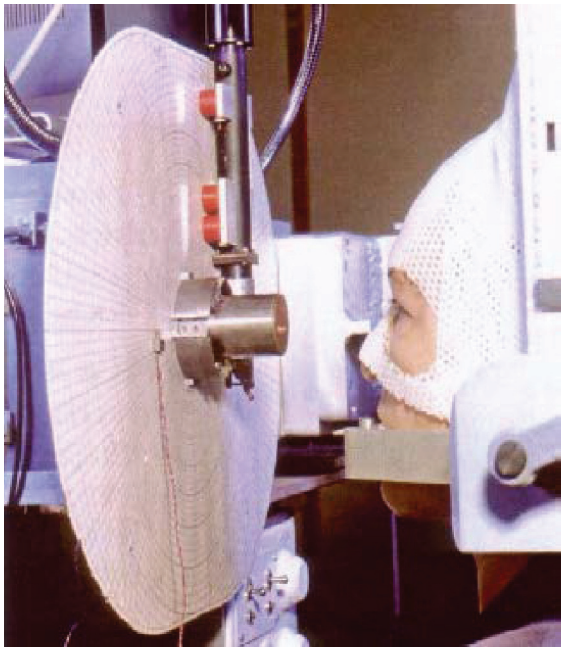
Identifying the clips on X-ray images and determines clip positions

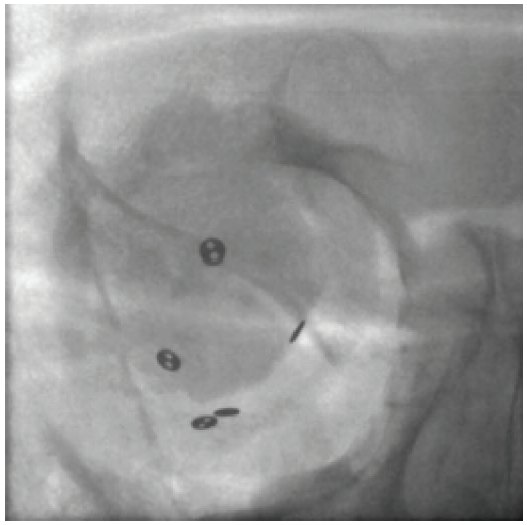


Lateral view

Axial (beam-s eye) view

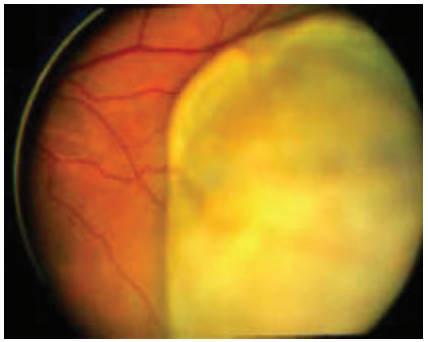
Eye position adjusted until clips are matched (<0,2 mm)

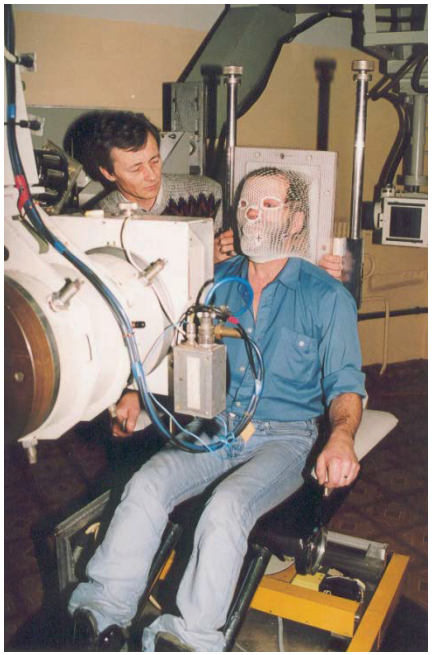




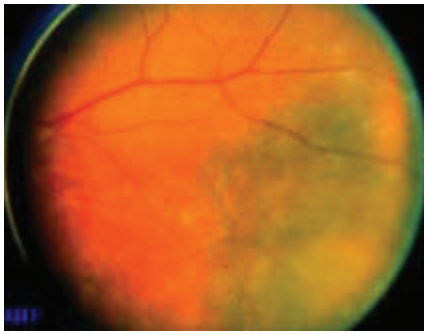
Main achievements

Ocular fundus
PRIOR to proton therapy





Ocular fundus
AFTER proton therapy



- **local tumor control - 98,0%;**
- **eye preservation - 88,7%;**
- **preservation of vision – 50%;**
- **five-year survival rate - 95,0 - 97,0%.**

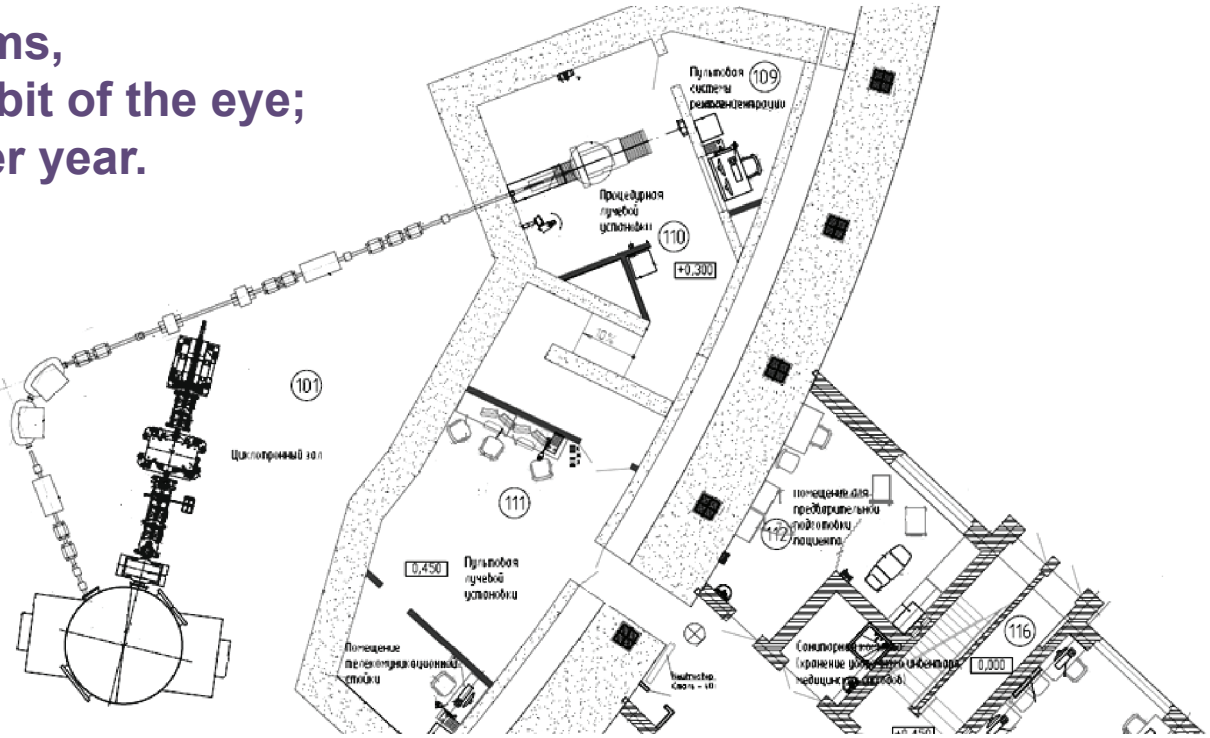
More than 15,000 patients have been treated worldwide;
over 98% of diagnoses - uveal melanoma.

Radiation oncophthalmic center based on the C-80 accelerator at the NRC "Kurchatov Institute" – PNPI

Total area of 630 м^2:
- **medical part – 255 м^2**
- **physical and technical part – 375 м^2**

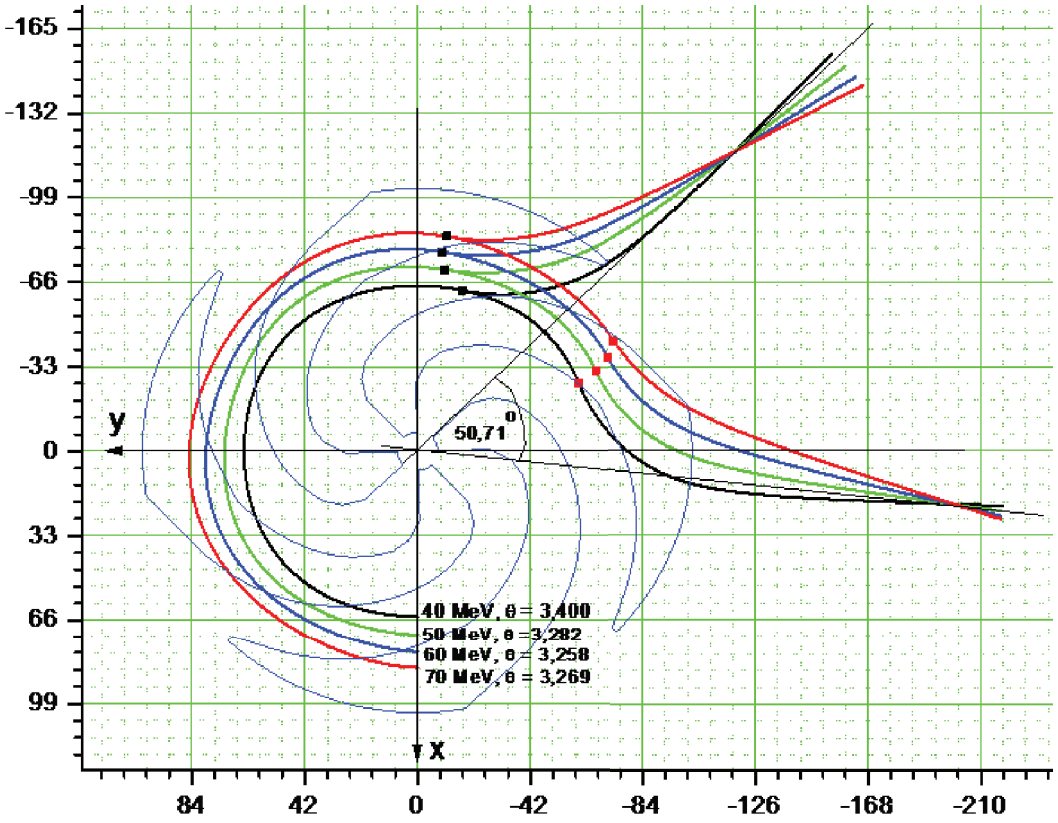
- **proton beam energy 70 МэВ;**
- **passive beam system;**
- **maximum dose field of radiation 50мм;**
- **localization:**
  - **intraocular neoplasms,**
  - **neoplasms of the orbit of the eye;**
- **bandwidth of 400 people per year.**

- **Chair positioner;**
- **beam delivery system;**
- **patient positioning system;**
- **X-ray positioning system;**
- **treatment planning system.**



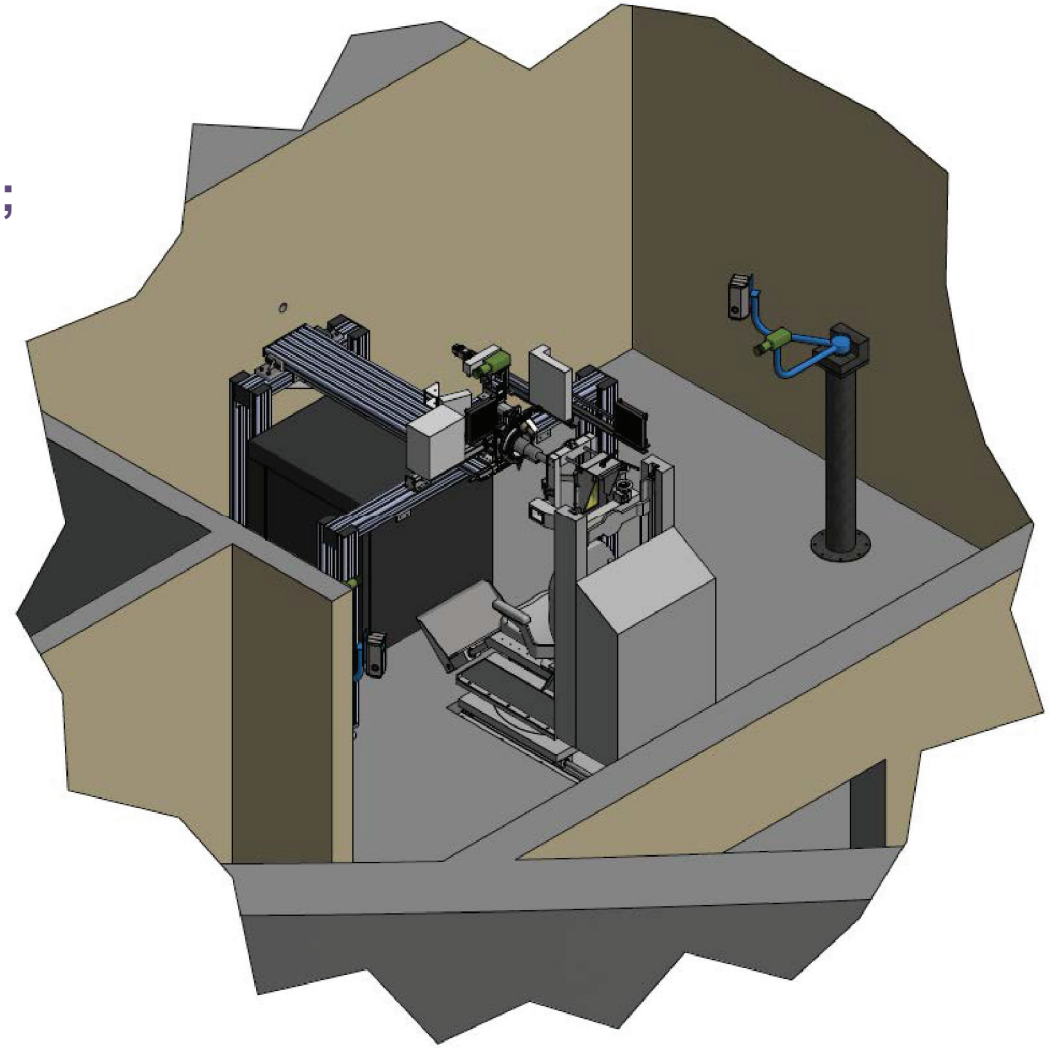
Independent of the therapeutic proton beam output

Estimated and made calculations for the organization of an independent output of a low-intensity ($5x10^{10}$p/s) proton beam, by introducing the second charge-transfer system of H^- ions

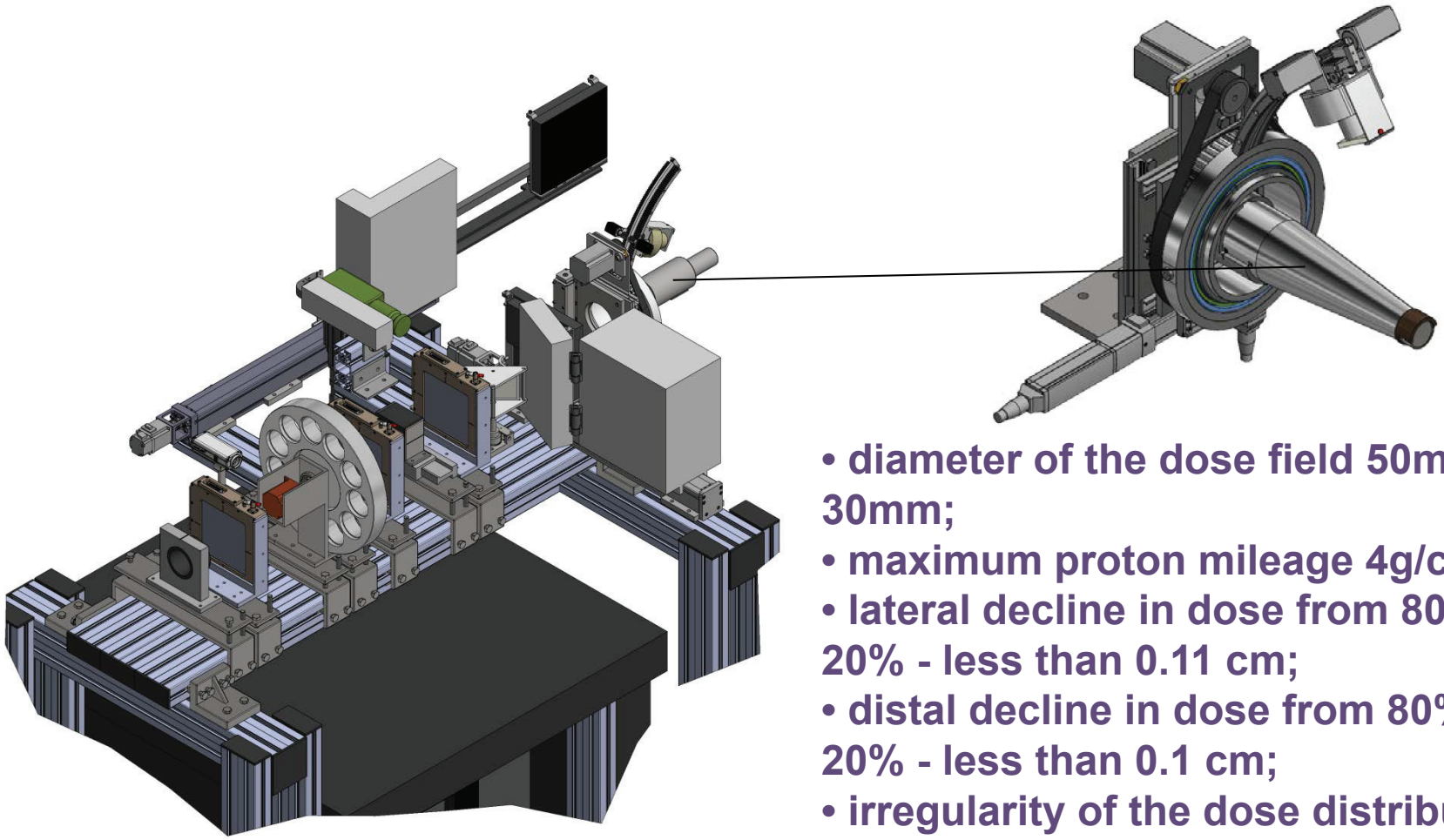


General view of the treatment room

- Chair-positioner;
- beam delivery system;
- patient positioning system;
- X-ray positioning system;



Beam delivery system



- diameter of the dose field 50mm and 30mm;
- maximum proton mileage 4g/cm^2;
- lateral decline in dose from 80% to 20% - less than 0.11 cm;
- distal decline in dose from 80% to 20% - less than 0.1 cm;
- irregularity of the dose distribution is not more than ± 2.5%;
- dose rate of at least 50Gy / min.

Chair positioner

- two job positions:
  patient position
  irradiation position
- precision displacement in three coordinates X, Y, Z with an accuracy of 0.1mm;
- independent angular displacement of head holders;
- independent movement of chair elements for comfortable patient accommodation.

Summery

Realization of NRC "Kurchatov Institute" - PNPI research project to develop an oncophthalmological complex of proton beam therapy will provide high-tech care for patients in the whole North-West region of Russia.

Thank you for attention!