

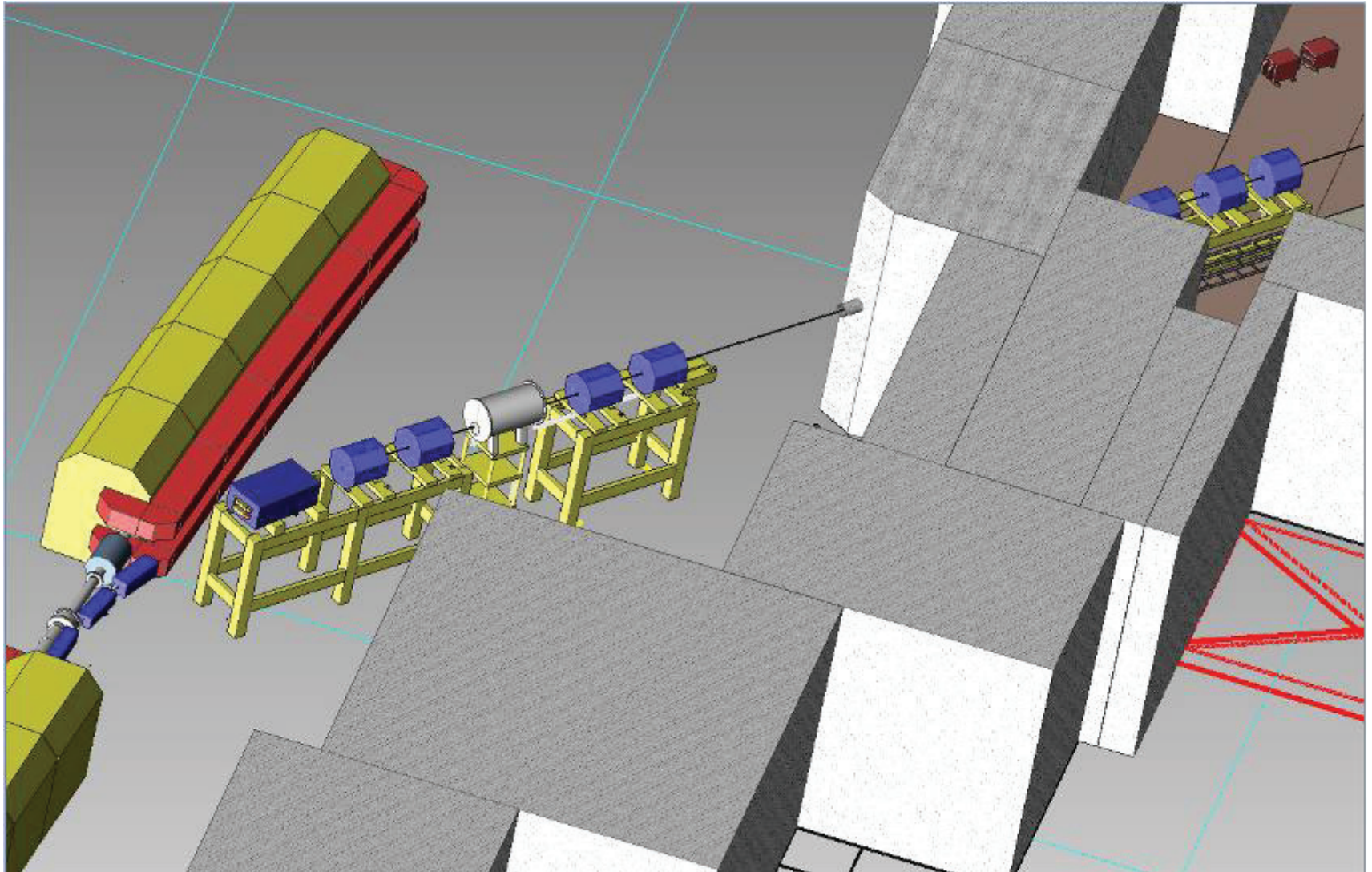


The Results Obtained on “Radiobiological Stand” Facility, Working With the Extracted Carbon Ion Beam of the U-70 Accelerator.

Report FRB06

Vladimir Pikalov

25 channel. Placement of magneto-optical equipment



Channel head 25

vacuum chamber

TV box

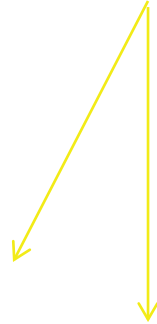
corrector

quadrupoles



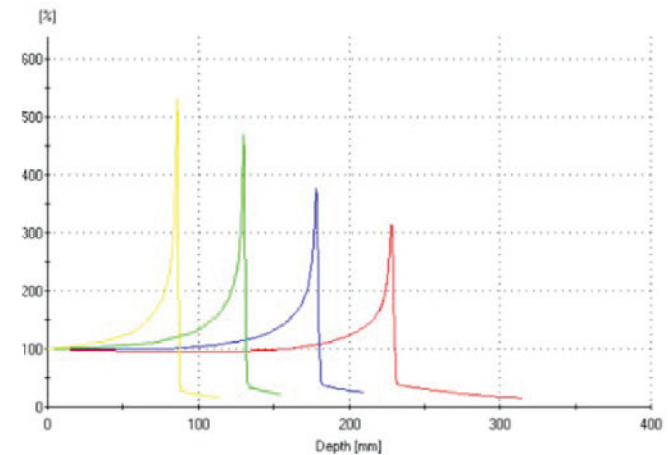
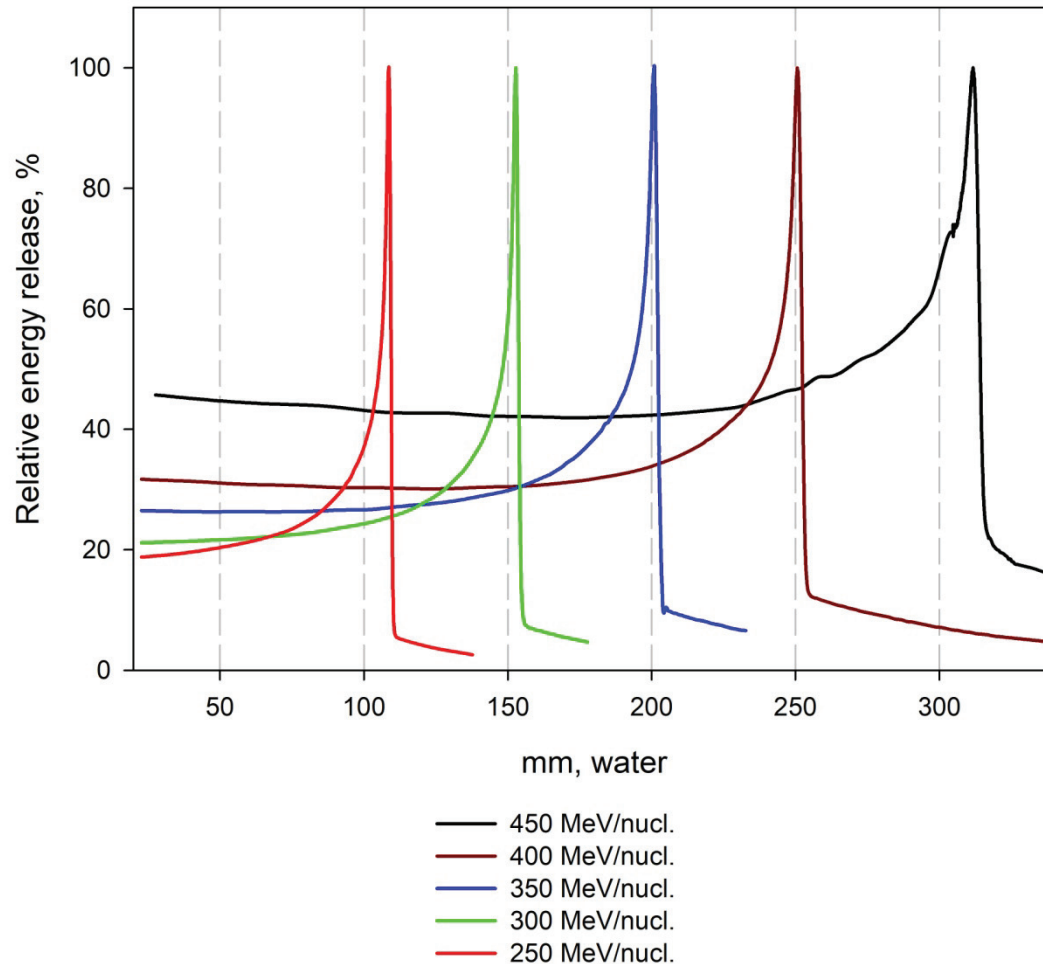
Channel 25 target station

Two target boxes with 4 Be targets in each

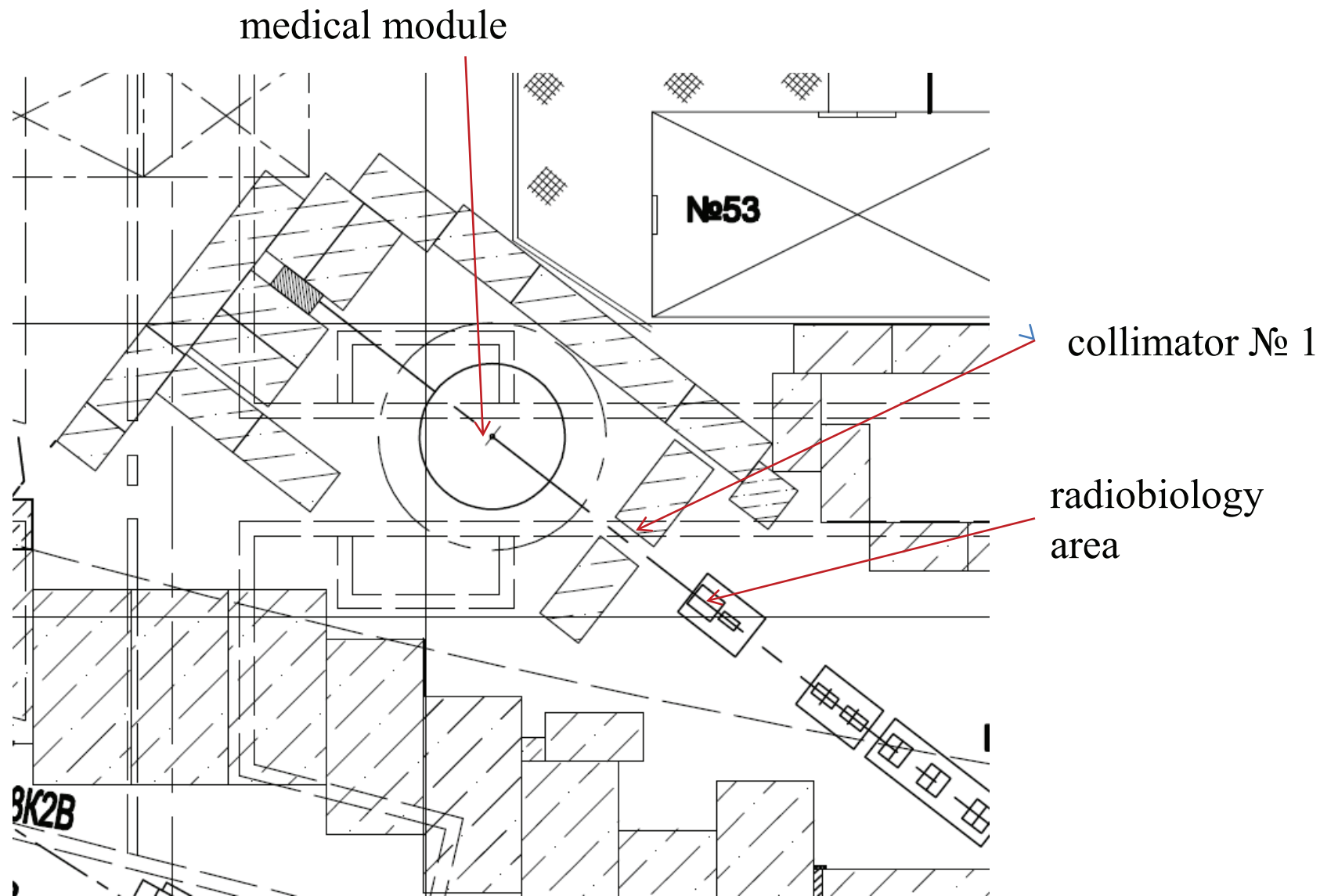


Extraction of carbon beam (different energies)

Bragg Peak of carbon ions in water.
Energy from 450 to 250 MeV/nucl.

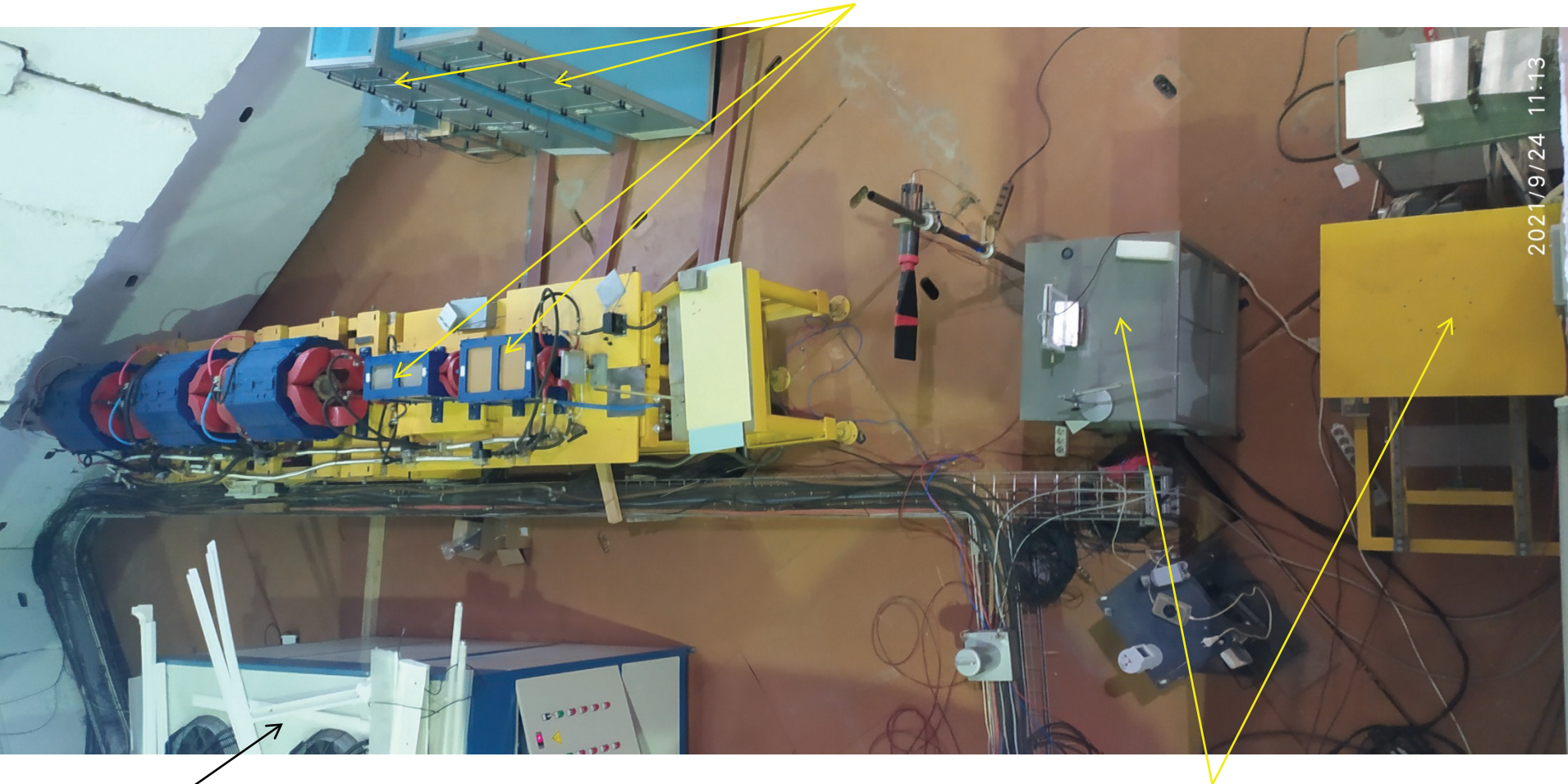


Biological shield of the Radiobiological Stand



Radiobiology area

electromagnetic scanning system



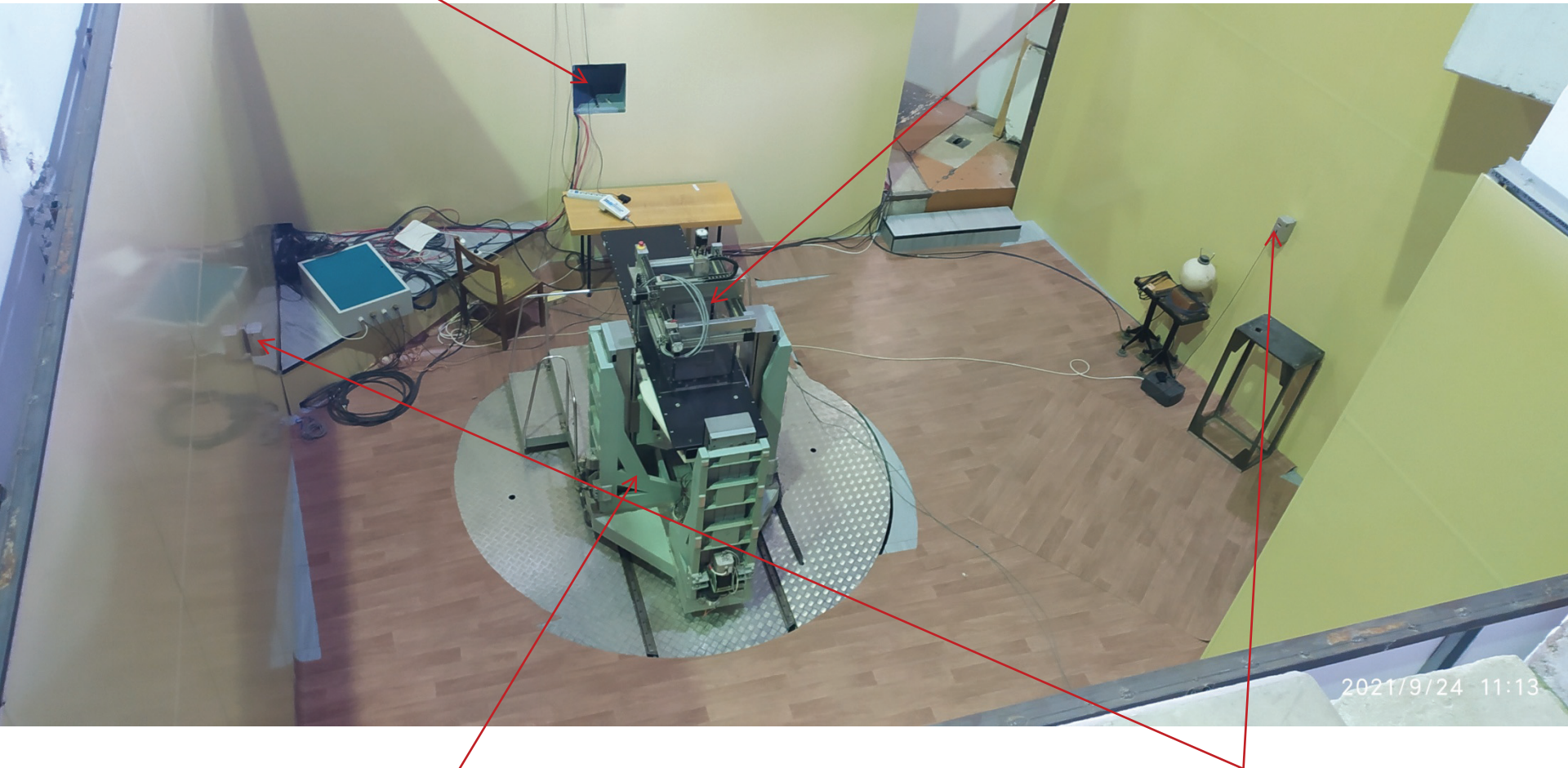
chiller

experimental zone

Medical module

collimator № 1

water phantom with 3D movement system

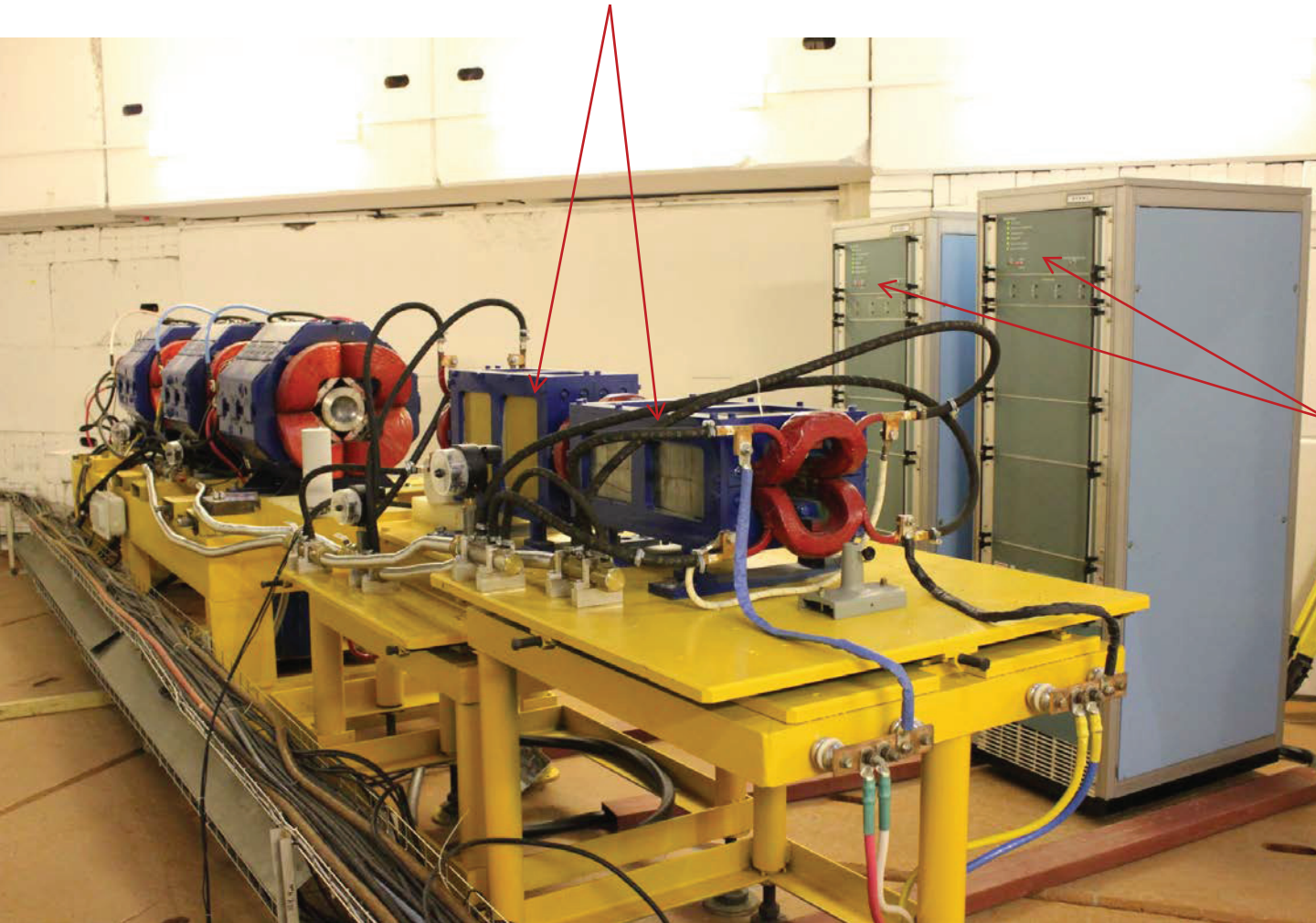


6-axis table

laser centralizer

Electromagnetic scanning system

dipole magnets



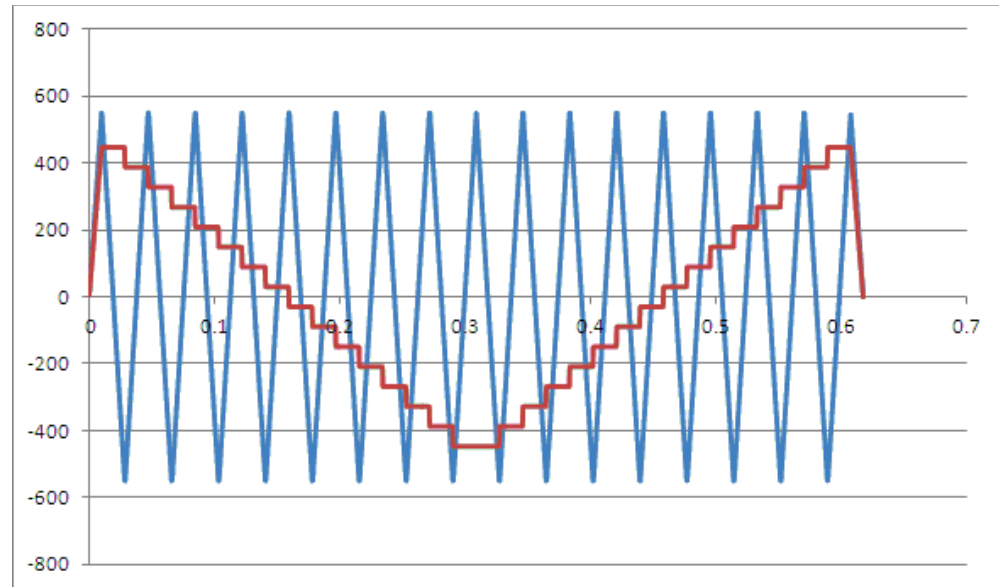
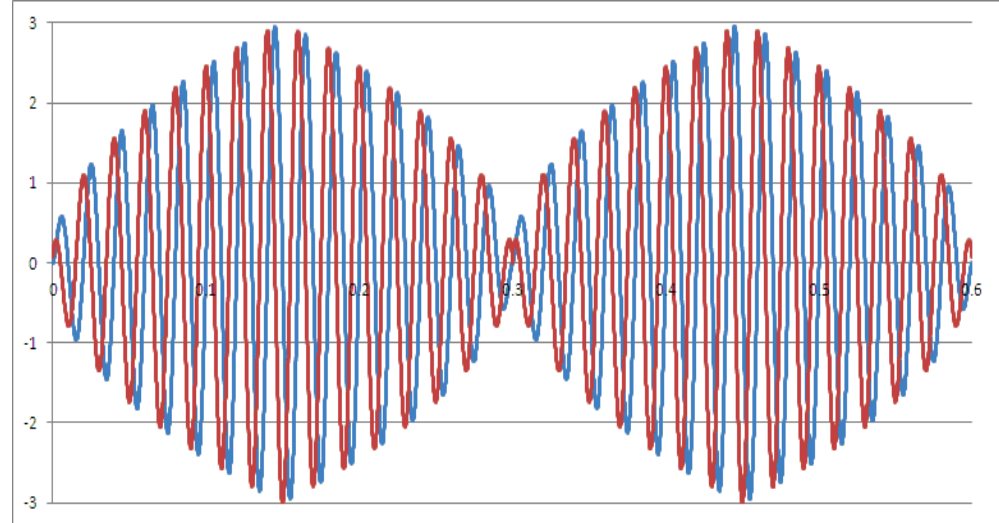
Power supplies:

Output current
amplitude $\pm 700\text{A}$

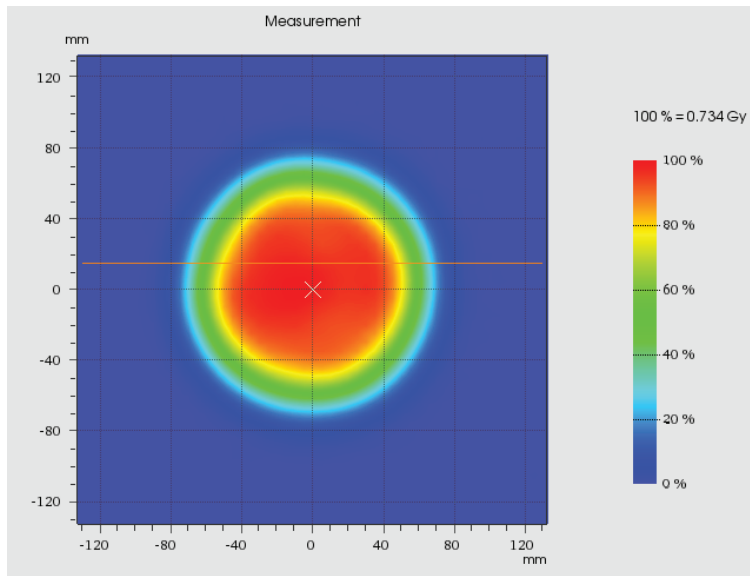
Output current
frequency 20-60 Hz

Load inductance
 $\leq 0.42\text{ mH}$

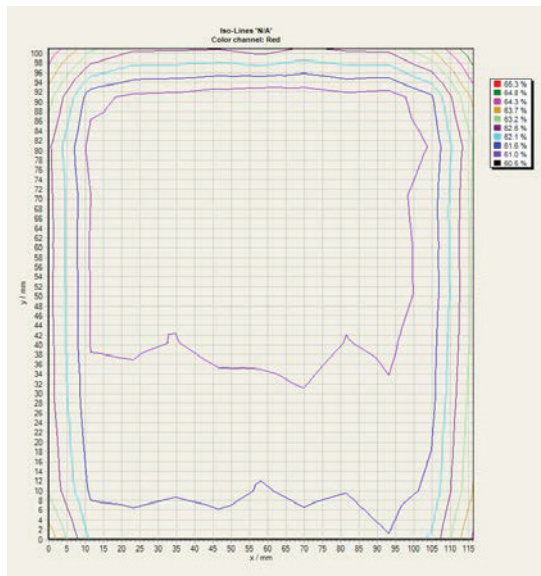
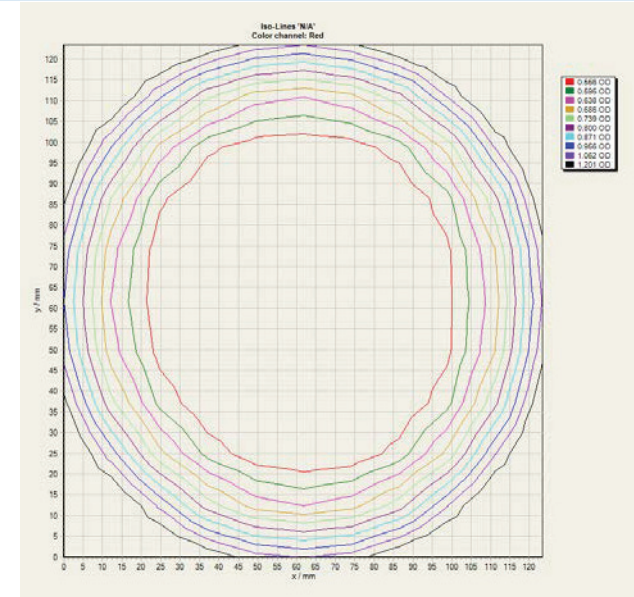
Examples of load current waveforms



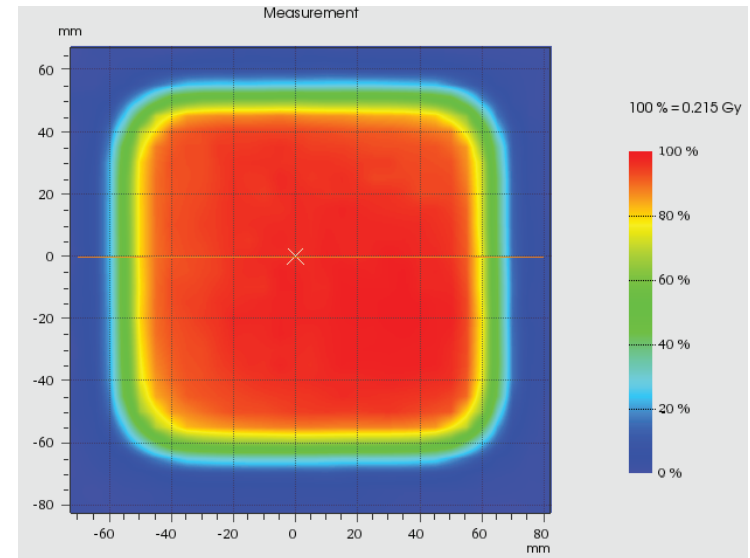
Dose distribution in the irradiation area



spiral

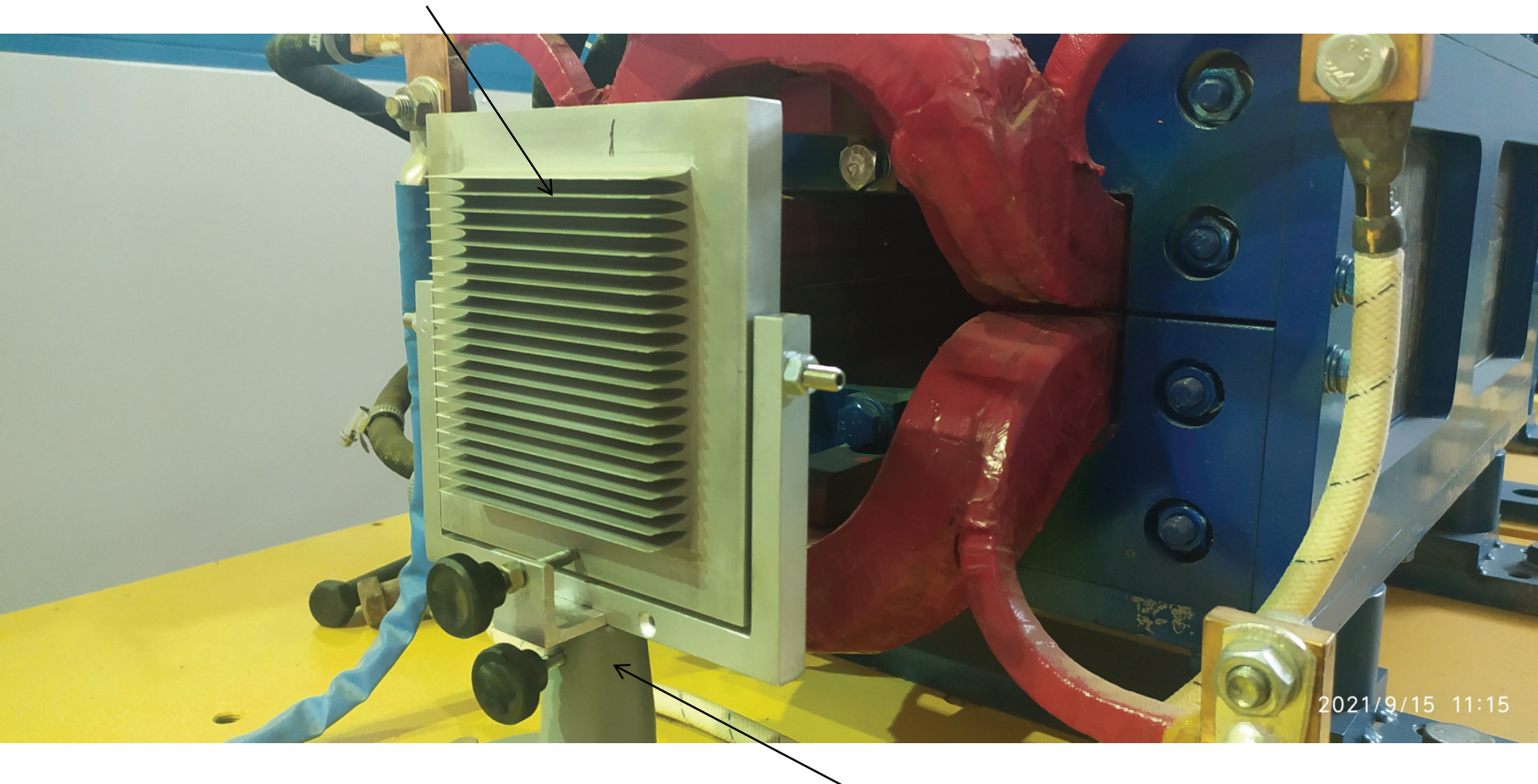


scanning



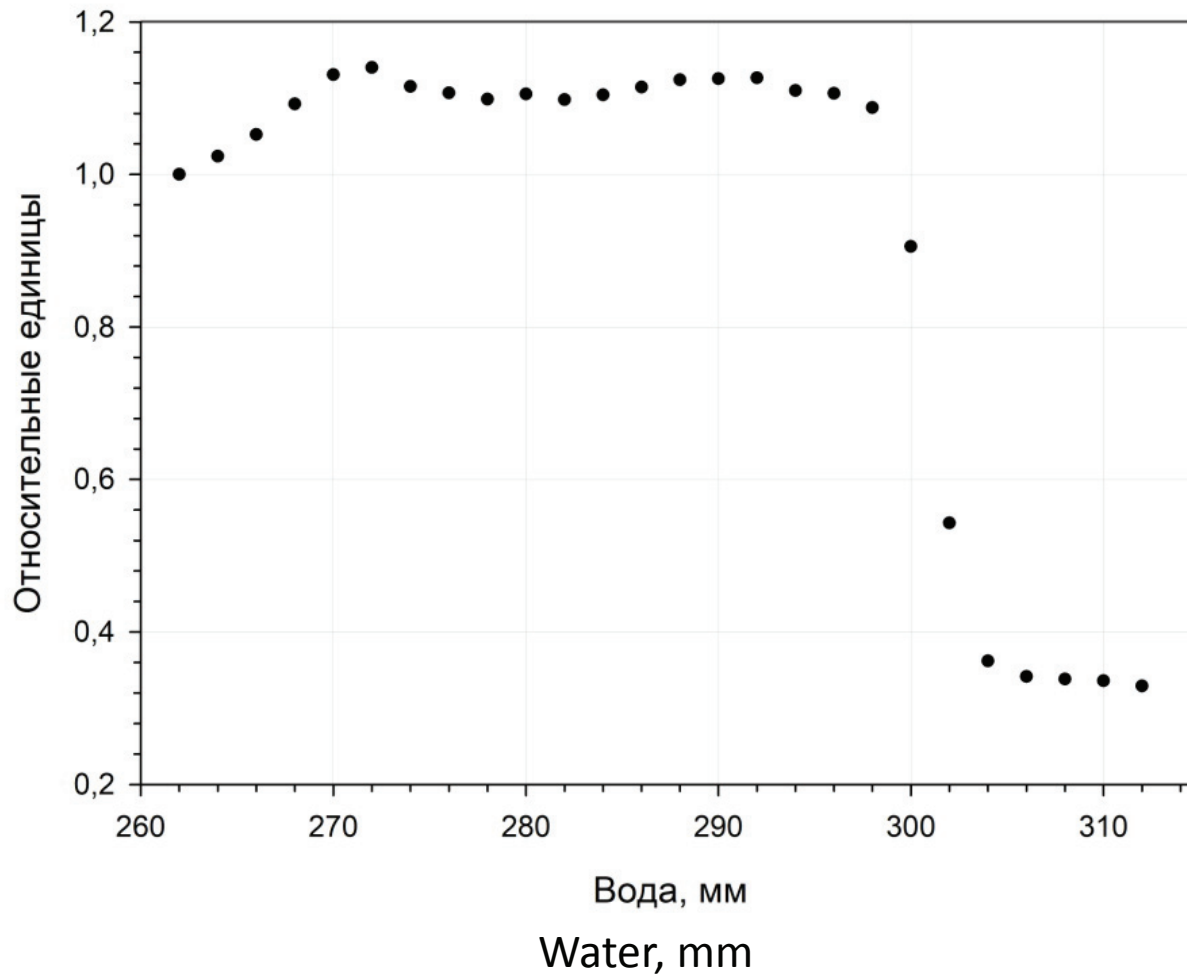
Ripple filter

Al ripple filter 16 mm



alignment stand

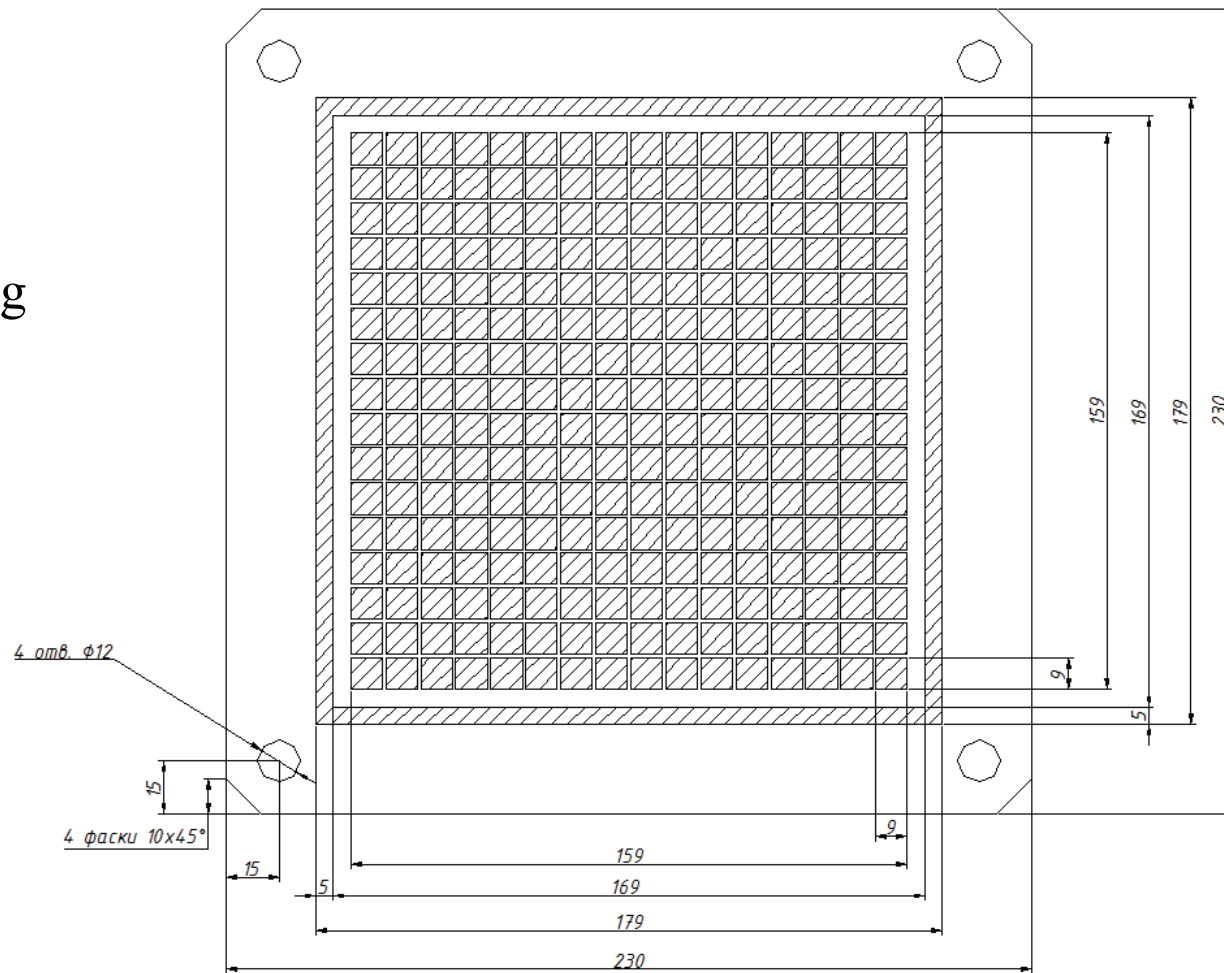
Bragg's Peak with a ripple filter



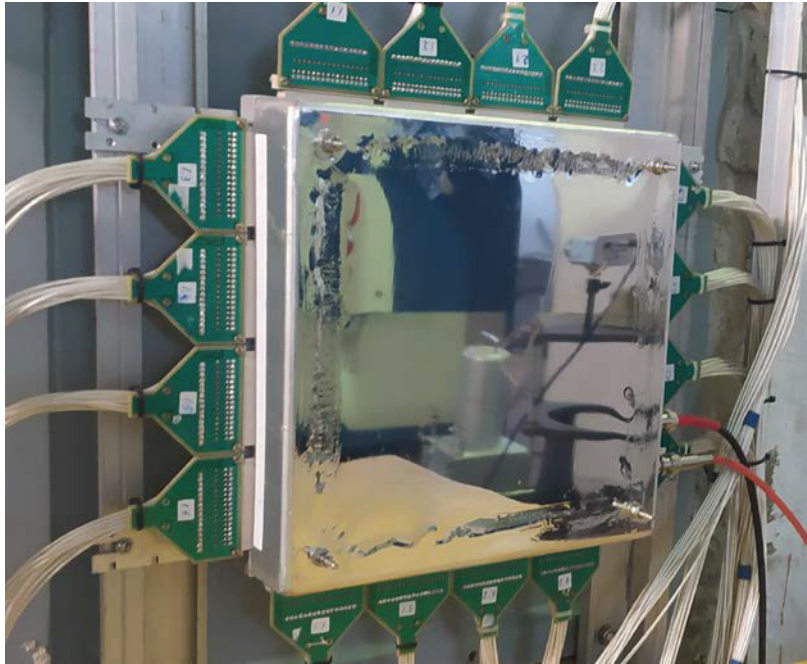
E=450
MeV/nuc

Mosaic 256-cell plane-parallel ionization chamber

drawing

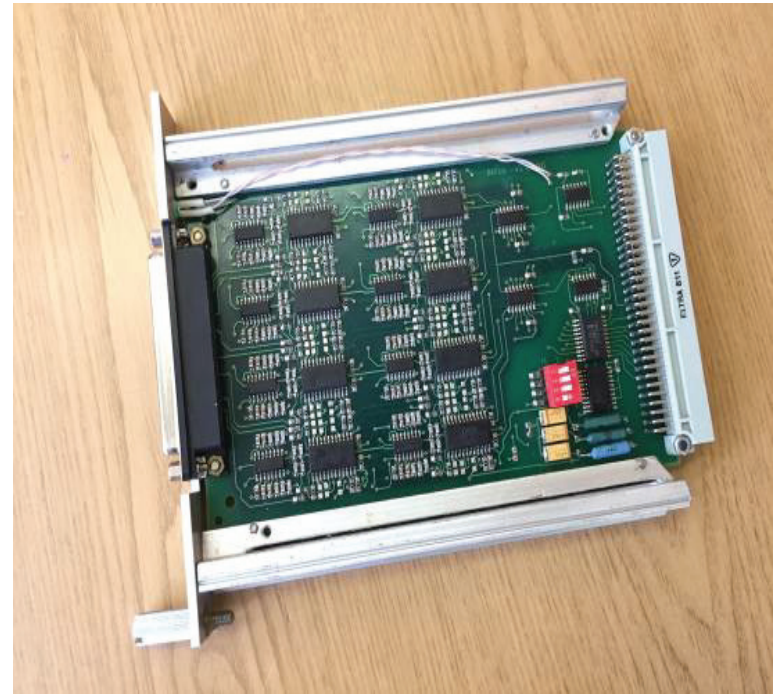


Mosaic 256-cell plane-parallel ionization chamber

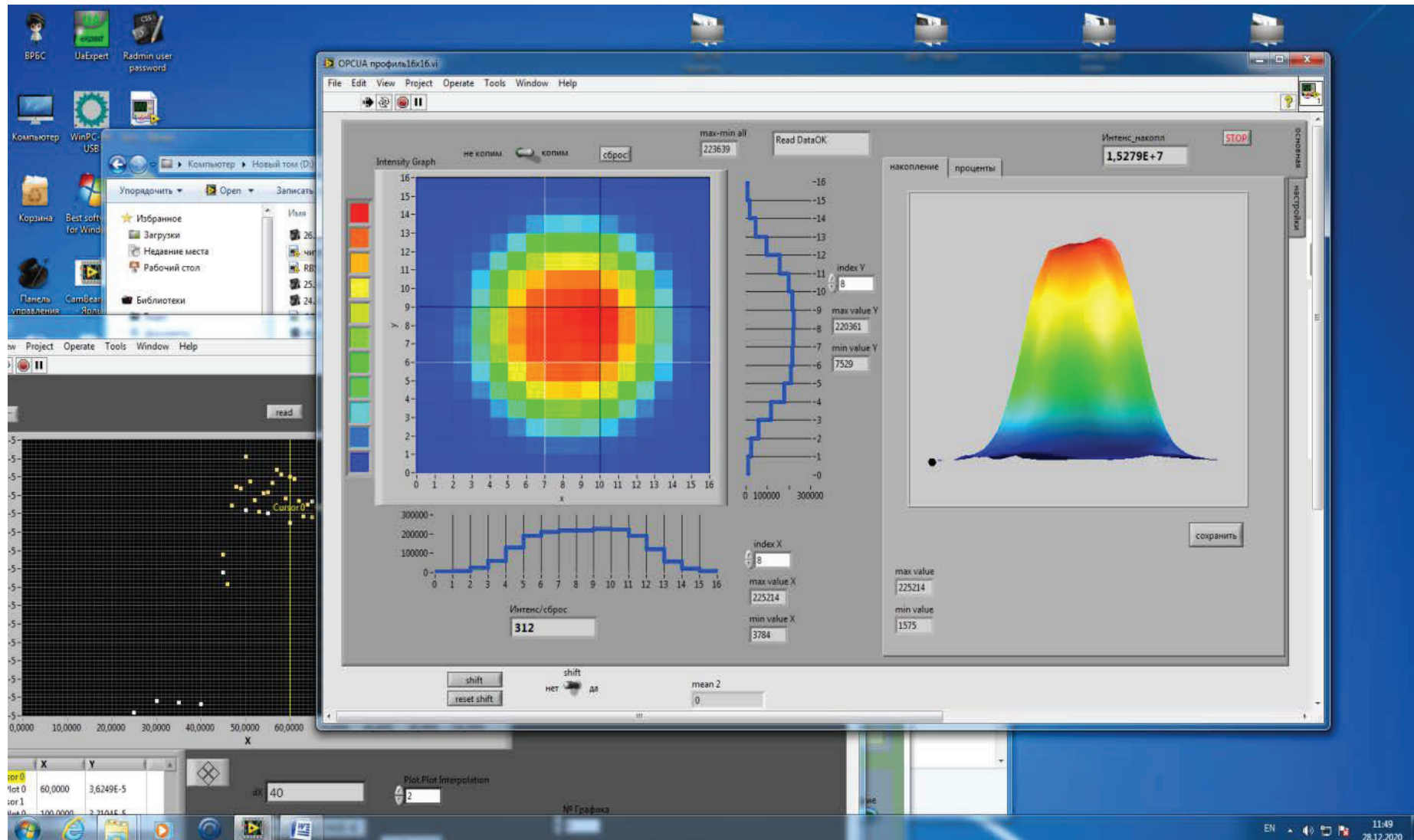


camera view without
electronics

charge integrator module for 16
channels

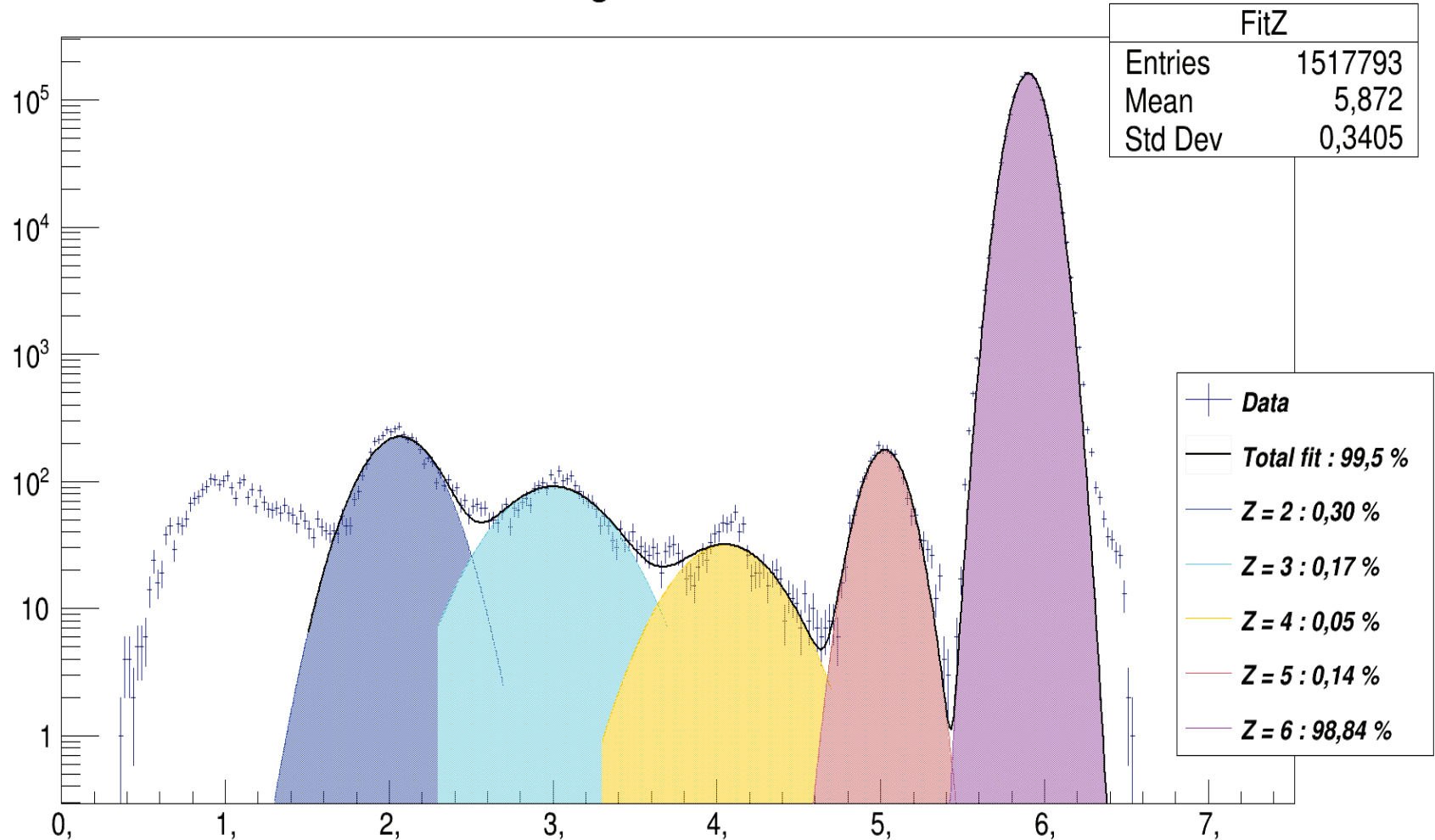


Screenshot of the program for the 256-channel ionization chamber

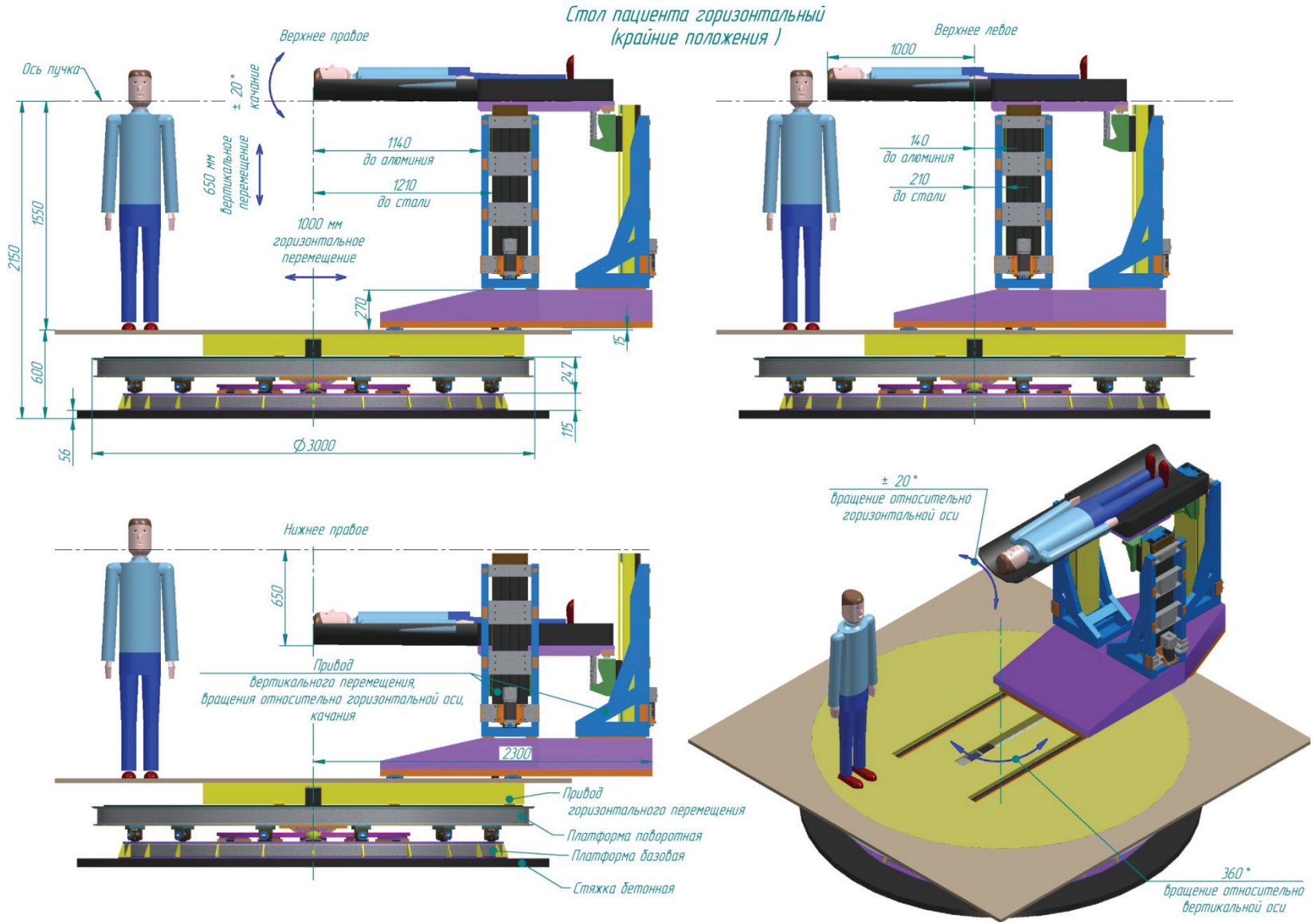


Carbon ion beam composition. 300 MeV / nuc

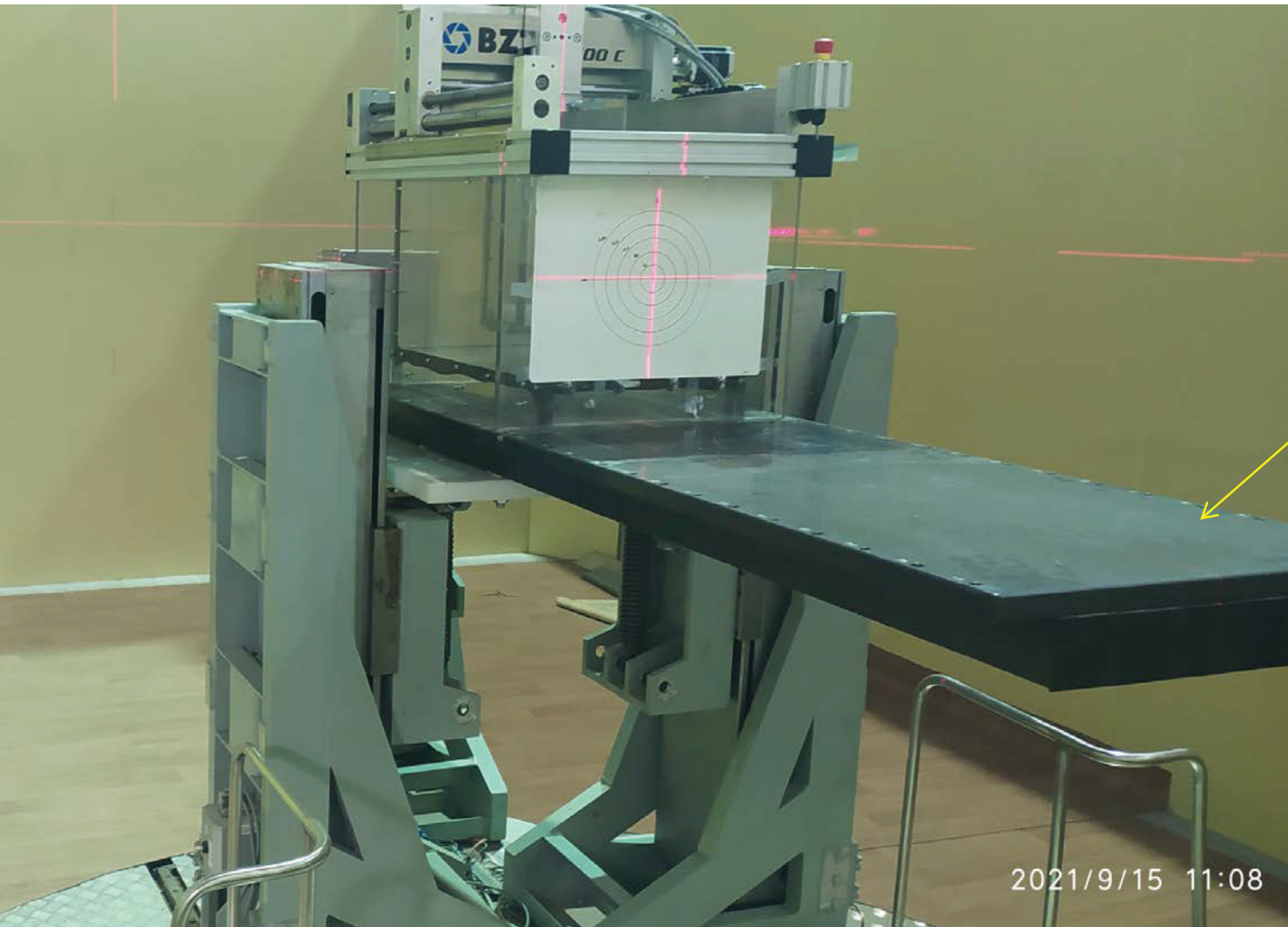
Charge distribution



6-axis table. 3D model.



6-axis table in the medical module



positioning
accuracy $<0.5\text{mm}$

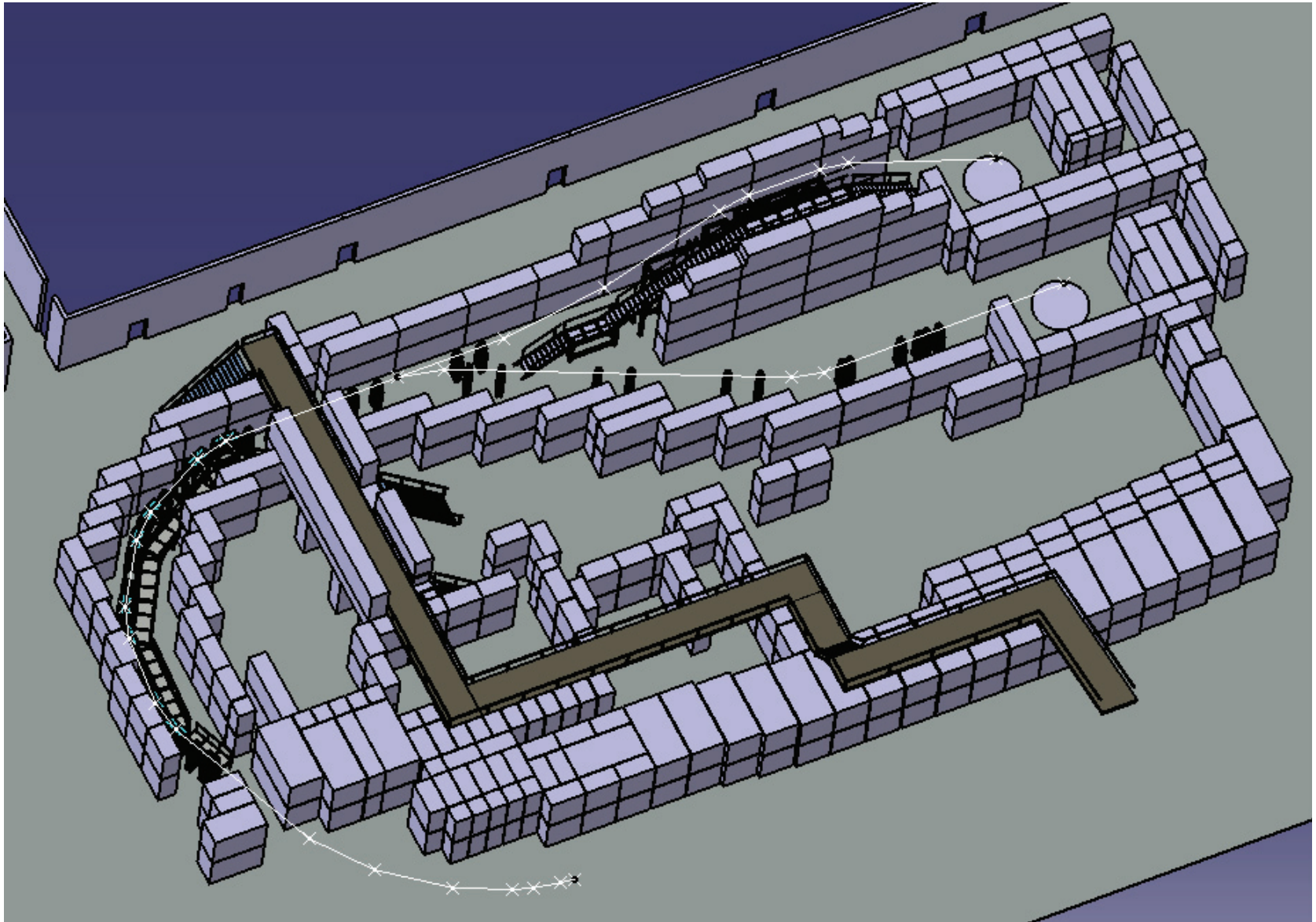
CT scanner deck

Multitom Rax - Twin Robotic X-ray system for medical module

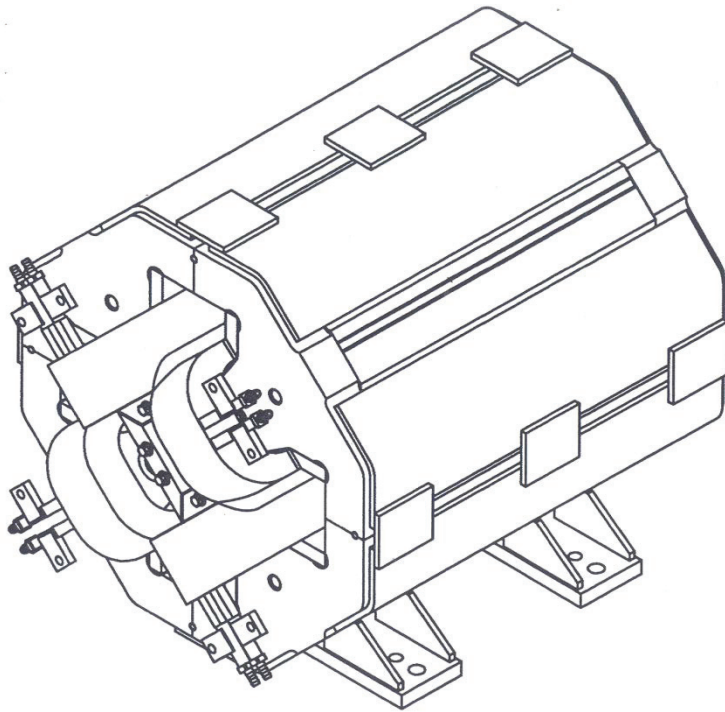


[illegible]

26 channel 3D model

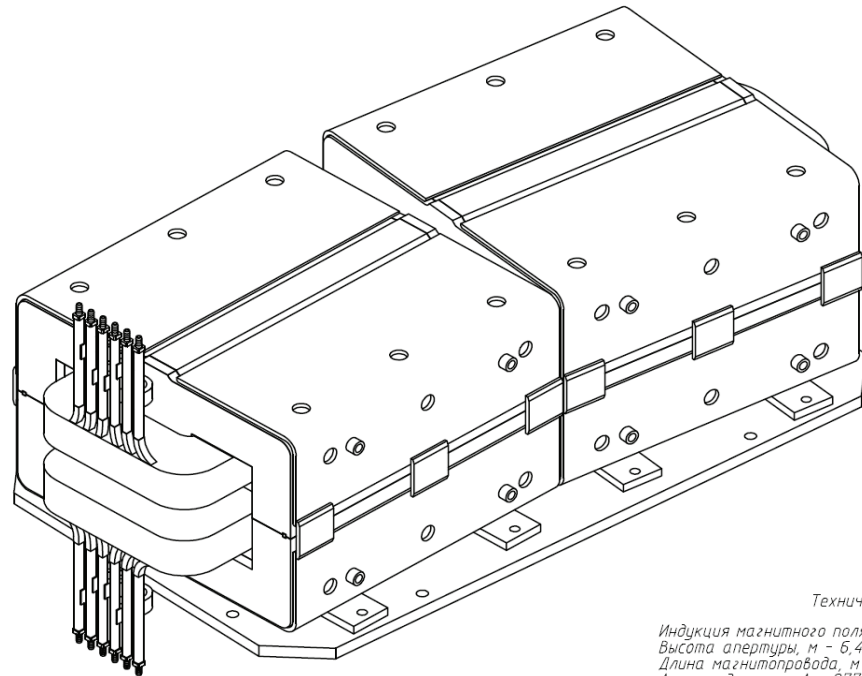


Magneto-optical elements of the 26 channel



lens 220x75 mm
24,6 T/m

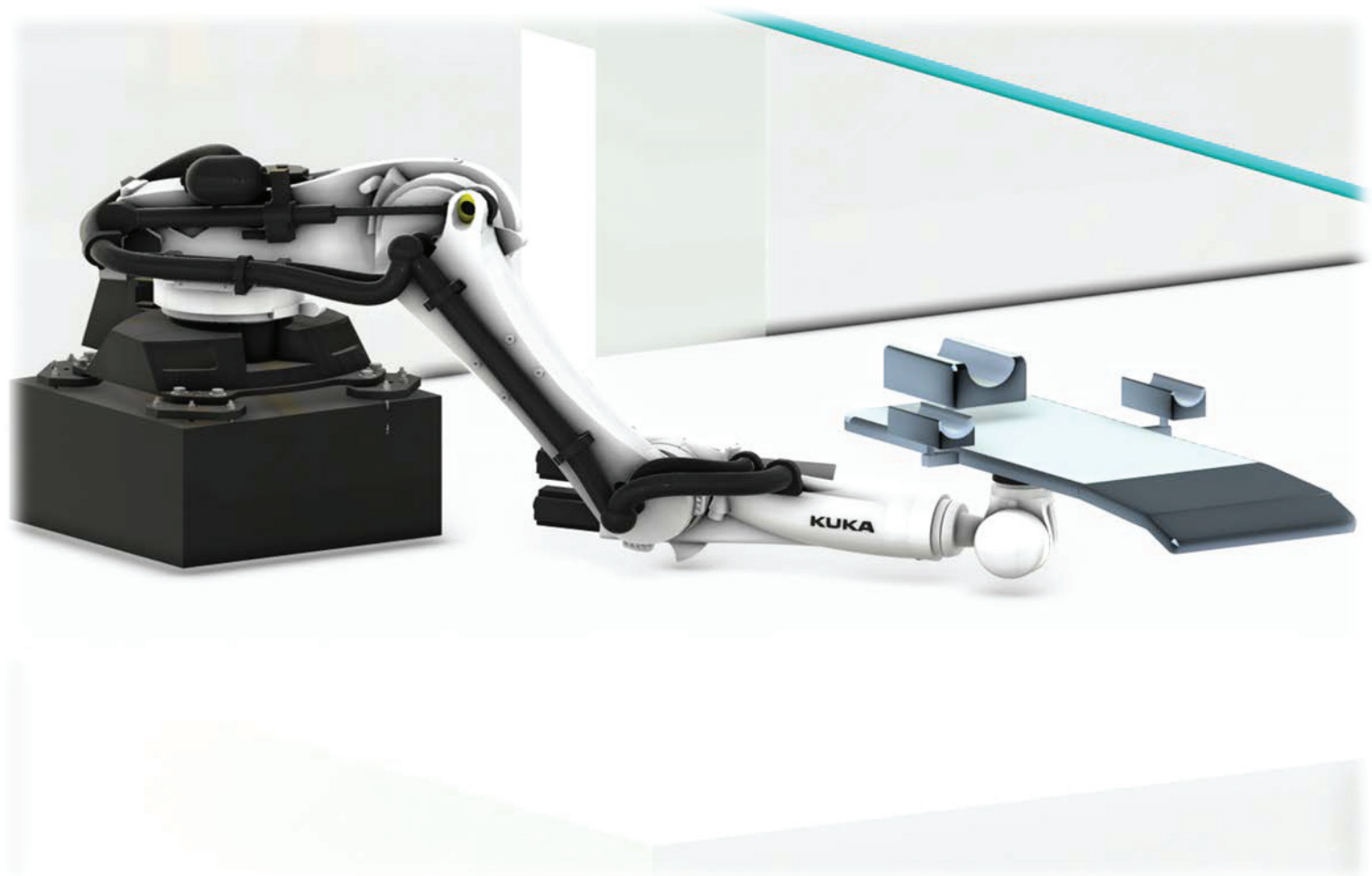
dipole
 $L=1.3$ m
 $B=1,4$ T
 $h=64$ mm



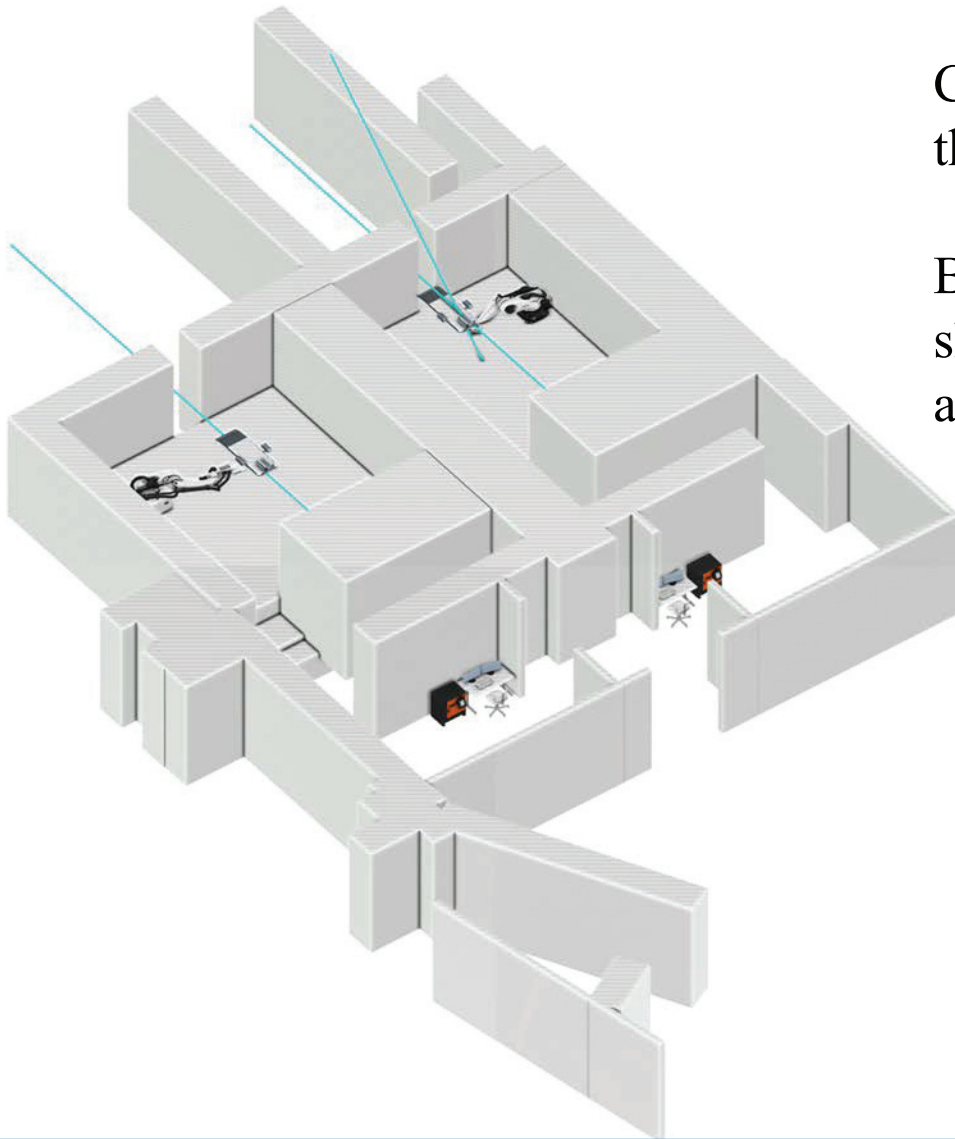
Техническая характеристика

Индукция магнитного поля, Тл - 1,38
Высота апертуры, м - $5,4 \times 10^{-2}$
Длина магнитопровода, м - 1,256
Амплитуда тока, А - 977
Активное падение напряжения, В - 36,03
Масса активной стали, кг - 1690

6-axis table based on the KUKA robot



Medical modules biological shield



Calculations performed using the FLUKA program.

Beam absorbers and biological shielding of medical modules are designed

Conclusion

Radiobiological Stand” Facility :

- works in continuous mode;
- according to the results obtained, 21 articles were published over the last 3 years;
- developed and implemented an electromagnetic beam leveling system (wobbler system);
- beam diagnostics tools were developed and manufactured;
- now has slow extraction of 200, 250, 300, 350, 400, 455 MeV per nucleon of $^{12}\text{C}^{6+}$ beam for radiobiology and future prior-to-therapy studies.

On the basis of the government decree No. 287 of 04.16.2020, work is underway to design the Ion Radiation Therapy Complex.

Thank you very much

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