The Henryk Niewodniczański Institute of Nuclear Physics
Polish Academy of Sciences, (IFJ PAN)

Proton irradiation facilities and radiotherapy centre at IFJ PAN

Jan Swakoń

Department of Radiation Research

and Proton Radiotherapy

The Henryk Niewodniczański Institute of Nuclear Physics
Polish Academy of Sciences, IFJ PAN

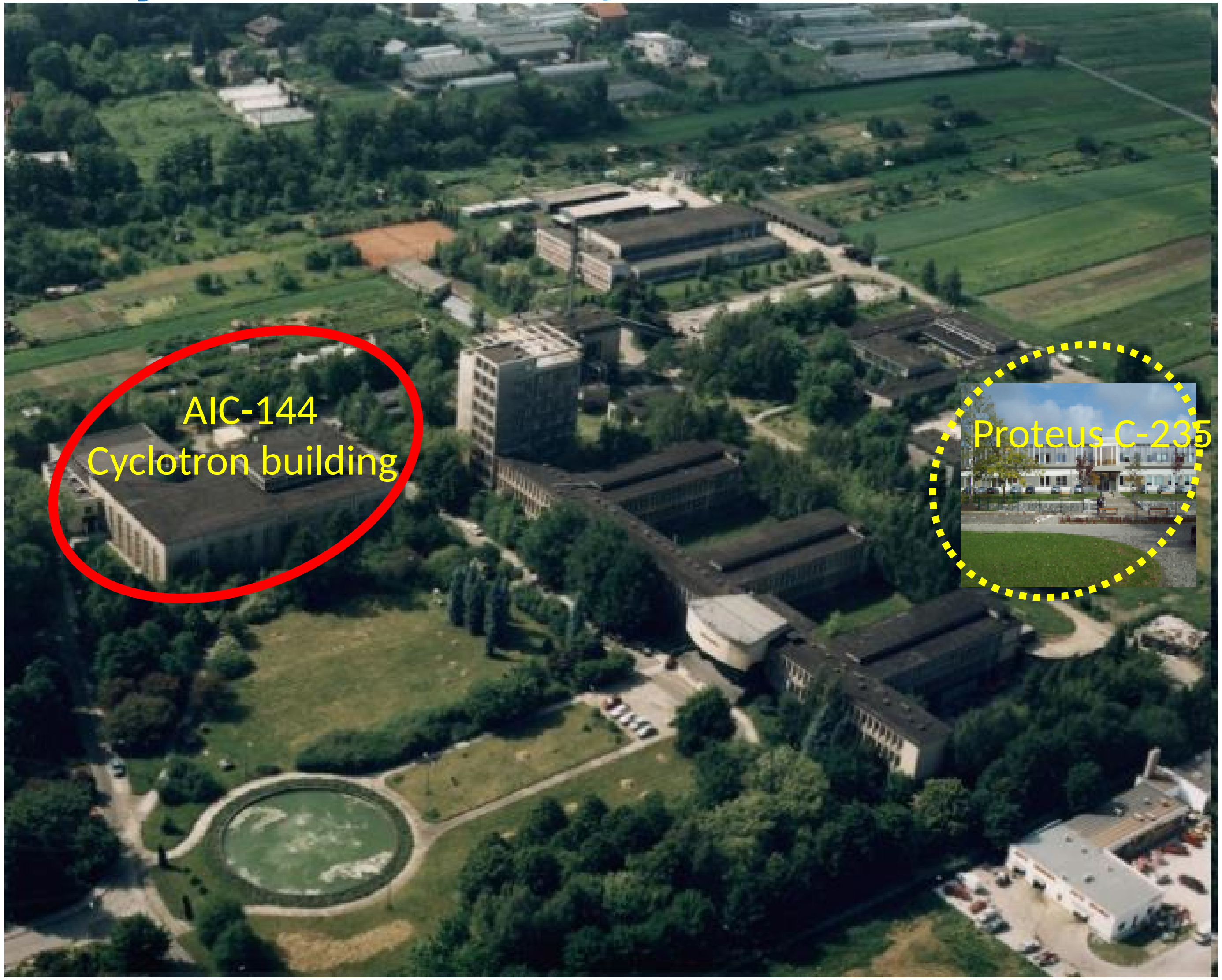
- established 1955

- 550 employees (220 with Ph.D. degree)+70 Ph.D. students

- main interest:
  particle physics (CERN)
  nuclear physics

- applied research:
  60 MeV proton cyclotron
  230 MeV Proteus IBA

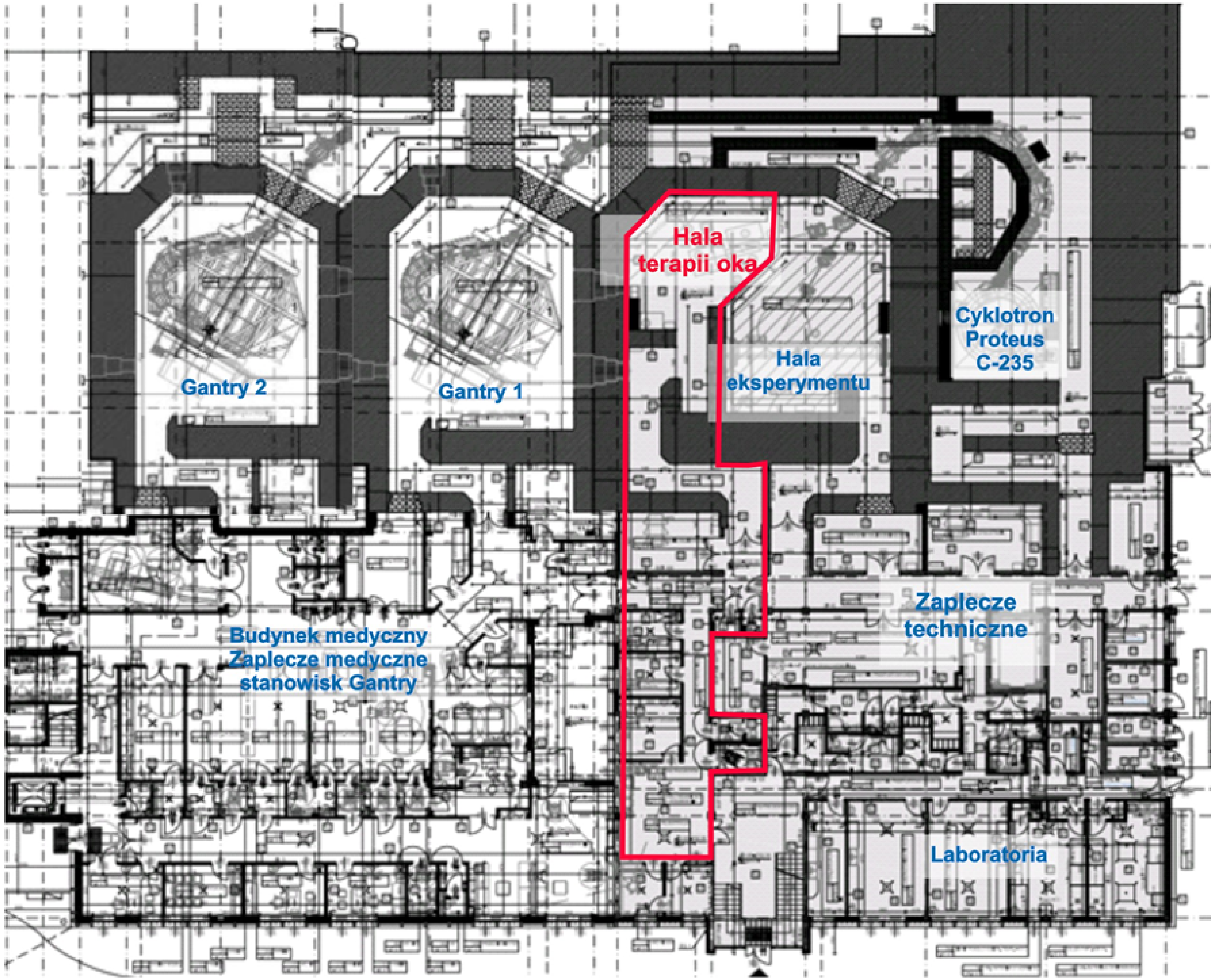
- proton radiotherapy
  Cyclotron Centre Bronowice

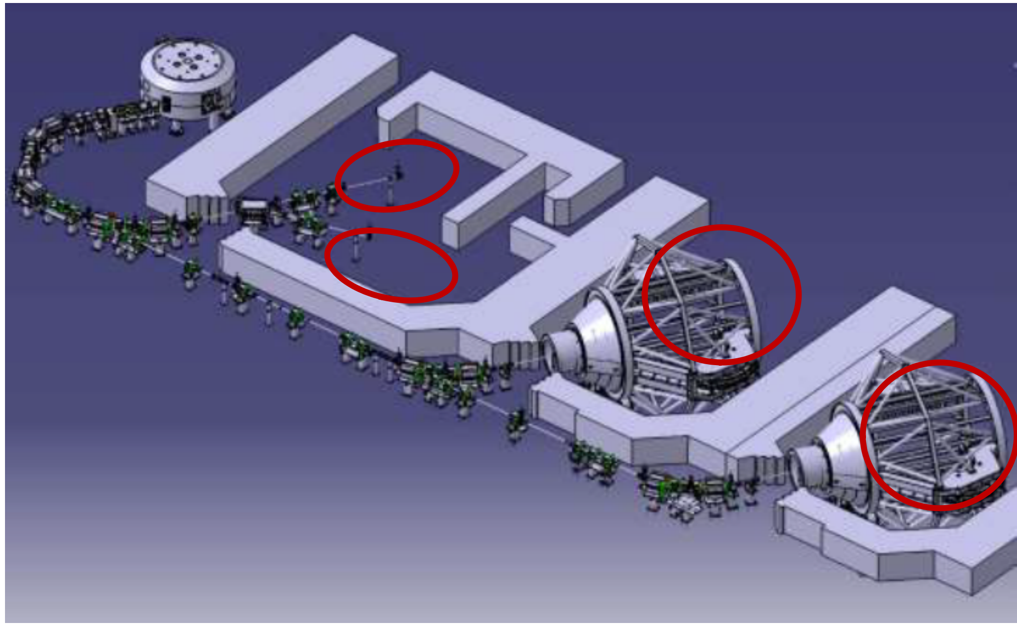


Proteus C-235

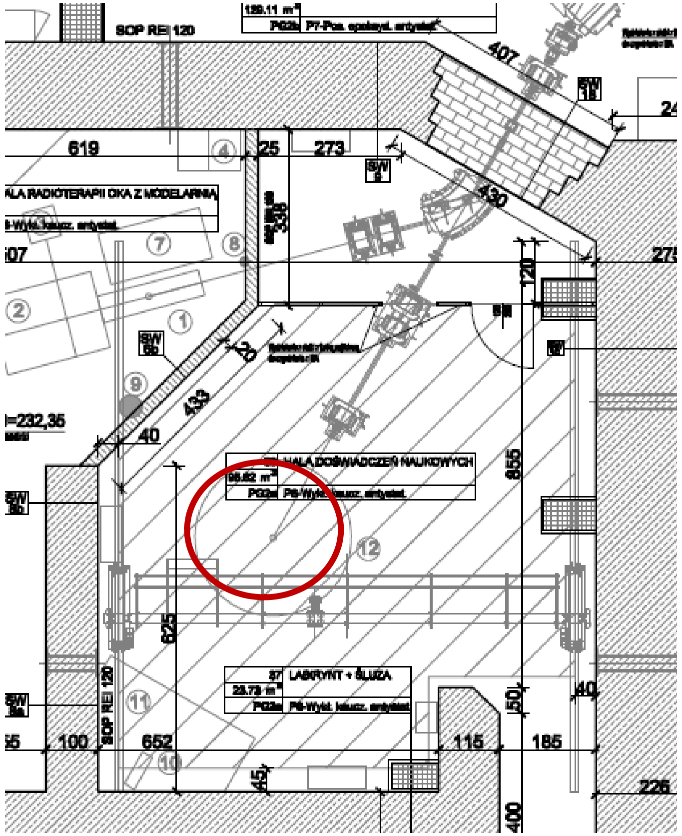
BEAM PARAMETERS:
Energy 230 MeV; RF 106 MHz;
quasi continuous beam; beam current 500 nA (for 230 MeV);

CCB infastructure





Experimental room (CCB Proteus C-235 building)



Proton beam energy:

70MeV – 230MeV;

Beam current: 1nA - 100nA for 230MeV;

up to 2nA for 70MeV;

Spot size: 5.5 mm (1σ);

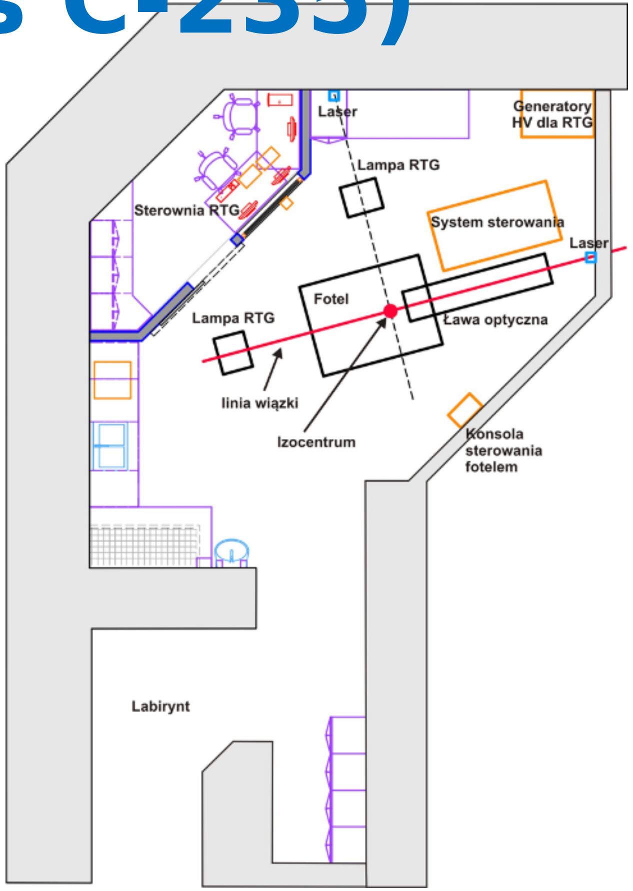
Energy less than 70MeV after degradation;

Difficult access due to experiments in nuclear physics;

It is not possible to deposit high doses.

Proton eye therapy room ELTR in CCB (proton beam from Proteus C-235)

Energy : 0 - 60 MeV;
Precise Energy regulation in range 10 MeV – 60 MeV
Dose rate: 0.001 – 0.3 Gy/s (measured in water);
Single scattering;
Field size: ≤ 40 mm;
Beam field homogeneity≥ 5%;
Irradiation in SOBP available;
Sample positioning precision (> 0.1 mm);
It is not possible to deposit high doses (>1 kGy);



Eye therapy room

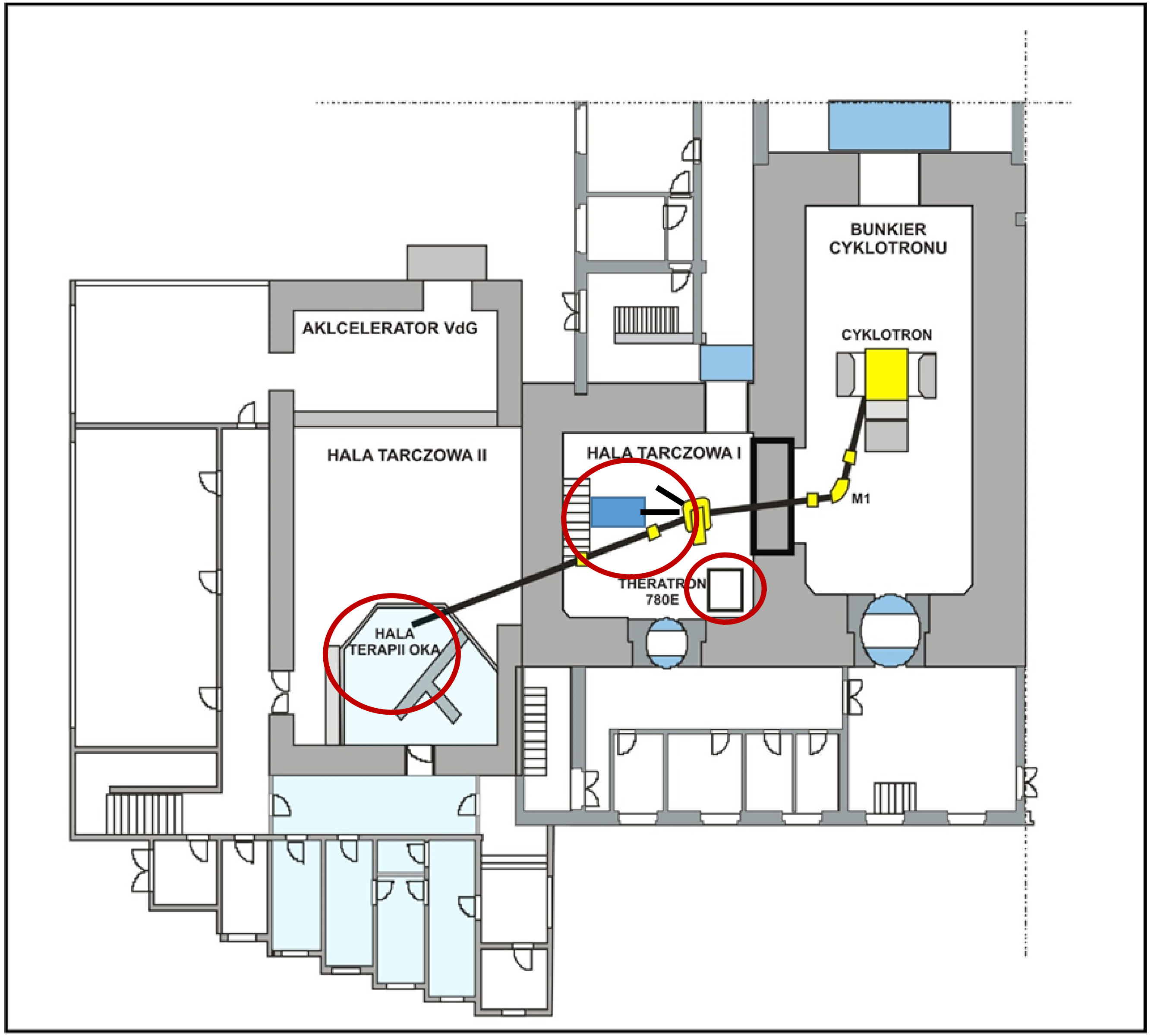
Difficult access to the room due to medical applications

Gantry (GTR3, GTR4)

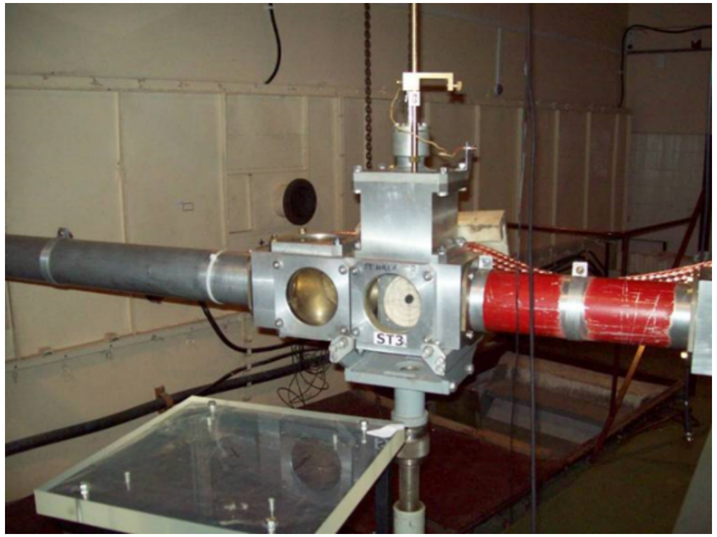
Energy range: 70 MeV – 230 MeV;
Spot size: 3 – 7 mm (1σ);
Field size (scanning beam): 30cm x 40cm;
Field homogeneity: ≤ 2%;
Dose rate: 2Gy delivered into 1 litre volume in 90 s;
Irradiation in SOBP available;
Sample positioning precision (> 0.1 mm);
It is not possible to deposit high doses (>1 kGy);

Difficult access to the room due to medical applications

AIC-144 cyclotron facility

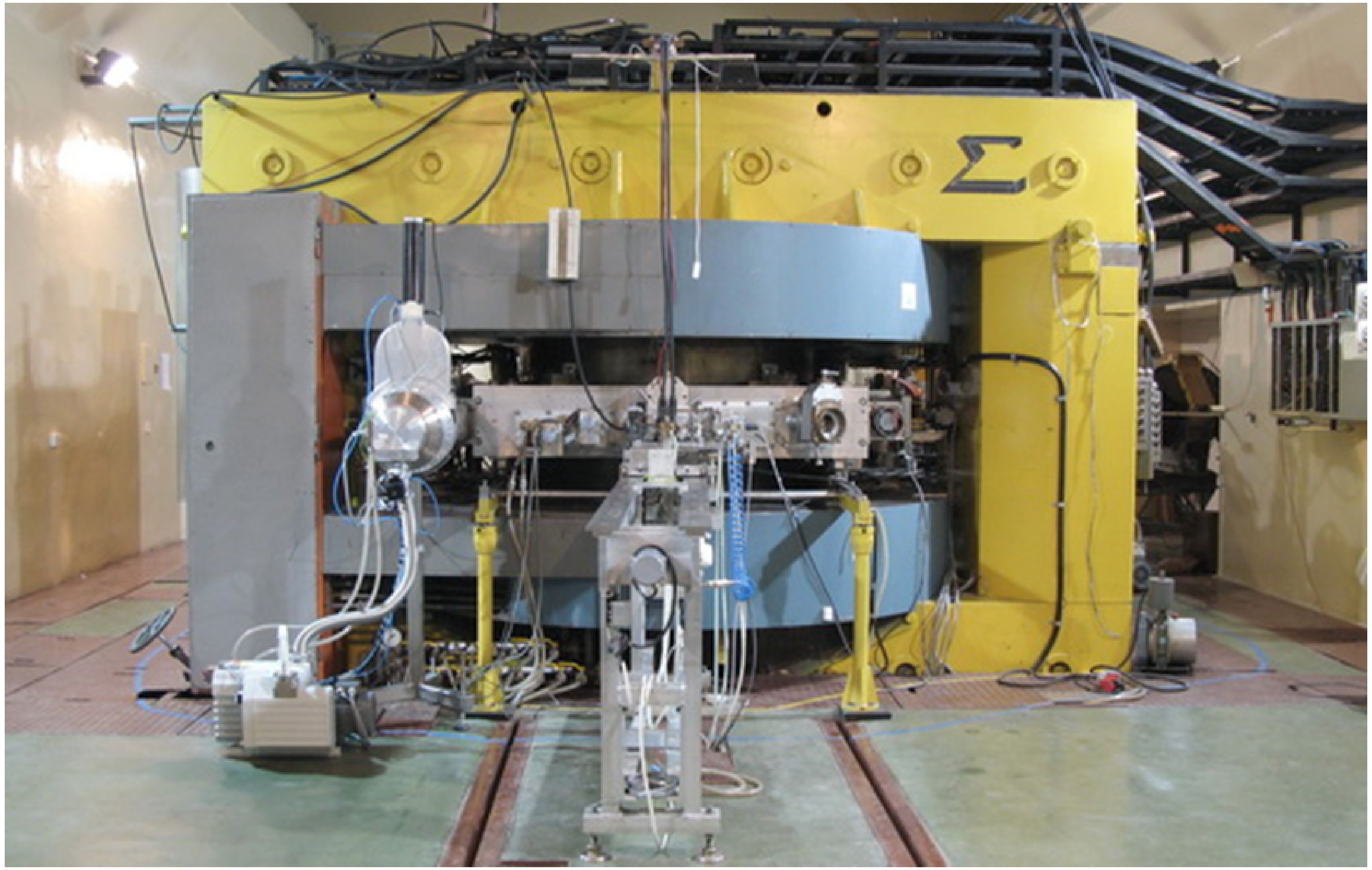


Beam lines



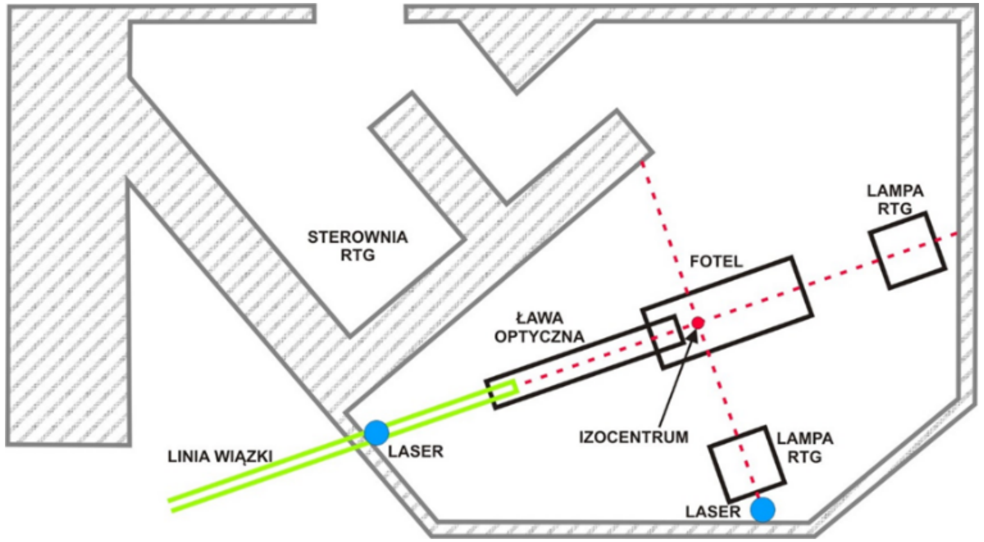
Scattering foil *(tantalum 25um)*

AIC-144 isochronous cyclotron



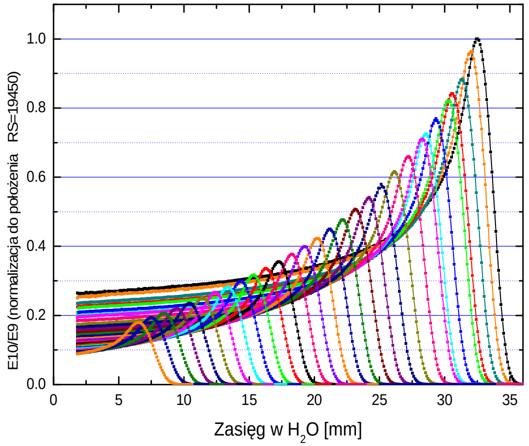
BEAM PARAMETERS:
Energy 60 MeV; RF 26,26 MHz;
Beam macro structure 50 Hz, macro pulse length 0.5 ms, beam current 80 nA *(110nA)*

Irradiation facility with horizontal beam line (AIC-144 cyclotron)



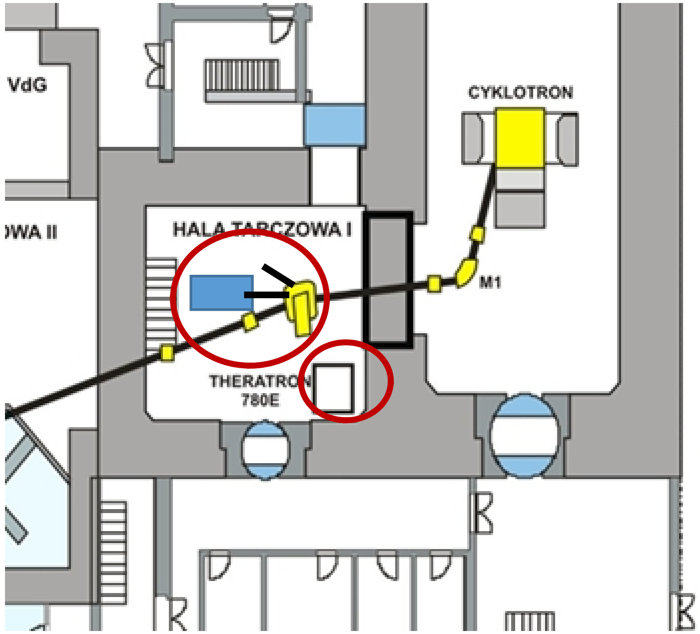
Eye therapy room

Energy: 0-58 MeV;
Dose rate: 0.001 – 1 Gy/s (measured in water);
Single scattering;
Beam field size: ≤ 40 mm;
Field homogeneity ≥ 5%;
Min flux of protons: 5e5 p/cm2·s (50MeV);
Typical flux: 10e8 – 10e9 p/cm2·s;
Irradiation in SOBP available;
Sample positioning precision (> 0.1 mm);
It is not possible to deposit high doses (>1 kGy);



Easy access to the facility

Optical line at the experimental room at the AIC-144 cyclotron building



Energy: 60 MeV (*10MeV-60MeV*);
Proton beam current: 2nA – 100nA;
Spot size: ~ 10mm (1σ, estimated);
Possible Energy degradation to the 10 MeV;
Irradiation field diameter < 12 cm;
Flatness ≥ 15% (≅10%);
High beam and irradiation field configuration flexibility

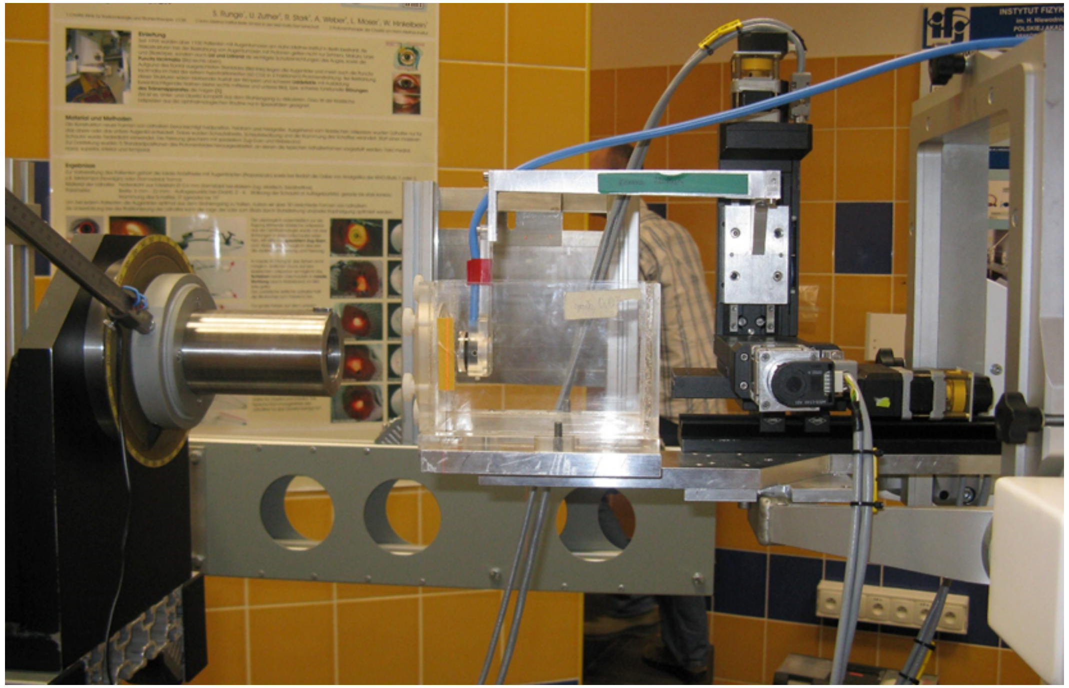
Facility dedicated to low energy protons (10-60MeV) and high beam intensity (10-20 Gy /s);
Possibility to deposit very high doses (> 120kGy in H2O);

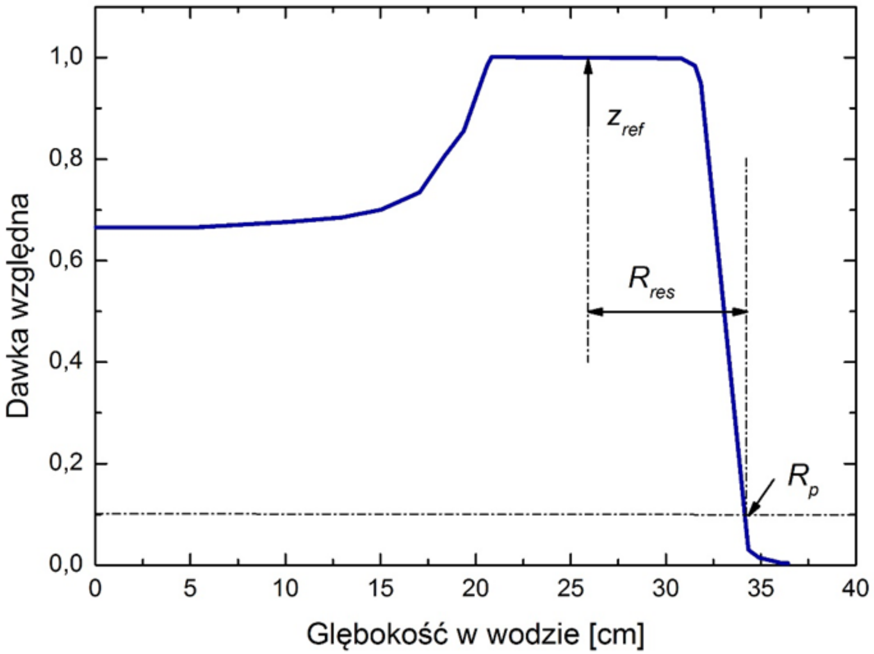
Easy access to the beam

Beam dosimetry for electronics radiation hardness tests

Proton beam reference dosimetry based on the recommendations of the IAEA TRS-398 Code of Practice protocol

dose measurement with ionization chambers calibrated in the Co-60 radiation field, dose measurement performed in a water phantom



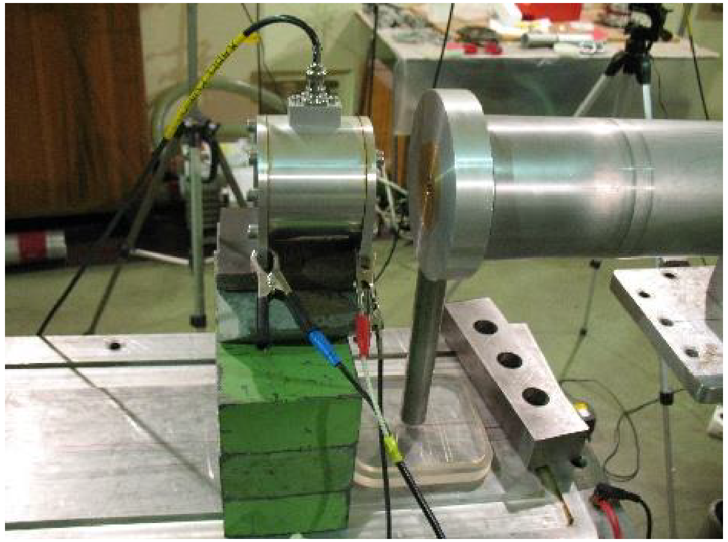


$$D_{w,Q} = M_Q \cdot N_{D,w\,Q_o} \cdot k_{Q,Q_o}$$

Dosimetry methods

Dose and proton beam current measurements:

- Ionisation chambers: semiflex IC, Markus IC, transition parallel IC;
- Diamond detectors semiconductor diodes;
- Reference class electrometers: PTW UNODOS, PTW UNIDOS Webline;
- Water phantoms, solid state phantoms, (PMMA, RW3), anthropomorphic phantoms,



Beam current measurement with Faraday cup

Beam current measurements:

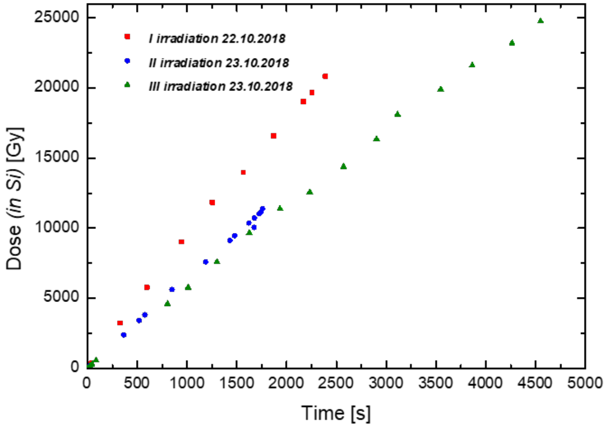
- Faraday cup, Keithley electrometers;

Measurement of transverse profiles and imaging of beam transverse distributions (scintillator +CCD camera):

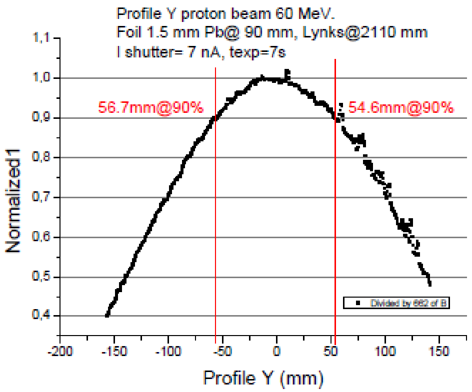
- ProBimS:
- Lynx;

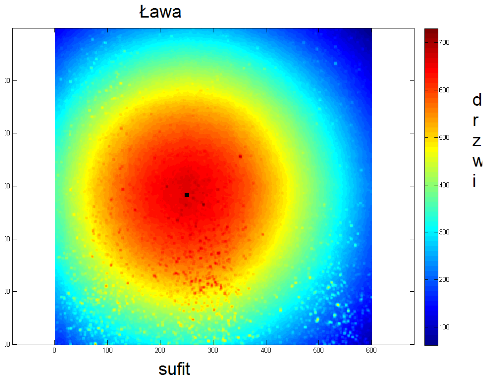
Passive:

- Gafchromic EBT3;
- TLD, 2DTLD dosimeters;
- Alanine pellets



Irradiation





LynX beam profile measurements

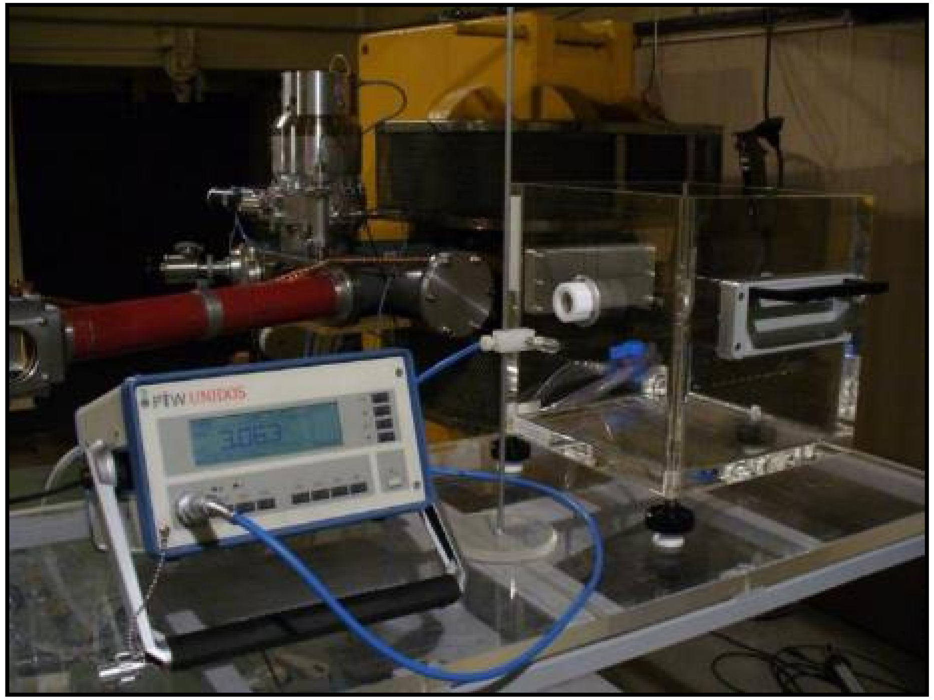
THERATRON 780E

^{60}Co γ-rays 237 TBq

Dose rate 0.5 -2 Gy/min

Field size 20 cm x 20 cm;

Traceability: Secondary Standard Laboratory, Centre of Oncology Warszawa (->IAEA)



How to make irradiation at IFJ PAN at Krakow?

InspireProject

up to 31.12.2022

As part of the INfraStructure in Proton International Research INSPIRE project (HORIZON 2020), our centre offers free beam access for research related to proton radiotherapy.

EURO-LABS

EUROPEAN LABORATORIES FOR ACCELERATOR BASED SCIENCES

1.09.2022 – 31.12.2026

EUROpean Laboratories for Accelerator Based Sciences (EURO-LABS) project (HORIZON EUROPE), our centre offers free beam access for AIC-144 cyclotron 60 MeV proton beam.

Commercial irradiation is also available

Support from the INSPIRE and EURO-LABS projects

The support includes:

- *Free use of the infrastructure facilities (in agreement with any potential applicable national laws, local safety and health regulations, or other conformity rules)*
- *Administrative and logistical support*
- *Technical and scientific support*
- *Specific training (for use of the infrastructure and/or instrumentation).*

For details see:

INSPIRE:
https://inspire.ifj.edu.pl/en/index.php/dostep-do-infrastruktury-badawczej/

EURO-LABS:
The website will be available soon,
currently please contact me directly by e-mail: jan.swakon@ifj.edu.pl


Thank you for your attention
STARBUCKS
STARBUCKS
PERONI
La grande mamma
PERONI
Droga wewnętrzna