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

Proton beam preparation and selected QA elements for the irradiation stations at the AIC-144 cyclotron facility

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ACCELERATOR AND MAGNET INFRASTRUCTURE FOR COOPERATION AND INNOVATION
iFAST
European Commission

Main customer requirements for irradiation of electronics and materials

Dose determination
Dose and fluence
Energy
.
.
.

Irradition field size
Radiation shielding

The requirements are often not well defined

Dose determination

Dose - radiation units (Gy vs rad)

1Gy = 1J/kg = 100 rad

Dose - in what material?

Water ?
Silicon ?

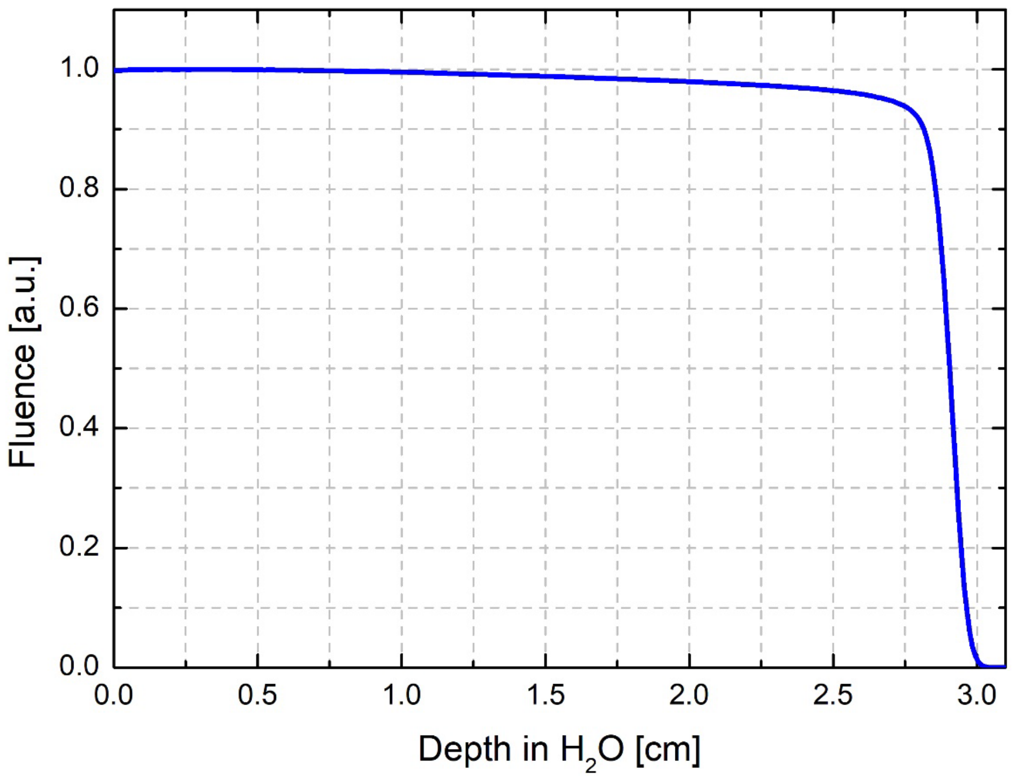
Other: (ceramic, glass, aluminum, SiO2, ….)?

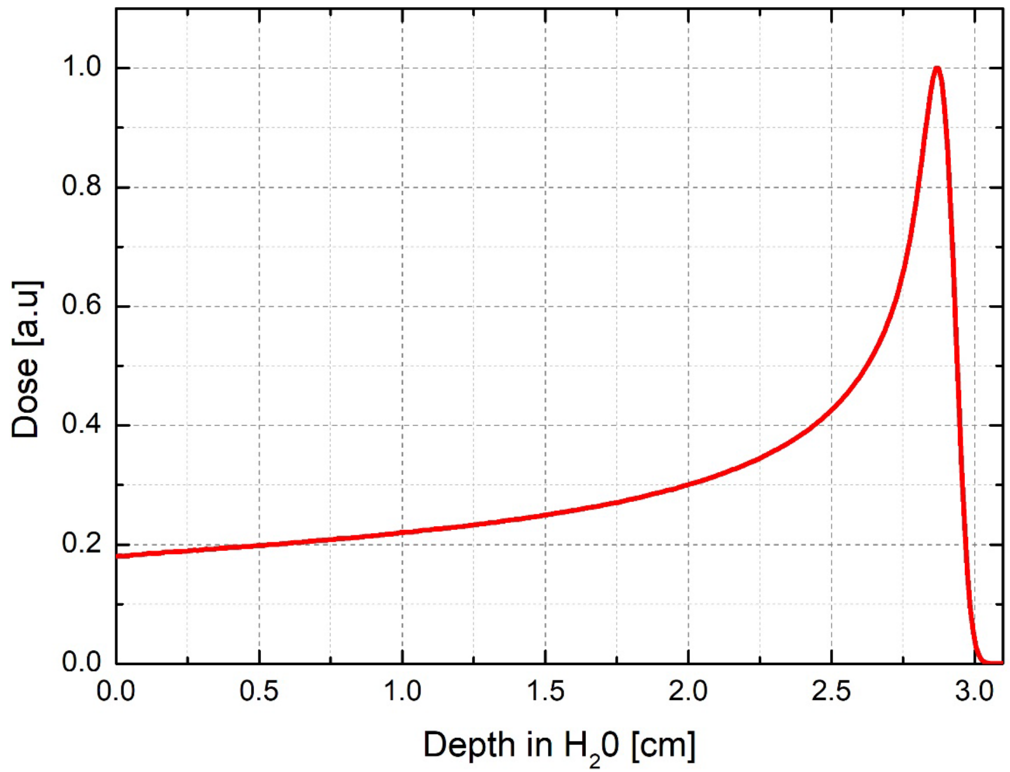
Proton beam reference dosimetry based on the recommendations of the IAEA TRS-398 Code of Practice

In our centre, dose measurement is performed using ionization chambers calibrated in a Co-60 radiation field, dose measurement performed in a water Phantom.

Dose or fluence

Fluence and dose for 60 MeV proton beam from AIC-144 cyclotron

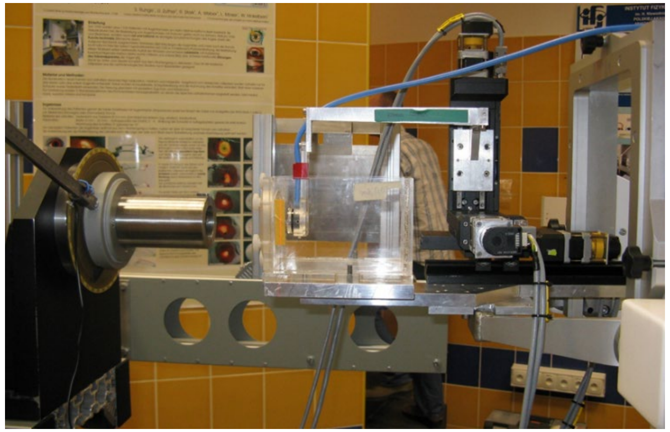


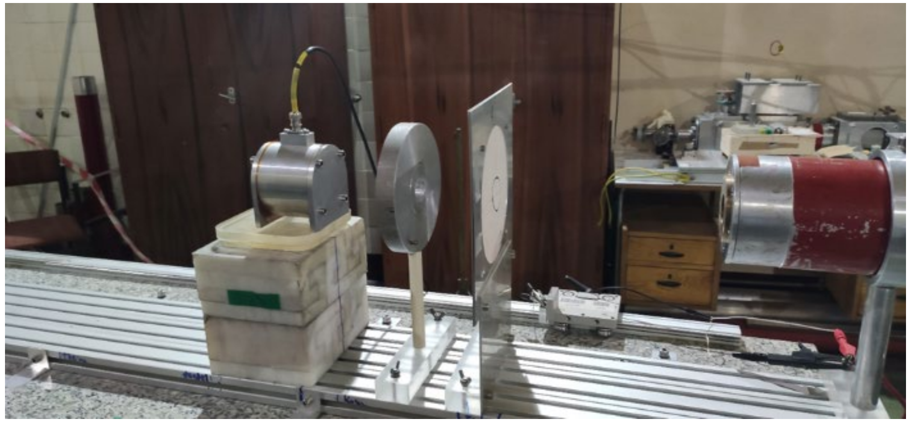


fluence and proton beam energy = clear information about irradiation parameters

Calculations by Leszek Grzanka

Dose and fluence measurement





$$D_{w,Q} = M_Q \cdot N_{D,wQ_0} \cdot k_{Q,Q_0}$$

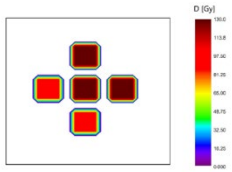
Dose measurement with Markus chamber in water or PMMA phantom

Charge measurement with Faraday cup, dose determination

Calibration of monitor chambers at the irradiation station

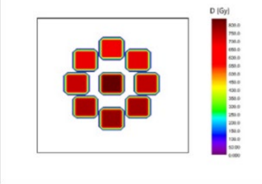
Irradiation

D < 1kGy



TL dosimeters

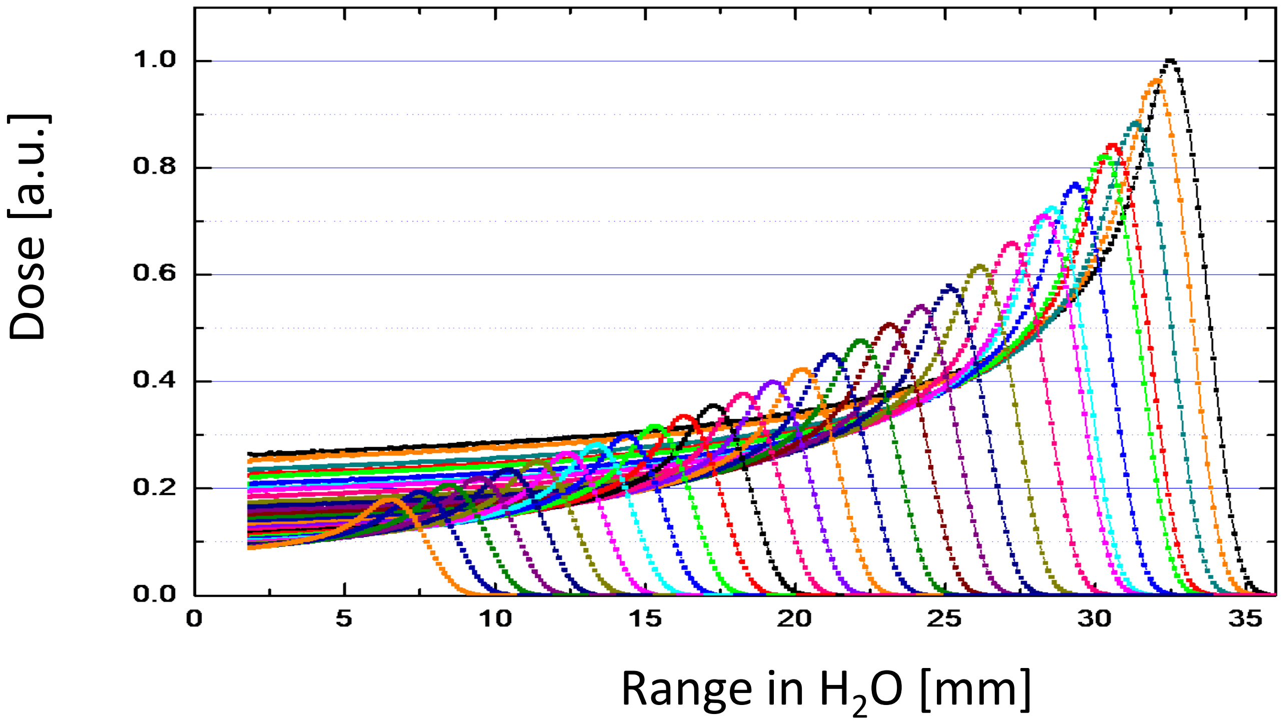
D > 1kGy



Alanine pellets

Dose verification

Proton beam energy degradation



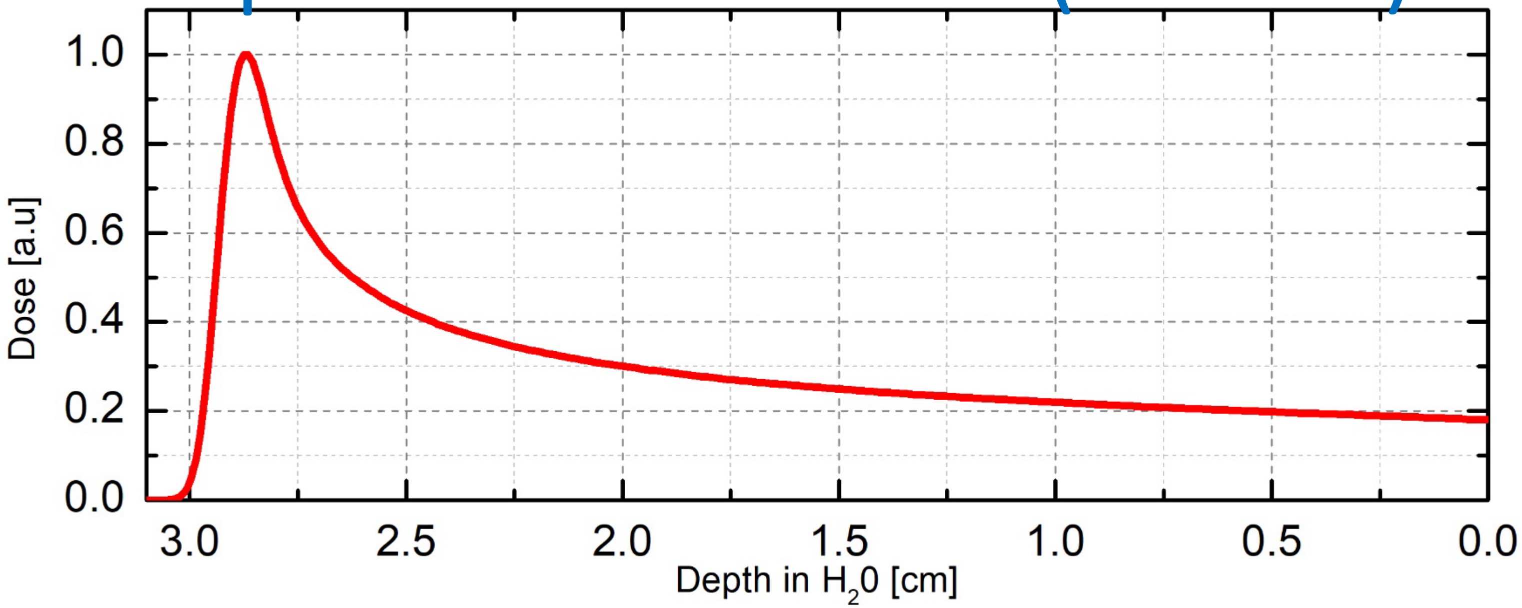
Beam energy degradation methods:

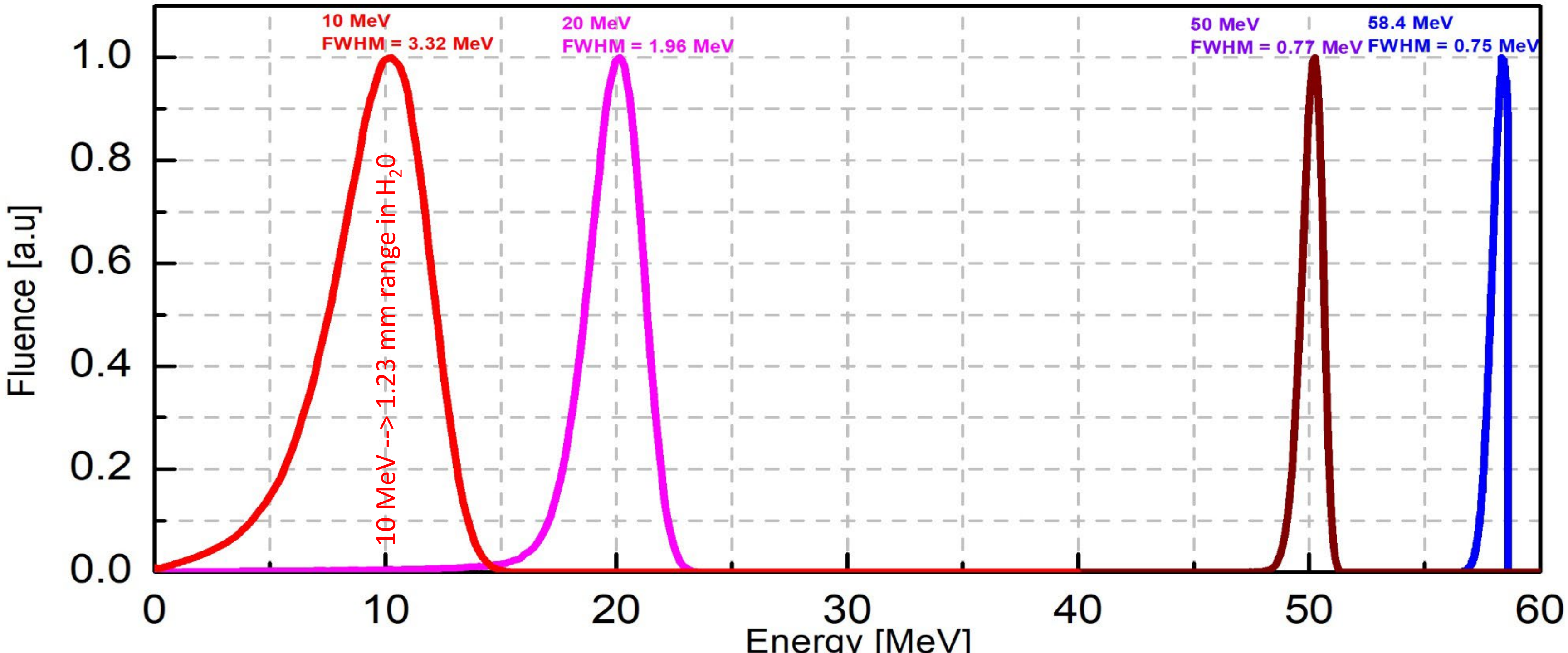
PMMA range shifter wheel
PMMA plates
Plates of other materials

Beam range: *CSDA calculations*

Range [mm]	Proton energy [MeV]							
	60	50	40	30	20	15	10	5
H2O	30.9	22.3	14.9	8.86	4.26	2.54	1.23	0.362
Si	**16.9**	**12.3**	**8.23**	**4.94**	**2.41**	**1.45**	**0.715**	**0.218**
SiO2	16.4	11.8	7.93	4.74	2.3	1.38	0.678	0.205
Epoxy (cast)	26.7	19.2	12.85	7.63	3.66	2.18	1.05	0.310
Iron	5.9	4.29	2.9	1.75	0.862	0.524	0.262	0.082
Al	15.0	10.9	7.29	4.37	2.12	1.28	0.632	0.192
Cu	5.4	3.94	2.67	1.62	0.799	0.488	0.245	0.078

Depth dose distribution (in water)

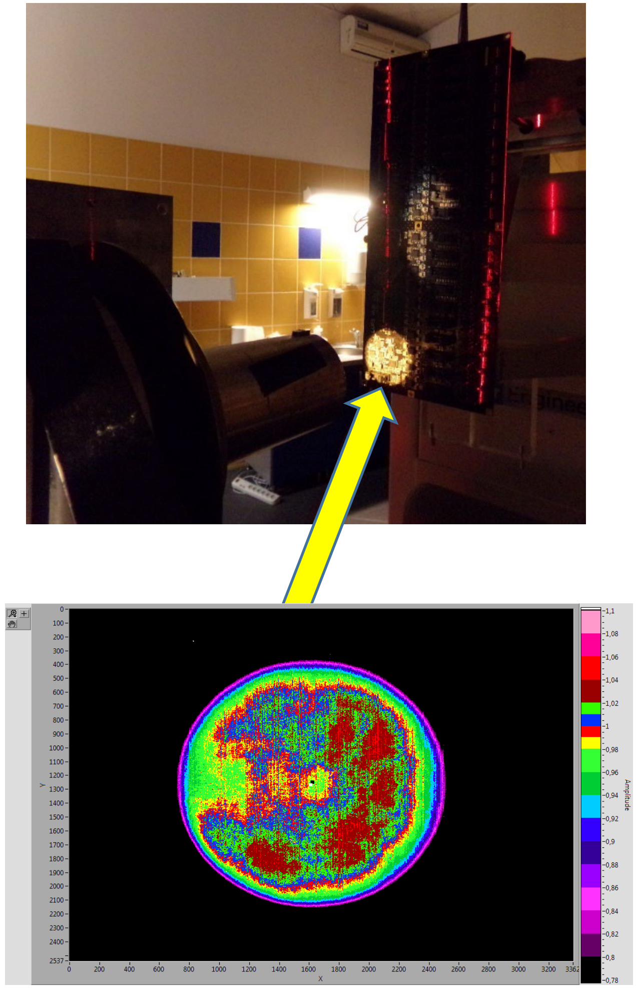




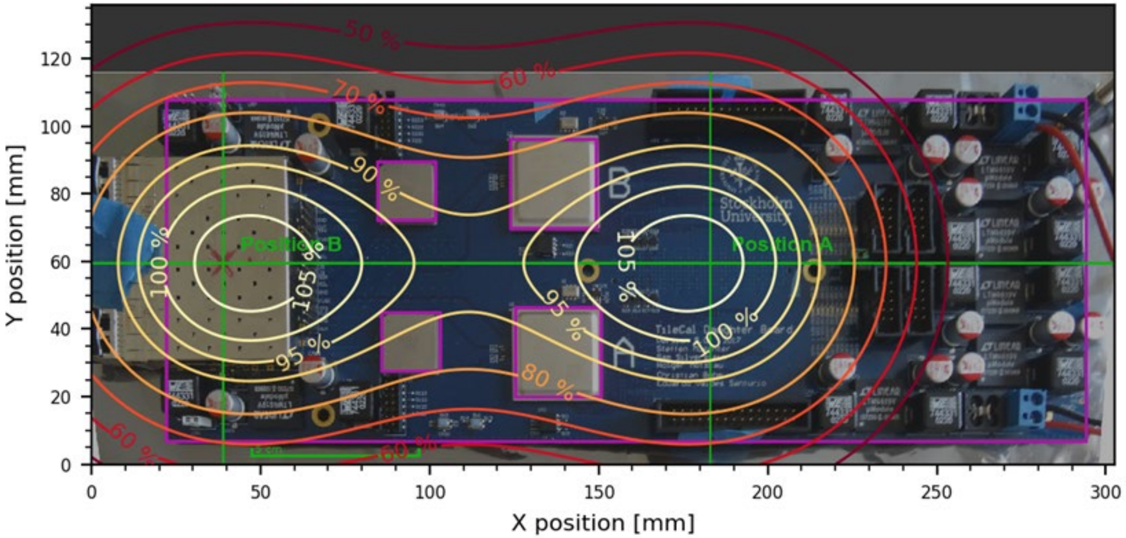
Calculations
by Leszek Grzanka

Irradiation field size

Small irradiation field, well-defined irradiation area.
Verification of the radiation field ProBimS system
/Scintilator + CCD camera/



Large irradiation area 250 mm x120 mm.
Verification of the radiation field with Gafchromic EBT3

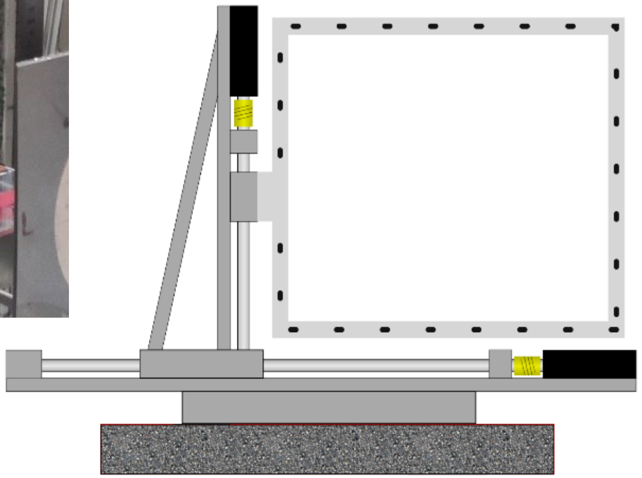


2D moving table

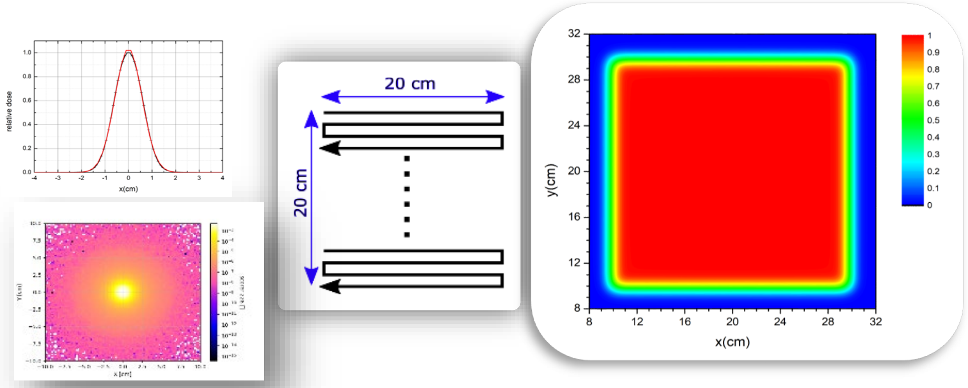
Just installed and tested

Modernization and automation of sample irradiation

1) The automatic, remote controlled 2D moving table has been constructed to enable moving the probes perpendicular to beam’s axis.



Simplified design of an automatic movable table.



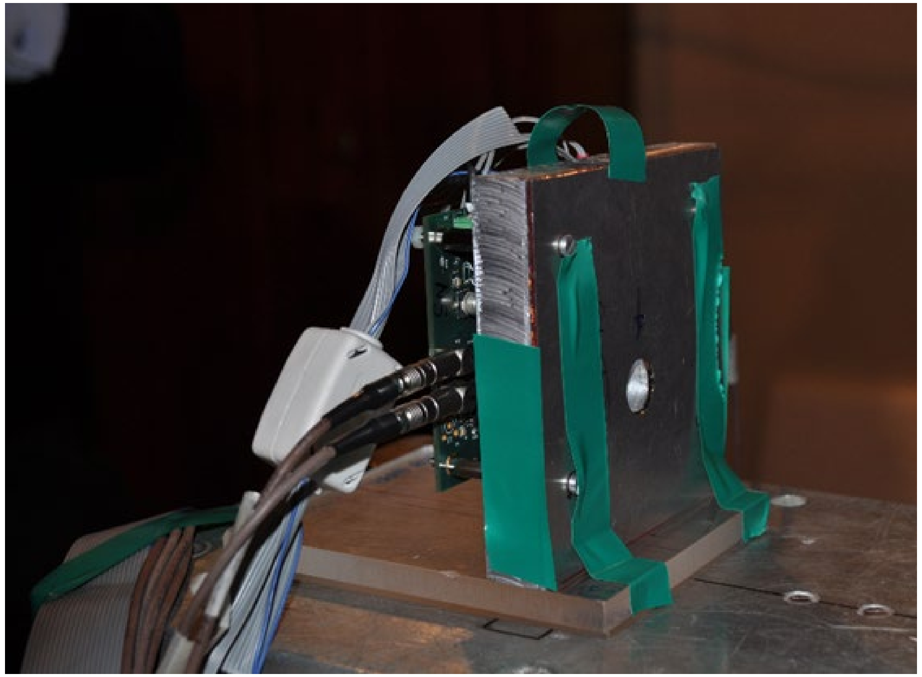
Simulation of radiation field with moving table:

a) 2D single beam dose distribution,

b) example of moving table scanning trajectory,

c) simulation of dose distribution with moving table

Radiation shielding



Collimator application

Connectors covered with
a layer of polyethylene

Shielding:

- *Protection of sensitive areas;*
- *Reduces PCB activation;*

Feel free to discuss