

The R&D proton beam line of HollandPTC for radiation hardness tests

M.Rovituso¹, E. van der Wal¹, T.C. Toet¹, M. Hoogeman¹

Presenter: Dr. Marta Rovituso – HollandPTC Beam line scientist

RADNEXT Annual Meeting 2024 – 11th of June 2024

¹HollandPTC, Research and Development department – Delft, The Netherlands

Consortium of



- Founded in 2013
- First patient treated in Sept 2018
- Final commissioning of beam lines in July 2019
- Assignments:
 - Perform excellent clinical care.
 - Perform R&D from fundamental to clinical research
- Specific research tasks:
 - Show added value of proton therapy.
 - Improve and optimize proton therapy treatment

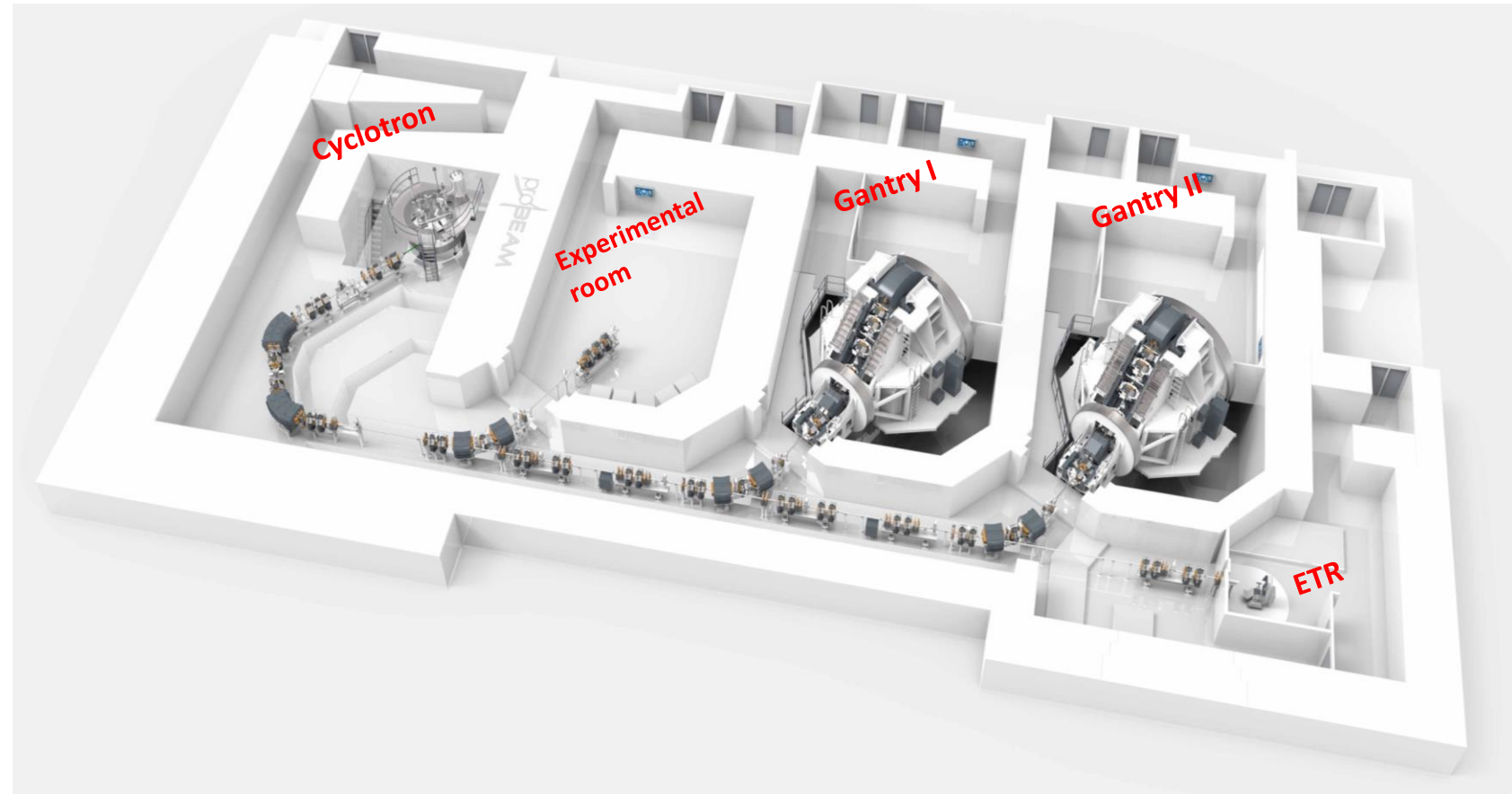


The HollandPTC protontherapy centre

- VARIAN Protontherapy Center
- Superconductive Cyclotron ProBeam
- 4 rooms: 2 rotating gantries, 1 eye treatment room, 1 R&D room

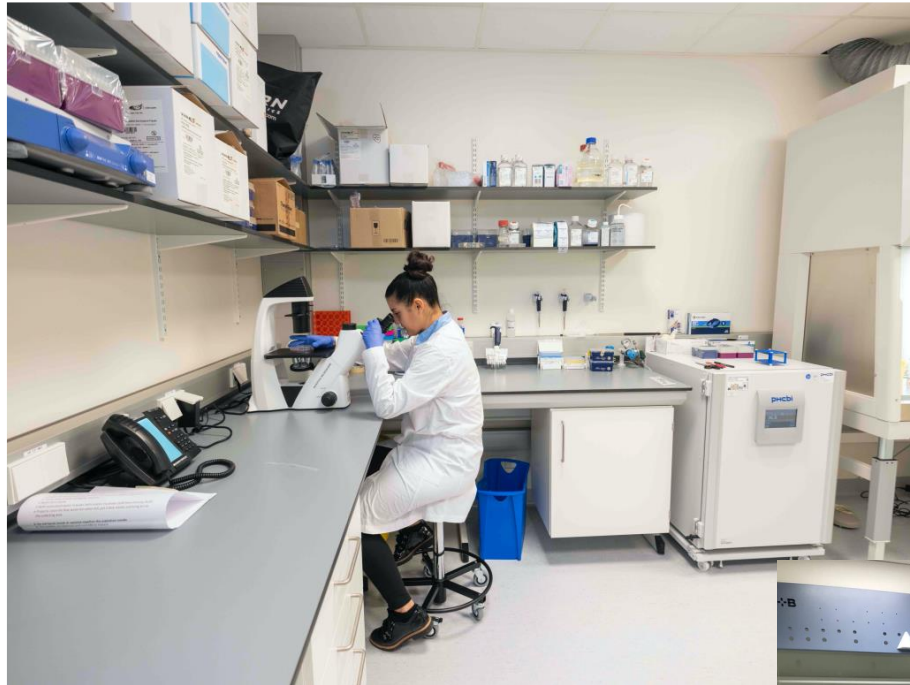
In the R&D room:

- Proton beam energy from 70 up to 250 MeV
- Beam current ranging from 0.04nA up to 340nA



The R&D facility

Biology Lab cell culture work

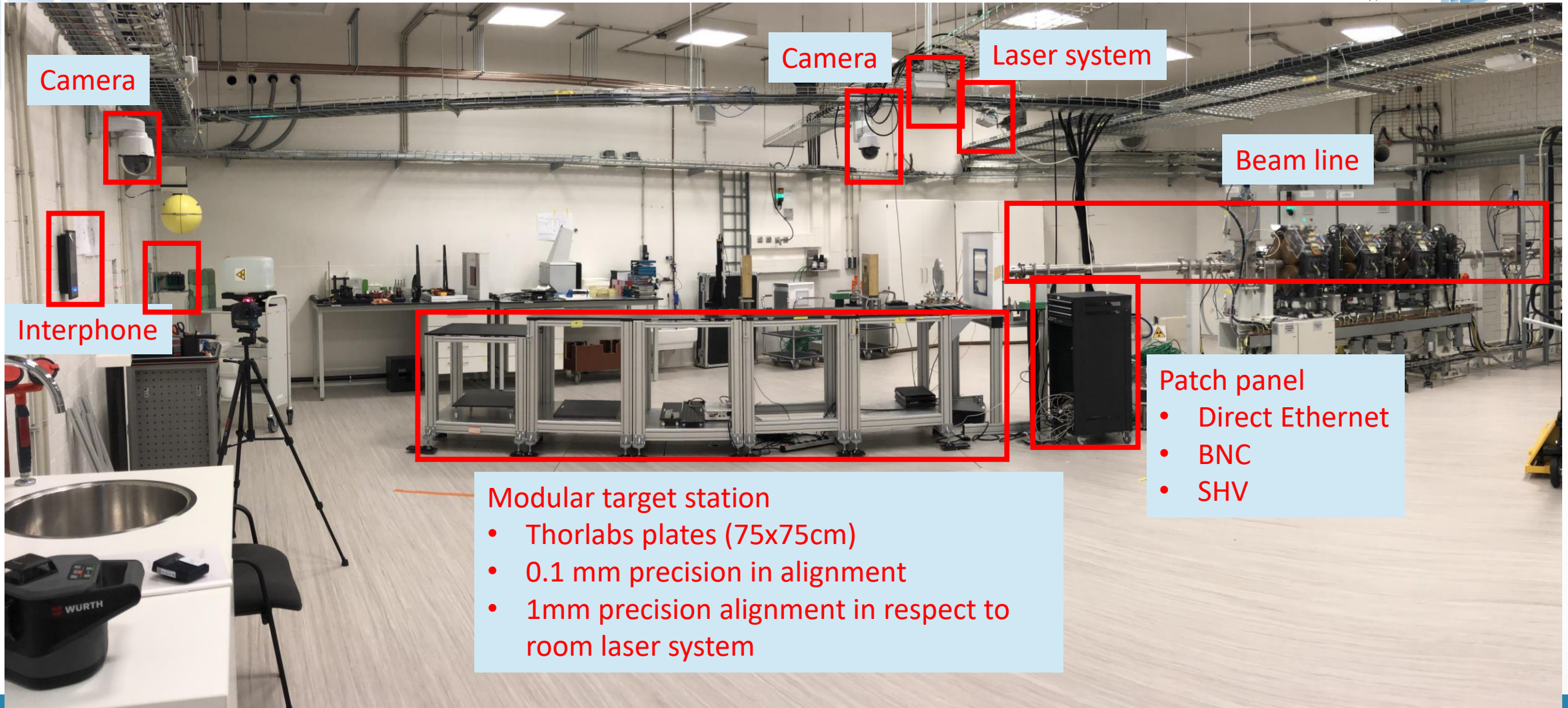


Physics and Chemistry lab



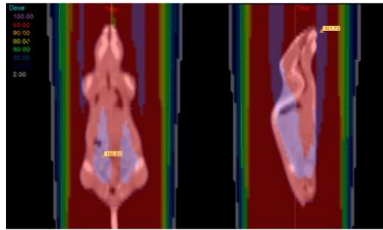
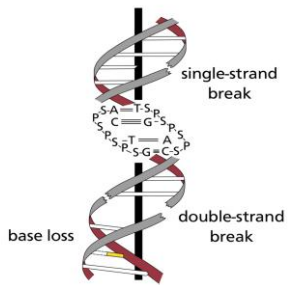
Pre-clinical preparation room for in vivo experiment

The experimental room



Applications in the R&D beam line

Radiobiology



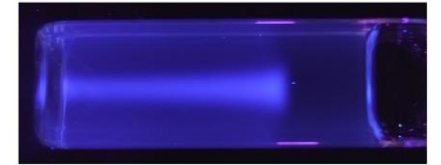
Advanced Technology



Space applications

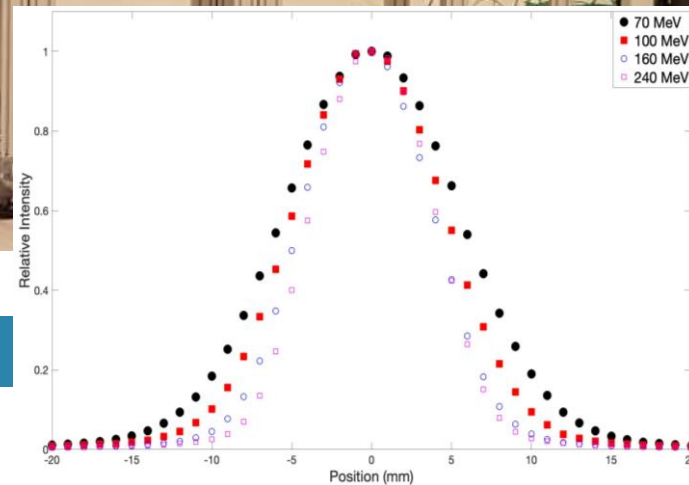
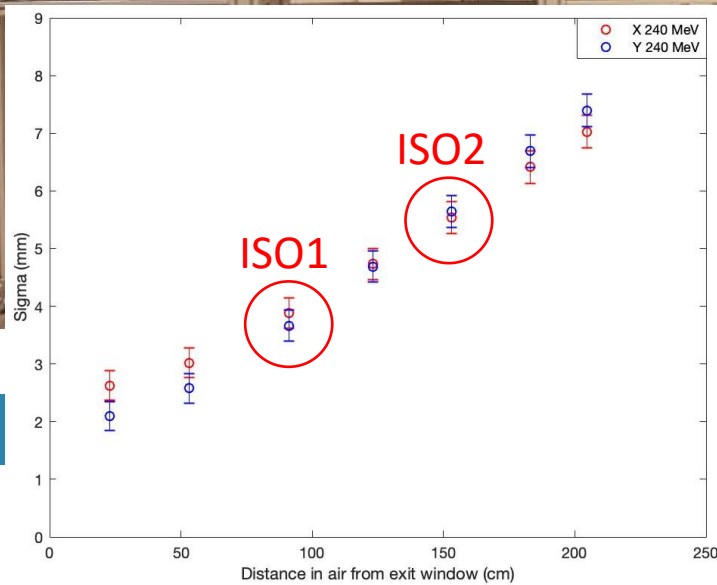
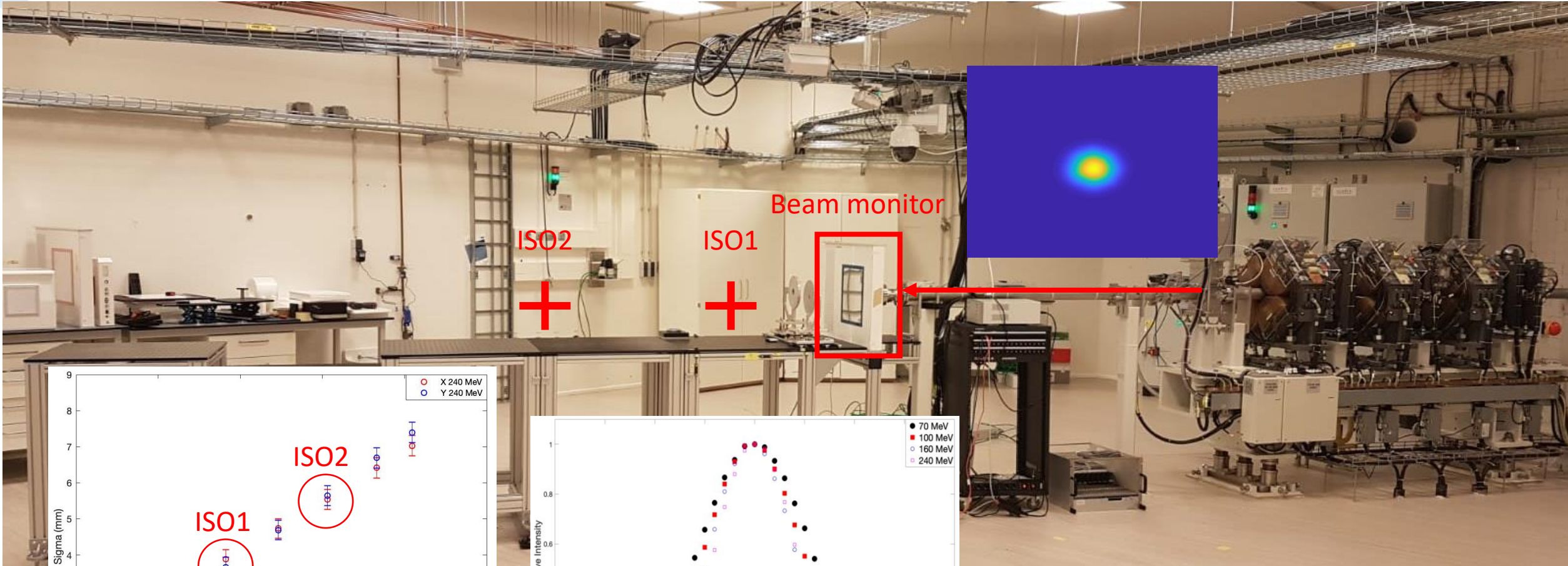


Dosimetry

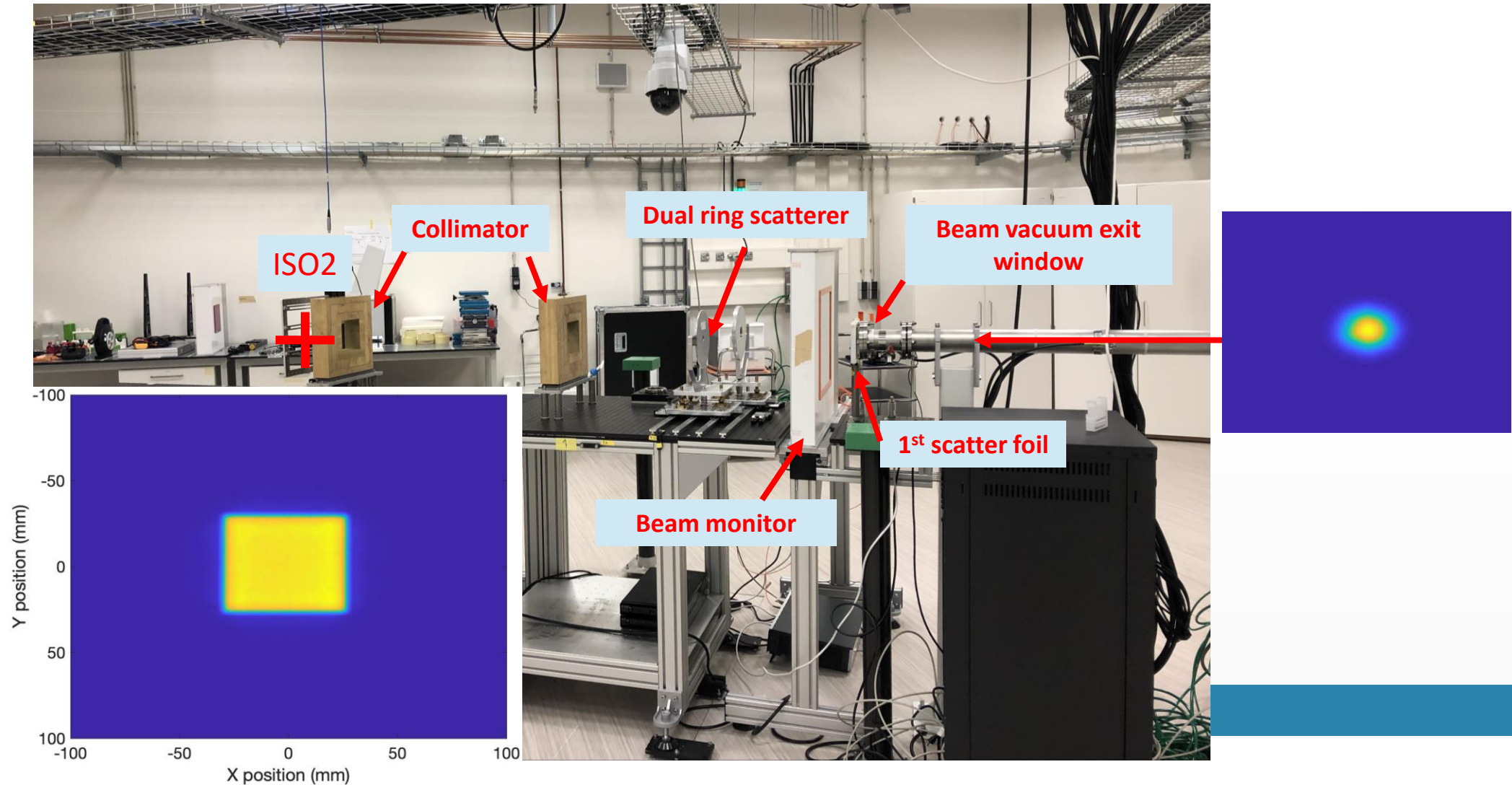


Beam characteristics

The experimental beam line



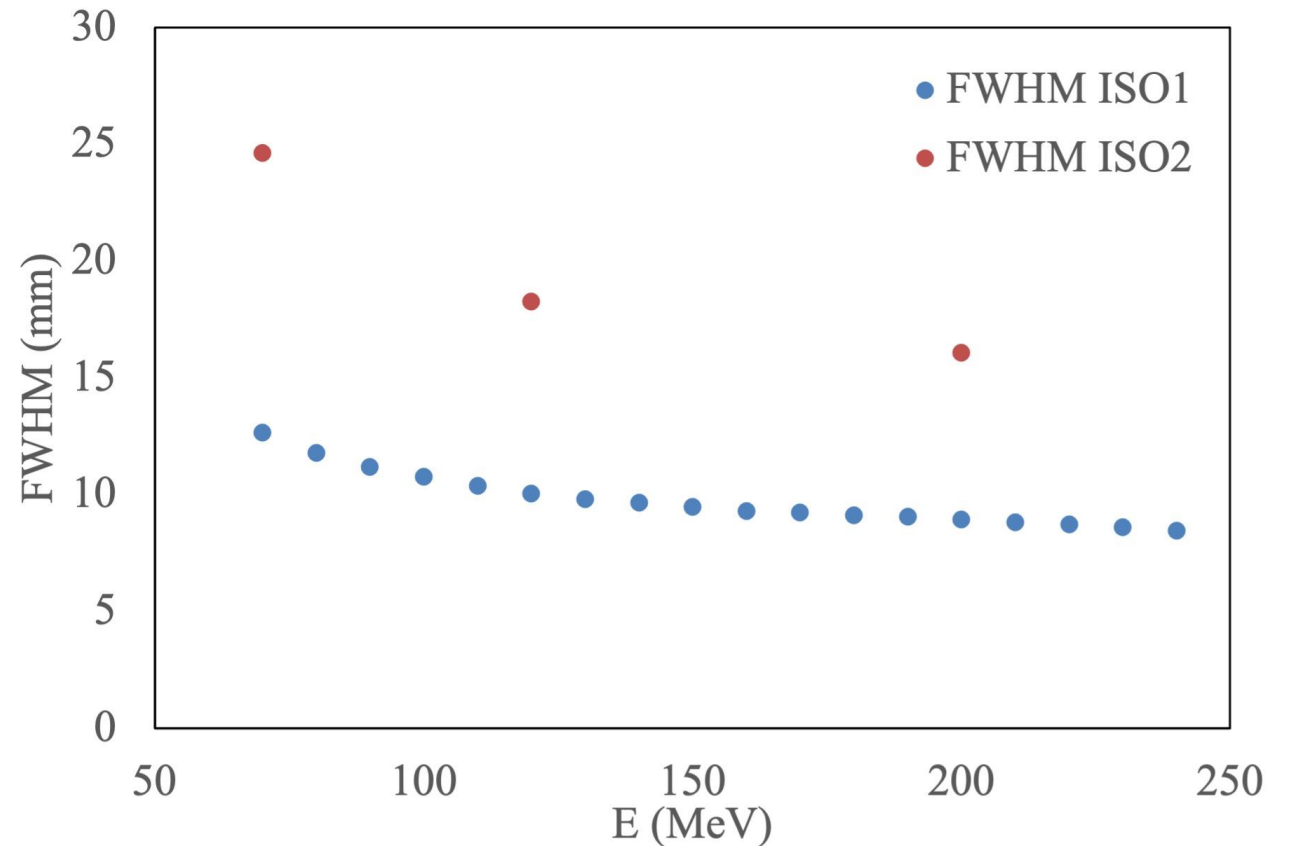
The experimental beam line



Pencil beam size

Detector: Lynx2D (Fluorescent screen with CCD camera – 0.5mm spatial resolution)

Energy (MeV)	FWHM ISO 1 (cm)	FWHM ISO 2 (cm)
70	1,27	2,4
80	1,18	
90	1,12	
100	1,08	
110	1,04	
120	1,00	1,8
130	0,98	
140	0,97	
160	0,93	
180	0,91	
190	0,91	
200	0,90	1,6
210	0,88	
220	0,87	
230	0,86	
240	0,85	

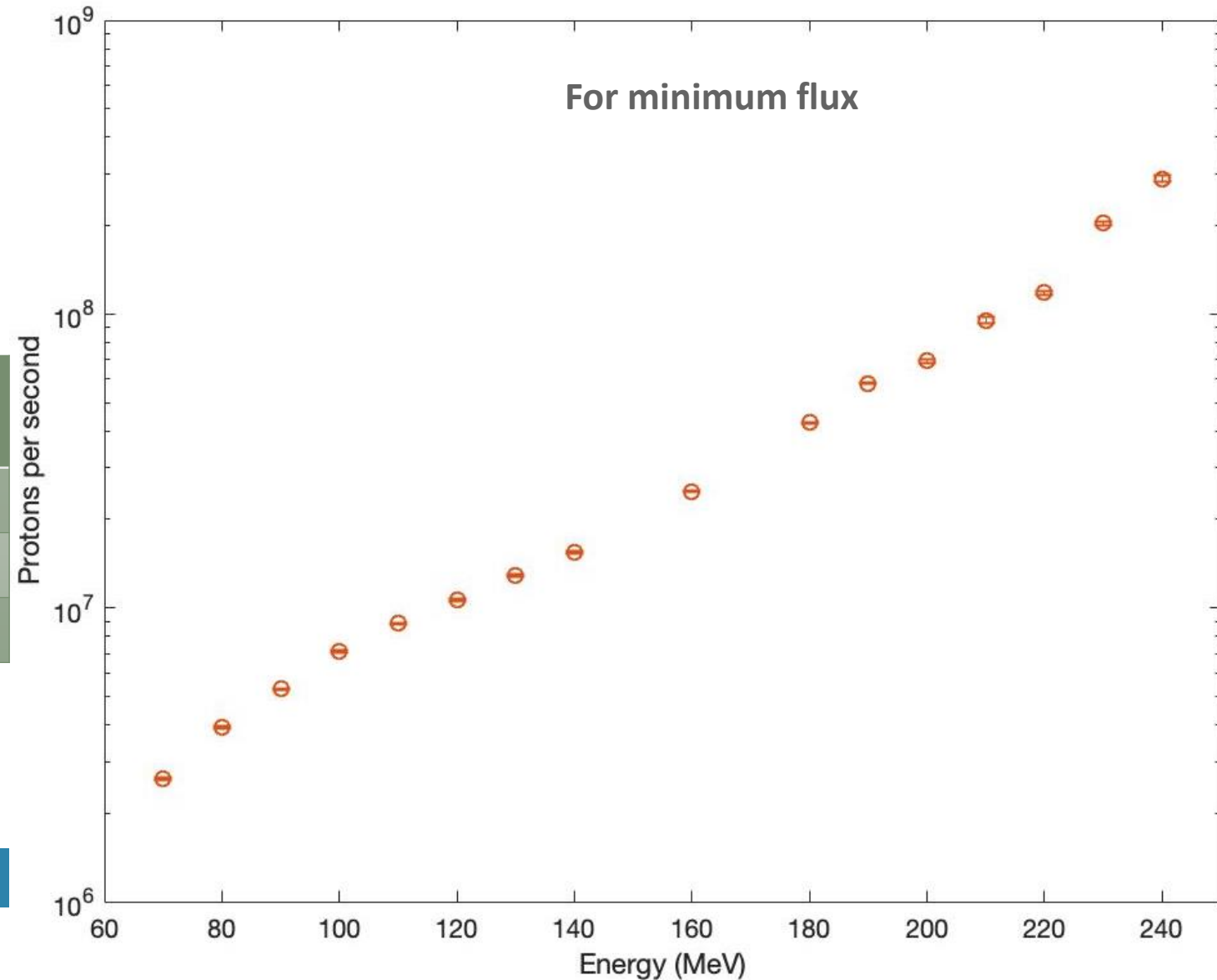


Pencil beam flux

Detector:

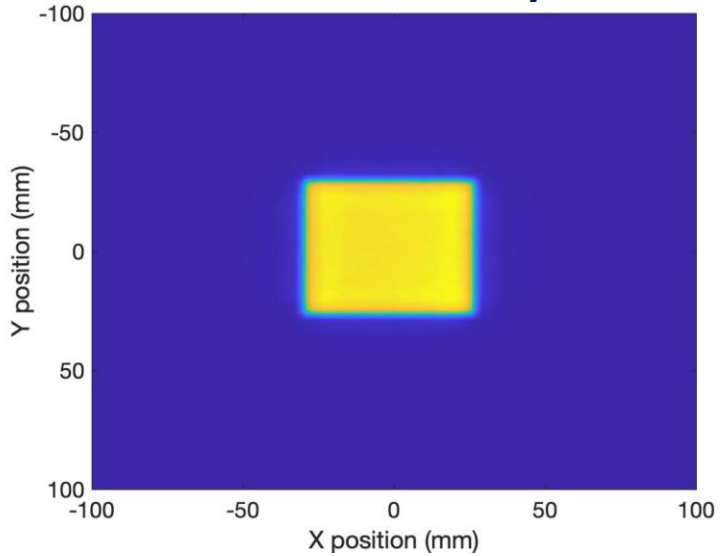
- Faraday cup (built to measure up to 250 MeV proton beam)
- Advanced Markus chamber

Energy @ target (MeV)	Min Flux (p/s/cm ²)	Max Flux (p/s/cm ²)
70	2.1×10^6	1.7×10^9
120	1.3×10^7	1.0×10^{10}
200	1.1×10^8	8.8×10^{10}

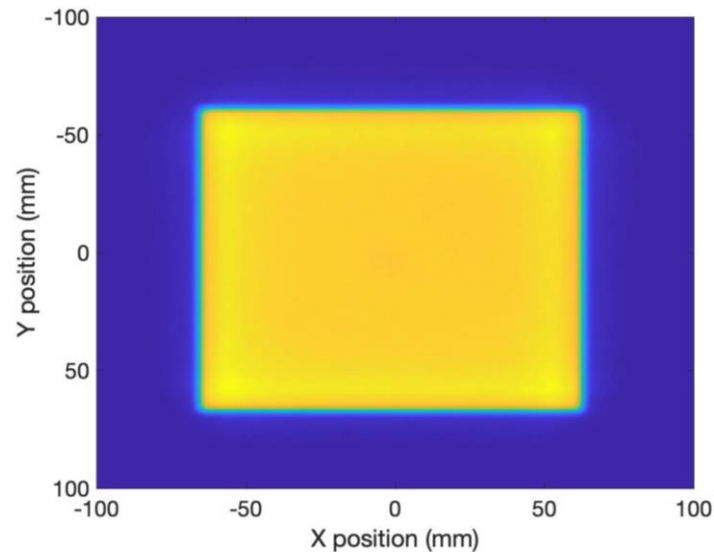


Broad beam profiles

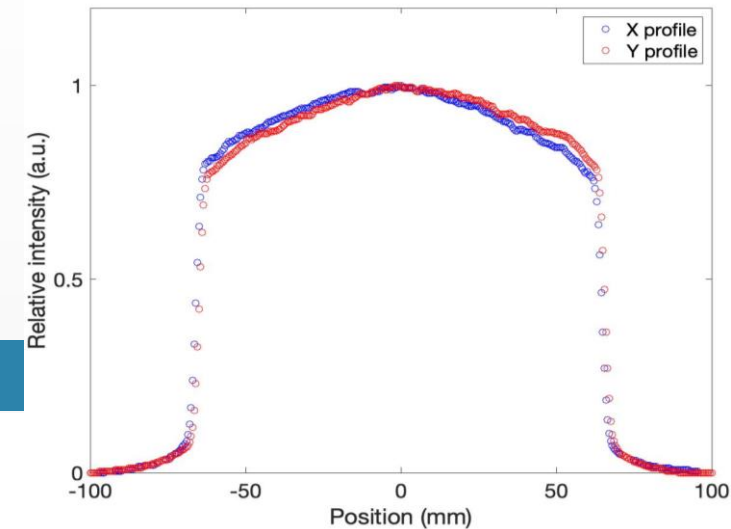
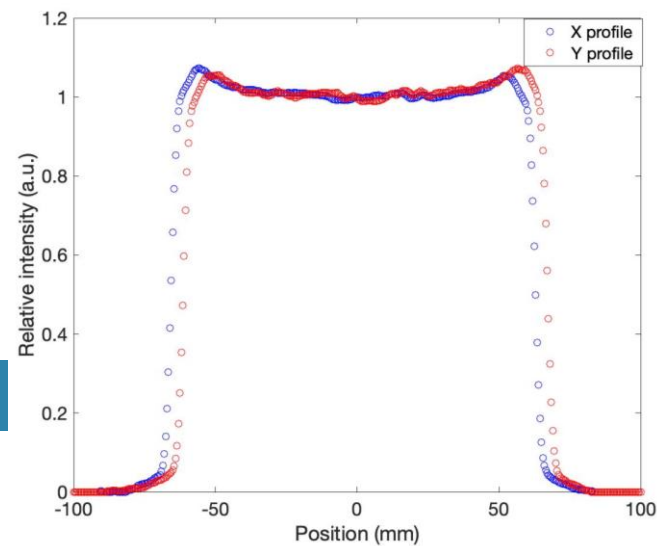
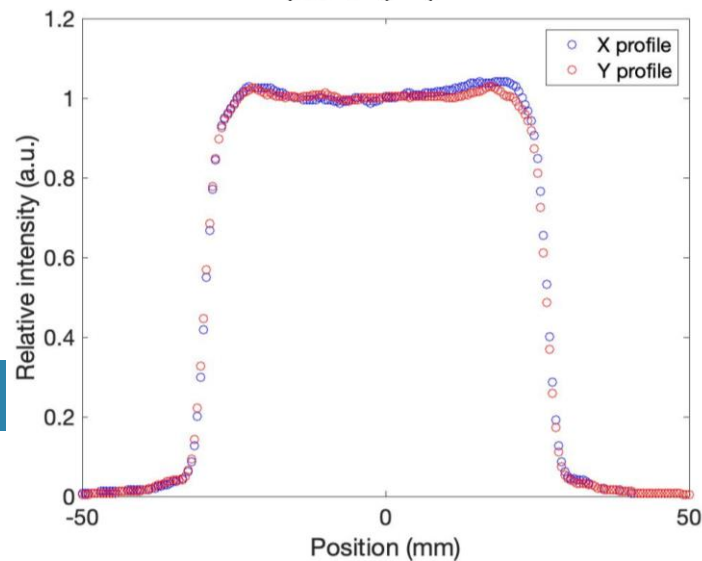
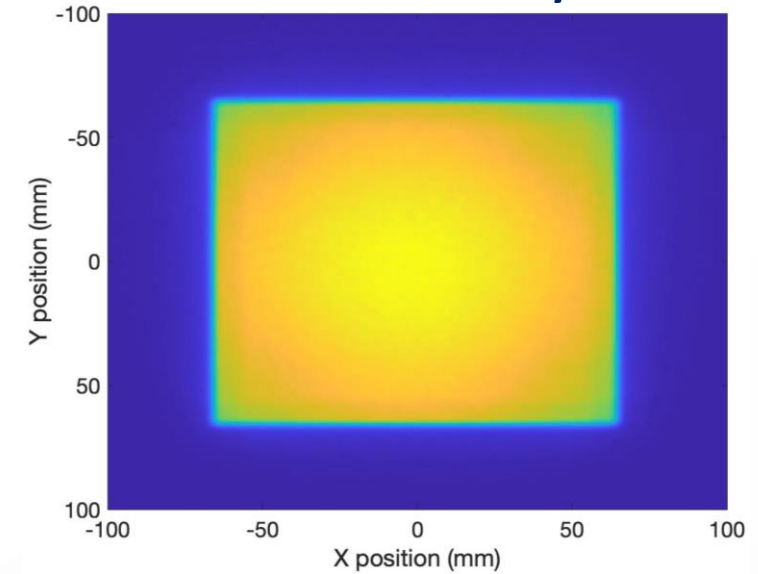
70 MeV @ target 4x4cm
98% Uniformity



120 MeV @ target 10x10cm
98% Uniformity



200 MeV @ target 10x10cm
92% Uniformity



Broad beam flux

70 MeV @ ISO2 - 10cmx10cm Field

Cyclotron Nominal Beam Current (nA)	ϕ [#/(cm ² ·s)]
1	6,87E+04
5	3,93E+05
10	7,87E+05
20	1,57E+06
40	3,15E+06
100	7,87E+06
200	1,57E+07
300	2,36E+07
400	3,15E+07
500	3,93E+07
600	4,72E+07
700	5,51E+07
800	6,29E+07

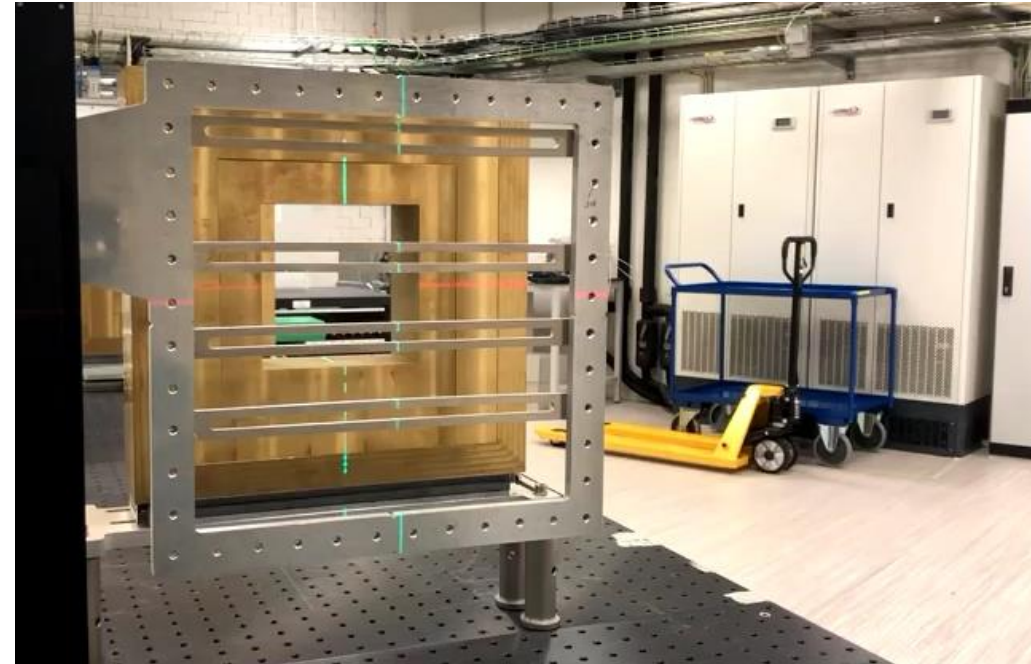
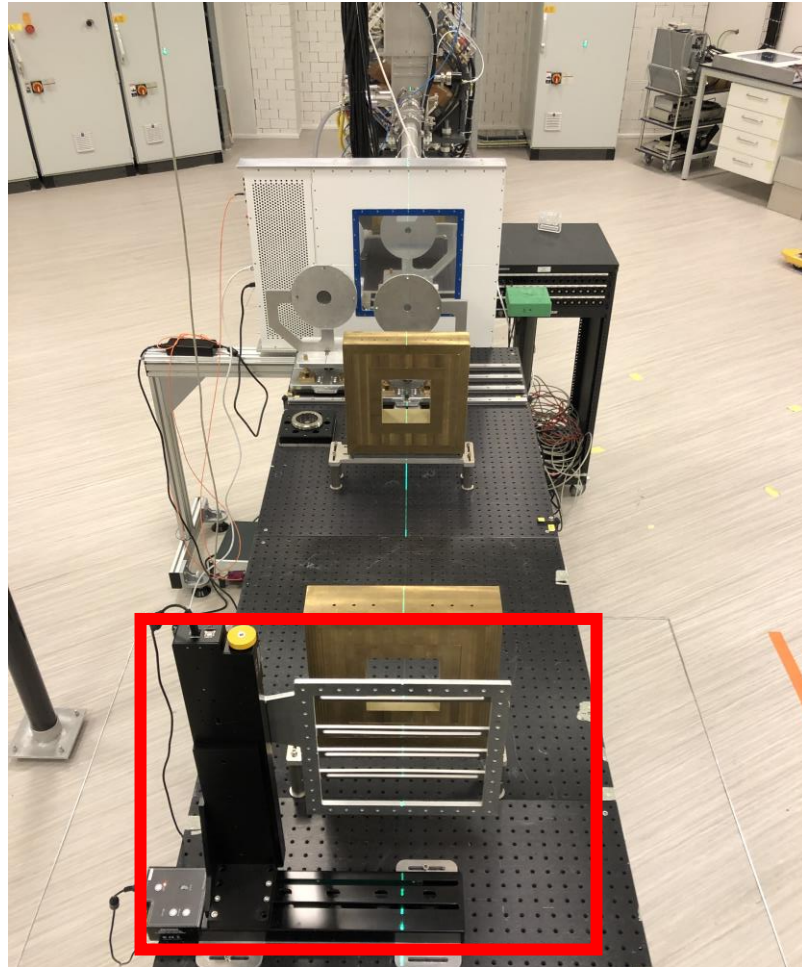
120 MeV @ ISO2 - 10cmx10cm Field

Cyclotron Nominal Beam Current (nA)	ϕ [#/(cm ² ·s)]
1	6,33E+04
5	3,16E+05
10	6,33E+05
20	1,27E+06
40	2,53E+06
100	6,33E+06
200	1,27E+07
300	1,90E+07
400	2,53E+07
500	3,16E+07
600	3,80E+07
700	4,43E+07
800	5,06E+07

200 MeV @ ISO2 - 10cmx10cm Field

Cyclotron Nominal Beam Current (nA)	ϕ [#/(cm ² ·s)]
1	6,27E+05
5	3,13E+06
10	6,27E+06
20	1,25E+07
40	2,51E+07
100	6,27E+07
200	1,25E+08
300	1,88E+08
400	2,51E+08
500	3,13E+08
600	3,76E+08
700	4,39E+08
800	5,02E+08

Target station for radiation hardness tests

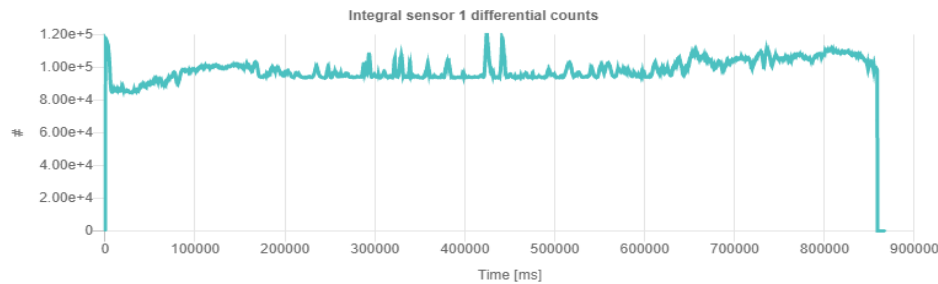
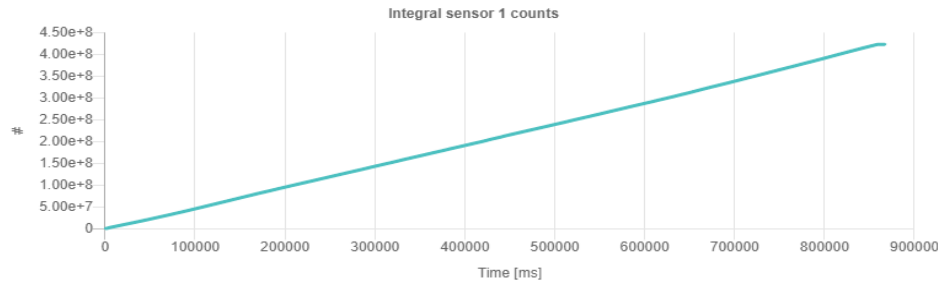


Motorized X-Y stage remotely controlled

Beam delivery system

CH 1

DAQ time [ms] 867400 DAQ counts [#] 422701865
DAQ count rate [# /ms] 487.32
Beam-on time [ms] 0 Beam-on counts [#] 0
Beam-on count rate [# /ms] 0.00

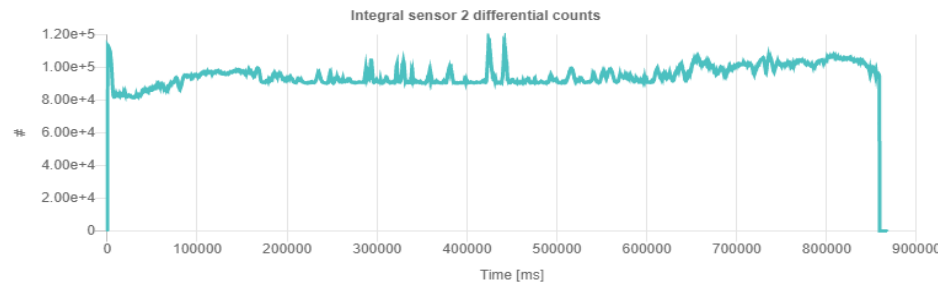
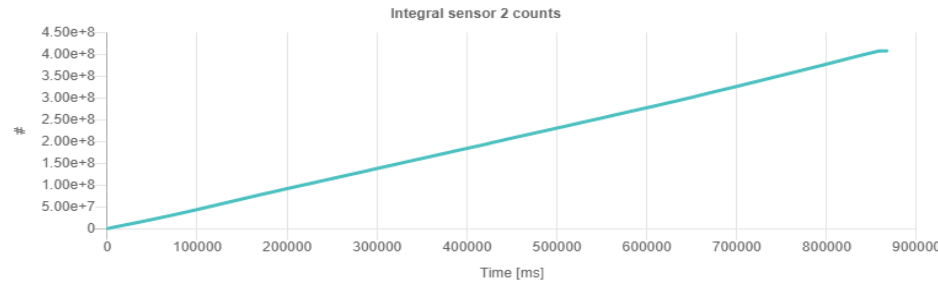


CH 1

THR [#] 0 Apply
Tot time [ms] 0 Tot counts [#] 0
Rate [# /ms] 0.00

CH 2

DAQ time [ms] 867400 DAQ counts [#] 408022399
DAQ count rate [# /ms] 470.40
Beam-on time [ms] 0 Beam-on counts [#] 0
Beam-on count rate [# /ms] 0.00



CH 2

THR [#] 0 Apply
Tot time [ms] 0 Tot counts [#] 0
Rate [# /ms] 0.00

Device status

- HV
- Control Unit
- Beam request
- GDU control

Temp [V] 0.225
Pres [V] 4.027

Memory Usage



Clear Alarms/Interlocks

Settings

DAQ mode Continuous
Record Data [ms] 200

- Master CH 1
- Master CH 2

TOT time [s] 10.0
TOT counts [#] 1000

Select Interlock
Reset Counters

Calibration

Calib file 100MeV_calib
 Apply calibration

Acquisition

Enable beam request



Enable stream

What we tried to achieve as service-based facility

- Flexible way to setup your experiment (standard board holder, specific 3D printed holder, remote controlled motorized stage for precise alignment, etc..)
- Flexibility in the planning (scheduling between few weeks and a couple of months)
- Comfortable beam time hours, between 5pm and 11pm
- Setup time during day time, possibility to setup the day before (or setup test in the physics laboratory, without extra costs involved)
- Possibility to have 2-3 shifts in a row
- Possibility to have longer shift over the weekend
- Possibility to have short irradiation during day time (below 2min)

The “easys” of HPTC

- Easy to travel to HPTC from Europe (Amsterdam airport 30min away)



- Easy access HPTC and get beam time (no paper work required 😊)



- Easy to get information on the beam line and get a quote (within 1-2 days)



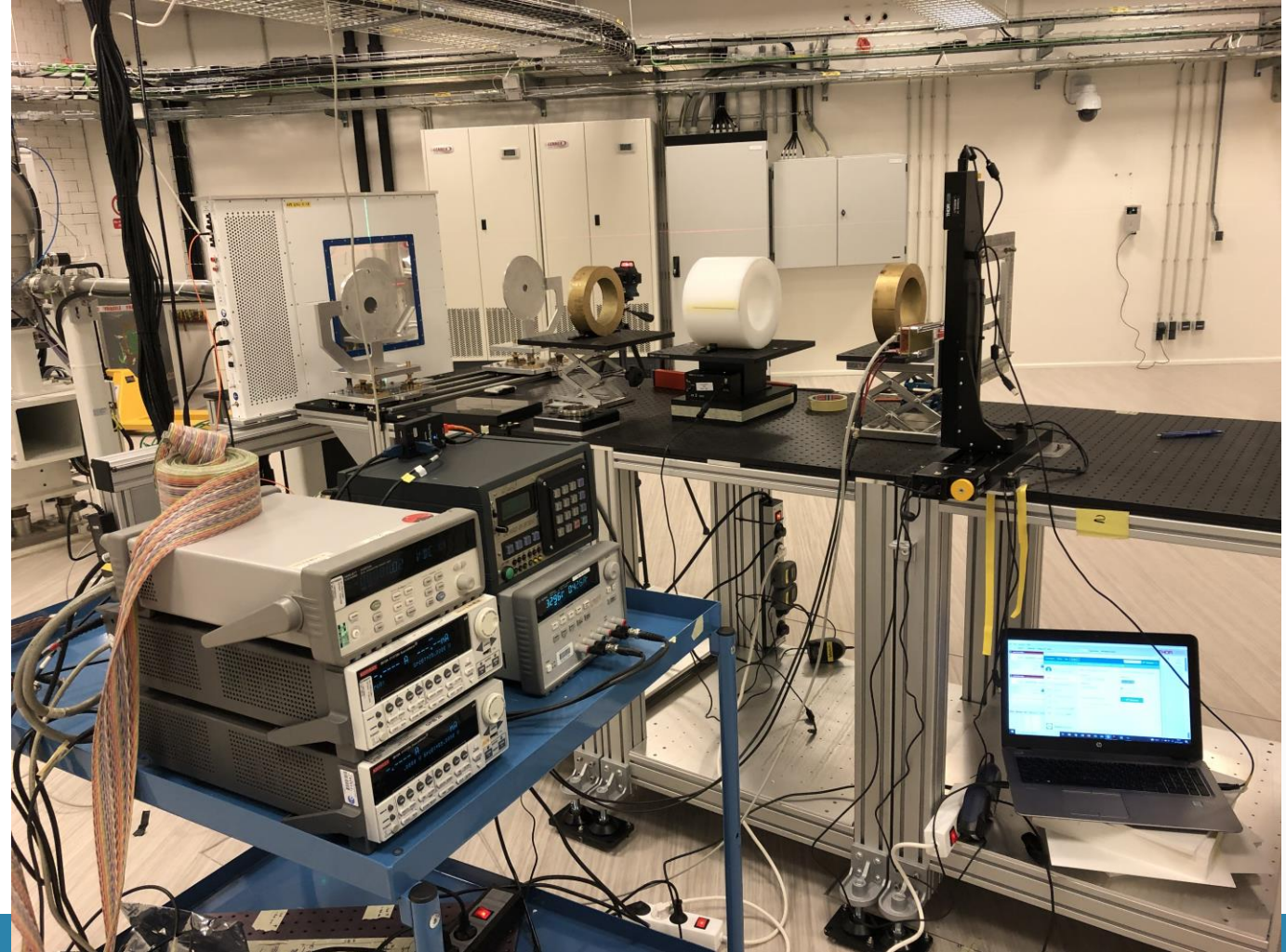
Users from 2022 to 2024

16 experimental campaigns in 2022

22 experimental campaigns in 2023

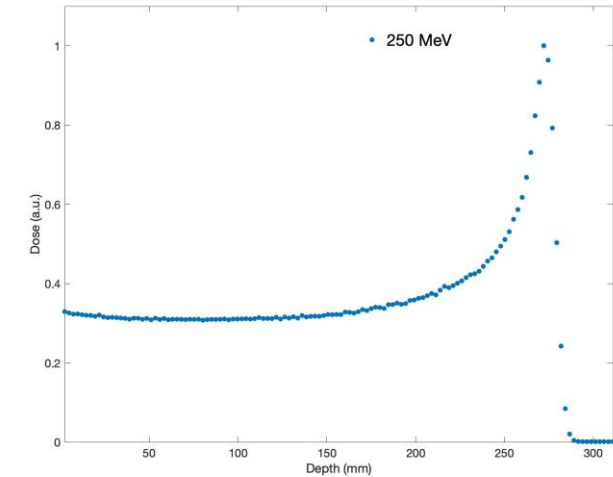
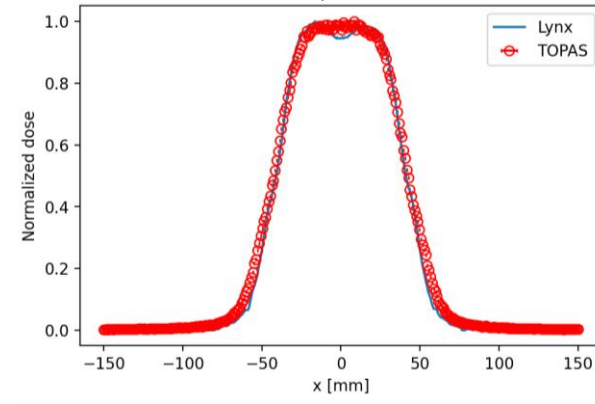
4 experimental campaigns Q1 2024

Total 42

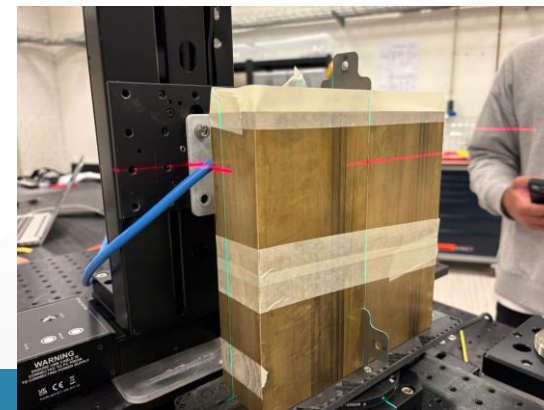


New possible developments

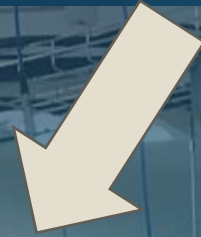
Tune energies between 200 and 250 MeV for pencil beams and 5x5cm field
with the possibility of high fluxes



Possibility to have small beam size of the order of few mm in FWHM



How to get beam time



Direct e-mail to Research office:
researchoffice@hollandptc.nl

RAD
NEXT

The beam line team

Ernst van der Wal

(beam line manager and beam line engineer)



Thomas Toet

(beam line technician and
beam line operator)



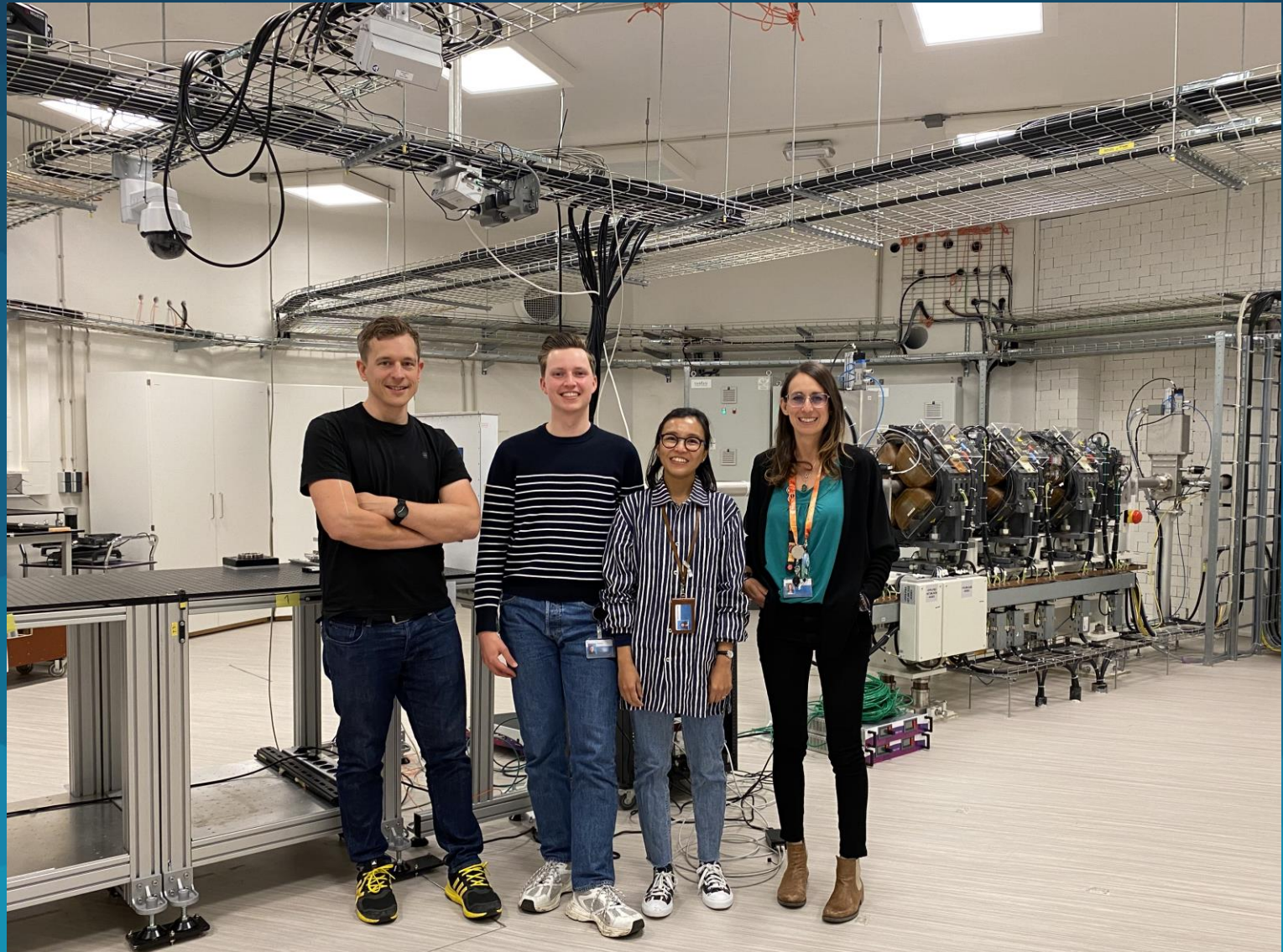
Reni Puspitasari-Kokko

(beam line radiobiologist)



Marta Rovituso

(beam line scientist)



Thank you all for your attention!

Special thanks to

ESA-Estec team: A. Costantino - A. Pesce - M. Muschitiello - M. Tali - T. Borrel

HollandPTC R&D head M. Hoogemann & HollandPTC Director I. van Haaren

