The experience of HollandPTC in setting up a radiation hardness test beam facility: pre-requisites and challenges

M.Rovituso[1], E. van der Wal[1], T.C. Toet[1], M. Hoogeman[1]

Presenter: Dr. Marta Rovituso – HollandPTC Beam line scientist

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

Consortium of

TU Delft

Erasmus MC
Universitair Medisch Centrum Rotterdam

LUMC Leiden University Medical Center

- 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

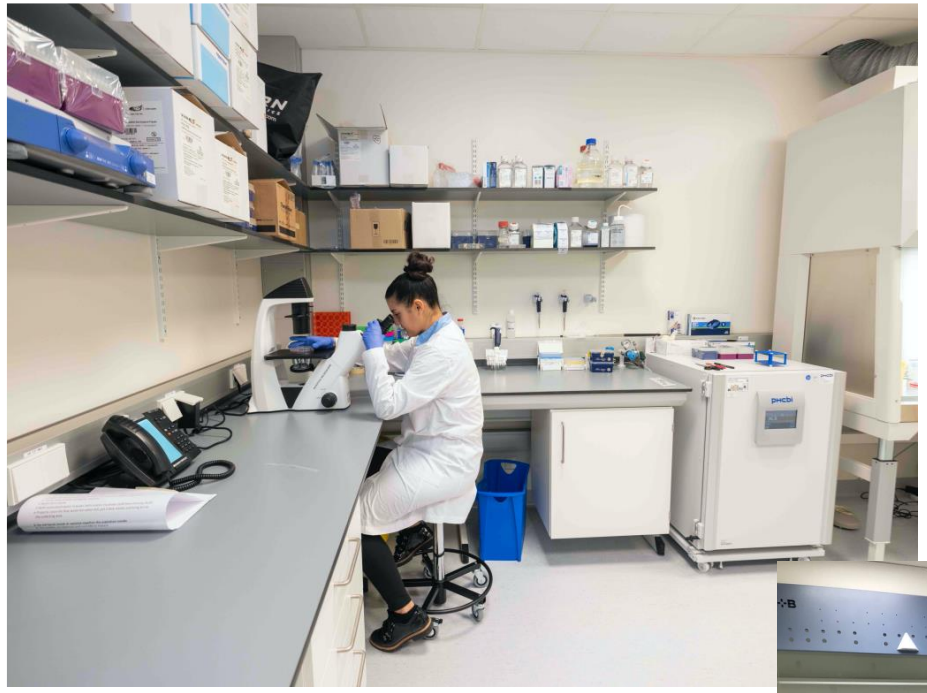
In the R&D room:

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

The R&D facility

HollandPTC
Proton Therapy Centre

Biology Lab cell culture work

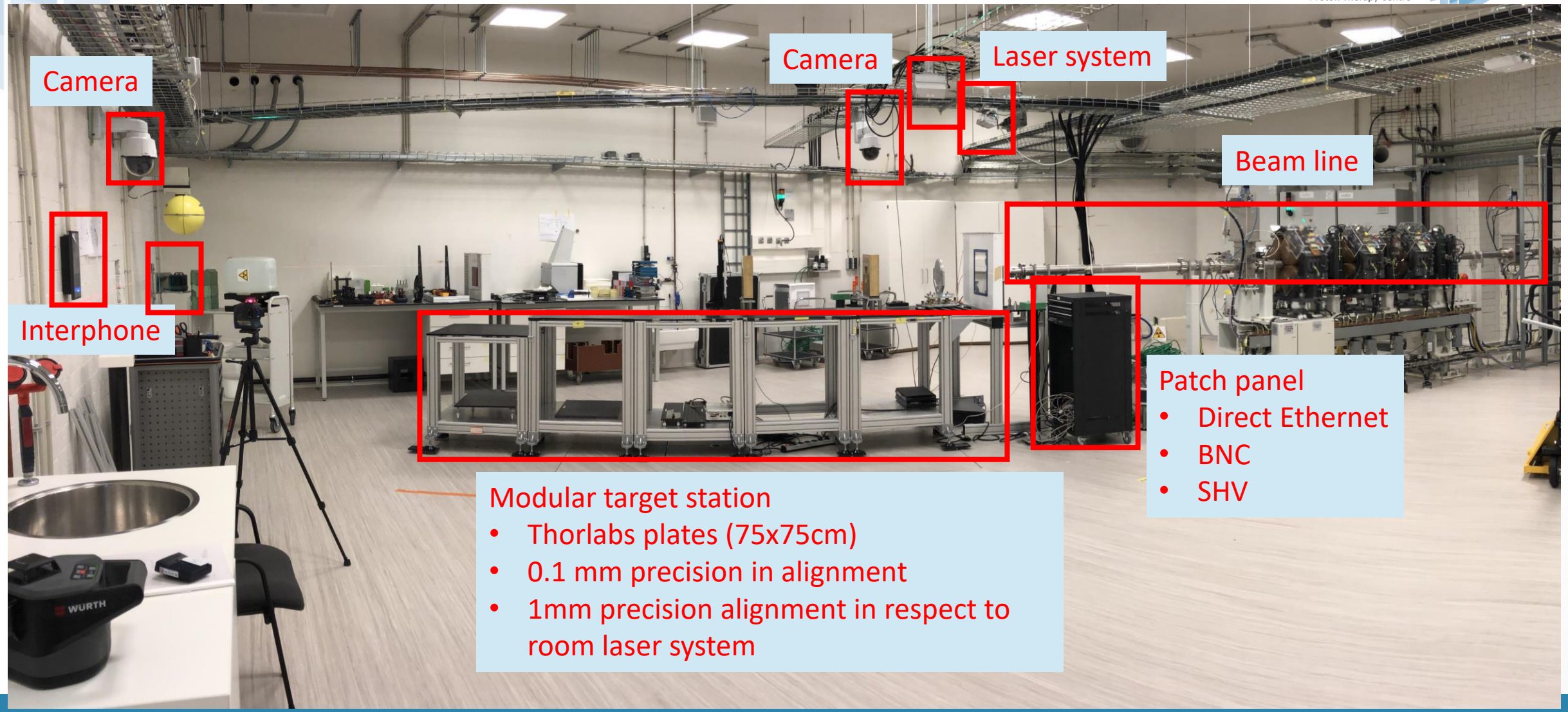


Physics and Chemistry lab

Pre-clinical preparation room for in vivo experiment

TU Delft · Leiden University Medical Center · Erasmus MC

The experimental room



Applications in the R&D beam line

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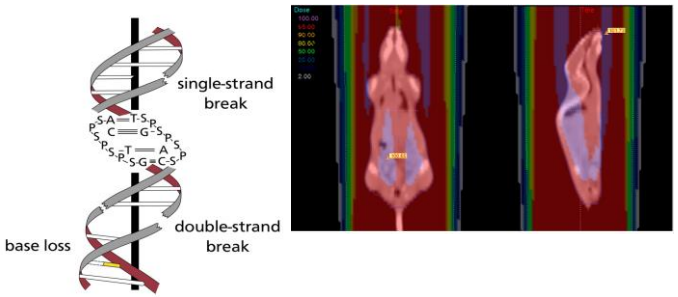
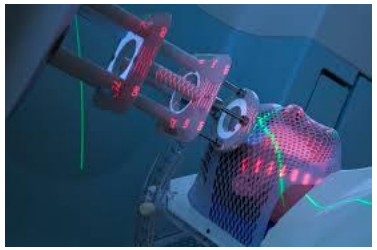
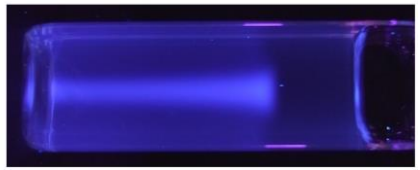
Radiobiology



Advanced Technology



Dosimetry



Space applications

Beam characteristics

The experimental beam line

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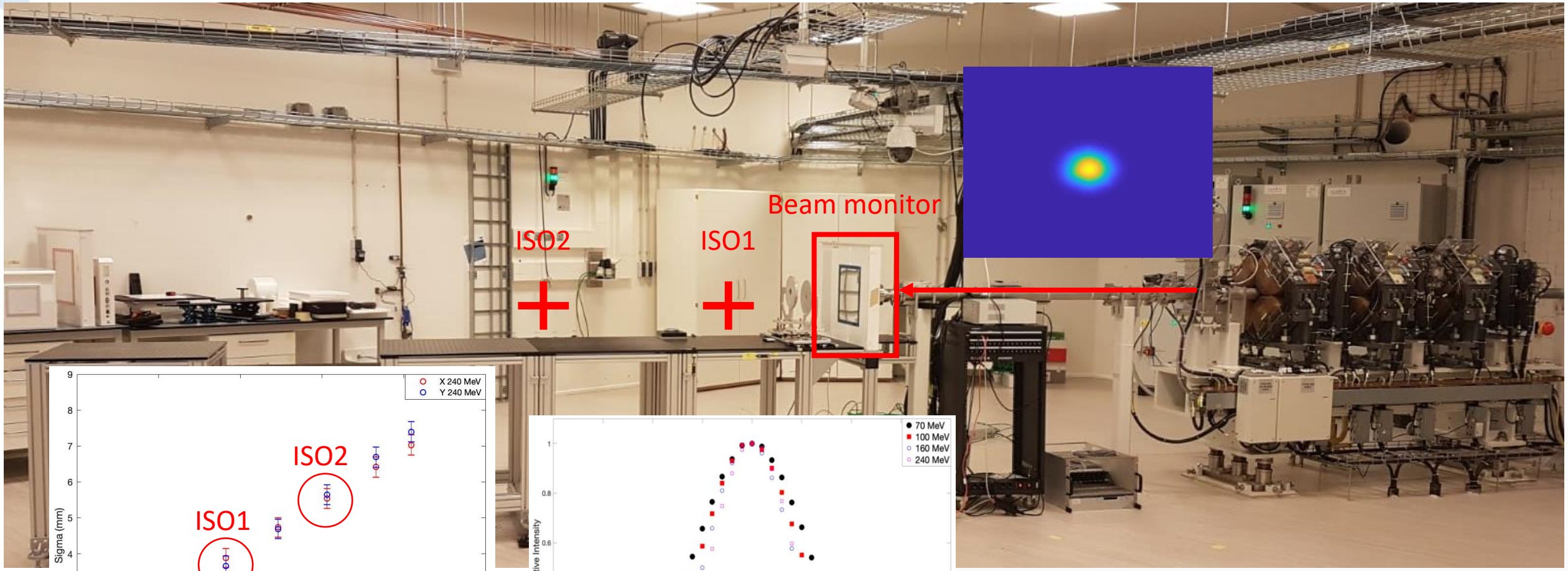
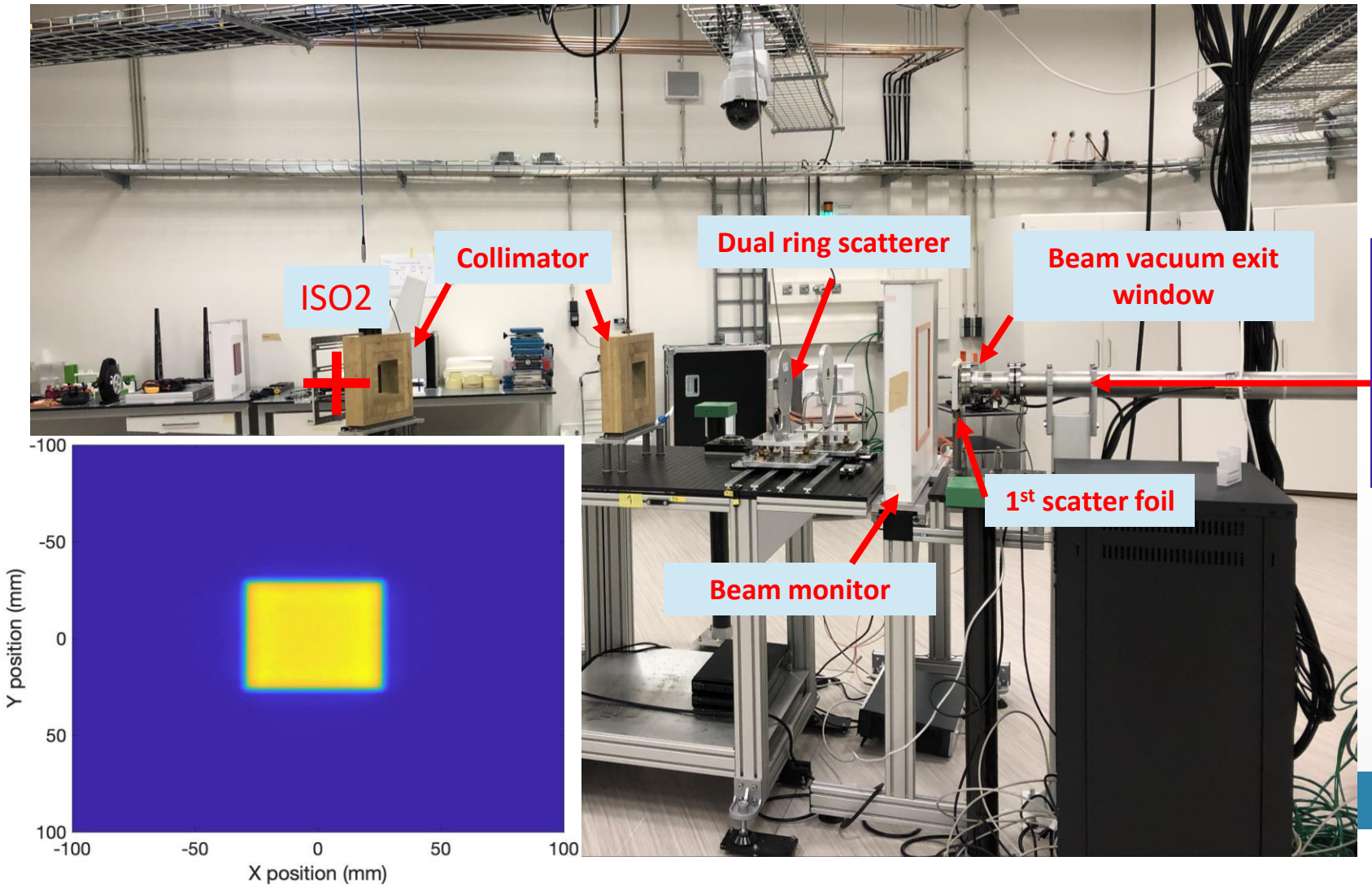
Proton Therapy Centre



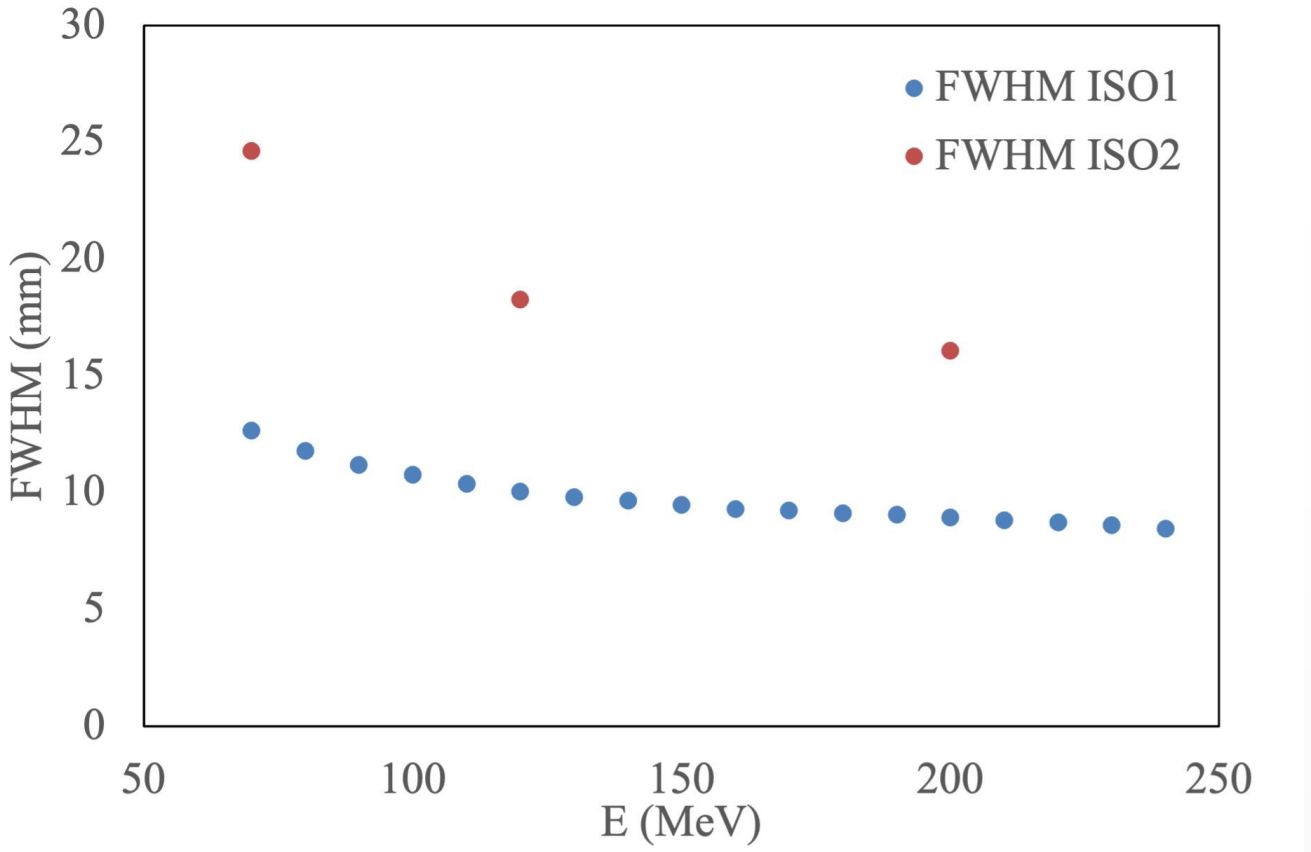
The experimental beam line



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	

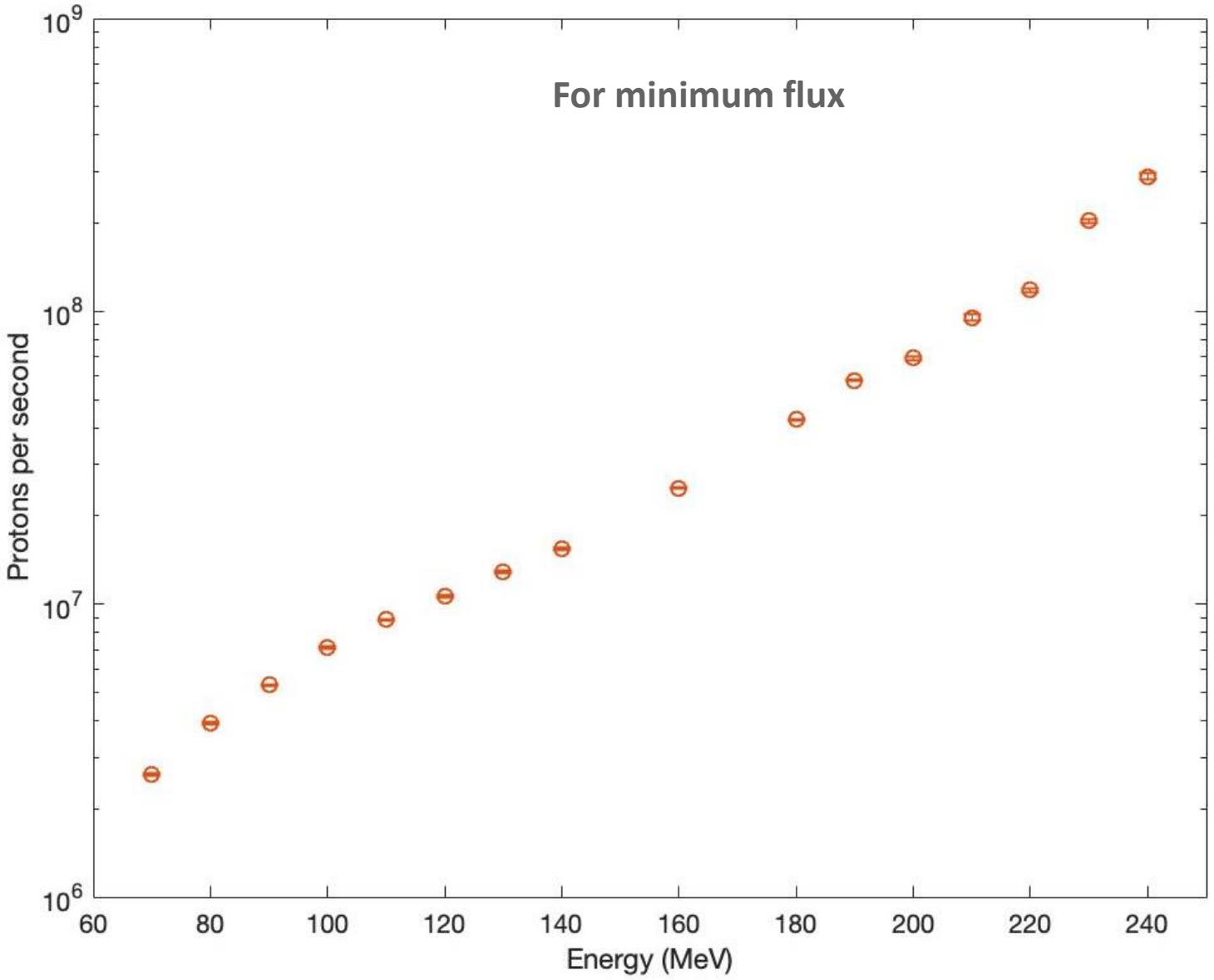


Pencil beam flux

Detector:

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

Energy @ target (MeV)	Min Flux (p/s/cm2)	Max Flux (p/s/cm2)
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

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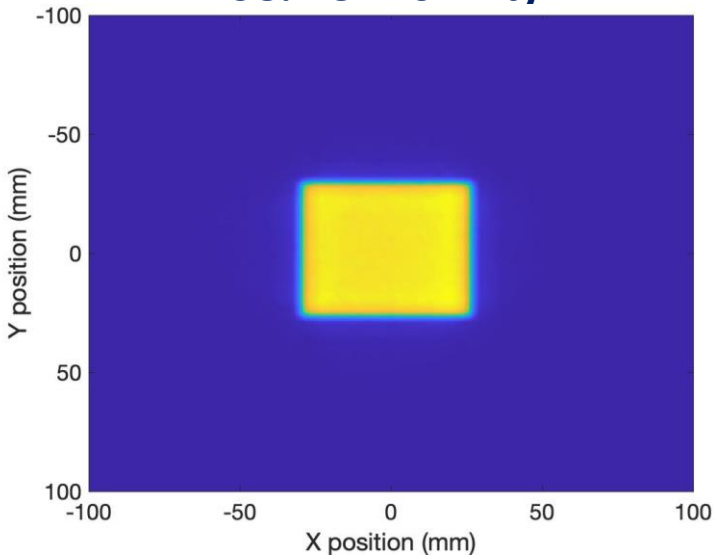
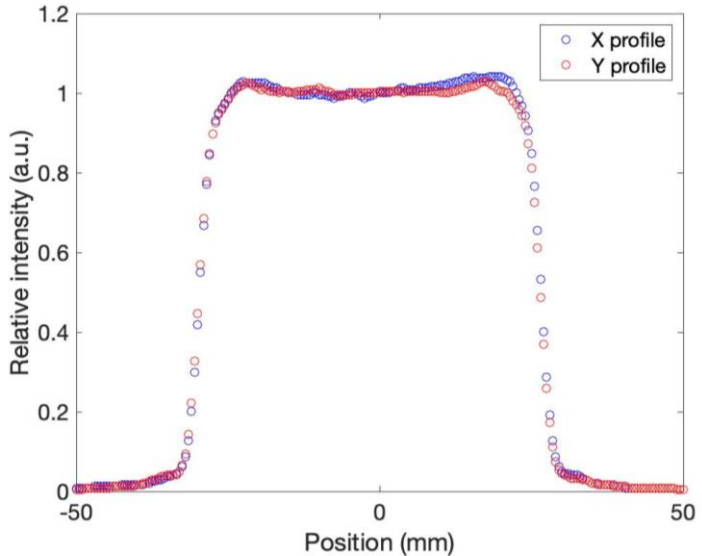
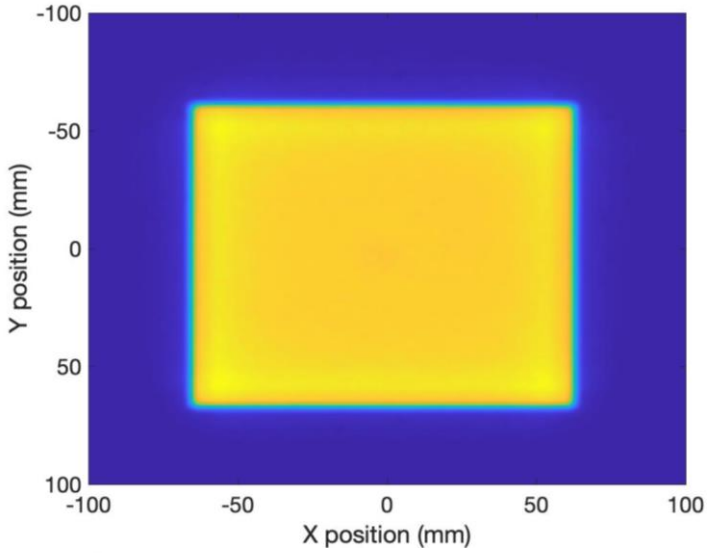
Proton Therapy Centre

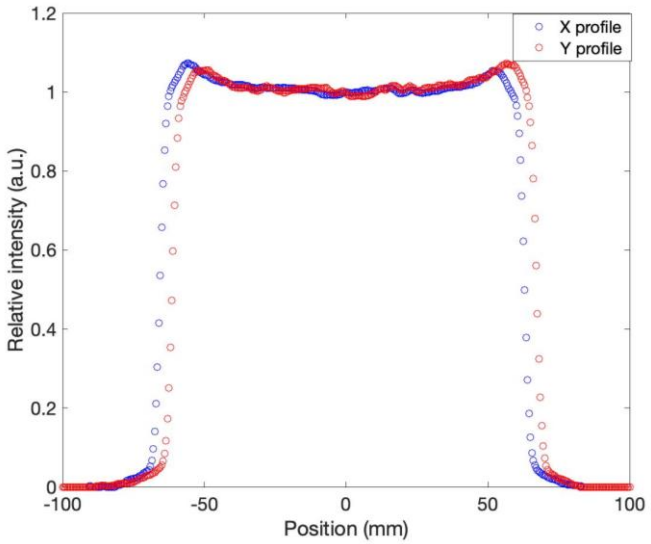
70 MeV @ target 4x4cm
98% Uniformity



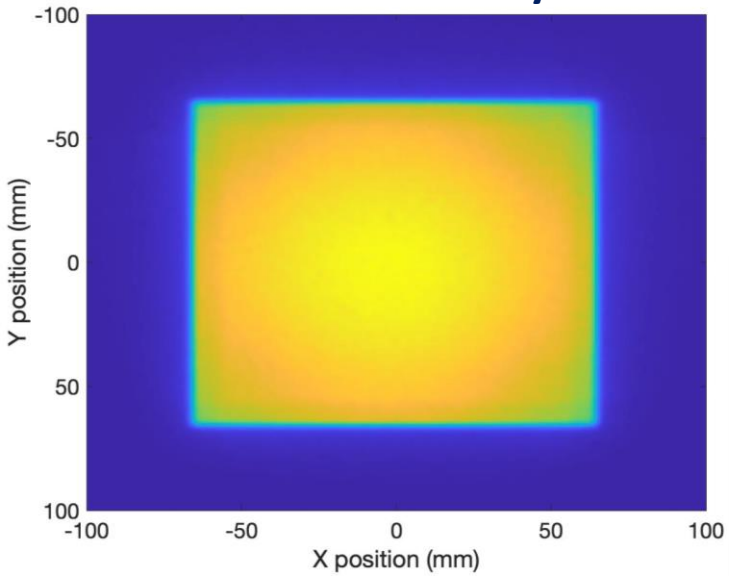


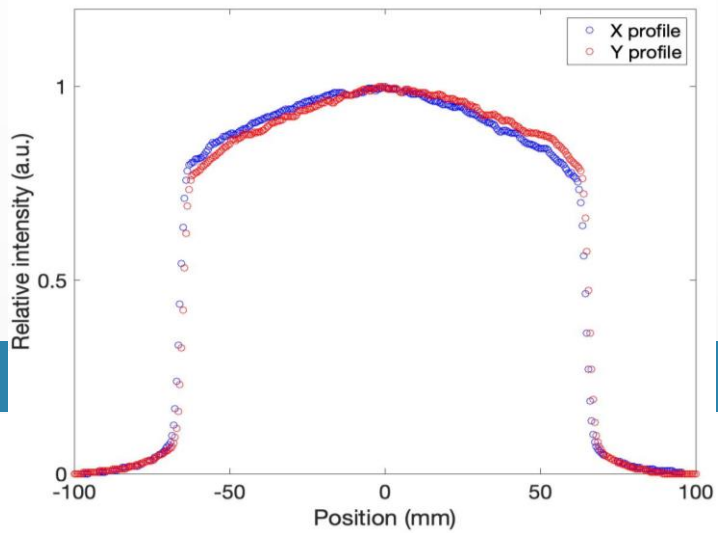
120 MeV @ target 10x10cm
98% Uniformity





200 MeV @ target 10x10cm
92% Uniformity





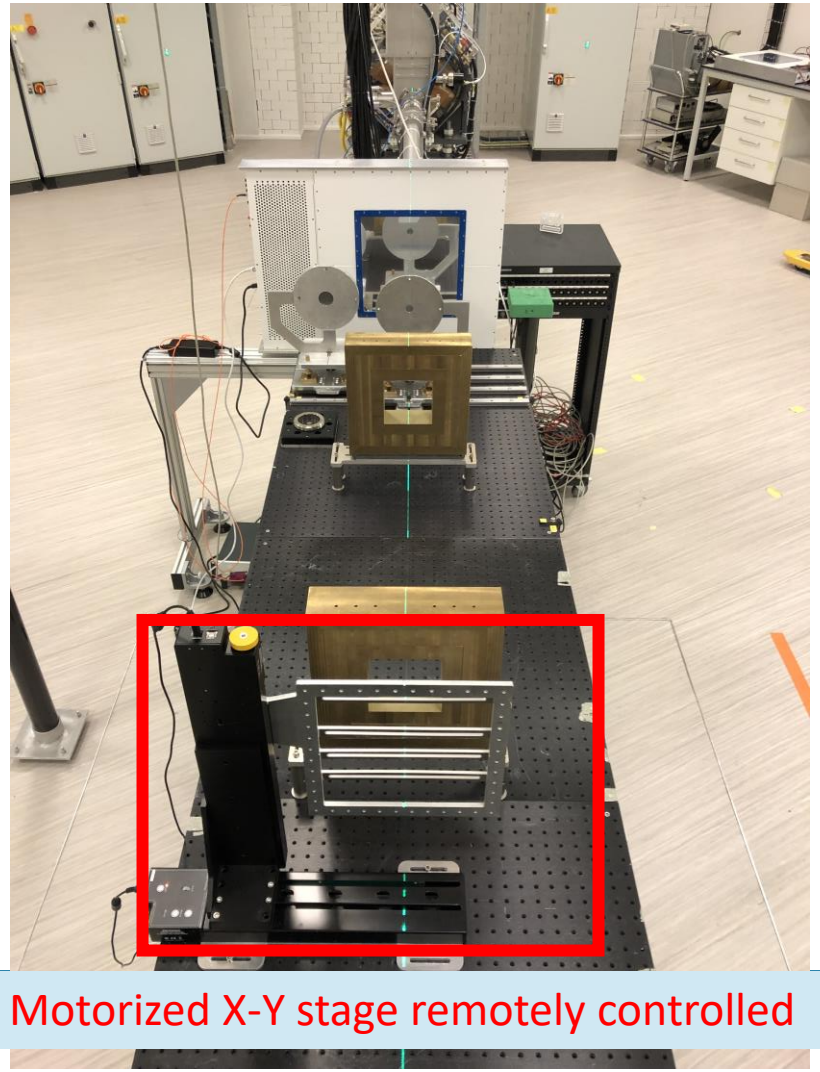
Broad beam flux

70 MeV @ ISO2 - 10cmx10cm Field	
Cyclotron Nominal Beam Current (nA)	ϕ [#/(cm2·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

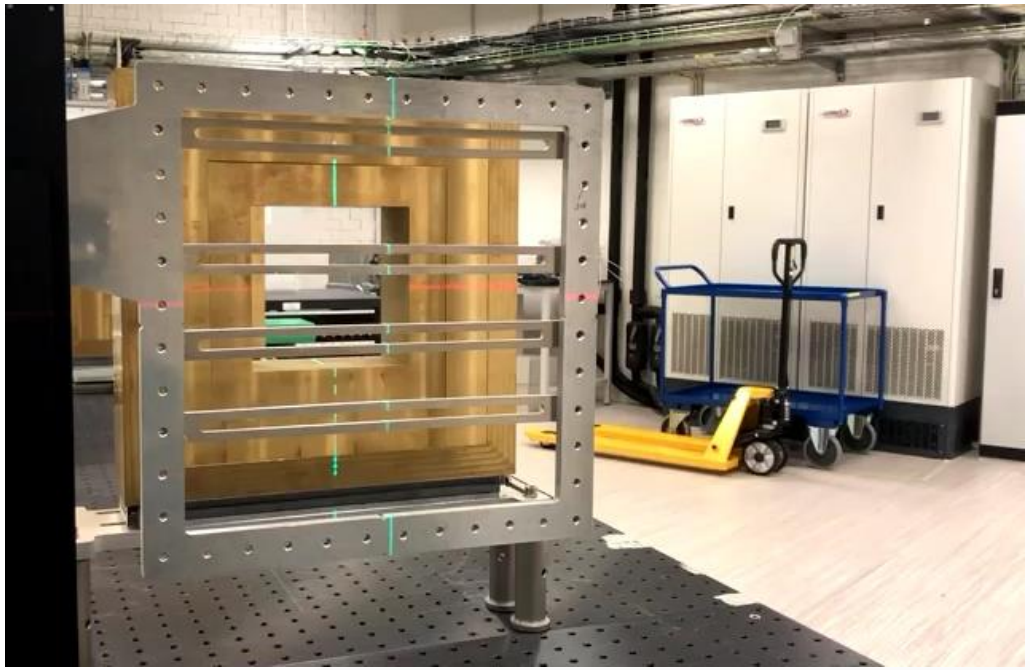
120 MeV @ ISO2 - 10cmx10cm Field	
Cyclotron Nominal Beam Current (nA)	ϕ [#/(cm2·s)]
1	6,33E+04
5	3,16E+05
10	6,33E+05
20	1,27E+06
40	2,53E+06
100	6,33E+06
200	1,27E+07
300	1,90E+07
400	2,53E+07
500	3,16E+07
600	3,80E+07
700	4,43E+07
800	5,06E+07

200 MeV @ ISO2 - 10cmx10cm Field	
Cyclotron Nominal Beam Current (nA)	ϕ [#/(cm2·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

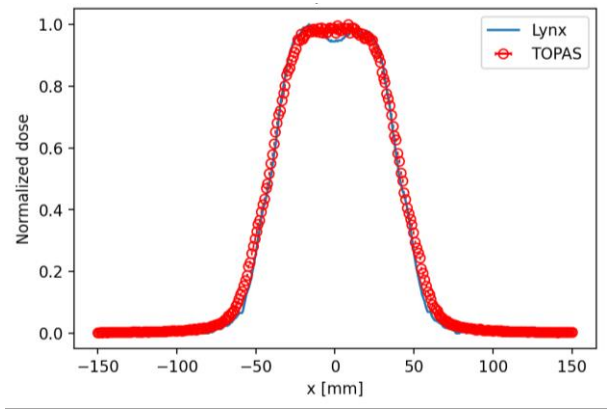


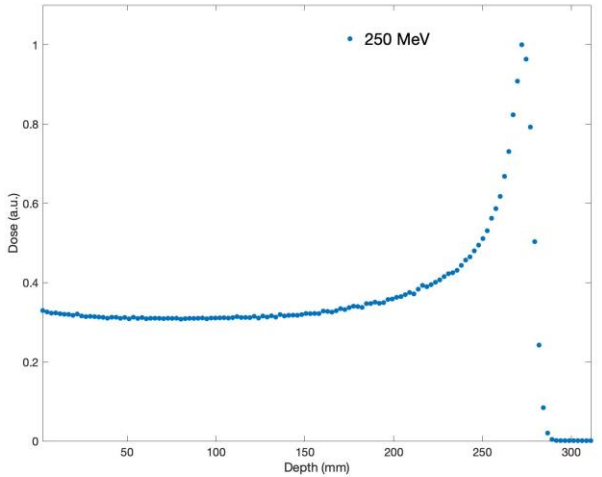
Beam delivery system

New possible developments

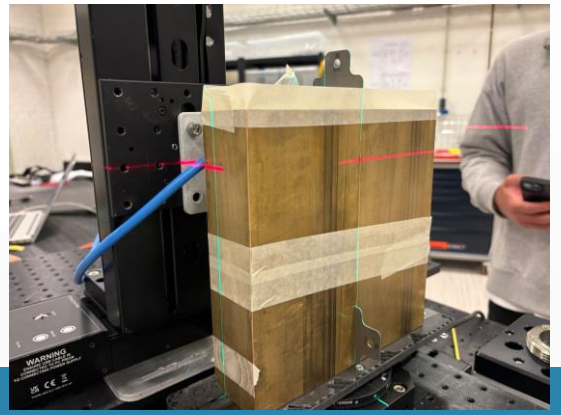
Tune energies between 200 and 250 MeV for pencil beams and 5x5cm field

with the possibility of high fluxes





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



OUR JOURNEY TO RADNEXT

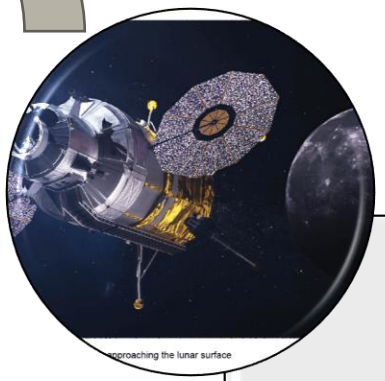
Starting in 2019…

An empty room with one main goal:

Create an R&D environment to show the added value of proton therapy and enhance treatment

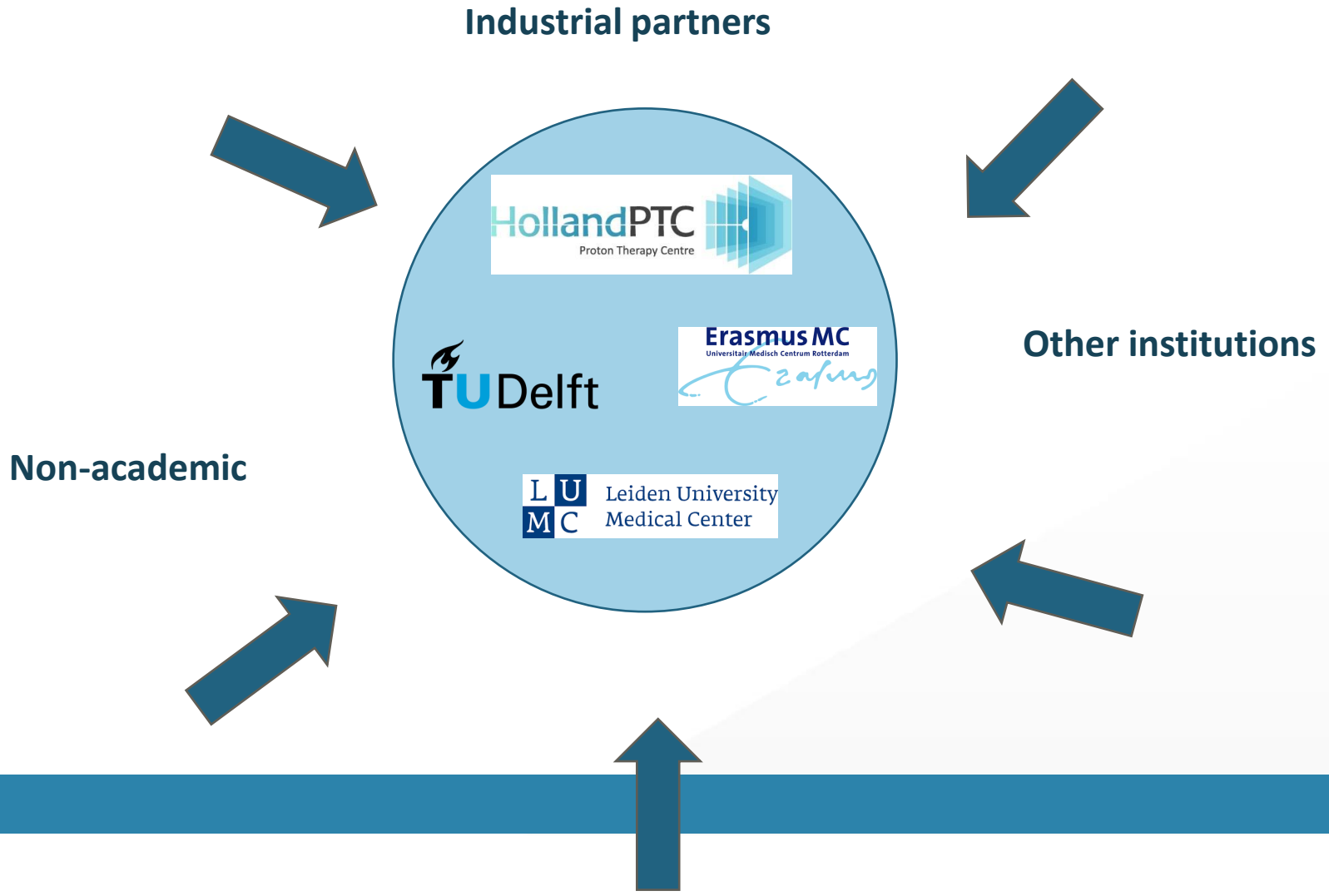
Implementation

Clinical environment



Radiation effect in space applications

Open the doors to outside world and industry

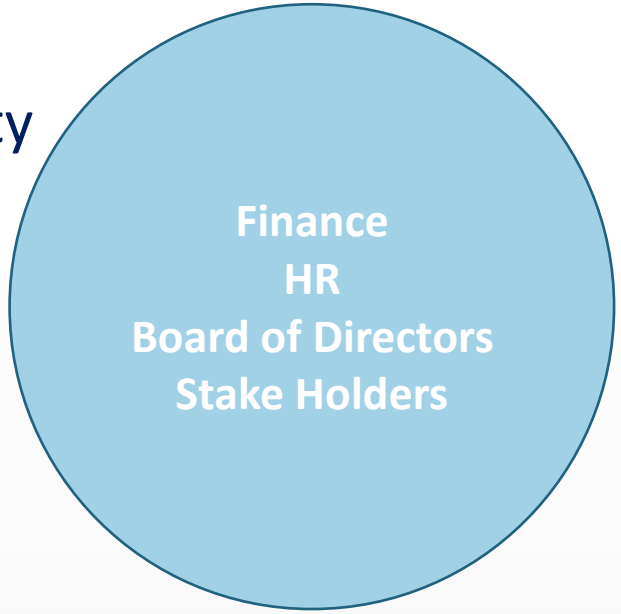


Creating a service for external

HollandPTC
Proton Therapy Centre

Create a service-oriented facility within our research program:

- Define cost price
- Get approval from stake holders
- Dedicated office for communication and interface
- Define capacity in respect to the consortium partners activity
- Organize beam time and operator capacity
- Radiation protection matters
- NDA



Collaborator partner for feasibility study

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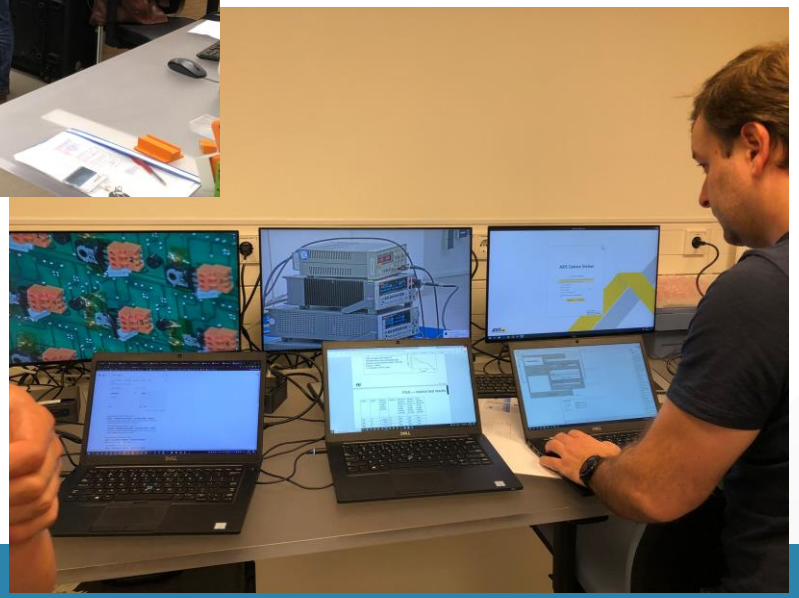
Proton Therapy Centre



esa
ESTEC

Feasibility study to assess:

- Beam characteristics
- Target station
- Logbook
- Practicalities for external users to enter HPTC

TU Delft
Leiden University Medical Center
Erasmus MC

How to get more users?

The HollandPTC proton beam line for radiation hardness tests in space application

***M. Rovituso*[1]**, *A. Constantino*[2], *T. Borrel*[2], *W. van Burik*[1], *E. Schenk*[1], *A. Pesce*[2], *M. Tali*[2]

[1]*HollandPTC – Delft, The Netherlands*

[2]*ESA-ESTEC – Nordijk, The Netherlands*

RAD NEXT

In summary

Pre-requisites:

- Have a proton beam with energies of interest for radiation hardness tests (from 20MeV up to 200 MeV)
- Have the possibilities to have different fluxes from low to high (10^4 till 10^9 p/s/cm)
- Beam capacity of at least 4h per shift

Challenges:

- Implement this type of application into a different research environment
- Dedicate beam time capacity and organize operator capacity accordingly
- Have a straightforward approach to get users in house
- Give users flexibility in the setup and beam settings

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)

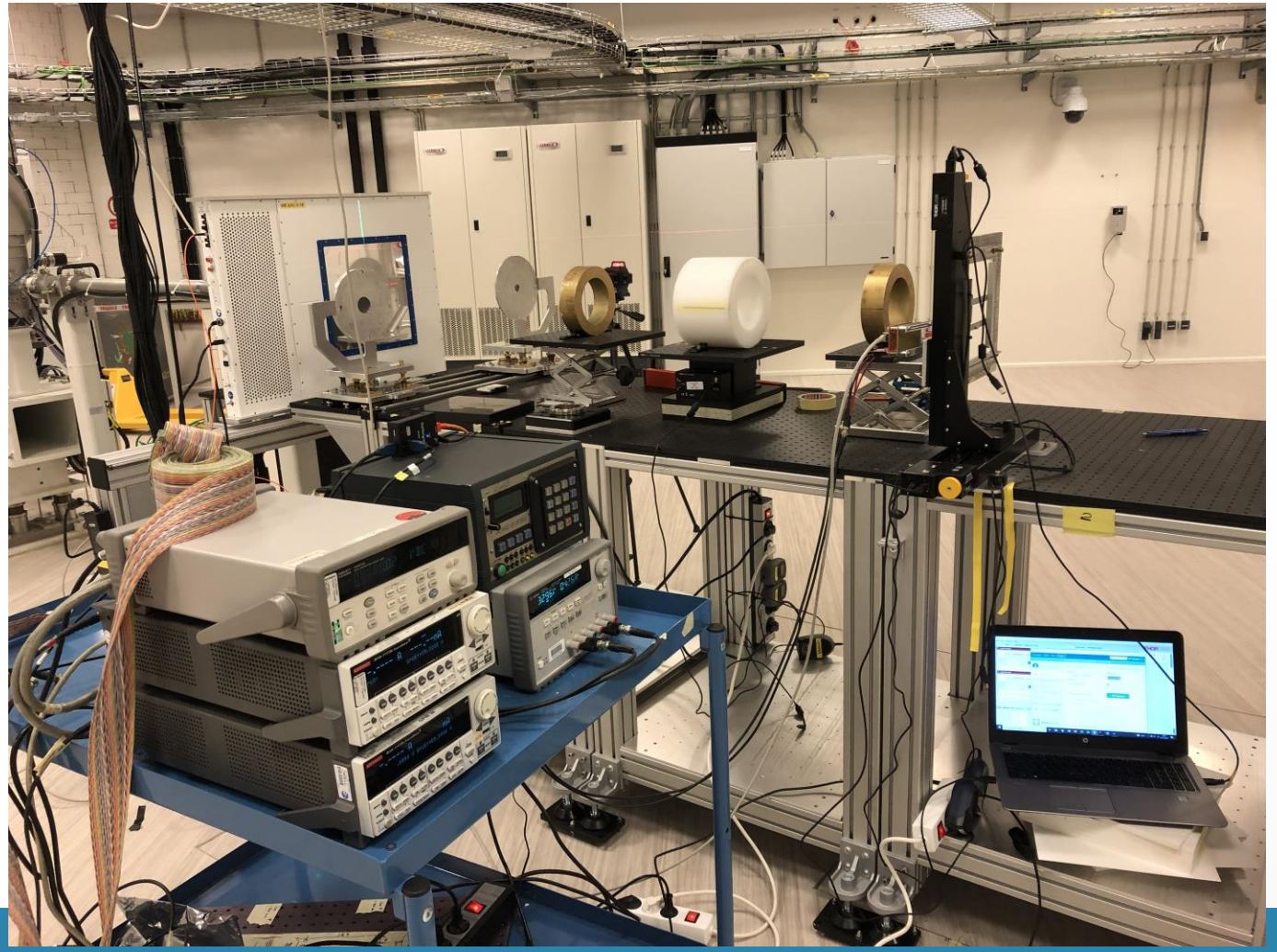
Users from 2022 to 2024

16 experimental campaigns in 2022

22 experimental campaigns in 2023

4 experimental campaigns Q1 2024

Total 42



How to get beam time

With quotation

Direct e-mail to Research office:

researchoffice@hollandptc.nl

RAD NEXT

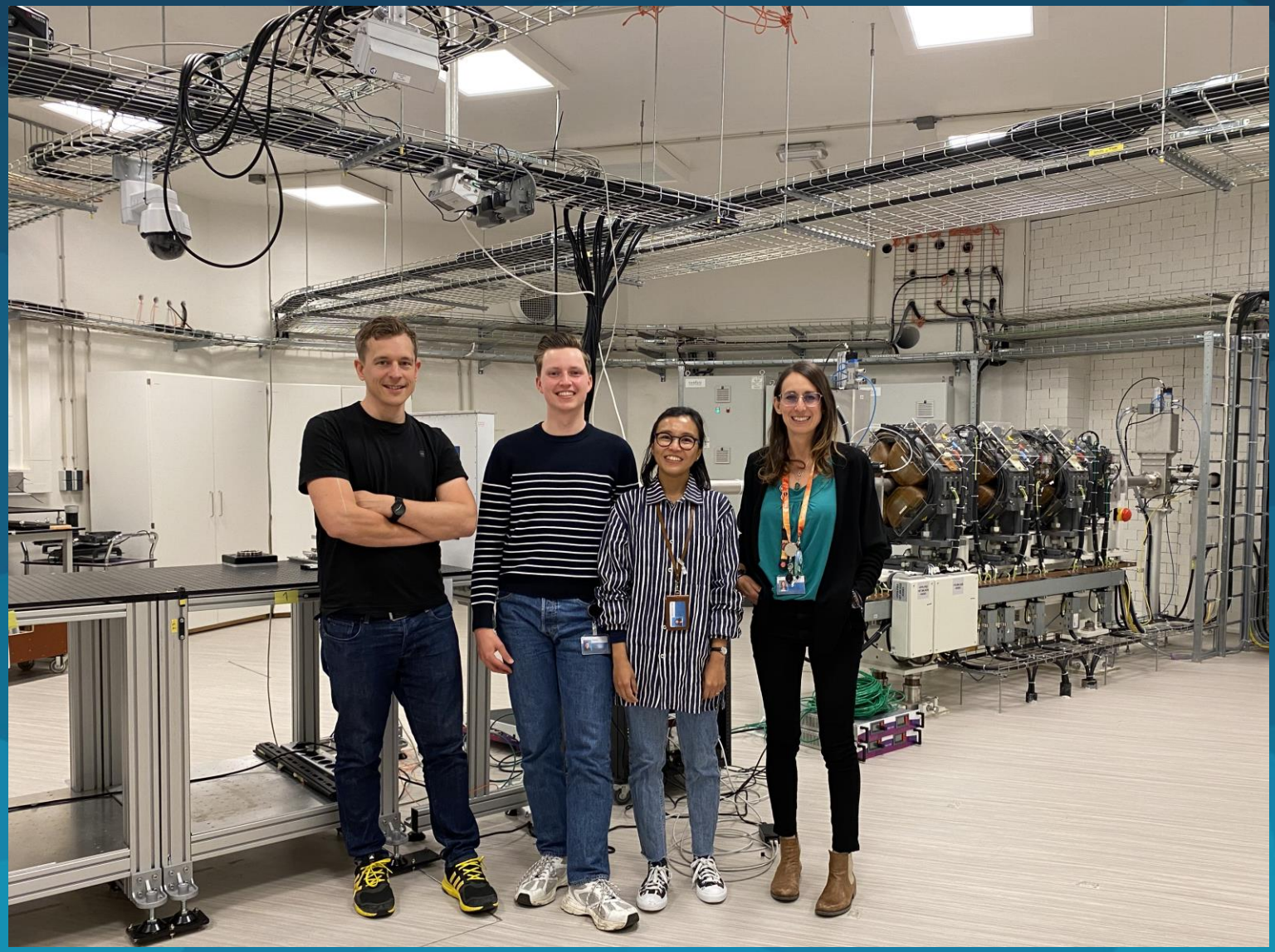
The beam line team

Ernst van der Wal
(beam line manager and beam line engineer)

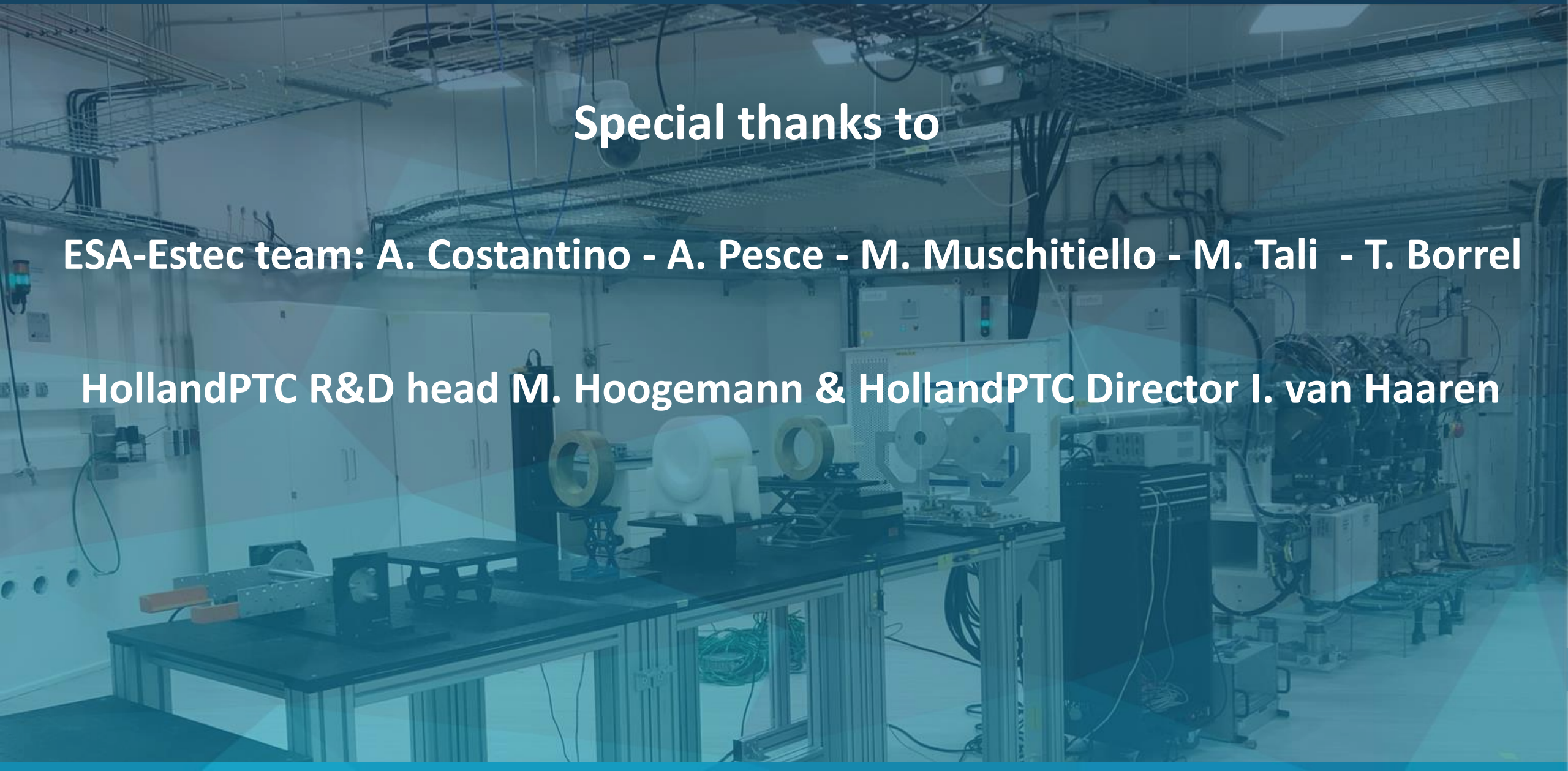
Thomas Toet
(beam line technician and
beam line operator)

Reni Puspitasari-Kokko
(beam line radiobiologist)

Marta Rovituso
(beam line scientist)



Thank you all for your attention!



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