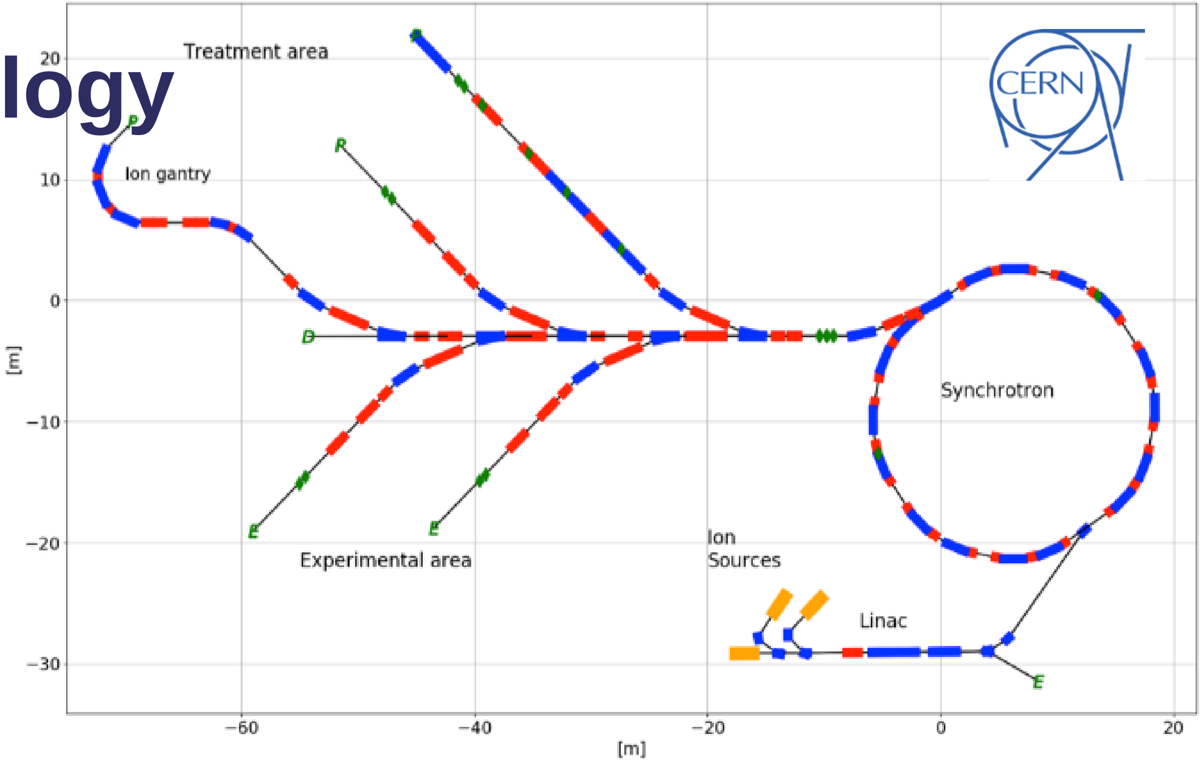
ITRF: WP3

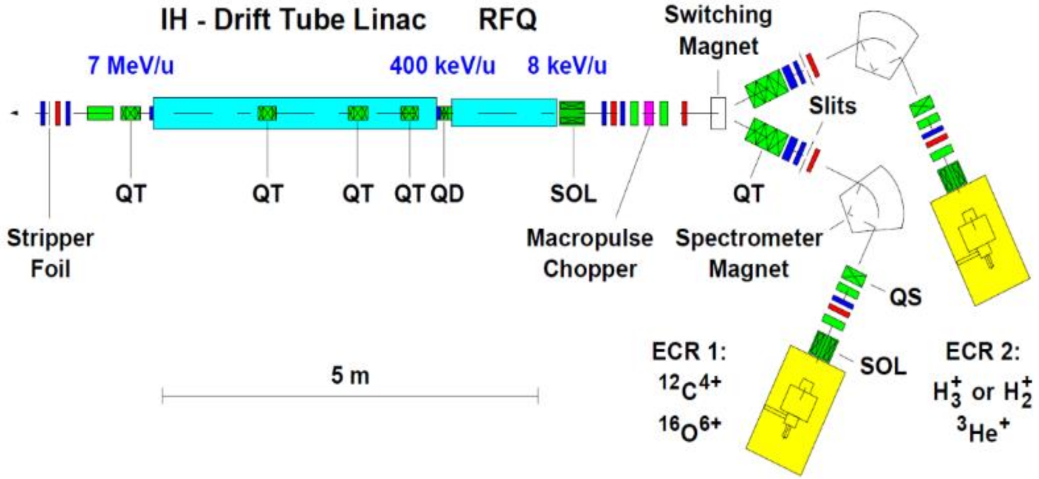
Karen Kirkby and Hywel Owen*,
University of Manchester, The Christie NHS Foundation Trust
*Accelerator Science and Technology Centre

20th September 2022
ITRF Kickoff Meeting

WP3 – Conventional Technology

- Conventional technology (e.g. synchrotron) is:
  - Proven
  - Already available at other facilities
- For costing and preparation, we need:
  - Parameters and layout
  - Understanding of the end station design
- Will use STFC staff to translate existing CERN designs on PIMMS and NIMMS
- STFC/CERN Framework Agreement signed; access to design information and collaboration
- Dedicated PhD student to work on beamline/end station (intending to start in Jan 2023)
- Will review linac as 3rd option

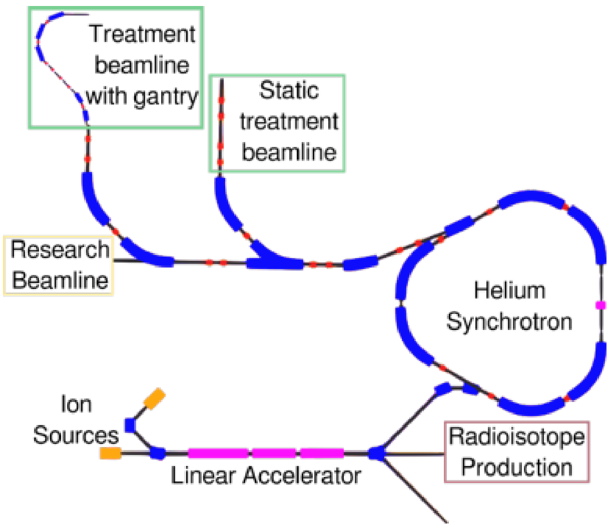




Science and Technology Facilities Council
Daresbury Laboratory

Adaptation of He Synchrotron

- (see Elena’s talk and doi:10.18429/JACoW-IPAC2022-TUOZGD2)
- Will take He synchrotron design and scale to lower energy output
- Examine accelerator chain from injector to end station
- Utilise experience gained from Christie scanning station to explore options e.g. vertical/horizontal irradiation
- Comparison with WP1.5 design
- PhD student (Uni Manchester) will undertake beamline design, starting c. Jan 2023



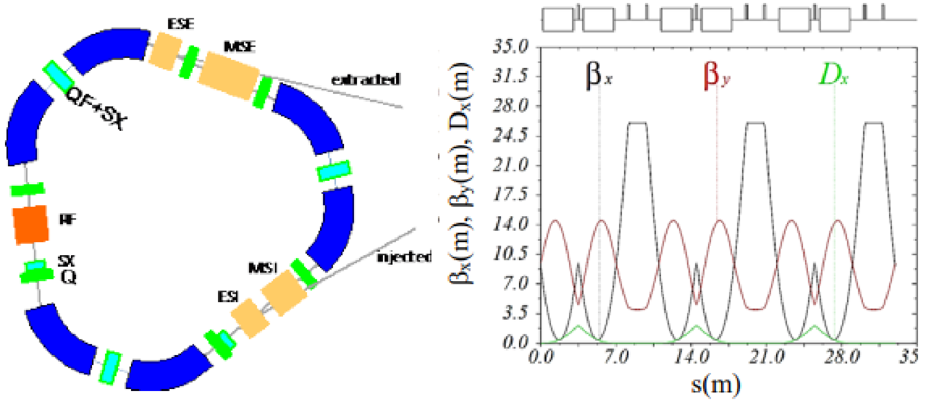
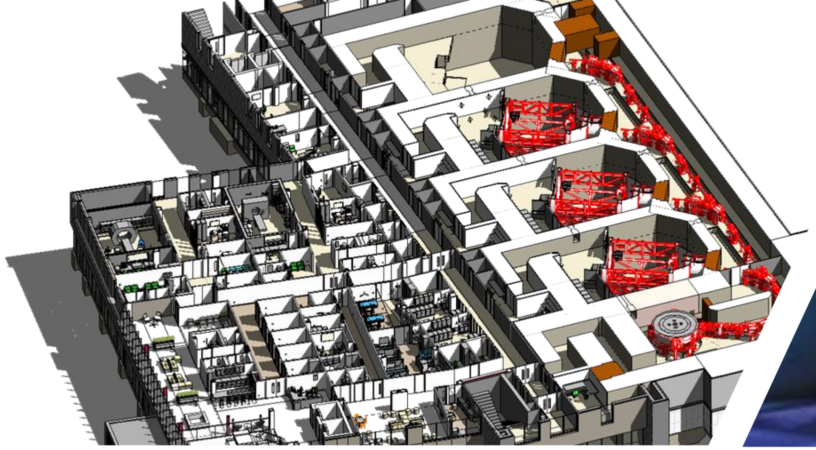


Figure 2: Sketch of the lattice layout and a preliminary optics, generated with MAD-X [8].

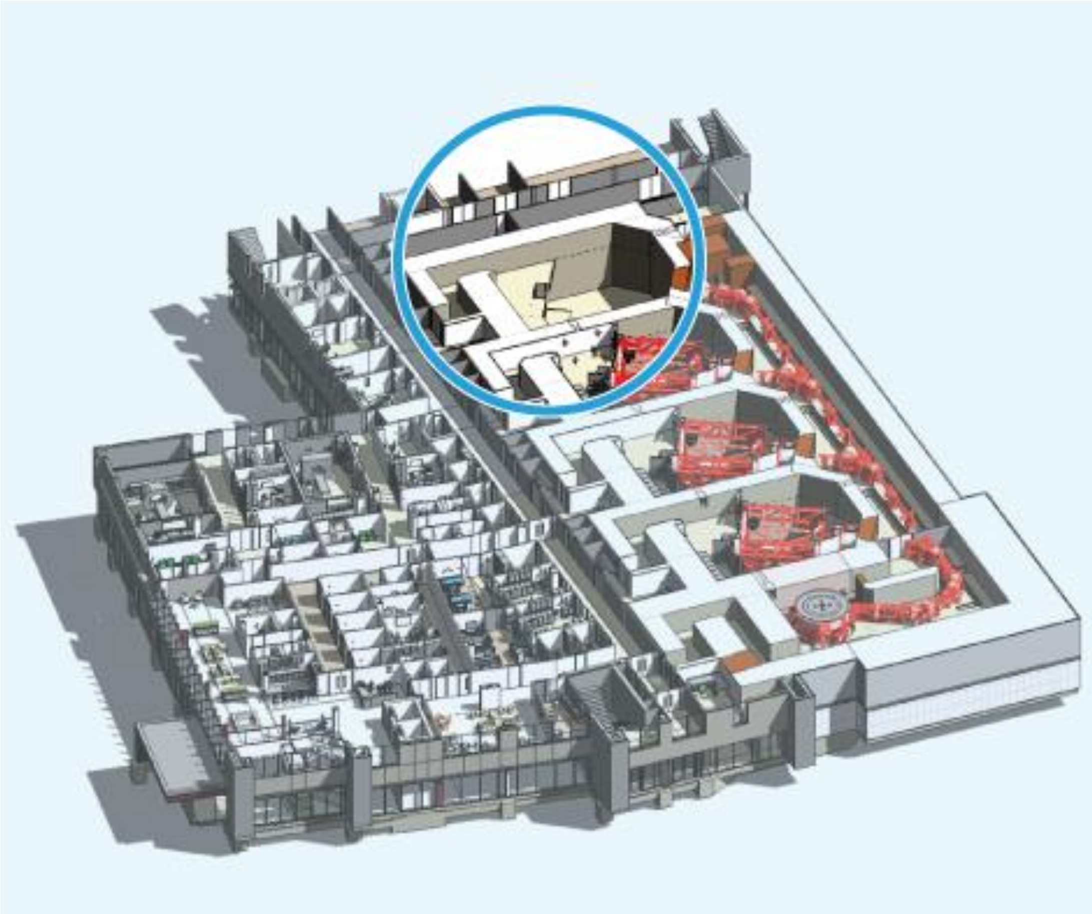
Science and Technology Facilities Council
Daresbury Laboratory



Building on expertise at Christie PBT centre: Treating patients since Dec 2018

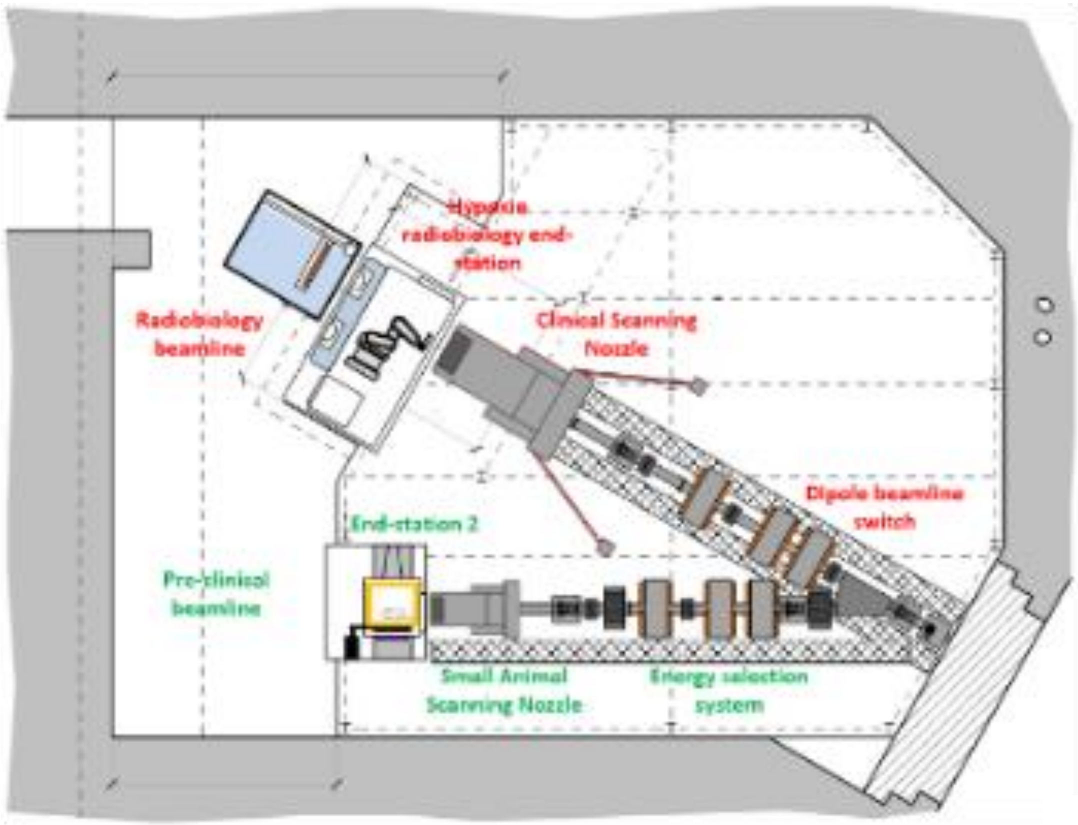
Ran Mackay

PBT Research room



The Christie
Charitable Fund

PBT Research room: design



Mike Merchant

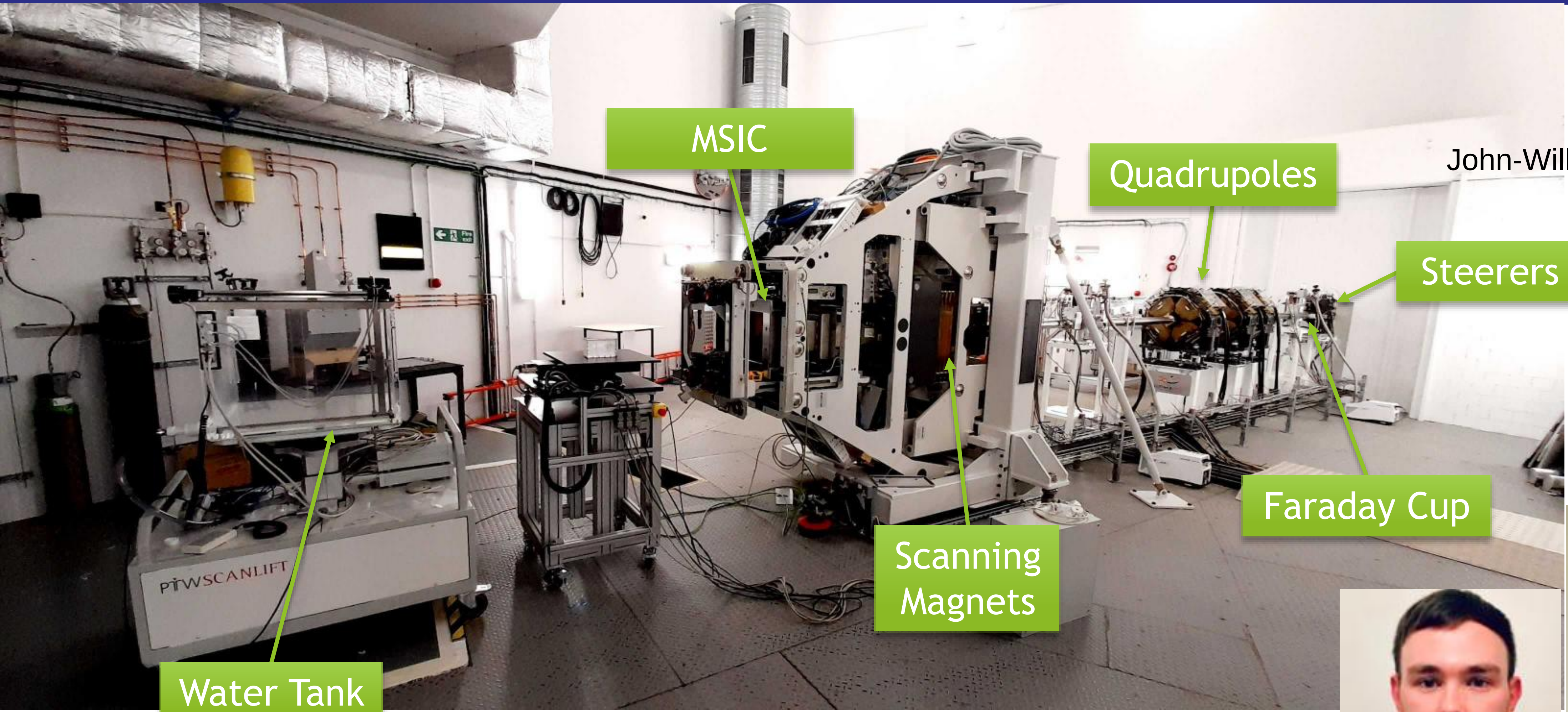
Mike Taylor

Hywel Owen

- Flexible design
- Floor
- Water
- Electricity
- Earthing
- Radiation protection
- Infrastructure
- Beam lines
- End Stations
- Clinical nozzle

The Cockcroft Institute
of Accelerator Science and Technology

PBT Research room: Beamline A



John-William Warmenhoven

Nick Henthorn

Sam Ingram

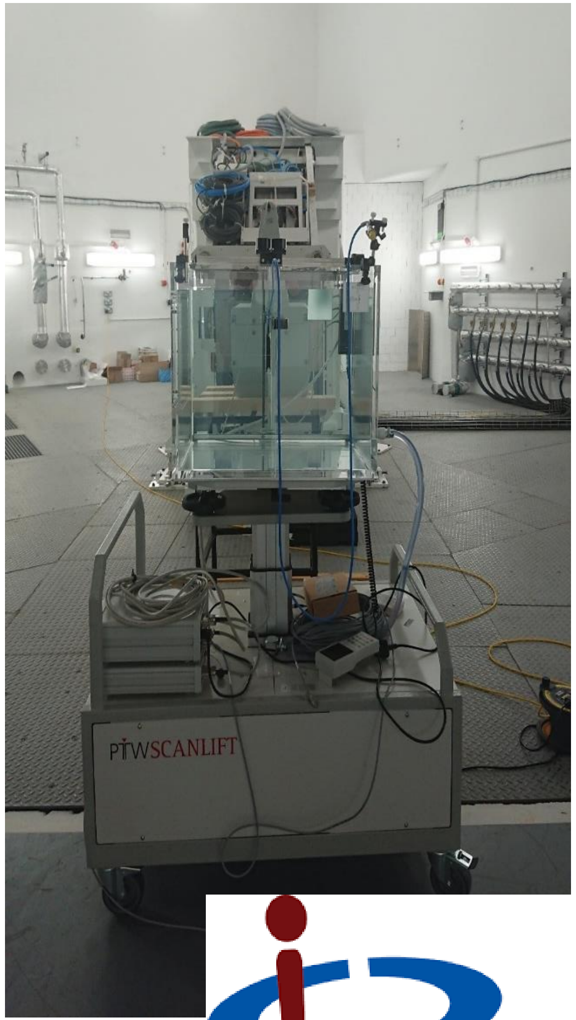
Sam Manger

MANCHESTER 1824
The University of Manchester

The Precise Group

NHS The Christie NHS Foundation Trust

PBT research room: beamline A



The Christie
Charitable Fund

The Cockcroft Institute
of Accelerator Science and Technology

End Stations: Hypoxia; high throughput end station

Environmental Control

- **O_2:** 0.1% - ambient
- **CO_2:** 0% - 20%
- **Temperature:** ambient +4°C - 45°C
- **Humidity:** ambient – 100%

Irradiation:

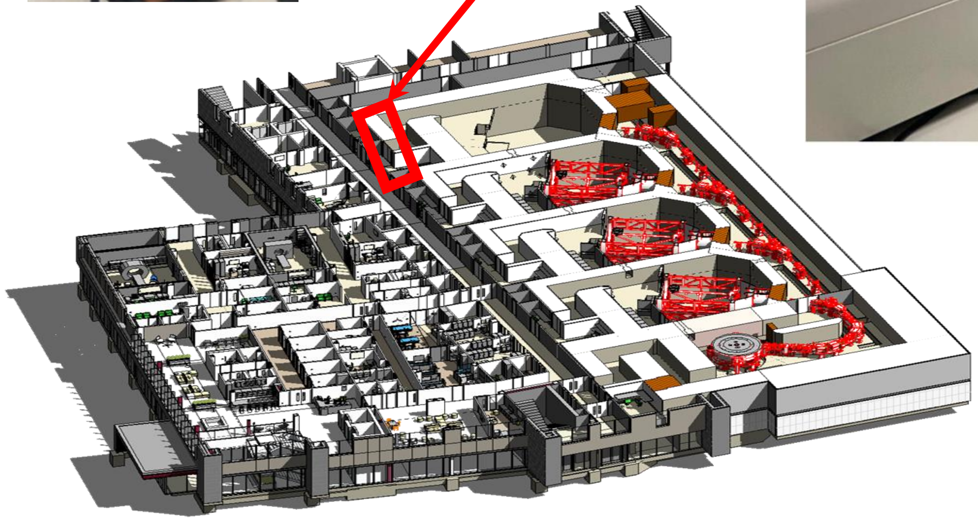
- 20 x 20 cm scanning area
- 6-axis robot: 30s between sample
- 36 sample hotel
- Automated liquid handling for 96-well plates
- Scattered dose to hotel at worst 1.27 mGy/Gy
- Conventional; FLASH

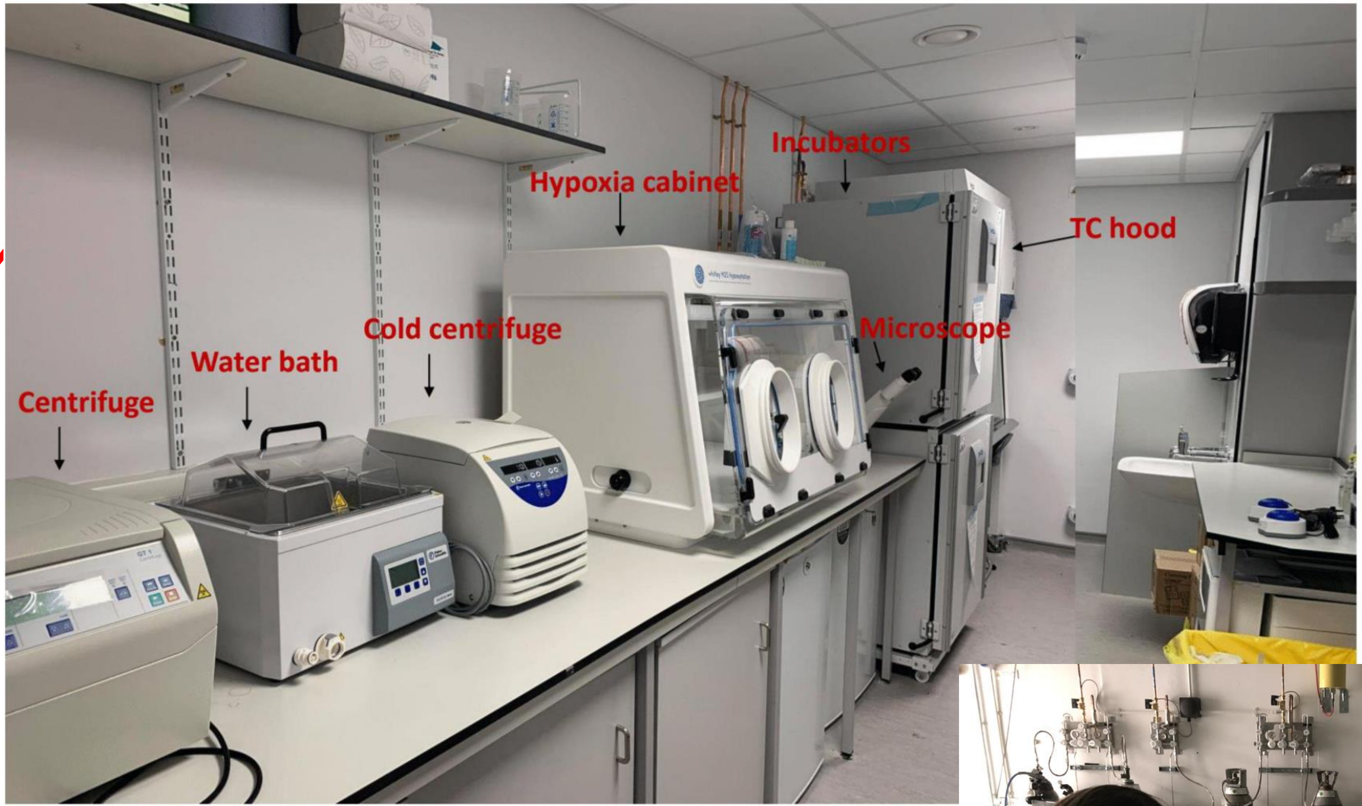
Example experiment:

- 56x Samples, 300 Gy delivered, 2 hours

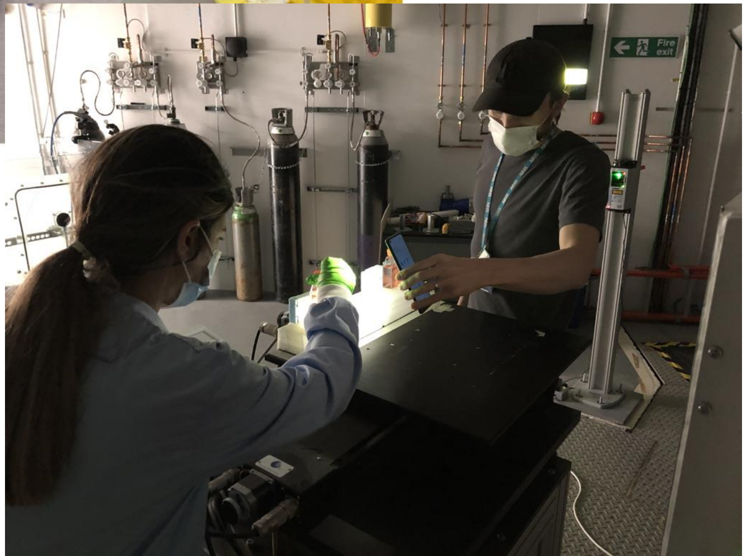
PBT Research room: Bio Prep room: Build

The Christie
Charitable Fund



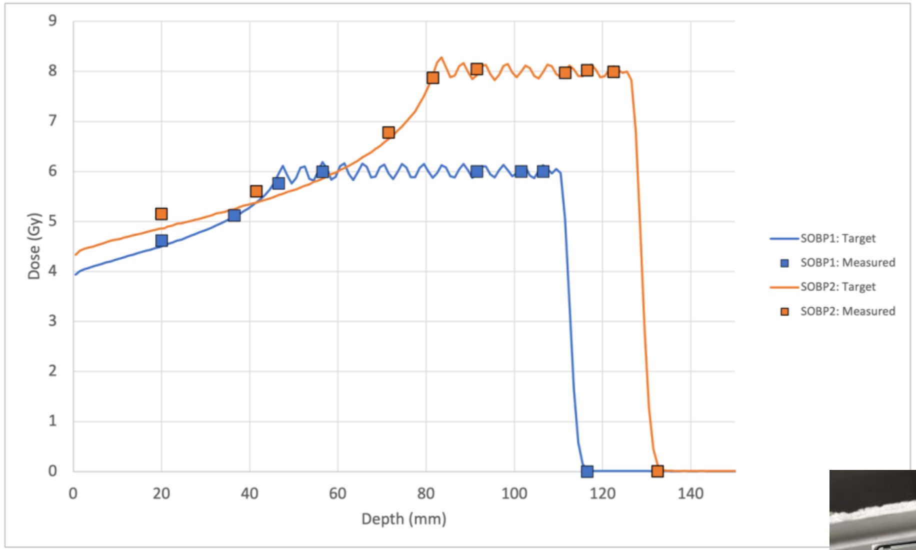


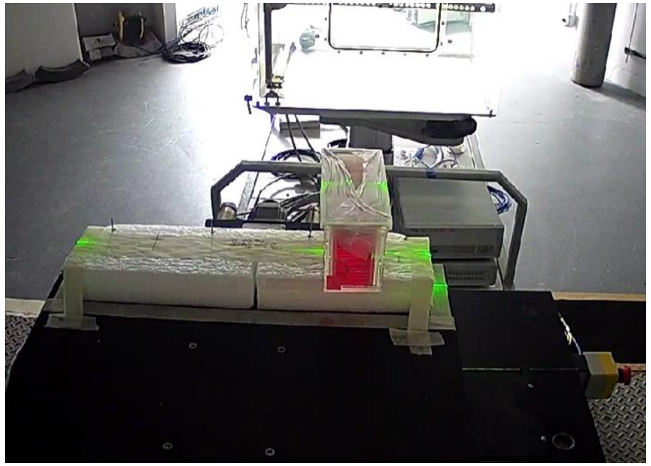
Live cell imaging system

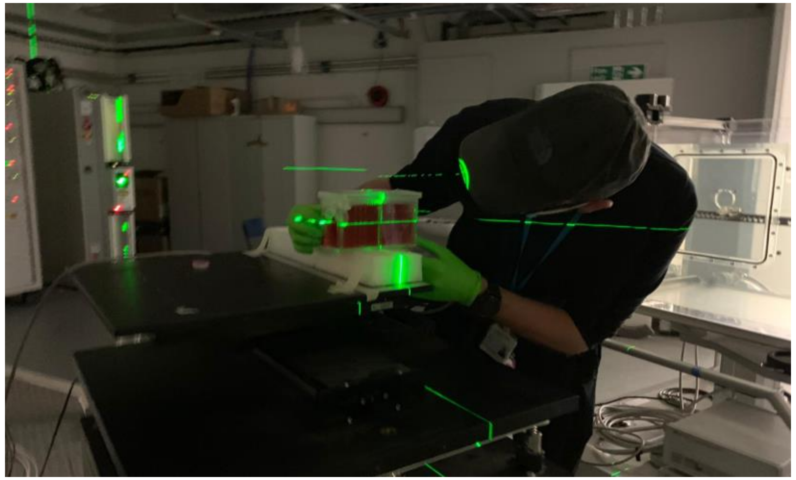


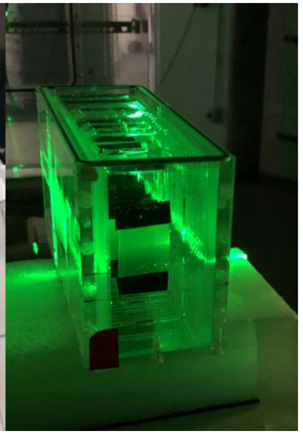
Commissioning, QA and dosimetry

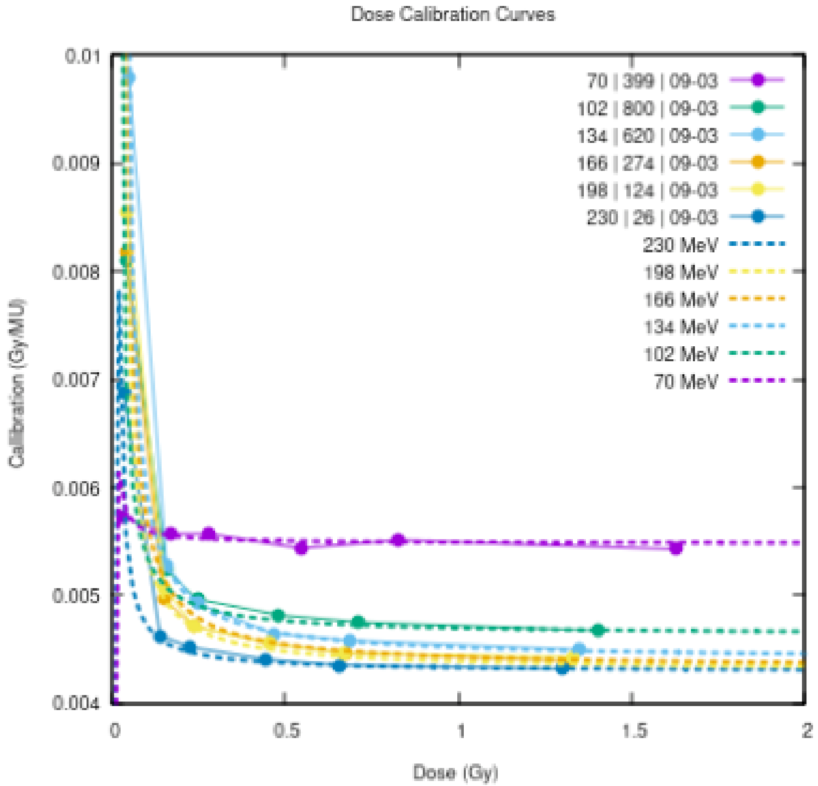
- Accurate, reproducible Dosimetry











120 MeV | 800 nA

Target Dose (Gy)	Measured Dose (Gy)	StDev (Gy)
2.00	2.0074	0.0006
4.00	4.022	0.005
6.00	6.00	0.03
10.00	10.03	0.01

InspireProject

Ultra high dose rate FLASH

Sam Manger
@spmngr

A Manchester bee drawn with the proton FLASH beam at the end of the night in the @Proton_Research research room 🐝 Thanks to Nick Henthorn, @mike_merchant, @ranmackay, @jackdaylward and @SamPIngram for work on FLASH these last two weeks 🐝

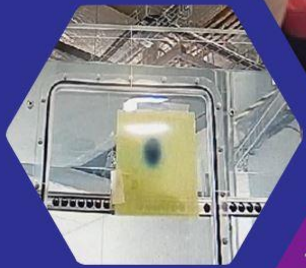
9:52 AM · Aug 6, 2021 · Twitter for iPhone

MANCHESTER CANCER RESEARCH CENTRE | CANCER RESEARCH UK | MANCHESTER CENTRE

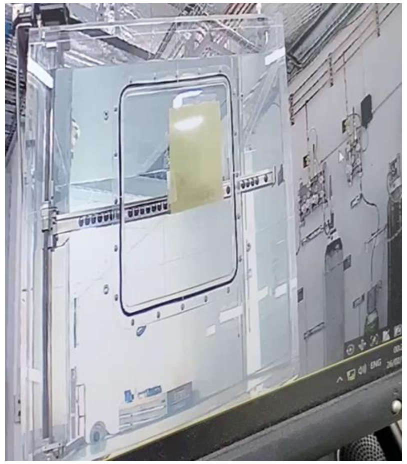
A DAY IN THE LIFE....

"On the night of 25th February 2021 members of the University of Manchester PRECISE group and The Christie Medical Physics and Engineering set out to deliver the first Ultra-High Dose Rate (UHDR) proton beams into the Stoller Research Room of the Proton Beam Therapy Centre......."

Jack Aylward,
Postgraduate Researcher
Research Group: PRECISE



Training and Education Newsletter
Autumn/Winter 2021



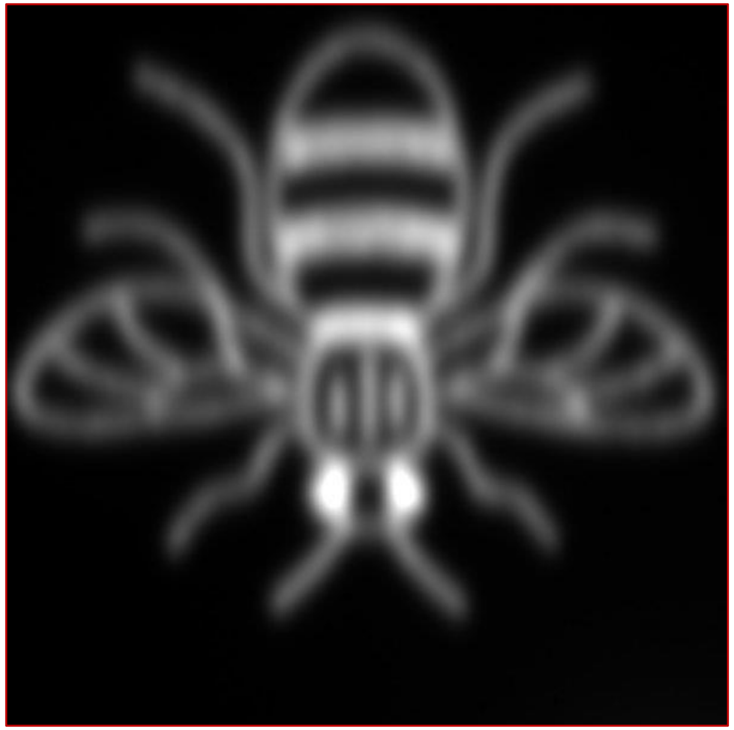
varian
A Siemens Healthineers Company

FlashForward™ Consortium

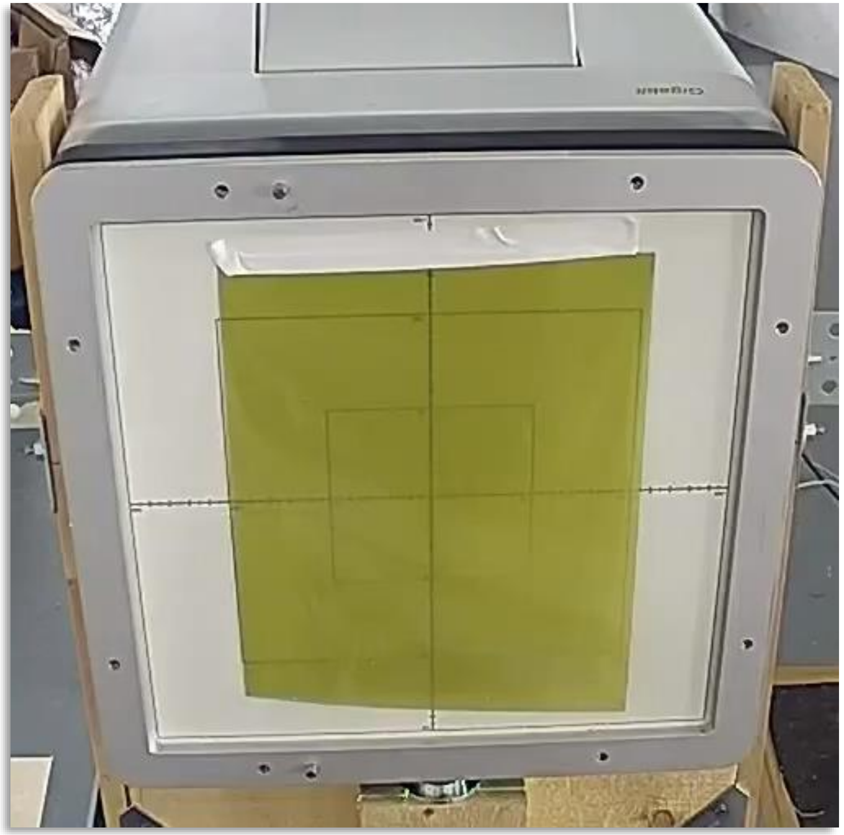
Standard Operation (<=2 nA at nozzle)		
Energy (MeV)	Minimum Nozzle Current (nA)	Maximum Nozzle Current (nA)
70	0.0025	0.41
244	0.52	2.0
FLASH Operation		
Energy (MeV)	Maximum Nozzle Current (nA)	Dose Rate (Gy/s)
244	88	175

FLASH:
Scanning Test

Conventional

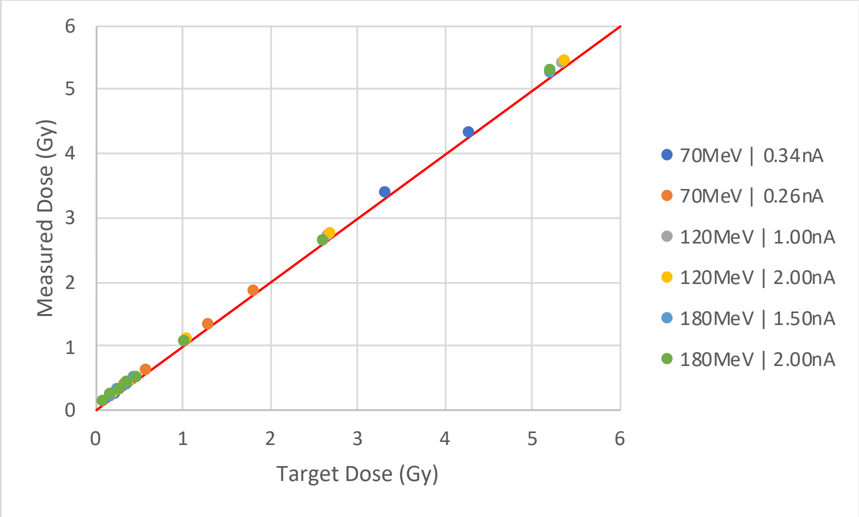


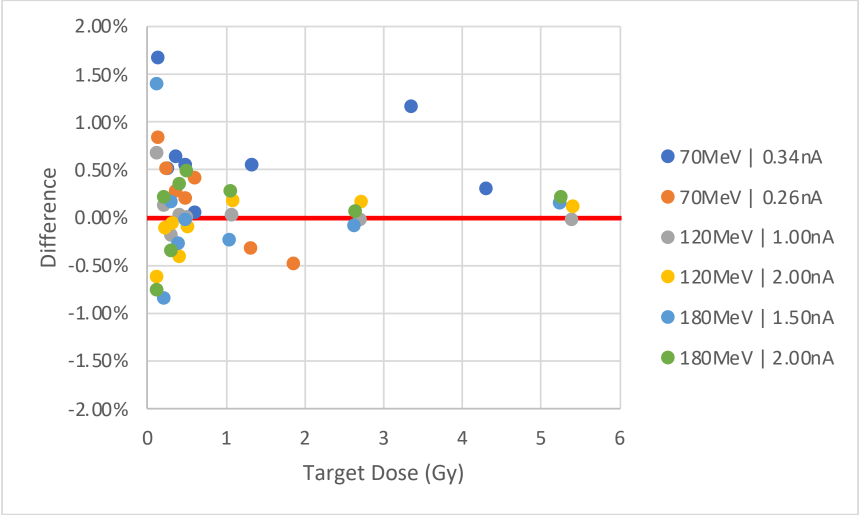
FLASH



DROPBOX/Research Room/Experiments/2021-04-28_Bee

Beamline A – CONV & FLASH dosimetry



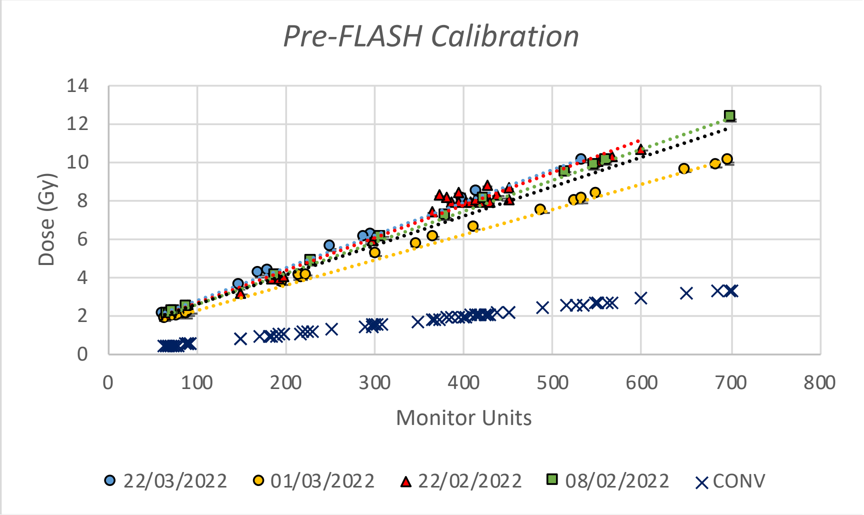


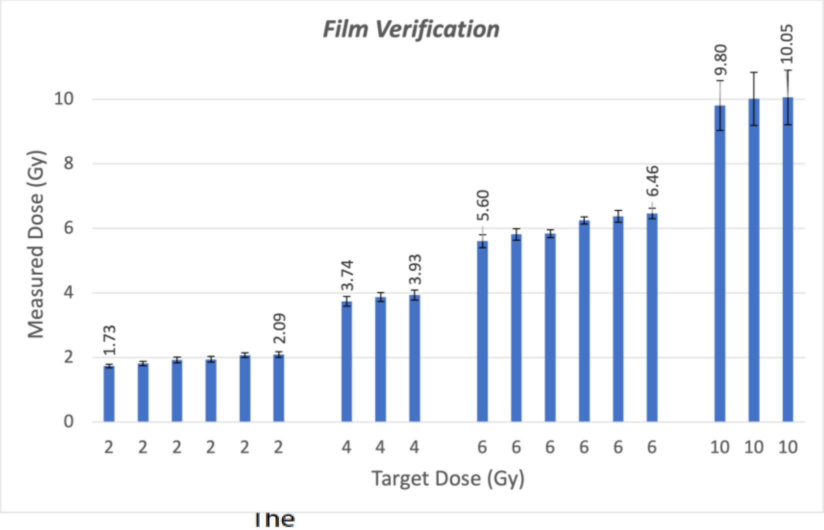
Conventional

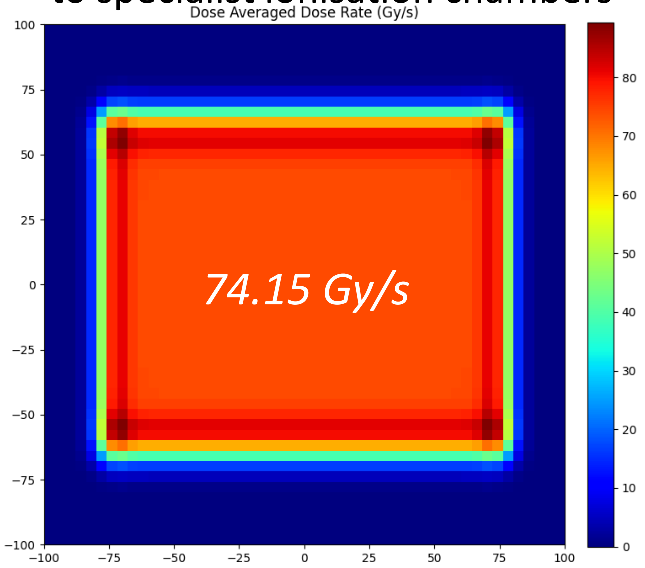
- <= 2 Gy/min
- Comparable dose accuracy and reproducibility to clinical service

FLASH

- >= 40 Gy/s
- Increased dosimetric uncertainty compared to conventional (~5%)
- Competitive performance compared to specialist ionisation chambers







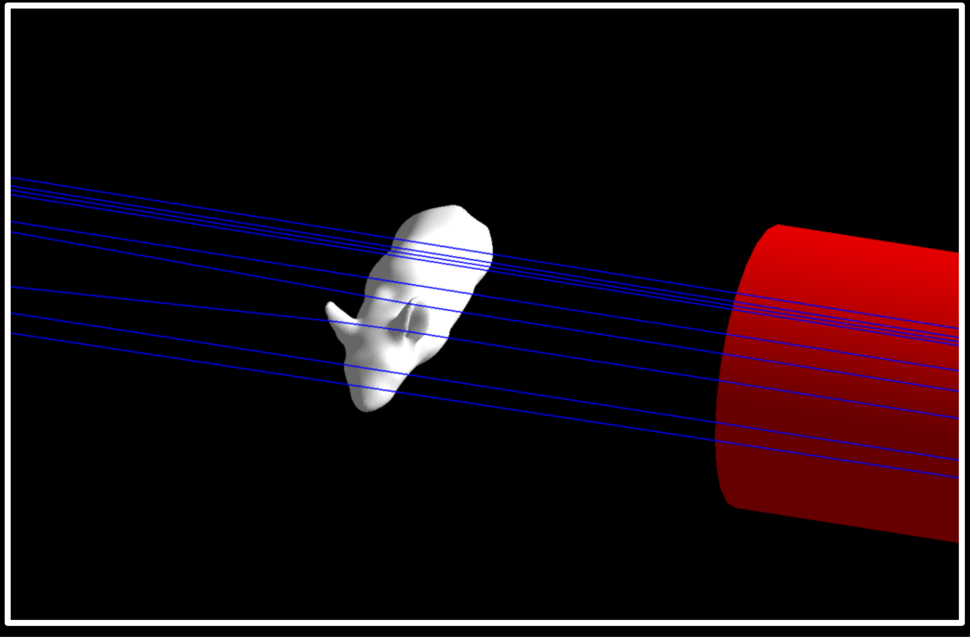
The Precise Group

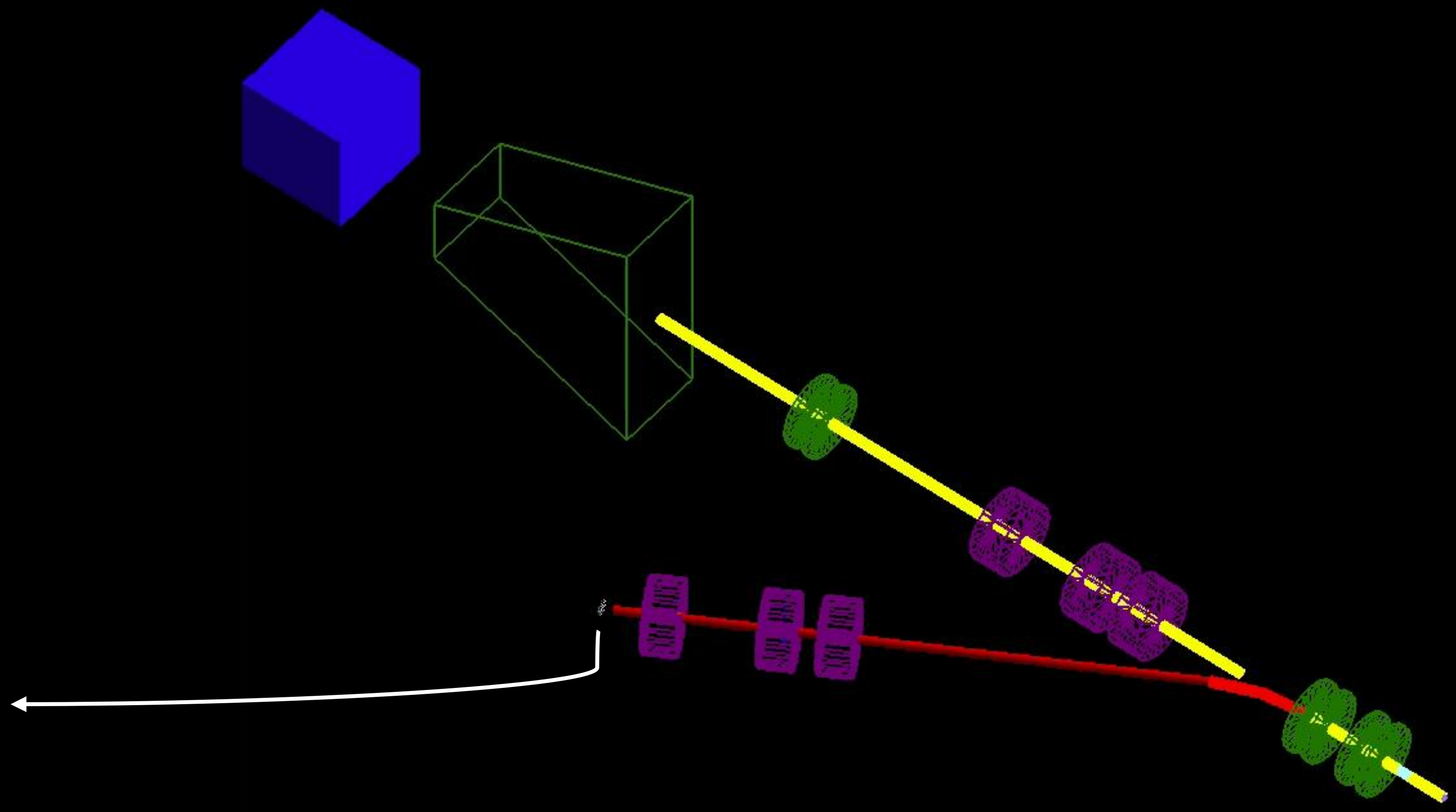
MANCHESTER 1824
The University of Manchester

NHS
The Christie
NHS Foundation Trust

Beamline B – Developing a preclinical beamline

- Monte Carlo model of pre-clinical beamline
- Optimising beamline layout and components
- Investigating beam optics and potential capabilities





MCRC Driving Cancer Team Science
MANCHESTER 1824 The University of Manchester
CANCER RESEARCH UK
NHS The Christie NHS Foundation Trust
CANCER RESEARCH UK | RADNET MANCHESTER

Pre-clinical Beamline End-station Automation

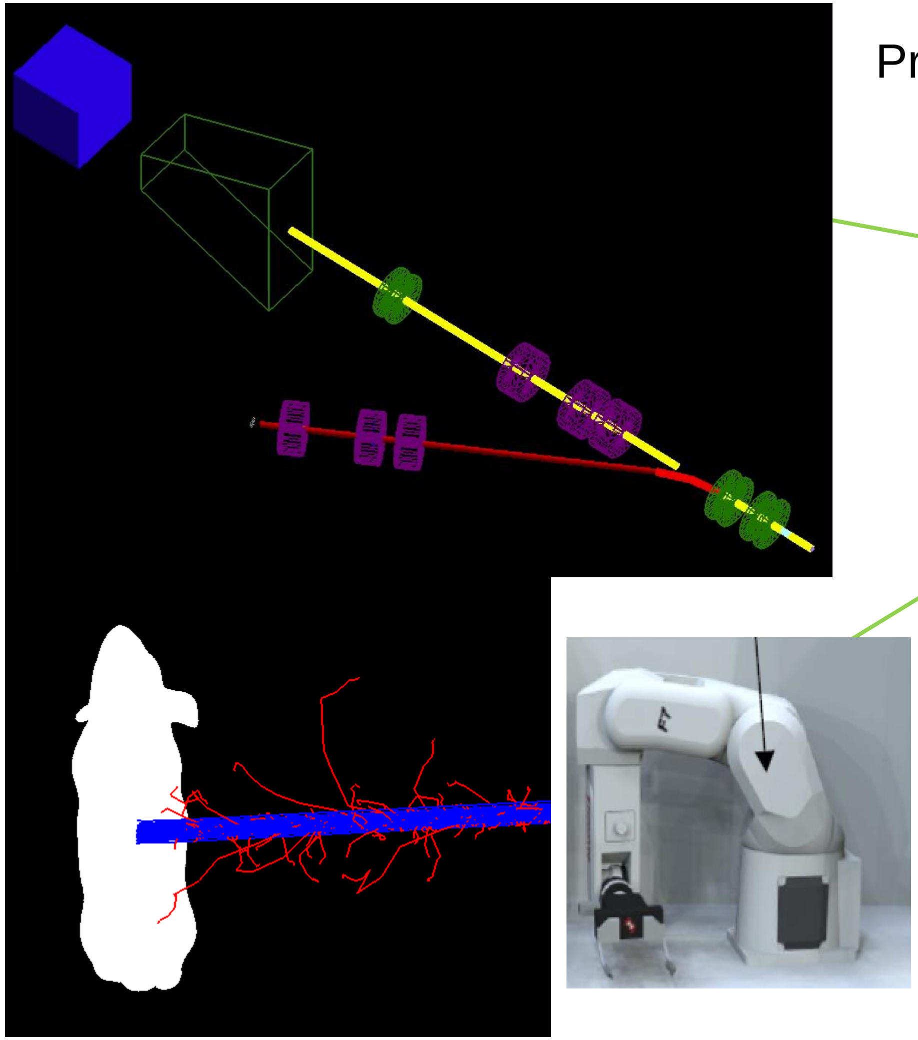
Pre-clinical Beamline

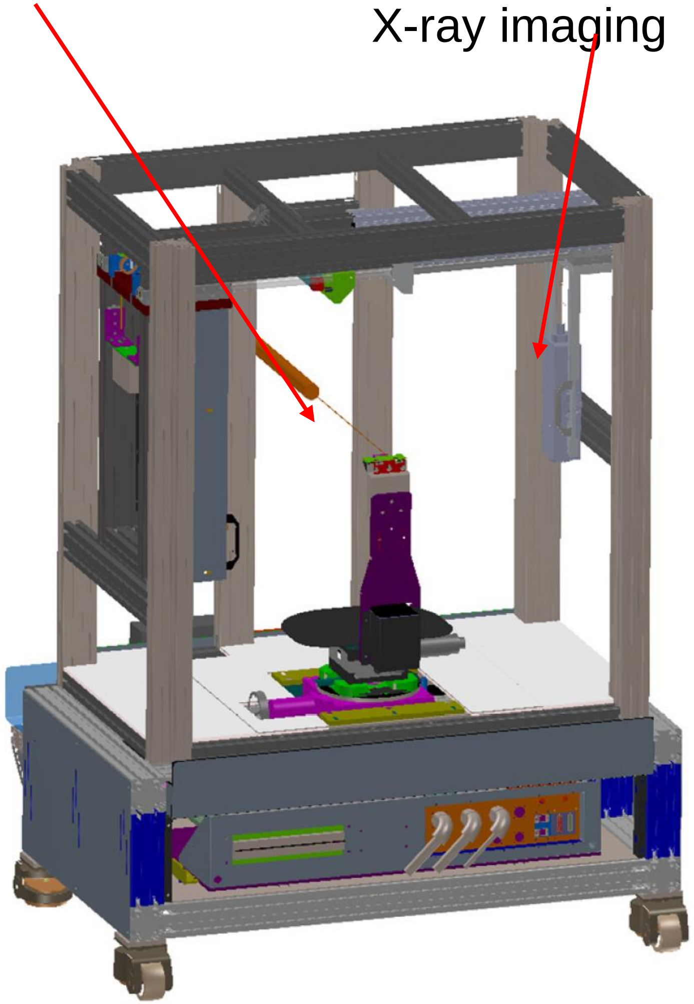
- 1 mm σ spot, 3 cm x 3 cm scanning area
- Flash capable (Bragg peak) [1 MeV – 65 MeV]
- Working with Cockcroft Institute (Prof R Appleby)

Investigating automation solutions.

High throughput and high repeatability are central to design philosophy.

Working with XStrahl





XStrahl SARRP Proton Platform

MANCHESTER 1824
The University of Manchester
The Cockcroft Institute of Accelerator Science and Technology
The Precise Group
NHS
The Christie
NHS Foundation Trust

Conclusions

- A group of amazing people have built a research room in a clinical proton facility
- Will work with CERN and Daresbury Labs to use this expertise in ITRF
- Truly Multidisciplinary

Thankyou to a brilliant group of people

The PRECISE Group		
Ran MacKay Norman Kirkby Neil Burnet Mike Merchant Mike Taylor Helena Kondryn Rebecca Parker	Adam Aitkenhead Amy Chadwick Elham Santina Tom Mee Nickolay Korabel Sam Ingram Sam Manger Noemie Defourny John-William Warmenhoven Nicholas Henthorn Emma Biglin	Ed Smith Beth Rothwell Yunzhou Xia Charlie Heaven Danni Love Hannah Wanstall Jack Aylward Sam Burford-Eyre Abigail Hemming
Additional Thanks to:		
Shaun Atherton Richard Ling Adam Glover Hywel Owen Rob Appleby Staff of Cockcroft Institute		

INSPIRE is funded from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 730983

Questions?