Proton Therapy: Highlights of Inspire project: advances in Proton therapy

Karen Kirkby

Richard Rose Chair in Proton Therapy

University of Manchester/ The Christie NHS Foundation Trust

Cockcroft Institute

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008548

Disclosures

- Member Varian FlashForward™ consortium
- Varian Framework Agreement

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

Thank you

- Invitation to speak
- Colleagues in INSPIRE
- International Advisory Committee, Ethics Committee, User selection panel
- EU for funding INSPIRE
- PO and reviewers
- Wonderful Project Managers Helena Kondryn, Rebecca Parker

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

Collaborations

ARIE PUBLICATIONS

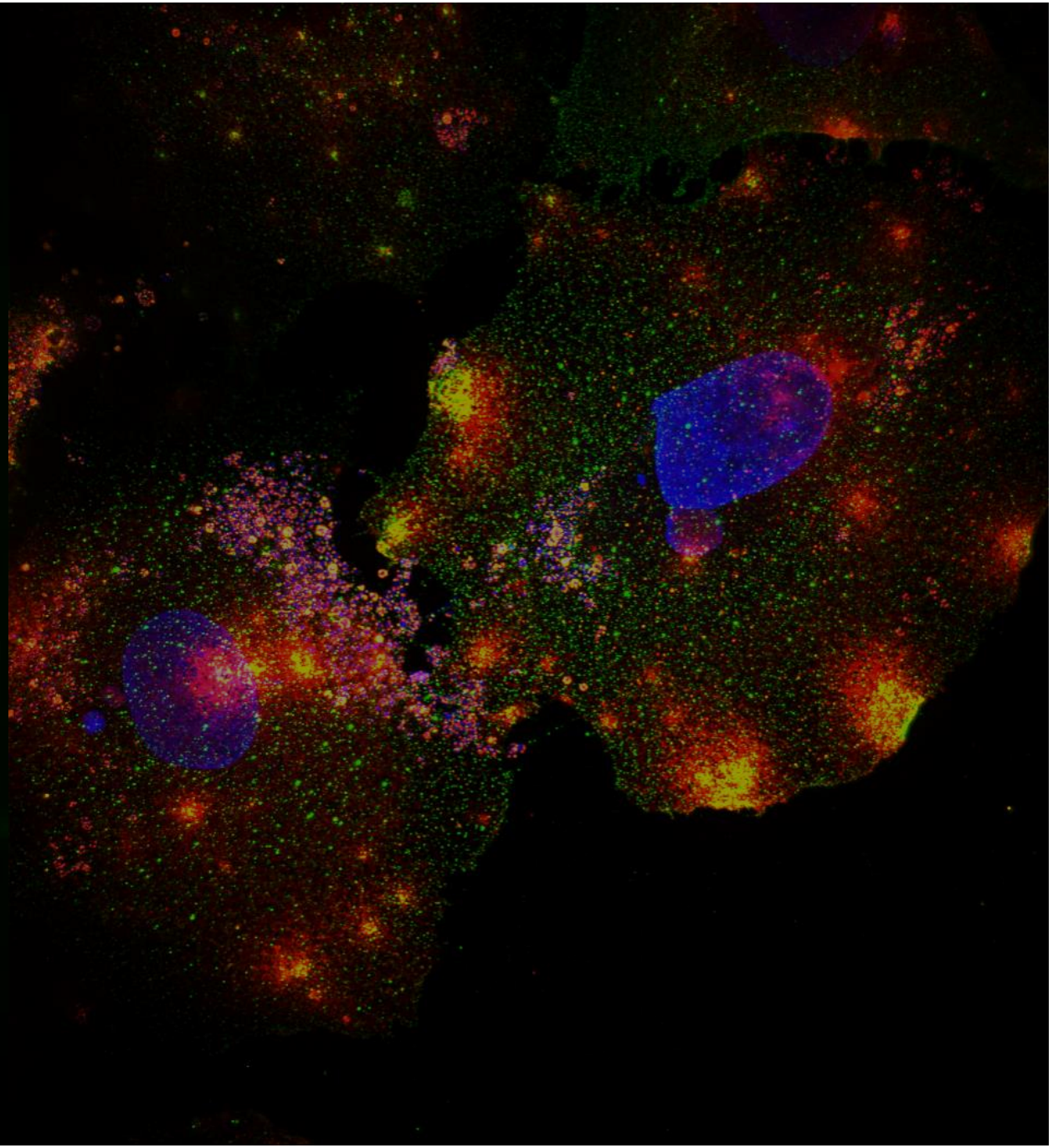
https://doi.org/10.5281/zenodo.4049768

https://doi.org/10.5281/zenodo.4049719

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

Contents

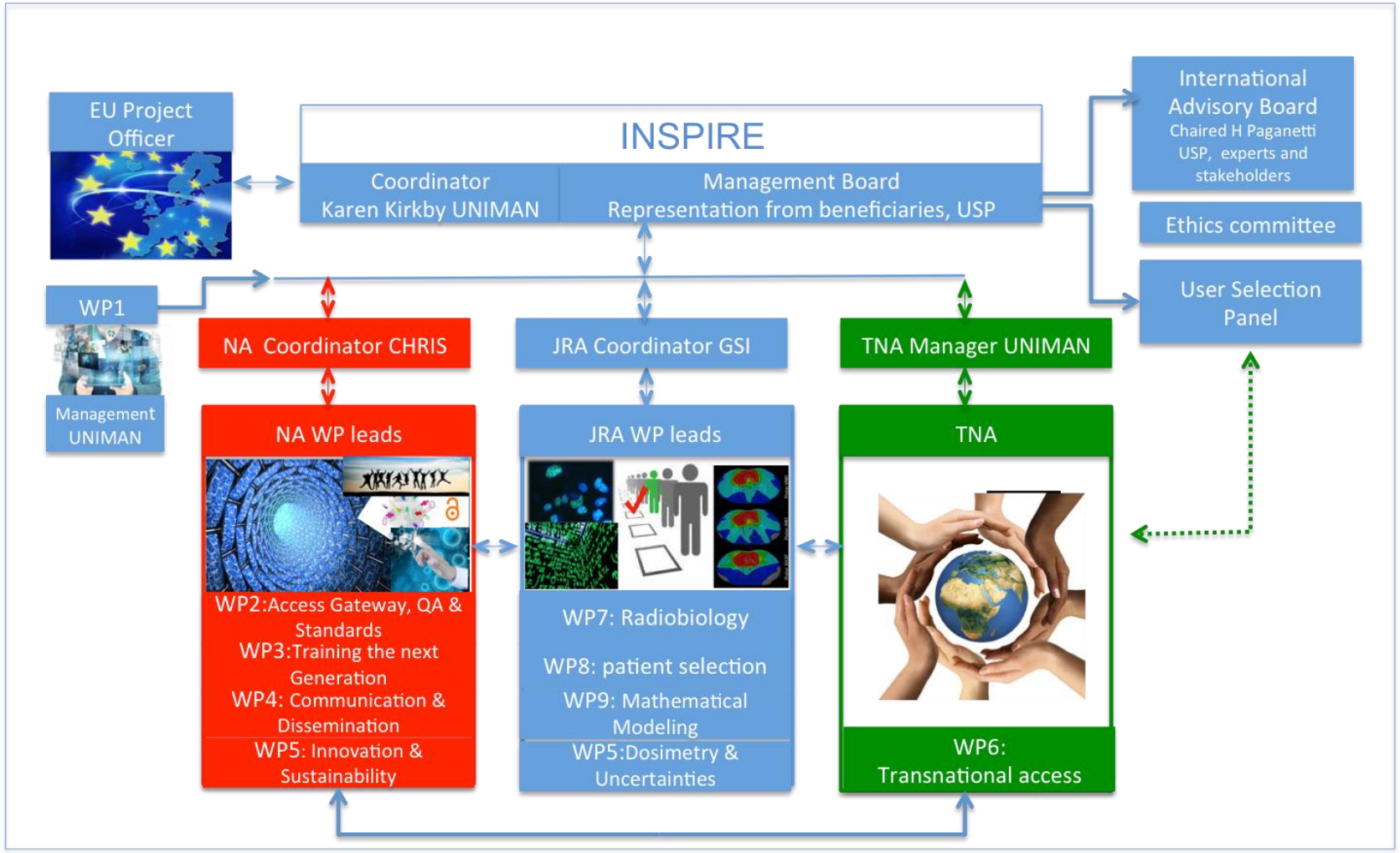
- What is Inspire
- Transnational Access
- Networking Activities
- Future



What is INSPIRE?

- €5M (Coordinated by Manchester)
- Integrating proton research across Europe (now contains heavy ions GSI, KVI)
- 17 partners
- Networking, Transnational Access, Joint Research Activities
- 11 TNA providers
- 12 PBT centres; national hubs
- Industry Varian and IBA involvement
- https://protonsinspire.eu

- Management WP1
- Networking WP2-5
- TNA WP6
- JRA WP7-10



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

Transnational Access

Access to research rooms in PBT clinical facilities

”Clinical beams” in a research environment

Gantries

Fixed beamlines

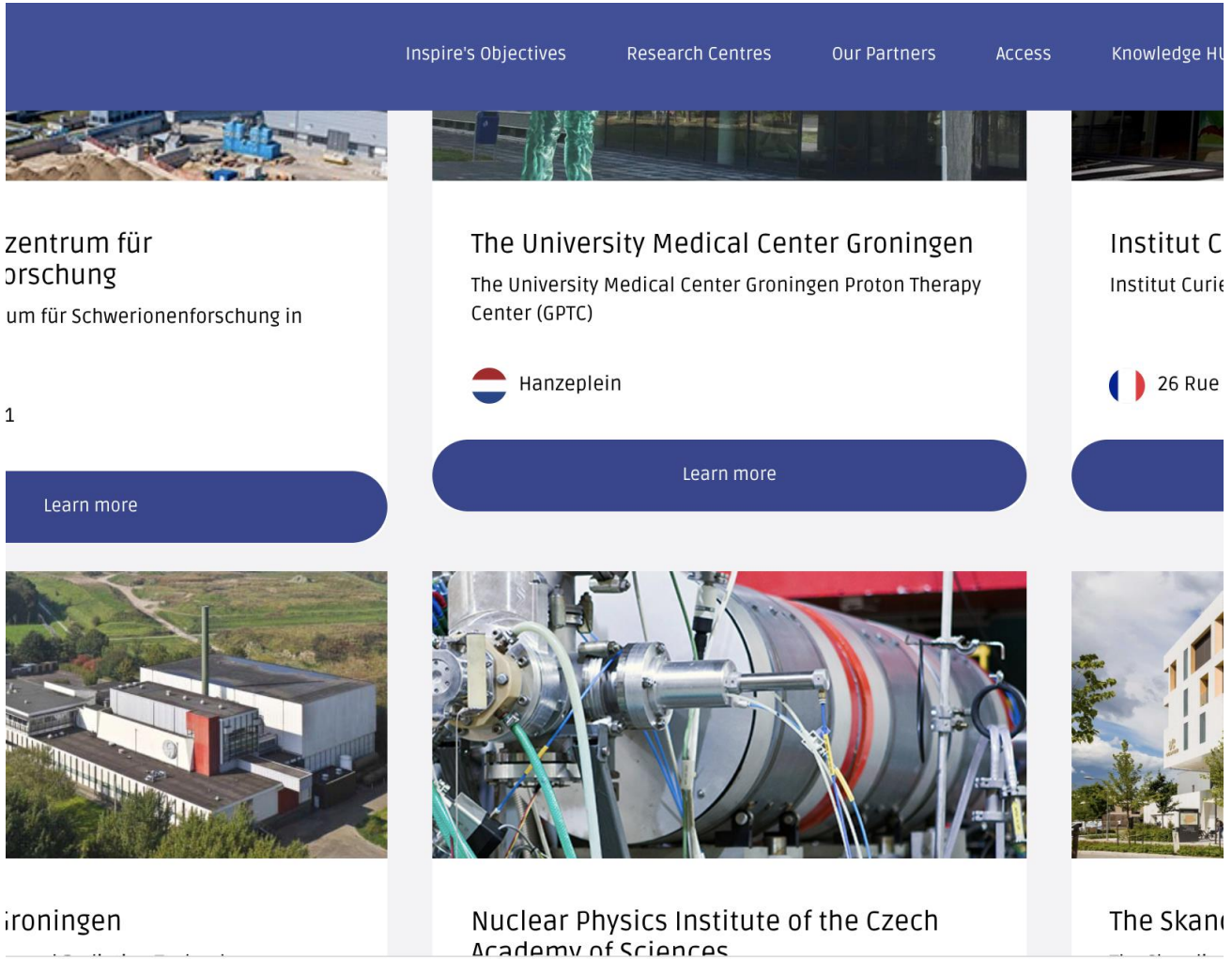
With or w/o scanning nozzle

Some became operational during INSPIRE

Late due to Covid-19

Range of ions GSI and RUG (now part of UMCG)

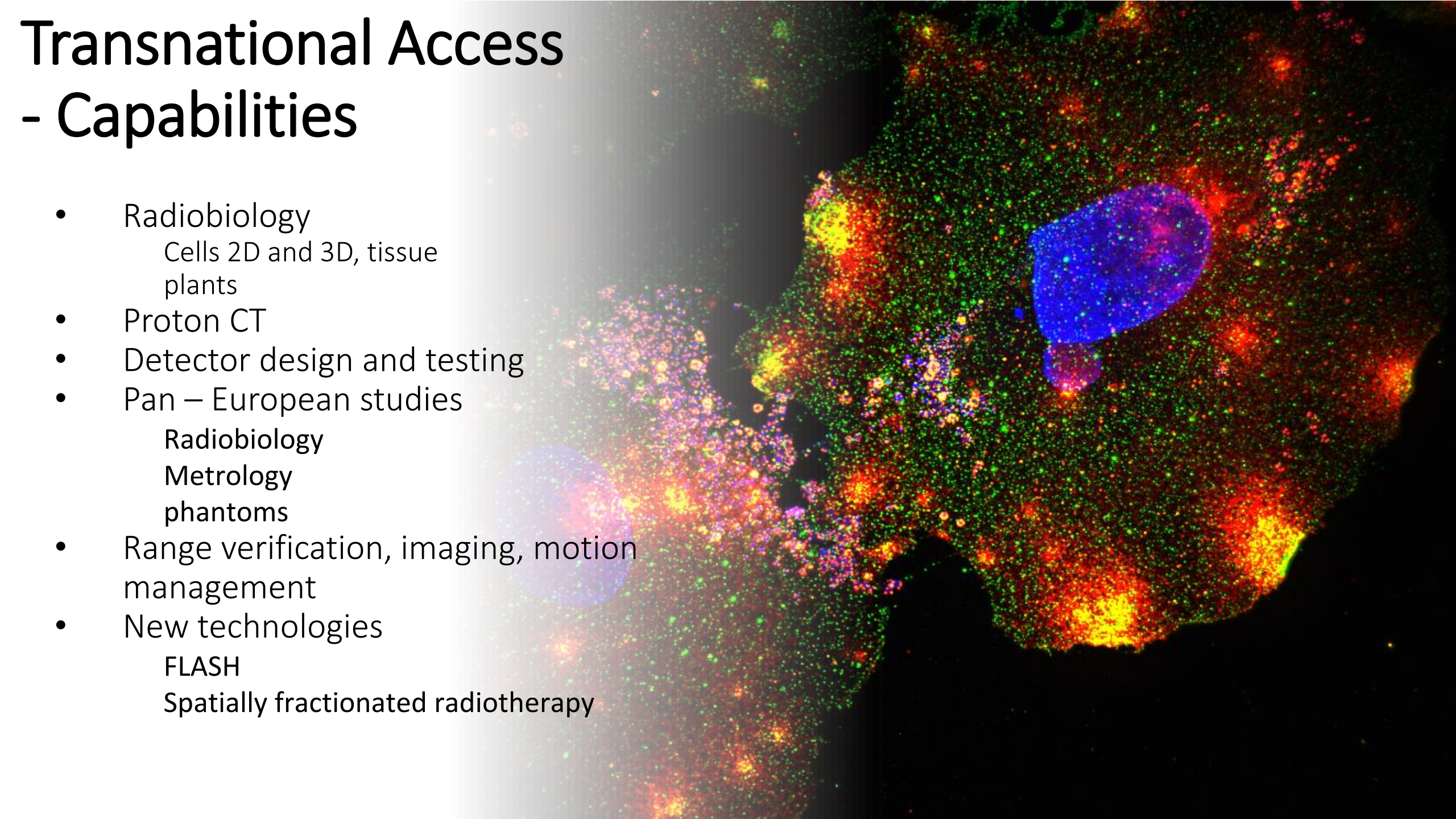
Apply via the website



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

Transnational Access - Capabilities

- Radiobiology
  - Cells 2D and 3D, tissue
  - plants
- Proton CT
- Detector design and testing
- Pan – European studies
  - **Radiobiology**
  - **Metrology**
  - **phantoms**
- Range verification, imaging, motion management
- New technologies
  - **FLASH**
  - **Spatially fractionated radiotherapy**



Transnational Access - Capabilities

- Radiobiology
  - Overview of INSPIRE centers' capabilities to perform *in vitro* and *in vivo* experiments with proton beams

REVIEW ARTICLE
Front. Phys., 06 October 2020 | https://doi.org/10.3389/fphy.2020.565055

Download Article Export citation

1,970
TOTAL VIEWS

View Article Impact

Mapping the Future of Particle Radiobiology in Europe: The INSPIRE Project

Nicholas T. Henthorn[1,2†], Olga Sokol[3†], Marco Durante[3,4*], Ludovic De Marzi[5], Frederic Pouzoulet[6], Justyna Miszczyk[7], Pawel Olko[7], Sytze Brandenburg[8,9], Marc Jan van Goethem[8,9], Lara Barazzuol[9,10], Makbule Tambas[9], Johannes A. Langendijk[9], Marie Davídková[11], Vladimír Vondráček[12], Elisabeth Bodenstein[13], Joerg Pawelke[13,14], Antony J. Lomax[15,16], Damien C. Weber[15,17,18], Alexandru Dasu[19,20], Bo Stenerlöw[20], Per R. Poulsen[21], Brita S. Sørensen[21], Cai Grau[21], Mateusz K. Sitarz[21], Anne-Catherine Heuskin[22], Stephane Lucas[22], John W. Warmenhoven[1,2], Michael J. Merchant[1,2], Ran I. Mackay[1,23] and Karen J. Kirkby[1,2]

[1]Division of Cancer Sciences, Faculty of Biology, Medicine and Health, School of Medical Sciences, The University of Manchester,

frontiers in Physics

REVIEW
published: 06 October 2020
doi: 10.3389/fphy.2020.565055

Mapping the Future of Particle Radiobiology in Europe: The INSPIRE Project

Nicholas T. Henthorn[1,2†], Olga Sokol[3†], Marco Durante[3,4*], Ludovic De Marzi[5], Frederic Pouzoulet[6], Justyna Miszczyk[7], Pawel Olko[7], Sytze Brandenburg[8,9], Marc Jan van Goethem[8,9], Lara Barazzuol[9,10], Makbule Tambas[9], Johannes A. Langendijk[9], Marie Davídková[11], Vladimír Vondráček[12], Elisabeth Bodenstein[13], Joerg Pawelke[13,14], Antony J. Lomax[15,16], Damien C. Weber[15,17,18], Alexandru Dasu[19,20], Bo Stenerlöw[20], Per R. Poulsen[21], Brita S. Sørensen[21], Cai Grau[21], Mateusz K. Sitarz[21], Anne-Catherine Heuskin[22], Stephane Lucas[22], John W. Warmenhoven[1,2], Michael J. Merchant[1,2], Ran I. Mackay[1,23] and Karen J. Kirkby[1,2]

[1] Division of Cancer Sciences, Faculty of Biology, Medicine and Health, School of Medical Sciences, The University of Manchester, Manchester, United Kingdom, [2] Manchester Academic Health Science Centre, The Christie NHS Foundation Trust, Manchester, United Kingdom, [3] Department of Biophysics, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany, [4] Department of Condensed Matter Physics, Technische Universität Darmstadt, Darmstadt, Germany, [5] Radiation Oncology Department, Institut Curie, PSL Research University, Paris, France, [6] Translational Research Department, Experimental Radiotherapy Platform, Institut Curie, PSL Research University, Orsay, France, [7] Department of Experimental Physics of Complex Systems, Institute of Nuclear Physics Polish Academy of Sciences, Krakow, Poland, [8] KVI-Center for Advanced Radiation Technology, University of Groningen, Groningen, Netherlands, [9] Department of Radiation Oncology, University Medical Center Groningen, University of Groningen, Groningen, Netherlands, [10] Section of Molecular Cell Biology, Department of Biomedical Sciences of Cell and Systems, University Medical Center Groningen, University of Groningen, Groningen, Netherlands, [11] Department of Radiation Dosimetry, Nuclear Physics Institute of the CAS, Prague, Czechia, [12] Proton Therapy Center Czech, Prague, Czechia, [13] OncoRay – National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Helmholtz-Zentrum Dresden – Rossendorf, Technische Universität Dresden, Dresden, Germany, [14] Helmholtz-Zentrum Dresden – Rossendorf, Institute of Radiooncology - OncoRay, Dresden, Germany, [15] Centre for Proton Therapy, Paul Scherrer Institute, Villigen, Switzerland, [16] Department of Physics, ETH, Zurich, Switzerland, [17] Department of Radiation Oncology, University of Zurich, Zurich, Switzerland, [18] Department of Radiation Oncology, University of Bern, Bern, Switzerland, [19] The Skandion Clinic, Uppsala, Sweden, [20] Department of Immunology, Genetics and Pathology, Uppsala University, Uppsala, Sweden, [21] Danish Center for Particle Therapy, Aarhus University Hospital, Aarhus, Denmark, [22] LARN-Laboratory, Namur Research Institute for Life Sciences (NARILIS), University of Namur, Namur, Belgium, [23] Christie Medical Physics and Engineering, The Christie NHS Foundation Trust, Manchester, United Kingdom

OPEN ACCESS

Edited by:
Federico Giove, Centro Fermi - Museo storico della fisica e Centro studi e ricerche Enrico Fermi, Italy

Reviewed by:
Michela Marafini, Centro Fermi - Museo storico della fisica e Centro studi e ricerche Enrico Fermi, Italy
Giuseppe A. Pablo Cirrone, Laboratori Nazionali del Sud (INFN), Italy

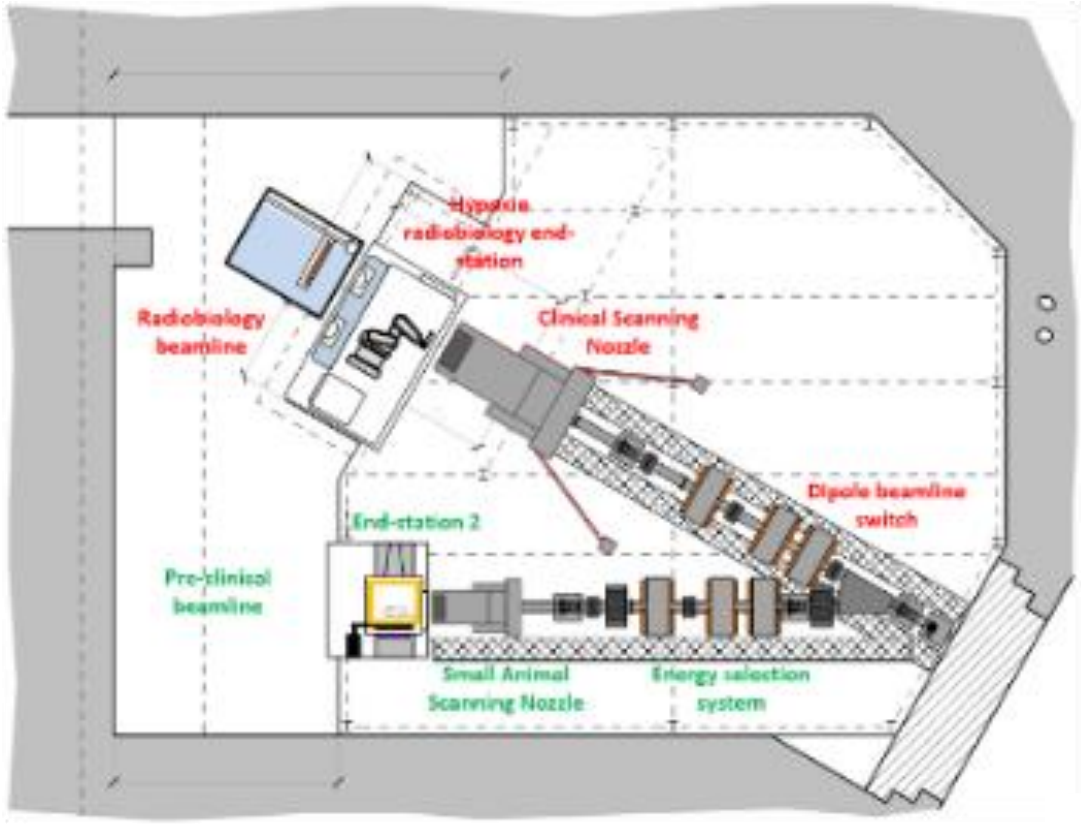
***Correspondence:**
Marco Durante
m.durante@gsi.de

†These authors have contributed equally to this work

Specialty section:
This article was submitted to Medical Physics and Imaging, a section of the journal Frontiers in Physics

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

PBT Research room: design



Mike Merchant

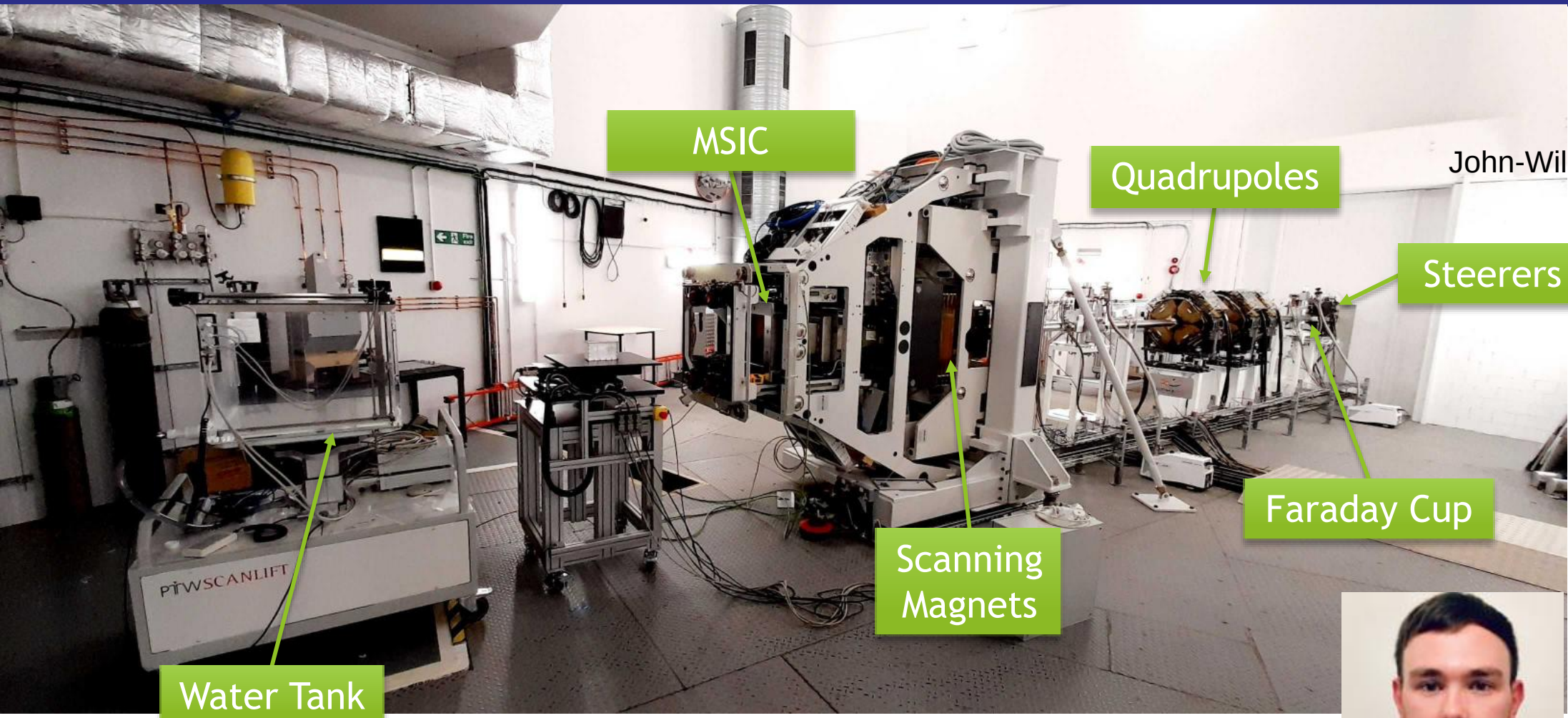
Mike Taylor

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

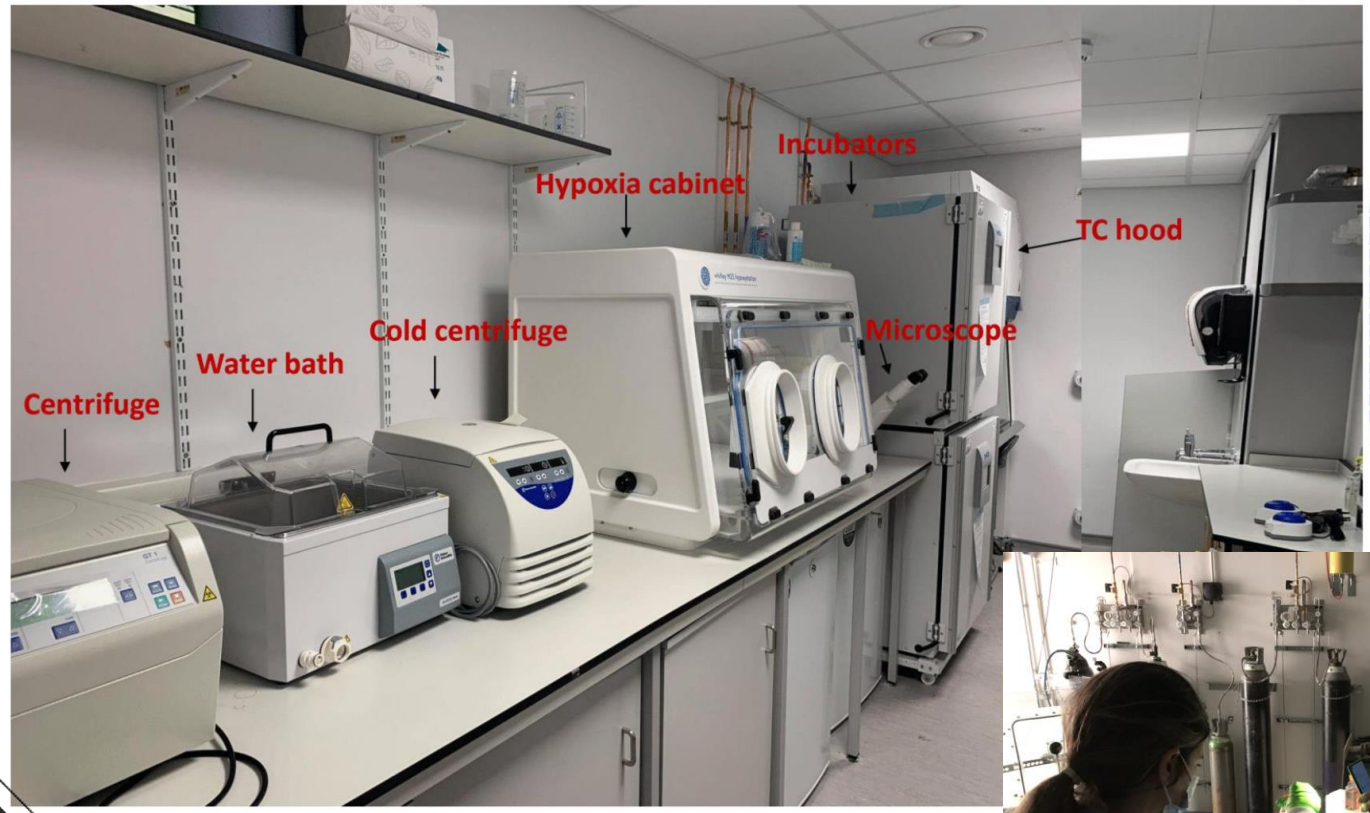
Nick Henthorn

Sam Ingram

Sam Manger

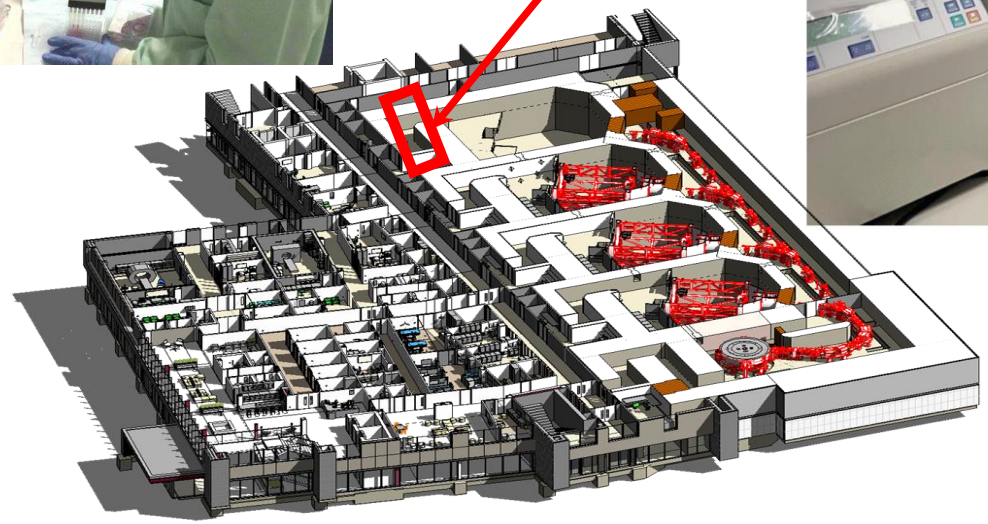
PBT Research room: Bio Prep room

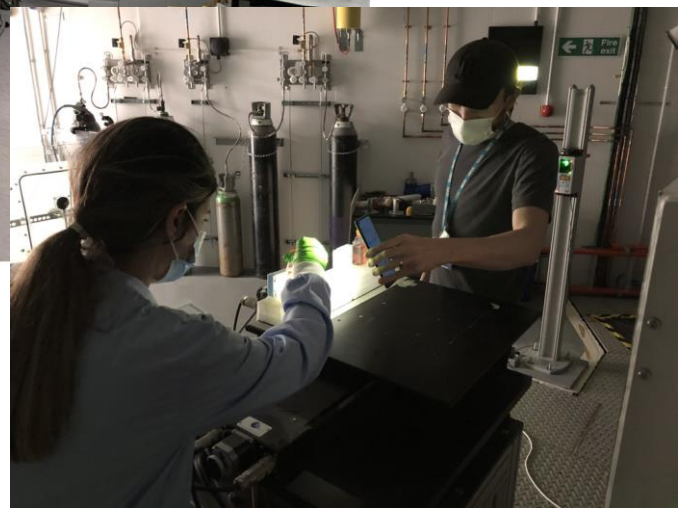
The Christie
Charitable Fund



Live cell imaging system

EVOS m7000





MANCHESTER 1824
The University of Manchester

The Precise Group

NHS
The Christie
NHS Foundation Trust

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 x2 0 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

Ultra high dose rate FLASH

MANCHESTER CANCER RESEARCH CENTRE

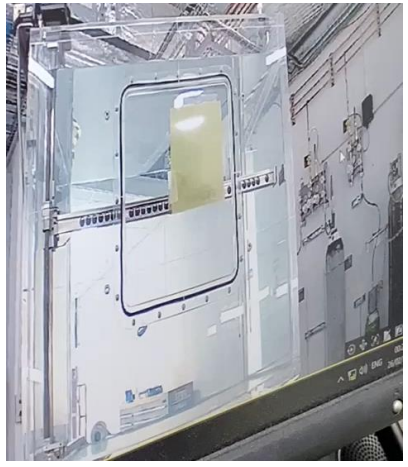
CANCER RESEARCH UK | MANCHESTER CENTRE

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



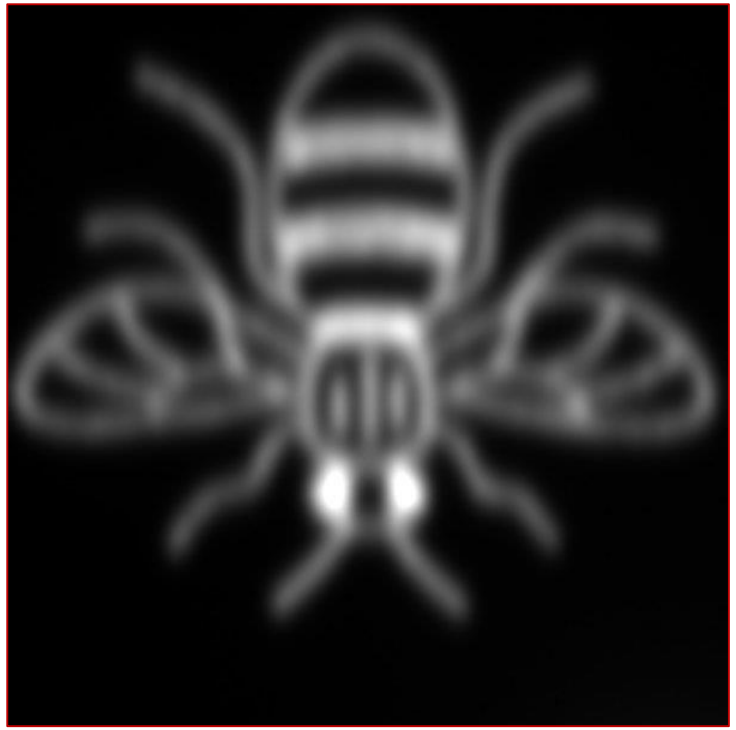
varian
A Siemens Healthineers Company

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

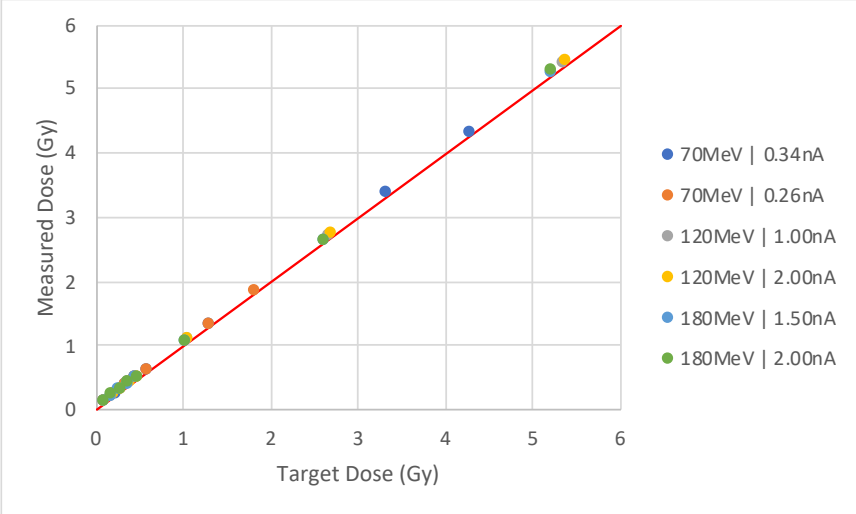
Conventional

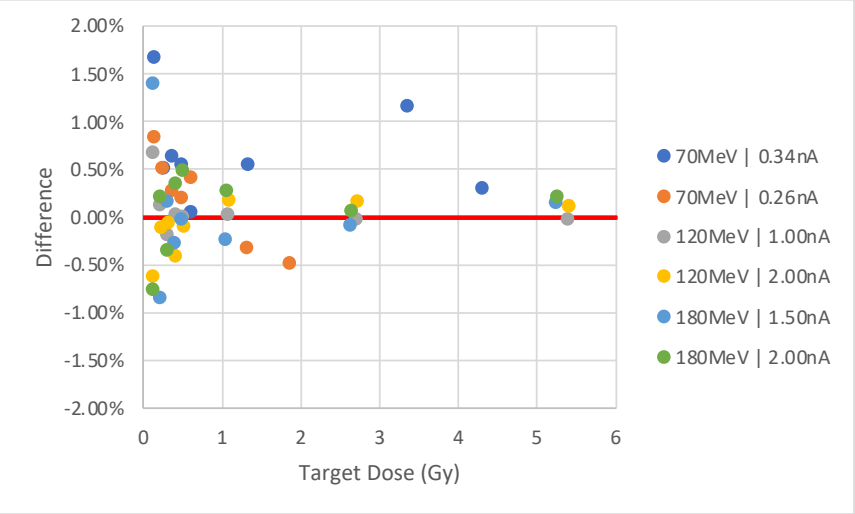


FLASH

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

Beamline A – CONV & FLASH dosimetry



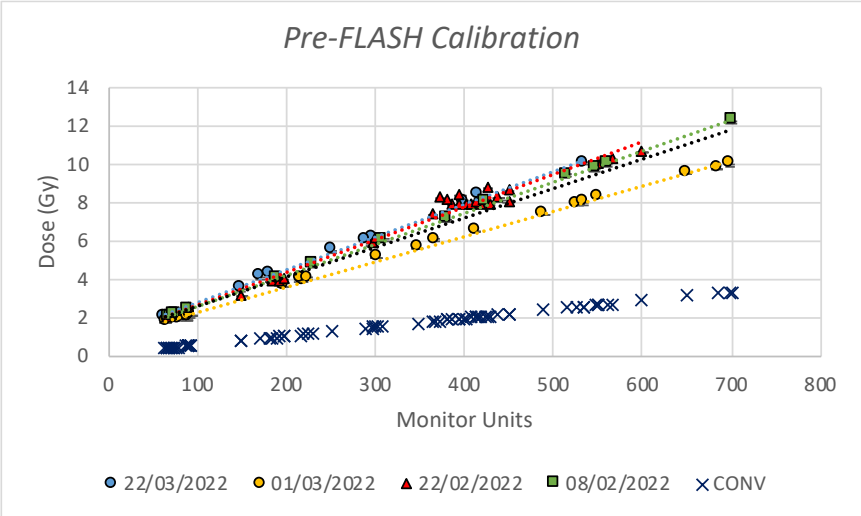


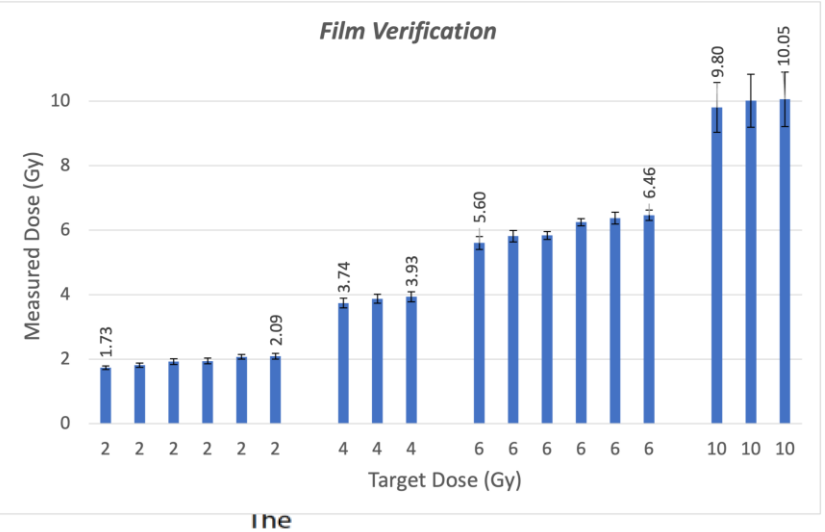
Conventional

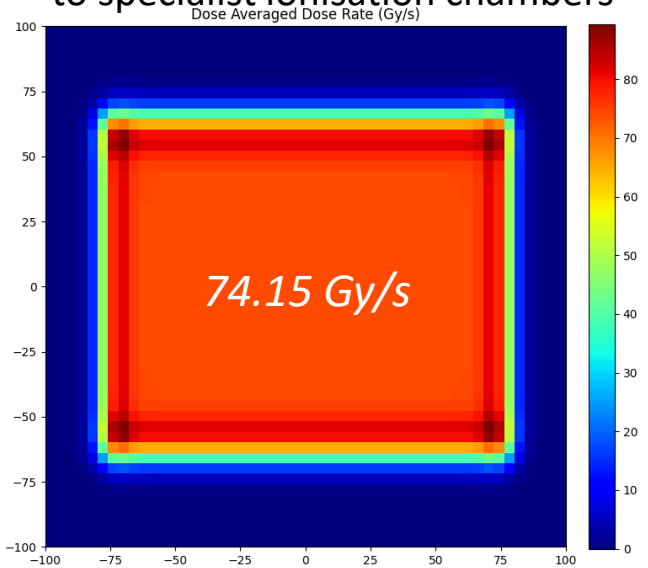
- <= 2 Gy/min
- Comparable dose accuracy and reproducibility to clinical service

FLASH

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







The University of Manchester

The Precise Group

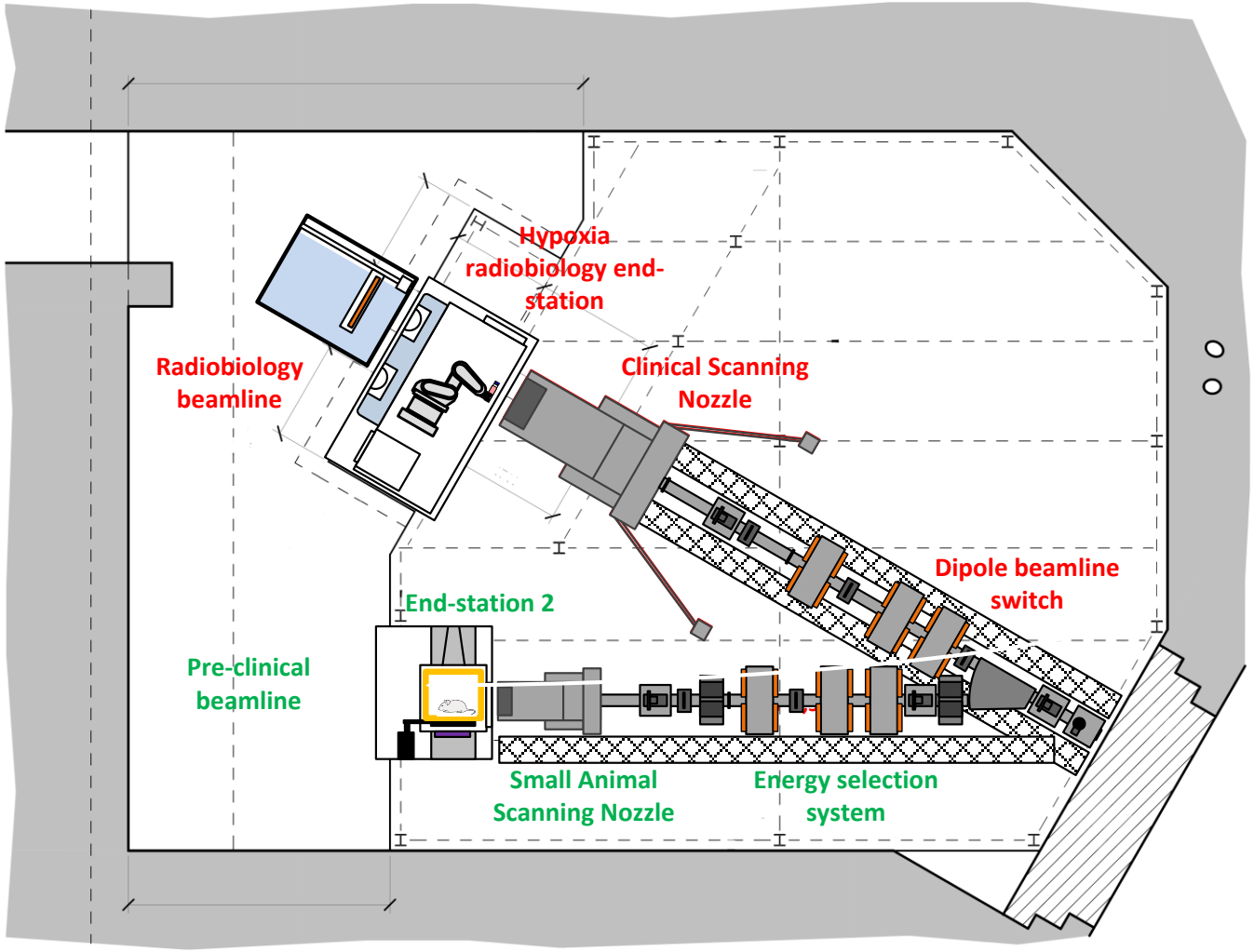
The Christie NHS Foundation Trust

Beamline B – Developing a preclinical beamline

Pre-clinical beamline
in design & evaluation phase

Design aims:
1 mm σ spot
3 cm x 3 cm scanning area

Imaging capability – Xstrahl SAARP



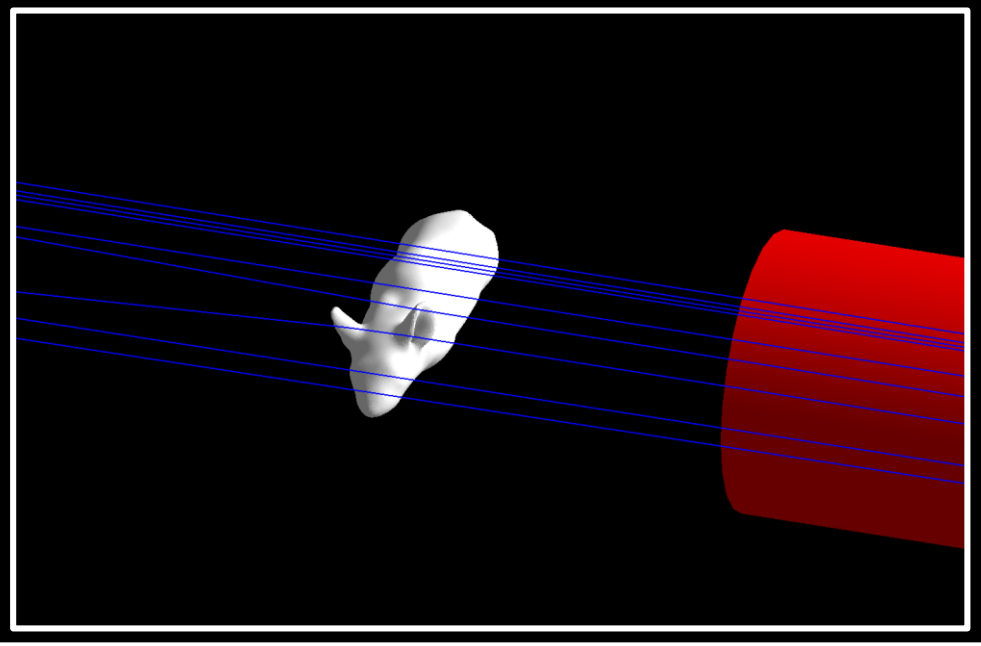
Beamline A:
Built and commissioned.

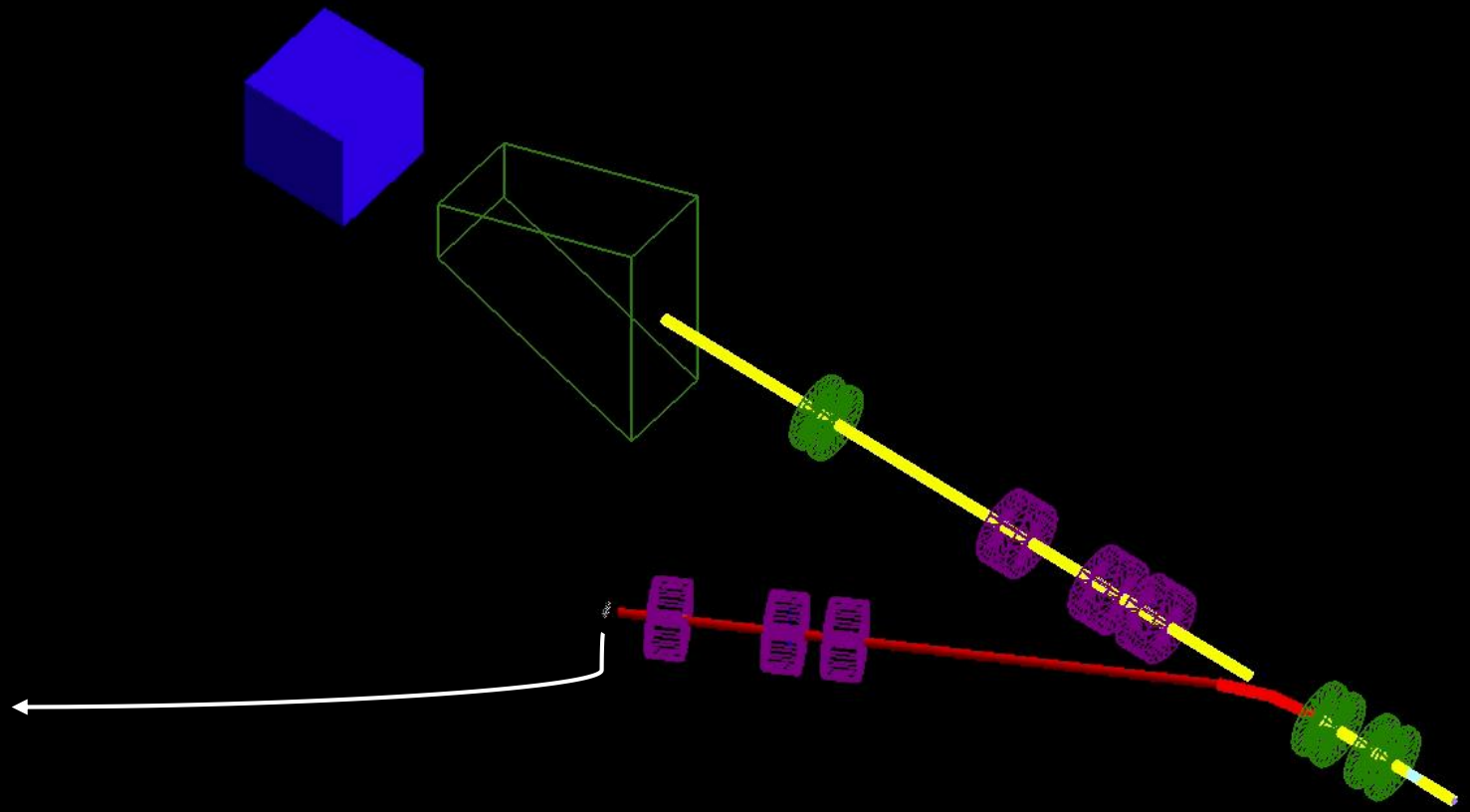
Specifications
70 – 245 MeV
5.5 mm σ spot
30 x 40 cm scan area

- Automated Proton Hypoxia Endstation
- Can deliver FLASH beams

Beamline B – Developing a preclinical beamline

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





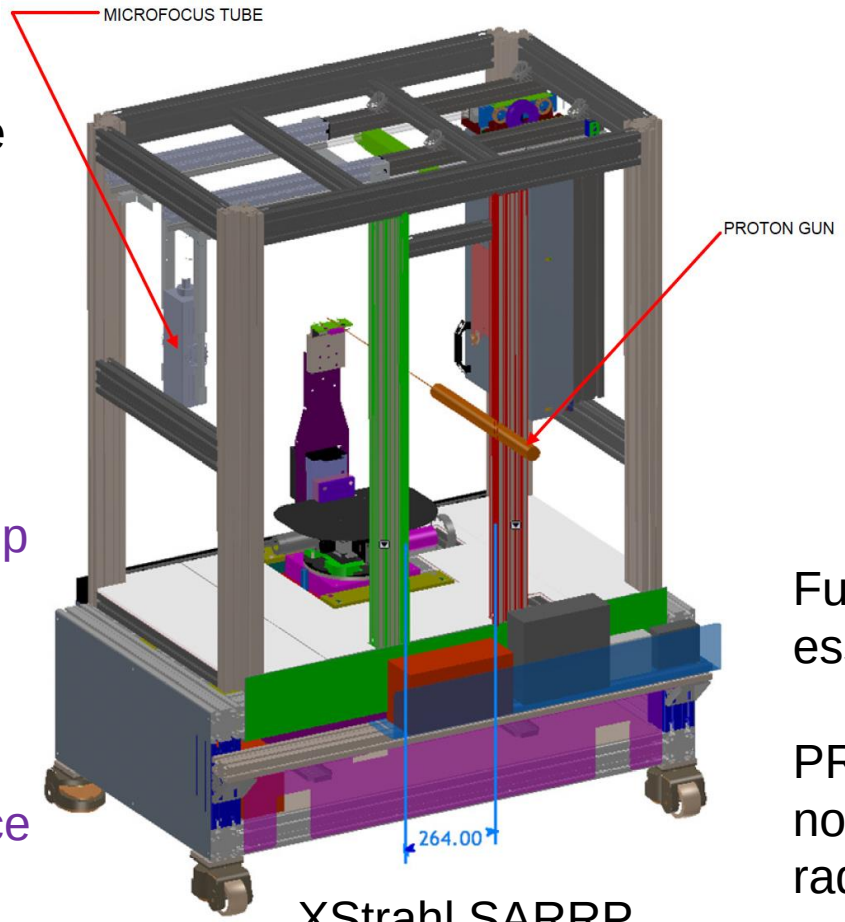
Pre-clinical Beamline End-station Automation

End-station design investigating automation solutions.

High throughput and high repeatability are central to design philosophy.

The consequence of not completing an experiment with animals is higher than *in vitro* radiobiology.

- Experimental requirement to irradiate up to 14 animals per session.
- 4 hours max beam-time per night, including set-up, **dosimetry** tests, and mitigation for any cyclotron maintenance etc



XStrahl SARRP

Full automation from the control room essential especially for FLASH.

PRECISE has experience developing novel automation solutions for radiobiology.

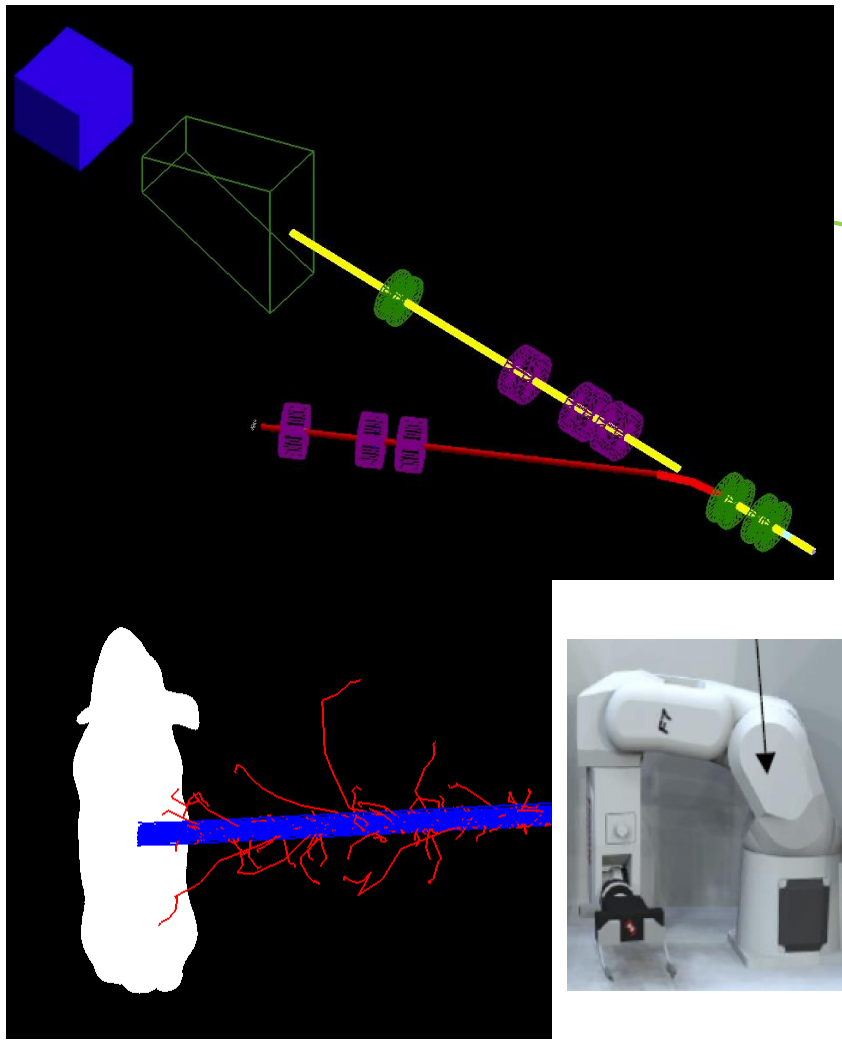
Pre-clinical beamline B development

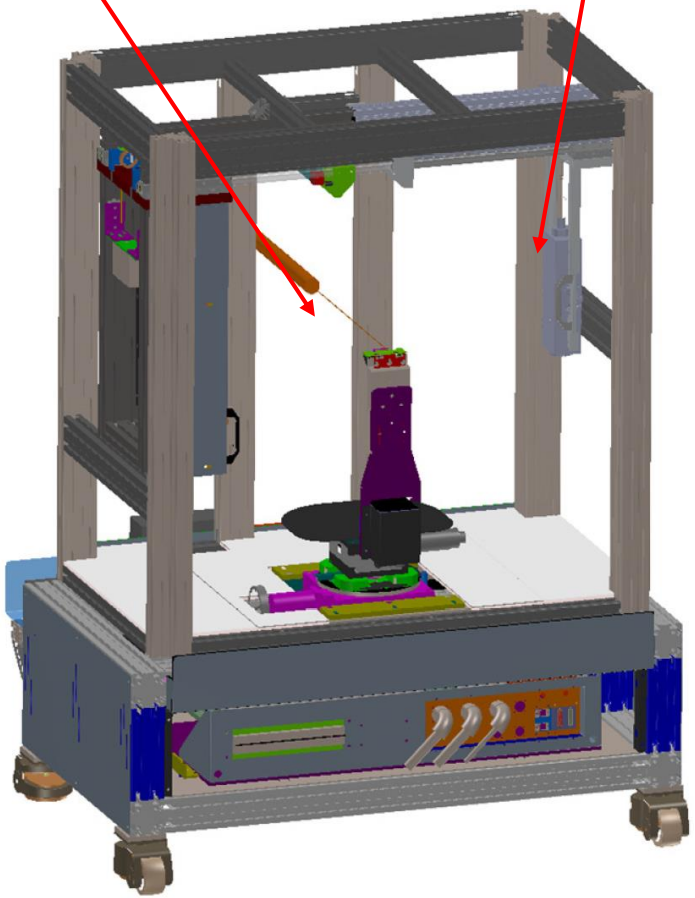
Pre-clinical Beamline

- 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)

Timeline

- **Now**, Design development consultation with suppliers (XStrahl, SigmaPhi), Safety and Licences evaluation
- **Sep 2022**, Formal procurement
- **March 2023**, Begin modifications to RR
- **June 2024**, Install, Commission
- **March 2025**, First experiments





XStrahl SARRP
Proton Platform

The University of Manchester

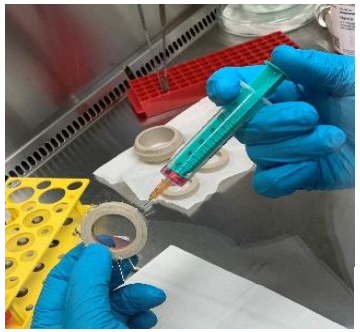
The Cockcroft Institute of Accelerator Science and Technology

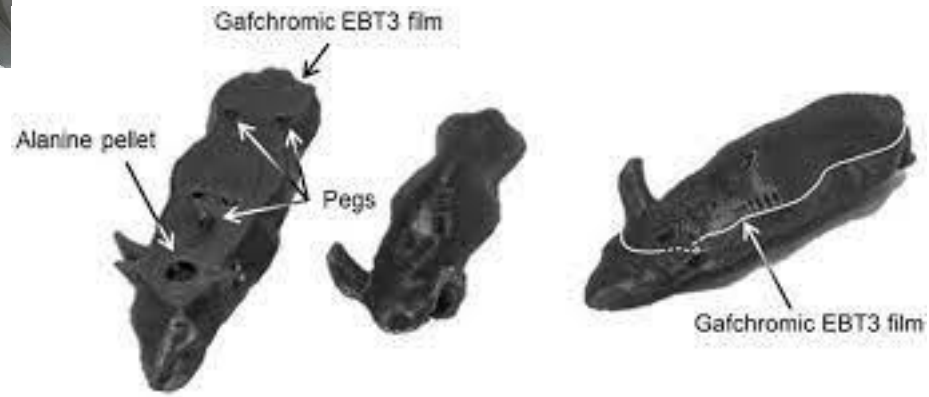
The Precise Group

The Christie NHS Foundation Trust

Transnational Access – expanding capabilities through JRA

- Hypoxia
  - Across a range of different oxygen tensions
  - Compact hypoxia chamber (patent)
- Building a Flash capability
- Zoomorphic phantoms
- Animal irradiation on gantries (patent)
- Software
- Databases
- Drug delivery nano-peanuts (patent)





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

Networking

WP2 QA and Standards

- Joint collaborative projects for benchmarking
  - Radiobiology Olga Sokol GSI
  - Dosimetry Marie Davidkova NPI-CAS
  - RBE and LET Armin Luhr Dresden

WP4 Public Engagement and outreach

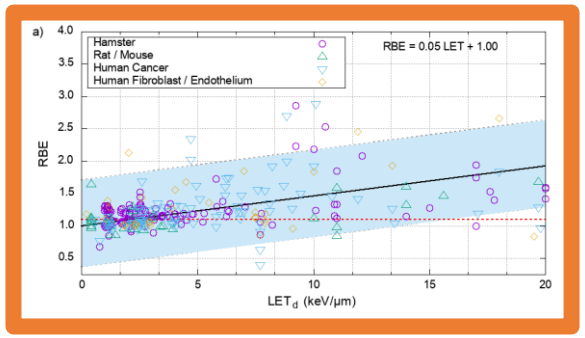
WP5 Innovation and Sustainability

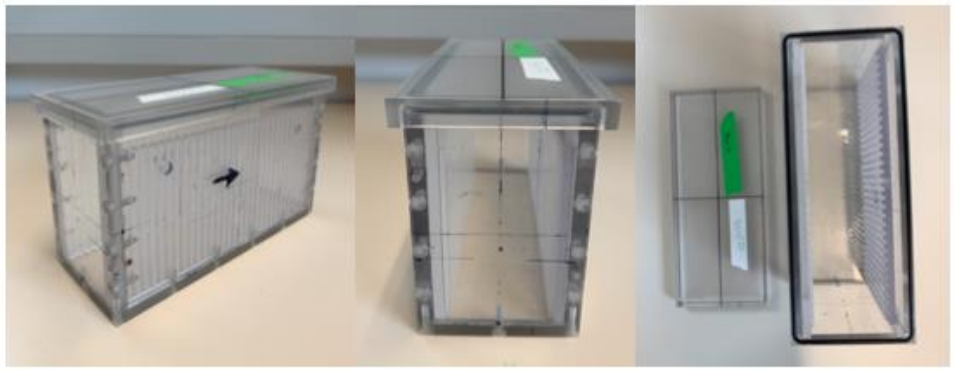
- Innovation Gateway
  - Example of very successful project Varian

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

The INSPIRE Experiment

A Fair Test





Parameters*	Geometry A	Geometry B
Target area size, mm (x, y, z)	60 x 80 x **60****	60 x 80 x **40****
Target center position, mm (z)*	80	105
Physical dose in the target, Gy	6	8

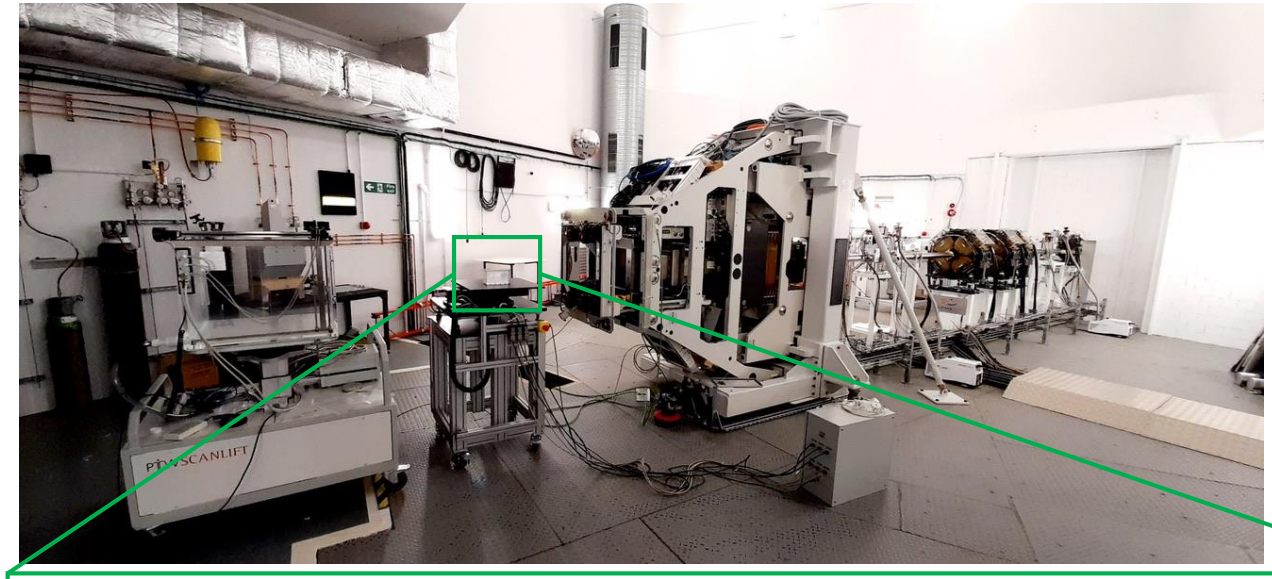
- Same geometry
- Same cell-line (V79)
- Same beams (sort of)
- 9 Institutes:

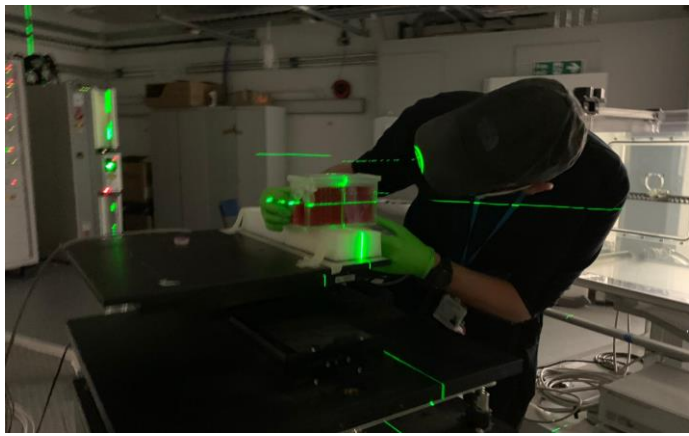
KVI, Groningen; OncoRay, Dresden; Skandion, Uppsala; NPI-CAS, Prague; IFJ-PAN, Krakow; AU, Aarhus; IC, Paris; GSI, Darmstadt; UoM, Manchester

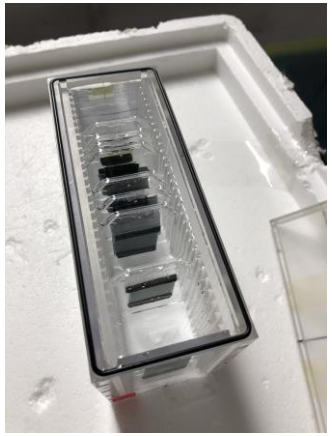
INSPIRE is funded from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement no. 730983

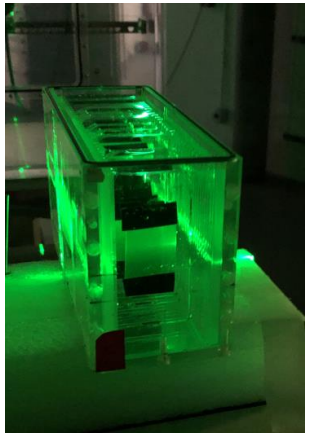
The INSPIRE Experiment

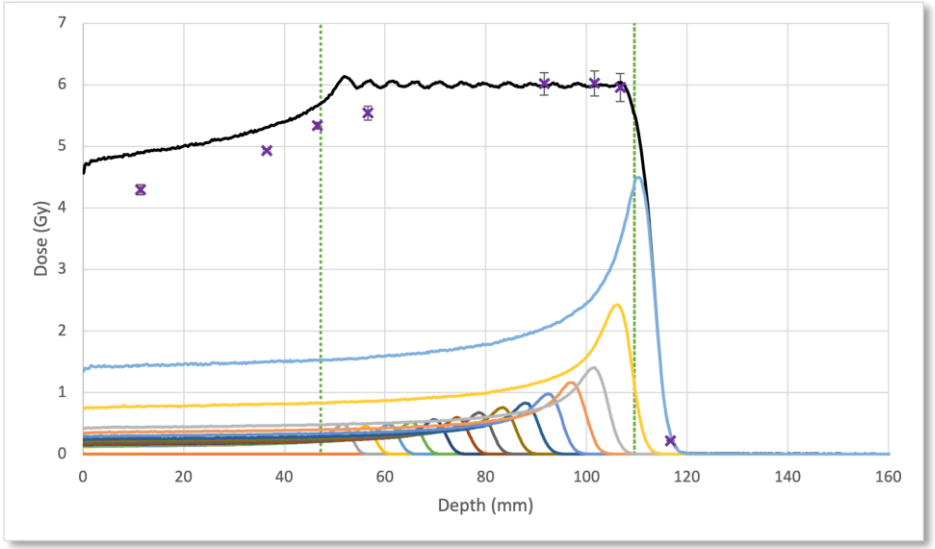
A Fair Test

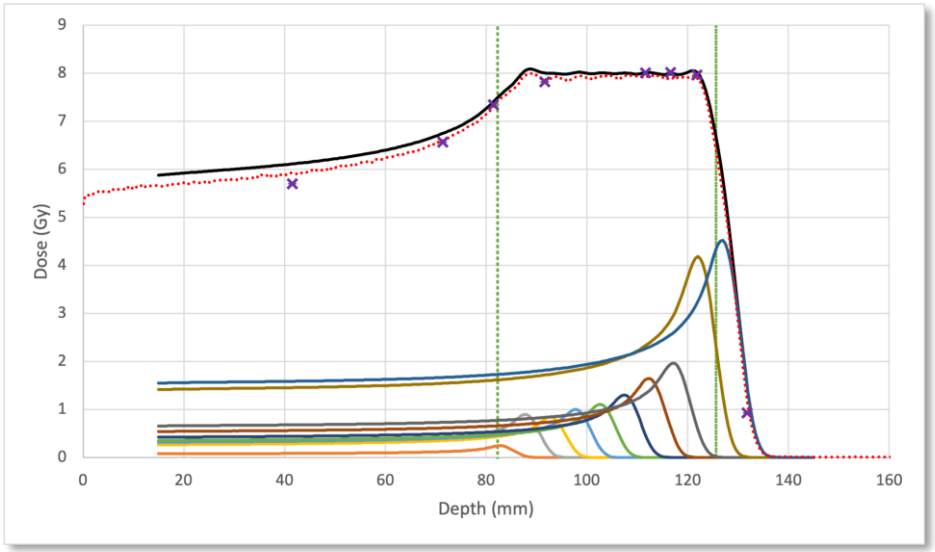












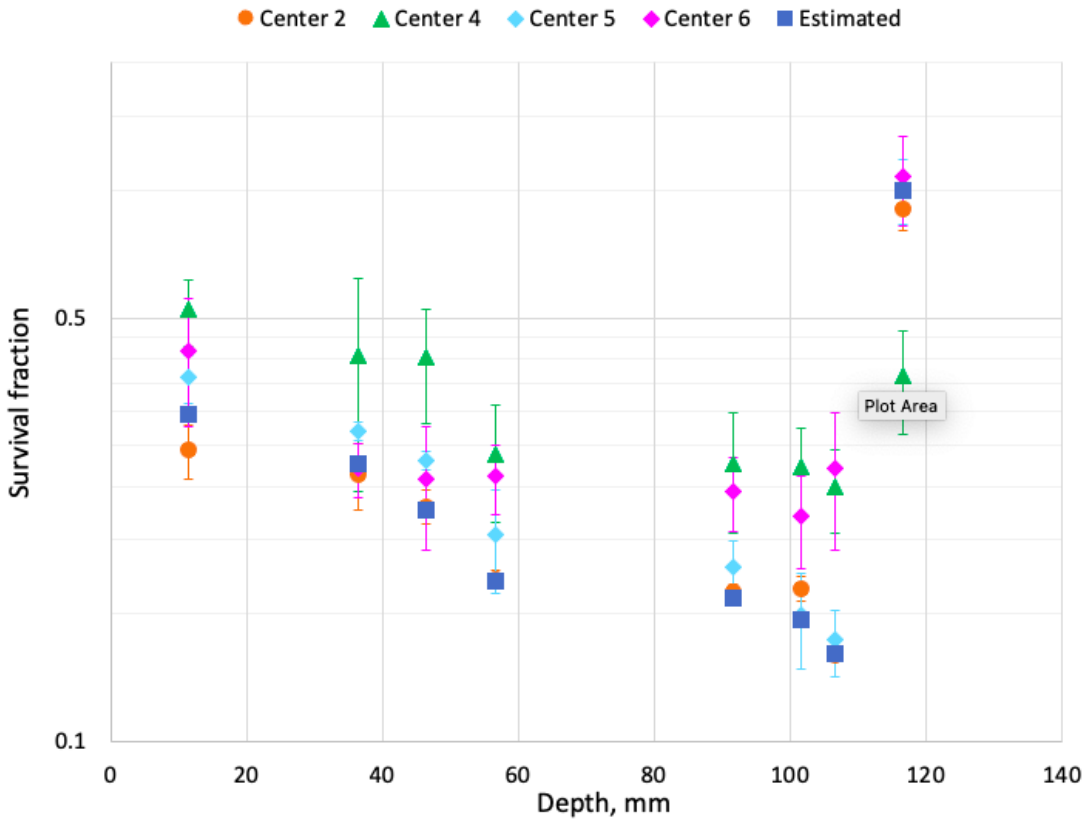
INSPIRE is funded from the European Union's Horizon 2020 Research
nnovation Programme, under Grant Agreement no. 730983

The INSPIRE Experiment

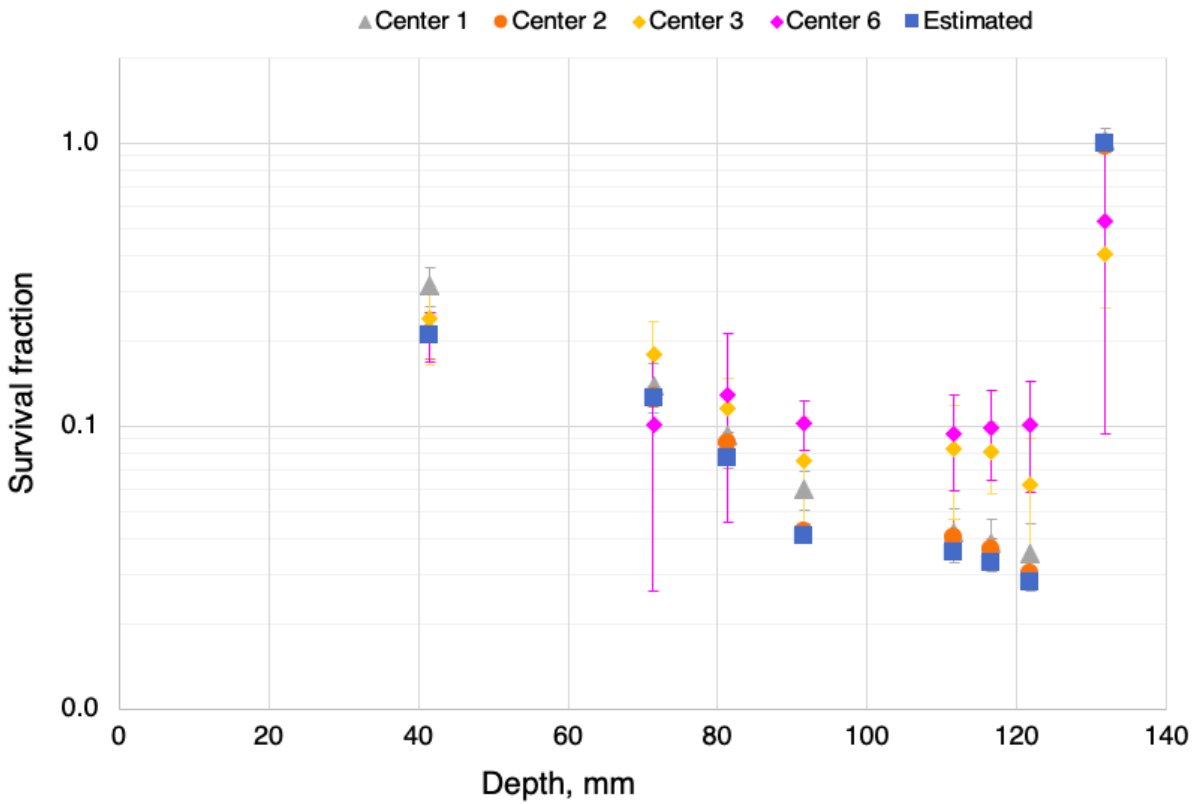
Preliminary Results

InspireProject

6Gy SOBP



8Gy SOBP



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

WP2 and WP9 Benchmarking RBE & LET

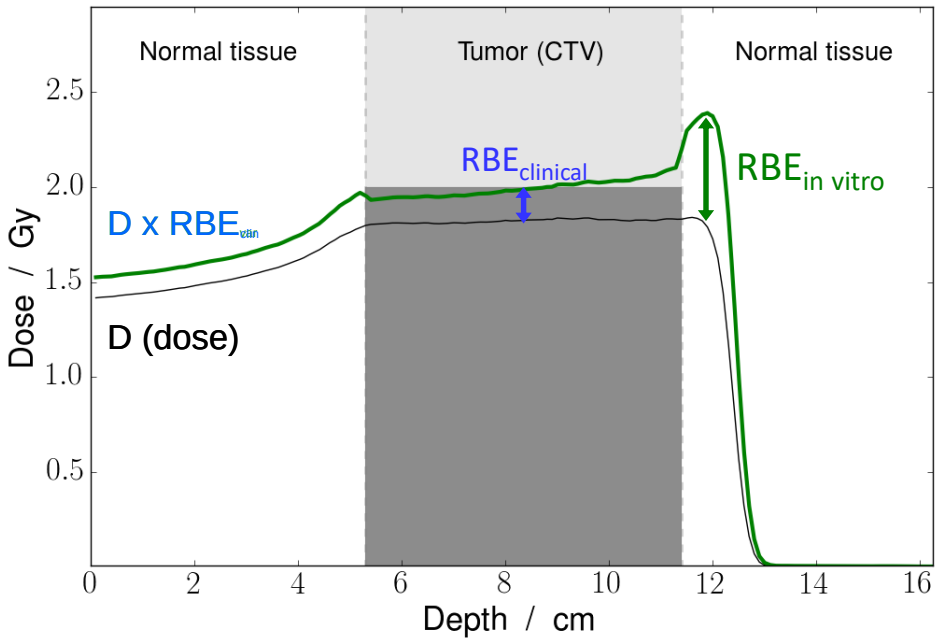
- RBE varies with LET
- Compare and harmonise LET calculations
- 9 INSPIRE partners
- Centre TPS with centre beam model
- Constant and variable RBE
- Water phantom
- Patient cases

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

European framework for RBE calculation in patients WP9, WP2

InspireProject

Motivation



- **Clinical practice:** protons are 10% more biological effective than photons (RBE = 1.1)
- **Research finding**: varying RBE as a function of dose and linear energy transfer (LET)

Problems

- Center-specific RBE modelling
  - ➢ LET calculation not
  - ➢ Variable RBE modeling
- Impacts quality of patient treatment and comparibility of clinical outcome data

Aims

- Towards variable RBE-modelling in clinical proton therapy
- Harmonizing LET definition and calculations in Europe
- Compare and harmonize clinical RBE-modelling in Europe

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

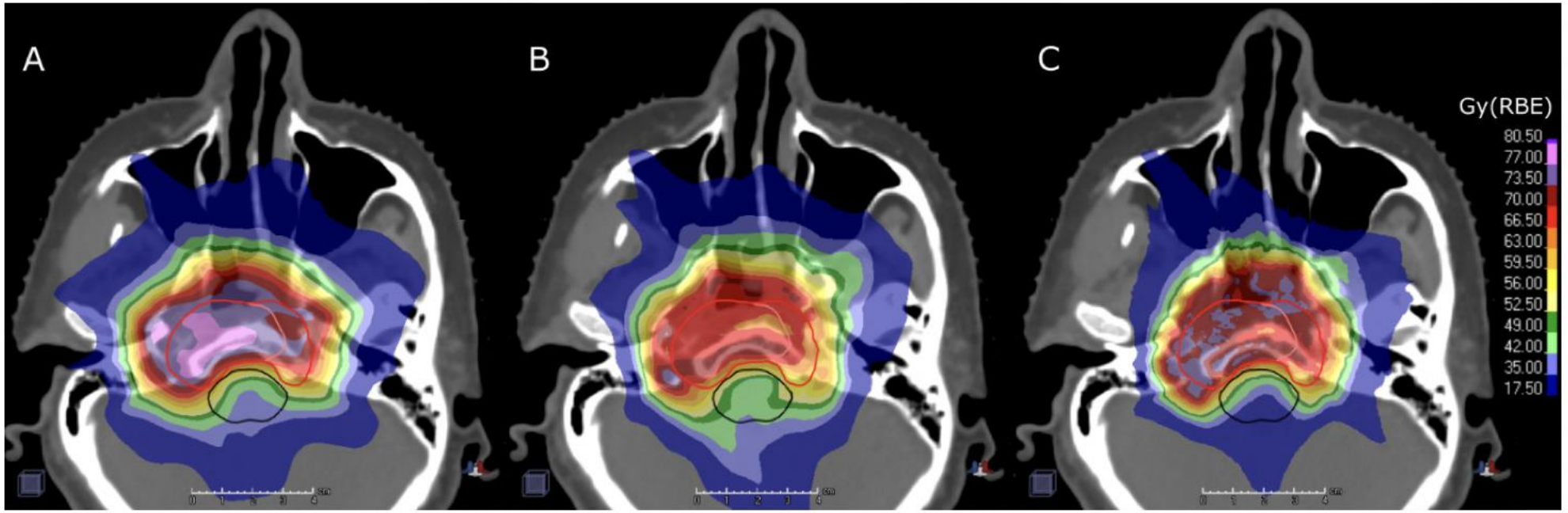
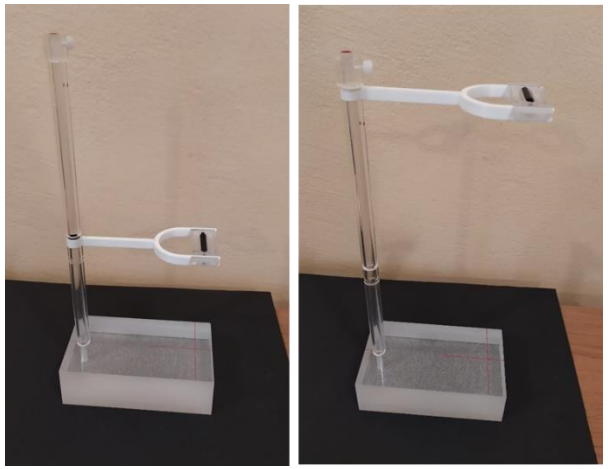


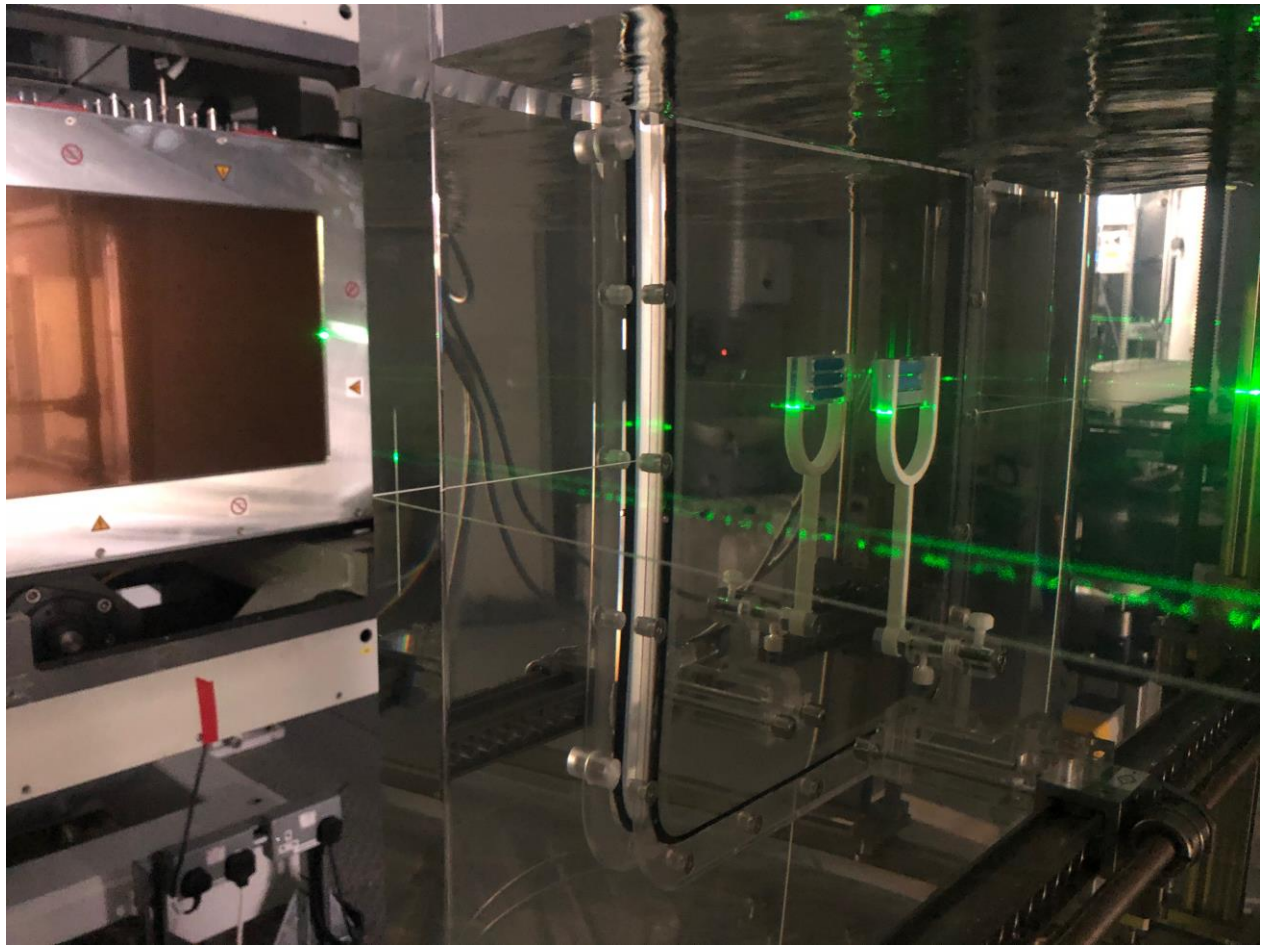
Figure 1: Dose distributions for the base of skull case from each centre using their centre-specific variable relative biological effectiveness (RBE) models: A) McNamara model with α/β=2Gy everywhere, B) Wedenberg model with α/β=10Gy in the clinical target volumes (CTV) and 3Gy elsewhere, C) McMahon model without α/β dependency. Prescription dose was 57 Gy(RBE) to the CTV (darkred) and 70 Gy(RBE) to the CTVboost (lightred) in 33 fractions and planned as simultaneous integrated boost. Brainstem: black.

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

WP2 and WP10 Dosimetry Audit

- 7 INSPIRE partners + EURADOS WG9
- Special assembly for positioning in water phantom
- Thermoluminescent (capsules with TLD powder)
- Alanine pellets
- Radio-photoluminescent detectors
- On gantry and infront of horizontal beam line





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

News & Newsletters

InspireProject

17 November 2020

Funding available for the PSI Winter School for Protons - Jan 2021

The PSI Winter School will be taking place virtually this year. The course will cover a range of topics related to Proton Therapy and has internationally renowned speakers. This is a great opportunity for physicians and physicists to learn more abou

Read More

3 November 2020

Research during corona crisis at GSI

TNA progress update from GSI.

Read More

NEWSLETTER

Issue 4. Winter 2020

InspireProject

Infrastructure in Proton International Research

Inside this issue:

Welcome and update

As we move into 2021, the INSPIRE Consortium are looking back at the achievements from the past year.

TNA

User Groups continued to submit applications this year for TNA and INSPIRE has now received over 33 requests for access. Many of these experiments have

an international survey to gain an insight into how adults are selected for Proton Therapy across Europe. The eight partners in WP9 (Mathematical Modelling and Simulation) have formed a European network to simulate biological effects (LET, RBE) of PBT and WP10 (Dosimetry, Robustness & Uncertainties) have worked

2021. We are pleased to announce that the INSPIRE joint led conference 'Flash Radiotherapy and Particle Therapy' will take place in December 2021. Click here for details.

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

Public Engagement and Outreach

- Open Nights programme at IFJ-PAN have continued, despite Covid-19
- Now online and attracted even more participants 1000 in the case of IFJ-PAN.

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

Science Museum: Cancer Revolution

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

Knowledge Hub and Fact Sheets

- Links to information materials in various languages on partner sites :

Germany


Universitätsklinikum Carl Gustav Carus
Klinik und Poliklinik für Strahlentherapie und Radioonkologie
Direktorinnen: Prof. Dr. med. Mechthild Krause, Prof. Dr. med. Dr. Esther Troost

Universitäts Protonen Therapie Dresden

Patienteninformation und Einwilligungserklärung: Protonen- vs. Photonentherapie

- Patienteninformation zur Protonentherapie bei noch fehlendem wissenschaftlichen Nachweis einer Überlegenheit gegenüber der Standard-Photonentherapie -

Sehr geehrte Patientin, sehr geehrter Patient,

wir möchten Sie über Ihre weitere Behandlung im Rahmen der Strahlentherapie informieren. Am Universitätsklinikum Dresden, Klinik und Poliklinik für Strahlentherapie, wird seit Ende 2014 zusätzlich zu der weltweit üblichen Photonentherapie (ultraharte Röntgenstrahlen) eine Strahlentherapie mit Protonen angeboten. Die Behandlung mit Protonen ist weltweit nur an wenigen Standorten verfügbar, in Deutschland kann die Behandlung neben Dresden nur noch an derzeit drei weiteren Standorten durchgeführt werden.

UK

brainstrust
the brain cancer people

Sweden

Så här går en behandling till

Protonstrålning går till på samma sätt som annan strålbehandling. Patienten får lägga sig på ett behandlingsbord och placeras med hjälp av

De patienter som bor för långt från Uppsala för att kunna åka hem mellan behandlingarna bor ofta på Hotel von Kraemer, som ligger i samma byggnad som kliniken. Barnfamilier har

France

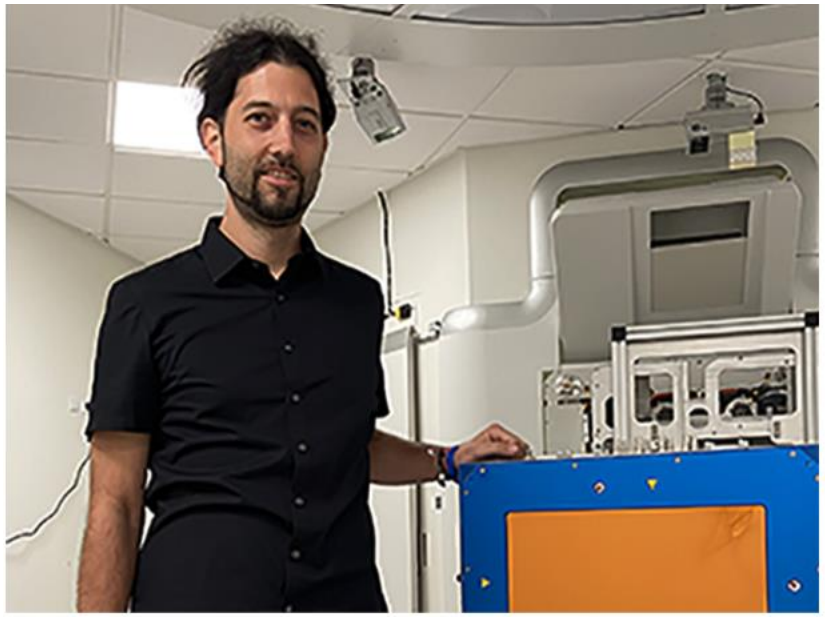
L'enseignement

La diffusion des savoirs pour faire progresser la recherche et la médecine est une composante essentielle de la mission de service public de l'Institut Curie, œuvrant dans la lutte contre les cancers.

Chiffres-clés de l'Ensemble Hospitalier

2100 professionnels de santé
13 500 patients pris en charge
170 000 consultations

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



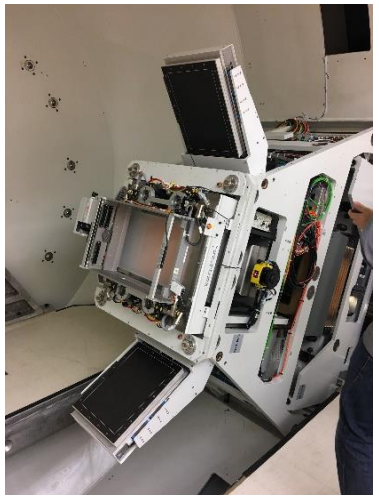
30 September 2021

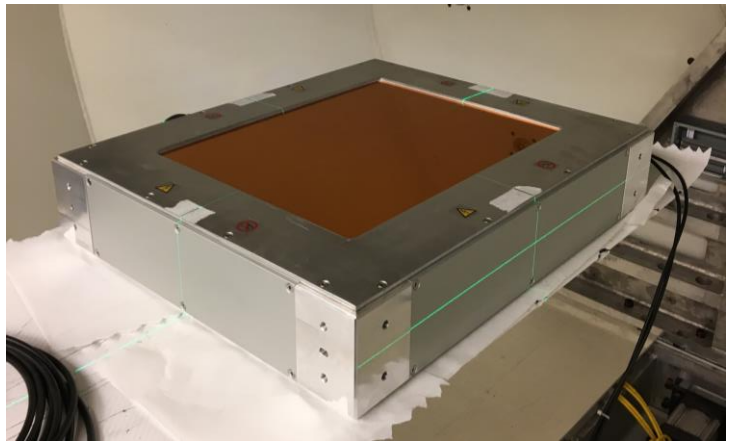
An Industry Academic Partnership Yields Fruit - An Ultra-High Dose Rate Beam Monitoring Tool for FLASH Trials

Varian, supported by the INSPIRE Project, partners with two members of the FlashForward Consortium to test novel ionization chamber for FLASH research.

Read More

InspireProject





WP5 Innovation Gateway: Pathfinder

Worlds first PBT FLASH trial FAST01, Cincinnati

Commercial research product FLEX developed

Clinical prototype being tested Aarhus

Varian and PTW-Freiburg, (UHDpulse) on FLASH dosimetry equipment

GSI Darmstadt and THM Gießen 3D printed range modulators FLASH Bragg peaks

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

WP5 – Innovation and Sustainability: Example: Golden ticket ADVACAM

InspireProject

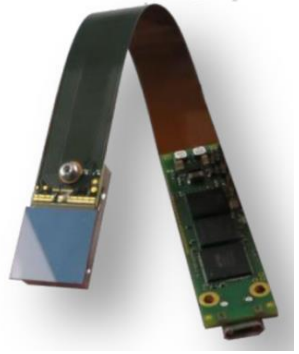
- Working with EMPIR project UHDPulse
- New detector from AVACAM Czech republic, measurement of stray radiation
- At Dresden measurements in a water phantom dose rates 1 Gy/min to FLASH dose rates of 150 Gy/s
- Extended range of proton beam current available at Dresden from 2-300 nA to 0.001 -500nA

MiniPIX TimePIX3

AdvaPIX TimePIX3

Single chip Timepix 3 pixel detectors (each pixel records deposited energy)

Prototype FLEX MiniPIX TimePIX3



UHDpulse

ADVACAM
Imaging the Unseen

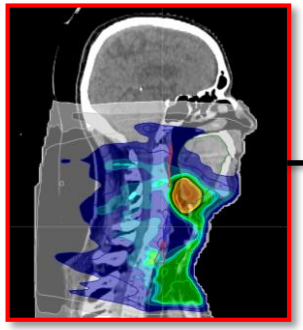
INSPIRE is funded from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement no. 730983

How does model-based selection work?

umcg

Plan comparison

Photons



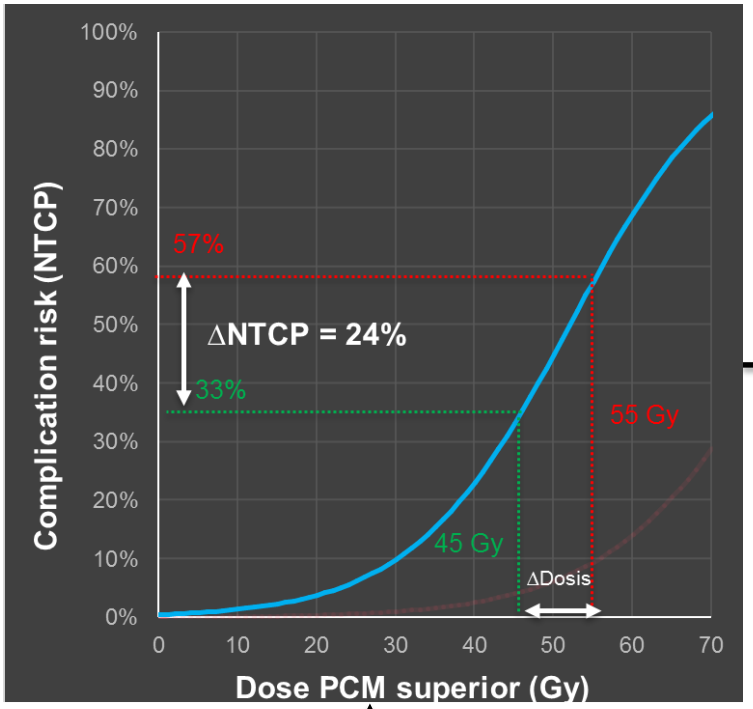
PHOTON plan (VMAT)

Protons

PROTON plan (IMPT)

ΔDose profile

NTCP-model



ΔNTCP

Selection

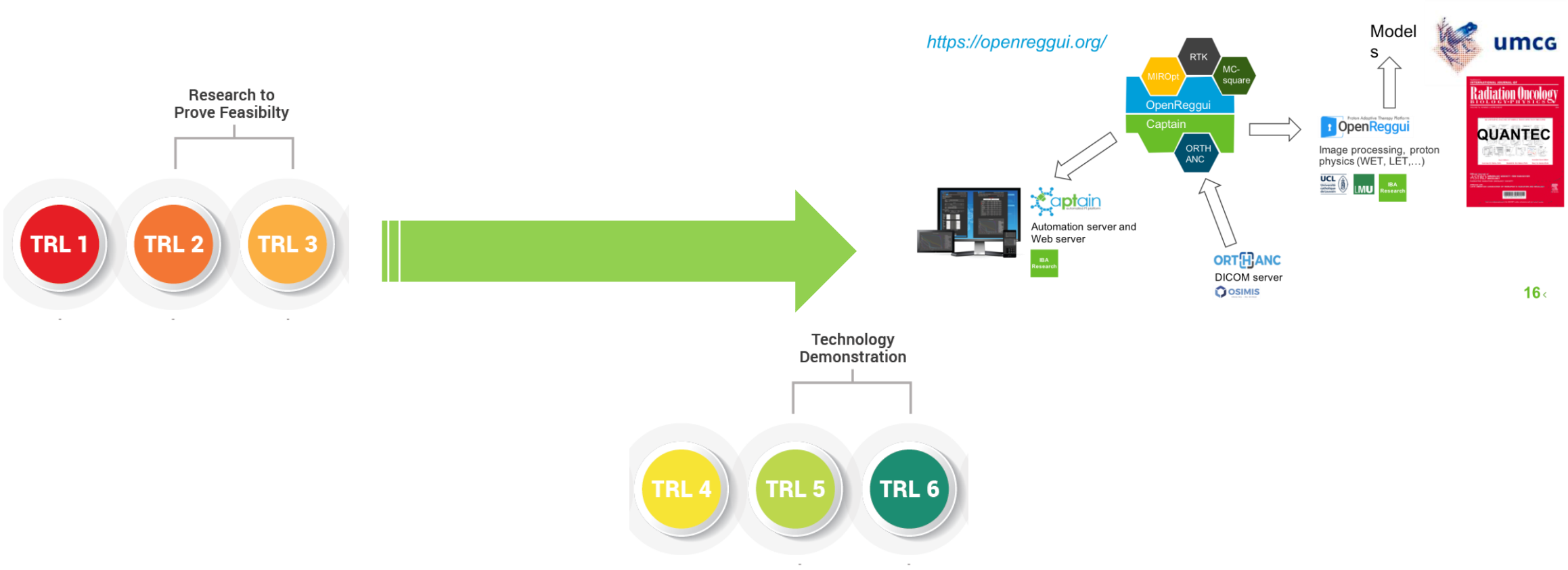
Criteria National Indication Protocol met?

no → **Photons**

yes → **Protons**

WP5 – Innovation and Sustainability: Example: Integrating Cultures, KE, Pathfinder IBA

- Uses research from WP8 to develop a NTCP database 3 TRLs



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

PTCOG
June 2019

> 1350 delegates

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

FRPT: Flash Radiotherapy & Particle Therapy

- Working with Kenes and international leaders in the field
- > 700 participants
- 40 countries
- **Next meeting 29 Nov-2 Dec 2022 Barcelona**
- Special edition Green Journal
- In person & virtual
  - Building and operating a PBT centre
  - FLASH
  - Spatially fractionated radiotherapy
  - Protons & Ions (INSPIRE, HITRIplus)
- Modalities, mechanisms and the clinic
- 3 webinars – Proton FLASH 10th June
- Green conference

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

New horizon in
therapy & treatment

FRPT

FLASH
RADIOTHERAPY
& PARTICLE
THERAPY

2021

VIENNA & ONLINE

1-3 DECEMBER 2021

FRPT 2021

KENES GROUP · NHS The Christie NHS Foundation Trust · MANCHESTER 1824 The University of Manchester · Biophysics · CHUV · EMPIR EURAMET · UHDpulse · InspireProject Integrating proton research across Europe Horizon 2020 · institutCurie

FRPT-Conference.org

Future

- Collaboration
- Increase TNA capacity
- Move closer to the clinic
- Working with industry
- Personalizing treatment
  - Outcomes: clinical outcomes, eproms
  - Wearables: real time monitoring
  - Involving patients in decision making
  - Digital biomarkers, learning from particle physics and astronomy communities
  - Integrating with imaging
- Next generation clinical trials
  - Paediatric & rare tumours so pan European approach needed
- Health research
  - Who benefits most from PBT and how are they chosen
  - Health inequalities
  - Impact of Covid

canSERV

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

Thankyou

Colleagues in INSPIRE

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	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
Jamie Honeychurch
Mat Lowe

InspireProject

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

UKRI Science and Technology Facilities Council

varian A Siemens Healthineers Company

UKRI Engineering and Physical Sciences Research Council

FlashForward™ Consortium

MANCHESTER BIOMEDICAL RESEARCH CENTRE

CANCER RESEARCH UK | RADNET MANCHESTER

The Christie Charitable Fund

Questions?

Thank you for listening

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

"This material was prepared and presented within the HITRIplus **Specialised Course on Heavy Ion Therapy Research,** and it is intended for personal educational purposes to help students; people interested in using any of the material for any other purposes (such as other lectures, courses etc.) are requested to please contact the authors (karen.kirkby@Manchester.ac.uk).

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