PROTON THERAPY ACCELERATOR RESEARCH IN THE UK

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Cockcroft Institute for Accelerator Science and Technology

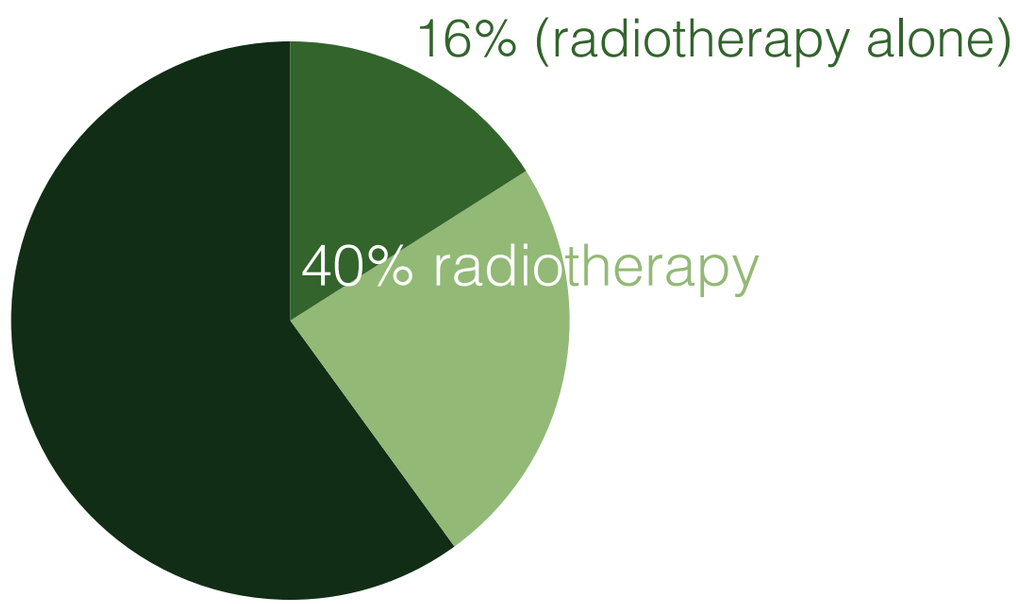
The Cockcroft Institute of Accelerator Science and Technology

The Christie NHS
NHS Foundation Trust

Radiotherapy statistics for the UK

320 000 diagnosed with cancer

130 000 treatments



~300 linacs in use

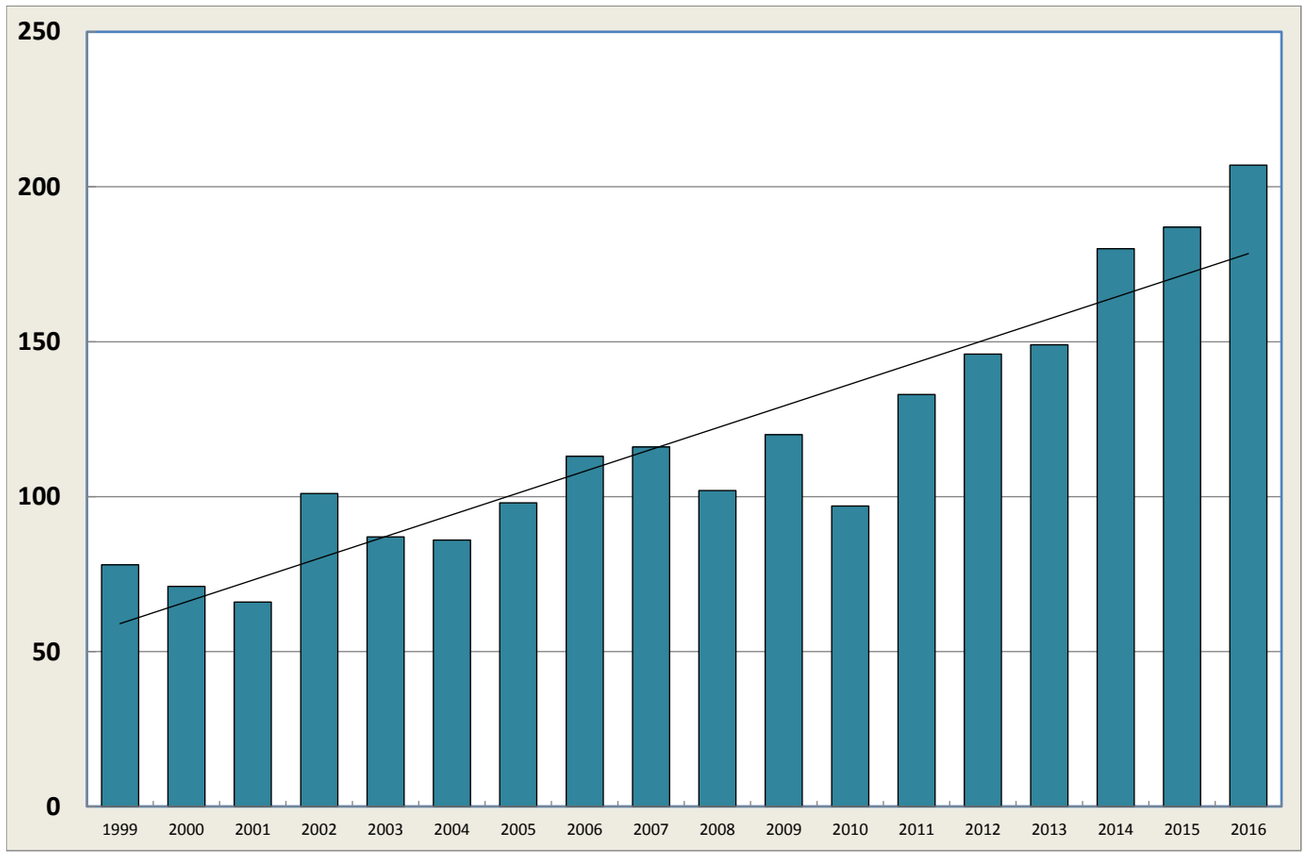
each machine: > 7000 ‘attendances’

‘Radiotherapy Services in England 2012’, Department of Health

Clatterbridge Cancer Centre

eye treatment

started operation in 1989:
first hospital-based proton treatment centre in the world



62 MeV cyclotron

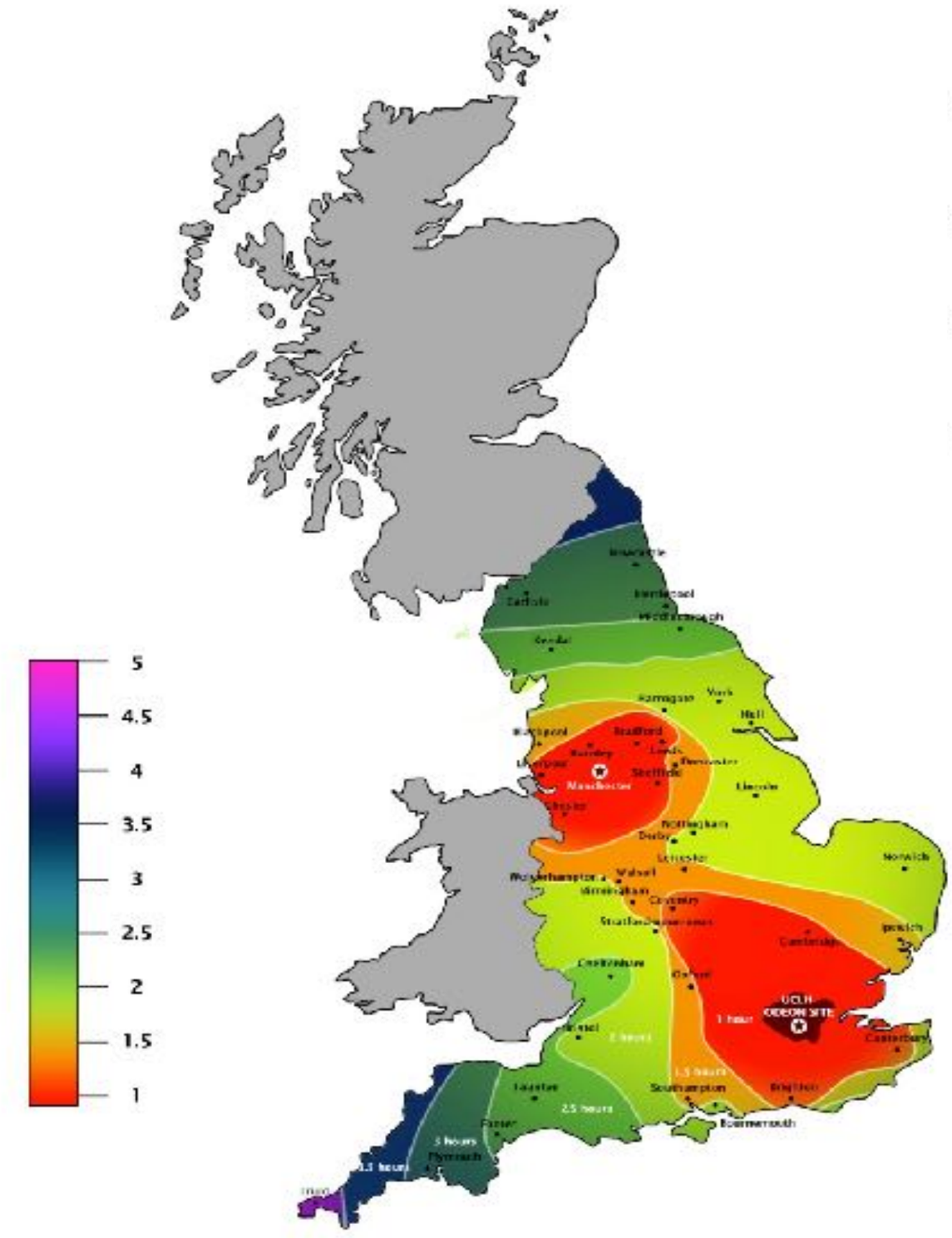
Courtesy of Andrzej Kacperek (CCC)

Update on UK proton therapy centres

VARIAN medical systems	Clatterbridge Cancer Centre	operating
VARIAN medical systems	Christie Hospital	2018
	University College London Hospital	2019
iba	Newport, Newcastle, Reading	2017?
A	London Harley Street	2017?
PRONOVA	Oxford	2018?

NHS

NHS Centres benefits for UK patients



- travel time
- public transport
- return home during treatment

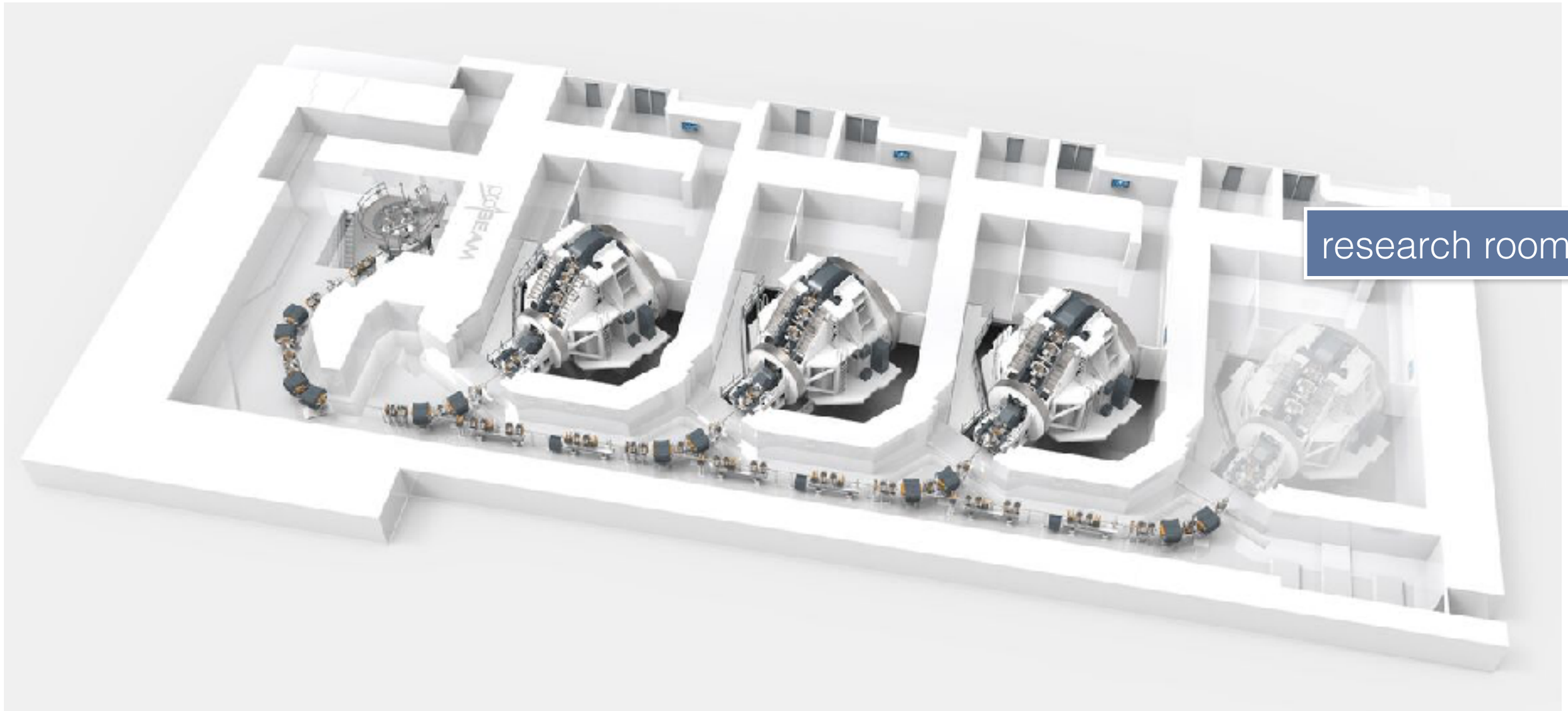
Source: NHS case for proton therapy

Christie Hospital

- **largest** single-site cancer centre in Europe
- chemotherapy delivery on 15 sites
- 16 networked linacs
- regional and national services

The Christie

SC cyclotron: Varian ProBeam 254 MeV, 2.4T
NC gantry: 250 MeV

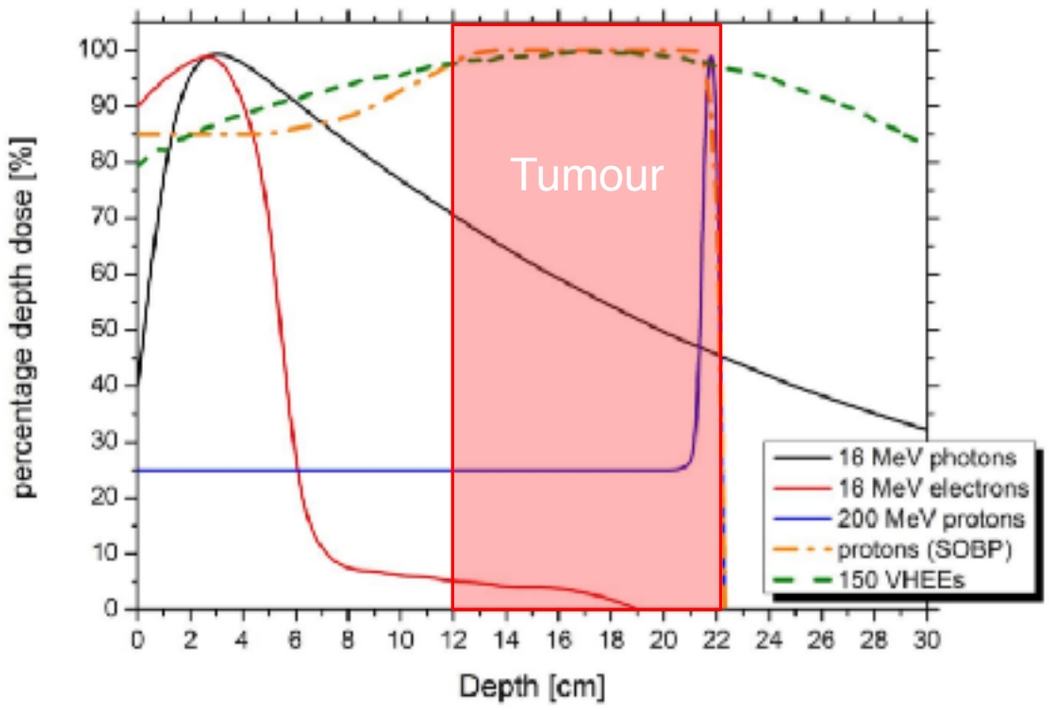


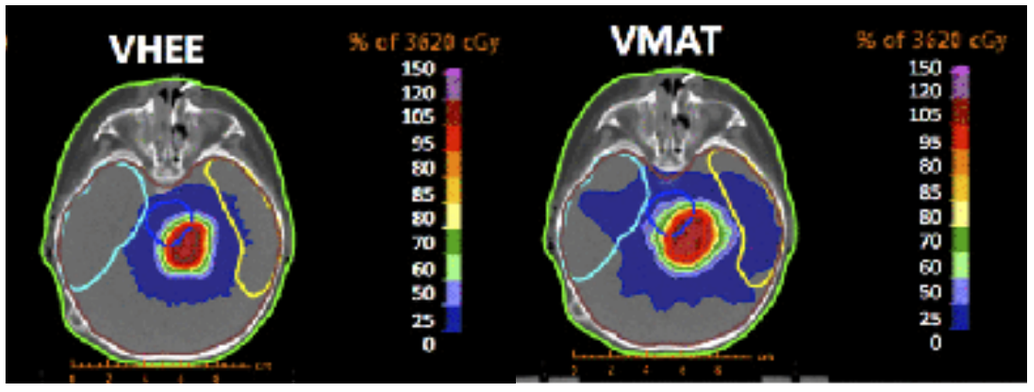
Research themes in the UK

VHEE

<u>disadvantages:</u>
- exit dose still very high compared to protons

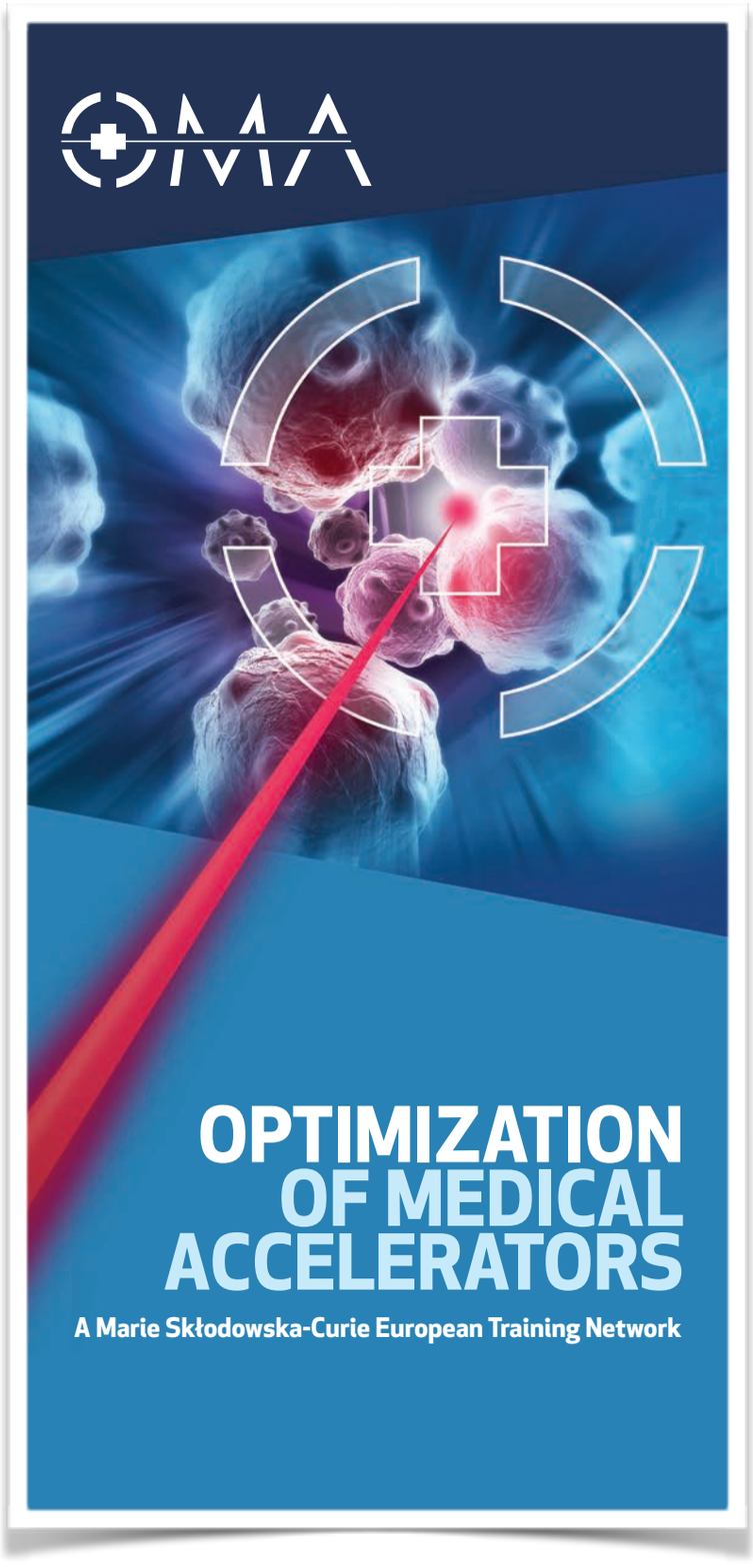
<u>advantages:</u>
+ very good dose conformation (vs photons)
+ faster dose delivery
+ electromagnetic steering
+ potentially cheaper than protons





Courtesy of Agnese Lagzda

The OMA network



The Optimization for Medical Accelerators
Marie Skłodowska-Curie European Training Network

beam imaging and diagnostics

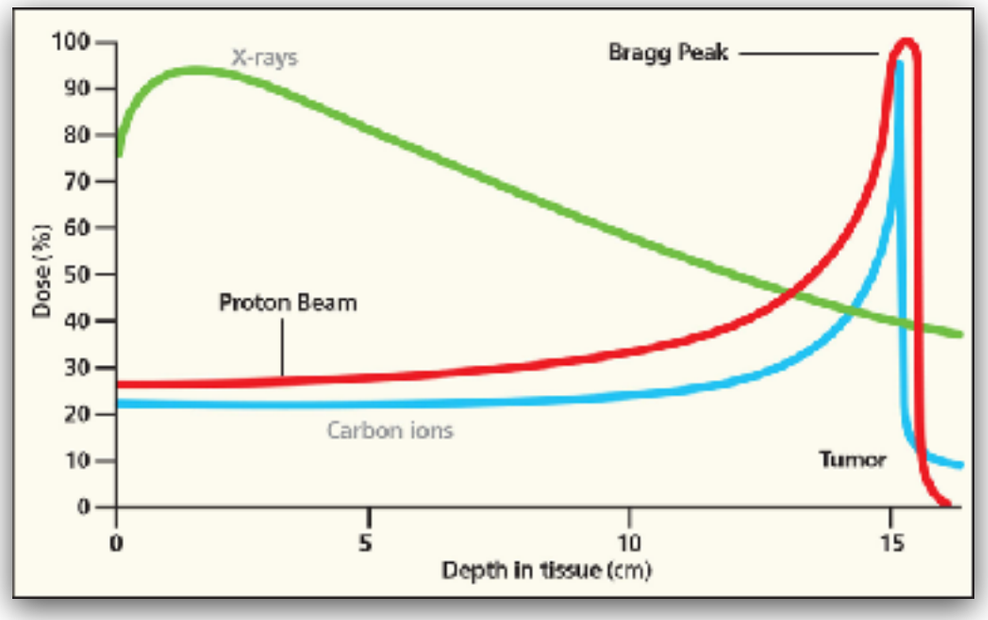
treatment optimisation

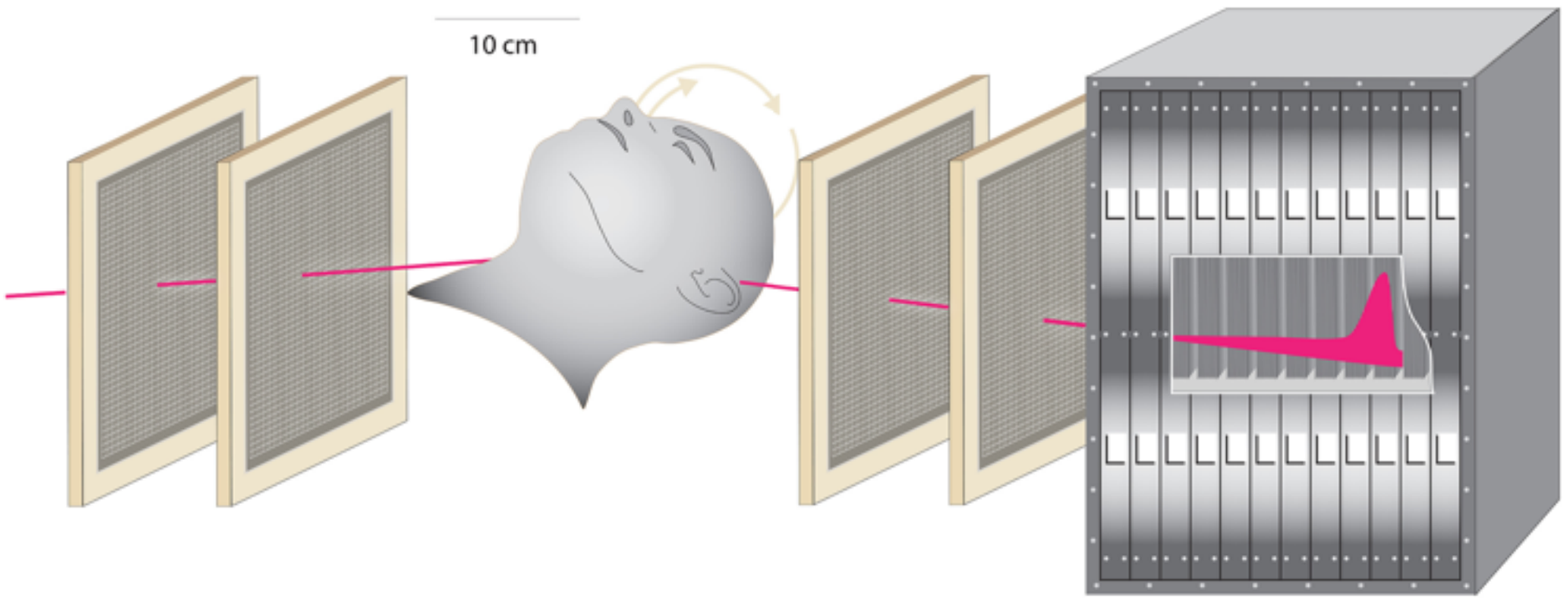
facility design and optimisation

www.oma-project.eu

Research themes in the UK

high-energy protons





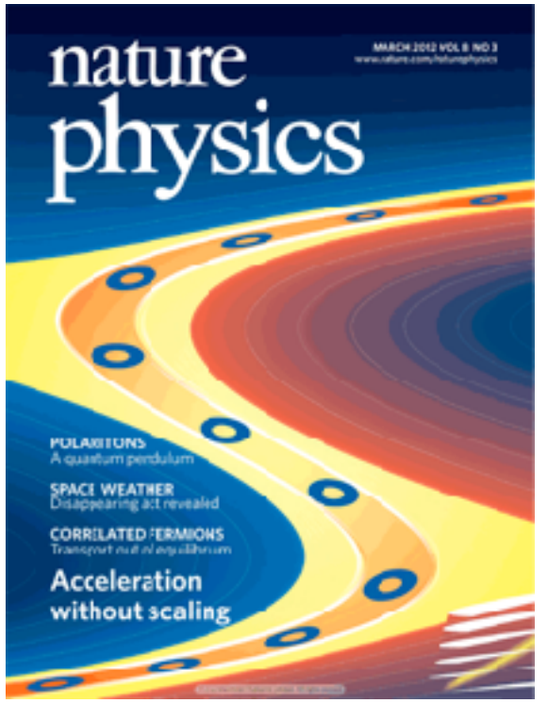
www.quantumdiaries.org/2014/07/21/prototype-ct-scanner-could-improve-targeting-accuracy-in-proton-therapy-treatment/
https://www.scripps.org/services/cancer-care__proton-therapy/what-is-proton-therapy__bragg-peak

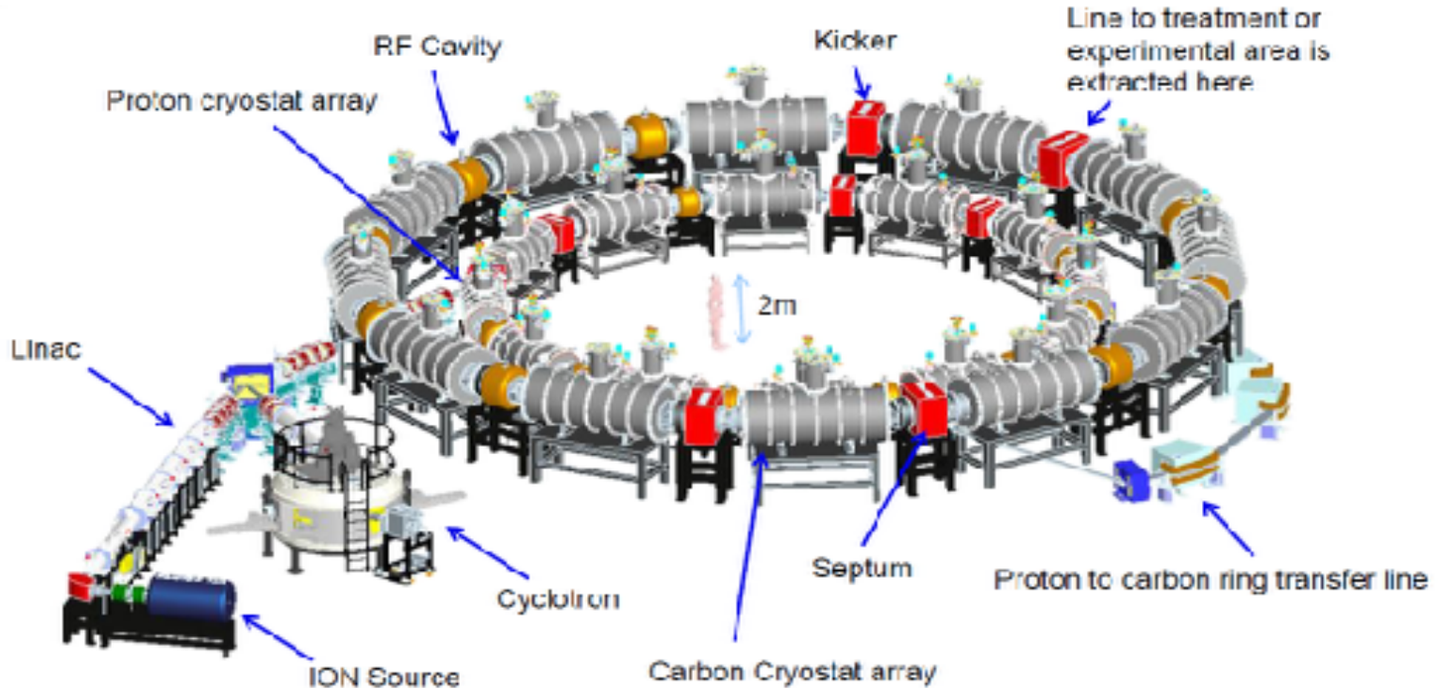
Our main projects

FFAG

PAMELA

injection energy	70 MeV (cyclotron)
extraction energy	250 MeV protons, 430 MeV/u carbon
RF cycle rate	1 kHz

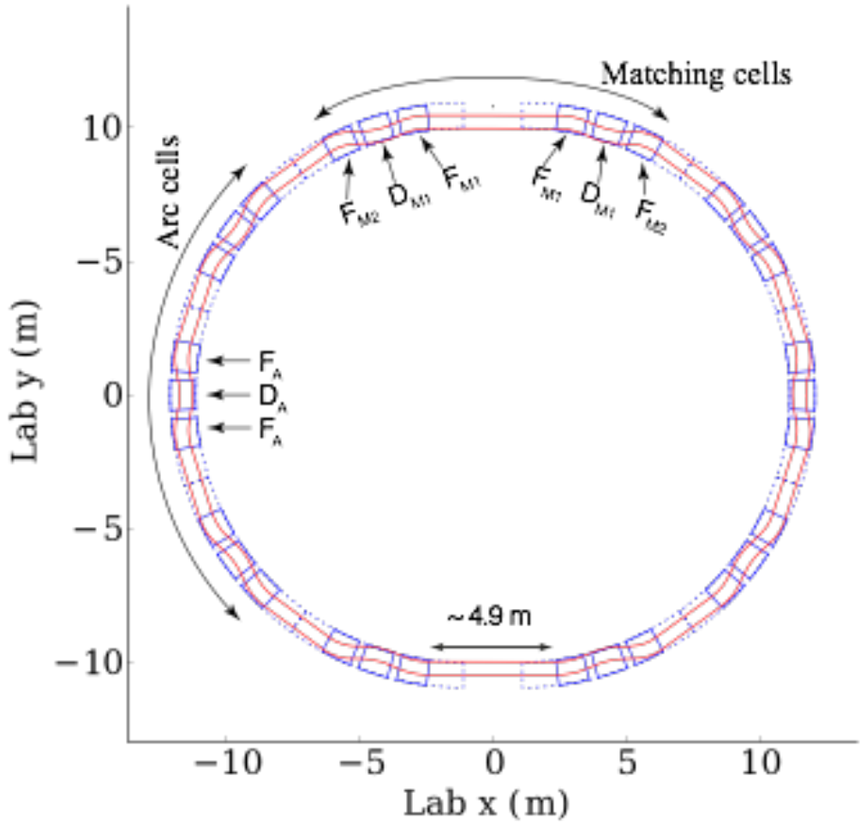




Our main projects

NORMA: 350 MeV NC FFAG, 1 kHz pulses + imaging

	Ring	Racetrack
Cell Radius (m)	9.6	10.55
Circumference (m)	60.4	70.7
Orbit excursion (cm)	43	49
Ring tune	7.72, 2.74	7.71, 2.68
Peak field (T)	1.57	1.74
DA (mm mrad)	68.0	57.7
Max drift (m)	2.4 (x10)	4.9 (x2)



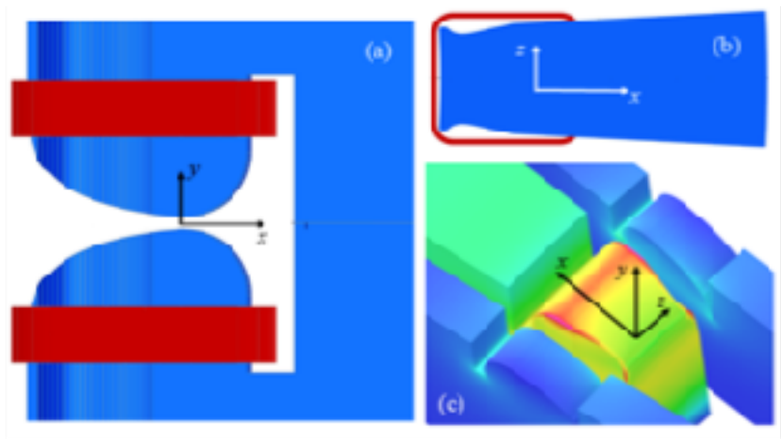
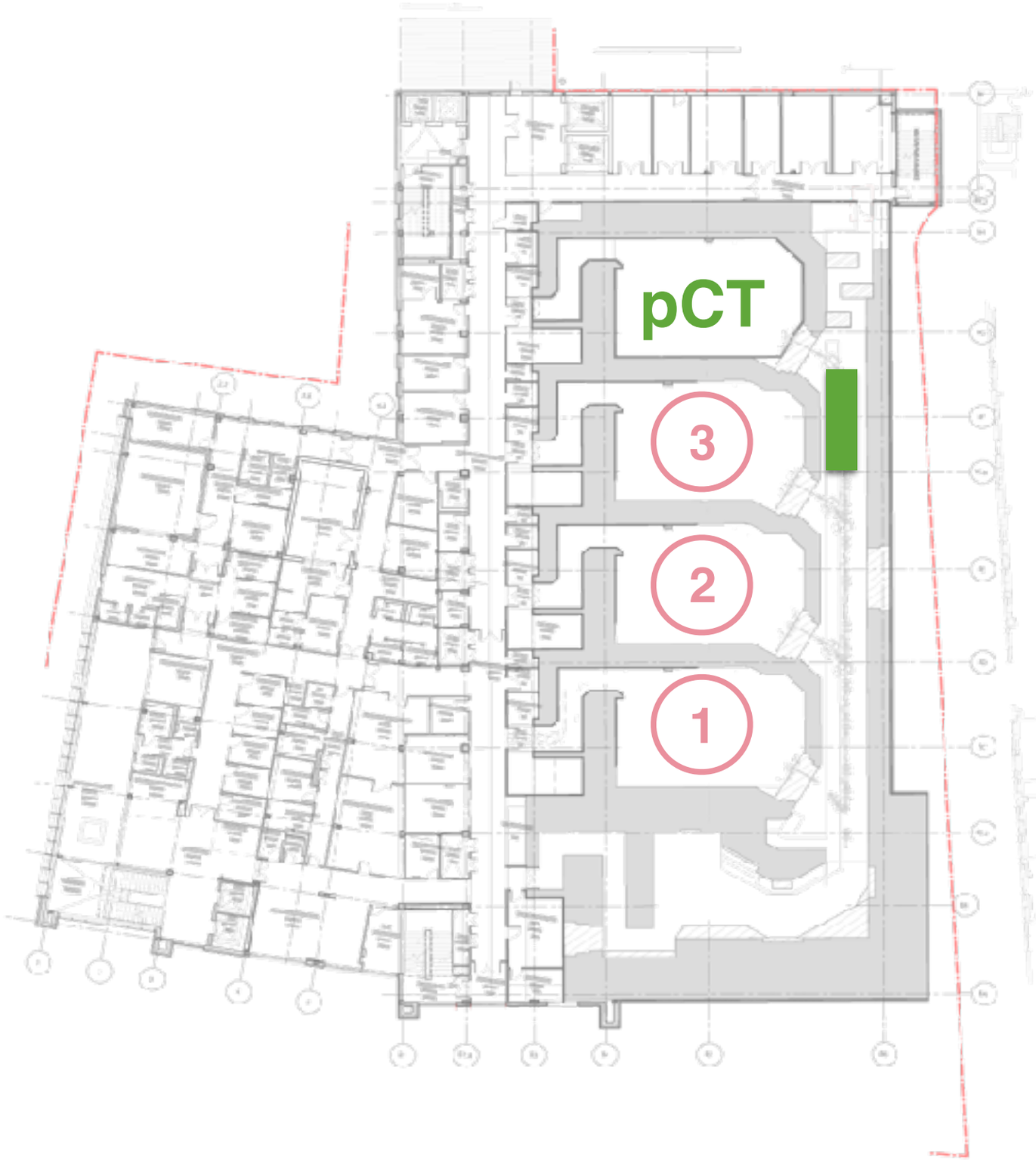


FIG. 9. 3D model of the F magnet (a) Side view without the clamping plates (b) View from the top showing the pole edge profile without the clamping plates (c) Half of the pole area with the clamping plates. The magnetizing coil is not shown.

Our main projects

booster linac

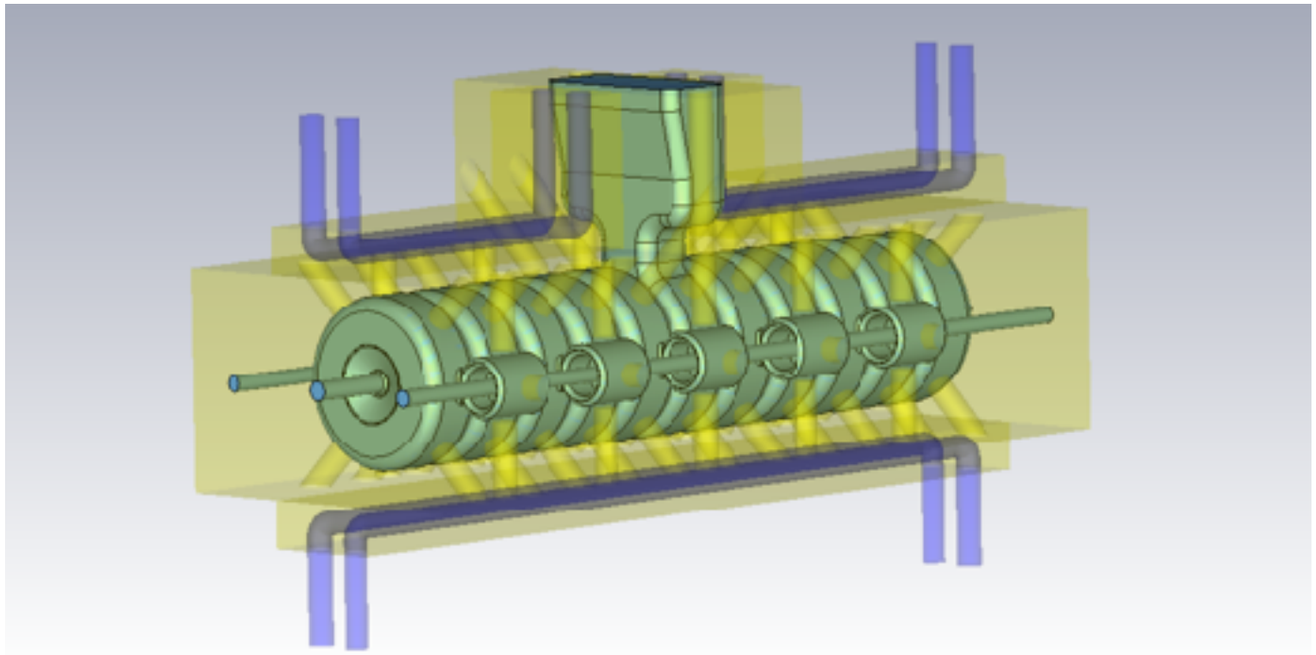
Christie Hospital



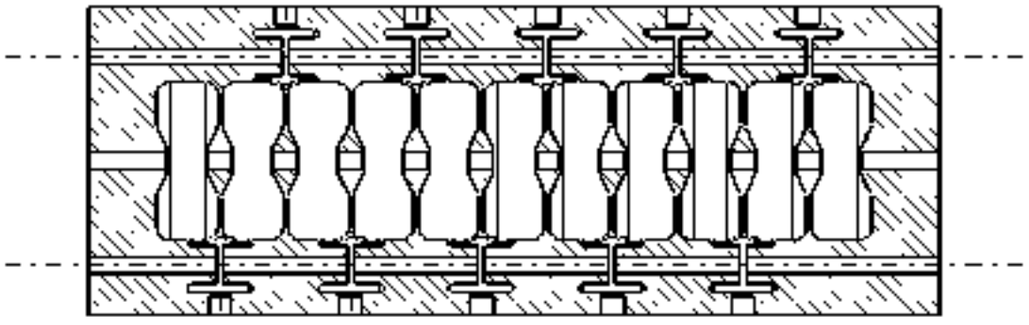
Our main projects

booster linac

Christie Hospital



- S-band side coupled standing wave
- 250 MeV - 350 MeV
- 54 MV/m

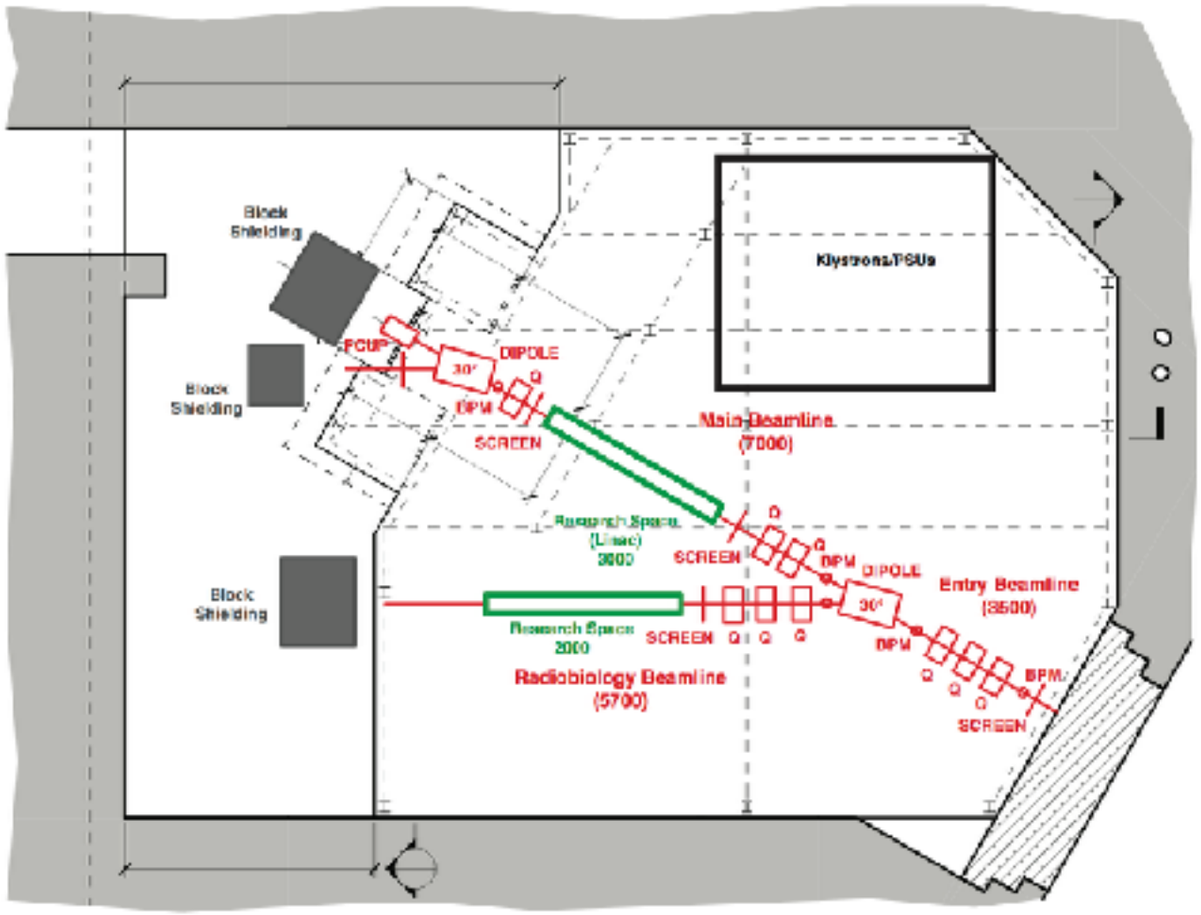


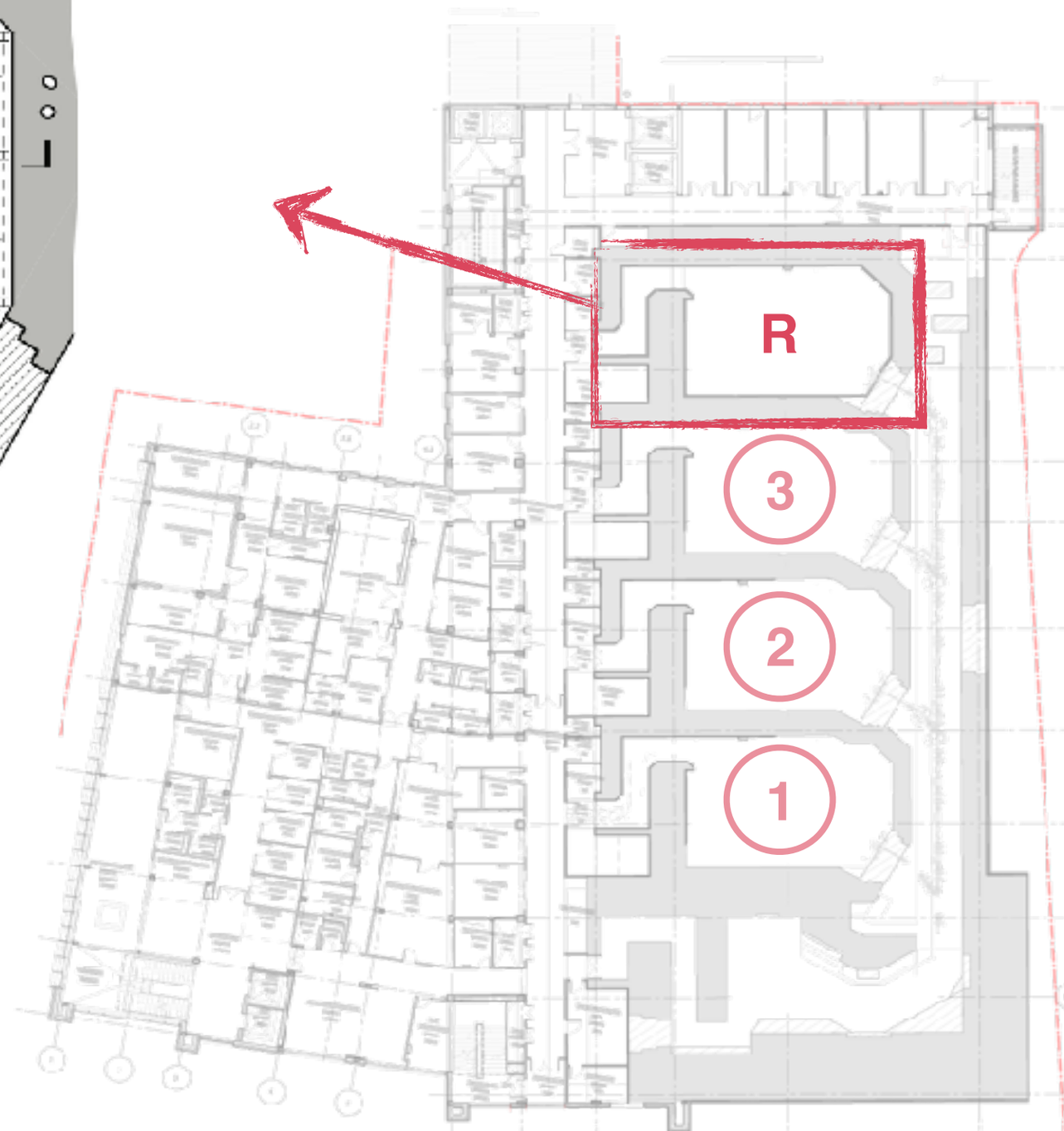
A-A
1:1

Our main projects

research beamline

Christie Hospital





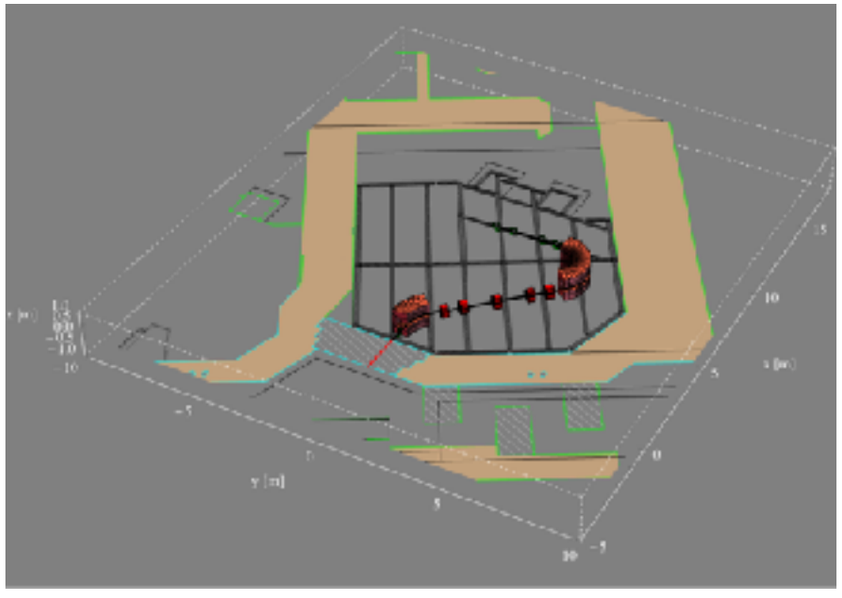
Our main projects

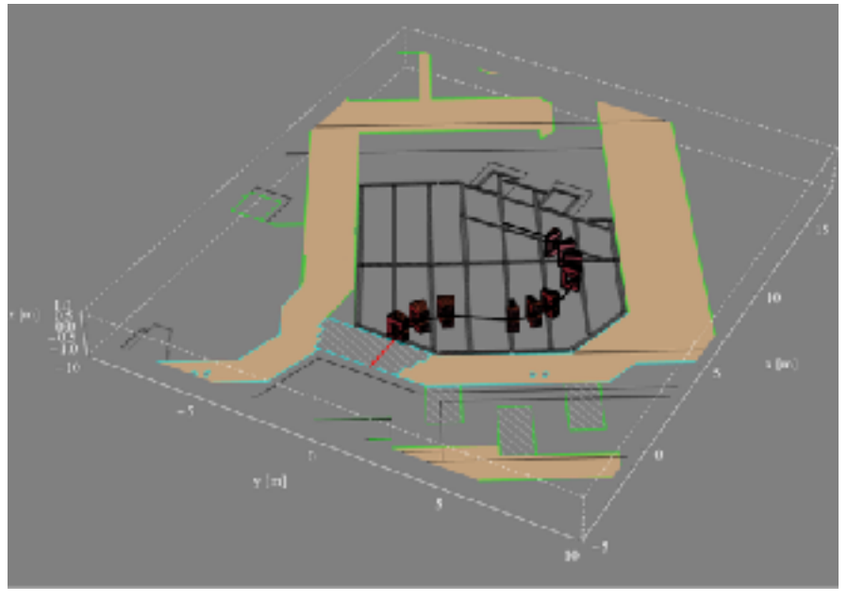
gantry (just starting)

	NC	SC	Hybrid
p^+	230 MeV	UoM	ProNova PSI/LBNL
C^{6+}	HIT	NIRS	-

Our main projects

gantry (just starting)





Varian (245 MeV)

pCT (330 MeV)

- **70 - 350 MeV**
- **SC** vs NC
- FFAG vs conventional magnets
- **downstream** vs upstream scanning

Next steps

Gantry design study:

- optics design
- magnet feasibility design
- beam tracking
- inclusion of the linac

Building research beamline

Testing linac