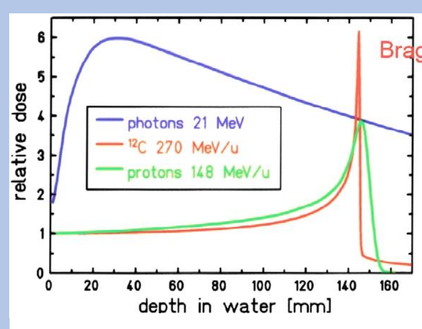
LhARA

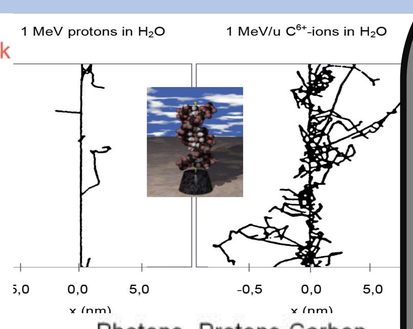
Laser-hybrid Accelerator for Radiobiological Applications

Colin Whyte on behalf of the LhARA Collaboration

Ion Therapy

Therapy	Rationale for clinical benefit
Proton	▪ Deliver a higher, targeted radiation dose with decreased toxicity to surrounding tissue compared with photon therapy, especially near critical structures
Carbon	▪ Further increase target tissue damage with decreased secondary tissue affected compared with proton ▪ Specific potential benefit with intractable radio-resistant tumors

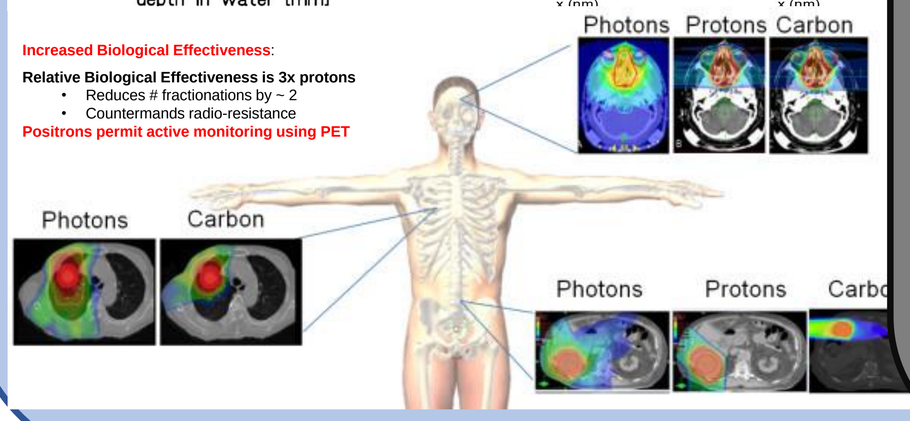




Increased Biological Effectiveness:

Relative Biological Effectiveness is 3x protons
- Reduces # fractionations by ~ 2
- Countermands radio-resistance

Positrons permit active monitoring using PET



Multi-disciplinary UK Lhara Ion Therapy Program

Superior Dose Depth Distribution & Physical Beam Characteristics
-Higher LET
-Superior RBE
-Low OER
-Narrow penumbra

Clinical Biology Research
-Dose limitations, Toxicity
-Which tumor histologies benefit most
-Tumor microenvironment
-Development of new clinical trial design

Clinical Physics Research
-Treatment *planning*
-*Develo*pment of IMCT
-Absorbed Dose Calcs
-Modeling RBE

Engineering
Gantry
Miniaturisation

Radiology
-Ionacoustic Imaging
-Positron imaging
-Dose distribution

Physics
Beam Characteristic
Beam Heterogeneity

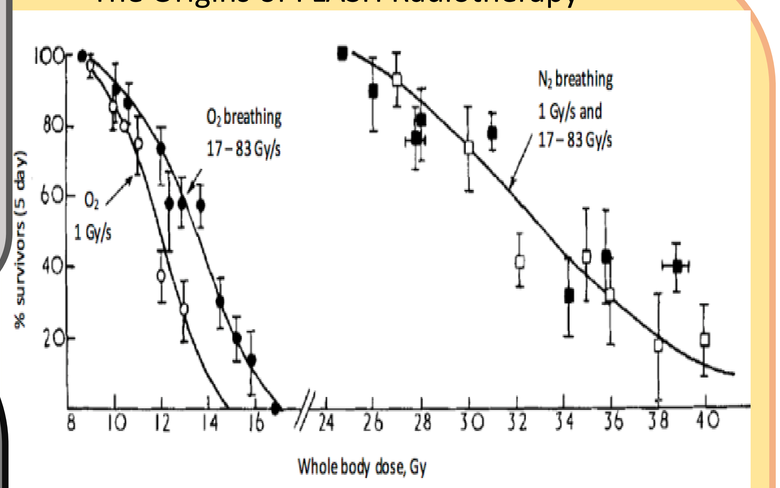
Patient Experience
-New Lhara Ion therapy
-Less toxicity
-Given in short period of time
-Cost effectiveness research

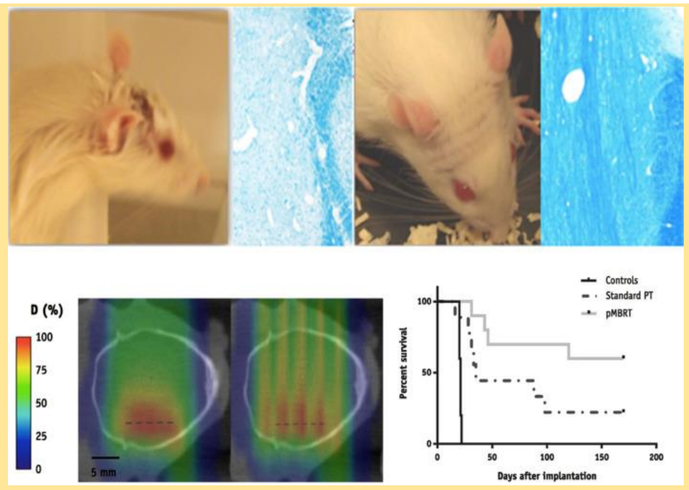
Materials Science
Target production
Shielding

Radiobiological Research
-Radioprotectors
-Carbon ion interactions
-Metabolism
-Microenvironment

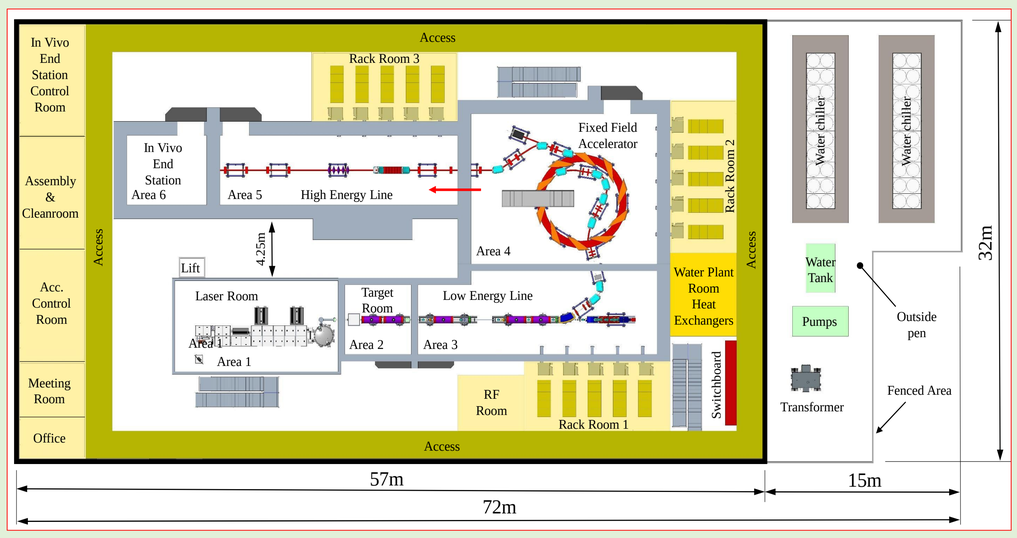
STFC/UKRI/ITRF
-Accelerator miniaturization
-Active and Passive Beam Shaping
-Beam Production
-Beam Delivery

The Origins of FLASH Radiotherapy





LhARA Facility Design and Engineering



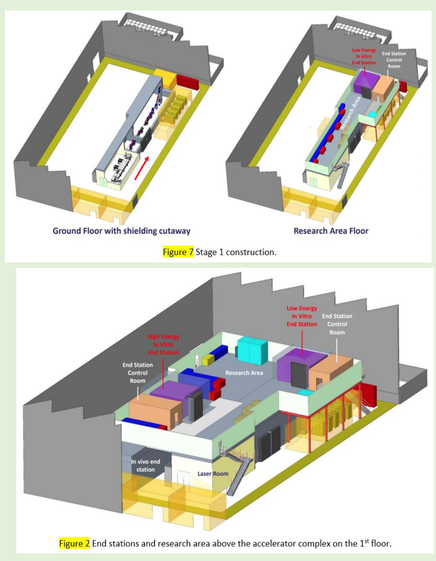
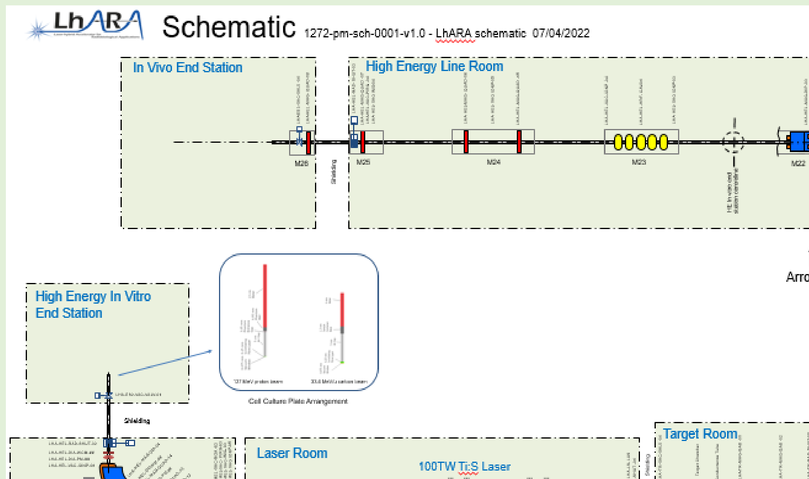


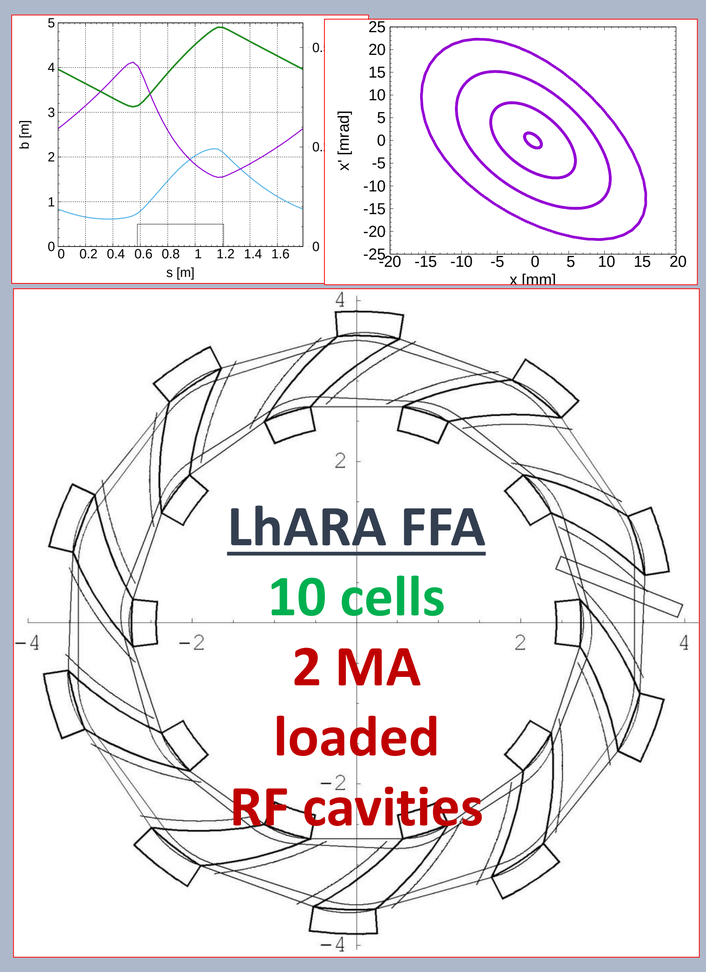
Figure 7 Stage 1 construction.

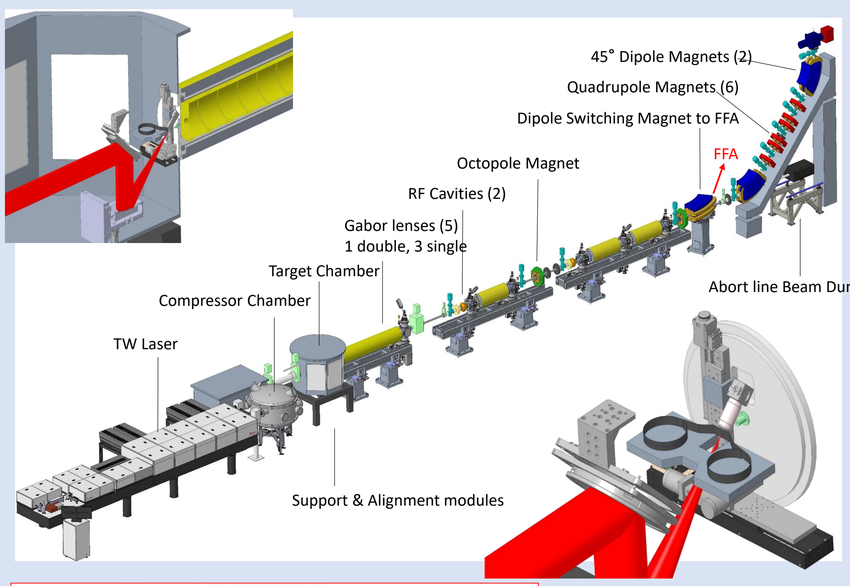
Figure 2 End stations and research area above the accelerator complex on the 1st floor.



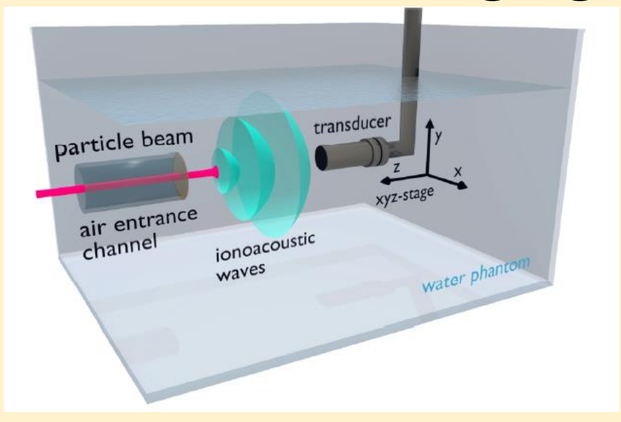
LhARA: Stage 2 FFA

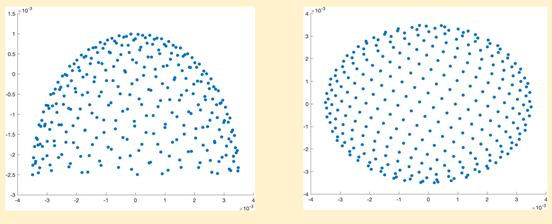
Spiral FFA: accelerate 12-15MeV beam to :
Protons : 127MeV
Carbon : 33.4 MeV/u



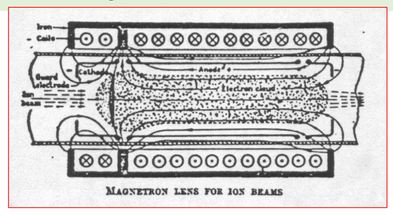


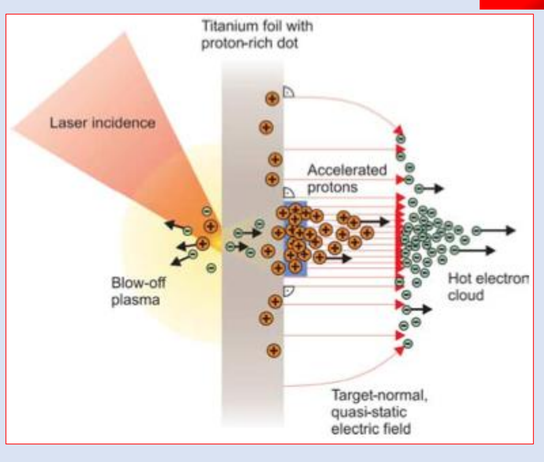
Ion-acoustic Imaging





Capture – Gabor lens





Source
TNSA
12-15 MeV
10 Hz

End Station Design

- Vertical beamlines for both low and high energy
- Horizontal beamline for high energy only
- 4 consultations.
- High throughput
- Integrated diagnostics

Partners: Imperial College London; ICR The Institute of Cancer Research; Medical Research Council Oxford Institute for Radiation Oncology; University of Oxford; John Adams Institute for Accelerator Science; CCAP; Imperial College Academic Health Science Centre; Cancer Research UK; Imperial College Healthcare NHS Trust; LhARA; Manchester 1824 The University of Manchester; University of Birmingham; University of Liverpool; NHS University Hospitals Birmingham NHS Foundation Trust; NHS The Clatterbridge Cancer Centre NHS Foundation Trust; NHS The Christie NHS Foundation Trust; institut Curie; Queen's University Belfast; Swansea University Prifysgol Abertawe; UCL Medical Physics & Biomedical Engineering; Netherlands Cancer Institute Antoni van Leeuwenhoek; Hampton University Proton Therapy Institute; University of Strathclyde Glasgow Department of Physics; Royal Holloway University of London; Lancaster University; University of Birmingham Cyclotron Facility; Positron Imaging Centre; University Clinical Partners Accelerator Laboratory Industry; UKRI Science and Technology Facilities Council; ASTeC Daresbury Laboratory Particle Physics Department ISIS Neutron and Muon Source; Central Laser Facility; INFN Catania; The Cockcroft Institute of Accelerator Science and Technology; CERN; Corerain 鲲云科技; LEO Cancer Care; Maxeler Technologies Maximum Performance Computing; The Rosalind Franklin Institute; NPL National Physical Laboratory