2 October 2021

The LhARA initiative

Overview

LhARA is a ground-breaking biomedical initiative that will revolutionise cancer treatment. A consortium of researchers, clinicians, and engineers, brings together expertise from across the UK to build this world-leading research facility. LhARA will be a hybrid system in which a laser will produce protons and ions to drive a transformation in cancer care by delivering breakthroughs in physics, chemistry, and biology. LhARA is an important infrastructure project because it will create jobs, drive investment, and attract additional scientists from around the world to the UK. LhARA will catapult the UK to the front of the technological revolution taking place in radiobiology.

To realise the benefits of the LhARA intiative we need to:

- Demonstrate the feasibility of the laser-hybrid approach in a facility dedicated to biological research; and
- Create the national and international partnerships necessary for LhARA to become a multidisciplinary research centre of excellence in the UK.

Vision

LhARA will revolutionise cancer treatment.

> In the UK it is anticipated that 1 in 2 people will develop cancer. The present incidence of 17 million new cases per year globally is predicted to increase to 27.5 million new cases per year by 2040. Radiotherapy (RT) is used in 50% of cancer patients and results in 40% of cancer cures, second only to surgery.
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> High energy X-rays are used most frequently in the delivery of radiotherapy. There is increasing understanding of the additional benefits of particle-beam RT (proton and ion beams) as these deliver the radiation dose more precisely to the tumour and spare healthy tissues. Ion beams, in particular, can deliver a much stronger dose to the tumour, thereby killing more cancerous cells more efficiently.
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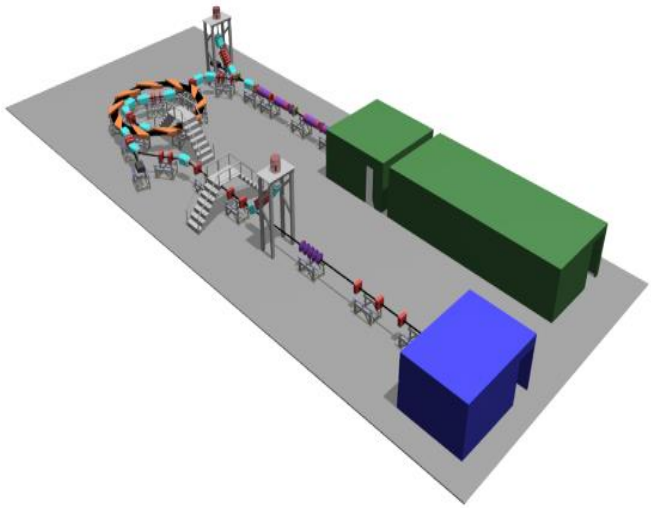
> The UK has already invested in two clinical proton machines at the Christie Hospital in Manchester and at UCLH in London. Currently the UK has no ion beam facilities, as these are currently too expensive, not so well developed, and rely on large synchrotrons to accelerate the ions. UK scientists are developing a completely new way to produce these important particles, using lasers. Laser-driven proton and ion sources offer enormous potential for clinical practice by providing more flexible, compact and cost-effective, multi-ion sources.

A group of multidisciplinary UK scientists working together to develop LhARA; a revolutionary, internationally leading system that uses a laser to produce high energy protons and ions. If successful this new technique will have the greatest impact on the most difficult cancers to cure while at the same time stimulating new research directions in fundamental physics, material science and radiation biology. Entirely new areas of research into DNA damage and the effect of ionizing radiation on the immune system will be made possible. As an Ion Therapy Research Facility it will be a UK investment which will attract scientists from all over the world, create jobs in engineering, construction, science and technology (lasers, electron-plasma lenses, accelerator physics, ionacoustic imaging, robotics, chemistry, and biology), will develop increased collaboration with CERN in Switzerland, the European Organization for Nuclear Research, as well as the National Institute of Radiological Sciences in Japan, and attract inward and external industrial funding. If successful, commercial products for clinical use will be developed and sold throughout the world.

Concept

In LhARA, a high-power pulsed laser will be used to drive the creation of a large flux of protons or ions which are captured and formed into a beam by strong-focusing electron-plasma lenses. Rapid acceleration will be performed using a fixed-field alternating-gradient accelerator.



LhARA: The laser and the laser-target vessel are housed in a shielded bunker (green structures). The capture line, composed of three Gabor lenses emerges, from the bunker and guides the beam to the acceleration system and biological research laboratories.

Multidisciplinary LhARA collaboration

The LhARA collaboration spans academia, oncology, the NHS, industry, and has international collaborations. Institutes from each of the four UK nations play critical roles in the collaboration.

UK leadership and impact

The UK-led LhARA collaboration seeks to establish an entirely new technique for the automated delivery of personalised, precision, multi-ion Particle Beam Therapy (PBT).

> To do this the LhARA collaboration will bring together novel technologies, each developed for, or demonstrated in, unrelated fields. This programme carries significant technical risk. The high-risk approach is justified by the high level of reward and will place the UK at the forefront of the PBT field, establish UK industry as a key player in the delivery of novel clinical equipment, and allow significantly enhanced access to state-of-the-art PBT across the UK.

Through the execution of the LhARA programme the collaboration seeks to deliver impact and benefit in clinical, technology, industrial and scientific areas, create jobs and inward investment, and ensure the UK leads the world in science and technology in this area.

Steps

1. Funding being sought from UKRI for an initial concept and risk-mitigation phase (£2M)
2. Funding for building the research facility in the UK (in the region of £100M)
3. R and D costs over ten years and development of the concept of the clinical facility
4. Development of commercial product

LhARA: The Laser-hybrid Accelerator for Radiobiological Applications

LhARA: pre Conceptual Design Report