Radiobiological Science and technology

M7.1: Develop beamline and bespoke facilities at SCAPA for radiobiology experimentation M30
We will develop the beamline at SCAPA to enable irradiation of well characterised cell lines, which will include establishing a staging system to hold the appropriate cell holders (bespoke glass rings) and to enable medium throughput irradiations. Appropriate radiobiological capabilities (e.g. biological safety cabinets, CO_2 incubators, microscopes) will also be established in close proximity to the beamline.

M7.2: Preliminary results from cell survival experiments at SCAPA M36
Preliminary experiments will be performed to analyse the survival of well characterised tumour cell lines to laser-accelerated protons at SCAPA at different dose rates (including FLASH). These experiments and setup will be optimised to enable accurate and reproducible survival measurements to be made.

M7.3: Preliminary results from DNA damage and repair experiments at SCAPA M39
Preliminary experiments will be performed to analyse the levels of DNA damage and kinetics of repair (using immunofluorescence microscopy and comet assays) in well characterised tumour cell lines following laser-accelerated protons at SCAPA at different dose rates (including FLASH). We will establish the experimental conditions and setup needed to enable more routine and reproducible DNA damage assessments to be made.

M7.4: Assessment of cell survival analysis (RBE's) of laser-accelerated protons M48
We will establish survival rates (RBE's) of well characterised tumour cell lines following laser-accelerated protons at SCAPA at different dose rates (including FLASH). These will be comparatively analysed against pre-existing data using cyclotron-accelerated protons (and X-rays) in Birmingham to discover any novel radiobiological differences.

M7.5: Assessment of levels of DNA damage and kinetics of repair of laser-accelerated protons M48
We will acquire data analysing the levels of DNA single and double strand break damage (directly or using surrogate markers) and the kinetics of their repair in well characterised tumour cell lines following laser-accelerated protons at SCAPA at different dose rates (including FLASH). These will be correlated with survival analysis, but also comparatively analysed against pre-existing data using cyclotron-accelerated protons (and X-rays) in Birmingham.

M2A.1: Demonstration of beam delivery to end station. M36
We will install a series of quadrupole magnets into the existing target chamber at the SCAPA laser facility, and integrate them with the laser driven proton source. We will demonstrate the transport of the proton beam and measure the beam properties at the end station, supported by numerical simulations.

M4.3: Iterative reconstruction methods M42

M4.5: LhARA ion-acoustic test results M48

M5.4: Deliver PoPLaR end-station M33.
Construct an end-station compatible with the MC40 cyclotron at the University of Birmingham and SCAPA for the PoPLaR experiments. The gas jet profiler will be loaned from University of Liverpool and the end-station will interface with this as well as being free standing for preliminary tests. It will automate the movement of cell dishes using a custom stepping motor and cell dish holder designed for conventional 35mm cell dishes as well as 20mm diameter glass rings with Kapton bases. Relevant additional beam monitors such as film holders, and ionisation chamber holders for dosimetry will also be included.

M5.6: Report on LhARA stage 1 beam monitoring system M48.
The report will build on the comprehensive literature review from PA1. We will report on the status of the gas jet profiler for measurements of proton beams at SCAPA as well as radiochromic films and novel detector systems identified and tested during the bridging funding.

ITRF/LhARA Facility R&D

Work package 2: Laser-driven proton and ion source

M2.3: Investigation and demonstration of 10 Hz debris and damage challenges at ICL M36

Using the Zhi laser at Imperial College London, we will demonstrate a laser driven ion source running at a repetition rate of 10 Hz, matched to the envisioned ITRF facility. Although the source will be generating proton beams with a lower maximum energy than required by the ITRF, we will be able to utilise the setup to perform studies of debris generation and damage to laser beamline optics and other sensitive components critical to the laser source.

M2.4: Assessment of beam performance during PoPLaR experiment on SCAPA M48

We will diagnose and monitor the performance of the laser driven ion source while providing the beam for the PoPLaR experiment, and determine beam stability and integrated system operation. This will aid in developing facility specifications and operational procedures to inform the design of the ITRF.

M3.3: Progress report on performance of increased voltage Penning trap operation and simulation. M36.

Towards developing a plasma suitable for use as a Gabor Lens, we will design and implement an upgrade of the Swansea Penning trap to accommodate voltages which are higher than those presently available. We will establish and characterize trapping performance at the higher voltages, and we will investigate electron plasma loading and diagnostics with larger space-charge. Simulation will be needed to aid in understanding details of the plasma and the diagnostics.

M3.4: Final report higher voltage Penning trap operation. M48.

We will present a comprehensive summary of results from the Swansea Penning Trap campaign to develop a Gabor lens. Quantitative experience will provide guidance for developing a functional Penning Trap plasma lens for use in LhARA.

M6.2: Final review of R&D work M42.

Management

Work Package 0 & 1. Project management

Deliverables plus internationalisation

D5: Initial PoPLaR and LhARA de-risk update M30
D6: Interim PoPLaR and LhARA de-risk update M36
D7: Final PoPLaR and LhARA de-risk update M42
D8: PoPLaR and LhARA de-risk report M48

M8.1: Creation of collaborative international clinical research group M40

1. **Launch of LhARA**: Delivery of a launch event to inform stakeholders, potential users, and the public about the project's existence, purpose, and goals. It will provide a platform for networking, collaboration and forming partnerships with relevant industry members, potential collaborators, government and funders.
2. **Website Build and Maintenance**: Creation and ongoing maintenance of a website for the LhARA project.
3. **Patient Engagement Session**: Delivery of a session aimed at involving patients in the project, gathering their insights and feedback.

Creation of accessible content: Updating current information to improve accessibility and understanding.

M8.2: Wider public engagement - All party parliamentary group on radiotherapy M48

1. **Patient Engagement Group programme**: Development of a group representative of the patient community to offer their perspectives, preferences and experiences to inform and co-design the delivery of the LhARA project.
2. **Content creation and development:** Working with all stakeholders, planning, creating and distributing high quality content to engage and educate.
3. **Website maintenance:** Ensuring website remains functional, secure and user-friendly.