# LhARA pre-CDR review: terms of reference

## Background

LhARA, the Laser-hybrid Accelerator for Radiobiological Applications, is conceived as the new, highly flexible, source of radiation that is required to explore the vast "terra incognita" of the mechanisms by which the biological response to ionising radiation is modulated by the physical characteristics of the beam. The laser-driven source allows protons and ions to be captured at energies significantly above those that pertain in conventional facilities, thus evading the current space-charge limit on the instantaneous dose rate that can be delivered. This makes it possible to consider dose rates up to and potentially significantly beyond the current ultra-high dose-rate, "FLASH", regime. Rapid acceleration will be performed using a fixed-field accelerator (FFA) thereby preserving the unique flexibility in the time and spatial structure of the beam afforded by the laser-driven source.

It is proposed that LhARA be developed in two stages. In the first stage, the laser-driven beam, captured and transported using plasma lenses and bending magnets, will serve a programme of in-vitro experiments with proton beams of energy up to 15 MeV. In stage two, the beam will be accelerated to allow in-vitro and in-vivo experiments to be carried out with proton-beam energies of up to 125 MeV. Ion beams (including $C^{6+}$) with energies up to 30 MeV per nucleon will also be available. The rapid acceleration provided by the FFA preserves the unique flexibility in the time-structure of the beam provided by the laser-driven source.

Since October 2019 work on the LhARA pre-CDR has been funded by an STFC Opportunities 2019 award. This modest award supports 6-months' full-time effort of a post-doc at Imperial, who is coordinating the work and contributing to the accelerator design, and a post-doc in Liverpool who is contributing to the radiobiological aspects of the work. The STFC investment has leveraged additional support from across the consortium.

The pre-CDR will define the scope of the LhARA project, present an indicative costing for the facility, and an initial evaluation of the "technology-limited schedule". The pre-CDR also defines the R&D programme required to take the project forward. The pre-CDR will be submitted for publication in Applied Nuclear Physics at Accelerators. The LhARA consortium will use the pre-CDR as the springboard from which to launch the next round of bids for funding.

## Terms of reference

The review panel will consider the pre-CDR document and a series of short presentations which will summarise its content to:

- Review the objectives of the LhARA consortium and comment on their scientific merit and timeliness;
- Review the scope of the programme and comment on its potential to deliver the consortium's objectives; and to
- Review and comment on the cost and schedule evaluation paying particular attention to the pre-construction R&D programme.

At the end of the review meeting the panel will prepare a short report summarising its findings and recommendations for transmission to the LhARA Steering Group.

## Membership

Paul Bolton; Munich
Mike Lamont; CERN
Yolanda Prezado; Curie Institute, Paris
Francesco Romano; INFN

## Timetable

$25^{\text{th}}$ *March 2020*: Y. Prezado will meet with the project team to review the radiobiological aspects of the programme. A report will be provided to inform the review of the technological aspects of the programme.

$31^{\text{st}}$ *March 2020*: The review panel will meet to consider the technological aspects of the programme.

$3^{\text{rd}}$ *April 2020*: The panel's report will be finalised and sent to K. Long for transmission to the LhARA Steering Group.