Proposed agenda for the LhARA review

The review is going to take place tentatively in the afternoon/evening of 29 and 30 September 2022.

The panel is invited to assess and comment on:

- The quality of the science and technology involved in the proposal, the stated scientific and technical objectives, and to consider whether the proposal is likely to achieve those objectives;
- The likely scientific impact of the project within the UK and internationally, and the degree to which the LhARA collaboration's aims and objectives are supported by the relevant scientific communities;
- The timeliness of the project and its relevance with respect to alternative approaches;
- The standing of the groups and collaborators involved in the project, including the track records of the proponents;
- The project management structure, including the alignment between the LhARA collaboration and the ITRF, and the procedures required to ensure that the stated project goals are achieved;
- The scientific, technical, schedule, and financial risks attendant on the project and the degree to which the proposed activity addresses these risks;
- The costing and the proposed milestones against which the project will be monitored; and
- The industrial-engagement, outreach, involvement, and engagement plans.

The panel Is requested to provide the Executive Board of the LhARA collaboration with a written report suitable for transmission to the STFC and other stakeholders within 30 days of the completion of the review.

The review will take place remotely and will be split into two parts focussing on:

1. Radiobiology and longer-term ambitions (29/9)
2. The machine and associated technology (30/9)

Though the review is going to be split in 2 parts it might be important to make sure that the science agenda addressed by LhARA, user requirements and expected machine capabilities are discussed collegially (e.g. during the part on Radiobiology and longer term ambitions but with accelerator and technology reviewers present). The same applies for the general project scope/organization/structure/resources description.

We propose to have early and ultimate specifications for the required parameters with an assessment of the difficulties and risks associated with the achievement of the ultimate ones. This could allow identifying risks and possible mitigations knowing their expected impact on the scientific programme.

<u>Plenary session:</u>

Participants: CCAP IAB + machine/radiobiology experts' panels

- ITRF: Motivation and background of the proposal
    - Medium term and long term perspective/objectives
    - Why? and why now?
    - LHARA as a first step towards ITRF (relationship) ?
    - Integration/collaboration of radiobiology and accelerator experts

- Radiobiology motivation and science agenda with LhARA and functional specifications:
  - Preliminary (pre-stage 1) R&D and where (Clatterbridge etc…)
  - 2 stage (without and with post accelerator) approach: vision from the users and what new radiobiological regimes are sought?
  - Early requirements for each stage and their criticality:
    - Intensity
    - time structure: bunch duration and rep rate
    - beam size/divergence
    - energy and energy spread
    - reproducibility, pulse-to-pulse stability
    - beam parameters to be measured
    - which ones? beam size, intensity, energy, bunch duration
    - what is the required precision, accuracy, bunch-to-bunch reproducibility…?
    - expected modes of operation: typical measurement runs, duration, single pulse irradiation vs. multi-pulse irradiation,….,
    - …….
  - Ultimate requirements for each stage and their criticality (same as above)
  - Biological endstations and associated endstation instrumentation
  - Will spot scanning/image guidance be needed in stage 2 ?
  - Is there potential for future multiple beam irradiation (eg. protons + x-rays)
  - Likely scientific impact and support of scientific community
  - timeliness and relevance of new science agenda
  - Extent of collaborative activity

- Expected machine capabilities (compare to user bunch/performance requirements?)
  - 2 stage approach (without and with post accelerator): vision from the machine
  - Expected early parameters and modes for each stage (see above for the possible list)
  - Ultimate parameters (include mode if important) for each stage
    - Indicate level of difficulty/uncertainty in reaching them

- R&D proposal for the preliminary and pre-construction phase of ITRF:
  - Scope
  - Main milestones and timeline
  - Required resources (material, manpower)
  - Available resources (material, manpower)
  - General risks and mitigation measures (to be further addressed in the specific talks)

- Project Structure and Organization:
  - LhARA and ITRF respective roles (LhARA as ITRF prototype/testbed?)
  - management structure, including alignment between the LhARA collaboration and the ITRF
  - timeliness and relevance of project
  - costing assessment(s)/issues
  - Reporting

Accelerators and technology session:

Participants: CCAP IAB + machine experts panel

Each of the items below can be covered by one or more presentations as

- Laser-driven proton and ion source (WP2)
  - Description of the source and interfaces
  - Early and Ultimate beam parameters at the exit of the source (see earlier lists for reference)
  - Suggested laser system specifications
  - Targetry (range of potential rep-rated target development for ~ 10 Hz operation)
  - R&D plans and milestones (how to get beyond 1 Hz?)
  - Reproducibility and reliability considerations
  - Instrumentation and any special development for source characterization and operation
  - Ion/proton selection and switching (include realistic assessment of ease with which ion species can be changed during operation)
  - Technical risks (e.g. poor reliability, reproducibility) and mitigations (hardware? Modelling, feedforward, ….)
  - Other back-up plans?
  - Milestones and Timeline for the design, R&D
  - Required resources (material and personnel)
  - Available resources (material and resources)
  - Other risks and proposed mitigations

- Proton and ion capture (WP3)
  - Expected early and ultimate input beam parameters (see earlier lists)
  - Expected early and ultimate output beam parameters
  - Description of the capture system and interfaces (include collimation, momentum selection and radiation protection considerations? Here or in WP6)
  - Gabor lens:
    - Why a Gabor lens?
    - State of the art and required parameters (early and ultimate)
    - R&D plans to achieve required parameters (early and ultimate). Is the test in Swansea sufficient to assess the feasibility of the final design?
    - Technical Risks (plasma stability, high voltages, plasma filling factor, radius,…) and mitigations
  - Magnetic (solenoid) lens:
    - Why not starting with solenoids?
    - State of the art and required parameters (early and ultimate)
    - Design and R&D plans?
    - Technical Risks (reduced performance?) and mitigations
  - Required beam diagnostics and special instrumentation in (and at end of) capture section (here or in WP6 presentation(s) (use of SciWire and SmartPhantom ?)
  - Machine learning role(s)
  - Other back-up plans (hybrid solutions mixing Gabor lens and solenoids?)?
  - Milestones and Timeline for the design, R&D: is there a decision point when to select among the two options?
  - Required resources (material and personnel)
  - Available resources (material and resources)
  - Other risks and proposed mitigations

- Transfer lines and post accelerator (WP6)
    - Stage 1 and Stage 2 vision
    - Expected early and ultimate output beam parameters form the capture section
    - Expected early and ultimate input beam parameters at the post accelerator
    - Expected early and ultimate output beam parameters at the post accelerator
    - Expected early and ultimate parameters at the radiobiology stations (Stage 1 and 2)
    - Beam lines (2 in vitro and 1 in vivo)
        - Main parameters
        - Acceptance
        - Collimation, momentum selection and radiation protection considerations
        - Beam diagnostics/instrumentation
        - Requirements for beam operation and characterization
    - Post-accelerator:
        - FFA:
            - Description and main machine/system parameters
            - Why an FFA?
        - Alternative solutions (linacs, Rapid Cycling Synchrotrons,…)
        - Beam diagnostics
        - Technical Risks and mitigations
        - Milestones and Timeline for the design, R&D: is there a decision point when to select among options (if any alternative option is worth pursuing)?
    - Injection and Extraction sections
    - Required resources (material and personnel)
    - Available resources (material and resources)
    - Other risks and proposed mitigations

- General facility infrastructure and integration (WP6)
    - Stage 1 and Stage 2 vision
    - General radiation protection considerations
    - Power consumption and operation (skill required, maintenance and operation costs, reliability considerations, too early?)
    - Milestones and Timeline for the design
    - Required resources (material and personnel)
    - Available resources (material and resources)
    - Identify notable areas for possible industrial collaborative R&D and other outreach
    - Project scientific, technical, schedule, and financial risks attendant and the degree to which they are addressed in proposed activity
    - Other risks and proposed mitigations