Science and Technology Facilities Council

ITRF - LhARA

General Facility Infrastructure and Integration
ITRF WP2 & LhARA WP1.6

12 Month Design Review (Summary of Progress & Status)

20th September 2023

Andy Goulden, Clive Hill, UKRI-STFC-Daresbury Laboratory, On behalf of the team

Progress since the 6 month design review

- **Mechanical engineering design and Finite Element Analysis of a Fixed Field Accelerator vacuum chamber to inform the combined function magnet gap**, document RFS-1055-meng-fea-0001-v2.0-FETS-FFA-Vacuum-Chamber-2023-09-08.
- Update to the **Building concept** in this report. Figures 1-7 and facility room sized Tables 2 & 3.
- Update to the **low energy line engineering concept** in this report. Figure 8.
- Update to the **Vacuum design**. Amended section 1.7 in this report.
- Update to the **Controls design**. Amended section 1.8 in this report.
- Update to the **Electrical Engineering** design based on the electrical power consumption. Amended section 1.9 in this report.
- **Cooling System** design concept based on the electrical power consumption added. New section 1.10 in this report.
- **Compressed Air and Air Conditioning** section 1.11 and 1.12 added to this report.

Progress since the 6 month design review - continued

- **Sustainability** contributing to Net Zero by 2040, section 1.1 added.
- Estimate of the **ITRF power consumption**, document 1272-pa1-pm-est-0001-v2.0-power-consumption-est-2023-09-07.
- **Estimate of the Full Infrastructure cost** for UKRI IF preliminary activity 2 proposal, document 1272-pa2-pm-fin-0002-v2.0-ITRF-construction-cost-model-2023-09-08.
- Update to the **Facility Schematic**, document 1272-pa1-pm-sch-0001-v3.0-ITRF schematic. Figure 10 in this report.
- New draft ITRF **vacuum flow diagram**, document 1272-pa1-vac-vfd-0001-v0.1
- **Mechanical design concept for the laser target chamber** for a proton beam tape drive configuration, document 1272-pa1-meng-prs-0009-v1.0-target-chamber-2023-08-22. Update to Figure 9 in this report.
- **Target chamber vacuum simulations**, document 1272-pa1-vac-prs-0001-v1.0-nozzle-gas-trans-prob-2023-08-15

Building & Technical Services

- General introduction describing the design concept for the building and technical services
- Current ideas that will need developing
- Updates will be required when the accelerator design provides enough information on the Magnets and RF requirements to develop the overall power and cooling requirements.
- Rational for the location of the technical services equipment & rooms described
- Size/number of transformers, switchboard, racks and cooling plant will change when we have the numbers
- No equipment yet shown in the end stations
- Novel end station consultation with peer-group in progress

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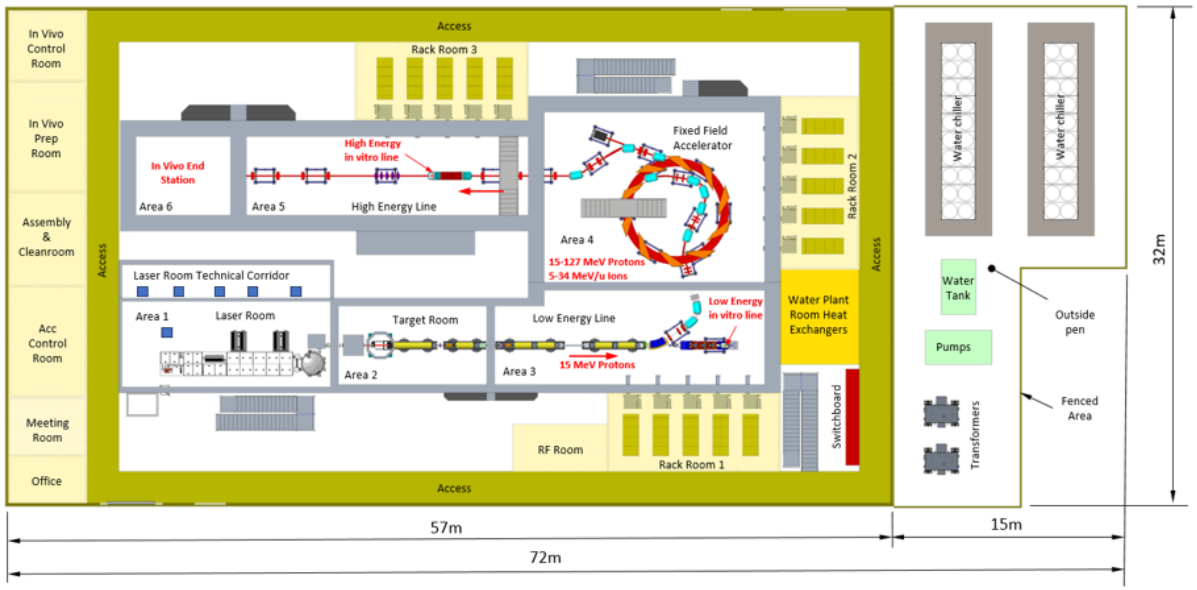

Figure 1 Facility ground floor plan.

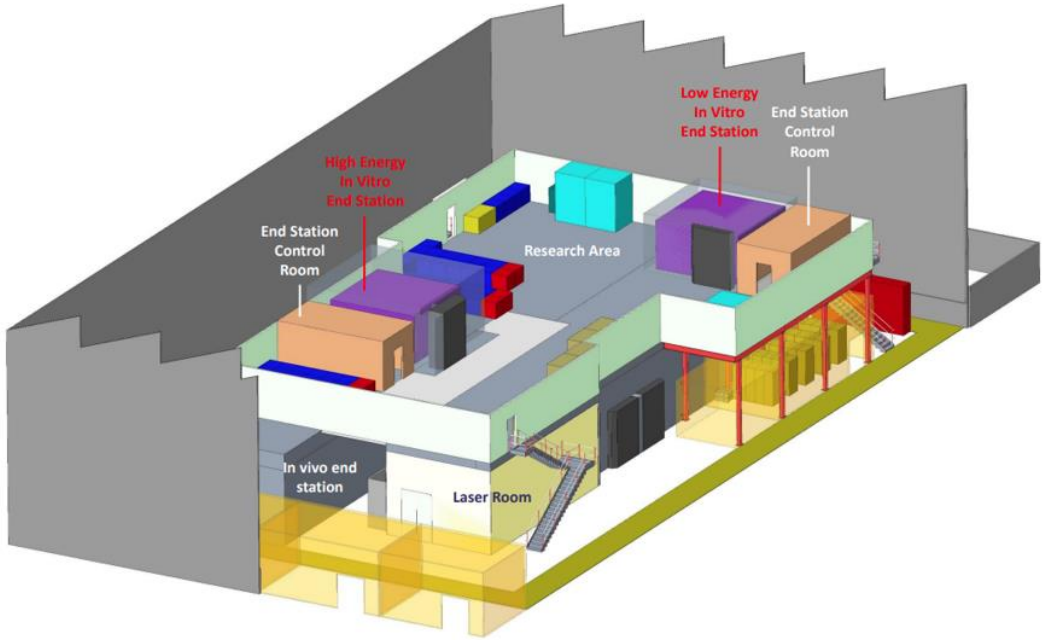

Figure 2 End stations and research area above the accelerator complex on the 1st floor.

Building & Technical Services

- The facility includes an open area shown in figure 4
- Radiation safety section includes with generic description of requirements without any numbers yet
- The plan is that a a specialist company will perform a Radiation Study & concrete sustainability from November 2023 and contain the following activities:
  - A high level shielding design basis report that creates a point of reference for all the shielding protection calculations.
  - Radiological classification of areas
  - Preliminary bulk shielding requirements
  - Concrete sustainability appraisal
  - Some ideas for composite radiation shielding block included
- Some ideas already for composite radiation shielding block

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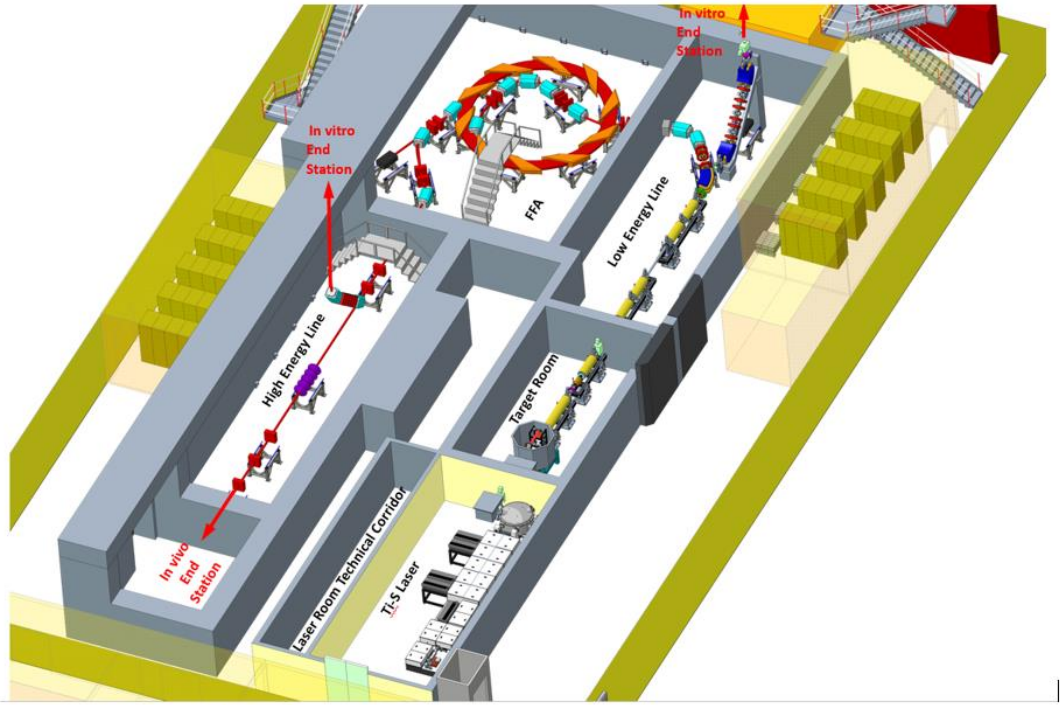

Figure 3 Accelerator complex with shielding cut away to see equipment. Three end station described in red text.

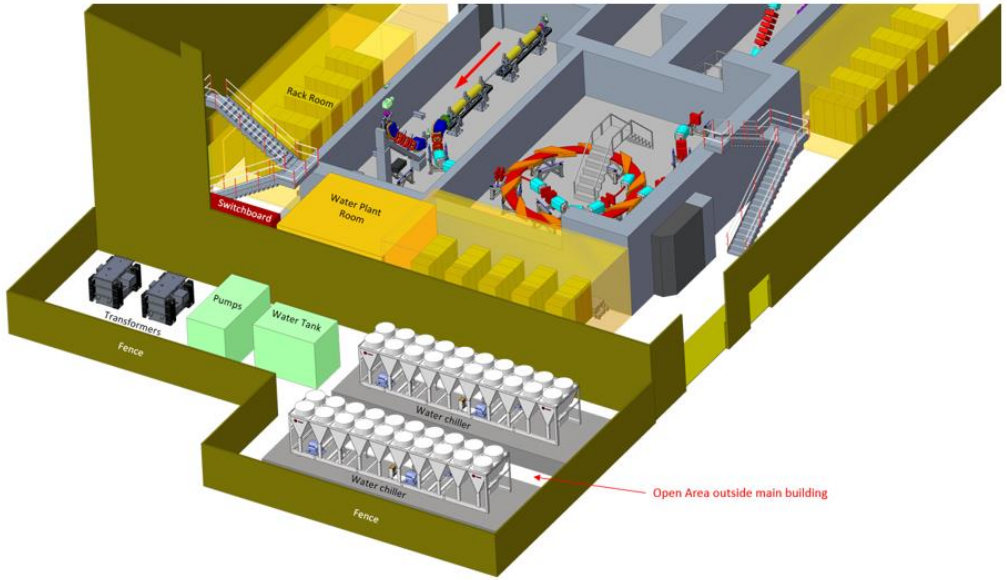

Figure 4 Water cooling plant and transformer(s) outside pen.

Building & Technical Services

- Overall height is estimated as 14m that allows the implementation of an overhead crane to install and decommission the facility
- Lifting solutions will also be required inside the radiation enclosures for installation, maintenance and decommissioning.
- Saw-tooth roof construction is proposed comprising of a series of ridges with dual pitches either side. The steeper surfaces at ~70° to have double glazed windows to admit natural light. The shallower surfaces at ~35° are proposed for the installation of solar panels facing south to receive the most direct sunlight and energy gain.

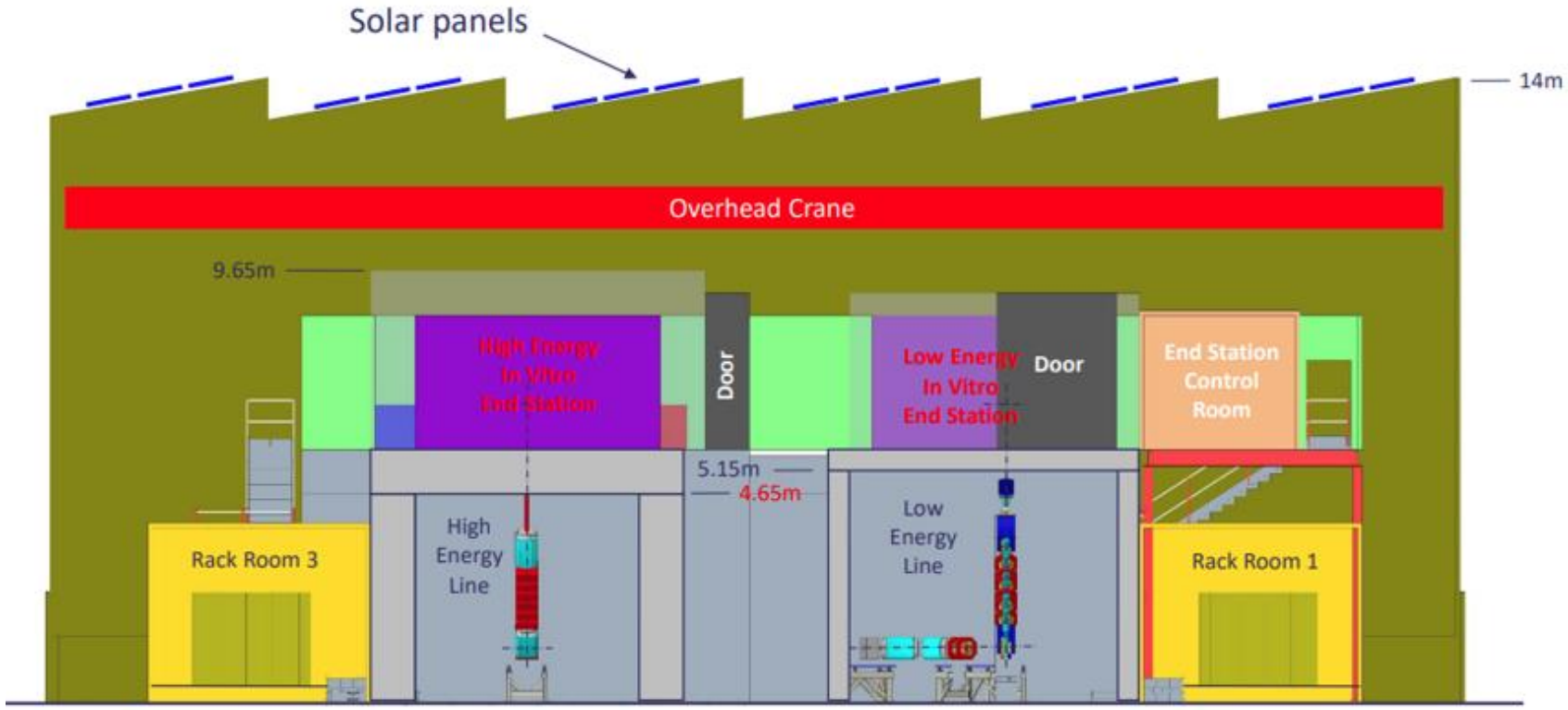

Figure 5 Cross section through the facility.

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Building & Technical Services

- **Stage 1** construction proposed is the full building envelope and outside pen to house the laser, target, low energy line, low energy in vitro end station, control rooms and research area.
- **Stage 2** development would add the FFA, high energy beamline, high energy in vitro end station, in vivo end station and upgrade to the technical services and research areas
- More breakdown detail of the above descriptions in the review report.

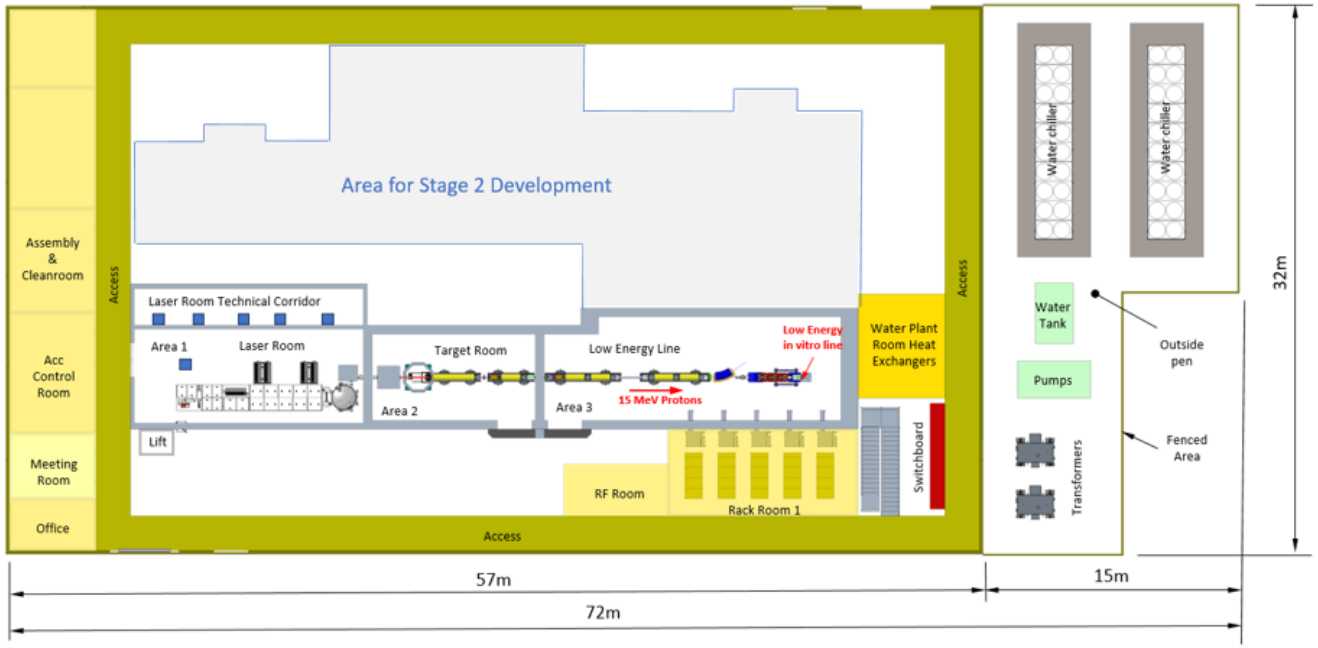

Figure 6 Stage 1 floor plan

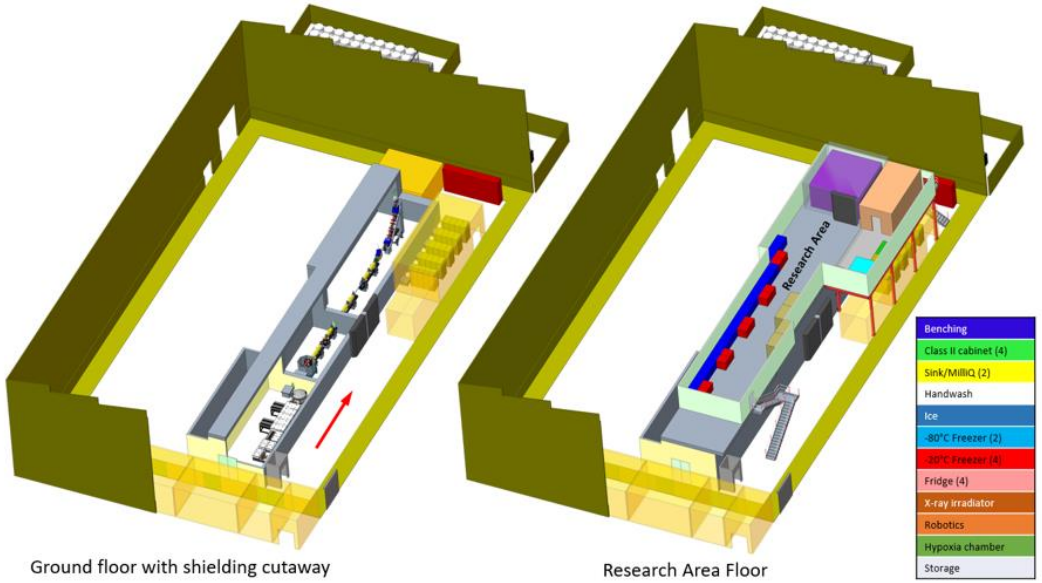

Figure 7 Stage 1 construction.

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Key Installation Milestones

Stage 1

- First demonstration of the capture of a laser-driven ion beam using a Gabor lens system;
- Demonstration of the energy selection capabilities of a Gabor lens system;
- Irradiation of cells with a laser-driven ion beam.

Stage 2

- Injection line to the FFA;
- Fixed Field Accelerator;
- Extraction line from the FFA and the transfer line to the in vivo end station;
- High energy in vitro arc;
- High energy in vitro end station;
- In vivo end station.

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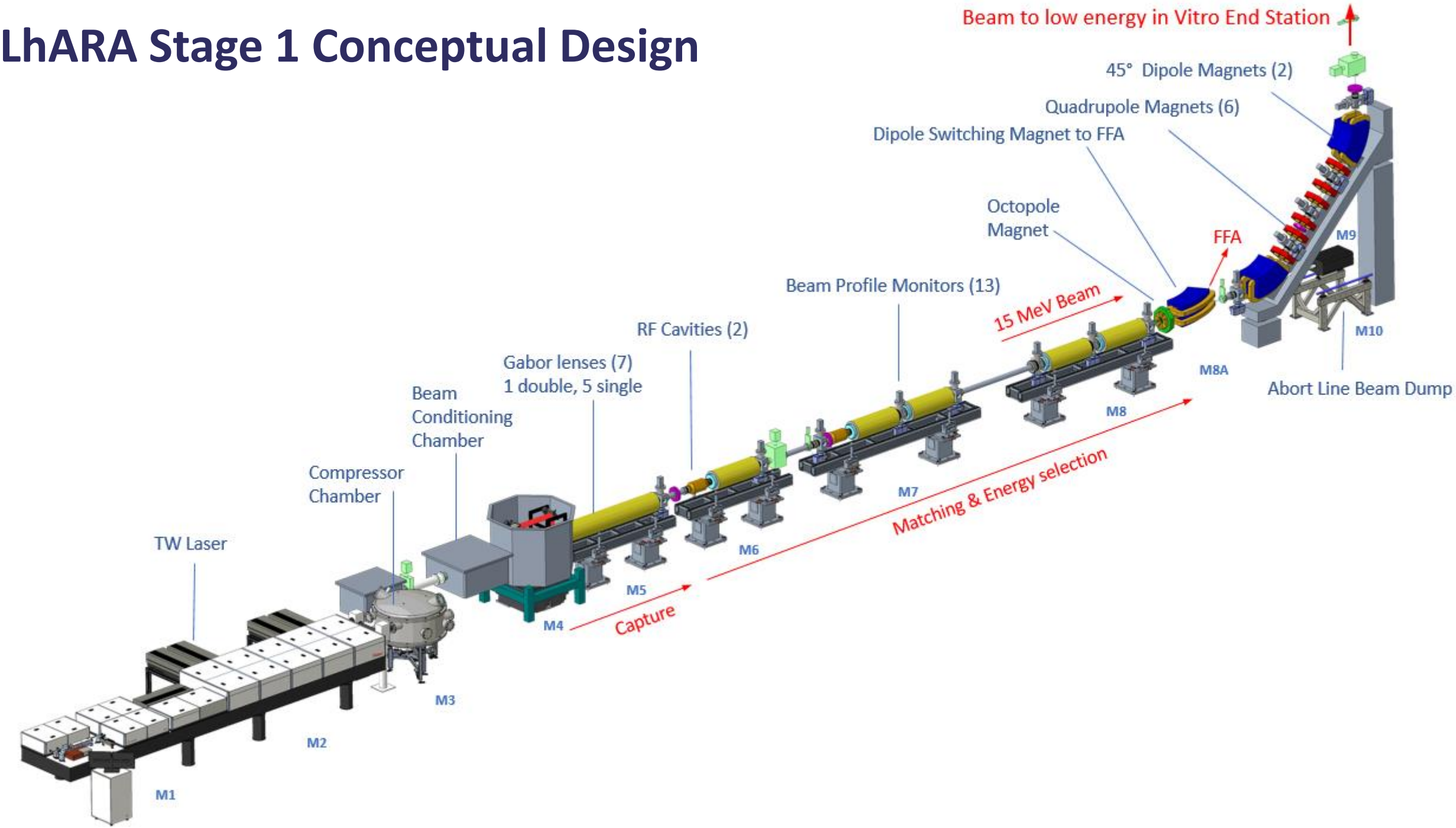
LhARA Stage 1 Conceptual Design



Laser Target, Nozzle, Gabor Lens Concept Design

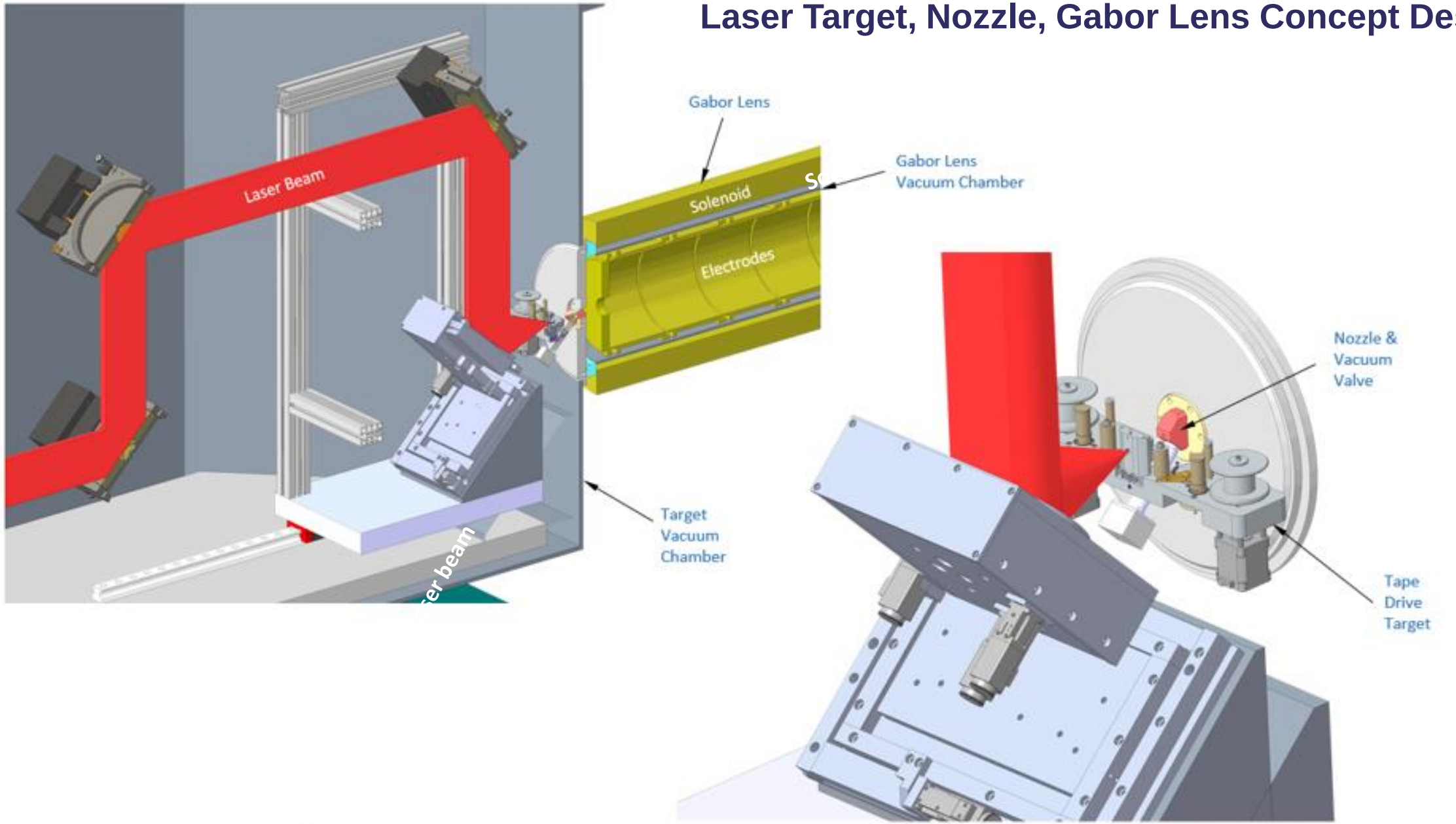


Figure 9 Concept design of the Target, Conductance Nozzle and 1st Gabor Lens.

LhARA Schematic

Document: 1272-pa1-pm-sch-0001-v3.0-ITRF schematic

https://stfc365.sharepoint.com/sites/ITRF

The intention is to capture all the required equipment in the schematic

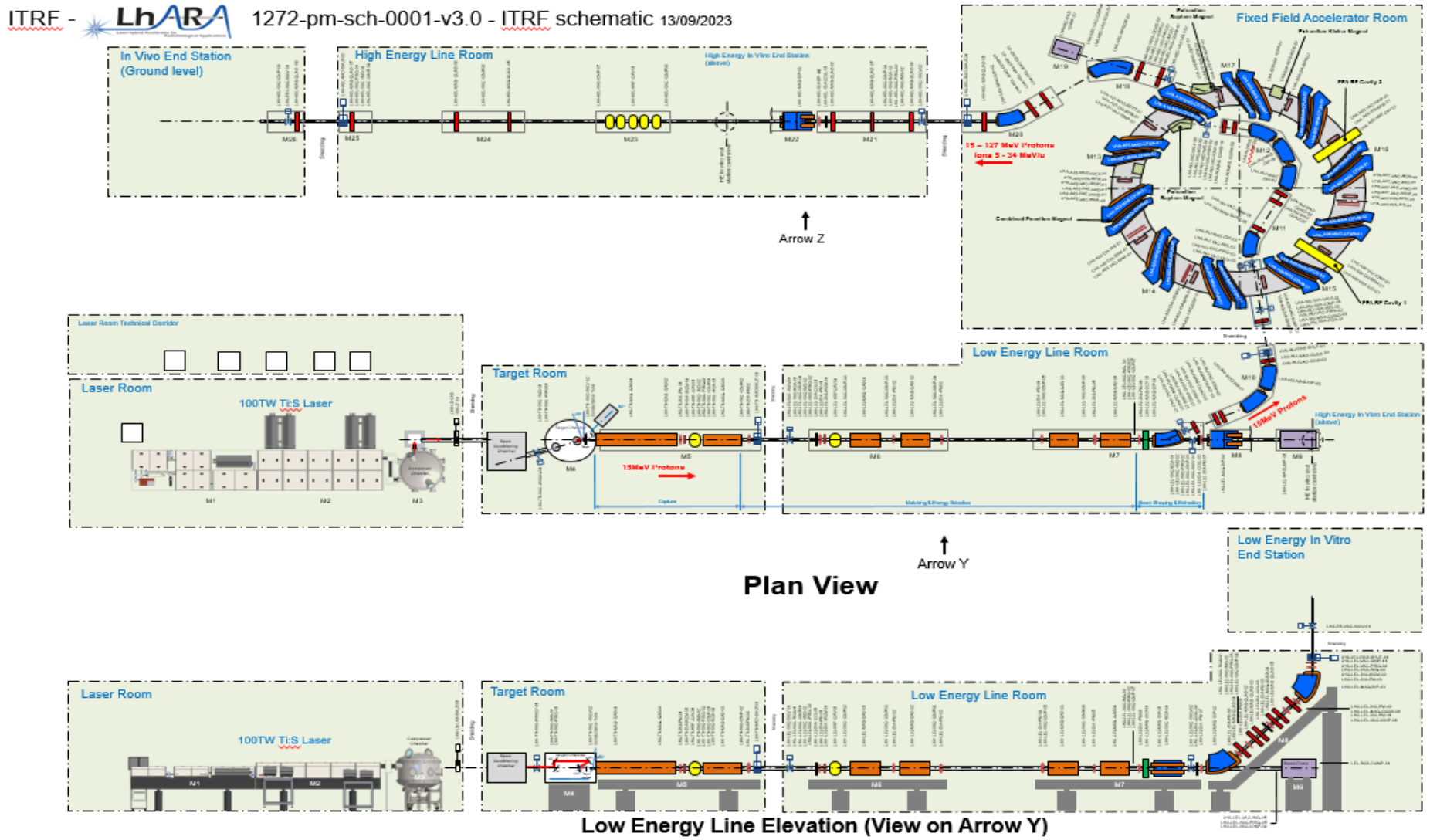
The diagram is available at large format

A device naming convention has been adopted to;

Each device with a unique name.

The function of a device can be derived from its name

Names can be adopted by the LhARA Control System.



Vacuum Systems & Controls

Review Report document describes;

- General Vacuum Systems Design Objectives
- How the facility is broken down to several vacuum regions
- Provisional working pressures in the various vacuum regions
- Vacuum Design Principles
- Vacuum Pumping
- Pressure Measurement
- Vacuum Values
- Bakeout considerations

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Summary

- Infrastructure plan is well established
- Low energy line is well defined
- Need to ramp up the engineering design of the FFA
- Obtain a better understanding of the:
  - Magnet definition for the high energy line
  - Diagnostics
  - End stations
- Update the schematic diagram, vacuum flow sheet & CAD model as the design evolves.
- Providing an understanding to inform the Planning and Cost Model