Science and Technology Facilities Council

ITRF - LhARA

Milestone Reporting M6 Summary Notes

1272-pa1-wp2-prs-0009-v1.0-ITRF and LhARA Summary Notes 2024-04-25

18 Month Design Review

25th April 2024

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

LhARA Building Concept Design - Neil Bliss & Clive Hill (STFC Daresbury)

- Requirement for stability and vibration control
- Energy efficient
- 2 floor construction
- In vitro end stations on first floor (roof)
- Site plan 72m x 32m
- Laser room stability 20-22°C ±1°C with ISO7 cleanliness
- Sustainability contributing to net zero by 2040 – considerations on material choices, power consumption and cooling requirements
- Comply with Ionising Radiation Regulations 2017
- Ground floor accelerator complex divided into 6 areas for flexibility during construction and operation

Bulk Shielding Assessment- James Bebbington (STFC Daresbury)

- Entirely dependent on the source terms
- Functional source term data sheet schematic of the facility has been generated displaying each significant source where a substantial proportion of the beam is lost (such as collimator, shutters and beam dumps)
- Beam loss % established for different modes
- Source terms also contain the operating schedules for expected duration of “beam on”
- Source terms have now been specified for use in the bulk shielding calculations
- TÜV SÜD work on bulk shielding calculations is in progress with estimated completion date of May/June 2024

Location	Source description	Beam loss percentage (%)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
A0	Plasma source	98	98	98	98	98	98
A	Source nozzle	30	33	30	30	30	30
B	Collimator	25	25	25	25	25	25
C	Source shutter	0	0	100	0	0	0
D	In-vitro Stage 1 delivery (arc collimator)	25	0	0	25	0	0
E	In-vitro Stage 1 station	100	0		100	0	0
F	Injection line (Stage 1 shutter)	0	25		0	25	25
G	FFA acceleration		10			50	10
H	FFA extraction		10			10	10
I	FFA beam dump		0			100	0
J	FFA shutter		0			0	0
K	In-vitro Stage 2 delivery		0 or 25				0 or 25
L	In-vitro Stage 2 station		0 or 100				0 or 100
M	Stage 2 shutter		0				0
N	In-vivo delivery		0 or 100				0 or 100

	Stage 1 operation		Stage 2 operation	
	Protons	C6+ ions	Protons	C6+ ions
Max beam energy (MeV)	15 MeV	48 MeV	127 MeV	400 MeV
Repetition rate (Hz)	100			
Particles required at delivery point (#/s)	1×10^{10}	1×10^{9}	1×10^{10}	1×10^{9}

Nominal bounding source terms for each stage of normal operation

Mechanical Systems Integration Support Concepts - Clive Hill (STFC Daresbury)

- Stable and minimise effects due to vibration
- Facilitate adjustment – X, Y, Z, pitch, roll and yaw
- Optical support systems such as target chamber will be isolated from vacuum chamber
- Low energy beamline modules – aluminium girder supported on two pedestals with kinematic system and X, Y and Z adjustment
- Accelerator devices on girders have independent kinematic support system and X, Y and Z adjustment
- Modular system which facilitates assembly and testing offline
- Support concepts designed by STFC Daresbury and proof tested on projects such as CLARA and ESS

Vacuum Concepts – Andrew Vick (STFC Daresbury)

- Target chamber has significant gas load and directly coupled to the first Gabor lens. Performance needs to be optimised to avoid degrading the beam properties
- Low and high energy line requires similar vacuum level
- FFA will require higher vacuum specification due to recirculating particles
- Vacuum level for end stations are unknow at this stage?
- UHV design principle has been adopted and vacuum regions separated by valves
- Vacuum achieved using combination of pumps including ion pumps with NEG cartridges for maintaining vacuum
- Diagnostic instrumentation has been included in each section
- Vacuum modelling is required especially in two areas of concern
    - Target chamber to first gabor lens
    - Gabor lens 01 has no provision for pumping in upstream region

Subsystem	Mean working pressure (mbar)
Laser systems	TBC
Laser beam Conditioning chamber	TBC
Target chamber	1×10^{-6}
Gabor lenses	1×10^{-8}
Low energy line	1×10^{-8}
Low energy in vitro end station	TBC
Fixed Field Accelerator	1×10^{-9}
High energy line	1×10^{-8}
High energy in vitro end station	TBC
High energy in vivo end station	TBC

Power Consumption and Cooling Requirements – Steve Griffiths/Andy Goulden (STFC Daresbury)

- The figures shown ion the table below assume the use of Gabor lenes (line 4). If alternative solution with solenoids was adopted the power requirement would increase by an estimated 850kW
- Estimated peak power consumption for the facility is 3.5MW. The average power is likely to be significantly smaller and will be determined later.
- The power consumption for the FFA magnet will need to be reviewed

	Technical Equipment	No of racks	Power/rack	Total load kW
1	Laser	4	12	48
2	Target	4	2	8
3	Radio Frequency	5	n/a	186
4	Gabor Lenses (Solenoid only configuration)	7	n/a	56
5	Pulse Power	4	n/a	14
6	Power converters (magnets)	12	n/a	1411
	Controls & Instrumentation:			
7	Laser			
8	Vacuum	6	2	12
9	Diagnostics	9	1	9
10	Personnel Safety	3	1	3
11	Network/control	3	1	3
12	RF Control & Auxiliaries	3	2	6
13	Motion Control	6	2	12
14	End stations			0
	Total number of racks	66		1768
	Services			
15	Lighting			10
16	Climate Control			135
17	Chiller System			294
18	Water pumps			73
19	Compressed Air			50
20	Offices/Laboratories			15
	Total ancillary load (kW)			577
	Total ITRF operational electrical load			2345
	Total ITRF Electrical Infrastructure Requirement (10% contingency)			**2580**

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