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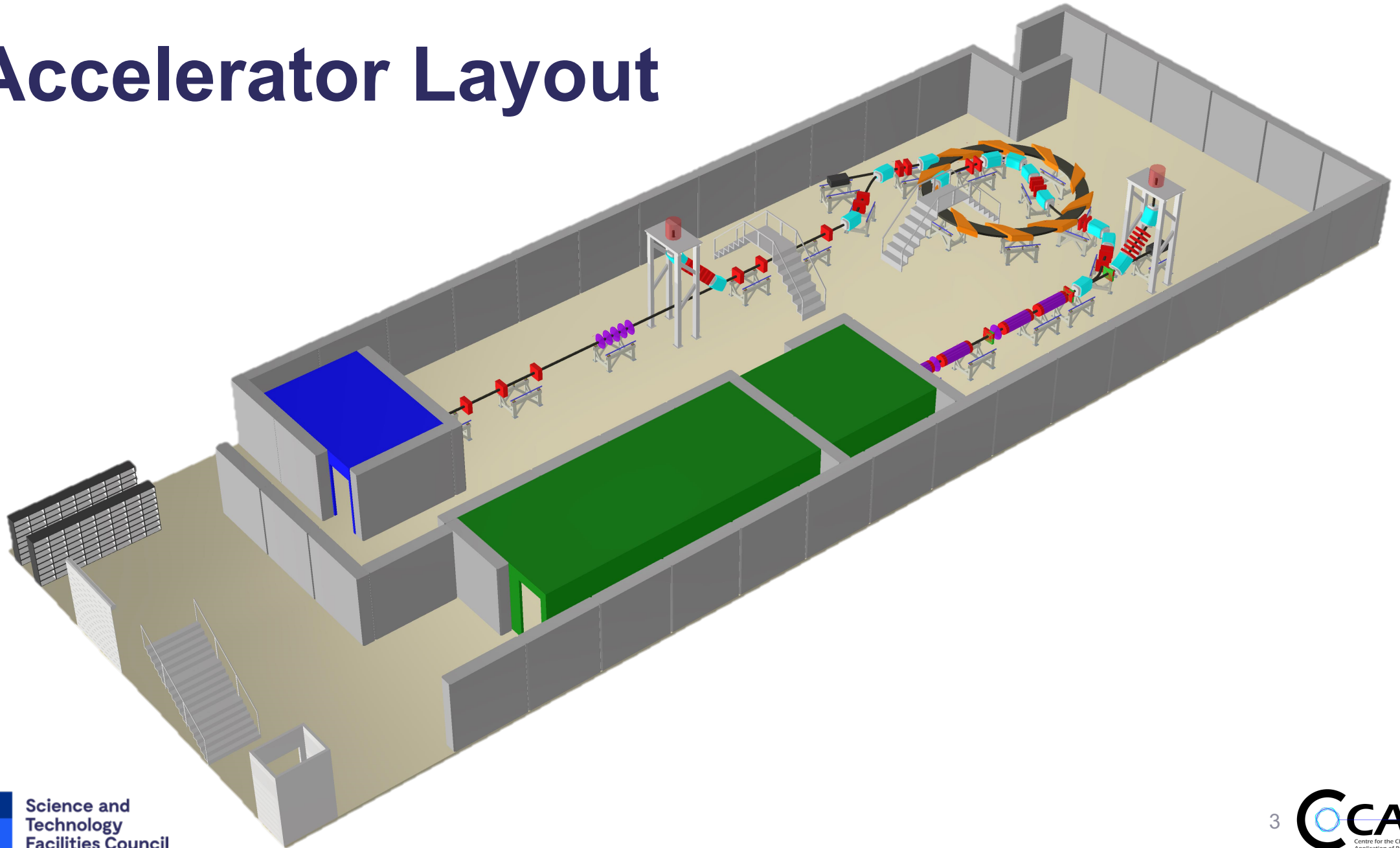
LhARA pre-CDR: Infrastructure, Integration & Safety

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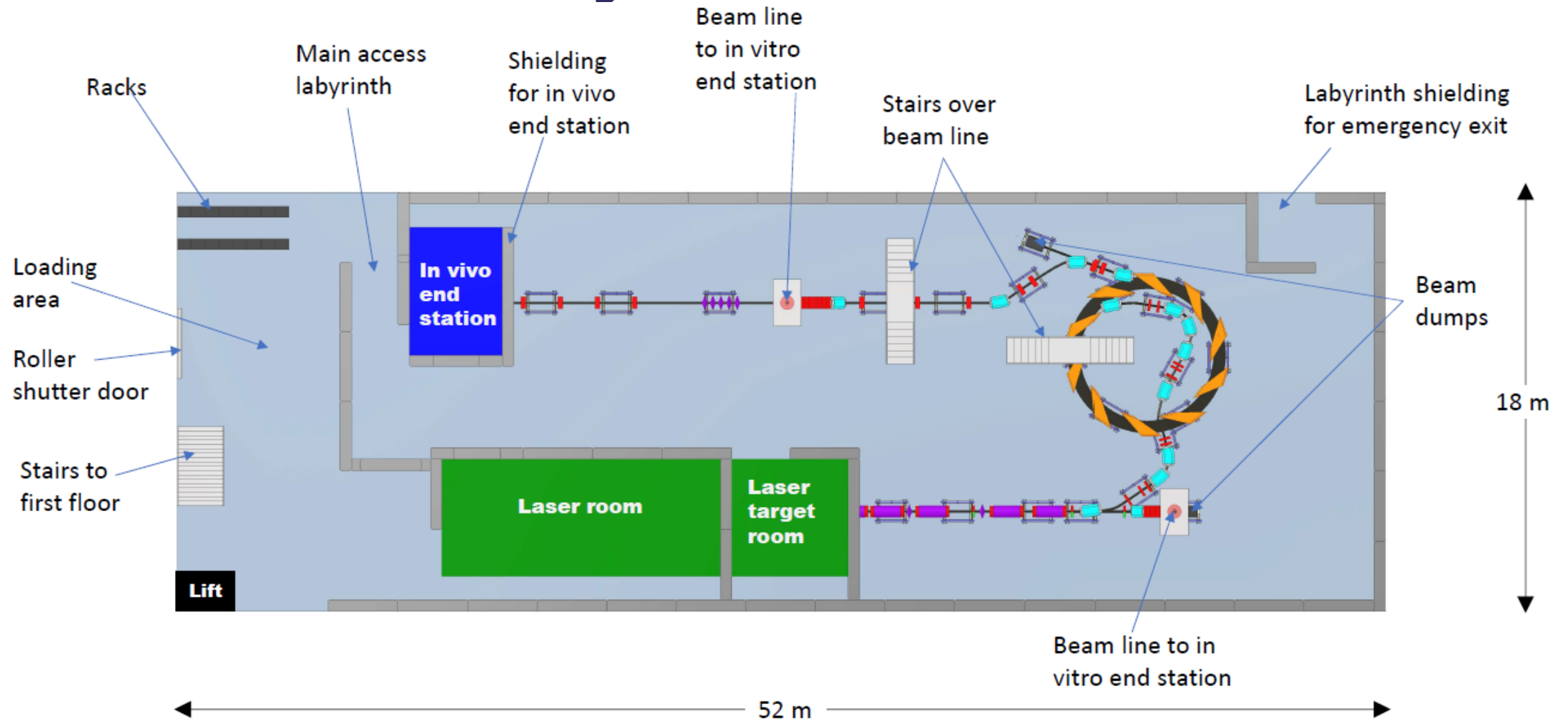
Outline

- Floor Layout
- Safety
- Costing
- R&D

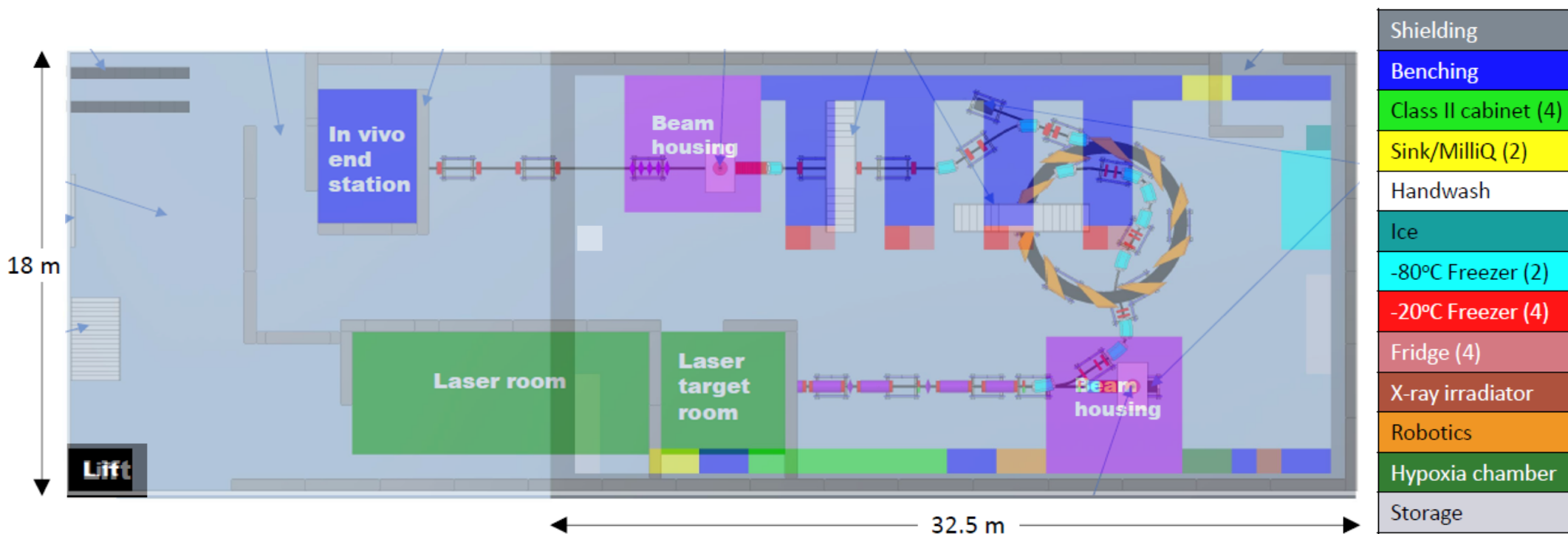
Accelerator Layout



Accelerator Layout



End Station Layout



Safety

The facility is expected to be built at an STFC National Laboratory or equivalent research institute

Safety will follow guidelines set out by the institute and with the support of staff and appointed responsible persons, such as

- Radiation Protection Advisors
- Laser Responsible Officers
- Authorising Engineers

Safety

Relevant STFC safety codes:

- SC6 – Risk management
- SC13 – Construction design and management
- SC16 – Biological safety
- SC22 – Working with lasers
- SC23 – Working with time-varying electro-magnetic fields
- SC29 – Management of ionizing radiation at work
- SC34 – Electrical safety

Safety

Comparable facilities operated by STFC

Lasers:

- Gemini Target Area 2 – 0.5 J, 5 Hz, 30 fs
- Gemini Target Area 3 – 15 J, 0.3 Hz, 30 fs
- Extreme Photonics & Applications Centre (EPAC) – higher energies at 10 Hz

Accelerators:

- Front End Test Stand (FETS) – H⁻ ions, 3 MeV, 60 mA, 2 ms, 50 Hz
- ISIS Neutron & Muon Facility – H⁺/Protons, 800 MeV, 240 μ A, 10 ms, 50 Hz

Safety

End Stations

- Administration of chemicals and drugs to cell performed in Class II biological safety cabinets in the laboratory
- As necessary, plates and dishes sealed prior to irradiation in end-station

Radiation

- Controlled under Regulation 8 of the Ionising Radiation Regulations 2017 – a risk assessment is required prior to starting work
- To consider: nature of the source, dose rates, contamination, dosimetry, engineering controls, PPE, access, accidents, failures

Costs

Total Cost Estimates			
Optimistic		Most Likely	Pessimistic
£22M		£33M	£53M
Description	Optimistic cost (£k)	Most likely cost (£k)	Pessimistic cost (£k)
Laser	2197	2746	3295
Capture	409	545	681
Stage 1	607	759	1139
Stage 2	6924	8656	12984
End stations	799	999	1198
Integration	2612	3265	4898
R&D	400	500	600
Safety	595	850	1275
Building	4060	9160	18320
Installation and commissioning			

Table 10: Cost breakdown for the LhARA project.

Costs

Estimates are

- Comparative
- Parametric
- Formal quote
- Budgetary quote
- Guess/Prediction

Comparative

Guess/Prediction

Parametric

Stage 2 Accelerator

Description	Optimistic cost (£k)	Most likely cost (£k)	Pessimistic cost (£k)
Quadrupole Magnets (x20 @ £10k each)	192	240	360
Dipole Magnets (x10 @ £10k each)	80	100	150
Power Supplies (x32 @ £3k each)	77	96	144
Beam Dump (x2 @ £15k each)	48	60	90
FFA Magnets (x10 @ £250k each)	2000	2500	3750
FFA magnet power supply (x10 @ £75k each)	600	750	1125
RF Cavities (x4 @ £300k each)	960	1200	1800
RF Power supply/drive system (x4 at £400k each)	1280	1600	2400
Kicker Magnets (x2 @ £200k each)	320	400	600
Septum Magnets (x2 @ £200k each)	320	400	600
Kicker & Septum power supplies (x4 @ £60k each)	192	240	360
Bunching Cavities (x4 @ £30k each)	96	120	180
Beam pipe (25m @ £3k/m)	60	75	113
Frames (25m @ £5k/m)	100	125	188
Rails (25m @ £5k/m)	100	125	188
Diagnostics (25m @ £25k/m)	500	625	938

Table 14: Cost breakdown for Stage 2.

Costs

Estimates are

- Comparative
- Parametric
- Formal quote
- Budgetary quote
- Guess

Budgetary & formal quotes

End Stations

Description	Optimistic cost (£k)	Most likely cost (£k)	Pessimistic cost (£k)
Refrigerated centrifuge (x2) - Eppendorf 5804R	9.6	12	14.4
Refrigerated ultracentrifuge - Beckman Coulter Optima MAX-XP	40	50	60
Hypoxia chamber - Baker InvivoO2/Don Whitley	32	40	48
Ice Flaker machine - Scotsman AF80	2	2.5	3
CellRad x-ray irradiator - Faxitron	56	70	84
Class II cell culture cabinet (x4) - Esco Airstream	22.4	28	33.6
Digital microscope - Invitrogen EVOS M5000	16	20	24
Light microscopes (x3) - Nikon Eclipse TS100	7.2	9	10.8
CO2 cell incubator (x2) - Panasonic	11.2	14	16.8
Fridges/-20°C Freezers (4 each)	1.6	2	2.4
-80°C Freezers (x2) - Panasonic	16	20	24
MilliQ water - Avidity 60L	4.8	6	7.2
Colony counter - Oxford Optronix GelCount	20	25	30
Fluorescence microscope/Live cell imaging	80	100	120
Robotic workstation (research laboratory) – Tecan/Beckman	160	200	240
End station cabinet (hypoxia enabled) - BakerRuskin/Don Whitley	160	200	240
Robotics within end station cabinets (x2)	160	200	240

Table 15: Cost breakdown for the end stations.

R&D Plan

Four key areas for infrastructure and integrations:

1. Full project risk analysis (e.g. resource availability and technical challenges)
2. Full facility safety risk assessment
3. Radiation simulations and shielding design
4. Control systems development



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Thank you