LhARA Pre-CDR

Biological End Stations

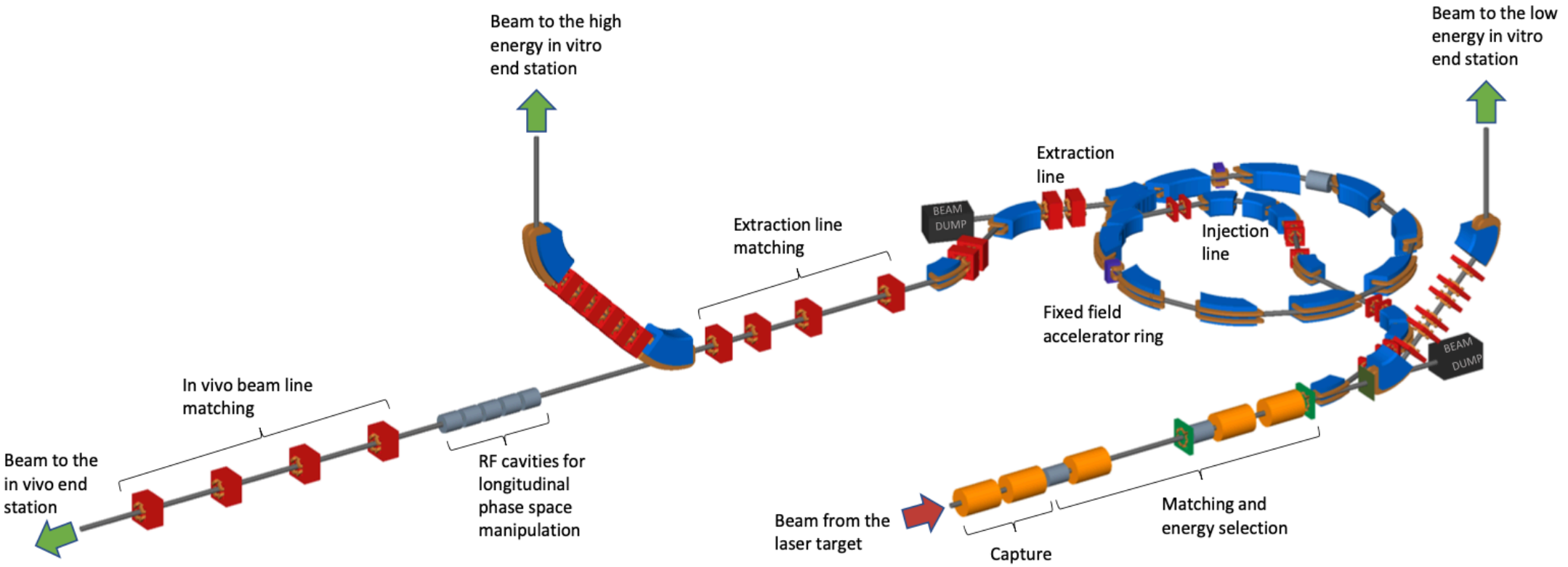
31/03/20

Jonathan Hughes

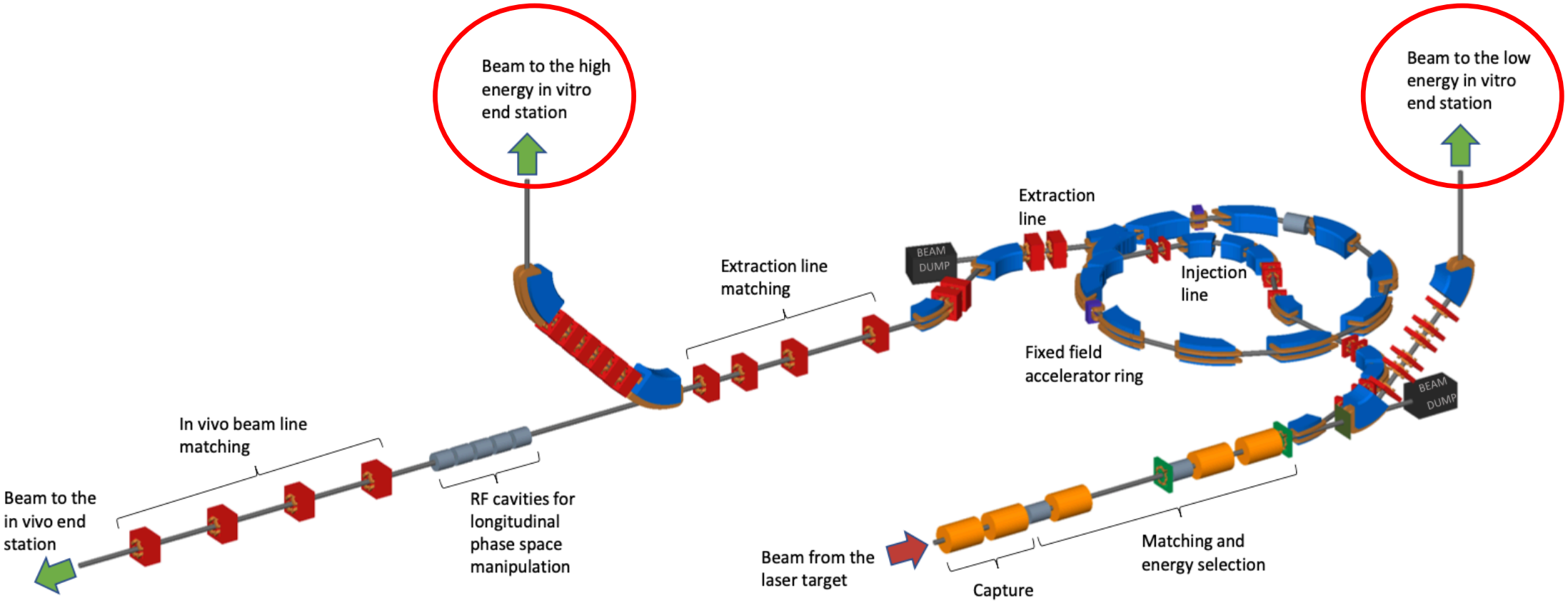
LhARA Biological End Stations

- Three biological end stations (two ***in vitro*** and one ***in vivo***)
- Low energy ***in vitro*** – proton beams between 12 – 15 MeV
- High energy ***in vitro*** – proton beams between 15 – 127 MeV
  – ion beams (including C^{6+}) up to 33 MeV/u
- High energy ***in vivo*** – proton beams between 15 – 127 MeV
  – ion beams (including C^{6+}) up to 33 MeV/u

LhARA Biological End Stations



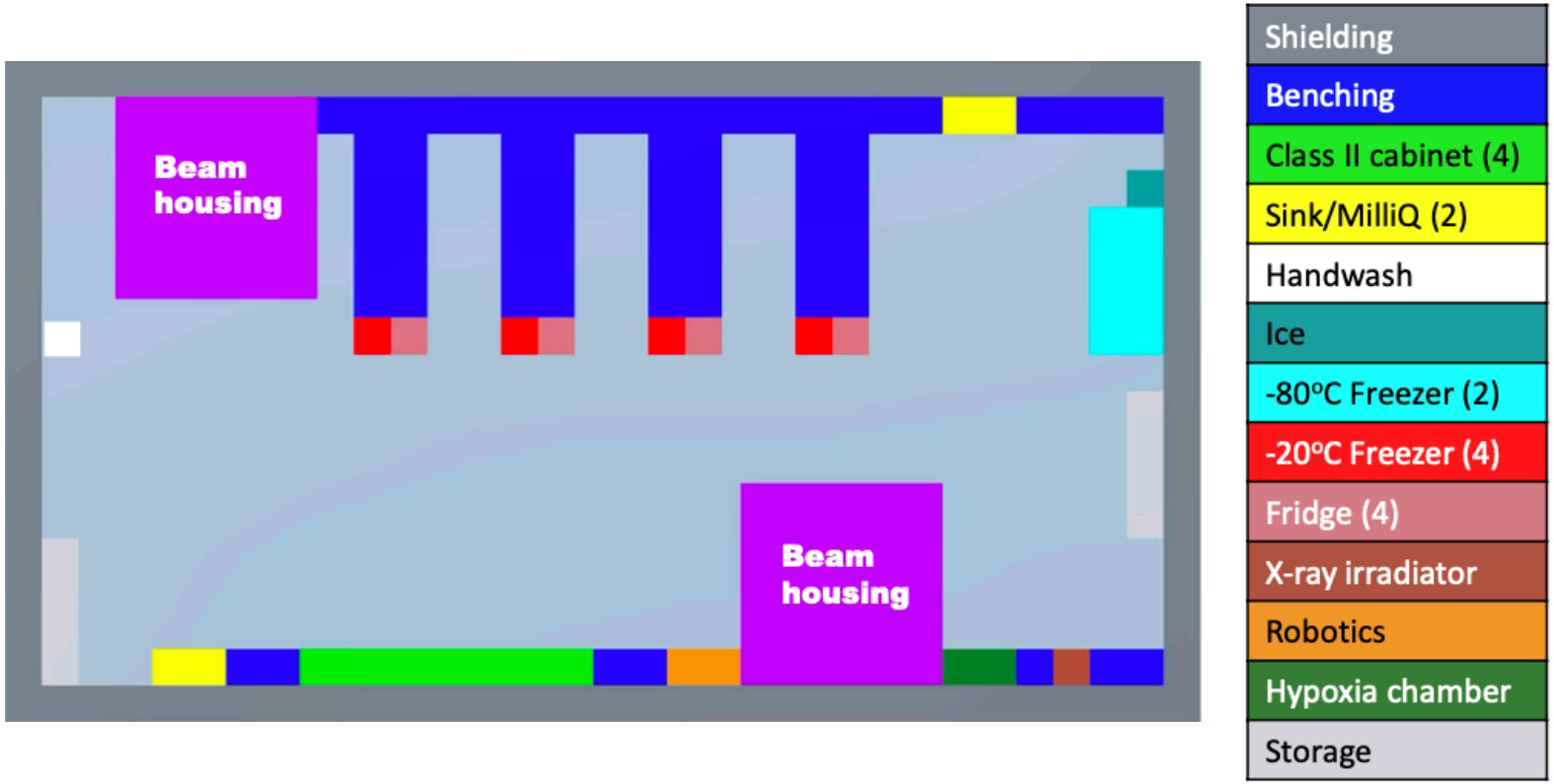
In vitro Biological End Stations



In vitro Biological End Stations

- Two *in vitro* end stations – high and low energy
- Located within a state-of-the-art laboratory, fully equipped with various work spaces
- Irradiation of a wide range of biological models (2D cell monolayers and 3D spheroids/patient-derived organoids)
- Investigate a myriad of biological end points (clonogenic survival, spheroid/organoid growth, angiogenesis, inflammation)
- Additional capabilities include hypoxia studies (0.1 – 1 % oxygen) and high-throughput screening (compound drug libraries, siRNA/CRISPR-Cas9)

In vitro Biological End Stations



In vitro Biological End Stations

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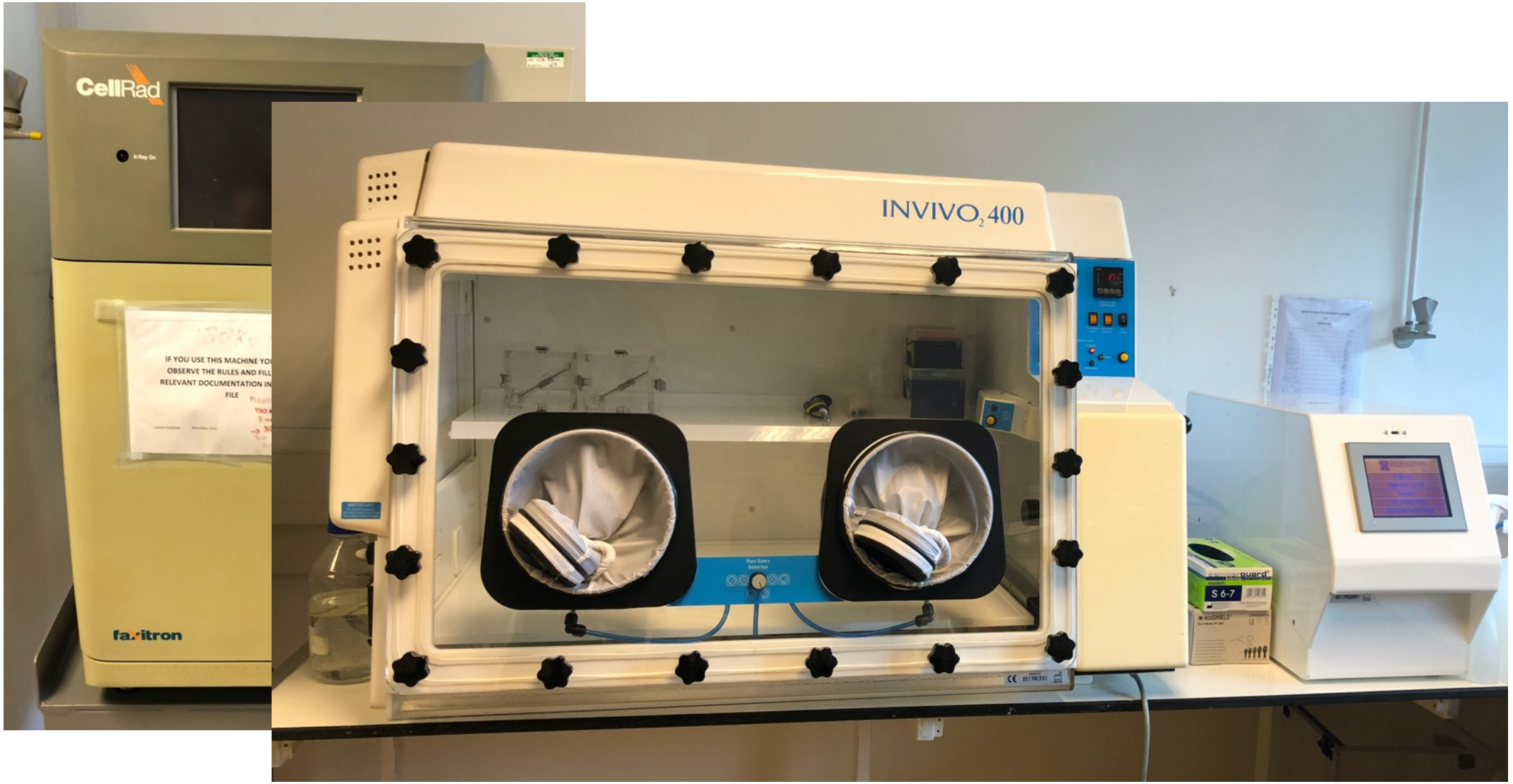

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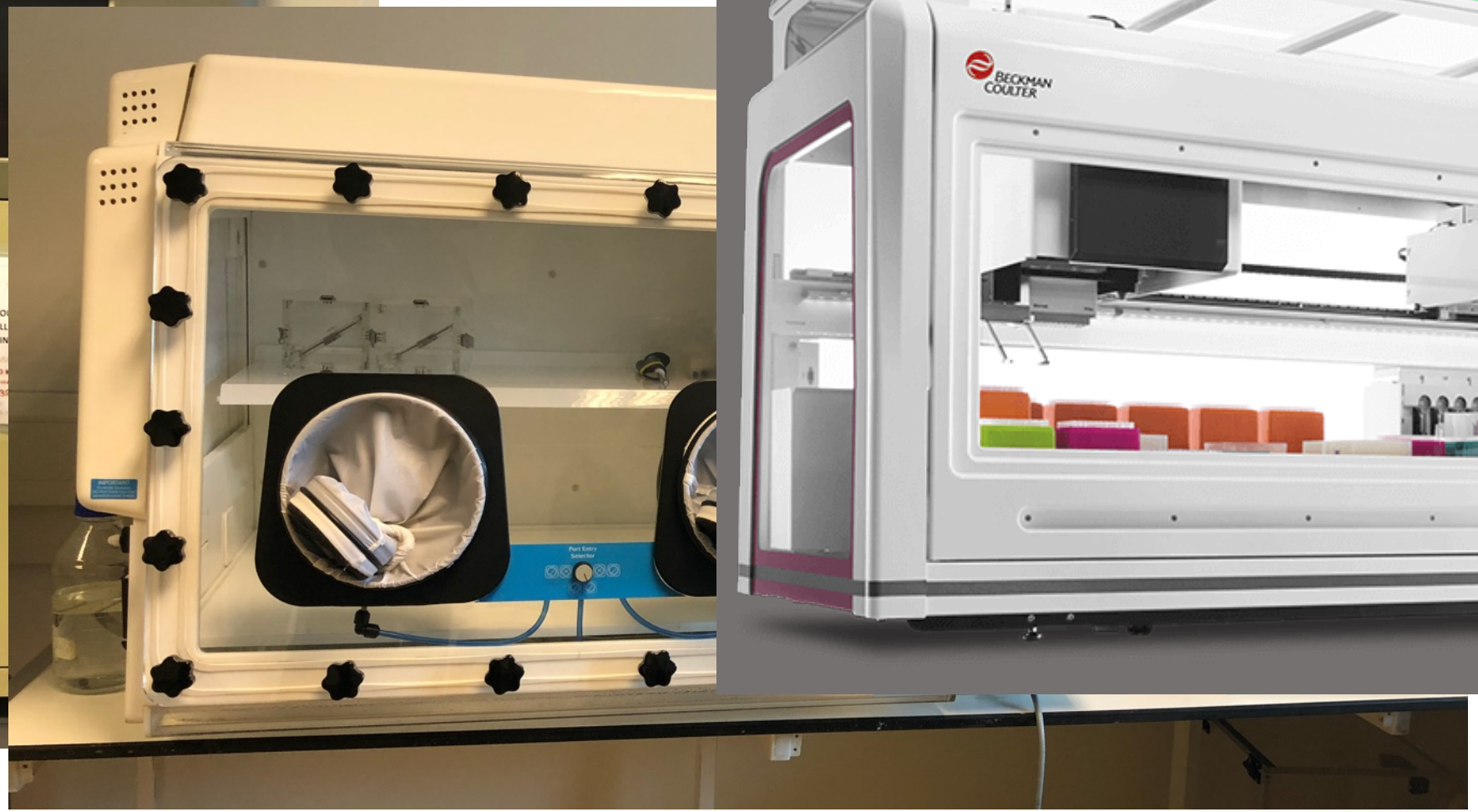
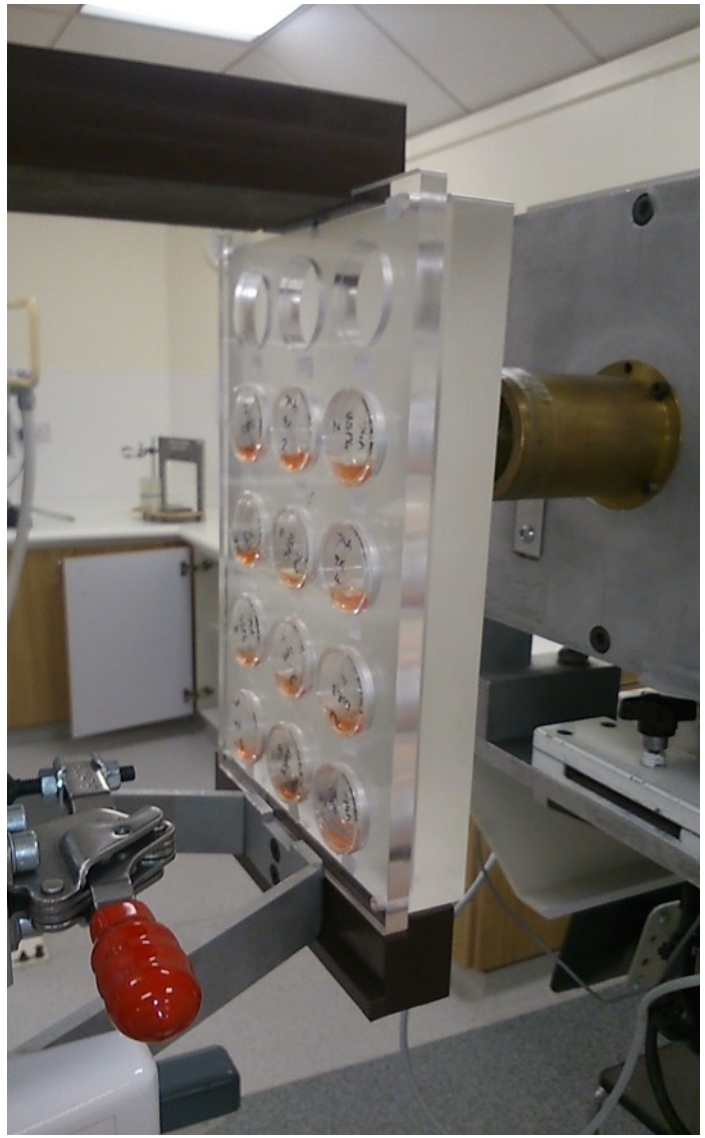
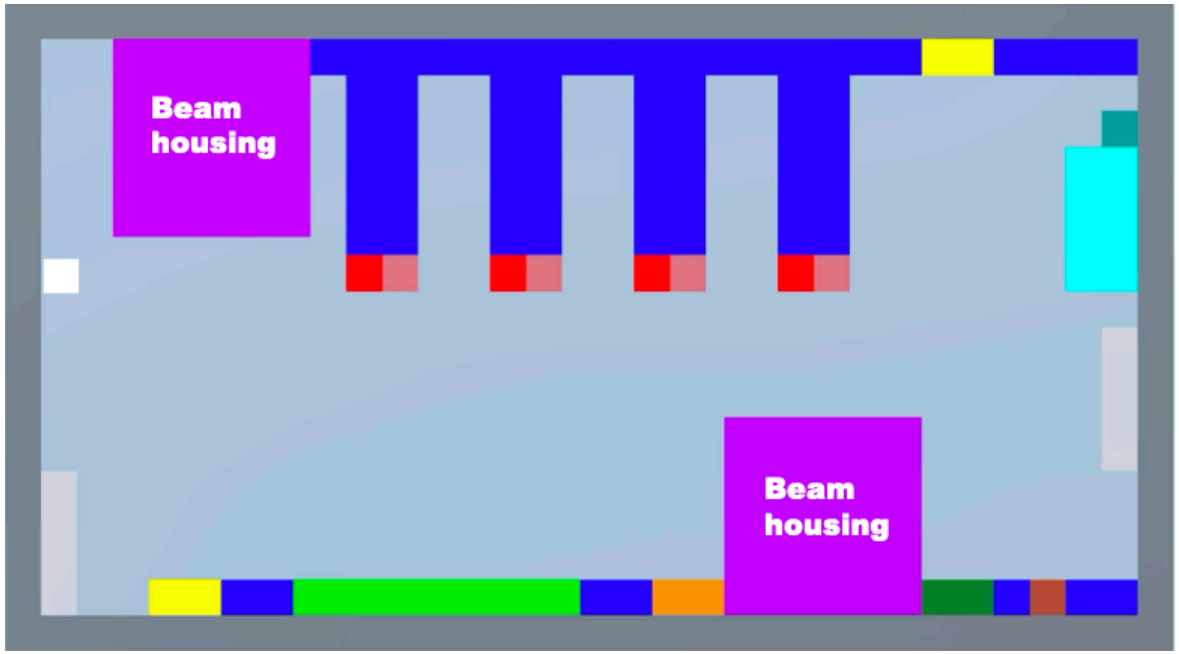


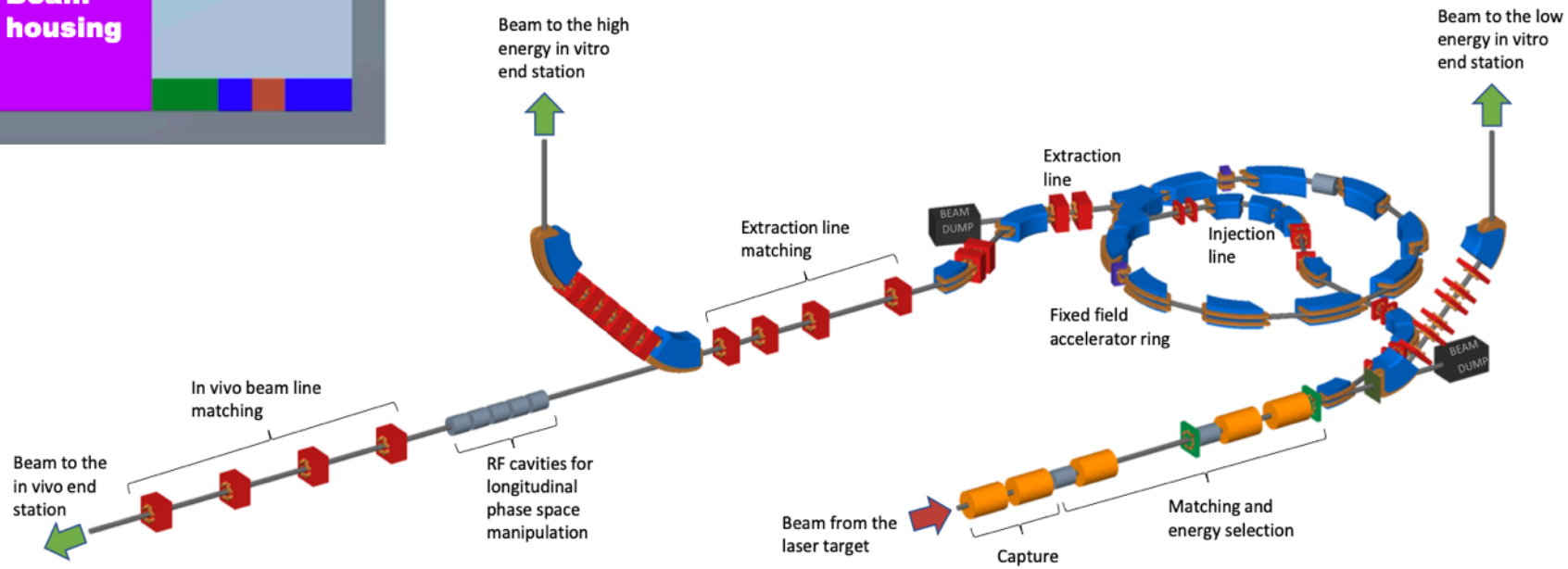
Clatterbridge Cancer Centre (CCC) – Clinical proton beam



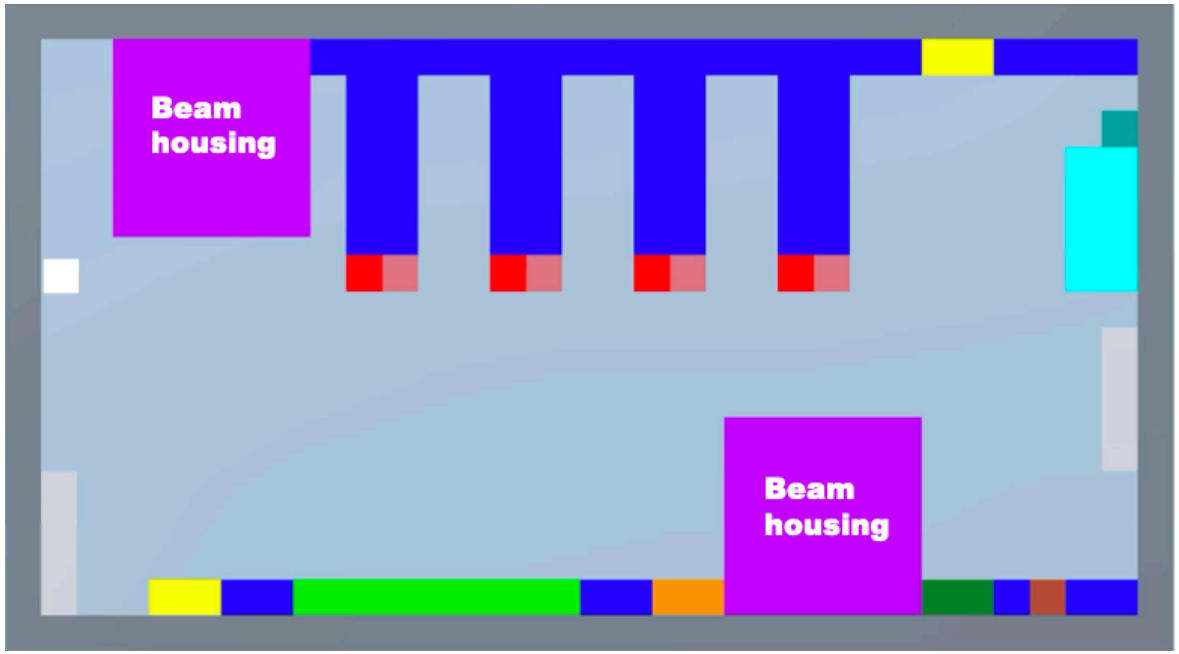
In vitro Biological End Stations



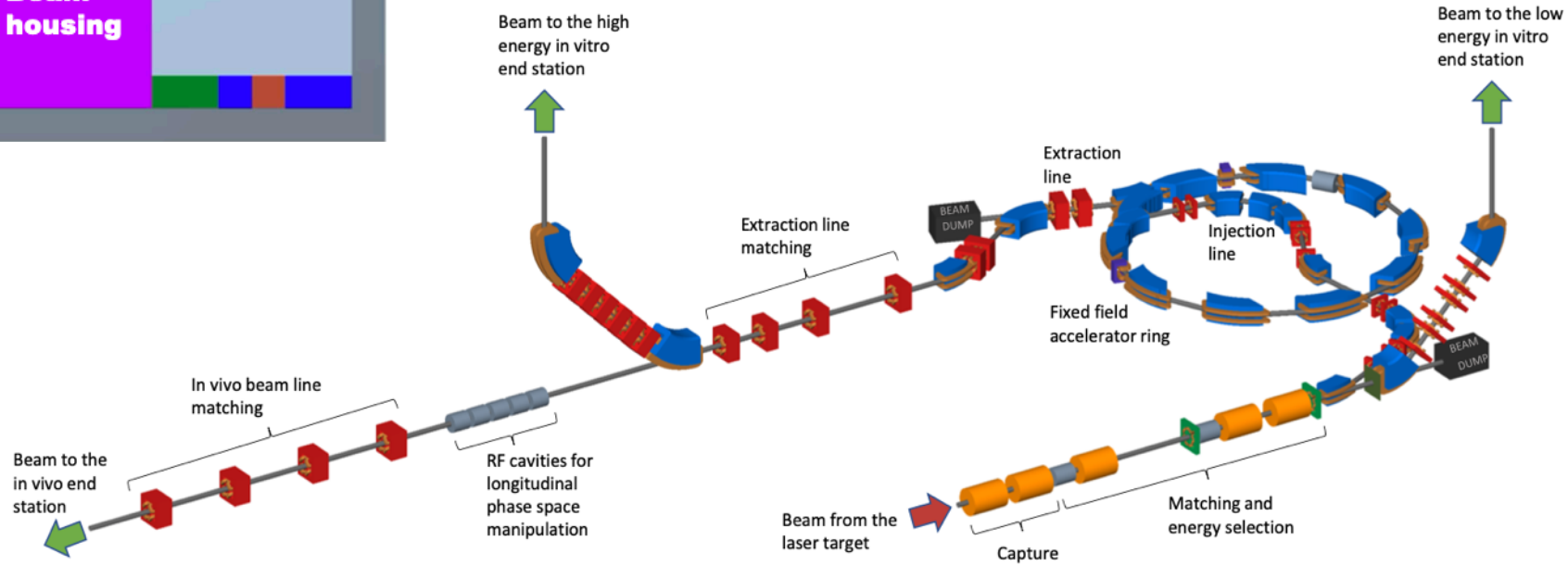
- Vertical beam allows culture vessels to be flat



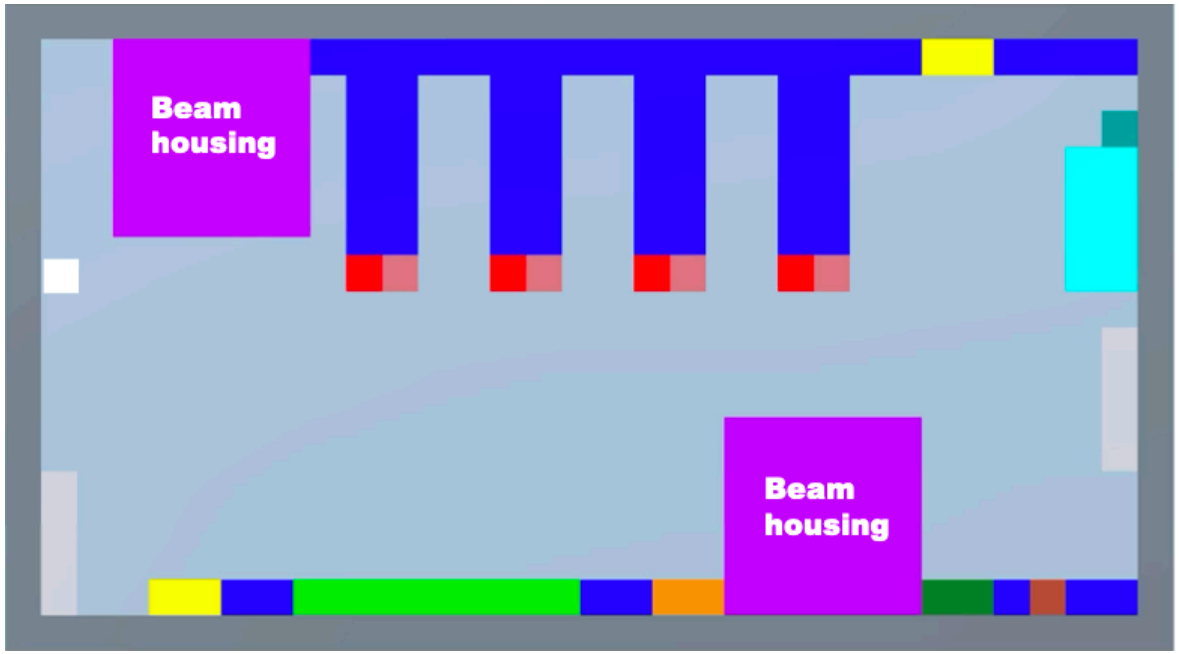
In vitro Biological End Stations



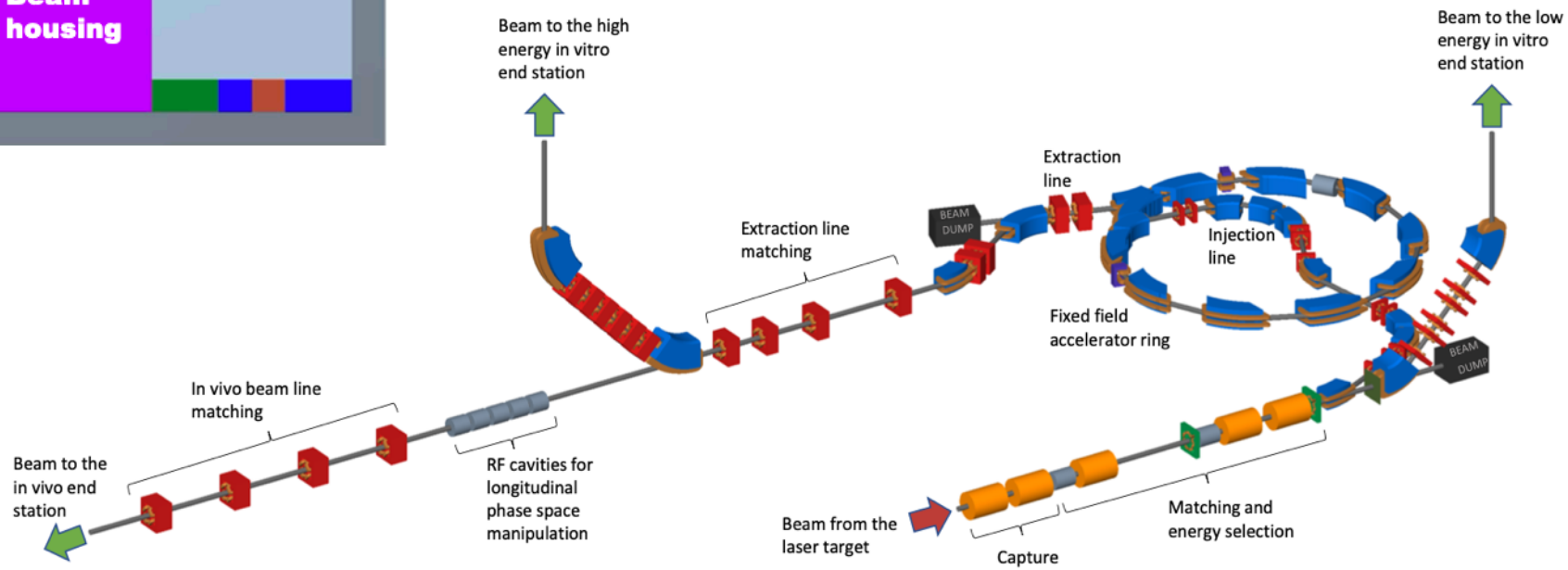
- Vertical beam allows culture vessels to be flat
- Beam line within the end stations to be sealed within units supplied with gases (CO_2, N_2), act as hypoxia chamber



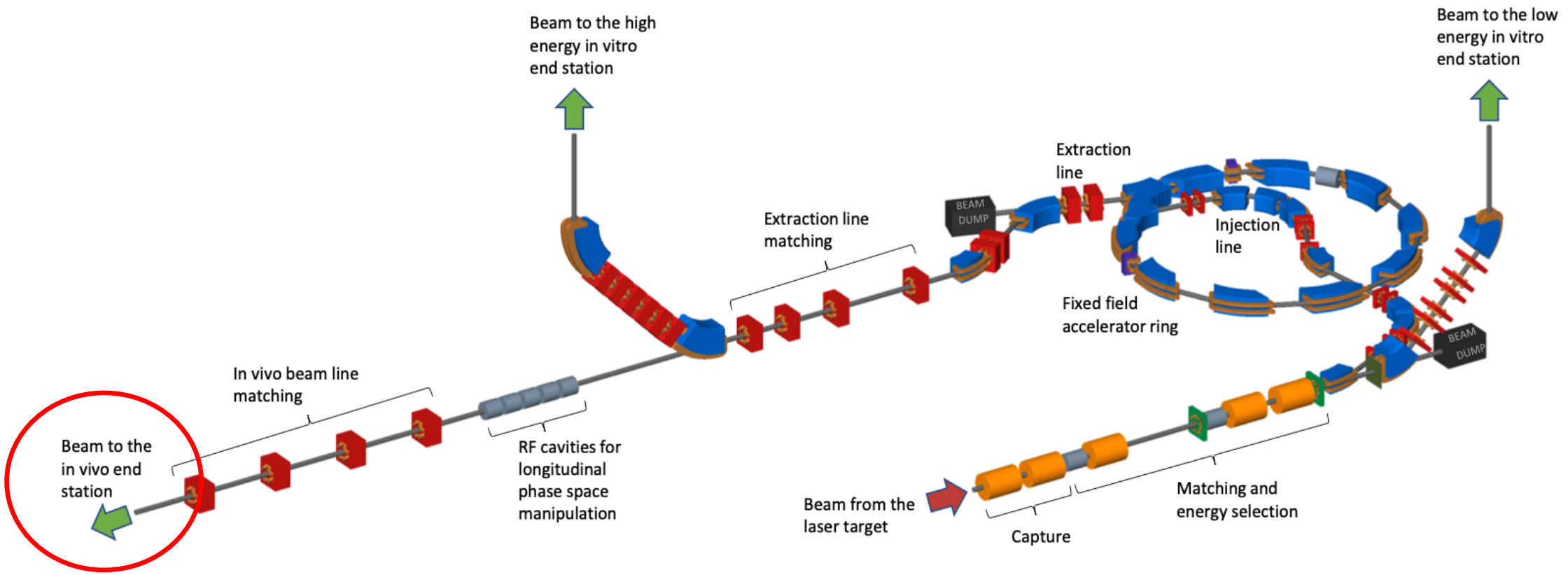
In vitro Biological End Stations



- Vertical beam allows culture vessels to be flat
- Beam line within the end stations to be sealed within units supplied with gases (CO_2, N_2), act as hypoxia chamber
- Robotic arm within sealed units to position culture vessels in front of and away from the beam line



In vivo Biological End Station



In vivo Biological End Station

- High energy protons (up to 127 MeV) and ions (up to 33 MeV/u)
- Located on the basement floor
- Irradiation of small animal models to investigate the effect on PBT on appropriate biological end points (e.g. tumour growth)
- Beam flexibility - passive scattering, pencil beam scanning, micro beams
- Animal handling area within end station for anaesthetisation of animals
- CT scanner to guide targeting
- Animal holding facility off site for long term biological measurements

Conclusion

- Three biological end stations, fully equipped to fulfil radiobiological research requirements
- Multiple energies (high and low), particle irradiation types (proton, carbon ions), dose rates (conventional vs FLASH)
- Capable of irradiating a wide range of biological models, both *in vitro* and *in vivo*, to investigate a myriad of biological end points (tumour growth, clonogenic survival, inflammation, angiogenesis)
- Additional *in vitro* capability to perform hypoxia studies and high-throughput screening using robotics
- Translation into future effective patient treatment