Science and Technology Facilities Council

ITRF - LhARA

General Facility Infrastructure and Integration

ITRF WP2 & LhARA WP1.6

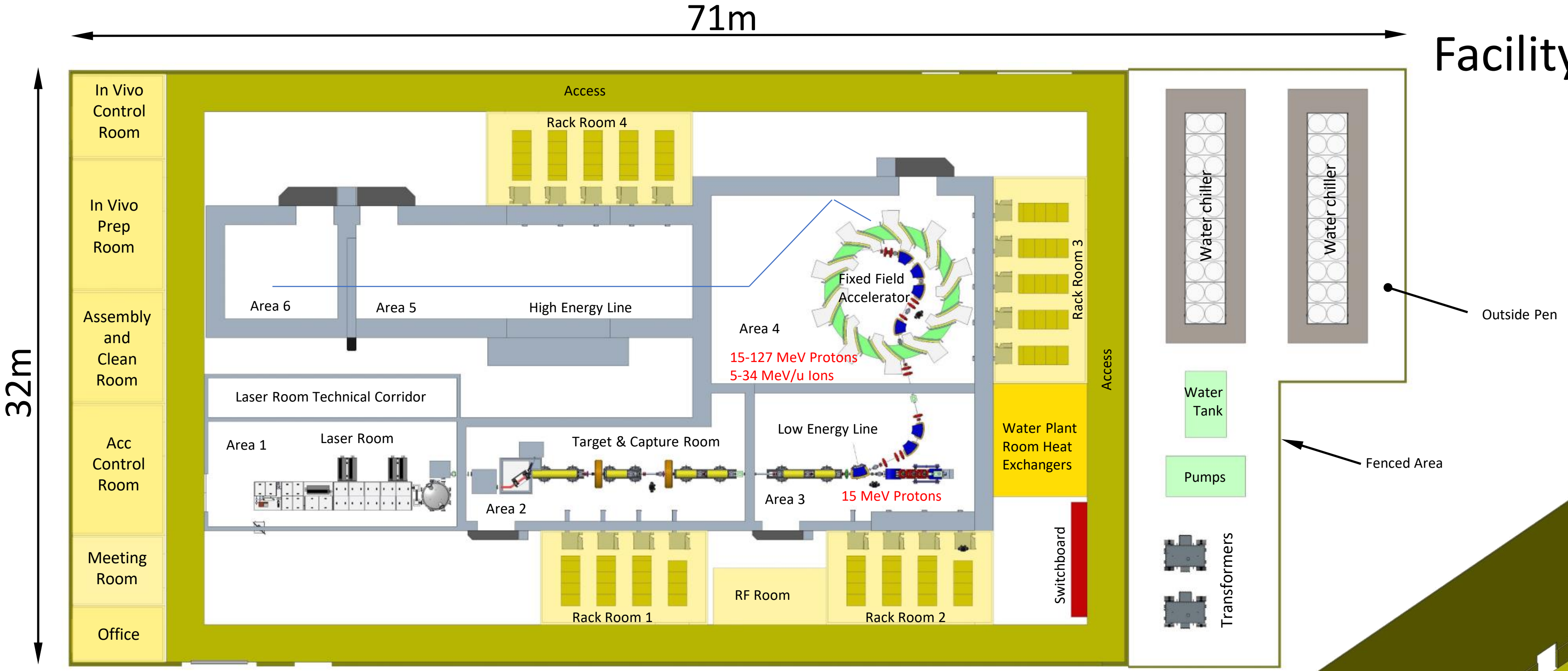
1272-pa1-wp2-prs-0008-v1.0-ITRF-18-month-design-review-WP6-infrastructure-2024-04-25

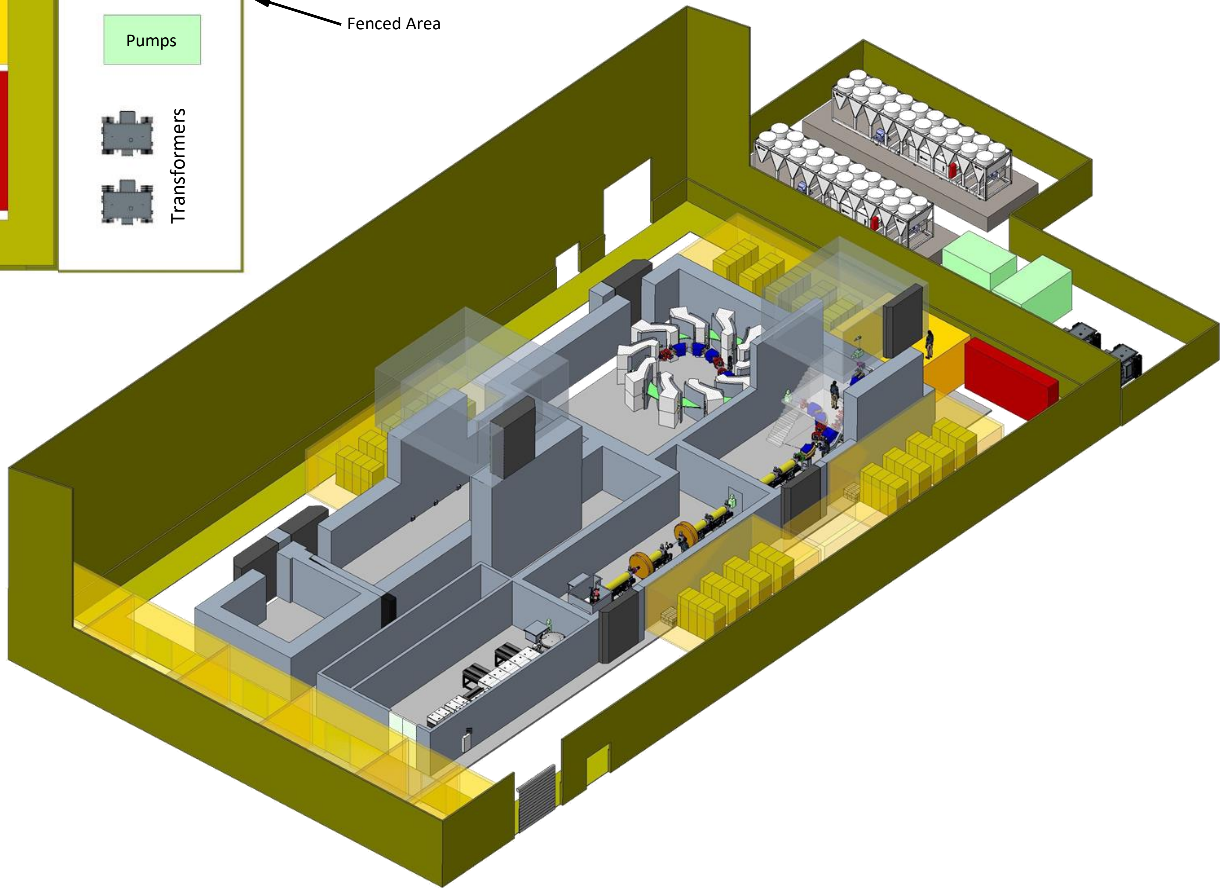
18 Month Design Review

25th April 2024

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

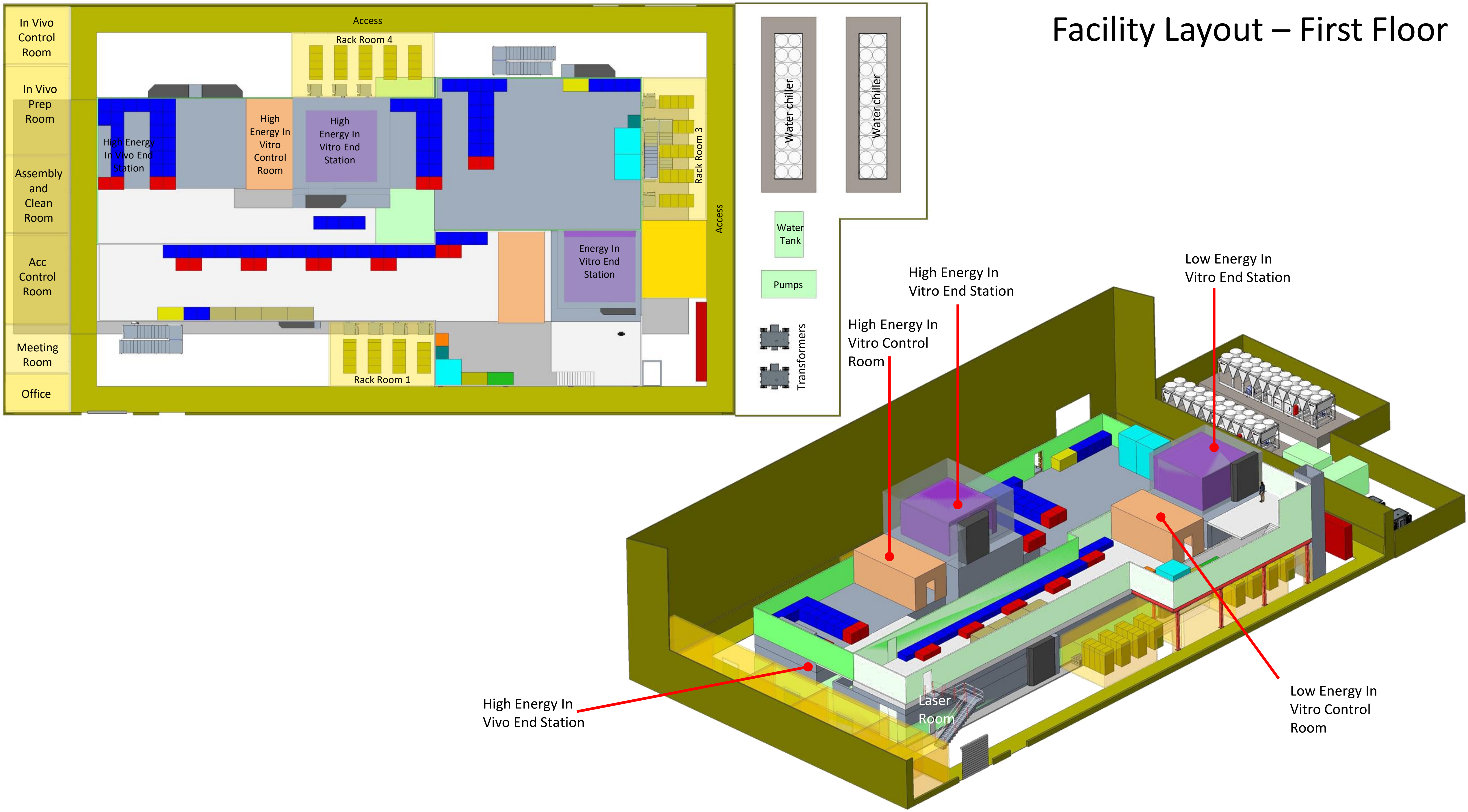
Facility Layout – Ground Floor



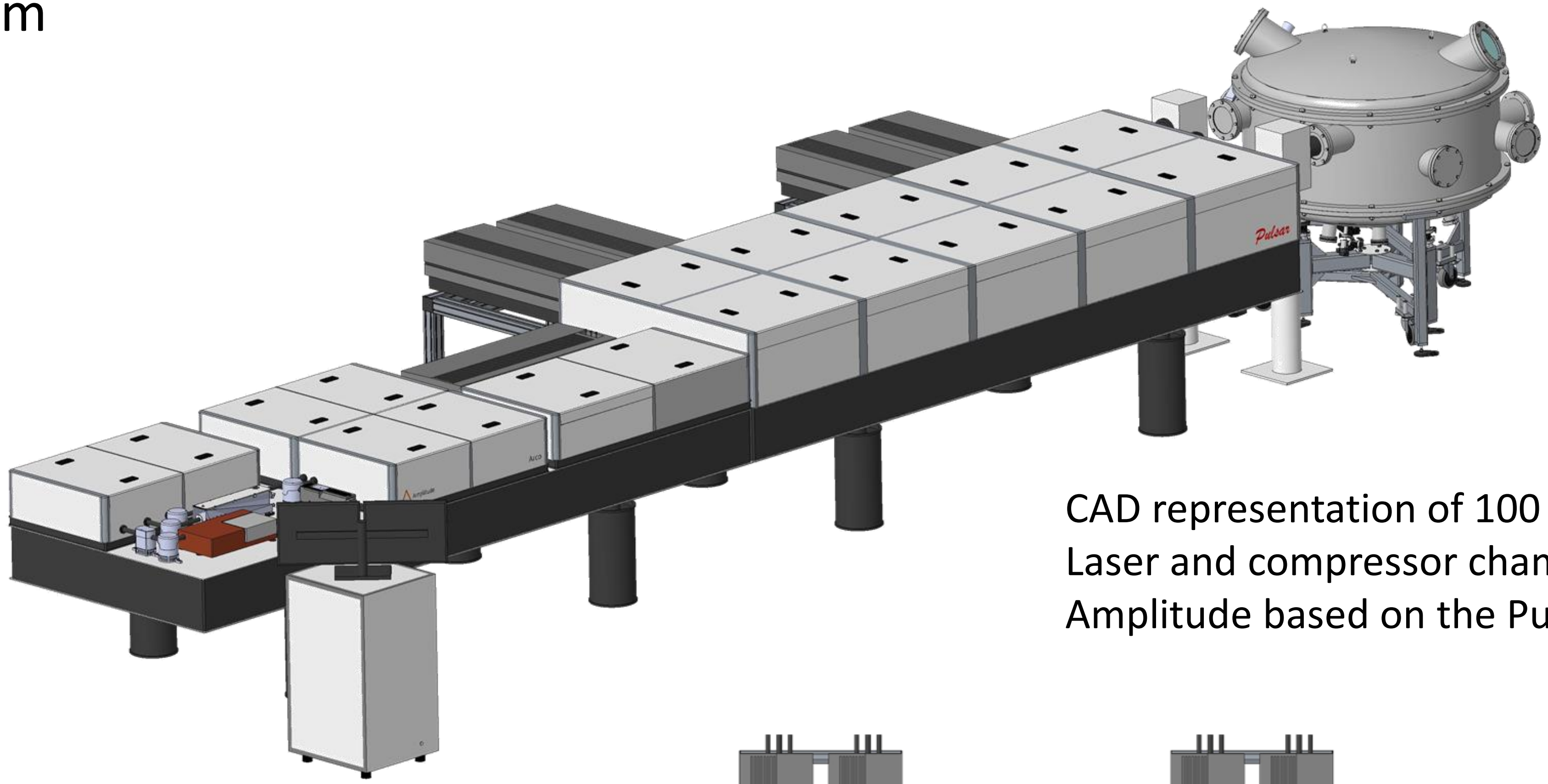


Radiation Assessment

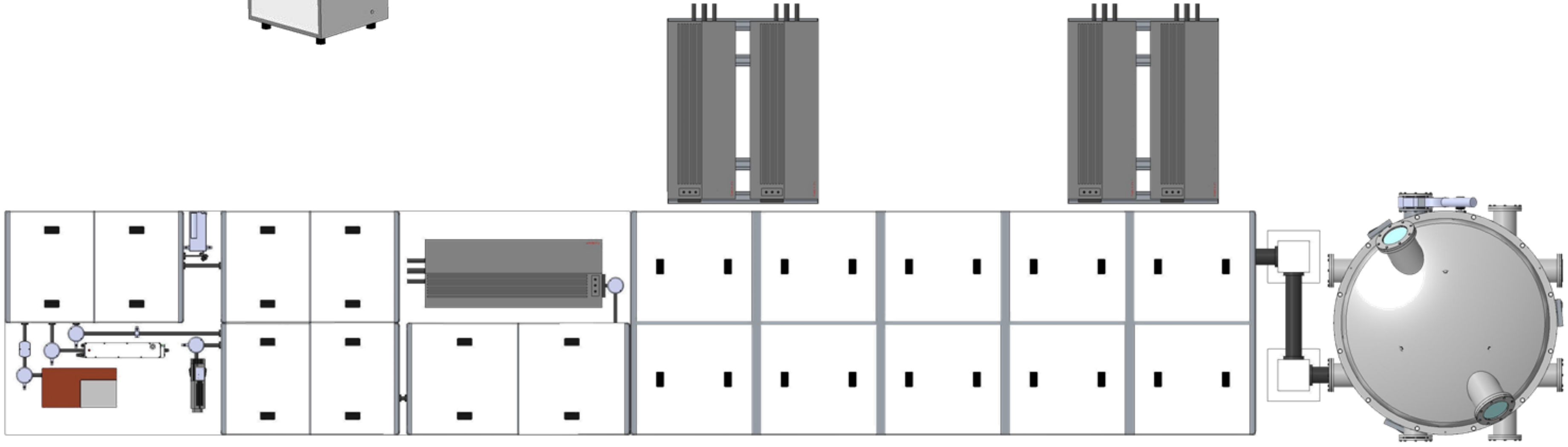
Facility Layout – First Floor



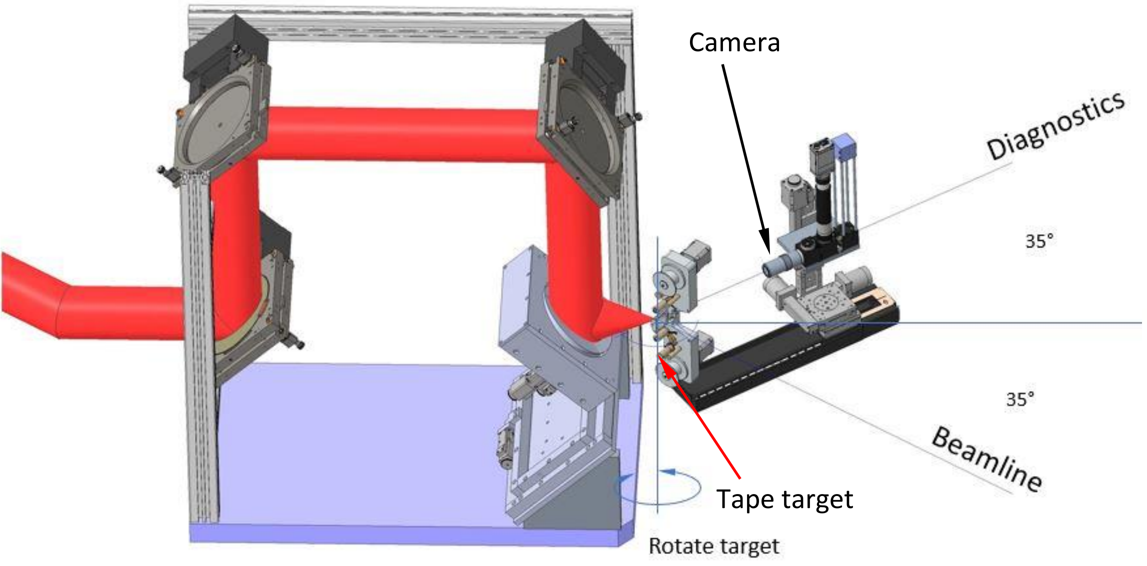
Laser System

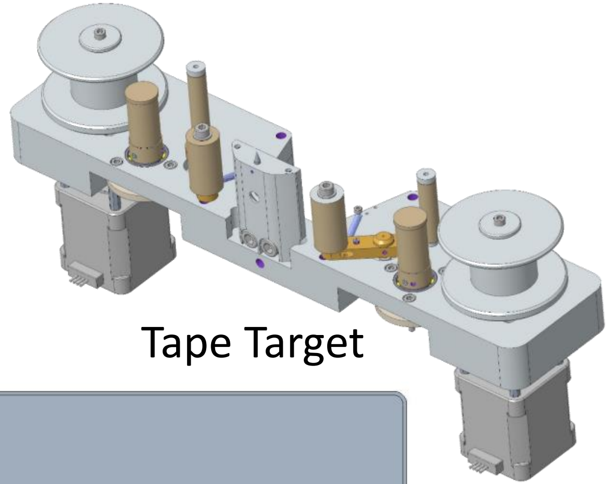


CAD representation of 100 TW Ti: Sapphire Laser and compressor chamber provided by Amplitude based on the Pulsar 140 system

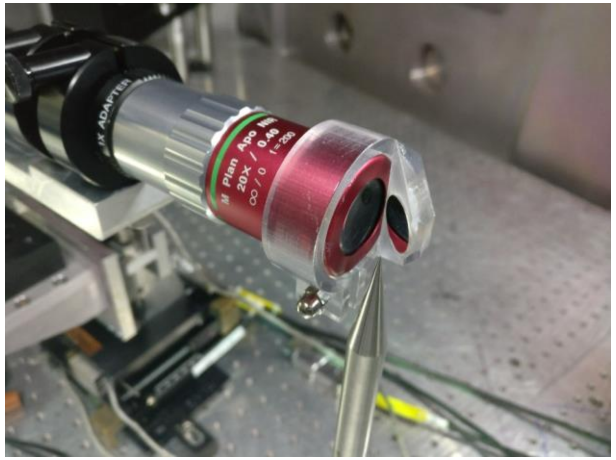


Target



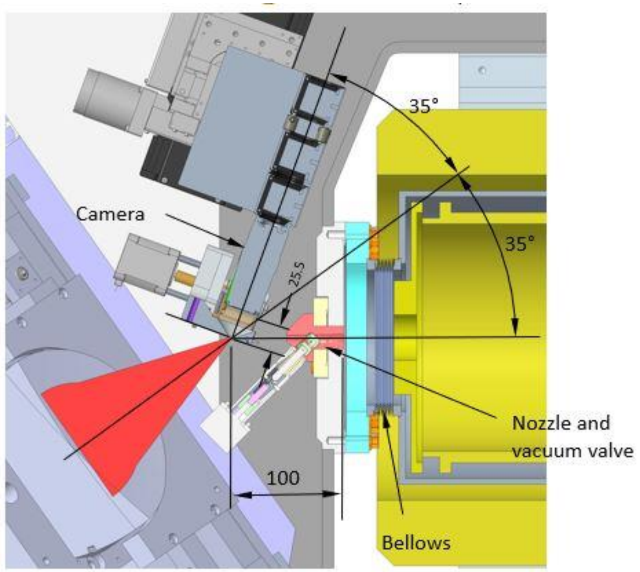


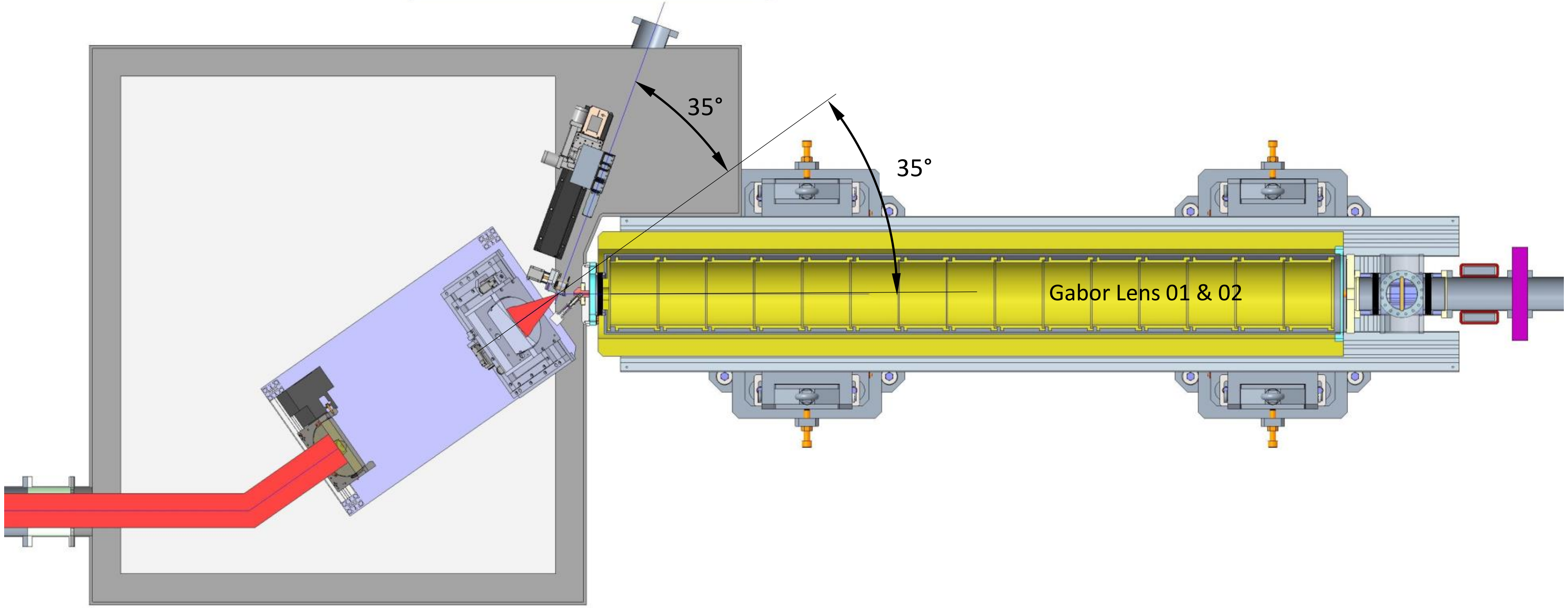
Tape Target



Diagnostics Camera

Diagnostics chamber





LhARA Target Chamber Vacuum Simulations

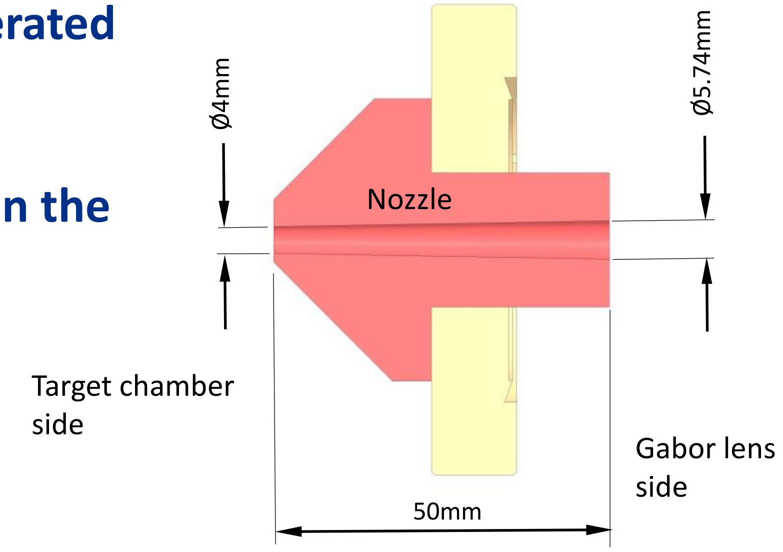
Results

ITRF Transmission Probability Results

	Cosine Desoprtion		CosN = 2 Desorption		CosN = 10 Desorption		CosN = 100 Desorption	
Position along vessel	Number of hits	Transmission Probability (w)	Number of hits	Transmission Probability (w)	Number of hits	Transmission Probability (w)	Number of hits	Transmission Probability (w)
Number of gas molecules generated	2850083		4554821		2707689		14327524	
Entrance to nozzle (4 mm)	15761	5.53E-03	31061	6.82E-03	48074	1.78E-02	1701677	1.19E-01
Exit of nozzle (5.4 mm)	2063	7.24E-04	4626	1.02E-03	9767	3.61E-03	449590	3.14E-02
1/4 way along Gabor Lense	79	2.77E-05	184	4.04E-05	383	1.41E-04	17535	1.22E-03
1/2 way along Gabor Lense	28	9.82E-06	55	1.21E-05	120	4.43E-05	5120	3.57E-04
End of 1st Gabor Lense	18	6.32E-06	47	1.03E-05	79	2.92E-05	3613	2.52E-04

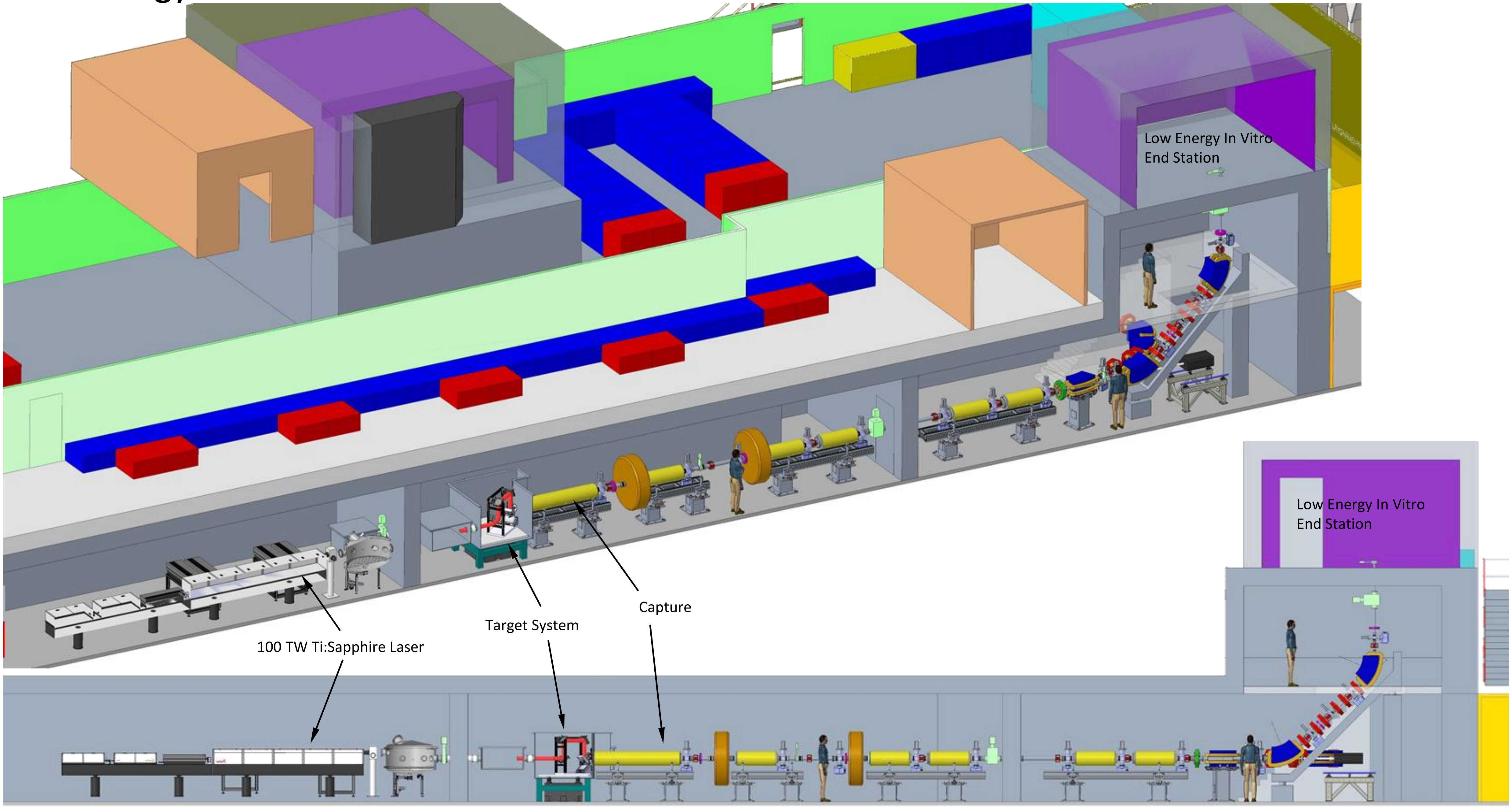
Transmission Probability represents the probability of a gas molecule generated in the target chamber reaching the Gabor lens through the nozzle.

To achieve the 2 orders of magnitude pressure difference required between the target chamber and the Gabor Lens we are looking for the transmission probability to be better than 0.01 or 1E-2

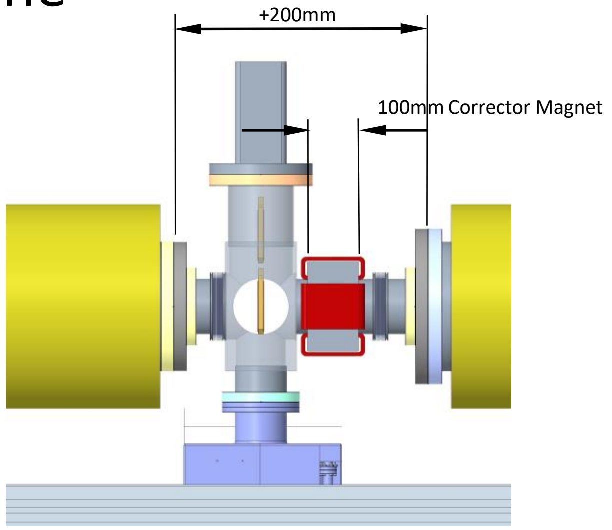


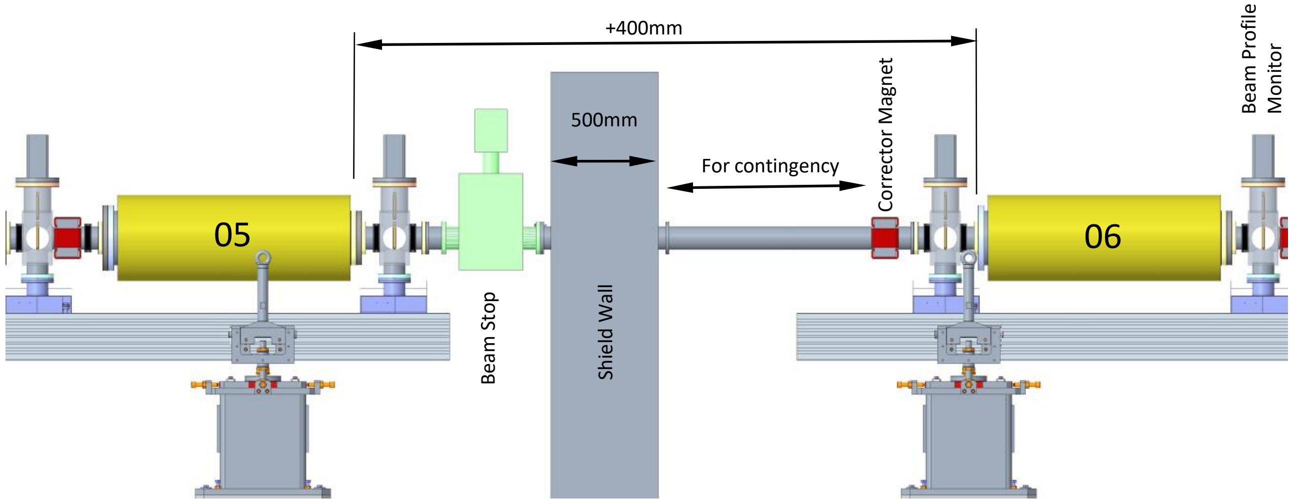
Keith Middleman
ASTeC Vacuum Solutions Group
STFC Daresbury Laboratory

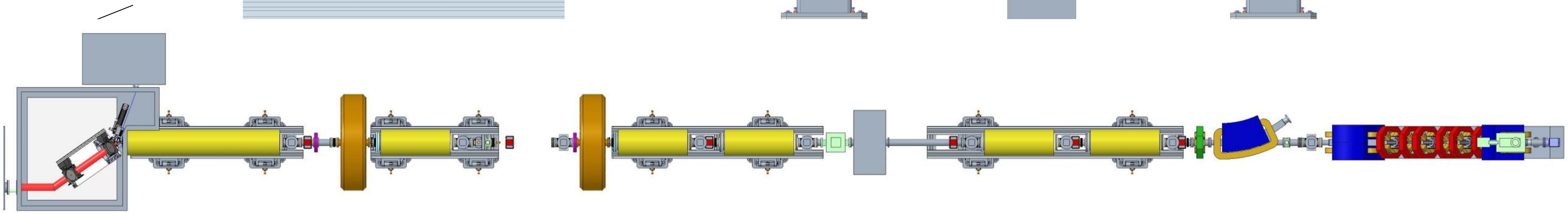
Low Energy Line

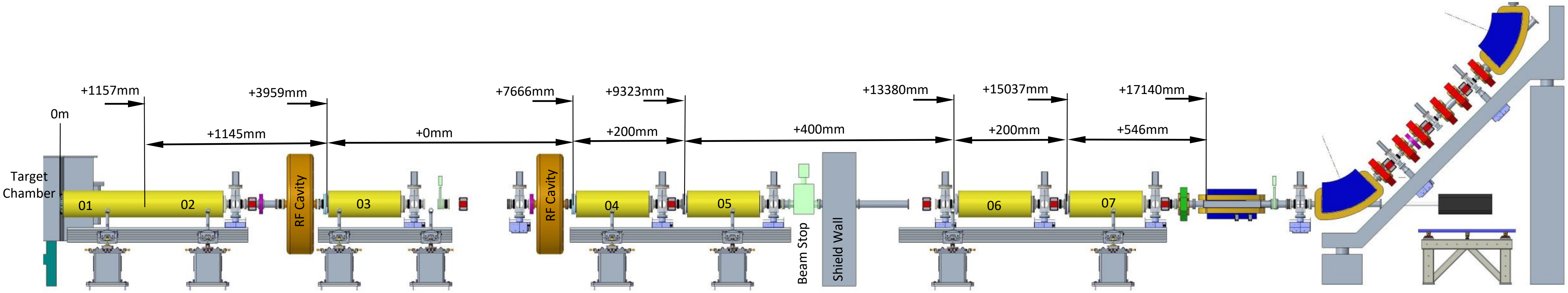


Low Energy Line



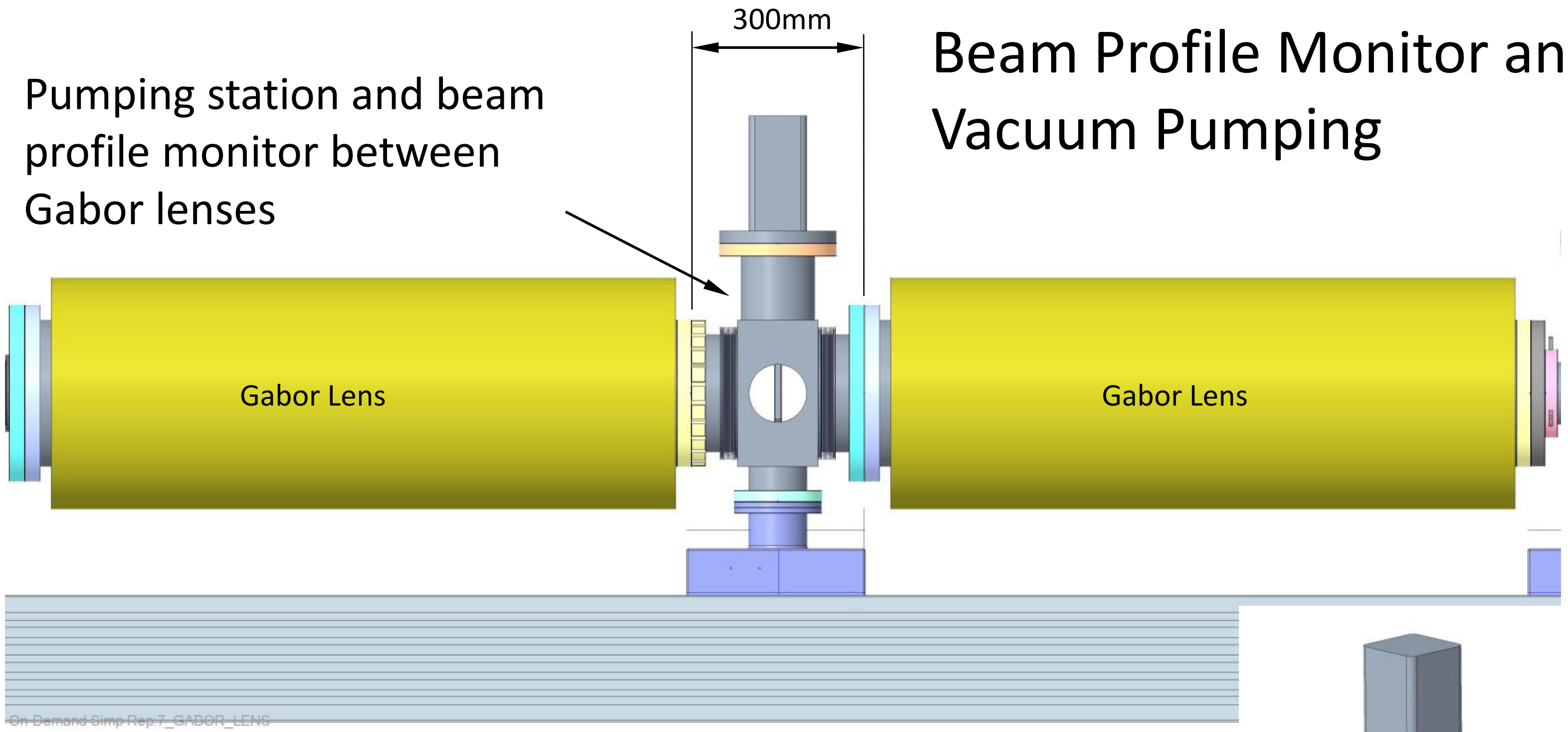


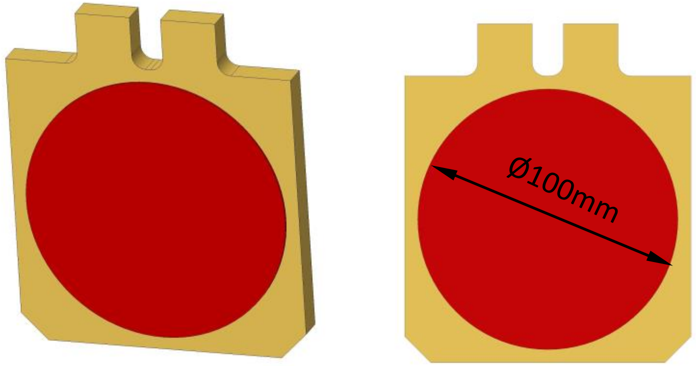


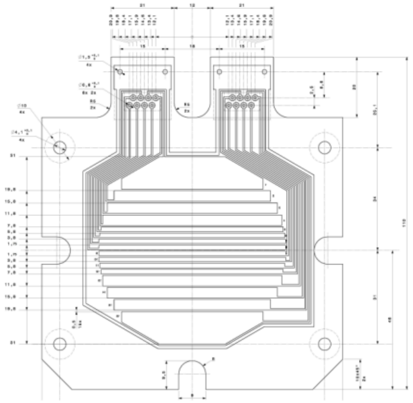


Beam Profile Monitor and Vacuum Pumping

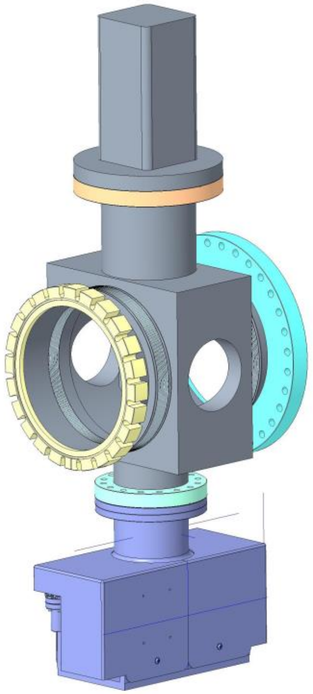
Pumping station and beam profile monitor between Gabor lenses

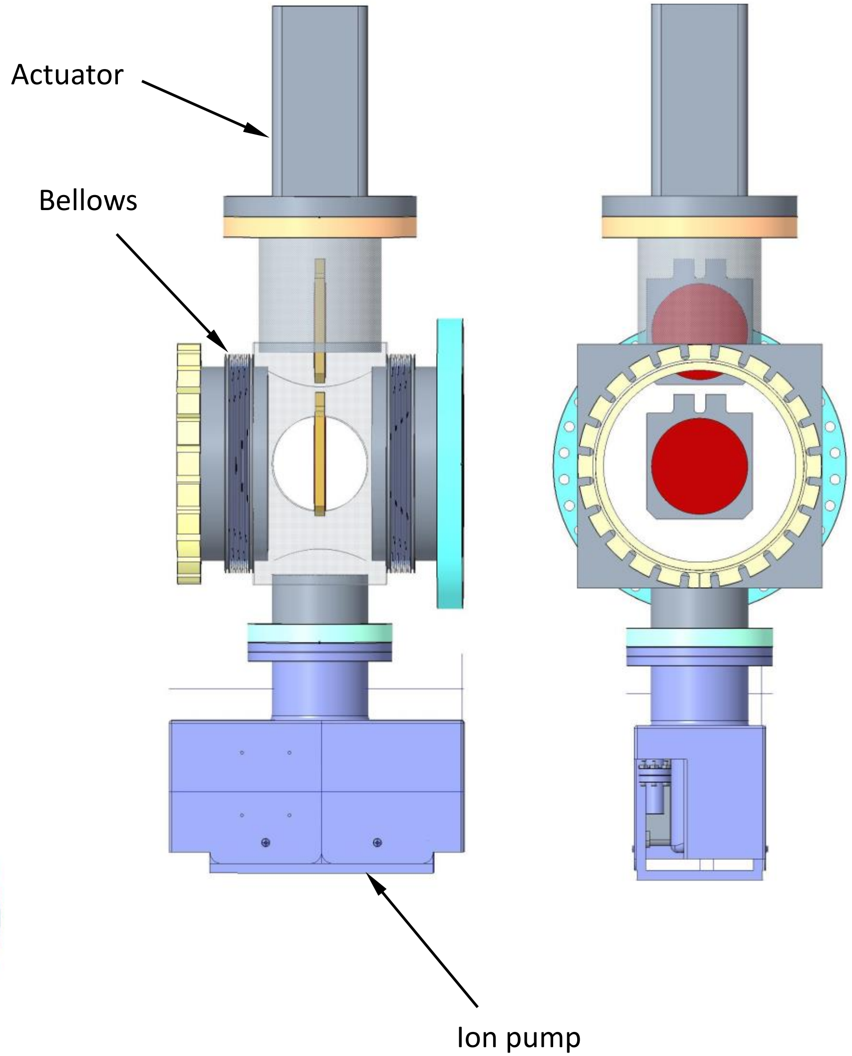




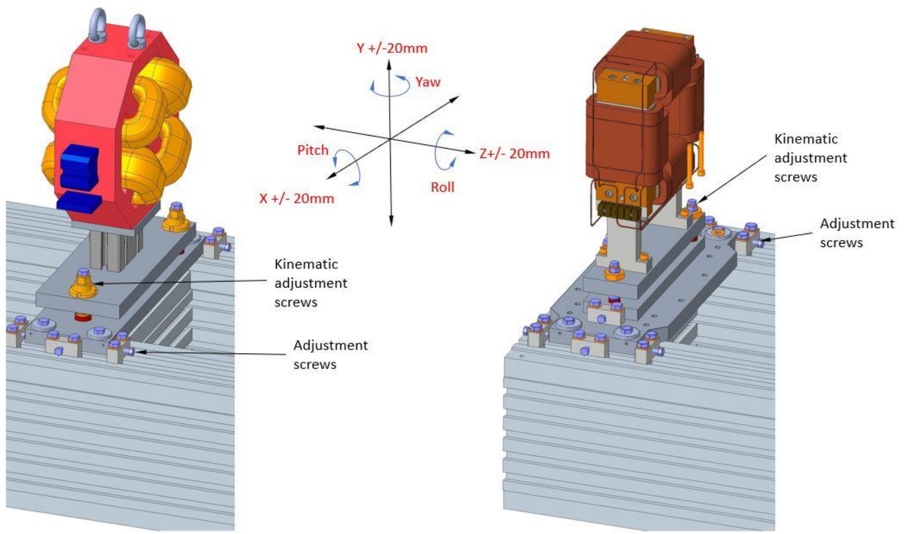


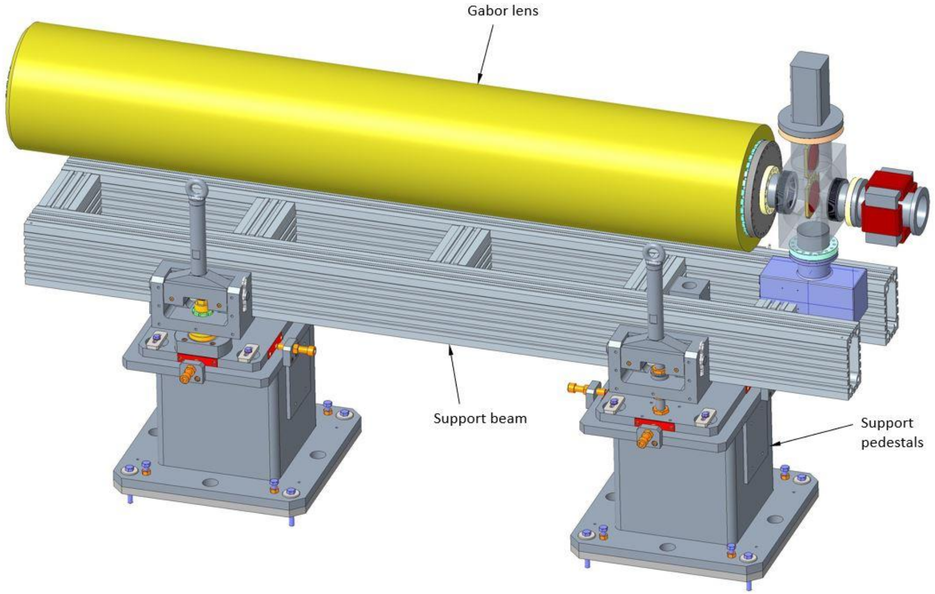
Beam Profile Monitor
Courtesy of IBA

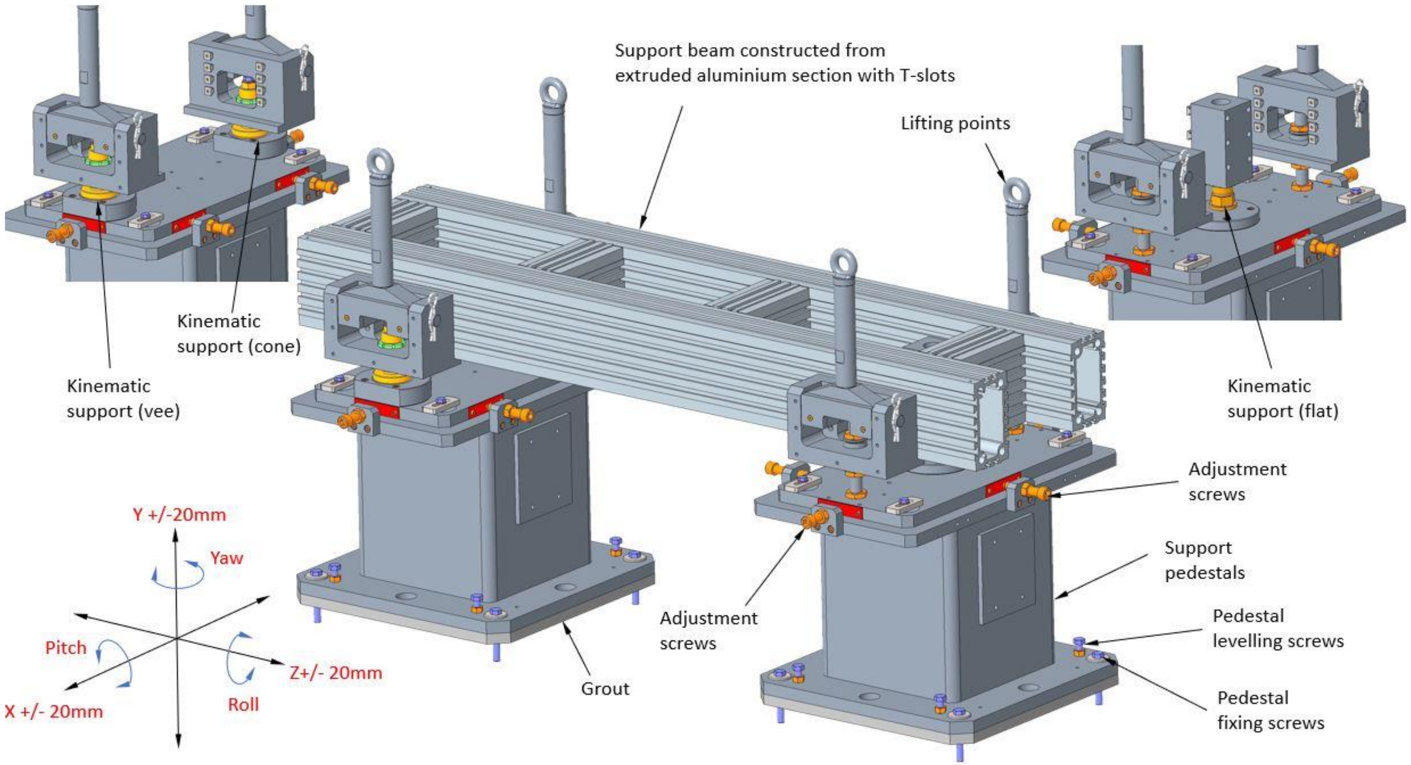


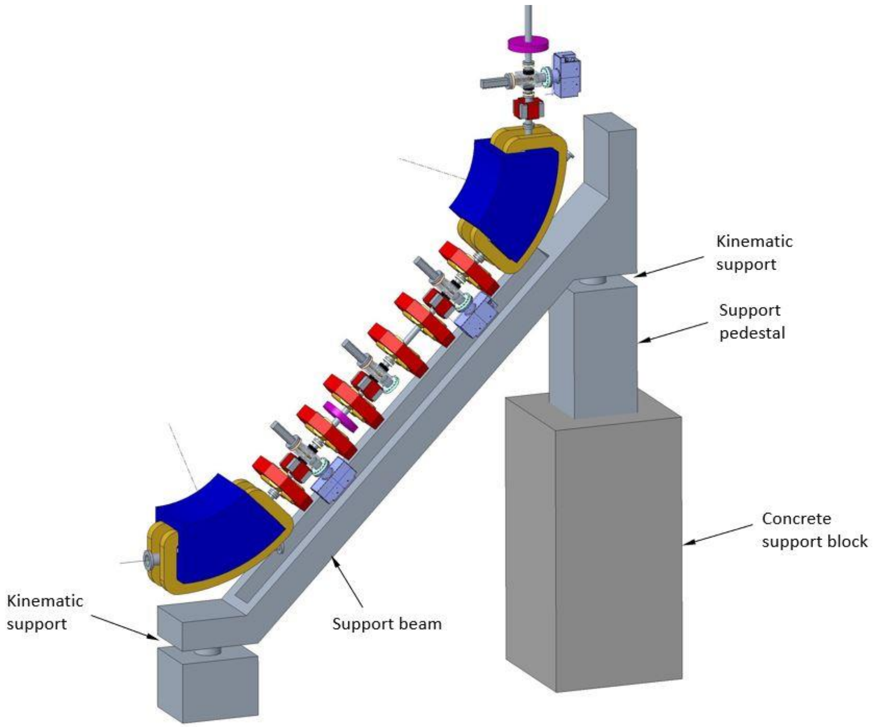


Low Energy Line Support Systems



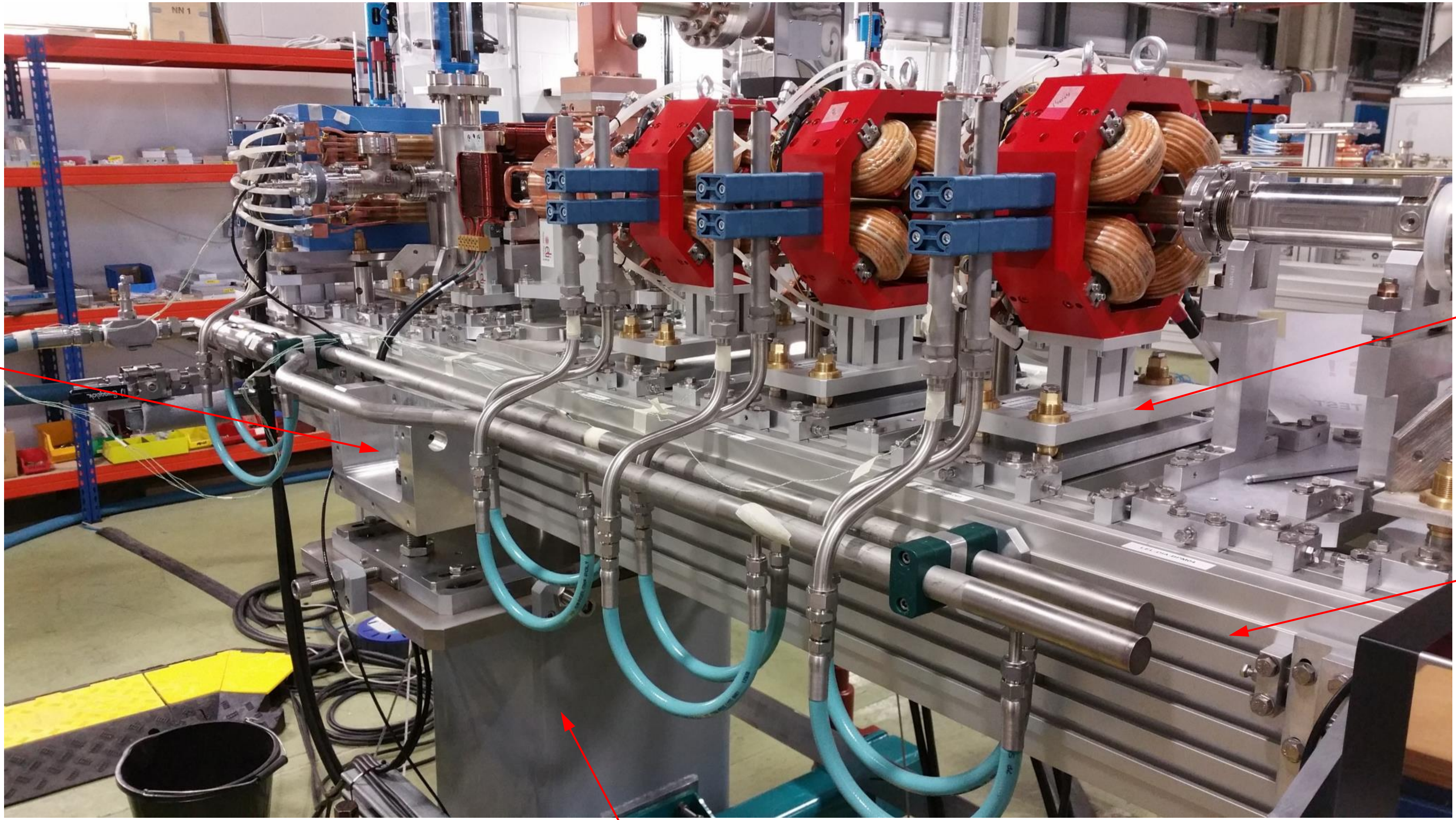






Low Energy Line Support Systems Example

Lifting points

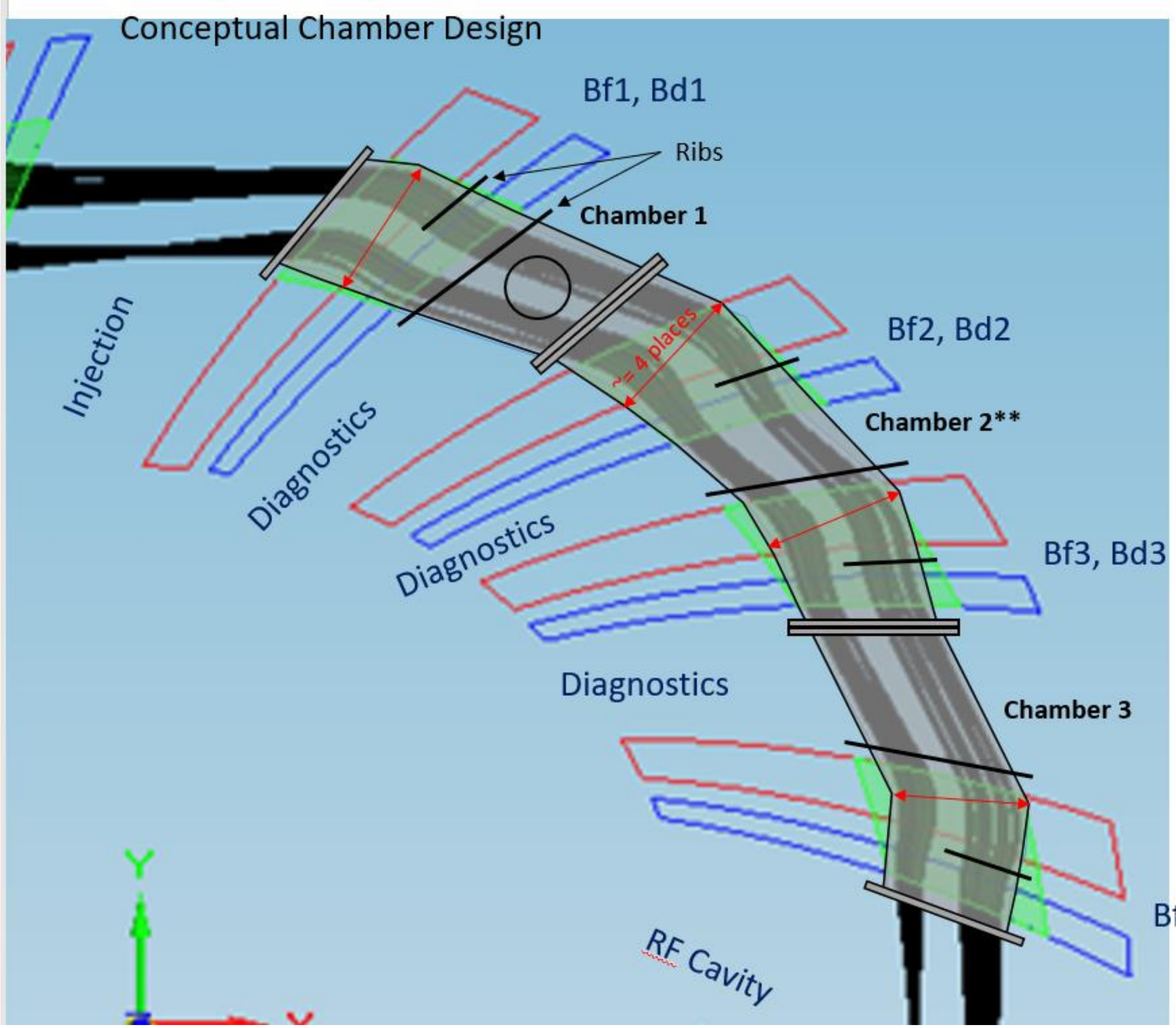


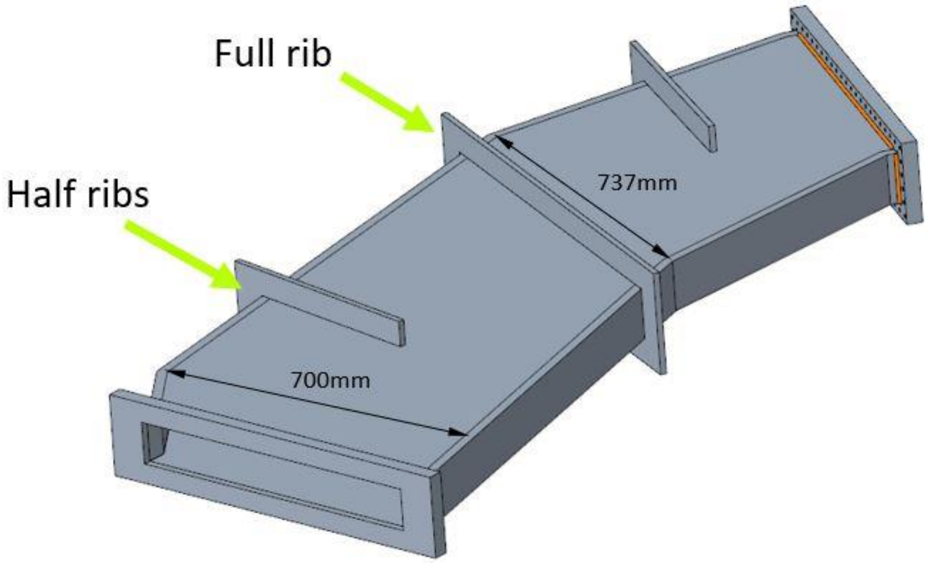
Kinematic supports

Support Beam

Support Pedestal

FETS FFA - Vacuum Chamber





The following success criteria were used:

- Maximum stress less than 2/3 yield, i.e., yield safety factor of 1.5
- Maximum deflection < 2mm

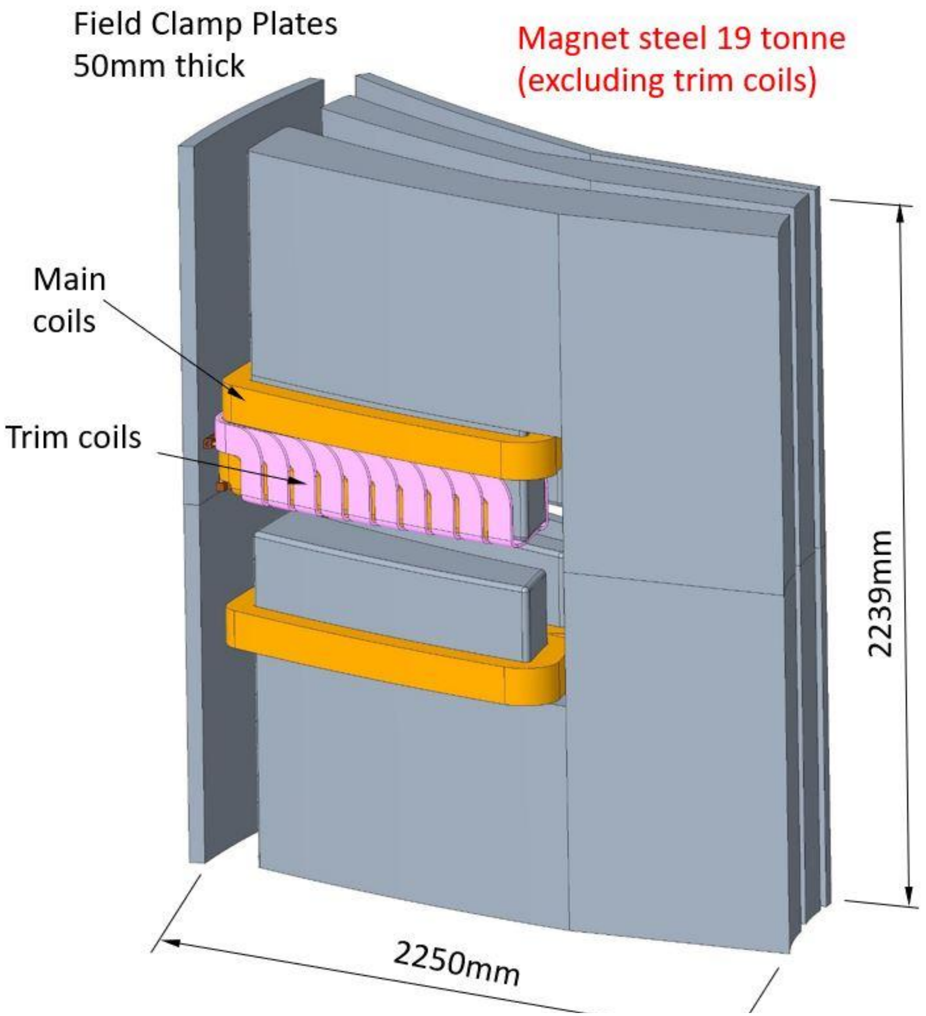
Yield safety factor is defined as:

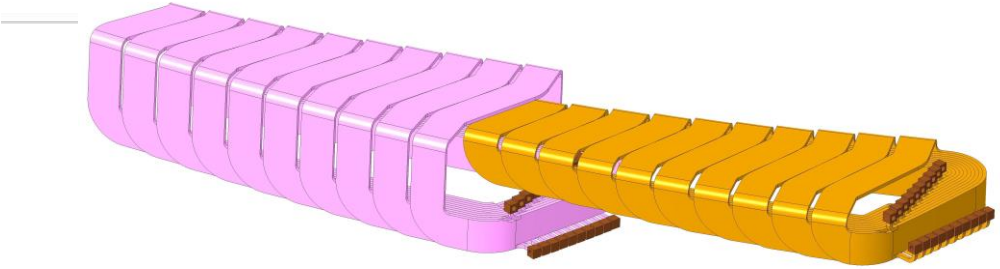
$$Yield\ safety\ factor = \frac{Yield\ stress}{Stress}$$

Yield safety factors are used for easier comparisons between materials. It is clearer to determine whether stresses are acceptable without having to refer back to the yield stress for each material.

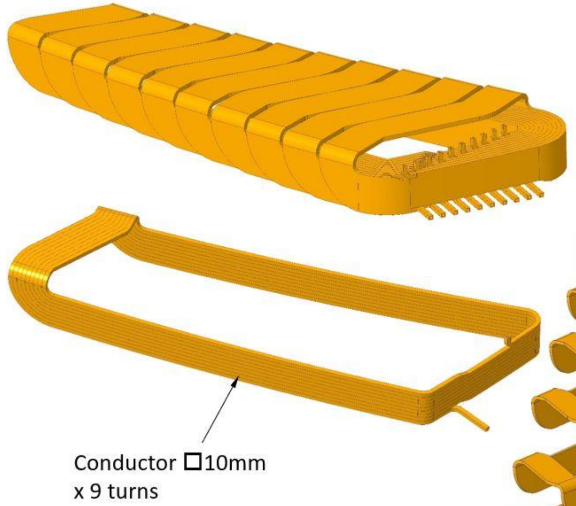
	All Ribs			No Half Ribs			No Ribs		
	Max Deflection (mm)	Max Stress (MPa)	Max Yield/ Stress	Max Deflection (mm)	Max Stress (MPa)	Max Yield/ Stress	Max Deflection (mm)	Max Stress (MPa)	Max Yield/ Stress
6063 T6	7.23	5.38E+02	0.48	12.71	4.28E+02	0.61	12.94	6.67E+02	0.39
316LN	2.47	5.65E+02	0.45	4.40	4.31E+02	0.59	4.49	7.18E+02	0.35
Ti6Al4V	4.37	5.34E+02	1.58	7.61	4.28E+02	1.98	7.75	6.59E+02	1.28

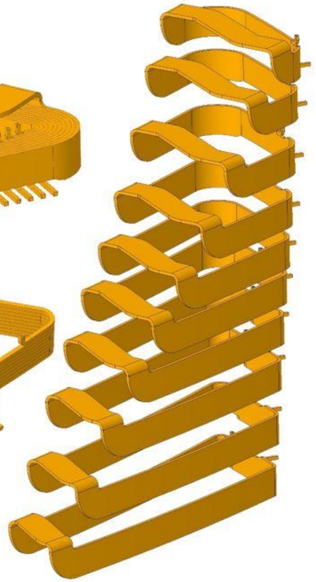
FETS FFA – Magnet and Trim Coil Construction

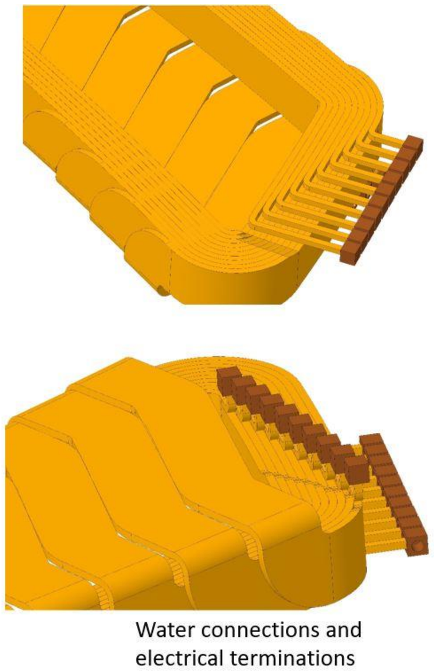


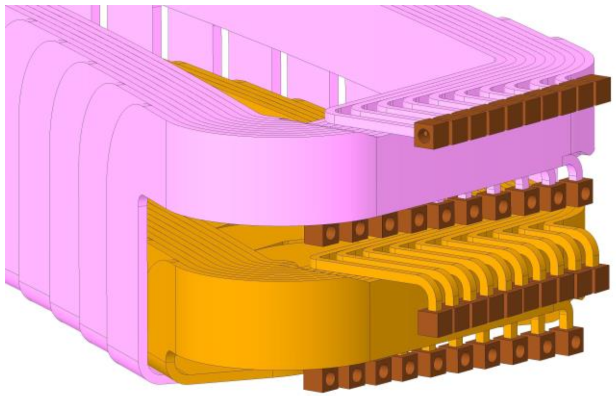


Assembly of Trim Coils Layer 1

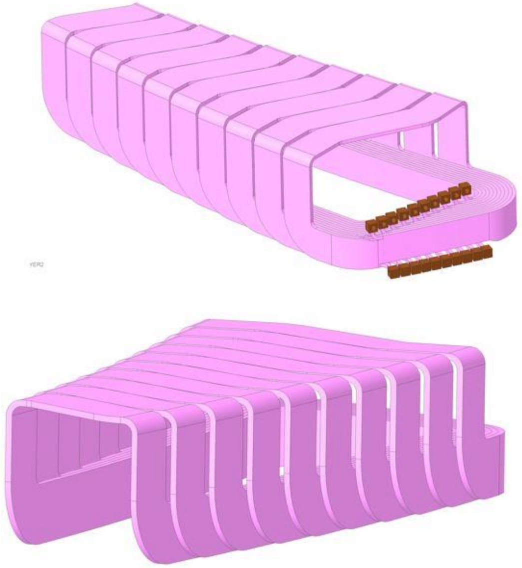


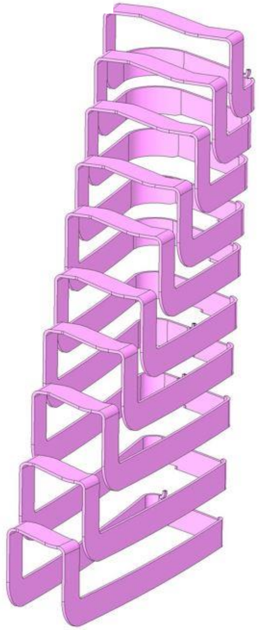




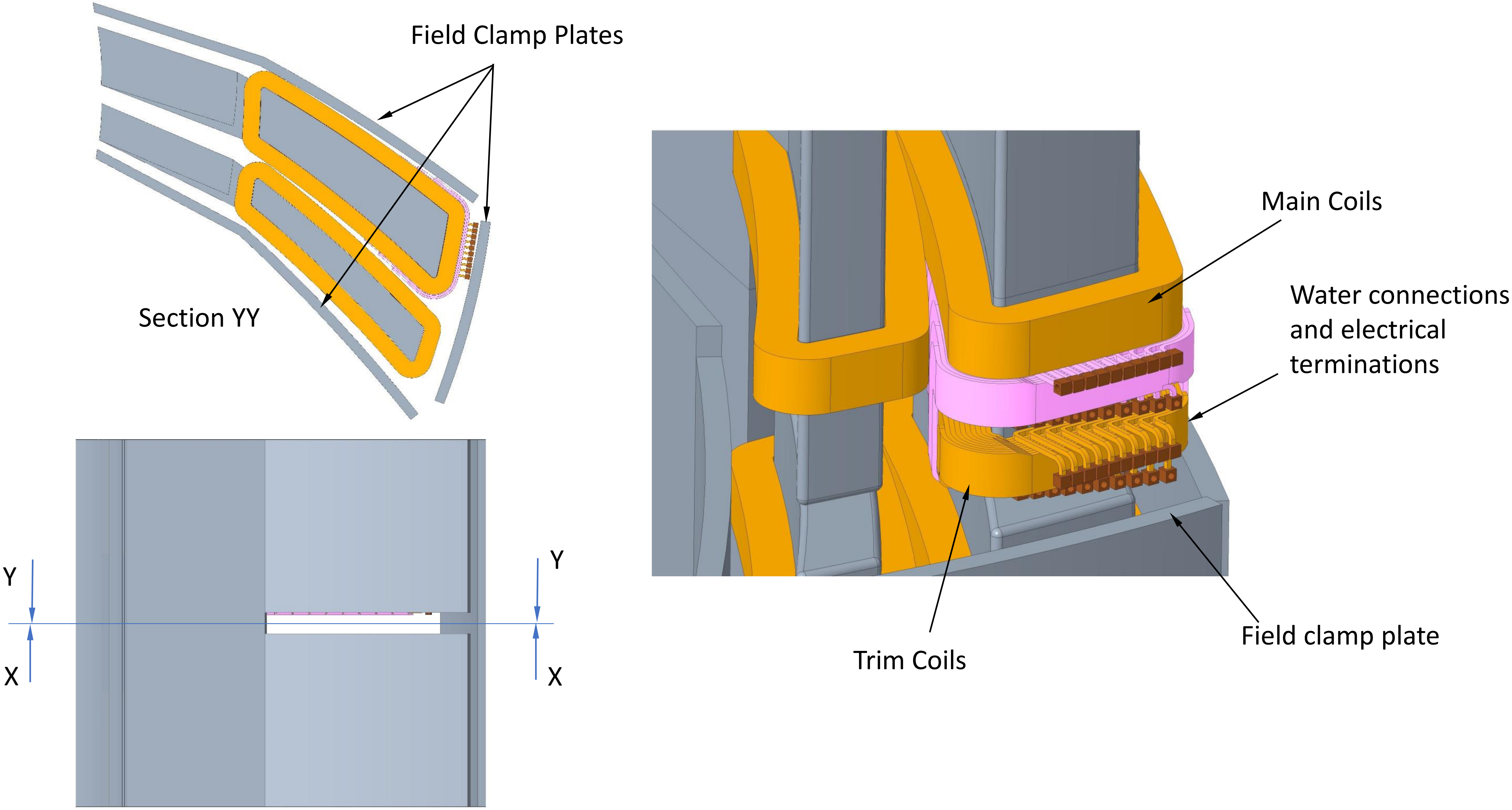


Assembly of Trim Coils Layer 2





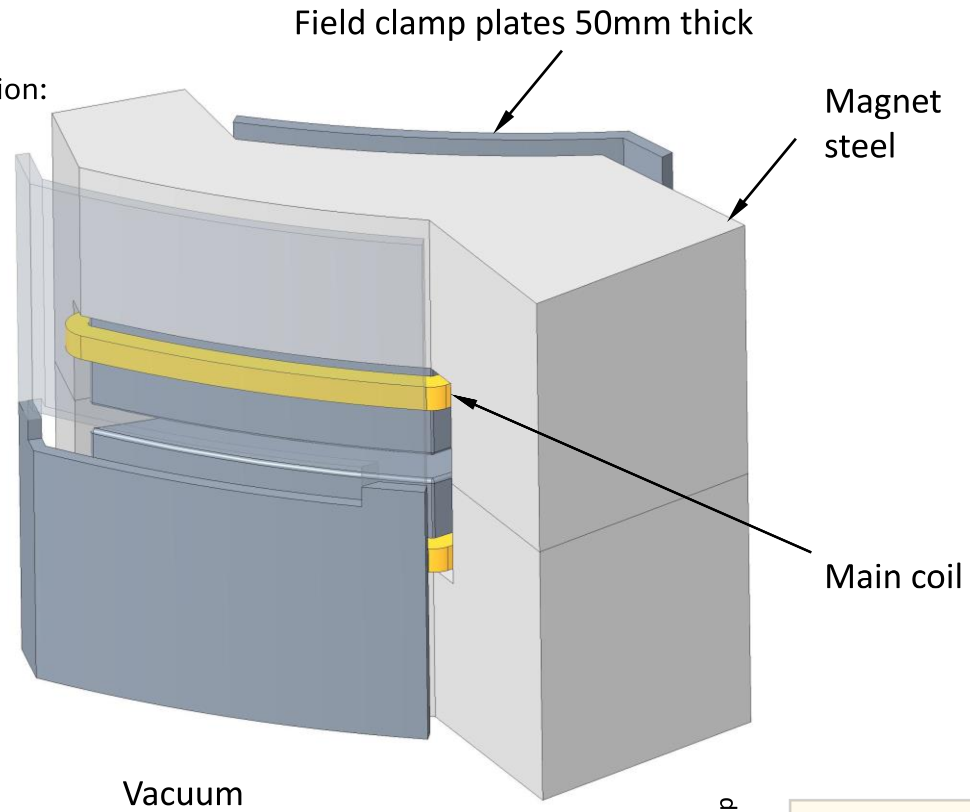
FETS FFA Water Connections and Electrical Terminations

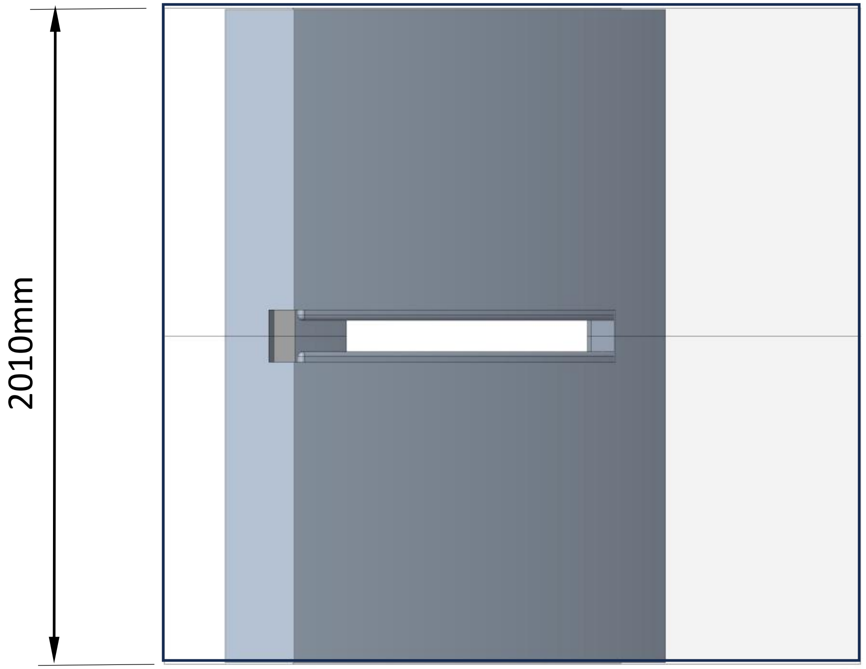


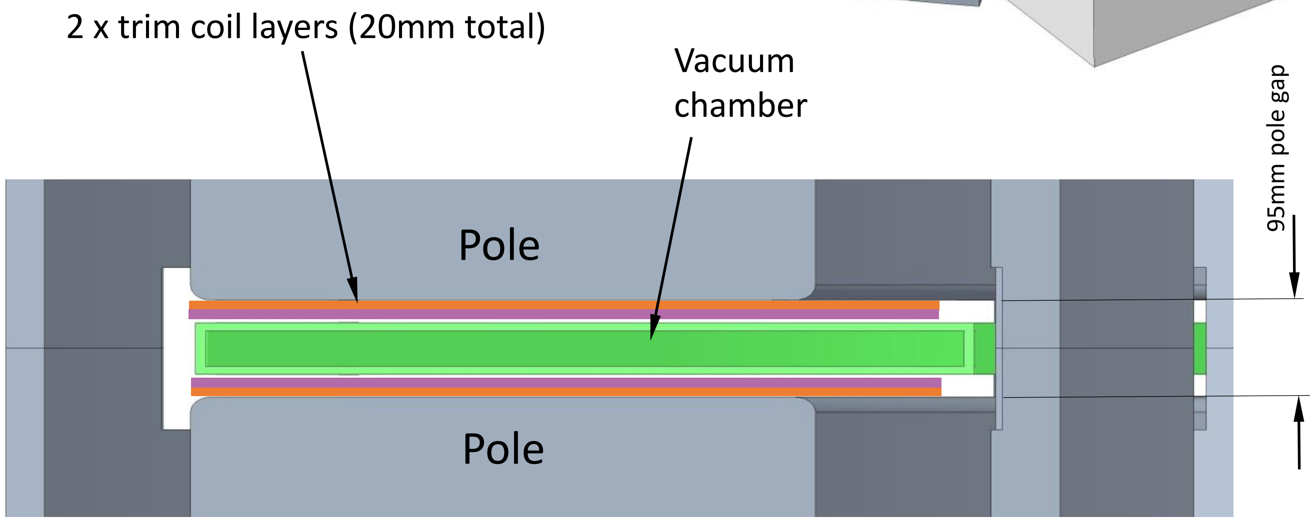
LhARA FFA Magnet

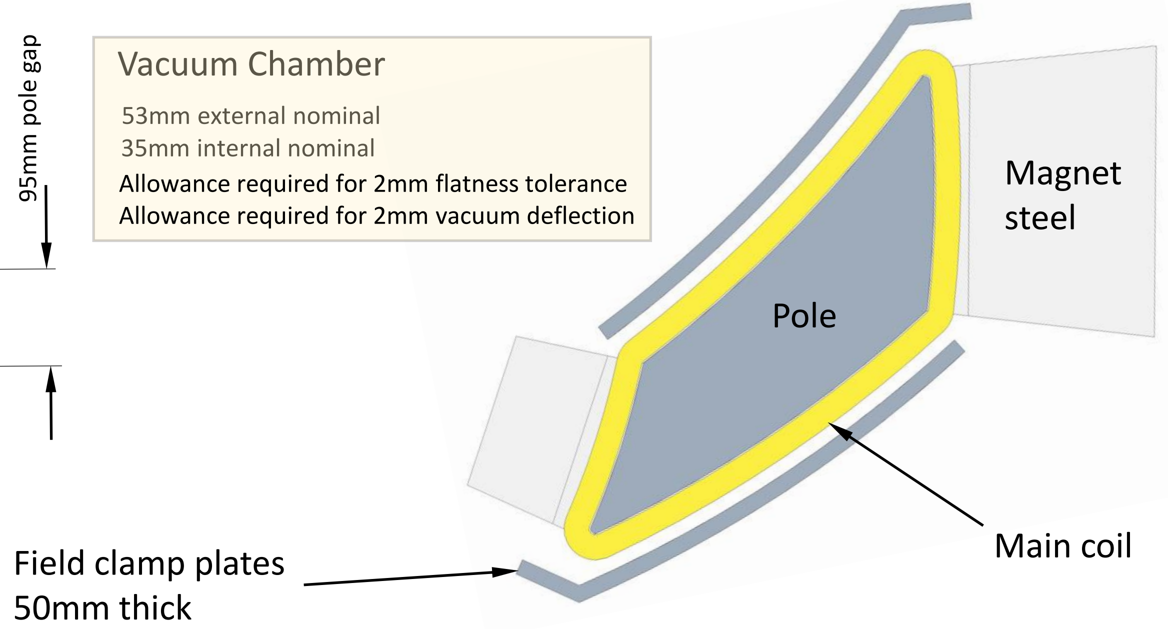
Preliminary LhARA FFA magnet specification:

lattice : spiral scaling singlet,
N: 10,
k: 5.33,
k range: 4.37-5.55,
dk/k<1*10^-2,
ksi: 48.7 degree,
R0: 3.477m,
B0: 1.405T,
Rmax: 3.53m,
Rmin: 288m,
Pf: 0.34,
(Qh, Qv): (2.83, 1.22),
Gap: 9.5cm.

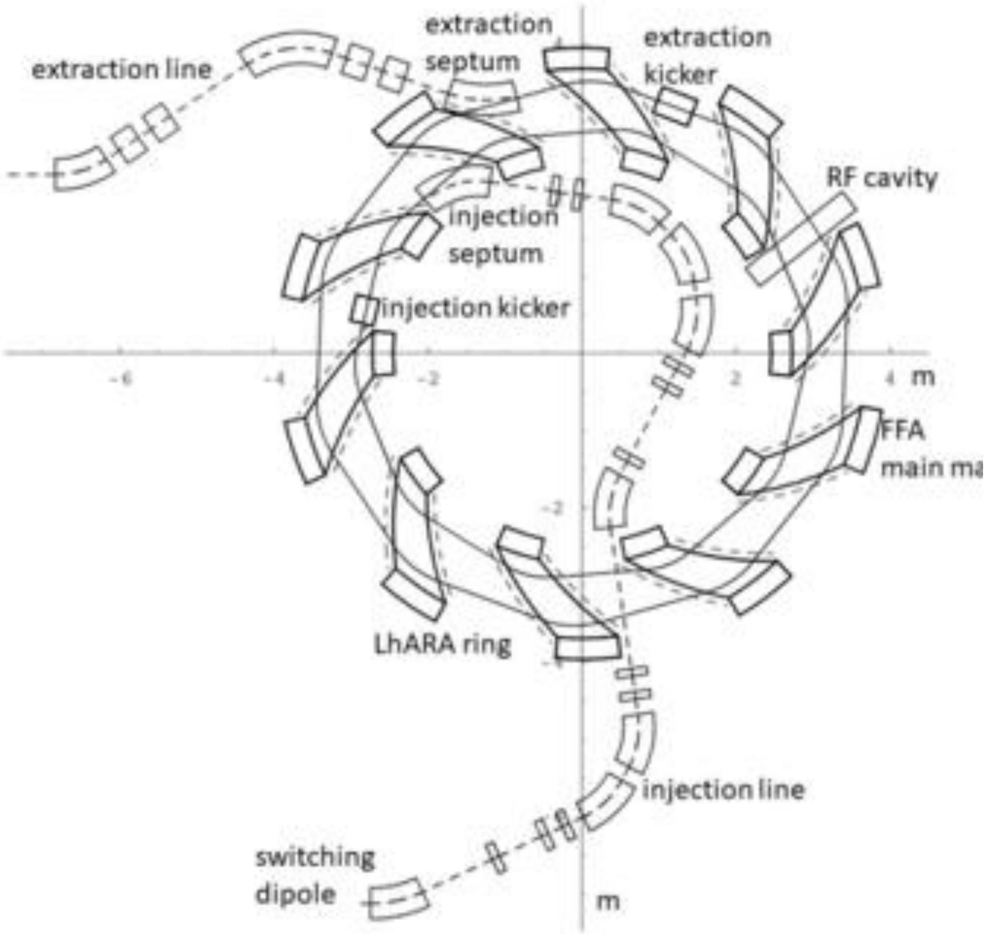




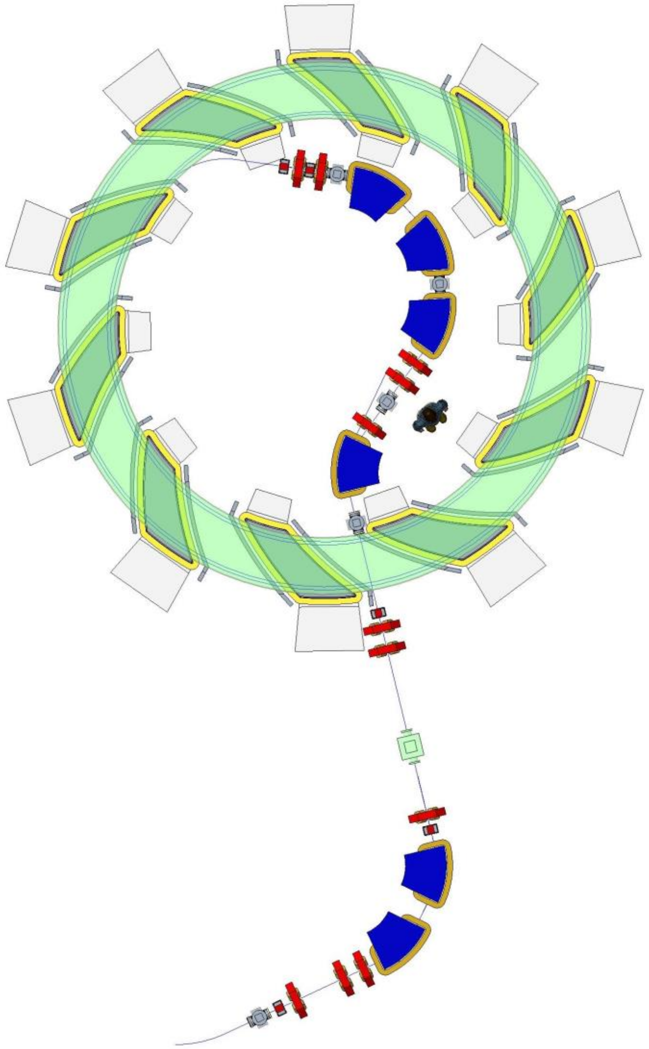




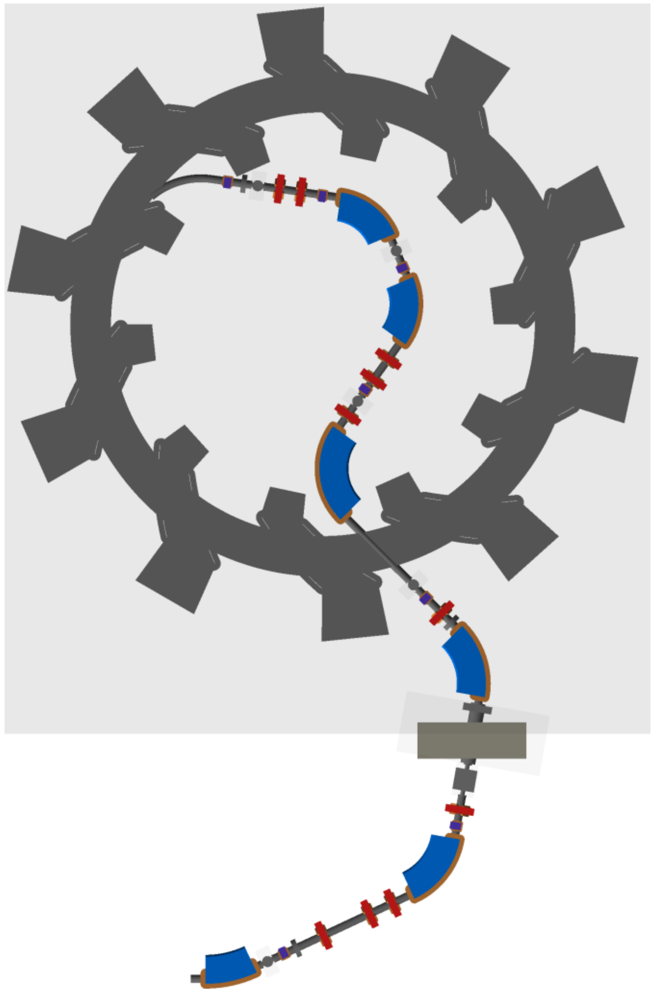
LhARA FFA Ring



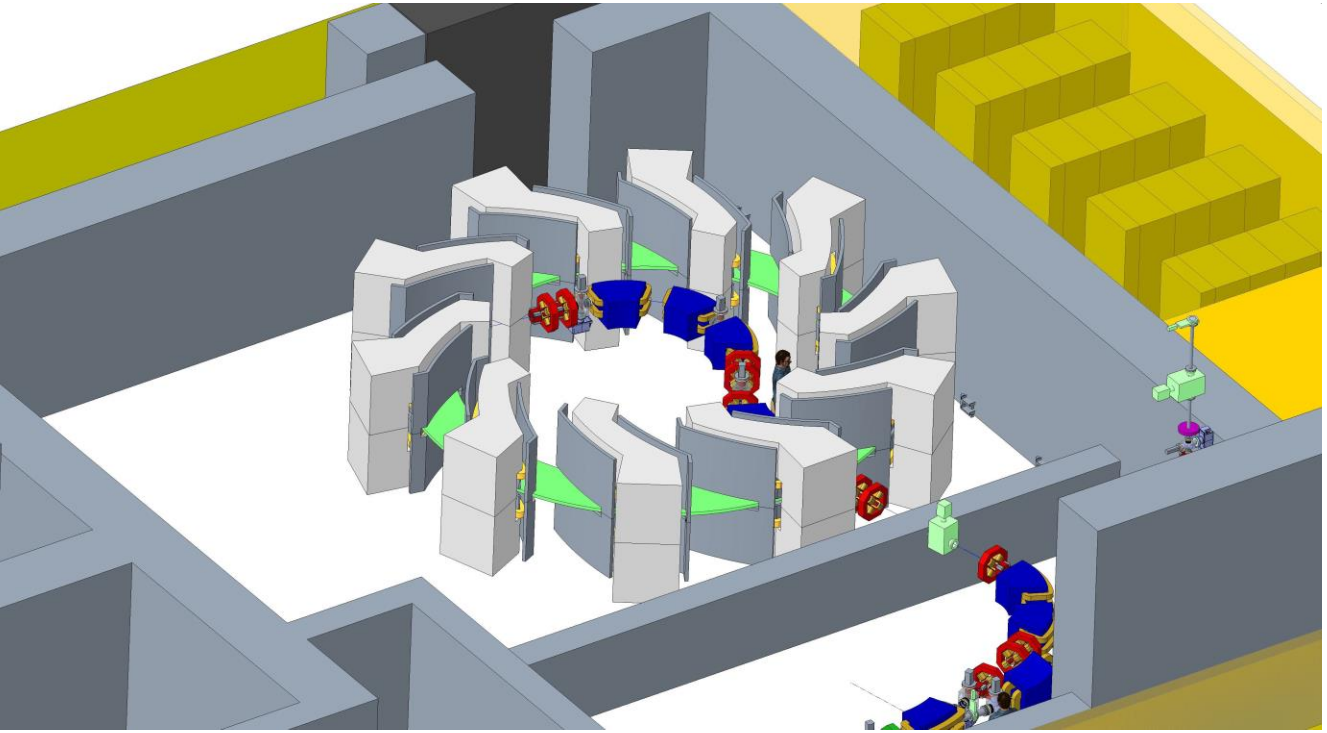
1st Concept Diagram



1st Concept CAD Model



Iterated Concept



Building requires increasing for FFA