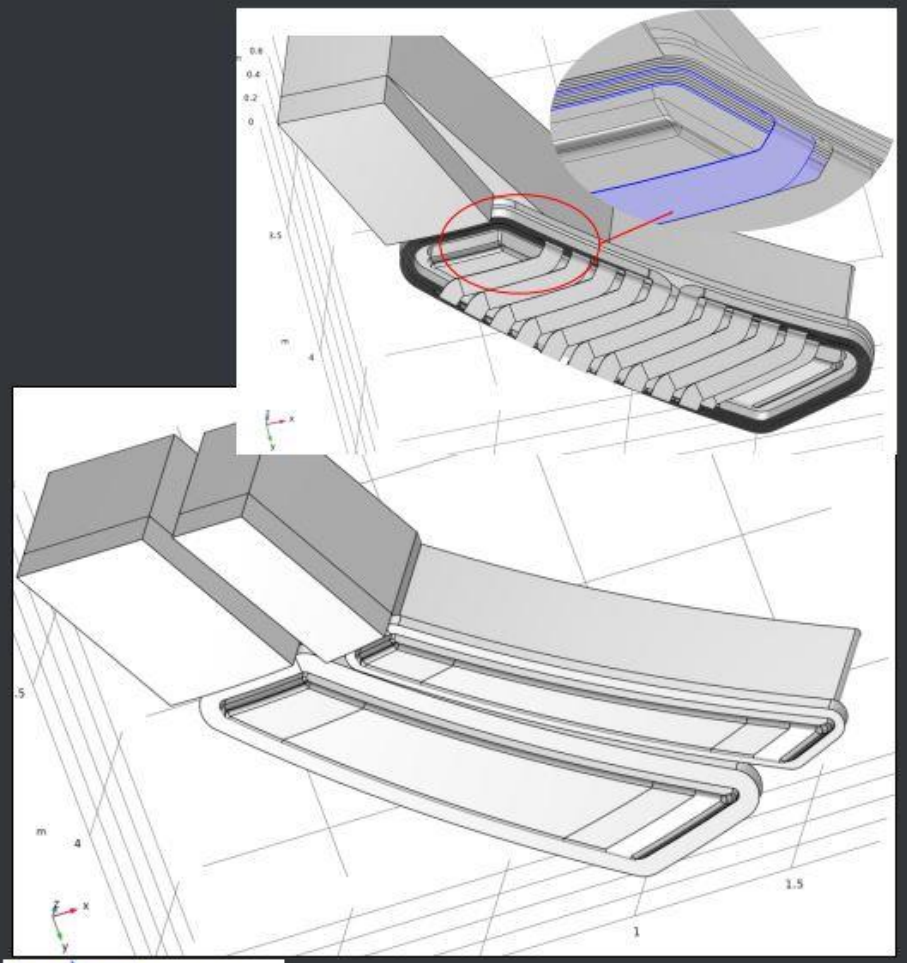
Joint LhARA FETS FFA Meeting Mechanical Design

Clive Hill with contributions from Neil Bliss and Mitchell Kane

16/01/24

Taken from 230503_magnet_lagrange 07/02/2023

Magnet specifications



Cell type	FD spiral
Number of cells in the ring	16
Cell opening angle	22.5 deg.
spiral angle	45 deg
k-value range	6 – 11
Injection, Extraction proton energy	3, 12 MeV
F Magnet opening angle	4.5 deg. (31 cm at r=4 m)
D Magnet opening angle	2.25 deg. (16 cm at r=4 m)
Short drift opening angle	2.25 deg.(16 cm at r=4 m)
Full gap size (include vacuum chamber)	80 mm
Good field region excursion	580 mm
Maximum vertical field in good field region	1 T
Fixed average injection/extraction radius	4.0 m/4.42 m

C-type magnet to fit in R9 at RAL

Science and Technology Facilities Council

JB Lagrange 5

Taken from 230503_magnet_lagrange 07/02/2023

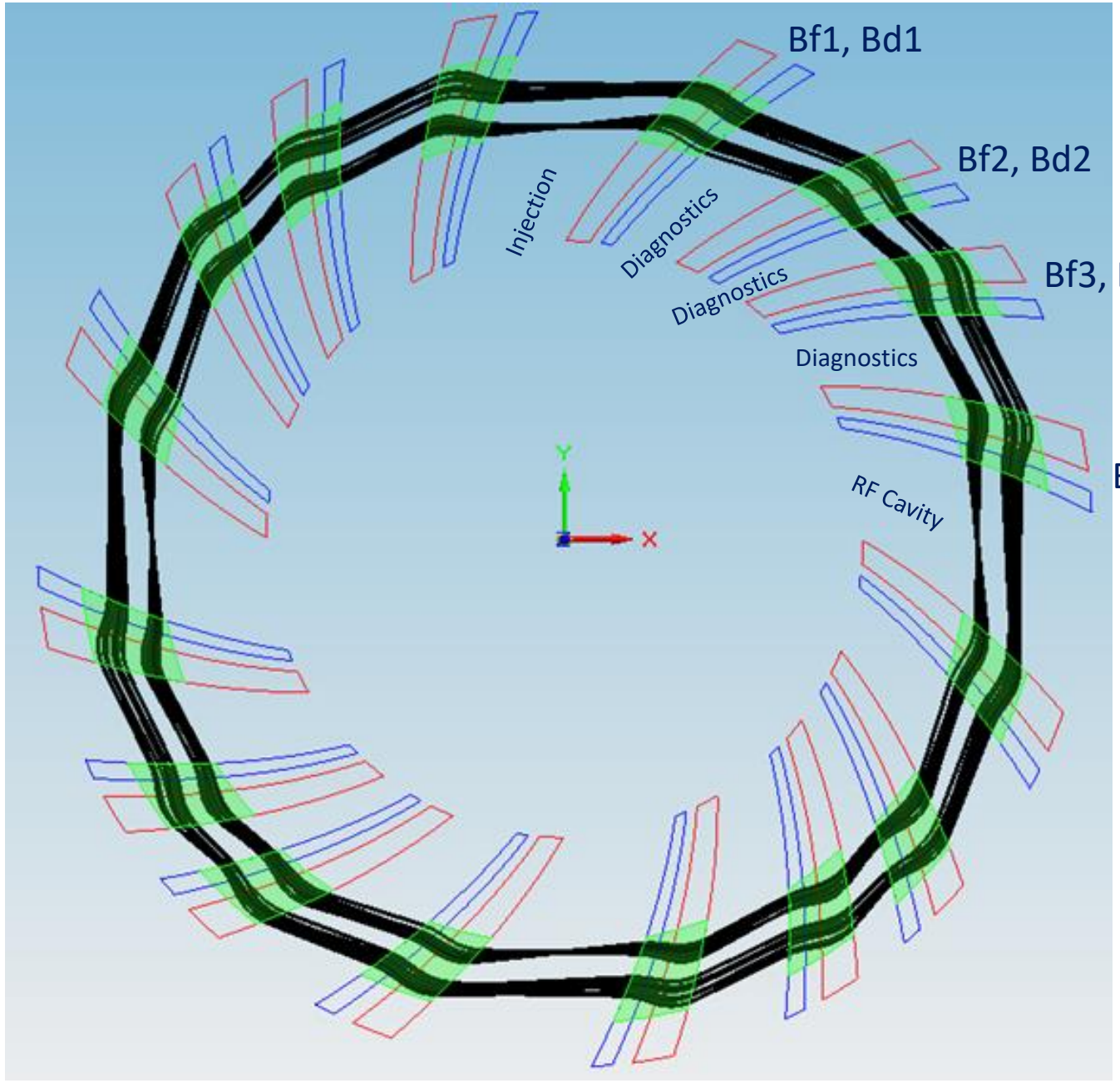
Remaining critical tasks

- Magnetic 3D design (field clamps, currents optimisation) → Sept. 2023
- Mechanical design → Nov. 2023
- Tender for manufacturing → Dec. 2023
- Prototype manufacturing → Dec. 2024
- March 2025 Deadline for deliverables
- Magnetic measurements (in 2025)
- Analysis and publication (in 2025)

Science and Technology Facilities Council

JB Lagrange 7

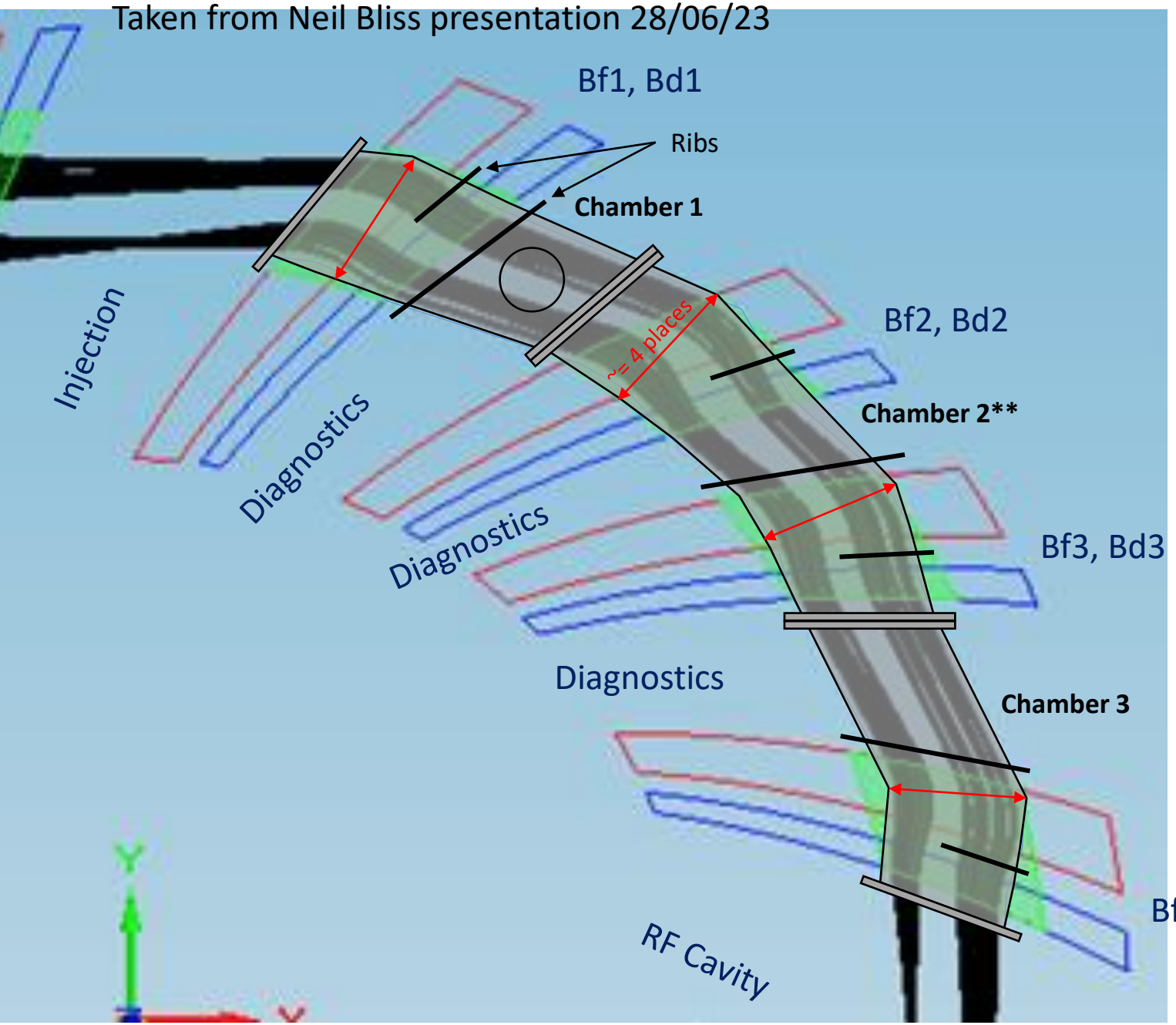
Taken from Neil Bliss presentation 28/06/23



FETS FFA
4 – fold symmetry lattice

Step file received from FETS FFA team

Taken from Neil Bliss presentation 28/06/23



Simplified Vacuum Chamber

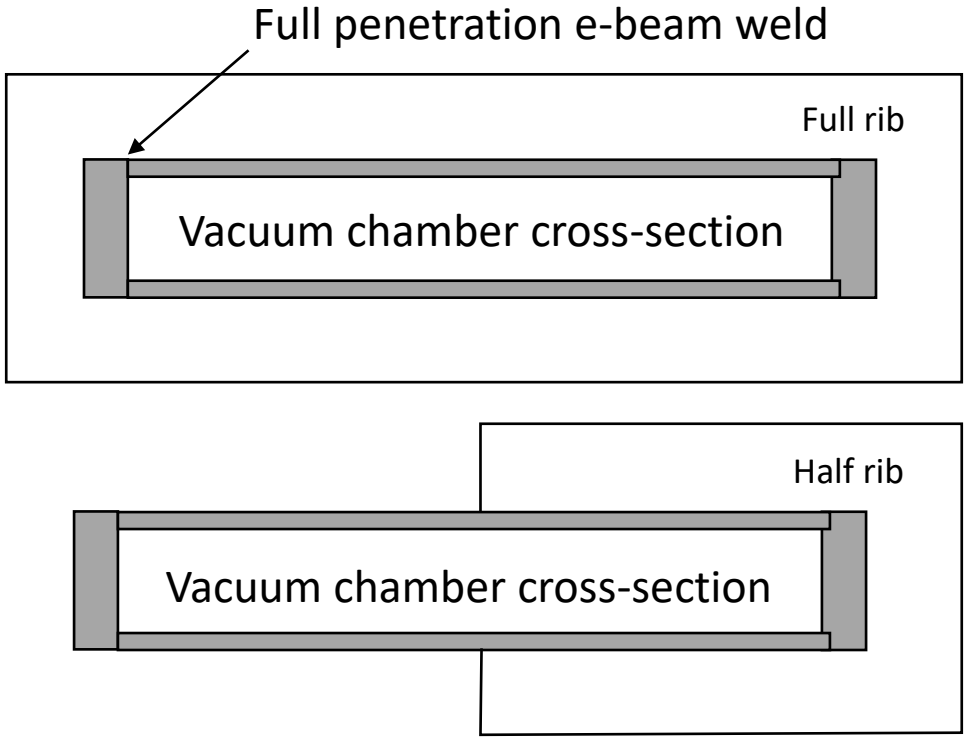
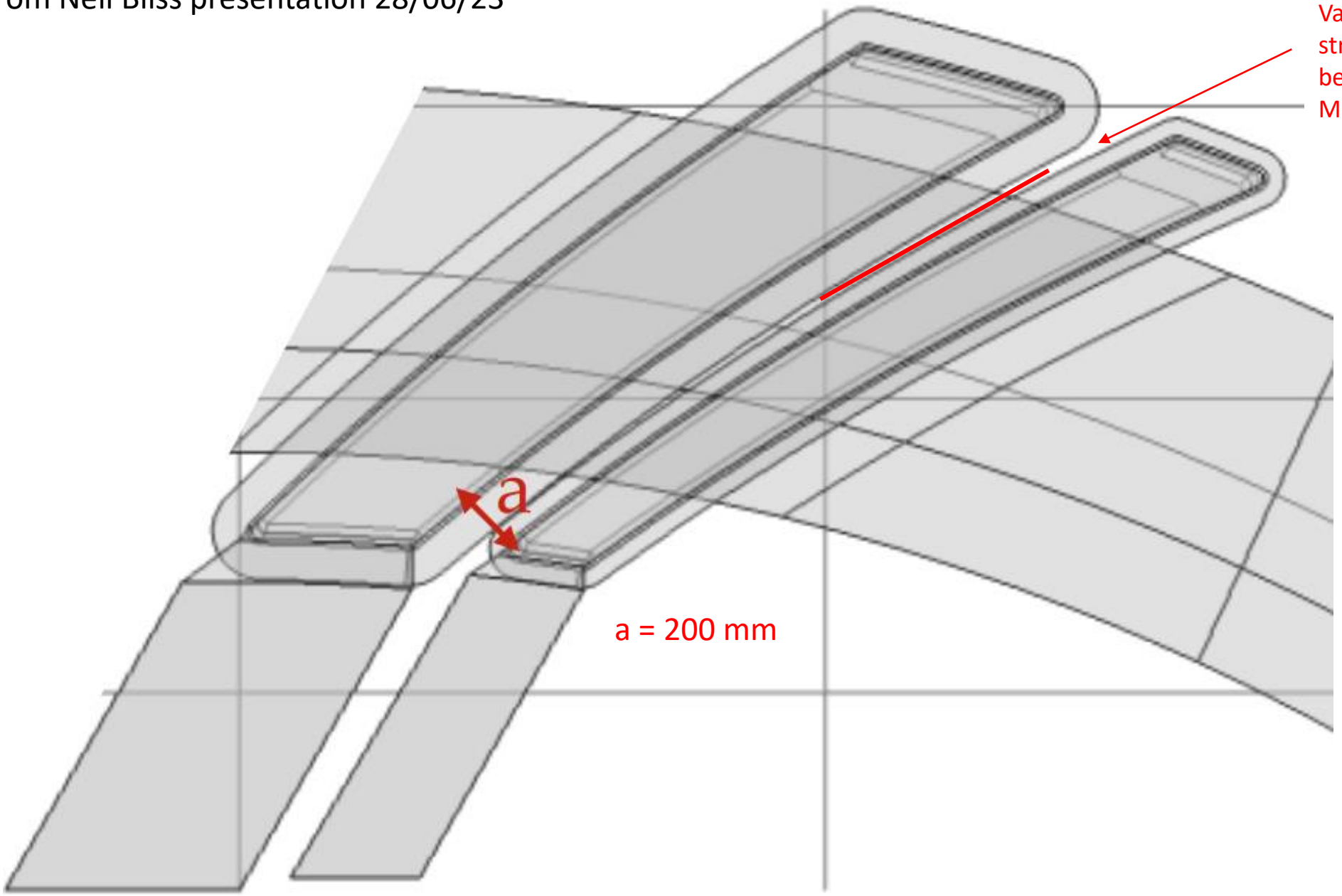


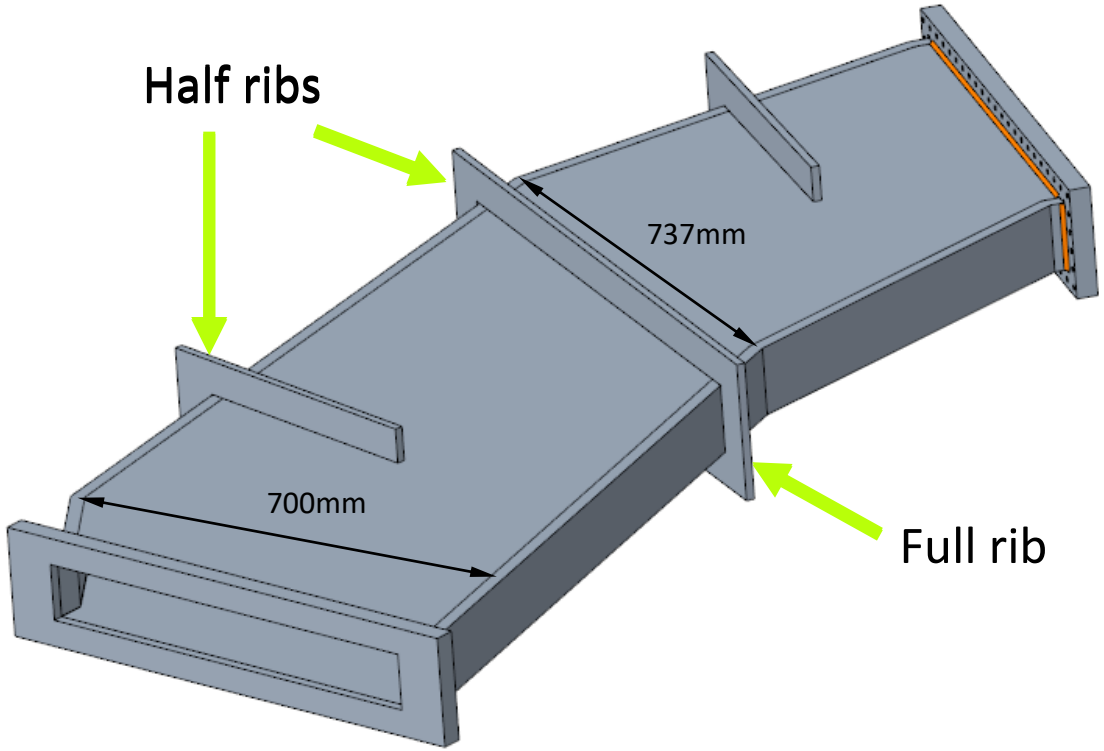
Table 2.10: Vertical aperture

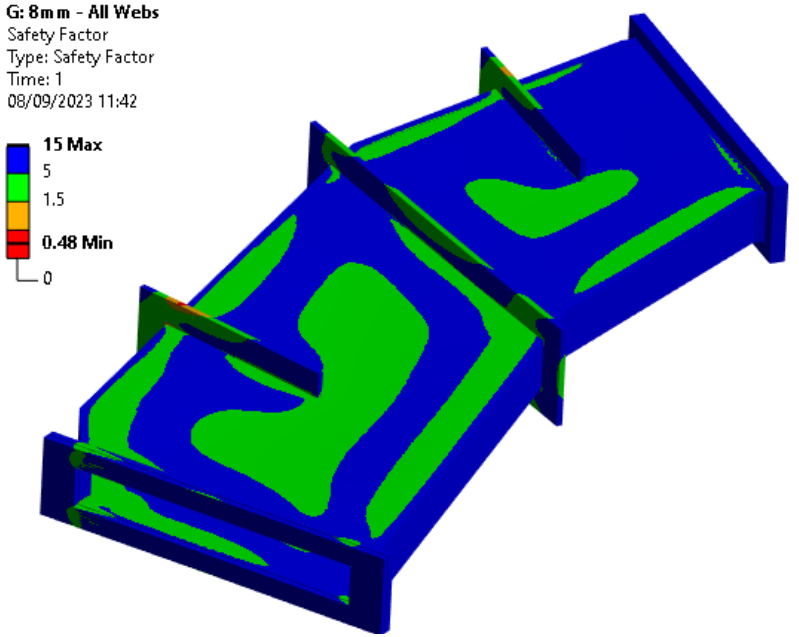
	doublet 1-4
physical acceptance [mm]	±32
closed orbit distortion [mm]	±8
beam stay clear [mm]	±40
vacuum chamber thickness [mm]	10
trim coil thickness [mm]	20
magnet aperture mm]	±70

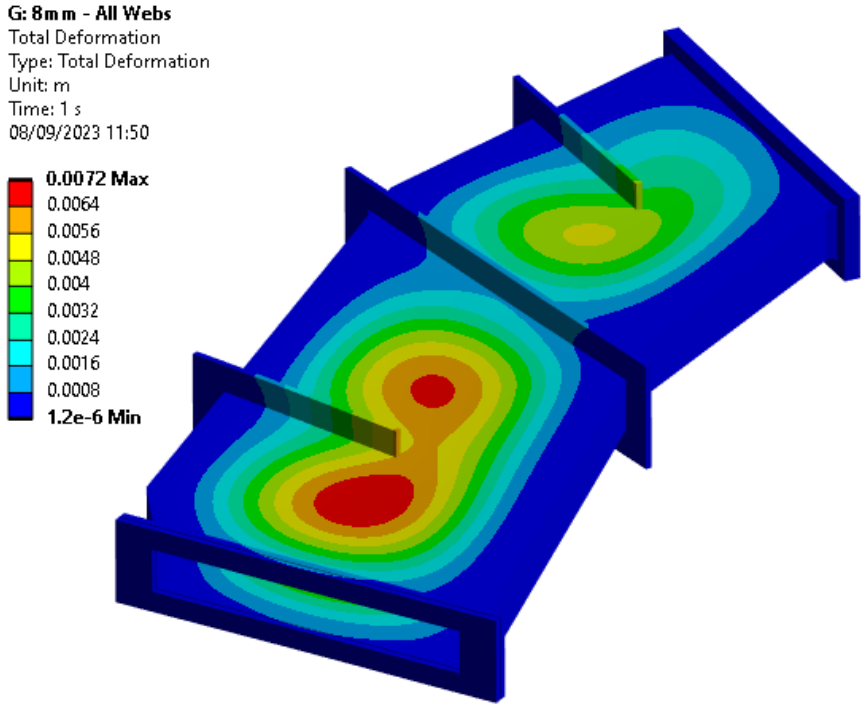
Taken from Neil Bliss presentation 28/06/23



Taken from RFS-1055-meng-fea-0001-v2.0-FETS-FFA-Vacuum-Chamber-2023-09-08

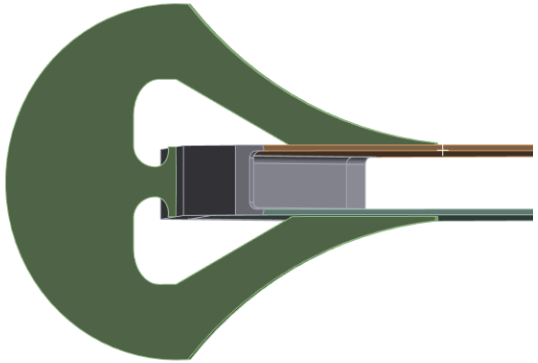


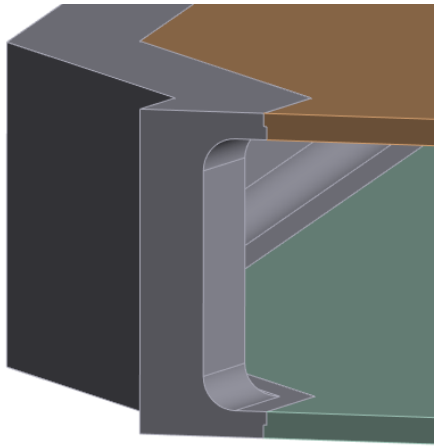


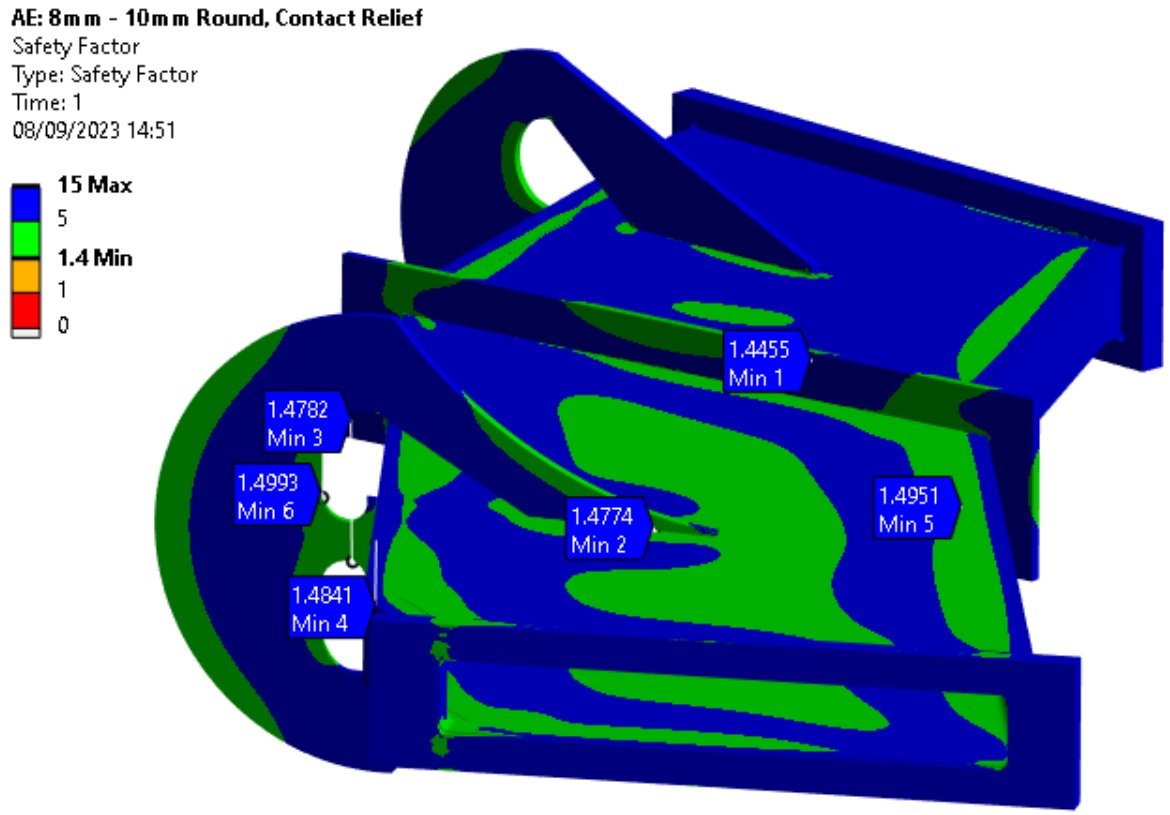


	All Ribs			No Half Ribs			No Ribs		
	Max Deflection (mm)	Max Stress (MPa)	Max Yield/ Stress	Max Deflection (mm)	Max Stress (MPa)	Max Yield/ Stress	Max Deflection (mm)	Max Stress (MPa)	Max Yield/ Stress
6063 T6	7.23	5.38E+02	0.48	12.71	4.28E+02	0.61	12.94	6.67E+02	0.39
316LN	2.47	5.65E+02	0.45	4.40	4.31E+02	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

Taken from RFS-1055-meng-fea-0001-v2.0-FETS-FFA-Vacuum-Chamber-2023-09-08







Titanium and aluminium alloys are unsuitable due to their high deflections. 316LN is the only viable material of the three with the current geometry.

The original design is only suitable for the stress if made of Ti6Al4V.

Modifying the design to include rounds on the internal corners, and altering the shape of the ribs for stress relief, can achieve both the stress and deflection criteria

Email sent by Neil Bliss 13th September

Notes from the meeting with FETS group on 6th September:

- The magnet design has now included Field Clamp plates on 3 sides. Before and after the doublet and on the outside of the ring. The field clamp plate on the outside of the ring can be in 2 pieces to let the vacuum chamber half rib protrude.
- The magnet design will take ~ another 3 weeks.
- The vacuum chamber described shows the worst case. In the final design there will be large box shapes in between the combined function doublet magnets to house septums, kickers, cavities and diagnostics. The introduction of the boxes will provide extra stiffness to the chamber.
- With the amendments described in the FEA report the vacuum chamber wall thickness could be 8mm if designed carefully.
- Allowance for the vacuum chamber deflection is 2mm.
- Allowance for vacuum chamber tolerances and distortion is 2mm.
- Amount that the magnet gap would have to increase is 4mm. FETS group decision is to keep the magnet gap as specified at 140mm. The beam stay clear region can reduce from 80mm to 76mm.
- The field clamp plates may be able to be used to help reduce the chamber deflection.
- Realistic clearances and tolerances for the coils should be engineered into the magnet design.
- When further work has been done on the magnet design a STEP file of the magnet doublet can be made available to conduct further mechanical design. Integration of the magnet and chamber and further optimisation of the vacuum chamber.
- **Action:** Request from FETS group for the DL PME group to look after the magnet tender. ***- Richard and Clive will need to discuss and respond.***
- **Action:** Mitchell to complete the FEA report write up and distribute ***– complete 8/9/23*.**

Questions

- When will the magnet model with coils be ready?
- The procurement schedule will need to be revised
- Is the scope of work by TD@DL for the magnet only or will scope include the design of ring chambers?
- Mechanical design of septum and kicker magnets?
- Mechanical design of RF cavity?