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VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA

Investigation of magnetic heat shielding using high-temperature superconductor

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1. Introduction

- Spacecraft undergoing atmospheric entry dissipates a vast amount heat, which must be shielded.
- A proposed concept is to employ a strong magnetic field using high-temperature superconductor (HTS) to reduce the direct interaction between the spacecraft and the plasma, thus lowering the heat load on the shields.
- In collaboration with German Aerospace Centre (DLR), the proof of concept will be investigated in the HEG shock tunnel, which can recreate flow conditions for hypersonic flight configurations
- Shock stand-off distance will be measured by the Schlieren imaging.
- This poster introduces the magnet design and the mechanical structures required for this study in the shock tunnel.

2. DLR's HEG high-enthalpy shock tunnel

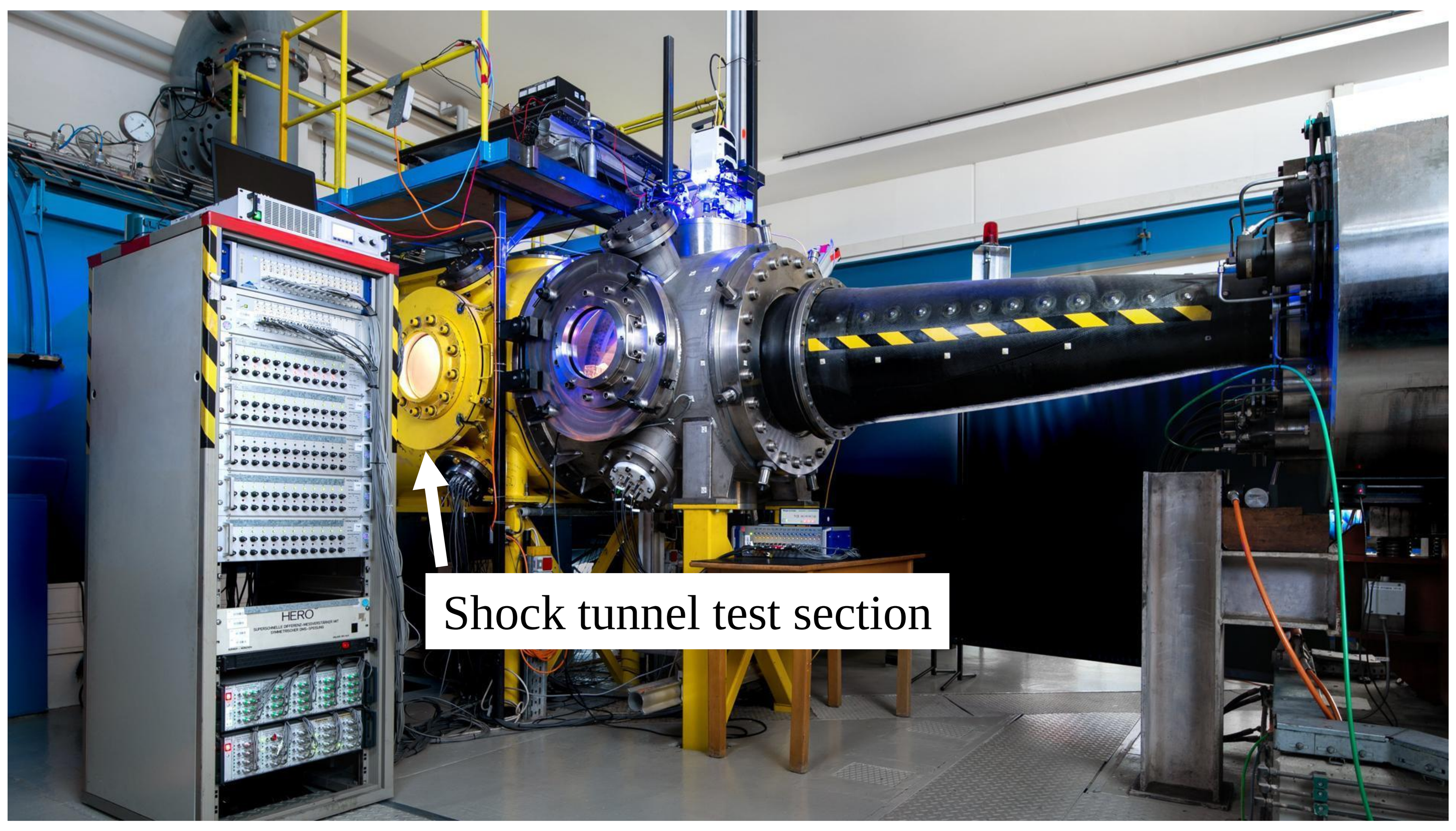
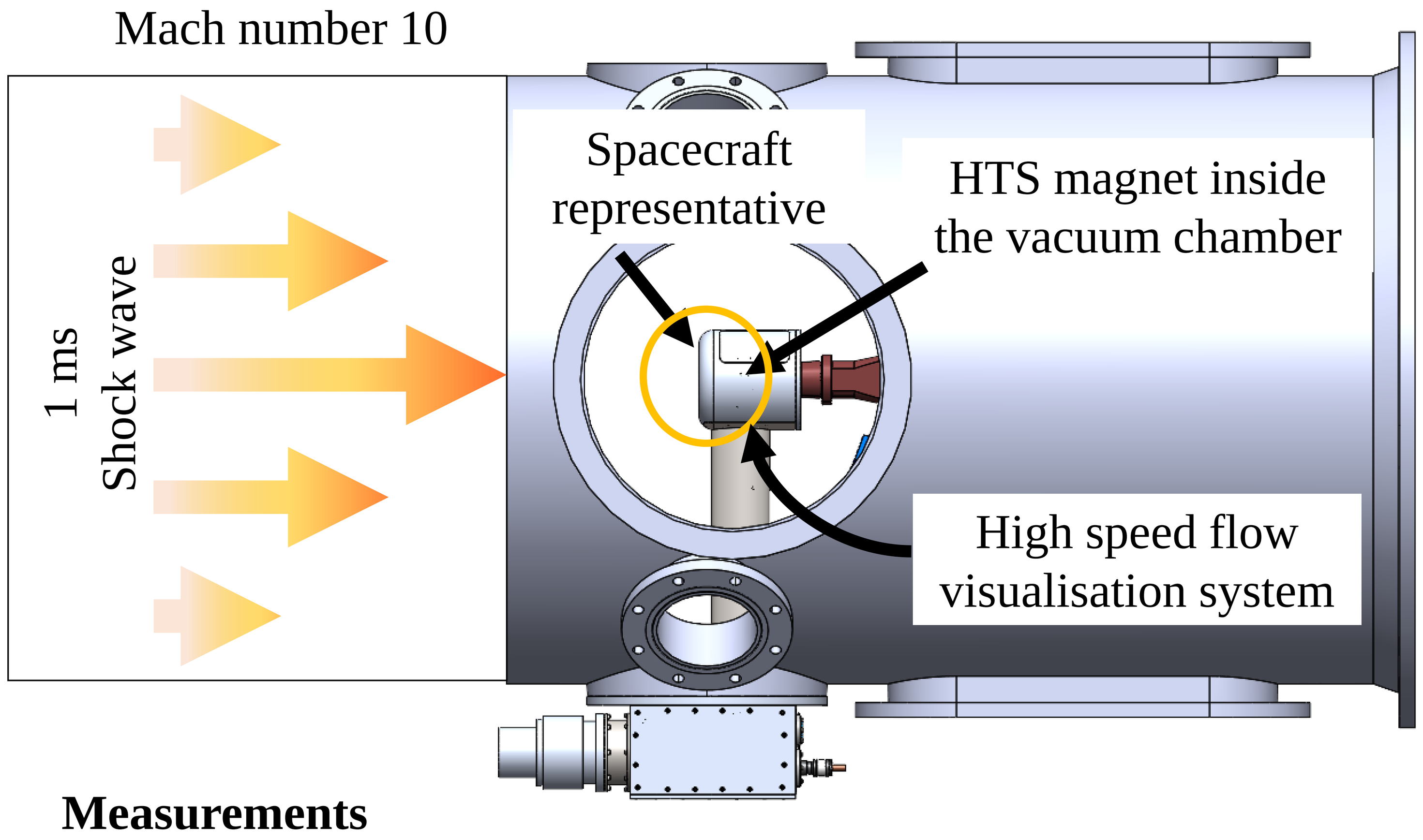


Fig 1. Photograph of the test shock tunnel

3. Experimental setup

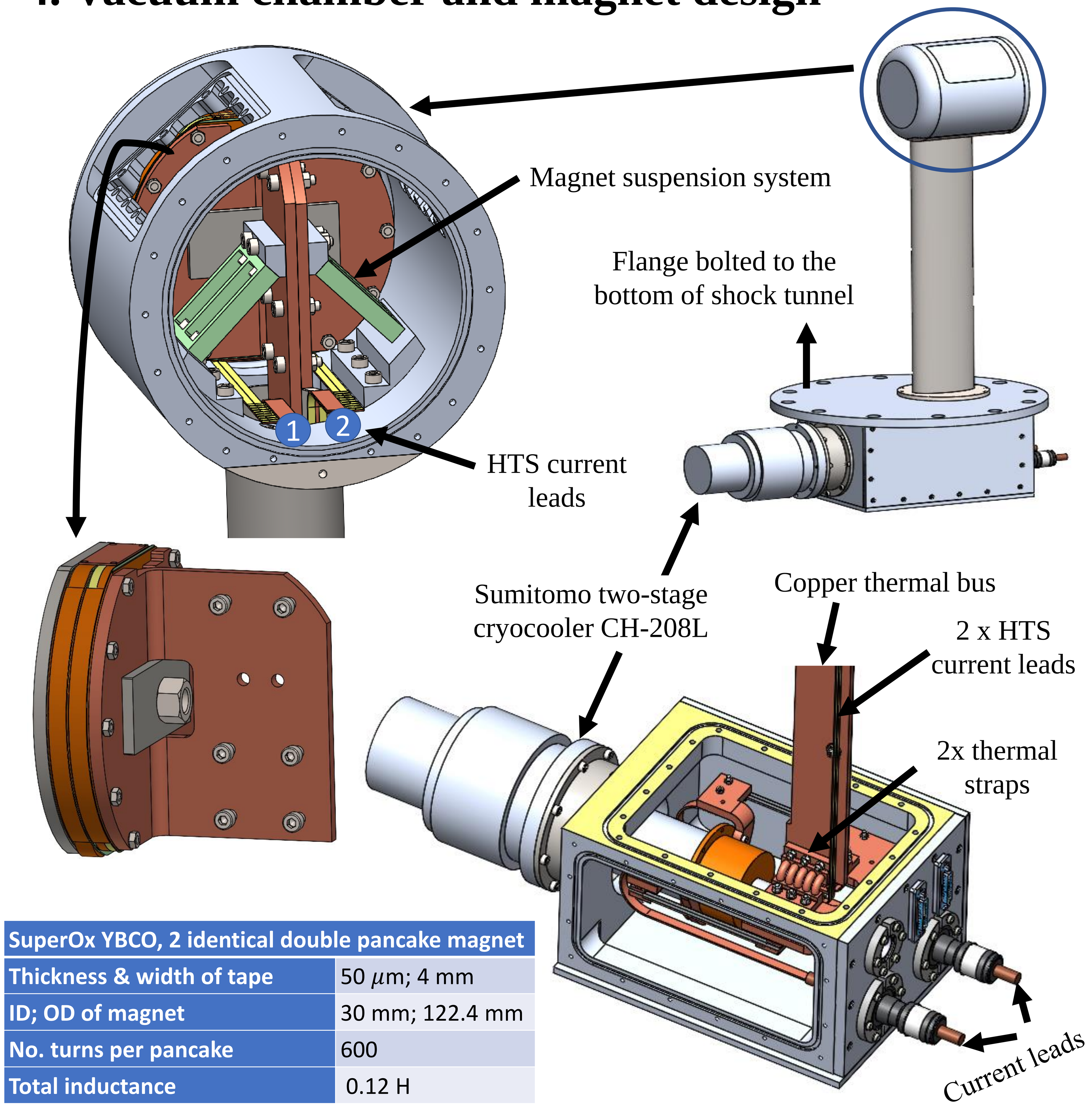


Measurements

1) Surface pressure; 2) Heat flux; 3) Shock stand-off distance

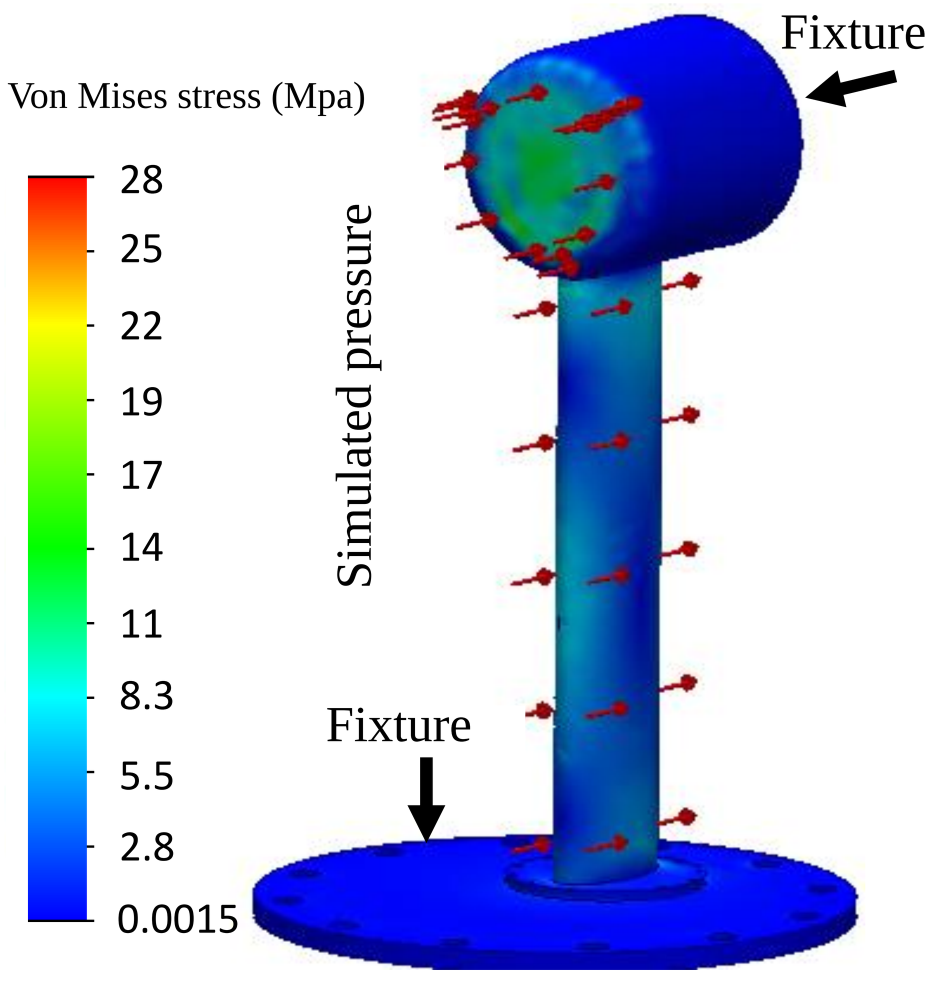
Fig 2. Overall view of the experimental setup in HEG shock tunnel

4. Vacuum chamber and magnet design



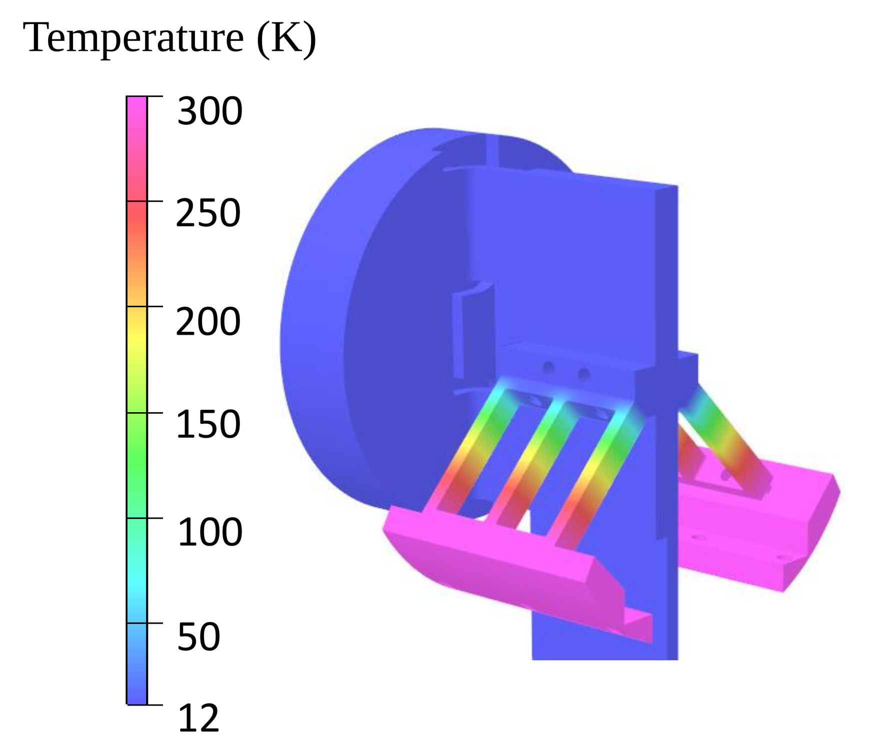
SuperOx YBCO, 2 identical double pancake magnet	
Thickness & width of tape	50 μm; 4 mm
ID; OD of magnet	30 mm; 122.4 mm
No. turns per pancake	600
Total inductance	0.12 H

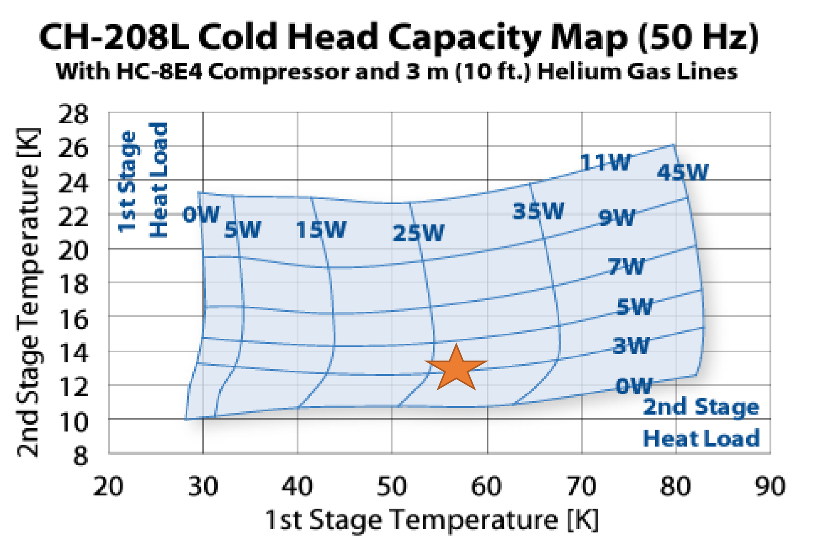
5. Structure analysis



Factor of safety above 8 for Aluminium alloy 6061 and stainless steel 304 under the simulated shock wave

6. Thermal simulation





Magnet is expected to be operated at 12 K

7. Magnetic field simulation

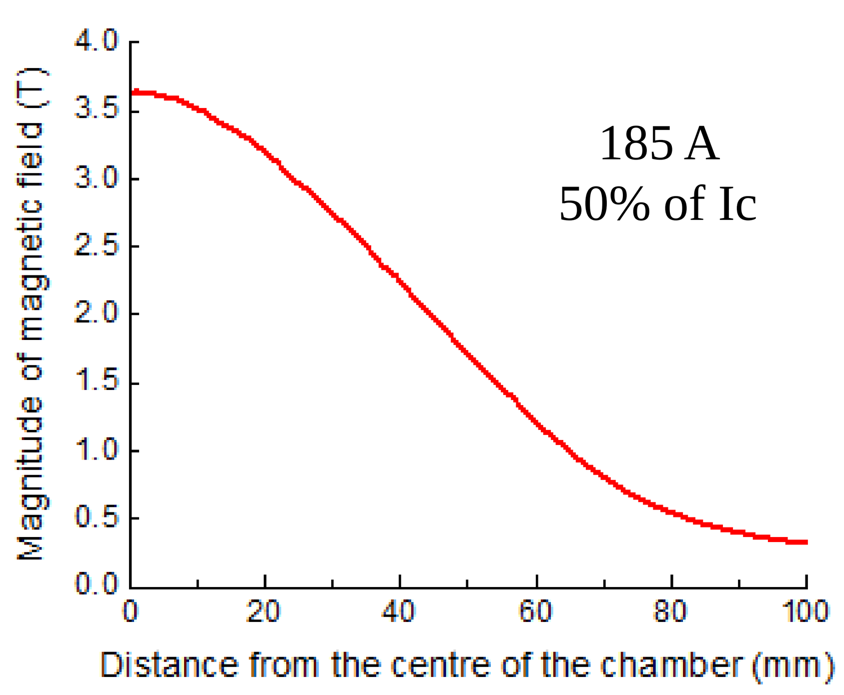
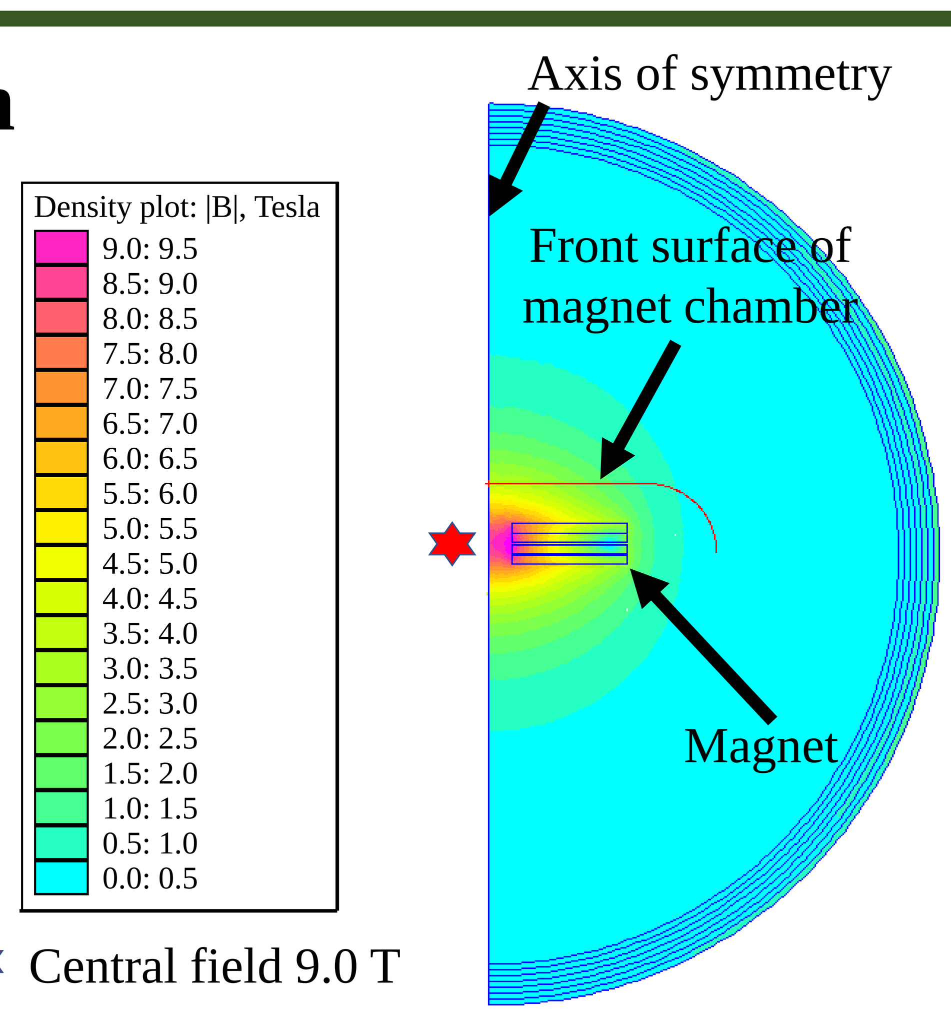


Fig 3. Magnitude of magnetic field on the front surface of the chamber



8. Conclusion

1. A HTS magnet which can generate a **central field of 9.0 T** is currently being built at Robinson Research Institute.
2. The magnet will generate **3.6 T** on the front surface of the magnet chamber. The shock stand-off distance under this magnetic field will be investigated in HEG shock tunnel in **mid 2024**.
3. The vacuum chambers experiencing the shock in the tunnel have a factor of safety of 8.

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