MuC Target – Engineering

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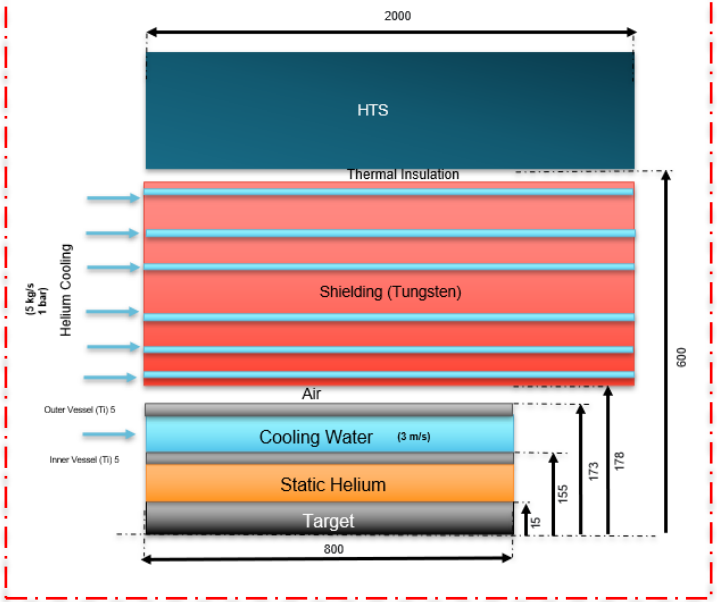
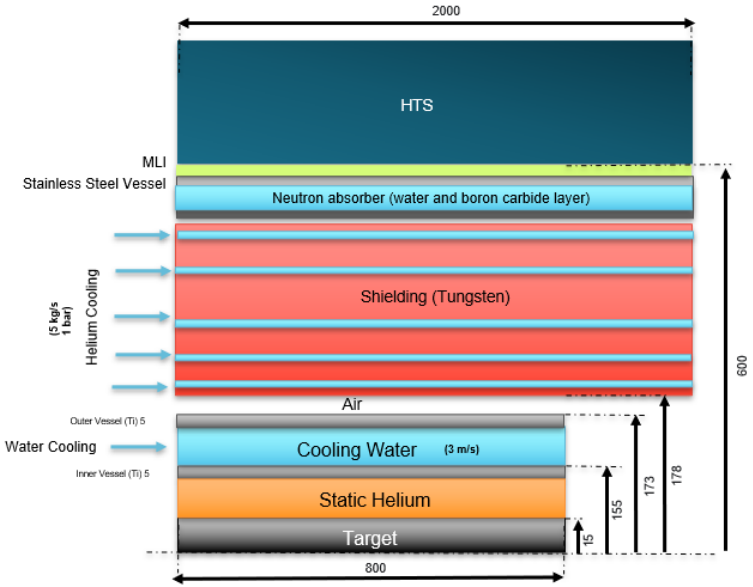
Current and future concept

Current concept



Next evolution

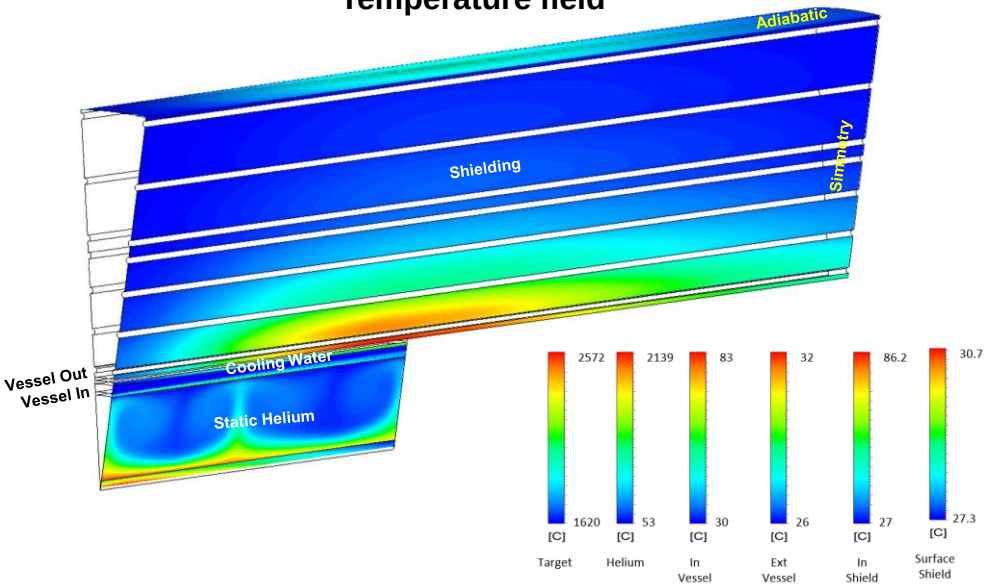


- Several cooling pipes through the shield (not only the surface). Helium cooling instead of water (+ Ta cladding).
- Similar results using air instead of vacuum between vessel and shielding. Reduce complexity.
- 1-3 cm of Multi Layer Insulation Layer ¿?

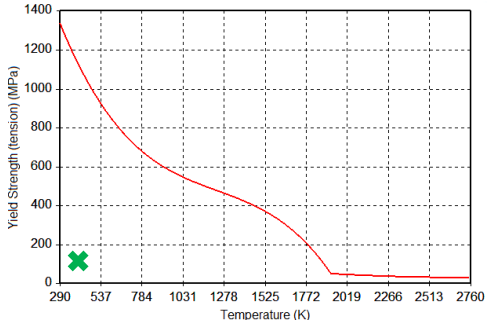
(all dimensions in mm and radius)

Thermomechanical Analysis

Temperature field



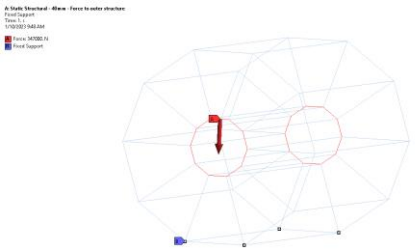
Shielding tensile stress



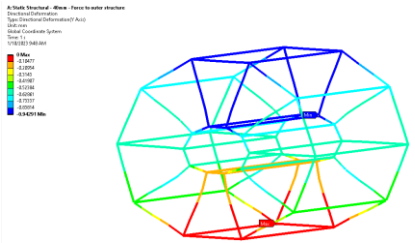
- Temperatures are **below the material limits**. **Surface** shielding temperature should be acceptable for the surrounding solenoid. (1.5 MW)
- First structural analysis suggest tensions around **150 Mpa**. This value falls under the yield strength and fatigue limit of tungsten (at RT). This stress appears around the **supports**, not at the beam impact zone. More detailed structural calculations are foreseen to be done.
- **Irradiated** tungsten increase max temperature up to 102 °C and surface temperature to 35 °C.
- For **2 MW:** target reaches 2892 °C and shielding 126 °C.

Shielding blocks & support structure

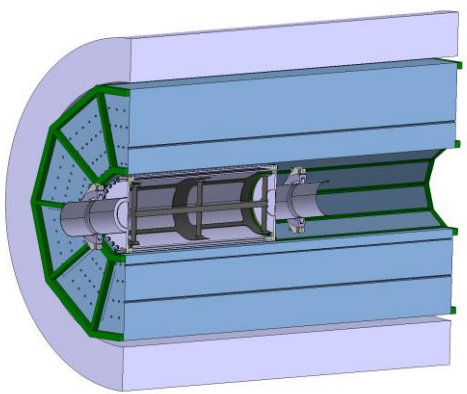
- Tungsten sectors supported by an external structure (structure material and dimensions to be defined).
- Shape thought in order to block direct radial radiation paths to the solenoid.
- Support structure is made of 40 mm squared stainless steel profile.
- Preliminary calculations shows acceptable deformation and stresses.

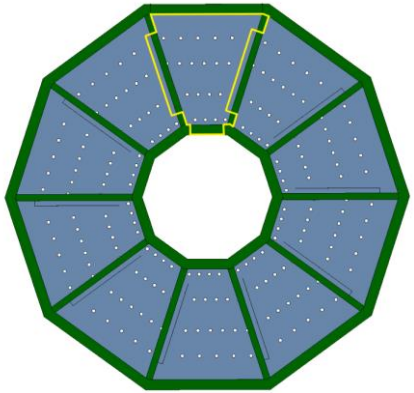


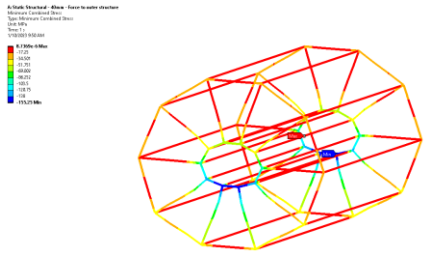
Boundary conditions
(34.7 Tons)



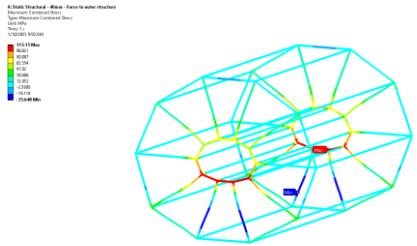
Deformation
(-0.94 mm Vertical)







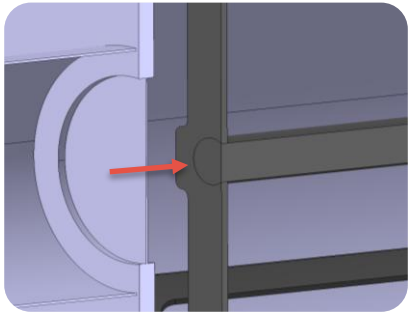
Minimum Combined Stress
(-155 Mpa)

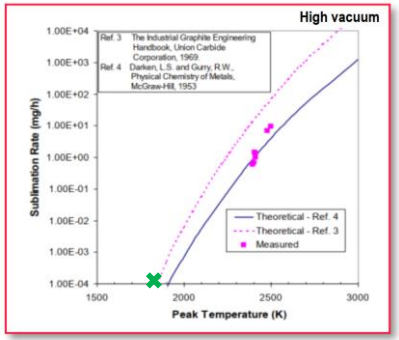


Maximum Combined Stress
(113 Mpa)

Window

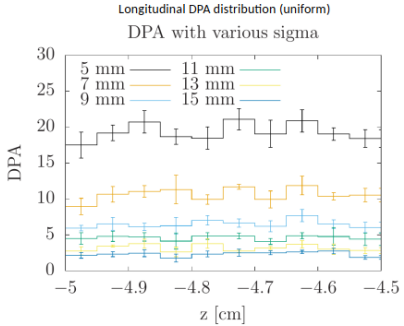
- A window is necessary to store static helium because:
  - In high vacuum, graphite may sublimate in a rate of around 1e-04 mg/h.
  - Experiments using an atmosphere of static helium reduced the graphite sublimation rate by a factor of 30. *#C.C. Tsai*

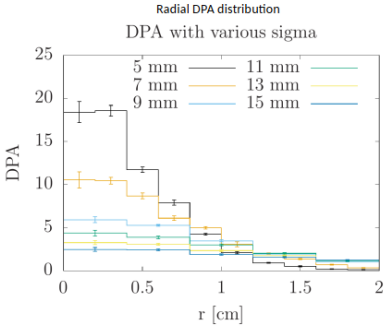




#Graphite sublimation rate - J.R. Haines & C.C. Tsai -2001

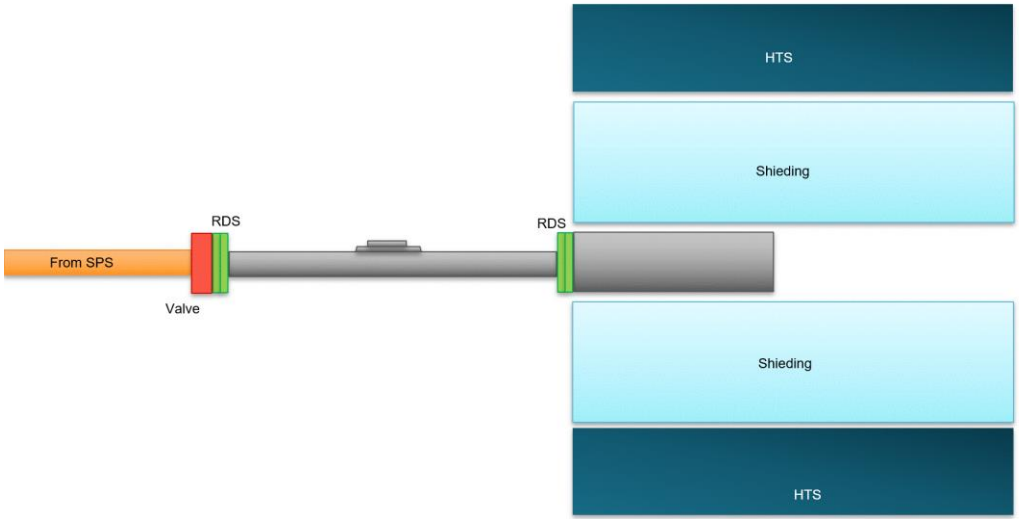
- First aproximations foresee very high temperatures, stresses and DPA. (Due mainly to the small beam size and high intensity)
- This fact entails the need of a remote handling system (such as T2K), to exchange the vessel, positioning and to align back into place.





@ Daniele Calzolari / Anton Lechner

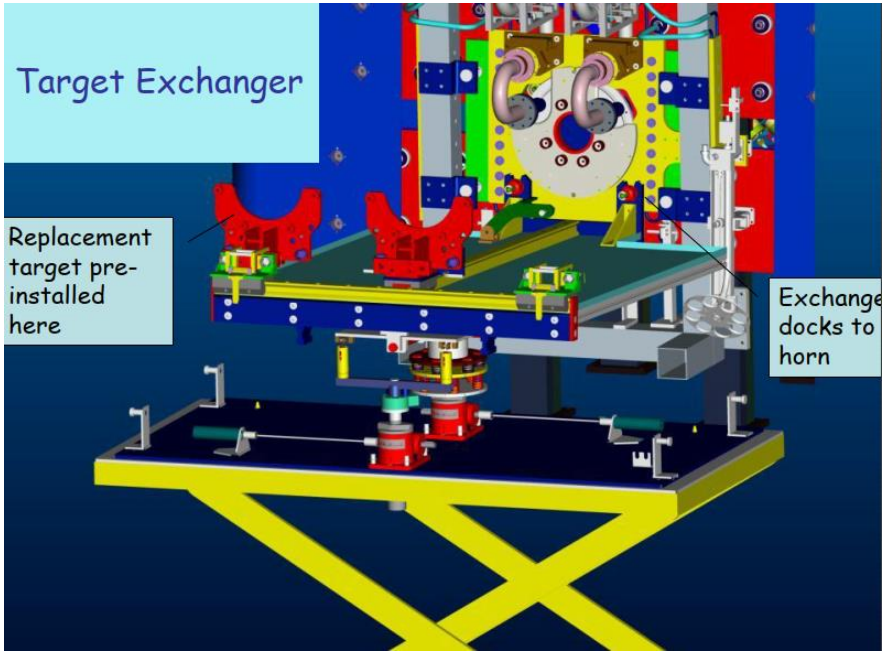
Remote handling – first ideas



 # Inspired in DONES and T2K remote handling systems

Remote handling concept

- Exchange system
- Vertical translation
- Leveling



#Chris Densham - T2K

Conclusions & future work

Conclusions

- The current shielding design is acceptable in terms of solenoid thermal protection, temperaturas, thermal stresses and weight.
- First ideas about construction and integration and remote handling have been provided.
- The target window is currently the most challenging part in terms of DPA, temperatures and stresses.

Future work

- A neutron absorber layer will be integrated in the shielding.
- We will continue detailing the mechanical design of the whole target/shielding to have a realistic idea of how it will look and finding construction & integration problems.
- More work will be done to improve the window durability and the remote handling to exchange the whole vessel.

MuC Target – Shielding Thermal Studies

Thanks for your attention

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