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Institute for Neutron Physics and Reactor Technology (INR)

Neutronics Analyses of the IFMIF-DONES Test Cell

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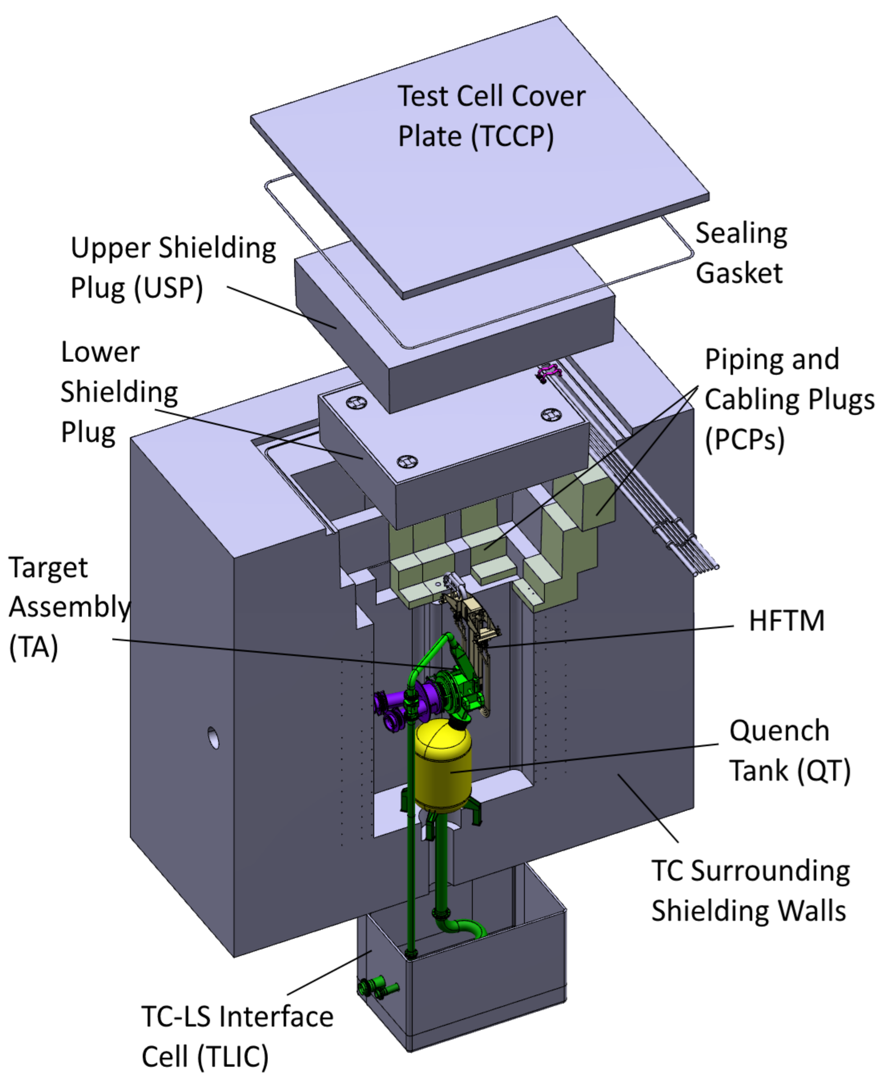
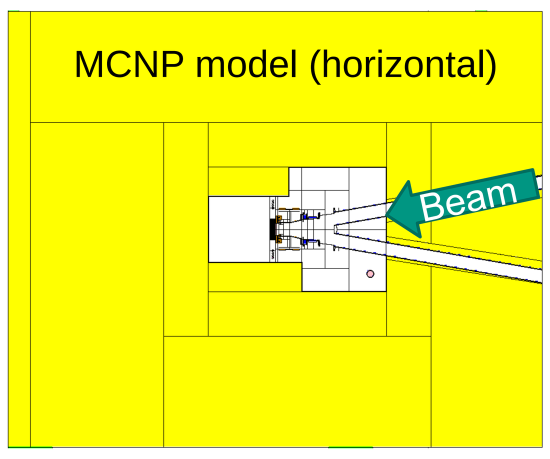
Introduction

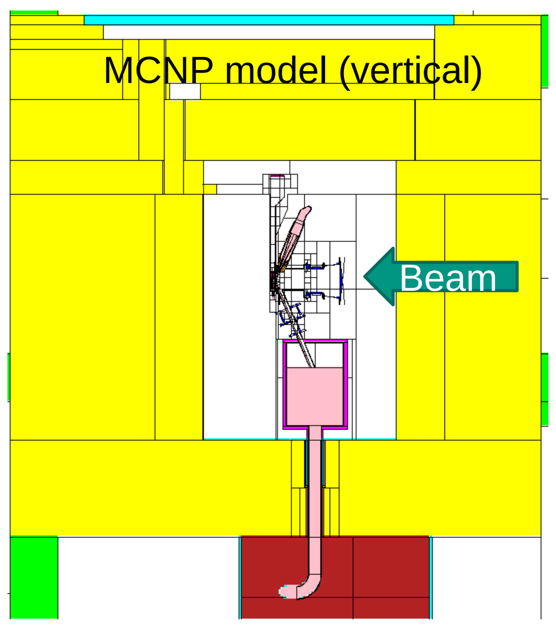
- IFMIF-DONES is a **D**EMO **O**riented **NE**utron **S**ource providing the irradiation data needed for the construction of DEMO. The Test Cell (TC) is the central room enclosing the target and the test module.
- The design of the TC is has being changed continuously comparing with the IFMIF engineering design (IFMIF/EVEDA). It is necessary to re-evaluate the TC neutronics analysis and provide data for TC engineering design.

Neutronics model

- TC CAD model



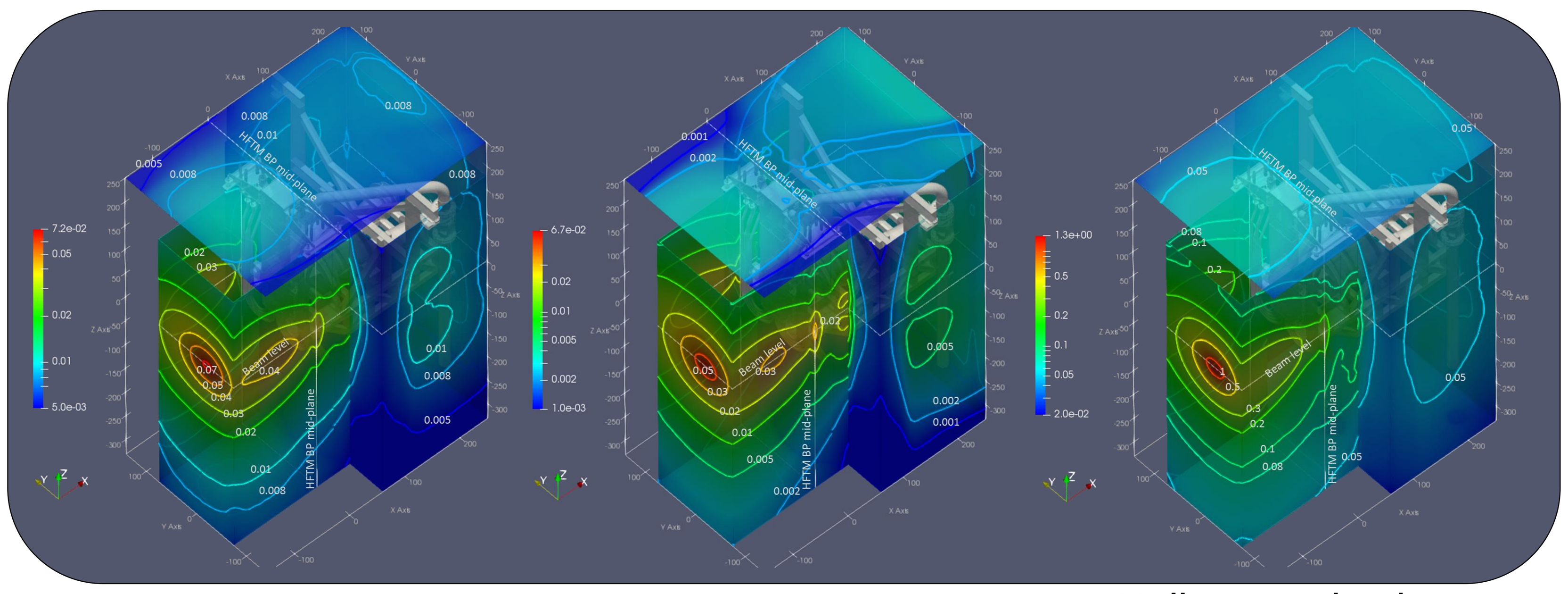




- McDeLicious-17 (MCNP version 6) and FENDL-3.1b neutron cross-section have been used for the calculations.
- Mesh tally with resolution of 5 × 5 × 5 cm^3 covers the center region and 1 m-thick wall.

Liner nuclear responses

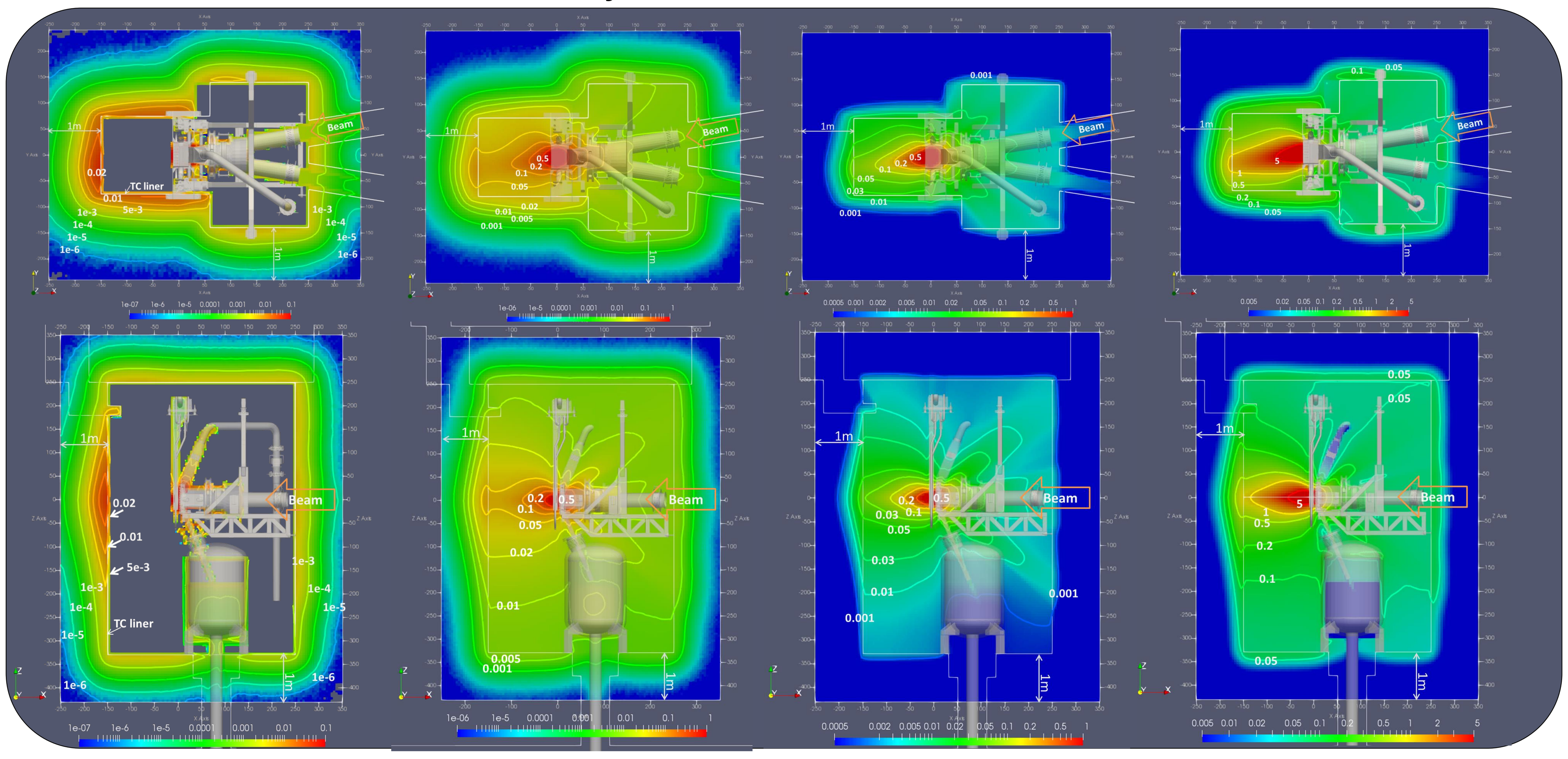
- TC liner is the confinement of TC atmosphere and the accidental lithium leakage.
- The detail results on the TC liner have been obtained using an unstructured mesh based interpolation method.
- Actively cooling of the liner is required to remove the convective and radiation heat inside the TC, as well as the nuclear heating.
- The technology limit the helium production to 1 appm for re-welding. The maintenance of the liner has to be carefully planned.



Nuclear heating (W/cm^3) DPA (dpa/fpy) Helium production (appm/fpy)

TC nuclear responses

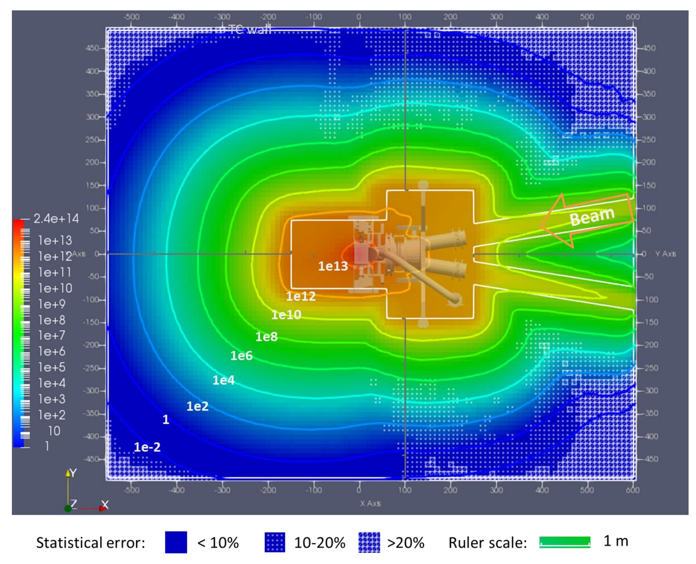
- Local maximums of the nuclear heating and the SS316L helium production are found at the thin layer of inner wall, due to the softening of the neutron spectrum.
- The concrete region with heating > 10^{-5} W/cm^3 and the 1 cm steel slab with > 0.15 W/cm^3 need to be actively cooled.



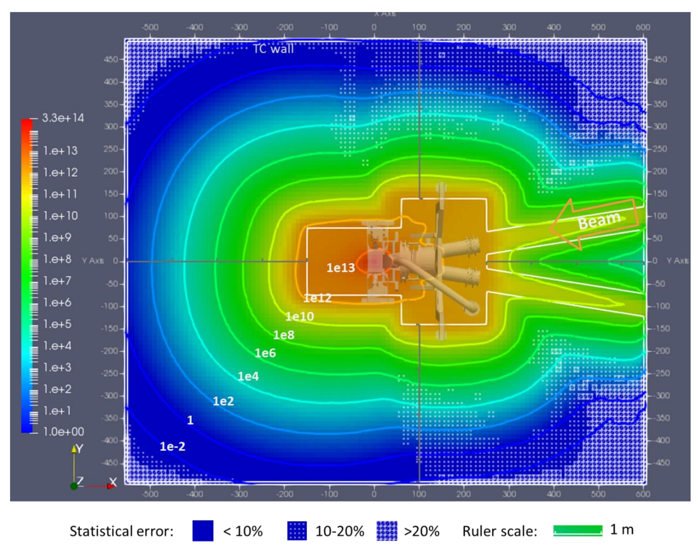
mix-material heating (W/cm^3) SS316L heating (W/cm^3) DPA (dpa/fpy) Helium production (appm/fpy)

Impact of footprint size

- Neutron Flux ($1/cm^2/s$) using the beam footprint sizes of 20 × 5 cm^2 and 10 × 5 cm^2 are compared.
- Similar distributions are obtained on TC.



20 × 5 cm^2



10 × 5 cm^2

Summary

- The softening of the neutron spectrum increases the heating and the helium production at the thin layer of the wall.
- The helium production is a major concern when considering the maintenance of the liner.
- No significant impact on TC neutron flux is found using reduced beam footprint size of 10 × 5 cm^2 comparing with using footprint 20 × 5 cm^2.

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