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Mechanical Design of a 1-kW Neutron Production Target at KOMAC

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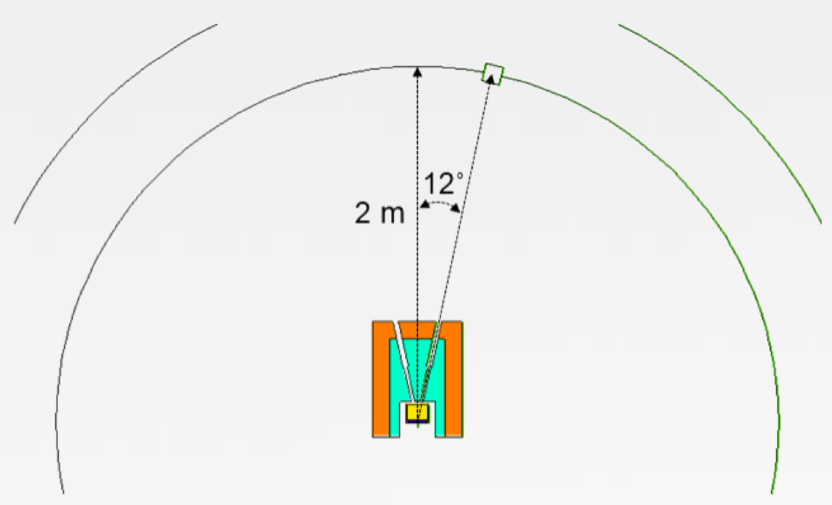
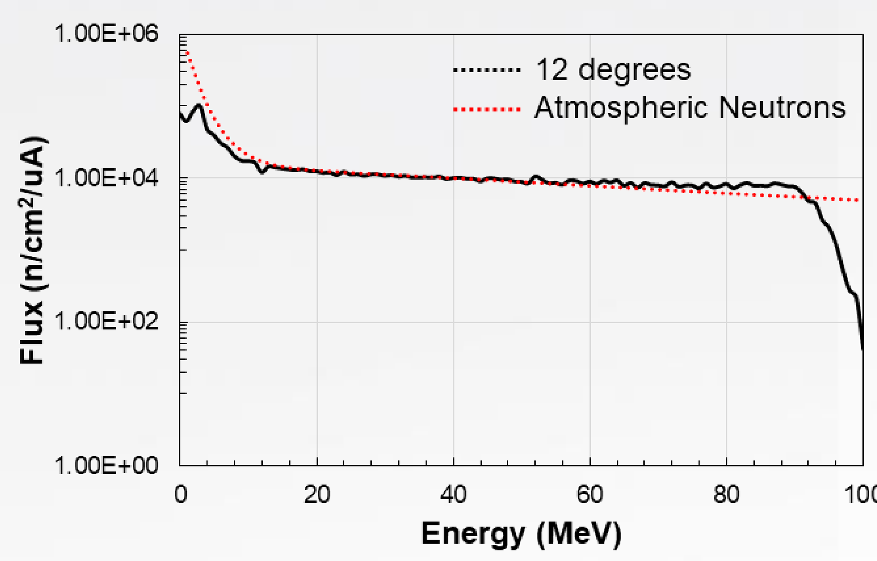
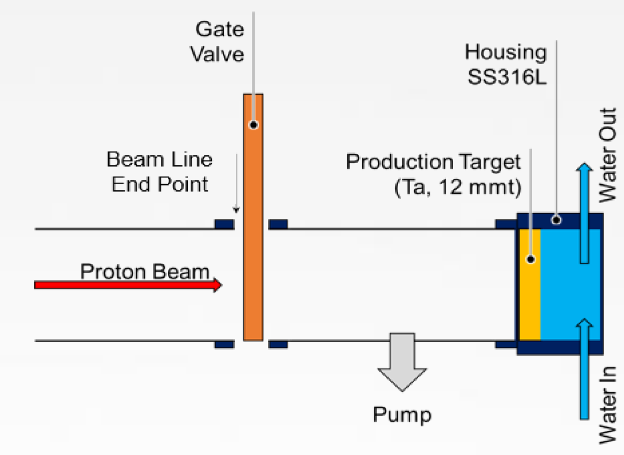
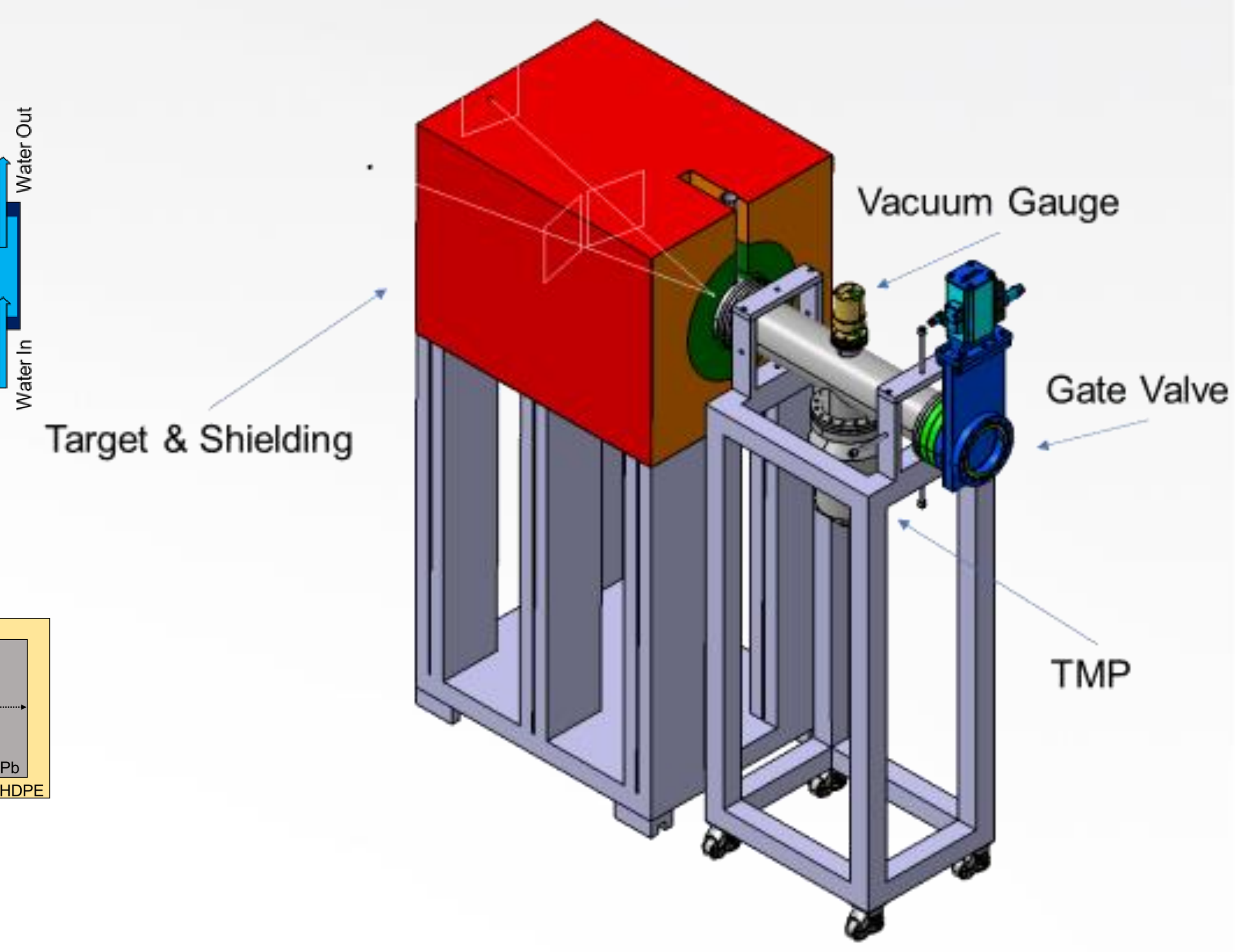
Concept of 1 kW Neutron Source



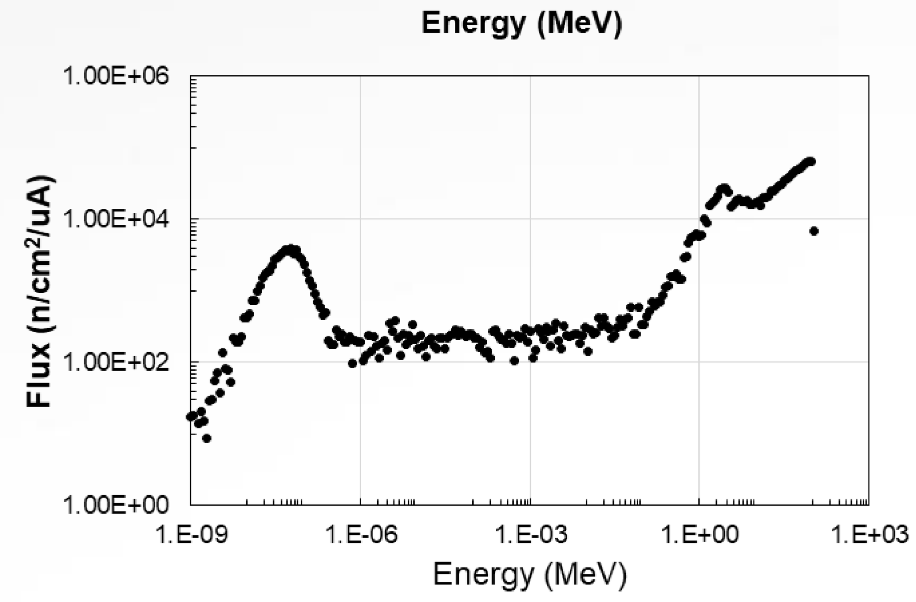


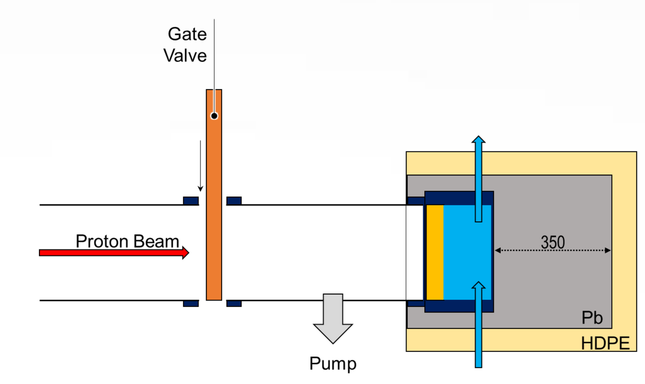




- Neutron flux at the reference position

[E > 1 keV] 1.3×10^6 $n/cm^2/uA$
[E > 10 MeV] 7.9×10^6 $n/cm^2/uA$
[Thermal] 6.3×10^6 $n/cm^2/uA$



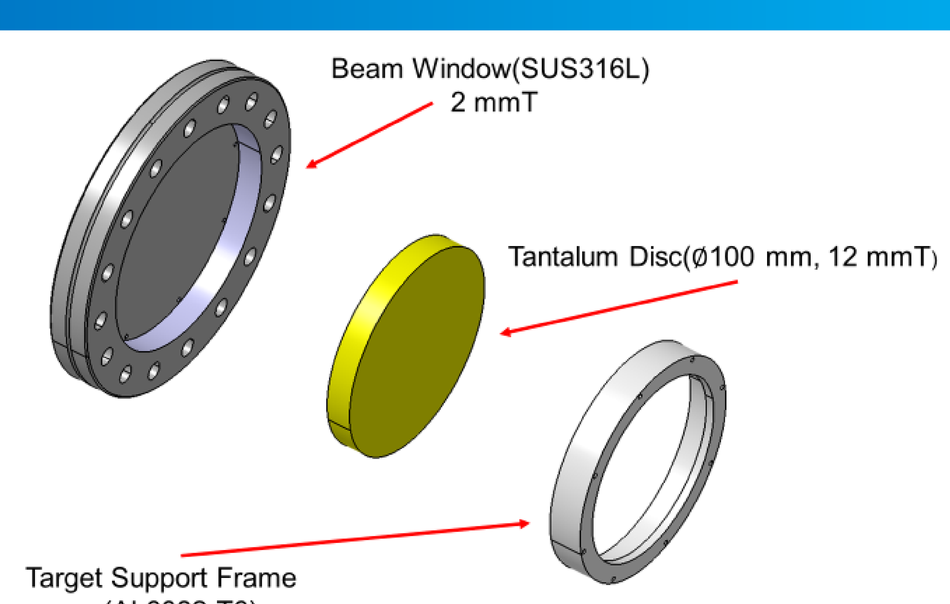


Target Material

	Lead	Tungsten	Tantalum
Atomic number (Z)	82	74	73
Density (g/cm^3)	11.34	19.3	16.69
Melting point (K)	600.61	3695	3290
Thermal expansion (μm/(m·K))	28.9	4.5	6.3
Thermal conductivity (W/(m·K))	35.3	173	57.5

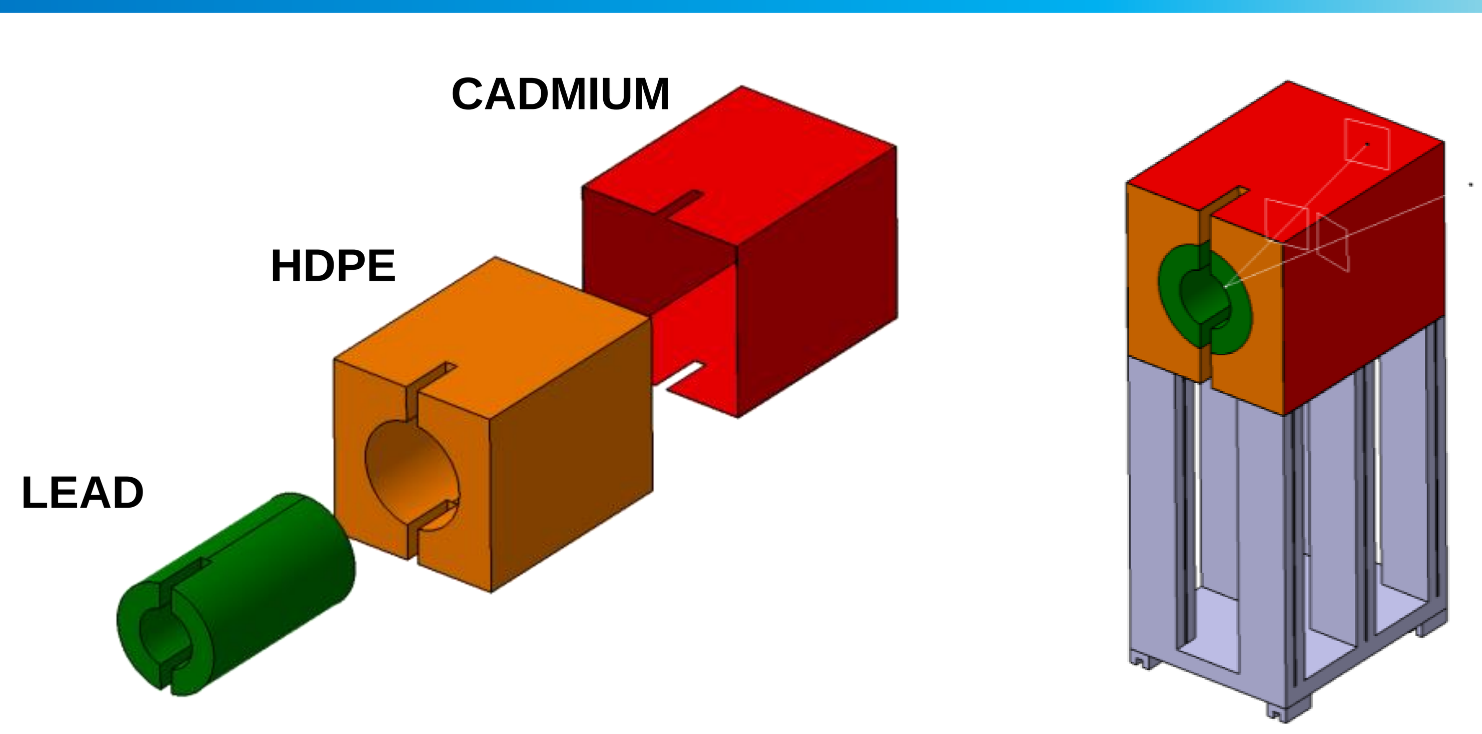
- Lead has a low melting point and tungsten has to do tantalum-cladding to avoid corrosion by hot water.
- Tantalum is resistant to hydrogen blistering and water corrosion, and it has a neutron yield similar to tungsten.

Target Assembly



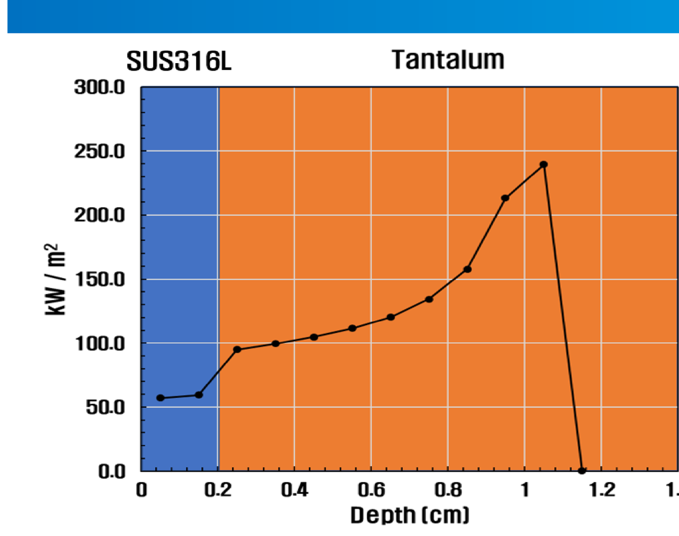
- SS316L 2 mmT (E_{dep} = 8.19 MeV)
- Ta 12 mmT (E_{dep} = 94.41 MeV)

Biological Shielding Design



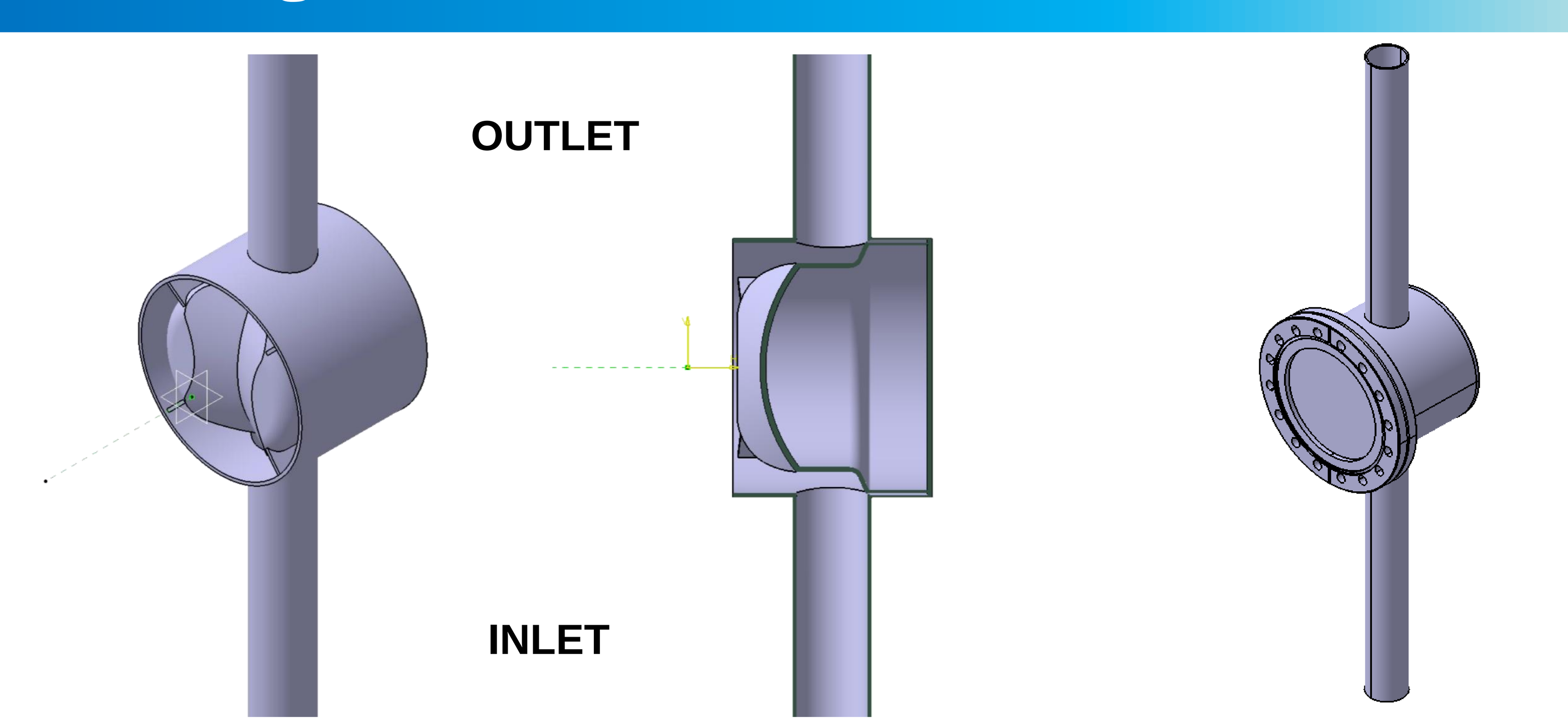
- Lead is used for gamma ray shielding
- HDPE is used on the outer side of a lead layer to moderate fast neutrons
- Cadmium layer is added around the HDPE layer to reduce thermal neutron flux escaping the biological shielding

Thermal Load of Target by Proton Beam

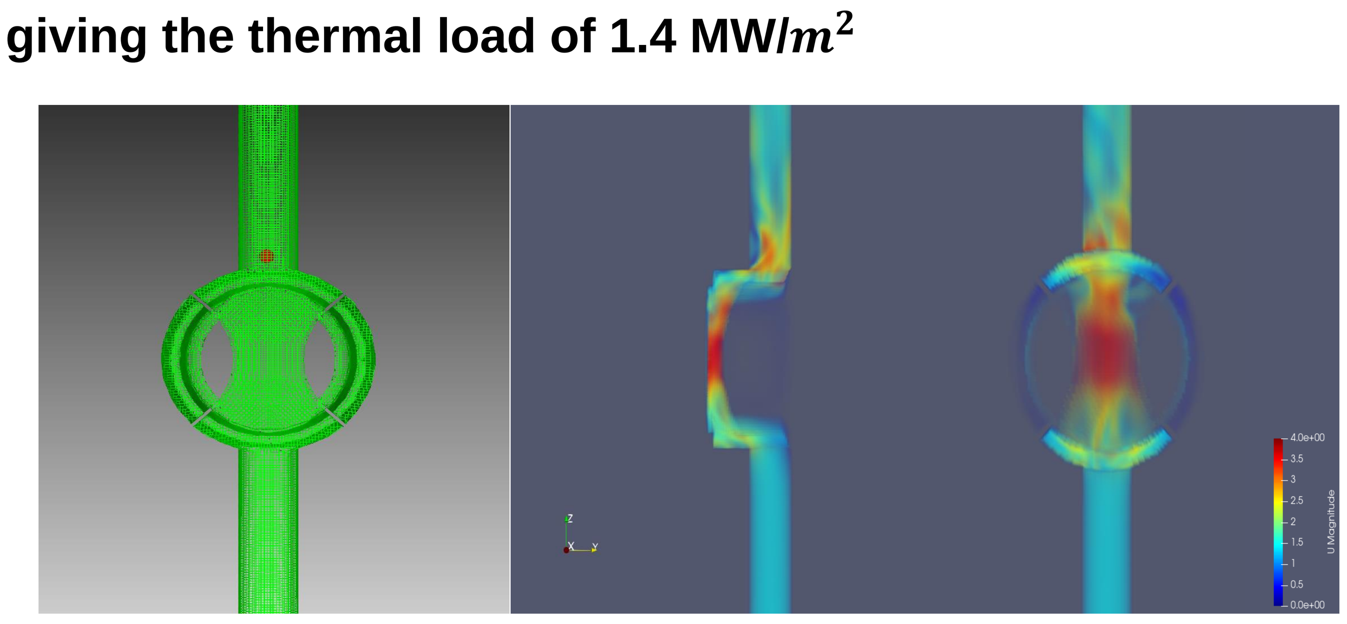


- The beam has a range (8.64 mm) within the target
- The thermal load induced by the proton beam in the stainless and tantalum area is about 8% and 92% of the total beam power, respectively

Cooling Chamber



- The diameter of the proton beam incident on the target is assumed to be 3 cm, giving the thermal load of 1.4 MW/m^2



- The improved chamber is assessed Based on the fluid flow analysis
- The flow velocity near the center of the target is faster than in other places

Summary

- A 1-kW neutron-production target including biological shielding was designed to generate a neutron beam using the 100-MeV proton accelerator in KOMAC
- The 1-kW neutron source could be improved. Especially, we will put a lot of effort into increasing performance