Conceptual Design of Fixed Tungsten Target for Spallation Neutron Source : A Replication Study

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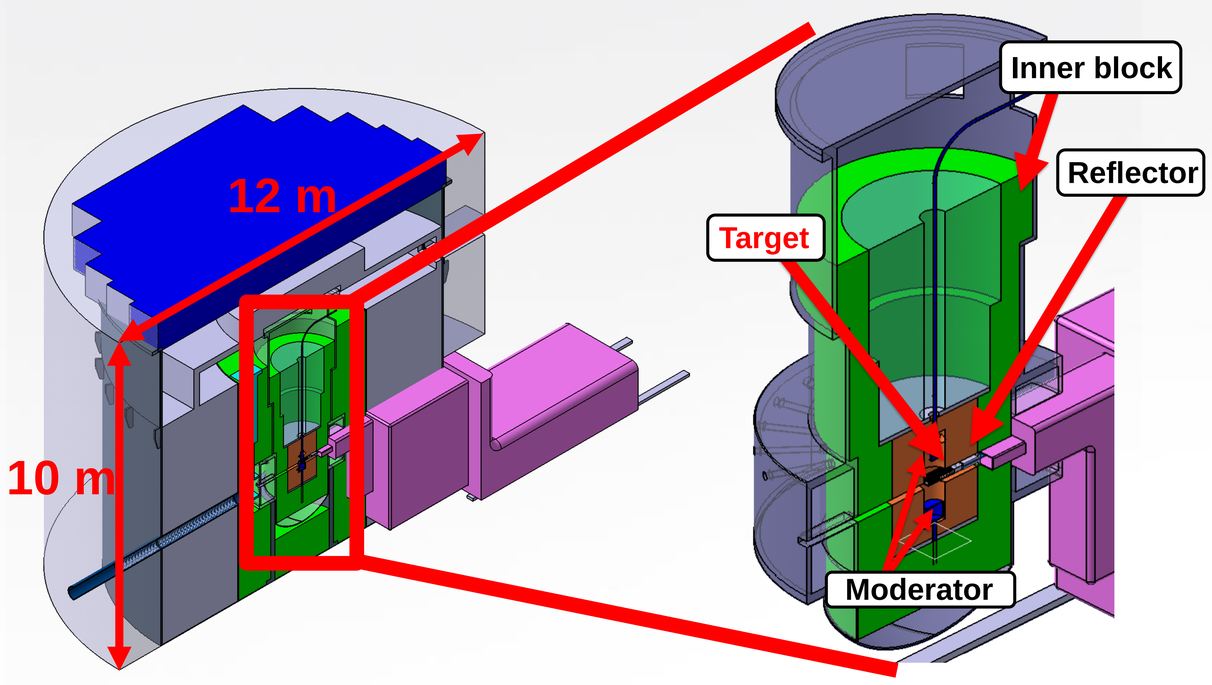
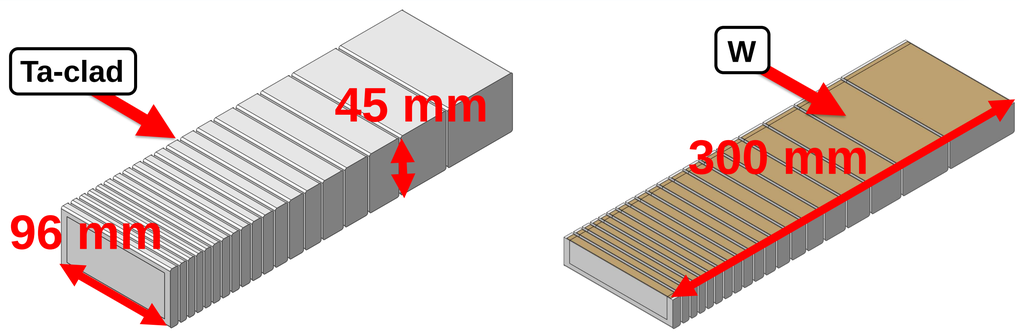
Concept Model of Spallation Neutron Source

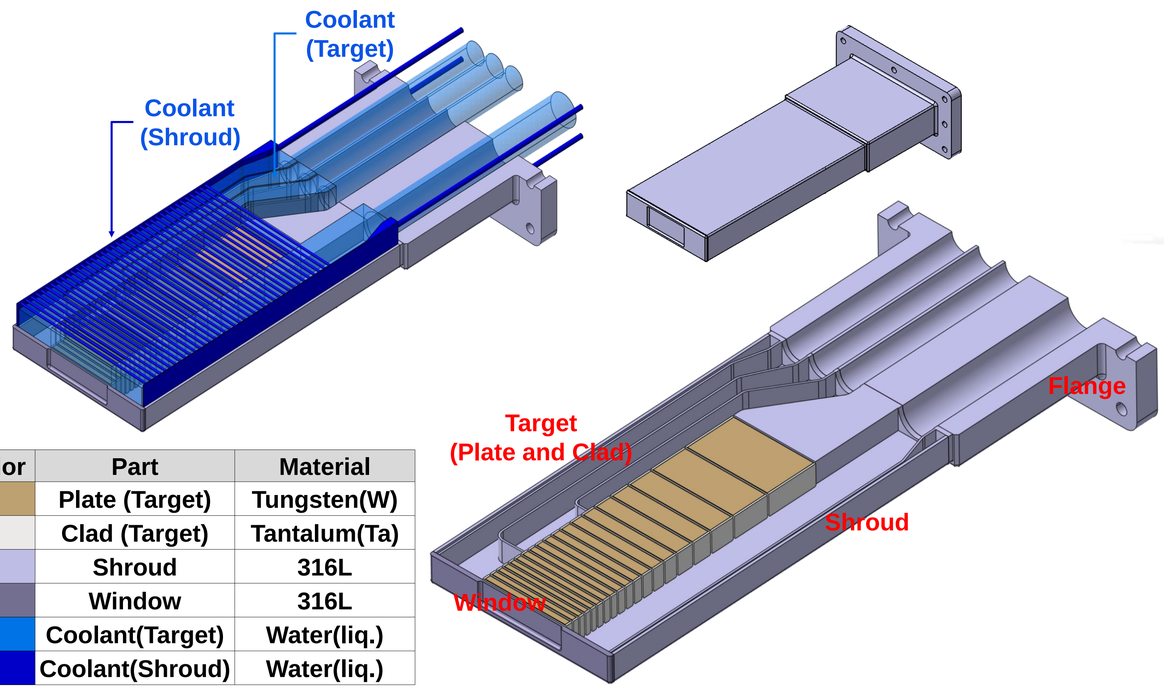


- The objective of this study was to obtain the development direction of high-power metal targets. To achieve this, a target model was secured by performing target modeling that replicated the shape of stationary tungsten targets in Spallation Neutron Source(SNS)

Tantalum-clad Tungsten Target

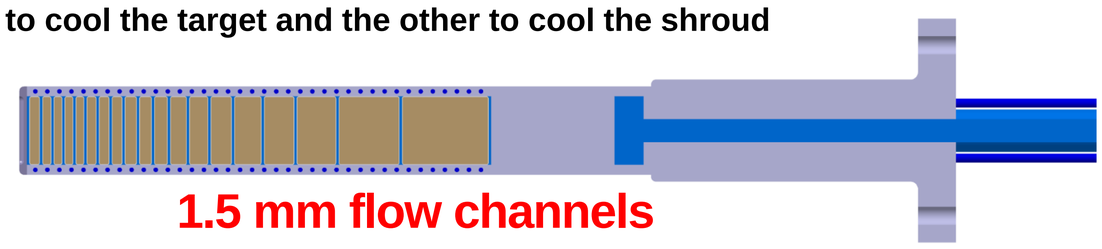


- The fixed tungsten target modeling was designed based on the 8.6 cm * 3.5 cm proton beam
- The target is a cuboidal piece of tungsten, with a tantalum cladding to prevent corrosion due to direct contact with the coolant

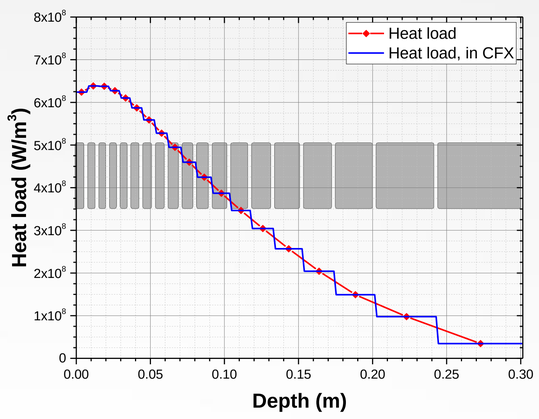


Color	Part	Material
	Plate (Target)	Tungsten(W)
	Clad (Target)	Tantalum(Ta)
	Shroud	316L
	Window	316L
	Coolant(Target)	Water(liq.)
	Coolant(Shroud)	Water(liq.)

- The coolant flows horizontally across each target from three supply channels on one side to a single outlet channel on the opposite side
- The coolant flows independently of each other in two separate areas, one to cool the target and the other to cool the shroud



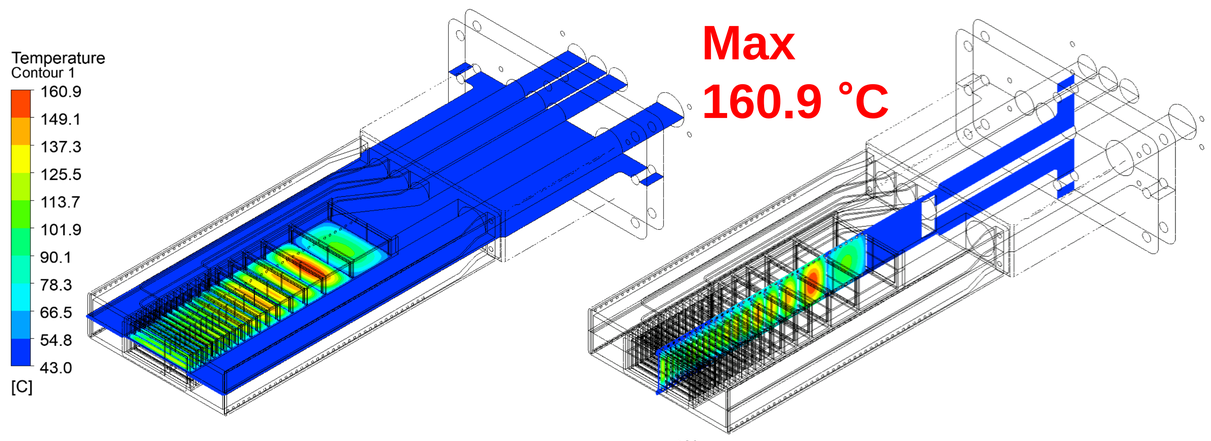
Boundary Condition

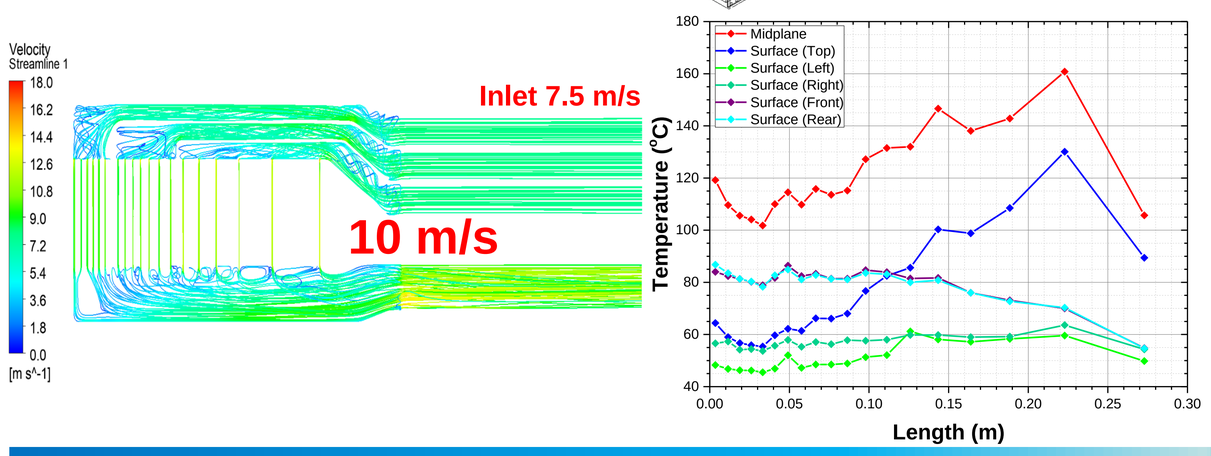


	W	Ta	SS316L
Molar Mass(g/mol)	183.84	180.95	180.9
Density(kg/m3)	19,250	16,600	7,919
Specific heat(J/kg-K)	128.3	139	485
Thermal conductivity(W/m-K)	174.9	57.2	14.7
Elastic Modulus(GPa)	398	188	200
Poisson's ratio	0.28	0.35	0.3
Thermal expansion(/K)	4.3E-6	6.3E-6	15.3E-6
Yield stress(MPa)	1,360	705	190

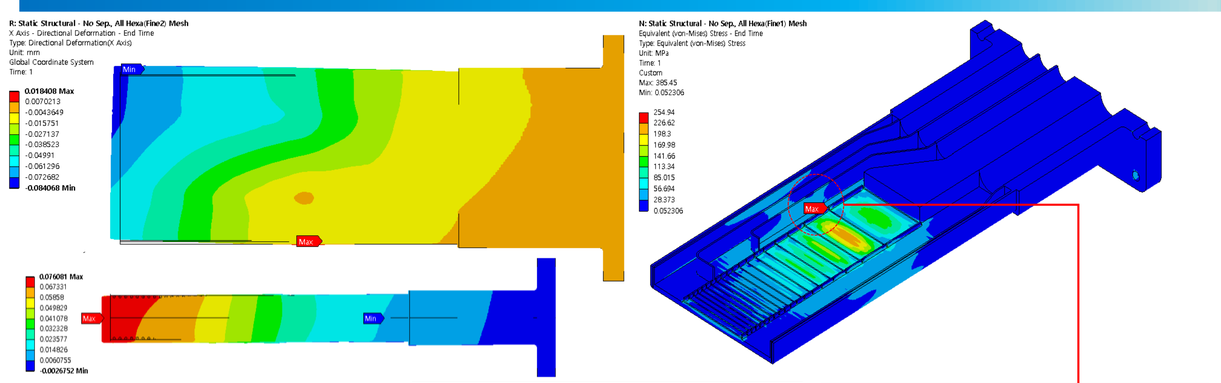
- The target was designed with a proton beam power of 500 kW and 1.3 GeV
- The heat load due to the proton beam can be calculated using MCNP6, and it is used as the thermal boundary condition
- A single-phase analysis was conducted using the turbulent model (k-ω) with a reference water pressure of 3.5 bar
- Initial cooling water temperature of 43 °C was used. And water flow rate entering between the 19 target was 13.564 kg/s(215 gpm)

Thermal-hydraulic Analysis

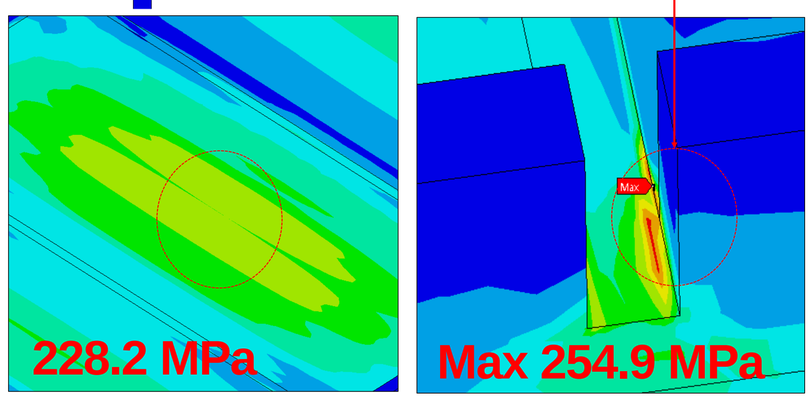




Thermal-structural Analysis



- X-axis Max Deformation : -0.08 mm
- Z-axis Max Deformation : 0.08 mm
- It was confirmed to exceed the yield stress of SS316L at 254.9 MPa



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