Moderator Mechanical Structure

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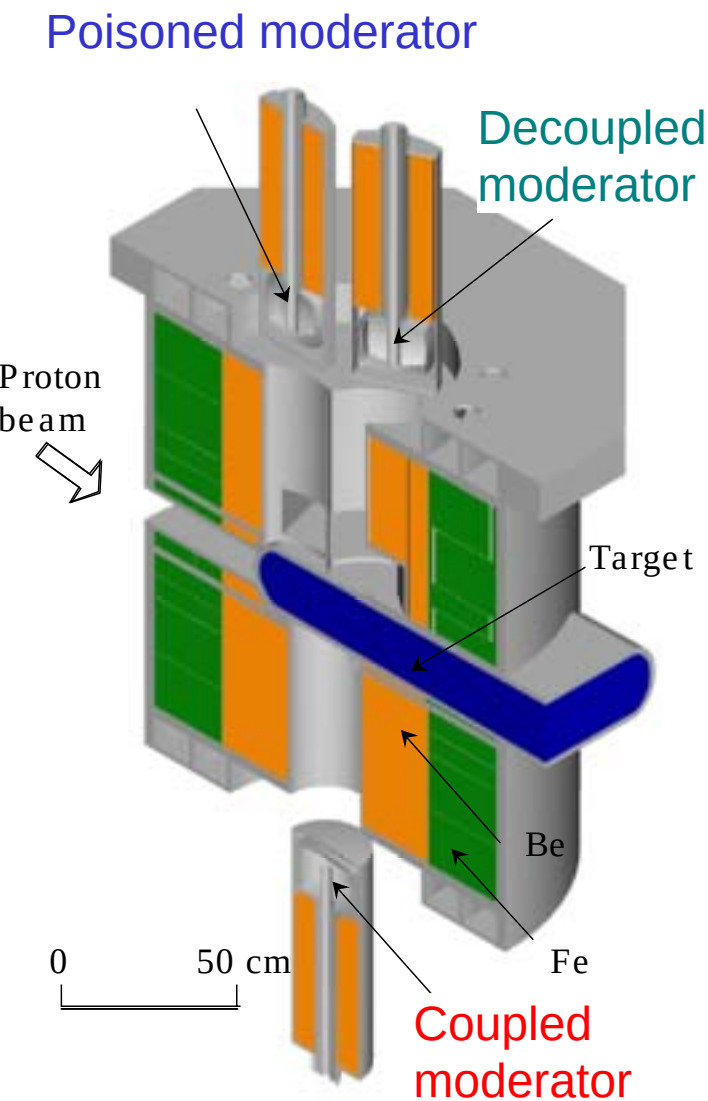
Design concepts



3 moderators are inserted in the reflector vessel.
- Coupled moderator
- Decoupled moderator
- Poisoned moderator

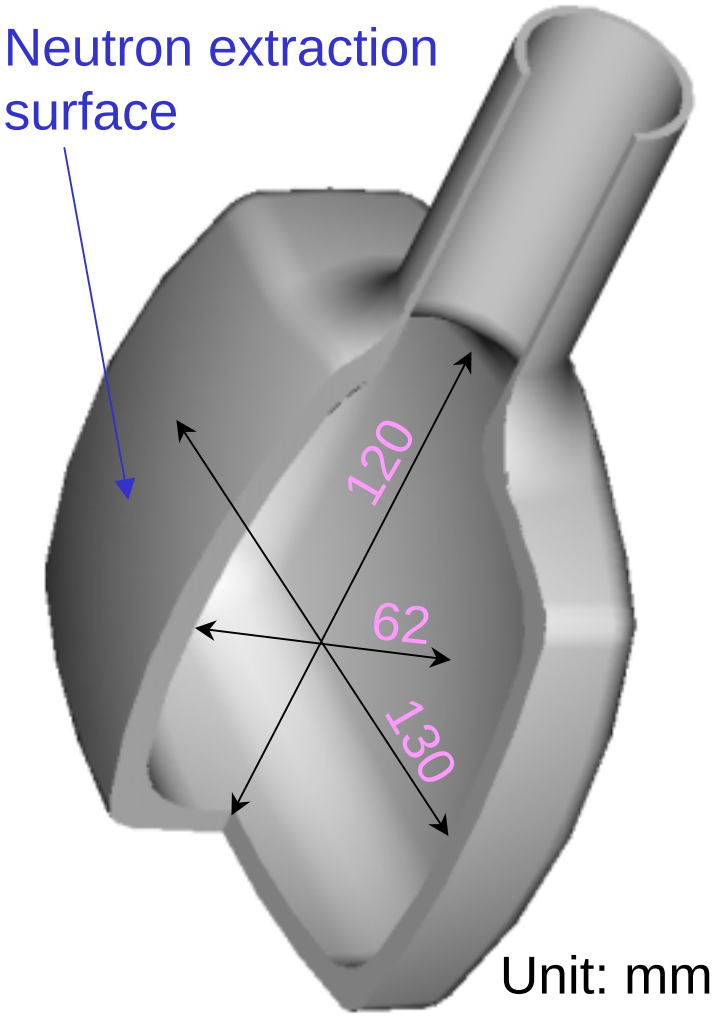
Material : Aluminum alloy (A6061-T6)
Allowable stress*: ca.60 MPa
(including bending stress)

*The allowable stress is decided in the Japanese regulation of high pressure gas component.

Design pressure : 2.0 MPa
(operational pressure: 1.5 MPa at maximum, safety factor along the Japanese regulation of high pressure gas component: 1.5)

Limit of displacement : 1 mm at maximum

Decoupled moderator

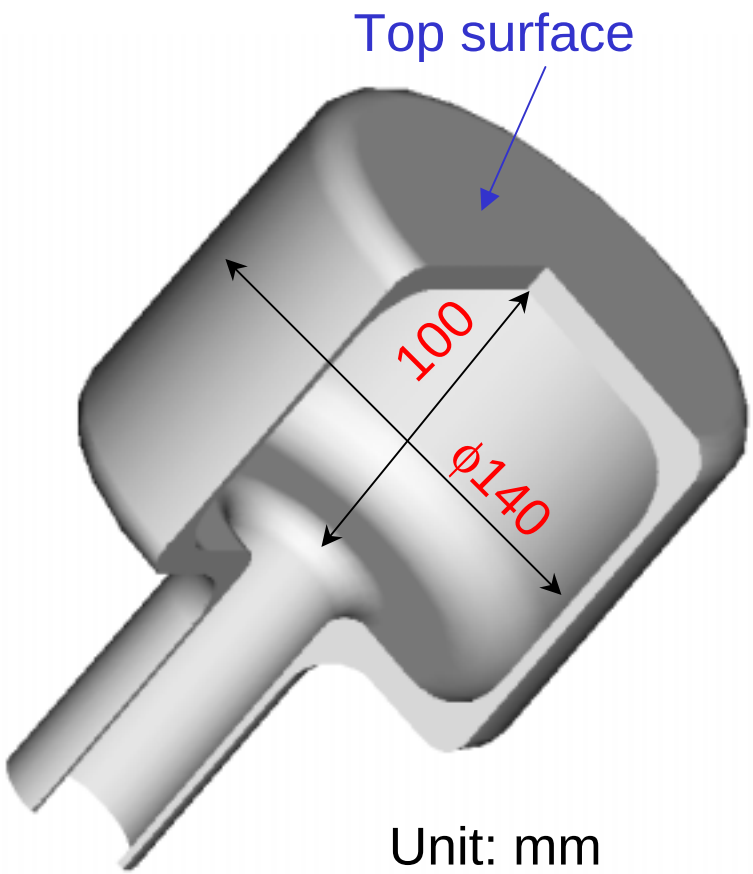


- Configuration was decided on the basis of neutronic calculation obtained under 100% para H_2 condition.
  130 mm (W) x 120 mm (H) x 62 mm (D)

- LH_2 outlet has dimension of
  Inner diam. D_{in}: ϕ34.1 mm
  Outer diam. D_{out}: ϕ38.1 mm

- Vessel, especially neutron-extraction surface is required to be as thin and flat as possible
  - to reduce neutron intensity loss and nuclear heat in vessel
  - to avoid pulse broadening of neutron.

Coupled moderator



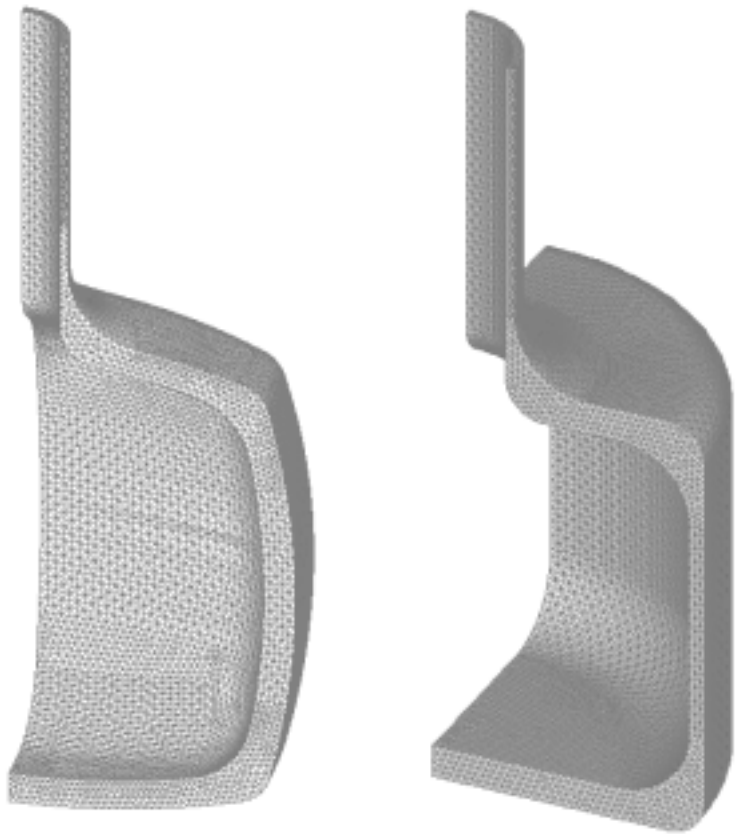
Unit: mm

- Configuration was decided on the basis of neutronic calculation obtained under 100% para H_2 condition.
  - ϕ 140 mm x 100 mm (H)
    (Cylindrical configuration)

- LH_2 outlet has dimension of
  Inner diam. D_{in}: ϕ34.1 mm
  Outer diam. D_{out}: ϕ38.1 mm.

- Vessel is required to be as thin as possible and to be flat top surface
  - to increase neutron intensity and to reduce nuclear heat in vessel.

Analytical condition



Decoupled moderator

Coupled moderator

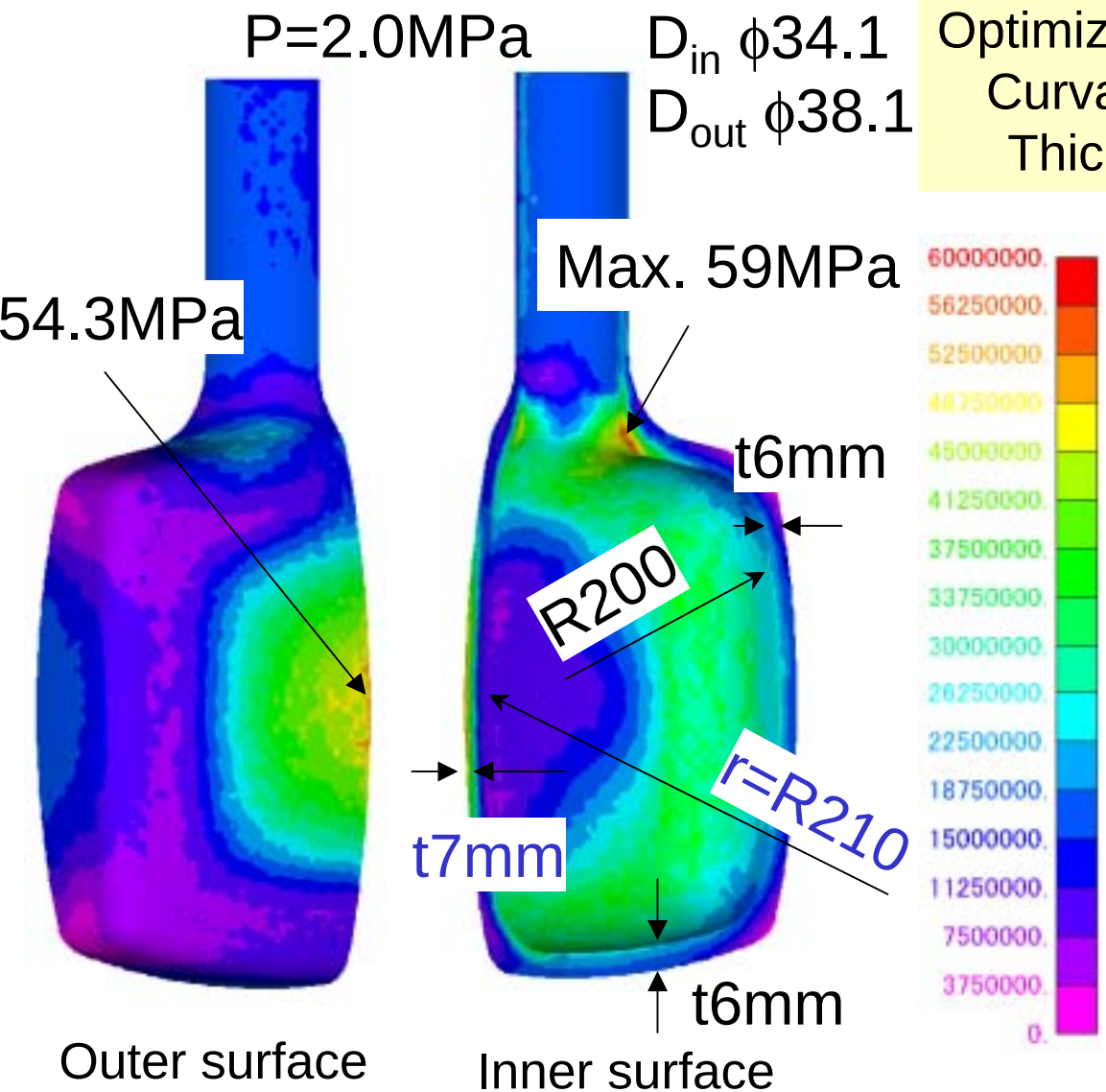
Analytical model

Analytical model :	1/4 model
Analytical code :	ABAQUS
Element :	10nodes-tetra
No. of Elem. :	ca. 60,000
No. of Nodes :	ca. 120,000
Inner pressure :	2.0 MPa

Material properties of aluminum alloy

Young’s modulus:	68.5 GPa
Poisson's ratio:	0.35

Von Mises stress distribution in decoupled moderator vessel

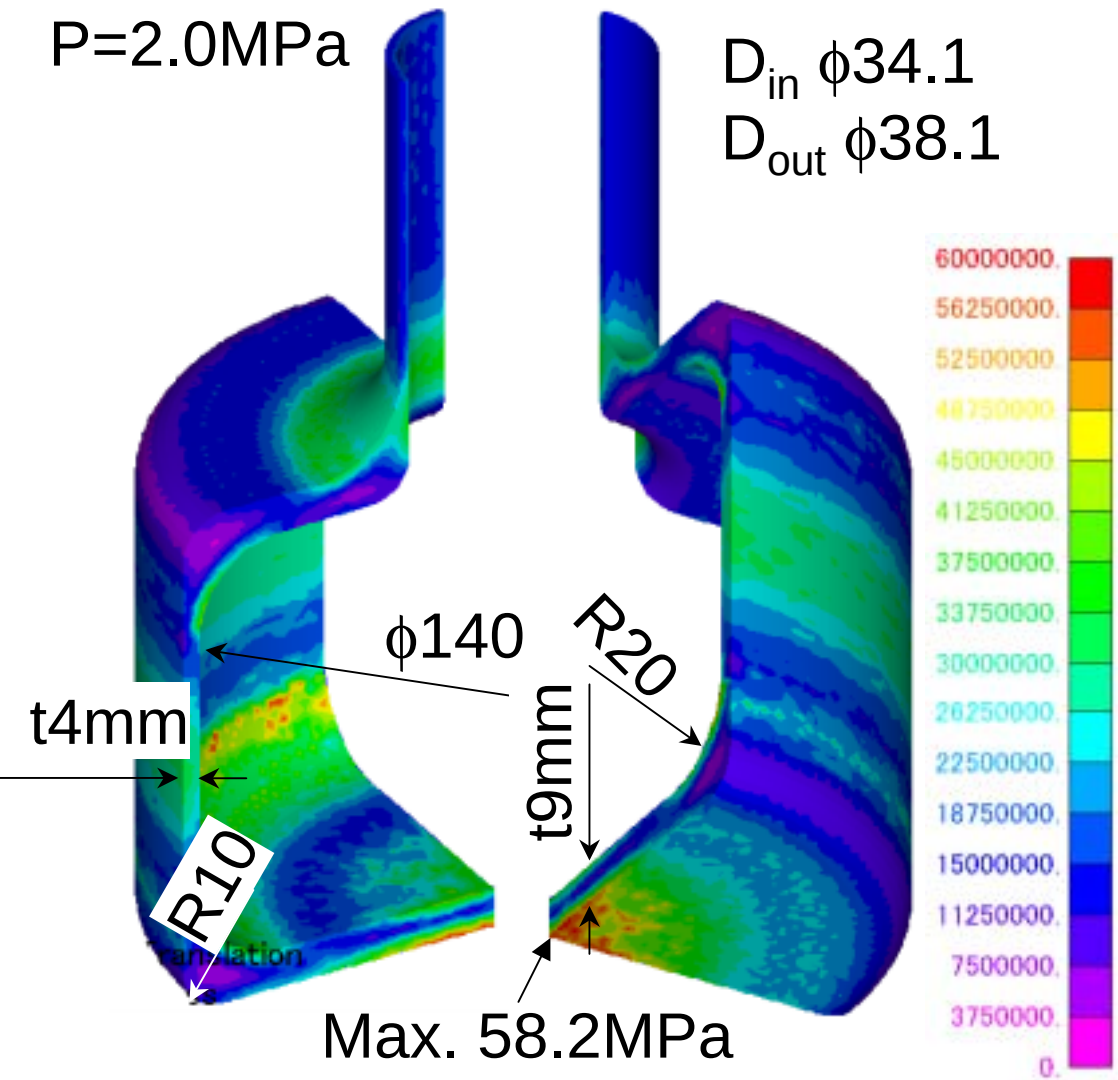


Optimized neutron extraction surface
Curvature radius (r): 210 mm
Thickness (t): 7 mm

Maximum stress of 59 MPa was appeared at neck of outlet, which is less than the allowable stress of A6061-T6 (60 MPa).

Maximum displacement of 0.113 mm was occurred at center of neutron extraction surface, which is also less than the limit of displacement (1 mm).

Von Mises stress distribution in coupled moderator vessel



Optimized thickness
-Neutron extraction surface
t 4 mm
-Top surface
t 9 mm

Maximum stress of 58.2 MPa was appeared at center of top surface, which is less than the allowable stress of A6061-T6 (60 MPa).

Maximum displacement of 0.211 mm was occurred at center of top surface, which is also less than the limit of displacement (1 mm).

Concluding remarks

- Stress generated in all 3 moderator vessels are below the allowable stress.

- Based on these analytical results, we will decide welding locations considering the manufacturing process.