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CFD Evaluation and optimization of the HEMJ Divertor cooling design

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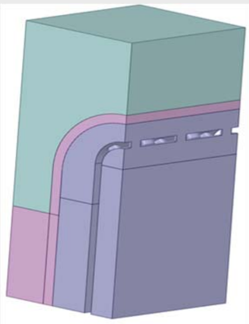
1. Motivation and goal

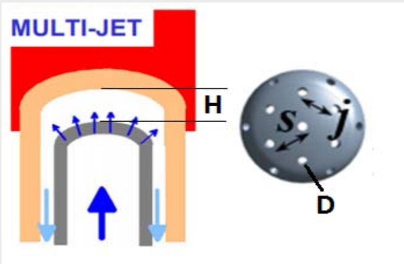
- He-cooled divertor with multiple-jet cooling (HEMJ) is optional for EU-DEMO
- HEMJ must be able to accommodate at least 10 MW/m² during normal operation
- Evaluation and optimization of the heat transfer in HEMJ divertor cooling system
- CFD can optimize the cooling design and give a clear view of jet impinging

2.1 Parameters in simulation of HEMJ divertor

	Pressure (MPa)	Mass flow (g/s)	Inlet temperature (C)	Target heat flux (MW/m²)
Helium Flow	10	3.35	500	10

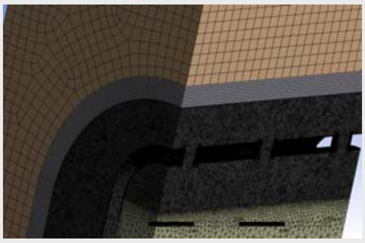
2.2 Geometry and parameters of HEMJ divertor





- Heat transfer is very sensitive to Jet Array Parameterization
- Projected row (s/D, j/D), jet-to-wall distance (H), jet diameter (D) are expected to be evaluated and optimized.
- In the present article, H/D was optimized

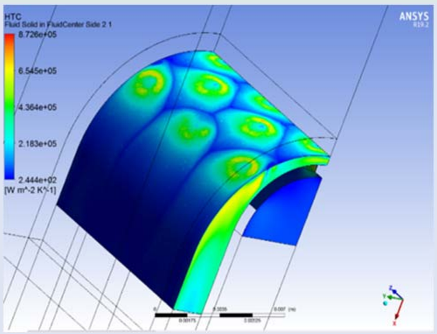
2.3 Mesh and turbulent models

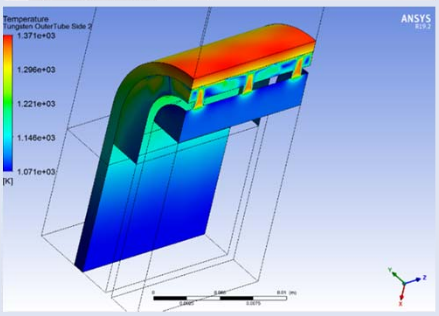


- ANSYS V19.2 Meshing and CFX
- 3.8 Million Mesh in fluid center
- SST turbulent model
- y+ close to 1

- Fluid & solid properties based on ITER material properties handbook

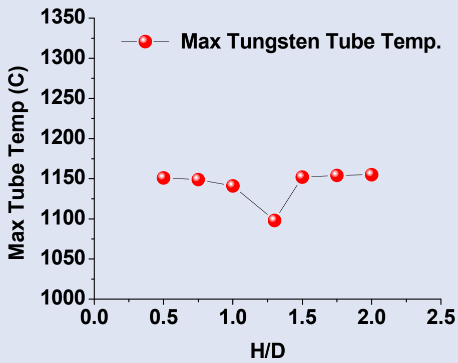
3. Evaluation of HEMJ Divertor cooling system





- Max local HTC can reach to 872.6 kw/m².K at the projection center and max temperature of tungsten tube is 1371K.
- Spent helium flow from the neighboring leads to cross flow between impinging jets

4. Optimization of HEMJ Divertor cooling design



- H/D ratio strongly affects the local heat transfer
- H/D=1.3 is the best cooling ability or the minimum surface temperature

5. Conclusions

- Thermal-hydraulic studies of HEMJ divertor have been performed
- H/D was optimized and best cooling ability or the minimum surface temperature at H/D=1.3
- Max local HTC at the projection center and spent helium flow leads to strongly cross flow

Outlooks

1) **Further works of optimizing jet arrangement, e.g. hexagonal versus in-line, equal jet diameter versus unequal nozzles**
2) **Comparison between experiment results and CFD simulations**