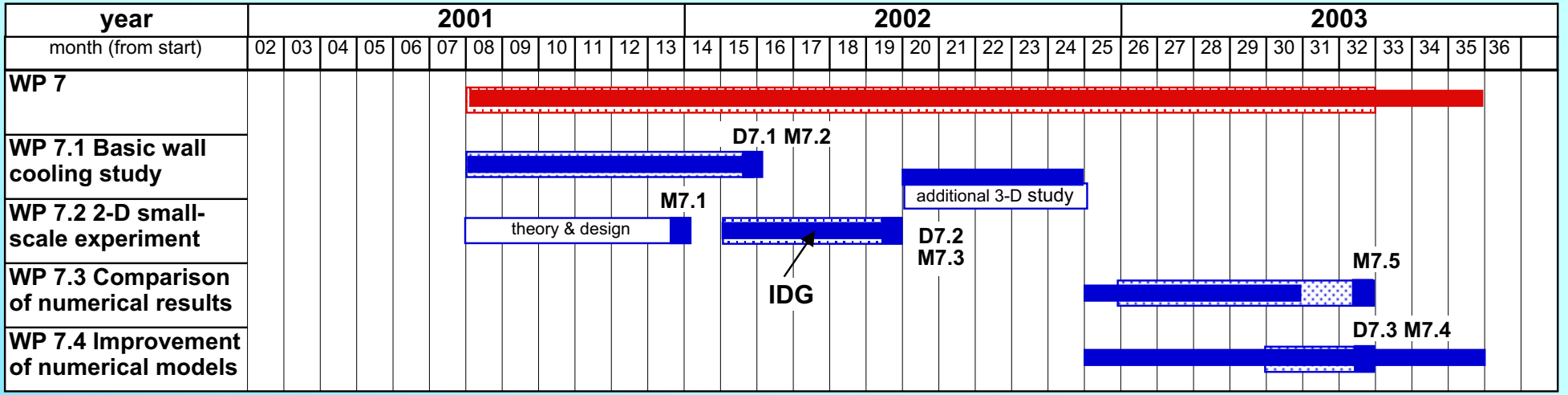
FLOXCOM - WP 7

Modelling and Optimisation of Wall Cooling - Wall Temperature and Stress Analysis

B&B-AGEMA

Dr.-Ing. K. Kusterer

1. Status report
2. 3-D simulation of final combustor geometry
3. Publications



DELIVERABLES (Reports):

D7.1 Design specifications for the pilot combustor from thermal load point of view (M15) (✓)

D7.2 Evaluation of the results from operation of the small-scale model (M19) (✓)

D7.3 Numerical simulations of wall cooling including combustion aerodynamics (M32) (✓)

MILESTONES (Reports):

M7.1 Prediction of thermal load for small-scale model will be performed (M12) (✓)

M7.2 Design specifications for the pilot combustor from thermal load point of view will be determined (M15) (✓)

M7.3 Testing of small-scale model will be performed (M19) (✓)

M7.4 Evaluation of the performance of the wall-cooling model will be performed (M32) (✓)

M7.5 Preliminary results and conclusions from comparison between predictions & experiment (M32) ?

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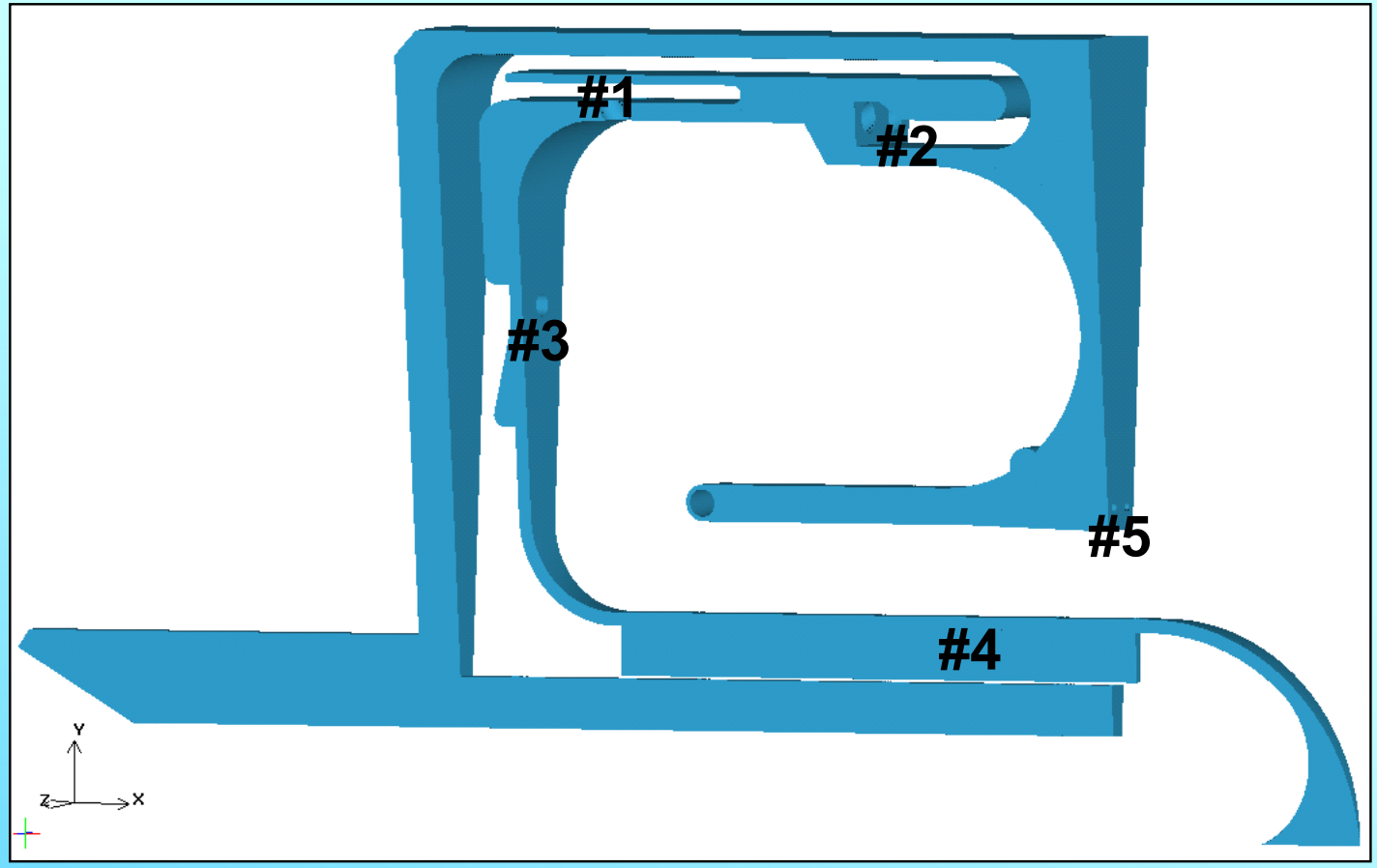
WP7 - Project Plan



segment for 8.5714°

total geometry:

#1 & #2: 84 holes with 6mm diameter, #3: 42 holes with 5mm diameter

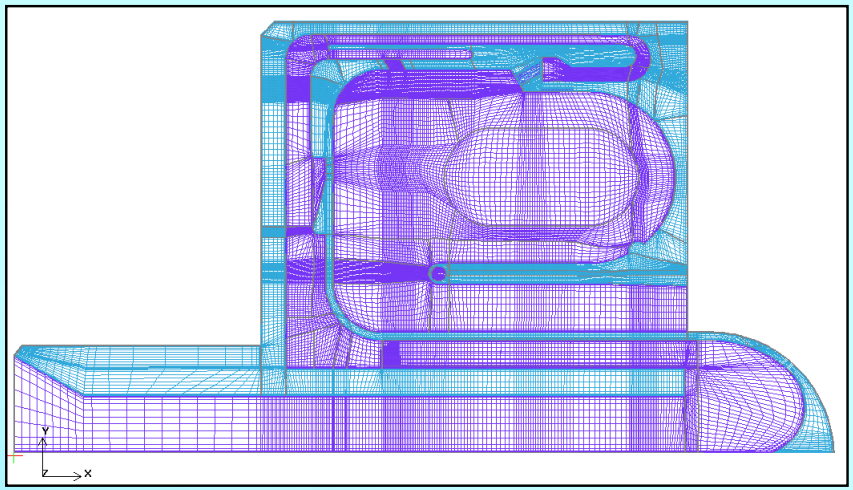
#4: 42 cooling plates instead of 24

#5: 84 cooling pipes instead of 4, 2mm diameter instead of 4mm (lead to 4 times higher convective cooling air flow)

Final geometry / segment

3-D grid for complete configuration (segment model)

including all fresh air inlets (full 3-D) and convective cooling



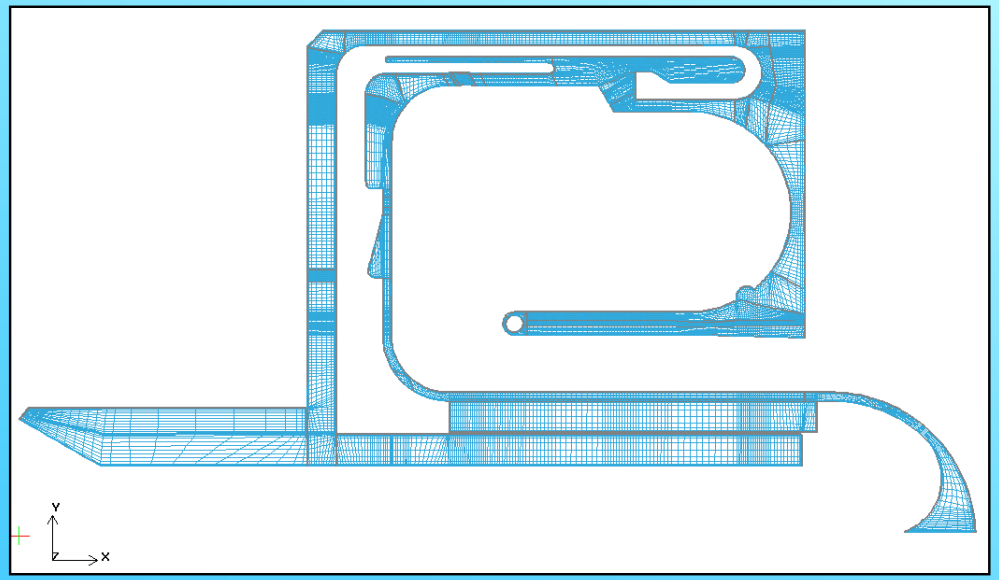
105 blocks,

3.5 million grid points

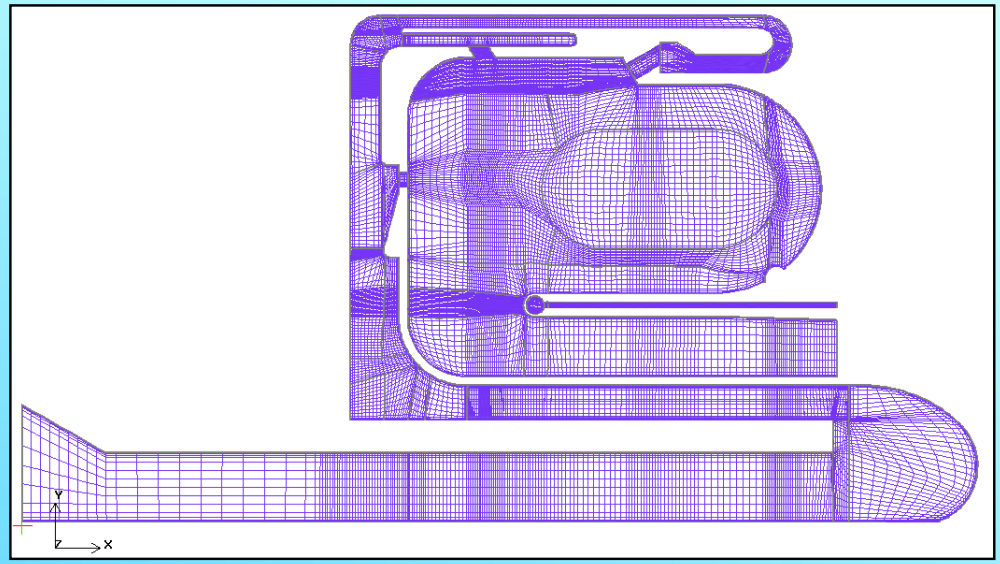
fluid: 2.0 milliongrid points

splid: 1.5 million grid points

solid wall grid



fluid flow grid



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3-D numerical model

cooling:

inlet: P_total=1.7 bar, T=393 K

outlet: p=1.0 bar, P_total=1.18 bar

mass flow: 0.02 kg/s (360°)

inlet:

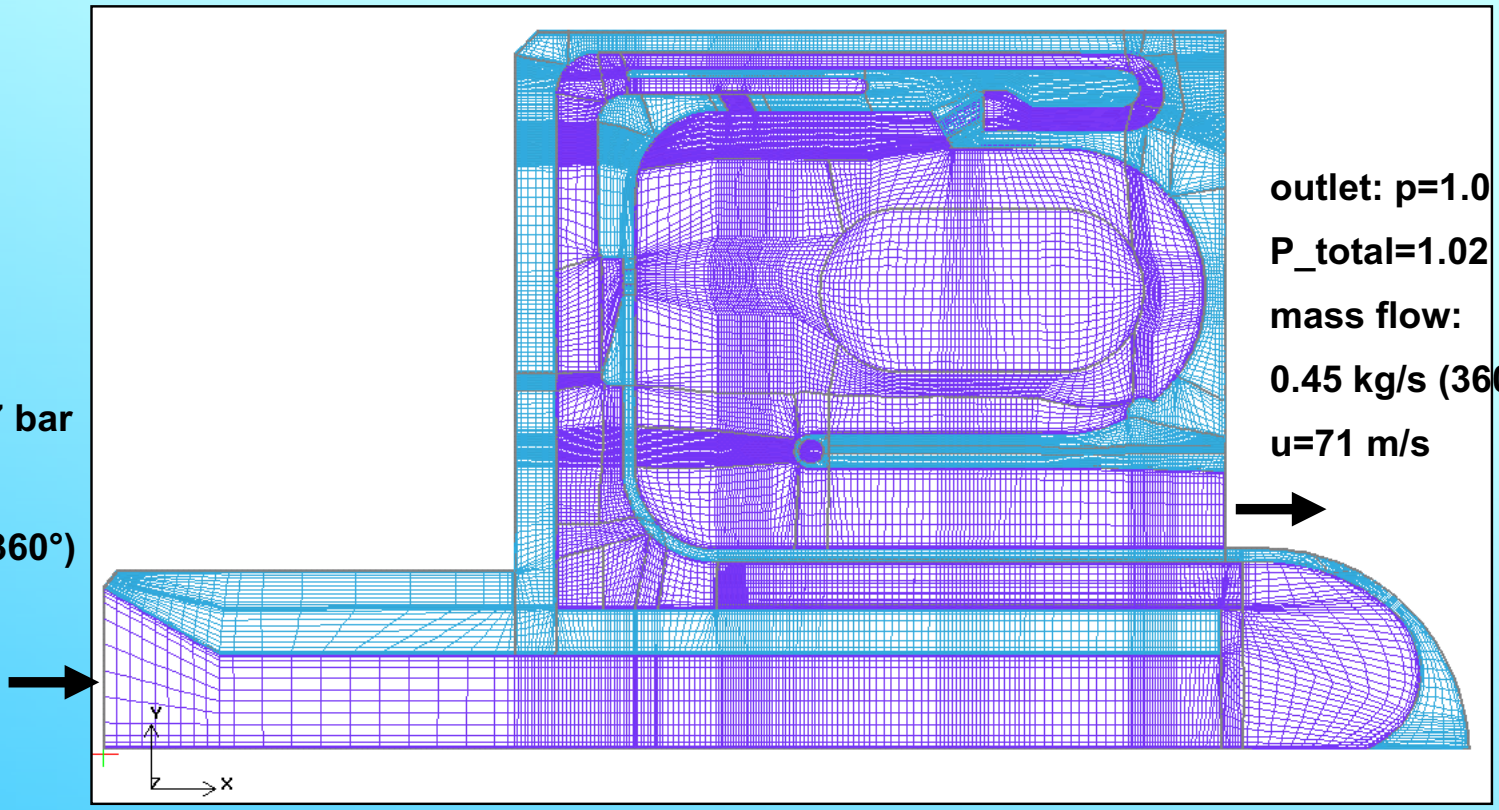
T=393 K

P_total=1.7 bar

mass flow:

0.45 kg/s (360°)

u=60 m/s



outlet: p=1.0 bar

P_total=1.02 bar

mass flow:

0.45 kg/s (360°)

u=71 m/s

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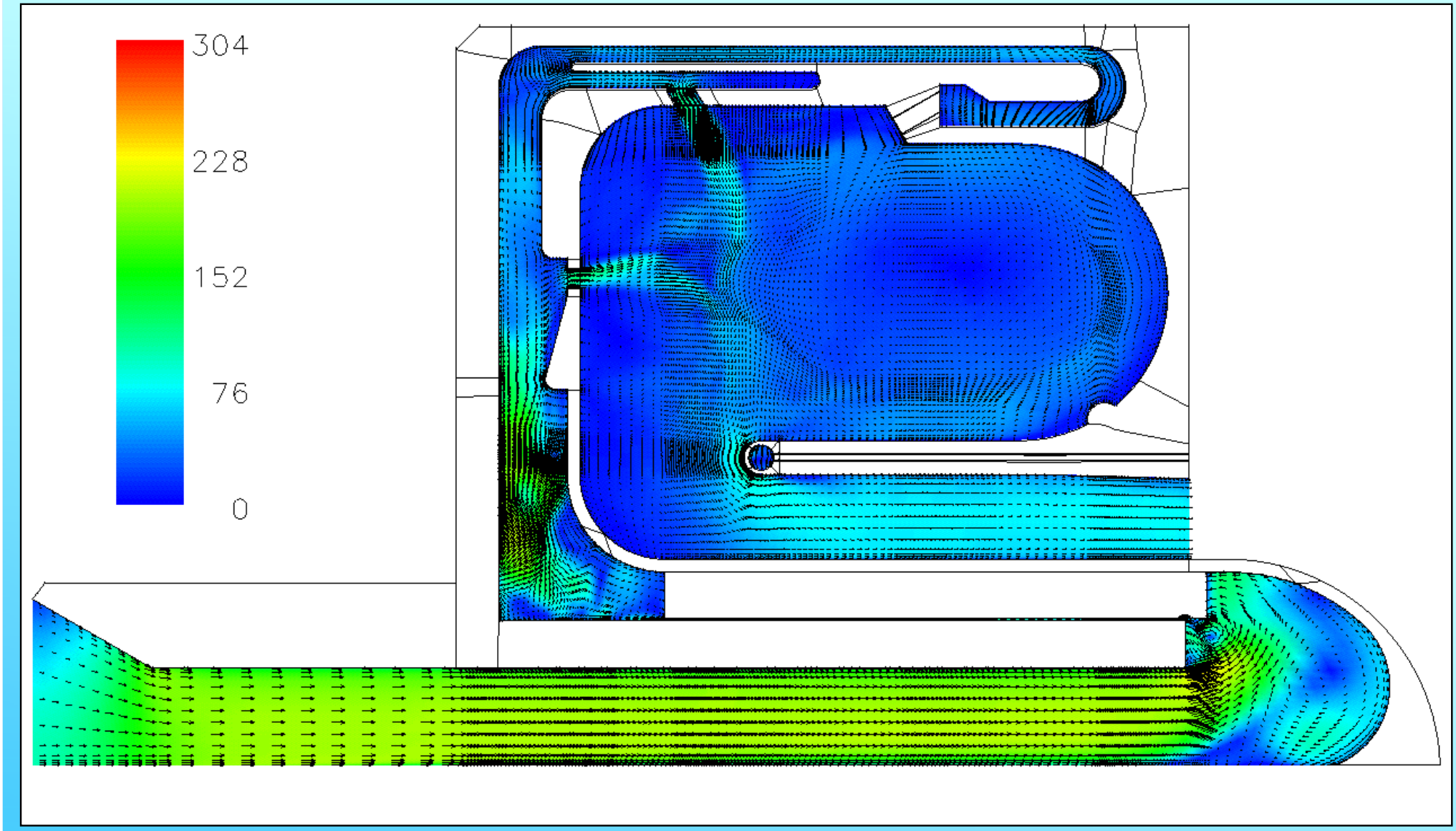
Boundary conditions



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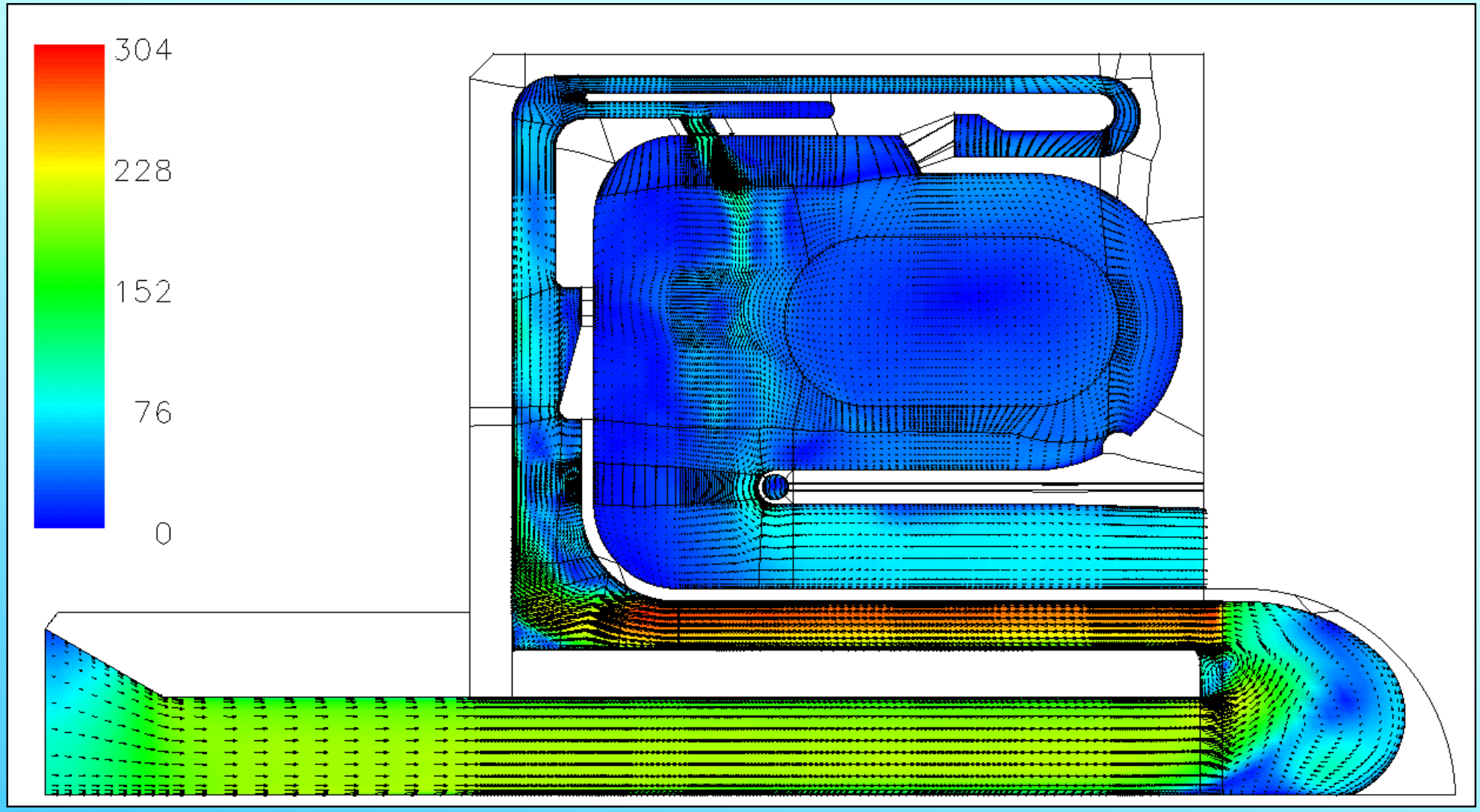
Velocity field - plane 1



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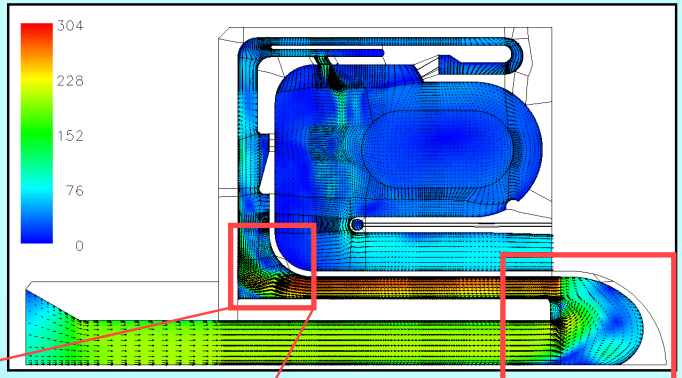
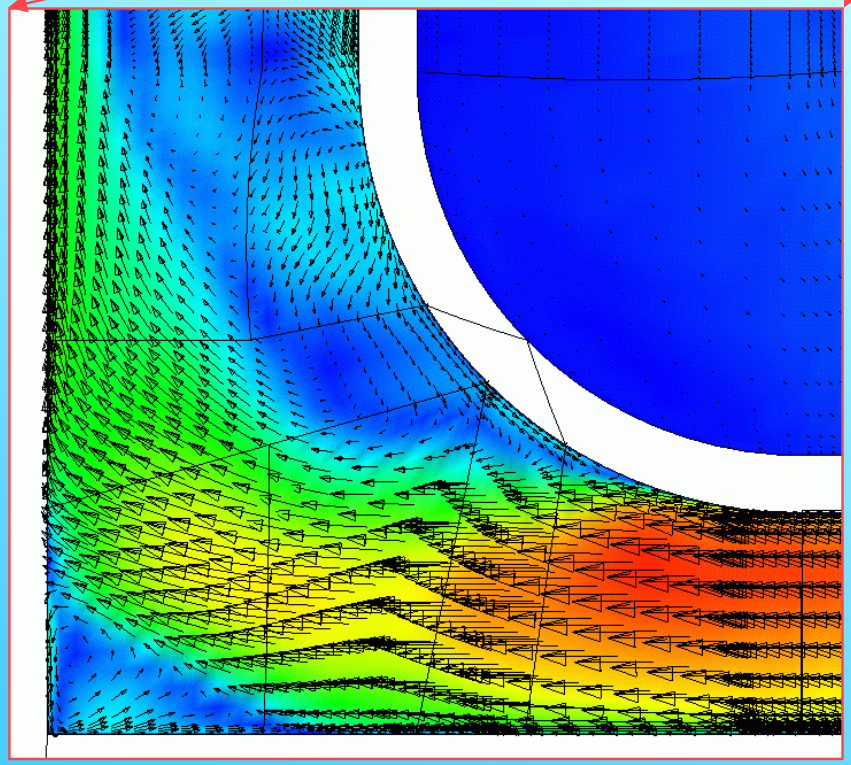
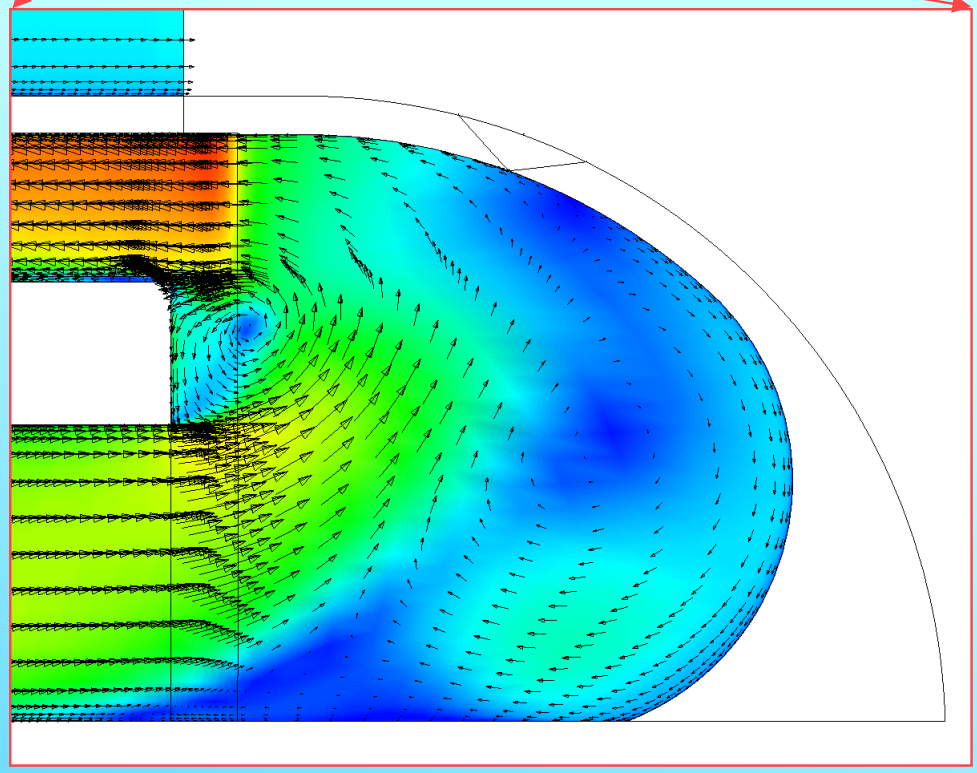
Velocity field - plane 2







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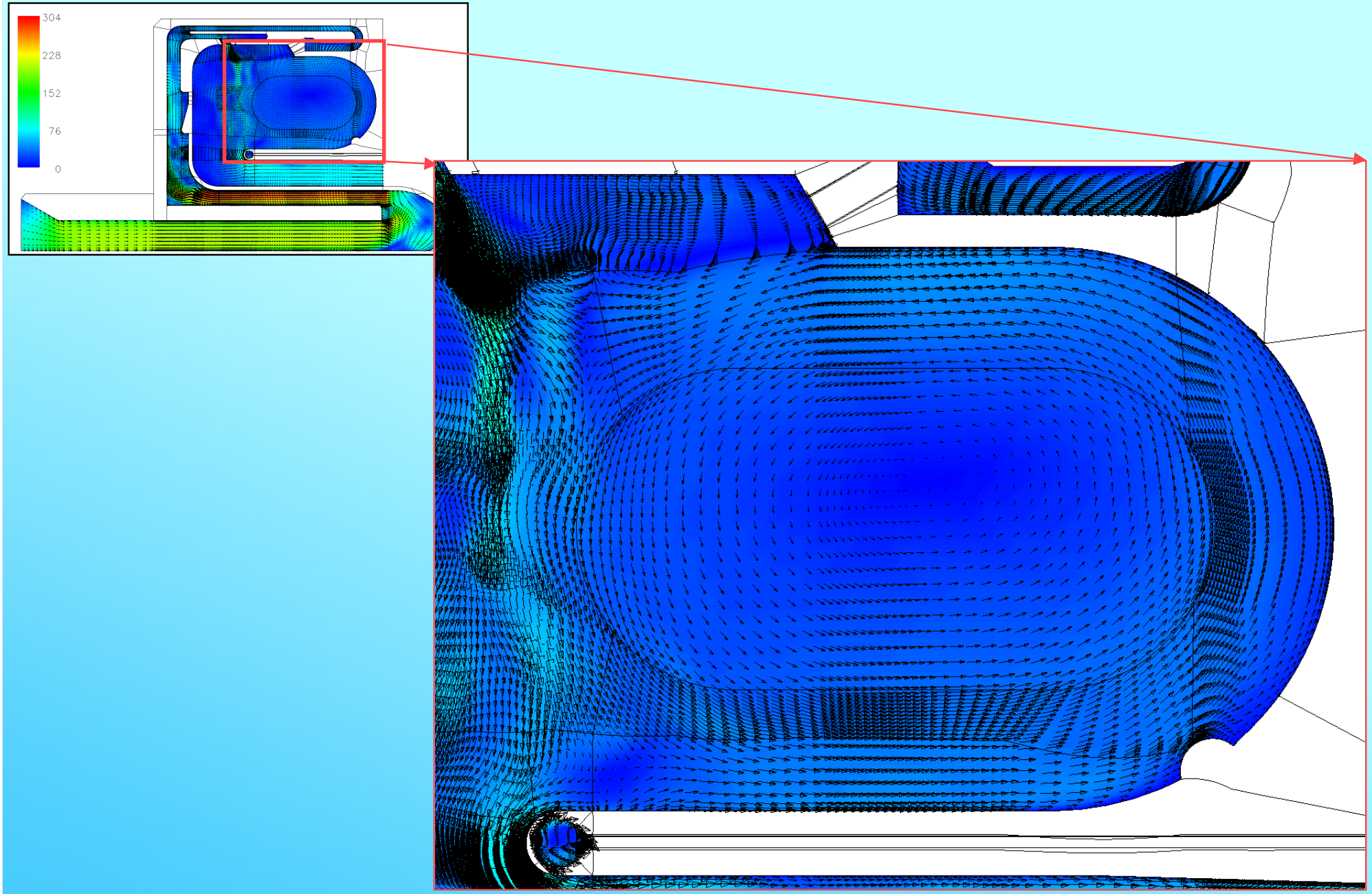
Flow details of inlet duct



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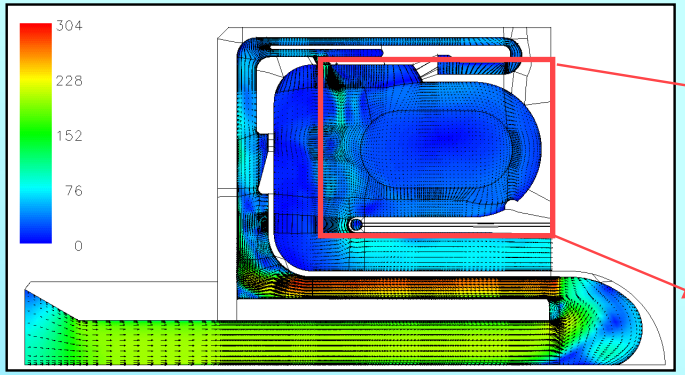
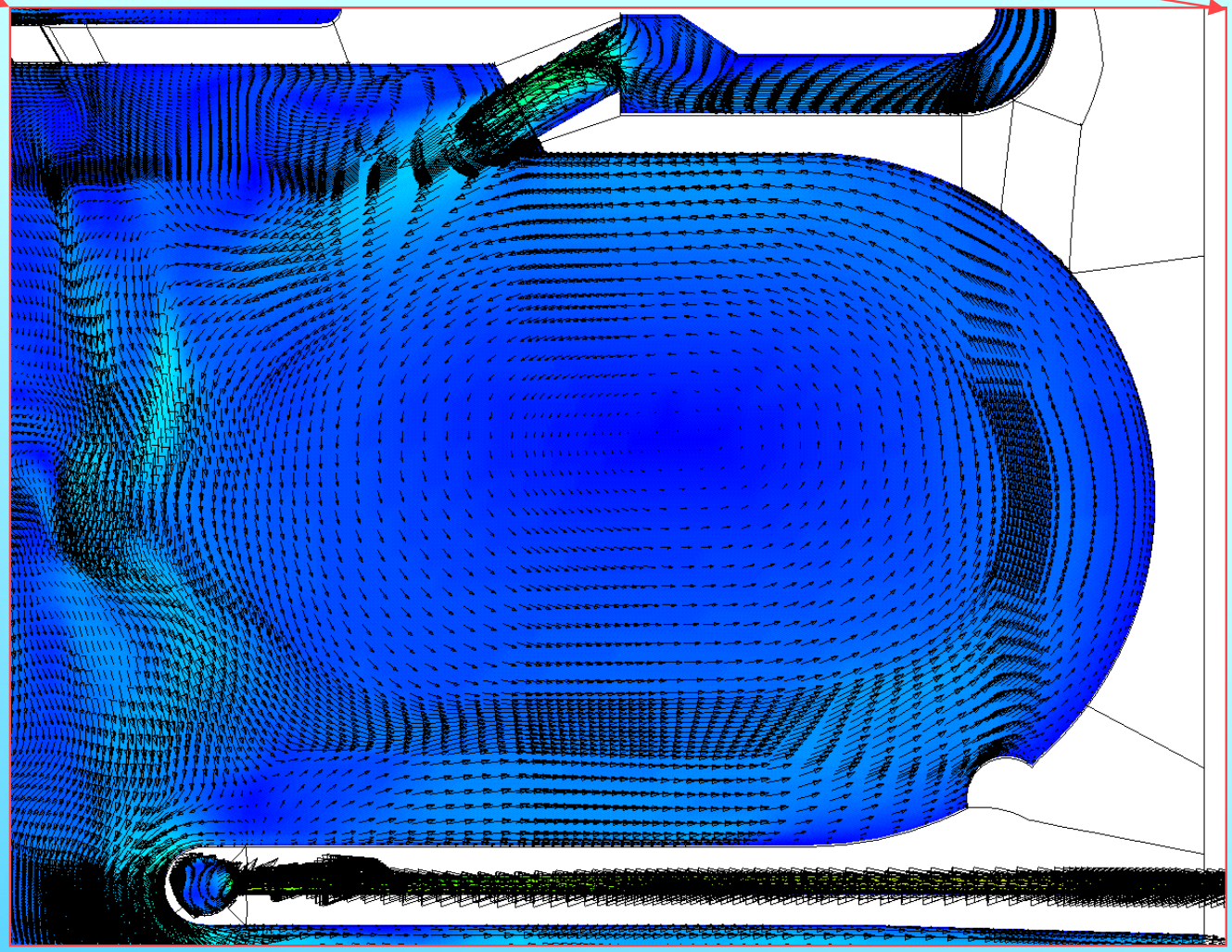
Flow details of vortex 1





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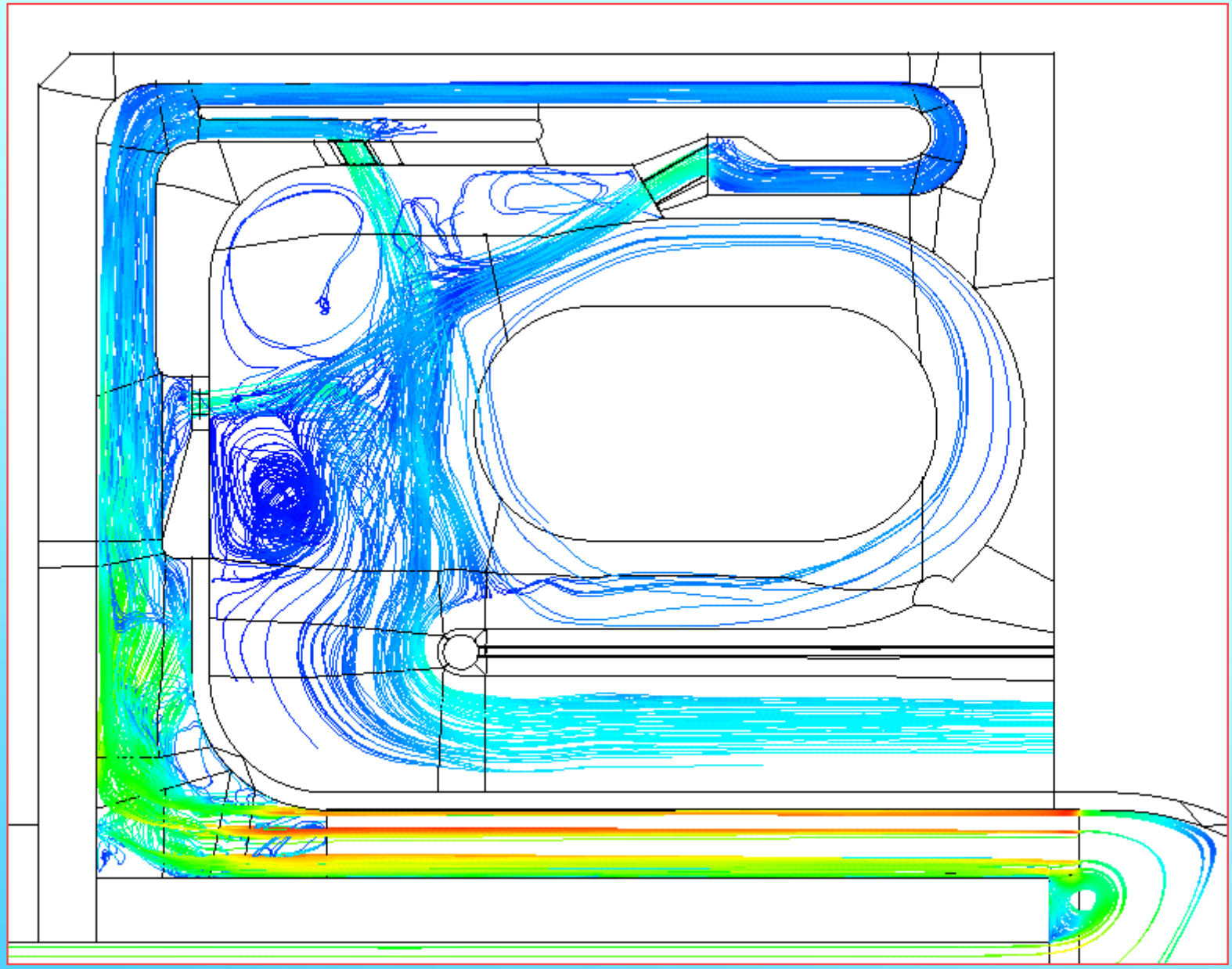
Flow details of vortex 2



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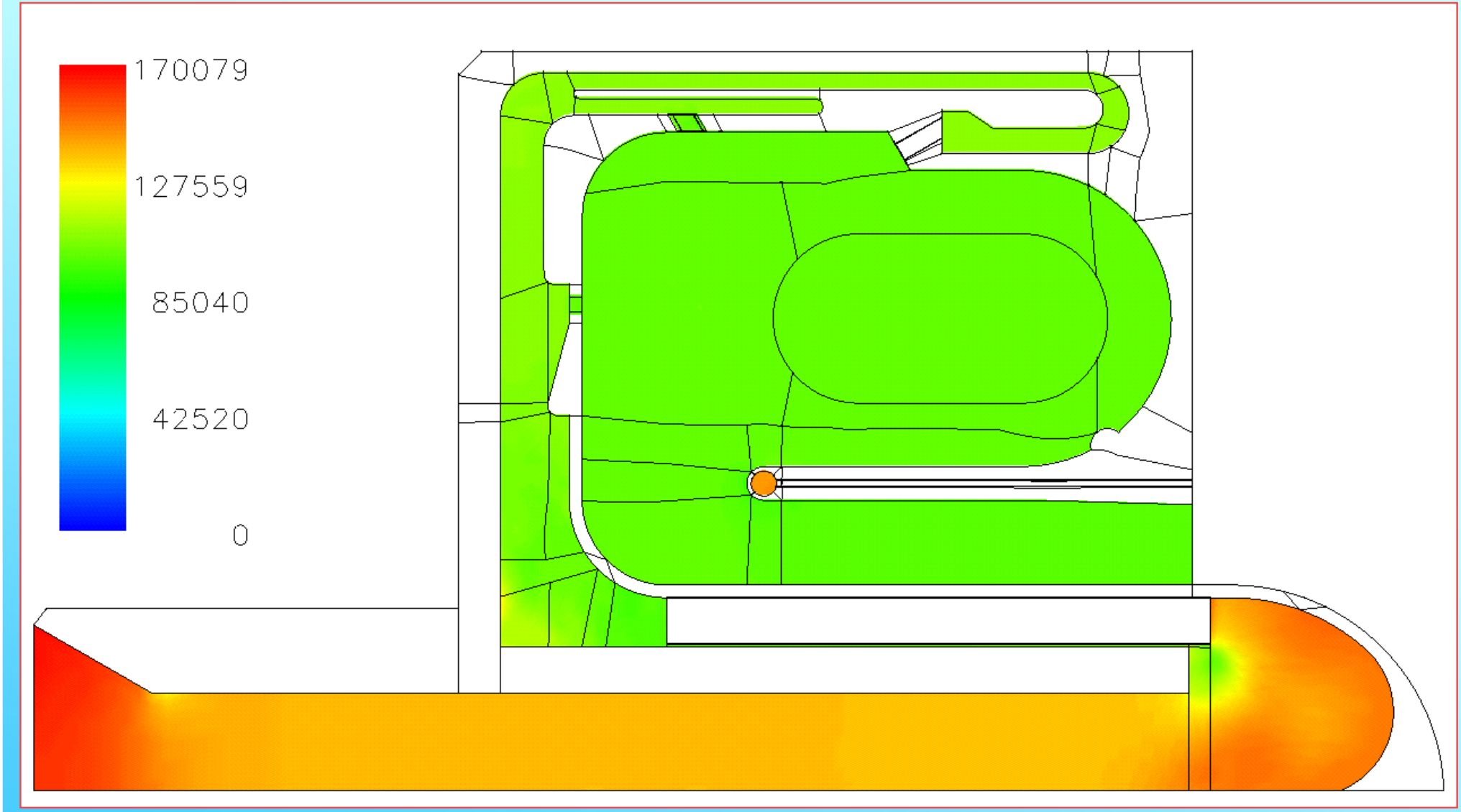
streamlines



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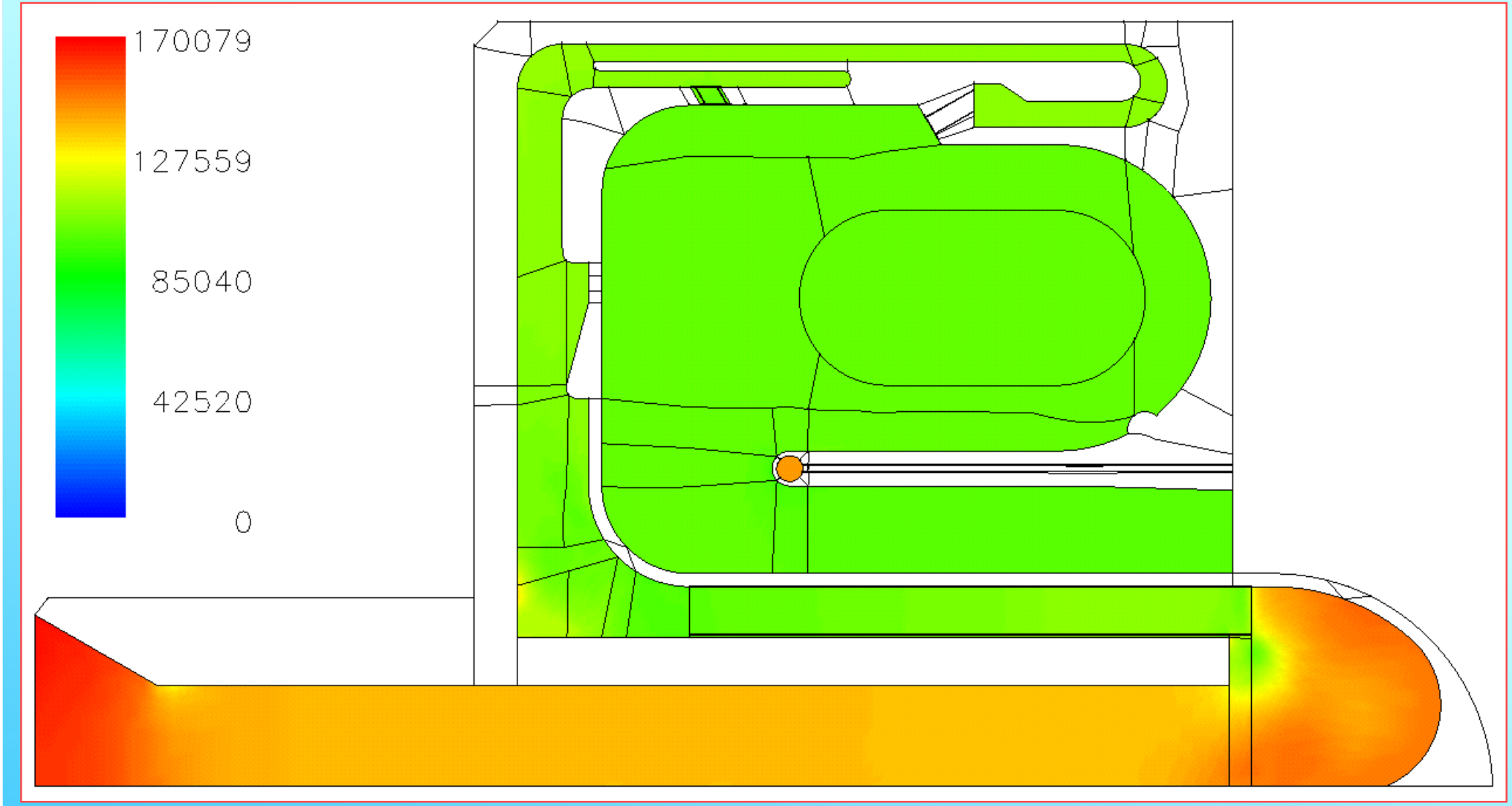
static pressure - plane 1



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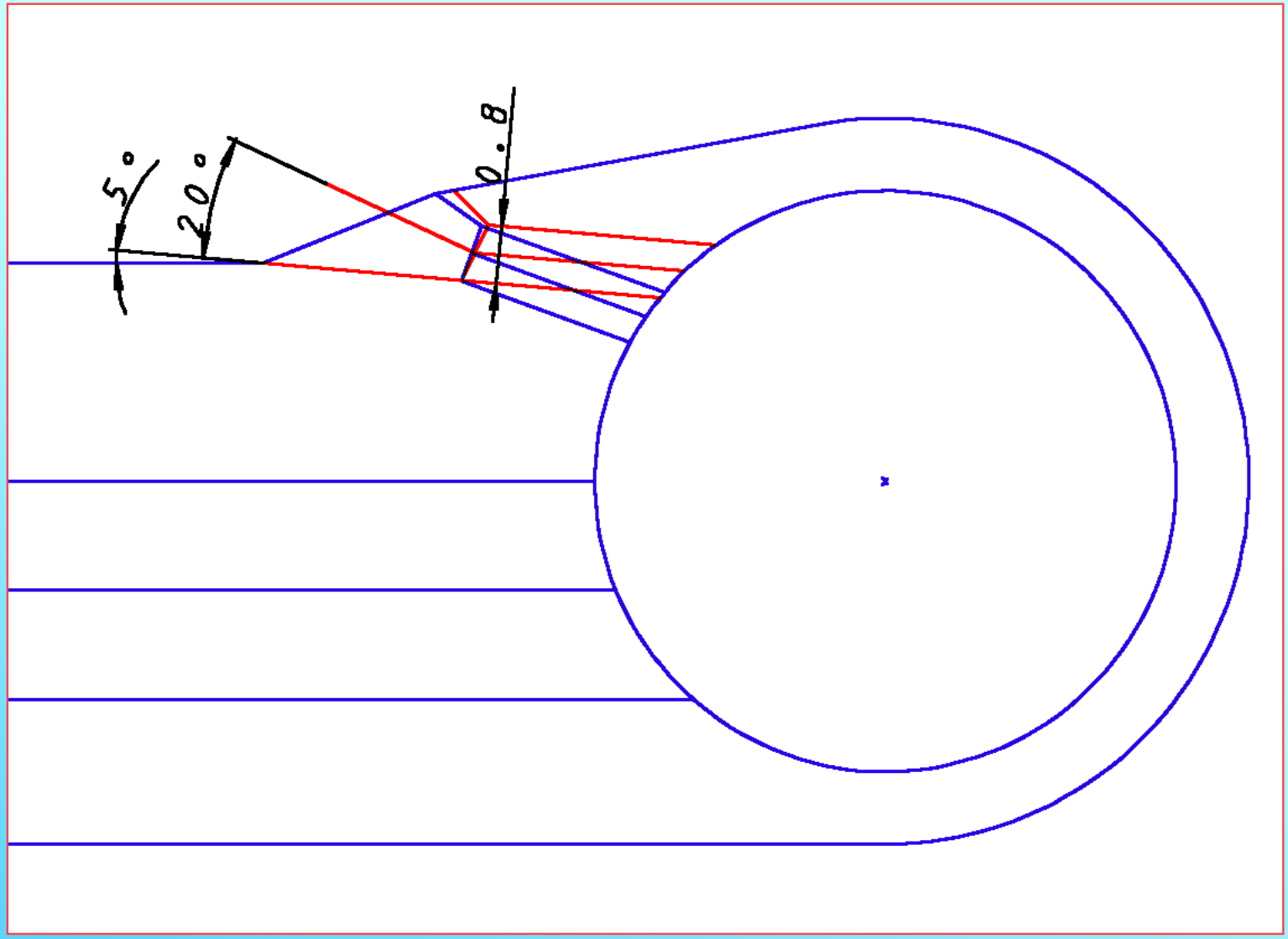
static pressure - plane 2



improved hole geometry (red) for enhanced wall contact of cooling film

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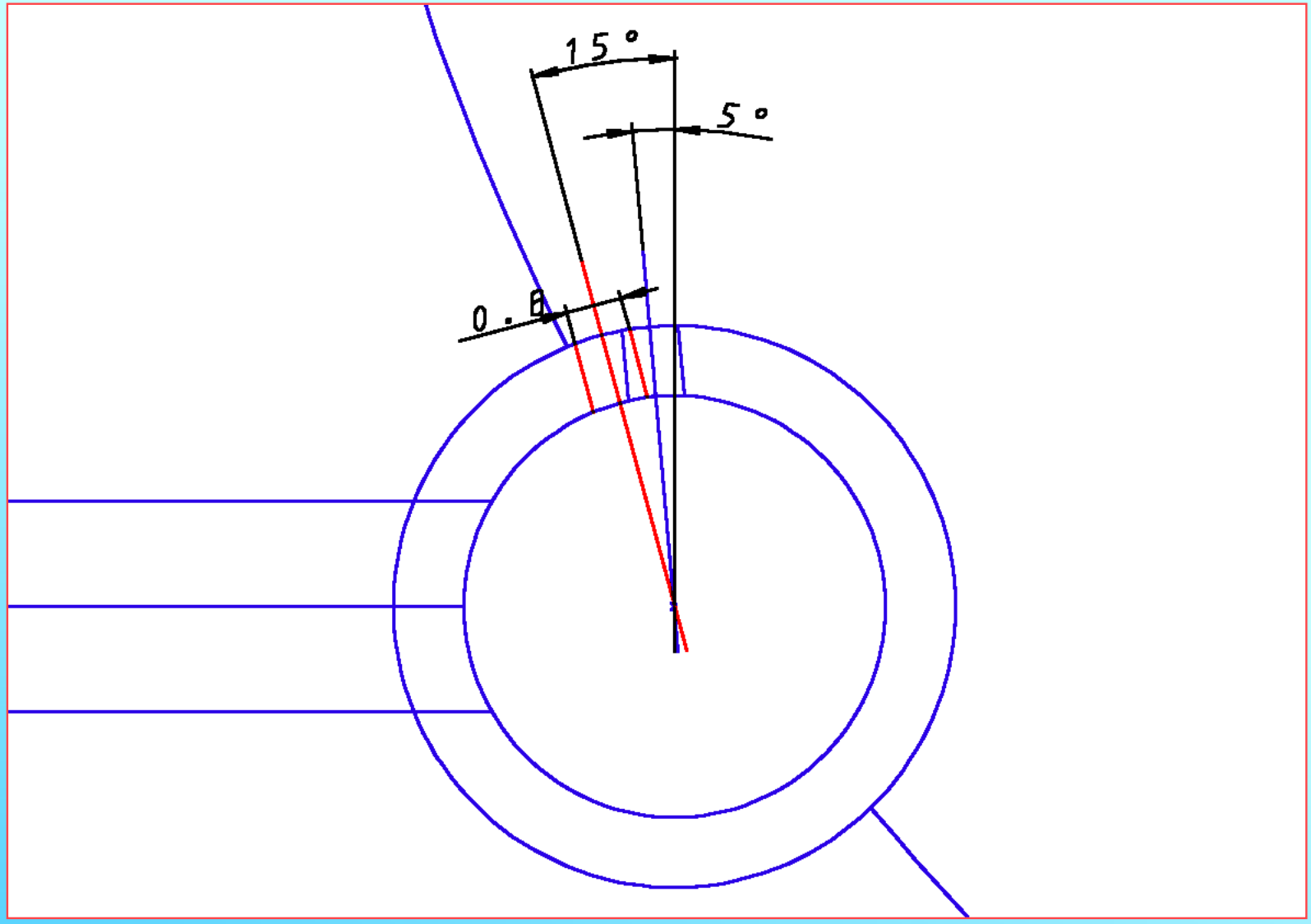
Improvement of shaped hole



improved hole geometry (red) for enhanced wall contact of cooling film

Improvement of CIS

Recent publications & presentations on results of colling ejection simulation within FLOXCOM project:

- **Conjugate Heat Transfer Analysis of Cooling Jets Ejected from a Row of Shaped Holes** by D. Bohn, J. Ren & K. Kusterer, 6th ISAIF Conference, Apr. 7 - 11, Shanghai, China
- **Influence of Conjugate Heat Transfer on Film Cooling** by D. Bohn, J. Ren & K. Kusterer, 5th European Conference on Turbomachinery, 18-21 March, Prague, Czech Republic, pp. 475 - 485 of the proceedings (presented by K. Kusterer)
- **Conjugate Heat Transfer Analysis for Film Cooling Configurations with Different Hole Geometries** by D. Bohn, J. Ren & K. Kusterer, ASME Turbo EXPO 2003, paper-No. GT2003-38369,June 16-19, Atlanta, USA
- **Gekoppelte numerische Simulation von Strömung und Wärmeübergang zur thermischen Auslegung einer Brennkammer** by T. Hagedorn, Diplomarbeit, RWTH Aachen (under preparation)