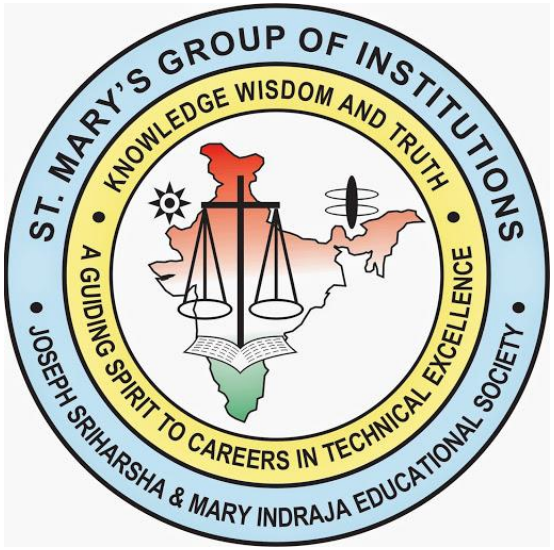
Design and Analysis of Fluid Structure Interaction for Elbow Shaped Micro Piping System



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COMSOL CONFERENCE 2014 BANGALORE

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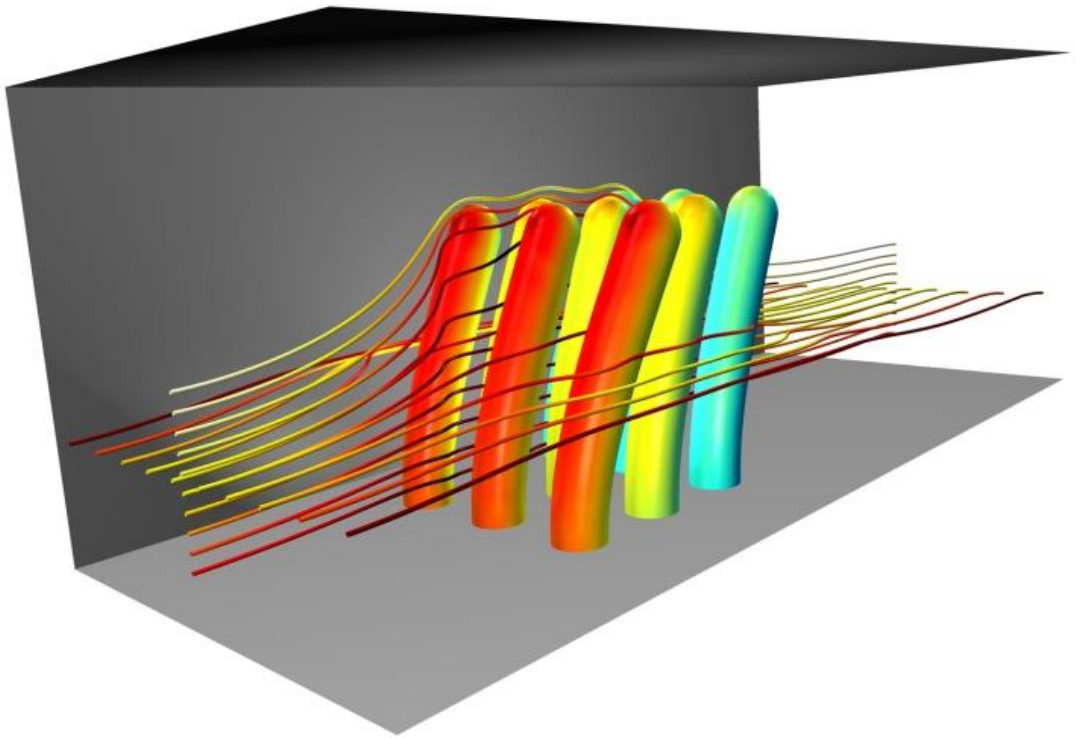
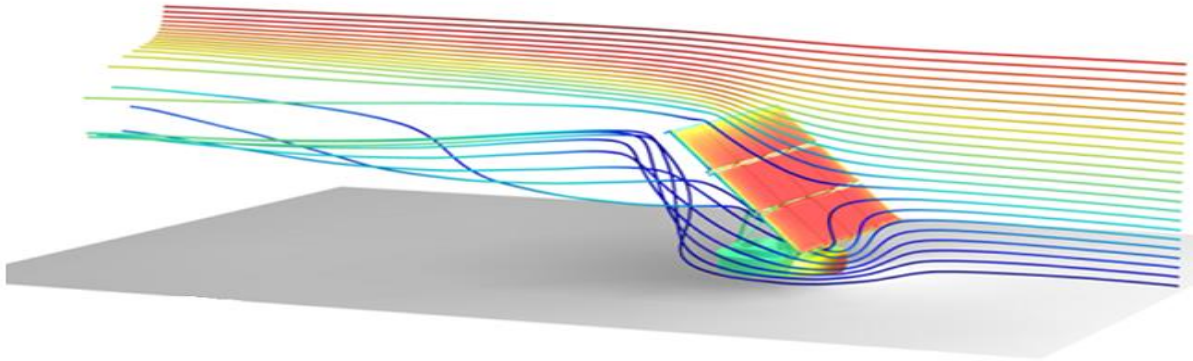
CONTENTS

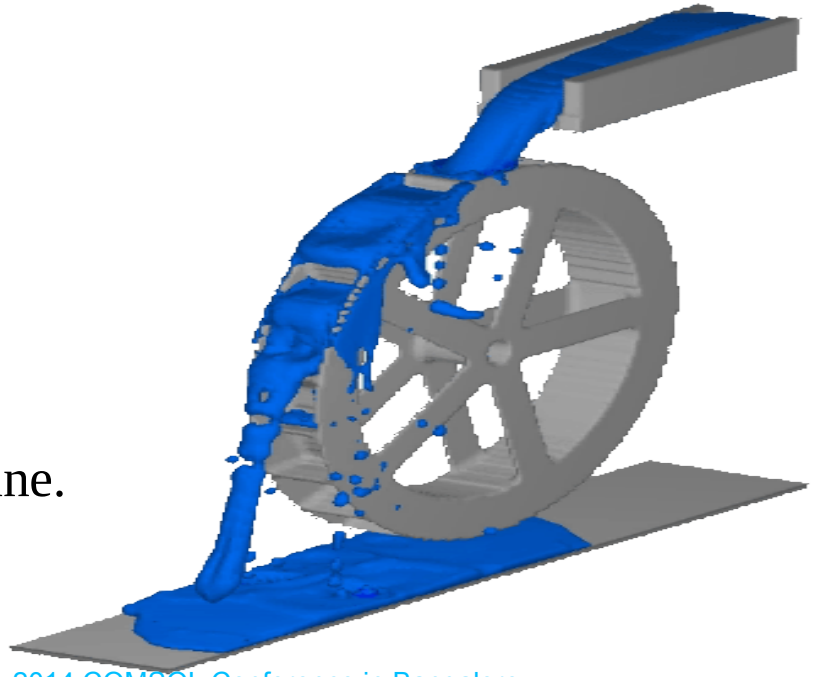
1. FLUID STRUCTURE INTERACTION



Problems of FSI:

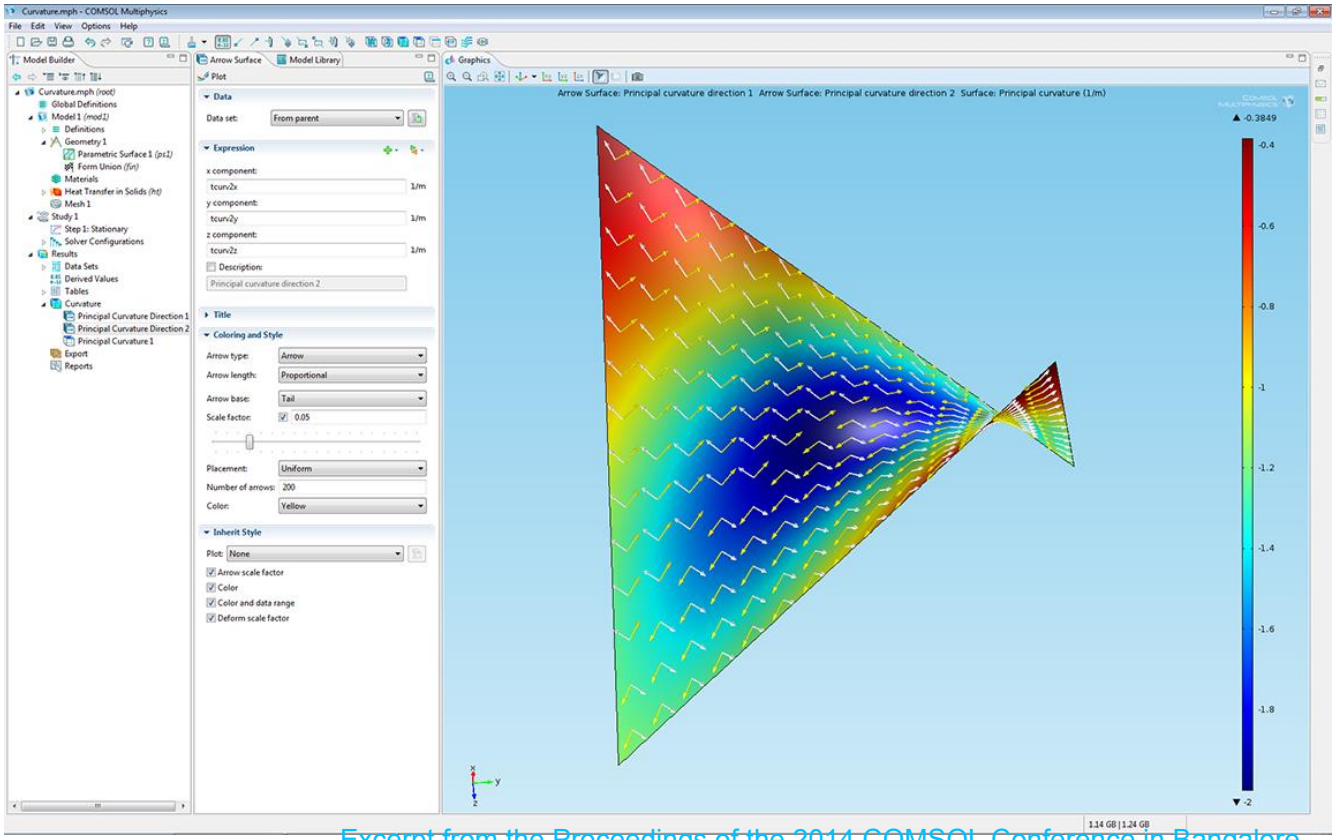
- Inelasticity,
- Noise generation,
- Nonlinear response,
- Flow induced vibrations,
- New path for the flowing fluid,
- Change in boundary conditions,
- Expansion or Contraction in pipe line.



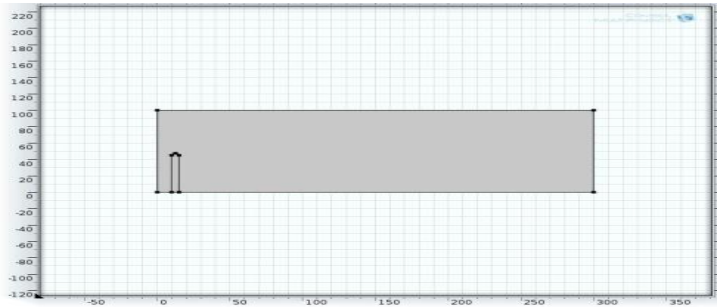


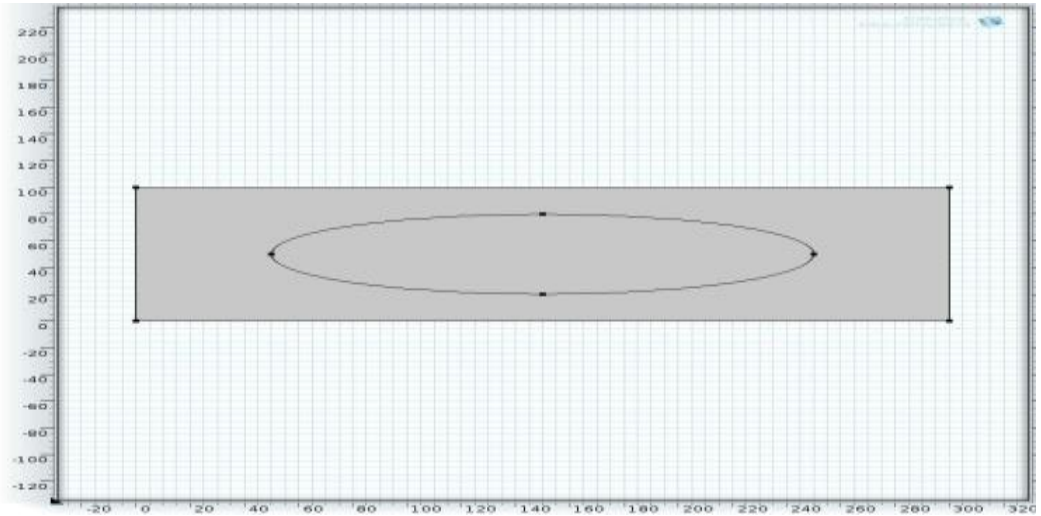
2. COMSOL MULTIPHYSICS

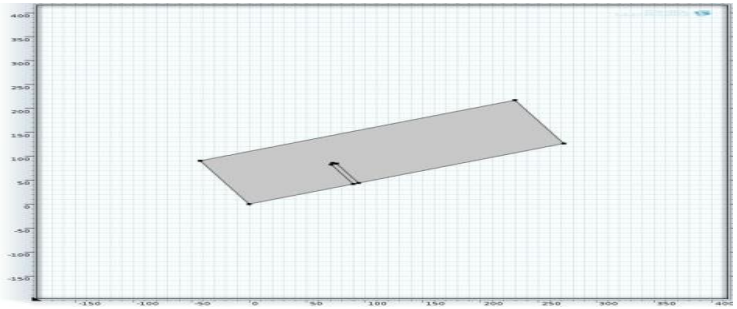
COMSOL Multiphysics computes new mesh coordinates on the channel area based on the movement of the structure's boundaries and mesh smoothing.

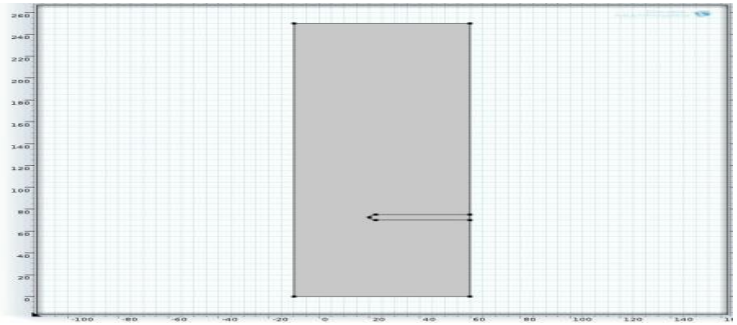


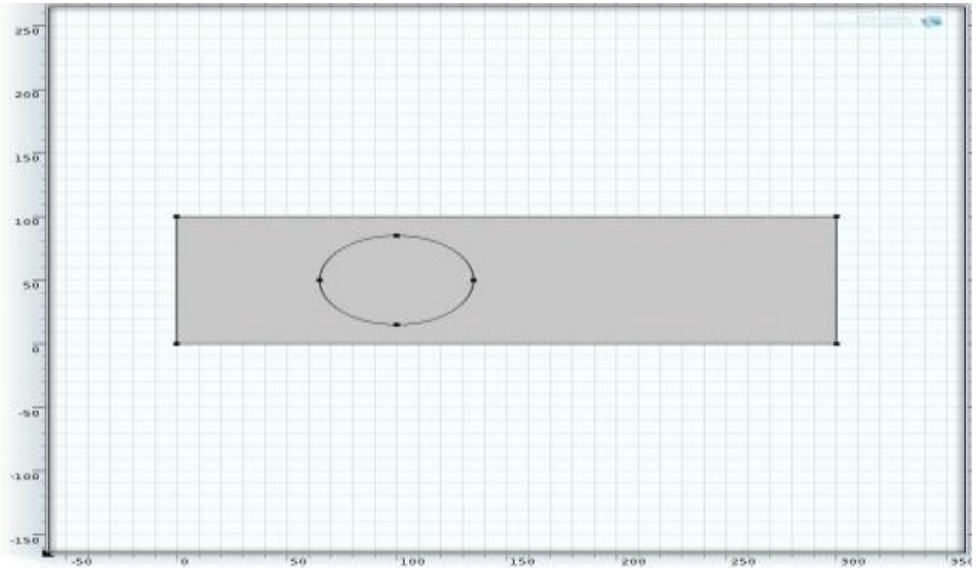
3. DESIGN PROCESS





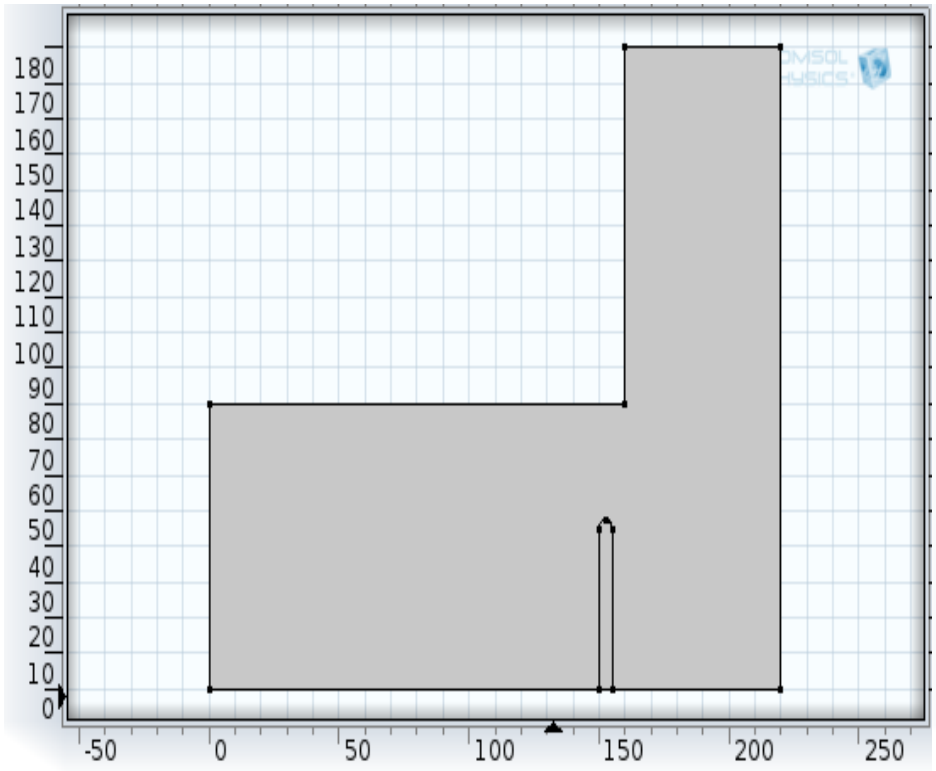


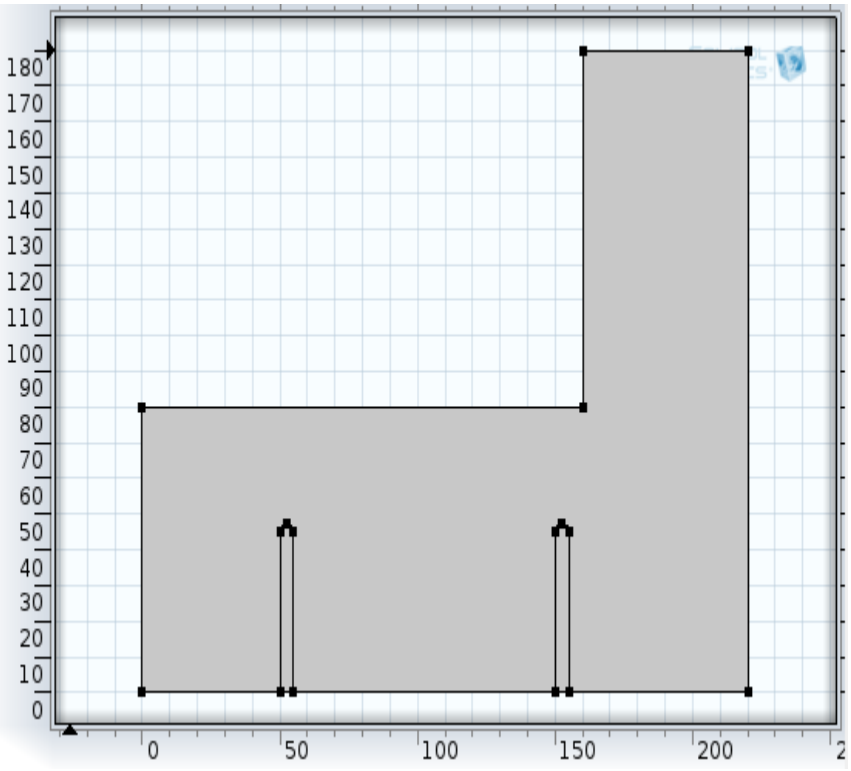




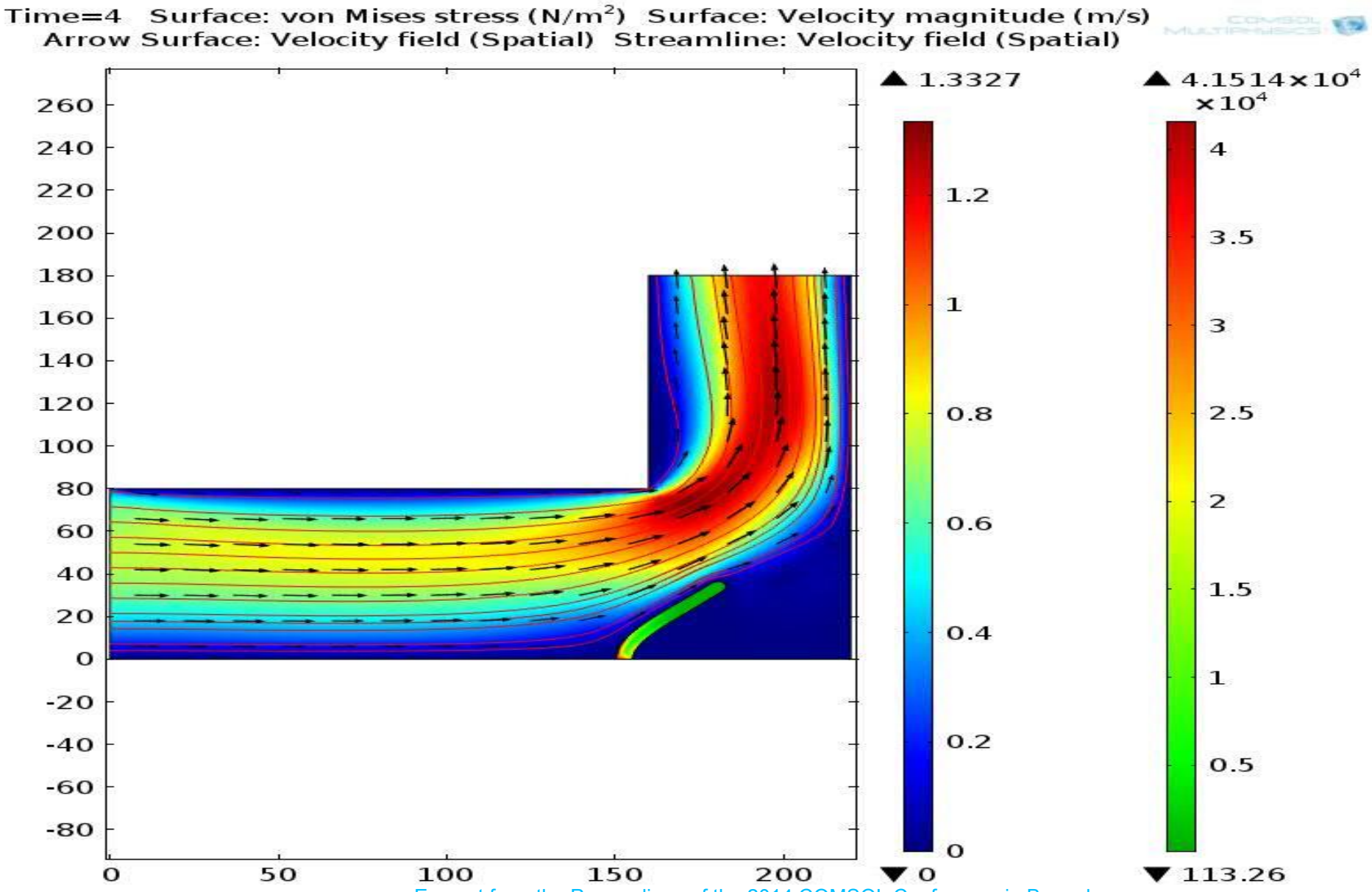
4. SIMULATION

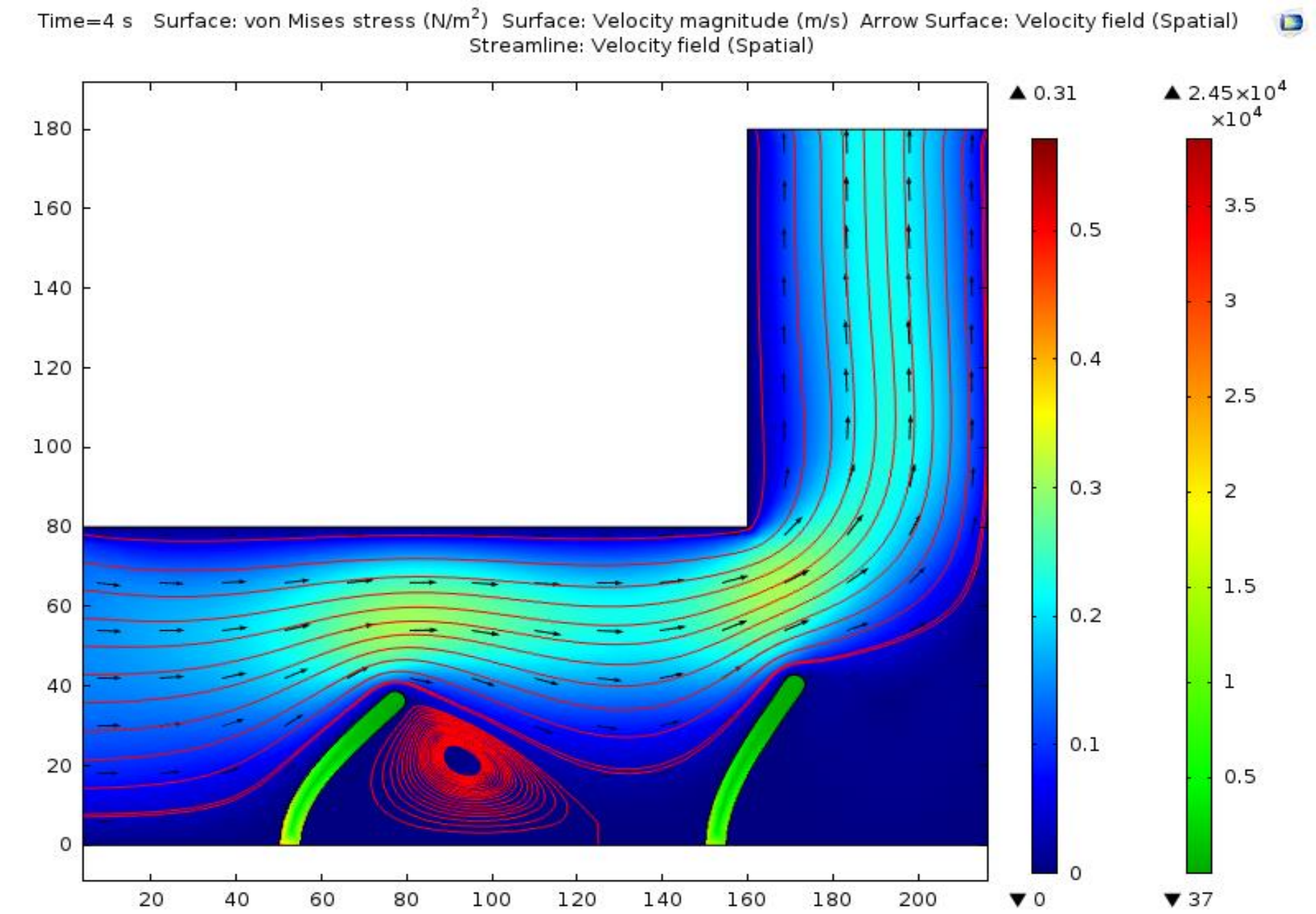
- Flow channel is 85 μm high and 200 μm long .
- Vertical rectangular obstacle with 5 μm wide, 47.5 μm.
- Semicircular top sits 150 μm away from the channel left boundary.

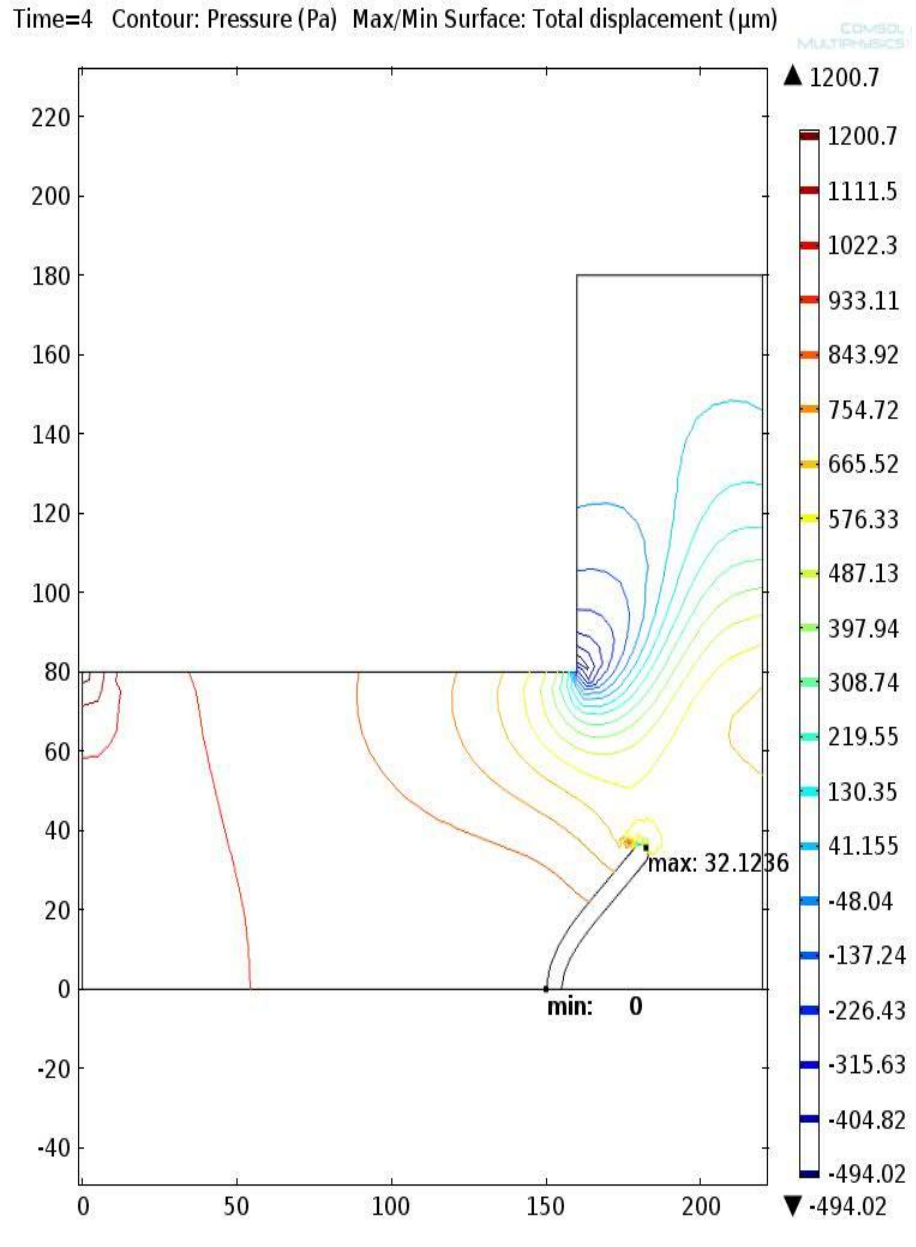




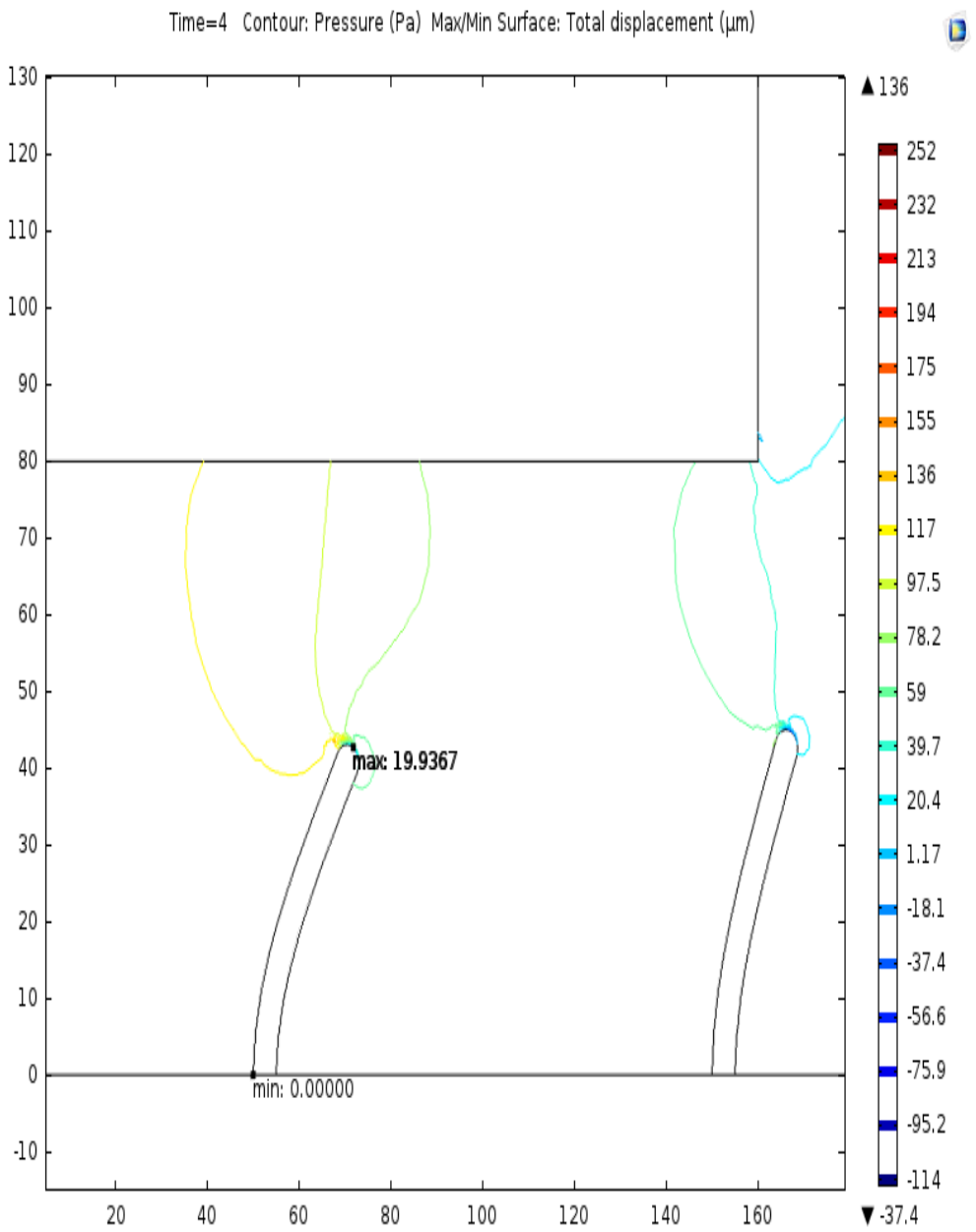
5. RESULTS


Time=4 Surface: von Mises stress (N/m²) Surface: Velocity magnitude (m/s)
Arrow Surface: Velocity field (Spatial) Streamline: Velocity field (Spatial)
▲ 1.3327
1.2
1
0.8
0.6
0.4
0.2
0
▼ 0
▲ 4.1514×10⁴
×10⁴
4
3.5
3
2.5
2
1.5
1
0.5
▼ 113.26
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
0
50
100
150
200

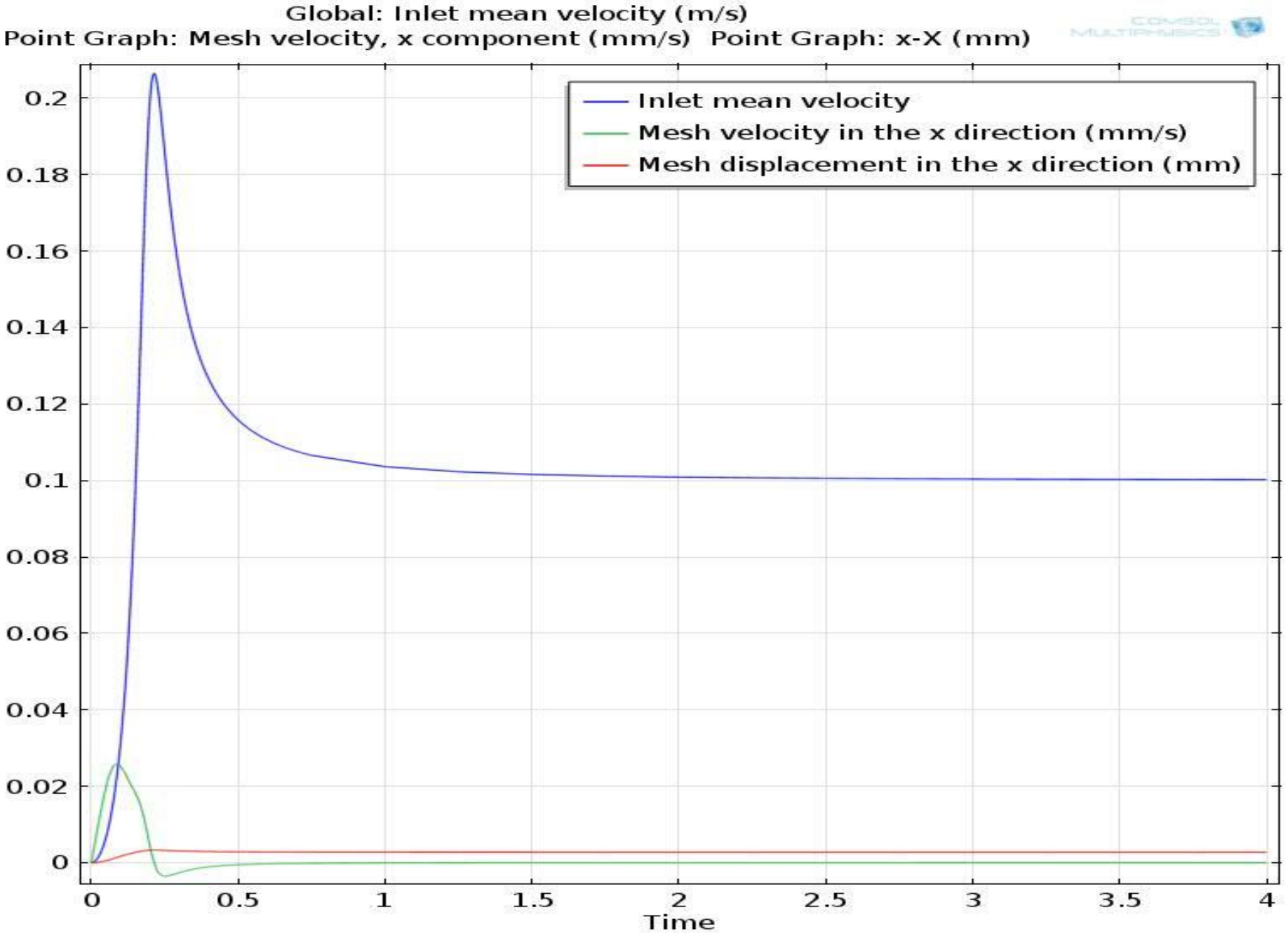

Time=4 s Surface: von Mises stress (N/m2) Surface: Velocity magnitude (m/s) Arrow Surface: Velocity field (Spatial)
Streamline: Velocity field (Spatial)
▲ 0.31
0.5
0.4
0.3
0.2
0.1
0
▼ 0
▲ 2.45×10^4
×10^4
3.5
3
2.5
2
1.5
1
0.5
▼ 37
180
160
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
160
180
200



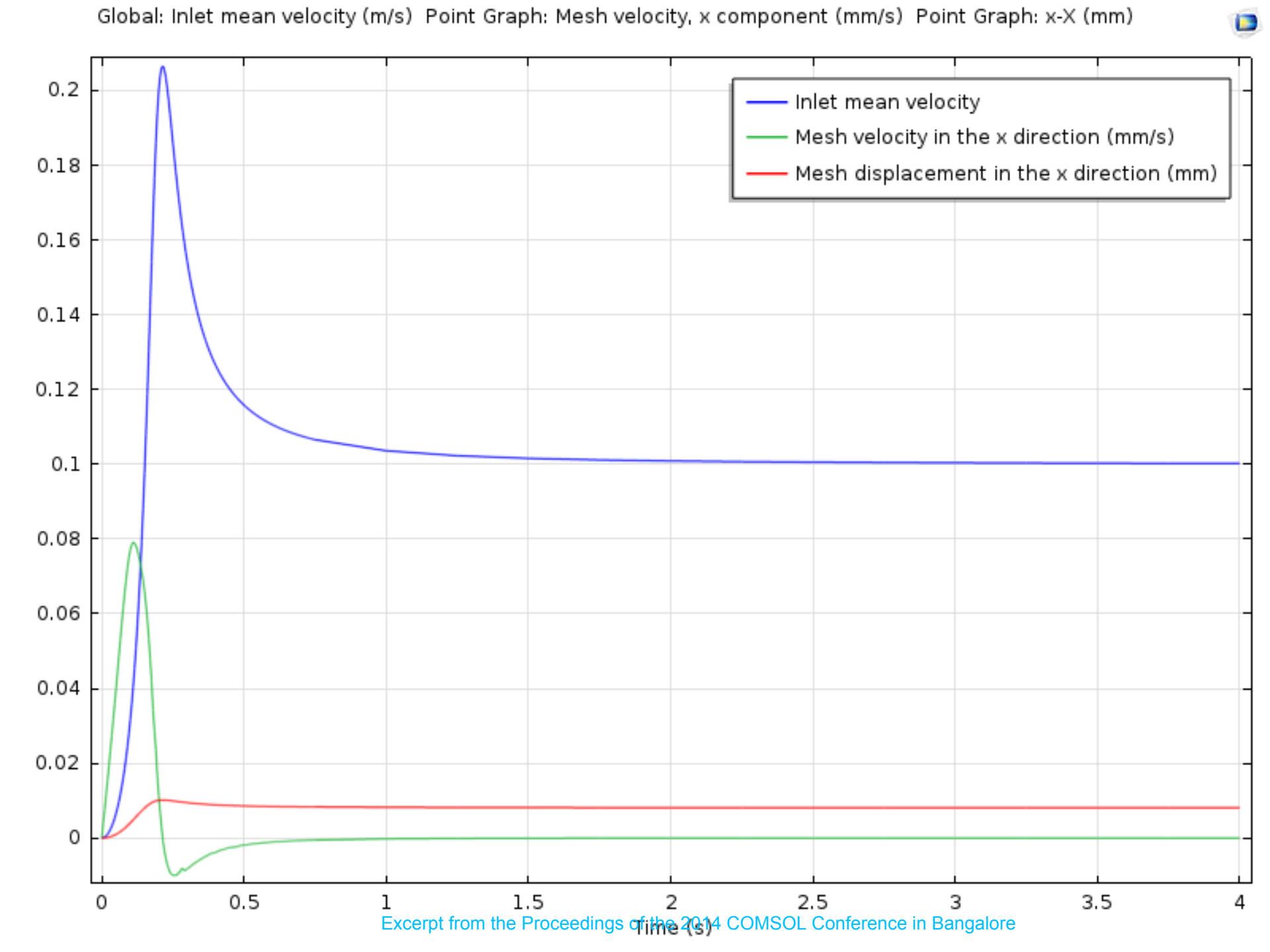
Min/ Max surface distribution for single obstacle.



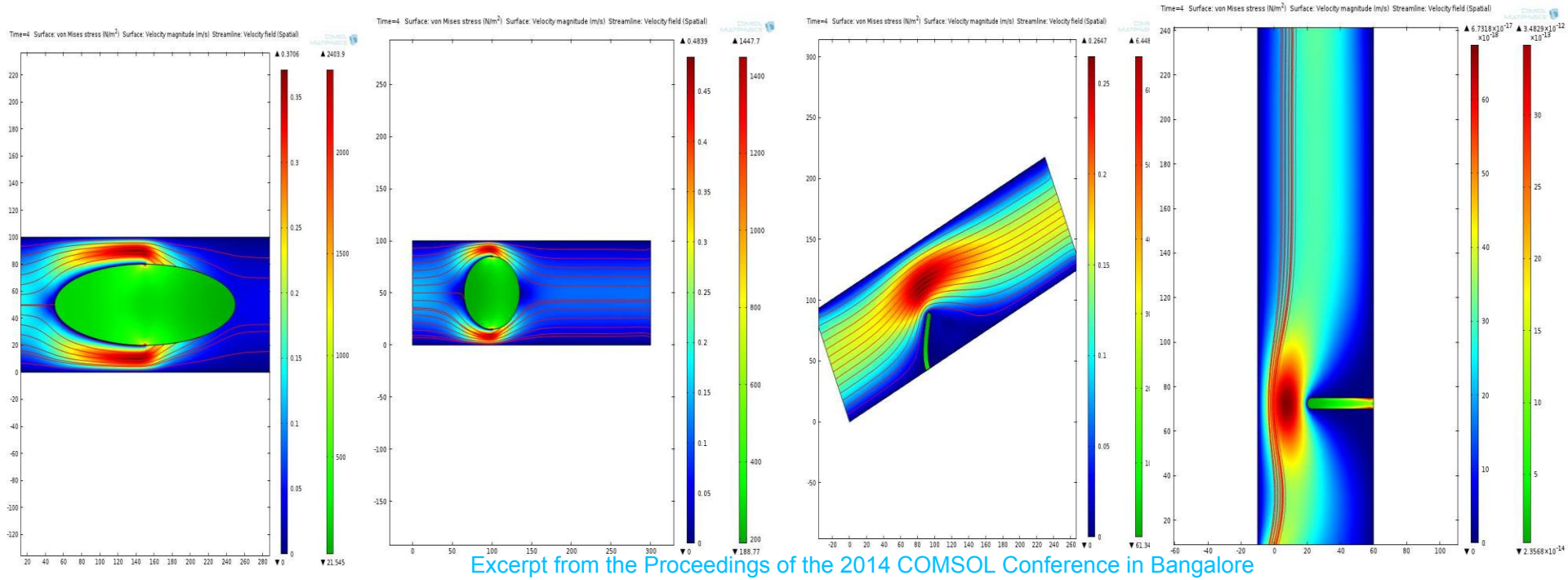
Min/ Max surface distribution for two obstacles.



Point graph for single obstacle.


Global: Inlet mean velocity (m/s) Point Graph: Mesh velocity, x component (mm/s) Point Graph: x-X (mm)
Inlet mean velocity
Mesh velocity in the x direction (mm/s)
Mesh displacement in the x direction (mm)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Time (s)

No. of Obstacles	Stress (N/m2)	Velocity (m/s)	Displacement (μm)
Single Obstacle	1.3327	4.1514x10^4	32.1236
Two Obstacles	0.1704	1.5316x10^4	19.9367



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6. CONCLUSION

Finite element analysis plays an important role in helping to understand the interactions of the system under conditions that are simulated to replicate nature and provides a tool for visualizing phenomena not possible to be observed using conventional observation equipment.