COMSOL CONFERENCE 2017 BOSTON

Modeling and Simulation of Control Valves via COMSOL Multiphysics

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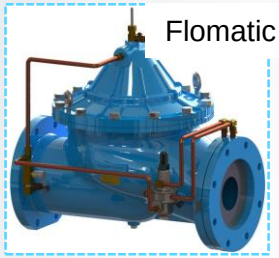
Introduction

- **Control valves**

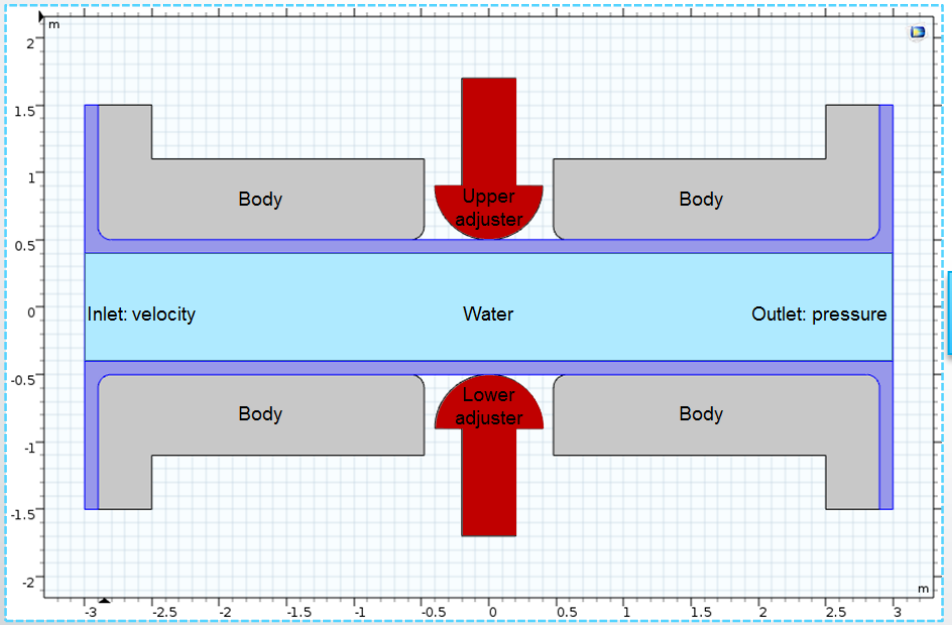

Flomatic Corp.


Cal-Val


Talis UK


Cal-Val

- **Control valves with deformable sleeves**

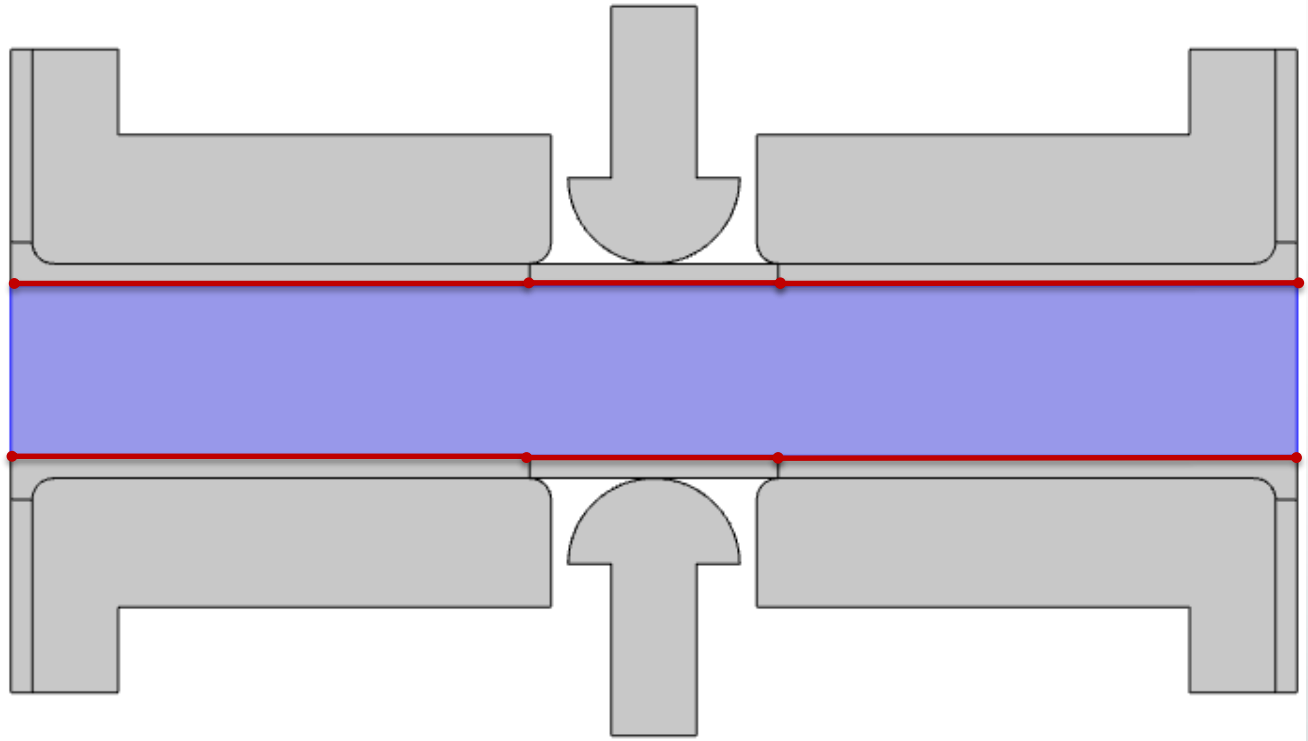


Challenges

- Complex flow state
- Fluid-structure interaction
- Large deformation
- Complicated contact
- Nonlinear material

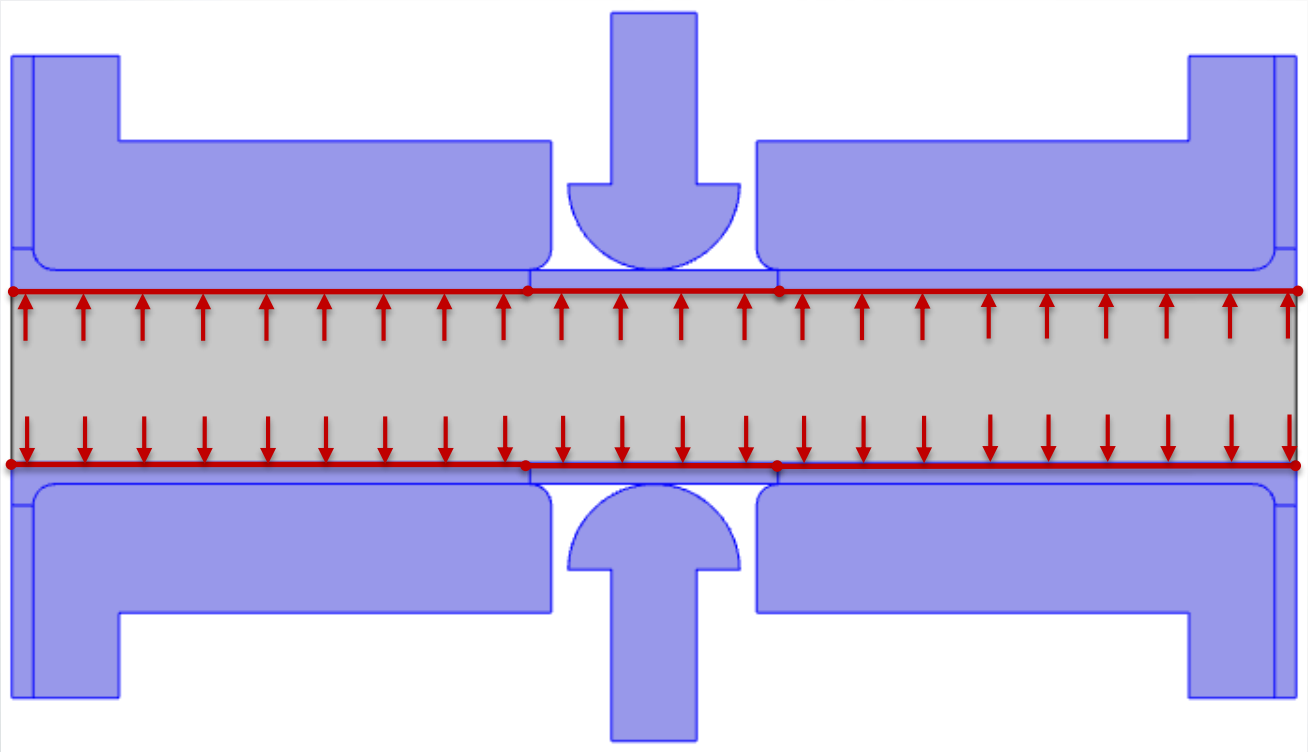
Moving-Mesh Coupling Method

- **Incorporating 3 physics types**
  - Laminar Flow
  - Solid Mechanics
  - Moving Mesh
- **'Laminar Flow': "Wall" definition**



Moving-Mesh Coupling Method (cont'd)

- **'Solid Mechanics': "Pressure" boundary load to account for the influence of fluid pressure on valve sleeves.**

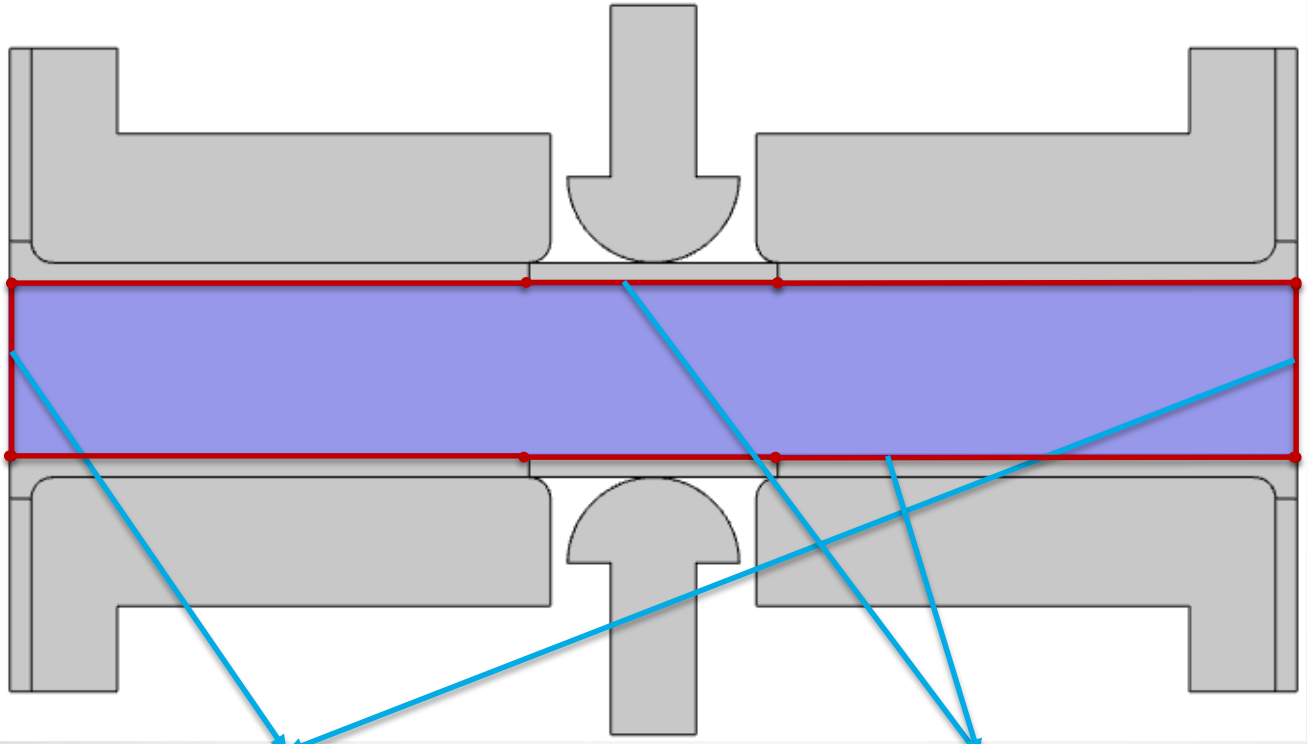


Boundary load with 'Pressure"

$$p = p_2$$

Moving-Mesh Coupling Method (cont'd)

- **'Moving Mesh': Two 'Prescribed Mesh Displacement' boundaries should be defined.**

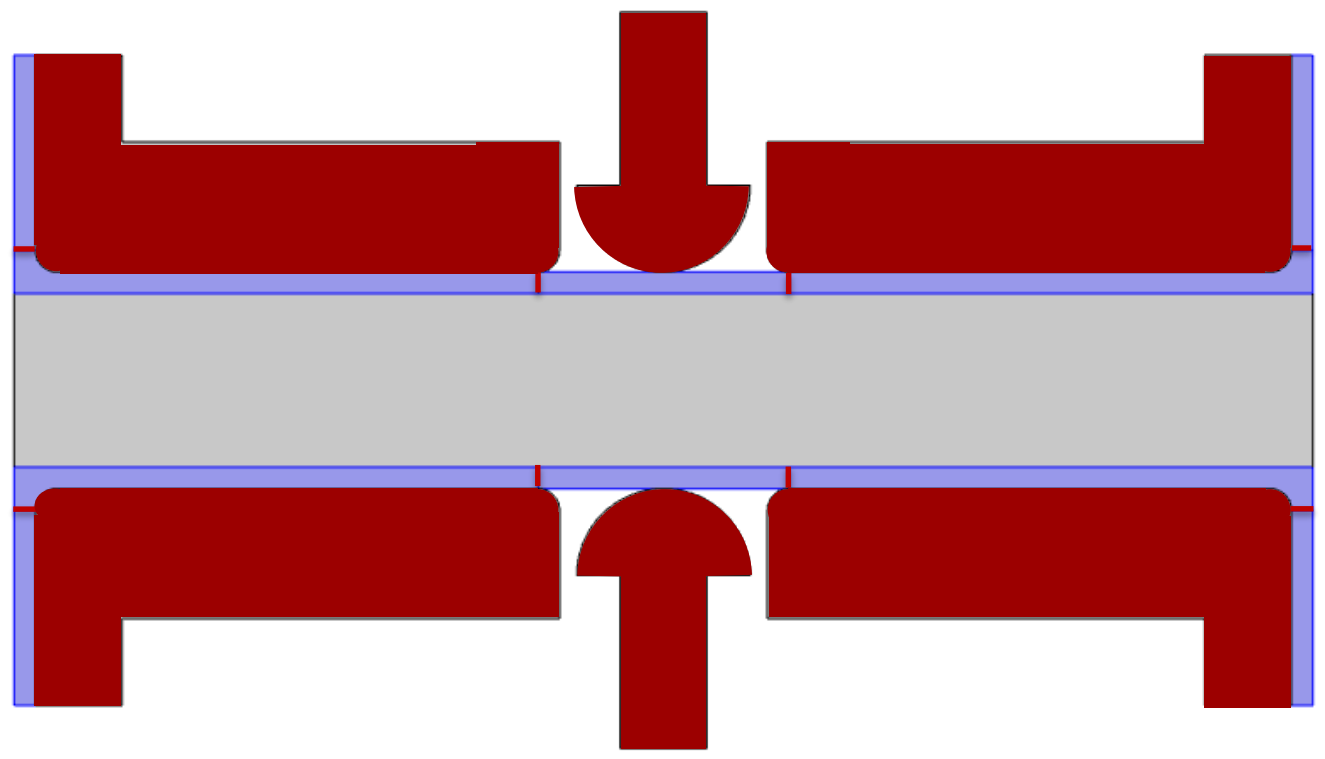


$$d_x = 0$$
$$d_y = 0$$

$$d_x = u_2$$
$$d_y = v_2$$

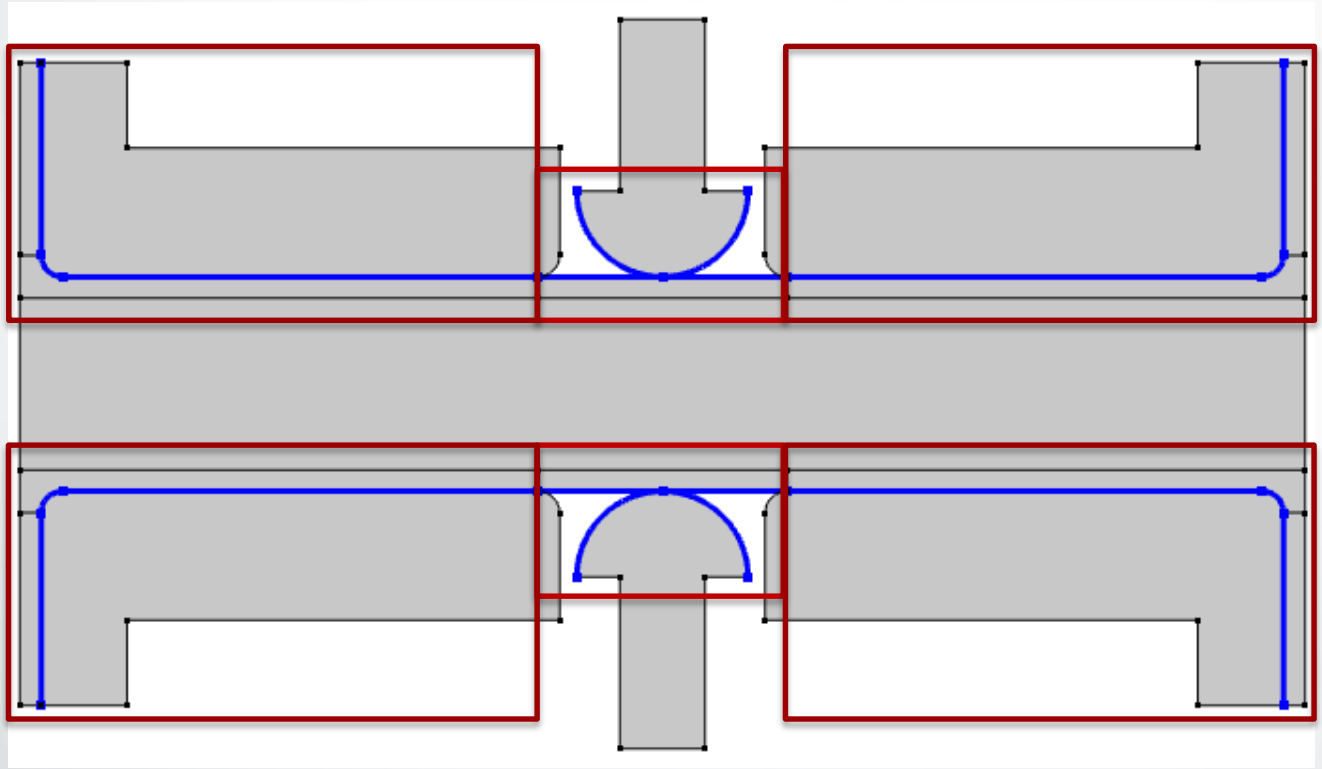
Model Set-up

- The sleeve domain is partitioned for definition of boundary conditions and contact pairs.
- The valve body and adjusters are defined as rigid domain.



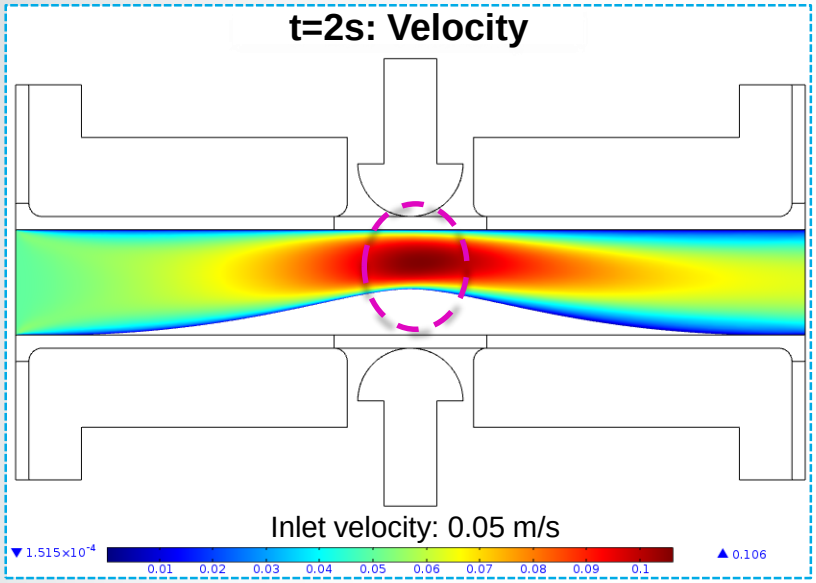
Model Set-up (cont'd)

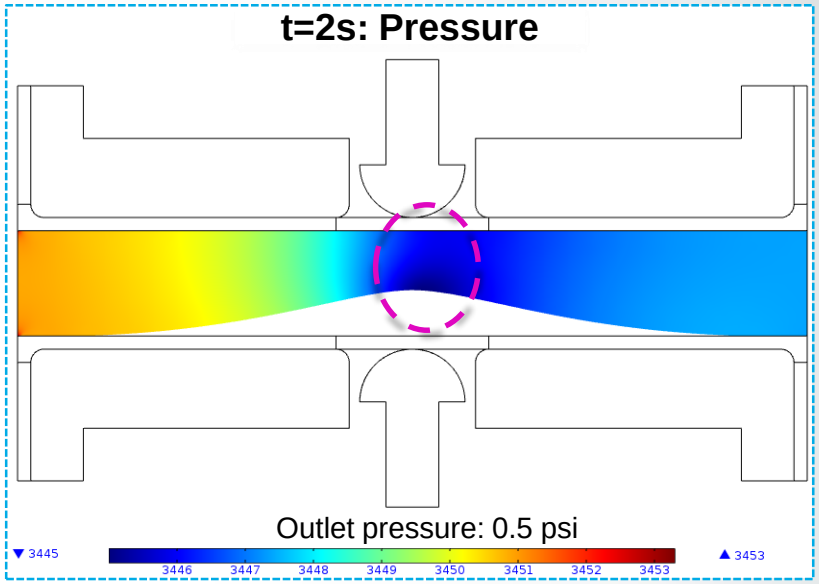
- **Contact definition: 6 contact pairs**

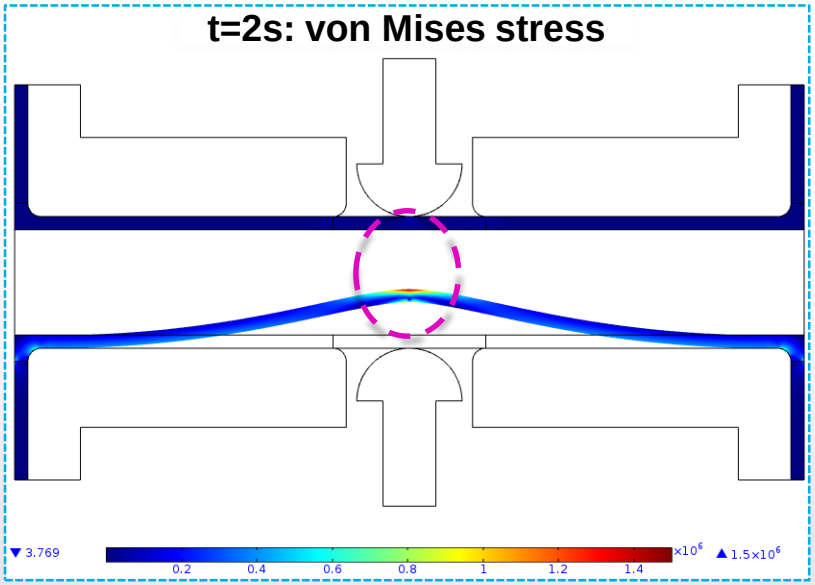


Augmented Lagrangian method

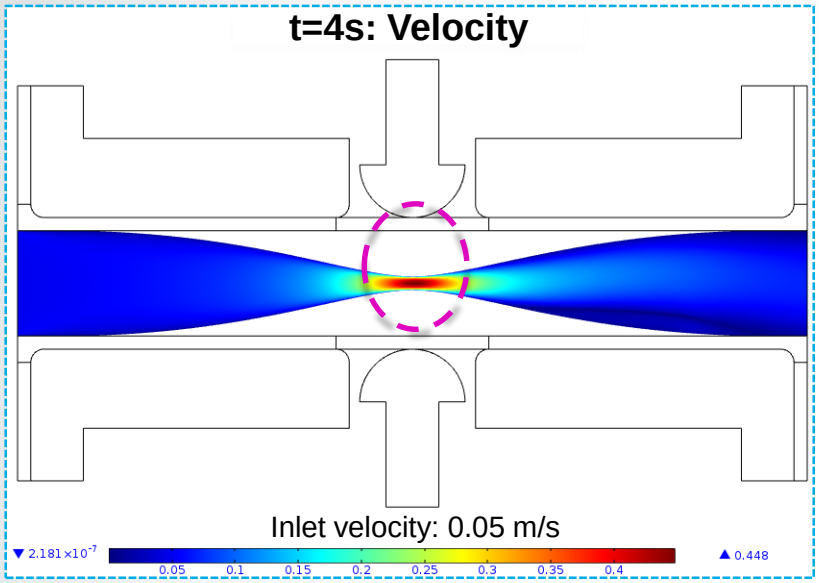
Results – t=2s

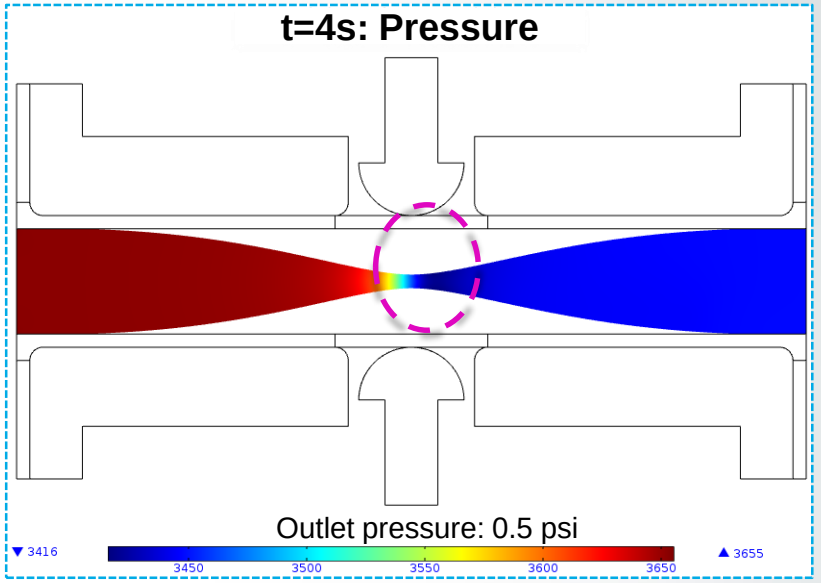

t=2s: Velocity
Inlet velocity: 0.05 m/s
▼ 1.515×10⁻⁴
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
▲ 0.106

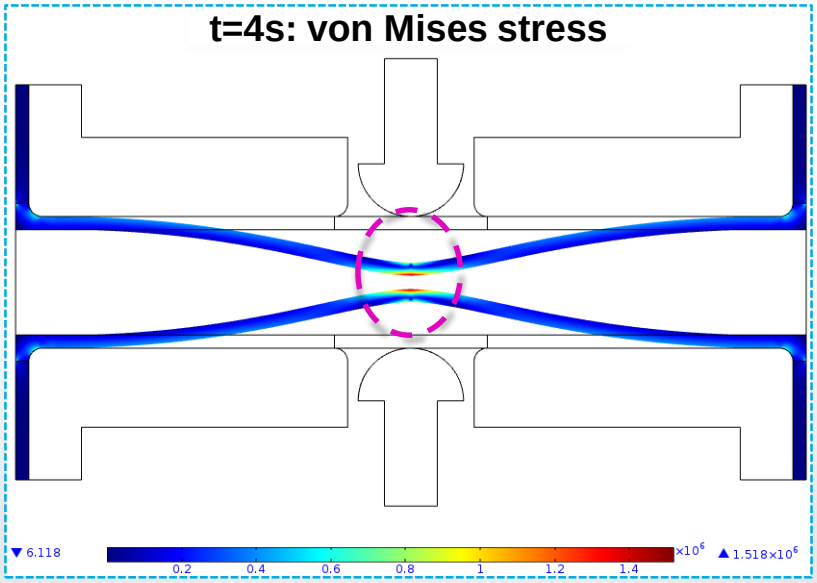

t=2s: Pressure
Outlet pressure: 0.5 psi
▼ 3445
3446 3447 3448 3449 3450 3451 3452 3453
▲ 3453


t=2s: von Mises stress
▼ 3.769
0.2 0.4 0.6 0.8 1 1.2 1.4
×10⁶
▲ 1.5×10⁶

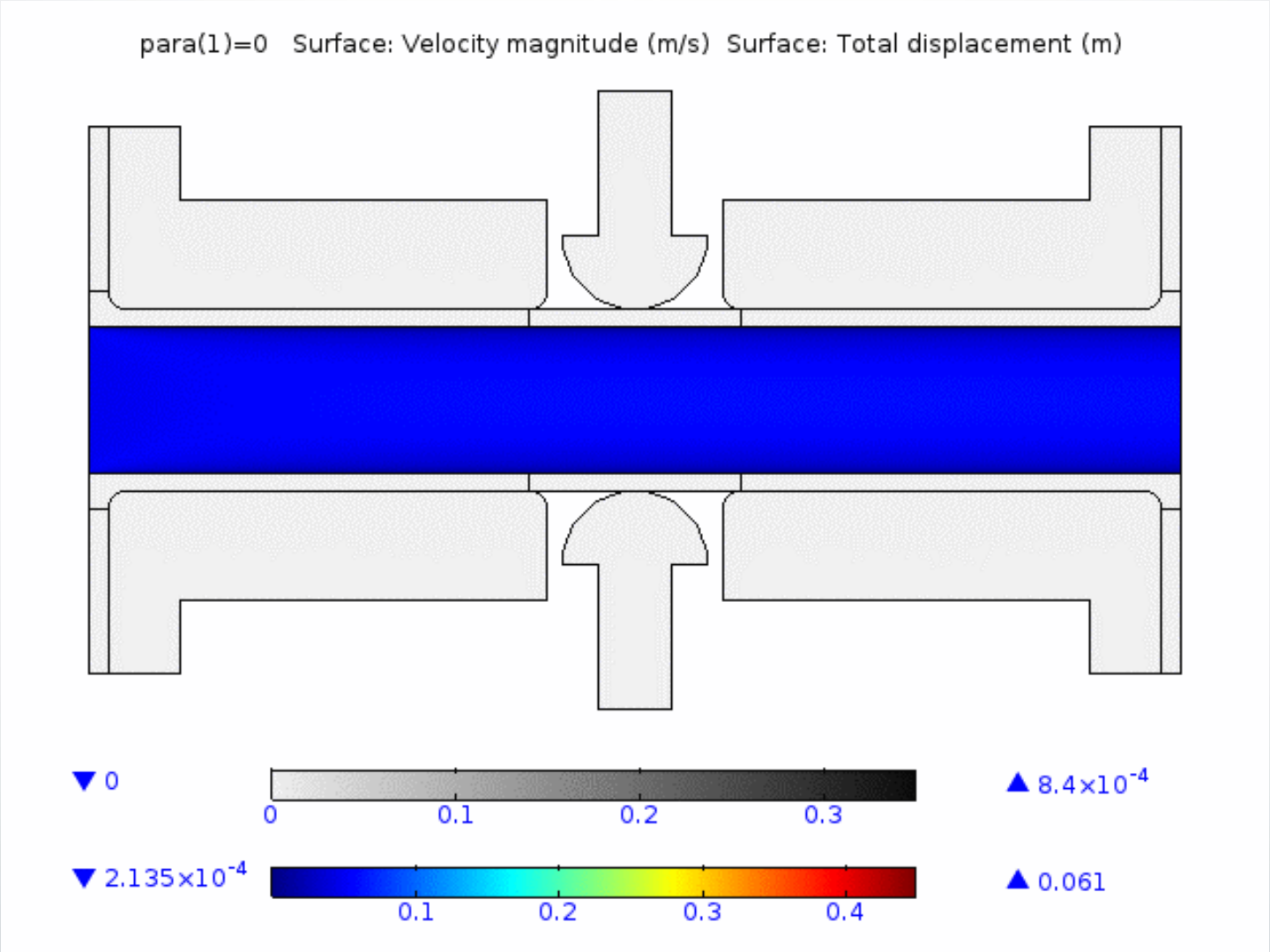
Results – t=4s


t=4s: Velocity
Inlet velocity: 0.05 m/s
▼ 2.181×10⁻⁷
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
▲ 0.448

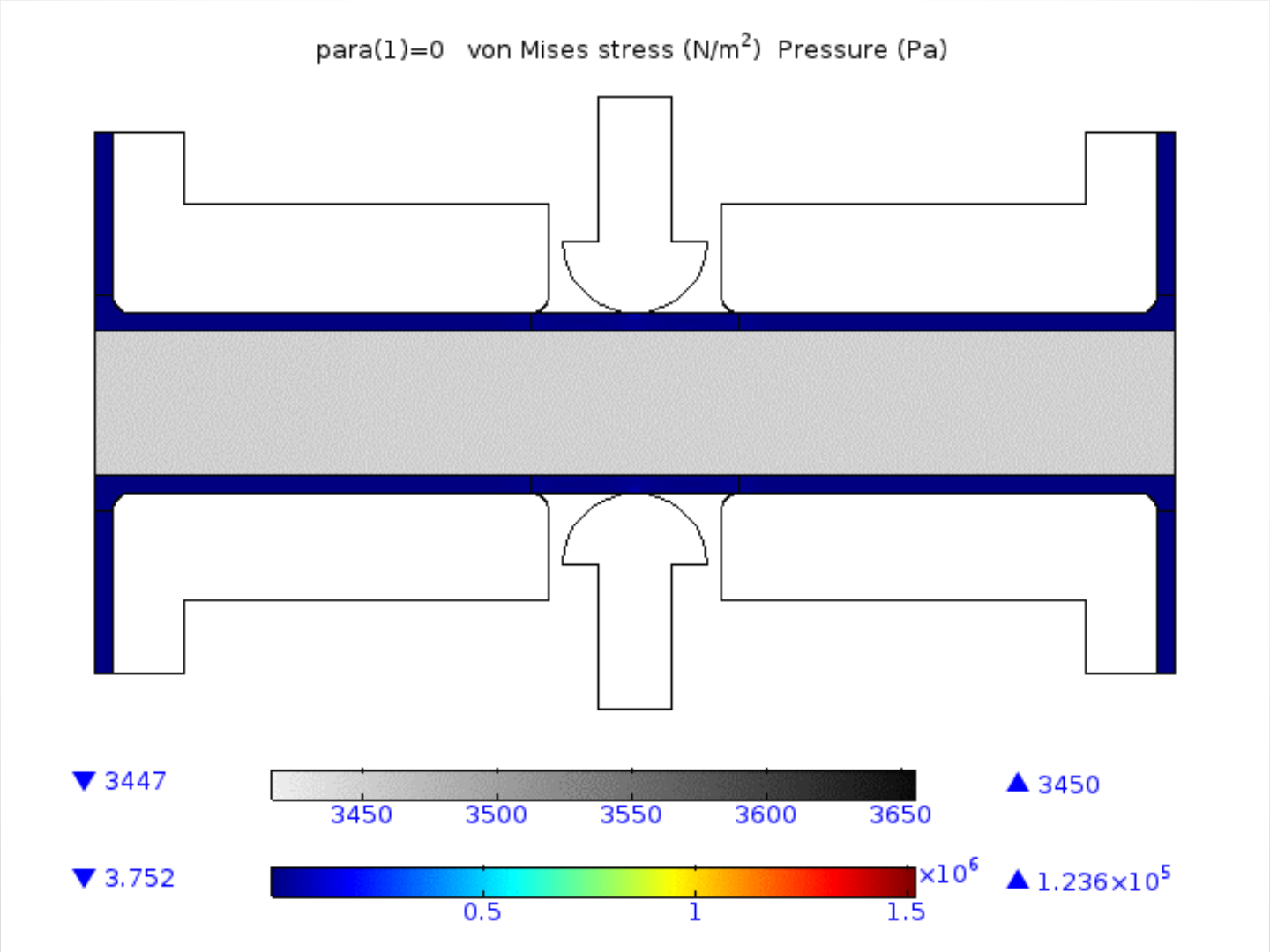

t=4s: Pressure
Outlet pressure: 0.5 psi
▼ 3416
3450
3500
3550
3600
3650
▲ 3655


t=4s: von Mises stress
▼ 6.118
0.2
0.4
0.6
0.8
1
1.2
1.4
×10⁶
▲ 1.518×10⁶

Results – Velocity and Displacement



Results – von Mises Stress and Pressure



Conclusions

- **The moving-mesh coupling method incorporates three physics types, each of which is easy to set up.**

- **The moving-mesh coupling method is capable of simulating control valves with deformable sleeves, where large deformation, contact interaction and material nonlinearity are included.**

THANKS FOR YOUR ATTENTION!

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