

Flow Past Flap

FEBio Workshop
FSI Simulation

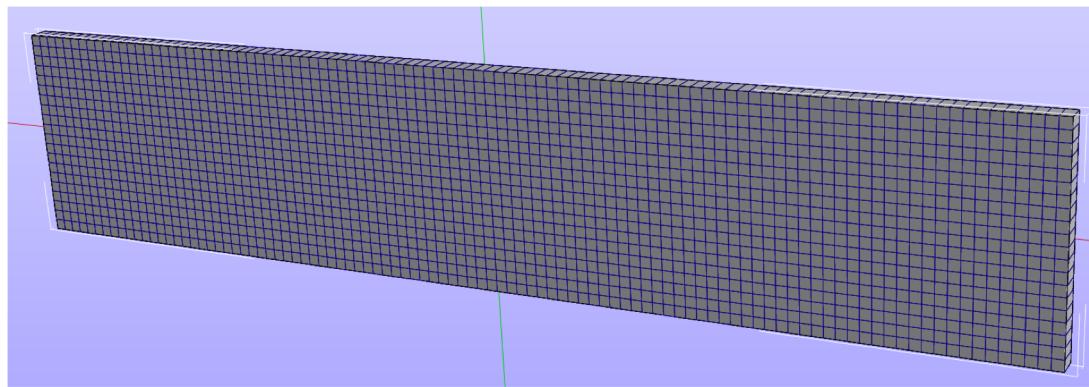
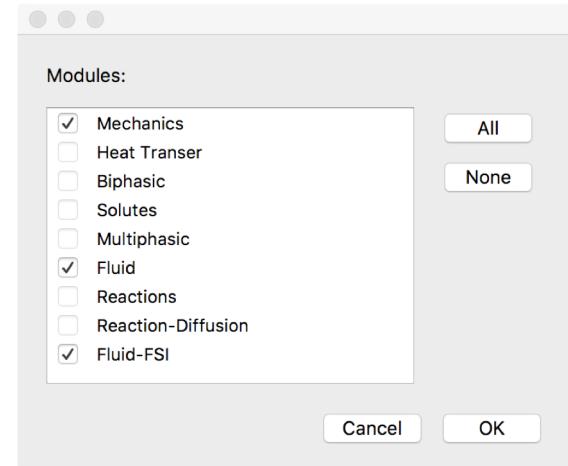
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Objective

- The objective of this advanced tutorial is to demonstrate the use of the FSI solver in FEBio, which was introduced in version 2.8.
- This tutorial requires PreView 2.1.0 and PostView 2.3.0 or higher.
- FEBio uses a specialized fluid-solid mixture to model fluid domains whose mesh (defined on the solid constituent) may deform as a result of fluid-structure interactions (FSI).
- FSI analyses use the “fluid-FSI” module and the “fluid-FSI” material.
- For domains that are assigned a “fluid-FSI” material, users need to define boundary conditions for the fluid and solid constituents.

Geometry and Mesh

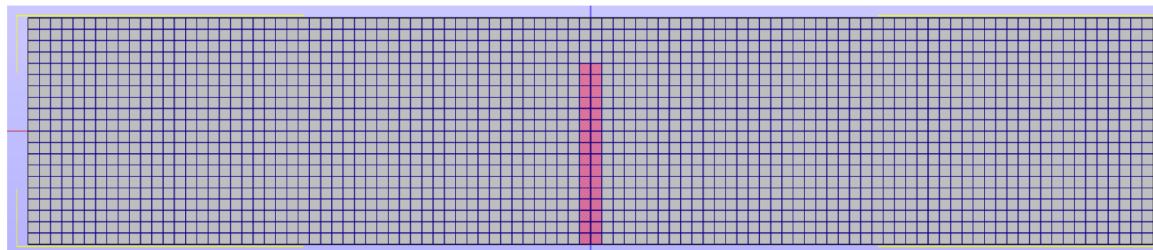
- Launch PreView. Edit->Edit Project Settings ...
- Create a box  with dimensions
 - Width = 0.1, Height = 0.02, Depth = 0.002
- Mesh the box using hex8 elements with
 - Nx = 100, Ny = 20, Nz = 1



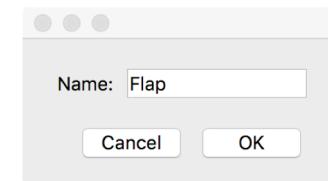
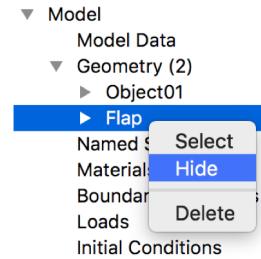
Remember to
save your file!

Create Flap

- Convert the mesh to Editable Mesh
- Select elements as shown



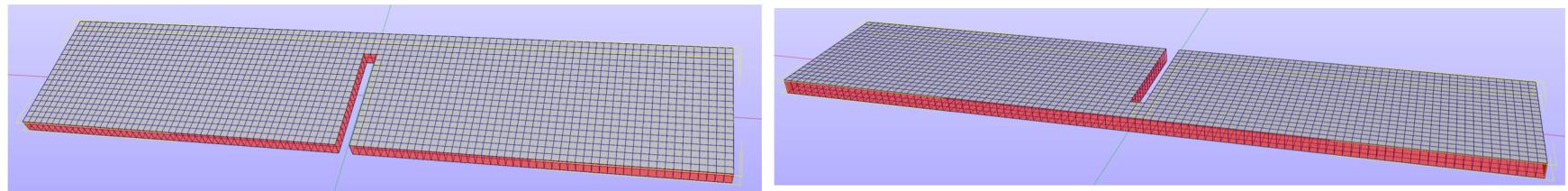
- Detach  these elements into an object named Flap
- Hide this object



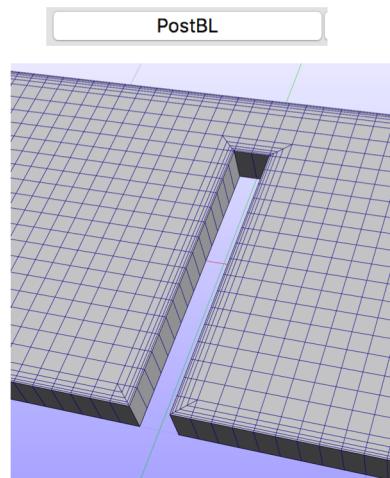
Remember to
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Boundary Layer Mesh

- Select the element faces as shown



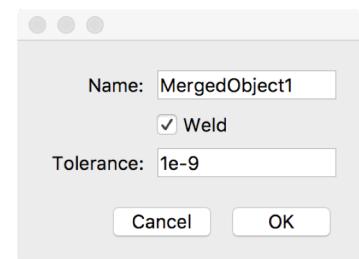
- In the Edit Mesh panel select PostBL
 - bias = 1.5, Segments = 5, Apply



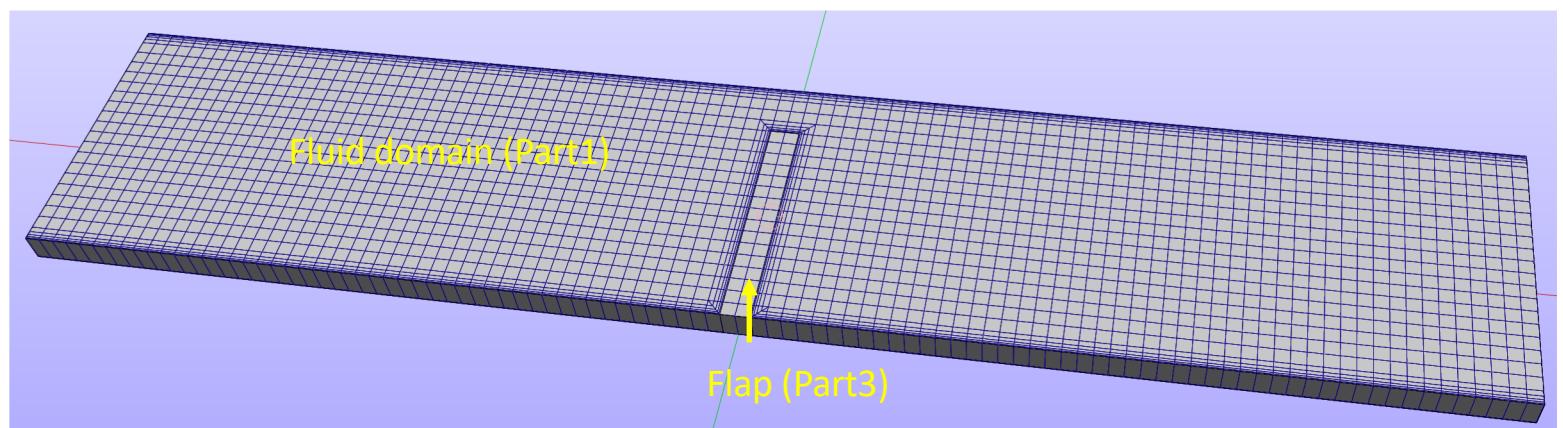
Remember to
save your file!

Reattach Meshes of Fluid and Flap Domains

- Deselect any mesh selection option
- Unhide flap, select both objects (use Shift key) and Merge them
 - Weld with Tolerance = 1e-9



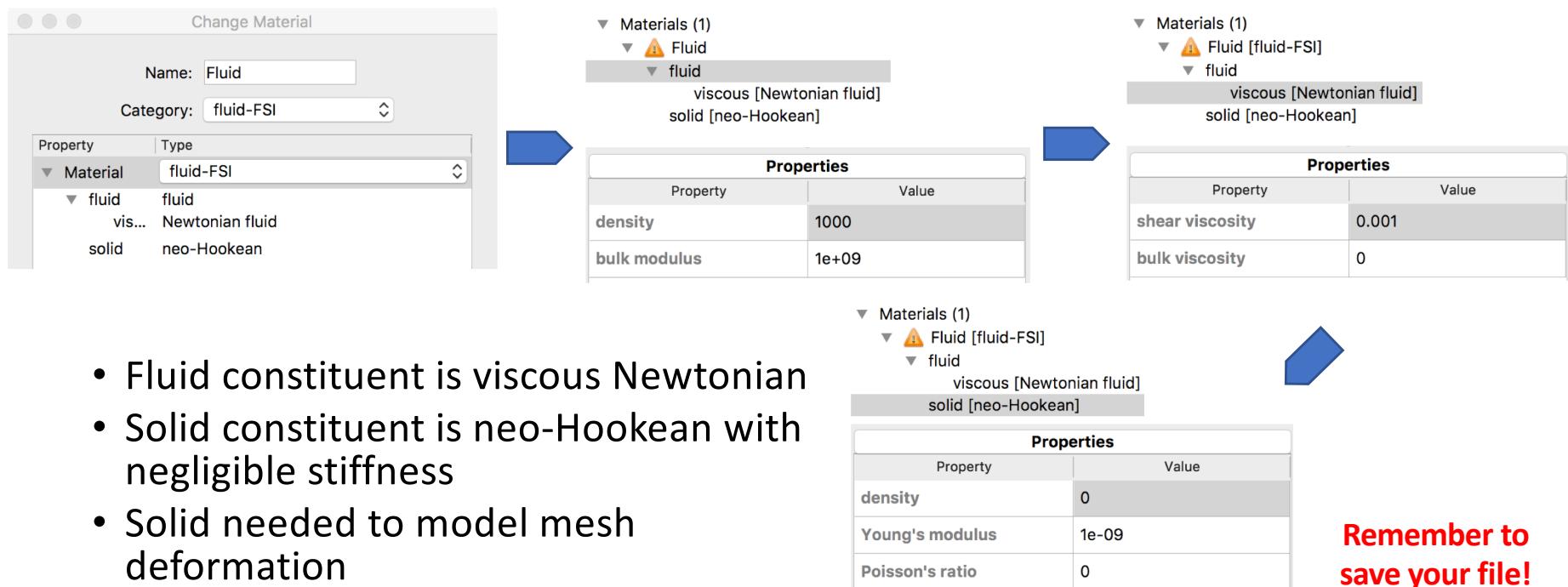
▼ Model
 Model Data
▼ Geometry (1)
 ▼ MergedObject1
 ▼ Parts (2)
 Part1
 Part3



Remember to
save your file!

Fluid-FSI Material

- Add Material



Flap Material

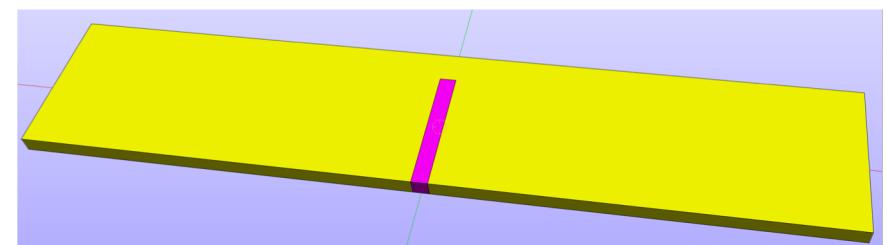
- Add Material 



Remember to
save your file!

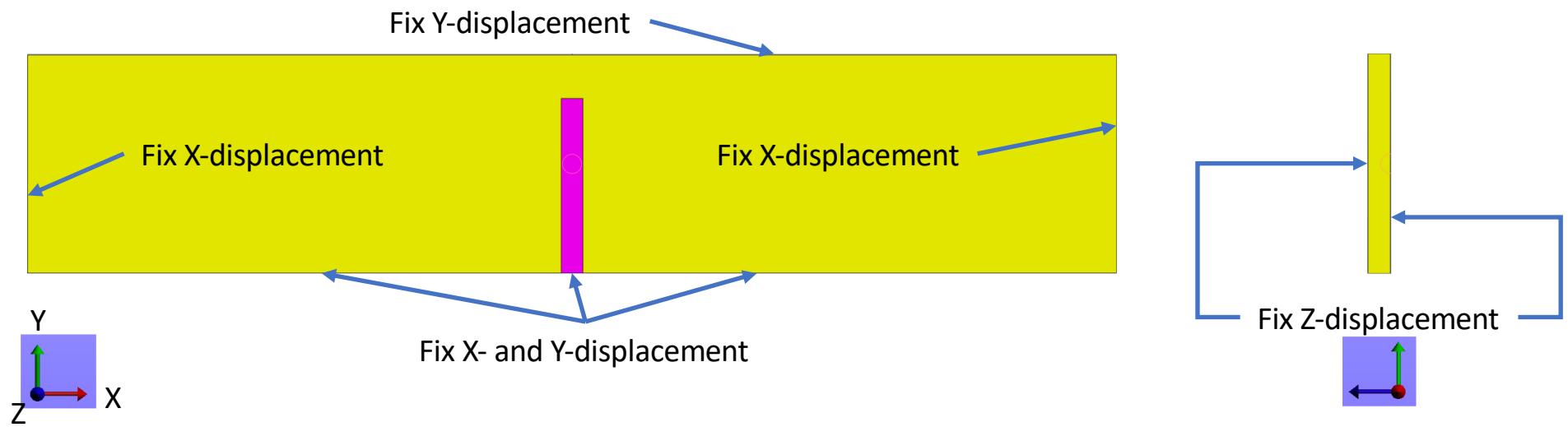
- Assign materials

- Select  Part1, assign Fluid material
- Select  Part3, assign Solid material



Mesh Displacement Boundary Conditions

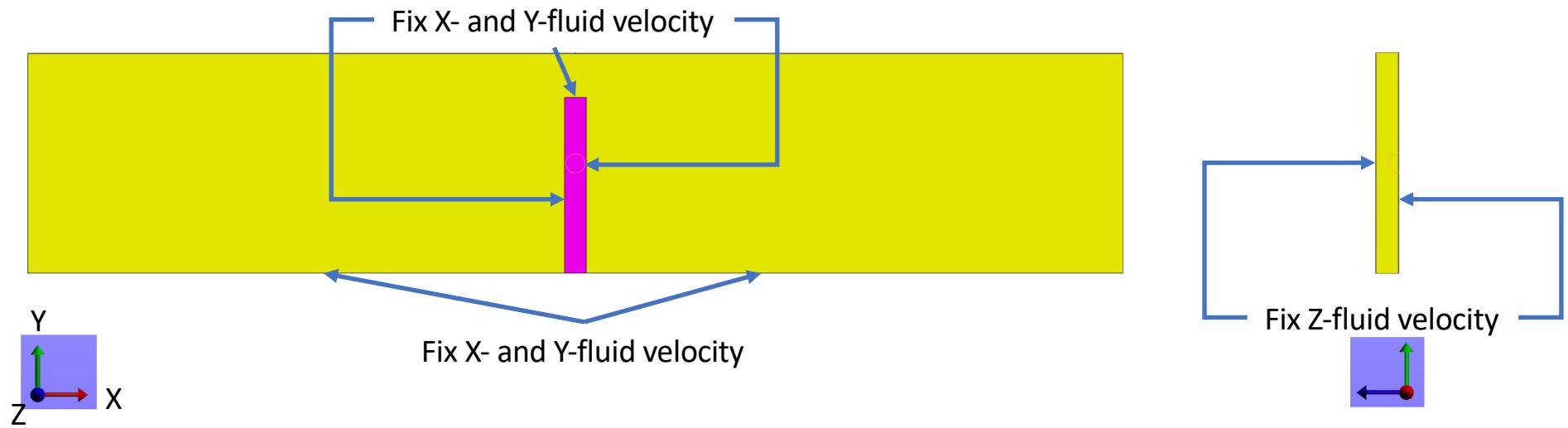
- Physics->Add Boundary Condition... -> Fixed displacement



**Remember to
save your file!**

Fluid Velocity Boundary Conditions

- Physics->Add Boundary Condition... -> Zero fluid velocity



Remember to
save your file!

Fluid Surface Loads

Apply a pressure gradient from upstream (left) to downstream (right) to drive the flow. Use back flow and tangential stabilization to deal with flow reversals at inlet and outlet. Use FSI Interface Traction to transfer the fluid traction to the flap.

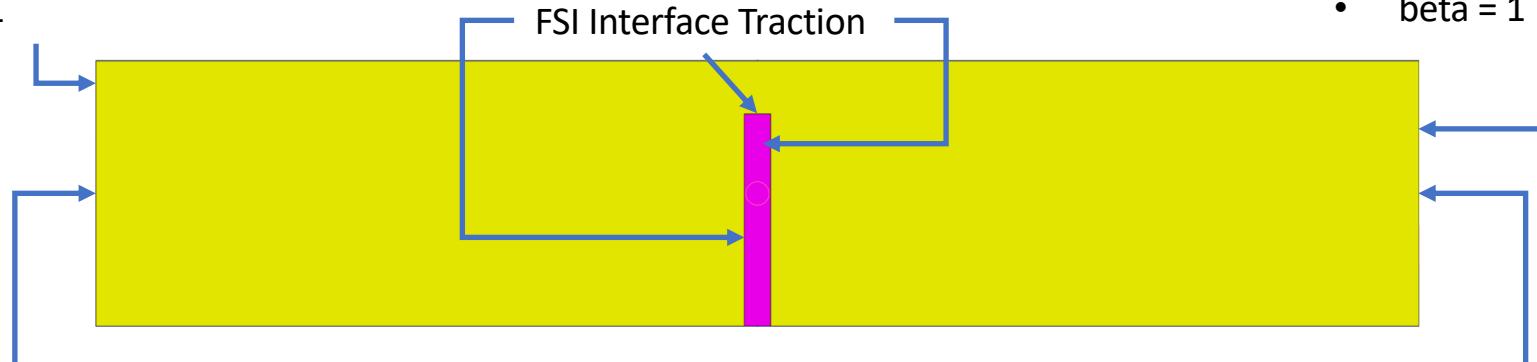
- Physics->Add Surface Load

Fluid back flow stabilization

- beta = 1

Fluid tangential stabilization

- beta = 1



Fluid flow resistance

- resistance = 0
- pressure_offset = 500

Remember to
save your file!

Fluid back flow stabilization

- beta = 1

Fluid tangential stabilization

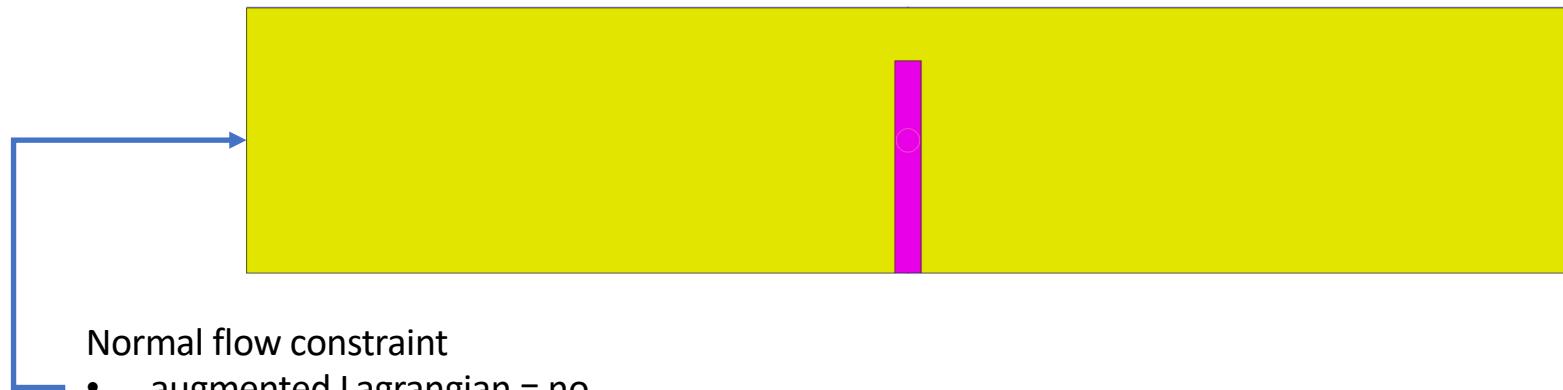
- beta = 1

Fluid flow resistance

- resistance = 0
- pressure_offset = 0

Normal Flow Constraint

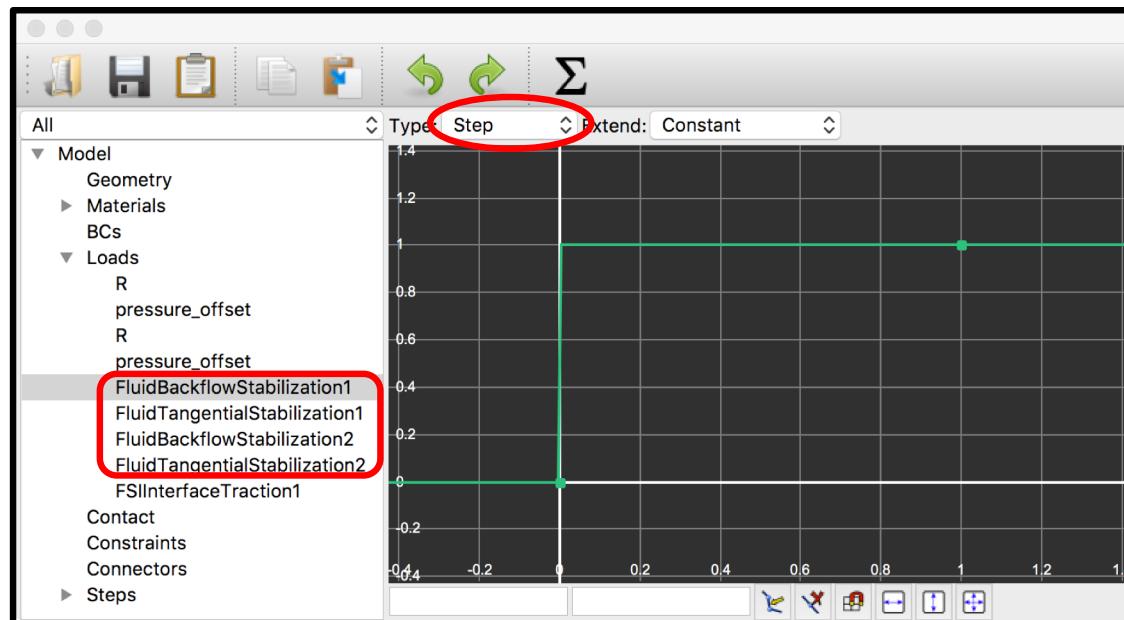
- Physics->Add Contact



Remember to
save your file!

Load Curves

- Set all flow stabilization load curves to Step

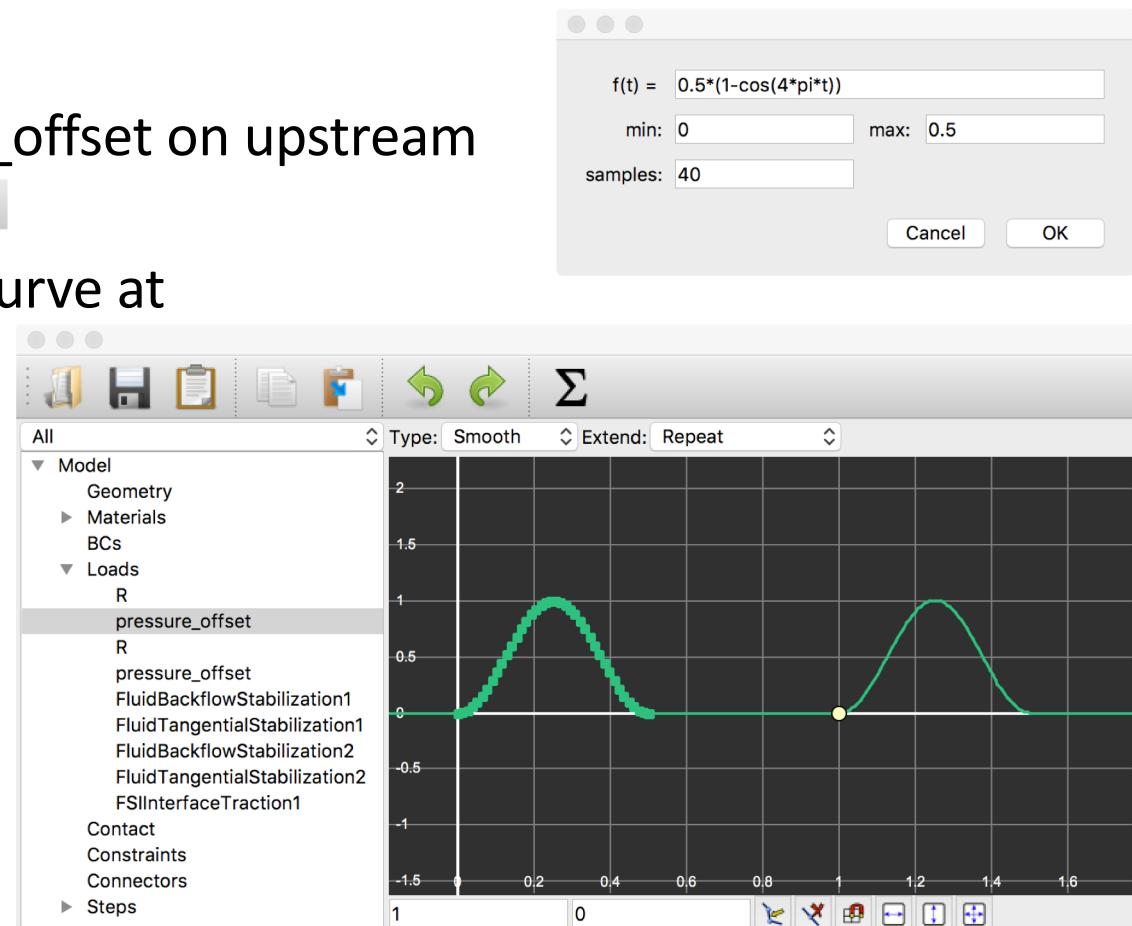


Remember to
save your file!

Pulsatile Flow

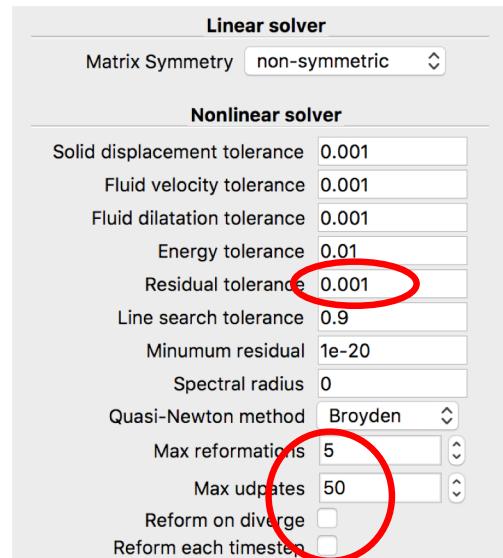
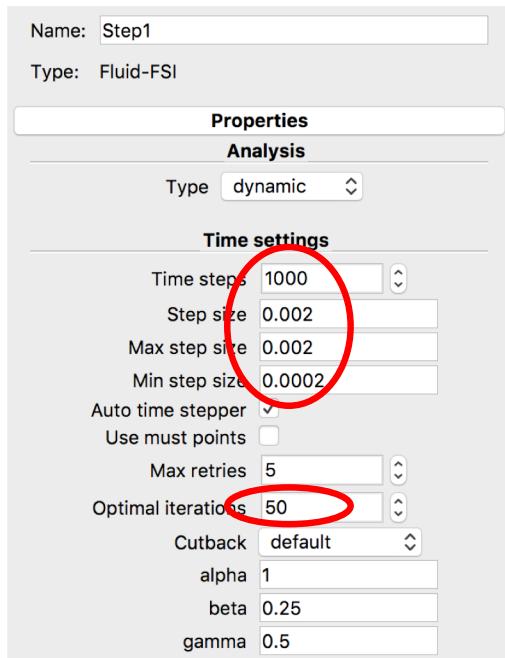
- Set load curve of pressure_offset on upstream (left) face using formula Σ
- Add new points  to loadcurve at
 - (0.501,0)
 - (1,0)
- Set Extend: Repeat

Remember to
save your file!



Fluid-FSI Analysis

- Physics->Add Analysis Step ... ->Fluid-FSI Mechanics



Non-default
settings

Remember to
save your file!

Run Analysis and View Results

- File->Export FE model...
- Run analysis
 - febio2 FlowPastFlap.feb
- Approximate run time is 20 minutes on laptop
- View results in PostView
 - Open FlowPastFlap.xplt

