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Elmer FEM – Parallelisation, nonlinear and time dependent problems

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TECHNISCHE UNIVERSITÄT WIEN

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Case 1: finite deformations on a U-shaped rod

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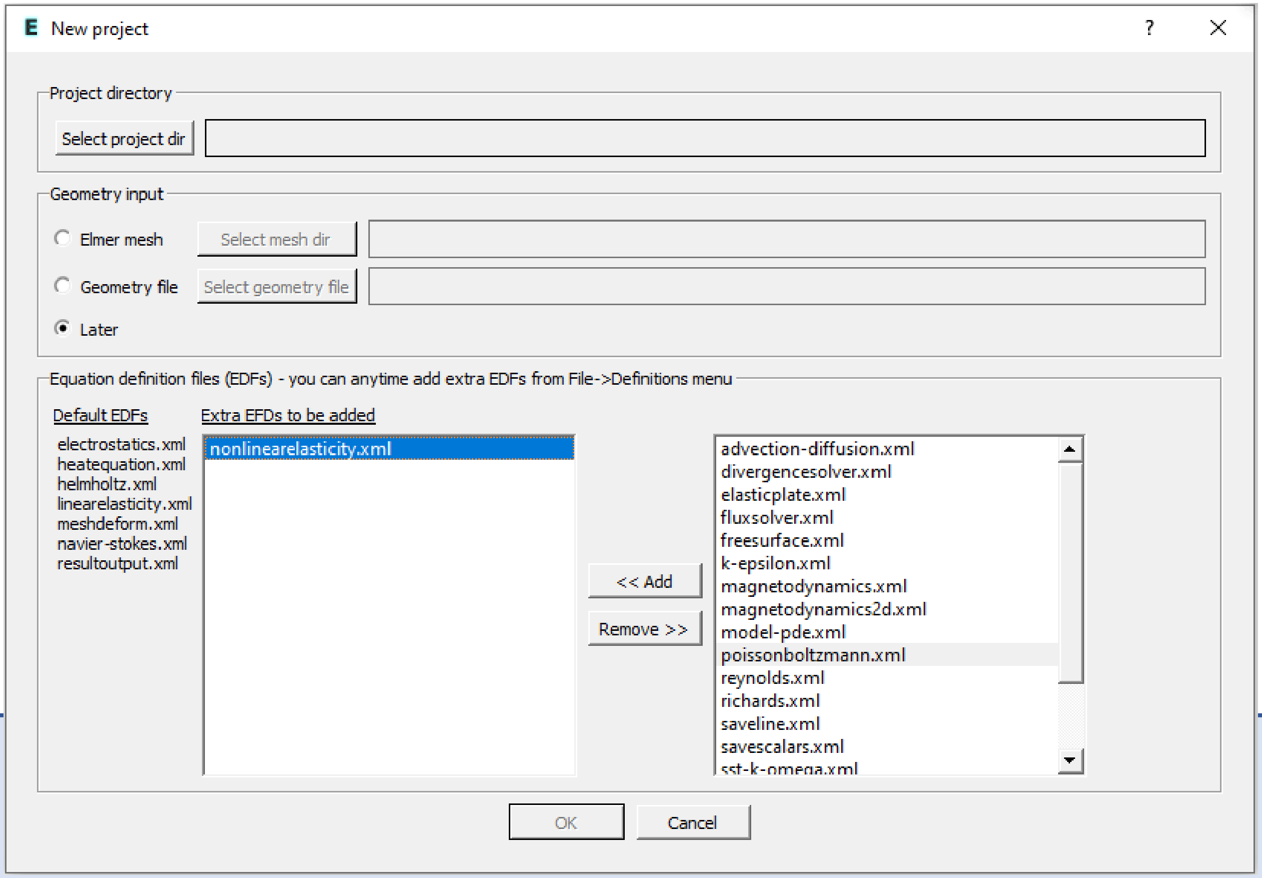
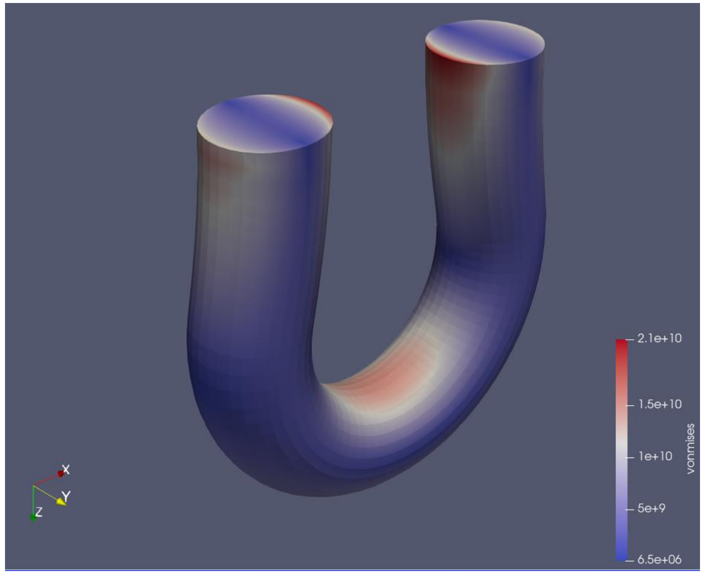
Step 1 – Open ElmerFEM - New project – Choose directory and analysis type

- module load elmer/foss-2018b
- ElmerGUI





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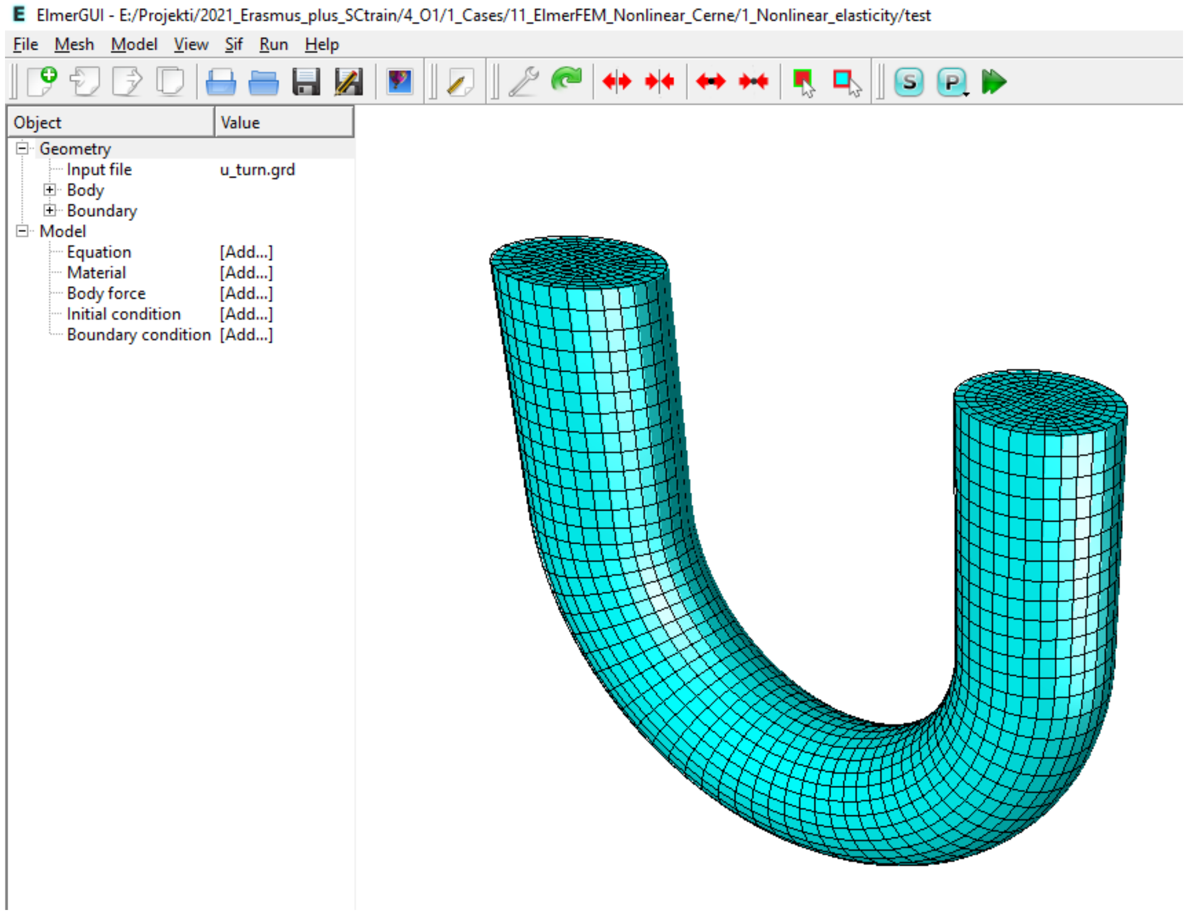
Step 2 – Load Geometry

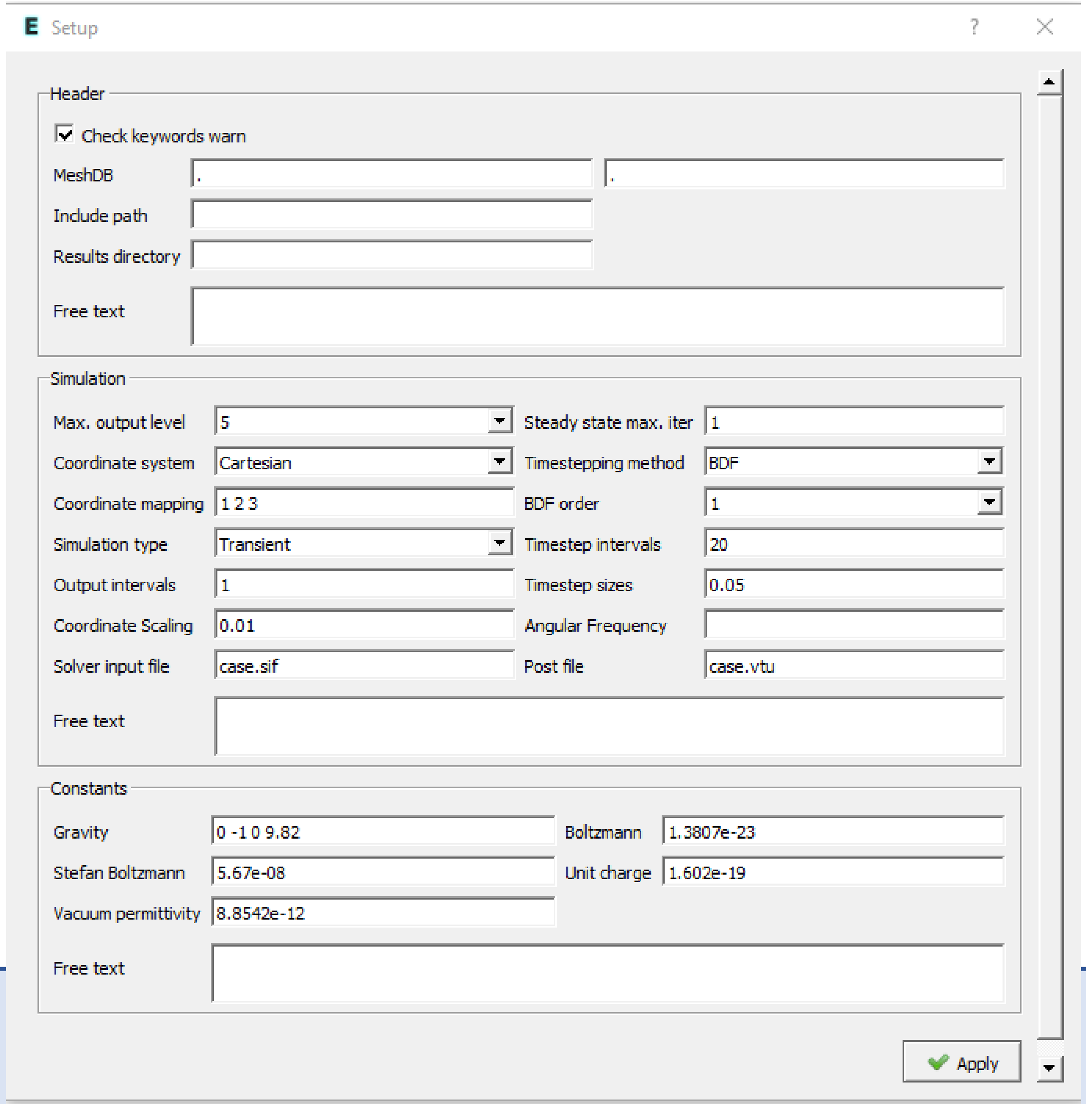
Open > select *u_turn.grd* file



Case 1: finite deformations on a U-shaped rod

Step 3 – Model setup

- Scale geometry to correct unit system
- Define time-dependent type analysis



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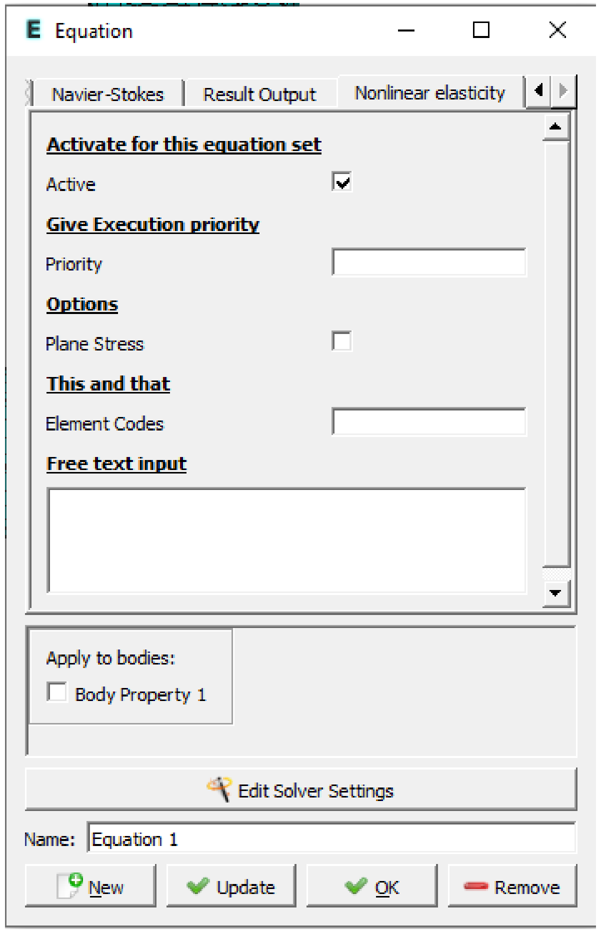
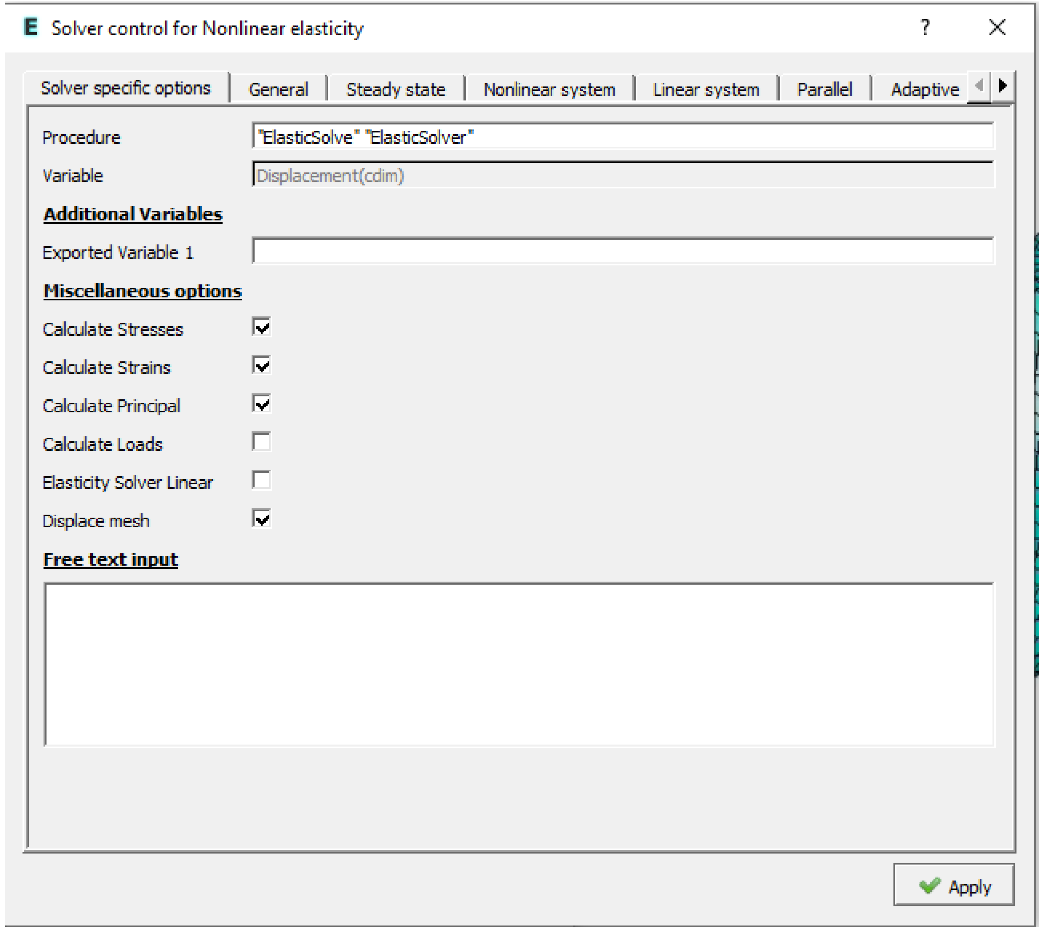
Step 4 – Select model

- *Equation* > Nonlinear elasticity
- Edit Solver Settings

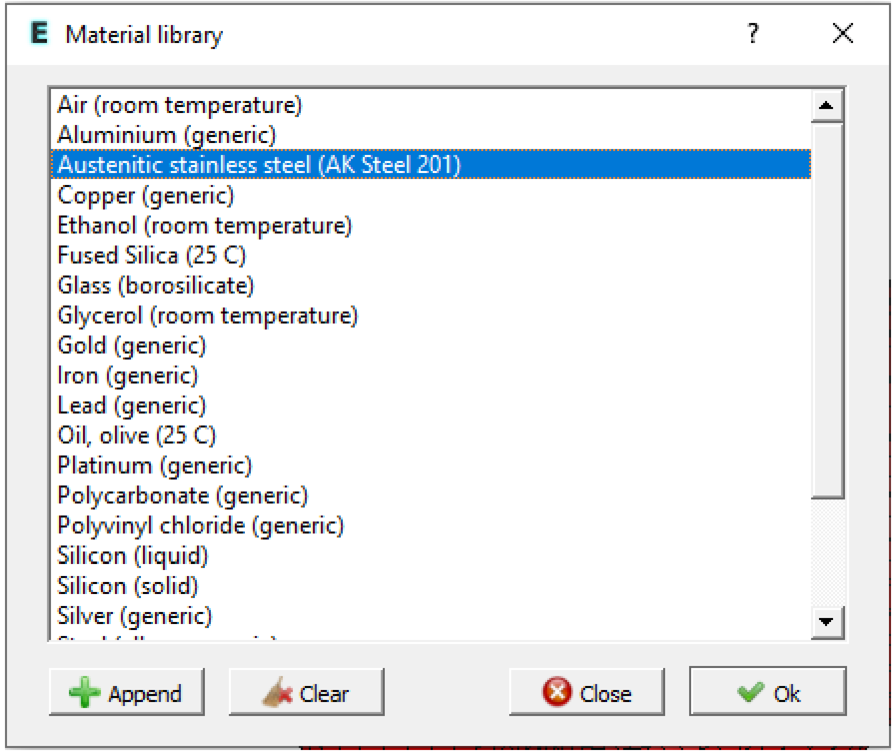




Case 1: finite deformations on a U-shaped rod

Step 5 – material

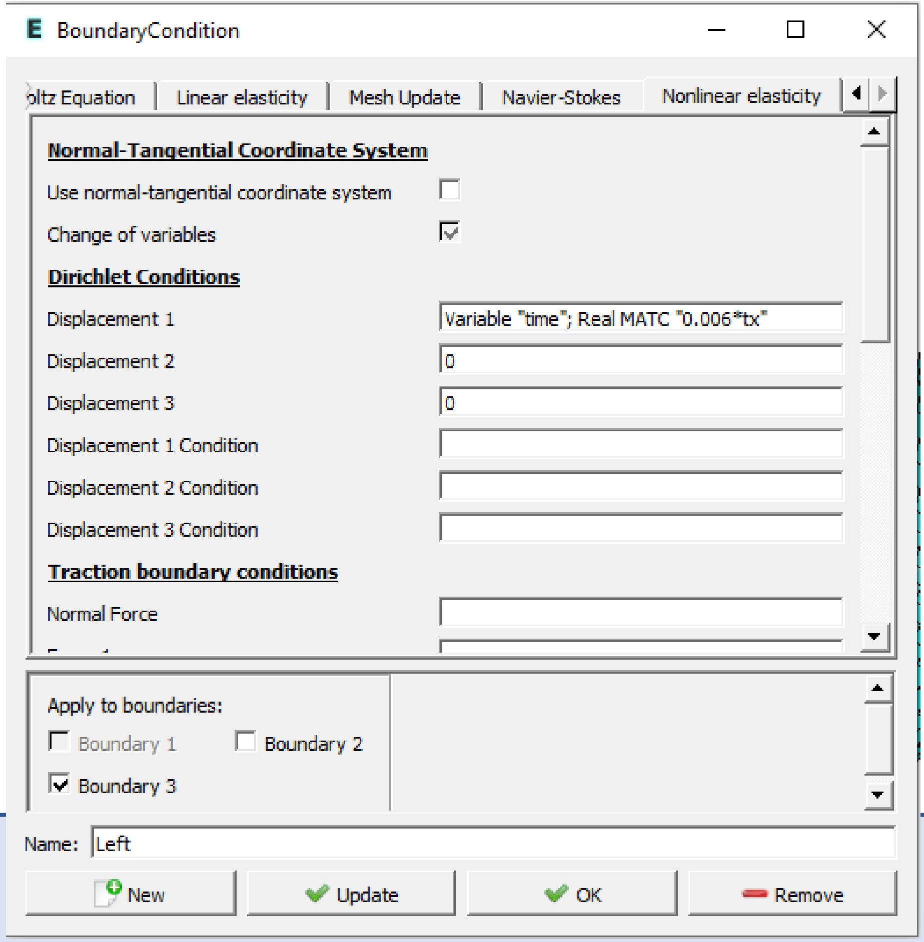
- *Material* > Material library > Austenitic stainless steel



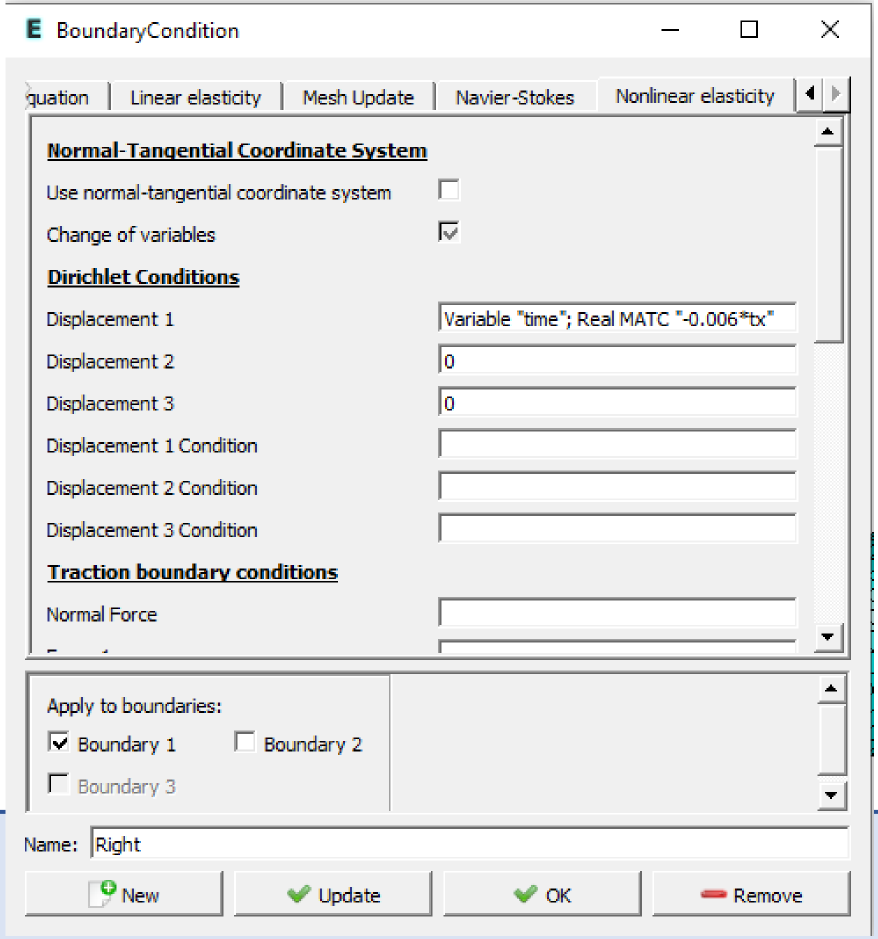
Case 1: finite deformations on a U-shaped rod

Step 6 – Boundary conditions

- Boundary condition > Left



- Boundary condition > Right



Case 1: finite deformations on a U-shaped rod

Step 7 – Run analysis

- Generate .sif file

Solver Input File

File Edit Preference

```
Header
  CHECK KEYWORDS Warn
  Mesh DB "." "."
  Include Path ""
  Results Directory ""
End

Simulation
  Max Output Level = 5
  Coordinate System = Cartesian
  Coordinate Mapping(3) = 1 2 3
  Simulation Type = Transient
  Steady State Max Iterations = 1
  Output Intervals = 1
  Timestepping Method = BDF
  BDF Order = 1
  Timestep intervals = 20
  Timestep Sizes = 0.05
  Coordinate Scaling = 0.01
  Solver Input File = case.sif
  Post File = case.vtu
End

Constants
  Gravity(4) = 0 -1 0 9.82
  Stefan Boltzmann = 5.67e-08
  Permittivity of Vacuum = 8.8542e-12
  Boltzmann Constant = 1.3807e-23
  Unit Charge = 1.602e-19
End

Body 1
  Target Bodies(1) = 1
  Name = "Body 1"
  Equation = 1
  Material = 1
End
```

- Use batch file to run the cases

CaseRun_Elmer.txt

```
#!/bin/bash
#SBATCH --export=ALL,LD_PRELOAD
#SBATCH --partition=westmere
#SBATCH -n 2
#SBATCH -o output.log

module purge
module load elmer/foo-2018b

N=$SLURM_NTASKS

dir=$(pwd)

echo case.sif > ELMERSOLVER_STARTINFO
cat ELMERSOLVER_STARTINFO
ElmerGrid 2 2 $dir -metis $N 3
srun -n $N -o output$N.log ElmerSolver_mpi
```

Case 1: finite deformations on a U-shaped rod

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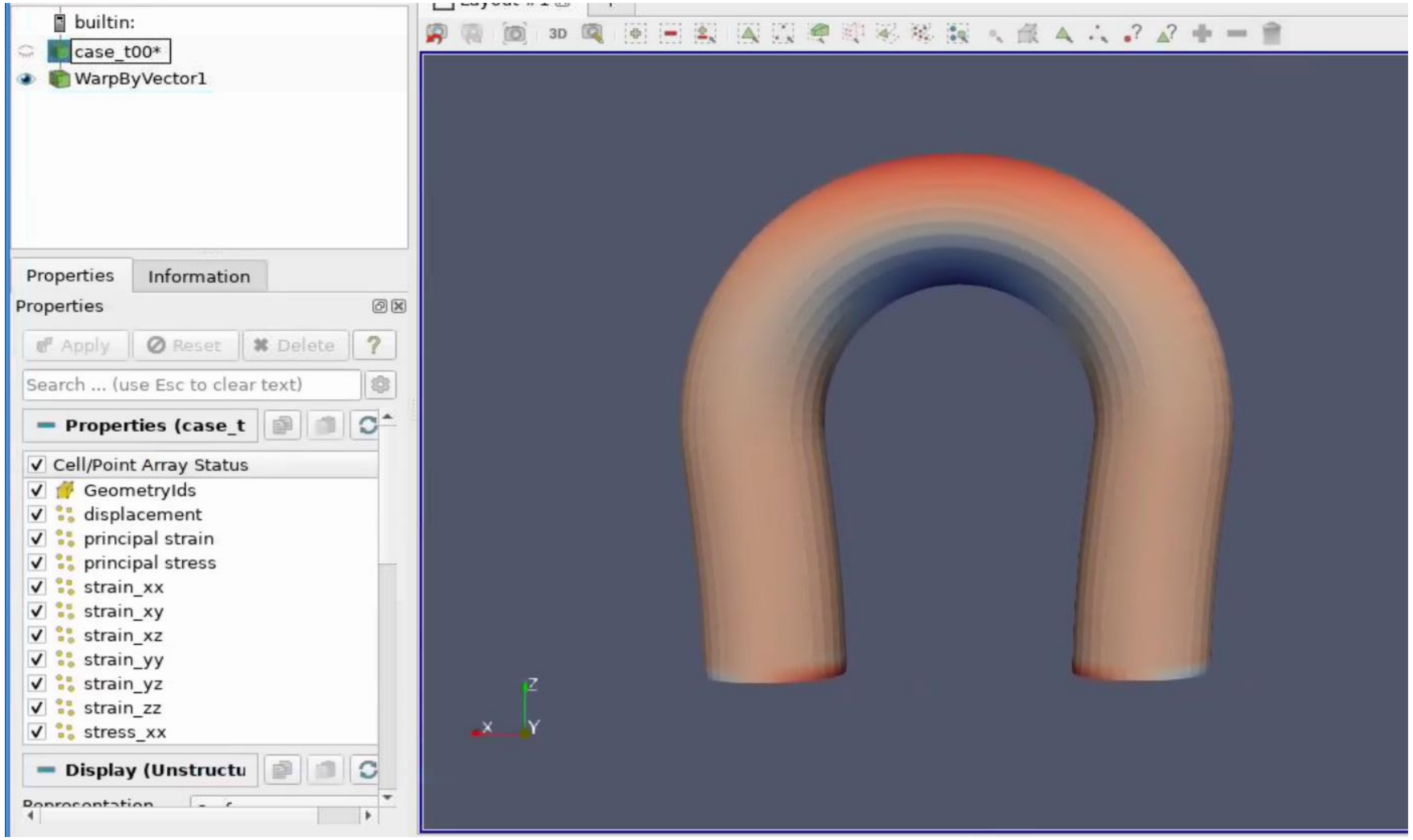
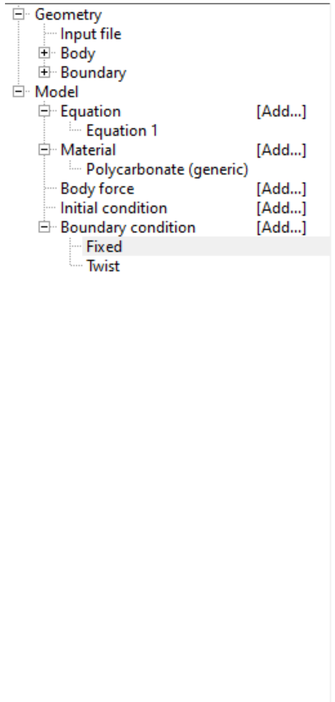
Step 8 – Postprocessing - Paraview

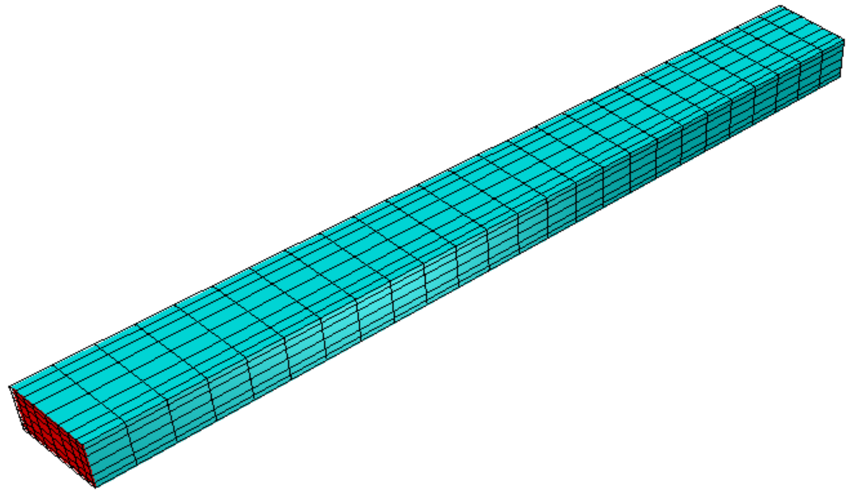
- ➢ module load ParaView/5.8.1-foss-2020b-mpi
- ➢ paraview



Case 2: Beam twisting

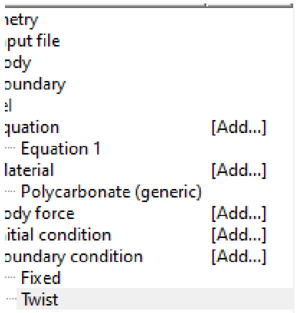
- Use similar procedure as in the previous example
- Analysis is again time-dependent: use 10 x 0.1 s time steps
- Mesh file: beam3d.grd
- Use nonlinear elasticity model
- The material in this case is Polycarbonate
- One side is fixed

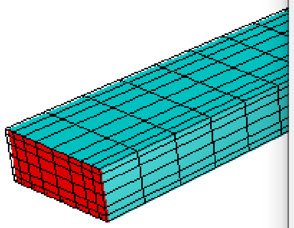


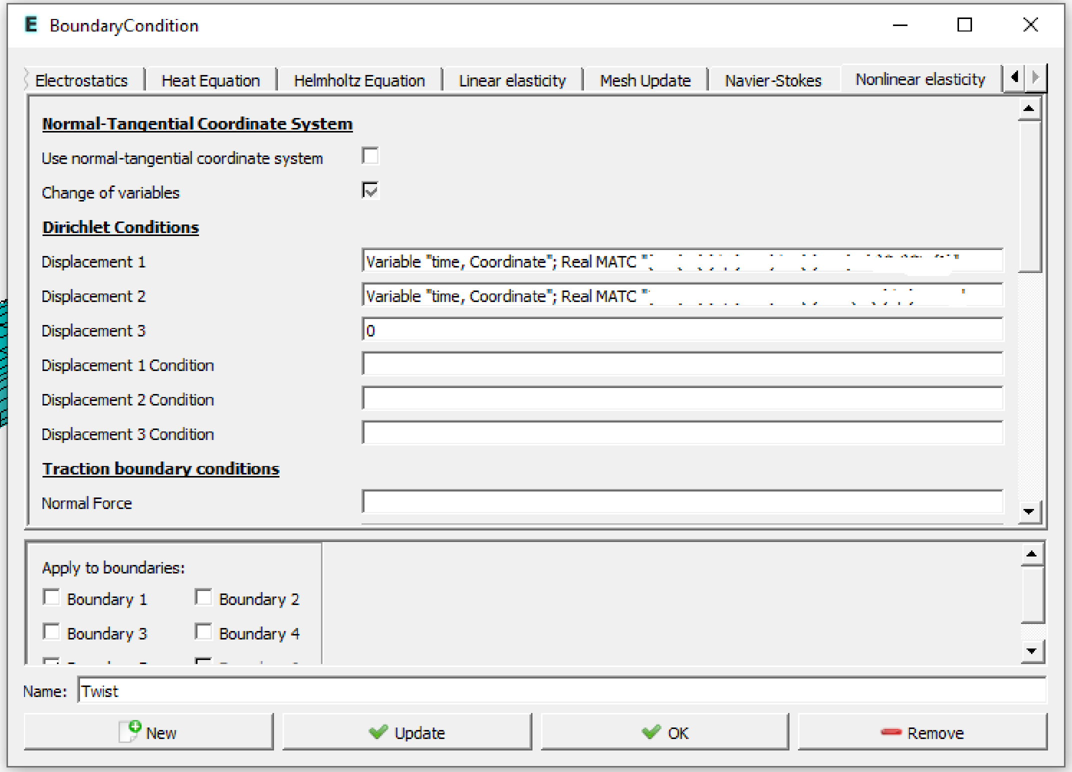


Case 2: Beam twisting

- On the other side apply rotational (twist) boundary condition
- Use set of equations below
- Use variables tx(0) for time and tx(1), tx(2) for coordinate displacements







$$
\begin{aligned}
u_x &= (\cos(\phi)-1)x - \sin(\phi)y \\
u_y &= (\cos(\phi)-1)y + \sin(\phi)x
\end{aligned}
$$

Case 2: Beam twisting

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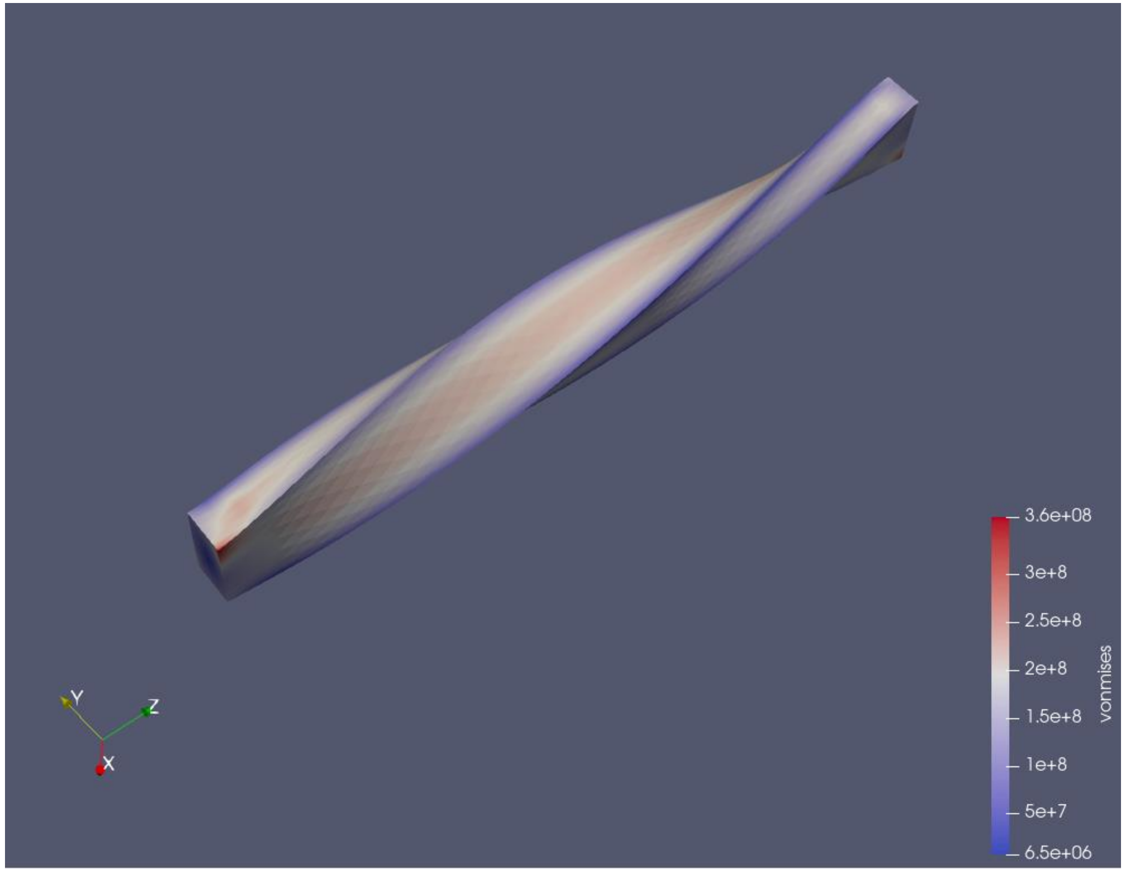
- Perform analysis using .sif input file and CRun_Elmer.txt
- Visualize time-dependent results in ParaView



Thank you for your attention!

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