# Linear Elasticity Tutorial 3D bar problem clamped at one end wile being pulled at the other end (Dirichlet-Neumann case)

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**Abstract**

This document details a single tutorials of 'linear elasticity' module of PSD in a more verbos manner.

In this section we present a 3D PSD simulation of a clamped bar which his being loaded in vertical direction at the non-clamped end. This simulation is like the one presented in previous tutorials, however in 3D. The material properties are same as before, and at the non-clamped end traction $t_y = -10^9$ units.The same problem from previous tutorials 1 and 2 is used here in 3D, a bar 5 m in length and 1 m in width and 1 m in height, and is supposed to be made up of a material with density $\rho = 8 \times 10^3$, Youngs modulus $E = 200 \times 10^9$, and Poissons ratio $\nu = 0.3$.

Here is how PSD simulation of this case can be performed.

### Step 1: Preprocessing

First step in a PSD simulation is PSD preprocessing, at this step you tell PSD what kind of physics, boundary conditions, approximations, mesh, etc are you expecting to solve.

In the terminal cd to the folder /home/PSD-tutorials/linear-elasticity. Launch PSD_PreProcess from the terminal, to do so run the following command.

```
PSD_PreProcess -problem linear_elasticity -dimension 3 -dirichletconditions 1 -tractionconditions 1 -postprocess u
```

the comandline flag -dirichletconditions 1 notifies to PSD that there is one Dirichlet border —the clamped end of the bar— in this simulation; -dimension 3 means the simulation is 3D. And the flag -tractionconditions 1 notifies to PSD that there is one traction border —the right end of the bar— in this simulation.

To provide Dirichlet conditions of the clamped end ($u_x = 0, u_y = 0, u_z = 0$) in ControlParameters.edp set Dbc0On 1, Dbc0Ux 0., Dbc0Uy 0., and Dbc0Uz 0., where 1 being the surface mesh label of the clamped end. To add the traction boundary condition set Tbc0On 2 and Tbc0Ty -1.e9, here the mesh label number of the right end is 2. For this end $\mathbf{t} = [t_x, t_y, t_z] = [0., 10^9, 0.]$, hence in ControlParameters.edp we only use Tbc0Ty -1.e9.

### Step 2: Solving

Let us now use 4 cores to solve this problem. To do so enter the following command:

```
PSD_Solve -np 4 Main.edp -mesh ./../Meshes/3D/bar.msh -v 0
```

Notice, that this is the exact same command used in solving the previous bar problems from other tutorials.

Note that for this simple problem, the bar mesh (bar.msh) has been provided in ../Meshes/3D/" folder, this mesh is a triangular mesh produced with Gmsh. Moreover detailing meshing procedure is not the propose of PSD tutorials. A user has the choice of performing their own meshing step and providing them to PSD in .msh[1] or .mesh format, we recommend using Salome or Gmsh meshers for creating your own geometry and meshing them.

### Step 3: Postprocessing

Launch ParaView and have a look at the .pvd file in the PSD/Solver/VTUs_DATE_TIME folder.

In fig. 1 there are four subdomais in the partitioned mesh since four cores were used.

[1] Please use version 2

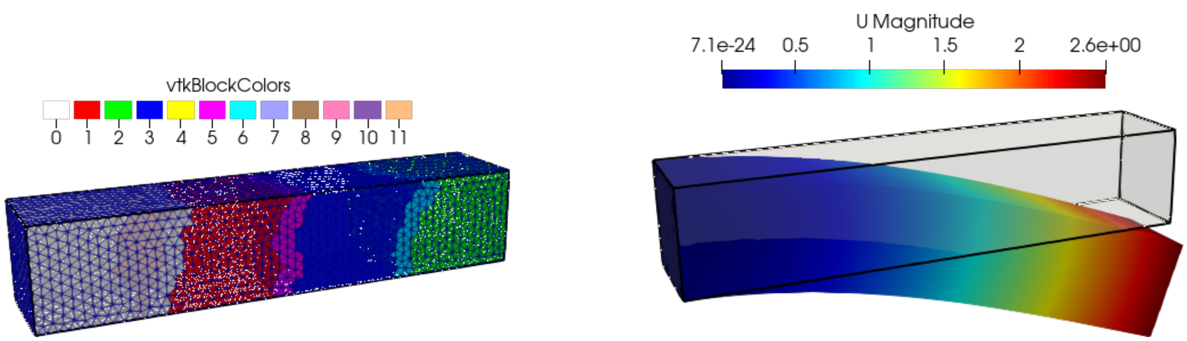


Figure 1: 3D bar results. Partitioned mesh (left) and 0.5X warped displacement field (right).