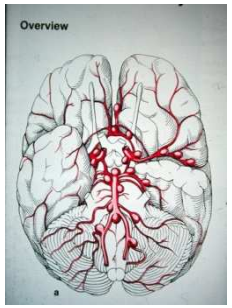
Ferenc Nasztanovics – Imre Bojtár

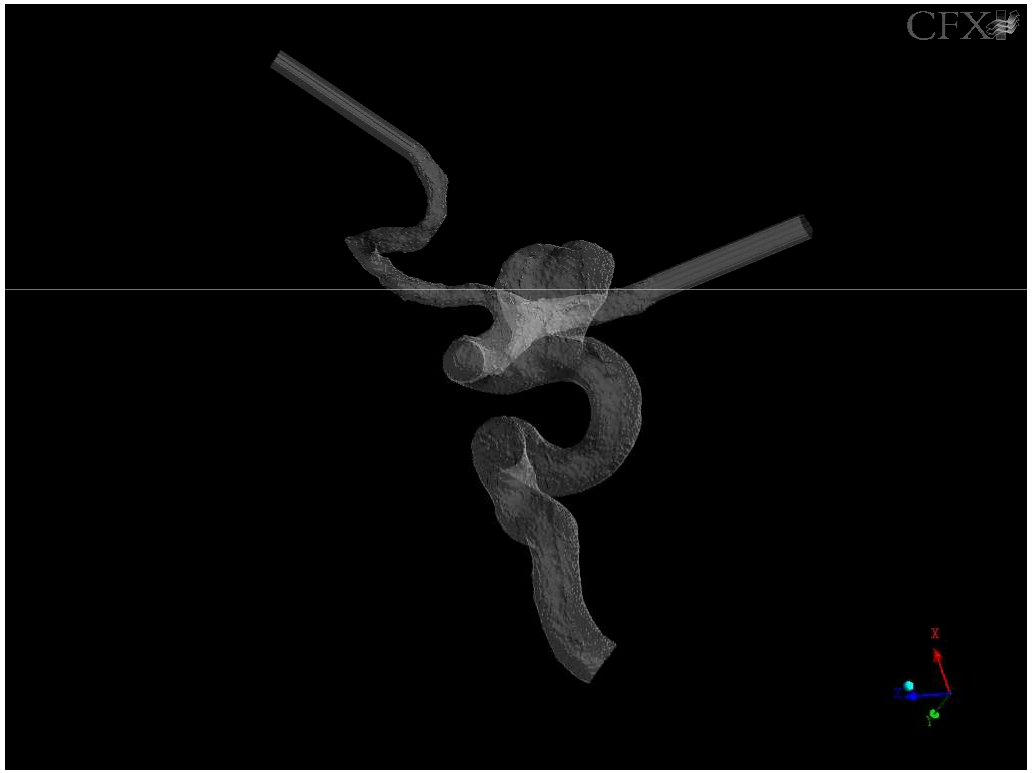
Numerical analysis of human aneurysms

The aneurysm

3D solid structure with irregular geometry and with layered nonlinear elasto-plastic orthotropic material

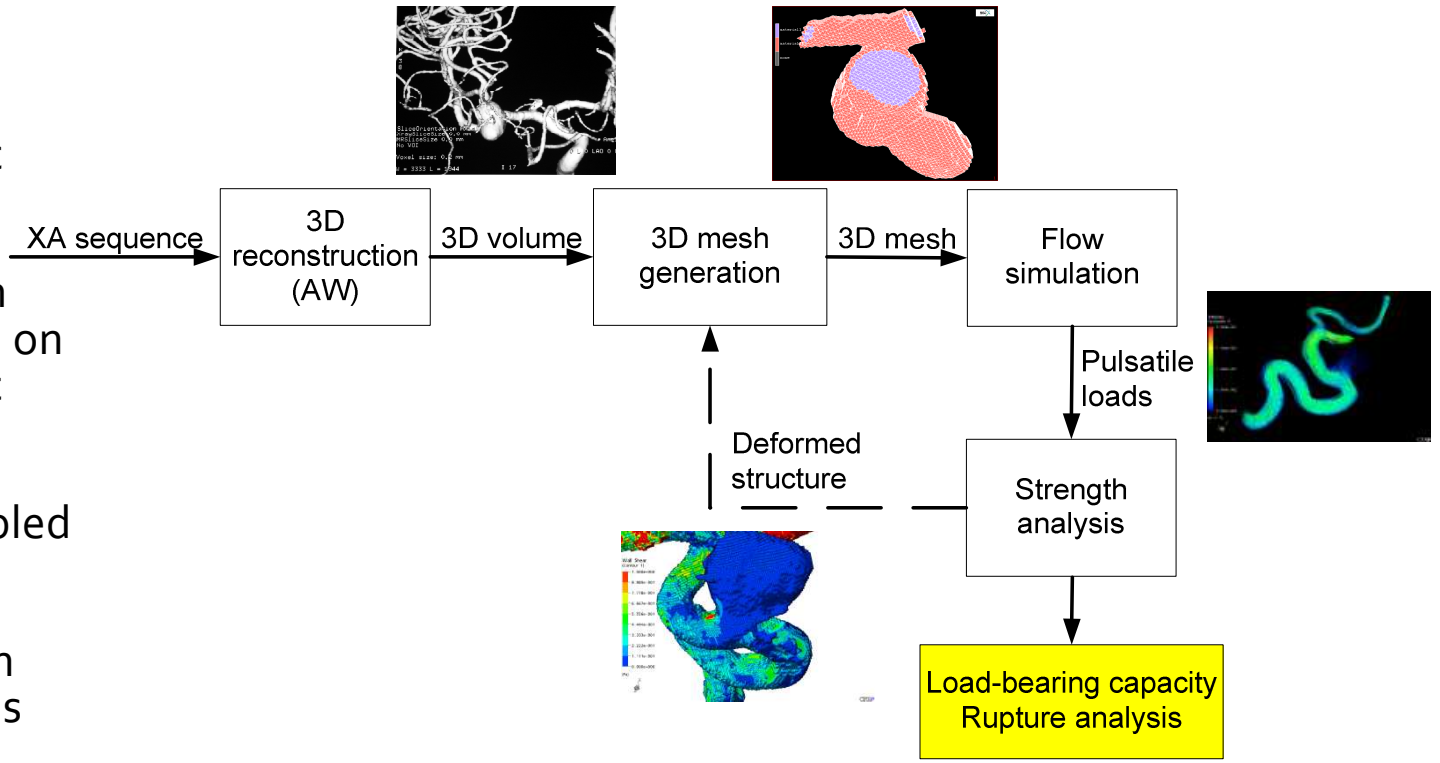
Engineering task: Coupled fluid flow - structure problem with pulsate loads – rescue the rupture





The workflow of coupled solution

- Create FE model for any GE angiograph's model
- Solve hemodynamic problem
- Solve strength analysis based on hemodynamic solution
- Solve the coupled problem
- The doctor can easier make his decision



Programs

- Our developments:
  - Data converter from GE's angiograph
  - Mesh generator module
  - Mesh and parameter writing modules
- Commercial products:
  - Ansys 10
  - CFX 10

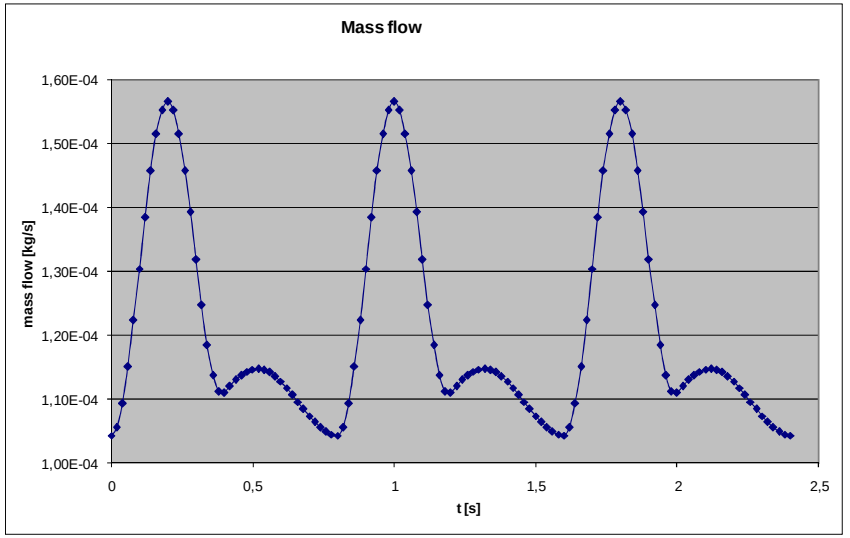
Model generating

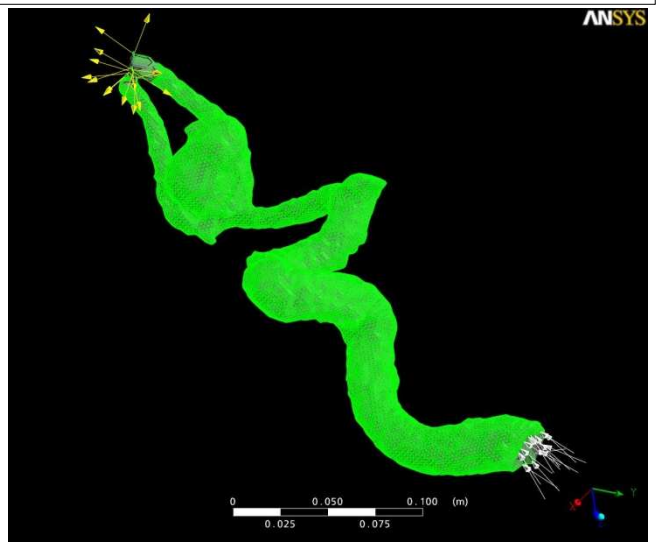
- It coded in C++
- Use only STL (Standard Template Library)
- Effective algorithm
- Parametric mesh

- Input:
  - 512 x 512 x 512 = 134.217.728 point's density
  - A threshold – a special value, assume the cell is blood
  - Distance between points
- Output:
  - FEM mesh
  - ANSYS/CFX running script

Hemodynamic analysis

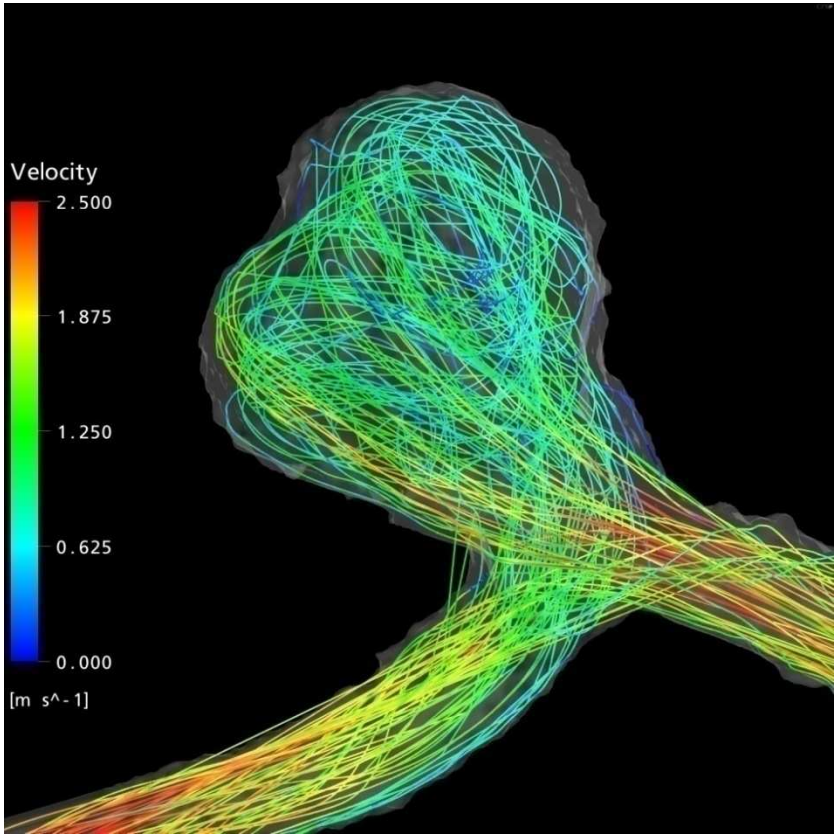
- Boundary conditions
  - Wall: v = 0 m/s
  - Inlet: time depend mass flow →
  - Outlet: p = 0 Pa
- Coupled case
  - Wall: displacement got from strenght analysis
  - Inlet: time depend mass flow →
  - Outlet: p = 0 Pa



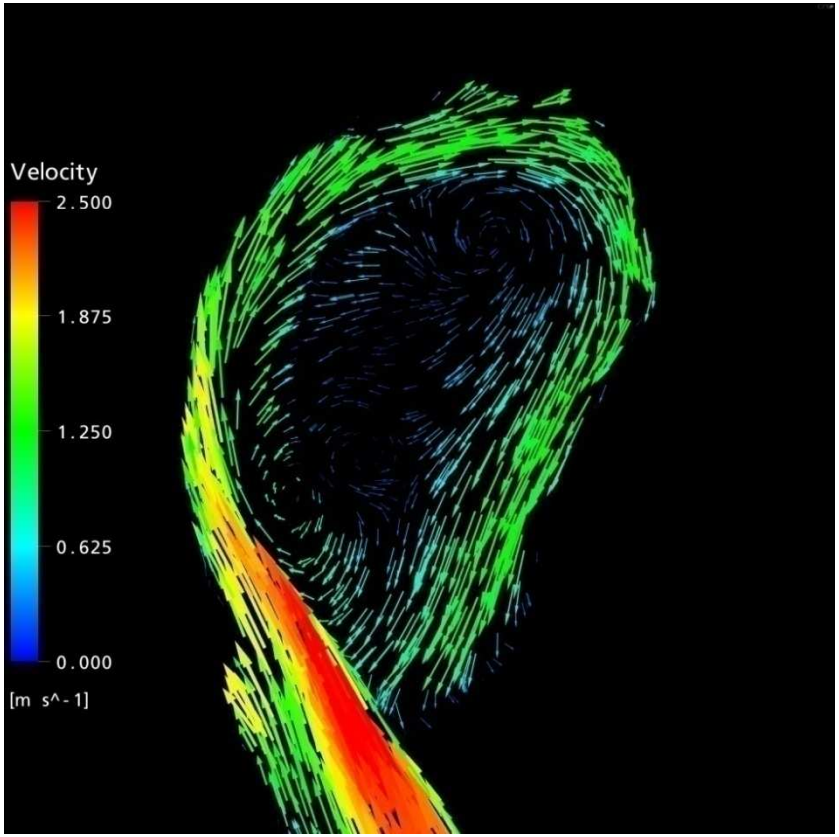


Hemodynamic analysis

STREAMLINE

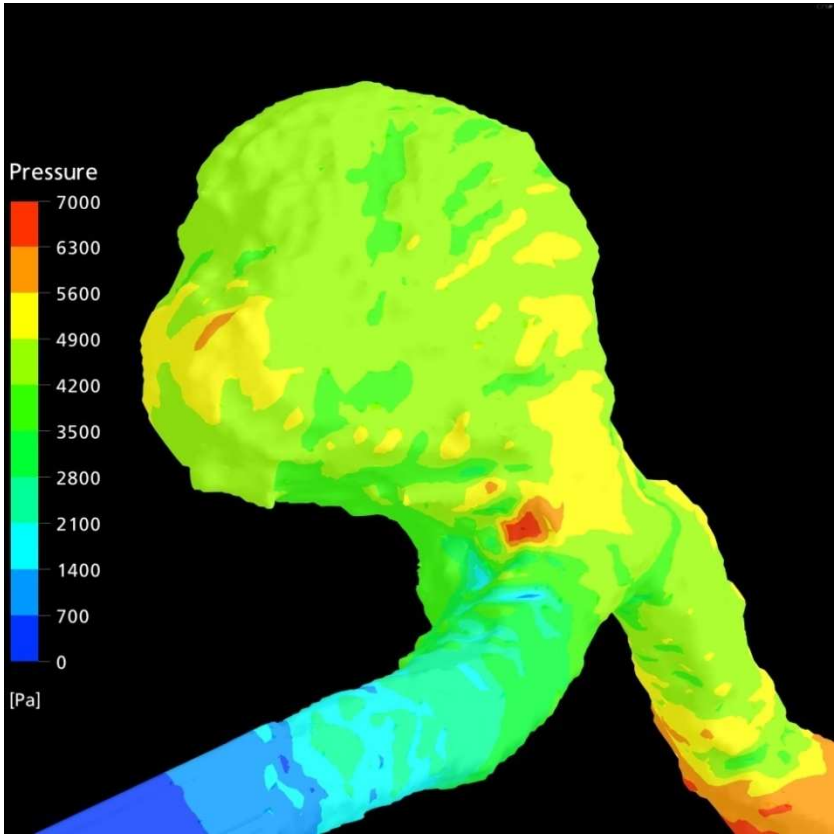


VELOCITY VECTORS

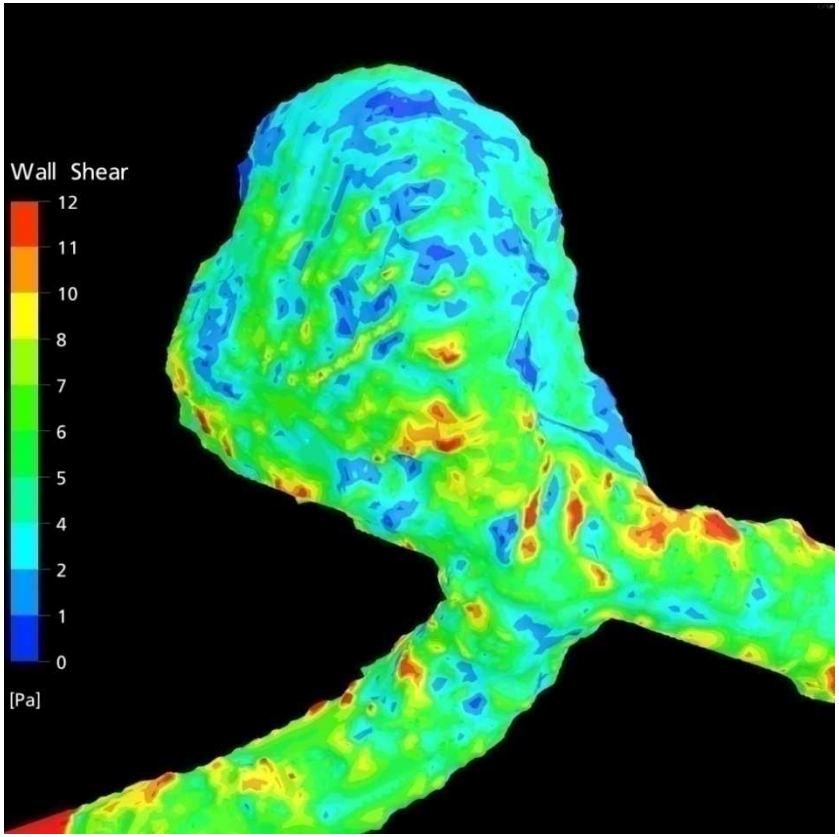


Hemodynamic analysis

PRESSURE

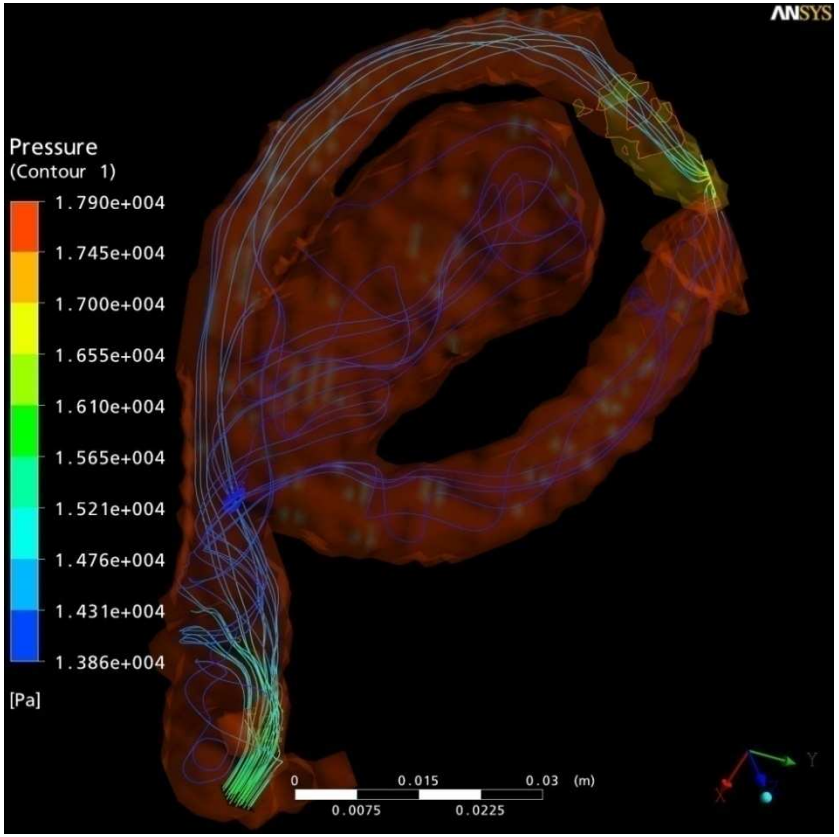


SHEAR

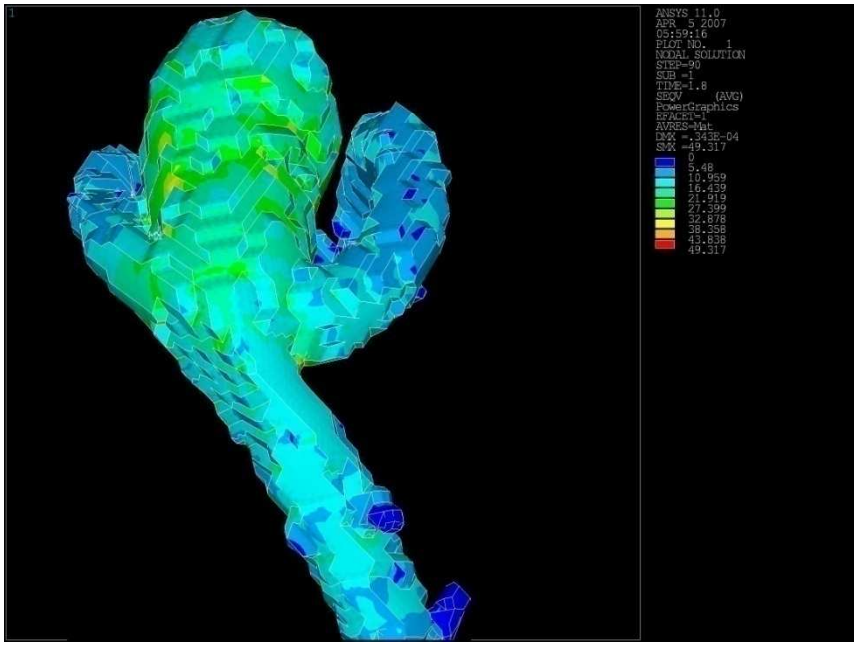


First coupled analysis

STREAMLINE & PRESSURE

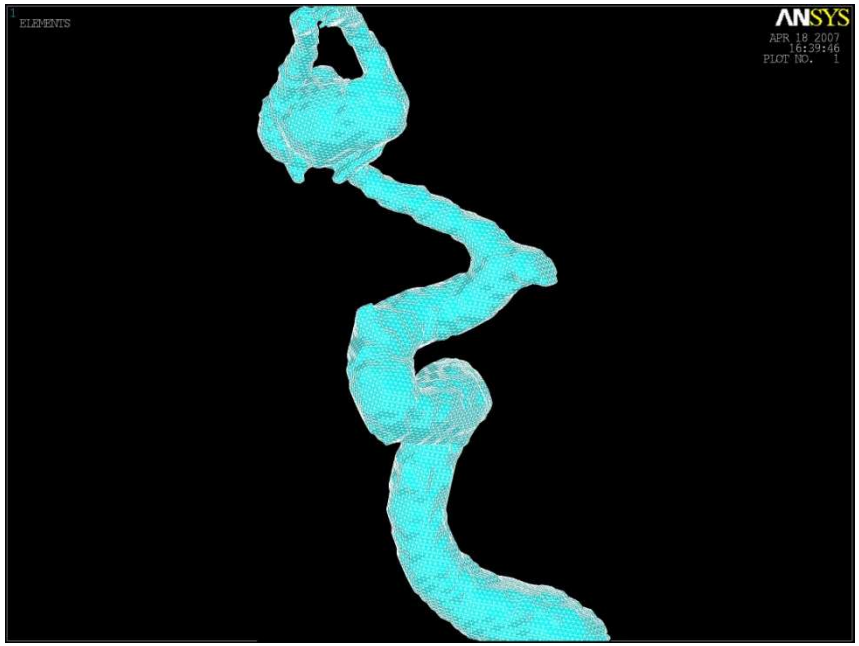


VON MISES STRESS

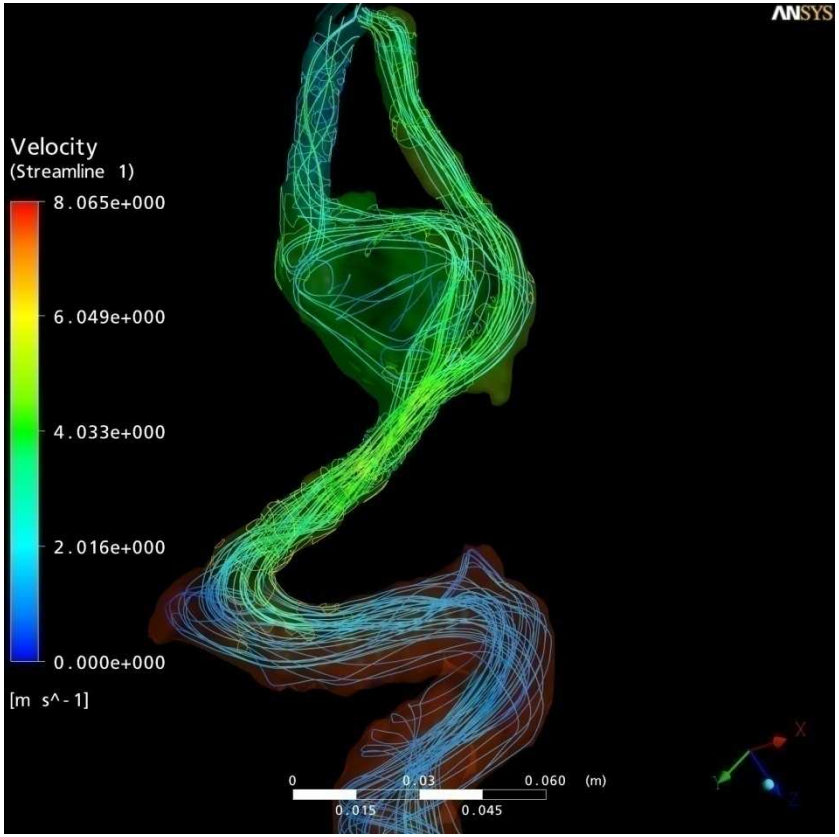


Coupled solution

ORIGINAL GEOMETRY

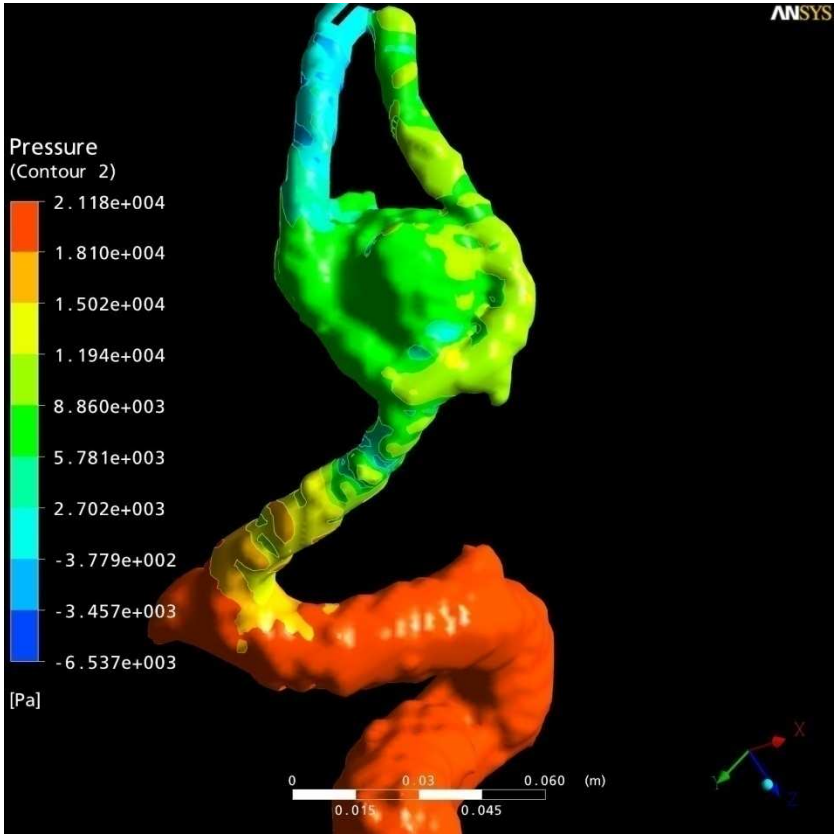


STREAMLINES

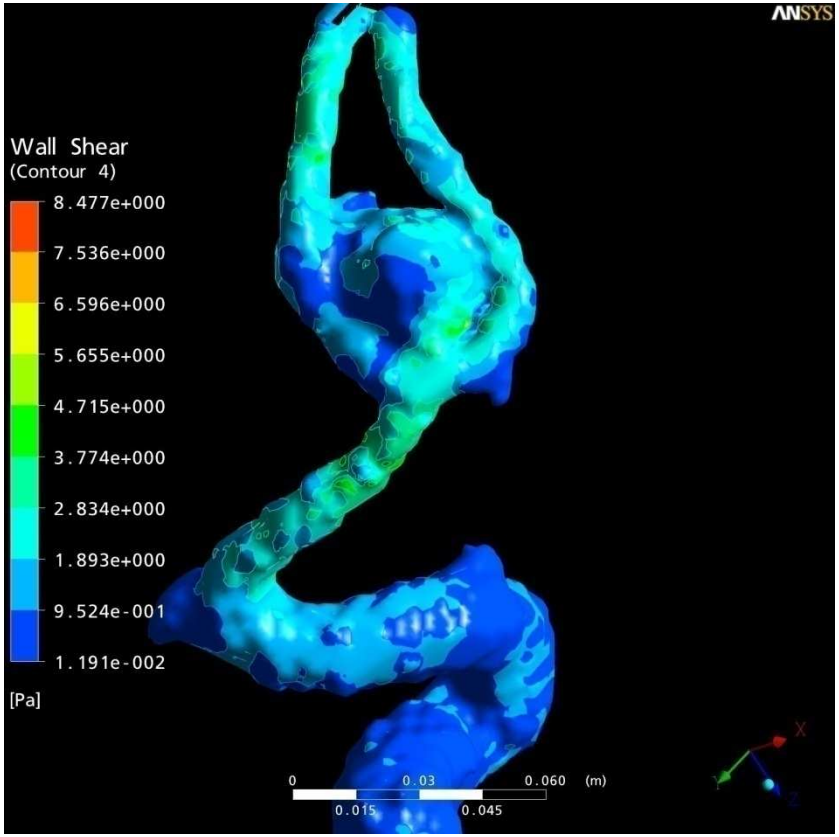


Coupled solution

PRESSURE

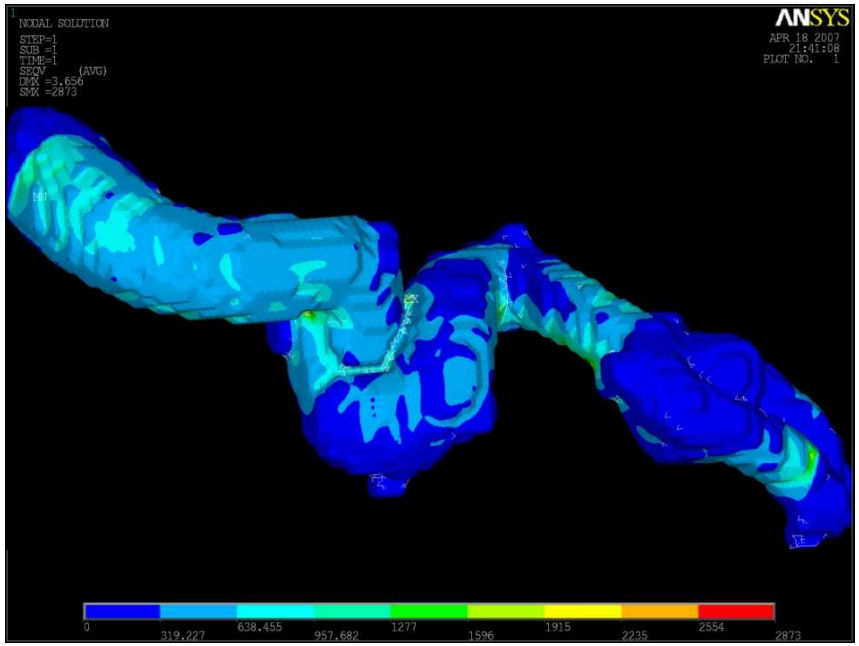


SHEAR

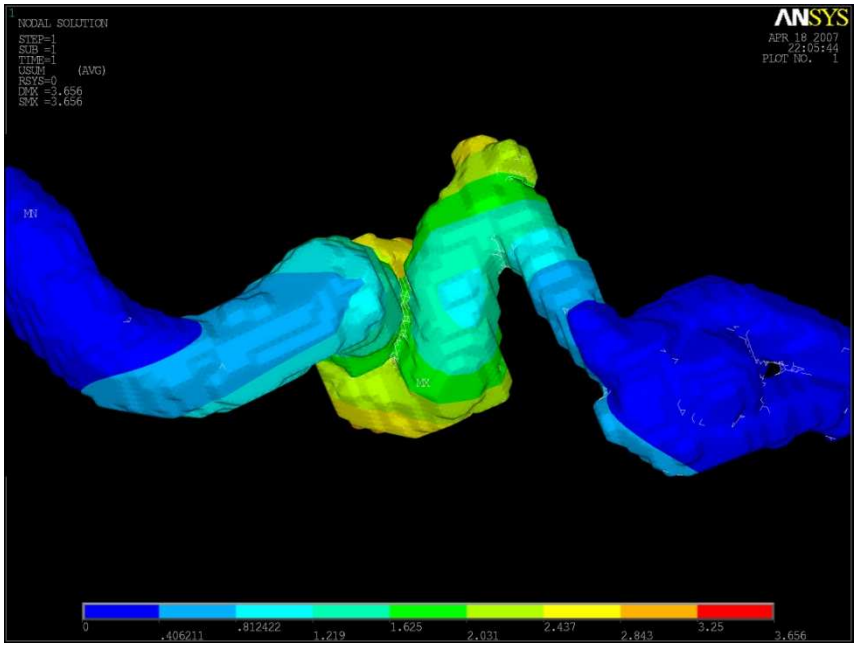


Coupled solution

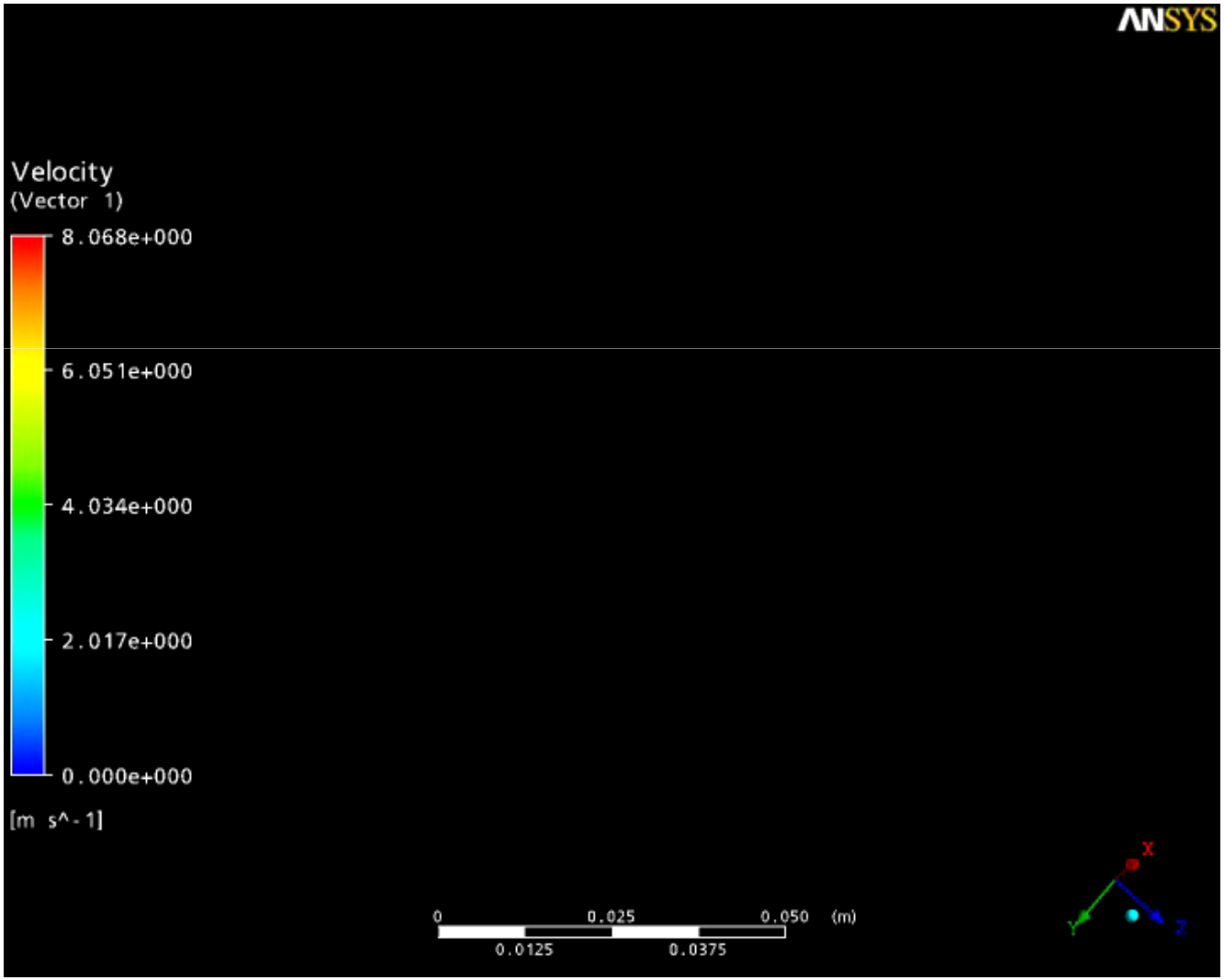
VON MISES



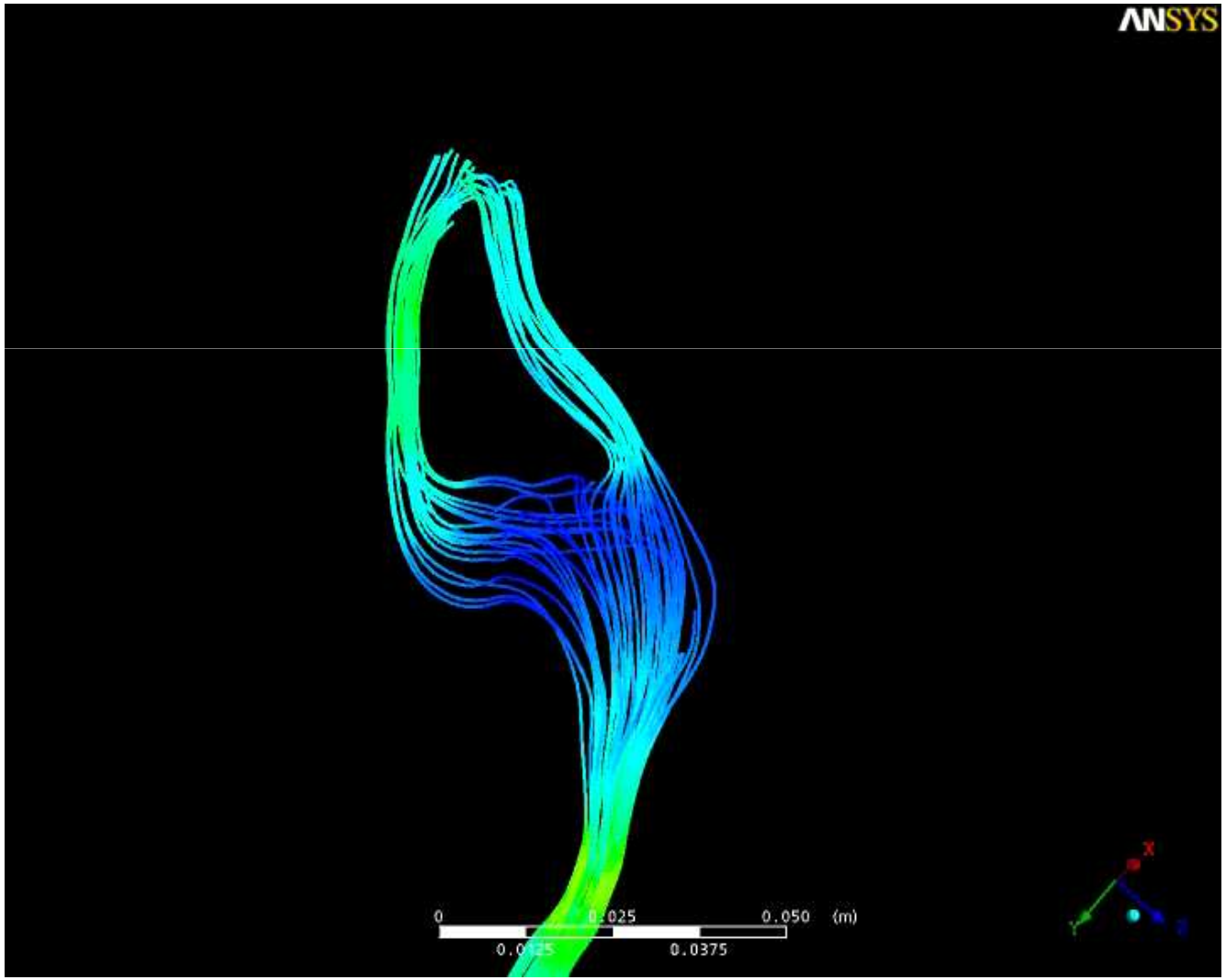
DISPLACEMENTS



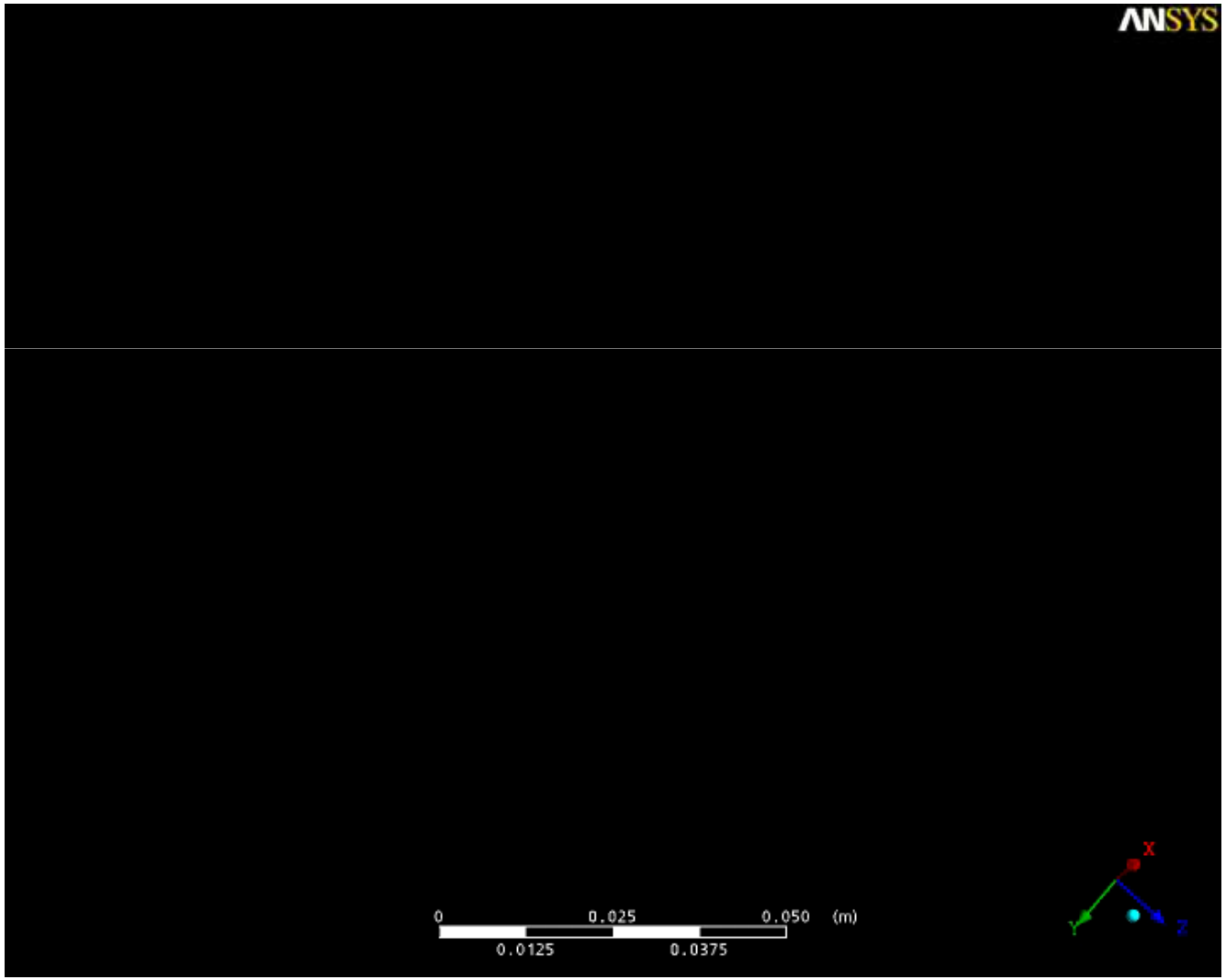
Animation


ANSYS
Velocity
(Vector 1)
8.068e+000
6.051e+000
4.034e+000
2.017e+000
0.000e+000
[m s^-1]
0
0.025
0.050
(m)
0.0125
0.0375
X
Y
Z

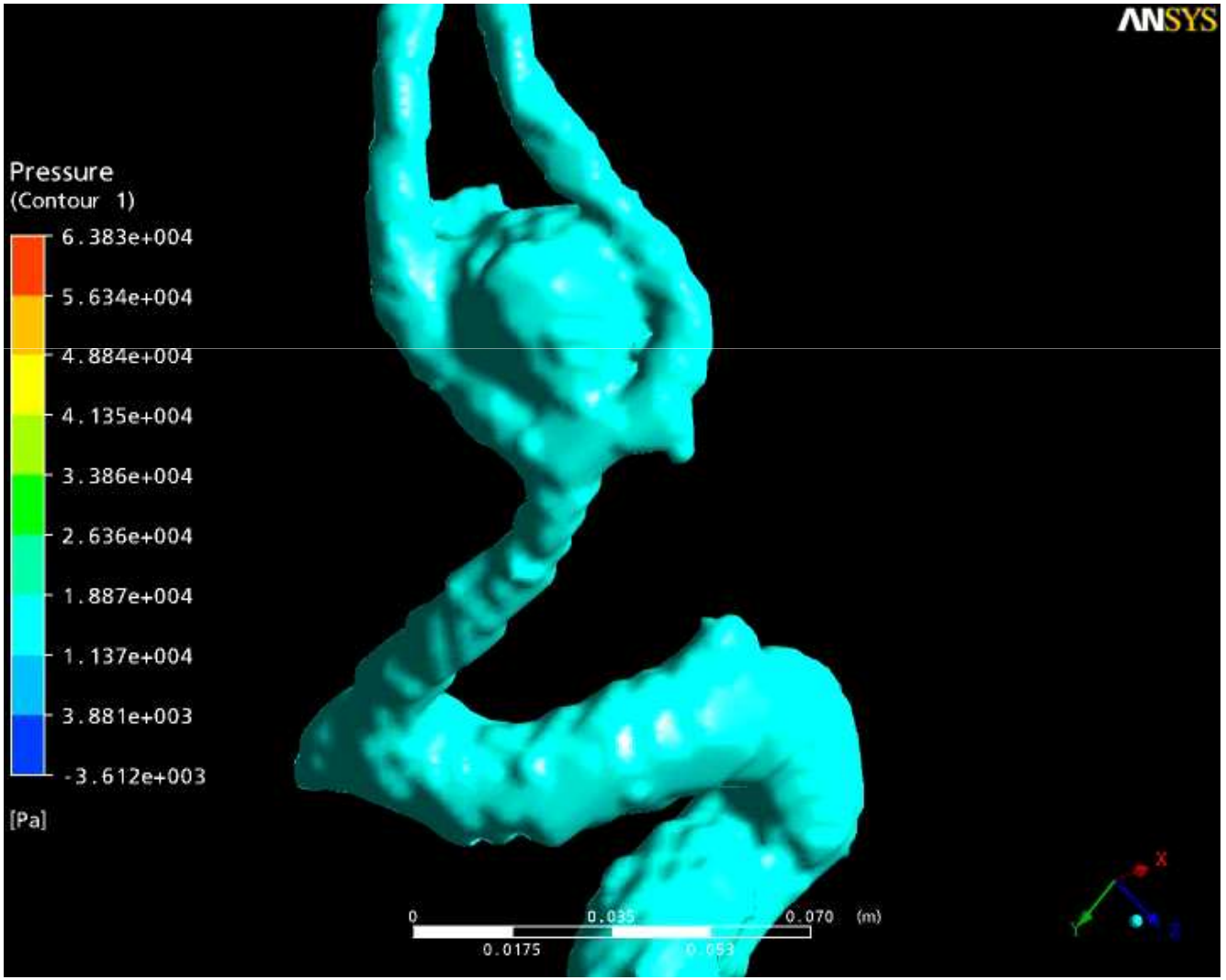
Animation



Animation



Animation


ANSYS
Pressure
(Contour 1)
6.383e+004
5.634e+004
4.884e+004
4.135e+004
3.386e+004
2.636e+004
1.887e+004
1.137e+004
3.881e+003
-3.612e+003
[Pa]
0
0.035
0.070
(m)
0.0175
0.053
X

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Thank you for your attention!