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Modeling of Corrosion in Oxygen Controlled Lead Bismuth Eutectic Systems with the Coupling of Chemical Kinetics and Hydrodynamics

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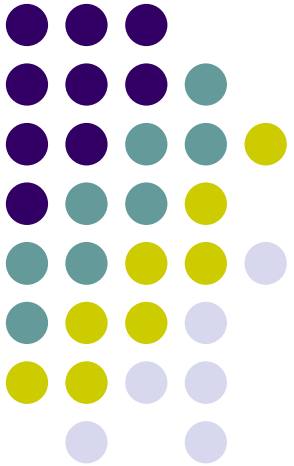
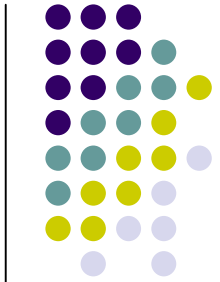
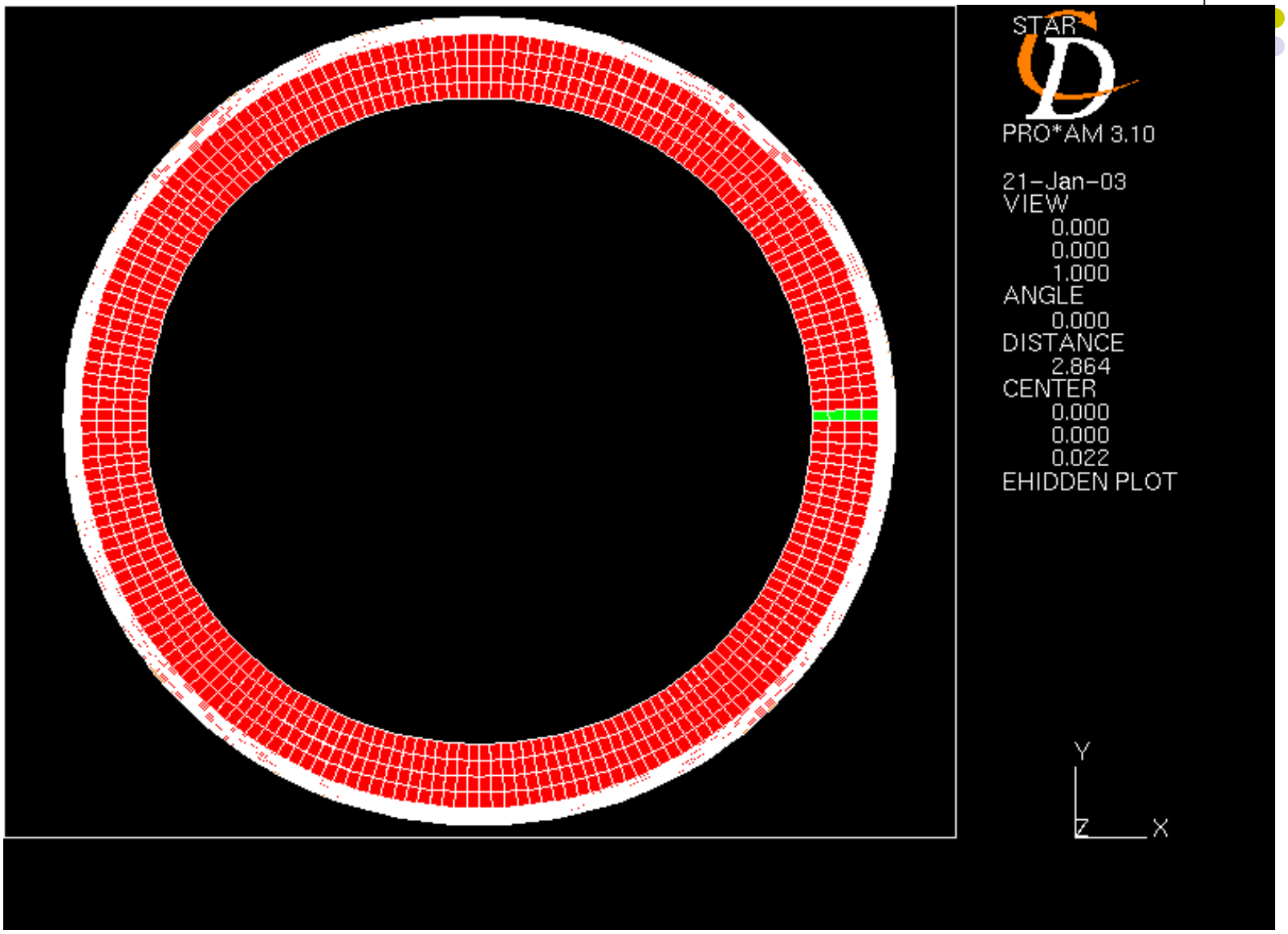


Objectives - 1

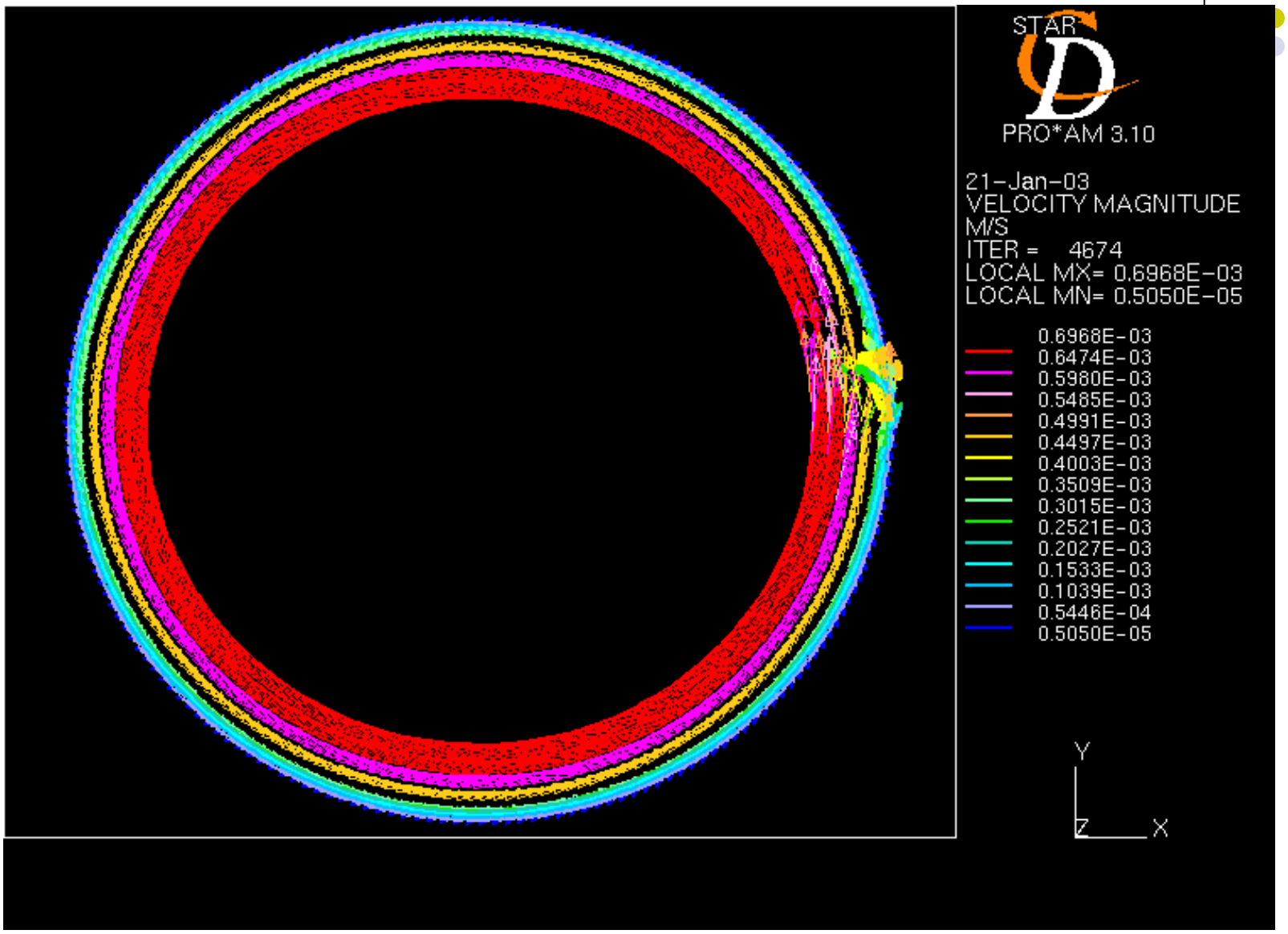


- To simulate a 2-D model of the Materials Test Loop by approximating it to be a toroid with a pie cross section for the purpose of comparing the simulated results with the analytical results.
- The temperature and concentration profiles on the wall boundaries imposed are similar to the actual test model.

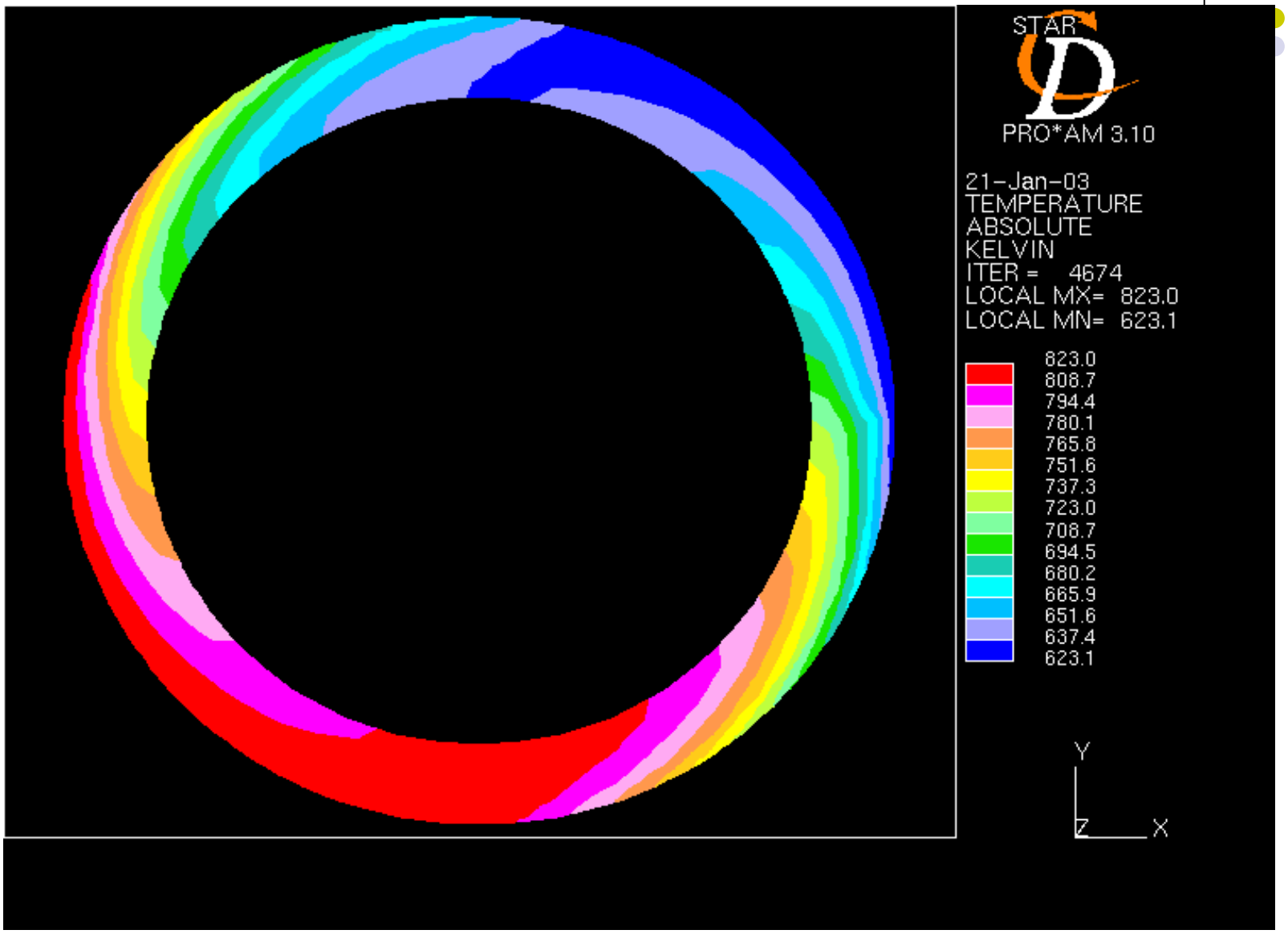
Geometry of the Model Loop Considered for Simulation



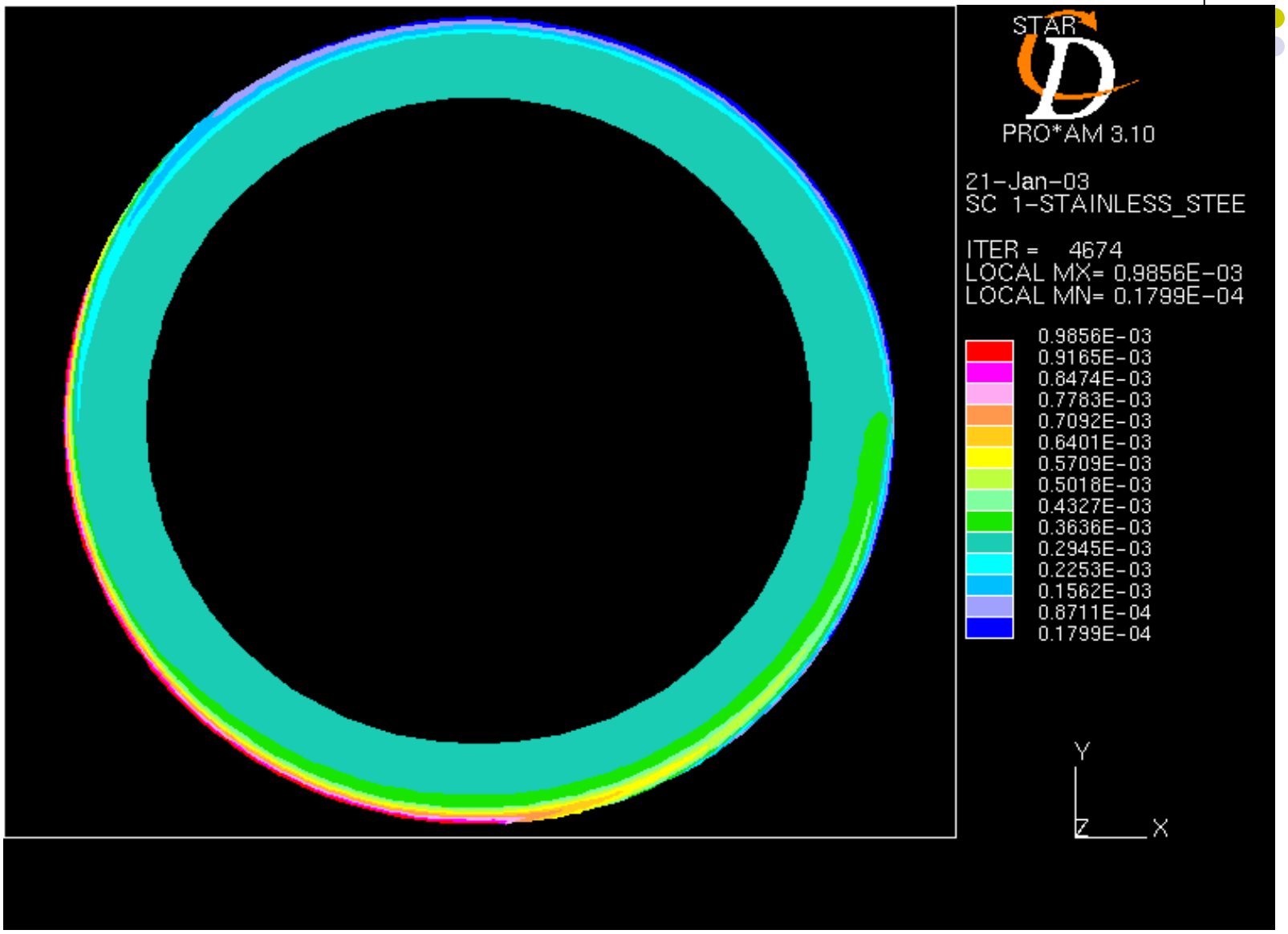
Velocity Profile of the Fluid Flowing in the Loop



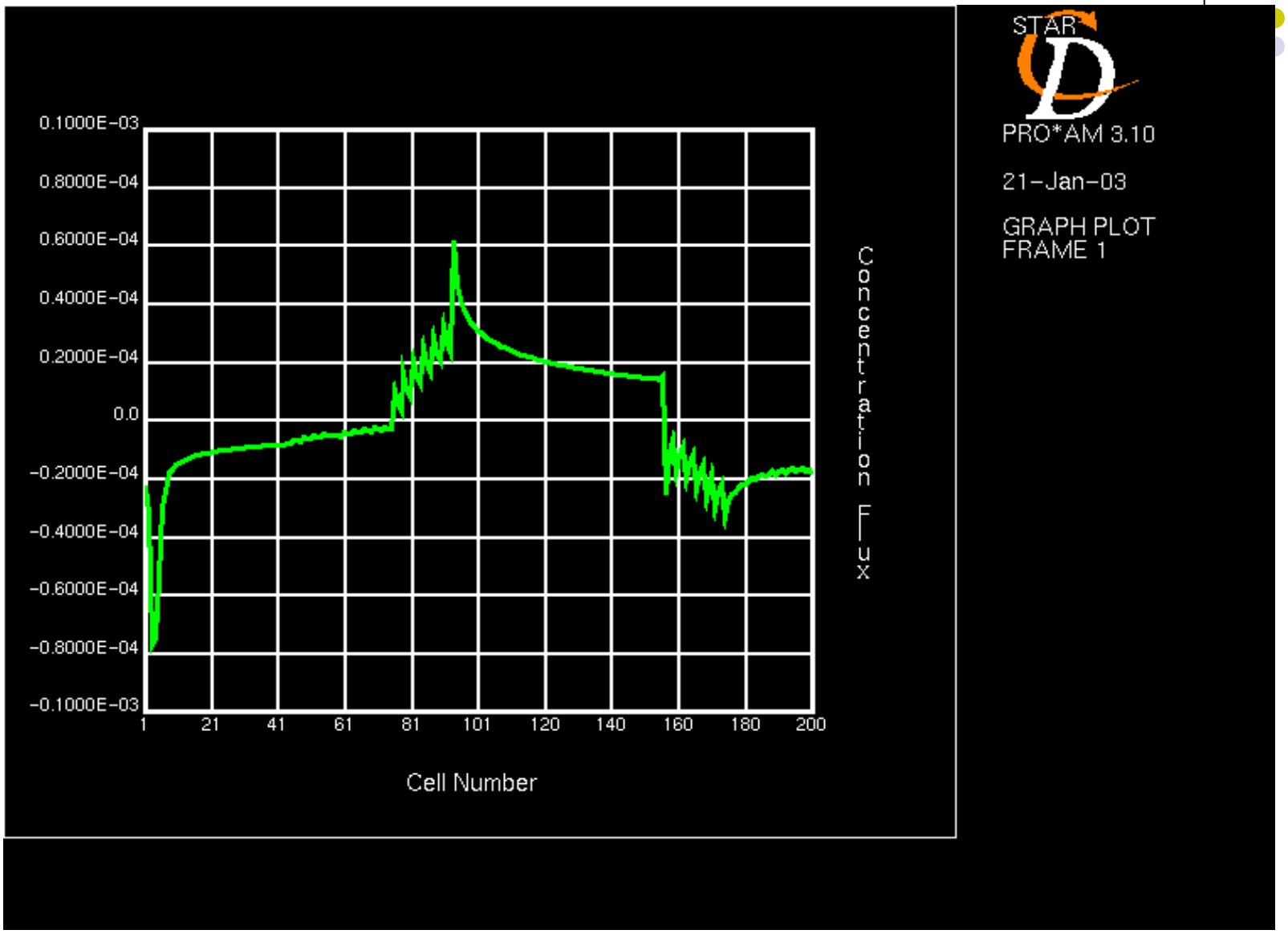
Temperature Profile of the Fluid Due to the Imposition of the Wall Temperatures



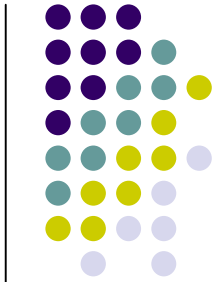
Concentration Profile of the Fluid Due to the Imposition of the Wall Concentrations



Variation of the Corrosion Rate Along the Length of the Loop

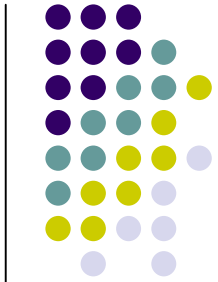


Objectives – 2



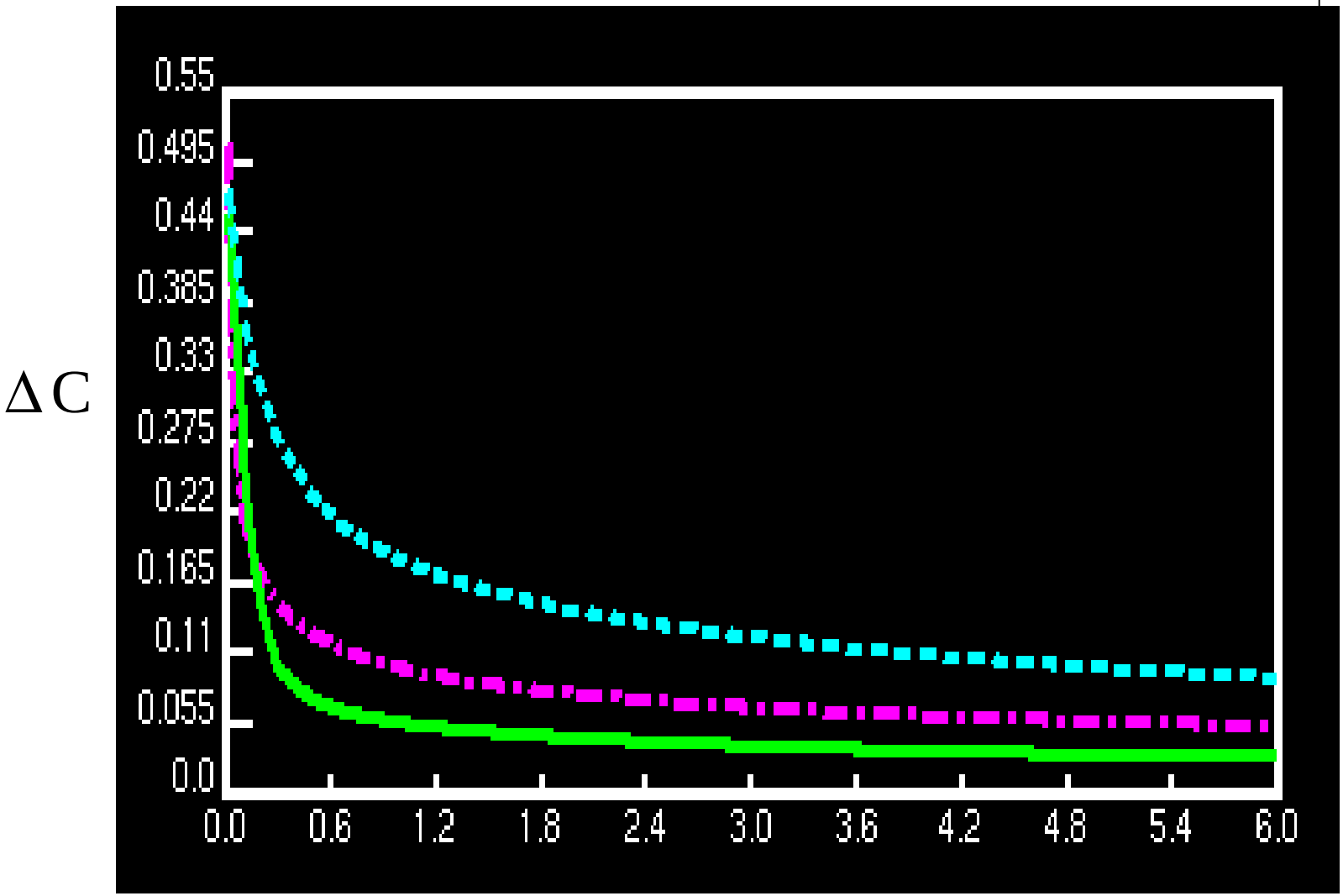
- Geometry effects have great influence on local corrosion rate.
- A 2-D benchmark problem and a sudden expansion case are studied which show good consistency to analytical solution.
- Results from 2-D sudden expansion problem are similar to experimental data obtained by other researchers.

Benchmark Problem

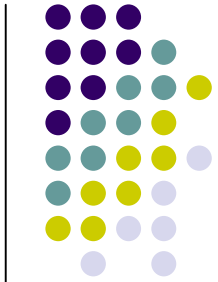


- Two flat plates are 6 meters long each, and the distance between them is 0.5 meter. Temperature along the length of the plate is assumed constant. Plates have fixed species concentration.
- Concentration difference at wall is proportional to $x^{-1/3}$ (x is loop length) by calculation.
- Solid line is at Re=1000. Dash line is at Re=10000. Pink line is the function of one tenth of $x^{-1/3}$.

Results

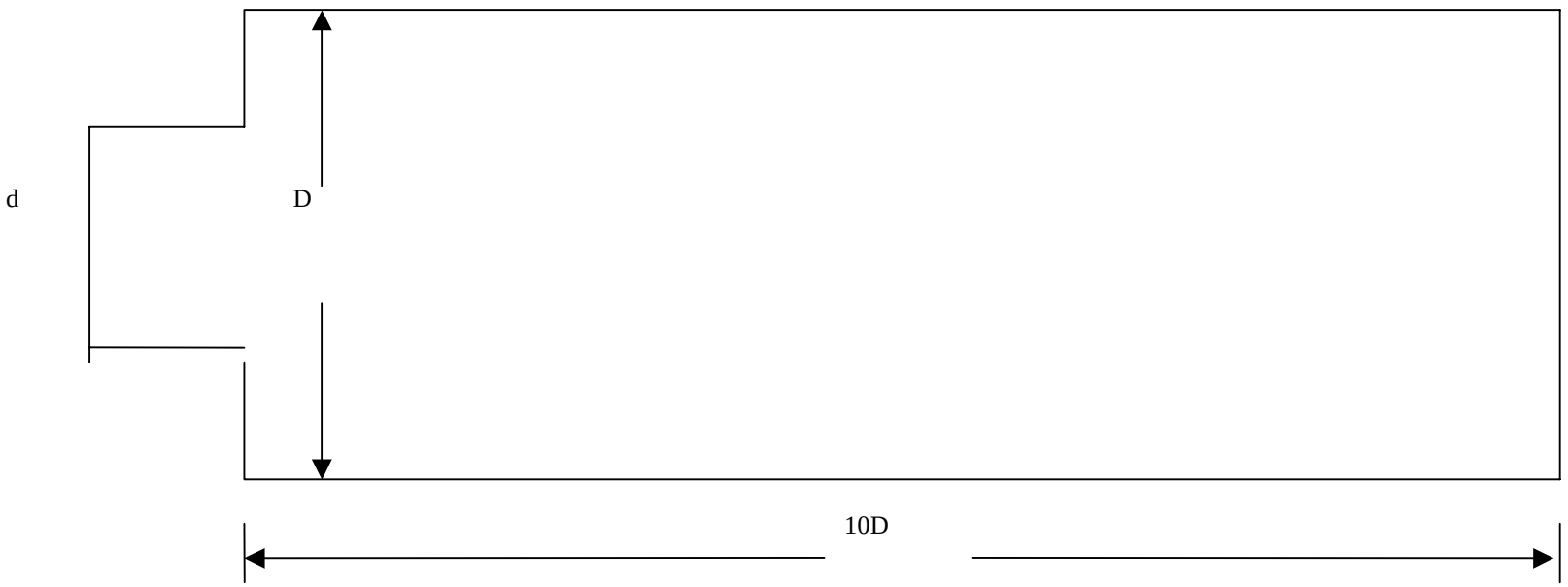

0.55
0.495
0.44
0.385
0.33
0.275
0.22
0.165
0.11
0.055
0.0
ΔC
0.0
0.6
1.2
1.8
2.4
3.0
3.6
4.2
4.8
5.4
6.0
X

Sudden Expansion

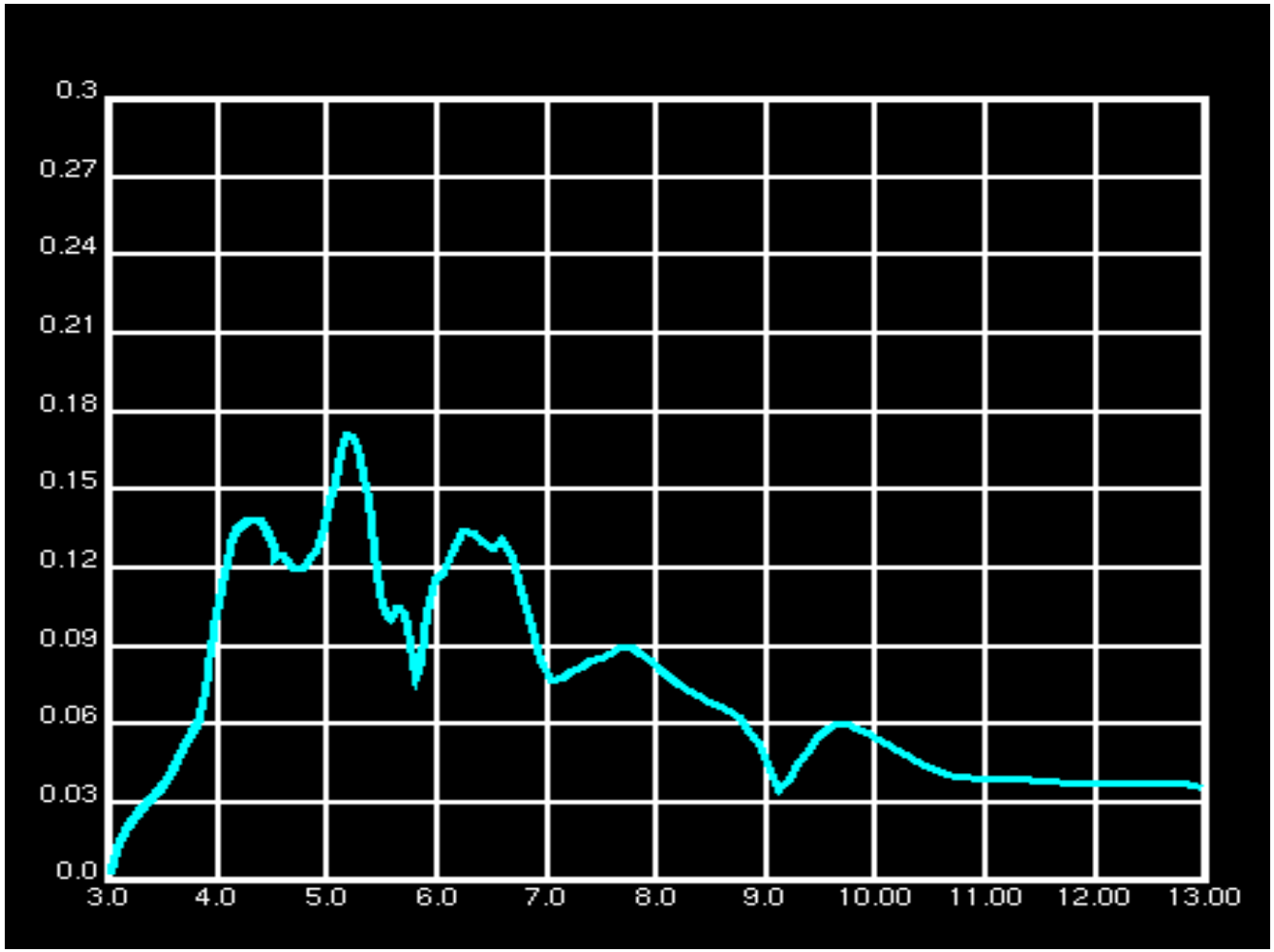


- Sudden expansion model has same boundary condition as previous benchmark problem.
- Geometry is given in next slide in which d is equal to 0.5m and D is equal to 1m.
- The result for Re=1000 is shown. Each peak on the curve occurs at the location where the separation point exists.

Geometry



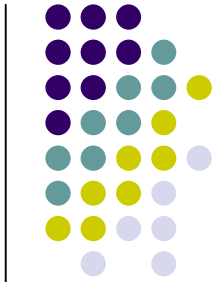
Results



ΔC

X

Future Work



Short Term Goals:

- To improve the currently simulated model of the MTL to best fit the actual experimental model.
- To develop a 3-D sudden expansion and sudden Contraction model to estimate the corrosion rates.

Long Term Goals:

- To estimate the corrosion rates in complicated geometries viz. gradual expansion, gradual contraction, elbow sections, wye – joints and tee – joints.
- To simulate a 3-D model of the MTL and estimate the corrosion rates.