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

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## Investigators

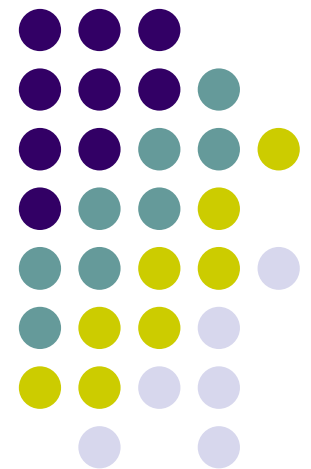
Dr. Samir F Moujaes

Dr. Yitung Chen

## Graduate Students

Mr. Kanthi Kiran Dasika

Mr. Chao Wu

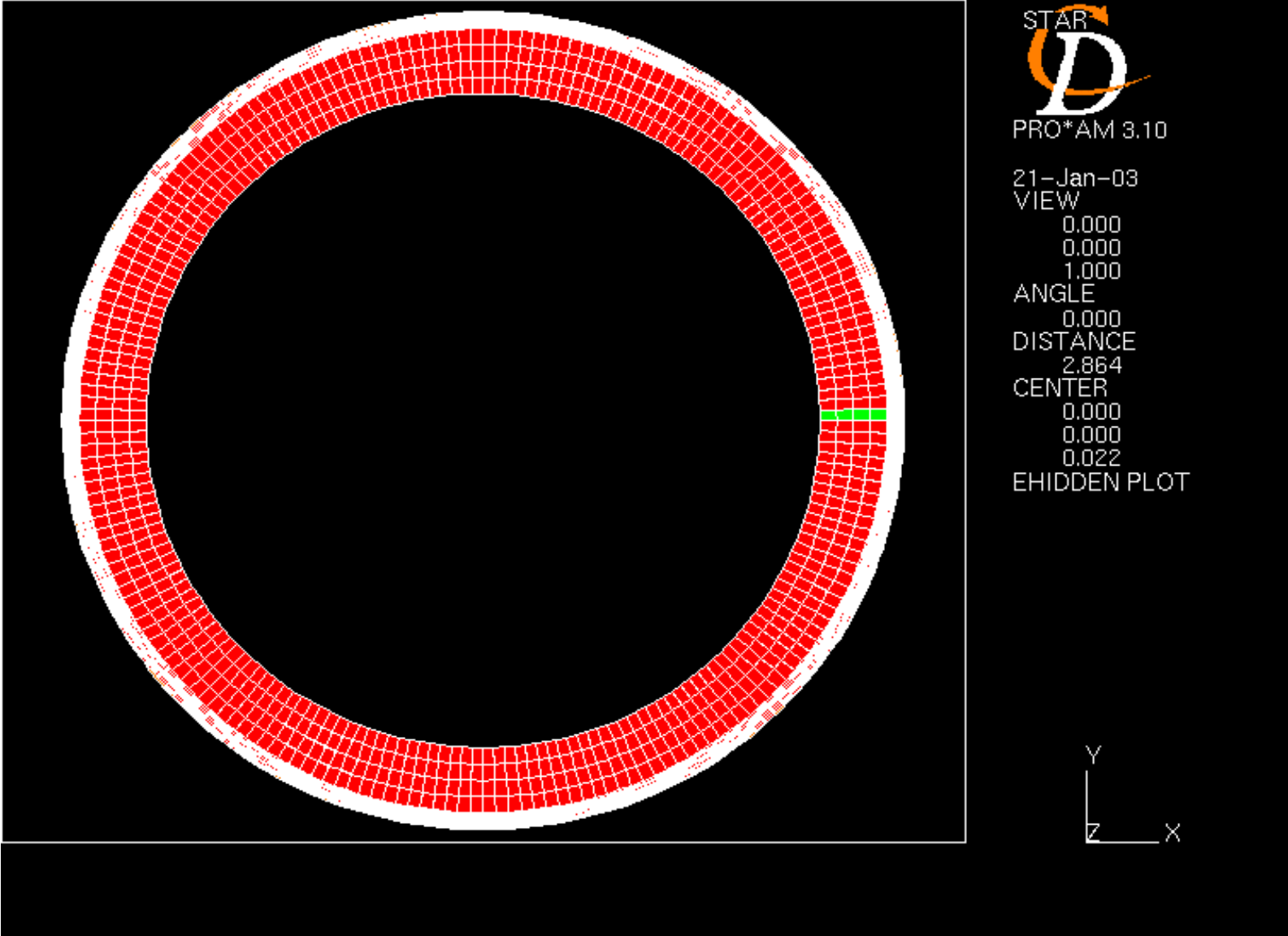




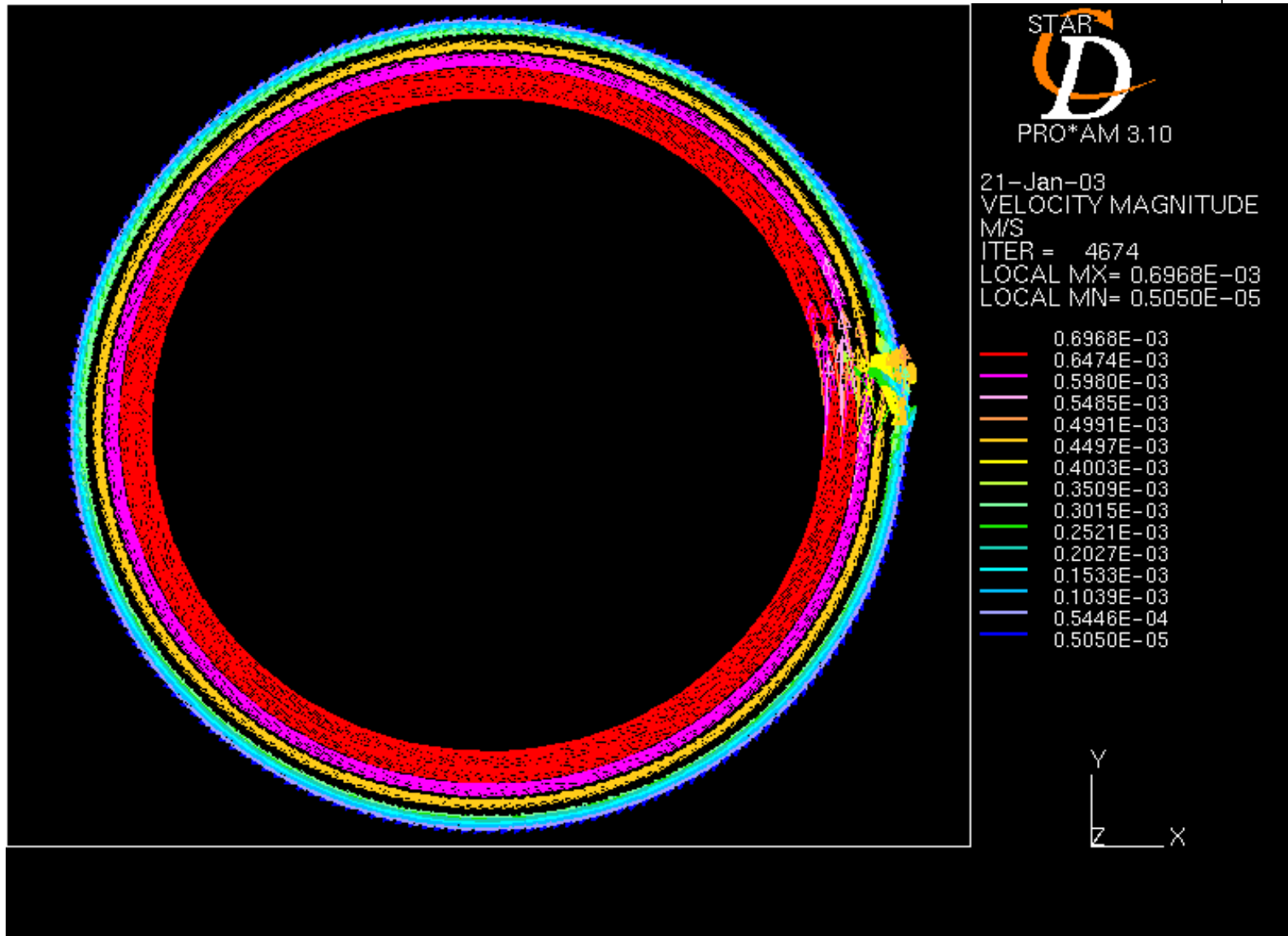
# Objectives - 1

- 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.

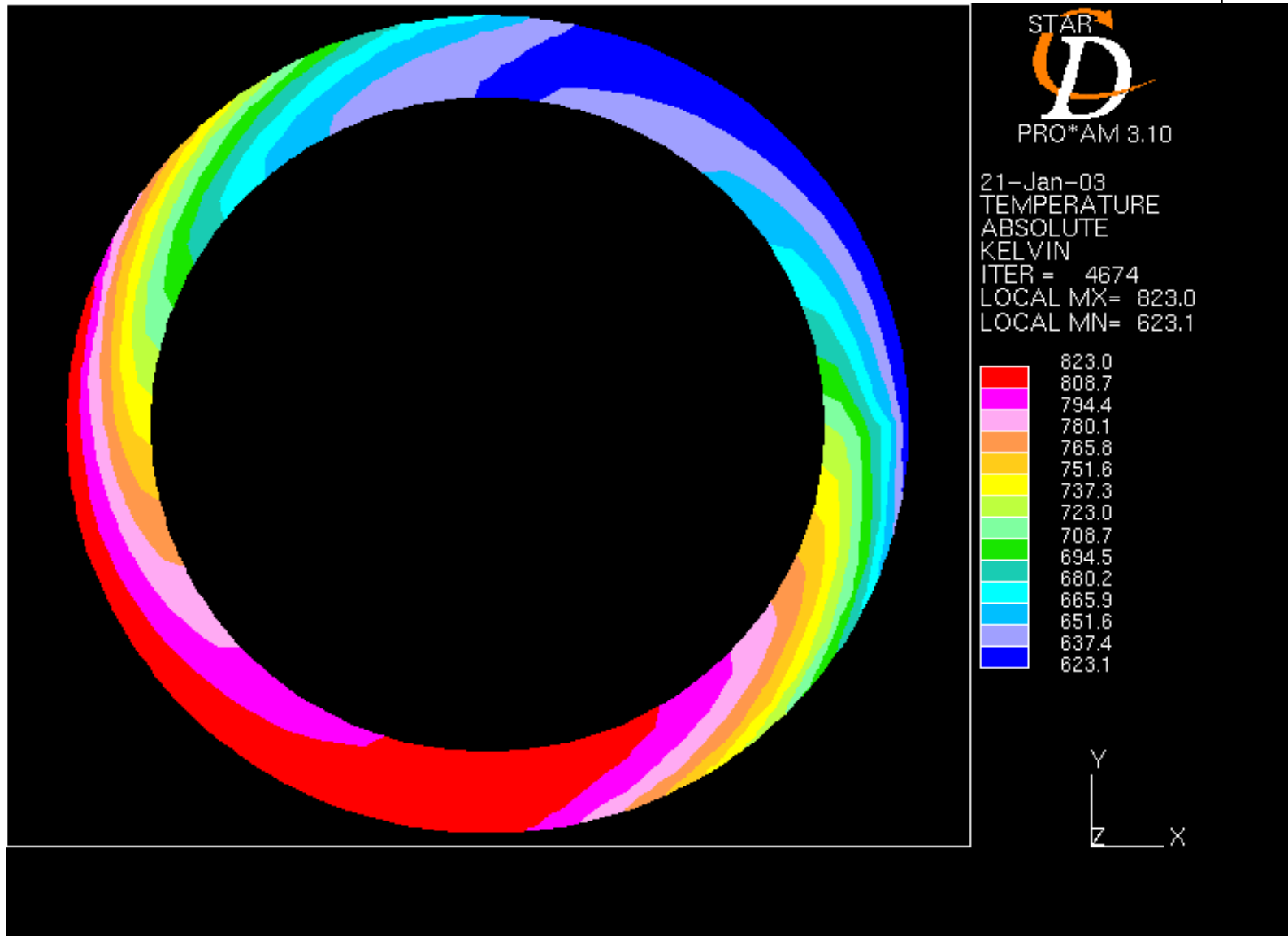
# Geometry of the Model Loop Considered for Simulation



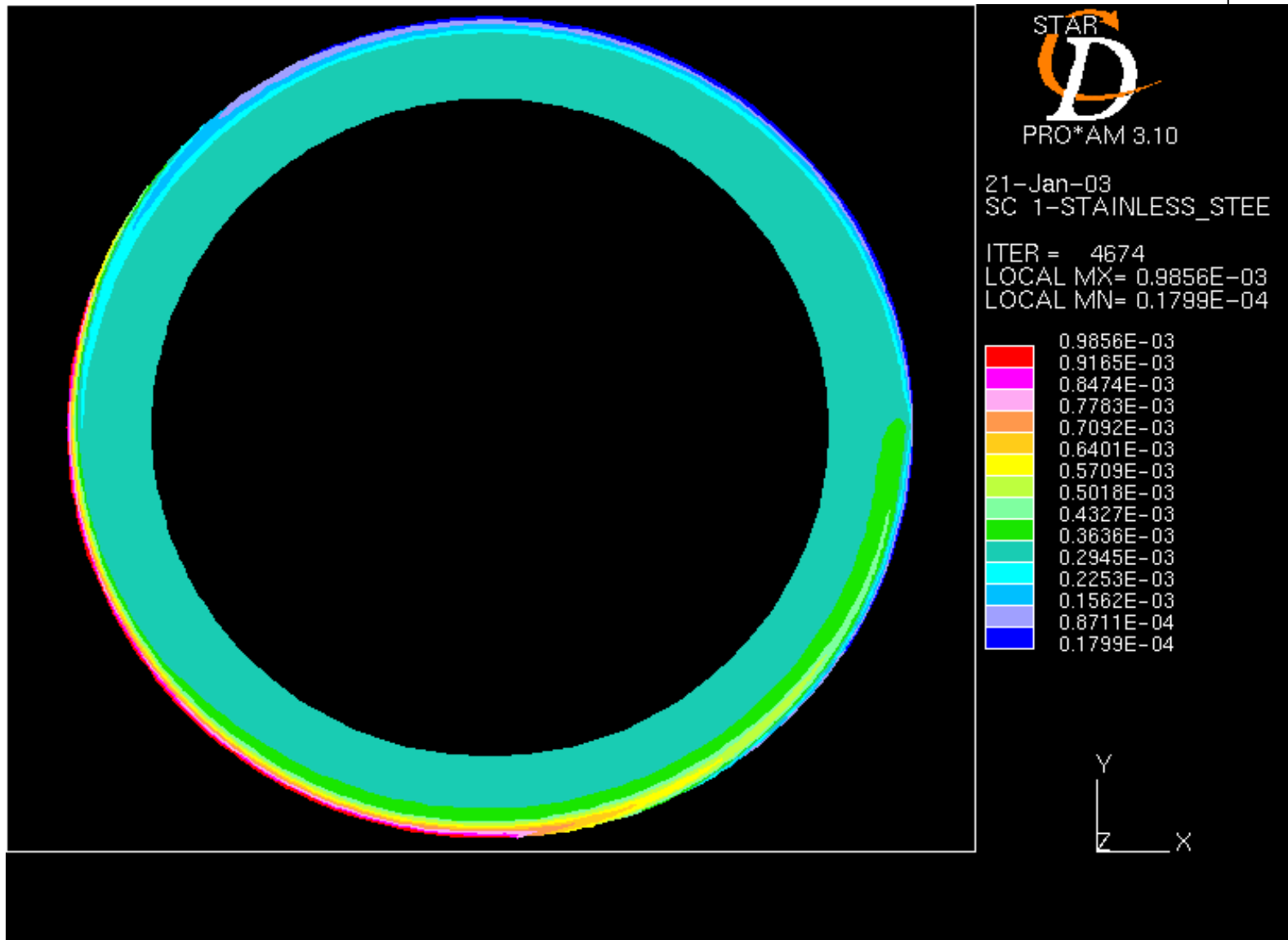
# Velocity Profile of the Fluid Flowing in the Loop



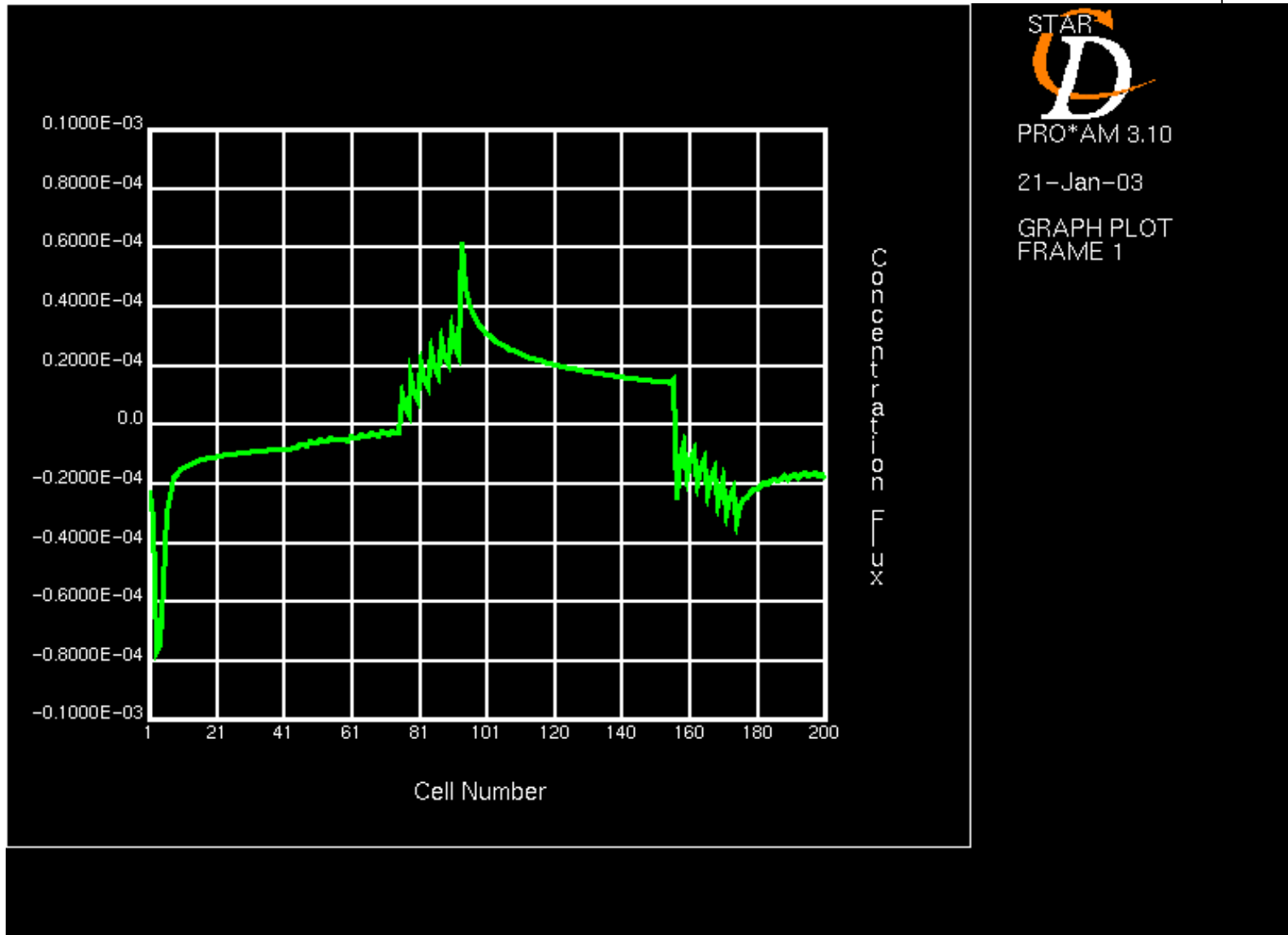
# Temperature Profile of the Fluid Due to the Imposition of the Wall Temperatures



# 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

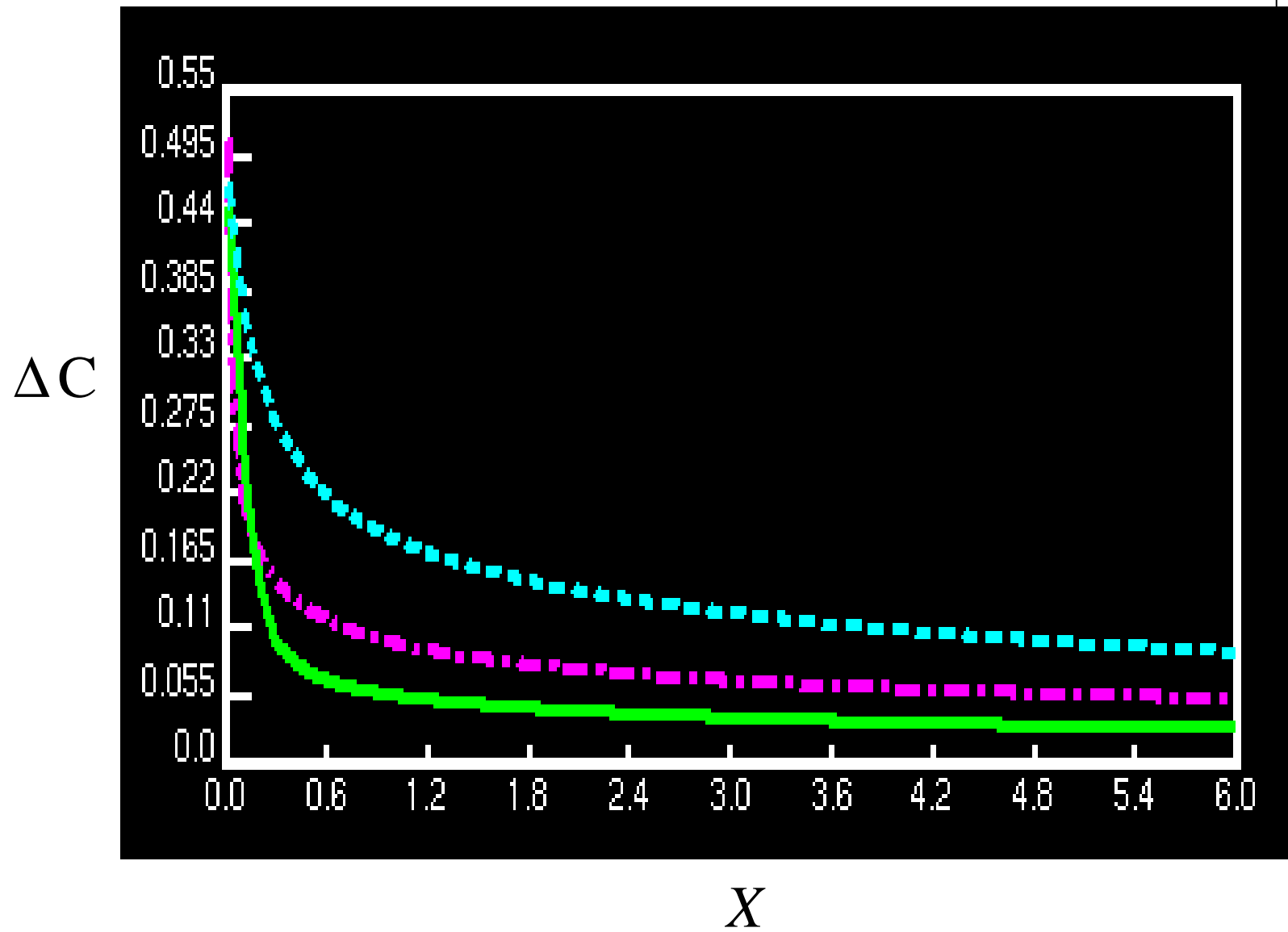
- Geometry effects have great influence on local corrosion rate.
- A 2-D benchmark problem and a sudden expansion case are studied which show good consistency to analytical solution.
- Results from 2-D sudden expansion problem are similar to experimental data obtained by other researchers.

# 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

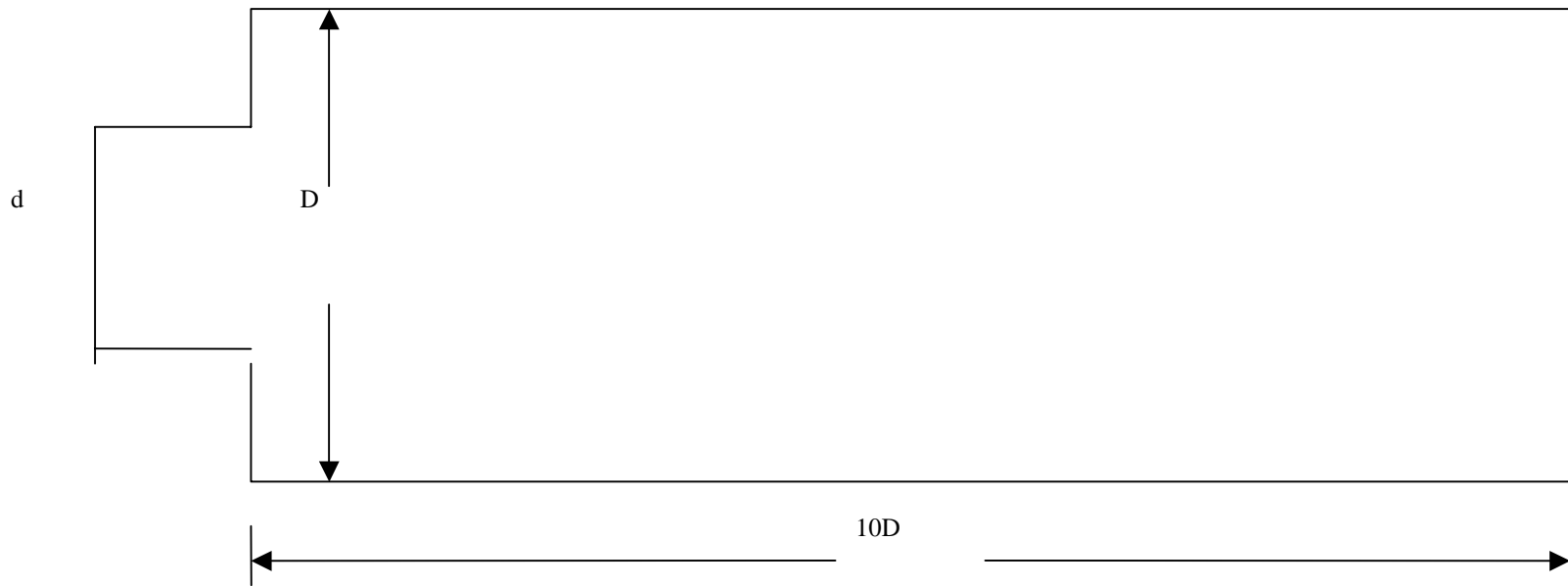


# Sudden Expansion



- 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.

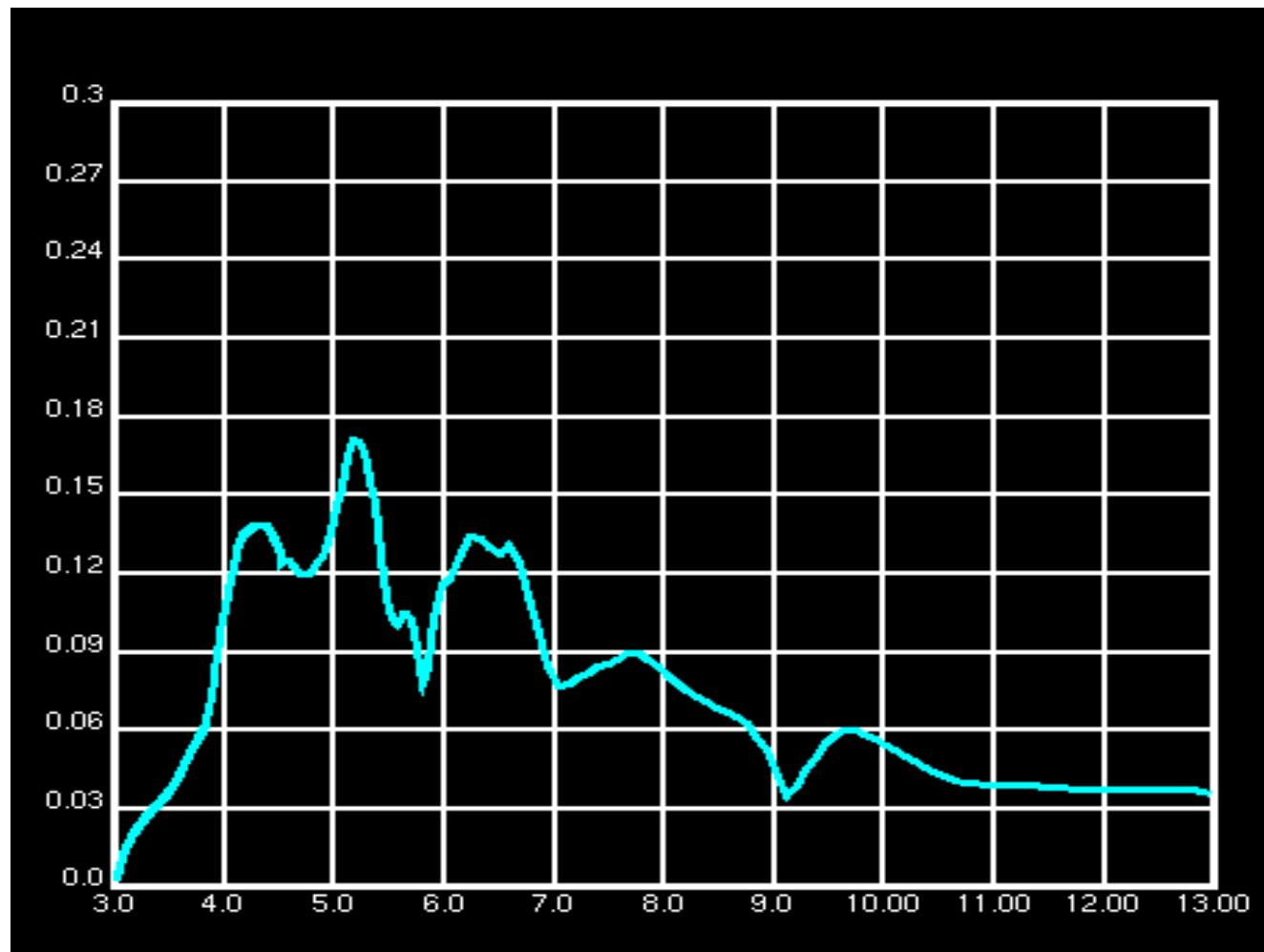
# Geometry



# Results



$\Delta C$



$X$



# 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.