

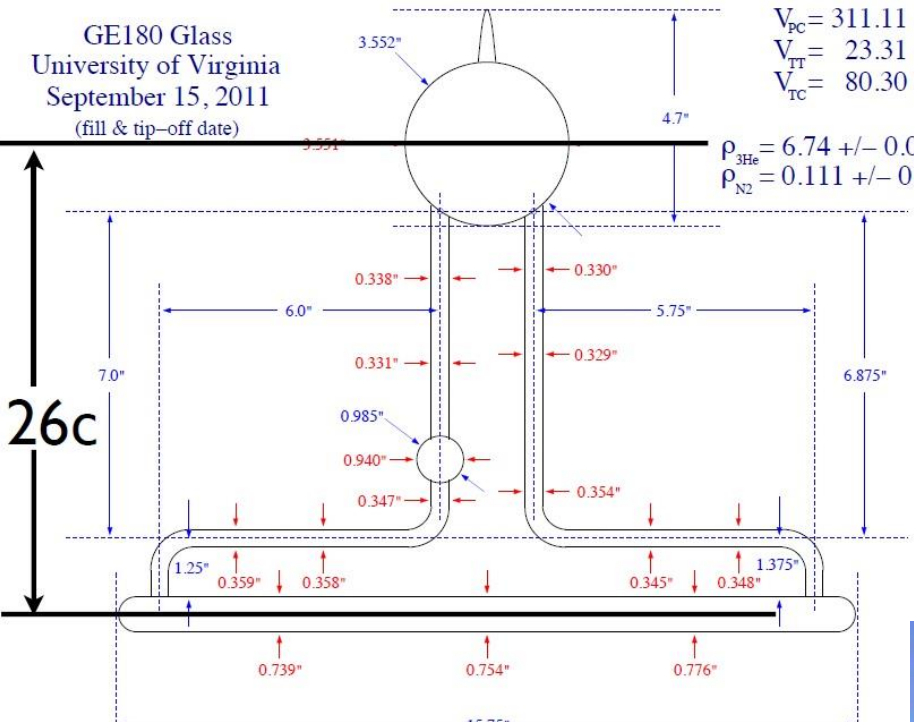
# Protovec UVA $^3\text{He}$ Target Cell Preliminary Flow and Thermal Analysis

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22 Apr 2015

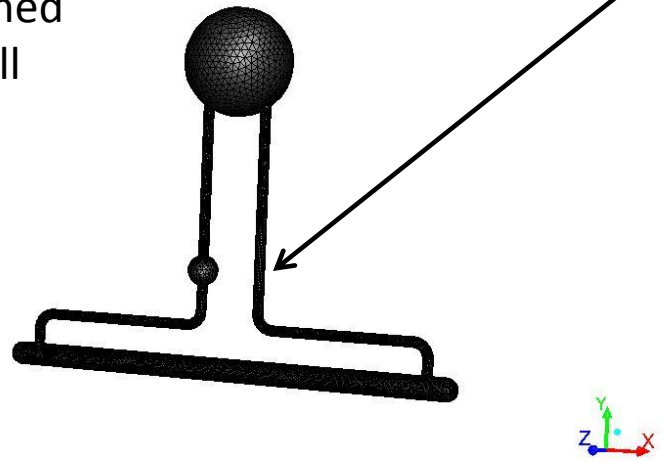
$V_{PC} = 311.11 \text{ cc}$   
 $V_{TT} = 23.31 \text{ cc}$   
 $V_{TC} = 80.30 \text{ cc}$   
 $\rho_{\text{He}} = 6.74 \text{ +/- } 0.06 \text{ amg}$   
 $\rho_{\text{N}_2} = 0.111 \text{ +/- } 0.001 \text{ amg}$

3D-CAD model  
generated based on  
this 2D UVA sketch

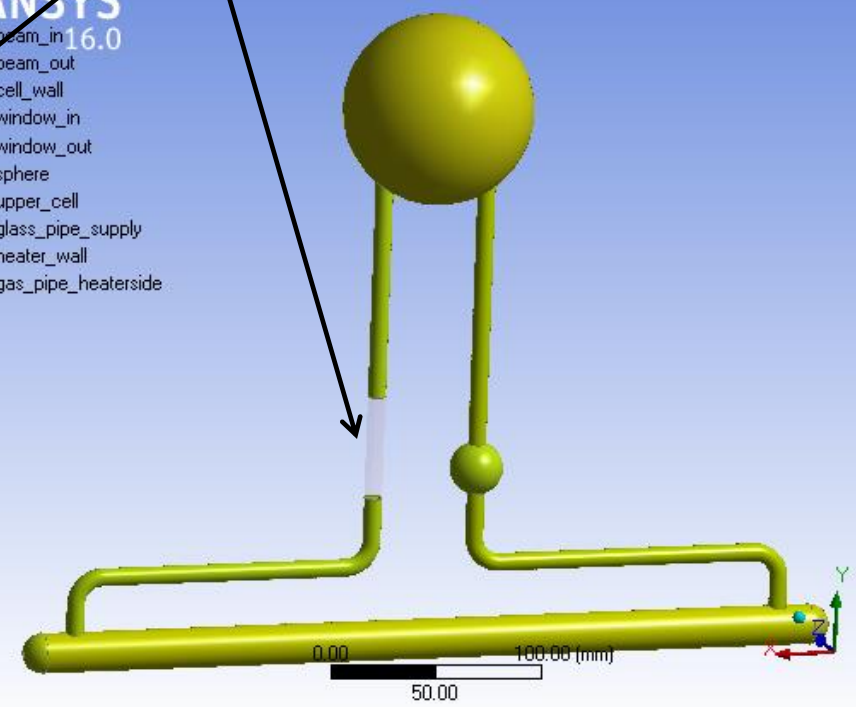


Heater  
section

Meshed  
Cell



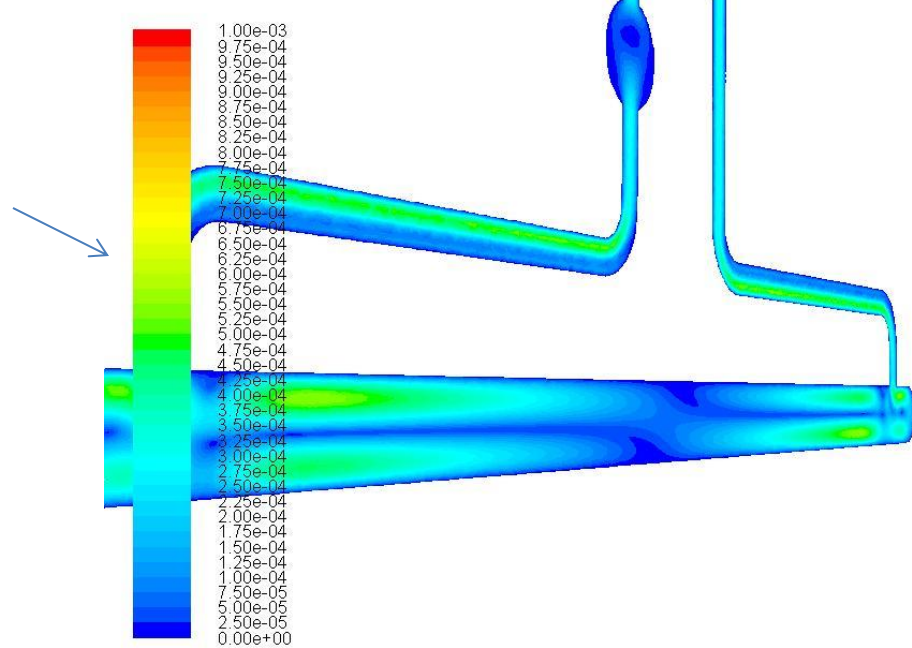
- Named Selections  
4/20/15 11:25 AM
- beam\_in16.0
  - beam\_out
  - cell\_wall
  - window\_in
  - window\_out
  - sphere
  - upper\_cell
  - glass\_pipe\_supply
  - heater\_wall
  - gas\_pipe\_heaterside



# Conditions

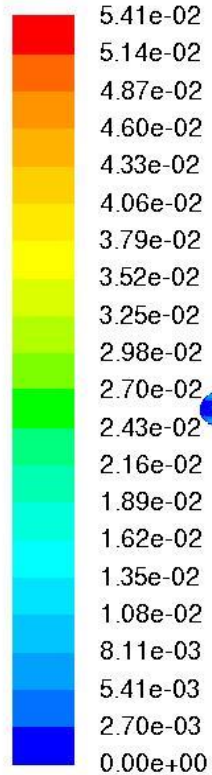
- Heater section is 5 cm long and kept at 50-90°C when the heater is ON
- Glass walls (GE 180) on the heater side radiate, the rest of the walls are kept at 300 K or radiate, outside radiation temperature 300 K
- The polarizing cell is kept between 215-240°C
- $^3\text{He}$  modeled as ideal gas for density, rest of the thermal properties taken for  $^4\text{He}$  (cannot find data for  $^3\text{He}$  vs. temperature) at 10 atm
- Natural convection and radiative heating are included in the model

Heater OFF, no net flow through the cell

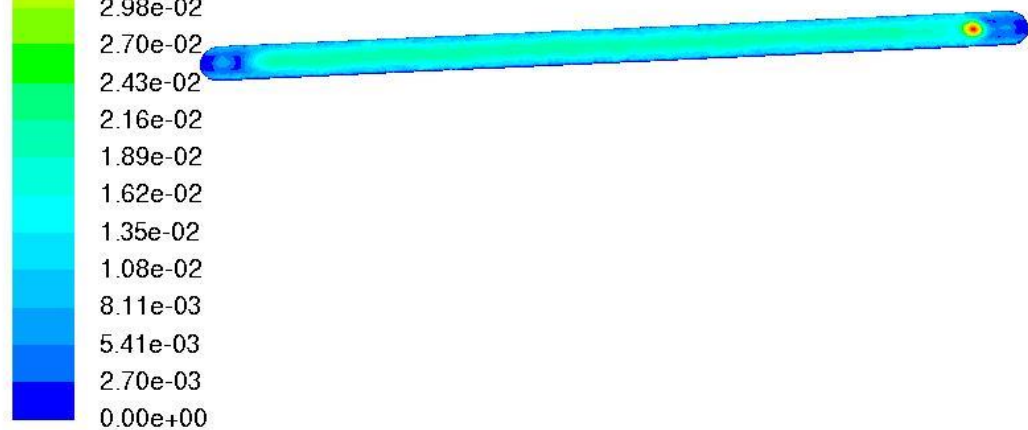


Contours of Velocity Magnitude (m/s) (Time=4.0600e+02)

Feb 04, 2015  
ANSYS Fluent 15.0 (3d, dp, pbns, rke, transient)



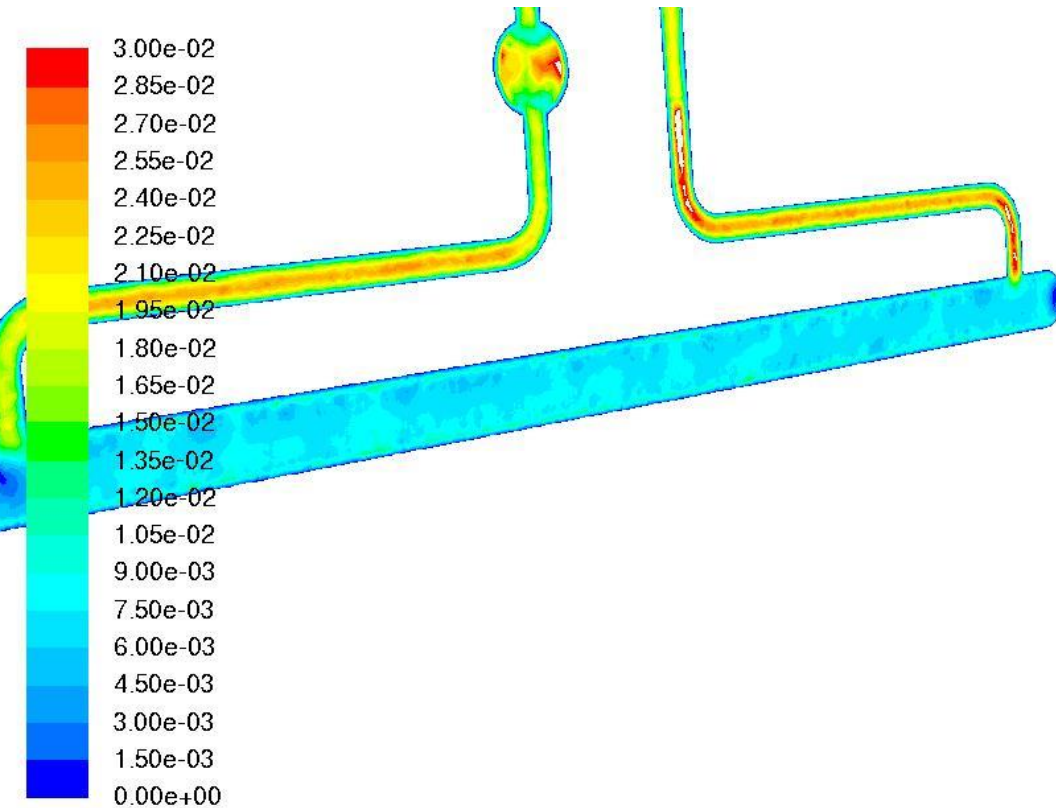
Heater ON (90 °C), few cm/s net flow through the cell



Contours of Velocity Magnitude (m/s)

Apr 16, 2015  
ANSYS Fluent Release 16.0 (3d, dp, pbns, rke)

Heater ON (50°C) flow through the whole geometry,  
average flow velocity through the cell 4 mm/s,  
through the beam volume 2 mm/s

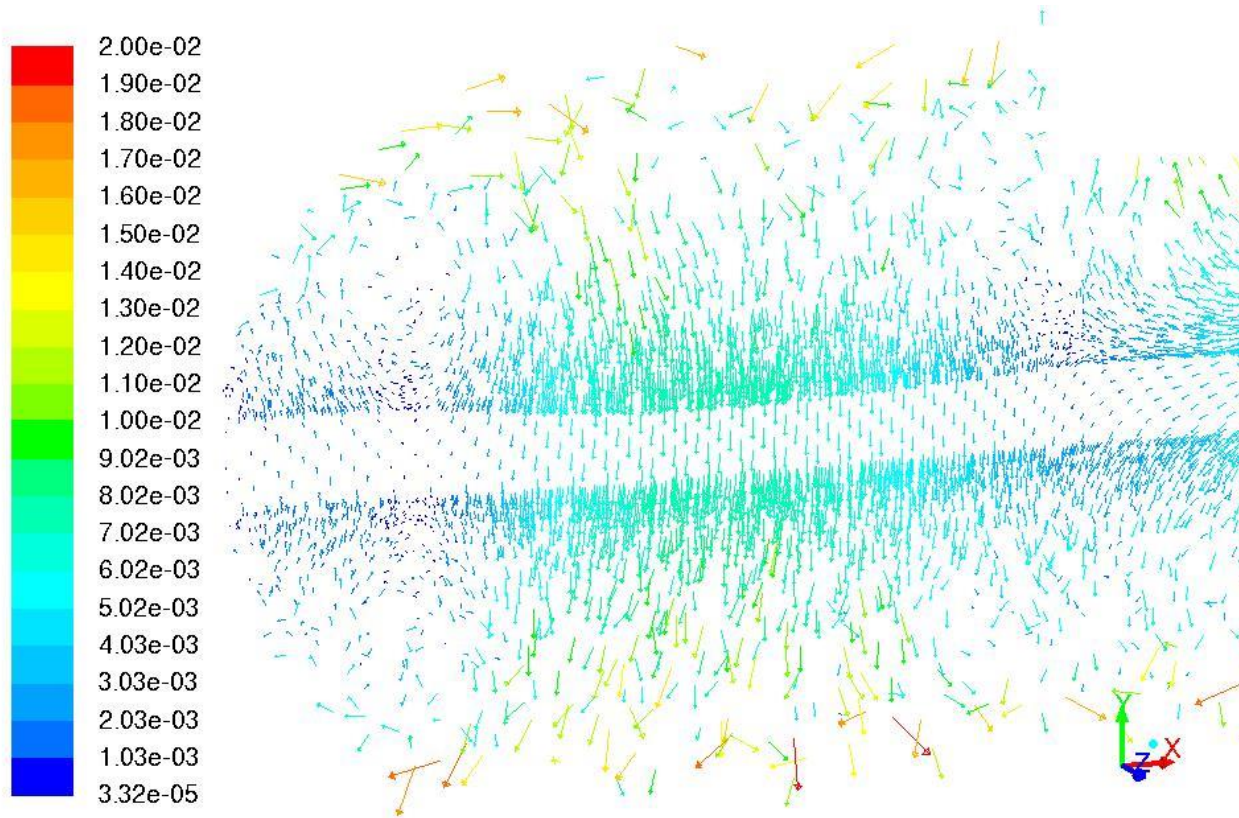


PRC **84**, 065201 (2011): 7.2  
amg 3He, oven at 215°C,  
heater at 50°C, flow in the  
cell 3.3 mm/s

Boundary conditions at  
walls may not be realistic  
in the model yet



# Flow in the endcap, by velocity vector, vertical mid cross section through the cell



Velocity Vectors Colored By Velocity Magnitude (m/s)

Apr 21, 2015  
ANSYS Fluent Release 16.0 (3d, dp, pbns, rke)

# What Next?

- The e-beam is already modeled but not turned ON, could turn the beam on and see the density changes along the beam path, vs beam current and beam raster size
- Could vary the temperature of the heater to see how it influences the flow in the cell
- Could change boundary conditions at walls
- Try the metal end-cap cell design and see the beam heating in the walls
- ?