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Beam Pipe Bakeout

100-200 C N_2

Ansys

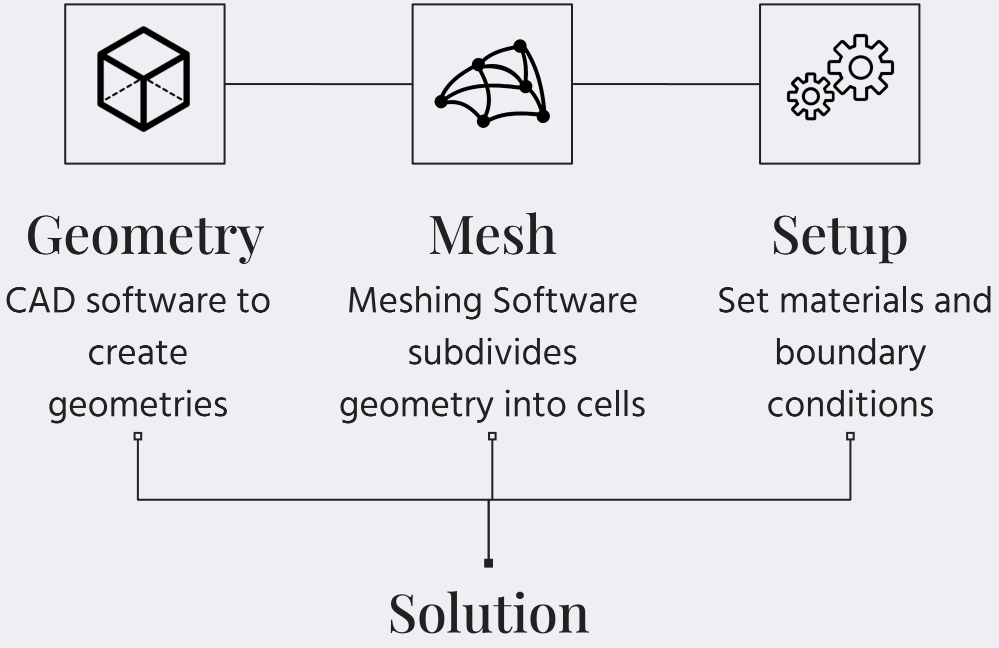
Nicole/Emma/Skye

Outline

Ansys	About Ansys thermal simulations
The Bakeout Problem	Removing water molecules while keeping the silicon cool.
Geometry	Beryllium Beam Pipe with three layers of Silicon
Boundary Conditions	Materials, Temperatures, and Convection
Contours	Thermal contours
Results	Graphs of results varying N2 temperature from 100-200C
Conclusions	Conclusions and future simulations

Ansys

Ansys is advanced engineering simulation software used to predict material and structural behavior. It simulates thermal analysis, fluid dynamics, and more to optimize designs and validate product performance before physical testing. By inputting design parameters, Ansys provides insights for informed decision-making and early issue identification in product development.



Geometry

CAD software to create geometries

Mesh

Meshing Software subdivides geometry into cells

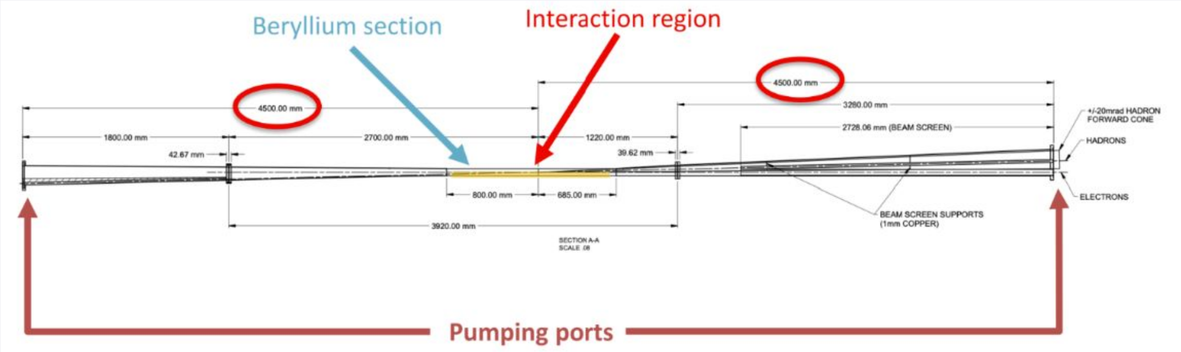
Setup

Set materials and boundary conditions

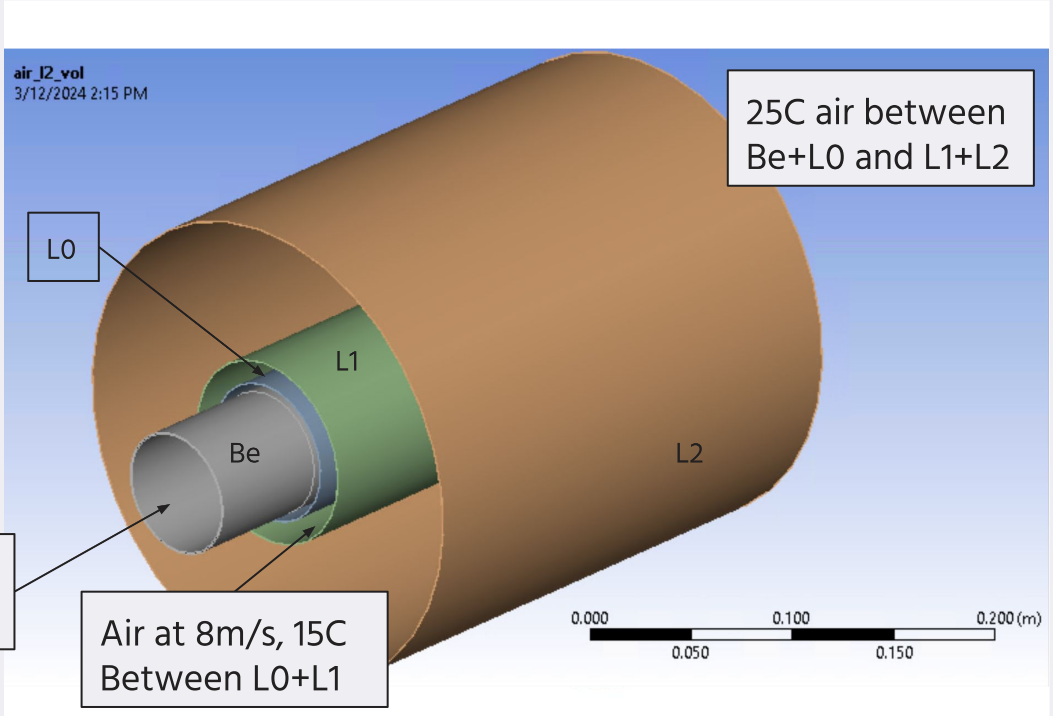
Solution

The Bakeout Problem

- We need to remove water molecules and other contaminants from the interior section of the beampipe (beryllium interaction region)
  - Pump hot gas in at > 100C to break water molecule bonds. Silicon needs to remain at < 30C
- A previous ANSYS study found the minimum distance between Layer 1 and the beampipe to be ~5mm in order to keep Layer 1 around 30C but the study neglected the effects of air cooling on the beampipe.



Geometry



L0

25C air between
Be+L0 and L1+L2

Filled
with N2

Air at 8m/s, 15C
Between L0+L1

Beampipe & Silicon

The Geometry is made up of a Beryllium beam pipe with three silicon shells (L0, L1 and L2). The volume inside of the Beryllium is N2 gas and the volume between the silicon layers is air.

Boundary Conditions

Materials

Beryllium

Density: 1850 Kg/m^3
Specific Heat: 1825 J/KgK
Thermal Conductivity: 190 W/mK

Silicon

Density: 2330 Kg/m^3
Specific Heat: 700 J/KgK
Thermal Conductivity: 148 W/mK

N2

Density:1.251 Kg/m^3
Specific Heat: 1040 J/KgK
Thermal Conductivity: 0.02547 W/mK

Air

Density: 1.225 Kg/m^3
Specific Heat: 1006.43 J/KgK
Thermal Conductivity: 0.0242 W/mK

Temperature

Beryllium

Dependent Quantity

Silicon

Dependent Quantity

N2

100-200C

Air

15C

Convection

N2

0m/s

Air

8m/s

Other

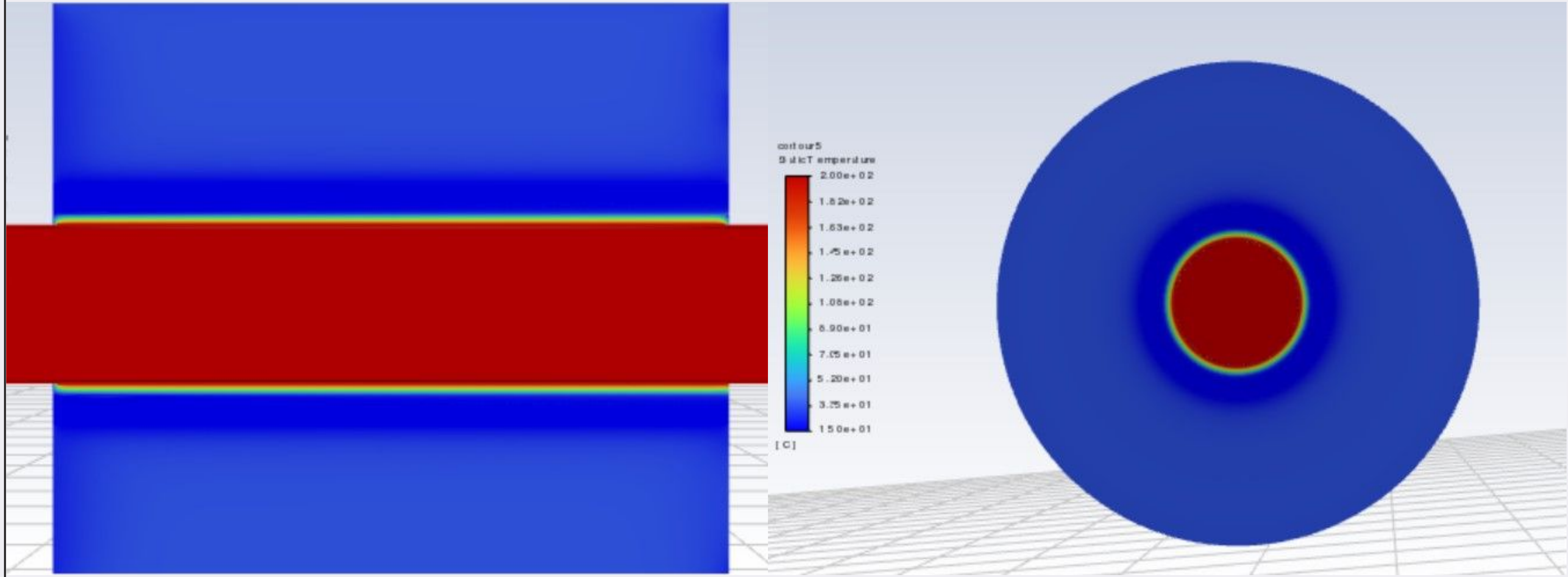
Heat Transfer: Forced Convection

Iterations: 50

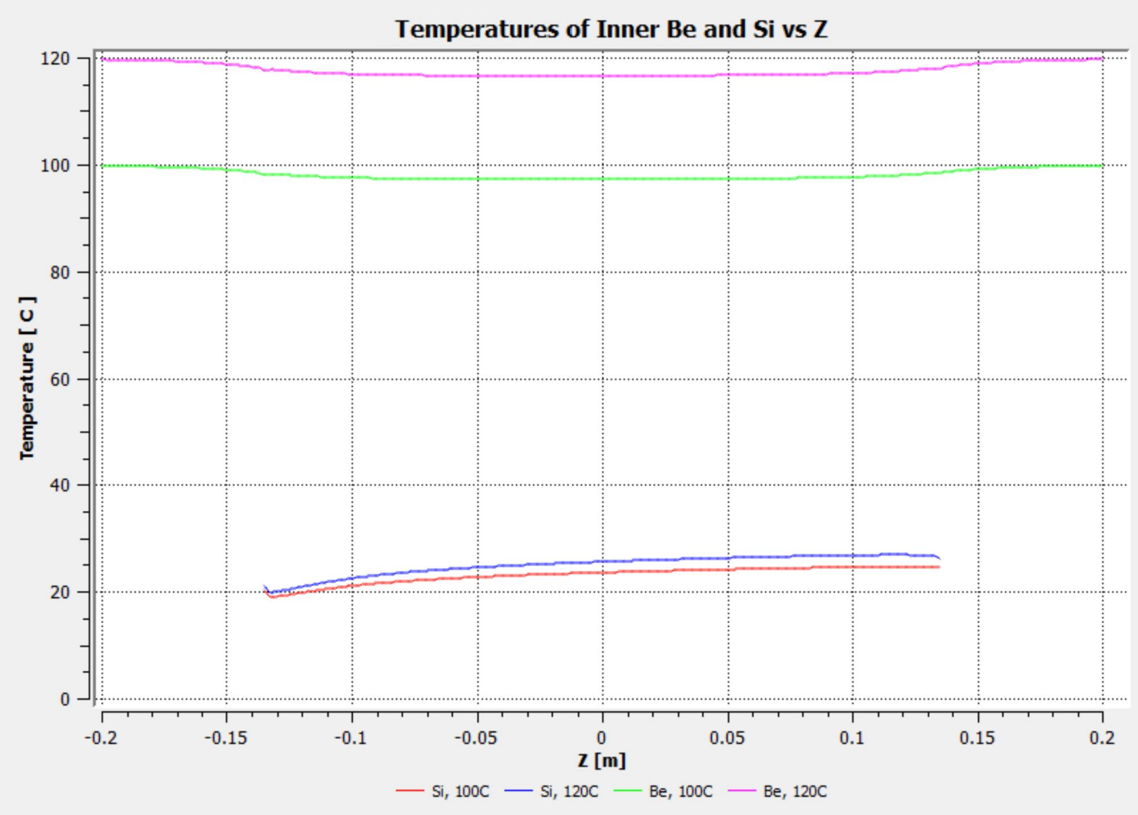
Precision: Double

Viscous Model: k-omega, Shear Stress Transport (SST)

Contours


contour5
Static Temperature
2.00e+02
1.82e+02
1.63e+02
1.45e+02
1.26e+02
1.08e+02
8.90e+01
7.05e+01
5.20e+01
3.35e+01
1.50e+01
[C]

Solutions


Temperatures of Inner Be and Si vs Z
Temperature [C]
120
100
80
60
40
20
0
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
Z [m]
Si, 100C
Si, 120C
Be, 100C
Be, 120C

Conclusions & Future Simulations

Conclusions

Only having airflow between L0+L1 works with the mentioned constraints for internal N2 temperatures greater than ~ 120C

Future Simulations

Incorporating silicon matrix + periphery thermal output

Higher Temperatures