EIC Test Stand With Aerogel Thermal Simulation

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The Detector Support Group assembled a test bench to attempt to replicate the components of the beampipe central section and monitor its thermal effects when a heat of source is applied inside the beampipe, which is wrapped with 1mm aerogel and air is flowed through the annuls space; available components were assembled in a test bench with a location similar to the actual EIC beampipe; however the material for the pipes, separation between beampipe and pipe used to simulate the first silicon layer, and air flow velocity were different

I generated a simplified model with only the components that could have a significant thermal affect for the simulation. The model is basically conformed by various pipes, a heater used as the heat of source and . See fig.1. Model was build on SpaceClaim, dimensions and material for each component is show in Table I. I used Shared topology option used to ensure contact between touching or intersecting bodies and surfaces.

With the model completed, I proceeded with the mesh of the model using *Fluent Meshing* option, which allows adding local sizing, improve surface mesh, establish part fluid or solid domain, add boundary layers and improve volume mesh. During the process I had issues to mesh the thin walls formed between the beam pipe and the heater pipe, which was created to ensure more than one point of contact and transmit the heat. Adjusting of the face size and body size mesh elements was required to solve issue.

Part Name	ID [in]	OD [in]	Material
Heater Pipe	1.61	1.9	Steel
Beam Pipe	2.43	2.5	Aluminum
Aerogel	2.5	2.5787	Aerogel
O-Ring	2.5787	3.06	Rubber
Silicon Pipe	3.06	3.5	Aluminum

Table I. Model components dimensions and materials

- **Modeled EIC Test stand central section for the thermal interaction**
- **Meshed model and configured all required cell zones and boundary conditions**
- **Generated contour plots to show resultant velocity and temperature**
- **Plotted simulated temperature results with measurements**

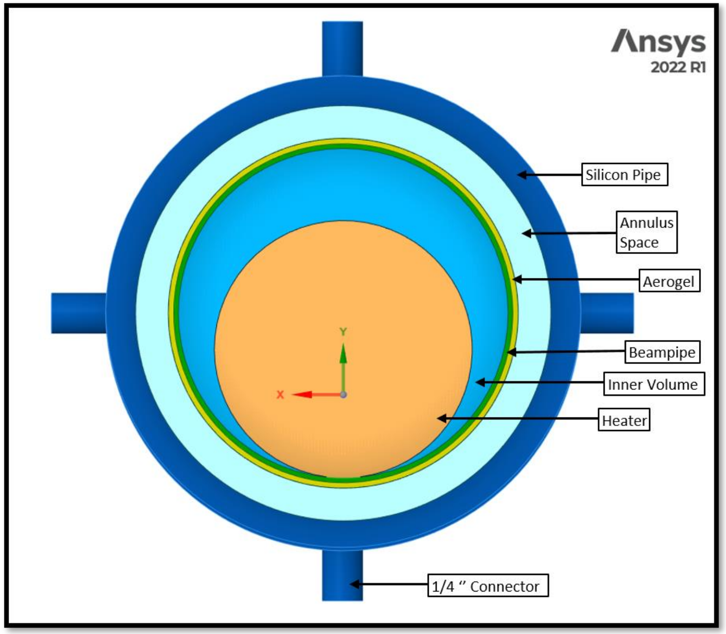

Fig. 1. EIC Test Stand model with aerogel

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I calculated the inlet velocity for each inlet connector of the model, the total air flow rate supplied to the model was divided by four and the velocity was calculated based on the connector's cross section areas and air properties, values were required to be set in Fluent.

Model was meshed and implemented to Ansys-Fluent where all required boundary and cell conditions were set, some of these included the setting a fixed temperature for heater pipe at 102 °C (different from the actual test stand setup, which is variable), the inlet air temperature 23 °C, convection for silicon pipe with air temperature at 23 °C and 5 W/m^2K.

Initial simulations were run for different flow rates from 0 to 250 l/min, same as the test stand model, this range was limited by the mass flow controller utilized in the test stand model. Same flow point selected for the simulations. From the results I generated velocity and temperature contour plots. See fig.2. showing the temperature contour when air flow rate supplied is 250 l/min. I Also a plotted the outlet silicon pipe temperature vs flow rate to compare simulation results with tests stand measurements. See fig.3

As observed in the plot under the mentioned simulated conditions, the resulted silicon pipe temperature at its outlet in Ansys-Fluent are close to the measured values in the test stand when the airflow rate in the annulus space is greater than 100 l/min.

I plan to work on another model to get a better approximation to the actual test stand thermal conditions, specifically, for the heater pipe and beam pipe, therefore, the results from the simulations can be used to validate and compare with the other temperature sensors' readouts of test stand located at the heater pipe and beam pipe.

I completed the Ansys-Fluent thermal simulation for the central section of the EIC test stand model, results showed an expected temperature of the silicon pipe and velocity of the air flow in the annulus space.

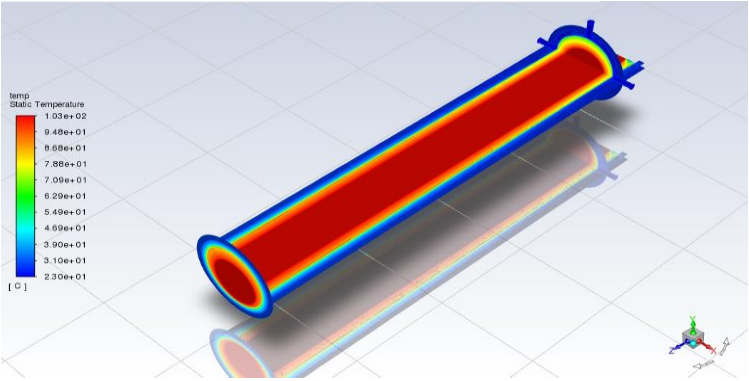

Fig.2. Temperature contour plot

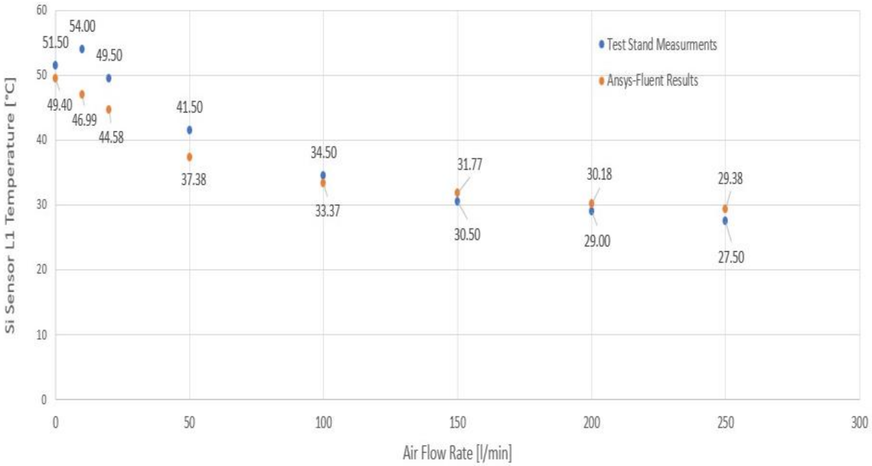

Fig.3. Silicon temperature vs Air flow rate comparison between Ansys analysis and measurements on the test stand