CFD simulation
- Thermal mock-up program-

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Motivation

- CFD simulations have already been performed to check the thermal behavior of IBL during bake-out and normal operation.
- A validation of CFD simulations is needed.
- The results of CFD simulations will be compared against experimental data from the thermal mock-up.
Geometry and materials properties

NITROGEN (no axial flow)

TITANIUM PIPE
\[ k = 7.2 \text{ W m}^{-2}\text{K}^{-1} \]

GLUE
\[ k = 1.1 \text{ W m}^{-2}\text{K}^{-1} \]

ALUMINUM STAVE
\[ k = 167 \text{ W m}^{-2}\text{K}^{-1} \]
emissivity = 0.1

IST
OD 85.8 mm, 0.52 mm thick
\[ k = 155 \text{ W m}^{-2}\text{K}^{-1} \]
emissivity = 1

PLEXIGLASS TUBE
ID 270 mm, OD 300 mm
\[ k = 0.2 \text{ W m}^{-2}\text{K}^{-1} \]

PYROGEL
thickness 3 mm
\[ k = 0.0147 \text{ W m}^{-2}\text{K}^{-1} \text{ @ 38 °C} \]
\[ k = 0.028 \text{ W m}^{-2}\text{K}^{-1} \text{ @ 250 °C} \]
emissivity = 0.5 (kapton)

ALUMINUM BP
ID 44.68 mm, 1.05 mm thick
\[ k = 167 \text{ W m}^{-2}\text{K}^{-1} \]
Boundary conditions

OUTER ENVIRONMENT
\[ h = 10 \text{ W m}^{-2} \text{ K}^{-1}, \quad T = 25^\circ \text{C} \]

COOLING PIPE
INNER WALL
\[ T = -40^\circ \text{C} \]

ALUMINUM BEAM PIPE
\[ T = 250^\circ \text{C} \]
Computed temperature field

- **Beam Pipe**: 250 °C (boundary condition)
- **IST**: ~10 °C
- **Insulation Outer Surface**: ~110 °C
- ** Plexiglass Outer Surface**: ~23 °C
Computed temperature field

UNCOOLED STAVE (TOP) ~ 60°C

UNCOOLED STAVE (BOTTOM) ~ -15°C

COOLED STAVEs ~ -40°C
Computed heat fluxes

FROM OUTSIDE ~20 W/m

TO COOLING PIPES ~ 190 W/m
(4400 Wm\(^{-2}\) referred to pipe inner surface)

FROM BEAM PIPE ~170 W/m
(15% radiative heat transfer)
Thank you