Mechanical Design of the EIC Beampipe Thermal Test Stand

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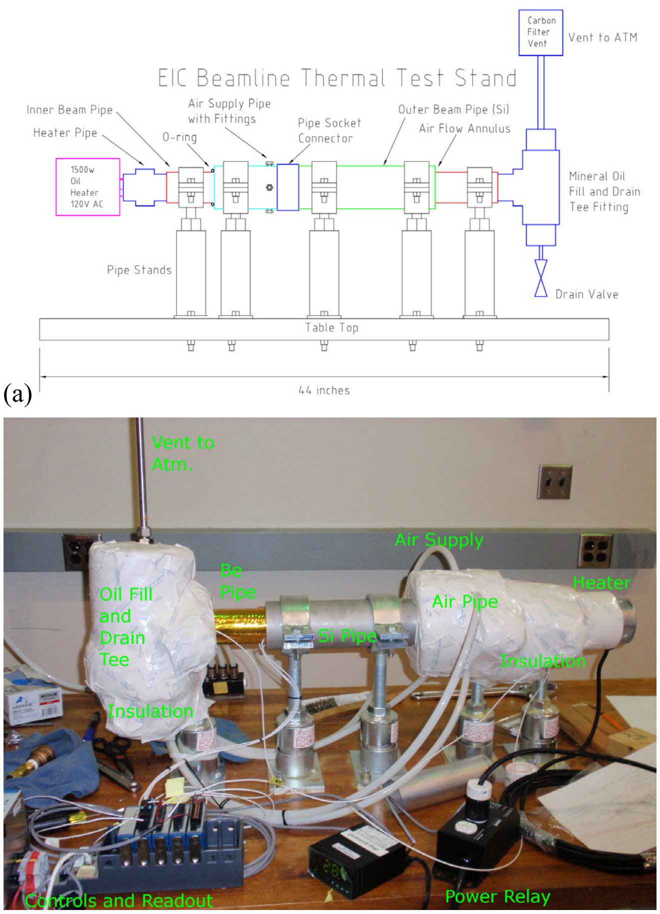
This note describes the mechanical design and assembly of the EIC beampipe thermal test stand.

The EIC beampipe test stand, Fig. 1, is being used to determine whether the proposed cooling method—heating the beryllium beampipe to 100°C and flowing ambient air at 20°C in the space between the beam pipe and the inner surface of the silicon detector's layer 1 (SL1)—will keep the temperature of the inside surface of SL1 less than 30°C.



(a)

(b)

FIG. 1. (a) Test stand design, (b) photo of assembled test stand.

The test stand is constructed using off-the-shelf components. Pipe stands are mounted to the table to support the components and maintain proper alignment. The inner and outer pipes are made concentric using an O-ring on the air supply side and spacers at the exhaust end.

Figure 2 shows dimensions and the air supply setup. The outer aluminum pipe, which represents SLI, has an inner diameter of 73.66 mm; SL1 and the inner aluminum pipe, which represents the beampipe, has an outer diameter of 63.5 mm to match the dimensions of the EIC beam design, providing an annulus with a Δr of 5.1 mm.

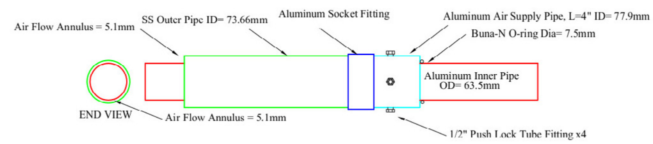


FIG. 2. Test stand dimensions.

The air supply pipe, a machined aluminum pipe that matches the outer diameter of the outer aluminum pipe, has drilled and tapped ports for connecting air supply hoses, which are attached using aluminum socket connectors and are sealed with silicone for high temperature applications.

Airflow is supplied by a compressor and metered by a mass flow controller. Air enters the air pipe at four locations evenly distributed around the circumference of the outer pipe. An O-ring seal between the inner pipe and air pipe forces the air to flow through the annulus. Airflow in the annulus is regulated by a mass flow controller.

Figure 3 shows the design of the heat source for the beampipe, a 1500-W oil heater with ~1.8 L of mineral oil, assembled inside a stainless steel threaded pipe. Fiberglass insulation is used to cover and insulate the heater pipe to increase thermal efficiency and to prevent personal injury. The heater is controlled by a PID loop.

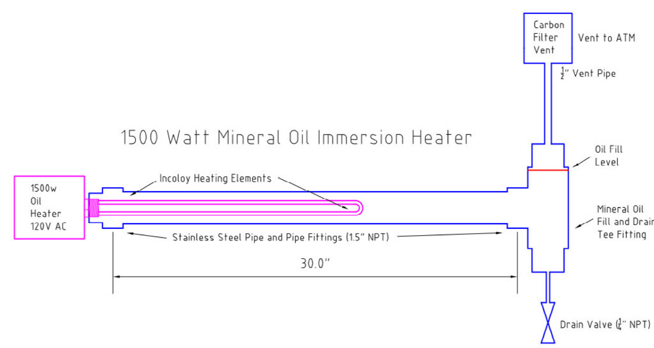


FIG. 3. Heater assembly without the beampipe or air supply.

The inner pipe is heated to a minimum of 100°C. The temperature of the pipes and heater are monitored by sensors to determine whether the air-cooling flow rate will maintain the temperature of the inner surface of the outer pipe below 30°C.

To conclude, the thermal test stand setup checks at what airflow the proposed airflow cooling method would cool SL1 to below 30°C.