

Thermal FEA of L0 Sensors

Using Circular Cooling Tubes

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A thermal analysis of the silicon sensors in the Layer 0 of the Run 2b upgrade for the D0 inner detector was run using Ansys v7.0. The geometry for a two sensor section of L0 was created using the Unigraphics CAD system and then transferred to Ansys via a Parasolid file. The symmetry of the detector allowed the use of a one twelfth azimuthal sector of L0.

The model was modified from a previous study to use a circular section cooling tube inside the castellations on the carbon fiber structure. This offers very significant simplification in manufacturing, installation and in providing the flow turnaround at $Z=0$.

Part of the meshed model is shown in Figures 1. The carbon fiber parts have correct orthotropic thermal conductivity properties.

The model was loaded with a heat load of 0.1 W on each of the silicon sensors. The coolant flow through the tube in the castellation was modeled using the Fluid 116 element. The convective heat transfer at the tube wall was modeled using the Surface 152 element. The fluid was taken to be a 40% solution of ethylene glycol in water and the flow velocity was 0.2 m/s.

The overall temperature distribution in the model is shown in Figure 2. The temperature on the sensors is shown in Figure 3. For the complete set of 6 sensors, the highest on sensor temperature would be $-12.984\text{ }^{\circ}\text{C}$.

The temperature in the coolant is shown in Figure 4. The inlet temperature was $-15\text{ }^{\circ}\text{C}$. For the complete set of 6 sensors and including the return flow in the adjacent castellation, the total temperature rise in the coolant is $0.054\text{ }^{\circ}\text{C}$.

The obvious conclusion is that round tubes will work very well.

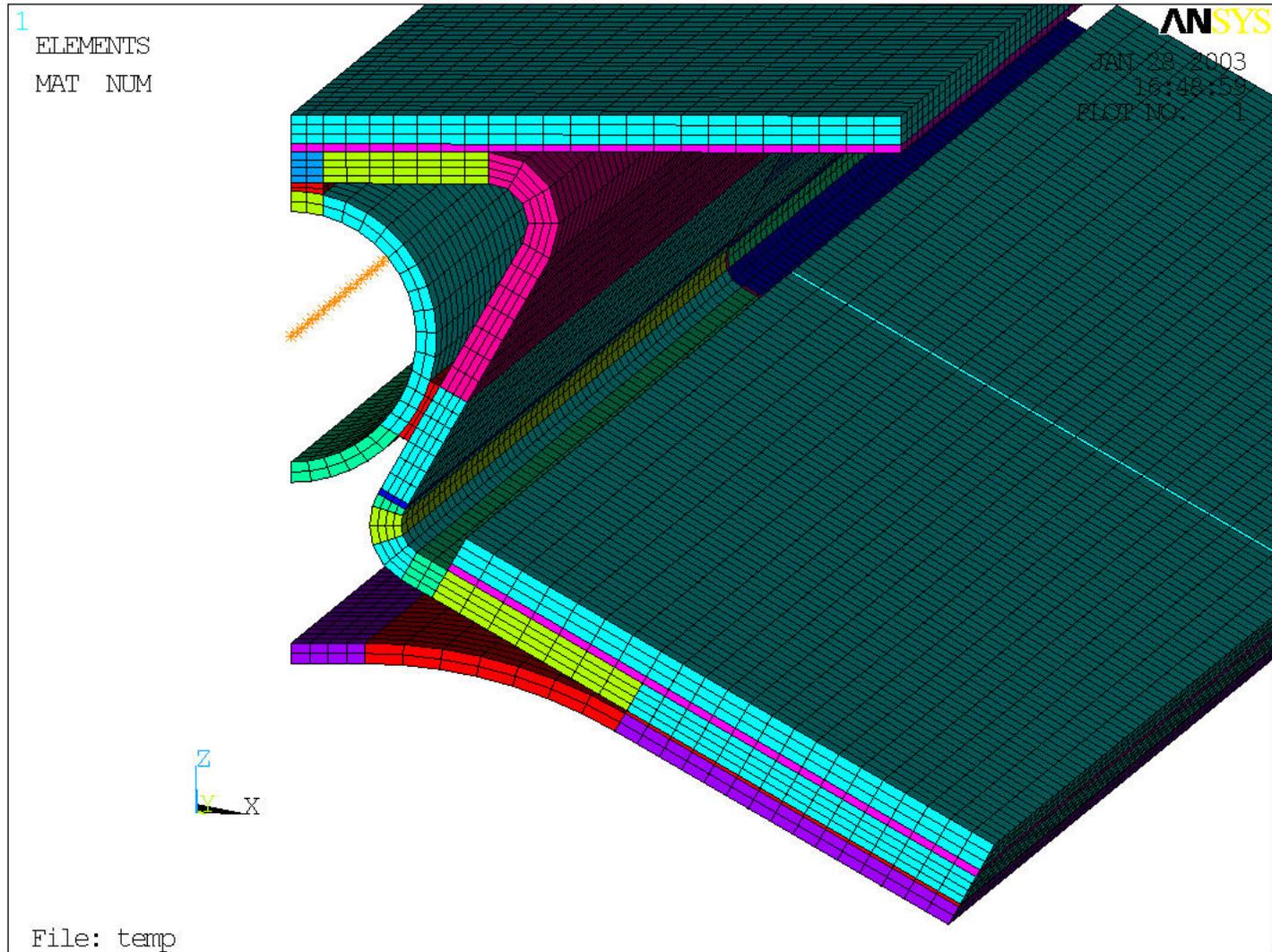


Figure 1: Thermal FEA model of the L0 sensors.

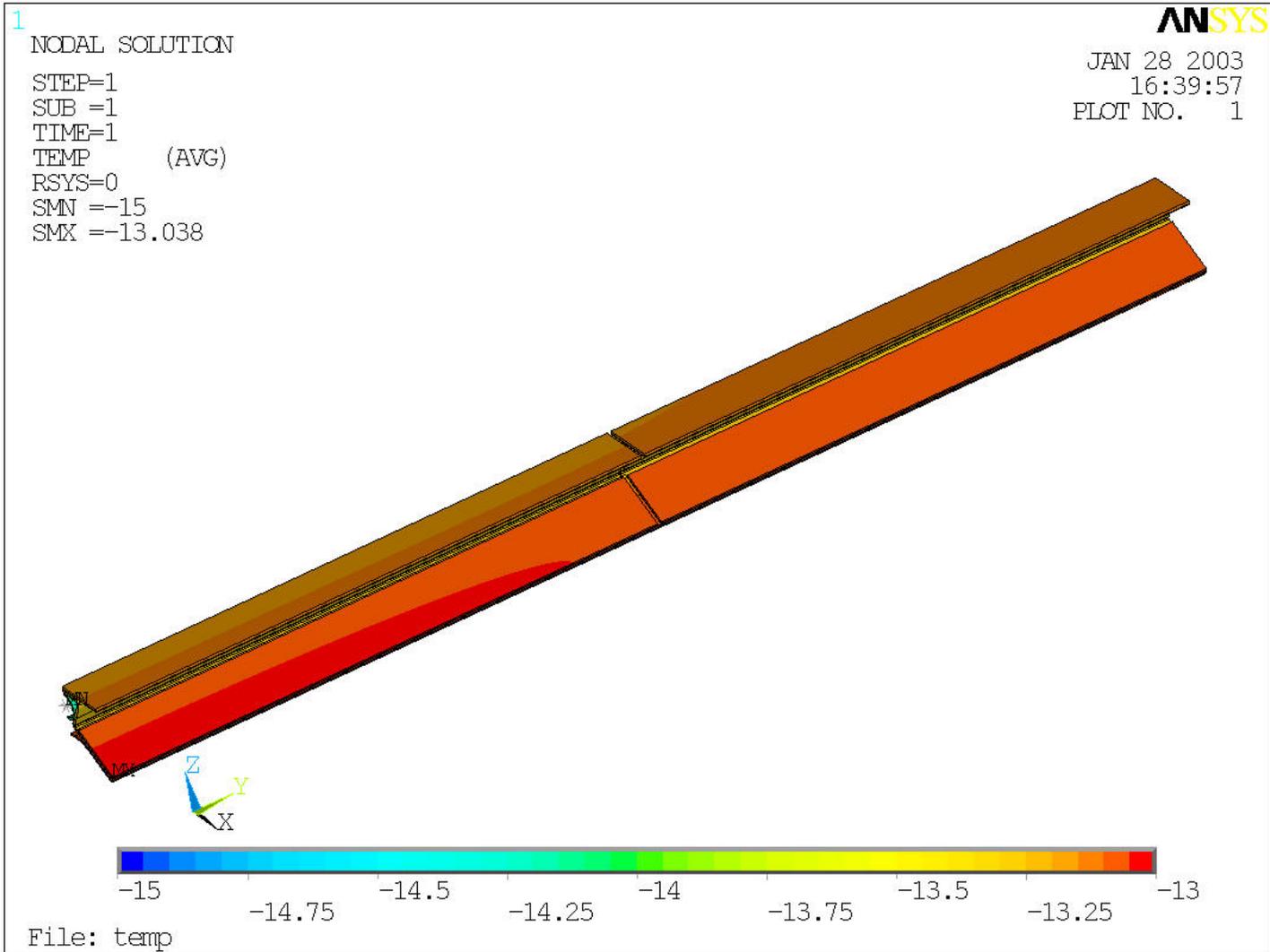


Figure 2: Temperature distribution in the FEA model. Temperature is in °C.

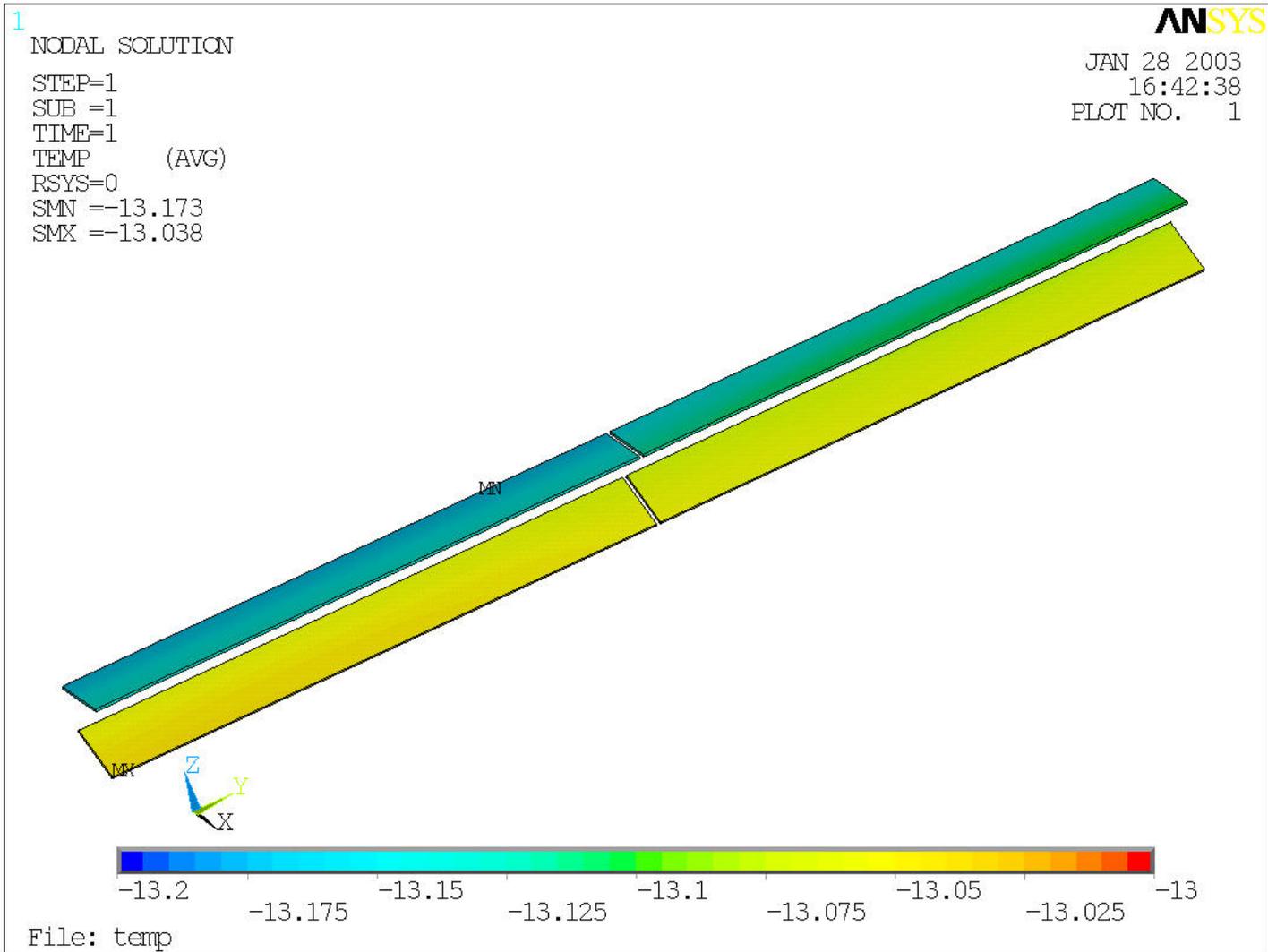


Figure 3: Temperature distribution in the sensors. Temperature is in °C.

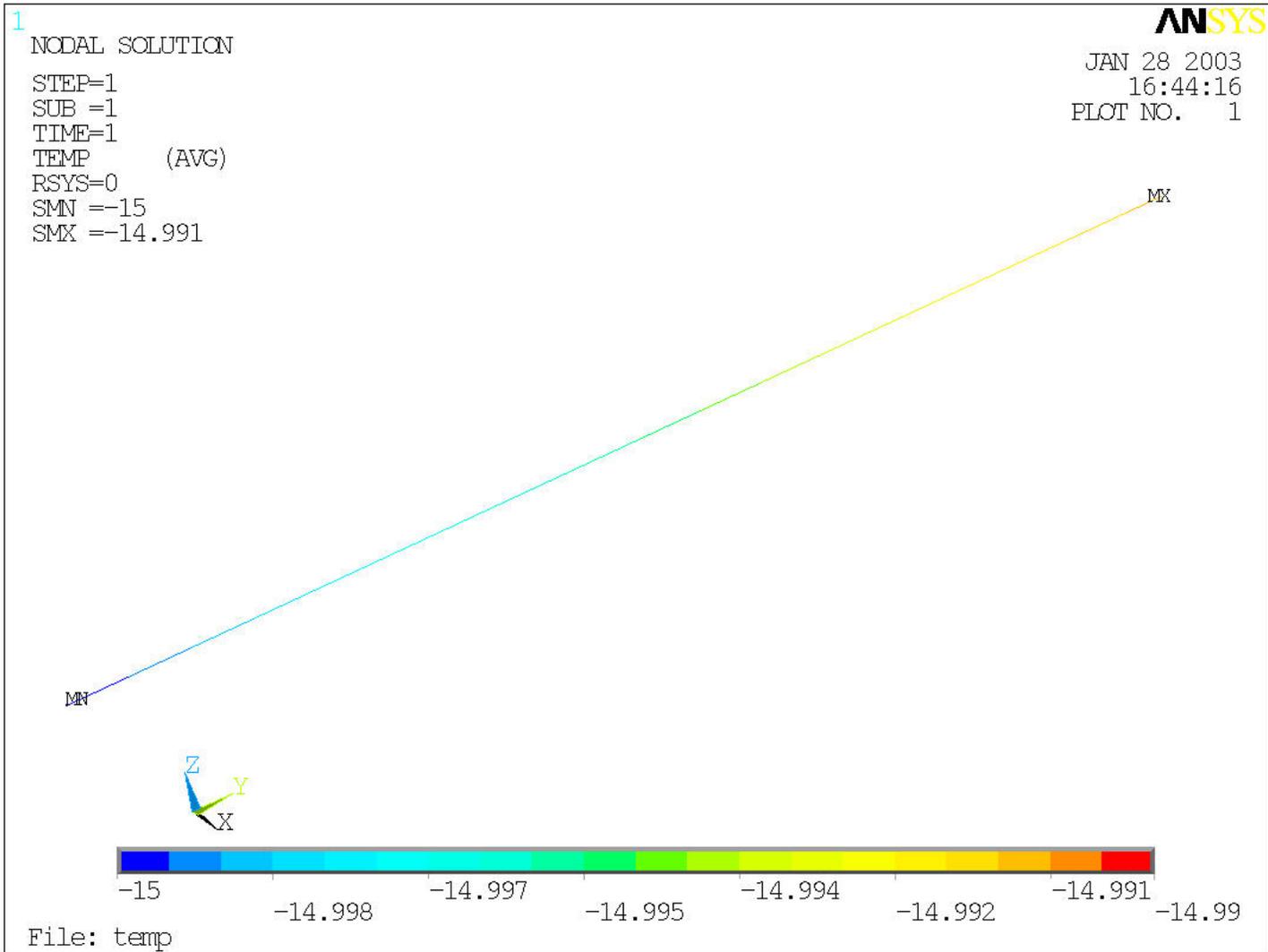


Figure 4: Temperature distribution in the coolant. Temperature is in °C.