

## RHIC Tunnel Temperature Sensor Locations and Graphing Data Analysis.

There are 1056 temperature sensors that are mounted on four different types of voltage monitoring lead-trees, and there are 36 Humidity/Temperature sensors that are mounted on the tunnel walls or hanged from the cable trays near Q3/Q4 and Q21/Q21. Refer to “RHIC Tunnel Temperature Sensor Routing” document for detailed mounting locations of all 1092 sensors. The Humidity/Temperature sensors are used to monitor the ambient temperature and the relative humidity level of the tunnel. Whereas the lead-tree temperature sensors are used to monitor the temperature of the lead-trees, and alarm users when temperature drops below the ice-ball forming level. Each lead-tree has one pair of temperature sensors that are mounted near the feed through. The left hand side sensor always labeled “A” and the right hand side sensor is always labeled “B”.

The thermo mass for each types of lead-tree is different; therefore, they behave differently during the heating and cooling cycle. The following paragraphs discuss and give examples for each type of lead-trees.

1. DX, Q1, Q2 or Q3 type - This type of lead-tree has no insulation around the heater tube. Force air from an outside mounted fan is used to stable the temperature and to help the prevention of moisture collection. Photo 1 shows a typical DX type lead tree location and Photo 2 shows a typical Q1, Q2 and Q3 types of lead trees. Photo 3 is the close-up of the mounting for DX, Q1, Q2 and Q3 types of temperature sensors. Long term captured data are plotted as in Graph 1 (Refer to “Procedure to monitor the RHIC Tunnel Lead” for steps to view more sensor plots). Interpretation and description for modes of operation are as follows:
  - a. Heater Off with Fan On or Off – This is not a normal condition for operation; the heater must cycles at room temperature. Since there is no external heat source, the temperature variation is within 1 degree Fahrenheit (sensor accuracy level). The drift will follow the tunnel ambient temperature and the tree temperature. Graph 2 is a typical plot showing sensor’s response for this condition. Condensation will form when the lead temperature falls below the dew point, usually around 45 degree F, and ice ball will form when the lead temperature falls below the freezing point. Schedule the inspection and repair before temperature drops below 45 degree F.
  - b. Heater cycling with Fan On – This is the only normal operation condition. Cycling temperature is within 7 degrees F and the cycling time is about 15-20 minutes. The temperature drift is between 75 to 90 degrees F. Details are shown in Graph 4.
  - c. Heater cycling with Fan Off – This is not a normal condition for operation, either the fan is moved out of place or failed to operate. Excess heat is not being moved away by force air. The cycling temperature is increased to 18 degree F and cycling time is increased to 40 minutes. The drift is between 80 to 110 degrees F. Since air flow is stopped, ice balls might form on local cold spots. Inspect and repair when schedule is allowed. Details are shown in Graph 5.
  - d. Heater stuck in the ON mode, with or without Fan - No data, never tested.

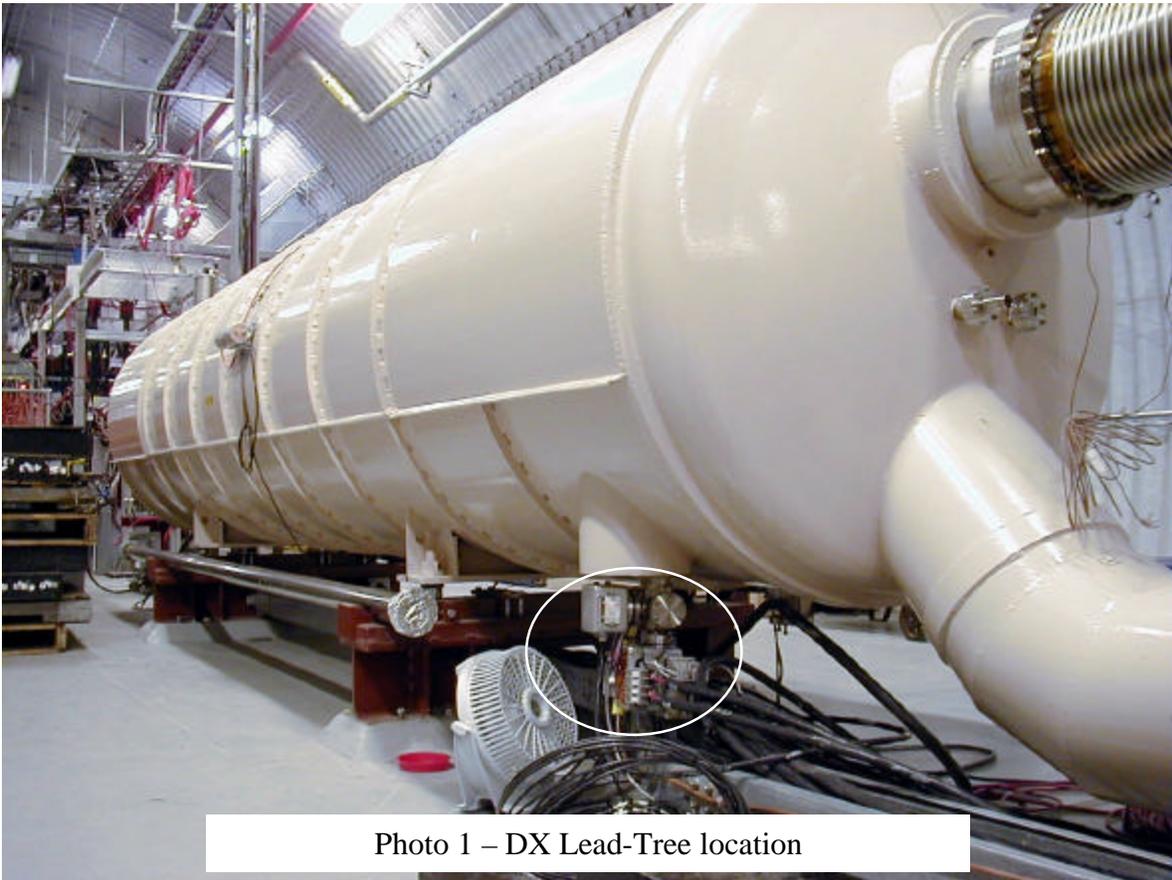
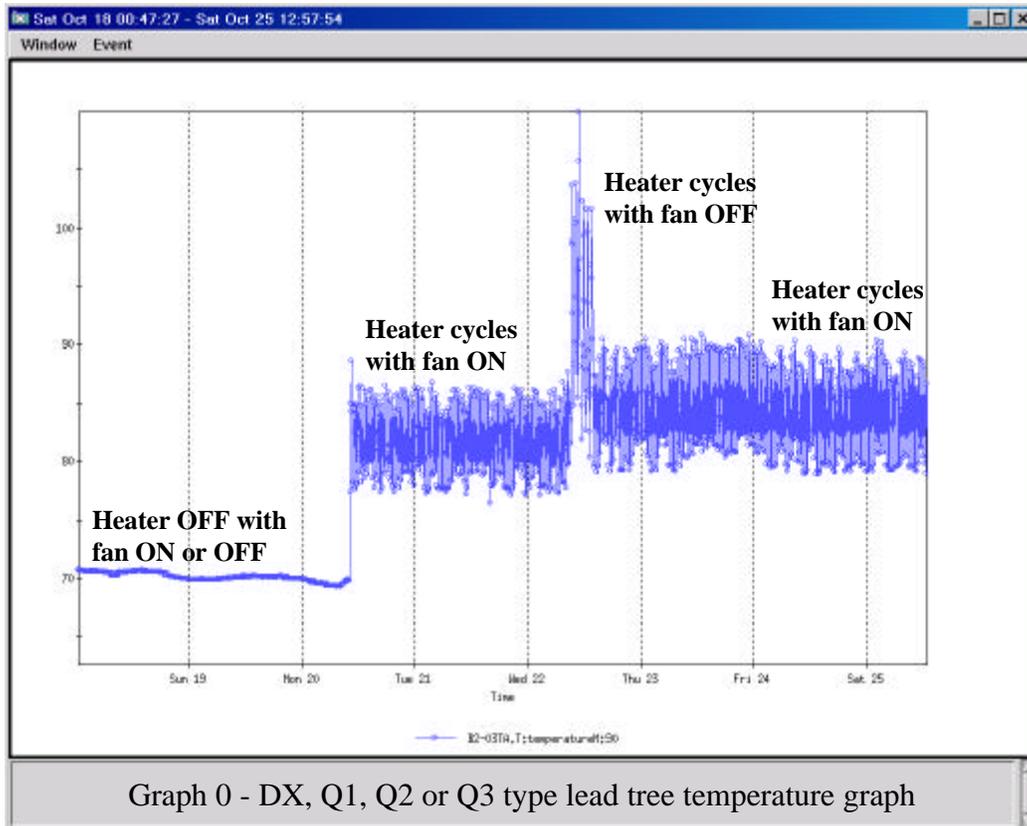
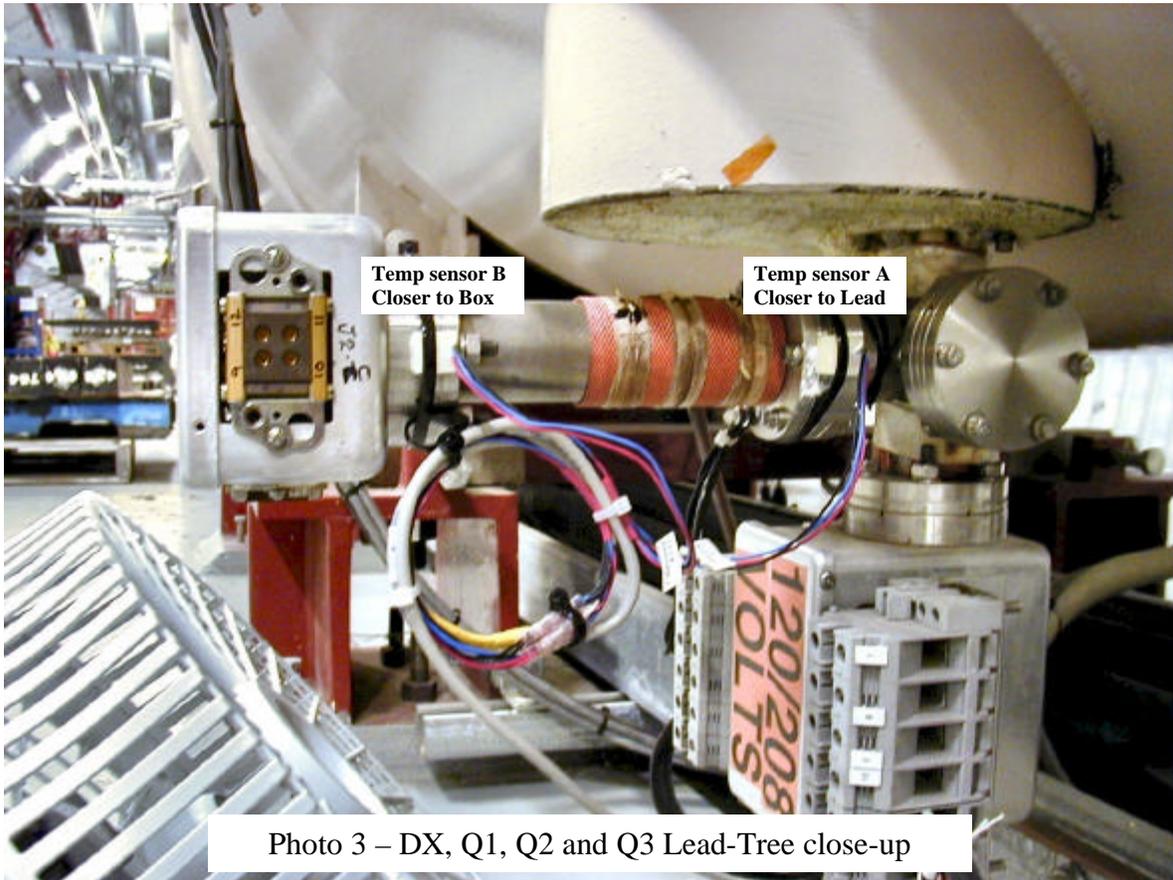
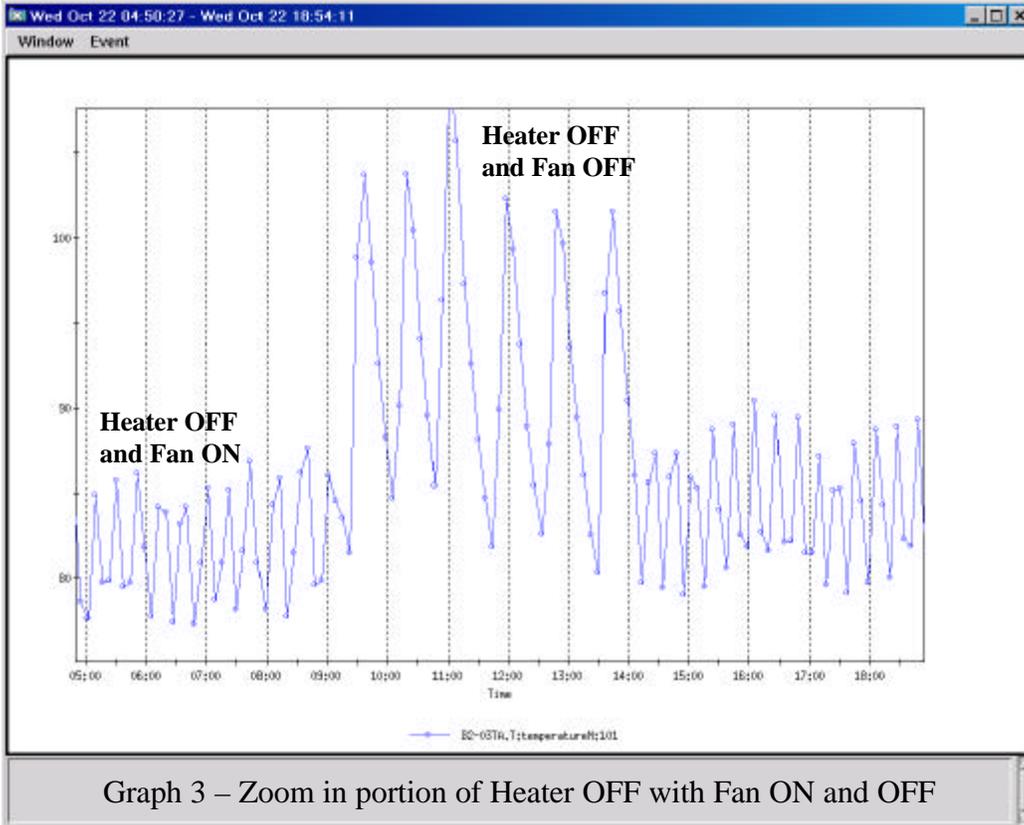
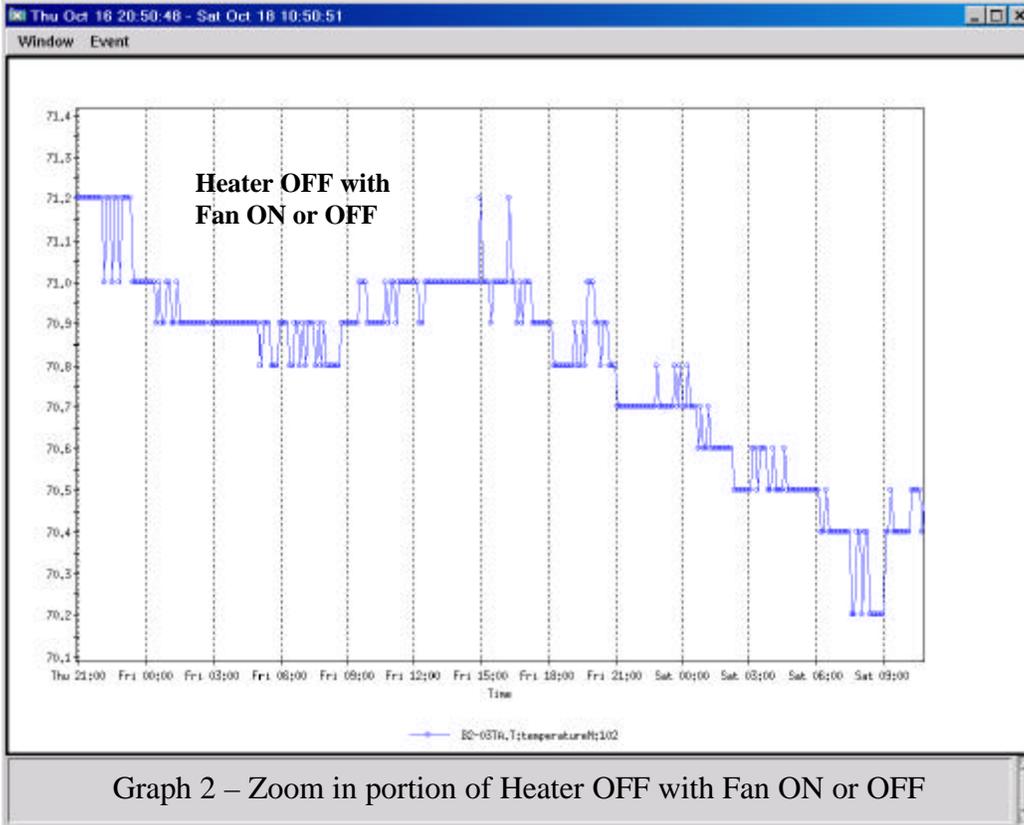


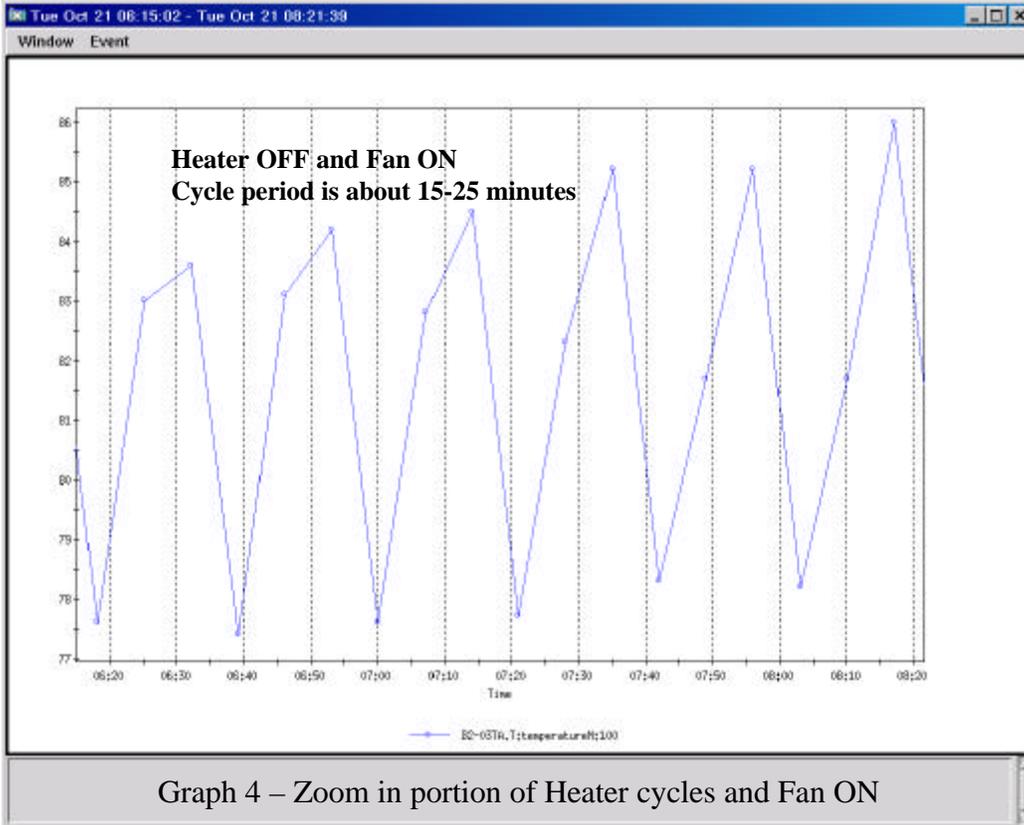
Photo 1 – DX Lead-Tree location



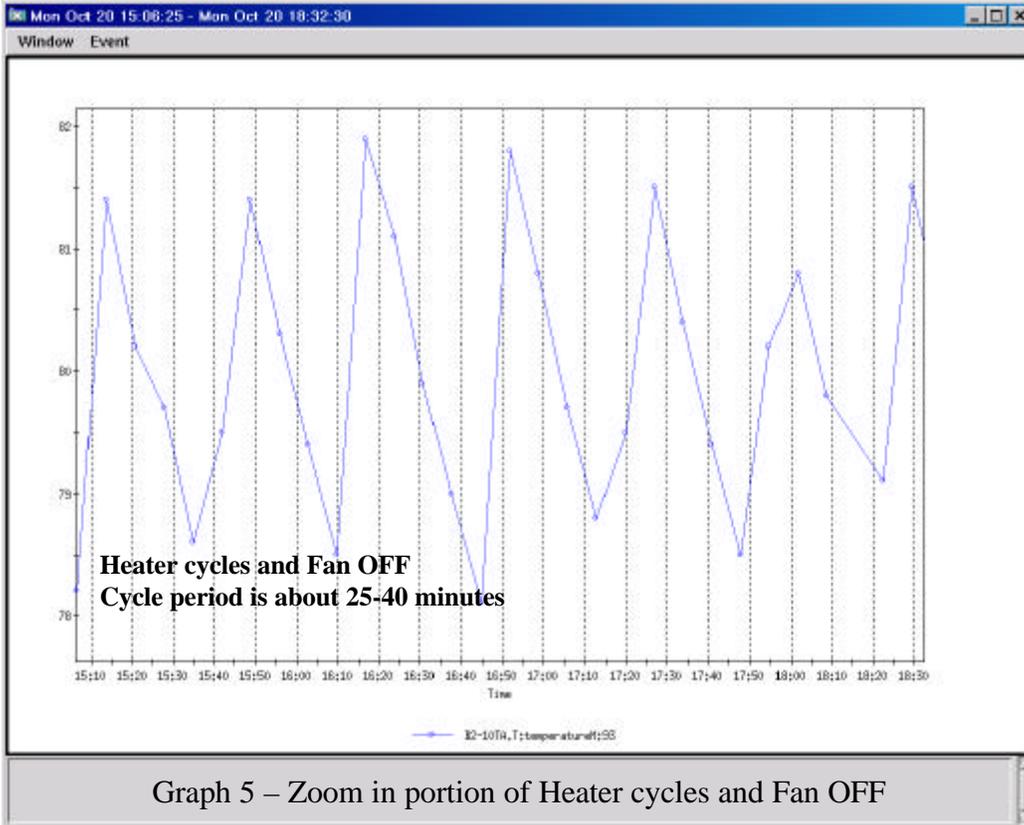
Photo 2 – Q1, Q2 and Q3 Lead-Tree locations







Graph 4 – Zoom in portion of Heater cycles and Fan ON



Graph 5 – Zoom in portion of Heater cycles and Fan OFF

2. Q4 to Q21 type - This type of lead has two layers of insulation wrapped on top of the heater tube to stabilize the temperature and to prevent ice ball forming and collecting moisture. No fan is needed for normal operation. Photo 4 shows a typical Q4 to Q21 type lead tree. Captured data are plotted in Graph 6. Interpretation and description for modes of operation are as follows:
  - a. Heater Off – This is not a normal condition for operation, the heater must cycle at room temperature. Since there is no heat source, the temperature variation is within 1 degree Fahrenheit (sensor accuracy level). The drift will follow the tunnel ambient temperature and the tree temperature. Condensation will form when the lead temperature falls below the dew point, usually around 45 degree F, and ice ball will form when the lead temperature falls below the freezing point. Schedule the inspection and repair before temperature drops below 45 degree F. Details are shown in Graph 7.
  - b. Heater cycles – This is the only normal operation condition. Cycling temperature is within 5 degrees F and the cycling time is about 15-25 minutes. The temperature drift is between 75 to 90 degrees F. Details are shown in Graph 8.
  - c. Heater stuck in the ON mode - No data, never tested.

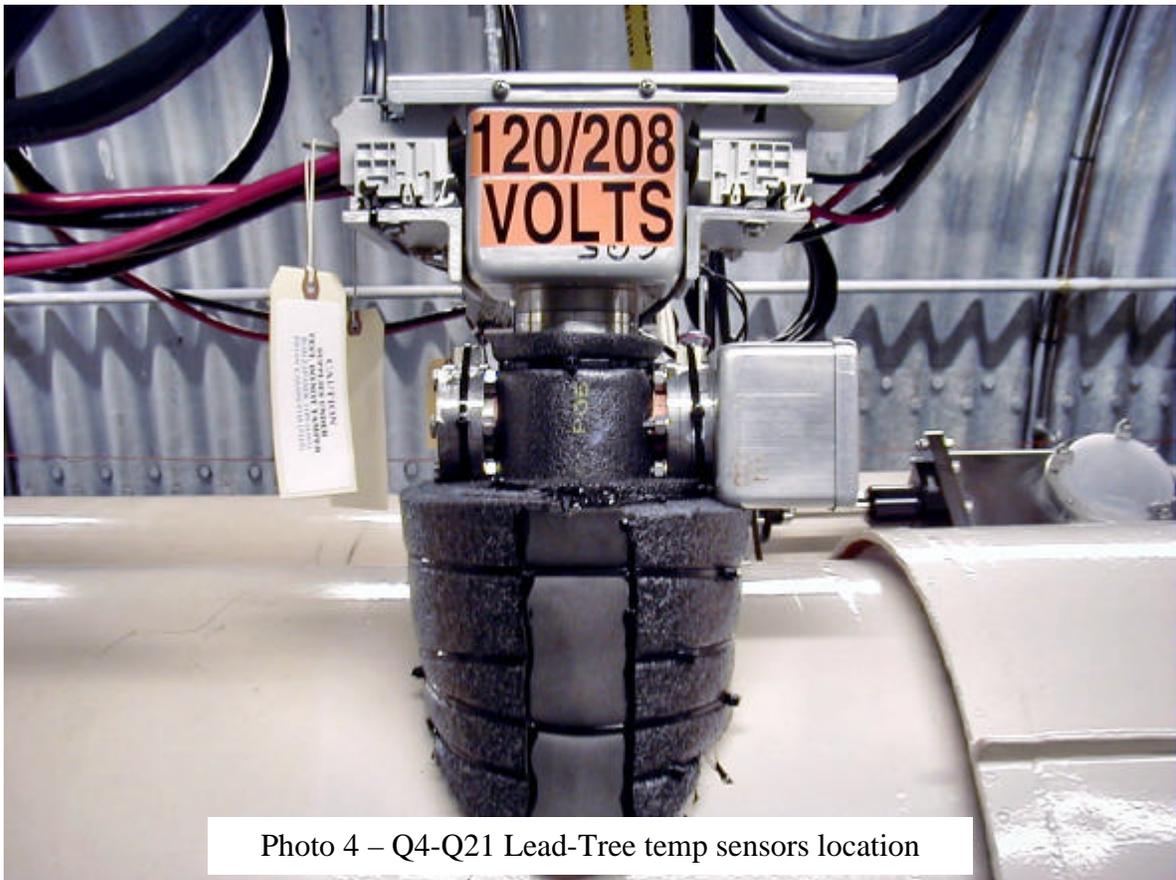
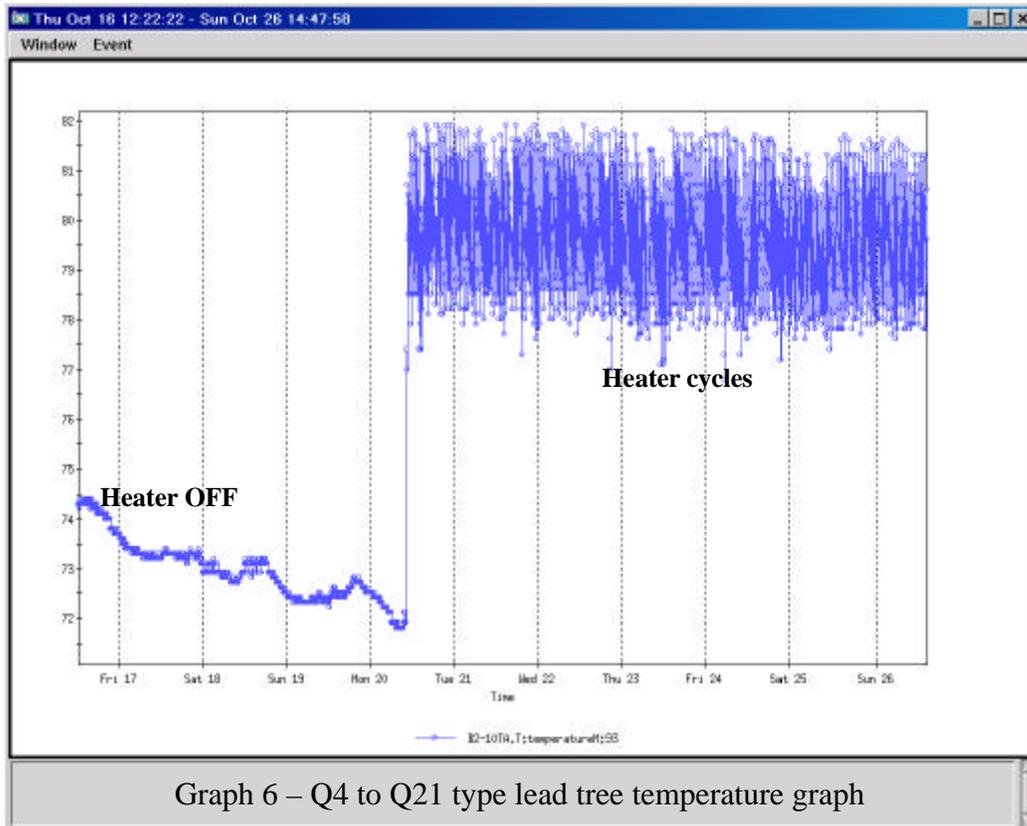
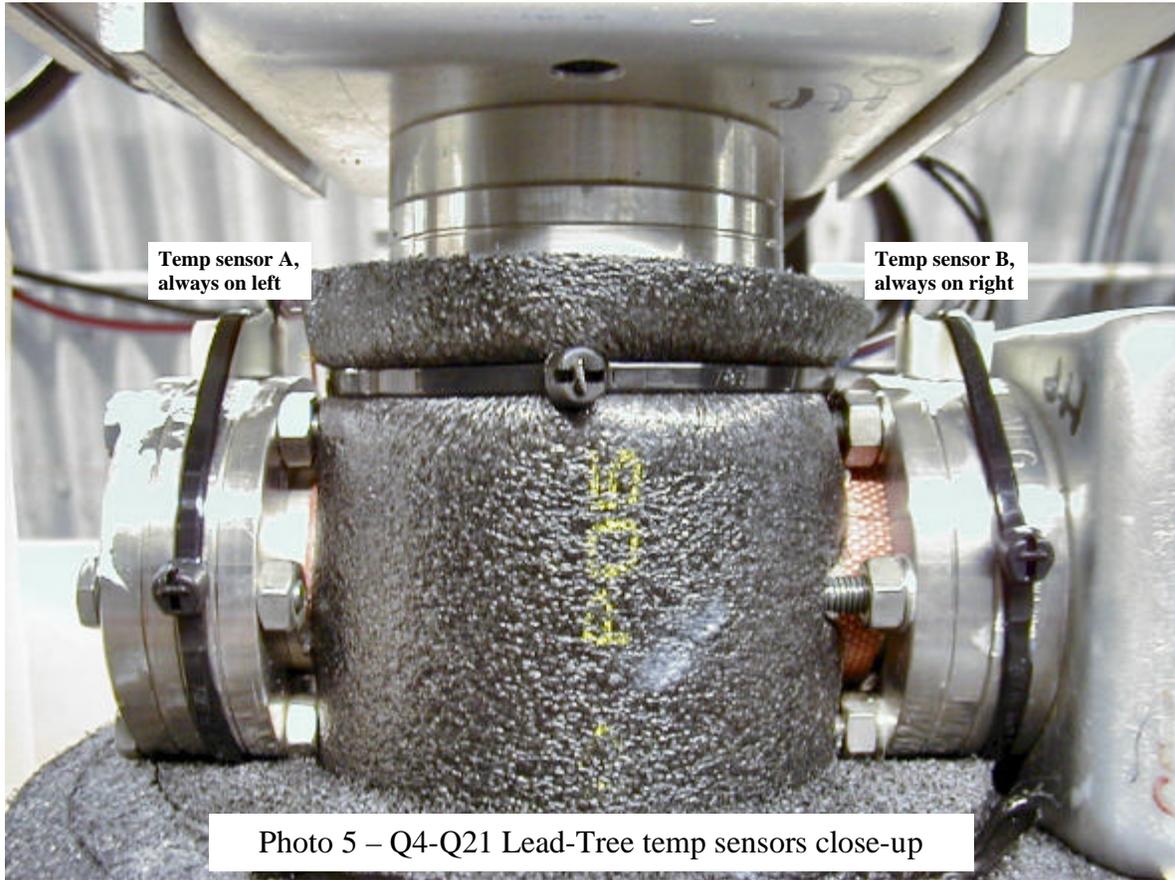
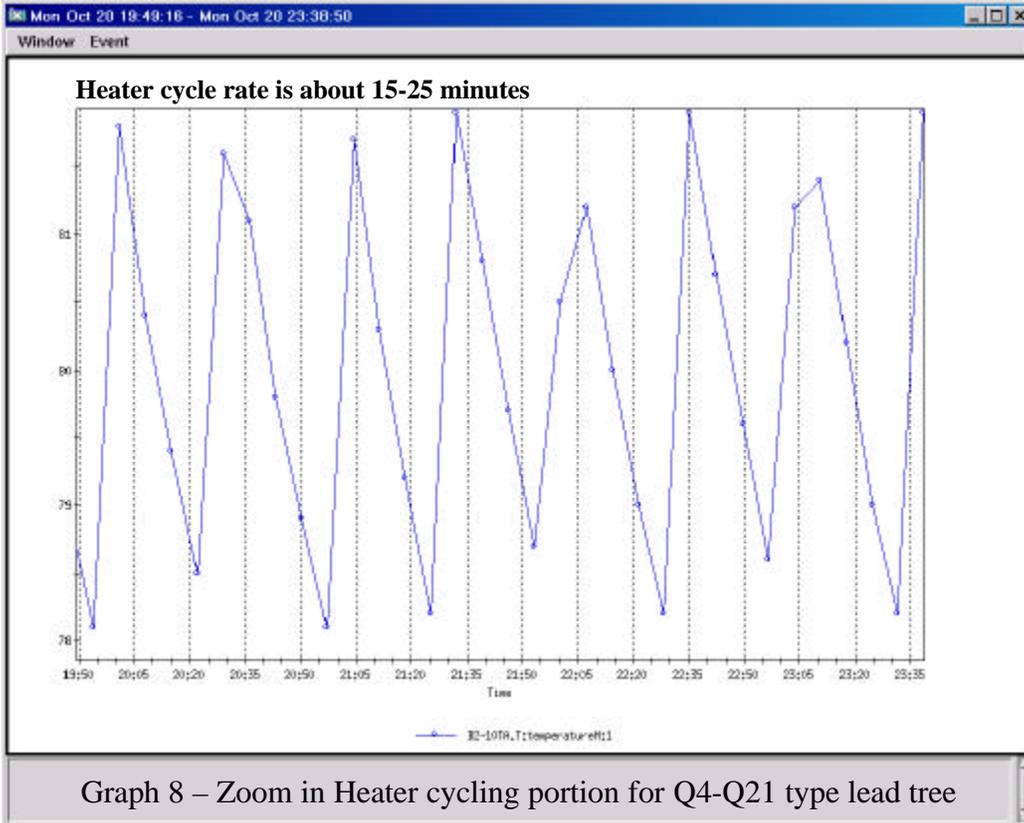
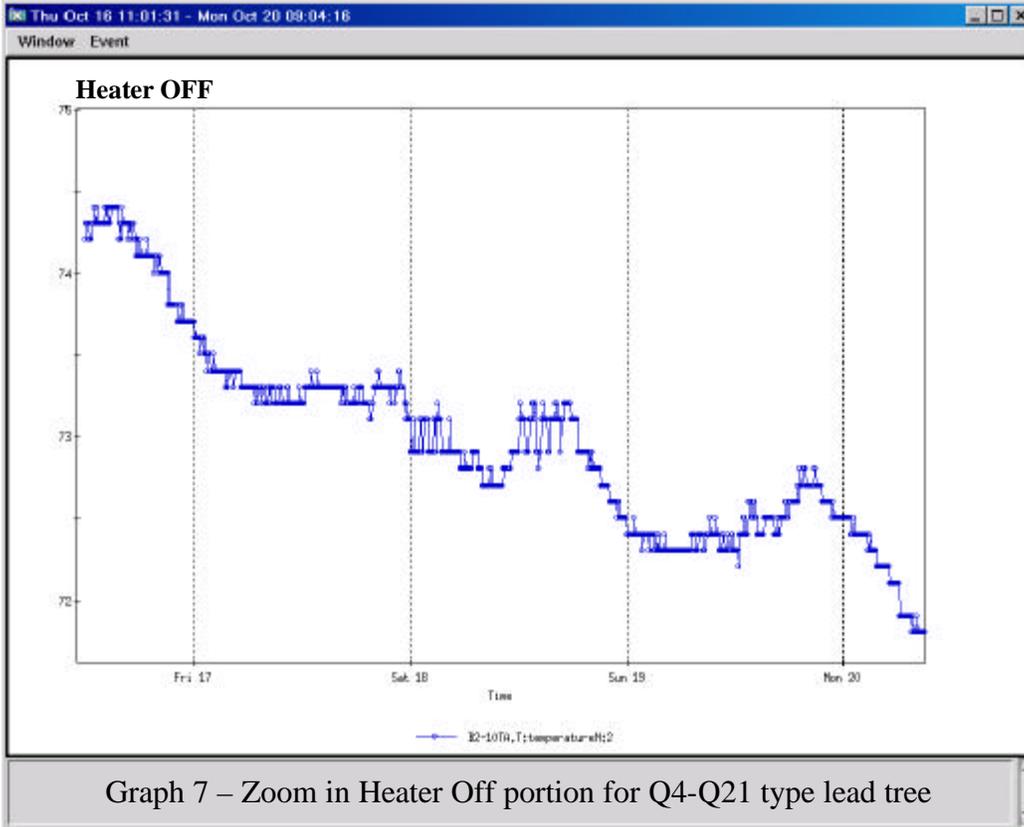


Photo 4 – Q4-Q21 Lead-Tree temp sensors location





3. Snake or Spin-Rotator type – This type of lead-tree has no insulation around the heater tube as shown in Photo 6. One fan is mounted on the top, inside the cable entry enclosure. Air intake is from the top and exhausted through vent holes on the side near the bottom as shown in photo 7. Force air is used to stable the temperature and to help the prevention of moisture collection. Captured data are plotted in Graph 8. Interpretation and description for modes of operation are as follows:
  - a. Heater Off with Fan On or Off – This is not a normal condition for operation; the heater must cycle at room temperature. Since there is no heat source, the temperature variation is within 1 degree Fahrenheit (sensor accuracy level). The drift will follow the tunnel ambient temperature and the tree temperature as shown in Graph 9. Condensation will form when the lead temperature falls below the dew point, usually around 45 degree F, and ice ball will form when the lead temperature falls below the freezing point. Schedule the inspection and repair before temperature drops below 45 degree F.
  - b. Heater cycling with Fan Off – No data, never tested.
  - c. Heater cycling with Fan On – This is the only normal operation condition. Cycling temperature is within 12 degrees F and the cycling time is about 30-40 minutes. The temperature drift is between 75 to 95 degrees F. Details are shown in Graph 9.
  - d. Heater stuck in the ON mode, with or without fan - No data, never tested.

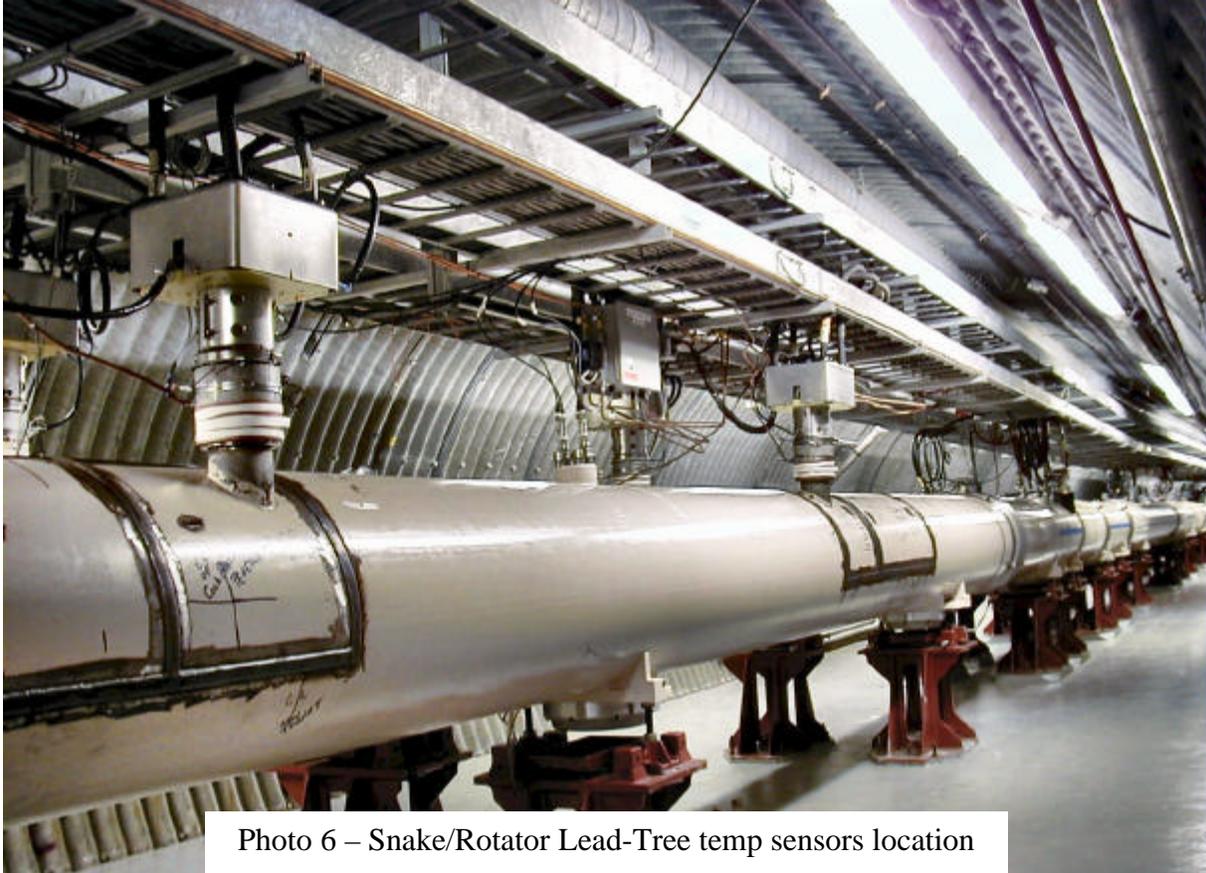


Photo 6 – Snake/Rotator Lead-Tree temp sensors location

