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TECHNICAL NOTE

MICE Spectrometer Solenoid: Magnet Instrumentation

1. Introduction

This document summarizes the current configuration of the instrumentation on the spectrometer solenoid magnets and describes the proposed changes and additions to the system. The existing instrumentation layout for the last magnet assembled (Magnet 2B with three 2-stage coolers and one single stage cooler) is shown in Figure 1. The instrumentation shown includes temperature sensors (silicon diode, platinum resistor and Cernox), voltage taps and helium level gages; heaters are also shown on the diagram. Figure 2 shows a more detailed view of the voltage tap locations. The following sections provide details of the proposed changes to the system.

2. Temperature Sensors

The Spectrometer Solenoids already incorporate a large number of temperature sensors. However, some modifications and additions are proposed in order to improve the diagnostic capabilities during cool down and training. The temperatures during cooldown and training will continue to be logged using the previously developed system.

The 2-stage cryocoolers have previously incorporated a platinum resistor sensor directly mounted to the first stage cold head and a platinum resistor sensor mounted directly on the second stage cold head. The wires were brought out using a specially designed feedthrough flange at the upper end of the cooler. In order to obtain an accurate measurement of the second stage cold head during operation (and thus the amount of heat being removed at 4.2K), it is proposed that the sensor here be replaced by a calibrated Cernox sensor. The first stage sensors would remain as is.

The interior of the cold mass is instrumented with a variety of temperature sensors. As these sensors are inaccessible, they will be left in place.

The current layout includes three platinum resistor sensors on the thermal shield: one at the top close to where the connection is made from the first stage copper plate and one on either end of the shield assembly (one higher up and one lower down). It is proposed that a fourth sensor be installed near the middle of the shield bore tube. This area is expected to be the hottest spot on the shield. Two additional sensors would be located on the intermediate links of two of the cold mass supports. Note that the heat coming down the cold mass supports from 300K is intercepted by copper straps that are welded to the intermediate links and to the shield. These sensors would be located on one of the upper supports on one end of the magnet and on one of the lower supports at the other end.

3. Voltage Taps

Prior to the last series of magnet training runs, an additional set of eight voltage taps was added to the lower end of the HTS leads (refer to Figure 2). These taps allow the continuity of the HTS leads to be checked independently from the magnet cold leads. For the next series of magnet training runs, a fast data logger will be used to record the various system voltages. This information will be used to determine the coil that initiated a magnet quench and establish the subsequent timing of the quenches in the other coils.

4. Helium Level Gages

Currently, the cold mass contains two internal helium level gages, one for the lower half of the enclosed space around the coils and one for the upper half (refer to Figure 1). There is a gap between the gages near the midpoint of the cold mass. Also, a small space at the bottom and at the top of the cold mass are out of the range of the gages. It is proposed that a third level gage be installed that will cover the upper portion of the cold mass and will extend the coverage up into the cryocooler condenser tubes. This gage will allow the cold mass to be run at a completely full level while ensuring that the system is not over-full such that the LHe is in contact with the coolers' second stage condensers.

5. Pressure Transducers

The previous magnet assembly included a pair of dial gages and an electronic transducer to measure the pressure at the vent and fill pipe tower. This setup will continue to be used; however, the electronic pressure transducer will also be connected to an oscilloscope or other appropriate storage device during cooldown and training in order to look for any signs of thermo-acoustic oscillation.

6. Insulating Vacuum

Instrumentation for the magnet insulating vacuum will include thermocouple, piranni and ionization gauges as well as an RGA. Previously, the only gauge on the system was a thermocouple gauge that could read down to 1 mTorr. Once the magnet was cold, the actual level of the insulating vacuum could not be determined. We do not plan to use all of the instrumentation in normal operation, but these diagnostics may be useful to identify or rule out any problems during the initial testing of the magnets.

7. Instrumentation Wires

The wires used for instrumentation of the magnet will be checked to ensure that they are all phosphor bronze. These types of wires will also be used for any additional instrumentation. Quad flat 4-wire cable (phosphor bronze) made by LakeShore will be used where possible due to its superior electrical and thermal properties and the fact that it can be readily fixed to a first stage heat sinking surface.

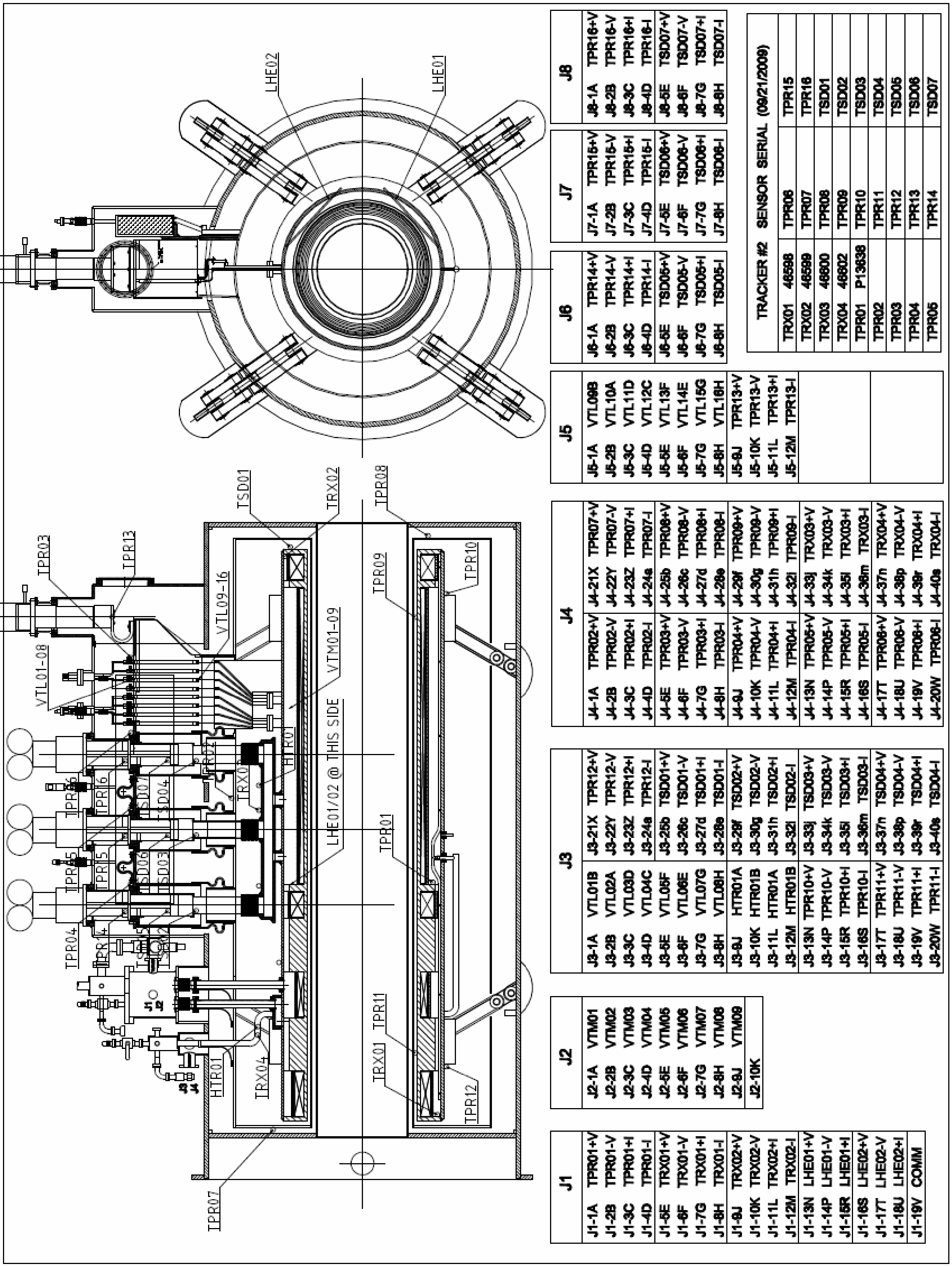

Figure 1: Existing layout of temperature sensors, level sensors, voltage taps and heaters.

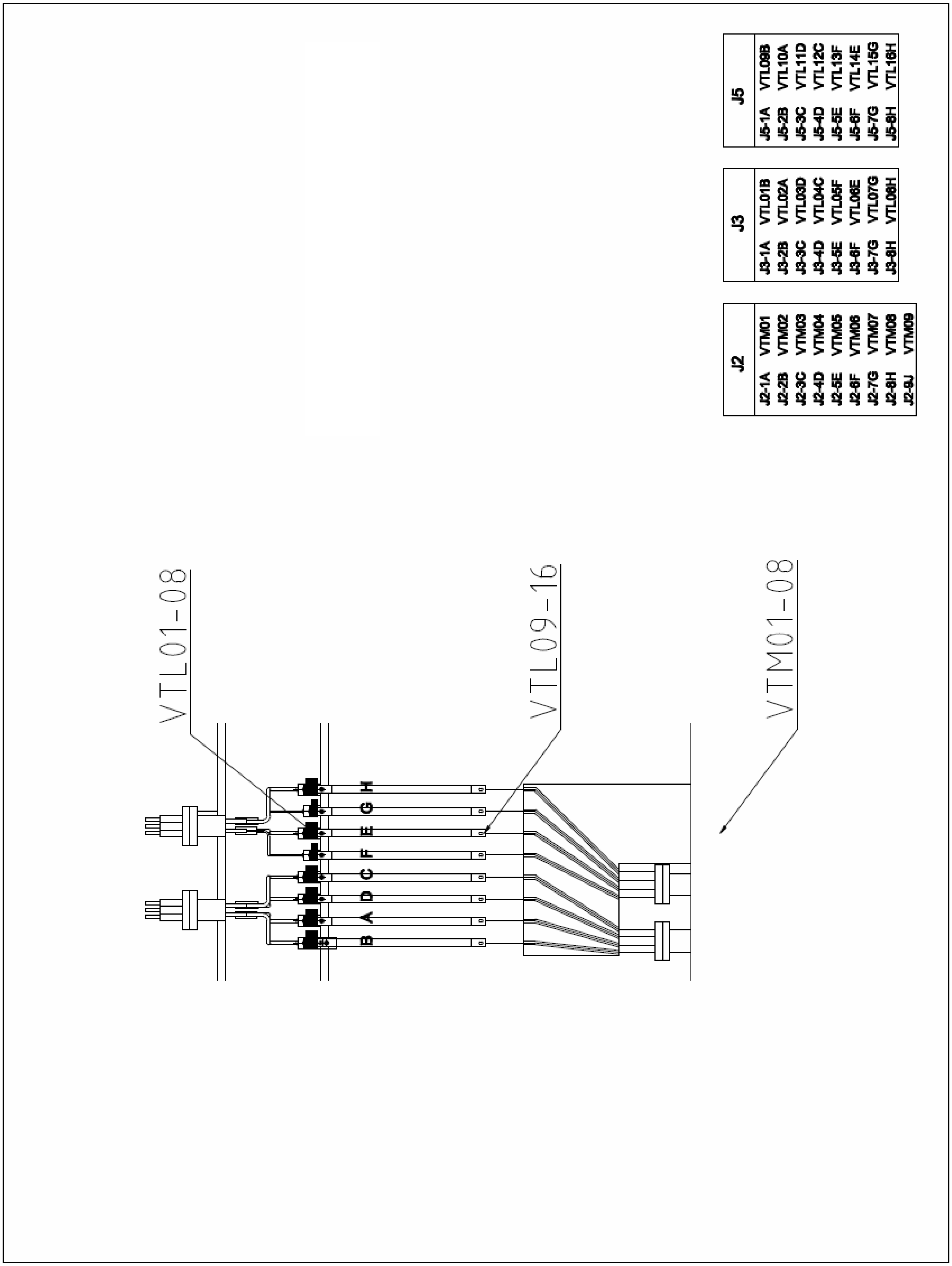

Figure 2: Existing layout of lead voltage taps (detail).