Debugging the Thermocouple Readback Issues of the Neutral Particle Spectrometer

Aaron Brown, Mary Ann Antonioli, Peter Bonneau, Pablo Campero, Brian Eng, George Jacobs, Mindy Leffel,
Tyler Lemon, Marc McMullen, and Amrit Yegneswaran

Physics Division, Thomas Jefferson National Accelerator Facility, Newport News, VA 23606

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This note presents the outcome of debugging the thermocouple readback issues of the Neutral Particle Spectrometer (NPS).

The NPS crystal array has 112 thermocouples—the front and back sides each having 56 thermocouples, Fig. 1. The thermocouples (PN 201-301) are connected to four Keysight terminal blocks (PN 34921T) in the NPS, Table I, each of which is connected to a Keysight multiplexer (PN 34921A) installed in the Keysight mainframe (PN 34980A), via a Keysight D-sub cable (~10 ft.) connected to an in-house fabricated 60-ft. extension cable, Fig. 2.

Thermocouple locations	Terminal block	Number of thermocouples
Crystal array back	1	40
	2	16
Crystal array front	3	40
	4	16

TABLE I. Thermocouple connections to terminal blocks.

During the physics run, temperature values of the thermocouples scanned by the thermal readback program were at times incomprehensible. Even though a terminal block was populated with at least 16 thermocouples, values shown for all the thermocouples of a terminal block would be -99000, an indicator of no connected sensors, or would be -0.0°C, Fig. 3.

Power cycling the Keysight mainframe sometimes resolved the issue, but was unreliable. Further, neither swapping the multiplexer with a working multiplexer nor replacing the in-house manufactured extension cable and manufacturer's cable with spare cables solved the problem. Eventually, replacing the terminal block resolved the issue.

To date, terminal blocks #1, #2, and #3 have been replaced. The faulty terminal blocks will be tested using the Keysight test stand.
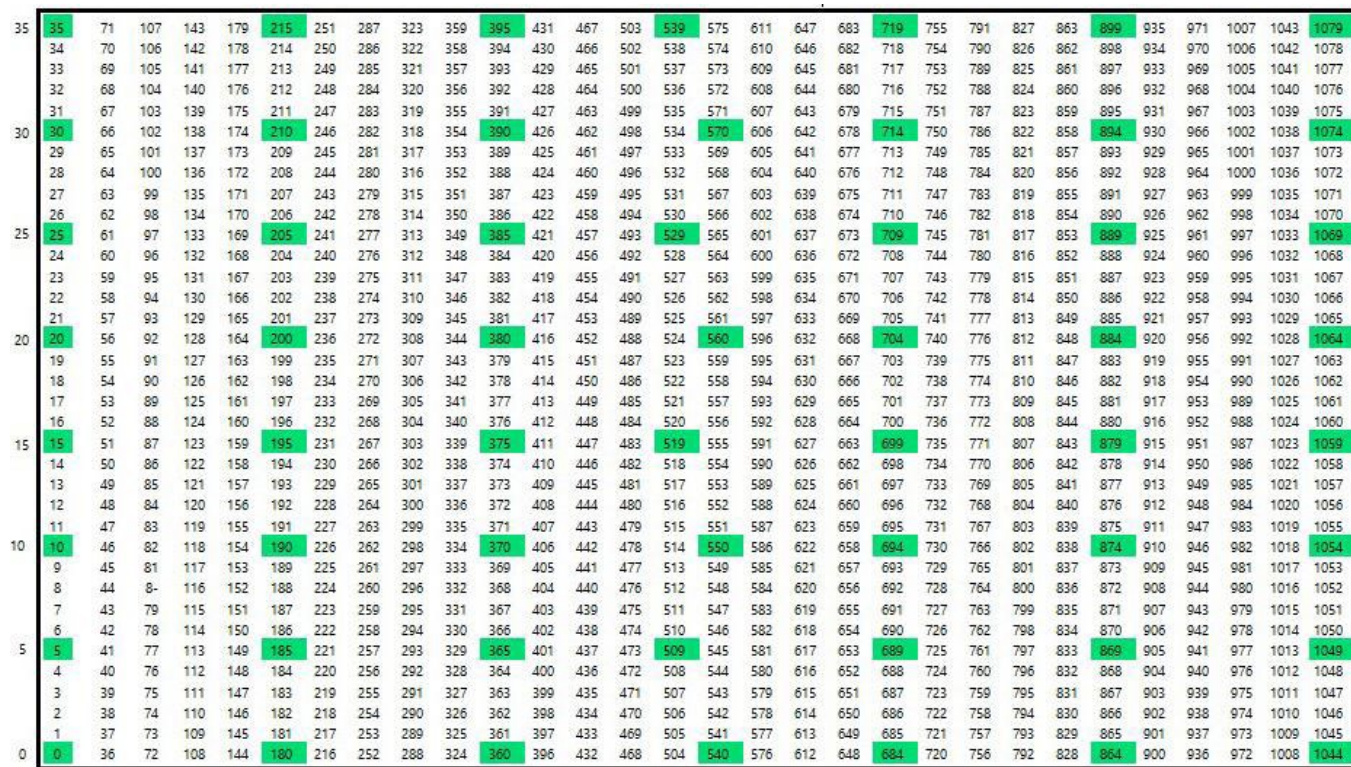

FIG. 1. Front crystal face with a thermocouple indicated in green. Backs of the same crystals have thermocouples as well.
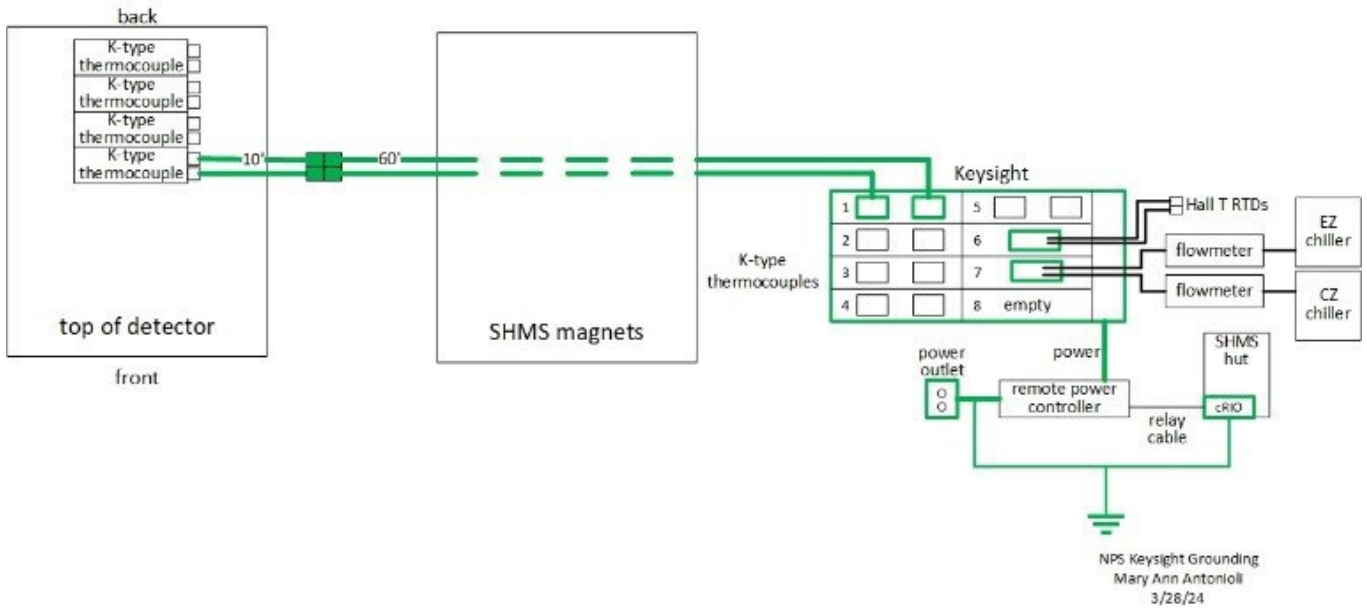
FIG. 2. Connection scheme of the NPS control and monitoring system. Green lines indicate grounding. Dashed green lines indicate cables under the magnets.

FIG. 3. Screenshot of Back Crystal Zone Temperatures Phoebus screen showing erroneous temperatures for multiplexer #2 (boxed in red).