

MDP-BNL Subscale Instrumentation Plan

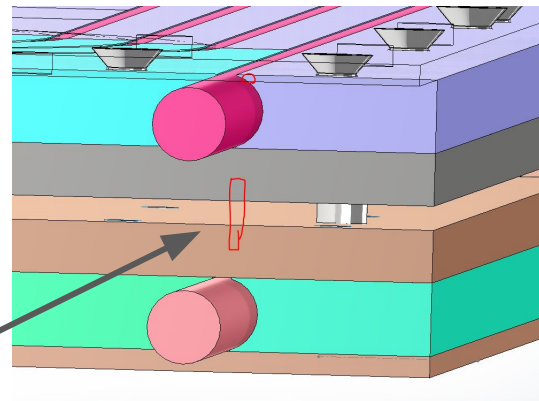
December 2020

Overview

- Basic measurement needs
 - Co-wound sample voltages
 - Hall sensor for dipole field measurements, hysteresis
 - *Heater / heater array*
- Instrumentation R&D
 - Terminal Hall probes
 - Acoustic thermometry
 - Will be integrated at a later date
- Requested modifications
- **Proposed tests**
 - *Make sure heaters are integrated in design and included in test plan*

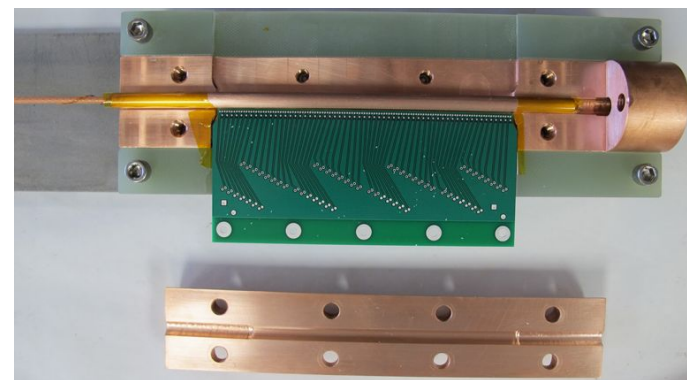
Basic Measurement Needs

- Sample Voltages
 - Co-wound voltage taps
 - Noise will be important with background field
 - Monitor as many pairs as possible (minimum 2 pairs)
 - Nanovolt meters (e.g., Keithley 2182A, Keysight 34420A)
- Hall Probes
 - Minimum one (?) Hall sensor to measure main dipole field
 - *May need to modify plate for clearance?*
 - Map hysteresis during trapezoidal current ramp
- **Quench Heater**
 - Heaters (2+?) in location of lowest and highest field
 - Should be in intimate contact with cable (*epoxied?*)
 - *Danko - additional thermal insulation*
 - Consider flex PCB / trace on top of CORC in stack
 - Flex PCB could double as quench antenna



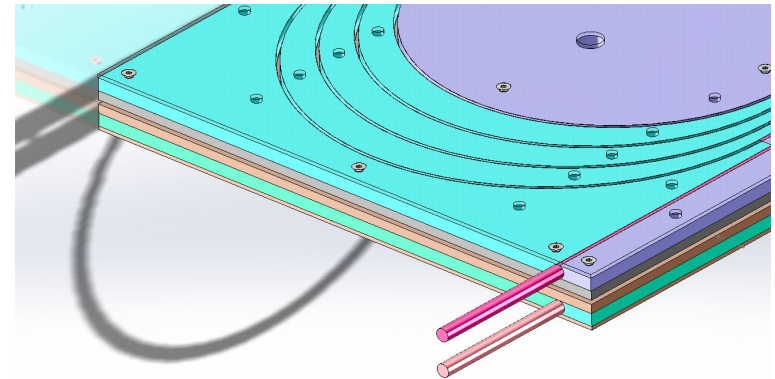
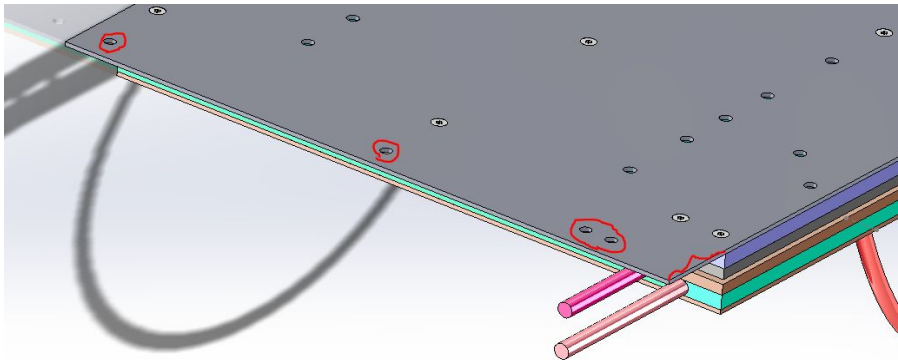
Terminal Hall Probes

- Integrate sensor arrays outside terminal
 - Working on a new PCB array that captures this functionality but is easier to implement
- Integrate sensor arrays inside terminal
 - **Requires modifications to terminal**
- Targeting both techniques
 - Need to identify suitable DAQ (*operate remotely?*)
 - Requires a plan to feed many channels (~20-40 pairs) out of cryostat - (*discussion on header*)
 - *Anticipated levels of background field at terminal?*



Requested Modifications

- Need to iterate on how quench heaters will be implemented
 - Need to feed wires out for heaters
 - *Danko - may need to machine clearance for heaters*
- Would like a few extra tapped holes that we can mount sensors to
 - Is it possible to add an “overhang” near the leads at either thin or thick sheet?
 - Original (right) and ~ 1.5” overhang (left) with multiple 10-32 tapped holes (or similar)
 - Gives flexibility to add more instrumentation later (e.g. mount acoustic thermometry, mount



Proposed Tests (assumed series connection)

- System / cable health test - IV curve at 77 K
 - **Objective: baseline critical current and n-value after handling**
- Trapezoidal current ramps (up and down ramps)
 - **Objective: investigate hysteresis, ramp rate dependence**
 - *What is expected I_c in series configuration?*
 - Investigate at various ramp rates
 - Monitor co-wound voltage taps with fast DAQ (in addition to nanovm)
 - *What is max ramp rate of background magnet?*
- Heater quench tests
 - **Objective: investigate current redistribution, spatial MQE**
 - Fire heater until quench is induced
 - *All heaters to be insulated / epoxied / close contact with CORC*
 - Repeat at multiple heater locations
 - How does quench energy change with location?
 - Repeat for different cable currents - starting from highest current and moving down