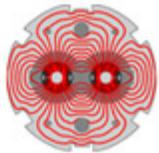




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LQ Instrumentation and Quench Protection



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Trace Design Summary

Layer 1: *design presented at CM 10*

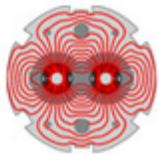
- 13 voltage taps on the trace
- 4 strain gages stations (azim, and axial) wired externally
- 1 external spot heater



Layer 2: *design presented at CM 10*

- 7 voltage taps on the trace
- 1 strain gages stations (azim, and axial) on the trace => optional

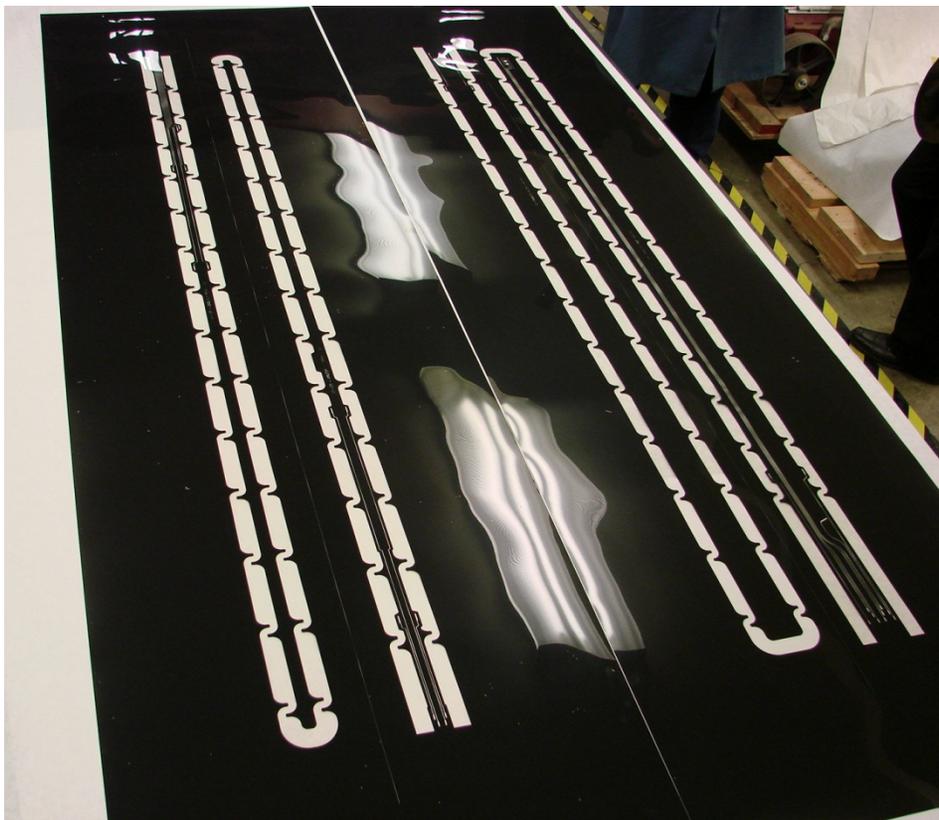




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Trace fabrication: 1st set

Artwork



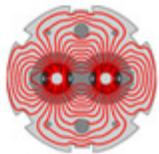
Traces



R measured

Layer 1 = 6.78 lead / 6.79 W return

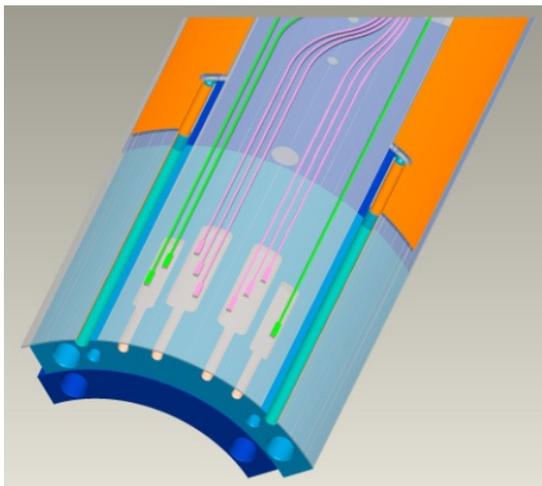
Layer 2 = 6.78 lead / 6.67 W return



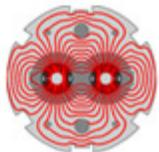
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CM11 Status

- Fabrication of 6 sets of traces
 - 1 sets of traces not used
 - ⇒ modification of the voltage taps circuits to accommodate the lifting holes
 - ⇒ introduction of a cutout in the heaters to accommodate the pockets in the outer layer
 - ⇒ boxes on the traces to indicate the location of the strain gages



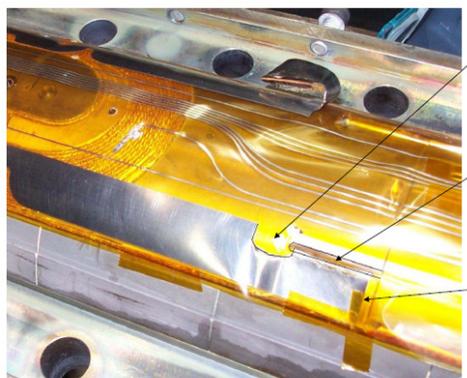
5 sets of traces used in coils #3 to #7



Trace Design: improvements since CM 11

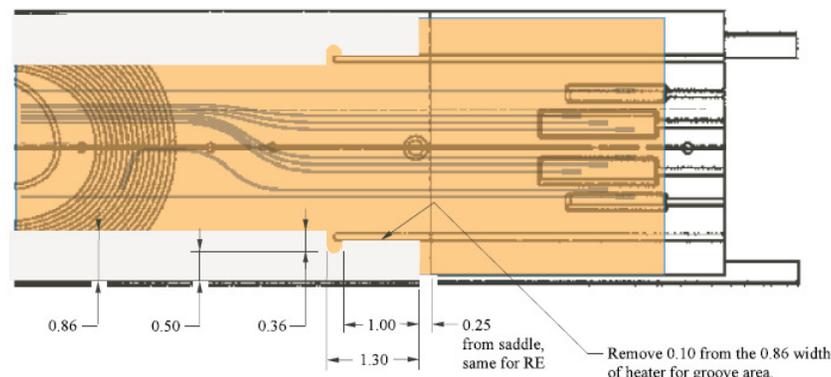
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-Modifications in the end region of the heaters have been requested to better fit in the pocket (based on coil #4 and #5 fabrication)



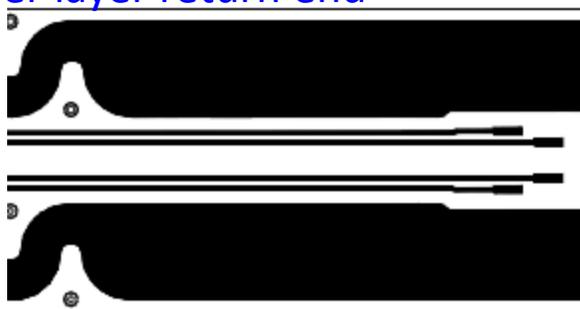
BNL – coil #4 – J. Schmalze

Modification required based on coils #4 and #5 feedback implemented in coil #8 and subsequent coils

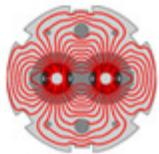


FNAL – F. Nobrega

- Increase of spacing between vtaps to allow a hole for the fixation of a G10 strain relief piece on the inner layer return end



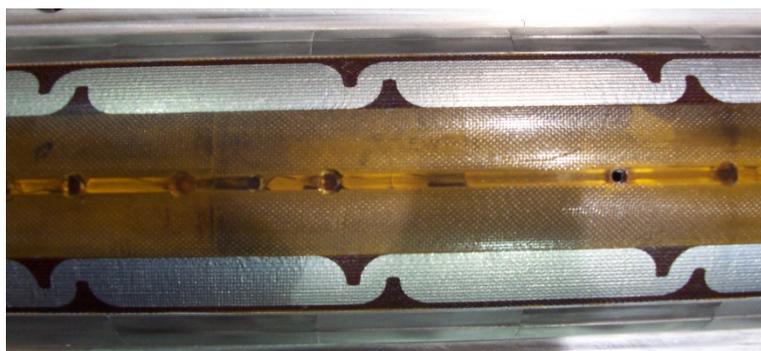
Modifications implemented in traces for coil #8 to #11



LARP

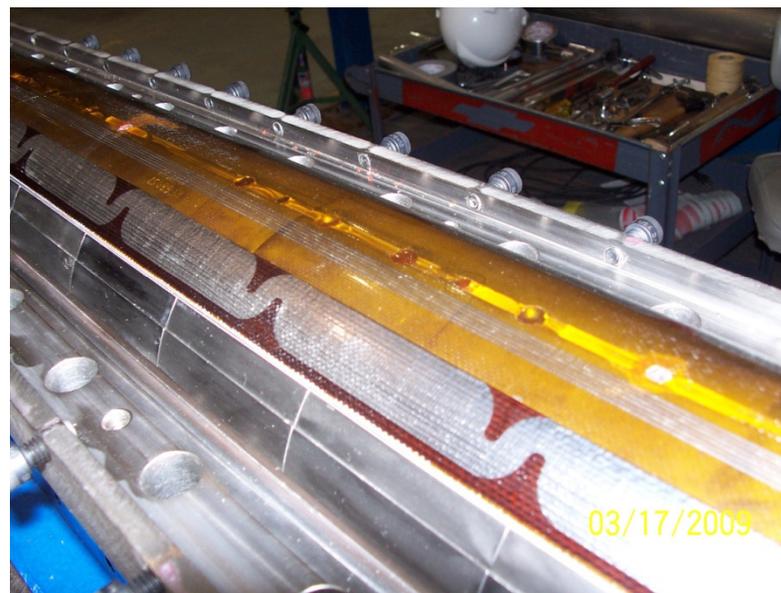
Trace improvements for next coils

- Request for coil #12 and subsequent coils: to increase the spacing between the coil pole and the heaters

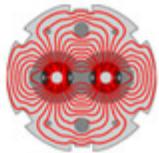


J. Schmalze

During potting, the trace tends to be sucked by the groove in the pole of the outer layer

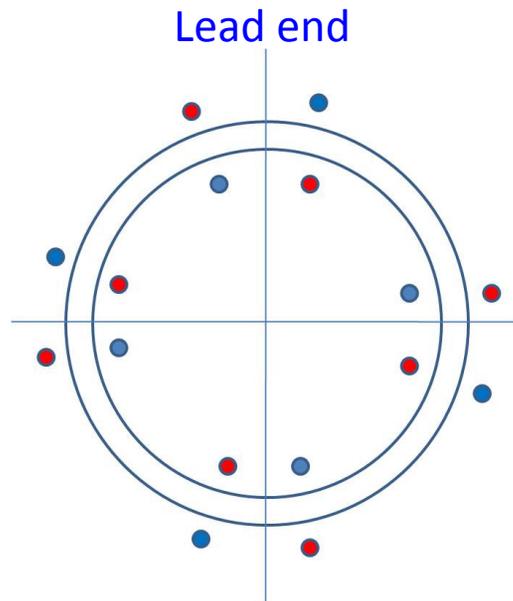


Additional feedback expected from fabrication of coils #8 to #11



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Heaters Powering



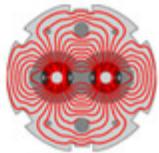
- All the coils have to be wired the same way
- Need to have the outer and inner layer powered with opposite current to cancel flux change

Inner layer seen from the bore



Outer layer seen from outside



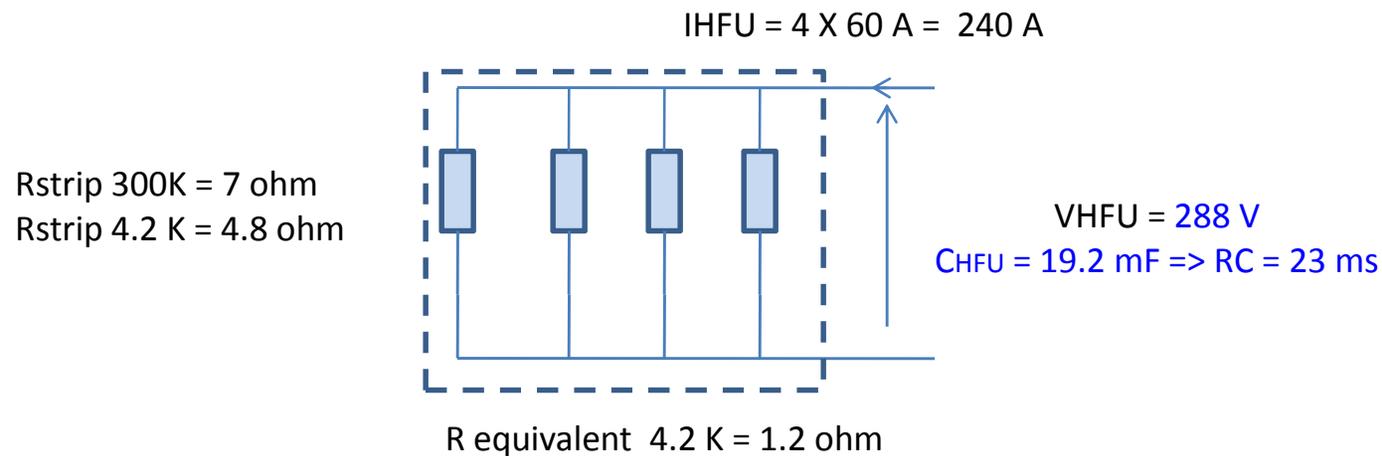


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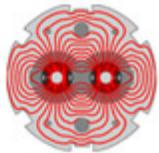
Heaters Connections

-4 circuits:

- 4 inner layer RE heaters in parallel powered by 1 heater firing unit (HFU)
- 4 inner layer LE heaters in parallel powered by 1 HFU
- 4 outer layer LE heaters in parallel powered by 1 HFU
- 4 outer layer RE heaters in parallel powered by 1 HFU



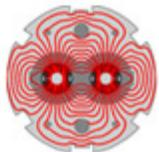
Question: what is the maximum current which can be delivered by each HFU?



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Coil #5 Heaters Test Motivation and Set up

- Coil #5 => practice coil
- Opportunity
 - to check the reliability of the heaters after several discharges => in particular the inner layer heaters
 - by visual inspection
 - by Hipot at 1 kV
 - to check the HFU performances for currents above 200 A
- Heater test in Liquid Nitrogen
 - 2 configurations: 1 strip or 4 strips in parallel connected to HFU
 - Capacitor bank range: 2.4, 4.8, 9.6 and 19.2 mF
 - Max voltage: 450 V



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Coil #5 Heaters Test at FNAL



Before the test:

- Hipot of the coil at 1 kV at 300 K and 77 K

During the test:

- Heater resistance measurement
- Hipot of the coil

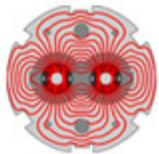
- Maximum current delivered by HFU during the test:
285 A

- Maximum current in the heaters:
90 A (450 V single strip \Leftrightarrow 195 W/cm²)

Visual inspection: no damage

Hipot test: ok at each step (leak current below 0.02 μ A)

FNAL – coil #5 – Guram Chlachidze

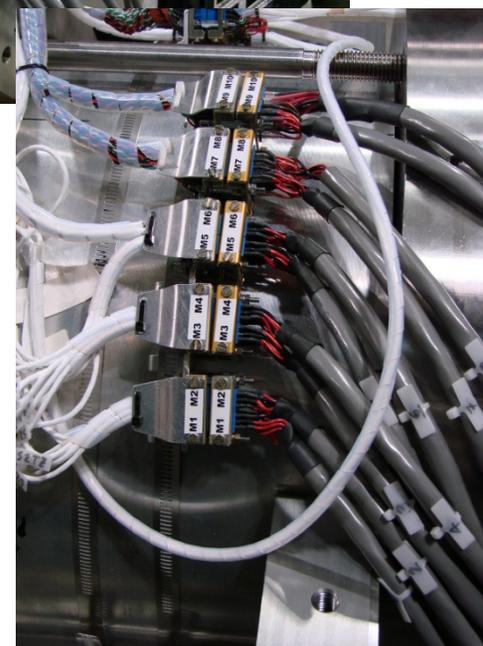
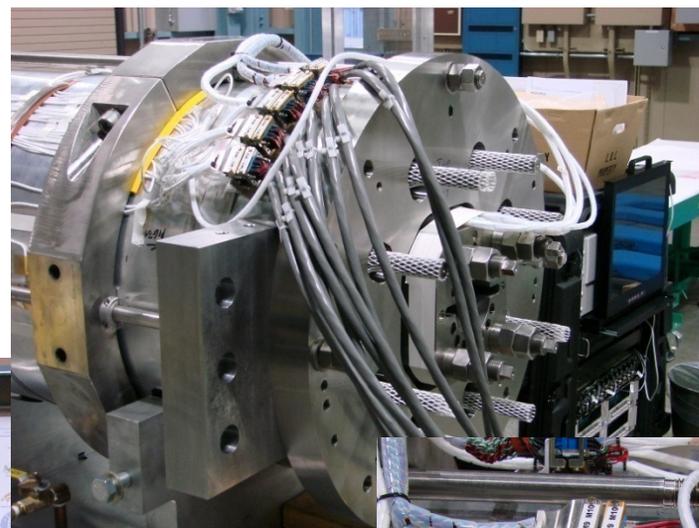


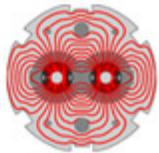
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Connectors

Connectors for instrumentation located on the shell
Instrumentation wires exiting from Lead end and Return end

LQSD – B. Bingham





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Issues encountered

On coil #7 (BNL)

⇒ a short was detected between the heaters and the end saddles ⇒ pocket

⇒ no coil/heater short

Hipot of the traces before installation on the coil performed
Review of the wiring procedures in all labs

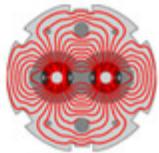
OL Traces for coils #8 and 10 (FNAL)

⇒ Hipot ok

OL Traces for coils #9 (BNL)

⇒ Hipot detected 4 pinholes: 1st failure of the heaters

Additional insulation between saddles and trace (Nomex at BNL, kapton at FNAL)
under discussion



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Status

Coil Instrumentation

- Coils #5 and #6 received at LBNL
 - Electrical checks performed on Monday
- Coils #4 and #7 expected at LBNL this week
- Instrumentation of the inner layer to be completed
 - 13 Vtaps
 - 8 Strain gages (4 stations per coil)
- Schematic in preparation for connection of the instrumentation to the top of the shell



Trace fabrication

Feedback from coils #8 to 11 before artwork revision