

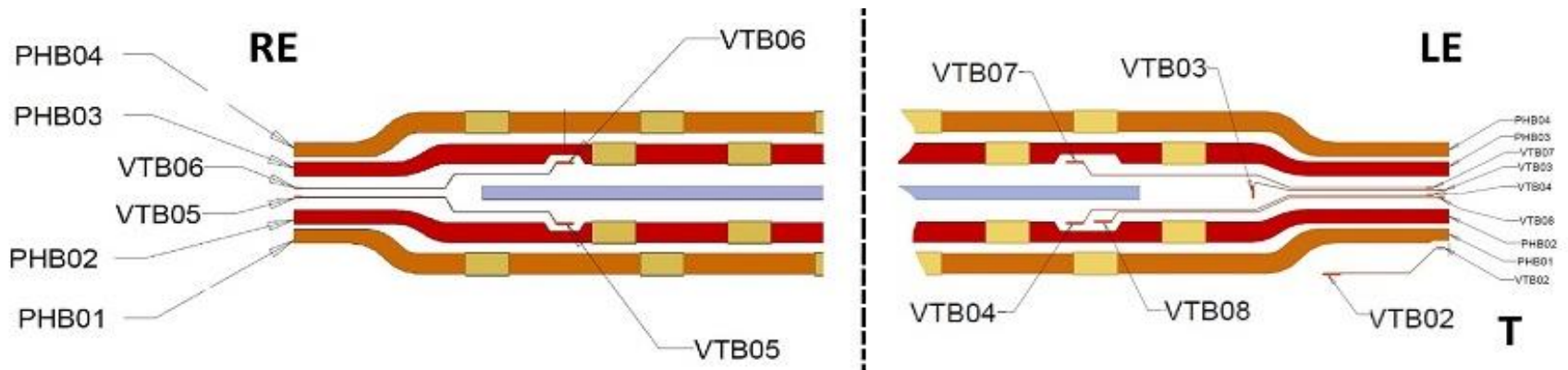


Quench Heaters resistance

M. Baldini - FNAL



MQXFA quench heaters



MQXFA Pre-series and series magnets QH: 26 stations each strip

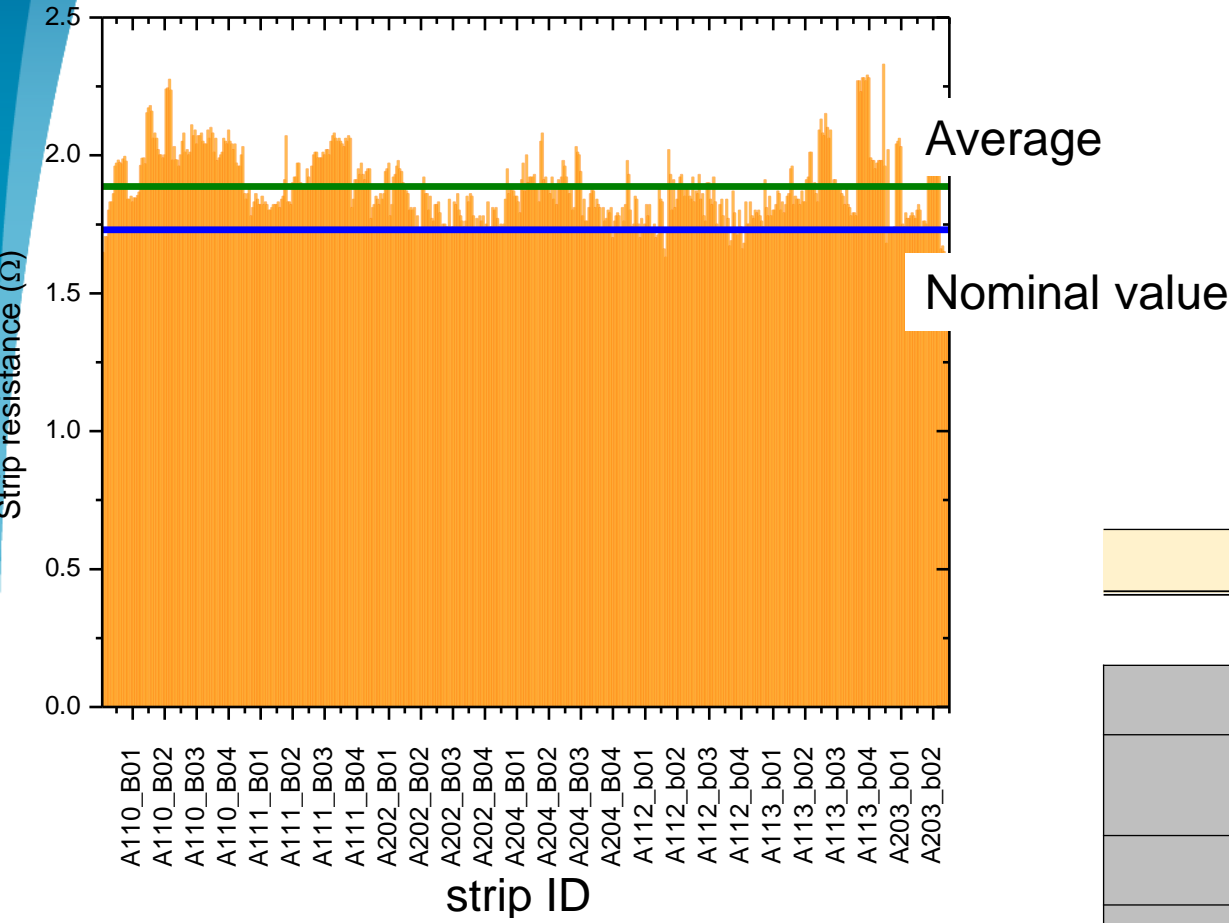
AUP QH resistance measurements

- Resistance is measured on each QH strip before coil fabrication at FNAL and BNL
 - This is part of the QC and those are 4W measurements
- Resistance is measured on each QH circuit at several stage at BNL (Circuits consist of two QH strips connected in series):
 - Magnet horizontal
 - Wire stand
 - Magnet at 4.5 K
 - Magnet in the dewar at 300 K
 - Magnet after cold test before shipment

Nominal Values

			MQXFA	MQXFB
Geometry	Magnet length	(m)	4.2	7.15
	Heater SS width	(mm)	20	20
	Heater Cu width	(mm)	20	20
	Heater SS thickness	(mm)	0.025	0.025
	Heater Cu thickness	(mm)	0.01	0.01
	Station length	(mm)	40	40
	Station period	(mm)	160	160
	Number of stations		25	44
Room temperature strip resistance	SS resistivity at RT	(Ω m)	7.30E-07	7.30E-07
	Cu resistivity at RT	(Ω m)	1.80E-08	1.80E-08
	SS station resistance at RT	(Ω)	5.84E-02	5.84E-02
	Cu station resistance at RT	(Ω)	1.08E-02	1.08E-02
	Total strip resistance at RT	(Ω)	1.73E+00	3.05E+00
Cold strip resistance	SS resistivity at 10 K	(Ω m)	5.45E-07	5.45E-07
	Cu resistivity at 10 K	(Ω m)	6.00E-10	6.00E-10
	SS station resistance at 10 K	(Ω)	4.36E-02	4.36E-02
	Cu station resistance at 10 K	(Ω)	3.60E-04	3.60E-04
	Total strip resistance at 10 K	(Ω)	1.10E+00	1.93E+00
Circuit resistance (nominal)	Number of strips in series		2	2
	Resistance of the warm leads	(Ω)	2.3	0.6
	Total resistance	(Ω)	4.5	4.5
Powering parameters (nominal)	Voltage	(V)	900	900
	Capacitance	(mF)	7.1	7.1
	Peak current	(A)	200	200
	RC	(ms)	32	32
	Peak power density	(W/cm ²)	218	218
	Energy density in the heater stations	(J/cm ²)	3.46	3.46

QH strip resistance data @300K



- Data collected at FNAL with 4W measurements

532 stripes measured

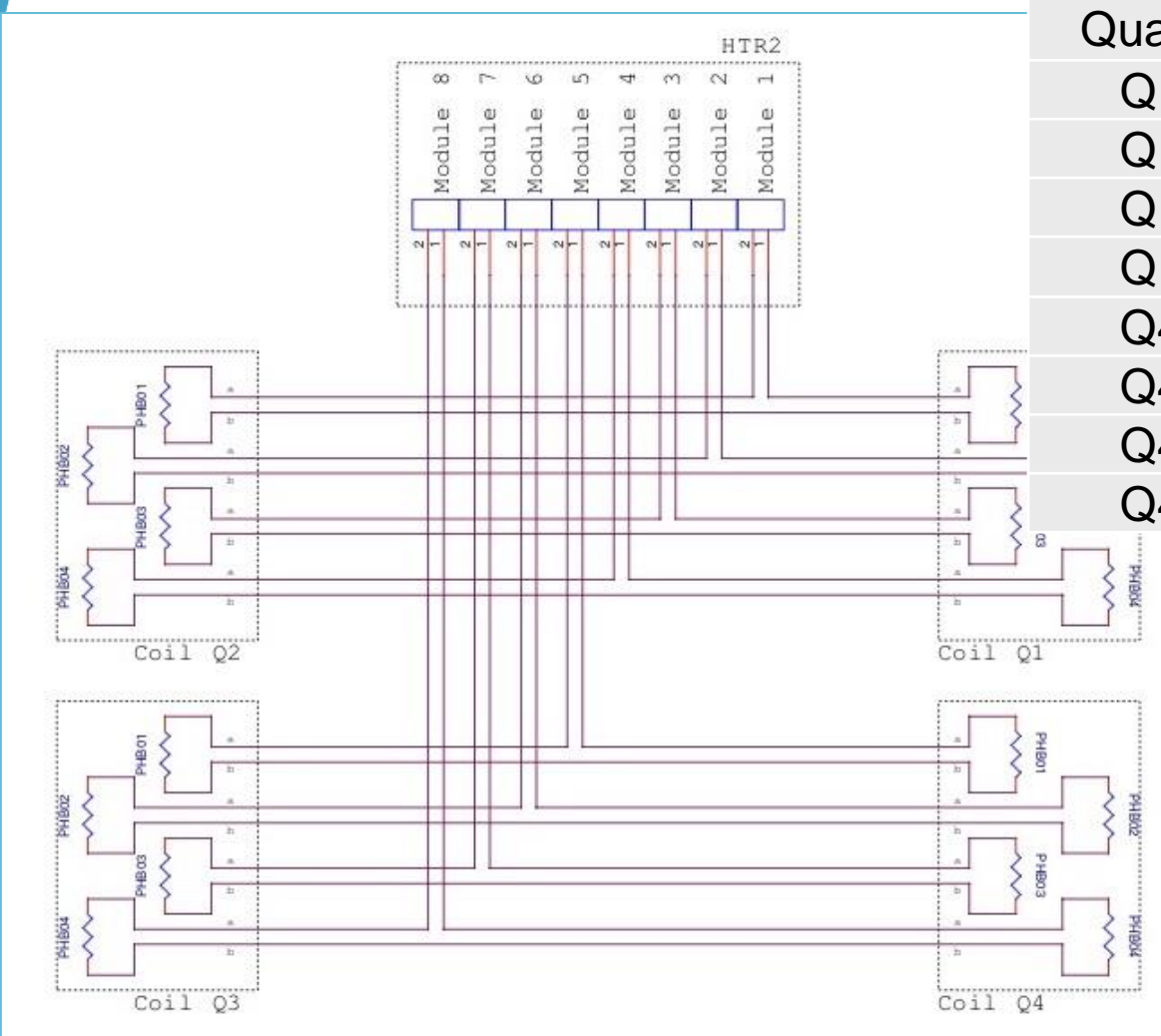
R [Ω]	
	Warm
Avg. strip	1.88678
St. Dev	0.13109
Max	2.33
Min	1.57
Range	0.76
Range (%)	39%



MQXFB Prod. average @ RT = $3.12 \pm 0.19 \Omega$

*percentage over the average strip value

MQXFAP2 and MQXFA pre-series



Quadrants	Heaters circuit
Q1-Q2	PHB01
Q1-Q2	PHB02
Q1-Q2	PHB03
Q1-Q2	PHB04
Q4-Q3	PHB01
Q4-Q3	PHB02
Q4-Q3	PHB03
Q4-Q3	PHB04

**EACH QH CIRCUIT
CONSIST OF 2
STRIPS**

Resistance measurement at BNL

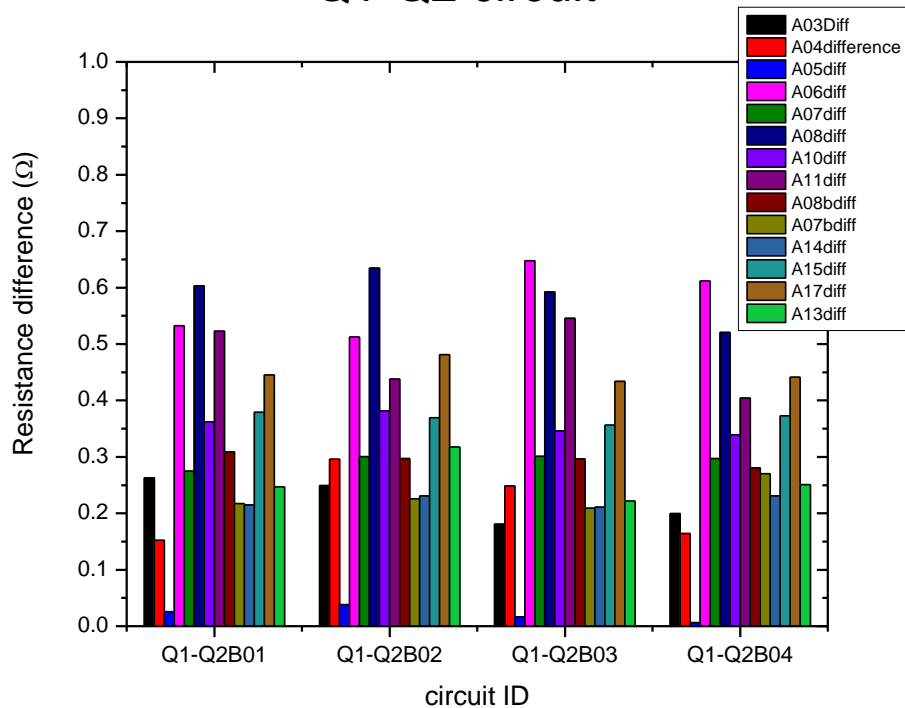
	Measurement location:	Horizontal	Wiring Stand	Dewar
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- HORIZONTAL: magnet is in horizontal position and the measurement are taken from the magnet connectors
- WIRING STAND: magnet is vertical attached to the top head. Measurements are taken from the top head connectors
- DEWAR: measurements at cold taken from the top head connectors

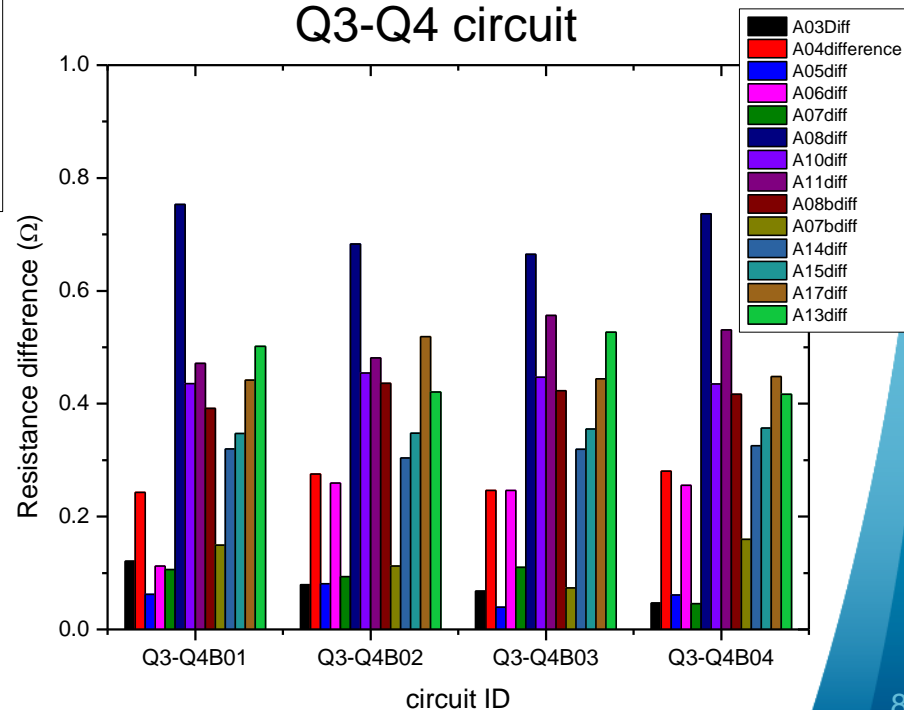
QH circuit resistance data @300K

- QH resistances were measured and then averaged. Results were compared with circuit resistance calculated using single strip 4W measurements
- Here the difference between the measured R vs calculated R is reported
- Can we use this difference to estimate the warm wire contribution?

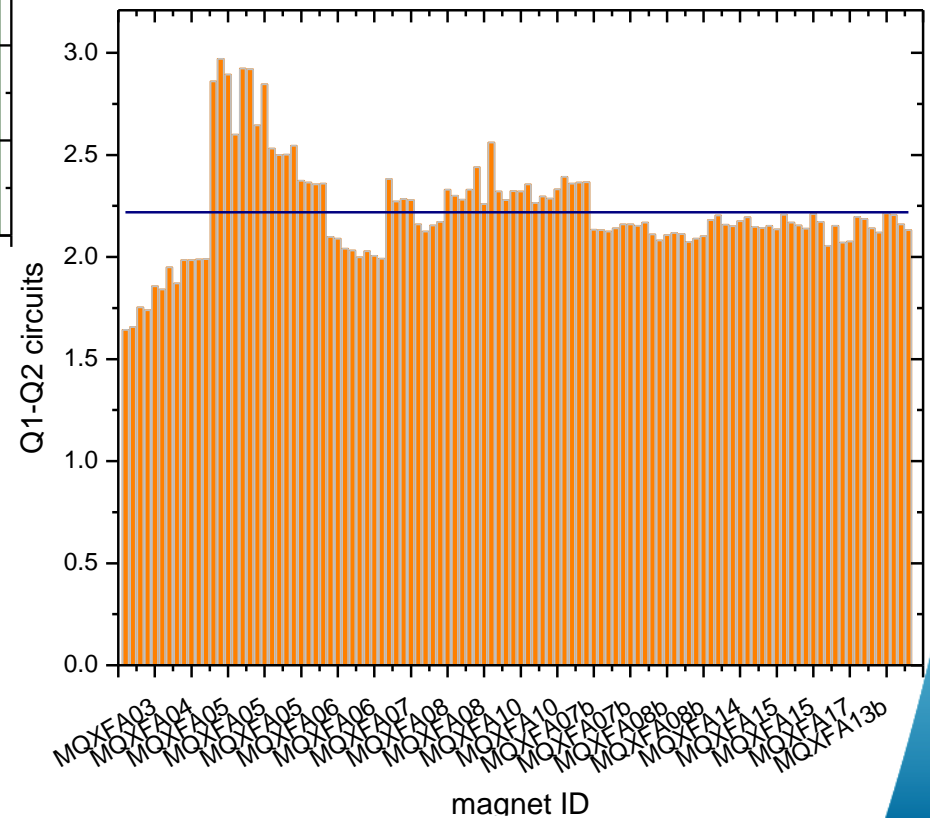
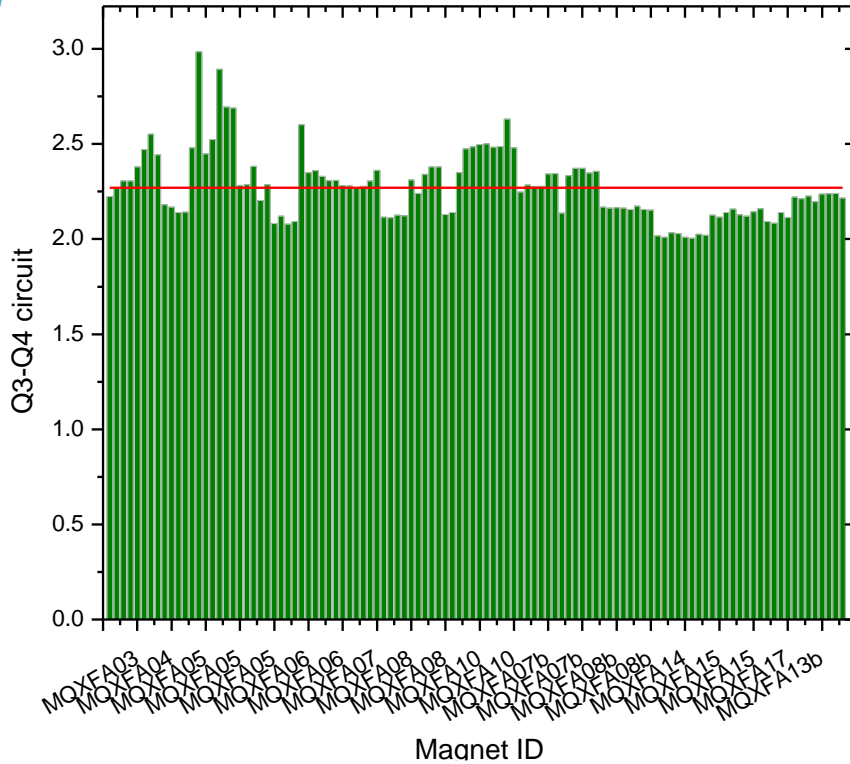
Q1-Q2 circuit



Q3-Q4 circuit



QH circuit resistance data at 4.5 K



2 wire data taken at BNL

MQXFA05 data are higher than the rest of the magnets

Summary

R [Ω] MQXFA		
	Warm	1.9 K
Avg. circuit	4.12195	2.24543
St. Dev	0.25637	0.21566
Max	5.145	2.98
Min	3.38	1.642
Range	1.765	1.338

The average was calculated using all the measured data