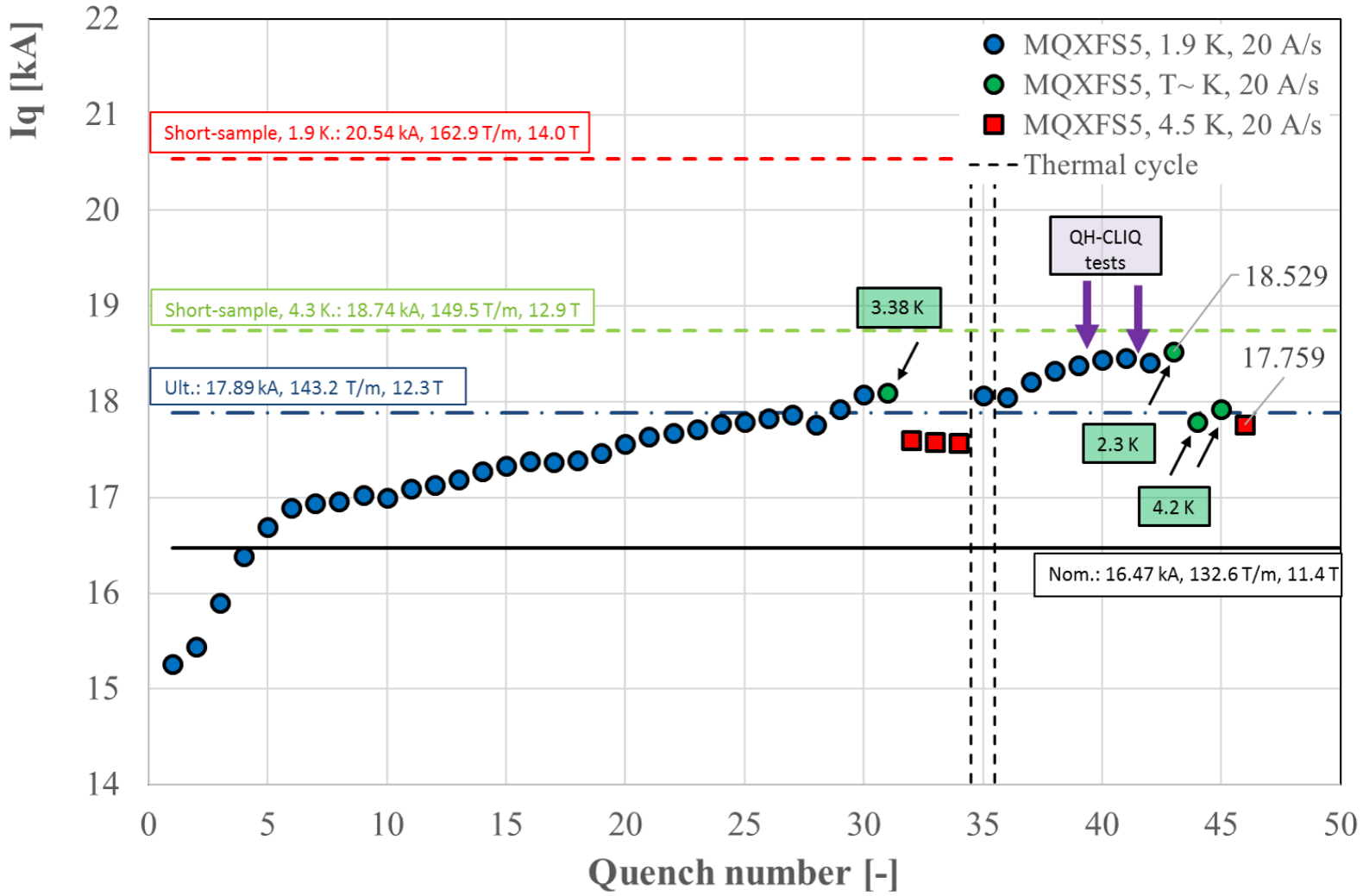
Short model test results

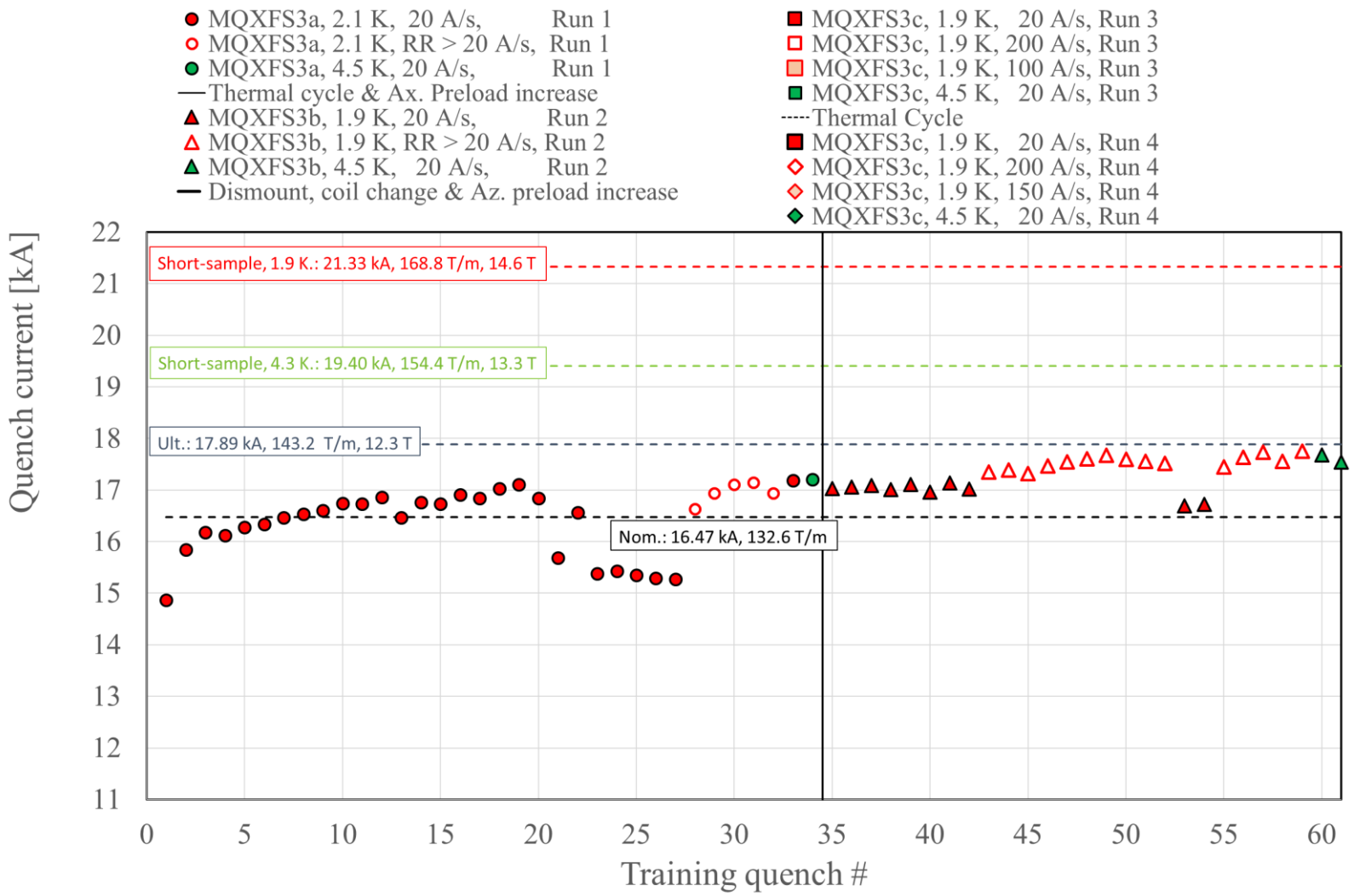
H. Bajas

2nd International Workshop on Superconducting Magnet Tests Stands

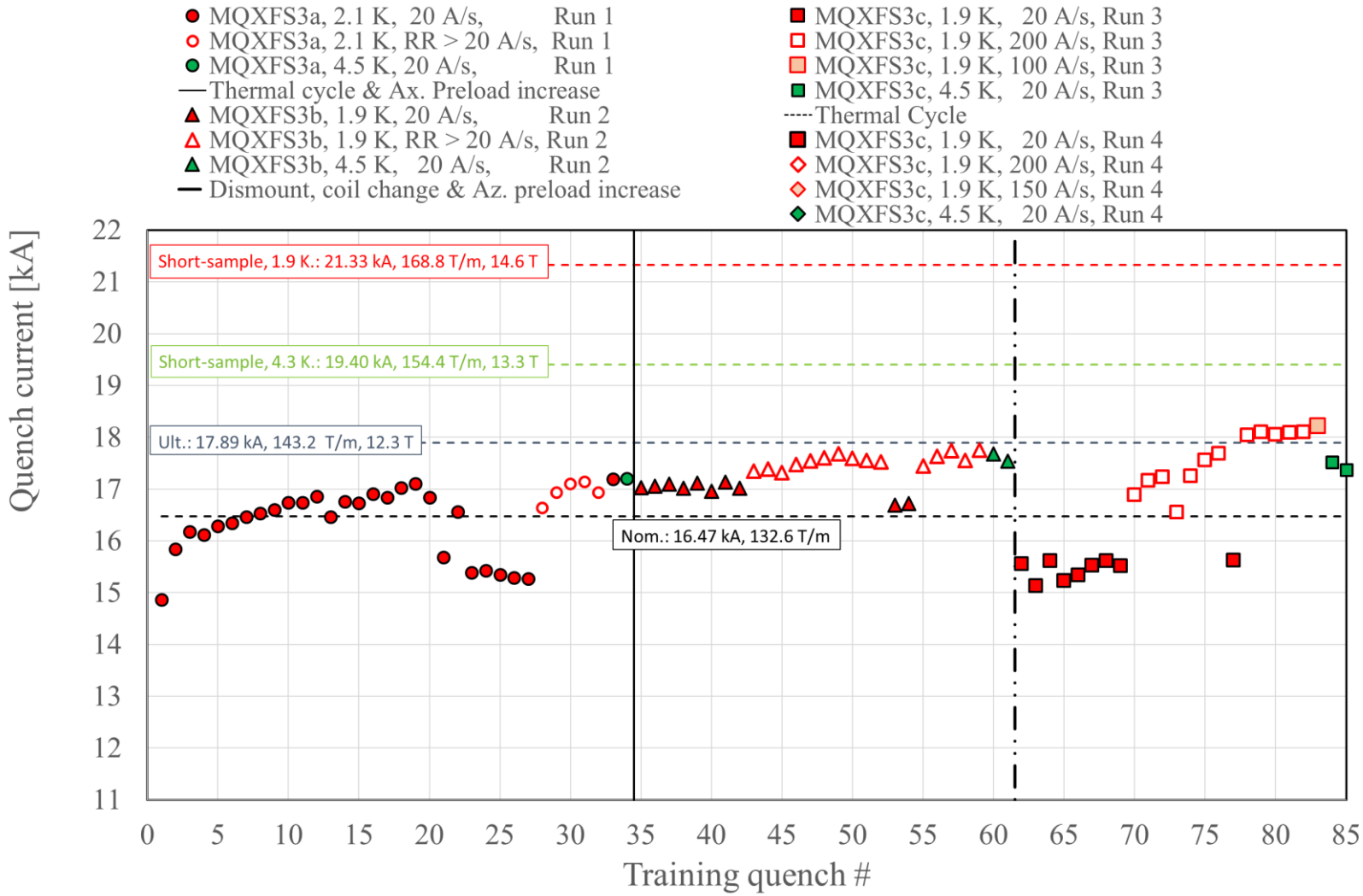
MQXFS5


Iq [kA]
Quench number [-]
MQXFS5, 1.9 K, 20 A/s
MQXFS5, T~ K, 20 A/s
MQXFS5, 4.5 K, 20 A/s
Thermal cycle
Short-sample, 1.9 K.: 20.54 kA, 162.9 T/m, 14.0 T
Short-sample, 4.3 K.: 18.74 kA, 149.5 T/m, 12.9 T
Ult.: 17.89 kA, 143.2 T/m, 12.3 T
Nom.: 16.47 kA, 132.6 T/m, 11.4 T
3.38 K
QH-CLIQ tests
2.3 K
4.2 K
18.529
17.759

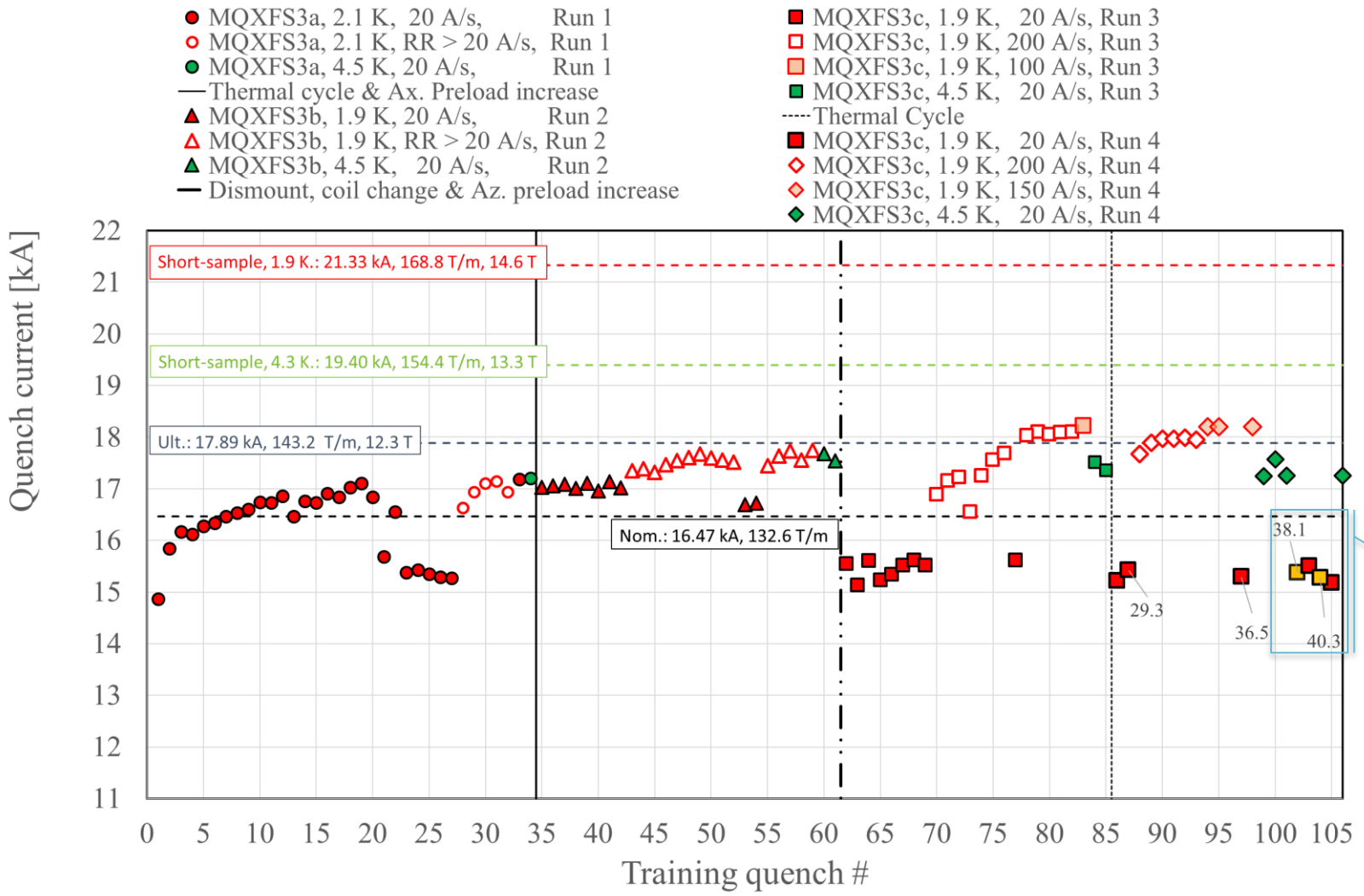
MQXFS3a


MQXFS3a, 2.1 K, 20 A/s, Run 1
MQXFS3a, 2.1 K, RR > 20 A/s, Run 1
MQXFS3a, 4.5 K, 20 A/s, Run 1
Thermal cycle & Ax. Preload increase
MQXFS3b, 1.9 K, 20 A/s, Run 2
MQXFS3b, 1.9 K, RR > 20 A/s, Run 2
MQXFS3b, 4.5 K, 20 A/s, Run 2
Dismount, coil change & Az. preload increase
MQXFS3c, 1.9 K, 20 A/s, Run 3
MQXFS3c, 1.9 K, 200 A/s, Run 3
MQXFS3c, 1.9 K, 100 A/s, Run 3
MQXFS3c, 4.5 K, 20 A/s, Run 3
Thermal Cycle
MQXFS3c, 1.9 K, 20 A/s, Run 4
MQXFS3c, 1.9 K, 200 A/s, Run 4
MQXFS3c, 1.9 K, 150 A/s, Run 4
MQXFS3c, 4.5 K, 20 A/s, Run 4
Short-sample, 1.9 K.: 21.33 kA, 168.8 T/m, 14.6 T
Short-sample, 4.3 K.: 19.40 kA, 154.4 T/m, 13.3 T
Ult.: 17.89 kA, 143.2 T/m, 12.3 T
Nom.: 16.47 kA, 132.6 T/m
Quench current [kA]
Training quench #
22
21
20
19
18
17
16
15
14
13
12
11
0
5
10
15
20
25
30
35
40
45
50
55
60

MQXFS3c


MQXFS3a, 2.1 K, 20 A/s, Run 1
MQXFS3a, 2.1 K, RR > 20 A/s, Run 1
MQXFS3a, 4.5 K, 20 A/s, Run 1
Thermal cycle & Ax. Preload increase
MQXFS3b, 1.9 K, 20 A/s, Run 2
MQXFS3b, 1.9 K, RR > 20 A/s, Run 2
MQXFS3b, 4.5 K, 20 A/s, Run 2
Dismount, coil change & Az. preload increase
MQXFS3c, 1.9 K, 20 A/s, Run 3
MQXFS3c, 1.9 K, 200 A/s, Run 3
MQXFS3c, 1.9 K, 100 A/s, Run 3
MQXFS3c, 4.5 K, 20 A/s, Run 3
Thermal Cycle
MQXFS3c, 1.9 K, 20 A/s, Run 4
MQXFS3c, 1.9 K, 200 A/s, Run 4
MQXFS3c, 1.9 K, 150 A/s, Run 4
MQXFS3c, 4.5 K, 20 A/s, Run 4
Short-sample, 1.9 K.: 21.33 kA, 168.8 T/m, 14.6 T
Short-sample, 4.3 K.: 19.40 kA, 154.4 T/m, 13.3 T
Ult.: 17.89 kA, 143.2 T/m, 12.3 T
Nom.: 16.47 kA, 132.6 T/m
Quench current [kA]
Training quench #
22
21
20
19
18
17
16
15
14
13
12
11
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85

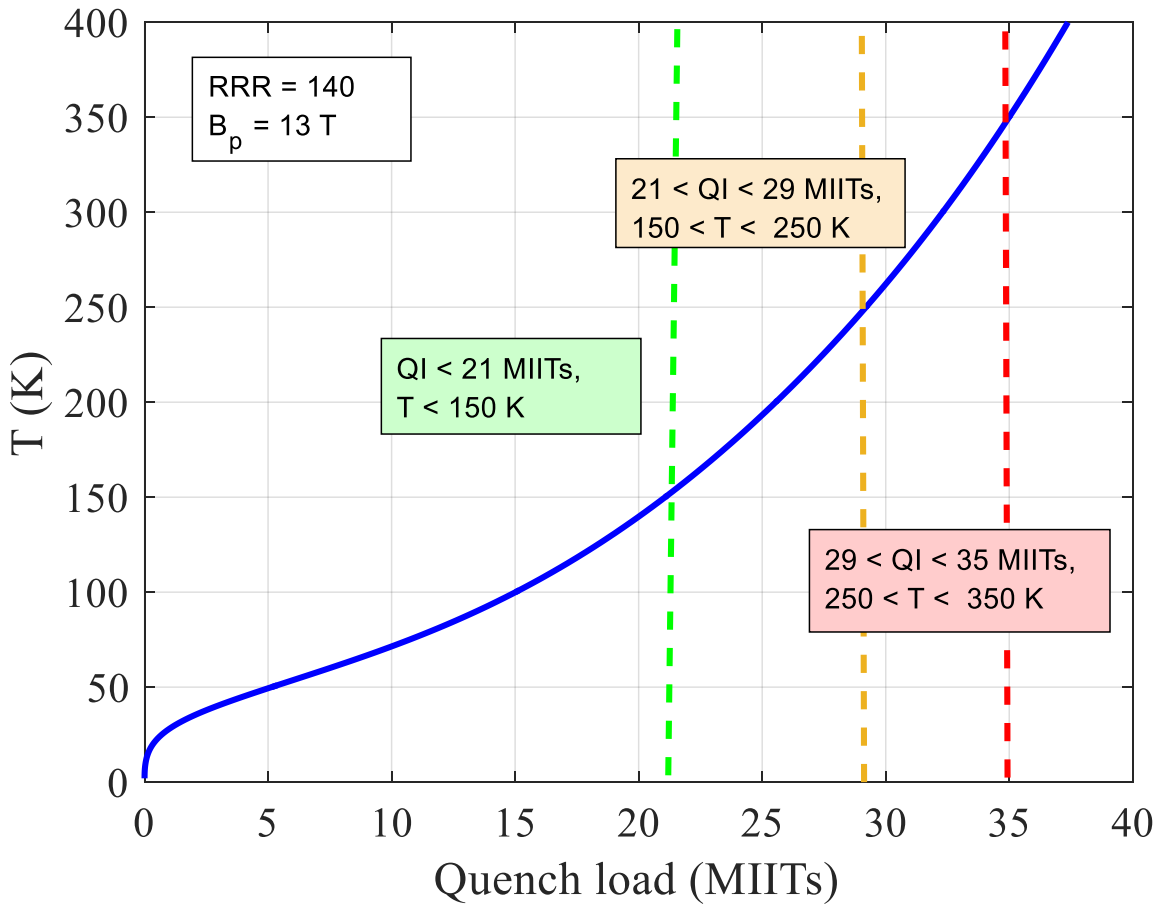
MQXFS3c



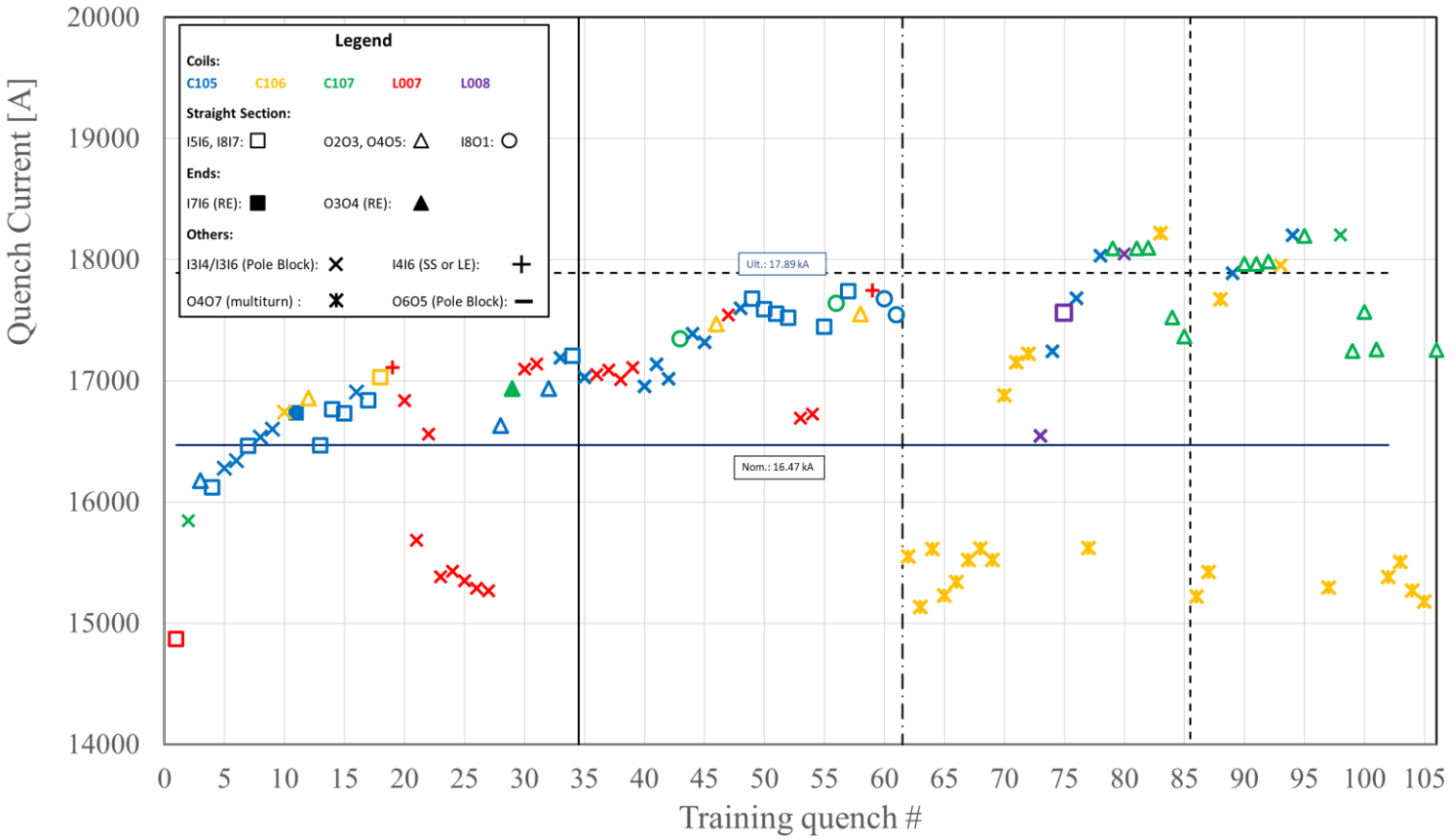
Miits: 40.3 MA^2.s
T_{hs} > 350 K

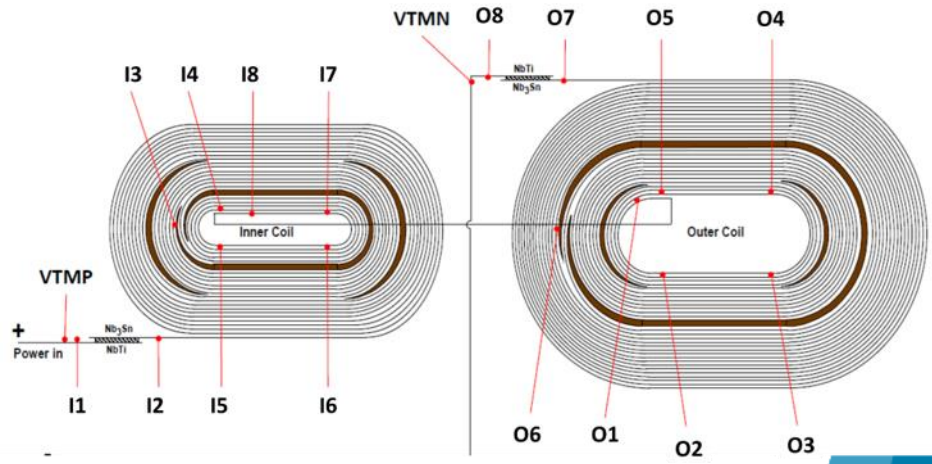
w/o EE
w/ CLIQ
w/ QH

delay wrt. to QD

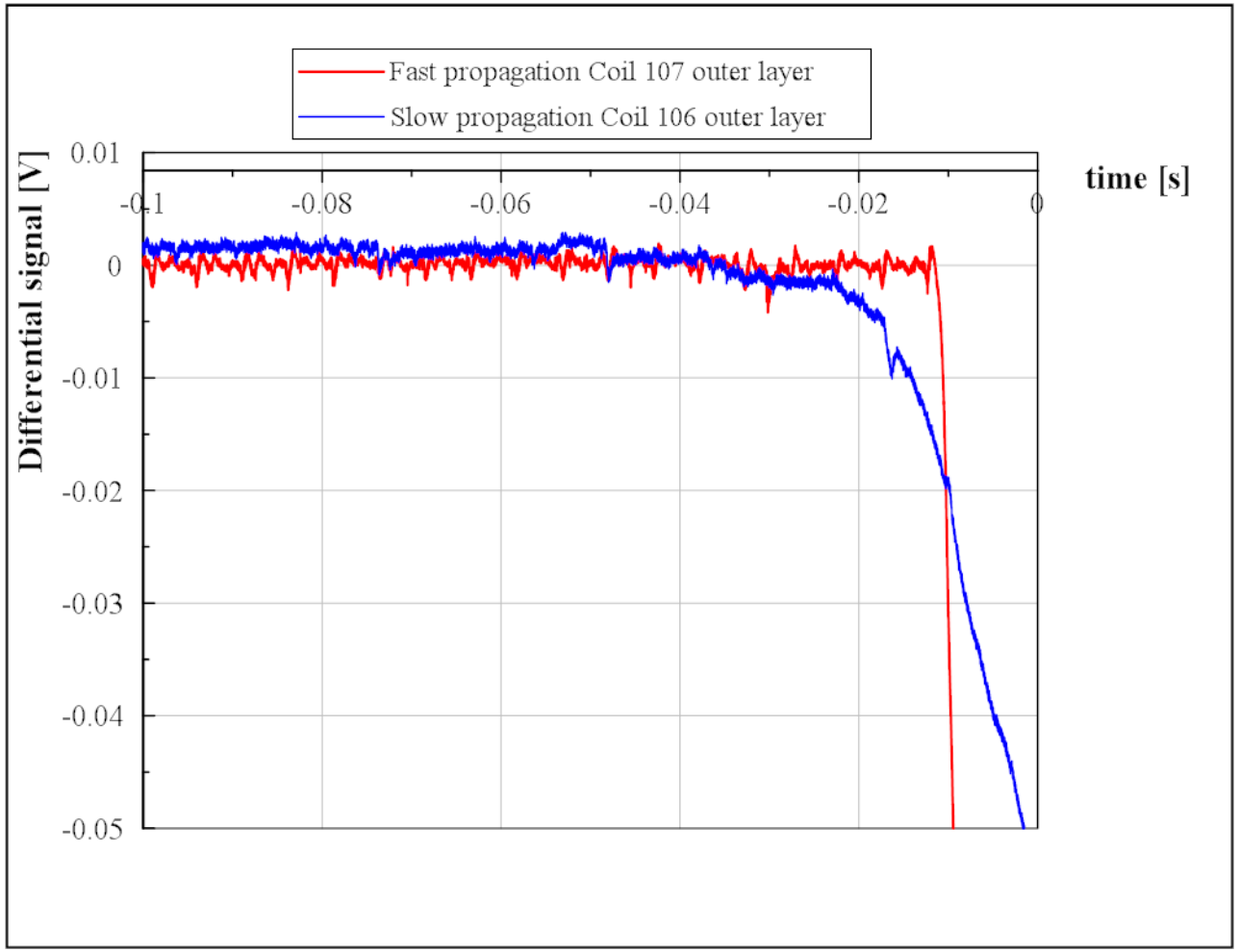

RRR = 140
B_p = 13 T
21 < QI < 29 MIITs,
150 < T < 250 K
QI < 21 MIITs,
T < 150 K
29 < QI < 35 MIITs,
250 < T < 350 K
T (K)
Quench load (MIITs)
0
50
100
150
200
250
300
350
400
0
5
10
15
20
25
30
35
40

Quench location

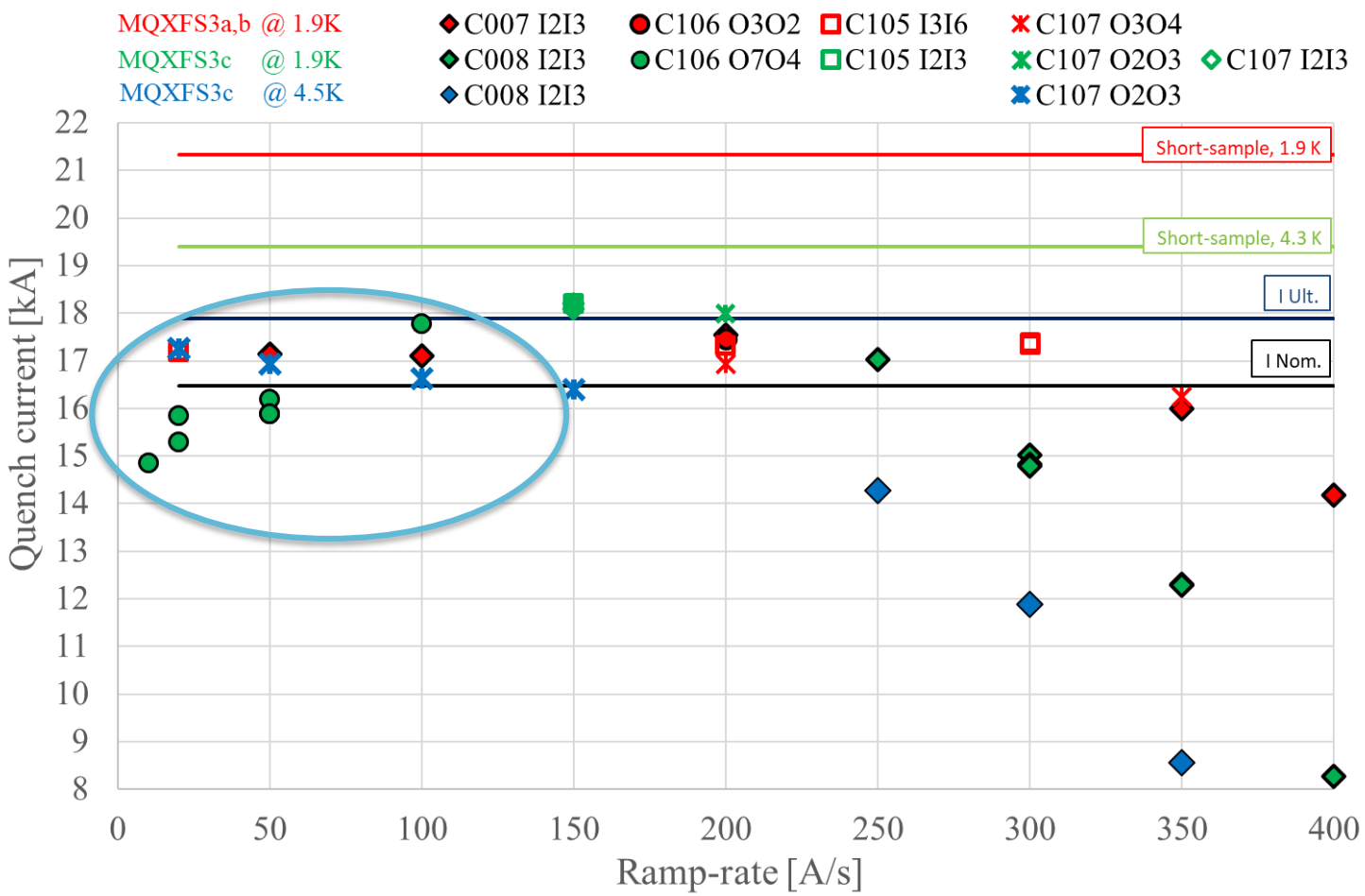




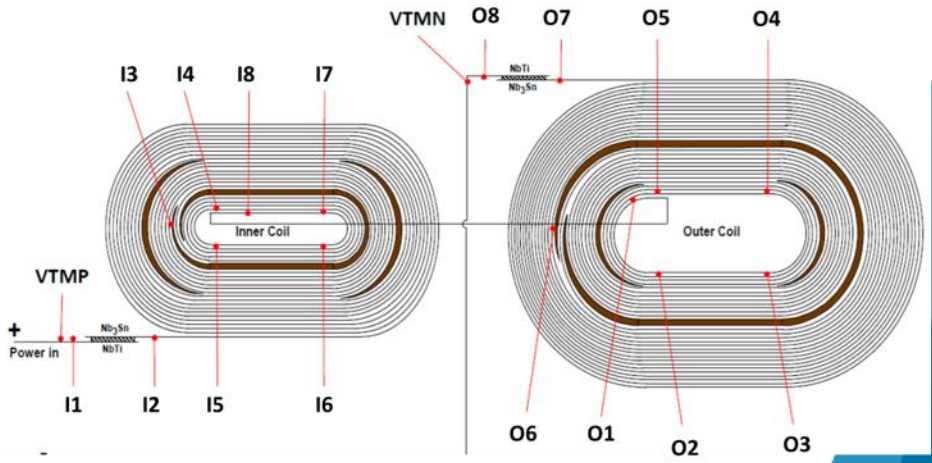
Slow and fast propagation in MQXFS3c



MQXFS ramp rate dependence



The comparison with the results obtained at 1.9 K confirms **"the self-field instability enhanced by a damage in Coil 106"**
Unlike 1.9 K behaviour, the quench current at 4.5 K decreases with the ramp rate.
The maximum current, 17258A being obtained at 20 A/s and correspond to 89% of Iss at 4.2K .
Unlike 1.9 K, no quench is detected in the problematic segment in Coil 106 O4O7.

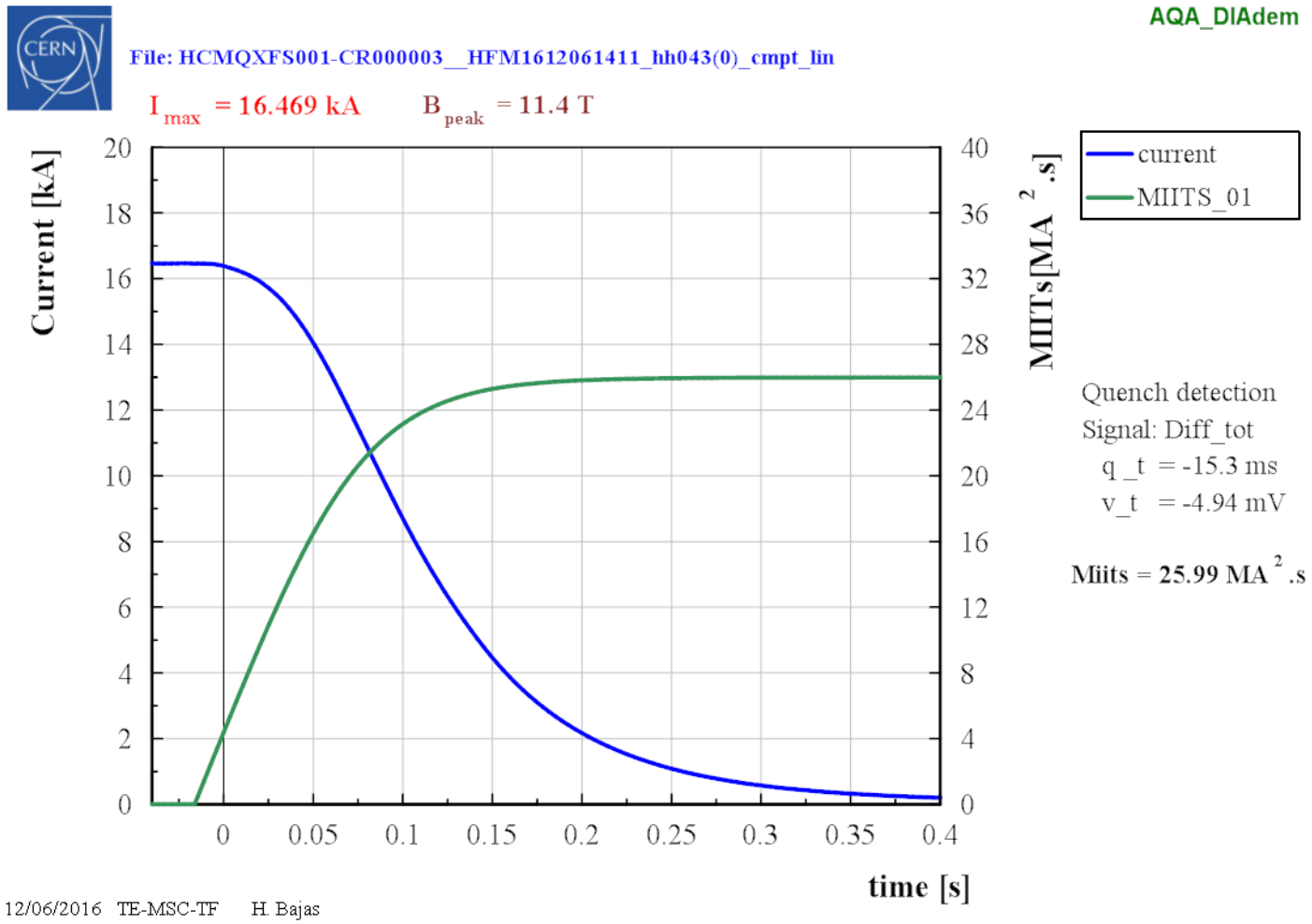


Holding current

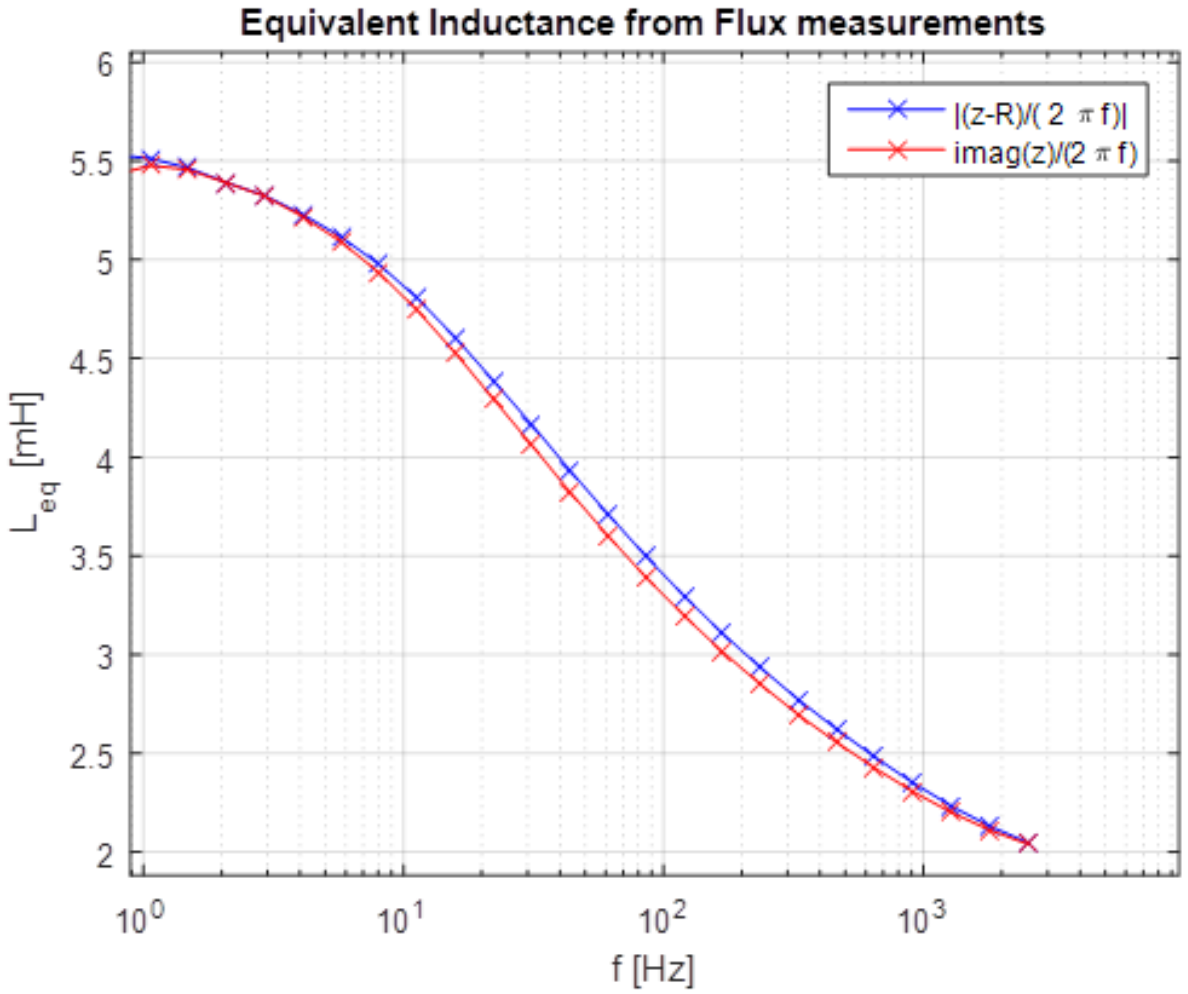
- **Holding current test at 1.9 K**
  - Doing intermediate plateau every 200 A from 13 kA for 10 minutes, the maximum current we could obtained was 15.2 kA.
  - Quench occurs after few minutes then.

- **Holding current tests** at 4.5 K
  - **Nominal current successfully maintained for one hour,** after which an issue with the Energy Extraction switch cooling led to a slow abort.
  - Once this issue solved the test has been repeated again with stable behavior as well.
  - **During the same test performed at 1.9 K, only few tens of second could have been held.**
  - Current level has then been gradually increased by step of 200 A for 10 minutes.
  - **17400 A (97% of ultimate current)** could have been maintained.
  - Ramping to 17600 A, the magnet quenched in Coil 107.

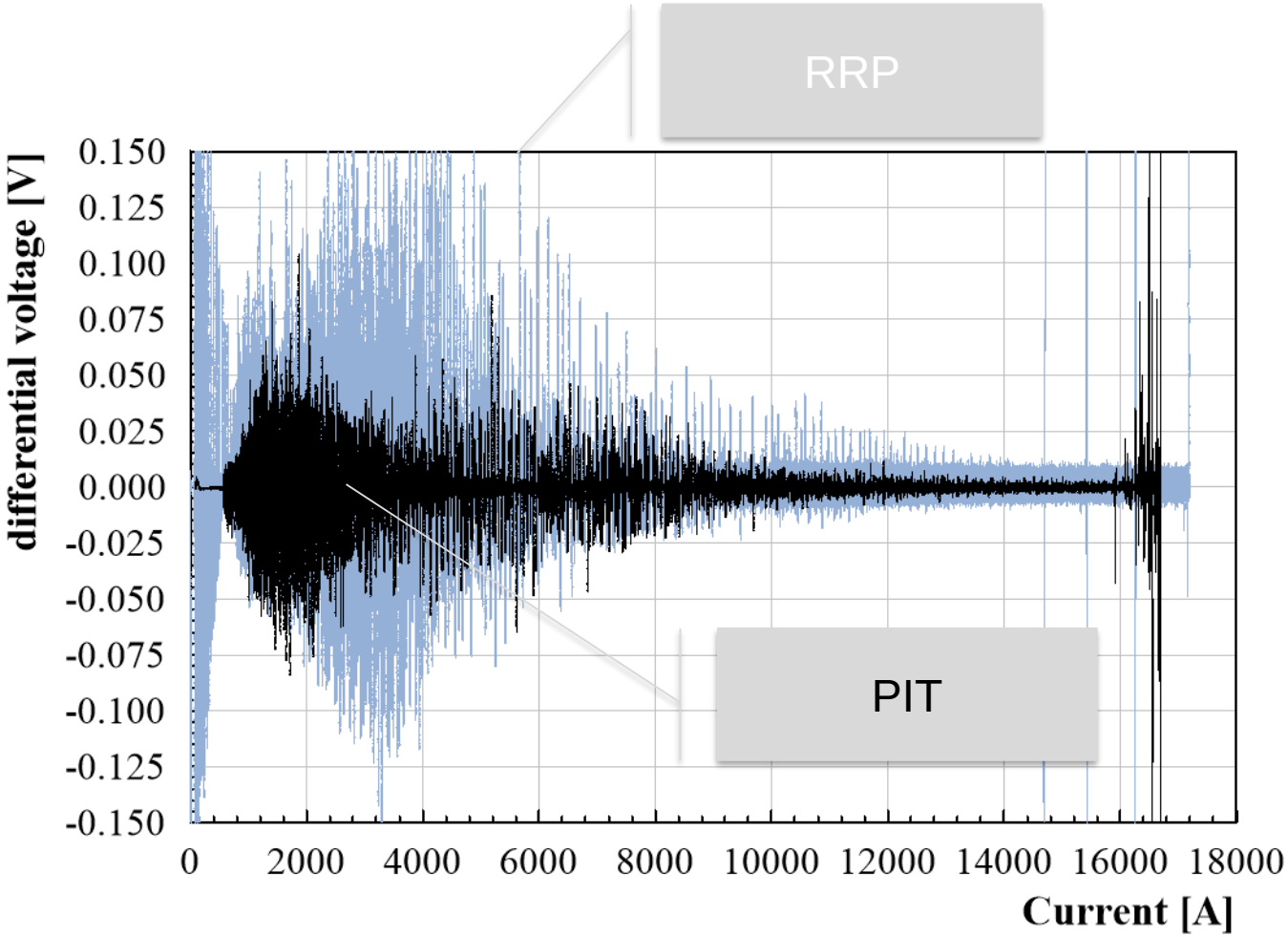
Nominal current (No EE, w/ OL, w/o CLIQ)



Transfer function measurement for beam



Flux Jump


RRP
PIT
differential voltage [V]
0.150
0.125
0.100
0.075
0.050
0.025
0.000
-0.025
-0.050
-0.075
-0.100
-0.125
-0.150
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Current [A]

Discussion

- MQXFS5
  - Stable nominal performance 
  - Stable ultimate performance 
  - Magnetic measurement completed 
  - Protection study completed 

- MQXFS3
  - Stable nominal performance at 4.2 K 
  - Stable Nominal performance at 1.9 K 
  - Ultimate performance at 4.2 K 
  - Ultimate performance at 1.9 K 
  - Magnetic measurement completed 
  - Protection study completed