Results from MQXFBP1 cold tests

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Meeting on MQXFBP2 assembly, 11-08-2020

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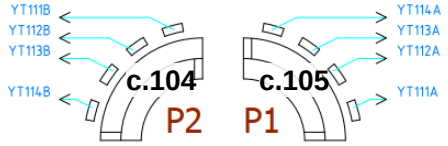
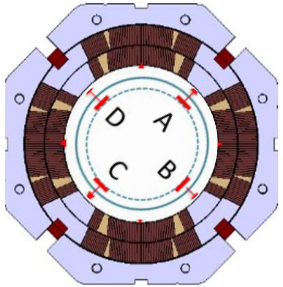
Introduction

First MQXF magnet on the horizontal test bench in SM18

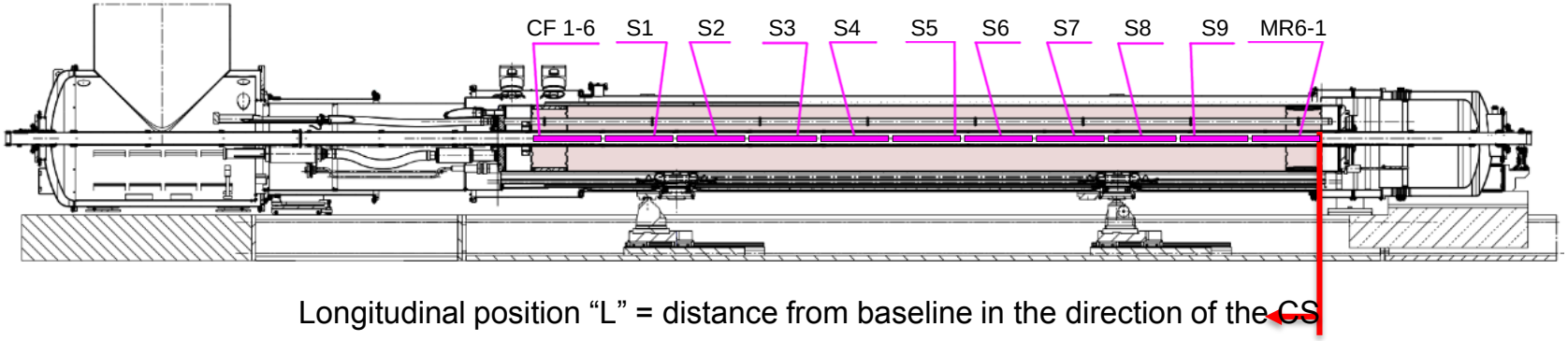
New Quench Antenna shaft produced and in used during this test and placed in the new anti-cryostat.



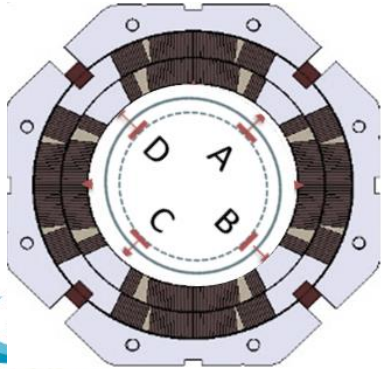


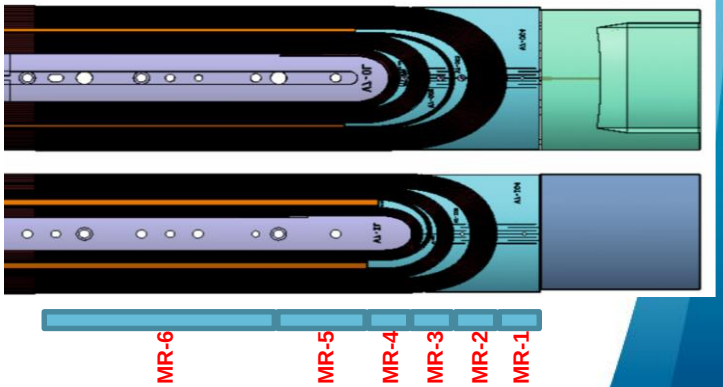
60 cm long straight segments
5 cm long head segments
Full magnet length covered.

Baseline QA position (used as reference)

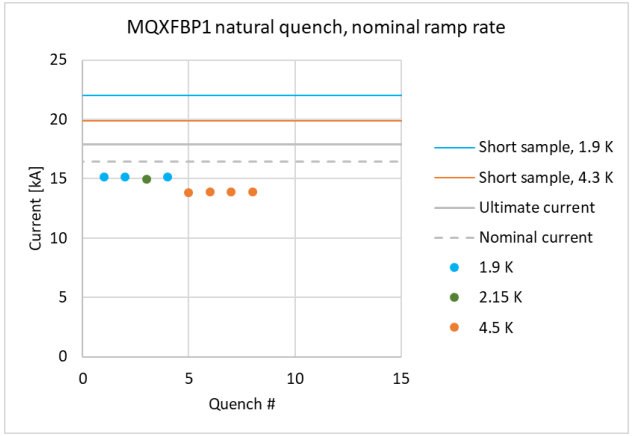


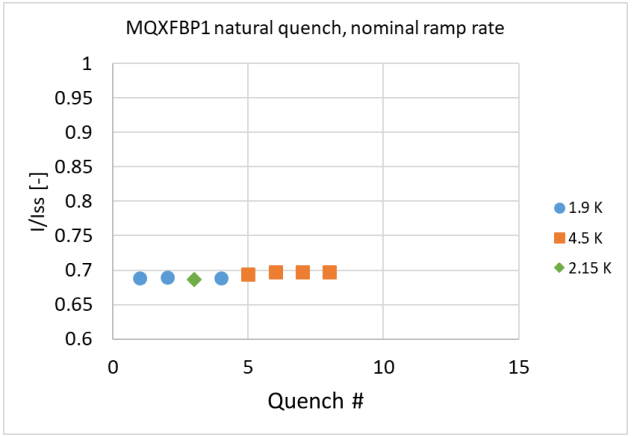
Longitudinal position “L” = distance from baseline in the direction of the CS





Magnet training



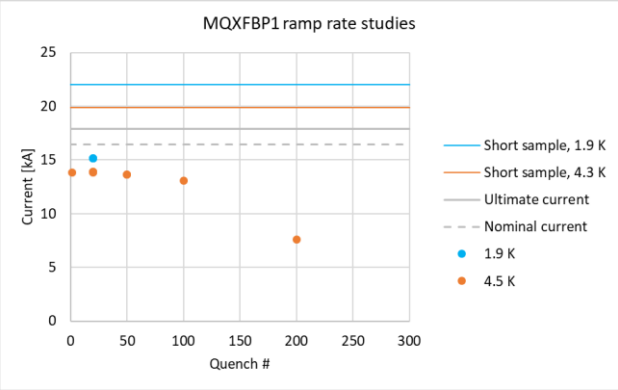


- Powering started at 1.9 K at nominal 20 A/s ramp rate.
- No “training quenches” for the magnet up to 15.2 kA
- All quenches go to a coil limitation at around 69 to 70 % of I_{ss} both at 1.9 K as at 4.5 K.

All quenches at 20 A/s were in the center of the magnet, straigth pole turn segment in coil 108 (pole 3), see later slides.

Note:
We would have liked to do much more testing, but were at 1.9 K limited to about 1 test per day and at 4.5 K the helium level was not stable. To be improved for the next cooldown or magnet.

Ramp Rate studies



- “Normal” ramp rate behavior at 4.5 K
- Up to 20 A/s: Quench in EE3126-EE3113
- 50 and 100 A/s: Quench in EE3126-EE3113
- 200 A/s: Quench in EE3113-EE3112

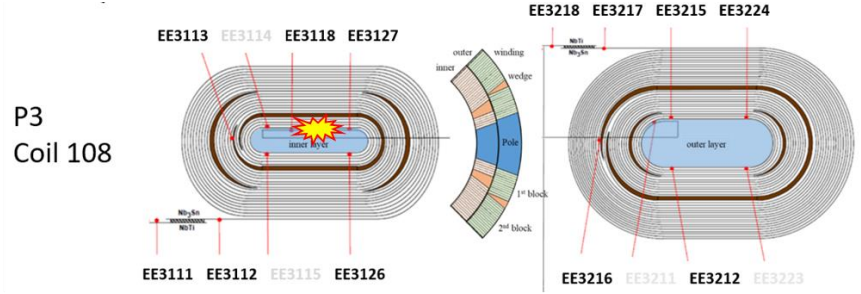
- All quenches in Pole 3 (coil 108)
- None of the quenches show a pre-cursor.

Quench Location – up to 20 A/s

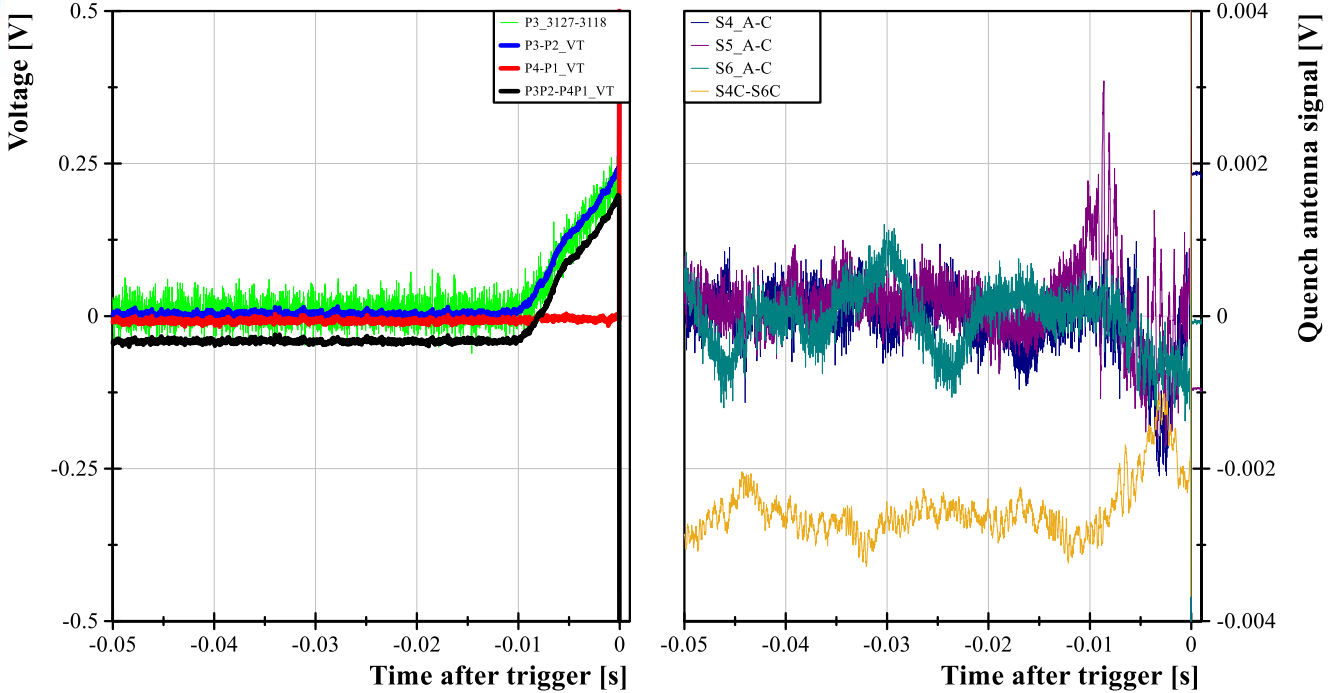
Quench location:

- Vtaps: P3, EE3118-EE3127
  - Inner layer pole turn
  - Straight segment.
- QA: segment 5 (covering the magnetic center ± 30 cm)

By moving the 5 cm short quench antenna to the quench location, we could localize it to the magnetic center ± 30 cm



Example of quench signals for a 20 A/s quench



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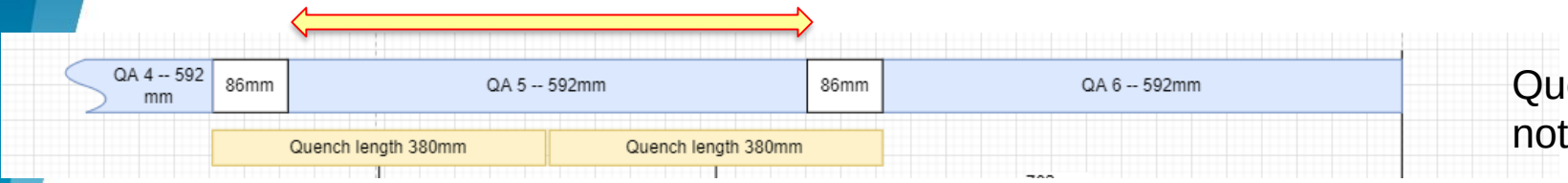
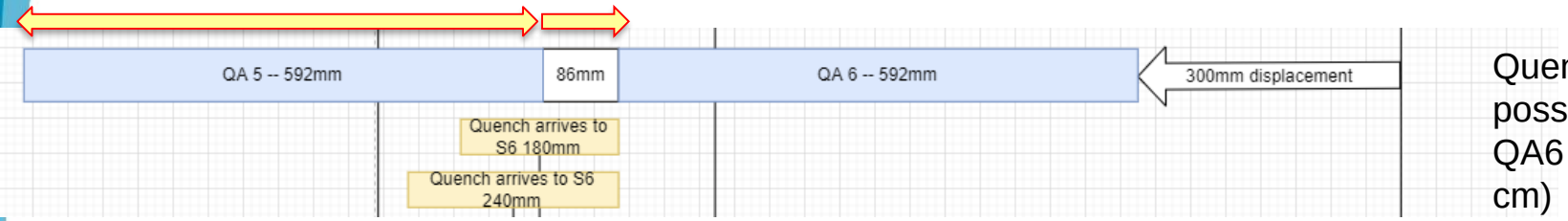
- Voltage build up seems normal
- Propagation velocity is about 15 m/s, which is with normal range.
- Quench Antenna data analysis and date treatment is undergoing optimization, but is clear enough for quench localization.

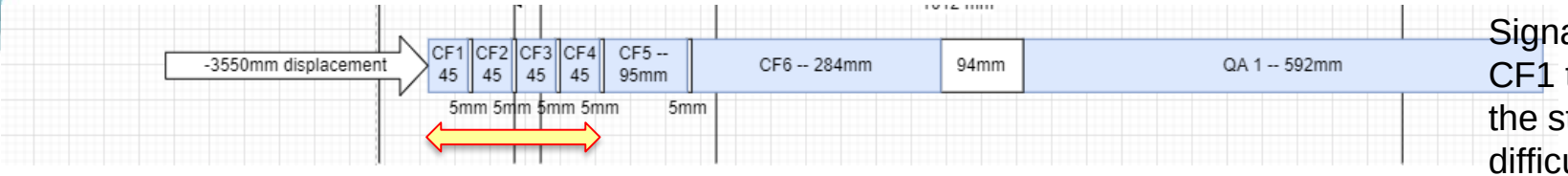
Longitudinal quench localisation: shifting QA positions



Quench in QA5, not in 4 or 6



Quench in QA5 possibly going in QA6 after 8 ms. (9 cm)



Signals seen in CF1 to CF4 from the start but difficult to interpret.

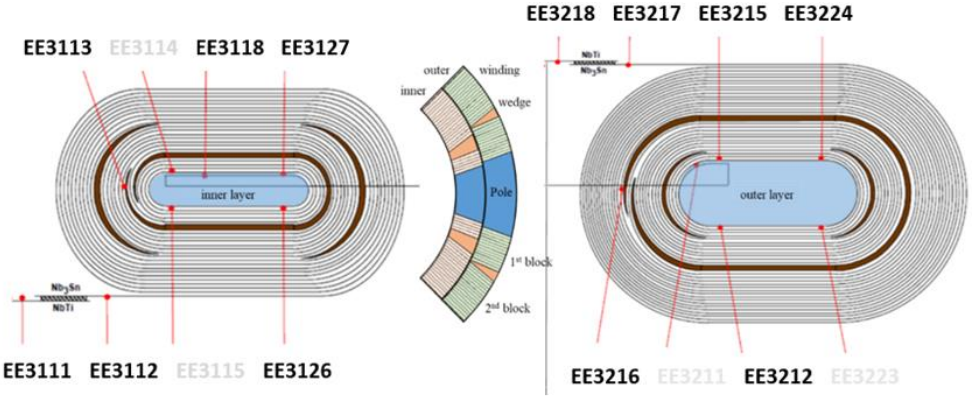
Quench Location – 50 and 100 A/s at 4.5 K

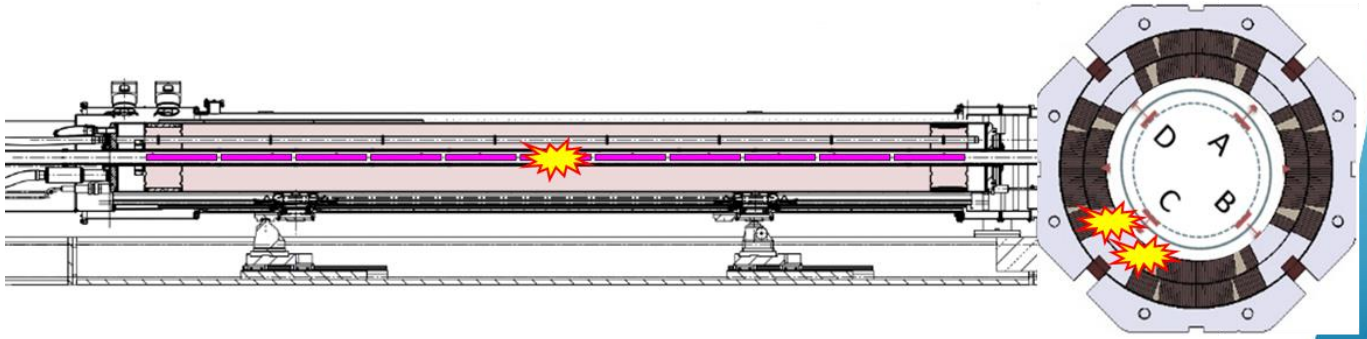
Quench location:

- Vtaps: P3, EE3126-EE3113
  - Half of the pole turn +
  - About 5 of the first block seen from pole

QA: segment 5 (covering the magnetic center ± 30 cm)

P3
Coil 108





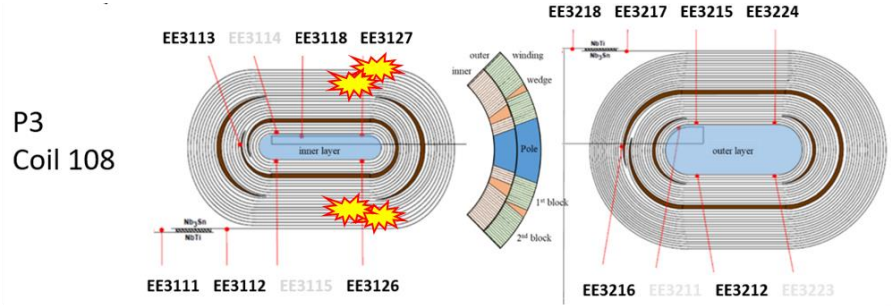
Quench Location – 200 A/s at 4.5 K

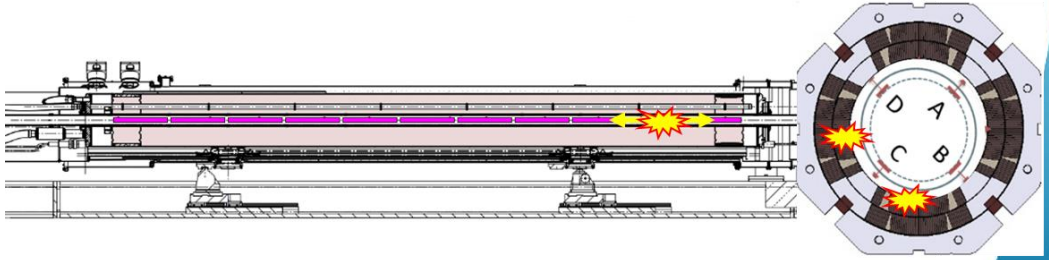
Quench location:

- Vtaps: P3, EE3113-EE3112

  Multiturn (excluding first block from pole)

  QA: Segment 9 (40 to 100 cm from the head)

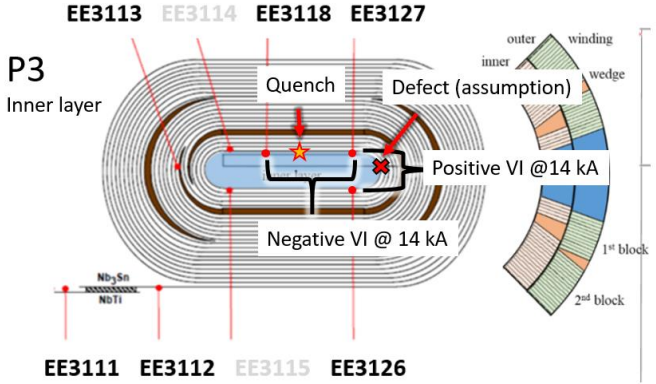


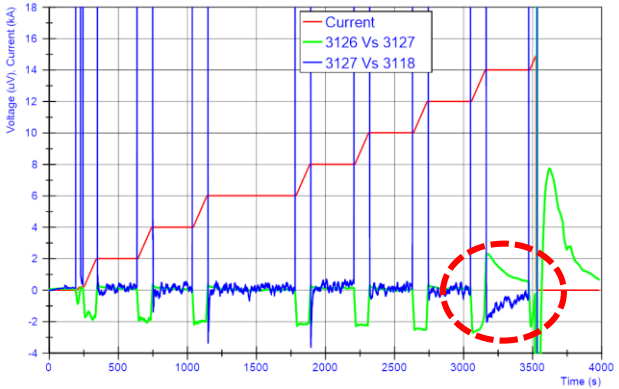


V-I measurements

Anomalous voltage signals during the VI measurement at 14 kA plateau

- **Positive** decaying voltage in the head (3126-3127)
- **Negative** decaying voltage in the straight section (3127-3118), quench at 14.96 kA





From calculations and modeling:

- Decaying voltage points to degradation in one or a few strands.
- Negative voltage can only occur in a segment neighboring a degradation.

- Is under furhter investigation.

Other results

Quench Detection by uQDS, CLIQ and QH worked fine
(one QH not connected from the start)

Lower quench integral than calculated

HV test OK (1.9 K, 90 K, 300 K)

Summary

- No “training” quenches, first ramp straight to coil limit at 69-70 % of I_{ss}

- 3 quench locations
  - All quenches in pole 3 (coil 108).
  - All quenches very repetitive for a specific temperature and ramp rate
- Main quench location is in the middle of the magnet at ± 20 cm from magnetic center in the pole turn.
- V-I measurements indicate decaying voltage, hence current redistribution with a positive voltage in the pole turn, head of pole 3.

Thank you

And thanks to the many persons involved in making this first test possible.