



Production Testing summary of the MQXFA Magnets

14th HL-LHC Collaboration Meeting

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Outline

- Scope of Vertical Cold Tests at BNL
- Brief introduction of BNL Test facility
- Training summary of MQXFA magnets tested since October 2023
- Summary

Scope of work at BNL

- Scope
 - Receive MQXFA magnets from LBNL
 - Prepare magnet for test at 1.9K in vertical test cryostat
 - Test magnet and analyze results
 - Ship magnet to FNAL
- Deliverables:
 - 23 magnet tests as per baseline.
 - BCR in process to test all remaining magnets with shorter test. Shorter test will not have second thermal cycle and only one z-scan for field harmonics measurement at operating current and 1.9K

BNL Test facility for MQXFA magnets

Electrical Systems

- 30kA SCR Power Supply
- 24kA IGBT Switch for Energy Extraction
- Energy Absorbing ceramic resistor bank with values from 30mohms to 600mohms, 5MJ capacity
- Two FPGA based multi channel quench detectors with dynamic threshold
- 352 channels of fast data logger at 100kHz, 16-bit simultaneous sampling
- 64 channels of multiplexed slow data logger.
- Strain gage measurement system.
- Vertical Field Measurement system.
- Quench antenna and its logger.
- Two top plate assemblies for 1.9K operation. One top plate equipped with Fiber Optic feed throughs and interrogator system for FBGs.

BNL Test facility for MQXFA magnets

Cryogenic Systems

- Old Helium liquefier model CTI4000 with capacity of 270 liters/hour
- Small Linde 1610 with the capacity of 70 liters/hour
- Two new Linde models to be commissioned from October 18, 2024, with capacity of 110 liters/hour
- Vacuum Pump for 1.9K operation
- Liquid helium storage capacity 17000 liters

Typical Magnet Test Sequence (Scope)



Incoming inspection of Magnet
(Warm measurements)



Magnet is Upright and attached
to top hat



Prepared magnet with all power and
instrumentation connection transported to
test Dewar



Magnet in Test Dewar with
Field Measurement Probe

MQXFA Magnets tested since Oct 2023.

- **Five Magnets tested at Brookhaven National Laboratory:**
 - MQXFA-14b: Magnet successfully trained to operate at nominal current.
 - MQXFA-7b: Retest of MQXFA-07 after repair. Magnet successfully trained to operate at nominal current
 - MQXFA-15: Magnet successfully trained to operate at nominal current.
 - MQXFA-17: Magnet did not reach stable operating current.
 - MQXFA-13b: Magnet successfully trained to operate at nominal current.
 - MQXFA-18 vertical test is under way.
 - High current successful ramps (16230A and above) performed during this period=72
 - High current unsuccessful ramps (quenches below 16530A)=48
 - Total high current ramps performed at this facility=120.

Summary of Training

First Ramp	Last Ramp	Magnet	Number of successful Ramps	Number of unsuccessful quenches
7/28/23	8/18/23	MQXFA 14b	13	6
12/4/23	1/19/24	MQXFA07b	16	1
2/27/24	3/26/24	MQXFA 15	21	3
5/22/24	6/13/24	MQXFA 17	8	22
7/18/24	8/21/24	MQXFA 13b	14	16
10/7/24		MQXFA 18		

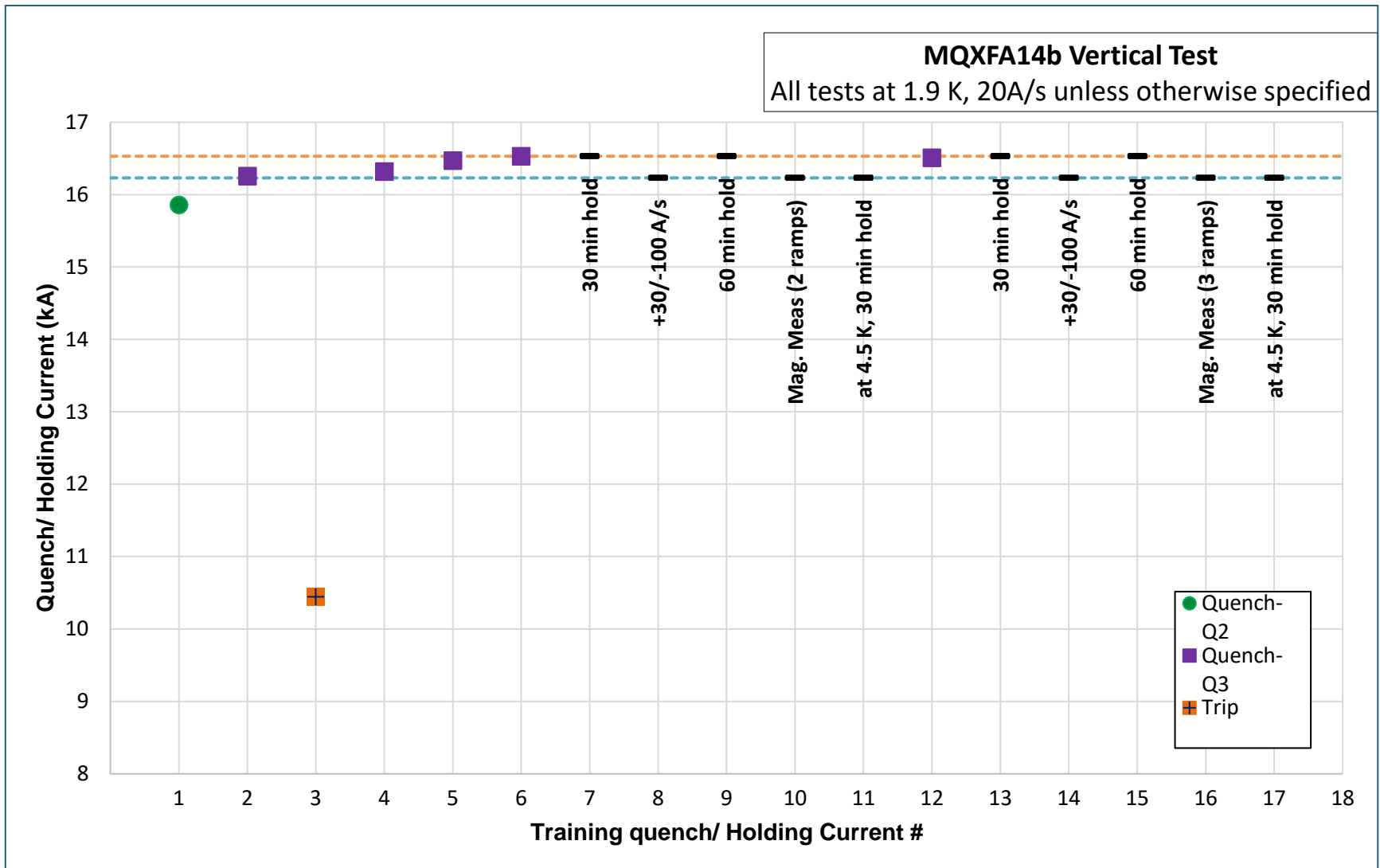
Total high current ramps: 120 (72 successful; 48 unsuccessful)



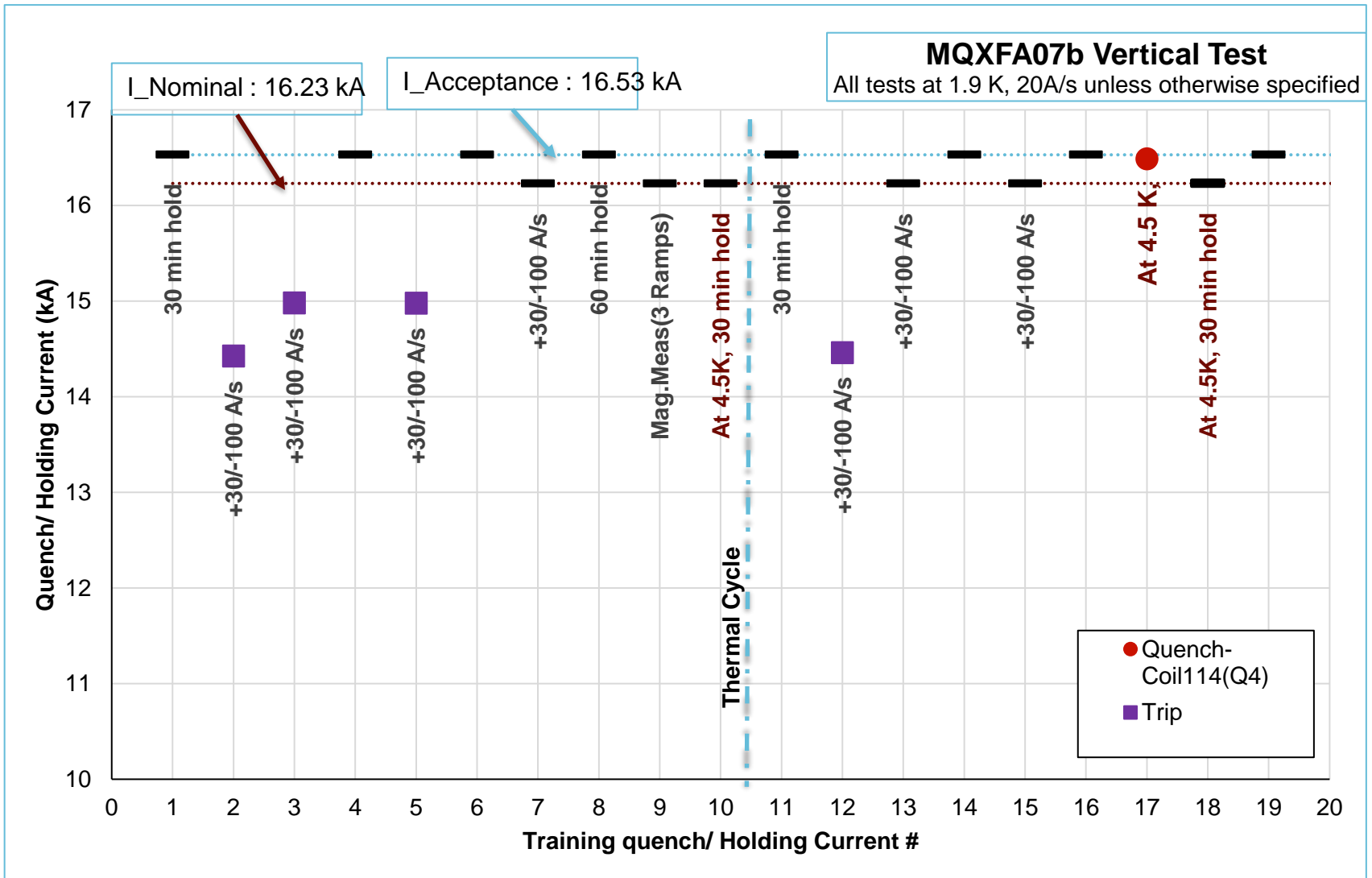
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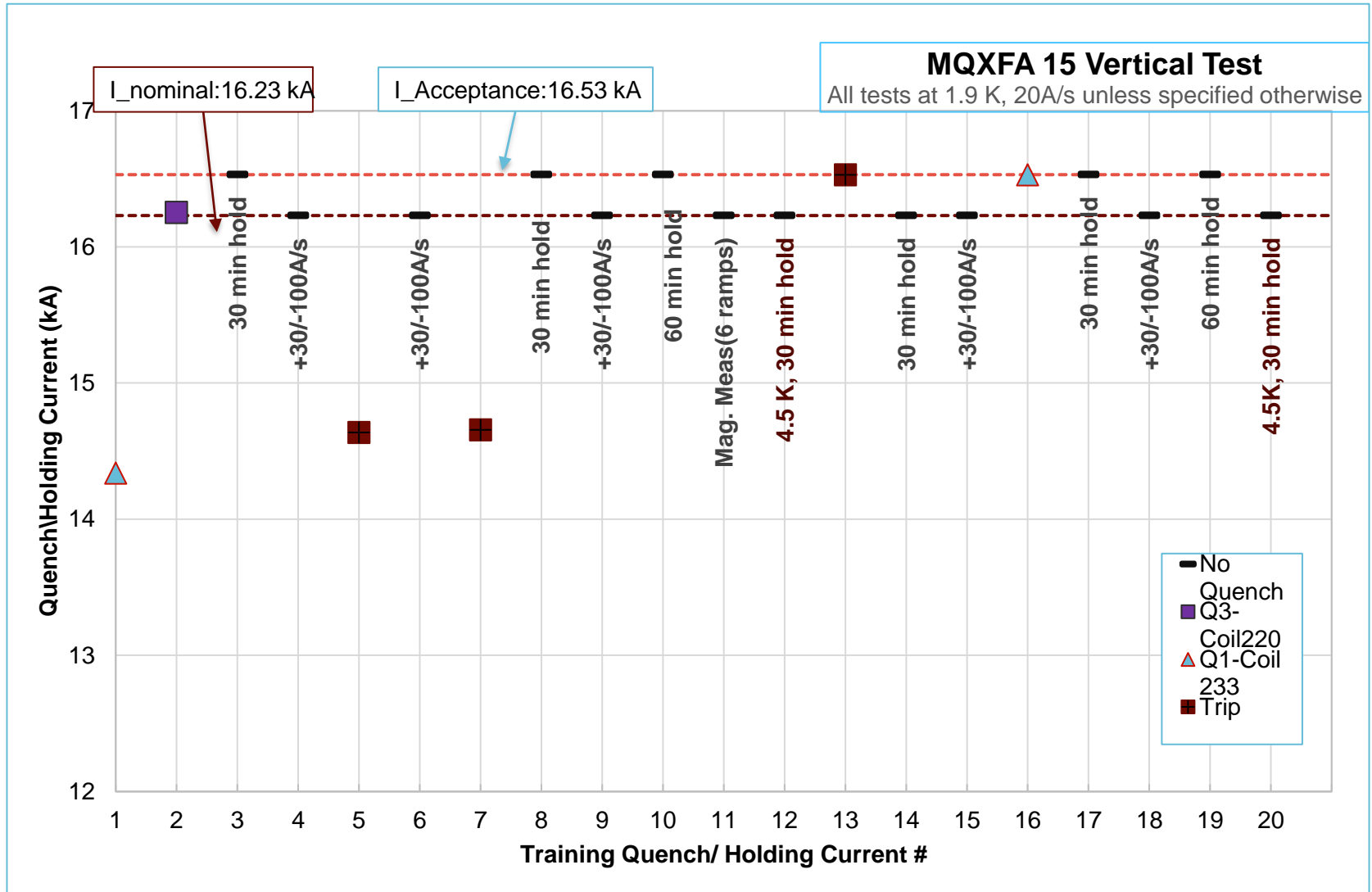
MQXFA-14b



MQXFA-7b



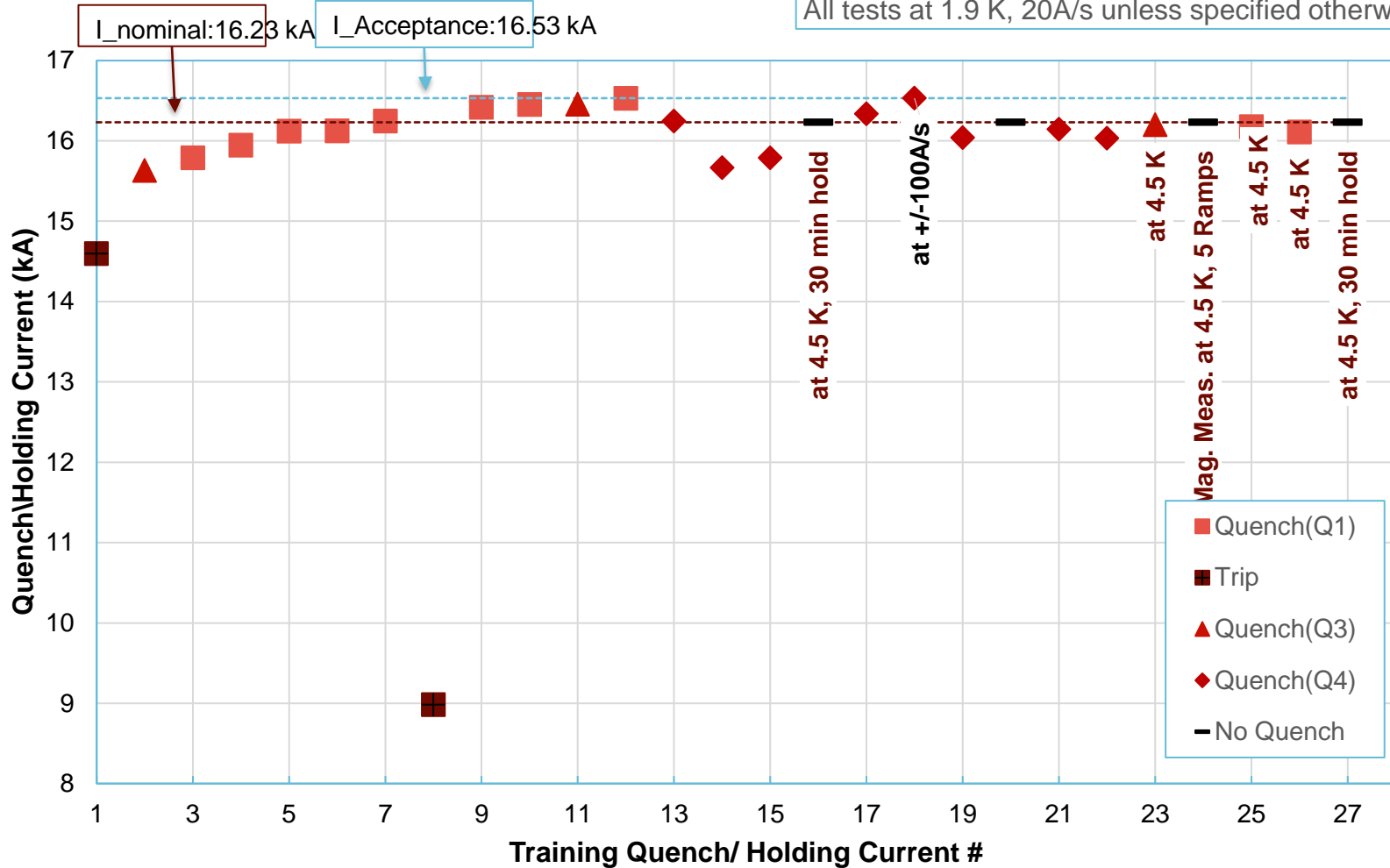
MQXFA-15



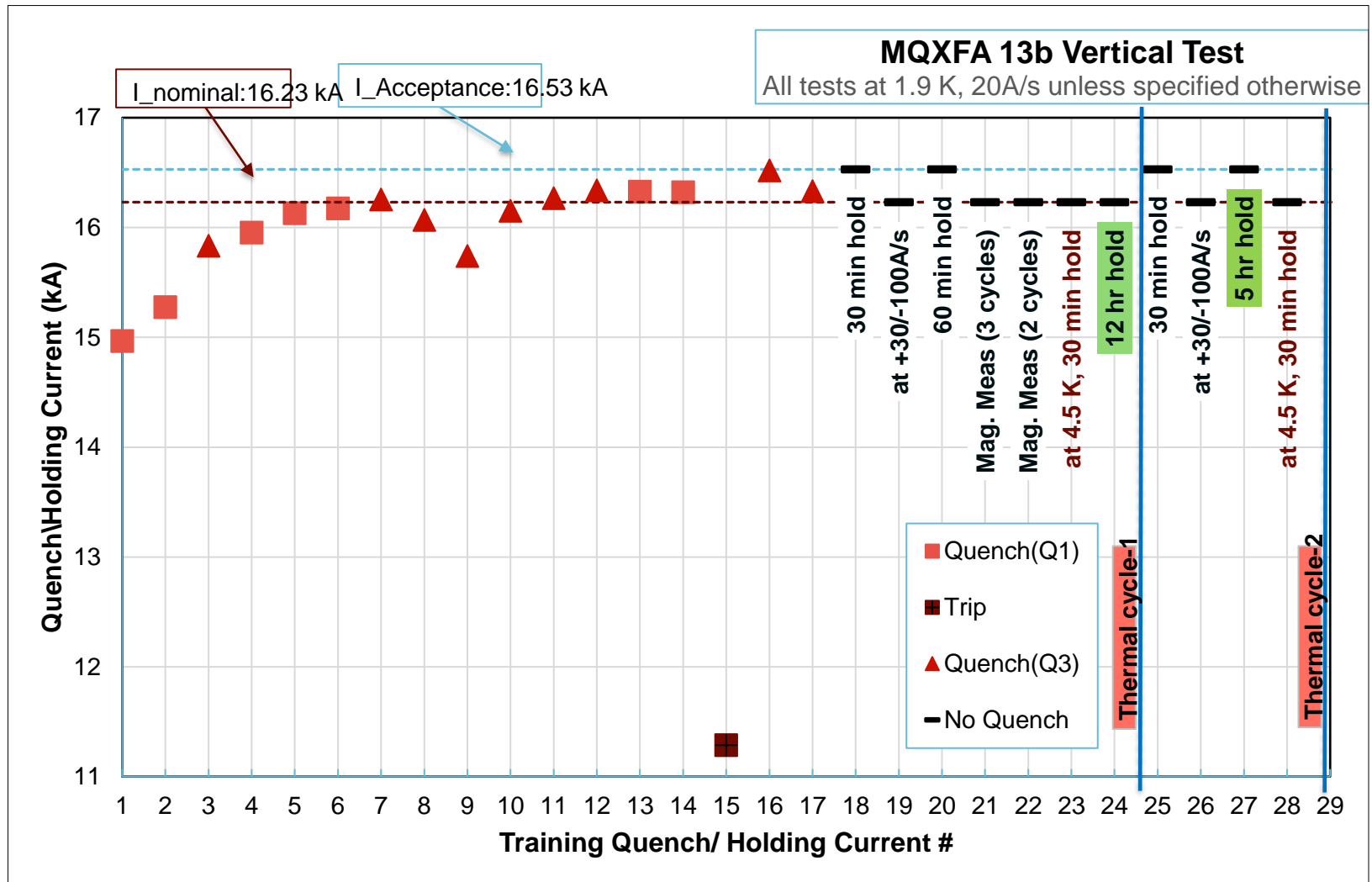
MQXFA-17

MQXFA 17 Vertical Test

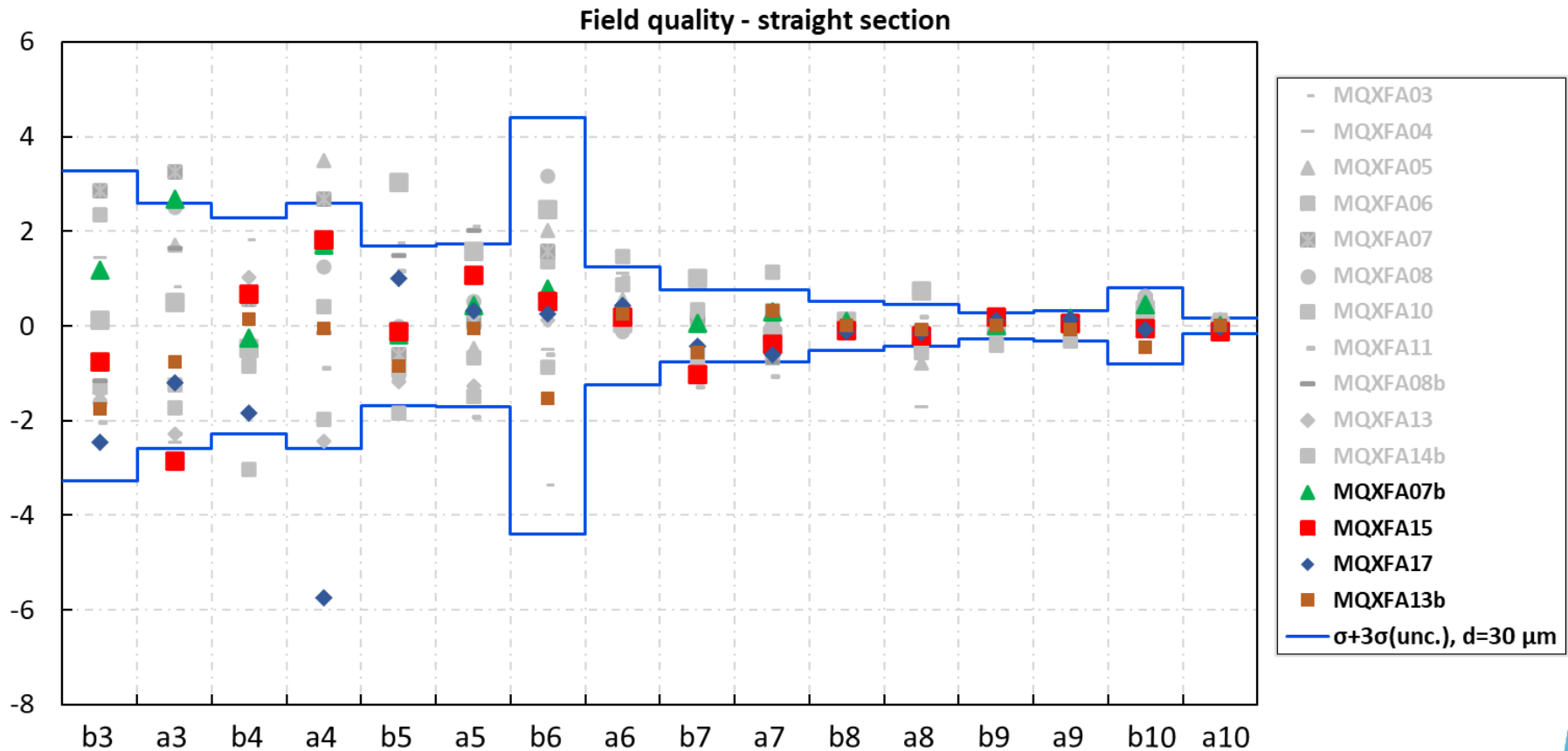
All tests at 1.9 K, 20A/s unless specified otherwise



MQXFA 13b



Field Quality- Straight Section: All Magnets



Summary

- We have successfully completed testing of 5 magnet since October 2023.
 - Four magnets attained acceptance criteria.
 - One magnet (MQXFA-17) did not attain acceptance criteria.
- Regular maintenance, upgraded control and monitoring system has improved the performance of our main helium liquefier plant.
- Addition of Linde 1630 and Linde 1430 helium liquefiers will add liquifying capacity of 110 liters/hour after commissioning.
- Vertical testing program is on schedule and not in critical path.

Backup Slides



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WBS 302.4.01: Achievements since Rebaseline

Charge #1



Installation of New Purifier



Installation of New Linde 1630 (70l/h)
and 1430(40l/h)

WBS 302.4.01: Achievements since Rebaseline

Charge #1

New DI water system and controls.



Pumps and heat exchanger

500kW cooling capacity
300GPM



Controls and VFD



Chiller