



DQW Series Cavities

Tests in SM18

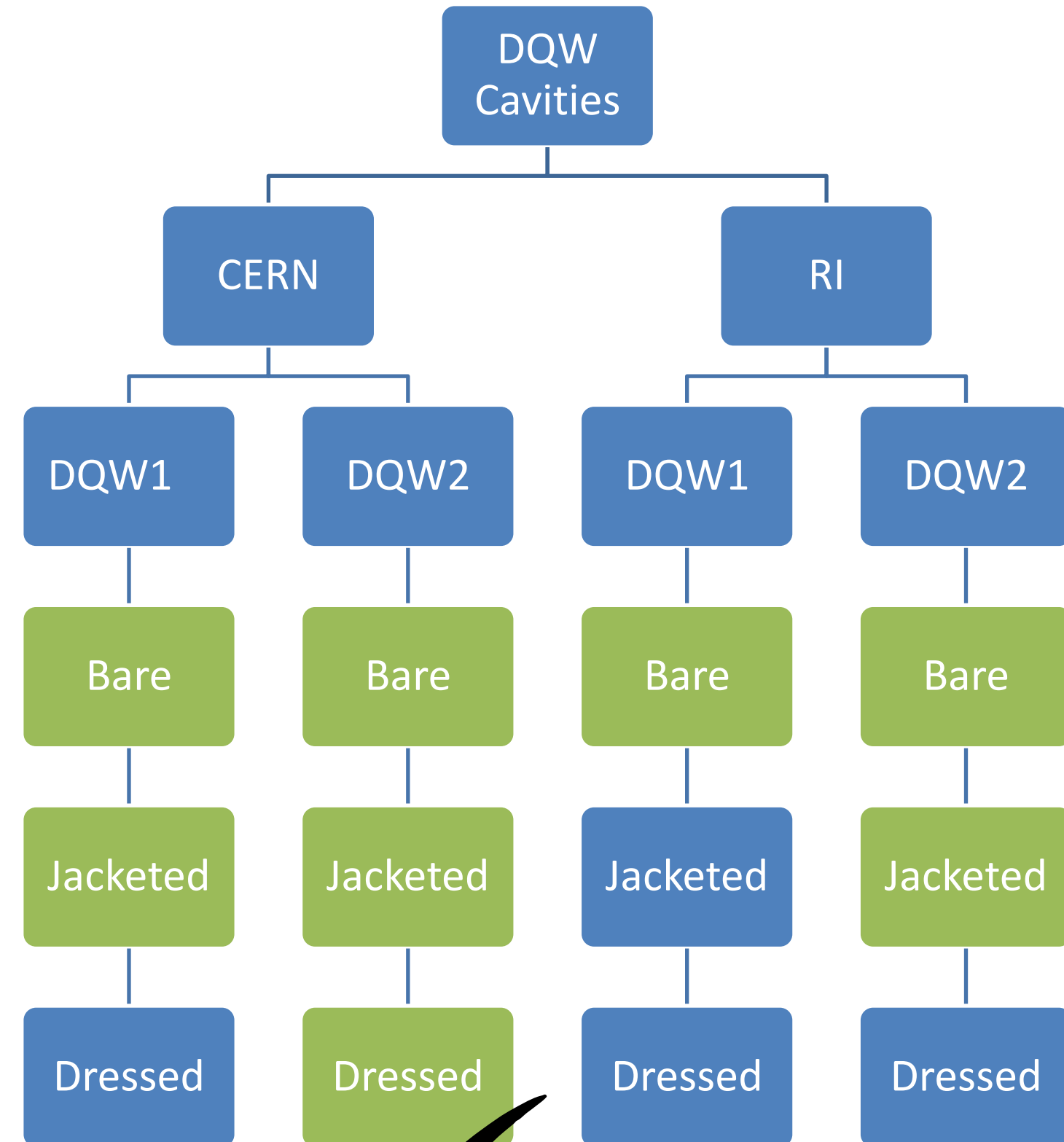
Amelia Edwards on behalf of HL-LHC WP4
14th HL-LHC Collaboration Meeting - Genoa - 7th-11th
October 2024



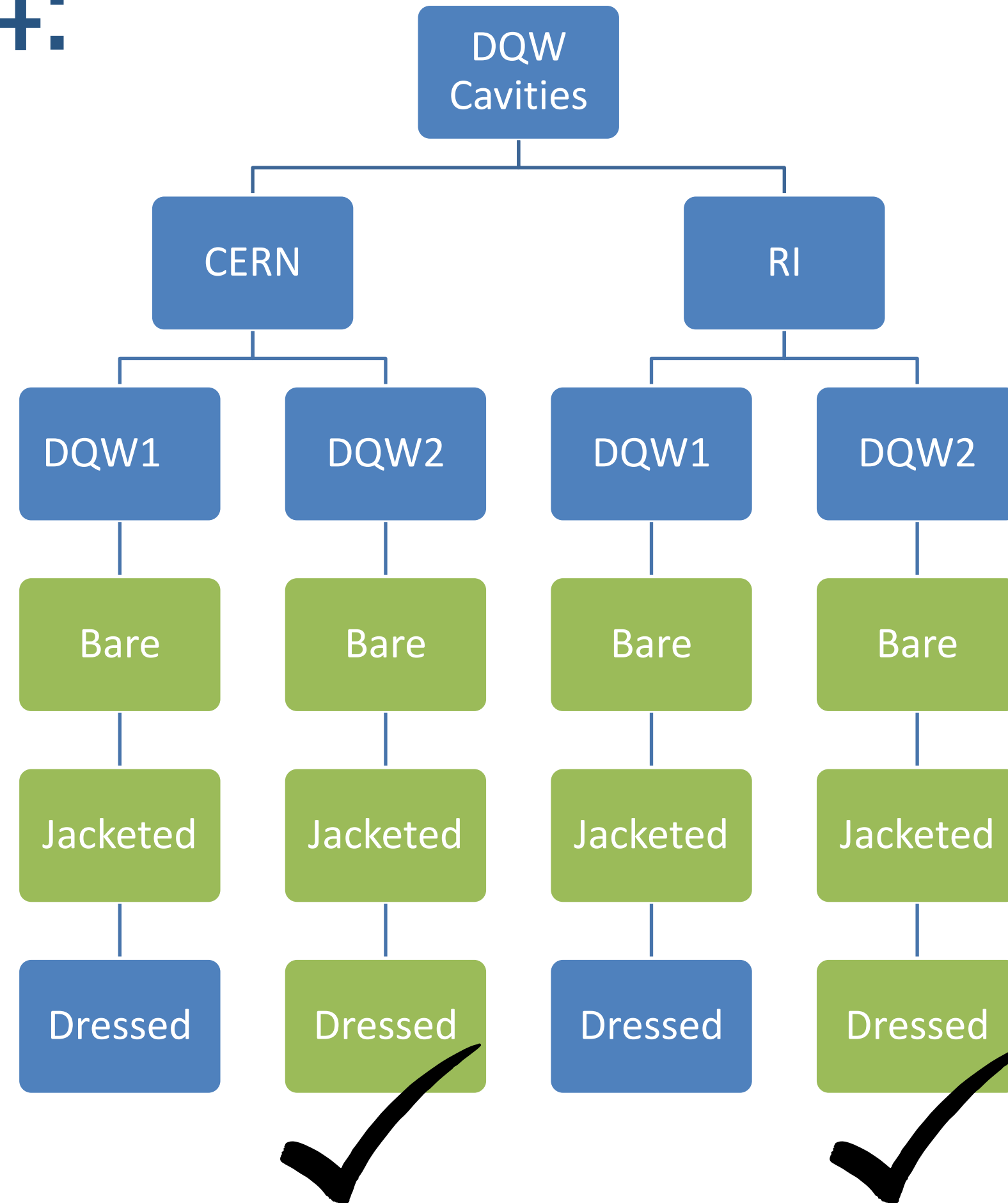
Outline

- Updated status 2024
- Test results by cavity:
 - RI DQW2
 - RI DQW1
 - CERN DQW1
- HOM Measurements
- Notes on current issues
- Summary

Status Oct 2023:



Status 2024:



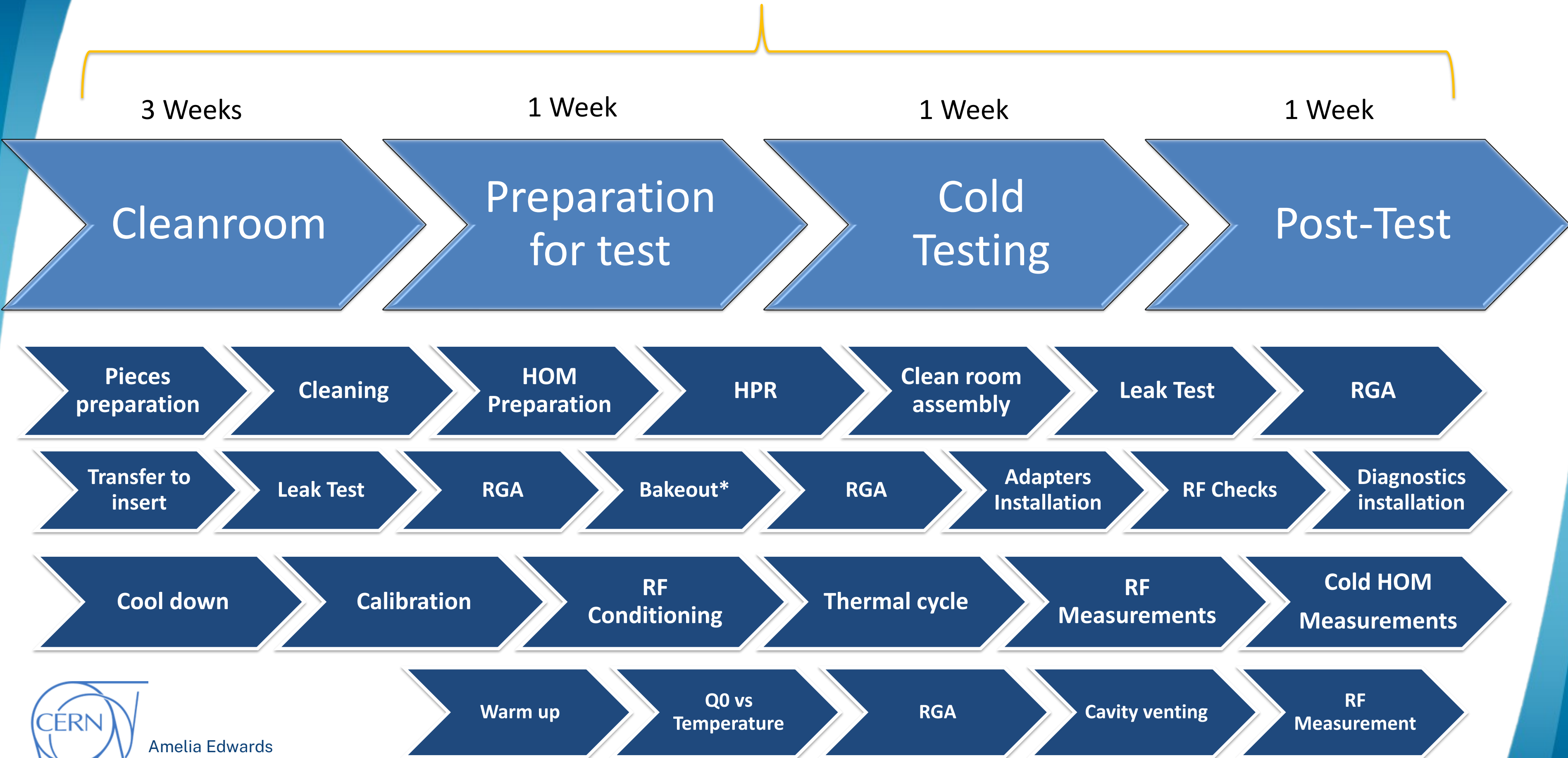
Tests since HL-LHC Meeting 2023:



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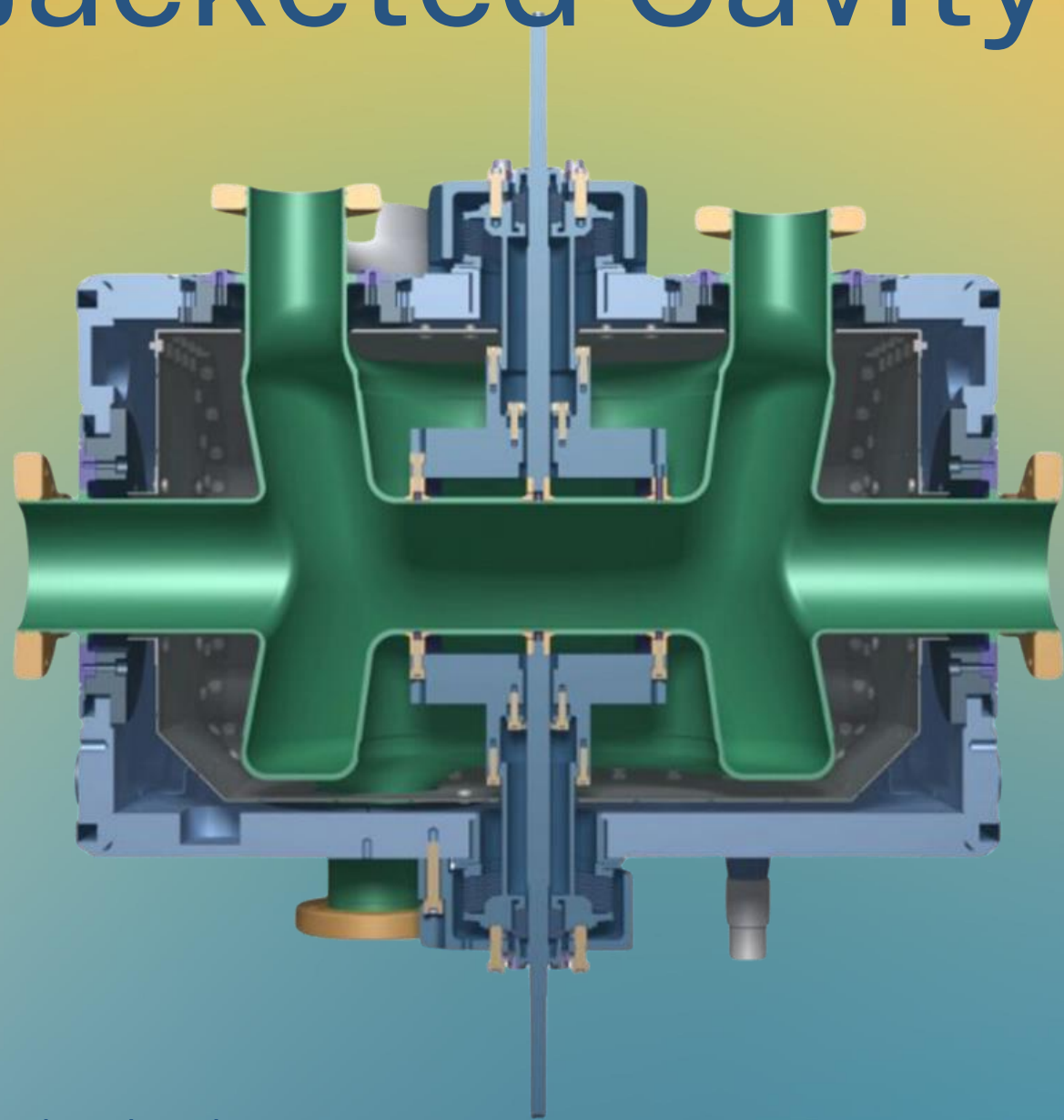


Total Duration: 6 weeks

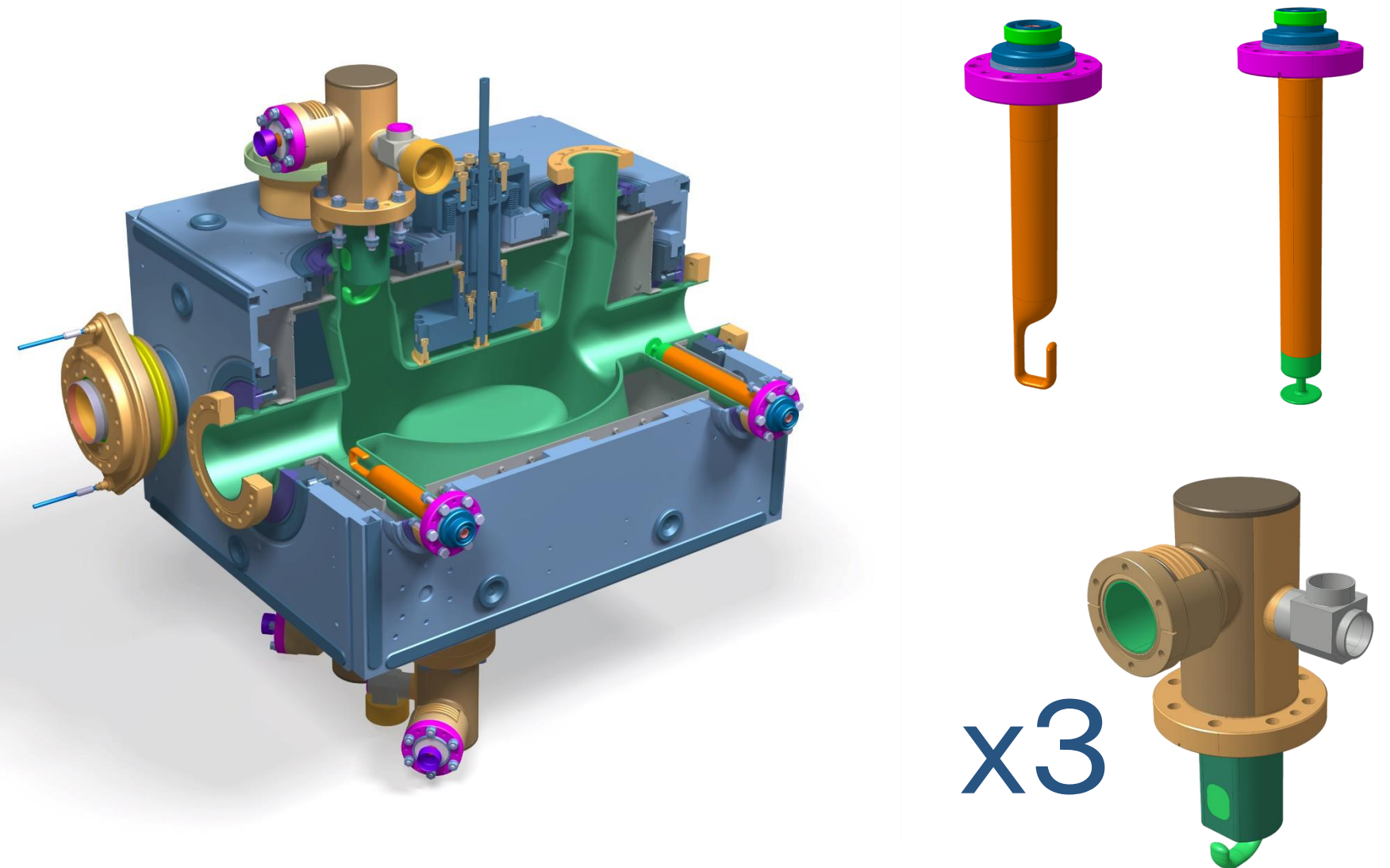


Recap: Test configurations

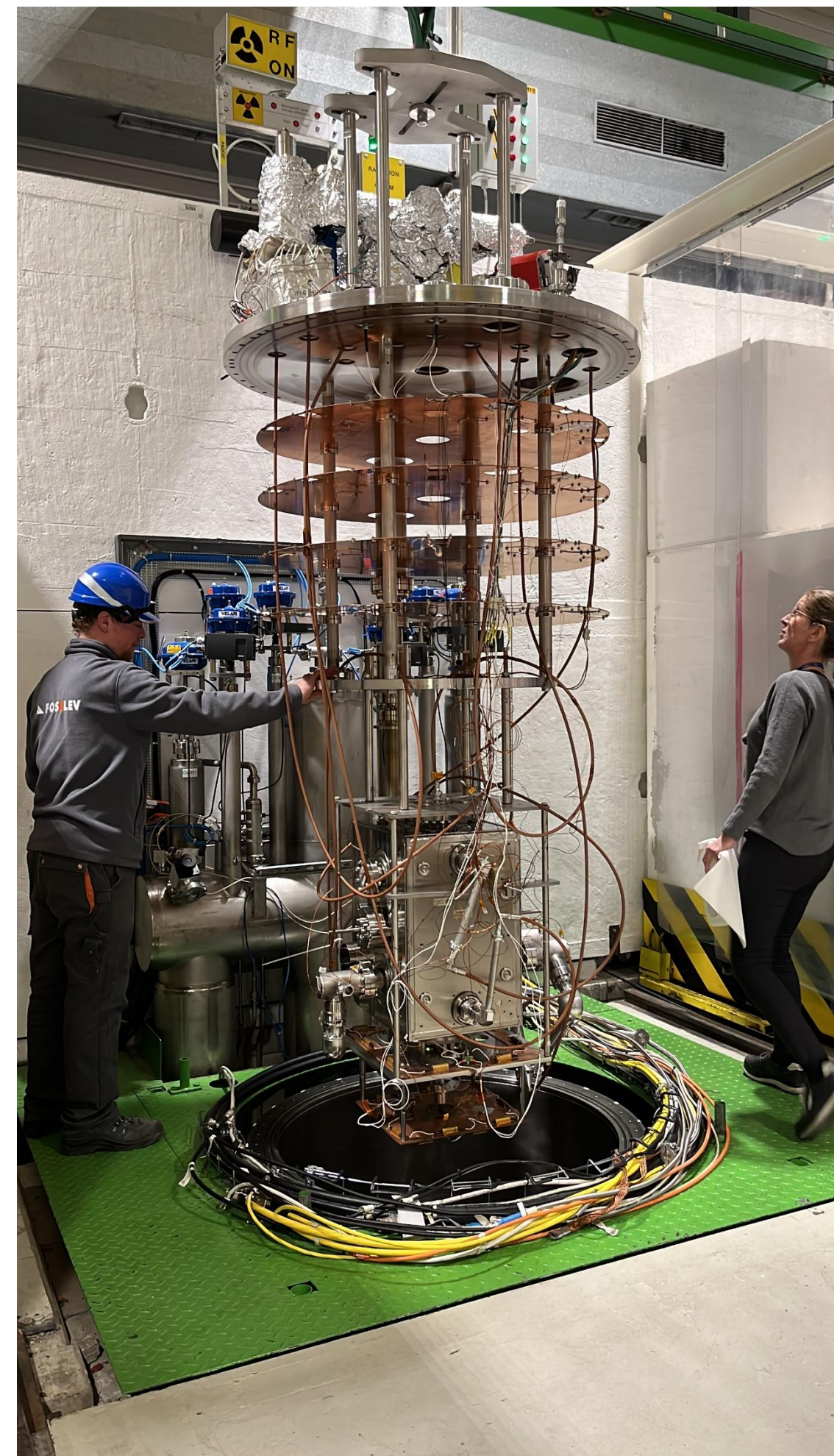
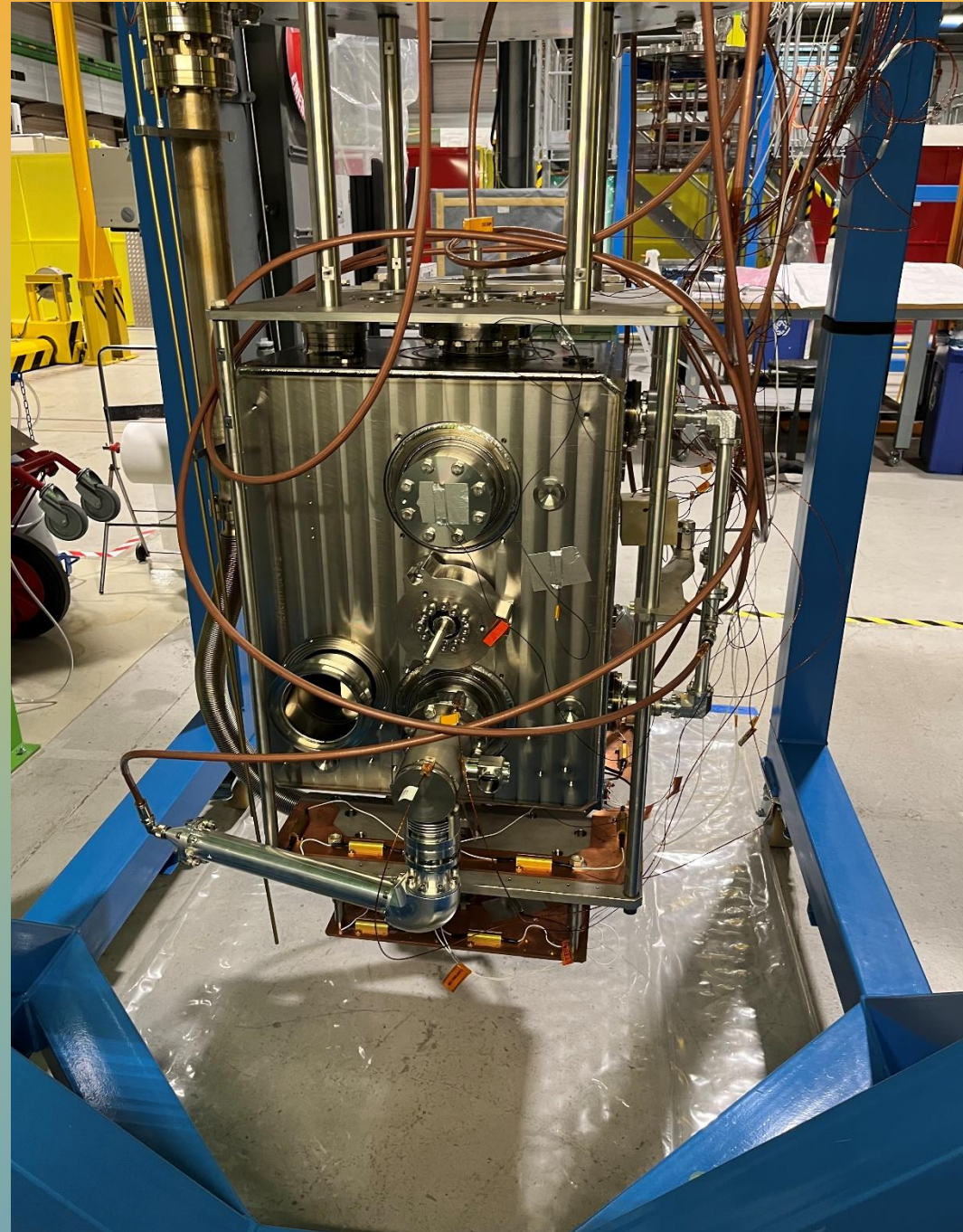
Jacketed Cavity



Dressed Cavity



Test configuration



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Recap: Dressed Cavity Specification

From EDMS 2488213 & 1389669

Cavity frequency @2k (MHz)	400.79 ± 0.15
Deflecting Voltage @2K - Dressed cavity (MV/M)	≥ 4.1
Q0 @2K, 4.1MV/M	$3e9$
LFD (Hz/MV²)	< 400
Field Antenna Power @ 400MHz (W)	1
HOM power @ 400MHz (W)	≤ 6.7
P dyn @2K, 4.1MV/M (W)	≤ 10



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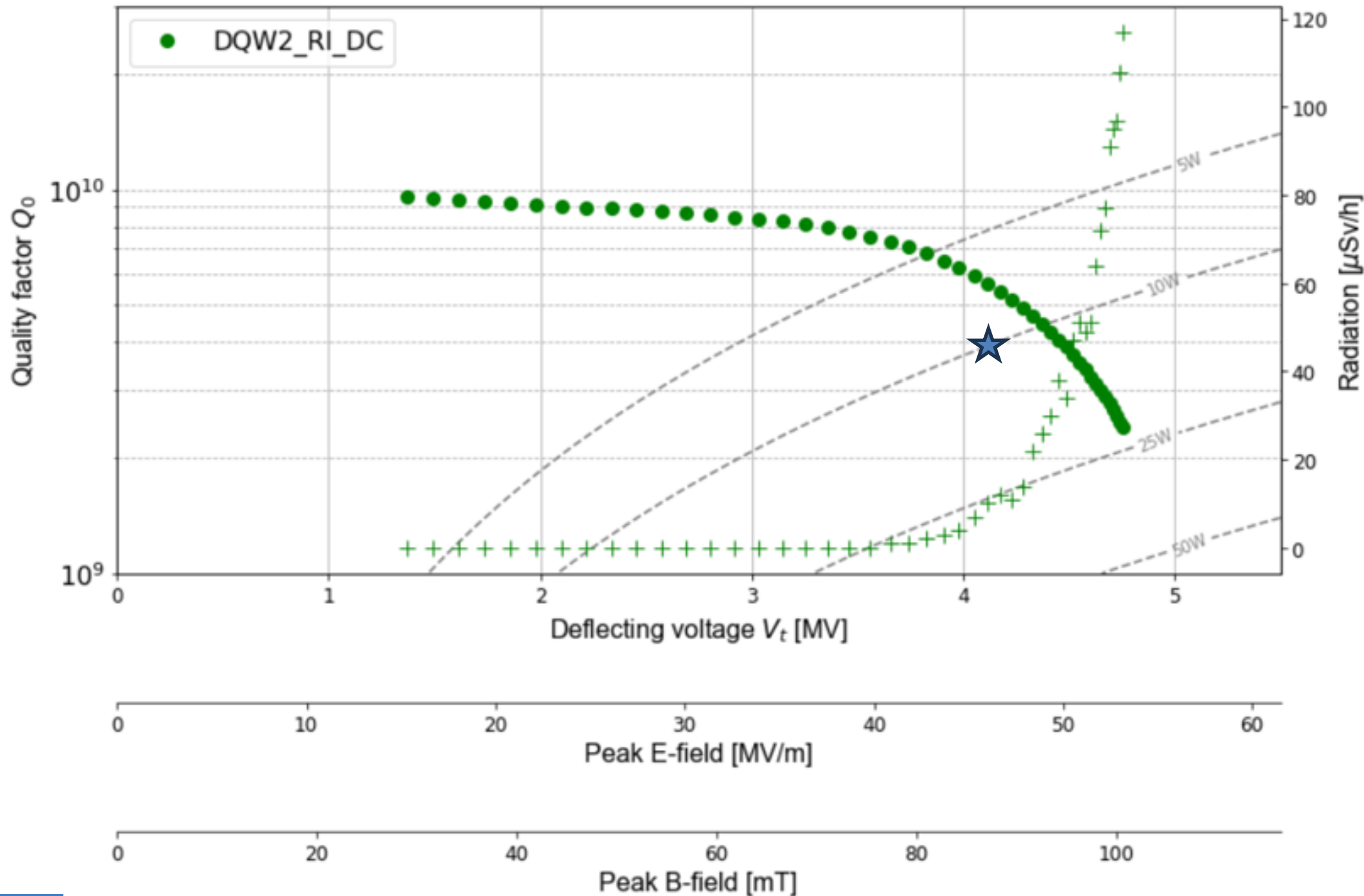
...Also, requirement to measure HOM frequencies
and impedances at 2K

Test Results by Cavity: RI DQW2



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RI DQW2 - Dressed Cavity Test



- First dressed cold test of this cavity
- Surpassed target of 4.1MV
- **Maximum field 4.75MV/M**
- **Higher order modes measured at cold and meet impedance criteria**

RI DQW2 Dressed Cavity - 1st Cold Test

Frequency (MHz)	400.789
Deflecting Field (MV)	4.1
Q0 @ 4.1MV	5e9
LFD (Hz/MV ²)	-196.871 ± 0.561

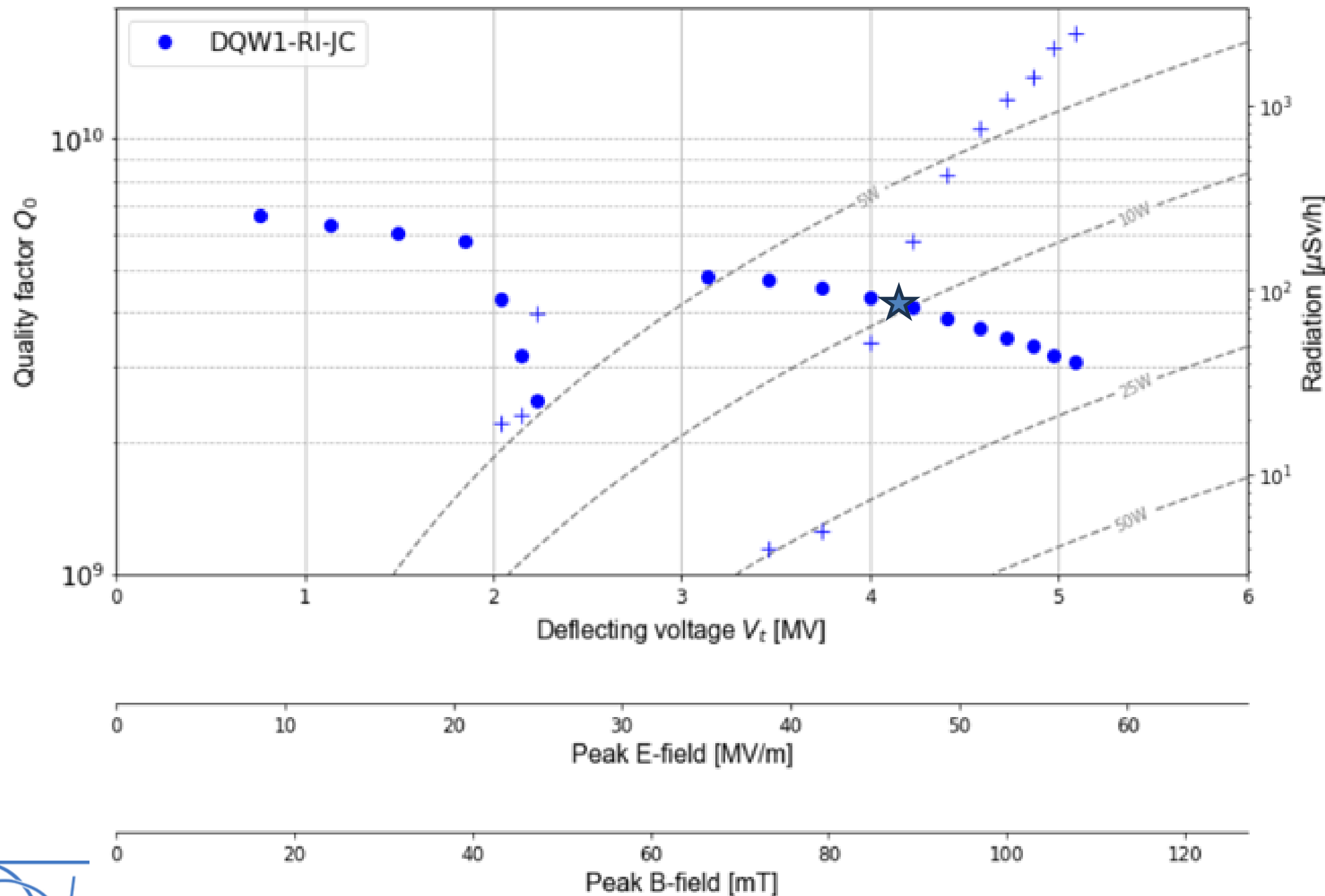


Test Results by Cavity: RI DQW1



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RI DQW1 - Jacketed Cavity Test



- First jacketed test of this cavity
- **Maximum field 5.0MV/M**
- Test stopped due to radiation

RI DQW1 Jacketed Cavity

Frequency (MHz)

401.036

Deflecting Field (MV)

5.0

Q0 @ 4.1MV

~3.8E9

LFD (Hz/MV²)

-237.67 ± 0.209

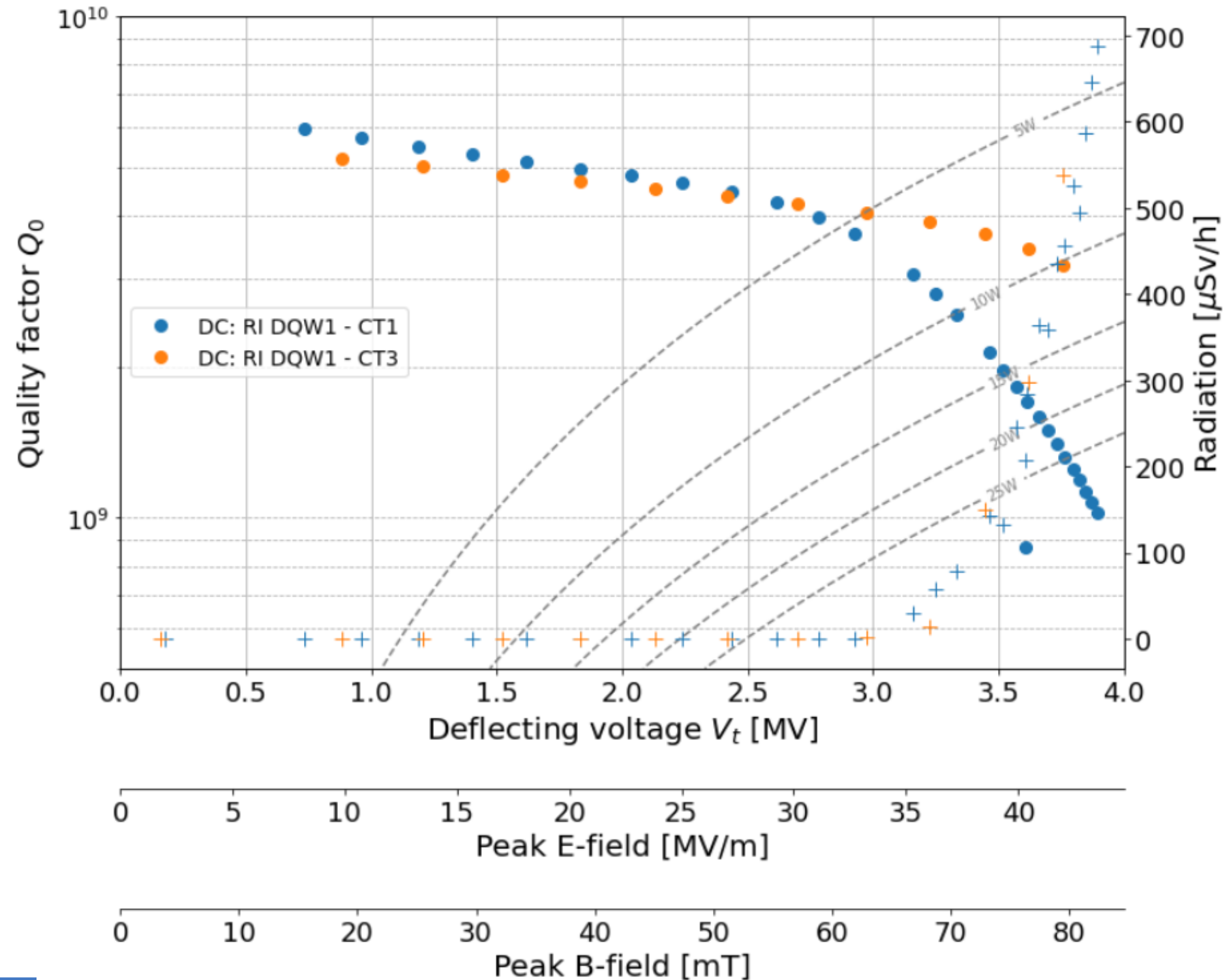


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RI DQW1 - Dressed Cavity Tests



- Three dressed tests so far
- Field is not limited due to cavity at 5MV was reached during jacketed test
- During 2nd test, leak appeared at 4.5K so no RF test was done.
- During 1st & 3rd test, maximum field was 3.9MV & 3.75MV respectively
- Quench-like behavior in both tests
- Radiation onset similar

Next steps..... BCP completed & re-test imminent

RI DQW1 - Dressed Cavity Test Summary

RI DQW1 Jacketed Cavity		RI DQW1 Dressed Cavity			
	Oct 23	Feb 24	April 24	June 24	
Comment	Passed!	Spec. not achieved	Leak at 4.5K, No RF test	Spec. not achieved	
Frequency (MHz)	401.036	401.016	N/A	401.015	
Deflecting Field (MV)	5.0	3.9	N/A	3.75	
Q0 @ 4.1MV	~3.8E9	9.6e8 @ 3.9MV	N/A	3.2e9 @ 3.75MV	
LFD (Hz/MV²)	-237.67 ± 0.209	-216.73 ± 0.47	N/A	-268 ± 0.99	



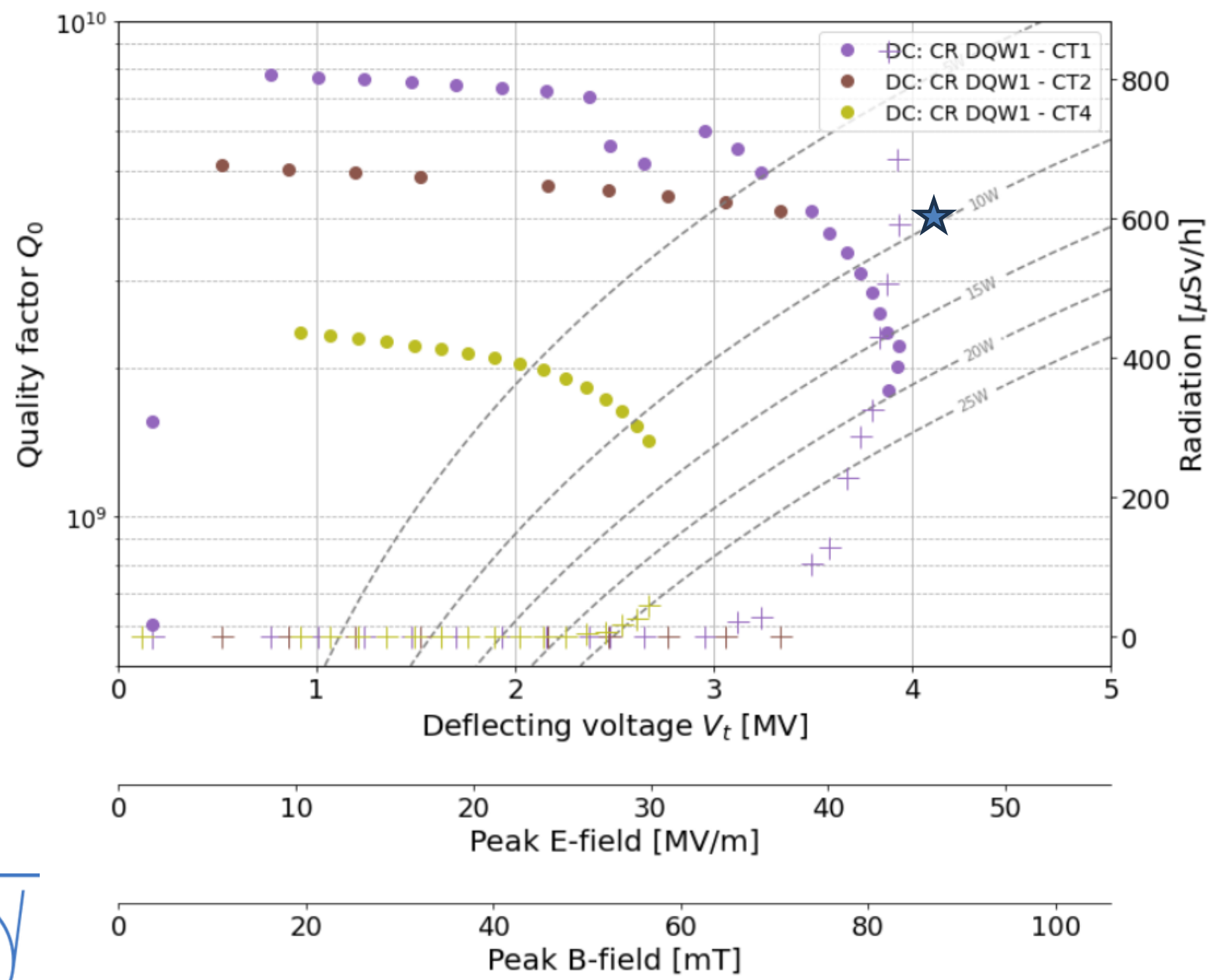
Test Results by Cavity: **CERN DQW1**



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CERN DQW1 - Dressed Cavity Tests

- By 14th HL-LHC meeting there has been x5 dressed tests....
- After several dressed tests the jacketed test was repeated to re-validate the cavity



May 2023

CERN DQW1 Dressed

Oct 2023

CERN DQW1 Dressed

Mar 2024

CERN DQW1 Dressed*

Jun 2024

CERN DQW1 Dressed

Aug 2024

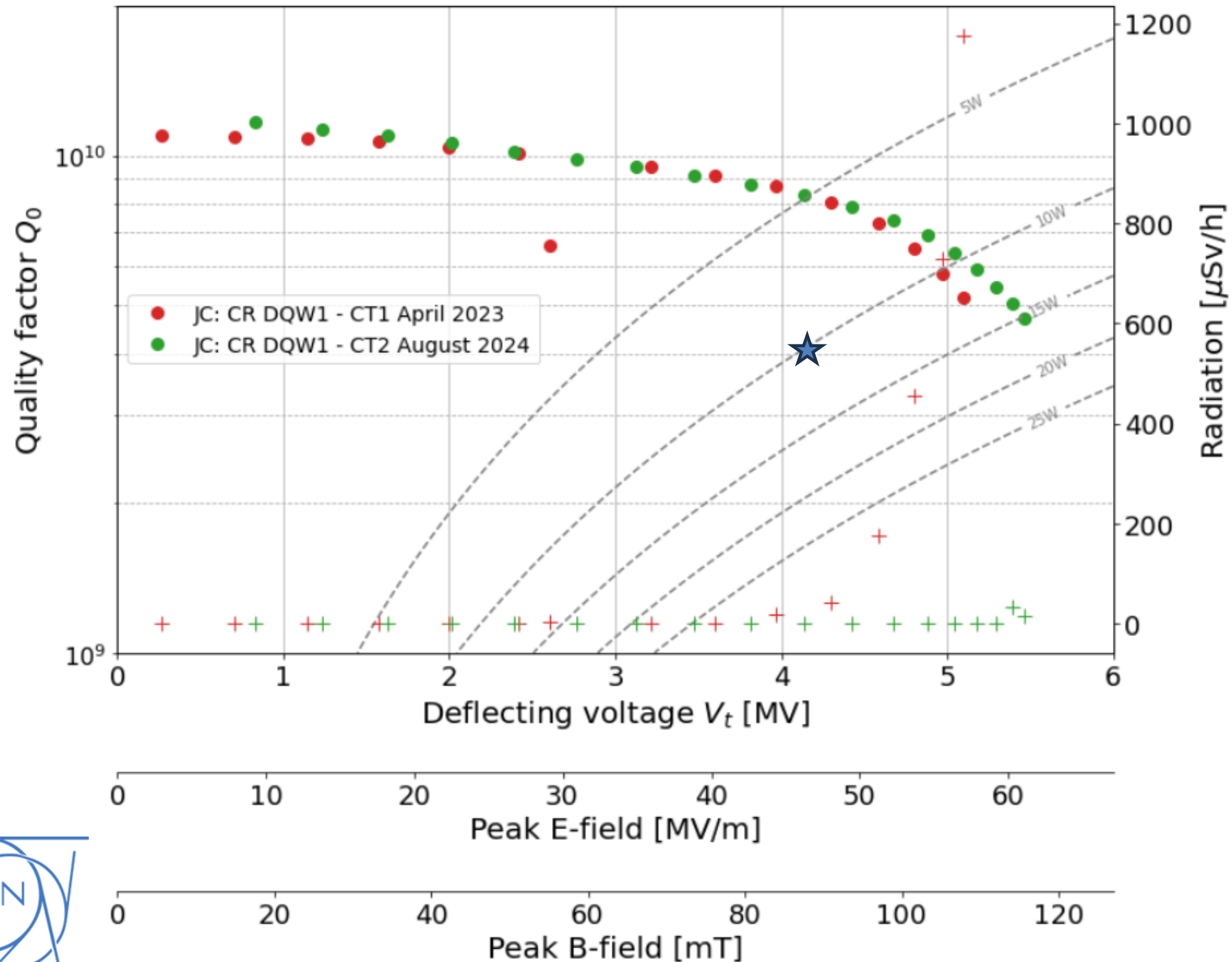
CERN DQW1 Jacketed

Sep 2024

CERN DQW1 Dressed



CERN DQW1 - Jacketed Cavity Tests



- Two jacketed tests of this cavity
- Second jacketed test was performed ~ 1 year later after several (unsuccessful) dressed cold tests
- **Maximum field 5.4MV/M**
- First test stopped due to radiation
- Second test - field is limited by thermal quench behavior
- For second test, radiation onset begins at higher field level - possibly due to cleaner surface after many iterations of rinsing?
- Performance very similar between tests and Q_0 of cavity retained

CERN DQW1 - Dressed Cavity Test Summary

CERN DQW1 Jacketed Cavity			CERN DQW1 Dressed Cavity				
	Oct 23	Aug 24	May 23	Oct 23	Feb 24	June 24	Sept 24
Comment	Passed!	Passed! *Superfluid leak	Field Limited	<i>Quench</i> before field emission	Leak @4.5K No RF	Field Limited	TBD
Frequency (MHz)	400.70	400.69	400.69	400.67	N/A	400.68	...
Deflecting Field (MV)	5.1	5.4	3.9	3.5	N/A	2.7	...
Q0 @ 4.1MV	5.1e9	4.7e9	6.0e9 @ 3.9MV	3.7e9 @3.5MV	N/A	1.43e9 @ 2.7MV	...
LFD (Hz/MV²)	-221 ± 0.15	-268 ± 0.19	-232 ± 0.18	-230 ± 0.62	N/A	-216 ± 0.149	...

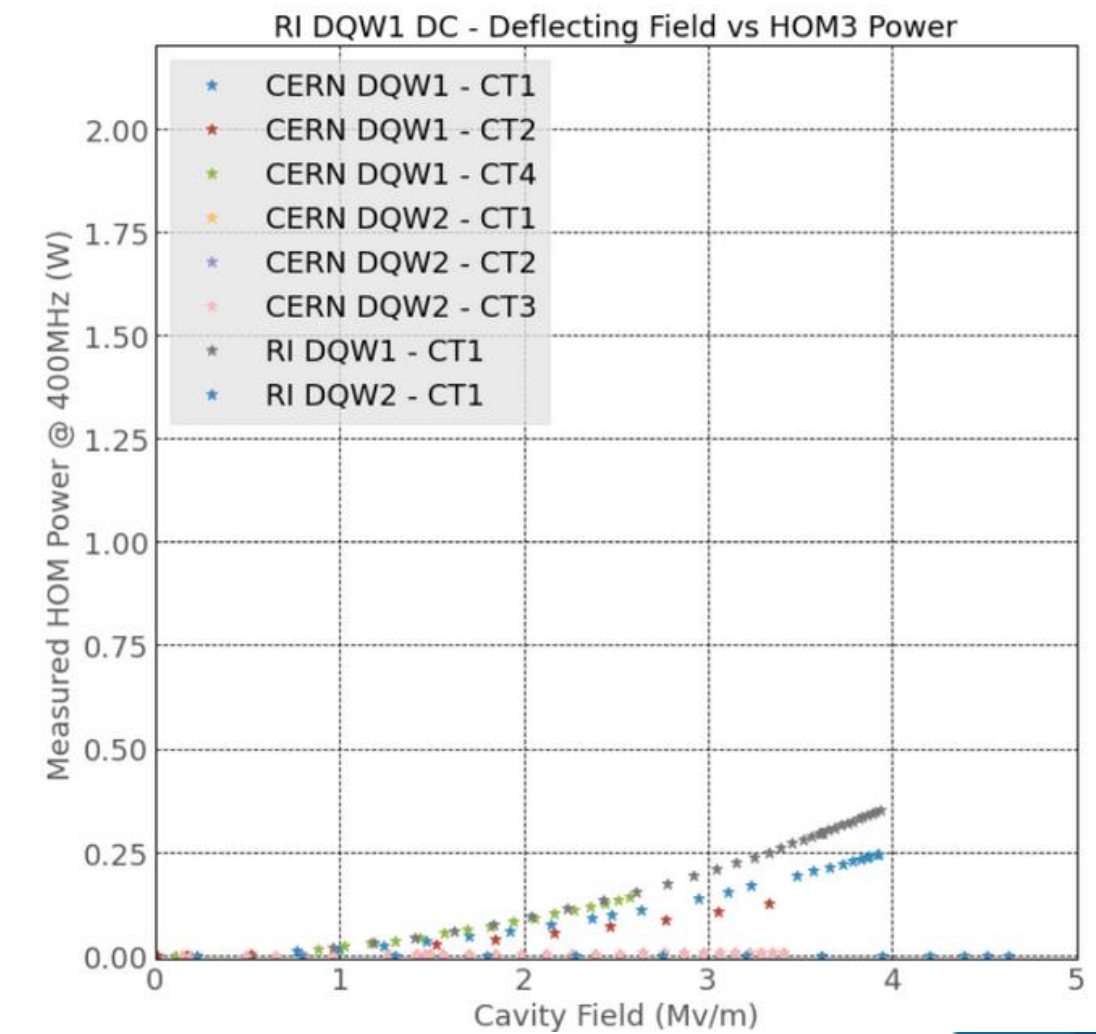
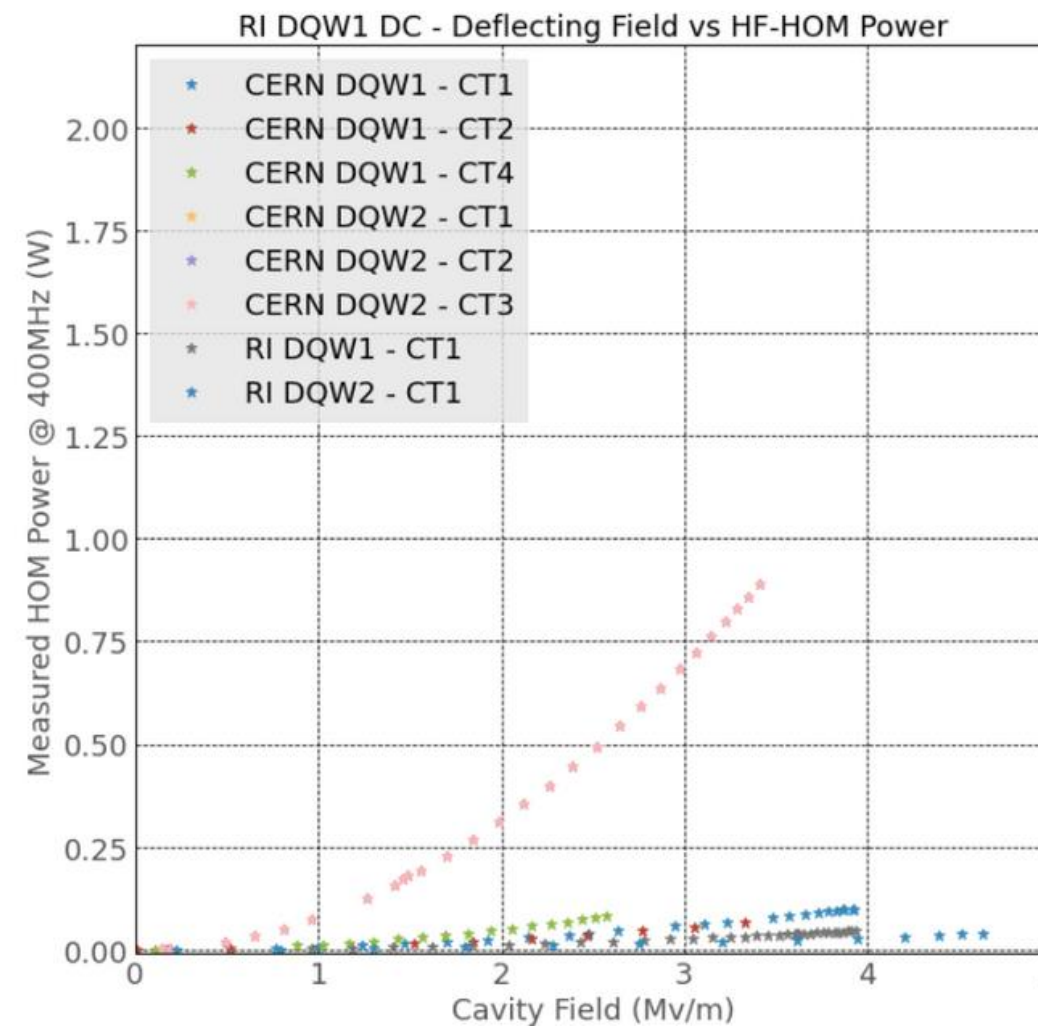
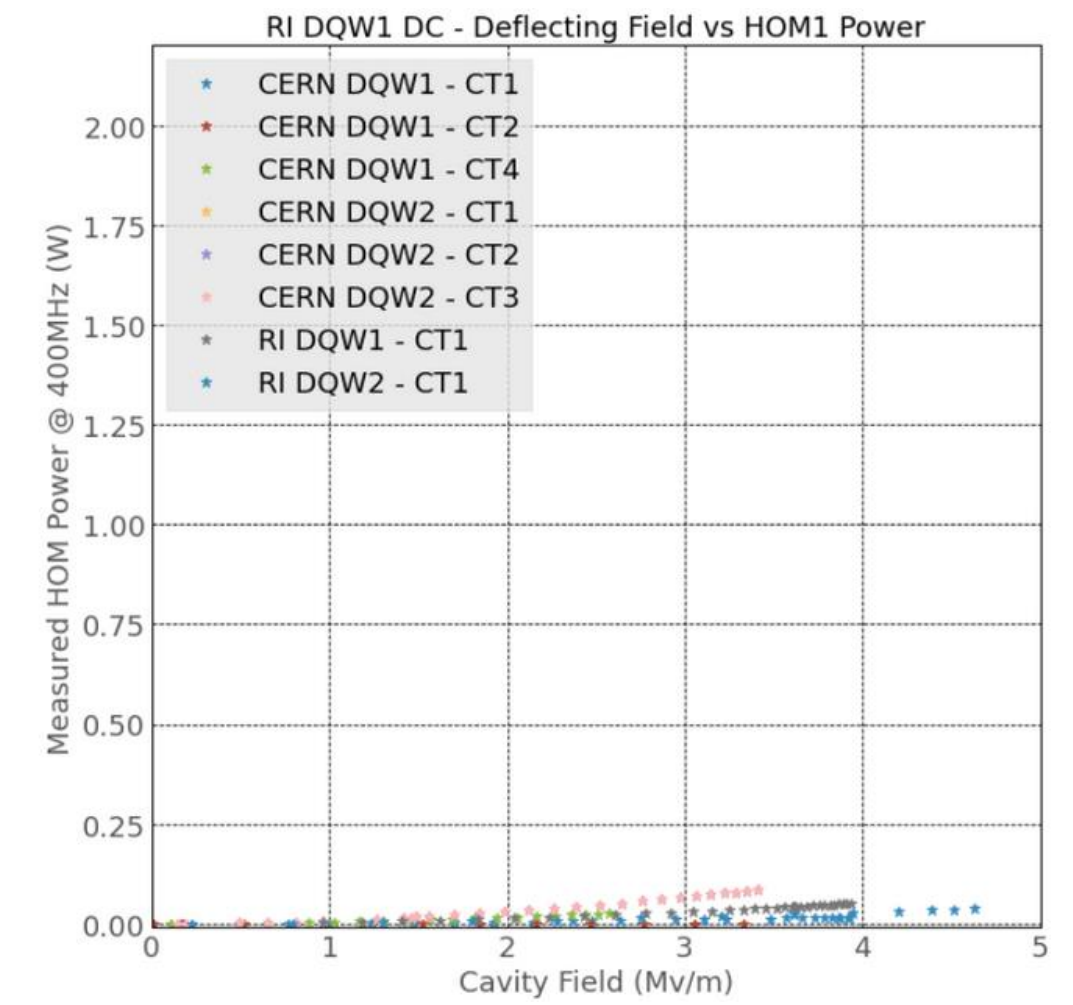
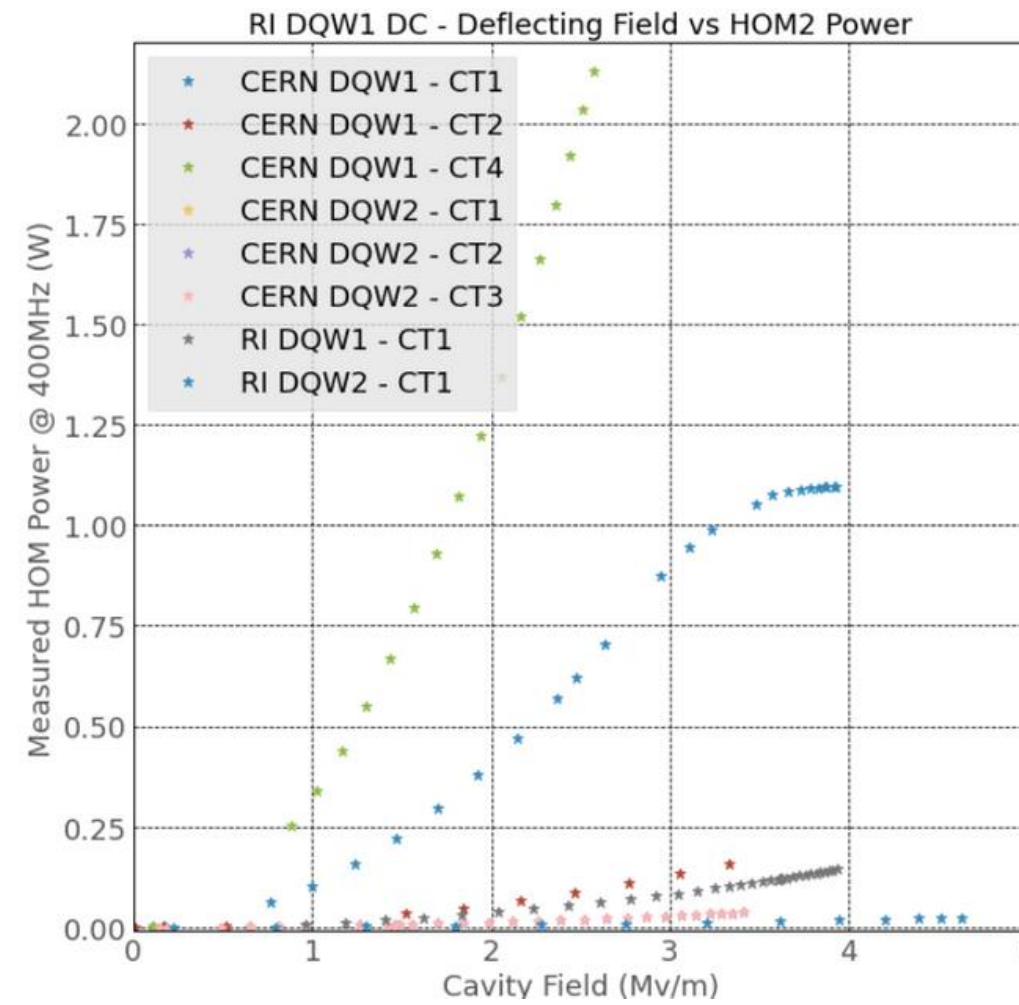
HOM Measurements



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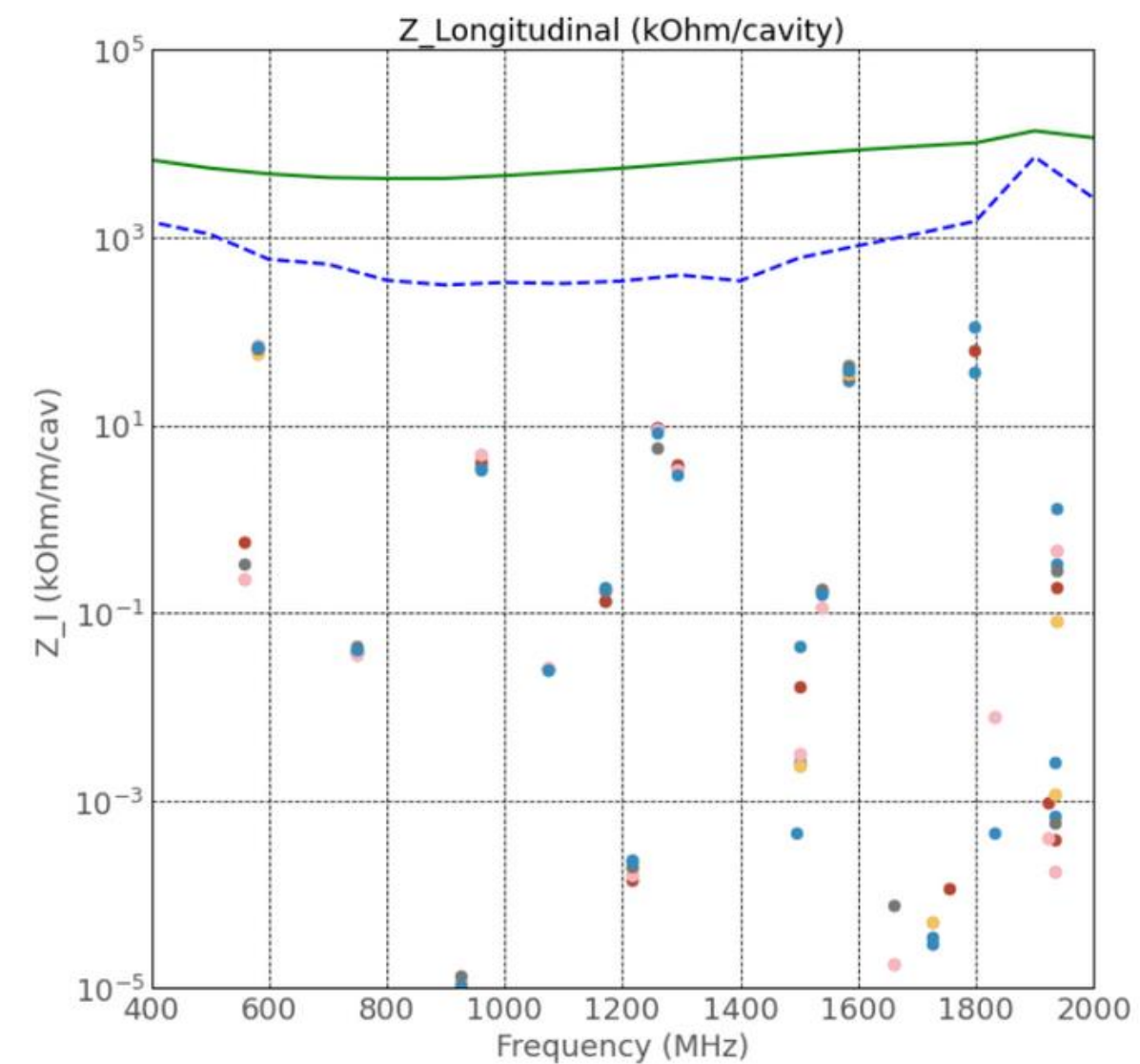
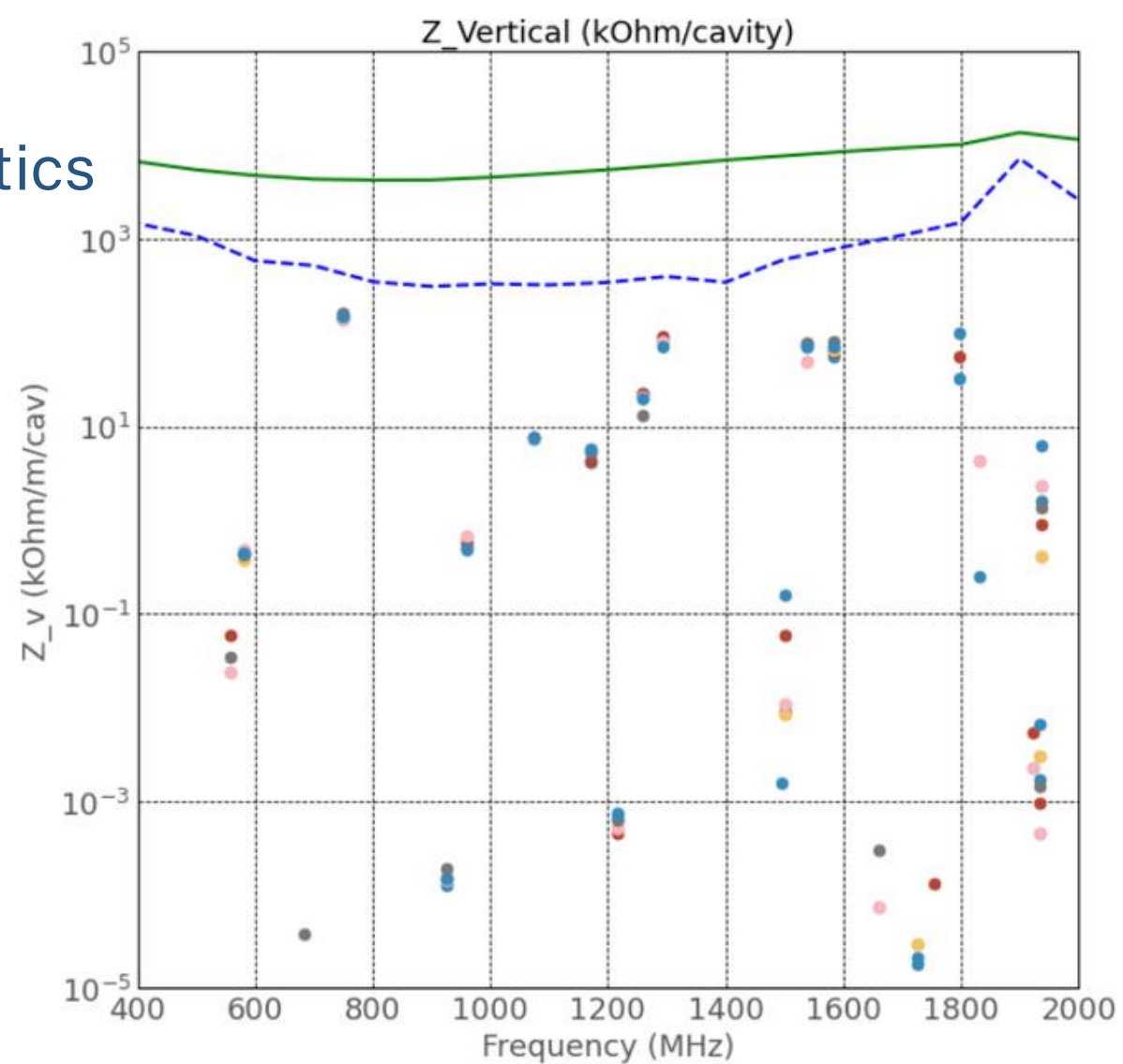
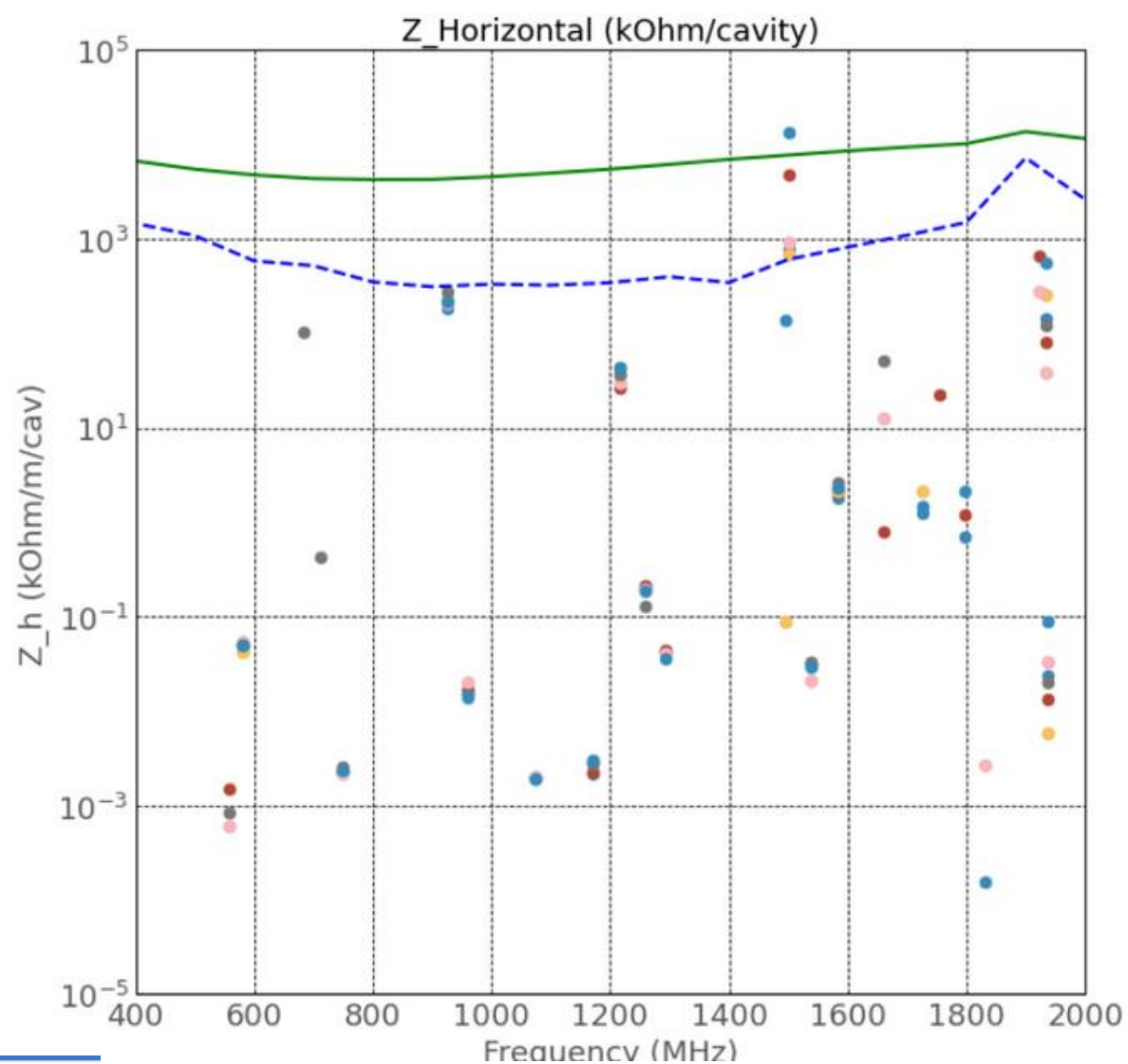
Fundamental Power Extraction

Acceptance Criteria:
Power @ 400MHz ± 0.15 ,
VT = 4.1MV
< 6.7W
(EDMS 2488213)



HOM Impedance at 2K

- Calculated from 2GHz HOM spectrum measured at 2K
- Successful use of 50Ω to 25Ω adapters
- Impedance limits come from collision optics



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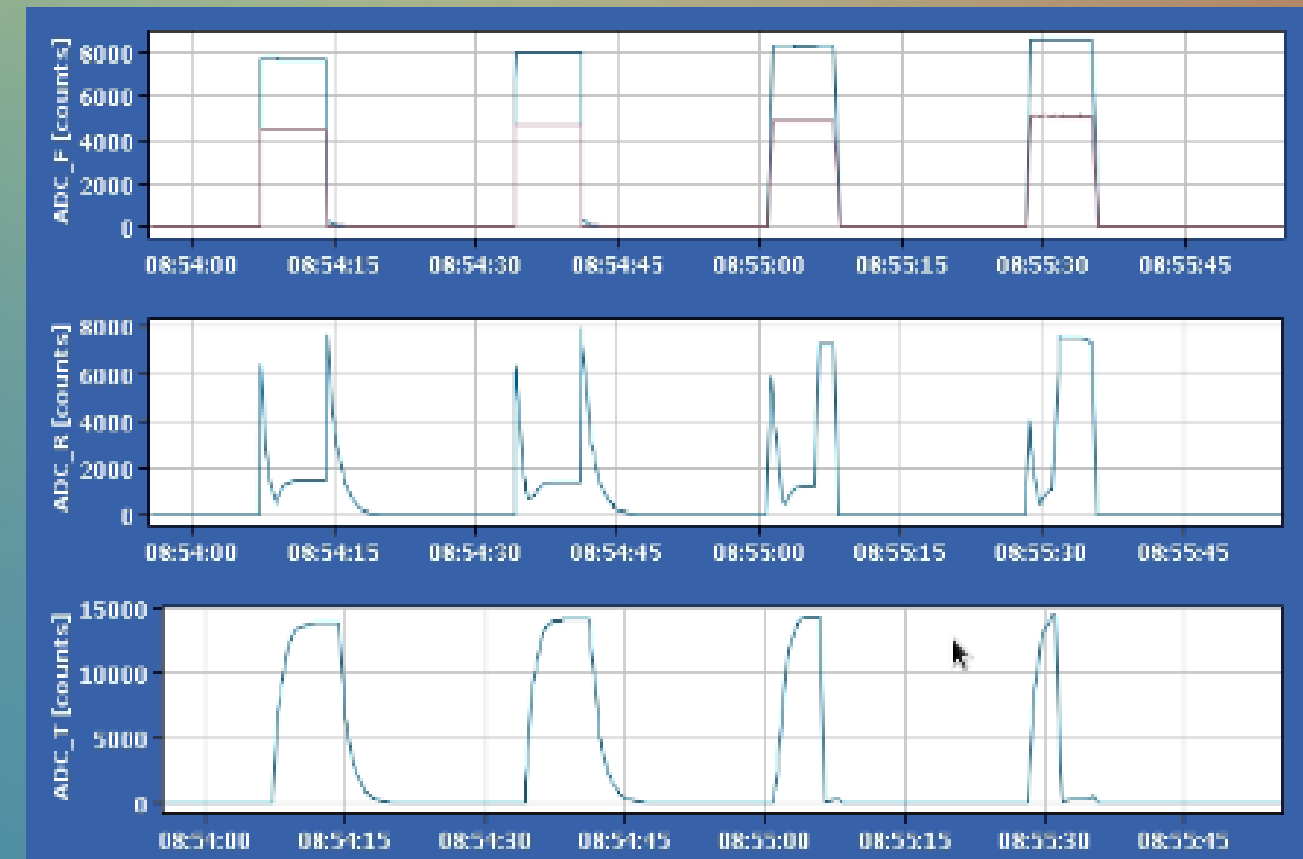
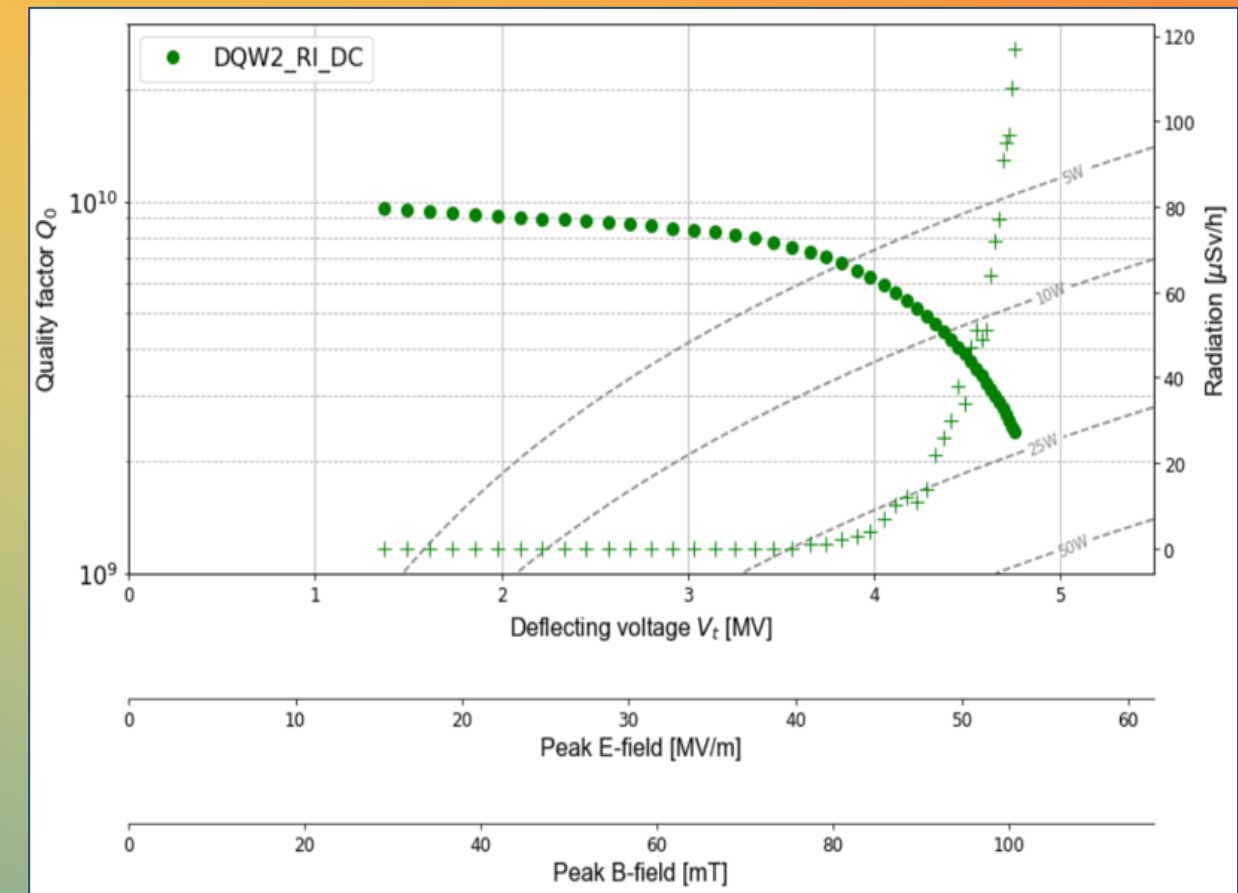
Experience & Issues



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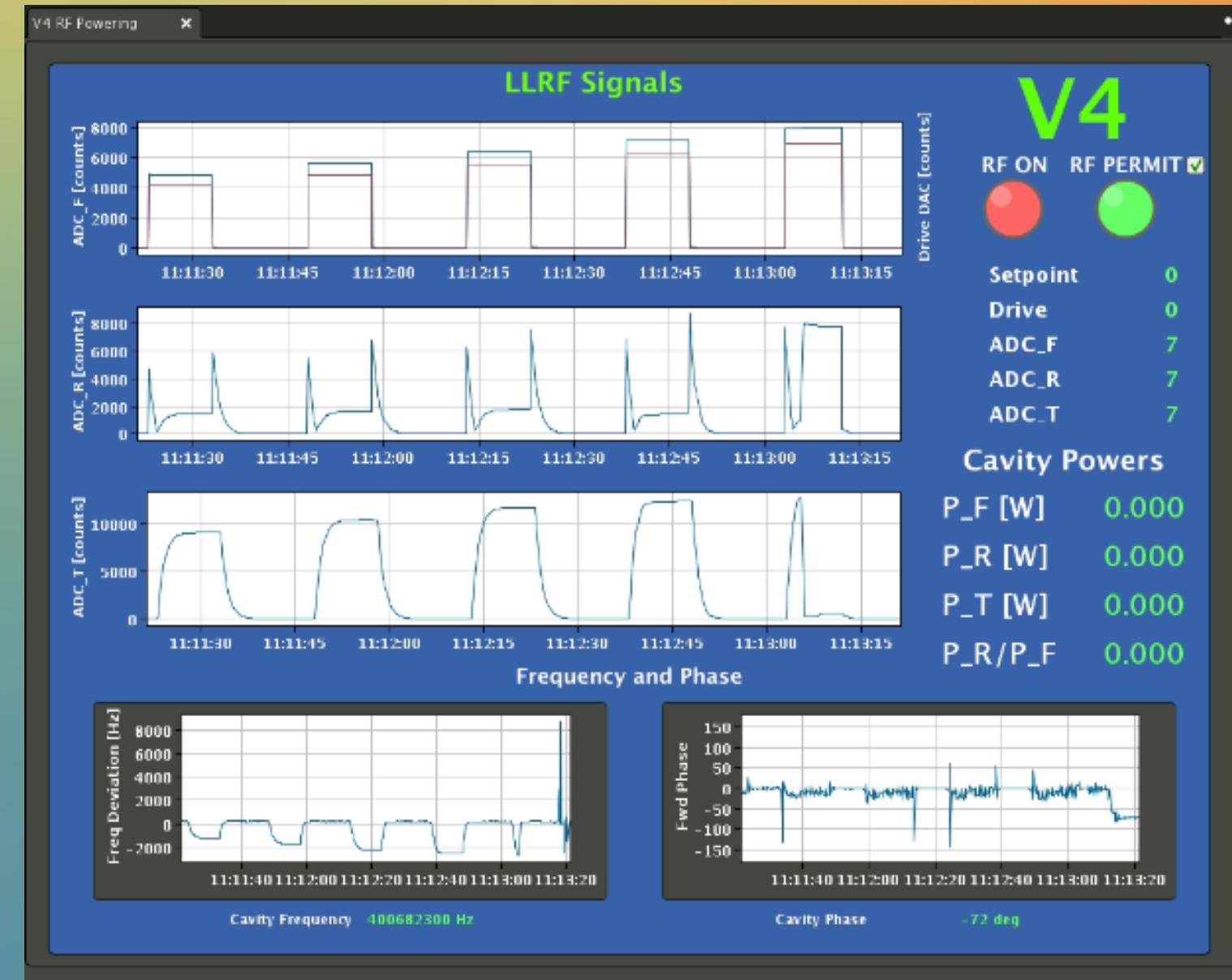
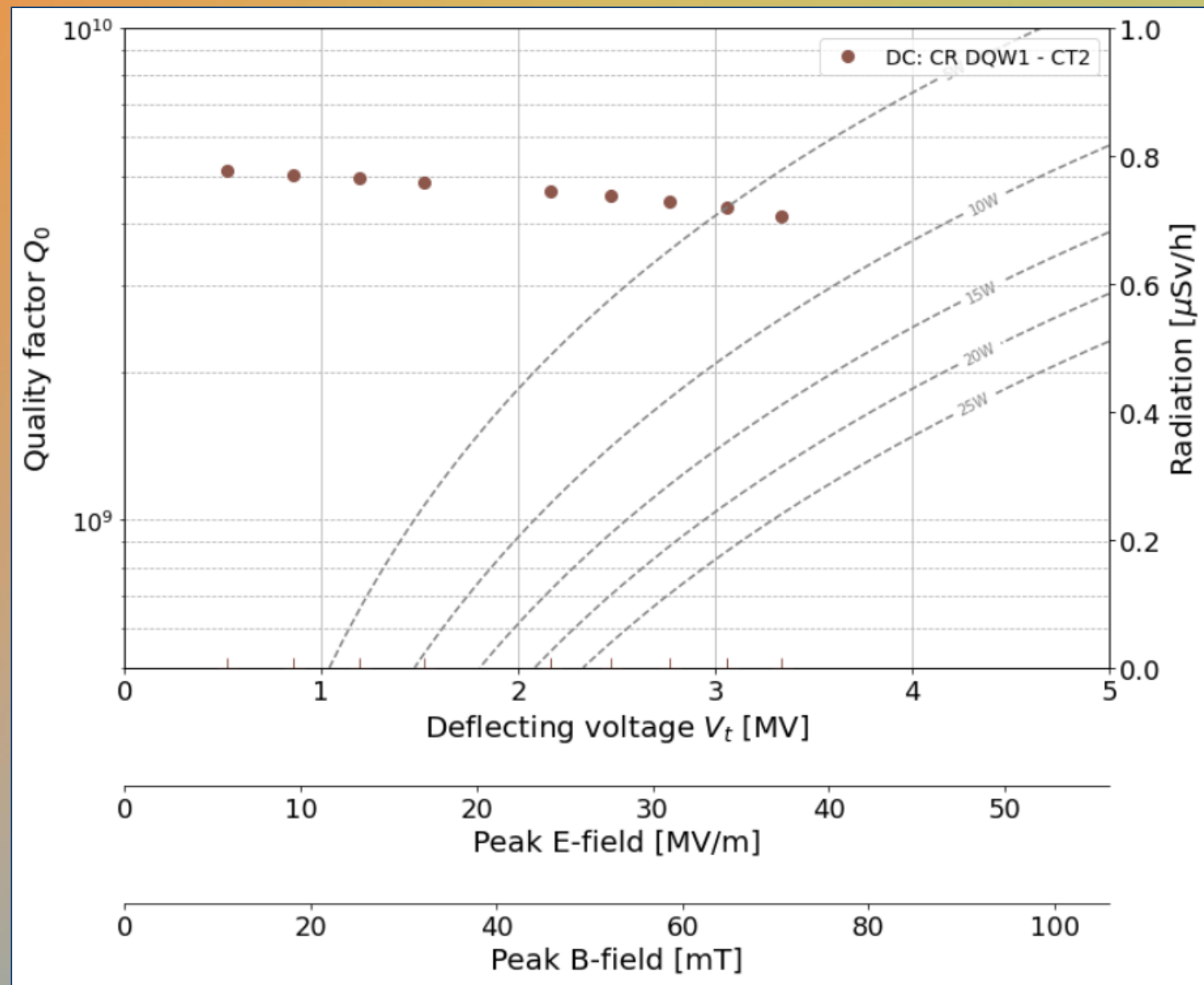
Experience from Dressed cavity tests

- Vacuum leaks occurring more often w.r.t bare & jacketed tests
- Logical as more couplers in the cavity
- HOM power @400MHz within specification but occasionally we see one coupler with higher power extraction
- The maximum field is often dominated by the escalation of field emission
- At which point we observe ‘quench-like’ behavior



Experience from Dressed cavity tests

- Field emission behavior – this is not the case for every test which leads us to believe it is not just a cleanliness issue...
- On one occasion we observed quenching at 3.5MV without field emission (CERN DQW1 - October 2023)



Summary

- x10 Cavity tests since the last meeting,
- x2 successful tests (1 DC & 1 JC)
- Procedure for dressed cavity testing now well developed
- Validating the cavities CERN & RI DQW1 is quite challenging
- **x2 Dressed cavities validated & shipped to UK - CERN #2 & RI #2**
- HOMs consistently within specification from dressed cavity measurements at 2K



Field Emission

Superfluid Leaks

Quench



Thankyou for listening!

Any questions?

On behalf of WP4, SY-RF-SRF, SY-RF-AC, EM-MME, TE-VSC, 4030.....

