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# Sub Scale Stress-Managed Common-Coils

**Preliminary testing results**

D. Araujo, B. Auchmann, A. Brem, T. Michlmayr, C. Müller, A. Stampfli and A. Haziot (CERN)  
PSI, 18 July 2024

# Work packages overview – KE5943



| RD Line | Work Package | Tasks, deliverables | TASK/DELIVERABLE DESCRIPTION  |
|---------|--------------|---------------------|---|
| RD2     | RD2          | RD2                 | HTS Conductors and HTS Magnet Technologies                                  |
| RD2     | WP2.19       | WP2.19              | R&D relating to HTS technology - PSI/CHART collaboration KE5943             |
| RD2     | WP2.19       | D2.1                | HTS Roadmap Conceptual Report   |
| RD2     | WP2.19       | D2.2                | ReBCO Cable Test Report   |
| RD2     | WP2.19       | D2.3                | Technology Racetrack Test Report  |
| RD3     | RD3          | RD3                 | Nb3Sn Magnets   |
| RD3     | WP3.14       | WP3.14              | R&D relating to LTS technology - PSI/CHART collaboration KE5943             |
| RD3     | WP3.14       | D1.1                | BOX Powered-Sample Test Report  |
| RD3     | WP3.14       | D1.2                | SMCC Sub-scale Test Report  |
| RD3     | WP3.14       | D1.3                | SMCC Ultimate-Field Demonstrator Conceptual Design Report                   |
| RD3     | WP3.14       | D1.4                | SMCC Ultimate-Field Demonstrator Technical Design Folder                    |
| RD3     | WP3.14       | D1.5                | Reel-to-reel Inspection and 10-Stack Characterization of Cables as Received |

This presentation

SSSMCC1

# Subscale Stress-Managed Common-Coils (SubSMCC) | Acknowledgment



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CHART: B. Auchmann, A. Brem, T. Michlmayr, C. Müller, J. Schmidt, A. Stampfli

LBNL: D. Arbelaez, I. Pong, P. Ferracin, S. Prestemon (Nb<sub>3</sub>Sn cable)

CERN: E. Ravaioli, A. Verweij (protection studies)

CERN: T. Boutboul, S. Hopkins, A. Bonasia (Ic measurements from witness samples)

CERN: G; Wilering, F-J. Mangiarotti, J-L Guyon, C. Petrone, J. Feuvrier, S. Russenschuck (testing, magnetic measurement)

CERN: F-O. Pincot, J-C. Perez, A. Haziot, E. Todesco (reaction of two coils out of 4)

CERN: L. Gentini (magnet integration into the cryostat)

# Agenda

- Magnet Parameters and Assumptions
- 1<sup>st</sup> cool-down test results (G. Wilering)

# Subscale Stress-Managed Common-Coils (SubSMCC)

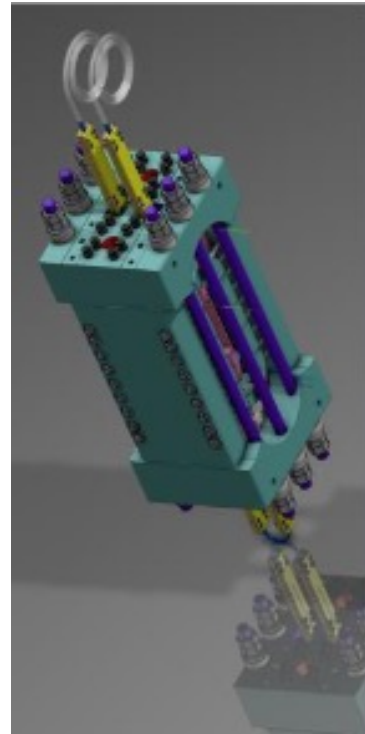
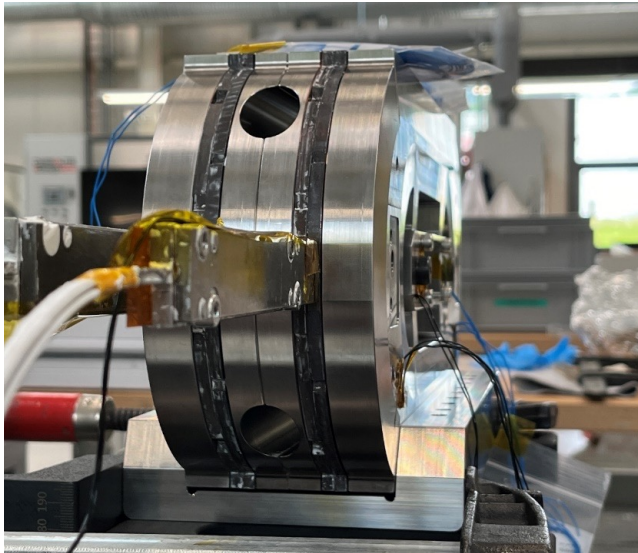


Validating **manufacturing process** and introducing advanced concepts: **coil pre-load free**, at room temperature; stress-management structure and **splicing on the low-field region**.

Fast turn-around platform for testing matrix systems; protection concepts and cooling options.

Possibility to test a Hybrid magnet with LTS (Nb<sub>3</sub>Sn) Common-Coils and HTS racetracks

LTS (Nb<sub>3</sub>Sn) conductor manufactured by LBNL (cct subscale cable)



| Number of turns | Wire type                             | N wire x dia in mm | Cu/nCu | Bare Cable dimension s in mm | Insulation thickness in mm |
|-----------------|---------------------------------------|--------------------|--------|------------------------------|----------------------------|
| 18 / layer      | Nb <sub>3</sub> Sn<br>RRP®<br>132/169 | 11 x 0.6           | 1.17   | 3.8 x 1.3                    | 0.155                      |

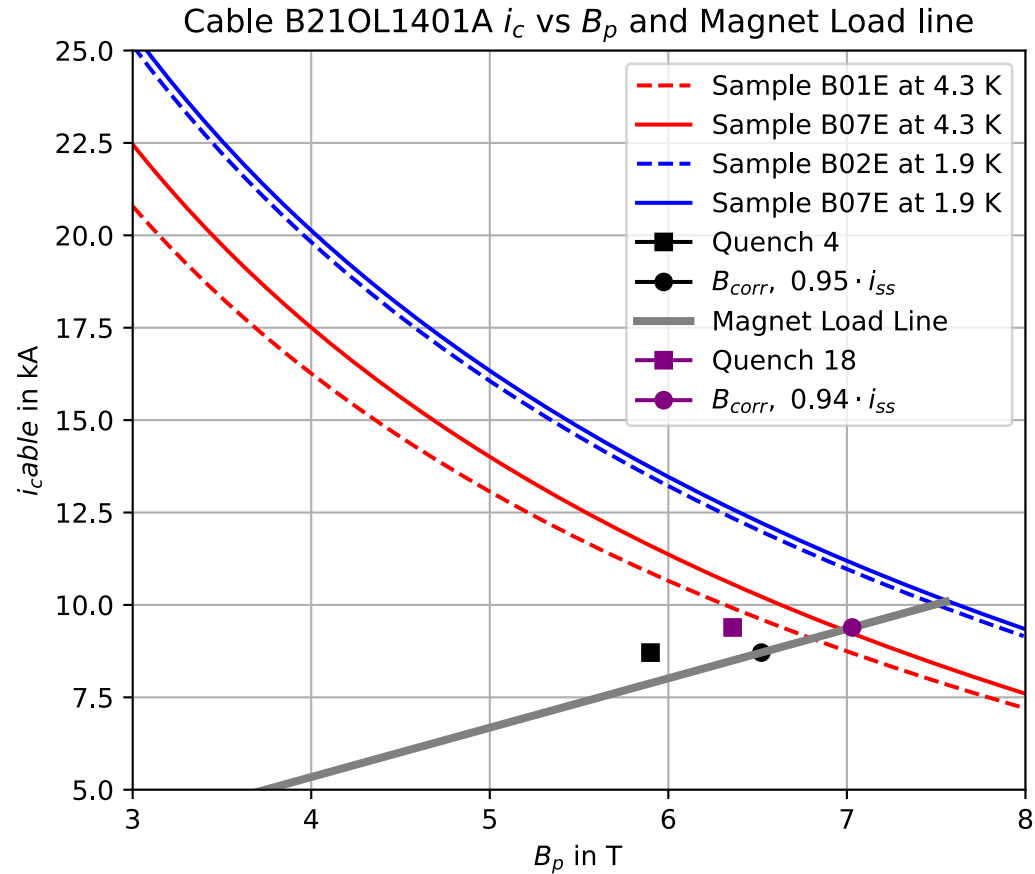
  

| T <sub>op</sub> | I <sub>ss</sub> * | B <sub>peak</sub> in T | B <sub>0</sub> in T | J <sub>sc</sub> in A/mm <sup>2</sup> | J <sub>cu</sub> in A/mm <sup>2</sup> | J <sub>ov</sub> ** in A/mm <sup>2</sup> |
|-----------------|-------------------|------------------------|---------------------|--------------------------------------|--------------------------------------|---|
| 4.3 K           | 9.1 kA            | 6.8                    | 5.1                 | 6418.9                               | 5486.3                               | 1390.3                                  |

\* From 2D without including the self-field contribution

\*\* Including insulation area

# Assumptions and load line



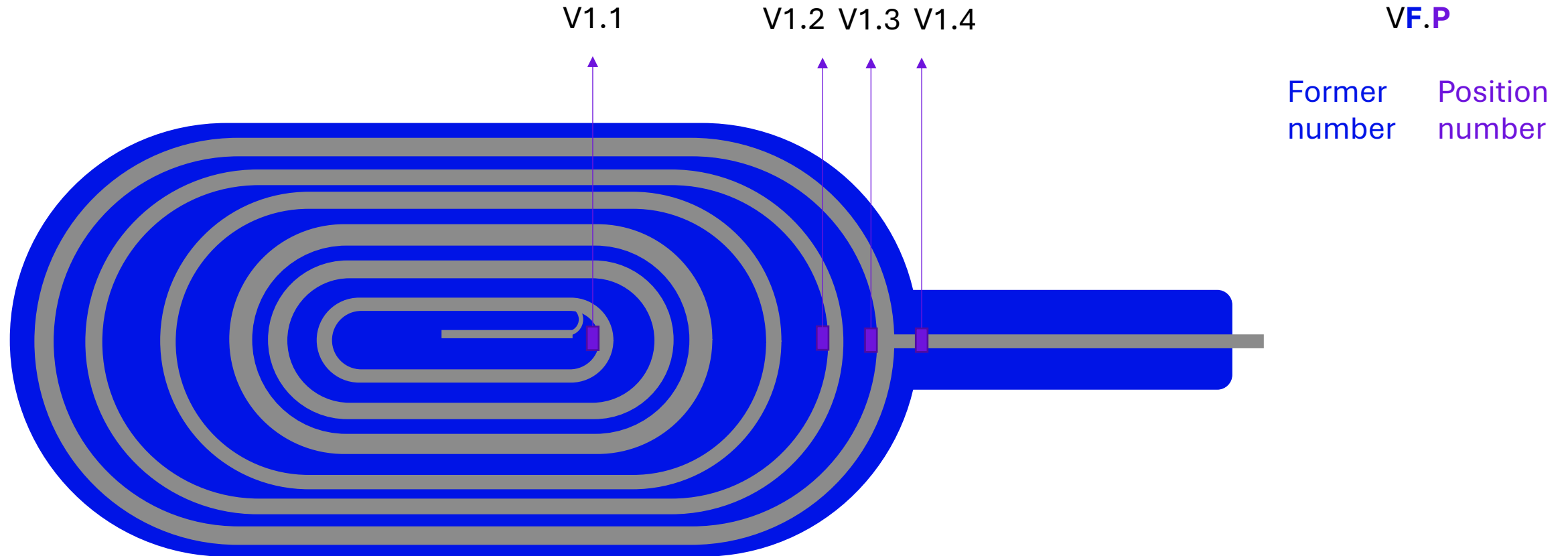
| Parameter           | CCs 4.3 K short sample values | CCs 1.9 K short sample values |
|---------------------|-------------------------------|-------------------------------|
| $B_{0\_ss}$ in T    | 5.0                           | 5.5                           |
| $B_{peak\_ss}$ in T | 6.8                           | 7.5                           |
| $I_{ss}$ in kA      | 9.1                           | 10.0                          |

Plot based on the extracted wire measurements

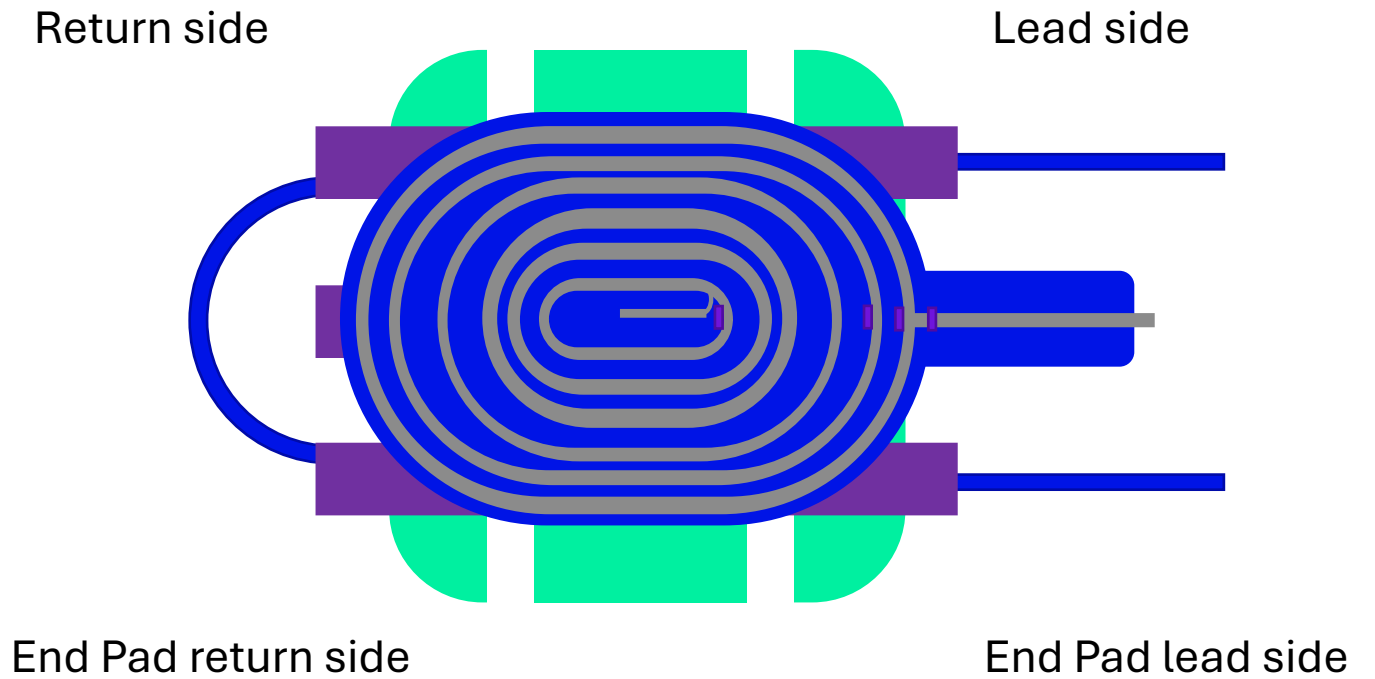
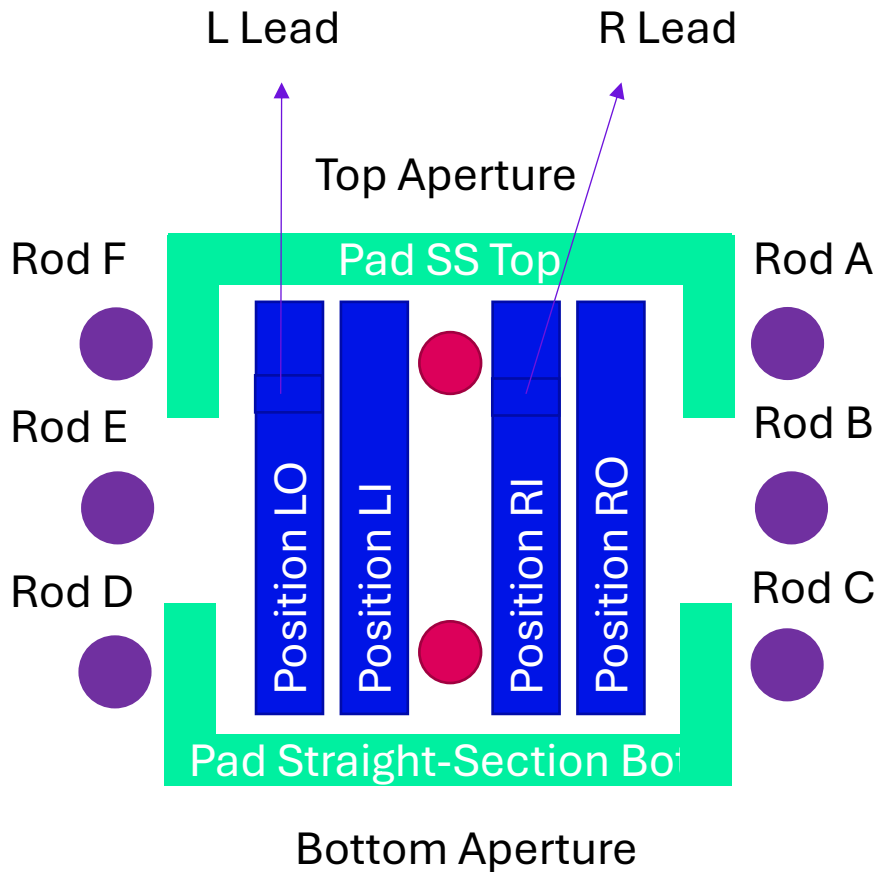
# Instrumentation: Nomenclature of voltage taps (former 1)



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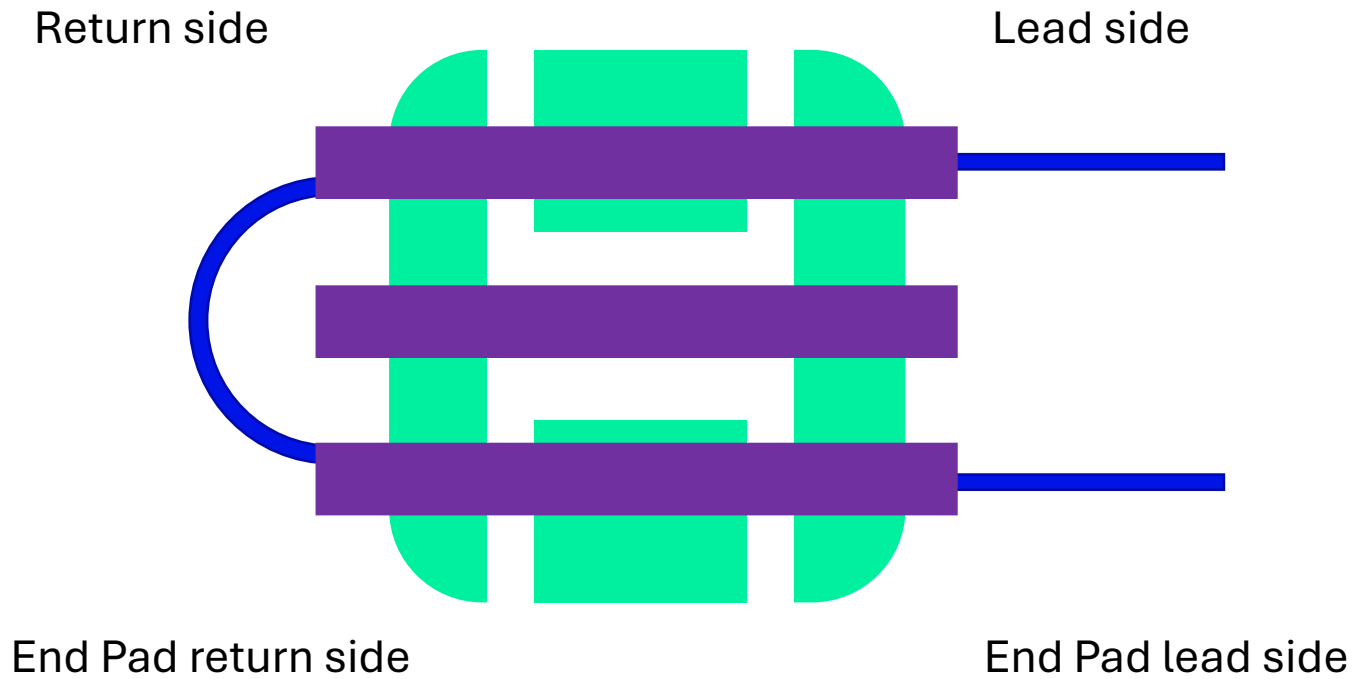
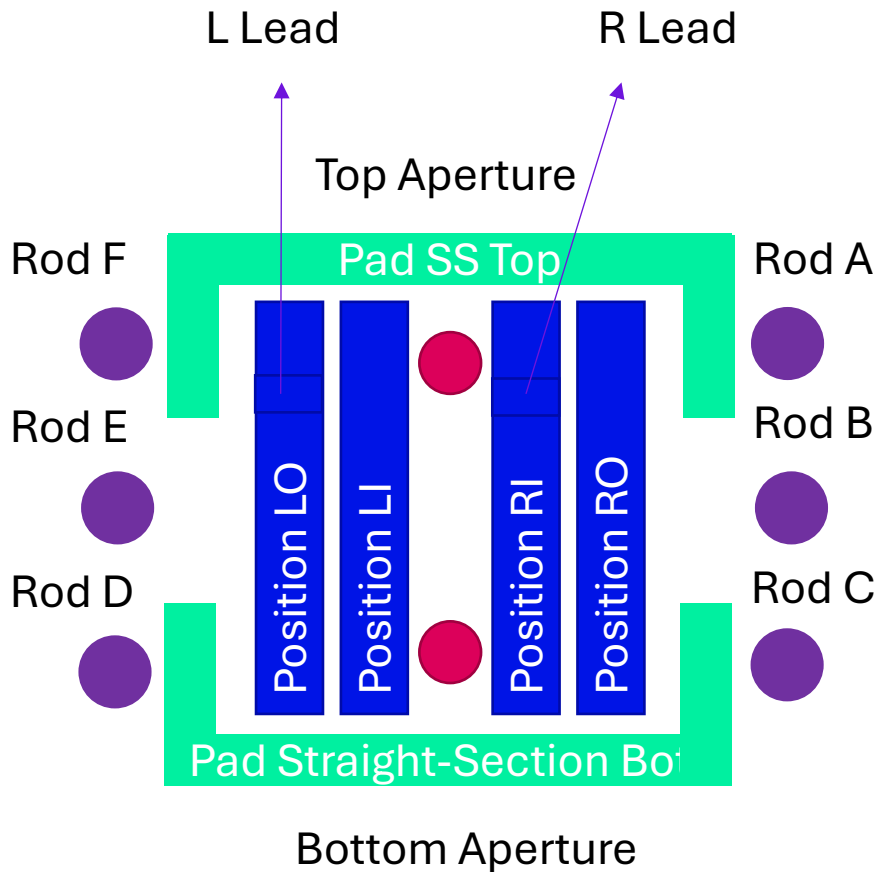


# Instrumentation: Nomenclature of parts

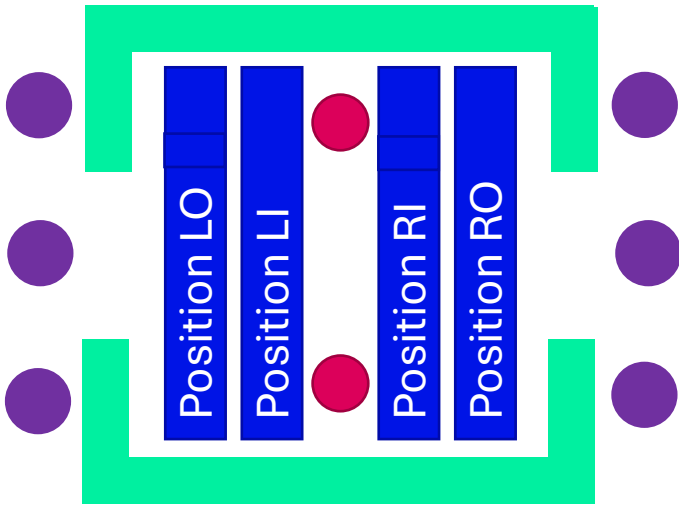




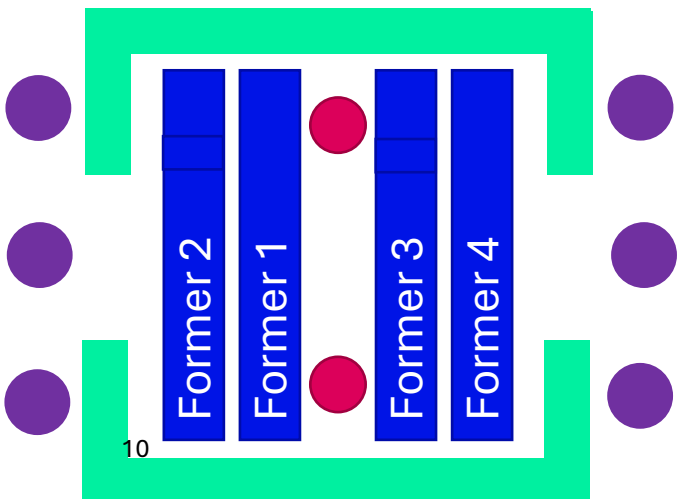
# Instrumentation: Nomenclature of parts



# Instrumentation: voltage taps pairs



Test configuration



10

## Twisted Pairs

Right Side      Left Side

V3.4 – V3.3      V1.4 – V1.3  
V3.3 – V3.2      V1.3 – V1.2  
V3.2 – V3.1      V1.2 – V1.1

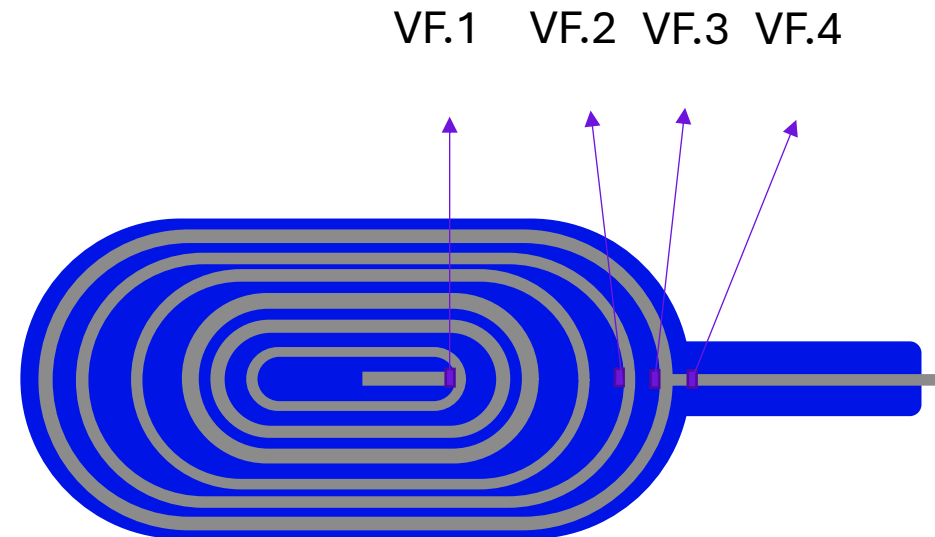
Layer jump V3.1 – V4.1      V1.1 – V2.1

V4.1 – V4.2      V2.1 – V2.2  
V4.2 – V4.3      V2.2 – V2.3  
V4.3 – V4.4      V2.3 – V2.4

Return Side       $V_{tot}$

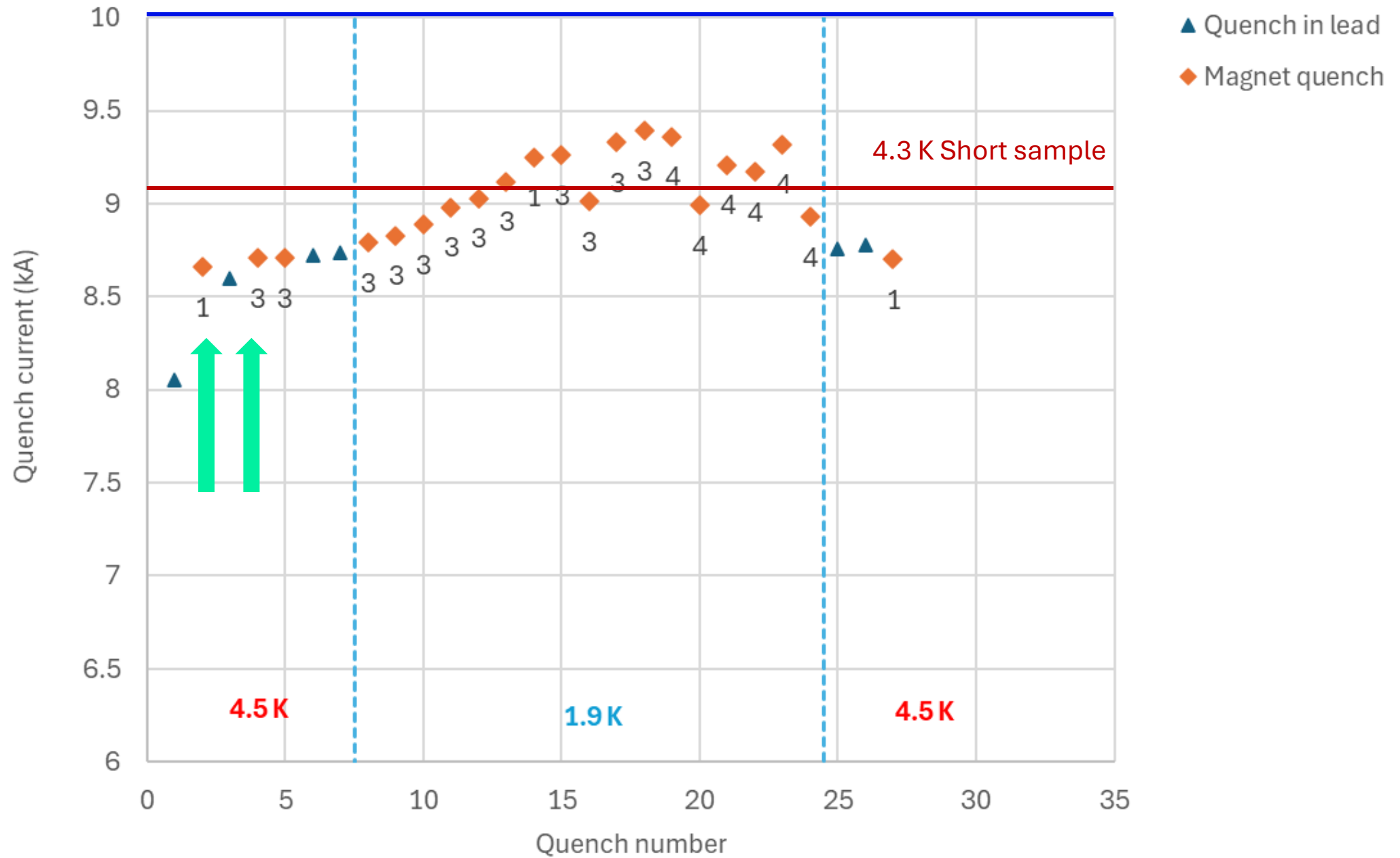
V4.4 – V1.4      V3.4 – V2.4

Magnet Structure: V MS

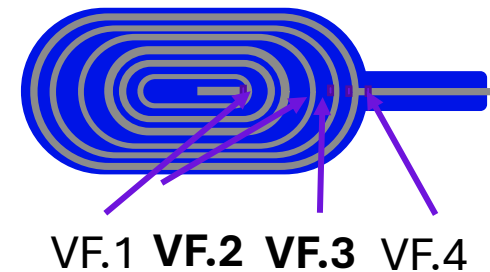
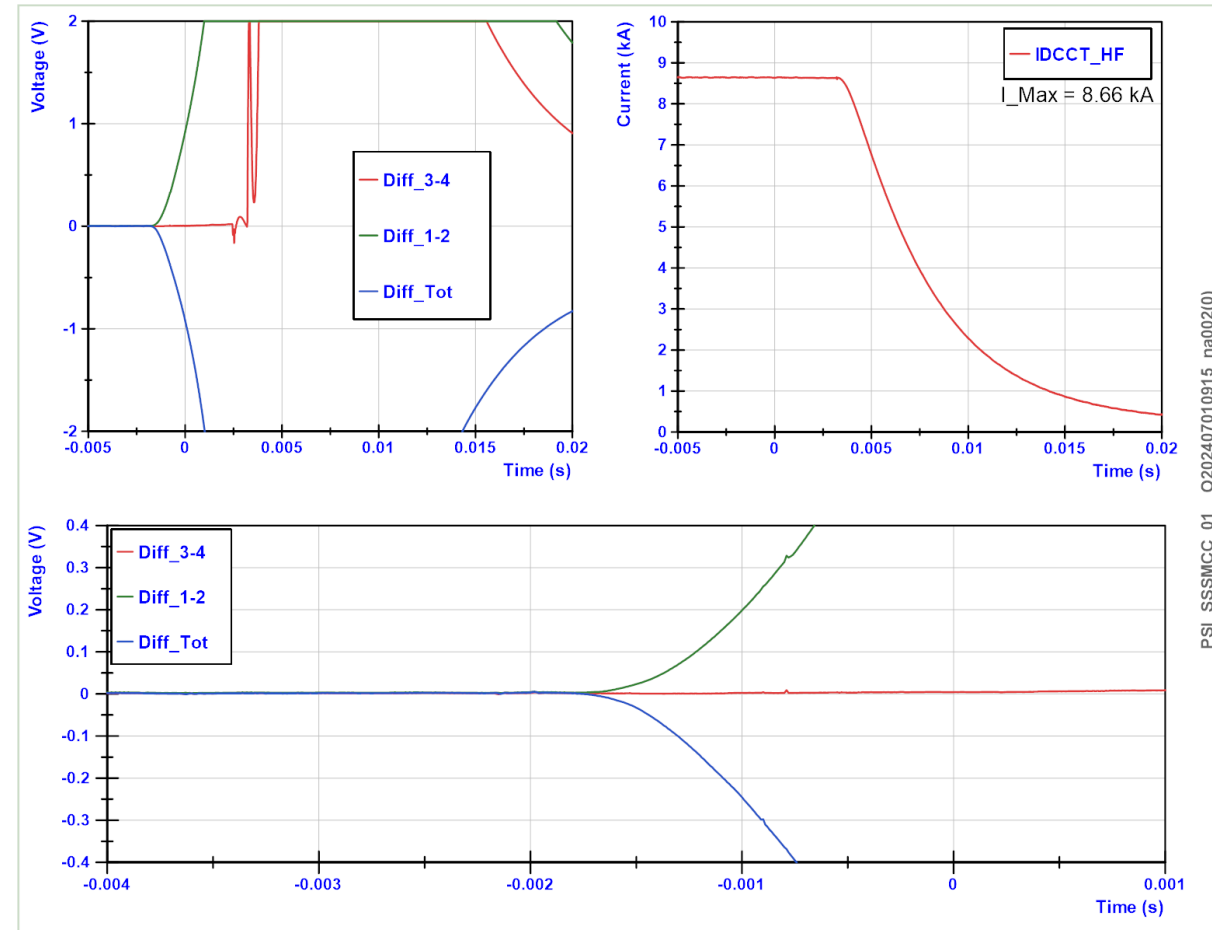
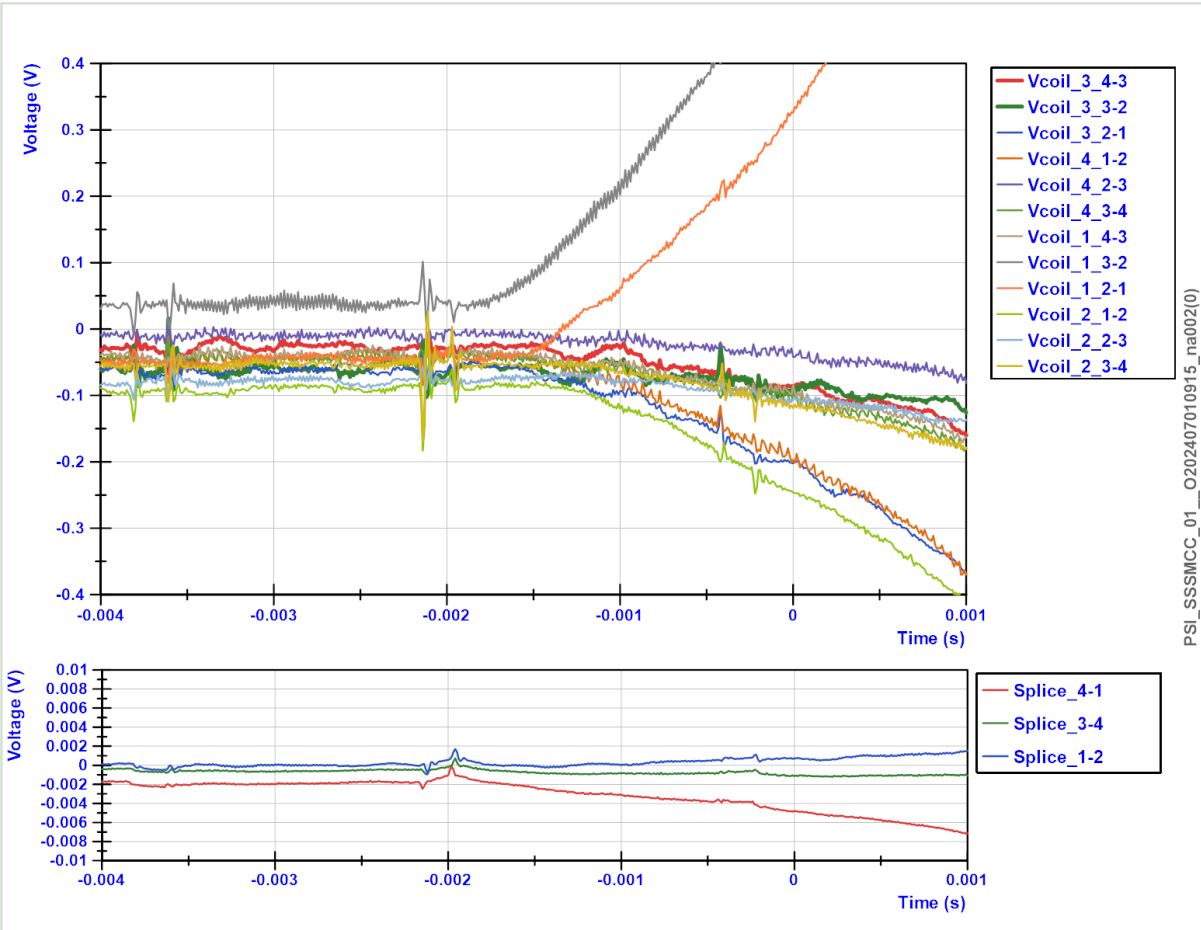


VF.P

Former      tap  
number      Position



# Event 2: 1<sup>st</sup> CD - 4.5 K – I<sub>max</sub> = 8.66 kA | Coil 1



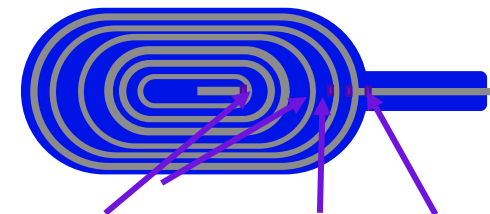
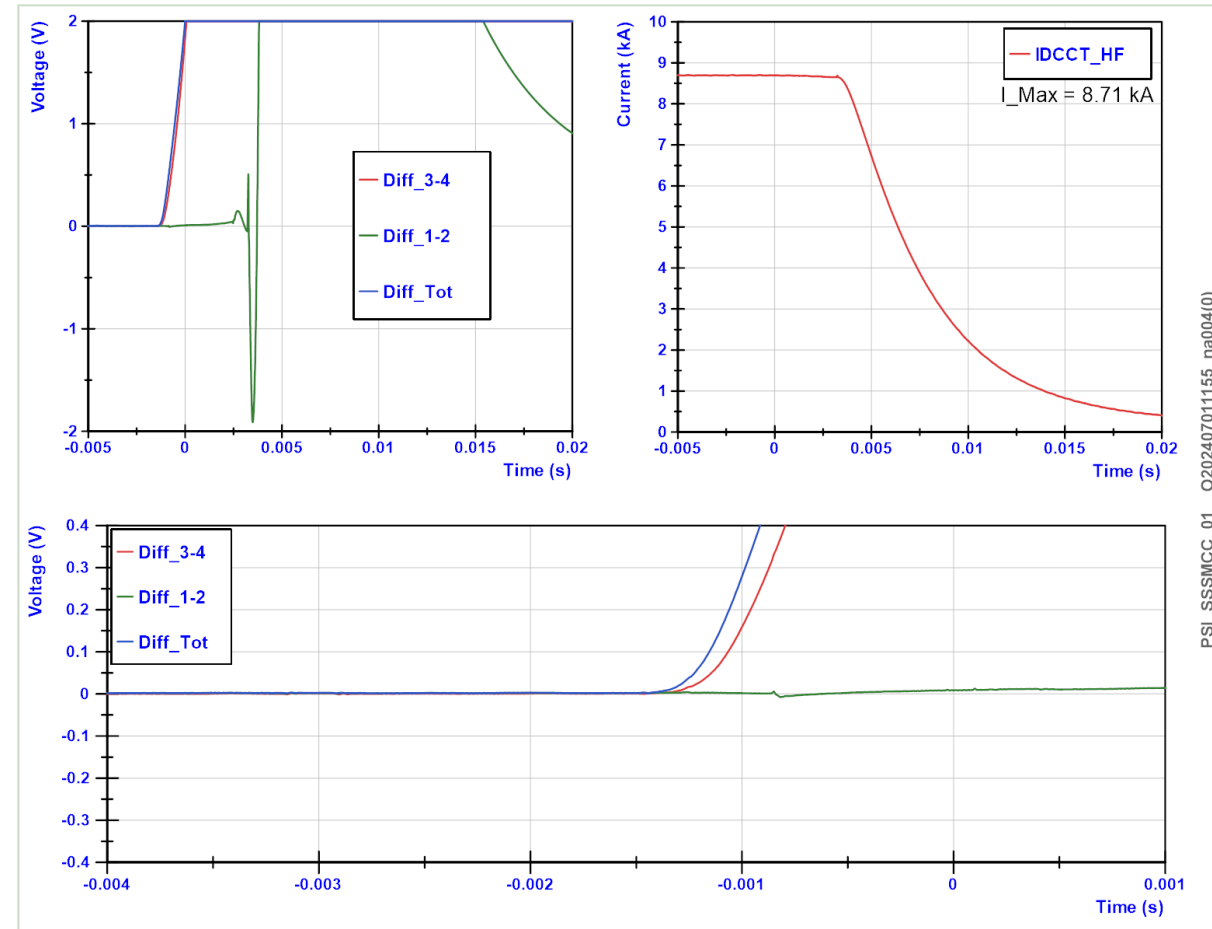
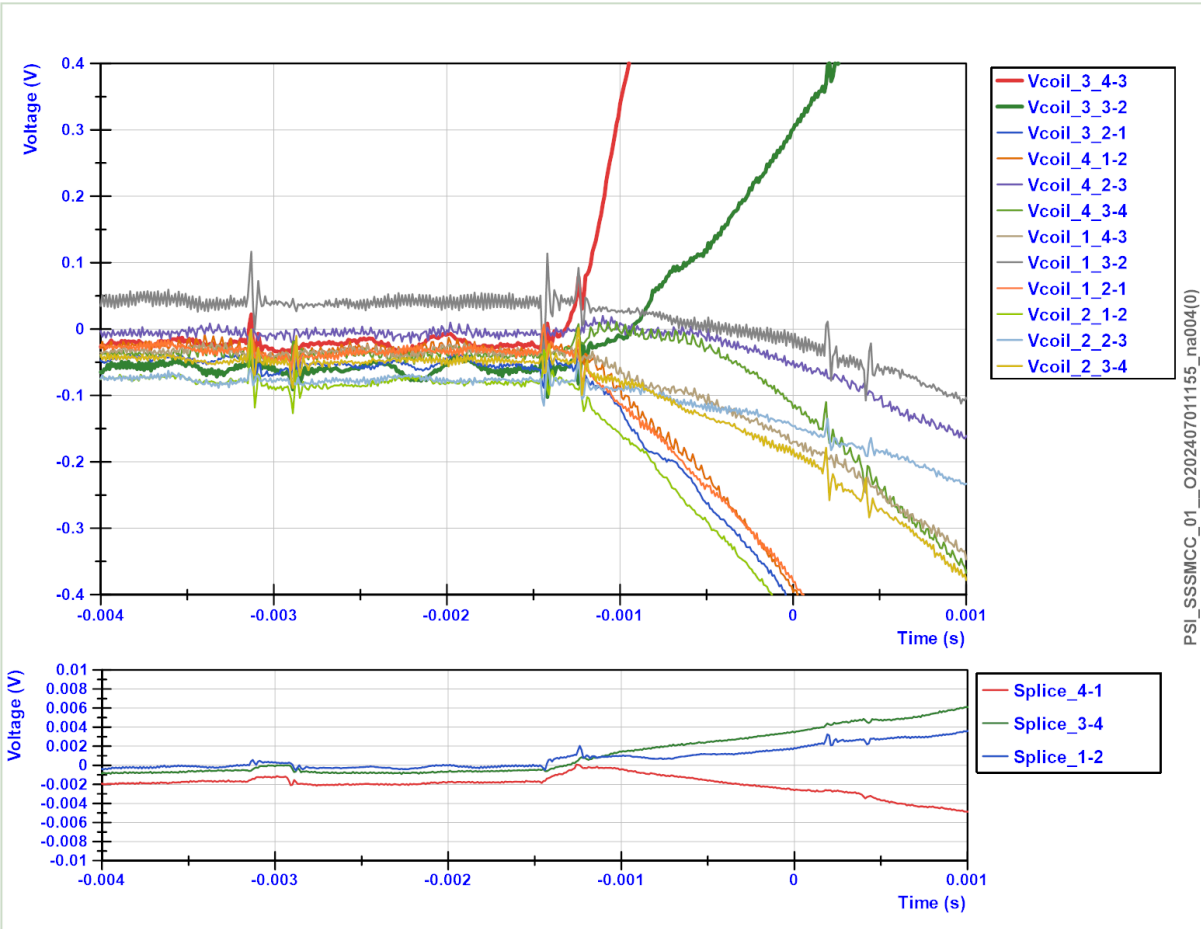
# Event 4: 1<sup>st</sup> CD - 4.5 K – I<sub>max</sub> = 8.71 kA | Coil 3



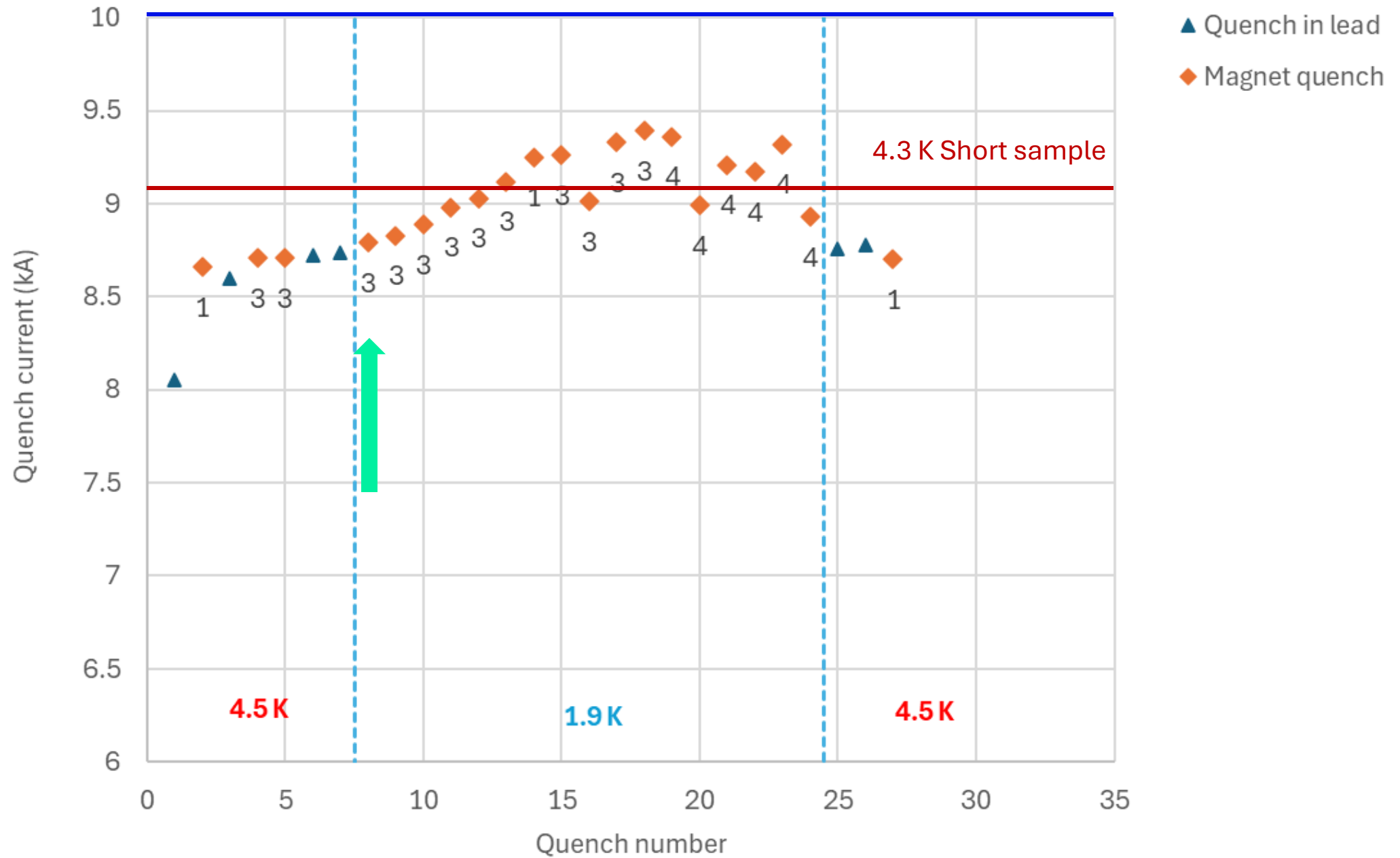
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**VF.1 VF.2 VF.3 VF.4**



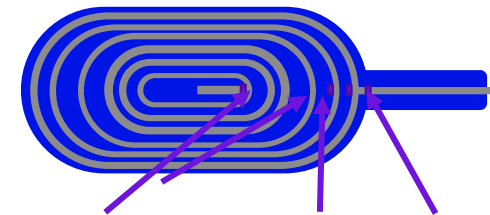
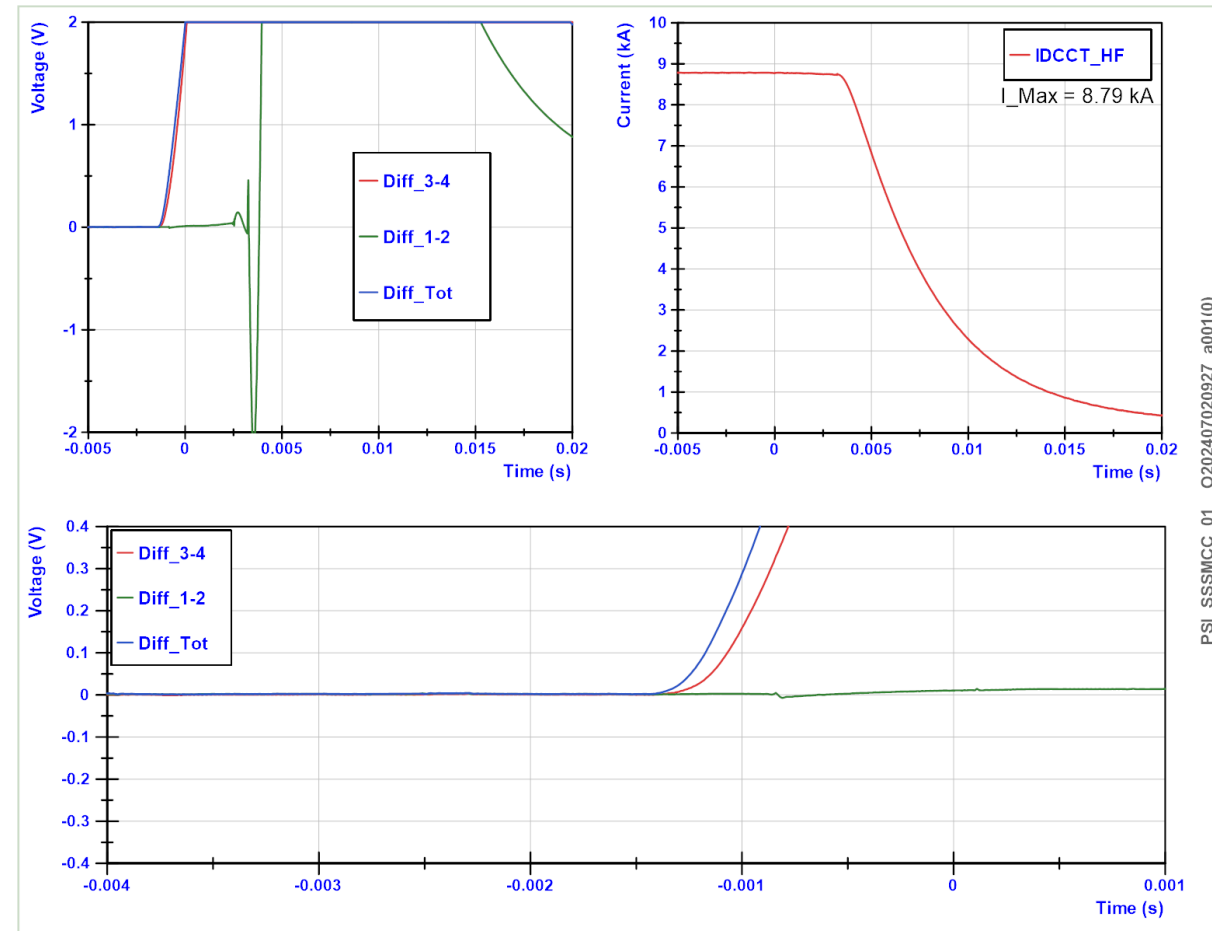
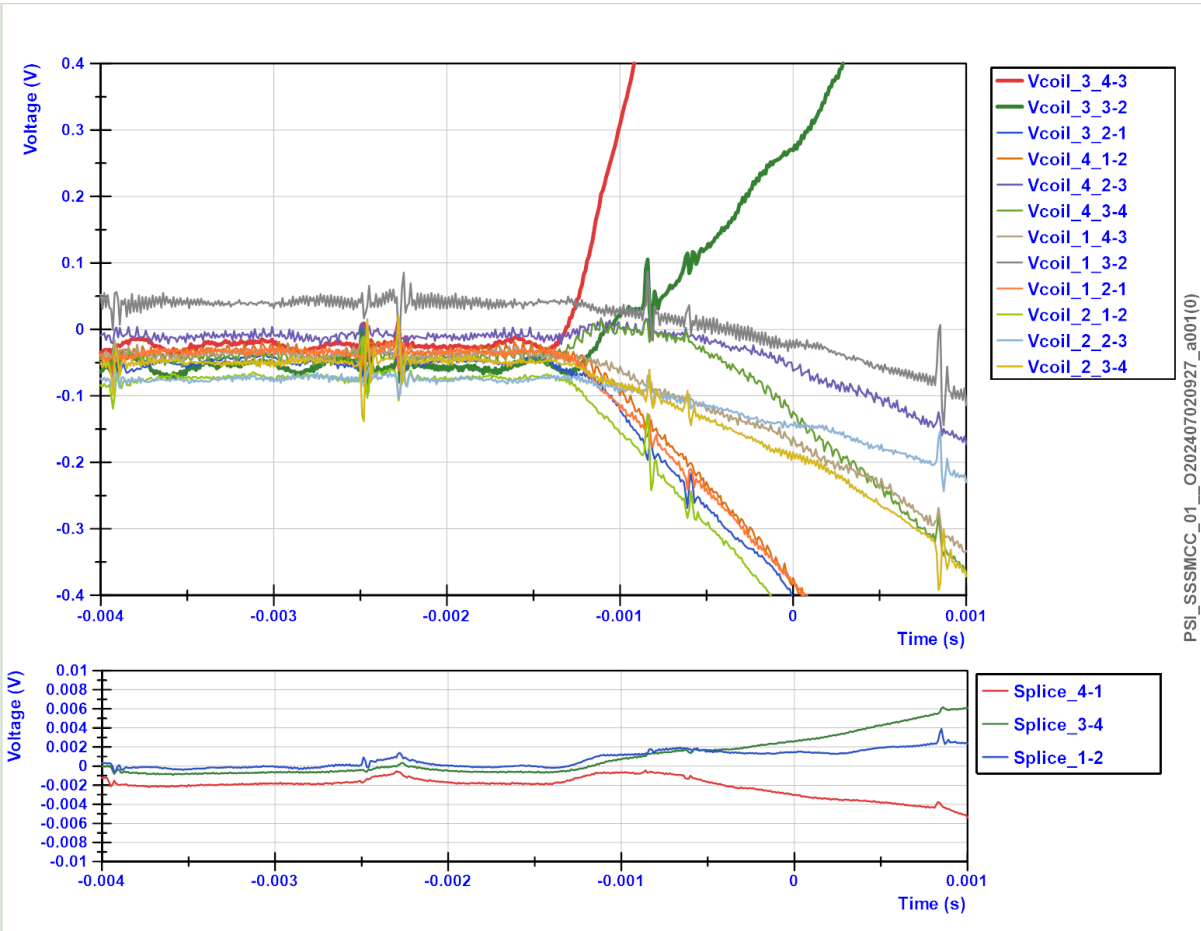
# Event 8: 1<sup>st</sup> CD - 1.9 K – I<sub>max</sub> = 8.79 kA | Coil 3



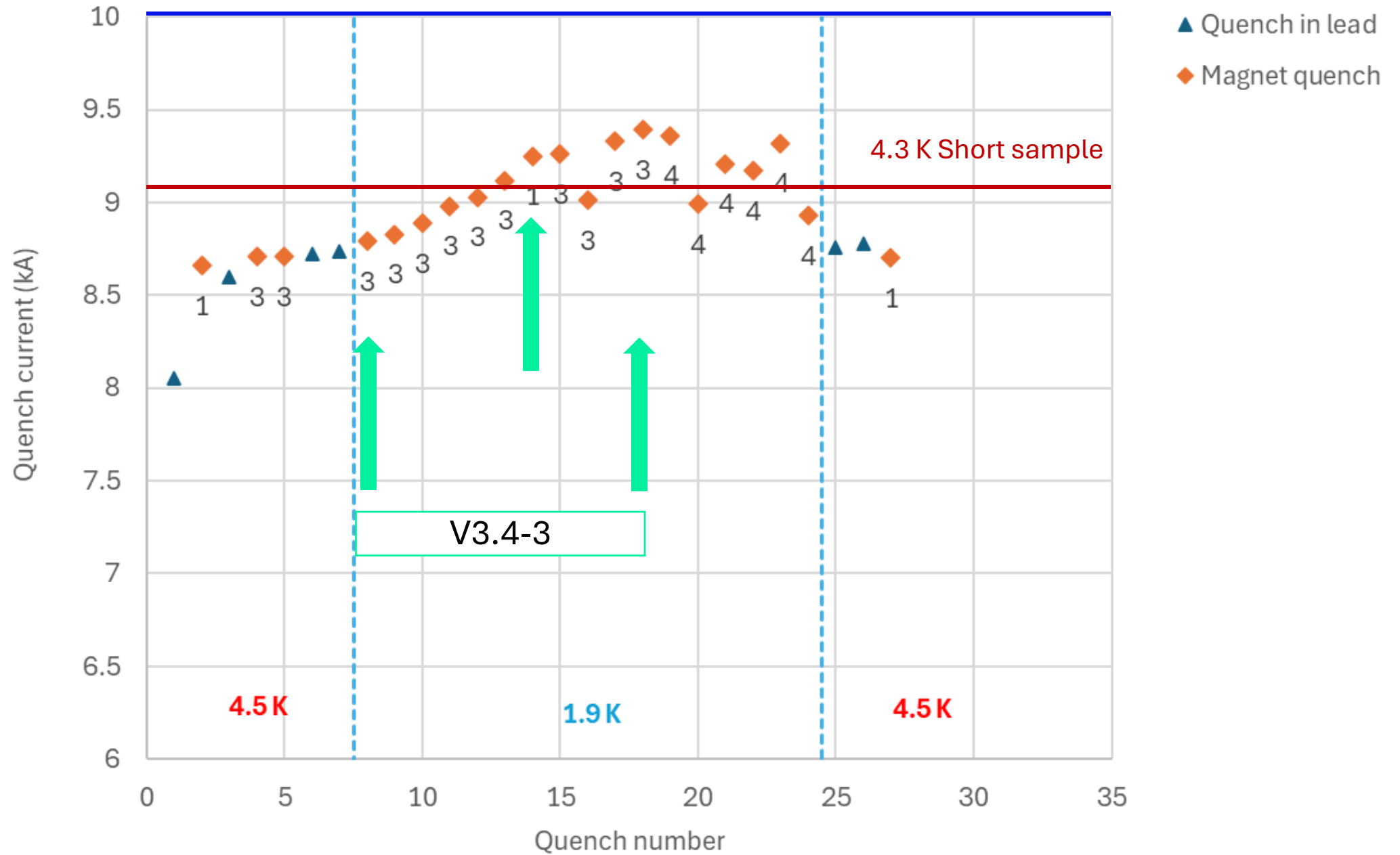
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**VF.1 VF.2 VF.3 VF.4**





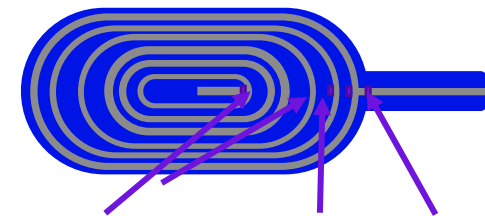
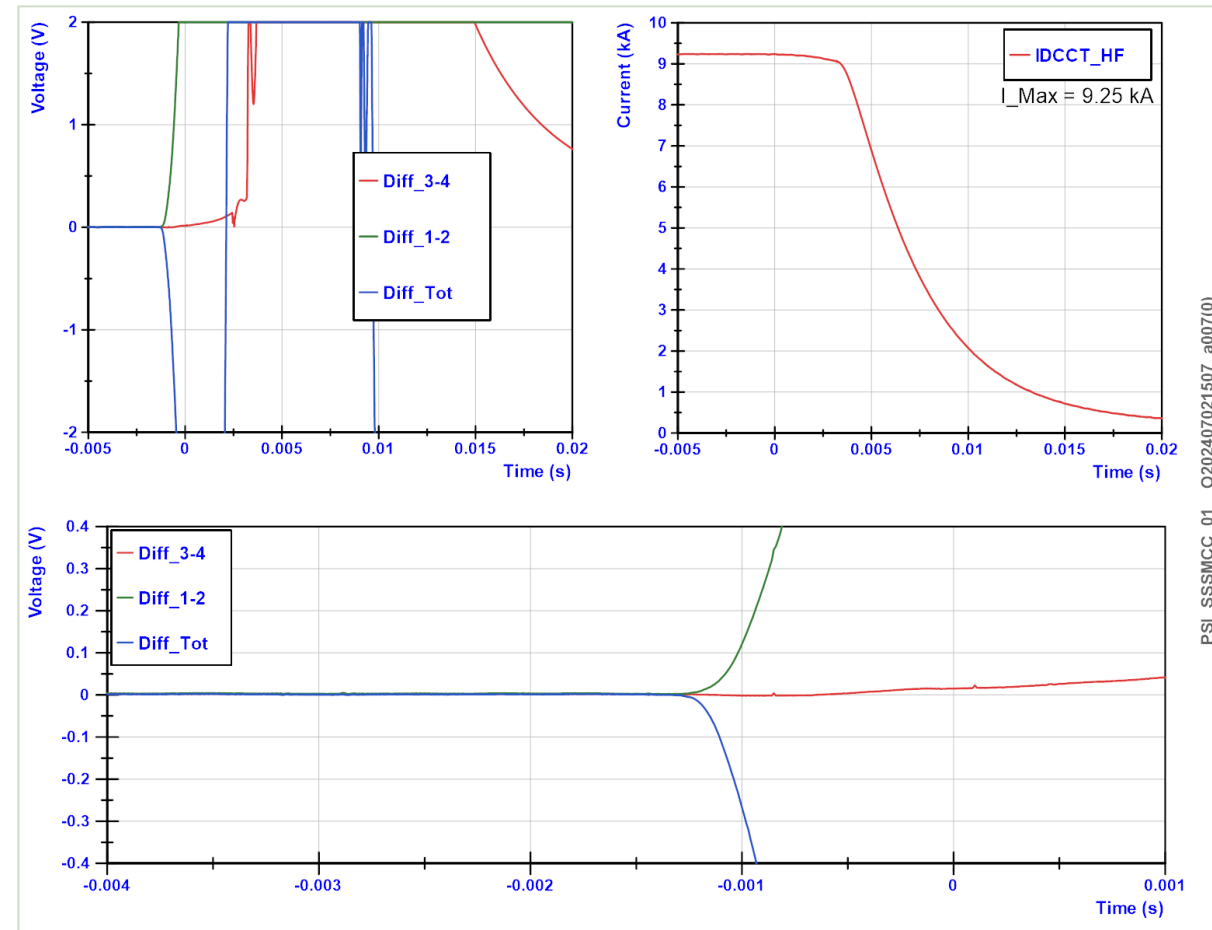
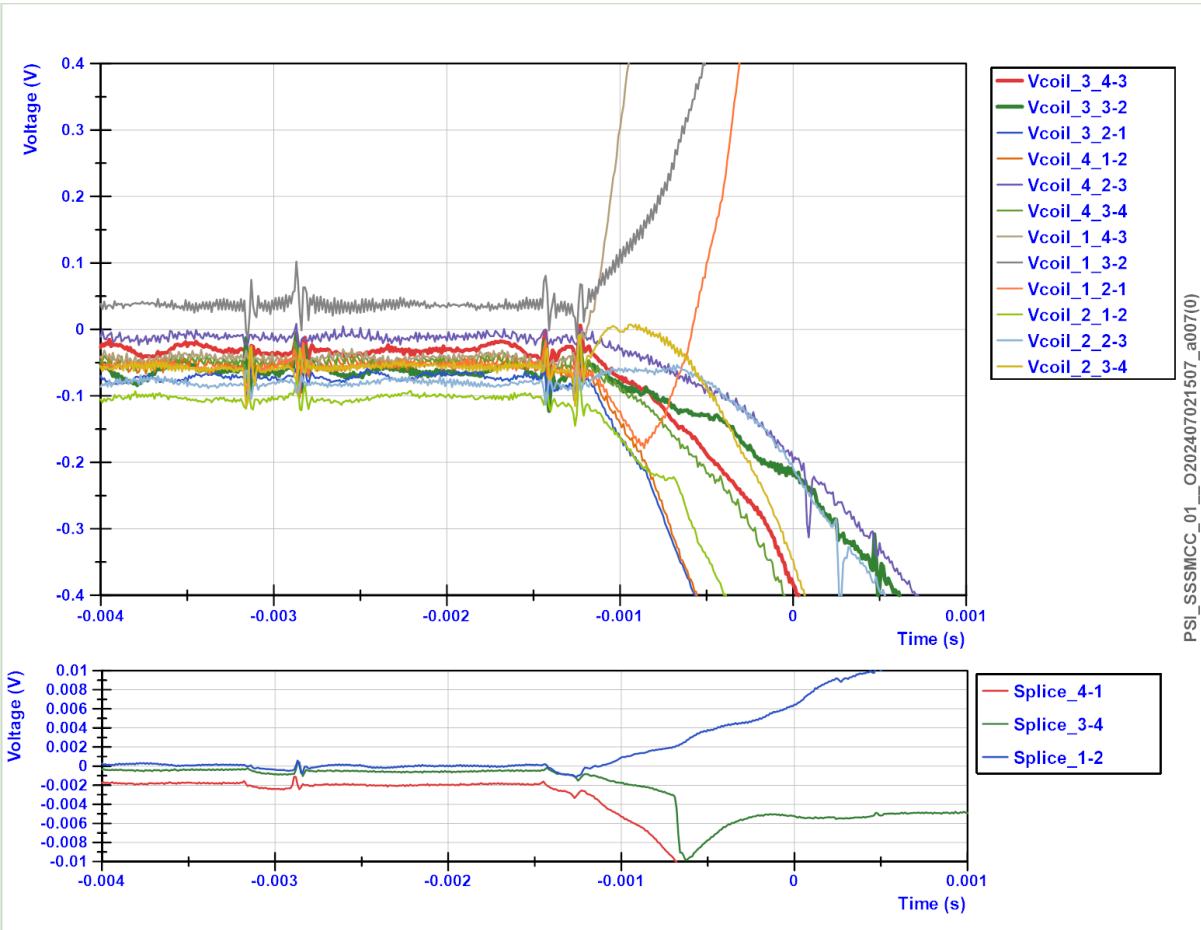
# Event 14: 1<sup>st</sup> CD - 1.9 K – I<sub>max</sub> = 9.25 kA | Coil 3



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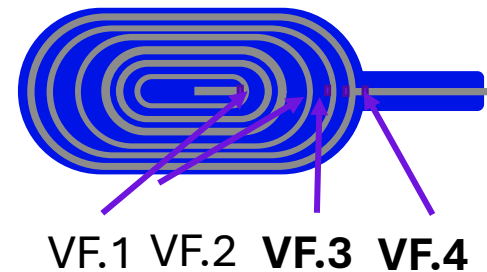
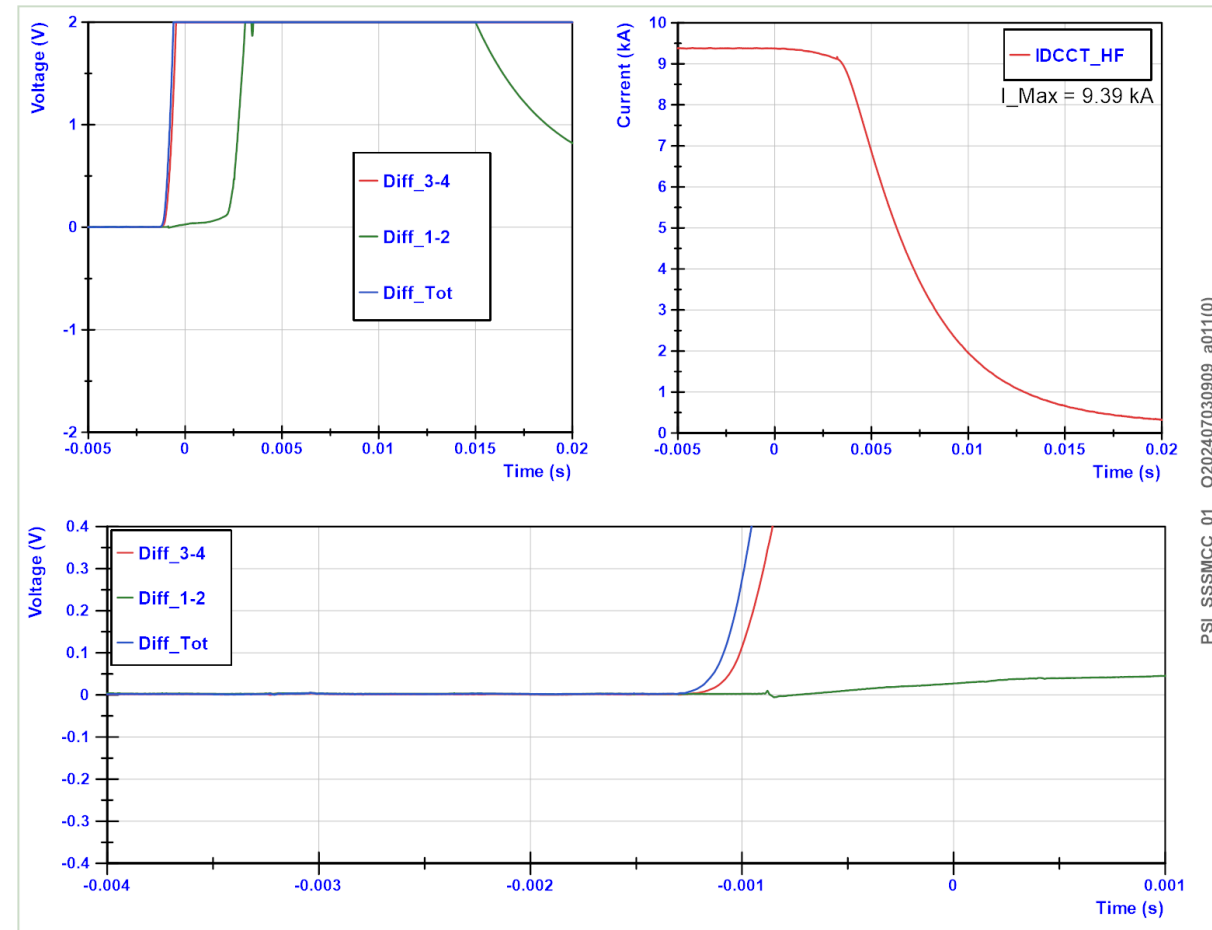
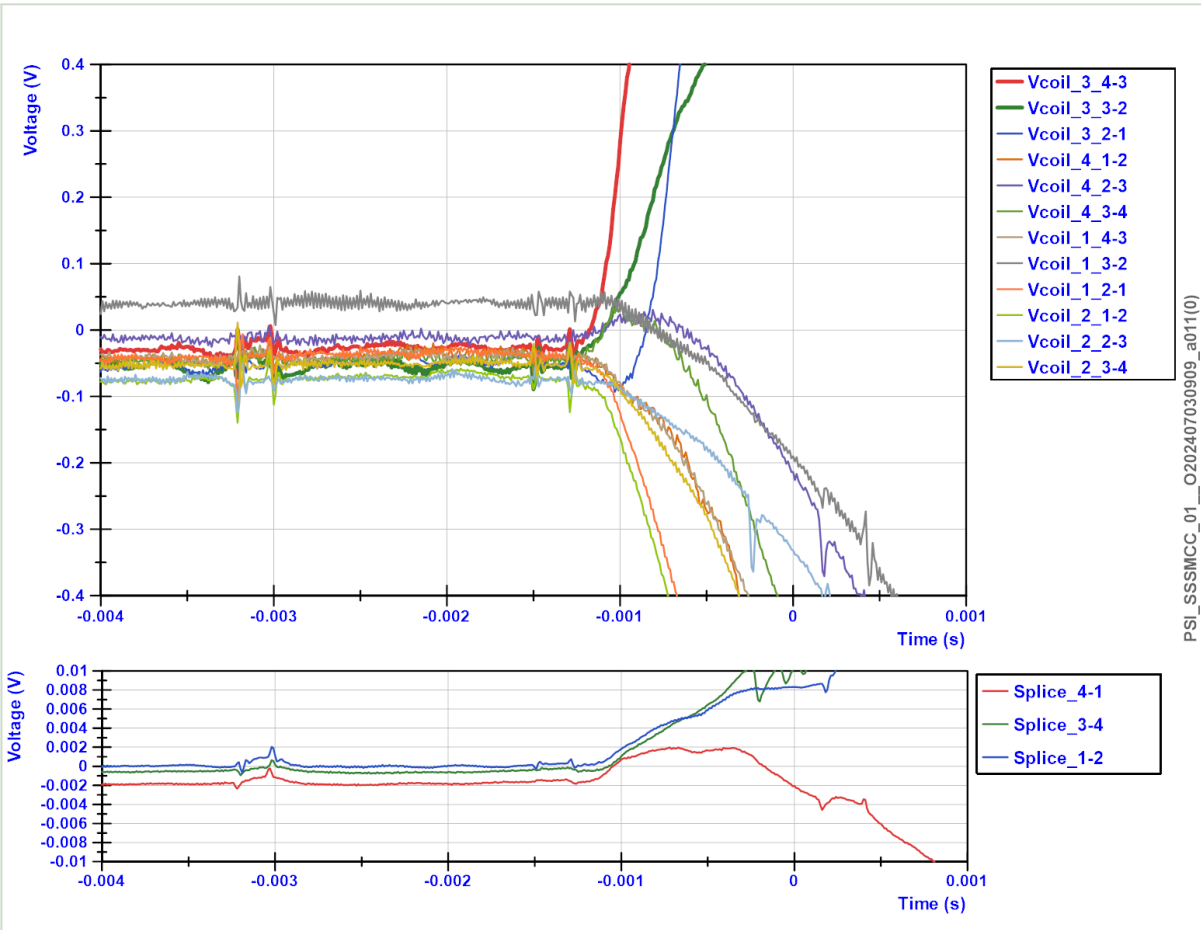


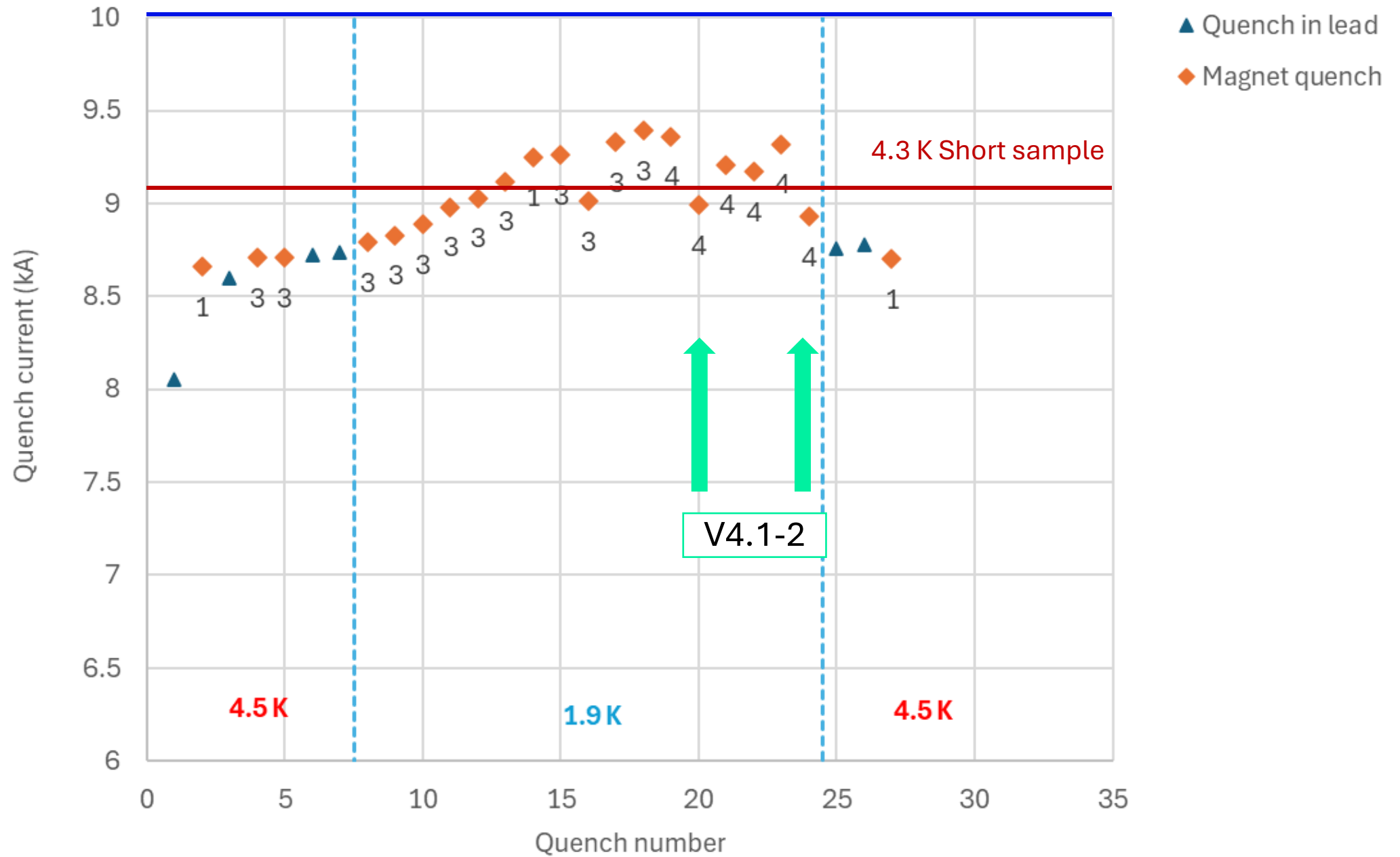
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**VF.1 VF.2 VF.3 VF.4**

# Event 18: 1<sup>st</sup> CD - 1.9 K – I<sub>max</sub> = 9.39 kA | Coil 3





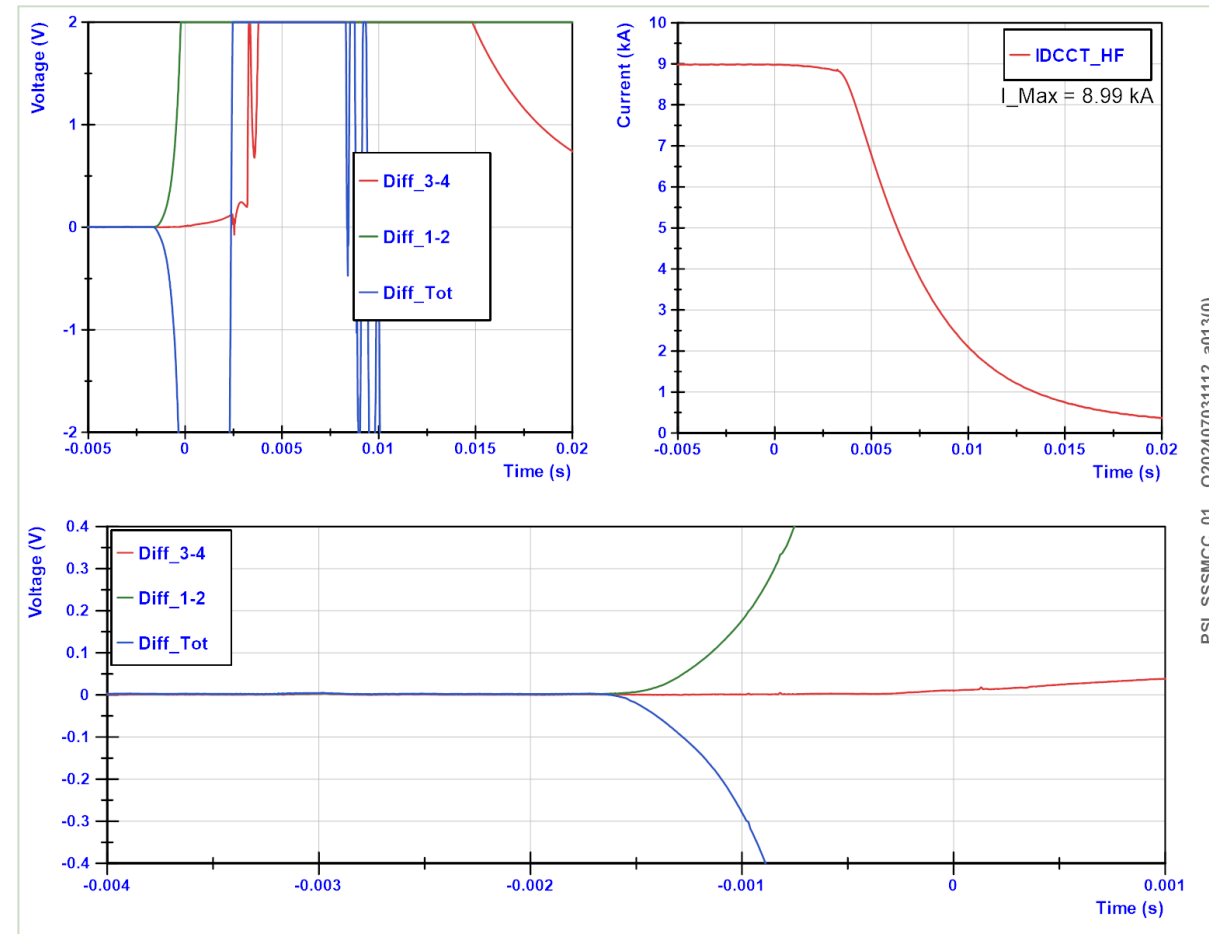
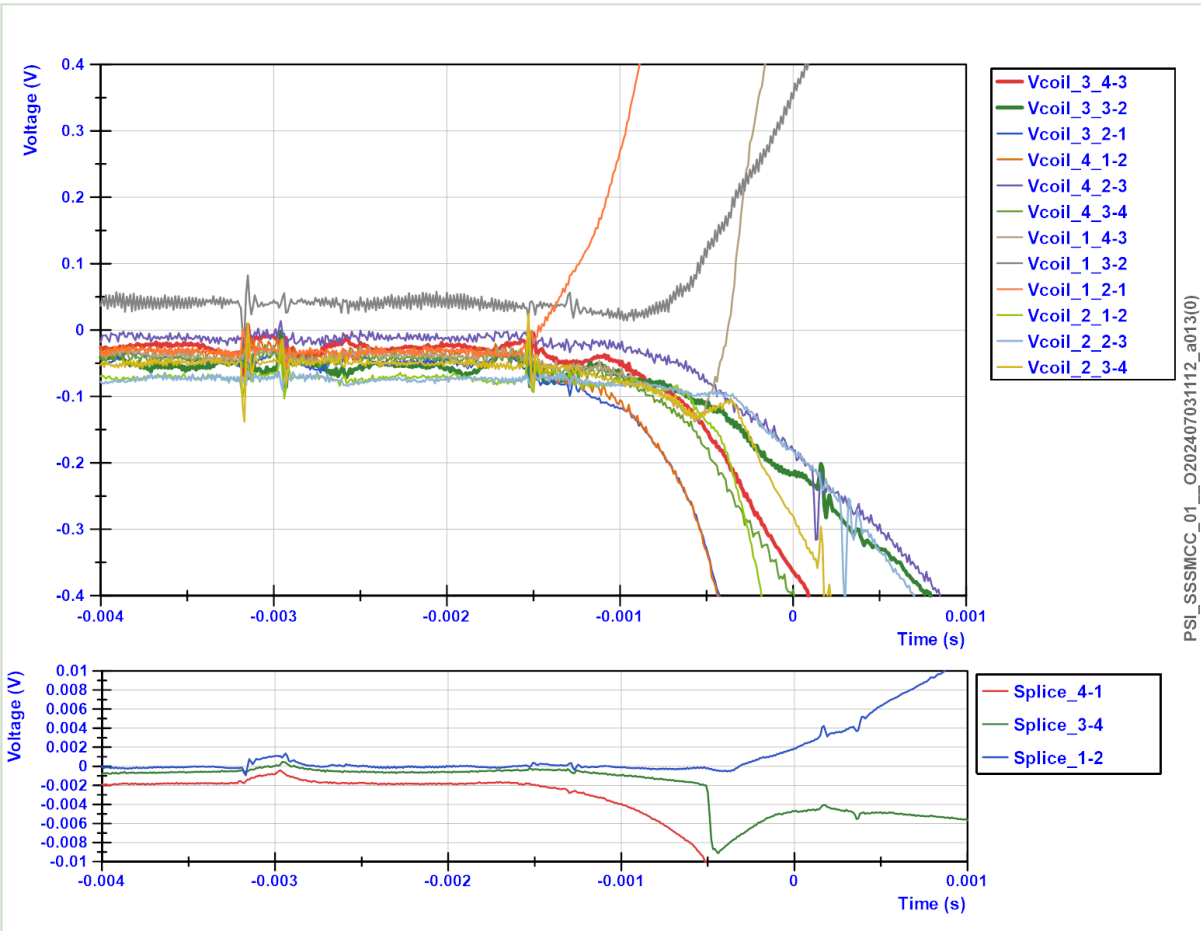
# Event 24: 1<sup>st</sup> CD - 1.9 K – I<sub>max</sub> = 8.99 kA | Coil 4



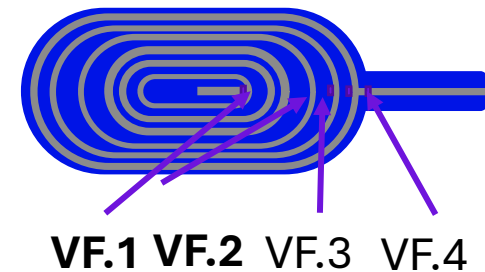
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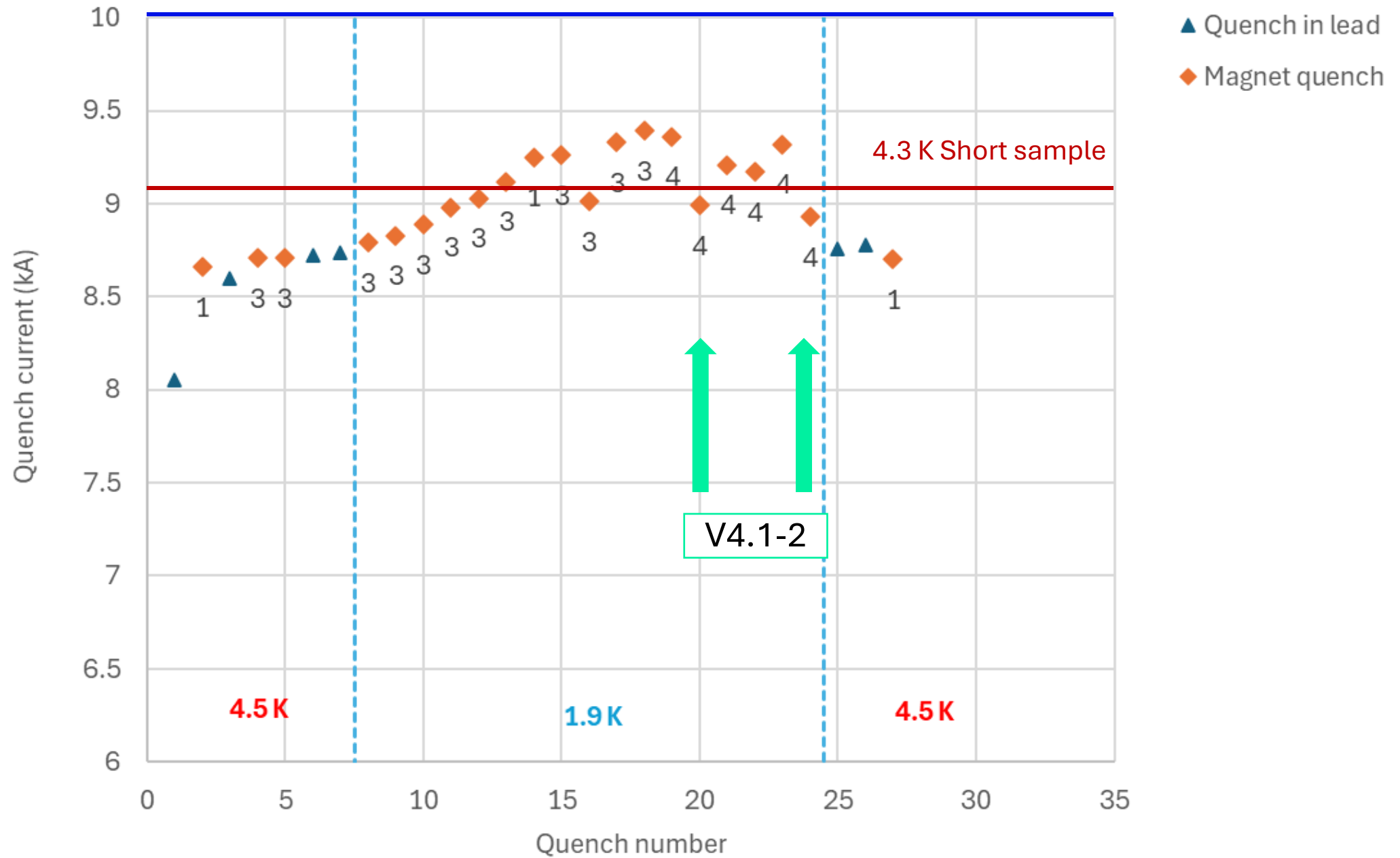


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I<sub>event18</sub> – 400 A

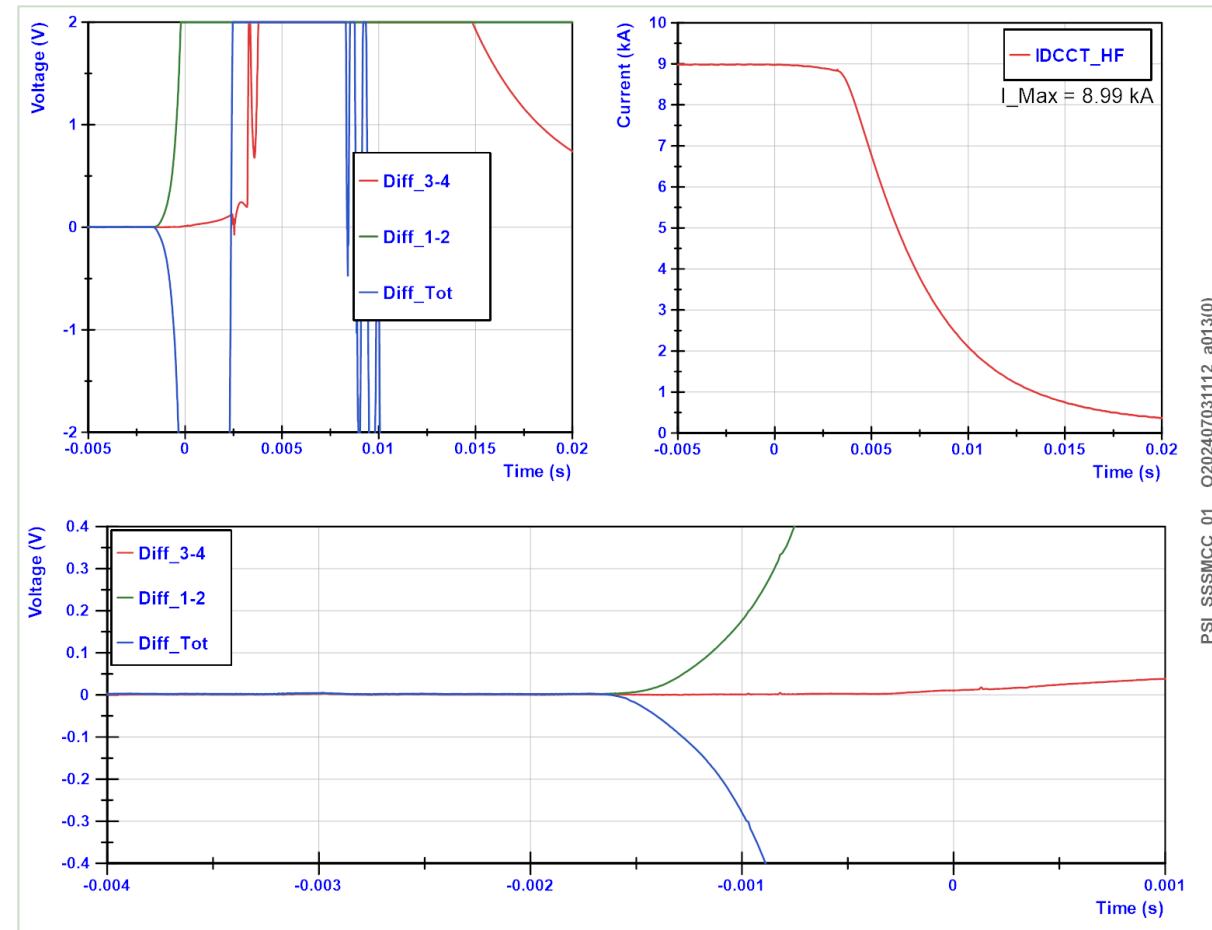
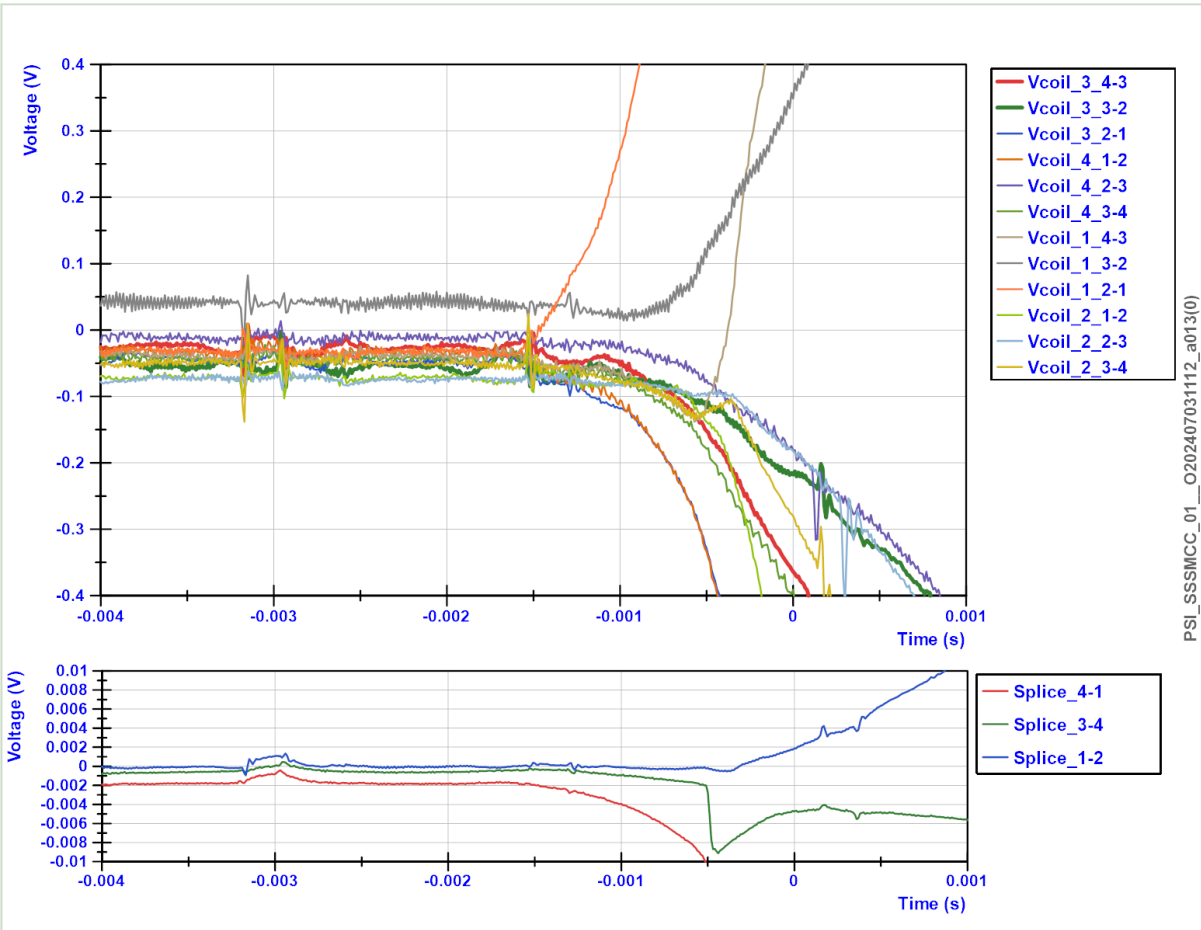




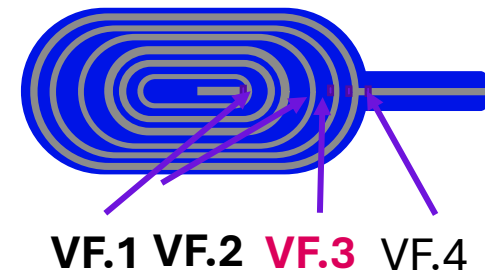
# Event 24: 1<sup>st</sup> CD - 1.9 K – I<sub>max</sub> = 8.99 kA | Coil 4

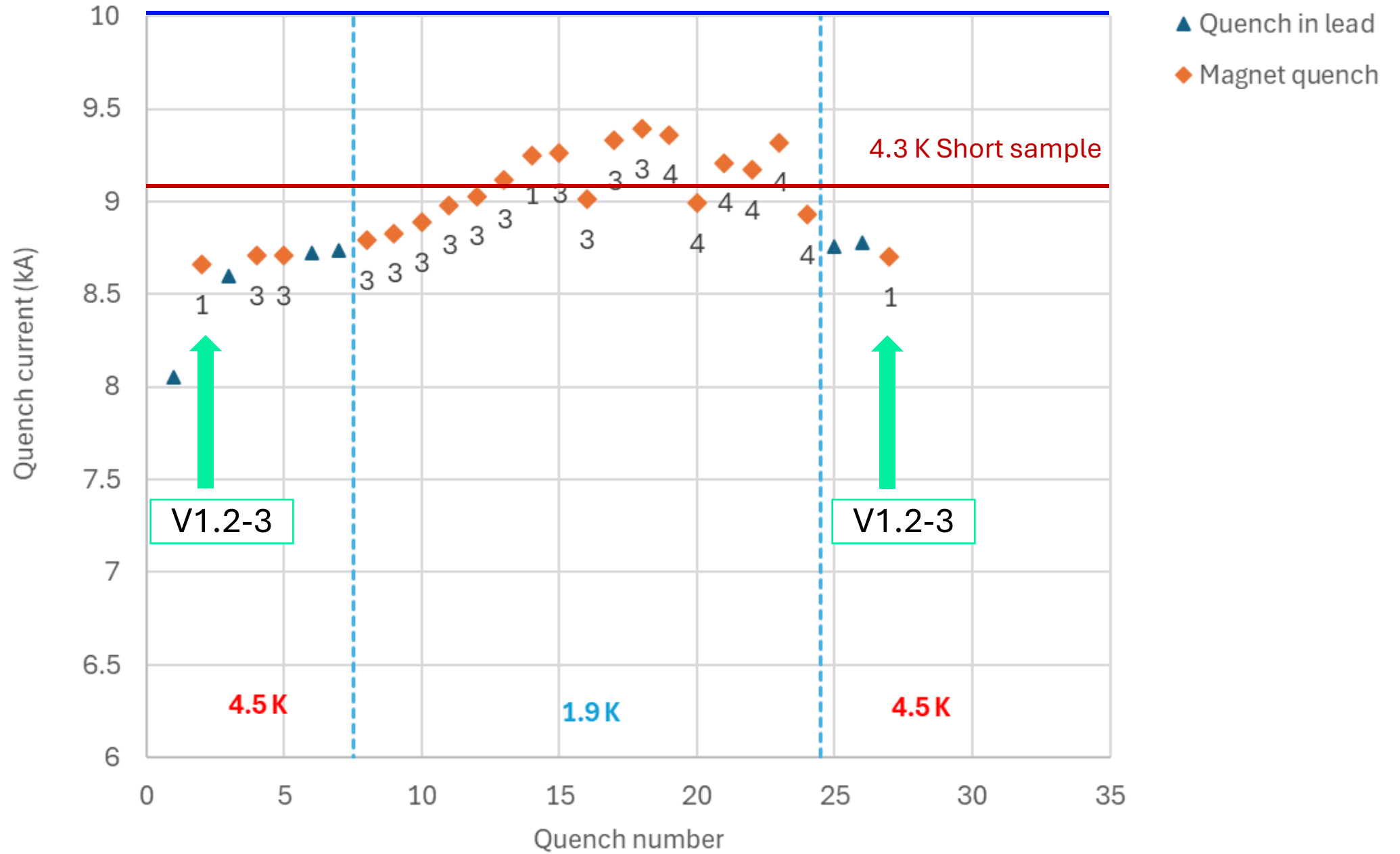


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I<sub>event18</sub> – 400 A (4.3%)





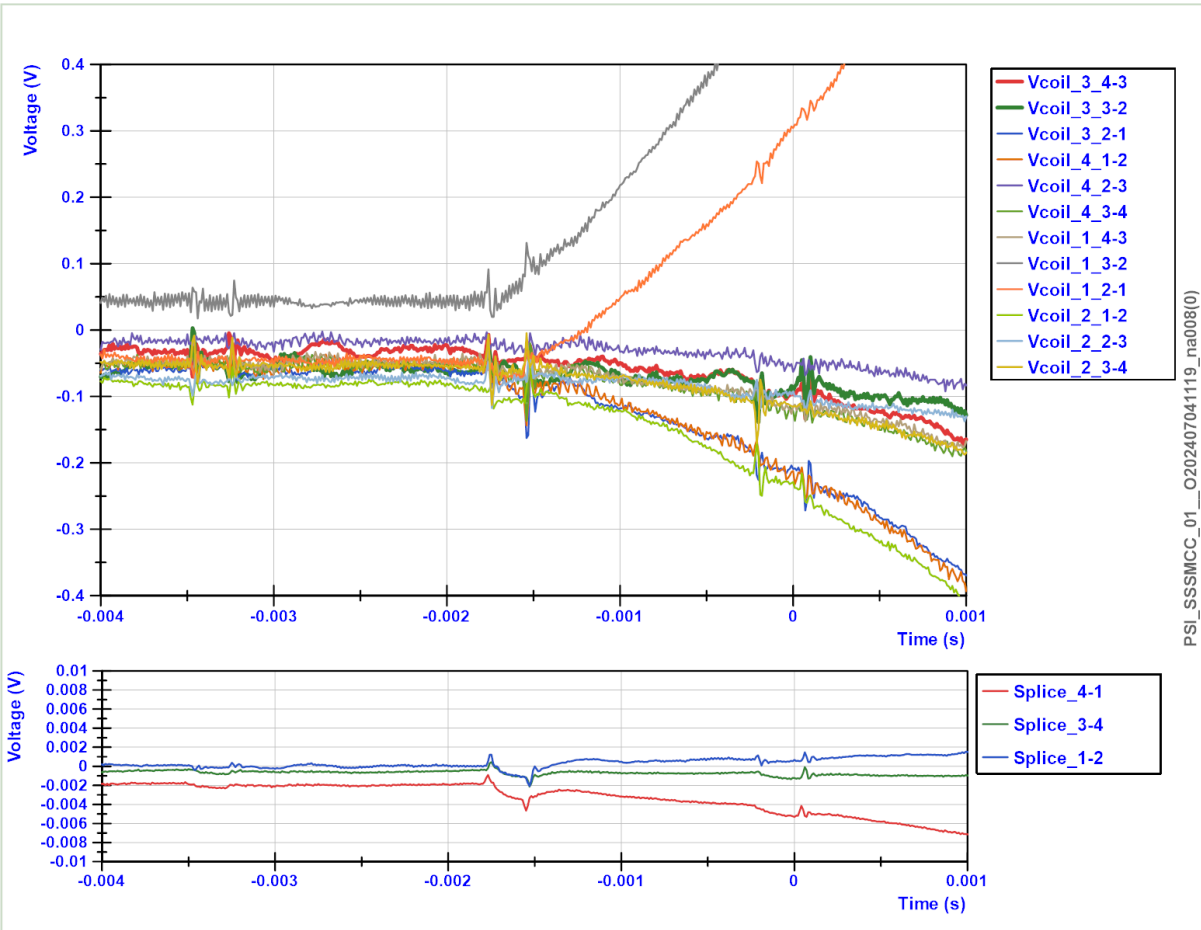
# Event 27: 1<sup>st</sup> CD - 1.9 K – I<sub>max</sub> = 8.7 kA | Coil 1



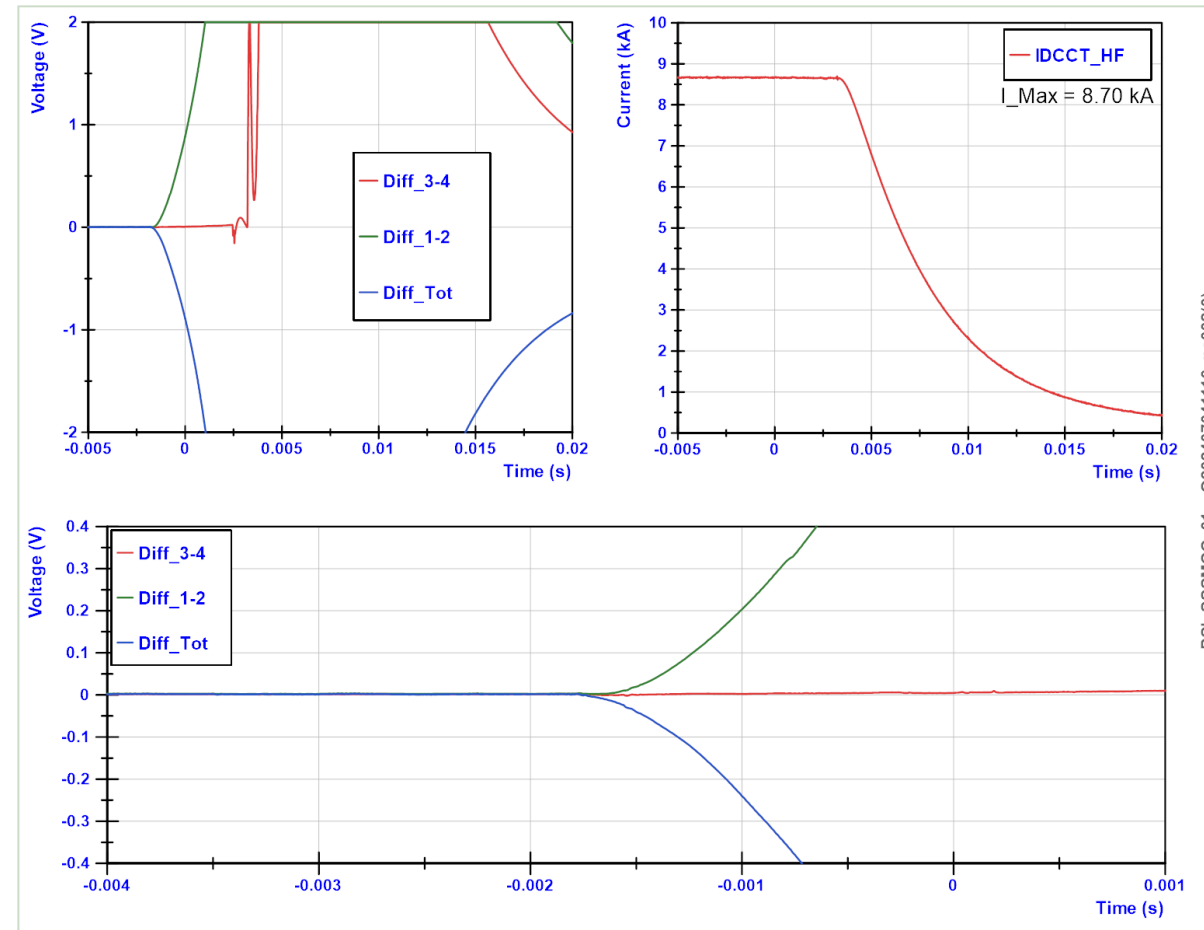
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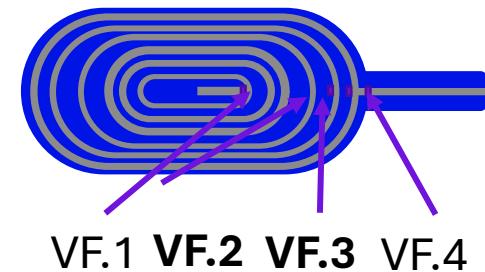


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PSI\_SSSMCC\_01\_O202407041119\_na008(0)

$I_{\text{event2}} = 8.66 \text{ kA}$

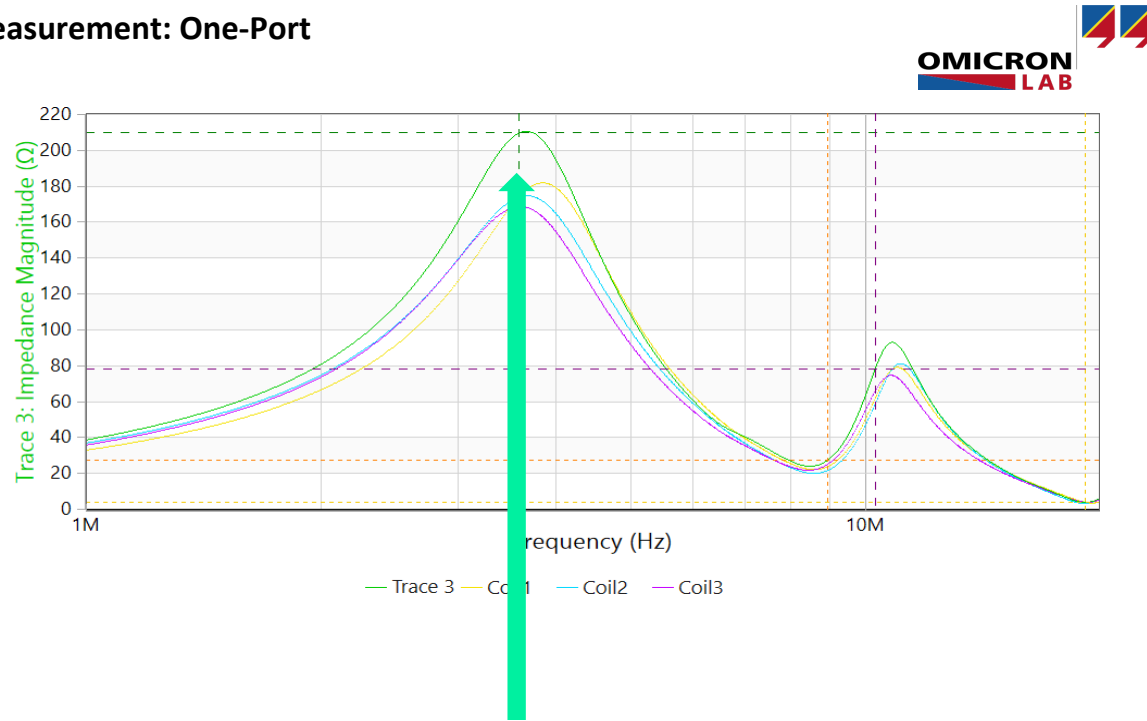




# Impedance measurements



Measurement: One-Port



Coil 4 deviates from  
de others

Measurement: One-Port

