PSI

HFM
High Field Magnets Programme

CHART
Swiss Accelerator Research and Technology

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

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

LBNL: D. Arbelaez, I. Pong, P. Ferracin, S. Prestemon (Nb_3Sn 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
- 1st cool-down test results (G. Wilering)

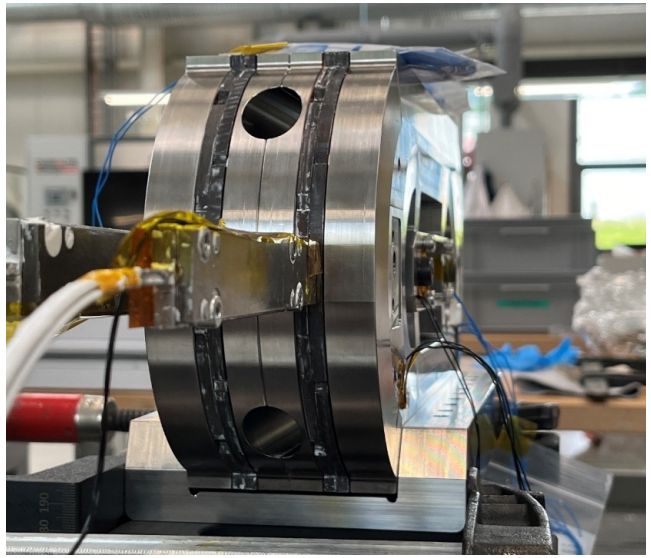
Subscale Stress-Managed Common-Coils (SubSMCC)

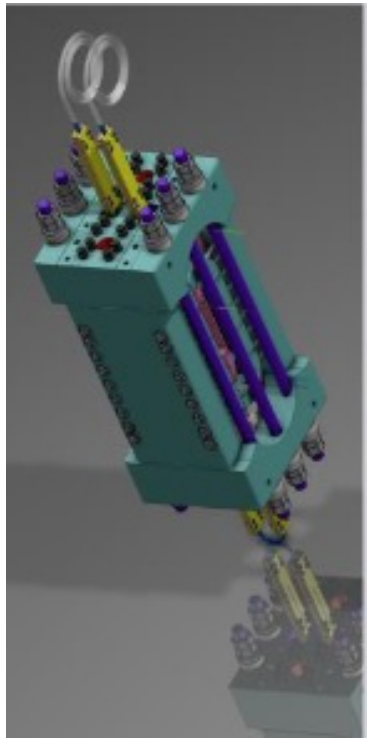
Validating manufacturing process and introducing advanced concepts: coil pre-load free, at room temperature; stress-management structure and splicing on the low-field region.

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

Possibility to test a Hybrid magnet with LTS (Nb_3Sn) Common-Coils and HTS racetracks

LTS (Nb_3Sn) conductor manufactured by LBNL (cct subscale cable)





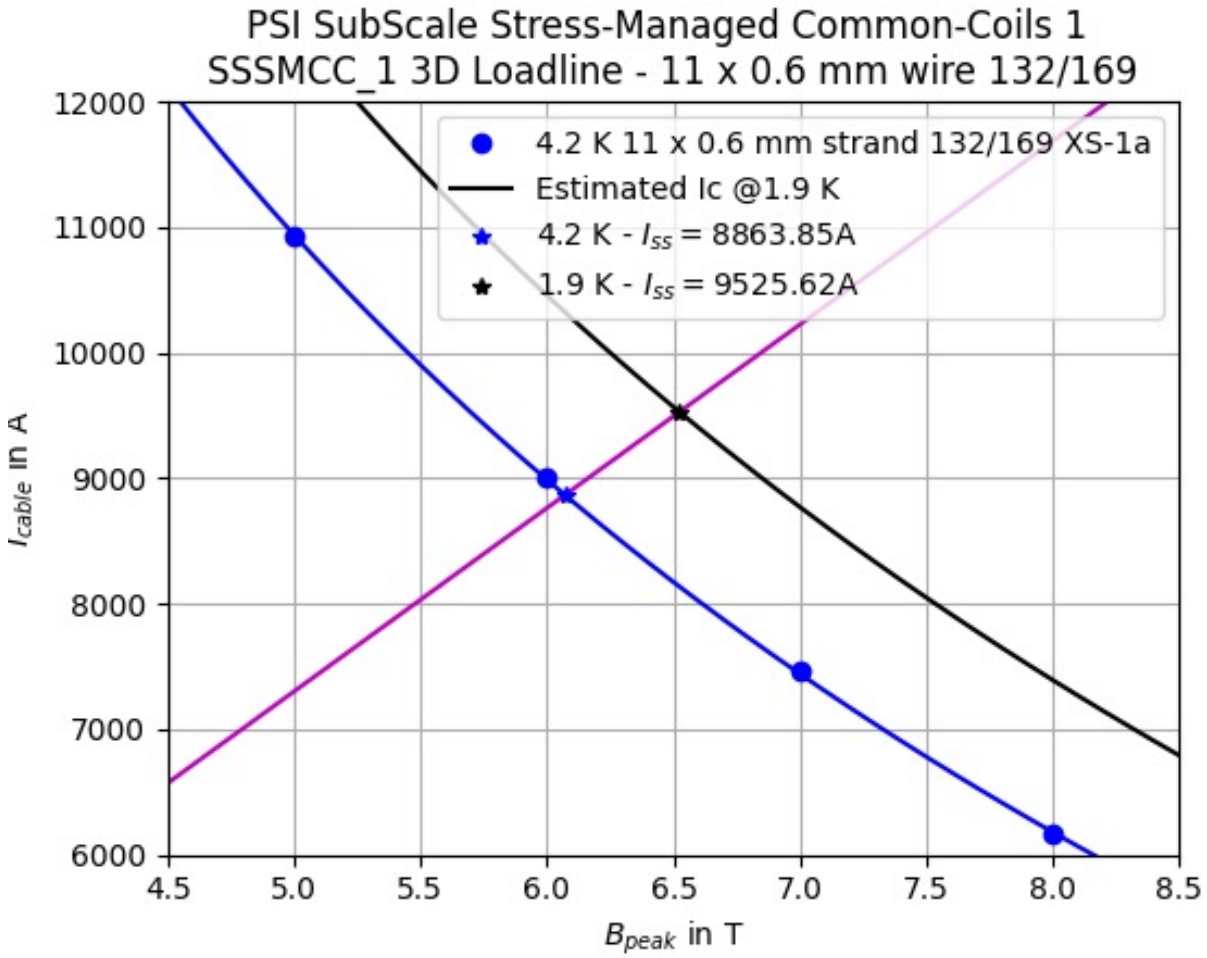
Number of turns	Wire type	N wire x dia in mm	Cu/nCu	Bare Cable dimensions in mm	Insulation thickness in mm
18 / layer	Nb_3Sn RRP® 132/169	11 x 0.6	1.17	3.8 x 1.3	0.155

T_{op}	I_{ss} *	B_{peak} in T	B_0 in T	J_{sc} in A/mm²	J_{cu} in A/mm²	J_{ov} ** in A/mm²
4.5 K	9.2 kA	6.3	5.1	6418.9	5486.3	1390.3

* From 2D without including the self-field contribution

** Including insulation area

Assumptions and load line



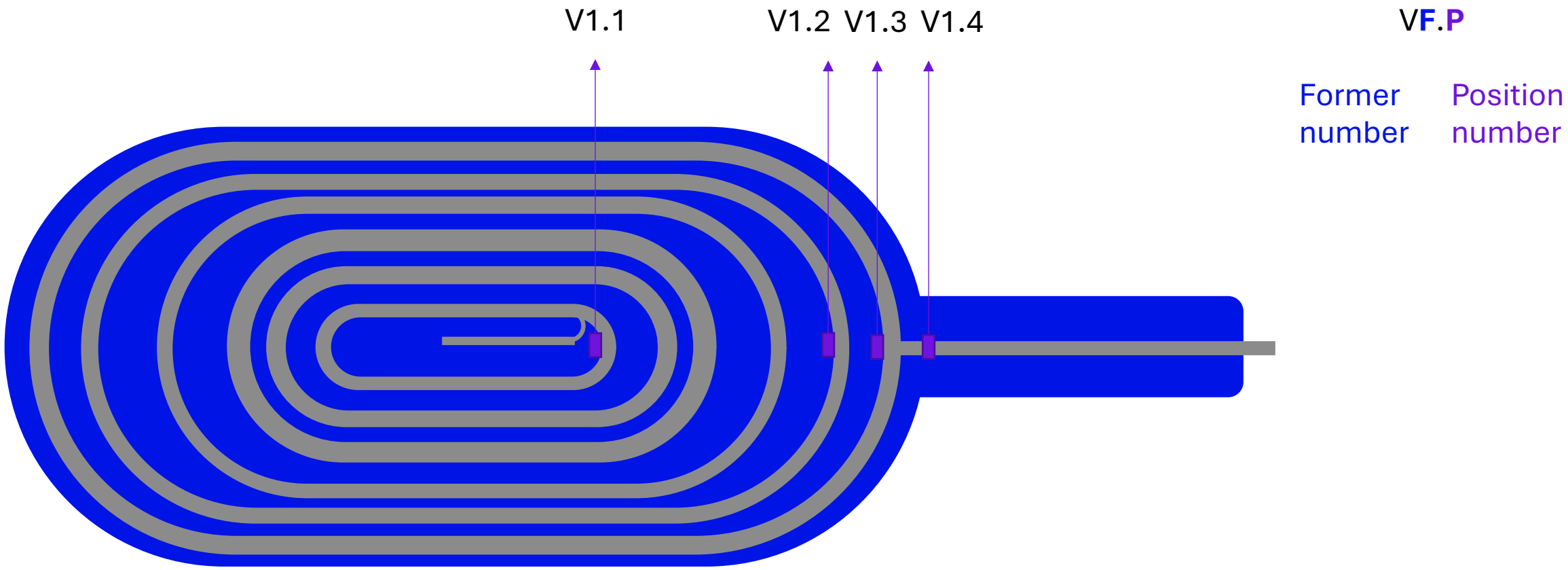
Parameter	CCs 4.5 K short sample values
B_{0_ss} in T	4.9
B_{peak_ss} in T	6.1
I_{ss} in kA	8.86
E_{mag_ss} in kJ	16

Plot based on the round wire measurements

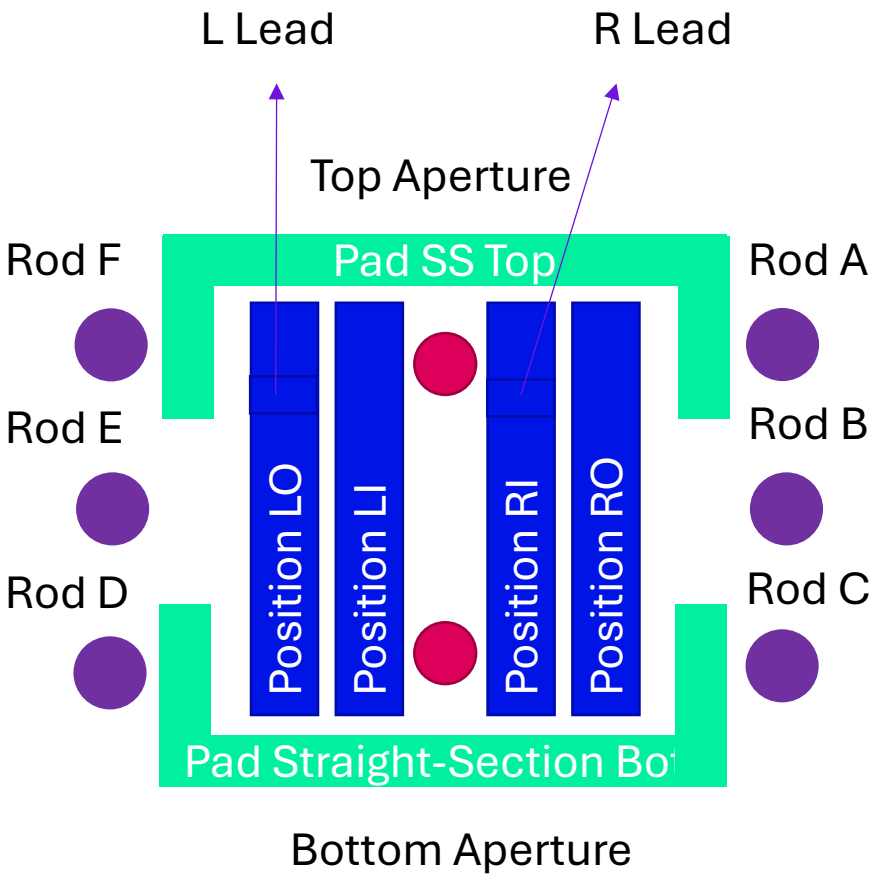
4.5 and 1.9 K witness samples results pending

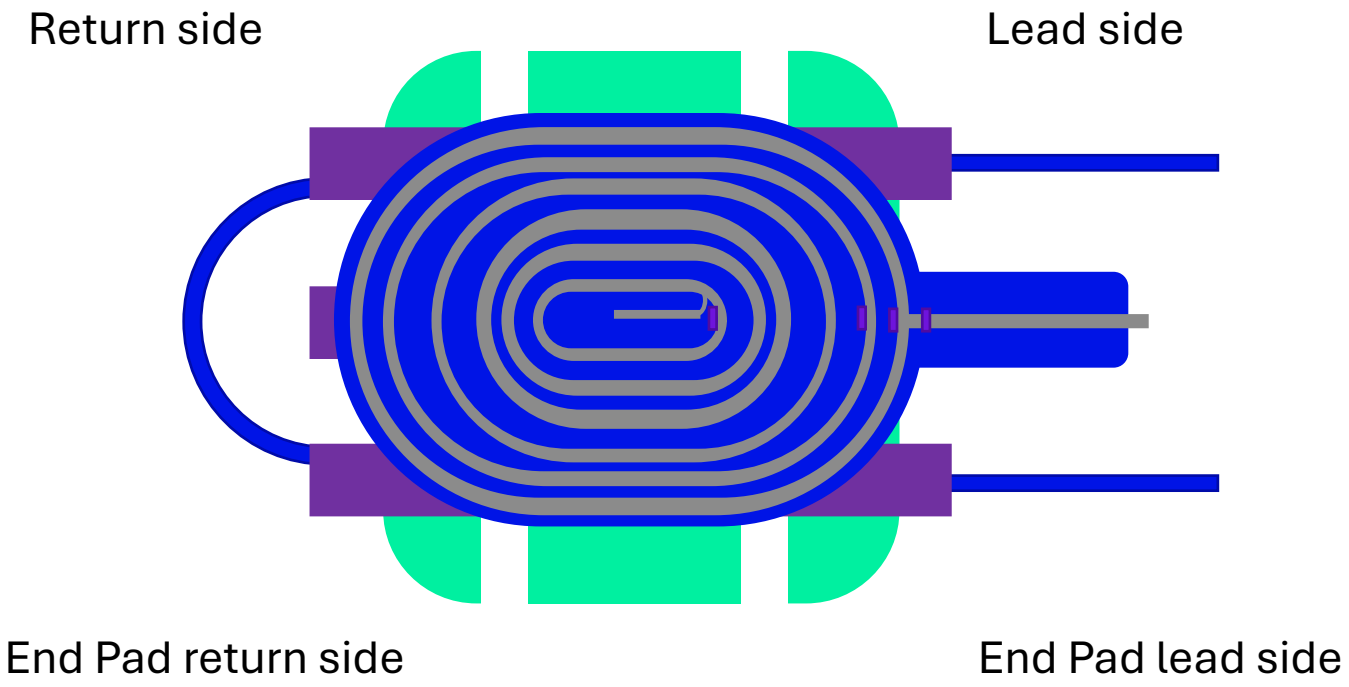
1.9 K curve scaled using a T_{C0} = 16 K

Instrumentation: Nomenclature of voltage taps (former 1)

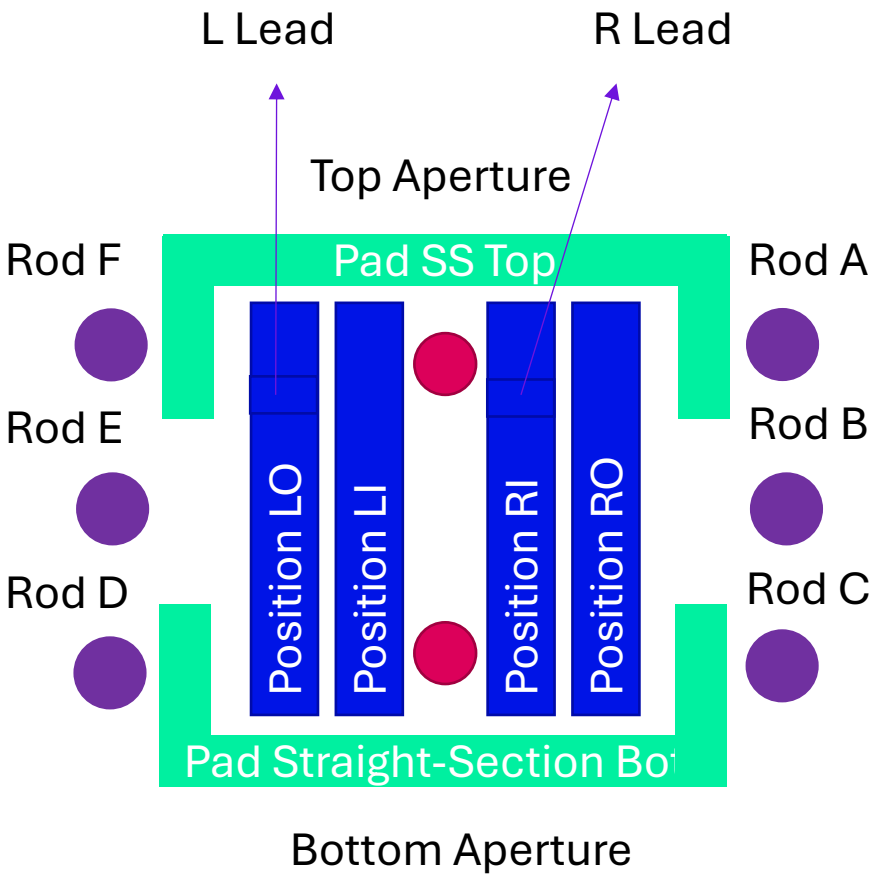


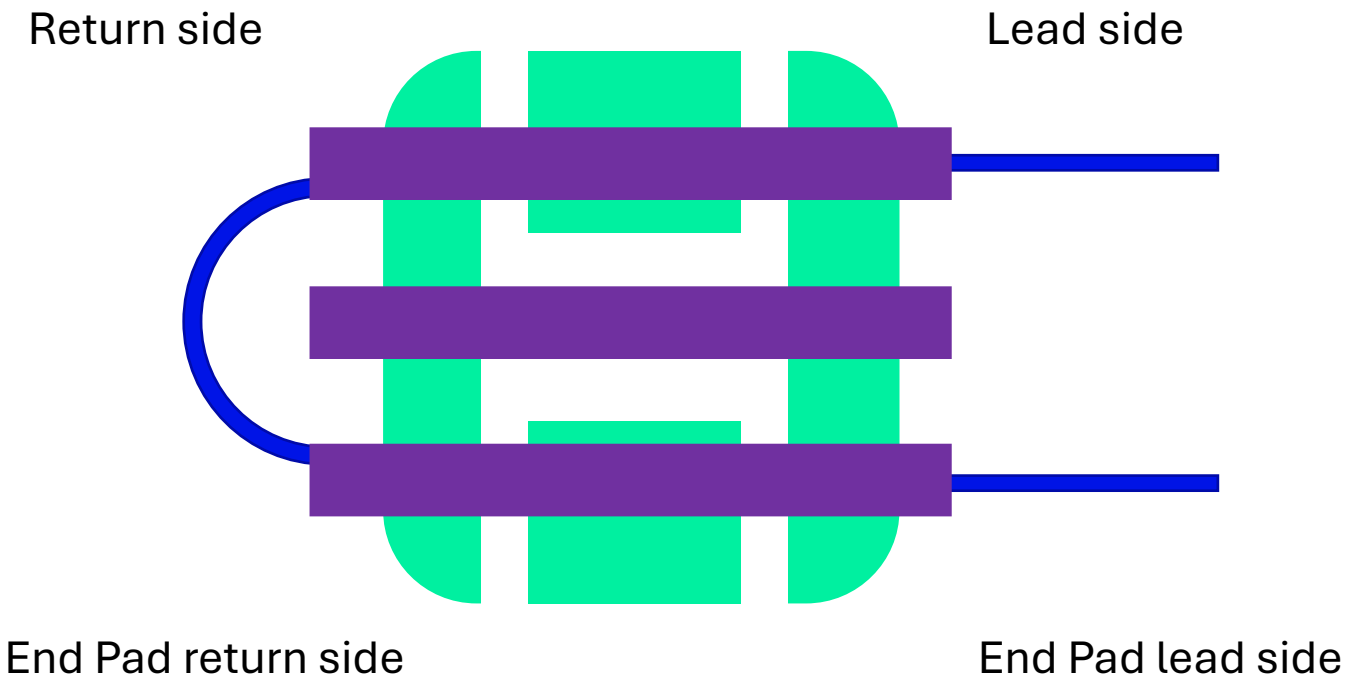
Instrumentation: Nomenclature of parts



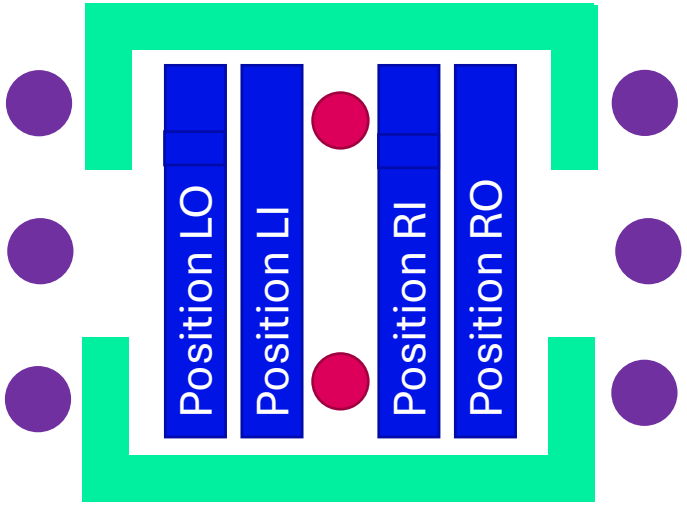


Instrumentation: Nomenclature of parts

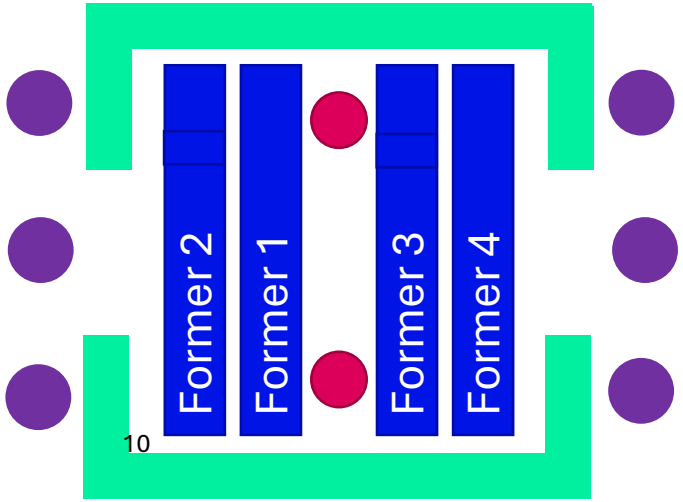




Instrumentation: voltage taps pairs



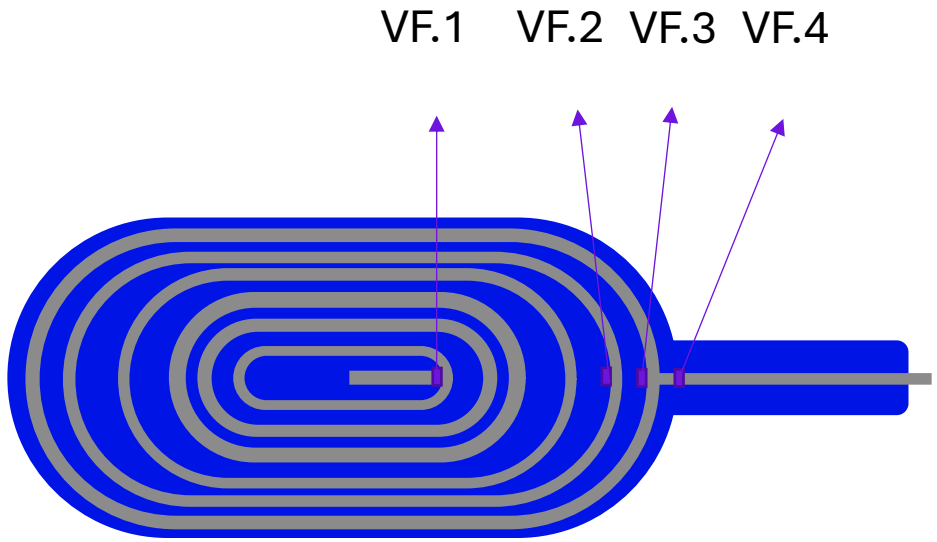
Test configuration



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

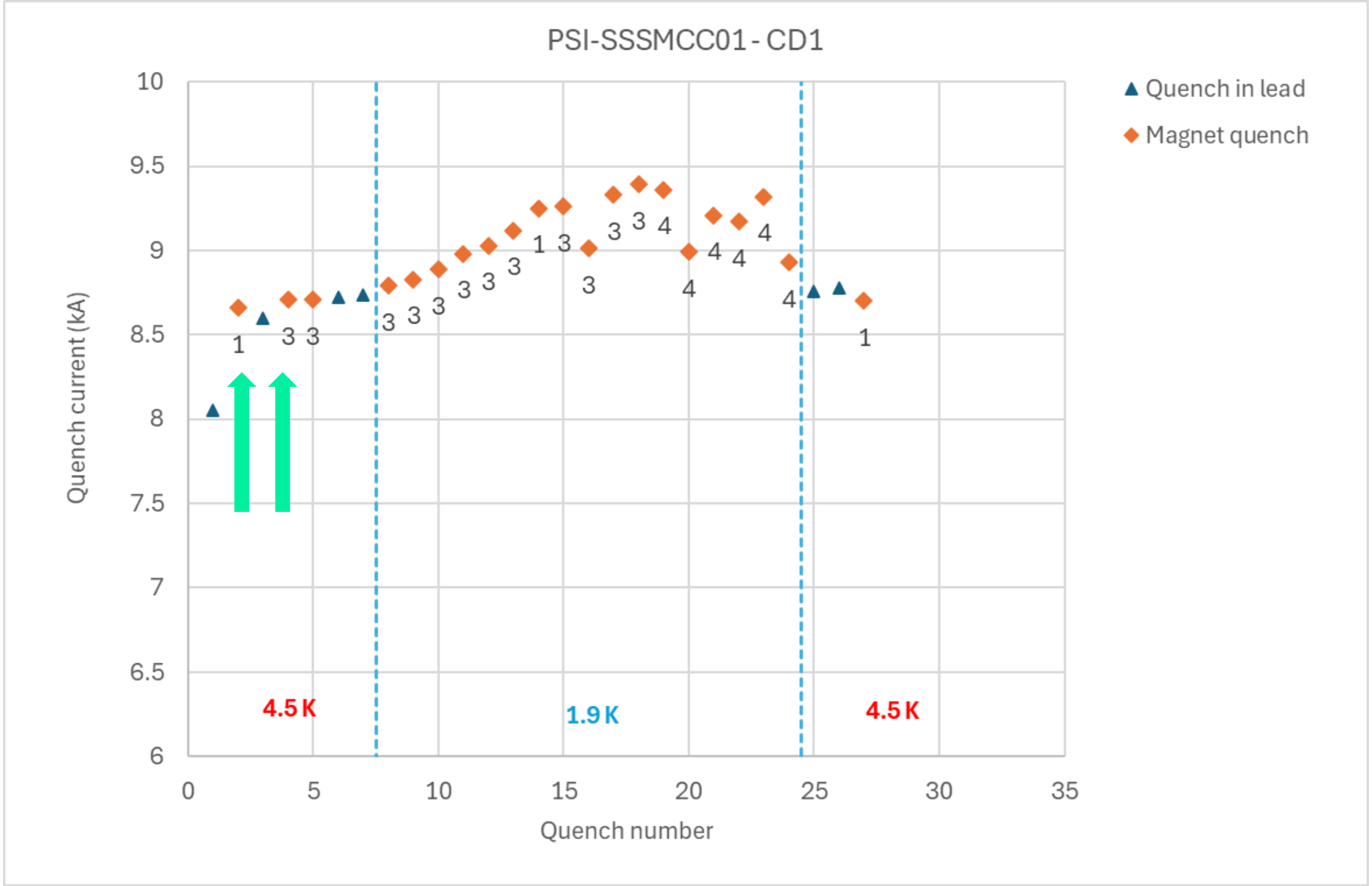
Magnet Structure: V MS



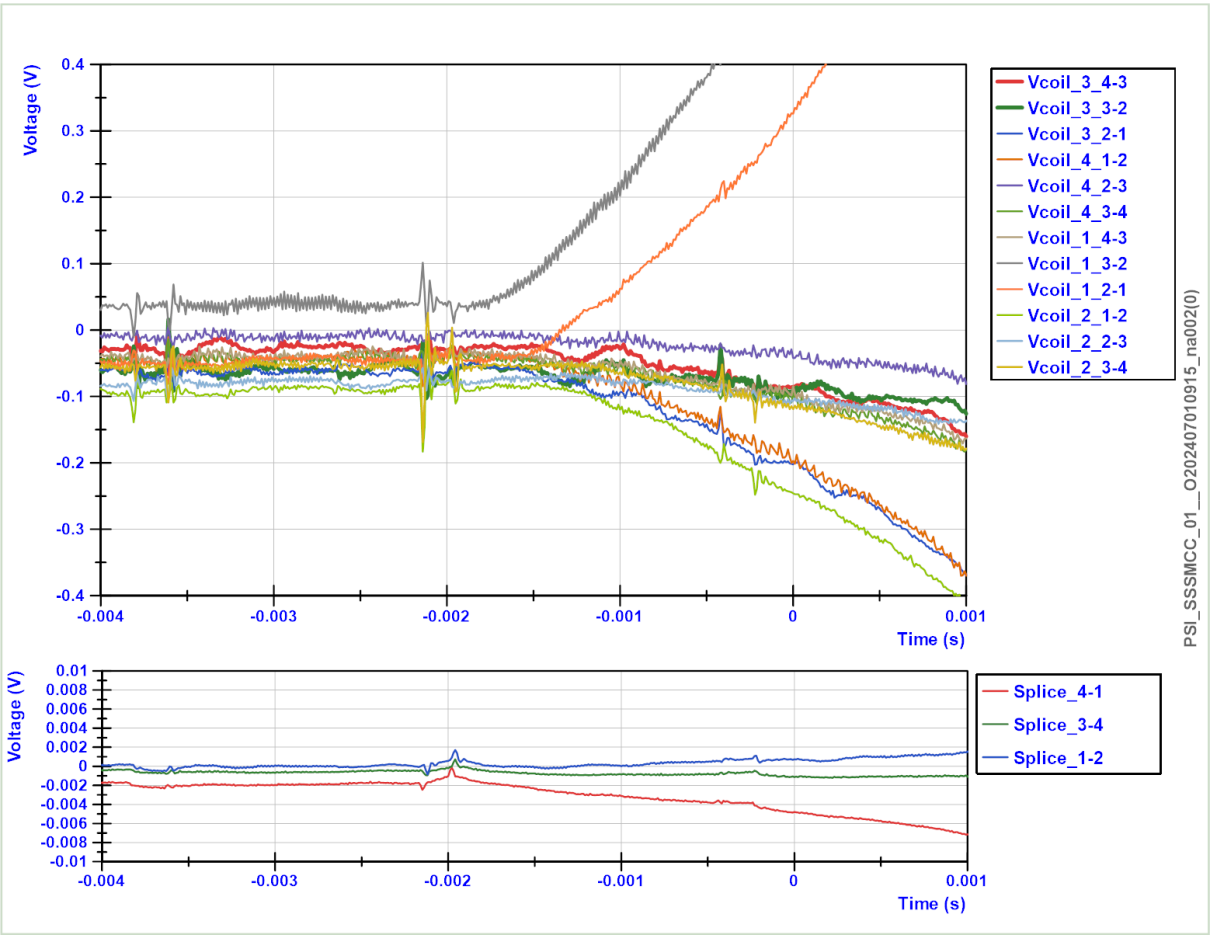
VF.P

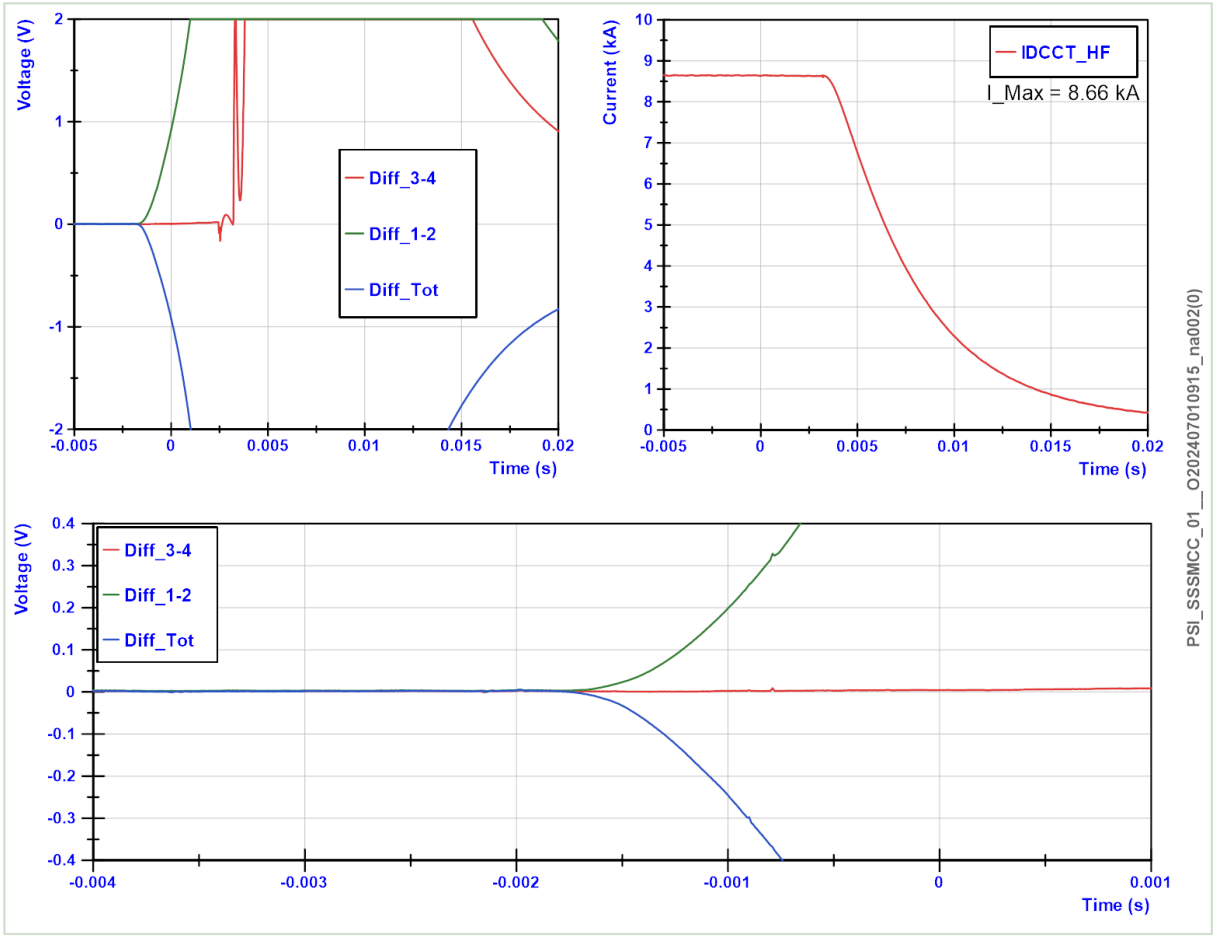
Former number

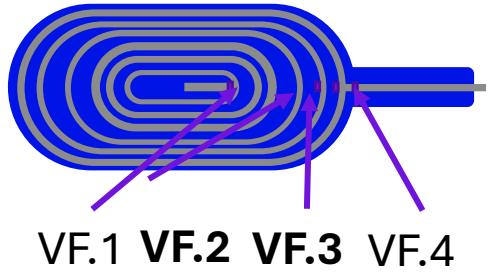
tap Position


PSI-SSSMCC01 - CD1
Quench in lead
Magnet quench
Quench current (kA)
Quench number
10
9.5
9
8.5
8
7.5
7
6.5
6
0
5
10
15
20
25
30
35
4.5 K
1.9 K
4.5 K

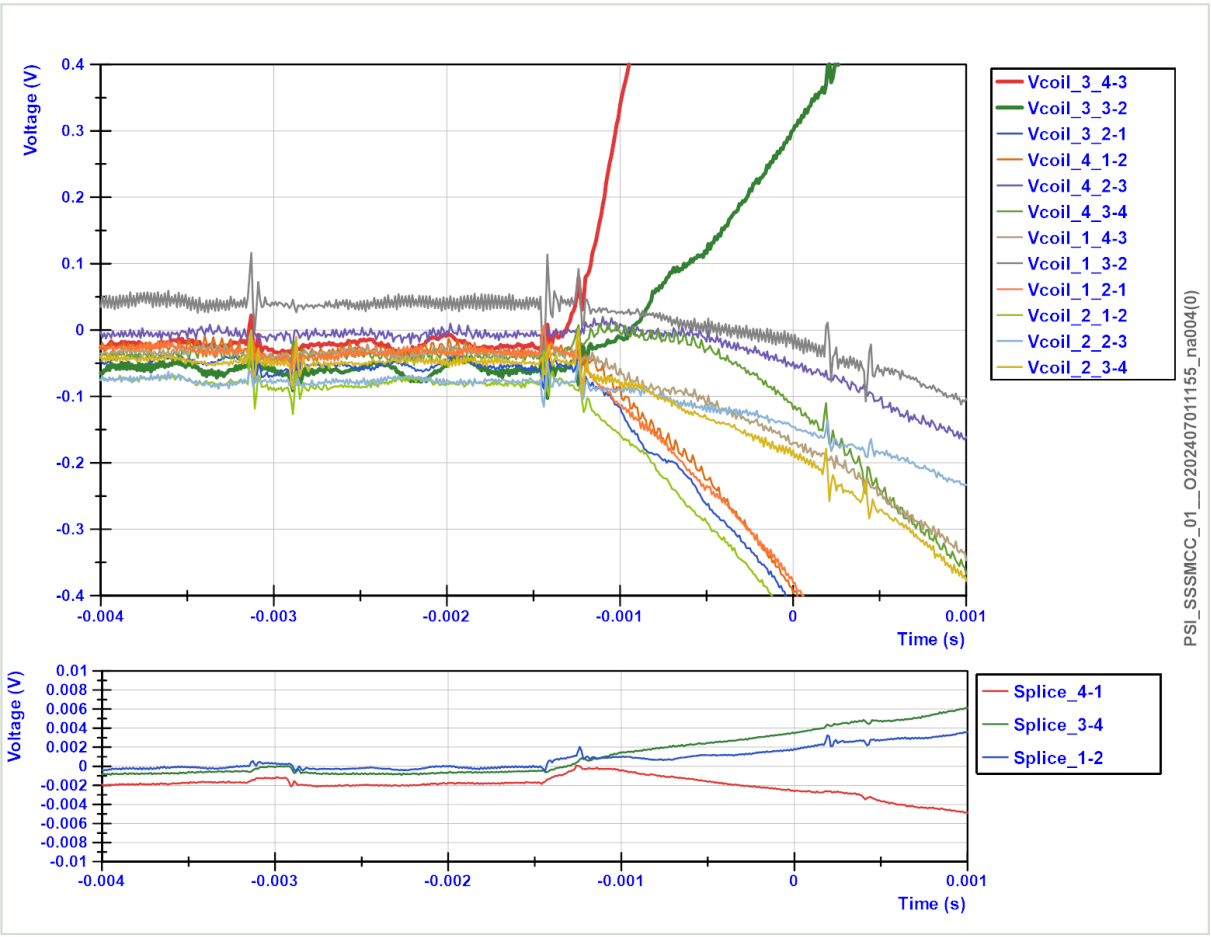
Event 2: 1st CD - 4.5 K – Imax = 8.66 kA | Coil 1

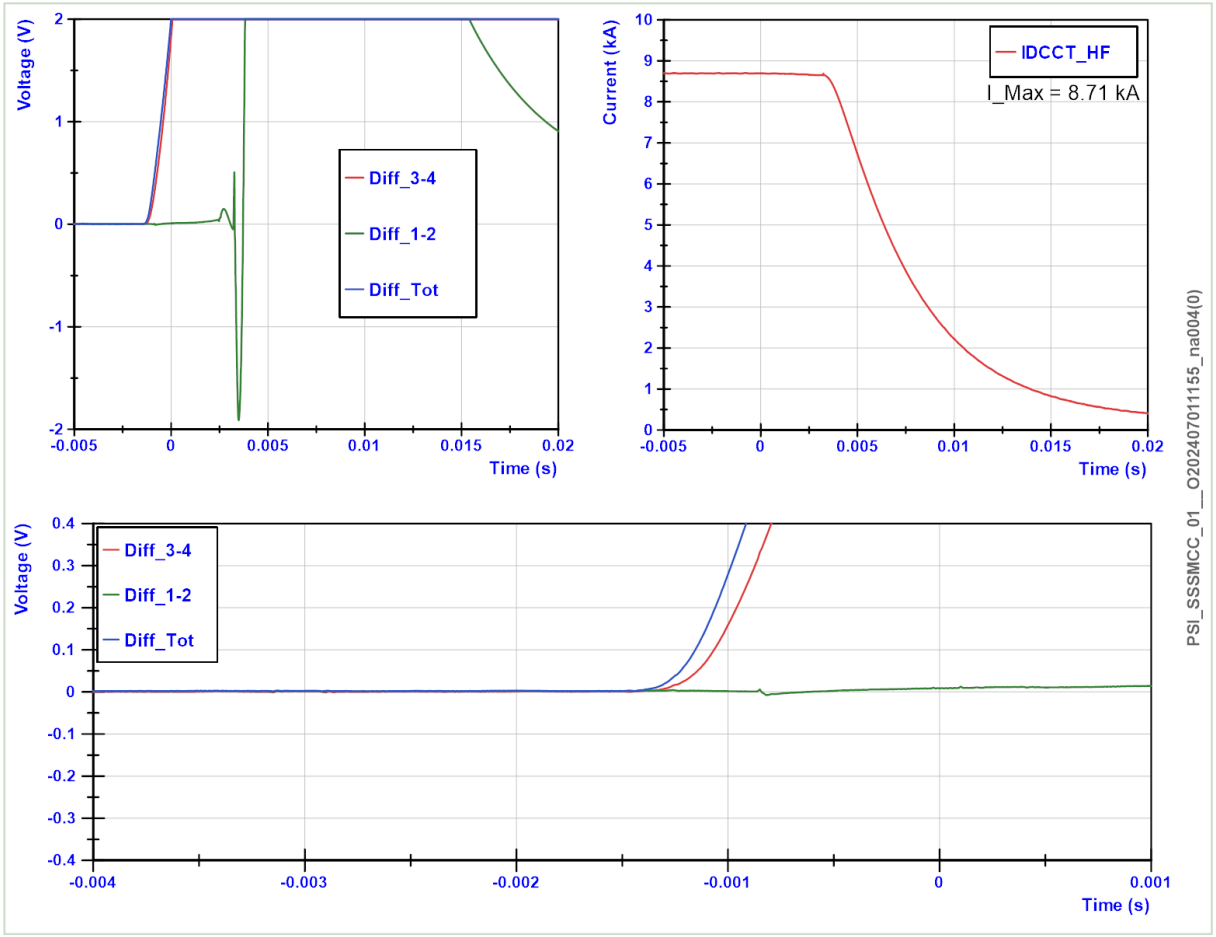


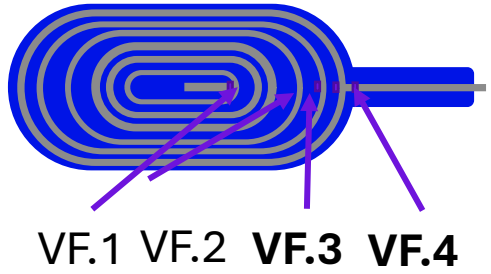


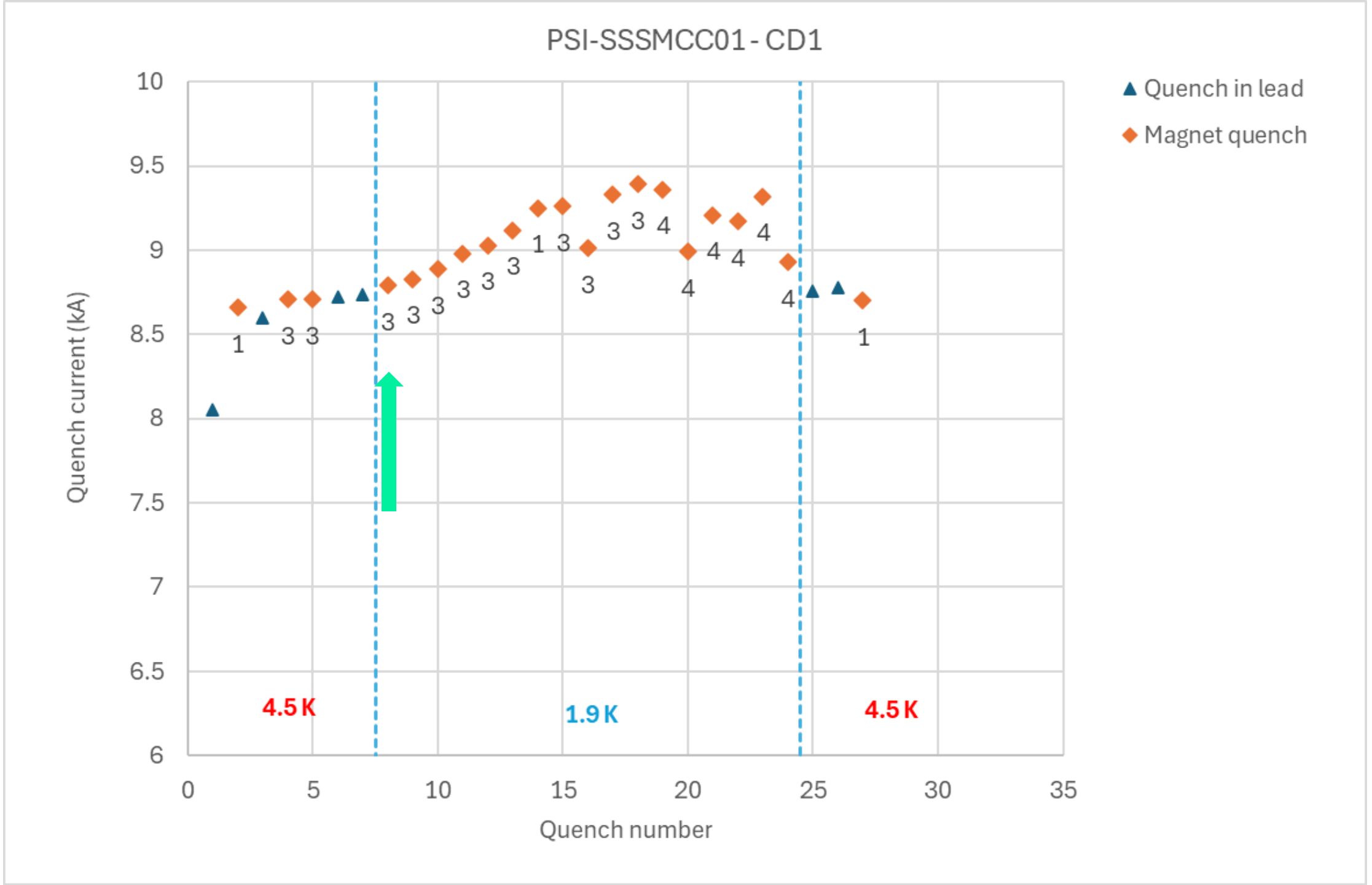


Event 4: 1st CD - 4.5 K – Imax = 8.71 kA | Coil 3

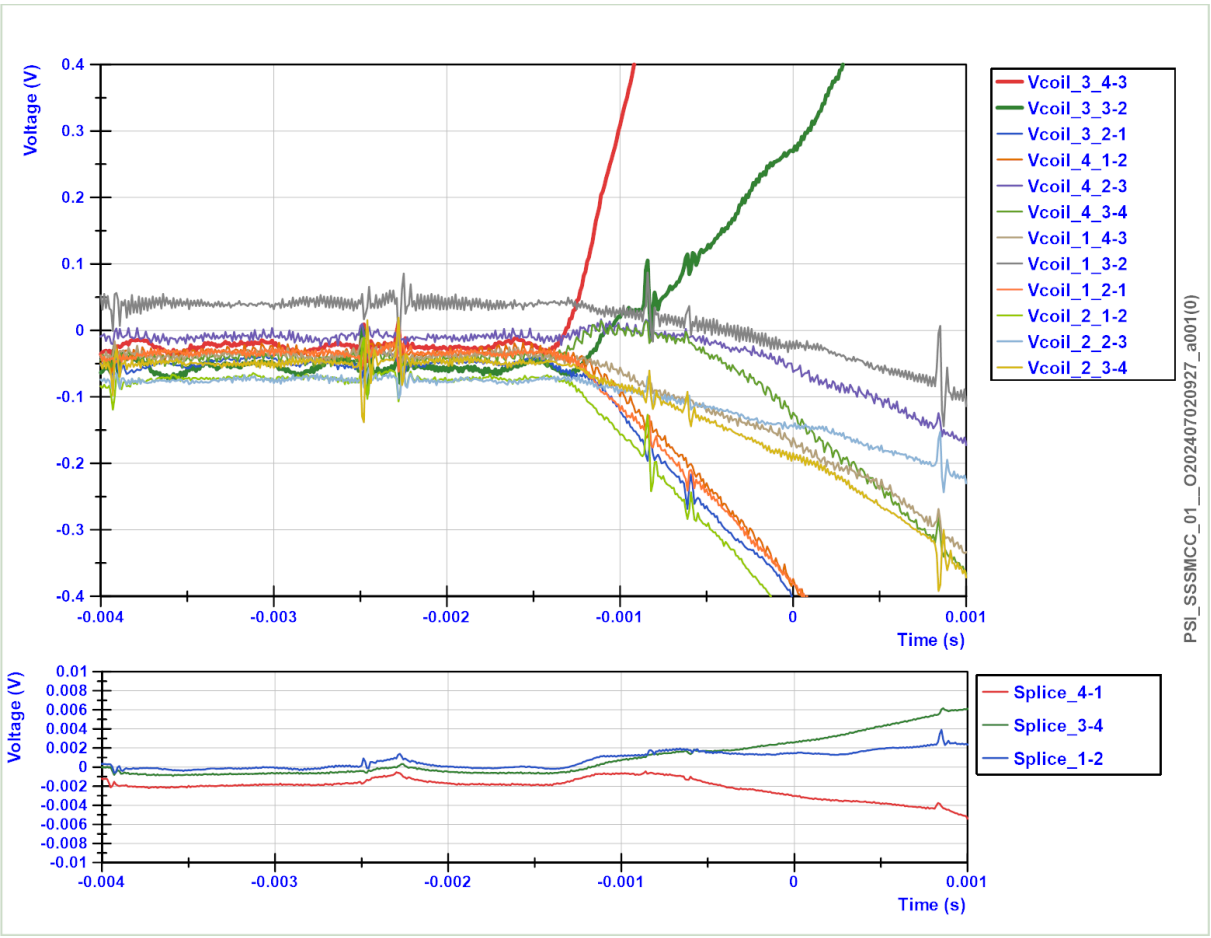


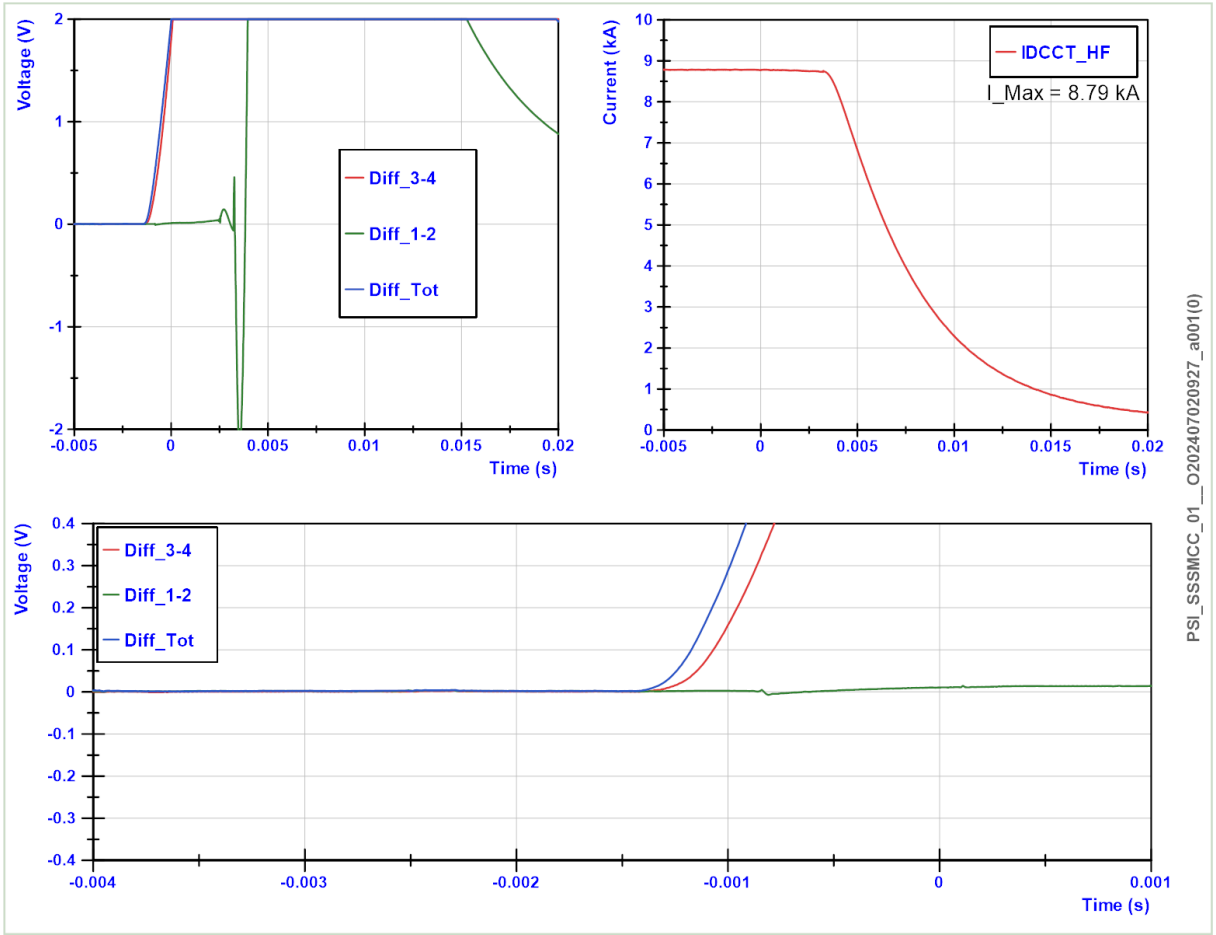


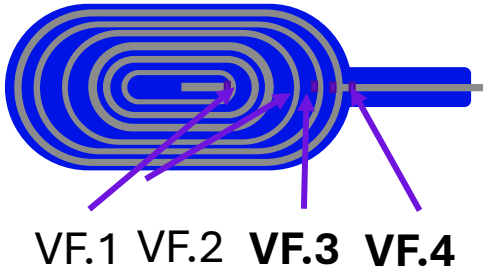


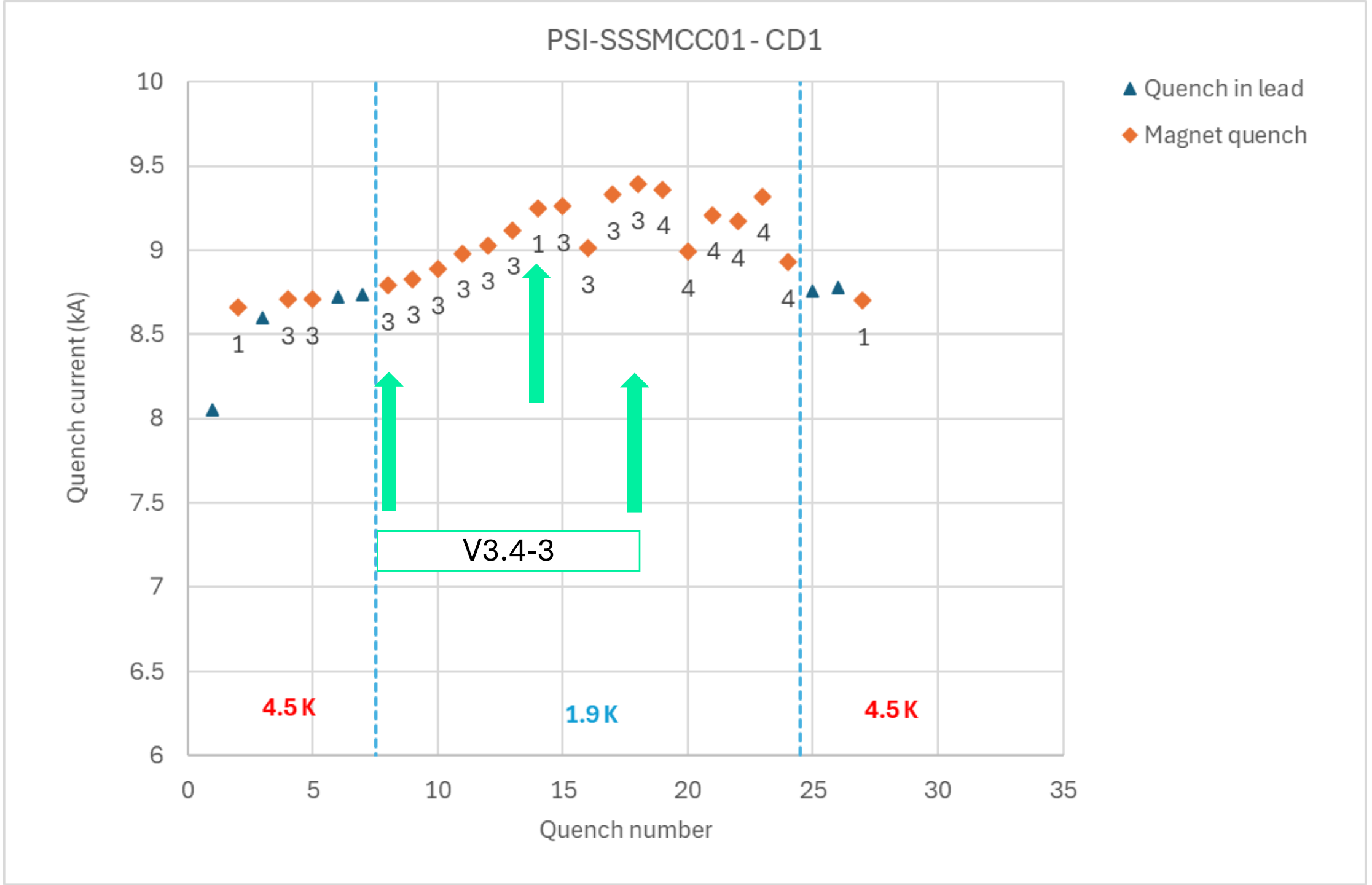

PSI-SSSMCC01 - CD1
Quench in lead
Magnet quench
Quench current (kA)
Quench number
10
9.5
9
8.5
8
7.5
7
6.5
6
0
5
10
15
20
25
30
35
4.5 K
1.9 K
4.5 K

Event 8: 1st CD - 1.9 K – Imax = 8.79 kA | Coil 3

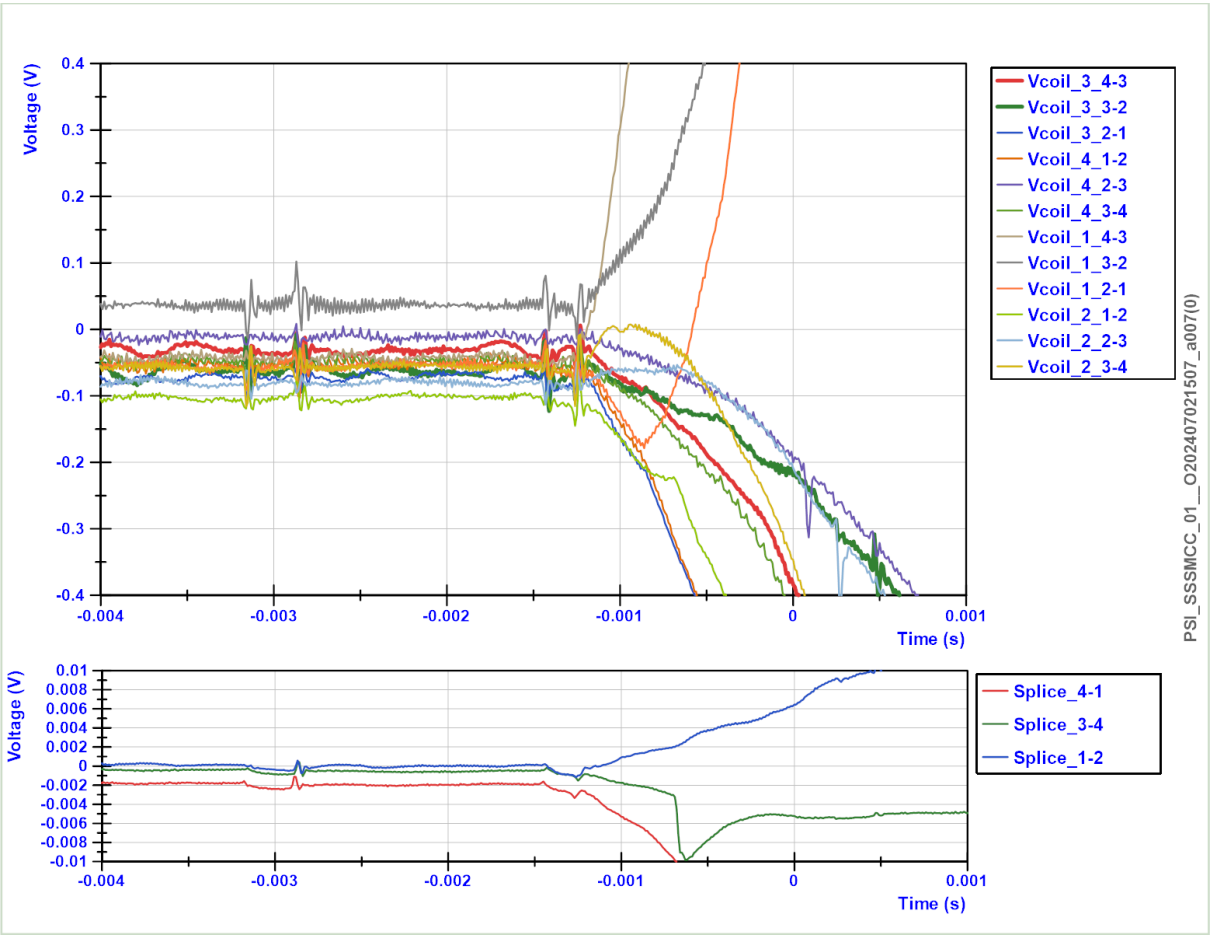


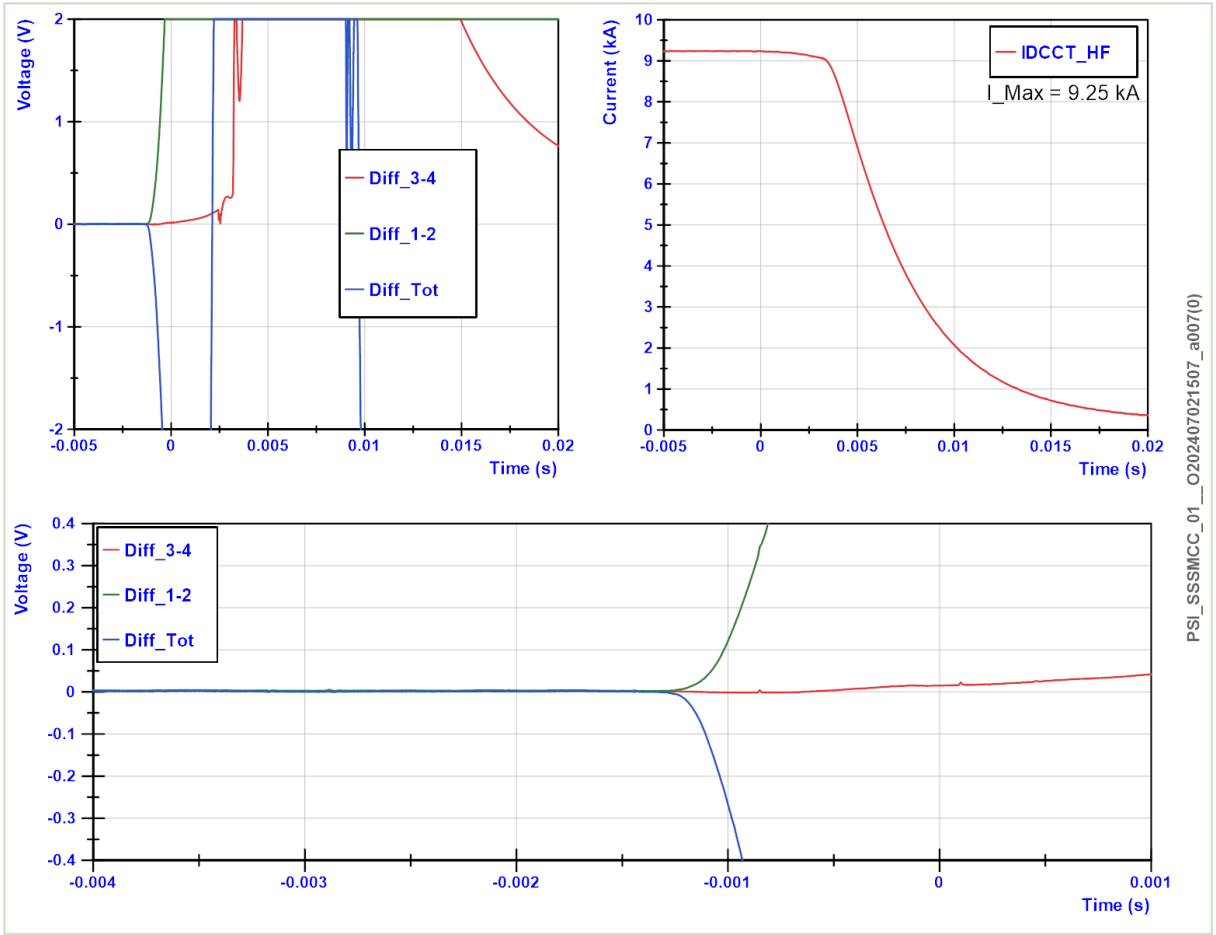


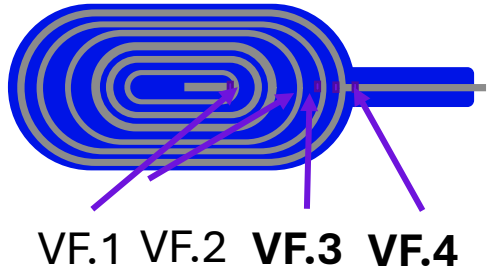



PSI-SSSMCC01 - CD1
Quench in lead
Magnet quench
Quench current (kA)
Quench number
10
9.5
9
8.5
8
7.5
7
6.5
6
0
5
10
15
20
25
30
35
1
3 3
3 3 3 3 3 1 3 3 3 4
4 4 4 4
4
1
V3.4-3
4.5 K
1.9 K
4.5 K

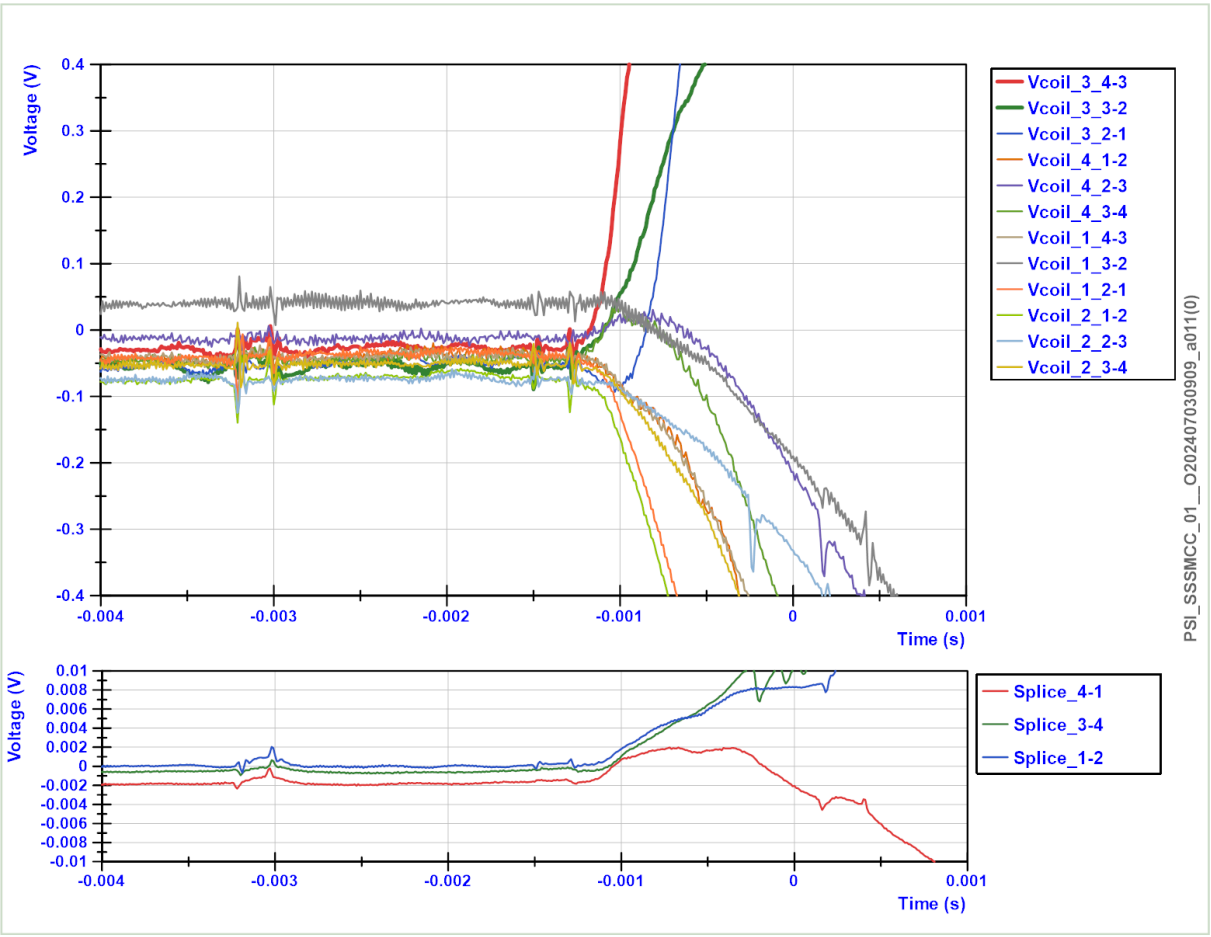
Event 14: 1st CD - 1.9 K – Imax = 9.25 kA | Coil 3

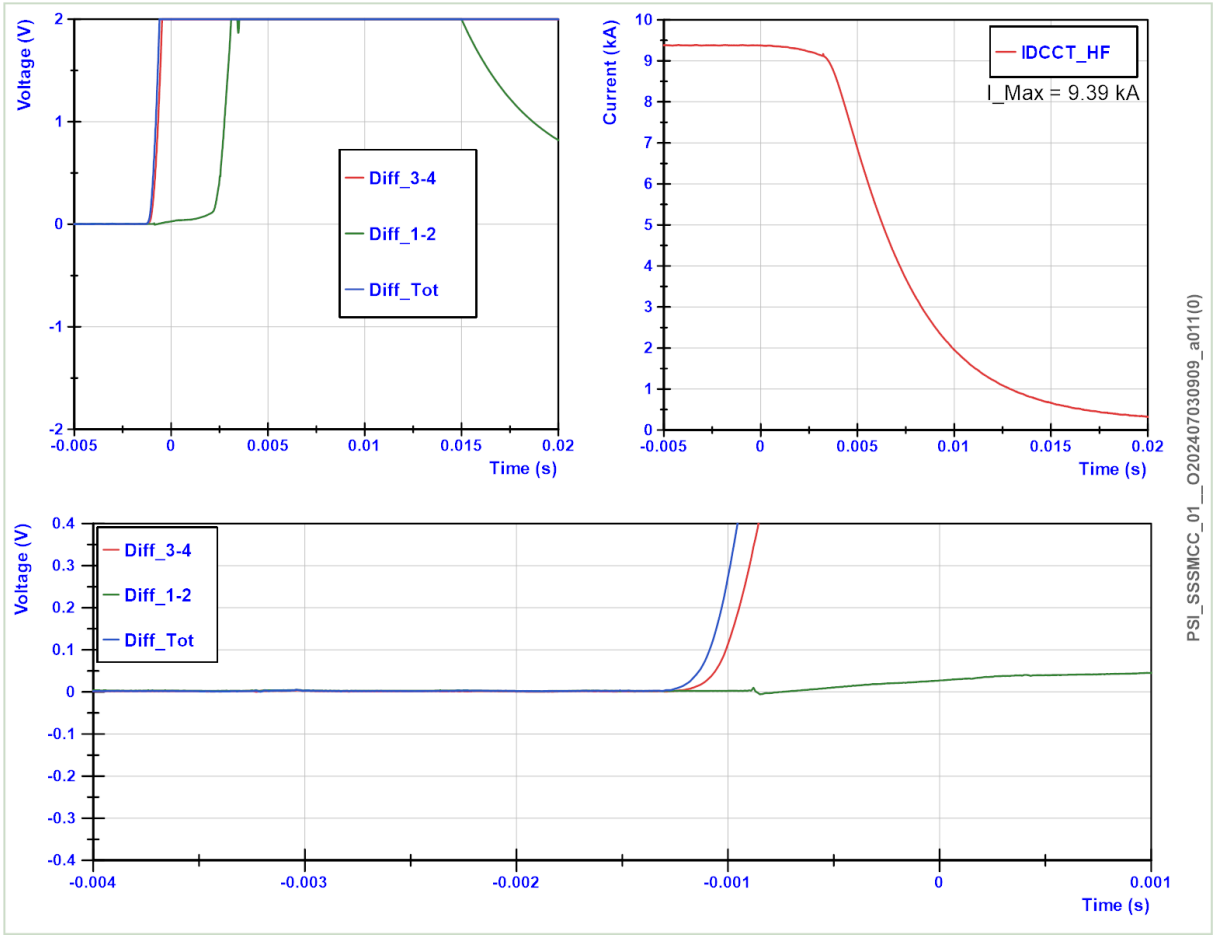


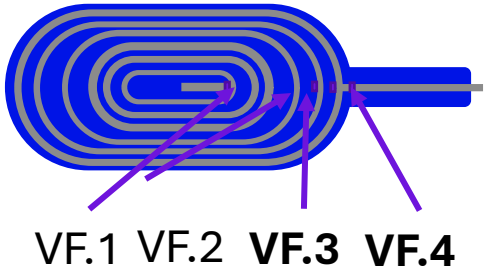


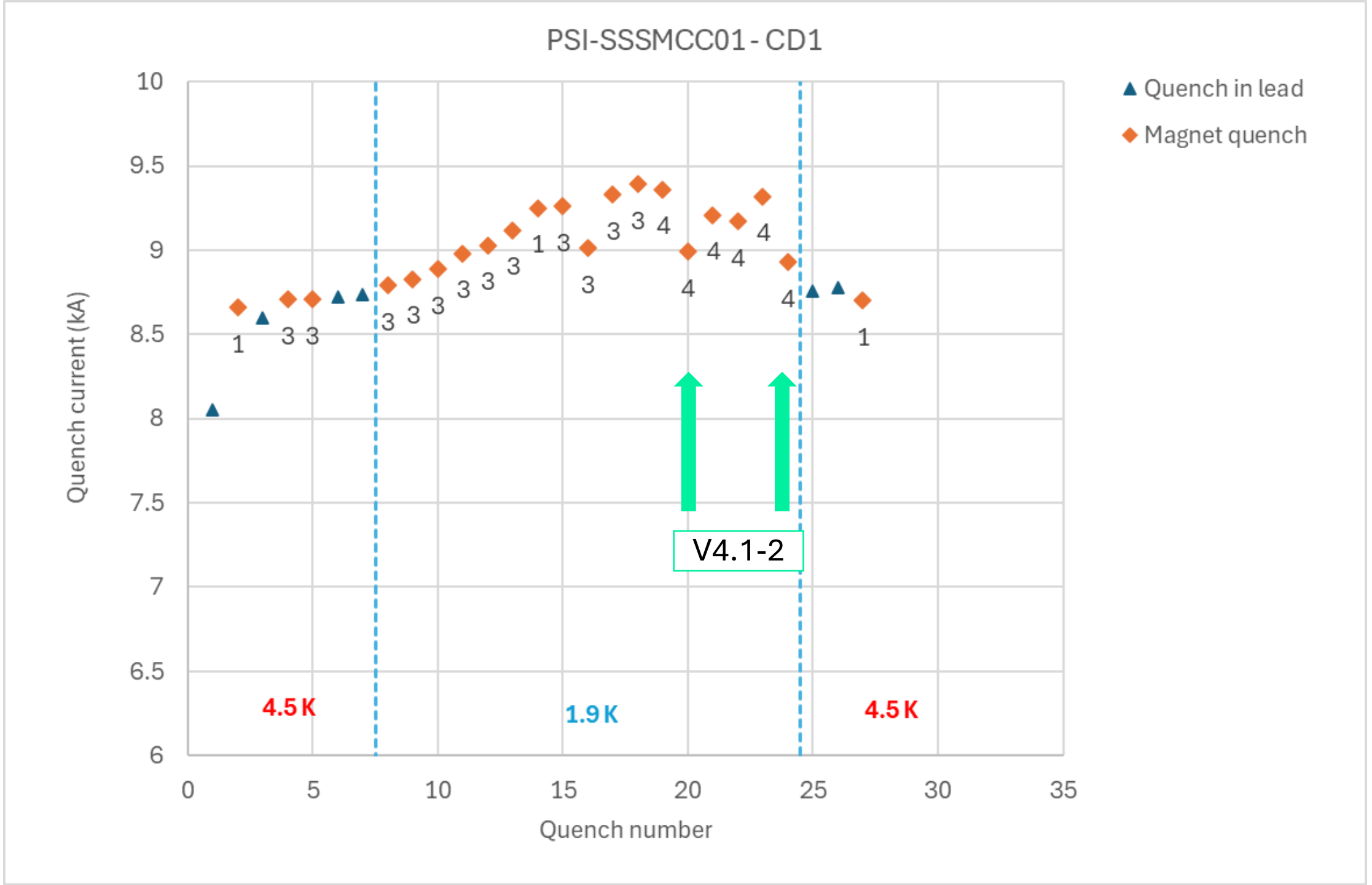


Event 18: 1st CD - 1.9 K – Imax = 9.39 kA | Coil 3

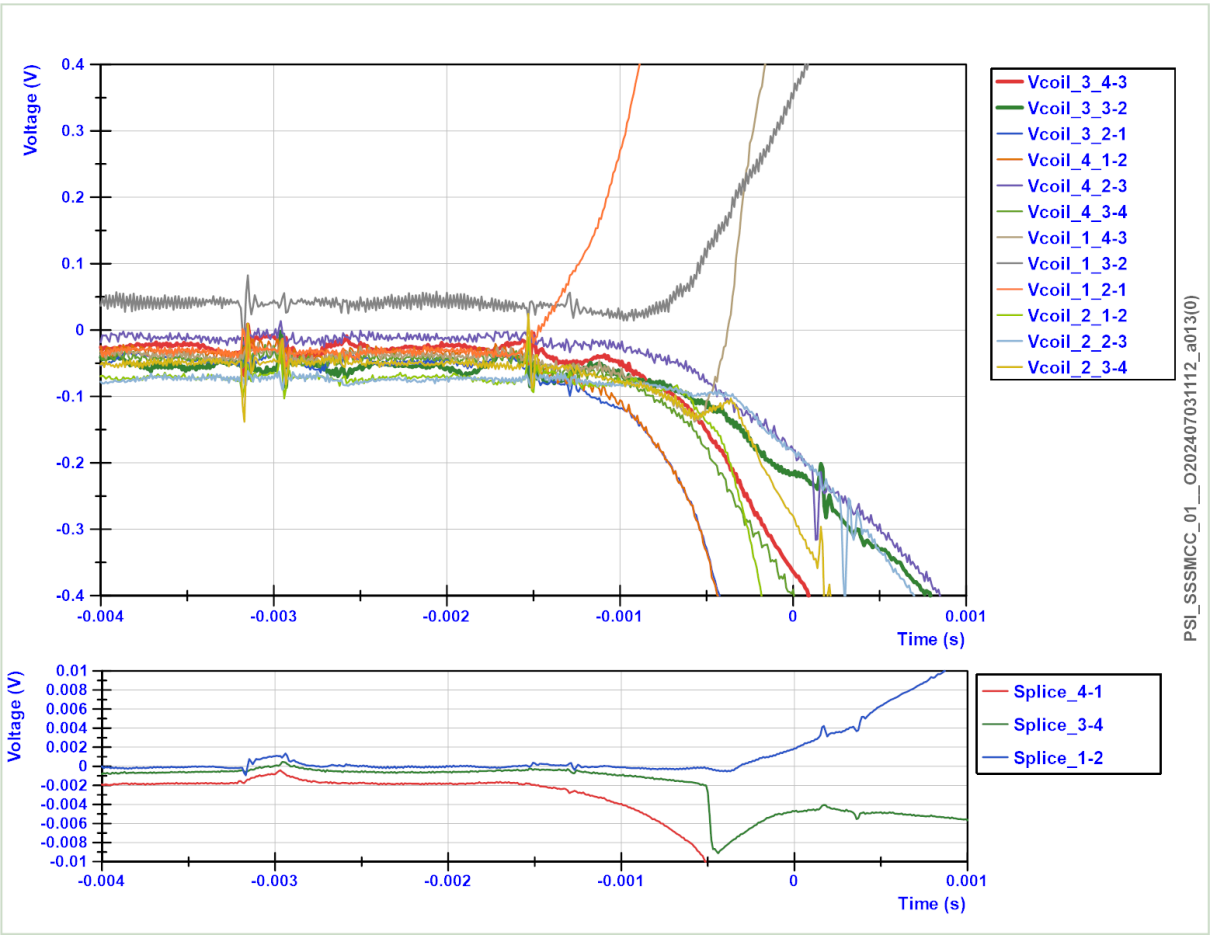


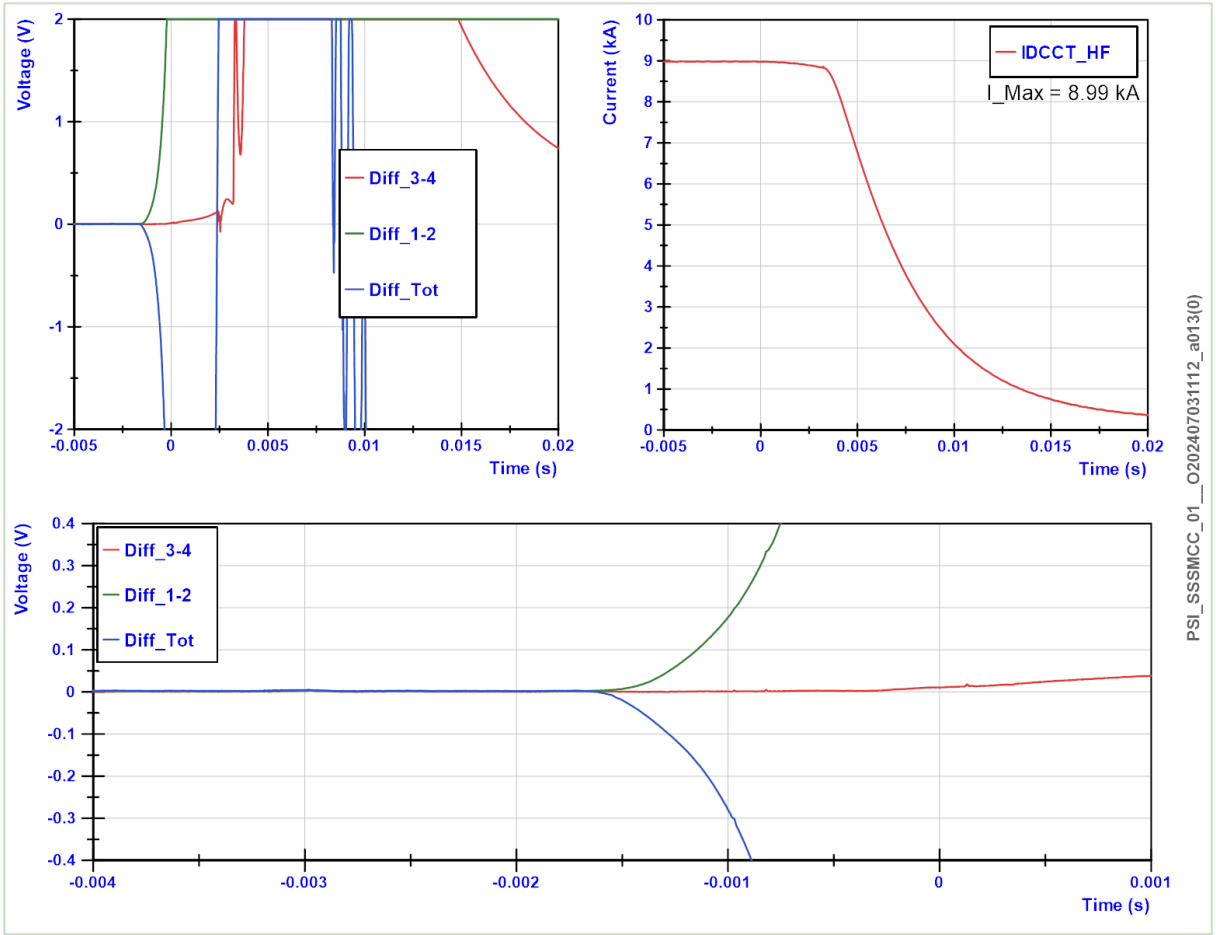


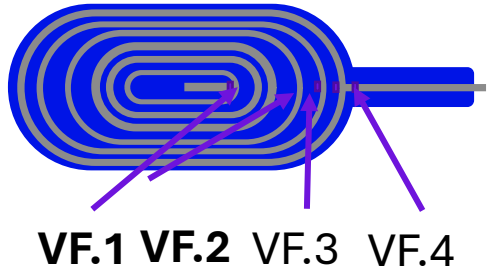



PSI-SSSMCC01 - CD1
Quench current (kA)
Quench number
Quench in lead
Magnet quench
10
9.5
9
8.5
8
7.5
7
6.5
6
0
5
10
15
20
25
30
35
4.5 K
1.9 K
4.5 K
V4.1-2

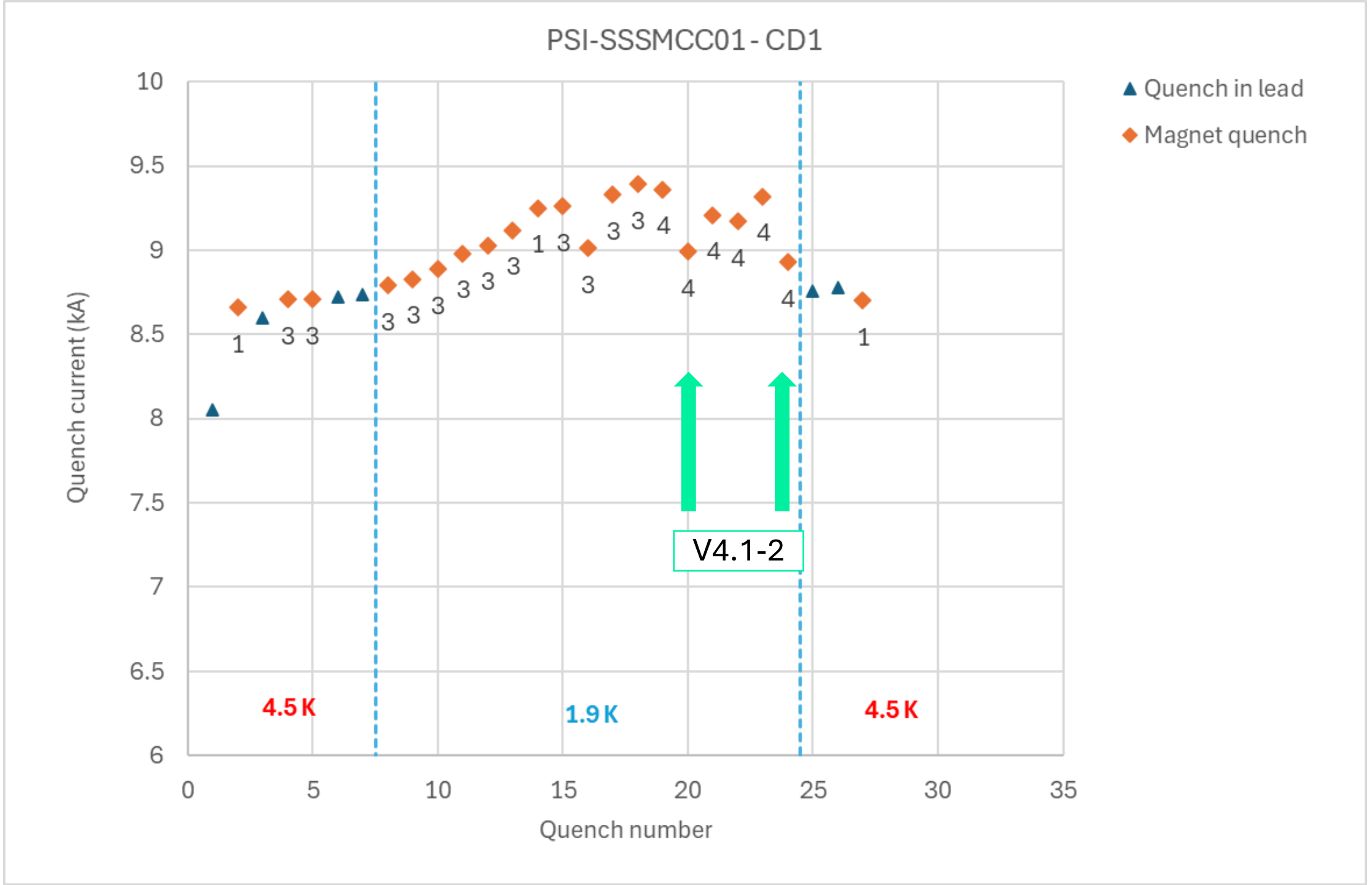
Event 24: 1st CD - 1.9 K – Imax = 8.99 kA | Coil 4



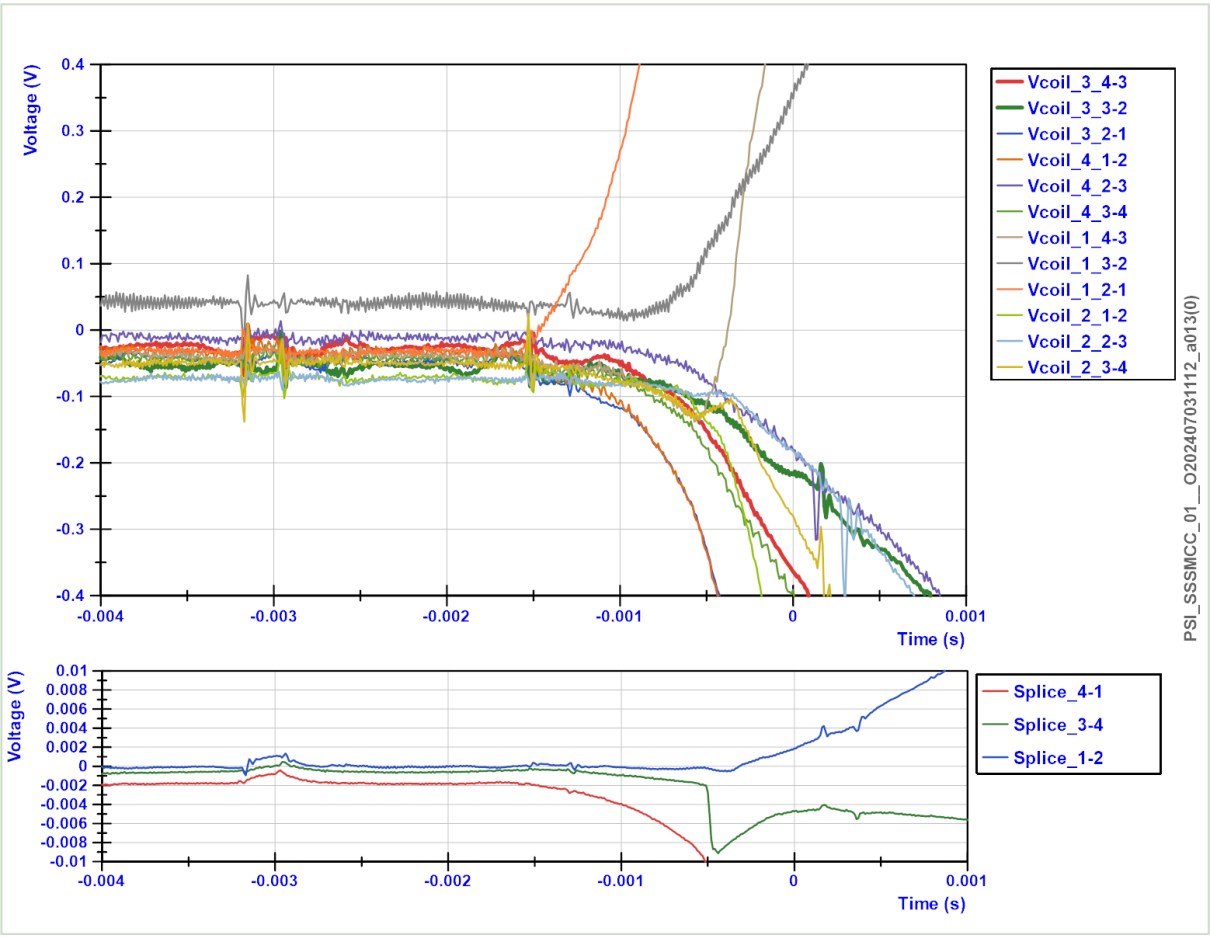


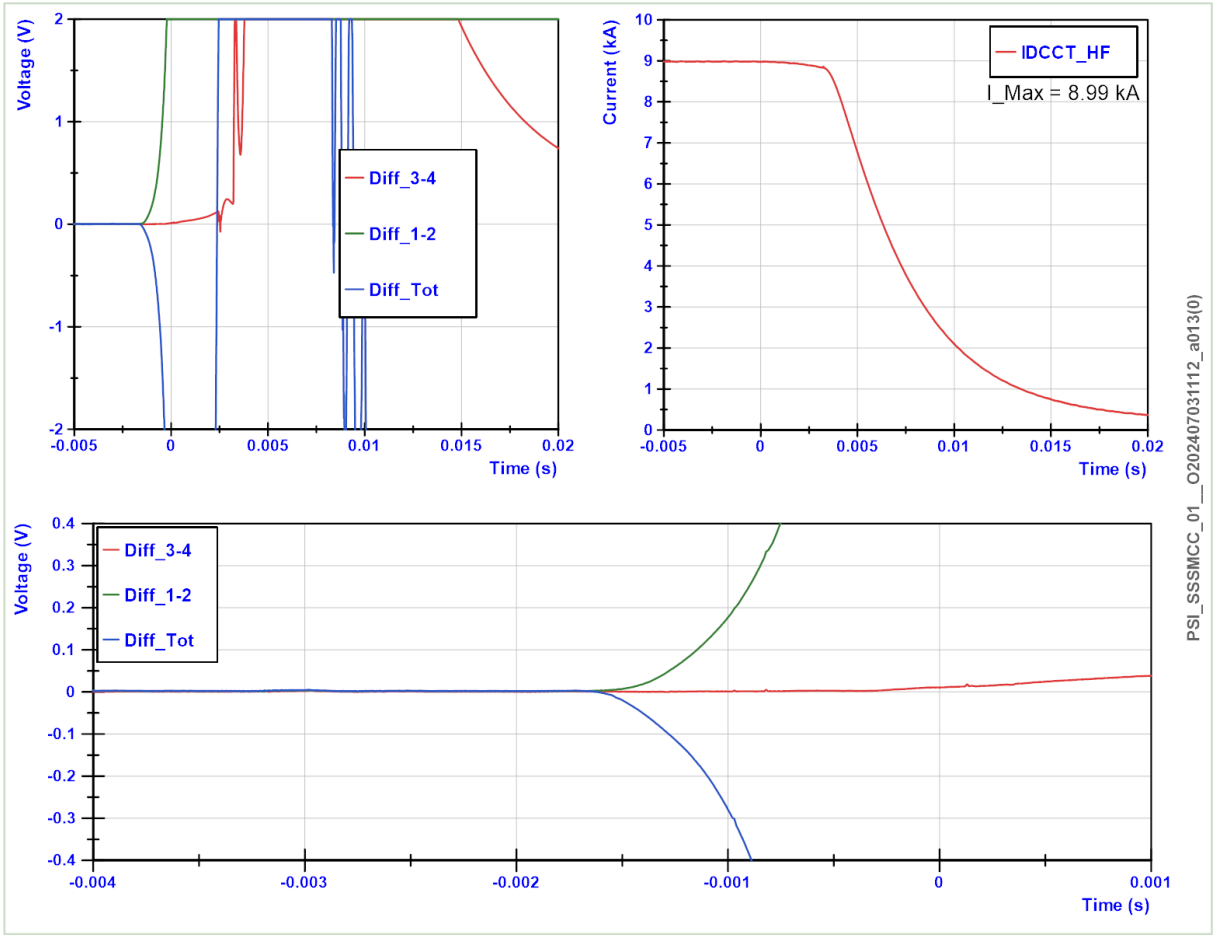


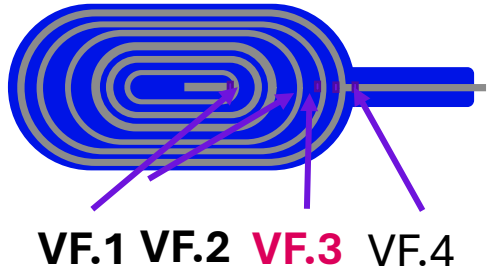
$I_{event18}$ – 400 A


PSI-SSSMCC01 - CD1
Quench in lead
Magnet quench
Quench current (kA)
Quench number
10
9.5
9
8.5
8
7.5
7
6.5
6
0
5
10
15
20
25
30
35
1
3 3
3 3 3 3 3 1 3 3 3 4
4 4 4 4
4
1
V4.1-2
4.5 K
1.9 K
4.5 K

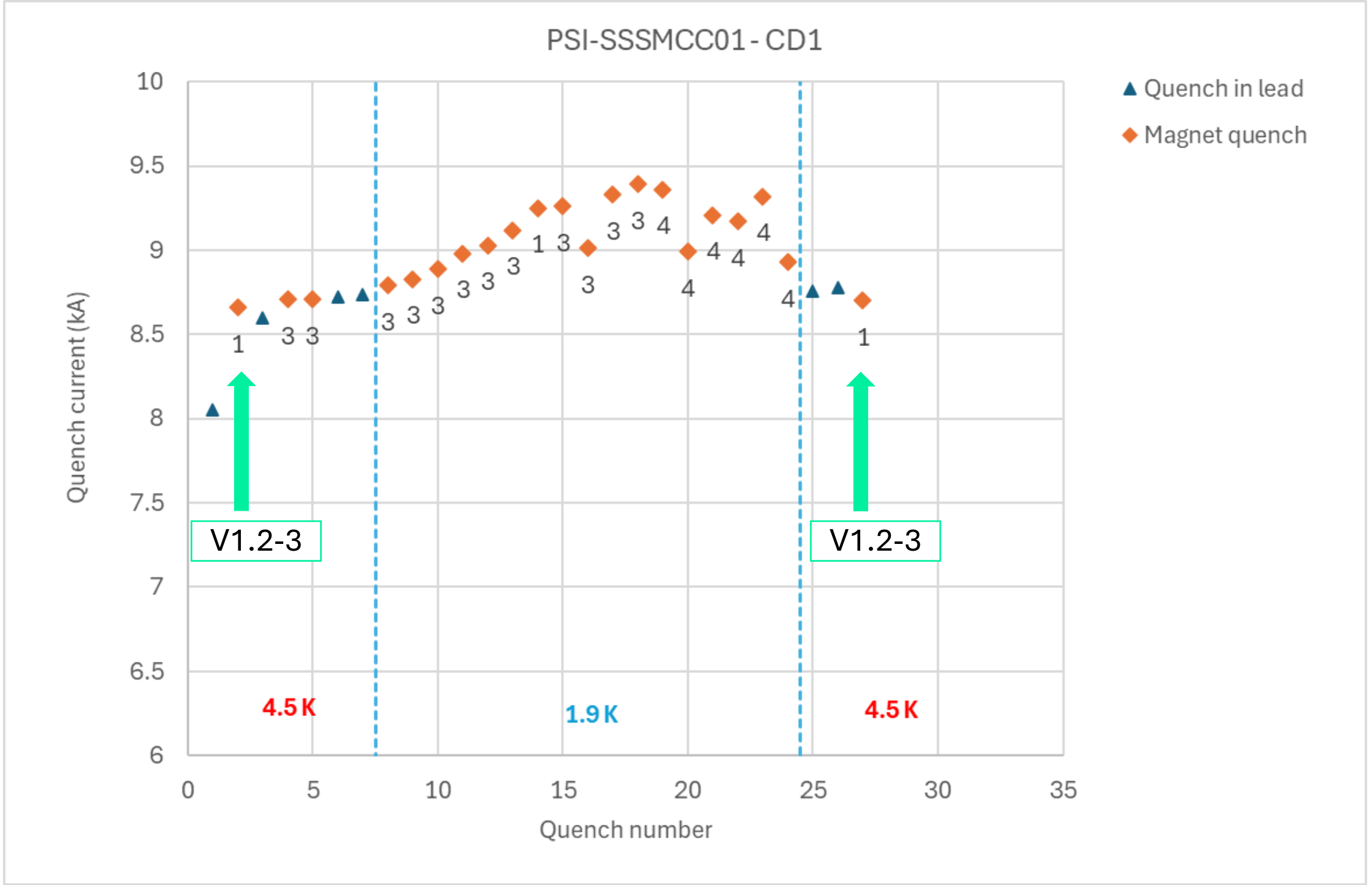
Event 24: 1st CD - 1.9 K – Imax = 8.99 kA | Coil 4



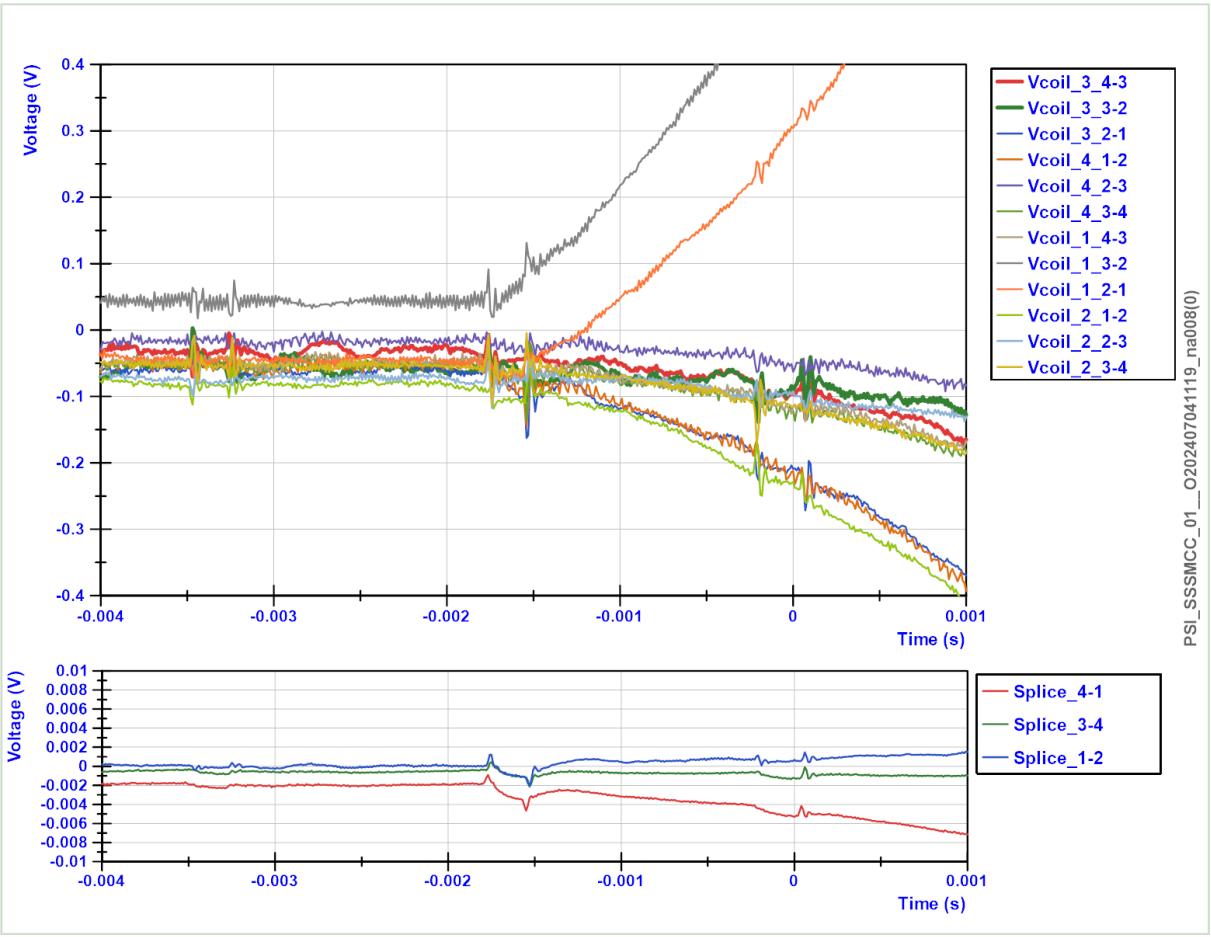


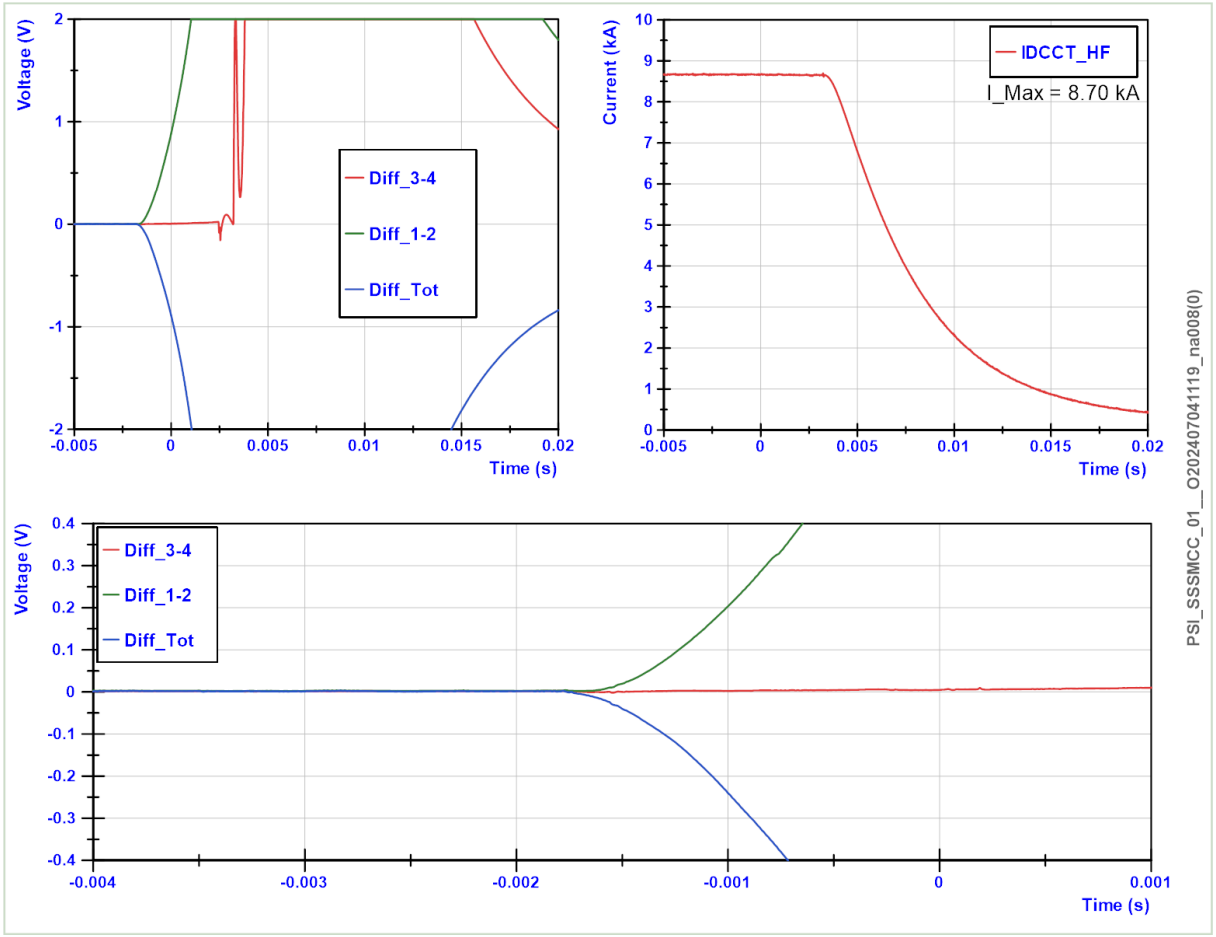


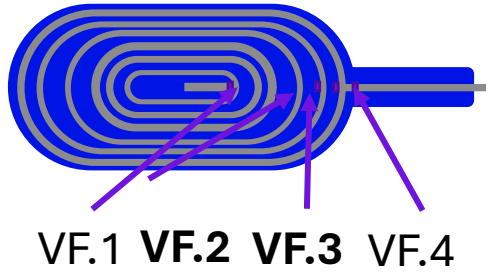
$I_{event18}$ – 400 A (4.3%)


PSI-SSSMCC01 - CD1
Quench current (kA)
Quench number
Quench in lead
Magnet quench
V1.2-3
V1.2-3
4.5 K
1.9 K
4.5 K

Event 27: 1st CD - 1.9 K – Imax = 8.7 kA | Coil 1



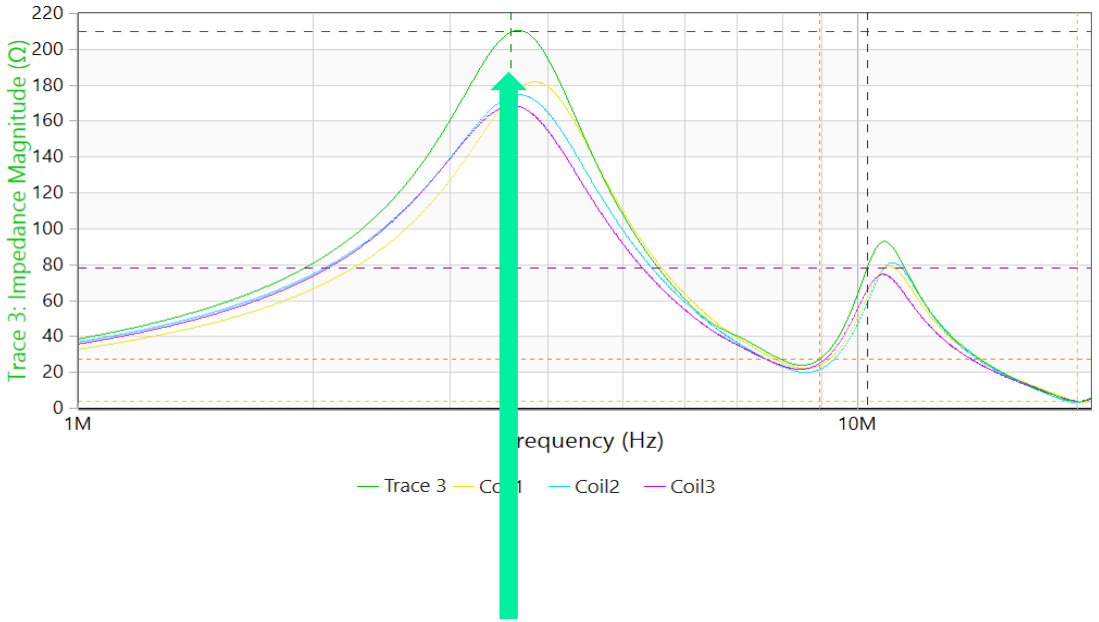




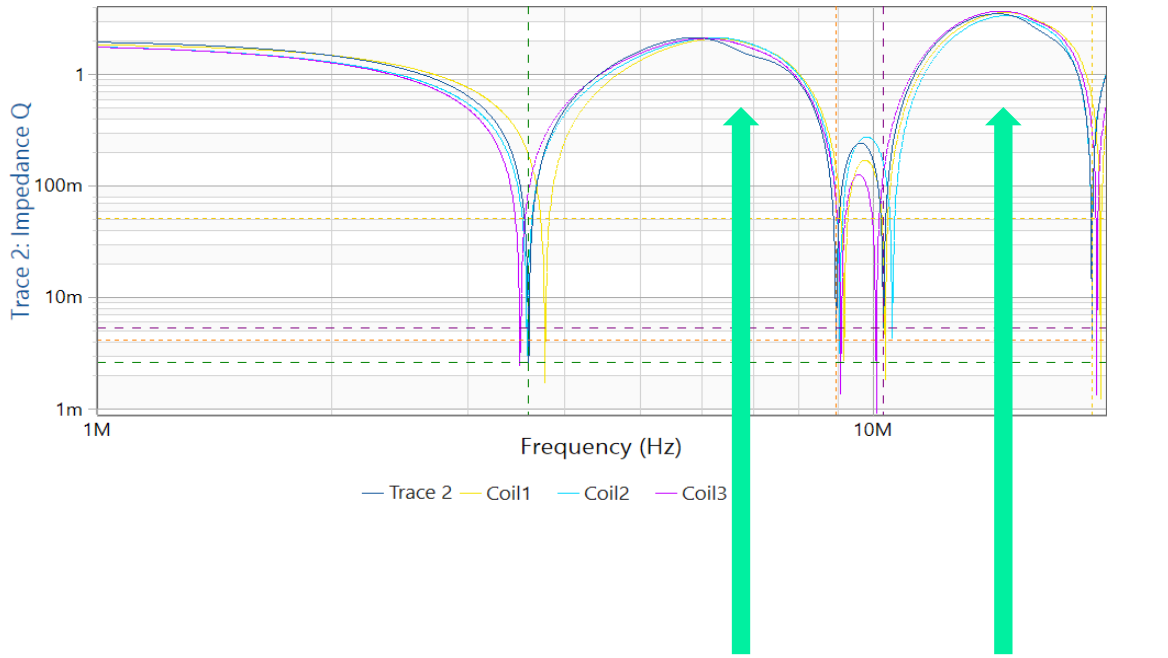
I_{event2} = 8.66 kA

Impedance measurements

Measurement: One-Port



Measurement: One-Port



Coil 4 deviates from de others