



SMACC2: feasibility study and initiative on Nb-Ti wire and cable with low copper content

PSI/CERN LTS WP Progress Meeting

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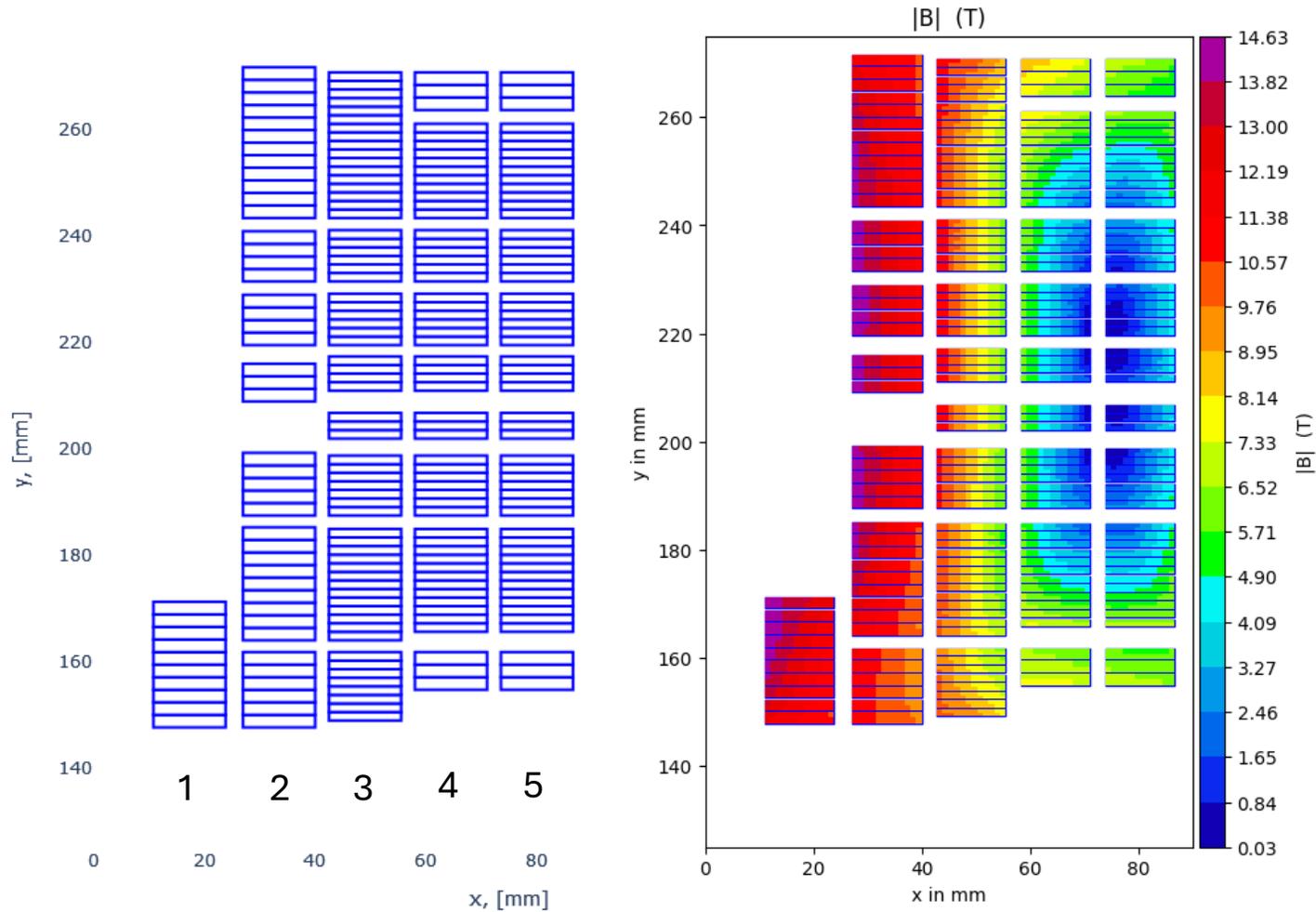
November 2025

Agenda

Feasibility study

Initiative on Nb-Ti wire and cable with low copper content

Magnet Parameters (V4)

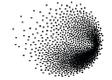


parameter	value	unit
Bore	50	mm
Intra-beam	400	mm
T_{op}	1.9	K
B_0	13.97	T
B_{peak}	14.63	T
I_{op}	10.5	kA
Load line Margin	18	%
F_x	17.8	MN/m
F_y	0.5	MN/m

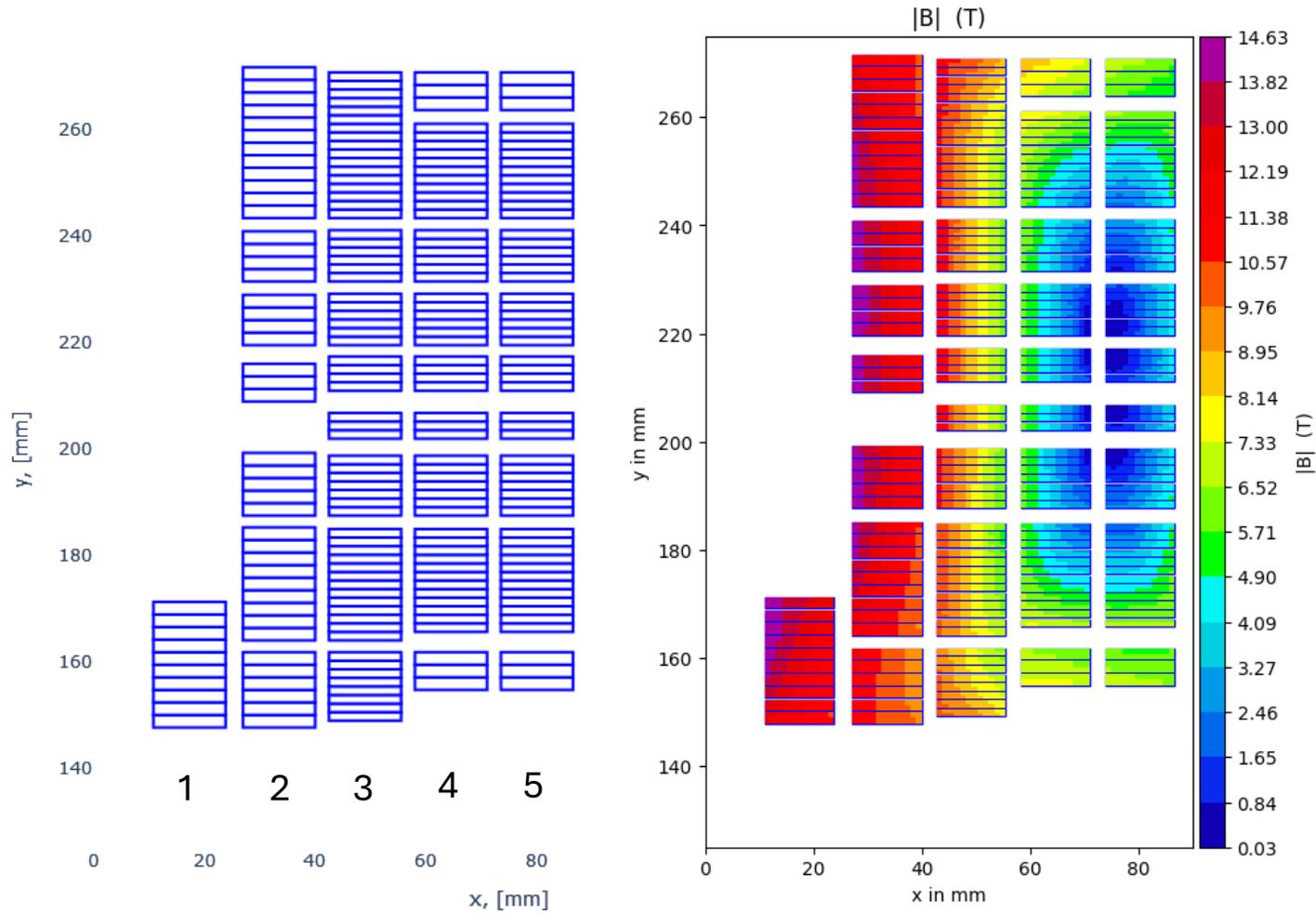
Magnet Parameters (V4)



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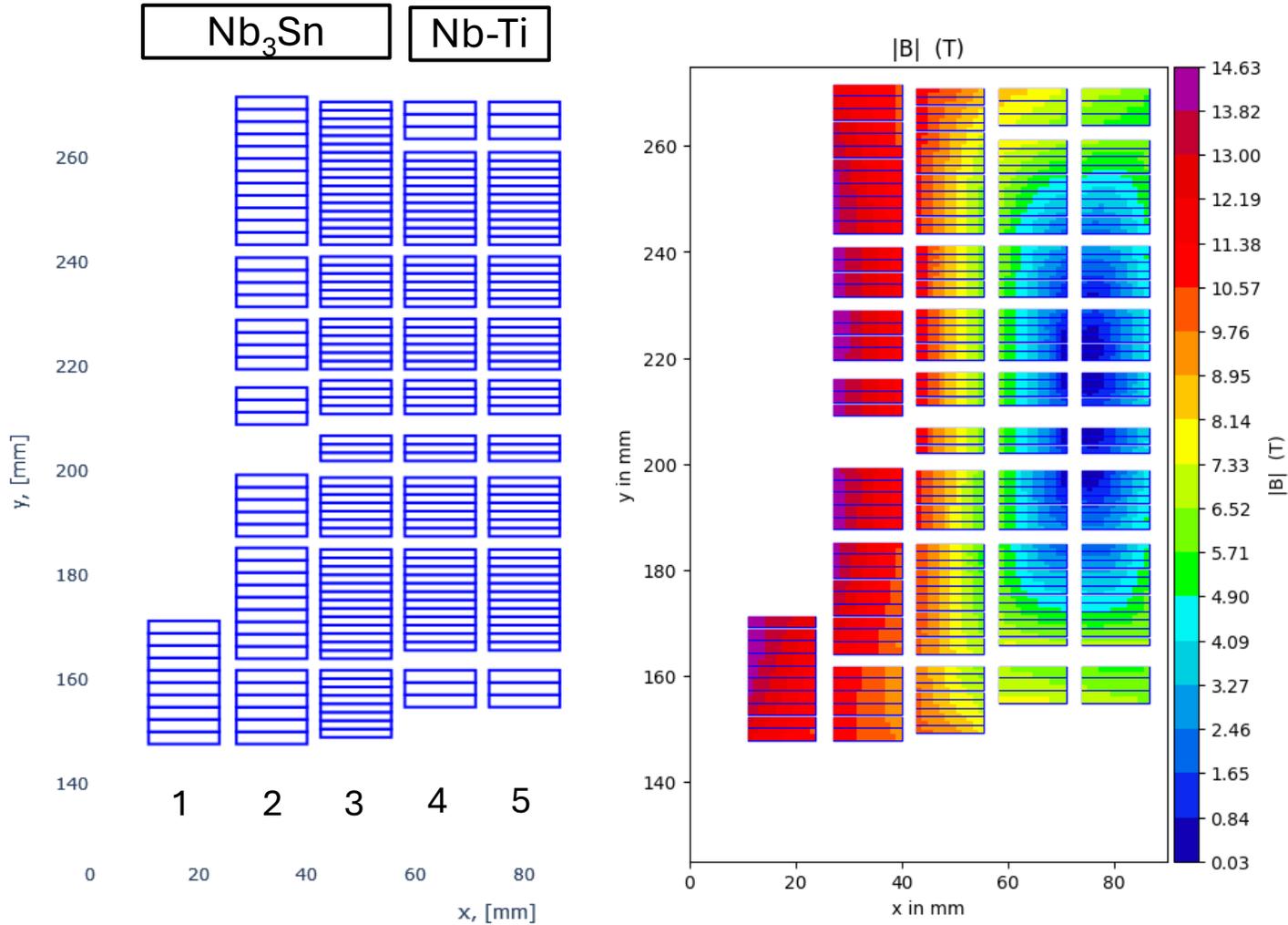


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@14 T Multi poles	value	unit
a2	2.6	10 ⁻⁴
a4	-8.5	
a6	10.7	
a8	2.7	
b3	12.0	
b5	-1.6	
b7	-2.6	
b9	-0.8	

Cable Parameters (V4)

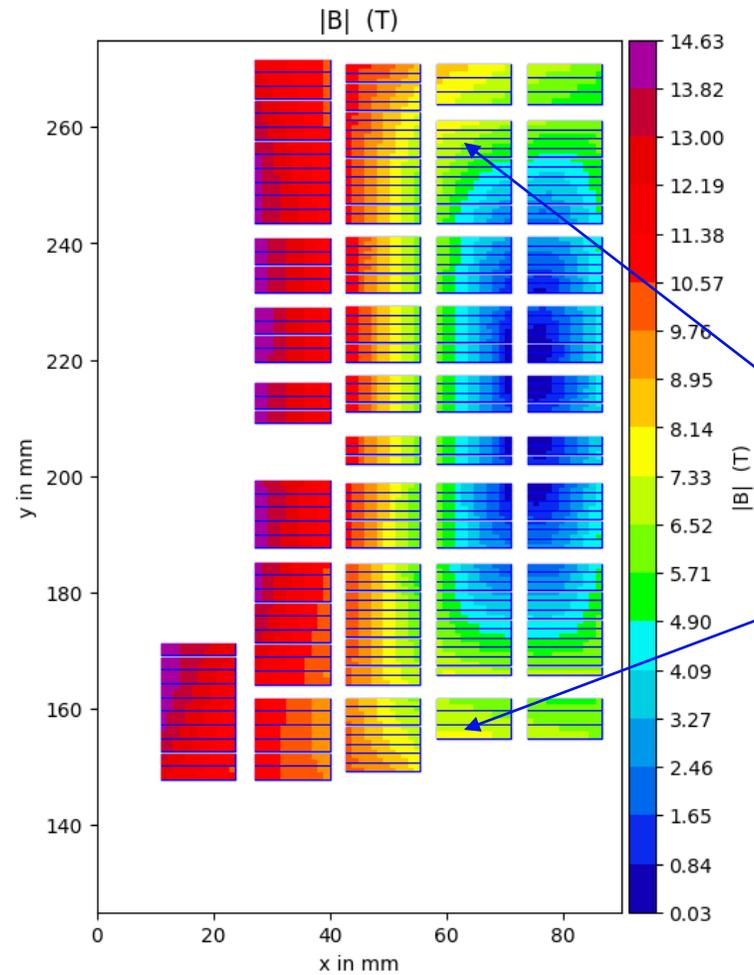
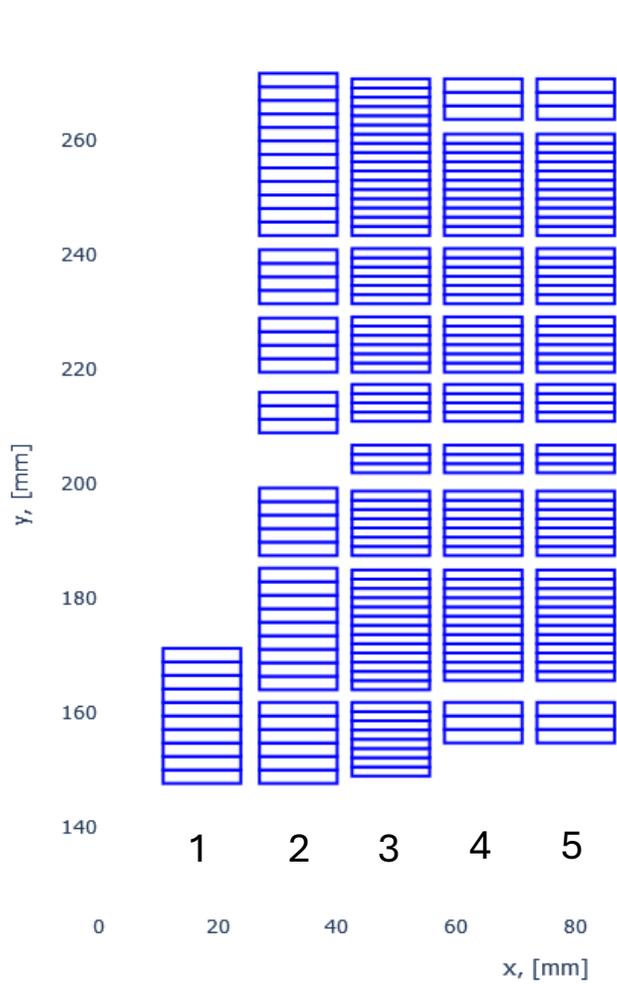
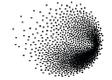


Layer	LTS Type	Turns
1	Nb ₃ Sn	10
2		43
3		64
4	NbTi	6 + 49
5		

Layer	Number of strands	Strand type and diameter in mm
1	21	RRP 162/169 - 1.1
2		
3	34	RRP 78/91 - 0.7
4 - LF	34	Nb-Ti 0.7
5 - LF		
4 - HF	21	Nb-Ti 1.1
5 - HF		

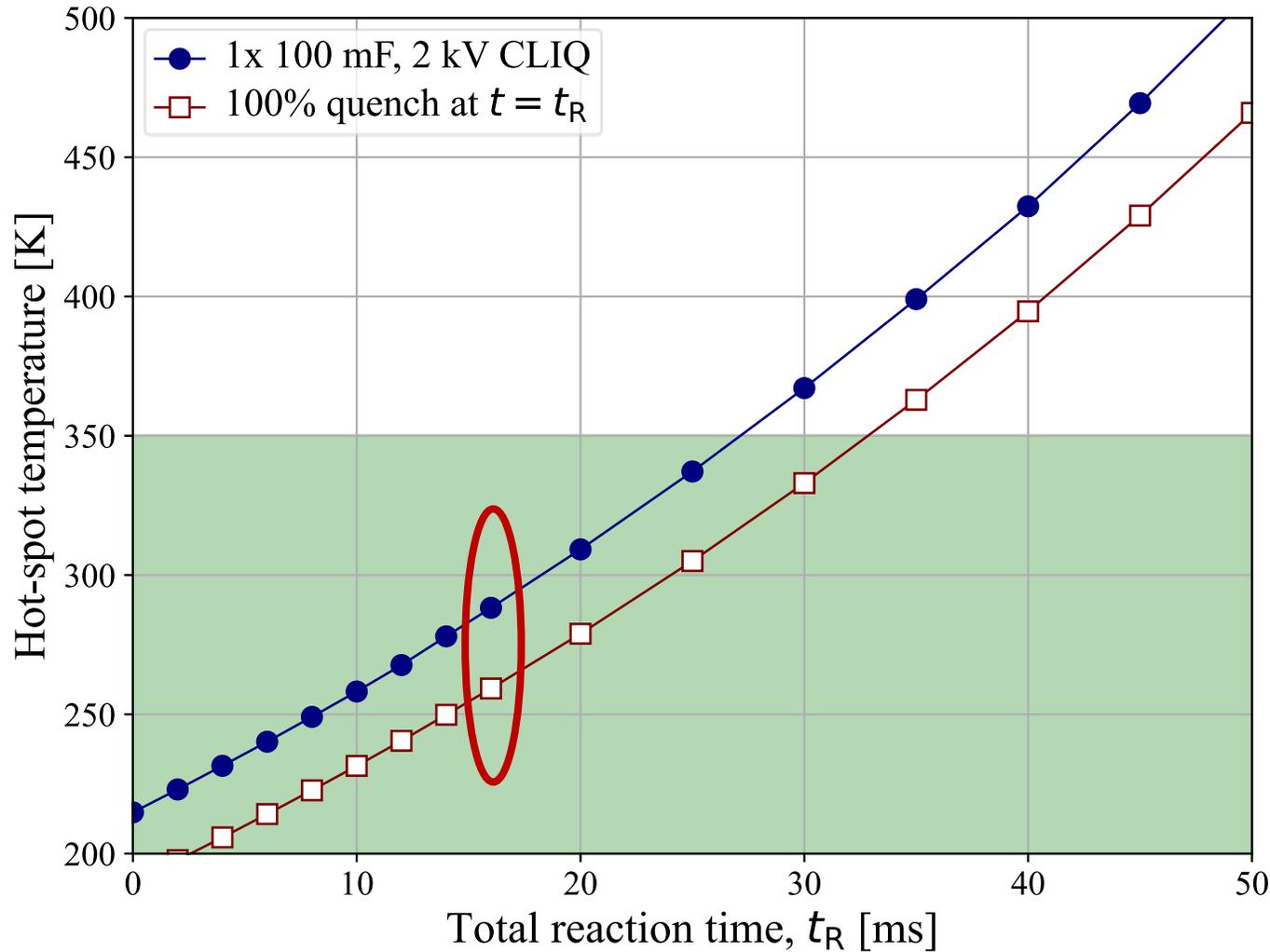
In this version, the Nb₃Sn and Nb-Ti HF and LF cables have the same number of strands and the same strand diameter.

Magnet Parameters (V4)



Layer 4 thin conductor peak
field >
On Layer 4 thick conductor
The inner blocks could use
the thin conductor

Hot-spot temperature as a function of total reaction time



The total reaction time t_R is the sum of quench detection time, validation time, and trigger time.

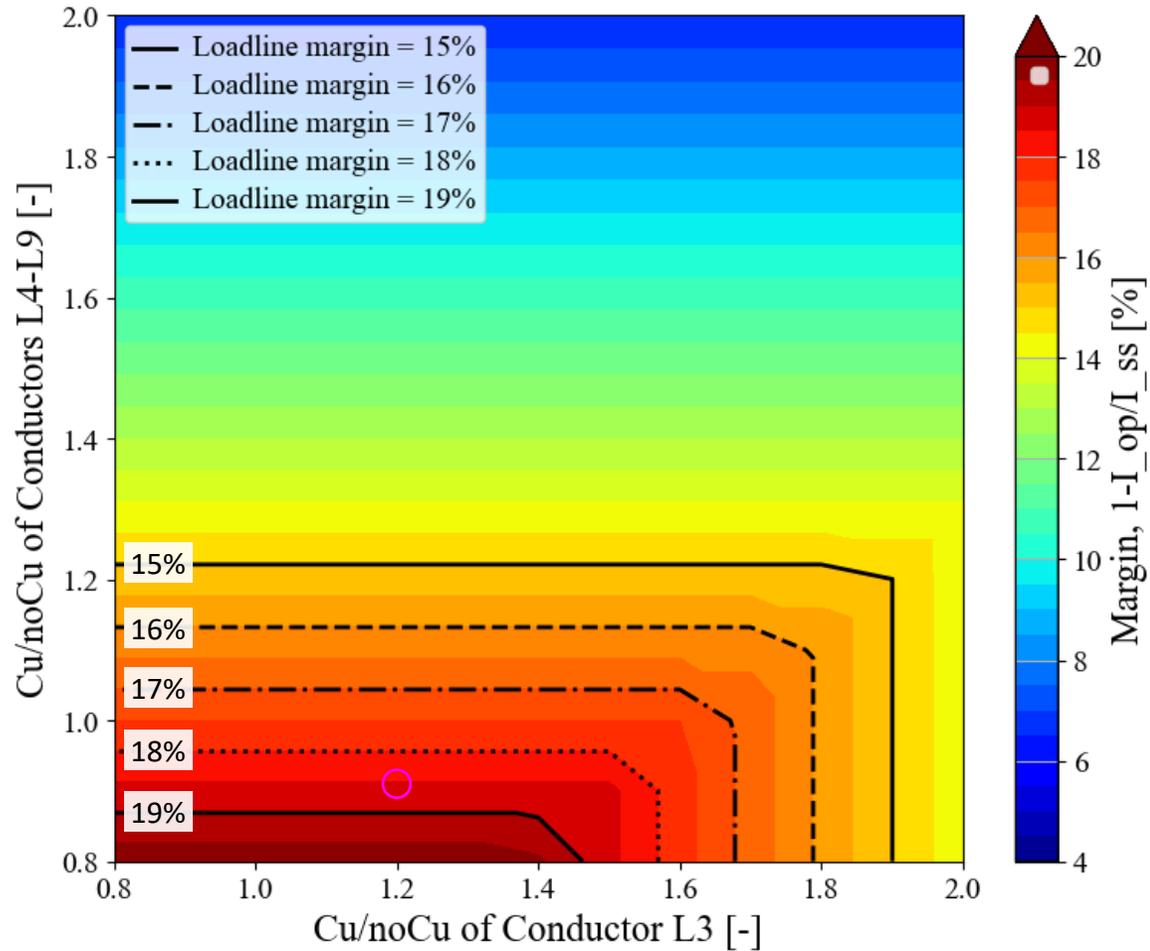
The adiabatic hot-spot temperature can be kept

<300 K with $t_R < 18$ ms

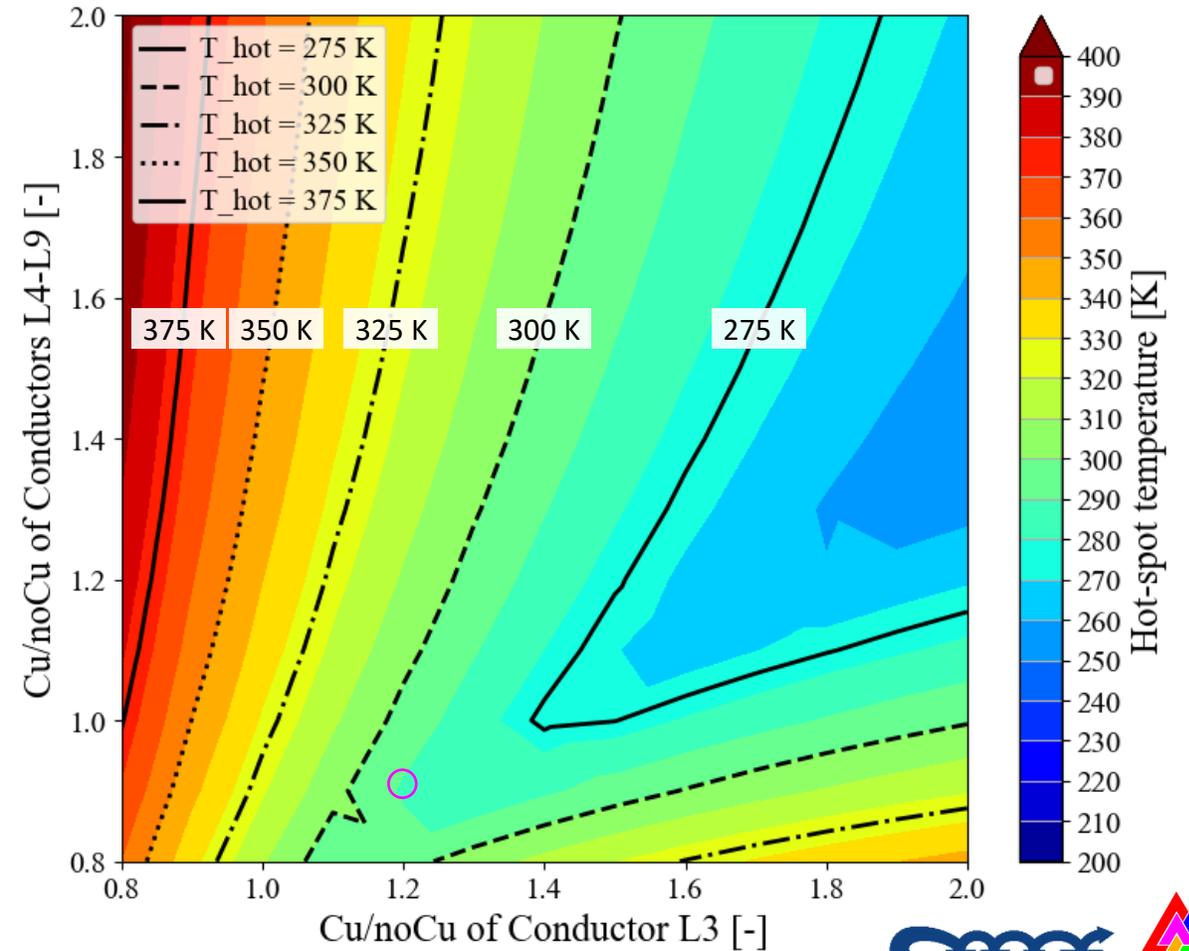
<350 K with $t_R < 27$ ms

SMACC2_V4 parametric study – Varying Cu/noCu in L3 and L4-9 PSI

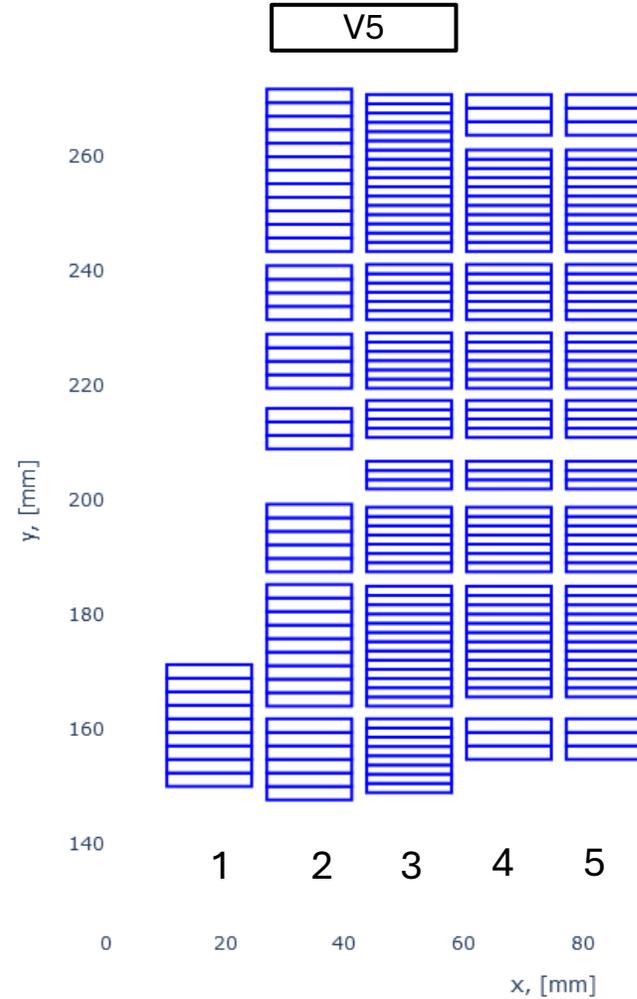
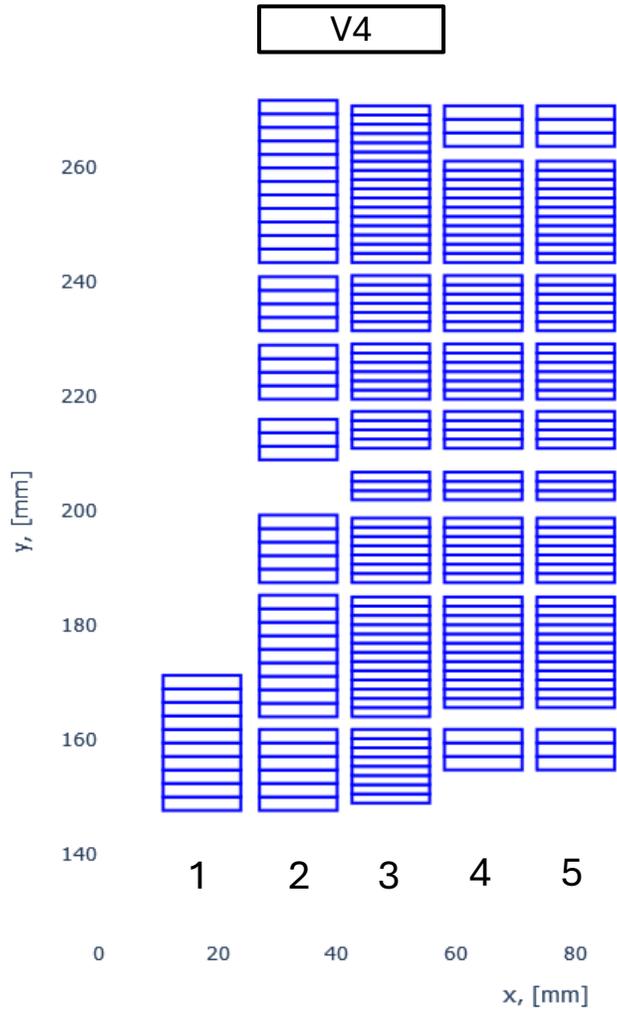
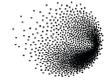
Margin $1-I_{op}/I_{ss}$ in L3-9



Hot-spot temperature



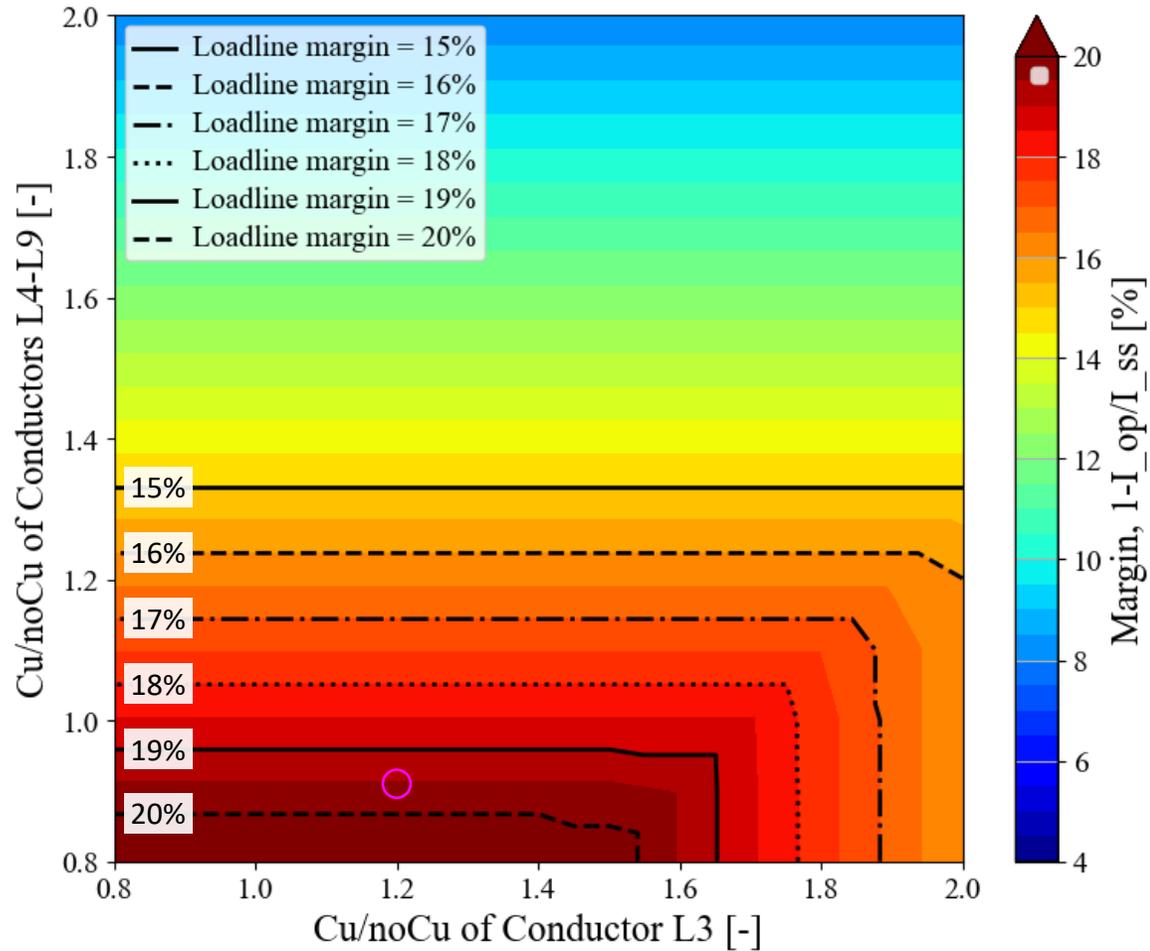
Magnet Parameters (V4&V5)



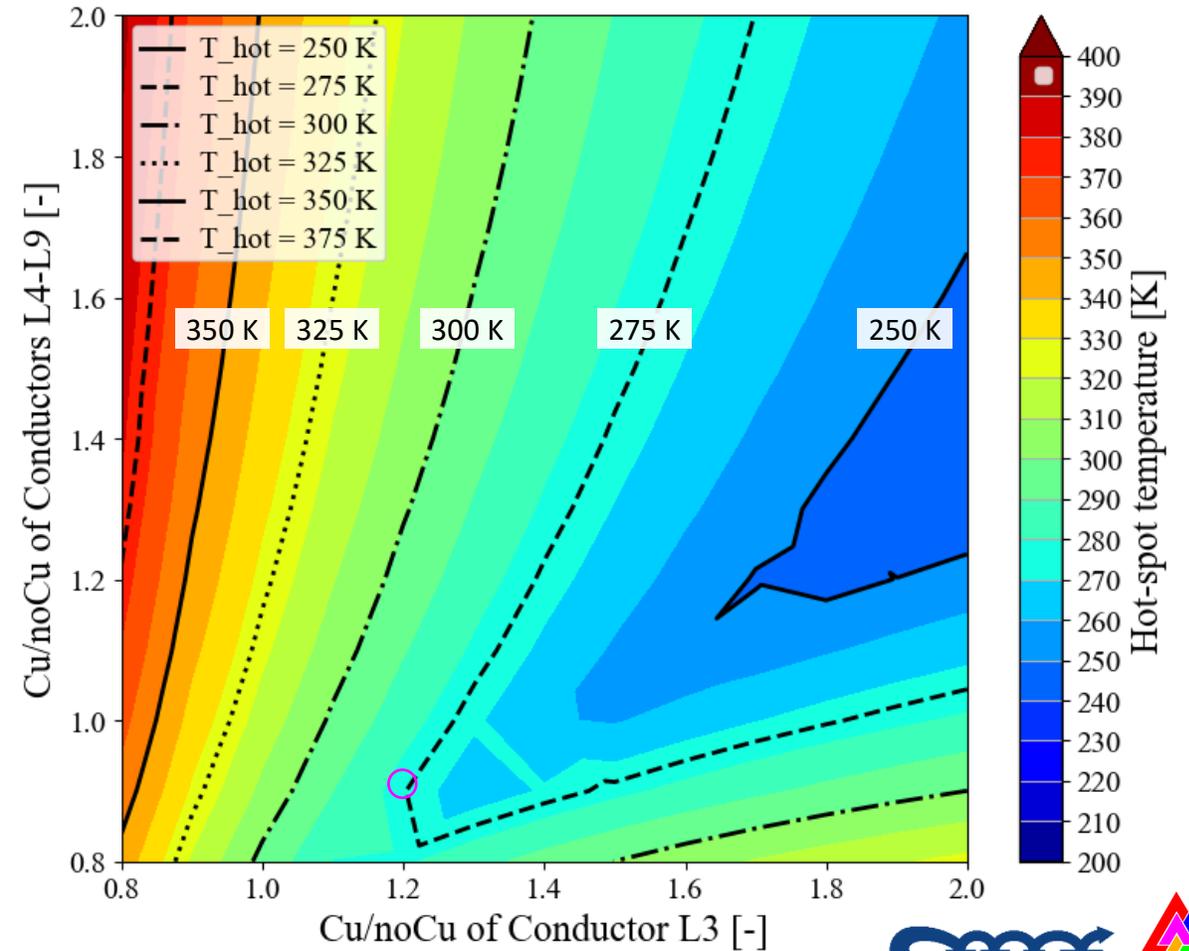
parameter	V4	V5
Bore	50 mm	
Intra-beam	400 mm	
T_{op}	1.9 K	
B_0	14 T	
B_{peak}	14.63	14.61
I_{op} in kA	10.5	10.78
Load line Margin in %	18.5	19.5 + 1 %
Strand Area in mm ²	13667	14822 + 8.5%

SMACC2_V5 parametric study – Varying Cu/noCu in L3 and L4-9 PSI

Margin $1-I_{op}/I_{ss}$ in L3-9



Hot-spot temperature



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Nb-Ti Conductor



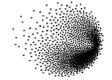
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- We discussed with Nb-Ti wire manufactures and the conductor with a Cu/Non-Cu ratio of 0.9 to match the SMACC2 requirements **can be produced**.
- Such a wire is not an existing product and would require **8 to 10 months of lead time**.
- The manufacturability of the Rutherford cable, due to the low copper content, which may require post-heat-treatment optimization, is to be studied.
- One of the manufactures currently has Nb-Ti conductor (diameter of ~1.5 mm) with a Cu/Non-Cu ratio of 0.85 but lower I_c available off the shelf. This material could be used to manufacture a test cable and to try different post-heat-treatment to assess manufacturability and I_c degradation due to cabling.

Nb-Ti / Nb₃Sn Conductor: tentative plan



	Q3/2025	Q4/2025	Q1/2026	Q2/2026	Q3/2026	Q4/2026	Q1/2027	Q2/2027	Q3/2027	Q4/2027	Q1/2028
Procurement of existent Nb-Ti 0.85 Cu/Ncu	█	█									
Cabling with 2 or 3 different heat treatments			█								
Ic round vs extracted samples				█							
Winding trials				█							
Finalize SMACC2 Cable Design	█	█	█	█	█						
Procurement of final wire						█	█	█			
Cabling with final wire and insulation Nb-Ti type 1									█	█	
Cabling with final wire and insulation Nb-Ti type 2										█	█
Beginning of SMACC2 Nb-Ti coils production											█
Nb ₃ Sn Cable manufacturing and insulation run type 1						█	█				
Nb ₃ Sn Cable manufacturing and insulation run type 2						█	█	█			
Beginning of SMACC2 Nb ₃ Sn coils production								█	█	█	█

The PO for Nb-Ti wire for post-heat-treatment, sharp-bending tests, cabling, and Ic-reduction studies has been placed.