

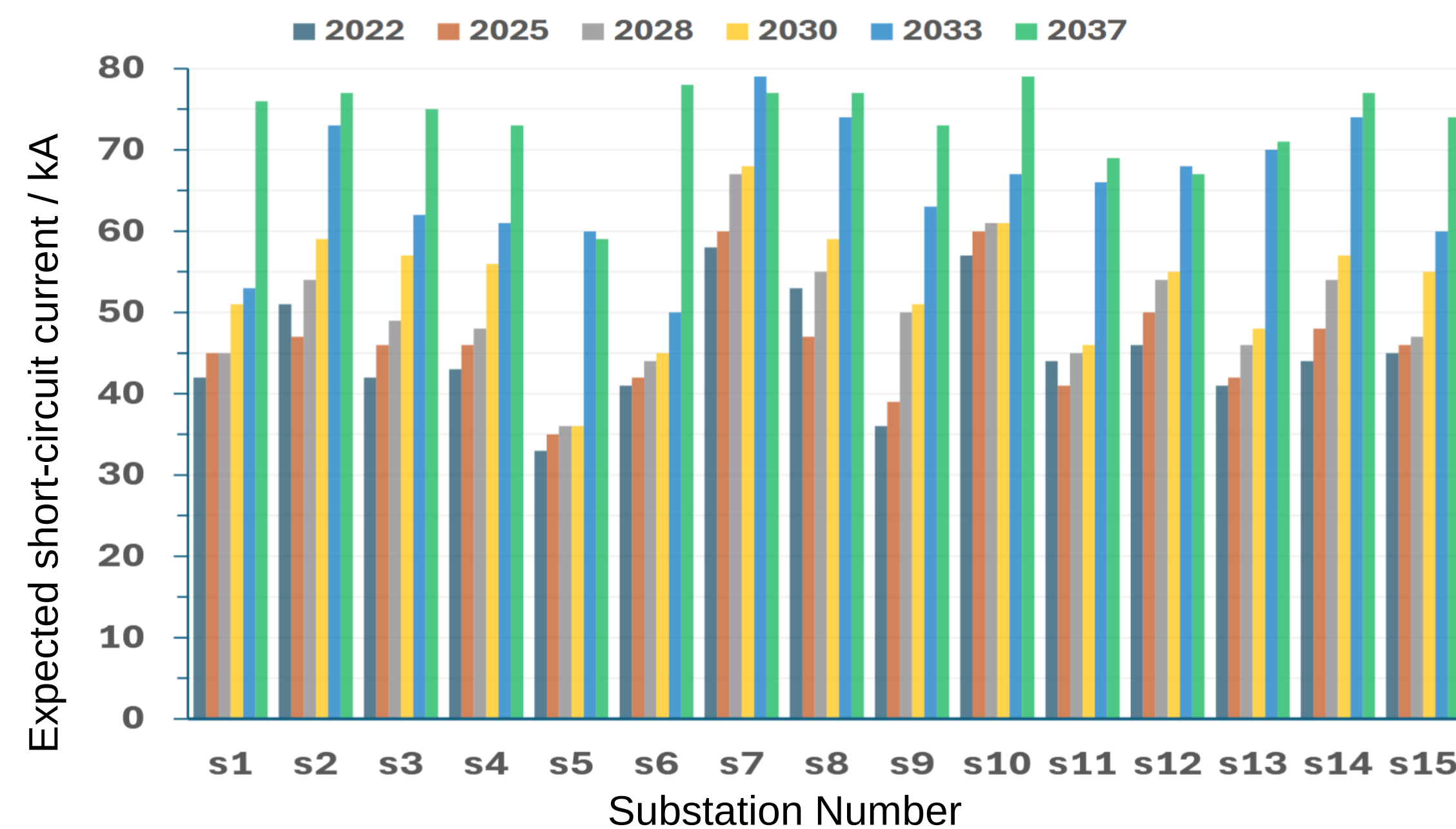


Qualification and testing of coated conductor tapes for high-voltage resistive type superconducting fault current limiter

Mathias Noe¹, Andreas Kienzler¹, Sonja Schlachter¹, Simon Kasper¹, Wesley Batista de Sousa¹, Quoc Hung Pham¹, Johann Willms¹, Sven Lautensack¹, Steffen Elschner¹, Christof Humpert², Daniel Zerbes², Alexander Büdding², Christian Schacherer³, Hannes Leuthold³, Bernhard Heil⁴, Matthias Stedler⁴, Ulrich Löffler⁴, Thomas Lainck⁵, Georgios Georgiadis⁶, Michael Peiß⁷, Volker Vahrenholt⁸

¹ Karlsruhe Institute of Technology, ² TH Cologne, ³ Siemens Energy, ⁴ HSP Cologne, ⁵ TenneT, ⁶ Amprion, ⁷ Transnet BW, ⁸ 50 Hertz

1) Motivation for 380 kV SFCL



Grid extension and increase in renewable energy lead to increased short-circuit currents

Alternative: Superconducting Fault Current Limiter

2) CURL380 Project Objectives

- Development and test of critical components of a 380 kV, 5 kA superconducting fault current limiter
 - HTS current limiting module and cryogenic 380 kV feedthrough
- Investigation of grid application scenarios for the most attractive locations
- Conceptual design of a complete 3 phase system
- Description of a follow-up project to develop and test a single phase 380 kV, 5 kA superconducting fault current limiter

3) 380 kV SFCL Requirements

Parameter	Value
Nominal voltage	380 kV (rms)
Nominal current	5 kA (rms)
Max. short circuit current	63 kA (1 s) (rms)
Max. limited current	19 kA (rms)
Fault duration	250 ms
Highest voltage (30 Min.)	440 kV (rms.)
Rated impulse lightning voltage (1,2/50 µs)	1425 kV (peak)
Chopped impulse lightning volt.	1570 kV (peak)

7 times more power than present state of the art

4) HTS Material and Module Specification

Material parameters

Tape width: 12 mm
 Substrate material: Hastelloy
 Substrate thickness: 50 µm
 Ag thickness: 2 µm
 Tape width: 12 mm
 Min. average I_c : 700 A at 77 K, sf
 I_c Homogeneity: $\pm 10\%$

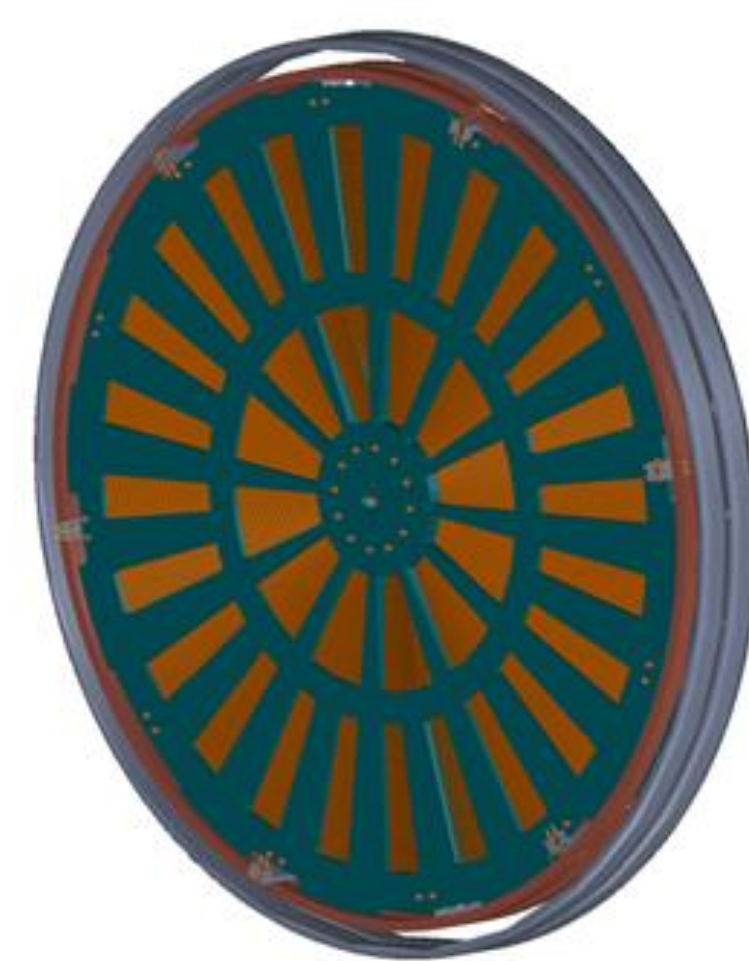
Insulated twin tapes



Module parameters

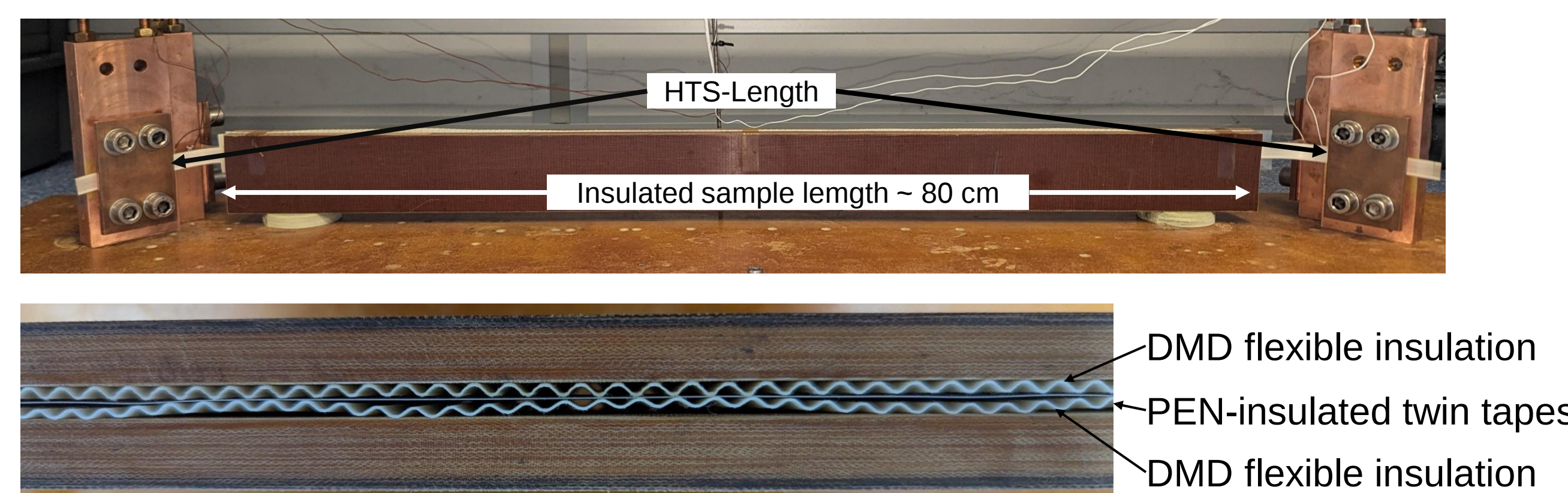
6 bifilar coils in parallel co-wound, made of insulated twin conductors (50 µm PEN insulation)
 Single piece length: 45,8 m
 Inner diameter: 200 mm
 Outer diameter: 1200 mm
 Total no. of modules: 90 for a single phase SFCL

One module

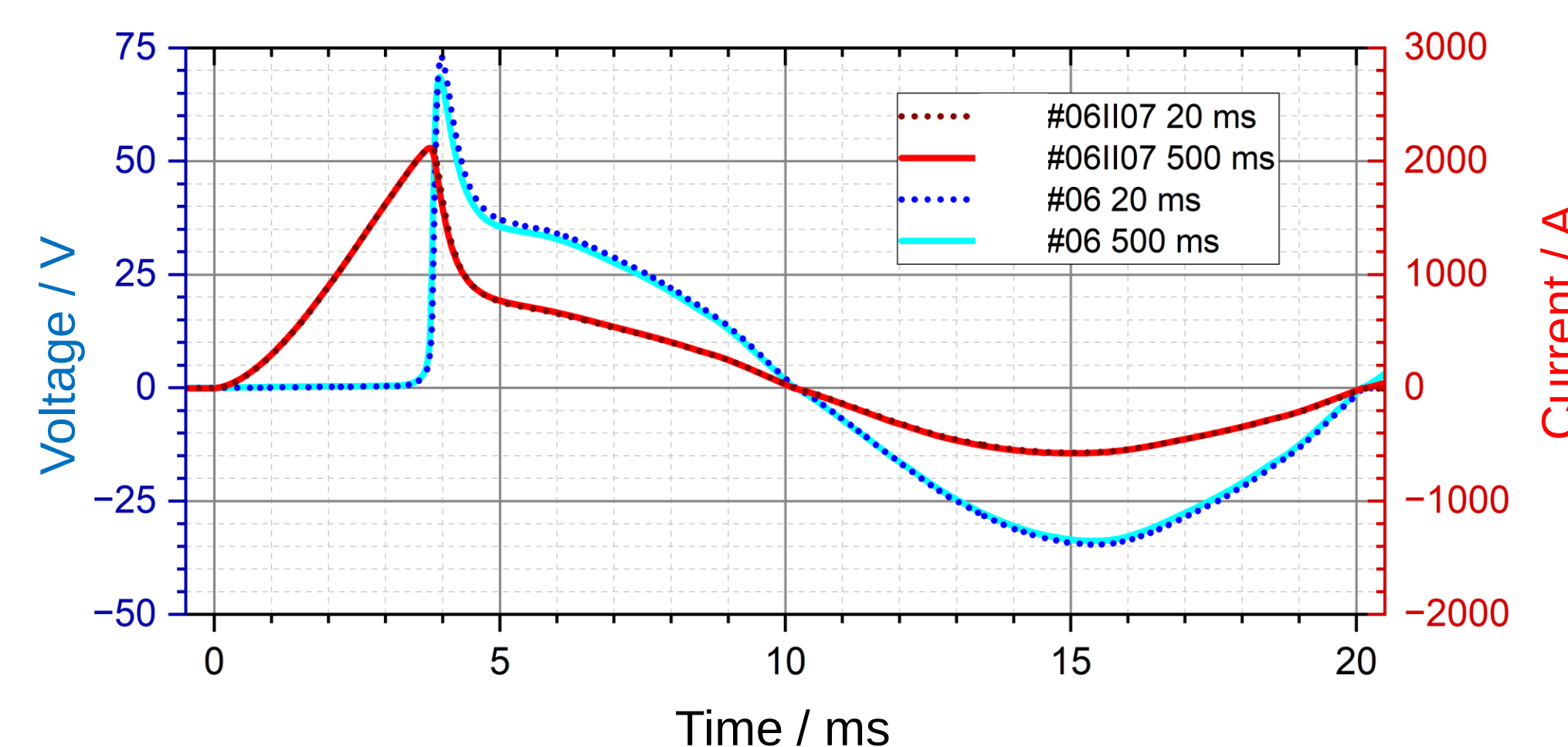


5) Material Pre-qualification

Setup for short-circuit tests



Typical current-voltage curve at short-circuit



6) Project Status

Project start: April 1st, 2025

Tests with short samples

June 2025: Delivery of material samples, each 50 m, from 7 companies
 June-October 2025: Pre-qualifications tests
 October 2025: 4 material manufacturers pre-qualified

Tests with subscale samples

Oct.2025-until now: Pre-qualification tests
 April 2026: Decision on preferred material manufacturer and material order

Status

July 2026: Delivery of 40 HTS tapes, each 60 m long, within specification

Next steps:

Extensive short-circuit testing and final setup for insulating the HTS twin tapes