

Development status of the HTS SECAS conductor for a full-size test sample



July 5, 2025

Abstract ID: Sat-Af-Spe1-04

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This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

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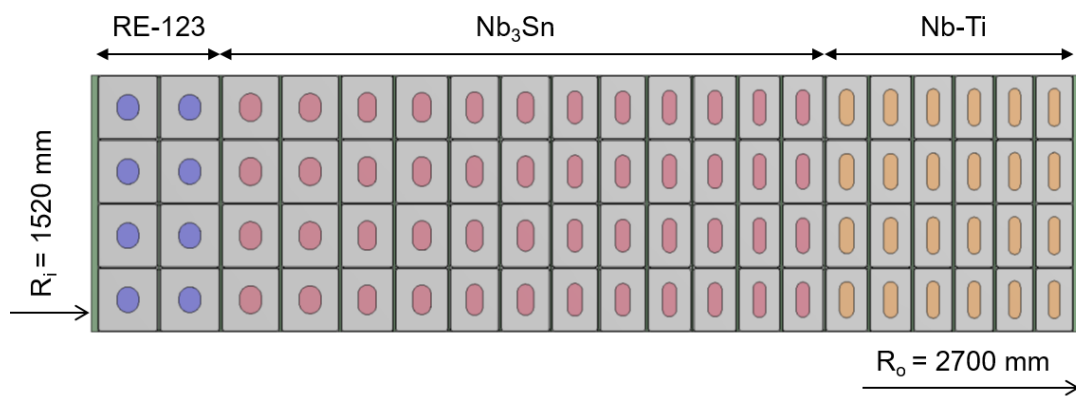
Introduction and Motivation



European DEMO Design studies

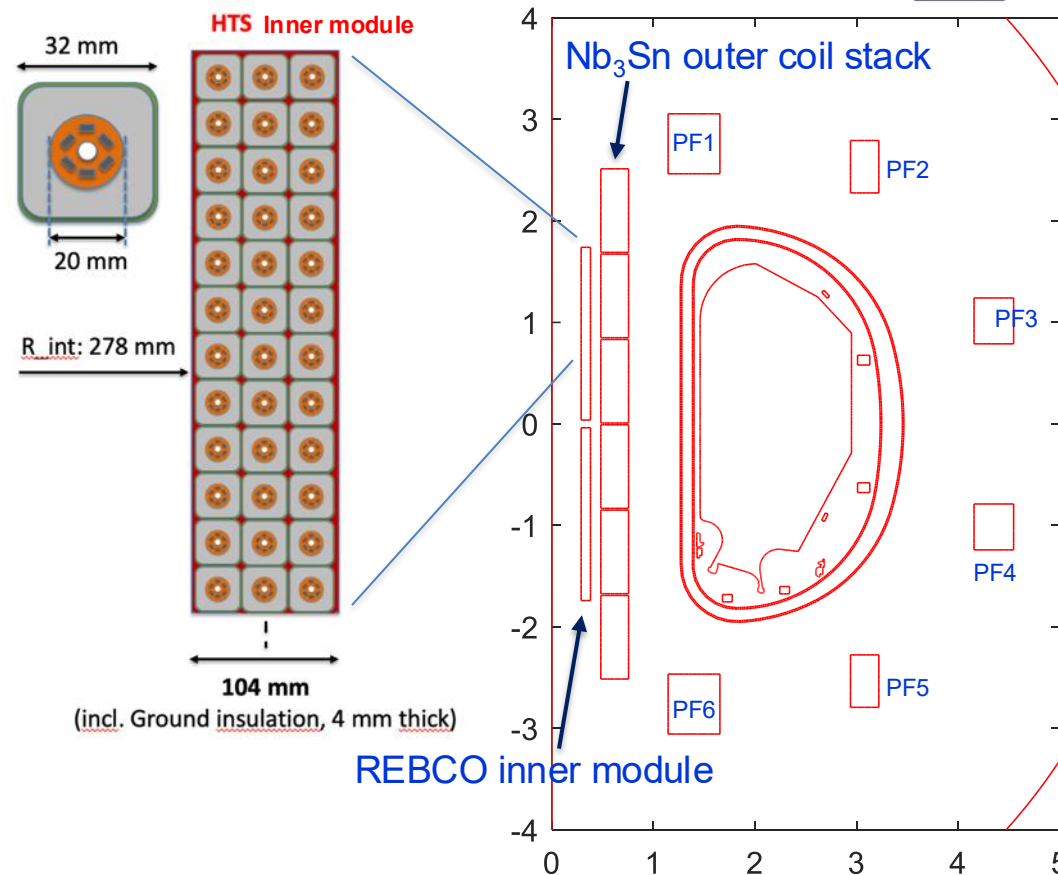
Strategic interest in developing high-current HTS conductors, *for example* for a **hybrid (LTS + HTS) Central Solenoid**, to improve performance, *i.e.* magnetic flux capability.

→ *Layer winding with grading on superconductor and stainless-steel.*



→ Corato - Sun-Mo-Or1-05

DTT Central Solenoid



The addition of the 7th HTS module allows a magnetic flux improvement of about 10%



European DEMO Design studies

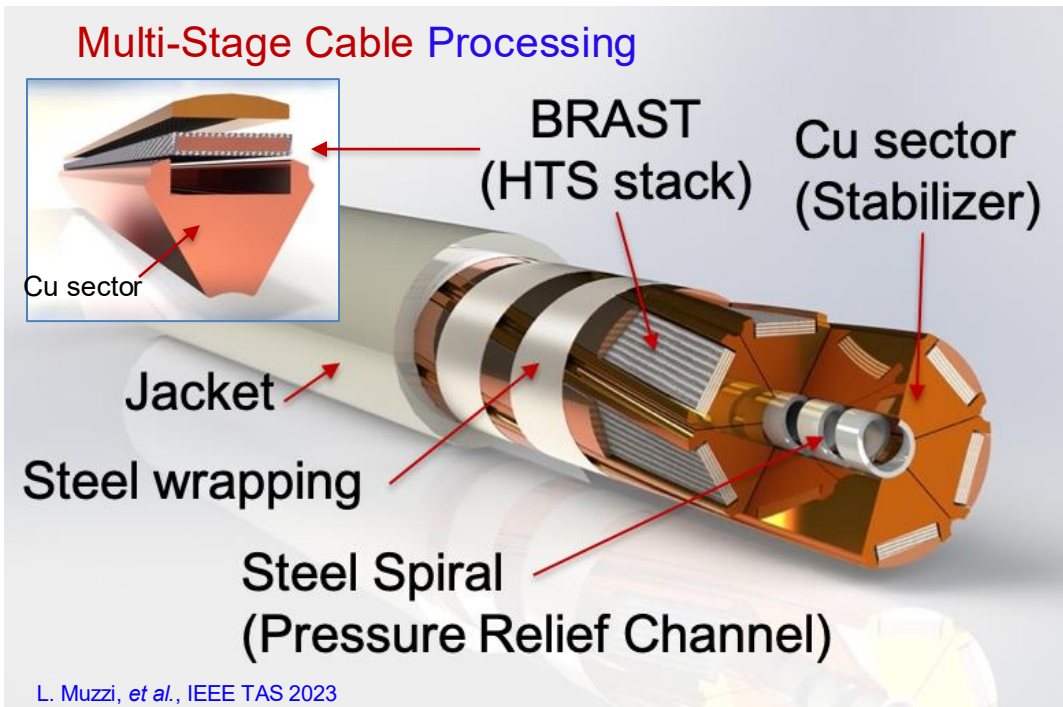
DTT Central Solenoid



Milestone: qualification of the **SECAS**

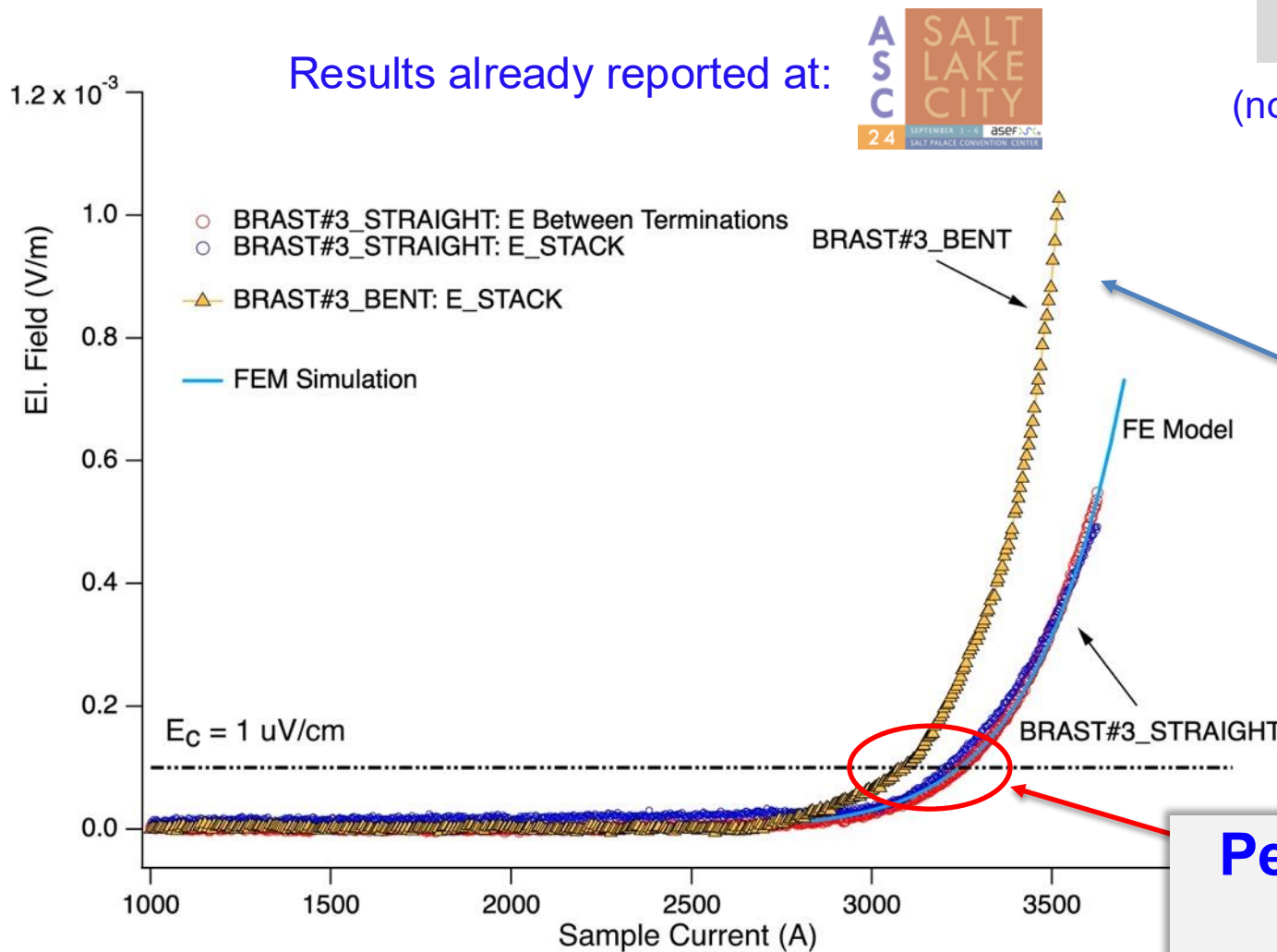
SECTor ASsembled cable (**SECAS**) CICC concept

based on BRAided STacks of tapes (**BRAST**)

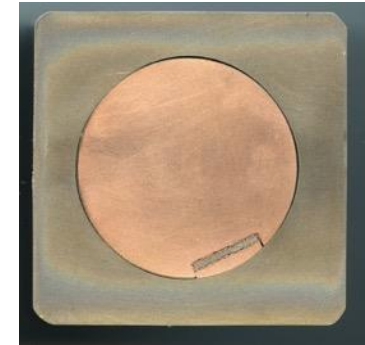


In this talk: qualification activities of the SECAS design, performance, and manufacturing approach

Initial qualification – BRAST (77K – s.f. tests)



BRAST #3
(non soldered stack)



Conductor Bent to target radius = 1.5 m



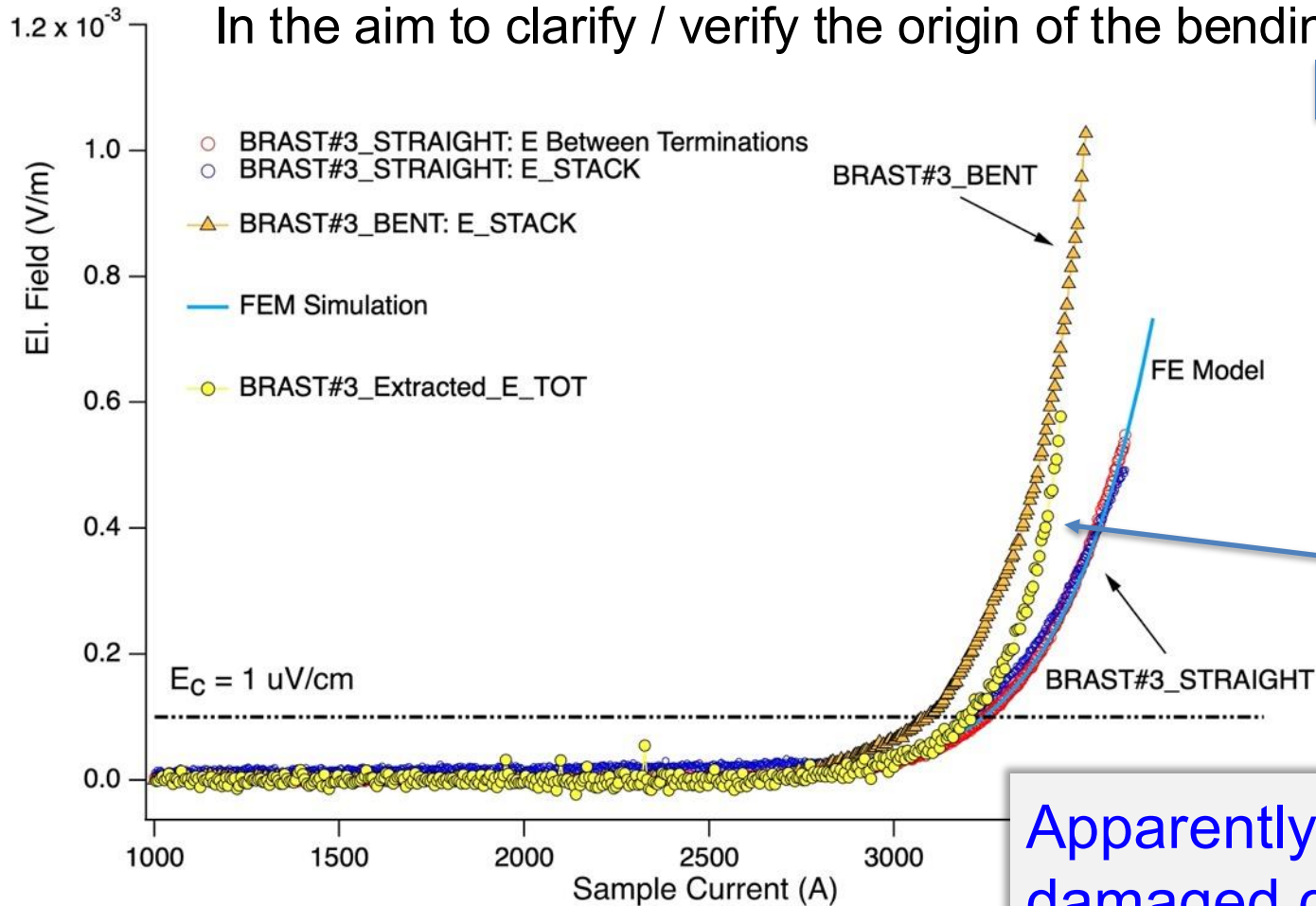
Performance moderately affected by bending (5% reduction) @ R = 1.5 m (DEMO CS relevant)

Initial qualification – BRAST (77K – s.f. tests) - bending

BRAST #3 (non soldered stack)

But voltage signals somewhat difficult to interpret.
In the aim to clarify / verify the origin of the bending effect:

BRAST was extracted from Bent conductor and re-tested



Apparently, the tape stack was not damaged during the bending

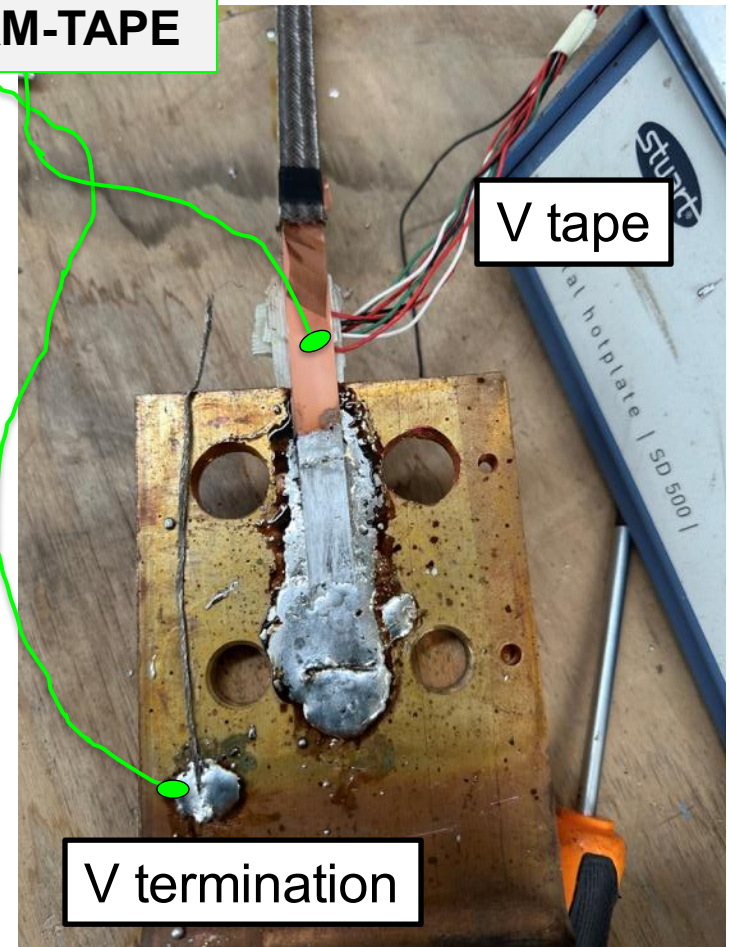
Current distribution study in BRAST (77K – s.f. tests)

Sample for current distribution study: «free-standing» BRAST with 9 tapes, 12 mm wide

Soldered terminations with staggered tapes

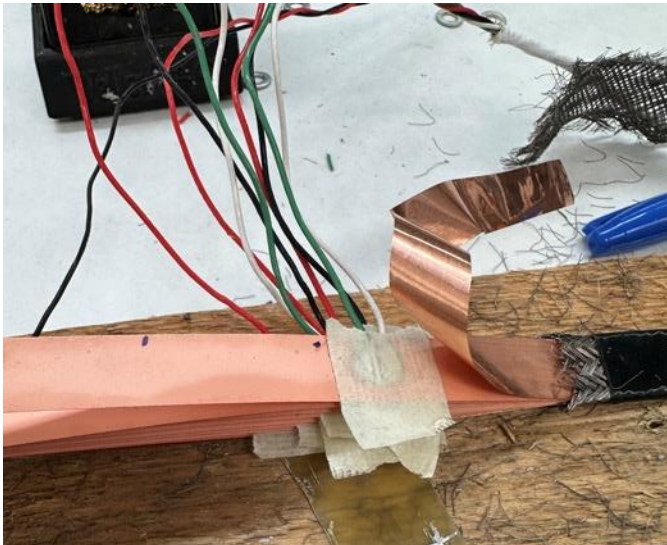


V_TERM-TAPE



V tape

V termination



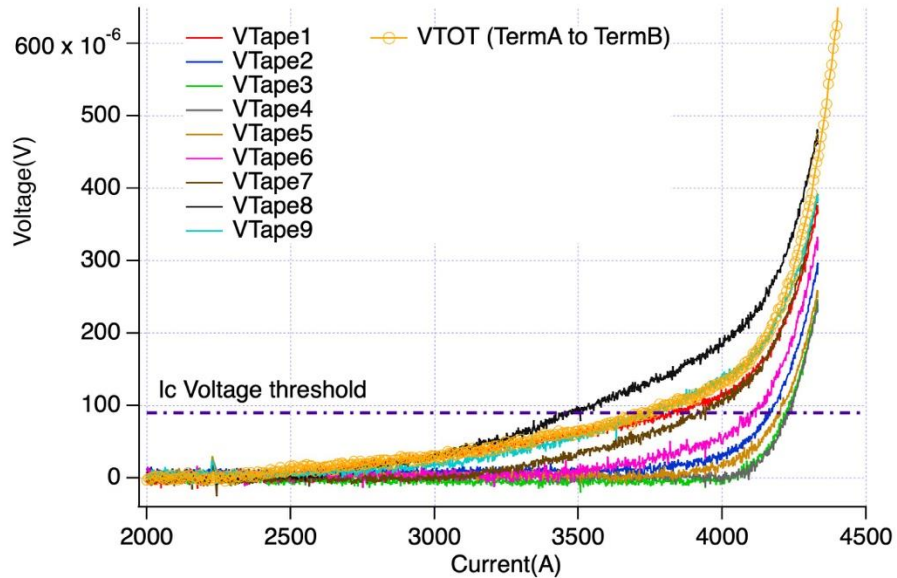
Voltage taps welded on tapes:

Voltage **between termination and tape**, as well as **along** each tape, can be measured

July, 5th 2025

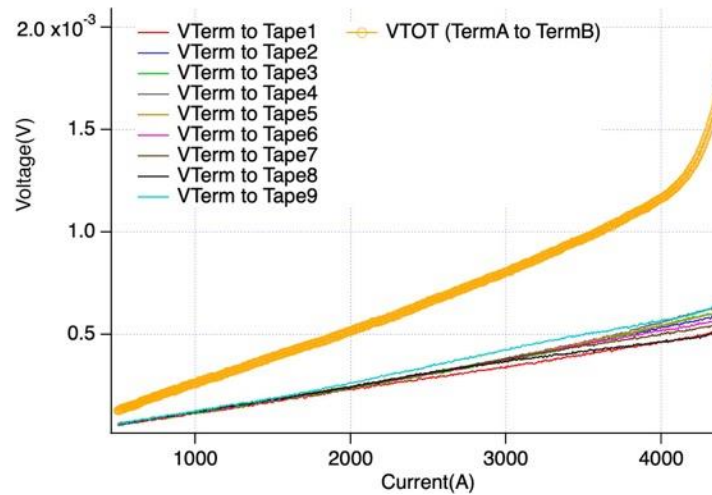
Current distribution study in BRAST (77K – s.f. tests)

Voltage along each tape during current ramp

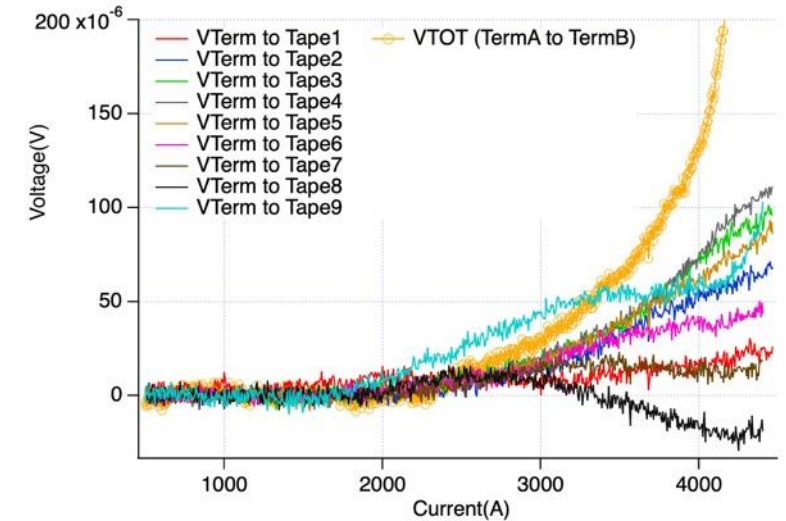


Voltage between termination and each tape

Raw data



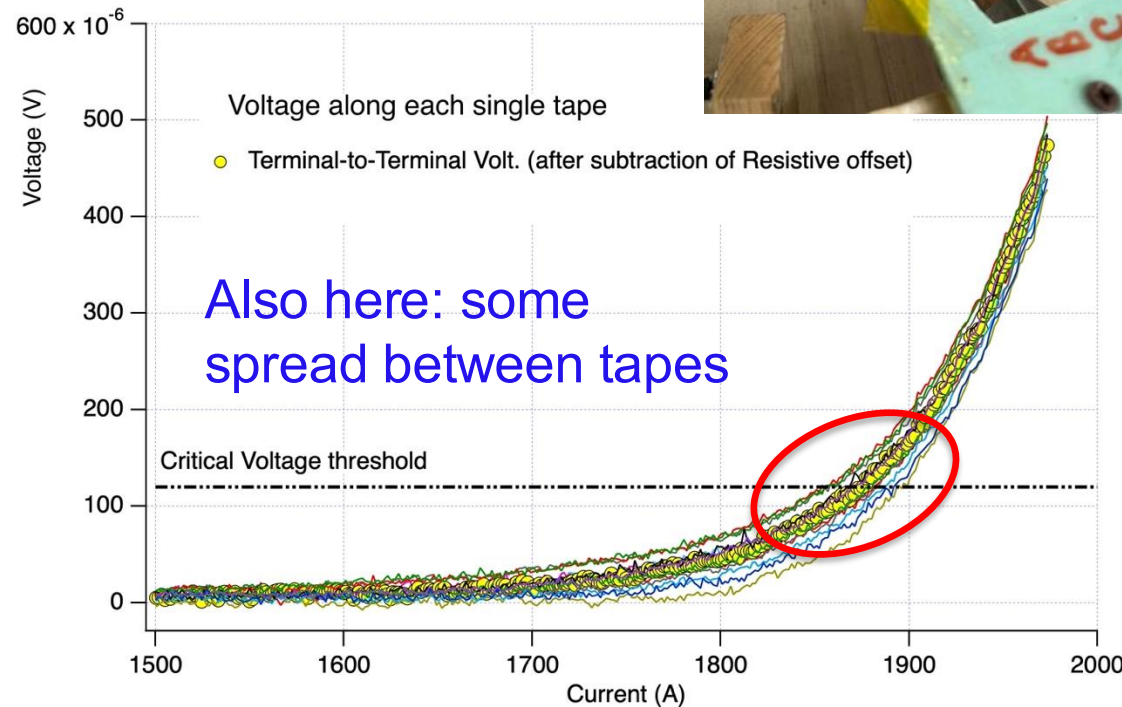
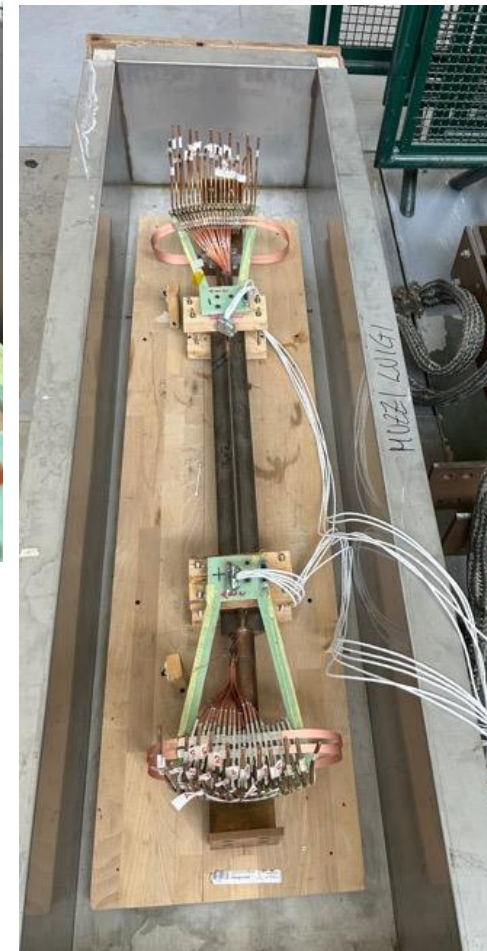
V after subtraction of the resistive component



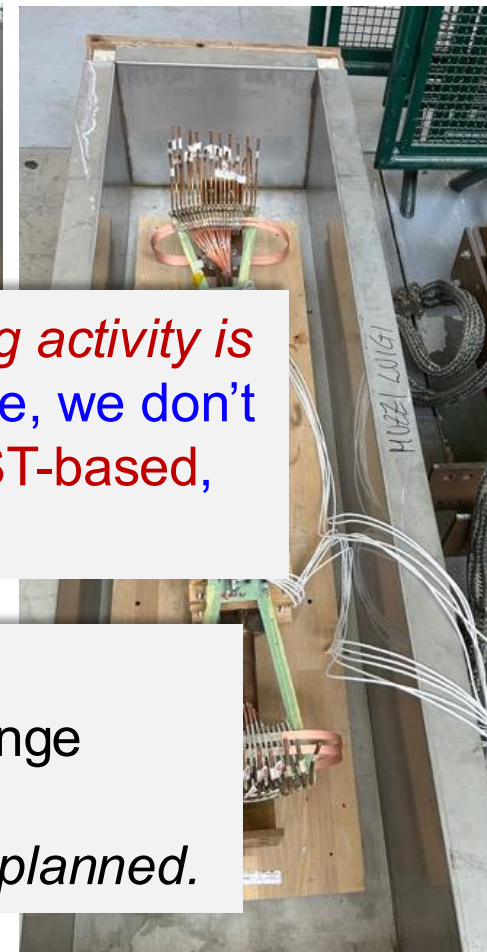
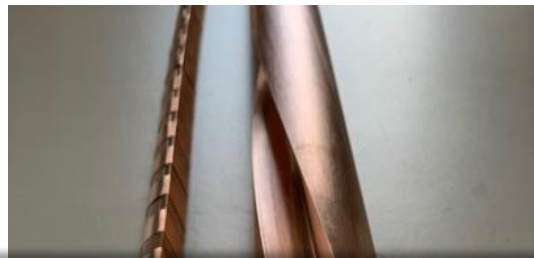
Wide transition «spectrum» for the different tapes.
Resistance distribution at terminations.

Complex current re-distribution among tapes (*in these samples, occurring at terminations*); self-field effects also play a role.
Same qualitative behaviour as observed on the BRAST extracted from the bent conductor prototype, tested as well in «stand-alone» mode.

Qualification – SECAS#2: 3 x 5 tapes BFAST (4 mm)



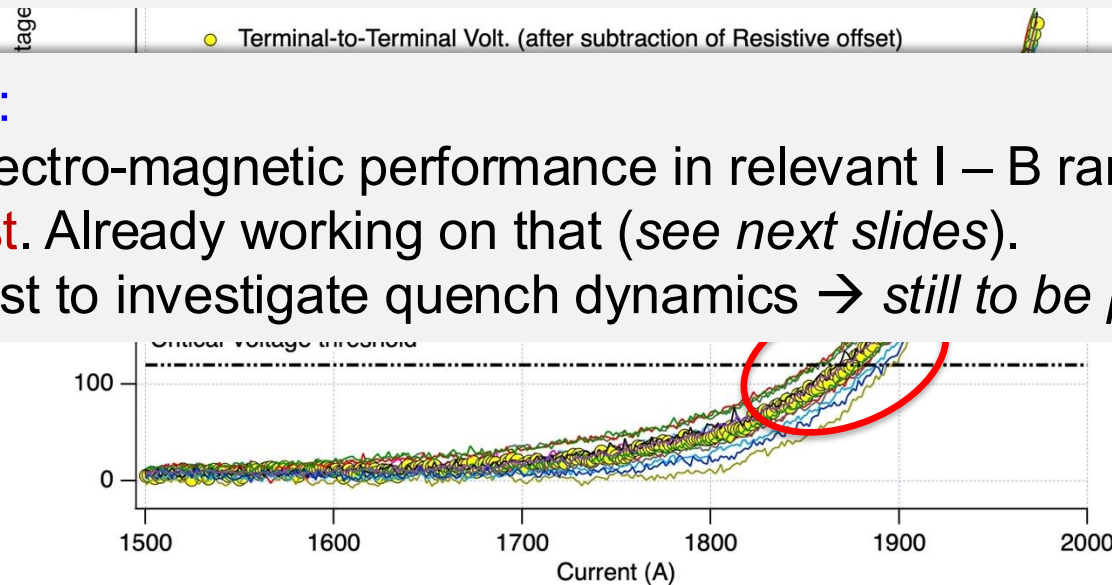
Qualification – SECAS#2: 3 x 5 tapes BFAST (4 mm)



Although not all experimental observations are fully clarified (*some modelling activity is on-going*), with all preliminary qualification tests, *some of which reported here*, we don't see any evident showstopper to the application of the **non-soldered, BFAST-based, SECAS conductor concept**.

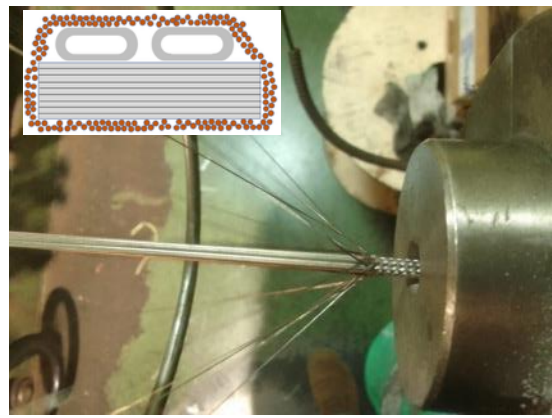
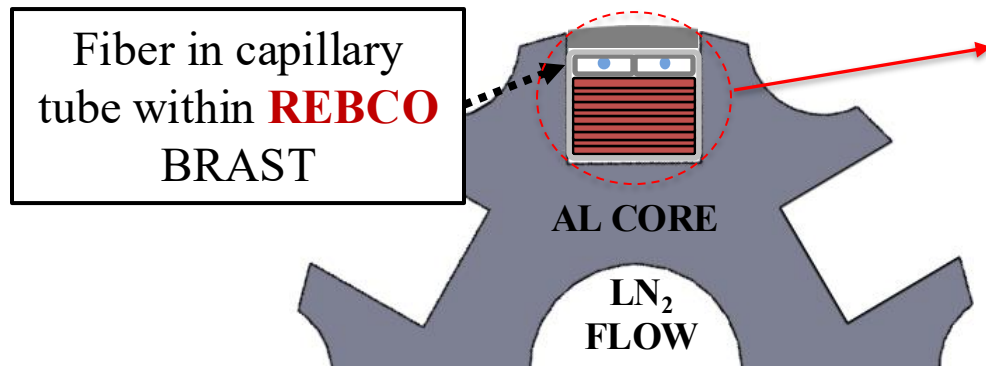
Next steps to qualification:

1. Verification of electro-magnetic performance in relevant I – B range → **SULTAN test**. Already working on that (*see next slides*).
2. Longer length test to investigate quench dynamics → *still to be planned*.

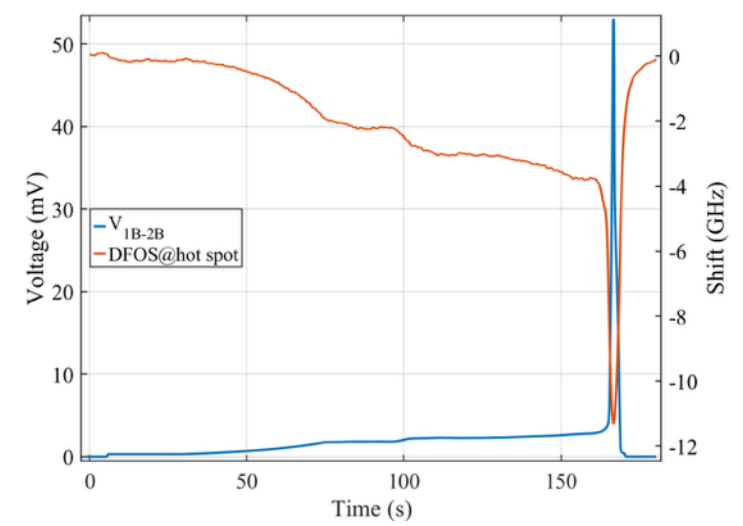


Pre-qualification – DFOS quench detection

Target: assess quench detection capability and implement FOS integration technology

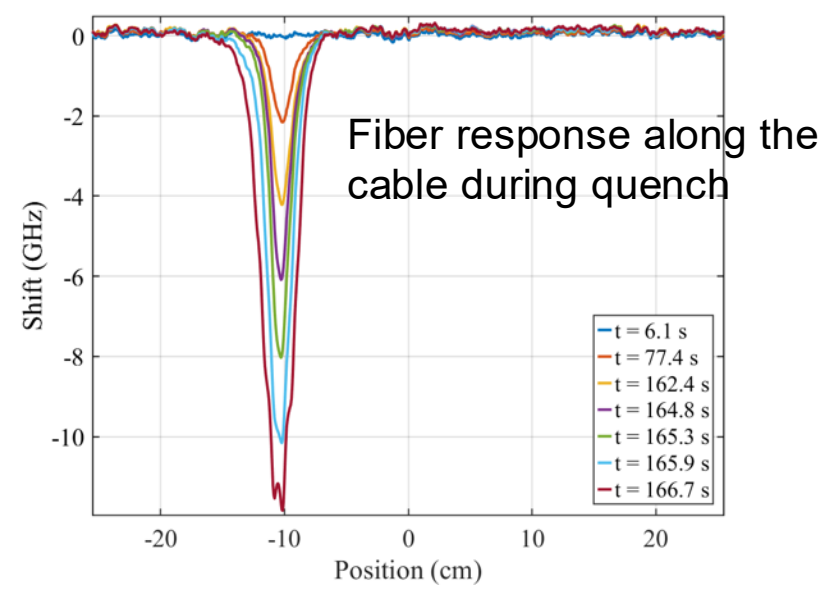


Voltage + fiber response at quench location



The quench was due to a local defect in the stack
 → Well localized by the DFOS.

What next?
 BRAFT and FOS in capillary tubes will be adopted for SECAS samples @SULTAN



SULTAN sample preparation: some key steps

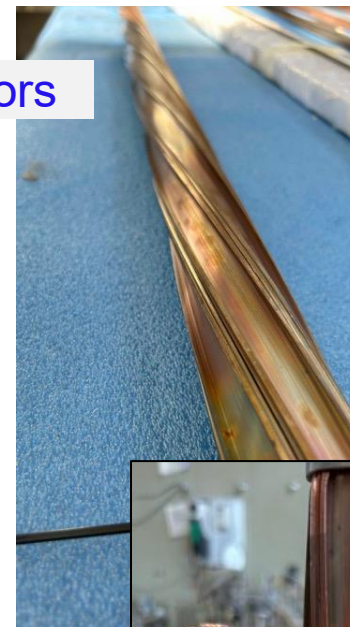
BRASST manufacture at:



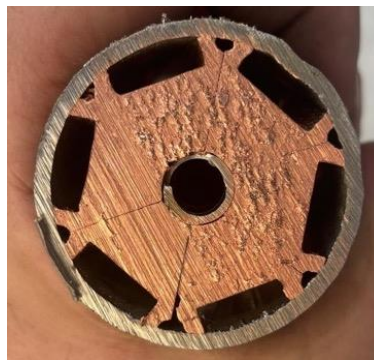
icas Cable assembly trials:
www.icasweb.com



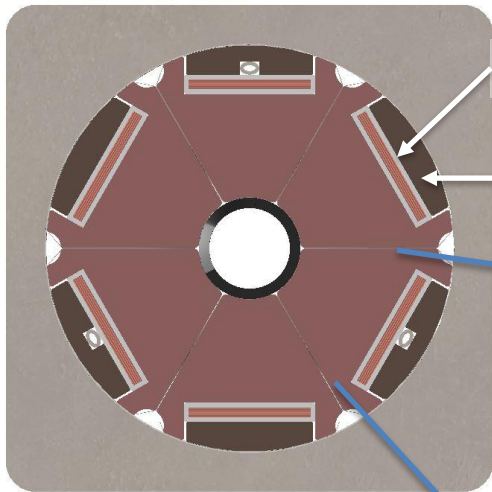
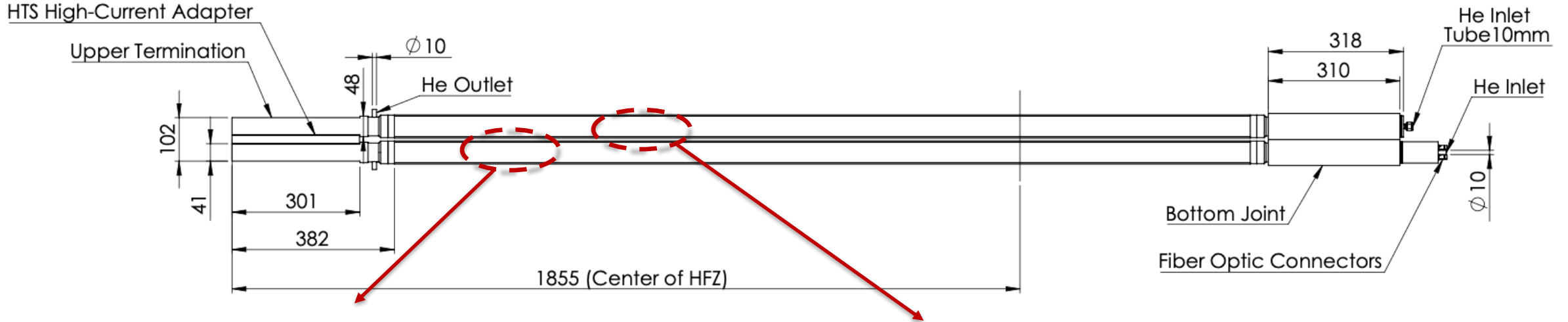
Twisting of Cu sectors



Short piece of assembled SECAS



SECAS SULTAN sample

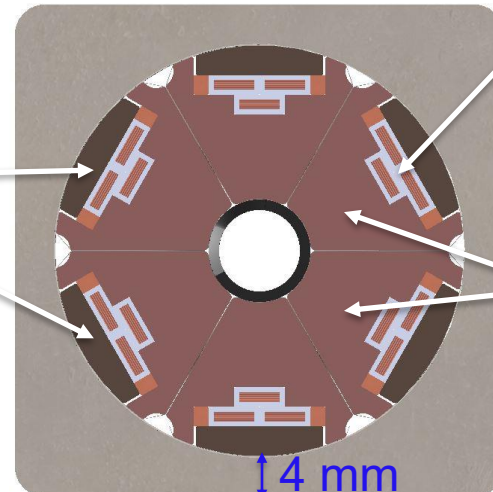


6 x BRAST with 12mm-wide tapes

Cu closing fillers



Steel capillary for fiber-optics



6 x 3 x BRAST with 4mm-wide tapes

Cu sectors

Conclusive remarks



- **qualification** activities on the **SECAS-BRAST** high-current / high-field / low-losses conductor have been carried out so far, on **prototypes** tested at different phases of the possible processing steps;
- although still with **some unclarified** aspects of test outcomes, **performance results are satisfactory** and mostly in line with expectations;
- modelling activities are on-going, to help clarify the observed effects of **current re-distribution** among tapes occurring **at terminations** in short samples tested in self-field configuration.
- the design has evolved in parallel to the development of industrial processing for applicable concepts.
- the **manufacture of SECAS prototype lengths** and **assembly** of a **full-size sample** with different tape arrangements is on-going, for *in-field* characterization in **SULTAN** → sample ready by the end of this month.