$REBa_2Cu_3O_7$ coated conductors for the FCC-hh collider beam screen

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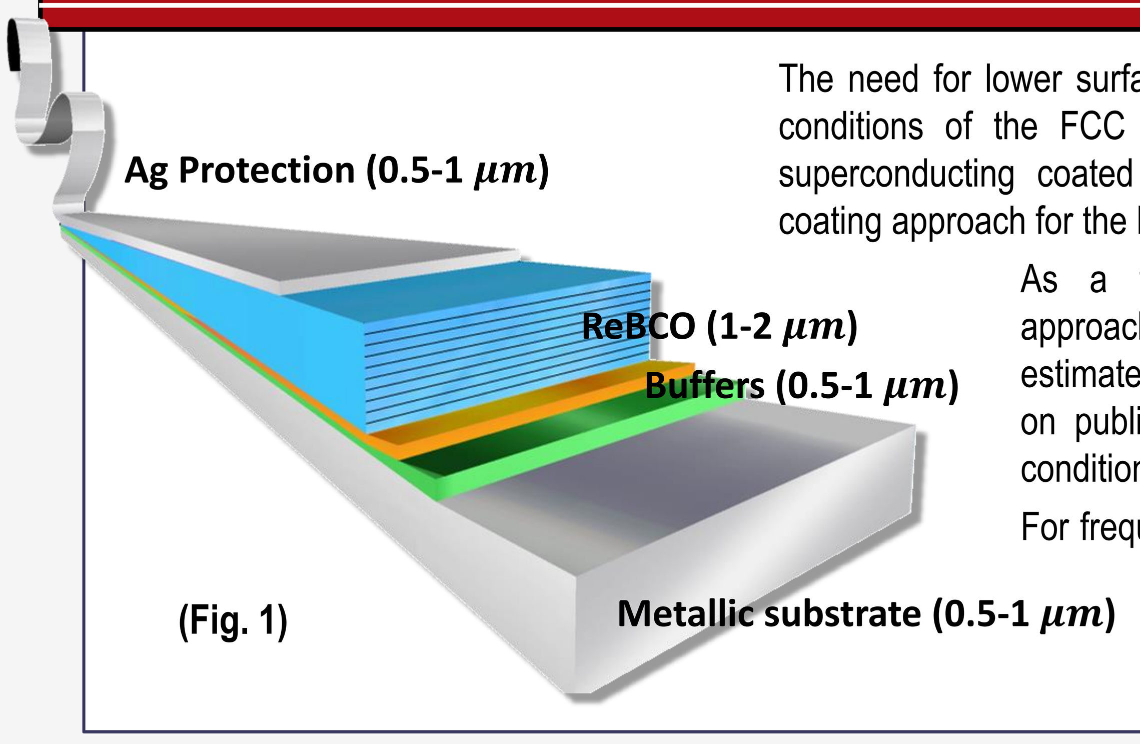
Background



(Fig. 1)

The need for lower surface impedance than copper under the operating conditions of the FCC motivates the exploration of high-temperature superconducting coated conductor (HTS-CC) tapes as an alternative coating approach for the beam screen (**Fig.1**).

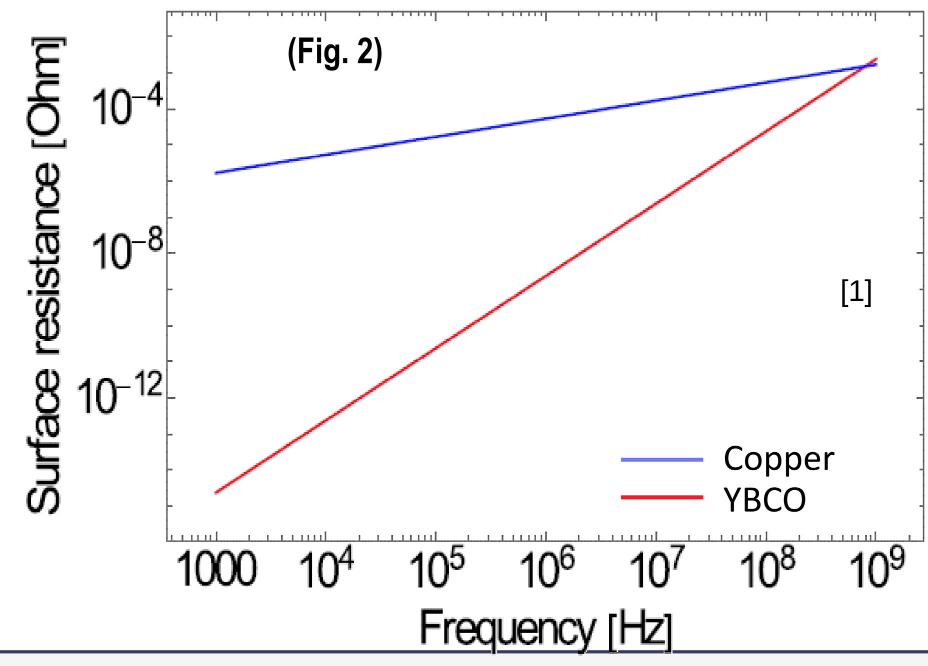
As a first assessment for the feasibility of this approach, the surface resistance of YBCO is estimated with the classical rigid-fluxon model based on published electrical transport data at the operating conditions of the FCC (**Fig. 2**).

For frequencies < 1Ghz, the surface resistance of YBCO is lower than for Cu, thus allowing potentially better performance over most of the frequency spectrum of interest.

Now, we are investigating the capabilities of commercially available HTS-CCs as a beam screen under the extreme conditions of FCC-hh. The specific objectives are:

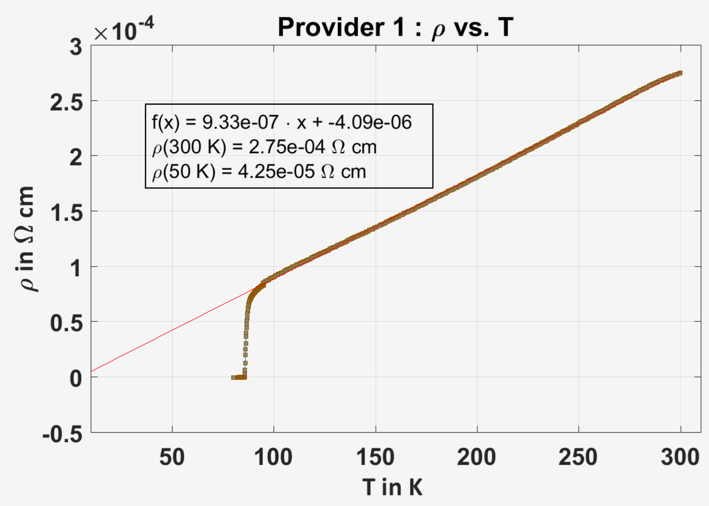
1. Evaluation of surface resistance using classical rigid-fluxon model
2. Measurement of SEY
3. Examine SC properties after synchrotron irradiation
4. Characterise strain distribution of HTS-CC when welded to vacuum chamber*

*not covered on this poster

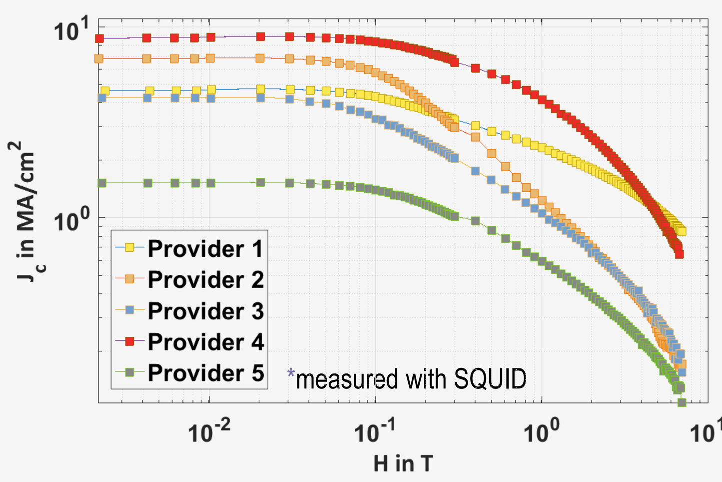


Depinning Frequency

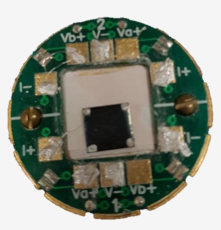
1. Normal resistivity $\rho_n(50K)$



2. Critical current density $J_C(50K, 7T)$*



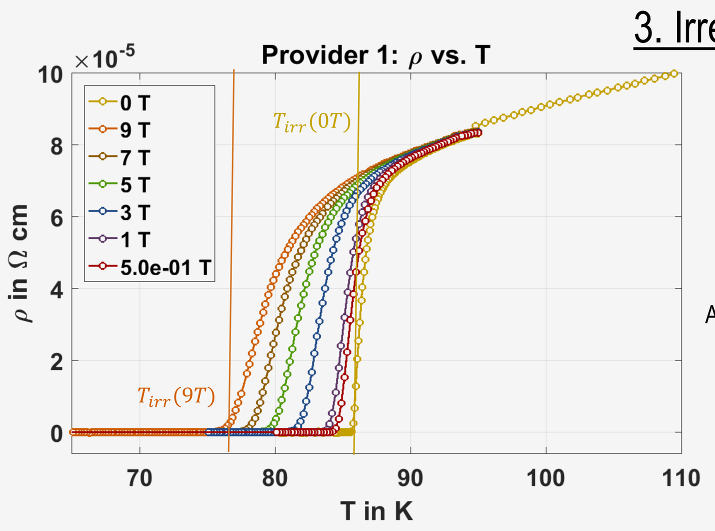
- Tapes differ in their temperature and field dependences due to different pinning sources
- Potential for optimization when transport properties can be linked to microstructure


AC transport PUK with bonded sample

DC transport data to determine $\omega_0(50K,7T)$

$$\omega_0(B) = 2\pi \frac{\rho_n J_c(T,B)}{B_{irr}} \sqrt{\frac{B}{\phi_0}}$$

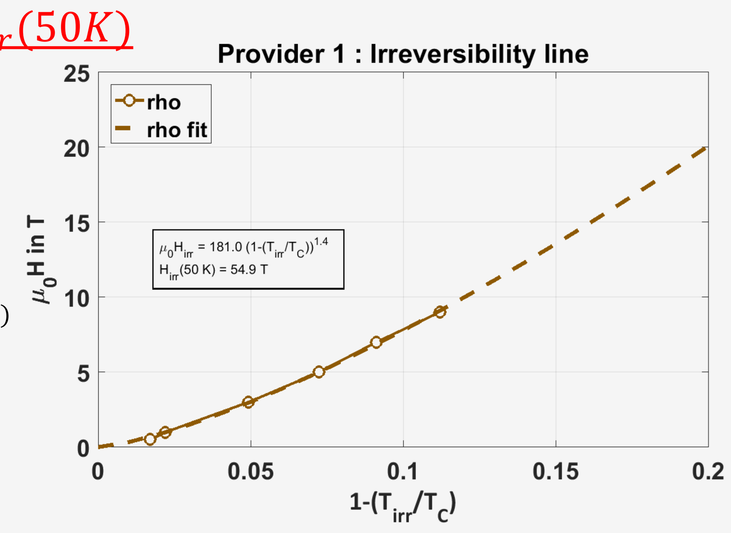
3. Irreversibility field $B_{irr}(50K)$



Power law behaviour:

$$\mu_0 H_{irr} = a\left(1 - \frac{T_{irr}}{T_C}\right)^b$$

Allows extrapolation of $H_{irr}(50\ K)$

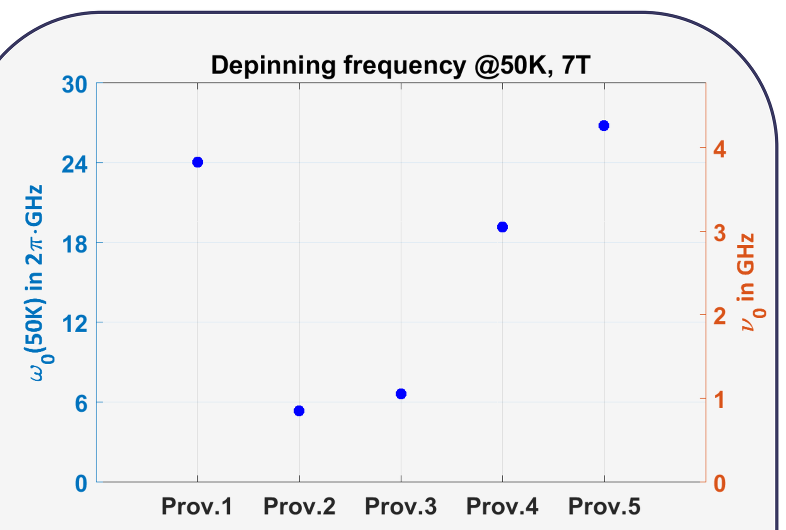


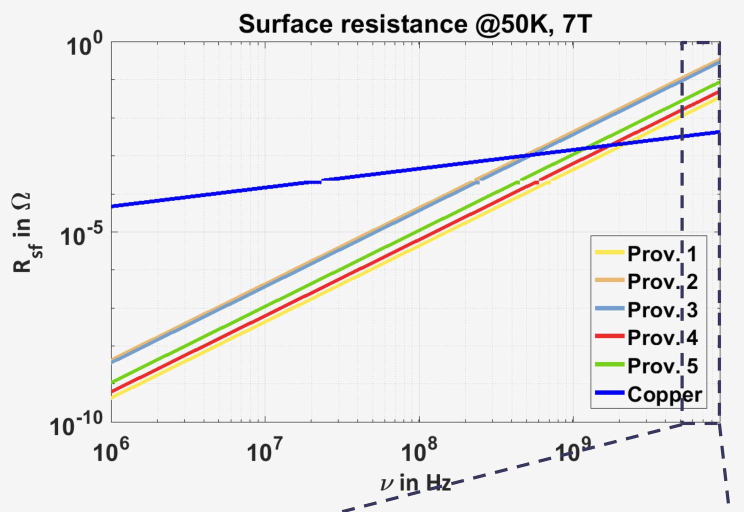
For the low frequency/high field limit, the depinning frequency is the surface resistance dominating magnitude[1]:

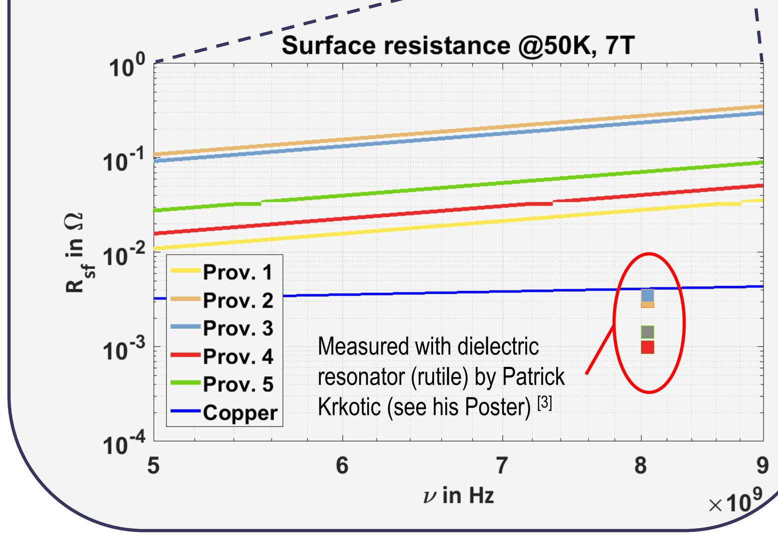
$$R_{sf} = \frac{R_n}{\sqrt{2}} \sqrt{\frac{B_0}{B_{irr}}} \left(\frac{\omega}{\omega_0}\right)^{3/2}$$

with

- $R_n \equiv$ superconductor surface resistance at normal state
- $B_{irr} \equiv$ irreversibility field
- $\omega_0 \equiv$ depinning frequency





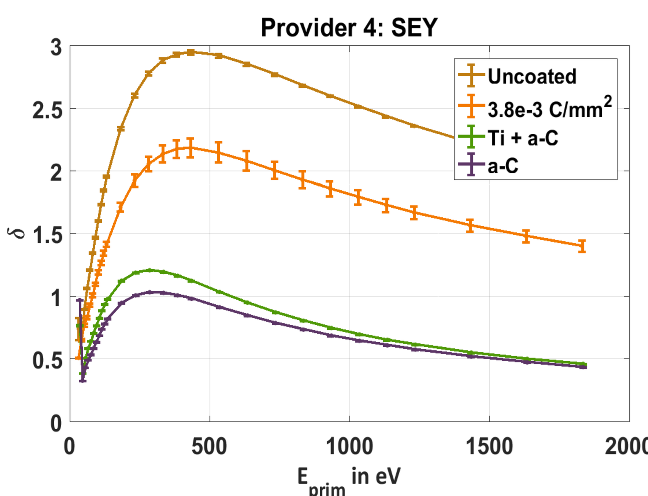


Secondary Electron Yield

CC sample in UHV chamber for conditioning with e-gun

- In beam pipes of particle accelerators, an e-cloud can be generated by i.e. photoemission from synchrotron radiation
- Leads to thermal load in vacuum systems, beam losses and more

→ electron build up has to be minimized (SEY~1)

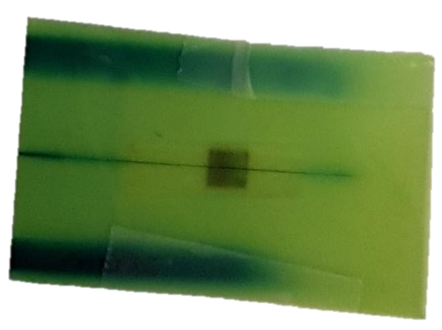


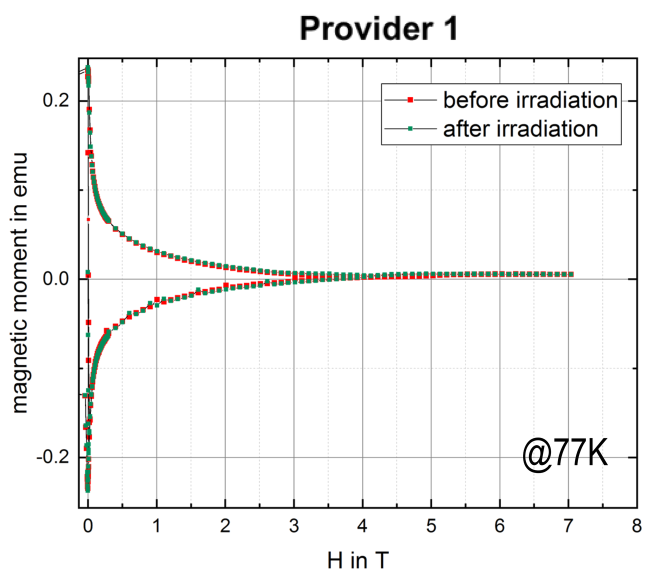
- Manipulation of tape surface to eliminate e-cloud

1. Surface conditioning
2. Low SEY thin film coatings

Synchrotron Irradiation

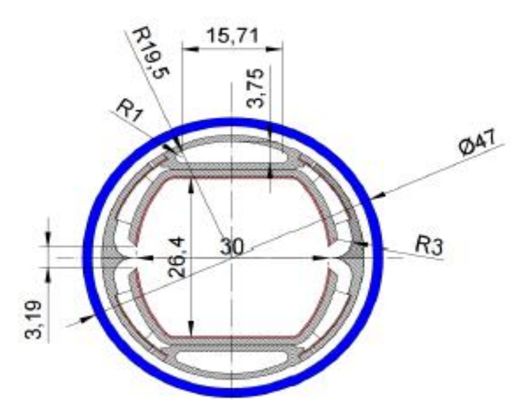
- Beam screen coatings have to sustain high synchrotron radiation loads
- HTS tapes were irradiated with high energetic electron synchrotron radiation for a week in ALBA synchrotron
- SC properties of samples before and after irradiation are compared by means of inductive measurements
- For all providers: no decrease of SC properties after irradiation


Irradiated 5x5 mm² CC sample



Outlook

- Characterisation of CC at operational conditions
  - Magnetic field $\mu_0 H = 16\ T$
  - RF fields
  - Synchrotron radiation
- Link transport properties to microstructure
- Evaluate SEY and synchrotron activation
- Develop a welding technology between CC and Stainless Steel plates of the chamber compatible with high vacuum
- Evaluate the strain field and mechanical fatigue of the ensemble



FCC chamber design

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