# Microstructural Analysis of Tl-1223 Superconducting Layers for the FCC Beam Screen

S. Holleis,[1] T. Baumgartner,[1] J. Bernardi,[2] K. Whitmore,[2] A. Moros,[2] A. Leveratto,[3] E. Bellingeri,[3] S. Calatroni[4] and M. Eisterer[1]

[1] *Atominstitut, TU Wien, Stadionallee 2, 1020 Vienna, Austria*

[2] *USTEM, TU Wien, Wiedner Hauptstraße 8-10, 1040 Vienna, Austria*

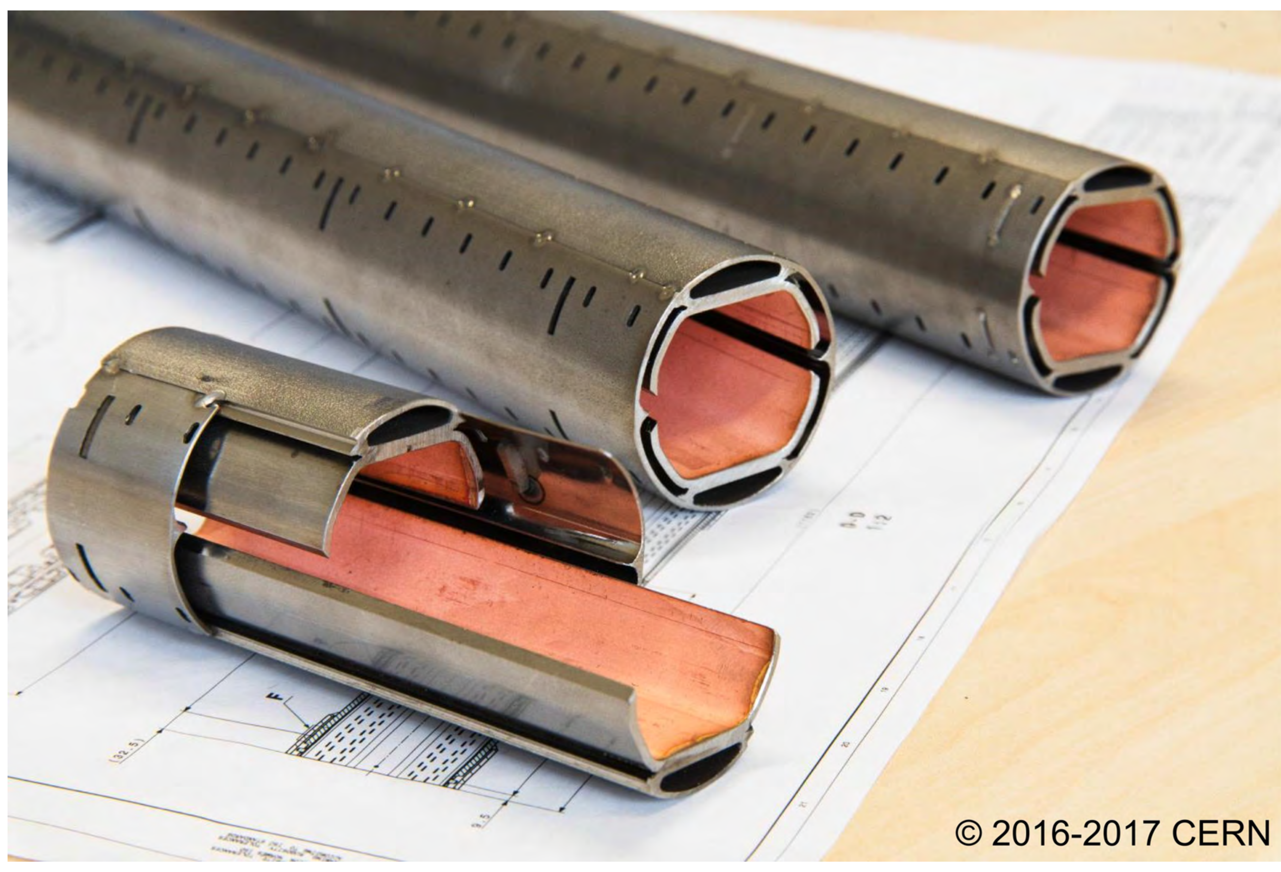
[3] *CNR SPIN, 16152 Genoa, Italy*

[4] *CERN, 1211 Geneva 23, Switzerland*

## Introduction

A part of the FCC-hh design study explores different superconducting materials, which could be suitable to function as a coating on the beam screen, held at 50 K. Such a superconducting coating should be able to carry the beam image currents and lower the beam impedance in order to guarantee a high beam stability margin [1,2]. Our study focuses on the still technologically unexploited thallium-based cuprates. For the development of the coating thin films of Tl-1223 are grown on untextured silver substrates. Here we present superconducting properties of the Tl-based films which are investigated by means of Scanning Hall Probe Microscopy. We compare the results from magnetic field mapping with microstructural features obtained with Scanning Electron Microscopy and Transmission Electron Microscopy where the chemical composition of the superconducting grains and especially the formation of the Tl-1223 phase is demonstrated.

## HTS Coating for the Beam Screen




Meeting vacuum requirements, the synchrotron radiation will be absorbed by a **beam screen** kept at **50 K**.

**There are consequences on the beam stability:**

- Joule heating in the screen
- Excitation of wakefields

Both effects are described by **beam impedance** = proportional to **surface impedance** of material facing the beam.

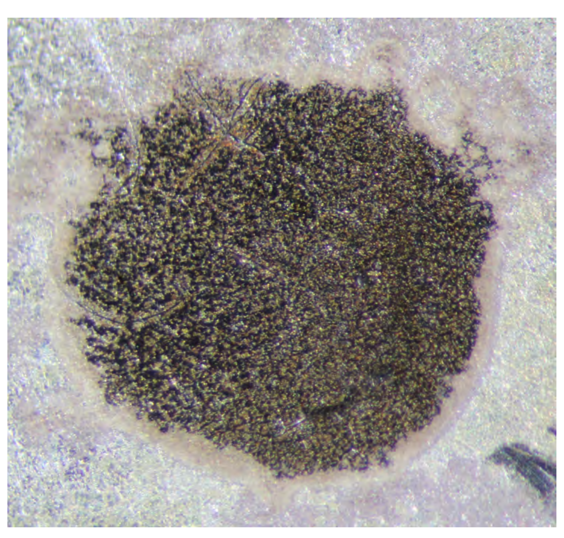
- Current design in LHC: **copper**
- Surface impedance of copper at 50 K **may not be low enough** to guarantee a safe operational margin for the FCC-hh beam.
- **Only HTS-materials have a lower surface impedance at 50 K.**

**HTS required properties:**

- Critical current density > $2.5 \times 10^8$ Am$^{-2}$ at 50 K and 16 T
- **Our proposition:** Revisit the Tl-based compounds $Tl_xBa_2Ca_yCu_{y+1}O_z$, in particular **Tl-1223**

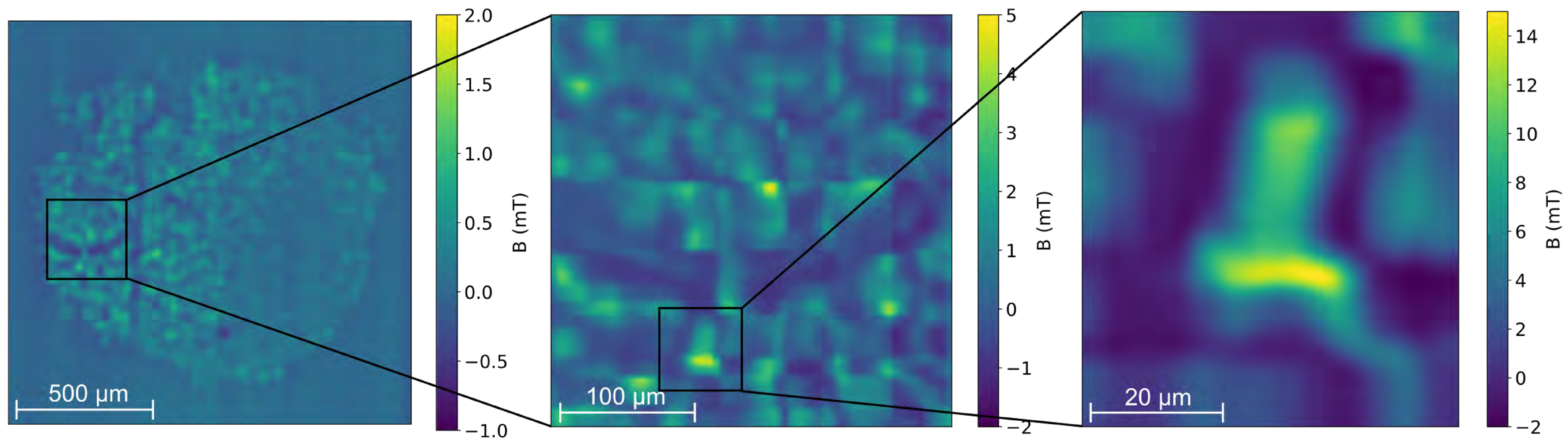
## Samples

- Samples are reacted in electrochemical cell
- Films are deposited on untextured silver substrates
- Deposition time: 600 s
- Spot etched free with hydrochloric acid for magnetic field mapping



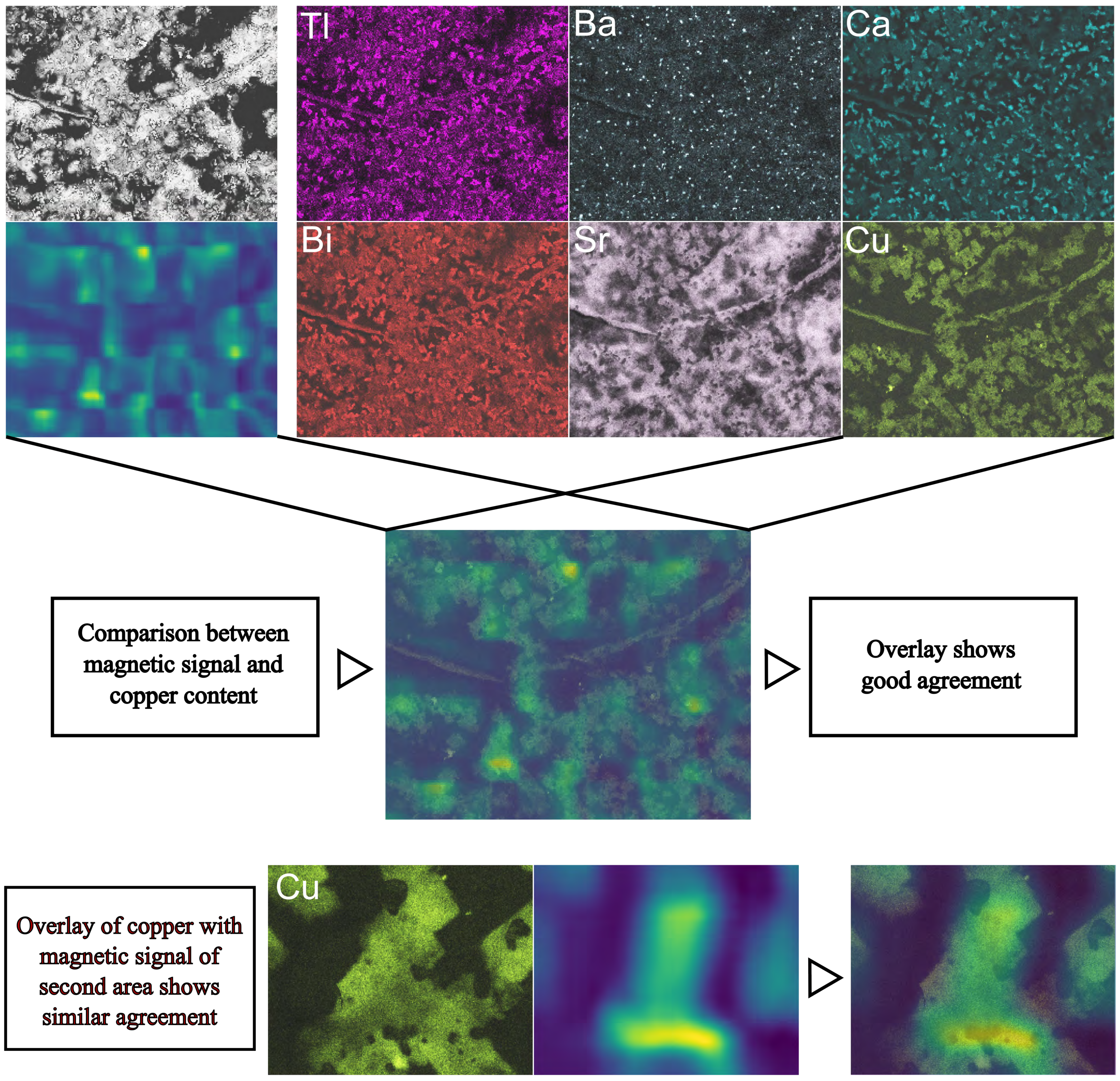
## Scanning Hall Probe Microscopy

- **Mapping of remanent magnetic field:** superconducting grains at different magnifications



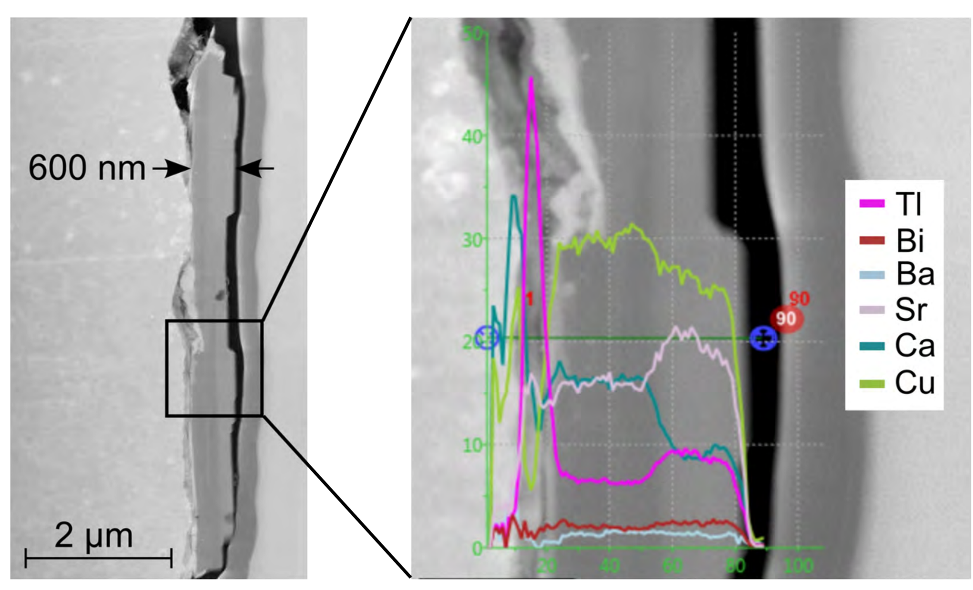

## Scanning Electron Microscopy

- **EDX elemental mapping:** comparison between magnetic signal and elements in the sample




## Transmission Electron Microscopy

- Superconducting phase forms a 600 nm thick layer
- TEM image shows clear evidence of stacking of different grains
- The superconducting phases of different grains can be determined through line scans
- TEM investigation shows sharp transition between Tl-1223 and Tl-1212 phase




## Summary

- HTS beam screen: investigation of thallium-based superconductors
- Remanent magnetic field can be compared to copper content in the sample
- TEM investigations show single grains and their superconducting phases

## References

[1] S. Calatroni, E. Bellingeri, C. Ferdeghini, M. Putti, R. Vaglio, T. Baumgartner and M. Eisterer. *Superconductor Science and Technology*, 30(7), 2017.

[2] S. Calatroni and R. Vaglio. *IEEE Transactions on Applied Superconductivity*, 27(5), 2017.

Scan QR-Code to download poster.