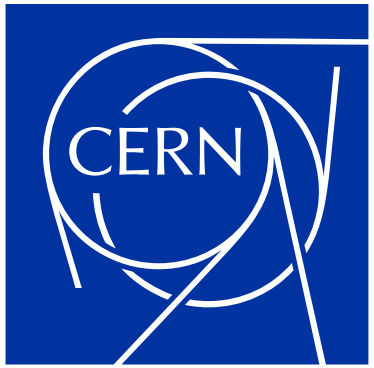
“HIGHEST”
High-Temperature High-Gradient Superconductors

CERN
CSIC-ICMAB (public research center, ES)
KIT Campus Transfer GmbH (KCT) (private company, DE)
SLAC as supporting partner

Note: KCT has replaced CERACO, who withdraw after submission of the proposal

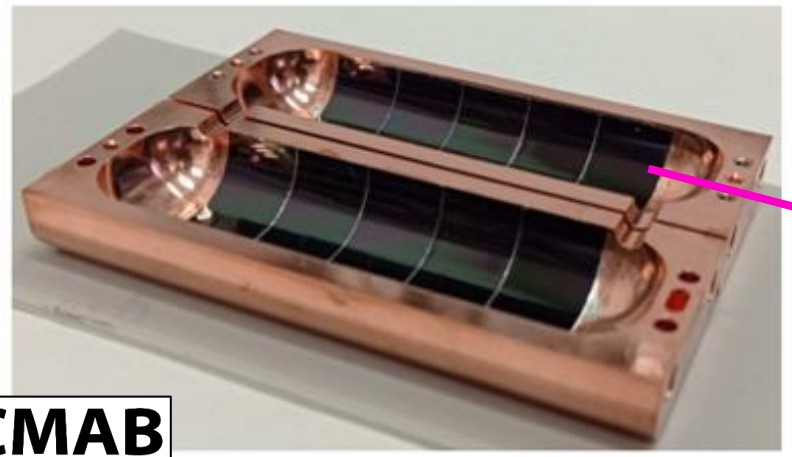


Submitted by:
Sergio Calatroni
Principal applied physicist

iFAST

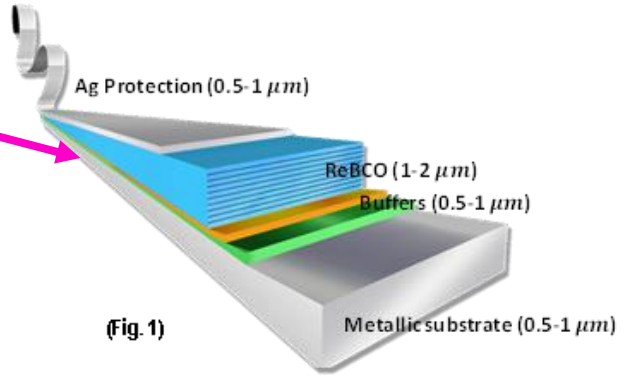
Technical overview

- We have developed within the FCC-hh study a technology for applying 2D HTS tapes to 3D structures, and demonstrated their potential on RF “RADES” cavities J. Golm et al., IEEE TAS, Vol. 32, No. 4, (2022) 1500605



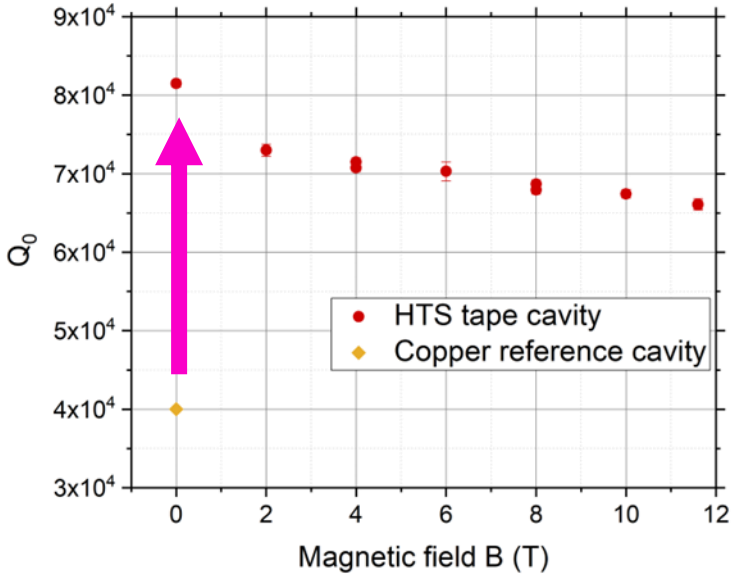
RADES cavity

HTS tapes



(Fig. 1)

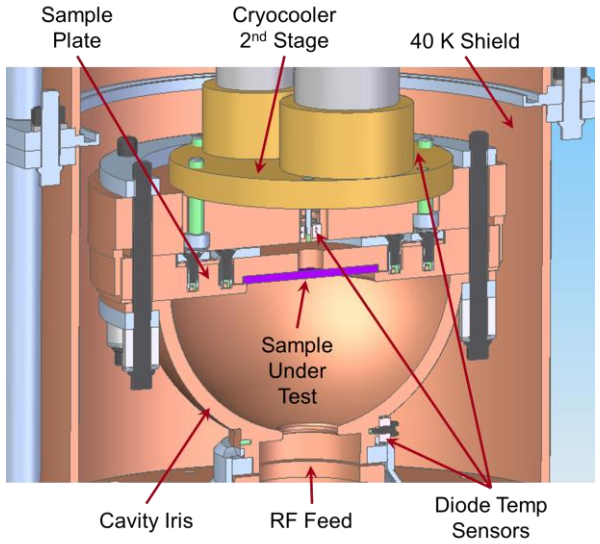
2x improvement of RF quality factor compared to copper
(new prototype 5x improvement)



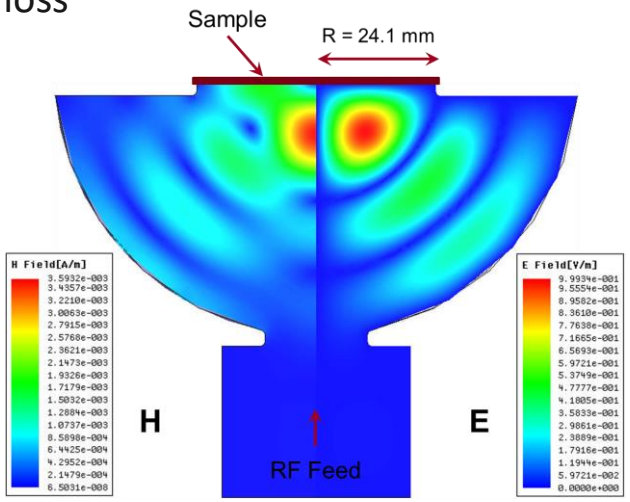
➢**We want to demonstrate the high-gradient performance of HTS**

Technical proposal - 1

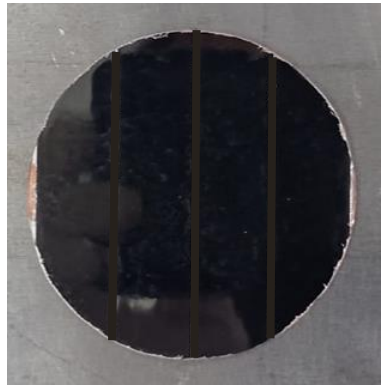
- Demountable high-power RF cavity
- Can achieve H_{peak} of about 360 mT using 50 MW XL-4 Klystron.



- High-Q X-band hemispheric cavity with a TE_{032}-like mode at 11.4 GHz.
- Zero E-field on the sample
- Maximum H-field on the sample
- Sample accounts for ⅓ of total cavity loss



HTS-coated with small tapes by CSIC-ICMAB

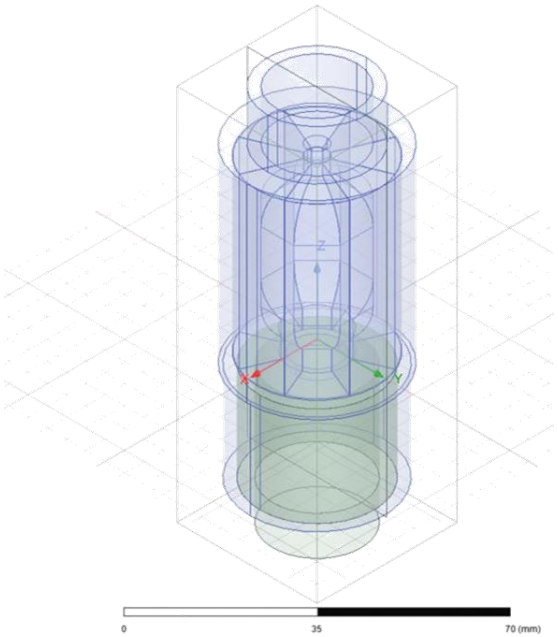


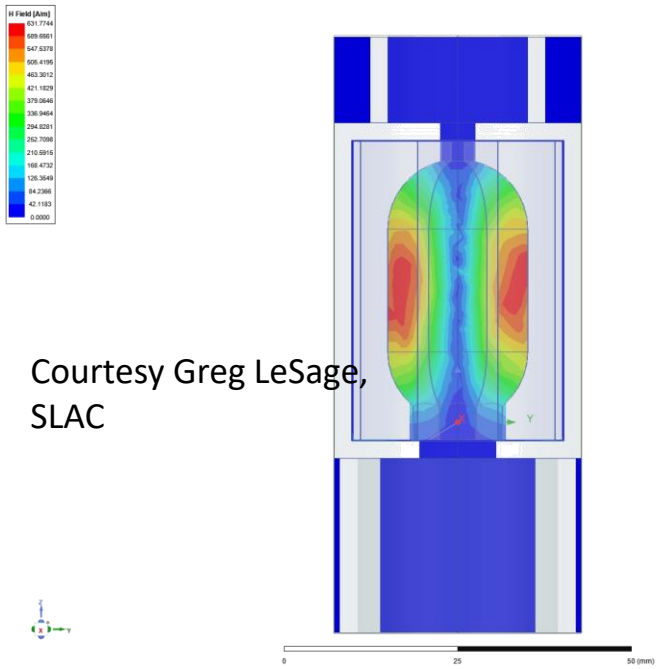
Goal: HTS-coated with large size tape produced by KCT on a stainless steel substrate
Aim to develop procedure for coating on copper substrates

➢**Goal: demonstrate high-gradient pulsed operation of HTS, at cryo-temperatures, and develop large size coatings**

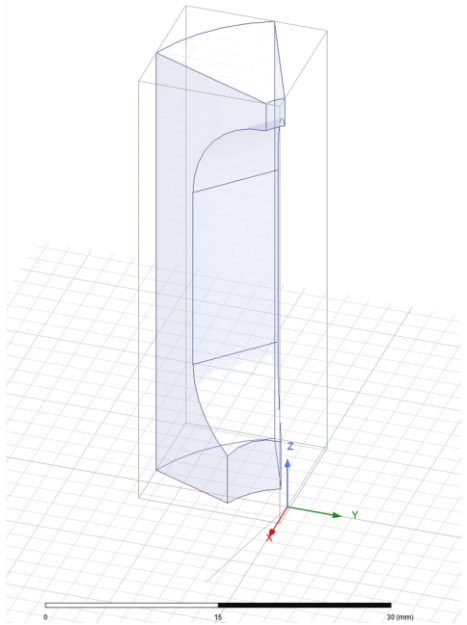
Technical proposal - 2

- Device approach: X-band pulse compressor (SLAC) as first “real” device
- **Coated with small tapes by CSIC-ICMAB for device validation**
- Future goal: full device with large-site tapes (possibly coated on copper, if feasible)





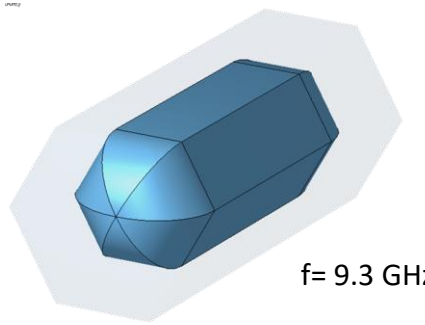
Courtesy Greg LeSage, SLAC



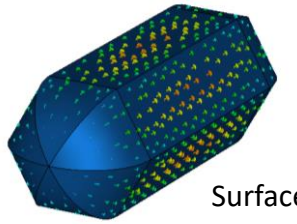
Max field surface 3.126 MA/m

For information only

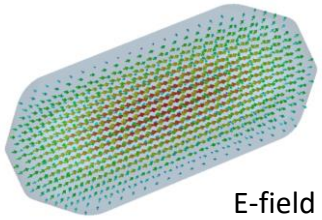
- Approach being validated also for cavities for axion detection in RADES, independently funded



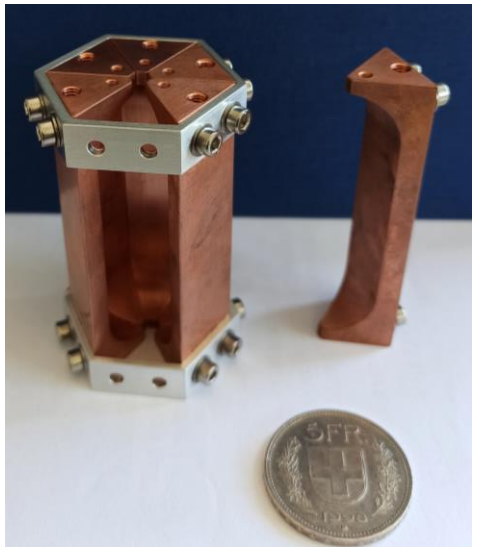
f= 9.3 GHz

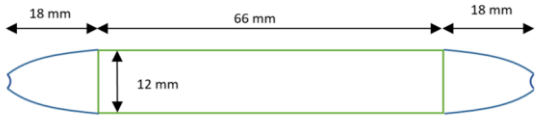


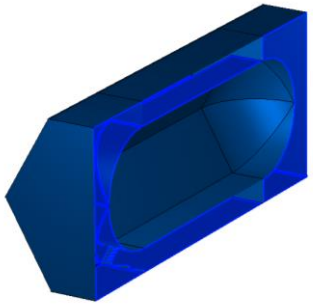
Surface currents



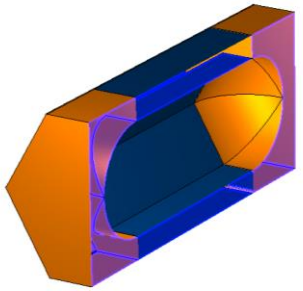
E-field







Q_0 = 356 070



Q_0 = 268 520 (75%)

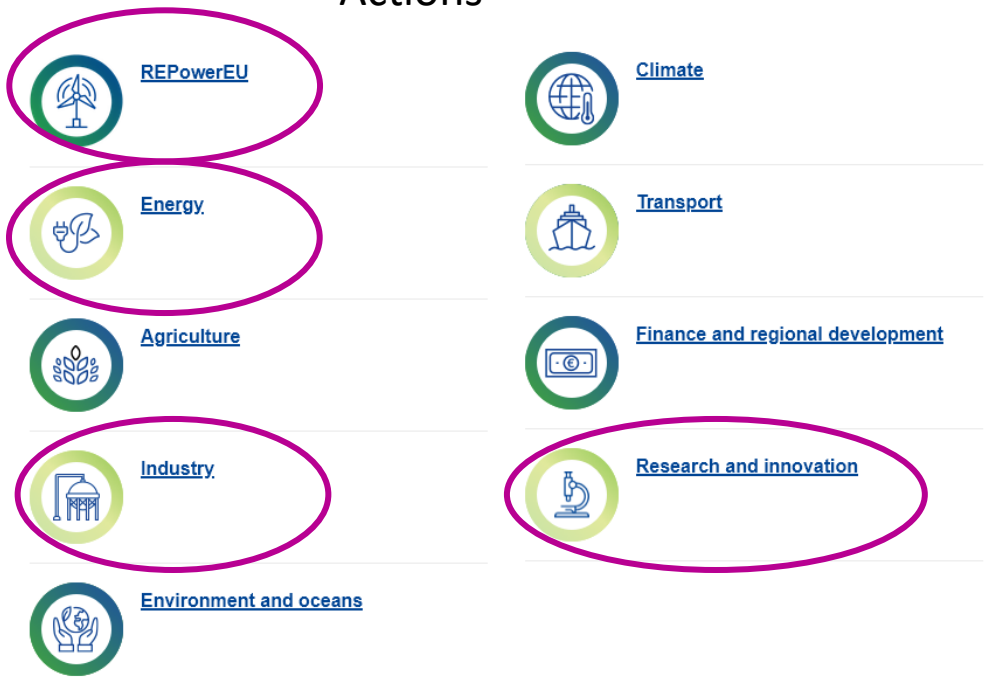
Work plan from 4/2023 to 4/2025

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
WP 1 (CERN)								
Coordination activities								
Samples and substrates procurement		M1						
RF low power characterization of segmented cavities (small tapes)					D1			
Final report								D2
WP 2 (KCT)								
Design and fabrication of sample holder system				M1				
HTS coating of large samples								D1
WP3 (CSIC-ICMAB)								
Coating on discs and segmented cavities for benchmarking (small tapes)				D1				
Measurement of superconducting properties of large size tapes								D2
SLAC supporting partner								
RF high power characterization of 3D coated HTS discs in their mushroom cavity								

Addressing the European Green Deal

Benefits

Actions



- New-generation collider linacs are expected to use hundreds of MW of electricity
- Energy savings from HTS are in line with current policies of societal impact minimization

Resources and budget

- CERN:
  - Provided resources: two senior physicist (scientific coordination, 0.2 FTE) and one senior Fellow (follow up, measurements, 0.5 FTE)
  - Requested resources: 10 kEUR (sample manufacturing)
- KCT:
  - Provided resources: one senior scientist (design, procurement, coating, 1 FTE)
  - Requested resources: 100 kEUR (80 kEUR manpower for coating operations, 20 kEUR sample holder manufacturing)
- CSIC-ICMAB:
  - Provided resources: one senior scientist (0.2 FTE), and one PhD student (0.5 FTE)
  - Requested resources: 50 kEUR (40 kEUR PhD student and manpower for coating and characterization work, 10 kEUR consumable)

Ratio for the requested IIF funds: 120 kEUR personnel and labour / 40 kEUR material

- Final deliverable is a report on the demonstrated achieved performance, and on the prospects for scalability to accelerator-scale RF devices.

Budget table

	Manpower	Materials	Total
CERN		10 kEUR	10 kEUR
KCT	80 kEUR	20 kEUR	100 kEUR
CSIC-ICMAB	40 kEUR	10 kEUR	50 kEUR
			160 kEUR

Contact information

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