This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

Report on WP/Task 8.6:

HTS ReBCO Cable

T. Winkler, GSI on behalf of WP 8.6

I.FAST Period 1 Review, 07.02.2023

iFAST

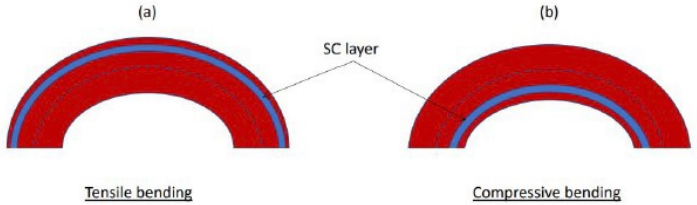
WP/Task structure and objectives

- Design Parameters for a round, high current, low ac loss HTS ReBCO cable
- Application: fast ramped, high field accelerator magnets
- Milestone: M24 lab-scale cable prototype
- Deliverable: M32 Report on cable parameters
- Members:
  - Institute of Electrical Engineering (IEE), Slovak Academy of Sciences, Slovakia
  - ILK Dresden, Germany
  - GSI, Germany
  - EMS Chair, University of Twente (UT), Netherlands

Summary of activities in P1

Mechanics

- Investigation of I_c degradation as a function of:
  - Bending diameter
  - Winding angle
- cable samples for:
  - contact resistance
  - AC loss measurement
- non-conductive former
- 2 layers (2x 5 tapes)



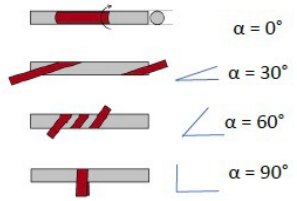
Tensile bending

Angle bending: α = 45°
Former diameter:
- 3 mm
- 4 mm
- 5 mm
- 6 mm
- 7 mm
- 8 mm
- 9 mm
- Reference (no bending)

Conclusions
Lower former diameter lead to:
- higher density of the cracks
- cracks are longer and wider

Compressive bending

Former diameter: 3 mm
Angle bending:



Conclusions
Cracks follow tube axis in 80-95% and ReBCO crystal planes in 5-20%

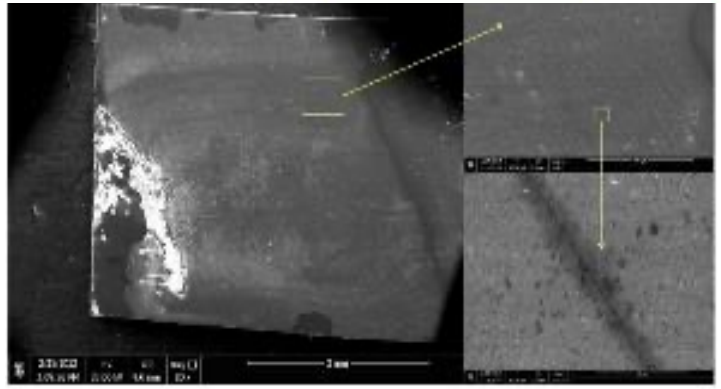
Angle bending: α = 45°
Former diameter:
- 3 mm
- 4 mm
- 5 mm
- 6 mm
- 7 mm
- Reference (no bending)

planed

Conclusions
There were found no cracks or other damage after compressive bending considering 7,6,5 mm former diameters

Planed

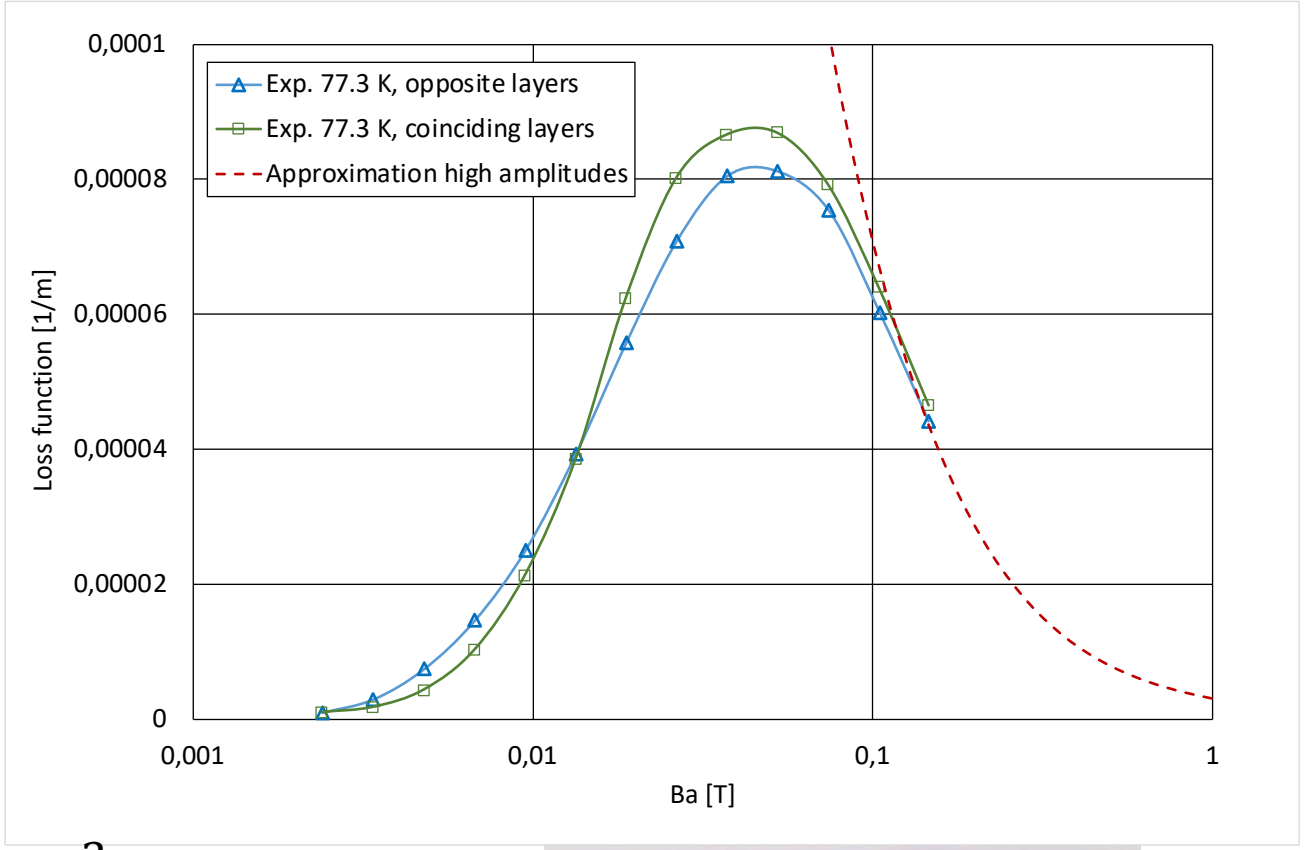
I_c measurement vs. former diameter considering compressive bending



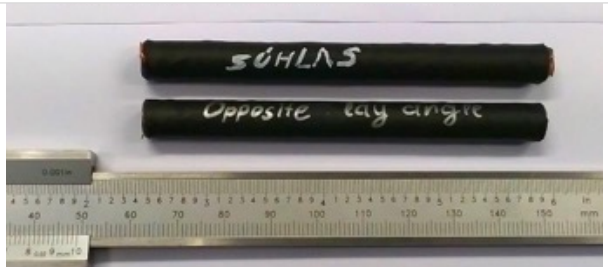
Summary of activities in P1

AC loss

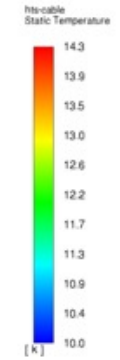
- Simulate AC loss for winding direction
- Measure coupling loss in LN_2, LHe
- Simple formula for hysteresis loss in cables (above full penetration)

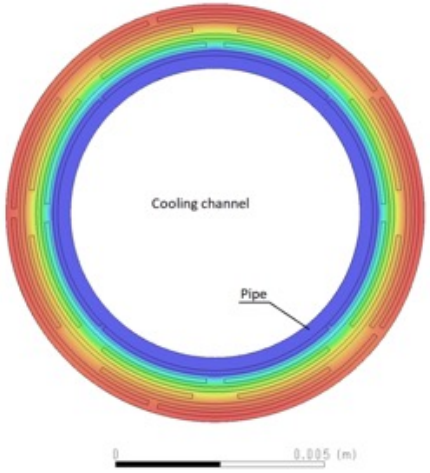


$$Q_{h,CORT} = B_{max} N I_c \frac{1}{\pi cos\alpha} w \rightarrow \frac{Q_{h,CORT}}{Q_{h,LTS}} = \frac{3}{8cos\alpha}\frac{w}{d_f} \approx \frac{w}{2d_f} = 500$$



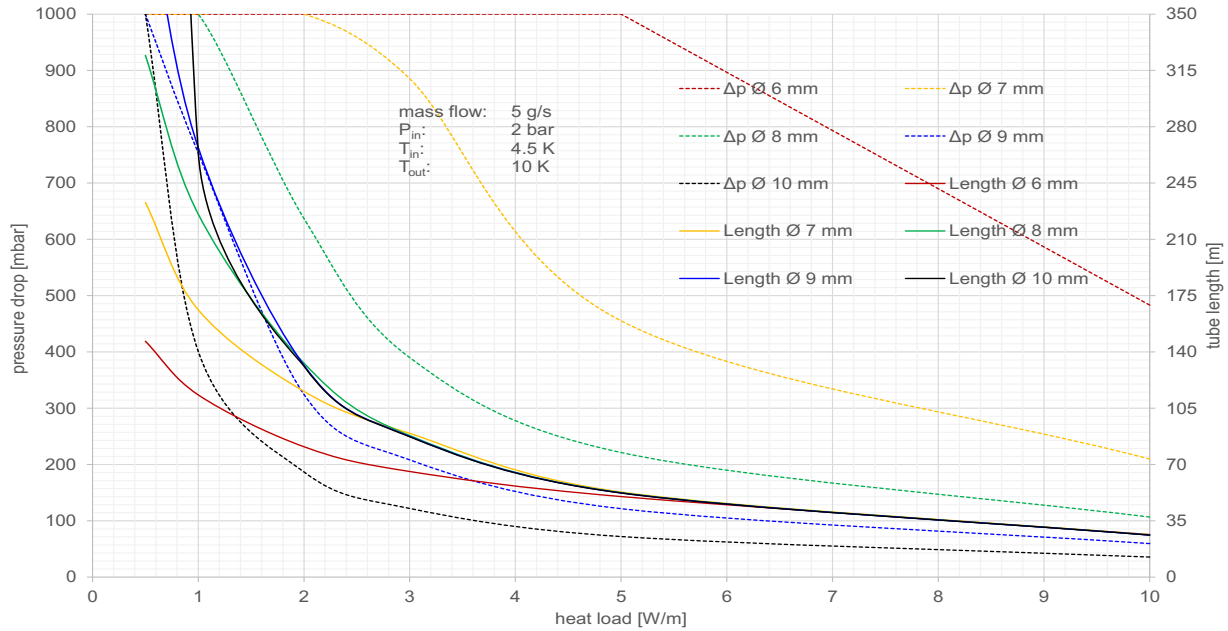
Summary of activities in P1





Cooling

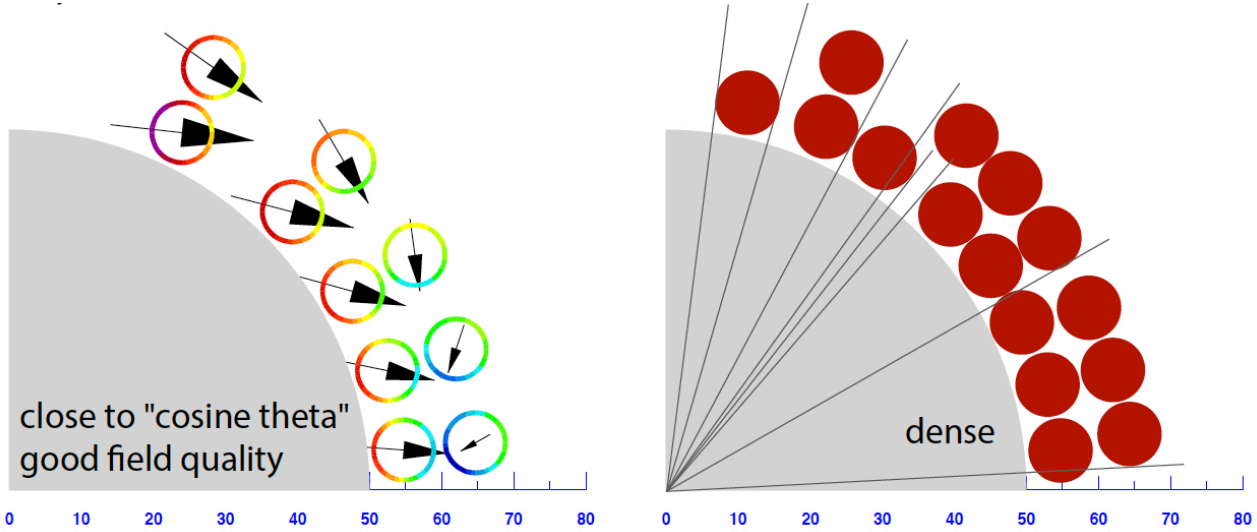
- Parametrised model for axial cooling
- Parametrised model for radial cooling
- Setup for thermal contact measurement between HTS tapes

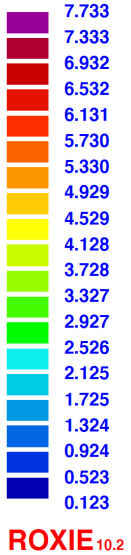


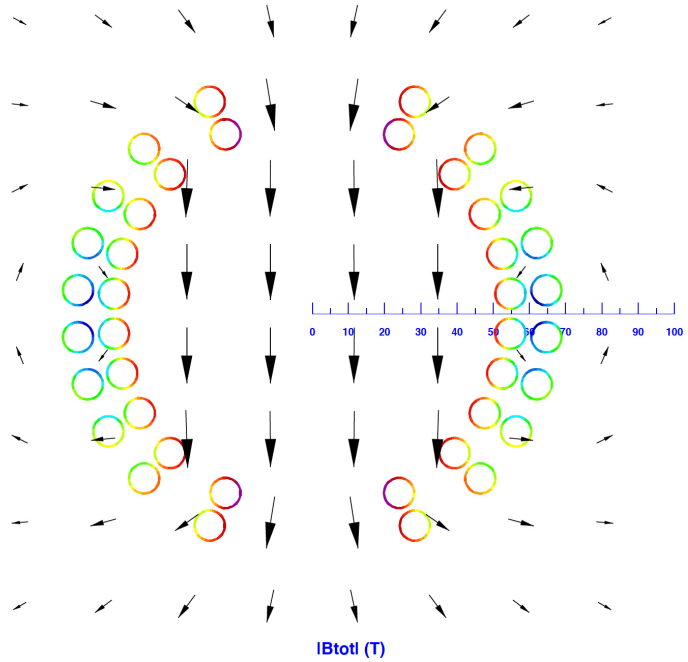
Summary of activities in P1

Magnet Design

- design of coil head
- Optimize coil layout for field quality







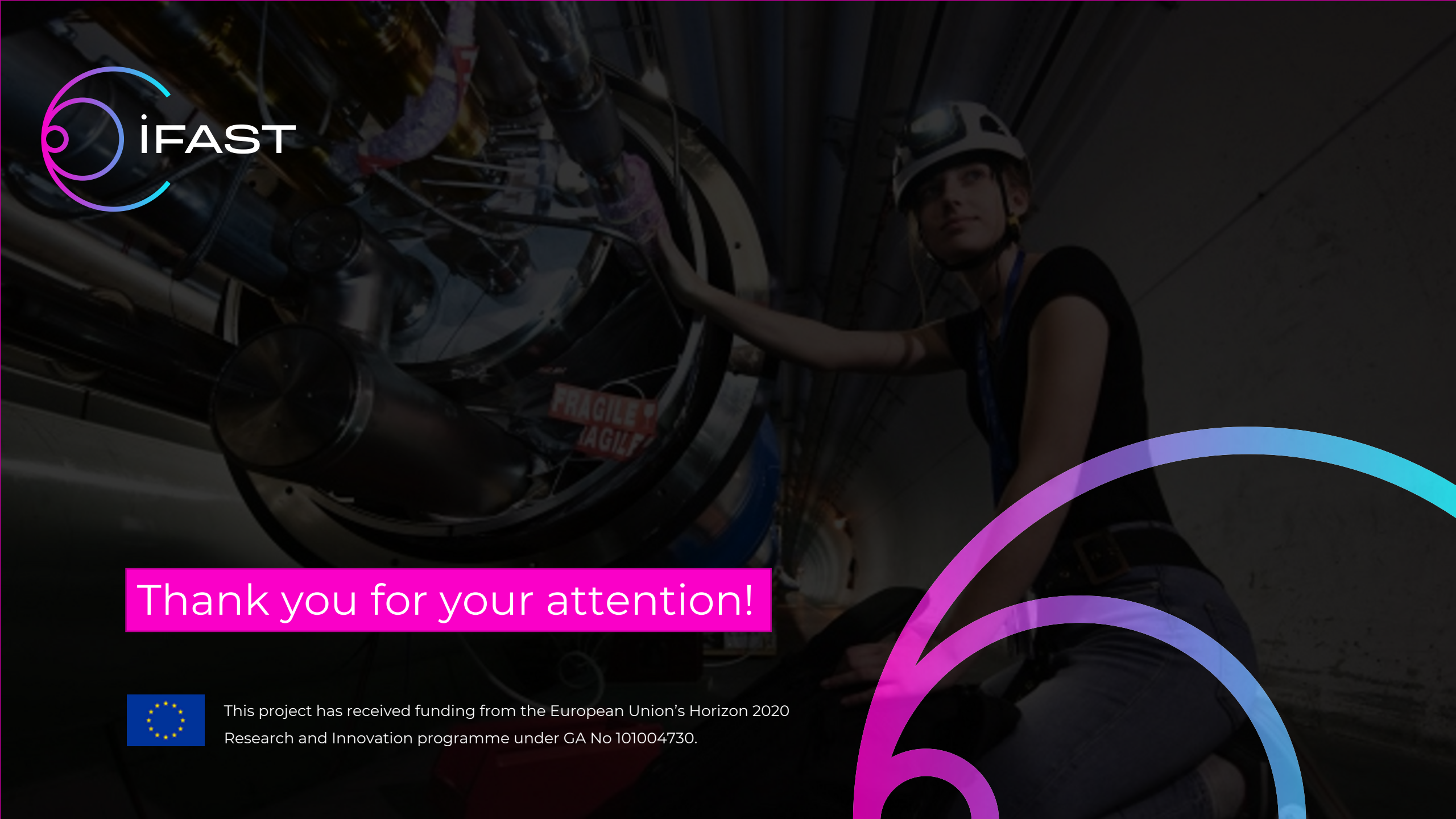
Relevance of objectives and impact

Fast ramped high field magnets are very challenging due to high AC loss and high forces

HTS materials enable a magnet design

- with higher coolant temperatures resulting in lower operating costs and energy savings.
- with higher magnetic field strengths resulting in compact machines

Hollow round HTS cables are very suitable for these objectives due to their mechanical stability and the inner cooling channel.



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