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Karlsruhe Institute of Technology

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Mechanical Characteristics of HTS CrossConductor Strands at Cryogenic Temperature

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Introduction

In the field of superconducting high current applications, there is the need to assemble a number of high temperature superconducting (HTS) tapes as a conductor or cable.

Several possible conductor layouts exist with different degrees of complexity. One of these is the so-called **HTS CrossConductor** (HTS CroCo) which uses HTS tapes of two different widths to obtain an improved filling factor in a round shaped copper tube. These HTS CroCos serve as a strand that can be used as single or multi-strand cable.

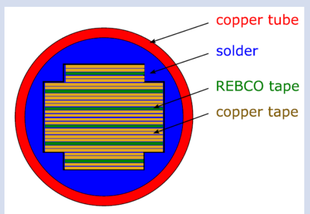
However, as these cables are exerted to Hoop and Lorentz forces, one key characteristic is their mechanical performance at cryogenic operating temperature.

In this work **transversal mechanical investigations** are performed of HTS CroCos.

Sample and Setup

Tapes by Superpower

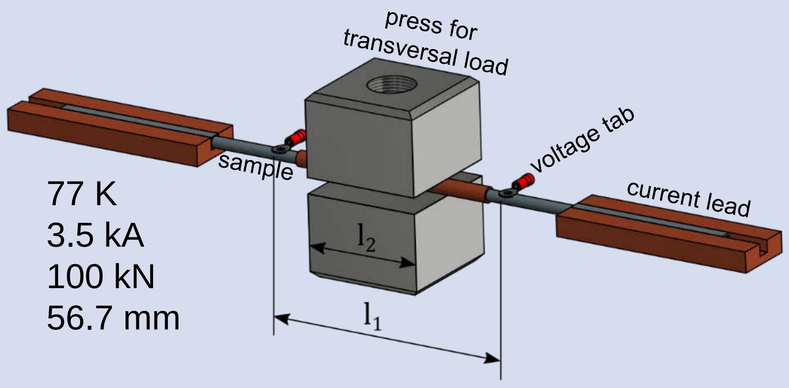
	SCS 4050-AP bzw. 3050-AP
thickness	~95 µm
width	4 mm and 3 mm
$I_{c,4mm}$	85-115 A (77 K s.f.)
$I_{c,3mm}$	105-115 A (77 K s.f.)



CroCo Details

outer dia	~7.7 mm
inner dia	~5.6 mm
28 x 4 mm wide tapes	
10 x 3 mm wide tapes	
$I_{c,CroCo}$	~2.1 kA (77 K s.f.)

Test Configuration



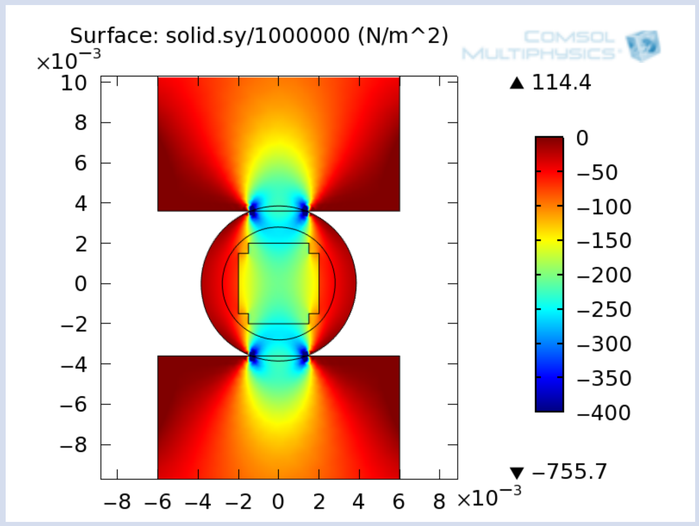
T_{meas}	77 K
I_{max}	3.5 kA
F_{max}	100 kN
$l_{2,comp}$	56.7 mm

FEM Analysis for approx 50 kN at 0° transversal load (compare cross section view upper-right)

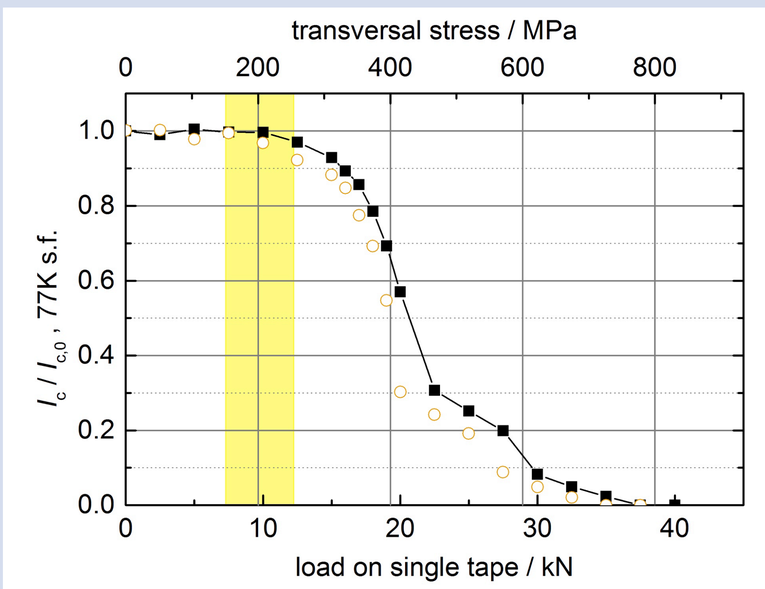
Stress range in CroCo stack

→ 150 to 220 MPa

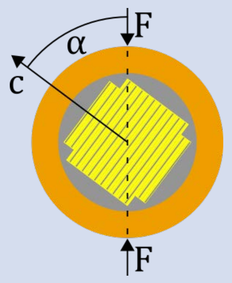
Stress is mainly taken by CroCo section

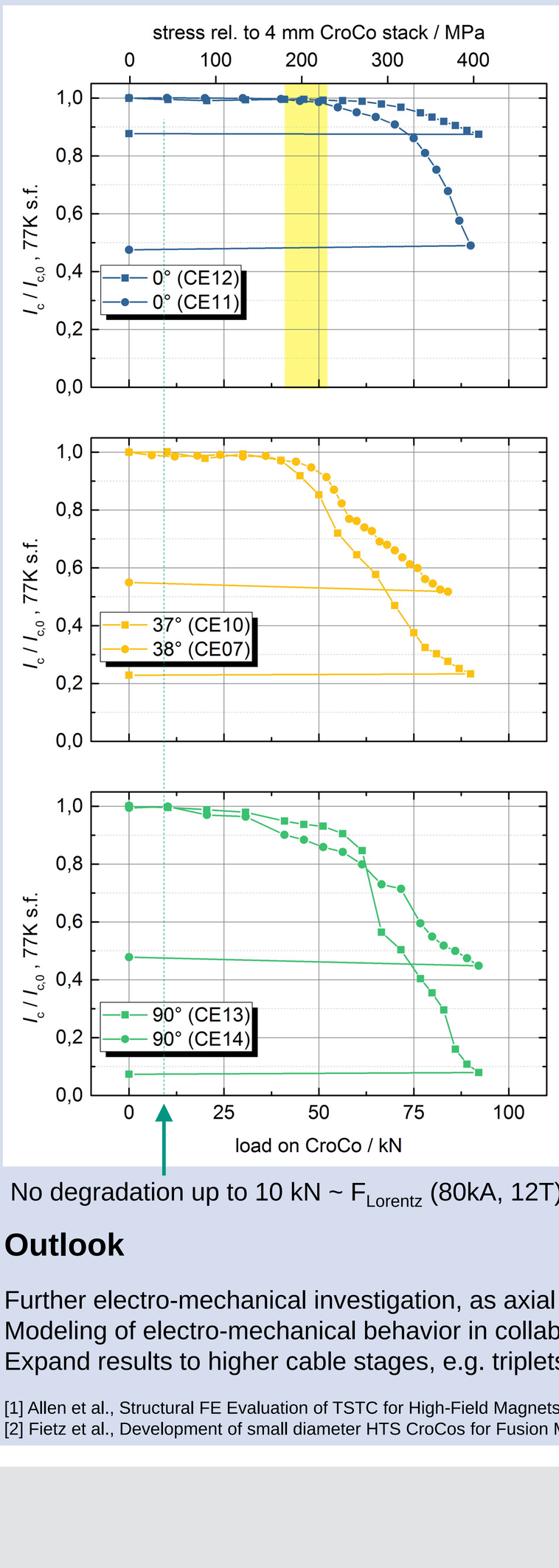


Results Transversal Compression for Tape & CroCo

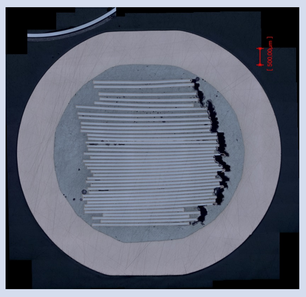


single tape
width 4 mm
compression 12 mm

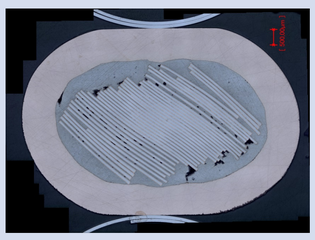




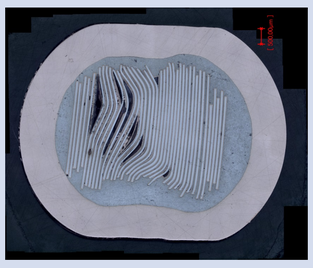
load 0° orientation



load ~37° orientation



load 90° orientation



No degradation up to 10 kN ~ $F_{Lorentz}$ (80kA, 12T) / 6 CroCo on $l_{2,comp}$

Outlook

Further electro-mechanical investigation, as axial and fatigue loading.
Modeling of electro-mechanical behavior in collaboration with TUFTS [1].
Expand results to higher cable stages, e.g. triplets and 6-around-1 [2].

[1] Allen et al., Structural FE Evaluation of TSTC for High-Field Magnets, 10.1109/TASC.2017.2652304
[2] Fietz et al., Development of small diameter HTS CroCos for Fusion Magnet Application, MT -25 (2017)