Possible KIT contributions to FP9-WPMAG and in particular hybrid HTS-LTS CS coils
MS Teams, April 13, 2021 4:00 pm
KIT, SPC, ENEA

Institute for Technical Physics

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053.
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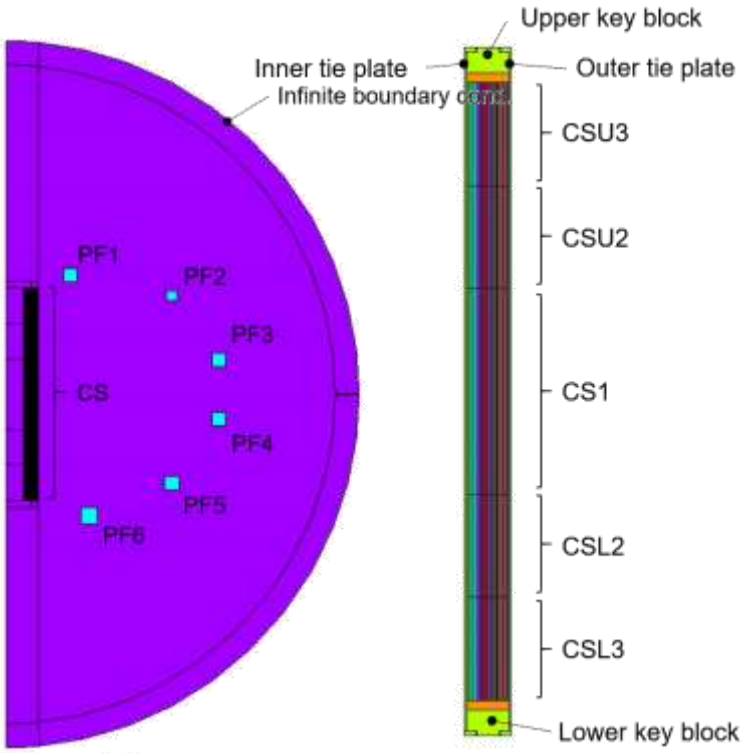
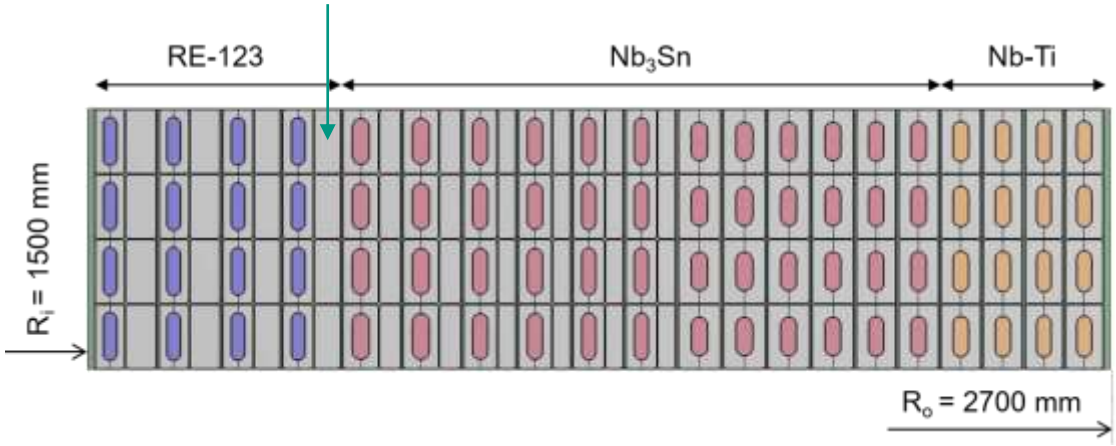
Agenda / Presentations

Valentina Corato:	Update GA / FP9
P. Bruzzone (SPC)	hybrid CS conductor design and test strategy
N. Bykovskiy (SPC):	Status ASTRA conductor
M. Wolf (KIT)	KIT HTS conductor development
	ENEA HTS conductor development
All	Discussion of next steps

Final Report on Deliverable(s)
Investigation of CS coil design options in 2020
X.Sarasola, IDM EFDA_D_2PDAUA





ri = 1509 mm

Iop = 55.5 kA

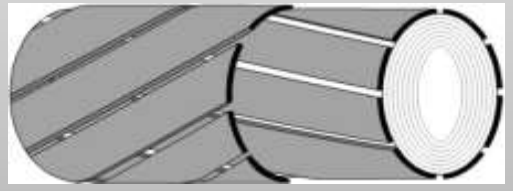
CS1 Center: Bz ~ 18.8 T, Br << 1T,

CS3U: Bz ~ 12 T, Br ~ 5T (Babs ~13 T angle ~ 20deg)

*RE*BCO High Current Cable Concepts

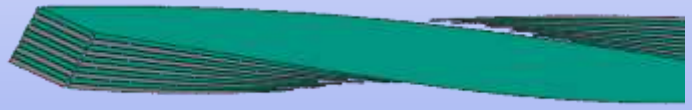
CORC:
Conductor on Round Core

D. van der Laan,
SUST 22 (2009) 065013



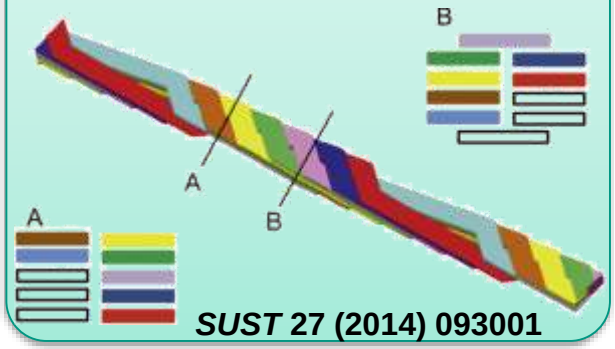
TSTC:
Twisted Stacked Tape Cable

M. Takayasu *et al.*,
***IEEE TAS* 21 (3) (2011), 2340**



Roebel - Cable:

W. Goldacker *et al.*
J Phys. Conf. Ser. 43 (2006) p. 901



***SUST* 27 (2014) 093001**

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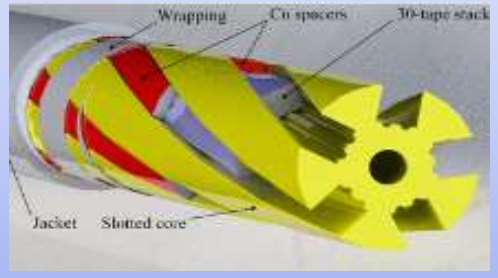
Stacked-Tape HTS High Current Cable Concepts

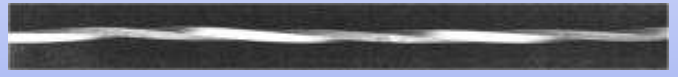
TSTC - CICC

G. Celentano, *et al.*,
***IEEE TAS* 24 (3) (2014), 4601805**



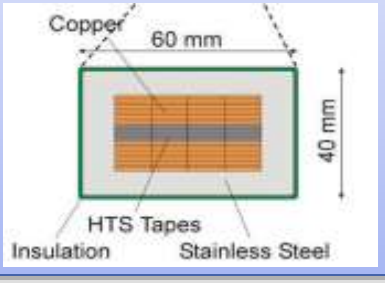
TSTC
Twisted Stacked Tape Cable

M. Takayasu *et al.*,
***IEEE TAS* 21 (3) (2011), 2340**



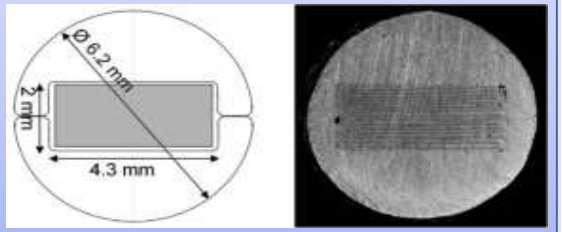
STARS

N. Yanagi,
***FUS. SC. & TECH.* 60 (2) (2011), 648**



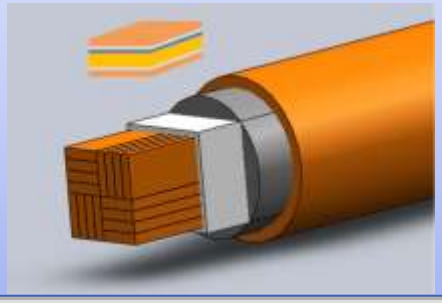
Round - TSTC

D. Uglietti, *et al.*,
***IEEE TAS* 24 (3) (2014), 4800704**



Quasi-isotropic strand

Y. Wang, *et al.*,
***IEEE TAS* 26 (4) (2016), 4804406**



HTS CrossConductor

M. J. Wolf, *et al.*,
***IEEE TAS* 26 (2) (2016), 6400106**

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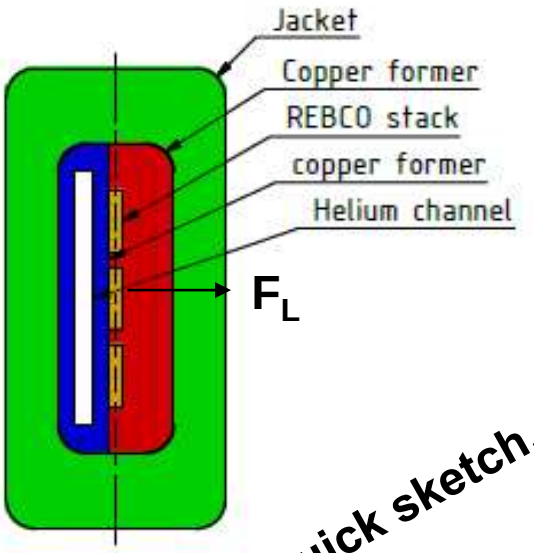
Conductor options for HTS part hybrid CS

Quantity	Benefits	Challenges	Comments
Monolithic stack e.g. STARS	Alignment of tapes w.r.t. field possible easy fabrication Strong mechanical support forces parallel to tape normals	Large losses if B perp. Stack (CS3U/L) No length compensation on HTS level	
Roebel from stacks e.g. ASTRA			Covered by SPC
Slotted core e.g. ENEA / VIPER			Covered by ENEA
Roebel from tapes	Alignment of tapes w.r.t. field possible	Mechanical rigidity? Max. tape width 12 mm -> 100 tapes (50 per side) -> accumulation of Lorentz loads	
CICC from (T)STC strands	Experience in manufacturing, first samples tested (mechanical issues identified, however) Comparatively low AC losses	No alignment of tapes to field Length compensation during winding with rather rigid strands? Mechanical issues with strands? No profiles, only round strands in a flat cable (line loads)	

Starting point: STARS-like conductor



NB:
This is just a quick sketch,
Not a real design

„Simplest possible conductor“:

- Tapes parallel to the field direction
- Tapes oriented at the radial conductor center
- Several non-twisted stacks
- Stack thickness < 3mm → bending strain < 0.1 %
- Lorentz forces perpendicular to tapes
- Low-resistive contact to stabilizer (quench)
- Simple fabrication (pre-fabricate soldered stacks, solder to profiles, assemble, weld jacket)
- Scalable also to higher currents

Challenges and potential show-shoppers:

- AC losses (in particular at the ends of CS3U/L) ?
- Quench and Quench detection?
- Mechanical rigidity of flat jackets?

Possible KIT HTS work within EUROfusion in 2021

- Completion of the HTS quench sample (IC-EU-CN)

- FBI test on a HTS CroCo based triplet sample
- (goal: final qualification of procedures towards the assembly of the EU-CN-SULTAN sample)

- Definition of a third (SPC, ENEA, KIT) HTS conductor option for the hybrid CS

- Prepare a subscale test in FBI (1 stack + „environment“ + manufacturability)

- Purchase and characterize tapes

- TH calculations (in cooperation with PoliTo?
  additional cooling at HTS-LTS-interface due to high AC losses in HTS necessary?)