

HTS CCT prototype progress

Elytt Energy
Wigner RCP

2023-11-16

Winding

Recap:

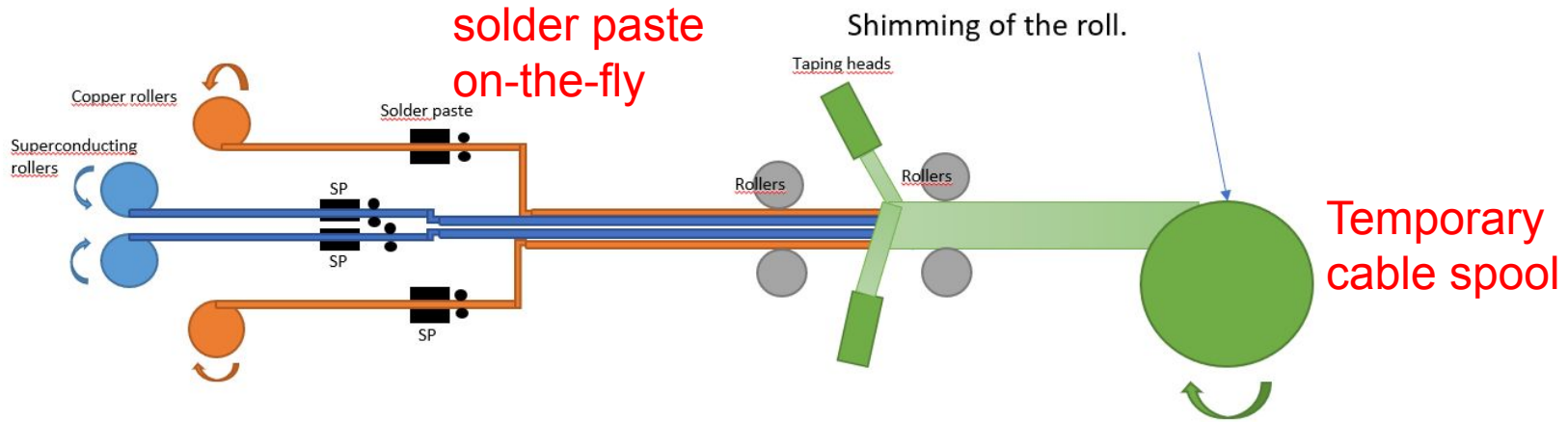
- Composite cable: 2 x HTS + 2 x Cu
- kapton-insulated
- soft-soldered for stable electrical/thermal connection, current sharing, stabilization

Problems:

- Few mm difference between innermost and outermost tape in a cable over one turn
 - If pre-soldered: Creasing, too high stress?

Julio's proposal in Trieste, 2023

Conductor manufacturing



There will be 6 copper rolls and 4 HTS rolls. Each tape will pass through a solder paste applicator. The tapes are put together and wrapped in polyimide tape.

The roll containing the stacked conductor should have a curvature similar to the curvature in the slot of the mandrel.

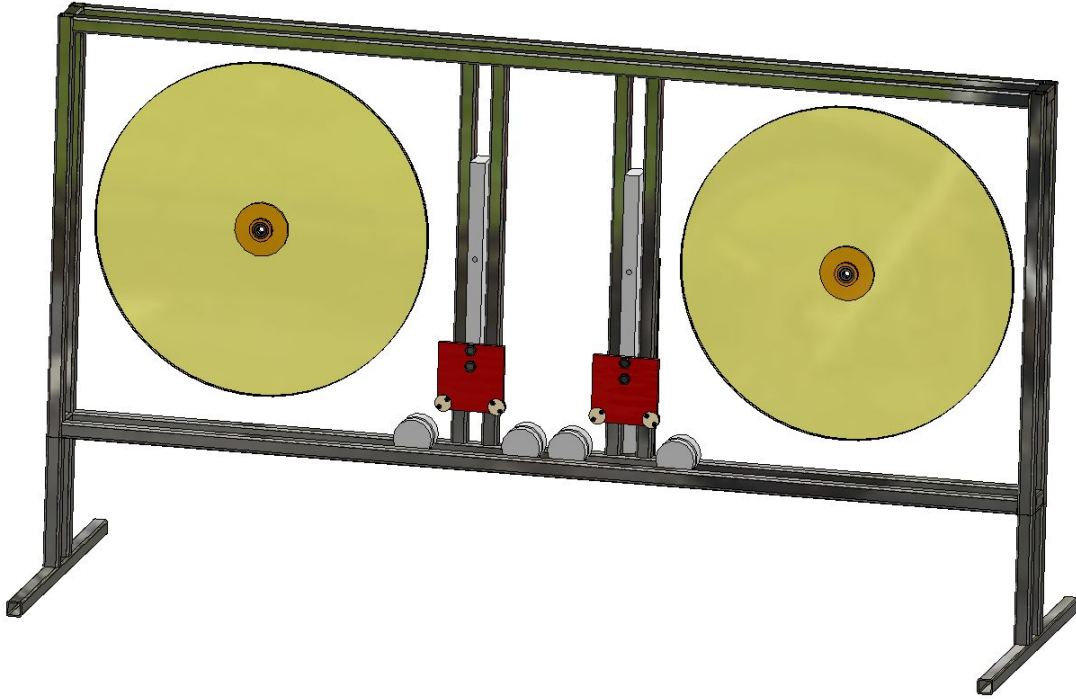
Further concerns

- Solder in paste form (suspension): paste evaporates when melted, gas/liquid coming out from kapton insulation, opening it
- $T > 200\text{ C}$ for a few minutes \rightarrow Ic degradation. Only short interval allowed
 - Can not do if soldered in-situ due to huge thermal inertia of the former
- Find low-temperature solders
 - $\text{IN}_{52}\text{SN}_{48}$ - $118\text{ }^\circ\text{C}$ (works best if around $170\text{ }^\circ\text{C}$!) - remains ductile at cold
 - Bismuth-based: $\sim 100\text{-}170\text{ }^\circ\text{C}$ but due to bismuth, prone to cracking when cooled.

Strategy

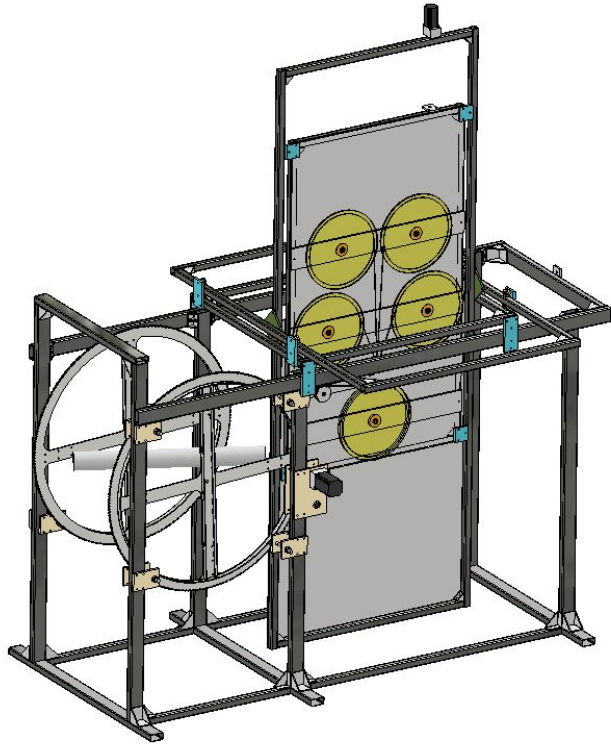
- Solder-coat each tape separately
- Wind, creating the composite cable on-the-fly (allow for different tape lengths)
- Solder in-situ

Solder coating machine



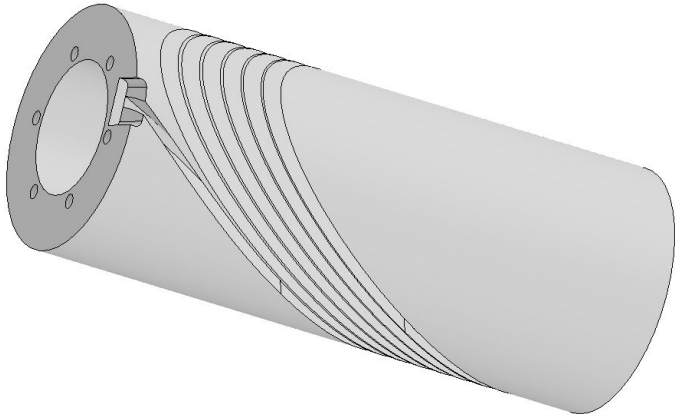
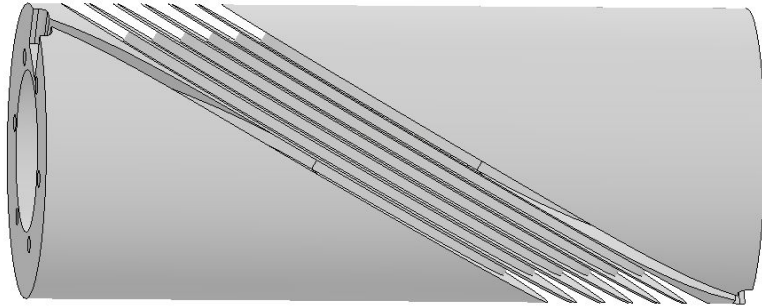
All components ordered

Winding machine



- Under construction
- All components ordered
- Control software ~70%

Former manufacturing

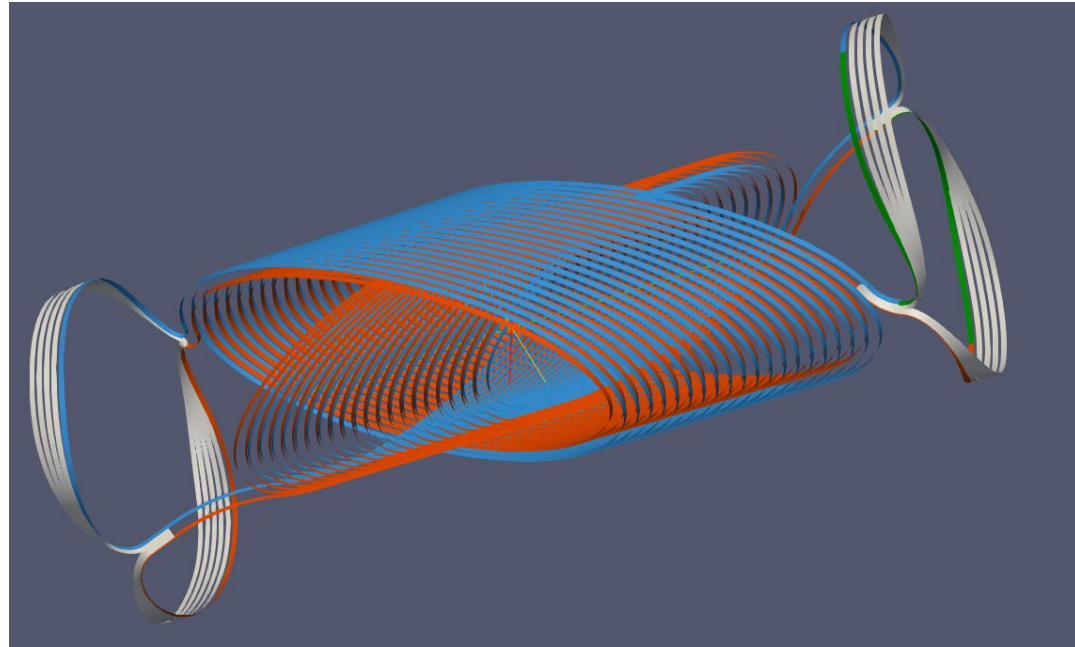


- 6 turns
- Variable rib thickness (0.4 .. 0.9 mm)
- Goal: find manufacturer (not easy!), test manufacturing, wall thickness, practice/test winding
- <http://hsm.as> (recommended by CERN)

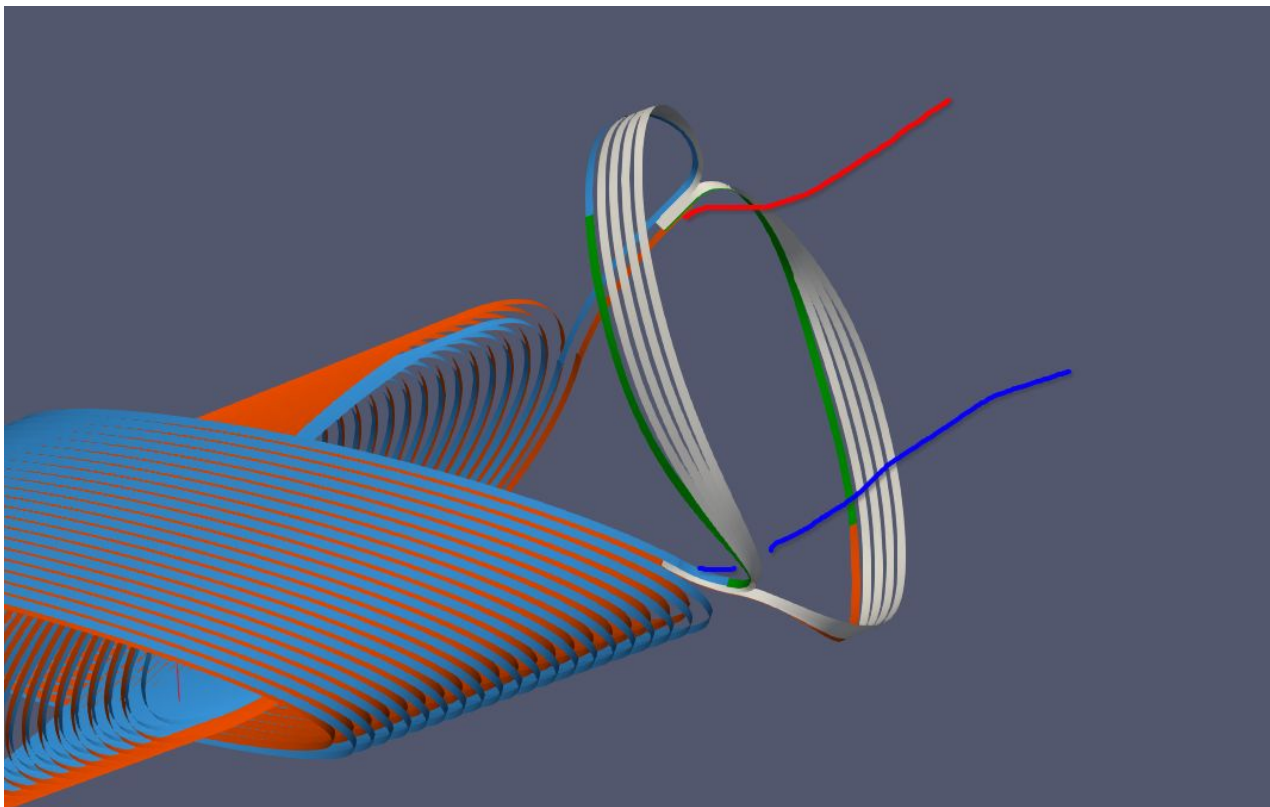


Splice geometry

- C++ library for tape path optimization, matching curvature/torsion/direction etc at segment interfaces
- Each single cable is modelled
- Have code to transfer into Autocad Inventor
 - 3D print the splice-box with complicated geometry
- 11+11 splices at both ends, on two sides of the tubes
(only 5+5 are shown)
- Easy access and same geometry of each splice
 - soldering
 - thermalization
- Checked splicing scheme and logic



Current leads



Outlook

- Last touches in the tape geometry code
- By Christmas:
 - First (dummy, illustrative) CAD model: formers with grooves + splice supports
 - Winding machine assembled
 - Test former arrives (hopefully)
 - Manual winding test (1 cable maybe)
- Early next year
 - Winding machine control
 - Test windings with real setup, several cables
- Mid next year
 - In-situ soldering, wax impregnation first tests (or concepts)....