PSI

HFM
High Field Magnets Programme

14 T block-coil benchmark

HTS Modeling WG Mtg

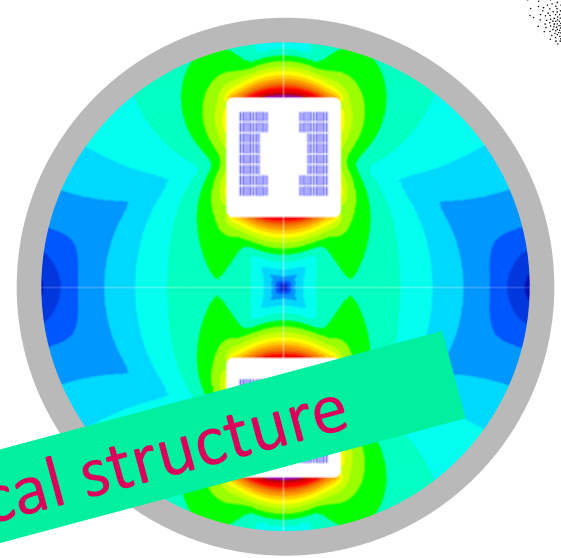
B. Auchmann
24 October 2024

Block Coil Benchmark – Purpose and Design Goals

- The 14 T block coil benchmark does not constitute an EM *design*.
- Rather, it is a tool to evaluate numerical models and techniques for the simulation of ramp-induced effects (AC losses, field quality on ramp and stability on plateau, screening-current induced forces).
- With a better understanding of our numerical tools, and their eventual experimental validation, we create a commonly accepted basis for design work that informs our R&D roadmaps.
  - Collateral benefit: we get a feeling for ramp-induced effects as compared to an LTS 14 T magnet → we try not to be too pessimistic.
- Benchmark design goals (all debatable for an actual *design*):
  - 14 T central field at 20 K
  - Geometric harmonics < 5 units
  - Max current 30 kA
  - Local temperature margin for homogenous current distribution of 5 K
    - (*highly debatable*, the goal is to leave margins for radial gradients in the coil and temperature differences along a cryogenic sector)
  - Tape performance: Fleiter fit of best tape from Faraday Factory Japan on record (exceeds currently available tape in performance – but may plausibly be reached in the future)
  - Stabilizer J_{cu} ~ 1000 A/mm^2

Full benchmark description here (Cernbox)

The 14 T Block Coil Design



Cable:

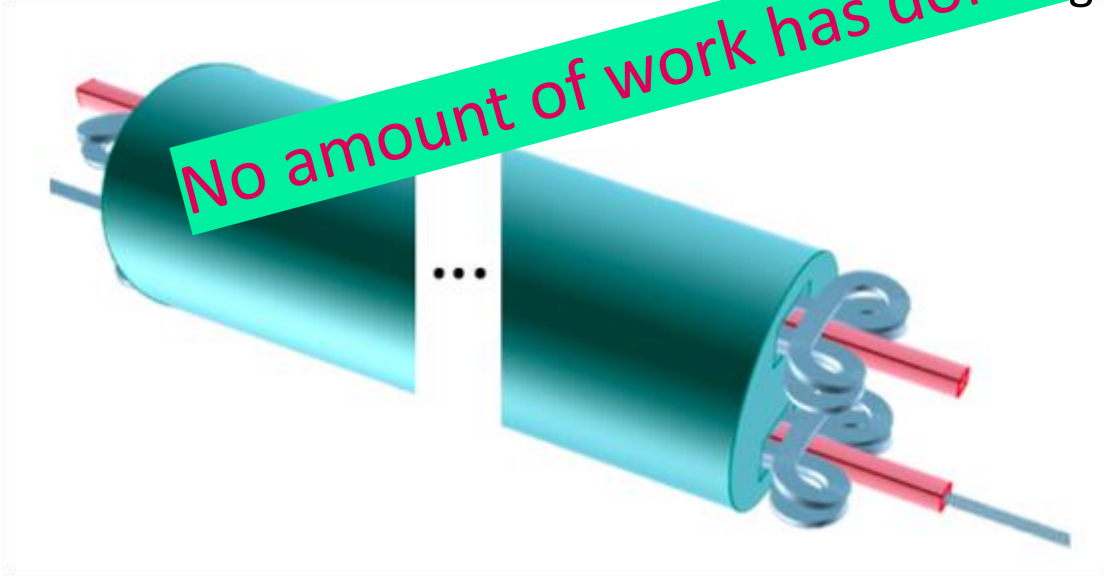
Non-graded design. 15x 12 mm tapes per cable. Tape-stack surrounded by 1 mm copper. 0.15 mm insulation thickness.

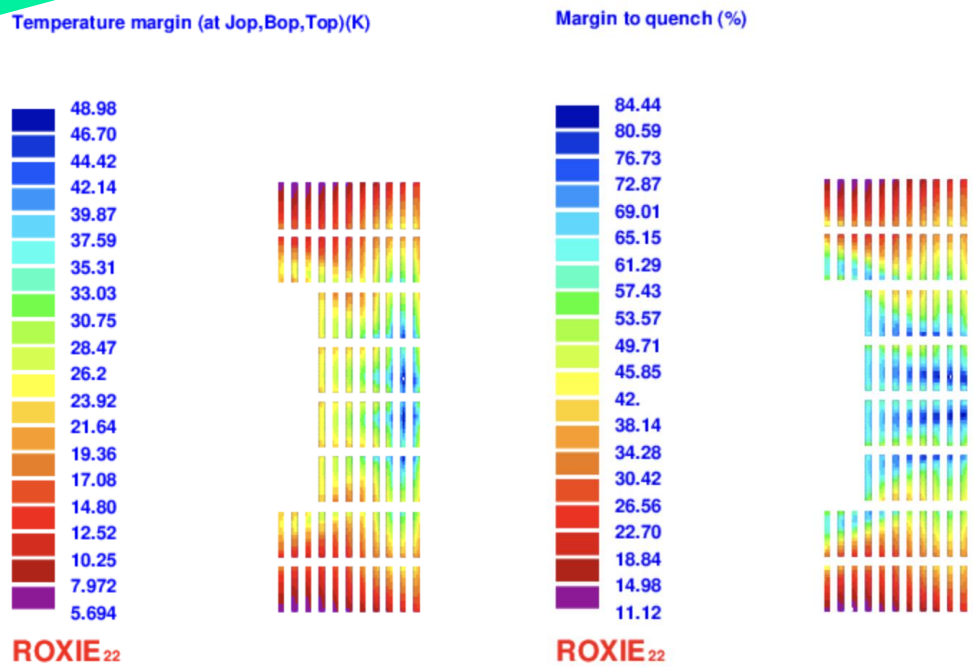
Coil geometry:

Vertical arrangement of apertures for independent clover-leaf ends. Yoke diameter 700 mm.

There is space for an internal structure around the [illegible] and for a 4.5 K screen for condensation [illegible].

No amount of work has done on the mechanical structure





5-stack and 14 T block-coil benchmarks

On the 5-stack benchmark we can evaluate modeling depth and convergence with different numerical approaches – even if a detailed model is too heavy for use in magnet design.

With the 14 T block-coil benchmark we can compare our implementations before we embark on a design study, and we may implement very detailed models once to evaluate the relevance of simplifications.

FINE