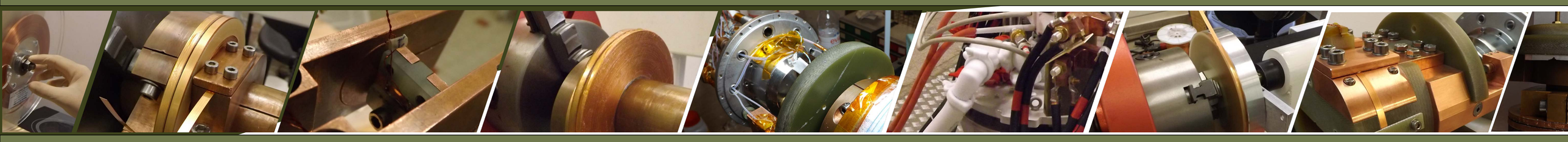

REBCO HTS wound coil model for critical current calculation and comparison with wound sample experiment

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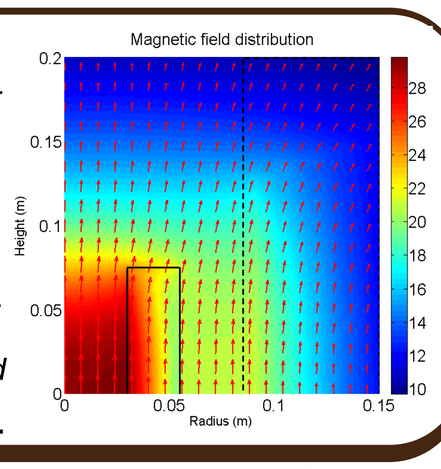
Context

The ANR NOUGAT aims at developing and testing a 10 T High Temperature Superconducting insert working inside a 20T background field. The insert is designed as a stack of pancakes wound with REBCO tapes. Although Metallic Insulated winding has been chosen mostly for its self-protection ability, electrical Insulated coils are still studied as they are required for some applications and show some advantages for user magnets. However, transition detection and protection remain challenging. A model has been developped to better understand the quench propagation inside a winding. One fully instrumented single pancake coil has been studied under high field up to 19 T to provides materials to allow comparisons between model and experiments.

Simulations made on Flux/Cedrat®, the field generated by the insert is calculated and added to the resistive contribution provided by LNCMI



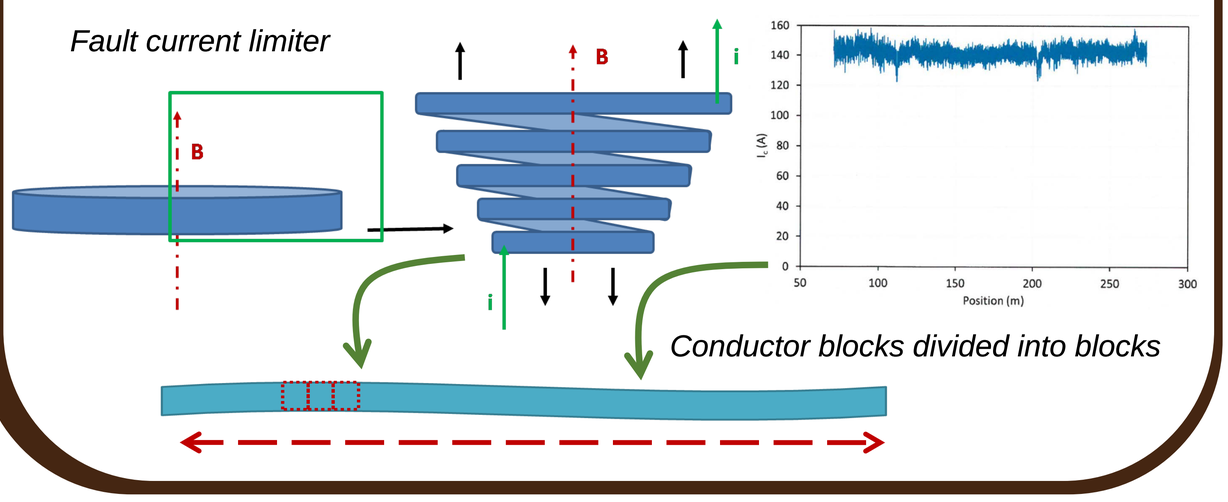
1D- Model for fault current limiter, self-field

Origins of the model: Fault current limiter model

- Take into account the inhomogeneity along the length of the conductor; ☺
- Does not calculate the field generated by the coil; ☹
- No background field. ☹

Ic measurement at 77K, self-field

Fault current limiter

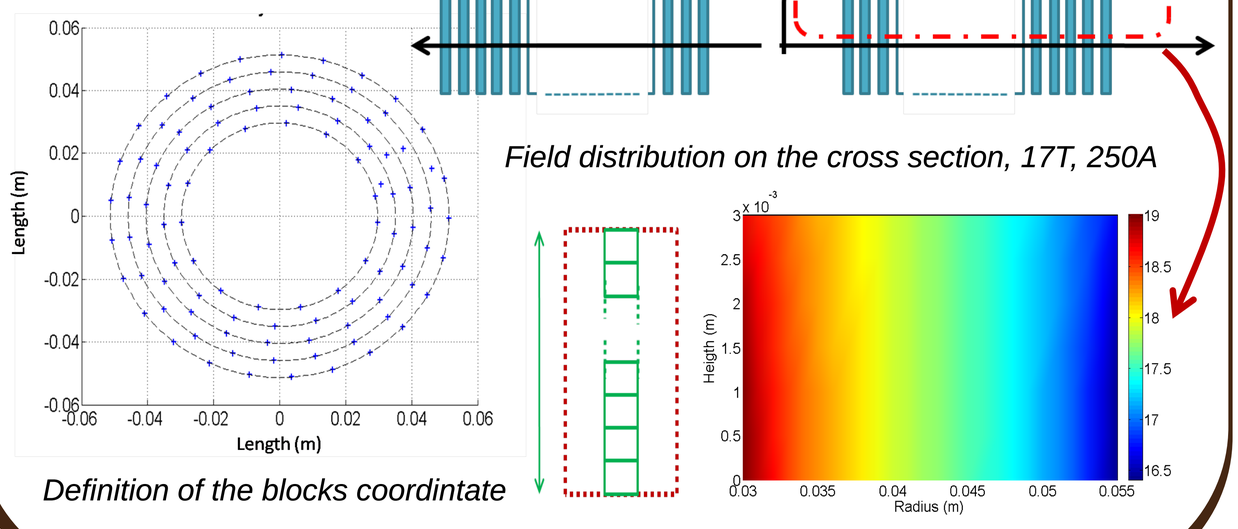


Conductor blocks divided into blocks

Model 2D, for magnet coil under magnet field

Objectives :

- Evaluation of the critical current of each block taking into account the component of the field to evaluate the critical current on each blocks;
- Each block is subdivided along its wide.



Field distribution on the cross section, 17T, 250A

Definition of the blocks coordintate

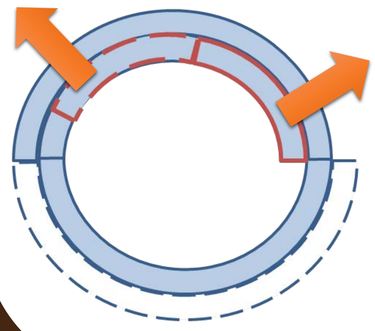
Subdivision of one block

Addition of the thermal behavior, 1D and 2D

- Knowing the critical current of each block, the current sharing can be evaluated and so the energy dissipation of each block;
- First in 1D, along the length of the conductor;

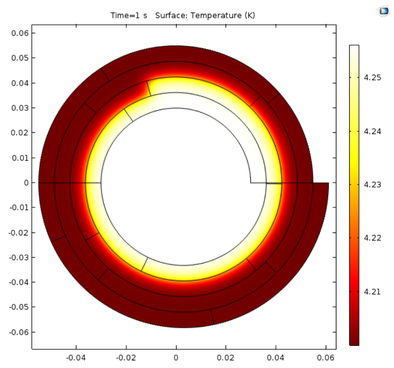
Propagation along the length

- Then in 2D, coupling Matlab with COMSOL.



Propagation along the turns

Where and how to define the initial heating to match the experiments ?



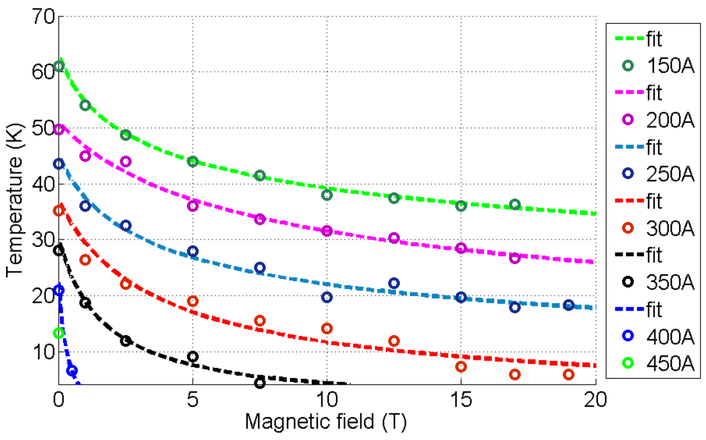
Heat propagation in COMSOL

Comparison to experimental study

Single pancake description	
Number of turns	170
Tape wide	6 mm
Inner diameter	60 mm
Outer diameter	110 mm
Field coef.	3.038 mT/A
Inductance	1.16 mH

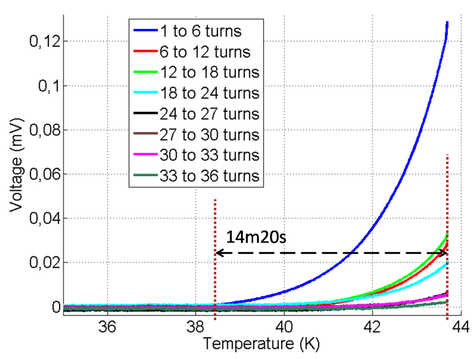
Objectives :

- Comparison of the model with the experimental study under high field of a fully-instrumented single pancake.



Main results: temperature when voltrage threshold is reached

Conclusion and further work

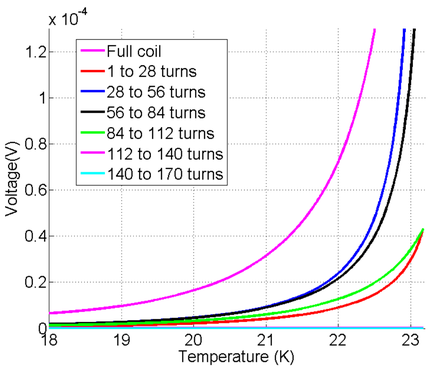


Next objectives of the model :

- Simulate the whole coil behavior under high field to anticipate the location transition and the way it propagates inside the winding.
- Match the previous study of a single pancake fully instrumented

Difficulties :

- Definition of the heating initialization to match the experimental study



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