# AC loss and quench analysis of an MgB2 SMES magnet with cryogen free cooling

3-LP-LE-S13

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*See also 3-LP-LE-I03*

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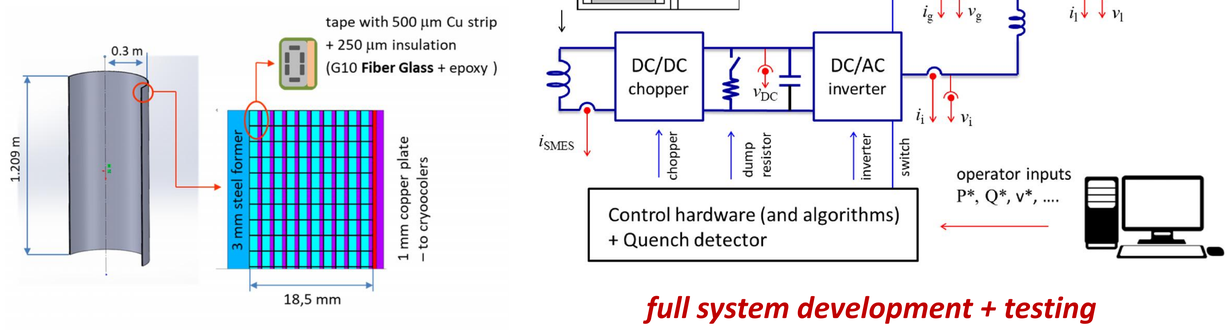
## The DRYSMES4GRID project: development of a a 500 kJ / 200 kW SMES system with conduction cooled based on MgB2 SMES

**MISE -** Italian Ministry of Economic Development

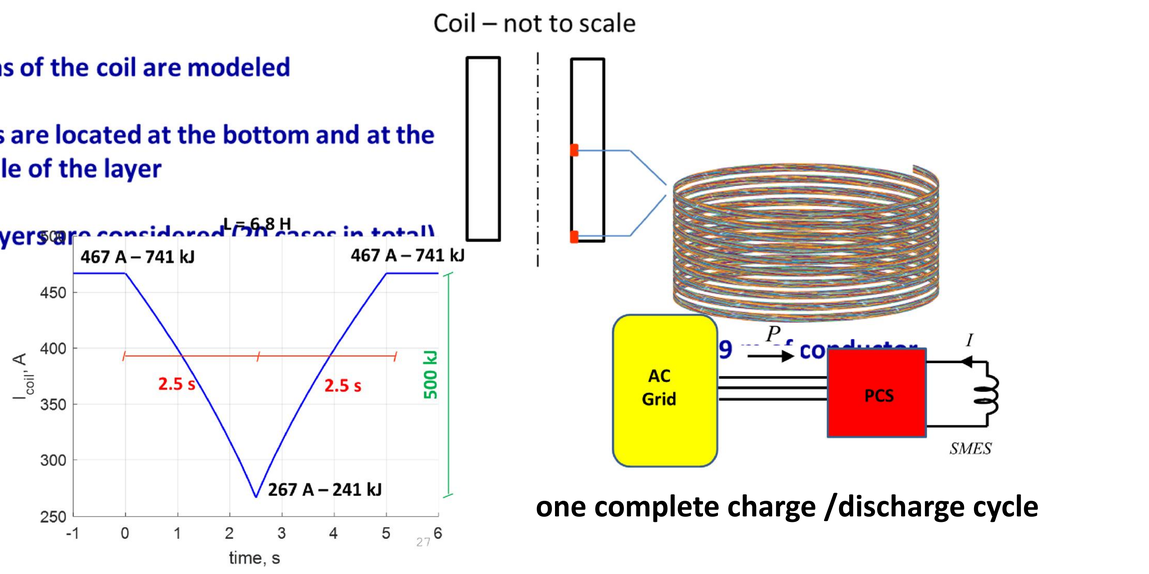



***full system development + testing***

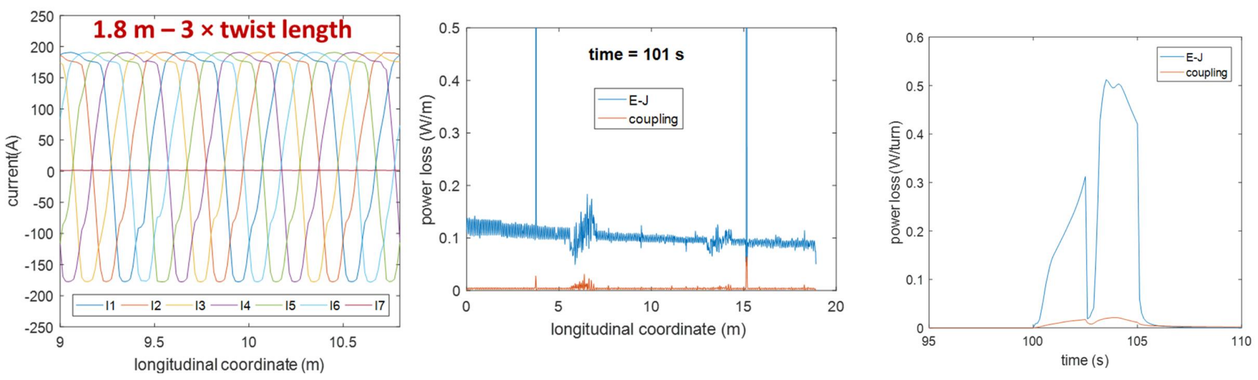
## AC loss – model and simulated cases

**Ten turns of the coil are modeled**

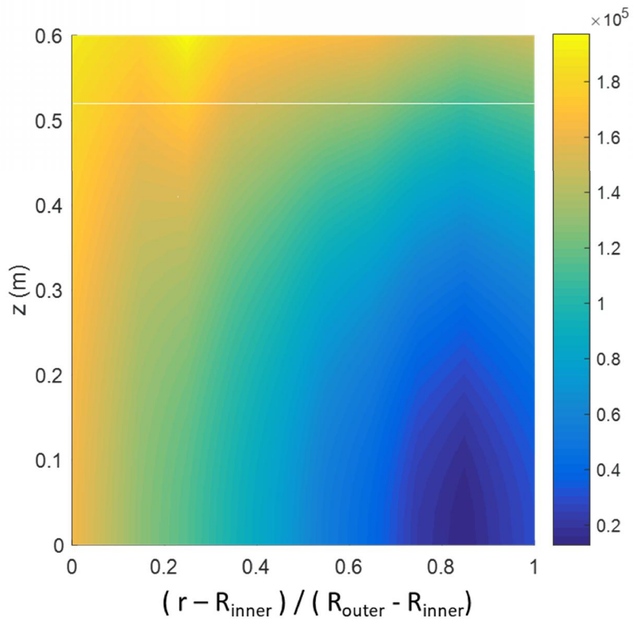
- **Turns are located at the bottom and at the middle of the layer**
- **All layers are considered (2m cases in total)**




## AC loss – Results




**Energy loss per unit volume of coil (J/m³) in one discharge/ charge cycle**




- **Higher losses are obtained at the innermost end of the coil**
- **By assuming a cooling power of 2 × 20 W @ 20 K this loss can be removed in about 130 s**
- **A waiting time in the order of the minutes is needed before the next cycle**

**The total loss of the SMES coil in one cycle is 5.2 kJ**

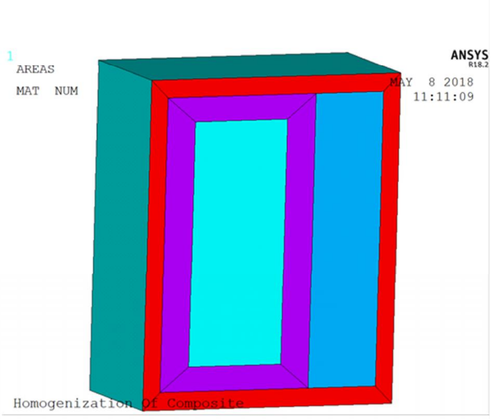
## Quench - Homogenization of composite material

Allows the replacement of the composite medium by an "equivalent" homogeneous medium to solve the global problem

For thermal conductivity a unit temperature drop has been applied separately on each direction, to evaluate the flux on cell.

For mechanical properties the unit deformation on each direction and a unit shear deformation has separately applied

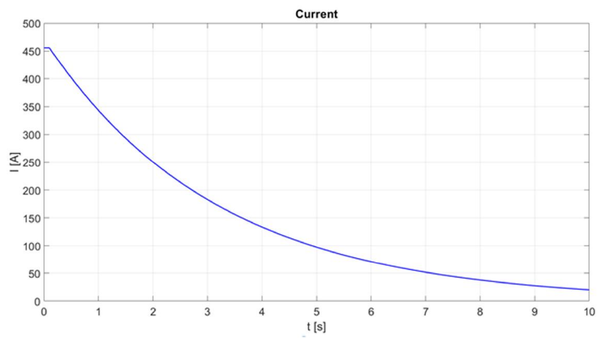
Thermal capacity are wheigted on volume fractions and resistivities have been considered in parallel.

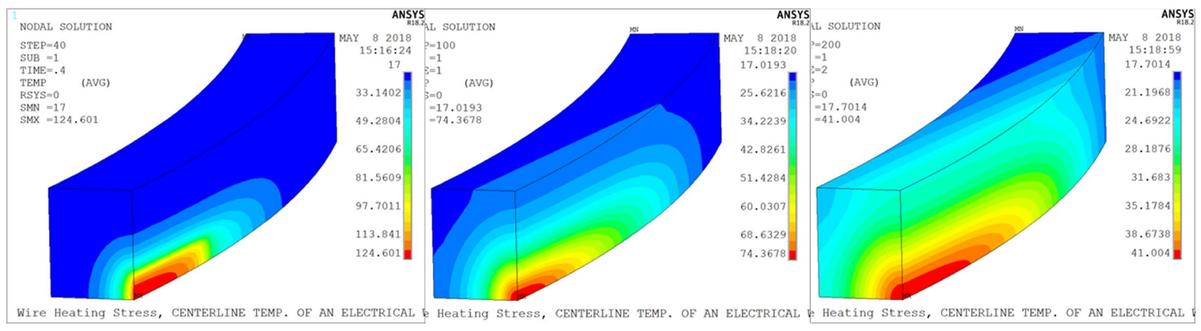



## Quench - temperature evolution

A disturb of 50 J has been considered. Geometry has the dimension of a 15° sector of 5x5 strand in **±200 kW / 2,5 s** configuration. After the detection of quench (tau_delay=0,1 s) the current discharge on the dump resistor with a characteristic time:

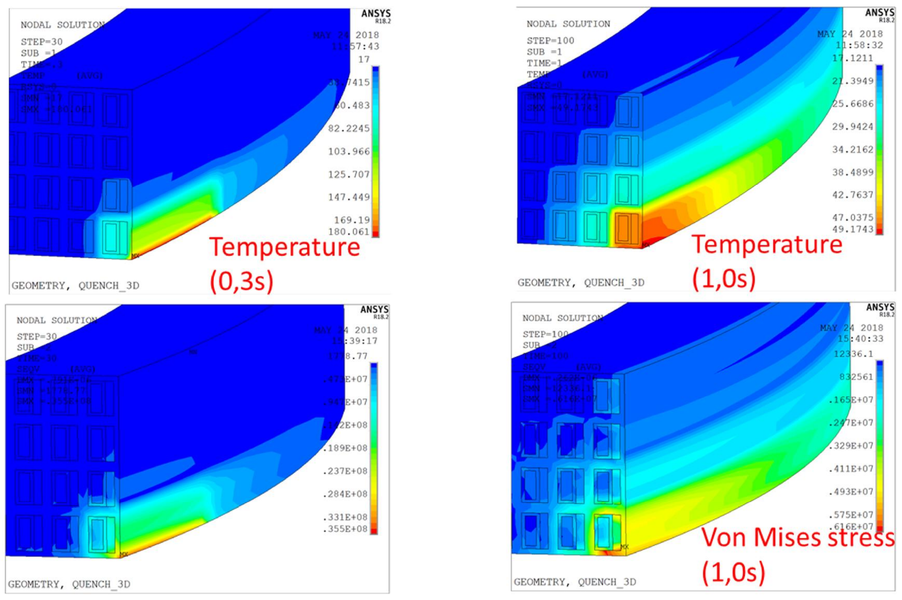
$$\tau = \frac{L}{R} = 6{,}8/2{,}14$$




## Quench – Mechanical stress

A disturb of 50 J has been considered. Geometry has the dimension of a 15° sector of 5x5 strand in **±200 kW / 2,5 s** configuration. After the detection of quench (tau_delay=0,2 s) the current discharge on the dump resistor with a characteristic time:




**Safe operation of the SMES during the quench is obtained**

***SEE 3-LP-LE-I03 FOR DETAILS ON COIL'S CHARACTERISTICS***