



# Short-Term Internship Programme: March 2019 – September 2019

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TE-MPE-PE section meeting, 14<sup>th</sup> March 2019

# Profile

- Carmelo Barbagallo
- Italian
- My town: Catania (Sicily)



- Academic background:



→ Master thesis



→ M.Sc. in Mechanical Engineering



→ Bachelor thesis



→ B.Sc. in Mechanical Engineering

- Hobbies:

- Football

- Physics

- Cooking

- Photography

# Main Scientific Projects

**Bachelor thesis:** FE Models for Thermo-Mechanical and Thermal Fatigue Analysis of Power Modules.



- Thermal transient analysis (junction temperature and stress-strain distribution);
- Thermal fatigue life prediction (number of cycles to failure under power and thermal cycles);
- SAM (Scanning Acoustic Microscope) measurements to validate simulations.

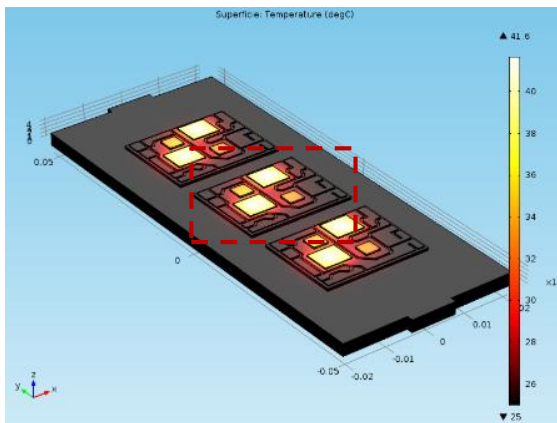


Figure 1: Thermal map of power module [1].

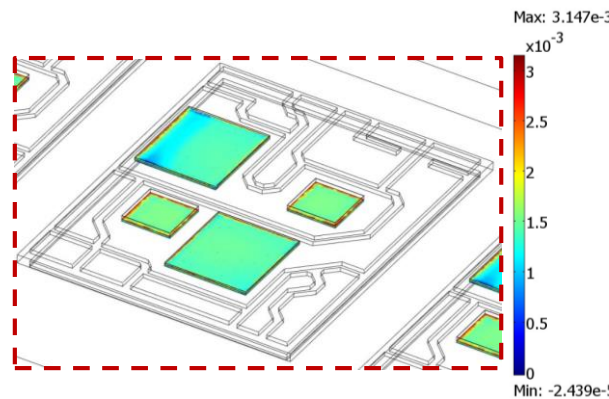


Figure 2: Effective plastic strain distribution on dies [1].



Figure 3: SAM image after 300 thermal cycles [1].

# Main Scientific Projects



**Master thesis:** Quench Protection Heaters FE Analysis and Thermal conductivity Measurements of Nb<sub>3</sub>Sn Cables for High-Field Accelerator Magnets

- Heat conduction simulation from heater to the superconducting cable (MQXF and 11 T magnet short models) [2];
- Quench heater delay detection (SM18 facility) to validate simulations [2];
- Steady-state measurements and numerical modelling of thermal conductivity of impregnated Nb<sub>3</sub>Sn cable stacks [2].

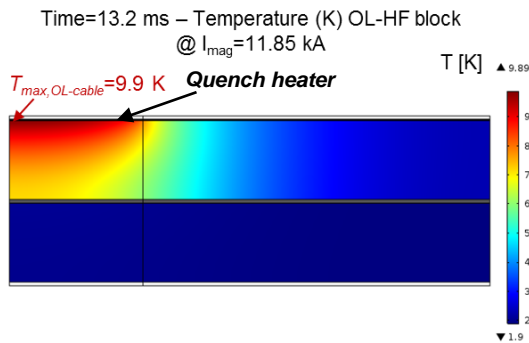


Figure 4: Maximum temperature for HF block turns for MBHSP106 magnet [3].

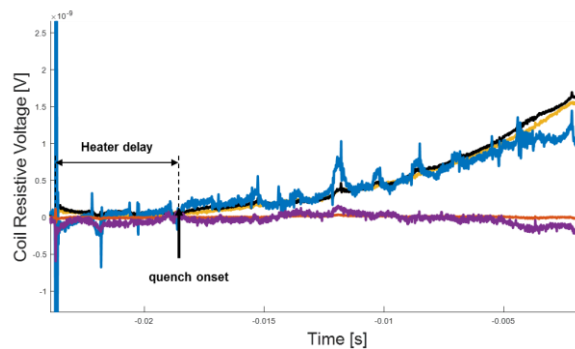


Figure 5: Real coil resistive voltage signals from cold test on MBSHP106 magnet [3].

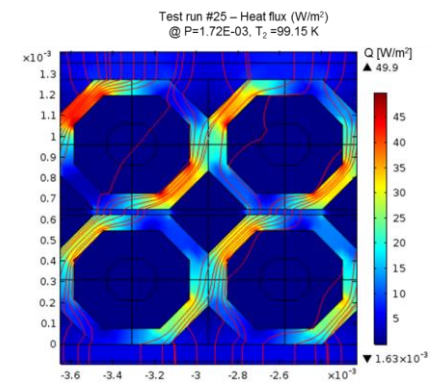


Figure 6: Heat flux magnitude and heat streamlines inside cable strands [3].

# Collaborations

**BE-CAE & Test** – COMSOL certified consultant,  
Catania, Italy.



- From simulation to the APP:
  - Thermo-Mechanical Analysis and Fatigue Life Prediction for an Electronic Surface-Mount Device (SMD);
  - Simulation of cooling process of metal spheres in a forced air-flow;
  - Simulation of thermal process inside a can packaging for food.

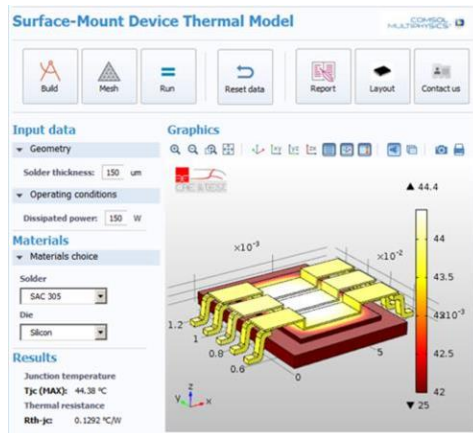


Figure 7: COMSOL APP for electronic devices simulation [3].

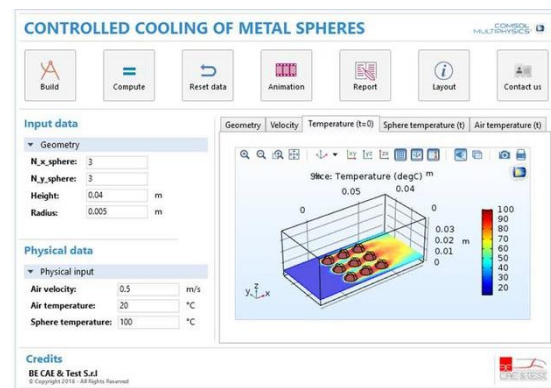


Figure 8: COMSOL APP to simulate cooling of metal spheres in a forced air-flow [4].

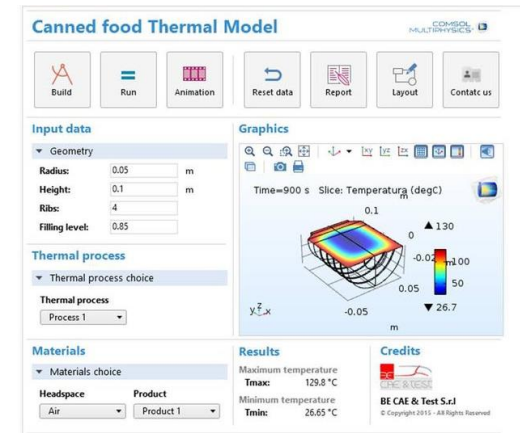


Figure 9: COMSOL APP to simulate temperature inside a can for food [5].

[3] G. Petrone, C. Barbagallo and M. Scionti, 2015, A COMSOL APP for thermal analysis of electronic devices, COMSOL Conference 2015, Grenoble, France.

[4] G. Petrone and C. Barbagallo, 2016, An Application Built with the COMSOL Multiphysics Software for Managing Computational Sequences in Thermal Fluid Applications, COMSOL Conference 2016, Munich, Germany.

[5] G. Petrone and C. Barbagallo, 2017, How Apps Can Support COMSOL Multiphysics Users?, COMSOL Conference 2017, Rotterdam, The Netherlands.



# What's next?

## TE-MPE-PE Short-Term Internship Programme



- FEM simulations on superconducting cables, coils and magnets;
- Study of homogenization over the cross-section of Rutherford cables and its effect in transient conditions.

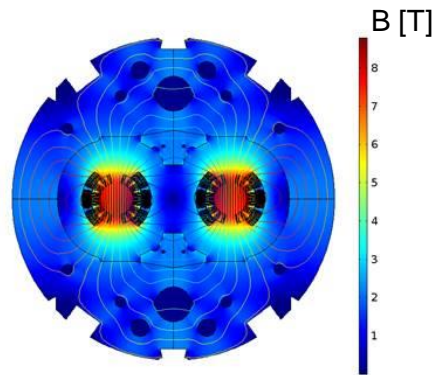


Figure 10: LHC MB (main dipole) magnetic flux density [6].

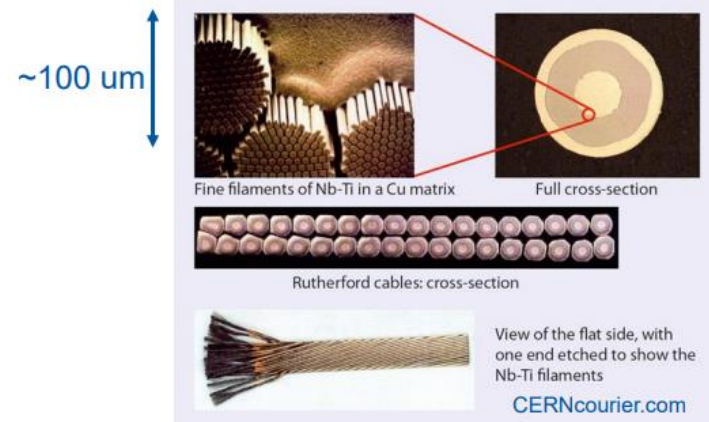


Figure 11: Rutherford cable [7].



Thank you for your attention