

Presented at the COMSOL Conference 2009 Milan

# ROCTOOL

INNOVATIVE MOLDING TECHNOLOGIES



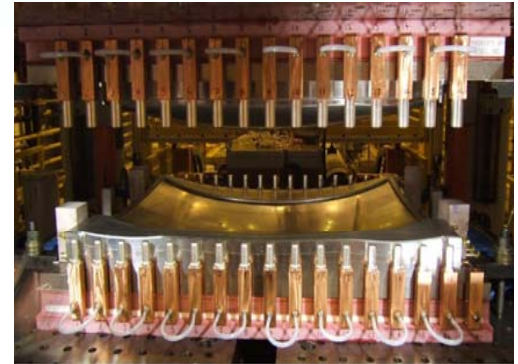
Dr José Feigenblum – RocTool  
European COMSOL Conference  
Milan, Italy  
14 - 16 oct. 2009



- Company presentation
- Induction principle of Cage System<sup>®</sup>
- Study parameters
- Other version
- Conclusion and future



- **Licensing out** of innovative molding technologies
- Headquarter in FR & Technical Office in FR + India
- Sales offices in US and JP
- Listed on French stock market NYSE Euronext





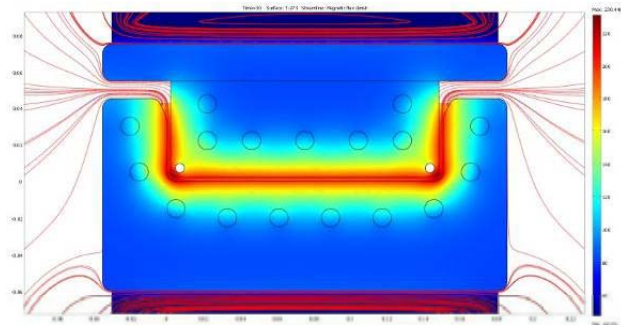
- AUTOMOTIVE / TRANSPORTATION
- SPORT AND LEISURE
- AEROSPACE
- EMERGING MARKETS
  - 3C (Laptop, Flat TV...)
  - Food Packaging
  - Metal Processing





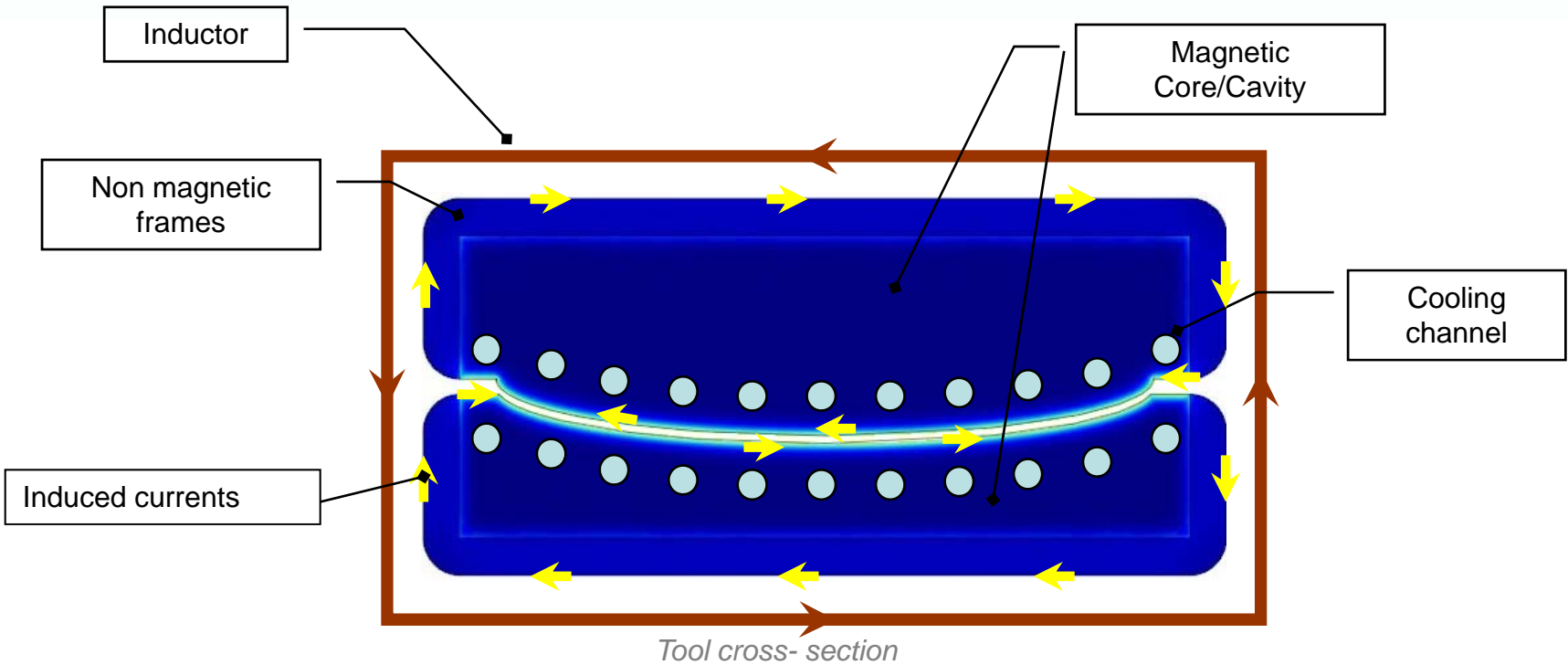
### Tool Surface Heating Technology

- **Inductive** heating process
- Fast **heating** of the **molding surface**
- Fast **cooling** of the tool
- Accurate temperature control

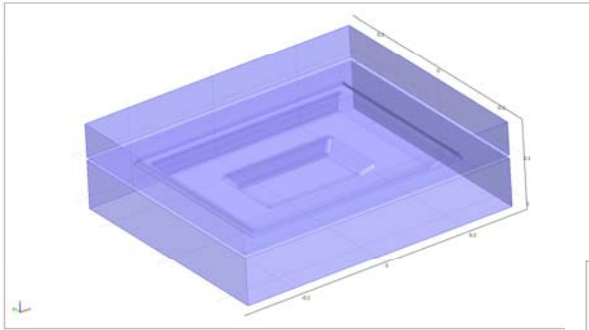




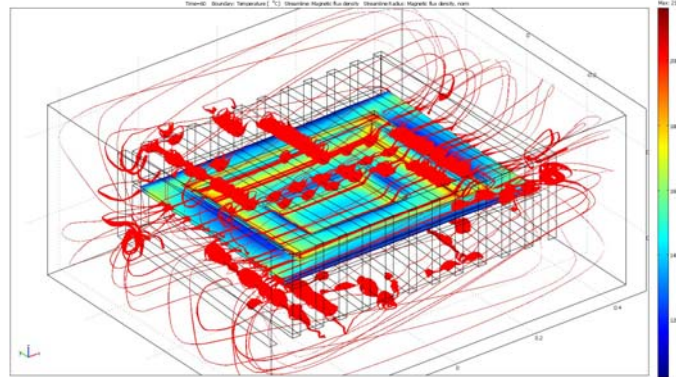
## Cage System<sup>®</sup> inductive principle



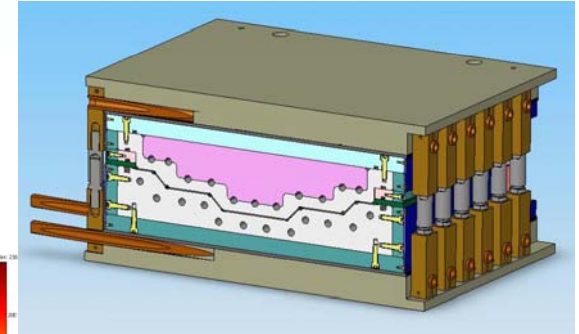
Mould heating is directly initiated on the molding surface



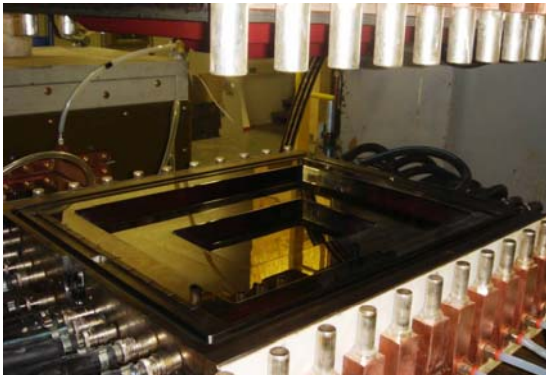
#1 - Import CAD file



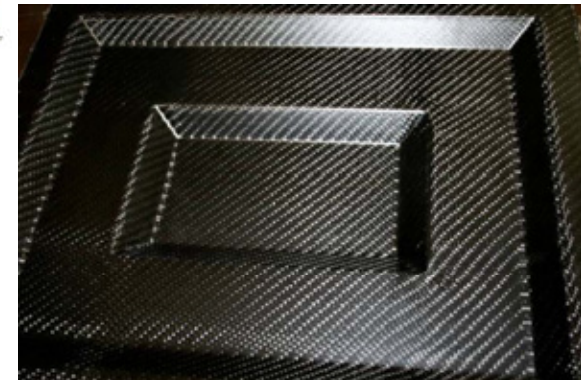
#2 - FEA Study



#3 - CAD design



#4 - Tool design

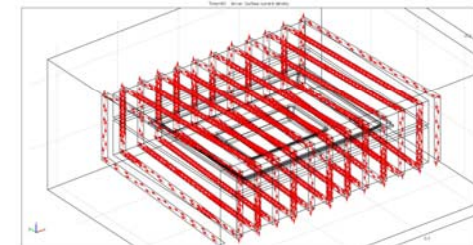
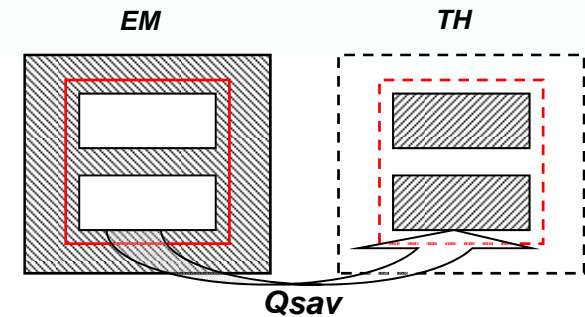


#5 - Moulding parts 7



## Simulation framework

- Weak coupling between EM and TH (linear mode)
  - Use of boundaries impedance
  - Re-computing of source term (instead of  $Q_{sav}$ )
  - Time harmonic but F not relevant (MF range)
- EM specifications
  - Bands representation of the inductor (currents density as Cst)
  - Material parameters as Cst (Electrical resistivity  $\rho_e$  and Relative permeability  $\mu_r$ )
- TH specifications
  - Free convection negligible
  - Material parameters as Cst (Thermal conductivity  $\lambda$ ; Density  $\rho_v$  and Specific Heat  $C_p$ )

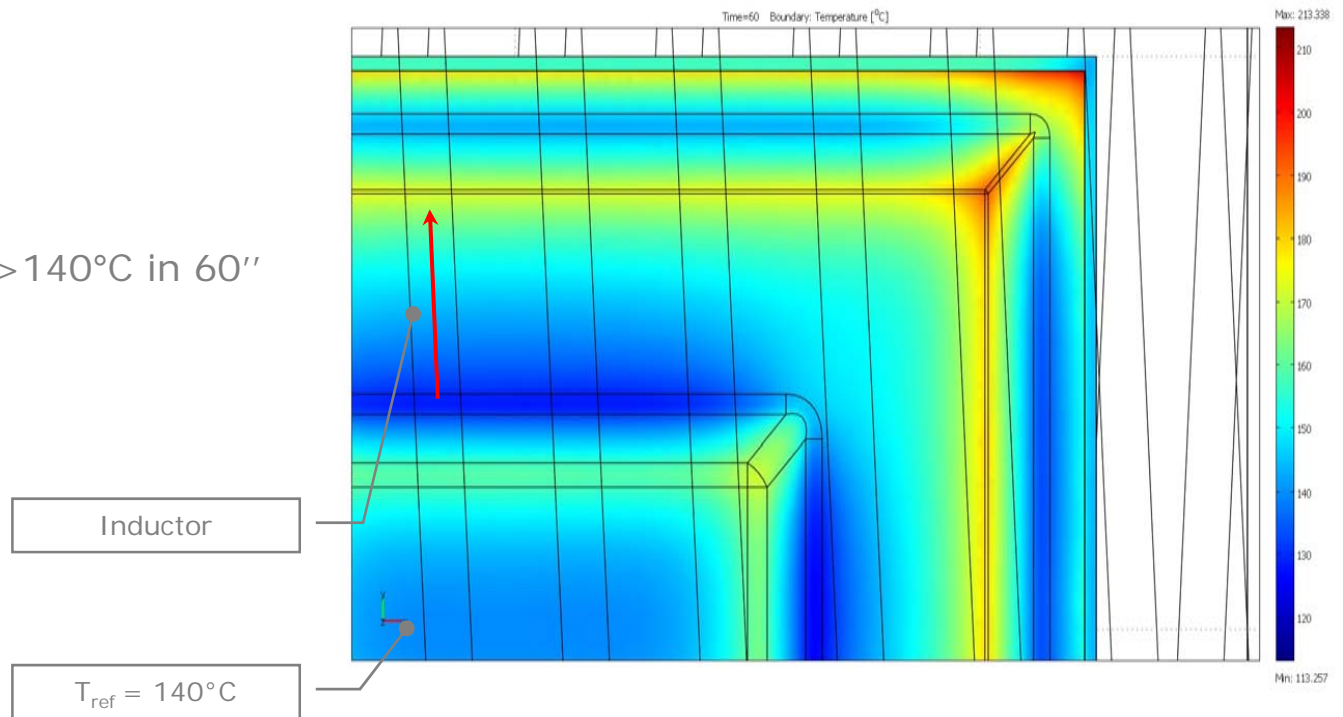






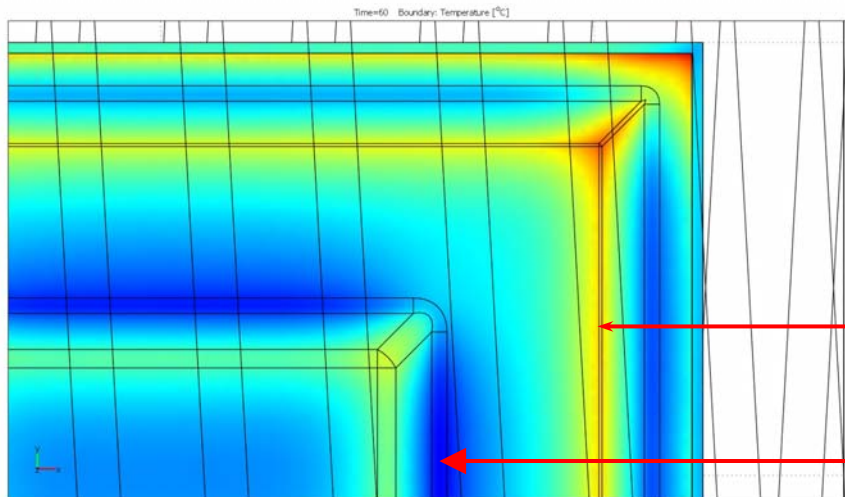
- Global mesh size : *normal*
  - 10mm on copper surfaces (*inductor and external frame*)
  - 5mm on steel surfaces
- Model : 1.150.000 elements
  - EM : 725.000 *dof* and 21' for computing
  - TH : 135.000 *dof* and 2' for computing

- Heat Cycling 50 => 140°C in 60''

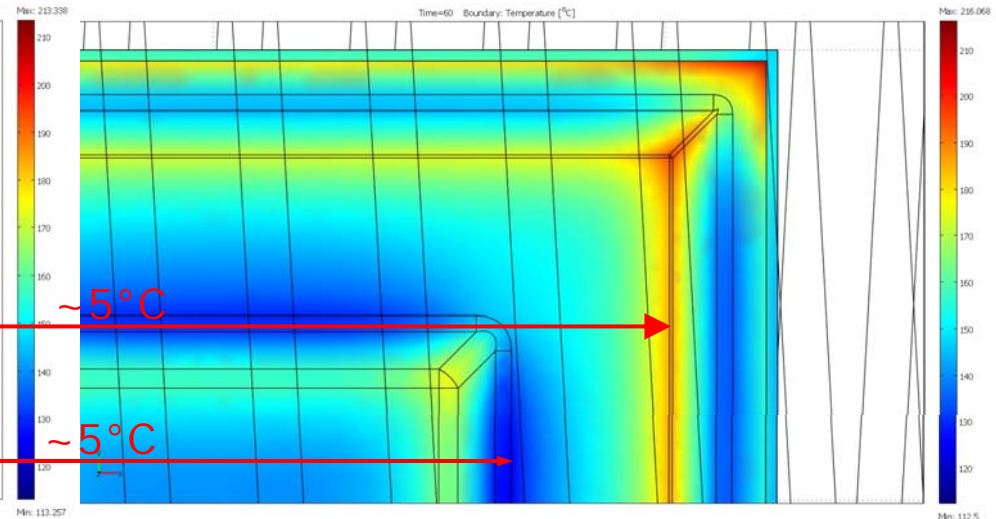




- Global mesh size : *normal*
- Model : 235.000 elements
  - EM : 785.000 *dof* and 2h15' for computing
  - TH : 195.000 *dof* and 5' for computing



Linear mode

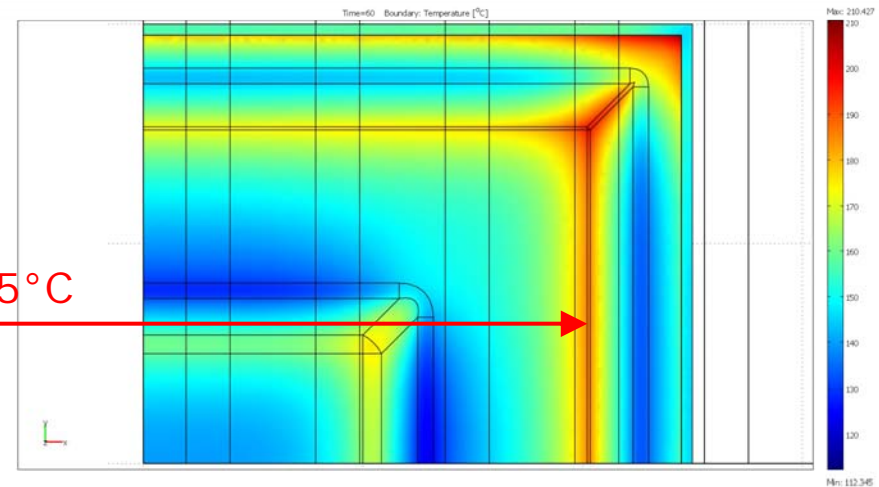
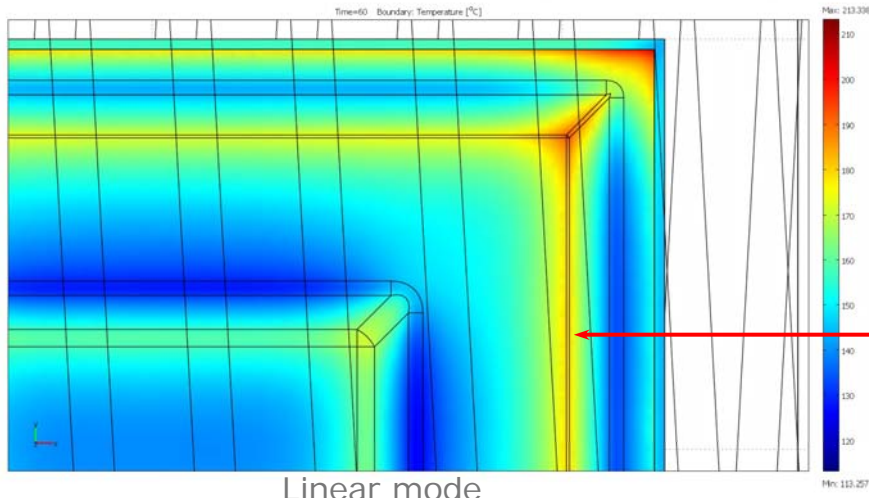
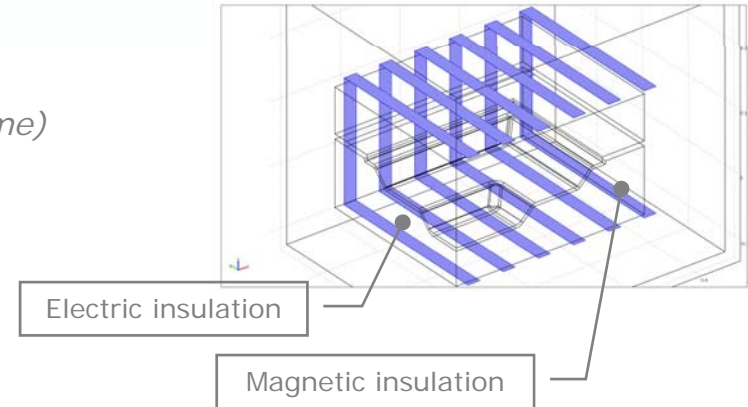


Quadratic mode

A better physical interpretation with coarse mesh seems identical than weak physical representation with a fine mesh



- Linear mode
- Global mesh size : *normal*
  - 20mm on copper surfaces (inductor and external frame)
  - 5mm on steel surfaces and 1mm on curved zones
- Model : 915.000 elements
  - EM : 530.000 dof and 78'' for computing
  - TH : 115.000 dof and 60'' for computing

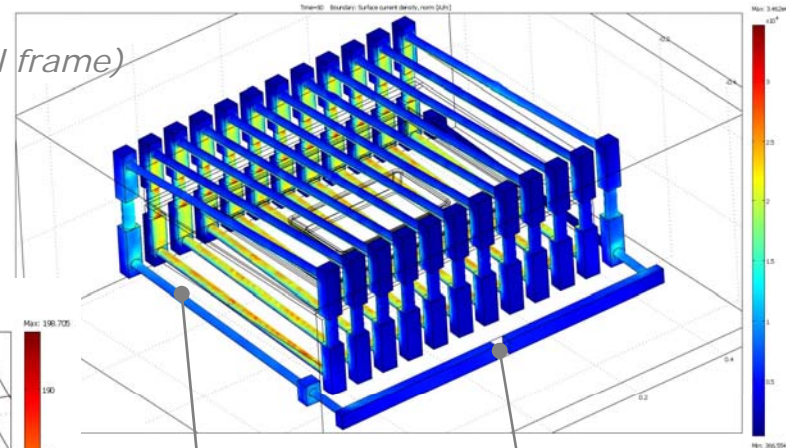
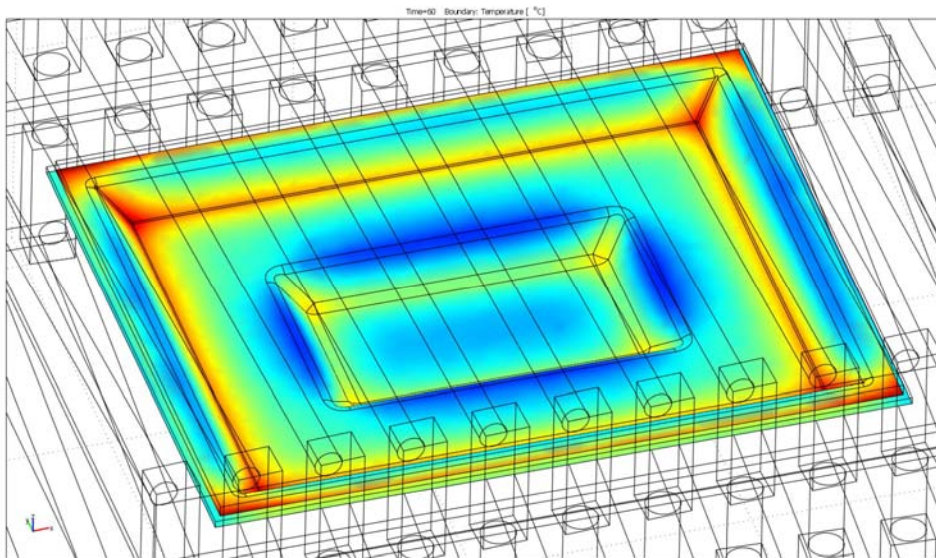


~5°C

Interesting but limited with non symmetric geometry or coil with more helicity



- Potential version : more realistic currents distribution (Linear mode)
- Global mesh size : *normal*
  - 10mm on copper surfaces (inductor and external frame)
- Model : 575.000 elements
  - EM : 410.000 *dof* and 265'' for computing
  - TH : 50.000 *dof* and 24'' for computing

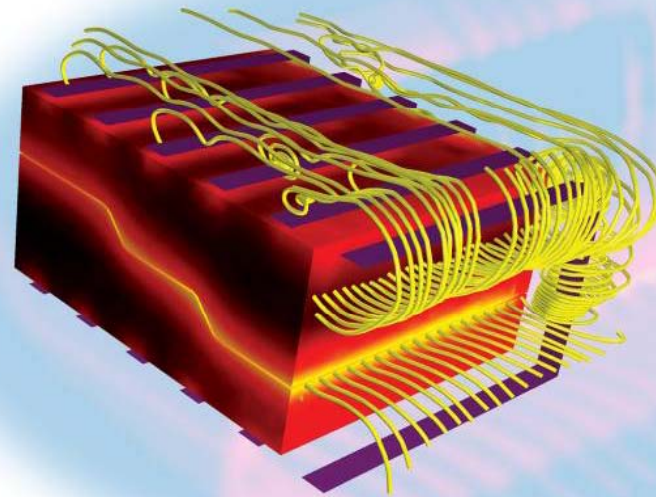


Electric field surface

Effect of mutual inductance



- Limit of the use of  $Zf$
- Limit of the use of *magnetic insulation* (*external boundaries conditions*)
- Cooling 3D
- Optimization module





**Thank you for your attention !**

**For more information**

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**[www.roctool.com](http://www.roctool.com)**