LSEE – EA 4025

Laboratoire Systèmes Electrotechniques et Environnement

Motor Workshop 2017 – European Copper Institute

Brussels - March 7th 2017

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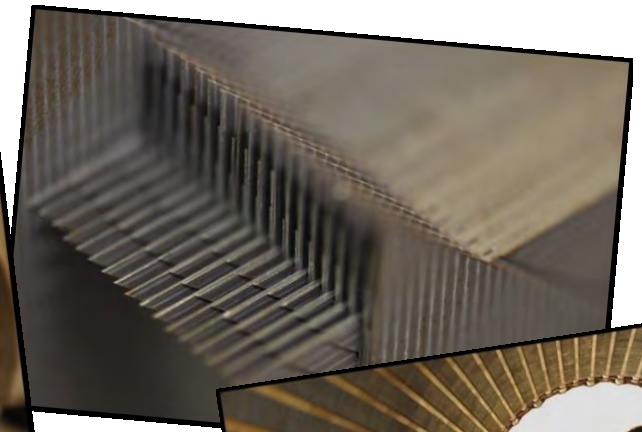
Lab characteristics

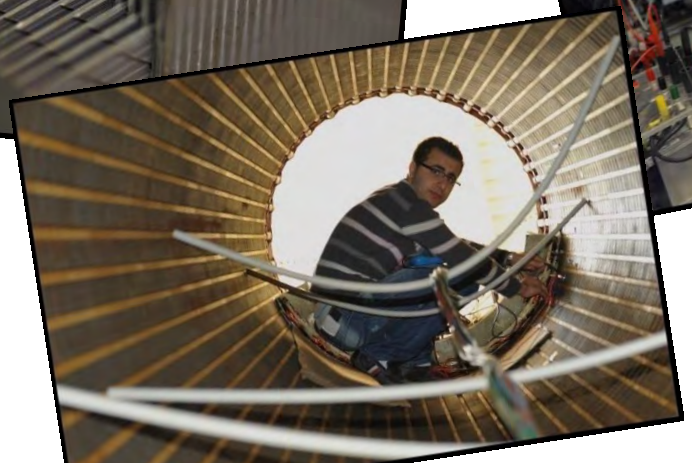
→ **Staff :**

- 6 full Prof, 9 Associate Professor
- 12 Ph-Students – 4 Post-Doc & Engineers
- 2 technical staff

→ **Research Field** ⇨ Applied research on :

- Electrical machines and transformers
- Their constitutive parts





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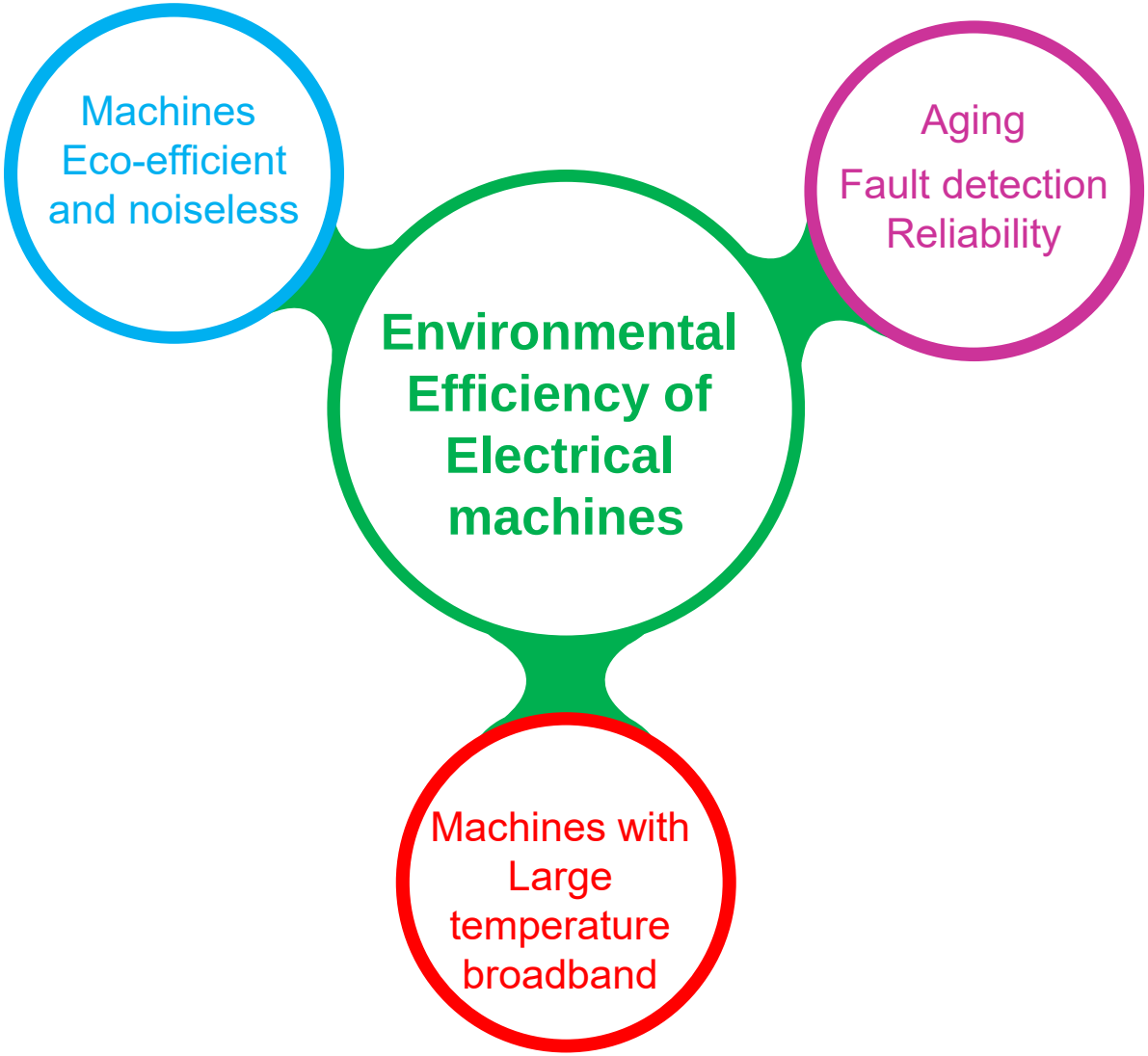
Research axes



Research axes

Noise and vibrations

Machines Eco-efficient and noiseless

Efficiency

Non-intrusive Analysis of efficiency

Innovative machines

Life Cycle Analysis

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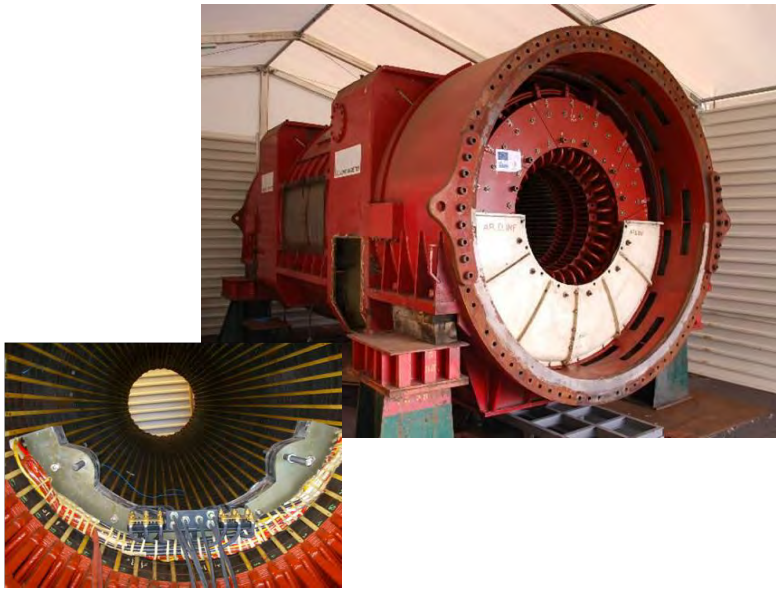
Research axes

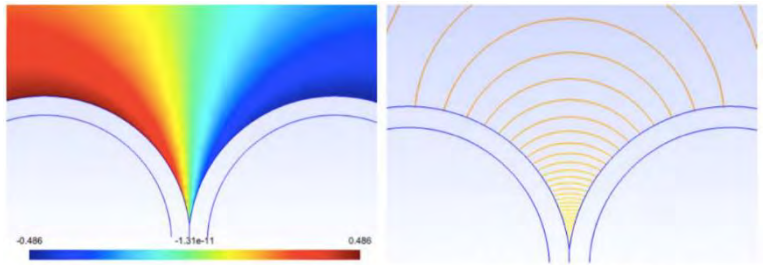
Fault detection

Aging
Fault detection
Reliability



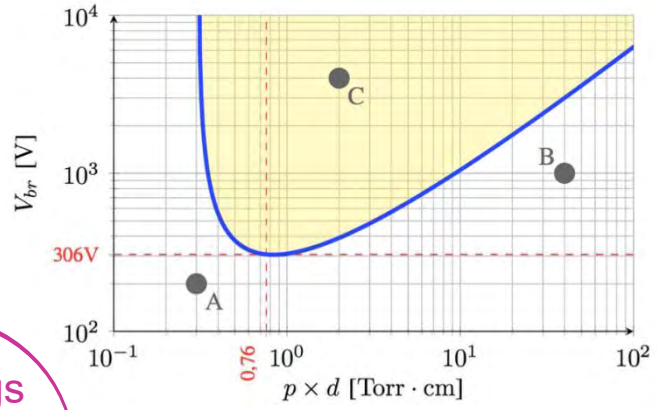
Machine lifetime increase

Electrical Insulation System



(a) Scalar potential distribution

(b) Electric field lines



Widnings Free of Partial discharges

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Research axes

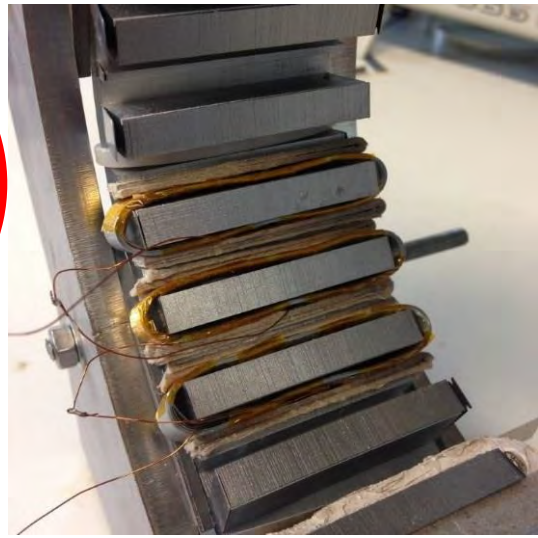
Why increasing temperature ?

Machines with Large temperature broadband

New structures of machines

What kind of insulation for winding ?

New Material !



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Examples of applications in link to copper

Laminated Busbar (LBB) improvement

→ Partner : AUXEL

→ Performance Increase (Voltage, power, temperature, switched frequency, ...)

→ New technologies of components electronics power (SiC, …)

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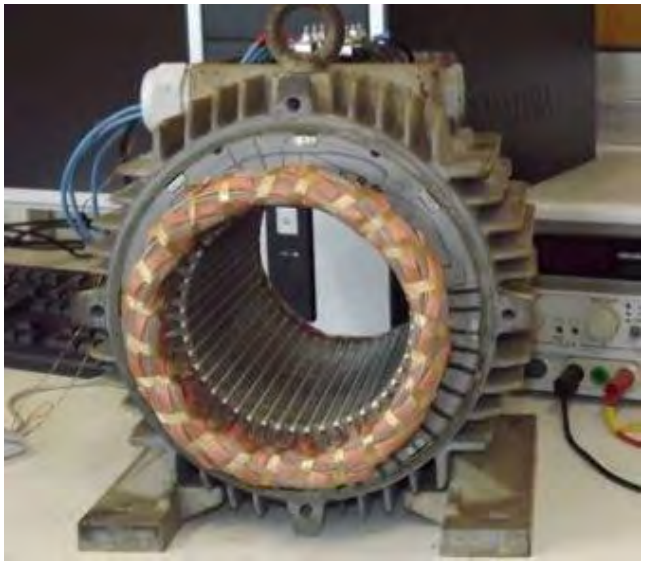
Examples of applications in link to copper

Induction machine with low environmental footprint

→ Partners : EDF R&D / ADEME / TKES / Green Isoligth International

→ **Eco balance >0 over a cumulative operating period of 10 years (1500h/y)**



- Wires enamelled :
  - polymerised by UV extrusion
  - without solvent
- Thermobonded winding

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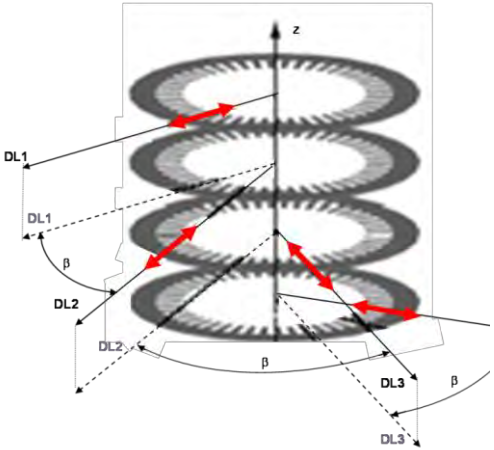
Examples of applications in link to copper

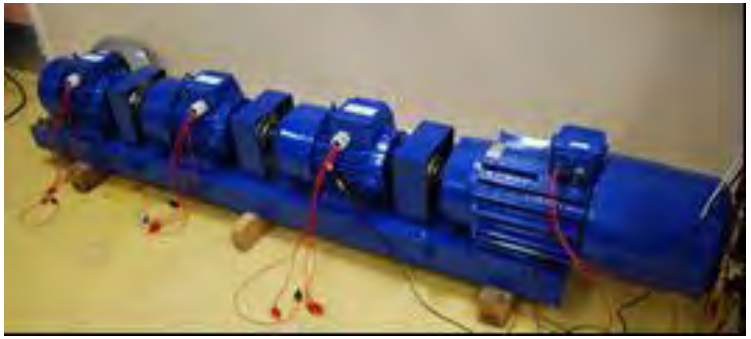
Induction machine with low environmental footprint

- Shifted GO sheets to reduce iron losses

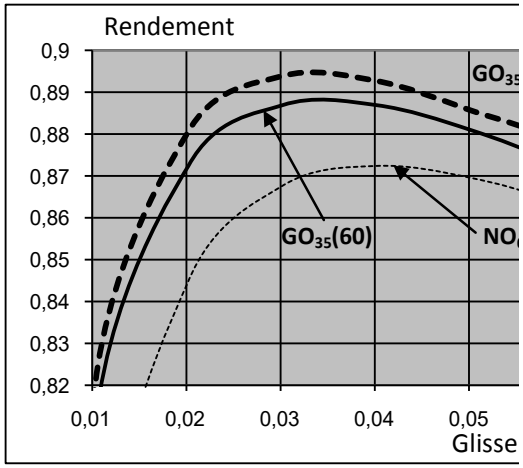
PARTNER :

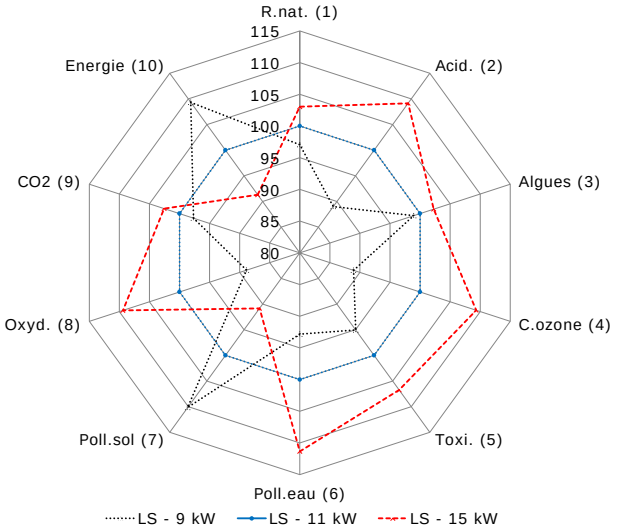
thyssenkrupp





- Life Cycle Analysis

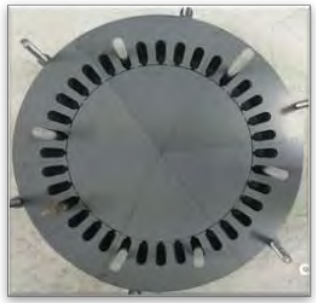




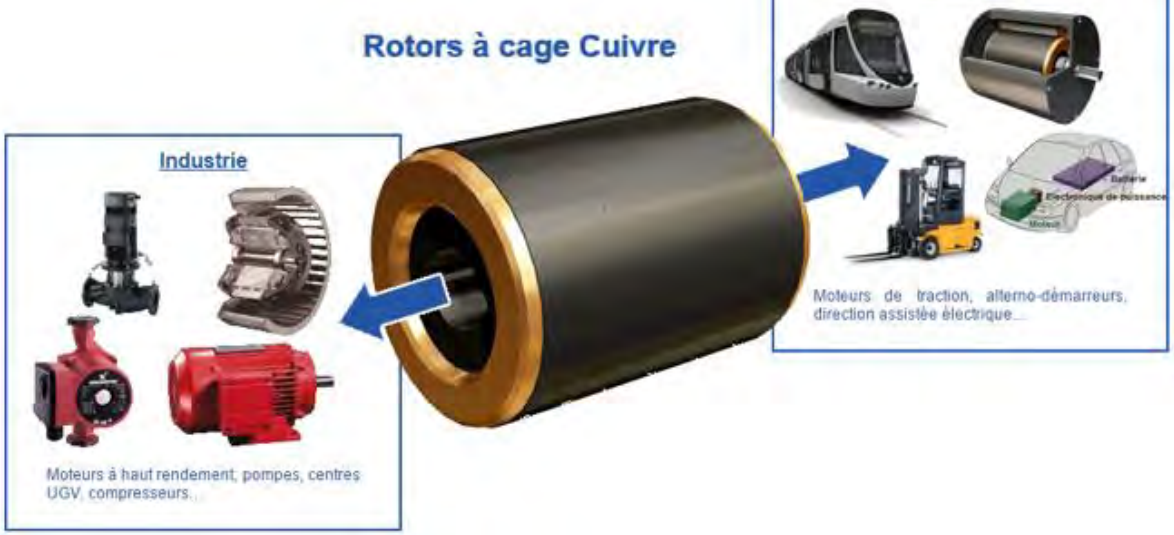
Examples of applications in link to copper

Induction machines with very high efficciency obtained by copper die cast rotor and grain oriented electrical steel

up to 4 kW per kg for induction motor



→ Modification of the magnetic rotor and stator circuit: use of GO steel
→ Implementation of an overmoulded copper cage rotor
→ Determination of the impact of a thermal shock on GO sheets



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Examples of applications in link to copper

Insulation characterization :

→ Partner : SKYAZUR

→ Increase performance

↳ Copper fill factor raised to 80%

→ Optimisation :

↳ Size of the headwindings

⇨ Patent N° WO2015/166188

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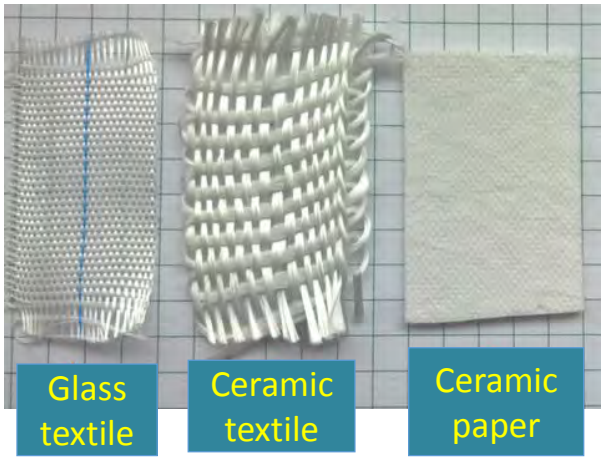
Examples of applications in link to copper

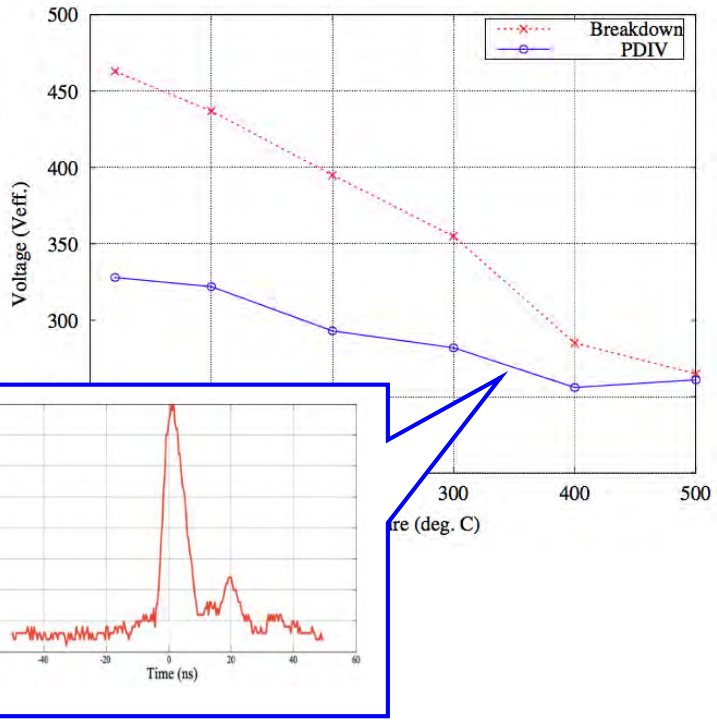
High temperature machines

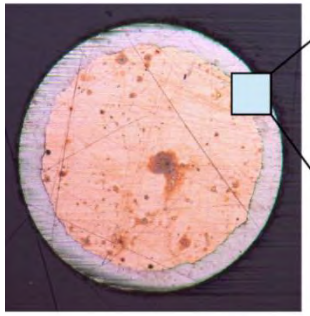
Nickel Clad Copper wires insulated by :

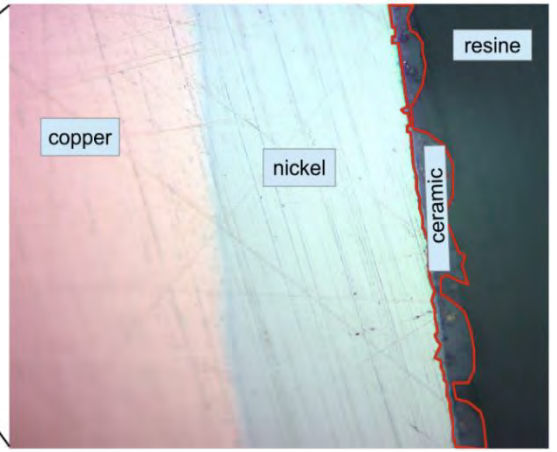
→ Mineral sheet (Mica)
→ Ceramic coat

The nickel is a buffer layer used as a diffusion barrier









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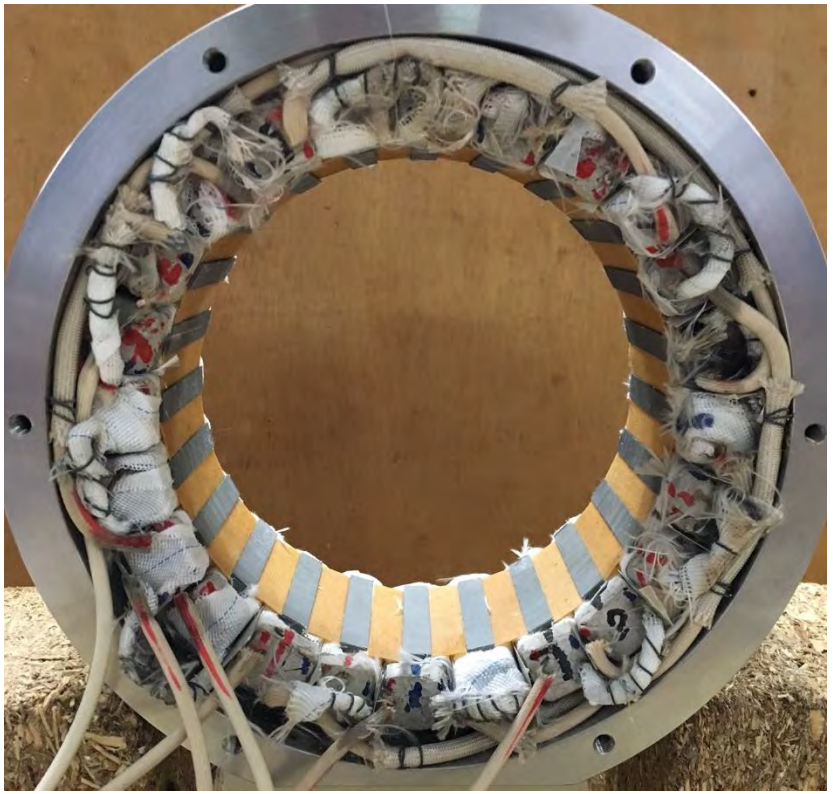
Examples of applications in link to copper

High temperature machines

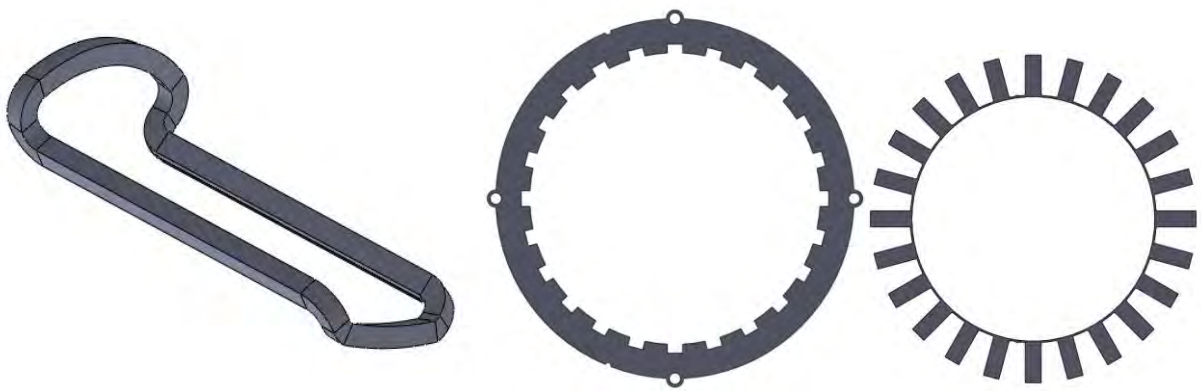
- ⇨ Stator coils of synchronous machine capable of operating at 500 ° C
- ⇨ For *aeronautic applications*

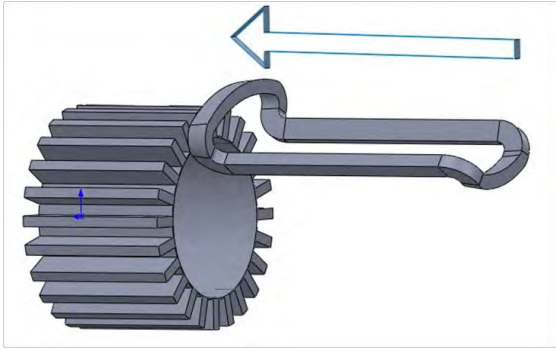


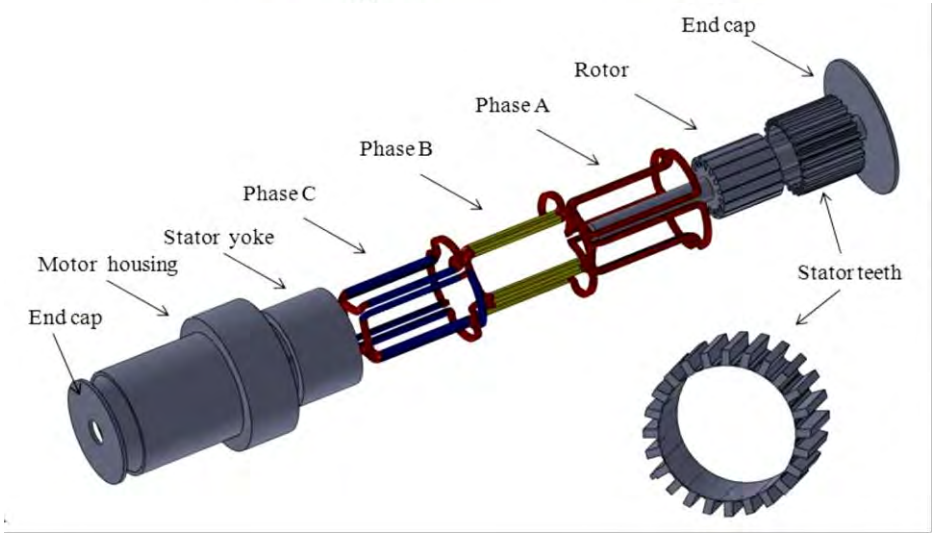
Examples of applications in link to copper

High temperature machines : exemple of an induction machine

- ⇨ Coil with “S shape”
- ⇨ Stator magnetic circuit with separated teeth and yoke







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Equipments

Noise and vibrations

→ Microphones
→ Accelerometers
→ Shaker
→ Hammer
→ Modal analysis

Equipments

Insulation characterization

→ Partial discharges detectors
→ Impedence bridge from 20Hz to 100MHz
→ PWM sources
→ Aging monitoring
→ Impregnation stand
→ Furnace up to 1200°C with gaz line
→ Climatic chamber (-70°C -180°C) and humidity (0% to 95%)

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Equipment

Enemalled horizontal machine

→ Open to test new insulation varnish or new products (sol gel, oxyde,…)

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Actions in the futur :

Continue our expertise for industrial partners

Study of Nickel clad influence on electrical and magnetic properties with increasing temperature.

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