

**VIRTUAL  
PROTOTYPING:**  
Electromagnetics  
Thermo-Mechanics  
Fluid Dynamics

**Design &  
Prototyping**

[www.LTCalcoli.it](http://www.LTCalcoli.it)

**companyprofile**

 **LT**CALCOLI



# LTCALCOLI



## COMPANY PROFILE

### HISTORY:

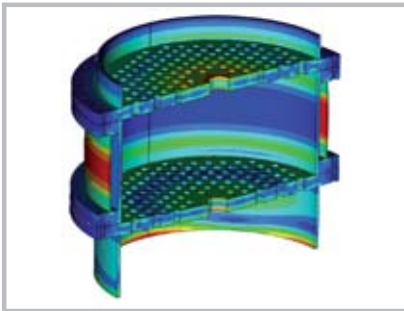
LTCalcoli was founded in 1996, finalising a long experience in electromagnetic analyses gained at ENEA (the Italian National Research Centre for Alternative Energies). At that time, the idea of the founder was to activate a consultancy company specialised in electromagnetic analyses that could mainly satisfy the needs of the ENEA Research Centre.

Progressively, the company activities extended to other numerical simulation fields such as structural mechanics and fluid dynamics and also to other types of engineering services, from initial product design to operative prototyping.

Since LTCalcoli works in cooperation with national and international partners involved in scientific research, like universities and scientific agencies, its know-how is constantly maintained at high standards. This allows LTCalcoli not only to reliably analyze very complex systems and propose alternative designs, but also to develop innovative methods and customized solutions.

The expertise in numerical technologies so acquired by LTCalcoli allows dealing with a wide variety of problems, both related to standard design-phase support and to applied research for small, medium and large industries. Numerical simulation activities can be also complemented with the preparation of prototypes in order to verify that product functionalities satisfy the project needs.

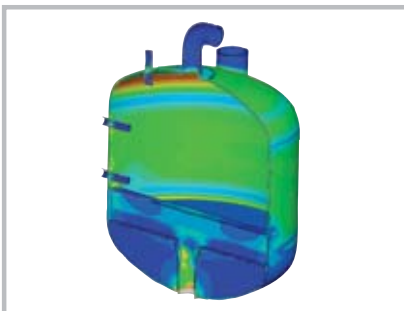
LTCalcoli is owner of technological patents, both national and international.



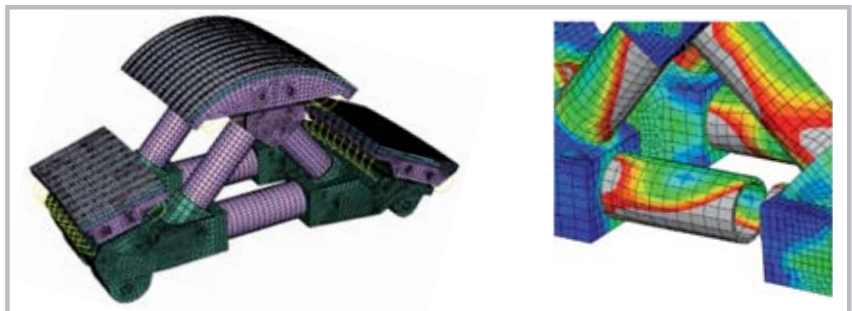
▲ The structural model of the Heat exchanger and stress distribution

The company, constantly grown through the years, is located in Merate (Lecco), very close to Milan, the centre of gravity of the Italian industry.

LTCalcoli offers numerical simulation services using the Finite Elements Method. Numerical analysis with this methods has been widely used for many years by the automotive, aeronautical, aerospace and manufacturing industries as an integral part of their design process.



▲ Pressure Vessel elastic structural linear analysis



▲ The structural model and stress distribution of the ITER Dome





# LTCALCOLI



## ACTIVITIES

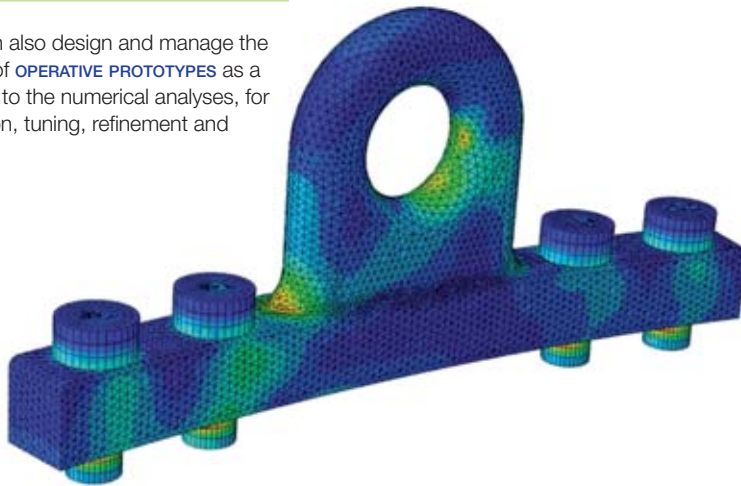
### Simulation

LTCalcoli operates since 1996 in several engineering fields, offering numerical analysis services aimed at designing, evaluating, improving and optimizing systems of varying complexity. Most numerical technologies used at LTCalcoli are based on the Finite Elements Method.

The following engineering fields are covered:

- ▲ ELECTROMAGNETICS
- ▲ STRUCTURAL MECHANICS
- ▲ FLUID DYNAMICS
- ▲ THERMAL ANALYSIS
- ▲ THERMO-STRUCTURAL ANALYSIS
- ▲ VIBROACOUSTICS

LTCalcoli can also design and manage the preparation of **OPERATIVE PROTOTYPES** as a complement to the numerical analyses, for their validation, tuning, refinement and testing.



### Research Activities

The R&D activities performed by LTCalcoli have concentrated on the development of new computational methodologies and dedicated computer codes.

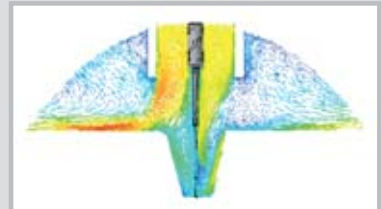
### Training

LTCalcoli offers trainings and courses on the Finite Elements Method and on the most widely used software programs for numerical engineering analyses.

### EXAMPLES:



▲ Vacuum Test for 2 MW, 170 GHz Calorimetric Matched Loads (ITER)



▲ Flow field for arc welding process with filler wire



▲ Magnetic Flux line distribution inside an electric motor





### LTCalcoli for Nuclear Fusion Reactors

LTCalcoli has a very well established experience in the analysis, design and operation of Nuclear Fusion Reactor machines.

This experience has been built up from a strong and long-term collaboration with ENEA (Italian National Research Centre for Alternative Energies), ITER Organization (International Thermonuclear Experimental Reactor), FUSION FOR ENERGY (EURATOM agency for the management of ITER Project), IPP (Max Planck Institute for Plasma Physics) and CNR (the Italian National Research Council).

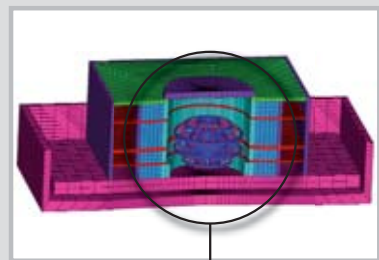
The technical and professional knowledge required for carrying out this kind of activities covers the different and overlapping areas of computational electromagnetism, computational mechanics and nuclear fusion engineering.

The LTCalcoli team was involved in the design analysis of several nuclear fusion reactors and of the related components.

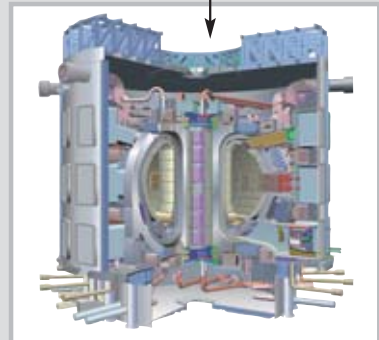
Among these:

- **ITER (International Thermonuclear Experimental Reactor)**
- **IGNITOR (High Field Tokamak machine)**
- **W7-X (IPP Stellarator Fusion Reactor)**
- **JET (European Tokamak machine located in Oxford)**
- **FTU (ENEA Tokamak Upgrade located in Frascati)**
- **DEMO (ITER Evolution)**

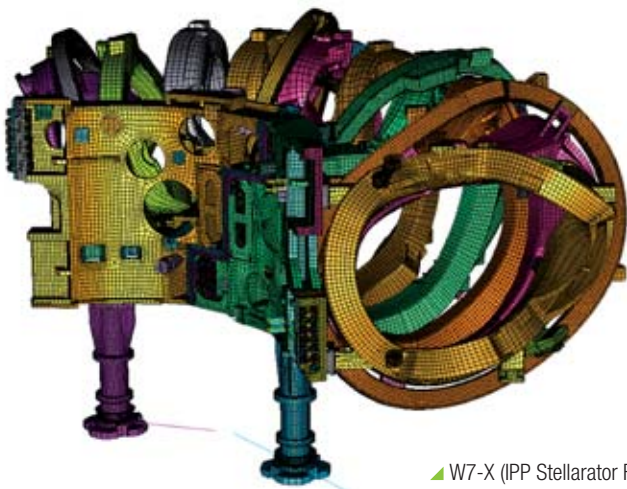
#### EXAMPLES:



▲ The Magnetic Model of ITER Building

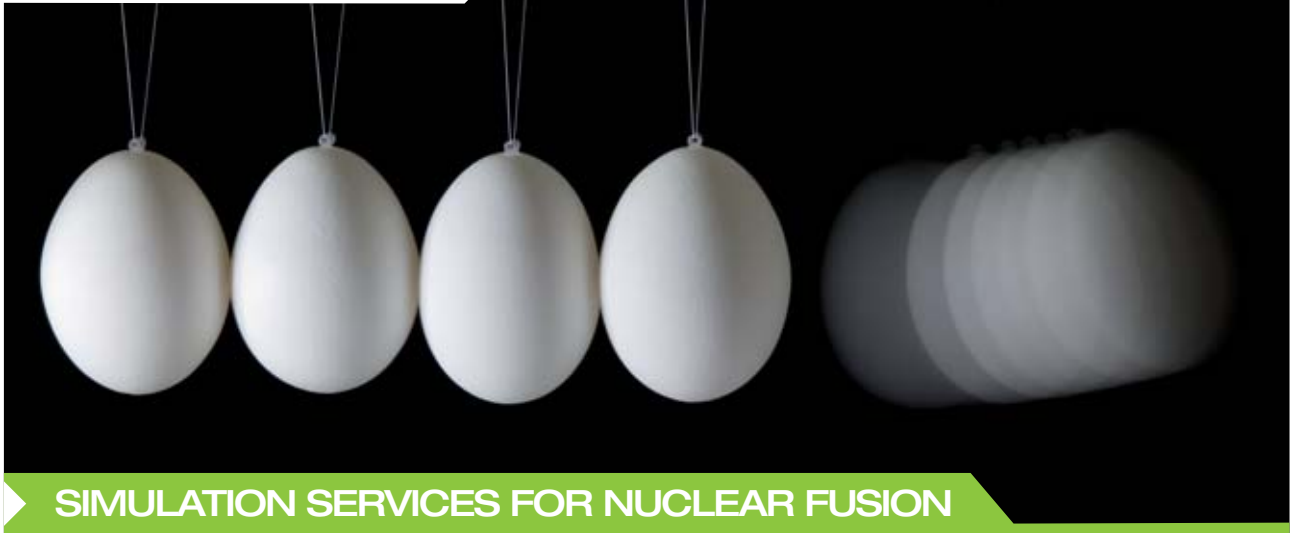


▲ ITER (International Thermonuclear Experimental Reactor)



▲ W7-X (IPP Stellarator Fusion Reactor)





## SIMULATION SERVICES FOR NUCLEAR FUSION

For all these devices, different aspects of the design were analysed by the LTCalcoli team, from eddy-currents evaluations to thermo-structural analyses to electromagnetic optimization and fusion plasma engineering. As recognition of its expertise, LTCalcoli has strongly operated on the design review of several Nuclear Fusion Reactors' components like (among others) the ITER divertor, toroidal field coil, winding pack and some diagnostic supports, the IGNITOR vacuum vessel and first wall.

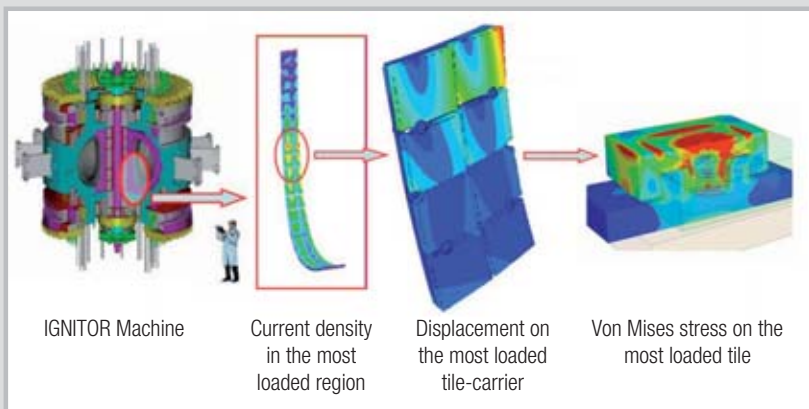
In particular, in the field of thermo-structural analysis and design optimization, LTCalcoli performed detailed analyses on the main nuclear fusion reactor components following various procedures:

- transient heat transfer analysis under the effect of the neutronic heat deposition or plasma heat flux;
- static and dynamic elastic and elasto-plastic analysis under different load conditions: dead weight, pre-load, thermal strain due to neutronic heat deposition or plasma heat flux, electromagnetic loads;
- seismic analysis;
- fatigue analysis;
- structural assessment according to different standards like (among others) SDC-IC, ASME, RCC-MR.

### EXAMPLES:



▶ Demo: ITER Evolution EM, Thermal and Structural Analyses



▶ Ignitor: EM, Thermal and Structural Analyses

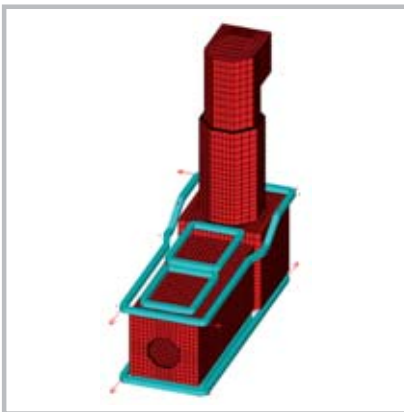




In the field of fusion plasma engineering, electromagnetic numerical codes have been developed for the analysis of:

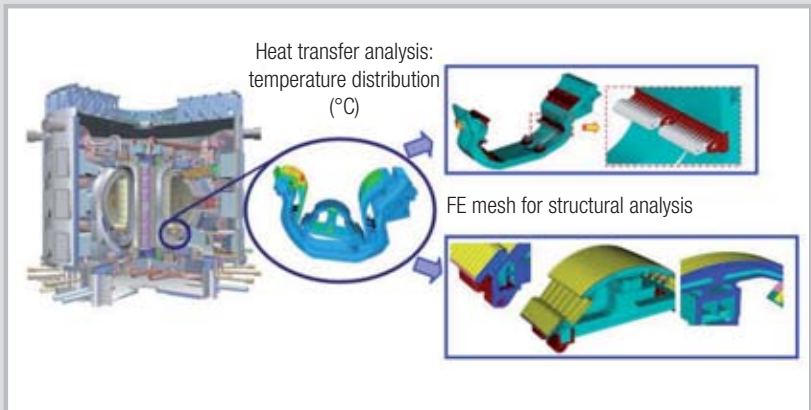
- plasma flux consumption;
- plasma scenarios;
- plasma disruptions.

Related to this, LTCalcoli has also developed and well validated (for instance on the ITER Divertor, Blanket Modules and on the IGNITOR First Wall) an electromagnetic “zooming” numerical procedure that allows to extract, from a complex electromagnetic system, the excitation induced on a subsystem, thus allowing a more detailed and separate analysis of the same subsystem in isolated conditions.

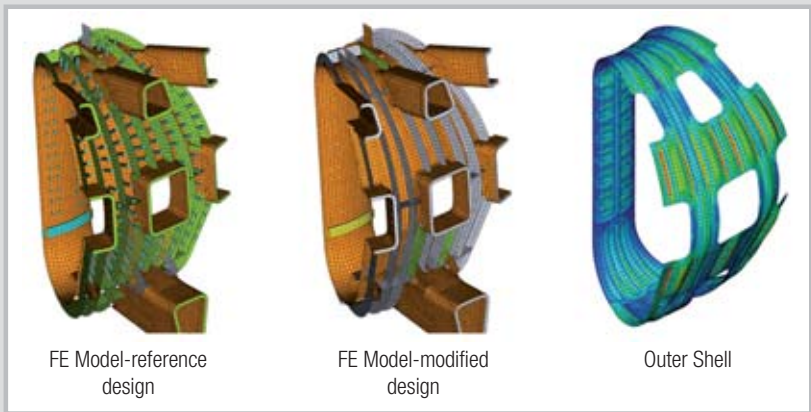


▲ Heating Neutron Beam Injector: FE model of Passive Magnetic Shields and Active Correcting & Compensating Coils

**EXAMPLES:**

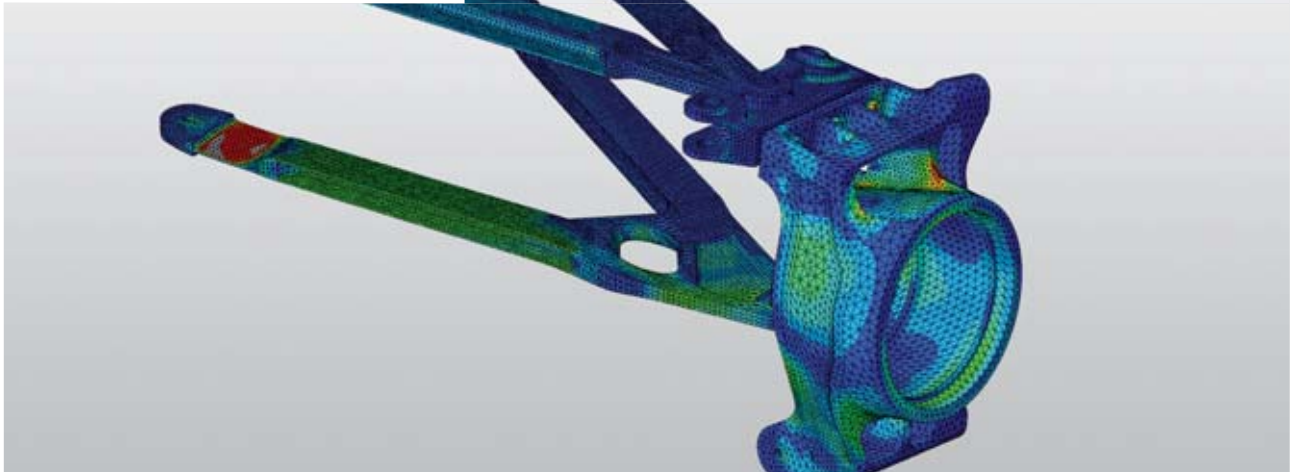


▲ ITER Divertor: EM, Thermal and Structural Analyses



▲ ITER Vacuum Vessel: stress analysis





**SIMULATION SERVICES FOR INDUSTRY**

**LTCalcoli for Industry**

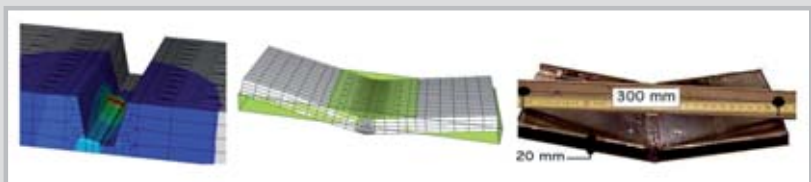
LTCalcoli expertise in numerical analysis can support small, medium and large industries in the design, assessment and optimization of simple and complex systems, with the final objective of improving product performance and/or reducing development times.

The expertise in **structural and thermal analyses** available at LTCalcoli covers a very wide range of simulations.

The possible fields of application of this kind of analyses covers practically every branch of engineering such as:

- **Structural and thermo-structural assessment, to verify that a system can support a predefined structural or thermo-structural load;**
- **Vibro-acoustics (including fluid-structure coupling);**
- **Analysis and design of Composite materials;**
- **Structural design of Formula 1 Chassis parts;**
- **Metal forming and welding;**
- **Biomedical devices (Stent, Orthodontic archwires, Spinal vertebrae spacers).**
- **Buckling and post-buckling**
- **Highly non linear material behavior**
- **Modal/Harmonic/Transient dynamics**
- **High speed dynamics**

**EXAMPLES: WELDING**



▲ Welding distortion analysis

**EXAMPLES: BRAKE DISK AND WISHBONES**



▲ Formula One Brake disk bell

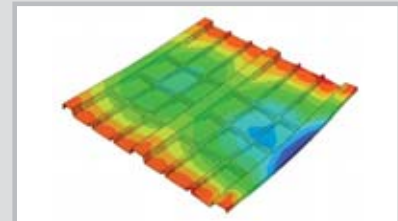


▲ Formula One vehicle front suspension Wishbones

**EXAMPLES**

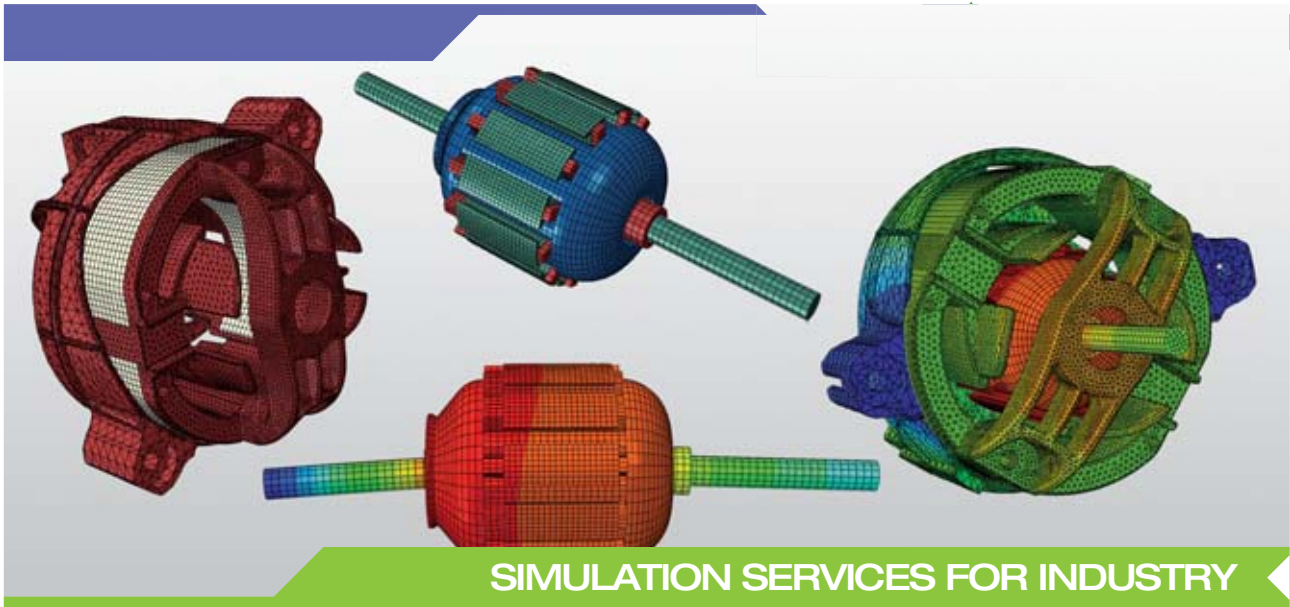


▲ Stinger rollers structural analysis



▲ Composite panel structural analysis



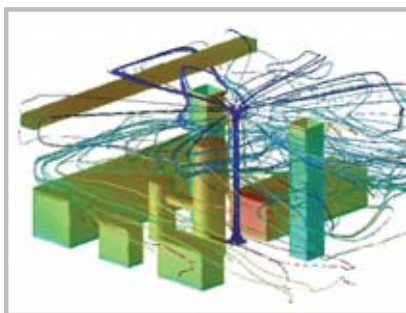


## SIMULATION SERVICES FOR INDUSTRY

Also in the field of **computational fluid dynamics** L'Calcoli has a long experience and a good record of successful activities. Both laminar and turbulent flow analyses can be carried out, including also energy exchange between different system components. Mutual interaction between fluid flow and structures can be accounted for, when this is judged to be necessary.

Possible applications for this kind of analyses are:

- **Laminar flow/turbulence analysis with energy exchange for internal combustion or electrical systems (from hair dryers to trains);**
- **Fire hazard;**
- **Aeroacoustics;**
- **Gas mixture and diffusion;**
- **Multiphase flow.**



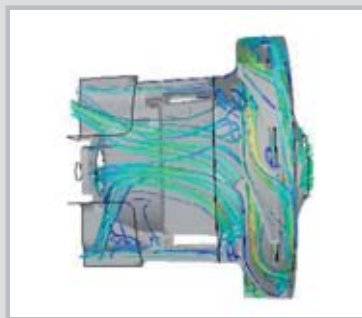
▲ Path Lines of fire evolution

### EXAMPLE OF STRUCTURAL AND CFD ANALYSIS ON AN ELECTRIC MOTOR FOR NOISE RADIATION REDUCTION

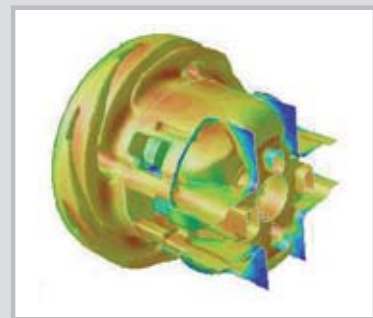
Dynamical behaviour analysis of an electric motor plastic cap for the determination of the critical modal contributions to the vibration coupled to a fluid-dynamics analysis of the fluid paths with the evaluation of the noise sources. Optimization of the structure aimed at a reduction of the noise level.



▲ Displacement contour map at the working frequency

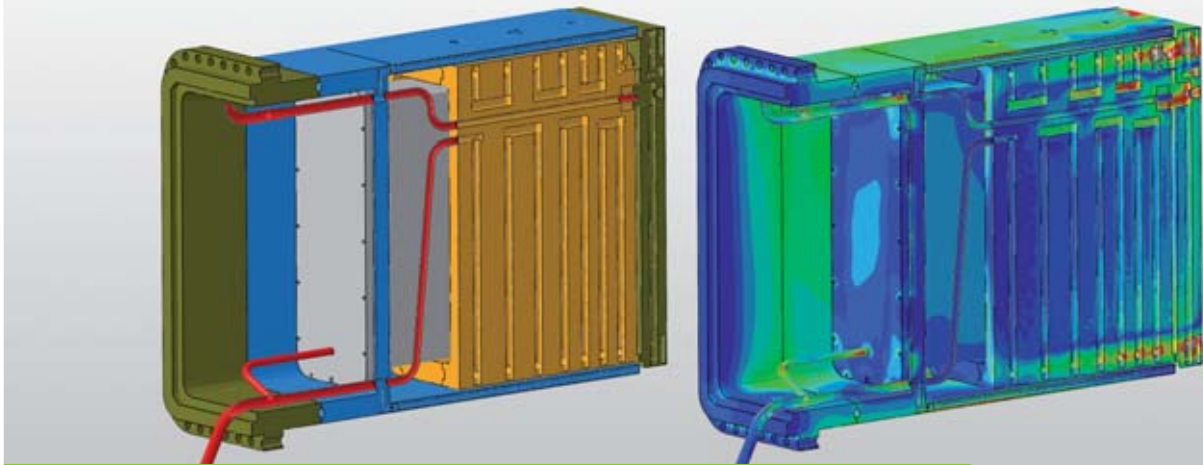


▲ Forced air flow trajectories resulting from CFD analysis



▲ Distribution of noise sources around the motor cap





**SIMULATION SERVICES FOR INDUSTRY**

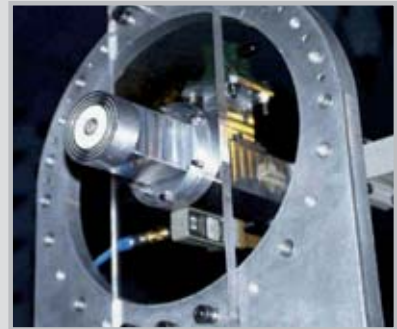
Last but not least, the expertise in **computational electromagnetics** developed by LTCalcoli mainly in the field of nuclear fusion reactors has been widened through the years to include the possibility of coupling magnetic and thermal phenomena (thermo-magnetic coupling) as well as electrical and mechanical phenomena (electromechanical coupling).

This has led to the possibility of applying such expertise also in other fields:

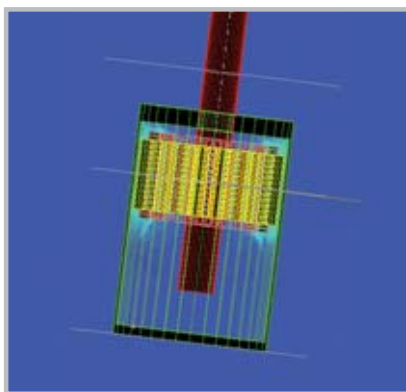
- **electromagnetic compatibility;**
- **analysis of wave-guides**
- **design of electro-mechanical devices;**
- **design of electromagnets.**

**ELECTROMAGNETIC ANALYSIS OF A DUAL BAND COAXIAL FEED**

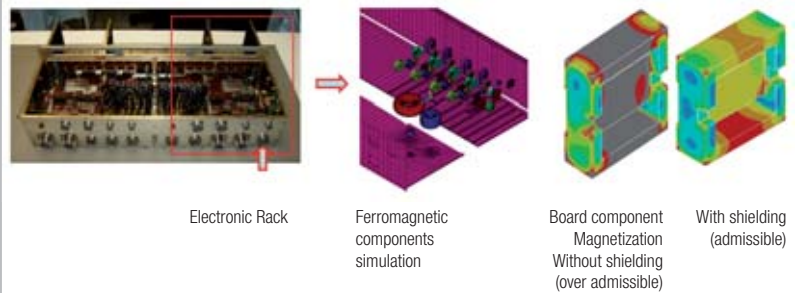
Dual Band Coaxial Feed (32 and 8.4 GHz) for Doppler Tracking of the Cassini Mission from the Primary Focus of VLBI Antennas. Electromagnetic numerical optimization and construction of the complete feed structure made of the radiating apertures, polarizers, OMT junctions and transformers to standard waveguides, at both Ka and X bands installed at Italian VLBI antenna in Noto (Sr).



**EM COMPATIBILITY OF ELECTRONIC BOARDS VS EXTERNAL MAGNETIC FIELD**



Electric Motor B field distribution



Electronic Rack

Ferromagnetic components simulation

Board component Magnetization Without shielding (over admissible)

With shielding (admissible)





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