



COMPANY BACKGROUND



❑ OE DEVELOPS AND SELLS SIMULATION SOFTWARE

- OE solutions are for the multiphysics market
- OE solutions are based on OOFELIE



A Siemens Business

❑ OE PROVIDES SERVICES

- Customization (Flexibility)
- Engineering



SoftMEMS

Bringing MEMS to the Mainstream

❑ OE PARTICIPATES TO PROJECTS

- EC
- ESA
- WR



World Wide Representation

Distribution Channels

AbleMAX (Korea)
Bee Pitron (Russia)
CnTech Beijing (Republic of China)
CnTech Shanghai (Republic of China)
CnTech Wuhan (Republic of China)
COPAC (Scandinavia)
DAG Technologies Sdn Bhd (Malaysia)
ESTI SERVICES (Pakistan)
GDTech (France)
K.P.R. ENGINEERING s.r.o. (Czech Republic)
KSIMETRO (Bulgaria)
NUMECA International - Corp. OFFICE
NUMECA USA Inc.
Open Engineering S.A. (HQ)
SHAMA Technologies (Singapore)
SOFTMEMS (Europe)
SOFTMEMS (North America)
TATA ELXSI LIMITED (India)



Reference Partners

Business partners



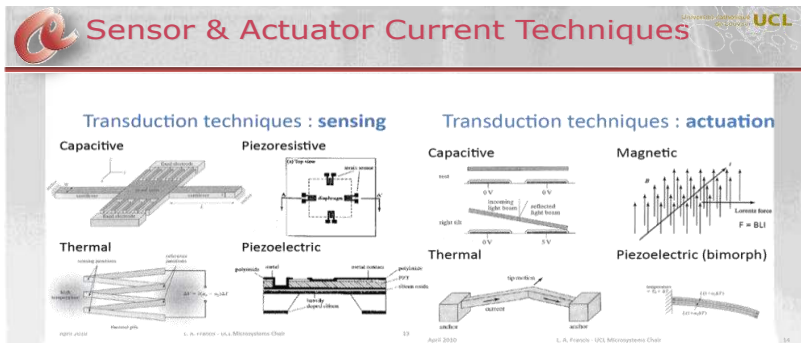
Universities and Research Centers



OOFELIE::Multiphysics

Sensors, Actuators & Optics

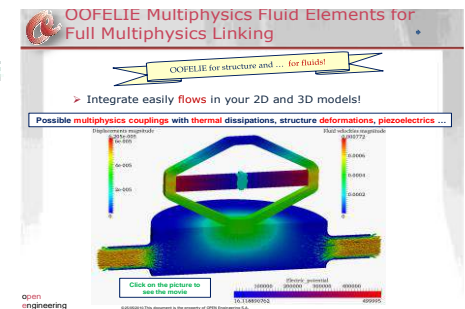
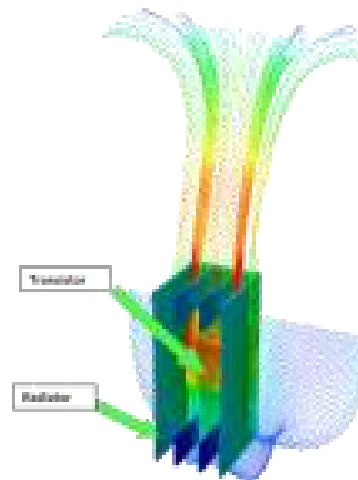
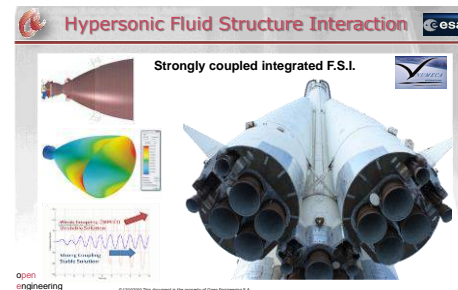
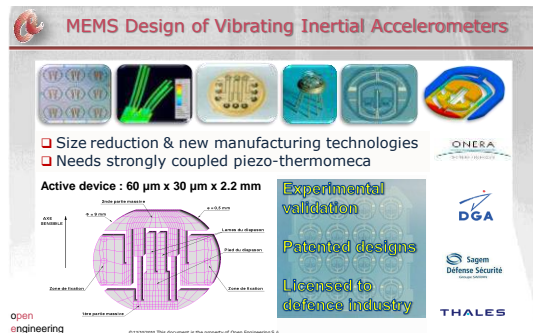
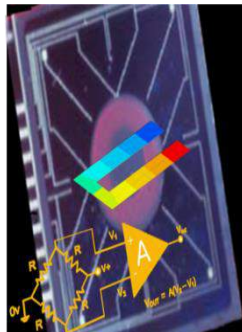
Fluid Structure interaction



Oofelie fully addresses Today's Advanced Design Needs

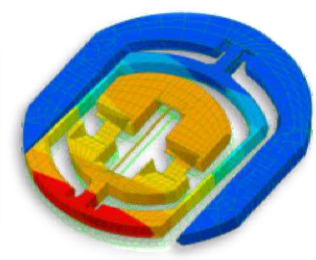
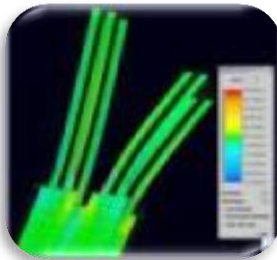
open
engineering

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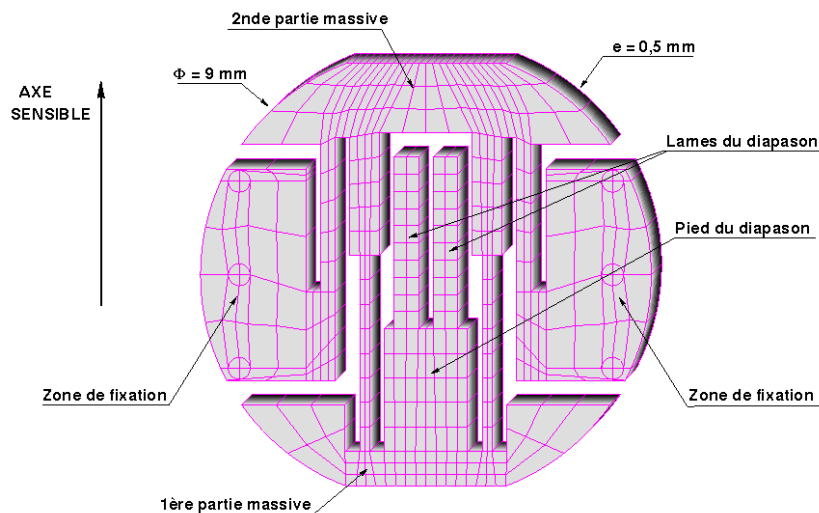
Why Multiphysics?



- ❑ Size reduction & new manufacturing technologies
- ❑ Needs strongly coupled piezo-thermomeca



Active device : $60\ \mu\text{m} \times 30\ \mu\text{m} \times 2.2\ \text{mm}$



Experimental validation

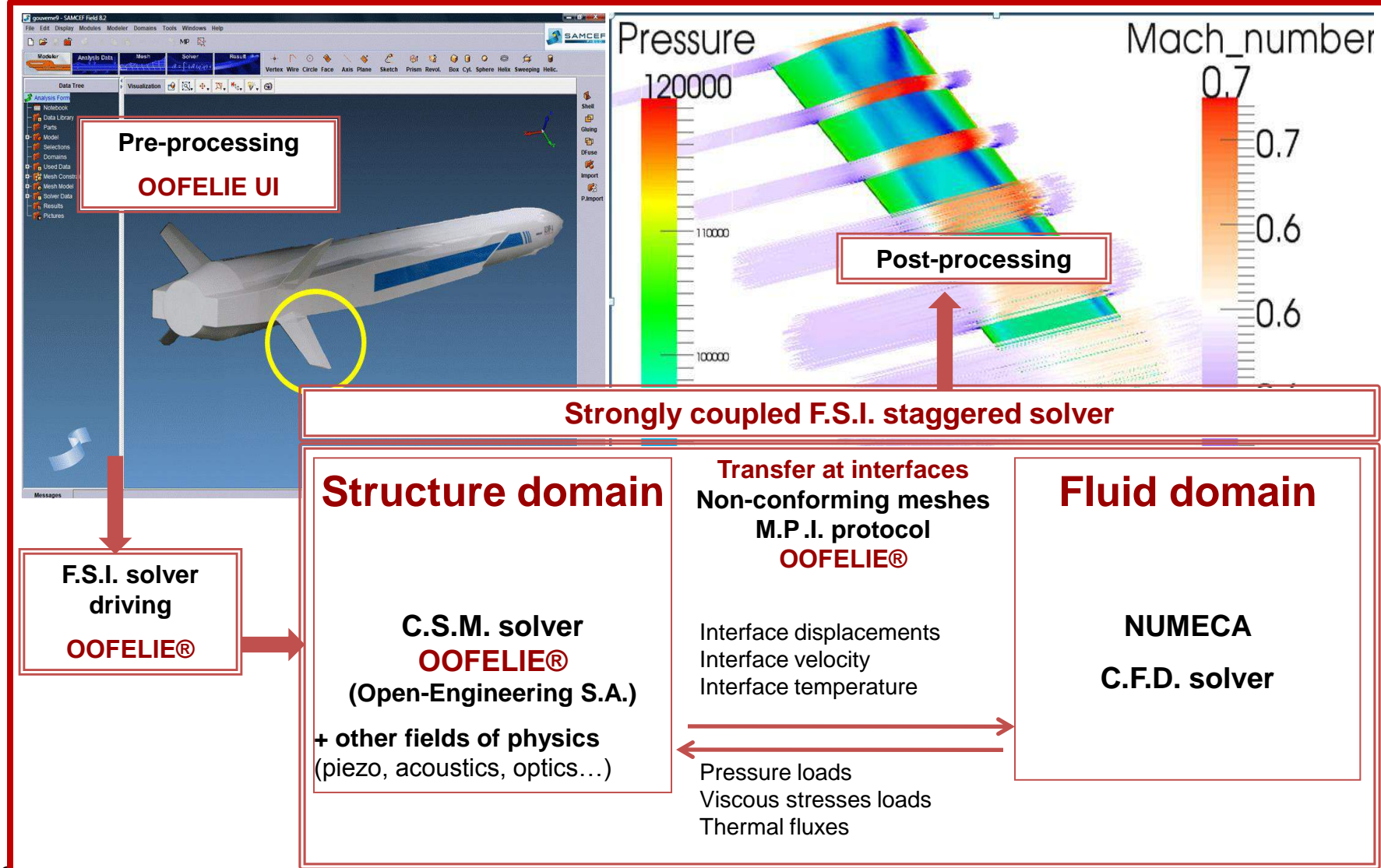
Patented designs

Licensed to defence industry





Fully integrated F.S.I. or fluid – multi-physics solution





OOFELIE::MULTIPHYSICS BACKGROUND

Multiphysics Computer Aided Engineering

OOFELIE::Multiphysics

Thermomechanics

F.S.I.

Mechanics

Piezoelectricity

Thermics

Pyro-piezoelectricity

Fluids

Electrostatics

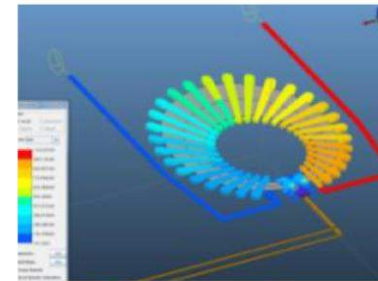
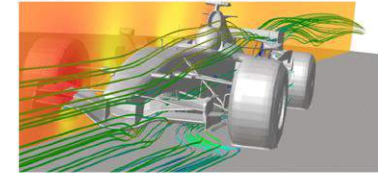
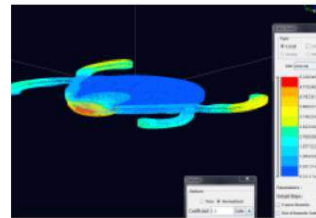
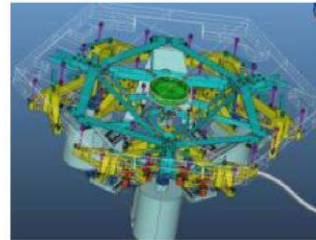
Electric

Electro-
thermomechanics

Acoustics

Electromagnetics

Vibro-Acoustics



Moldex3D
MOLDING INNOVATION


Radiant Zemax


NUMECA
INTERNATIONAL

 **SoftMEMS**
Bringing MEMS to the Mainstream

Injection Analysis
and Coupling

Optics Analysis
and Coupling

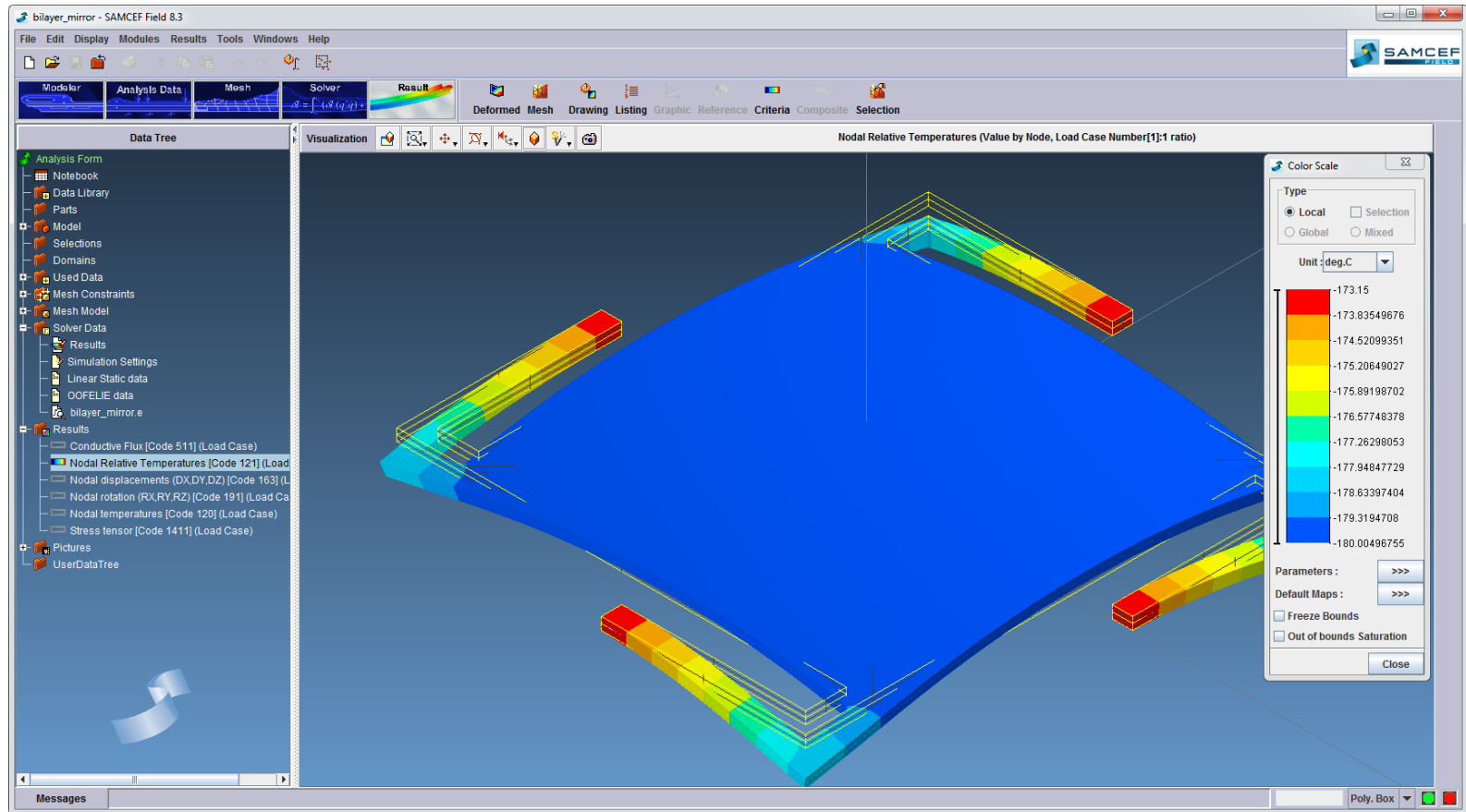
CFD Analysis
and Coupling

EDA link and
coupling

OOFELIE::Multiphysics



INDUSTRY STANDARD DESIGN FLOW – 5 INTUITIVE STEPS





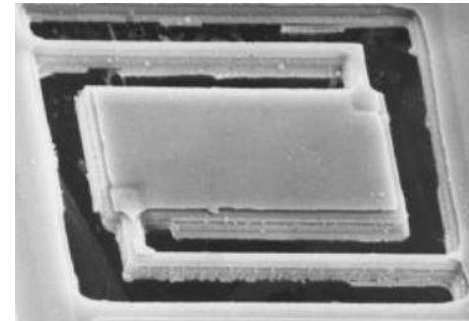
RECENT APPLICATIONS



Infrared Sensor Design

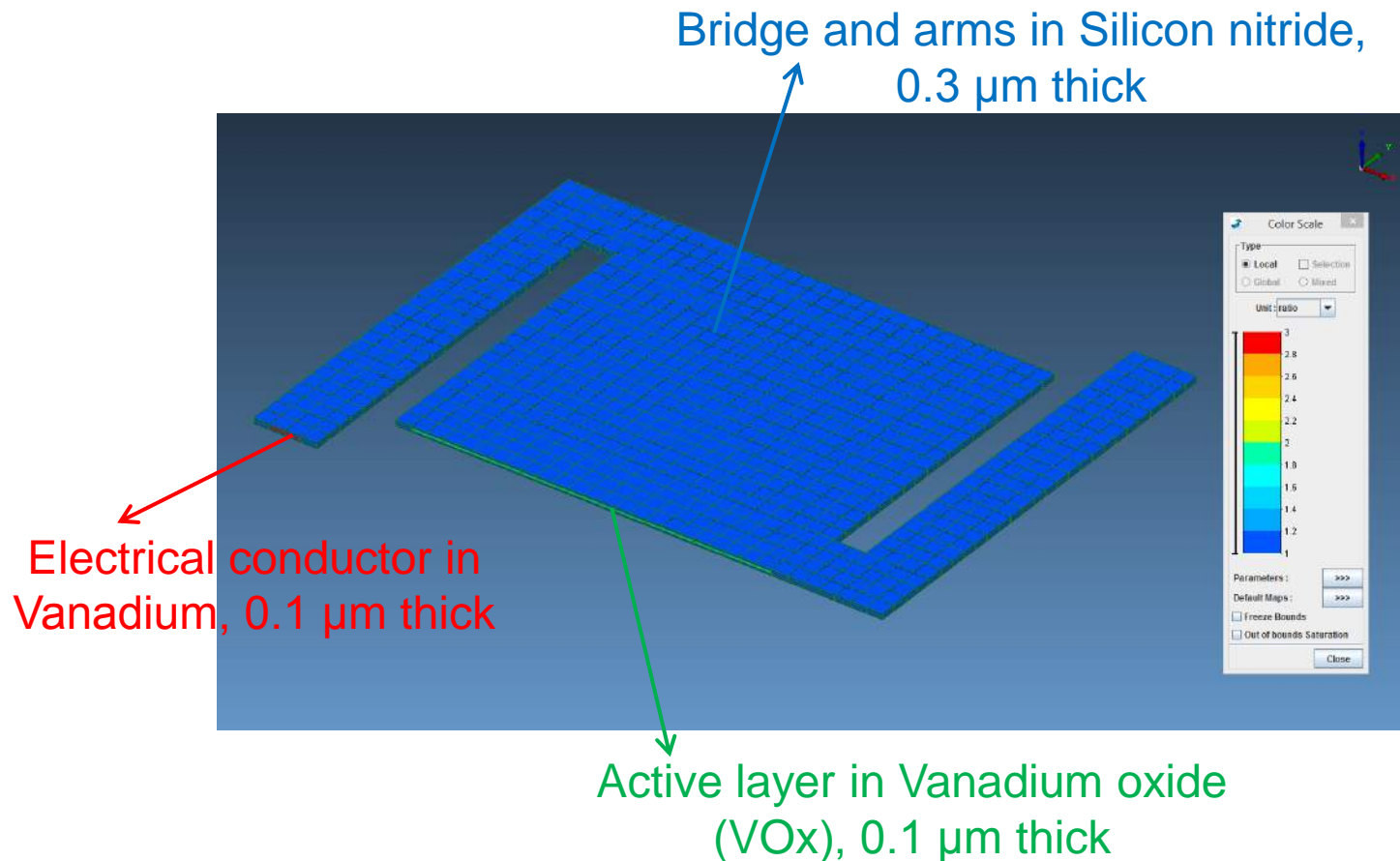
Using

Electro-thermo-mechanical
Capabilities in OOFELIE





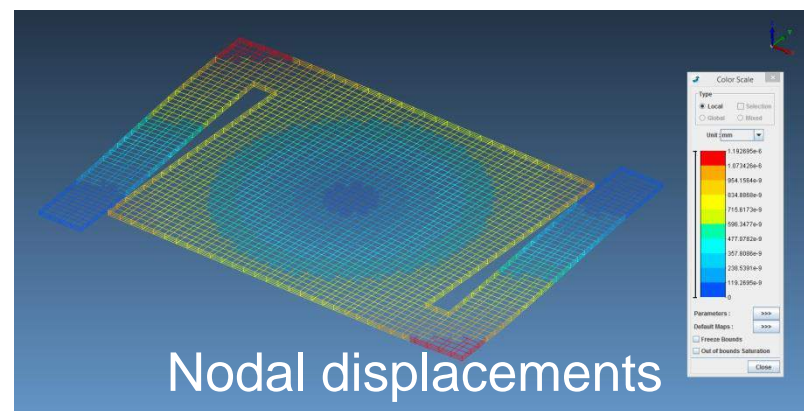
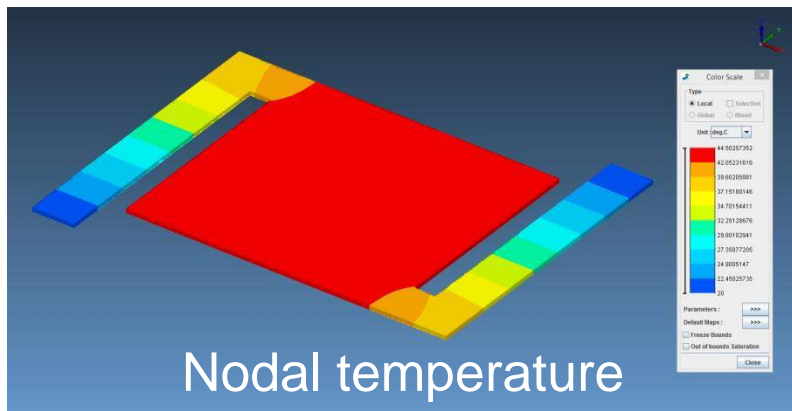
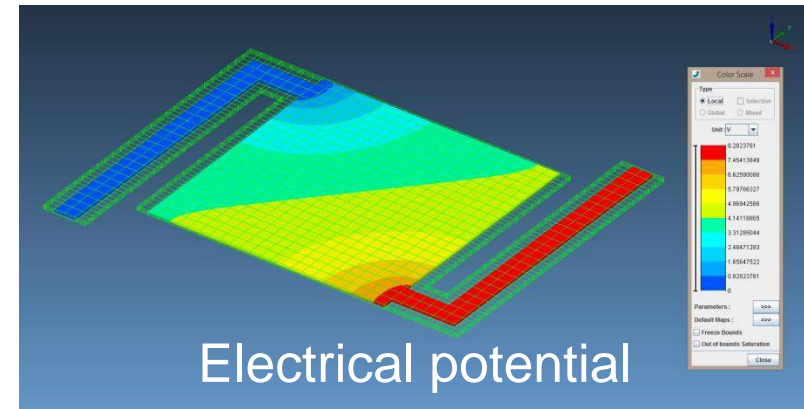
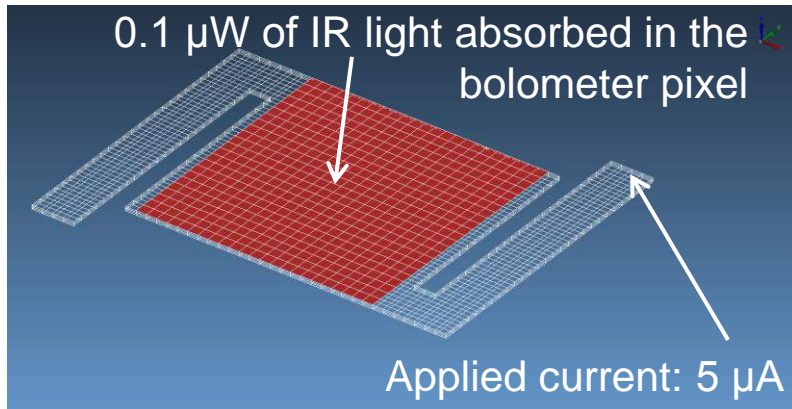
IR sensor (design of a micro-bolometer)



- ✓ **Parametric model**
- ✓ **Accounting for the temperature dependent thermal resistivity of the active layer**



IR sensor (design of a micro-bolometer)

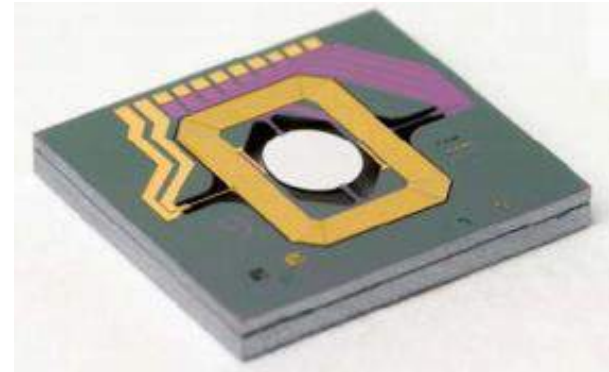




Micro-mirror Design

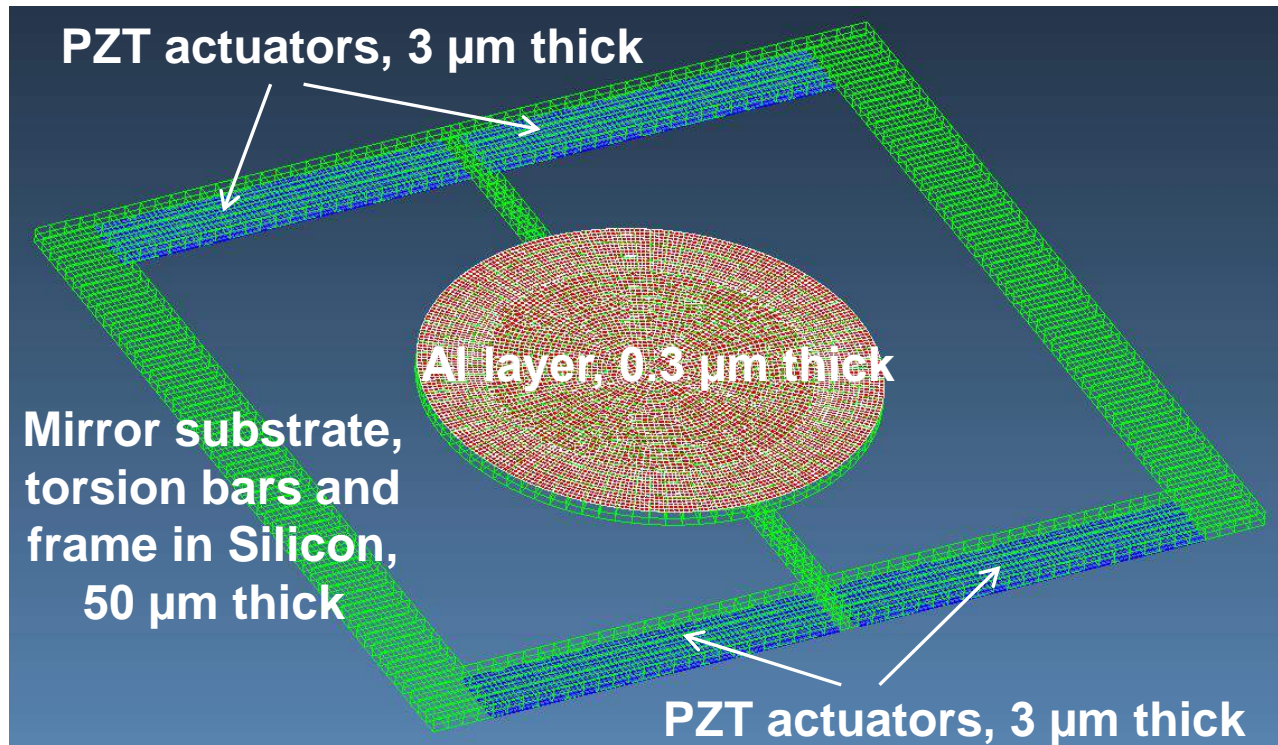
Using

Piezoelectric
Capabilities in OOFELIE

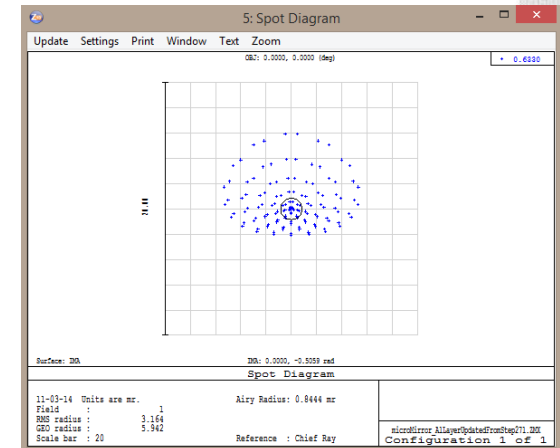
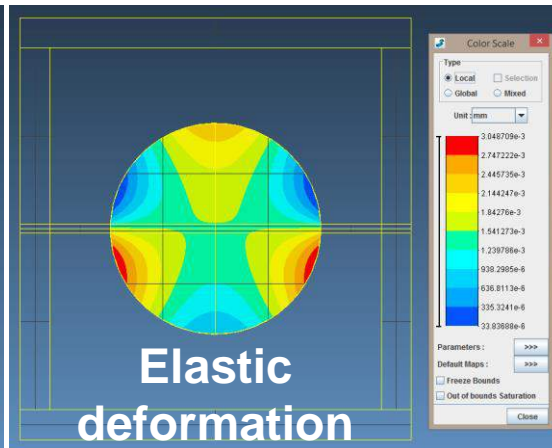




Micro-mirror Modeling & Optimization



- ✓ **Parametric model**
- ✓ **Prestress can be defined**



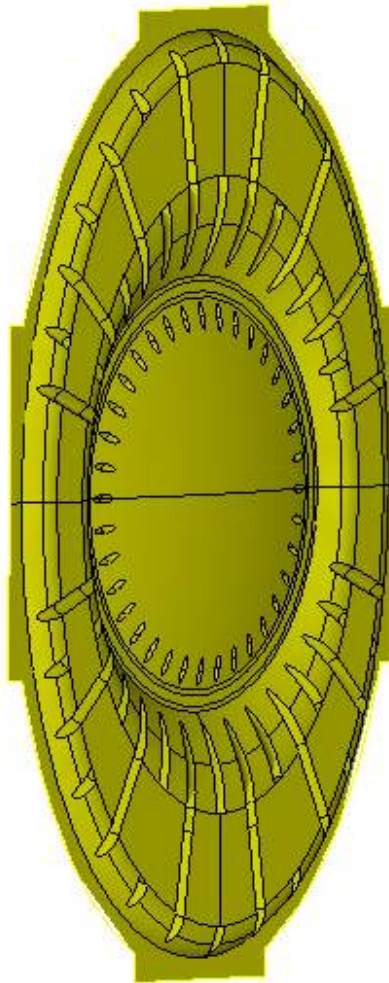
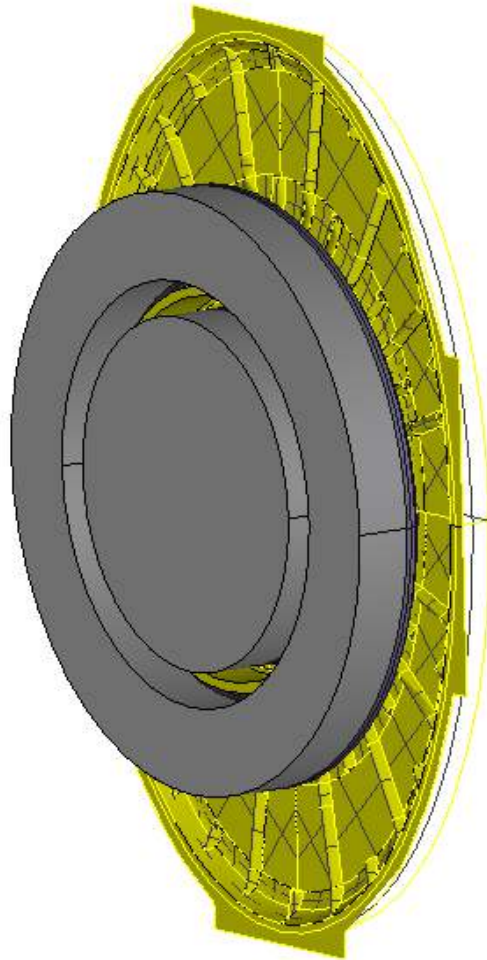


Micro loudspeaker Design

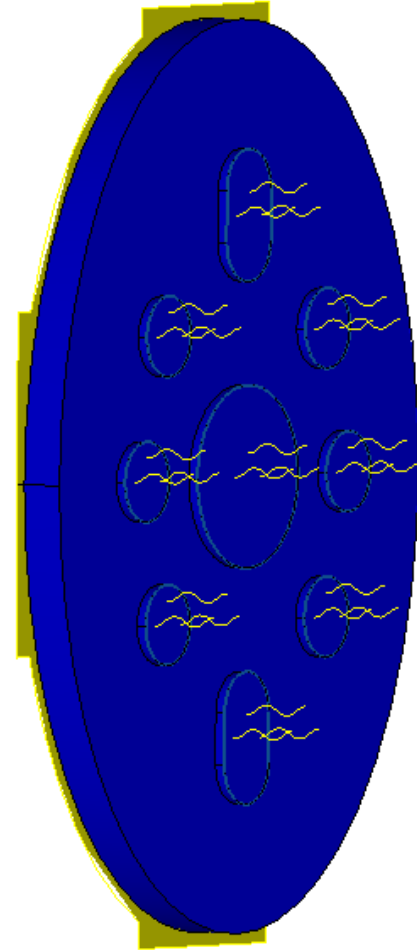
Using

EMAG and
VibroAcoustics
Capabilities in OOFELIE



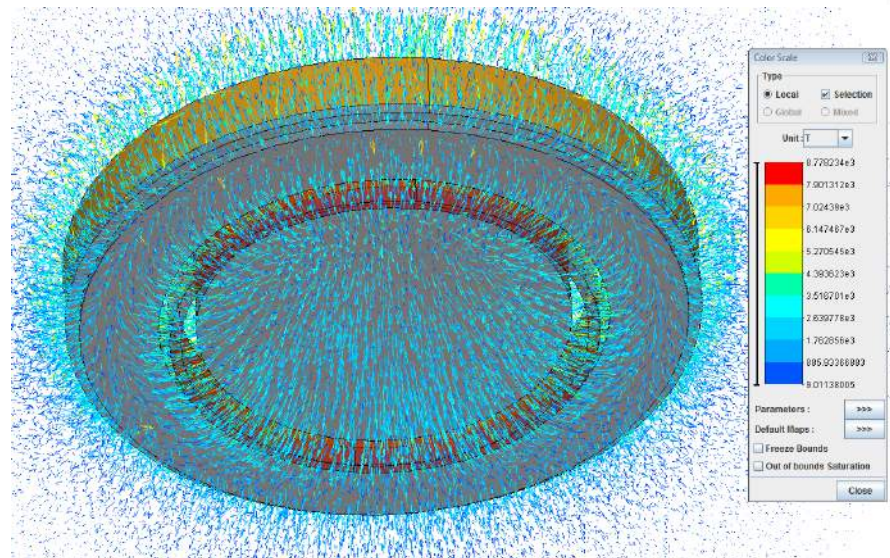
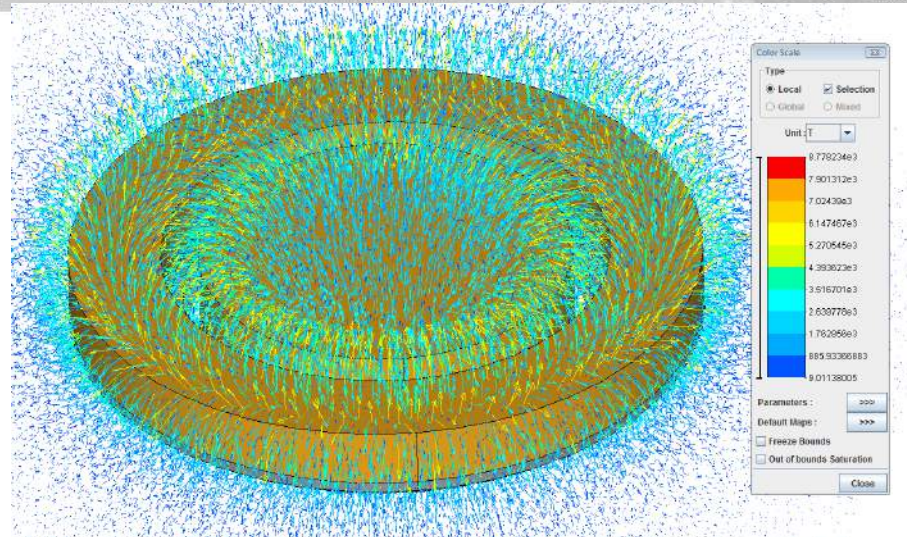
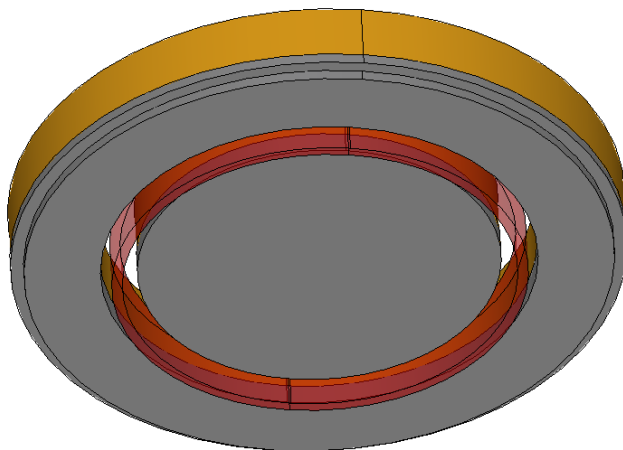
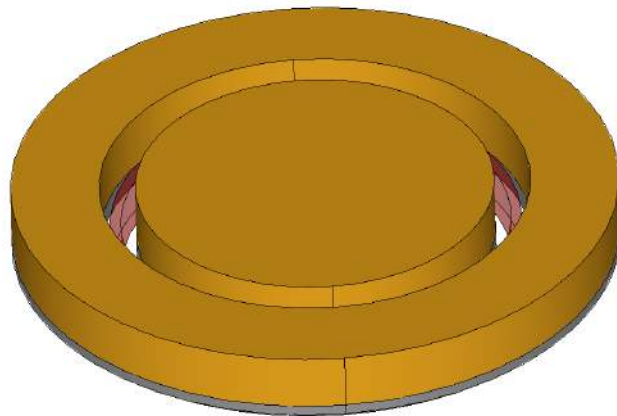


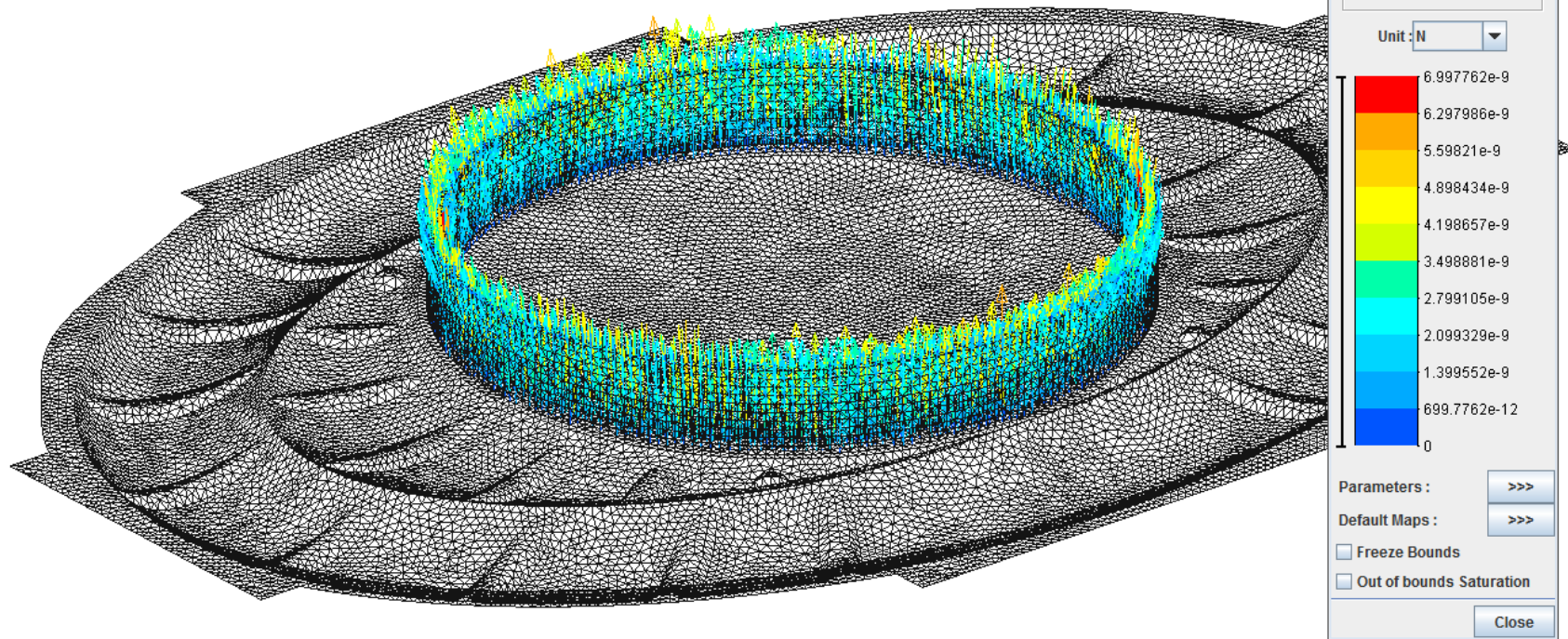
The vibrating plate (rear and front view)



The opened acoustic cavity on the vibrating plate

Magnetic 3D results (B Vector)

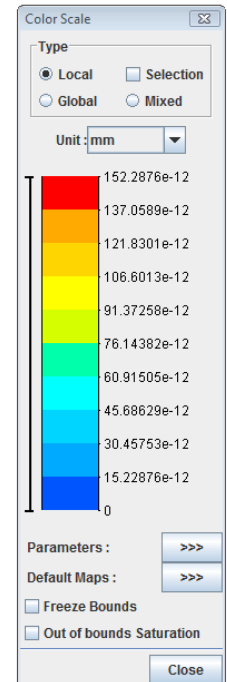
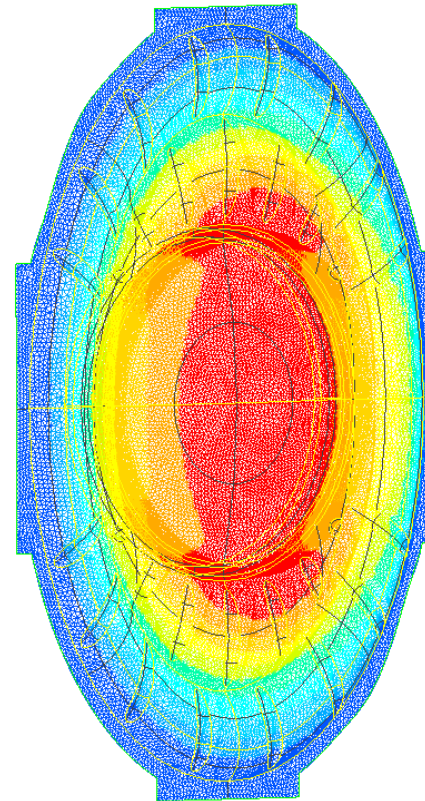
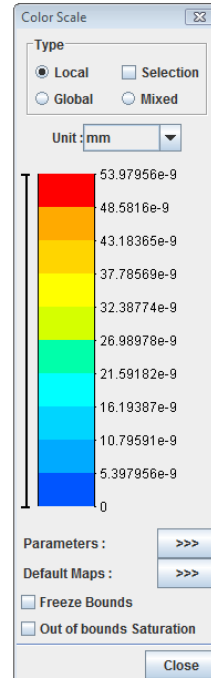
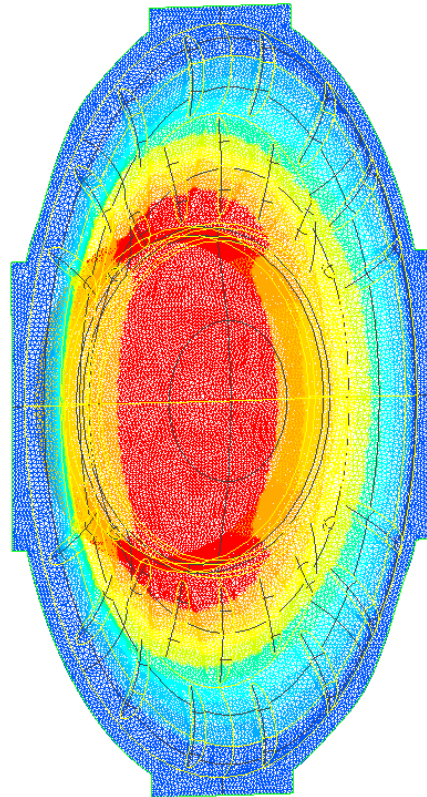




Nodal force distribution in the coil



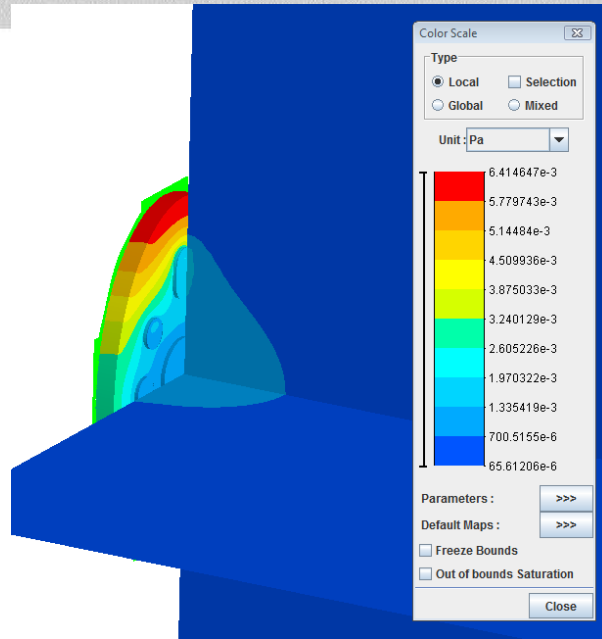
Vibroacoustic results



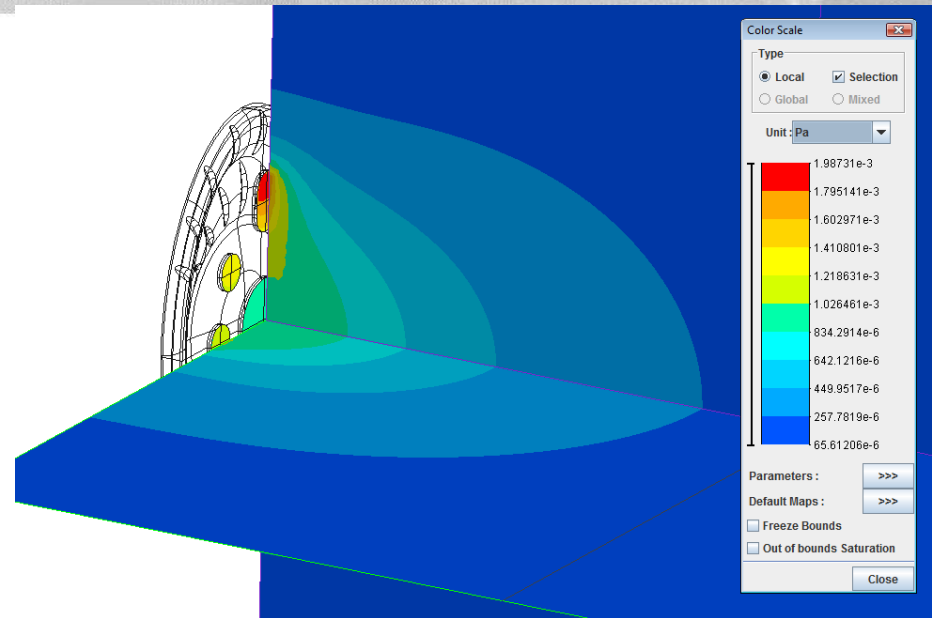
The real & imaginary parts of the displacement field



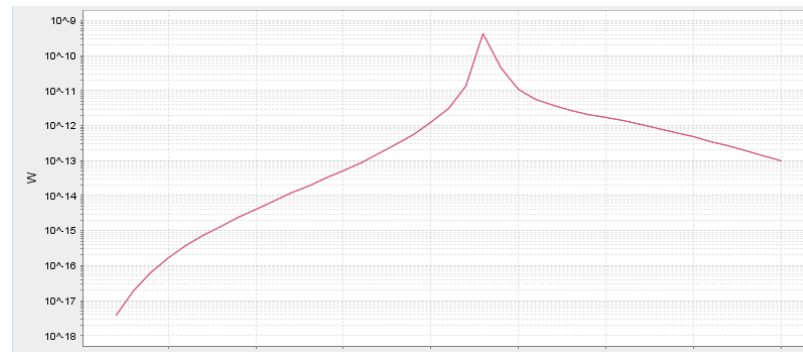
Vibroacoustic results



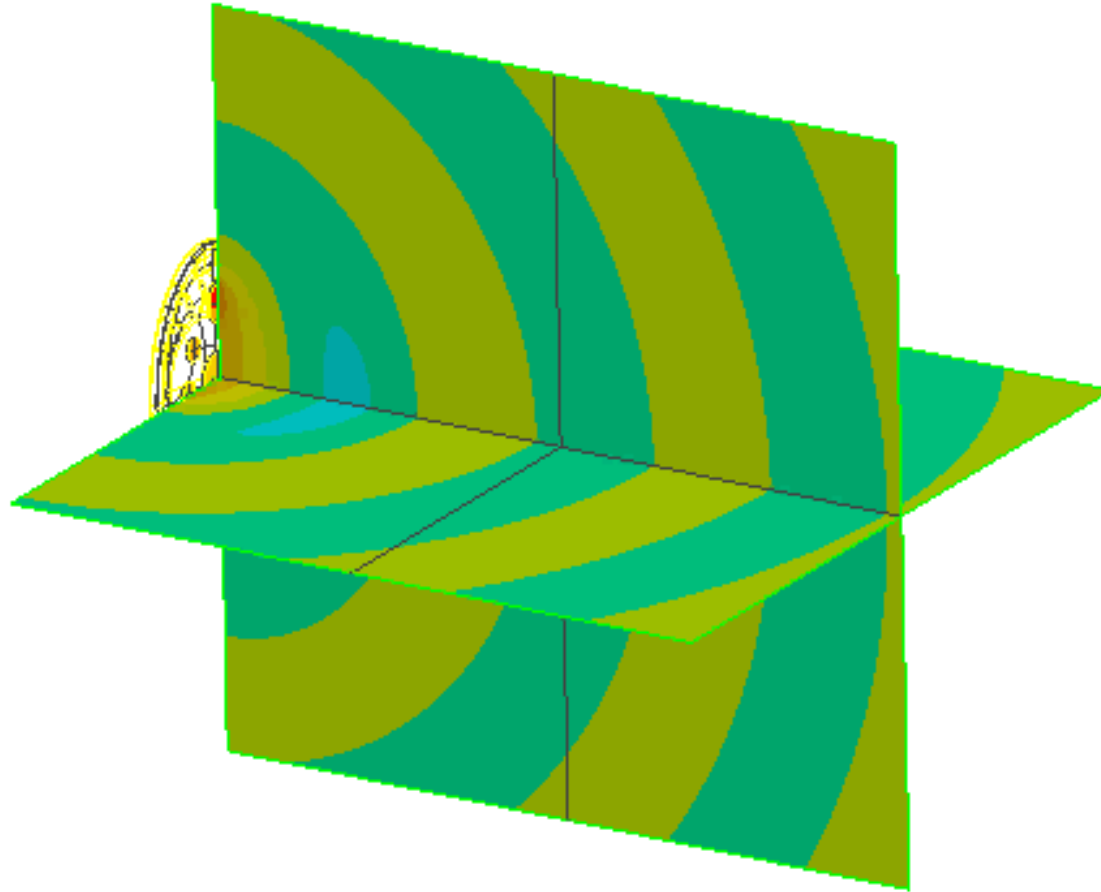
Pressure field amplitude



Pressure field amplitude



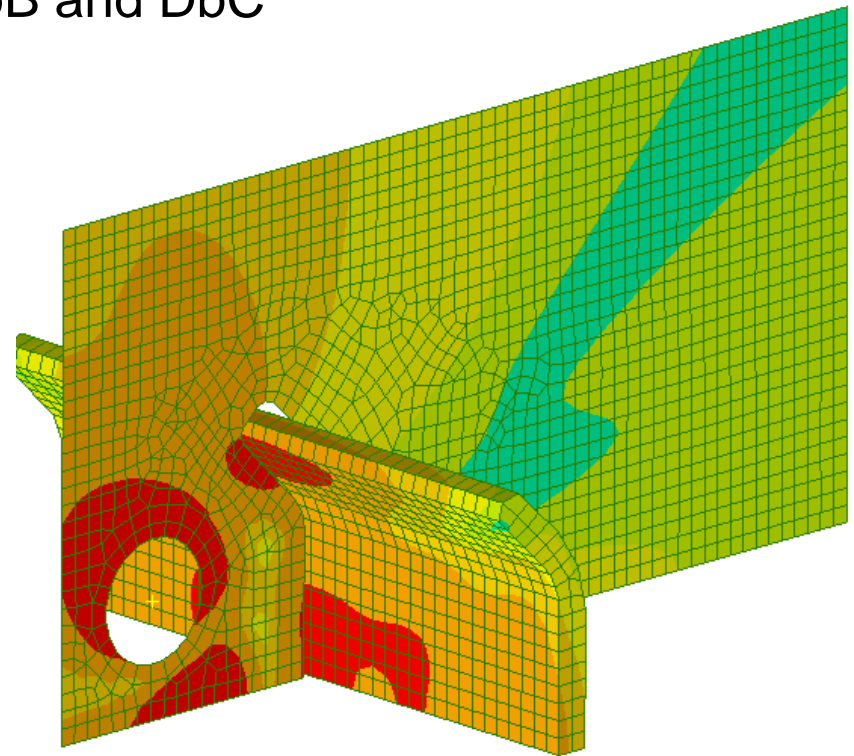
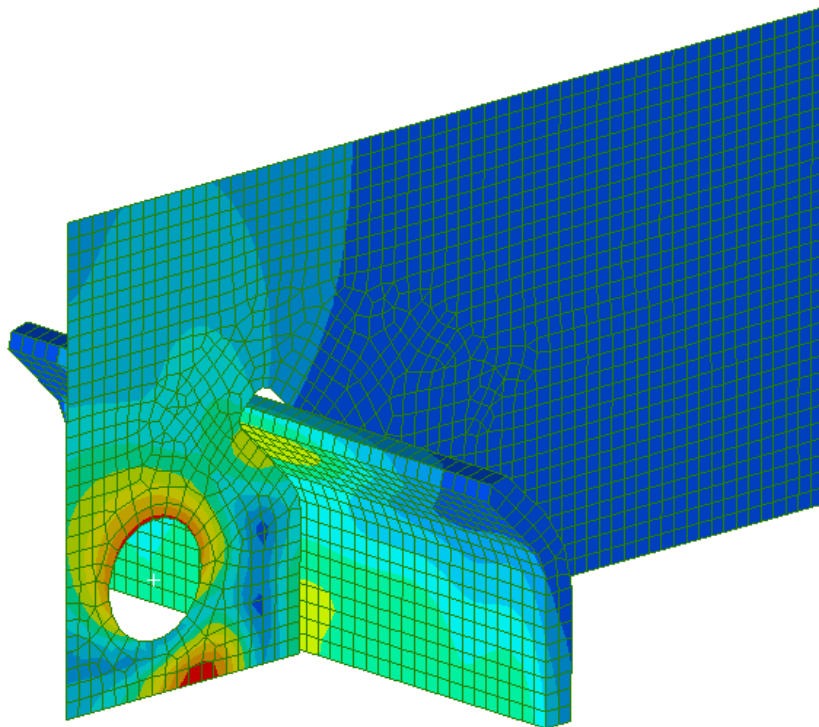
Radiated
acoustic power



Pressure field (translation in temporal domain)

❑ NEW FEATURES

- Support of symmetry and anti-symmetry planes in FMM solver
- Introduction of CHIEF method to deal with singular frequencies in BEM
- Pressure field in Db, Dba, DbB and DbC





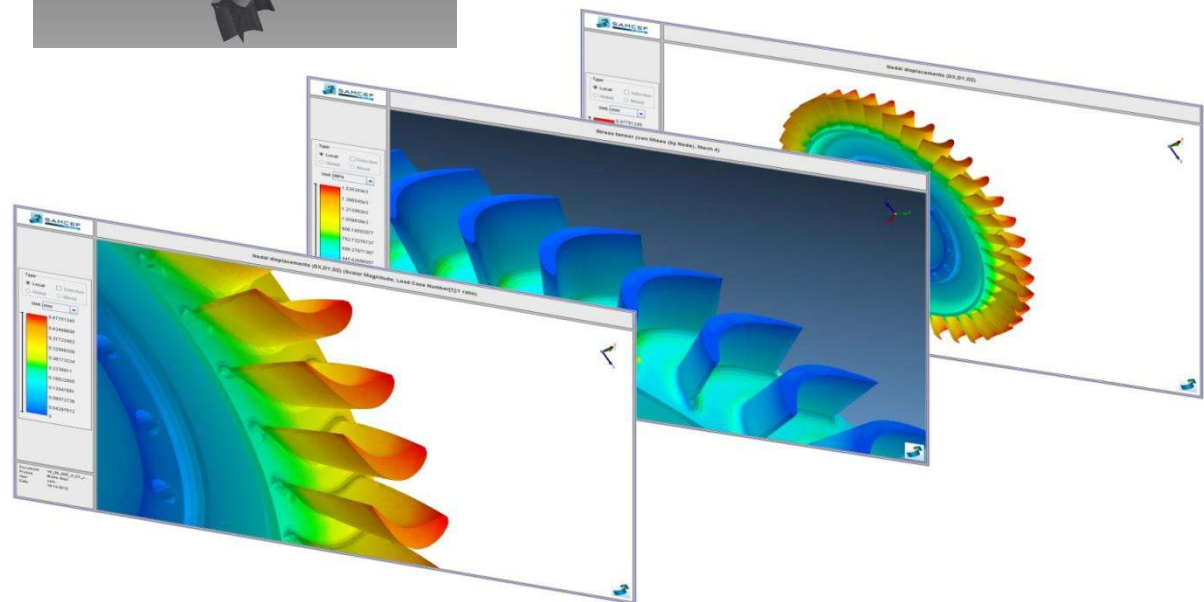
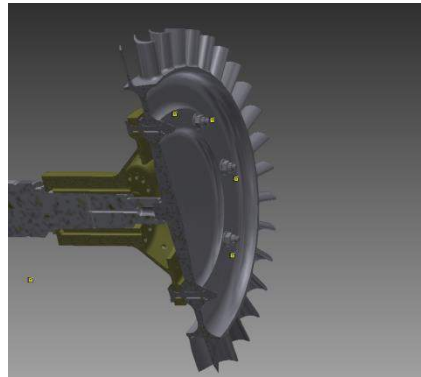
Gaz Turbine Design

Using

Thermo-mechanical
Capabilities in OOFELIE

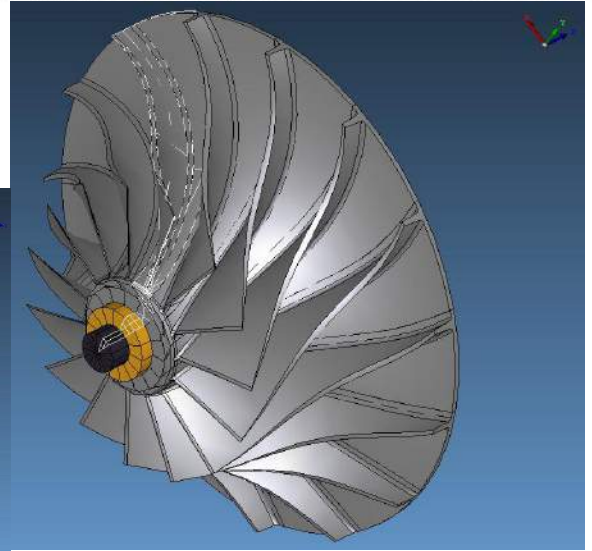
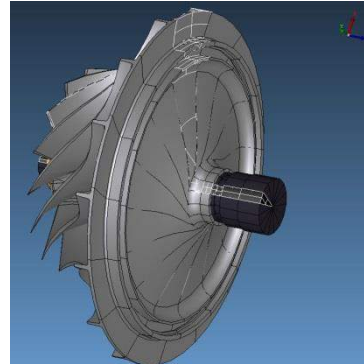
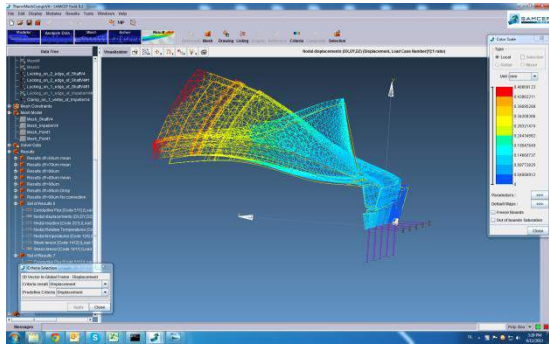
❑ THERMO-MECHANICAL STRESSES / DEFORMATIONS

- Turbine
- Hub
- Impeller
- Shaft
- Assemblies

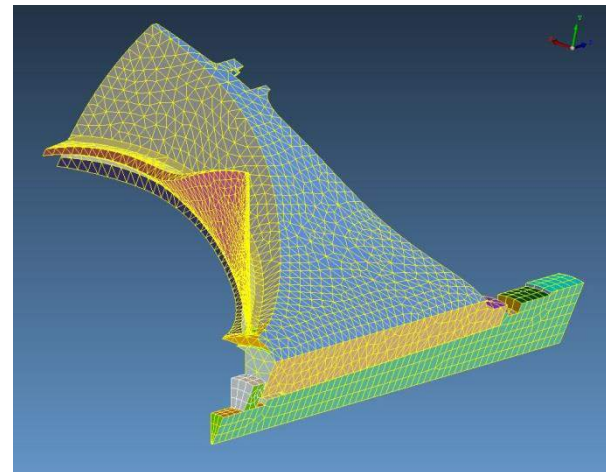
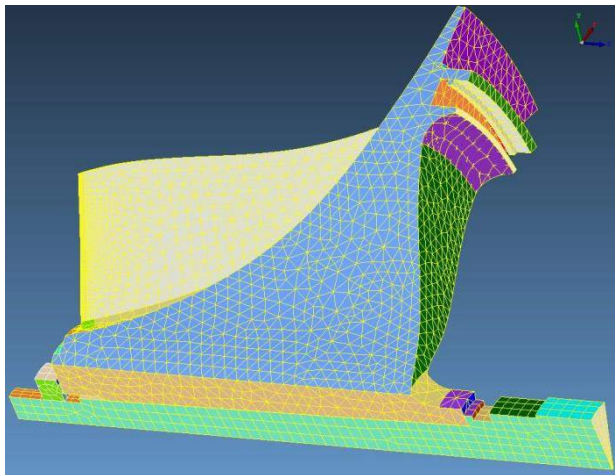


❑ CYCLIC SYMMETRY

- Consequently reduces the model size

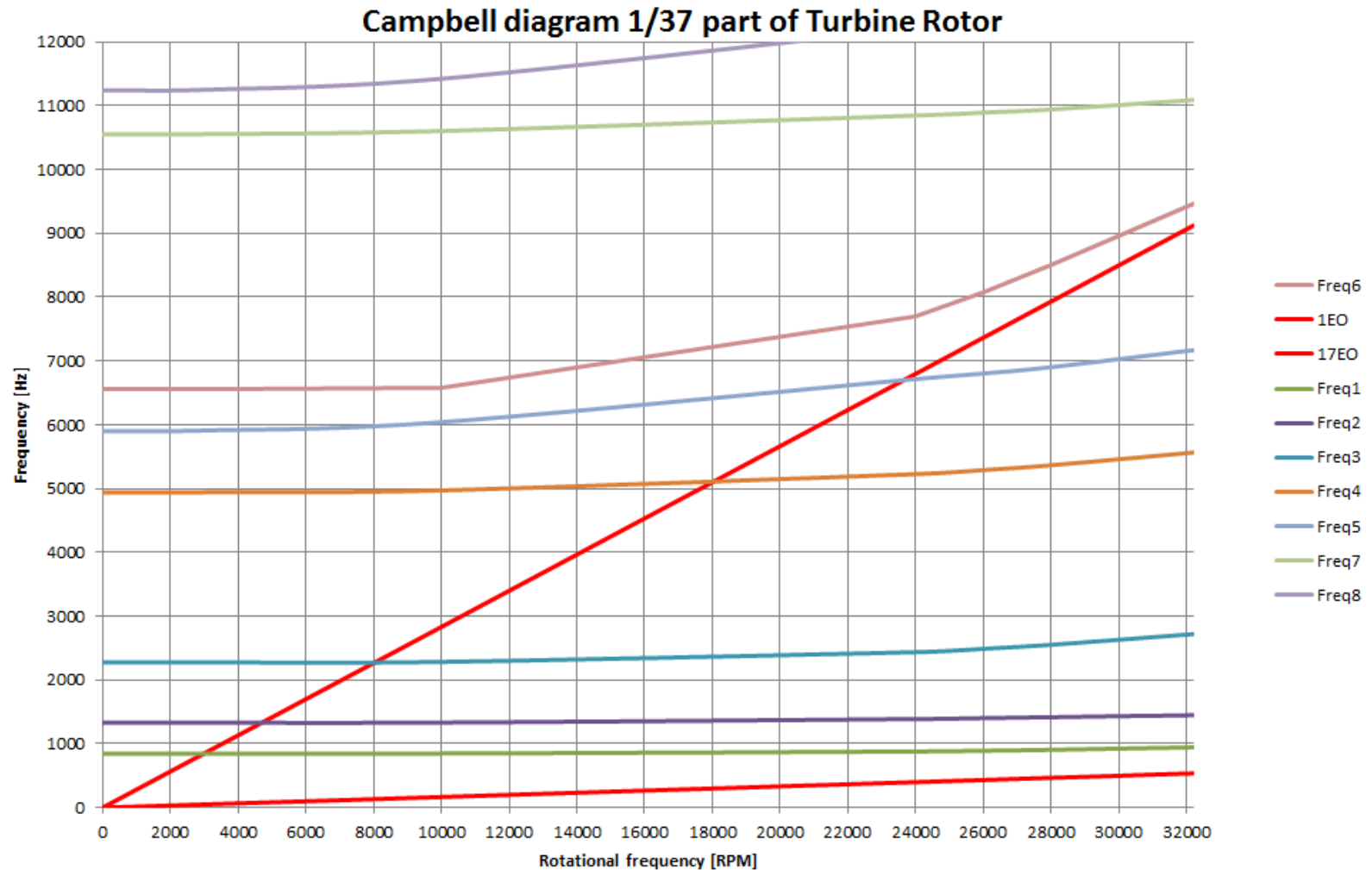


- Allows to improve the mesh quality => Results Accuracy





Campbell diagrams





NEW FEATURES

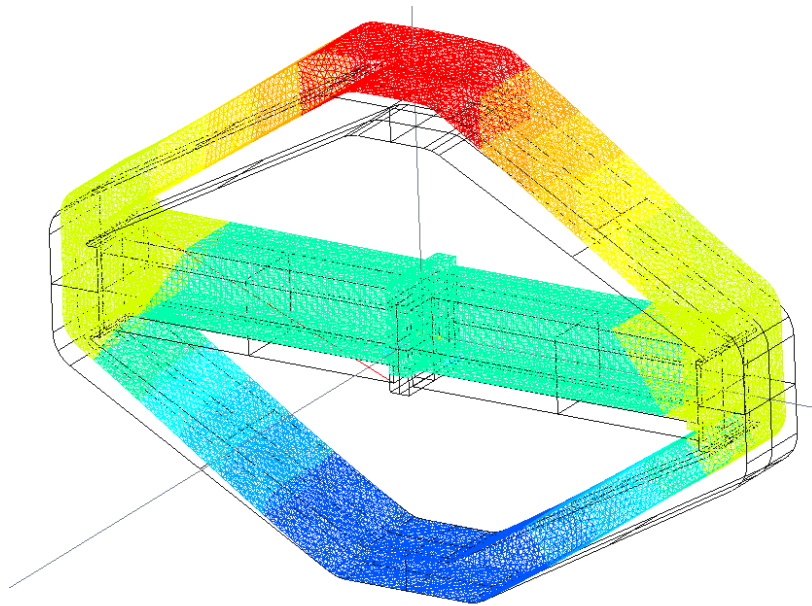


Parallel computing using Open MP

❑ Parallel parts in OOFELIE::Mutiphysics using Open MP

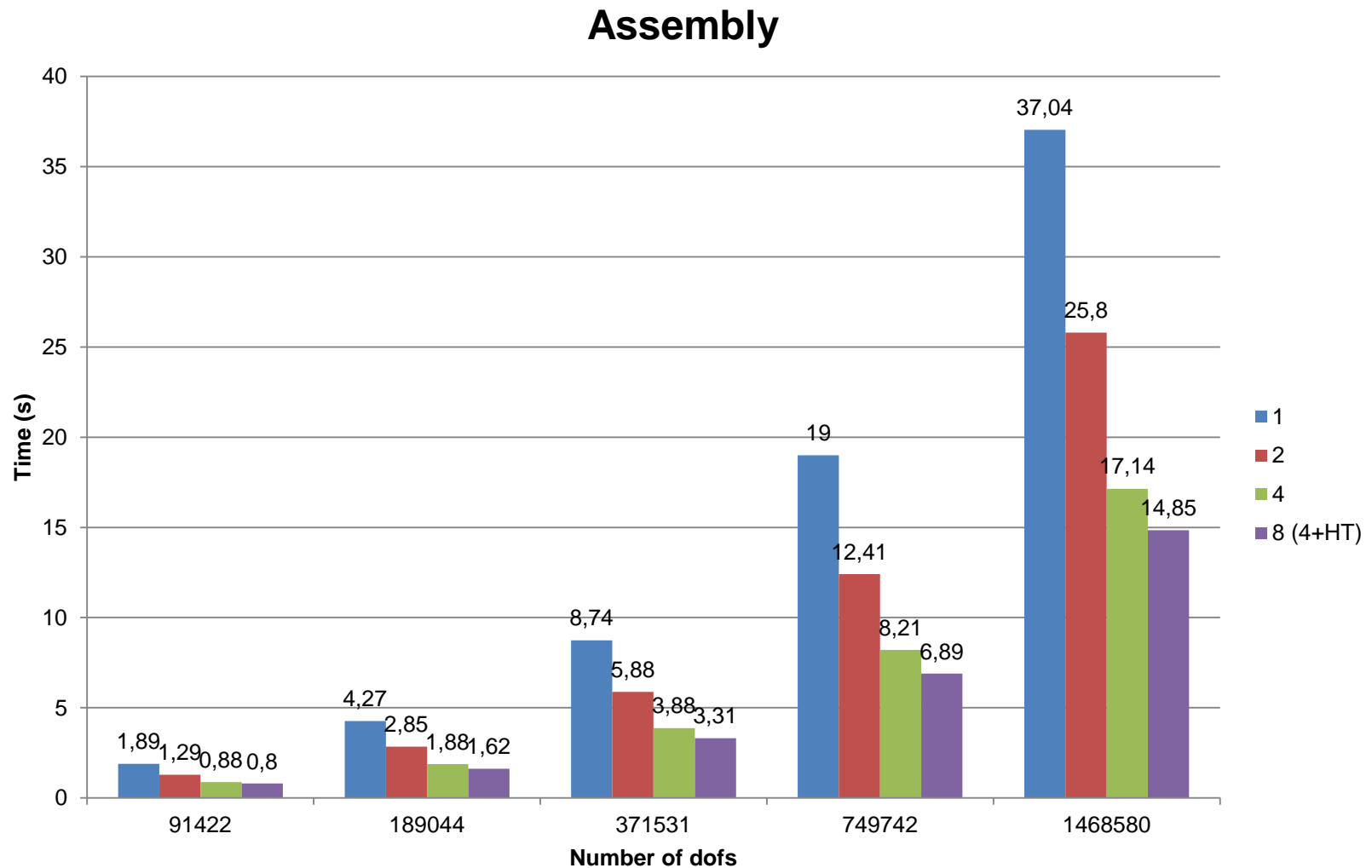
- Linear Solver call (PARDISO, MUMPS)
- BEM Element construction (full matrix system, field point visualisation)
- Raytracing for Mutual radiation
- Contact detection in new multiphysic contact element & gluings elements
- **Assembly of Structural matrices (NEW!!!)**

❑ Example: linear static analysis of an APA actuator

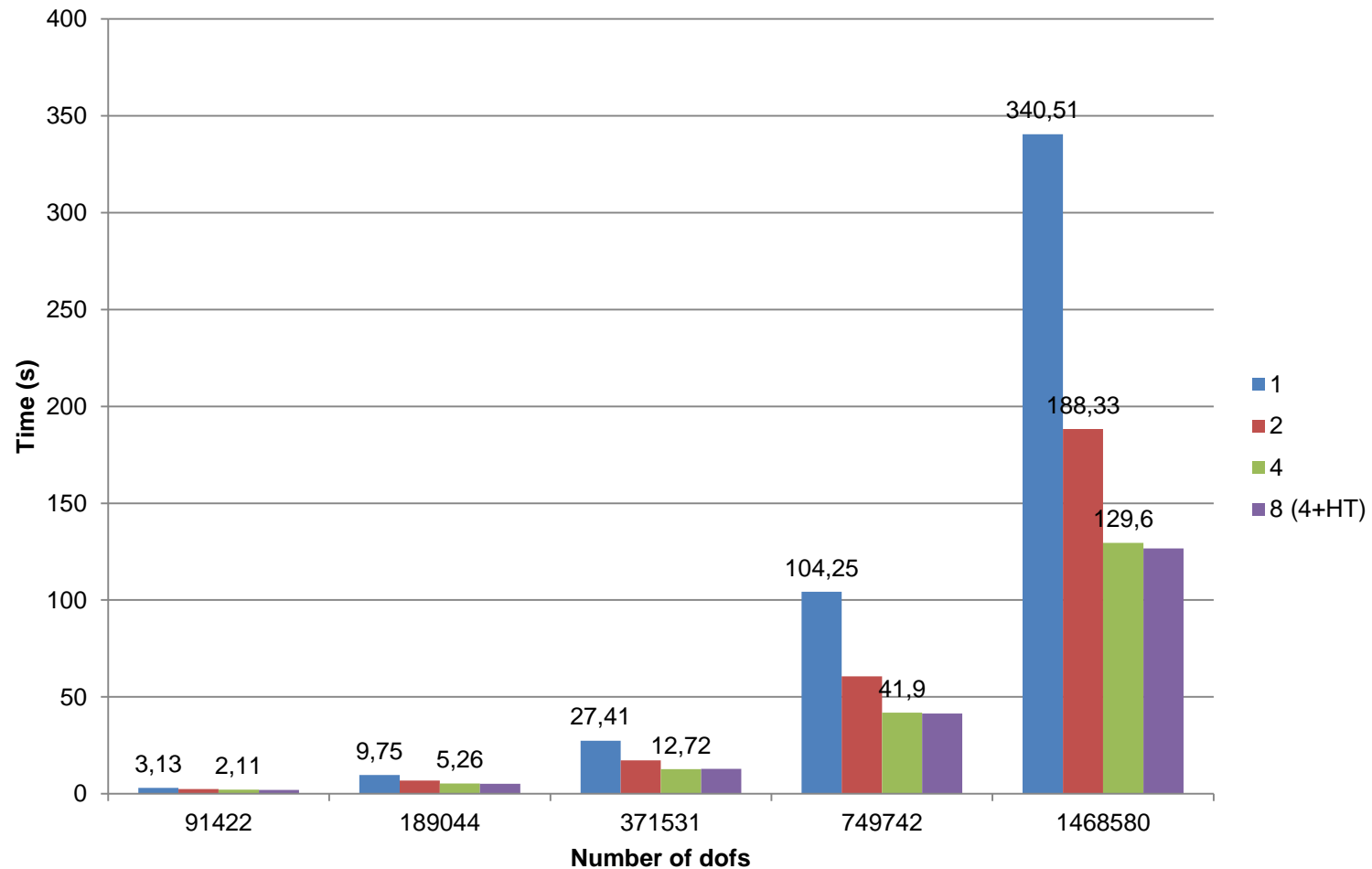


Mesh size	Nb dofs
0.49 mm	91,422
0.4 mm	189,044
0.3 mm	371,531
0.23 mm	749,742
0.177 mm	1,468,580

On Intel Core i7-4770
CPU @ 3.40 GHz



Factorisation (PARDISO)





❑ OBJECTIVES

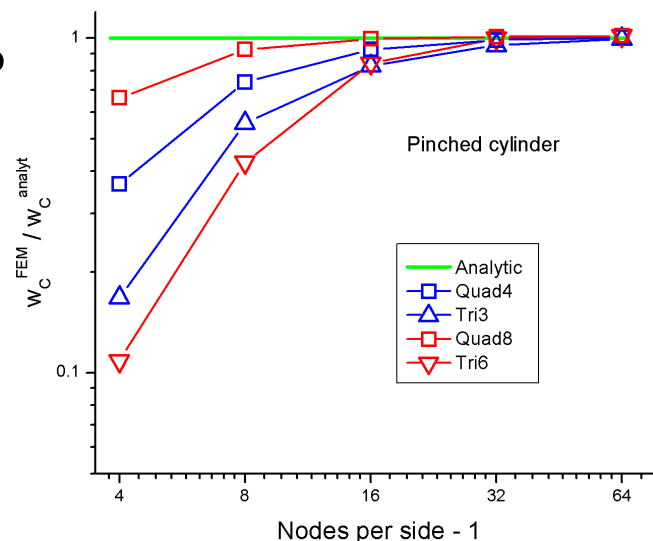
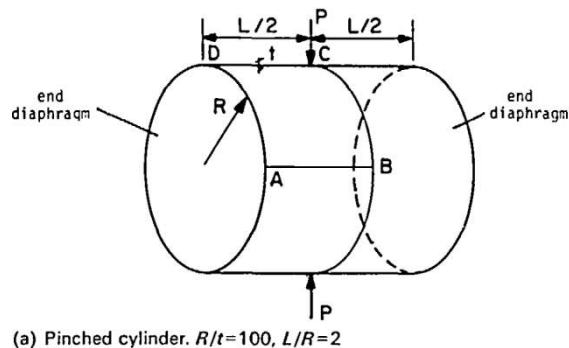
- Second order accuracy
- Geometric nonlinearity (large displacements)

❑ MAIN FEATURES

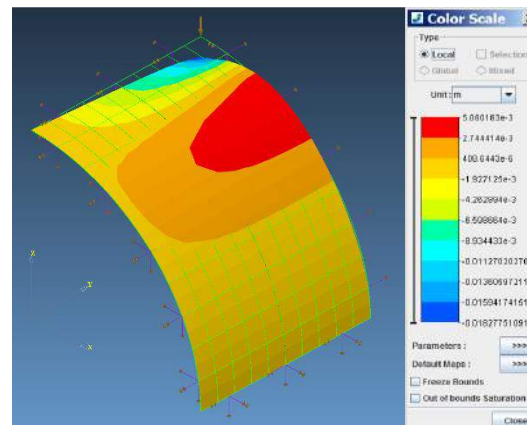
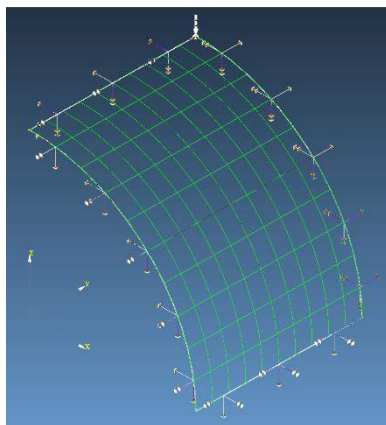
- First and second order elements (Tri3, Tri6, Quad4, Quad8)
- Transverse shear stress (Mindlin-Reissner)
- Eccentricity
- Variable thickness (it is specified at each node)
- Geometric nonlinearity (large displacements)

❑ PINCHED CYLINDER

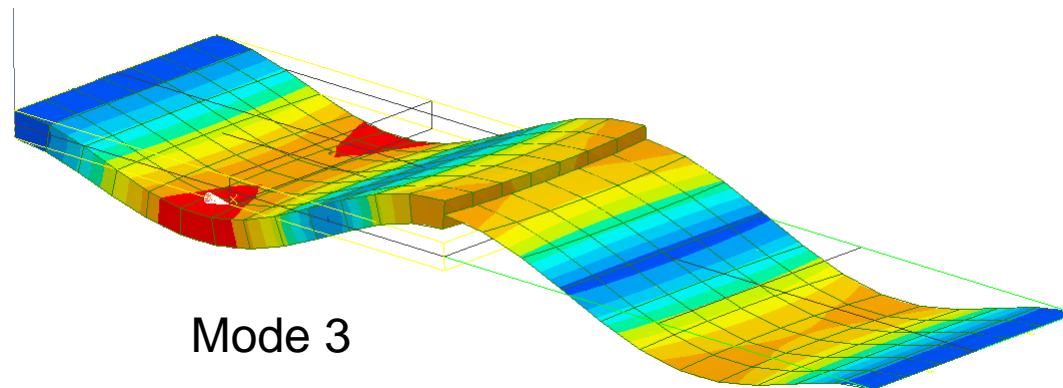
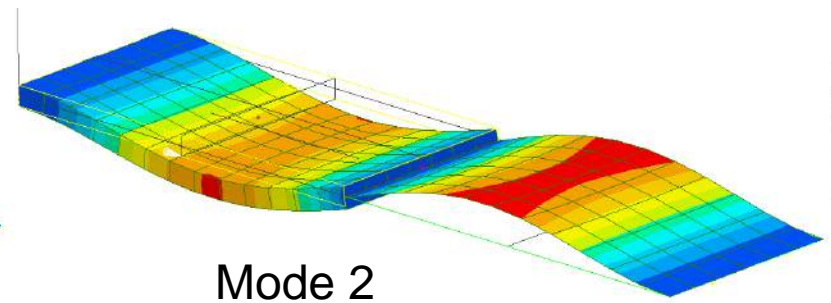
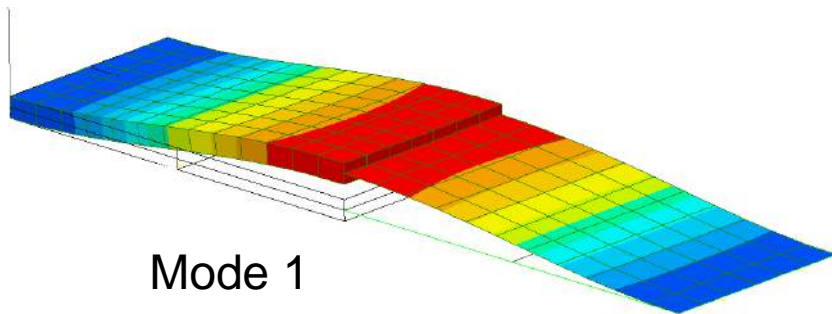
- Cylinder pinched by two forces P



- Simulation of 1/8 of the roof (ref. value: vertical displacement at point C)



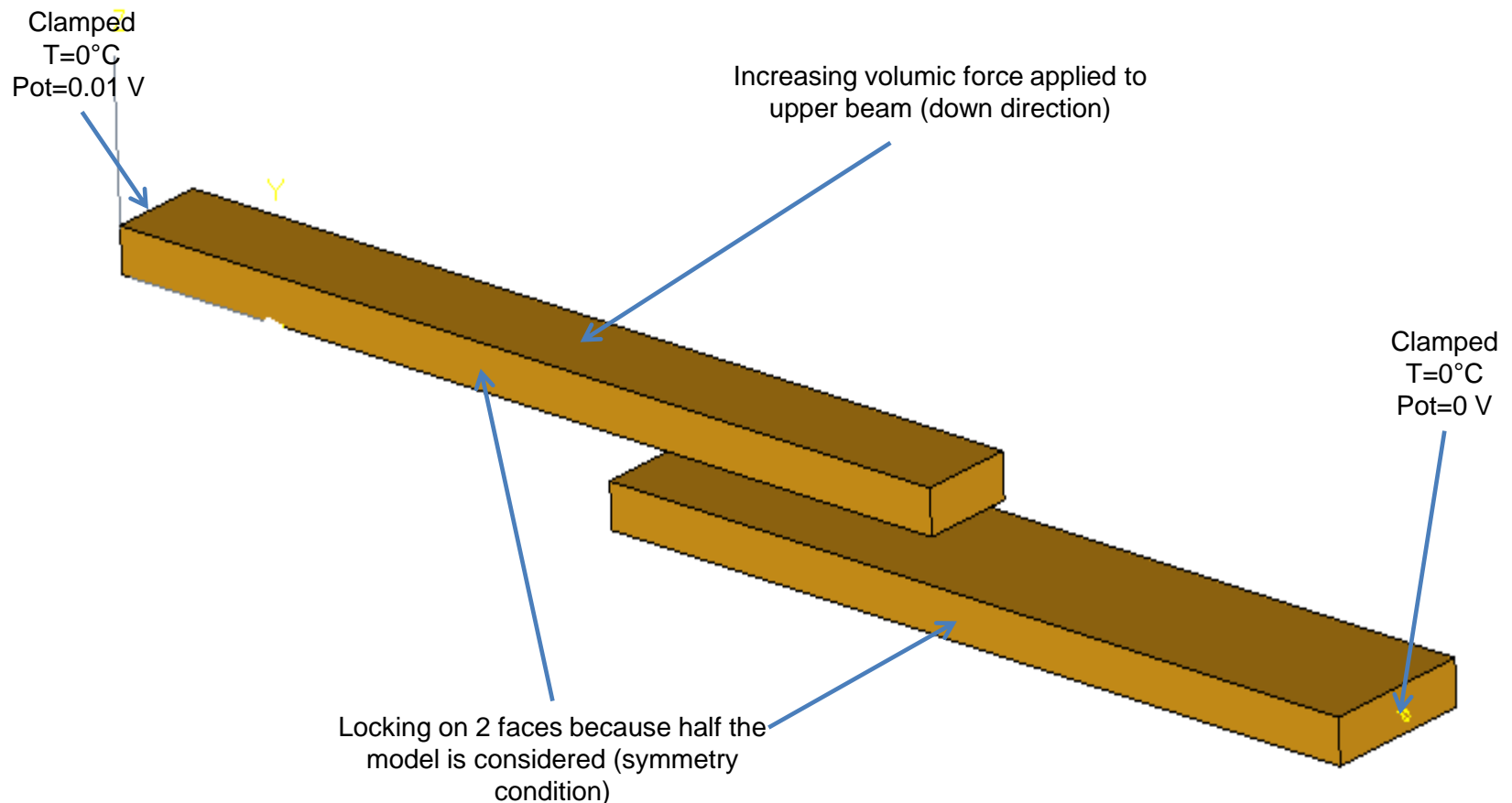
- ❑ **EDGE OF SHELL TO FACE OF VOLUME**
- ❑ **Example: modal analysis of a bi-clamped « plate »**



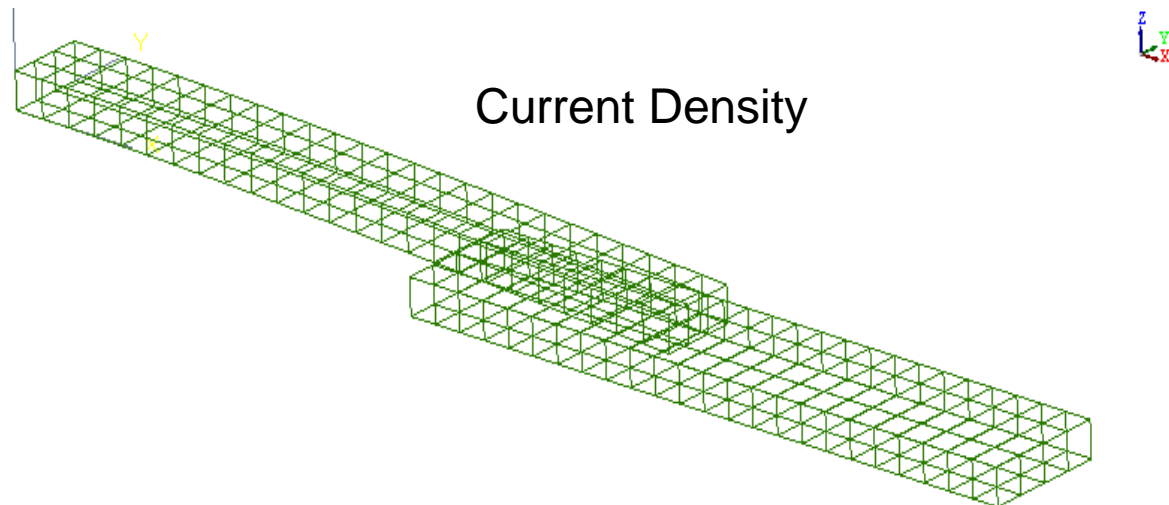
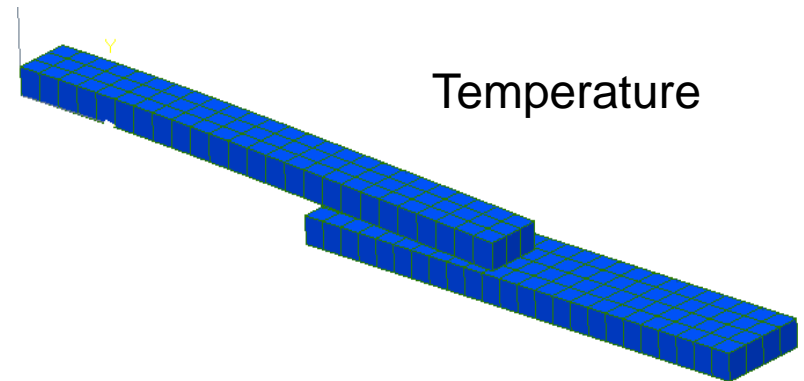
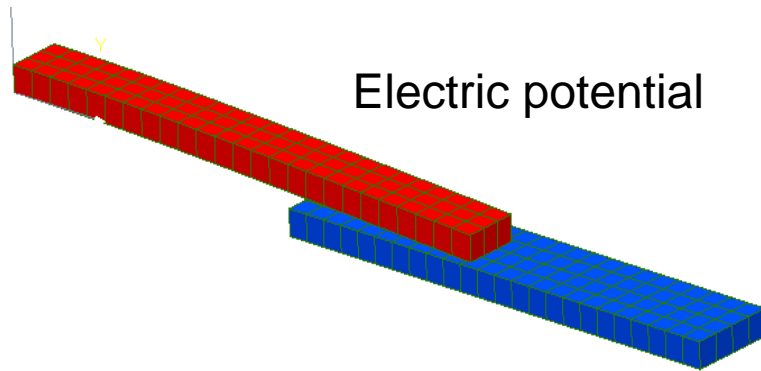
❑ MP CONTACT ELEMENT ABLE TO TAKE INTO ACCOUNT

- Mechanical contact
 - ✓ governed by a mechanical contact stiffness
- Thermal contact
 - ✓ governed by a thermal admittance (eventually a function of contact pressure)
- Electrical contact
 - ✓ governed by a electrical admittance (eventually a function of contact pressure)
- All connectivities are supported: Tri3, Tri6, Quad4 & Quad8

❑ 2 ELECTRO-THERMOMECHANICAL BEAMS (STATIC ANALYSIS WITH SEVERAL LOAD CASES)

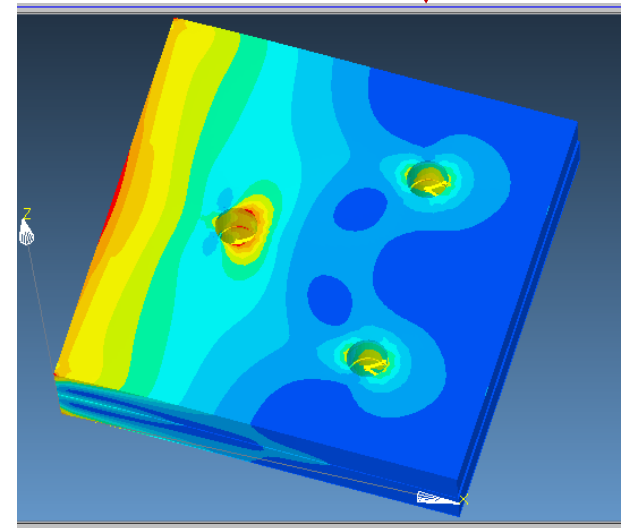
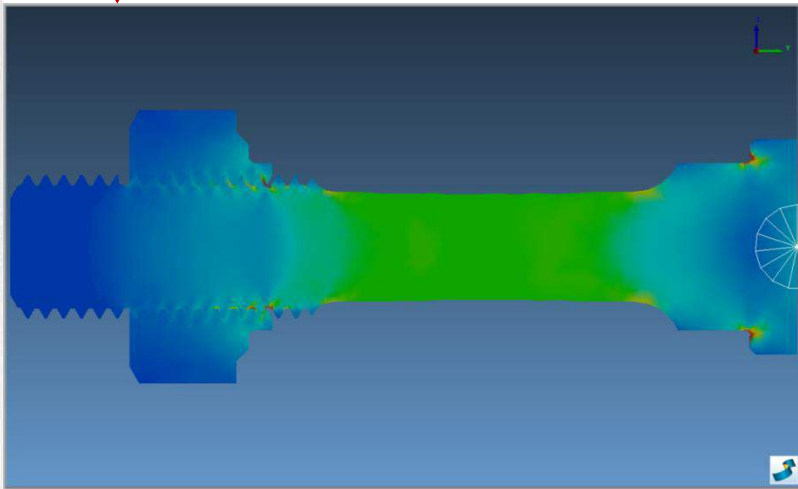
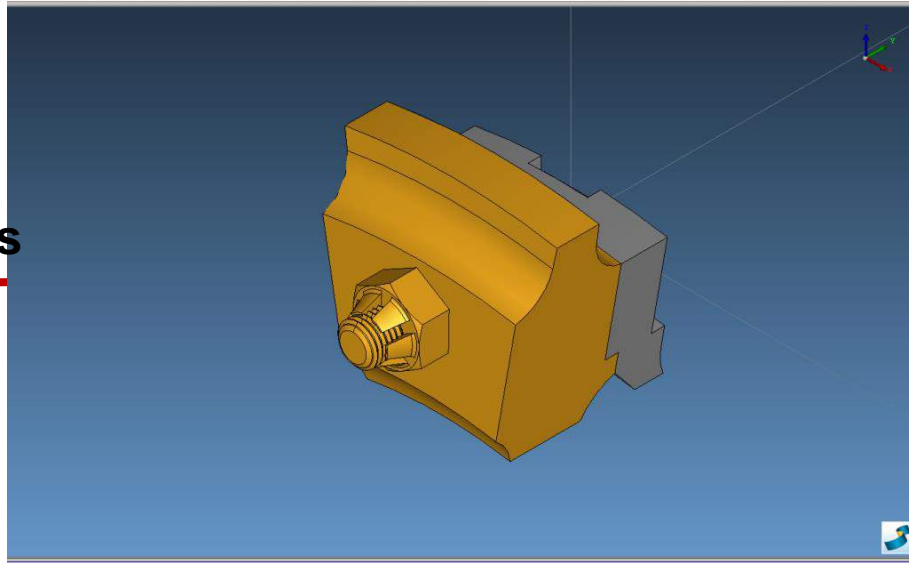


Multiphysic contact element



Detailed analysis

MEAN element

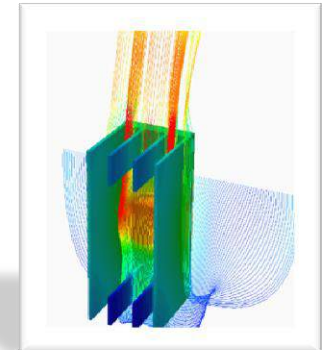
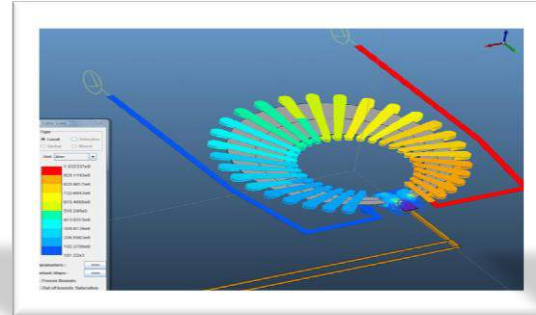
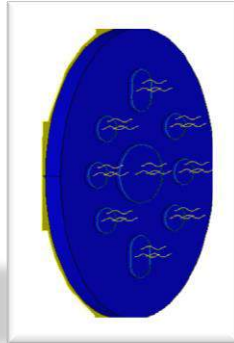
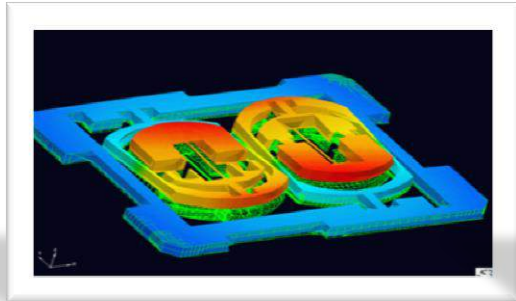




CONCLUSION



OOFELIE::Multiphysics Key Features



- ☐ **INTEGRATED CAE ENVIRONMENT**
- ☐ **ENGINEERING STANDARD, INTUITIVE, TIME-SAVING DESIGN FLOW INCLUDING SCRIPTING, PARAMETERIZATION AND OPTIMIZATION.**
- ☐ **STRONGLY COUPLED MULTIPHYSICS YIELDS FASTER AND MORE ACCURATE CONVERGENCE IN DYNAMICS**
- ☐ **BROAD SENSORS DOMAIN COVERAGE**
- ☐ **EFFICIENT HANDLING OF SUPERSIZED STRUCTURE AND FLUID PROBLEMS**
- ☐ **ITAR FREE SOLUTION**

