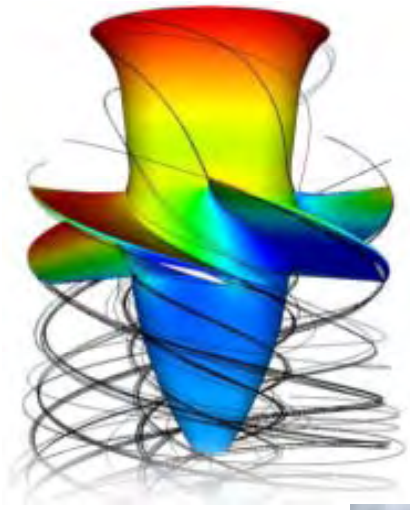
PIATTAFORMA MECCANICA E MATERIALI

Angelo O. Andrisano

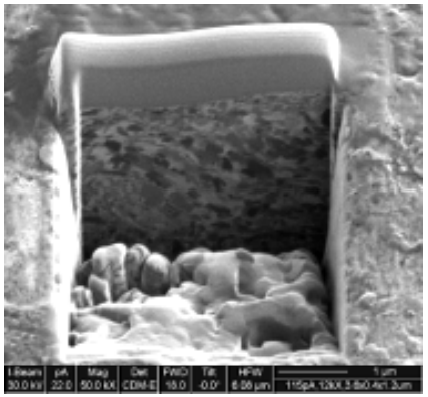
Università degli Studi di Modena e Reggio Emilia

- Piattaforma Meccanica Materiali
  - si rivolge a tutte le imprese - non solo del settore meccanico - che hanno **problematiche di ricerca industriale** connesse a:
    - ottimizzazione di prodotti e processi,
    - sviluppo e caratterizzazione di materiali altamente performanti,
    - miglioramento dell'efficienza e della produttività.
- Ambiti di intervento
  - Progettazione, prototyping e testing; processi di lavorazione e nano fabbricazione; sviluppo e caratterizzazione di nuovi materiali; trattamenti superficiali; fluidodinamica; rumore e vibrazioni; automazione: controlli e diagnostica; attuatori; sensori.
- Riferimenti
  - Responsabile scientifico
    - angelo.andrisano@unimore.it
  - Aster
    - leda.bologni@aster.it
    - elisabetta.toschi@aster.it



Fluid dynamic design of turbomachines

Integrated design and simulation of robotic workcell



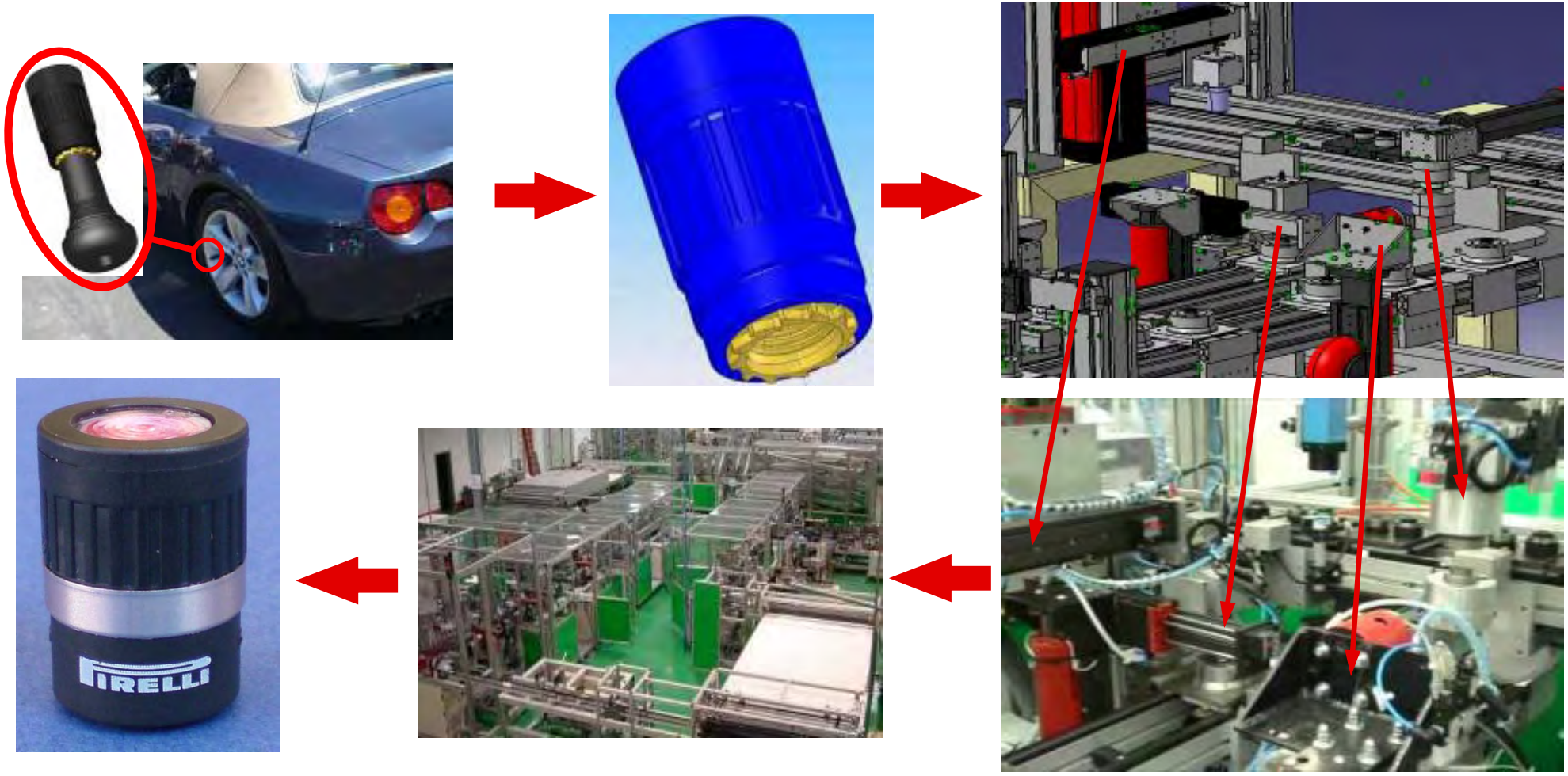
µ- wave sintering of SLS metal parts and nanostructured powders

- Meccanica - progettazione, prototyping e testing
- Meccanica, processi di lavorazione
- Meccanica - scienza dei materiali
- Meccanica - analisi rumore, vibrazioni e comfort (NVH)
- Termo-fluidodinamica - Macchine e veicoli
- Termo-fluidodinamica - Impianti e sistemi per la conversione dell'energia
- X-tronica, automazione, modelli matematici
- X-tronica, automazione, modelli logici
- X-tronica, attuatori, elettronica di controllo, elettronica di potenza
- X-tronica, attuatori idraulici
- X-tronica, sensori

http://www.aster.it

New product/process development and re-engineering

Robust Design, DFMA and Digital Manufacturing

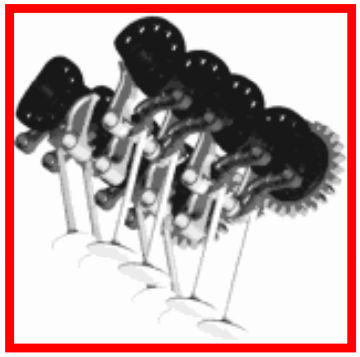


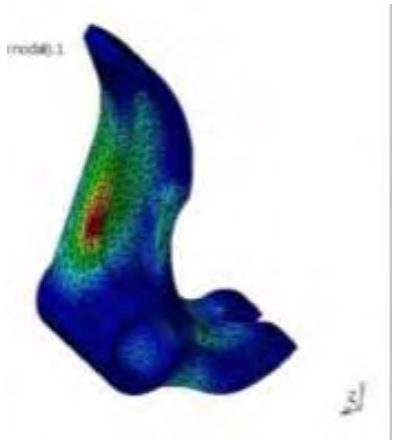
Design & Manufacturing

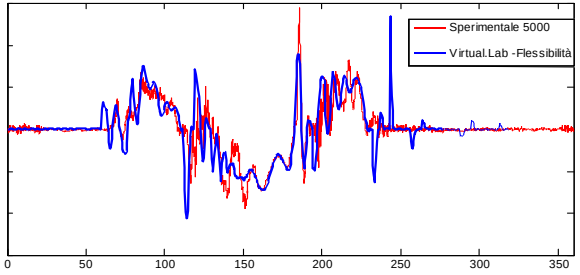
RETE ALTA TECNOLOGIA DELL'EMILIA-ROMAGNA

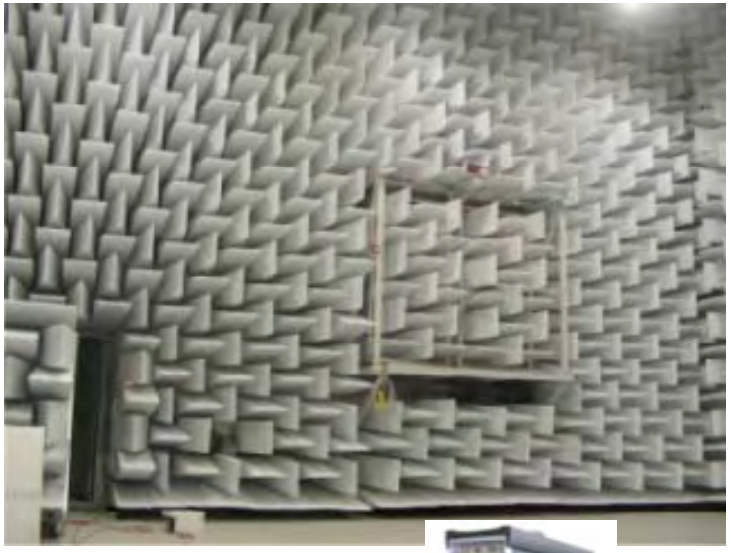
Acoustics and Vibration Area

Mechanical system modeling for vibro-acoustic optimization









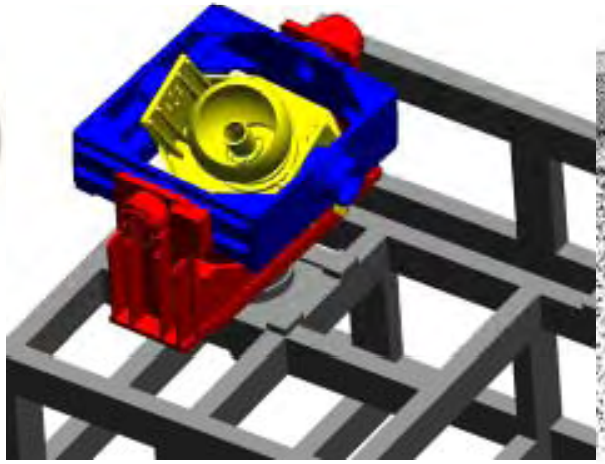
Vibration-based diagnostics and quality control

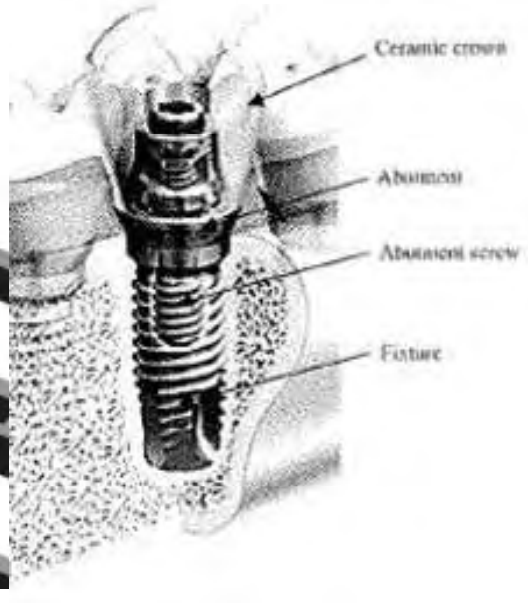
RegioneEmilia-Romagna

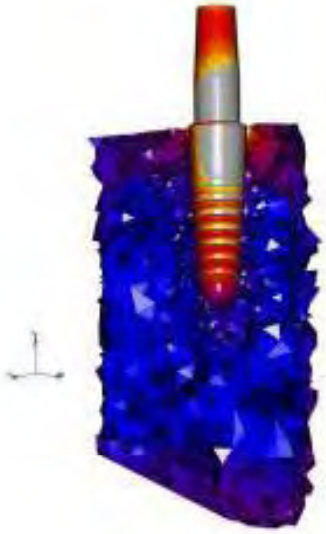
InterMech Mo.Re.

Biomechanics & implantology

- Multiple tooth replacement
- Finite element stress - strain analysis
- Hip joint wear simulation
- Development of hip joint prostheses





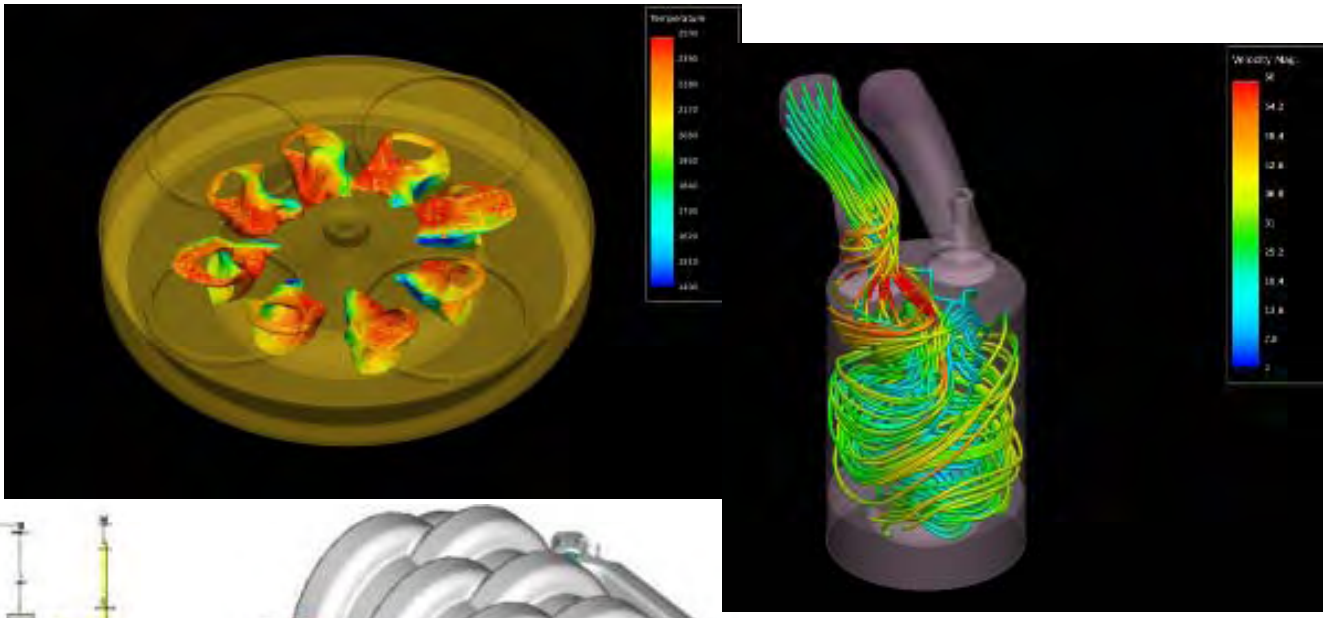


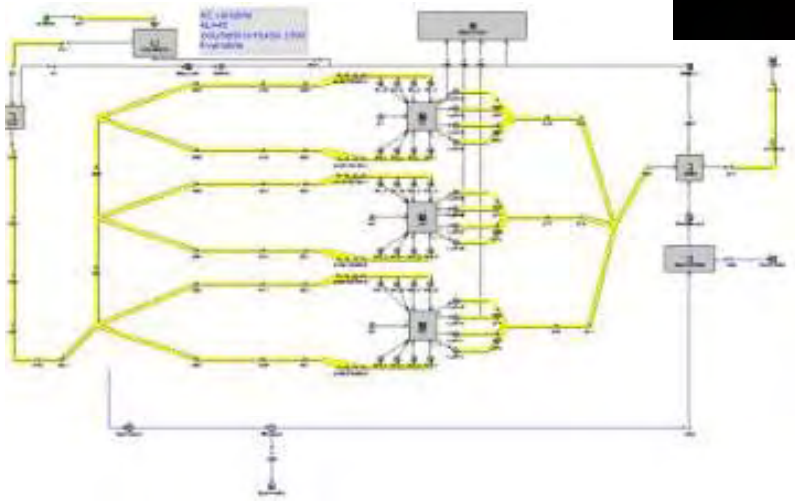
Engines & Automotive

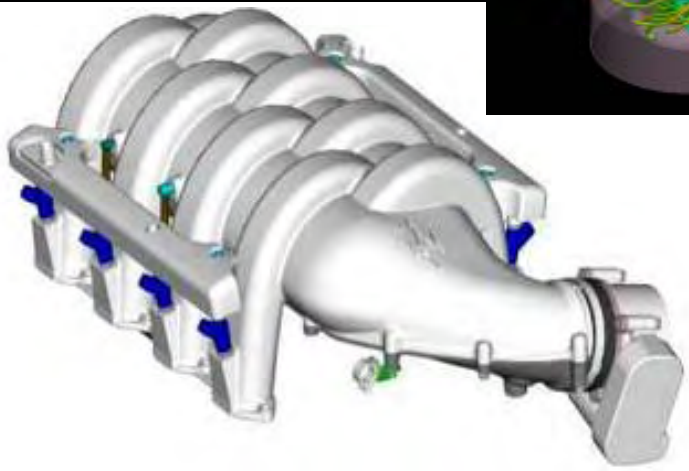
RETE ALTA TECNOLOGIA DELL'EMILIA-ROMAGNA

Engine thermofluids 1

- Full engine system analysis
- Sub-system analysis
- Combustion&turbulence
- Injection systems







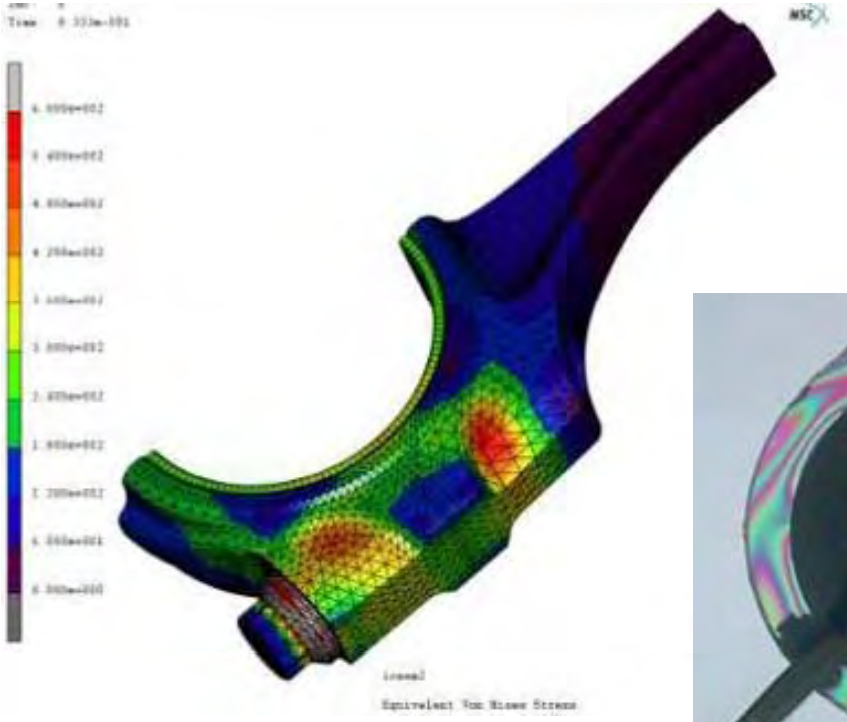
Ferrari Auto e GeS; VM Motori; Ducati; Lombardini; Alfa Romeo; Casappa; CNH
Imperial College (UK); Chalmers University of Technology (SWE)

RegioneEmilia-Romagna

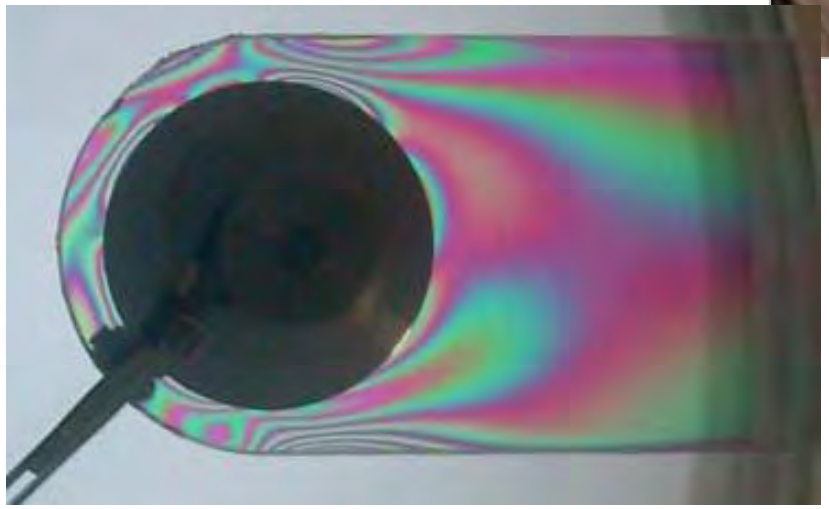
InterMech Mo.Re.

Engine components analysis and design

FEM analysis of a connecting rod. The eye is made with two parts, to allow the assembly of a monolithic crankshaft



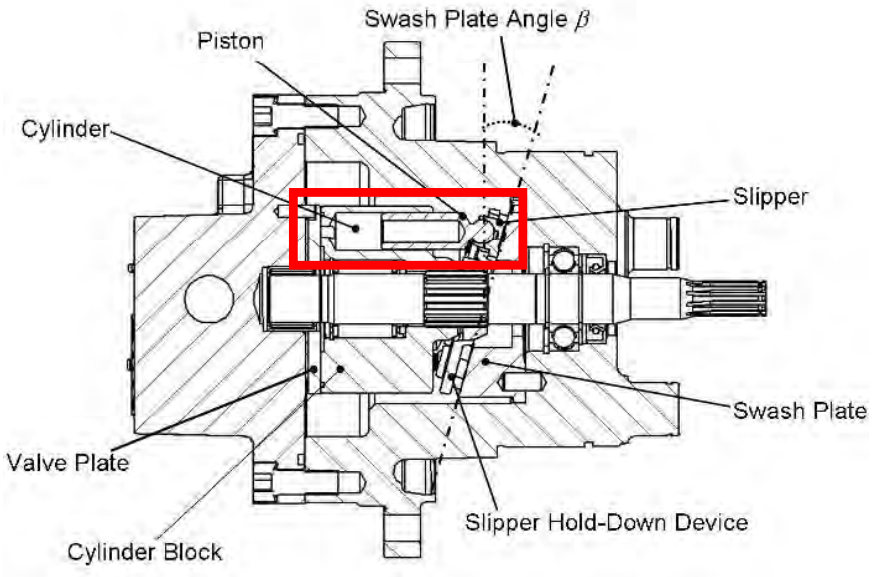
Motorbike frame, instrumented with strain gauges, for stiffness estimate

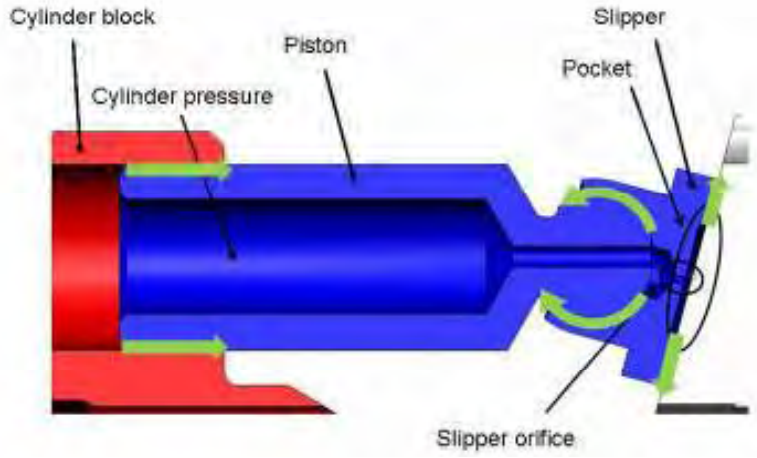


Photoelasticity: eye of a connection rod; stress concentrations occur at the bore sides

Hydraulic Components and Systems

Analysis of the lubrication mechanism within the gaps of hydraulic machines → to determine volumetric and mechanical efficiency

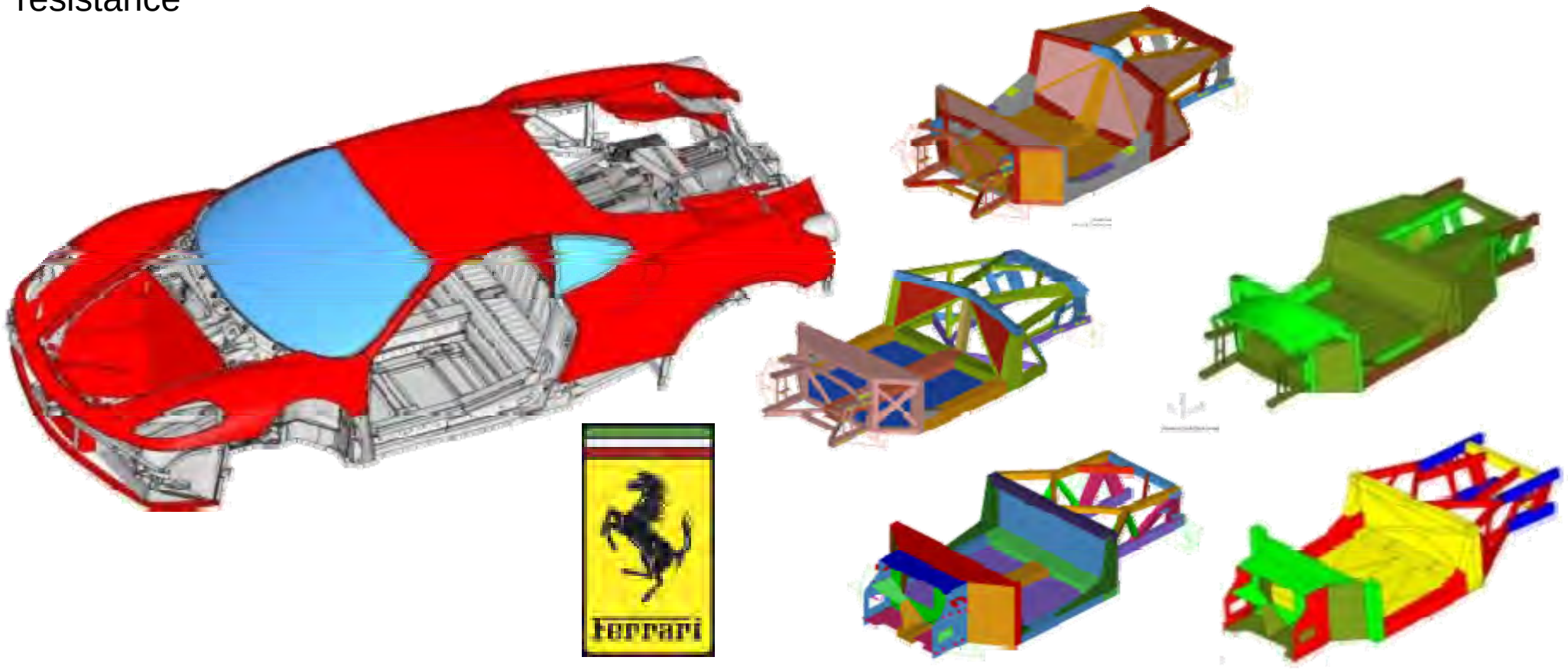




Numerical procedure to determine the gaps height, tilt and the pressure distribution in the gap → viscous forces, and leakages

Millechili Lab

In collaboration with Ferrari SpA we aim at finding new solutions for car chassis design in order to reduce the weight of the car complying with the company quality standards for the vehicle in terms of: torsional and bending stiffness, fatigue resistance, modal analysis, crash test resistance



Engines & Automotive

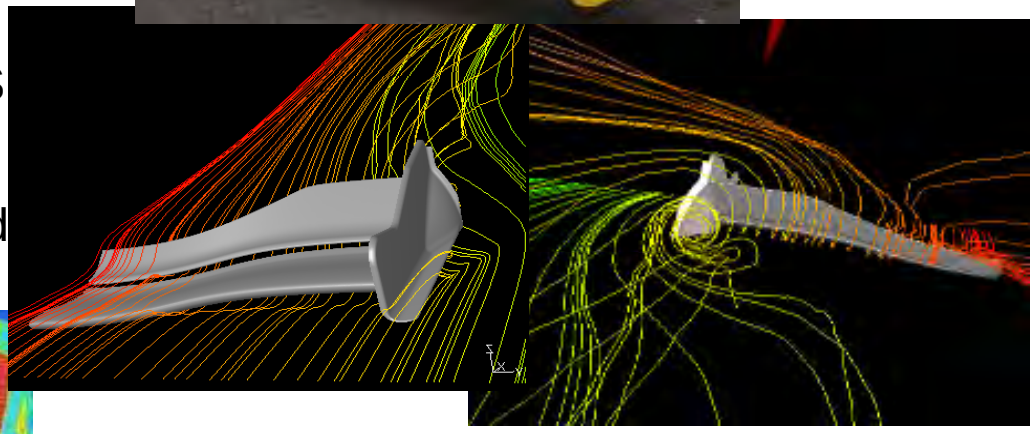
RETE ALTA TECNOLOGIA DELL'EMILIA-ROMAGNA

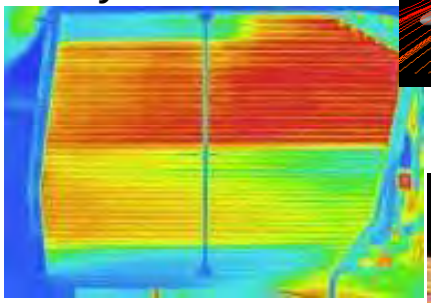
Thermofluid dynamics
Aerodynamics and Fluid Flow aspects

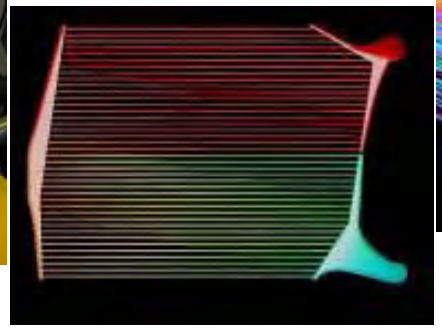
Numerical and experimental research

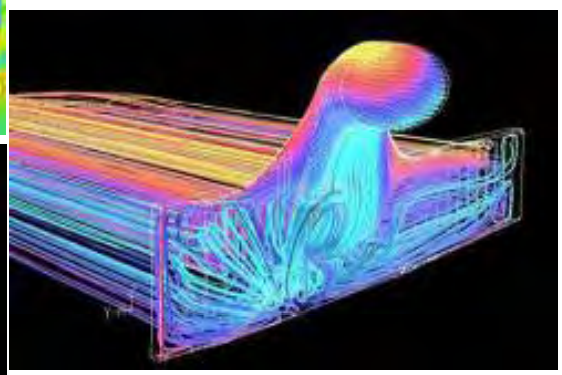
- Navier-Stokes RANS simulation of vehicle, vehicle subsystems and fluid circuits and LES aerodynamic simulation
- Time resolved High frequency Stereo PIV and conventional fluid dynamic analyses
- IR thermography studies

TATUUS F Renault front wing: CFD analysis







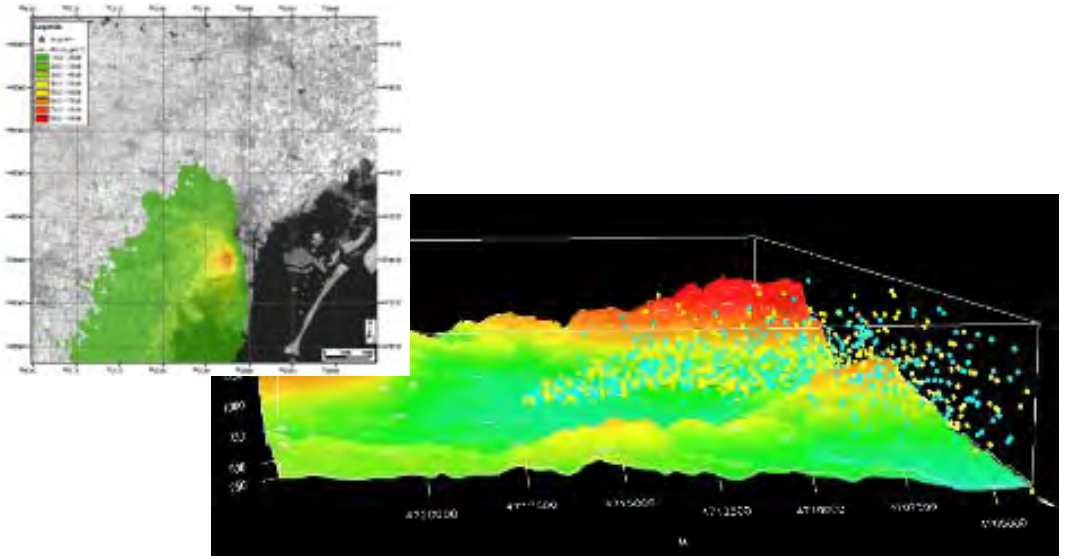


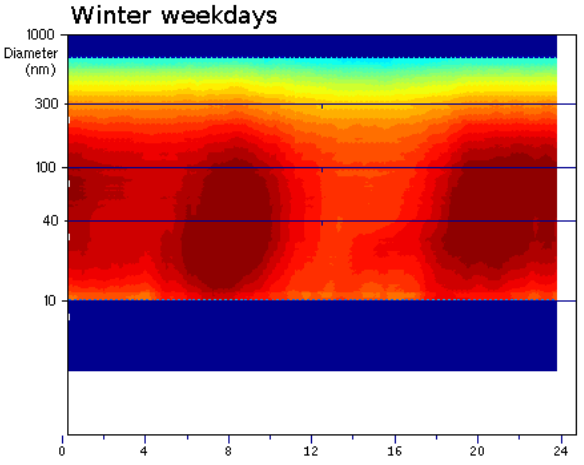
MINARDI F1 heat exchanger: IR termography and numeric simulations

RegioneEmilia-Romagna

InterMech Mo.Re.

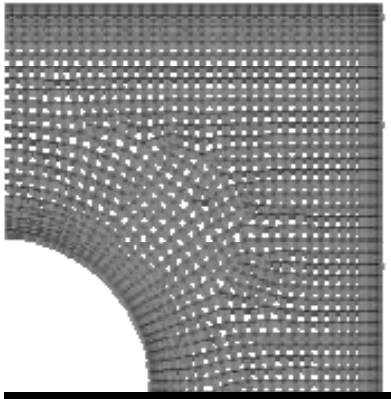
- **Atmospheric Pollution**
  - Simulation of pollutant distribution in atmosphere by means of Lagrangian dispersion models
  - Verify removal and accumulation processes, condensation of finer particles and particle generation by nucleation of gaseous components through experimental monitoring of:
    - particle mass concentration (PM1, PM2.5 and PM10), by TEOM with FDMS
    - total concentration of particles and particle size distribution, in the diameter range 10 -700 nm, by Differential Mobility Analyzer (DMA).

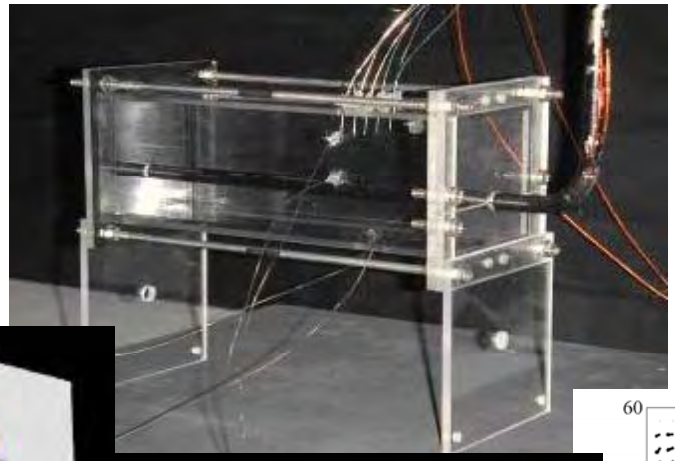


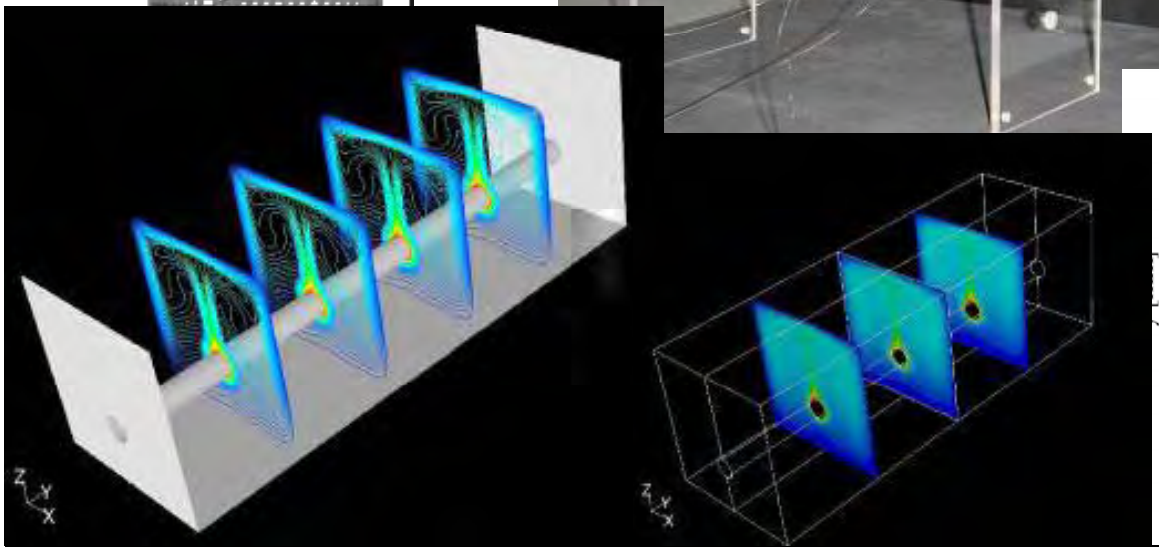


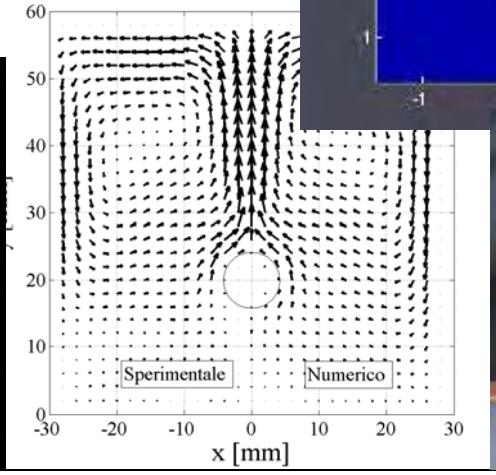
Natural Convection in enclosures

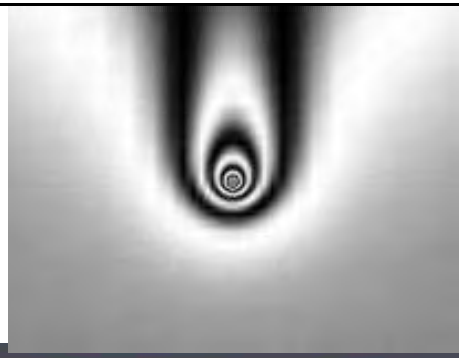
DNS simulations and PIV & UPDV measurements

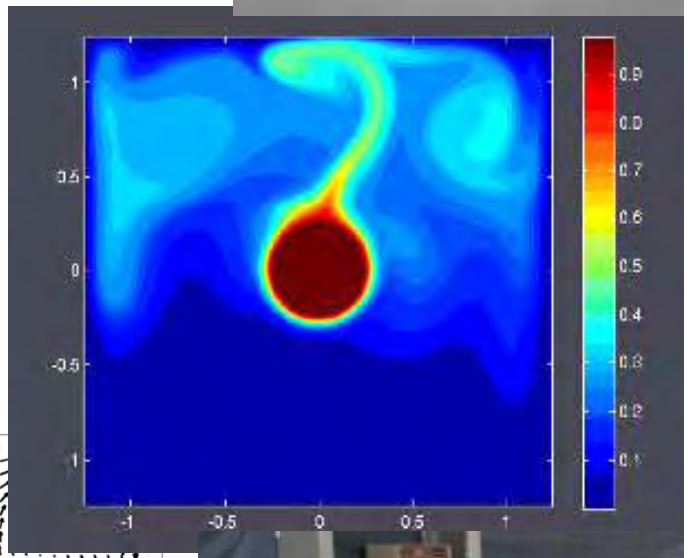


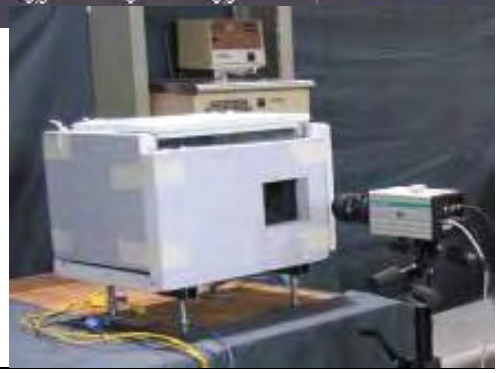






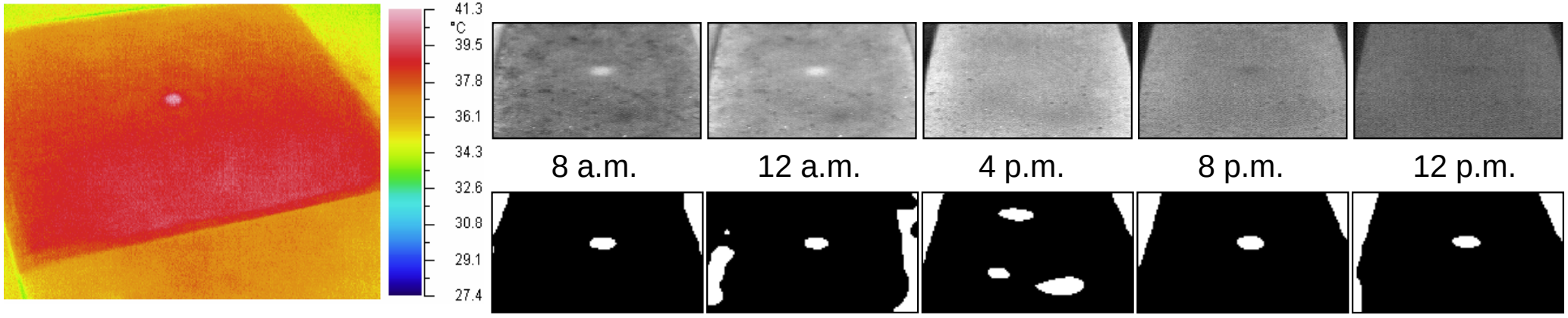






IR landmine detection

Experiments on landmine scale-models to develop data analysis and automatic detection algorithms

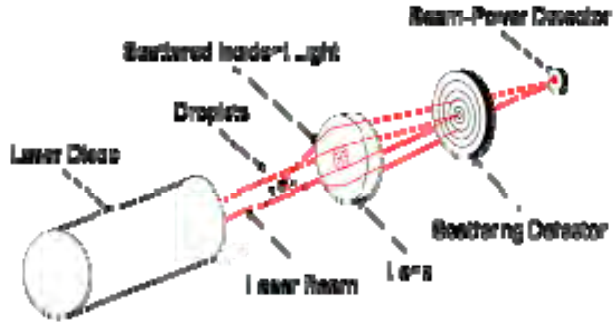


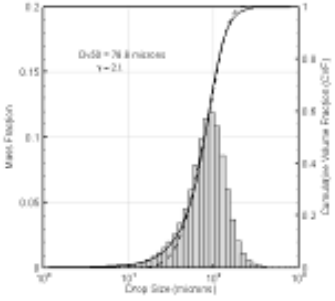
Fire Protection: Water Mist Systems

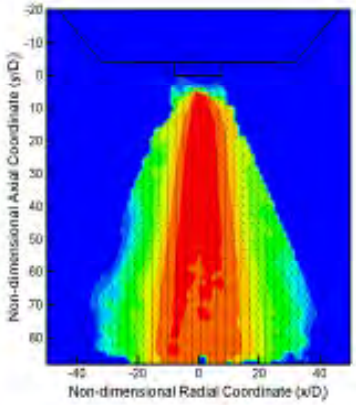
Discharge and dispersion analysis of water mist sprays

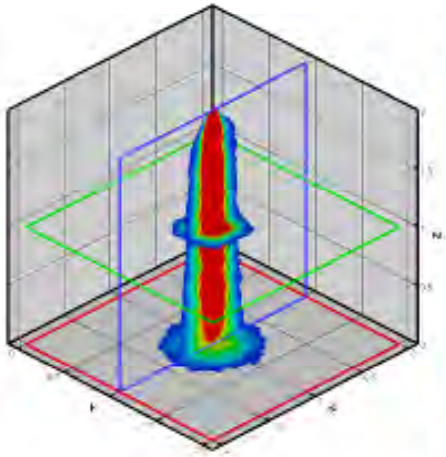
Characterization of the atomization process of a water jet exiting a high-pressure single injector :

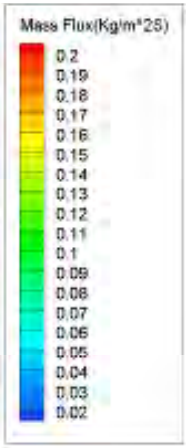
- laser-based experimental device
- data on the drop size distribution are collected by experiments at high pressure (80 bar)
- a theoretical model has been developed to predict velocity at the injector outlet
- CFD predictions by FDS code are carried out for the distribution of mass flux at different heights from the outlet



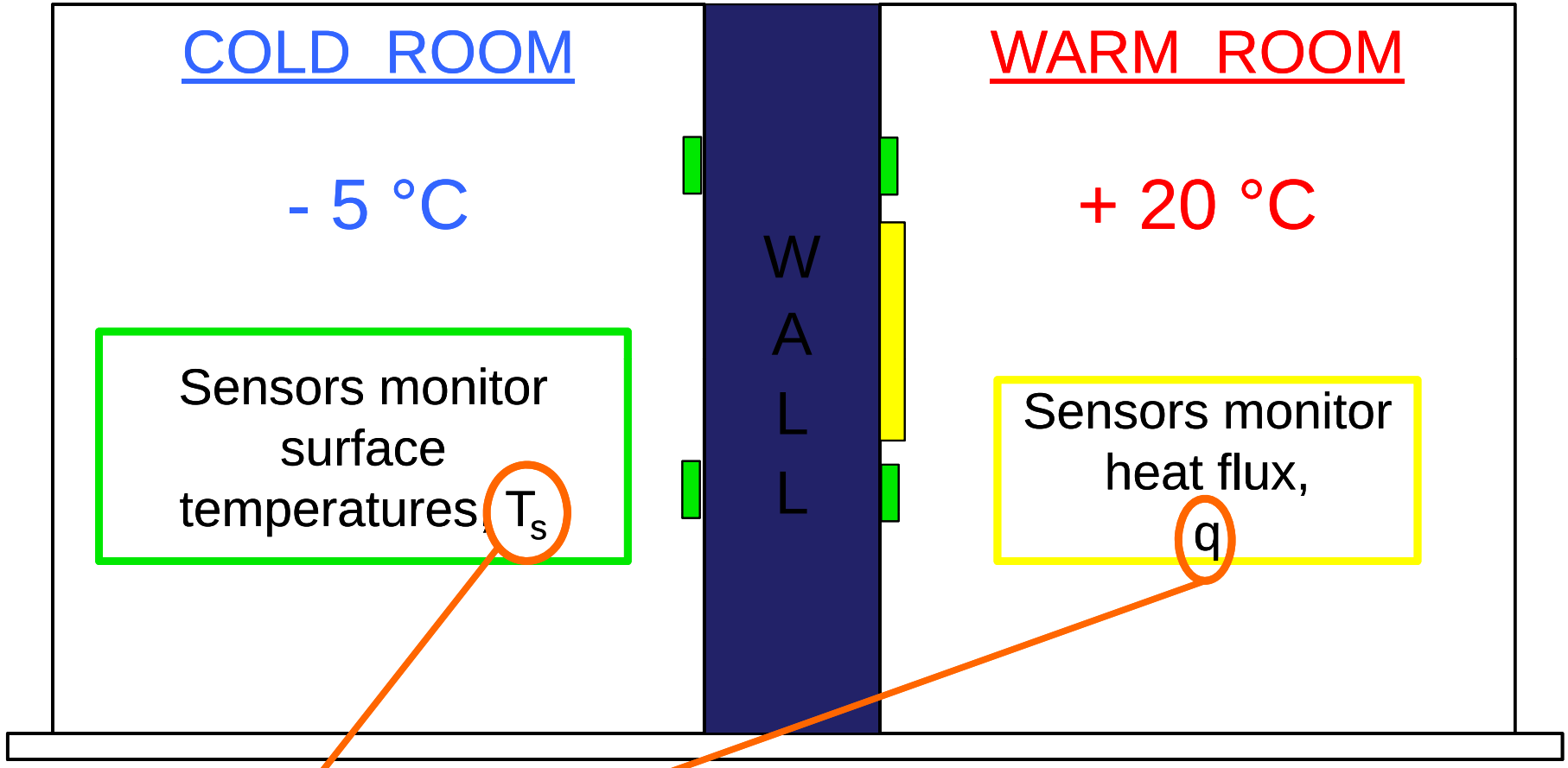








Wall U-values - Experimental Analysis

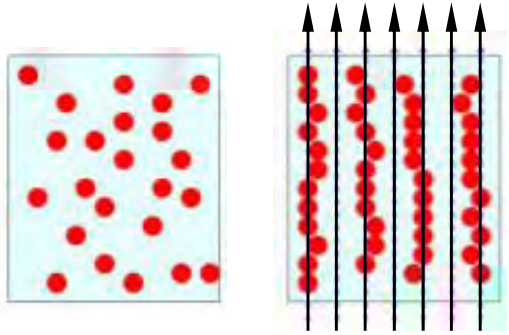


$$R_{parete} = \frac{T_{s,h} - T_{s,c}}{q} \left[\frac{m^2 \cdot K}{W}\right]$$

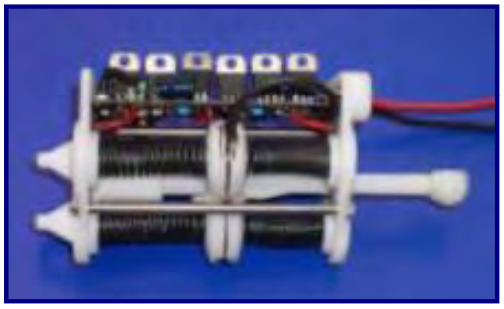
$$U = \frac{1}{R_{conv,in} + R_{cond,wall} + R_{conv,out}} \left[\frac{W}{m^2 \cdot K}\right]$$

MATERIALI MECCATRONICI

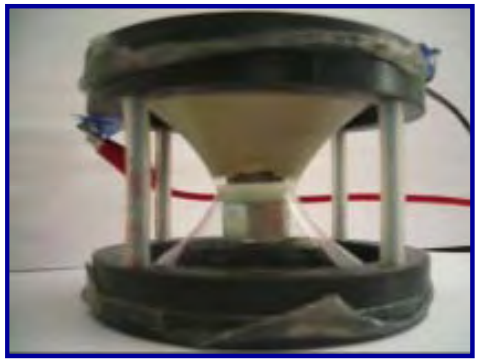
Fluidi magnetoreologici



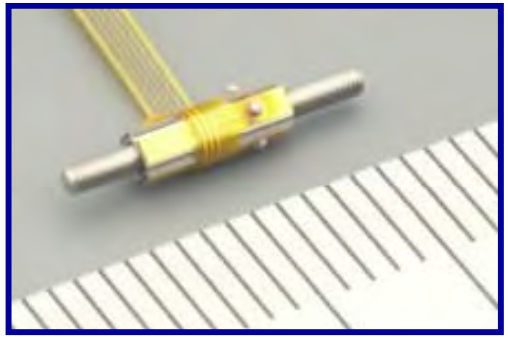
Leghe a memoria di forma



Polimeri elettroattivi

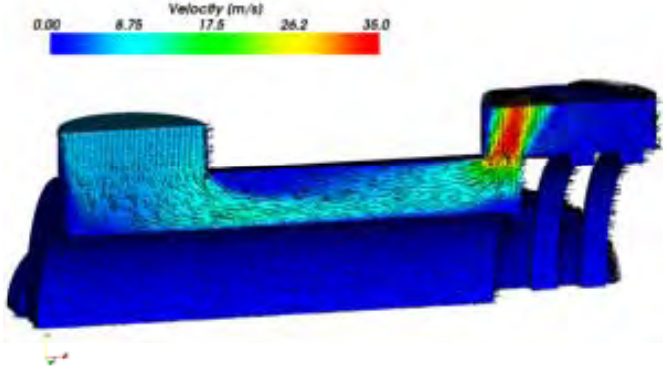


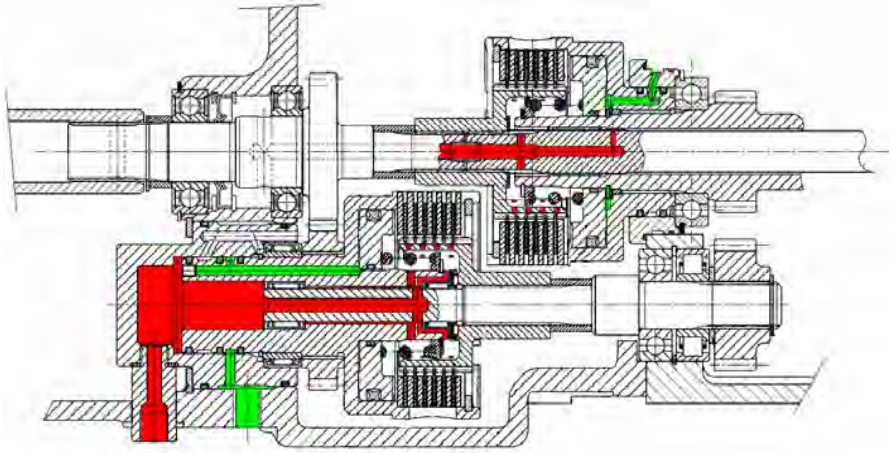
Ceramiche piezoelettriche

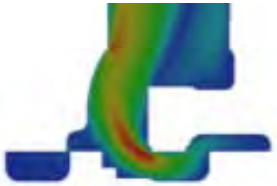


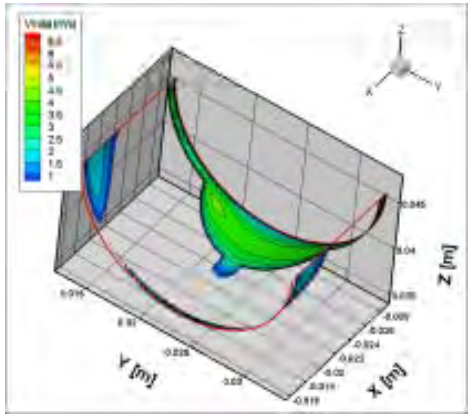
OLEOMECCATRONICA

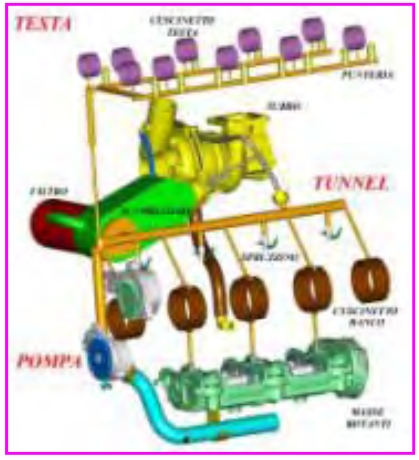
Concetto – Modello – Prototipo – Collaudo











Materials

RETE ALTA TECNOLOGIA DELL'EMILIA-ROMAGNA

Materials Engineering

Inertization, recovery and valorization of inorganic wastes and biomass and engineering of the valorization and recovery systems.

Formulation and production of ceramics, glasses, glass-ceramics, bricks, composites, cement and pigments starting from residues and wastes (ashes from incinerator plants, ceramics sludges, glass cullet, wastes from electrical and electronic equipments, wastes from agroindustrial field...) alternative and/or competitive to products on the market.

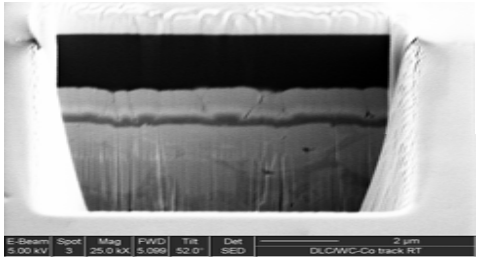
RegioneEmilia-Romagna

InterMech Mo.Re.

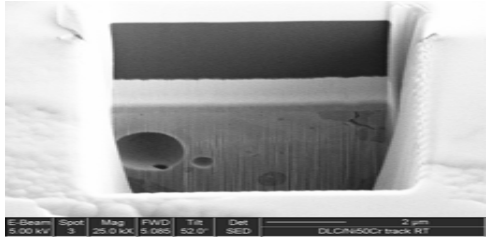
RETE ALTA TECNOLOGIA DELL'EMILIA-ROMAGNA

- Attività
  - Rivestimenti e trattamenti superficiali alla micro-nano scala
  - Ingegnerizzazione di rivestimenti alla macro-micro scala
    - Modifica delle proprietà tribologiche attraverso l'impiego di metodologie di "texturing" superficiale, combinazione di "texturing" e ricoprimenti superficiali.
    - Ottimizzazione dei parametri di deposizione di rivestimenti decorativo-funzionali.

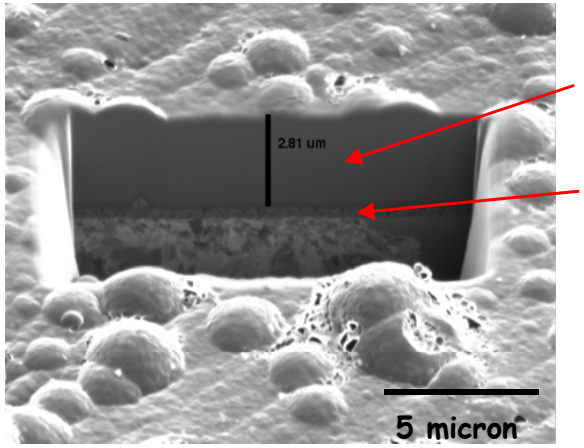
Messa a punto di opportuni multistrati, delle tecniche di analisi (cross-section) e di caratterizzazione



DLC (magn.sputt-2.5 um)/**WC-Co** (magn.sputt-1.5 um)/***Cr*** (flash-buffer layer)/**WC-Co** (termospruzzato-200 um)/**acciaio C40** bulk



DLC (magn.sputt-2.5 um)/**WC-Co** (magn.sputt-1.5 um)/**Cr** (flash-buffer layer)/**Ni50Cr** (termospruzzato-200 um)/**acciaio C40** bulk

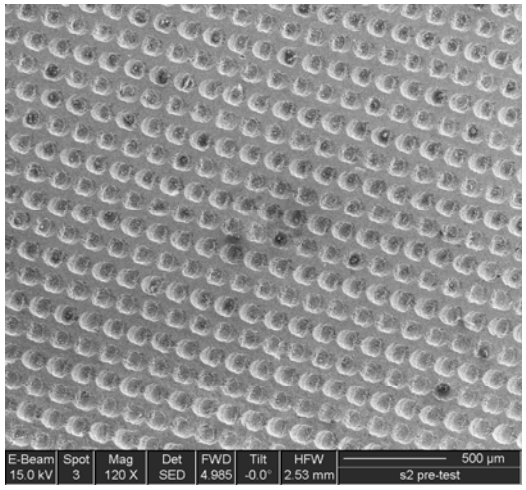


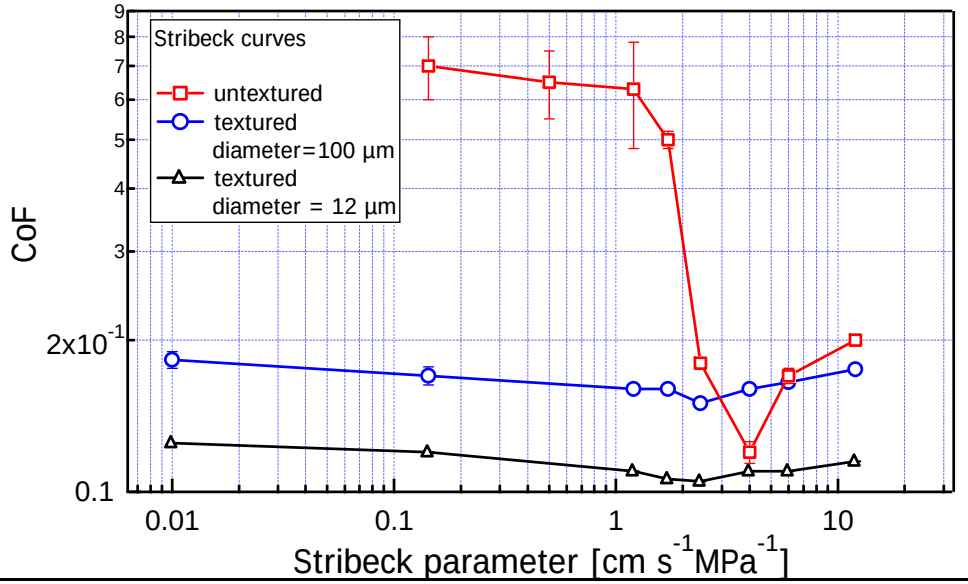
DLC con buffer layer di Nitruri

Sviluppo di rivestimenti e trattamenti a base Carbonio per elevate prestazioni tribologiche, estetiche ed anticorrosive

RETE ALTA TECNOLOGIA DELL'EMILIA-ROMAGNA

- Attività
  - **Proprietà meccaniche dei materiali e fenomeni di attrito ed usura alla multiscala**
    - Comprensione dei regimi di attrito e adesione nei contatti a singola e multi-asperità;
    - Definizione di modelli predittivi per lo studio delle proprietà macroscopiche;
    - Analisi degli effetti di scala sulle proprietà meccaniche dei materiali;
    - Miglioramento della risposta tribologica di superfici attraverso texturing e funzionalizzazione.





motoriduttore

RegioneEmilia-Romagna

InterMech Mo.Re.

GRAZIE PER L'ATTENZIONE

Angelo.andrisano@unimore.it