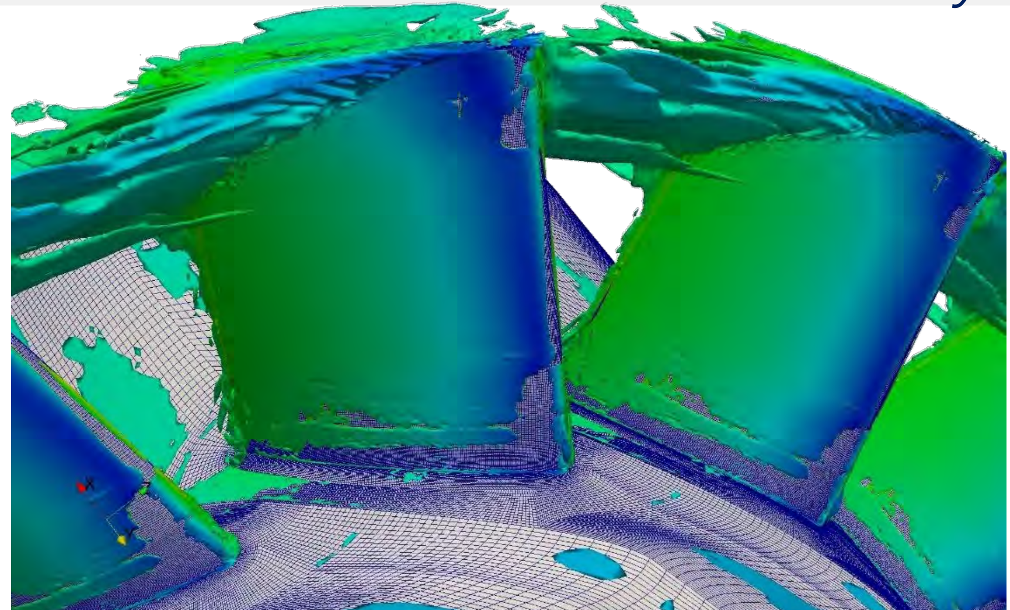
Team



Research Assistant & PostDoc
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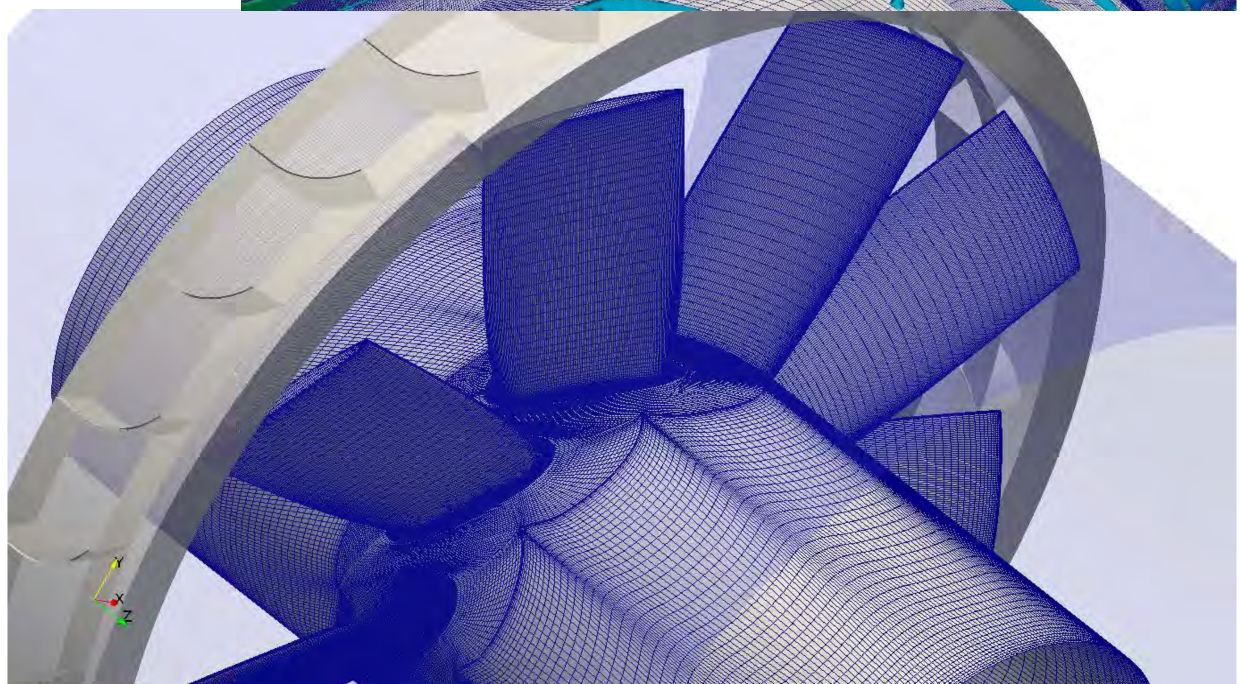
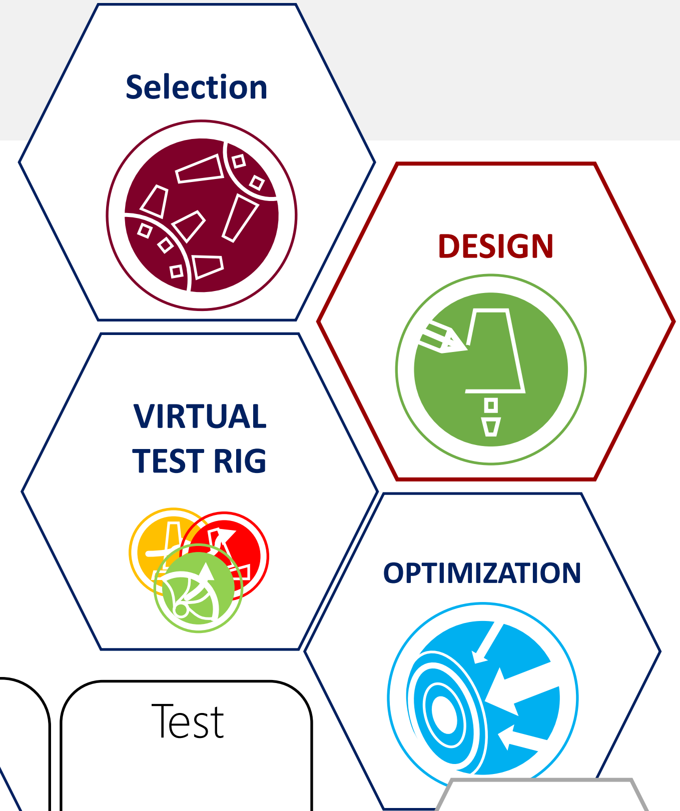
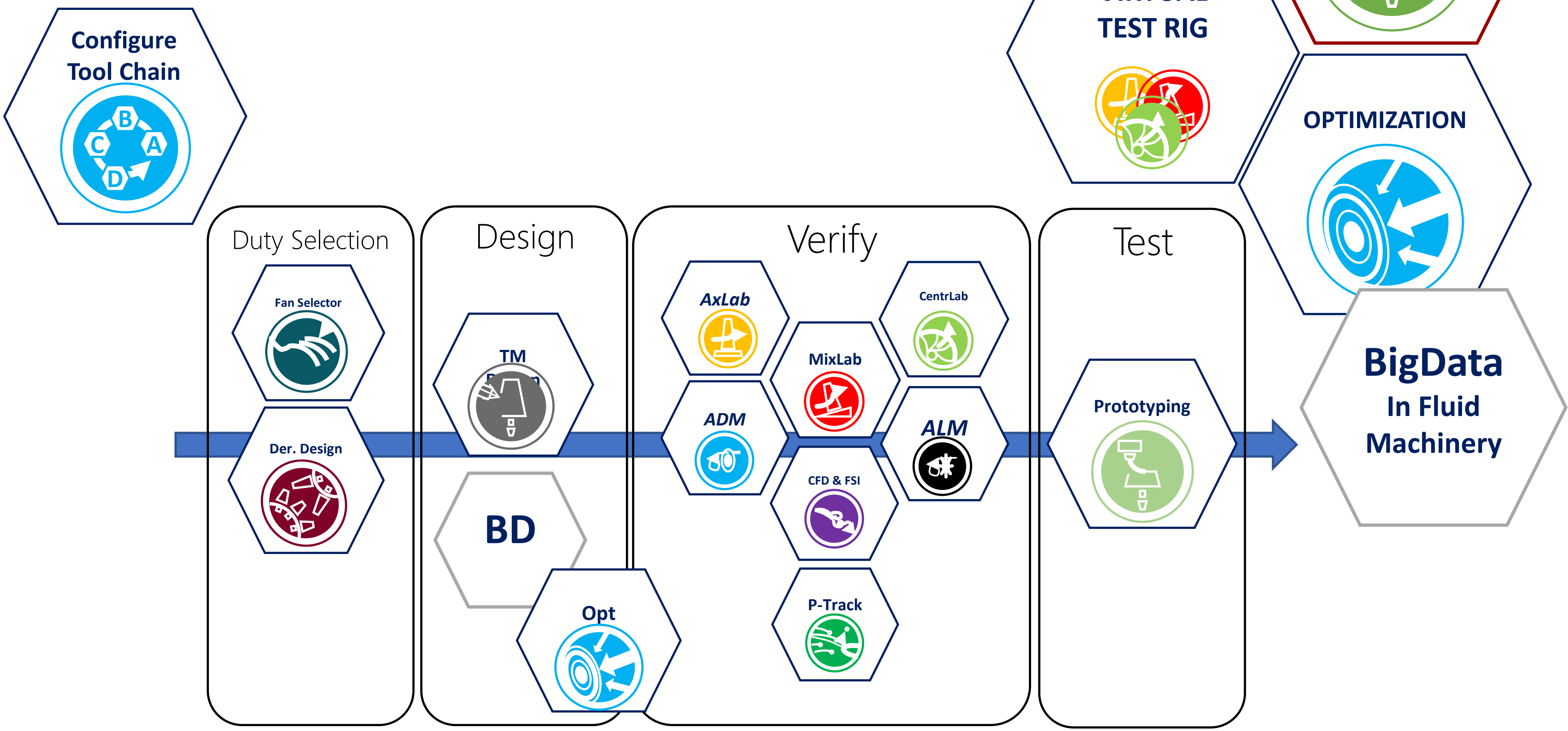
Ph.D. students
Tommaso Bonanni,
Lorenzo Tieghi, Gino Angelini



Fluid Machinery R&D Environment



Smart environment is configured in order to give the user the possibility to customize the experience selecting tools optimizing time and accuracy.



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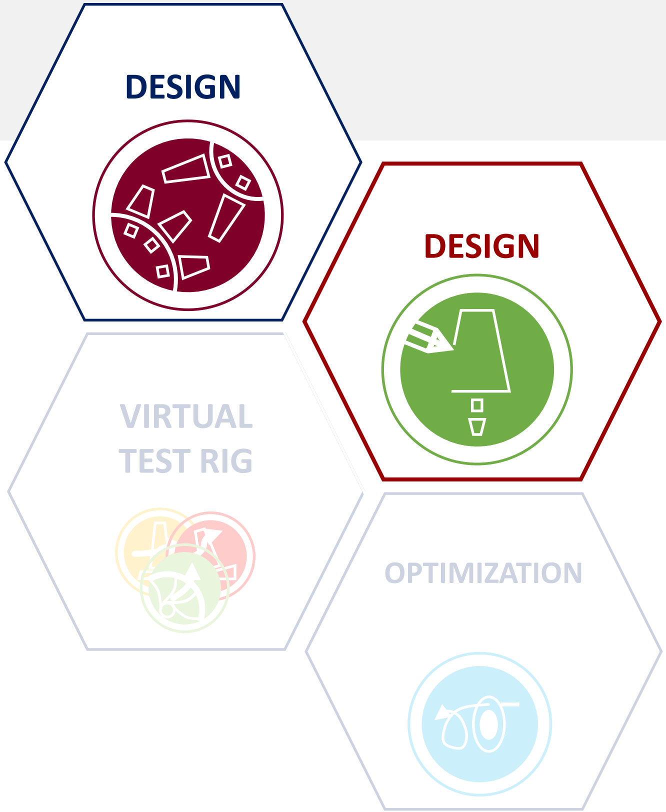
Integrated tool for industrial design of turbomachinery blades



- Develepod in Python, based on an axisymmetric solution of the indirect problem.
- Designed to be Multi-Platform and Expandable.
- It allows to test innovative design solutions.
- Save, Export, Share and Compare different Designs.

SED
Soluzioni per l'Energia e la Diagnostica

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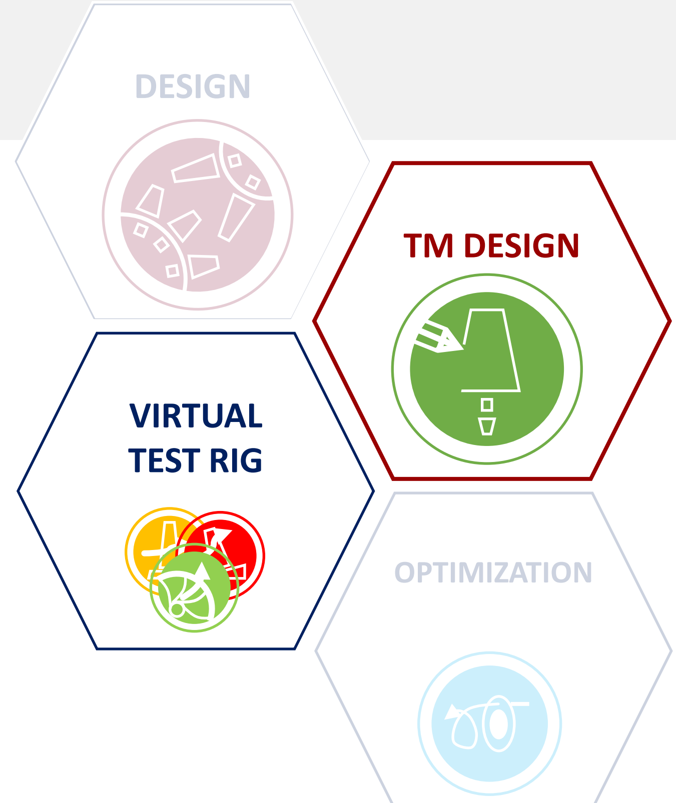
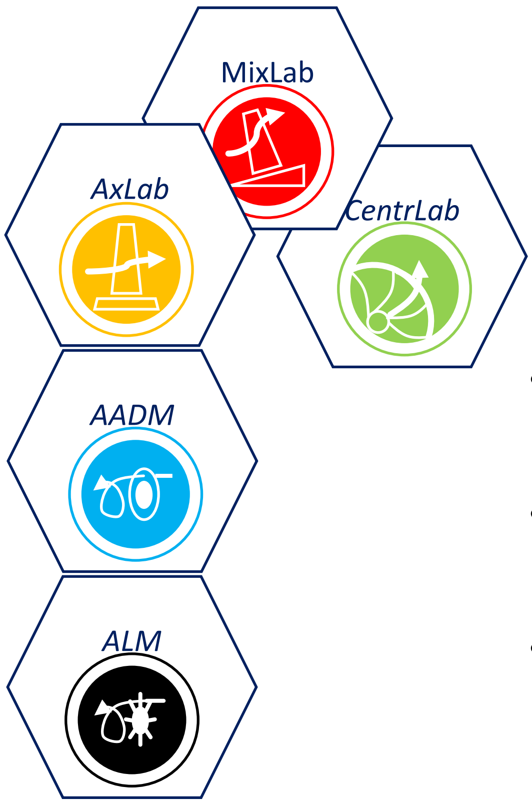
VIRTUAL TEST RIG



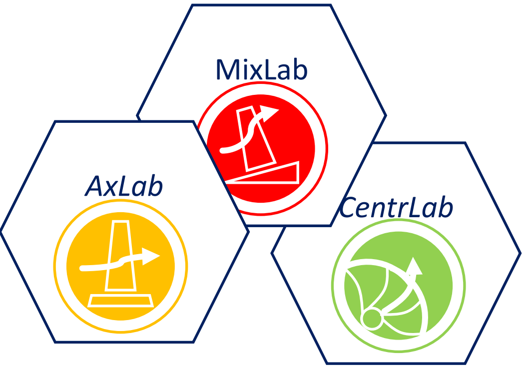
The **virtual test rig** consists of different analysis tools:

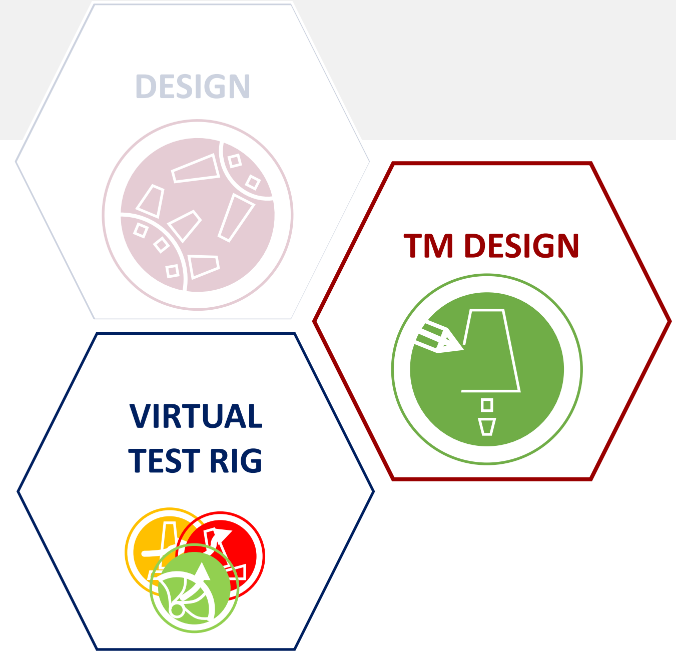
- Reduced Order Solvers: AxLab, MixLab, CentrLab
- Actuator Disk Model
- Actuator Line Model
- Ljungstrom Heat Exchanger



- Each tool is designed for performance analysis on different level; from a quasi-3D steady state approach to transient problems.
- Set of instruments for fan performance analysis in order to simplify fans performance prediction.
- Designed both for axial and centrifugal machinery

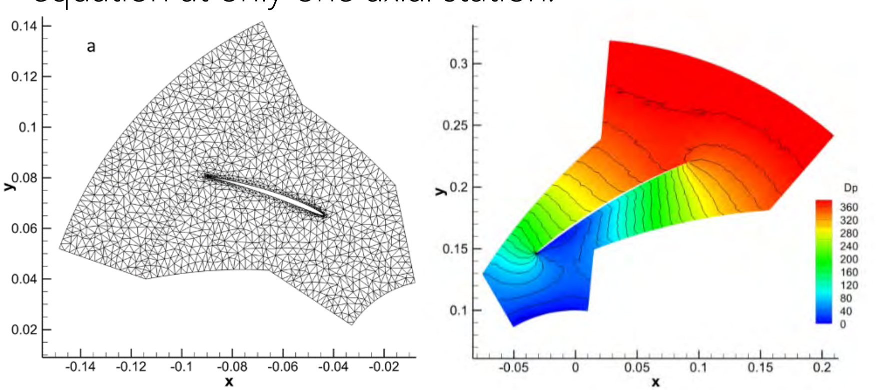
Reduced Order Solvers: AxLab – MixLab





AxLab and **MixLab** software are python programs for performance analysis of ducted axial or mixed-flow fans.

- Based on a blade element axisymmetric principle whereby the rotor blade is divided into a number of streamlines.
- For each streamline, relations for velocity and pressure are derived from incompressible conservation laws for mass, tangential momentum and energy.
- Produce dependable results with small computing costs requiring solution of a simplified radial equilibrium equation at only one axial station.



CentrLab software is a python program centrifugal fans performance analysis.

- Based on the blade-to-blade analysis of a two-dimensional inviscid flow
- Continuity and vorticity equation in cylindrical coordinates are reduced to the blade-to-blade equation by defining a stream function Ψ
- Equation solved on a unstructured grid can be easily automated through well-known algorithms of triangulation

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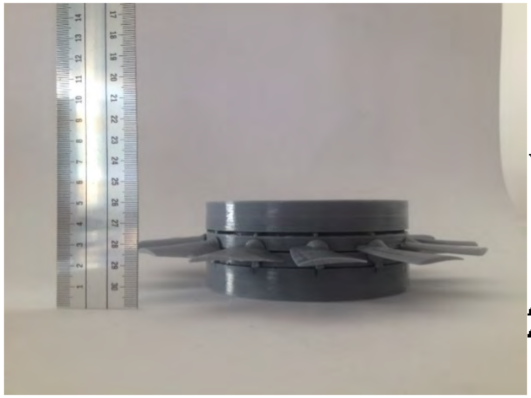
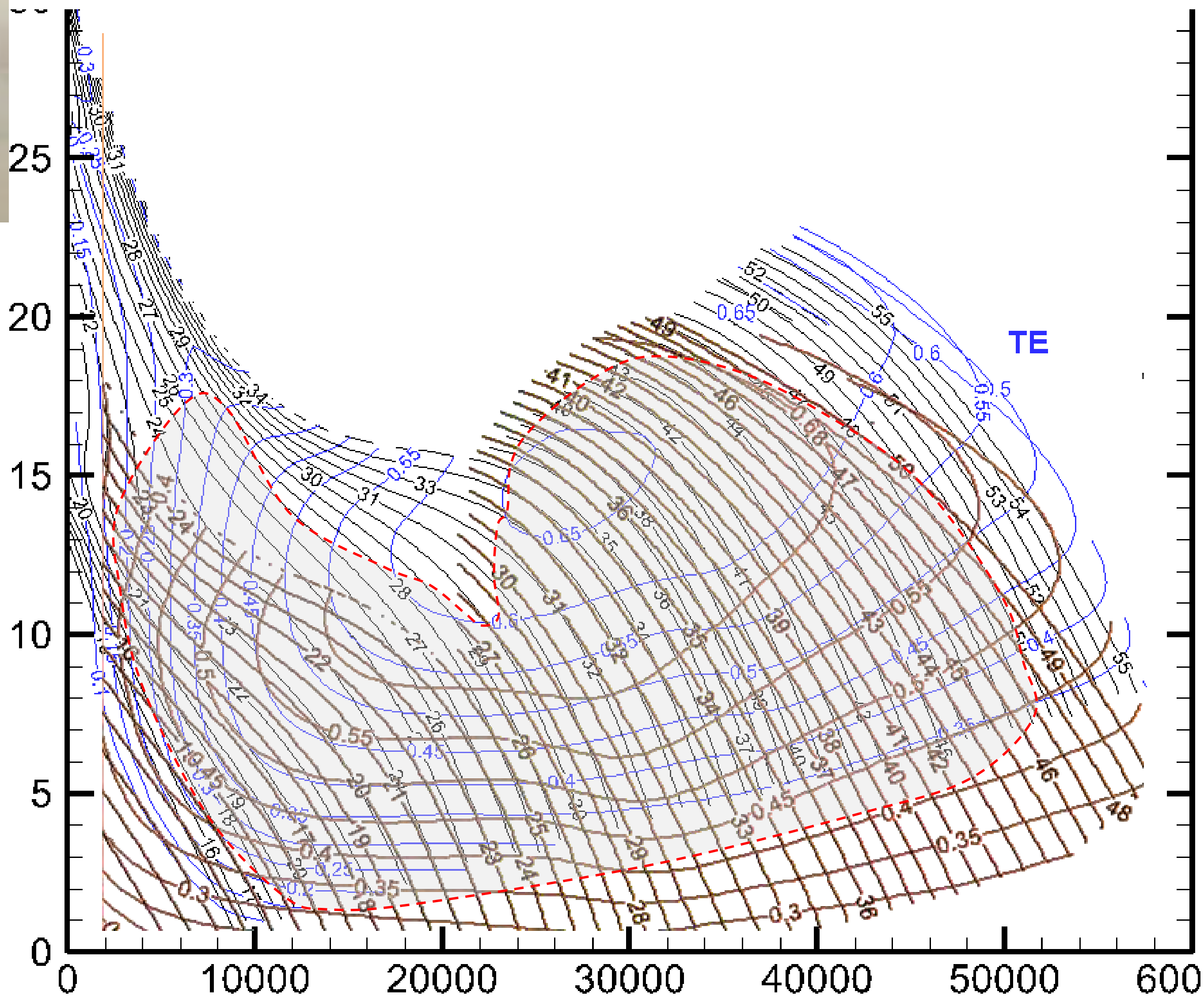
- Re-design of High-pressure combustion fan





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AERODYNAMIC DESIGN OF AGRICULTURAL SPRAYERS UNIT

DIMA

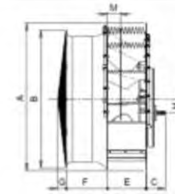
Blade Inverse design

CFD verification of perfomance & FEA

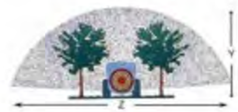
Fieni

Industrialization and

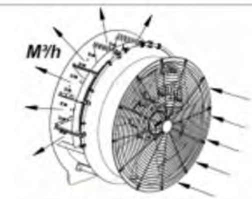
lab tests



A	B	C	E	F	G	H	M	Kg
1280 mm	1190 mm	163 mm	330 mm	354 mm	75 mm	121 mm	109 mm	188

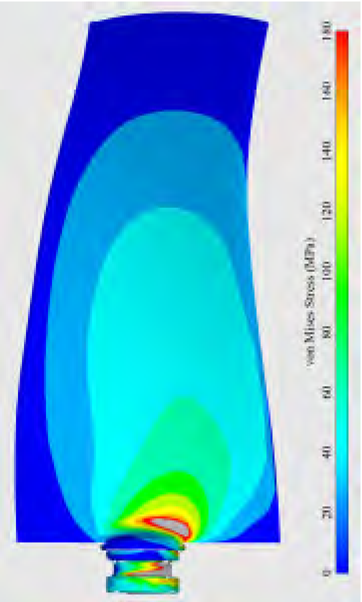


Y	Z	HP	Lt.
12 m	25 m	>=95	>=3000



Art.	Ø (mm)	Ø (")	N	∡	RPM	M3/h	HP Flusso
VNF1060	1060	41.73	9	64° 72° 80°	1780 1780 1780	84696 99929 108618	35,38 50,08 70,23

fieni
Gruppi ventola per atomizzatori



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DESIGN OF A FAN FOR A SNOW GUN

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fieni
Gruppi ventola per atomizzatori

D800 vs D800+

	P [kW]	Z_{rot}	dBA	normalised weight of rotor blade
D800	18.5	12	84.8	1
D800^{+}	17.4	6	83.2	0.6
Δ	-1.1	-50%	-1.6 dBA	-40%

Power requirements of the D800+ blade was 1,1kW lower than D800

Number of blades was halved and an overall 40% of weight reduction was achieved

1.6 dBA reduction of noise was achieved

fieni

Gruppi ventola per atomizzatori

me

fieni® SPRAYER UNITS

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SYNTETIC METHODS

CFD & FSI

NUMERICAL RECIPIES

Models for devices in ventilation systems

- ADM and ALM for axial flow fans (see other slides)
- Rotating heat exchangers
    - collaboration with ENEL
- Gravity dampers and fire shutters
    - collaboration with GE Oil & GAS

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ACTUATOR DISK MODEL

AADM

DESIGN

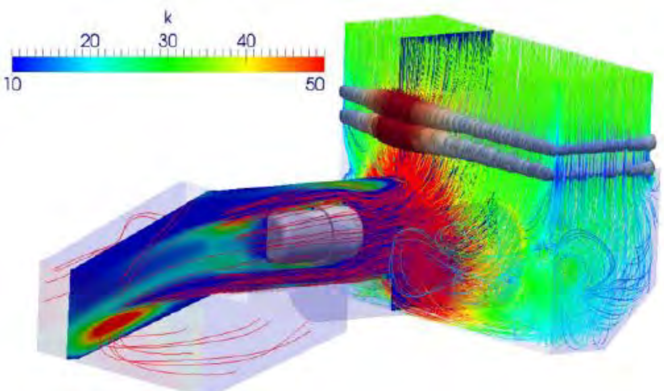
TM DESIGN

VIRTUAL TEST RIG

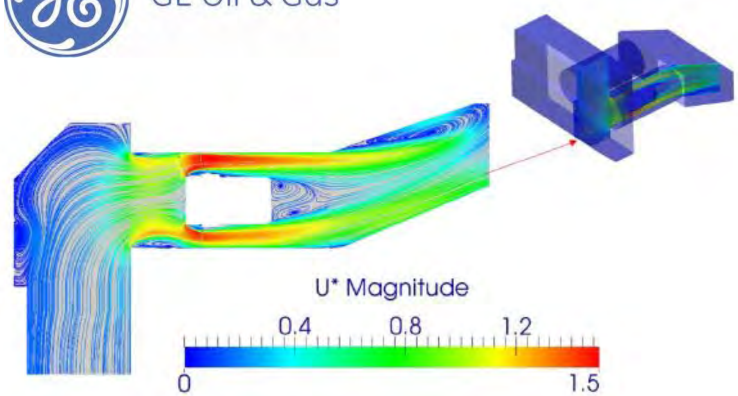
OPTIMIZATION

The **Actuator Disk Model** is implemented in Open Foam (C++ language) and allows a synthetic rotor simulation

- We have developed and validated a Advanced Actuator Disk Model for industrial turbomachinery performance prediction in complex industrial system layouts
- Limitations of AADM: able to reproduce only the average behavior of the fan within the ventilation system, without giving information on the unsteady flow field



GE Oil & Gas



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LJUNGSTROM HEAT EXCHANGER

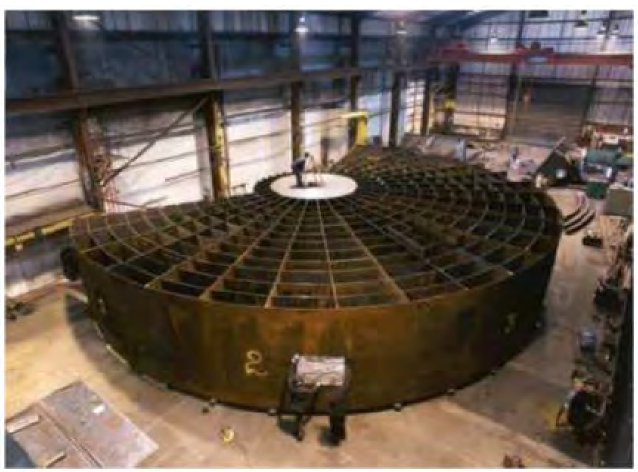
A **Ljungstrom** heat exchanger is used in thermal power plant to preheat the primary air with the exhaust gasses of the combustion process

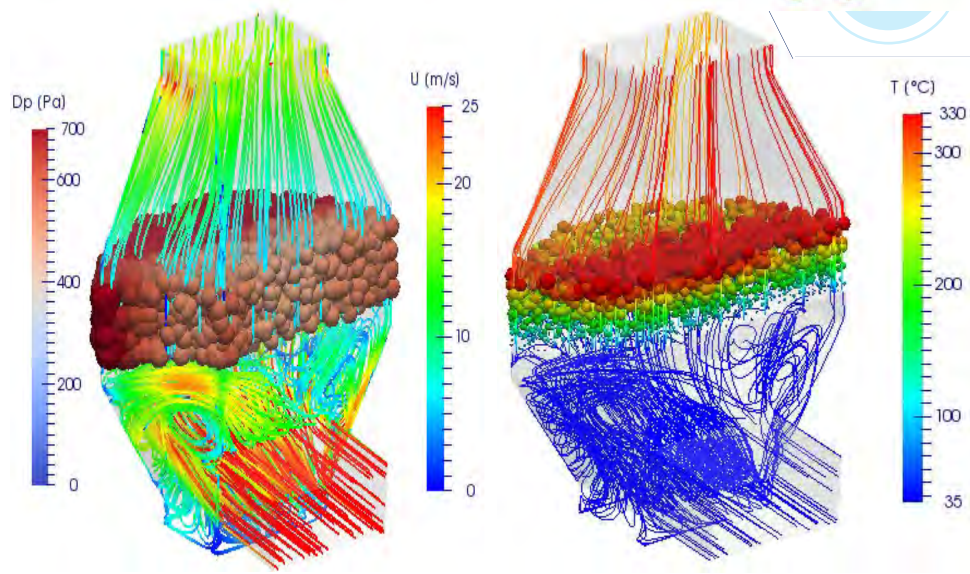
To reproduce the effect of the Ljungstrom heat exchanger on the fluid, a synthetic model has been implemented in OpenFOAM (C++)

The operating principle of the device is dicretized by:

- A porous mean, modelling the fluid pressure drop
- A source term, added in the temperature equation, modeling the complex heat exchange mechanism

Modelization and coefficients have been derived from experiments and empirical formulations from literature-





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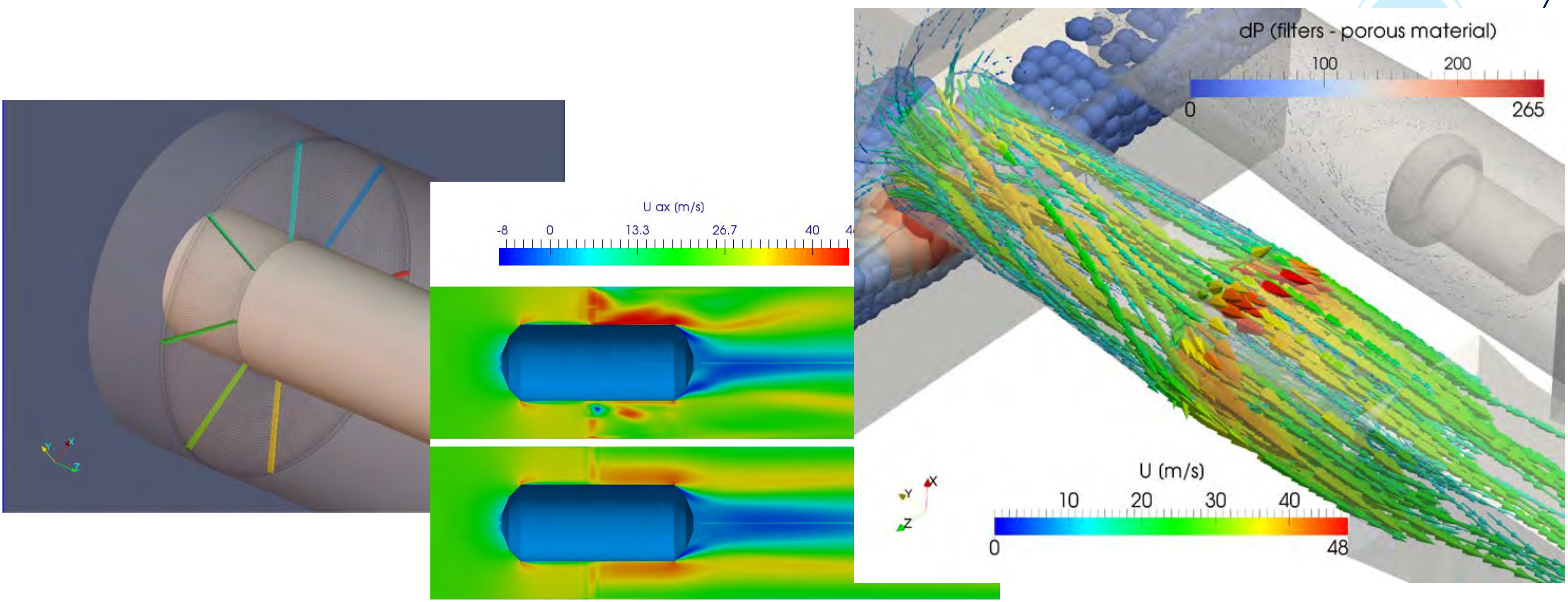
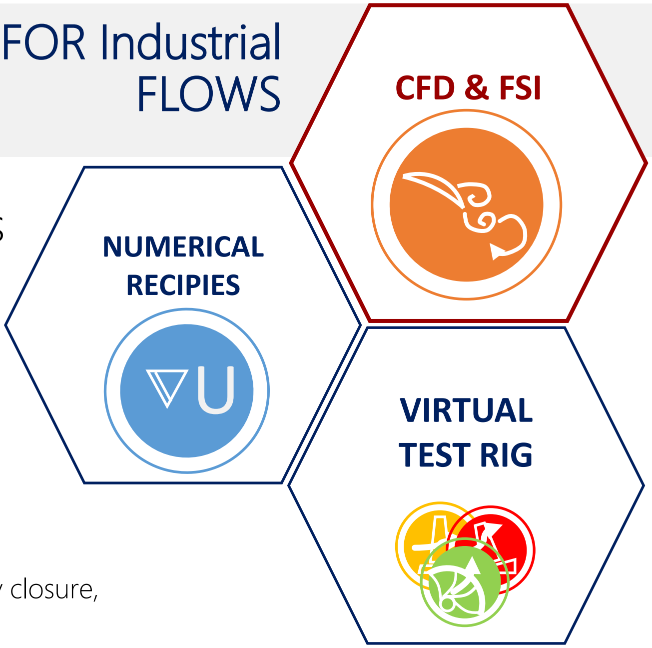
ACTUATOR LINE MODEL

The **Actuator Line Model** is implemented in Open Foam (C++ language) allows a synthetic rotor simulation

- Created to overcome the limitations of AADM : blades are physically reproduced in the computational geometry assigning force source terms only to some cells
- This kind of approach can be used CFD environment that can be based on any kind of unsteady approach (URANS, LES, hybrid LES/RANS, DNS) providing unsteady system effect on the behavior of the fan





Advanced URANS modelling based on recovery of Reynolds stress anisotropy implemented and validated in X^{++} and OF:

- cubic k-ε model
- ζ-f model

(Selected) papers

A Corsini, F. Rispoli. Flow analyses in a high-pressure axial ventilation fan with a non-linear eddy-viscosity closure, International Journal of Heat and Fluid Flow

G. Delibra, D. Borello, K. Hanjalić, F. Rispoli, URANS of flow and endwall heat transfer in a pinned passage relevant to gas-turbine blade cooling, International Journal of Heat and Fluid Flow

Hybrid LES/RANS models implemented and validated in X^{++} and OF and applied to TM flows

- ζ-f model
- No-model LES based on DCDD discontinuity capturing operator

(Selected) papers

L. Cardillo, A. Corsini , G. Delibra, F. Rispoli, T. E. Tezduyar, Flow Analysis of a Wave-Energy Air Turbine with the SUPG/PSPG Method and DCDD, Advances in Computational Fluid-Structure Interaction and Flow Simulation, 2016

G. Delibra, D. Borello, K. Hanjalić, F. Rispoli, Vortex structures and heat transfer in a wall-bounded pin matrix: LES with a RANS wall-treatment, International Journal of Heat and Fluid Flow 2010

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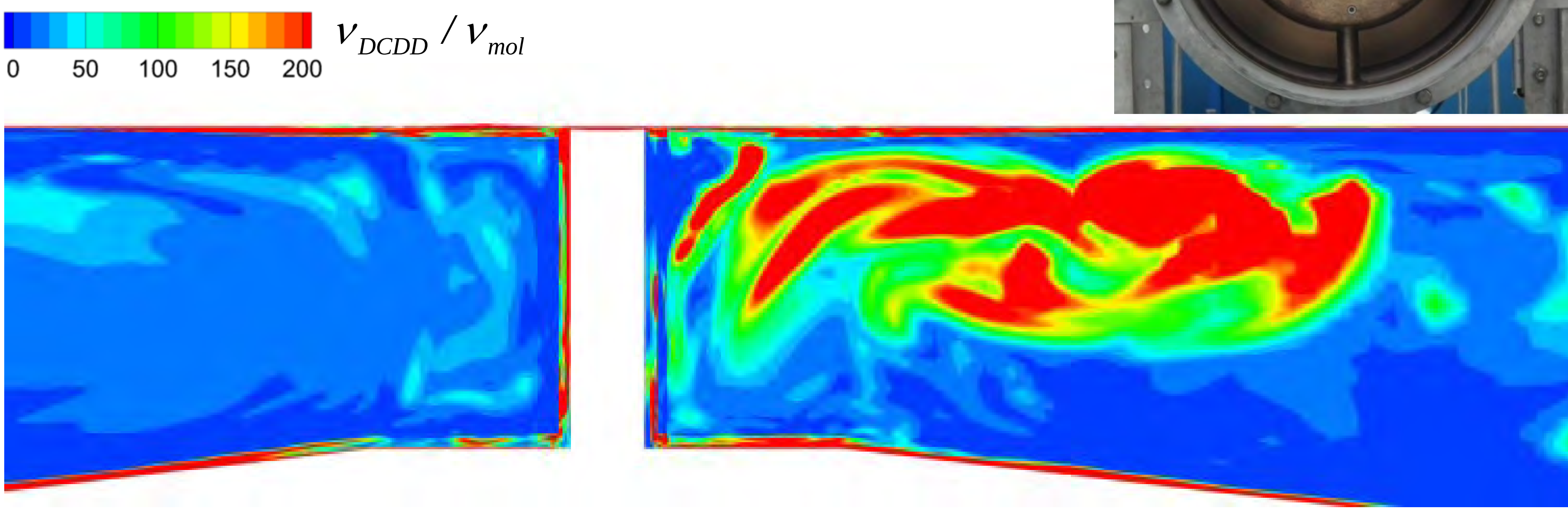
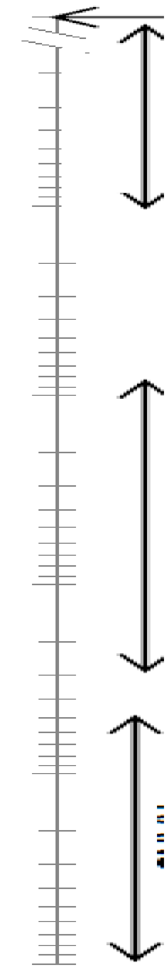
DCDD inner working

POSEIDONE consortium

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

DIMA_FP Wells Turbine 1.5 kW





LES mesh approx 100 M elements

DCDD mesh 3.5 M elements

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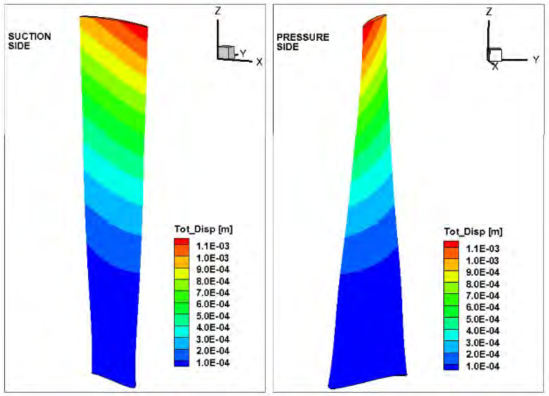
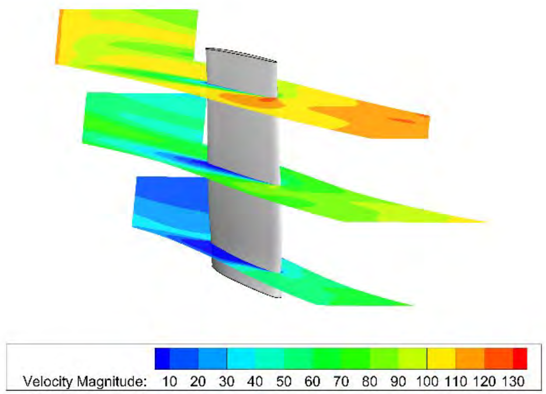
CAE tool development for FSI applications on rotating blades

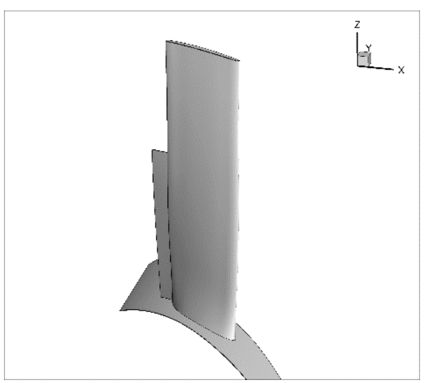
Direct FSI study on FAN blades: improvement in numerical testing capabilities for virtual prototyping

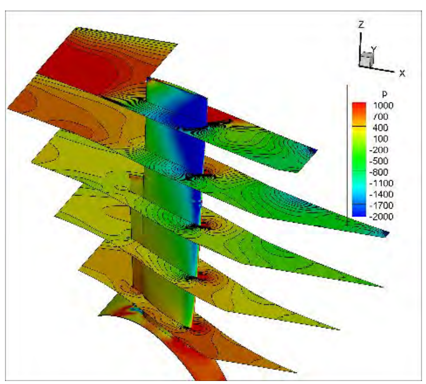


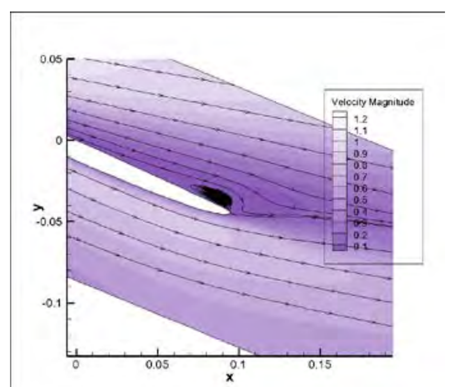


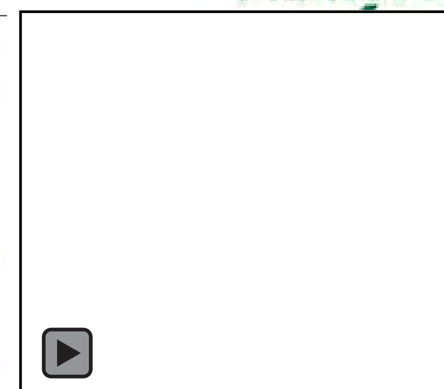
Castorrini et al. Fluid-structure interaction study of large and light axial fan blade, Proceedings of ASME TurboExpo 2017

Passive morphing control Numerical testing of new concepts for passive flow control









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Castorrini, A., et al. Numerical Study on the Passive Control of the Aeroelastic Response in Large Axial Fans. Proceedings of ASME TurboExpo 2016
Castorrini et al., Numerical testing of a trailing edge passive morphing control for large axial fan blades, Proceedings of ASME TurboExpo 2017

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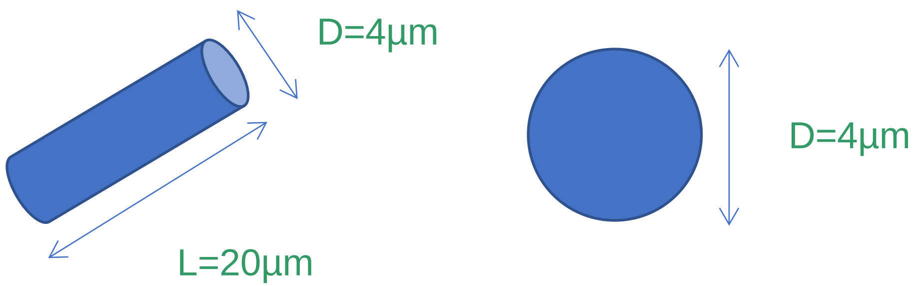
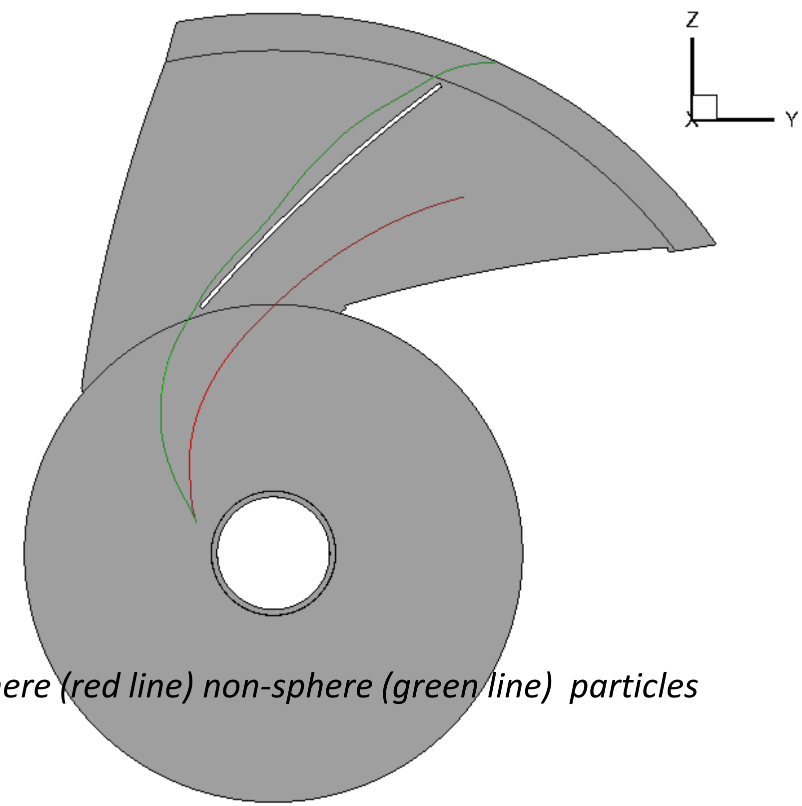
Results, *particle impact on fan blades – non-spherical*

Simulated particles

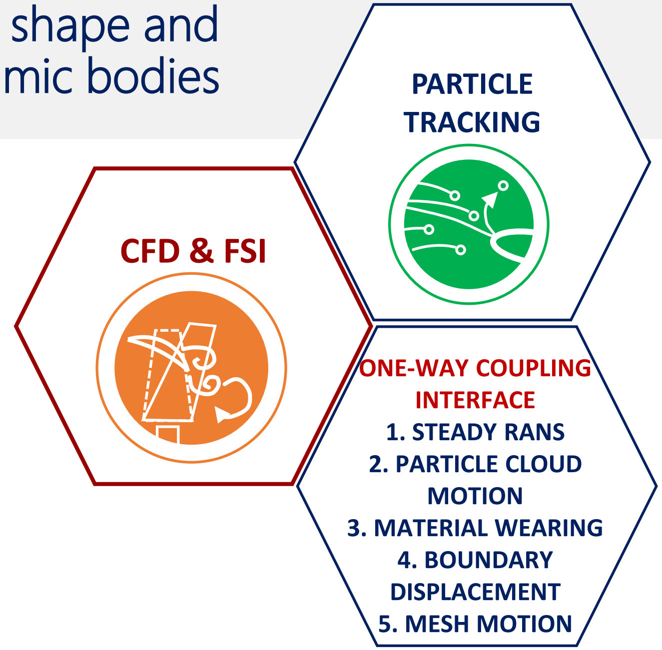




sphere (red line) non-sphere (green line) particles

Howden

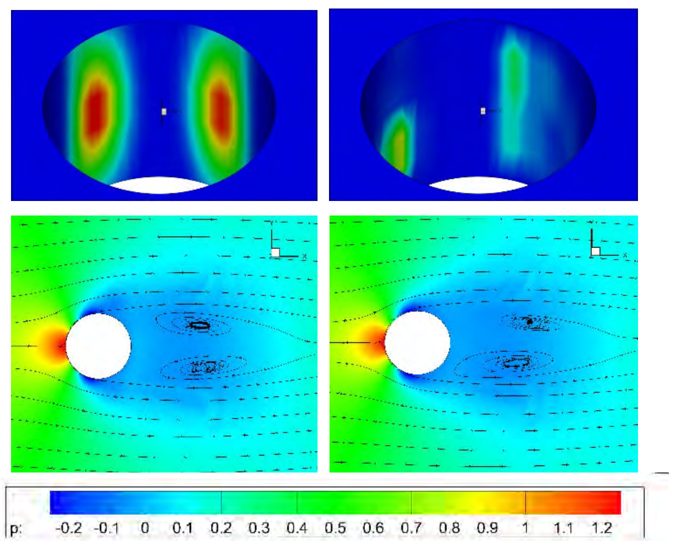
Prediction of erosion/deposit effect on shape and performance of aerodynamic bodies



Material wearing on turbomachinery blades can produce after years of working, a change in the aerodynamic shape of the profile.

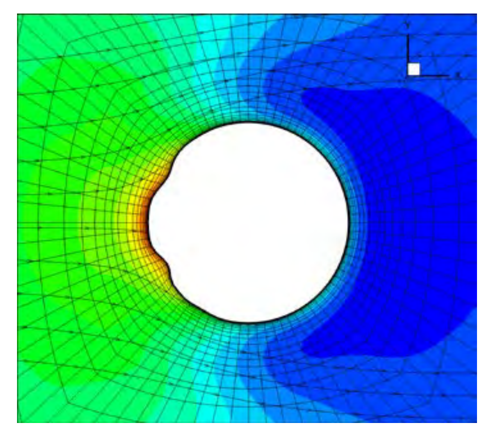
The capability to predict the **performance degradation** during the design phase can be of great help to plan the maintenance interventions

Normalized erosion patterns (Blue: no erosion, 0; red: 1) and aerodynamic field (pressure and streamlines) on the first iteration and at the end of the process



As example, taking a metal cylinder immersed in a flow transporting coal ash particles, we can see that after 16 months of operation the eroded shape brings to a change in flow field symmetry and thus to a change of the expected aerodynamic behavior

Presentation example (magnified)



Castorrini et al., Numerical simulation with adaptive boundary method for predicting time evolution of erosion processes, Proceedings of ASME TurboExpo 2017

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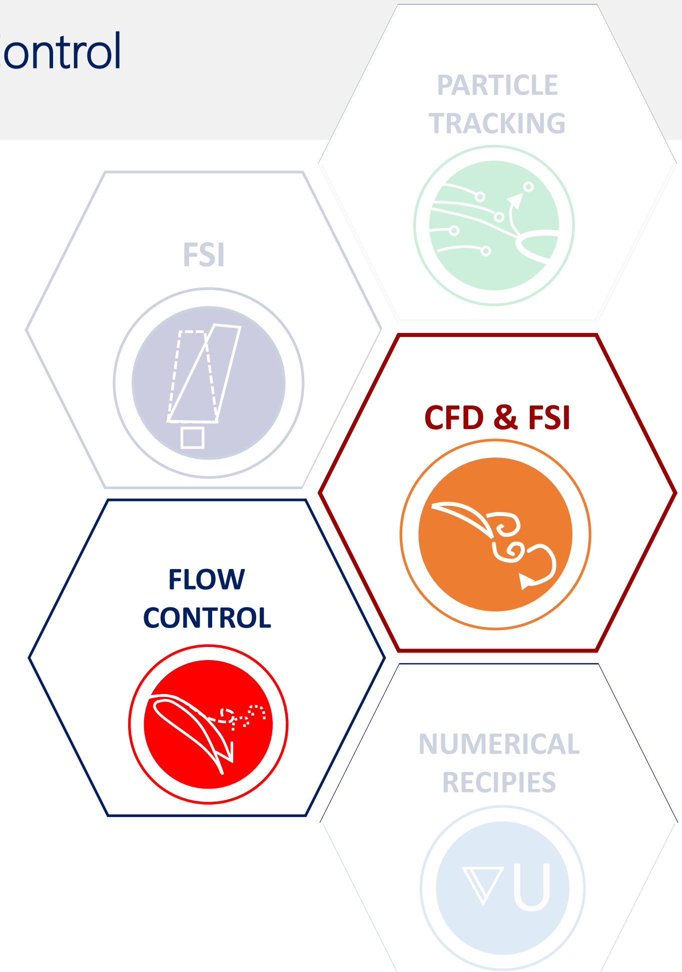
Projects on Flow Control



Stall control on axial-flow fans: leading edge bumps

Anti-stall ring in tunnel and metro axial flow fans

Axial thrust control in multistage pumps

STALL CONTROL ON AXIAL FANS: LEADING EDGE BUMPS

Sapienza Università di Roma

FläktWoods

Stall control is a key issue to be addressed for R&D of compressors and fans.

A number of active and passive techniques were developed aiming at increasing the aerodynamic stability of compressors, eg:

- **variable pitch in-motion**

Corsini and Rispoli, 2004, Using sweep to extend the stall-free operational range in axial fan rotors, Proceedings of the IMechE, Part A

Bianchi, Corsini, Sheard, 2011, Stall inception, evolution, and control in a low speed axial fan with variable pitch in motion, J. of Eng. for Gas Turbines and Power

We carried-out an **investigation of the flow control capabilities of biomimicry-inspired the leading edge bumps on tunnel and metro fans**

- Impact on the pressure rise capability and efficiency of the fan
- Characterisation of the flow mechanisms associated with the sinusoidal leading edge

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CFD & FSI

FLOW CONTROL

1 BIOMIMICRY

WHALES ARE THE ONLY EXAMPLE OF EVOLUTION AT HIGH REYNOLDS (COMPARABLE WITH TM APPLICATIONS)

2

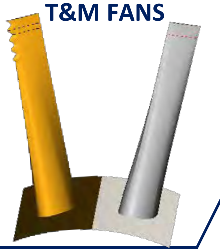
tubercles

3 LEADING EDGE BUMPS

CAN CONTROL FLOW SEPARATION AT THE TRAILING EDGE OF NACA PROFILES

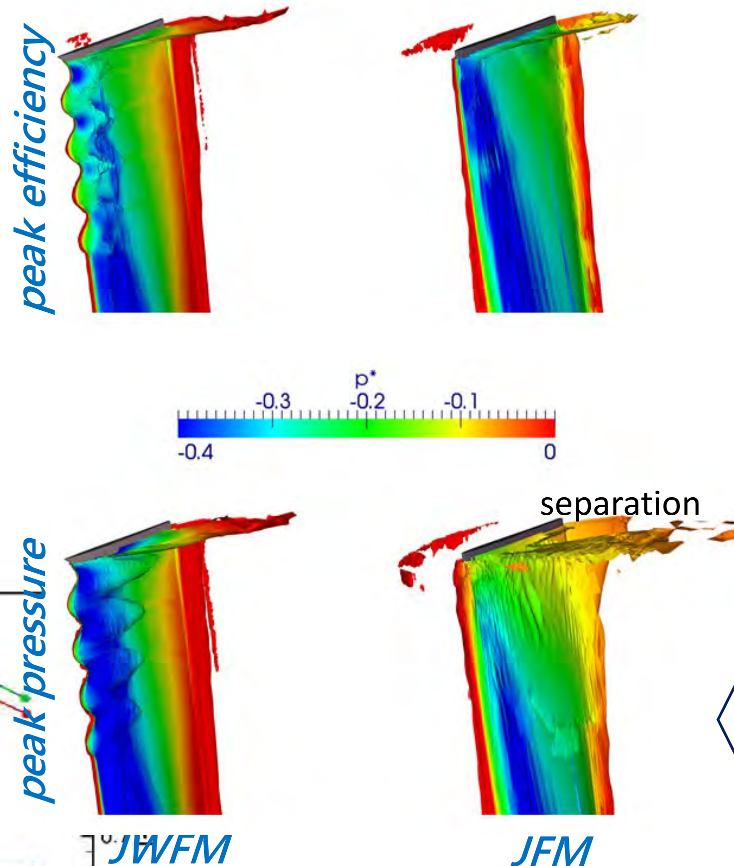
4

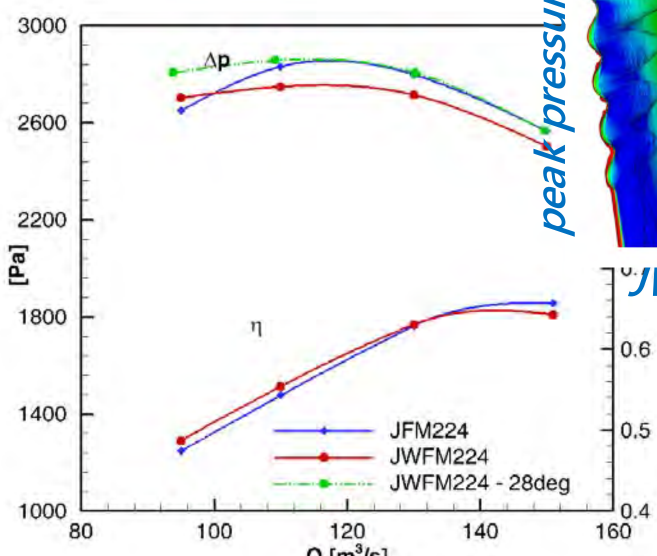
5 APPLICATION TO T&M FANS



STALL CONTROL ON AXIAL FANS: LEADING EDGE BUMPS

FLOW CONTROL MECHANISM





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FLOW CONTROL

1 **BIOMIMICRY**

WHALES ARE THE ONLY EXAMPLE OF EVOLUTION AT HIGH REYNOLDS (COMPARABLE WITH TM APPLICATIONS)

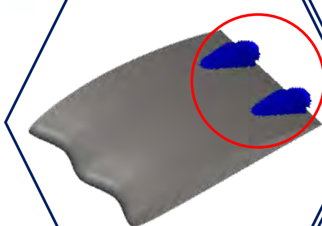
2

tubercles

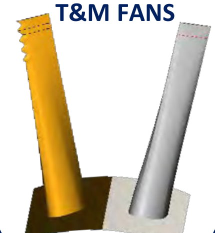
3 **LEADING EDGE BUMPS**

CAN CONTROL FLOW SEPARATION AT THE TRAILING EDGE OF NACA PROFILES

4



5 APPLICATION TO T&M FANS



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ANTI-STALL RING IN TUNNEL AND METRO AXIAL FANS

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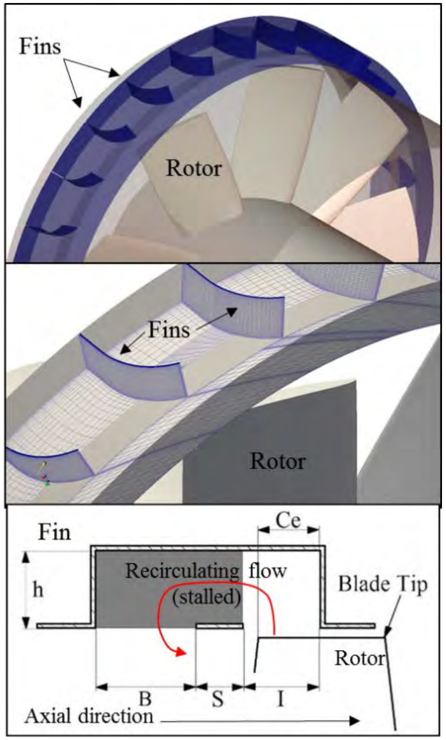

A stabilisation ring consists of an annular chamber incorporated in the fan casing, fitting over the fan blades' leading edge.

It is a casing treatment able to protect a fan driven into stall from stresses that would inevitably result into its mechanical failure

The chamber is supposed to accomodate recirculating flow as the fan is driven into stall, and re-inject it in the main flow upstream of the rotor

This chamber is divided into vanes by cambered fins welded into the annular chamber with a shroud to separate stabilisation ring inlet and discharge

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FLOW CONTROL

1

UE GOES GREEN AND ENFORCE MINIMUM EFFICIENCY GRADES

US FOLLOWS

2

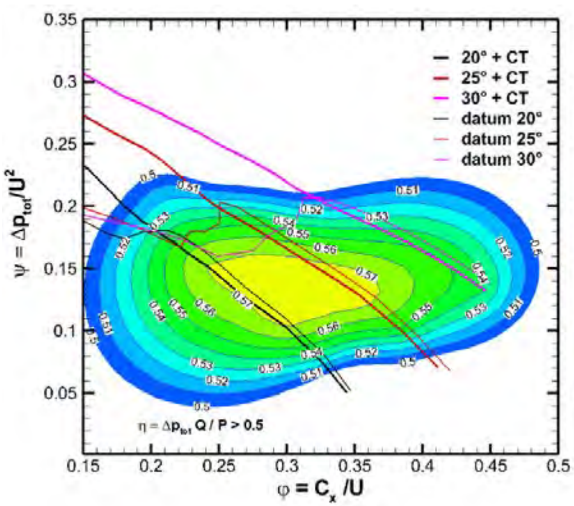
IS AN ANTI-STALL RING AN AVAILABLE CHOICE FOR A FAN DESIGNER?

AND BTW HOW IT WORKS?

3

MEASUREMENTS ON TEST RIG

CFD ANALYSIS



The primary characteristic of a fan fitted with a stabilisation ring is continuously rising pressure back to zero flow

The secondary effect of the anti-stall ring is a decrease of efficiency in the stable range of operations

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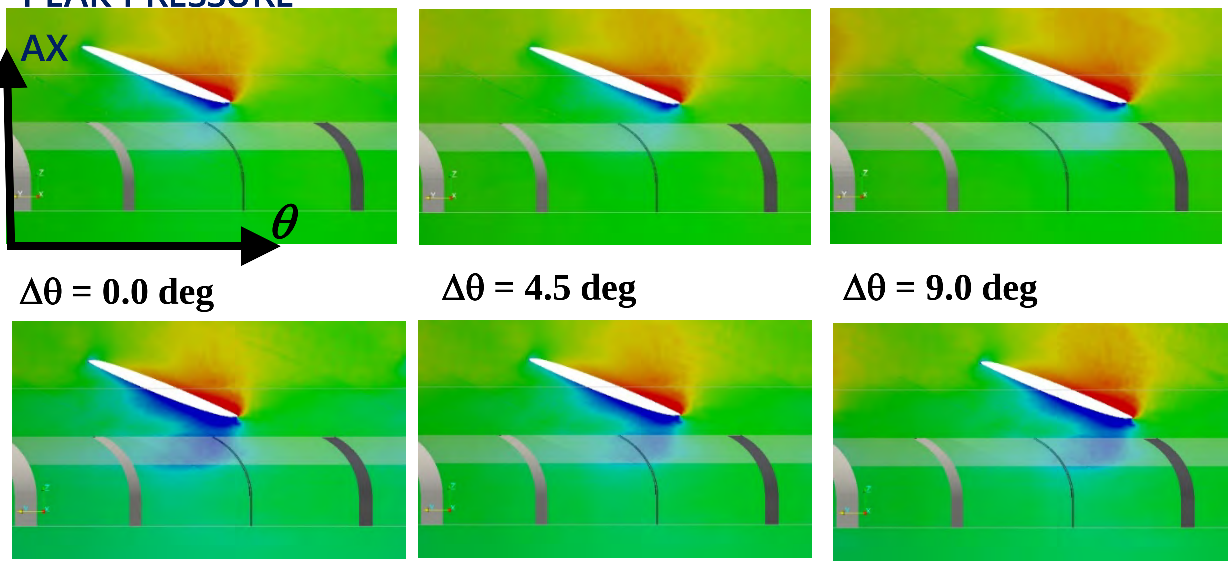
ANTI-STALL RING: CFD

PEAK PRESSURE

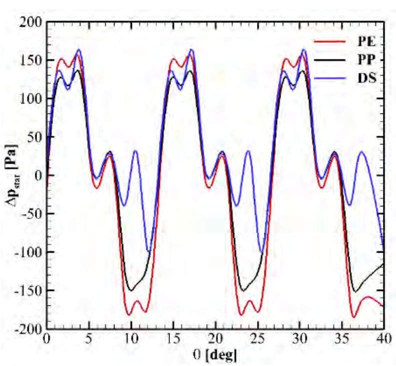


DEEP STALL

Pressure contours at 99% of the blade span

At PE AND PP the low pressure core on the suction surface of the rotor is not large enough to interact with the ASR chamber

At DS operations it extends further upstream and contracts and expands when interacting with the different fins.



Pressure fluctuations in the ASR for 40° of rotor revolution (rotor passing three fins of the ASR)

CFD & FSI

FLOW CONTROL

1
UE GOES GREEN AND ENFORCE MINIMUM EFFICIENCY GRADES

US FOLLOWS

2
IS AN ANTI-STALL RING AN AVAILABLE CHOICE FOR A FAN DESIGNER?

AND BTW HOW IT WORKS?

3
MEASUREMENTS ON TEST RIG

CFD ANALYSIS

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AXIAL THRUST CONTROL IN MULTISTAGE PUMPS

CFD & FSI

FLOW CONTROL

REDUCTION OF AXIAL THRUST IN MULTISTAGE PUMP

EBARA

We have this series of multistage pumps with way better performance of those of our competitors (in terms of both total head and efficiency)

Yet more than 20% of our costs come from the system required to balance the axial thrust of the pump. Our competitors don’t have these costs because their axial thrust is negligible

Can you help us?

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CFD ANALYSIS OF PUMP STAGE

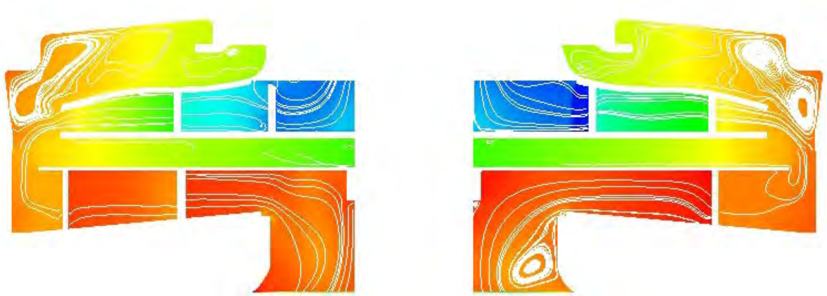
CFD & FSI

FLOW CONTROL

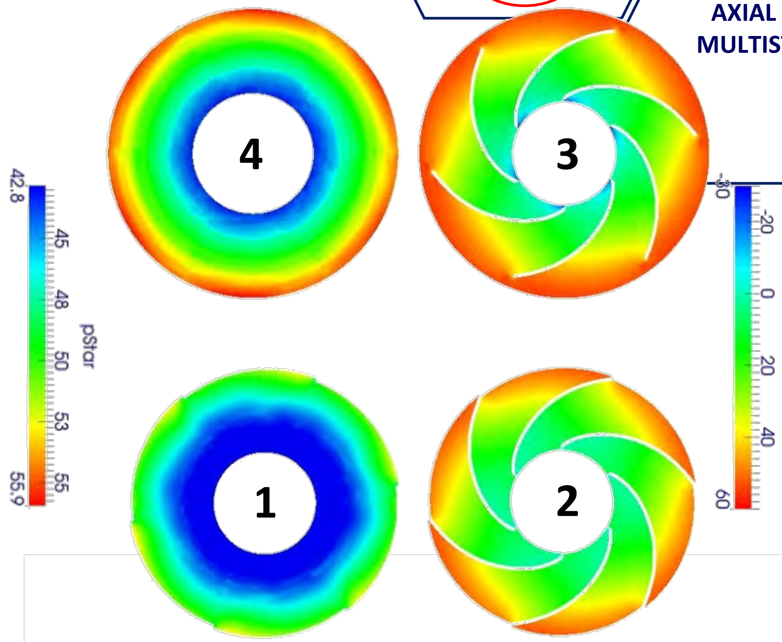
REDUCTION OF AXIAL THRUST IN MULTISTAGE PUMP

CFD ANALYSIS OF DATUM PUMP

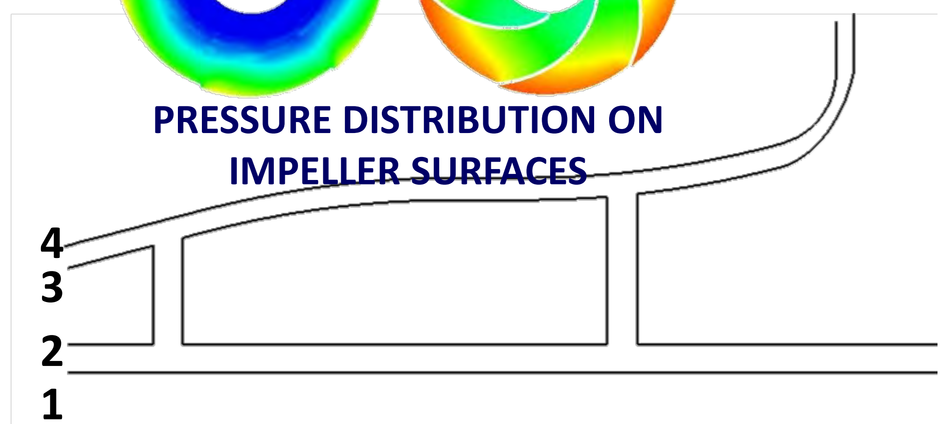
ANALISYS OF THRUST ON IMPELLER



ANALISYS OF PRESSURE IN THE STAGE (MERIDIONAL VIEW)



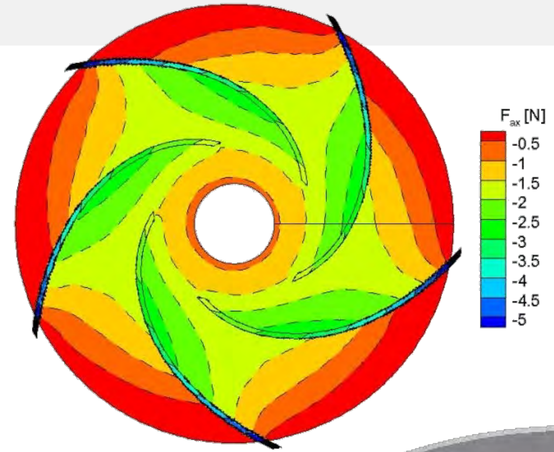
PRESSURE DISTRIBUTION ON IMPELLER SURFACES

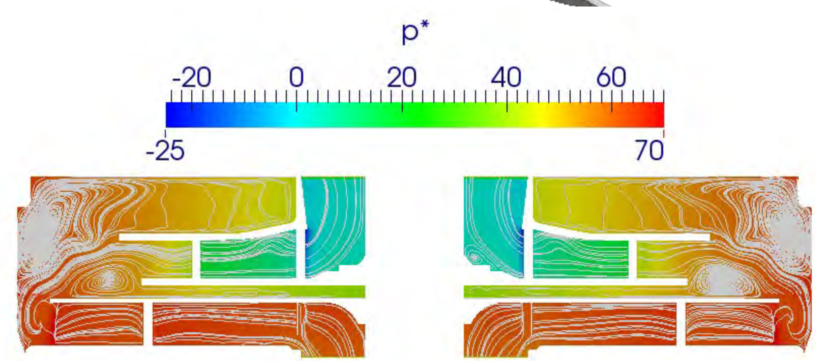


FROM CFD ANALYSIS TO FLOW SOLUTIONS

- CFD ANALYSIS OF DATUM PUMP
- ANALISYS OF THRUST ON IMPELLER
- SOLUTION FROM CROSS-FERTILIZATION
- NUMERICAL TEST OF PROTOTYPE
- LAB TEST OF PROTOTYPE

ITERATION





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CFD ANALYSIS OF PUMP STAGE

CFD & FSI

FLOW CONTROL

REDUCTION OF AXIAL THRUST IN MULTISTAGE PUMP

Title CFD ANALYSIS OF PUMP STAGE	
Participants: Corsini (Ass. Prof.) – Delibra (AdR) – Cardillo (PhD)	
Period: 2014	Sponsor: Ebara Pumps Europe

Patent

Masashi Obuchi, So Kuroiwa, Dai Sakihama, Renato Groppo, Fabio Balbo, Mariano Matteazzi, Lucio Cardillo, Alessandro Corsini, Giovanni Delibra, Franco Rispoli, , Franco Rispoli
"Impeller assembly for centrifugal pumps".
International publication number WO-2016/060221

SSD: ING IND-09

OPTIMIZATION

BIG DATA IN TM

SSD: ING IND-09

OPTIMIZATION

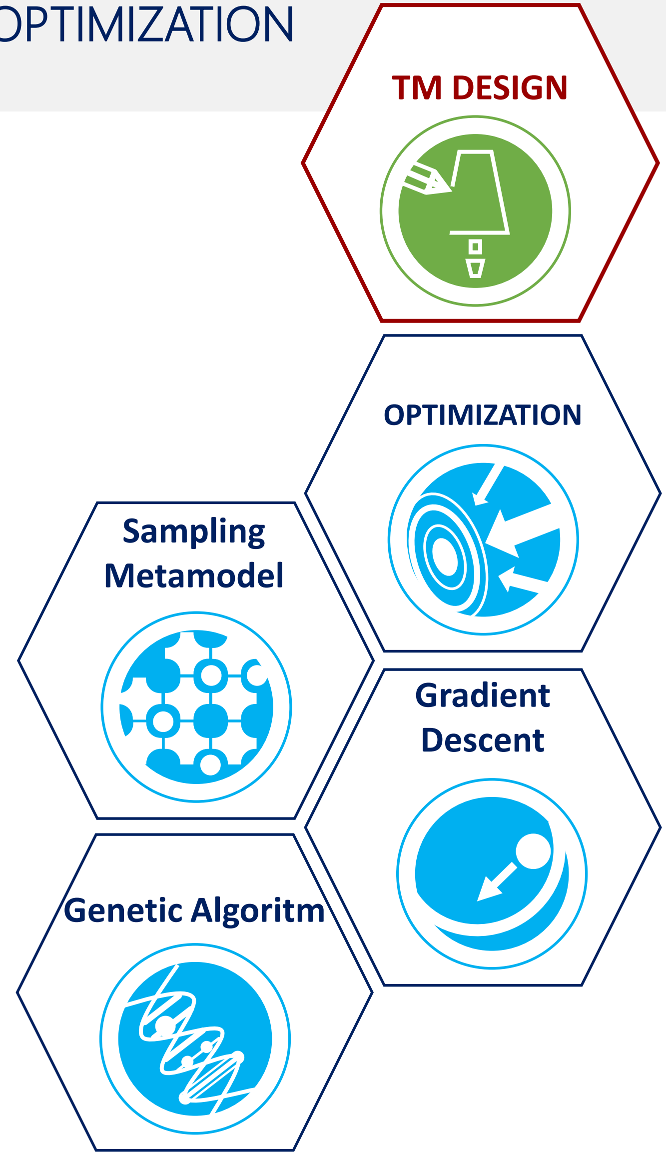
AxLab, ADM and ALM, consisting in "reduced order" models are also valuable **Optimization tools**.

Reduced Order or "Synthetic Models" are perfect to replace fitness function in optimization process

Fitness function is used to summarize, as a single figure of merit, how close a given design solution is to achieving the set aims.

Perfect models for :

- Genetic Algorithm Optimization;
- Sampling in Metamodeling;
- Gradient descent Optimization.



OPTIMIZATION: MinWater Fan Design

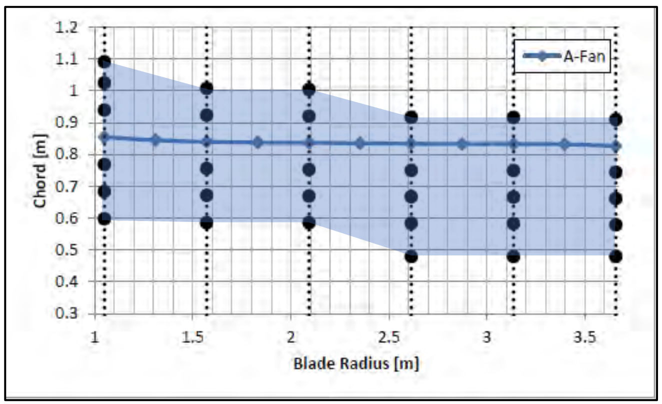
TM DESIGN

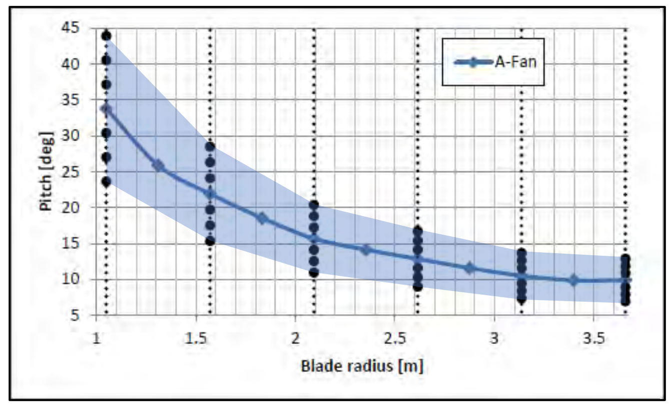
MinWaterCSP
Minimized water consumption in CSP plants
MinWaterCSP

OPTIMIZATION

Sampling
Metamodel

Multi-objective optimization





More than **400’000 individuals** were simulated with AxLab Software in less than a week. Comparing to other works in literature (Carolous and Demeulenaere) **time saved** for this operation was **98.6%.**

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654443

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OPTIMIZATION: MinWater Fan Design

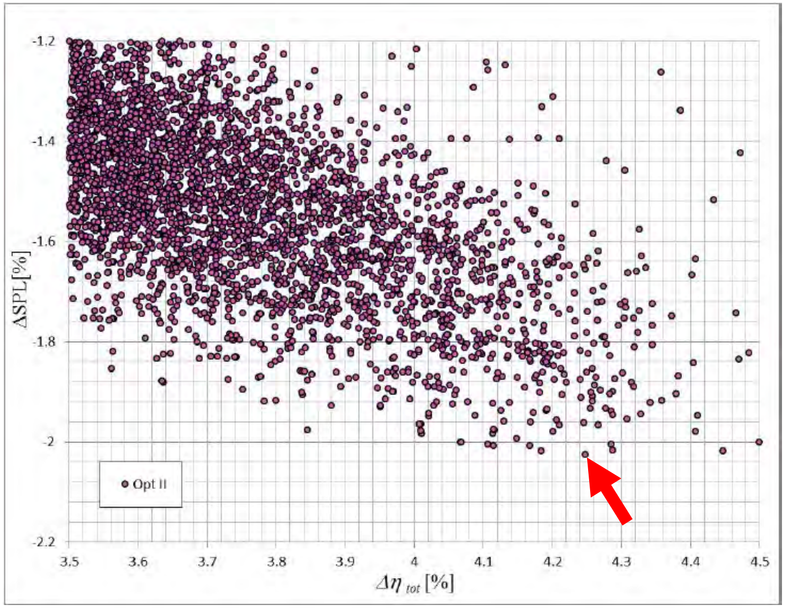
MinWaterCSP

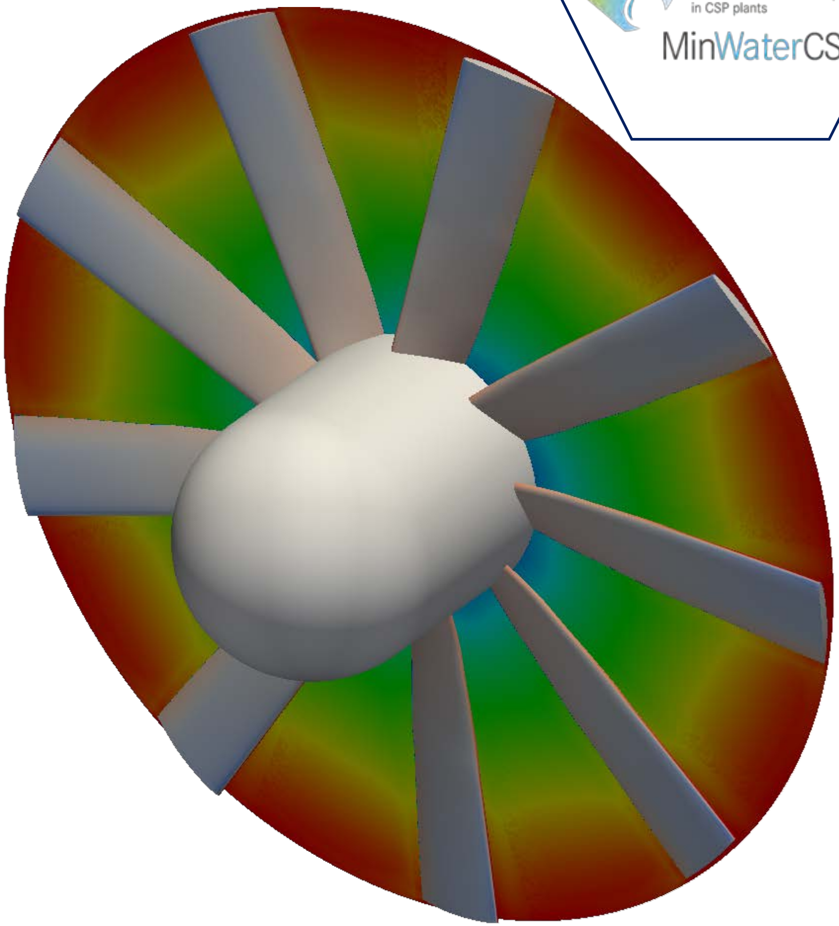
Minimized water consumption in CSP plants

MinWaterCSP

Main duties of DIMA team for MinWaterCSP:

- Noise-reduction aimed axial fan design
- Optimization of fan design





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654443

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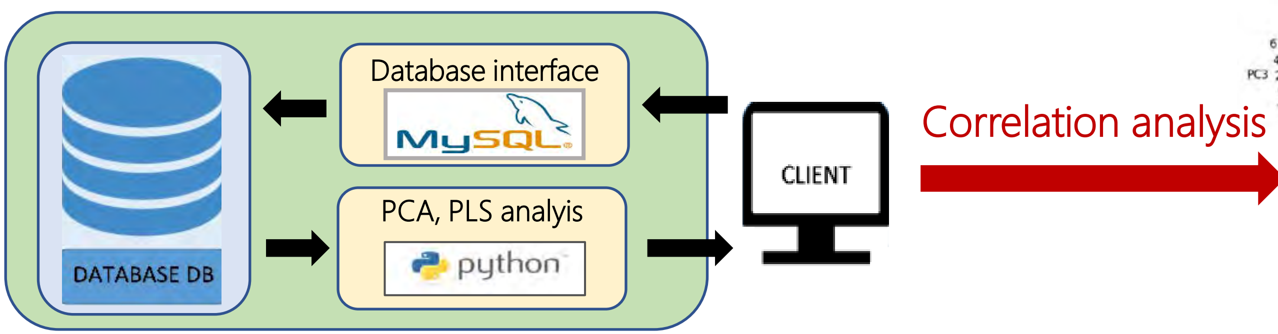
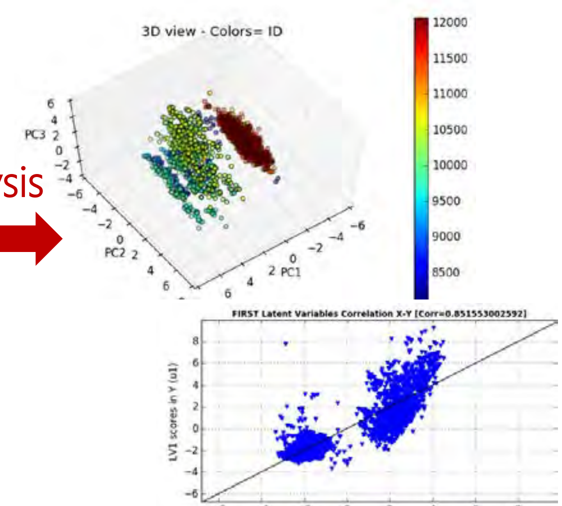
BIG
DATA
IN TM

- Data-intensive techinques, widely named **Big Data**, allow for new applications of information technologies in science and engineering
- **Big Data** techniques (PCA, PLS) analysis on large set of data of complex systems are empoyed to provide data correlations, performance indicators or complex cause-effect reltionship models with latent varables
- These thechniques can be applied to industrial process, analysis of energy efficiency or turbomachinery characterization and design

This technology is here applied to turbomachinery; the aim is the study of unknown correlations between design parameters of industrial fans

- Creation of a **database** platform (MySQL)
- Application of the PCA or PLS analysis (Python) to the dataset analysis of the correlation
- Application of the new correlations to the design and analysis of new geometry (possible interfacing with an optimization process





Progetto Ateneo Sapienza 2016

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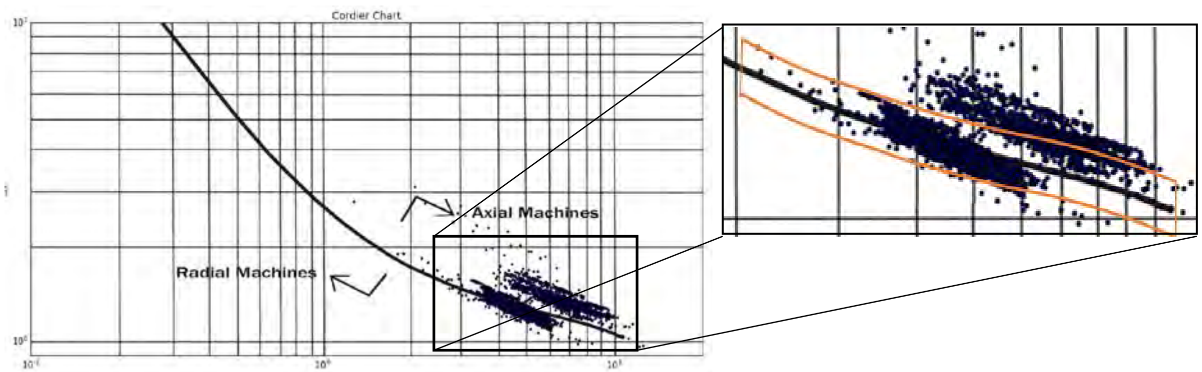
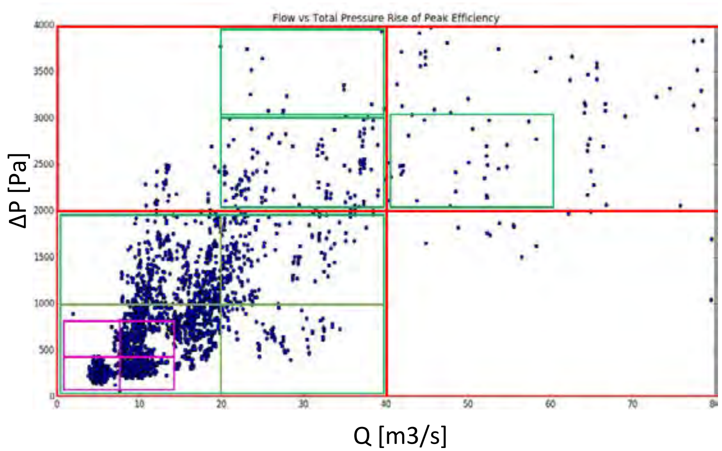
APPLICATION TO INDUSTRIAL TM

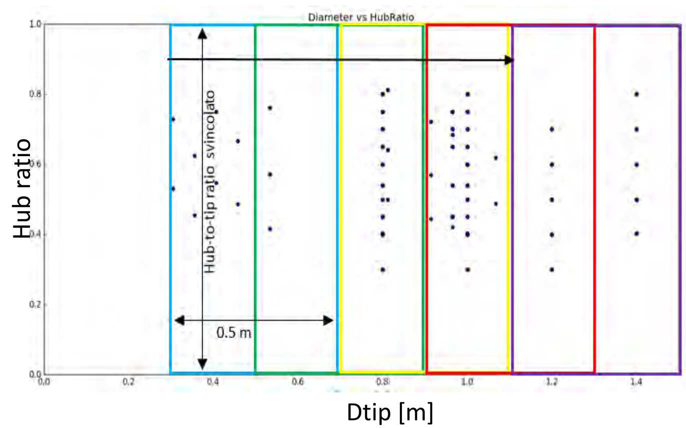
BIG
DATA
IN TM

It is possible to make a query on the database considering diferent machine characterization

- On a Ns-Ds plane i.e. considering the distance from the maximum available efficiency (Cordier)
- On a Q-Δp plane i.e. considering a performance characterization
- On a Diameter-HubToShroud ratio plane, i.e. considering a diemension characterization



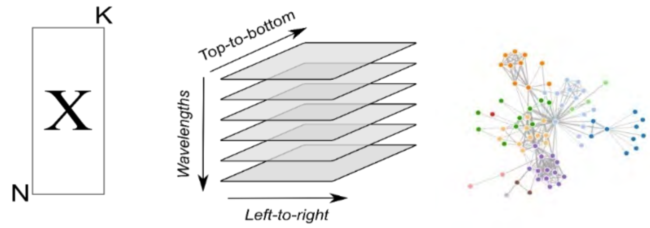




EXPLORATION OF DESIGN SPACE

BIG DATA IN TM

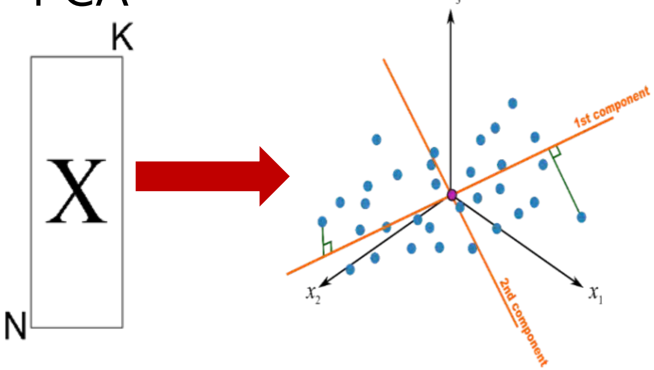
The **database** X consist of a large number of uncorrelated variables (N) and is an high-dimensional (K) system



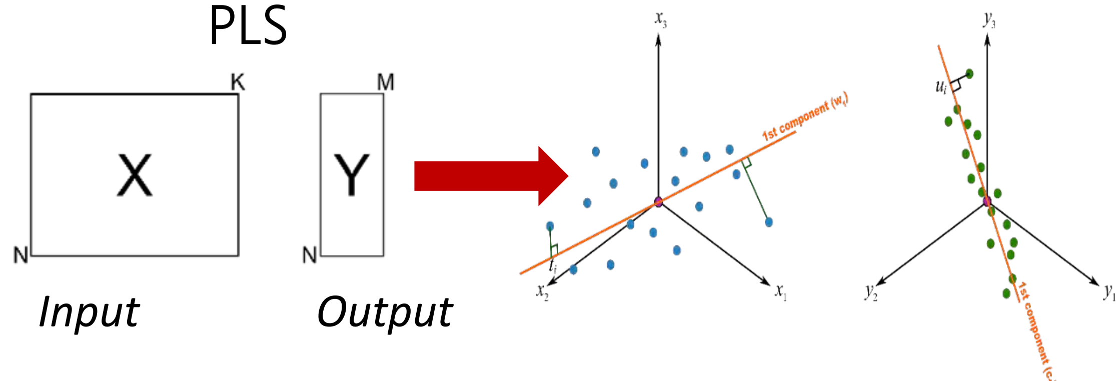
The **PCA** and **PLS** are statistical methods which find a linear regression models by orojecting the predicted and observable varaibles to a new space

- The **PCA** uses an orthogonal transformations to convert a set of observation of possibly correlated variables into a set of values of linearly uncorrelated variables, the principal components
- The **PLS** uses an iterative algorithm to model the covariance structures in in two spaces. It is a component based approach that allows estimating complex cause-effect relationship models with latent variables

PCA



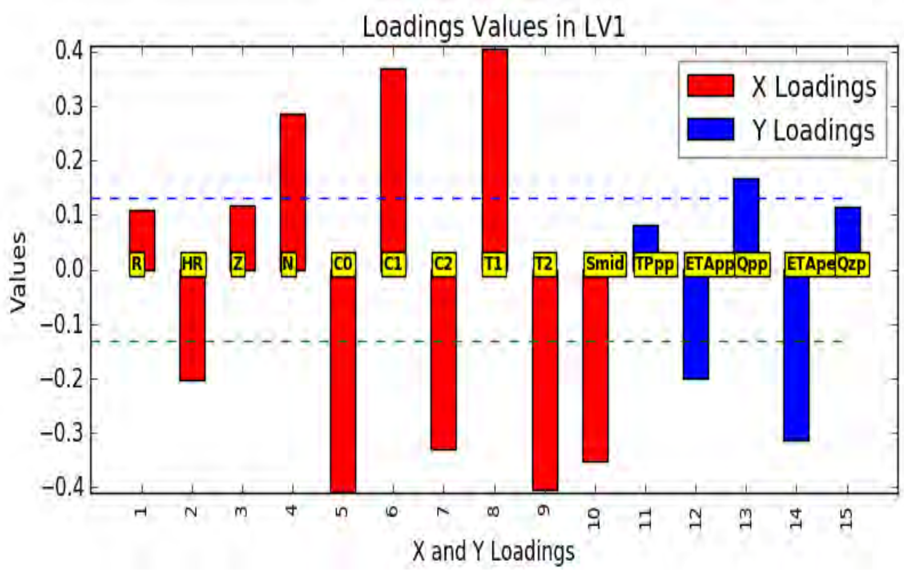
PLS

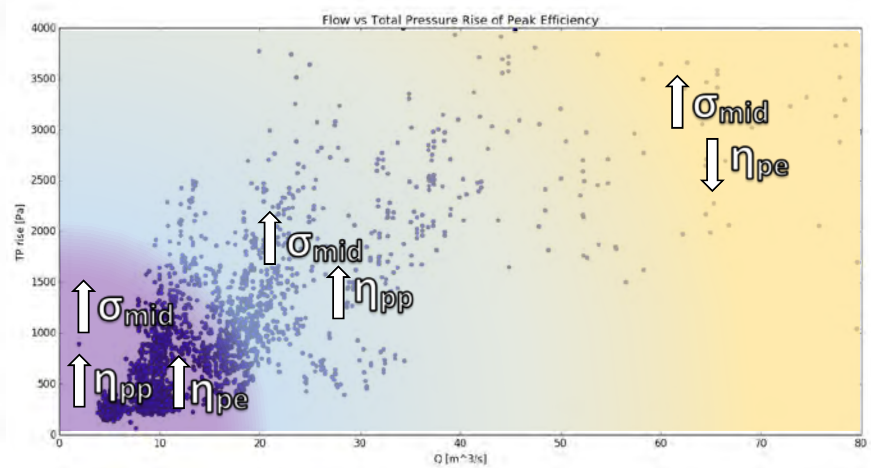


BIG
DATA
IN TM

Different correlations and features can be find in the dataset analysis:

- Well-known correlation from literature
- The influence of the input parameters on the global performance of all the analyzed machines (Loading Plots)
- The definition of new correlation betwen input and output parameters
- The definition of the most important parameters to be considered in an optimization process





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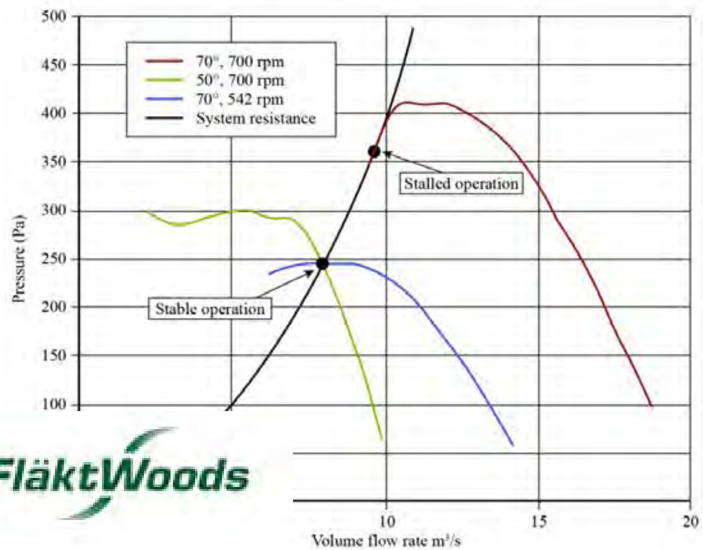
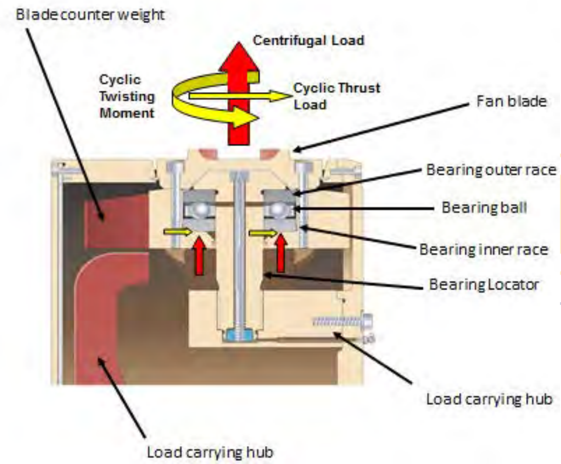
Investigation on stall dynamics, variable speed vs variable pitch

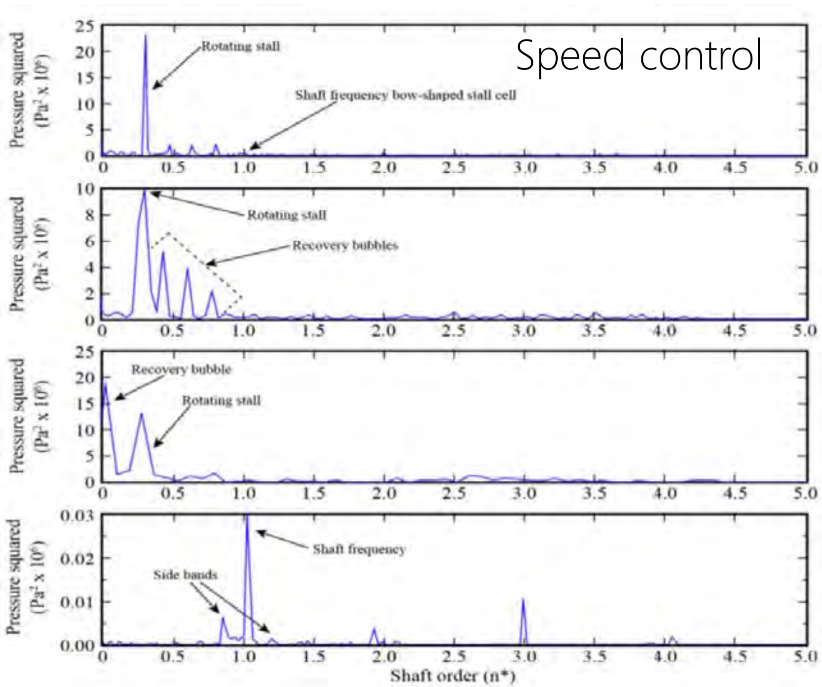
LAB

NOISE



FläktWoods



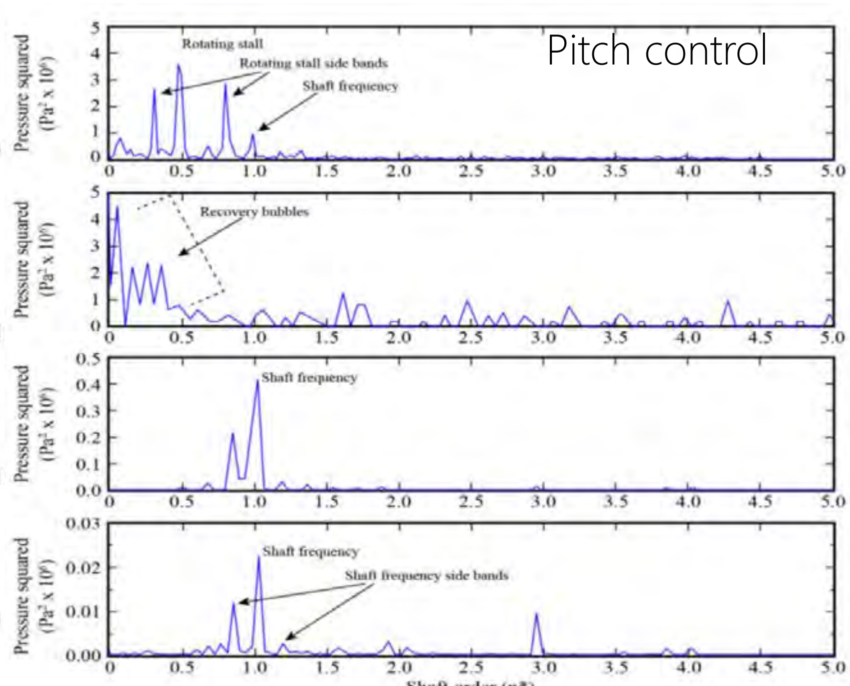


70° a 562 rpm

70° a 547 rpm

70° a 544 rpm

70° a 542 rpm



52.5° a 700 rpm

51° a 700 rpm

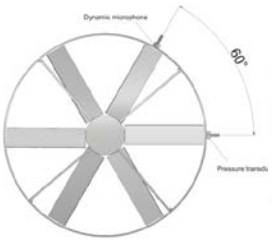
50.5° a 700 rpm

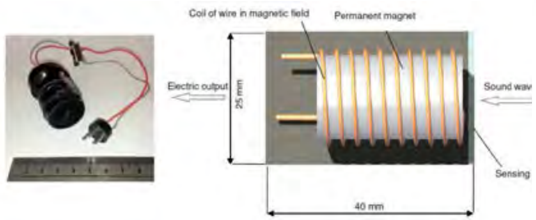
50° a 700 rpm

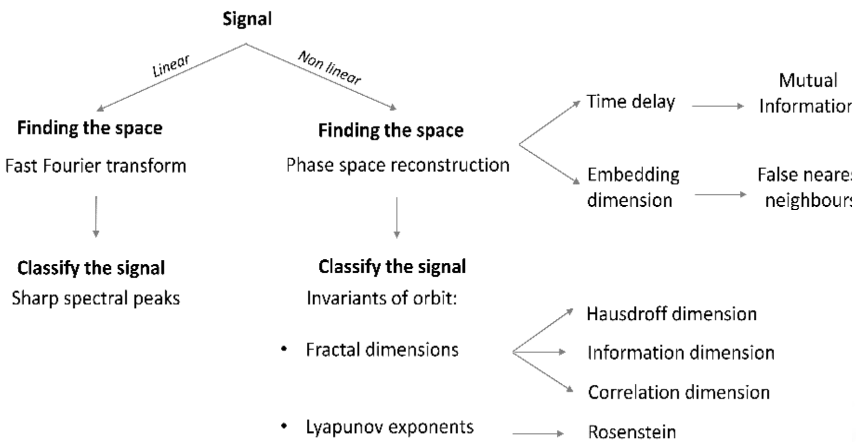
DIY probes & FDD in rotating machineries

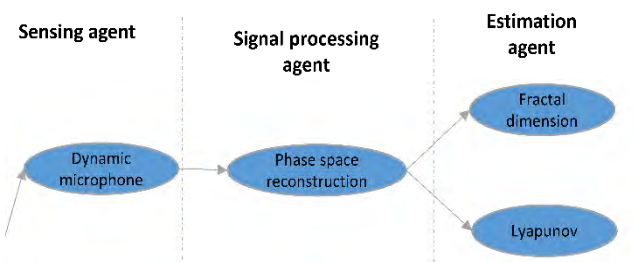
SED Soluzioni per l'Energia e la Diagnostica

DIY probe

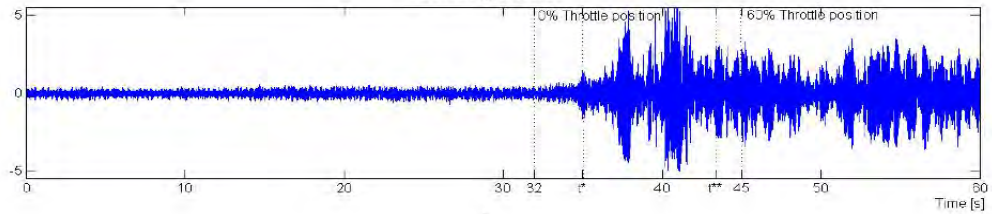






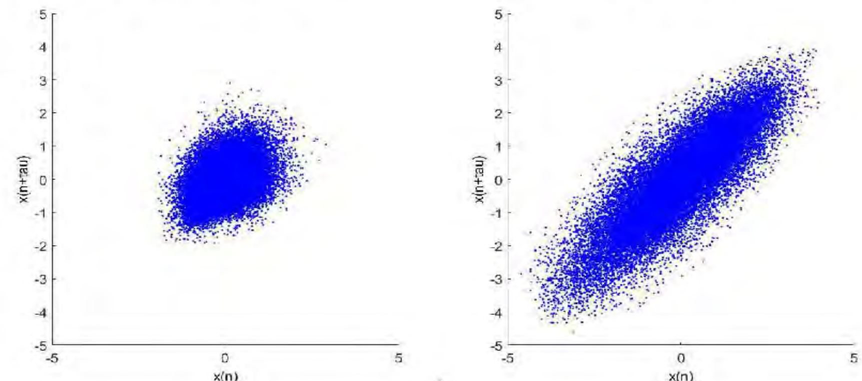


Sensing agent

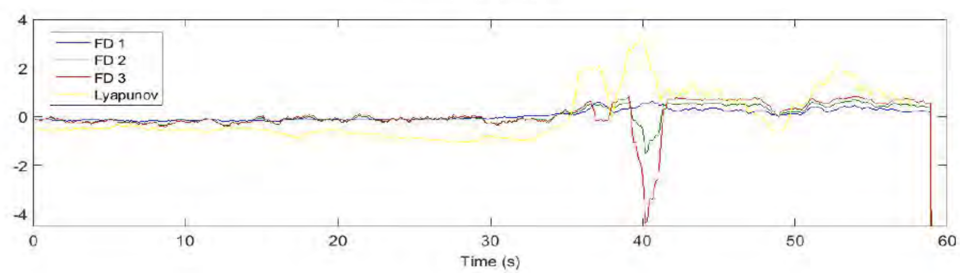


Signal processing agent

0% Throttle position | 60% Throttle position



Estimation agent



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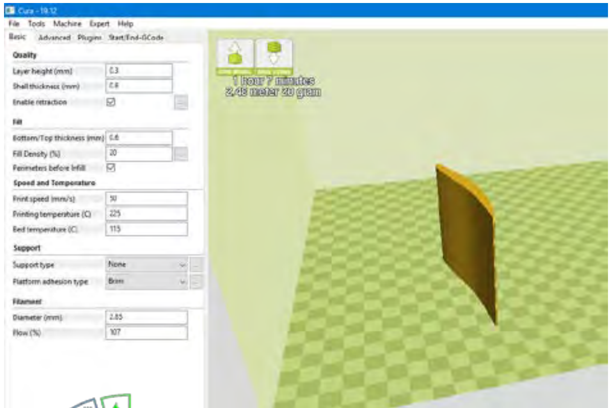
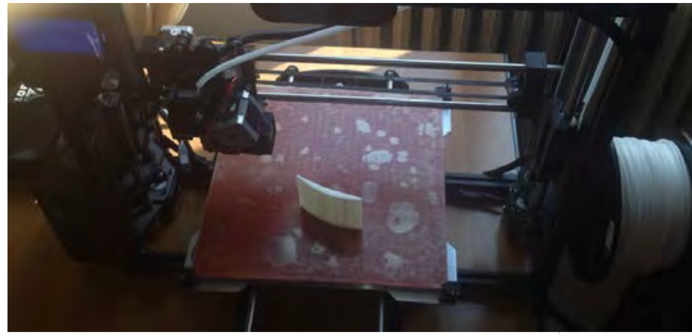
Rapid prototyping and testing

3D printing

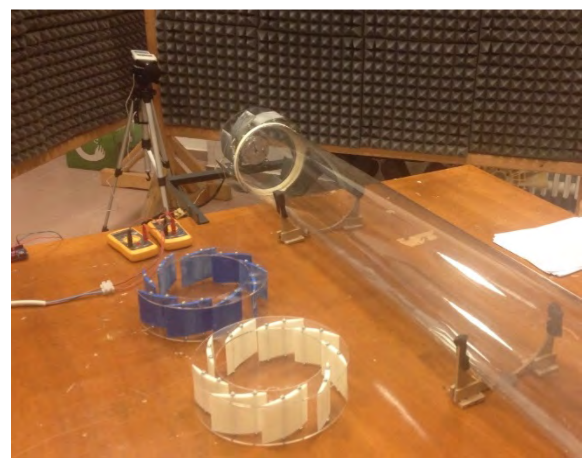




SED Soluzioni per l'Energia e la Diagnostica

Centrifugal and axial in-duct test rigs for aerodynamic measurements

Acoustic measurement



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Team

Research Assistant & PostDoc (5)
Paolo Venturini (ASN), Silvia Sangiorgio, Eileen Tortora, Andrea Marchegiani, Sara Feudo

Doctoral candidates (2)
Fabrizio Bonacina, Francesca Lucchetta

Industrial Collaborations

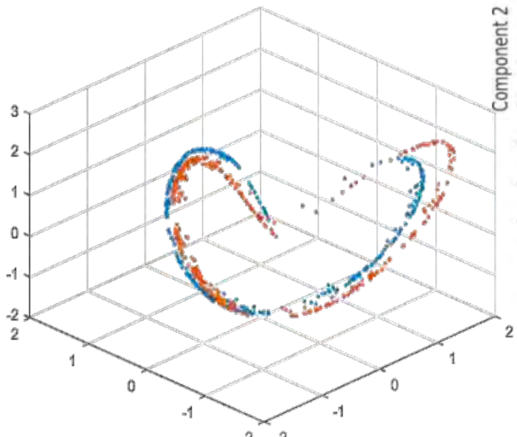
Acqua Latina Spa,
Elettra Investimenti Spa,
ALPLA Spa,

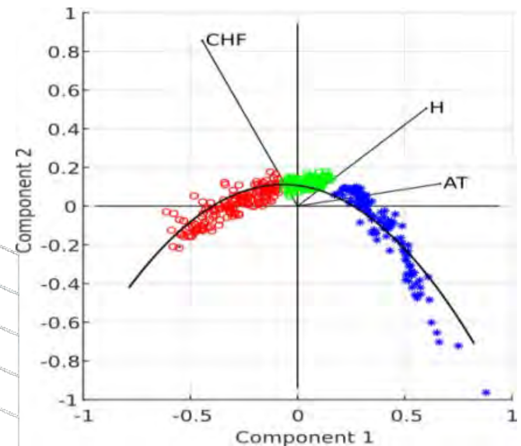
SED Soluzioni Energia & Diagnostica Srl

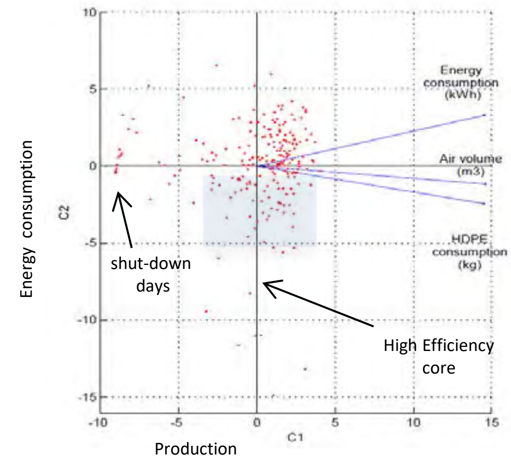
SAPIENZA
UNIVERSITÀ DI ROMA

Metabolismo dei sistemi energetici – Metodologie: Data analytics

DA sviluppati con strumenti analitici avanzati basati su tecniche di machine learning per gestione di big data







VANTAGGIO COMPETITIVO DA

- *Identificazione di KPI per sistemi ingegneristici complessi (Multivariate Analysis e Graph Database)*
- *Valutazione del metabolismo del sistema (Pattern Recognition & Clustering), modellazione delle correlazioni (Graph Database), individuazione delle relazioni nascoste (Graph Mining)*
- *Ottimizzazione delle strategie di gestione (Algoritmi Genetici)*

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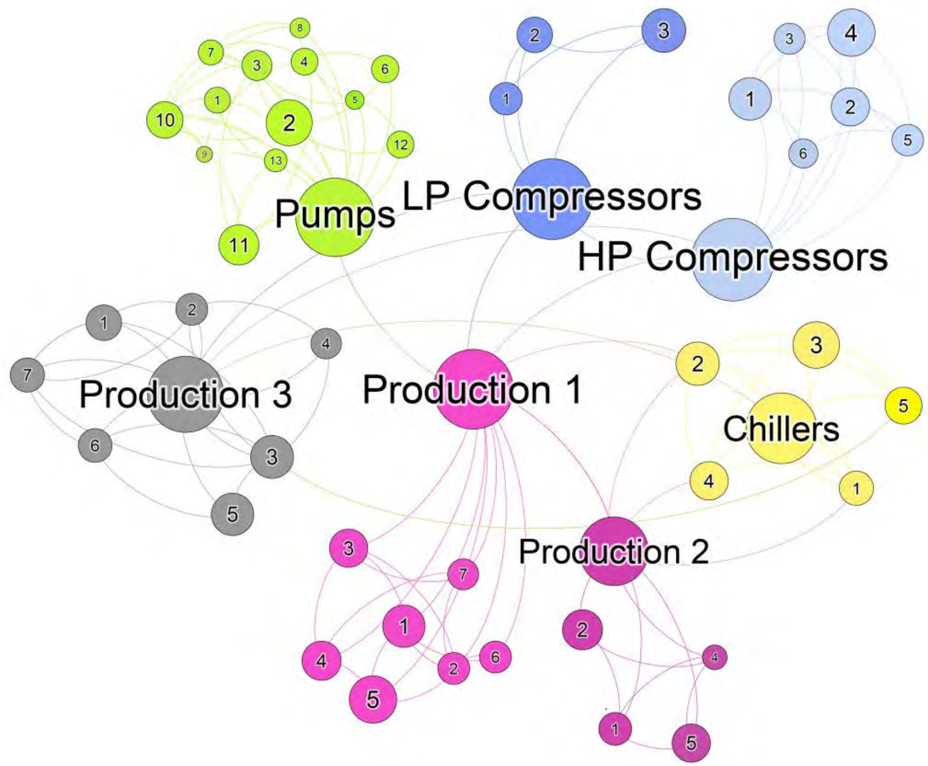
Graph Modeling



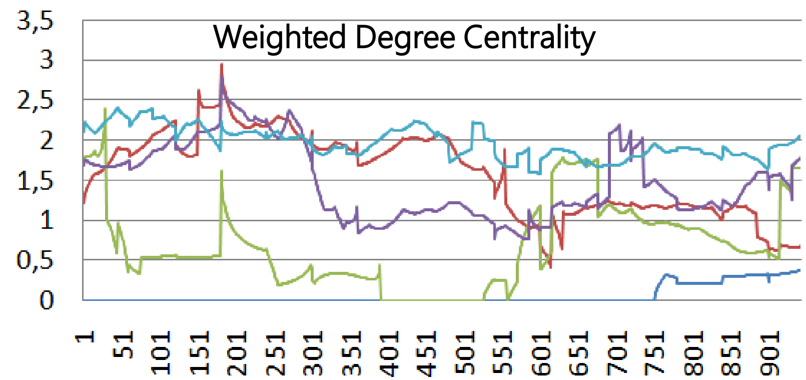
Evaluation of system energy performance based on an analysis of sensor data

Correlation Matrix

Node	1	2	...	n
1	Q_{11}	Q_{12}	...	Q_{1n}
2	Q_{21}	Q_{22}	...	Q_{2n}
...	...	...	...	...
n	Q_{n1}	Q_{n2}	...	Q_{nn}

- Normalized Mutual Information
- Transfer Entropy
- Etc.

Graph Property



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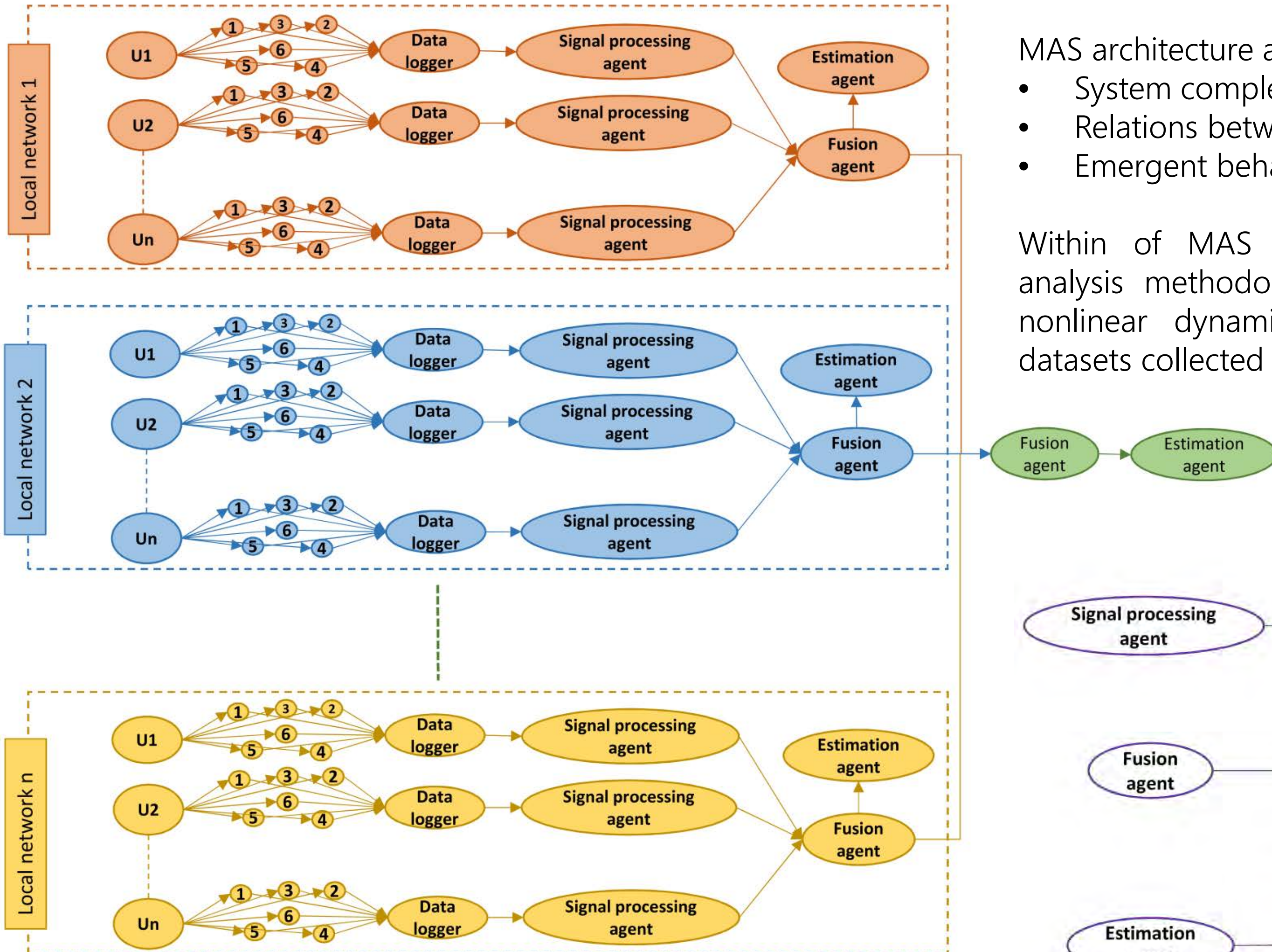
Metabolismo dei sistemi energetici – Metodologie: modellazione multi-agente dei sistemi complessi

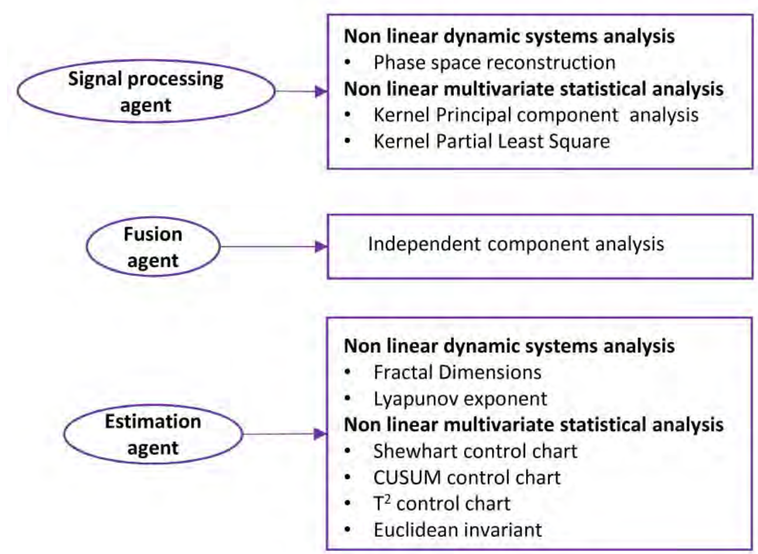


MAS architecture allows to represent

- System complexity
- Relations between elements of the system
- Emergent behaviours

Within of MAS structure different kinds of analysis methodologies allows to analyse the nonlinear dynamic features of multivariate datasets collected by the monitoring system

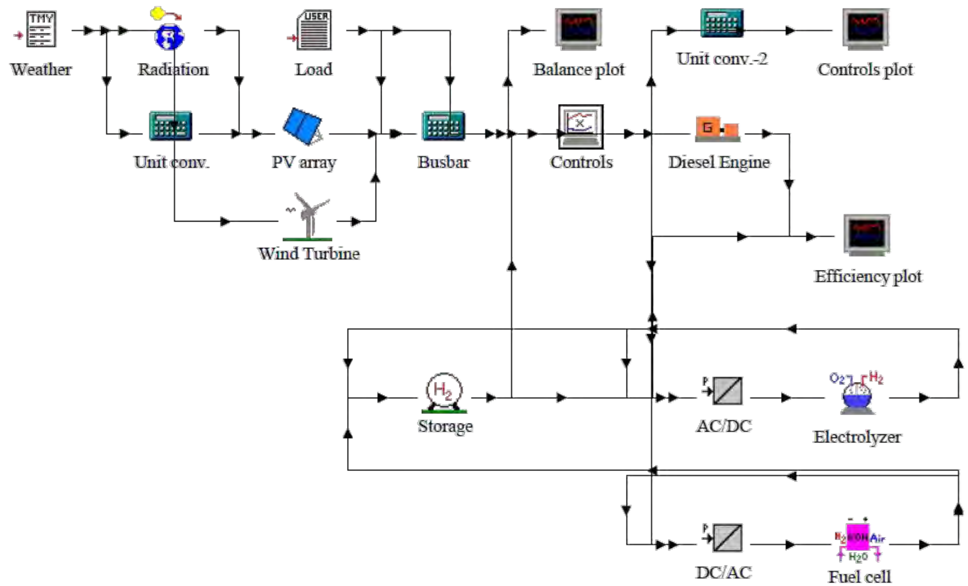
Metodologie



Sviluppo in-house di modelli per la simulazione di tecnologie energetiche specifiche.

Sviluppo di logiche di controllo di sistemi energetici complessi, e modellazione.

Modellazione e analisi delle prestazioni di sistemi energetici integrati convenzionali/rinnovabili/storage off-grid e grid-connected tramite modellazione transitoria.



Vantaggi

- Modularità del sistema energetico
- Corretta interpretazione della variabilità delle prestazioni dovute alla aleatorietà delle FER
- Valutazione degli effetti di integrazione di tecnologie diverse nello stessa sistema energetico
- Valutazione di diverse logiche di gestione dell’energia in sistemi complessi con esigenze diversificate

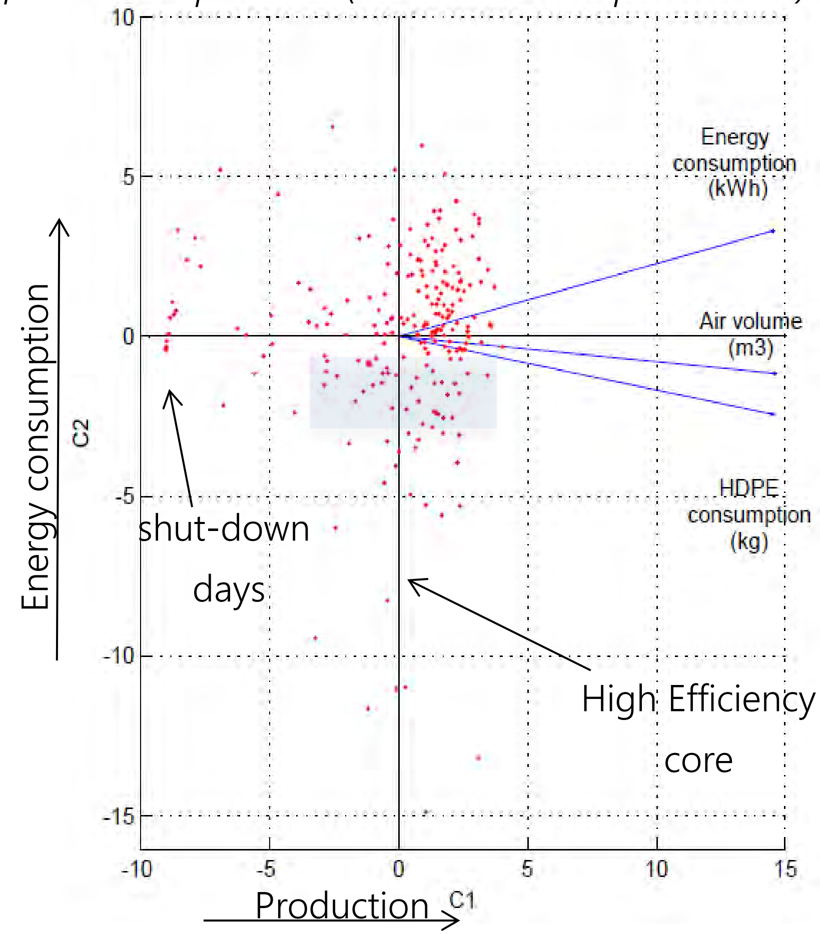
DIAGNOSI ENERGETICA DI UNA RETE AD ARIA COMPRESSA

Ambito
Analisi e valutazione energetica dell'uso energetico *aria compressa*, ausiliario ad un processo industriale per la produzione di contenitori di plastica

Obiettivo
Definire un indicatore energetico in grado di tener conto dell'efficienza del processo produttivo

Metodologia
Analisi statistica multivariata per correlare i dati di monitoraggio del sistema di compressione al processo produttivo

L'area grigia indica i giorni in cui si è verificato un ridotto consumo energetico garantendo al contempo un elevata efficienza del processo (elevati valori di produzione)



ALPLA

SED Soluzioni per l'Energia e la Diagnostica

SSD: ING IND-09

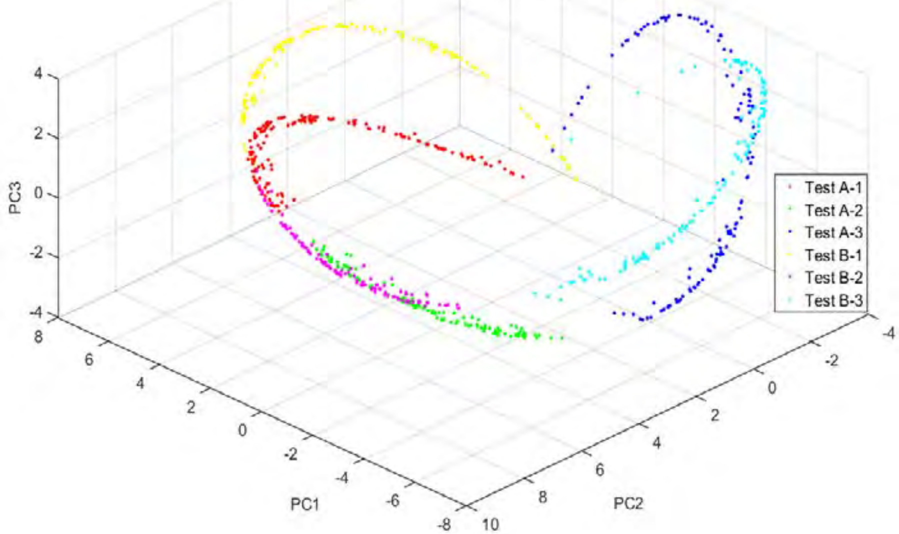
Profilo energetico di un forno industriale esercizio fuori progetto

Ambito
Analisi e valutazione energetica di un forno industriale impiegato per la cottura del pane

Obiettivo
Definire delle metriche per la valutazione delle performance energetiche del processo di cottura in grado di tener conto della qualità del prodotto

Metodologia
Analisi statistica multivariata per correlare i dati di monitoraggio del processo di cottura alla qualità del prodotto i.e. rapporto convezione/irraggiamento

Le due curve rappresentano due profili energetici al variare delle condizioni di ventilazione del forno (Test A e B) nelle diverse sezioni del forno o fasi del processo di cottura (1, 2 e 3).



	SEC (m^3 methane/n.bread)	Section 1 (%)	Section 2 (%)	Section 3 (%)
Test A	1.7×10^{-4}	37	29.5	33.5
Test B	1.8×10^{-4}	37.7	28.3	34

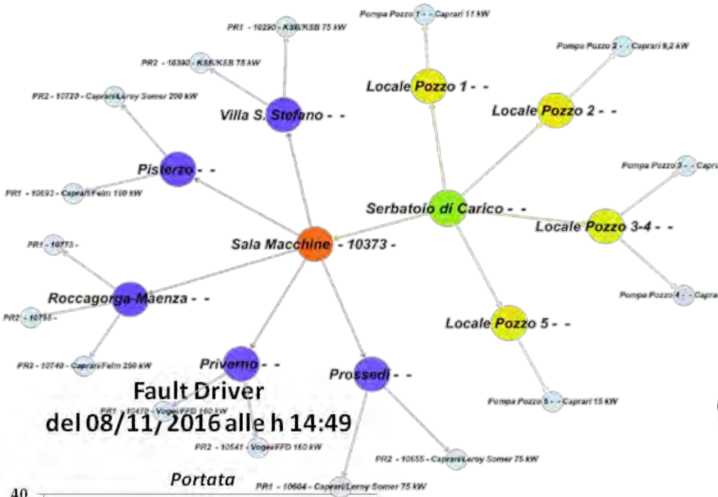
Digitron
Bakery Council EUROPE
SED Soluzioni per l'Energia e la Diagnostica

SSD: ING IND-09

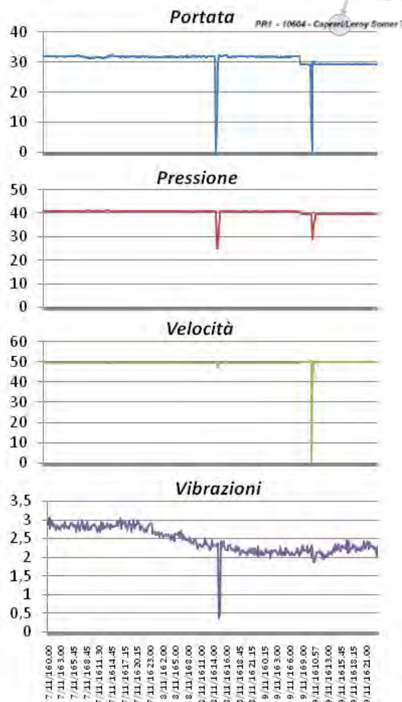
SAPIENZA
UNIVERSITÀ DI ROMA

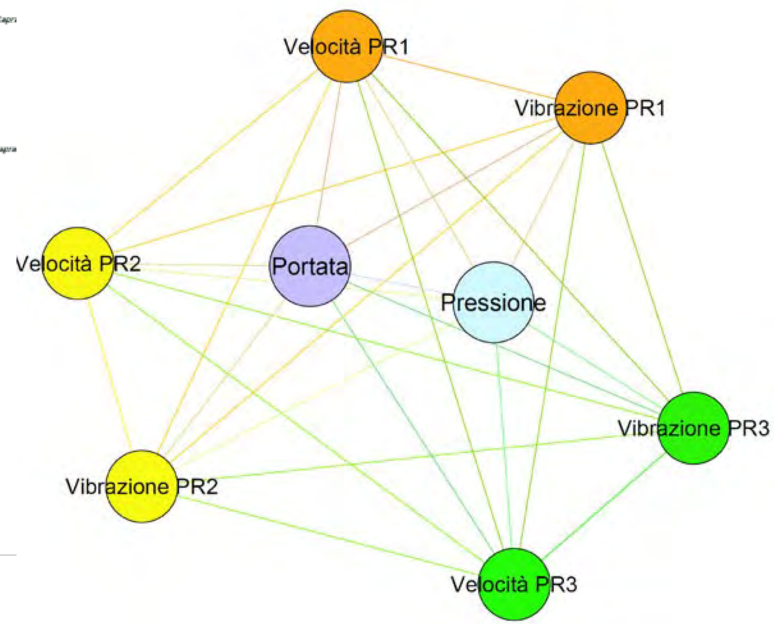
Modellazione di un sistema industriale mediante Social Network Analysis per reti di sensori

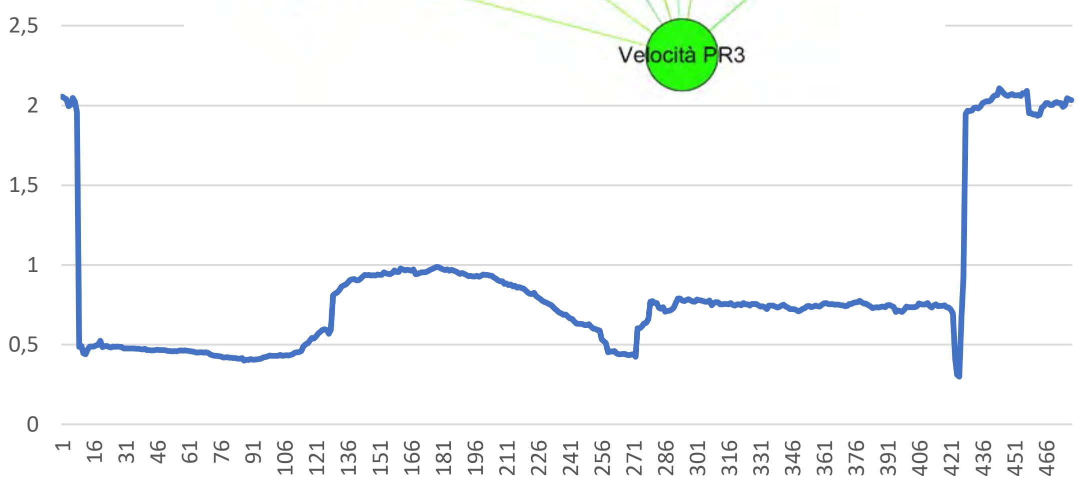
SED Soluzioni per l'Energia e la Diagnostica
WssTP
ACQUA LATINA Al Servizio del Territorio



Fault Driver
del 08/11/2016 alle h 14:49







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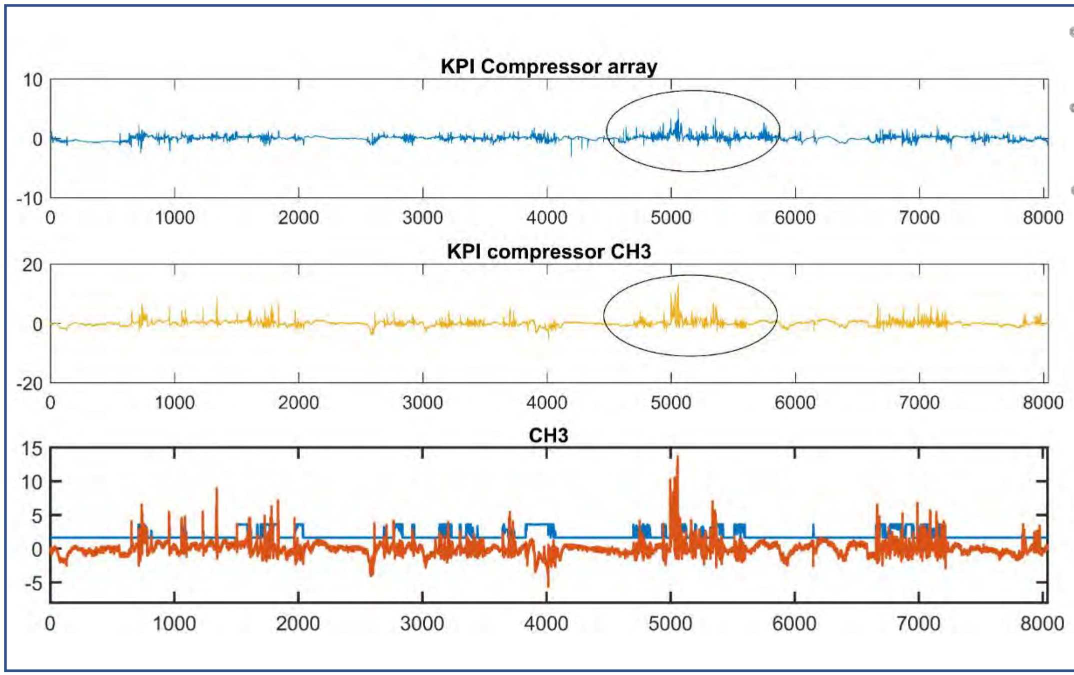
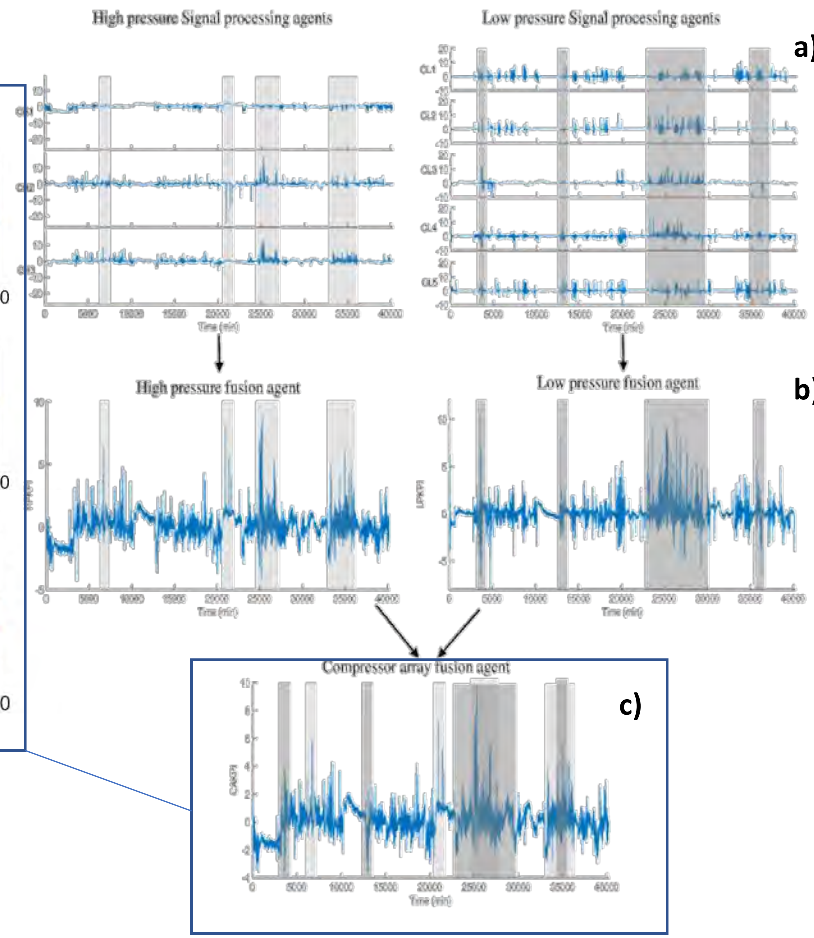
Indicatori di performance energetiche per ammonia chiller industriali

Indicatore di Performance Energetiche multivariato singolo compressore (a), cluster di compressori alta e bassa pressione (b) ed intero array (c)





ALEA Lazio Spa

SSD: ING IND-09

Modellazione time-dependent. Dissalazione da rinnovabili nelle isole minori

Ambito

Modellazione e analisi di un sistema integrato FER/OI per l'approvvigionamento idrico dell'isola di Ponza.

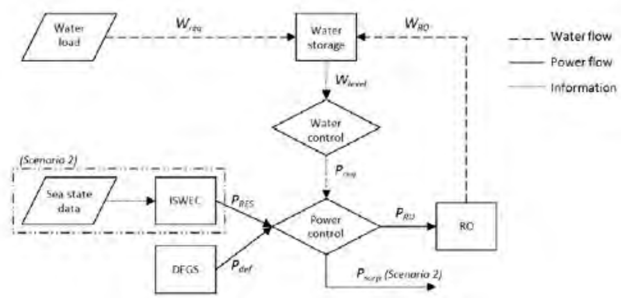
Obiettivo

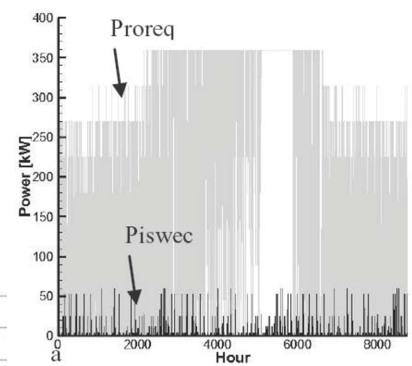
Massimizzare l'uso di energia rinnovabile per la dissalazione compatibilmente con i vincoli territoriali e spaziali presenti.

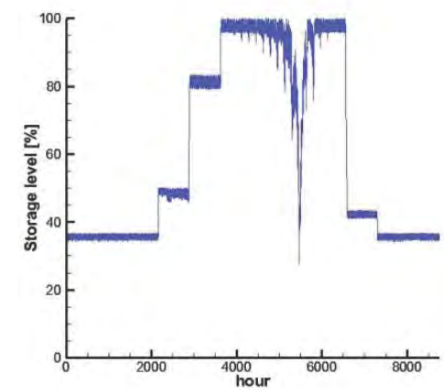
Metodologia

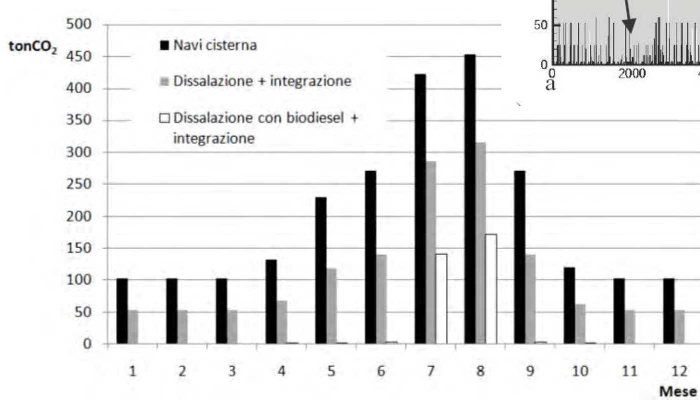
Valutazione delle tecnologie più opportune. Definizione di una logica di controllo. Modellazione transitoria. Analisi delle prestazioni e confronto con il sistema attuale di approvvigionamento.

Scenario	F.E.R.	Presenza Storage	Energia disponibile [GWh]	Energia Utilizzata	Energia Persa	Copertura del Fabbisogno Idrico	Emissioni di CO2 evitate [ton]
1	Fotovoltaico	-	1,5	72%	28%	53%	1.400
2	Eolico	-	0,55	50%	50%	13%	340
3	ISWEC	-	0,58	50%	50%	14%	365
4	Tutte	-	2,7	58%	42%	75%	1.950
5	Fotovoltaico + ISWEC	si	2,1	100%	0	99%	2.600







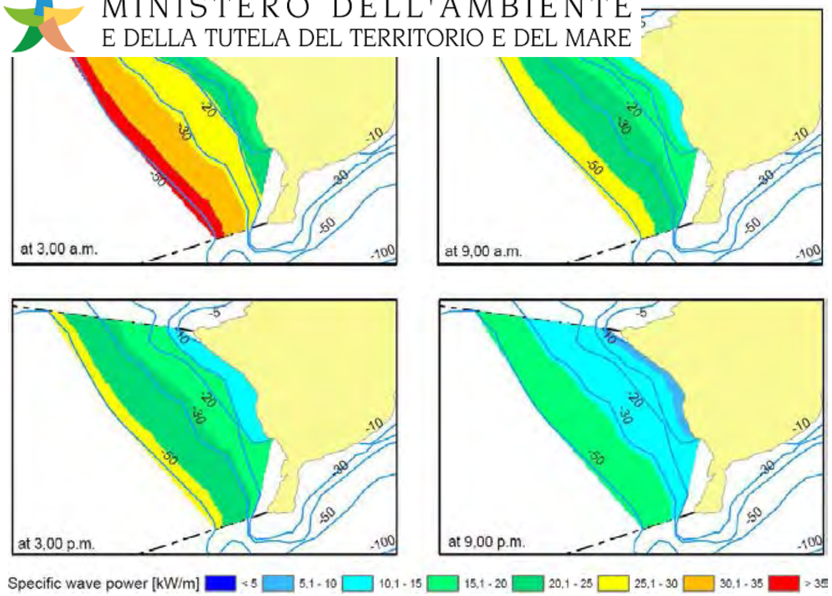


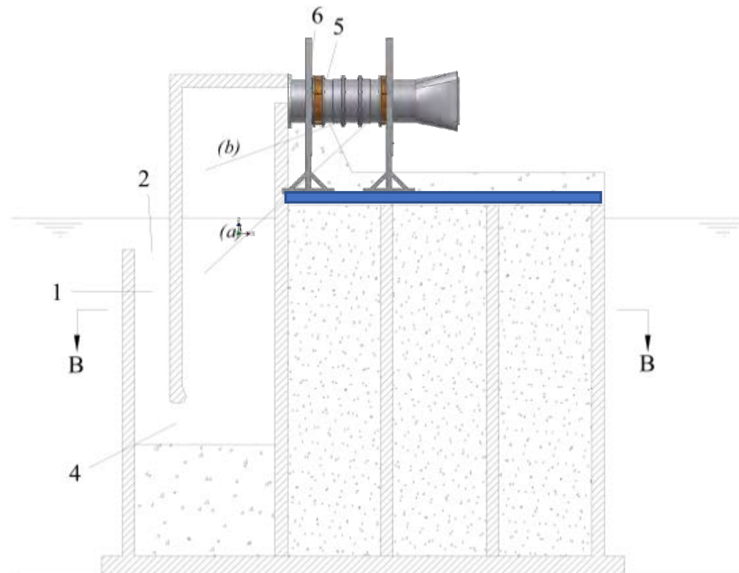
ACQUA LATINA
Al Servizio del Territorio

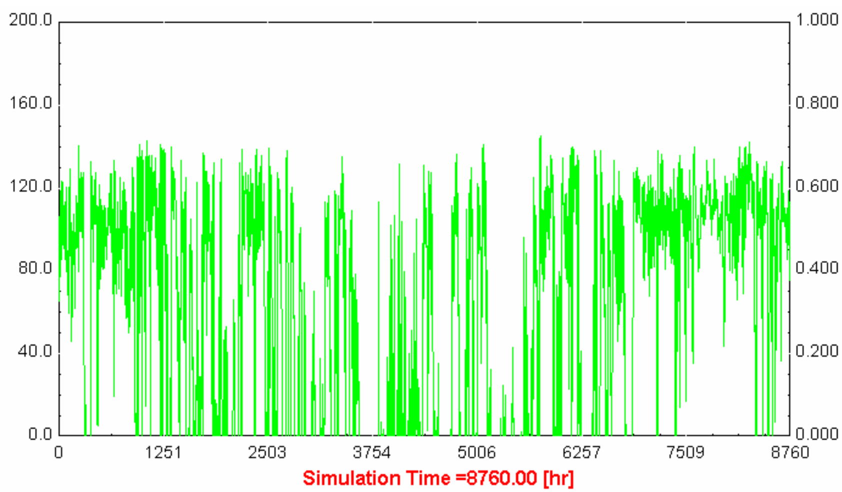
Modellazione time-dependent. Potenziale da moto ondoso nelle isole minori

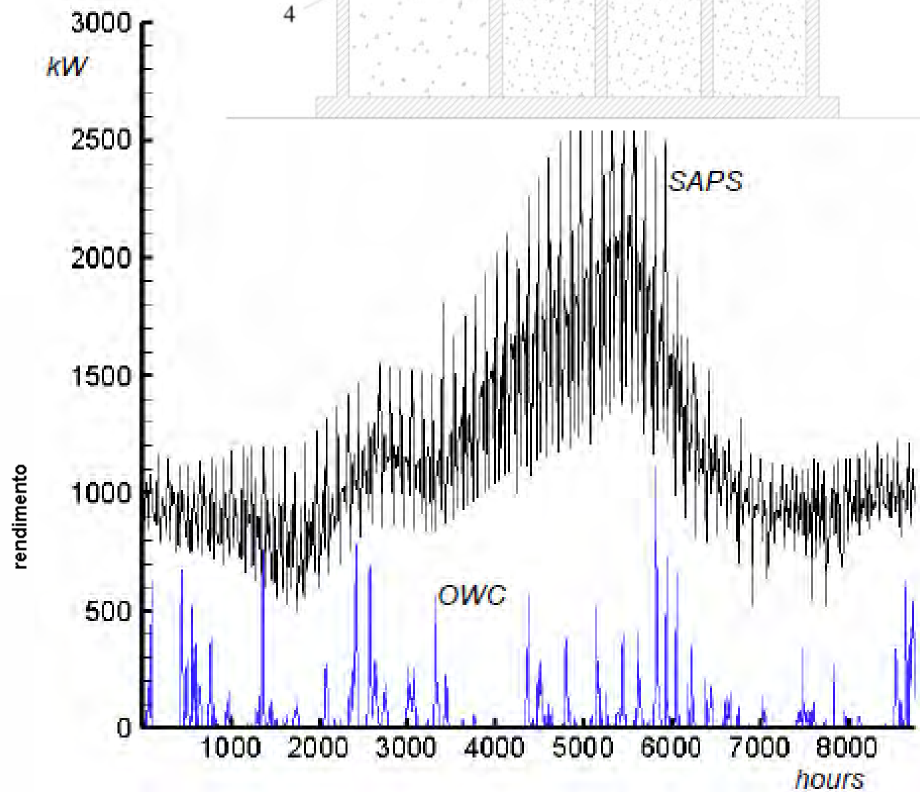
POSEIDONE consortium

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE









ICE

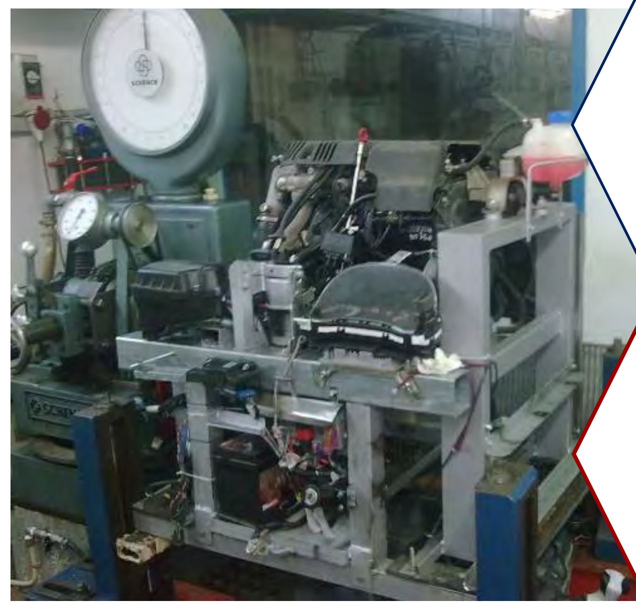
LAB

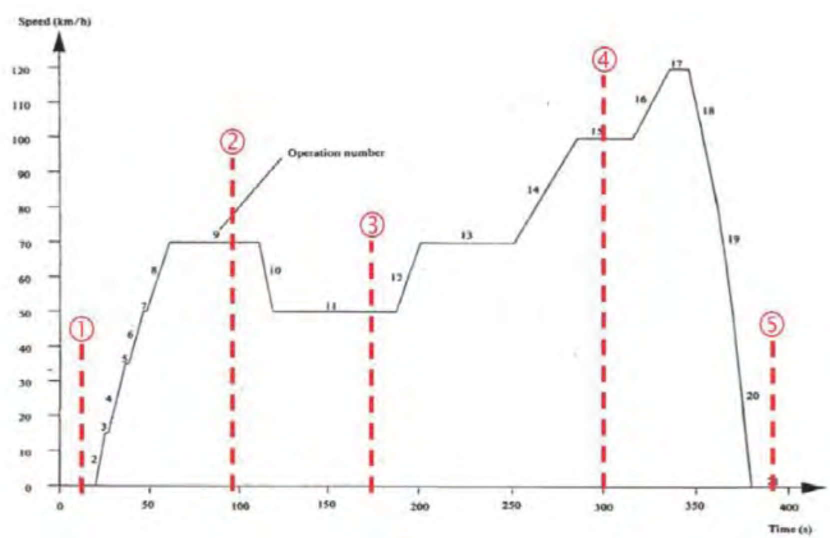
Vegetable oils fuelled common-rail engine

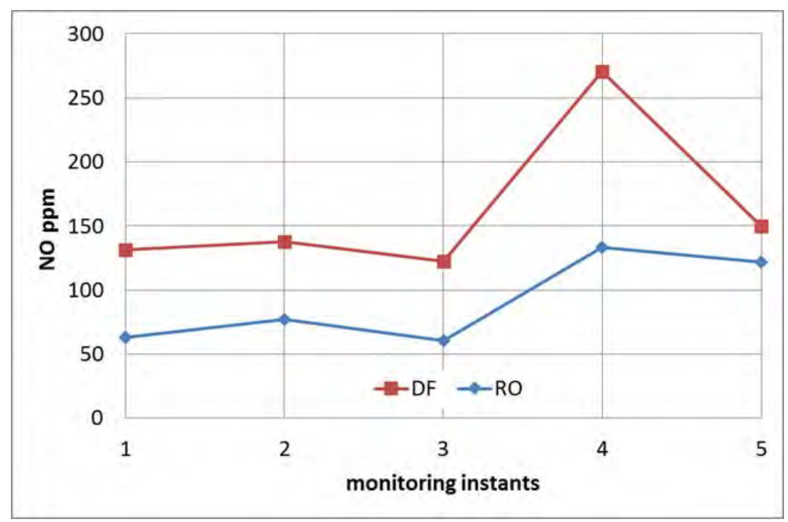
(A. Corsini, V. Giovannoni, S. Nardecchia, F. Rispoli, F. Sciulli, P. Venturini, ECOS2012, 2012, Perugia; Corsini A., Fanfarillo G., Rispoli F., Venturini P., Energy Procedia, 2015; Corsini A., Marchegiani A., Rispoli F., Sciulli F., Venturini P., Energy Procedia, 2015; A. Corsini, R. Di Antonio, G. Di Nucci, A. Marchegiani, F. Rispoli, P. Venturini, Energy Procedia, 2016)

Fuels used: rapeseed oils, waste cooking oil (WCO), biodiesel, gasoil, gasoil-WCO blends

Experimental setup: 1.9 JTD common-rail Diesel engine, dual fuel system, Bosch BEA emissions monitoring unit







Engine installed at DIMA Lab

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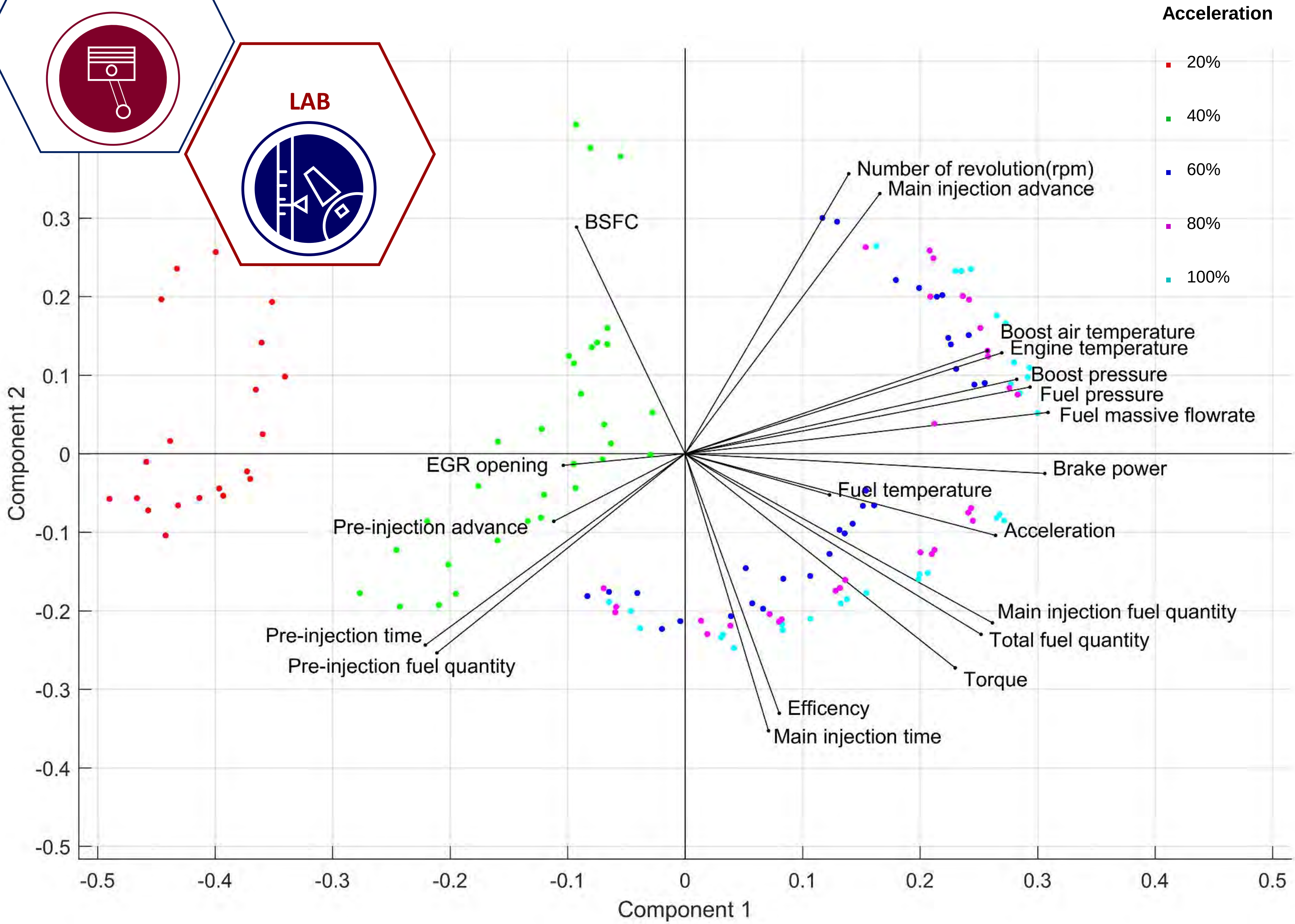
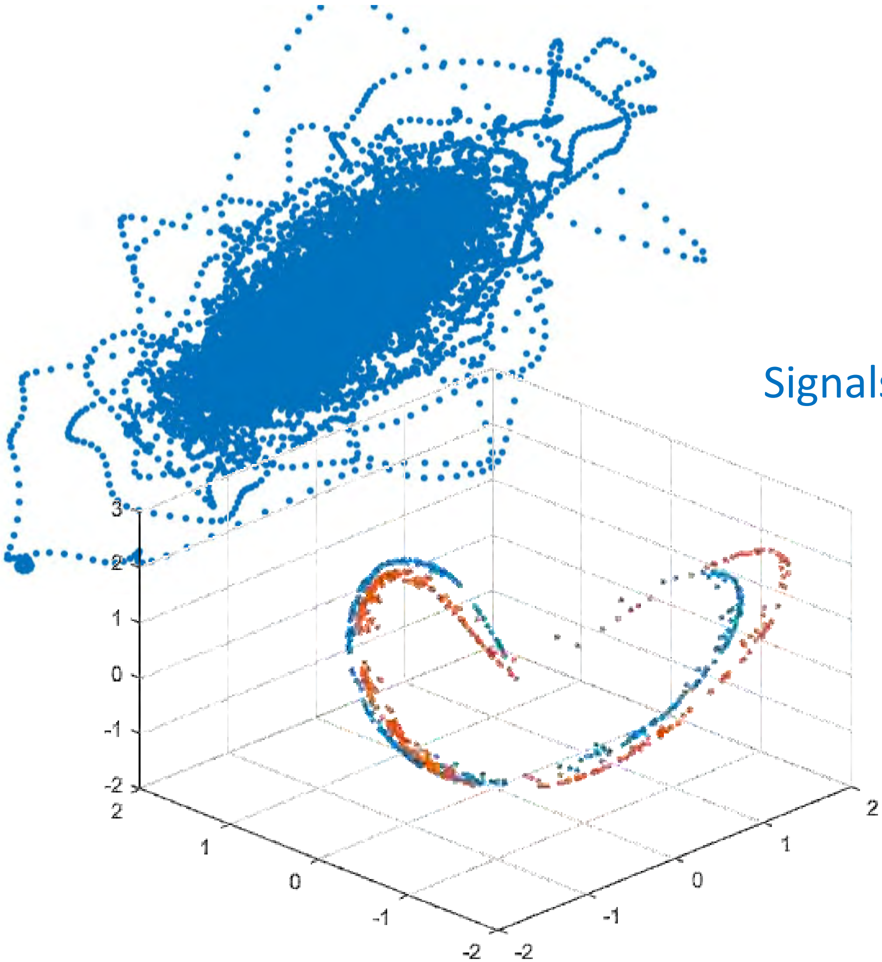
PCA based diagnostics in ICE





One sentence pitch

Signals are not to provide numbers but insights

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