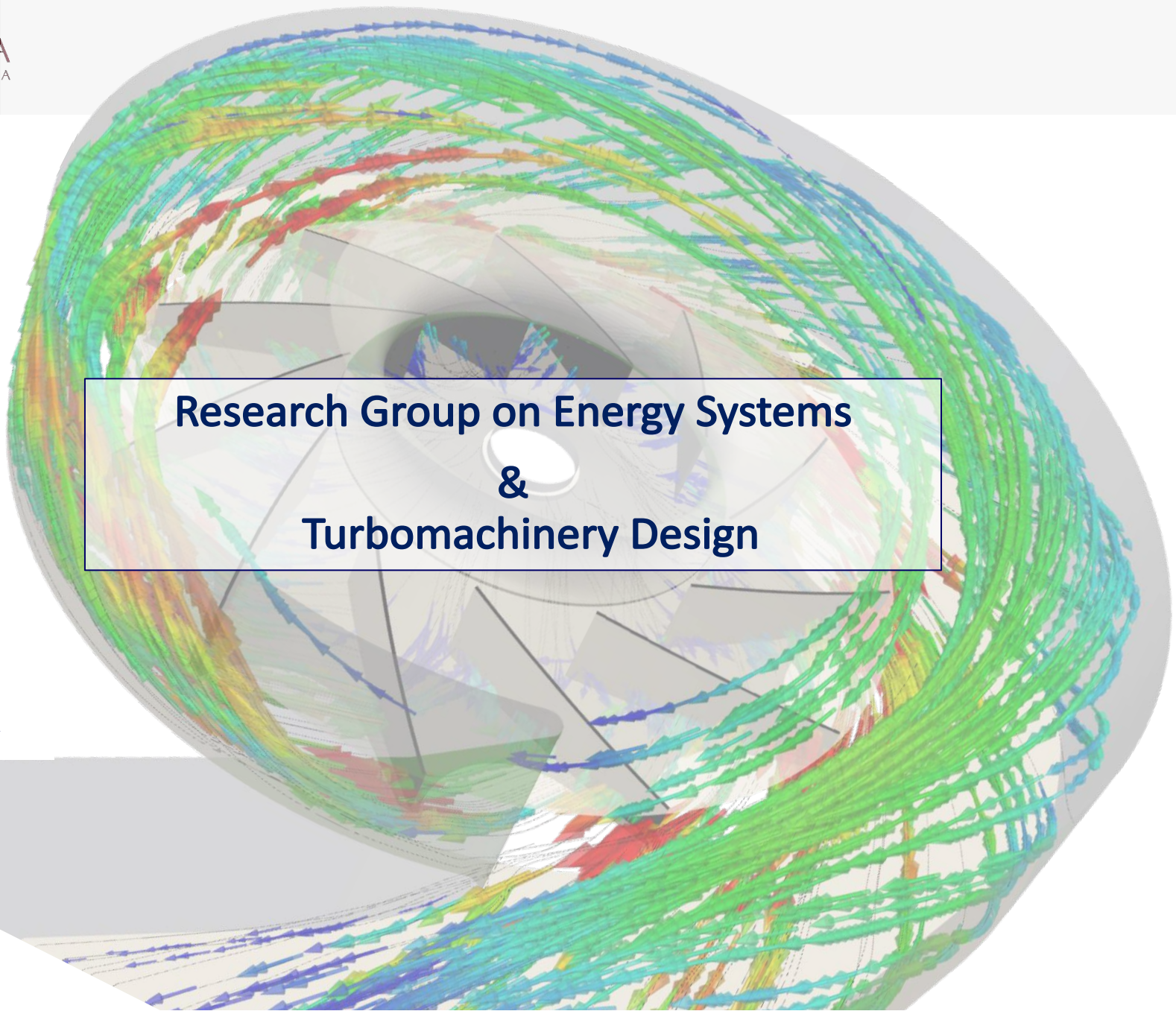
SAPIENZA
UNIVERSITÀ DI ROMA



Research Group on Energy Systems
&
Turbomachinery Design

Franco Rispoli

SSD ING-IND/09 SISTEMI PER L'ENERGIA E

Professors *(5)*
Franco Rispoli

Alessandro Corsini (Associate Professor, ASN-PO)
Domenico Borello (RTD-B, ASN-PA under evaluation as ASN-PO)
Luca Cedola, (RTD-A), Andrea Micangeli (past RTD-A under evaluation as ASN-PA)

Research Assistant & PostDoc *(8)*
Giovanni Delibra (under evaluation as ASN-PA),
Paolo Venturini (under evaluation as ASN-PA),
Katiuscia Cipri, Silvia Sangiorgio, Eileen Tortora, Andrea Marchegiani, Andrea Calabriso, Alessandro Tallini

Ph.D. Candidates *(6)*
David Volponi, Sara Feudo, Alessio Castorrini, Alessandro Salvagni, Simone Santori, Fabio D'Orta

Ph.D. students *(8)*
Tommaso Bonanni, Fabrizio Bonacina, Francesca Lucchetta, Giuliano Agati, Lorenzo Tieghi, Gino Angelini, Arash Aghaalikhani, Riccardo Del Citto

Bibliometry

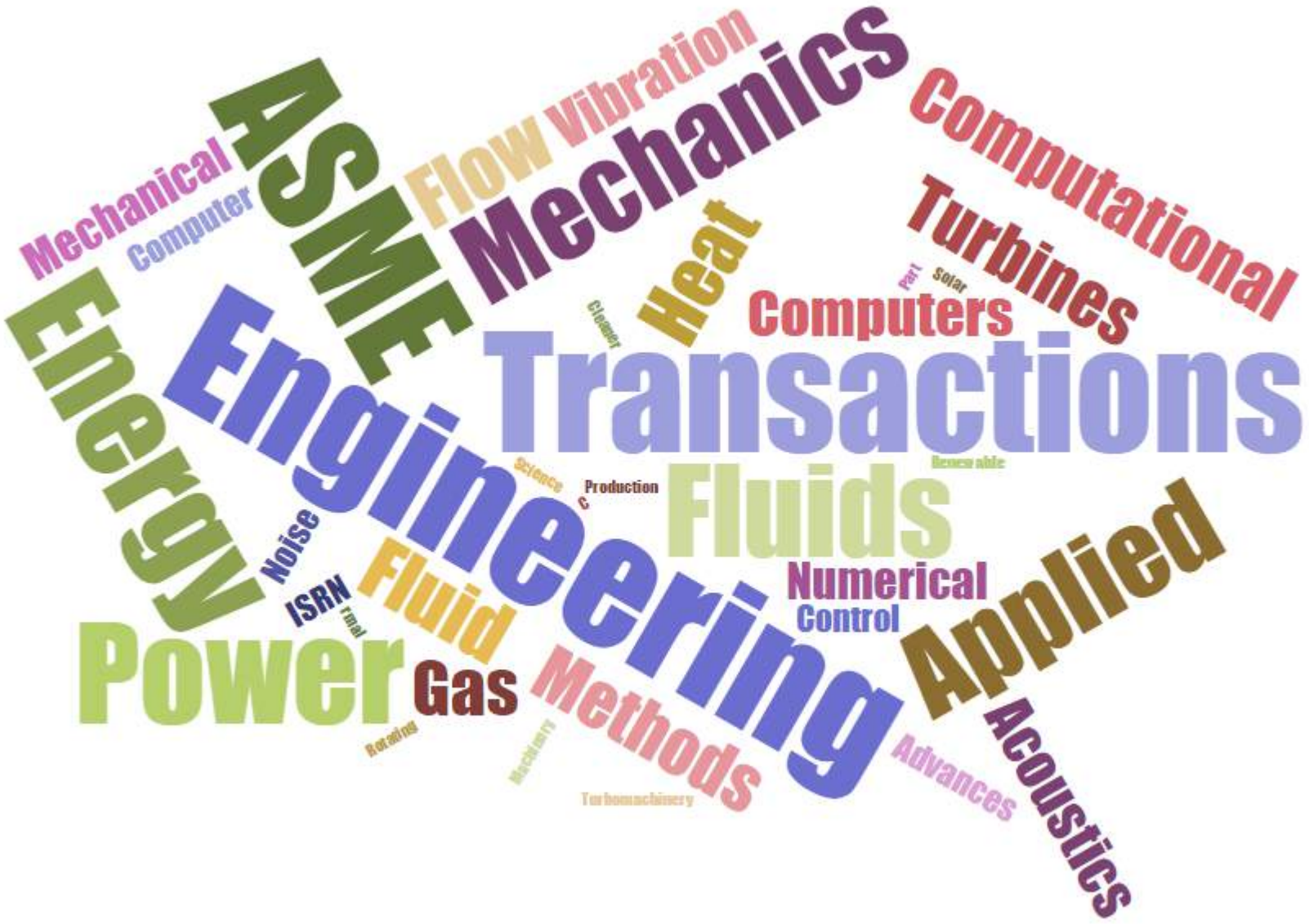
Scopus	*Rispoli*	*Corsini*	*Borello*	*Cedola*	*Delibra*	*Micangeli*	*Venturini*	*ASN PA*	*ASN PO*
Journals & Proc.s	128	113	70	15	37	19	34	6	10
h-index	18	16	12	4	6	8	8	5	7
Citations	884	741	440	25	149	130	150	60	159

Awards

THMT Young Researcher Prize, 2009
IMechE Donald Groen Prize on Fluid Machineries, 2013

ASME-IGTI Best Paper Award Coal Biomass and Alternative Fuels, 2013
ASME-IGTI Outstanding Service Award, 2015
ASME-IGTI Best Paper Award Fans&Blowers Committee, 2016

KEYWORDS ON TITLES OF JOURNAL WE PUBLISHED IN



Technical & Scientific Associations

Chair of OWEMES
Chair of ATI Lazio

Leadership roles in ASME Turbo Expo Technical Committees

Vanguard Chair Turbomachinery TC,
Vanguarda Chair Heat Transfer TC,
Committee Chair Fan & Blowers TC

Leadership roles in Scientific Conferences

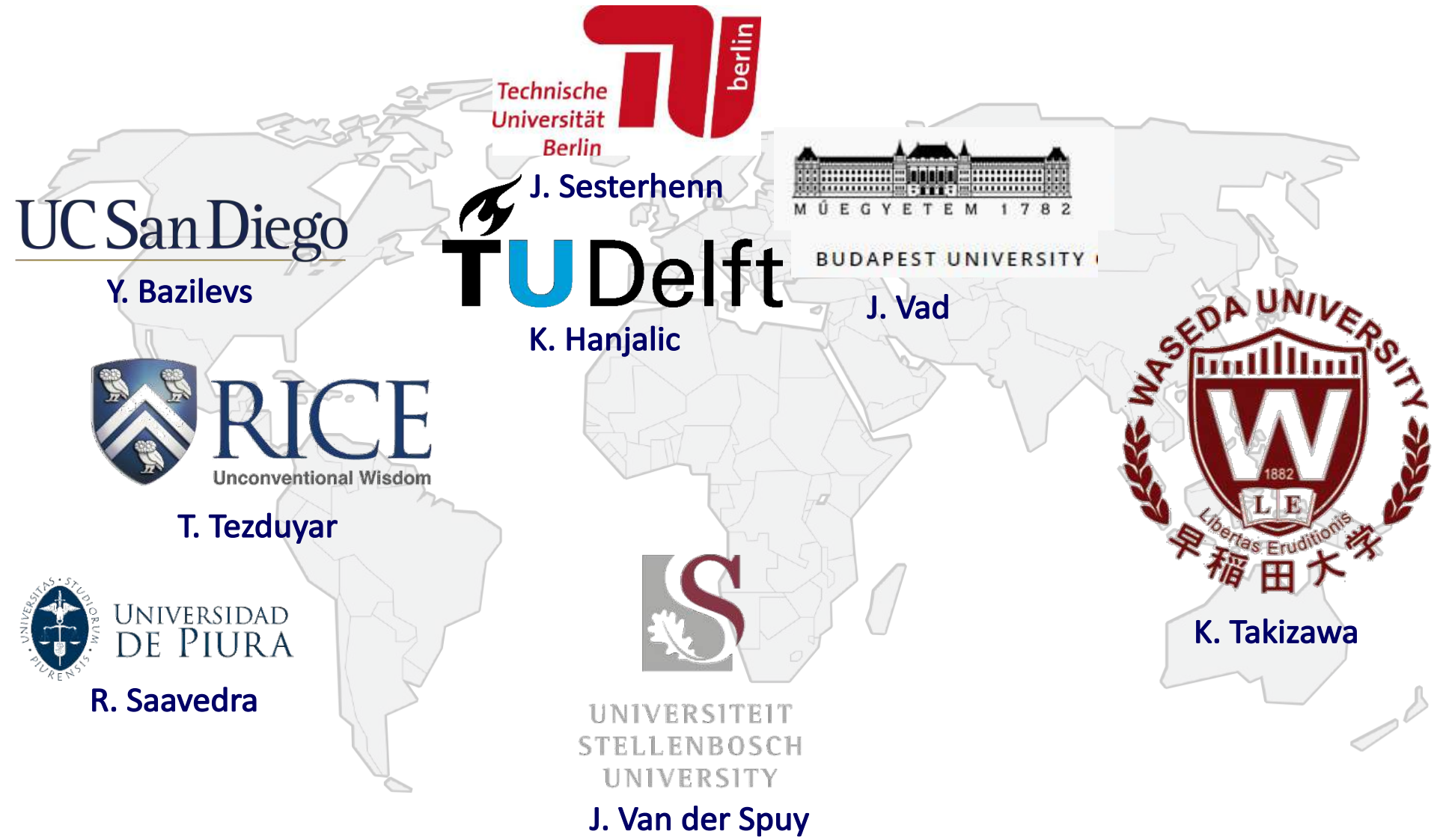
ICHMT, Scientific Committee

International Fan Conference Committee, Co-Chair

Finite Element in Fluids 2017 Conference, Co-Chair

OWEMES 2017 Seminar 2017 Conference Chair

SCIENTIFIC COLLABORATIONS



RELEVANT INDUSTRIAL COLLABORATIONS: 27 CONTRACTS, 6 PATENTS

EU FOUNDED PROJECTS

SSD: ING-IND/09

GOVERNMENTAL COLLABORATIONS

Consiglio Nazionale
delle Ricerche

3M+ CPU HOURS

CLUSTER TECNOLOGICO NAZIONALE

SSD: ING-IND/09

SSD: ING-IND/09

Modelling of Industrial Flows

In-House codes

FEM URANS LES Code for incompressible and compressible flows (XENIOS++)
FVM URANS, LES Code for incompressible flows (T-FlowS)
FSI Incompressible flow and linear elastic material (XENIOS++/FSI)
Single and cloud particle-tracking for deposit and erosion FEM-Based (P-Track)
FDM Multiphase DNS code (NSF, developed at TU Berlin and currently jointly advanced)

Open Source & Commercial codes

FVM Open source multi-purpose code (OpenFOAM)
FEM Multi-physics (electric field and incompressible flows) modelling of Fuel Cell (COMSOL)

In-house tools

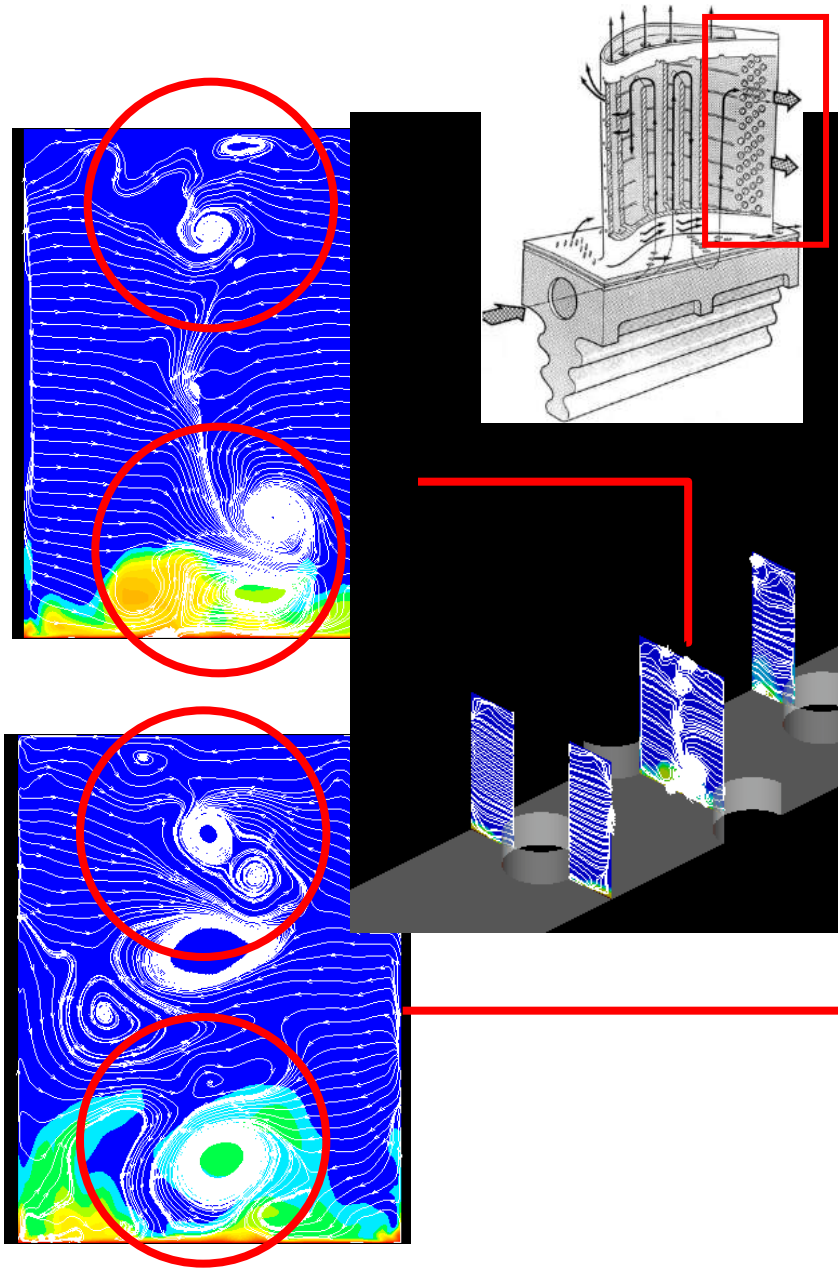
1D gas dynamic solver
Industrial TM design suite & optimization tools
Pattern recognition

Modelling of Energy Systems

Transient energy system modeling suite (TRNSyS)
Modelling of energy conversion processes (ASPEN Plus/ChemCad and WEC-Sym)
Data analytics for energy system diagnosis and prognosis

SSD: ING-IND/09

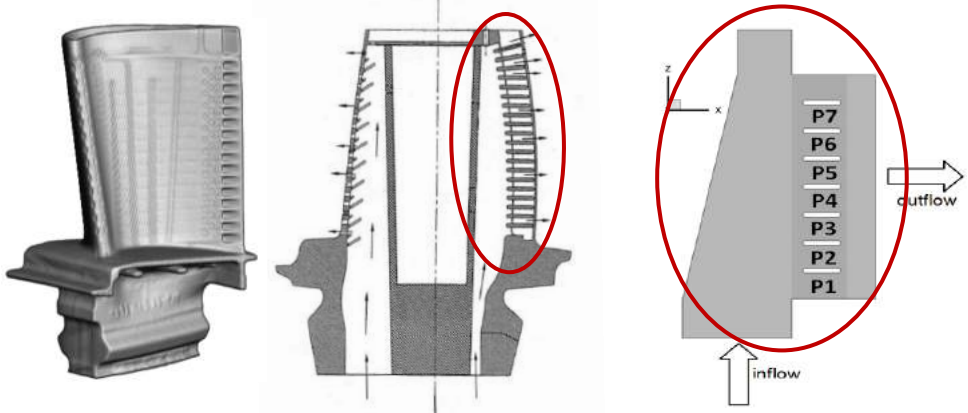
Internal cooling of GT blades with pinned passages

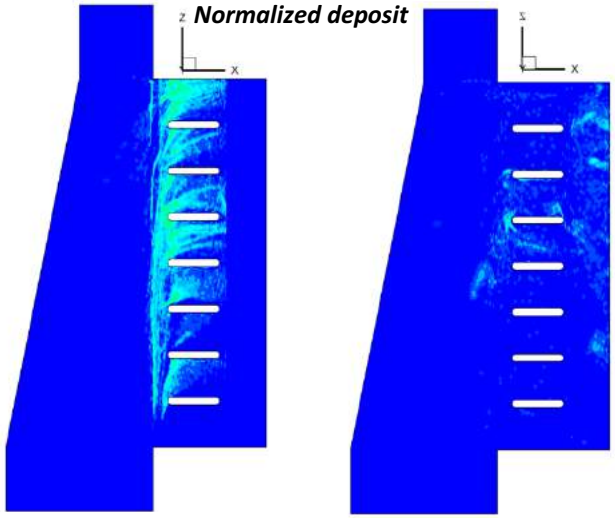


PARTICLE TRACKING: PREDICTION OF DEPOSIT FORMATION IN TURBOMACHINERY APPLICATIONS

Particle deposition on GT internal cooling channel

Turbulence Modelling: U-RANS ζ-f model
Single Particle Tracking
Adhesion model: impact mechanics (Johnson-Kendall-Roberts)



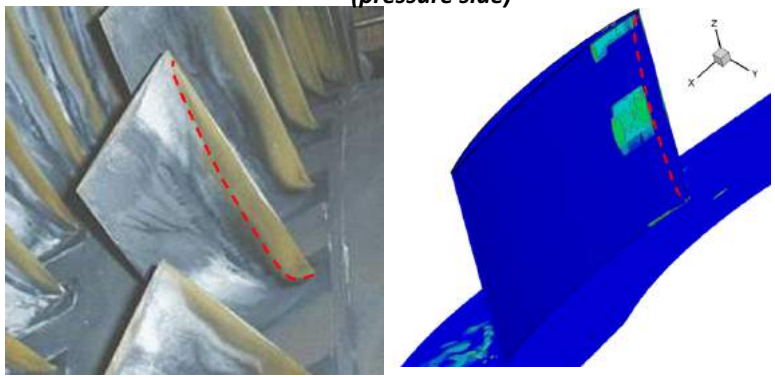


Pressure surface *Suction Surface*

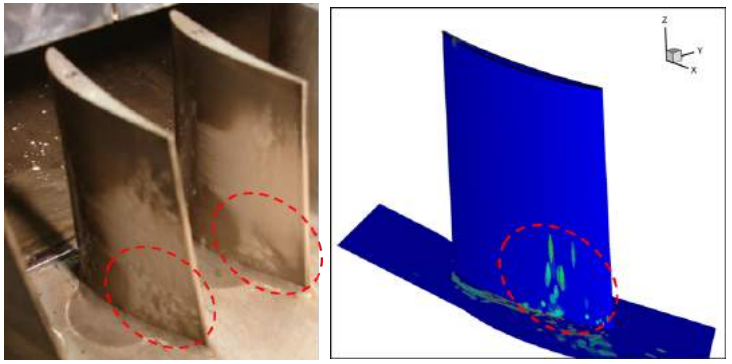
Compressor blade erosion

Turbulence Modelling: hybrid LES-RANS ζ-f model
Single Particle Tracking
Erosion model: semi-empirical (Tabakoff)

) ***Qualitative comparison between actual and simulated eroded blade (pressure side)***



Qualitative comparison between actual and simulated eroded blade (suction side)



CAE TOOL DEVELOPMENT FOR FSI APPLICATIONS ON ROTATING BLADES

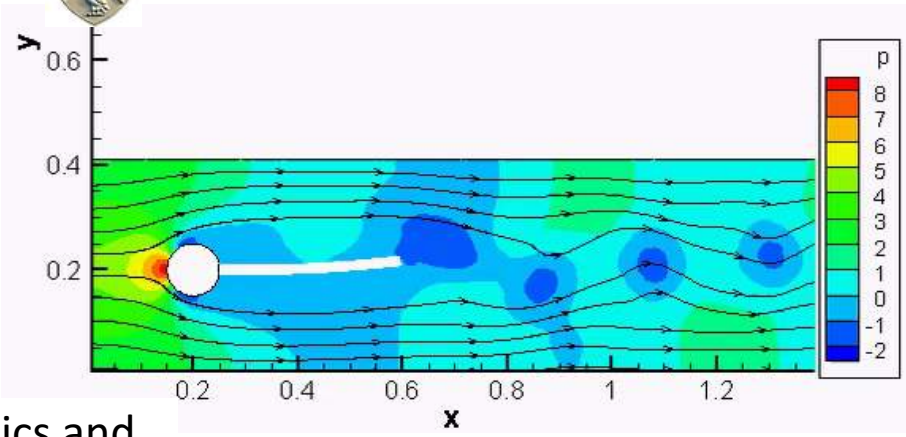
SAPIENZA UNIVERSITÀ DI ROMA

Waseda University

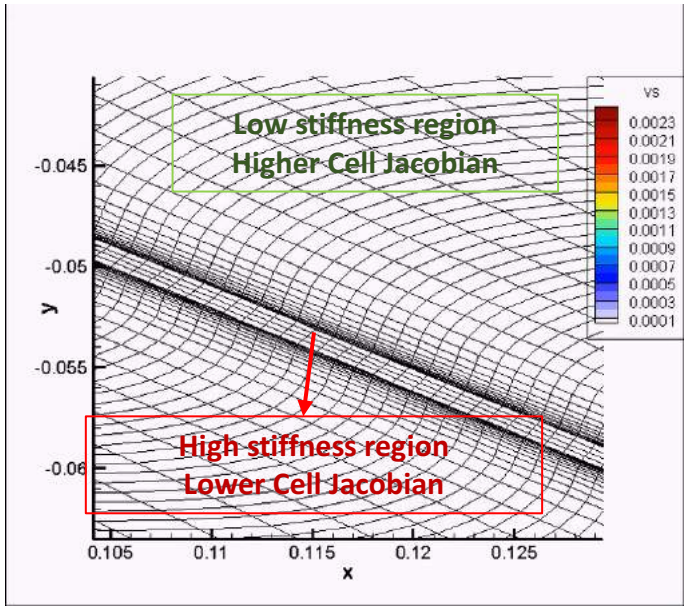
RICE University

CFD & FSI

FSI SOLVER CAPABILITIES



- Fluid dynamics and structure motion mutual and direct interaction
- Non-linear aerodynamic effects
- Mesh quality control during motion



FSI SOLVER

STRONG COUPLING FSI
PARTIALLY-SEGREGATED ITERATIVE SOLUTION OF 4-COUPLED S.O.E.:
1. ALE-URANS
2. ALE K-ε
3. SD
4. MM

1-2
ALE-URANS
ARBITRARY LAGRANGIAN-EULERIAN FORMULATION OF URANS EQUATIONS WITH K-Eps TURBULENCE MODEL

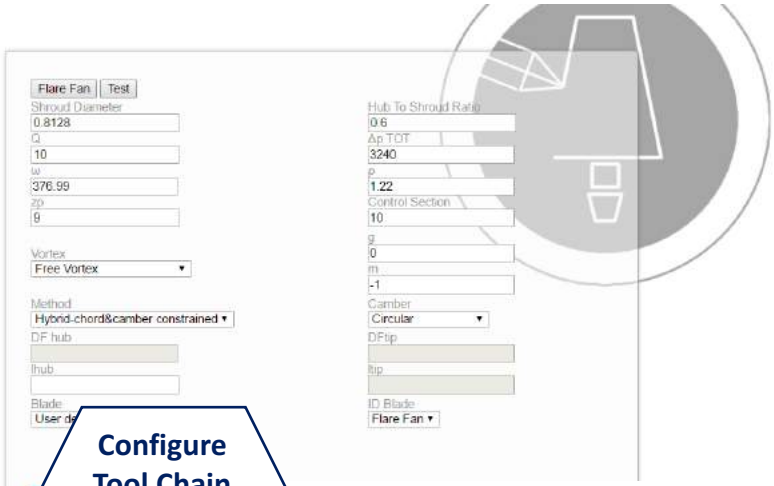
3
SD
(STRUCTURE DYNAMICS)
UPDATED LAGRANGIAN FORMULATION OF SOLID STRUCTURE DYNAMICS

4
MM
(MOVING MESH)
SOLID EXTENSION TECHNIQUE WITH ELEMENT JACOBIAN BASED STIFFNESS

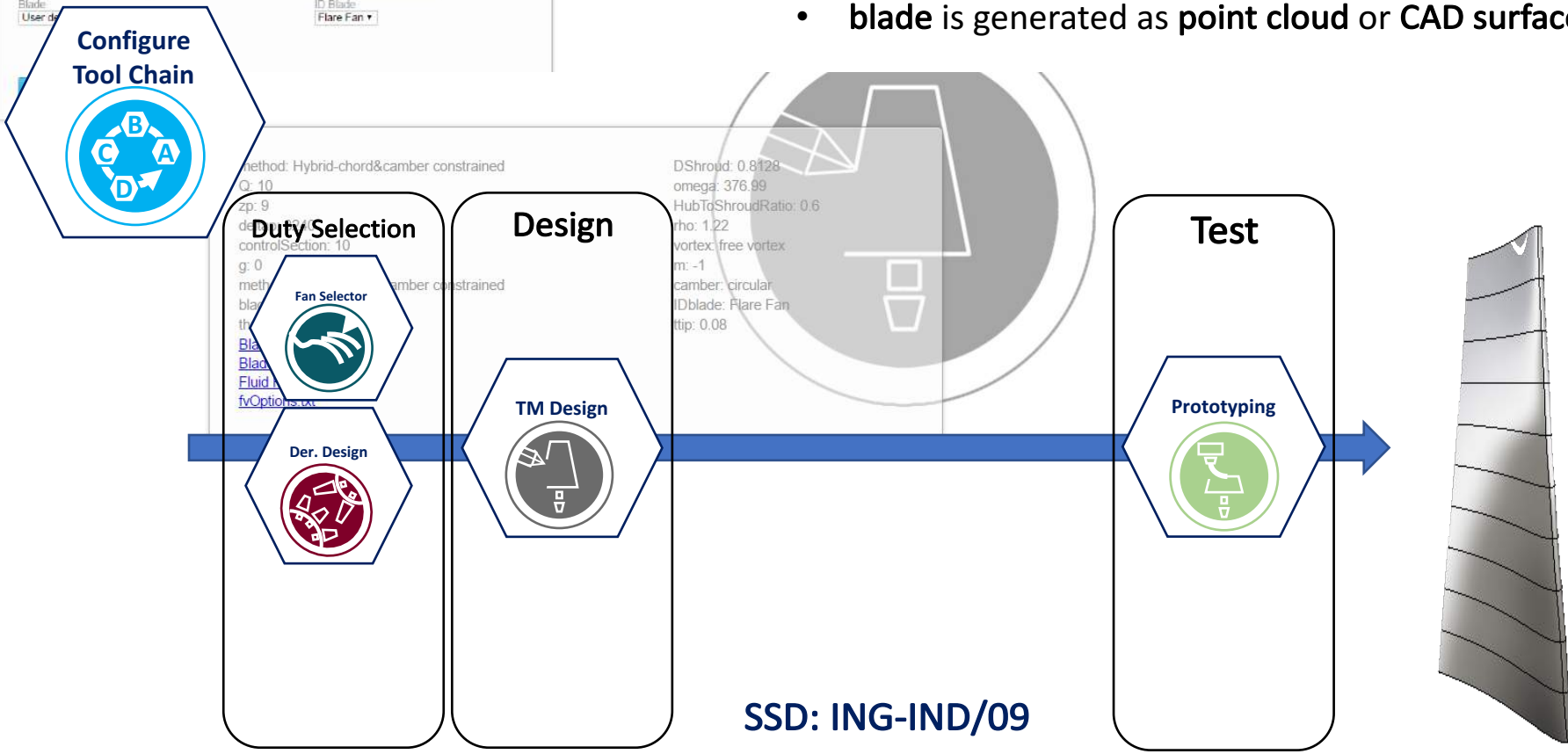
FEM STABILIZED FORMULATIONS
GLS – SUPG/PSPG/DRDJ
VS – GENERALIZED – α NEWMARK MODEL

SSD: ING-IND/09

INDUSTRIAL TM DESIGN SUITE & OPTIMIZATION TOOLS



- written in **Python**, based on an **axisymmetric solution of the indirect problem**
- Web application
- allows to test **innovative design solutions**
- **export**, **share** and **compare** different designs.
- **blade** is generated as **point cloud** or **CAD surface**



SSD: ING-IND/09

DESIGN AND EXPERIMENTAL INVESTIGATION OF TURBOMACHINERY

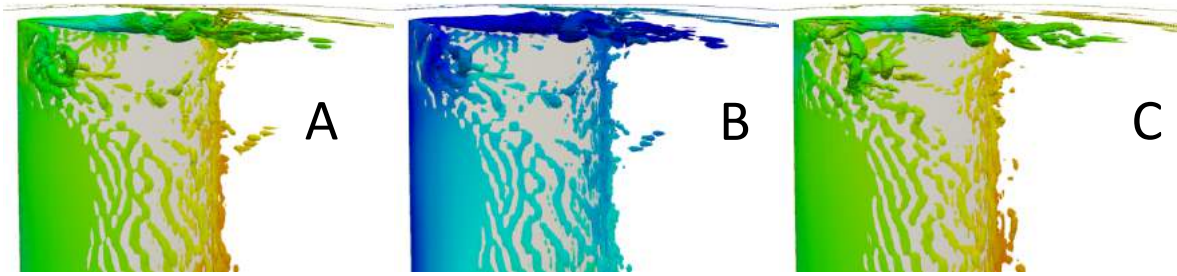
- *Passive noise control technology in industrial fans – Flakt Woods, Howden*
- *Stall identification, control and suppression – Flakt AB, SED Solutions*
- *Control of secondary flow phenomena in industrial fluid machineries – Ebara*
- *Design and onshore installation of a Wells Turbine tailored to Mediterranean Sea Operations (MATTM)*
- *Design of Offshore 15MW Wind Turbine (Micoperi)*
- *3D Design and optimization of turbomachinery*
- *Data Intensive turbomachinery design methodologies*
- *DIY experimental techniques (for stall and instability detection) – SED Solutions*

SSD: ING-IND/09

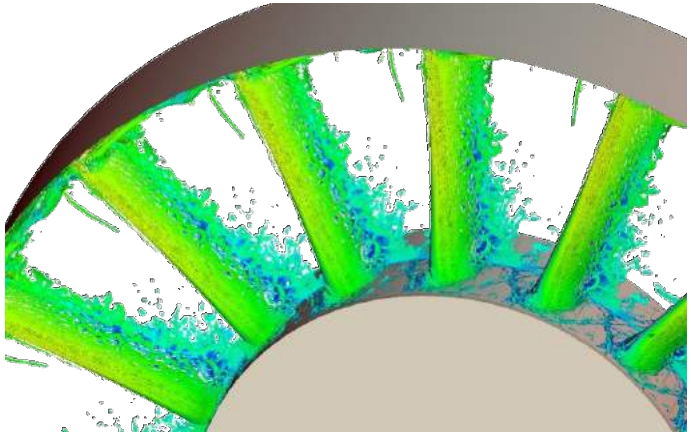
TUNNEL & METRO FAN IN OFF-DESIGN OPERATIONS

FläktWoods

2.24 m tunnel&metro fan

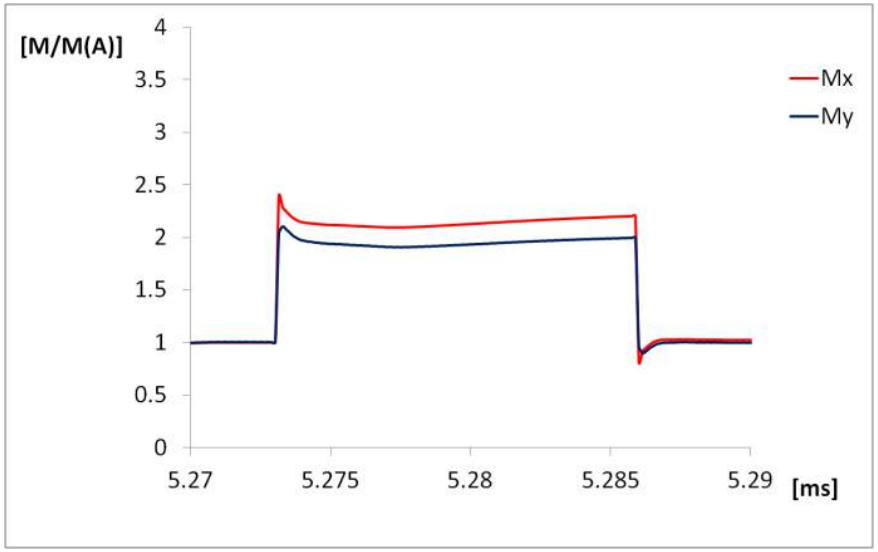


TLV before the pressure pulse (A), during pressure pulse (B) and after pressure pulse (C)

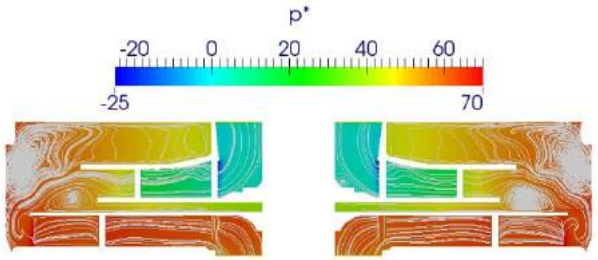


AIM of the work: investigate how pressure pulses propagating through the tunnels affect the aerodynamics and mechanics of the fan

Findings: torque during PP double (may lead to failure)

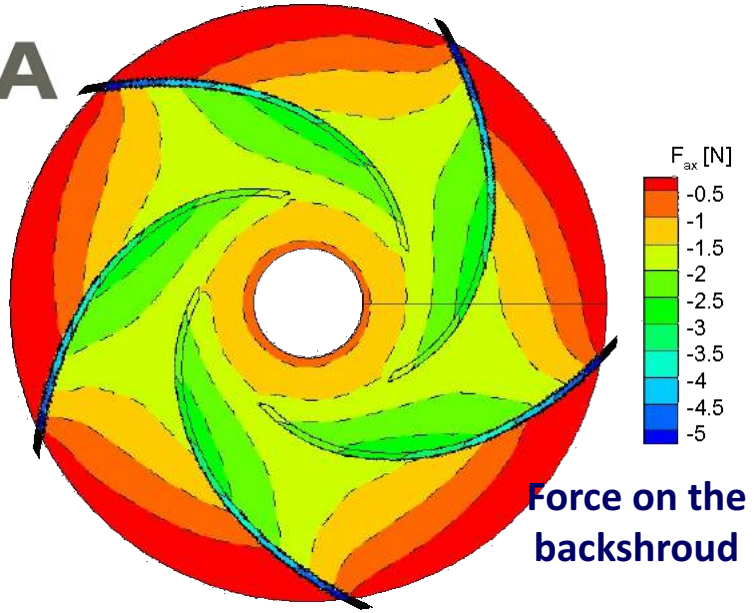


ZERO-THRUST MULTISTAGE AXIAL PUMP



ANALISYS OF PRESSURE IN THE STAGE (MERIDIONAL VIEW)

EBARA



Force on the backshroud

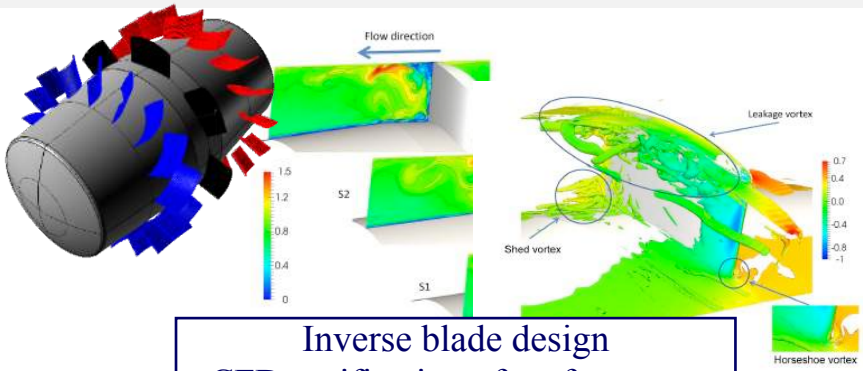
Prototype

Final product

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

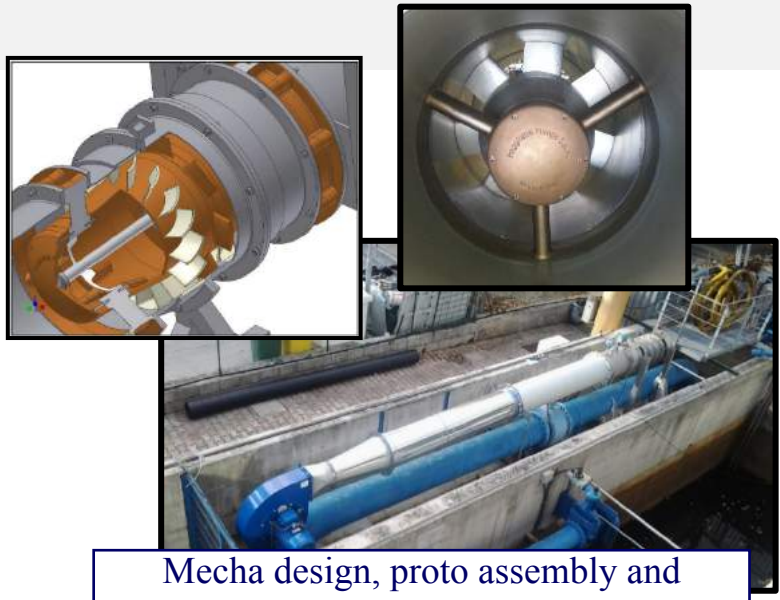
SAPIENZA
UNIVERSITÀ DI ROMA

POSEIDONE PROJECT



Inverse blade design
CFD verification of performance

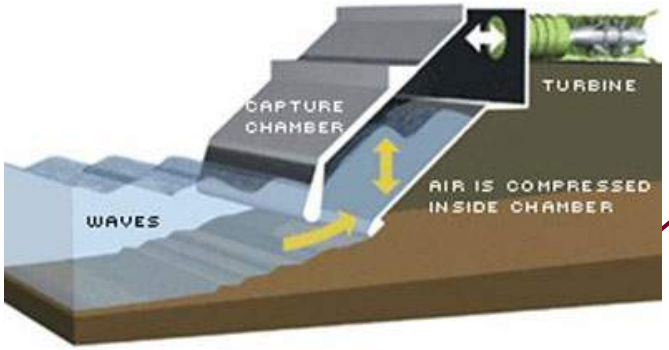
SAPIENZA
UNIVERSITÀ DI ROMA



Mecha design, proto assembly and experimental validation in lab

FAGGIOLATI PUMPS S.p.A.
ISO 9001 - ISO 14001
ISO 80079 (ATEX)
Macerata - Italy
Divisione Energia

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



OWC caisson design

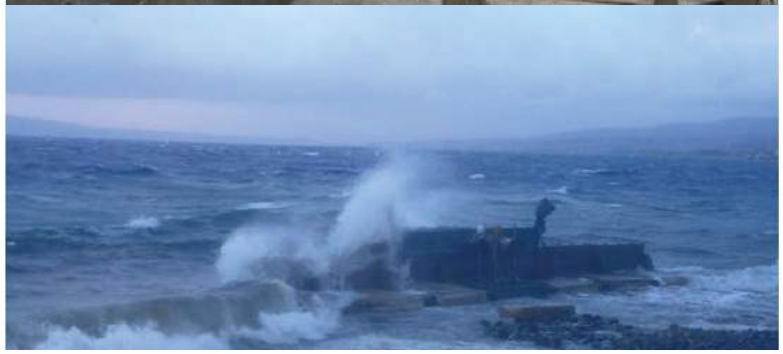
WAVENERGY.IT

On-shore installation and test

Università degli Studi Mediterranea di Reggio Calabria
DICEAM

SSD: ING-IND/09

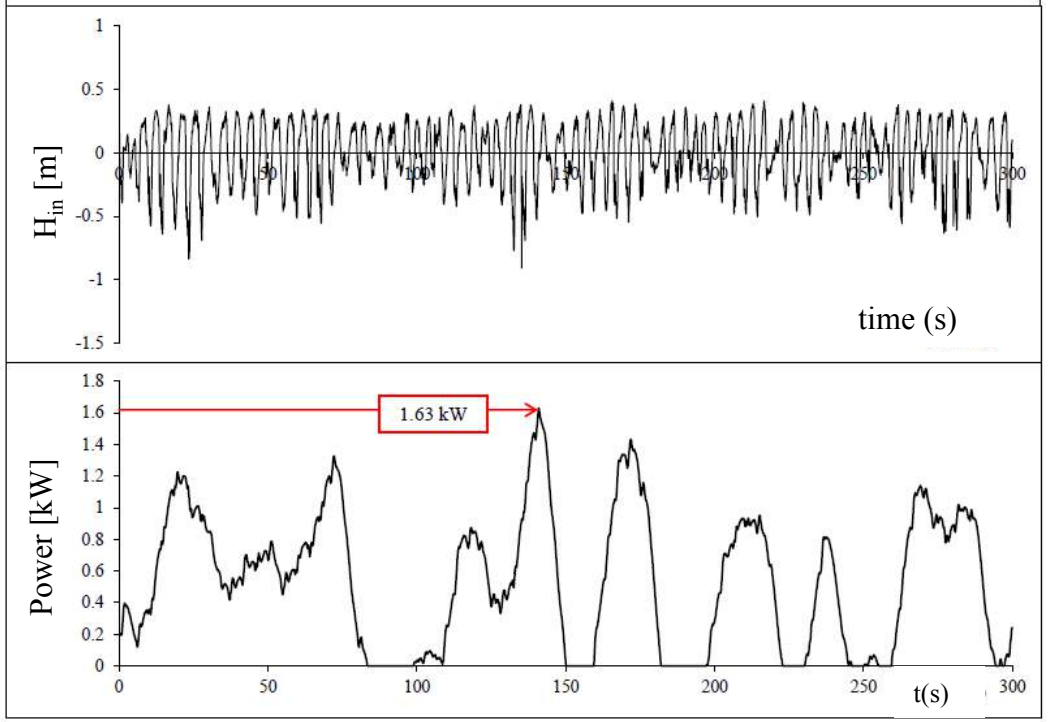
WELLS TURBINE: OPEN SEA RESULTS



record 1163 (01/09/2014)

Average Power: 492 W @ 3500 rpm

Sea conditions: H_s = 1.03 m T_p = 3.8 s



Università degli Studi Mediterranea di Reggio Calabria

DICEAM

SAPIENZA UNIVERSITÀ DI ROMA

FAGGIOLATI PUMPS S.p.A Human Technology Produzione Pompe Sommergibili

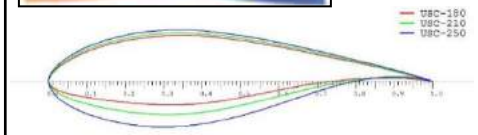
WAVENERGY.IT

SSD: ING-IND/09

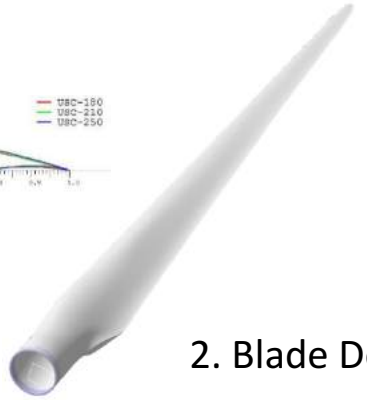
WIND TURBINES TECHNOLOGY: INDUSTRIAL AND RESEARCH PROJECTS

Project: Aero-mechanical design of 15MW HAWT – 190 m diameter

MICOPERI ENERGIA

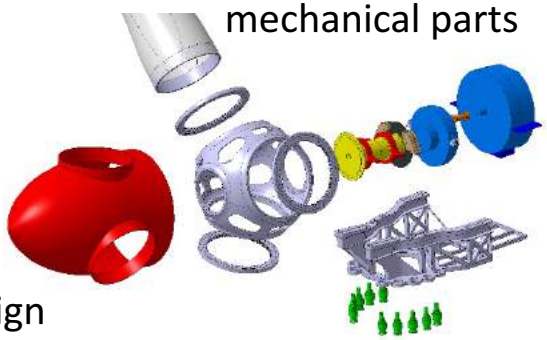


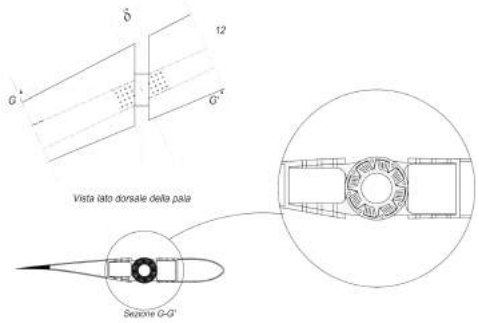
1. Optimized airfoil design



2. Blade Design

3. Preliminary sizing of mechanical parts

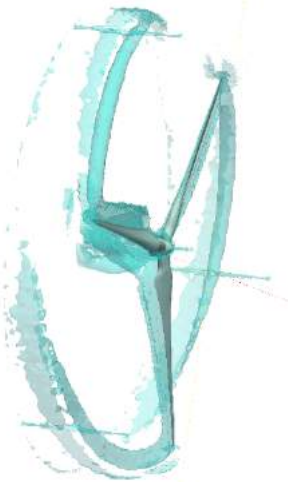




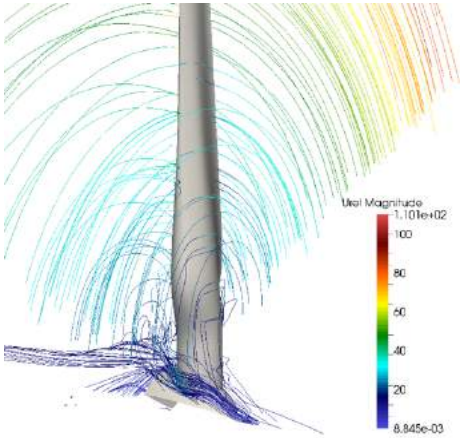
Patent: Modular HAWT with elastomeric joint (concept)

Research: Numerical prediction of rain erosion on Multi MW-HAWT blades

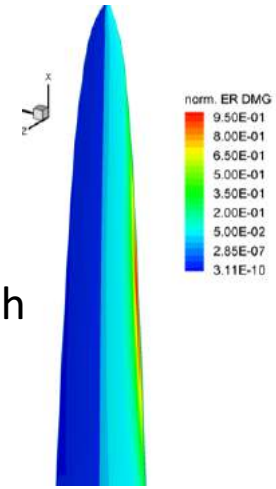
1. RANS of design operating point



2. PCT with different rain drop sizes



3. Erosion Damage on the blade with empirical models



Castorrini et al.. "Computational analysis of wind-turbine blade rain erosion." Computers & Fluids 141 (2016): 175-183.

SSD: ING-IND/09

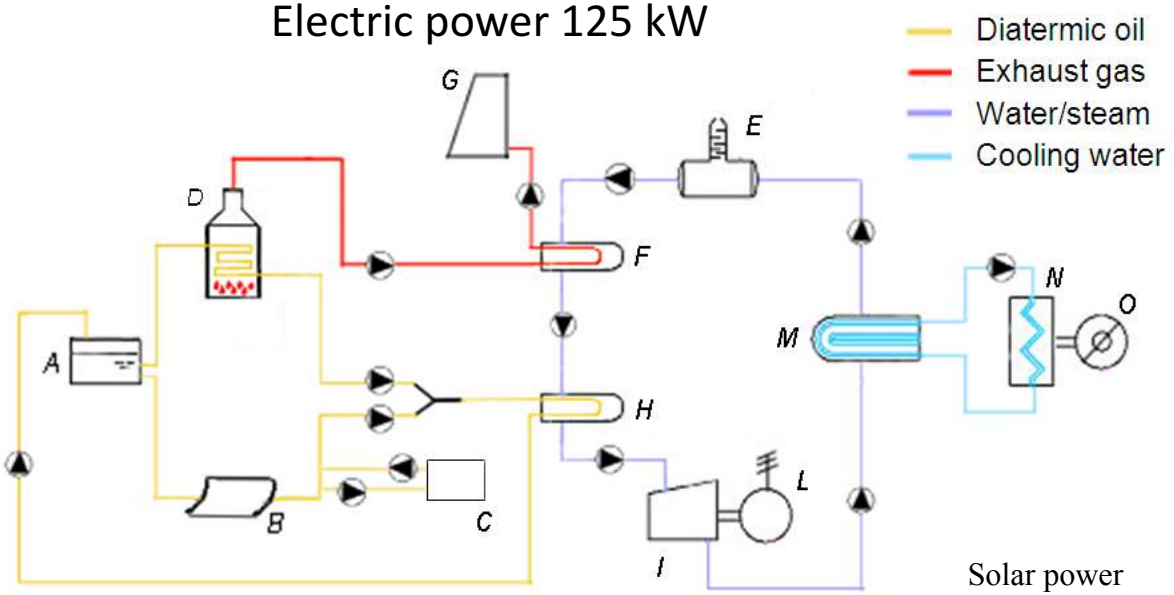
DESIGN AND EXPERIMENTAL INVESTIGATION OF ENERGY SYSTEMS

- *Biomass Gasification: TAR reduction and plant assisted fitoremediation with:*
- *RESET s.r.l., ISPRA, CNR*
- *Direct Methanol Fuel Cells: advanced configurations – with MM and Fincantieri*
- *Lithium Batteries: Management &Verification (Prof. Del Prete) - with MM and Fincantieri*
- *Development of CC4E (Clean Canvas 4 Environment) process – with Regione Lazio*
- *Biofuels in Internal Combustion Engines – with CURSA and Power Clean*
- *Pulse tube Stirling Engine: Molecular Freezing -to promote*
- *Coal Gasification: CCS techniques – with PAR-ENEA*
- *Design of Wave Energy Converter - with PAR-ENEA and MATTM*

SSD: ING-IND/09

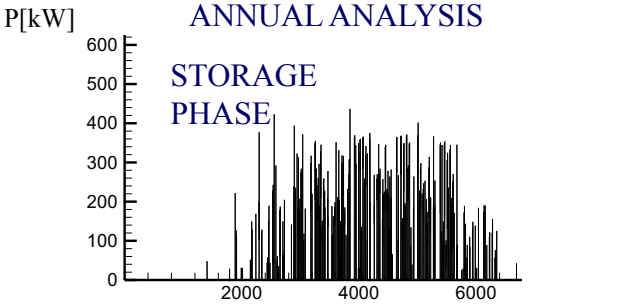
CSP WITH THERMAL STORAGE

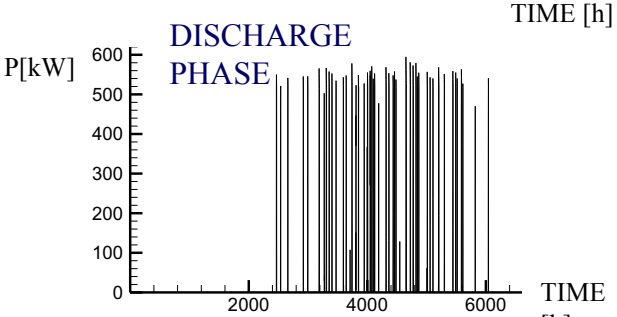
Electric power 125 kW

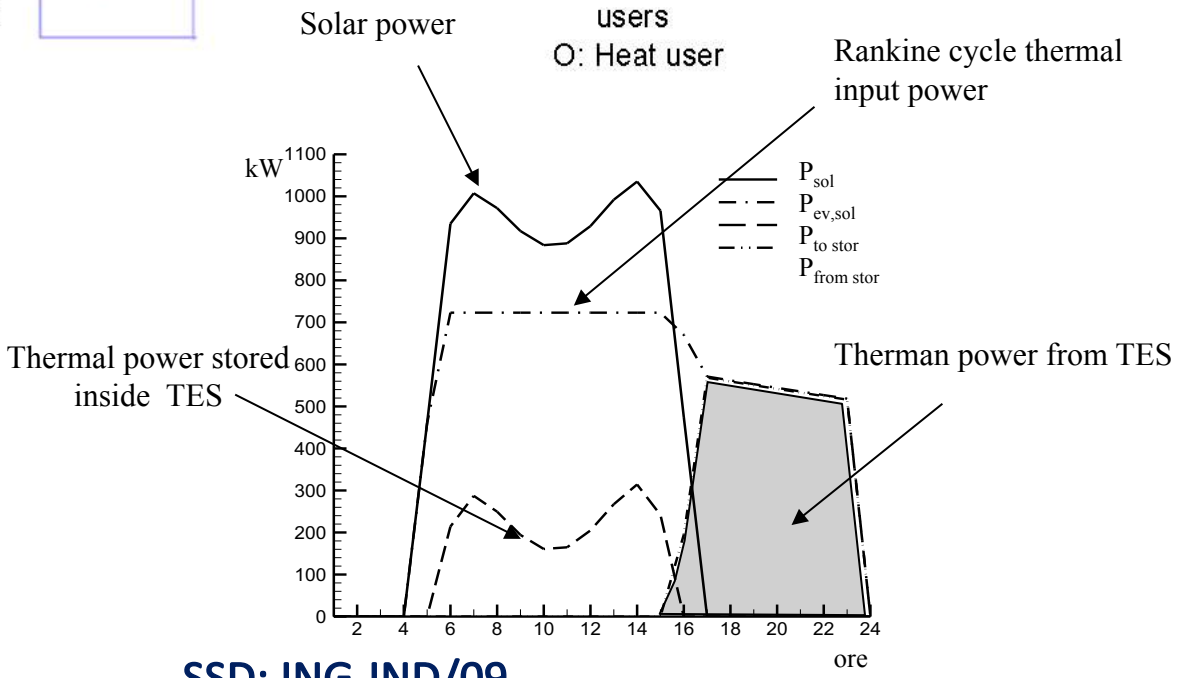


A: Oil vessel
B: Parabolic trough field
C: Therma energy storage
D: Biomass furnace
E: Degasser
F: Economizer
G: Chimney
H: Evaporator
I: Steam engine
L: Electricity user
M: Condenser
N: Heat exchanger for low temperature users
O: Heat user

ANNUAL ANALYSIS







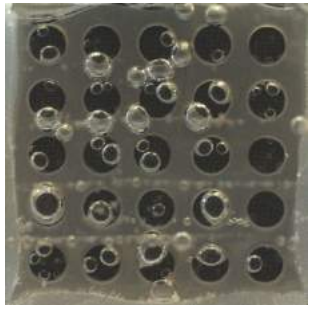
SSD: ING-IND/09

DMFC – DIRECT METHANOL FUEL CELL

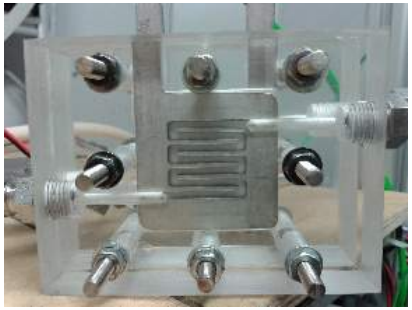
Projects:

- **Ecocell**, 2013-2014. Development of a test rig for a 120 W DMFC.
    a. Assembly and test of single DMFC
    b. Assembly of the test bench and test of a commercial short stack
- **Stealth Energy**, 2015-2016. Design of a 1.3 kW DMFC stack and assembly of a test bench for higher power.
- **FarSeas**, 2016-2017. Design of a DMFC system for an *AIP* (Air Indepndent Propulsion).
    a. Experimental tests measuring the permanent degradation over *800 h* of functioning on a commercial *1 kW* stack.
    b. Sizing of a DMFC system for a *240 kW*.

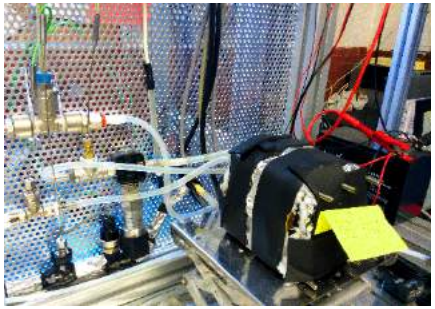
DMFC7. *Test rig for a 1.5 kW DMFC system for 800 h of permanent degradation test*



DMFC4. *Passive DMFC under high current density.*



DMFC5. *Active DMFC assembly*

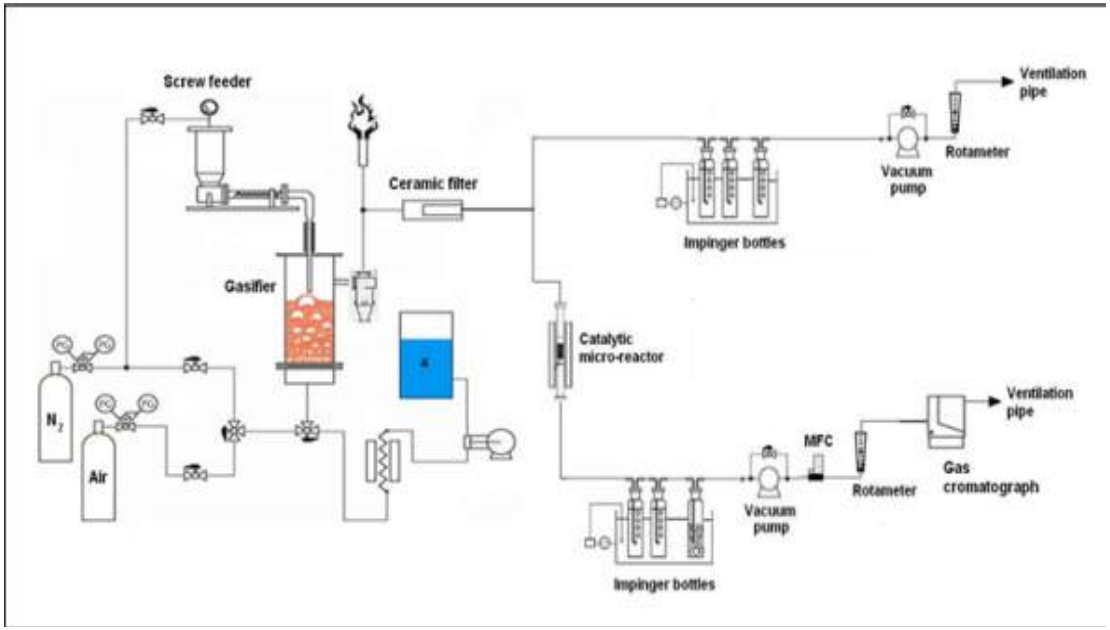


DMFC6. *120 W DMFC stack under test*

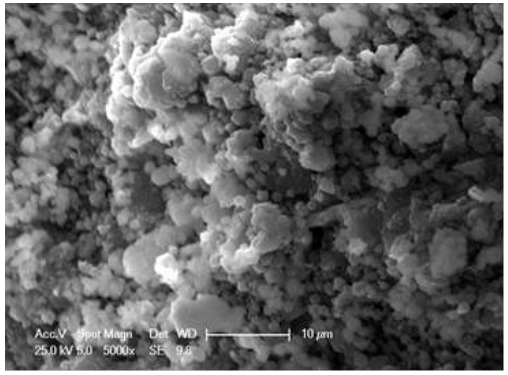
Catalyzers for tar reforming

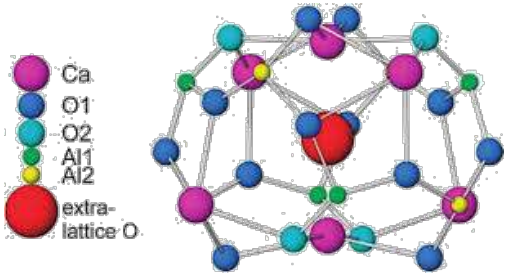
Plant-assisted Fitoremediation

✓ Experimental test-rig, cooperation with RESET s.r.l., CNR and ISPRA



Ni-Mayenite catalyzer



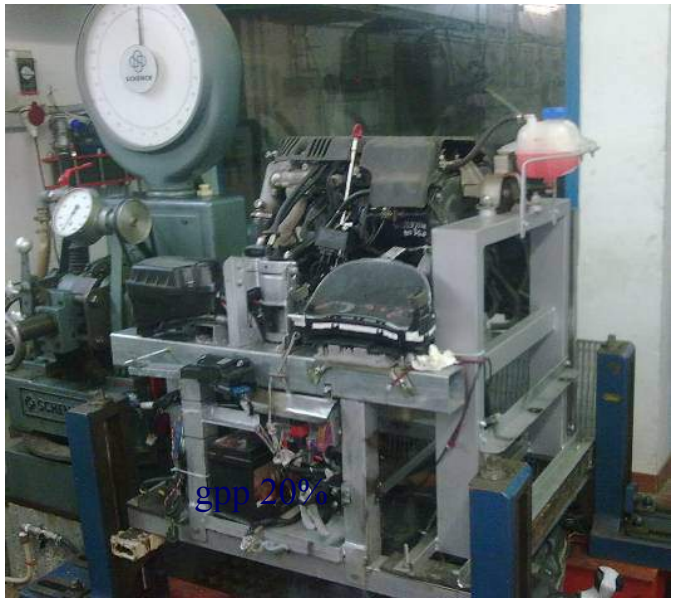


Mayenite structure

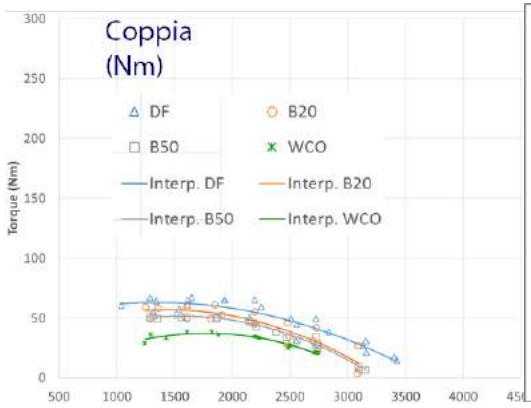
SSD: ING-IND/09

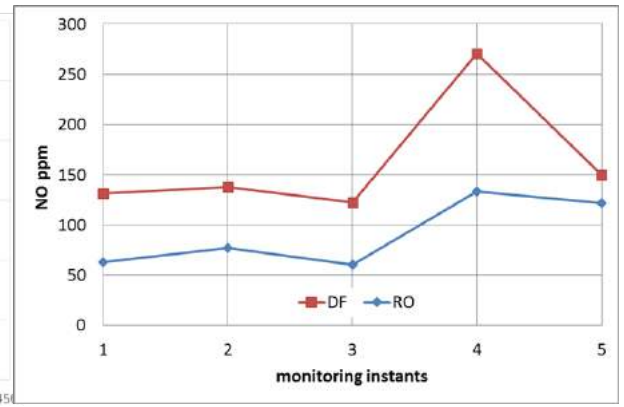
Vegetable oils fuelled common-rail engine (CURSA)

Fuels used: rapeseed oils, waste cooking oil (WCO), biodiesel, gasoil, gasoil-WCO blends
Measurements: engine performance, pollutant emissions, exhausts opacity
Software developed: code for acceding the electronic control unit
Experimental setup: 1.9 JTD common-rail Diesel engine, dual fuel system, Bosch BEA emissions monitoring unit



Engine installed at DIMA Lab

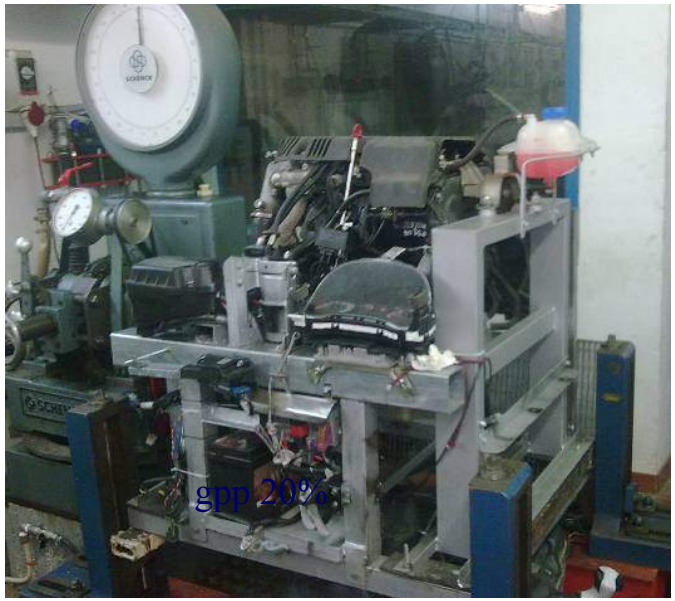




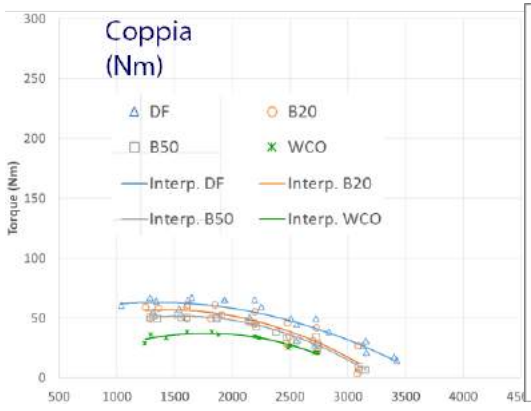
SSD: ING-IND/09

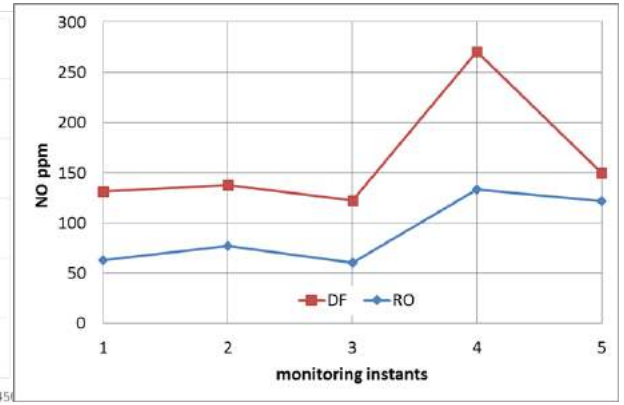
Vegetable oils fuelled common-rail engine (CURSA)

Fuels used: rapeseed oils, waste cooking oil (WCO), biodiesel, gasoil, gasoil-WCO blends
Measurements: engine performance, pollutant emissions, exhausts opacity
Software developed: code for acceding the electronic control unit
Experimental setup: 1.9 JTD common-rail Diesel engine, dual fuel system, Bosch BEA emissions monitoring unit



Engine installed at DIMA Lab





THANKS

SSD: ING-IND/09