SAPIENZA
UNIVERSITÀ DI ROMA

Dipartimento di Ingegneria Meccanica e Aerospaziale

Welcome to DIMA

Paolo Gaudenzi

Director of Department of
Mechanical and Aerospace Engineering

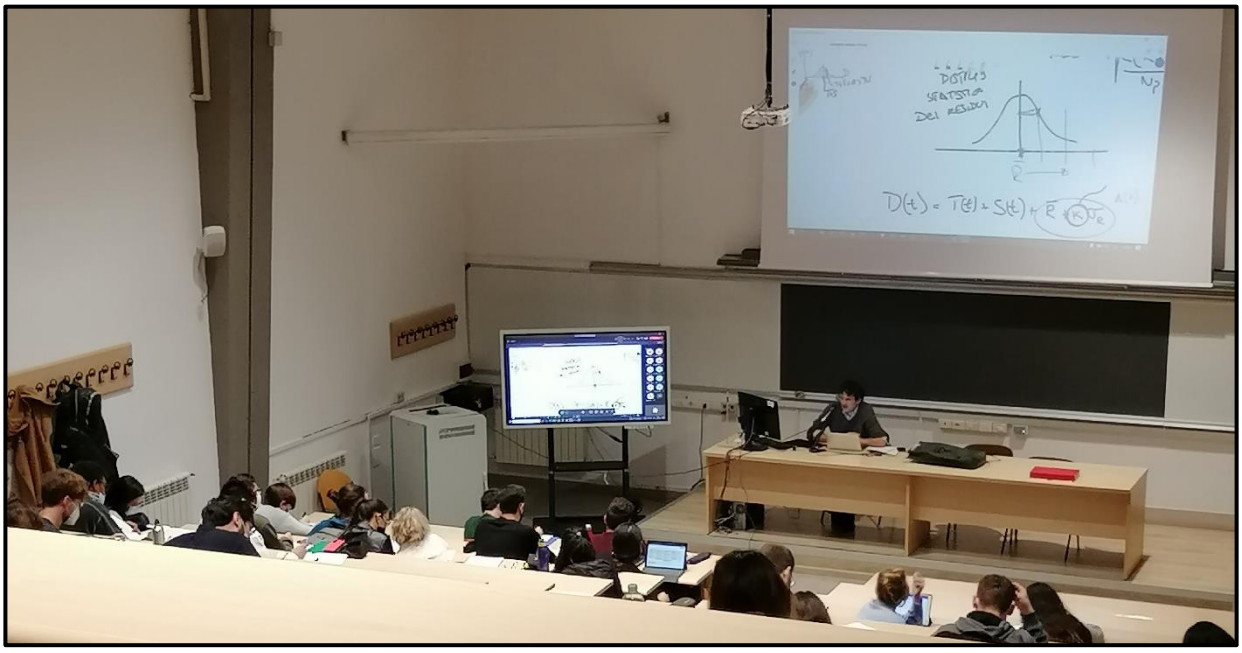
The Department of Mechanical and Aerospace Engineering – DIMA - is part of Sapienza University of Rome. DIMA inherits the tradition of the School of Industrial Engineering and the School of Aerospace Engineering, founded in 1913 and 1926, respectively.

We are about 130 people, including faculty members, technicians and administrative staff.

We offer 2 Bachelor Degrees and 3 Master Courses plus 2 Programs entirely taught in English, as well as three Ph.D. programs and four Professional Master Courses.

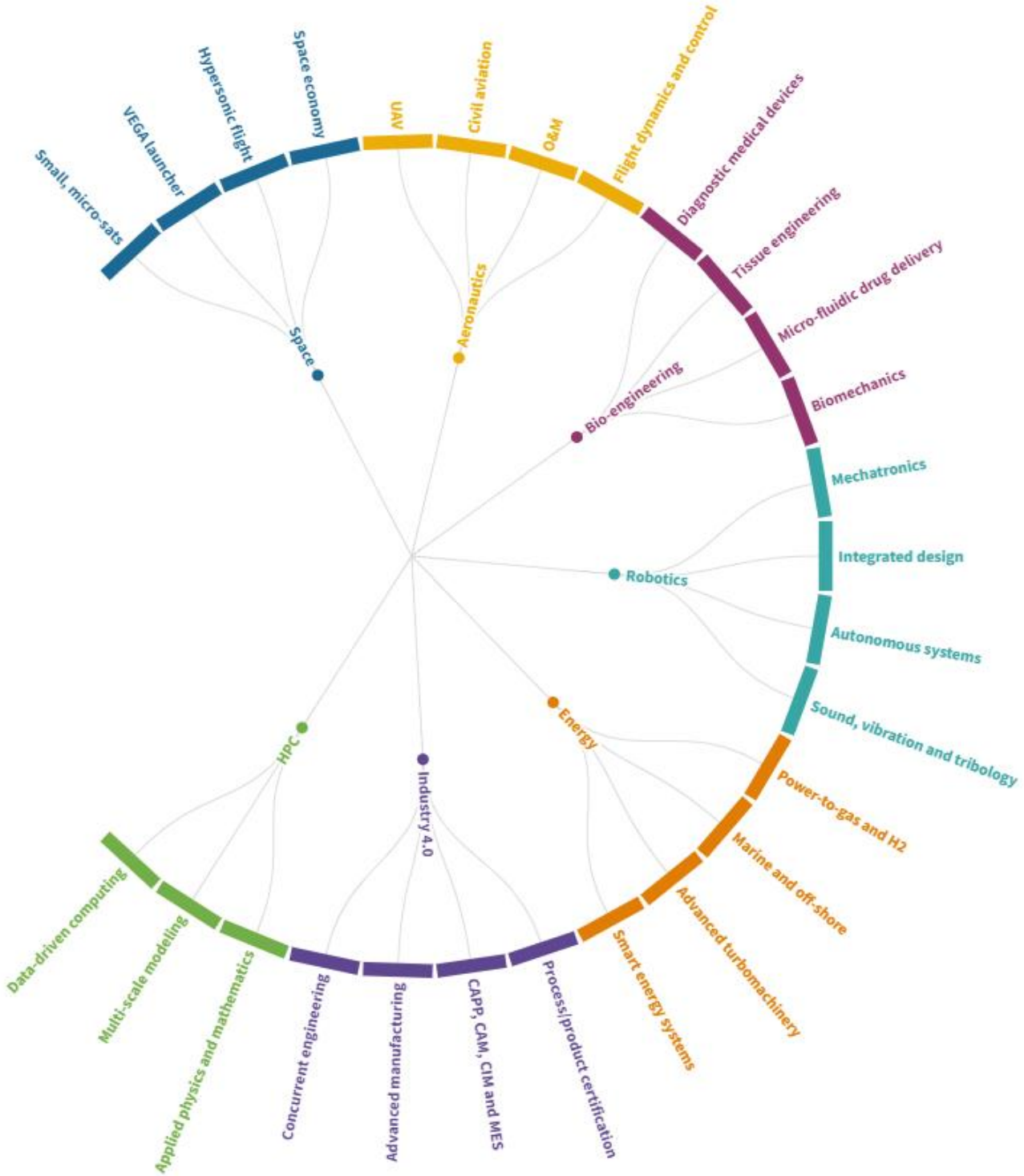
Our research activities are focused on theoretical and applied mechanics, fluid dynamics, aerospace propulsion, technological projects, mechanical and thermal measurements, machines and industrial plants management, energy and power systems, buildings, space systems and structures.

The department is located in the premises of the Faculty of Civil and Industrial Engineering of Sapienza, on the Esquiline Hill, near the Flavian Amphitheatre, also known as Colosseum, and next to the church of San Pietro in Vincoli.



DIMA strategy

DIMA strategy resonates with national and international policies driven by the challenge of a paradigm jump towards sustainability, and smart technologies in industry, space and health.



DIMA strategy

DIMA is active in the promotion of a modern approach to the academic mission, well grounded in the integration of three pillars, i.e. education-research-innovation. According to DIMA strategic plan, instrumental to this vision is the implementation of the activities around the following 7 Department Divisions.

Space sciences, access to space, new aerospace systems and small sats division. The focus is on future solar system missions, on the design of small and micro satellites and to boost space access by contributing to launchers, e.g. VEGA, new stratospheric platforms and hypersonic sub-orbital flight systems. In addition, areas of research interests are smart materials, integrated with sensors and actuators, also in energy harvesting configurations. The Space division is a key enabler of Space economy plans of Italian, and European governments.

Aeronautics, aviation management and operations division develops capabilities and technologies to innovate integrated design of future AV and UAV (aerodynamics, structures, flight dynamics, control and energy management) with a special interest on sustainability. The division is also active in the area of airport operations integrating aeronautical technologies with strategic planning, security, safety regulations & risk, operations and maintenance. The division is one of the key partner of the Italian Civil Aviation Authority ENAC.

DIMA strategy

High performance computing (HPC) division empowers DIMA research promoting the use of High-Fidelity numerical simulation in applied mathematics and physics on parallel computing platforms. This division is active in the development of new HPC-specific strategies, and data-intensive modeling techniques. The HPC division enables the access of DIMA research community to world top-of-class computing resources. Because of its expertise, the division research interests are cross-disciplinary and range from aerospace, to applied mechanics and bio-engineering.

Bioengineering and Medical Devices division. The division is routed in the areas of bio-medical technologies and rehabilitation engineering. Strategic actions are in the Health Technology Assessment, a reference center of Ministry of Health. Research areas are: medical device performance verification, digital design for patient specific pre- and post-surgery treatment, tissue engineering, regenerative medicine, and the development of virtual instrumentations. In collaboration with Sapienza School of Medicine the division also works on concerted experimental-numerical approaches to develop endo-vascular devices, and, in collaboration with the Center for Life NanoScience@Sapienza IIT in the ambit of the ERC INVICTUS, micro-fluidic chips for drug-delivery.

DIMA strategy

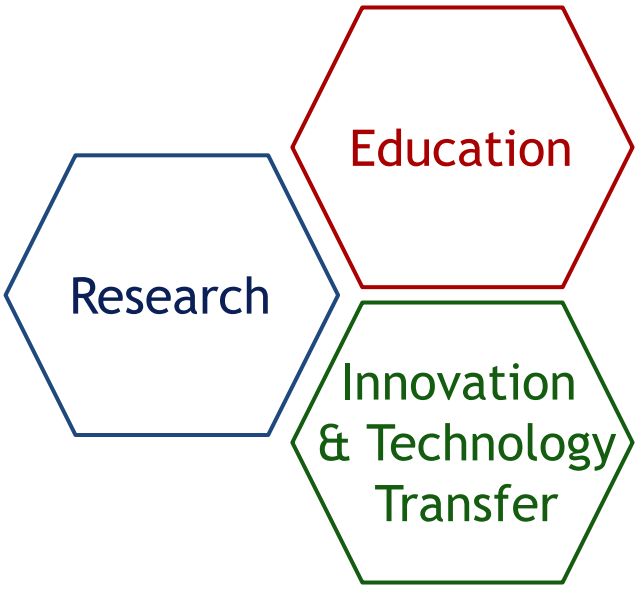
Sustainable Energy division**.** This is the reference center on energy conversion technologies, and energy and environmental systems evolution. DIMA Energy center, with its historical roots in the Institute of Fluid Machinery established in the 60's, at the turning point of the energy transition is leading a number of research programmes: marine and wind renewables, combining cutting edge modeling competences and industry/academy collaborations; power-to-H2 solutions with a specific focus on heavy transportation (railways, and naval) and storage; smart energy systems and communities; AI models for the energy sector. In addition to this mainstream, sustainability activities are gaining momentum with a focus on Carbon Capture and Sequestration, as well as biomass and bio-fuels, microbial fuel cells.

Industry 4.0 & Advanced Manufacturing and Industrial Systems Engineering division. This division has the profile of a modern System Design & Engineering School dedicated to the new industrial revolution using so-called Simultaneous Engineering (aka Concurrent Engineering). It offers cross-disciplinary research competences along the value chain of product/process innovation: from product design digitalization to advanced manufacturing and process technologies and system operations with innovative management models (including resilience engineering). Special emphasis is given to the development of CPS (Cyber Physical System) in a Life-Cycle perspective, from cradle-to-grave, including process/product certification.

DIMA strategy

Mechanics, Robotics and autonomous systems division**.** This division includes all the research activities in the field of Mechanics, Mechatronics and Integrated Design. Key competences are in the ambit of mechanical systems ranging from theoretical modelling, to computational simulation and development experimental prototypes and models. It coordinates, end-to-end, from concept design, to testing and validation the development of innovative projects in the field of mechanics, mechatronics and robotics.

Research activities can be found in the field of system integration (mechanics, electrics, electronics and optics) for sensing and actuation of structures and mechanical systems (robots, drones and self-driving cars). The division also integrates competence areas in the field of non-linear mechanics, materials dynamics, sound and vibration, and contact physics. Finally, it is one of the reference center in the field of cultural heritage with research interest on conservation and restoration technologies.



PEOPLE

EDUCATION

RESEARCH

INNOVATION &
TECHNOLOGY
TRANSFER

DIMA is a community of professors, students and technical, administrative and library staff, which promotes research, training and innovation in the fields of mechanical and aerospace engineering, bio-medical engineering, energy, management engineering, nanotechnologies and related sectors.

DIMA pursues its mission through an integrated vision of three pillars of research, education and innovation (third mission) in a multidisciplinary dimension of excellence and quality according to the highest international standards, responding to the societal challenges at Italian, European and international level and to the needs of advanced training of students.

PEOPLE

69
Faculty
Members

42
Research
Fellows

19
Staff

3000+
students

DIMA

Director

Prof. Paolo GAUDENZI

+39.06.44585.266

Administrative Responsible

Dott.ssa Maria Pia GIAMMARIO

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Full Professors

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Alessandro CORSINI
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Dionisio DEL VESCOVO
Giulio DI GRAVIO
Annalisa FREGOLENT
Paolo GAUDENZI
Giorgio GRAZIANI
Luciano IESS
Franco MARINOZZI
Francesco MASSI
Franco MASTRODDI
Francesco NASUTI
Fabrizio PIERGENTILI
Sergio PIROZZOLI
Franco RISPOLI
Giovanni P. ROMANO
Fulvio STELLA
Massimo TRONCI
Mauro VALORANI
Francesco VENIALI

Associate Professors

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Alberto BERSANI
Daniele BIANCHI
Fabiano BINI
Alberto BOSCHETTO
Giovanni B. BROGGIATO
Francesca CAMPANA
Giuliano COPPOTELLI
Luca CORTESE
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Francesco BATTISTA
Pietro Paolo CIOTTOLI
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Eduardo PALERMO
Mauro PASQUALI
Riccardo PATRIARCA
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Michele BICI
Luana BOTTINI
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Antonio TINTI
Davide TONAZZI

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Gianmarco BRUNETTI
Paolo CAPPUCCIO
Simone CARPENELLA
Alessandro CECI
Simone D'ALESSANDRO
Livio D'ALVIA
Giacomo DELLA POSTA
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Sooraj Francis MANI
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Federica MEZZANI
Michele V MIGLIARESE CAPUTI
Mario Tindaro MIGLIORINO
Silvia MILANA
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Andrea PALUMBO
Flavio PETRICCA
Andrada PICA
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Manoj SETTEM NARASIMHA
Lorenzo TIEGHI
Felix WEBER
Ming YU

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Giuliana DE BONIS
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Maria ZEMA
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Valentina BENVENUTI
Paola GRASSO

Support to Laboratory and IT services Staff

Antonello BINNI
Maximo O. CAPPONI
Alessandro CATERINA
Stefano ZANASCO

EDUCATION

BACHELOR AND MASTER OF SCIENCE

Bachelor and Master of Science programs last three and two years respectively. They have a fixed number of students, admitted by competitive examination. DIMA offers two Bachelor (Aerospace and Mechanical Engineering) and three Master of Science programs (Aeronautical, Space and Astronautical, and Mechanical Engineering). Specific curricula are entirely taught in English.

Ph.D. PROGRAMS

Ph.D. is the highest level of university education and can be accessed after the Master of Science. The three-year research program is accessed through a competitive examination and it is reserved to a limited number of participants.
DIMA offers three Ph.D. programs (Aeronautical and Space Engineering, Industrial and Management Engingeering, and Theoretical and Applied Mechanics).

PROFESSIONAL MASTER PROGRAMS

The one-year Master Programs can be accessed after the Master of Science. They offer highly specialised courses, designed to meet the current demands of the industrial world.
DIMA offers four Professional Master Programs in the fields of Energy, Space and Aeronautical engineering.

Aerospace Engineering

Chair: Prof. Franco Mastroddi
www.ingaero.uniroma1.it

ARWU 27 ww - 2 IT (Sapienza 151-200 ww)
QS 84 ww (Sapienza 171 ww)
Source data 2021

Employment rate (1 year after grad.)
Space&Astronautics 84.4%, Aeronautics 90.9%
Almalaurea 2019 report

Aerospace industry has attained a role of primary importance both in Europe and worldwide as a driving force of economic growth and as a technologically intensive supply chain bringing about innovation in a great number of industrial sectors. All the main industrialized countries now consider aerospace industry as a strategic sector in terms of added economic value, social relevance and contribution to the general well being and safety of its citizens. As such, aerospace industry is in continuous search for talented and motivated young engineers to be employed in a European or international context and, for this to be feasible, requires constant and widespread access to an up-to-date knowledge base for the efficient training of its employees.
In this context, we view our Aerospace Engineering program as a tight-knit community of students and professors that on the one hand operates in close collaboration with industry personnel, research centers and institutions, and on the other hand is setting the following standards for the educational system: Aspire, reach and maintain levels of excellence — Promote and reward a sense of responsibility, the value of knowledge and passion for studies and research — Maintain a pioneering spirit with respect to the constant development of technology — View the aerospace sector as a unique opportunity for students and researchers to contribute to crucial technological challenges in communications, space exploration and safety — Promote international and multicultural exchanges in view of the globalization of the technological markets — Promote awareness of the social and environmental implications of research and development activities.

Accreditations

European Accreditation of Engineering Programmes
EUR-ACE®


PEGASUS - Industry Alliance awards to
Sapienza – Università di Roma
the PERSEUS label
PEGASUS
in recognition of
the excellence in education and strong international cooperation
in Aerospace Engineering at Master level
The Chair of PEGASUS
Issued October 2016

Aerospace Engineering

www.ingaero.uniroma1.it

Bachelor Degree in Aerospace Engineering

The aim of the curriculum is to give the students a solid basic grounding in mathematics and physics and ensure that they have knowledge of the fundamental aspects of the required disciplines of Aeronautical Engineering and Space Engineering. The experimental and numerical workshop modules help to develop interdisciplinary and applicable skills that are also useful for the industry. Upon completion of the Personal Study Plan, the student will be prepared to operate effectively in the job environment. The general education provided by the course, together with the independent work, enables the graduate to acquire further specific skills. At the same time, the 3-year Degree Course has the essential function of preparing students for the Graduate Degrees in Aeronautical Engineering and in Space and Astronautical Engineering.

∞

Master of Science Degree in Aeronautical Engineering (International Program)

The MSc Degree in Aeronautical Engineering takes the students to an advanced level of disciplinary and professional training and specific engineering skills, enabling them to address complex problems that require the analysis, development, simulation, and optimisation of the various components of a fixed or rotating-wing aircraft. The learning process focuses primarily on the most advanced research and design tools and on the innovation in the aeronautics industry with particular reference to improved efficiency, reduction of weight, and of chemical and noise pollution.
A new curriculum is recently introduced with two distinct pathways: the first, Management and operations in civil aviation, is aimed at managers in aeronautical industries and/or companies, specialists in the areas of maintenance and operations at the level of commercial aircraft, airline and/or airport. The second, Flight systems, is aimed at system engineers who work in the technology area of Air Traffic Control in the integrated scenario of telecommunications, satellite navigation, surveillance and on-board systems and airport systems.

∞

Master of Science Degree in Space and Astronautical Engineering (International Program)

The MSc Degree in Space and Astronautical Engineering equips the students with advanced disciplinary and professional training and specific engineering skills, enabling them to address complex problems that require the use of modern methods of analysis, design, simulation, and optimisation. The course also provides an appropriate level of expertise in basic space access technologies, the utilisation of terrestrial orbits, and space exploration, with particular reference to the systemic and scientific aspects of interplanetary missions by launch vehicles, astronautical vehicles, and manned space missions. The student learns to use the most advanced research and design tools for innovation in the space industry, e.g. improving the performance of launch systems to reduce the cost of entry into orbit per unit mass of payload, payload mass reduction (for platforms, sensors, and power units), and increasing the efficiency and utilisation of the available on-board power. These areas of investigation are re-elaborated in relation to a human crew, placing particular emphasis on life support technologies and systems in space.

Mechanical Engineering

Chair: Prof. Antonio Carcaterra
www.ingmecc.uniroma1.it

ARWU 101-150 ww - 2 IT (Sapienza 151-200 ww)
QS 84 ww (Sapienza 171 ww)
Source data 2021

Employment rate (1 year after grad.) 90.9%
Almalaurea 2021 report

Mechanical Engineering Degree has been established at Sapienza University of Rome in 2000, as a natural evolution of the historical five-year *curriculum studiorum* in Mechanics, one of the pillar of the engineering culture of the former School of Engineers of the Papal State founded by Pope Pius VII in 1817, which in 1824 merged with the University of Rome.
With an eye to the modern view of Mechanical Engineering, the present Course keeps the original educational spirit and objectives, combined with the innovation in the teaching approaches, designed to transfer the academic
research to teaching experiences and methodologies. Our School preserves and advances knowledge in the fields of mechanical engineering and shares this knowledge with students, providing them with background knowledge and technical skills, teaching them how to approach new scientific challenges with innovation-oriented thinking. Presently the School has more than 70 faculty members, including full and associate professors and researchers. The School of Mechanical Engineering offers training to professionals with advanced university education in planning, designing, and managing complex activities associated with the development of scientific and technological research and the promotion of research in a broad range of disciplines. The educational goals are pursued by strengthening mathematical skills and advanced physical understanding, in order to tackle complex mechanical problems ranging from the design of systems and machines (conceptual and detailed design), of processes, the development of technologies, systems, manufacturing processes as well as production and management, organization and safety of the associated industrial and technological innovation.

Accreditations

European Accreditation of Engineering Programmes EUR-ACE®

Mechanical Engineering

www.ingmecc.uniroma1.it

Bachelor Degree in Mechanical Engineering

The Bachelor In Mechanical Engineering prepares individuals to apply mathematical and Scientific principles to the design, development and operational evaluation of physical systems. Students are also concerned with the flow of matter, such as air and water, and the transfer of heat. Practical applications, theory, computer simulated coursework and evaluations are all methods used to develop skills. Core curriculum covers mathematics, design, engineering concepts, and many others allowing for a diversification of information. With a Bachelor in Mechanical Engineering program, students are prepared for professional practice in an era of rapidly advancing interdisciplinary technology. Those holding a Bachelor in Mechanical Engineering degree can have careers in industry and government in areas related to fluid, solid, thermal, and mechanical systems. Many students pursuing a Bachelor in Mechanical Engineering continue on to the graduate program.

Master of Science Degree in Mechanical Engineering (International Program)

The Master of Science in Mechanical Engineering aims at training young engineers with an advanced education, providing them with skills in designing, planning, and managing complex activities of research and development in an industrial environment. This goal is achieved by means of a broad training proposal based on advanced mathematics and physics, and professional expertise targeted to the solution of complex engineering problems concerning the design of processes, plants, systems, devices, and machines. Engineering Design professionals educated at Sapienza can work as technology specialists in a wide range of fields, including manufacturing, mechatronics, transportation (automotive, naval, aeronautical and railroad), conventional and renewable energy production, biomechanics and many others. In these settings mechanical engineers are responsible for design, testing, management, research and development.

Subsidiary education areas

Biomedical Engineering

The master of Biomedical Engineering is the natural continuation of the Degree course in Clinical Engineering and aims to complete and specialize the training of an Engineer dedicated to the development and coordination, within the biomedical industries, of design of algorithms and innovative technologies, to organizational and management functions of the health system, as well as to research activities for both the biomedical sector and large equipment.

Energy Engineering

The Master of Science in Energy Engineering provides an in-depth study of the various specific disciplines which deal in detail with the system engineering, control and management aspects of plant technologies aimed at energy production.

To leave room for the different technologies, three different paths are planned, aimed at deepening two technological chains: Technologies and plants from conventional and renewable sources Technologies, plants and science of nuclear energy, Energy Engineering

Management Engineering

The Master of Science of Managment Engineering aims to provide knowledge and develop high-level skills that integrate the technological-design contents typical of engineering disciplines with a full understanding of the economic-managerial aspects and decision-making problems. Methods, models and tools for analysis and intervention used in the management of complex systems are analyzed and discussed, with a high level of interaction between the evolution of technology, the structure of the markets and the competitive strategies of companies.

NanoTech Engineering

The Master of Science in Nanotechnology Engineering is designed to offer an advanced scientific and professional education focused on the analysis, development, simulation and optimization of devices, materials and processes based on the use of nanotechnologies for several applications in the field of Industrial Engineering.

PhD Programs

Aeronautics and Space Engineering

Number of doctoral students (3-year period): 36

Open position per academic year: 12

Fellowships and Industrial PhD: 11 & 2

Disciplinary areas: 6

Theoretical and Applied Mechanics

Number of doctoral students: 24

Open position per academic year: 8

Fellowships and Industrial PhD: 3 & 5

Disciplinary areas: 3

Industrial and Management Engineering

Number of doctoral students (3-year period): 31

Open position per academic year: 9

Fellowships and Industrial PhD: 3 & 8

Disciplinary areas: 6

PhD Programs

Aeronautics and Space Engineering

Chair Prof. Mauro VALORANI

web.uniroma1.it/aerophd/

The PhD program in Aeronautics and Space Engineering represents the highest level of university education in the aerospace engineering field offered by Sapienza. The PhD program aims at developing the skills needed to carry out high quality research activities in the aerospace field. The characteristics of pure and applied research in the aerospace industry have led to a strong link between major companies and national and international institutions, particularly those with head offices in Lazio. In this collaboration several scholarships have been funded by major corporations and companies in the sector such as ESA, ASI, Thales Alenia Space, Avio, Telespazio, Elv, Selex, etc. The main areas where research is carried out by faculty and students of the PhD program are: numerical and experimental fluid dynamics, aeroelasticity, dynamics and control of aerospace structures, design and testing of materials and innovative structures, flight mechanics, space missions, combustion, efficiency and emission control in aircraft engines, space propulsion, design of launchers, turbomachinery for aviation and space, dynamics and control of helicopters.

Theoretical And Applied Mechanics

Chair Prof. Antonio CARCATERRA

web.uniroma1.it/dottomta/

The PhD program in Theoretical and Applied Mechanics deals with rigorous theoretical, numerical and experimental approaches to solve new problems of Applied Mechanics. Applied Mechanics actually combines concepts and techniques from Theoretical Mechanics and other branches of Mathematics to attack complex problems of interest for engineering, thus contributing to the growth of new theories and mathematical constructions inspired by issues arising from emerging technologies. Aim of the program is providing the student with a sound basis of mechanics and the related mathematical foundations needed to independently attack and solve new research problems. In this framework, students are called to master and develop innovative experimental and numerical techniques instrumental to the application of original theoretical insights to emerging fields. The program is based on a first block devoted to fundamental aspects, two parallel blocks dealing with experimental and numerical methods in mechanics, respectively, and a third block dealing with specific applications. The research focuses on a specific branch of applied mechanics (solid mechanics, fluid mechanics, mechanical systems) and culminates in the final Doctoral Thesis.

PhD Programs

Industrial and Management Engineering

Chair Prof. Giulio di Gravio

web.uniroma1.it/ingindgestphd/

The PhD program in Industrial and Management Engineering aims at driving the contemporary industrial evolution by focusing on the following objectives:
a) Defining methodologies for the design, development, management, and enhancement of products, processes, and organizational structures.
b) Monitoring the continuous growth and evolution of innovation processes.
c) Transferring and adapting knowledge on an industrial scale.
d) Exploit the results of the research to expand innovation and define new evolutionary requirements for products, processes, and organizational structures.

Doctors should be able to design and manage production systems and innovative services with a holistic approach, by making technological choices that are consistent with existing business strategies and with specific industrial contexts. Therefore, the PhD program provides a multidisciplinary approach, where the outcomes need to be assessed against the broader concept of community, wellbeing, and in terms of sustainability.
Research activities will include, but will not be limited to, the main Industry 4.0 pillars: advanced production techniques, including Additive Manufacturing; biomedical engineering; ergonomics and human factor management; complex socio-technical systems resilience; Cyber Physical Systems and Internet of Things integration in Smart Factories; reliability, maintainability, safety and security management; business risk management and governance; integrated design and optimization of supply chains, production processes and services, including Product Service System; management of complex projects and their portfolio; environmental management of industrial systems.

Professional Masters

Satellite Systems and Services

Chair Prof. Paolo GAUDENZI

www.mastersatelliti.it

The Master course in Space Systems and services, organized with the support of space agencies, space companies, and public bodies aims at developing an advanced professional education and training activity in cooperation with the academia. The Master responds to theneed for advanced education in the space sector, especially towards the development of both technical and management capabilities and skills. The Master is oriented in particular towards the new markets of the “space based” services in the area of remote sensing, telecommunication, and navigation that are very promising in terms of benefits for the population and for the improvement of its daily life standards. The course encourages the inernational dimension of educational process. Lectures are coming from universities, companies and space agencies from all over the world. The Master is organized in two semesters: the first is devoted to regular classes in which applications, case studies teamwork activities are combined. A the end of the semester the students prepare a technical and economical proposal for a complete satellite system meeting the requirements of a proposed mission. The students spend the second semester performing an internship in a company under the joint tutorship of a University professor and a company manager. The course is taught in English and in Italian.

Space Transportation Systems

Chair Prof. Daniele BIANCHI

web.uniroma1.it/mastersts

This Master Course aims at filling the gap between industrial needs and educational programs offered by the European Universities involved in the Space Transportation sector.
In the job market, there is a high demand for System Engineers with expertise in Space Transportation/ Analysis and Design of space vehicles and launchers. Despite those needs, the curricula of the European universities only partially cover the specific needs of this sector.
The Master STS, founded in 2002, is a highly innovative initiative, unique in the EU context, aimed at fostering: the assessment of transversal skills and promote professional development; the hiring of young graduate engineers in European and Italian space industries and agencies; the relationship between education and industry, which is the founding concept of the Master; the major international industry leaders, top executives from agencies and university specialists in the field of Space Transportation Systems will be involved in the planned activities and will share their experience with all trainees.
This training course is founded upon one of the pillars of the European space policy, to guarantee independent access to space, consolidating its leadership in the international scenario.

Professional Masters

Energy Efficiency and Renewable Energy Sources

Chair Prof. Franco RISPOLI

web.uniroma1.it/masterefer

The Master in Energy Efficency and Renewable Energy Sources is aimed at professionals who want to increase their knowledge in the energy field, focusing on resource use, environmental sustainability, energy efficiency and energy production from renewable sources.
The Master is addressed to engineers and professionals such as architects, physicists, chemists, science graduates, and economists.
The Master is composed of 11 modules and provides technical in-depth analysis including different aspects of the sector within context of short medium and long terms. Technical requirements of energy plant, methodologies and interventions for energy efficiency, plant management, and waste-to-energy are the main topics of the Master in Energy Efficency and Renewable Energy Sources. Furthermore, Master topics are deeply correlated with the new ICT technologies, with the perspective of smart city, Big Data, and the Internet of Things. The Master modules are organised in technical inspection, exercises and projects providing more practical details of the proposed materials. An entire module is dedicated to job-market orientation and evolution

Civil Aviation Management

Chair Prof. Giuliano COPPOTELLI

www.masteraviation.it

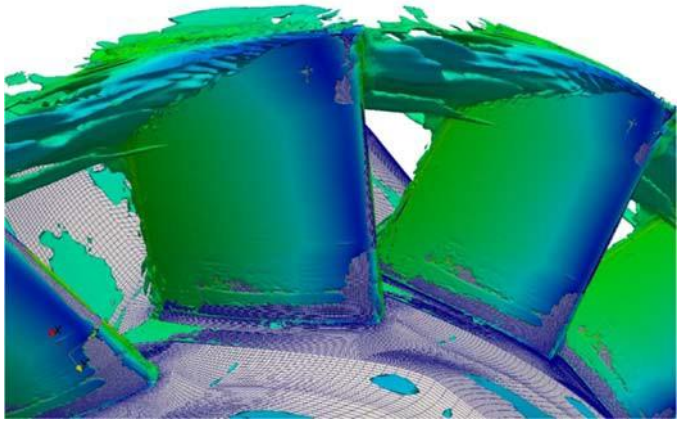
The main target of the Master is the advanced education of young people, who have a Master Degree in Engineering, towards high-level Management jobs in Civil Aviation environment. The Master is jointly organised by Sapienza Mechanical and Aerospace Engineering Department (DIMA), Italian Civil Aviation Authority (ENAC), Rome Society of Professional Engineers and with the contribution of Centro Studi Demetra. All these contributors guarantee to the attendants to gain specific competences that allow them to obtain good job oportunities in airlines, certified maintenance companies, airports, handling companies, and also in National and European regulators. It is a one-year, full time study course (1500 hours, including an internship at an aviation company), directed to students interested in developing a Solid professionalism in the field of Civil Aviation, both in Italy and in Europe. Furthermore, the Italian Civil Aviation Authority (ENAC) provides the attendants with a special reduction of the number of years needed to obtain significant job positions in aviation companies.

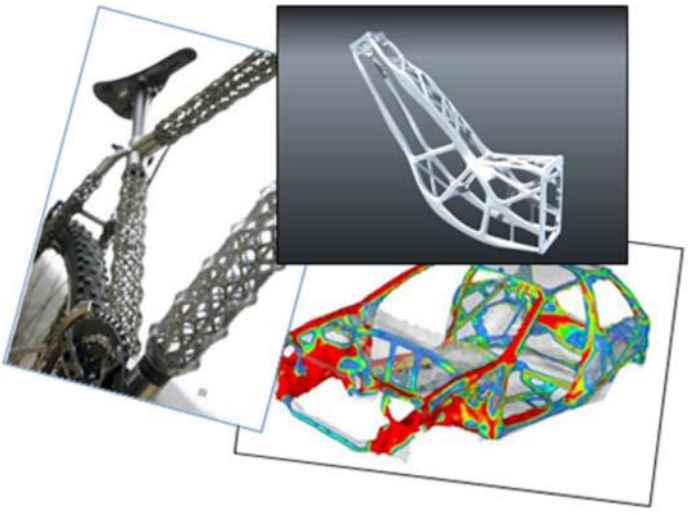
RESEARCH

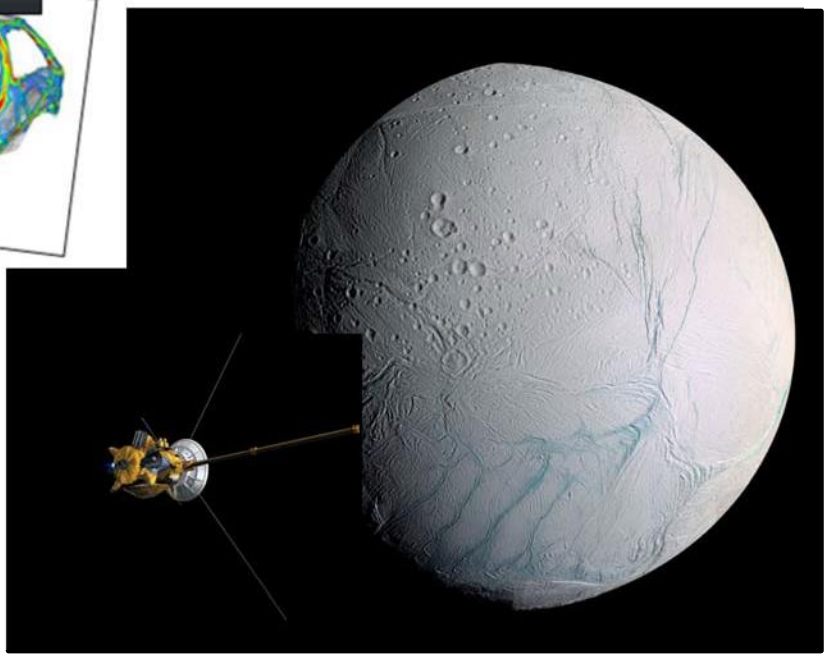
Our research activities are organized in areas, according to the so called Academic Disciplines defined by the Italian Government.

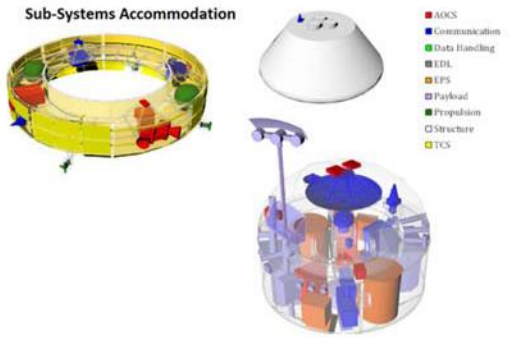
DIMA supports research with infrastructural facilities and labs.

Numerous collaborations with foreign universities and research agencies, as well as companies interested in the progress of science and technology reflect our reputation and our values: integrity, autonomy, ambition, teamworking, transparency and excellence.









Metrics

Publications	*2019*	*2020*	*2021*
Journals	156	128	189
Proceedings	79	104	41
Volume chapters	11	15	6

Research activities	*2015*	*2016*	*2017*
Agreements	60	58	43
Peer-reviewed projects	19	20	33
Visiting scientists	3	3	3
Post-doc fellowships	36	47	35
Post-grad fellowships	43	53	55
Industrial research grants and contracts	21	35	21
Patents	4	4	4

Five DIMA Faculty members listed in database of top 2% scientists

Updated science-wide author databases of standardized citation indicators
John P. A. Ioannidis, Kevin W. Boyack and Jeroen Baas, 2020
https://doi.org/10.1371/journal.pbio.3000918

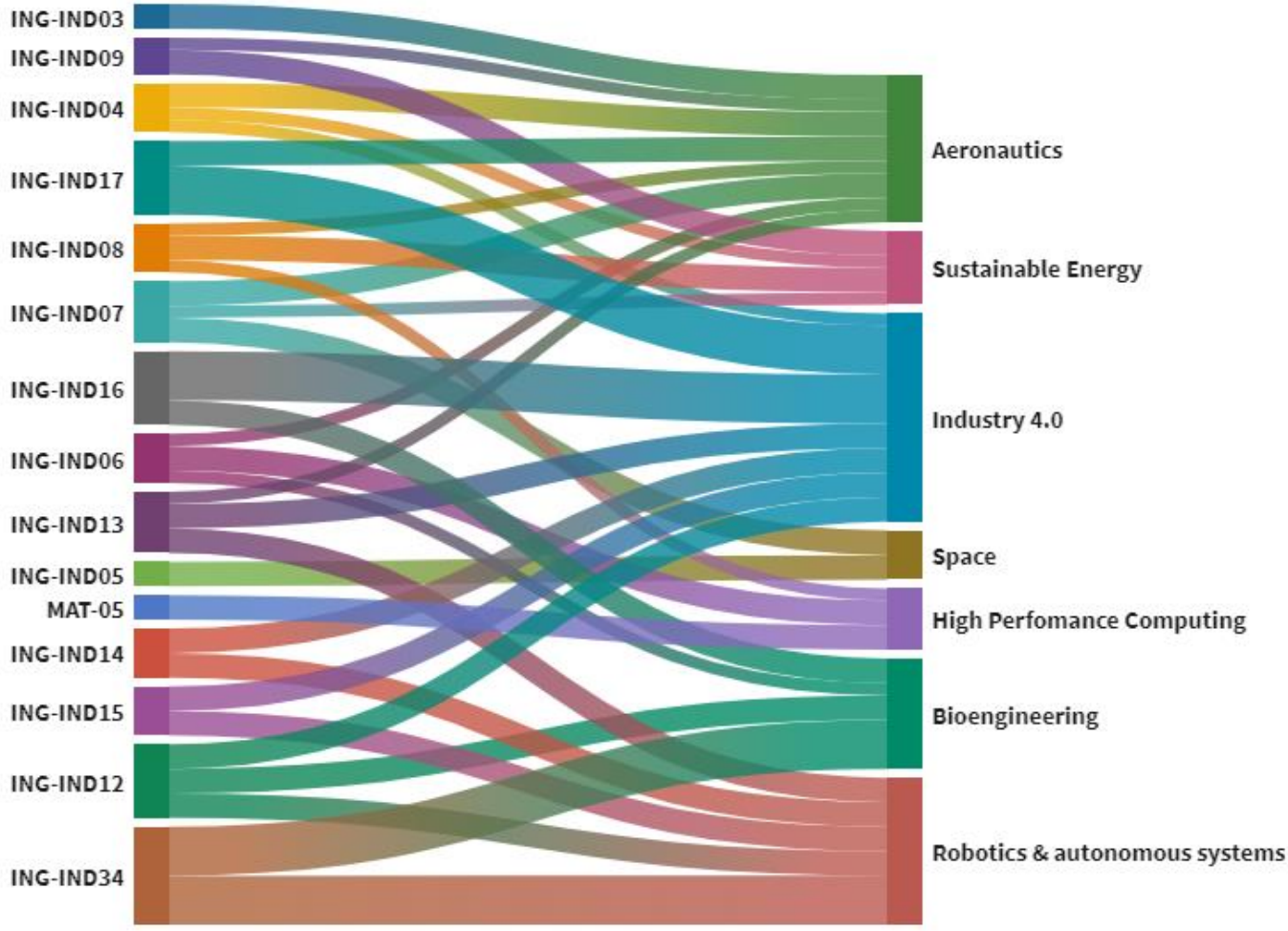
A standardized citation metrics author database annotated for scientific field
John P. A. Ioannidis, Jeroen Baas, Richard Klavans, Kevin W. Boyack, 2019,
https://doi.org/10.1371/journal.pbio.3000384

Department Divisions-driven Research

Innovation and frontier research in Mechanical and Aerospace engineering requires key enabling capabilities, a result of an integrated and multidisciplinary vision. As such DIMA exploits an integrated vision of education, research and innovation through the establishment of **Department Divisions** on specific strategic research lines.

Department Divisions are *open* scientific and technological hubs, coordinated by DIMA research groups to operate in multidisciplinary and cross-disciplinary way on scientific lines of DIMA to develop business relationships through specific "labs for design". In **Department Divisions**, researchers and students can share design lines collaborating with other universities, institutional agencies, research centers and companies.

As such, DIMA research is articulated according to the following Academic Disciplines (Settori Scientifico Disciplinari—SSD), clustered in 7 **Department Divisions**.



ING-IND/03 FLIGHT MECHANICS

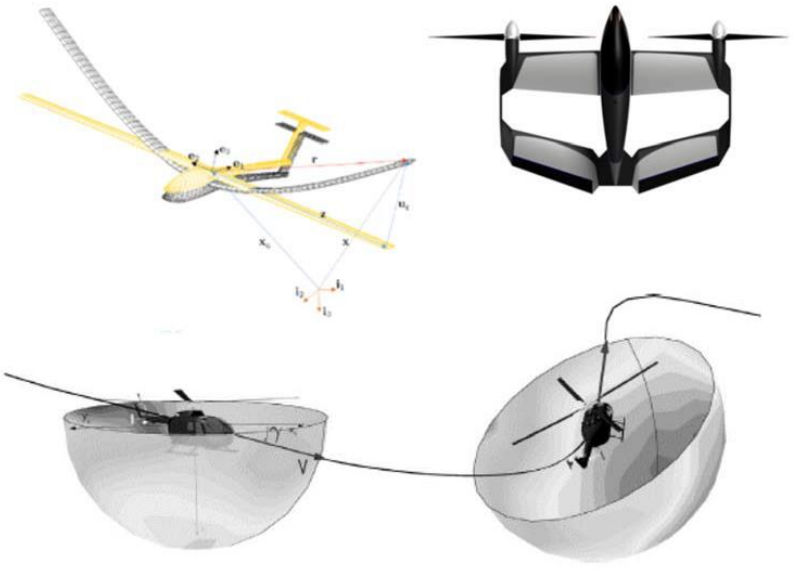
The research activities of this discipline include:

AVIATION

- Inverse simulation techniques as a support for helicopter modeling and the determination of guidance and control laws for minimum-noise-impact maneuvers
- Analysis of helicopter performances and stability
- Highly flexible modeling and stability analysis for aircraft
- Development of guidance and control systems for small fixed and rotary wing UAVs
- Aerodynamic modeling for the study of dynamics and driving test of unmanned re-entry vehicles
- Methodologies for determining rotational and non-stationary stability derivatives

SPACE

- Analysis and design of systems for setting and control of satellite balance
- Development of optimization methods for spatial trajectories, both direct (meta-heuristic/developmental) and indirect, with special attention to three different types of applications:
  - Ascentional problem of multi-stage launchers subject to various constraints (e.g., dynamic pressure, heat flux, falling point of the exhausted stages);
  - interplanetary trajectories that take advantage of multiple gravity assists, with impulsive or finite-thrust models;
  - Terrestrial missions, characterized by a very high number of revolutions, typical of satellites with electric propellers (characterized by low values of thrust and high specific impulse).



ING-IND/04 AEROSPACE STRUCTURES AND DESIGN

The research activities cover emerging issues in the field of Aerospace Structures and Design in theoretical, numerical, experimental, and planning aspects related to the aviation and space industry.

- Aeroelastic modeling of fixed wings, rotary wings and launchers. Integrated aircraft design with MDO approaches (multidisciplinary Design Optimization) and MOO (Multi Objective Optimization). Analytical and numerical methods for nonlinear aeroelastic systems.
- Development of experimental modal analysis methodologies. Development of structural updating methodologies. Vibration Reduction.
- Structural dynamics and inverse problems applied to multidisciplinary design.
- Dynamic, guidance and control of complex structures and multibody systems in the space environment. Realization of experimental testbed for the study of autonomous robotic systems.
- Advanced/active aerospace structures in composite materials. Wireless structural monitoring with use of wavelet transform and developing of self-powered sensors. Multiphysics Analysis, Finite Element modeling, and verification of real structural elements. Newly developed Space Missions and procedures of concurrent and cost engineering.
- Mechanical characterization of composites with natural fibers. Partially "green" composites

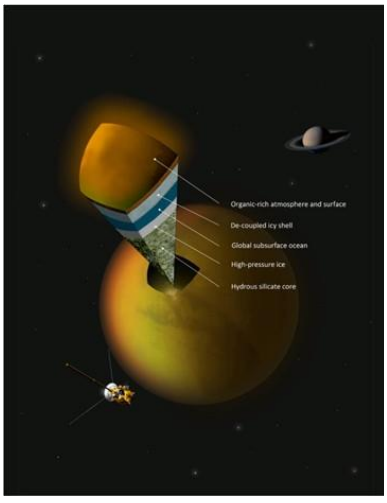
ING-IND/05 AEROSPACE EQUIPMENTS AND SYSTEMS

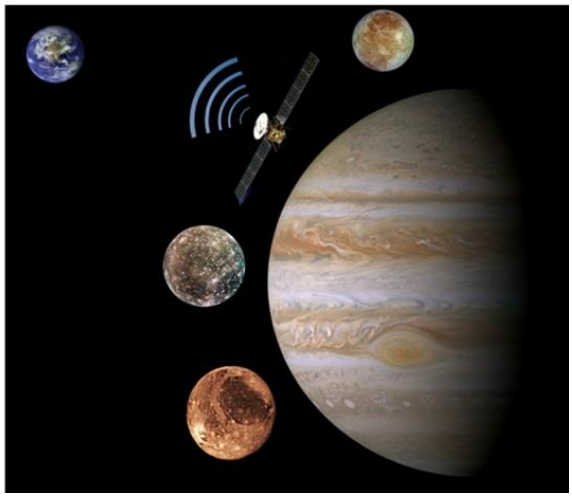
Definition, development, and data analysis of the radio science and space geodesy experiments, especially in the context of planetary missions:

- Cassini: analysis of the Doppler data of Cassini space probe, in orbit in Saturn system. Determination of the gravity field of Titan, Enceladus, Rhea, and Dione. Determination of tidal deformations of Titan. Search for internal oceans in the bodies of the Saturn system. Numerical simulations of gravity field of Saturn and its satellites for future phases of the mission. Development of dynamic models of the Saturn system.
- Juno: planning of the radio science experiment of Juno mission (NASA) to Jupiter. Numerical simulations of the orbital phase for the determination of Jupiter's gravity field and its tidal variations.
- BepiColombo: development and management of radio science experiment MORE for BepiColombo mission (ESA) to Mercury. Numerical simulation of orbital phase for gravity field, tidal effects, and rotational state determination.
- JUICE: Development and management of radio science experiment 3GM of the JUICE mission (ESA) to the satellites of Jupiter. Numerical simulations of the gravity field and tidal effects of Europa, Ganymede and Callisto. Search for internal oceans on the moons of Jupiter. Support to the industrial development of scientific payload of 3GM experiment.
- Delta-DOR: Maintenance and development of new features of the ESA correlator DeltaDOR. Codes for data processing in wideband configuration using multiple receivers. Development of correlation algorithms in low levels conditions of the signal-to-noise ratio. Code Development to support the CCSDS standard for the inter-agency exchange of DeltaDOR data.

Space debris: analysis of optical measurements of objects in Earth's orbit to identify their dynamical and physical properties. Goals: supporting the collision avoidance maneuvers, and characterization of the debris environment in space.

On-board systems: realization of automatic landing support systems for manned and unmanned aircrafts and to the realization of components for micro- and nanosatellites. Specific focuses: space surveillance, space debris mitigation, systems and components on board.

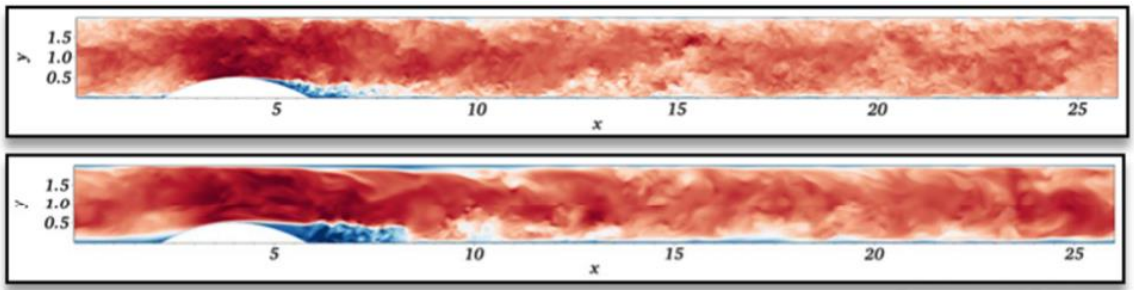


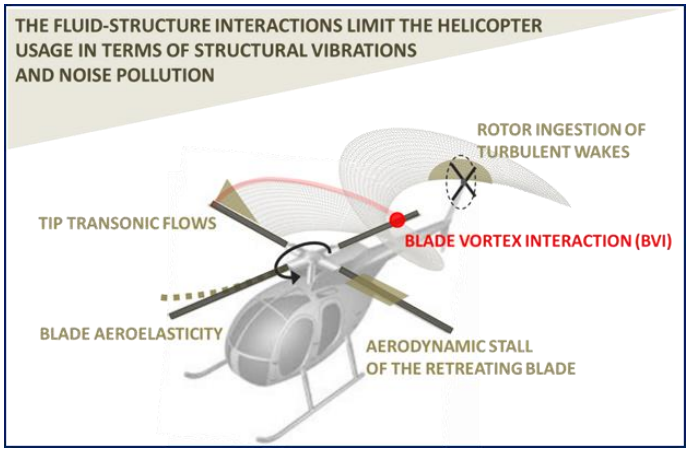


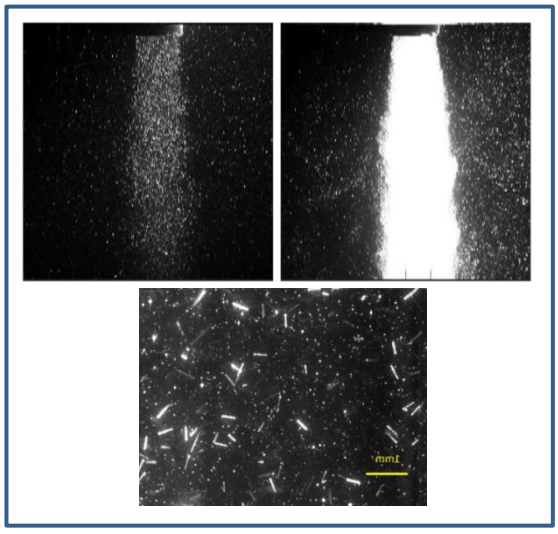
ING-IND/06 FLUID DYNAMICS

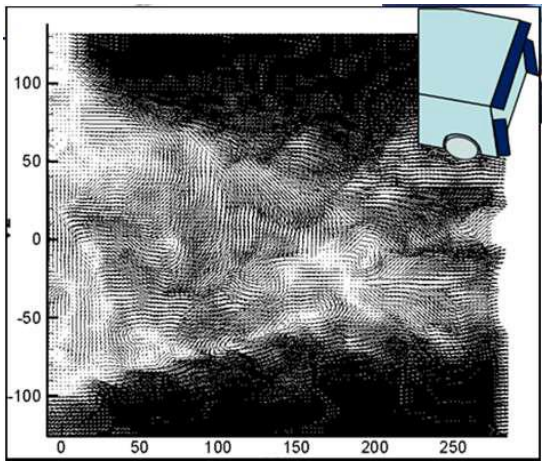
- Analysis of the interaction between vortices and blades in helicopters in motion and of the consequent generation of noise.
- Experimental aeroacoustics analysis of free jets interacting with solid surfaces.
- Numerical simulation of nucleation, turbulent transport, and collapse of cavitation bubbles. Multiscale cavitation and multiphase flows.
- Superhydrophobic surfaces: wetting/dewetting. Turbulent modulation by inertial particles. Experimental activities: laser induced cavitation, cavitation-enhanced drug delivery, experimental microfluidics.
- Hemodynamics investigations by numerics and experiments. Post-implantation and in vitro analysis of stent, heart valves and biomedical devices.
- Numerical simulation of high-Reynolds number wall-bounded flows. Drag reduction and heat transfer in turbulent channel flows. Analysis and control of transitional flows on lifting surfaces.
- Control of shock wave/turbulent boundary layer interactions. Computational aeroacoustics. Supersonic turbulent boundary layers. Compressibility effects in roughness-induced transition.
- Turbulent combustion. Analysis of solid propellant rocket motors. Fluid dynamic effects of distributed combustion in solid propellant engines. Aluminium particles combustion: modeling and numerical simulation.
- Fluid-particle interactions in turbulent flows with applications to propellers and microflows. Optical techniques for multiphase flows in two-way coupling regime. Single point and multi-point measurements. Two-phase flows in T-junction microchannels.
- Experimental study of turbulent jets: single phase and multiphase as generated by orifices, pipes and contractions.
- Experimental and numerical analysis of free-surface flows. Hydroelasticity in sloshing tanks and wave impact for shallow-water condition: experimental and numerical analysis.
- High performance computing for computational fluid dynamics. GPU-accelerated flow solvers for direct numerical simulation of turbulent flows.
- Advanced measurement systems for experimental fluid-mechanics. Particle Image Velocimetry, Ultrasound Anemometry, High-speed Imaging, Laser Doppler Anemometry.
- Fluid-body interaction and self-propelled motion. Numerical simulation of fish swimming for biomimetic applications.
- Nanofluidics: molecular dynamics simulations of interfaces and fluids in nanoscale confinement; capillarity, non-continuum effects, confined phase transitions, hydrophobic nanopores, ion channels.

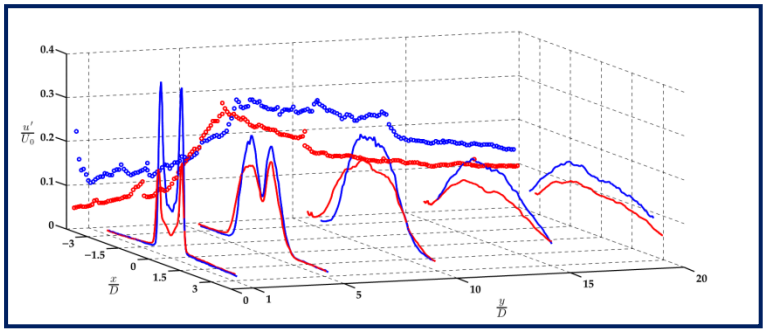
ING-IND/06 FLUID DYNAMICS

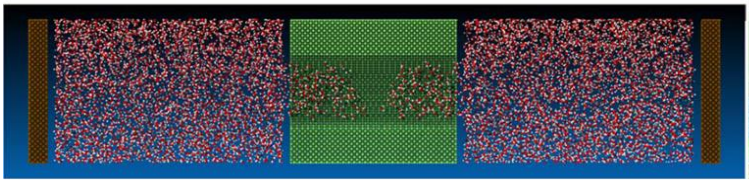


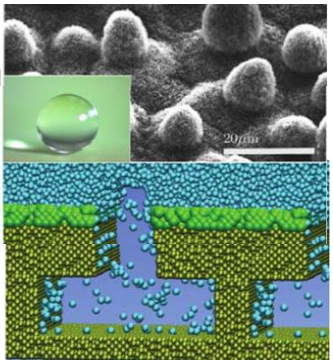


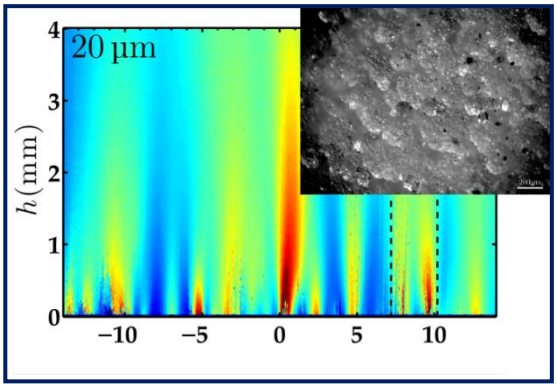






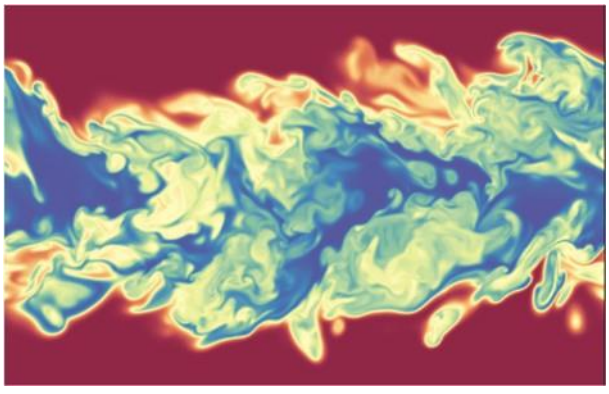


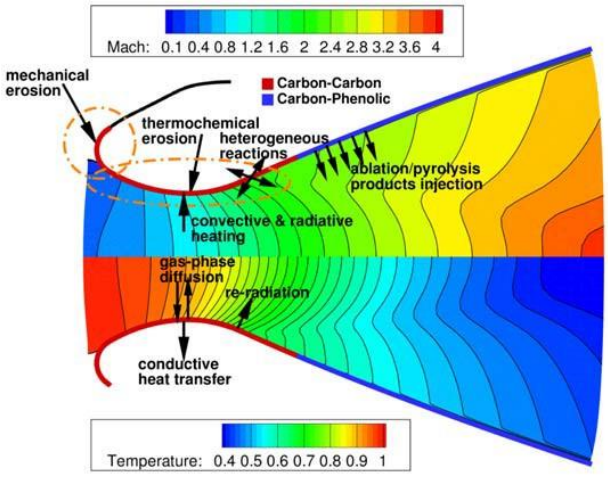




ING-IND/07 AEROSPACE PROPULSION

- Fluid dynamics of propulsion systems: RANS-based CFD models; chemical-physical properties and fluids in supercritical conditions; cavitation cryogenic fluids including Thermodynamic Suppression Head effects; liquid propellant injection; pressure oscillations in solid rocket motors.
- Heat Transfer: numerical modeling of the evolution of supercritical fluids in ducts with heat transfer deterioration; modeling of wall heat transfer in liquid rocket engines; fluid-surface interaction models including catalysis, pyrolysis and ablation; modeling of gas and soot thermal radiation in turbulent combustion; modeling of surface kinetics of active and passive oxidation of carbon and silica thermal protection systems of reentry vehicles.
- Combustion: RANS modeling of turbulent combustion of compressible flows in supercritical conditions; LES modeling of turbulent combustion of compressible flows in supercritical conditions; DNS modeling of premixed laminar and turbulent flames in the presence of instabilities; modeling of ignition transients of solid rocket motors; modeling of combustion surface evolution of solid rocket motors; modeling of internal ballistics of solid rocket motors by 3D un-steady simulations; flameless oxidation combustion modeling; experimental study with PIV techniques of turbulent premixed flames.
- Propulsion system analysis: intrusive and non intrusive methodologies to analyze systems with uncertain parameters; development of system analysis software for engine parametric analyses and startup transients; reduced order models for the study of thermoacoustic and low frequency instabilities.
- Algorithms: automatic generation of simplified (skeletal) and reduced kinetic models for detailed chemical kinetics; feature detection and sensitivity analyses in reacting flows on the basis of time scale diagnostics; integration methods for multi-scale problems (stiff differential equations) with deterministic and uncertain parameters; mesh generation by conformal mapping; adaptive mesh resolution using wavelets; analysis of numerically generated time series using wavelets.



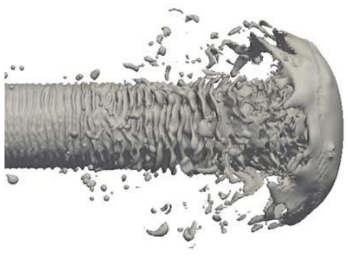


ING-IND/07 AEROSPACE PROPULSION

The research activities cover emerging issues in the field of Aerospace Structures and Design in theoretical, numerical, experimental, and planning aspects related to the aviation and space industry.

Applications

- Liquid rocket engines: modeling of turbulent combustion in the thrust chamber of liquid rocket engines in super-critical conditions; numerical modeling and RANS/LES simulations of the thrust chamber of a liquid rocket engine m(LOx/ LCH4); analysis of ignition processes in combustion chamber by means of deposition of energy with laser pulse; analysis of thermal loads in thrust chambers of liquid rocket engines; analysis of regenerative cooling systems with super-critical methane; RANS and DES analyses of separated flows for propulsion applications (air-intakes, nozzles); modeling of cavitation in turbopump inducers for liquid rocket rockets; simplified models of liquid rocket engine components for system analysis; feed systems for liquid rocket engines.
- Solid rocket motors: study and analysis of the ignition transient of solid rocket motors of VEGA launcher; study and analysis of pressure oscillations in solid rocket motors of VEGA launcher; models for performance analysis of the solid rocket motors of Vega; modeling the evolution of propellant grain surface; ablation modeling for nozzle walls based on pyrolyzing and non-pyrolyzing materials.
- Hybrid propellant rockets: flow/surface interaction modeling for solid and paraffinic fuels; combustion modeling and performance analysis; ablation modeling for nozzle walls based on pyrolyzing and non-pyrolyzing materials.
- Aircraft engines: off-design performance analysis of gas turbine engines with uncertain parameters.
- Prediction and measurement of pollutants: generation of simplified/reduced chemical kinetic mechanisms for application in aviation, energy, and automotive including pollutants (NOx), PAH and soot predictions. [Experimental techniques for soot concentration measurement].
- Space Propulsion: design, test and in-orbit demonstration of a cold gas micro- thruster.
- Mission Analysis: exploration on Mars and Venus through ISRU (In Situ Resource Utilization); propulsive solutions for return missions of planet surface samples; mission analysis of single-stage-to-orbit vehicles.
- Re-entry vehicles: modeling the active and passive oxidation of carbon and silica thermal protection systems of reentry vehicles.



ING-IND/08 TURBOMACHINERY

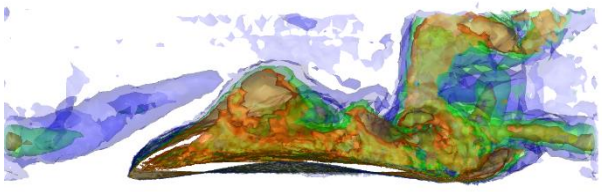
- *Turbomachinery (TM) Design*. DIMA is constantly developing and improving design tools for turbomachinery. We have developed a software platform based on open-source libraries to design and optimize TM, that constantly incorporate new knowledge from open literature and in-house studies.
  - Wind, Tidal and Ocean Turbines
  - Mini-Hydro Turbines
  - Steam Turbines and Gas Turbines
  - Fans, pumps and industrial fluid-machineries

- *Computational Methods for Fluid Machinery*. Analysis, development and implementation of numerical models for the simulation of turbulence and heat transfer in TM applications. Our study involve advanced modelling of flow and heat transfer in URANS, hybrid LES/RANS, LES.

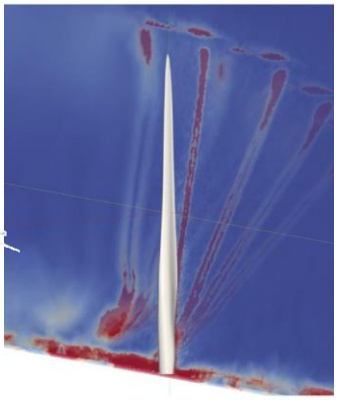
- *Machine Learning Methods for Turbomachinery*. Implementation of machine-learnt strategies for TM design and optimization, improved CFD predictions (machine learnt wall functions and turbulence modelling), predictive maintenance, fault diagnosis in TM operations.

- *TM fast prototyping lab*. TM designed at DIMA can be printed and tested in our lab to verify their aerodynamic and noise performance.





Ocean Energy Converters for Mediterranean operations

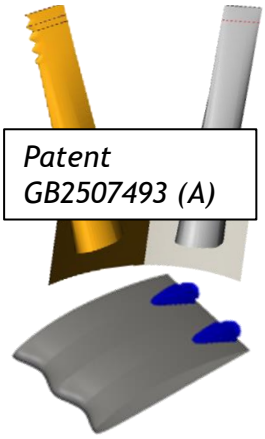



Wind energy techologies

4 Int.l Patents

Zero axial thrust impeller for multi-stage pump

Patent GB2507493 (A)

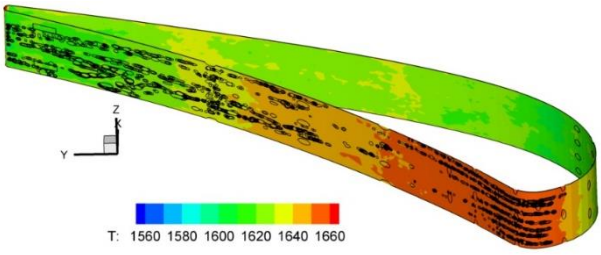


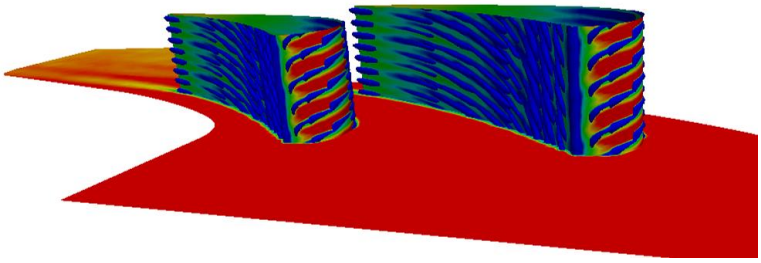
Leading edge bumps for separation control in axial and mixed flow fans

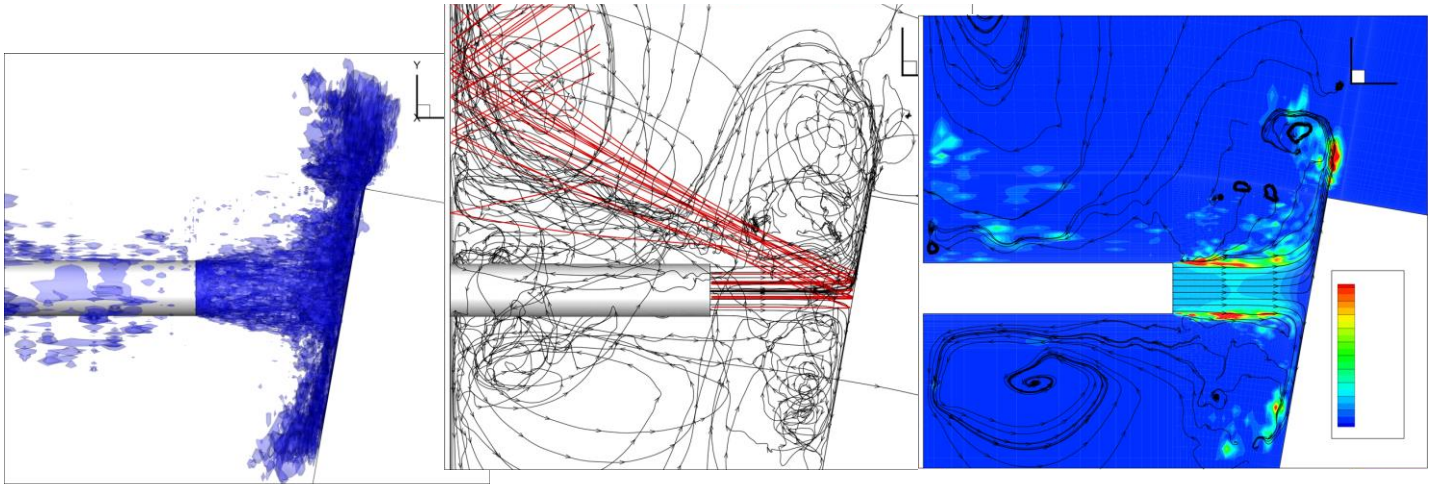
ING-IND/08 TURBOMACHINERY

- *Multiphase Flows in Turbomachinery*. Analysis, development and implementation of multi-phase models (Lagrange) for particle-loaded flows in industrial applications. Our studies involve particles-cloud and single-particle monitoring. Modelling of particles/droplet impact on solid walls: elastic and elasto-plastic impact models; influence of temperature; adhesion of particles; particle/droplet erosion. Modelling of deposit growth and erosion evolution with mesh morphing techniques; use of machine learning algorithm for fast predictions. Modelling of cavitation.

- OTHER TOPICS IN TURBOMACHINERY: blade cooling; thermo-fluid behavior of a gas turbine blade with ceramic porous coating; general features of the entropy generation rate in TM channels; a novel concept of a vortex-based highly compact combustion chamber for a micro TG; heat recovery systems for a UMTG; super-compact modular heat exchanger for UMTG.



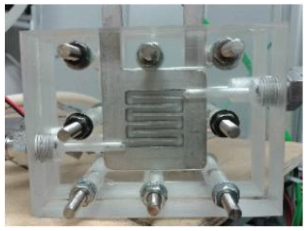




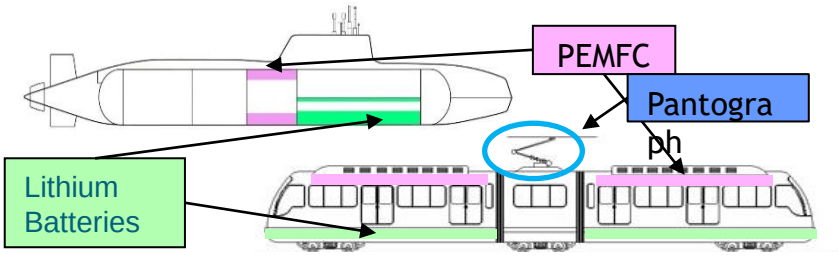
ING-IND/09 ENERGY SYSTEMS AND POWER GENERATION

- Thermo-computational fluid dynamics of turbomachinery. Analysis, development, and implementation of numerical models (U-RANS based) for the description of turbulence and heat transfer in turbomachinery applications. Analysis and implementation of simulation approaches (Large Eddy Simulation - LES) for turbulence and heat transfer in turbomachinery applications and in general industrial applications.
- Forecast of fouling and erosion caused by dispersed particles, for industrial applications. Analysis, development and implementation of multi-phase models (Lagrange) for particle-loaded flows in industrial applications (two methods are considered: particles-cloud and single-particle monitoring). Modeling of particles impact on solid walls: elastic and elasto-plastic impact model; influence of temperature; adhesion of particles; erosion.
- Study of energy systems based on conventional and renewable energy sources.
- Renewable Sources: concentrating solar power, biomass, organic fraction of municipal solid waste, gasification. Development and implementation of numerical models of power systems with Aspen Tech, CHEMCAD and TRNSYS softwares. Gasification of biomass for the production of hydrogen-rich syngas with a low CHAR content. Experimental analysis and software modeling of the Life Cycle Assessment of distributed energy systems; cogeneration.
- Experimental study of fuel cells performance. Analysis, testing and optimization of direct methanol fuel cells: study of the performance of the whole system; Micro-PIV investigation of CO_2 bubbles generation and dynamics in the micro channels of the cell. Analisys, testing and optimization of solid-oxide fuel cell fed with syngas produced from biomass gasification.
- Experimental study of recycled materials for liquid hydrocarbons absorption. Testing of properties of crude oil absorption by waste materials from recycled tires; Full-scale testing and process optimization.

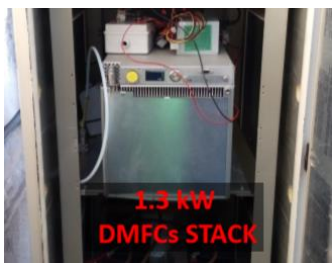
Biomass gasifier



PEMFC



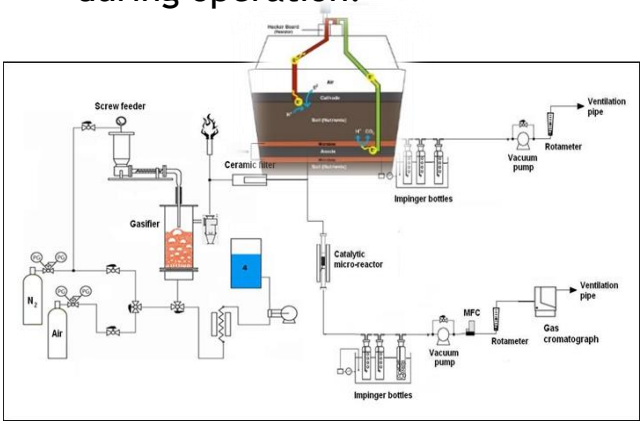
'Heavy' hydrogen mobility



Hybrid DMFC/battery

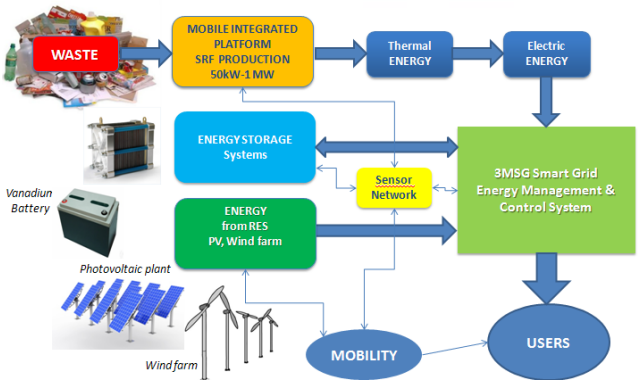
ING-IND/09 ENERGY SYSTEMS AND POWER GENERATION

- Solar cooling: micro absorption machine for solar thermal systems.
- Biomass: experimental numerical analysis for the conversion of multi-fuel gas turbine groups (with particular attention to the burners) to vegetable oils or biogas. Study and optimization of digesters operating parameters. Study of ozonation of different types of biomass, and other pre-treatments designed to improve energy efficiency (use of microwaves and two-stage systems).
- Smart Grid: management of electrical loads as a function of tariffs and availability of autoproduction from renewables.
- Sustainable buildings: integration of systems, active and passive interventions for energy efficiency
- Storage systems for electricity from renewable sources: study of mechanical systems for small power generation.
- Air quality monitoring: statistical investigations, Simulation models of pollutants dispersion into the atmosphere; analytical techniques for sources separation; short and long term forecast models; pollution abatement and air treatment systems; Environmental impact assessments.
- Cryogenic Machines: Pulse Tube and reverse cycle Stirling type and absorption systems; Stirling: development of a new hybrid heater for solar applications, based on research activities with the Bruno Kessler Foundation (TN).
- Pulse Tube: evaluation and characterization of thermo-acoustic processes during operation.

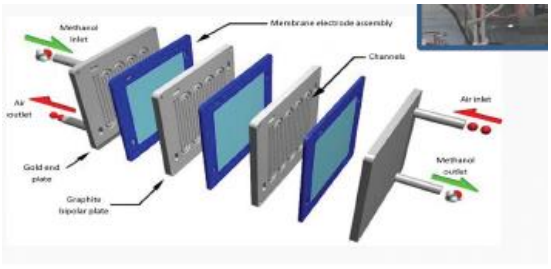


Sustainable energy and bioremediation

Hybrid&Integrated Energy Systems



Advanced FCs

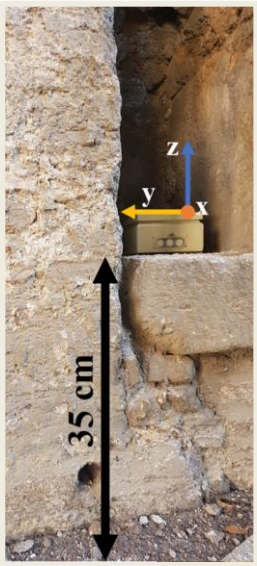


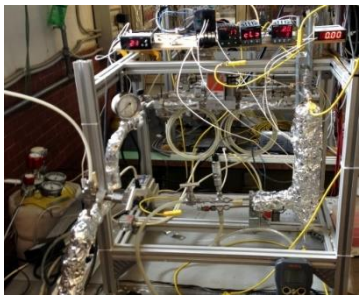
ING-IND/12 MECHANICAL AND THERMAL MEASUREMENTS

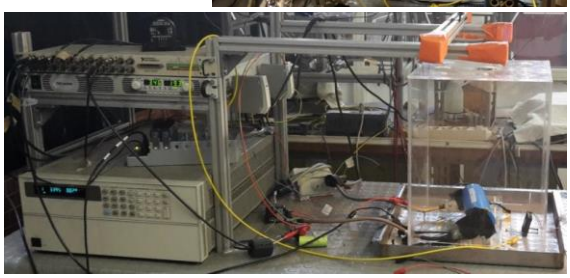
The research focuses on the validation and design of measurement chains both for industrial and biomedical applications: from signal transduction to signal acquisition preserving the quality of information.

In the field of mechanical industry, the group is specialized in:

- Installation of strain gauges for the measurement of deformations, vibrations, and stress of structures and/or mechanical parts.
- Installation of interferometric or reflection optical benches for studying micro-deformations of structures.
- Rotary torque measurements for the characterization of rotary actuators and braking systems.
- Installation of thermal gradients measurement chains, both for environment and mechanical parts, including thermocouples, PT100, surface thermometers, thermistors, thermal imaging cameras.
- Thermo-mechanical characterization of structures, using contactless solutions for measuring displacement (laser optical distance sensors) and temperature (infra-red radiation thermometers), for monitoring and reverse engineering.
- Characterization and real-time monitoring of energy production systems (catalytic converters) and the use of hydrogen (fuel cells).
- Development of benches for function monitoring and incipient fault detection of ions and lithium polymer batteries.
- Development of wireless sensor networks and microwave-based portable systems for the measurement of environmental parameters and water content, respectively, for Cultural Heritage applications.



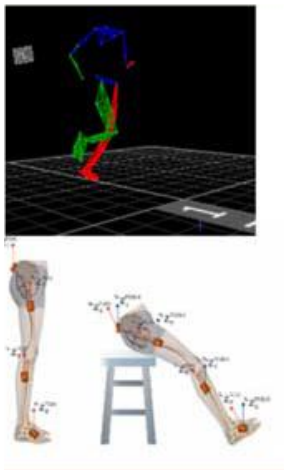


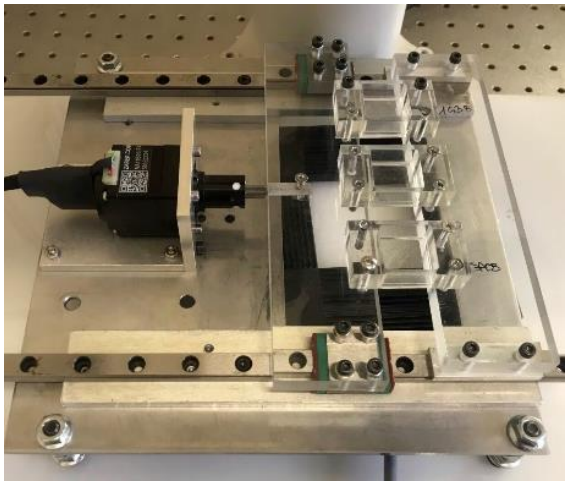


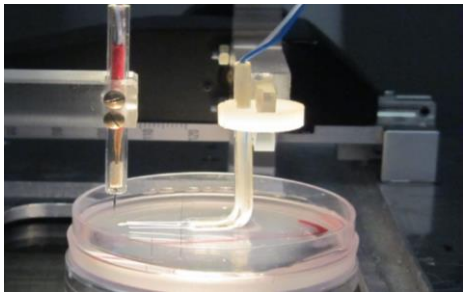
ING-IND/12 MECHANICAL AND THERMAL MEASUREMENTS

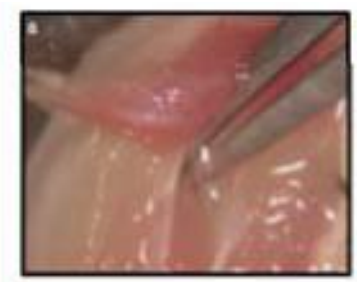
In the field of experimental biomechanics, the focus is on the:

- Metrological characterization of optoelectronic systems and force platforms for the analysis of human kinematics and kinetics.
- Development of 3-degrees of freedom robotic devices for the balance rehabilitation and for the study of motor control in pathological subjects.
- Development of wearable lower limb exoskeletons for adults and children, of solutions for natural or haptic interfaces for home rehabilitation, of solutions for biomechanical assessment in sports and of robotic exoskeletons for haptic feedback in virtual reality.
- Development of advanced and specific biomechanical models.
- Development of measurement methods and experimental protocols for ex-vivo characterization of several mouse model biological tissues: muscle, connective, bone, skin, neuromuscular junction.
- Generation and characterization of a 3D in vitro model of muscle tissue for drug testing and transplant, and of a 3D in vitro model of neuromuscular junction for the study of the communication between muscle and nerve in neuromuscolar diseases
- Study of cell mechanotransduction in mesenchymal stem cell differentiation and in bone tumors development.
- Development of microwave sensors and experimental protocols for the cells and tissue recognition.









ING-IND/13 APPLIED MECHANICS

- Vibroacoustics - non linear models + random loads (Statistical Linearization-Statistical Perturbation)
- High frequency vibroacustic (Uncertainty propagation - Statistical Energy Analysis - Force identification)
- Medium-high frequency optimization using Statistical Energy Analysis (SEA) model – application: noise reduction on aeronautic and aerospace structures
- Tribology and contact mechanics
- Friction induced vibrations, contact damping and contact instabilities
- Friction and wear
- Numerical contact simulation and experimental contact instrumentation
- Control Robotics Mechatronics - Isotropic compliance
- Identification Substructuring - Experimental dynamic substructuring (dynamic behavior of complex mechanical systems)
- Micronano Mechanics - Theoretical and experimental research in micro-electro mechanical systems (MEMS)
- design and fabrication MEMS-based devices
- development of a new concept CSFH (conjugate surface flexure hinge)
- Signal Processing and Detection
- Damping Dissipation - damping control and energy harvesting - Variational Approach to Optimal Control - Variational Feedback Control (VFC)
- Metamaterials - dynamic problems for metamaterials (wave propagation, piezoelectric mechanical structures for vibration control, active vibration control)
- Multi-physics Technology Application
- Vehicles (new Methods for crash detection, damage detection) - Vehicle control systems – smart tire Early Stage Damage Monitoring and Detection
- Aerospace – Bearings damage – Brake noise and performances
- Biomechanics

ING-IND/14 MECHANICAL DESIGN AND MACHINE CONSTRUCTION

The research activities can be grouped into three major fields:

- Advanced mechanical characterization of engineering materials

The research topic aims at the experimental characterization and numerical modelling of the structural behaviour of materials, focusing on large strain elasto-plastic description, ductile damage accumulation, and fracture prediction. Investigated materials range from isotropic and anisotropic metal alloys (Steel, Titanium, Aluminum) to composites, and additive manufacturing alloys. Experiments are devised to induce complex stress states in material samples through multiaxial tests, mainly executed using a standard axial machine and a custom made bi-axial tension-torsion machine, both available in the Lab. Numerical models, to be used within Finite Element codes, are taken from the literature or developed on purpose. They are calibrated and validated using the experimental results. Over the years, the research results have been applied for the structural integrity assessments and design of several actual applications of structures such as: off-shore and on-shore oil and gas pipelines, similar and dissimilar welded joints, crash dampers, sheet metal stamping processes, and more.

- Full field strain measurement using optical techniques

The validation of theoretical/numerical models which describe material behavior can greatly benefit from a full-field local comparison between measured and computed strains. In this context, optical techniques provide contactless non-invasive information of the strain distribution on the surfaces of material samples or actual parts. In this regard, an original white light speckle image correlation method algorithm was developed, which granted accurate measurements in a very wide deformation range (from 10^{-5} to 10^{0} m/m). The technique was profitably applied to the study of the behaviour of different kinds of materials like metals, composites, biological tissues, and artworks.

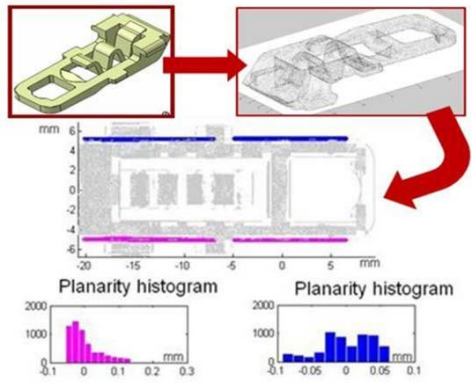
- Experimental and numerical methods for the restoration of Cultural Heritage

A long-standing collaboration with the "*Istituto Superiore per la Conservazione e il Restauro*" of Rome offered the group a chance to give an engineering support to the study, preservation and restoration of cultural heritage, particularly of canvas paintings. In this regard, experimental techniques and numerical Finite Element models, usually employed in industrial engineering, were used to estimate the state of stress and pretensioning of important artworks, such as: "L'annunciazione" by Antonello da Messina, Caravaggio's "La resurrezione di Lazzaro" and Raffaello's cartoon for the painting of the fresco "La Scuola di Atene". Results contributed to the assessment of the overall wear and aging effects of the paintings under study.

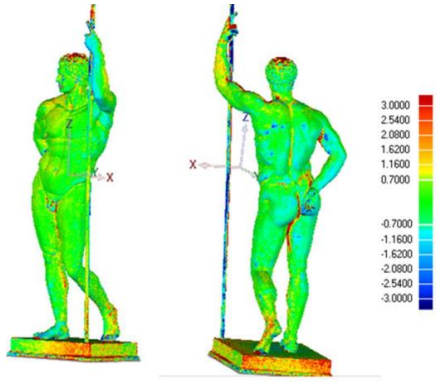
ING-IND/15 DESIGN METHODS FOR INDUSTRIAL ENGINEERING

Research activities and applications pertains to CAD-CAE and computer-based simulations such as:

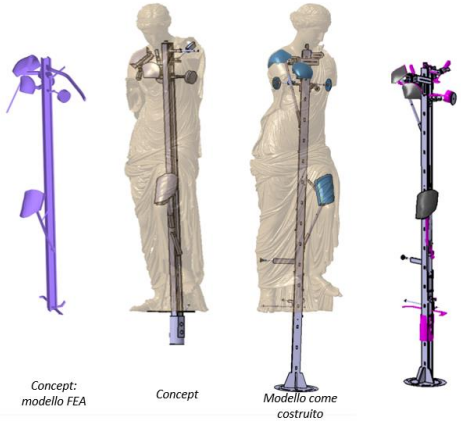
- Reverse Engineering: acquisition and post-processing solutions for complex shape modeling, recognition and control (e.g. springback of sheet metal forming, pipelines external damage, cultural heritage applications).
- Computer Aided Tolerancing & Inspection: development of algorithms for the verification of geometrical tolerances from digital acquisition.
- CAD-CAE Methods to support archaeological investigation, restoration, and conservation (with specialization towards bronze statues).
- Product Lifecycle Design: Study of methods for managing optimization process in developing product-process design, quality control and design for X (reliability, ecodesign, ergonomics, …)
- Virtual prototyping and modeling of applications with nonlinearity such as plastic and hyperelastic materials.



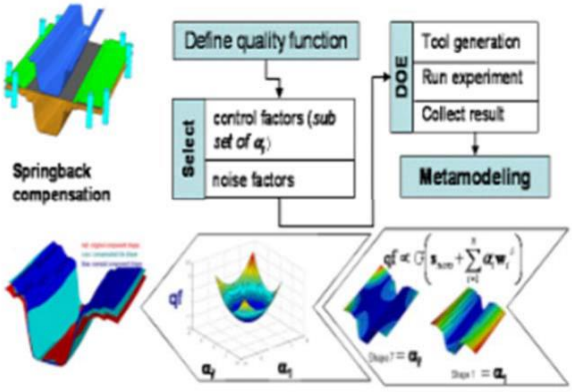
Tolerance Inspection



Cultural Heritage Acquisition



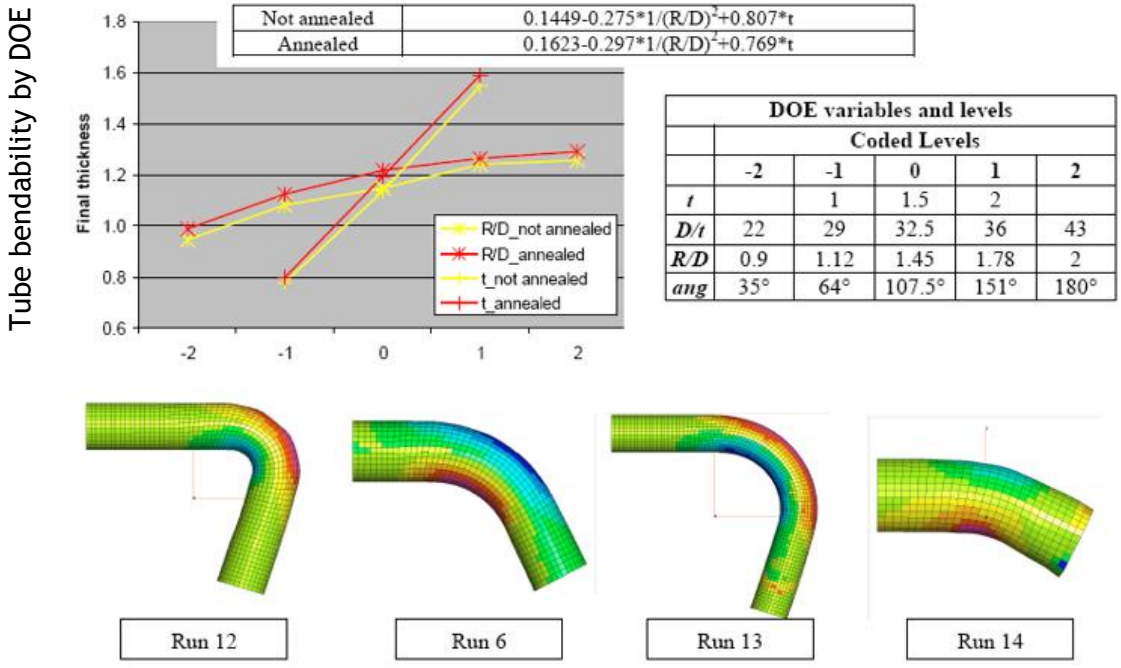
Bronze Statue Inner Frame Design



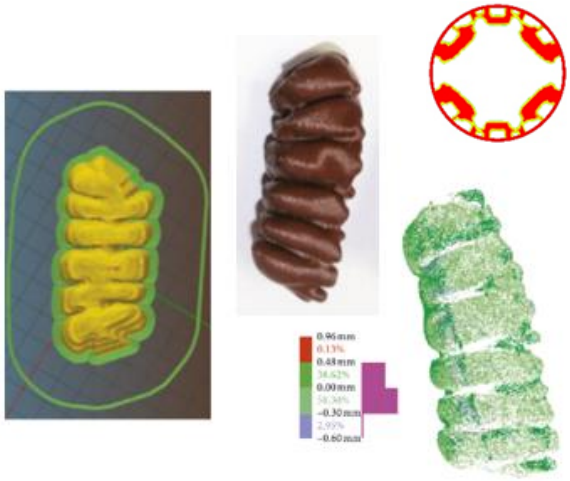
Springback Optimization

ING-IND/15 DESIGN METHODS FOR INDUSTRIAL ENGINEERING

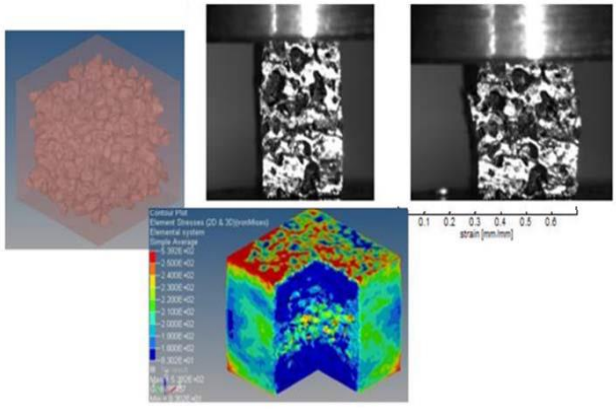
- CAE tools with particular interest to Robust Design and to integrated product-process design
- Design of Experiments applications and optimization
- Topological optimization and Digital Design.
- Cellular materials and lattice structure mesoscale modeling and structural assessment.



Design of Experiments Applications



Digital Design and
Topological Optimization



Cellular Materials Modeling

ING-IND/16 MANUFACTURING TECHNOLOGIES AND PRODUCTION SYSTEMS

Research activities are mainly focused on the traditional and non traditional Technologies, such as Additive Manufacturing processes, machining, laser processing, and surface technology.

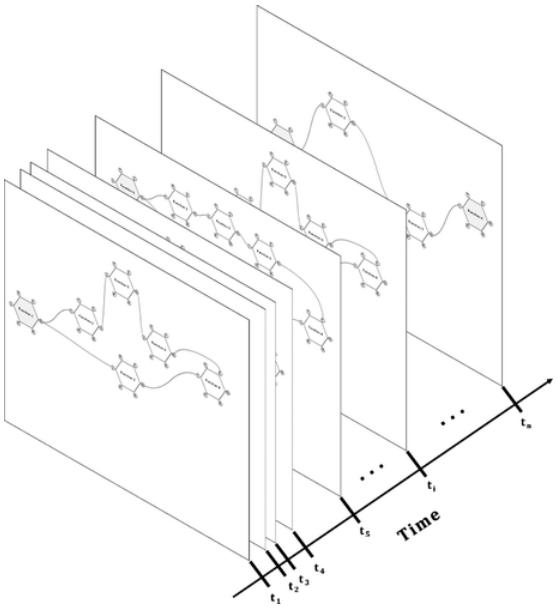
Over the years, the group has developed specific skills in the field of:

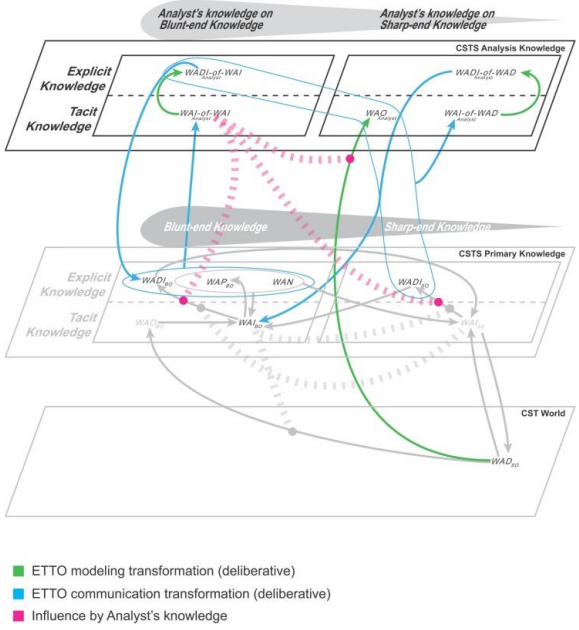
- Production of prototypes and components by additive manufacturing, with Fused Deposition Modeling technology and development of a rapid prototyping experimental apparatus;
- Machining with computer numerical control systems of free-form mechanical components;
- Finishing of mechanical components via mass finishing and laser techniques;
- Manufacturing of metal foams through salt infiltration;
- Reverse engineering through laser scanning and structured light of complex geometry components;
- Laser thermal treatments aimed at increasing the mechanical and/or tribological properties of metal and composite components;
- Recycling polycarbonate from electronic waste (optical media, such as CDs and DVDs);
- Laser forming for folding and shaping aluminum and stainless steel sheets with
- complex shapes;
- Aesthetic welding for conducting light alloys and precious metal alloys;
- Metal-polymer hybrid laser joints for applications in automotive, biomedical, food and pharmaceutical packaging;
- Modeling and optimization using artificial intelligence techniques and numerical simulation of many processes, such as laser processing and fused deposition modeling;
- Functionalization of organic or inorganic coatings for aesthetic and functional purpose.

ING-IND/17 INDUSTRIAL MECHANICAL SYSTEMS ENGINEERING

Industrial Mechanical Systems Engineering addresses a broad range of topics from production design to operations management. The team develops analytical and simulation models, expert systems and data-driven approaches to trade-off competitiveness, effectiveness, efficiency, and sustainability. The research activities focus on advanced scientific solutions for decision makers in a smart manufacturing environment. The main fields of research are:

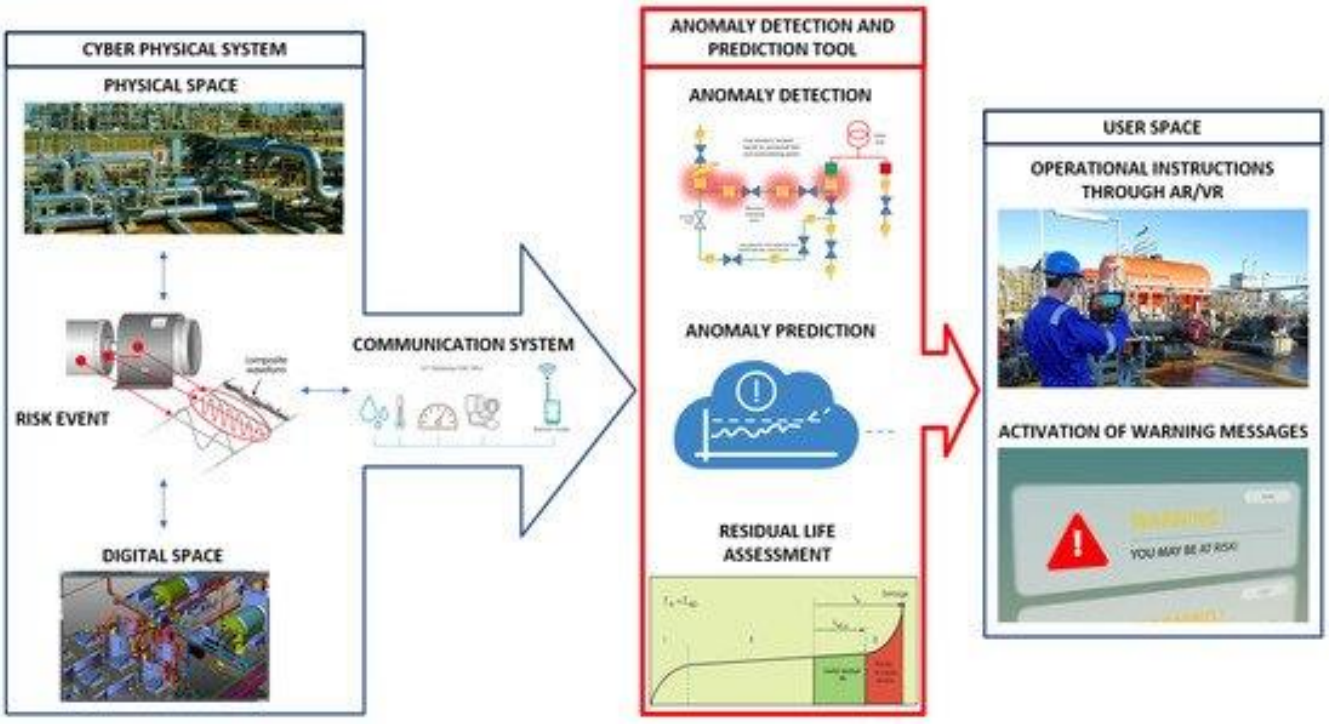
- Design of industrial systems: efficient design of industrial and service systems, economic evaluation and investment analysis, plant layout and facility design, environmental impact assessment, warehouse and material handling systems optimization, project protfolio selection and management.
- Operations management: tools and techniques to design, manage, control, and improve production processes by system-wide optimization that encompasses lean management and six sigma, besides Business Intelligence and Artificial Intelligence solutions.
- Logistics and Supply Chain Management: design, management, assessment, and optimization of logistics systems' and supply chains' performance with specific reference to coordination and planning of ordering policies, production optimization, rating models, disruptions management, supply chain resilience and cyber-resilience modeling.
- Risk Management: methodologies to identify, assess, and manage risks. The group develops diverse modelling solutions adopting the principles of resilience engineering for complex socio-technical systems (large-scale plants, airports, hospitals, etc.) that jointly involve human agents along with cyber-physical and organizational elements.





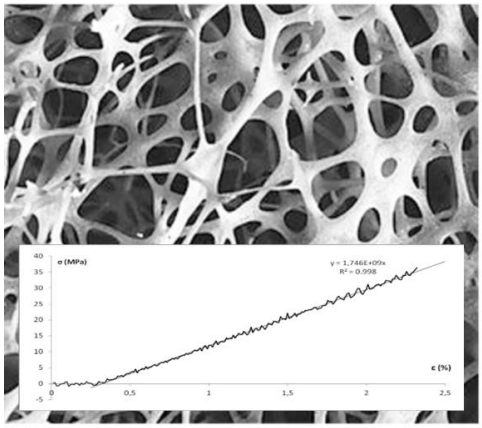
ING-IND/17 INDUSTRIAL MECHANICAL SYSTEMS ENGINEERING

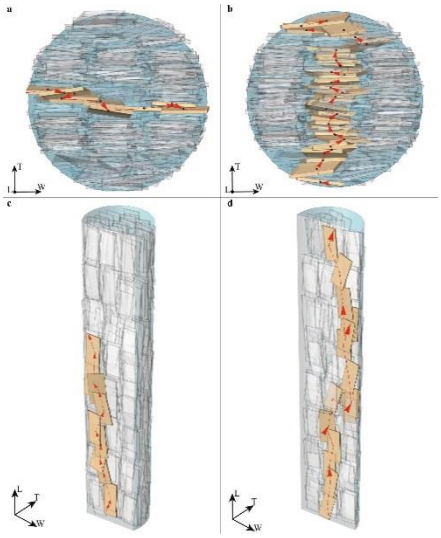
- Safety and maintenance: advanced maintenance, prognostic and health management, including Tele-Maintenance, predictive Safety Intelligent Systems, ergonomics, and resilience engineering applied to safety management. Innovative modeling for spare parts management in multi-echelon multi-item multi-indenture logistic networks to ensure inventory costs reduction, and service improvements through heuristic optimization algorithms.
- Life Cycle Assessment and Management: approaches focusing on sustainability through cost-benefit analyses and life-cycle optimizaiton to improve products, services, product-service systems, or even processes, management systems, and supply chains at a larger scale.
- Environmental and Quality Management: business practices to increase stakeholders' satisfaction and reduce or prevent environmental pollution through management solutions; development of Total Quality Management and Standard of Excellence models, and Governance-Risk Management-Compliance (GRC) models.
- Industry 4.0 and production digitalization: methodologies to enable the adoption of IoT solution into production systems, with the development of specific frameworks and data-driven approaches relying on machine learning solutions, aimed at increasing enterprises' competitiveness. This research includes as well a focus on human-machine interactions for industrial robots and cobots, and the assessment and management of risks associated with digital opportunities.

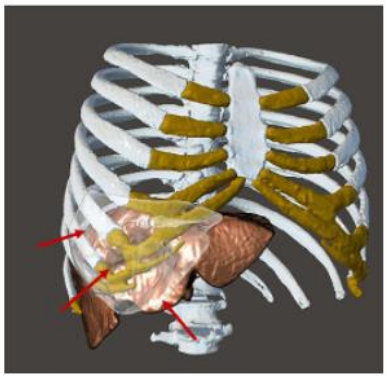


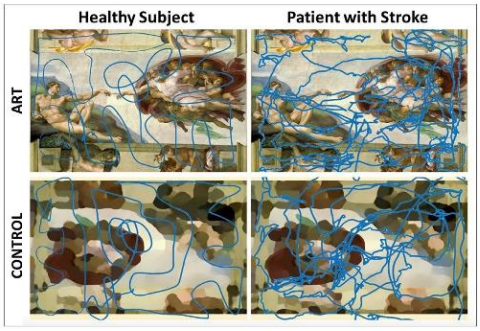
ING-IND/34 INDUSTRIAL BIOENGINEERING

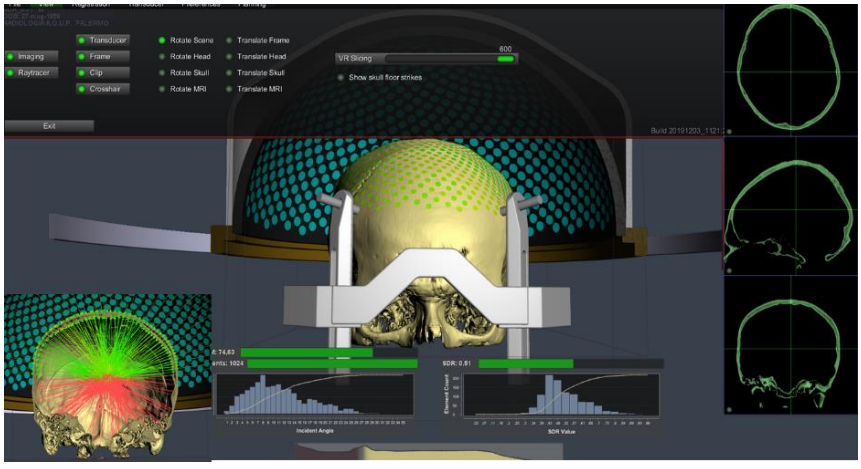
- Analysis of structure property relations and transport phenomena in nano-structured biomaterials;
- Analysis of the Ultrasound-Tissue interactions
- Effect of microgravity conditions on bone remodeling
- Proof of Concept devices for the mechanical characterization of biological tissues
- Hysto-Morphometric analysis of bio-images (Radiomics)
- Augmented and mixed reality exergaming for clinical evaluation and rehabilitation.
- 3D Models for Surgical planning and training
- Medical Devices characterization
- Quantitative analysis of Bio-Archaeology (Anthropological Archaeology) samples











LABORATORIES

Lay-out

Footprint and locations

Areas

Equipments and large experimental infrastructures

Lay-out, foot-print and locations

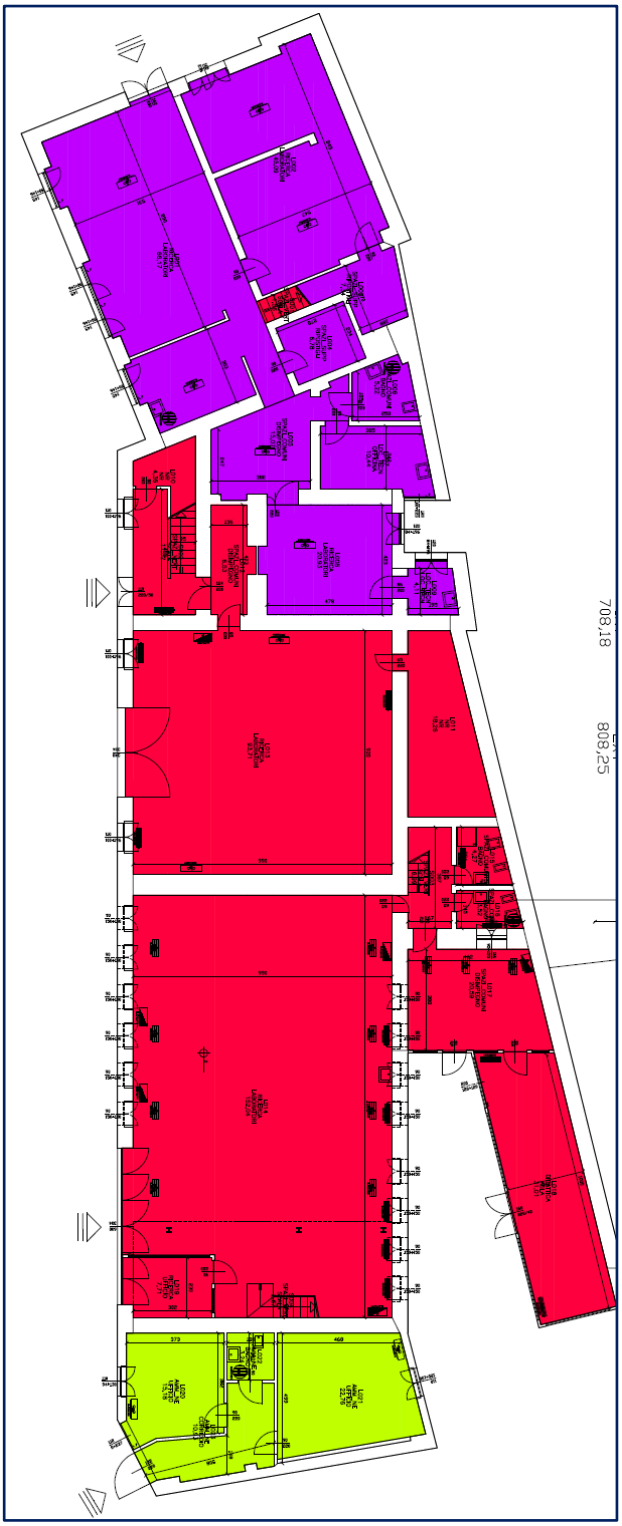
Total lab area

Didactic & Research Labs: 1500 m^2

Buildings

San Pietro in Vincoli RM031

San Pietro in Vincoli RM035



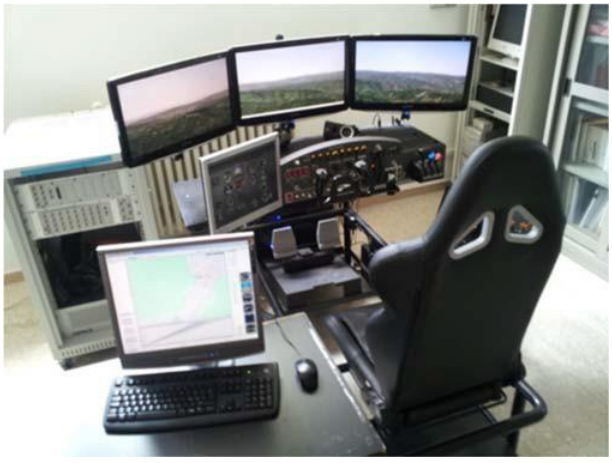
Flight Dynamics (LAPIS)

Fields of research:

- Development of fixed and rotary-wing UAVs (Unmanned Aerial Vehicle): design and construction of small aircraft (drones) with innovative features, equipped with thermal or electric propellers;
- Autopilot Design: drive and control algorithms developed through an automatic SW generation and implementation on the on-board computer;
- Aircraft modeling and flight simulation by a real-time simulation system, with a realistic cockpit for the human-machine interface study.
- Design, prototyping and validation via simulation of systems for determining balance control of nano satellites.

Laboratory equipment:

- Fully instrumented UAVs for GN&C test and validation using scale models;
- dSPACE equipment for rapid prototyping of flight control and hardware-in-the-loop simulation systems:
  - dSPACE modular system based on DS1006 Processor Board, 2.5 GHz and and various cards (I/O Serial Interface Board, Digital I/O Board, A/D and D/A Board, Timing and Digital I/O Board etc.);
  - dSPACE System DS1103 PPC Controller Board, single-board system with real-time processor and comprehensive I/O;
  - dSPACE MicroAutoBox II system.
- CPU boards, GPS, I/O, power supply in PC/104 format for embedded computer realization;
- Inertial navigation system C-III MIGTS - Systron Donner Inertial Division;
- Professional Flight Console with hand wheel and pedals by Precision Flight Control Inc., with digital avionics and navigation system emulation by Garmin GNS 530W for single-engine, twin-engine propeller and turbojet .
- MathWorks Family products (Matlab, Simulink and toolboxes); products by dSPACE and applications for aerodynamics analysis (Tornado, VSAERO).



Aerospace Structures and Design

Structural Dynamics Lab

Development of experimental modal analysis technique based on both input/output and output-only measurements. Identification of structural dynamic properties from flying test and GVT of fixed and rotating wing vehicles. Environmental testing for design qualification and flight acceptance of space structures and mechanical components undergoing severe vibration levels. Vibration reduction methods via PZT patches passively used. Development of sensitivity-based structural updating techniques and structural damage identification methods.

Aerospace Composite Material Lab

Design, manufacturing and testing of high performance composite materials for aerospace applications. Embedding of sensors/actuators for health monitoring. The laboratory is equipped with the following facilities: autoclave for vacuum bagging technique with 440mm diameter, and 770 mm length, curing cycle with programmable logic controller for temperatures up to 200° C, pressures up to 8 atm and 10 mbar of vacuum; tooling facilities for post-processing of composites; ultrasonic device for non-destructive testing with linear phased array probe with 64 transducers at 3.5 MHz and encoder. The Lab is involved in the development of natural fiber composites for aeronautics and other fields of application.

Smart Structures Lab

Development of active structures for vibration control, health monitoring and shape morphing in aerospace systems. Exploitation of piezoelectric materials for wireless sensors networks and energy harvesting capabilities. Vibration control of active structures, active control of composite structures, electro-active polymers, smart thermal protection system. The laboratory is equipped with the following facilities: LMS SCADAS III advanced platform for data acquisition and analysis for vibration engineering, electrodynamic shaker, electronic equipment for circuit design, breadboarding and testing, equipment for piezoelectric material treatment, telecom devices for wireless network communications.

Aerospace Structures and Design

Computational Mechanics Lab

Numerical simulations of aerospace structures by finite element procedures for nonlinear analysis (large displacements, large strains, material nonlinearity e.g. rubber) and multiphysics (thermal and thermoelastic analysis, piezoelectric analysis).

Computational Space Robotics and Multibody Dynamics Lab

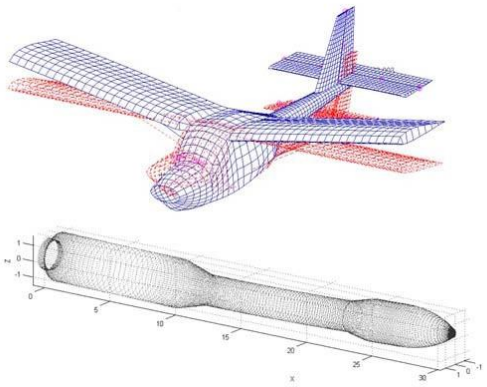
The activities of the laboratory are relevant to the development of space manipulators and robotic arms from the mechanical, dynamical, and control point of view. Interactions with autonomous space systems are also investigated, studied, and simulated numerically and experimentally.

Computational Dynamics and FSI Lab

Development of multidisciplinary reduced-order models (ROM) for the dynamics of aerospace structures and for the solution of stability and response problems induced by fluid-structures interactions (FSI) in aircraft, launch vehicles, and rotorcraft. Use of ROMs for multidisciplinary design and optimization (MDO) of innovative aircraft configurations.

Concurrent Engineering Lab

Preliminary design of satellite systems in the frame of multidisciplinary analyses and pre-phase A sizing criteria in a concurrent engineering SW and HW environment.

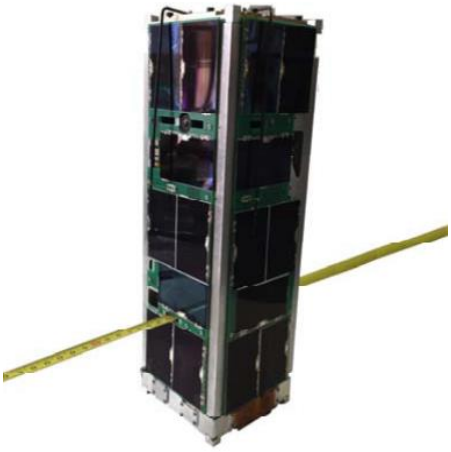


Aerospace Systems and Radio Science

Aerospace Systems Lab

Development of techniques for the analysis of optical measurements of Earth orbiting objects. In particular, the activity aims at the dynamical (trajectory and attitude motion) and physical (material, colour, shape, area-to-mass ratio) characterization of space debris.

To achieve space debris optical measurements the laboratory produces and operates observatories dedicated to space debris measurements. Astrometry and photometry is accomplished by exploiting a network of small observatories deployed all over Italy, multicolour photometry and spectroscopy is performed from the Loiano observatory in Bologna and in collaboration with the Cerro Tololo observatory of the University of Michigan.



Moreover, the laboratory of Aerospace-systems design, manufactures and tests components and subsystems for aircraft and spacecraft. In particular, the activities in this field involve a system for supporting landing of airplanes, helicopters, and drones based on optical tracing of the target and systems for testing microsatellite components as vacuum chamber and Helmholtz coils for simulating variable magnetic fields.

Radio Science Lab

The Radio Science Lab is active in radio science experiments, precision tracking systems, planetary geodesy, and orbit determination. The laboratory hosts a network of high-power computers for the processing of tracking data used both for scientific investigations and deep-space navigation. In the period 2011-2013 twelve people (graduate students, postdocs, and research assistants) worked in the lab. The team has joined flagship missions of NASA and ESA planetary exploration program, such as Cassini (ongoing, in orbit around Saturn), Juno (now in cruise to Jupiter), BepiColombo (to Mercury, launch in 2016), and JUICE (to the Jovian satellites, launch 2022). The lab partecipated in these missions with flight hardware and data processing of radio science and planetary geodesy investigations. These activities wer carried out in an international context, with extensive collaborations with academic and scientific institutions, and aerospace industries.

Over the past years the Radio Science Lab took part in industrial studies, with the participation of prominent European aerospace industries (such as BAE Systems and Thales Alenia Space). Of special relevance was the development of the Delta-Differential One-way Ranging (DDOR) correlator, a crucial asset for Europe's access to deep space. This operational tool for the navigation of ESA's planetary probes was entirely developed by the lab's personnel.

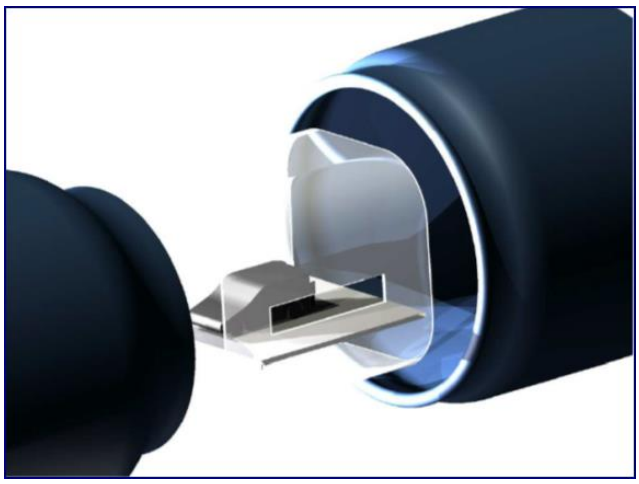
Aerodynamics and Fluid-Mechanics

Aerodynamics

- Subsonic Wind tunnel, open circular test-section of about 1 m in diameter and a maximum air velocity of 50 m/s. Equipment: Multi-hole Pitot Tubes, Pressure Gauge, Particle Image Velocimetry system (PIV), Continuous and Pulsed Lasers, High-Speed Video Camera (up to 100,000 frames per second), cross-correlation cameras,3D-frame lenses and video camera, Laser Doppler Anemometer (LDA), Ultrasound Anemometer (UA), three-component balance. Oil and Bubble pressurized generators. Models of wings and ailerons, wind turbines (HAWT and VAWT), cars, MAV and other geometries.
- Anechoic wind tunnel, with a standing chamber connected to a high pressure system. The section of the chamber is circular (diameter 50 cm) and the velocity of an input jet can range from 50 m/s to more than 450 m/s depending on the jet output diameter. Equipment: 8 microphones (1/4 in Bruel-Kjaer 4939) connected to a PULSE X-3570 scan system. Set of Absolute and Differential Pressure Gauges (MKS). Set of air and nitrogen flow meters (MKS). Nozzles of various sizes and shapes.
- Small wind tunnels for flow visualization and teaching purposes.

Fluid-Mechanics

- Water ducts and jets, with a maximum output speed of 1 m/s and an outlet section of about 2 cm in diameter, has a square cross-section measuring area of 80 cm side and 120 cm lenght.
- Water-jet orifice, continuous and pulse configuration with a 3 cm output diameter, with a square cross-section area of 50 cm side and 60 cm lenght. It is equipped with remotely controlled linear gear to generate pulsed biomedical flows with assigned forcing. Different types of orifices from circular to rectangular.
- Free-surface tank for experiments on free-surface flows, as jets interacting with walls, rivers and wave formation.
- Microfluidic devices, for investigation on heat transfer and flow fields at millimiter scale.



Advanced Energy Systems

Cryogenics and Stirling Engine

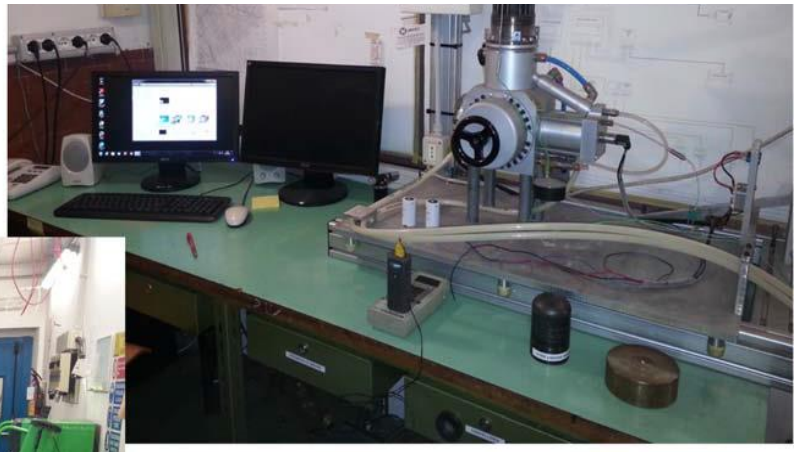
Experimental activities: the laboratory has been active for over 20 years for the study and testing of closed cycle Stirling machines. There is also a complete test-bench for the measurement of the various functional parameters and the analysis of Stirling engine cycle and cryogenic thermoacoustic machines. The lab is supplied with a National Instrument acquisition bench, a high-vacuum pump, a vacuum chamber for cryogenics (volume=3 dm3) with a chilled water auxiliary circuit for thermal stabilization. There is also a specific library and a rich collection of Stirling machines prototypes.

Engine test room

The engine test room has three test benches, one with hydraulic brake suitable for teaching, a tilting scale for torque and power measurements; the other two benches are for eddy currents for the testing of internal combustion engines up to a power of 80 kW. Equipped with external conveyors and refrigeration circuits of flue gas it can also accommodate test-benches for Stirling machines (with 25 kW dynamo-brake) and microturbines. According to necessity can also be installed on a test bench burners up to a power of 60 kW.

Other available equipment includes a BOSCH gas analyzer, a unit for measuring the indicated cycle,and an AVL balance for the fuel.

A facility for the preparation of prototypes is also available.



Suistainable Energy

Biomass Laboratory

The biomass laboratory is equipped with a bench scale fluidized bed gasifier (10 kW). The experimental setup is mainly composed by a screw feeding system for the biomass, a bench scale fluidized bed gasifier, gas and steam supply systems, systems for the removal of the particulate from the gas, a gas cooling system and metering and analysing systems for the gas produced. Wood-gas composition is measured with an on-line GC, while heavy hydrocarbons are sampled at regular interval and successively measured in a GC-MS. Several research activities were carried out by using the fluidized bed gasifier: a) evaluation of wood-gas from different feedstocks (i.e. changing humidity, biomass type); b) development of improved catalysts for tar reduction; c) development of efficient traps for heavy metals dispersed in the biomass; d) development of carbon capture techniques aiming at assessing negative emission schemes.

Fuel Cell Laboratory

Design, manufacturing and testing of fuel-cell based on energy conversion systems. V/I, power curves, impedentiometric analysis and contact resistance measurements for single MEA. Fuel-cell stack design testing and optimization. Design of Direct Methanol Fuel-Cell systems for APU or UPS applications. Design of PLC for fuel-cell systems. PIV analysis of two-phase flows for flow channels optimization. Testing of Direct Methanol Fuel Cell single MEA, working in passive configuration, for low power electrical devices.

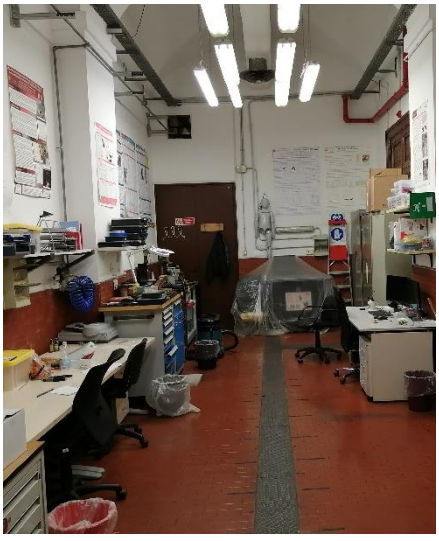
Mechanical and Thermal Measurements

The Mechanical and Thermal Measurements Laboratory includes 14 computer stations, 7 work-benches, a welding station and 2 benches under extractor hood. The instrumentation, both for basic and for specific applications includes:

Essential Equipment: Measurement chains for strain gauges, thermocouples, piezoelectric accelerometers, electromagnetic exciters, bench power supplies, signal generators, power amplifiers, multimeters, digital oscilloscopes, temperature sensors (thermocouple, PT100, infrared sensors, etc.), sensors for displacement (LVDT, linear and rotary encoders, potentiometers, laser optical sensors), speed and acceleration (tachometers, and capacitive and piezoelectric accelerometers) measurement, sensors for force and torque measurement, sensor for pressure measurement (piezoresistive sensors), Raise3D ProDuo 3D printer, FARO CAM measuring arm, CNC 3040 Z-DQ for PCB and Mini-VNA.

Energy Systems measurements instrumentation: 4-channel Micro Gas Chromatograph, Power-train "tank-to-wheel" fully instrumented with catalytic reformer and PEM fuel cell for global efficiency measure. Thermal imaging camera, bench with power supply and electronic load for measuring the efficiency of lithium batteries, system for measuring the efficiency of the PV panels (with pyranometer).

Biomechanics Measurements instrumentation: System of twelve IMU sensors for motion analysis, 6-camera optoelectronic system for motion analysis, two 6-components AMTI force platforms, 16-channels EMG system, robot for upper limb rehabilitation, pressure matrix suitable for posturography, two biaxial electrogoniometers, robot for ankle rehabilitation



Industrial Bioengineering

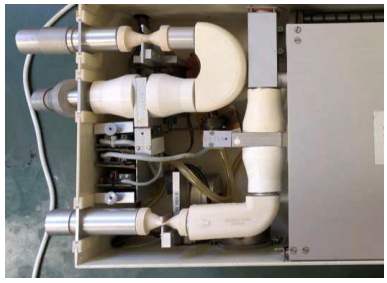
The Industrial Bioengineering Laboratory includes computer stations, and work-benches. The instrumentation, both for basic and for specific applications includes:

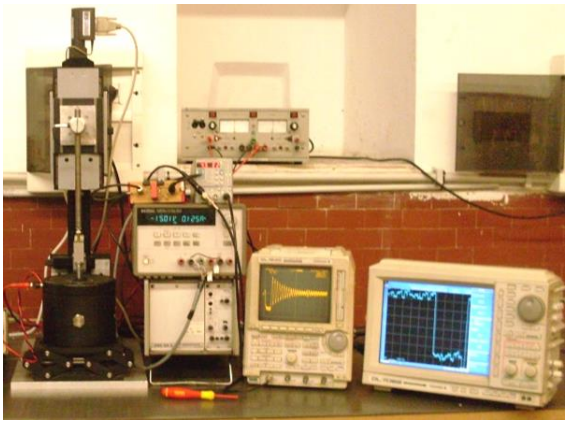
Essential Equipment: Bench power supplies, signal generators, power amplifiers, multimeters, digital oscilloscopes.

Mechanical characterization of biological tissues: Load and displacement sensors and actuator, high accuracy multi-axis translation/rotation stages for testing proof of concept devices.

Mixed Reality for diagnostic and rehabilitation: PC interfaced boards for proof of concept remotely controlled devices. Mixed reality wearable devices.

Medical Devices: 1 Clinical Ultrasound Scanner with several probes and test objects (phantoms). Demo Devices for Students training (Pulmonary Ventilator, Invasive and non-invasive blood pressure devices, integrated ECG board)





Vibroacoustic and Contact Mechanics

Vibroacoustic and Contact Mechanics

The vibroacoustics and contact mechanics laboratory is developed around the main experimental research topics of the applied mechanical group: vibroacoustics, tribology, biomechanics, and dynamics of mechanical systems.

Different test benches were developed within the laboratory for dynamic and tribological characterization of systems.

The lab has a wide range of vibration transducers, dynamic exciters, force transducers, microphones and two dynamic acquisition/analyzers.

A tribometer and a laser scanning vibrometer are also present.

Machine Construction

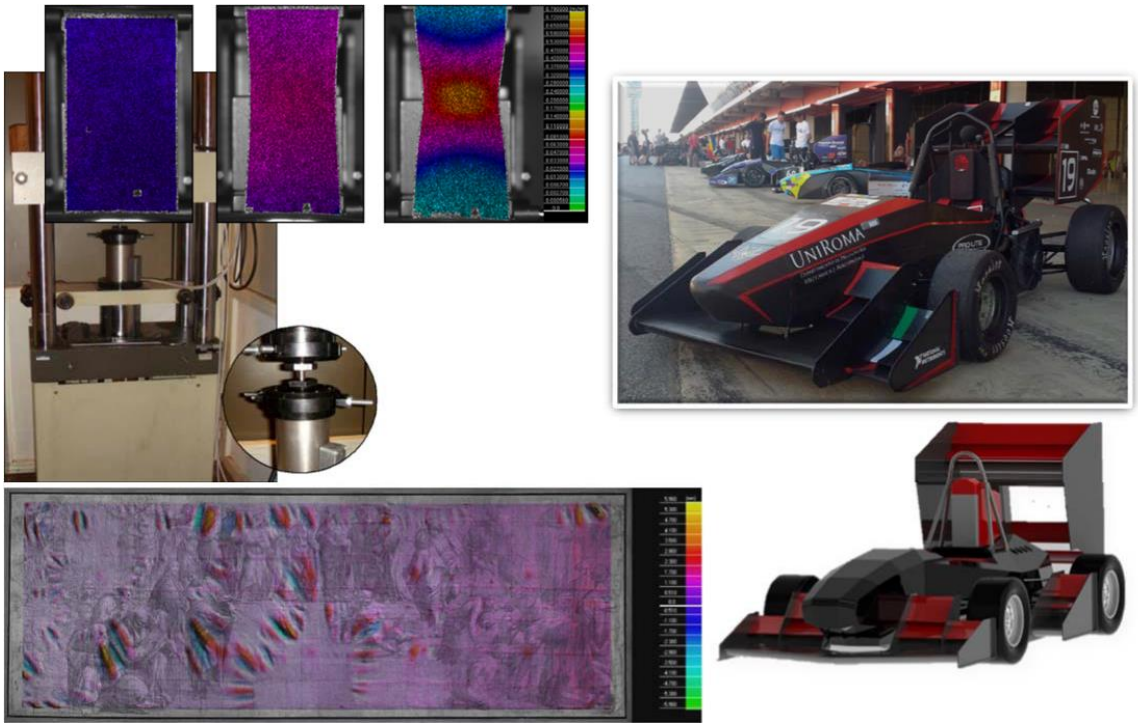
Testing facilities

An hydraulical MTS testing machine, for axial tensile/compressive static and fatigue loads up to 250 kN. The equipment is controlled by a 407 MTS hardware while load signal, crosshead displacements and specimen elongation data are collected by a National Instrument card and Labview software.

A tension-torsion custom designed electro-mechanical testing machine is available, based on a Schenck-Trebel four-columns frame, which allows axial and torsional loads up to 100 kN and 1000 Nm, respectively. Loads are acquired by a custom-made biaxial load cell, while displacements and rotations are recorded by means of digital encoders embedded in the actuators. The real-time control is provided by a National Instrument FPGA card programmed in Labview environment. The two axes can be independently loaded or displacement controlled. The equipment, in conjunction with proper specimen geometries, allows the execution of multiaxial tests characterized by very different loading conditions and stress states.

Digital image acquisition equipment for DIC analysis

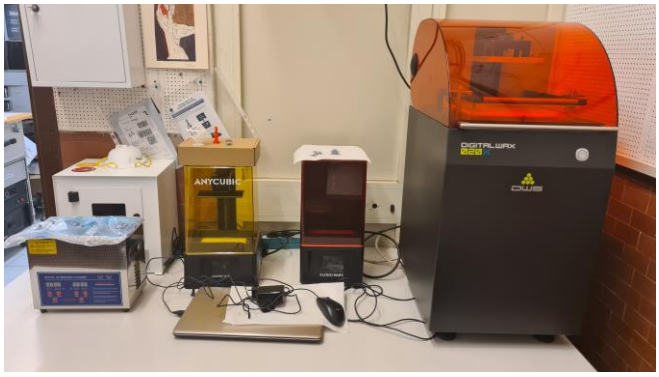
The group has a consolidated expertise in surface strain measurements relying on the "white light speckle image correlation" technique. A high resolution digital image acquisition framework can be used for the experimental activities, based on 2208×3000 pixel PixeLink cameras, controlled by a personal computer through a FireWire high speed connection. The system can be used with different testing machines available in the lab. The acquired data can be properly post-processed to quantify full-field displacements of the specimen with a spatial resolution up to a fraction of a pixel and strains during test execution.



Manufacturing and Technology

In addition to standard support equipment, such as rugosimeters, microscopes, data acquisition systems, the technology and processing systems laboratory, the following equipment is dedicated to scientific and technological research in the field of mechanical machining:

- CNC milling machine;
- centrifugal disc finishing plant - ECO MAXI;
- FDM additive manufacturing system;
- Rofin-Sinar DL015 Diode Laser Source;
- Forced ventilation stove (model FD 53 Binder) in the range 5-300 °C;
- NextEngine 3D scanner based on light scattering;
- GOM ATOS 4M SO 3D scanner for small components based on structured light;
- Industrial and experimental barrel finishing systems;
- Powder Bed Fusion EOS M290 Selective Laser Melting system and related machines for platform detachment, sand blasting, kiln for thermal treatments;
- Additive manufacturing system based on Stereolithography technology (inverted configuration and laser based) with post curing apparatus;
- Additive manufacturing system based on Masked Stereolithography technology (inverted configuration and led based) with ultrasonic vat for post processing.


High-Performance Computing

Monolith Cluster

- **1 Front-End Node**
  2x 8 core Intel(R) Xeon(R) Silver 4208
- **10 CPU Computing Nodes**
  4x 20 core Intel Xeon Gold 6230 192 GB ram
- **1 GPU Computing Node**
  2x 20 core Intel Xeon Gold 6230 192 GB ram 2x NVIDIA TESLA V100S GPUs

Innovation, Technology Transfer and Societal Impact

INDUSTRIAL PARTNERSHIPS

FUNDING AND GOVERNAMENTAL AGENCIES

SPIN-OFF

Spin-offs are the quintessential means of developing highly innovative businesses based on the research and knowledge base accomplished within the University. Sapienza fosters and promotes the birth of start-ups with the aim of transferring to the market patents, inventions, know how, or devices which are the result of scientific research.

With this idea, DIMA members have founded several spin-offs in diverse fields.

AIComply

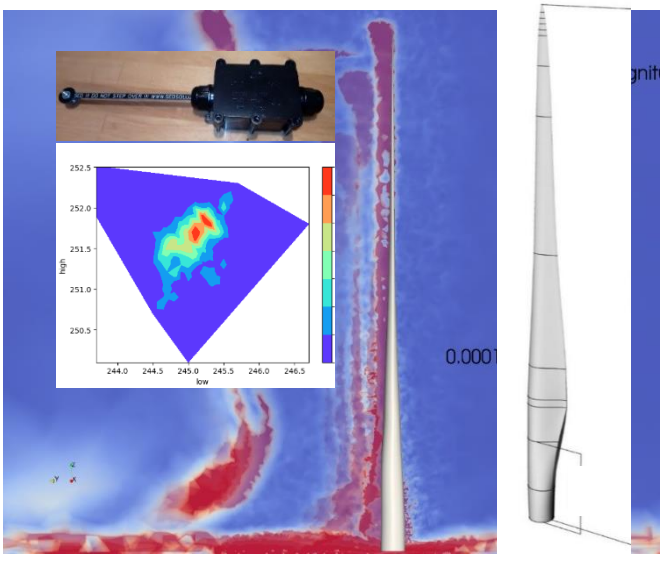
(Contact Person: Prof. Giulio Di Gravio)

AIComply has the mission to develop and supply innovative services for Compliance Management in order to ensure the fulfillment of regulations or on a voluntary basis. The integrated approach is based on a technological platform which accounts for multiple regulations ready to launch on the market. The goal of the service offered to the market is that of contributing to the evolution of statical management systems of Compliance, moving towards an innovative Compliance & Risk Management, by offering methodological and technological support that, based on the output of processes, controls, and action plans, is capable of assessing the actual risk level to which the company is exposed.

SED Soluzioni per l'energia e la diagnostica

(Contact person: Prof. Alessandro Corsini)

The goal of SED is to develop and provide products and services for supporting the technologies for the diagnosis and prognosis of rotating machines, turbomachinery, and energy and power systems. In particular, SED is concerned with the development of the industrial production of on-time and on-line monitoring systems implementing new softwares for the diagnosis of unstable operation regimes and for their control by suitable actuators.



SPIN-OFF

Smart Structures Solutions

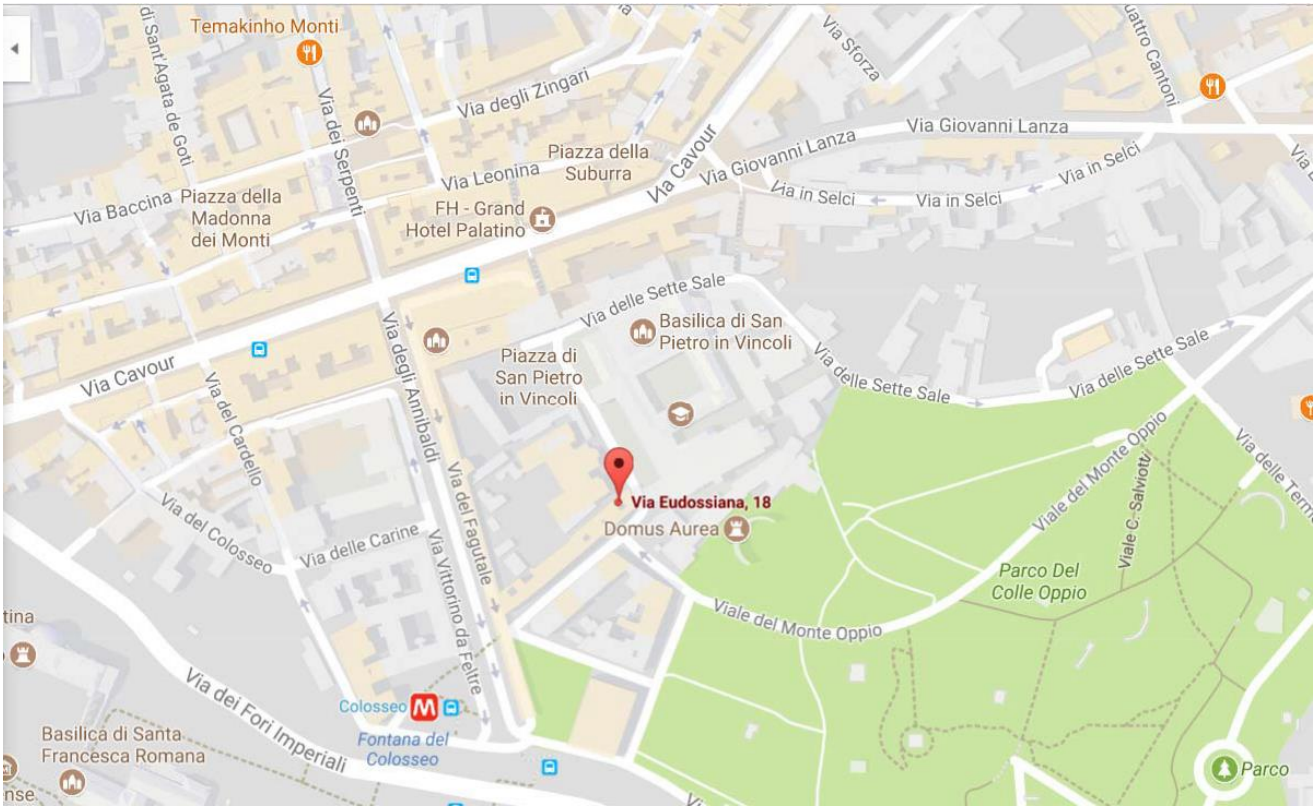
(Contact person: Prof. Paolo Gaudenzi)

This spin-off stems from the idea of realizing monitoring systems for structural safety based on wireless communications and autonomous operation (i.e., without external electrical power supply). Smart structures technologies, which have been studied and developed in several international research centers including Sapienza, offer a number of technological solutions for both the choice of sensors and self-production of power, using energy harvesting methods and/or technologies.

WHERE WE ARE

DIMA is located in the Faculty of Civil and Industrial Engineering of Sapienza.
Our location can be easily reached by bus/metro, by train, by taxi or by car.

Via Eudossiana 18—00184 Roma



Please check our website for further information:

https://www.dima.uniroma1.it

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