

## NEWSLETTER DEL DIPARTIMENTO DI INGEGNERIA INDUSTRIALE DELL'UNIVERSITÀ DEGLI STUDI DI PADOVA



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

**dii** DIPARTIMENTO  
DI INGEGNERIA  
INDUSTRIALE



## C O P E R T I N A

*Scaffold bioceramici contenenti silicati di Ca-Mg.*



P A G I N A

3

**Bioingegneria, biotecnologia e tecnologie per la salute**

*Characterization of bileaflet mechanical heart valves closing sound*

4

**Ingegneria dei sistemi elettrici**

*Normative (IEC, IEEE) and working group activities (CIGRÉ) of Power System Group*

5

**Ingegneria dei sistemi meccanici**

*DII successfully completed Wind Tunnel Tests on Optimized Tiltrotor*

6

**Mobilità sicura e sostenibile**

*Structural analysis and fatigue life prediction of electric lightweight moped frames*

7

**Processi, prodotti e servizi**

*CESQA: Strategic Environmental Management tools to support the sustainable development of Industrial Processes*

8

**Ambiente**

*Container Transport System Security - CBRN Decontamination*

9

**Achievements**

12

**Cover story**

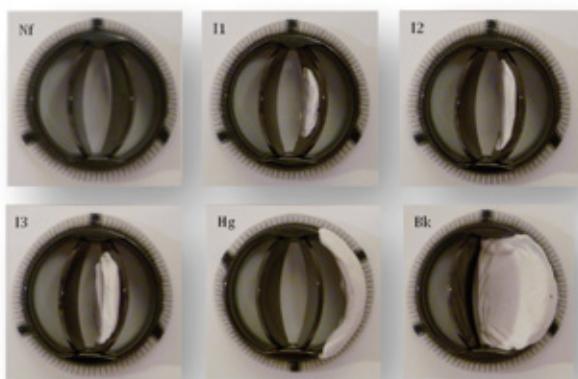
# Characterization of bileaflet mechanical heart valves closing sound

Hemodynamic performances of any bileaflet Mechanical Heart Valve (MHV) can be affected by the formation of thrombotic deposits whose early detection could be fundamental for prompt diagnosis and adequate therapy. This study aims at designing a diagnostic tool able to detect valvular thrombosis at early stages of formation and assign each MHV recipient to a risk class.

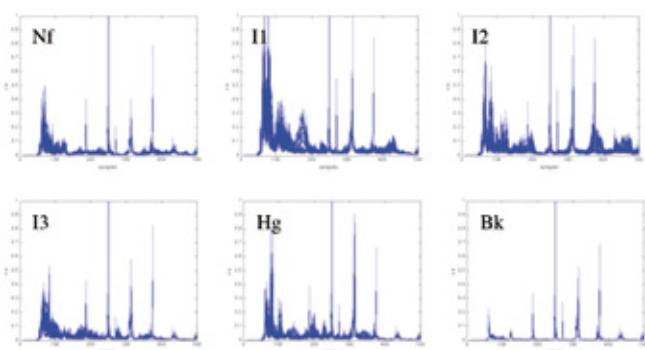
The proposed approach is based on feed-forward artificial neural networks applied to the power spectra of the signals produced by the closing sounds of MHVs leaflets. Five bileaflet MHVs were investigated in a Sheffield Pulse Duplicator. Six functional conditions were reproduced (Figure 1): one normofunctioning (Nf) and five thrombosed, which have been simulated by placing artificial deposits of increasing weight and shape on the valve leaflet (I1, I2, I3) and on the annular housing (Hg); the case of one completely blocked leaflet was also investigated (Bk).

In vitro, the acoustic signals (e.g., closing sounds) were acquired by phonocardiographic means, then analyzed in terms of power spectra (Figure 2) and finally classified by an artificial neural network. The neural network, trained with the in vitro data, was also used to classify the acoustic signals from 48 recipients of one MHV in the aortic position. For all patients four recordings were acquired: the average spectrum was calculated to reduce intra-operator variability. The average spectrum was classified and assigned to a risk class. From the average spectra acquired from the patients, 38 spectra (80.85%) were clearly assigned to the proper risk class by the artificial neural network.

The implementation of a diagnostic tool able to detect thrombotic formations on MHVs leaflet and then assign patients to one of the six risk classes, can help clinicians in establish adequate therapeutic approaches before the appearance of critical symptoms due to prosthetic valve thrombosis.



*Fig. 1. The six simulated functional classes for in vitro tests.*



*Fig. 2. The average power spectra calculated for the six simulated functional classes.*

Bioingegneria, biotecnologia  
e tecnologie per la salute  
**Bioengineering**

Chemical Bioengineering



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This research activity has been carried out in collaboration with:

Prof. Gino Gerosa, Prof. Tomaso Bottio and Dr Vincenzo Tarzia  
(Cardiosurgery Unit, University of Padova)  
Prof. Vittorio Pengo  
(Cardiology Unit, University of Padova)

[www.dii.unipd.it](http://www.dii.unipd.it)

Main research topics:

- Innovative biomaterials: synthesis of bioactive peptides and covalent functionalization of surfaces
- Matrixes of self-assembling peptides chemoselectively modified for regenerative medicine
- Biomechanical characterization of animal pericardium for prosthetic heart valves
- Functional assessment and classification of mechanical heart valve prostheses
- Analysis of skin perfusion by laser Doppler fluxmetry

Ingegneria dei  
sistemi elettrici  
*Electric systems*

DII research group  
Power System Group



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The normative activity is carried out in collaboration with:

Dr. Sebastian Dambone Sessa,  
post-Phd at the Department of  
Industrial Engineering, Padova.



Main research topics:

- Smart grids: the operation and control of active networks
- Voltage regulation in the distribution network with high penetration of distributed generation
- Large-scale energy storage in the network
- EHV/HV dc and ac innovative transmission lines e.g. insulated cables and gas insulated lines
- Synergy between railway and highway infrastructures and insulated cables
- Multiconductor cell analysis (MCA) of asymmetric systems by means of self-implemented matrix procedures (insulated cables with screens and armours, gas insulated lines with enclosures, overhead lines with one or more earth wires)

## Normative (IEC, IEEE) and working group activities (CIGRÉ) of Power System Group

IEEE (Institute of Electrical and Electronic Engineers founded in 1884) and Cigré (Council on Large Electric Systems founded in 1921) are the two most important international non-profit associations in the electrical and electronic fields for sharing knowledge and joining forces in order to improve electric power systems of today and tomorrow. IEC (International Electrotechnical Commission founded in 1906), is the world's leading organization for the preparation and publication of International Standards for all electrical, electronic and related technologies. Their activities are chiefly focused on the creation of working groups (WGs) or task forces aiming at investigating given topics and producing standards or technical brochures (TBs). The participation in these WGs is decided by the different associations by choosing among the greatest experts in those topics. To be chosen to participate in a WG is a prestigious award even if it is an economic burden since no refund of travel expenses is foreseen (and no other money reward). The Cigré WG duration is nominally of three years after which a comprehensive TB is published. IEEE and IEC standards can take from 3 to 10 years. IEEE, IEC standards and Cigré TBs are not indexed in the major databases but they do have a great scientific impact. Some components of Power System Group have participated in 11 WGs whose TBs or Standards are shown below. In two of these ones (TB # 351 and 639), R. Benato has been nominated as Secretary. Moreover, R. Benato and S. Dambone Sessa are Members of Cigré WG B1.56 "Cable rating verification" and WG B1.45 "Thermal monitoring of cable circuits and grid operators' use of dynamic rating systems" which will be disbanded in 2018.



Cigré TBs with author R. Benato (TBs: 351, 403, 531, 556, 639, 689) and S. Dambone Sessa (TB # 680)



IEEE Standard on Gas Insulated Lines (R. Benato)



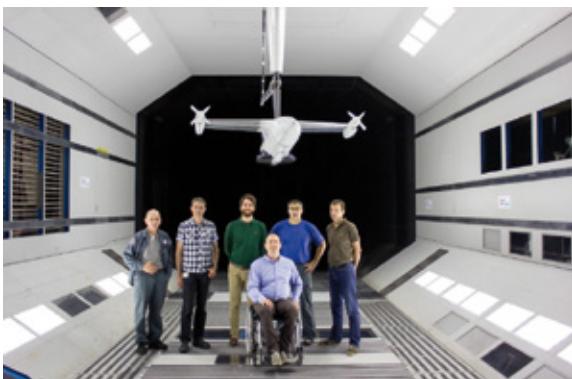
IEC Technical Specification on Energy Storage System (R. Benato)

# DII successfully completed Wind Tunnel Tests on Optimized Tiltrotor

A part of the Clean Sky initiative, funded by the European Union under the FP7 Program, the Green Rotorcraft ITD addressed the challenge of halving the specific impact of rotorcraft operations on the environment, operating together with other already launched technology programmes at European or national levels. A consortium involving DII and the research group leaded by prof. Ernesto Benini, Hit09 Srl (I) and RUAG Aviation (CH) underwent a research program for both computational fluid dynamics (CFD) investigations/optimizations and wind tunnel tests (see pictures), which aimed to validate fuselage drag reduction measures for a tilt-rotor configuration that had been developed only by CFD analysis. The DREAm-TILT wind tunnel campaign performed in RUAG's Large Wind Tunnel in 2016 successfully confirmed the drag reduction goals (-5%) predicted by design optimization studies. Leonardo Helicopters (formerly AgustaWestland), the DREAm-TILT topic manager and owner of the wind tunnel model, also commissioned the consortium to perform three-component Particle Image Velocimetry (S-PIV) measurements to improve understanding of the complex flow structures and to validate CFD imulations.



*Fig. 1. Optimized tiltrotor 1:8 scaled model during wind tunnel testing at RUAG's Large Wind Tunnel.*



*Fig. 2. Partners of the DREAm-TILT project underneath the optimized tiltrotor model at RUAG's Large Wind Tunnel.*

Ingegneria dei sistemi  
meccanici  
*Mechanical systems*

DII research group

Fluid Machines  
and Energy Systems



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This research activity has been carried out in collaboration with:

Rita Ponza, Hit09 Srl, IT

Daniel Steiling, RUAG Aviation, CH

Fabrizio De Gregorio,

CIRA Centro Italiano Ricerche Aerospaziali, IT

Alberto Verna, Alexandros Thomopoulos,

Antonio Saporiti, Leonardo Helicopters, IT

Main research topics:

- Advanced optimization methods applied to drag reduction in aircraft design
- Validation of Computational Fluid Dynamics (CFD) predictions using large-scale wind tunnel testing
- Stereo Particle image velocimetry (S-PIV) in wind tunnel testing

## Mobilità sicura e sostenibile *Safe mobility*

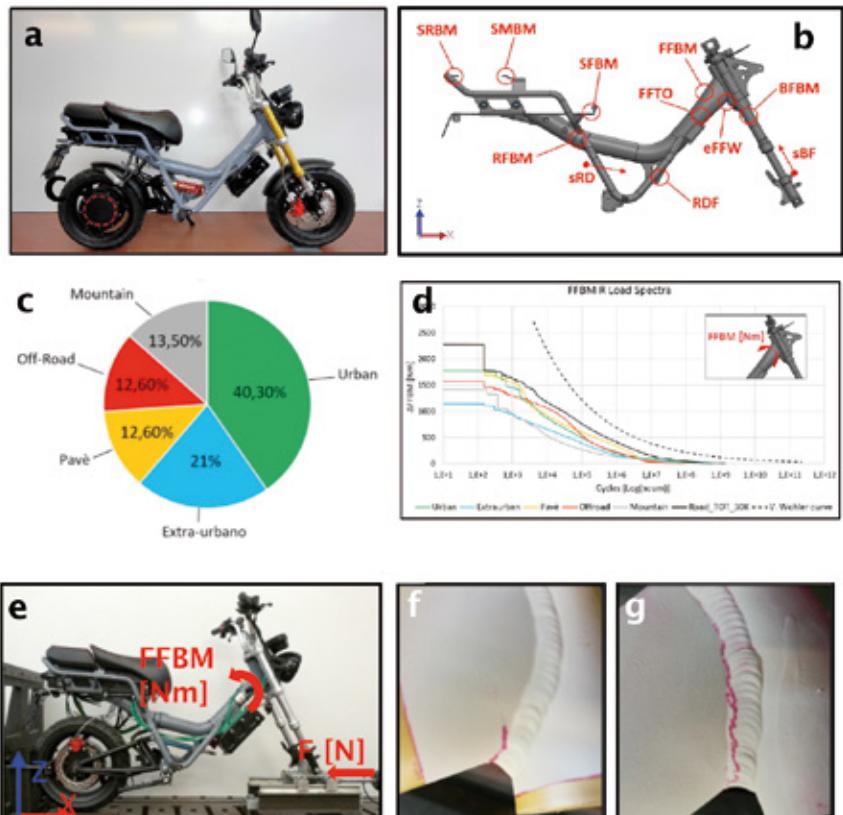
DII research group  
Machine Design, Sports &  
Rehabilitation Engineering



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# Structural analysis and fatigue life prediction of electric lightweight moped frames

Structural design of lightweight vehicles is becoming more and more urgent after the increased popularity of electrical vehicles that includes also small mopeds (Figure a) with engine at the rear wheel hub and battery pack below the saddle. The study addressed the field load spectra collection and the laboratory fatigue testing of such a prototype, to be introduced in the market in the next months. The moped was instrumented with eleven strain gauges bridges and two linear potentiometers as shown in Figure b. After laboratory calibration of each channel, a road data collection campaign was carried out in order to explore the road mix shown in Figure c. Two channels were assumed to represent the main loads acting on the frame: FFBM as the bending moment at the front main tube, and RFBM as the bending moment at the rear main tube. Load spectra from the different surfaces were obtained after rainflow counting of time histories, extended to the mission life of 30k km and combined in order to estimate the minimum Wohler curve needed to survive the assumed mission life (Figure d). A set of prototype frames underwent frontal horizontal fatigue tests as in Figure e and vertical fatigue with load applied to the saddle. As a result, fatigue cracks developed at the weld toe (Figure f) or at the weld root (Figure g) of the joint between main tube and steering tube, requiring the reinforcement of the frame structure and enabling the achievement of the desired life of the final product.



Figures. a) Electric moped analysed. b) Channels of the instrumented moped.

c) Road mix collected. d) Field load spectrum and virtual Wohler curve.

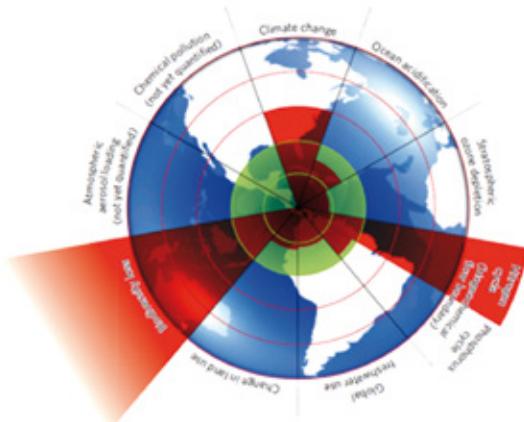
e) Horizontal Fatigue tests. f) Weld toe crack. g) weld root crack.

# CESQA: Strategic Environmental Management tools to support the sustainable development of Industrial Processes

Environmental sustainable development of Industrial processes has become a key issue for the competitiveness of companies worldwide. Reasons for this interest are manifold and directly related to the development of green markets and the consequences of climate change. CESQA research group is characterized by the conduction of applied research projects related to the development of models and tools to support companies in understanding their performances with reference to their environmental, economic and social interventions and consequently set adequate strategies and actions towards continuous improvement.

One of the research frontier is the quantification and management of scarce resources such as energy, water, land, minerals and metals. Our research is focused at the organizational level, product level and process level. The organizational level deals with the combination and where possible the integration of environmental sustainability tools such as Environmental Management Systems for the identification of critical issues and suitable solutions towards continuous improvement, and Organizational Life Cycle Assessment for the quantification and interpretation of organizational environmental hot-spots in a life cycle perspective. The product level deals with the development of environmental footprints, as Life Cycle Assessment, Carbon Footprint, Water Footprint, Nitrogen Footprint, Energy Footprint, defined as metrics used to report the overall environmental impacts of a product with a life cycle perspective, addressing a specific Environmental topic defined by the interest of managers, markets and stakeholders. The process level deals with the implementation of environmental metrics and models with the aim to explore the environmental hot-spots related the industrial processes, and to underline where it is preferable a technological or organizational improvement, in terms of environmental benefits and economic costs. Within these topics, currently the main research lines of CESQA concern the design and testing of new Scarce Resource footprints ranging from water to land scarcity, with focus on various industrial sectors interested in environmental assets.

The CESQA's activities can support the companies in their projects related product innovation, process and organization improvement, marketing strategies, supply chain cooperation. The results of CESQA's research are systematically discussed through the publication in scientific journals and the communication in international congresses.



*Rockström et al., Nature, Vol 461,  
24 September 2009.  
"A safe operating space for humanity"  
Figure 1 "Beyond the boundary"*

Processi, prodotti e servizi  
*Processes, products  
and service*

DII research group

CESQA



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[www.cesqa.it](http://www.cesqa.it)



Main research topics:

- Life Cycle Assessment modelling of Industrial processes
- Product eco-design for the minimization of environmental Impacts
- Development of Footprints
- Environmental Impact Assessment modelling
- Design and development of Sustainability Indicators
- Carbon and Water Footprint of products and Organizations
- Design and Development of innovative Environmental Managent Systems
- Integration and combination of Environmental Assessment tools and methods

Ambiente  
*Environment*

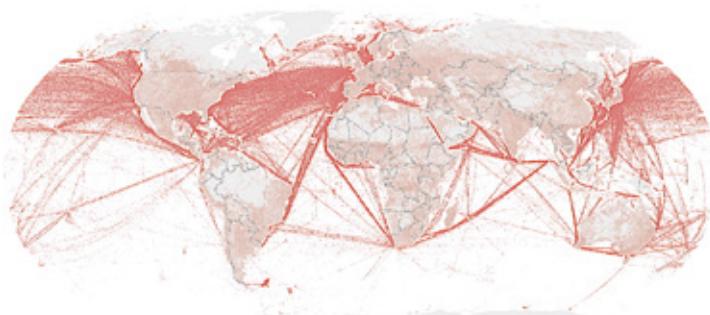
## DECON/DEMIL



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Collaboratori:  
Stefano Miorotti  
CBRN Subject Matter Expert

## Container Transport System Security CBRN Decontamination



Containers are the basic unit for delivering goods through any international market. Every year million containers reach the seaports around the world and million of them travel along the road, on land. The movement of containers brings a risk of illicit trafficking, as well as CBRN threats. Sealed containers pose a growing risk of prohibited or hazardous material to be shipped worldwide. The impact of CBRN attacks perpetrated by terrorist to containerized transport reaching economic, psychological and personal targets can be devastating for the maritime and land containers transportation sector.

The security problems in the chain container transport are mainly related to internal freight integrators, carriers operating in the starting and ending links of the chain. Whereas a CBRN incident occurs (accidentally or intentionally), effective response and recovery plans must be activated. An action for the resolution of incidents will be taken, depending on the location of the incident itself, either public or shipping/logistics company; the essential matter for the transport companies is to be aware of the problems associated with the incident response and recovery.

The preparedness phase takes place before an incident; planning, tools and procedures will help to take action faster, thus providing a more efficient in response.

To contain a CBRN incident, the first consideration should be to reduce the impact of contamination above all. Decontamination efforts are essential to mitigate the effects of hazards in order to enhance effectiveness of post-event restoration. Typically, decontamination should be performed as soon as possible to maximize effectiveness.

The areas exposed to CBRN agents should be considered contaminated, with a presumption of validity until the contrary is demonstrated. This is why the decontamination and clean-up must be carried out in order to reduce or avoid exposure to CBRN materials for first responders and staff, thus avoiding the risk of an uncontrolled spread.

Historically, decontamination has been viewed and used as a defensive measure, normally as part of military force protection on the battlefield, but most experts agree that future threats are more likely related to urban or semi-urban environment and to critical infrastructures. An agile adversary also may seek to develop complex CBRN incidents that may involve a combined chemical and biological or radiological release, or any combination thereof.

Speed of response and multifunctional solutions are an intrinsic part of a new philosophy to help overcoming these challenges. This has a huge impact on training, operational procedures, logistics and supporting capability management and relating cost benefits, but above all it brings a real improvement at the operational level. If a respirator and suit can protect the operator against multiple types of hazards, why should decontamination be any different? R&D can work to refine processes and develop creative solutions for those who need them. Saving of life is the priority and decontamination must be timely provided.

With the development and the advances in decontamination technology, decontamination operations are refined to be used for the reduction of threat vulnerability. Decontamination systems and methods have increased their importance compared to few decades ago.

The protection of critical infrastructures, such as logistics and transportation systems, harbours, airports, industrial and commercial facilities, etc., is based, among the possible measures to prevent, mitigate and respond effectively to a potential CBRN incidents, on the development of adequate capabilities and their timely and flexible deployment and performance.

## Main research topics

- WMD proliferation and non-state terrorist or criminal use of CBRNE, environmental Remediation and Recovery

# PACMAN

## Position and Attitude Control with MAgnetic Navigation

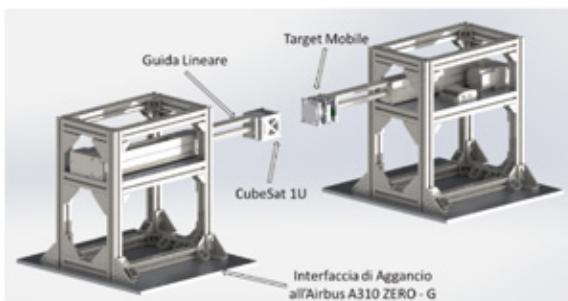


PACMAN è un dimostratore tecnologico il cui obiettivo è sviluppare e validare in condizioni di gravità ridotta un sistema di docking per piccoli satelliti basato su attuatori magnetici. Tali dispositivi, integrati con sensori per la navigazione di prossimità, hanno la duplice funzione di garantire il controllo d'assetto e assicurare l'aggancio del satellite.

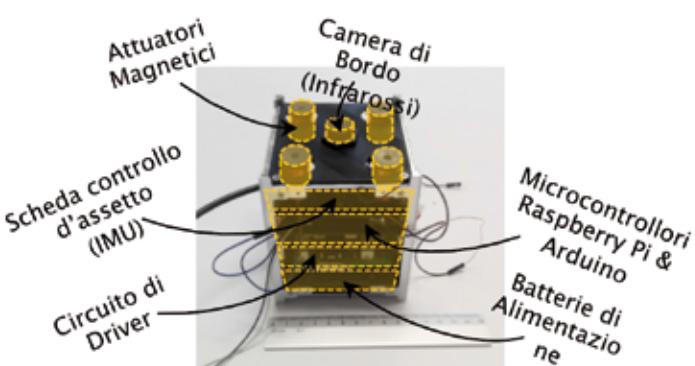


PACMAN è stato uno dei 6 esperimenti selezionati in Europa da una Review Board composta da esperti della European Low Gravity Research Association (ELGRA), dell'ESA Human Spaceflight and Robotic Directorate e dell'ESA Education Office.

La configurazione di volo di PACMAN prevede il lancio tramite una guida lineare di un piccolo satellite miniaturizzato (CubeSat 1U) verso un target mobile in grado di generare un campo elettromagnetico; una serie di solenoidi montati all'interno del satellite, coadiuvati da sensori di localizzazione, sono utilizzati per controllarne la posizione e l'assetto relativo al target. Alcune telecamere esterne sono usate per monitorare l'esperimento durante i test in gravità ridotta.



La realizzazione di PACMAN permetterà lo studio del comportamento in gravità ridotta di un piccolo satellite soggetto a forze elettromagnetiche. I risultati raccolti durante la fase di test daranno importanti informazioni riguardanti le possibili applicazioni di questa tecnologia innovativa per manovre di assetto, navigazione di prossimità e aggancio magnetico.



## Achievements



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Endorsing professor 1



## PACMAN Team & Collaboratori.

Da sinistra in piedi: Mattia Mazzucato, Matteo Duzzi (Team Leader), Fabrizio Vitellino, Matteo Vitturi, Luca Moro.  
Da sinistra seduti: Davide Povoledo, Riccardo Casagrande, Filippo Trevisi.

## Co-supervisori al progetto

Prof. Angelo Cenedese  
Prof. Enrico Lorenzini

Lo Space Systems Group (SSG), coordinato dal prof. Francesconi, è composto da 3 dottorandi e 6 assegnisti e le sue attività di ricerca riguardano tre tematiche principali: Detriti Spaziali (analisi numeriche e sperimentali di impatti iperveloci e sviluppo di sistemi di protezione), On-orbit servicing (cattura di oggetti non cooperativi, sistemi di docking, attuatori e simulatori robotici) e tecnologie per piccoli satelliti (stabilizzazione di strutture flessibili, sensori di navigazione e controllo d'assetto).

<http://ssg.dii.unipd.it>

<http://ssg.dii.unipd.it/student-projects/pacman/>

<https://www.facebook.com/PACMANEXPERIMENT>

<https://twitter.com/PACMANfly2017?s=09>

## Achievements



**Responsabile del progetto**  
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## Una nuova galleria aerodinamica per ventilatori industriali

Ricordati, quando commenti l'acqua, d'allegar prima la esperienza e poi la ragione scriveva Leonardo da Vinci nel codice Trivulziano. Con questa frase il genio toscano riassumeva uno dei traguardi dell'allora pionieristico metodo d'indagine scientifica: il comportamento dei fluidi (come sono l'acqua e l'aria) non è intuitivo. L'intuito (la ragione) può fornire spiegazioni di un fenomeno fluidodinamico non effettivamente rappresentative del fenomeno oggetto di studio.

Esistono nella storia casi eclatanti di teorie aerodinamiche fittizie (uno su tutti, l'erronea teoria della portanza di Isaac Newton). Pertanto, è fondamentale acquisire esperienza del fenomeno fluidodinamico prima di passare al necessario ragionamento analitico. Tale concetto acquisisce ancor più importanza per uno studente di ingegneria, quando si pensa alla moltitudine di applicazioni che utilizzano fluidi (ad es. l'aerodinamica interna ed esterna, le turbomacchine, le applicazioni spaziali, ecc.) e che noi stessi viviamo immersi in un fluido (l'aria) che non si può vedere perché trasparente.

Partendo da questi presupposti è stata realizzata una galleria aerodinamica subsonica all'interno del Laboratorio di Macchine Aerauliche e Termiche.

La galleria (si vedano le Figure nella pagina successiva) è stata progettata da Stefano Castegnaro (dottorando DII) nell'ambito del suo lavoro di ricerca sui ventilatori industriali.

Peculiarità del progetto della galleria è la modularità, che consente un impiego sia come banco prova per ventilatori con diametro fino a 0.8 m (secondo la norma ISO 5801) sia come galleria aerodinamica convenzionale a circuito aperto.

In quest'ultimo caso la sezione di prova è di 1.4 x 1.8 m (per basse velocità del vento,  $v' \leq 10$  km/h), mentre si riduce a 0.45 x 0.45 m per velocità prossime a 150 km/h. La galleria presenta un sistema di ugelli multipli per le misure di portata dell'aria; inoltre è possibile eseguire misure di parametri globali (pressione del ventilatore, efficienza, ecc.) e locali (pressione e velocità dell'aria, temperatura, ecc.) con elevata accuratezza grazie alla strumentazione presente in Laboratorio.

La fase iniziale del progetto ha beneficiato dei consigli e suggerimenti del prof. Mario Carbonaro (Von Karman Institute, Belgio), un'autorità internazionale nel campo del progetto di Gallerie del Vento. Durante la fase realizzativa invece, altrettanto fondamentale è stato l'aiuto dei proff. Carlo Bettanini, Gianmaria Concheri e Roberto Meneghelli del nostro Ateneo, nonché dei tecnici del Laboratorio, in particolare del sig. Gianfranco Zanon.

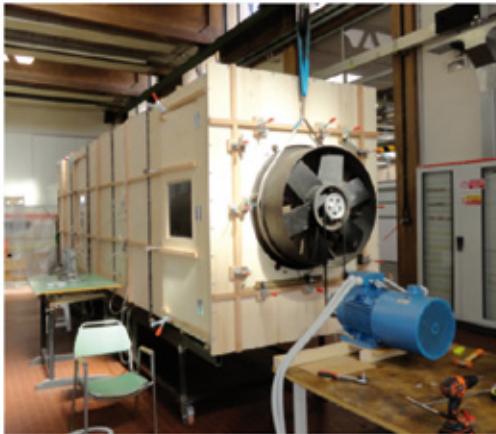
La costruzione è cominciata il 19 Maggio 2017 ed è stata eseguita meticolosamente dalla ditta Cappellaro Snc di Padova. Gli ugelli per le misure di portata di aria sono stati realizzati dalla ditta Metalpebo Srl di Vigodarzere (PD).

Il completamento dell'assemblaggio e le relative prove di collaudo sono state condotte con successo il 17 Luglio scorso: le prime prove hanno mostrato un ottimo accordo con misurazioni eseguite precedentemente su altri impianti.

Inoltre, l'estensione del campo a portate d'aria non misurabili in precedenza ha permesso di osservare un'importante variazione delle prestazioni dei ventilatori in prova quando le condizioni operative presentano un numero di Reynolds inferiore ad un livello critico. Tali condizioni sono effettivamente riscontrate per diverse installazioni esistenti.

## Una nuova galleria aerodinamica per ventilatori industriali

### Achievements



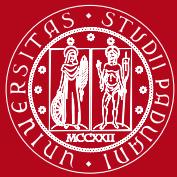
*La Galleria vista dalla sezione terminale in cui è installato un ventilatore in prova di diametro 0,8 m.*



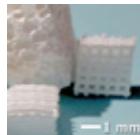
*Vista frontale del ventilatore di 0,8 m durante il test. Si noti la flow visualization tramite tufts, a sinistra.*



*La galleria permette di effettuare prove su macchine di dimensioni differenti. Nell'immagine, un ventilatore di 315 mm in prova.*



## Cover story



### L'ingegneria tissutale dell'osso.

Scaffold bioceramici contenenti silicati di Ca-Mg, ottenuti attraverso trattamento termico di polimeri preceramici (resine siliconiche) con addizione di micro e nano-filler, possono essere prodotti in forma di schiume porose o come matrici tridimensionali mediante 3D-printing. Tali potenziali sostituti d'osso vengono funzionalizzati covalentemente e selettivamente con sequenze peptidiche resistenti alla proteolisi enzimatica che promuovono l'adesione e la proliferazione cellulare favorendo l'osseointegrazione dell'impianto.



### Ing. Annj Zamuner

Nata a Vittorio Veneto il 21/03/1987, ha conseguito la laurea magistrale in Ingegneria Chimica e dei Processi Industriali presso l'Università di Padova nel 2012. Ha iniziato la sua attività di ricerca come Assegnista presso il laboratorio di Bioingegneria Chimica ed è attualmente dottoranda in Ingegneria Industriale, curriculum Ingegneria dei Materiali. La sua attività di ricerca è focalizzata su: sintesi e caratterizzazione di sequenze biologicamente attive; peptide mimicry di proteine di adesione e fattori di crescita; chemoselective ligation; analisi conformazionali e strutturali di biomolecole; studio delle interazioni tra biomateriali e tessuti biologici; scaffolds di peptidi auto-aggreganti e funzionalizzazione di matrici polimeriche, metalliche, biologiche, vetrose e ceramiche con particolare interesse per i supporti ceramici porosi da precursori polimerici finalizzati all'ingegneria tissutale dell'osso.

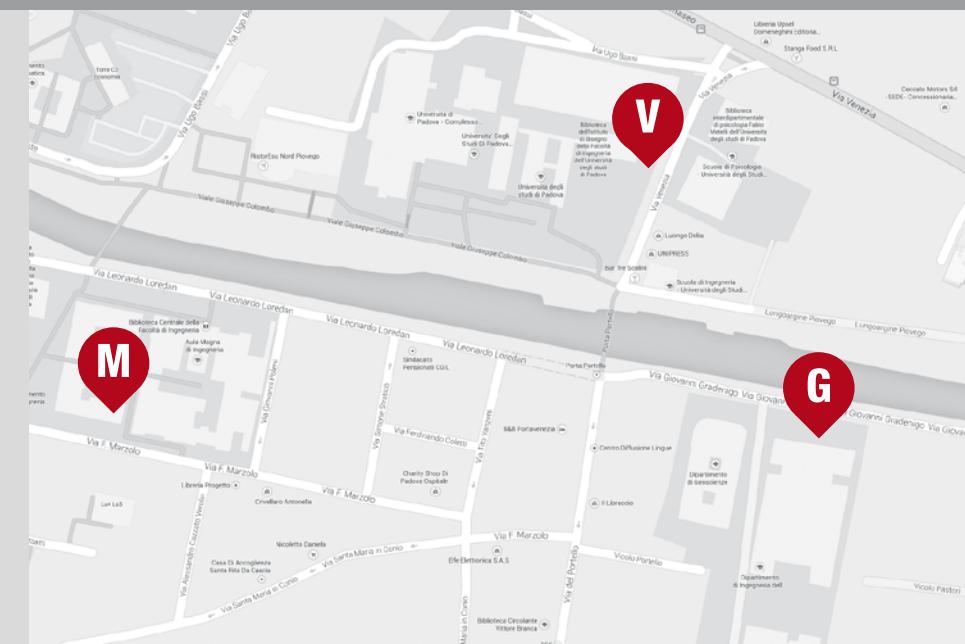
[www.dii.unipd.it](http://www.dii.unipd.it)

Direttore: Massimo Guglielmi

Vicedirettore: Stefania Bruschi

Segreteria amministrativa:  
Paolo Rando

### SEDI



### DII

Dipartimento di Ingegneria Industriale,  
Università degli Studi di Padova

### Sede legale e amministrativa

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