Scuola Politecnica e delle Scienze di Base
Università degli Studi di Napoli Federico II

Dipartimento di Ingegneria Industriale

Aerothermodynamics, Propulsion and Space Experiments

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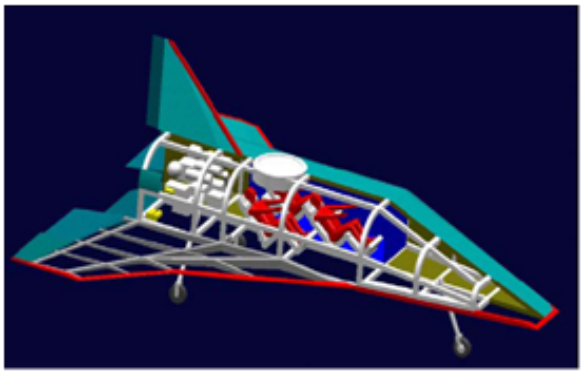
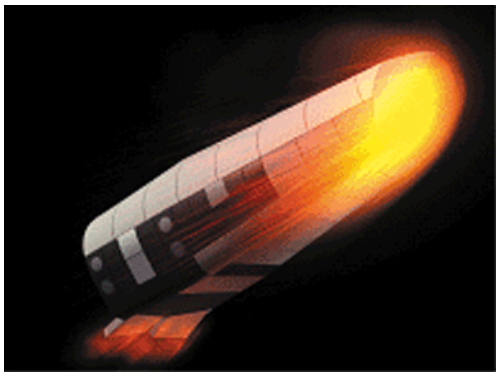
Courses
Aerodynamics, Hypersonic Aerodynamics, Aerospace Propulsion, Space Experiments

Aerothermodynamics

In this field, following long-term tradition dating back to the first studies on aero-thermo-chemistry in the 60s and 70s and to international hypersonic programs such as Hermes, Tethered Space Mail, USV and EXPERT, in the 90s and 2000s, new research activities are carried out on innovative configurations of space transport systems. For instance, in the period 2005-2010, the European programme "High Lift over Drag Vehicles for Earth Reentry" was coordinated in collaboration with the German company OHB Systems; more recently numerical and experimental studies have been performed within the European Intermediate Experimental Vehicle (IXV) programme. The research is currently focused on the study of advanced concepts of re-entry capsules with variable geometry and new generations of hypersonic aircrafts, in collaboration with CIRA, ASI, ESA, private companies, national and international universities and research institutes. The research is also focused on the development of thermal protection systems based on ultra-refractory ceramic materials for wing leading edges and for aero-propulsive applications, in collaboration with CNR-ISTEC. A European Horizon 2020 project (C3harme) is in progress on this subject.



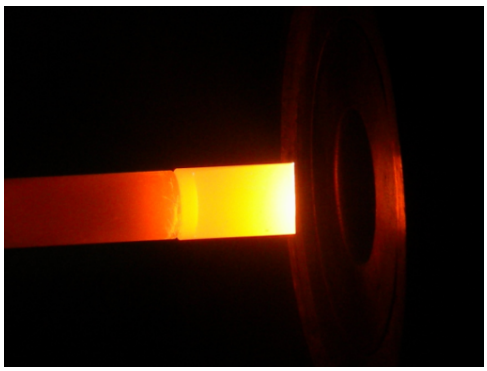
Space-plane designed in collaboration with ESA and OHB



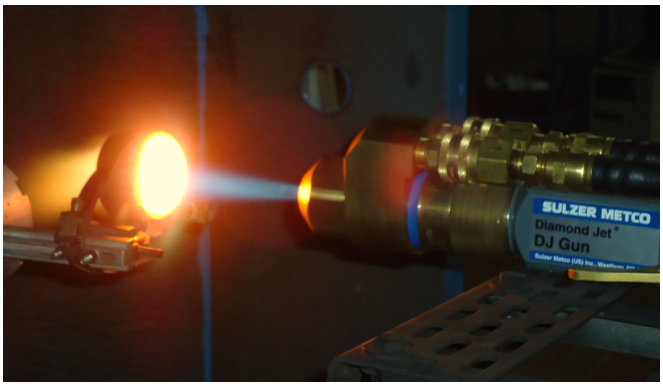
ESA Intermediate Experimental Vehicle (IXV)

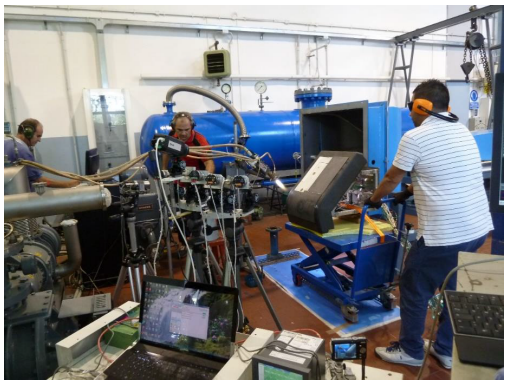
Hyplane, a hypersonic business jet for intercontinental transport: rendering (left) and model aircraft developed as part of a student project (right)

Theoretical and numerical research, including advanced molecular aerodynamics simulations, is constantly supported by experimental activities. International collaborations are active with international research institutes, such as DLR, and universities in Europe and in the United States as well as with important industries such as AIRBUS, OHB, Avio, Thales. The aerothermodynamics facilities include a hypersonic arc-jet wind tunnel for experimental studies on hypersonic flows and tests on thermal protection materials.



Typical experiments in the hypersonic arc-jet wind tunnel.



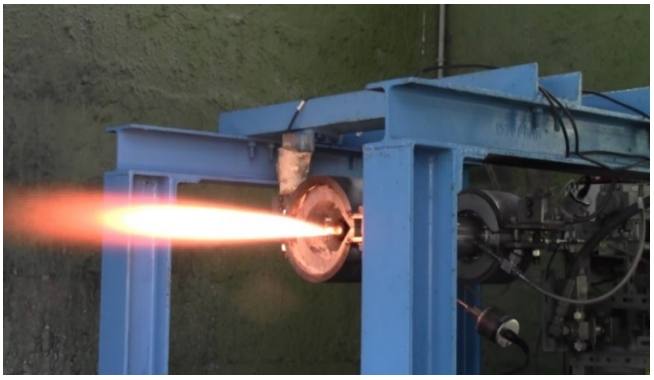


Test of the thermal protection system of the ESA - IXV re-entry hypersonic vehicle.

Aerospace Propulsion

In the field of Space Propulsion, research is focused on the study of hybrid and monopropellant engines in collaboration with CIRA, Avio and other national and international companies, continuing the experiences developed at the Department in previous projects funded by the European Union in the 7th Framework Program. In this context, it is possible to study in depth the rockets internal ballistics and the performances achieved by using different fuels (HDPE, HTPB, Paraffin blends) and oxidizers (Oxygen, Nitrous Oxide, Hydrogen Peroxide). In particular, the main research topics combustion stability, combustion efficiency, interaction of acoustic modes in the combustion chamber with vortex shedding phenomena, the dependence of the regression rate on the oxidizer mass flux and other parameters, e.g. the injection mechanisms. A laboratory is available at the Grazzanise military base (CE) where, in collaboration with the Air Force Academy, a test bench has been set up to carry out tests on several rocket engines. Engines of different scale have been developed and tested with thrust up to 1 kN and combustion chamber pressures of 35 atm. Different subsystem have been validated such as injection and ignition systems. Other activities include studies on materials for thermal protection and zero nozzle throat erosion. Master's degree and PhD thesis are developed in this field.

Experimental activities in the laboratory based in Grazzanise

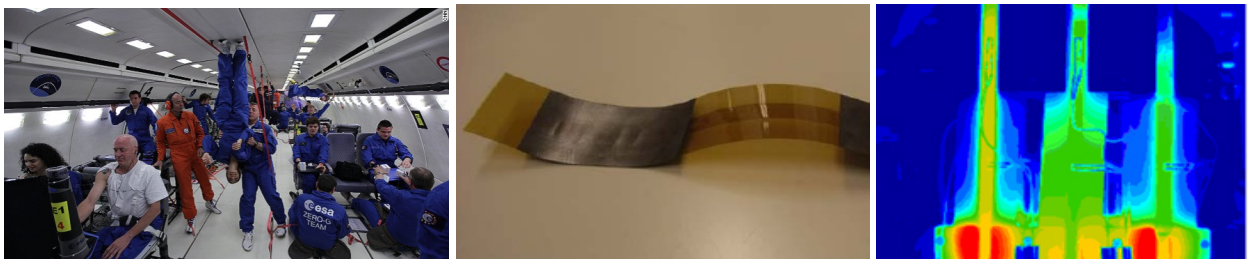


Test of a hybrid rocket engine

Microgravity and Space Experiments

In the field of Microgravity, the activity is focused on fluid sciences and some of the most interesting research lines concern the study of phenomena of free convection and surface-tensions-driven flows; fluid dynamic modeling of multiphase systems; residual acceleration effects during fluid and material science experiments. The long-term experience at the University of Federico II on these topics dates back to the 80s and 90s with various experiments in fluid physics in microgravity on the Space Shuttle and on sounding rockets. As part of these studies, experiments are carried out on microgravity platforms, including airplanes in parabolic flights, pressurized space laboratories, orbiting satellites. The experimentation is carried out with different diagnostic systems (including thermography and interferometry) and is integrated with numerical simulations carried out with computational fluid dynamic softwares. The research group performs these activities in collaboration with the Italian (ASI) space agency, the European (ESA) space agency, other research centers and various universities abroad (in Europe, the United States, Canada, China and Japan). A very active line of research concerns the study, on the International Space Station, of two-phase flow heat transfer processes, particularly for the development of high efficiency heat exchange and cooling devices such as heat pipes and heat spreaders. In this field, the group has coordinated a project funded by the European Space Agency (ESA) on "Innovative Wickless Heat Pipes", and also collaborates with research groups from the Shibaura Institute of Technology in Tokyo and other universities in Japan.

As regards the teaching activities in the master's degree in Aerospace Engineering, since 2016 students who attend lectures on Space Experiments the opportunity to experience parabolic flight and low gravity conditions on board general aviation aircrafts.



Experiments on flexible heat pipes during parabolic flights of the European Space Agency (ESA)

Experiences of students flying on a Tecnam P92 ultralight aircraft during parabolic maneuvers