ANNEX B

GENERAL DESCRIPTION OF THE INFRASTRUCTURES AND MAIN SERVICES

IDEAS - Integrated Digital and Experimental Aerospace for Sustainability

C.so Marche, Turin, "Città dell'Aerospazio"

The mission of the Infrastructure is to develop technical solutions and scientific knowledge to support the sustainable development of future aeronautical, space and exploration missions, systems and technologies. The infrastructure is divided into five scientific areas: two laboratories for space in the up-stream segment (Moon/Mars Analog Habitat and Stellar), one for the down-stream segment (Digital Planet) and two for aeronautics (Advanced Air Mobility and Sustainable Aviation). Each laboratory is based on three pillars: the digitalization of design processes and simulation, the development of technologies, and their testing. The ambition of the infrastructure is to make the most out of the competencies of the territory for the benefit of a wider community. To achieve this, the infrastructure: undertakes frontier research, supports innovation and competitiveness and offers skills and education.

Main Services

- Tests of technologies for human space systems and inhabitated systems for extreme environments in an integrated environment (analog habitat) in "human-in-the-loop" conditions and design and development of related technical solutions and technologies in a multi-disciplinary integrated digital environment (digital twin), considering also the support and contribution of Articial Intelligence.
- Support for the definition of operational procedures, logistics/maintenance and training activities in nominal or out-of-nominal scenarios in "human-in-the-loop" conditions for human space systems or inhabited systems for extreme environments
- Design methods and advanced technologies (3D printing, innovative materials, etc.) for the development of high-performance space components, with a focus on efficiency, modularity, and sustainability for long-term missions.
- Integrated multidisciplinary design of space missions and systems with concurrent model-based design tools and development of technical solutions and hardware and software technologies for space applications in Earth orbit and deep space.
- Analysis and verification of technical solutions and space technologies through advanced simulations, either totally digital or with hardware-in-the-loop approach, and implementation of test campaigns in radiative and thermal environment, representative of the conditions in orbit.
- Development and testing of advanced sensors, offering cutting-edge infrastructures and multidisciplinary skills, to monitor the natural and anthropic environment, linked to green and climate, digital, energy, social and employment, food, agricultural and industrial transitions.
- Development of climatological maps of extreme events, to support the insurance sector, and of generative Artificial Intelligence models, for the creation of tools for risk analysis associated to climate change; support for weather forecasts by providing measurements of meteorological variables at very high spatio-temporal resolution.
- Development of methodologies Hardware in the loop (HIL) and (SIL) for sustainabale propulsion systems.
- Analysis of environmental impact (acoustic and dispersion of pollutants) in the vicinity of residential areas/airports; analysis of chemical and noise emissions along the aircraft trajectory.
- Prototyping of materials, structures, and technologies, as well as the entire hydrogen aerospace product (for example, hydrogen fuel cells, electric machines with superconductors, and hydrogen combustors), through integrated simulations and experiments, and modeling, simulation, analysis, and optimization of technologies, equipment, subsystems, and the overall system (hydrogen civil aircraft).

INNO 5.0: Innovation 5.0

Mondovì and Torino (CWC Interdipartimental Center)

INNO5.0 aims to develop innovative solutions for the agro-industrial system according to the paradigms of industry 5.0 concerning:

- water quality assessment and the development of sustainable processes for water treatment in the agri-food system, to safeguard water resources;
- reuse and transformation of waste from the agri-food production chain and their transformation into bioactive and functional ingredients to be reused in numerous industrial sectors;
- the development of digital solutions and mechatronic solutions for monitoring the various phases of the agri-food supply chain (production, processing, transport and sales);
- the development of innovative solutions based on new products and processes, new materials and new production processes with the goal of waste reduction and production efficiency;
- the implementation and streamlining of processes for the reuse and valorization of fibrous by-products, from the production, transformation and consumption of food and from agro-forestry-industrial supply chain.

Main Services

- water quality analysis and development of innovative processes for the treatment of contaminated water;
- characterization of waste from the agri-food chain and analysis of their transformation for reuse;
- development of advanced solutions for monitoring the different phases of the agri-food chain;
- mechanical and compatibility characterization of new materials and evaluation of innovative processes for the agro-industrial system;
- development of solutions for the efficiency of reuse processes and the valorization of by-products of the activities of the agro-forestry-industrial supply chains.

DigiMiQ: Digital Microelectronics Design, quantum & Photonic systems

Digital Revolution House – Politecnico di Torino

PhotoNext, ChiLab, and E2PLab are experimental laboratories that have been active for years in the fields of photonic and quantum applications, microelectronics, and microsystems. This project proposal aims to significantly enhance the capabilities of these laboratories, enabling them to align with the state-of-the-art in the design, integration, and testing of microelectronic systems (ASIC, chiplets, system-in-package), as well as photonic and quantum systems. The laboratory represents a concrete response to the need for high-tech applied research, aimed at generating cutting-edge knowledge and transferring it to the industrial sector. The objective is twofold: on one hand, to support the rapid technological evolution of photonic and quantum applications and systems, including the necessary microelectronic interfaces and packaging; on the other, to provide advanced technological and microelectronic support to local production sectors. This support is now essential in many strategic fields, from aerospace to healthcare, mobility, and food.

Main Services

- Design, Emulation, Integration, and Testing Services for Digital Integrated Circuits (ASIC, Chiplets): Accessing integrated digital technologies today faces several barriers, from high costs to a shortage of skilled personnel. The proposed laboratory can help overcome these obstacles by working in synergy with measures under the National Chips Act, aimed at strengthening the Italian chip ecosystem.
- Design, Integration, and Testing Services for Complex Microelectronic Systems Across Various Applications: Given the pervasive role of microelectronics in societal and industrial contexts, the need for a competent and reliable technological reference point in the territory is particularly acute.
- Development of a Regional Reference Center for Advanced Quantum Hardware and Infrastructure: The laboratory aims to become the go-to hub for the acquisition, deployment, and maintenance of advanced quantum hardware and its interfaces for computing and communication applications, including quantum cryptography and distributed quantum networks. Furthermore, it will provide services for the development, emulation, implementation, and testing of quantum and hybrid algorithms and circuits to solve industrial and scientific problems. It will also address the software stack for integrating quantum machines with dedicated HPC systems, a key topic for national and European research projects.
- Assisted Access to Laboratory Infrastructure and Instrumentation: The laboratory will offer support for conducting tests and experiments, as well as for the characterization and integration of photonic components and systems. Applications will span sectors such as telecom/datacom, quantum networking, fiber optic sensors, and industrial uses, including high-power lasers.
- FEM Design, Prototyping of Heterogeneous Electronic Microsystems, System-in-Package, and Advanced Packaging Services: The laboratory will provide comprehensive characterization services, including electrical, climatic, thermal, and RF testing, to support the design and development of next-generation microsystems.

Computing4GenAI: computing Infrastructure for Generative AI workloads

Head Quarter – Politecnico di Torino

The Computing4GenAI project aims to develop a next-generation federated computational platform for research and innovation in Machine Learning (ML), Big Data, High-Performance Computing (HPC) and Generative AI. By integrating heterogeneous clouds with local resources of the proposing partners, it will create a computational continuum that optimises the use of resources, simplifying job execution regardless of the underlying infrastructure. Based on multi-cloud solutions, the platform will promote energy sustainability and the integration of local and national infrastructures.

The project involves companies and researchers from the Politecnico di Torino and the Fondazione Italian Institute for Artificial Intelligence in co-design and prototyping activities, from conception to pre-production scale-up. This approach will foster the development of skills and innovations for Piedmont, generating positive impact for companies, academic institutions, and public administrations, exploiting the potential of generative AI for industrial transformation and scientific progress.

Main Services

- Access to a federated computational continuum. Service enabling Machine Learning (ML), Big Data Analytics and High-Performance Computing (HPC) jobs through an integrated platform. Users can leverage heterogeneous resources (GPU cloud, CPU cloud, departmental servers, edge resources) without worrying about physical location, thanks to an advanced and transparent scheduling system.
- Co-design and co-prototyping for industrial innovation. Collaborative platform for companies and researchers to develop and test prototypes of innovative solutions, from initial idea to pre-industrial scale-up. It includes tools for simulation, design and optimisation of AI models, accelerating technology transfer and value creation.
- AI-powered scheduling resource optimisation services. Customised solutions to optimise application deployment and workload balancing across multiple clusters. Using advanced Machine Learning and Reinforcement Learning techniques, the system reduces operating costs, increases energy efficiency and ensures high performance.
- Technology transfer and scientific support. Technology transfer, training and scientific support programmes for companies and academic institutions on the use of AI and HPC technologies, integrated with a technical consultancy service. It includes support for the integration of tailor-made solutions in the business or research contexts.

PiQuET+: Piemonte Quantum enabling Technologies +

c/o Campus Inrim, Strada delle Cacce, Turin

PiQuET+ (Piemonte Quantum Enabling Technology +) is an applied research and technology transfer infrastructure focused on the development and application of micro and nanoscale technologies and quantum technologies, with a very strong vocation for multidisciplinarity, both in the skills of the personnel working there and in the application areas.

It is co-managed by Inrim, PoliTo and UniTo and fully operational since 2023. PiQuET is an enabling infrastructure for the development of ambitious research lines for the benefit of both the scientific community and industrial innovation.

PiQuET+ is equipped with a 400 m2 cleanroom (ISO5 and ISO6) with 6 technological areas (Quantum devices, Nanostructure/device characterization, Optical/electronic/ionic lithography, Thin film etching and deposition, Packaging, Wet chemical processes) plus some annexed laboratories (Quantum Metrology and Communication Laboratory, Microfluidics Laboratory, Polymeric Additive Manufacturing Laboratory).

Main Services

- Access to the infrastructure for training and/or autonomous or assisted use of equipment/technologies
- Support for the development of innovative micro and nanostructured materials
- Development and implementation of micro and nano-scale processes under particulate (ISO5 and ISO6) and thermo-hygrometric control conditions
- Design and technological development of micro and nano-scale and quantum devices for customized applications
- Design and development of test and measurement benches for on-demand applications
- Consulting and metrological validation services

Topic: Advanced Manufacturing

DREAMJM: Design and Research for Enhanced Additive Manufacturing, Joining and Materials

Turin / Alessandria

In the contemporary industrial landscape, technological evolution is marking the transition from Industry 4.0 to 5.0, two fundamental phases in the history of production. Industry 5.0 is a business model characterized by human-machine cooperation, with the aim of giving added value to production while respecting consumer needs and the environment. It is a natural evolution of Industry 4.0 focused on digitalization and enabling technologies that has allowed companies to increase productivity and efficiency. In this transformation perspective, the advanced manufacturing infrastructure can be summarized as a set of multidisciplinary solutions (additive manufacturing, joining, materials) to improve the efficiency of innovative production and assembly processes by reducing waste to make manufacturing activities socially, environmentally and economically sustainable.

Main Services

- Supporting the formulation of polymeric materials for specific applications
- Preparation of polymeric formulations at laboratory scale
- Morphological evaluation of surfaces and sections
- Processability evaluation of polymer formulations by rheological analysis
- Design and production using additive manufacturing and 3D printing systems
- Development of innovative methods for finishing additive manufacturing components in metallic and polymeric materials
- Development of solutions for the dimensional, surface and individual characterisation of defects using 3D scanners and tomography
- Non-destructive characterisation of joints using thermography and tomography (with the possibility of mechanical testing in the tomograph)
- Basic mechanical characterisation of products made by additive manufacturing (hardness, compression, bending, tensile)
- Mechanical fracture tests up to 1200 °C, elastic modulus measurement up to 1600 °C
- Joints for all classes of materials, similar and dissimilar, using polymer adhesives, glass and brazing alloys
- Development of reversible adhesive joints for end-of-life products
- Study, simulation and optimisation of fusion and solid-state welding processes
- Predictive maintenance, monitoring and quality control of joining processes

PATH: Progressive Advanced Transportation Systems Hub

Politecnico di Torino & Links

The aim of PATH is to complete the supply chain on vehicle and component testing infrastructures already available at Politecnico di Torino and Links Foundation. The objective is to offer to the industries of the automotive sector the availability of test executions on components (e-motors, technologies and solutions for autonomous and connected vehicles), subsystems (e-powertrain and alternative fuels based powertrains) and complete vehicles (4 dynos vehicle testing facility).

In detail, the project aims to complete the supply chain with testing facilities able to characterize the following components/subsystems:

- electrification of the vehicle powertrain– next generation electric motors, power electronics, integrated e-axles, storage systems;
- new generation internal combustion engines based on fuels that are alternative to fossil fuels;
- automation and digitalization of the vehicle – methods and tools for the validation of technologies and function for autonomous and connected vehicles.

The project aims to implement the following testing infrastructures:

1. test benches for the next generation of e-motors and e-axles: (a) test rig for e-motors and inverters, (b) test rig for electrified axles;
2. testing facility for the packaging of power electronic modules for e-motors (development and testing of power electronics modules for e-motor and e-chargers)
3. improved ICE test cell to study the performance of e-fuels.
4. integration of the vehicle testing facility available at the centers CARS to test also automated vehicles.

Main Services

PATH is aimed to complete the services in the field of automotive engineering already available at Politecnico di Torino and in detail at the Interdepartmental centers CARS, PEIC and Chilab.

Electrification of the vehicle powertrain:

- experimental characterization of traction electric motors an power inverters (power: 400 kW, max speed: 25,000 rpm, nominal torque: 400 Nm),
- experimental testing and calibration of e-motors and inverter controllers;
- experimental characterization (calibration and parameter identification) of the complete traction system, from the inverter to the wheels, with the capability to manage 880 kW (440 – 5000 Nm x wheel);
- development of methodologies for the packaging and test of power electronic components.

New generation of Internal Combustion Engines:

- Experimental validation of ICE performance utilizing alternative fuels.

Vehicle automation and digitalization

- Laboratory experimental validation of technologies and control strategies for autonomous and connected vehicles;
- Analysis of the impact of the above mentioned technologies on the vehicle system;
- Laboratory tests of vehicle equipped with automation functions.

PAsTISs+: Parco delle Tecnologie Innovative per la Salute

Turin

PAsTISs+ is a federation of Research Infrastructures that will form a network for the development of innovative technologies aimed at health and well-being. By fostering collaboration between Politecnico di Torino and Università di Torino, PAsTISs+ will generate beneficial technological and social impacts for the region. Having adequate technological infrastructure is essential to support these activities and ensure the development of innovative and competitive solutions in the medical sector.

Main Services

1. Support for Biomedical Companies:
- Development of proof-of-concept solutions for innovative medical software
- Support in the certification of AI algorithms for clinical use
- Validation of medical devices and software
- Specialized training on emerging technologies
- Biorobotics for usability evaluation of devices and performance testing of medical devices under realistic conditions using experimental emulators
- Biomechanical characterization (structural, fluid dynamics, thermal) of medical devices, nitinol for medical applications, and biological or synthetic biomaterials using experimental and/or computational methods
- 3D cellular printing for creating biomimetic models
- Fluorescence imaging from micro to macro scale (including time-lapse)
- In vitro biological characterization, protein quantification via imaging, or nucleic acid quantification using digital PCR
- Support for testing new delivery methods for therapies targeting respiratory diseases

2. Support for Local Healthcare Providers:
- Optimization of diagnostic and care pathways through data analysis and process modelling
- Development of CAD (Computer-Aided Diagnosis) systems for clinical decision support
- Creation and management of data warehouses for multicenter clinical studies
- Implementation of solutions for the standardization and interoperability of health data
- Continuous evaluation of indoor air quality in healthcare settings (e.g., surgical units, laboratories for microbiology, virology, genetics)
- Quality control of respiratory protective equipment and assistance in identifying suitable products

3. Innovation in the Healthcare System:
- Development of standardized pipelines for clinical data analysis
- Creation of methodologies for monitoring healthcare service quality
- Implementation of solutions for personalized medicine
- Structural and fluid dynamics evaluation through computational and/or experimental modelling of medical devices, surgical, and therapeutic procedures
- Containment of airborne nosocomial infections (aerosols) and monitoring of indoor air quality
- Implementation and support of public health activities to protect healthcare workers and the population from pandemic and routine airborne diseases

Having adequate technological infrastructure is essential to support these activities and ensure the development of innovative and competitive solutions in the medical sector.

MEGASTREAM: Modeling and Experiments for Generation, Accumulation, Storage and Transport of Renewable Energy And decarbonization Measures

Envipark & Energy Center - Turin

MEGASTREAM is a hub of international strategic importance dedicated to developing materials and technologies and offering services for the energy transition supply chain, whose key elements are the generation and storage of electricity from renewable and low-carbon sources, green production, the use and storage of H2 and green fuels, the reduction of CO2 emissions into the atmosphere through its capture and transformation into products with high added value or its disposal underground. The hub stands out for the availability of cutting-edge equipment that guarantees the ability to address complex technological challenges by investigating all aspects according to principles of sustainability and resilience and to analyze energy strategies also through scenario modeling.

Main Services

- Digital Twin software as a service for the simulation and visualization of energy scenarios with a multi-risk approach in an immersive environment;
- Testing and validation of technologies for the generation of marine wave and wind energy in controlled conditions
- Characterization (materials, technologies, systems) of solar-fed processes for energy production and storage and for the production of solar chemicals
- Characterization (materials, technologies, systems), modeling of processes and advanced solutions for the capture and valorization of CO_2, production and use of hydrogen and electrochemical storage, with technologies for the production of self-supporting electrodes for batteries, supercapacitors, electrolyzers and fuel cells, using sustainable processes and without toxic solvents. Synthesis of innovative materials, in operando analysis with electronic microscopy, XRD analysis and Raman and XPS spectroscopy, and electrochemical measurements with potentiostats. Permeability testing for membranes, small-scale prototyping, and technical support for integration into corporate systems
- Characterization of technologies for the production and storage of energy from distributed renewable sources.
- Transient kinetic analysis of catalytic materials for CO2 adsorption and conversion by isotopic labeling: from fundamental mechanisms to industrial development
- Physical-chemical and mechanical characterization of materials for fluid transport and storage
- Fluid-dynamic, biogeochemical and geomechanical characterization and simulation of underground systems for hydrogen storage and CO2 disposal

CIST: Construction and Infrastructure for Societies and Territories
Turin / Network Location (PoliTO Headquarters, Energy Centre, Torino Expo, Valentino Castle, Mirafiori, etc.)

CIST has the goal to provide research teams, and more generally those involved in the transformation of the built heritage and territory, with a platform capable of tackling the great contemporary challenges (environmental, climatic, economic, social, mobility, etc.) with a data-based and evidence-based approach, based both on the analysis and intersection in real time of large masses of data, and on the construction of multi-scalar simulations, from the individual building component to the territory, which make it possible to prefigure alternative scenarios and measure the effects of the choices made in advance.

The project brings together four service blocks:

- Prototyping and modelling labs at the building and territorial scale;
- Performance lab, for physical and performance testing of materials, components and environments.
- Virtual modelling of urban and territorial areas.
- Decision-making and scenario lab, to manage socio-spatial transformations.

CIST, with the aid of the most up-to-date technologies in the sector, collects, makes interoperable and systematizes databases, information systems, archives and, more generally, any form of structured knowledge on the territory, the city and its artefacts, setting itself as the point of convergence of the numerous skills operating in real contexts.

Main Services

- Construction of full-scale prototypes of building products and their assembly-mockups
- Realization of small- and medium-scale models
- Experimentation on portions of large buildings/infrastructures or scale models
- Performance tests of various kinds (mechanical strength, energy performance, durability, etc.);
- Assembly/experimentation tests of new building systems.
- Monitoring of existing works, through the realization of scale twins.
- Simulations of the insertion of building blocks in urban contexts through real or virtual models
- Virtual modelling of spatial contexts at various scales, in particular urban and territorial.
- Calculation, representation and simulation of specific phenomena (socio-economic trends, real estate dynamics, environmental risks, traffic, logistics, energy production and management, state of the architectural heritage and landscape, state and dynamics of the subsoil, etc.).
- Development of scenarios and monitoring of environmental and socio-economic impacts, to support decision-making processes at various scales and in different sectors, through simulations and dashboards, to interact with external actors.