List of laboratories and facilities

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L-1. Laboratory for structural, morphological, and electrochemical materials characterization

The laboratory houses the following equipment: X-ray diffractometer, BET, Scanning Electron Microscope and Atomic Absorption, represented respectively in figure 1 a), b), c) and d) for morphological, chemical and structural characterization, ball milling, heating/stirring plates, muffles, stove, precision scales, dry-boxes, chemical hood, ultrasound bath, buki, etc. for material preparation, are instead reported, in part, in figure 2 e) and f) and finally automated devices to carry out battery charge and discharge cycles, multimeters, galvanostat-potentiostats, electrochemical impedance (Frequency Response Analyzer) for electrochemical characterization, are shown in figure 2 g) and f).

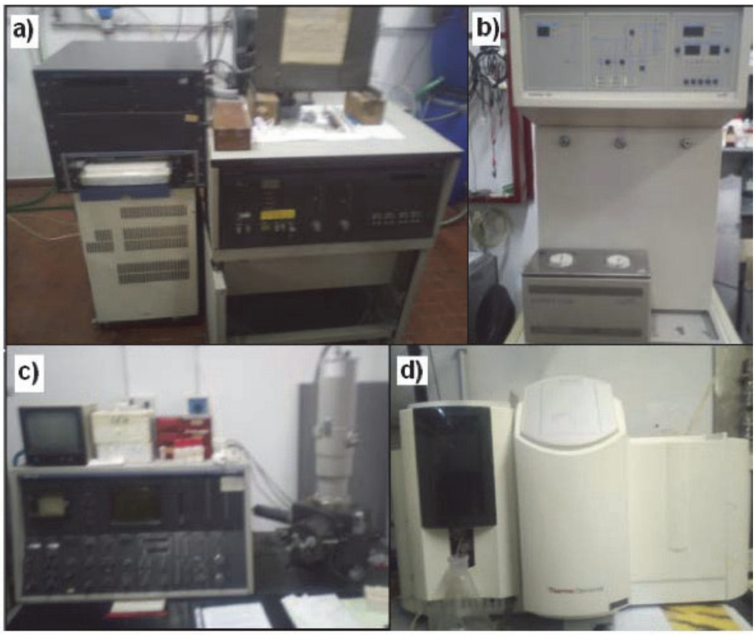

Figure 1: a) X-ray diffractometer, b) BET, c) Scanning Electron Microscope d) Atomic Absorption.

Figure 2: a) Chemical hood, b) Dry-box, c) Frequency Response Analyzer d) Galvanostat-potentiostats.

L-2. LEOS - Laboratory of Electrochemistry and Organic Synthesis

Facilities
LEOS is equipped with the following technical instrumentation:
- BRUKER Avance AC200 NMR Spectrometer
- Perkin Elmer 841 InfraRed Spectrometer
- Perkin Elmer Series 2 HPLC Liquid Chromatograph apparatus
- AMEL System 5000 Multifunctional Electrochemical System
- AMEL 2551 potentiostat/galvanostat apparatus
- Amel 552 potentiostat equipped with an Amel 566 function generator and an Amel 563 multipurpose unit
- Electrodes and microelectrodes for Voltammetric Techniques and Electrolysis (RVC, GC, Au, Pt, Zn, Fe, Mg, ITO,. . .)
- GC-MS Hewlett-Packard 5890 series II Gas Chromatograph coupled with a Hewlett-Packard 5871 series II quadrupole Mass selective detector
- UltraSound high-energy sonicator
- Ultrasound bath apparatus
- complete experimental setup for chromatographic techniques (TLC, Flash)
- complete experimental setup for synthetic organic chemistry
- Bchi melting point apparatus
- Schlenk apparatus for manipulation and synthesis of air-sensitive compounds (vacuum or inert gas atmosphere)

LEOS Expertise
The group has more than twentyfive years of experience in the field of organic electrochemistry, particularly for the synthesis of materials for organic electronics, small molecules of industrial and pharmaceutical interest, incorporation of carbon dioxide in organic compounds. The research group has specific skills in organic synthesis, electrochemical characterization of organic molecules and salts, also in view of their application in organic electronics. In the laboratory various instruments are available for basic and applied electrochemical studies, for preparation and for some spectroscopic characterizations of the materials. The group has always carried out training of young researchers in the field of organic and electroorganic synthesis.

Figure 1: Left panel: NMR spectrometer; right panel: electrochemical apparatus

L-3. Laboratory of Molecular Electrochemistry and Mass Spectrometry, MEMaS

The laboratory located at RM017 P01 L022 houses instruments used to study the electrochemical behaviour of substrates of interest: potentiodynamic methods (Voltammetry) are performed by a three-electrode multipolarograph AMEL 472 coupled with a digital x/y recorder AMEL 863; controlled potential electrolyses (CPE) are performed by a potentiostat AMEL 552 coupled with an integrator AMEL 731 and an x/y recorder LINSEIS L250E. CPE are mainly carried out using a three-electrode UV-vis cell modified for spectroelectrochemistry and an Agilent 8453 diode array spectrophotometer (see Fig. 1).

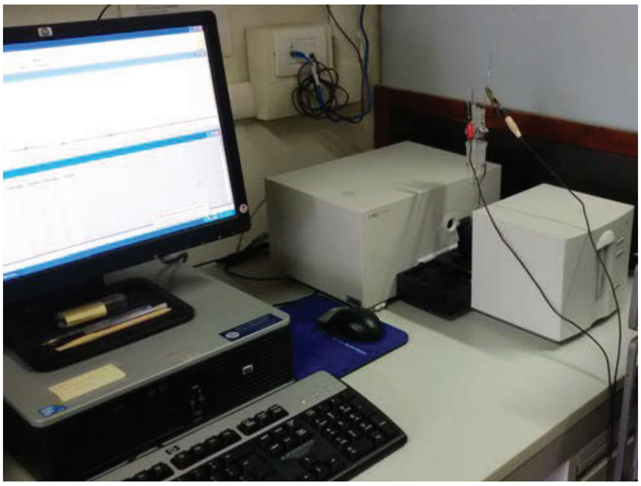

Figure 1: UV-vis ChemStation for spectroelectrochemistry.

The Laboratory located at RM017 PS1 L022 houses instruments for analytical purpose, as detection, determination and characterization of compounds in/from different matrices. The apparatus is composed of a High Performance Liquid Chromatography HPLC separation module 1525μ Waters, linked to a photodiode array detector Waters 996 PDA and to a Quattro Micro Tandem MS-MS with an electro-spray interface ESI Waters (Micromass, Manchester UK) as mass spectrometry detector (see Fig. 2)

Figure 2: HPLC-PDA-MS/MS Waters system.

L-4. Laboratory for thermal characterization of materials

For more than 20 years we have been dealing with thermal analysis with particular reference to the assessment of thermal stability and lifetime prediction of a wide range of materials. The laboratory, located in room 1.15 of the raised floor of building RM017, is equipped with the following apparatuses:

STA 625 Stanton Redcroft simultaneous thermoanalyzer, for thermogravimetric and differential scanning calorimetry measurements for condensed phase materials, in a controlled gas atmosphere (argon, air, carbon dioxide) up to 625C;

STA 1500 Stanton Redcroft simultaneous instrument (on loan for use by the Department of Chemistry of Sapienza University of Rome), for thermogravimetric and differential thermal analysis measurements for materials in the condensed phase, in a controlled atmosphere (argon, air, carbon dioxide) up to 1500C;

Nicolet Impact 410 Fourier Transform Infrared (FTIR) spectrophotometer equipped with standard accessory and diffused reflectance.

L-5. Physical Acoustics Lab

The Physical Acoustics Lab at SBAI Department undertakes long-term, leading-edge researches on both acoustic wave propagation in complex media, including nonlinear effects, and interaction of acoustic waves with matter.

Research activities are primarily focussed on the following two subjects:

1. **Acoustic waveguides**
   The question: "*How much time it takes for a quantum particle to tunnel through a barrier?*", is a basic problem in quantum mechanics, being today also of technological importance. Backward propagating Lamb waves (plate modes) are used to experimentally investigate the transit time of phonons through a potential barrier. In backward wave propagation, the direction of the energy flux, or group velocity, is antiparallel to the phase velocity direction, or direction of motion of the phase fronts. Backward wave propagation has seen a growing interest in both acoustic and optics due to fact that it offers new ways to manipulate acoustic and optical fields and leads to non-intuitive physical effects such as anomalous (negative) reflection and refraction phenomena on which, for example, acoustic cloaking effect relies.

2. **Biomedical ultrasonics**
   Ultrasound attenuation caused by dispersed solutions of microbubbles and nanobubbles, is an important physical parameter that is measured in the Lab to improve the backscatter properties of such systems that are increasingly used as ultrasound contrast agents (UCAs) in clinical applications. Furthermore, the elastic characteristics of lipid-coated microbubbles and nanobubbles are becoming even more important to be measured as these systems have been recently promoted for transport and delivery of various bioactive substances.

   High frequency shear acoustic waves biosensors in a Quartz Crystal Microbalance (QCM) measuring system are used for non-invasive, label-free and highly sensitive chemical and cell biology studies with a special focus on cell-substrate interactions. Measurements on the rheological properties of biological fluids are also carried out.

Lab equipment includes:

- High-frequency broadband ultrasonic pulse-echo measuring system with fourier trasform spectroscopy analysis for nondestructive evaluation of biological samples;
- Two computer-controlled optical interferometers for contactless amplitude measurement and frequency analysis of mechanical vibrations in frequency range 10 Hz - 40 MHz (displacement resolutions down to 1 nm, lateral resolution 10 μm). Vibrational amplitude map are generated with a field-of-view up to 5 cm^2;
- Network analyzer for real-time impedance measurement of ultrasound piezoelectric transducers;
- Computer-controlled Quartz Crystal Microbalance (QCM);
- Temperature-controlled apparatus for the study of cavitation and single-bubble sonoluminescence.

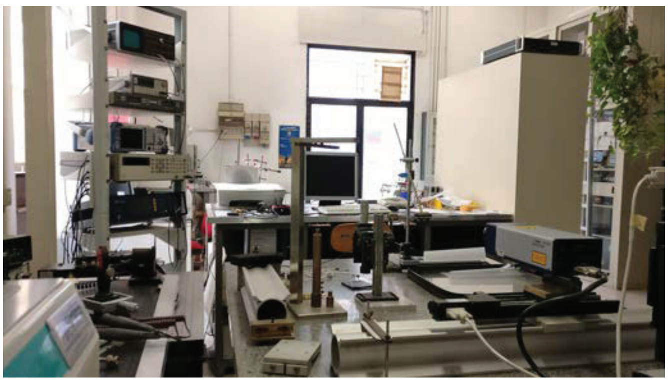

Figure 1: The Physical Acoustics Lab at SBAI Department

L-6. Ultrafast Photonics Laboratory (U-Pho Lab)

The Ultrafast Photonics Laboratory (U-Pho Lab) gathers equipment, expertise and experiments in the framework of linear and nonlinear optics, environmental monitoring, high-resolution single-photon luminescence and optical sensing. It was established in 1992 and since then it has performed both fundamental and applied researches in collaboration with private companies and other research laboratories. Its main activity regards the realization of innovative self-assembled integrated photonic circuits. Such research is going towards the design of innovative cognitive configurations of photonic devices. Noteworthy researches regard also the nonlinear characterization of nanostructured media, single-photon counting of light emission by biological structures and optical very-early diagnostic of Alzheimer disease. Since 2008 the Laboratory has generated a spin-off company, called OptSensor s.r.l., which performed innovation in the framework of optical sensing for chemical industries and environmental pollution detection.

Instrumentation. The Ultrafast Photonics lab is a complete optical laboratory. Thus, any kind of transmission /reflection/absorption/emission test can be performed on materials. U-Pho Lab possesses many lasers and LED sources of different wavelengths, ranging from violet to infrared, from CW to femtosecond regime. Slow and fast detectors are present as well as many devices for beam-quality analysis, like optical spectrum analyzers of beam profilers. U-Pho Lab has a 20-year experience in imaging and characterizing laser beams. The laboratory is equipped also with very sensitive detectors and photon-counting systems with ultralow dark noise (?1015 counts/sec). A custom monitoring station for PM1-PM2.5-PM10 particulate pollution has been built in the lab and perfectly working. Using an innovative optical detection method, it allows to perform fully-automatic and fully-programmable monitoring loops of particulate pollution, both indoor and outdoor.

Work for third parties. U-Pho Lab provides a number of activities outwards, and more specifically:
A) laser safety training courses;
B) design of laser-safe laboratories and procedures;
C) design of custom optical systems and sensors;
D) characterization of optical materials;
E) technical consulting on optoelectronic optical and photonic systems, as well as on innovative sensors based on light;
F) forensic technical consulting in the optical and laser fields, and in the field of road accidents for the kinematic and dynamic reconstruction of major car crashes.

http://www.sbai.uniroma1.it/users/fazio-eugenio

L-7. Laboratory for non-destructive analyses and archaeometry LANDA *Sebastiano Sciuti*

The laboratory has a long-lasting experience in the field of the archaeometric study of Cultural Heritages. By using non-destructive analytical methods mural and easel paintings, ceramics, metal and stone artifacts, manuscripts books, etc. are analyzed in order to obtain information on the materials constituting the artifacts and on the techniques employed to realize them.

All the equipment available in the laboratory is portable and allows to perform the analyses in situ.

- **Energy dispersive X-ray fluorescence spectroscopy (ED-XRF)**
  It allows to obtain information on the chemical elements present in the analyzed material and, in some cases, on their concentrations. The spectrometer is constituted by an miniaturized X-ray generator and a silicon drift detector integrated with a multichannel analyzer. It allows the detection of all the elements starting from aluminum with a limit of detection ranging from 10^2 ppm to 10^3 ppm.
- **UV-Vis-Near Infrared (NIR) Multispectral Imaging system**
  The system is devoted to the in situ analysis of easel and mural paintings, manuscripts and books. It is equipped with a Peltier cooled CCD camera, halogen lamps, UV and Vis LEDs and a set of 20 narrow interferential filters from UV to NIR. It allows to acquire reflectance or UV induced fluorescence images corresponding to narrow portions of the spectral region and from those to obtain information on the organic and inorganic materials that constitute the pictorial layers or to reveal preparatory drawings and *pentimenti*.
- **UV-Vis-NIR spectrophotometer**
  For reflectance and absorbance measurements and spectrofluorimetry.
- **Raman spectrometer**
  Portable Raman spectrometer equipped with a laser at 532 nm. It is used for the identification of chemical compounds.
- **Digital radiography system**
  A portable system that allows to perform a radiography of the artworks without moving them from the place where they are kept.

https://web.uniroma1.it/landa

L-8. Laboratory of PhotoAcoustic and Photothermal Techniques for nondestructive testing of materials – PA&PT LAB

In the PA&PT Lab, located in Building RM008, floor PS1, Room L012, the following techniques have been designed, realised, and optimized: UV VIS NIR photothermal deflection and photoacoustic spectroscopy, photothermal radiometry and infrared thermography, and standard optical techniques. Theoretical modeling and simulation tools for optical and thermal meta-nanomaterials are available in a protected area of the Lab.

Main applications: measurements of thermal diffusivity of materials; optical and infrared refectance, transmittance and absorbance; infrared signature of filters and targets; optical, thermal and hardness depth profiling in graded materials; detection of subsurface layers; analysis of traces of gaseous pollutants, optimization of photovoltaic cells, detection of dichroism and resonances in nanostructures, UV VIS NIR spectroscopy for agrifood, thermophysical properties of materials for nanophotonics and nanophononics.

Laboratory equipment

- Sources: Argon Ion Laser, INNOVA 70-3, CO2 CW Laser MPB Technologies 10W @10600nm, Laser diode, Coherent 2W @810nm, Laser diode, Hitachi 3mW @635nm, Laser diode, LaserMax Crisel 5mW@1310nm, He-Ne Meles Criot 5mW @633nm , Xenon Lamp.
- Optics: Lenses, Interferential filters, mirrors, beam splitters, Monochromator (Jobin Yvon).
- Detectors: Si and GaAs photodiodes. Pyroelectric sensor. HgCdZnTe IR detectors. Position sensors. Photomultiplier. Infrared Camera 8-14 μm.
- Electronics: 2 Lock-in amplifiers. Digital oscilloscope Tektronix- - Microvoltmeter HP
- Mechanics: 2 optical tables (Newport). Automatized rotation and translational stages.
- HW and SW: 4 desk-top PCs. Software LabView.

Figure 1: From left to right: Infrared radiometric set-up; photothermal detection apparatus; photoacoustic cell.

https://wwwsbaiuniroma1it/strutture/tecniche_fototermiche_fotoacustiche

L-9. Molecular Photonics Laboratory

The Molecular Photonics Laboratory (MPL) gathers equipment, expertise and experiments used for the study of the linear, nonlinear, photoluminescence and electroluminescence properties of molecular and polymeric organic materials. Such materials are used for the fabrication of integrated optical devices, organic light emitting diodes (OLED) and dye-sensitized organic solar cells (DSSC).The laboratory expertise has been developed since 1992, also in the frame of master of science and doctorate projects carried out in particular by students of the Electronic Engineering, Nanotechnology Engineering and Physics Courses.

Since 2007 the laboratory started migrating towards the field of Biophotonics, in which the materials are still organic but of biological origin. We worked hard to pursuit such a transition, which involved a modification of the experimental techniques and their integration with new expertise in chemistry and biochemistry. We believe the transition is now complete as witnessed by our latest publications in the field.

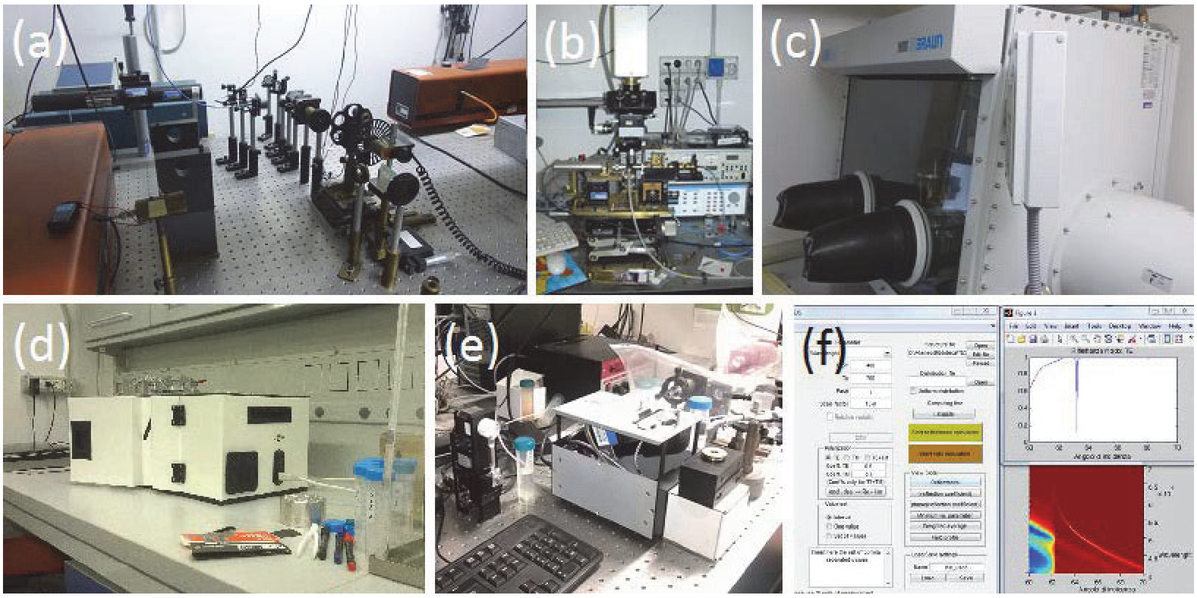

Figure 1: (a) Custom benchtop optical setups, (b) Integrated photonics setup, (c) Glove-box, with DC sputtering and spin coating systems, (d) BSW early cancer biomarker detection platform developed in the project BILOBA, (e) Infrared Surface Plasmon Resonance platform, (f) Custom and commercial tools for advanced numerical simulations in optics and photonics.

The MPL is equipped with the following technical instrumentation:

- CW He-Ne lasers (632.8 and 543 nm) and laser diodes (635, 670, 1300, 1550nm, tunable 1490-1590nm);
- modelocked Nd:YAG laser (1064nm, SH 532nm, f=76MHz, 100ps), dye laser (R6G band, f=0.147-38MHz, 1ps), Q-Switched Nd:YAG laser (1064nm, SH 532nm, f=1-10Hz, 6ns);
- optical components (mirrors, lenses, beamsplitters, polarizers, phase retarders, fibers, objectives) and mountings (manual/motorized) used to assemble benchtop laboratory setups in optics and photonics;
- complete experimental setup for the characterization of photonic integrated circuits, with microscope;
- equipment for the chemical functionalization of optical biosensors (gold/dielectric surfaces), with a glove-box;
- equipment for microfluidics (cells, motorized pumps, tubings, switches, valves, temperature control);
- CW sputtering (gold) and spin coating systems;
- Range of didactic kits used in the optics and photonics courses, including a WEB accessible ellipsometer (https://remotelab.ing2.uniroma1.it/)

https://web.uniroma1.it/labmp/

L-10. Particle Accelerator Laboratory

The laboratory is devoted to the design and measurement of Radio Frequency (RF) devices for modern particle accelerators. Those devices are designed with the aid of standard software, widely used in modern RF engineering, e.g. Ansoft-HFSS or CST-Microwave Studio; the dynamics of particles inside those devices is also optimised with dedicated tools widely used in the Accelerator Physics community (e.g. TSTEP). The laboratory is equipped with servers dedicated to those softwares.

Vector Networks Analysers (VNA) are used to bench measure any particle accelerator RF device, e.g. accelerating and deflecting structures, beam position monitors, resonant cavities as well as low power electronics. The laboratory hosts four VNAs operating from few kHz to 20GHz, as well as the necessary mechanical and electronic calibration kits. High frequency signal generators, spectrum analysers and calibrated antennas are also available for Electro-Magnetic compatibility measurements. Typical RF devices, such as amplifiers, attenuators, power splitters, directional couplers, filters, high accuracy cables are also present covering the 20GHz range. All our instruments can be remotely controlled with standard application (such as Labview and Matlab) as well as integrated in complex bench measurements requiring the synchronisation of the instrument with external devices (e.g. step motors).

The laboratory can perform complex, general purpose RF measurements (e.g. Time Domain Reflectometry) as well as bench measurements typical of the accelerator engineering, e.g. coaxial wire or bead pull techniques. The Coaxial Wire method is used to estimate the coupling impedance of accelerator devices, a quantity affecting the beam stability in accelerators. Bead pull is used to measure the electro-magnetic field acting on the particles both in resonant and non resonant devices; the perturbing object can be calibrated in dedicated pillbox cavities.

Most of the devices designed and measured in the accelerator laboratory are standard S-band (3GHz) devices, in particular deflecting cavities; we also measured and tuned C band (6GHz) travelling wave devices before the high power tests. We also designed and measured different accelerating multi-cell cavities in X Band (12GHz). All our activity is in tight collaboration with INFN Laboratori Nazionali di Frascati, where such devices are used in operating accelerators.

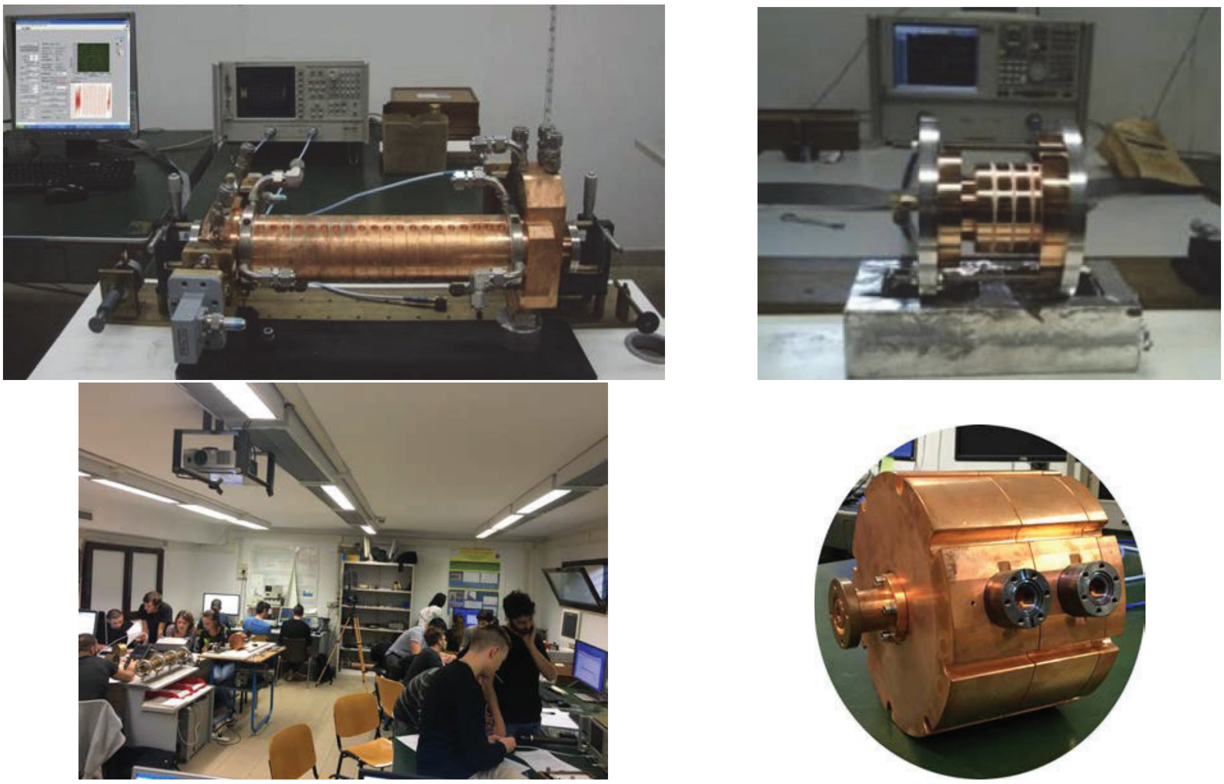

Figure 1: Bead pull measurement of C band travelling wave device (top left picture), X band standing wave multi-cell cavity (top right picture), students working in the laboratory for the microwave measurement laboratory course (bottom left picture) and S band multi-cell deflecting cavity (bottom right picture)

L-11. Laboratory of Radiation Protection

The Laboratory of Radiation Protection is mainly devoted to experimental applications related to environmental radioactivity (radon in air/water, radioactivity of building materials), and to nuclear measurements (alpha/beta/gamma spectrometry and neutron techniques). Laboratory hardware includes:

- AlphaGUARD, for measurements of radon concentration in air;
- AquaKIT, coupled with AlphaGUARD, for measurements of radon concentration in drinking waters;
- Tracerlab BWLM-PLUS-2S, for measurements of radon-related potential alpha energy concentration in air (PAEC), Figure 1;
- Radon chamber (founded with Sapienza grant 2017 Prot. N. RP11715C7846C2E5) for radiometric characterization of radon instrumentation in static and dynamic tests;
- Prototype for an electrostatic precipitation system designed to control radon-related potential alpha energy concentration in air as a remedial action against radon issues;
- Sodium Iodide-based gamma spectrometry systems for analyses of samples in low-background shielded well;
- High spatial-resolution tomographic system for analyses of small samples by means of a X/gamma-based automatic reconstruction system;
- Alphaino detector, for low-cost alpha spectrometry of samples;
- Radonino detector, for low-cost measurements of radon-related potential alpha energy concentration in air (PAEC);
- 3D printer for self-building of components;

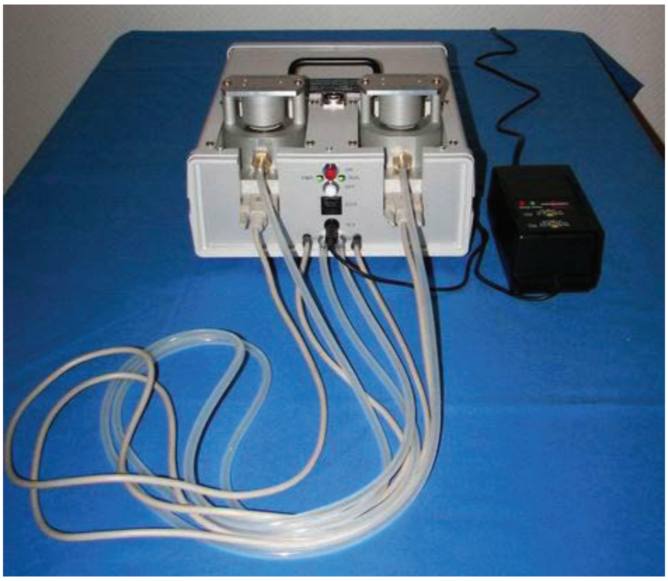

Figure 1: The Tracerlab system for measuring attached and unattached radon decay products

The Laboratory endowment also includes the following software: Monte Carlo N-Particle eXtended code MCNPX, for shielding calculation, detector simulations and radiation-based techniques optimization; GoldSim Simulation software for radionuclide dispersion and transport through environmental pathways; Canberra suite Genie2000 and Ortec Gamma Vision software for gamma spectrometry.

L-12. Electron Microscopies and Nanoscopies (EMINA)

Facilities of EMINA scanning probe microscopy (SPM) laboratory include a set of three SPM platforms (NT-MDT, Russia), i.e., two atomic force microscopy (AFM) and one scanning tunneling microscopy (STM) setups. In particular, AFM platforms can perform standard morphological characterizations in tapping and contact mode both in air and in liquid, including also the facility for mechanical, electric and magnetic characterizations.

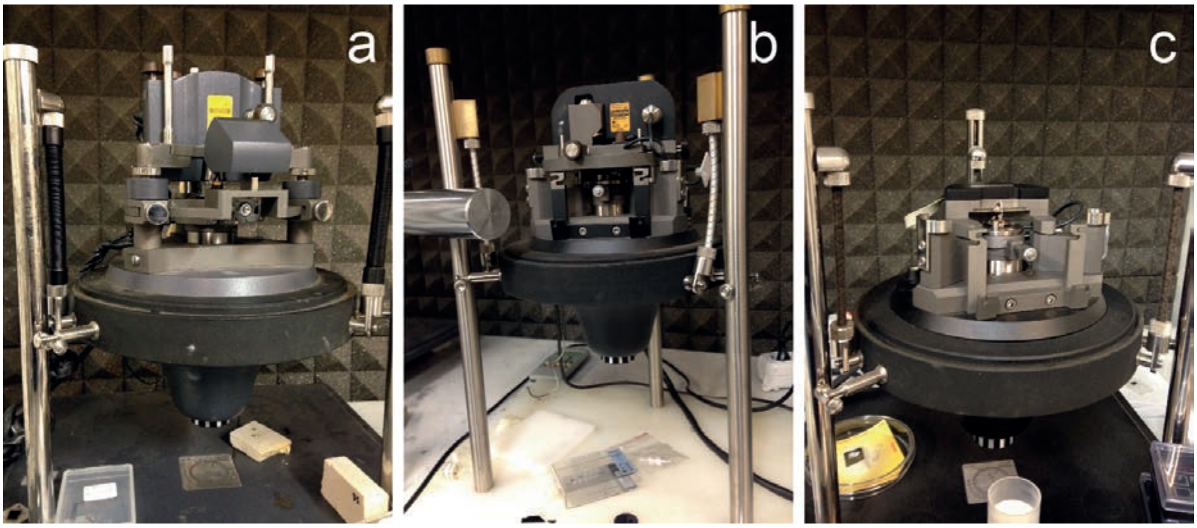

Figure 1: SPM setups available at EMINA: (a) AFM with the facility for mechanical characterizations, (b) AFM which can operate both in air and liquid, (c) STM setup.

http://www.nanothings.it/eminalab/

L-13. SBAM (Scienze di Base Applicate alla Medicina) laboratory

The SBAM (Scienze di Base Applicate alla Medicina) laboratory is a facility hosting the tools and necessary equipment for the development of state of the art particle and radiation detectors with applications in the Medical Physics field. Several detector, of different radiation types, are available in the laboratory or can be assembled in the SBAI mechanical workshop. Figure 1 shows the laboratory during the assembly and test of a multi-purpose detector setup aiming to the simultaneous detection of prompt photons, PET annihilation photons and charged fragments produced by the interactions of carbon ion beams used in particle therapy treatments with thick targets.

Figure 1: SBAM laboratory during the assembly of the table-top experiment performed at Heidelberg in 2014. The experiment setup foresaw the simultaneous detection of prompt photons, PET annihilation photons and charged fragments produced by the interactions of carbon ion beams used in particle therapy treatments with thick targets.

The SBAM lab is equipped with different types of detectors (see Figure 2 for example) that can be used to measure incoming radiation of the energy of interest for Medical Applications, especially in Particle Therapy. The full data detection chain can be exploited within the SBAM facility: the detector construction and test, the electronics development, the readout implementation and the data acquisition and analysis can be performed using the hardware and software tools available.

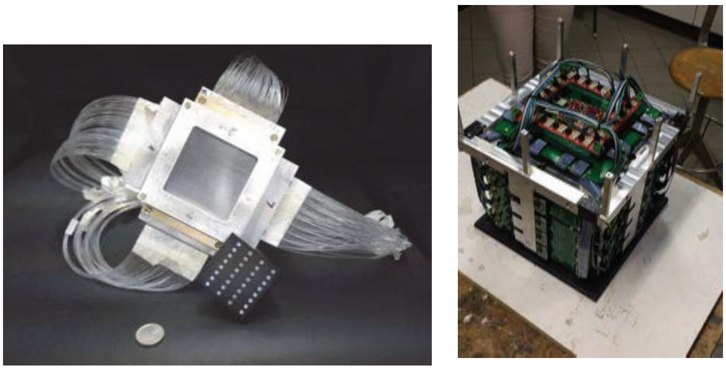

Figure 2: (Left) Plastic scintillator detector optimised for ToF measurements. The readout is performed using fibres. (Right) Dose Profiler detector: a charged particles tracker optimised for the monitoring of Particle Therapy treatments performed using carbon ions.

http://arpg-serv.ing2.uniroma1.it/arpg-site

L-14. Nonlinear Photonics Lab

The Nonlinear Photonics has been active for years in experimental research and in the modeling and simulation of nonlinear optical and optical processes and devices, with applications in nanophotonics, plasmonics and "quantum information" as:

- study and design of novel single photon emitters, nonlinear sources based on photonic crystals;
- Linear and Nonlinear optical filters for the manipulation of the electromagnetic radiation in different spectral ranges;
- The laboratory is equipped with numerous computers running both commercial (Optiwave, Comsol Multiphysics, Lumerical), as well as customized software.
- It is also equipped with different laser sources, monochromators, spectrum analyzers and tools for experimental investigations in both of linear and nonlinear optics.

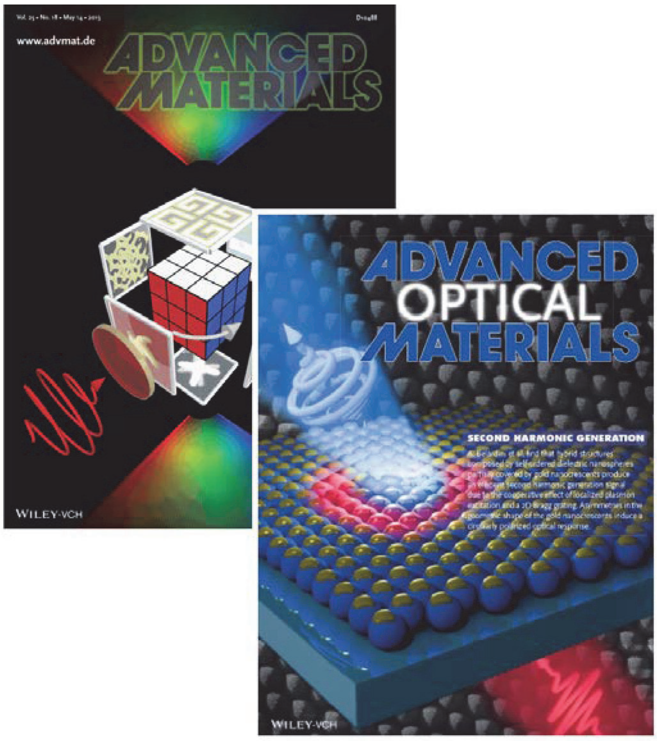

Figure 1: Simulations and Experiments on nonlinear artificial chiral materials

L-15. Laboratory of physics of semiconductors and nano-structures

The laboratory is mainly devoted to the study of the structural and the electronic properties of semiconductors and nano-sized materials, both from the experimental and the theoretical/computational point of view. Concerning the theoretical and computational physics activity, the laboratory owns a computational infrastructure with a total of more than 250 cores and four servers for high performing computing (HPC) (see Fig.1(a)). Structural characterization of materials and nano-structures is mainly performed by Transmission Electron Microscopy (TEM), optical microscopy and Reflection High Energy Electron Diffraction (RHEED). The laboratory owns two electronic microscopes, the first one operating in transmission at 160 kV [Fig. 1(b)], the other equipped with an high resolution reflection stage for RHEED measurements and shown in Fig. 1(c). The laboratory owns also the entire equipment needed to build and prepare samples for TEM, including the final ion milling stage [Fig. 1(d)].

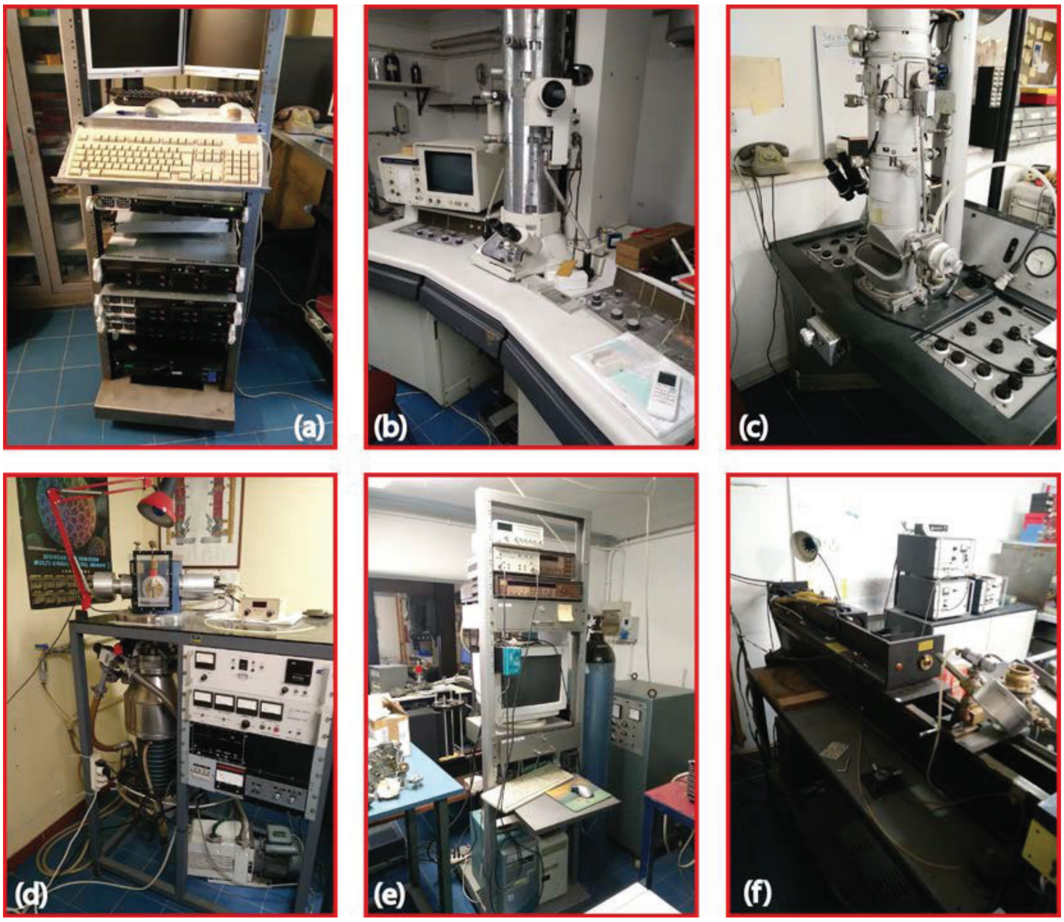

Figure 1: Some of the main apparata owned by the laboratory

Concerning the electrical and the electronic characterization of materials, the laboratory is equipped with a set-up for measuring a variety of quantities such as the sheet resistance, the Hall voltage, the carrier density in semiconductors and thin films. The same experimental set-up has been equipped wth a liquid nitrogen cryostat to perform temperature controlled measurements of the activation energy of defects and traps [Fig. 1(e)]. With the same set-up, that is entirely controlled remotely, it is possible to perform Current Transient Spectroscopy (CTS) and Photo-Induced CTS (PICTS) measurements to study the behavior of traps and defect in semiconductors. Lastly the laboratory is equipped with a High Power Pulsed Laser system in conjunction with a controlled atmosphere system to perform experiments of laser induced modifications of the structural and the electronic properties of materials [see Fig. 1(f)].

L-16. Scientific Computing Facilities

SBAI researchers perform scientific computations both using external High Performance Computing resources (e.g. at CINECA and ENEA-CRESCO) and in-house facilities.

A first in-house facilities is a Scientific Computing Laboratory, located at the ground floor of the building RM002. The laboratory activity started in 2012. The laboratory was originally equipped with two Server Sun Fire – X2100 M2 rack 1U – 1 AMD Opteron modello 1210 – DDR2–667 4Gb. More recently one Server SuperMicro rack 2U – Double Processor Intel Xeon E5620 – DDR3 1333Mhz 24Gb has been added. This server is equipped with the Scientific Linux release 6.10 (Carbon) system. In the past few years the laboratory has been mainly used as a support for the mathematics research lines, mainly as an instrument to run Monte Carlo simulation and to perform numerical studies of partial differential equations. The laboratory has been used not only by the researchers of the Department, but also by many PhD students of the PhD school Mathematical Models for Engineering, Electromagnetics and Nanosciences.

A computational infrastructure with a total of more than 250 cores and four servers for high performing computing (HPC) is hosted by the Laboratory of physics of semiconductors and nano-structures.

The Department has also designed and assembled a simulation server with four GPUs running in parallel for raytracing applications and for developing new-generation Monte-Carlo codes. Thanks to a closed-circuit liquid cooling system, the GPU cards can sustain continuous operation, since the temperature of the computing hardware is kept well below 45 Celsius. For the described applications, the server has a performance comparable to that of a conventional cluster of more than 1000 CPU computing nodes.

Figure 1: Closed circuit liquid cooled GPU server.

L-17. Departmental Library

The Library of Basic and Applied Sciences for Engineering (SBAI) is divided into three topical sections (Mathematics, Physics and Chemistry) holding about 20,000 volumes, 200 journals (between current and closed) and online-only periodicals (SIAM Journals, OSA Journals, Royal Chemical Society).
In addition the Library houses a number of collections of considerable value (including Laurence donation and Martinelli donation).

The library has four reading rooms. The largest one with seventy seats was inaugurated in May 2017 as a 24 hours service. The room is accessible after normal opening hours using a personal magnetic card. Students can request access to the facility directly via the Infostud system.

The H24 studying and reading room.

The three smaller rooms are reserved for specialist consultation, and reach a total of forty-three study seats. The Library also provides access to people with disabilities and offers two terminals for consulting catalogs and digital bibliographic resources.
The Library makes it available to the specialized user a study room for the consultation of mathematical series, equipped with a workstation connected to the Internet.

The Library adheres to the National Library System (SBN), the National Archive of Periodicals (ACNP), the inter-library loan service SBN / ILL, the network Inter-library document exchange (NILDE) for the mutual exchange of articles and documents scientific among libraries.
The SBAI Library offers consultation services, bibliographic assistance, supply of scientific articles and interlibrary loan to all users. The Library assists in carrying out research activities mainly on the topics of chemical, physical and mathematical disciplines that present a significant application aspect.

Students in the reading room.

http://www.sbai.uniroma1.it/strutture/biblioteche

L-18. Mechanical workshop

The Department's mechanical workshop (Fig. 1) is equipped with several traditional machine tools including a lathe, two vertical milling machines, column drills of different sizes, band saws, a shear. An FDM 3D printer is also available. It has been used to produce a variety of objects, from small optical media to complex research prototypes.

The workshop, albeit with traditional machines, actively supports research by producing functional prototypes of considerable complexity and automation, as well as mechanical accessories for the various work groups. It also provides assistance to departmental educational laboratories. In addition. the mechanical workshop assists researchers in the design and implementation phase of the CAD part of the projects.

Recently produced prototypes of considerable complexity include a detector and scintillating dose-profiler fibers (Fig. 2), a thermobalance for the determination of the vaporization and sublimation enthalpy (Fig. 2) a remote control system for various optical experiments with revolver system; a beam monitoring system for the ELI accelerator.

Figure 1: Partial wiew of the workshop

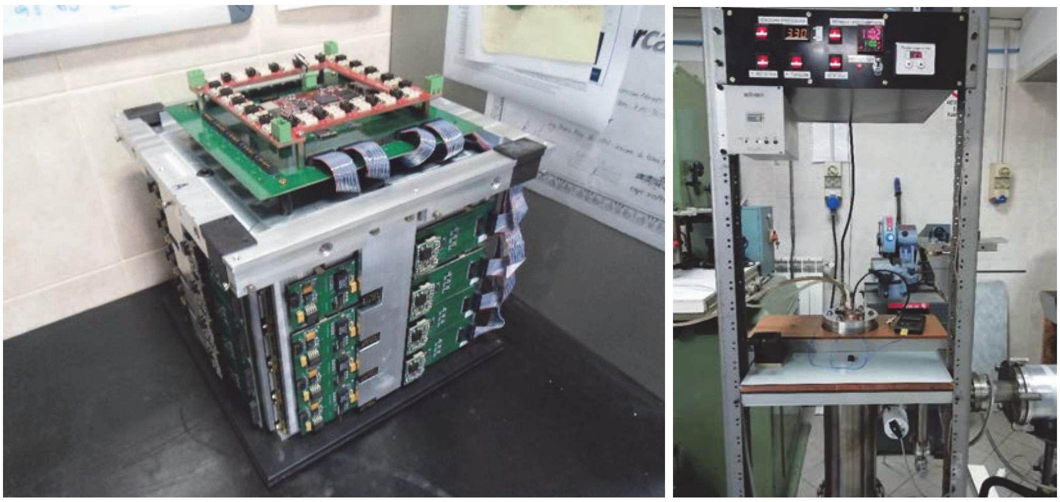

Figure 2: detector and scintillating dose-profiler (left); thermobalance (right)