DAΦNE-Light Laboratory and Activity

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1 Summary

The scientific activity at the DAΦNE-Light laboratory, in 2018, was performed using conventional sources and the DAΦNE synchrotron radiation beam. About 40 experimental teams got access to the DAΦNE-Light laboratory coming from Italian and European Universities and Research Institutions. In 2018 we continued giving beamtime to experimental proposals submitted by European users within the EU CALIPSOplus Transnational Access program and the facility was also involved in the organization of the *Life Science and IR Micro-Spectroscopy Thematic School* at SESAME in Jordan within the EU project OPEN SESAME. The commissioning of the two XUV beamlines went on and changes were performed on the High Energy Beamline (HEB) to include the WINDY (White lIgth liNe for Desorption Yields) branch line for experiments related to a MoU with CERN. The experimental activities, performed in 2018, included also some upgrades of the other beamlines, and the installation of new instrumentation.

2 Activity

2.1 SINBAD IR beamline - *Resp. Mariangela Cestelli Guidi*

The SINBAD IR beamline is dedicated to FTIR (Fourier Transform InfraRed) micro imaging and spectroscopy in different research fields, including material science, biology, radiobiology, live cell imaging, cultural heritage and geophysics. All these studies are possible owing to the imaging capabilities of the IR microscope coupled to the synchrotron source. The beamline is open to all users involved in the experiments mainly coming from institutions involving Italian and International teams through the CALIPSplus EU project, that will end in 2021.
Concerning the instrument upgrade performed in 2018 two things must be underlined:

1. The existing IR microscope has been ungraded with a Z-control motorized stage to perform micro-Attenuated Total Reflection experiments.

2. A portable FT-IR spectrometer (Alpha II), funded by the INFN CHNet network for Cultural Heritage, is now operational and available for users, dedicated to on-site cultural heritage diagnostics and biological samples analysis.

In 2018 the SINBAD-IR beamline has been involved in the following projects:

1. ***ADAMO-DTC, Lazio***

   As part of the District Technology of Culture supported by the Lazio region, the **ADAMO** project (**A**nalysis technologies, **D**iagnostics **A**nd **MO**nitoring for the Preservation and Restoration of Cultural Property) is aimed at transferring technologies from the DTC partners (ENEA, Roma Sapienza, Roma Tor Vergata, Roma 3, Tuscia University, CNR and INFN (see Fig. 1) to industries operating in the area.

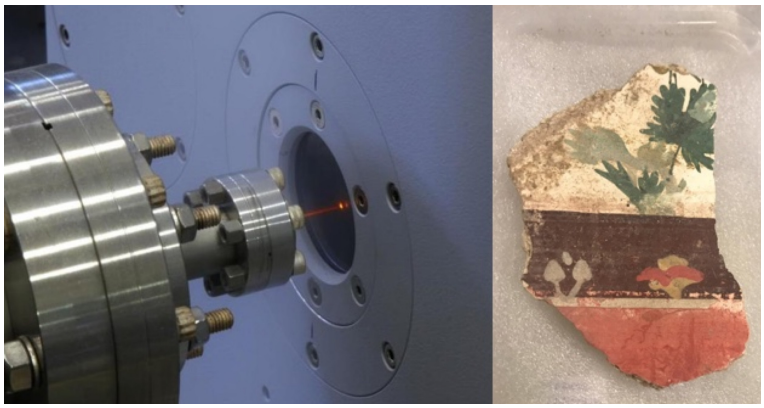

Figure 1: SINBAD-IR beamline of the DAΦNE-Light synchrotron radiation facility and cultural heritage studies.

In the area of the former Centocelle airport, the Capitoline Superintendency of Cultural Heritage had coordinated the excavation a large suburban Roman villa called ″Villa della Piscina″, where were found numerous fragments of frescoes realized in different phases of the complex life. The aim of the IR spectroscopic analysis carried out at DaΦne-Light is to support both the reconstruction of the frescoes and their dating with experimental data related to the composition of the materials, constituting both the painted surface and the substrate, and the realization technologies.

2. ***Graphene 3D*** - Italian-Chinese Collaborative Research Projects between the Ministry of Foreign Affairs and International Cooperation (MAECI) and the National Natural Science Foundation of China (NSFC)

   Graphene is the first thermodynamically stable two-dimensional material discovered in nature. Its properties are extraordinary: from the very high electric mobility based on linear dispersion electrons (Dirac electrons), to the strong interaction with the electromagnetic field, to the high thermal conductivity, to the remarkable mechanical hardness. In recent years research has focused on providing a third dimension to graphene. Recently three-dimensional (3D) graphene-like materials have been discovered with micro and nano-porous structures, or made by mesoscopic filaments that are distributed on macroscopic spatial scales. These topological structures allow preserving the extraordinary electrical and thermodynamic properties of 2D graphene extending them in 3D. The porous or filamentous nature, and the high surface/volume ratio of these 3D architectures open interesting application scenarios and opportunities for fundamental physics researches: batteries and super-capacitors, flexible electronics, IR and THz photonics, plasmonics and finally, the manufacture of novel highly-efficient devices capable of transduce light into sound.

3. ***TERA*** - INFN CSN5

   Terahertz radiation (0.3-20 THz, 1 THz = 4 meV = 300 μm), is the most important portion of the electromagnetic spectrum in terms of multi-disciplinary use in basic science and technology, as defined by the European THz road map in 2017. The aim of the TERA project is to build a synergic interdisciplinary collaboration among different INFN sections with the final goal to push forward a strong R&D activity on THz technology with particular regard to

THz acceleration. LNF is contributing to WP2 (Acceleration Beam Dynamics and Cavities) and WP3 (Detectors).

More than 15 experimental teams submitted proposals for beam time at the SINBAD-IR beamline. A selection of some scientific studies performed in 2018 is here summarized:

1. *Search for an IR Signature of a J=1/2 $\longrightarrow$ J=3/2 Transition in a Pyroxene.*

   P. Zajdel, Jagelonian University, Poland.

2. *Characterization of synthetic binders and protective materials used in ancient and contemporary artworks by Time Gated Laser Induced Fluorescence spectroscopy (TGLIF) and FT-IR analysis.*

   M. Marinelli, University of Tor Vergata (Rome), Dep. Industrial Engineering.

3. *Archaeology and Archaeometry of Textiles: Scientific Analysis of Archaeological Textile Fibres and Tools.*

   F. Coletti, University La Sapienza (Rome), Dep. of Archaeology.

4. *The complex interaction between lipid membrane and amyloid protein studied by infrared spectroscopy (PrOtein- Lipid Infrared Spectroscopy , PoLIS).*

   A. Nucara, University La Sapienza (Rome), Dep. of Physics.

5. *Terahertz and Infrared Plasmonic Absorption of 3-Dimensional Nano Porous Graphene.*

   S. Lupi, University La Sapienza (Rome), Dep. of Physics.

The SINBAD-IR beamline in 2018 was also involved in activities on behalf of third parties like:

1. Artelab s.r.l. Company: Characterization of stratigraphic sections of oil paintings of the '600.

2. Rosati Company: Characterization of organic substances on tissues.

Mariangela Cestelli Guidi in 2018 was also the Chair of the *Life science and IR Micro-Spectroscopy Thematic School* funded by the EU Project OPEN SESAME that was organized in April at the SESAME Synchrotron Radiation Facility in Jordan.
Between the different activities, the SINBAD beamline is also routinely hosting different students performing their thesis or PhDs:

1. S. Macis, *Deposition and characterization of thin MoO_3 films on Cu for technological applications.*, PhD Thesis, University of Tor Vergata (Rome)

2. F. Coletti, *I tessuti di Pompei: materiali, tecniche e lavorazione e contesti*, PhD Thesis (Archeology), University La Sapienza (Rome).

3. C. Cicero, *Hydrothermal stability evaluation for parchment deterioration assessment: a novel opto-thermal method by Light Transmission Analysis (LTA)*, PhD Thesis, Industrial Engineering, University of Tor Vergata (Rome)

4. E. Bonaventura, *Optical properties of "stanene-like" thin films on Sapphire*, Master Thesis (Physics)

5. E. Fardelli, *Characterization of Chroococcidiopsis, irradiated with Mars-like conditions, using different spectroscopic techniques: Raman, FTIR and THz-TDs*, Master Thesis (Physics)

6. F. Galdenzi, *Dynamics of dehydrogenation processes in amphiboles.* PhD Thesis, University of Roma Tre (Rome)

2.2 DXR1 Soft X-ray Beamline - *Resp. Antonella Balerna*

The DAΦNE soft X-ray beamline, DXR-1, is mainly dedicated to soft X-ray absorption spectroscopy. The X-ray source of this beamline is one of the 6-poles equivalent planar wiggler devices installed on the DAΦNE electron ring (0.51 GeV) for the vertical beam compaction. The 6 wiggler poles and the high storage ring current (higher then 1 Ampere) give a useful X-ray flux for measurements well beyond ten times the critical energy. The useful soft X-ray energy range is 900 eV - 3000eV where the lower limit is given by the Beryl crystals used in the double-crystal monochromator and the higher limit is given by the wiggler working conditions.
In 2018, operation in top up mode continued and was used in all experiments. In february 2018 the first tests of the first finger shaped **ARDESIA** (**AR**ray of **DE**tectors for **S**ynchrotron rad**I**ation **A**pplications) detector using the DXR1 soft X-ray beam were performed (see for more details also the specific contribution in the Activity Report). ARDESIA is a 4-channel SDD-based detector optimized for synchrotron experiments that require high count rates (>1Mcps/channel) and good energy resolution. The detector finger was closed with an AP5 MOXTEK window (needed to separate its vacuum from the one of the experimental XAFS chamber) and inserted in the experimental chamber at 90 degrees with respect to the incoming beam in order to reduce the elastic scattering. X-ray Fluorescence (XRF) spectra down to the C K $_{\alpha}$ line and the XAFS spectra of a Pyrex glass sample (Fig. 2) were measured.

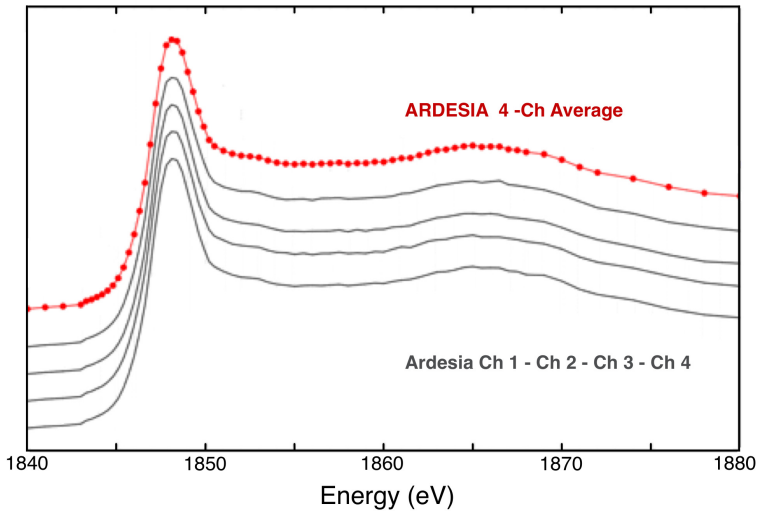

Figure 2: XANES spectra at the Si K edge of a Pyrex glass sample.

In 2019 the ARDESIA detector will be definitively installed on the DXR1 beamline and the software needed to perform XAFS measurements will be developed. Probably starting from 2019 there will be the possibility to perform XAFS measurements in fluorescence mode on diluted and supported samples. The soft X-ray beamline is equipped also with a microfocus, W, x-ray source to test samples and to perform X-ray fluorescence (XRF) measurements using an available SDD (Silicon Drift Detector) detector and a vacuum compatible experimental chamber for samples containing low Z materials.
In 2018 beamtime was given also to two very interesting proposals:

1. *Extraframework molecules in lazurite: a combined XAS/FTIR study* - Università Roma Tre - Rome, Italy

Lapis lazuli is a rare and precious pigment exploited and prized for its deep blue colour since, at least, the 5th millennium B.C. when it was first used to fashion jewels, amulets, seals, and inlays. Lapis lazuli is indeed a complex rock characterized by the abundance of the mineral lazurite $(Na,Ca)_8(AlSiO_4)_6(SO_4,S,Cl)_2$, which is responsible for its overall blue hue. The mineral lazurite is a member of the sodalite group, which includes sodalite ($Na_8(Al_6Si_6O_{24})(Cl_2)$), nosean ($Na_8(Al_6Si_6O_{24})(SO_4)\cdot H_2O$) and haüyne ($((Ca,Na)_{4-8}(Al_6Si_6O_{24})(SO_4,S,Cl)_{1-2}$), and is typically considered a sulfur-rich haüyne. Based on Raman and electron paramagnetic resonance (EPR) studies, it is now accepted that the color of ultramarine pigments is associated with reduced chalcogen species in the sodalite cages, particularly the polysulfide radical anions S_3^-, S_2^- and S_4^-. Following these results, the project proposed here aims at studying via XANES spectroscopy at the S K-edge a set of treated samples: the goal is to monitor the evolution of the X-ray absorption near-edge structure (XANES) due to the induced alteration of the ${SO_4}^{4-}/{S_3}^-$ ratio in the structure.

2. *Silicon K Edge XAS of Cobalt Based Silicates* - University of Silesia - Poland

   Silicate pigments have been known since millennia. Their properties were first investigated by Humphrey Davy already at the beginning of the XIX century but the exact structure and composition of $BaCuSi_2O_6$ (Han purple), $BaCuSi_4O_{10}$ (Han blue) and $CaCuSi_4O_{10}$ (Egyptian blue) were established over 100 years later. Contemporary, $CaCoSi_2O_6$ is used in industry as pigment varying in color from blue to pink. The research plan involves synthesis and study of several dozens of new samples starting from $CaCoSi_2O_6$.The existence of a high-spin to low-spin crossover in these materials opens up a possibility of using these compounds as optically switching materials. XANES measurements were performed at the Si K-edge at the DXR1 beamline. Despite the immense popularity of this type of pigments up to now such studies have never been done.

2.3 DXR2 UV branch Line - *Resp. Emanuele Pace*

The DXR2 beamline at DAΦNE- Light operates with UV radiation on an extended spectral range from 120 nm to 650 nm. The UV radiation can be used in a wide range of experiments such as reflectance/transmittance, ageing and response of optical systems and detectors. The UV light has been used at the DXR2 branch-line in many and different research fields from biological to high energy physics experiments, to study solar-blind UV diamond-based detectors or FOAM for space missions. Furthermore, coupling the UV radiation and IR spectroscopy it is possible to study the evolution of analyzed samples in real time, measuring the variation of IR spectra during UV exposure. The facility operates with UV radiation obtained as synchrotron radiation (SR) or standard sources (HgXe lamp in the 200-650 nm range and Deuterium lamp for the Deep UV 120-250 nm). In 2018 the biggest part of the activity, more then ten users, was related to the use of the SEM microscope and of the EDX analysis (this one only up to July because after there were problems with the SDD detector).
Concerning the use of the DXR2 beamline some planned experiments, due to the stop of DAΦNE, were necessarily moved to 2019 including plans to do bunch analysis to characterize diamond devices, developed by users coming from the University of Tor Vergata (Rome), using for the tests the new oscilloscope and the new Vigo detector of the DXR2 beamline. In the meantime the activity was focused on the implementation of an experimental setup for the analysis of planetary atmospheres in the laboratory and for these studies a multipass cell has been purchased. For this activity there are potential collaborations with Roma Tre, Palermo and Padua, but a systematic work will effectively start only when the setup will be completed and the operation of DAΦNE will restart.

2.4 XUV beamlines and laboratory - *Resp. Roberto Cimino*

Aim of this laboratory is to host three bending magnet beamlines. Two will offer monochromatic light with a photon energy range from 30 eV to 1000 eV, the third one, under construction, will provide non-monochromatized ″White Light″ SR light. The Low Energy Beamline, (LEB) will cover the energy range from 30 eV to 200 eV and the High Energy Beamline (HEB) will offer monochromatic photons from 60 eV to 1000 eV. The two monochromatic beamlines are under final commissioning and are foreseen to be fully operational in 2019. The third beamline, **WINDY** (White lIght liNe for Desorption Yields) has been fully designed and all orders have been placed during the present year. The laboratory is running and promoting some mainstream projects but is also running other activities, in the spirit of opening some resources to external users. All these activities are described in detail below.

1. In 2018, the XUV laboratory has hosted the experimental activities of the Work Package 4.4 of the European Project **EuroCirCol**, focused on issues related to cryogenic vacuum and its stability upon photon, electron and/or ion irradiation and thermal variation. In this framework, one of the most relevant results regards a detailed study on the compatibility of porous surfaces with cryogenic vacuum in future high-energy particle accelerators. Recently, pulsed laser processing of Cu samples has been demonstrated to produce rough surfaces whose structuring at the nanoscale ensures an impressive reduction of the secondary electron yield, which has an undoubted appealing for applications in future high energy particle accelerators. However, the effective use of such laser treated surfaces in this context requires a rigorous evaluation of the consequences on the vacuum stability, that may arise when exploiting porous surfaces as cryogenic components. For this reason a comparative thermal programmed desorption (TPD) investigation, between 20 K and 70 K, by dosing Ar on a laser treated copper substrate and on its flat counterpart, has been carried out. The results achieved, shown in Fig. 3, put in evidence that the sponge-like structural features confer to the laser treated sample non-negligible effects on the gas-substrate interaction, resulting in a much vaster and higher desorption temperature with respect to what observed from a flat substrate. This could render very difficult to find temperature intervals were vacuum stability could be granted for all the molecular species composing the residual gas in the cryogenic beam pipe components. Although the electron cloud mitigation efficiency has been settled, before definitely including porous surfaces in the machines's design, the consequences of having a rough rather than a flat wall on the vacuum stability should be carefully evaluated.

   The laboratory was also partially involved in the Task.4.6 of the EuroCircol Project ″ Measurements on Cryogenic Beam Vacuum System Prototype″, contributing to the design and development of the Beam Screen Testbench Experiment (BESTEX) and its installation at the KArlsruhe Reasearch Accelerator (KARA) light source at the Karlsruhe Institute of Technology. The performance of the experiment and data acquisition were of relevant interest as an input for the Future hadron Circular Collider (FCC-hh) Conceptual Design Report (CDR) delivered in December 2018. The goal of the test setup is the determination of the photo desorption yield, synchrotron radiation heat loads and photo-electron generation inside of FCC-hh beam screen (BS) prototypes, and their comparison with simulations. Its design and experimental development are important for the new desorption set up WINDY to be installed at DAΦNE.

2. The laboratory hosts also the Gr.V founded project **MICA** (see for more details also the specific contribution in the Activity Report), which is synergic to EuroCirCol and complementary to it in many instances. MICA is a national collaboration aiming to study various aspects connected to unwanted instabilities as derived by beam- material interaction, its

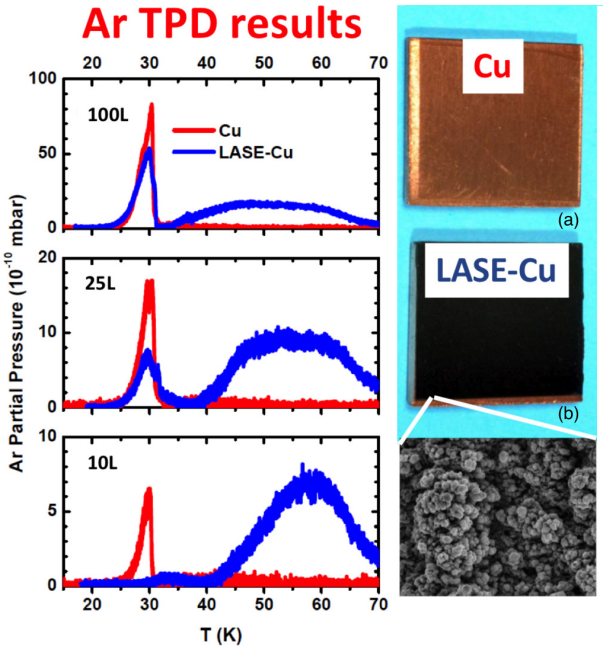

Figure 3: Comparison between the TPD curves obtained monitoring the desorption of 10 L, 25 L, 100 L of Ar dosed on a flat Cu substrate (a) and on a LASE-Cu sample (b). Below the Inset, a SEM micrograph 50 μm x 50 μm of the LASE-sample.

detailed analysis and possible mitigations. MICA activities, among other aspects, were concentrated also on the study of the interaction of photons (from SR) and electrons with gas ices grown on low temperature surfaces. MICA was involved in the study of ice forming at low temperatures in a more academic but very important astrophysical contest, because cold gasses desorption studies are fundamental for the understanding of interstellar dust behavior at the origin of the planetary systems. The MICA project launched also an intense experimental campaign to study at-wavelength synchrotron radiation reflectivity and photo yield of various materials because in order to correctly design the vacuum systems of particle accelerators and high energy colliders, the choice of materials to be used and of their treatment is an essential prerequisite. Within MICA the LNF was in the first line in the local and scientific organization of the topical workshop:″ECLOUD18″ at La Biodola (Isola d'Elba) Italy, from the 3^{rd} to 7^{th} of June, 2018

3. In 2017 a Memorandum of Understanding (MoU) between CERN and INFN-LNF has been signed. The general purpose of this MoU is to extract quantitative information about the reflectivity, photo-yield and photo induced desorption on small sample and on real 2-3 meters beam pipes, using the synchrotron radiation White Light (WL) of DAΦNE. These parameters have a fundamental role in the optimization of the existing particle accelerator, like LHC and its upgrade (HL-LHC and HE-LHC), and in the realization of the Future Circular Collider (FCC). For this purpose, in 2017, the realization of a new beamline WINDY started. The mirror chamber, has been recently mounted on the existing High Energy Beamline. The complete setup of the remaining beamline has been designed and acquired (Fig. 4).

   The setup includes a chamber for collimating and analyze the beam, a chamber for the

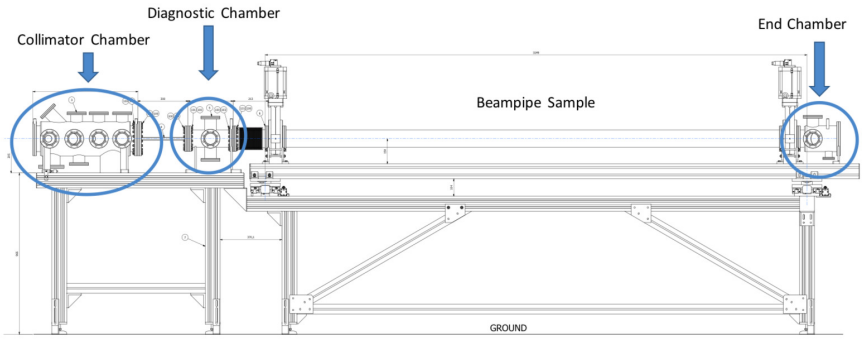

Figure 4: Schematic view of the WINDY beamline setup).

analysis of the photo induced desorption and an end station, after the beam pipes sample, for stopping the reflected beam. In the meanwhile, the first preliminary measurements with DAΦNE WL of photo-induced desorption and photo yield on a small sample have been done using the existing High Energy Beamline (Fig. 5).

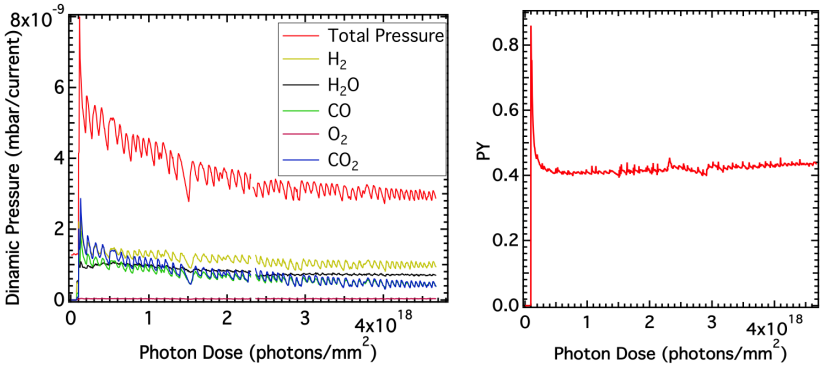

Figure 5: Behavior of total and partial pressure (left panel) and of the photo-yield (right panel) during the photon irradiation on a copper small sample.

Using the existing laboratory equipment, the sample has been also characterized by X-ray Photoemission Spectroscopy (XPS) and Secondary Electron Yield (SEY) techniques available in the HE Beamline chamber. These characterizations gave important information about the interaction between synchrotron radiation and the sample surface.

4. Concerning studies of new materials, the XUV Laboratory was involved in a scientific collaboration with **CHOSE** (Center for Hybrid and Organic Solar Energy, Department of Electronics Engineering, University Tor Vergata of Rome). The studies were focused on materials for the production of low cost and renewable energy and especially on the effects of adding MXenes on the used solar cell materials. MXenes are a new class of 2D materials presenting properties useful for photovoltaic applications as the tunability in terms of work function ranging from 1.6 eV to 6.5 eV. The Laboratory participated to the characterization through UPS and XPS measurements of different samples.

Together with the main stream projects the laboratory is open to the local and international community hosting also a number of minor projects and activities. Scope of this diffuse activity is to attract students and users at LNF.
The Laboratory is also routinely hosting students to perform their thesis or PhDs getting a direct experience with some state of the art experimental activity:

1. Wenting Dai - Studio dell'emissione di elettroni secondari da una superficie nell'ambito dello ″Spacecraft Charging″ - University La Sapienza, Rome, Master thesis in Aerospace Engineering (December 2018).

2. Eliana La Francesca - PhD School of Accelerator Physics, XXXI edition - University La Sapienza, Rome (2018).

3 List of Conference Talks and Posters

1. F. D′Apuzzo, F. Giorgianni, M. Cestelli Guidi, A. Marcelli, Y. Ito, M. Chen, S. Lupi, *Terahertz and Infrared Plasmonic Absorption of 3-Dimensional Nano Porous Graphene.* Bilateral Workshop 3D Graphene: From fundamental properties to applications,Frascati, Italy, 1-2 October 2018.

2. F. Coletti, *XII Antique Archaeology doctorals workshop. Documentation in Archaeology. Generating, storing and disseminating archaeological data.* German Archaeological Institute and the École Des Hautes études hispaniques et ibériques, Casa de Velázquez, Madrid, 4-8 June 2018 (CHNeT).

3. M. Romani, S. Almaviva, M. Cestelli-Guidi, F. Colao, R. Fantoni, M. Marinelli, A. Puiu, A. Pasqualucci, G. Verona-Rinati, *A reference data collection (Raman, TG-LIF and FT-IR) for contemporary artworks materials* , LACONA 12, Laser in the conservation of artworks, Paris, 10-24 September 2018 (CHNet).

4. A. Balerna, *DAFNE-Light DXR1 Soft X-ray Synchrotron Radiation Beamline: Characteristics and Applications.* Workshop on High precision X-ray measurements - LNF, 17th October 2018.

5. M. Marelli, A. Jouve, A. Villa, R. Psaro, A. Balerna, L. Prati, C. Evangelisti, *Disclosing the structure of hybrid Au-CuO bimetallic nanoparticles and their role in selective alcohol oxidation.* 6^{th} International Conference on Multifunctional, Hybrid and Nanomaterials, Meliá Sitges, Sitges, Spain, March 11 -15, 2018

6. E. La Francesca, A. Liedl, M. Angelucci, A. Sokolov, M. G. Sertsu, F. Schäfers, F. Siewert and R. Cimino, *Study of Reflectivity and Photo Yield on FCC-hh proposed beam screen surfaces*, FCC Week 2018, Amsterdam, The Netherlands, 9-13 April 2018.

7. M. Angelucci, L. Spallino, R. Larciprete and R. Cimino, *Desorption, scrubbing and surface modifications during Synchrotron Radiation light irradiation of accelerator walls*, FCC Week 2018, Amsterdam, The Netherlands, 9-13 April 2018.

8. L. Spallino, M. Angelucci, R. Larciprete and R. Cimino, *Study of Vacuum stability and desorption processes at low temperature for various FCC-hh candidate materials*, FCC Week 2018, Amsterdam, The Netherlands, 9-13 April 2018.

9. R. Cimino, M. Angelucci, L. Spallino, E. La Francesca, A. Liedl and R. Larciprete, *Beam Screen surface characterisation for high energy beams: test results at Frascati*, FCC Week 2018, Amsterdam, The Netherlands, 9-13 April 2018.

10. L. A. Gonzalez, V. Baglin, P. Chiggiato, C. Garion, M. Gil costa, R. Kersevan, I. Bellafont, S. Casalbuoni, E. Huttel and F. Perez, *Results on the FCC-hh Beam Screen prototype at the KIT electron storage ring*, FCC Week 2018, Amsterdam, The Netherlands, 9-13 April 2018.

11. A. Liedl, M. Angelucci, E. La Francesca, J. Buchheim, G. Gwalt, A. Sokolov, M. G. Sertsu, F. Schäfers, F. Siewert, and R. Cimino, *Metrology for High Energy Accelerator: SR at wavelength Investigations on Technical Surfaces*, International Workshop on X-ray Optics Metrology, Hsinchu, Taiwan, 6-9 June 2018.

12. A.Liedl, M. Angelucci, E. La Francesca, J. Buchheim, G. Gwalt, A. Sokolov, M. G. Sertsu, F. Schäfers, F. Siewert, and R. Cimino, *Photo Reflectivity and Photo Electron Yield of technical surfaces*, ECLOUD'18, La Biodola, Isola d'Elba, Italy, 3-7 June 2018.

13. L. Spallino, M. Angelucci, R. Larciprete and R. Cimino, *SEY and other material properties studies at cryogenic temperatures*, ECLOUD'18, La Biodola, Isola d'Elba, Italy, 3-7 June 2018.

14. L. A. Gonzalez, M. Angelucci, R. Larciprete and R. Cimino, *The effect of the structural properties on the SEY of C Materials*, ECLOUD'18, La Biodola, Isola d'Elba, Italy, 3-7 June 2018.

15. L. A. Gonzalez, M. Angelucci, R. Larciprete and R. Cimino, *Secondary Electron Yield from noble metals*, ECLOUD'18, La Biodola, Isola d'Elba, Italy, 3-7 June 2018.

16. R. Dupuy, M. Bertin, G. Feraud, X. Michaut, T. Putaud, L. Philippe, P. Jeseck, R. Cimino, V. Baglin, C. Romanzin, and J.-H. Fillion, *Synchrotron radiation interaction with cryosorbed layers for astrochemical investigations*, ECLOUD'18, La Biodola, Isola d'Elba, Italy, 3-7 June 2018.

17. Marco Angelucci, Luisa Spallino, Andrea Liedl, Rosanna Larciprete and Roberto Cimino, *Photons Interaction with technical surfaces*, ECLOUD'18, La Biodola, Isola d'Elba, Italy, 3-7 June 2018.

18. M. Angelucci, L.A. Gonzalez, Rosanna Larciprete and R. Cimino, *Stainless Steel SEY: A controversial story*, ECLOUD'18, La Biodola, Isola d'Elba, Italy, 3-7 June 2018.

19. L. A. Gonzalez, V. Baglin, P. Chiggiato, C. Garion, M. Gil Costa, R. Kersevan, I. Bellafont, S. Casalbuoni, E. Huttel and F. Perez, *Results on the FCC-hh Beam Screen at the KIT Electron Storage Ring KARA*, IPAC18, Vancouver, Canada, 29 April- 4 May 2018.

20. L. A. Gonzalez, V. Baglin, P. Chiggiato, C. Garion, M. Gil Costa, R. Kersevan, I. Bellafont, S. Casalbuoni, E. Huttel and F. Perez, *Photodesorption studies on the FCC-hh Beam Screen at the KIT electron storage ring KARA*, EVC-15, Geneva, Switzerland, 17-22 June 2018.

4 Lectures and outreach

1. A. Balerna, *Synchrotron light sources:amazing present and future.* INSPYRE - INternational School on modern PhYsics and Research 2018 - LNF, 16 February 2018.

2. M. Cestelli Guidi, *La spettroscopia infrarossa per lo studio dei materiali delle opere darte*, Vedere l′invisibile: la fisica per l'archeologia e i beni culturali, LuBeC 2018 - Lucca, 5th October 2018.

3. M. Cestelli Guidi, *Infrared Synchrotron microanalysis of cystic fibrosis cell models.* Workshop on the Present and Perspectives of IR spectroscopy, University La Sapienza, Rome, 8 October 2018.

4. M. Romani, *Il Laboratorio mobile di diagnostica per musei dellINFN (ADAMO-DTC)*, Rome Museum Exhibition, Fiera di Roma, 30th November 2018

5 Publications

1. G. Della Ventura, B. Mihailova, U. Susta, M. Cestelli Guidi, A. Marcelli, J. Schlüter, R. Oberti, ″The dynamics of Fe oxidation in riebeckite: A model for amphiboles.″, American Mineralogist **103**, 1103-1111 (2018) - DOI:10.2138/am-2018-6382

2. A. Jouve, G. Nagy, F. Somodi, C. Tiozzo, A. Villa, A. Balerna, A. Beck, C. Evangelisti, L. Prati, ″Gold-silver catalysts: effect of catalyst structure on the selectivity of glycerol oxidation″, J. of Catalysis **368**, 324-335 (2018) - DOI: 10.1016/j.jcat.2018.10.019

3. G. Bellotti, A. D. Butt, M. Carminati, C. Fiorini, L. Bombelli, G. Borghi, C. Piemonte, N. Zorzi, A. Balerna, ″The ARDESIA Detection Module: A 4-Channel Array of SDDs for Mcps X-ray Spectroscopy in Synchrotron Radiation Applications″ IEEE Trans. Nucl. Sci., **65**, 13551364 (2018) - DOI:10.1109/TNS.2018.2838673

4. I. Hafizh, G. Bellotti, M. Carminati, G. Utica, M. Gugiatti, A. Balerna, V. Tullio, G. Borghi, A. Gola, N. Zorzi, A. Capsoni, S. Coelli, L. Bombelli, C. Fiorini, ″ARDESIA: A fast silicon drift detector X-ray spectrometer for synchrotron applications″ X-Ray Spectrometry, 1-5 (2019) - DOI: 10.1002/xrs.3017

5. R. Dupuy, M. Bertin, G. Féraud, M. Hassenfratz, X. Michaut, T. Putaud, L. Philippe, P. Jeseck, M. Angelucci, R. Cimino, V. Baglin, C. Romanzin, and J.-H. Fillion, ″X-ray photodesorption from water ice in protoplanetary disks and X-ray-dominated regions″, Nature Astronomy **2**, 796-801 (2018) - DOI:10.1038/s41550-018-0532-y

6. L. A. Gonzalez, V. Baglin, P. Chiggiato, C. Garion, M. Gil costa, R. Kersevan, I. Bellafont, S. Casalbuoni, E. Huttel and F. Perez, ″Results on the FCC-hh Beam Screen at the KIT Electron Storage Ring KARA″, Proceedings of IPAC18, Page 55, (2018) - DOI: 10.18429/JACoW-IPAC2018-MOZGBE5.

7. M. Azzolini, M. Angelucci, R. Cimino, R. Larciprete, N. M. Pugno, S. Taioli and M. Dapor, ″Secondary electron emission and yield spectra of metals from Monte Carlo simulations and experiments″, J. Phys. Condens. Matter **31**, 055901 (2018) - DOI: 10.1088/1361-648X/aaf363

8. R. Cimino, ″The 6th electron-cloud workshop, ECLOUD'18″, Beam Dynamics Newsletter, **74**, 192-194 (2018)

6 Other pubblications

1. Web News INFN-LNF: *INTERSTELLAR ICE IN ACCELERATORS*, This study is funded both by INFN and by EuroCirCol, $http://w3.lnf.infn.it/interstellar-ice-accelerators/?lang=en$, 20 September 2018

2. Web News INFN-LNF: *THE COLOURS OF ANCIENT ROME IN A NEW "LIGHT"*, INFN activities within the CHNet (Cultural Heritage Network) network. $http://w3.lnf.infn.it/the-colours-of-ancient-rome-new-light/?lang=en$, 19 December 2018

3. LNF Highlights 2017: *Terahertz and mid-infrared plasmons in three-dimensional nanoporous graphene - Nature Communication* **8**, *14885 (2017)*, 2018