DAΦNE-Light Laboratory and Activity

M. Angelucci (Art. 23), A. Balerna (Resp.), G. Bellisola (Ass.) M. Cestelli Guidi, R. Cimino, G. Della Ventura (Ass.), A. Di Trolio (Ass.), F. Galdenzi (Dott.), A. Grilli (Tecn.), R. Larciprete (Ass.), A. Liedl (Ass. Ric.), A. Novelli (Dott.), M. Pietropaoli (Tecn.), L. Pronti (Ass. Ric.), A. Raco (Tecn.), M. Romani (Ass. Ric.), V. Sciarra (Tecn.), L. Spallino (Ass. Ric.), V. Tullio (Tecn.), G. Viviani (Tecn.).

1 Summary

The scientific activity at the DAΦNE-Light laboratory, in 2020, was performed mainly using conventional sources and DAΦNE synchrotron radiation beam only for alignments, tests and some measurements. Due to the COVID-19 pandemic, after two months shutdown, in March and April 2020, by the middle of May 2020 the operation with users slowly restarted. Due to travel restrictions the Main Proposers of the approved proposals were informed that, when possible, there was the possibility to mail-in their samples. About 34 experimental teams got access, in presence or mailing-in their samples, to the DAΦNE-Light laboratory coming from Italian and European Universities and Research Institutions. After the shutdown, the first user asking for transnational access was hosted in September 2020. Due to the situation and to the remaining number of approved proposals to be satisfied, in 2020, only the second call for proposals (20 October- 20 December 2020) was opened.
In 2020 the new website of the DAFNE-Light laboratory was realised and can be found at the following link: **http://dafne-light.lnf.infn.it/**.
Concerning the beamlines, some alignment operations were performed in January and February, some upgrades were realised on the experimental setup of different beamlines and new instrumentation was installed at the SINBAD-IR beamline.

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 coming from Italian and International Institutions and also to EU and non EU experimental teams through the CALIPSOplus EU project, that will end in 2021.
During the emergency related to the COVID-19 the Users' access were strictly reduced, in most cases the samples were mailed-in and the measurements were carried out by the beamline staff.

The laboratory setup in 2020 was upgraded with the following instrumentation:

1. MCT Photovoltaic Mid-IR detector D 317, range (4800 – 850) cm^{-1}, sensitivity $D^* > 3x10^{10}$ cm $Hz^{1/2}W^{-1}$, LNT cooled.

2. Inverted trinocular microscope for fluorescence including a mechanical stage PL Fluarex 10/20/40x (OX.2253-PLF).

3. Motorization for portable FT-IR ALPHA II by Bruker optics.

4. Realisation of experimental set-up for measurements with the MicrostatN cryostat (Oxford Instrument) for Hyperion 3000 microscope to perform refection and transmission analyses at low temperature (77 K).

Concerning the realisation of the experimental set-up to perform FT-IR analyses in low temperature conditions (77K), a dedicated set-up was designed and implemented to combine the Oxford Microstat-N cryostat with the Hyperion 3000 microscope.

Some new upgrades are listed below:

1. the realisation a the sample holder to optimise the thermal contact between the sample holder and cold finger;
2. implementation of a preparation procedure for thin sections.
3. the optimisation of the sample holder windows (CaF_2) in terms of transmittance and thickness;
4. the creation of a dedicated holder for the nitrogen dewar and the transfer tube.

The set-up of this last upgrade, reported in Fig. 1, is currently used to study the optical properties of geological materials such as opaline, cryptocrystalline silica and films of $PdCoO_2$ deposited on sapphire at low-temperature conditions.

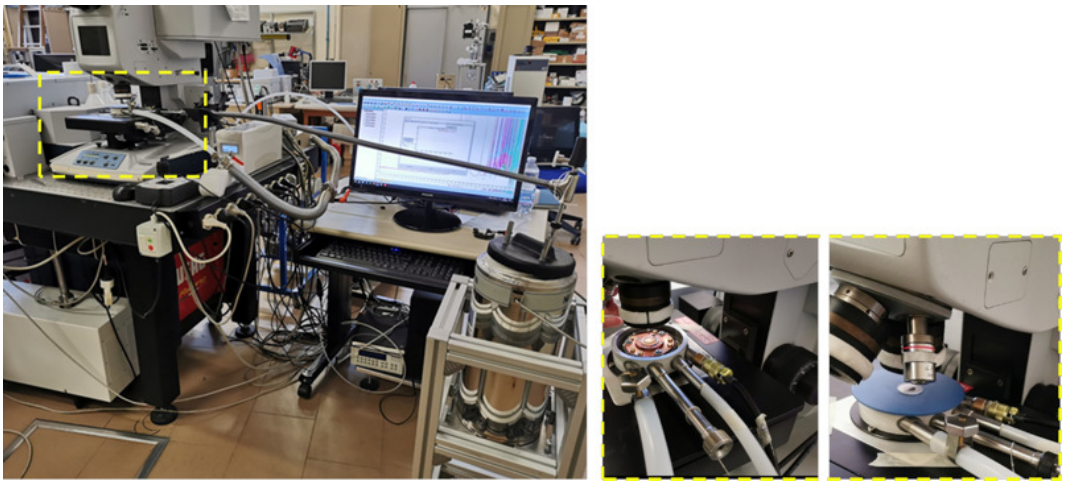

Figure 1: Experimental set-up for measurements combining the MicrostatN cryostat (Oxford Instrument) with the Hyperion 3000 microscope to perform reflection and transmission analyses at low temperatures (77 K).

In 2020 the SINBAD-IR beamline has been involved in the following projects:

1. ***ARTEMISIA, Regione Lazio***

   ARTEMISIA project or **ART**ificial intelligence **E**xtended-**M**ultispectral **I**maging **S**canner for in-s**I**tu **A**rtwork analysis. In collaboration with: Sapienza, Università di Roma Tor Vergata, X-Team software solutions s.r.l., Vianet. Project submitted to the Lazio Region and currently under evaluation.

2. ***TRANINING CAMP, Regione Lazio***

   The Training Camp, *Dalla diagnostica alla fruizione museale: le opere del Museo del Colle del Duomo di Viterbo* will be organised in collaboration with: Università degli Studi della Tuscia, Archeoares s.r.l., C.R. ENEA Frascati, CHNet sezione di Firenze. Project financed by the Lazio Region in the field of DTC Lazio.

3. ***TERA, INFN CSN5***

   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 14 experimental teams submitted their proposals for beamtime at the SINBAD-IR beamline. A selection of some scientific studies carried out in 2020 is summarized here:

1. **RIEBECON** - HT stability and iron oxidation processes in amphiboles and related silicates, B. Mihailova (**CALIPSOplus**)
2. **MYSTERY**- Microgels studied by Infrared Spectroscopy: Thermal properties and Molecular Interplay. F. Ripanti, University La Sapienza, Romae
3. **CulturalFTIR** - Application of FTIR Technique to Cultural Heritage. C. Lemorini, University La Sapienza, Rome
4. **UVEOFTIR** - Infrared analysis of liquid biopsies (aqueous humor and serum) from patients with uveitis. S. Caldrer, IRCCS Sacro Cuore -Don Calabria Ospedale Classificato e Presidio Ospedaliero Accreditato -Regione Veneto, Negrar (Vr).
5. **DIAGHREM**- Identification, characterization, and exploration of diagenesis of ancient human remains in Eastern Mediterranean and the Near East: Analyses of hair, bones, teeth, S. Lemmers, Cyprus Institute (Nicosia, Cyprus) (**CALIPSOplus**)
6. **FAST**-Multi-analytical approach to determine element and spectral variation and distribution in Pteris seedlings exposed to arsenic, G. Bonifazi University of La Sapienza, Rome

The SINBAD-IR beamline in 2020 was also involved in activities for third parties like:

1. Davide Rigaglia, Alpha Restauri, Chiesa di Santa Lucia alle Malve (Matera), FT-IR, Raman and SEM-EDX analyses stratigraphic sections of mural paintings.
2. **Collaboration** - Marco Mangano, collaboration between C.R. ENEA of Frascati and EURESARTE s.r.l., characterisation of painting cross section by FT-IR and SEM-EDX analyses.
3. **Collaboration** - Centro Restauro e Conservazione la Venaria Reale (TO), characterisation of resins using during restoration treatments of a Kandinsky painting by FT-IR analyses.
4. **Collaboration** - Istituto Superiore per la Conservazione e il Restauro (ICR), monitoring the presence of resins during the restoration treatments of two Antonello da Messina's paintings by FT-IR analyses.

Among the different activities, the SINBAD beamline regularly hosts also different students to carry on their Master or PhD thesis:

1. Alessia Damiani, *Spectroscopic analysis on photographic material: Characterisation of photographic material dating back to the last century and development of suitable cleaning methods.* Bachelor Degree (Chemistry), University of Tor Vergata (Rome)

2. Cecilia Taverna, *Applicazione di tecniche spettroscopiche Raman e FT-IR per lo studio di manoscritti miniati conservati nelle biblioteche romane.* Bachelor Degree (Physics), University of Sapienza (Rome)

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

4. Alessandra Conte, *Confined volatiles (H_2O and CO_2) in amorphous silica: implications for terrestrial and extraterrestrial materials.* PhD Thesis, University of Roma Tre (Rome)

5. Stefania Pasquale, *Sintesi e caratterizzazione di materiali nanostruttura per la conservazione di beni culturali.* PhD Thesis, Dip. Fisica e Astronomia "Ettore Majorana", University of Catania.

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 2020, some test to control the beam alignment were performed starting from the end of January. There was the need to move once again the experimental chamber but at the end there was a relevant increase of the photon flux compared to the starting conditions. Some test measurements were performed and one is reported in Fig. 2

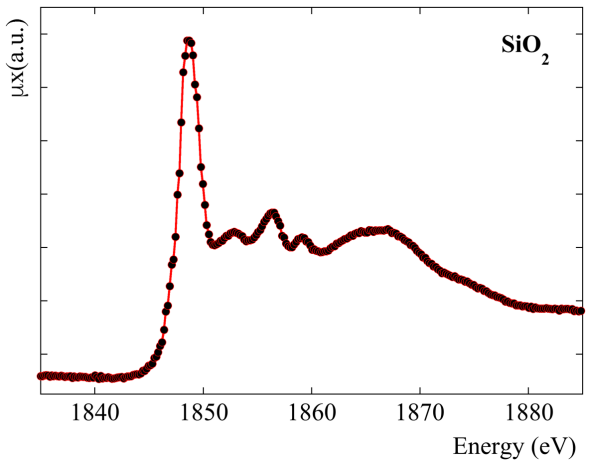

Figure 2: XANES spectrum of crystalline silica measured after alignment tests performed in February 2020.

Using the conventional x-ray source and the ARDESIA detector, some XRF measurements and tests were performed on different samples.
The realisation of the software to connect the monochromator of the DXR1 XAFS beamline to ARDESIA was developed and is waiting to be tested in the near future together with the program to measure XAFS spectra in fluorescence mode.
A new low power X-ray source (Rh Moxtek MAGNUM 40 kV - 4 W)) for a new system for in-situ XRF measurements was purchased and will be tested in 2021.

2.3 DXR2 UV branch Line - *Resp. Marco Angelucci*

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 in real time the evolution of analysed samples, 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 2020, the biggest part of the activity, with about 10 users, was related to the use of the Scanning Electron Microscope (SEM) and of the Energy Dispersive X-ray spectroscopy (EDX) analysis. The SEM and EDX measurements were preformed on different kind of samples like graphene, polymers with impurities and many samples related to cultural heritage studies.
Concerning the use of the DXR2 beamline, in the last Call for proposals in 2020, different experimental proposals have been received and measurements are planned in 2021. To meet the different technical requirements, the beamline has been equipped with new instruments.
The experiments are focused on the measurements of dynamic absorption spectra and on the study of fluorescence emission spectra under UV irradiation. For this reason, the available setup has been implemented with new instruments from Ocean Insight.
Three led sources with discrete wavelengths at 280, 365, 470 nm, a warm white led with color temperature of 3689 K, and an additional UV-VIS spectrometer, operating in the 200-850 nm range, have been purchased.
Moreover, a PTFE based integrating sphere gives the possibility to study intensity and spectral feature, in the UV-VIS range, of divergent beams.
Between the future measurements to be performed there is also a collaboration in the INFN CSN5 LLMCP approved project.
The aim of this projects is to develop a novel MCP-PMT Cherenkov-based detector with ps time resolution, moderate cost and high radiation resistance with potential application of interest for the LHCb and NA62 experiments. The activity at the UV-Vis beamline will concern the study, test and characterisation of different parts (photocathode efficiency and windows transmittance) under VUV (< 200nm) irradiation.
In 2020 the activity was also focused on the upgrade of the existing experimental setups.
The beamline has been equipped with new supports for the alignment of VUV monochromator and experimental chambers (Fig. 3) with the exit port of the beamline.

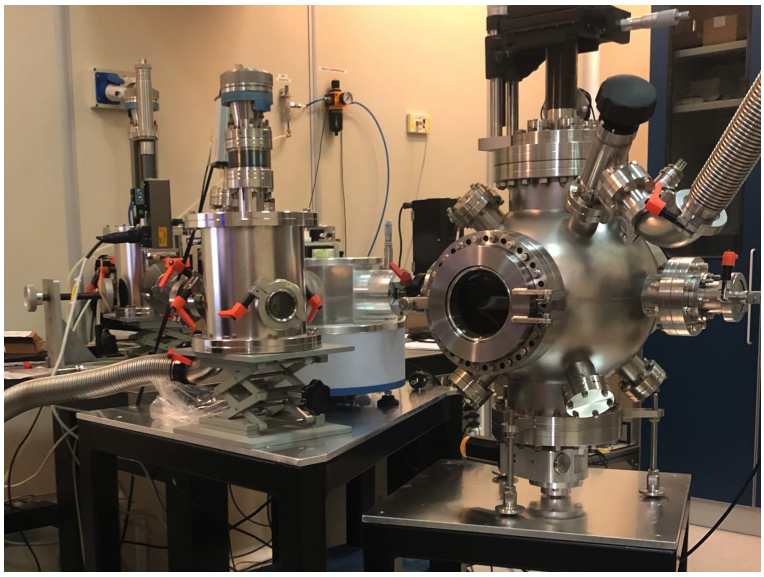

Figure 3: New setup of the DXR2 VUV end station.

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 while the third one will provide non-monochromatized 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 third beamline, *WINDY* (White lIght liNe for Desorption Yields) offers collimated SR for photo-desorption studies. The three beamlines still need some extensive use of SR delivered by DAΦNE to be finally commissioned.
During 2020, for various reasons, DAΦNE did not produce any continuously usable light. Even if SR was not available, a relevant activity was carried out concerning the consolidation all the three beamlines and their experimental stations hosting and promoting some mainstream projects.
These projects are set out below, together with other smaller activities, which have been performed in the spirit of opening some of our resources to external users.

1. ***ARYA***

   The laboratory hosts the CSN5 funded activity ARYA, at its first year. The allocated resources did not allow the requested infrastructure implementations that will be funded in 2021. The approved project allowed to continue the various activities already launched by the previous project MICA. Desorption studies, secondary electron yield (SEY) characterisations, photo yield and reflectivity studies etc. were therefore performed and finalised.
   Despite the unavailability of SR at LNF, studies on the interaction of photons with materials of interest for accelerator physics went on, rendering our group a reference for this important issue.
   The capabilities to perform thermal and electron desorption from surfaces in cryogenic vacuum were refined and studies were focussed on morphologically modified surfaces in cryogenic

vacuum. This kind of materials are of particular interest in many fields, ranging from accelerators applications to astrochemistry.
Cu substrates morphologically modified by laser ablation technique (LASE-Cu), for example, have turned out to be optimal materials to mitigate electron cloud phenomena for future high energy particle accelerators. Due to their very porous structuring (at sub-micrometric length scale), they exhibit, indeed, an impressive low Secondary Electron Yield (SEY$<$ 1), thus being appealing for this kind of application. However, a rigorous evaluation of the consequences on vacuum stability is required, when such porous surfaces are exploited as cryogenic components undergoing to thermal variation, photon and electron irradiation.
Porous or very rough materials are also found as small dust particles in the cold interstellar medium. They host molecular ices which, in turn, interact with photons, electrons and cosmic rays all-around in the space. Their study is fundamental to understand the formation (and abundance) of molecules in the space. Although along decades many laboratory studies have been made on molecular ices analogues, poor attention has been given to the possible role of substrate morphology in intermediating those interactions. Flat substrates are usually considered as reference in laboratory studies.
Even if apparently far away from each other, both aforementioned topics require a qualitative and quantitative knowledge of the gas/substrate interaction in the case of porous materials in cryogenic vacuum conditions.
Our previous studies on thermal desorption of gases from a LASE-Cu substrate have highlighted that the morphological structural features confer to this class of substrates non-negligible effect on the gas-substrate interaction, resulting in a vaster and higher desorption temperature with respect to what observed from a flat substrate.
This means not only that desorption in an unexpected temperature range can occur from porous substrates, but also that cryosorbed gas can be foreseen at a temperature at which no adsorbed gas should be on the surface. This gas can participate to other desorption mechanisms, such as electron desorption.
Quantitative evaluation of the electron desorption yield (η) from porous surfaces is a non-trivial task and, to the best of our knowledge, no Electron Stimulated Desorption (ESD) data exist in literature. η is defined as the number of desorbed molecules per incident electron. First measurements in this sense have been recently made in our laboratory considering Ar (as test gas) condensed on a LASE-Cu sample (considered as a representative porous material). Fig.4 shows some selected results.
The electron desorption yield (η) has been obtained comparing the electron desorption from different doses of gas on a flat Cu surface and on a LASE-Cu sample.
Electron irradiation has been done at 500 eV, on increasing the electron dose deposited on the sample. Differences in the trends can be likely attributed to the morphological features and to the different attitude of surfaces to allocate atoms.
These results imply the development of a method to obtain η from porous materials. This can be powerful to predict the relative amount of gas finally delivered from a porous surface under electron irradiation, whether it is exploited as cryogenic component in accelerators or it is a small dust particle in the cold interstellar medium. These results are important for real gases like the ones composing accelerator's vacuum and the ones forming the molecular ices on interstellar medium.
The effects of electrons in modifying the chemistry of such ices have also to be studied and this is part of our laboratory activity, carried out by A. Novelli for his PhD thesis work dealing with the effects of electrons on C-related molecular ices condensed on surfaces in use for accelerators. All these aspects have been presented in various conferences and will be argument of a forthcoming publications. The research, started in 2019, to establish the minimum

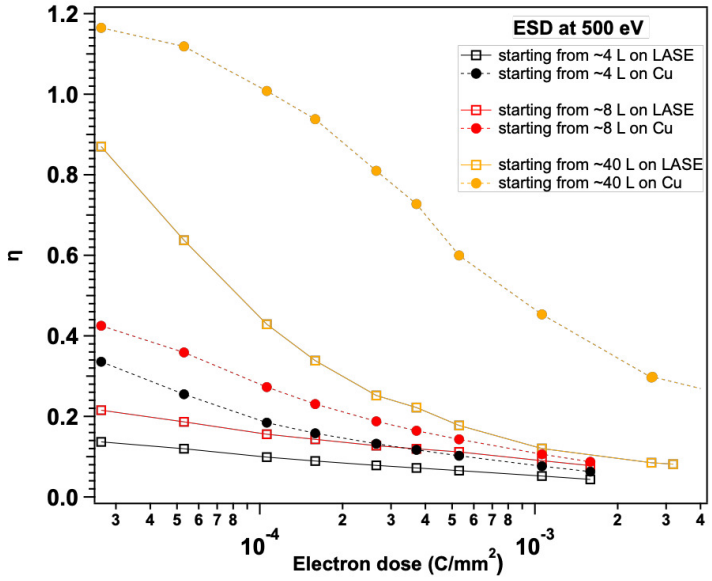

Figure 4: Electron desorption yield (η) from different Ar doses condensed at 10 K on a flat Cu and on a LASE-Cu sample. ηhas been obtained quantifying the number of atoms desorbed from the surface by Residual Gas Analysis on increasing the electron dose deposited on the sample at 500 eV.

thickness of an Amorphous Carbon Coating on Copper to obtain the full reduction of the Secondary Electron Yield was finalized. Amorphous carbon (a-C) is a well-known coating apt to reduce SEY to values as low as below 1.1. Such low SEY is compliant to most of the demanding requirements for e-cloud mitigation. Unfortunately, a-C is known to have a quite high resistivity and a thick coating is known to affect machine impedance to unacceptable levels. It was possible to provide a reasonable estimate of the minimum amount of a-C that should be deposited on a polycrystalline copper sample to reduce the secondary electron yield to avoid any electron cloud phenomena in accelerators. This work has been presented in various international workshops and published in international journals as reported in the Publication list.

2. ***CERN-LNF MoU: WINDY***

   In 2017, a Memorandum of Understanding (MoU) between CERN and INFN-LNF has been signed. The general purpose of the MoU is the extract quantitative information about the reflectivity, photo-yield and photo induced desorption on small samples 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 optimisation of the existing particle accelerator, like LHC and its upgrade (HL-LHC and HE-LHC), and in the realisation of the Future Circular Collider (FCC). A new beamline WINDY (White lIght liNe for Desorption Yields) is ready to take data once SR will become available.

3. ***Collaboration with BNL***

   Based on a service contract, a collaborative study has been carried out with the Brookhaven National Laboratory (BNL) to address material properties of interest for the construction

of the Electron Ion Collider (EIC). Measurements on Secondary Electron Yield (SEY) of Cu substrates with different C coating have been performed, both at room and cryogenic temperatures. The effects of long exposure to cryogenic vacuum have been investigated, together with the effects induced on SEY by electron irradiation (scrubbing) on varying the C thickness of coatings. This effort has been developed further to become a working package on beam physics for the EIC-INFN collaboration that will be considered and eventually institutionalised in the coming years.

4. ***Collaboration with Thales Alenia Space***

   Secondary Electron Yield (SEY) investigations have been performed for Thales Alenia Space on the basis of a service contract. Different substrates of interest for the company have been measured both at room and cryogenic temperatures. The effects of exposure to cryogenic vacuum have been investigated, together with the effects induced on SEY by mild thermal treatments (130 -150)°C of sample in vacuum (10^{-7} mbar). Modifications on secondary emission properties of surfaces have been highlighted.

5. ***Collaboration with CEA***

   During the year a collaborative effort started with CEA (Commissariat à l'énergie atomique et aux énergies alternatives, Paris) to address surface properties of thin films oxide coatings on Niobium samples. The purpose is focused mainly on new materials/hetero-structures for particle accelerators, tuning the SEY and improving the surface superconductivity for radio-frequency cavities and couplers. A first SEY investigation campaign has been conducted on some samples (Nb/Al_2O_3) at room temperature.

6. ***Collaboration with CNR and C.H.OS.E. laboratory in Rome***

   This collaboration is related to the characterisation of MXenes doped perovskite for application in solar cell devices.
   In 2020 the beneficial role of MXene doping for both perovskite absorber and electron transporting layer in NiO-based inverted perovskite solar cells were studied. The addition of MXenes permits on one side to easy tune the energy level alignment at perovskite/charge transporting layer interfaces, and on the other side to passivate trap states within the cell structure, which in turn improves charge extraction and collection at the electrodes. The MXene-based engineered cells showed superior performance, with power conversion efficiency exceeding 19% and improved stabilised power output with respect to reference devices. Due to the possibility to finely tune the MXene work function during their chemical synthesis and to their capability in modifying the optoelectronic properties of PSC layers when used as dopant, the proposed approach opens countless ways for engineering inverted PSC structure, strongly promising in term of long-term stability and future scalability on large area devices. The results will be published on Nano Energy in 2021.

7. ***Collaboration with the "Institute of Complex Systems – CNR"***

   In this collaboration the investigation started in 2019 on nanostructured catalysts based on graphene/Ni interfaces for hydrogen production and storage goes on. The most diffused methods for hydrogen storage are based on the use of transition metal alloys. The high metal density renders this approach quite inefficient in terms of stored energy per weight unit. The use of suitable nanomaterials with large specific surface may solve this issue. Graphene covered Ni polycrystalline substrates and Ni foams are becoming attracting and have been studied in our laboratory. Such work has some relevance also to satellites and particle accelerators when the potential reduction in the emission of secondary electrons

(SEY) is considered. The presence of an ultra-thin graphitic-like carbon coating deposited on the metal surface is in fact known [3] to reduce the yield of the emitted secondary electrons.

8. ***Collaboration with the "Einstein Telescope -ET- International collaboration"***

   In the last part of the year the involvement in the ET international collaboration started since its design study presents a series of complex challenges. The very demanding and large dimension vacuum system, together with the need to cool down the 200 kg suspended mirrors at cryogenic temperatures to reduce thermal noise, represents exceptional challenges where a material and surface science laboratory and a longstanding vacuum and cryogenic experience could surely be relevant. As a first step an innovative method to neutralise the electrostatic charge developing on mirror surfaces and potentially affecting its stability was proposed. Afterwards the open problem of cryosorbed gasses that will unavoidably deposit on the cold mirror's surfaces seriously affecting their optical properties was approached. This work has been presented to the 11th Einstein Telescope Symposium and will be published in the coming year. Those preliminary results envisaged a more active role that our laboratory could play in the newly born ET Instrument Science Board (ISB), and Roberto Cimino has been appointed as co-chair (with Christian Day from KIT, DE) of the Work Package IV.3 (Cryostats and Cryopumps) of this board aiming to write a conceptual Design Report of the entire infrastructure.

The Laboratory is also routinely hosting students to perform their thesis or PhDs but also Summer Students getting a direct experience with some *state of the art* experimental activities:

1. Armando Novelli - *Studies on carbon coating deposition methods and surface treatments for electron cloud mitigation inside particle accelerators* - University La Sapienza, Rome, PhD Thesis in Accelerator Physics (November 2019 - November 2022).

2. Gabriele Costella - *Optimization of the experimental setup needed to measure desorption yields* - INFN Summer Student - University La Sapienza, Rome (October-November 2020).

3 Acknowledgments

Acknowledgements are due to the INFN-LNF Synchrotron Light Service for providing a great technical service and in particular thanks are due to Vinicio Tullio for his precious activity carried out until the end of March 2020 when he retired.

4 List of Talks and Posters

1. M. Romani, G. Capobianco, L. Pronti, F. Colao, C. Seccaroni, A. Puiu, A.C. Felici, G. Verona-Rinati, M. Cestelli-Guidi, A. Tognacci, M. Vendittelli, M. Mangano, A. Acconci, G. Bonifazi, S. Serranti, M. Marinelli, R.Fantoni, , *Il restauro della Basilica di S. Nicola in Carcere a Roma: Approccio multi-analitico per la caratterizzazione dell'affresco absidale del pittore Vincenzo Pasqualoni*, Italian Physical Society (SIF), 106th National Congress, Online, 14-18th September 2020

2. L. Pronti, M. Romani, G. Viviani, C. Stani, P. Gioia, M. Cestelli Guidi, *Spettroscopia infrarossa FT-IR in riflessione (con luce di sincrotrone e portatile) per studi archeometrici di frammenti pittorici di epoca romana. Il caso dei frammenti rivenuti nella Villa della Piscina (Parco di Centocelle, Roma)*, Italian Physical Society (SIF), 106th National Congress, Online, 14-18th September 2020

3. M. Romani, F. Colao, R. Fantoni, *Assessment of Time Gated-LIF for the characterisation of frescoes and painted artworks: the cases study of the ADAMO project.*, Italian Conference of Optics and Photonics, September 8-10 2020 (Invited)

4. G. Della Ventura, N. Camilla, C. Alessandra, L. Federico, L., G. Federico, G., & R. Benjamin, *Opaline and cryptocrystalline silica from the Tolfa volcanic region (Latium, Italy).*, EGU General Assembly Conference 2020, 4-8 May 2020

5. P. Zajdel, M. Fijałkowski, A. Ślebarski, A. Balerna, M. Cestelli-Guidi, M. Romani, *Insight into precursor effects in selected superconducting stannides.* Joint Meeting of Polish Synchrotron Radiation Society and SOLARIS Users, Online, 9 -11 September 2020

6. A. Balerna, *The DAFNE-Light facility.* 28th European Synchrotron Light Source Workshop, ESRF, Online Talk, 16 -17 December 2020

7. L. Spallino, M. Angelucci, and R. Cimino, *Effects of substrate porosity on the desorption characteristics of ices condensed on dust grains*, Poster presentation at PCMI 2020, Le Havre (France), 6 - 10 July 2020

8. Roberto Cimino, *E-cloud/SEY studies and electron induced desorption from cryogenic surfaces*, EIC Workshop: "Promoting Collaboration on the Electron-Ion Collider", 7- 9 October 2020.

9. Luisa Spallino, Marco Angelucci, Andrea Chincarini, Riccardo Musenich and Roberto Cimino, *Synergies between dynamic vacuum issues in accelerators and GW instrumentations*, 11th ET symposium - rescheduled from the 30th of November to the 3rd of December 2020.

10. Gaetana Petrone, Francesca Zarotti, Marco Angelucci, Roberto Felici, Andrea Liscio, Roberto Cimino and Rosanna Larciprete, *Secondary electron yield of graphene coated metallic surfaces*, 5th European Workshop on Epitaxial Graphene and 2D Materials (EWEG2D'20), May 26 - 30, 2020.

11. R. Cimino, *Strategies for electron cloud mitigation at future accelerators*, ARIES-APEC virtual workshop "Mitigation Approaches for Hadron Storage Rings and Synchrotrons" 22 June - 1 July 2020

12. R. Cimino, *LNF Vacuum activities*, LAL, Paris 4 February 2020.

5 Lectures and outreach

1. A. Balerna, *Archeologia o fisica questo fu il dilemma!* Internazional Day of Women and Girls in Science 2020, INFN-LNF, February 11th, 2020

2. A. Balerna, *DAFNE-Luce*, Lavori in corso @LNF - Seminari online per il personale Tecnico-Amministrativo, INFN-LNF, Online May 7th, 2020

3. L. Pronti and M. Romani *Tecniche di diagnostica per i beni culturali: applicazioni della spettroscopia infrarossa allo studio della sezione stratigrafica di un'opera d'arte*, Stage Estivi di Fisica @UniFE - 15-19 June 2020

4. M. Romani and L. Pronti, *CHNet Fisica per i Beni Culturali*, Summer School 2020 INFN-Laboratori Nazionali di Frascati - 15-19 June 2020

6 Publications

1. M. Romani, L. Pronti, M. Sbroscia, F. Petrucci, O. Tarquini, G. Verona-Rinati, M.A. Ricci, A. Sodo, M. Colapietro, M. Marinelli, A. Pifferi, M. Cestelli-Guidi, ″St. Joseph with the Child" by Gian Lorenzo Bernini: a definitive artwork or just a preparatory drawing? A multidisciplinary study of the only autograph painting of the Artist, preserved at Palazzo Chigi of Ariccia (Rome)″, J. Cultural Heritage **46**, 283-288, 2020, DOI: 10.1016/j.culher.2020.08.003

2. L. Pronti, M. Romani, O. Tarquini, G. Verona-Rinati, F. Petrucci, M. Colapietro, A. Pifferi, M. Marinelli and M. Cestelli Guidi, ″Portrait of Mario Nuzzi": a preliminary analytical study of Mario Nuzzis pictorial production and of his artistic collaborations″. Eur. Phys. J. Plus **135**, 616 (2020), DOI: 10.1140/epjp/s13360-020-00607-1

3. A. Ciccola, M. Tozzi, M. Romani, I. Serafini, F. Ripanti, R. Curini, F. Vitucci, M. Cestelli Guidi, P. Postorino, ″Lucio Fontana and the light: spectroscopic analysis of the Artist's collection at the National Gallery of Modern and Contemporary Art″, Spectrochim. Acta A, **236**, 118319 (2020), DOI: 10.1016/j.saa.2020.118319

4. M. Romani, L. Pronti, F. Colao, C. Seccaroni, A. Puiu, A. C. Felici, G. Verona Rinati, M. Cestelli-Guidi, A. Tognacci, M. Vendittelli, M. Mangano, A. Acconci, G. Bonifazi, S. Serranti, M. Marinelli, R. Fantoni, ″Analytical chemistry approach in cultural heritage: the case of Vincenzo Pasqualoni's wall paintings in S. Nicola in Carcere (Rome) ″, Microchemical Journal **156**, 104920 (2020), DOI: 10.1016/j.microc.2020.104920

5. S. Cavalu, L. Fritea, M. Brocks, K. Barbaro, G. Murvai, T. O. Costea, I. Antoniac, C. Verona, M. Romani, A. Latini, R. Zilli and J. V. Rau,″Novel Hybrid Composites Based on PVA/$SeTiO_2$ Nanoparticles and Natural Hydroxyapatite for Orthopedic Applications: Correlations between Structural, Morphological and Biocompatibility Properties″, Materials **13**, 2077(2020), DOI: 10.3390/ma13092077

6. L. Pronti, M. Romani, G. Viviani, C. Stani, P. Gioia, M. Cestelli Guidi, ″Advanced methods for the analysis of Roman wall paintings. Elemental and molecular detection by means of synchrotron FT-IR and SEM micro-imaging spectroscopy″, Rendiconti Lincei. Scienze Fisiche e Naturali **31**, 485–493 (2020), https://doi.org/10.1007/s12210-020-00888-9

7. L. Ruggiero, A. Sodo, M. Cestelli Guidi, M. Romani, A. Sarra, P. Postorino, M. A. Ricci, ″Raman and ATR FT-IR Investigations of innovative silica nanocontainers loaded with a biocide for stone conservation treatements″. Microchemical Journal **155**, 104766 (2020), DOI: 10.1016/j.microc.2020.104766

8. M. Sbroscia, M. Cestelli-Guidi, F. Colao, S. Falzone, C. Gioia, P. Gioia, C. Marconi, D. Mirabile Gattia, E.M. Loreti, M. Marinelli, M. Missori, F. Persia, L. Pronti, M. Romani, A. Sodo, G. Verona-Rinati, M.A. Ricci, R. Fantoni, ″Multi-analytical non-destructive investigation of pictorial apparatuses of "Villa della Piscina" in Rome″. Microchemical Journal **153**, 104450 (2020), DOI: 10.1016/j.microc.2019.104450

9. S.J. Rezvani , D. Di Gioacchino, C. Gatti , C. Ligi , M. Cestelli Guidi , S. Cibella , M. Fretto , N. Poccia , S. Lupi and A. Marcelli. ″Proximity array device: a novel photon detector working in long wavelengths″. Condensed Matter **5**, 33 (2020), DOI: 10.3390/condmat5020033

10. S. J. Rezvani, D. Di Gioacchino, S. Tofani, A. D'Arco, C. Ligi, S. Lupi, C. Gatti, M. Cestelli Guidi and A. Marcelli. ″A cryogenic magneto-optical device for long wavelength radiation″. Rev. Sci. Instrum. **91**, 075103 (2020), https://doi.org/10.1063/5.0011348

11. A. D. Surowka, G. Birarda, M. Szczerbowska-Boruchowska, M. Cestelli Guidi, A. Ziomber-Lisiak, L. Vaccari, ″Model-based correction algorithm for Fourier Transform infrared microscopy measurements of complex tissue-substrate systems″, Analytica Chimica Acta **1103**, 143-155 (2020), https://doi.org/10.1016/j.aca.2019.12.070

12. M. S. Rider, M. Sokolikova, S. M. Hanham, M. Navarro-Cía, P. D. Haynes, D. K. K. Lee, M. Daniele, M. Cestelli Guidi, C. Mattevi, S. Lupi, V. Giannini, ″Experimental signature of a topological quantum dot″, Nanoscale **12**,22817–22825 (2020), https://doi.org/10.1039/D0NR06523D

13. C. Paluszkiewicz, N. Piergies, M. Cestelli Guidi, E. Pięta, W. Ścierski, M. Misiołek, B. Drozdzowska, P. Ziora, G. Lisowska, W.M. Kwiatek,″Nanoscale infrared probing of amyloid formation within the pleomorphic adenoma tissue″, Biochimica et Biophysica Acta - General Subjects **1864**, 129677 (2020), DOI: 10.1016/j.bbagen.2020.129677

14. F. Radica, S. Mura, D. Carboni, L. Malfatti, S. Garroni, G. Tranfo, G. Della Ventura, A. Marcelli, P. Innocenzi, ″Phenyl modified hybrid organic-inorganic porous films as high efficient platforms for styrene sensing″. Microporous and Mesoporous Materials **294**, 109877 (2020), https://doi.org/10.1016/j.micromeso.2019.109877

15. E. Sokolova, F. C. Hawthorne, F. Camara, G. Della Ventura, Y. A. Uvarova, ″From structural topology to chemical composition. XXVI. Revision of the crystal chemistry of the perraultite-type minerals of the seidozerite supergroup: jinshajiangite, bobshannonite and surkhobite″. The Canadian Mineralogist **58**, 19-43 (2020), https://doi.org/10.3749/canmin.1900070

16. D. Piazzolla, V. Cafaro, G. A. De Lucia, E. Mancini, S. Scanu, S. Bonamano, V. Piermattei, A. Vianello, G. Della Ventura, M. Marcelli, M., ″Microlitter pollution in coastal sediments of the norther Tyrrenian Sea, Italy: microplastics and fly-ash occurrence and distribution″ . Estuarine, Coastal and Shelf Science **241**, 106819 (2020), https://doi.org/10.1016/j.ecss.2020.106819

17. G. Ventruti, G. Della Ventura, M. A. Gomez, G. Capitani, M. Sbroscia, A. Sodo, ″High-temperature study of basic ferric sulfate, $FeOHSO_4$″. Phys. Chem. Minerals **47**, 43 (2020), DOI: 10.1007/s00269-020-01113-7

18. F. Villa, A. Balerna, E. Chiadroni, A. Cianchi, M. Coreno, S. A. Dabagov, A. Di Cicco, R. Gunnella, A. Marcelli, C. Masciovecchio, *Photon beam line of the water window FEL for the EuPRAXIA@SPARC_LAB project*, J. Phys.: Conf. Ser. **1596** 012039 (2020), doi.org/10.1088/1742-6596/1596/1/012039

19. E. La Francesca, M. Angelucci, A. Liedl, L. Spallino, L. A. Gonzalez, I. Bellafont, F. Siewert, M.G. Sertsu, A. Sokolov, F. Schäfers, and R. Cimino, ″Reflectivity and Photoelectron Yield from Copper in Accelerators″, Phys. Rev. Accel. Beams **23**, 083101 (2020), https://doi.org/10.1103/PhysRevAccelBeams.23.083101

20. M. Angelucci, A. Novelli, L. Spallino, A. Liedl, R. Larciprete, and R. Cimino, ″Minimum thickness of Carbon Coating for Multipacting suppression″, Phys. Rev. Research Rapid. Comm **2**, 032030(R) (2020) https://doi.org/10.1103/PhysRevResearch.2.032030

21. A. Novelli, R. Larciprete, M. Angelucci, A. Liedl, L. Spallino, and R. Cimino, ″Surface effects for electron cloud″, in Proceeding of IFCA mini workshop on "Mitigation of Coherent Beam Instabilities in particle accelerators" MCBI 2019 - CERN Yellow Reports: Conference Proceedings, **CERN-2020-009**, 186 (2020).

22. L. Spallino, M. Angelucci, and R. Cimino, ″Thermal desorption of cryopumped gases from laser treated copper″, Phys. Rev. Accel. Beams **23**, 063201 (2020), https://doi.org/10.1103/PhysRevAccelBeams.23.063201

23. L. Spallino, ″Material properties compliance with cryogenic vacuum for particle accelerators″, J. Vac. Sci. Technol. B **38**, 032803 (2020), https://doi.org/10.1116/1.5144664

24. R. Cimino, ″Interaction Between Beams and Vacuum System Walls″, Proceedings of the 2017 Course on vacuum for particle accelerators. Glumslov, Sweden, 6–16 June 2017. CERN Yellow Reports: Conference Proceedings, **CERN-2020-009**, 241-260 (2020).

25. R. Dupuy, G. Féraud, M. Bertin, C. Romanzin, L. Philippe, T. Putaud, X. Michaut, R. Cimino, V. Baglin and J. -H. Fillion,″Desorption of neutrals, cations, and anions from core-excited amorphous solid water″, J. Chem. Phys. **152**, 054711 (2020).

26. R. Cimino, M. Angelucci, L.A. Gonzalez, R. Larciprete, ″SEY and low-energy SEY of conductive surfaces″, J. Electron Spectros. Relat. Phenomena **241**, 146876 (2020), https://doi.org/10.1016/j.elspec.2019.06.008.

27. L. A. Gonzales, M. Angelucci, R. Cimino, R. Larciprete, ″SEY from noble metals″, Proceedings of the Joint INFN-CERN-ARIES Workshop on Electron-Cloud Effects (ECLOUD18), 3-7 June 2018 - CERN Yellow Reports: Conference Proceedings, **CERN-2020-007**, 115-118 (2020), https://doi.org/10.23732/CYRCP-2020-007

28. L. A. Gonzales, M. Angelucci, R. Cimino, R. Larciprete,″The effect of the structural properties on the SEY of C materials″, Proceedings of the Joint INFN-CERN-ARIES Workshop on Electron-Cloud Effects (ECLOUD18), 3-7 June 2018 - CERN Yellow Reports: Conference Proceedings, **CERN-2020-007**, 119-123 (2020), https://doi.org/10.23732/CYRCP-2020-007

29. L. Spallino, M. Angelucci, R. Larciprete and R. Cimino, ″SEY and other material properties studies at cryogenic temperatures″, Proceedings of the Joint INFN-CERN-ARIES Workshop on Electron-Cloud Effects (ECLOUD18), 3-7 June 2018 - CERN Yellow Reports: Conference Proceedings, **CERN-2020-007**, 153-158 (2020), https://doi.org/10.23732/CYRCP-2020-007

30. A. Liedl, M. Angelucci, E. La Francesca, F. Schäfers; M.G. Sertsu, F. Siewert, A. Sokolov, R. Cimino,″ Photo reflectivity and photo electron yield from technical surfaces″, Proceedings of the Joint INFN-CERN-ARIES Workshop on Electron-Cloud Effects (ECLOUD18), 3-7 June 2018 - CERN Yellow Reports: Conference Proceedings, **CERN-2020-007**, 125-130 (2020), https://doi.org/10.23732/CYRCP-2020-007

31. R. Dupuy, M. Bertin, G. Féraud, X. Michaut, T. Putaud, L. Philippe, P. Jeseck, R. Cimino, V. Baglin, Romanzin et al., ″Synchrotron radiation interaction with cryosorbed layers for astrochemical investigations″, Proceedings of the Joint INFN-CERN-ARIES Workshop on Electron-Cloud Effects (ECLOUD18), 3-7 June 2018 - CERN Yellow Reports: Conference Proceedings, **CERN-2020-007**, 147-152 (2020), https://doi.org/10.23732/CYRCP-2020-007

32. R. Cimino, F. Zimmermann, ″ECLOUD'18 summary and outlook″, Proceedings of the Joint INFN-CERN-ARIES Workshop on Electron-Cloud Effects (ECLOUD18), 3-7 June 2018 - CERN Yellow Reports: Conference Proceedings, **CERN-2020-007**, 229-236 (2020), https://doi.org/10.23732/CYRCP-2020-007

33. L. Spallino, M. Angelucci, and R. Cimino, ″Thermal desorption of cryopumped gases from laser treated Copper″, Phys. Rev. Accel. Beams **23**, 063201 (2020).

7 Other pubblications

1. LNF Highlights 2019: *The new beamline WINDY@DAΦNE-L*, 14 (2020)