DAΦNE-Light INFN-LNF synchrotron radiation facility

Antonella Balerna

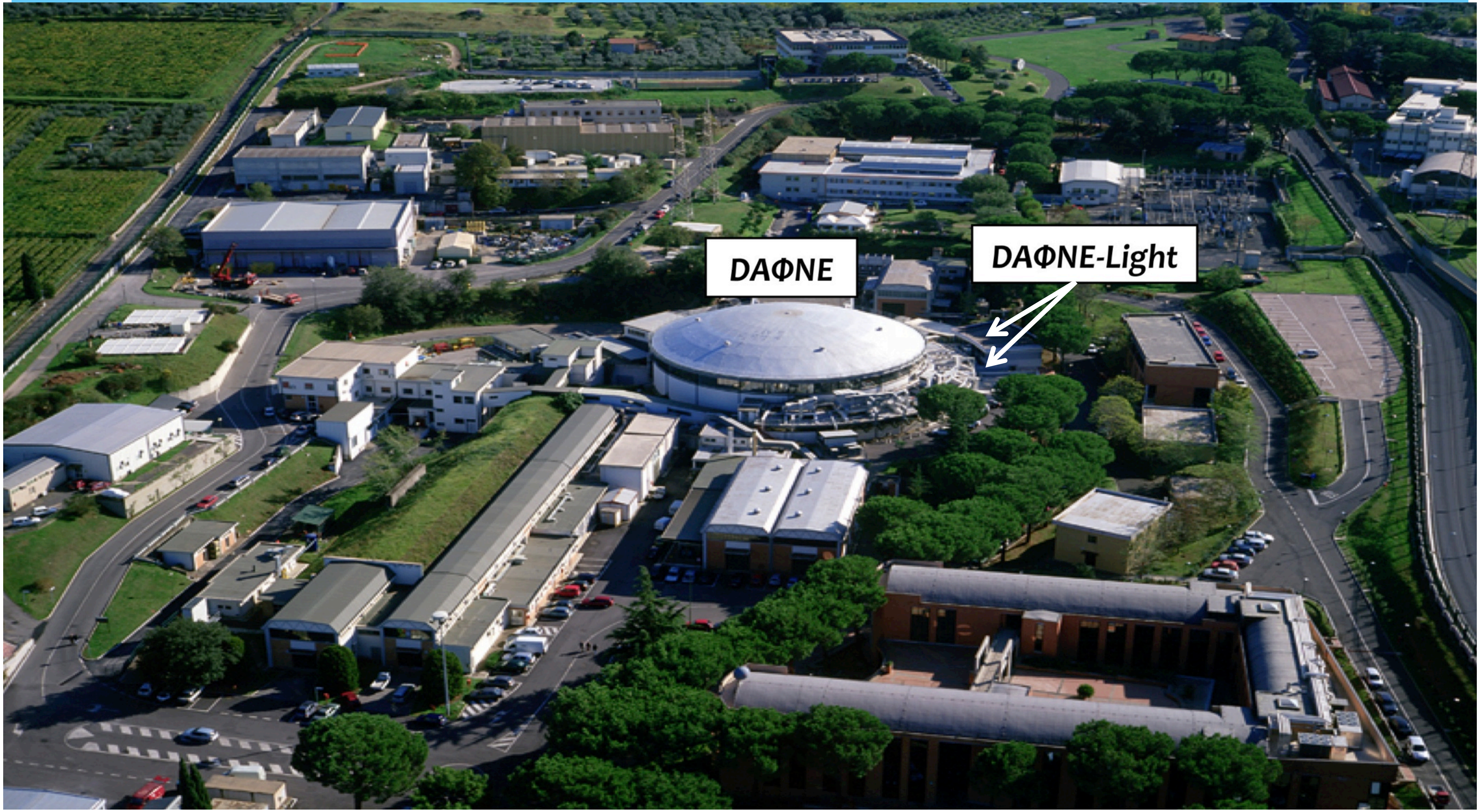
on behalf of the DAΦNE-Light Facility

DAΦNE-Light Synchrotron Radiation Facility

INFN – Frascati National Laboratory

52nd LNF Scientific Committee Meeting – November 21st, 2016

DAΦNE-Light
INFN-LNF Synchrotron Radiation Facility



Beamlines @ DAΦNE

Building 12

1) ***SINBAD** - **IR beamline (1.24 meV - 1.24 eV)***

2) ***DXR1- Soft x-ray beamline (900-3000 eV)***

3) ***DXR2 – UV-VIS beamline (2-10 eV)***

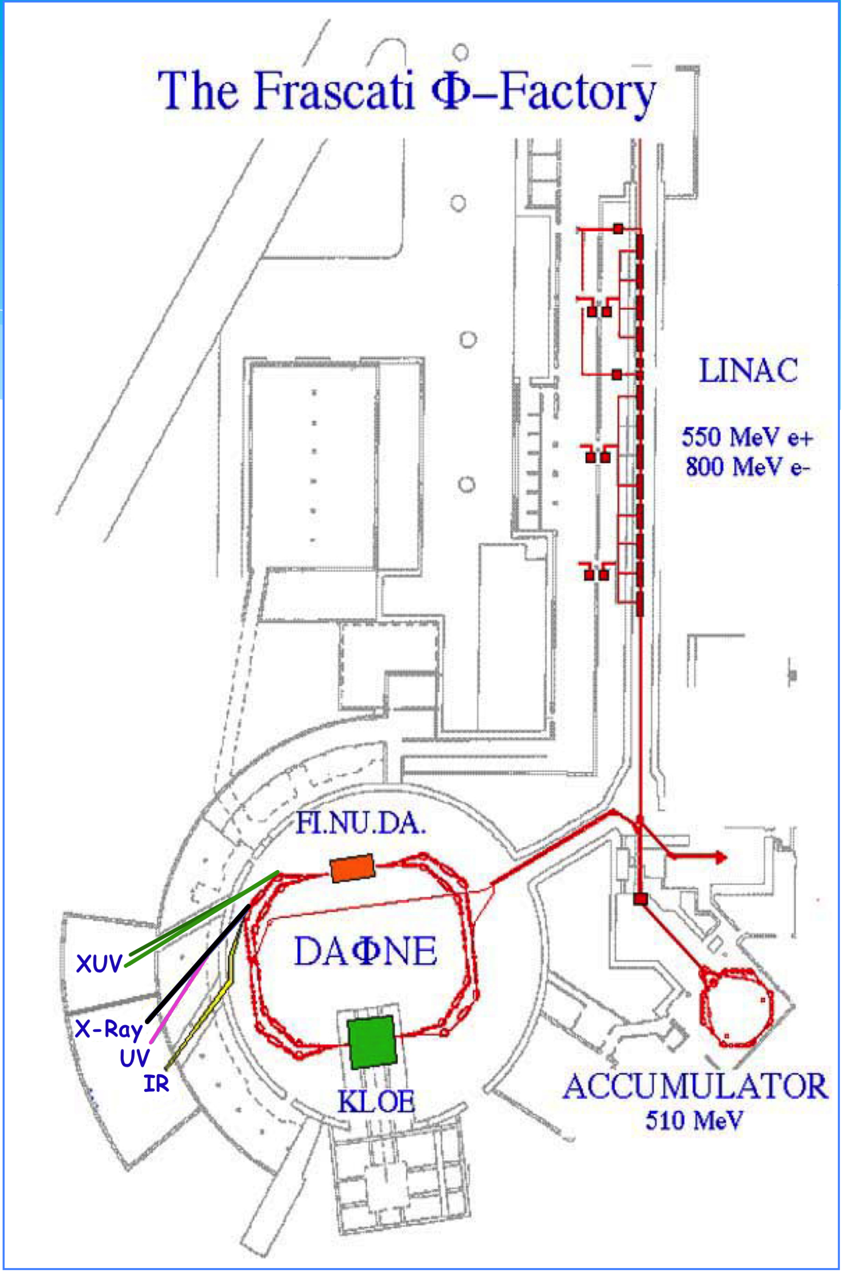
Building 13

XUV beamlines UNDER COMMISSIONING

from September 2016

4) ***XUV1 - Low Energy Beamline** (30-200 eV)*

5) ***XUV2 - High Energy Beamline** (60-1000 eV)*



DAΦNE-Light

INFN-LNF synchrotron radiation facility

The DAΦNE accelerator complex is the largest scientific asset of the Frascati National Laboratory. ***DAΦNE-Light is a Synchrotron Light facility where MATERIAL SCIENCE STUDIES can be performed*** but also ***a laboratory where new DETECTORS and OPTICS in a wide energy range moving from IR to soft X-rays can be tested using Synchrotron Radiation but also Conventional Sources.***

Available techniques

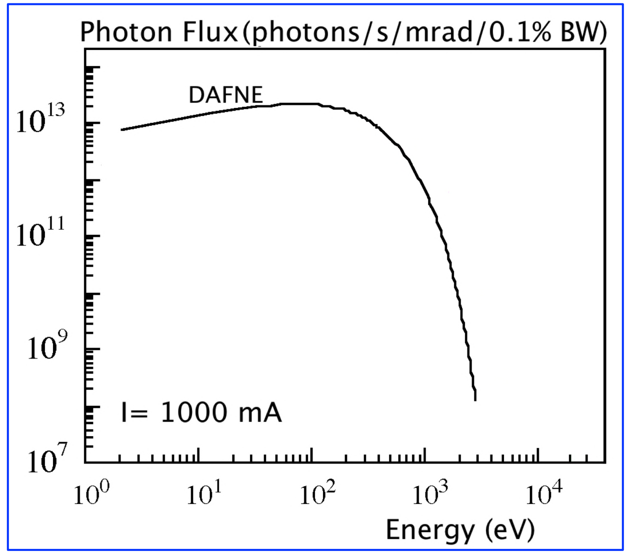
- FTIR spectroscopy, IR microscopy and IR imaging

- UV-Vis absorption spectroscopy

- Photochemistry: UV irradiation and FTIR micro-spectroscopy and imaging.

- Soft x-ray spectroscopy: XANES (X-ray Absorption Near Edge Structure) light elements from Na to Cl

- SEY (secondary electron yield) and XPS (X-ray photoelectron spectroscopy) – by electron and photon bombardment



In **2015** about ***50 experimental teams*** got access to the **DAFNE-Light Laboratory** coming from **Italian Universities and Research Institutions, and also from EU Countries.**

DAΦNE-Light

Principle Beamline Scientists

SINBAD - Infrared beamline – *Mariangela Cestelli-Guidi*

DXR2 - UV beamline - *Emanuele Pace (INFN - Univ. Fi)*

DXR1 - Soft X-ray beamline - *Antonella Balerna*

DXUV- XUV beamlines - *Roberto Cimino*

Technical Staff

Antonio Grilli, *Agostino Raco*, *Marco Pietropaoli*, *Vittorio Sciarra*, *Vinicio Tullio* and *Giacomo Viviani*

DAΦNE-Light and EU projects

EU CAPLIPSO program (2014-2015)

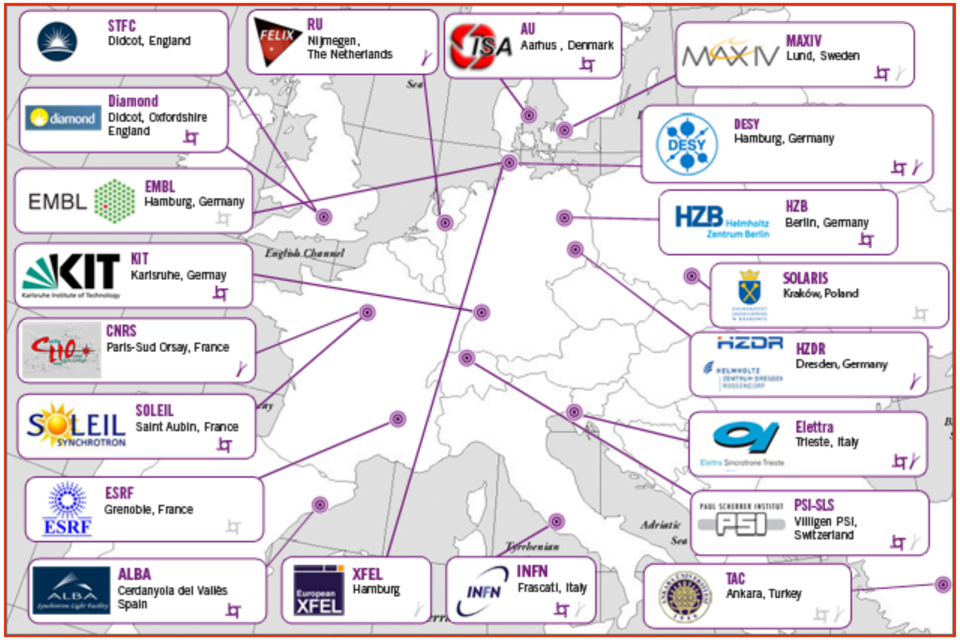
*Beamtime given **EU T**ransnational **A**ccess to **R**esearch **I**nfrastructures **FP7 program C.A.Li.P.S.O.***

First beamtime related to the ***EU project C.A.Li.P.S.O.*** (**C**oordinated **A**ccess to **Li**ghtsources to **P**romote **S**tandard**s** and **O**ptimization) ***for transnational access*** given in **2014** and ended in ***2015***

7 EU proposals achieved

15 EU supported Users

702 hours beamtime given / 600 promised hours



DAFNE-Light and EU Projects

In **2016** we participated to the **submission of 2 EU projects**:

- **CALIPSOplus** (**Transnational Access of EU Users**)

- **OPEN SESAME** (**Training** of people involved in the **SESAME light source in Jordan – Acc. Division** and **Organization of a IR school** for Middle East users – **DAFNE-Light IR**)

both EU projects will be financed from 2017 (info September 2016).

From ***June 2015*** the ***Synchrotron Radiation Service*** has been involved in the ***WP 4 of the EU project EuroCirCol*** (**R. Cimino**) focused on **issues related to: Cryogenic vacuum systems and their stability upon photon, electron and/or ion irradiation.**

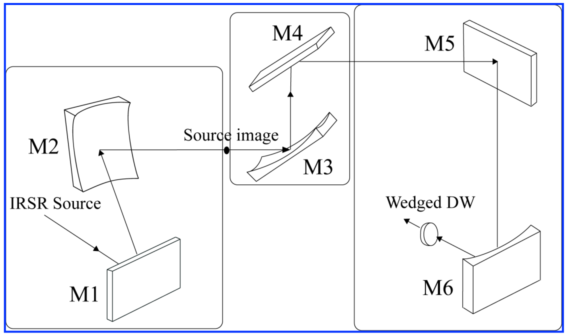
Activities at the different beamlines

SINBAD IR Beamline

SINBAD IR Beamline

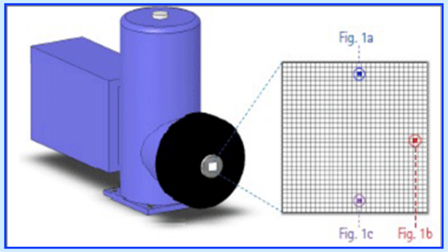
Resp. Mariangela Cestelli Guidi

Infrared range from 10 to 10000 cm^{-1}
(1.24 meV to 1.24 eV)

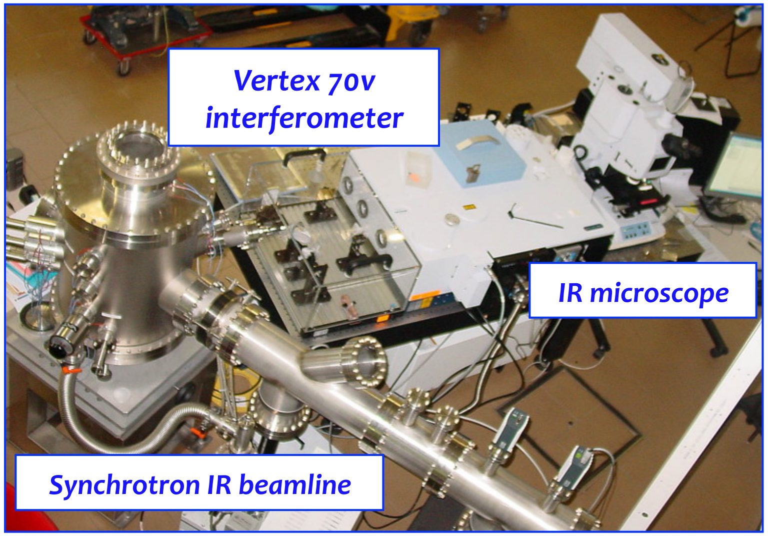


Some Applications

Material Science
Biology
Cultural heritage
Geophysics



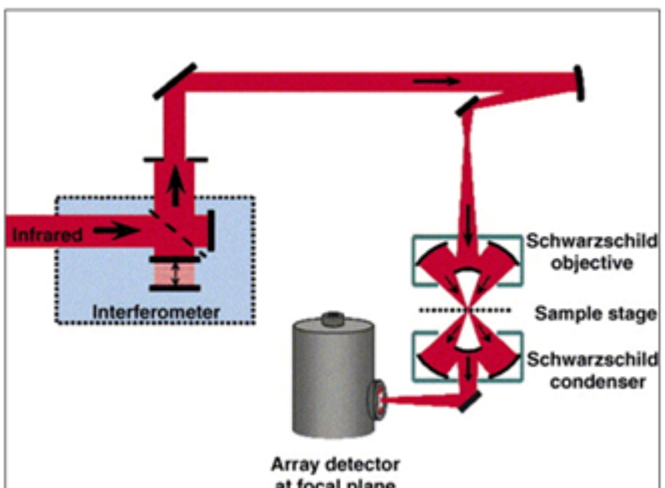
FPA- Imaging array detector 64x64 pixel

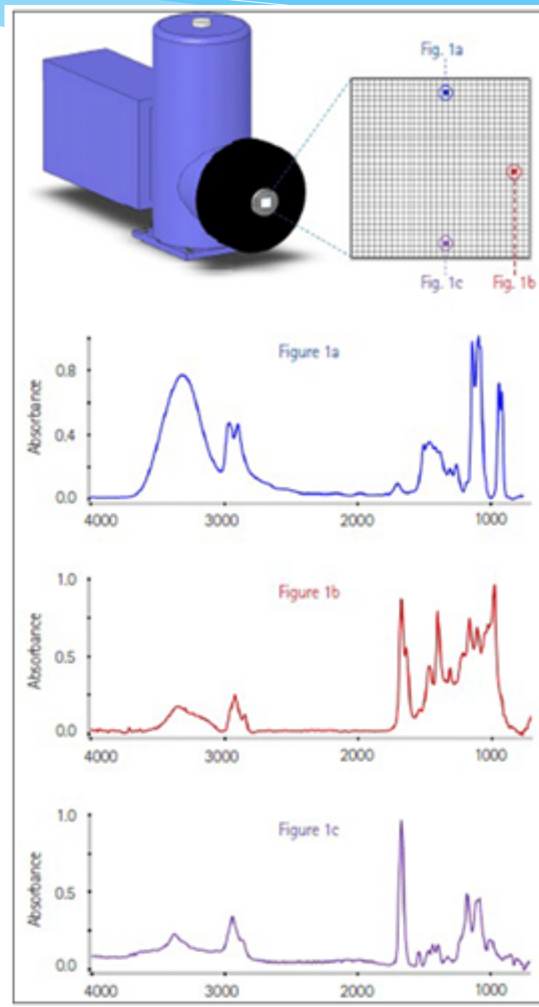


Clean-room laboratory to support sample preparation and conservation

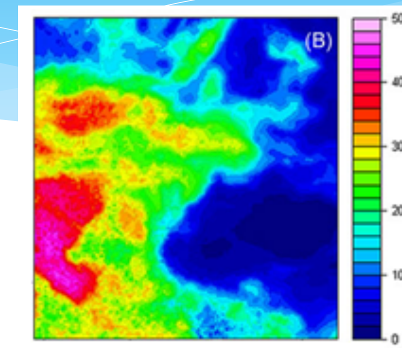
Two experimental end-stations: Equinox 55 and Vertex 70v interferometers

IR radiation and applications

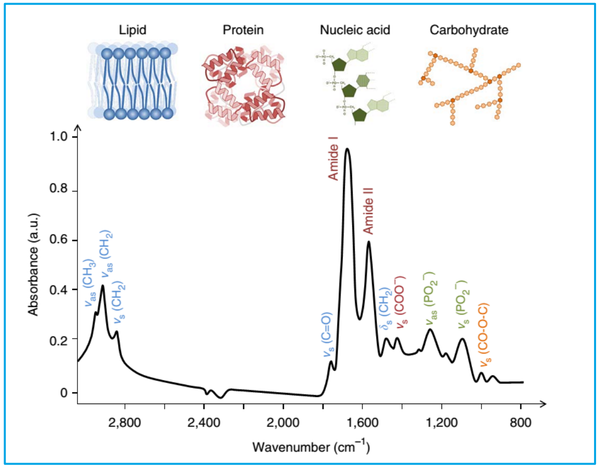




170x170 μm detector area



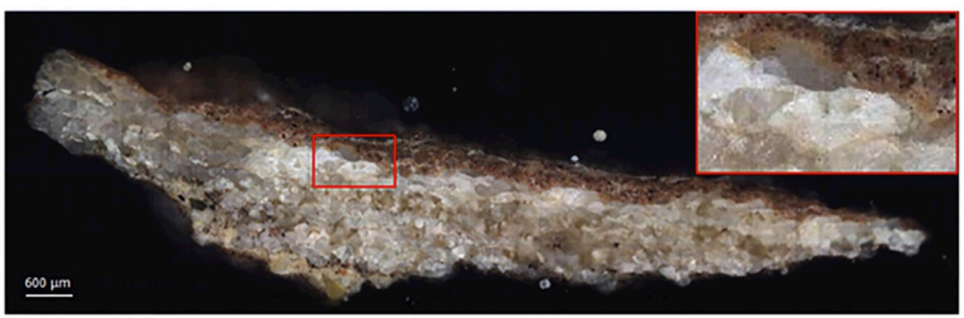
Chemical imaging

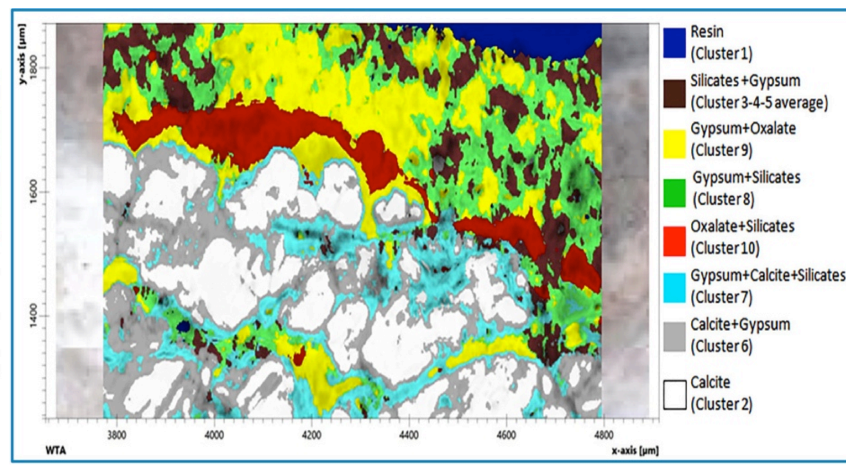


FTIR microspectroscopy

FTIR microspectroscopy applications: Cultural Heritage

Among the different analytical techniques, FTIR imaging provides information on the Molecular Composition of the Material on a micrometric-scale in a NON DESTRUCTIVE way. Establishing the distribution of materials and that of their degradation products in historical monuments/ paintings is fundamental to understand their CONSERVATION STATUS and give information for ART RESTORATION.



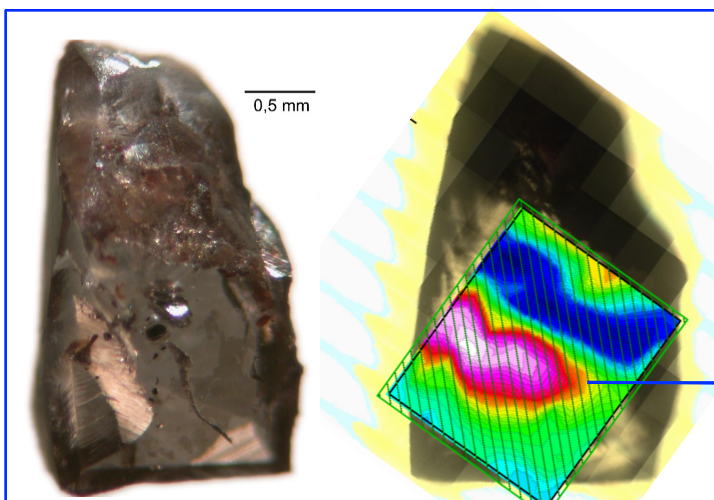


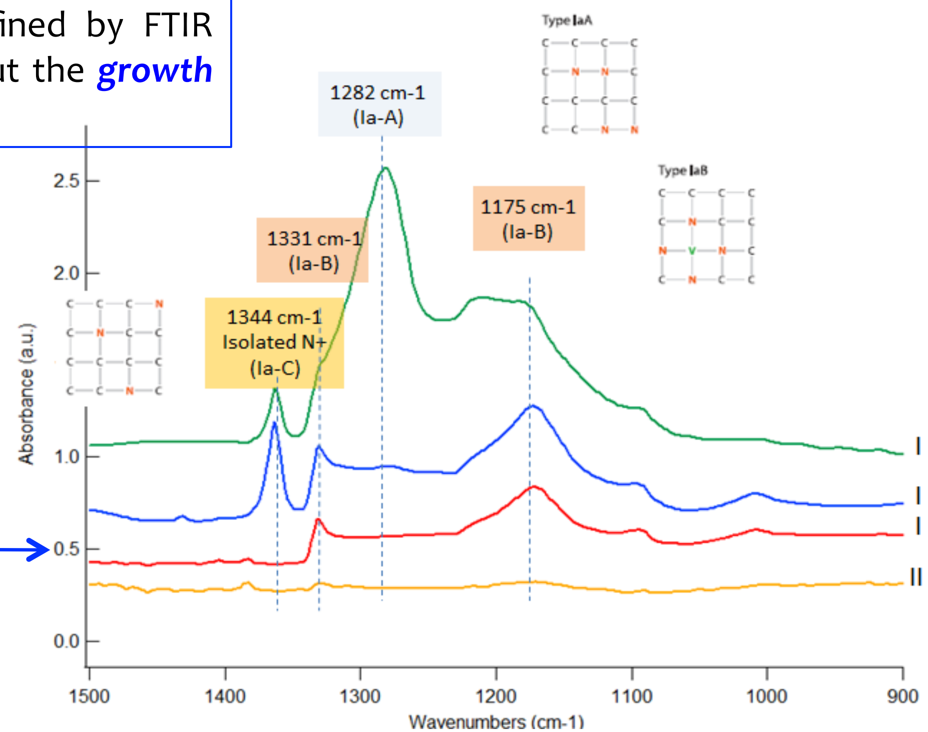
Small fragment of Septimius Severus's Arch** - Foro Romano (III AD)* **new perspectives for FTIR imaging in Art Conservation for the study of the distribution of different components –** ***M.P. Bracciale et al.

FTIR microspectroscopy applications: Geophysics

FTIR is a commonly used method for identifying either Organic or Inorganic Materials providing specific information on molecular structure, chemical bonding and molecular environment. It can be applied to study SOLIDS, LIQUIDS or GASEOUS samples being a powerful tool for QUALITATIVE and QUANTITATIVE studies.

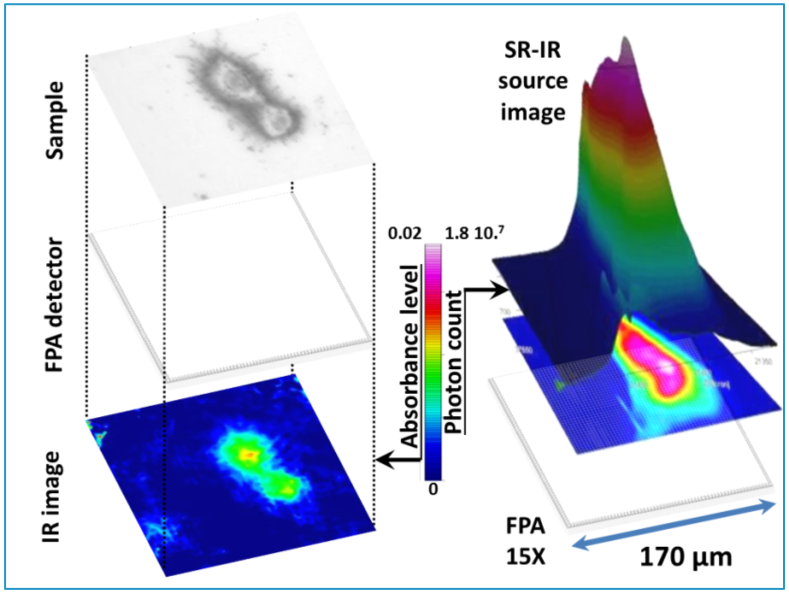
Nitrogen impurities classification in NATURAL DIAMONDS **:** classification, but also ***insights into their Age and/or Thermal history.*** The **spatial distribution of these impurities**, as defined by FTIR mapping, thus can reveal significant information about the ***growth history of diamonds***. *G. Agrosì, Univ. Bari*

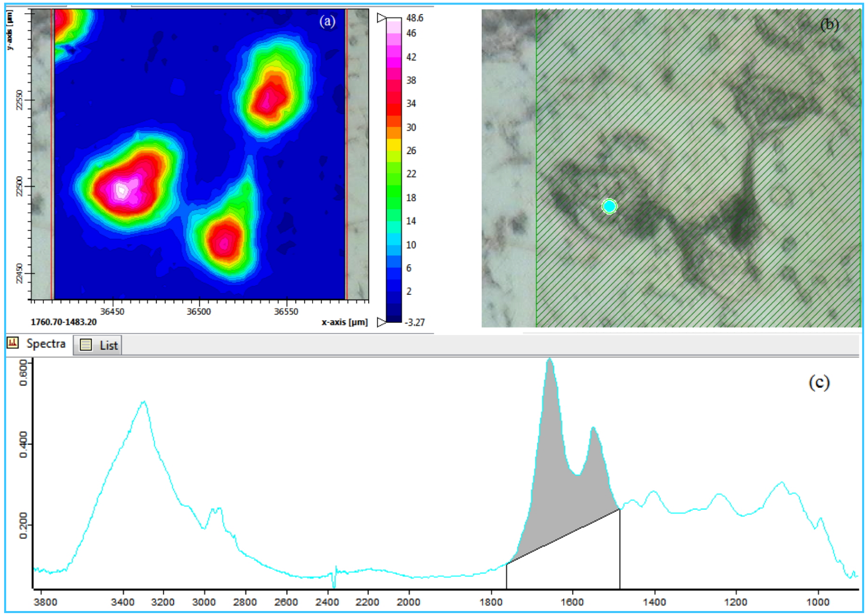




FTIR microspectroscopy applications: Biology and medical applications

FTIR microspectroscopy of biological CELLS and TISSUES is a rapidly growing area of Biomedical Research, especially, in Cancer Research. The technique sheds the brightest light on the dynamics of the molecular contents, and their changes over time. Those signs, of crucial importance for Diagnostic and/or Therapeutic studies.

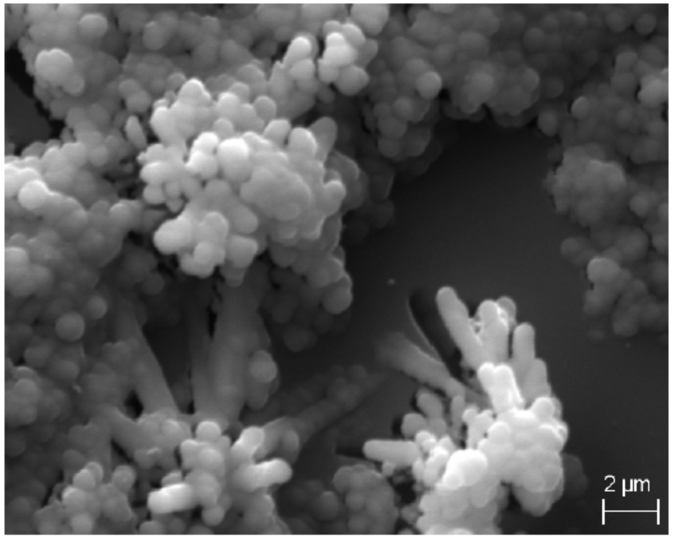




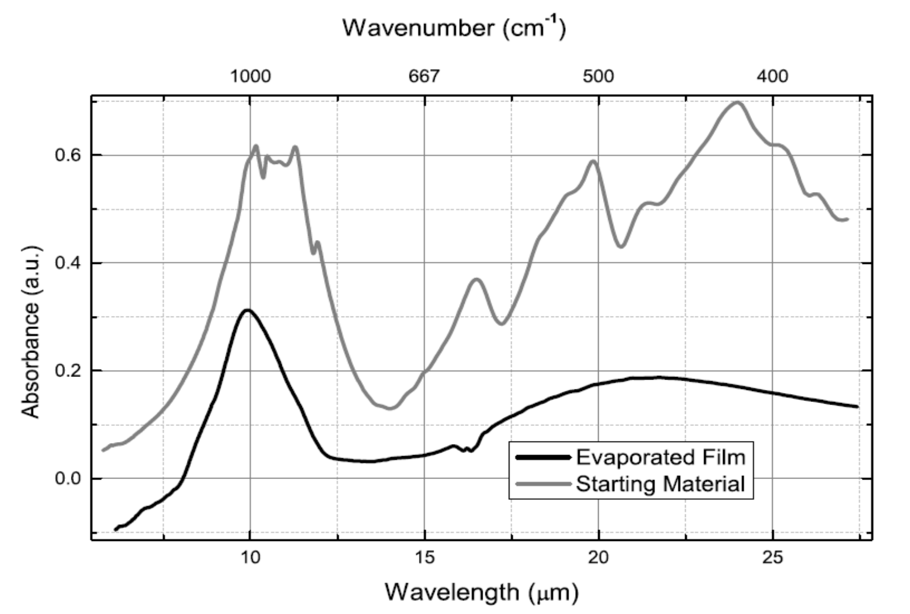
FTIR spectroscopy helps Discriminating Cancer Cells – FTIR chemical image of a *lung cell*, representing the *spatial distribution of the protein content of the cells.* *C. Petibois – Univ. Bordeaux*

FTIR microspectroscopy applications: Space applications

Physical vapor deposition synthesis** of amorphous silicate layers and nanostructures as **COSMIC DUST ANALOGS: **materials of wide interest for laboratory experiments. Cosmic dust** (CD) ***grains*** are part of the **evolution of stars and planetary systems and pervade the interstellar medium.**



SEM image showing typical particles synthesized with the **PVD evaporation technique**.



Absorbance FTIR spectra of a natural olivine used as **starting crystalline material (top)** and of the **evaporated amorphous and condensed layer (bottom)**. The ***broad absorption of the evaporated sample is compatible with a glassy state of the synthesized material.***

A. De Sio et al., ***Astronomy & Astrophysics*** **2016**

DXR2 UV-VIS beamline

DXR2 beamline and applications
Resp. Emanuele Pace (Uni. Firenze and INFN)

Wiggler UV branch line-deflection by a *grazing incidence gold coated mirror* (about 2°)

UV-VIS beamline new setup 2 -10 eV (650nm - 120nm). *Branch line in a 1000-class cleanroom*

- ***Space applications***
- ***Astrobiology and photo-biology***
- ***Optical technology***
- ***Detector technology (Diamond detectors)***
- ***Instrumentation testing and calibration***
- ***Optical properties of materials***

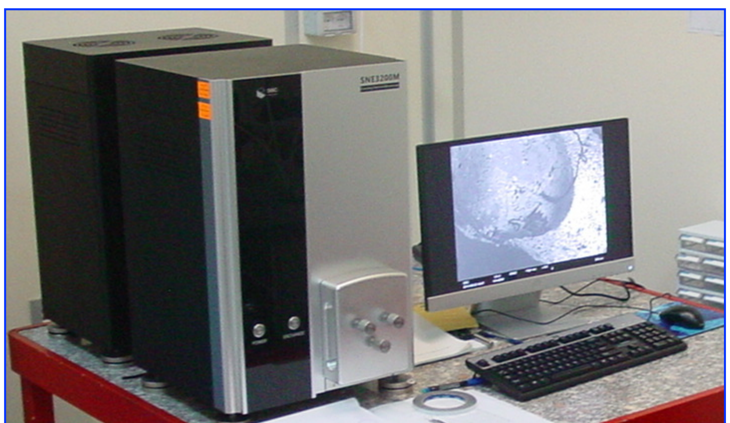
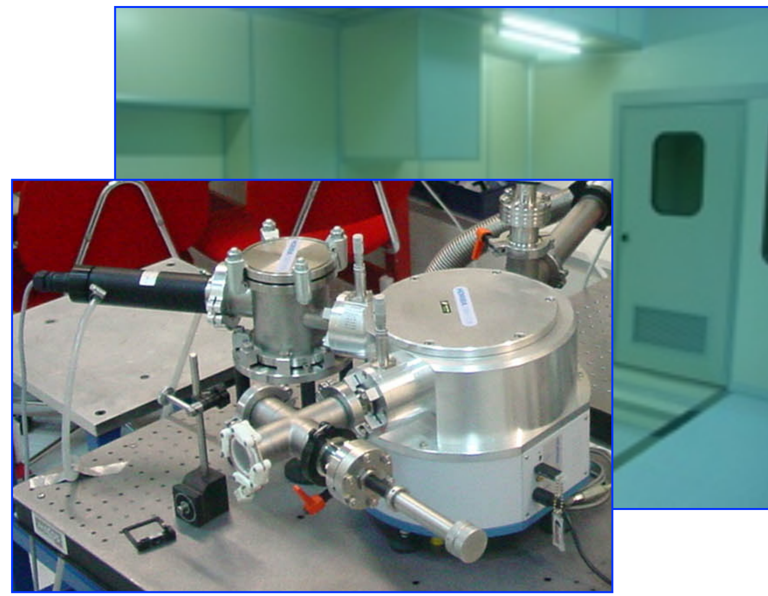


Table-top Scanning Electron Microscope (mini-SEM) with EDS to discriminate atomic elements.

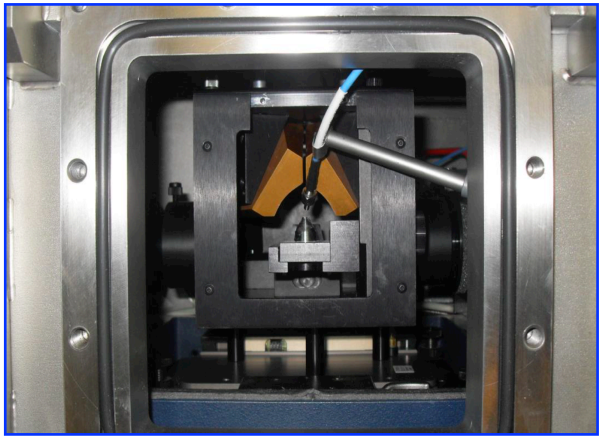


Instrumentation has been upgraded with a ***VUV monochromator*** (UVXL200 by Jobin Yvon) operating in the **120-250 nm** spectral range. The other **monochromator** operates in the range **200-650 nm**.

Photochemical facility

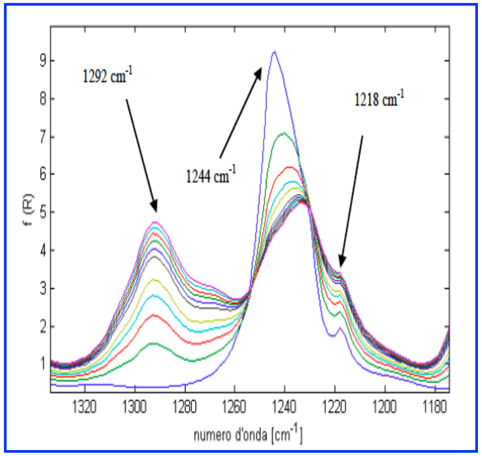
Resp. Mariangela Cestelli Guidi and Emanuele Pace

A ***UNIQUE*** facility combining ***Infrared*** and ***UV-VIS radiation*** and operating with **synchrotron radiation** and **standard sources** is **open to external users** for non destructive analyses and testing of materials of spatial interests.



UV radiation transferred through solarized optic fiber.

Simultaneous study of the effect of UV damage on DNA, cells, tissues and materials



FTIR spectrum of the as-prepared (blue) and irradiated Uracil sample.

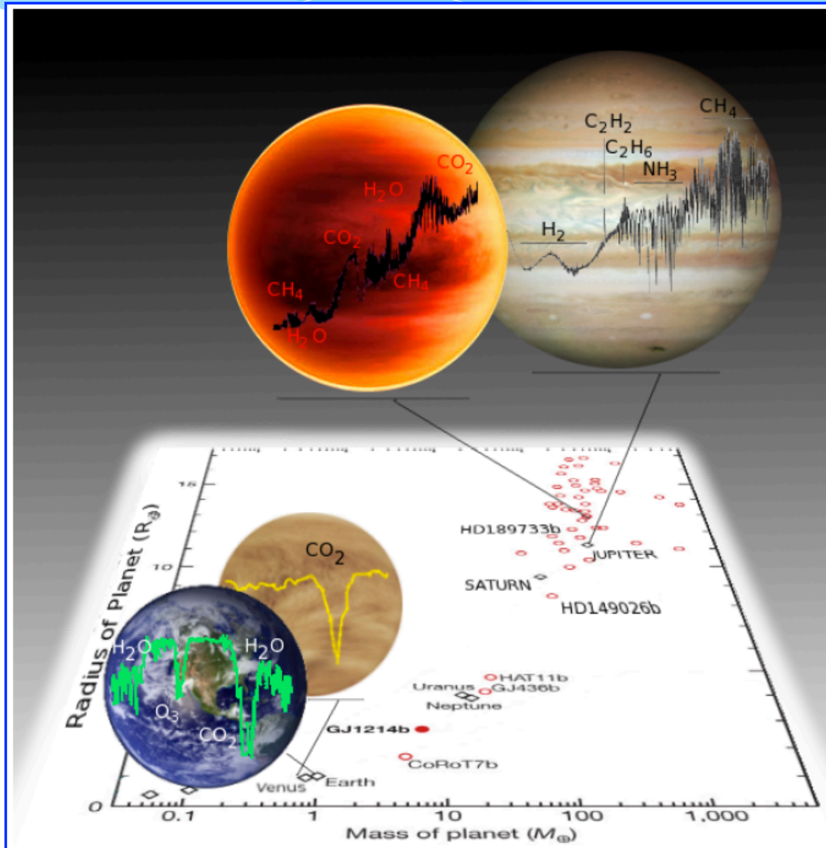
To study:

1) ***Photochemistry experiments like studies on exo-planet gasses***
2) ***Radiobiology on biological tissues***
3) ***UV aging*** of organic materials useful for ***space missions***

EXO- biology & planets @ DAFNE-L

Use of the ***UV and IR Synchrotron Radiation, Standard Sources and Solar Simulators*** (in collaboration with ***SCF_LAB***) to:

- **Study Exoplanetary atmospheres**
- **Search for life markers in exoplanetary spectra**
- **Study of survival mechanisms of organic and biological materials in space environments**



Collaboration with INAF (IAPS. TO, PD, PA, Arcetri) Univ. Roma 2, UniFI and several International Research Institutes.

PROJECTS

ARIEL – M4 ESA Cosmic Vision

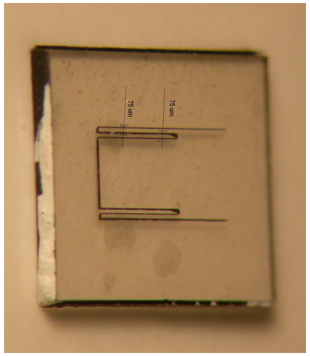
EXOLIFE – H2020

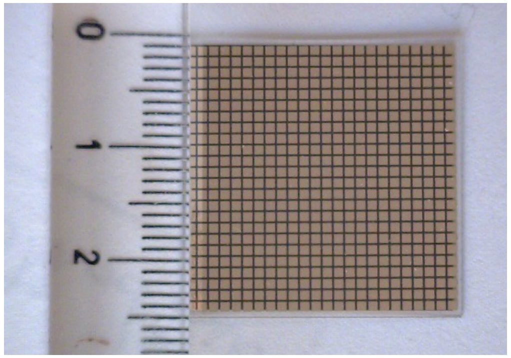
Atmospheres in a test tube – INAF

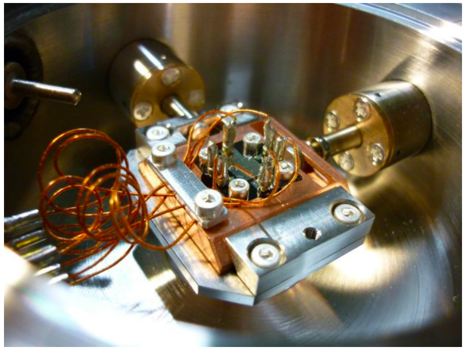
DXR2 some applications

Test of Diamond devices for space and ultra-fast applications

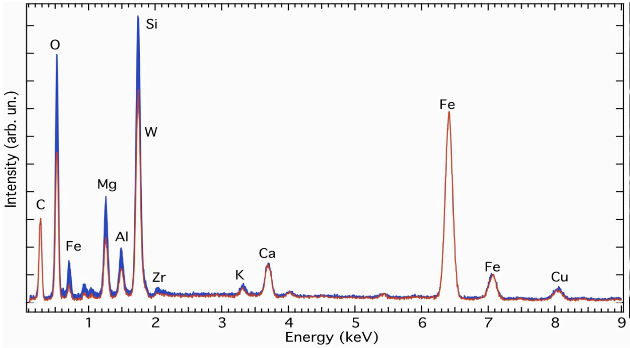
- **UV & X-ray ultrafast and rad-hard detectors**
- **Dosimeters for astronauts and space environments**
- **Pixilated structures for imaging**
- **Micro devices and micro patterning**

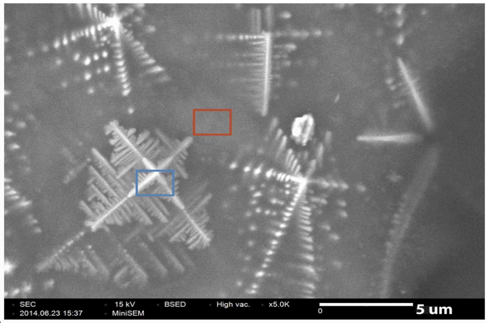






Exploitation of the Device Fabrication Lab @ LNF and **collaboration** with XUVLab @ UniFI



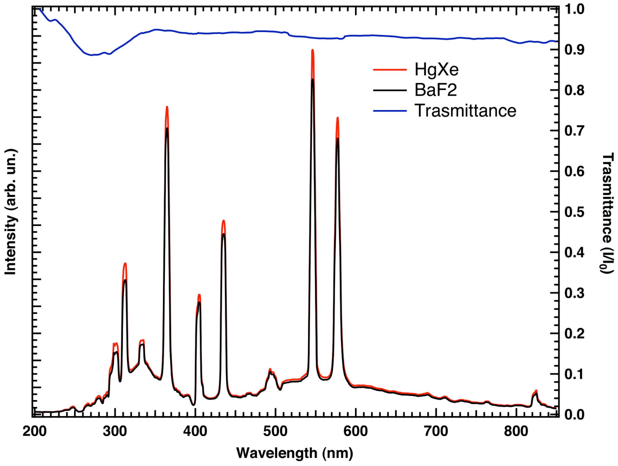


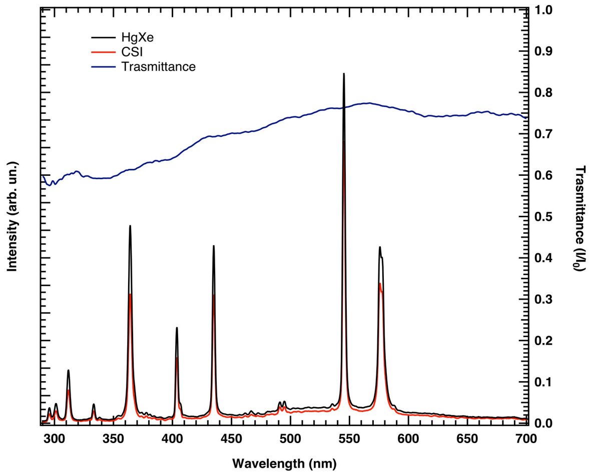
METEORITES studied using SEM and EDS: the blue and red squares reported in SEM microscope image correspond to the blue and red spectra recorded in the EDS analysis. The Different Concentrations of Fe, Al, Mg, O and C atoms in different areas of the sample confirm the Formation of Spinels and their Iron-Based Structure.

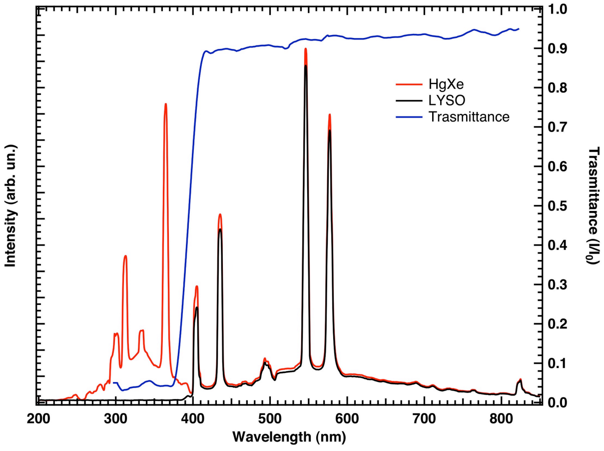
Characterization of scintillators for the Mu2e experiment

The **Mu2e (muon-to-electron-conversion) experiment**, that involves the INFN- LNF, is looking for ***Charged Lepton Flavor Violation*** by studying the **coherent neutrinoless muon-to-electron conversions** in the field of an atomic nucleus. The **produced electrons will be measured in a calorimeter using the fluorescence produced by BaF2 or CsI crystals.** The main fluorescence emissions of the crystals are centered at 220 and 310 nm for BaF2 and CsI respectively.

In this context, the DXR2 UV beamline was used to **characterize and test the crystals** that will compose the calorimeter.
The **transmittance is an important parameter to check the quality of the crystals and can be measured using the continuum spectrum produced by Synchrotron Radiation and a 500 W HgXe lamp** in the range of 200-600 nm using a SPM-002 spectrometer including multi pixel Silicon Photon Multipliers.





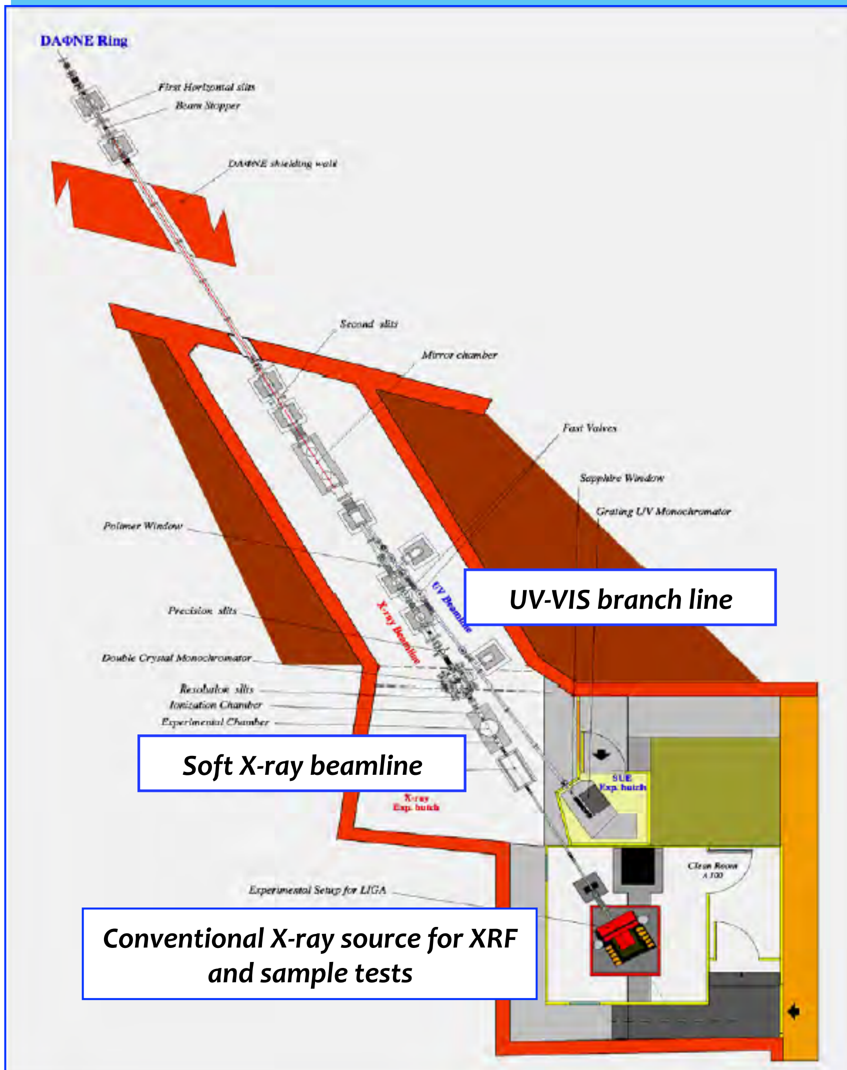


The results confirmed the good quality of the BaF2, CsI and LYSO crystals.

DXR1 soft X-ray beamline

DXR1 soft X-ray Beamline

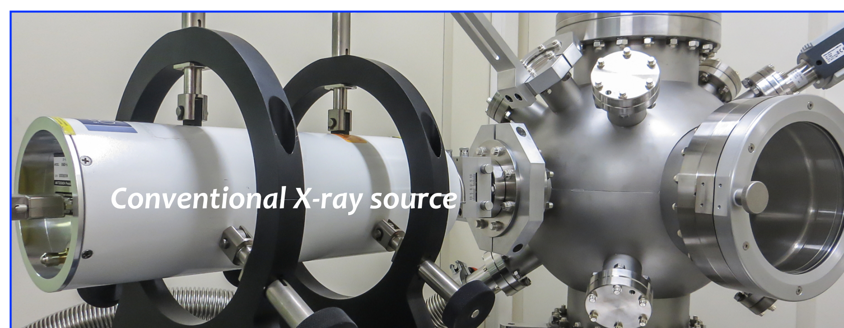
Resp. Antonella Balerna



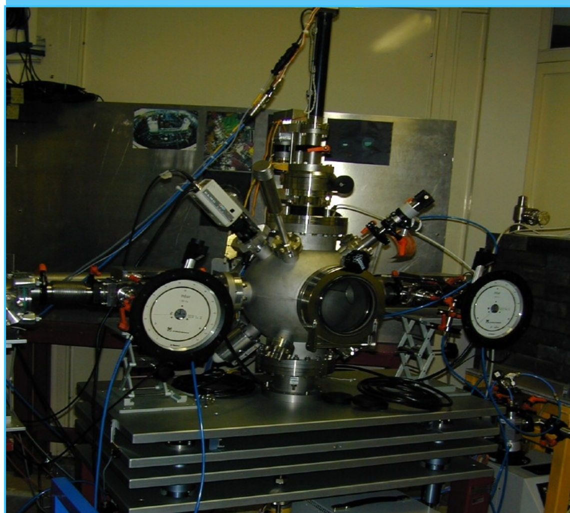
- *DXR1 is a wiggler soft x-ray beam line*
- **Energy range** ***0.9 - 3.0 keV***
- **TOYAMA double crystal monochromator with KTP (011), Ge (111), Si (111), InSb (111) and Beryl (10-10) crystals**
- **From 2016 working in Top-Up Mode**
- ***Some applications: Soft X-ray absorption spectroscopy and tests of soft x-ray optics and detectors.***

The ***monochromatic photon flux*** available as a function of photon energy, crystals used and DAFNE current is between ***10^7*** and ***10^9 ph/s***

White beam for optics tests is also available.

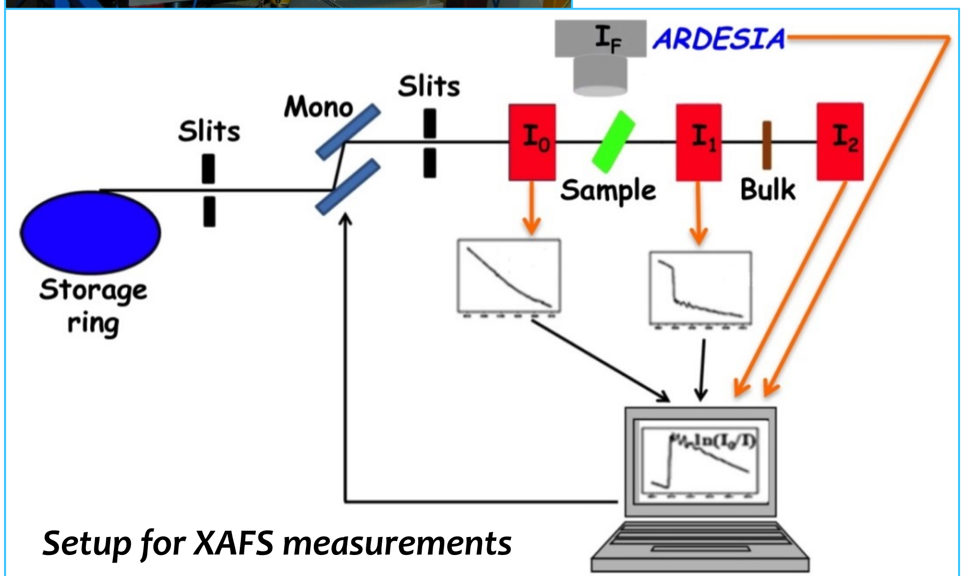


Soft X-ray applications

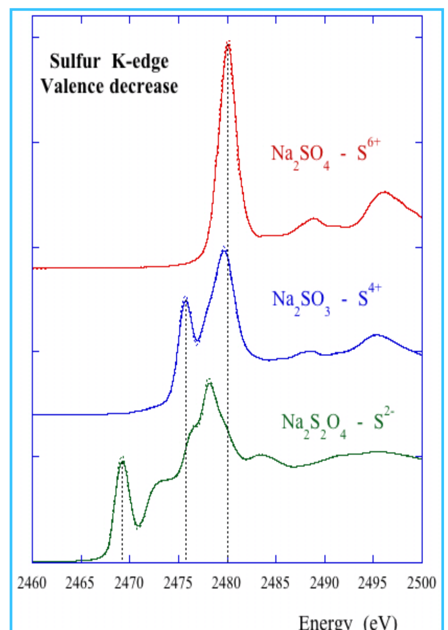


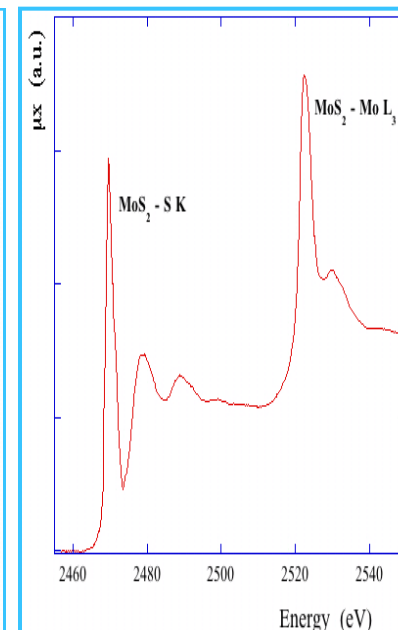
X-ray Absorption Fine Structure or *XAFS spectroscopy* is particularly useful for investigating the electronic structure and local environment of atoms in quite different samples (solids, liquids and gasses).

At the DXR1 beamline the K absorption edges of all light elements from Na to Cl can be studied.



Setup for XAFS measurements

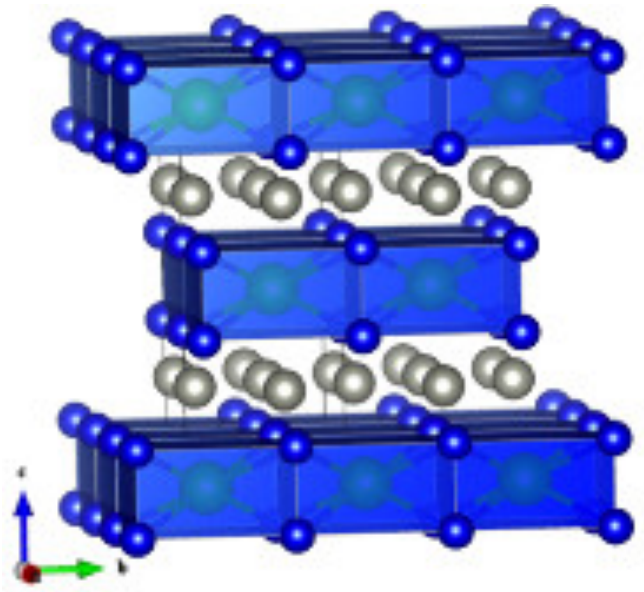




Studies of valence of selected rare earth silicides determined using Si K and Pd/Rh $L_{2,3}$ XANES and LAPW numerical studies.

The study concerns the investigation of **Si and Pd/Rh chemical environments using X-ray Absorption Near Edge Spectroscopy in two different families of rare earth silicides** R_2PdSi_3 (R = Ce, Nd, Tb, Dy, Ho, Er) and $HoRh_{2-x}Pd_x Si_2$ (x = 0, 0.5, 0.75, 1.0, 1.5, 1.8, 2.0).

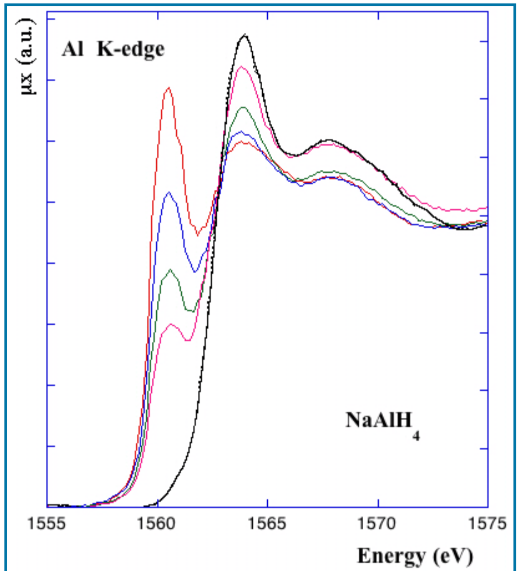
The observed changes indicate that **despite possessing a formal inter-metallic character**, the chemical bond between the R-Si and R-Pd interactions were different. The variation and the direction of the chemical shift of the Si K edge suggested a **weak ionic character of the R-Si bonds**, in agreement with the localized character of the 4f electrons. In turn, the changes of the Pd/ Rh edge are consistent with a metallic band that is affected by its long range chemical environment.



Projection of the tetragonal crystal structure of $Ho(Pd,Rh)_2 Si_2$ along *ab* plane and *c* crystallographic directions.

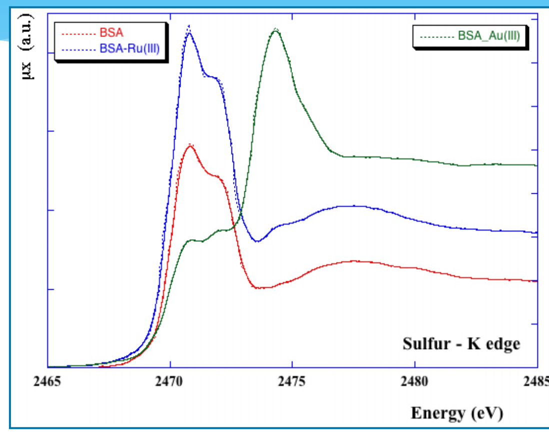
W. M. Kwiatek et al., *NIMB* **2015**

Soft X-ray applications and developments



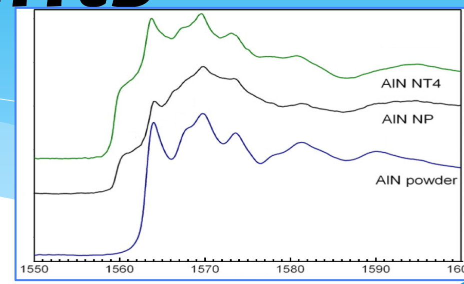
Development of higher-efficiency hydrogen storage materials

A. Leon et al. - KIT



Interactions of metal-based drugs with serum proteins having biological and pharmacological implications

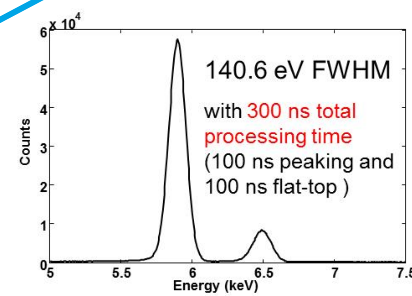
I. Ascone et al.

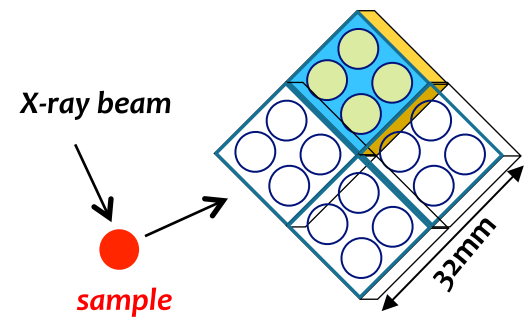


Catalysis and nanomaterial

C. Balasubramanian et al.

XAFS in fluorescence mode for studies on diluted samples and thin films on thick supports.



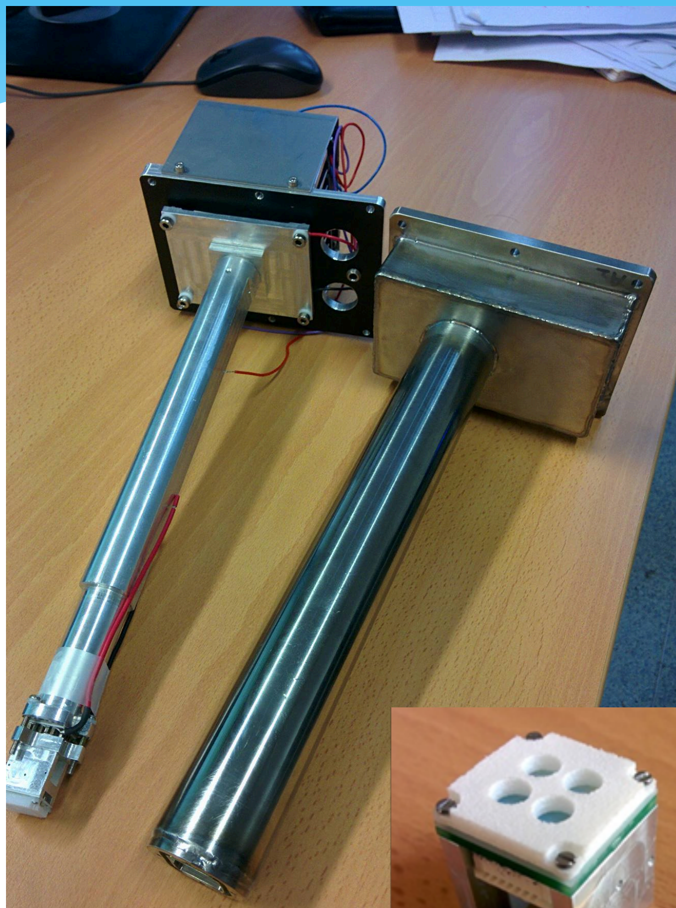


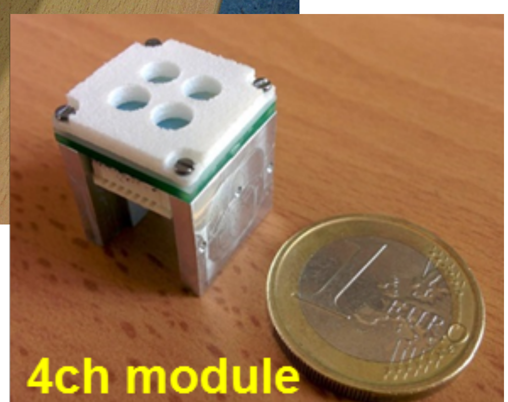
ARDESIA

ARRAY of DETECTORS for SYNCHROTRON RADIATION APPLICATIONS

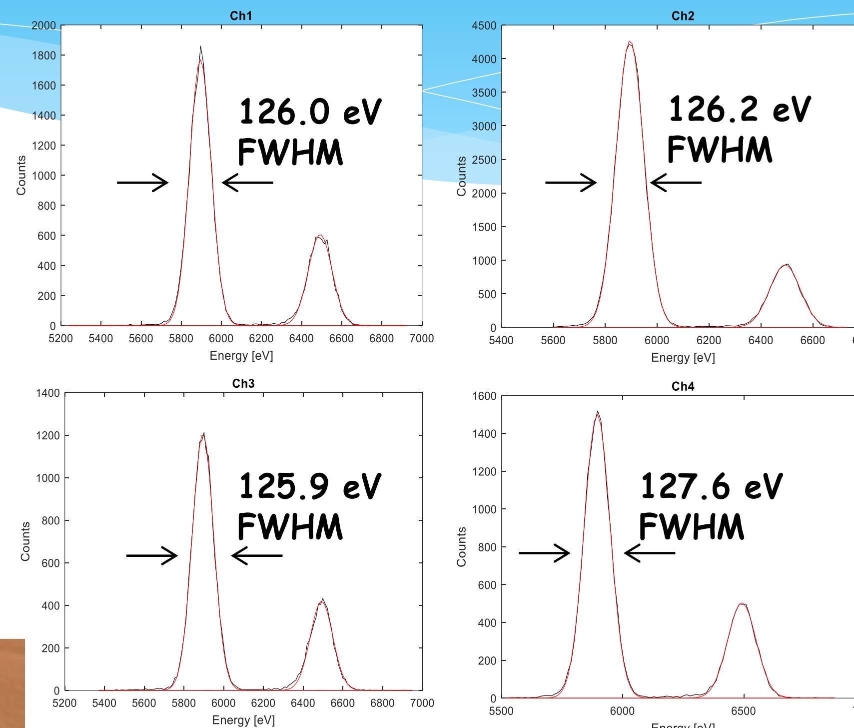
Development of a multi-element SDD detector high resolution and high count rate (INFN-CSN5).

ARDESIA SDD detector





First ^{55}Fe spectra



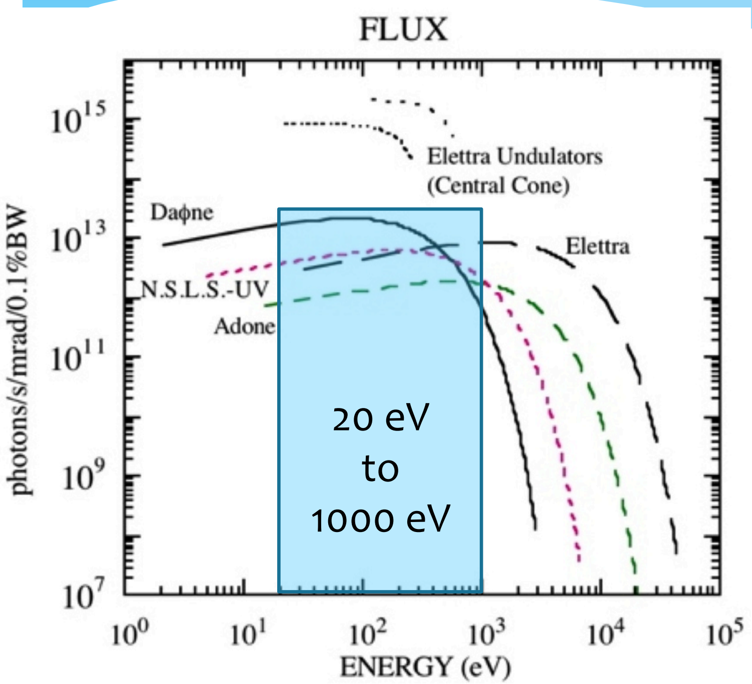
4×25mm² area, 1.6 µs peaking time, T=-29°C

ARDESIA 2015-2017

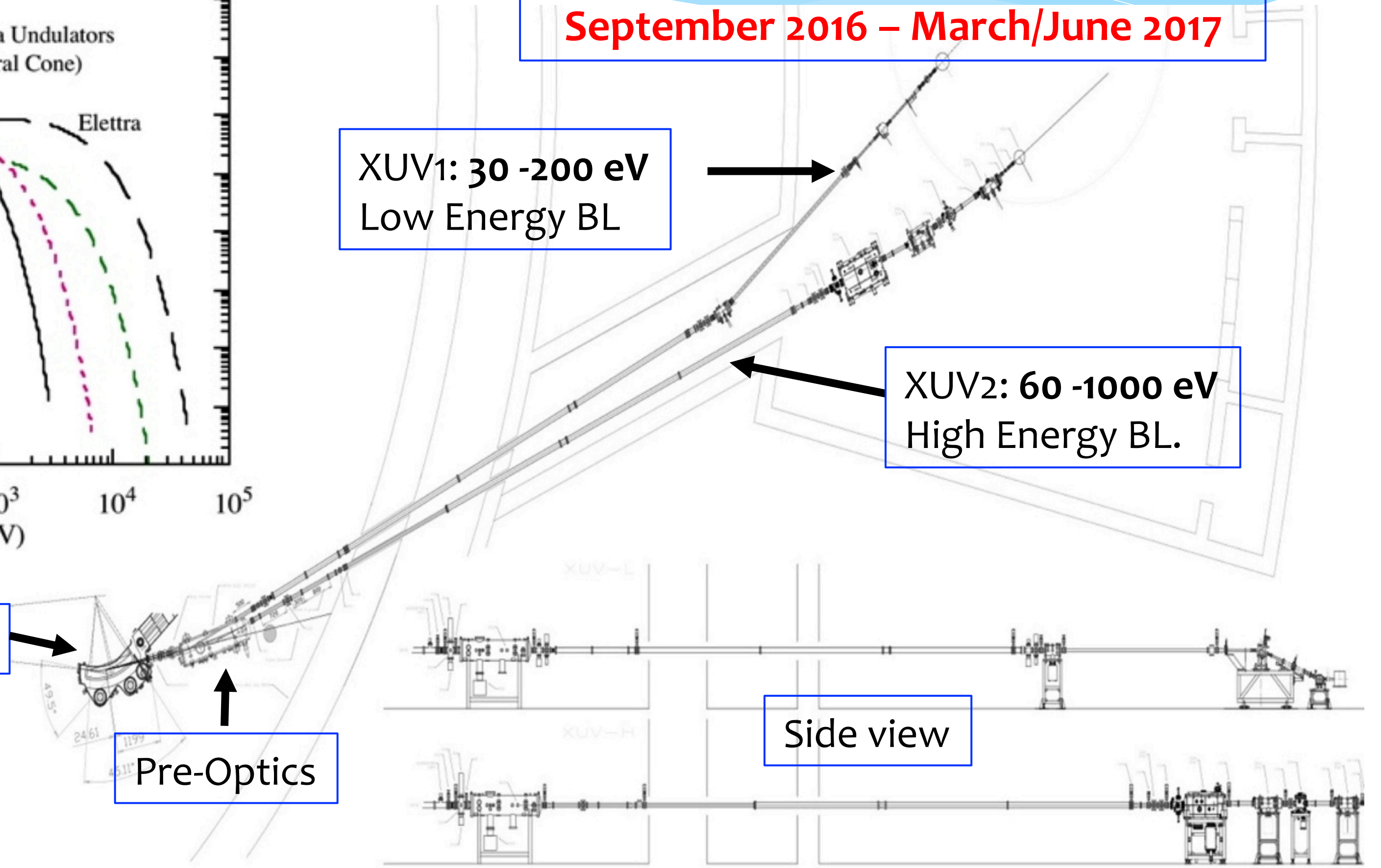
XUV beamlines

XUV beamlines

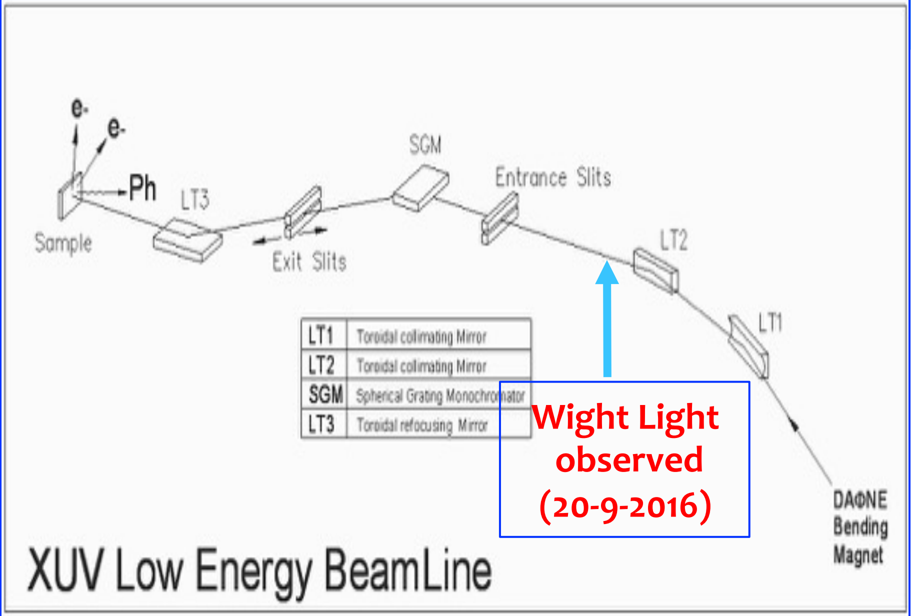
R. Cimino (Resp.) R. Larciprete (Ass.), A. Di Trolio (Ass.), M. Angelucci (EuroCirCol), L.A. Gonzalez (EuroCirCol), E. La Francesca (PHD RM1)



Under alignment / commissioning
September 2016 – March/June 2017

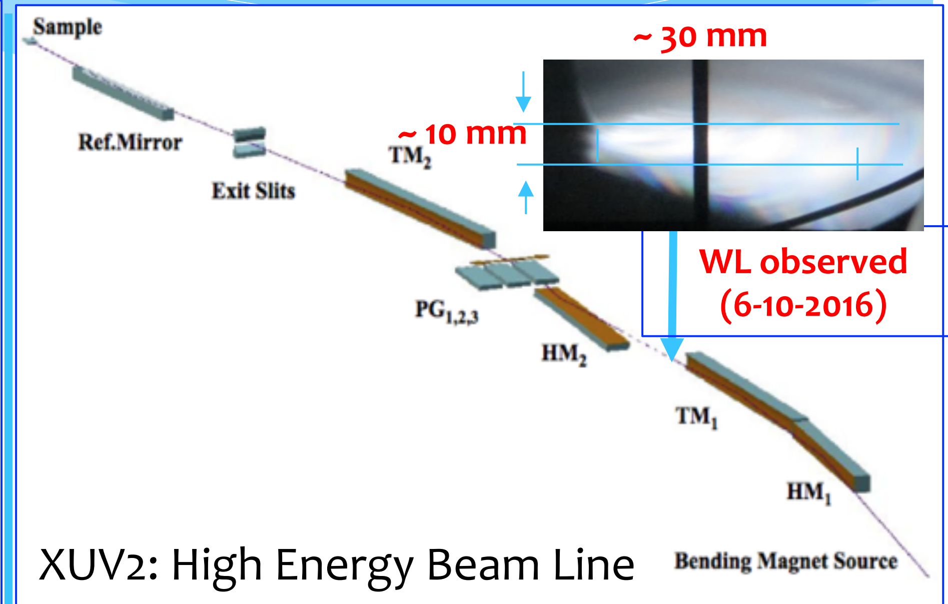


XUV1: Low Energy BL 30-200 eV



About **17 mrad** horizontally
Spot on sample : **2 x 2 mm**
Energy range **30-200 eV**
Mono: **Spherical grating**

XUV2: High Energy BL 60 -1000 eV



About **8 mrad** horizontally
Spot on sample : **1 x 1 mm**
Energy range **60-1000 eV**
Mono: **Plane grating**

Feasible experimental activity

Characterization of materials of wide interest for INFN and others

***in UHV*: SEY, XPS, UPS, STM/AFM** ***in air*: Raman**

In UHV:

- ✓ Radiation (electrons, photons, ions) induced surface modification
- ✓ Thermal programmed desorption (combined with XPS)
- ✓ Photon induced desorption (conventional sources)
- ✓ Film growth for SEY optimization

In the tube furnace:

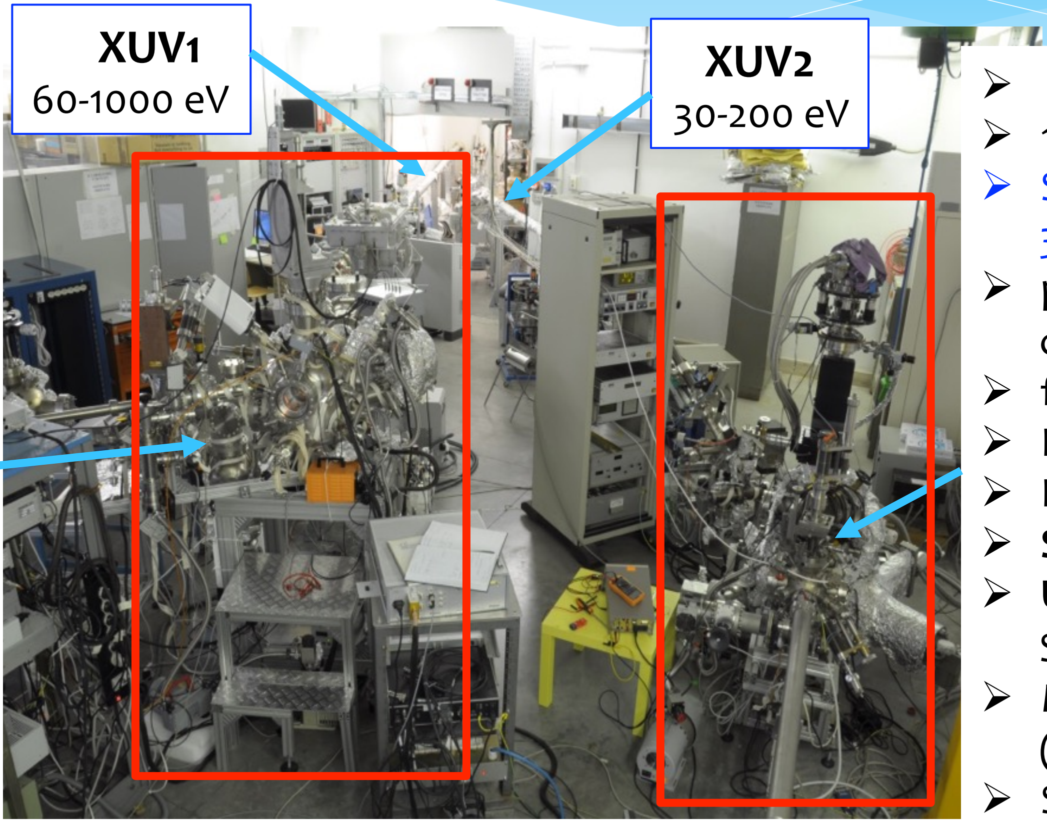
- ✓ High pressure material growth
- ✓ Controlled annealing processes of ‘large’ scale samples

With the DA*Φ*NE beams available (ideal for Surface Science):

- ✓ X-ray beam induced surface chemistry
- ✓ X-ray beam induced desorption

Experimental hall: the two beamlines and the two operating experimental setups

- UHV ~1x10^{-10} mbar
- 1x1cm^2 max. sample
- Sample T: RT - 1100°C
- preparation chamber
- fast-entry lock
- Electron gun
- Faraday Cup
- **SEY** set up
- **UPS** (UV ph. Spectr.)
- **XPS** (Xray ph. Spectr.)
- Sputtering
- Material growth
- RF magnetron 50W



- UHV ~1x10^{-10} mbar
- 1x1cm^2 max. sample
- Sample T: 10 K – 300 K
- preparation chamber
- fast-entry lock
- Electron gun
- Faraday Cup
- **SEY** set up
- **UPS** (UV ph. Spectr.)
- Mass Spectrometer (**desorption**)
- Sputtering
- Material growth

Activities

- The laboratory hosted many ***INFN-CSN5*** funded experiments of **interest** for **Accelerator R&D** (**instabilities**, **e^- cloud**) and detectors (**GARFIELD** to produce and characterize Graphene sheets to be used in Particles detectors) that allowed to buy most of the existing "state of the art" exp. end station (estimated value: >1M€ with DAΦNE-L funds to completion).

- The lab. is hosting the **EU funded program EuroCirCol – as PI for WP4**: ***"Cryogenic Beam Vacuum System Conception: vacuum stability at LT."***

- The lab. will host **MICA** - **M**itigate **I**nstabilities in **C**ircular **A**ccelerators, funded by the ***INFN-CSN5*** for **2017/20**, which will improve the available hardware.

Dissemination and Scientific production on Accelerator R&D:

- **One workshop chaired/organized (Ecloud 12)**
- **> 20 invited talks (universities, meetings, etc.)**
- **> 40 presentations at International Conferences**
- **1 Phd thesis + 3 bachelor thesis**

- **> 20 peer reviewed publications :**
  - **1 JIMPA (a Review of 65 pages)**
  - **1 conference proceeding Ecloud 12**
  - **2 Phys. Rev. Lett. (in 2012 and 2015)**
  - **8 Phys. Rev. S. T. – Acc. and Beams**

Contributions to Key Enabling Technology (KET)

Developed Key Enabling Technology (KET):

- The chemistry of the "scrubbing": why e-cloud mitigation @LHC works.
- Carbon: from its essential role during scrubbing to its "ad hoc" deposition.
- LE-SEY: how to measure it and its impact to simulations and on LHC.
- LE-SEY: Space application.
- R & PY: essential input parameters for instability simulations.
- How to deal with the SR huge heat load in FCC-hh.

- Identification of the chemical process occurring during scrubbing and its energy dependence and we help Identifying Carbon as a mitigation coating for e^--cloud issues. (R. Cimino et al PRL 2012 and other papers)

- Development of a unique method to measure accurately low energy SEY so the impact of this important region could be studied in accelerators and other research field. (R. Cimino et al Phys. Rev. ST-AB, 2015 other papers)

- Only group worldwide that studies with SR R &PY as input parameters used in e-cloud simulations (R. Cimino and F. Schäfers, IPAC14, 2014,and other recent papers)

- Suggestion of an innovative method to control the huge SR power in future highest intensity proton colliders. (R.Cimino et al. PRL ,2015)

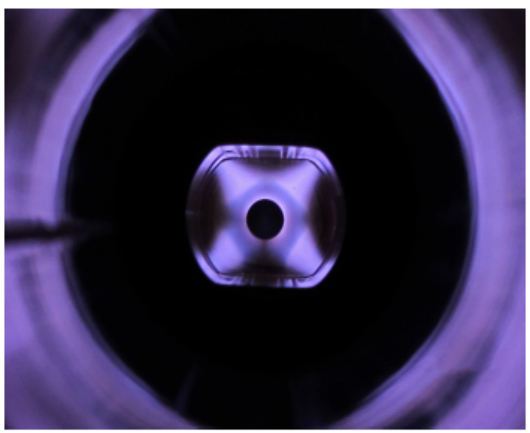
KET: HL – LHC base line

A NEW TYPE OF COATING TO CHASE THE CLOUDS AWAY

The electron cloud problem needs to be addressed with innovative solutions, particularly in view of the rapidly approaching HL-LHC upgrade. CERN's Vacuum, Surfaces and Coatings group has greatly improved its amorphous carbon coating technique, which is an alternative to the scrubbing process used so far. This technique is now fully mature and is being used for the vacuum chambers of the SPS magnets and the delicate beam screens of the LHC's quadrupole triplets.

CERN Bulletin

February 2016



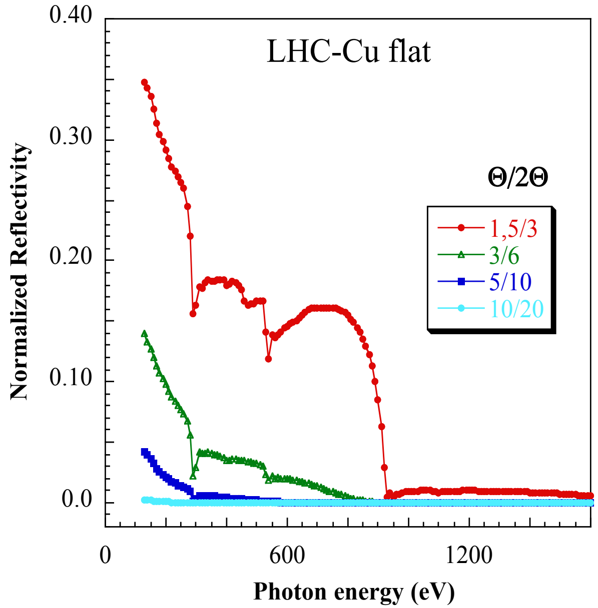
The violet light is produced by the argon plasma used when sputtering the amorphous carbon. The coating of the beam screen is done in this case using the magnetic field of the

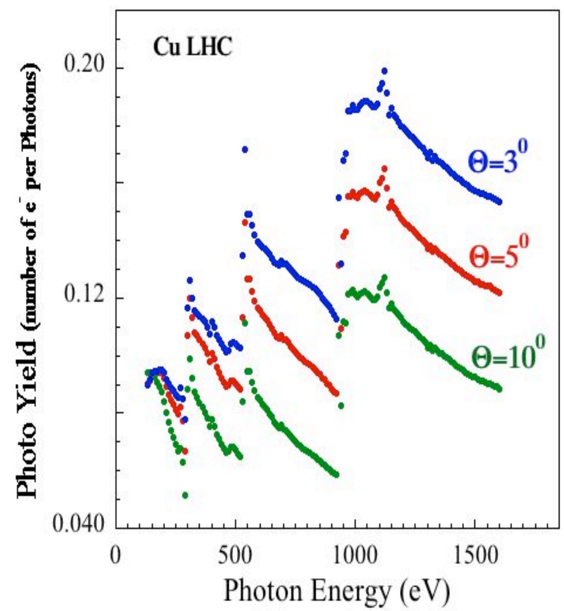
We know that conditioning (or "scrubbing") the beam pipe reduces the avalanche-like creation of secondary electrons from the tube's walls, thus preventing the formation of unwanted electron clouds. But it has also been observed that scrubbing naturally leads to an increase in the concentration of carbon on the pipe's surfaces. "This gave us the idea that applying a thin film of carbon to the walls of the vacuum chamber could provide an alternative solution to beam tube scrubbing," says Paolo Chiggiato, head of the Vacuum Surfaces and Coatings group of the Technology department (TE-VSC).

R. Cimino et al PRL 2012 and other papers contribute to this issue

KET: SR R &PY as input parameters used in e-cloud simulations

Reflectivity & Photo-Yield being used as **input parameters** in **e-cloud simulations. R & PY** also **essential ingredients for single bunch instabilities** just connected to the mere existence of a certain **density of e⁻ in the accelerator chambers.** (*K. Ohmi and F. Zimmermann PRL 2000*)



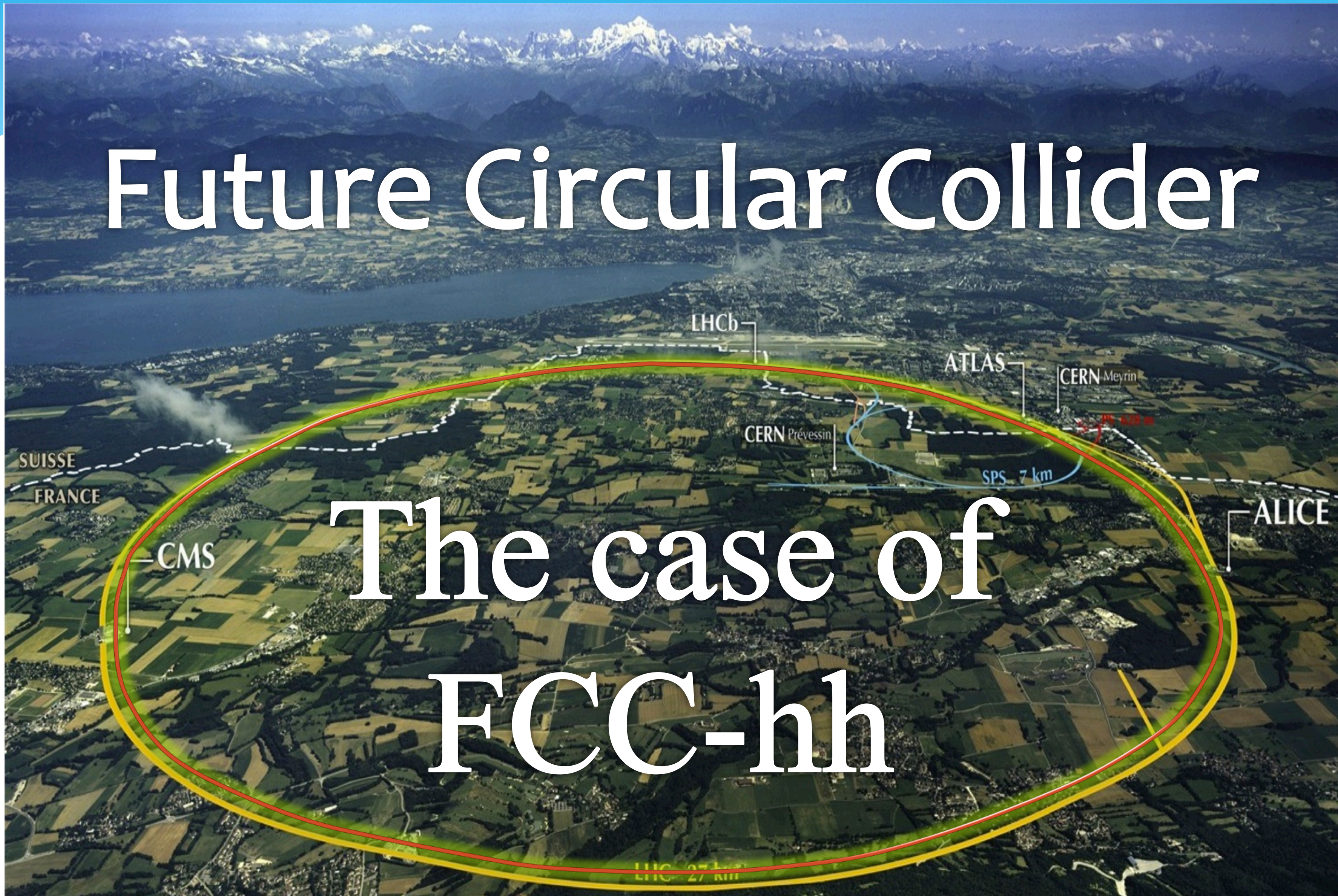


- **F. Schäfers and R. Cimino, Proc. ECloud-12, Isola Elba, 2012, CERN 2013-002 p 105-114.**
- **R. Cimino and F. Schäfers, IPAC14 (2014),**
- **G. F. Dugan, et al *Phys. Rev. ST-AB*, (2015).**
- **R. Cimino, et al *Phys. Rev. Lett* (2015).**

KET: Future Projects

Future Circular Collider

The case of FCC-hh

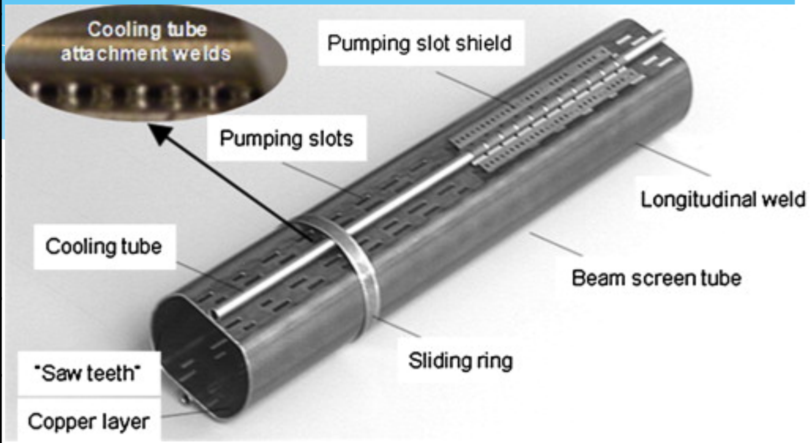


FCC-hh Key Parameters

Parameter	FCC-hh	LHC
Energy [TeV]	100 c.m.	14 c.m.
Dipole field [T]	16	8.33
# IP	2 main, +2	4
Luminosity/IP$_{main}$ [cm^{-2}s^{-1}]	5-10 x 10^{34}	1 x 10^{34}
Energy/beam [GJ]	8.4	0.39
Synchr. rad. [W/m/ap.]	**28.4**	**0.17**
Bunch spacing [ns]	25 (5)	25

Vacuum technology challenges

LHC beam screen at 20 K



- **SR power ~30W/m/beam** in arcs (E_{crit} =4.3keV), total 5 MW (LHC 7kW)
- Dipole Cold bore at 1.9 K
- Beam screen temperature at 50K
- **5 MW SR => 100 MW of cooling power**
- Need good vacuum between 40-60K
- Need to reduce Impedance budget.

Challenging R&D required on:

- **Cooling**
- **Vacuum**
- **Impedance**
- **Mechanical**
- **Electron cloud**
- **Costs**

Where the laboratory activity and SR meets

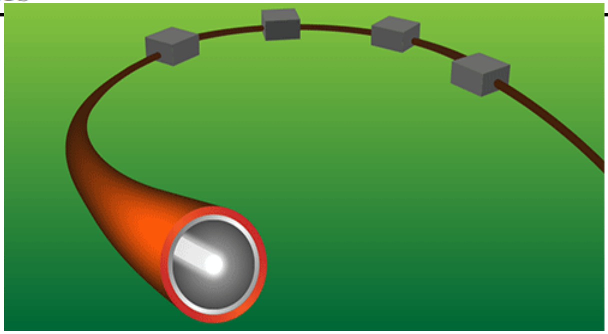
PRL **115,** 264804 (2015) PHYSICAL REVIEW LETTERS week ending 31 DECEMBER 2015

Potential Remedies for the High Synchrotron-Radiation-Induced Heat Load for Future Highest-Energy-Proton Circular Colliders

R. Cimino,[1,2,*] V. Baglin,[2] and F. Schäfers[3]

From: APS physics | Physics

Synopsis: Cooler Colliders



Superconducting magnets continuously radiates photons and hence heat. This **heat-removal process is already expensive**, costing a few thousand dollars per hour of operation; estimates suggest that the weekly bill for a 100-TeV accelerator might soar into the millions. The **proposal by Cimino (Phys. Rev. Lett. 115, 264804 (2015))** and his colleagues is to **coat the interior of the copper tube with a thin layer of carbon that reflects all the incident radiation**. The surface structure of the carbon coating is designed so that the **radiation, and the heat it carries**, is **transported away from colder regions towards periodically placed room-temperature absorbers**, which are **easier and cheaper to cool than the tube itself**. ***The authors claim that this design would reduce the power consumption potentially cutting the associated costs in half***. (***Katherine Wright, APS, Physics***)

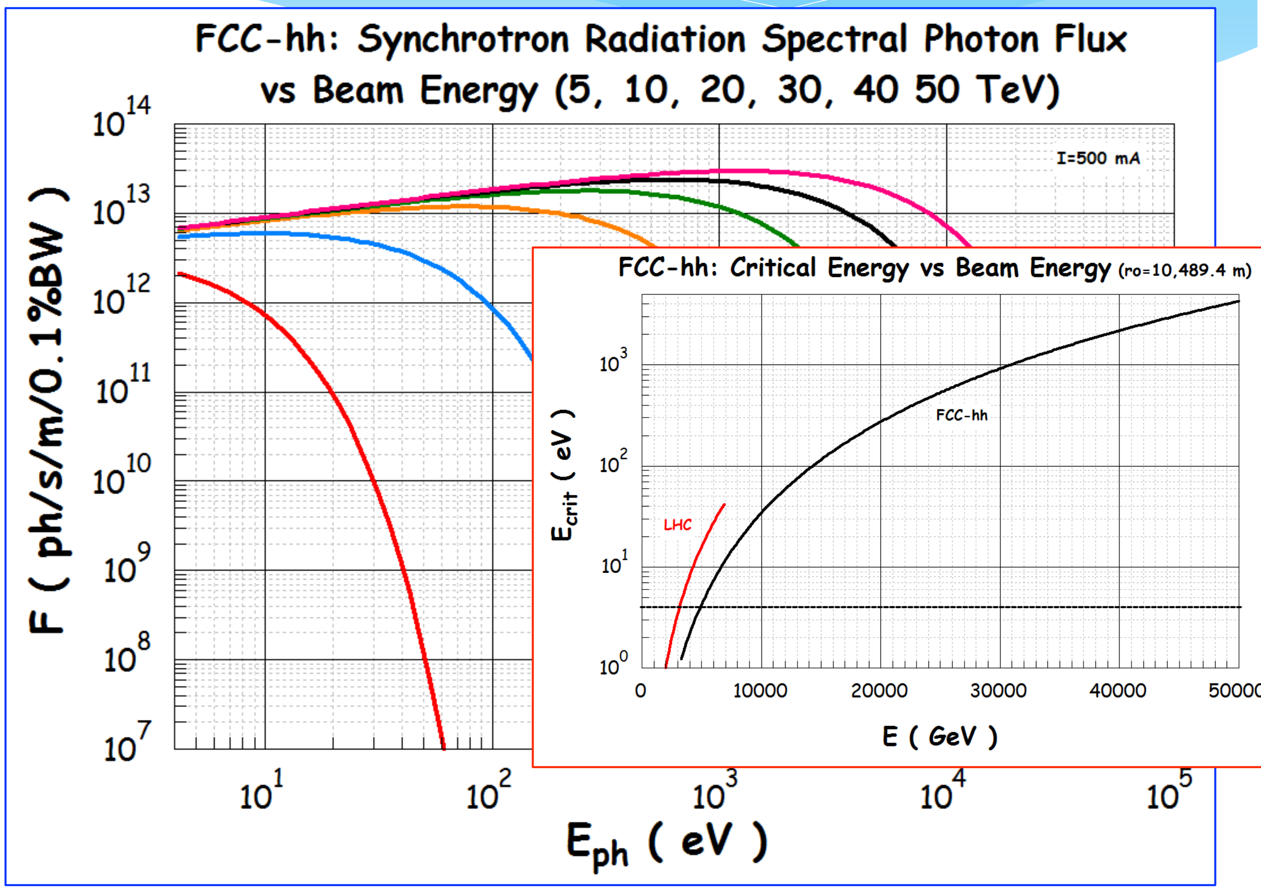
Some Thoughts About Possible Measurements with SR at DAΦNE

R. Kersevan, CERN-TE-VSC-VSM – Kick-off Meeting at LNF 14/10/2016

Although the **critical energy for FCC-hh at 50 TeV is much higher than that of the DAFNE**, it is nevertheless very likely that a future FCC-hh will have to **spend a considerable amount of time** at **lower beam energies**, during commissioning;

The several-hours-long **energy ramping time from 3.3 to 50 TeV** will need also to be **stable and void of beam- and cryo-instabilities driven by vacuum effects and SR**;

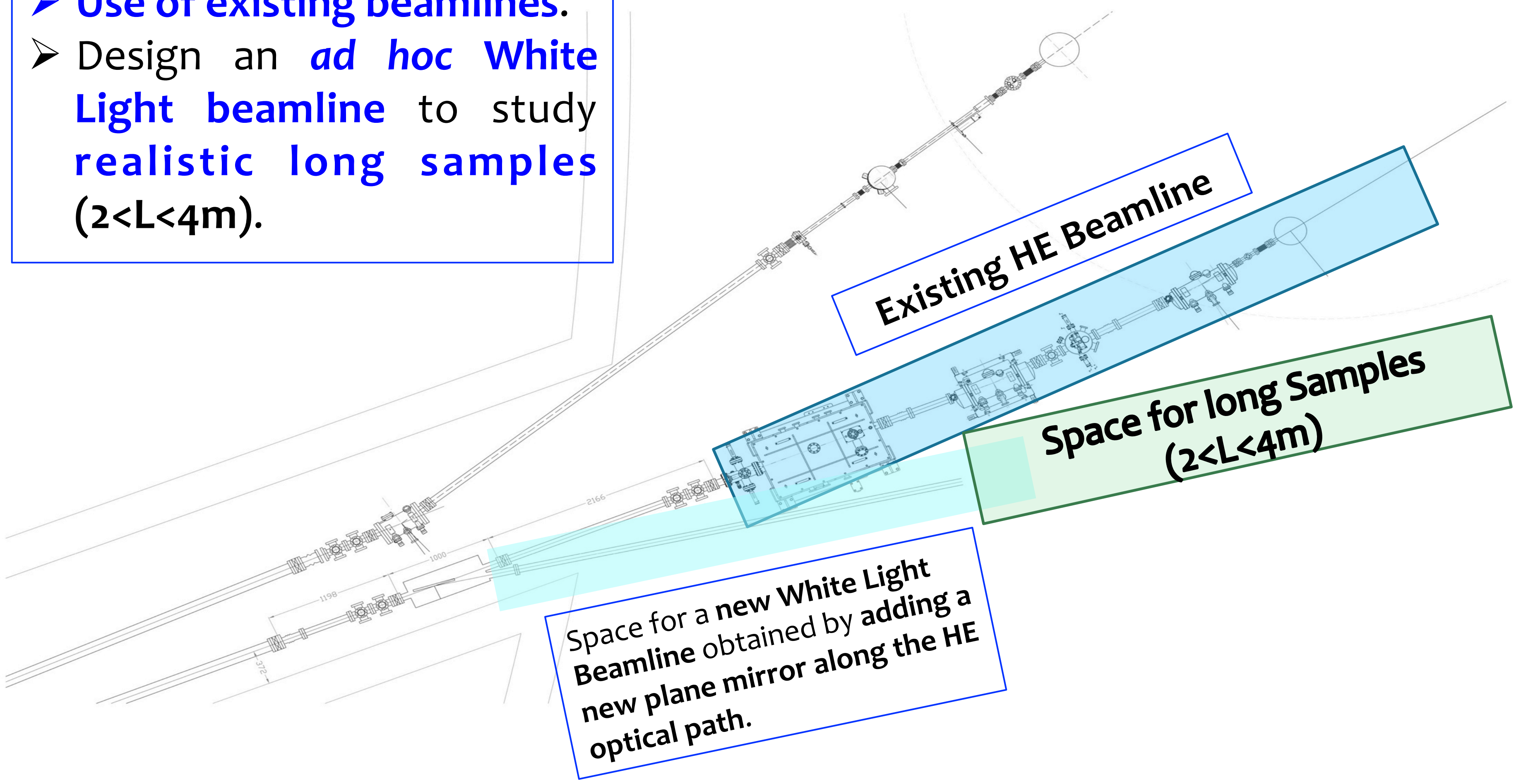
If successful, all these measurements could represent for years to come a **milestone achievement** in the fields of **vacuum and accelerator technology**, mirroring what the campaigns of similar measurements for LEP, SSC, and LHC did in the past, **which left some voids in the determination of some important parameters.**



Complementary to those are planned to be made next year at the **ANKA light source** in the framework of the **EuroCirCol collaboration**, at a critical energy of **6.2 keV** and being made at KEK Photon Factory > **4 keV** .

NEW: Use of DAFNE-L Synchrotron Radiation to perform R&D studies for High Luminosity LHC and FCC-hh.

- **Use of existing beamlines.**
- Design an ***ad hoc*** **White Light beamline** to study **realistic long samples** **(2<L<4m).**



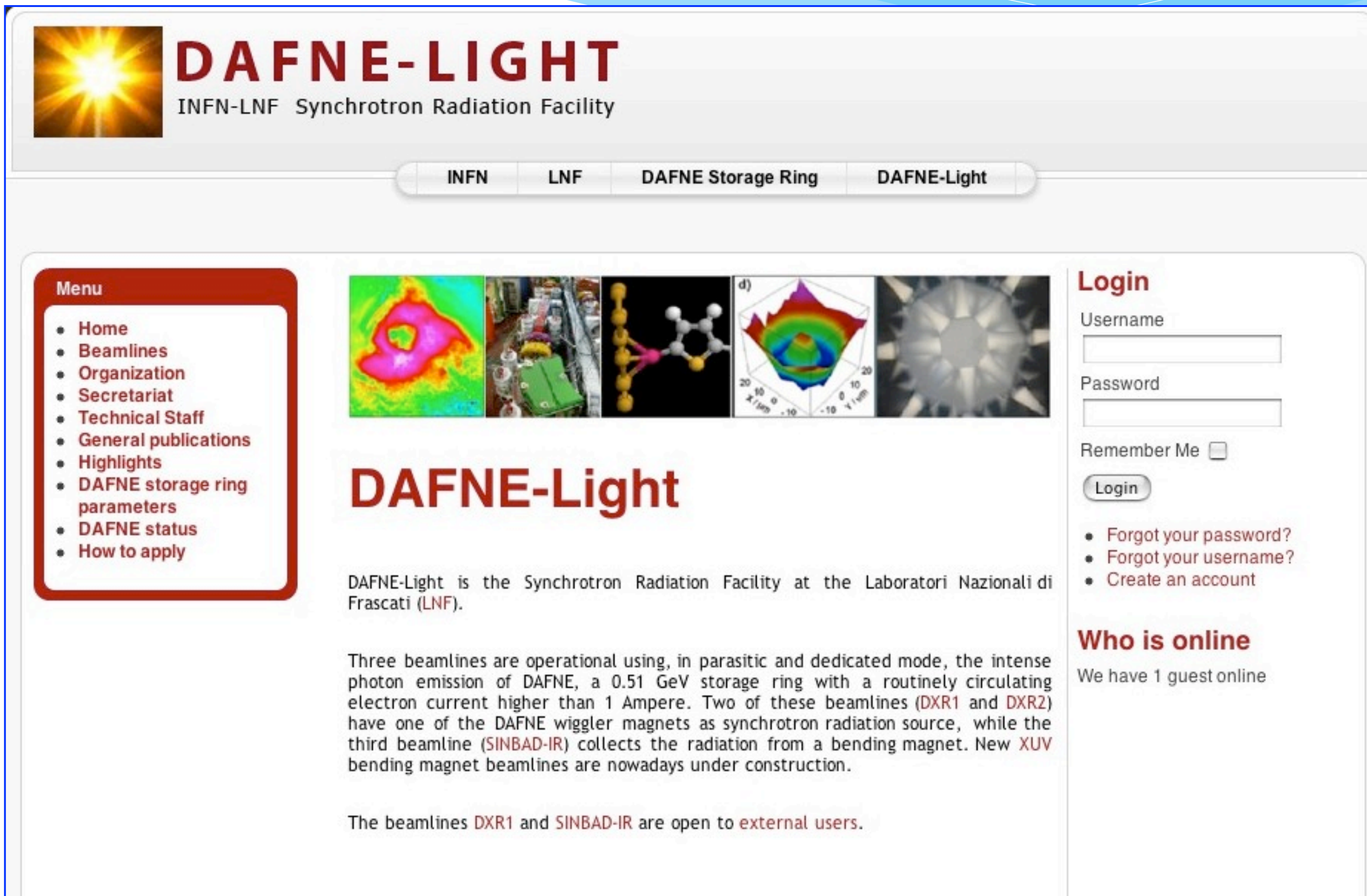
Perspectives: *A MoU with CERN to exploit the use of SR to collaborative R&D studies for High Luminosity LHC and FCC-hh.*

- From **March/June 2017** it will be possible to **use the existing beamlines** in the framework of a **CERN-INFN collaboration agreement**.

- It is conceivable at **reasonable costs and time** to open a **new WL beamline** compatible with the existing activities and **Fully Dedicated** to **Irradiate Long (2<L<4 m) Pipes** for **Grazing Reflectivity**, **PY** and **Desorption** (***eventually at Low T and in Magnetic field***). Irradiations will take place in the lab with full accessibility during studies making the system flexible and easy to use.

- **Combining small spot** (WL and Monochromatic) **studies with the ones on realistic beam pipes**, is a fundamental issue to **better understand most phenomena involving SR and Material Science in Accelerators**.

More information on the DAΦNE- Light facility
http://web.infn.it/DAFNE_Light



Some References 2015-2016

References

1. **S. Visentin, N. Barbero, F. Bertani, M. Cestelli Guidi, G. Ermondi, G. Viscardi a**nd V. Mussi, *Multivariate Analysis Applied to Raman Mapping of Dye-Functionalized Carbon Nanotubes: a Novel Approach to Support the Rational Design of Functional Nanostructures*, ***Analyst*** 150 , 5754 (**2015**)
2. **D. Di Gioacchino, A. Marcelli, A. Puri**, A. De Sio, M. Cestelli Guidi, Y. Kamili, G. Della Ventura, A. Notargiacomo, P. Postorino, **S. Mangialardo, E. Worner, E. Pace**, *Graphitic Patterns on CVD Diamond Plate as Micro heating/Thermometer Devices*, ***ACS Appl. Mater. & Inter.*** 7 , 10896 (**2015**)
3. **I.V. Kityk, M. Chrunik, A. Majchrowski, M. Cestelli Guidi, M. Angelucci, G. Kamel, A.O. Fedorchuk, M. Pepczynska, L. R. Jaroszewicz, O. Parasyuk, I. M. Bolesta, R. Kowerdziej**, *Second-order susceptibility spectra for* δ*-BiB*$_3$*O*$_6$ *polymer nanocomposites deposited on the chalcogenide crystals*, ***Spectrochim. Acta Mol. Biomol***. 146 , 187 (**2015**)
4. **G. Della Ventura, F. Radica, F. Bellatreccia, C. Freda, M. Cestelli Guidi**, *Speciation and diusion proles of* H_2O *in water-poor beryl: comparison with cordierite*, ***Phys. Chem. Miner***. 42 , 735 (**2015**)
5. **A. Drago, A. Bocci, M. Cestelli Guidi, A. De Sio, E. Pace and A. Marcelli**, *Bunch-by-bunch prole diagnostics in storage rings by infrared array detection*, ***Meas. Sci. Technol.*** 26 094003 (**2015**)
6. **I. Karbovnyk, P. Savchyn, A. Huczko, M. Cestelli Guidi, C. Mirri, A. I. Popo**v, *FTIR studies of silicon carbide 1D- nanostructures*, ***Materials Science Forum*** 821-823 261 (**2015**)
7. **W. M. Kwiatek, P. Zajdel, A. Kisiel, A. Szytula, J. Goraus, A. Balerna, A. Banas, P. Starowicz J. Konior, G. Cinque, A. Grilli**, *Studies of valence of selected rare earth silicides determined using Si K and Pd/Rh* $L_{2;3}$ *XANES and LAPW numerical studies*, ***Nucl. Instr Meth. B***, 364 , 76 (**2015**)
8. **F. Radica, G. Della Ventura, F. Bellatreccia, M. Cestelli Guidi,** *HT-FTIR micro-spectroscopy of cordierite: the* CO_2 *absorbance from in situ and quench experiments.* ***Phys. Chem. Min.*** 43, 69 (**2016**)
9. **A. De Sio, L. Tozzetti, Z. Wu, A. Marcelli, M. Cestelli Guidi, G. Della Ventura, H. Zhao, Z. Pan, W. Li, Y. *Guan and E. Pace*,** *Physical vapor deposition synthesis of amorphous silicate layers and nanostructures as cosmic dust analogs*, ***A&A***, 589 (**2016**)
10. **S. Yao, M. Cestelli Guidi, M. Delugin, G. Della-Ventura, A. Marcelli and C. Petibois**, *Methodology for FTIR Imaging of Individual Cells*, ***Acta Phys. Pol.*** 129, 250 (**2016**)
11. **H. Klym, I. Karbovnyk, M. Cestelli Guidi, O. Hotra and A. I. Popov**, *Optical and Vibrational Spectra of CsCl-Enriched* GeS_2*-*Ga_2S_3 *Glasses*, ***Nanoscale Res. Lett.*** 11, 132 (**2016**)

Thank you for your attention

DAΦNE Light

Synchrotron Radiation Facility

DAΦNE-Light Schools and Conferences

DAΦNE-Light other activities

The DAΦNE-Light laboratory, in 2015, has been involved in the workshop:
What Next at LNF: material science held in Frascati on the 26 and 27 of February and in the **International Schools**: **INSPYRE 2015** and **EDIT 2015.**

Within **EDIT 2015**, one of the ***two weeks laboratory courses***, was dedicated to ***synchrotron radiation with experiments and detectors tests*** performed in a wide ***energy range form IR to soft x-rays***.

Some Lectures 2015:

1. **A. Balerna**, *The synchrotron light: a brilliant torch and its uses* **, INternational School on modern PhYsics and REsearch** (INSPYRE 2015), LNF, 16-20 February 2015
2. **M. Cestelli Guidi**, *Diagnostic techniques for cultural heritage: applications of Synchrotron FourierTransform Infrared (FTIR) spectroscopy*, **INternational School on modern PhYsics and REsearch** (INSPYRE 2015), LNF, 16-20 February 2015
3. **M. Cestelli Guidi**, *FTIR microspectroscopy and imaging on single cells: experimental procedures and data handling*, 50 Zakopane **School of Physics Breaking Frontiers: Submicron Structures in Physics and Biology**, Zakopane, Poland, 18-23 May 2015
4. **A. Balerna**, *Acceleratori come sorgenti di luce* , **Open Labs 2015**, LNF, 23 May 2015
5. **A. Balerna**, *Introduction to Synchrotron Radiation*, **XIII School on Synchrotron Radiation: Fundamentals, Methods and Applications**, Grado, Italy 14-25 September 2015
6. **R. Larciprete**, *Nanotechnologies and new materials*, **International school EDIT 2015** (Excellence in Detectors and Instrumentation Technologies), LNF, Frascati, 20-29 October 2015
7. **M. Cestelli-Guidi**, *La spettroscopia IR e i Beni Culturali: gli spettri ed i materiali*, **Scuola di Spettroscopia IR Applicata alla Diagnostica dei Beni Culturali**: IV edizione – Venaria Reale (TO), 9-12 November 2015.

DAΦNE-Light other activities

Some conference Talks 2015:

1. **A. Balerna**, *The DAFNE-Light facility*, Workshop What Next at LNF: Scienza dei materiali. LNF, Frascati, 26-27 February 2015.

2. **M. Cestelli Guidi**, *Infrared Imaging*, Workshop What Next at LNF: Scienza dei materiali. LNF, Frascati, 26-27 February 2015.

3. **R. Cimino**, *Material Science applied to HEP accelerators*, Workshop What Next at LNF: Scienza dei materiali. LNF, Frascati, 26-27 February 2015.

4. **R. Larciprete**, *Growth, characterization and applications of new two dimensional materials,* Workshop What Next at LNF: Scienza dei materiali. LNF, Frascati, 26-27 February 2015.

5. **E. Pace**, *Diamond detectors*, Workshop What Next at LNF: Scienza dei materiali. LNF, Frascati, 26-27 February 2015.

6. **G. Kamel**, *Biomedical Applications of FTIR-Microspectroscopy at SINBAD*. The 6th International Conference on Optical Spectroscopy, Laser and their Applications, NRC, Cairo, Egypt, 07-09 April 2015

7. **R. Cimino**, *Low Energy Secondary Electron Yield and Material Science studies at LNF for next generation Accelerator systems*, International Workshop on Functional Surface Coatings and Treatment for UHV/XHV Applications, Chester (UK), 30 September 2015

8. **A. Balerna**, *DAFNE-Light INFN-LNF synchrotron radiation facility*, RAIN15 – Radiazione per l'INnovazione 2015, LNF - ENEA , Frascati, 12-13 October 2015.