

DAΦNE-Light INFN-LNF Synchrotron Radiation Facility



Antonella Balerna

INFN-LNF C. L. Aperto 6-7 July 2010

Beamlines @ DAΦNE

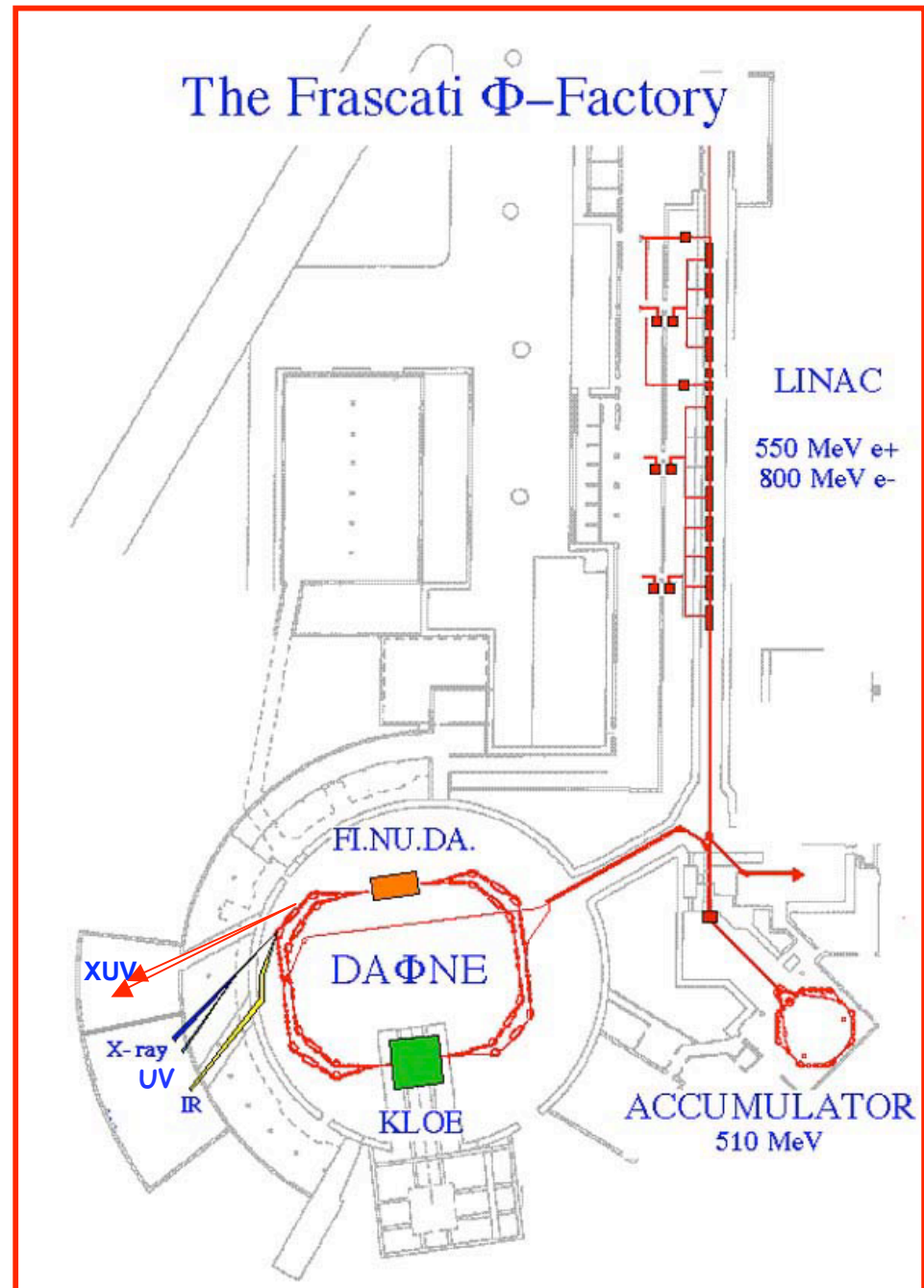
DXR1 - Soft x-ray beamline (900 eV - 3000 eV open to users)

DXR2 - UV beamline (2 eV - 10 eV)

SINBAD - Infrared beamline (1.24 meV to 1.24 eV open to users)

DXUV - Two new XUV beamlines (Low Energy Beamline (35-200) eV and High Energy Beamline (60-1000) eV)

*Schematic
view of the
DAΦNE-Light
Facility*



Scientists involved

DXR1 - Soft X-ray beamline - Antonella Balerna

DXR2 - UV beamline - Emanuele Pace (Univ. Firenze)
collaborations with **Antonio De Sio (Ass. Ric. Univ. Firenze)** - **Lisa Gambicorti (Ass. Ric. CNR-INOA)**

SINBAD - Infrared beamline - Mariangela Cestelli-Guidi (INFN Art. 23 - ?) - Chiara Mirri (EU contract from July 2010) - Seydoo Yao (PhD student)

DXUV- New XUV beamlines - Roberto Cimino - (LEB) Mario Commisso (Ass. Ric. LNF up to April 2011) - Valentin Nistor (Collab.) - (HEB) Davide Remo Grosso (PhD student) - Rosanna Larciprete (CNR)

Technical staff

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

Secretariat

Silvia Colasanti

OTHER SERVICE INVOLVED IN THE UPGRADE OF THE DAΦNE-L BEAMLINES

Servizio Elettronica ed Automazione

2009/2010

- Consegnato il controllo e gestione delle linee a Bassa Energia LEB e della Camera degli Specchi nuove linee XUV.
- Realizzazione del software per il controllo di quattro motori step (Controllori SIM-Step) per la "Mirror Box" e ampliato il programma per la gestione del Kiethley 6517B linea UV-VIS
- Implementazione sistema di controllo gas camere ad ionizzazione della linea Soft-X
- Revisione dei field point per controllo e sicurezze linee

2010/2011

- Richiesta realizzazione del controllo valvole - vuoto anche per la seconda linea HEB XUV.
- Richiesto sistema di controllo e acquisizione dati per la linea UV-Vis

Activity
2009 - 2010 - 2011

Recent and future activities at the DAΦNE-Light Beamlines

The **IR** and the **Soft X-ray** beamlines already open to users will go on delivering beam time to **Italian, EU** and **external EU users**, in the framework of the **INFN-Group V experiments**, of collaborations with **Italian Universities**, of the **Transnational Access to Research Infrastructures (FP7 E.Li.S.A. (from August 2009)) program** and of **collaborations using F.A.I. (2009/2010)**.

2009 (February to July and September to October)
23 weeks - 12 dedicated beamtime days
4 FAI experiments - 9 Italian experiments

The **new setup** of the **UV branch** line will **be completed in 2010**.

At the end of **2010** one of the two **new XUV beamlines**, the one with the **energy range (35-200) eV** will start the **commissioning**, while the **high energy one** will be ready in **2011**.

Integrated Infrastructure Initiative (I3) - FP7 E.L.I.S.A.

European LIght Sources Activities



E.L.I.S.A.

has two strategic objectives:

- 1 to *support transnational users of national facilities* in the domain of *synchrotron* and *FEL science*;
- 2 to *support joint research activities* (JRAs) with the purpose of: *a) enhancing the effectiveness of the facilities* in giving beamtime to users and in particular transnational users. *b) contributing to the development of novel sources* in this domain



E.L.I.S.A. is a program for *research cooperation involving 17 laboratories and institutions throughout Europe*. This corresponds to the *world largest network of synchrotron and FEL facilities*.

Status of the DAΦNE-Light Beamlines

*1) VUV beamlines LEB : ready for
commissioning end of 2010; HEB: under
construction (commissioning in 2011)*

*2) DXR2 UV beamline: new setup ready in
2010*

*3) SINBAD-Ir beamline: open to users +
upgrades on IR imaging*

*4) DXR1 soft x-ray beamline: open to users +
some upgrades*

New XUV beamlines

LEB (35-200 eV) commissioning by the end of 2010
HEB (60-1000 eV) commissioning in 2011

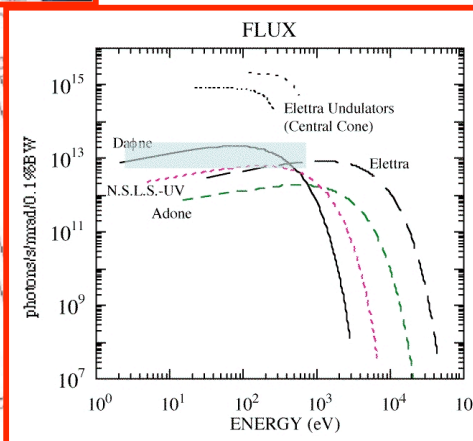
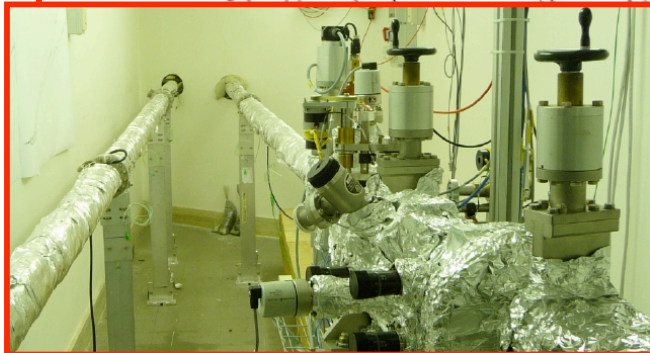
Fields of interest:

Biology

Surface Science

Material Science

R&D studies of INFN interest



IMCA-NTA INFN

project: **I**nnovative
Materials and **C**oatings for
Accelerators

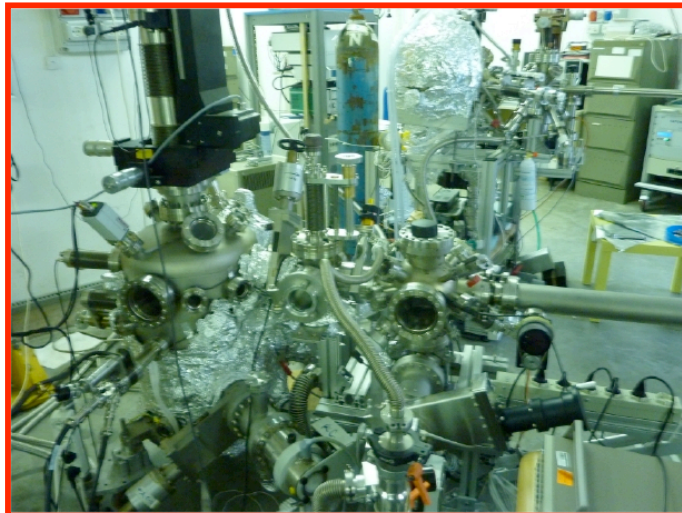
R&D of new materials and
thin films useful to
minimize beam instabilities
due to '*e-cloud*'.

Roberto Cimino

Status of the XUV LEB (35-200 eV)



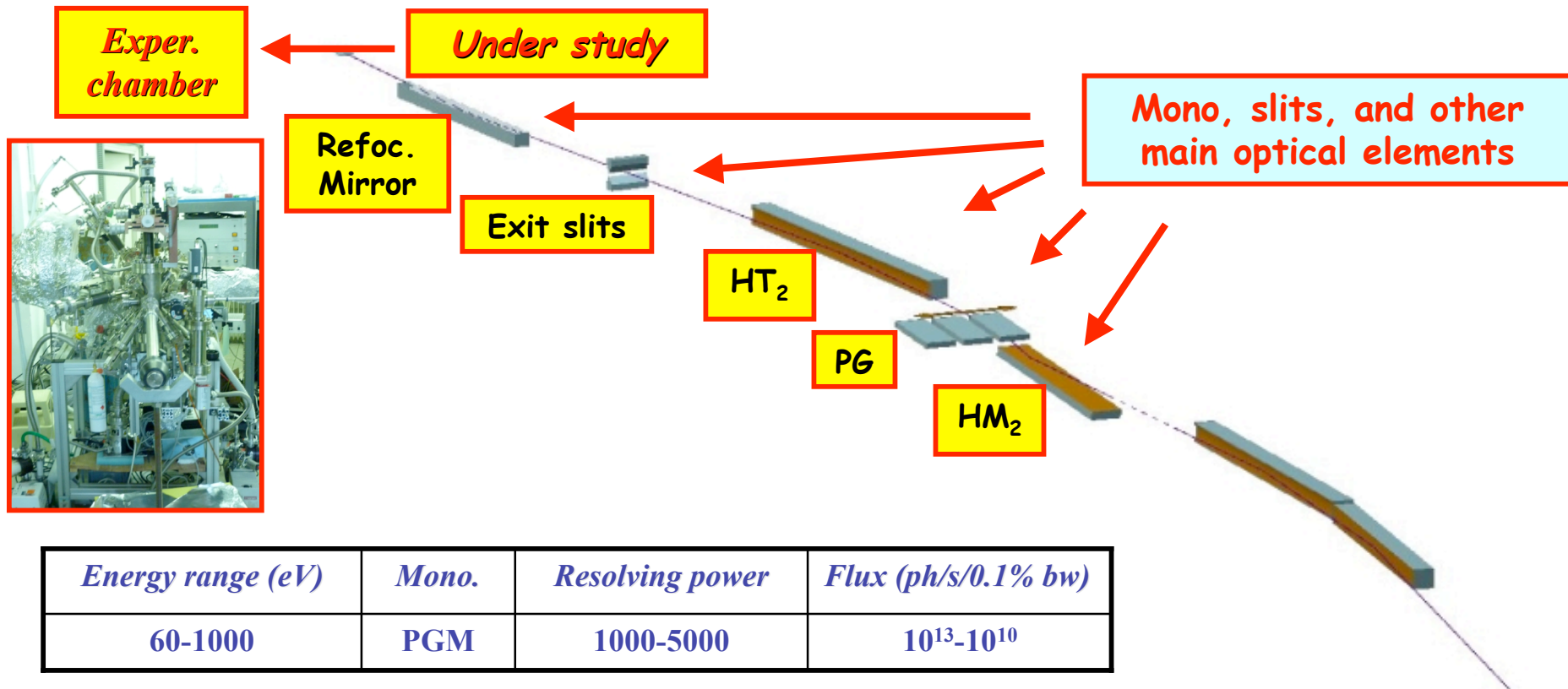
All the *optical and vacuum components* of the LEB beamline did become *available during 2008-2009*, and the DAΦNE-L team worked to mount them in the foreseen position.



The 2009 has been also devoted to the optimization of a 'state of the art' *spectroscopic chamber*, in order to be able to do *angle resolved photoemission experiments, also at low temperature*. This system has been *tested* at length during this year and *a fast load-lock system has been implemented* in order to be able to change samples to be studied with SR without breaking vacuum.

LEB - R. Cimino, M. Commisso (Ass. Ric. Maggio 2011), V. Nistor (Coll. Straniero Ottobre 2010)

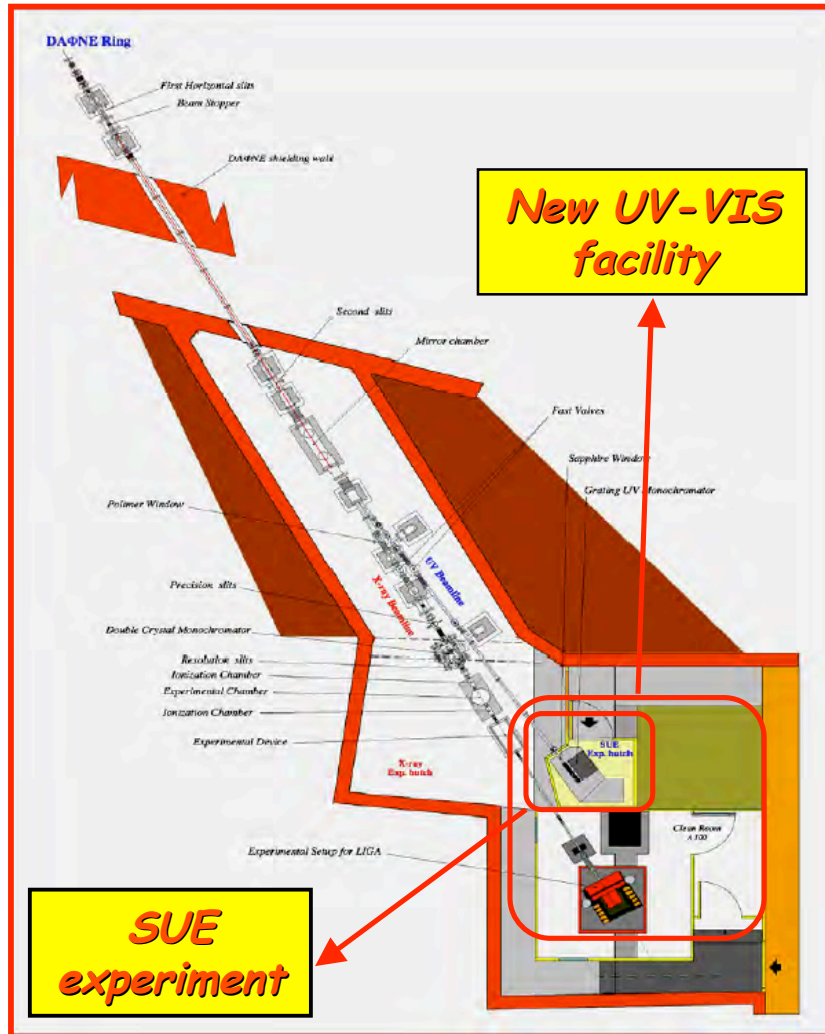
Status of the XUV HEB (60-1000 eV)



The optical elements and UHV vacuum chambers needed for the construction of the *HEB* have been ordered. Some were delivered in 2009, some (like the *PGM monochromator*) are still under construction and will be delivered by the end of 2010. Also for this beamline an *experimental set-up to perform SR photoemission and absorption spectroscopy in UHV condition* is under study. The setup will be ready within next year thanks to the active *collaboration with R. Larciprete (C.N.R.)* both for human resources and goods.

HEB - R. Cimino, R. Larciprete (CNR), D.R. Grosso (PhD 2011)

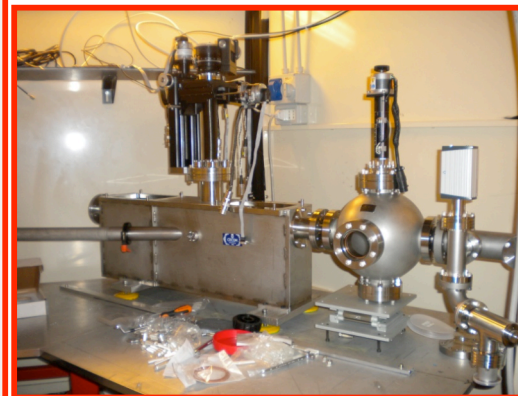
DAΦNE UV branch line: new setup



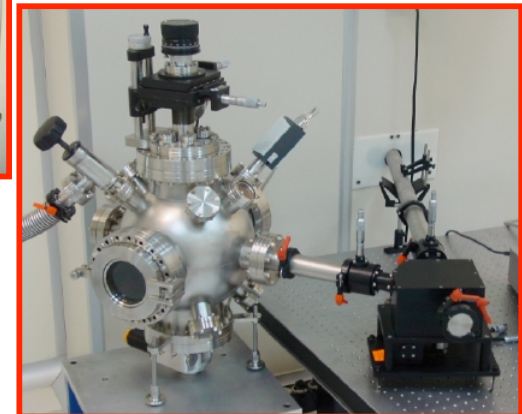
Wiggler UV branch line-deflection by a grazing incidence gold coated mirror (about 2 degrees)

UV beamline new setup **2 -10 eV**
(650nm - 120nm)

Branch line in a 1000-class clean room



Upgraded UV-VIS monochromatic radiation source (180-650 nm)



VUV monochromatic radiation 120-250 nm

Emanuele Pace

Present-2010

- *Completato il progetto ottico* di tutta la linea e delle uscite UV-VIS e VUV
- Fase di *montaggio della linea che sarà completato a fine settembre 2010*
- Progettato e in fase di *sviluppo il controllo software della linea* e degli strumenti
- Avviato il progetto per il canale polarimetrico

Past-2009

Nel 2009 si è scelto quindi di *fare esperimenti con il setup esistente* e rinviare l'upgrade della linea a dopo la fermata di DAΦNE.

Le *misure eseguite da giugno a novembre 2009* sono state:

- 2 sessioni di *irraggiamento UV su formammide in presenza di grani di TiO₂ per verificare la produzione di molecole organiche* (sottomesso a *Science* e da presentare alle conferenze VUVX2010 e COSPAR2010)
- *misure dei rivelatori UV a diamante sintetico*, caratterizzati poi nei raggi X sia a GILDA in Francia che a SSRF e NSRL in Cina (Proc. SRI09 e da presentare a VUVX2010)
- *Caratterizzazione dei nuovi fotodiodi XUV* acquistati per monitorare e misurare il flusso della radiazione di sincrotrone

Future 2010-2011

- **Commissioning delle 3 diverse uscite** [(280-320) nm - (120-250) nm - (180-650 nm)] con le lampade convenzionali e con **la radiazione di sincrotrone** (dipendente dalla disponibilità di fasci di luce)
- Completamento del canale polarimetrico
- **Completamento del software di controllo della linea** (richiesta di tempo al Servizio elettronica e automazione)
- Apertura delle linee a richieste di utenti
- **Misure su materiali organici e inorganici per il progetto PRIN2008** "Materiale extra-terrestre primitivo come memoria dei processi evolutivi nel Sistema Solare primordiale"
- **Irraggiamenti di materiali organici in presenza di catalizzatori inorganici** (Saladino et al., Univ. Tuscia di Viterbo)
- **Test di rivelatori CCD** della missione suborbitale su razzo SCORE/HERSCHEL
- **Test del rivelatore CCD dello spettrometro CAOS**, strumento di piano focale del telescopio dell'Osservatorio di Catania a Serra La Nave.
- **Test di rivelatori di radiazione UV basati su diamante** per caratterizzare la risposta a impulsi ultra corti (2.7 ns) e la risoluzione temporale.

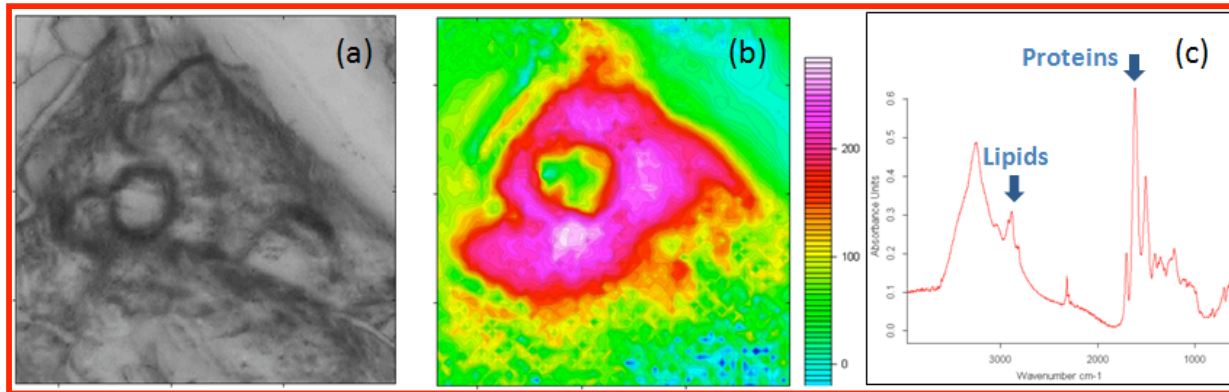
Partnership

- **INFN - LNF**
- **INFN - Firenze**
- **Università di Firenze - Antonio De Sio (Ass. Ric.)**
- **CNR - Istituto Nazionale Ottica Applicata (INOA)**
Lisa Gambicorti (Ass. Ric.)

SINBAD
Synchrotron INfrared Beamline At DAΦNE

Mariangela Cestelli-Guidi (art. 23)

A bright future for synchrotron IR imaging



(a) Visible image of a *skeletal muscle connective tissue* showing insertion between endomysium and perimysium . The image size is 170x170 μm . (b) Infrared image of the tissue with 1.3 μm pixel resolution (c) A typical absorption spectra where different cell contributions are resolved: proteins (amide I @1715-1600 cm^{-1}) and lipids (fatty acyl chains @3020-2880 cm^{-1}).

Among the analytical techniques able to yield molecular information about biological samples, there is a *growing interest in Fourier transform infrared (FTIR) microscopy*. A synchrotron source has the capability of providing infrared light through a 10 μm pinhole that is 2-3 orders of magnitude brighter than a conventional IR source. A superior signal-to-noise ratio is expected to allow imaging with a spatial resolution down to the diffraction limit.

The availability of the infrared focal plane array (FPA) detector and its recent installation at ultra-bright synchrotron radiation facilities around the world promise to reduce data acquisition time from hours to minutes, improving the spectral quality and overcoming possible contributions from synchrotron radiation instability. There is thus *a brilliant future for infrared synchrotron microscopy and imaging, and important results in biological and biomedical applications are expected in the coming years.*

C. Petibois, G. Deleris, M. Piccinini, M. Cestelli-Guidi, A. Marcelli, *Nature Photonics* 3, 179 (2009)

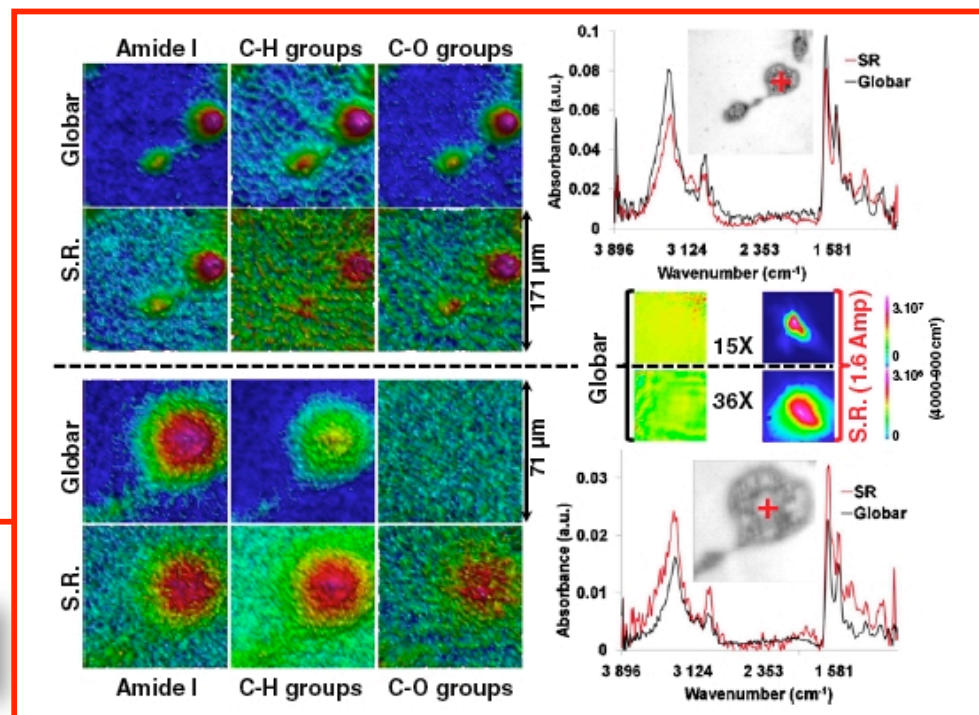
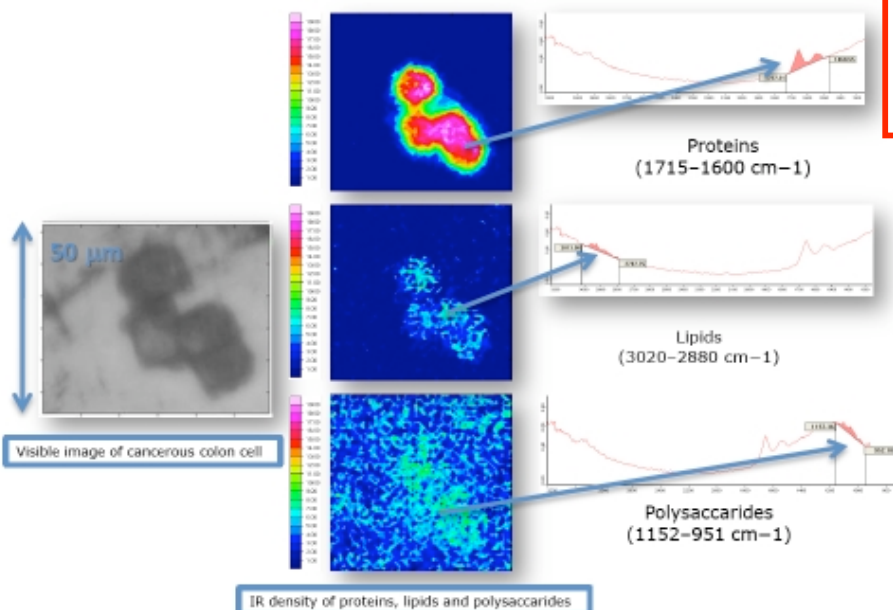
FTIR imaging

FTIR imaging - comparison between the use of **synchrotron radiation** and of a **conventional source**.

Synchrotron radiation FTIR imaging in minutes: a first step towards real-time cell imaging

C. Petibois, M. Cestelli-Guidi, M. Piccinini, M. Moenner, A. Marcelli *Anal. Bioanal. Chem* 397,2123 (2010)

FT-IR chemical imaging on cryofixed cells



FTIR imaging - chemical mapping of the cells

SINBAD-IR beamline new components and upgrade

- *Focal plane array (FPA) detector* (64x64 pixel with 40 μm pixel size) installed on IR Microscope Bruker Hyperion 3000. Using the 15X objective it is possible to cover an area 170x170 μm^2 with about 3 μm resolution-
- *Tested and used*
- *New cryostat* (T range= 4-500K)
- *High Pressure experiments* with a *DAC* (Diamond anvil cell) in the MIR & FIR
- *Reflectivity* experiments down to 4K
- At the end of 2009 *two mirrors* were bought, to *replace the first mirror* of the beamline and to *connect the second experimental station* to the SR source.
- New *instrumentation for biological samples treatment* (small microtome, thermo-controlled bath, freezer(-85 $^{\circ}\text{C}$), N_2 cryo-conservator for cells, etc)
- In 2011 proposal for a *new setup for the IR interferometer*

Activity 2010 and new projects

2010 (January to June)

40 days - Using conventional source

2 FAI experiments - 4 Italian experiments

- Project 'Vinci' Italy-France:

BORSE TRIENNALI PER DOTTORATI DI RICERCA IN CO-TUTELA;

Studente di Dottorato: *Seydou YAO* (Univ. Bordeaux/Univ. Rm3)

Titolo della tesi: *Immagini FTIR ad alta risoluzione dell'interazione fibra-cellula per lo studio degli effetti patogeni dell'amianto*

- PRIN 2008 (LNF collaboration with UDR Roma3)

Materiale Extraterrestre Primitivo come memoria dei processi evolutivi nel Sistema Solare primordiale

- INFN Group V experimental proposal submitted in June 2010 'LiveCell'

Development of an optical device for in-vitro infrared imaging on live single cells

Some SINBAD beamline 2009/2010 publications

E. M. Sheregii, J. Cebulski, A. Marcelli and M. Piccinini, Temperature Dependence Discontinuity of the Phonon Mode Frequencies Caused by a Zero-Gap State in HgCdTe Alloys, *Phys. Rev. Lett.* **102**, 045504 (2009)

M. Baldini, D. Di Castro, M. Cestelli-Guidi, J. Garcia, and P. Postorino, Phase-separated states in high-pressure $\text{LaMn}_{1-x}\text{GaxO}_3$ manganites, *Phys. Rev. B* **80**, 045123 (2009)

C. Petibois, G. Deleris, M. Piccinini, M. Cestelli Guidi and A. Marcelli, A bright future for synchrotron imaging, *Nature Photonics* **3**, April 2009.

P. Innocenzi, L. Malfatti, M. Piccinini, A. Marcelli, D. Grosso, Stain effect studied by time-resolved infrared imaging, *Analytical Chemistry* **81**, 551 (2009)

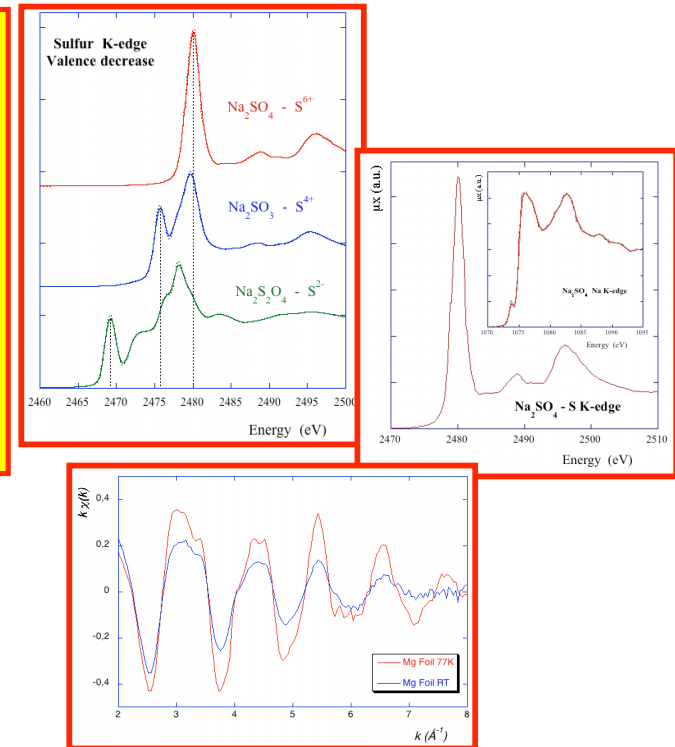
A. Nucara, P. Masel, P. Calvani, R. Sopracase, M. Ortolani, G. Gruener, M. Cestelli Guidi, U. Schade and J. Garcia, Sub-Terahertz Excitations in Manganites with Commensurate Charge Order, *J. Supercond. Nov. Magn.* **22**, 13 (2009)

C. Petibois, M. Piccinini, M. Cestelli Guidi and A. Marcelli, Facing the challenge of biosample imaging by FTIR with a synchrotron radiation source, *J. Synch. Rad.* **17**, 1 (2010)

DXR1 Soft X-ray Beamline DXR1

- Wiggler soft x-ray beam line
- Critical energy $E_c = 284 \text{ eV}$
- Working range $0.9 - 3.0 \text{ keV}$
- The *monochromatic photon flux* as a function of photon energy, monochromator crystals used and DAΦNE current is between 10^7 and 10^9 ph/s .

In 2009 mirror exposure in the DAΦNE-Light facility for *exploring the effect of soft X-ray on the performance of mirrors coated with protective dielectric coatings (International Thermonuclear Experimental Reactor (ITER))* to investigate morphological and chemical changes occurring in a carbon layer deposited on the mirrors under high soft X-ray dose as well as the characterization of optical properties modifications of mirrors coated with dielectrics.



Antonella Balerna

M.A Evsyukova, G. Yaloga, A. Balerna, A.P. Menushenkov, Ya V. Rakshun, A.A. Teplov, M.N. Mikheeva and A. V. Soldatov, Crystal-quasicrystal transition in the Al-Cu-Fe system: Analysis of the local atomic structure. *Physica B* 405, 2122 (2010)

R. Sathyamoorthy, P. Sudhagar, A. Balerna, C. Balasubramanian, S. Bellucci, A.I. Popov and K. Asokan, Surfactant-assisted synthesis of $\text{Cd}(1-x)\text{Co}(x)\text{S}$ nanocluster alloys and their structural, optical and magnetic properties. *Journal of Alloys and Compounds* 493, 240 (2010)

DAΦNE Soft X-ray Beamline :

new components installed and tested in 2009-2010

In 2009 a new system to *electronically control and set the pressure of the ionization chambers of the soft X-ray experimental chamber*, including the a sensor, a control valve and a computer interface, has been installed and tested while concerning the X-ray beam alignment a relevant improvement was effectively given by the installed *fluorescent target* and the *double wire beam monitor* also if some improvements are still necessary and will be performed in 2010.



New components needed:

- *new remote controlled sample linear translator*
- *($\theta - 2\theta$) goniometer for soft X-ray optics tests*
- *new software* for measurements in fluorescence and total yield mode and beam-monitor mapping.

*More information about the
DAΦNE- Light facility*

<http://www.inf.infn.it/dafnel>



DAFNE-LIGHT

INFN-LNF Synchrotron Radiation Facility

INFN

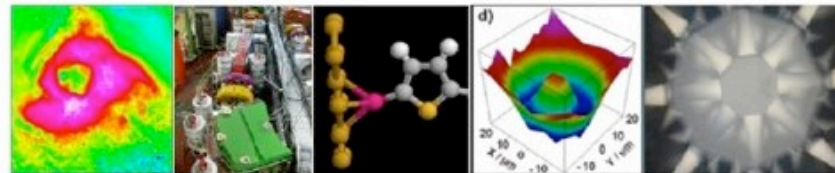
LNF

DAFNE Storage Ring

DAFNE-Light

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DAFNE-Light

DAFNE-Light is the Synchrotron Radiation Facility at the Laboratori Nazionali di Frascati (LNF).

Three beamlines are operational using, in parasitic and dedicated mode, the intense photon emission of DAFNE, a 0.51 GeV storage ring with a routinely circulating electron current higher than 1 Ampere. Two of these beamlines (DXR1 and DXR2) have one of the DAFNE wiggler magnets as synchrotron radiation source, while the third beamline (SINBAD-IR) collects the radiation from a bending magnet. New XUV bending magnet beamlines are nowadays under construction.

The beamlines DXR1 and SINBAD-IR are open to external users.

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Who is online

We have 1 guest online

*Thank you for your
attention*