

DAΦNE-Light

INFN-LNF Synchrotron Radiation Facility



Description of the facility and of some recent activities

Antonella Balerna

38th LNF Scientific Committee May 11th, 2009

Beamlines @ DAΦNE

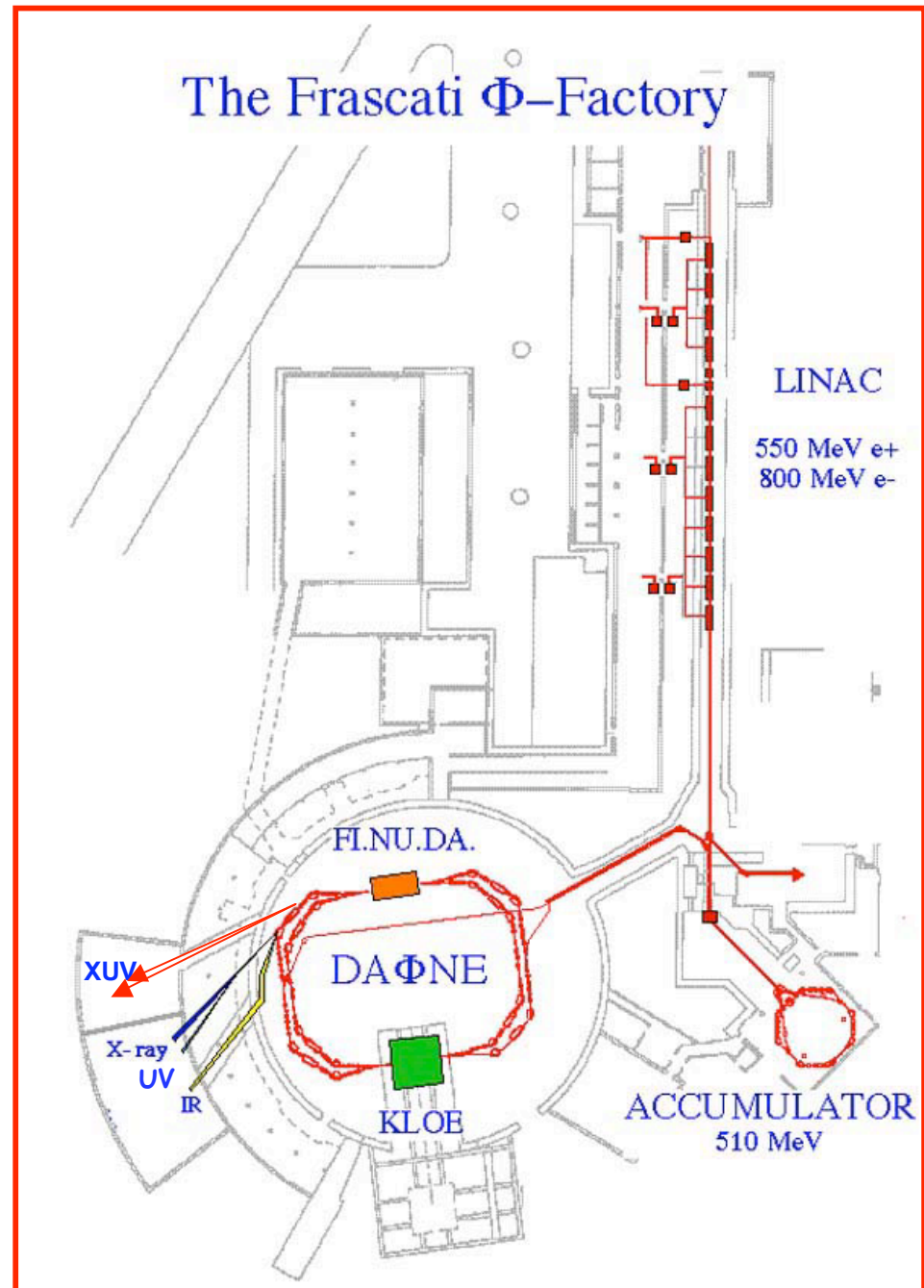
*DXR1 - Soft x-ray beamline (900 - 3000 eV
open to users)*

DXR2 - UV beamline (2 - 10 eV new setup)

*SINBAD - IR beamline (1.24 meV to 1.24 eV
open to users)*

*DXUV - 2 new XUV beamlines (30 - 1000 eV
under construction)*

*Schematic
view of the
DAΦNE-Light
Facility*



Scientists involved

DXR1 - Soft X-ray beamline - Antonella Balerna

DXR2 - UV beamline - Emanuele Pace (Univ. Fi) & Dariush Hampai (Ass. Ric. Roma1 - Up to 31/12 /2010)

SINBAD - Infrared beamline - Mariangela Cestelli-Guidi (INFN Art. 23 - ?) & Massimo Piccinini (Univ. Sassari from 2009)

DXUV- New XUV beamlines - Roberto Cimino & Mario Commisso (Ass. Ric. LNF up to 30 / 4 / 2011) - Shen Ning (Collab. Italy-Cina)

Activity
2008 - 2009

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** and of the **Transnational Access to Research Infrastructures** (Contracts **FP6 Hadron Physics (2008) - FP7 E.Li.S.A. (2009)**) **program**. A part of the not dedicated beam time will be used to make **tests to improve the beam line performances**

The **new setup** of the **UV branch** line will **be completed in 2009**.

At the end of **2009** one of the two **new XUV beamlines**, the one with the **energy range 30 eV - 200 eV** will be open to users, while the **high energy one** will be ready by the **end of 2010**.

SINBAD-IR and DXR1 Soft X-ray beamlines activity

2006 (from January to March)

10 weeks - 7 dedicated beamtime days

5 TARI (EU) experiments - *8* Italian experiments (GV and University)

2007 (from January to May)

18 weeks - 13 dedicated beamtime days

14 TARI (EU) experiments - *12* Italian experiments - *1* Non EU
experiment

2008 (March to July and October to December)

27 weeks - 15 dedicated beamtime days

13 (9+4) TARI (EU) experiments - *9* (6+3) Italian experiments

*Transnational Access to Research
Infrastructures
2008*

TARI IR: 63 (Rois 1 week), 64 (Roy 3 weeks),
67 (Paluszkiewicz 2 weeks), 72 (Petibois 7
weeks), 73 (Rokita 1 week), 75 (Banas 1 week),
76 (Berzina 3 weeks), 81 (Rokita 1 week), 83
(Paluszkiewicz 2 weeks).

TARI X: 68 (Zhukovskii 1 week), 74 (Fichtner
1 week), 79 (Zhukovskii 1 week), 88
(Zuburtikudis 1 week)

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***.

Workshop WUTA08

on
UV Techniques and
Applications

8-10 October 2008

WUTA08

1st Italian Workshop on UltraViolet Techniques and Applications

Frascati, 8-10 ottobre 2008
LNF - Aula Bruno Touschek

The workshop is aimed at reviewing the state of the art of Italian experiments using UV radiation and to pave the way for future applications. Scientists working with UV radiation in astrophysics, biology, metrology, physics, chemistry, materials science, interferometry, optics and detectors are invited to present their contribution. Emphasis will be given to SR and FEL applications, but contributions based on conventional sources are welcome.

Scientific Committee

Emanuele Pace (Universita' di Firenze - INFN, Firenze)
Augusto Marcelli (INFN LNF, Frascati)
Marcello Coreno (CNR IMP, Area della Ricerca di Roma 1)
Nicola Zema (CNR ISM, Roma)
Rosa Maria Montecchi (ENEA, Frascati)
Maurizio Benfatto (INFN LNF, Frascati)
Sultan Dabagov (INFN LNF, Frascati)

Chairmen

A. Marcelli
E. Pace

Organizing Committee

Antonio De Sio, Lisa Gambicorti,
Alessandra Giannini, Elisabetta Greco, Darlush Hampal

Secretary

Elisabetta Greco: greco@fi.infn.it
tel 0554572079 e fax 0554572125

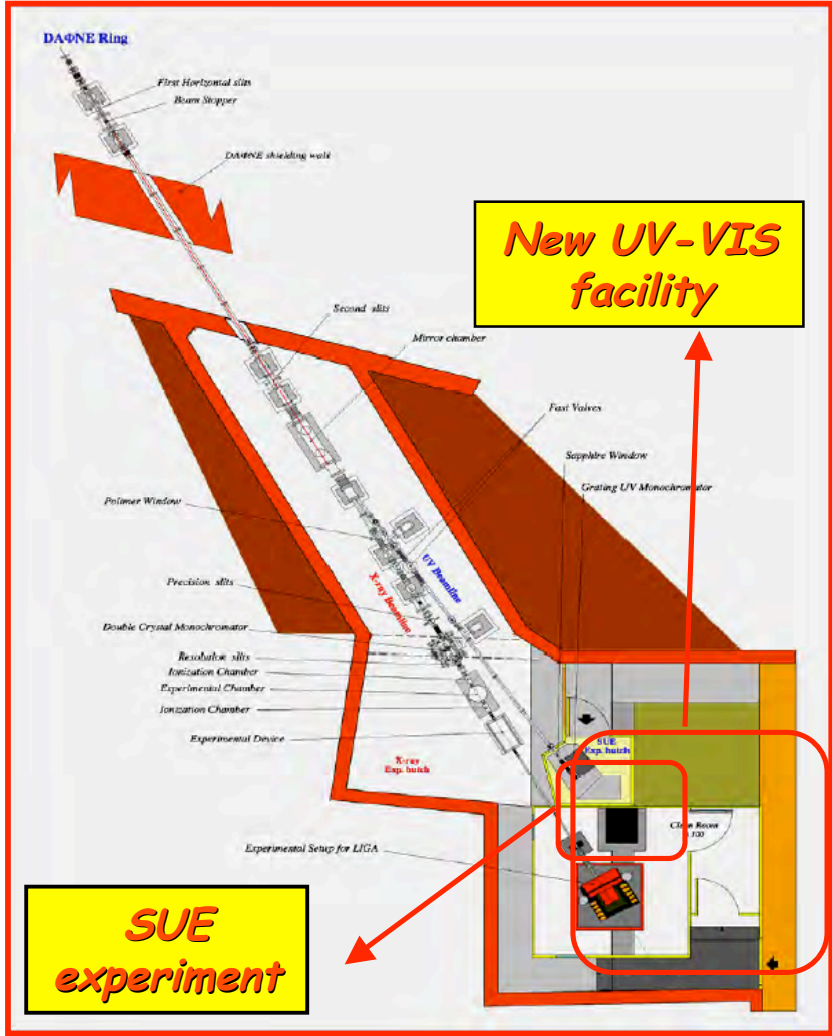
<http://www.inf.infn.it/conference/wuta08>



Status of the DAFNE-Light Beamlines

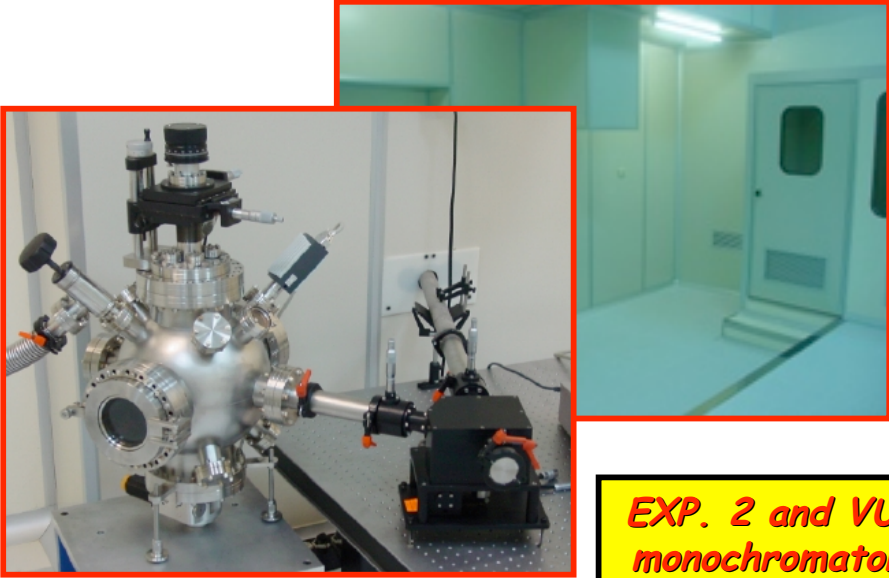
- 1) DXR2 UV beamline: new setup*
- 2) VUV beamlines LEB and HEB: under construction*
- 3) SINBAD-Ir beamline: upgrade*
- 4) DXR1 soft x-ray beamline: upgrade*

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)



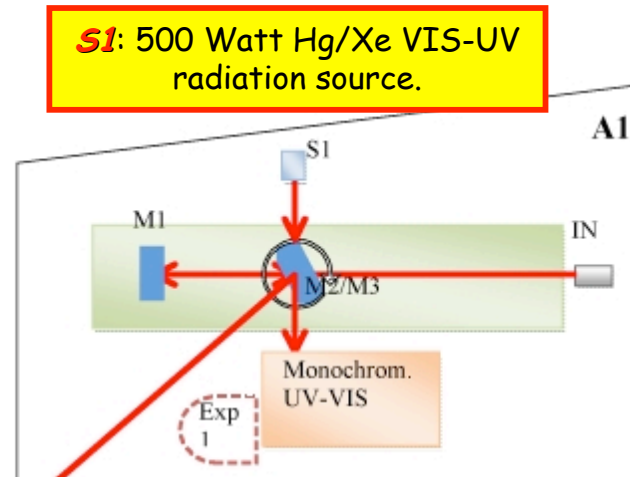
EXP. 2 and VUV monochromator.

Emanuele Pace and D. Hampai

Layout of the experimental stations at VIS-UV beamline

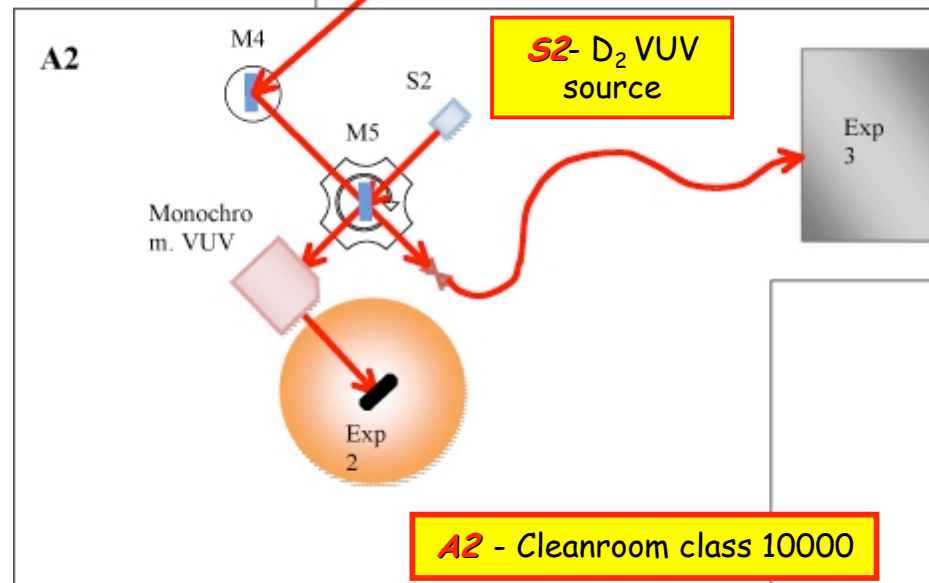
S1: 500 Watt Hg/Xe VIS-UV radiation source.

Exp.1- The **UV-VIS** monochromator **range** (180 ÷ 650 nm) ready for users .



The sapphire entrance (**IN**) window has been substituted with **MgF₂** to extend the spectral range to shorter wavelengths.

EXP.2. - **VUV radiation** (120÷300 nm) **HV chamber** for optical experiments: reflectivity, absorption, scattering and detector calibration **commissioned by the middle of 2009.**



S2- D₂ VUV source

EXP.3. Wide band **UV-VIS radiation** (200÷650 nm) UV-grade optical fiber brings SR to an optical bench for testing and calibration measurements of optical components and detectors **to be completed in 2009.**

A2 - Cleanroom class 10000

Scientific applications UV-VIS beamline

- ❑ Particle experiments (using Cherenkov light)
- ❑ Astro-particle experiments (using fluorescence light)
- ❑ Astronomy experiments
- ❑ Space experiments
 - Cosmic rays
 - Astronomy
 - Earth Observation

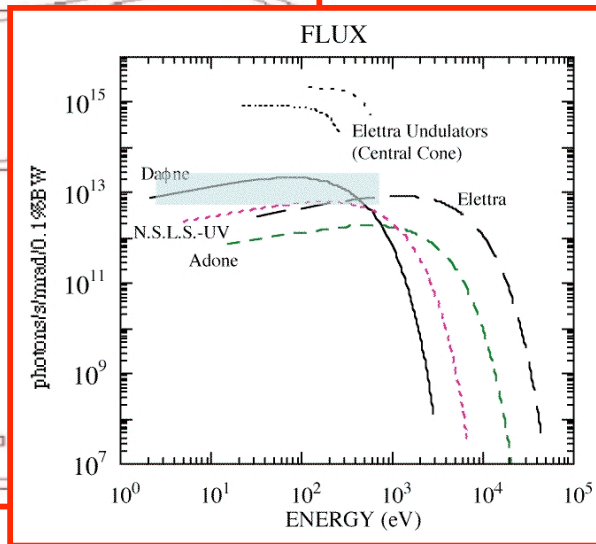
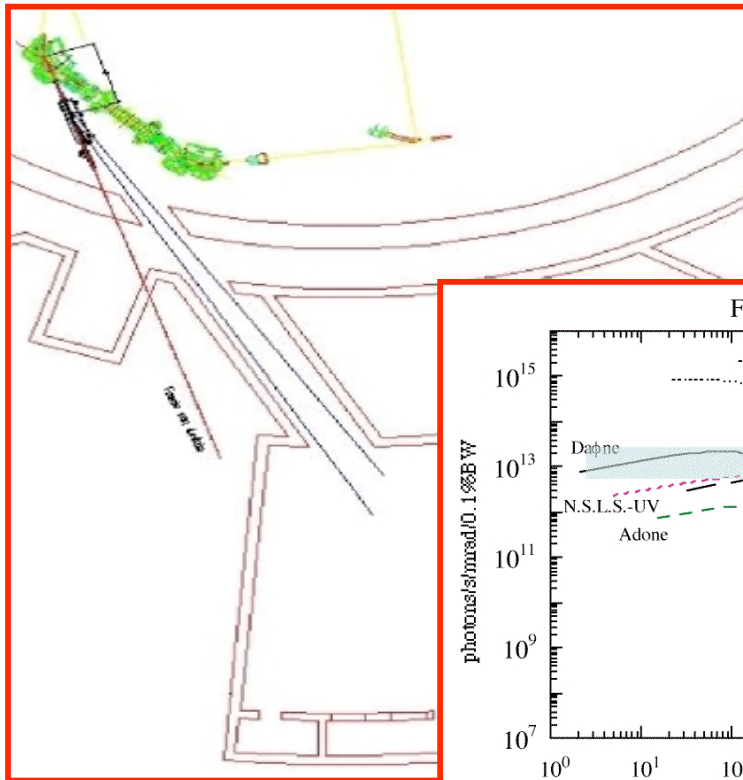
- ❑ Astrobiology and photo-biology
- ❑ Optical technology
- ❑ Detector technology
- ❑ Instrumentation testing and calibration
- Optical properties of materials

Partnership

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

New XUV beamlines

LEB (30-200 eV) ready by the end of 2009
HEB (60-1000 eV) ready by the end of 2010



Fields of interest:

Biology

Surface Science

Material Science

*R&D studies of INFN
interest*

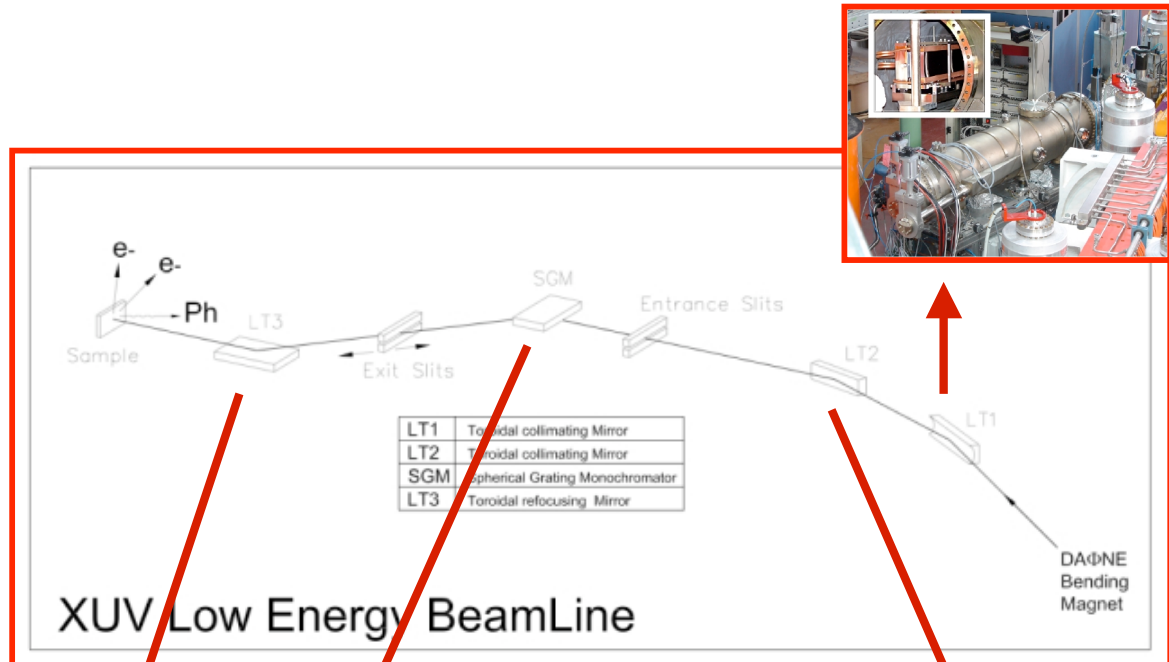
Roberto Cimino, M. Commisso and S. Ning

Status of the XUV LEB (30-200 eV)

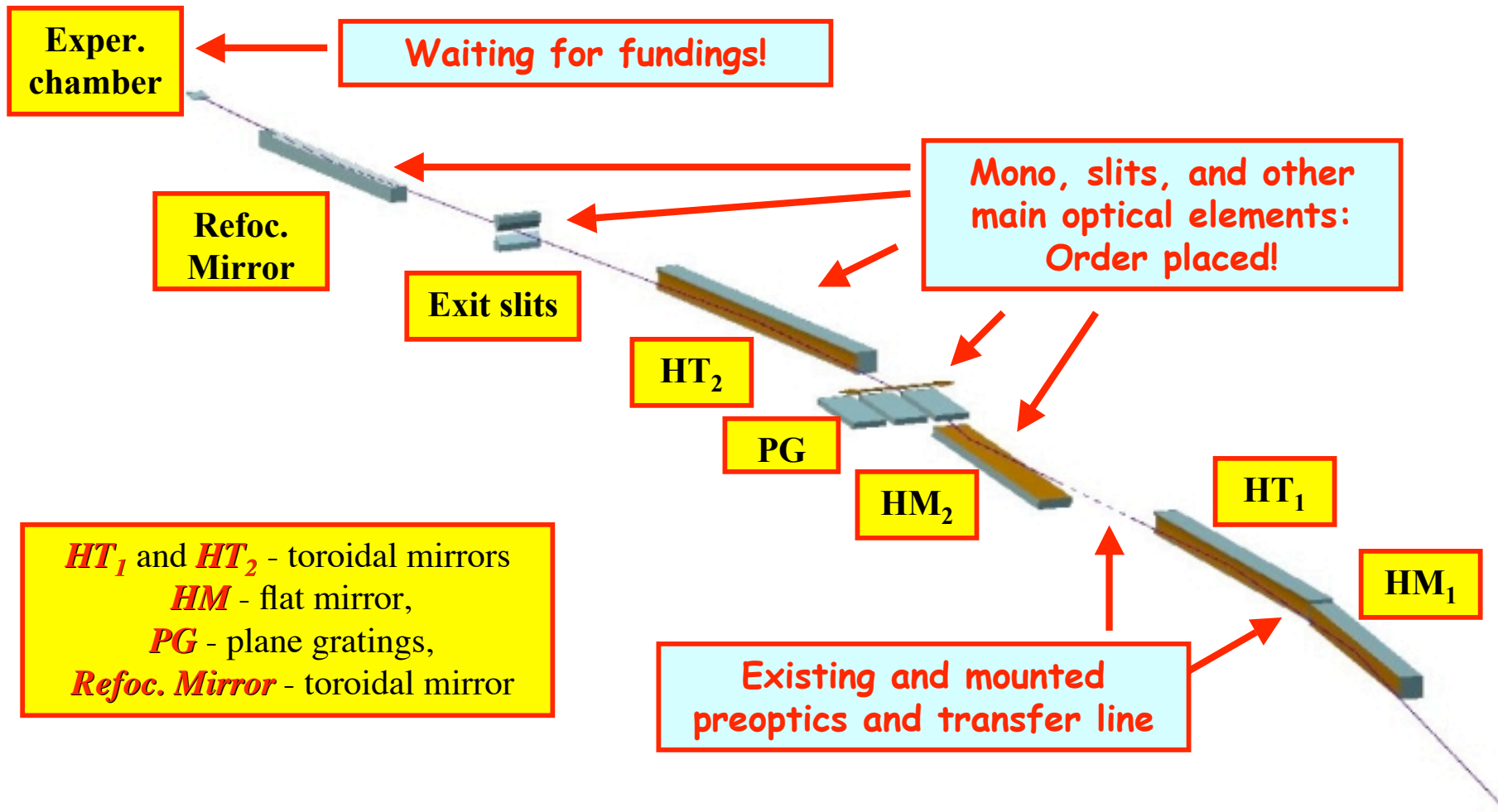
The Low Energy Beamline is all under vacuum (optics in UHV, but transfer line needs bake-out) and connected to DAΦNE.

Safety and remote controls need some more cabling and testing (also in the acc. building)

It is necessary to know the near future plans of the accelerator to use all maintenance and/or down-time periods to complete installation (in the acc. building) and start commissioning.



Status of the XUV HEB (60-1000 eV)



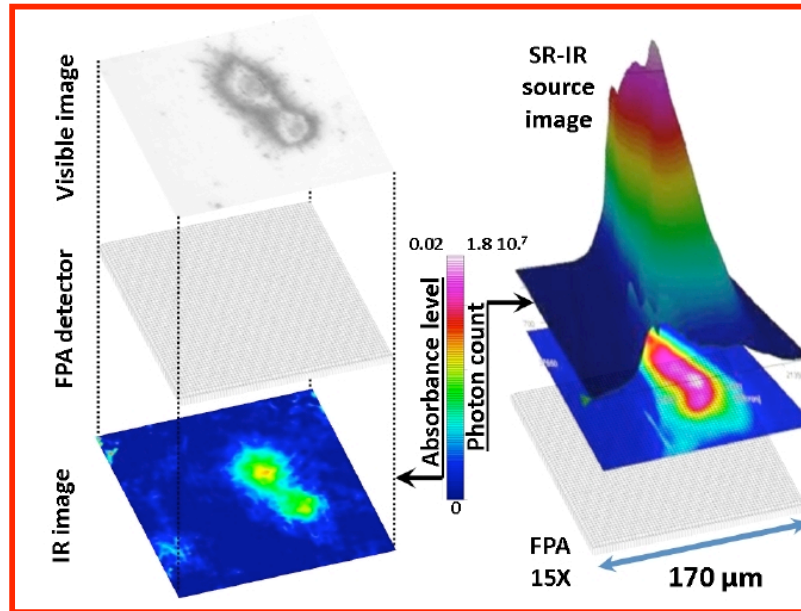
HT₁ and *HT₂* - toroidal mirrors
HM - flat mirror,
PG - plane gratings,
Refoc. Mirror - toroidal mirror

Energy range (eV)	Mono.	Resolving power	Flux (ph/s/0.1% bw)
60-1000	PGM	1000-5000	10 ¹³ -10 ¹⁰

SINBAD

Synchrotron *IN*frared Beamline At DAΦNE

*A bright future
for synchrotron
IR imaging*



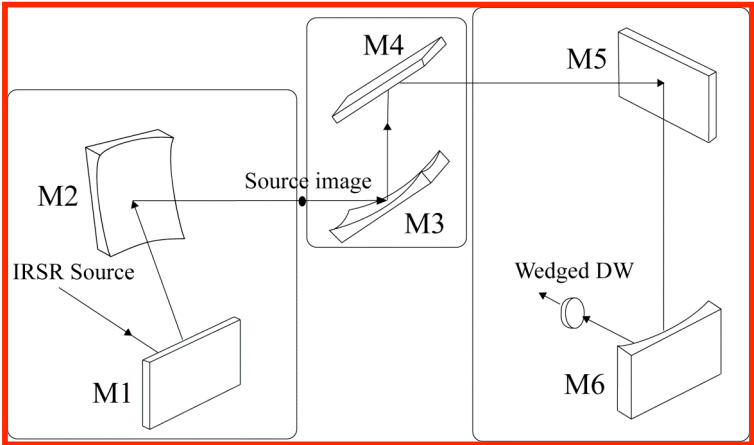
Left panel: Visible image and *infrared spectral mapping on a single cell of rat glioma* giving the biodistribution of collagen types within healthy and dystrophic connective tissues.

Right panel: Reconstruction of the IR DAΦNE source illuminating a FPA detector.

C. Petibois, G. Deleris, M. Piccinini, M. Cestelli-Guidi, A. Marcelli,
Nature Photonics 3, 179 (01 Apr 2009)

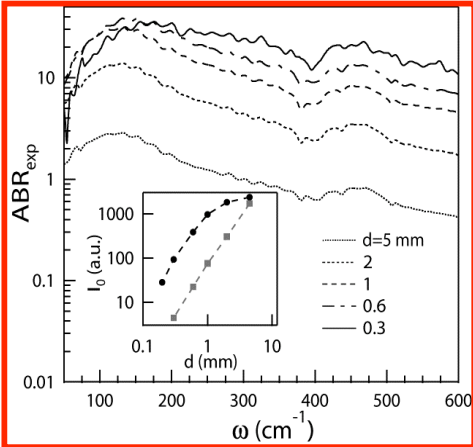
Mariangela Cestelli-Guidi

SINBAD beamline

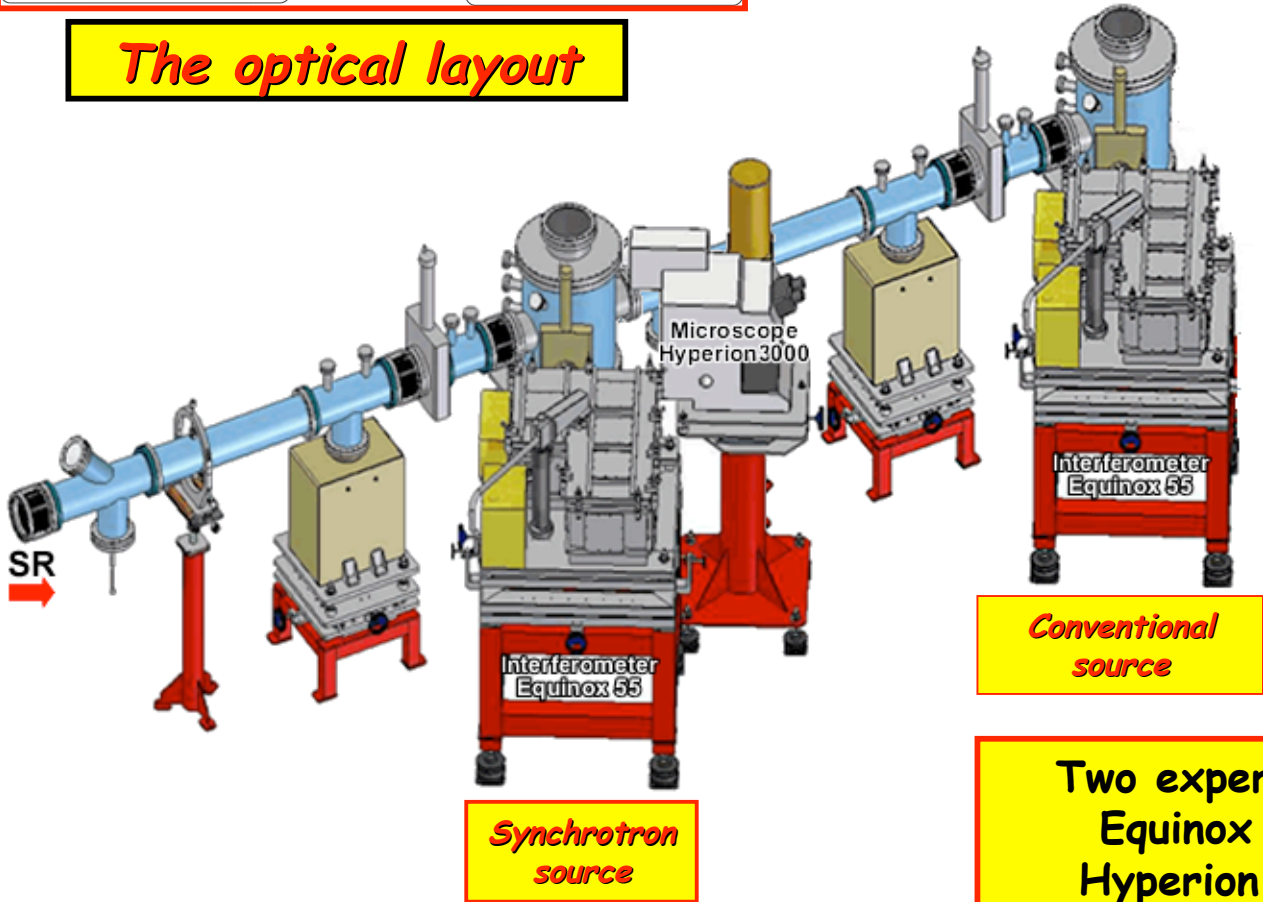


The optical layout

Actual Brilliance Ratio



**M. Cestelli Guidi et al.
JOSA 22 (2005)**



**Infrared domain from
10 to 10000 cm^{-1}
1.24meV to 1.24 eV**

**Conventional
source**

**Synchrotron
source**

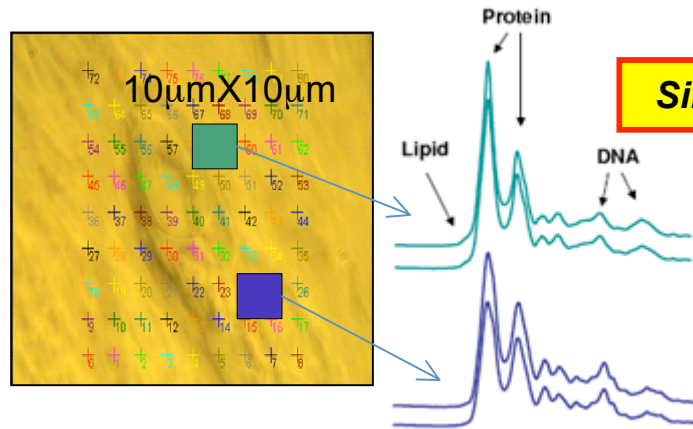
**Two experimental end-stations:
Equinox 55 interferometers
Hyperion 3000 IR microscope**

SINBAD-IR beamline upgrade

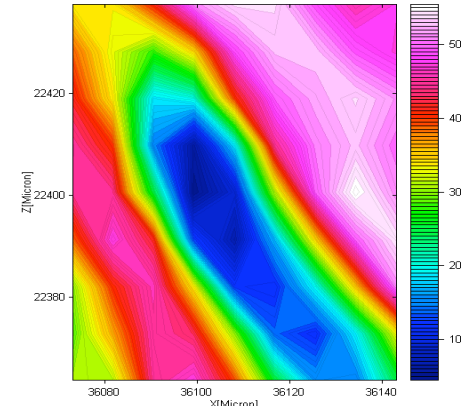
- *Focal plane array (FPA) detector* (64x64 pixel with 40 μm pixel size) installed in November 2007 on IR Microscope Bruker Hyperion 3000. Using the 15X objective it is possible to cover an area 170x170 μm^2 with about 3 μm resolution-
Tested and used in 2008
- *New cryostat* (T range= 4-500K)
- *High Pressure experiments* with a *DAC* (Diamond anvil cell) in the MIR & FIR
- *Reflectivity* experiments down to 4K
- At the end of 2008 *two mirrors* were bought, to *replace the first mirror* of the beamline and to *connect the second experimental station* to the SR source.

Present improvements with FPA detector

Spatial resolution >10 μm Integration time = 3 h

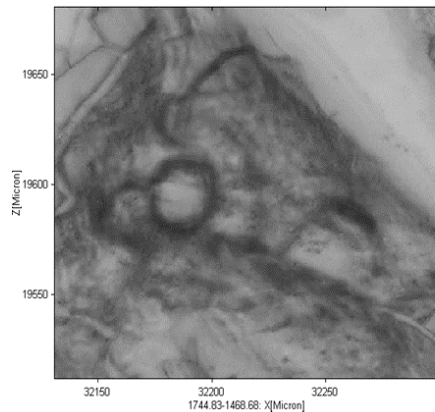


Single pixel imaging

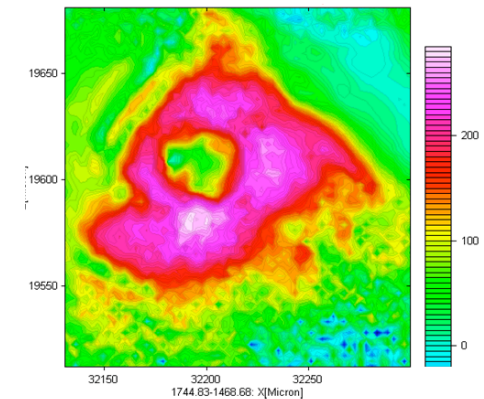
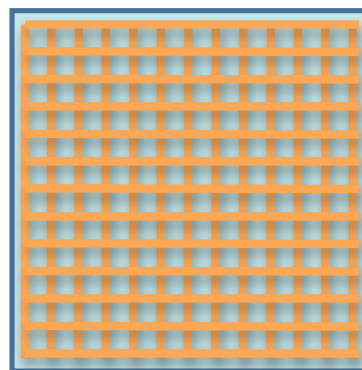


Infrared chemical map

Visible image of muscular connective tissue



FPA Imaging



Spatial resolution diffraction limited ($\approx 5 \mu\text{m}$ @ 2000 cm^{-1})
Integration time = 5 min

Some SINBAD beamline 2008 publications

C. Petibois and M. Cestelli Guidi, Bio imaging of cells and tissues using accelerator-based sources, *Anal. Bioanal. Chem* **391**, 1599 (2008)

A. Nucara, P. Maselli, P. Calvani, R. Sopracase, M. Ortolani, G. Gruener, M. Cestelli Guidi, U. Schade, and J. Garcia, Observation of Charge-Density-Wave Excitations in Manganites, *Phys. Rev. Lett.* **101**, 066407 (2008)

A. Nucara, P. Maselli, M. Del Bufalo, M. Cestelli Guidi, J. Garcia, P. Orgiani, L. Maritato and P. Calvani, Effect of Ga substitution on the optical properties of La-Sr manganites, *Phys. Rev. B* **77**, 064431 (2008)

P. Innocenzi, L. Malfatti, S. Costacurta, T. Kidchob, M. Piccinini, A. Marcelli, Evaporation of ethanol and ethanol-water mixtures studied by time-resolved infrared spectroscopy, *J. Phys. Chem. A* **112**, 6512 (2008).

G. Della Ventura, F. Bellatreccia, M. Piccinini, Presence and zoning of hydrous components in leucite from the Alban Hills volcano, Rome, Italy, *American Mineralogist* **93**, 1538 (2008).

DXR1 Soft X-ray Beamline upgrade

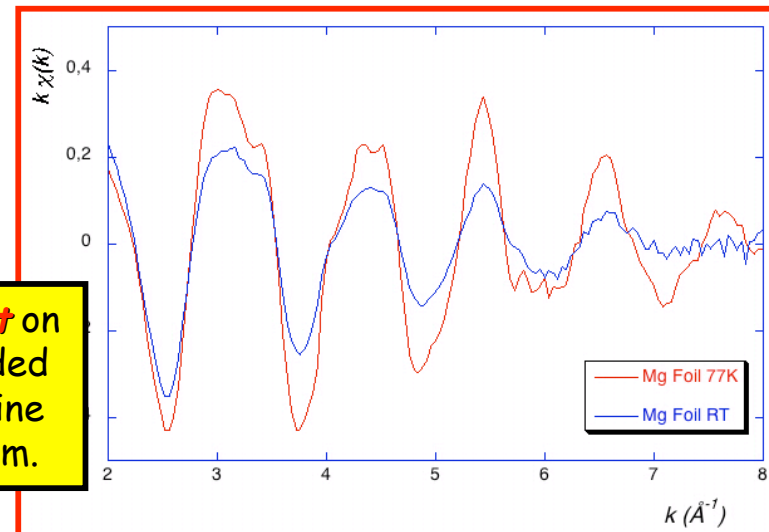
- Wiggler soft x-ray beam line
- Critical energy $E_c = 284 \text{ eV}$
- Working range ***0.9 - 3.0 keV***
- TOYAMA double crystal monochromator with KTP (011), Ge (111), Si (111), InSb (111) and Beryl (10-10) crystals
- ***Soft X-ray absorption spectroscopy and tests of soft x-ray optics and detectors.***

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

White beam for optics tests is available.

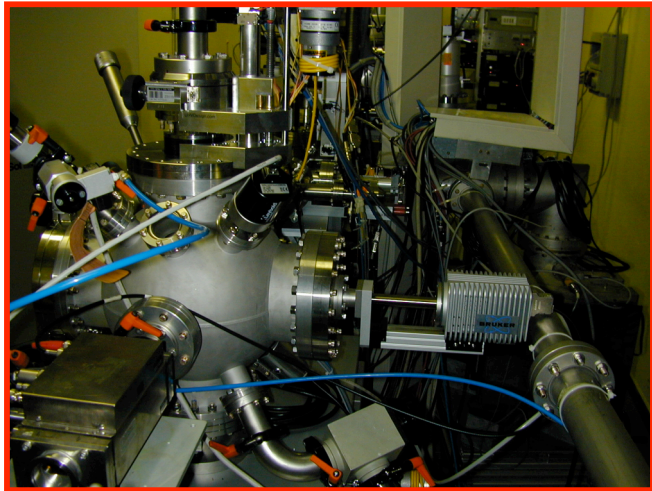
Antonella Balerna

Temperature effect on the EXAFS (Extended X ray Absorption Fine Structure) spectrum.

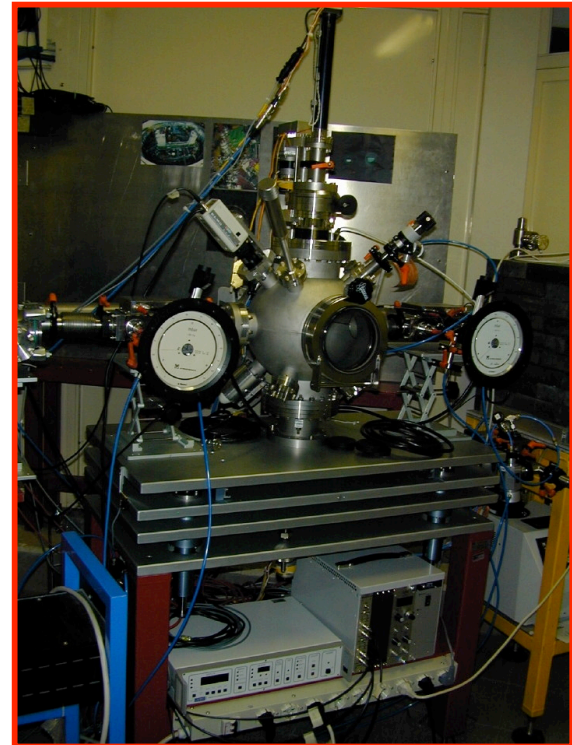


DAΦNE Soft X-ray Beamline :

new components installed and tested in 2008



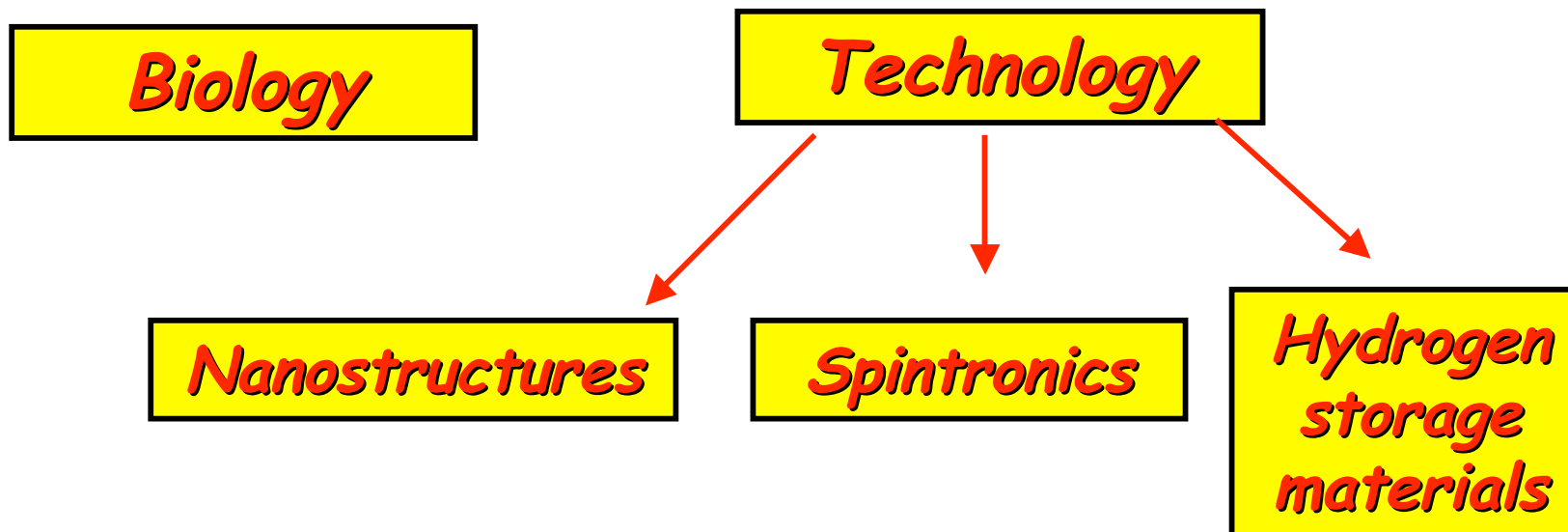
New *fluorescence SDD detector* installed on the experimental chamber and *new experimental chamber support with remote controls* were tested in 2008.



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.

Some Applications and Publications 2008



I. Ascone, L. Messori, A. Casini, C. Gabbiani, A. Balerna, F. Dell'Unto, and A. Congiu Castellano, Exploiting Soft and Hard X-Ray Absorption Spectroscopy to Characterize Metallodrug/Protein Interactions, *Inorg. Chem.* **47**, 8629 (2008)

W.M. Kwiatek, M. Podgorczyk, C. Paluszkiwicz, A. Balerna and A. Kisiel, Sulphur XANES analysis of cultured human prostate cancer cells, *Acta Physica Polonica A* **114**, 463 (2008)

L. Reale, A. Lai, M. Sighicellic, A. Faenov, T. Pikuz, F. Flora, P. Zuppella, T. Limongi, L. Palladino, A. Poma, J. Kaiser, M. Galiova, A. Balerna, G. Cinque, Qualitative detection of Mg content in a leaf of *Hedera helix* by using X ray radiation from a laser plasma source, *Microscopy Research and Technique* **71**, 459 (2008)

Organization

Organization



DAΦNE - Light Technical Committee



- **President of the Technical Committee (A. Balerna)**
- **Responsibles of the SR beamlines**
- **President of the Scientific Committee**
- **LNF Director**
- **Responsible of the SR Technical Staff**

SR Technical Staff

A. Grilli, M. Pietropaoli, A. Raco, V. Sciarra, V. Tullio, G. Viviani (art. 15).



DAΦNE - Light Scientific Committee



M. Benfatto - President
S. Dabagov - INFN
A. Balerna - INFN
R. Cimino - INFN
R. Felici - ESRF
U. Bottigli - Siena University
L. Bubacco - Padova University
P. Calvani - Roma La Sapienza
M. De Crescenzi - Roma II University
S. Mobilio - Roma Tre University
L. Palumbo - Roma La Sapienza

The GILDA beamline @ ESRF

GILDA @ ESRF Grenoble - France

G.I.L.D.A

*General purpose Italian Line for
Diffraction and Absorption*

Funded by:

INFN (1/3) and CNR (2/3)

Hard X-ray beamline:

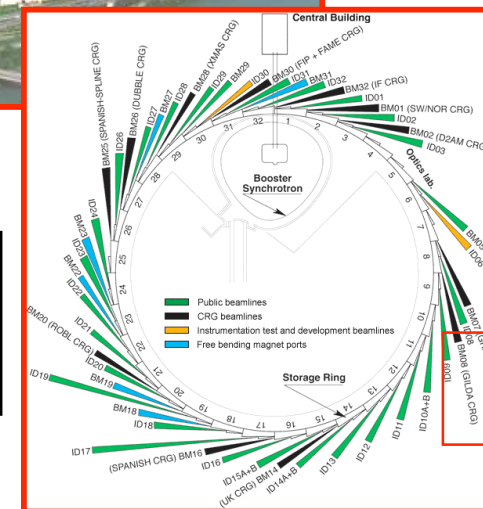
(4 - 90) keV

Experimental Hutches for:

*X-ray Absorption and X-ray
Diffraction*

Applications:

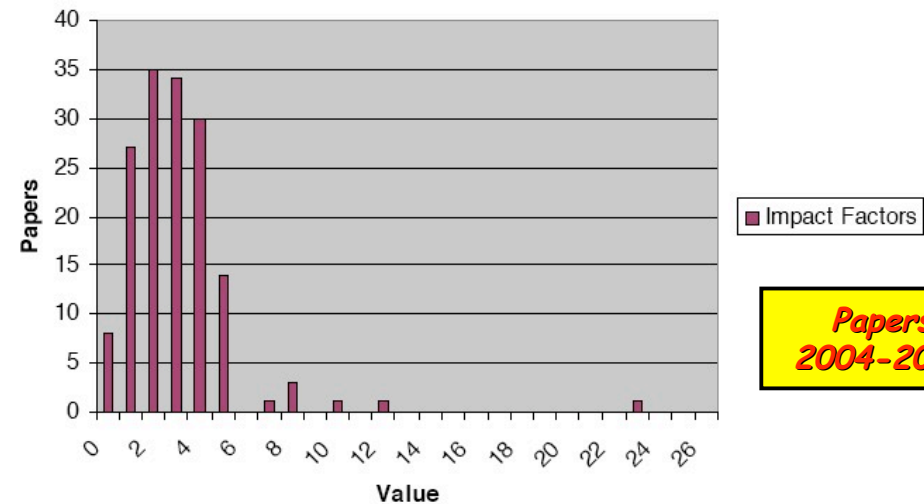
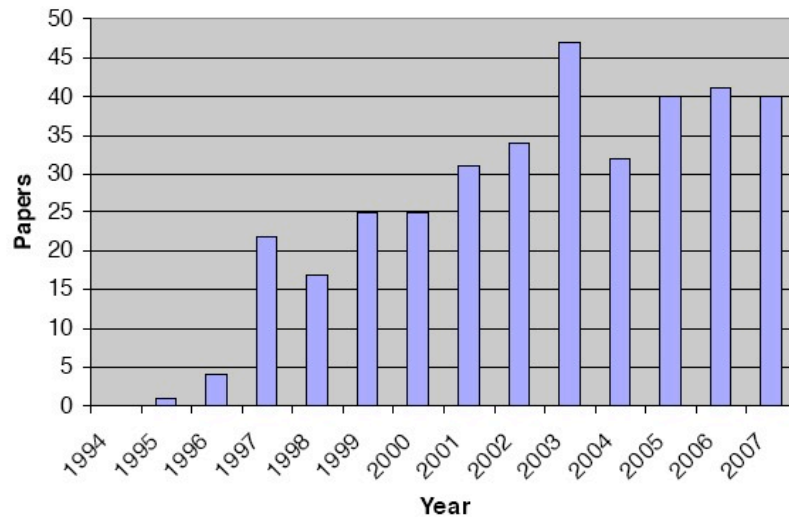
*Material science, biology, medical applications,
test of new x-ray optics and detectors*



*Open to
users from
1994*

*Settimio Mobilio and
A. Balerna*

GILDA's present and future



The *upgrade of the ESRF machine, to increase the brilliance of the source, will probably start by the end of 2011.*

GILDA is planning to *continue the activity up to end-2011* according to the actual organization:
for this reason *a two year extension of the contract that will end in 2009 is needed and has been asked to LNF and INFN .*

Thank you