The DAΦNE-Light facility

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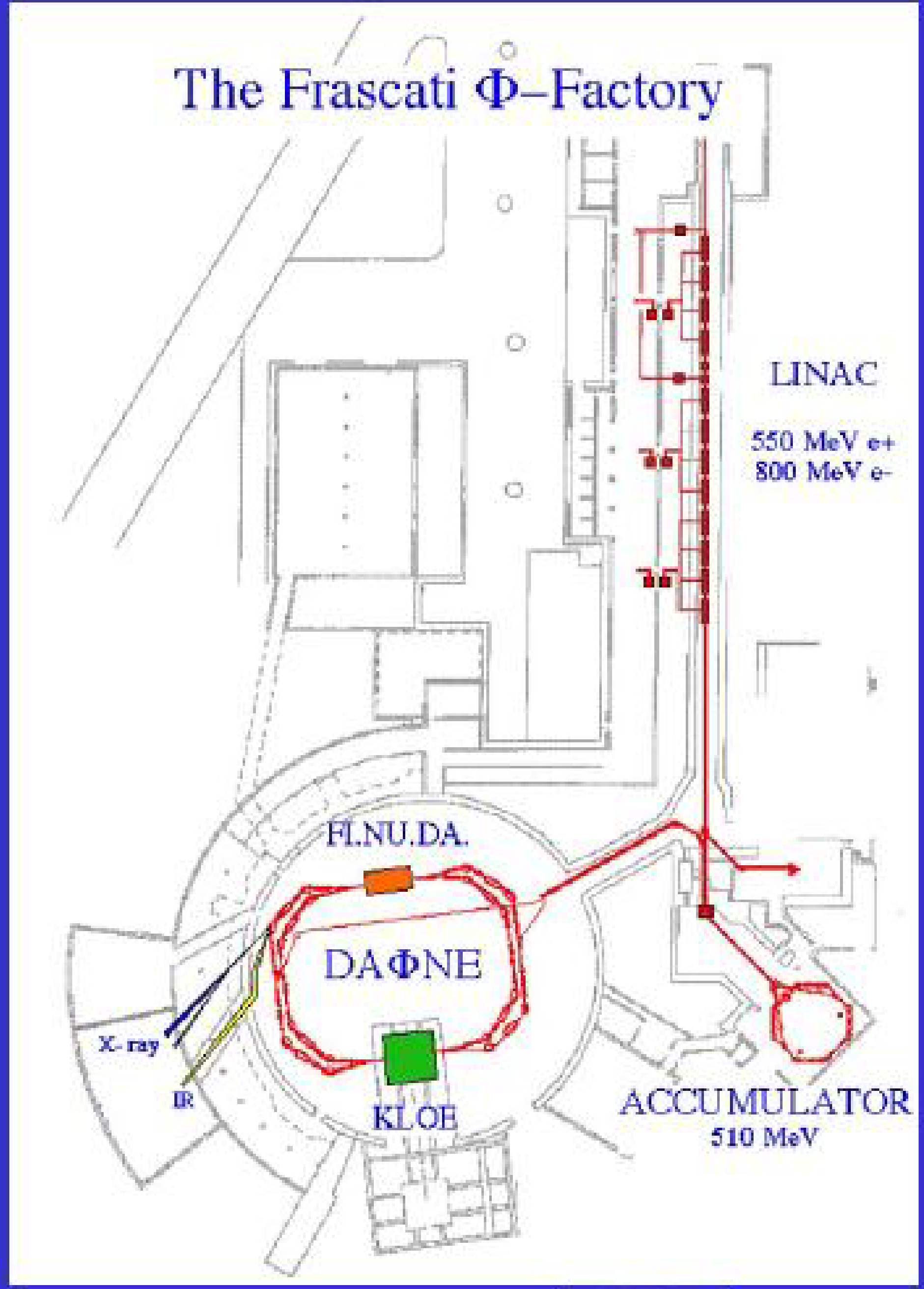
Layout

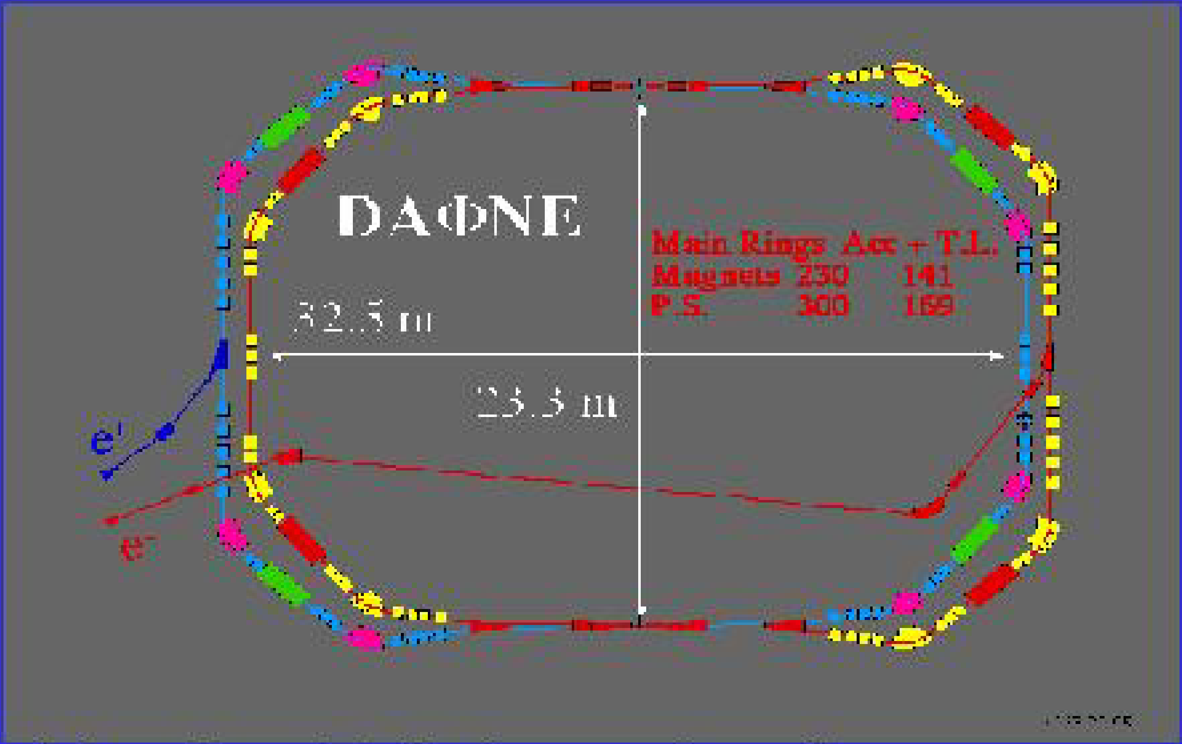
- ***DAΦNE storage ring (0.51 GeV & I>1 Amp)***
- ***The SR facility (DAΦNE-Light) - status (10/2001)***
- ***Potential applications***
- ***EU support & Marie Curie Fellowships***
- ***..........***

The complex system of storage rings, accumulator transfer lines and LINAC that constitute the DAFNE complex.



DAΦNE storage ring design

All the DAΦNE design is based on conventional technology. Two rings cross in the horizontal plane in two points and have a symmetry axis so that the two interaction regions, designed to host two large particle detectors for the investigation of the interaction between e+ and e-, have the same magnetic structure and the same optical functions. Each ring consists of two symmetric parts which have similar structure: an inner one named "*short*" and an outer one named "*long*". Photon beams for SR applications will be extracted by the '*long*' arc section. The sources planned for this application are one wiggler and two bending magnets.



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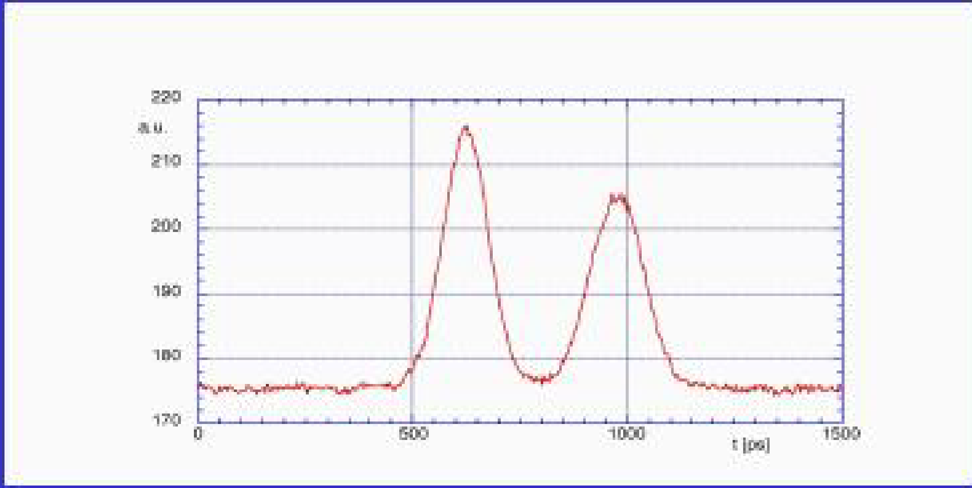
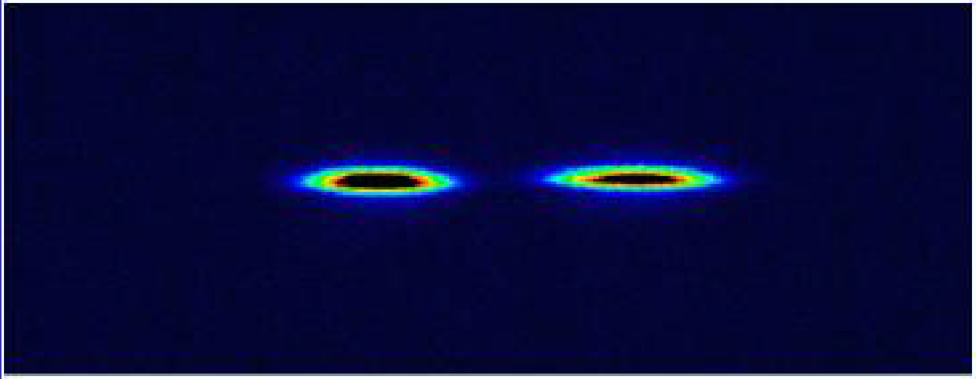
DAΦNE single ring parameters

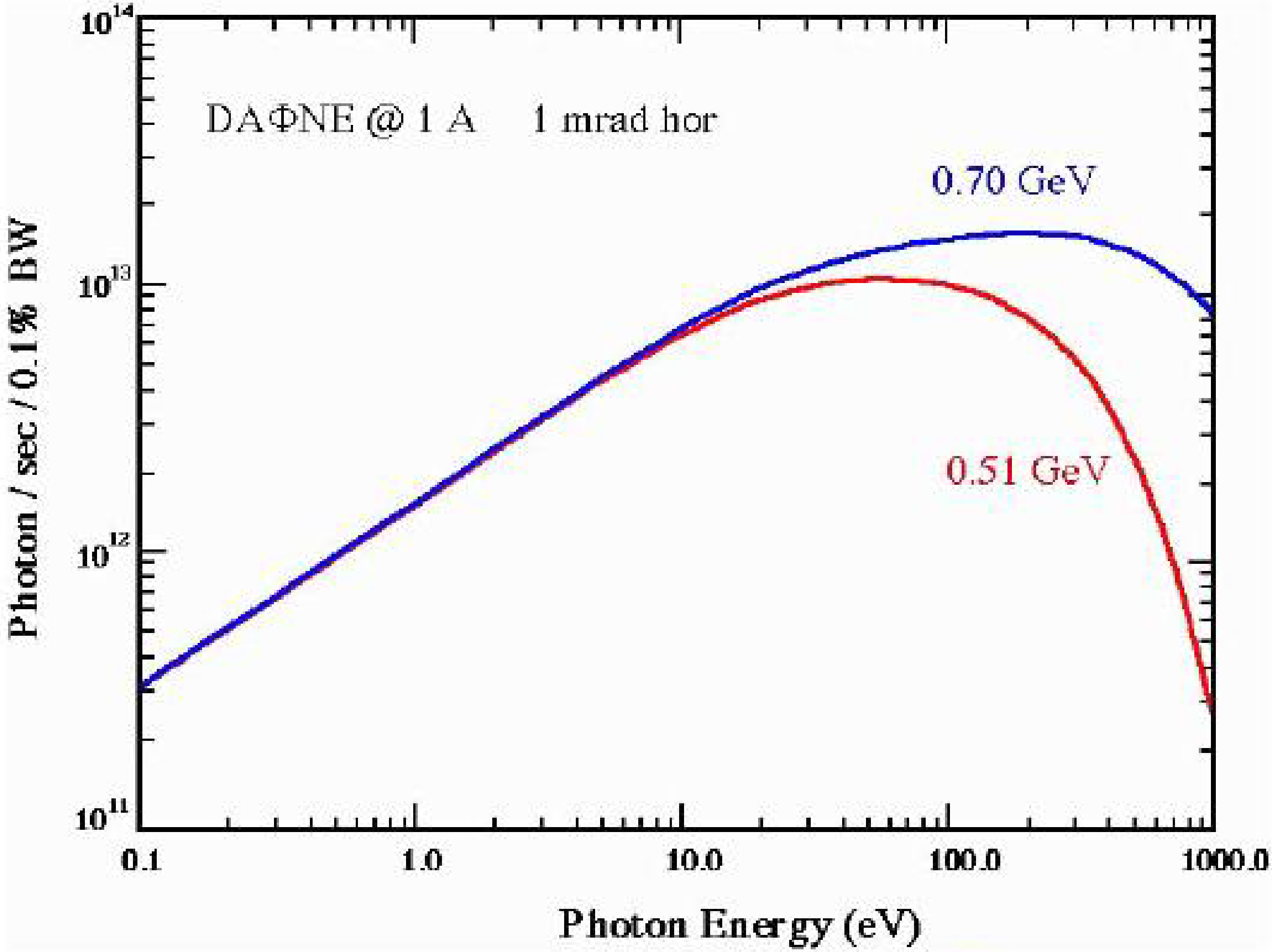
Beam Energy E	0.510 GeV	($\gamma = E/mc^2 = 10^3$)
Orbit length		97.69 m
Dipole bending radius	1.4 m	ε_c=208 eV (54.6 Å)
Dipole magnetic field	1.2 T	(bending angle 0.8 rad)
Wiggler bending radius	0.94 m	ε_c=311 eV (38.3 Å)
Wiggler magnetic field	1.8 T	
Wiggler length	2.0 m	
Wiggler period length	0.64 m	$N_{period} = 3$
Horizontal β-tune	4.87	
Vertical β-tune	4.85	
Momentum compaction	0.017	
Energy loss/turn (U_0)	9.3 keV	
Horiz. Emittance	10^{-6} m rad	10^{-6} m rad
Coupling coefficient k	1%	1%
Bunch length σ_z	30 ps	(70 ps)
Bunch separation	3 ns	
Number of particles/bunch		$8.9\ 10^{10}$
Number of bunches	30÷120	(48)
Average e-beam current	1.3÷5.2A	0.7 A (max >1 A)
Radiofrequency	368.25 MHz	
Harmonic number	120	
Max. SR Power/beam	49 kW	
rms Energy spread	$3.97\ 10^{-4}$	
Damping Time	τ_s=17.8 τ_x=36 τ_y=35.7 msec	
Total beam lifetime	156 min	~1 hour
Topping up time	<2 min	<5 min

Streak camera image of electron and positron bunches before collision at low current.





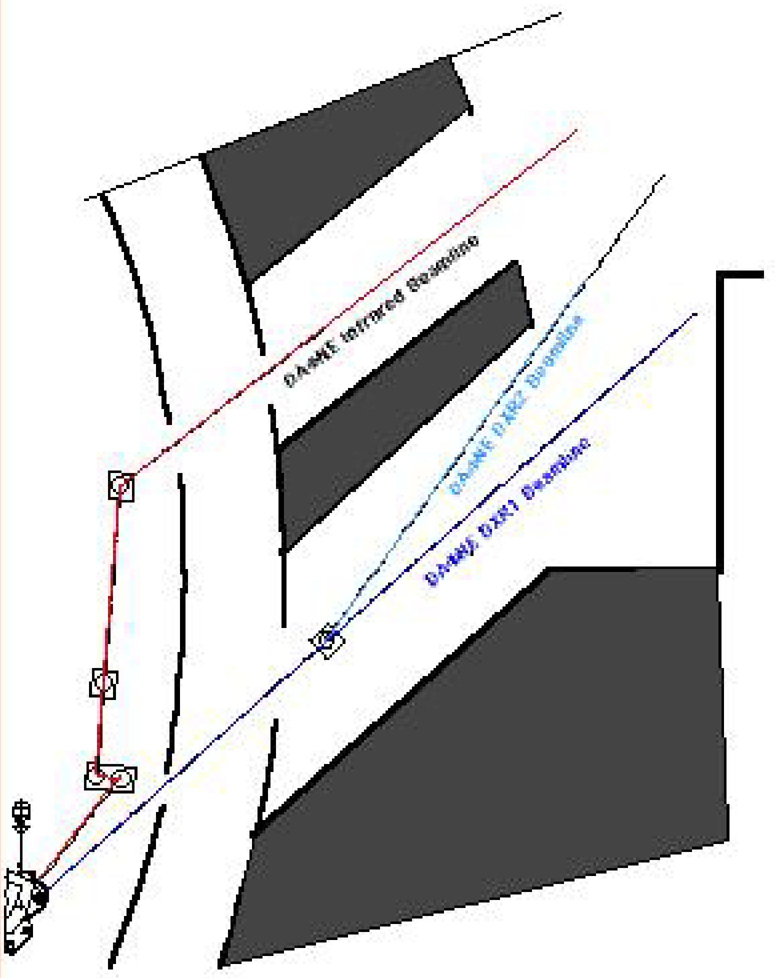
Synchrotron radiation



Schematic layout of the SR laboratory.

Three beamlines have been installed.

Two collects radiation from the wiggler and one from the bending magnet.



DAΦNE LIGHT Laboratory

DAΦNE-Light

- *2 beamlines in the x-ray region*

•DXR-1

- Wiggler ϵ_c= 311 eV Energy : 0.7-7 keV
- Energy resolution: $\Delta E/E=10^{-4}$ Photon flux: 10^{9}-10^{11}ph/s
- Absorption and fluorescence x-ray spectroscopy
- Diffraction and LIGA processes

•DXR-2

- Wiggler Energy : < 1 k eV

SR and technological applications

The first beamline will be used also for LIGA processes. In fact the final part of the wiggler beamline is installed inside a clean room – A 100 class – where a x-ray stepper K.SUSS will be used for microlithography processes. To perform the LIGA research activity the Laboratory is also equipped with a SEM that allows electron beam lithographic processes. The system allows making sensors or microdevices and may be used in the technology of the x-ray mask production.

In cooperation with the ENEA the electron beam lithography has been used to write a color-center channel on the surface of an optically polished LiF crystal.

This research program is devoted to the investigation of devices able to guide and amplifying the light.

VUV beamline

The second beamline, called DXR-2, is a branch line achieved by means of a 2 degree grazing incidence mirror which divides the DXR-1 beam in two parts.

The experiments planned at this beamline will be performed in a dedicated experimental area where photons in the spectral range between 1 eV and 800 eV will be selected by a monochromator.

The first planned experiment concerns the determination of biological effects induced by the B-band of UV radiation on cultures of human cells. A dedicated laboratory where *in situ* post-irradiation treatment on cell cultures will be performed is under way.

Beamline SINBAD

- Bruker Equinox INTERFEROMETER (modified to work in vacuum) and microscope (in air)

  Frequency Range : 10 - 6000 cm^{-1} (~2 - 2000 μm)

  Resolution : 0.5 cm^{-1}

  Brightness (BB 2000 K): 100 @ 50 μm

  Spot Size (f4 diffraction limited)

- OPTICAL CONFIGURATION (Mirror System)

  Water-cooled copper OHFC mirror to beam extraction. Beam is focused by an ellipsoidal mirror to provide a 1:2.2 image of the source on a CVD wedged diamond window. Beam passes through the window (UHV up to this point) and continues through an HV beamline to the interferometer. Transmission is made by a system of planar (3) and toroidal mirrors (2). The last one focus the radiation on the entrance slit of the instrument.

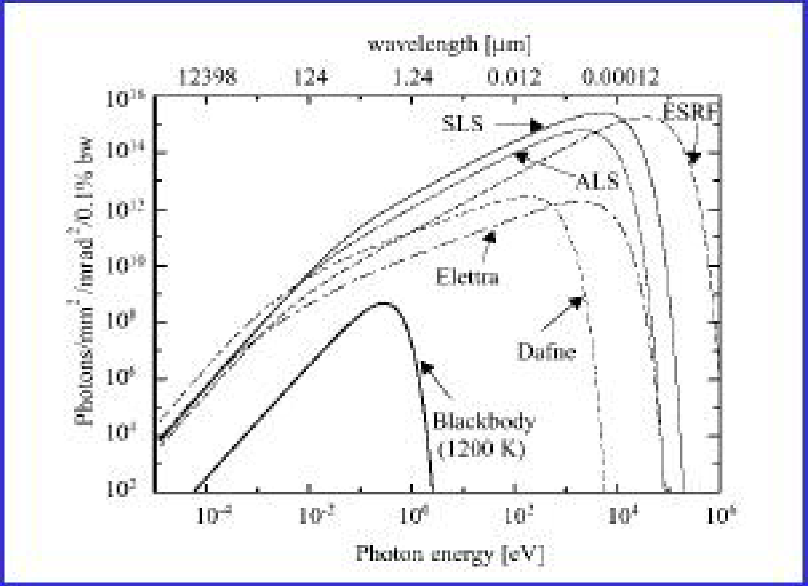
SINBAD

Infrared Synchrotron Radiation

- *The high photon flux combined with the highly collimated beam leads to a high brightness compared with thermal sources.*
- *The use of electron storage rings as dedicated light source in the IR spectral range has attracted a lot interest since the last three decades.*
- *Stevenson et al. (Appl. Opt. 2884, 1973) first discussed the possibility to use a storage ring as a brilliant infrared (IR) source.*
- *The major instrumental breaktrough in FT-IR μ-spectroscopy may be associated to the achievements of the first data using the SR emission of one large port the VUV ring at NLSL. (Reffner, Williams & Carr - September,1993)*

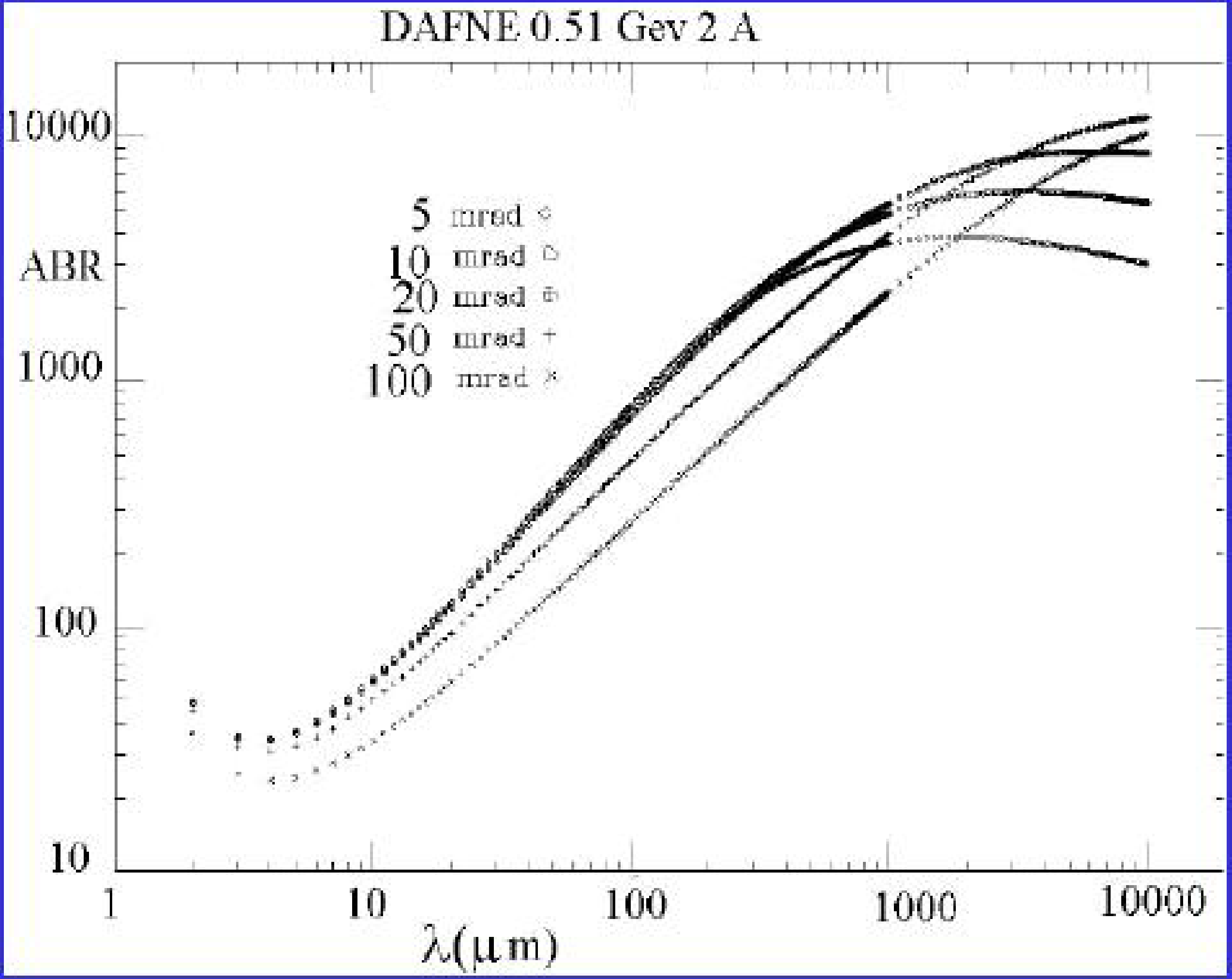
IRSR brilliance

- Brilliance (photons/mm²/mrad²/0.1%bw) is crucial for microscopy where one is trying to illuminate an area as small as possible with much light as possible. The advantage of IRSR over a conventional source when used to illuminate a 10 μm diameter sample area can lead to up to 4 orders of magnitude higher intensity, particularly in the mid-IR spectral range (MIR, i.e. 300 <ω<5000 cm^{-1}).



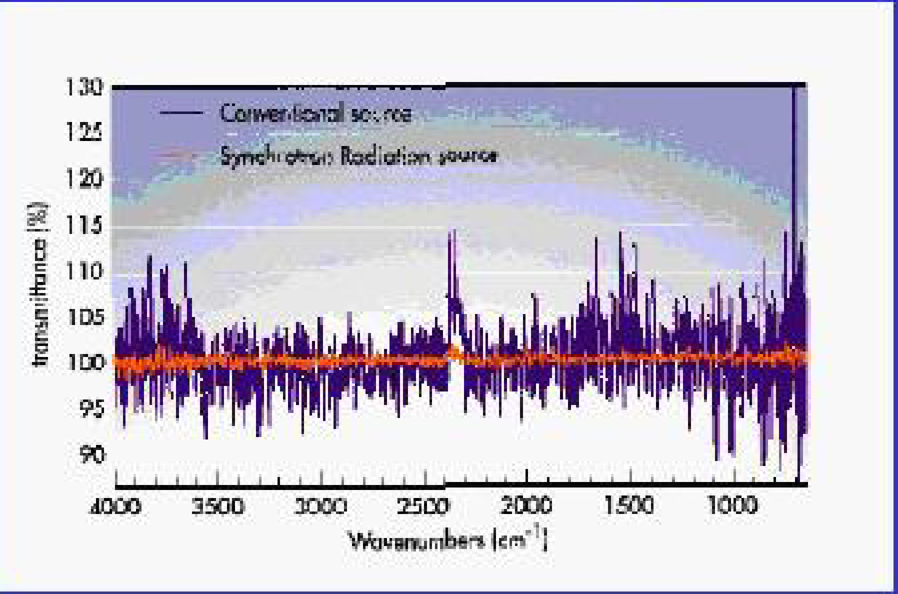
- Infrared maps are made by scanning the sample in a raster fashion, recording interferograms at each point, and then constructing images at selected wavelengths afterwards. Besides surface science research of semiconductor materials and devices, IR microscopy is a very powerful tool in biology and biophysics.

Actual Brilliance Ratio



When samples are small single crystals, or in the case of metals that have to be illuminated at grazing-incidence angles, the sample throughput is small. Also, since the IR absorbance of the vibrational modes is small, high brightness is required to obtain adequate signal-to-noise ratio. Moreover, the SR source intensity is strictly proportional to the beam current, meaning that the absolute reflectance changes can be measured to high accuracy.

Finally, the last advantage of SR is due to the fact that many of the samples are at room temperature, and then the main noise is the thermal background.
SR put the signal well above this background.



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The State of the Infrared Art: Spectroscopy and Imaging

- **With increasing complexity of the molecular structures under investigation, the role of IR spectroscopy keeps changing, as different questions are being asked of this "new" and yet "old" spectroscopic technique.**

- **Huge progress in the instrumentation has kept pace, and modern spectrometers allow us to take on ever more difficult problems on a smaller scale.**

- ***IR μ-spectroscopy (IMS) is a unique technique that combine microscopy and spectroscopy for purpouses of microanalysis.***

- ***IR spectroscopy allows analysis of the molecular chemistry of materials. Altough limited in spatial resolution, IR is able to resolve chemistry using the contrast of the absorption lines.***

Acknwoledgements

- *LNF-INFN*
- *DAΦNE-Light staff*
- *Prof. E. Burattini (responsible of the DAFNE-Light laboratory)*

- *Roma University "La Sapienza"*
- *Roma 3 University*
- *Verona University*

TARI

TARI is the acronym for "Transnational Access to major Research Infrastructures" which is one of the three schemes of action of the development programme "Improving the Human Research Potential and Socio-Economic Knowledge Base" within the Fifth Framework Programme of the EU.

The aim of the TARI scheme is to provide researchers from the European and Associated Countries with free access supported by the EU to the Major Research Infrastructures in Europe. These contracts support the mobility costs of visiting scientists and the expenses for the infrastructure.

The European Commission
Community Research
Improving Human Potential & the Socio-economic Knowledge base

The "Laboratori Nazionali di Frascati" (LNF) of the "Istituto Nazionale di Fisica Nucleare" (INFN) have been recognized as a Major Research Infrastructure (Contract No. HPRI-CT-1999-00088).

http://www.lnf.infn.it/cee/tari.html

Next call for proposals: 13 November 2001

Marie Curie Fellowship

The Laboratori Nazionali di Frascati have applied to the Marie Curie Training Sites Fellowships, offered under the Fifth Framework programme of the European Community, and have obtained the approval of the proposal:

"Application of Brilliant Infrared Synchrotron Radiation to Basic and Applied Research"

(Contract N. HPMT-CT-2000-00198)

The European Commission
Community Research
Improving Human Potential & the Socio-economic Knowledge base

The MCTS rules foresee that successful organizations advertise positions for young researchers, who will apply directly to the host organization.

More information can be obtained by visiting the EU web site

www.cordis.lu/improving/src/hp_mcf.htm

19th International Conference on X-ray and Inner-Shell Processes

Aula Magna, Università di Roma "La Sapienza" June 24-28, 2002

Chairman: Antonio Bianconi
Co-Chairman: Augusto Marcelli

This series of international conferences is a key forum to discuss fundamental issues in the field of x-ray and inner-shell processes and their application in various disciplines of science and technology. The 19th conference in the series is planned to emphasize the use of high brilliance synchrotron x- ray sources in hot topics in physics, chemistry, biology, engineering and related fields. Plenary talks, invited progress reports and poster presentations are planned.

SINBAD at DAΦNE

A dedicated beamline for FT spectroscopy and IR microscopy

SINBAD is the first Italian IRSR beamline. In the IR range the low energy of *DAΦNE* does not affect the SR spectral distribution, while the high current will make *SINBAD* more brilliant than that of a black body at 2000 K by two orders of magnitude at 100 μm. *SINBAD* radiation is focused at the end of the beamline, where two experimental stations will be in operation with a FT interferometer and a microscope.

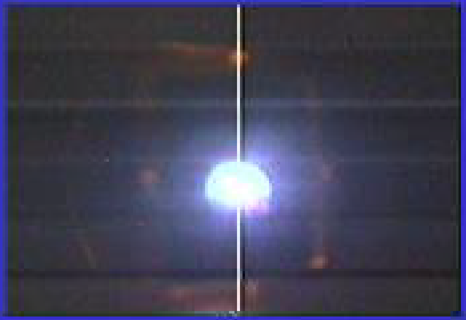
Spectroscopic investigations in condensed matter physics and materials science will be performed with a S/N and a resolution that are not reachable by any conventional source .

In particular, biology and biomedical researches would obtain significant advances, because of the brightness of the source and the expected focusing size of the IR beam. Both spectroscopy and microscopy will be possible in living cells and in in particular in human living cells, investigating real-time changes as function of different chemicals or doses, e.g. to evaluate efficacy of therapy for different diseases.

DAΦNE-Luce

Esperimenti TARI e collaborazioni gia' attive

- ***Proposte TARI accettate (510 man/days)***



- ***Esperimenti in collaborazione con strutture italiane***

- CNR - ROMA 2 - Diffrazione su polveri e film sottili
- ROMA 1 - Sviluppo di spettroscopia e microscopia IR
- ROMA 3 - Spettroscopia di assorbimento in materiali a strati
- Milano - Verona - Esperimento SUE (Gruppo V)
- Trento - Spettroscopia X su silicio poroso.

- ***Cooperazioni internazionali***

- CINA - Attivita' di ricerca sui processi LIGA (BSRF)
- CINA - Spettroscopia su materiali di interesse geofisico (BSRF)
- ARGENTINA -Analisi elementale in traccia in sistemi biologici (Cordoba)
- RUSSIA - Sviluppo di ottiche con policapillari per SR (Mosca)

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