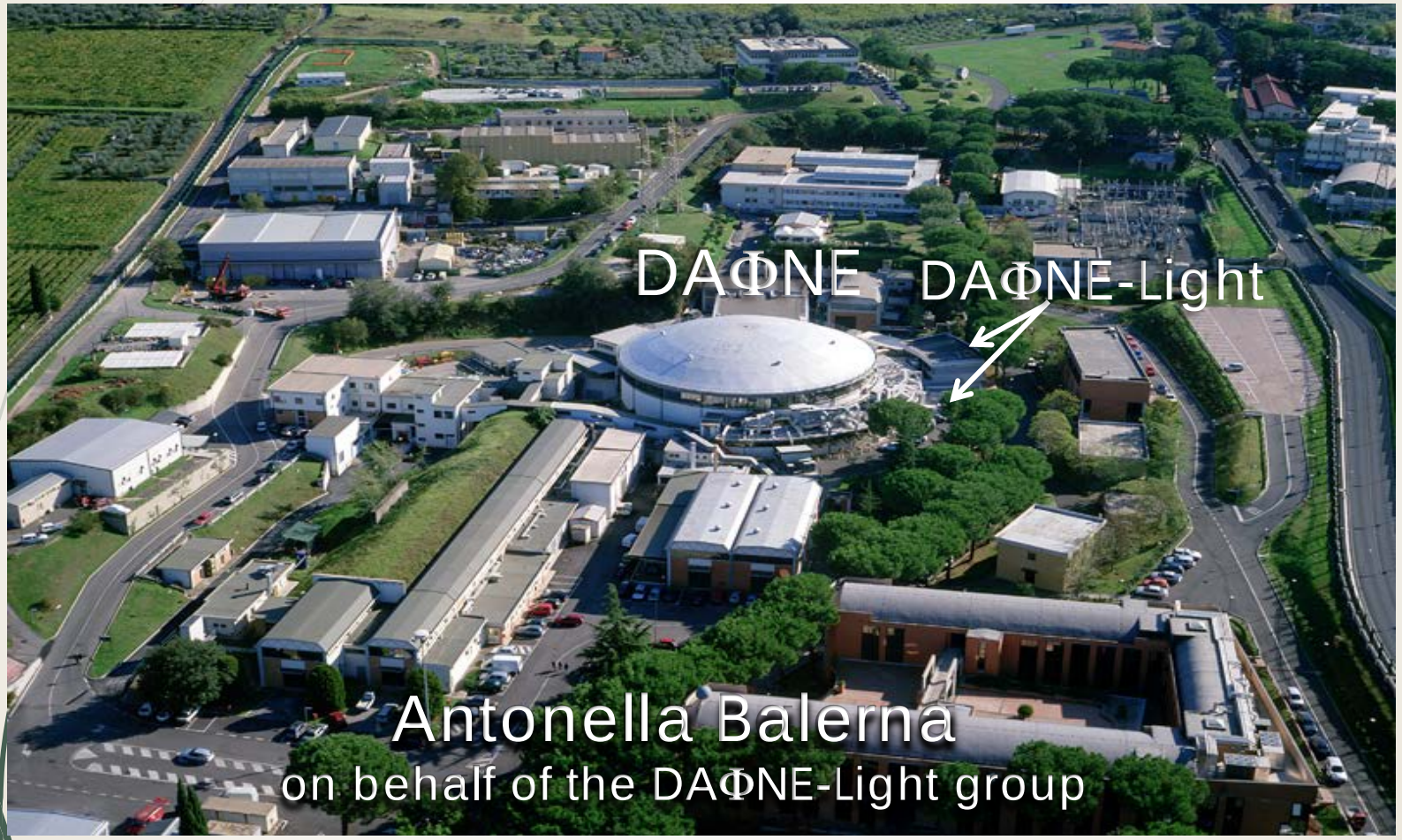
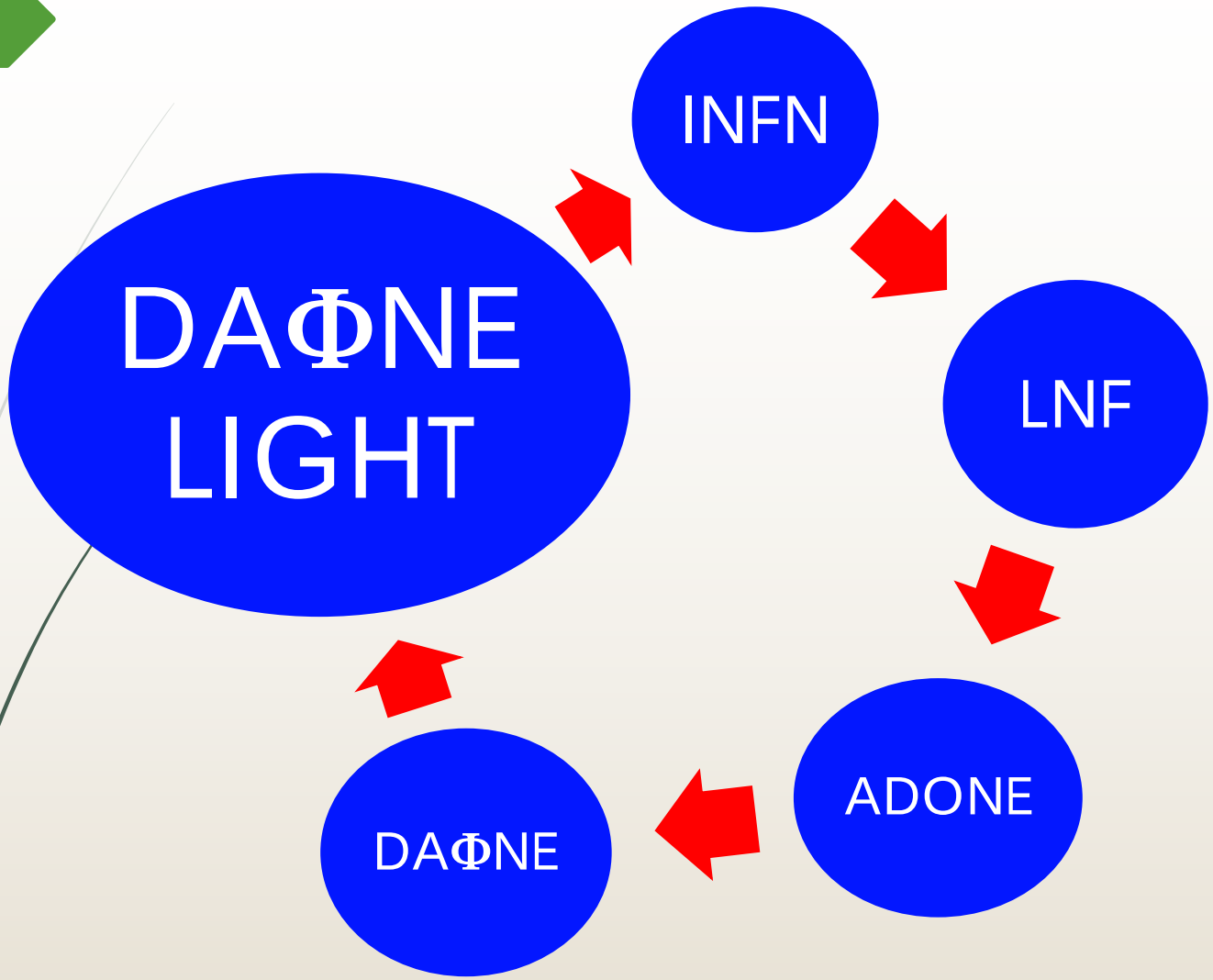
DAΦNE-Light

INFN-LNF Synchrotron Radiation Facility



Antonella Balerna
on behalf of the DAΦNE-Light group

28th ESLS 2020 Workshop 16-17 December 2020


DAΦNE LIGHT
INFN
LNF
ADONE
DAΦNE

Some information on INFN

The National Institute of Nuclear Physics (INFN), the Italian agency devoted to fundamental research in nuclear and sub-nuclear physics, has a complex structure that includes also

4 big laboratories

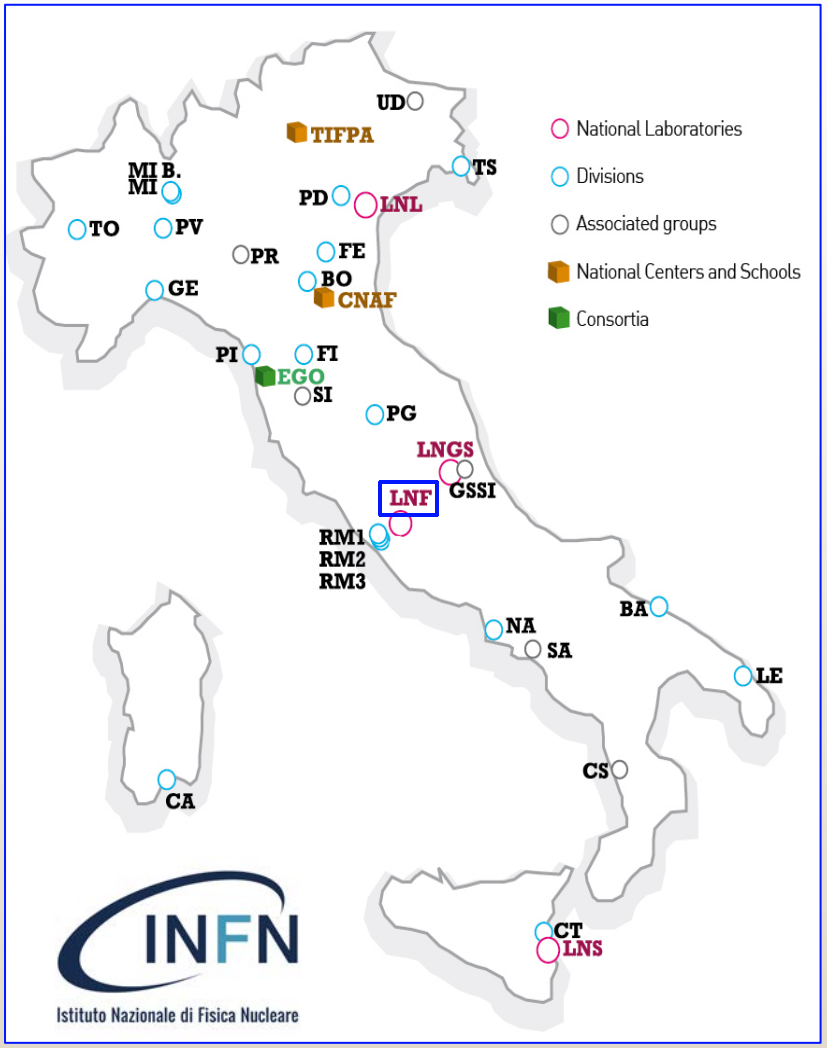
among which the Frascati National Laboratory (LNF) is the oldest and largest one.

LNF

LNGS

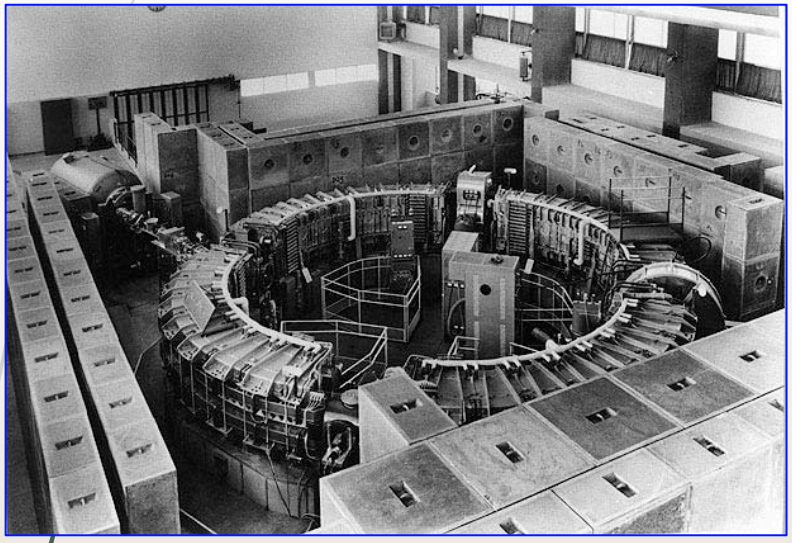
LNL

LNS



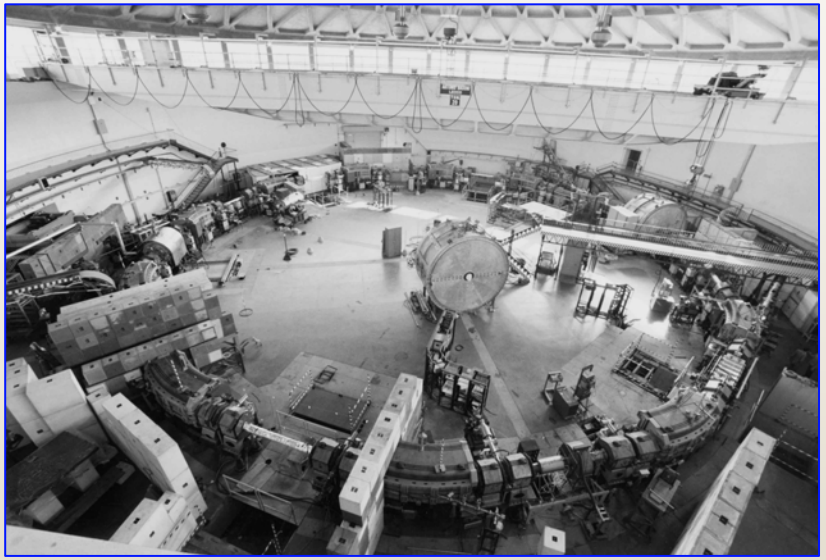
A bit of history: LNF

The LNF was the first Italian research laboratory for the study of nuclear and subnuclear physics with accelerators that included an electron synchrotron and the storage ring ADONE.



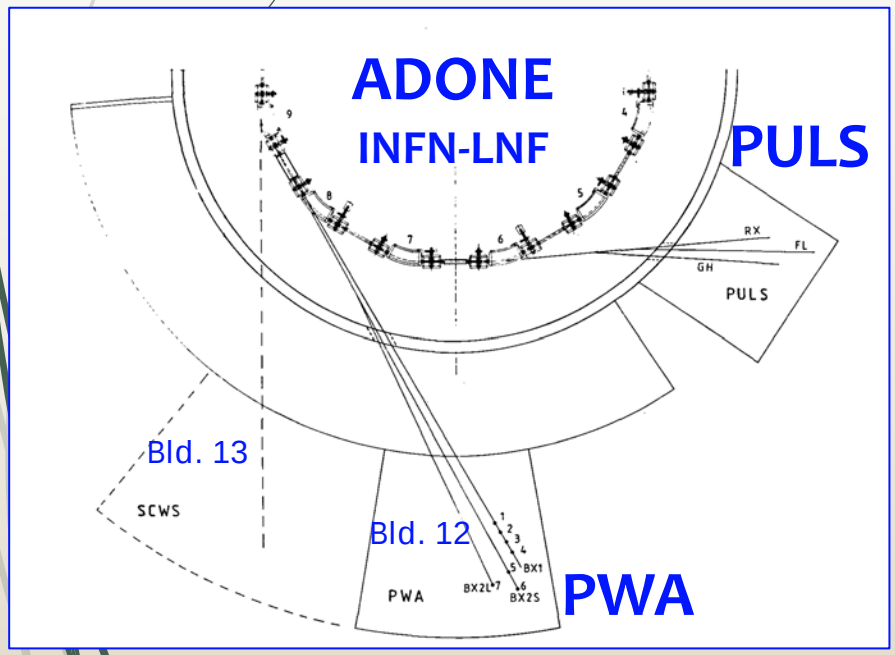
Electron Synchrotron
(0.4-1.1) GeV, C= 28 m (1959-1975)

LNF ADONE (big ADA)
electron-positron storage ring
1.5 GeV per beam, C = 105 m (1969-1993)



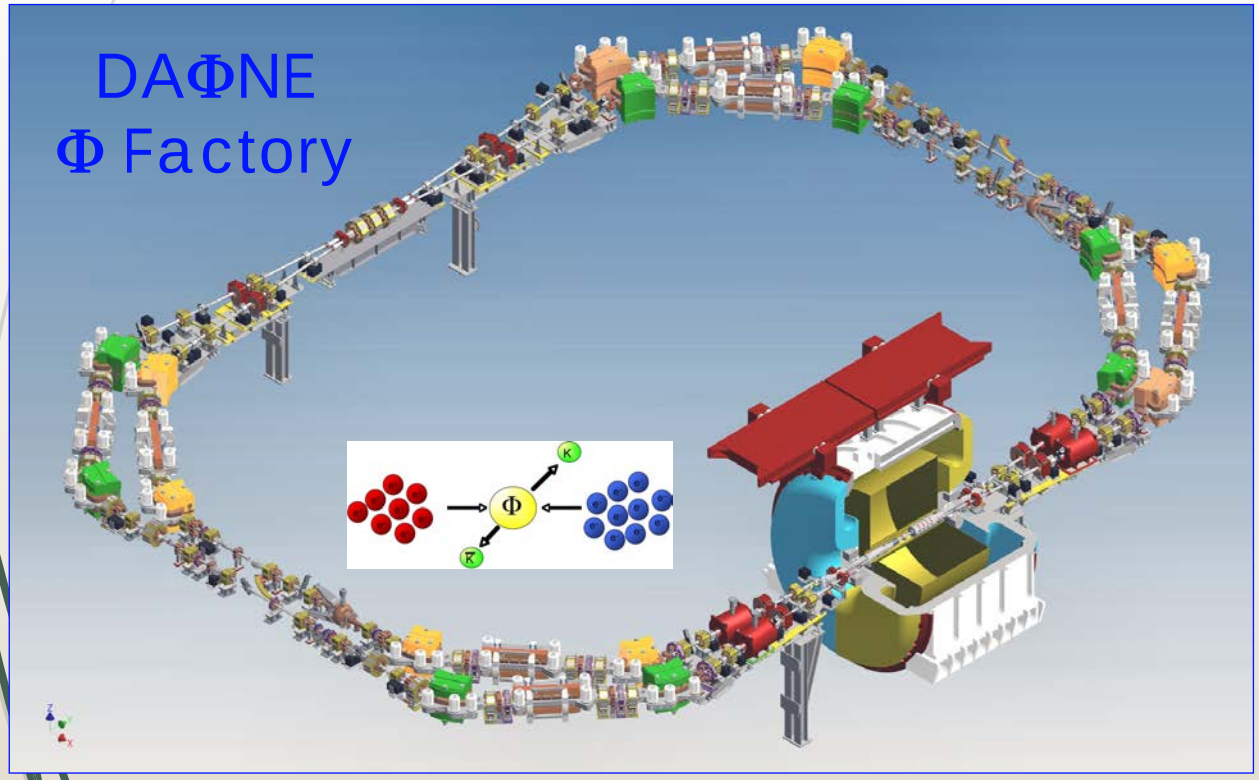
A bit of history: LNF and Synchrotron Radiation

The LNF, has also long standing tradition in using synchrotron radiation, which was developed in more than 10 year experience (1979-1993) using ADONE, that at the end of the high-energy physics program, became also a partially dedicated to synchrotron radiation (SR) source up to 1993.



DAΦNE

After the shutdown of ADONE the LNF started the procedures for the realization of DAΦNE (Double Annular Φ-factory for Nice Experiments) a high-luminosity, 0.51 GeV, electron-positron collider dedicated to high energy physics experiments.



First beam in 1997

Energy = 0.51 GeV

L = 97.7 m

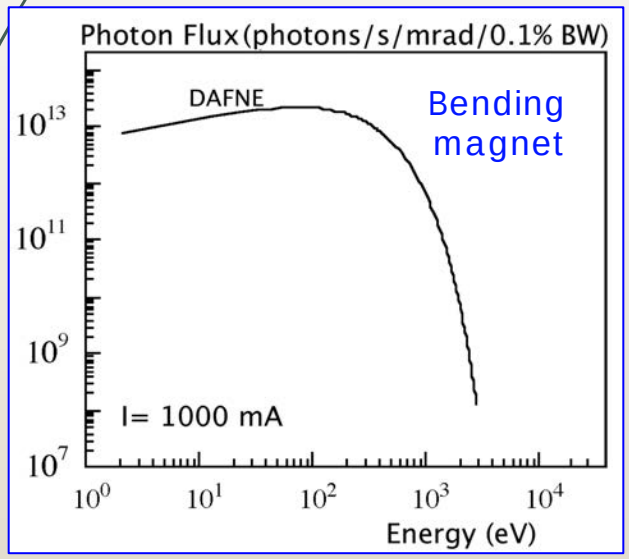
$I_{e-} > 1500$ *mA*

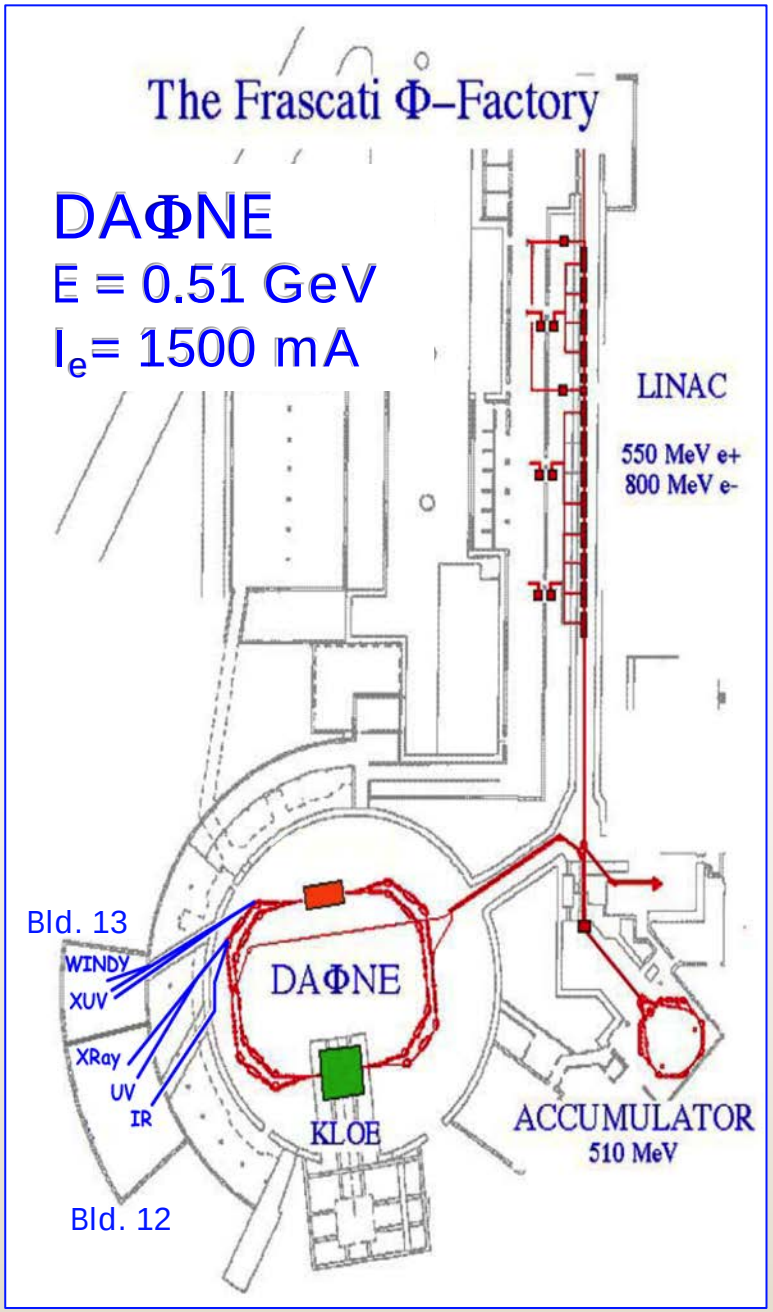
$I_{e+} > 1000$ *mA*

DAΦNE-Light

The extensive use of ADONE as a SR source up to 1993 has seen a community of researchers and users both internal and external to LNF that asked to use also DAΦNE as a SR photon source (1991).

DAΦNE-Light is a material science laboratory where also tests on new detectors and optics in the energy range moving from IR to soft X-rays can be performed (first IR beam 2001).





DAΦNE-Light group 2020

Beamline Scientists

SINBAD - Infrared beamline - Mariangela Cestelli-Guidi

DXR2 - UV-VIS beamline and SEM-EDS - Marco Angelucci (PDA)

DXR1 - Soft X-ray beamline - Antonella Balerna

LEB,HEB,WINDY- XUV beamlines - Roberto Cimino

3 Postdoc Fellows

2 PHD students

Technical Staff

A. Grilli, A. Raco, M. Pietropaoli, V. Sciarra and G. Viviani

Some Highlights

nature materials

ARTICLES

https://doi.org/10.1038/s41563-019-0478-1

Titanium-carbide MXenes for work function and interface engineering in perovskite solar cells

A. Agresti[1,2,7], A. Pazniak[3,7], S. Pescetelli[1,7], A. Di Vito[1], D. Rossi[1], A. Pecchia[4], M. Auf der Maur[1], A. Liedl[5], R. Larciprete[5,6], Denis V. Kuznetsov[3], D. Saranin[2] and A. Di Carlo[1,2*]

nature COMMUNICATIONS

ARTICLE

Received 24 Apr 2016 | Accepted 8 Feb 2017 | Published 27 Mar 2017

DOI: 10.1038/ncomms14885 OPEN

Terahertz and mid-infrared plasmons in three-dimensional nanoporous graphene

Fausto D'Apuzzo[1,2], Alba R. Piacenti[3], Flavio Giorgianni[3], Marta Autore[3], Mariangela Cestelli Guidi[4], Augusto Marcelli[4], Ulrich Schade[5], Yoshikazu Ito[6], Mingwei Chen[6,7,8] & Stefano Lupi[9]

Beamlines @ DAΦNE

Building 12

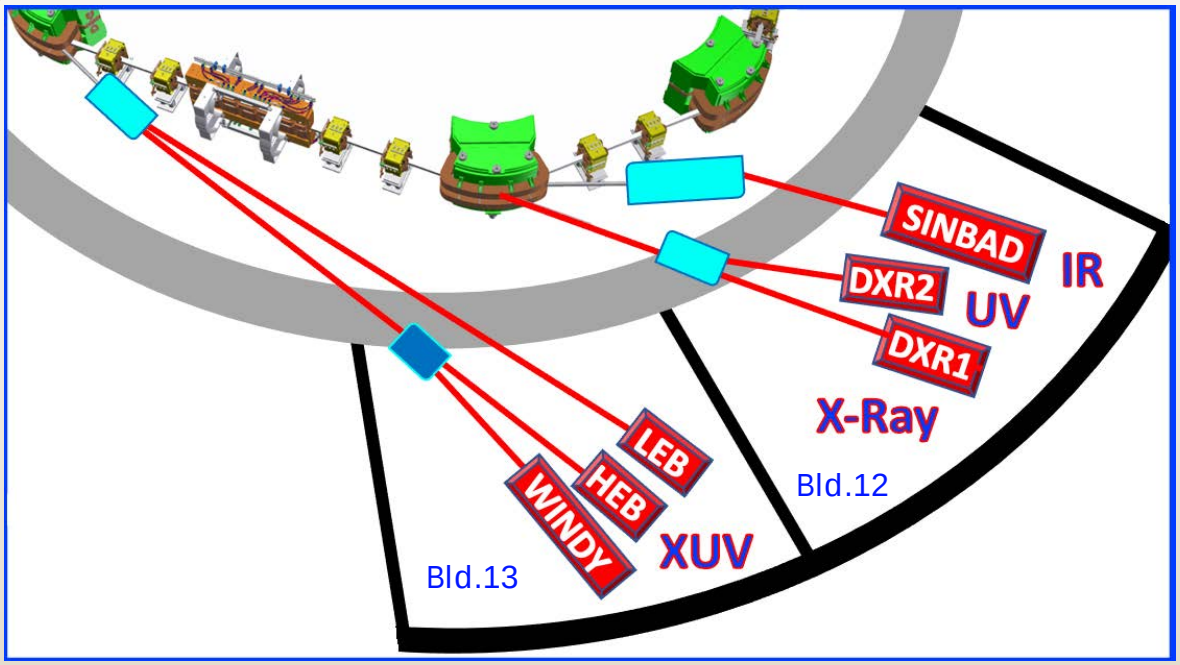
OPEN to USERS

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

4) LEB - Low Energy Beamline (30-200 eV)
5) HEB - High Energy Beamline (60-1000 eV)
6) WINDY HEB Branch White Line – MoU CERN



DXR2 and DXR1 beamlines

DXR2 - wiggler UV branch line - grazing incidence gold coated mirror

Energy range: (2 -10) eV - (650 - 120) nm

Two different monochromators: (VUV) 120-250 nm and 200-650 nm.

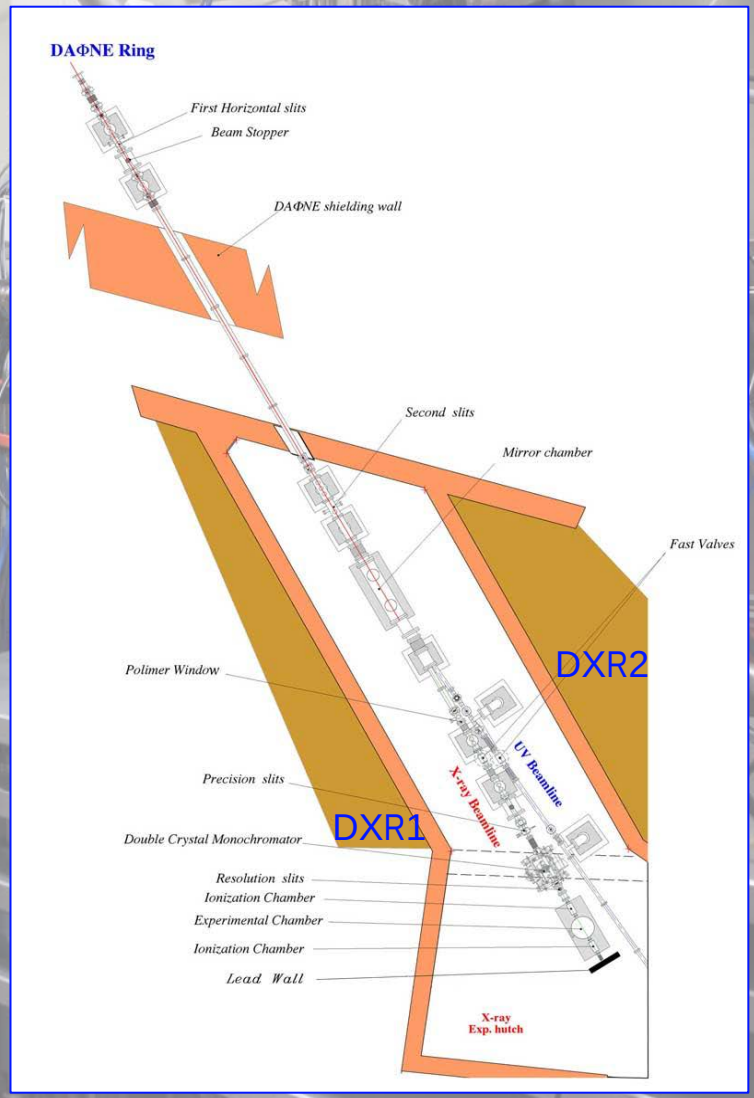
Main applications: photochemistry-ageing, reflectance spectroscopy.

DXR1 - wiggler Soft X-ray beam line

Energy range: (0.9 - 3.0) keV

TOYAMA double crystal monochromator

Main application: Soft X-ray Absorption Spectroscopy (XANES)



DXR1 - R&D: ARDESIA 2x2 SDD

4-channel SDD X-ray detector high energy resolution and high-count rates.

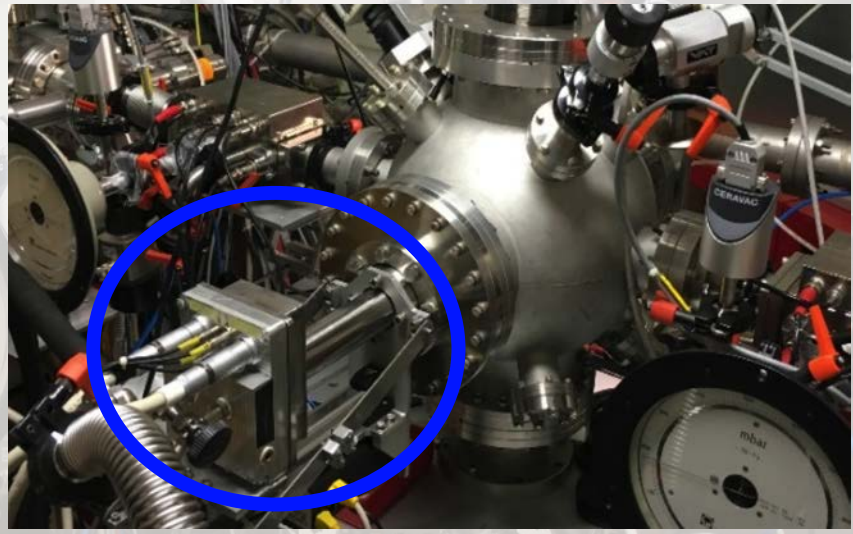
Financed by INFN through a CSN5 (INFN National Scientific Committee 5 for Technological Research Experiments).

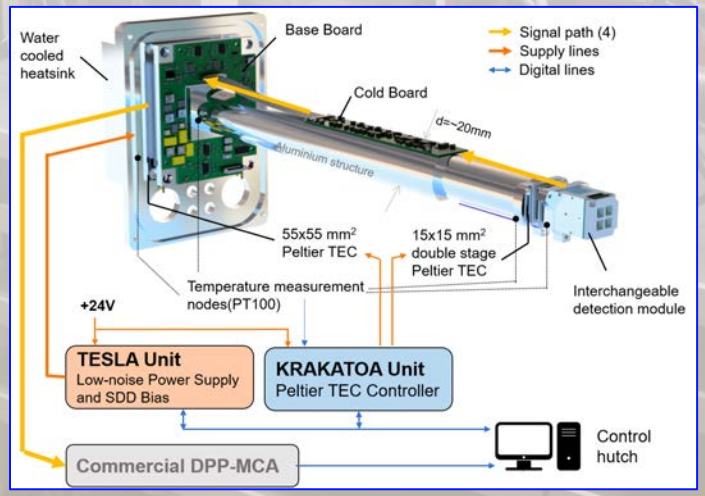
ARDESIA was a collaboration between:

-Politecnico di Milano (readout chain is based on the CMOS preamplifier CUBE, controls, power supply and bias)
-TIPFA-FBK (monolithic arrays of Silicon Drift Detectors very low dark current at RT)
-DAFNE-Light (cooling, vacuum, mechanics, materials)

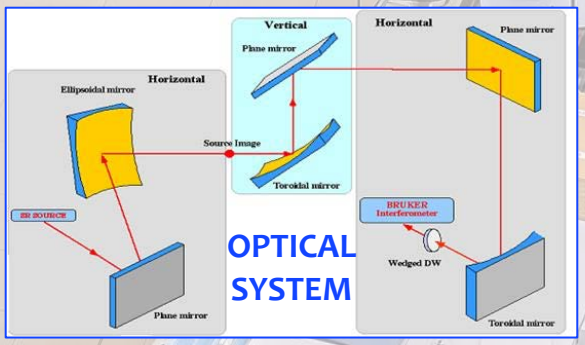
Measurements using ARDESIA at the DXR1 beamline at DAΦNE-Light, LISA CRG beamline at ESRF and Petra P65 beamline at DESY (2019).

Ongoing developments (Politecnico di Milano):
- thicker SDD substate from 0.45 mm to 1 mm
- extension to 16-channel monolithic SDD array.





SINBAD IR beamline

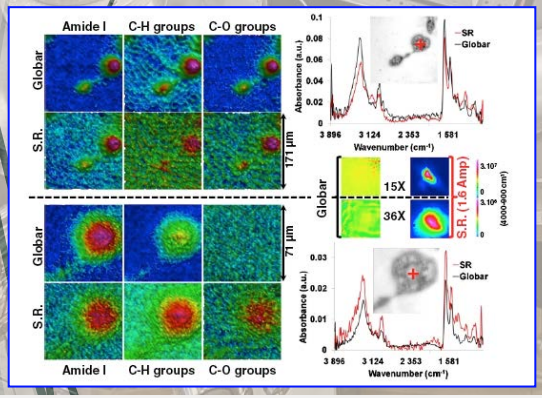


SINBAD-IR is a bending magnet beamline

Energy range from FIR to NIR: (1.24 meV - 1.24 eV) (10 to 10000) cm^{-1}

Main application: FTIR microspectroscopy and Chemical imaging

- Cryogenic setup: 2K -RT
- High temperature cells: RT-500 K
- High pressure setup - diamond anvil cell



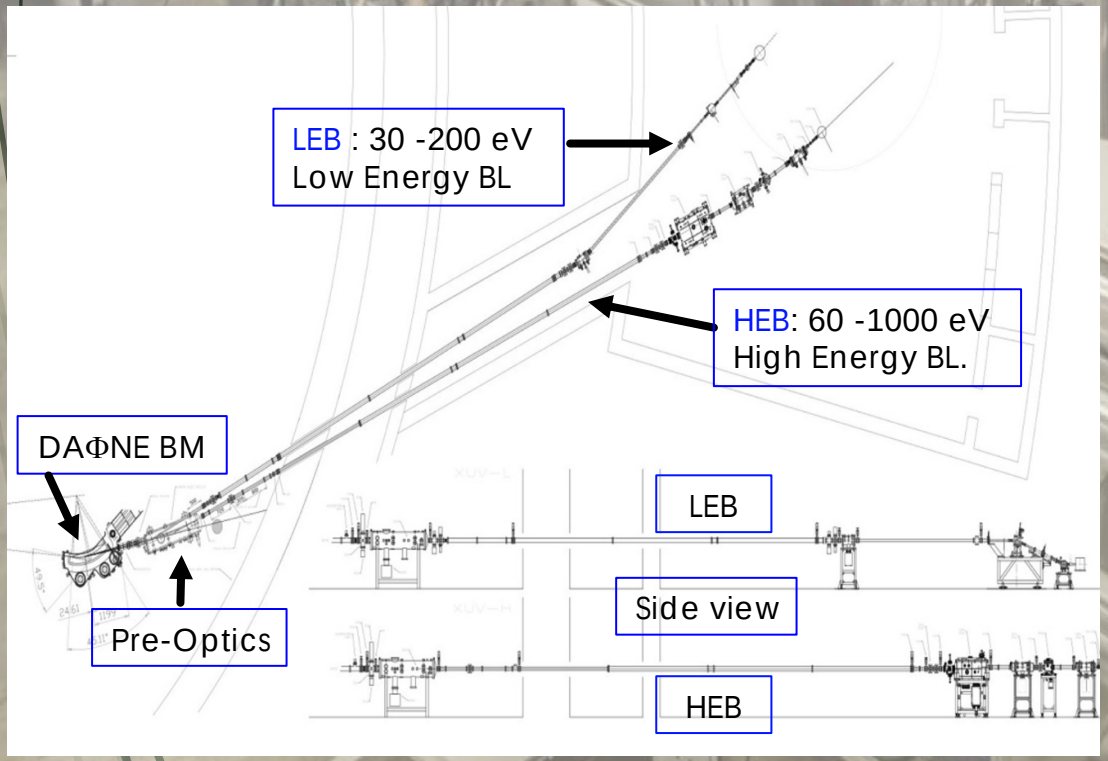
Biology and single cells studies

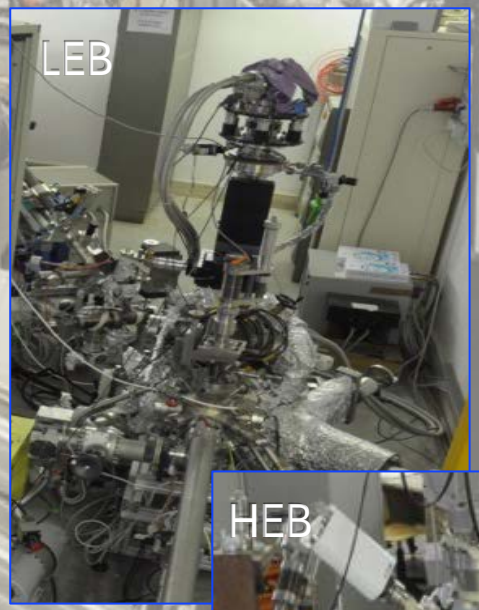
Huge involvement in the Cultural Heritage field

XUV beamlines

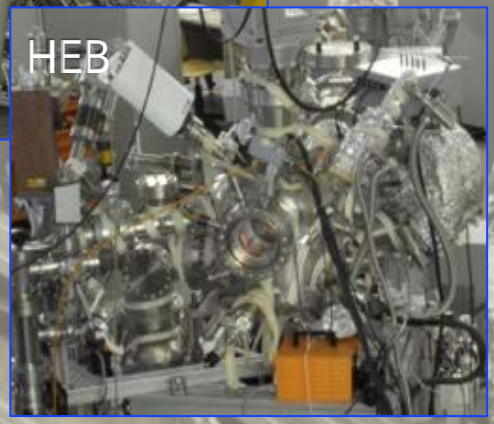
HEB: About 8 mrad horizontally
Spot on sample : (1 x 1) mm^2
Energy range: (60 - 1000) eV
Mono: Plane grating

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





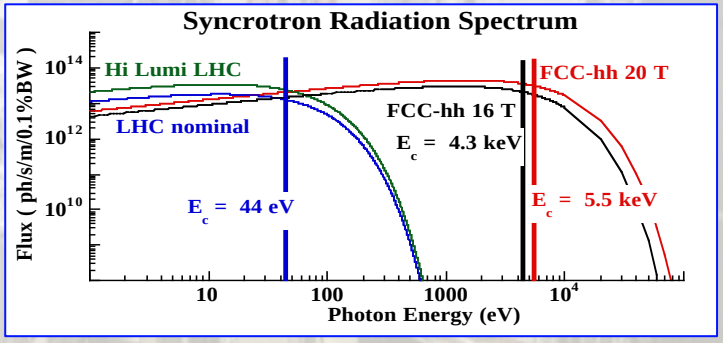
XPS
UPS
TPD
ARPES
SEY



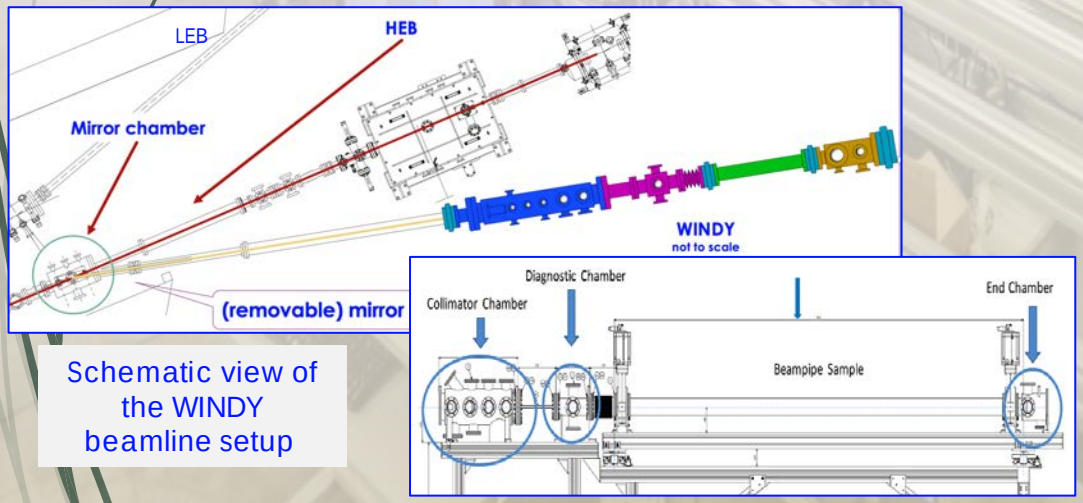
DAΦNE-Light and the new branch line WINDY (CERN-INFN)

WHITE LIGHT LINE FOR DESORPTION YIELDS

WINDY - Construction of a dedicated white light beamline for synchrotron radiation-based material studies in the framework of the High Luminosity LHC and Future Circular Colliders.



Synchrotron radiation-based material studies on small samples using the existing XUV beamlines and on real long beampipes using the WINDY beamline to study interactions that produce gas desorption, secondary electron emission, heat load on cold surfaces causing instabilities that affect beam lifetime and the overall accelerator performance.



Schematic view of the WINDY beamline setup

Users

- Normally two calls for proposals every year (20/6-20/8) and (18/10-18/12) for the beamlines open to Italian, EU and non-EU users.

  Information given using:
  - User mailing list

  - DAΦNE-Light web pages: https://web.infn.it/Dafne_Light/

  - Wayforlight: The catalogue of European Light Sources

- For transnational access (TNA) we are in the EU Projects CALIPSOplus

- Normally about 30 experimental teams/year get access to the DAΦNE-Light laboratory coming from Italian, European and non EU Universities and Research Institutions

- From May 2020 due to the pandemic situation we gave the possibility to users to mail-in their samples when and if possible.

DAΦNE-Light Activity 2020 and impact of the COVID-19 pandemic

- Beginning of 2020 Italian and EU users.
- From March 2020 to the beginning of May 2020 stop of all measurements.
- Restart middle of May 2020 with in-house research and measurements on samples mailed-in (proposals, collaborations, third parties, PHD thesis).
- From the middle of June 2020, requesting the reduction of the team sizes, Italian users and also the first external user coming from Cyprus.
- From the middle of November mainly measurements on samples mailed-in and PHD thesis.

✓ Increase of the pressure on beamline staff with the sample mail-in system not needed in the past.

✓ Only about 50% of the proposals received beamtime (travel restrictions, experimental proposals requesting particular sample preparation like biological samples, beam conditions).

✓ In 2020 only one call for proposals (18 October -19 December 2020)

Thank you for your attention

DAΦNE Light
Synchrotron Radiation Facility

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