

Elettra Laboratory Mission: Using Synchrotron and FEL radiation to conduct experiments considered impossible a decade ago !



Elettra Sincrotrone Trieste

IAEA CC 2005-2014
IAEA XRF beamline
Partner since 2014.

Renewed IAEA CC May 2020 – signed by DDG
Najat Mokhtar and CEO Alfonso Franciosi

Rome, JUNE 19, 2013

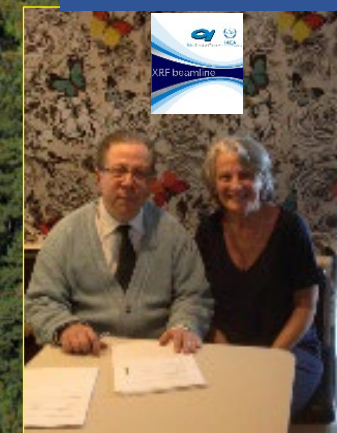
**IAEA-Elettra
collaboration
aims to
enhance
capacity
building and
facilitate the
expansion of
state-of-the art
synchrotron-
based research
in IAEA
Member States.**

June 7, 2019

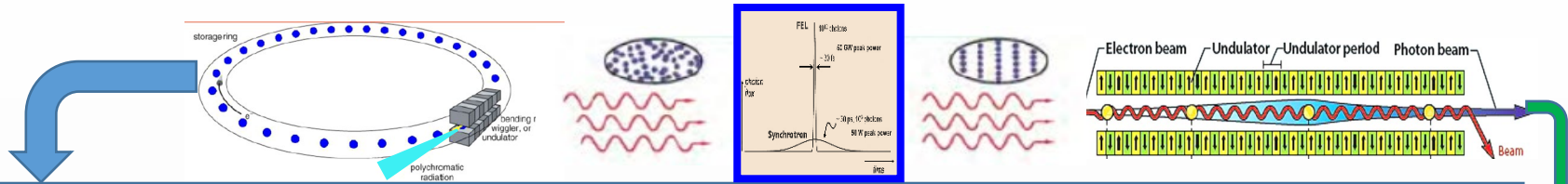
Elettra, OCTOBER 6, 2014



DDG Yukiya Amano



SYNCHROTRON? photon emission generated by relativistic electrons in circular or linear accelerators



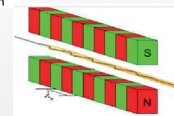
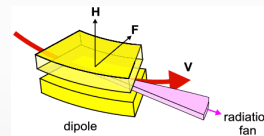
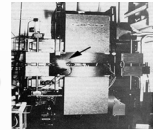
April 24, 1947 observed in General Electric Lab NY – “ugly duck” causing particles to lose energy. In 60s recognized as light with exceptional properties - used in parasitic mode @ accelerators called Synchrotrons.

1968 1st Gen. 'user' SR Tantalus (USA) “illuminating the path to scientific discovery”

1981 2nd Gen. SR (only BM) SRS (UK)

1993 3rd Gen. SR – Elettra (Italy)

2016 4th Gen. low emittance DLSR MAX IV (Sweden)



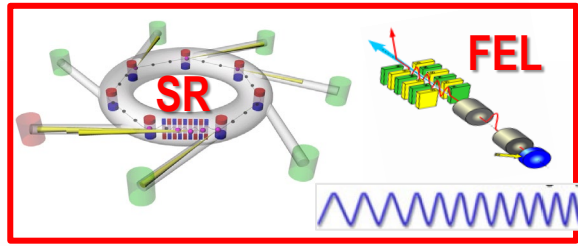
2005 – 1st XUV SASE FEL – FLASH (Germany)

2009 1st X-ray SASE FEL LCLS (USA)

2010 – 1st Seeded FEL FERMI (Italy)

2017 - 1st High-rep XFEL (Germany) 3.4 km



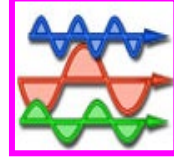


photons

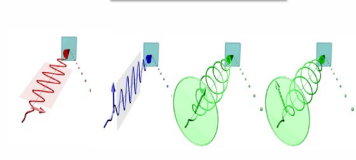
Bright



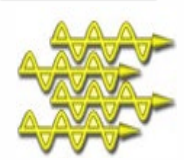
Tunable



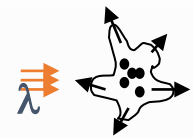
Polarized



Coherent



All methods are based on the interaction of photons with matter and find applications in all domains of science and technology



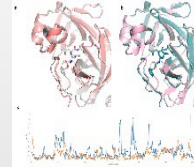
Scattered X-rays (elastic / inelastic)



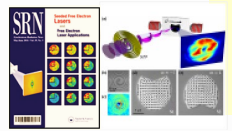
Efficient encapsulation and transport of high loadings of partially fluorinated drug molecules



Diffracted X-rays

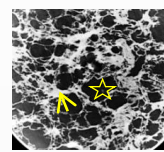


SARS-CoV-2 main protease recognized promising target for the development of effective drugs

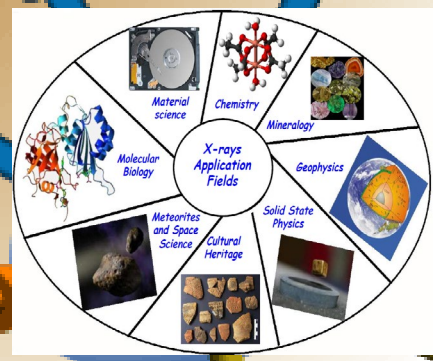


Coherent Diffraction Imaging - adds Dynamics using FELs

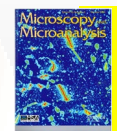
Reflected X-rays



Alveolar dilatation and thickening in lung tissue due to COVID - SR-CT 5 μm



Transmitted / Refracted X-rays XAS



XRM Histological Analyses of Asbestos Fibers and Bodies in Lungs and Pleura.



Spin-orbit coupling effects in quantum materials for electronics



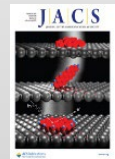
Reversible Manganese Electroactivity in Na-Rich Manganese Hexacyanoferrate for Li- and Na-Ion Storage

Incident X-rays



Lithics - hunting armatures hafted with complex adhesives used ~45000 years ago

Photoelectron Spectroscopy: PES - ARUPS & XPS-AES and XAS
Photo/Auger Electron Emission



Molecular Lifting, Twisting, and Curling during Metal-Assisted Polycyclic Hydrocarbon Dehydrogenation

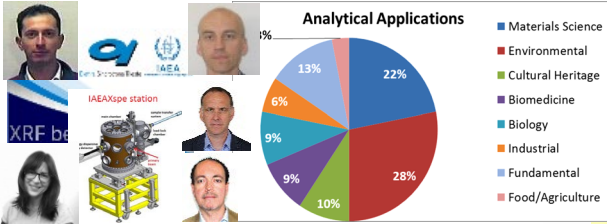
Fluorescent Emission
Fluorescence Spectroscopy XRF and XAS

XRF Beamline in partnership ELETTRA - IAEA

<https://iaea.mediasite.com/Mediasite/Play/9e939d26d0fe4bc1b4174e72a3ebb0c81d>

- IAEA SUPPORT TO SCIENTISTS FROM LESS DEVELOPED COUNTRIES WITH PROPOSALS APPROVED BY THE INTERNATIONAL PRP PANEL: 40% XRF BEAMTIME (~ 100 DAYS/ANN).
- ANNUAL TRAINING WORKSHOPS –NEXT JULY 25-29, 2022: <https://www.iaea.org/events/evt2104017>
- Participation in WSs and Schools in the frame of Elettra-ICTP cooperation

<https://www.elettra.trieste.it/it/lightsources/elettra/elettra-beamlines/microfluorescence/research.html>



IAEA Nuclear Science and Instrumentation
 Laboratory: Support to IAEA Member States and
 Recent Developments
EPJ Web Conf., Vol. 225 (2020)

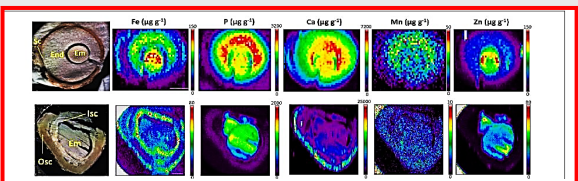
F. FOUL An IAEA multi-technique X-ray spectrometry endstation at Elettra Sincrotrone Trieste: benchmarking results and interdisciplinary applications
J. Synchrotron Rad. (2018). 25, 189–203

Andreas Germanos Karydas,^{a,b,*} Mateusz Czyzycy,^{a,c} Juan José Leani,^{d,e} Alessandro Migliori,^a Janos Osan,^{a,e} Mladen Bogovac,^a Pawel Wrobel,^f Nikita Vakula,^g Roman Padilla-Alvarez,^g Ralf Hendrik Menk,^{h,i} Maryam Ghahremani Gol,^h Matias Antonelli,^{h,i} Manoj K Tiwari,ⁱ Claudia Caliri,^j Katarina Vogel-Mikus,^{k,l} Iain Darby,^k and **Ralf Bernd Kaiser**^{*,j}

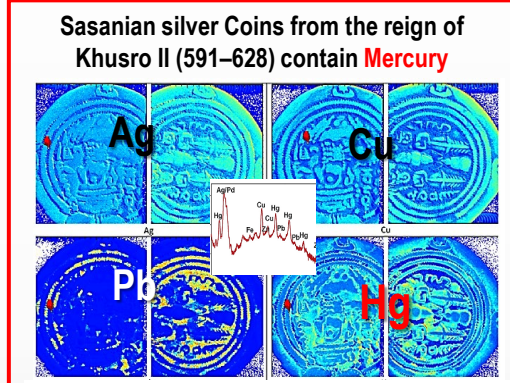
A first evaluation of the analytical capabilities of the new X-ray fluorescence facility at International Atomic Energy Agency - Elettra Sincrotrone Trieste for multipurpose total reflection X-ray fluorescence analysis
Spectrochimica Acta - Part B, 145, 8 (2018)

Eva Margui^{1,*}, Manuela Hidalgo¹, Alessandro Migliori², Juan José Leani^{2,3}, Ignasi Queralt⁴, Nikolaos Kallithrakas-Kontos⁵, Christina Strelli⁶, Josef Probst⁶, Adreas Germanos Karydas^{2,7}

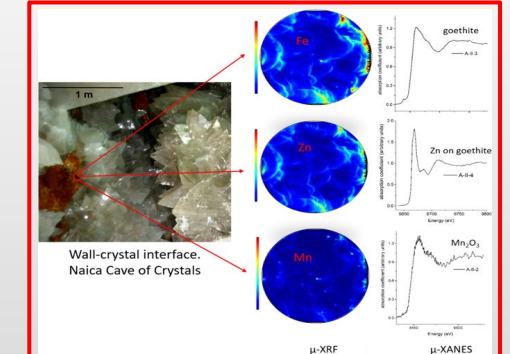
Experimental production cross sections for synchrotron radiation induced L-series X-rays of Sn and Sb at energies across their L_i (i = 1–3) absorption edges
 Kaur S., Ayri V., Kumar A., Czyzycy M., Karydas A.G.,
Puri Sanjiv (IAEA Grant - > 10 papers).
X-Ray Spectrometry, 51, 15 (2022),



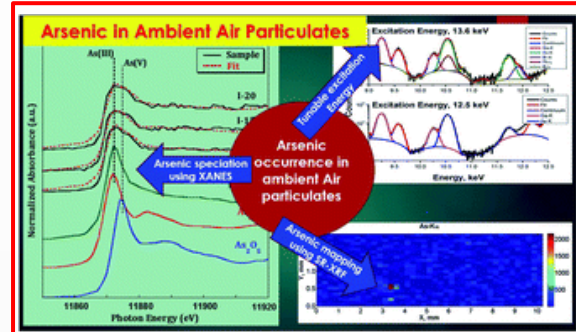
The Conservation of VIT1-Dependent Iron Distribution in Seeds (Turkey-Slovenia)
 Eroglu S., Karaca N., Vogel-Mikus K., Kavčić A., Filiz E., Tanyolac B. *Frontiers in Plant Science, 10, 907 (2019)*



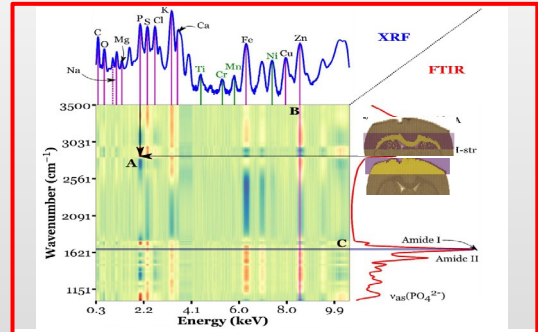
The Mystery of Mercury-layers on Ancient Coins, K. Uhlir, *Microchem. J. 125, 2016*



Naica's Giant Crystals: Characterization and Evolution of the Wall-Crystal Interface (Mexico) Pérez-Cázares Bernardo et al, *Crystal Growth and Design, 21, 5712 (2021)*



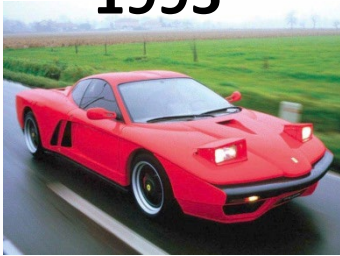
Assessment of Arsenic in Ambient Air Particulates Collected in Greater Cairo via Synchrotron Radiation Based X-ray Fluorescence and X-ray Absorption Near Edge Structure (Egypt, Jordan, Saudi Arabia)
 A. A. Shaltout et al, *J. Anal. Spectr. 36, 981 (2021)*



On 2D-FTIR-XRF microscopy – a step forward correlative tissue studies by infrared and hard X-ray radiation (Poland-IAEA) Artur D. Surowka et al, *Ultramicroscopy, 232, 113408 (2022)*

What is Elettra & FERMI future???

1995



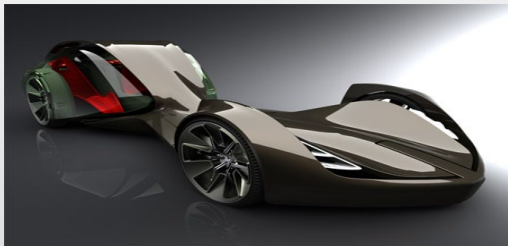
2010



- ❖ **ELETTRA storage ring is having its 30th Birthday October 2023. It has served as a user facility since 1995 with ring upgrades in 2008 and 2010.**
- ❖ **Fermi FEL-1 welcome users in 2012 and FEL-2 in 2016. Ongoing developments & upgrade under discussion.**

2026-27

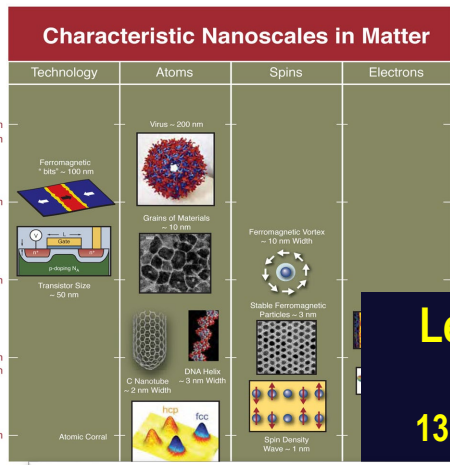
**ELETTRA
2.0**



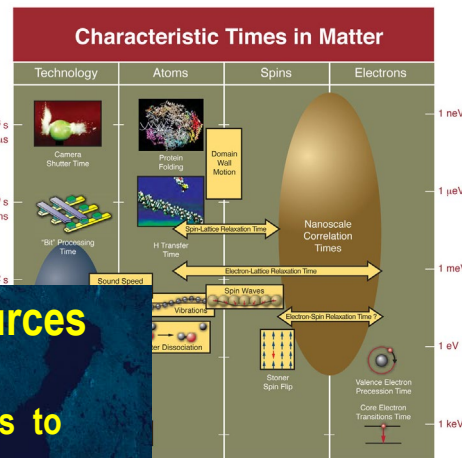
Elettra-2.0 performance (brightness – variable bunch lengths) in a broad range of photon energies should enable new exciting research opportunities for in-situ characterization of the structure and function of all types complex matter.

<https://www.elettra.trieste.it/lightsources/elettra/elettra-2-0.html?showall=>

Large Scale Facilities Consortia in Europe

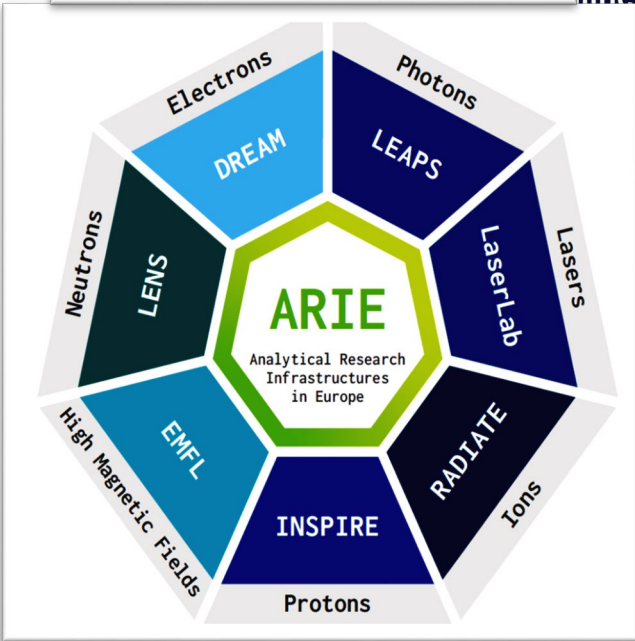


❖ Coming together is a beginning,
 ❖ Staying together is progress,
 ❖ Working together is success.
 (Henry Ford)



League of European Accelerator-Based Photon Sources (LEAPS)
 13 European Synchrotron Radiation and 6 FEL Facilities join forces to master the challenges of the next decades.

New Era of Knowledge-Based Design of Advanced Materials and Better Drugs
 Europe's Accelerator-Based Light Sources Join Forces



Springer EPJplus journal Special issue 2022

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 & innovation
 ices & Impact
 n, Training &



<https://www.leaps-initiative.eu/>

LEAPS League of European Accelerator-based Photon Sources

