EuPRAXIA @ SPARC_LAB

June 15th, 2023

TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA
Dipartimento di Fisica

INFN
Istituto Nazionale di Fisica Nucleare

WA8

Scientific Case

Francesco Stellato &

University of Rome Tor Vergata & INFN

on behalf of the WA8 collaboration team

Marco Angelucci
Antonella Balerna
Marcello Coreno
Zeinab Ebrahimpour
Federico Galdenzi
Luca Giannessi
Andrea Liedl
Augusto Marcelli
Federico Nguyen
Emiliano Principi
Luisa Spallino
Fabio Villa

Project Summary

Build up the **scientific case** and gather a **users' community** for a **plasma-based** SASE FEL lasing in the water-window (4 nm)
& for a seeded FEL lasing @ 50-180 nm

1- Experimental techniques

2- Users' community

3- Project status

Photon beams parameters

AQUA

Parameter	Value
Wavelength*	~4 nm
Photons/pulse	10^{10} - 10^{11}
Pulse duration	< 50 fs
Repetition rate**	100 Hz

ARIA

Parameter	Value
Wavelength	50-180 nm
Photons/pulse	10^{13} - 10^{14}
Pulse duration	20/200 fs
Repetition rate**	100 Hz

*Running at longer wavelength (~10 nm) is within the reach of the machine

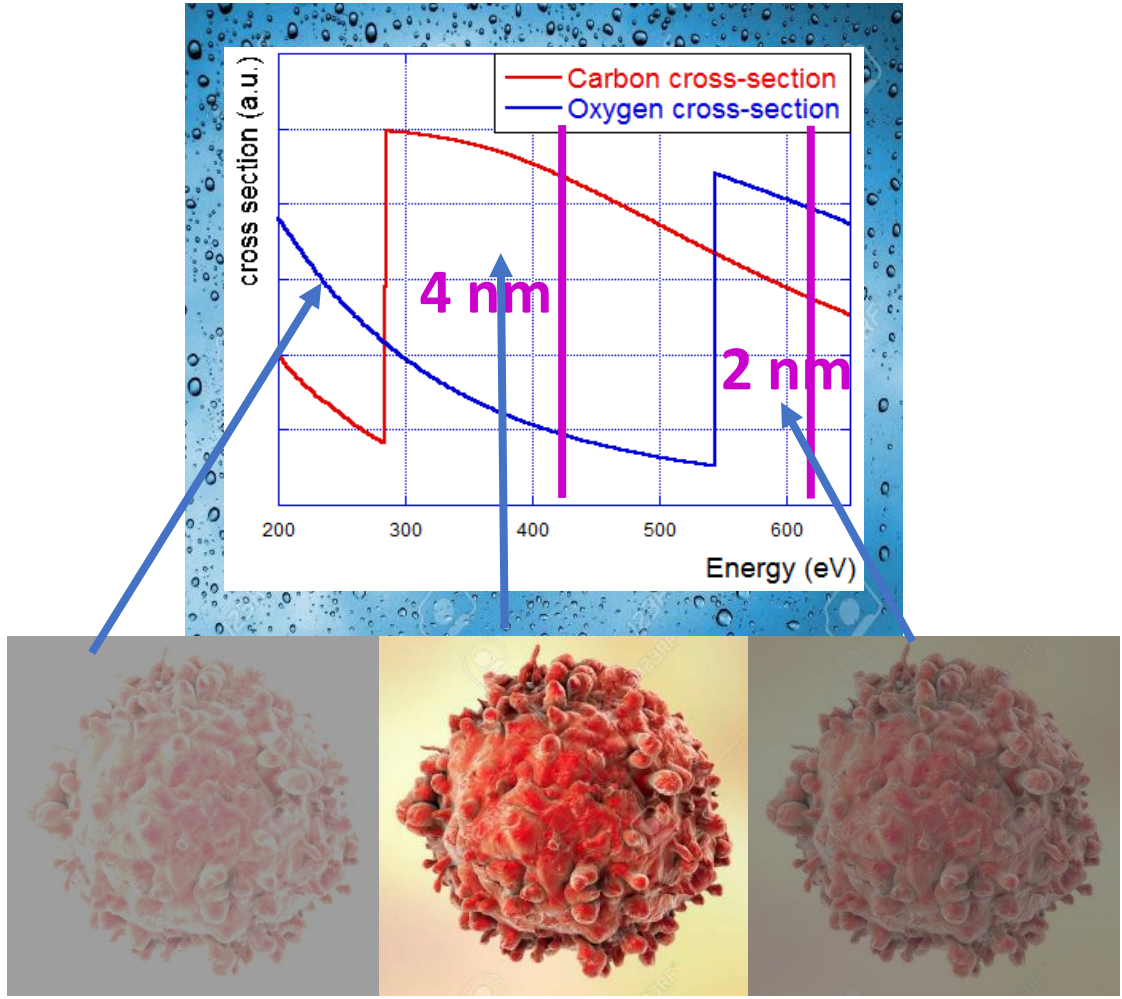
** Options to run @ 400 Hz are being explored

Experimental Techniques

Experimental Techniques
Coherent imaging

The water window is a «sweet spot» for imaging of biological samples in their native environment.

The expected resolution is tens of nanometers
However, only room-temperature measurements of fully hydrated samples allow aquiring 2D images of **living cells** and of **organelles** in their native state



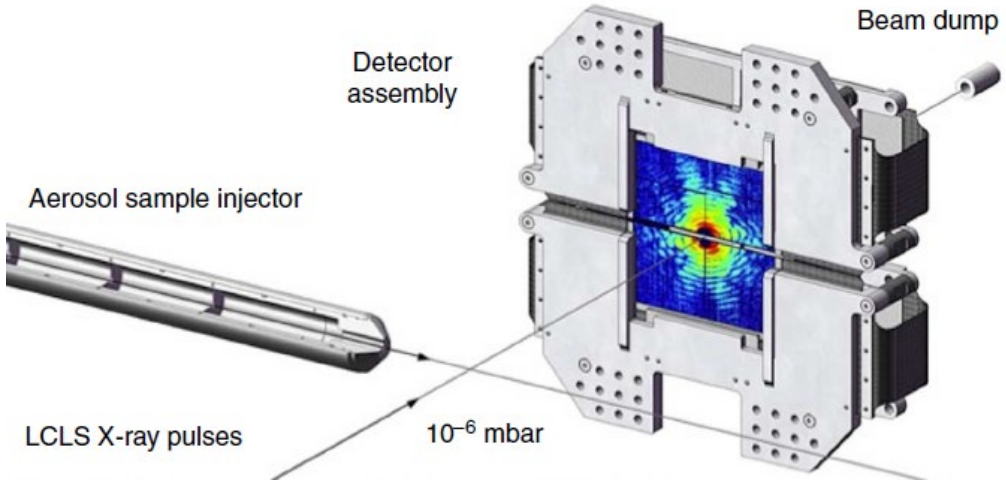
Experimental Techniques
Coherent imaging

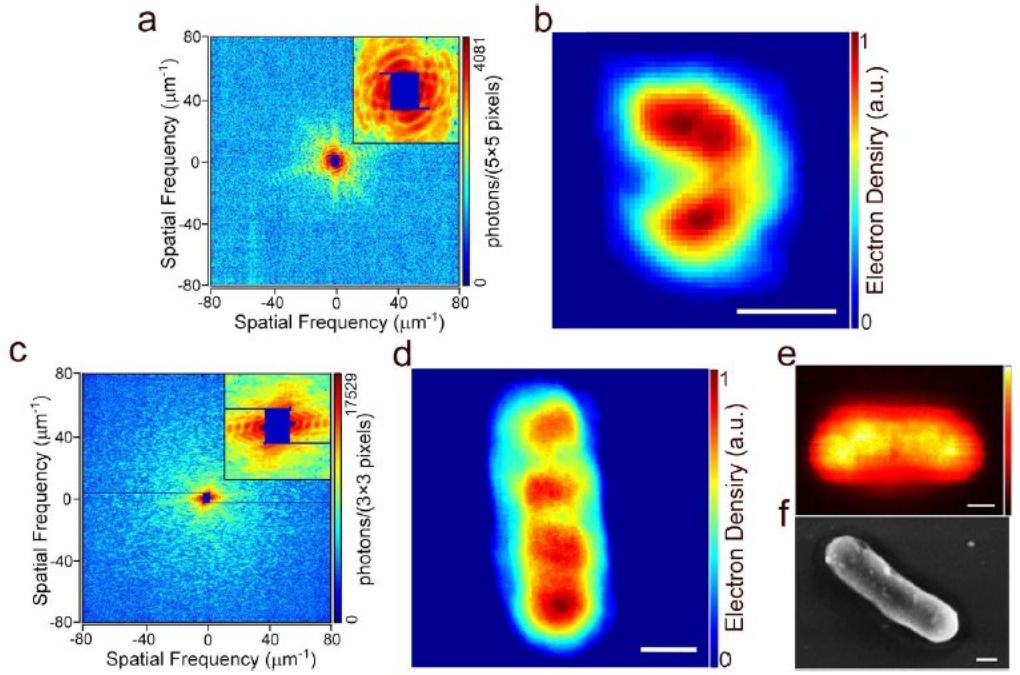
Images of living bacteria have been acquired at SACLA (*S. aureus*, 5.5 keV)

Fan, J., Sun, Z., Wang, Y., Park, J., Kim, S., Gallagher-Jones, M., ... & Jiang, H. (2016). Single-pulse enhanced coherent diffraction imaging of bacteria with an X-ray free-electron laser. *Scientific Reports*, *6*(1), 34008.

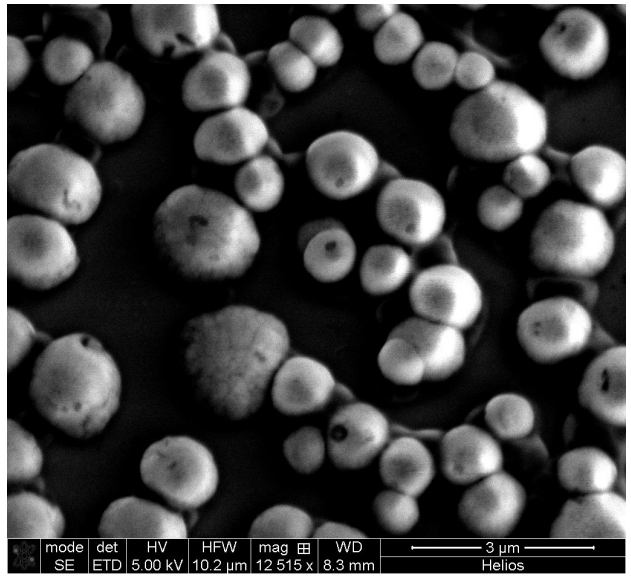
and LCLS (*C. gracile*, 517 eV)

Van Der Schot, G., Svenda, M., Maia, F. R., Hantke, M., DePonte, D. P., Seibert, M. M., ... F. Stellato, ... & Ekeberg, T. (2015). Imaging single cells in a beam of live cyanobacteria with an X-ray laser. *Nature communications*, *6*(1), 5704.





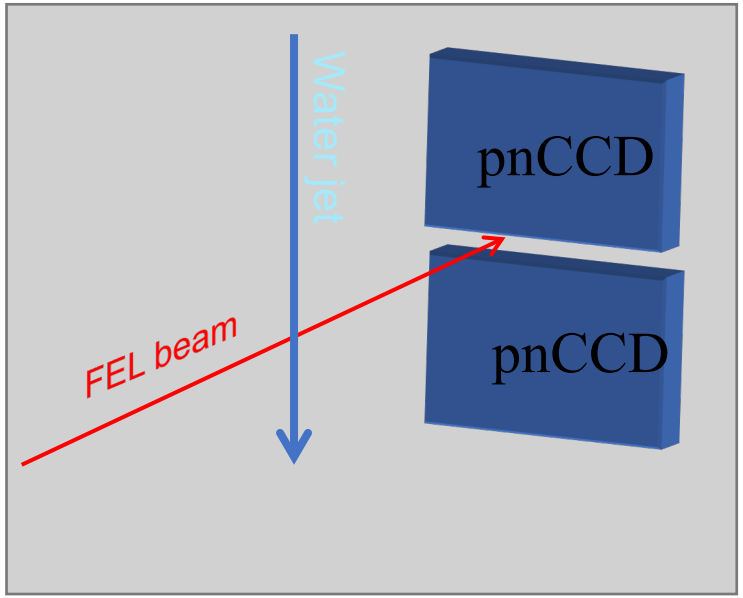
Experimental Techniques
Coherent imaging



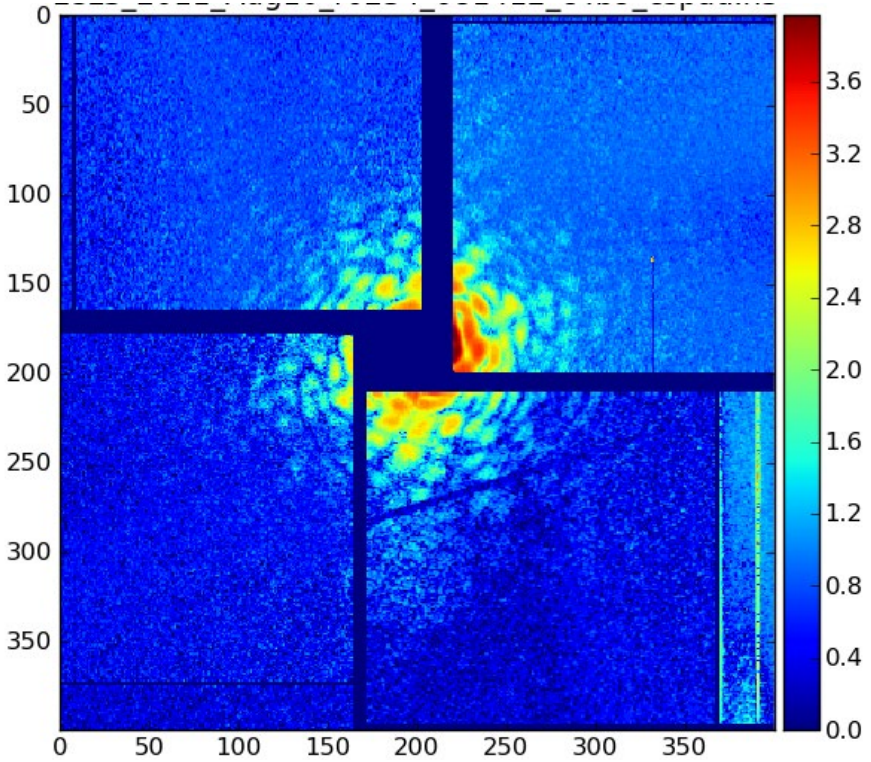
Yeast Nuclei
0.3 µm < diameter < 2 µm

LCLS experiments
(still) unpublished data

Atomic Molecular and
Optical science beamline
CAMP Chamber
pnCCD



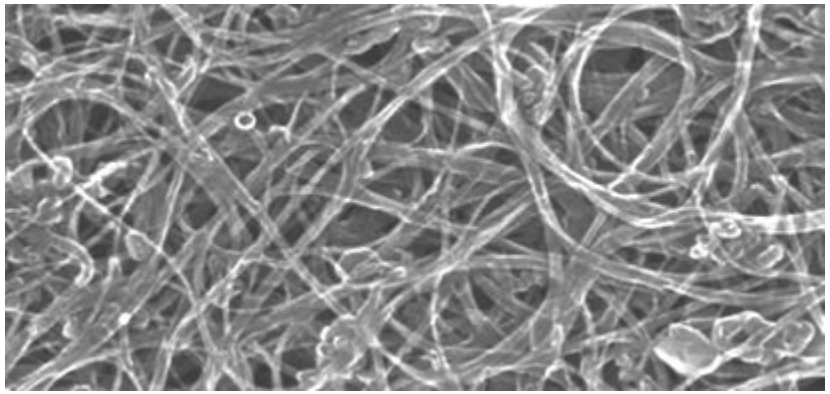
520 eV (2.4 nm) photons
3x2 µm² focus - 2 µJ

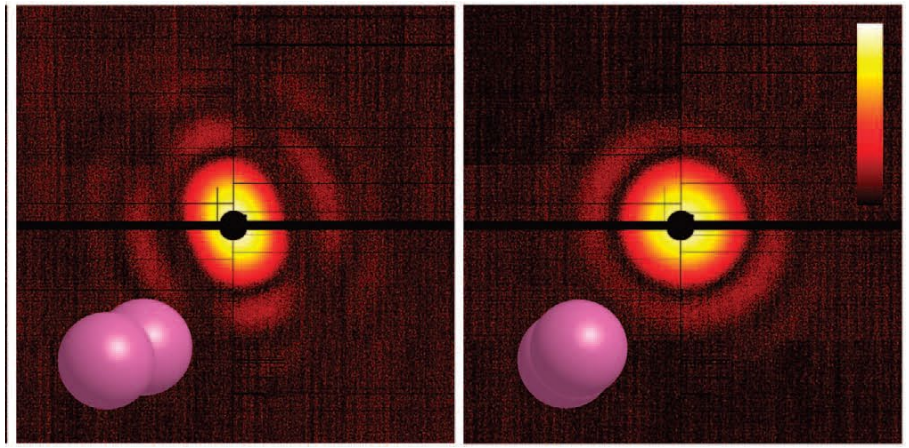


A yeast nucleus diffraction pattern exhibiting clearly visible speckles

Experimental Techniques
Coherent imaging

Imaging can be also performed on inorganic samples.





Nanotubes, nanoparticles, combustion products (soot)

Again, high time-resolution pump-probe studies are the target.

Experimental Techniques
X-ray spectroscopy: absorption (and emission)

AQUA

No **monochromator** in phase one (but space for a monochromator foreseen)

SASE w/o monochromator (ghost-spectroscopy) scheme

Klein, Y., Tripathi, A. K., Strizhevsky, E., Capotondi, F., De Angelis, D., Giannessi, L., ... & Shwartz, S. (2023). High-spectral-resolution absorption measurements with free-electron lasers using ghost spectroscopy. *Physical Review A*, *107*(5), 053503.

Downstream **spectrometer** for X-ray emission measurements

ARIA

Seeded w/o monochromator scheme with short (20 fs) pulses for VUV spectroscopy

Seeded with monochromator scheme with long (200 fs, 1014 photons/pulse) pulses for VUV spectroscopy

Experimental Techniques
X-ray spectroscopy: absorption (and emission)

AQUA

Tuned to study
C K-edge

Going at longer wavelength (up to about 10 nm) L, M and N-edges are also accessible

Al to K L-edges

Cu to Ru M-edges

Sb to Ne L-edges

Experiments exploiting higher harmonics or pushing the machine at shorter wavelength would suffer the lower number of photons/pulse

Experimental Techniques
X-ray spectroscopy: absorption (and emission)

C K-edge

Hydrocarbons, aminoacids

Al to K L-edges

Alloys, warm-dense matter (pump-probe)

Cu to Ru M-edges

Samples: cuprates, porphyrins, metalloproteins

Sb to Ne L-edges

Lanthanides superconductors, catalysts

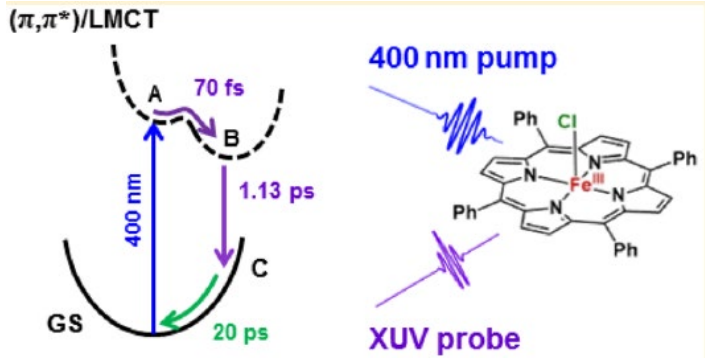
J Synchrotron Radiat. 2013 Jul 1; 20(Pt 4): 614–619.
Published online 2013 May 30. doi: 10.1107/S0909049513003142
PMCID: PMC3682637
PMID: 23765304

Soft X-ray absorption spectroscopy and resonant inelastic X-ray scattering spectroscopy below 100 eV: probing first-row transition-metal *M*-edges in chemical complexes

Hongxin Wang,[a,b,*] Anthony T. Young,[c] Jinghua Guo,[c] Stephen P. Cramer,[a,b] Stephan Friedrich,[d] Artur Braun,[e] and Weiwei Gu[b]

J|A|C|S JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
Article
Cite This: J. Am. Chem. Soc. 2018, 140, 4691−4696
pubs.acs.org/JACS

Tabletop Femtosecond M-edge X-ray Absorption Near-Edge Structure of FeTPPCl: Metalloporphyrin Photophysics from the Perspective of the Metal

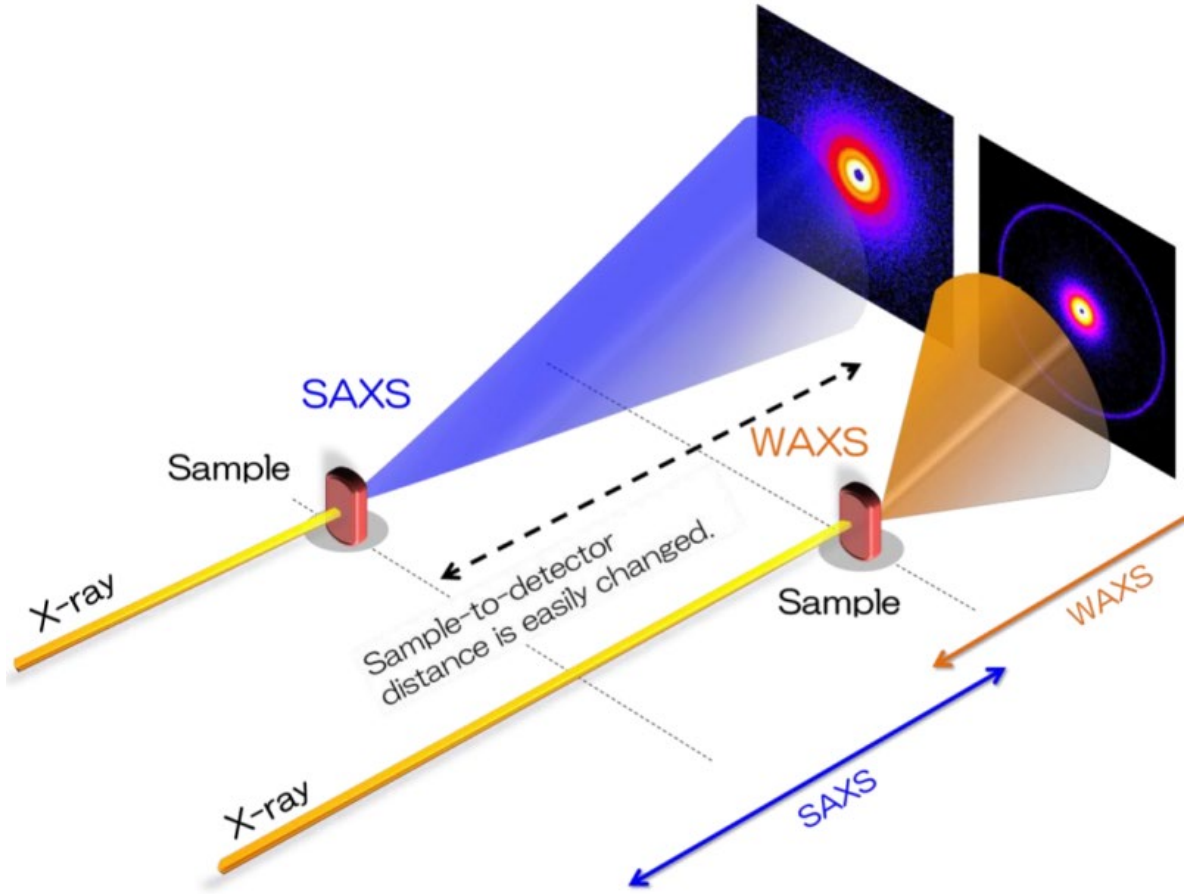


Experimental Techniques
Small (and wide) Angle X-ray Scattering

Small angle scattering measurements provide low-resolution structural information

The ultra-short FELs allows time-resolved pump-probe measurements

At both **AQUA** and **ARIA**, these measurements are @ reachable camera lengths



Experimental Techniques
Small (and wide) Angle X-ray Scattering

Pump-probe schemes allow to exploit SAXS (and WAXS) to track fast structural changes in catalysts, superconductors, photo-sensitive biological molecules, …

JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
pubs.acs.org/JACS
Communication

Operando Resonant Soft X-ray Scattering Studies of Chemical Environment and Interparticle Dynamics of Cu Nanocatalysts for CO_2 Electroreduction

Yao Yang, Inwhan Roh, Sheena Louisia, Chubai Chen, Jianbo Jin, Sunmoon Yu, Miquel B. Salmeron, Cheng Wang,* and Peidong Yang*

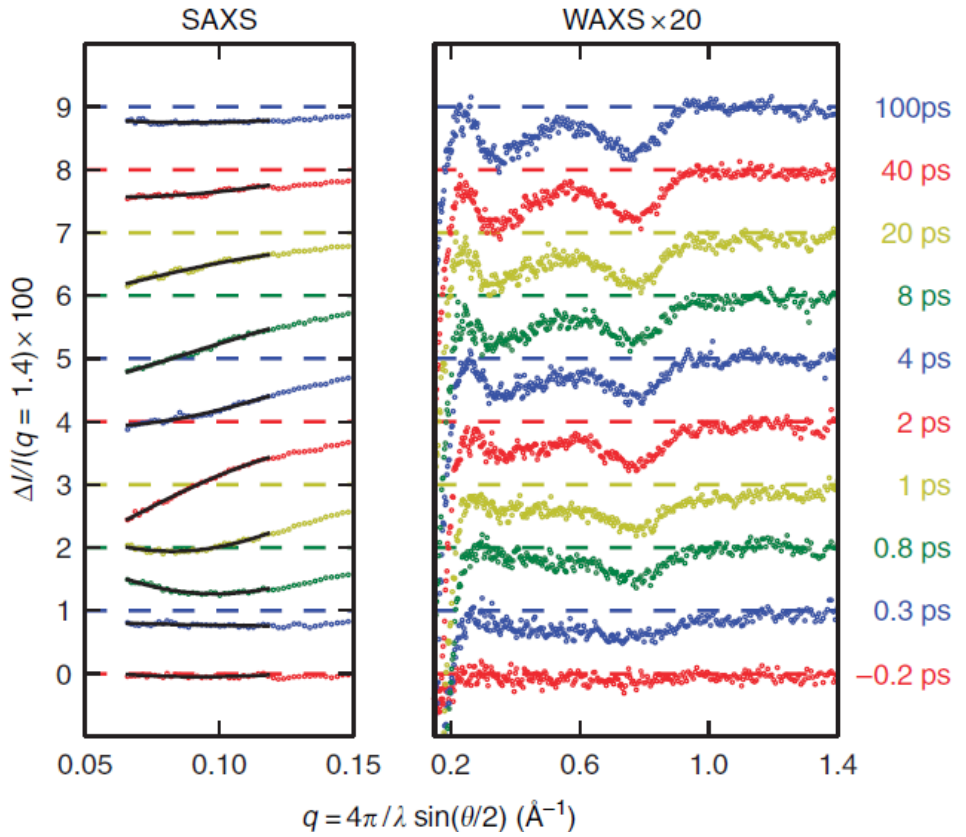
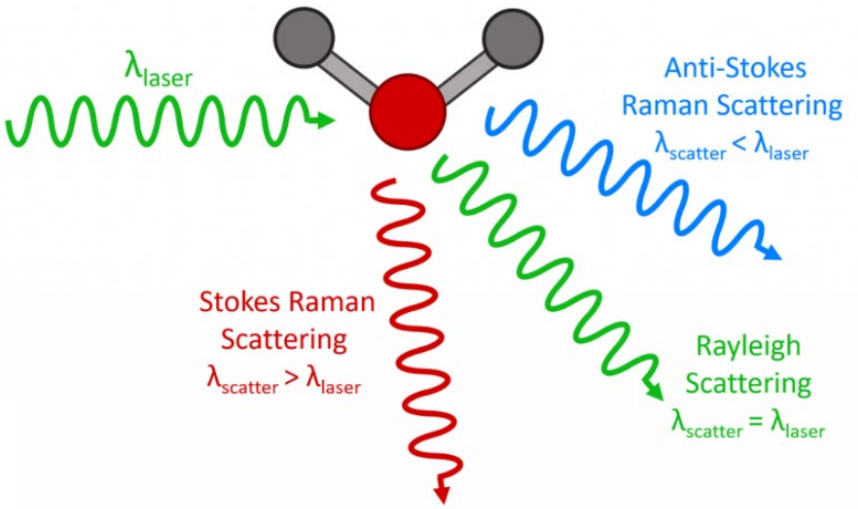


Photo-excitation of myoglobin monitored by SAXS & WAXS
Levantino *et al.*, Nat Comm 2014

Experimental Techniques
Raman Spectroscopy

FEL pulses can be exploited as pump pulse for stimulating chemical reactions or for generating coherent excitations, and, on the other hand, they can be used as selective probe to monitor the evolution from reactant to photoproduct.

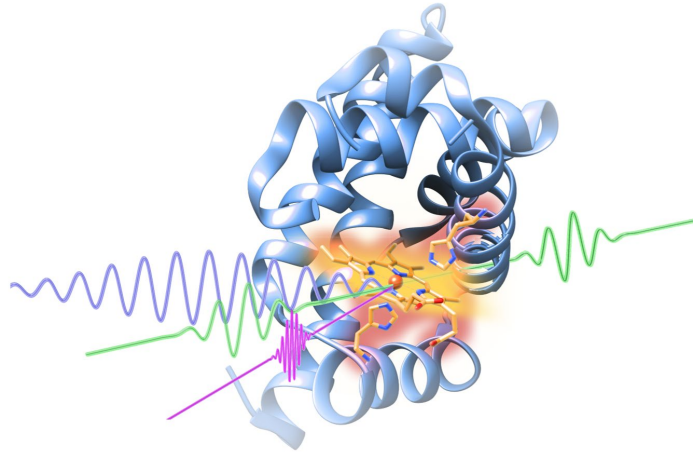


ARIA

Electronic transitions for **cluster materials** such as nanocarbons and potential gap dielectrics from **metal oxides**, **nano structure**, wide band-gap materials.

AQUA

Electronic information on materials such as Silicon carbide SiC, boron nitride BN, Zinc sulfide ZnS, energy transfer in TiO_2/Ln^{+3} doped glass).
Photocatalytic reactions CO_2 and N_2 reduction and H_2O oxidation

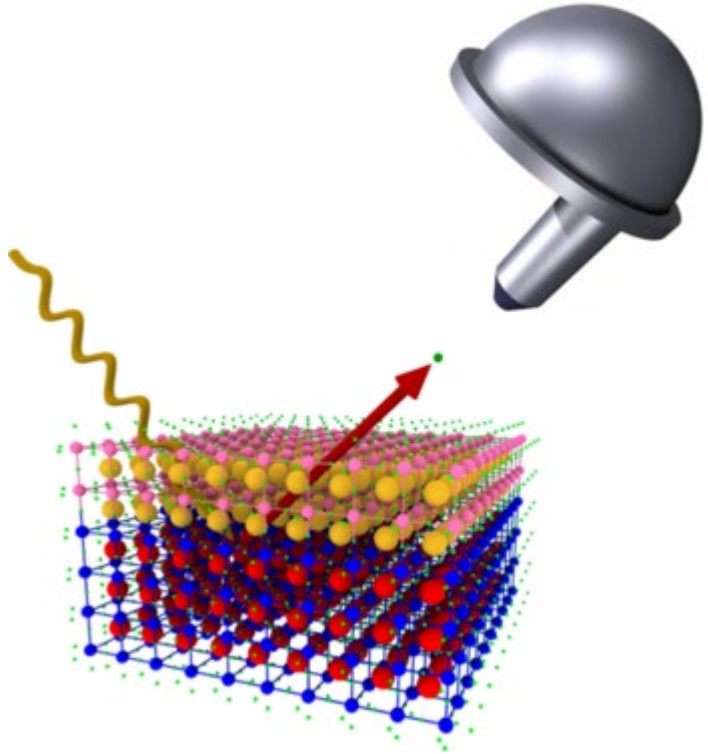


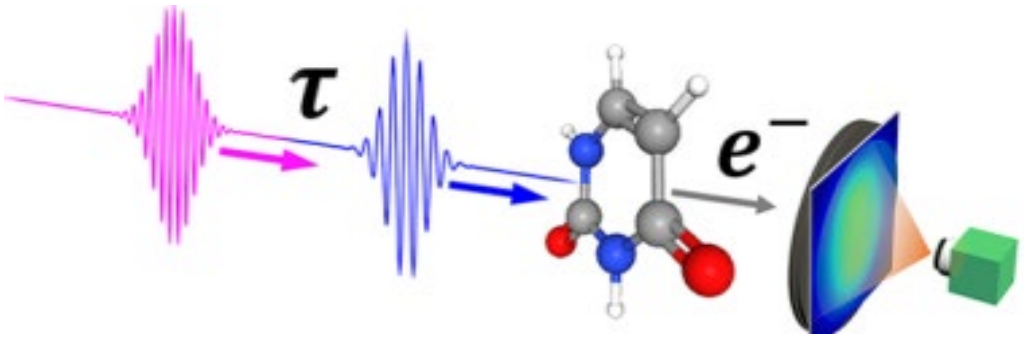
Courtesy of Zeinab Ebrahimpour

Experimental Techniques
Photoemission Spectroscopy

The **AQUA** and **ARIA** energy ranges are also suitable to perform Photoemission Spectroscopy (**PES**) experiments, in which the energy spectrum of the emitted photoelecton is measured.
This provides information on the electronic structure of the samples.

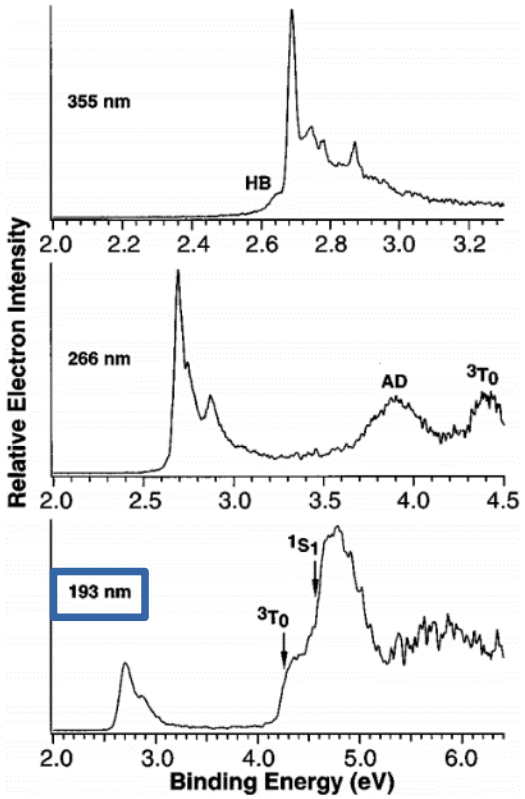
PES can be performed in different schemes and it will benefit from the ultrafast structure of the FEL radiation for pump-probe measurements.





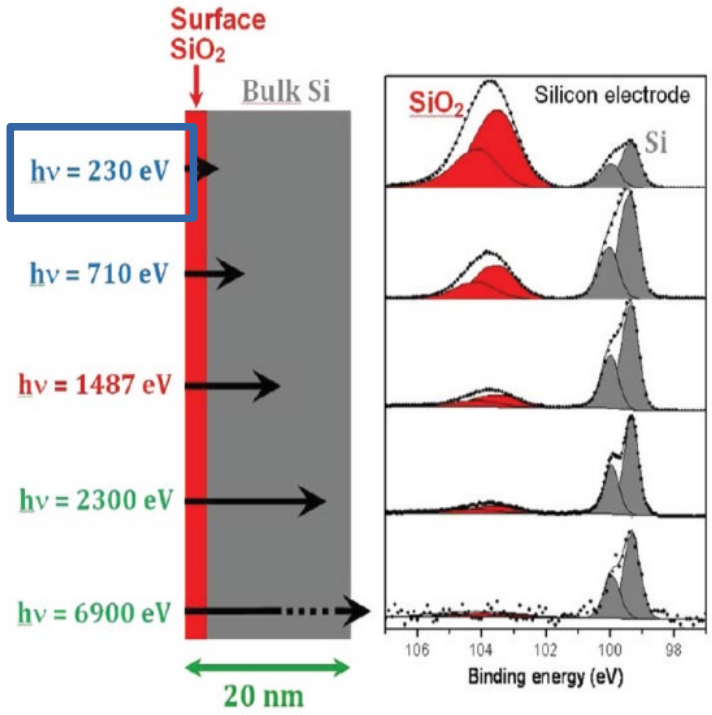
Experimental Techniques
Photoemission Spectroscopy

X-ray Photon Spectroscopy C^-_{60}



Photoelectron spectra of C60 2 at 355, 266, and 193 nm with photon fluxes of 5, 1.5, and 0.7 mJ/cm2, respectively. (Xue-Bin Wang, 1999)

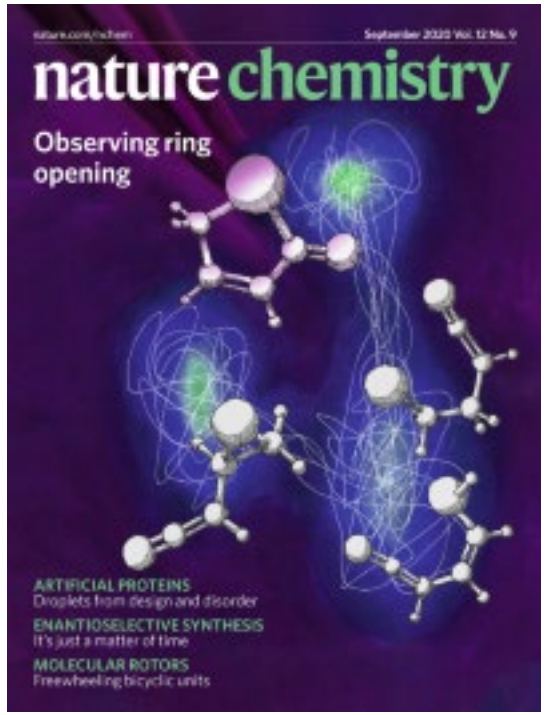
Lithium Battery interface during charge/discharge



Si 2p spectrum of the pristine silicon electrode (Bertrand Philippe, 2016)

Courtesy of Federico Galdenzi

PES measuements of organic rings opening

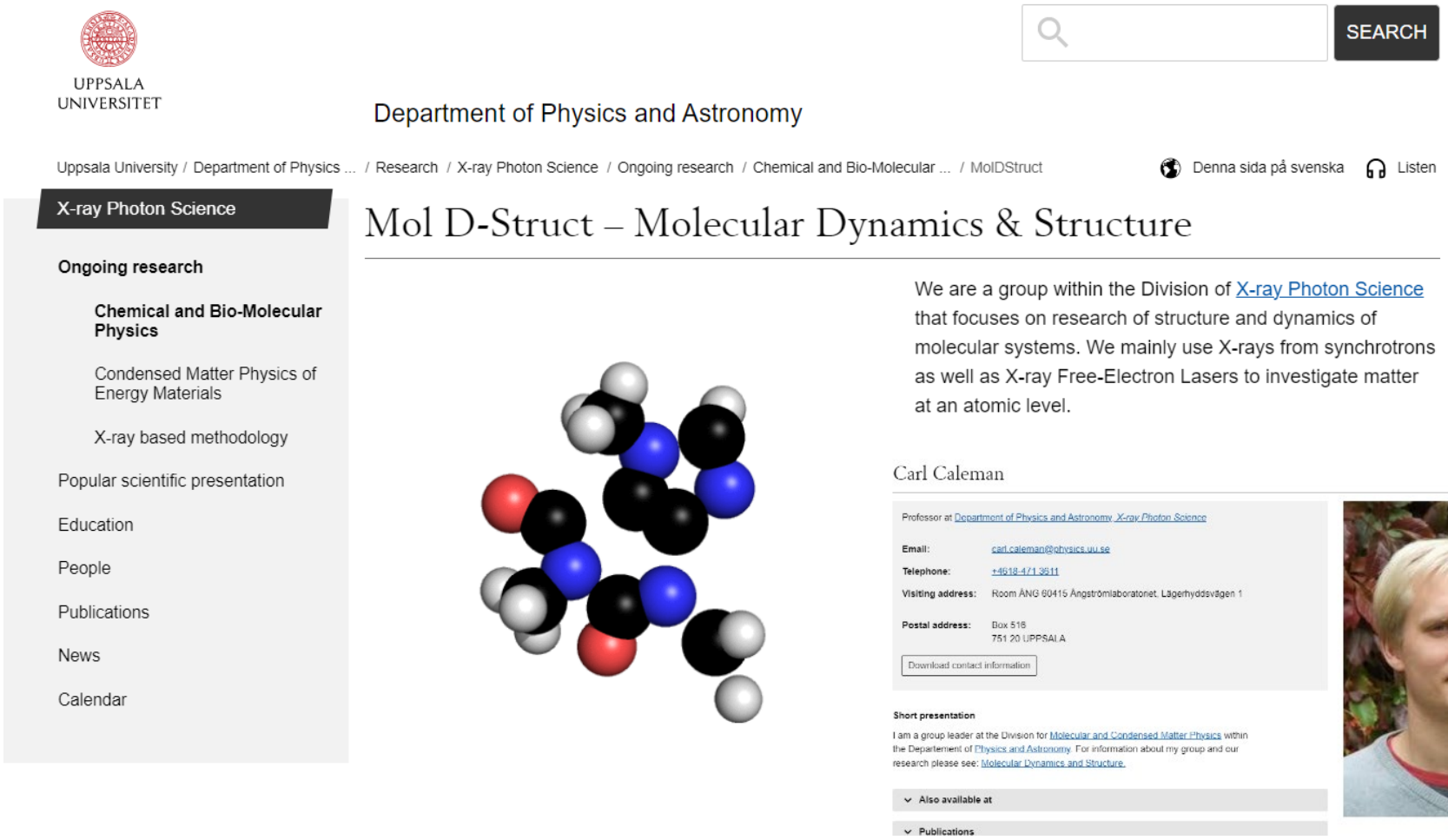


Users' community

Users' community

Prof. Carl Caleman
Uppsala University

Coherent imaging
&
Molecular fragmentation



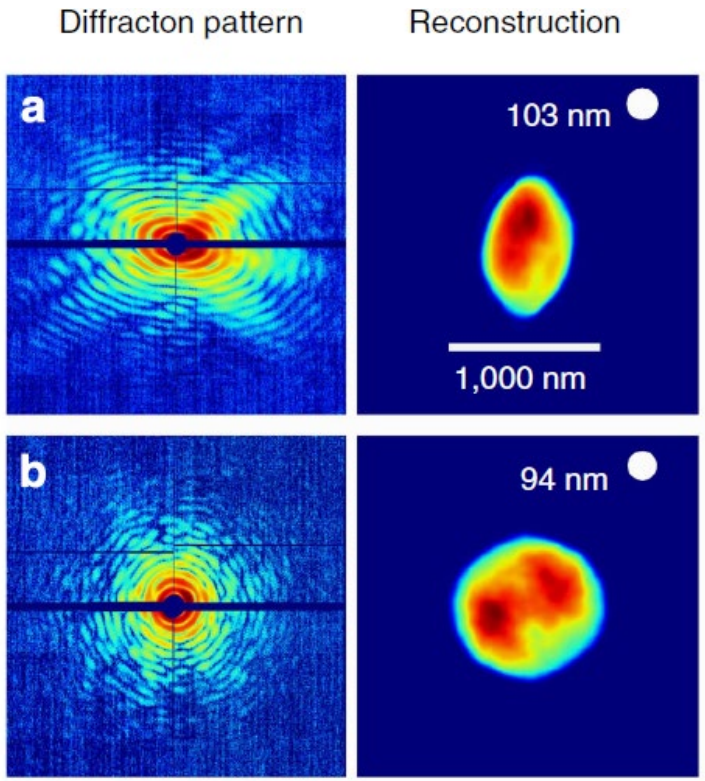
https://www.katalog.uu.se/profile/?id=N2-1236

Users' community

Coherent Imaging

Single-shot live-cell coherent imaging

Pump-probe damage studies

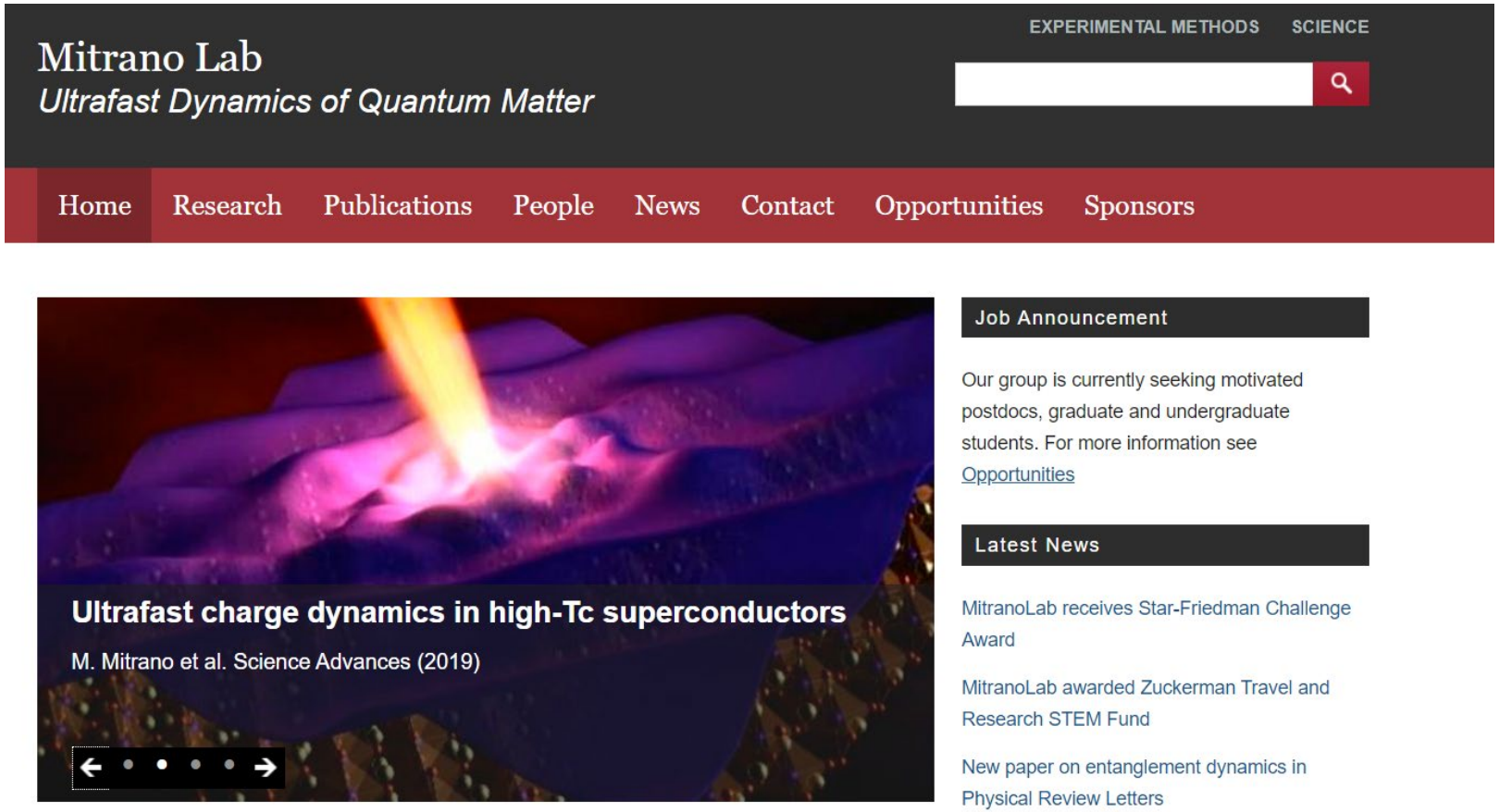


Van Der Schot, G., Svenda, M., Maia, F. R., Hantke, M., DePonte, D. P., Seibert, M. M., … F. Stellato, ... & Ekeberg, T. (2015). Imaging single cells in a beam of live cyanobacteria with an X-ray laser. *Nature communications*, *6*(1), 5704.

Users' community

Prof. Matteo Mitrano
Harvard University

X-ray Absorption Spectroscopy
Small Angle X-ray Scattering



Users' community

XAS and SAXS

The **AQUA** wavelengths would enable experiments of M-edge time-resolved, XAS, and energy integrated small angle scattering studies of hydrodynamic behavior in oxides such as La2-xBaxCuO4, Sr2CuO3, Sr14Cu24O41, as well as in van der Waals multiferroics such as NiI2.

Mitrano, M., Lee, S., Husain, A. A., Zhu, M., de la Peña Munoz, G., Sun, S. X. L., ... & Abbamonte, P. (2019). Evidence for photoinduced sliding of the charge-order condensate in La 1.875 Ba 0.125 CuO 4. *Physical Review B*, *100*(20), 205125.

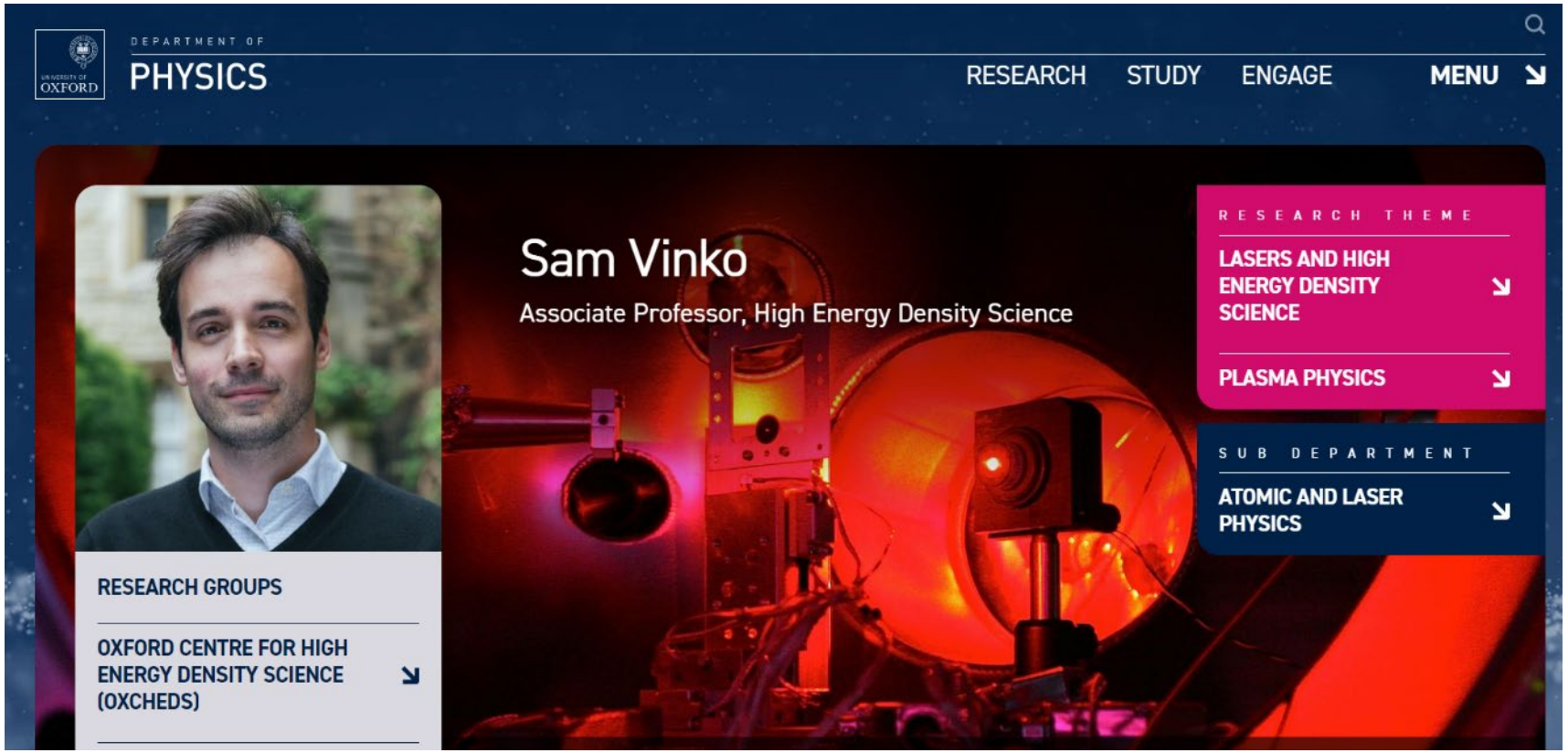
Baykusheva, D. R., Jang, H., Husain, A. A., Lee, S., TenHuisen, S. F., Zhou, P., ... & Mitrano, M. (2022). Ultrafast renormalization of the on-site coulomb repulsion in a cuprate superconductor. *Physical Review X*, *12*(1), 011013.

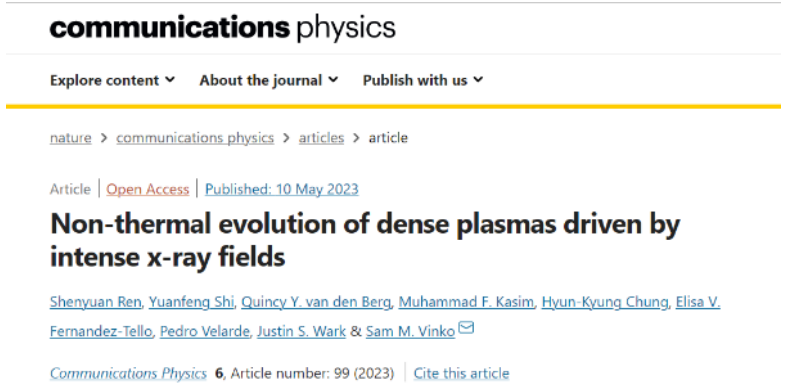
The **ARIA** wavelengths can be used to perform time-resolved SAXS measuements of superconductors and hydrodynamics of Abrikosov lattice.

Users' community

Prof. Sam Vinko
Oxford University
Non-thermal electron dynamics in solid-dense matter
XUV pump-probe experiments

Radiation-matter interactions on femtosecond timescales creates transient high-energy-density plasmas, where both the electrons and the ions may be far from local thermodynamic equilibrium.





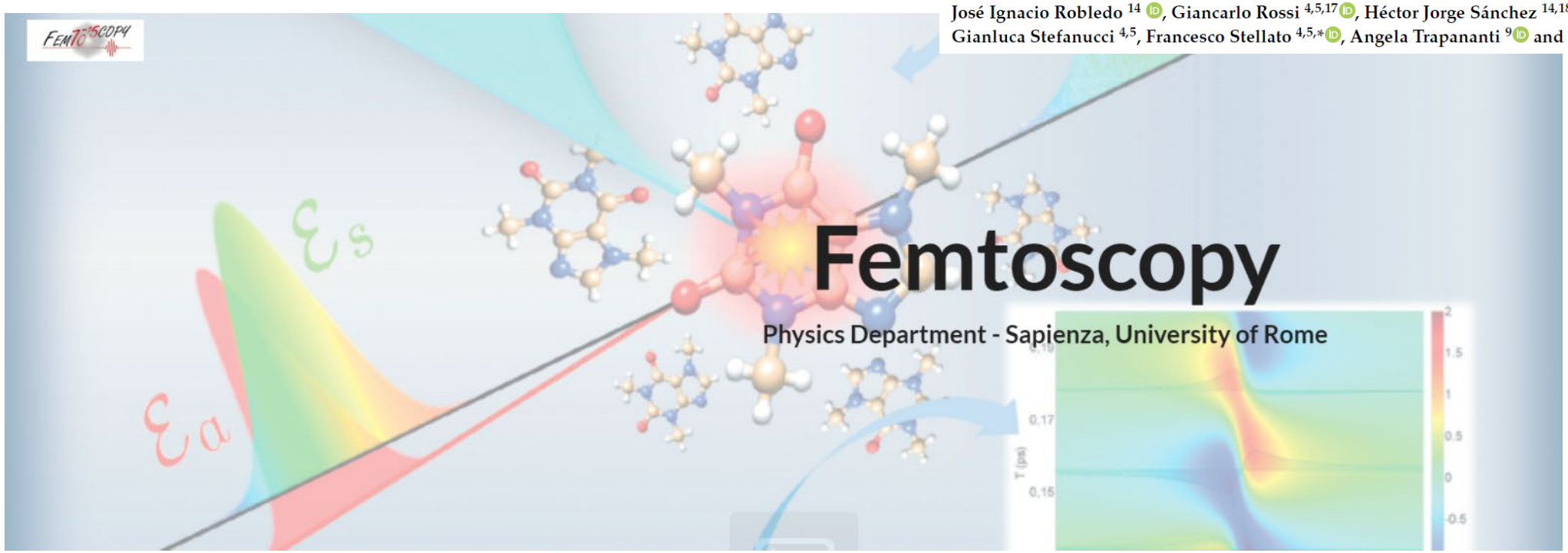
Users' community

Prof. Tullio Scopigno
Sapienza University

Raman Scattering

The Potential of EuPRAXIA@SPARC_LAB for Radiation Based Techniques

Antonella Balerna [1], Samanta Bartocci [2], Giovanni Batignani [3], Alessandro Cianchi [4,5], Enrica Chiadroni [1], Marcello Coreno [1,6], Antonio Cricenti [6], Sultan Dabagov [1,7,8], Andrea Di Cicco [9], Massimo Faiferri [2], Carino Ferrante [3,10], Massimo Ferrario [1], Giuseppe Fumero [3,11], Luca Giannessi [12,13], Roberto Gunnella [9], Juan José Leani [14], Stefano Lupi [3,15], Salvatore Macis [4,5], Rosa Manca [2], Augusto Marcelli [1,6], Claudio Masciovecchio [12], Marco Minicucci [9], Silvia Morante [4,5], Enrico Perfetto [4,16], Massimo Petrarca [3,15], Fabrizio Pusceddu [2], Javad Rezvani [1], José Ignacio Robledo [14], Giancarlo Rossi [4,5,17], Héctor Jorge Sánchez [14,18], Tullio Scopigno [3,10], Gianluca Stefanucci [4,5], Francesco Stellato [4,5,*], Angela Trapananti [9] and Fabio Villa [1]



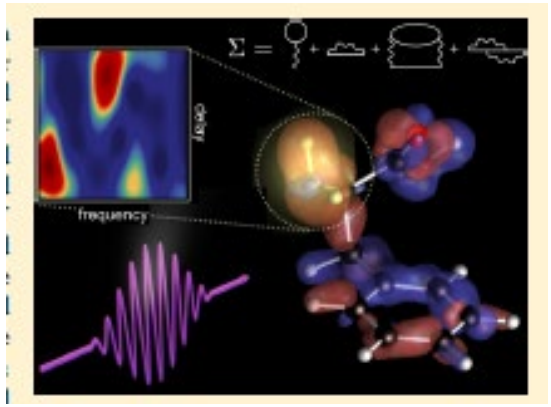
https://sites.google.com/uniroma1.it/femtoscopy/home

WA 8 – Users

Users' community

Prof. Enrico Perfetto & Gianluca Stefanucci
Rome Tor Vergata University

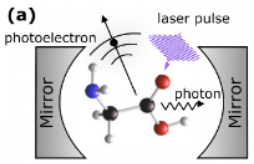
Green's functions time-dependent PES theory



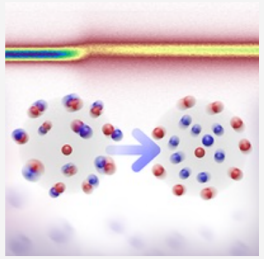
THE JOURNAL OF PHYSICAL CHEMISTRY Letters — Letter
Cite This: J. Phys. Chem. Lett. 2018, 9, 1353−1358 — pubs.acs.org/JPCL

Ultrafast Charge Migration in XUV Photoexcited Phenylalanine: A First-Principles Study Based on Real-Time Nonequilibrium Green's Functions

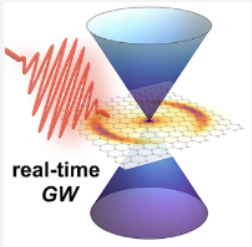
E. Perfetto,[†,‡] D. Sangalli,[†] A. Marini,[†] and G. Stefanucci*[,‡,§]



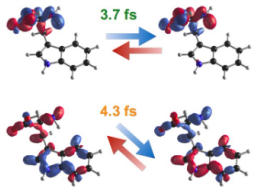
"**Interacting electrons and bosons in the doubly screened GW approximation: A time-linear scaling method for first-principles simulations**",
Yaroslav Pavlyukh, Enrico Perfetto and Gianluca Stefanucci
Physical Review B **106**, L201408 (2022).



"**Observation of an Excitonic Mott Transition through Ultrafast Core-cum-Conduction Photoemission Spectroscopy**",
Maciej Dendzik, R. Patrick Xian, Enrico Perfetto, Davide Sangalli, Dmytro Kutnyakhov, Shuo Dong, Samuel Beaulieu, Tommaso Pincelli, Federico Pressacco, Davide Curcio, Steinn Ymir Agustsson, Michael Heber, Jasper Hauer, Wilfried Wurth, Günter Brenner, Yves Acremann, Philip Hofmann, Martin Wolf, Andrea Marini, Gianluca Stefanucci, Laurenz Rettig, and Ralph Ernstorfer
Physical Review Letters **125**, 096401 (2020). EDITORS' SUGGESTION



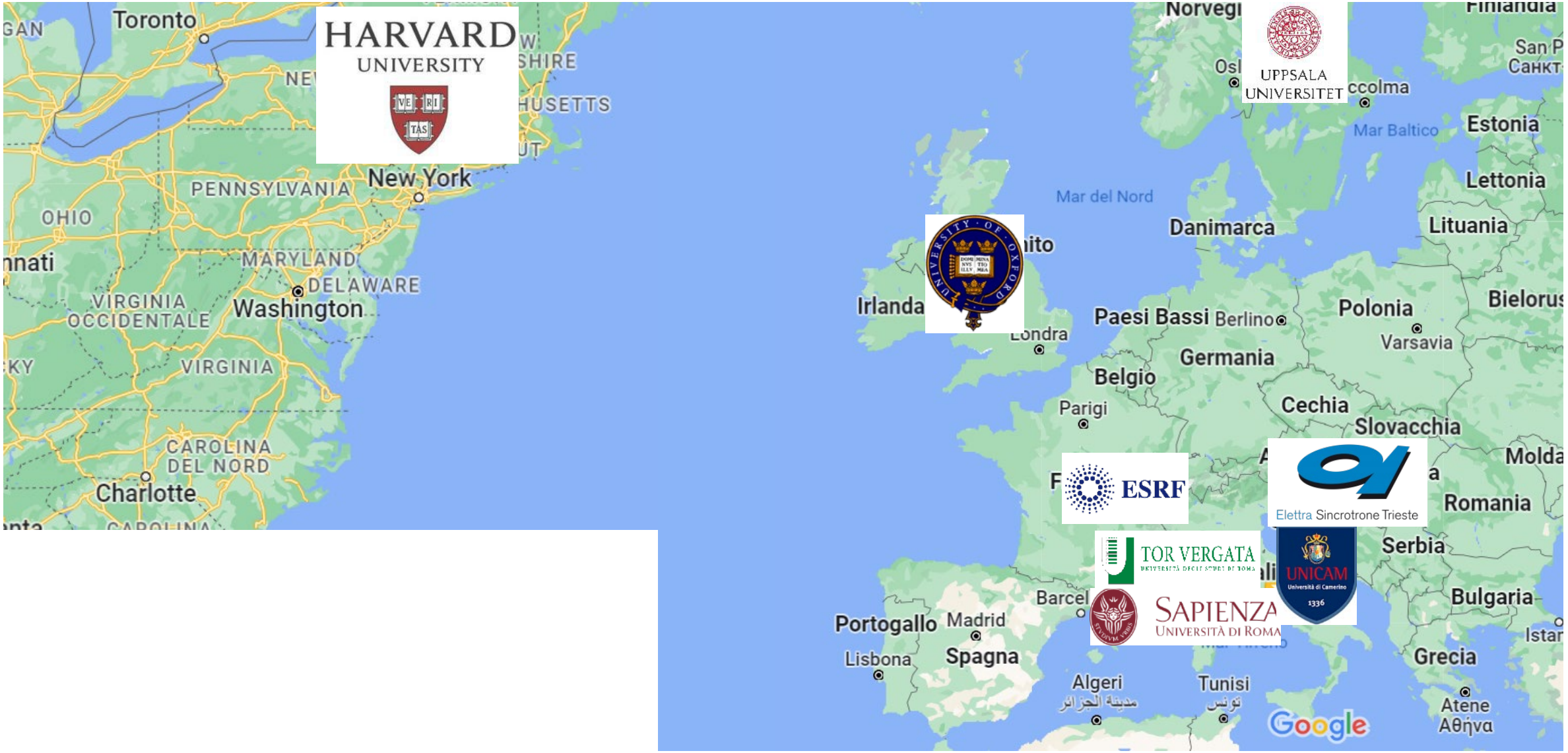
"**Real-Time GW: Toward an Ab Initio Description of the Ultrafast Carrier and Exciton Dynamics in Two-Dimensional Materials**",
Enrico Perfetto, Yaroslav Pavlyukh and Gianluca Stefanucci
Physical Review Letters **128**, 016801 (2022). EDITORS' SUGGESTION



"**Ultrafast Quantum Interference in the Charge Migration of Tryptophan**"
Enrico Perfetto, Andrea Trabattoni, Francesca Calegari, Mauro Nisoli, Andrea Marini and Gianluca Stefanucci
Journal of Physical Chemistry Letters **11**, 891 (2020).

https://sites.google.com/view/gianlucastefanucci/

Users' community



Users' community - Feedback

Pros

Energy ranges (both **AQUA** and **ARIA**)
not primary for many FEL sources

Flexibility in pulse duration

Multiple pulses in **ARIA**

Beamtime availability for long-term projects

Presence of two beamlines at very different energies

Presence of the **EuAPS** betatron source

(Possibility of HHG source for pump-probe)

Cons (limitations)

Limited photon flux

Limited repetition rate (mitigated if 400 Hz are reached)

Limited wavelength range (not reaching the O K-edge)

Endstations Costs – Estimate 2023

Element experimental chamber AQUA	Costs (k€)		Element experimental chamber ARIA	Costs (k€)
Vacuum components (pumps, valves)	100		Vacuum components (pumps, valves)	100
Sample delivery system: fixed targets	80		Sample delivery system: electrospray source	80
Sample delivery system: liquid sheet	100		Sample delivery system: aerosol injector	100
Sample delivery system: liquid jet	150		Manipulators	100
Sample delivery system: drop-on-demand	50		Vacuum-compatible pico-motors with controllers	120
Manipulators	100		Vacuum chamber	200
Vacuum-compatible pico-motors with controllers	120		Microscope and cameras	100
Vacuum chamber	200		Detector	400
Microscope and cameras	100		VUV X-ray spectrometer	300
Detectors (photons and electrons)	700			
Pump laser	400			
Soft X-ray spectrometer	300			
	2400			**1500**

Project Status and Actions

Ongoing actions

Bi-weekly WA8 meeting and joint meeting with WA6 (FEL), coordination with EuPRAXIA-PP and EuAPS

2nd Users' meeting organization (2024)

Presentations at local, national & international conferences

Optical and mechanical elements tests at (Elettra)

Liquid jet set-up collaboration with TIMEX (FERMI) and GasPhase (Elettra): activity restarted last May after detector replacement +
GDVN injection tests at EuXFEL

Closed actions & Decisions

Special issue "**Experimental Ideas for Novel FEL Facilities Based on Plasma Acceleration**" on "Condensed Matter" is (almost) out

2 published papers
1 (just) submitted paper

To Do

Experimental endsation and beamline technical design

Manpower (technical & scientific) issues

Ongoing Actions

2nd Users' meeting organization in 2024

- Updating the potential users' community about photon beams figures
- Gather requirements compatible with machine developments
- Commitment of selected (and motivated) groups to bring to the TDR level the experimental endstation description (aimed at performing the first experiments)

Ongoing Actions

Dissemination - presentation of EuPRAXIA@SPARC_LAB updates at

SPIE Optics + Optoelectronics 2023 (FV)

High Precision
X-ray Measurements 2023 (FV+FS)

European Biophysical
Societies' Association (FS)

Società Italiana
Luce di Sincrotrone 2023 (FS, ZE)

Condensed Matter Division
European Physical Society (FS)

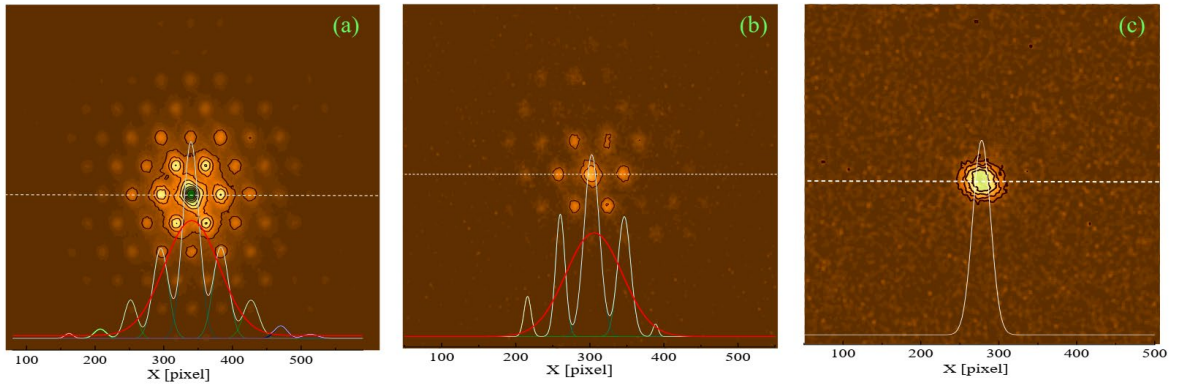
Gathering potential users both in "**condensed matter**" and "**biophysics**" and potential **manpower**

Ongoing Actions-Development of novel optics for focusing X-rays

Optical elements tests

Data analysis of the experiments
Proposal #20215699: (Submitted paper to JAP)

- Sensitivity to the Coherence of the SR beam,
- SR beam condensing potential

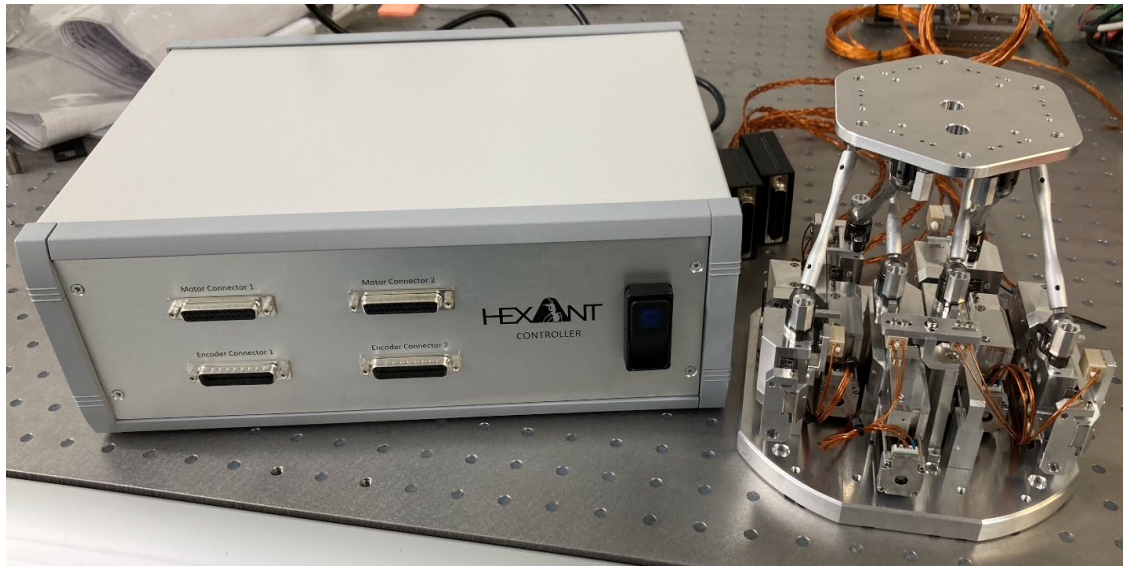


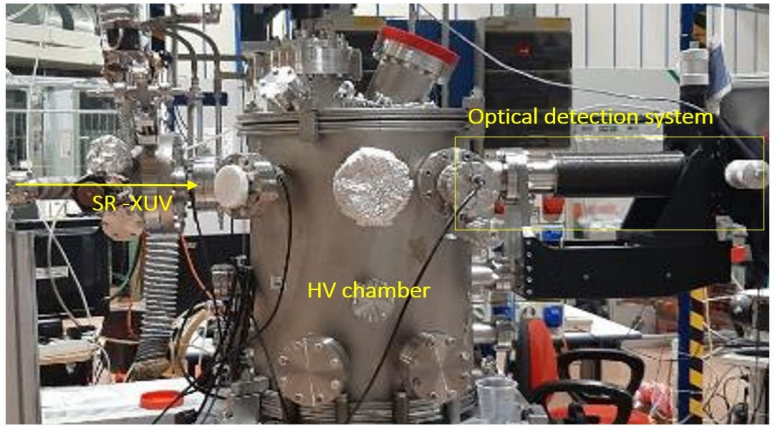
The diffraction patterns produced by a couple of MCPs for different incident beams, (a) at E_{ph}=92 eV in the undulator mode (b) at E_{ph}=92 eV in the wiggler mode, and (c) at E_{ph} =480 eV in the wiggler mode.

Upcoming experiment [#20230512] on the CiPo beamline @ELETTRA "*Focusing properties of single and double flat MCP-devices and coherence characteristics of transmitted X-ray radiation*"

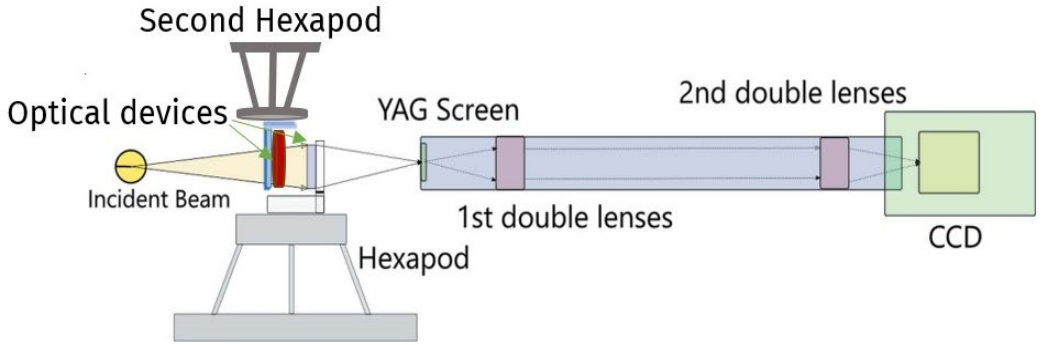
Mechanical elements tests

A hexapod robot with 6 degrees of freedom for rotational and translations movements has been delivered and is being tested (ZE & FV).





A side view of the high-vacuum (HV) experimental chamber located at the CiPo beamline's end station;

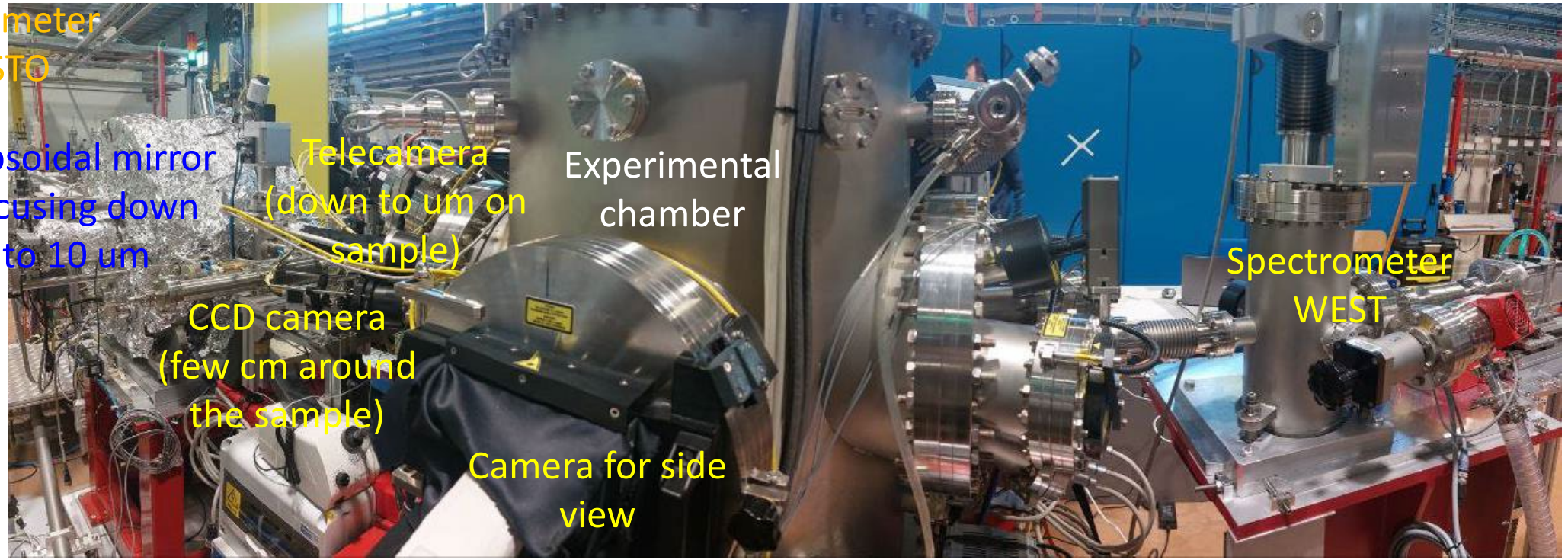


Ongoing Actions - Experimental activities @ FELs

Time-resolved XAS measurements across the Fe L3,2-edge

Beamtime at EIS-TIMEX, May 03-09, 2023, FERMI FEL Trieste

Project PI: Emiliano Principi*



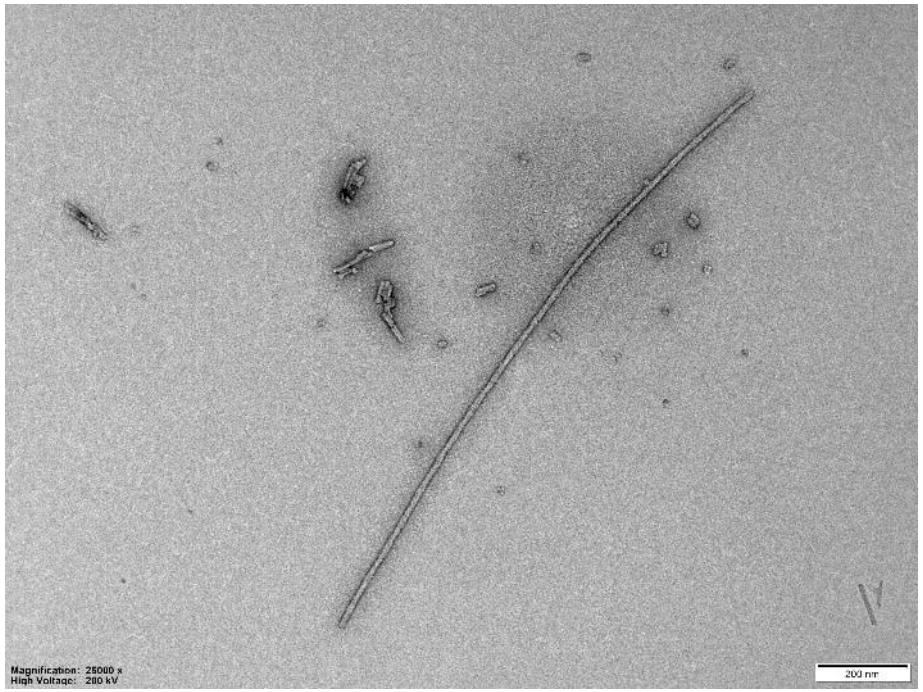
*Senior Scientist and beamline coordinator of the FERMI FEL

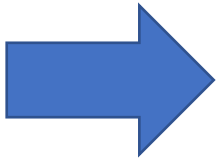
Ongoing Actions - Experimental activities @ FELs

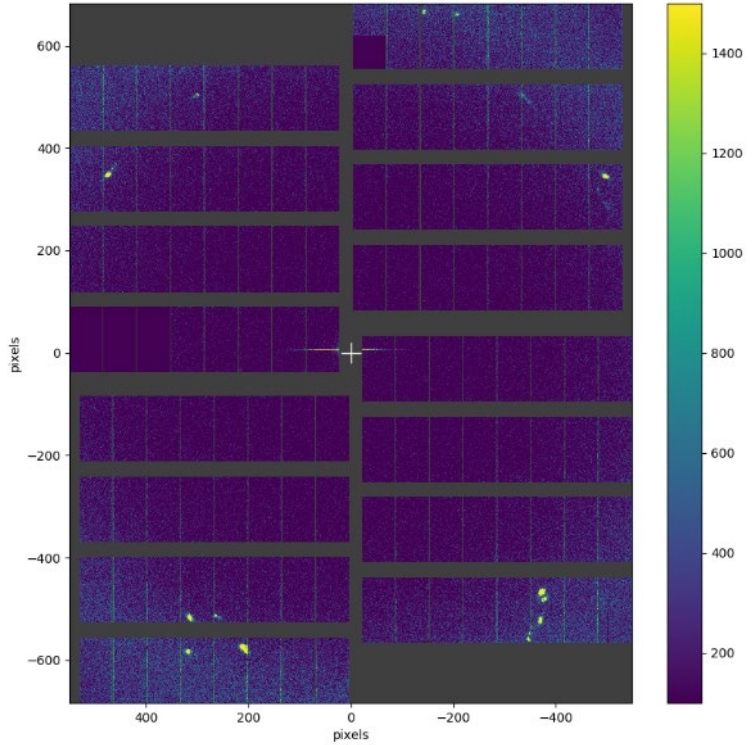
Fiber Diffraction+Coherent Imaging on alpha-synuclein protein fibrils @ EuXFEL SPB/SFX beamline

Contact points with EuPRAXIA@SPARC_LAB

- Sample characterization measurements (interaction with EuXFEL support scientists)
- Test of 3D printed nozzles @ different flowrates and thicknesses (interaction with EuXFEL injection team)



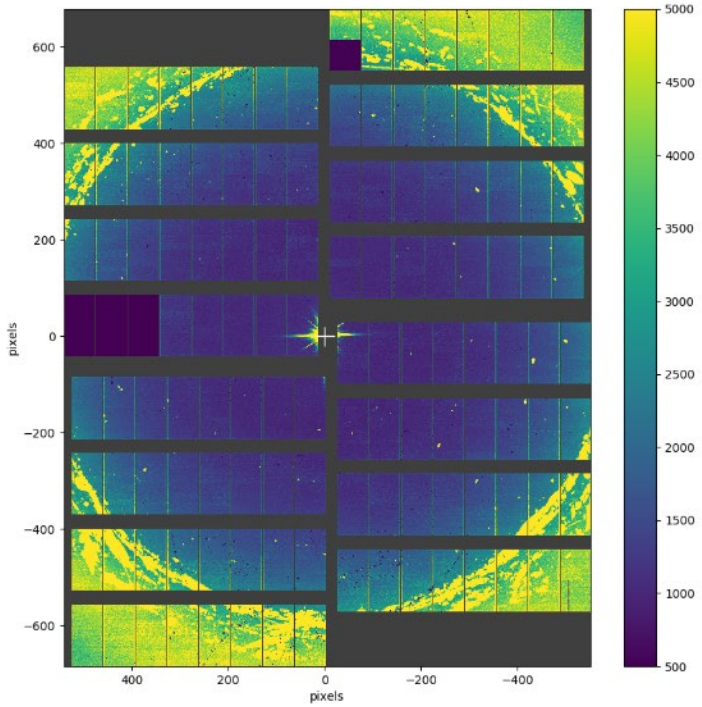


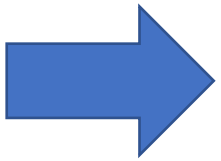


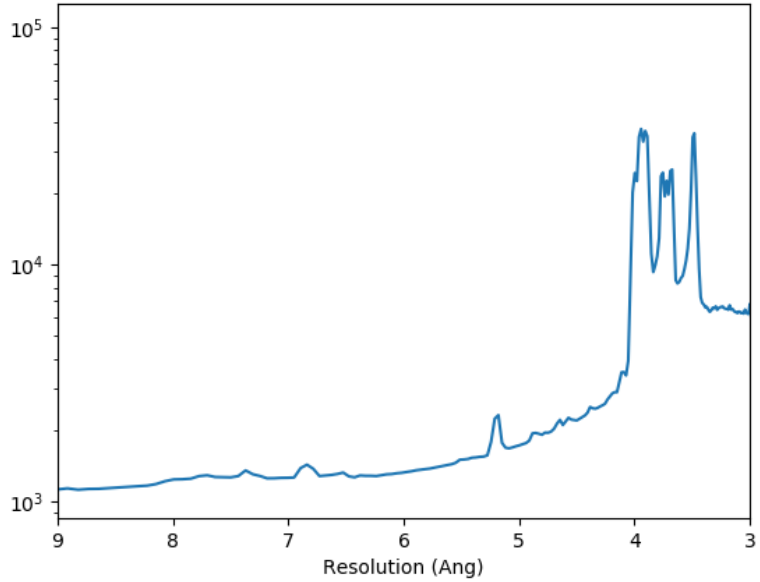
Ongoing Actions - Experimental activities @ FELs

Contact points with EuPRAXIA@SPARC_LAB:

- Handling of large datasets → data rejection criteria
- Pattern cleaning methods → from raw to usable data (interaction with EuXFEL data scientists)
- Data merging → from data to structural information (interaction with EuXFEL scientists)







Ongoing Actions - Experimental activities @ synchrotrons

(slow) X-ray pump – X-ray probe XAS measurements on Cu-amyloid complexes

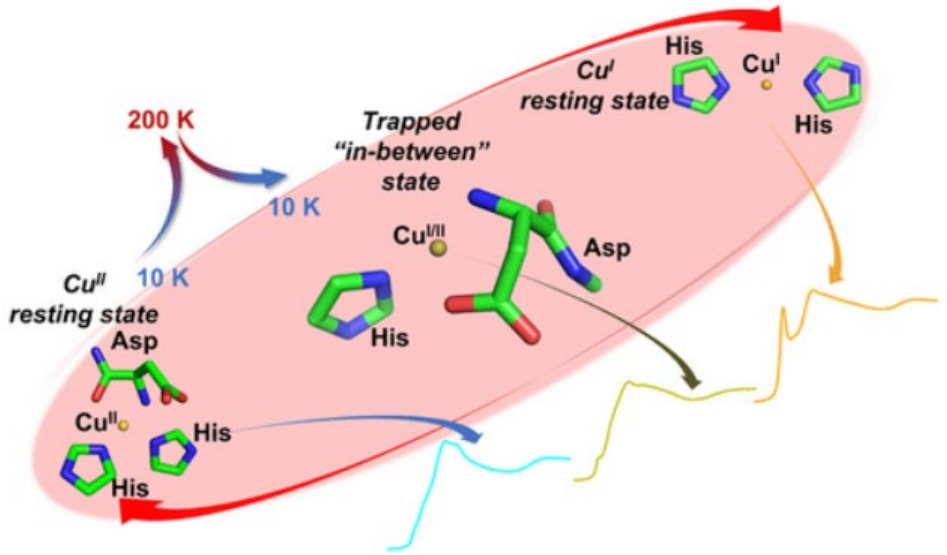
Angewandte International Edition Chemie
GDCh A Journal of the German Chemical Society

Communication | Open Access

Chasing the Elusive "In-Between" State of the Copper-Amyloid β Complex by X-ray Absorption through Partial Thermal Relaxation after Photoreduction

Enrico Falcone, Germano Nobili, Michael Okafor, Olivier Proux, Giancarlo Rossi, Silvia Morante, Peter Faller, Francesco Stellato

First published: 03 March 2023 | https://doi.org/10.1002/anie.202217791



Contact points with EuPRAXIA@SPARC_LAB:

- Cu XAS spectroscopy (K-edge → M-edge)
- Pump-probe measurements (from minutes to fs time resolution, from large structural relaxation to electron dynamics)
- Interaction with beamline scientist for detectors, focusing, sample delivery

ESRF

Closed Actions

Special issue

condensed matter

an Open Access Journal by MDPI

Tracked for Impact Factor

Experimental Ideas for Novel FEL Facilities Based on Plasma Acceleration

Papers
Published

The INFN-LNF present and future accelerator-based light facilities

Antonella Balerna, Massimo Ferrario & Francesco Stellato

The European Physical Journal Plus **138**, Article number: 37 (2023) | Cite this article

Pump-Probe X-ray Photoemission Spectroscopy of Free-Standing Graphane

by Roberto Costantini, Dario Marchiani, Maria Grazia Betti, Carlo Mariani, Samuel Jeong, Yoshikazu Ito, Alberto Morgante and Martina Dell'Angela

Condens. Matter **2023**, *8*(2), 31; **https://doi.org/10.3390/condmat8020031** - 27 Mar 2023

Viewed by 728

Abstract Free-standing nar
the sp^3 bonding component
unsupported graphane was

Exploring the Ultrafast Charge-Transfer and Redox Dynamics in Layered Transition Metal Oxides

by Guannan Qian, Xiaobiao Huang, Jun-Sik Lee, Piero Pianetta and Yijin Liu

025 - 05 Mar 2023

Theoretical Study of Vibrational Properties of Peptides: Force Fields in Comparison and Ab Initio Investigation

by Nicole Luchetti and Velia Minicozzi

Condens. Matter **2022**, *7*(3), 53; **https://doi.org/10.3390/**

Viewed by 1071

Abstract Infrared (IR) spectroscopy is a valuable tool to
(FIR) spectrum is characterized by a complex combinatio
interpreted with the help of quantum-mechanical (QM) ca

Perspectives of Gas Phase Ion Chemistry: Spectroscopy and Modeling

by Mauro Satta, Mattea Carmen Castrovilli, Francesca Nicolanti, Anna Rita Casavola, Carlo Mancini Terracciano and Antonella Cartoni

Condens. Matter **2022**, *7*(3), 46; **https://doi.org/10.3390/condmat7030046** - 21 Jul 2022

Viewed by 1475

Abstract The study of ions in the gas phase has a long history and has involved both chemists and physicists. The interplay of their competences with the use of very sophisticated commercial and/or homemade instrumentations and theoretical models has improved the knowledge of thermodynamics [...] **Read more.**

Progress and Perspectives of Spectroscopic Studies on Carbon K-Edge Using Novel Soft X-ray Pulsed Sources

by Zeinab Ebrahimpour, Marcello Coreno, Luca Giannessi, Massimo Ferrario, Augusto Marcelli, Federico Nguyen, Seyed Javad Rezvani, Francesco Stellato and Fabio Villa

Condens. Matter **2022**, *7*(4), 72; **https://doi.org/10.3390/condmat7040072** - 06 Dec 2022

Viewed by 1290

Abstract The development of novel coherent and brilliant sources, such as soft X-ray free electron laser (FEL) and high harmonic generation (HHG), enables new ultrafast analysis of the electronic and structural dynamics of a wide variety of materials. Soft X-ray FEL delivers high-brilliance beams [...] **Read more.**

"Characterization in the XUV Domain of Microchannel Plate Based Device Using Synchrotron Radiation"
"Journal of Applied Physics" on MCP measurements @ Elettra

To Do

Specs definition and Technical Design of endstation elements

- Experimental chamber, including vacuum requirements
  (in **synergy** with the EuAPS betatron source → Federico Galdenzi)
  - Sample manipulation
    (vacuum-compatible motors and stages)
    - Detectors (photons, electrons, ions)

To Do

Technical Design of endstation elements

- Sample Injection

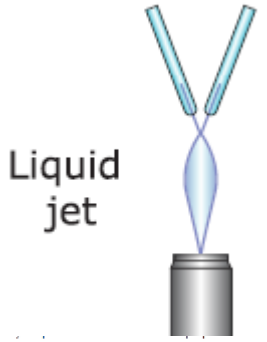
  Fixed target holder (more difficult at increasing repetition rate)

  Aerosol injectors (low background, but low particle density)

  Liquid jets, flat jets (good at high repetition rate, necessity of thin jets especially for the low-energy measurements)

  Colliding jets have already been used
  to produce sub-micron liquid sheets
  suitable for spectroscopy measurements

  (test @ Elettra → Marcello Coreno)




THE JOURNAL OF PHYSICAL CHEMISTRY Letters

pubs.acs.org/JPCL Letter

Femtosecond Soft-X-ray Absorption Spectroscopy of Liquids with a Water-Window High-Harmonic Source

Adam D. Smith,[¶] Tadas Balčiūnas,[¶] Yi-Ping Chang, Cédric Schmidt, Kristina Zinchenko, Fernanda B. Nunes, Emanuele Rossi, Vít Svoboda, Zhong Yin,[*] Jean-Pierre Wolf, and Hans Jakob Wörner[*]

Cite This: *J. Phys. Chem. Lett.* 2020, 11, 1981−1988 Read Online

To Do

Technical Design of endstation elements

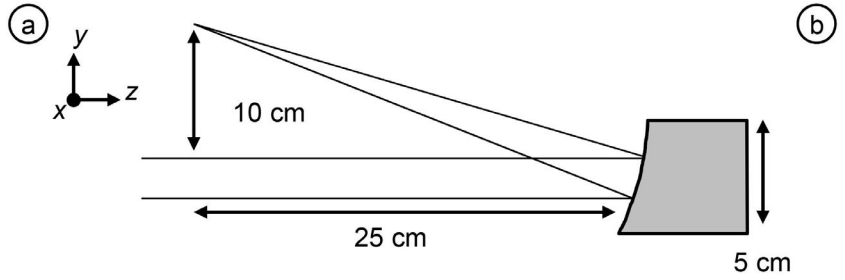
- Tight-focusing options
  (e.g. off-axis paraboloids)

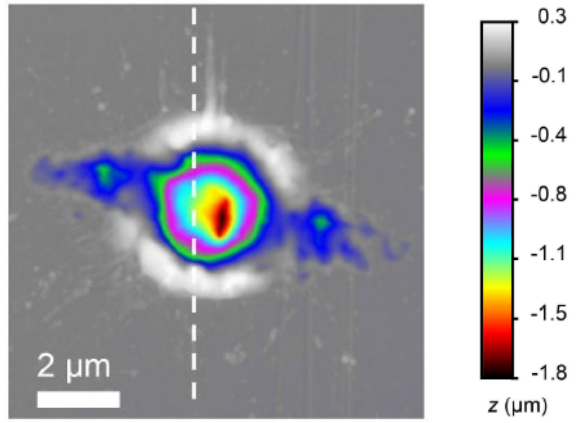
  - Smaller focal size

  - Increased power density

Characterizing the focus of a multilayer coated off-axis parabola for FLASH beam at λ = 4.3 nm

Adam F. G. Leontowich, Andrew Aquila, Francesco Stellato, Richard Bean, Holger Fleckenstein, Mauro Prasciolu, Mengning Liang, Daniel P. DePonte, Anton Barty, Fenglin Wang, Jakob Andreasson, Janos Hajdu, Henry N. Chapman, Saša Bajt





To Do

Specs definition and Technical Design of the endstation elements

- Experimental chamber, including vacuum requirements
  - Sample manipulation
    - Detectors
      - Sample injection
        - Tight focusing
          - Sample characterization laboratory and computing support

Integration with photon transport beamline → Fabio Villa