“ID21 at ESRF: sub-micron spectroscopy under cryogenic conditions for life and environmental sciences”

THE ID21 STAFF

Giulia Veronesi

Support teams: B. Baker, R. Barrett, G. Berruyer, C. Cohen, C. Cornu, E. Gagliardini, R. Hino, J. Keiffer, J. Morse, M. Papillon, V. A. Solé, A. Vivo, L. Zang, and many others

THE ID21 END-STATIONS (OCTOBER 2017)

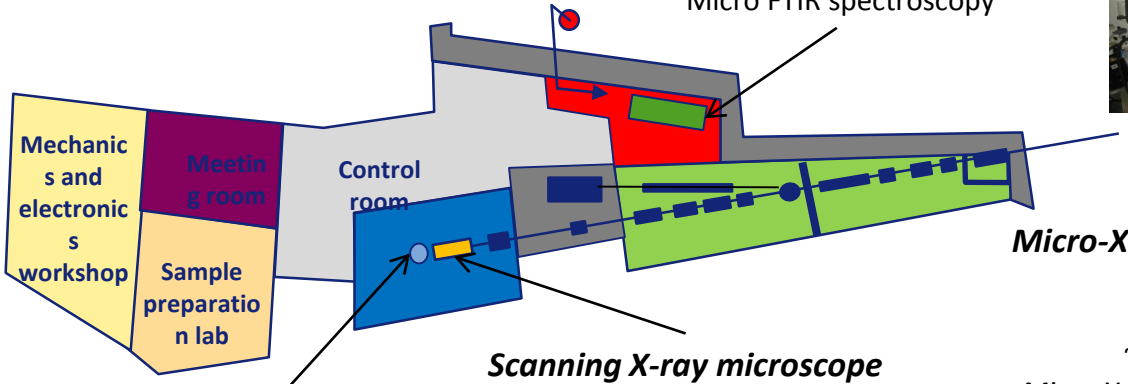
Molecular (and structural) mapping

Scanning infrared end-station

4000-700cm^{-1}

10×10µm² to 5×5µm²

Micro FTIR spectroscopy



Micro-X-ray diffraction

8keV

In air

~1×1µm²

Micro X-ray fluorescence

Micro X-ray diffraction

Full-field XANES set-up

2-9keV

Under vacuum

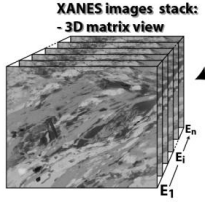
up to 4.10^{6} XANES spectra / stack

X-ray Absorption Spectroscopy

in transmission

Spatial resolution : 0.3 µm - 1.4 µm

Field of view : 600 µm - to 2 mm



Speciation mapping

Scanning X-ray microscope

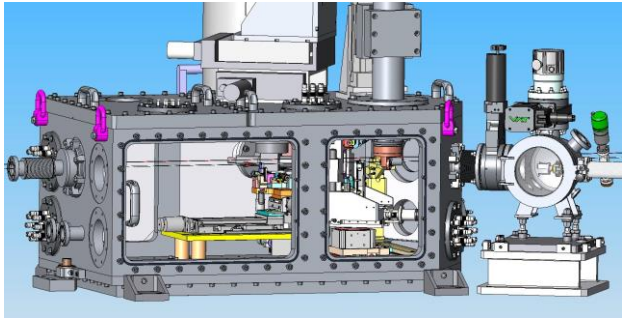
2-9keV

Under vacuum

0.2(V)×0.7(H)µm²

Micro X-ray fluorescence

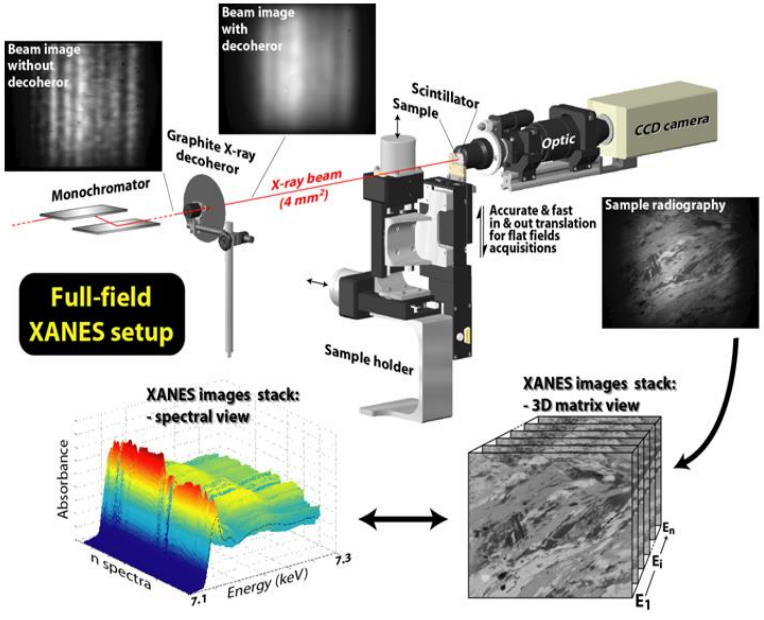
Micro X-ray Absorption Spectroscopy



Phase identification & mapping

Elemental mapping
Speciation / oxidation state

FULL-FIELD XANES END STATION



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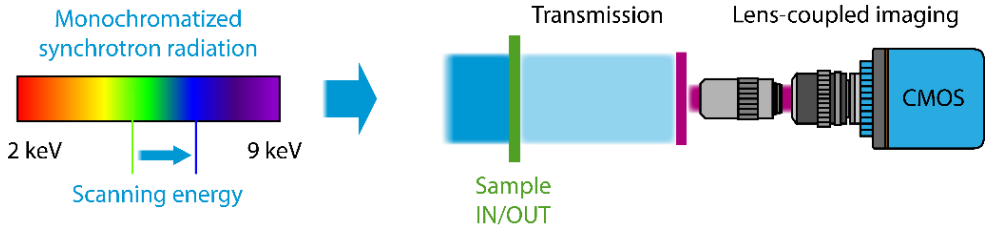
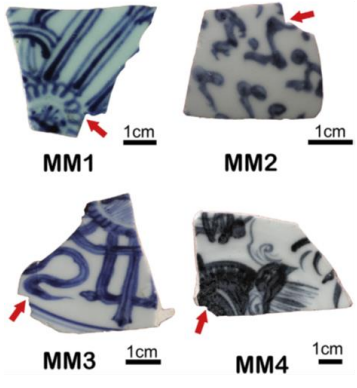
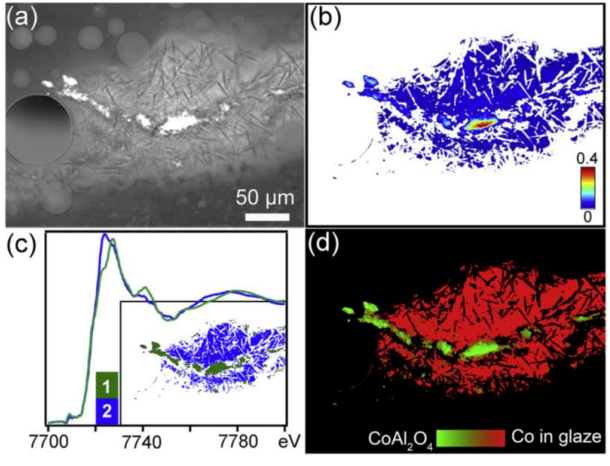
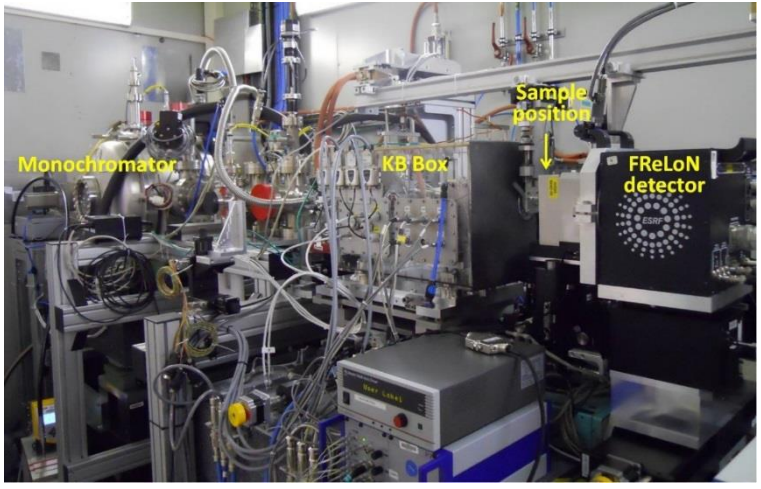


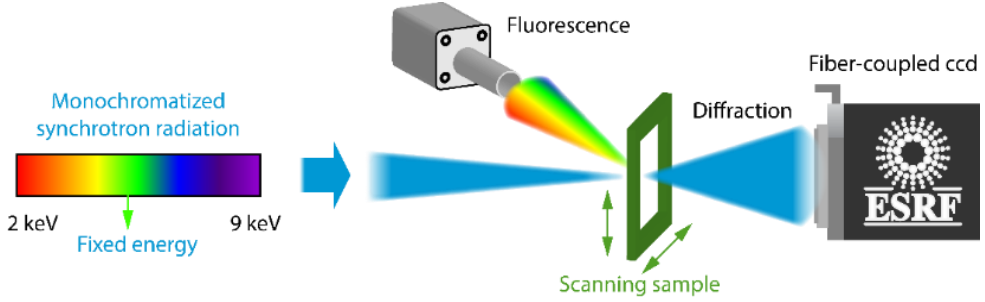
Wang et al. *Analytica Chimica Acta*, 2016, **928**, 20-31





THE IN-AIR SCANNING X-RAY MICROSCOPE





Micro-X-ray diffraction

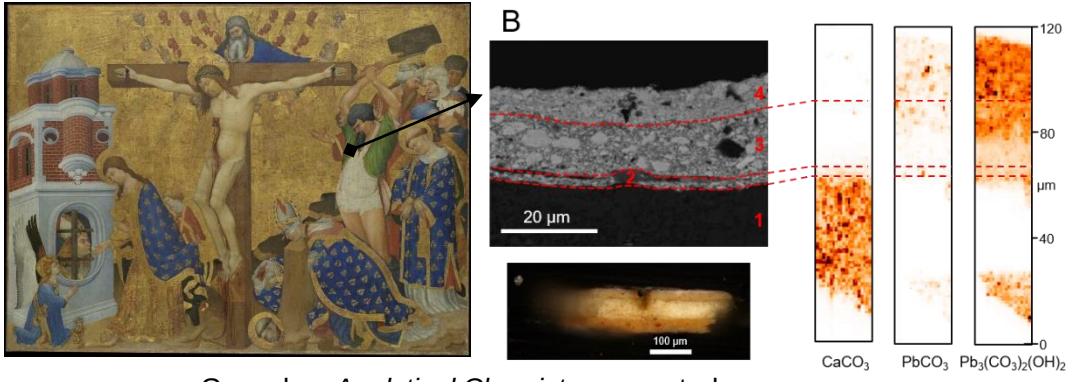
Fixed at 8keV

In air

~1×1µm²

Micro X-ray fluorescence

Micro X-ray diffraction



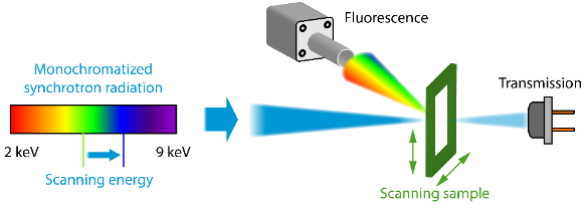
Gonzalez, *Analytical Chemistry*, accepted

LOCALIZATION AND SPECIATION OF ELEMENTS

Elements accessible for X-ray absorption spectroscopy

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub		Uuq		Uuh		Uuo
Lanthanides			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Actinides			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lw

K-lines L-lines M-lines



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Under vacuum

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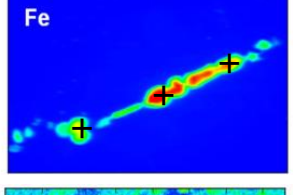
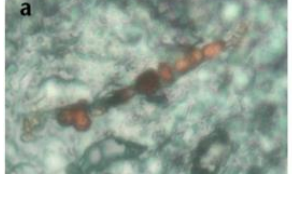
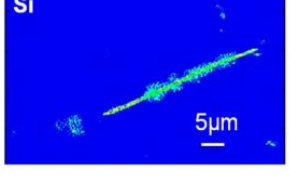
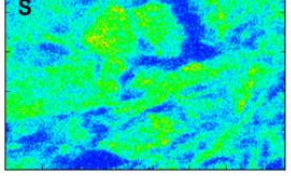
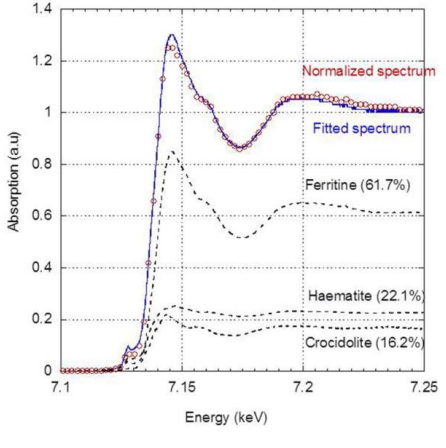
Micro X-ray Absorption Spectroscopy





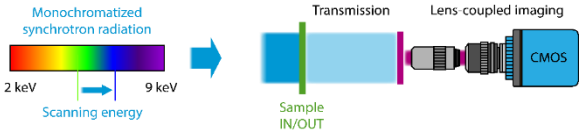




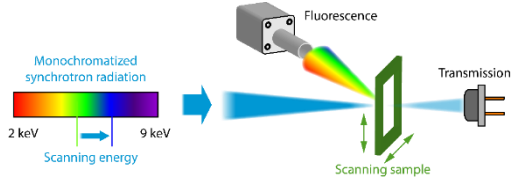


ID21 REFURBISHMENT

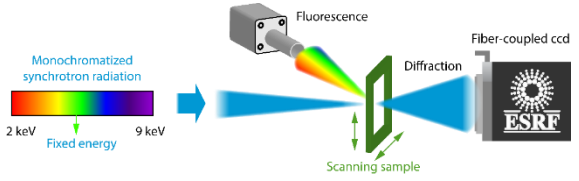
In vacuum Full-field XANES

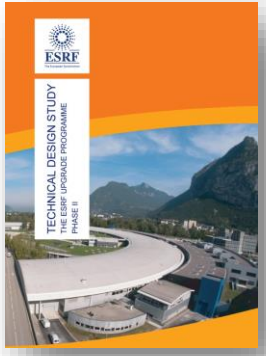


In vacuum cryoSXM



In-air SXM





PRIORITIES FOR THE REFURBISHMENT:

⇒ Cryo as a standard (user friendly), reduced dose

⇒ Higher resolution and more stable beam

⇒ Higher statistics (field of view + number of samples)

⇒ Increased energy range (> Zn K-edge)

⇒ Easier combination and additional imaging techniques

⇒ Higher sensitivity

NEW SOURCE AND PHOTON BEAM PARAMETERS

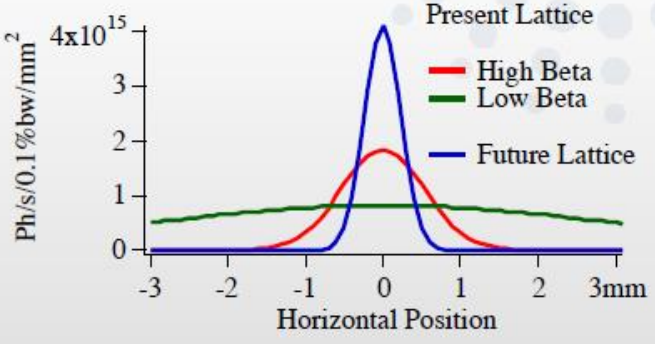
	Lattice	RMS size (μm)		RMS diver. (μrad)	
		H	V	H	V
Electron source	Current low β section	50	3.4	107	1.16
	Current high β section	413	3.4	10	1.17
	New lattice	**30.4**	**3.6**	**4.4**	**1.3**
Photon source 10 keV	Current low β section	49.8	6.2	105.6	5.1
	Current high β section	411.6	6.2	11.5	5.1
	New lattice	**28.2**	**6.1**	**7.2**	**5.1**

	ID21	RMS size (mm)	
		H	V
Photon beam 4keV, 26m	Current low β section	2.8	0.28
	New lattice	**0.39**	**0.37**

FLUX AND SPECTRAL BANDWIDTH WITH PRESENT AND FUTURE SOURCES

E=6 keV, 3.2 m U32 , 100 periods

Horizontal beam size @ 30 m

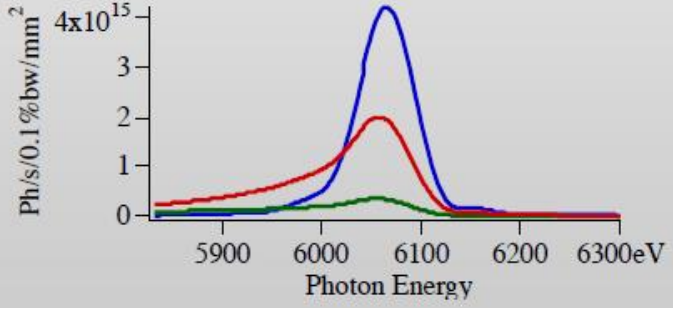


Reduction of rms horizontal size from present to future lattice

~ 2.5 for high beta

~ 12 for low beta

Spectrum



Reduction of relative bandwidth

~ 1.5

Courtesy J. Chavanne

ID21 REFURBISHMENT PROGRESS

Part1: Lead shielded optics hutch (**OH1**) and primary mirrors

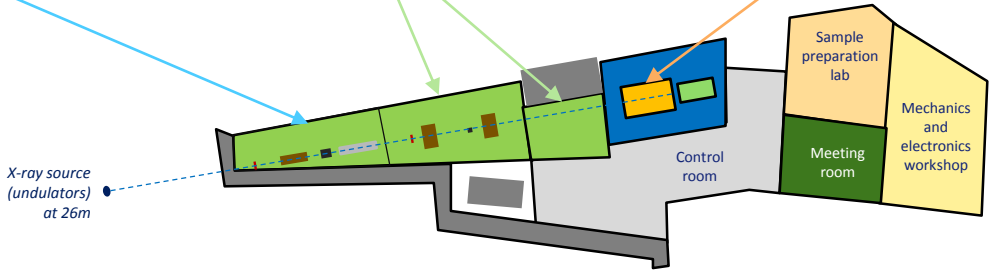
- ✓ Procurement : done
- ✓ Delivery: on-going
- ✓ Assembly: on-going
- ✓ Installation: March 2018
- ✓ Commissioning: April 2018

Part2: Optics cabins (**CC4 & CC5**) and new DCM commissioning

- ✓ Procurement : on-going
- ✓ Delivery: on-going
- ✓ Assembly: Fall 2017
- ✓ Installation: March 2018
- ✓ Commissioning: >May 2018

Part3: A new state of the art microscope for nano, cryo, spectroscopy
+ transfer of present side-branch end-station

- ✓ TDR: starting (2017-2018)
- ✓ Procurement, assembly: 2018-2020
- ✓ Commissioning: to be defined (2021?)



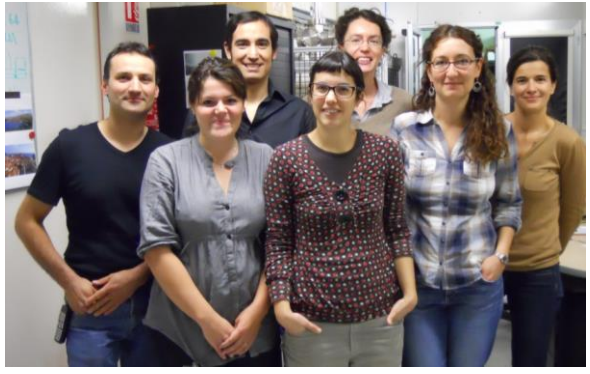
Infrastructure

Cryo-cooler
New racks (IR end-station shutdown)
New PLC
New network
New PSS

Current status (Oct 2017)

- ✓ µFTIR: closed
- ✓ Side-branch: closed
- ✓ Infrastructure works: started
- ✓ Available beamtime: reduced for next round

THANKS FOR YOUR ATTENTION!



Collaborators: G. Sarret, C. Larue, M. Roman, K. Vogel-Mikus, A. Servin, J. Villanova, I. Schreiver, and many others

Support teams: B. Baker, R. Barrett, G. Berruyer, C. Cohen, C. Cornu, E. Gagliardini, R. Hino, J. Keiffer, J. Morse, M. Papillon, V. A. Solé, A. Vivo, L. Zang, and many others