STREAMLINE

WP5

User engagement training and outreach

D5.1

Presentation material to introduce EBS beamlines

Expected date: 14 Jul 2021

STREAMLINE has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 870313.

PROJECT DETAILS

PROJECT ACRONYM	PROJECT TITLE
STREAMLINE	**Sustainable research at micro and nano X-ray beamlines**
GRANT AGREEMENT NO:	THEME
870313	**H2020-INFRADEV-2018-2020 Development and long-term sustainability of new pan-European research infrastructures**
START DATE	
15/11/2019	

DELIVERABLE DETAILS

WORK PACKAGE ID	EXPECTED DATE
WP5	**14/07/21**
WORK PACKAGE TITLE	DELIVERABLE TITLE
User engagement training and outreach	**Presentation material to introduce EBS beamlines**
WORK PACKAGE LEADER	DELIVERABLE DESCRIPTION
Marine COTTE	**Presentation material to introduce EBS beamlines - Task 5.1**
DELIVERABLE ID	PERSON RESPONSIBLE FOR THE DELIVERABLE
D5.1	**Gary ADMANS**

NATURE

☐ **R- Report** ☐ **P - Prototype** ☐ **D - Demonstrator** ☒ **O - Other**

DISSEMINATION LEVEL

☒ P - Public
☐ PP- Restricted to other programme participants & EC: Click here to enter text
☐ RE – Restricted to a group Click here to enter text
☐ CO – Confidential, only for members of the consortium

REPORT DETAILS

VERSION	DATE	NUMBER OF PAGES
	13/08/21	**18**
DELIVERABLE REPORT AUTHOR(S)	FOR MORE INFO PLEASE CONTACT	

STATUS

☐ **Template** ☐ **Draft**
☒ **Final** ☐ **Released to the EC**

ID03: HARD X-RAY MICROSCOPY BEAMLINE

Project coordinator: Carsten Detlefs

MAIN TECHNIQUES

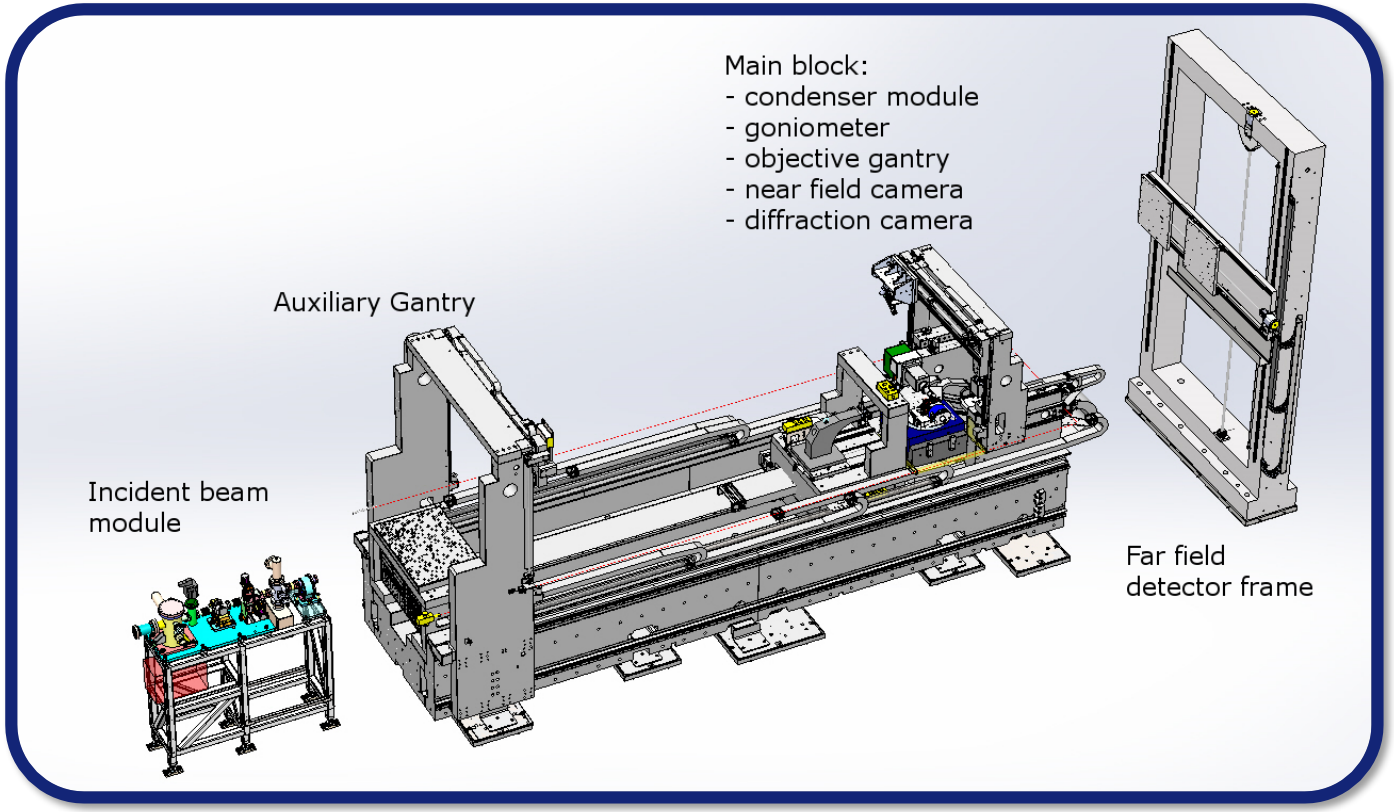
- Dark field x-ray microscopy
- Section topography
- Strain mapping

BEAMLINE SPECIFICATIONS

- Energy range 12-60 keV
- Pink and monochromatic beam
- Spatial resolution ~100 nm
- Multi-scale capability

EBS & REFURBISHMENT IMPROVEMENTS

- Dedicated beamline fully optimized for dark field x-ray microscopy
- Improved photon flux for faster acquisition and better signal/noise ratio
- Integration with 3DXRD



2020	2021	2022	2023	2024
USM on prototype instrument at ID06				
Technical design report				
		Implementation		
				USM

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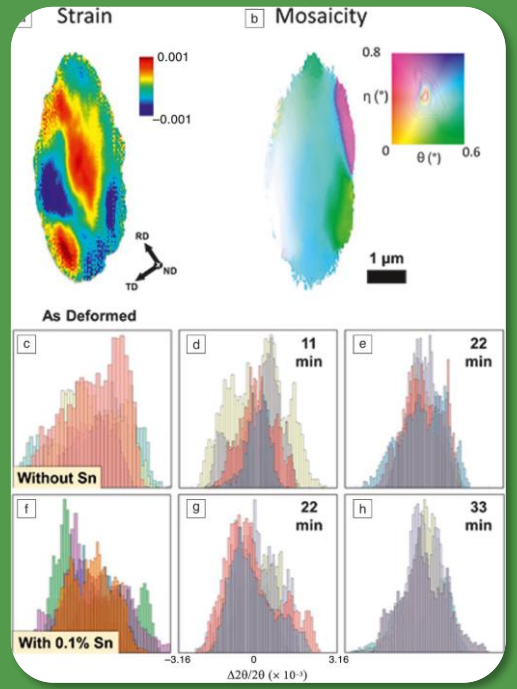
ID03: HARD X-RAY MICROSCOPY BEAMLINE

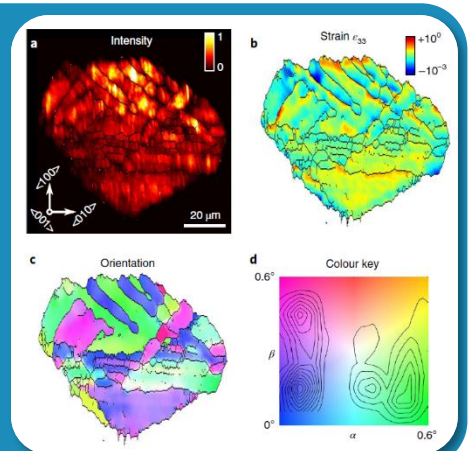
Metallurgy

- Pattern formation
- Materials fatigue
- Recovery and recrystallization



Functional materials

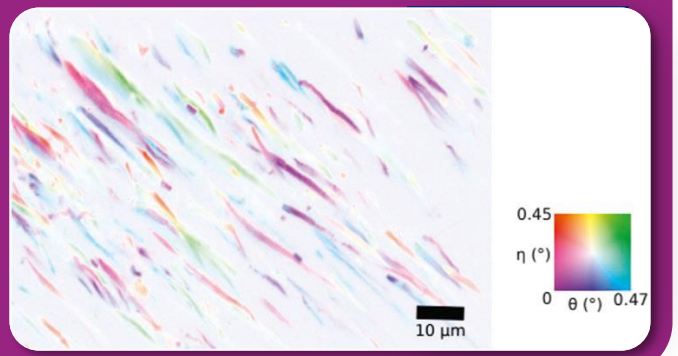
- Strain at grain boundaries
- Formation of domain patterns
- Dynamics of domain switching



3D strain maps with 100 nm spatial resolution

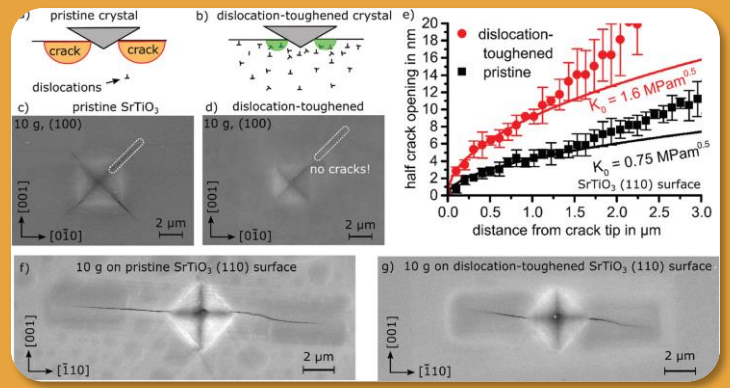
Biominerals

- Microstructure



Ceramics

- Dislocation-toughening
- Nano-twinning



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ID14: NUCLEAR RESONANCE SCATTERING

Project coordinator: Aleksandr Chumakov

MAIN TECHNIQUES

- Synchrotron Mössbauer source
- Nuclear forward scattering
- Nuclear inelastic scattering

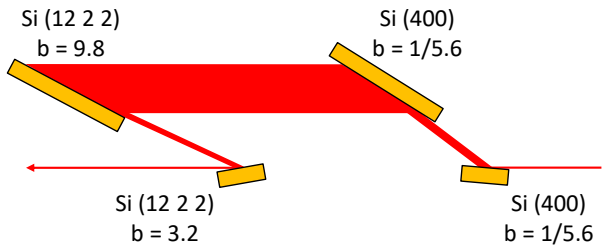
BEAMLINE SPECIFICATIONS

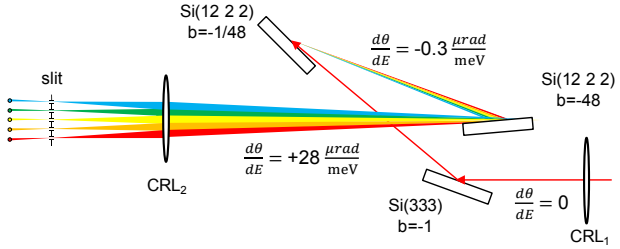
- Energy range: 7 – 90 keV
- Energy resolution: 3.7 neV – 2 meV
- Beam size: 2 × 9 μm^2 (present) down to 0.2 × 0.2 μm^2 (new Nanoscope)

EBS & REFURBISHMENT IMPROVEMENTS

- Smaller beam size
- Higher energy resolution
- Higher stability in space and in energy
- Higher flux

Improving resolution (here – energy resolution, but also spatial one) by orders of magnitude, but keeping the same flux:





High-resolution monochromator (2007)
- Energy resolution: ~500 μeV
- Flux: ~10^{10} photons/sec

High-resolution spectrograph (2022)
- Energy resolution: ~50 μeV
- Flux: ~10^{10} photons/sec

2017	2018	2019	2020	2021	2022	2023	2024
Test of the concept	Test user experiment	Design optimization		New instrument + USM on ID18			Transfer to ID14

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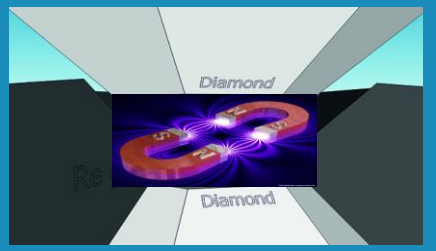
ID14: NUCLEAR RESONANCE SCATTERING

Geoscience and Exoplanets

- Identification of chemical phases
- Electronic and magnetic transitions
- Sound velocities, elastic moduli, thermodynamics and heat conductivity

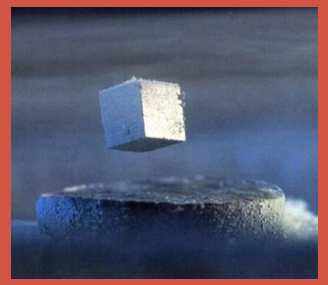
Magnetism at Megabars



- Magnetic states
- Magnetic transitions
- Transition from ferromagnetism to superconductivity

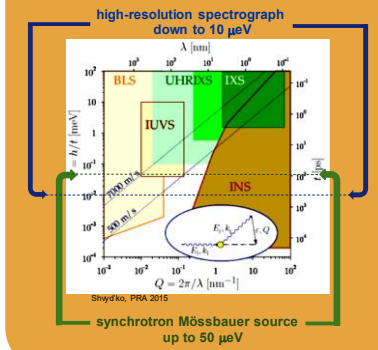
Electronic properties, magnetism and atomic dynamics at extreme conditions

Superconductivity



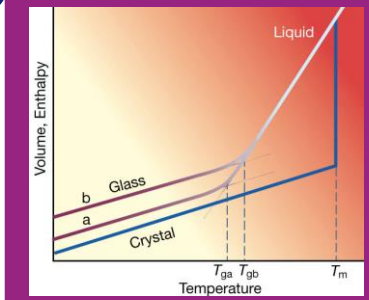
- Superconductivity at high pressure
- Visualization of the vortex structure

No-man's land



- Entering "No-man's land" between meV and neV energy transfer
- Anharmonicity, phonon life-time

Glass transition



- Dynamical heterogeneities
- Time and length scale

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ID18: COHERENT X-RAYS DYNAMICS AND IMAGING

Project coordinator: Marco Cammarata

MAIN TECHNIQUES

- X-ray photon correlation spectroscopy
- Coherent diffraction Imaging
- Ptychography

BEAMLINE SPECIFICATIONS

- Energy range: 6-35 keV
- Pink beam to highly monochromatic
- Variable sample detector-distance (2 to 25m)
- Tunable beamsize (1 to 20 µm)

EBS & REFURBISHMENT IMPROVEMENTS

- New building and optics
- Higher flux
- Tunable spotsize
- Ptychography setup
- Faster detectors

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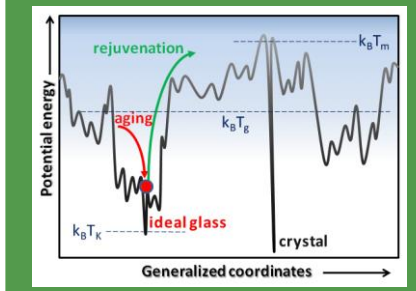
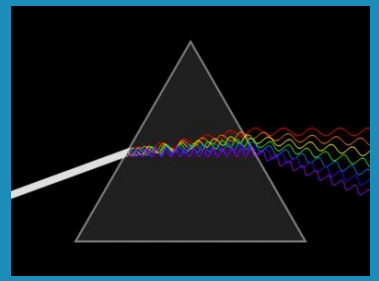
ID18: COHERENT X-RAYS DYNAMICS AND IMAGING

Dynamics of glassy state



- How do glasses age ?
- How do glasses rearrange ?

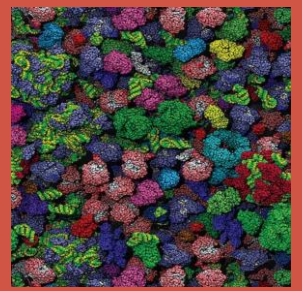
Physics of light



- Investigating fundamental quantum & non-linear optics processes (SHG, DFG)

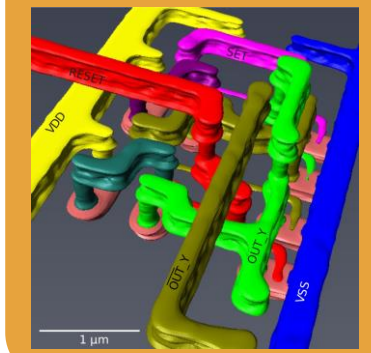
Mesoscale Structure and Dynamics

Dynamics in crowded systems



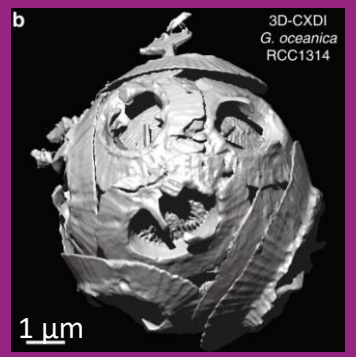
- How proteins move in crowded environment (e.g. cells) ?

High resolution 3D imaging



- How systems are organized in the mesoscale ?
- How manufacturing at sub micron can be optimized ?

Bioimaging



- Growth of mesoscale structures
- How are building blocks of life connected ?

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BM18: HIERARCHICAL PHASE-CONTRAST TOMOGRAPHY

Project coordinator: Paul Tafforeau

MAIN TECHNIQUES

- Hierarchical tomography
- Propagation phase-contrast imaging

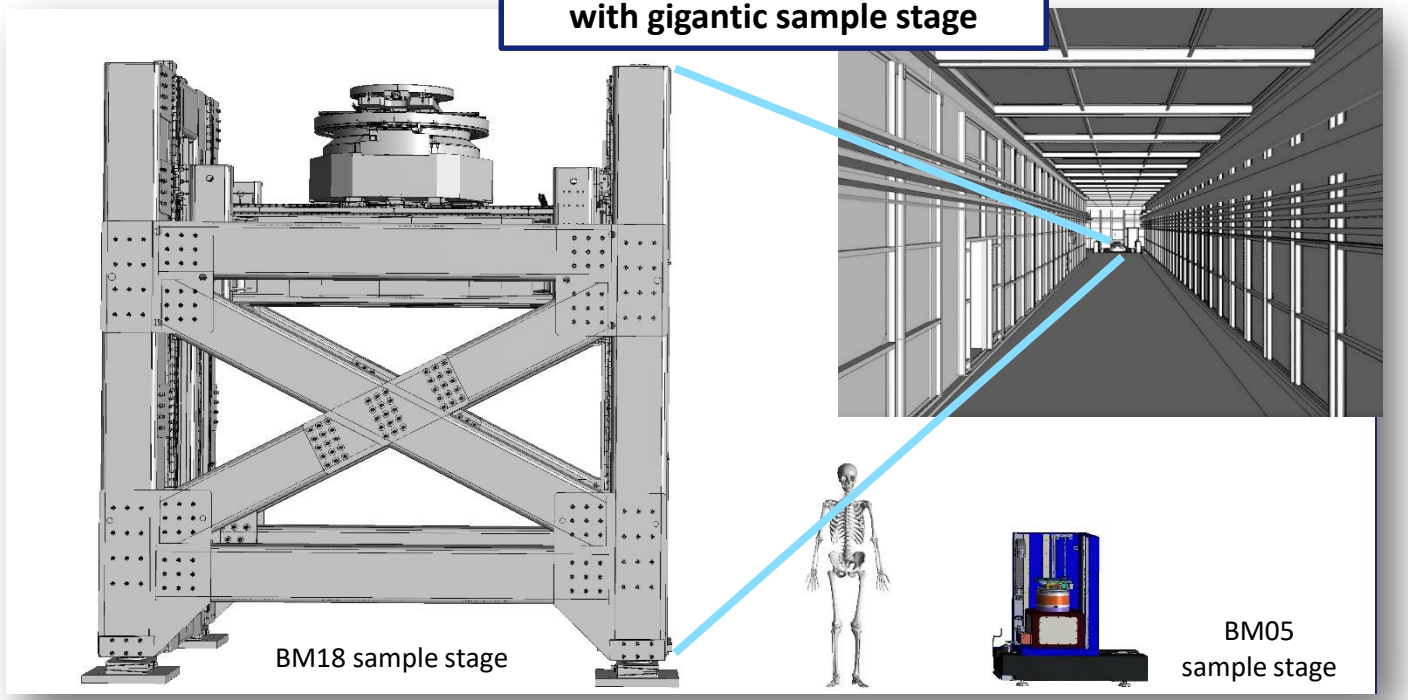
BEAMLINE SPECIFICATIONS

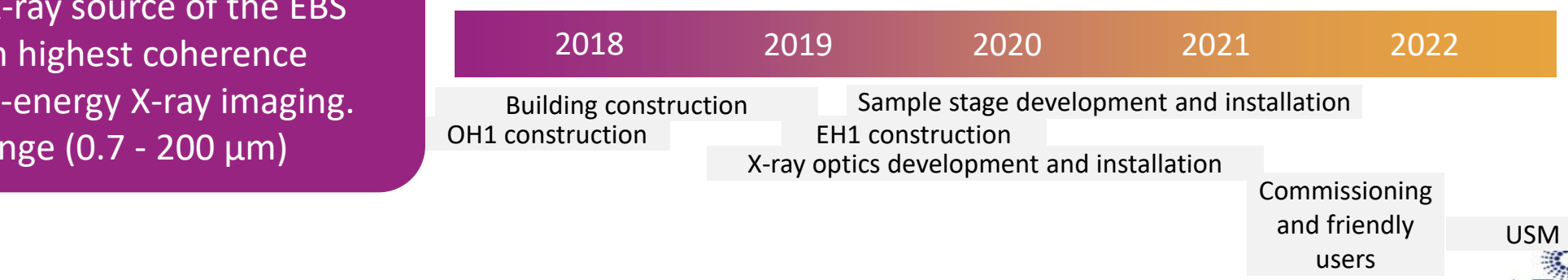
- Energy range:25-350 keV (polychromatic)
- 220m long beamline, up to 38m for propagation phase-contrast
- Sample size up to 2.5m and 300 kg
- High level of automation and high throughput

EBS & REFURBISHMENT IMPROVEMENTS

- Smallest possible X-ray source of the EBS
- Beam of 35cm with highest coherence worldwide for high-energy X-ray imaging.
- Large resolution range (0.7 - 200 µm)

45m long experimental hutch with gigantic sample stage





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BM18: HIERARCHICAL PHASE-CONTRAST TOMOGRAPHY

Biomedical imaging

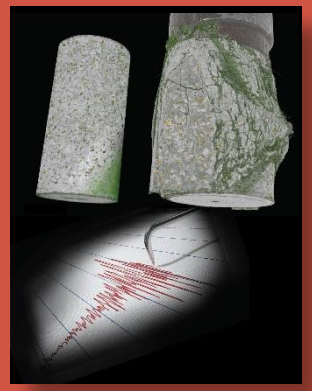
- A new scale in human body knowledge
- Understanding effects of diseases

Natural and cultural heritage

- Understanding the evolution of life on earth
- Non-invasive structural study of archaeological specimens and art pieces

High sensitivity phase-contrast tomography in large and complex samples

Geology



- Origin of earthquakes
- Mechanisms of volcanoes
- Climate change

Material sciences

- Non-destructive control of large devices (batteries, complex mechanical parts)
- Additive manufacturing (in-situ and ex-situ)

Industrial applications

- Testing high-value objects
- Analysis of 3D structures of industrial products
- Industrial processes

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ID21: MICRO X-RAY SPECTROSCOPY

Project coordinator: Hiram Castillo-Michel

MAIN TECHNIQUES

- Micro X-ray fluorescence 2D mapping
- Micro X-ray absorption spectroscopy
- Hyperspectral mapping

BEAMLINE SPECIFICATIONS

- Energy range:2-11keV
- Minimum beam size: 0.3×0.3µm² (present) down to 0.1×0.1µm² (new nano-scope)
- In-vacuum + cryo stage
- User friendliness

EBS & REFURBISHMENT IMPROVEMENTS

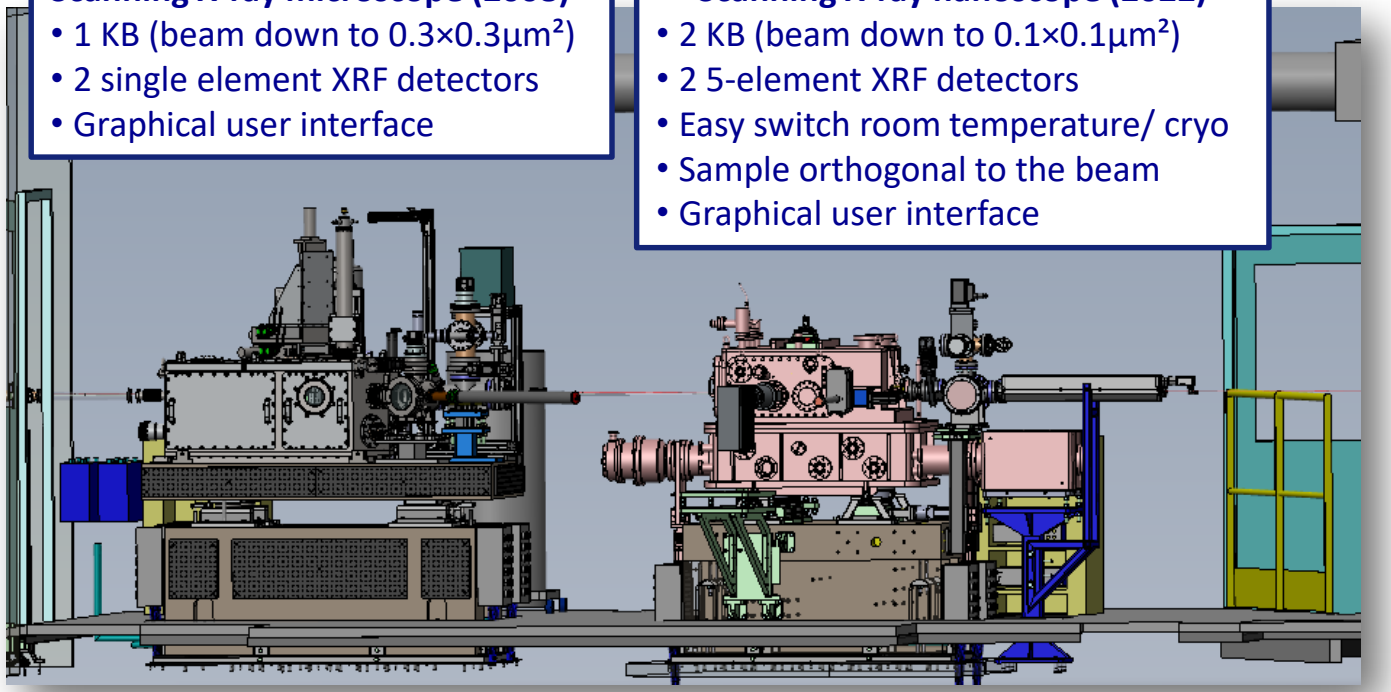
- Smaller, square and more stable beam
- Higher flux
- Faster acquisitions
- Better XRF collection
- Better cryo-preservation

Scanning X-ray microscope (2008)

- 1 KB (beam down to 0.3×0.3µm²)
- 2 single element XRF detectors
- Graphical user interface

Scanning X-ray nanoscope (2022)

- 2 KB (beam down to 0.1×0.1µm²)
- 2 5-element XRF detectors
- Easy switch room temperature/ cryo
- Sample orthogonal to the beam
- Graphical user interface



2018	2019	2020	2021	2022
New primary mirrors refurbished optics hutches	New DCM	EBS shutdown	USM	Infra-structure works	USM	New nanoscope

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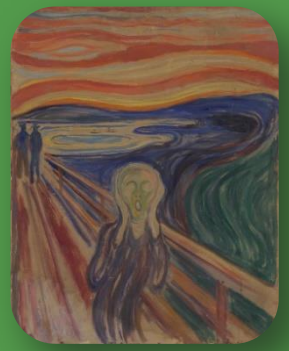
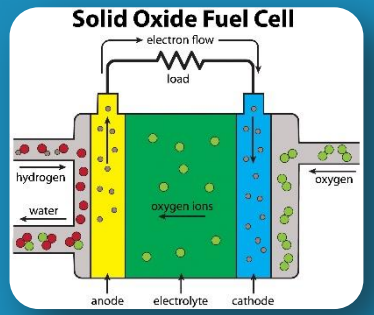
ID21: MICRO X-RAY SPECTROSCOPY

Cultural Heritage



- What are the masters' secrets?
- Why and how do artworks degrade?

Manufactured materials



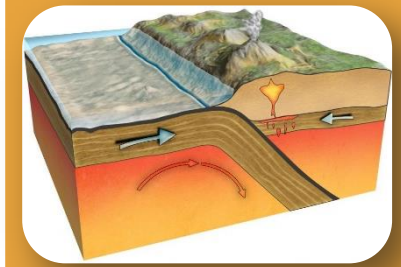
- Efficiency and stability of manufactured materials
- Chemical reactions at boundaries in electrodes, catalysts and micro-electronics

Identification and location of chemical markers in complex materials

Environmental science

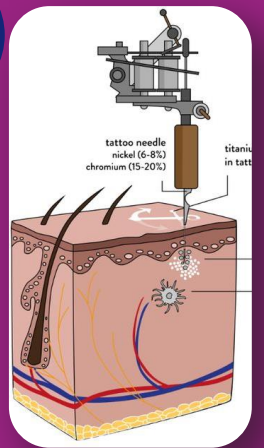
- Positive and negative impacts of materials in the environment
- Metal accumulation in plants

Earth and planetary sciences



- Chemical signature (element composition, trace elements, speciation) of geological processes
- Paleoclimate

Health



- Interactions of manufactured materials (drugs, implants, tattoos, etc.) with living systems
- Chemical modifications induced by neuro-degenerative diseases

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ID24: HIGH BRILLIANCE X-RAY ABSORPTION SPECTROSCOPY

Project coordinator: Olivier Mathon

MAIN TECHNIQUES

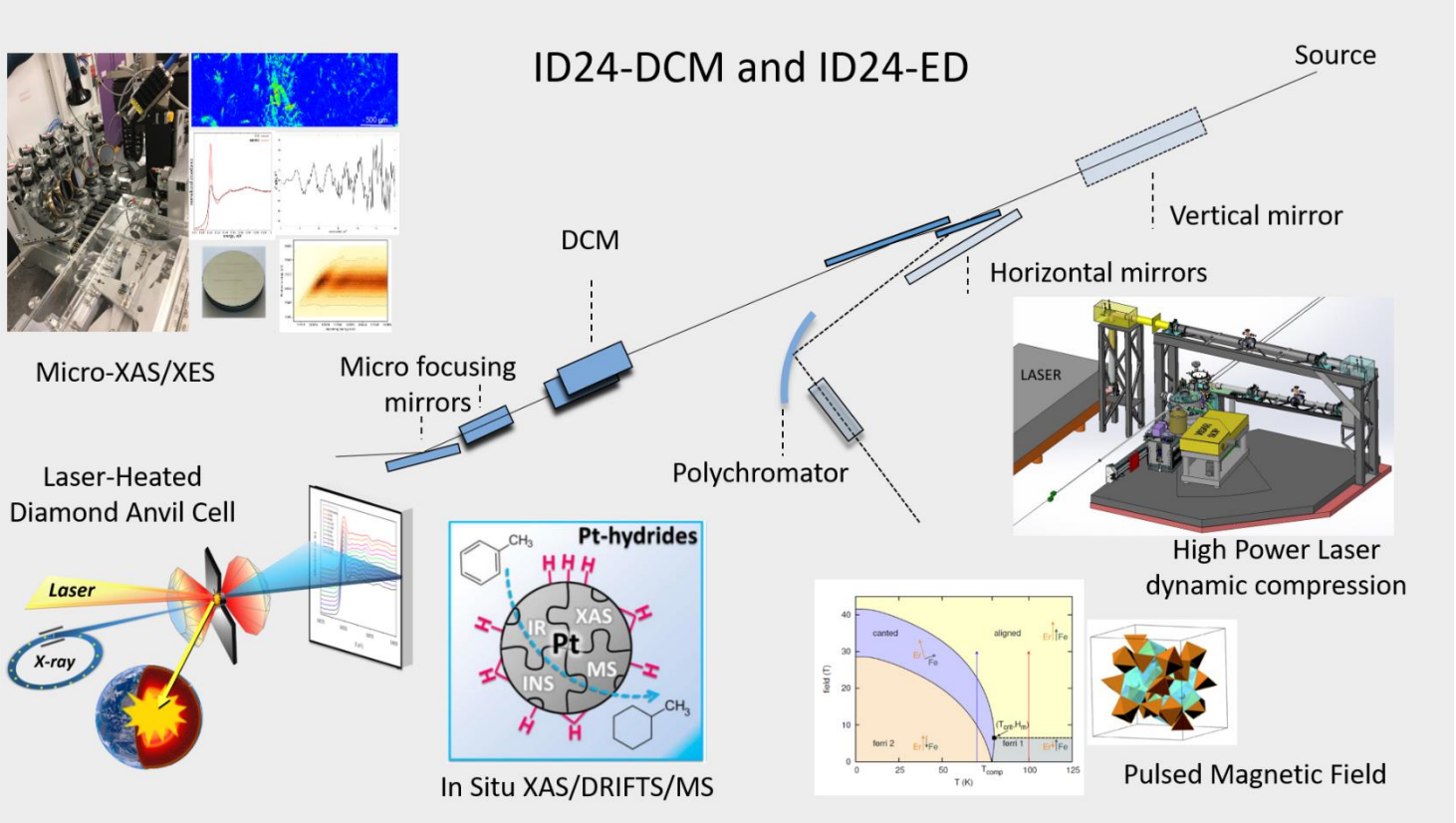
- X-ray Absorption Spectroscopy
- Micro-XAS / Micro-XES mapping
- Complementary techniques: XRD, DRIFTS, MS, UV-Vis …

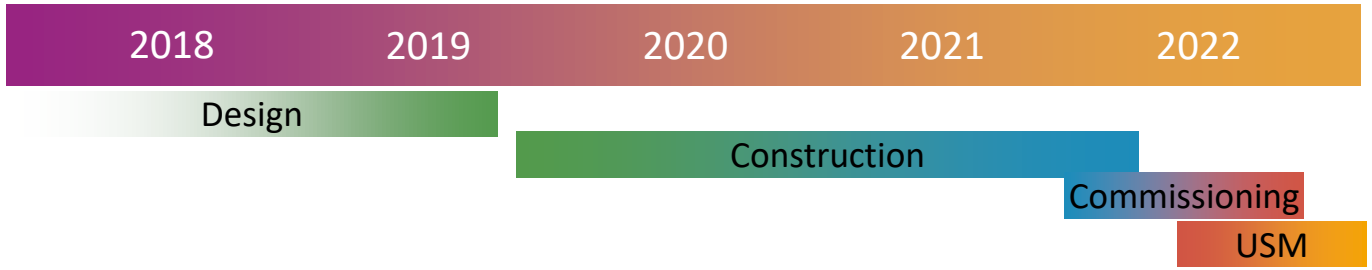
BEAMLINE SPECIFICATIONS

- ID24-ED energy Dispersive branch 5-25keV
- ID24-DCM energy scanning branch 5-45keV
- Focal spot down to 0.3x0.3 μm^2
- Flux up to 10^{14} ph./s

EBS & REFURBISHMENT IMPROVEMENTS

- Higher brilliance, smaller focal spot
- Fast acquisition, continuous scan
- High Power Laser for dynamic compression
- LH-DAC setup for static compression
- Micro-EXAFS/Micro-XES setup
- *Operando* chemistry facilities





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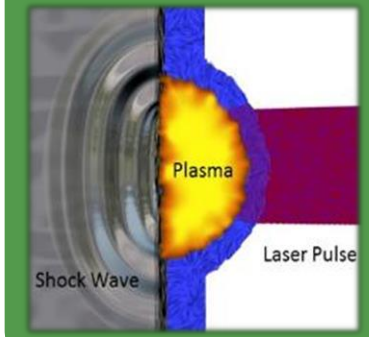
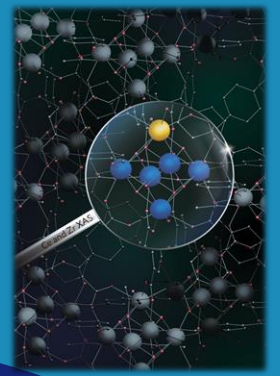
ID24: HIGH BRILLIANCE X-RAY ABSORPTION SPECTROSCOPY BEAMLINE

Laser shock science



- Warm Dense Matter
- Planets and Inertial Confinement Fusion
- Dynamic behavior of matter

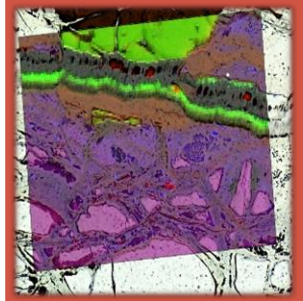
Structure of novel materials



- Batteries and fuel cells
- Nanoparticles
- Gas sensors and separators
- Drugs

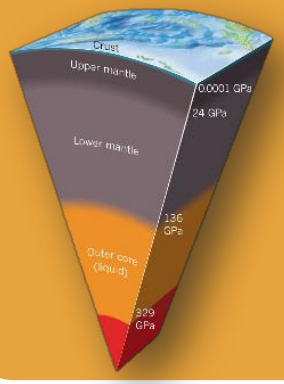
Physics and chemistry of complex materials under relevant conditions

Environmental science



- Geo-resources
- Biogeochemical processes
- Impact of human activity on our environment

Matter at extremes



- Planetary interiors
- Condensed matter physics
- Material sciences
- Materials under high pulsed magnetic field

In-situ and *operando* chemistry

- Catalysis
- Synthesis
- Electrochemistry
- Photochemistry

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ID27: EXTREME CONDITIONS BEAMLINE

Project coordinator: Mohamed Mezouar

MAIN TECHNIQUES

- Micro X-ray diffraction
- Micro X-ray fluorescence
- X-ray imaging

BEAMLINE SPECIFICATIONS

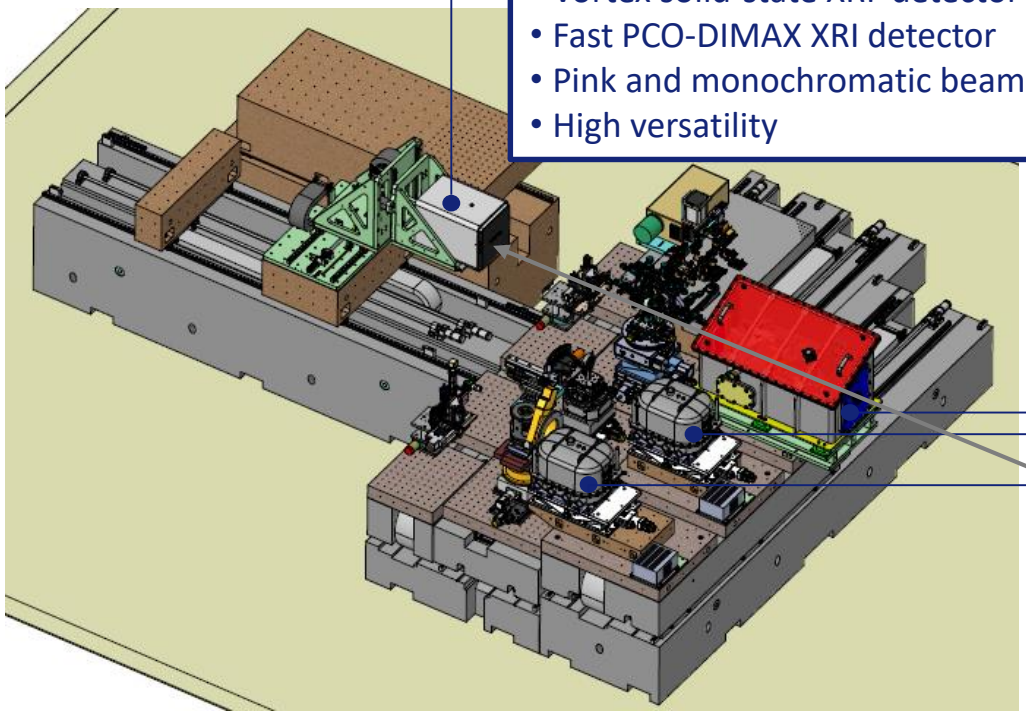
- Energy range:15-65keV
- Minimum beam size: 0.3×0.3µm²
- State-of-the art Eiger 9M XRD detector
- High P and T (P> 5 Mbar, T> 5000 K using Laser and resistive heating techniques)
- Low T (down to 5 K)
- Low dilution level (~1 ppm)

EBS & REFURBISHMENT IMPROVEMENTS

- Smaller and more stable beam
- Higher flux (x1000 in pink beam mode)
- Faster acquisitions (for XRD and XRI)
- Higher dynamic range (for XRD)

Extreme conditions beamline (2021)

- 3 KBs (beam down to 0.3×0.3 µm²)
- Eiger 9M CdTe detector
- Vortex solid-state XRF detector
- Fast PCO-DIMAX XRI detector
- Pink and monochromatic beam
- High versatility



2019	2020	2021	2022
Technical Design Report	Detailed Beamline Design	Infrastructure works	USM

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ID27: EXTREME CONDITIONS BEAMLINE

High Density Physics

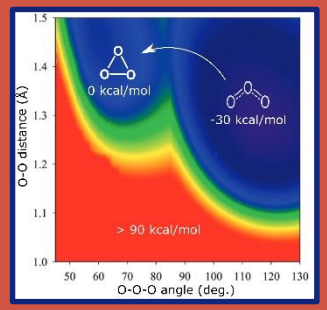
- Search for room temperature superconductivity
- Structure of metallic hydrogen

Materials under Extreme P&T

- Synthesis of superhard materials
- Materials under high stress

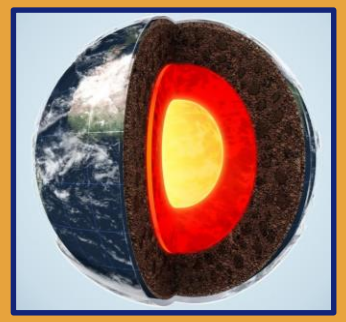
In situ studies of materials subjected to extreme P,T conditions

High Pressure Chemistry



- Emergence of structural complexity
- New high pressure compounds

Earth and planetary sciences



- Structure and dynamics of deep Earth materials
- Understanding large scale geological phenomena (volcanism, plate tectonics)

Soft and biological matter under pressure

- Polymerization
- Protein conformation

STREAMLINE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870313.

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ID29: SERIAL MACROMOLECULAR CRYSTALLOGRAPHY

Project coordinator: Daniele de Sanctis

MAIN TECHNIQUES

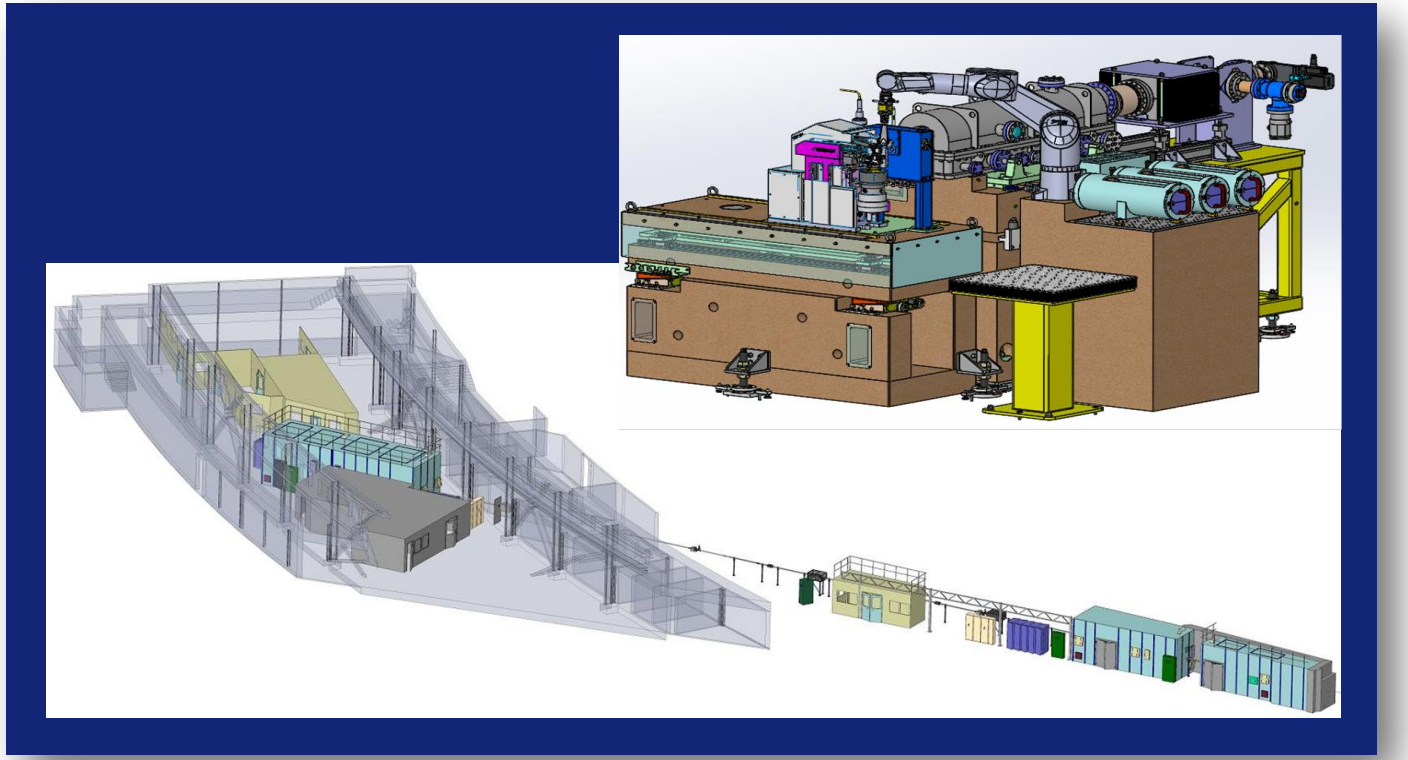
- Serial Crystallography X-ray diffraction
- Time resolved Crystallography
- Room temperature Crystallography

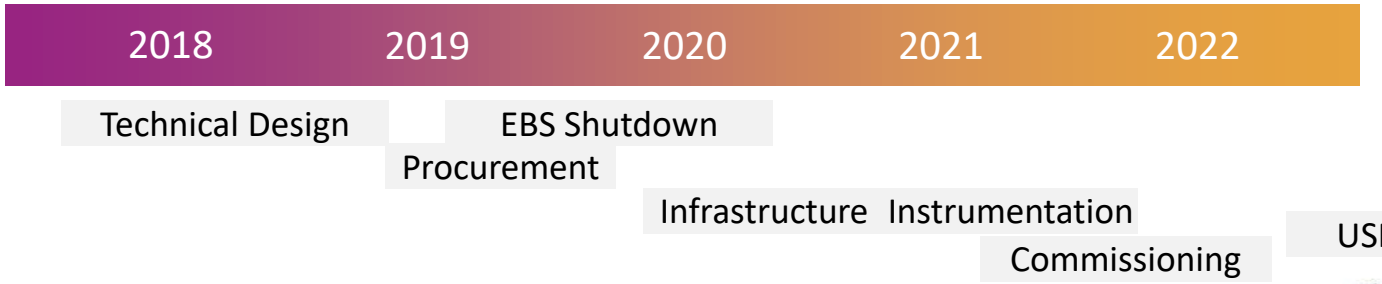
BEAMLINE SPECIFICATIONS

- Energy range 10-20keV with 1% bandwidth
- Minimum beamsize 0.6 x 0.4µm^2
- 10^{15} - 10^{16} ph/s flux
- Microsecond-to-millisecond time resolution

EBS & REFURBISHMENT IMPROVEMENTS

- Higher flux density and time resolution
- Diffraction from submicron samples
- Last generation of high frame rate integrating detector





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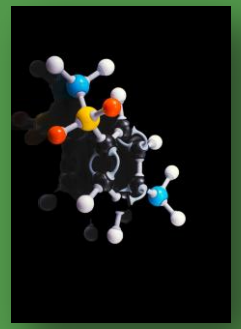
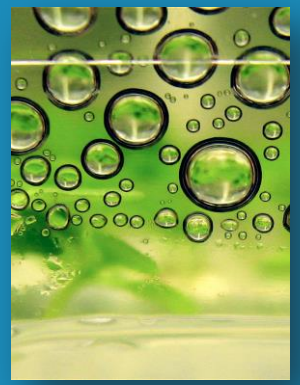
Drug design



- Exploit room temperature fragment screening
- Identify time dependent structure: ligand complexes

Biofuel



- Characterize and optimize biochemical processes for production new carburants
- Exploit novel sources for bioenergies

Serial and Time resolved Crystallography

Enzymology

- Study enzymatic reaction in crystals
- Enzyme design and repurposing by synthetic biology

Photobiology

- Study light activatable biological processes
- Investigate light dependent biochemical reaction

Bioremediation

- Study and engineering of macromolecular complexes involved in bioremediation
- Develop enzymatic processes for plastic waste treatment

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