



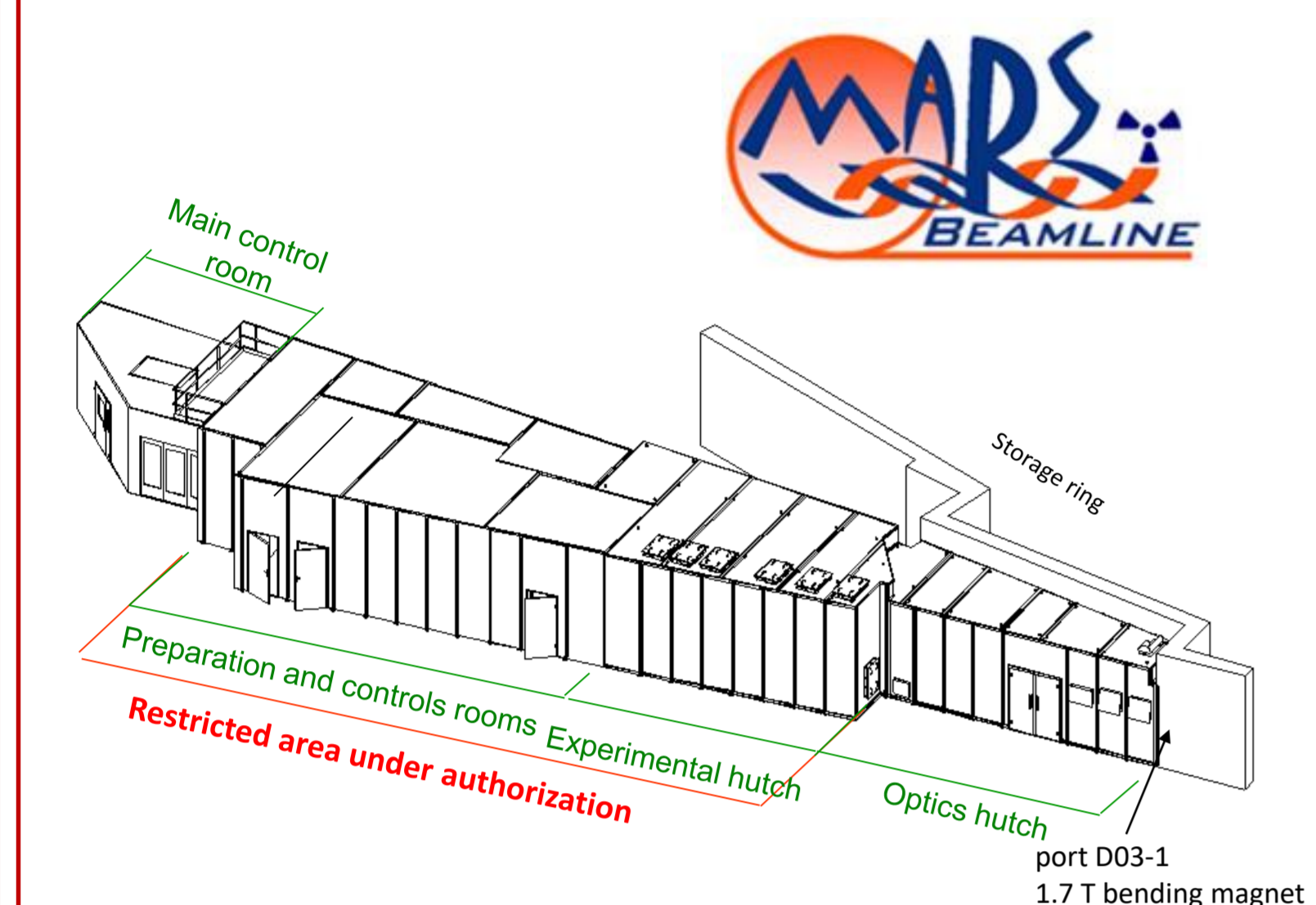
Two Shielded End-Stations at MARS Beamline of SOLEIL Synchrotron : Specific Devices for the Highly Irradiating Materials Analysis

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SOLEIL is the French synchrotron located on the “plateau de Saclay” in Saint Aubin (Essonne) near Paris, both a large scale facility (storage ring of 354 meter circumference) and a research laboratory. Actually, there are 29 operational Beamlines (on 43 possible slots).

SOLEIL covers fundamental research needs in physics, chemistry, material sciences, life sciences, earth sciences, and atmospheric sciences. It offers the use of a wide range of spectroscopic methods from infrared to X-rays, and structural methods such as X-ray diffraction and diffusion.



MARS (Multi Analyses on Radioactive Samples) beamline aims to extend **the research capabilities on radioactive matter** (α , β , γ and n emitters) with respect to national and European safety laws. The total equivalent activities present at the same time including the storage on the beamline can be **up to 185 GBq with a maximum of 18.5 GBq (0.5 Ci) per sample**.

The design of MARS beamline (infrastructure and optics) is optimized to alternatively run **two experimental stations (CX2 and CX3)** in order to perform characterizations on radioactive samples with X-ray beam between 3.5 and 35 keV.

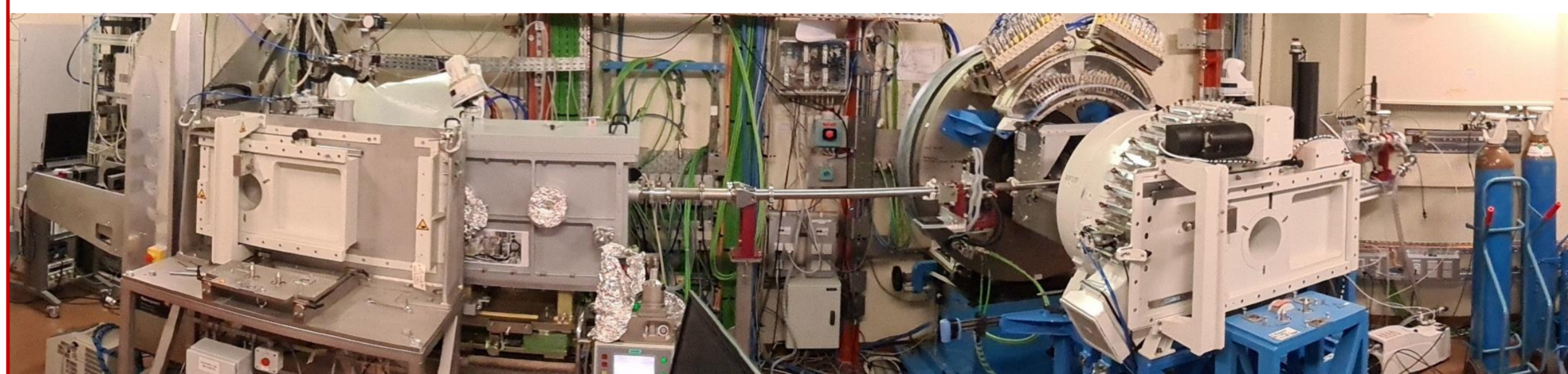
The design, calculation and realization laboratory (BCCR) of the CEA is based at Saclay near Paris.

BCCR manages the provision of mechanical equipment at all stages, from the writing of specifications and requirements until supervision of manufacturing :

- Experimental equipment (for reactors or laboratory),
- Nuclear transport packaging,
- Provides various mechanical assistance into diverse projects (mechanical expertise, commissioning, contribution to safety files, archival of construction drawings, etc.).

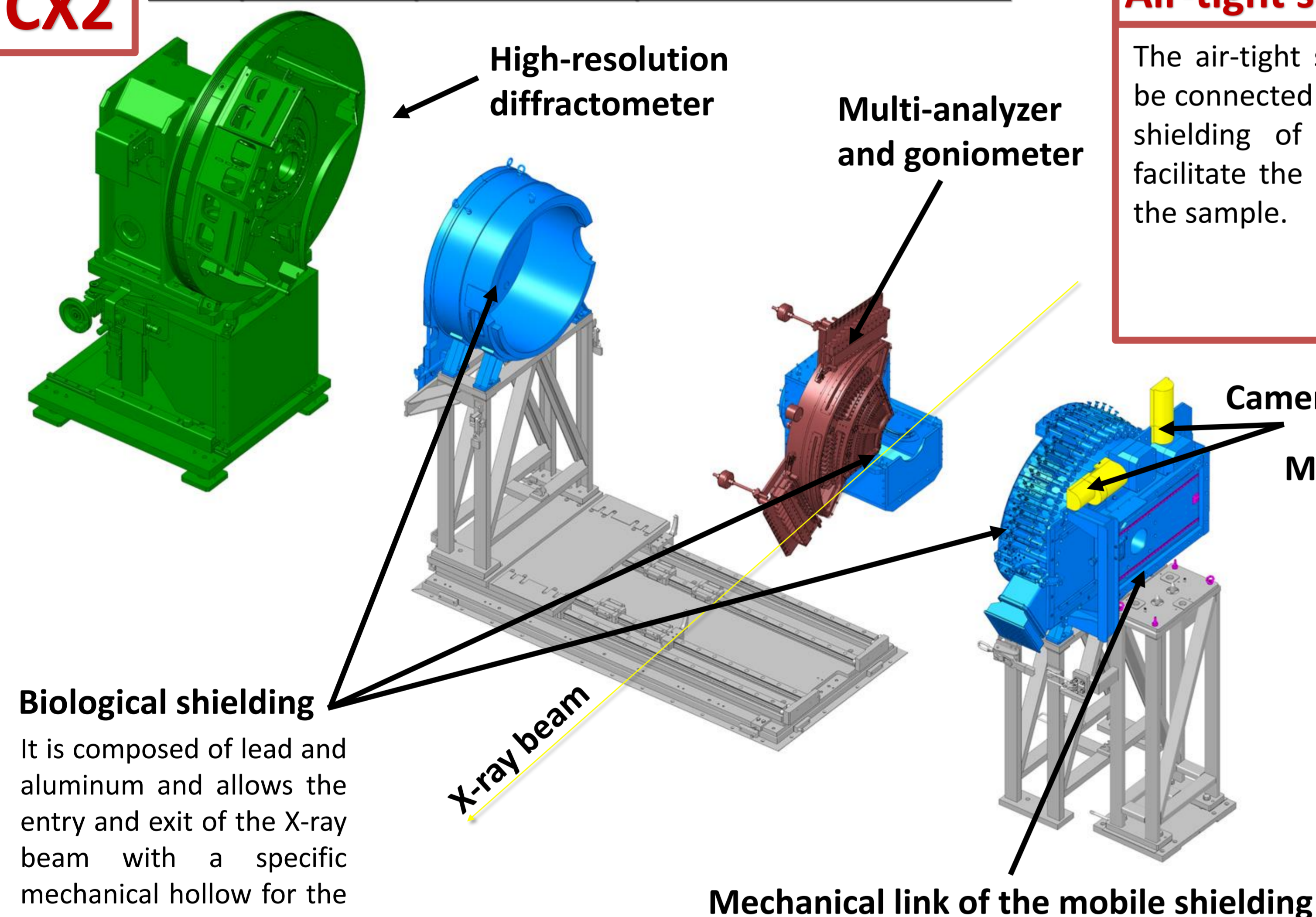
BCCR has followed each stage of design of the two shieldings associated to CX2 and CX3 stations of the MARS Beamline from the writing of specifications to the final set up in SOLEIL. This include numerous test with samples, which ones has never been irradiated, and scrupulous procedures to gain valuable experience to provide satisfaction to the Nuclear Safety Authorities.

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CX2

First experiment on spent nuclear fuel performed on December 2018

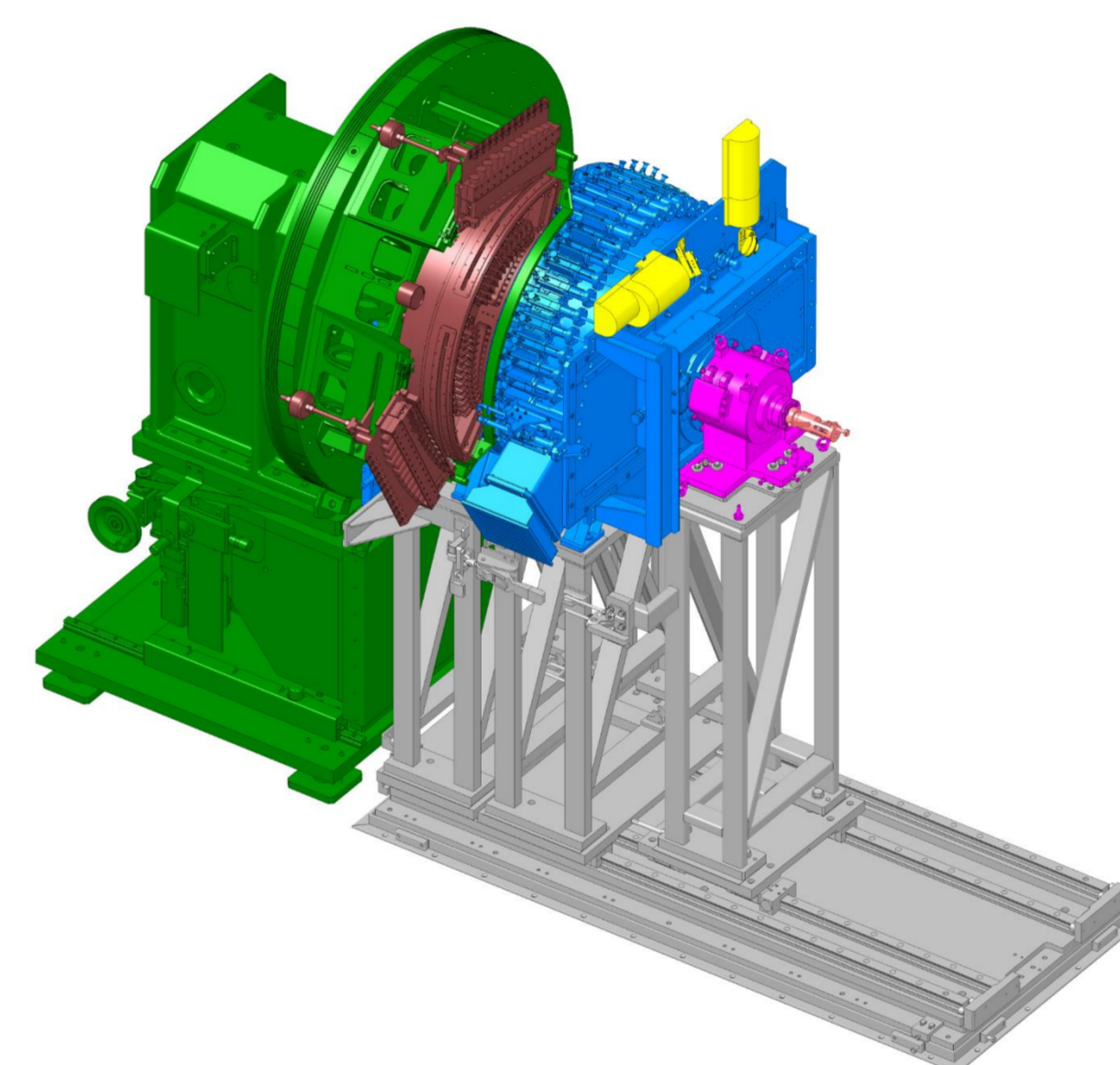
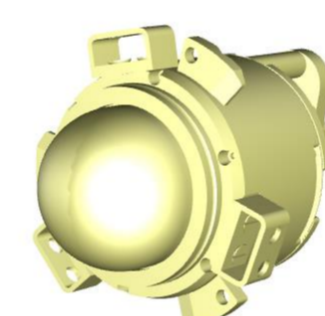


Biological shielding

It is composed of lead and aluminum and allows the entry and exit of the X-ray beam with a specific mechanical hollow for the use of the beam on the CX3 station.

Air-tight sample holder

The air-tight sample holder can be connected into the biological shielding of both stations to facilitate the characterization of the sample.

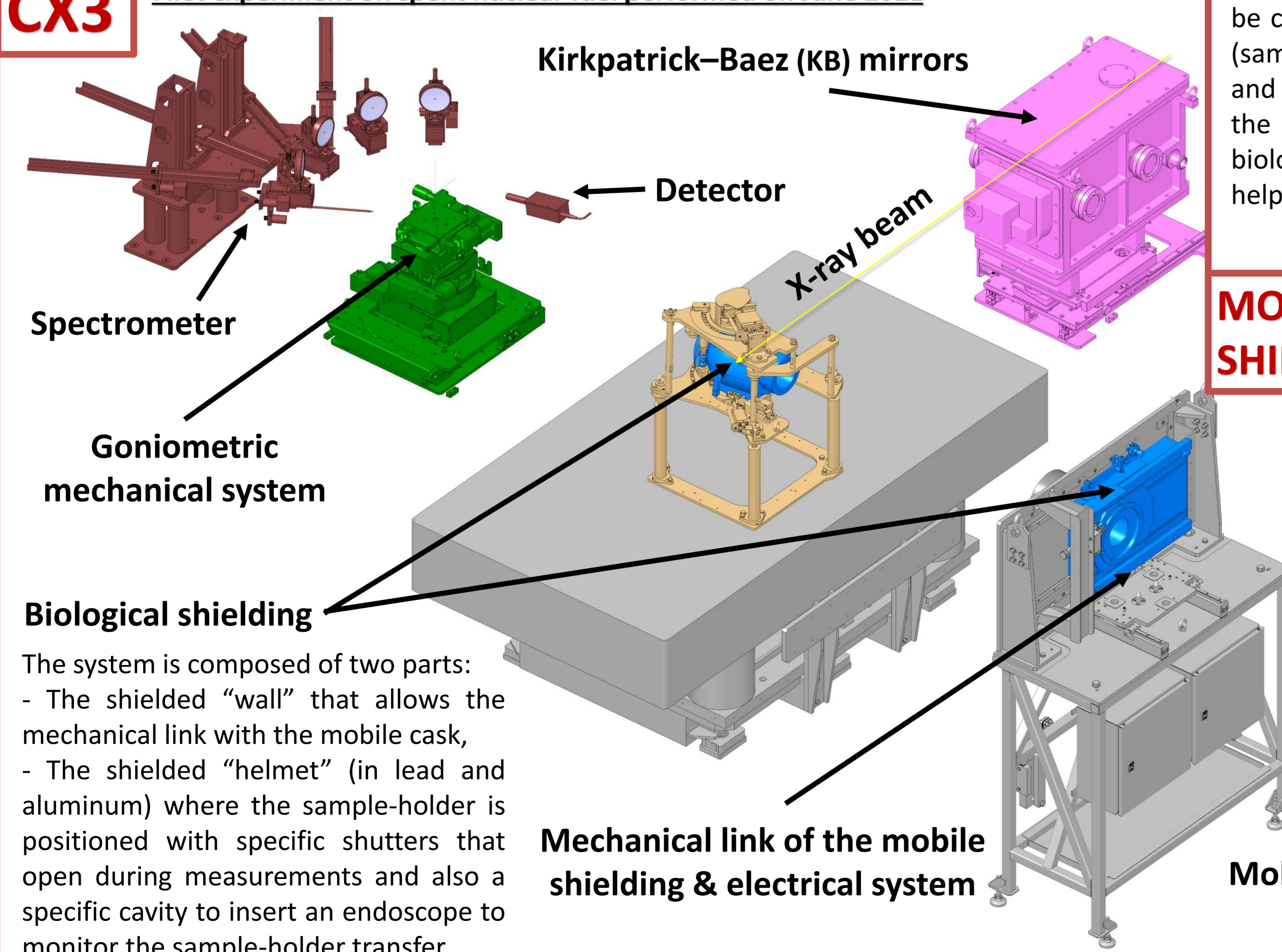


CX2 end-station is operational since 2011. When used for analyses on highly irradiating material, this station is composed of the following main mechanical components :

- The multi-analyzer detection system which is connected to the shielding of CX2 with a mechanical system which allows to perform measurements without the interference of the shielding while complying with SOLEIL's safety rules,
- The diffractometer and goniometer systems allow translations and rotations to perform the characterization of the sample at different positions,
- Biological shielding to prevent irradiation of users,
- Cameras to monitor the air-tight sample holder in the biological shielding,
- A mobile shielding for the transport of the sample.

CX3

First experiment on spent nuclear fuel performed on June 2021



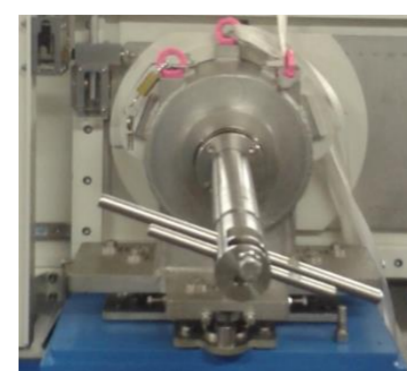
Biological shielding

The system is composed of two parts:

- The shielded “wall” that allows the mechanical link with the mobile cask,
- The shielded “helmet” (in lead and aluminum) where the sample-holder is positioned with specific shutters that open during measurements and also a specific cavity to insert an endoscope to monitor the sample-holder transfer

The mobile shielding carries the air-tight sample holder. It can be connected with each station (same mechanical link for both) and allows the movement of the sample-holder into the biological shielding with the help of a specific equipment.

MOBILE SHIELDING



CX3 end-station is operational since 2010. When used for analyses on highly irradiating material, this station is composed of the following main mechanical components :

- The spectrometer composed of 4 analyzer crystals that can be adjusted axially and horizontally to optimize the characterization,
- The SDD detector positioned vertically above the front shielding with a specific motorized stage (not shown),
- The goniometric mechanical system onto which the air-tight sample holder is connected (inside the shielding), to adjust precisely the position of the sample with the X-ray beam,
- The biological shielding for the protection of users,
- The mobile shielding cask to transport the sample,
- The Kirkpatrick-Baez (KB) mirrors to possibly micro-focus the incoming X-ray beam.

