MIRACLES: STAP Spectroscopy report (October 2021 – April 2022)

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General information

In the last six months, the MIRACLES instrument has been progressing in the detailed design towards the TG3 reviews (equivalent to the Critical Design Reviews, CDRs). In particular, two main design reviews (Intermediate Design Reviews, IDR) were held, to harmonize ESS requirements with the design of the components, prior to the CDR:

- Choppers.
- Scattering Characterization System (that includes vessel, analyzer, detectors, radial collimator) and Get-lost tube.

Additionally, the MIRACLES Team has incorporated José E.M. Pereira as a new member. José will take care of the development of the analyzer, as well as the equipment related with the scientific environment (Preparation areas, Sample positioning, Control hutch).

System Integration and Management

<u>High-level installation schedule</u>

Since ESS (and the NSS project) has conducted a rebaselining of their Master Schedule, the MIRACLES project's schedule has been integrated into such NSS Schedule. As a result, some milestones have changed, maintaining the final MS as Dec-2025. An overview of the status of the main work packages, and providers of the detailed design at this stage are depicted in Fig. 1.

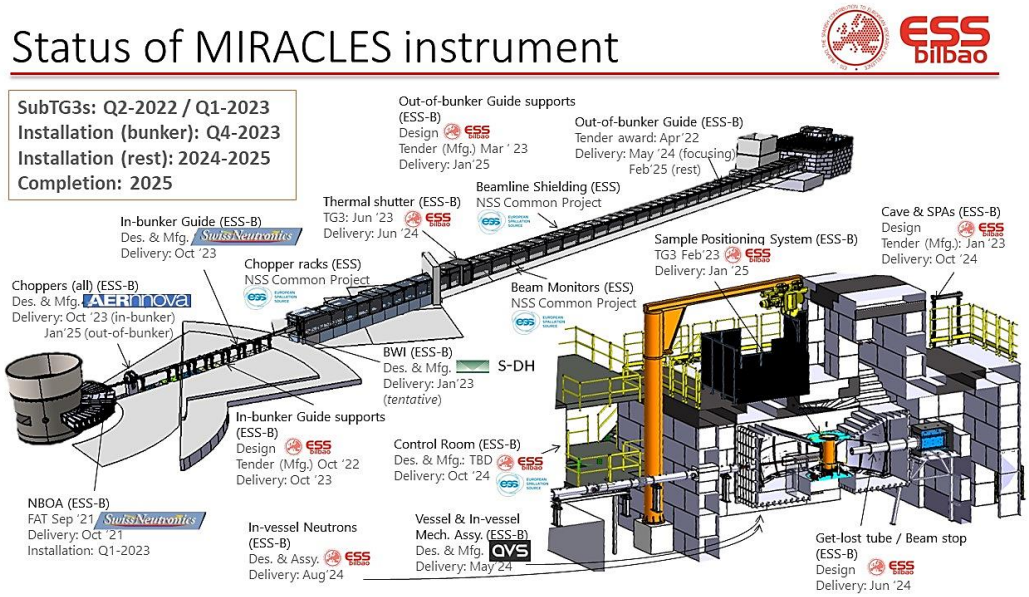

Figure 1. Illustration showing status, providers, and milestones for the different components of MIRACLES.

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This effort has provided a list of the following installation start dates for the 4 main installation slots, after the TG4 milestones. The list below is what the MIRACLES instrument team has proposed to NSS. The final dates will be confirmed by NSS in the following months:

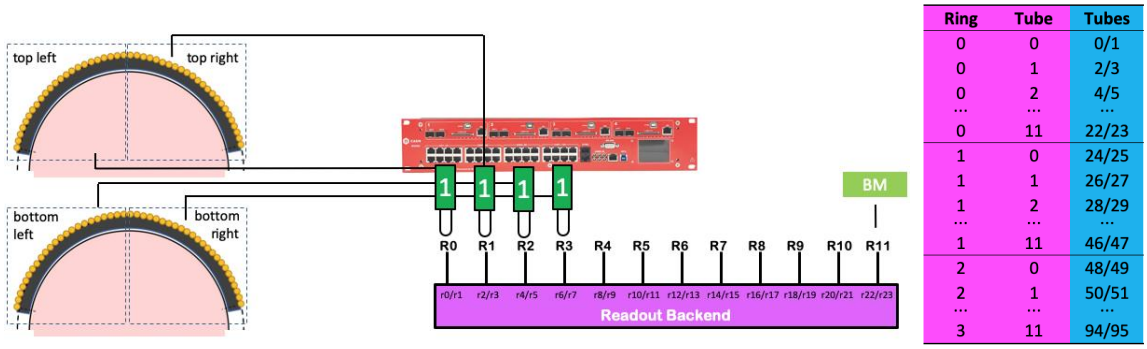
- In-bunker beamline: October 2023
- Scattering Characterization System: June 2024
- Experimental End Station: November 2024
- Out-of-bunker beamline: March 2025

Integration

After clarification of the scope between the ESS and ESS-Bilbao, related to the Common Shielding and other common projects, negotiations have been resumed to integrate MIRACLES into the Infrastructure Projects (Common Electrical Project and Common Utilities Project). Also, we have a clear interest that ESS Facility Management will deliver the Control Hutch (specifications have been sent to the Facility Management group). All these negotiations have just started and will take place in the following weeks.

The Beam Monitor Common Project is frozen, after the depart of the project leader and the head of the detectors' group.

One final update to be highlighted is that the MIRACLES team has had their first contact with the Data Management group (DMSC) to start creating the MIRACLES DAQ chain. First efforts have been focused on the ring allocation and the digital mapping (see Fig. 3).



Ring	Tube	Tubes
0	0	0/1
0	1	2/3
0	2	4/5
…	…	…
0	11	22/23
1	0	24/25
1	1	26/27
1	2	28/29
…	…	…
1	11	46/47
2	0	48/49
2	1	50/51
…	…	…
3	11	94/95

Figure 2. Schematics of the interface between MIRACLES data readout and data management.

Risk register

Top 5 Risks

Title	Severity	Category	Responsible	Response	Trend
Unsuitable beam monitors	16	Quality	ESS	Reduce	New
Guide components cost increase	12	Cost	ESS-Bilbao	Accept	Steady
Scattering characterization system: cost increases	10	Cost	ESS-Bilbao	Accept	New
Cave: delivery delay	9	Schedule	ESS-Bilbao	Reduce	Steady
Delayed delivery of vacuum vessel	9	Schedule	ESS-Bilbao	Reduce	Steady

Shielding

Beamline

The beamline shielding of MIRACLES is framed within the Common Shielding Project. Once the scope issue between ESS and ESS-Bilbao has been clarified, it is expected that design works can be carried out along the year (following the schedule priorities of the NSS Common Project).

Cave

The cave has shown some progress in the last months. The previous walls have been substituted by a double wall concept of different block dimensions, and the structure has been reinforced. Currently, a thorough structural analysis is being carried out.

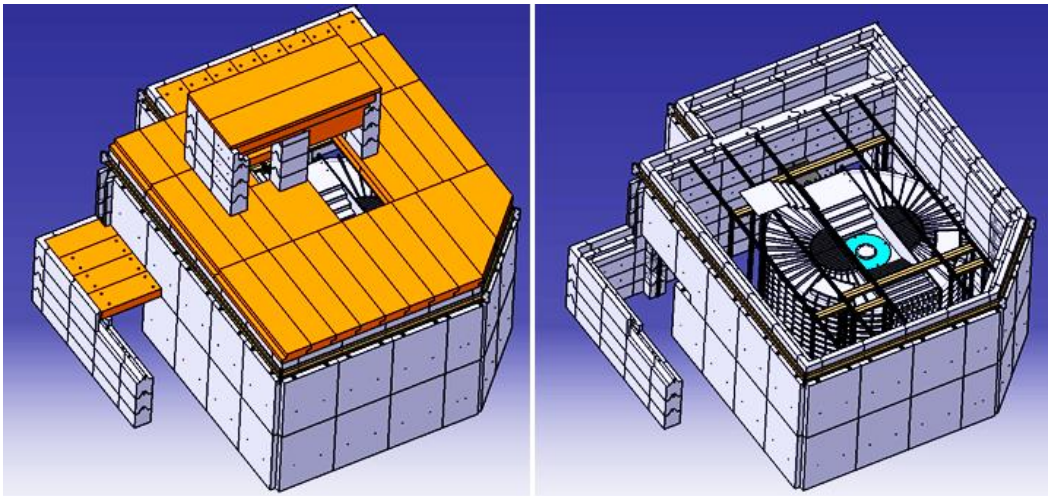


Figure 3. MIRACLES cave.

Choppers

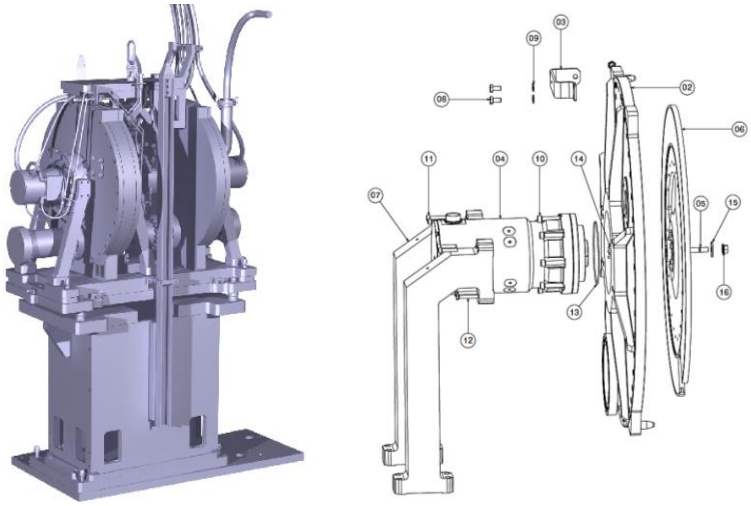


Figure 4. PWD-PS (in-bunker) chopper module, and exploded view of the first PWD disk obtained from Aernnova drawings.

An IDR was held in January. After the event, several meetings and subsequent interactions between ESS-Bilbao, the in-bunker guide provider (Swiss Neutronics) and the choppers provider (Aernnova) has given shape to the design of the chopper module, as well as to the installation plan.

Currently, the choppers present a mature level of design and are almost ready for the SubTG3, intended to take place (based on schedule) in early summer.

Finally, the Aernnova prototype, now at ESS-Bilbao premises, has been utilized by the MIRACLES team to test and understand operation of the chopper and the chopper controls.

Beam Transport System

NBOA

The Neutron Beam Optical Assembly, NBOA, (section of the neutron beam extraction system that goes through the ESS monolith) manufactured by Swiss Neutronics, arrived at ESS site in October 2021. It has been storage for future installation (planned in Q1-2023).

BWI

The design of the Bunker Wall Insert, BWI (section of the beamline that goes through the bunker wall) developed by S-DH, has been finalized. In turn, NSS has completed the design of the Bunker Wall Feedthrough (envelope designed by ESS to accommodate the BWI). Integration of the BWI design into the bunker wall and the Bunker Wall Feedthrough has been completed. The next step will be to secure a date for the SubTG3 as soon as possible, aiming at a potential installation starting date early 2023.

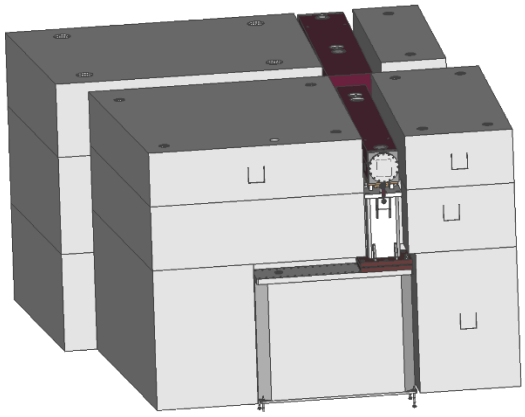


Figure 5. MIRACLES Bunker Wall Insert design integrated into the ESS bunker wall.

In-bunker guide

The In-bunker guide tender was awarded to Swiss Neutronics. The first steps were to design the Bridge Beam Guide – Optical Assembly (BBG-OA, guide element located at the ESS light shutter), the fine alignment with the two end guide units which interface this component (the NBOA and the BWI), and the interface with the PWD-PS chopper module (mentioned in the previous section).

Out-of-bunker guide

The tender for the Out-of-bunker guide was launched by end of February. A final decision is expected by the end of April.

Safety Systems

Shutter

The IDR held in October for the MIRACLES thermal shutter was well received and fruitful impact, mainly from the Personnel Safety System (PSS), was incorporated to the final design. The SubTG3 is scheduled for early 2023, together with the out-of-bunker guide (where it is located). However, we are seeking to secure an early date, in order to start manufacturing this year.

Slab

A sliding slab is located at the sample hatch to open and close the sample area, connected with the Personnel Safety System (PSS), so the only way of moving it to an open position is with the shutter in the closed position (Beam Off). The slab will slide by electrical motion guided by railed guides. The motion system will consist of a gearmotor which will move the load along the HEPCOMOTION MHD rack and pinion element. This component is still in the preliminary design and will be developed this year.

Instrument Specific

This section will encompass the Scattering Characterization System. All the components were reviewed by ESS during the IDR held in February. The whole system is reaching a mature level in terms of design, and we expect to hold the SubTG3 after summer.

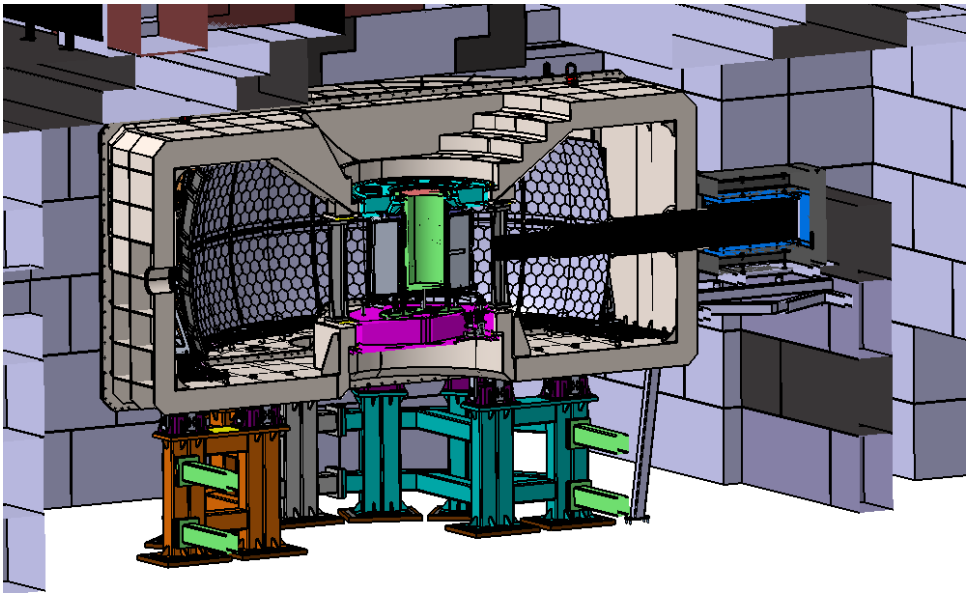


Figure 8. Designs of the Scattering Characterization System of MIRACLES (cut view)

Vessel

The design of the vessel (Fig. 8) has considered the ergonomics in the access to the sample area, the easiness in the installation and dismounting of the in-vessel components and keeping the requirement of a maximum vertical deflection of 1.5 mm at the sample axis.

Analyzer and radial collimator

The mechanical assembly of the analyzer (panels, structure, rails) and the radial collimator have progressed with a good pace in the last six months. Both components have been designed considering their installation and alignment within the scattering vessel.

On another note, the provider (AVS) has asked for an early manufacturing of the carbon fiber structure of the analyzer panels, due to issues with the supply chain of epoxy components to fabricate the prepreg. This petition is under evaluation, and we would like to thank the NSS Integration Lead Engineer, Giuseppe Aprigliano, for their fruitful feedback during the review process.

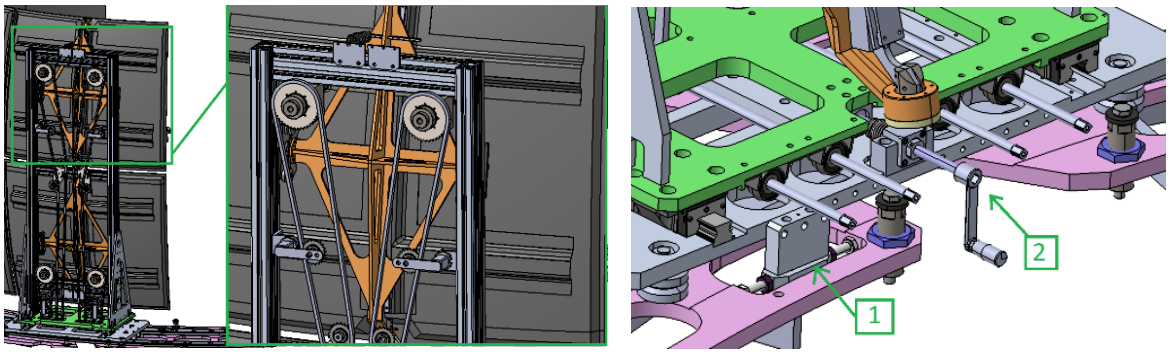


Figure 9. MIRACLES analyzer positioning/guiding system.

Additionally, as pointed out in the previous STAP (and as suggested during the pre-pandemic design review held at ESS in March 2020) we are intended to prepare some prototypes to carry out a systematic study and test different possibilities for the Si(111) crystal reflectors. Fabrication conditions (method, etching) and thickness, will be tested in a systematic way to give unambiguous results of the best choice for the crystals. This work will be carried out in collaboration with the staff at IN16B (ILL). Also, the provider of the MIRACLES analyzer (AVS) is involved in the process of development of the prototypes (see Figure below).

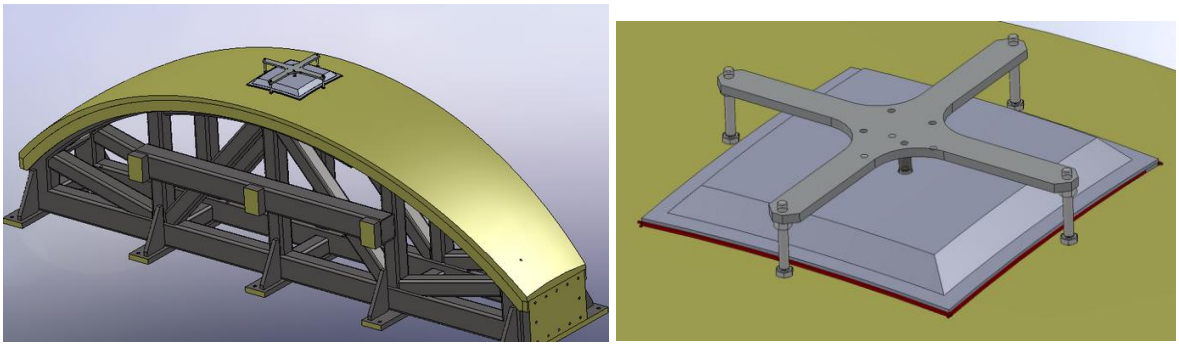


Figure 10. Proposal of panel prototypes for the analyzer, for the tests in IN16B (ILL)

Detectors

The mechanical assembly of the detector banks have the same maturity as the vessel and the rest of in-vessel mechanical assemblies.

On the other hand, using the prototype for U-shaped serial connection between 3He tubes, developed by Reuter-Stokes, we will carry out experiments using the Am/Be source available at the

Universidad Politécnica of Madrid (UPM) to validate this connection layout and check the good integration of the CAEN electronics readout and the Reuter-Stokes detectors.

Get-Lost Tube / Beam Stop assembly

The design of this component is now ready for the SubTG3, that will take place together with the Scattering Characterization System.

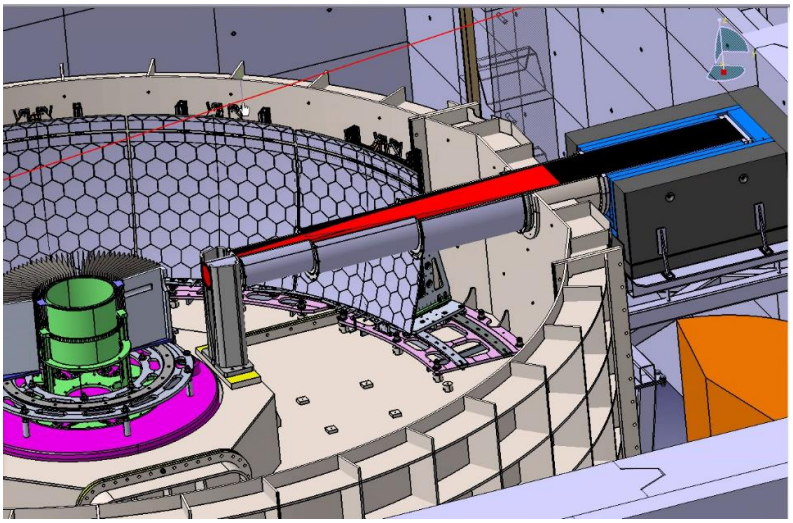


Figure 12. Get-lost tube / Beam stop assembly design integrated with the scattering characterization system.

Slits

Now that STAP meetings have resumed, the MIRACLES Team would like to seek advice from the STAP with respect to the location of the MIRACLES slits before the sample.

MIRACLES is planned to have slits before the sample, aiming at reducing the beam size at the sample for small samples, as well as simultaneously reducing the background contribution. A first idea was to install the slits between the guide and the sample chamber (close to the normalization beam monitor).

However, calculations demonstrate the intuitive idea that with the high divergent beam delivered by the MIRACLES guide, this position does not reduce the beamspot size conveniently, thus the performance of the slits is far from being adequate. Moreover (and of equal importance), access to the slit in case of malfunctioning is very complicated, and we would like the slits to be extracted from the top for maintenance. A potential solution that improves both issues is to move the slits inside the sample chamber (considering of course the space limitations).

During the meeting, we would like to present a detailed rationale and potential possibilities for the MIRACLES slits.