MAGiC progress report

Diffraction STAP: April 2020

This short report presents the progress made on the MAGiC instrument design since the October 2020 Diffraction STAP meeting.

1. CoViD 19 update

Impact on the project due to the lockdown is so far:

- French contribution
  - CNRS is still working remotely for all aspects regarding MAGiC. The call for tender for the guide system is under review by a dedicated committee. The call for tender for the Experimental Cave is currently being formalized.
  - CEA is closed up to 26th of April. Engineering work is stopped for 2 weeks.
- German contribution
  - JCNS is working remotely.
  - Detector is currently not affected
  - Chopper system is currently not affected
  - XYZ setup: Expected hiring of a CAD designer has been postponed because of CoViD 19.
  - Cryostat: We have started to renovate a cryostat at FRM-2 for MAGiC. This work is paused because of CoViD 19.
  - Beam monitors: we see a suitable solution and plan for tender. No delays expected.
  - Slit system: Conceptual design has been ready but with changes of the elliptic guide this needs reconsideration and may impact guide tender.
- Swiss contribution
  - Work is done remotely
  - Beamtimes are affected, expect roughly a 3 months delay
  - Simulation continues
  - Design is partially affected
- ESS contribution
  - Work is done remotely.

On the long term, we do not foresee a huge impact on the delivery of MAGiC due to the coronavirus.

2. Administrative/Legal update

LLB has a dedicated buyer assigned by CNRS to the project. Things are now going fast.
PSI has solved all MoU/TA/VAT problems.

3. ICEB

On the 9th of December 2019, the first Instrument Consortium Executive Board (ICEB) has been held in Jülich. Representatives of each institute were presents (management of LLB, FZJ, PSI and NSS) as well as the instrument team.
This meeting is scheduled at least every 6 months and is the occasion for every partner to freely exchange on the project.

A progress update has been made with a focus on:

- TG3 and construction timeline
- Interfaces
- Progress update
- News from partners
- Communication between partners
- Communication with ESS

The next ICEB will take place in VC on the 15th of June.

4. Timeline update

The instrument installation plan has been updated with the latest developments in terms of call for tender, suppliers' capabilities and so on.

Two scenarios are considered:

1) With a 6 months cold commissioning phase at the end of construction: end of construction is June 2023
2) With a cold commissioning all along the construction, optimizing all dead time in deliveries: end of construction is January 2023

The latest is the one retained so far as period of inactivity is foreseen between guide section deliveries.

5. Detector update

A kick-off meeting of the detector was held at CDT (Heidelberg, Germany) on the 12th of February. Multiple points have been addressed during this meeting:

1) Interfaces with other equipment (sample table, XYZ, analyzer, gas flow)
2) Instrument team input to the supplier (design, constraints, …)
3) Specification updated (angular aperture distribution, sample to active area distance)
4) Priority in fabrication
5) Tests and controls
6) Interfaces with EPICS at ESS (high voltage, 48 V power supply)

Since the meeting, a first revision of the large detector 1° segment has been produced and shared. This first segment will be used to ensure that detector support can be integrated inside the experimental cave.

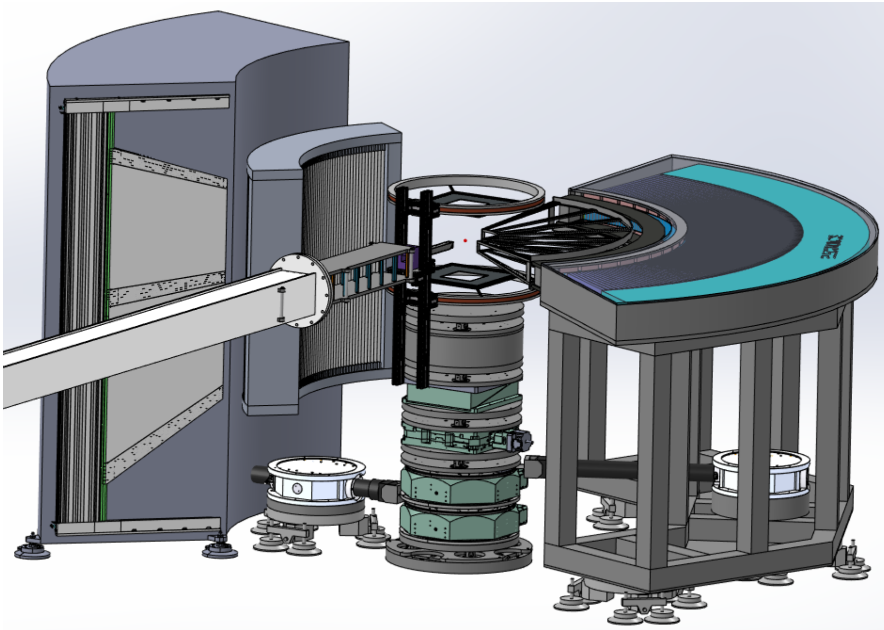

Figure 1: current sample and detectors area. The large detector model (on the left) has been updated.

6. Choppers update

Decision has been taken to sub-contract the choppers delivery to the ESS common choppers project. Since then, two milestones have been reached:

1) 9th of December: kick-off meeting of the project
    a. Specifications checked
    b. Updated planning (production, review, …)
    c. Identification of missing input from partners
2) 2nd of April: Preliminary Design Review with all stakeholders
    a. Design presented and accepted
    b. Switch into Detailed Design phase.

The next step will be the CDR.
The current manufacturing planning is consistent with the ESS in-Bunker installation window and with the overall installation plan of the instrument.

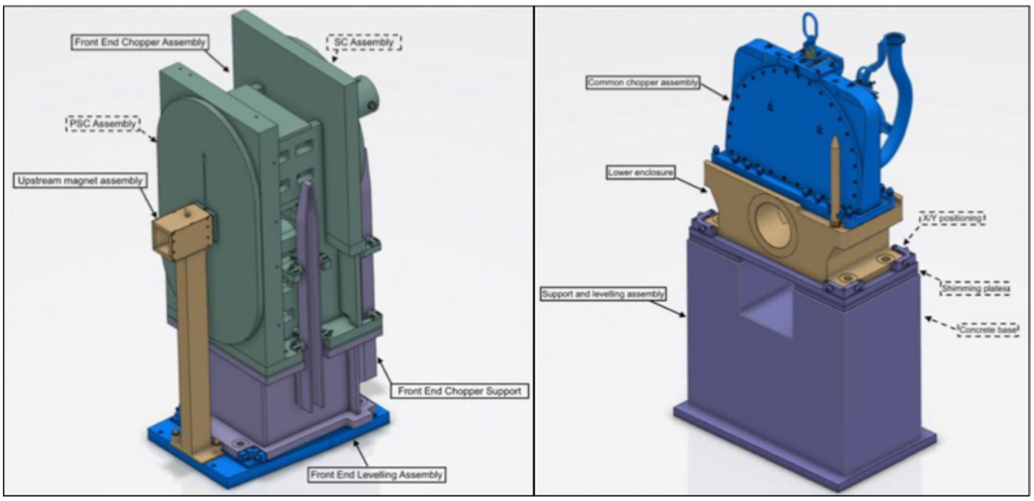

Figure 2: chopper design from PDR. (left) Pulse Shaping Chopper assembly. (right) Band Chopper assembly.

The design presented at the PDR can be seen on fig. 2 for both choppers assembly. Discs and vacuum housing designs have been simulated in ANSYS for mechanical rigidity. The current plan is to use Aluminum discs with boron coating. The Aluminum disc may not be suitable for the PSC rotating at speeds up to 154 Hz. A fallback solution with Carbon Fiber discs exists.

A joint effort between LLB and ESS is in progress to study the effects of the magnetic guide field on rotating aluminum discs:

1) Inductive heating of the discs
2) Forces opposing rotation at each disc opening

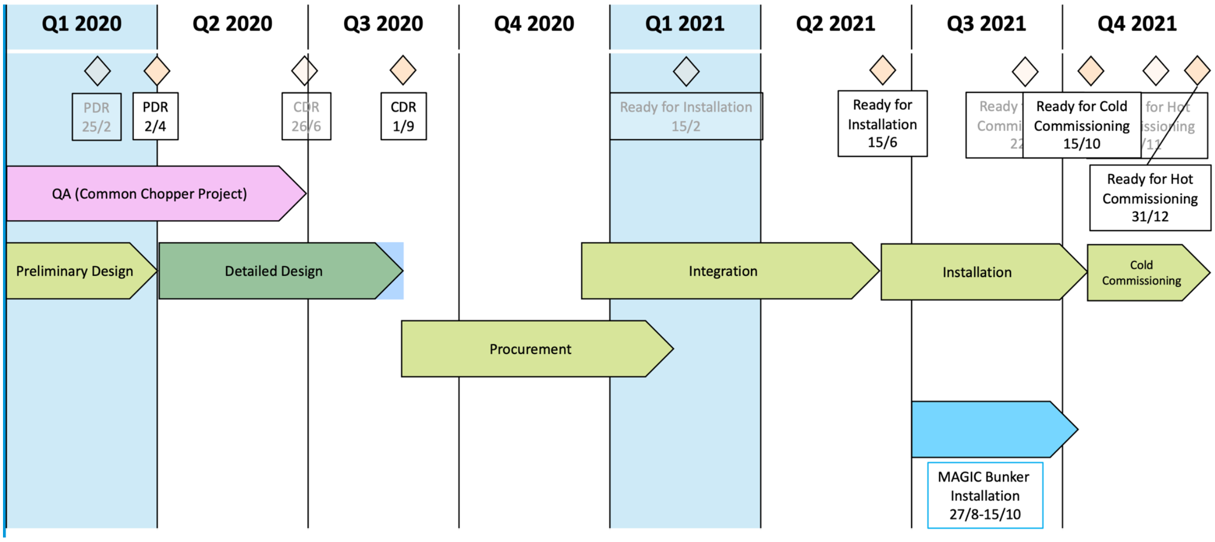

Figure 3: choppers design/manufacturing/installation/commissioning timeline.

7. Shielding update

The lower blocks of the beamline shielding have been installed in the last week of December.

Figure 4: MAGiC's lower block in E02 hall

Neutronics calculations are in progress to freeze the design of the lateral and top blocks. Installation of the lateral block will be done as soon as possible. The top blocks will be installed after installation and first alignment of the guide system.

8. Neutron guide system update

Tendering

The neutron guide call for tender is under review to check its compliance with CNRS rules. This is only the case for > 2000 k€ tenders.
The review will happen on the 2nd of May with a possible publication on the 1st of June.

The guide has been divided into four lots:
- Bunker Hall
- Bunker Wall
- Guide Hall
- Polarizer

The aim is to reduce manufacturing time by spreading it over multiple suppliers.

Redesign

A redesign of the guide is in progress to minimize cost and ease long term maintenance. The actual guide is fully elliptic. The redesigned one will be a combination of two half-ellipses with a long straight low *m*-value section. The current state of optimization indicates that a 70 m long straight section is possible.

9. Experimental cave

Tendering documents for the experimental cave are in progress. We expect a publication of the tender in June 2020. The goal is to start installation on site in March 2021.

In terms of design:
- The wall thickness is being checked with extensive MCNP/PHITS calculations (see next section)
- The height of the polished/marble floor is being reevaluated to ensure proper installation of the large detector.

The worst-case scenario would be to increase the wall thickness by 10 cm and reduce the polished floor height by 10 cm. This will not impact the delivery of the experimental cave nor impact the allocated budget.

10. Dose rate calculations

Before construction of the experimental cave and heavy shutter, doserate and activation calculations have to be carried out to ensure radiological safety for all personnel in the vicinity of the instrument. This is in progress at CEA with two calculations being performed in parallel using MCNP and PHITS.

Experimental cave

Both MCNP and PHITS calculations are setup.
The MCNP report is in progress and should be delivered in early May (CEA is until then).
The PHITS calculations require a strong increase in statistics to be conclusive. The model is now well defined with the geometry and all the materials properly described.

The scenario tested are:

1) Full neutron beam (10^{10} n/s) converted to 2 MeV gammas by a Cd sheet.
2) Full neutron beam (10^{10} n/s) diffracted by a HOPG sample

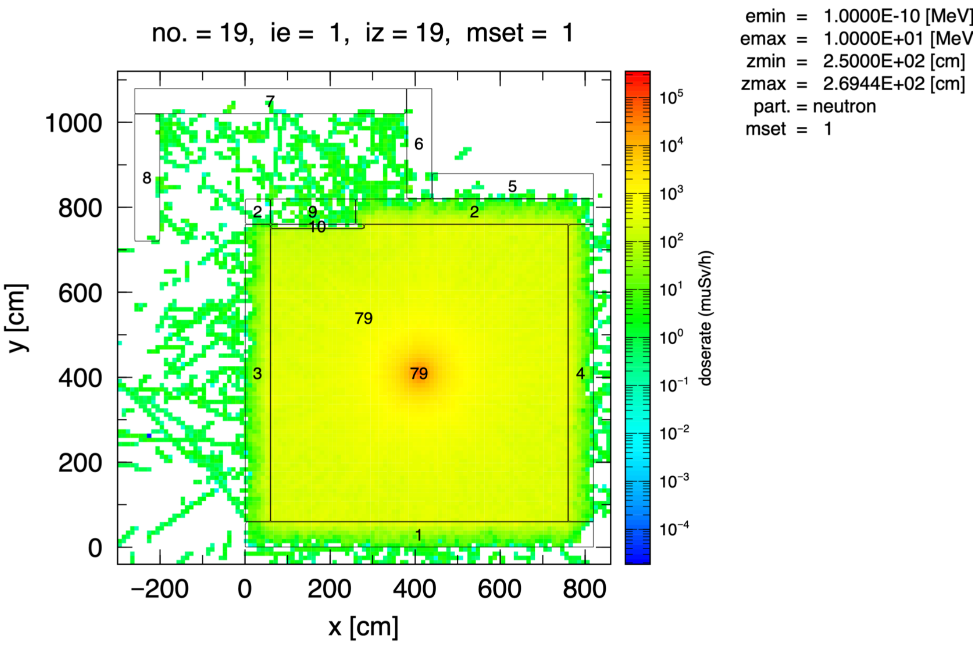

Figure 5: PHITS calculations of neutrons doserate at sample level (top view). Increase of statistics is in progress.

The current impact on cave design is:

- Increase of left cave wall (n°3 on fig. 3) by 10 cm to ensure < 1.5µSv/hr dose rate in scenario 1.
- No need for a Boron layer on the wall to stop diffracted neutrons (cost saving).

Heavy shutter

The attenuating power of the heavy shutter block must ensure <1.5 µSv/hr in the D03 building at full power in operation.

Simulations have started using PHITS. The attenuating block design is based on the one from the DREAM instrument for a total thickness of 1500 mm:

- Boron layer: 50 mm
- Lead: 200 mm
- Copper: 200 mm
- Polyethylene: 200 mm
- Boron: 25 mm
- Copper: 200 mm
- Polyethylene: 200 mm
- Copper: 200 mm
- Polyethylene: 200 mm
- Boron: 25 mm

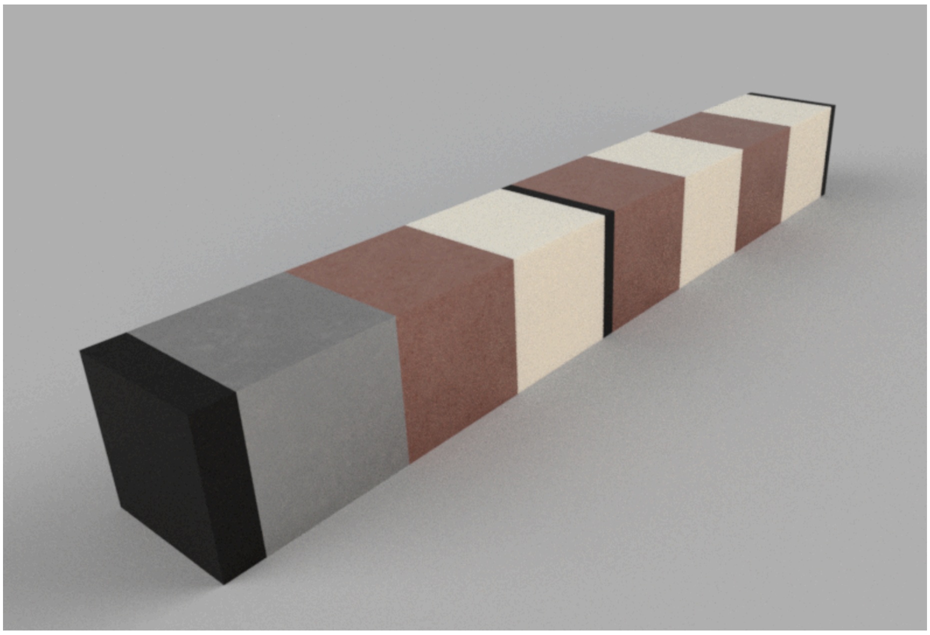

Figure 6: attenuating block design

With the old source term, calculations show an excellent efficiency of the attenuating block (see fig. 7 and fig. 8).

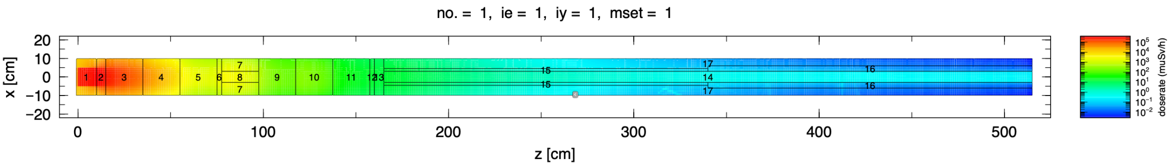

Figure 7: top view of the heavy shutter (areas 1-13) + bunker wall (areas 14+) dose rate distribution. The 1.5 μSv/hr threshold is located inside the bunker wall.

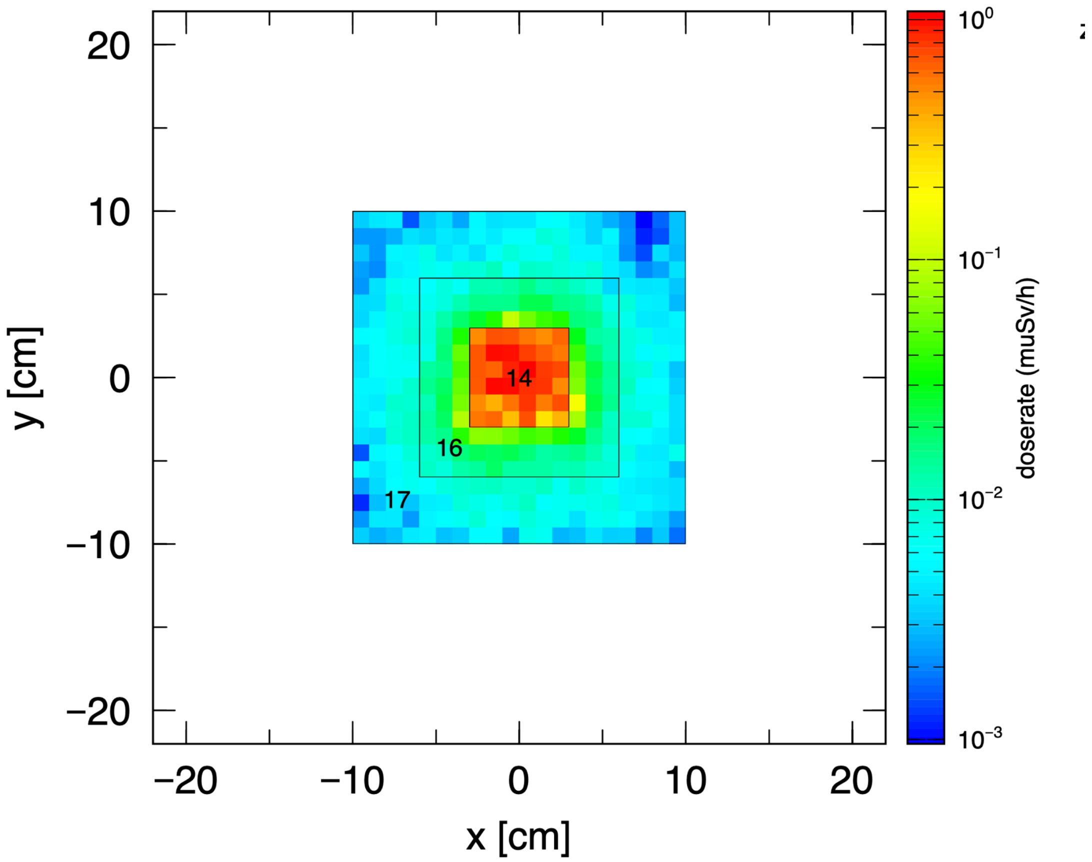

Figure 8: dose rate distribution outside of the bunker wall. The highest dose rate is attained in the guide cross-section (area 14 in red) and is well below the 1.5 μSv/hr threshold. This area is surrounded by Copper substrate (area 16) and the brass insert in the bunker wall (area 17).

11. XYZ update

During the ICEB, the instrument team held an additional meeting to properly define the interface between the XYZ setup and the rest of the instrument. Multiple interfaces exist, involving all partners (see fig. 9):

1) with incident guide field (LLB)
2) with Monitor (FZJ)
3) with sample table (LLB)
4) with Polarization Analyzer (PSI)
5) with detectors (FZJ)
6) with sample environment (FZJ)
7) with detector support (LLB)

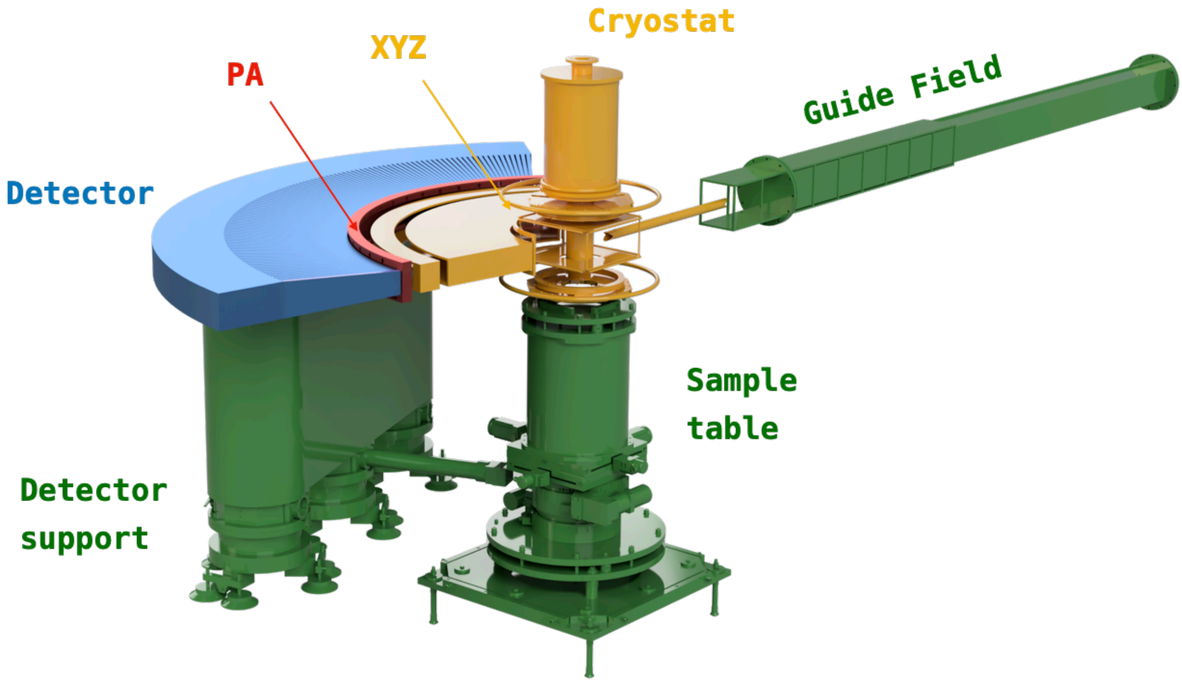

Figure 9: interfaces between XYZ and instrument at sample position.

A clear definition of available space was obtained as well as a conceptual design for the bridging between the incident guide field and the XYZ setup (see fig. 10).

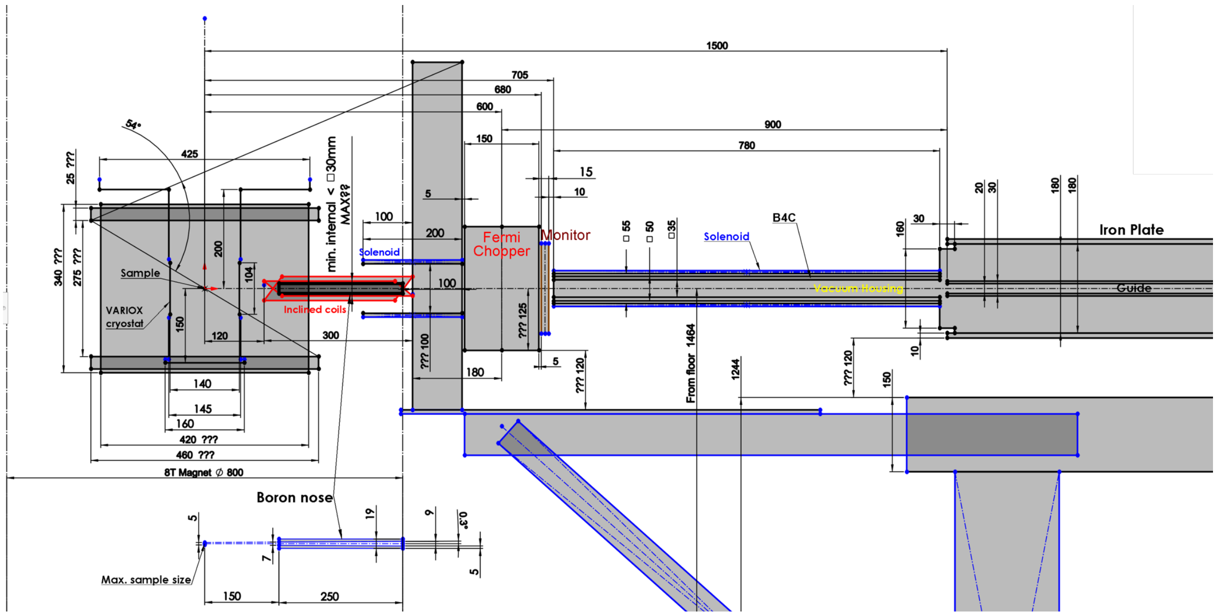

Figure 10: drawing of the interface between the incident guide field (right side) and the XYZ setup (left side).

The XYZ setup can be supported by the sample environment support or directly on the ground. Easiness of configuration change will drive the final decision.