IKON19

COMMON SHIELDING PROJECT
REPORT FOR IKON19

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1. INTRODUCTION

The initial suite of 15 instruments can be characterized as long, medium and short instruments, as in the following table. Short instruments are considered to be those, which do not have a significant length of guide shielding between the bunker wall and the cave, while both long and medium do.

Long instruments	**Medium instruments**	**Short instruments**
NMX	ODIN	SKADI
BEER	DREAM	ESTIA
CSPEC	VESPA	FREIA
BIFROST		LOKI
MIRACLES		
MAGIC		
T-REX		
HEIMDAL		

The 11 long and medium instruments have been offered guide shielding via the Common Shielding Project, CSP, run by the NSS. Each offer is a turn-key solution and includes design, neutronics simulation, production and installation of the guide shielding. These offers have been accepted (pending a final confirmation from T-REX).

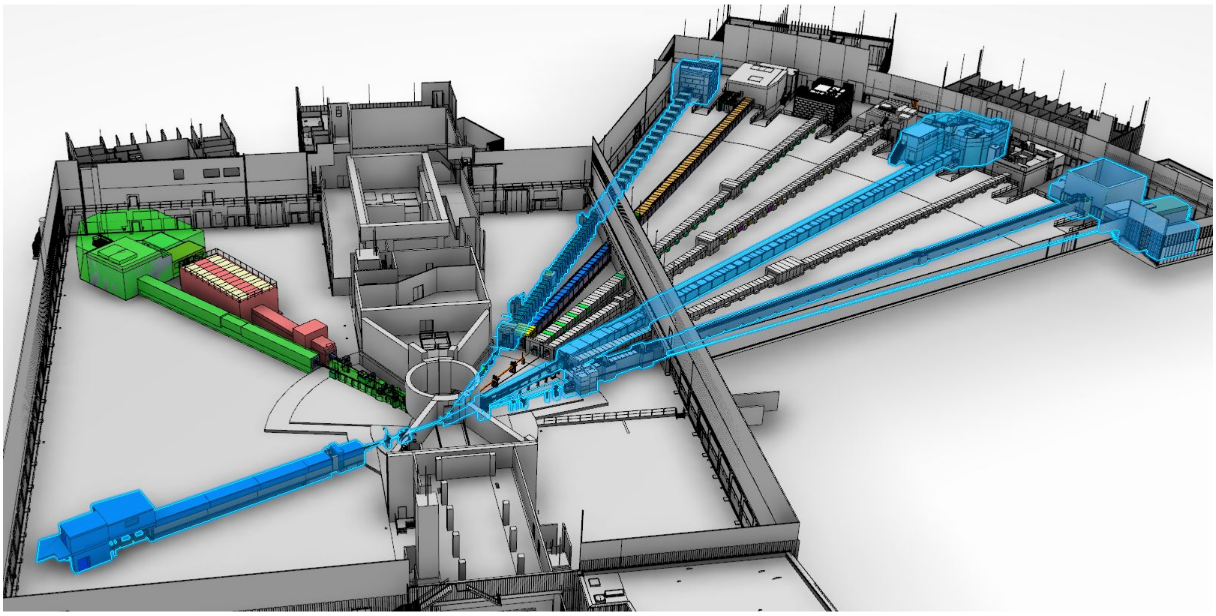

Figure 1. The instruments participating in the Common Shielding Project and the buildings layout.

The CSP offers the opportunity of standardization of shielding design and shielding performance validation, as well as a common tendering process. The shielding performance is validated by Monte Carlo neutronics simulations, which ensures a uniform compliance with the radiation dose requirements, while keeping the material budget, and thus costs to the minimum.

2. THE COMMON SHIELDING PROJECT TEAM

Management	Engineering	Neutronics
Zvonko Lazic Anton Khaplanov Marie-Louise Ainalem	Senad Kudumovic Mats Olsson Jesper Ringnér	Valentina Santoro Florian Gruenauer Rodion Kolevatov Miguel Magan Octavio Gonzalez Tsitohaina Randriamalala Tamás Bozsó Szabina Torok

In addition to the team above, the two key reviewers of the guide shielding simulations are Günter Muhrer and Riccardo Bevilacqua. The engineering is performed in close collaboration with the instrument engineers.

3. DESIGN BASED ON NEUTRONICS

The simulations are performed using the source term, from ESS-0416080 for the fast neutrons, and a McStas source term for the cold/thermal neutrons. These are propagated along the beam line, tracking both the original as well as secondary particles generated in guide coating, substrate and housing; in the shielding; choppers, beam windows, shutters and other in-beam instrumentation.

Due to the differences in the beam line design, in particular the curvature, M-values, and in-beam materials, the neutronics validation must be performed for each instrument design. The result is varying shielding thicknesses and, in some cases, shielding materials needed. Nevertheless, due to a consistent approach and thanks to a close communication of the physicists performing the simulation, the neutronics validation effort is greatly simplified by the CSP. Further details and method references can be found in ESS-2968653.

The following list shows the scope included in neutroncs simulations.

Dose rate on the surface of the guide shielding due to:

- Thermal/cold neutrons
- Fast neutron
- Prompt Gamma and Gamma coming from the target

Dore rate due to secondary radiation sources from in-beam components

- Guides
- Choppers (open/closed)
- Shutters (open/closed)
- Beam Monitors
- Beam windows

Optimization of shielding complexity and material combination using

- Concrete
- Heavy concrete
- Steel
- Boron carbide tiles
- Lead

Additional scope (not in the basic scope of the guide shielding)

Neutronics simulations of bunker feedthrough
Neutronics simulations of guide shielding-cave interface
Activation calculations

Studies performed

Contribution of borated tiles on the internal surface of shielding
Supermirror coating gamma production experimental validation (on-going)

The shielding is mechanically designed to fulfil the necessary radiation suppression derived from the neutronics simulations, using as many common solutions across the instruments as possible. The design is further aimed to facilitate a quick access to the guide, choppers and shutters through a modular design. For details, see Common Shielding General Design Specification (ESS-2068227).

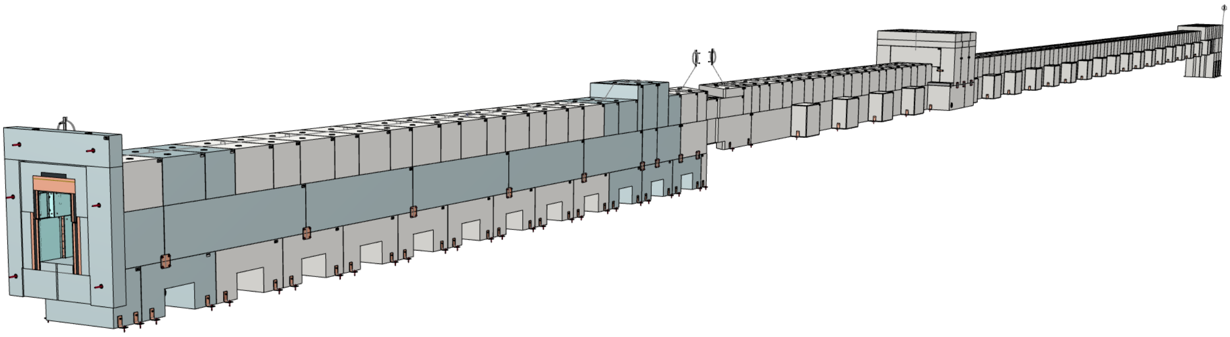

Figure 2. Common Shielding design (BIFROST). From left to right: Bunker wall interface; D03 shielding; shutter pit; building wall interface; E02 shielding with chopper pit; Cave interface.
Note the 3 layers of block in D03 and E03 – support, lower and upper blocks; 2 layers of blocks in E02 – lower and upper blocks.

4. TENDERING PROCESS

In October 2019 a first tender covering guide shielding for six instruments (manufacturing and installation) closed. Following is the list of instruments grouped in the order of the tendering process. Included in the current tender:

1.1 CSEPC
1.2 BIFROST
1.3 ODIN
2.1 DREAM
2.2 MAGIC
2.3 BEER

A kick off meeting with the chosen supplier PACADAR took place Jan 2020. Since the contract award, engineering designers on both sides have made steady progress in generating manufacturing documentation. Critical Design Reviews (CDRs or TG3) have by now been held for both CSPEC in May and for BIFROST in June. These are now both passed and the design is released to Pacadar for detailed design and production.

CDRs for ODIN and DREAM are planned for December 2020 / January 2021. The completion of CDRs sets the earliest date for the production start at Pacadar. There has so far not been any delay due to COVID19, however the FAT is complicated by current travel restrictions.

A following tender is to include:

3.1 NMX

3.2 T-REX

3.3 MIRACLES

3.4 HEIMDAL

3.5 VESPA

There is a certain limited possibility to move the instruments up and down in this prioritization, including swaps between the first and second tender if required. The CSP is for example considering advancing NMX, effectively shifting BEER to a later tender as a result of the missing signed agreements, ie Technical Annexes, for BEER.

5. PRODUCTION AND DELIVERY STATUS

In September 2019, ESS launched a first purchase order covering manufacturing and installation of E02:1 lower blocks for three instruments. These blocks were produced by MICO and were delivered and installed in Q4 2019 and Q1 2020 for MAGIC, BIFROST, CSPEC. As described above further production will be by Pacadar.

Figure 3. **Left:** MAGIC lower blocks installed in E02:1, Dec 2019. **Middle:** BIFROST lower blocks installed in E02:1, Jan 2020. **Right:** CSPEC lower blocks installed in E02:1, Feb 2020.

6. INSTALLATION

Installation of the blocks delivered so far has been performed using a forklift and was performed on the day of the delivery for each of the instruments. The forthcoming deliveries from Pacadar are expected significantly in advance of the possible installation. The delivery and shipping strategy are being discussed with ESS logistics and Pacadar. We are considering several options: a) We receive blocks from Pacadar per their production schedule, and store at ESS; b) We ask Pacadar to store the blocks in Spain until we need them; c) ESS Logistics investigate alternative shipping/storage options. If necessary, the blocks will be stored with an appropriate weather protection.

The schedule for installation will be determined on instrument-by-instrument basis and depends primarily on the guide delivery and installation dates. In most cases it is expected that the support and lower blocks can be installed before the guide is installed (possibly only one side of the lower blocks, depending on installation requirements). **Therefore, we encourage the instrument teams to provide/update their guide delivery schedules, and their required installation sequence.**