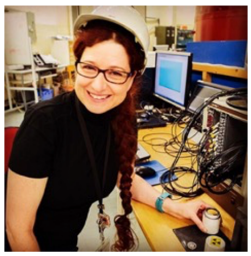
The HEIMDAL Instrument at ESS
Diffraction STAP Meeting October 2023
Update Summary

(1) Heimdal Team update:

We have recruited an additional engineer Bengt Jönsson Bengt will be permanently be based at ESS working full time of Heimdal on a two year contract funded by in-kind partner Aarhus University.

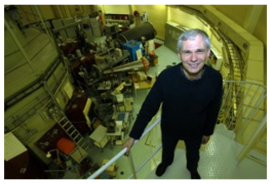


Isabel Llamas Scientist (IFE)
Choppers & Neutronics

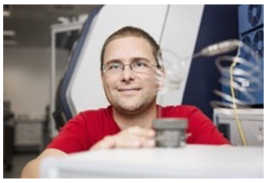
Dan Mannix (ESS)
Lead Scientist

Kåre Iversen (AU)
Lead Engineer

Bengt Jönsson (ESS)
Engineer 2023



Bjørn Hauback
In-kind Partner IFE



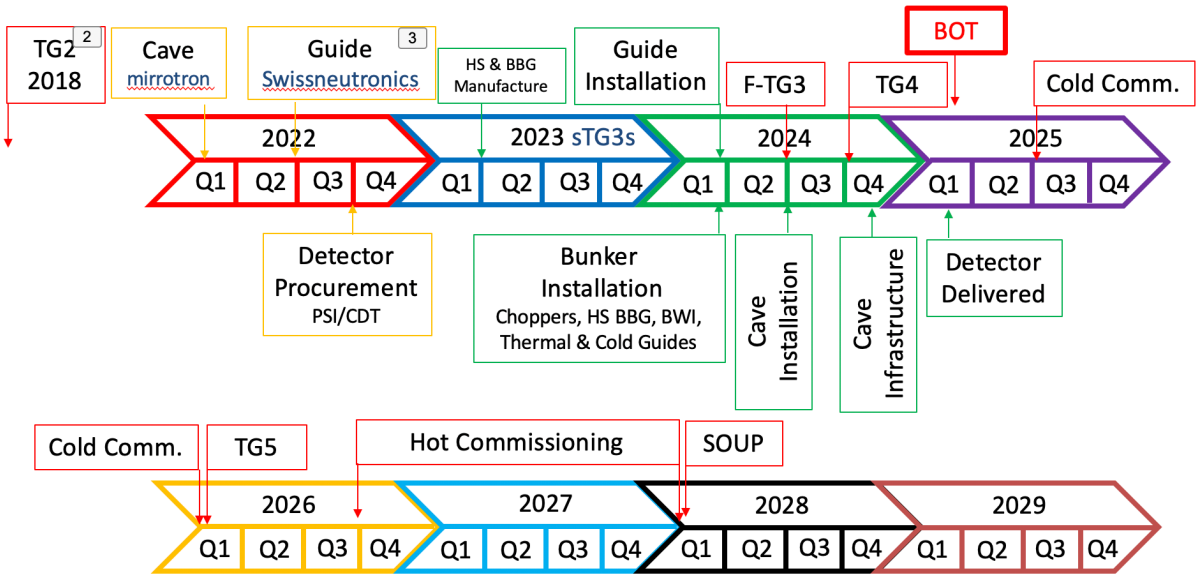
P.I Mogens Christensen
In-Kind Partner AU

Autur Glavic
In-kind Partner PSI

In addition, Artur Glavic will be the new in-kind representative for in-kind partner PSI.

(2) Instrument timeline and contract suppliers:

Swiss neutronics have the contract to deliver the guides. Mirrotron will deliver the cave and have now a new contract with ESS to deliver the guide shielding. CDT were awarded the contract for the 2D detectors as of August 2023 and we are moving forward with a kick-off start of project with them soon. The ESS common projects will deliver the choppers and T0 chopper. AU will delivery the heavy and light shutters.. The current focus is to have all items installed in the bunker before BOT.



(3) Inclusion of additional cold guide scope

The contract for the guide systems was awarded to Swiss Neutronics via in-kind partner PSI. We have been informed that the total thermal guide and vacuum housings together with a cold guide option-1 sections fits within the PSI budget. The cold guide option-1 consists of the in-bunker sections and long-straight section including vacuum housing. This corresponds to around 116meters of additional scope cold guide. See figure below. This will provide a streamlined upgrade of the Heimdal instrument to simultaneous diffraction and SANS. We now only need to fund 35 extra meters of cold guide and vacuum housings (464k Euros) to complete the guide systems to full scope. The upgrade will also require costs for changing the guide shielding from a narrow to wide format. The guide project is moving ahead, we have been optimising the design of thermal and cold guides in a coherent detailed design and working on optimising the beam transport with neutronics simulations. We have a sub-TG3 scheduled for the outside bunker guides in mid-october 2023 so that manufacturing can start.

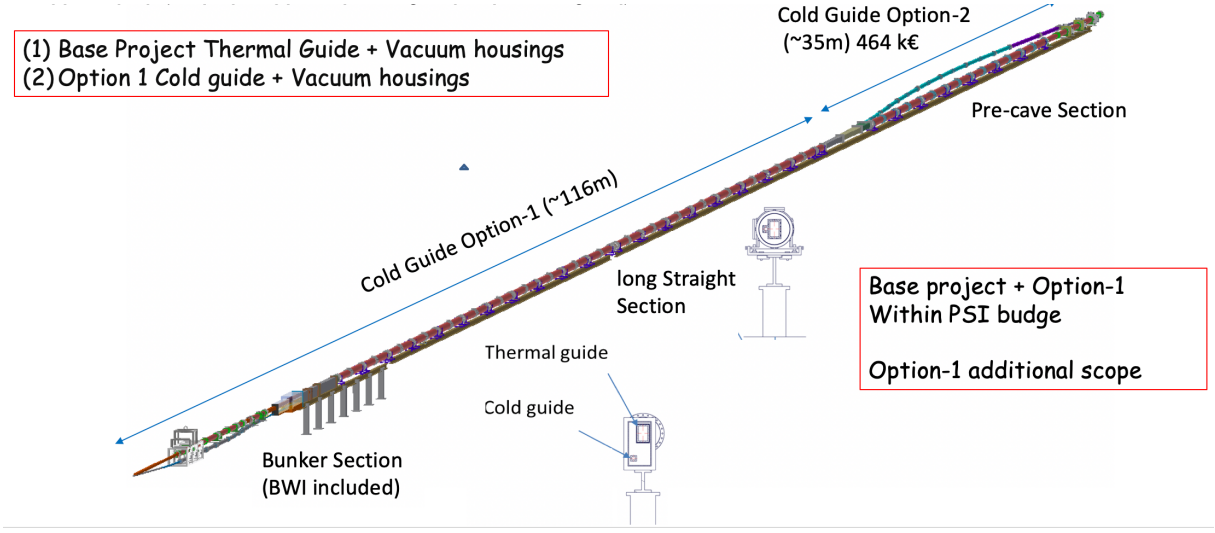


Figure 1. Drawing of the thermal and cold guides. The thermal guide and vacuum housings (base project) and the cold guide option-1 are within budget for the PSI guide systems. The corresponds to additional scope of 116meters of cold guide and vacuum housings in the bunker and long straight section.

(4) Toll Gate Milestones Schedule.

The ESS has instigated an alignment of the P6 TA milestones with the new rebaseline of the ESS. This review has led to new dates for certain milestones. The Final TG3 is now rescheduled for June 2024, TG4 October 2024, TG5 February 2026. Cold Commissioning January 2025 and Hot Commissioning Q3 2027. The current focus of the instrument is completing the installation of in-bunker components before BOT, which is currently forecast around May 2025.

(5) ICEB meetings: The last Heimdal ICEB took place in 8th May 2023.

(6) Instrumentation

6.1 NBOA

The NBOA has been manufactured by swissneutronics and we performed the FAT in February 2023, just after the kick-off meeting for the guide project also at swissneutronics. The NBOA is now delivered to ESS and will be mounted into the NBPI box in April 2023 and was installed at ESS in May 2023. This represents the first installation milestone for Heimdal.

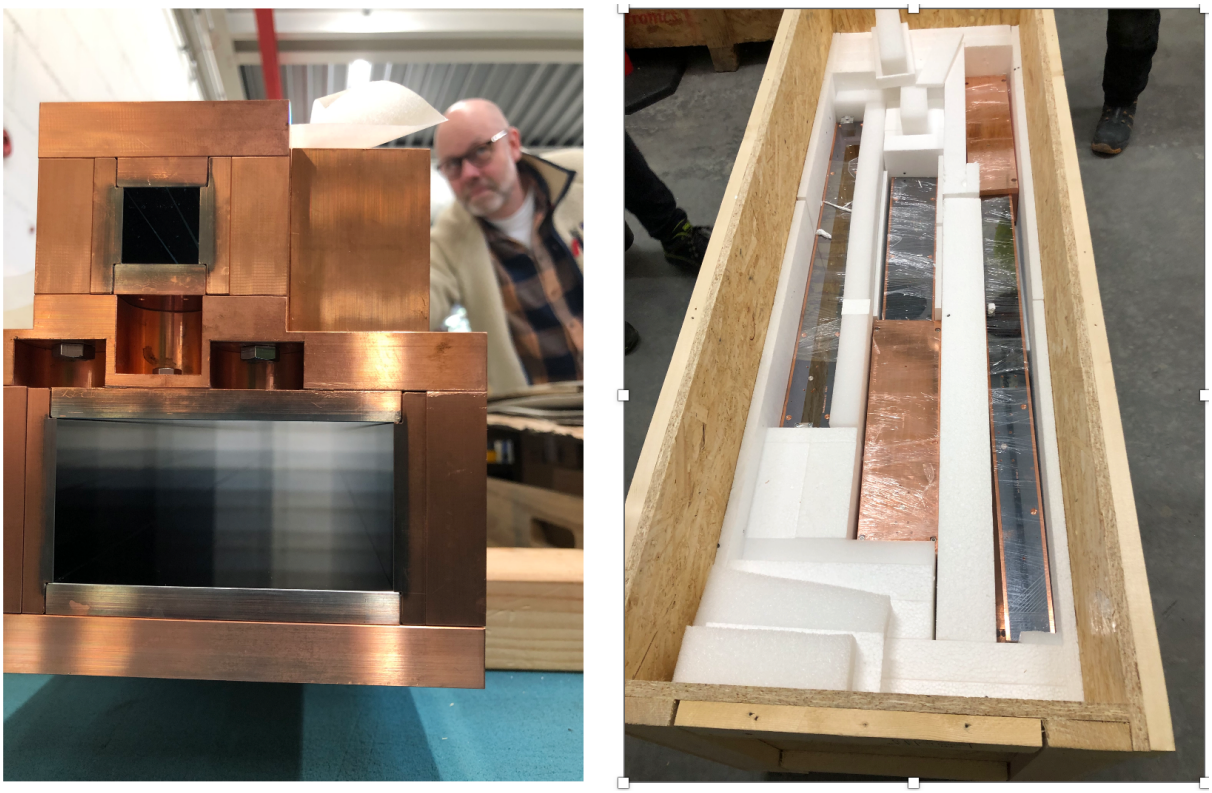


Figure 2: Left the Heimdal NBOA during FAT at swissneutronics, with thermal and cold guides. Right the Heimdal NBOA shipped to ESS.

6.2. Choppers

The choppers are being procured via the common monitor project. We have had the PDR for for the chopper systems. The Choppers are expected to arrive from ESS before BOT = Q3 2023. The scope is transferred to ESS and the Chopper project is within budget.

The T0 chopper: The T0 chopper based on the prototype developed by Mirrotron is being developed by ESS with some slight modifications. The technical specifications have now been finalised and reviewed. Scope will be transferred to ESS. The T0 Chopper project is currently with-in budget. It is not certain that the T0 will arrive before BOT. If not at piece of vacuum tube will be temporally installed until Bunker access in mid 2026.

6.3 Guides

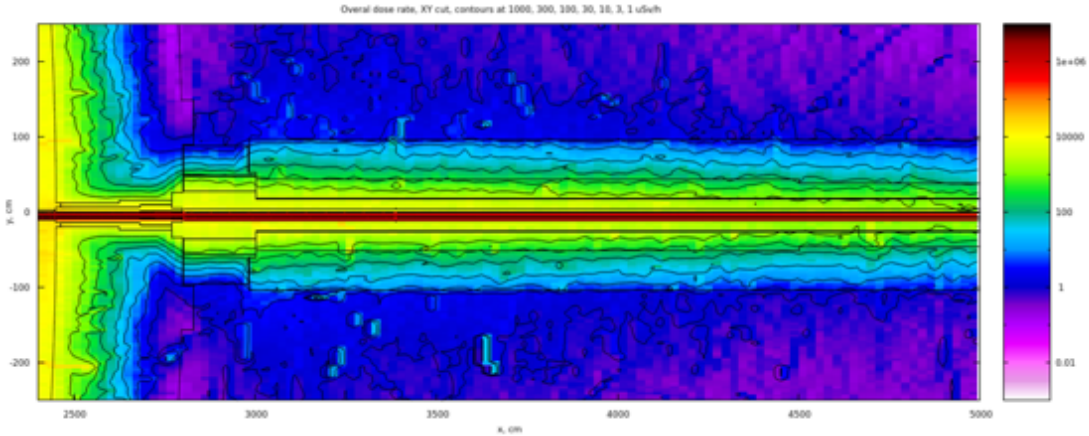
The guide kick-off meeting was help at swissneutronics in February 2023. The project is underway working toward detailed design of both the thermal and cold guide systems. Current focus is on the in-bunker components and we expect to have an intermediate design review for the bunker wall insert in May 2023. The detailed design review for the out of bunker straight section is scheduled for mid-october. This part is simplest to start manufacturing. We decided to start manufacture of this section so that we can keep to the project schedule for delivery of the whole guide system.

6.4 Detector:

The 2D project was awarded to CDT, like Dream and Magic, as not other manufacturers applied to fulfill the technical specification. The offer from CDT falls within budget and scope of the technical specification. This will be a limited 2D detector coverage of 1.0sr or around 80-degree coverage, which fulfils exactly the instrument scope. It is hoped money will be found to provide more detector coverage earlier on as being discussed for other instruments. The build-up to full detector coverage will be made during a later ESS upgrade.

6.5 Guide Shielding

The guide shielding will be provided by the common guide shielding project. The last round of the tender for the guide shielding was awarded to Mirrotron, who will also fabricate the Heimdal cave shielding.



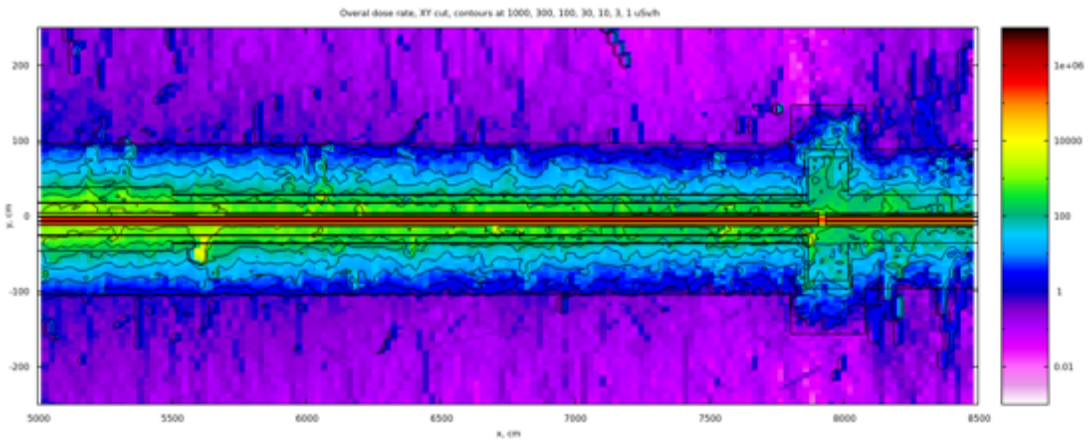


Figure 3. Guide shielding calculations for Heimdal guides. Top is for the section after the bunker wall from 25M to 50M. Bottom is from 50m to 85M, just after the frame-overlap chopper. The current design is still giving too high back ground and is being refined. This can be seen by the dark blue area just after the bunker.

The neutronics are performed for the below shielding.
Interface (28-30m, first 2 meters from bunker wall) 20 cm steel 40 cm heavy concrete (3.8 g/cm3)
30-45 m: 25 cm steel 50 cm regular concrete (2.3 g /cm3)
45-55 m: 20 cm steel 55 cm regular concrete
55-chopper pit: 10 cm steel 65 cm regular concrete
Chopper pit shielding according to common shielding project (will need extra steel when contribution from thermal neutron beam will be considered)
Beyond chopper pit: 60 cm regular concrete.
Inner steel shielding is lined with 5 mm B4C both inside and outside B4C/epoxy tiles.

6.6 Cave Shielding Neutronics:
The Call for Tender for the cave was awarded to Mirrotron with a bid including cave shielding and beamstop which was within budget. Due to quality issues in the Odin cave project delivered by Mirrotron, ESS advised us to look into a new design solution using smaller lego-type concrete blocks, that can be reused later by ESS. We have started to use this concept in the Mirrotron design. This means we need to re-start with a preliminary design again. The project moves ahead slowly and has some risk of delay compared. to the schedule forseen. We do now expect this to delay TG5 for the instrument. We have also decided on a modular design for the SANS section of the cave shielding. It can be completely demounted so that the SANS tank can be added from the back in the upgrade. The SANS cave can also be extended in future upgrades. It is currently constructed to have length of 8 meters. This can easily be extended to at least 10-12 meters in future upgrades if required.

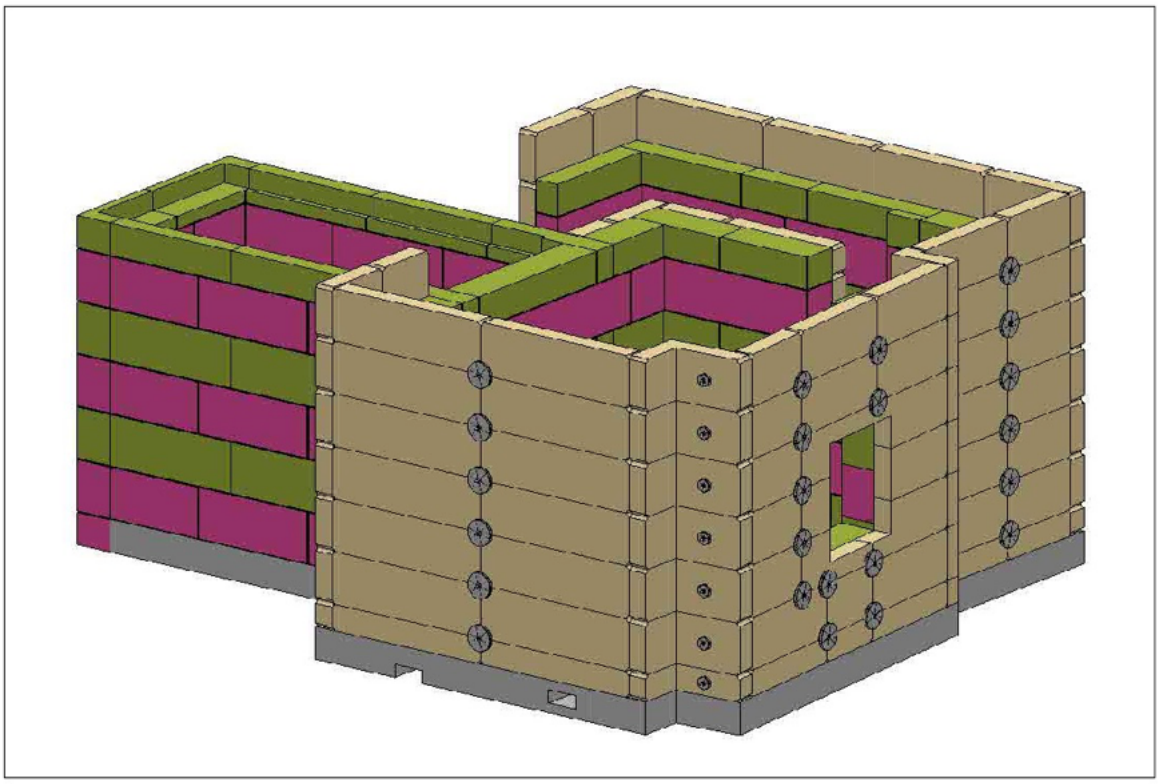


Figure 4. Cave shielding new design using small lego block concept. with walls of 40-90cm thick concrete.

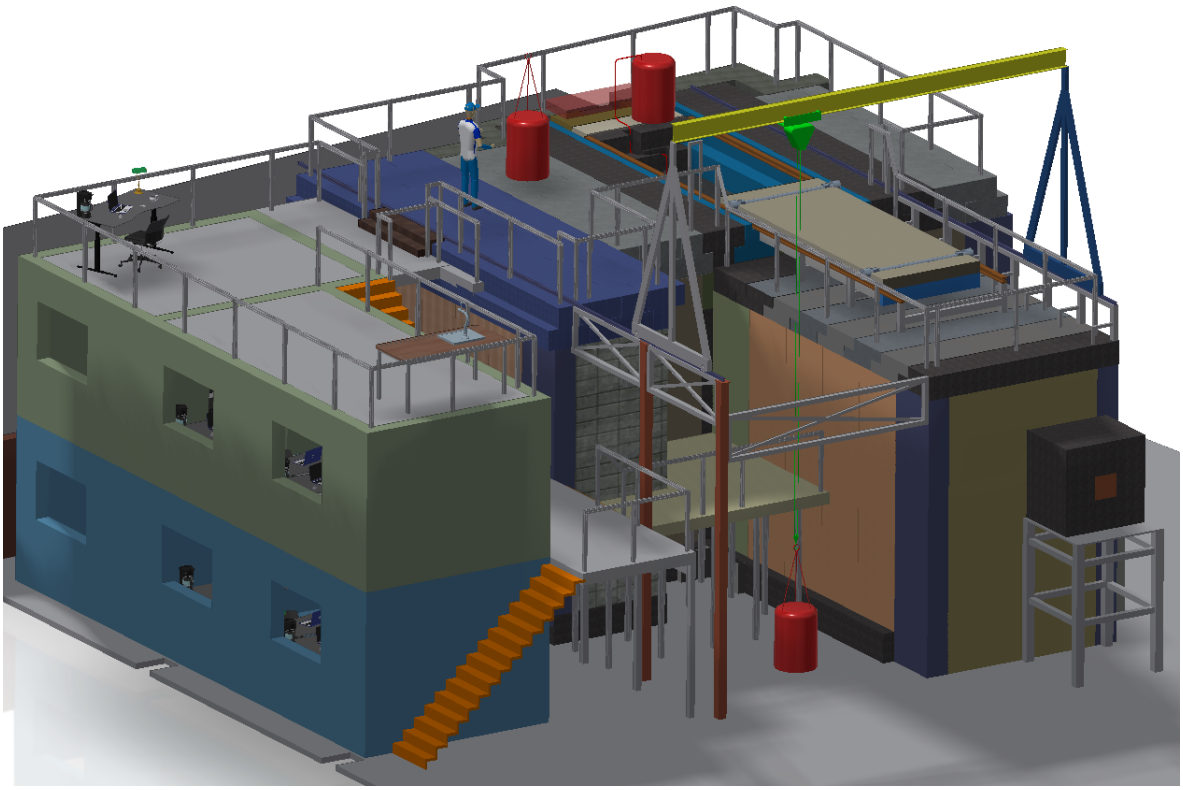


Figure 5: Design of the Heimdal Cave.

6.7 Polarised Neutrons on Heimdal

We have participated in the recent polarised neutron workshop organised by ESS. and we expressed an interest in polarised neutrons for Heimdal. The instrument could easily offer cold polarised neutrons as part of the SANS upgrade, by using a polarising mirror instead of the last deflecting mirror of the cold guide, maybe in some translatable double mirror solution. We have also discussed the possibility of polarised thermal neutrons as part of the initial thermal diffraction installation. This might also be possible using a 3He cell for polarisation analysis, with one section for the diffracted beam and another for the SANS scattered beam. This is still work in progress and we would like to leave open the possibility of polarised neutrons on Heimdal in long term upgrades. We are in discussion with swissneutronics on possible solutions for polarising the neutrons in the cold guide using supermirrors or V-cavity. Work ongoing.

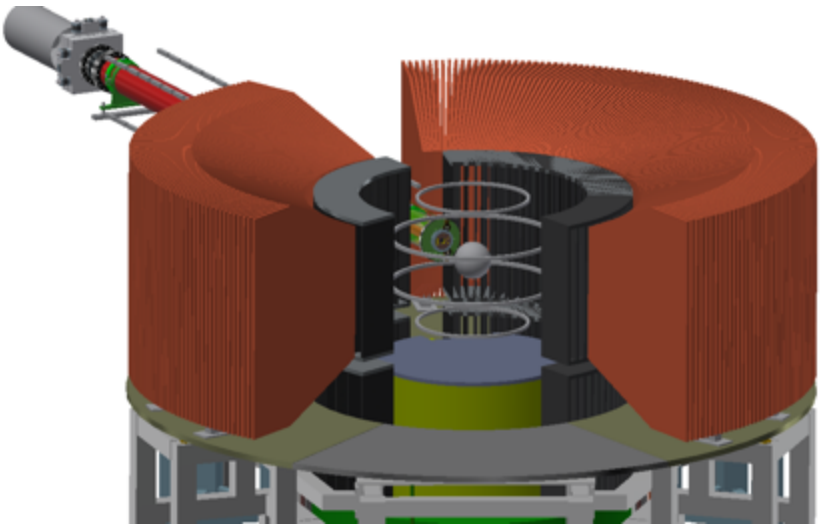


Figure 6: A sketch of the implementation of a possible 3He cell for polarised neutrons and how it might fit onto Heimdal.

7.0 Heimdal Instrument Risk Register

The previous highest risk to the instrument come from lack of man-power resources especially in engineering compared to other instruments and given the workload for instruments for TG3 at ESS. This has now been resolved with the hiring of a second engineer based at ESS.

Other RISKS on beamline largely being reduced or mitigated. The RISK of SANS upgradability looks to be reduced by the inclusion of significant cold guide into the PSI/swiss neutronics project.

At the moment there is a small Risk to the cave project with Mirrotron, which now using the lego block concept suggested by ESS is causing some delay in the project but not expect to change TG5.