

LoKI Progress Update

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1 Overview

Even in the current circumstances, the progress of the LoKI project remains good, with manufacturing complete for some major components and underway for most of the rest, and more detector testing and data processing currently underway. In this report we outline the progress on engineering matters and address progress on the action items raised by the STAP in April 2021.

2 Engineering

2.1 General Progress on the Instrument Components

2.1.1 Detector Vessel

- Delivered to ESS
- Awaiting access for installation



2.1.2 Detector modules

- 100% Assembled, 70% tested



2.1.3 Detector Mechanical Systems

- Manufactured and assembly complete
- Awaiting integration testing with modules & motion testing



2.1.4 Bunker to Cave Shielding

- Manufacture underway



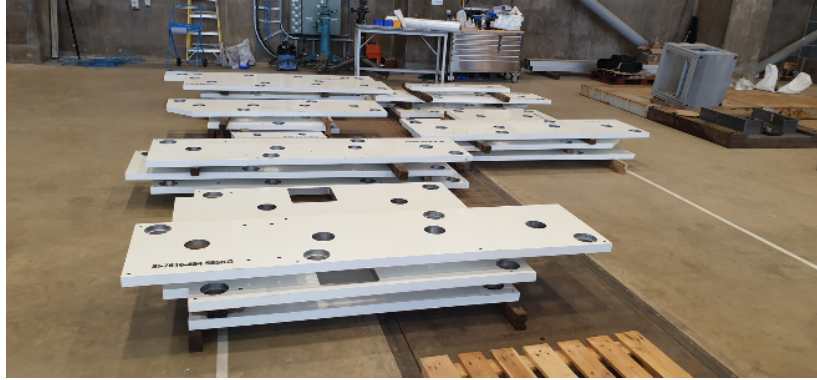
2.1.5 Cave Shielding

- Manufacture underway



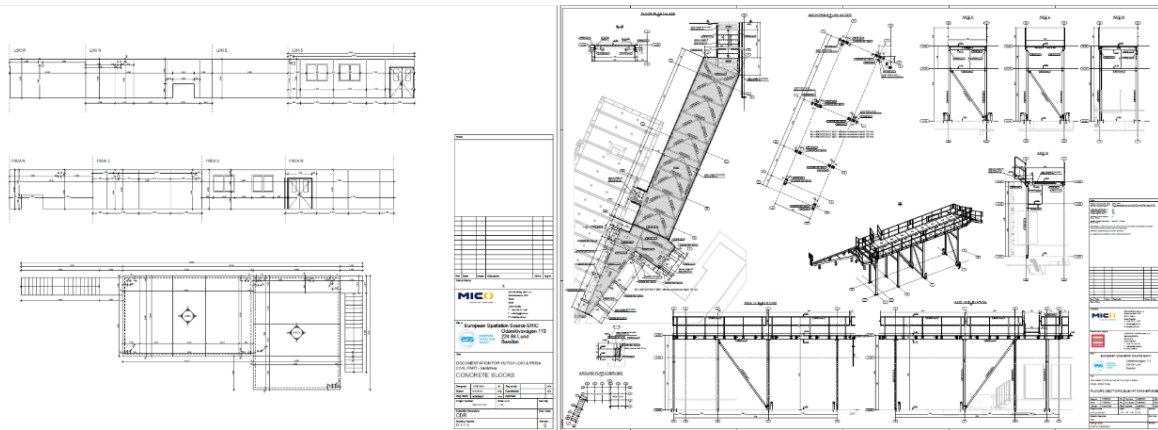
2.1.6 Base plates & plinths (added to reduce floor load concentration)

- Delivered to ESS
- Installation starting



2.1.7 Hutch

- Design completed
- Awaiting IRR approval



2.1.8 External Access & Supporting Systems (crane, goods lift, suspended floor)

- Specification drafted and market research completed
- Awaiting TG3 approval

2.1.9 Service Routes & Racks

- Detector DAQ hardware procured & tested (end-end ESS data chain)
- Motion racks sub-contracted to Daresbury
 - Awaiting design standards from ESS
- CEP & CUP underway

2.1.10 Sample environment

- Sample changer: Detailed design is progressing well, as shown in Figure 2.1, expected to be complete in the coming months. The design is basically an adaption of the cell holders on SANS2D in ISIS, with the following features:
 - 2 rows of cell holders, each row will have independent temperature control via two Julabo water baths
 - 4 interchangeable “cartridges” will be fixed onto each level of the rack. Multiple different cartridges will be available to accommodate narrow, wide and sandwich cells of different thicknesses
 - Minimum of 24 narrow cells per row, so 48 narrow cells can be loaded in total
 - 45 degree scattering angle in all directions, with B4C shielding on the front and back of the cell holder
- Rotating cell holder: detailed design to begin in the next few months.

- Other equipment:
 - Anton Paar rheometer MCR701 arrived to site in June, and is now undergoing integration
 - In the next 6 months procurement will include: spectrometers, HPLC pump, warm bore magnet (2.3 T), goniometer, 2 julabo water baths.

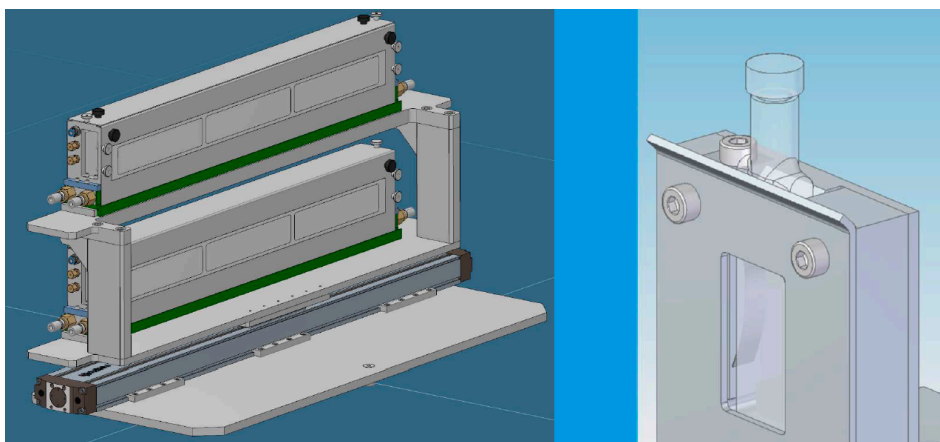


Figure 2.1 Design of the SANS cell holder for LOKI

2.2 ESS work packages

We have agreed budget and scope within the common electrical project. Requirements are complete and design work has begun. We are awaiting the budget from the common utilities project team before the design work can begin in earnest.

3 Installation

We got access to the instrument hall (DO3) in the middle of 2021. As mentioned, components have begun arriving at site, both directly from the suppliers (e.g. detector tank, concrete blocks) and from ISIS (e.g. baseplates, anchors). At the time of writing, the instrument hall floor is being surveyed and the positions of the 130 holes, which are to be drilled in the coming weeks, are being marked out.

3.1 Activities in the past 6 months

Date	Status/notes	Activity	Component
April 2021	Underway – scaffolding on the way	Marking and drilling	Customization of baseplates inside the bunker
May 7/21	Done	Reception at Arrival	NBOA
June 29/21	Done	Unloading	Detector vessel
Sep 27/21	Done	Reception at Arrival	Bunker wall insert (BWI) and supports
Sep 27/21	Done	Reception at arrival	Concrete plinths for collimation vessel
Sep 27/21	Done	Reception at arrival	Tank support and rail support legs, fasteners, shimming plates, Hilti anchors Bases for BWI and alignment supports
Sep 28/21	Marking Sep 27 Placing plinths Oct 7	Installation Grouting and drilling	Bases for cave, sample positioning and detector tank

3.2 Activities planned for the next 6 months

Date (est.)	Status/notes	Activity	Component
Sep 28/21	Marking Sept 27 Placing plinths Oct 7	Installation Grouting and drilling	Bases for cave, sample positioning and detector tank

Nov '21	Postponed	Site Acceptance test - SAT	Detector vessel
Nov '21	Planned	Installation	Detector vessel
Nov '21	Stage 2/planned, IRR approved	Installation grouting and drilling	Bases for BWI, Choppers No.2
Nov '21	Planned	Installation	Hutch
Noc '21	Planned	Reception at Arrival	Sample stack
Jan 17/22	NSS Planning	Installation	Bunker wall insert
Dec '21	Planned	Reception at Arrival	Heavy shutter
Jan '22	Planned	Reception at arrival	Baseplates for the collimation vessel
Jan '22	Planned	Reception at arrival	Choppers

4 Detectors

4.1 Detectors

- All modules built
- Neutron testing: Rear detector complete, mid detectors in progress, front detectors still to do.
- We did a trial fit of all the module lengths in their frames, with no major difficulties. It needs to be repeated with the cable hoses in place

4.2 Procurement

- Detectors and electronics completed
- The cables for the detector module are missing only the HT cables that will be delivered in a few weeks
- The cables to bring the signals from the modules to outside the tank have been delivered
- The HT and LV cables still need to be ordered.
- All cables from outside the tank to the racks have to be ordered.
- The HT/LV crate and cards have to be ordered

4.3 Detector test

- Modifications to the ADC firmware highlighted during the May test are required
- Larmor instrument scientists recognise the need for beamtime on Larmor. No dates available yet. All the equipment for this test is already at ISIS.

4.4 Next steps

- Complete neutron testing of mid and front detector modules
- Trial fit of the detector modules in their frame with the hoses
- Installing all the cables inside the modules
- Try moving the rear carriage with the detectors on
- Vacuum/pressure test all the modules after installing the cables

5 Monitors

- The new preamps work well. The noise levels are under control, and there is no sign of oscillations.
- Currently under test with ^3He rather than Nitrogen to increase the efficiency since we do not have a beam at ISIS
- Currently testing by using the final ADC. First firmware working to allow testing, but further development is still needed before integrating it with the ESS DAQ
- A new preamp layout is required to ease the mechanical fit of the electronics with the preamp
- HT boards still need to be designed and manufactured
- The mechanics of the monitors is completed for all except the rear transmission monitor

- g. The GEM for the rear monitor still needs to be designed and manufacture
- h. One of the two in-bunker monitors has been built, and it is the one currently used for the preamp testing

6 Data reduction using simulation and real data

Two detailed Geant4 models of the (a) full LOKI detector system is implemented based on CAD models - including B4C masks and movable rear detector bank; and (b) the set-up on the Larmor beamline. In both cases, Milán Klausz is creating simulation NeXus databanks to include different instrument configurations (collimation/detector distances) with different samples (Isotropic flat scatter, sharp peaks in Q, gaussian coil, monodisperse spheres, empty beam (with and without beamstop)). Challenges remain for good statistics, especially for the long wavelengths towards the back of the detector panels. Data reduction methods are being developed in Mantid as well as in Scipp. The Scipp code is currently being benchmarked and debugged by comparing with Mantid using real data from SANS2d. More details can be found in the *Software Report for SANS*.

6.1 Larmor/LoKI test data

Work is on-going on the reductions of the data from the Larmor tests at ISIS (Figure 6.1a-c). Isotropic “flood source” simulations are currently being trialed as a starting point for iteration of efficiency corrections for the detector pixels for the Larmor test data, with promising results. Figure 6.1b shows the simulated data from the ISIS standard polymer. If we assume the straws have equal efficiencies and normalise the data to only the monitor, we get significant offset between the intensities for all the straws in one tube. By including the relative efficiencies from an isotropic “flood source” simulation in the normalisation (and therefore accounting for the self-screening effect of the straws within a tube), we realise much better agreement, shown in Figure 6.1e. Issues remain at the low q end likely due to backgrounds in the real data, and the simulation is currently overestimating the number of neutrons detected towards the rear of the detector in comparison to the real data.

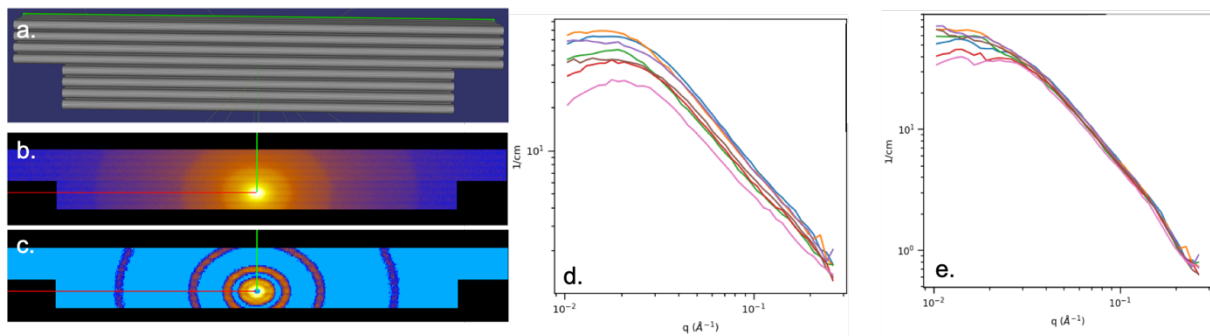


Figure 6.1 (a) Geant4 projection of the Larmor/LoKI detector panel, (b) and (c) show the simulated data of the ISIS polymer and a sample with logarithmically spaced sharp peaks, respectively. (d,e) Example reduced real polymer data of the 7 straws in tube 24 (at the front of the detector) assuming equal efficiencies in (d) and relative efficiencies from the simulation in (e).

6.2 Simulated data of the full LoKI array

Similar work is progressing with the GEANT4 simulations of the full LoKI detector array. An example of a sample with logarithmically spaced sharp peaks is shown in Figure 6.2, with the reduced $I(q)$ plot showing each of the detector panels shown in Figure 6.2c. Currently normalised only to incident monitor so intensities not correct, some of the Q position shifts may be due to resolution effects of the long pulse source.

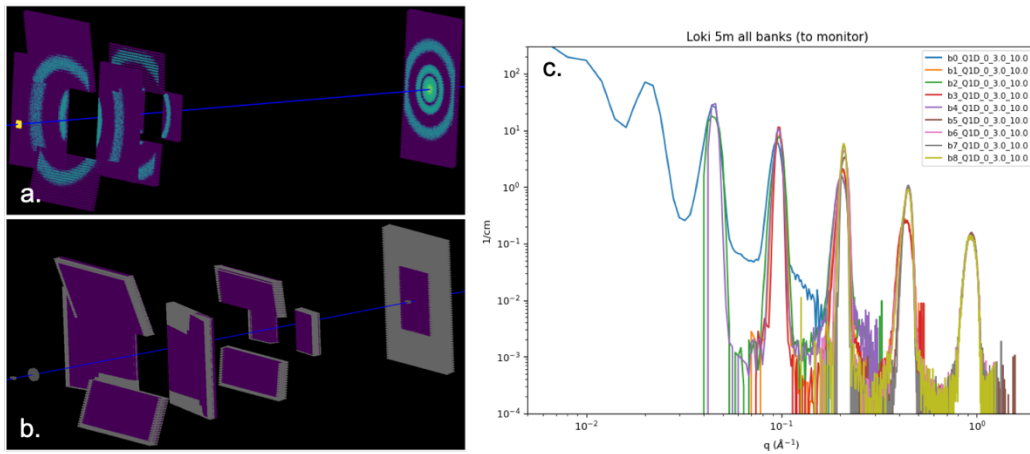


Figure 6.2 Geant4 simulations displayed in Mantid. (a) sample with logarithmically spaced sharp peaks. (b) masks generated using the Geant4 model. (c) $I(q)$ versus q plot of data (a) reduced in Mantid, each panel has been individually reduced.