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Data Acquisition and Experiment Control Review Process for Instrument Projects at TG3

	Name	Role/Title
Owner		
Reviewer	DMSC, GG, ICS	
Approver	Gabor Laszlo	Neutron Instruments Lead Engineer

SUMMARY

Phase 2 requires instrument projects to carry out detailed design work. At the end of Phase 2 teams need to submit the engineering designs to ESS for Toll Gate 3 reviews in order to move into Phase 3. It is at this point in the project that instrument teams will settle on what will actually be built and how/who will build it.

This document outlines the what aspects of the detailed instrument design impact delivery of key DMSC scope and therefore what design aspects DMSC shall review for TG3.

DMSC is responsible for all key areas of scientific computing scope for ESS. For the purposes of the TG3 process only the data acquisition and experiment control shall be considered. These are critical areas for successful beamline operation which should be considered during the detailed instrument design process.

The key areas for review are:

1. Is the instrument detector design and readout compliant with the standard DAQ system developed by DMSC, that is to say can the detectors be readout and the subsequent neutron data be saved to disk. (Including estimation of data rate & operation mode)
2. Does the instrument design consider treatment and normalisation of neutron data, that is to say is there a clear methodology in place to treat and correct tof data.
3. Is there a sufficiently detailed commissioning and calibration plan. That is to say does the instrument design documentation describe, and is the design compliant with commissioning and calibration of chopper axis, primary and secondary flight paths, beamline component positions and detector geometry.
4. Does the Instrument design allows for basic data treatment, that is to say can the data be programmatically converted from TOF to the base unit for the instrument science case.

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1. INTRODUCTION

1.1. Purpose

1.2. Phase 2 & Tollgate 3

There are three different types of reviews throughout Phase 2:

- "Specification Review with ESS": this sub-TG3 applies when an instrument team wants to do an early procurement for components where the design with be outsourced. It is also referred to as a "Call for Tender Verification".
- "Design Review with ESS": where an instrument team has performed the detailed design of an instrument device and wishes to being procurement/construction. This can be done on the "Sub-System Design Description for TG3 Stage x" and, if necessary a pre-review, a "Preliminary Sub-TG3" can be organised.
- "Final TG3": will assess the instrument as a whole and the remaining instrument devices that have not been subject to a sub-TG3.

Depending on the type of TG review and type of instrument device in question the deliverables will vary and is made clearer later in the document.

If there are any ambiguities at any stage over what is required instrument teams are encouraged to contact their MCA contact and not wait until the review itself.

1.3. Grading System

The assessment consists of a simple traffic light grading system; the same that was used to TG2. A number of criteria or sub-categories are considered and given an individual grading which will then form an overall grade for the complete MCA aspects of the project. The following sections aim to reduce the subjectivity of the assessment. It will list the specific tasks that MCAG feel should be completed during Phase 2. The traffic light colours have the following interpretations:

GREEN: All aspects of the criterion in question have been addressed satisfactorily.

ORANGE: Some aspects of the criterion in question have not been addressed satisfactorily..

RED: Some aspects of the criterion in question are in serious doubt. Additional information and serious consideration by the NSS management is necessary to continue commencement to the detailed next phase

WHITE: Not applicable for this review.

2. ASSESSMENT

2.1. Standards & request for information

Neutron Detector and Neutron Monitor integration, Event formation, DAQ and file writer

DMSC shall provide a standardised DAQ system for the ESS instrument suite consisting of event formation units, data aggregation system and file writer.

Whilst the high level design of the system is standardised the modularity and specification of the event formation units will be delivered in a detector system specific manner.

To ensure that this process is successful and that DMSC has confidence that the DAQ system will be functional it is important at TG3 to baseline the detector system and the detector system integration to the DAQ system.

The DAQ system integration shall be developed in close collaboration with the ESS detector group who hold the scope for the standard front / back end electronics system.

The key design information that shall form the DAQ baseline for each instrument is.

Data rate: Expected global data rate and peak instantaneous rate.

EFU algorithm: Description of the method / algorithm required to convert digitised raw detector data into neutron event data. i.e. the method required to determine where on the detector a neutron was converted.

Modularity of readout: Expected modularity of the detector and front/ back end electronics.

Note for non standard solutions. For some instruments integration into the standard DMSC DAQ system is not the best solution. (e.g. imaging cameras) for such systems an alternate solution should be described for each use case.

Note for neutron monitor systems. The DAQ integration for each neutron monitor system shall be described in the same way. i.e. Data rate, algorithm required for event formation.

Mode of DAQ operation. The standard operating modes of the instrument should be described in relation to the configuration of the DAQ system. Instruments that count neutrons in subsequent frames and / or skip accelerator pulses should document the standard modes of beamline operation for the instrument DAQ baseline.

Instruments should consider impacts on operation of the accelerator operation at below 14Hz and the impact of missed accelerator pulses, or accelerator pulses that are not 2.87ms in duration.

Neutron data normalisation

Each instrument project shall document the way in which detector data shall be normalised, for normalisation using a monitor in primary flight path the position of and specification of the monitor should be described, the stability of the monitor used to normalise neutron detector data has a direct impact on the quality of data. It is advised to consider the requirement for neutron monitor stability in respect of this point.

Calibration and commissioning plan

Detailed design should include reference to the commission and calibration of key beamline components. DMSC holds the scope for the top level experiment control system, and the Beamline Control Group provides the complete controls solution.

The following aspects of the beamline systems are known to require calibration and commissioning for TOF neutron operation. The high-level plan should be discussed at TG3 in ensure that commissioning and calibration are successful.

Shutter verification

Light shutter & BBG position: scan procedure

Heavy shutter**:** shutter scan procedure

Chopper axis verification

Calibration of axis position: description of procedure to calibrate chopper axis position

Phase / angle offset: Description of procedure to calibrate the axis phase offset

Open closed position: Description of the procedure to calibrate the chopper open & closed / parked reference positions.

Detector evaluation and calibration

Event formation performance: specification of acceptance criteria for EFU performance

Position calibration: Description of detector calibration procedure

Beamline component calibration.

Calibration of L1 & L2: Description of the procedure to calibrate the primary and secondary flightpaths and the sample position.

Verification of source performance & data processing

During commissioning verification of the instrument performance shall be performed against the benchmark expectations of the instrument project. For the TG3 process it would be beneficial to describe the methodology envisaged to perform these measurements.

Similarly, the methodology to verify the chopper cascade should be described for:

Verification of cascade transmission

Verification of Bandwidth

Verification of Resolution for PSC

Verification of operating mode WFM / RRM

Note on data processing.

For TG3 projects should document the algorithms, methodology and beamline components to be used to convert raw TOF data from time to the base unit of the instrument and include the results from existing prototype measurements pertaining to the instrument.

This will form the baseline of post TG3 DMSC development for data reduction workflows for each instrument project.

2.2. Technical

Category of Criteria	Call for Tender Verification (Pre-procurement)	Sub-TG/Design Review	Final TG3	Comments
DAQ detector / monitor integration specifications and requirements Commissioning & calibration plan for Controls and Data Treatment				Does the detector system integrate into the standard DAQ Monitor position and commissioning plan data normalisation
Data rate estimation Instrument operating mode definition				Global and instantaneous rates

Category of Criteria	Call for Tender Verification (Pre-procurement)	Sub-TG/Design Review	Final TG3	Comments

Table 1 Documents/information required for various stages of TG reviews

2.2.1. Prototyping Report(s)

Results of any prototyping activities should be reported, both hardware and software. This may not be applicable to all instruments.

2.3. Planning & Commissioning

2.3.1. Timelines & Milestones

Important milestones and dates to ensure project is completed on time and when resources are required.

2.3.2. Commissioning Plan

2.3.3. Risk Analysis

A risk analysis will form part of the general TG3 documentation so it will suffice to reference the material from this. Please reference that document and include short details regarding:

- Technical risks and potential issues with procurement and manufacturing Motion devices.

3. TEMPLATE FOR ASSESSMENT

Category of Criteria	Grade	Comments
Detector system integration to DAQ		•
Neutron Monitor integration		•
Calibration and commissioning plan for chopper systems L1 & L2		•
Detector Calibration procedure		•
		•
		•
		•
		•
		•
		•

Table 2 Grading for _Instrument XXX_

Assessment performed by _PERSON AAA_ on behalf of.

Date: XX.XX.2018

4. GLOSSARY

Term	Definition
CDR	Critical Design Review
DMSC	Data Management & Software Centre
E2H2C	ESS Electronics Hardware Harmonisation Committee
EPICS	Experimental Physics and Industrial Control System
ESS	European Spallation Source
FAT	Factory Acceptance Test
ICS	Integrated Controls Systems Division
IOC	Input Output Controller
MCA, MCAG	Motion Control & Automation (Group)
MCU	Motion Control Unit
NSS	Neutron Scattering Systems
PLM	Product Lifecycle Management
SAT	Site Acceptance Test
SSDD	Sub-System Design Description
SDD	System Design Description
TG	Toll Gate Meeting
ToM	Table of Motion

5. REFERENCES

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1			
2			