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Guidelines for the packaging and installation of neutron chopper systems for use at the ESS, the CHIM concept

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1. GENERAL REMARKS

1.1 Document objectives

The objective of this document is to give instrument project teams the background and objective of the CHIM and the guideline necessary to select an appropriate solution for the chopper system of that instrument.

1.2 Document scope

The scope of this document is to describe the basis of the CHIM and how to select the appropriate installation variant for ESS chopper systems. It also gives a short description of each selectable variant and an instruction how to proceed if the selectable variants are not suitable.

The document also provides design guidelines viable for all chopper variants.

1.3 List of abbreviations

Abbreviation	Explanation of abbreviation
CHIM	Chopper mechanical Integration Module
NCG	Neutron Chopper Group
ESS	European Spallation Source
DC-SR	Disc chopper small rotor
ICD	Interface Control document

2. THE CHOPPER MECHANICAL INTEGRATION MODULE (CHIM)

2.1 Introduction

There are many ways to integrate a chopper system, almost as many ways as there are neutron instruments. Some installation variants are better matched to the type of instrument the chopper assembly operates on, the location of the assembly, the type of chopper or even the type of source it operates on. The instrument performance requirements together with the maintenance are the driving factors, combined with the available space, when choosing an installation configuration.

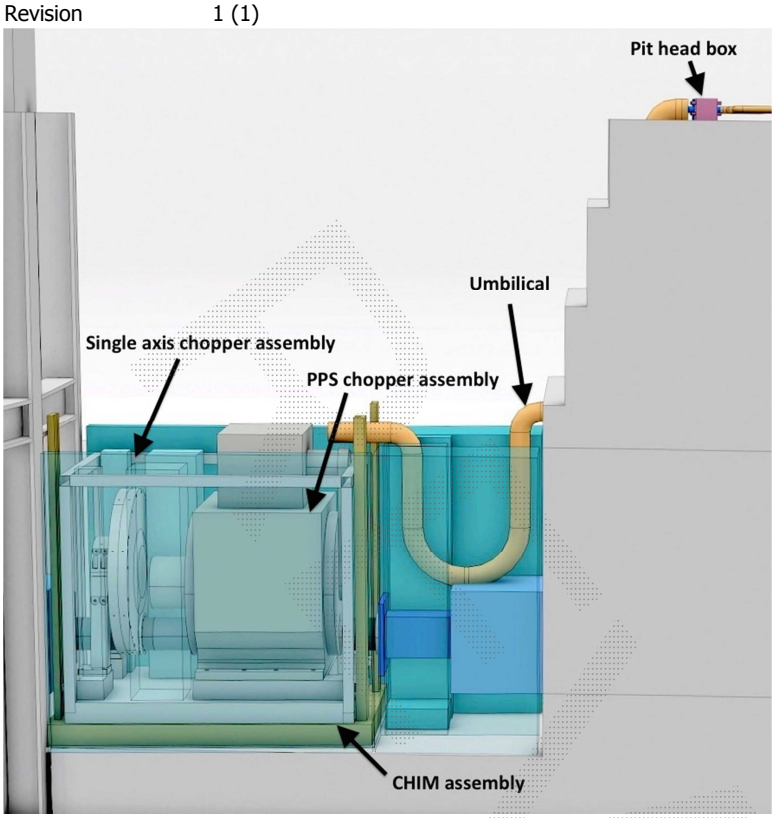

Figure 1 - A typical chopper pit assembly

In an attempt to achieve the best compromise for instruments at the facility the ESS chopper group has studied many chopper installation variants currently in use around the world and the unique constraints of installation and operation at this, the worlds first long pulse spallation facility. The considered response has been to propose an interface layer – the Chopper (mechanical) integration module (CHIM), to ensure the chopper system fulfils the access and maintenance requirements needed. The CHIM also handles most physical interfaces to the rest of the instrument, easing the design and integration of the instrument.

This document is intended as a guideline to assist the selection and design of variants depending on the specific constraints of the instrument.

2.2 Purpose

The CHIM's principal purpose is to provide standardised and functionally optimised single interface to the surrounding environment. In standardising interfaces and requirements it enables chopper suppliers to optimise their designs and reuse them on installations across the instrument suite, reducing instrument costs. It also enables the facility to establish common extraction processes and tooling simplifying support functions. The CHIM concept clearly separates the chopper's main purpose (shaping the neuron pulse) from the supporting functions (extraction, maintenance, cabling, etc.).

2.3 CHIM environment and constraints

The following section describes the environment where the chopper assemblies and the CHIM will operate and the implied constraints.

2.3.1 Shielding concept

The shielding of the ESS instrument is split up into two separate parts, the bunker and individual instrument shielding.

The bunker is a common area close to the monolith where several instruments share a large common void. This area is characterised by high radiation and tightly integrated instrument components. The access to the bunker is achieved vertically through the roof, by un-stacking shielding blocks. No personal access is permitted inside the bunker after installation is finished. The distance between the floor of the bunker and the roof approximately three meters and the roof is two meters thick. This means there is up five meters of vertical distance from the access point to the chopper equipment.

An interface drawing to the bunker and target system is available in ESS-0043981.

Outside of the bunker area space permits that shielding becomes independent and optimised for that specific instrument's requirements. It is generally more easily accessible than the bunker area.

2.3.2 Extraction and remote handling

The shielding concept of the ESS bunker leaves no other option than having all of the installed equipment being extracted vertically through the roof of the bunker shielding. Due to equipment activation by neutrons in operation, ambient radiation levels are expected to severely limit or prohibit human access within the bunker shielding .

For both of these reasons it is considered that the use of remote handling tooling to install, remove, align and maintain this equipment will be obligatory at the facility.

An interface drawing to the bunker and target system is available in ESS-0043981.

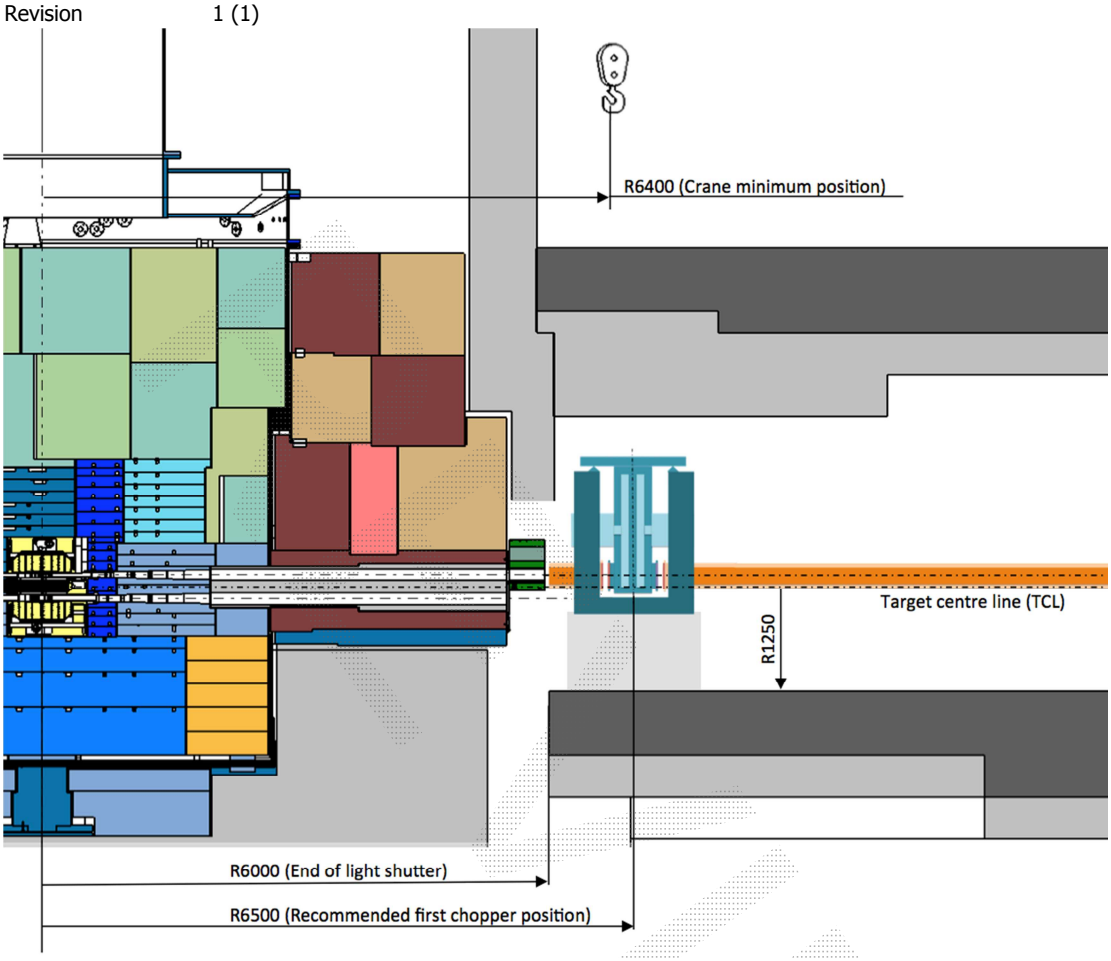

Figure 2 - First chopper position and target/bunker interface illustration

2.3.3 Utilities

The conduits for chopper component utilities must remain serviceable as those parts within the shielding will be subject to radiation damage and may require periodic replacement.

The routing of the utilities will follow an established ESS strategy and should be approved by the ESS chopper group during the design.

2.4 System description

The CHIM consist of all chopper-PBS components situated inside the chopper pit assembly apart from the chopper assemblies. It also includes the pit head box.

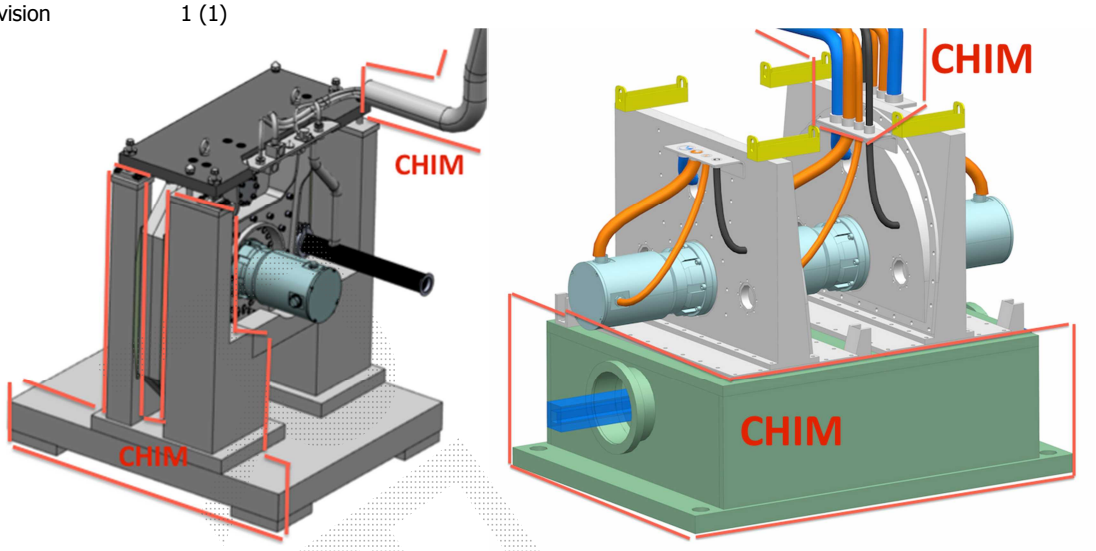

Figure 3 - Examples of CHIM

The CHIM's functions as a standardised integration layer between the chopper assemblies and the instrument. It also ensures structural support, alignment, positioning and extraction of equipment.

Depending on the instrument, the chopper system and the position along the beam the CHIM could be implemented and used differently, but the overall structure and functions remains the same.

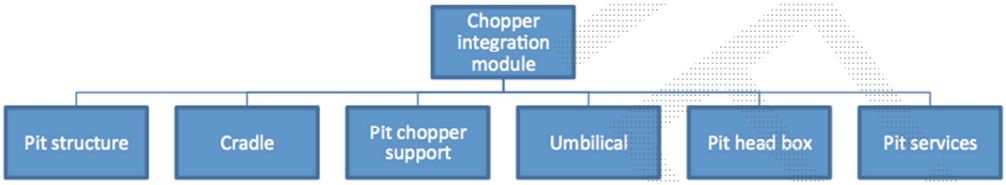

Figure 4 - CHIM PBS

2.4.1 Pit structure

The pit structure is composed of all fixed structural components inside the shielding, linked to the chopper system. It includes components such as the baseplate of the system.

2.4.2 Cradle

The cradle is a collective name for all components needed for the extraction and replacement of the chopper assembly, for example lifting frames and guide rail.

2.4.3 Pit chopper support

The pit chopper support is the structure the chopper assembly rests on. This is highly dependent on the installation variant, from a set of pillars in the pillar variant to a lower pressure enclosure in the horizontal split variant.

2.4.4 Umbilical

The umbilical is a collection of all cabling and routing going to the chopper assembly and/or CHIM. The umbilical starts with one half of the connection plate and ends at the pit head box.

2.4.5 Pit head box

The pit head box is an interface point between the chopper system and the rest of the instrument with regards to cabling and utilities. It is also a connection point where, during maintenance and installation, an operator can connect and perform local tests on the chopper assembly.

2.4.6 Pit services

The pit services are components not needed for the operation or extraction of the chopper assembly. It can include, but is not limited to, lights, stairs and walkways.

3. INTERFACES

The CHIM needs to take the following ICD in consideration during design,

- ESS-0034508 – ICD, NCG to Vacuum
- ESS-0034510 – ICD, NCG to Cooling
- ESS-0034511 – ICD, NCG to MCA
- ESS-0034512 – ICD, NCG to Health and safety
- ESS-0034513 – ICD, NCG to Optics
- ESS-0034514 – ICD, NCG to Shielding
- ESS-0034523 – ICD, NCG to Beam monitors
- ESS-0005748 – ICD, NSS to Target Project

This document will incorporate the technical implementation of these ICDs affecting the CHIM.

4. GENERAL SYSTEM GUIDELINES AND REQUIREMENTS

4.1 Construction materials

The CHIM should comply with ESS-0042895, Materials guideline intended for the construction of neutron chopper systems for use at ESS.

4.2 Size and weight

The environment of the neutron chopper pit assembly, the available cranes and other lifting devises dictates the sizes and weights possible for the neutron chopper components.

Assemblies installed within shielding should have a width of $\leq$900mm.

Assemblies installed within shieling should have height of $\leq$1500mm.

No component or assembly installed within shielding should have a length greater than the pit module.

No extractable assembly should weigh ≤2000kg.

Exceptions to these limitations shall require an integration study and approval by the ESS chopper group.

4.3 Fasteners

The CHIM should comply with ESS-0041943, Guideline for fastener design and use.

4.4 Approved components

The CHIM should comply with ESS-0034258, Requirements specification for components intended for the construction of neutron chopper systems for use at ESS.

4.5 Anchoring

All chopper assemblies should, through the pit chopper support and the chopper base plate, be anchored to the instrument baseplate. The design of each chopper base plate is individual and dependent on the selected variant (see chapter 5) and is described in the technical specification (see chapter 6).

The chopper baseplate shall be dimensioned to maintain the structural integrity of the plate in the case of a 0,4G vertical seismic event.

The chopper baseplate shall be dimensioned to maintain the structural integrity of the plate in the case of a 0,4G horizontal seismic event.

The chopper baseplate shall be designed to stop the chopper assembly escaping its mounts during a catastrophic failure of the rotor.

All parts of the chopper integration module shall be removable to allow for the insert casket to be placed, due to the requirements of the monolith guide insert. This is not considered a routine maintenance operation and personal access to the bunker can be permitted under those circumstances.

4.6 Handling

4.6.1 Extraction

One of the main functions for the CHIM is to provide the means of extraction of the chopper assembly from the shielding.

The extraction of the chopper assembly shall be possible without any person being present within the boundaries of the shielding.

All extraction shall be designed to be vertical.

The CHIM shall provide means to reinstall the chopper assembly with a repeatability of ±0.25mm

4.6.2 Remote handling

All extraction operations shall be designed for remote handling.

The umbilical strategy, the top plate, the connection plates and the pit head box are all part of this strategy. Specific implementation of extraction and remote handling is detailed in each CHIM variant specification.

4.6.3 Alignment

All chopper assemblies should be aligned with three point alignment system or with positional tight fitting points.

Specific implementation of extraction and remote handling is detailed in each CHIM variant specification.

4.6.4 Top plate

The top plate is the physical connection point for the connection plate. It could also function as the interface point for the remote handling equipment.

The top plate, ESS-0033150, should be present on all chopper assemblies, except PPS choppers, or extraction units.

4.7 Umbilical

The chopper assembly should be connected to the pit head box through the umbilical.

The CHIM should comply with the umbilical specification described in ESS-0041175.

The CHIM should comply with the connection plate specification described in ESS-0041173.

4.8 Pit head box

The pit head box should be connected to the chopper control rack.

The CHIM should comply with the pit head box specification described in ESS-0041175.

4.9 Neutron windows and neutron optics

There are two major types of interfaces between the optics system and the chopper system.

- Generic interfaces – interfaces that are common independent of chopper installation variant and/or optics type.
- Variant specific interfaces – interfaces that apply to certain chopper installation variants.

4.9.1 Generic interfaces

4.9.1.1 Beam path interface

This interface controls the different interfaces along the beam, such as neutron windows and vacuum housing interfaces.

The guide and chopper system can either have separate atmosphere or share the same atmosphere. If the atmospheres are separate between the two systems the following apply:

The end section of the guide system should be composed of a standard flange, as described below.

The chopper system should have a standard flange, as described below.

Both standard flanges should have a neutron window mounted on it. The recommended design, ESS-0042433, can be used.

The spacing between the neutron window surfaces should be at least 5mm to allow for enough space for chopper extraction.

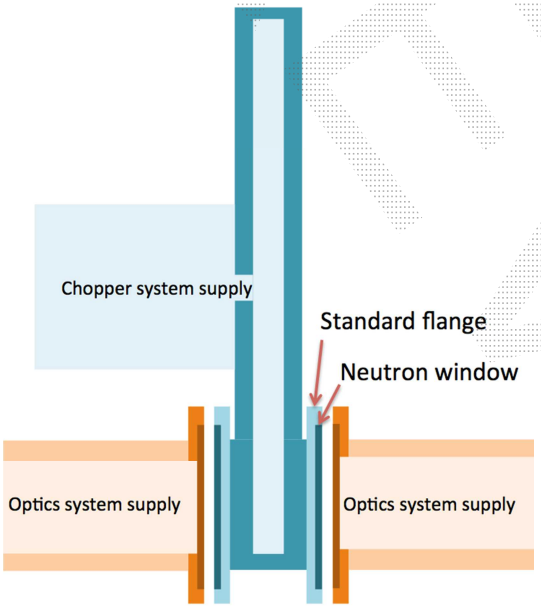

Figure 5 - Separate atmosphere interface diagram

If the systems share the same atmosphere the following apply:

The systems should connect through a standard flange, as described below.

The last section of the optics system vacuum housing should be composed of a standard bellow, as described below.

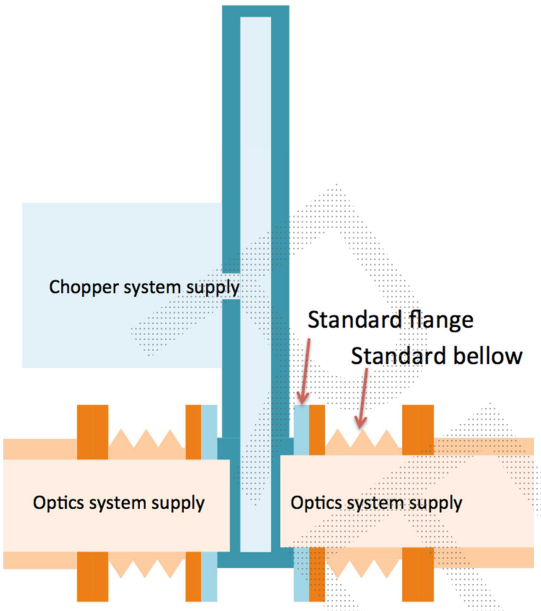

Figure 6 - Common atmosphere interface diagram

4.9.1.2 Standard flange

The standard flange should be a 160CF vacuum flange, according to ISO/TS 3669-2:2007(E). Alternative flange sizes should be limited to a 100CF or 300CF flange.

4.9.1.3 Standard bellow

The standard bellow shall be an edge-welded bellow according to a specification determined at a later release of this document.

4.9.2 Variant specific interfaces

The chopper variant specific implementation of the optics to chopper interface is specified the documents listed in section 6 of this document.

4.10 Beam monitors

Information about the integration of beam monitors into CHIM will be implemented at in a later release of this document.

5. INSTALLATION VARIANT SELECTION

The following section describes the supported chopper installation variants for instruments at the ESS. It also outlines the selection process and how to proceed if the instrument has requirements not met by the endorsed variants.

5.1 Variants selection process

Following the NCG process for chopper system development in phase 1, as outlined in ESS-0042711, the project goes through a series of steps. The individual chopper assembly use-case (see 5.2) shall be determined by the system requirements and the architecture choice.

During "Activity 4: Exploration and evaluation of design concepts" the use case is used to determine the installation variant. The ESS endorses a number of installation variants, evaluated to perform in the ESS environment (see 5.3). The instrument should use the endorsed variants if possible.

In chapter 6 the endorsed variants are described, also referring to technical specifications. The technical specifications should be used (together with this document) during the design, construction and installation of the chopper system. The technical specifications ensure conformity to the ESS standards and fulfilment of facility requirements.

If the instrument chopper system architecture or requirements are making the endorsed variants unsuitable section 5.4 describes the process for making a suitable unendorsed variant selection.

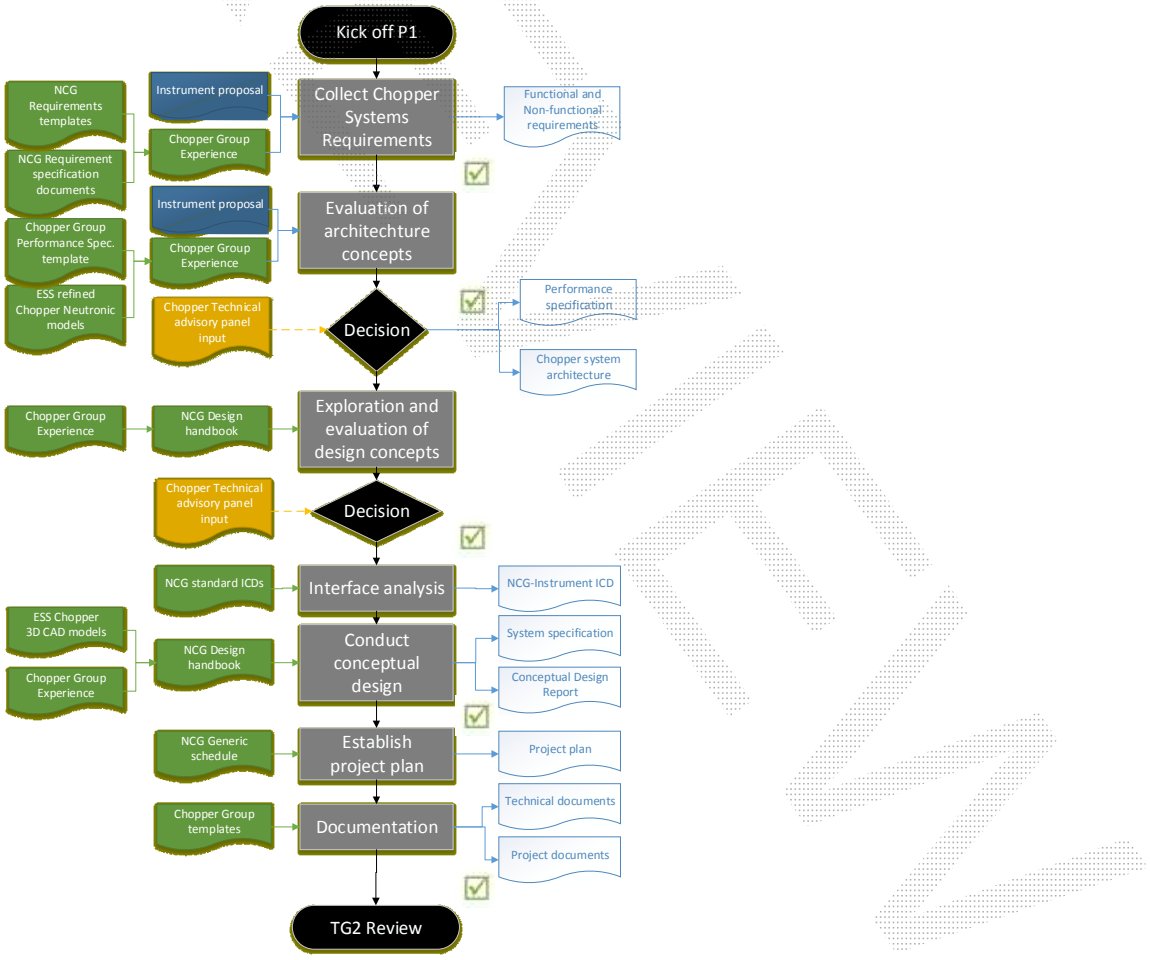

Figure 7 - The NCG process during P1

5.2 Use cases

Based on the overall requirement of the installation the chopper installation variants can be split into eight use cases. They are as follows:

- Single chopper assembly pit assemblies

  - Separate vacuum
  - Common vacuum
  - Chopper on translation stage
  - PPS variant
- Multiple chopper assembly pits assemblies
  - Separate vacuum
  - Common vacuum
  - Chopper on translation stage
  - PPS variant

If the instruments chopper use-case does not fall into one of these categories, contact the ESS chopper group for consultation.

5.2.1 Single chopper assembly pit assemblies

The following use cases are for pit assemblies with a single chopper assembly, or with enough space to allow for separate support and extraction structures.

- Separate vacuum cases – the chopper assembly operates in an independent atmosphere from the guide system.
- Common vacuum cases – the chopper assembly operates in a joint atmosphere with the guide system.
- Chopper on translation stage – the chopper assembly is installed on a translation stage, moving either along the beam line or in and out of the beam.
- PPSc variant – the chopper assembly installed is a PPS chopper.

5.2.2 Multiple chopper assembly pit assemblies

The following use cases are for pit assemblies with multiple chopper assemblies, where limited space does not allow for separate supports and/or extraction functions.

- Separate vacuum cases – the chopper assemblies operate in independent atmosphere from the guide system.
- Common vacuum cases – the chopper assemblies operate in a joint atmosphere with the guide system.
- Chopper on translation stage – one or more of the chopper assemblies is installed on a translation stage, moving either along the beam line or in and out of the beam.
- PPSc integrated variant – one or more of the chopper assemblies is a PPS chopper.

5.3 Selection matrix

The table below indicates the supported ESS installation variants. The table outlines a preferred variant for each use case. If the preferred variant is not suitable, the secondary option could be used. More details on the specific variants can be found in chapter 4.

	Use case	Preferred	Secondary
Single assembly pits	Separate vacuum cases	Pillar (S1A)	Enclosure integrated, unit extraction (S2B)
	Common vacuum cases	Horizontal split, independent guide (S3A)	Coffin (S6A)
	Chopper on translation stages	Pillar (S1A)	Enclosure integrated, unit extraction (S2B)
	PPSc variant	PPSc integrated enclosure, unit extraction (S7A)	PPSc Horizontally split enclosure, independent

			guide (S7B)
Multiple assembly pits	Separate vacuum cases	Chopper module, integrated guide (M1A)	Chopper module, Large gap (M1B)
	Common vacuum cases	Horizontal split, cut-out guide (M2D)	Horizontal split, integrated guide (M2B)
	Chopper on translation stages	Chopper module, Large gap (M1B)	Chopper module, integrated guide (M1A)
	PPSc variant	Chopper module, integrated guide (M1A)	Horizontal split, integrated guide (M2B)

Table 1 - Recommended variants

5.3.1 Placeholder models

Official placeholder models for all endorsed variants are available in ESS-0028589. The placeholder models should be used during phase 1 for establishing system architecture and general layout, unless more detailed models are available.

5.4 Unendorsed variants

If an preferred or secondary installation variant is not selected, the instrument team shall contact the ESS chopper group for consultation.

An evaluation of optional variants shall be needed based on the requirements shown below.

- Neutronic performance – The measure of the efficiency of the solution to transmit neutrons without losses
  - Gap in the guide – The maximum gap in the neutron guide.
  - Common vacuum – The possibility to implement a common vacuum design.
  - Translation – The possibility to implement the chopper assembly translating along or in and out of the beam.
- Serviceability – The Ease of installation and extraction of NC components for routine service or repair
  - Accessibility – The amount of interfering shielding or other components present to access vital connections.
  - Extraction path – The path needed for extraction of equipment.
  - Remote handling – The ease of which the installation can be remotely handled.
- Installation constraints – The impact of the installation, both in time and space.
  - Spatial impact – The volume required by the design.
  - Alignment complexity – The complexity of the alignment of the chopper assembly.
  - Impact on guide alignment – Risk of disturbing the guide alignment due to chopper assembly replacement or installation.
- Reliability – The impact on the operating life and probability and consequence of failure
  - Complexity – The complexity of the system, number of moving parts or complex shapes.
  - Vibration transmission – The likelihood of vibrational transmission from the installation to its surrounding.
  - Vibration sensitivity – The sensitivity of the installation to surrounding vibration
  - Severity of failure – The consequence of failure to the assembly, the instrument and the facility.

6. INSTALLATION VARIANTS DESCRIPTION

In this section describes the chosen available installation variants. It is important to remember that these only indicate the general architecture and principal solution of the chopper pit assembly. Specifications for each implementation are available in separate documents, as noted on each variant.

The variant pictures use the following colour code for components;

- – Light green – Ground or common base plate
- – Light orange – Guide housing and support
- – Dark orange – Guide part
- – Deep dark orange – Guide base plate
- – Light turquoise – Rotor and spindle unit
- – Dark turquoise – Chopper enclosure
- – Deep dark turquoise – Chopper support and base plate
- – Dotted line – Part of system that is extracted during maintenance.

6.1 Pillar, S1A

The pillar version rests on solid supports on a plane above the chopper centre of gravity. It allows for simple extraction and reinstallation. It is a variant used extensively in other neutron spallation facilities around the world.

Refer to document ESS-0041171 for a technical specification.

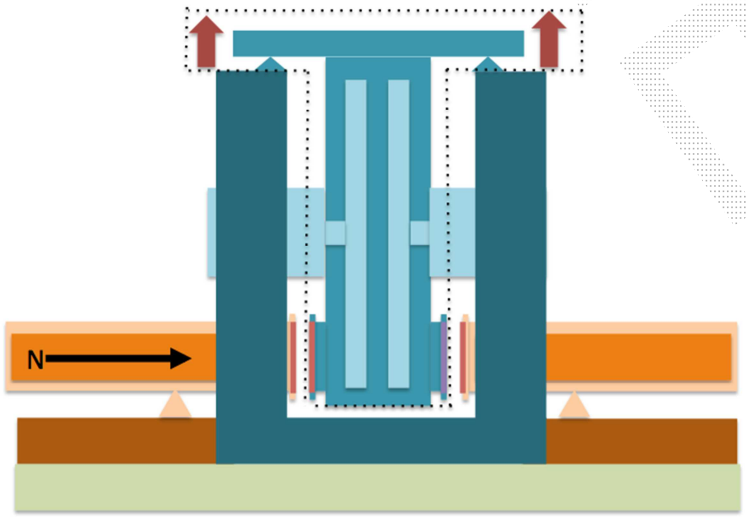

Figure 8 - Pillar variant, S1A

6.2 Enclosure integrated, unit extraction, S2B

This version rests on its own enclosure, it does not use any other support structure apart from the alignment system and other installation/maintenance components. It is widely used for heavier units such as the PPS or large rotor disc choppers.

Refer to the following documents for a technical specification, ESS-0041205 for small rotor chopper assemblies and ESS-0041199 for large rotor chopper assemblies.

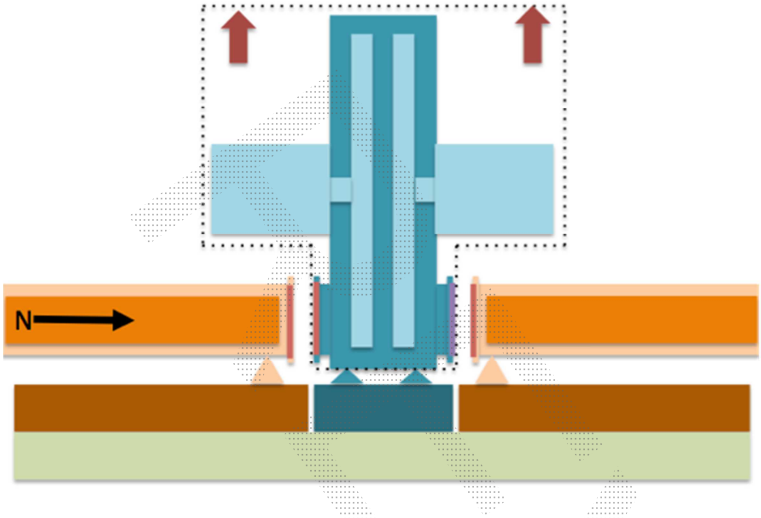

Figure 9 - Enclosure integrated variant, unit extraction, S2B

6.3 Horizontal split, independent guide, S3A

The horizontal split versions are designed to allow for a common vacuum environment between the guide system and the chopper. The preferred single assembly solution has the guide sections protruding through the sides on an overhung support.

Refer to the following documents for a technical specification, ESS-0041176 for small rotor chopper assemblies, ESS-0041172 for large rotor chopper assemblies and ESS-0041198 for translating chopper assemblies.

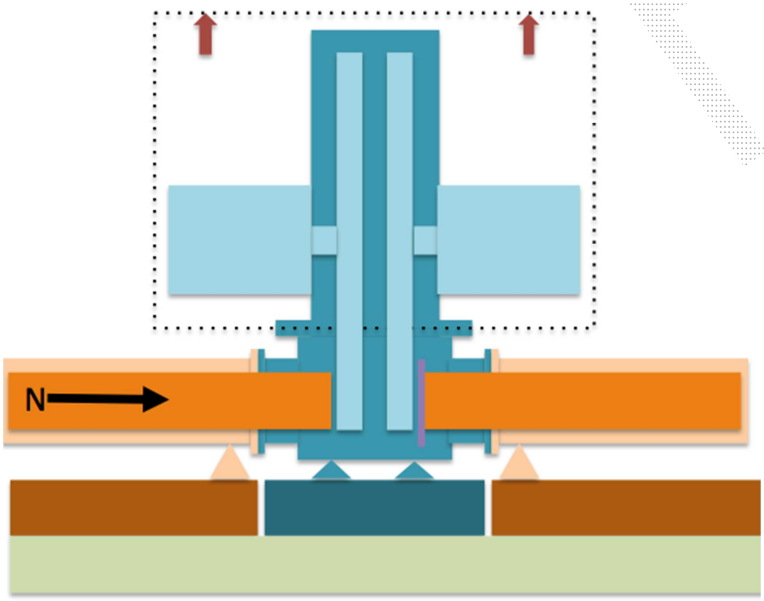

Figure 10 - Horizontal split, independent guide, S3A

6.4 Coffin, S6A

The design of the coffin variant is very flexible. It could have the chopper units attached to a large top plate for vertical extraction, but it could also have a pillar type version mounted inside a large vacuum tank.

Refer to the following documents for a technical specification, ESS-0041193 for small rotor chopper assemblies.

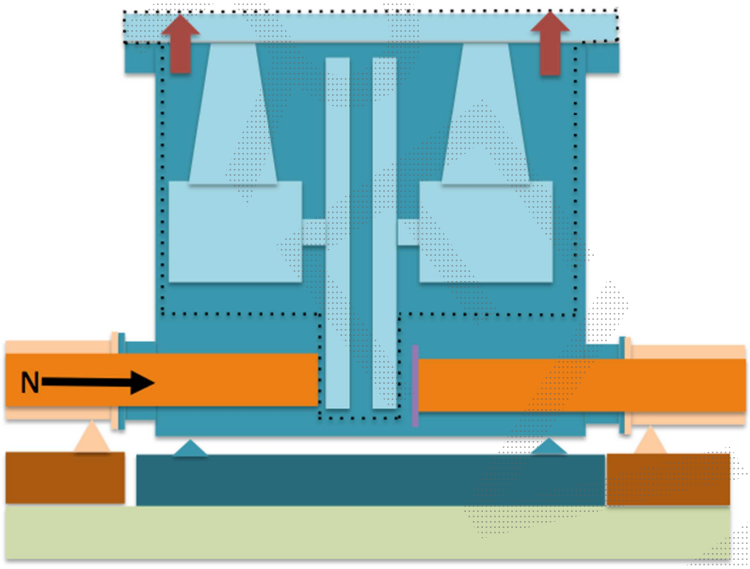

Figure 11 - Coffin variant, S6A

6.5 PPSc Integrated enclosure, unit extraction, S7A

This version rests on its own bottom part enclosure; it does not use any other support structure apart from the alignment system and other installation/maintenance components.

Refer to the following documents for a technical specification, ESS-0041204 for PPS choppers.

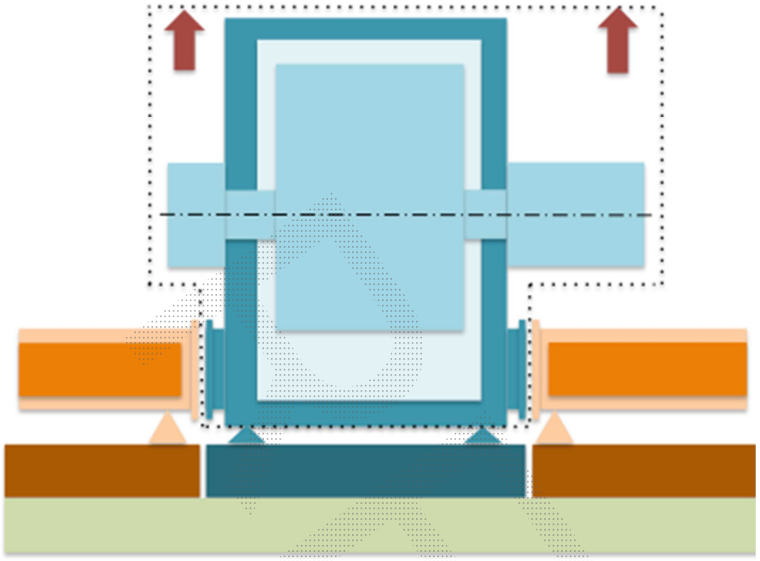

Figure 12 - PPSc Integrated enclosure, S7A

6.6 PPSc Horizontally split enclosure, independent guide, S7B

The horizontal split enclosure version is designed to allow for a common vacuum environment between the guide system and the chopper assembly. The preferred single assembly solution has the guide sections protruding through the sides on an overhung support.

Refer to the following documents for a technical specification, ESS-0041177 for PPS choppers.

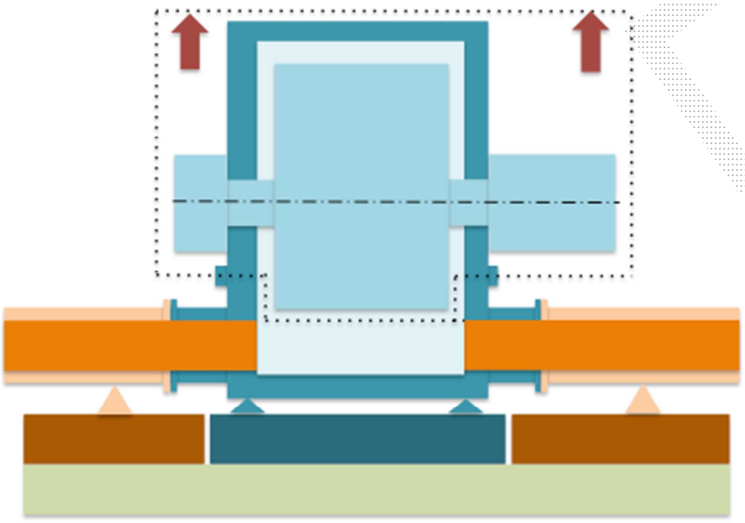

Figure 13 - PPSc Horizontally split enclosure, S7B

6.7 Chopper module, integrated guide, M1A

This variant integrates several chopper assemblies with sections of guide in a cradle. The entire module is designed to be extracted as a single unit. All components within the module need to be pre-aligned and then reinstalled without any adjustment to the alignment.

Refer to the following documents for a technical specification, ESS-0041178 multiple assembly configurations and ESS-001180 for multiple assembly configurations including PPS chopper.

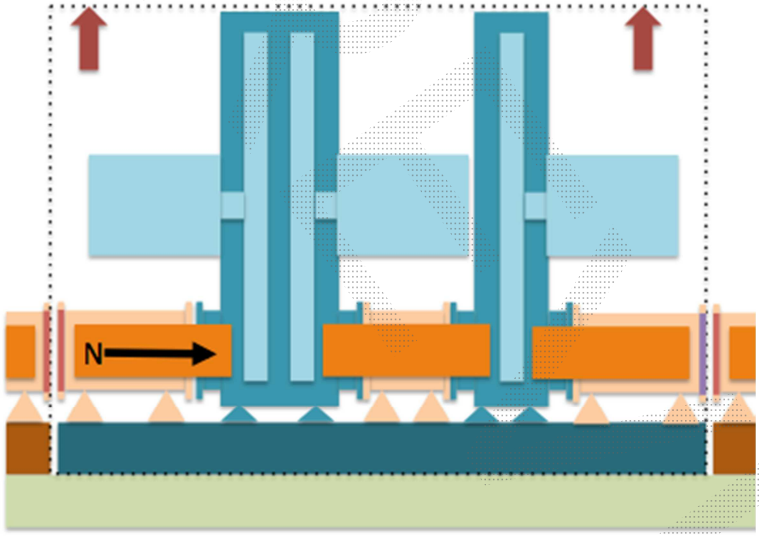

Figure 14 – Chopper module, integrated guide, M1A

6.8 Chopper module, large gap, M1B

This variant integrates several chopper assemblies, with one or more sections of guide left out, in a cradle. The entire module is designed to be extracted as a single unit. All components within the module need to be pre-aligned and then reinstalled without any adjustment to the alignment.

Refer to the following documents for a technical specification, ESS-0041178 multiple assembly configurations, ESS-001180 for multiple assembly configurations including PPS chopper and ESS-0041197 for translating multiple assembly configurations.

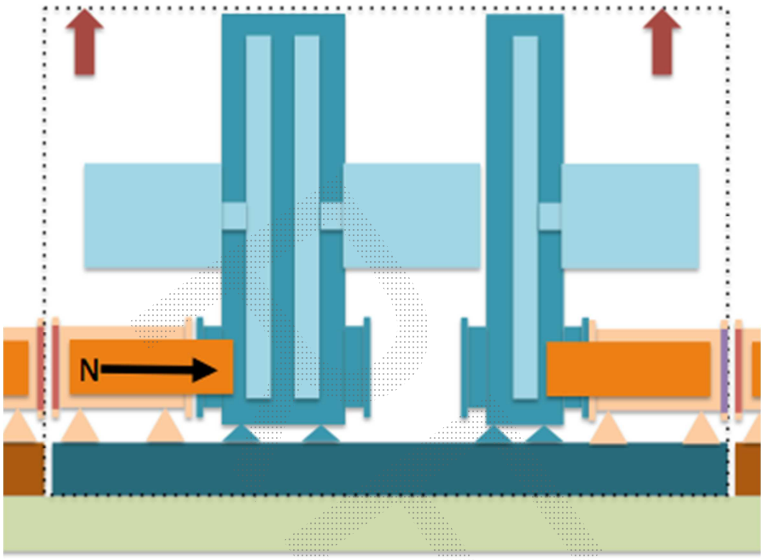

Figure 15 – Chopper module, Large gap, M1B

6.9 Horizontal split, integrated guide, M2B

The horizontal split versions are designed to allow for a common vacuum between the guide system and the choppers. This version integrates more than one chopper assembly with one or more guide pieces. The guide section is structurally supported inside the lower enclosure. The chopper assemblies can either be extracted as a single unit or individually, depending on the packaging constraints. Individual extraction is preferred.

Refer to the following documents for a technical specification, ESS-0041195 multiple assembly configurations and ESS-0041196 for multiple assembly configurations including PPS chopper.

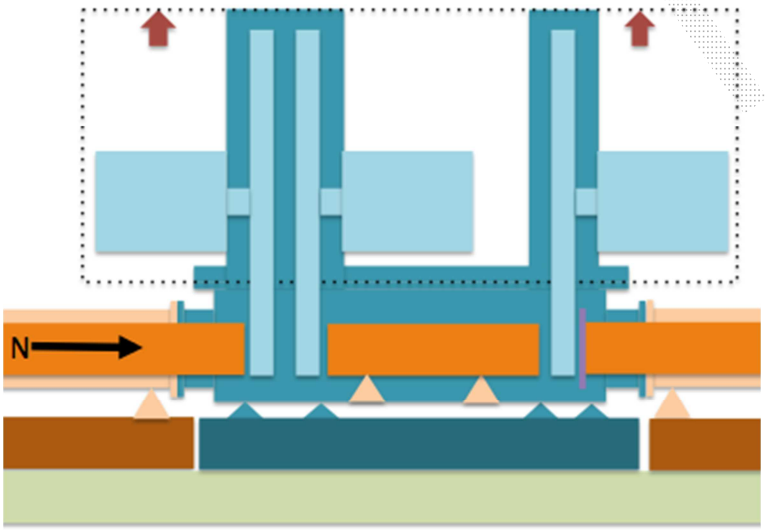

Figure 16 – Horizontal split, integrated guide, M2B

6.10 Horizontal split, cut-out guide, M2D

The horizontal split versions are designed to allow for a common vacuum between the guide system and the choppers. This version integrates more than one chopper assembly with one guide section. The guide section is structurally supported outside the chopper lower enclosure but extends through its entire length. It has cut-outs in the glass for the chopper disks. The chopper assemblies can either be extracted as a single unit or individually, depending on the packaging constraints. Individual extraction is preferred.

Refer to the following documents for a technical specification, ESS-0041194 multiple assembly configurations.

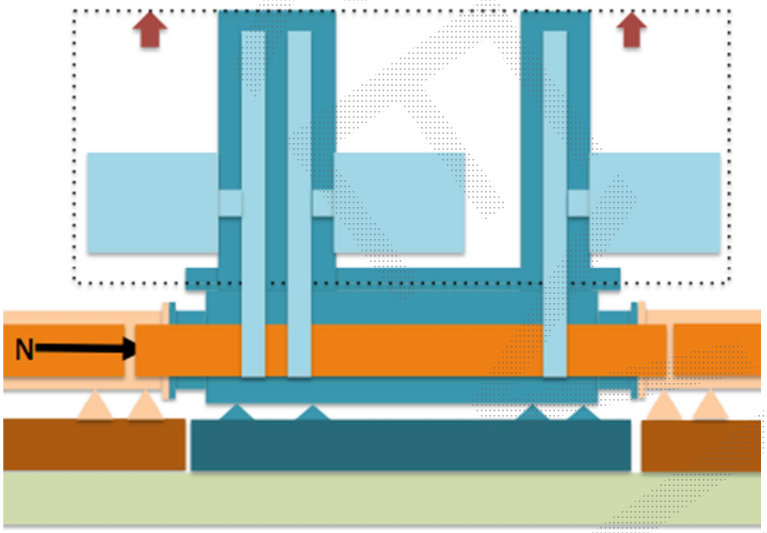

Figure 17 – Horizontal split, cut-out guide, M2D

7. COMPLIANCE MATRIX

See appendix A.

DOCUMENT REVISION HISTORY

Version	Reason for revision	Date
1.1	Compliance matrix inserted, updated optics interface and target interface, updated some requirements formulations.	2016-01-11
0.1	Draft release	2015-08-20

APPENDIX A – COMPLIANCE MATRIX

			Preliminary design (P1)		Final Engineering design (P2)		Procurement (P3)		Construction and installation (P4)		Cold commissioning (P5)		Comment
4	General system guidelines and requirements	Specified value	Check	Method of verification (P1)	Check	Method of verification (P2)	Check	Method of verification (P3)	Check	Method of verification (P4)	Check	Method of verification (P5)	Comment
4.1	**Construction materials**												
4.1.1	Should comply with ESS-0042895	True			x	TBD	x	TBD	x	TBD			
4.2	**Size and weight**												
4.2.1	Assemblies installed within shielding should have a width of	≤900mm	x	Drawing/Model check	x	TBD			x				
4.2.2	Assemblies installed within shieling should have height of	≤1500mm	x	Drawing/Model check	x	TBD			x				
4.2.3	No component or assembly installed within shielding should have a length greater than the pit module	True	x	Drawing/Model check	x	TBD			x				
4.2.4	Extractable assembly should weigh	≤2000kg	x	Drawing/Model check	x	TBD			x				
4.2.5	Exceptions to these limitations shall require an integration study and approval by the ESS chopper group	True	x	Design report review	x	TBD							
4.3	**Fasteners**												
4.3.1	Should comply with ESS-0041943	True			x	TBD	x	TBD					
4.4	**Approved components**												
4.4.1	Should comply with ESS-0034258	True			x	TBD	x	TBD					
4.5	**Anchoring**												
4.5.1	All chopper assemblies should, through the pit chopper support and the chopper base plate, be anchored to the instrument baseplate.	True	x	Drawing/Model check	x	TBD			x				
4.5.2	The chopper baseplate shall be dimensioned to maintain the structural integrity of the plate in the case of a 0,4G vertical seismic event.	True			x	TBD			x				
4.5.3	The chopper baseplate shall be dimensioned to maintain the structural integrity of the plate in the case of a 0,4G horizontal seismic event.	True			x	TBD			x				
4.5.4	The chopper baseplate shall be designed to stop the chopper assembly escaping its mounts during a catastrophic failure of the rotor.	True			x	TBD			x				
4.5.5	All parts of the chopper integration module shall be removable to allow for the insert casket to be placed	True	x	Drawing/Model check	x	TBD							

4.6	**Handling**												
4.6.1	**Extraction**												
4.6.1.1	The extraction of the chopper assembly shall be possible without any person being present within the boundaries of the shielding.	True	x	Drawing/Model check	x	TBD			x	TBD	x	TBD	
4.6.1.2	All extraction shall be designed to be vertical.	True	x	Drawing/Model check	x	TBD			x	TBD			
4.6.1.3	The CHIM shall provide means to reinstall the chopper assembly with a repeatability of	±0.25mm			x	TBD			x	TBD	x	TBD	
4.6.2	**Remote handling**												
4.6.2.1	All extraction operations shall be designed for remote handling.	True	x	Drawing/Model check	x	TBD			x	TBD			
4.6.3	**Alignment**												
4.6.2.1	All chopper assemblies should be aligned with three point alignment system or with positional tight fitting points.	True			x	TBD			x	TBD			
4.6.4	**Top plate**												
4.6.2.1	The top plate, ESS-0033150, should be present on all chopper assemblies, except PPS choppers, or extraction units.	True			x	TBD			x	TBD			
4.7	**Umbilical**												
4.7.1	The chopper assembly should be connected to the pit head box through the umbilical.	True	x	Drawing/Model check	x	TBD			x	TBD			
4.7.2	The CHIM should comply with the umbilical specification described in ESS-0041175.	True			x	TBD	x	TBD	x	TBD			
4.7.3	The CHIM should comply with the connection plate specification described in ESS-0041173.	True			x	TBD	x	TBD	x	TBD			
4.8	**Pit head box**												
4.8.1	The pit head box should be connected to the chopper control rack.	True	x	Drawing/Model check									
4.8.2	The CHIM should comply with the pit head box specification described in ESS-0041175.	True			x	TBD	x	TBD	x	TBD			
4.9	**Neutron windows and neutron optics**												
4.9.1	**Generic interfaces**												
4.9.1.1	**Beam path interface (Separate atmosphere)**												
4.9.1.1.1	The end section of the guide system should be composed of a standard flange	True			x	TBD			x	TBD			

4.9.1.1.2	The chopper system should have a standard flange	True			x	TBD			x	TBD			
4.9.1.1.3	Both standard flanges should have a neutron window mounted on it.	True			x	TBD			x	TBD			
4.9.1.1.4	The spacing between the neutron window surfaces should be at least	5mm			x	TBD			x	TBD			
4.9.1.1	**Beam path interface (Common atmosphere)**												
4.9.1.1.5	The chopper system should have a standard flange	True			x	TBD			x	TBD			
4.9.1.1.6	The last section of the optics system vacuum housing should be composed of a standard bellow	True			x	TBD			x	TBD			
4.9.1.2	**Standard flange**												
4.9.1.2.1	The standard flange should be a 160CF vacuum flange, according to ISO/TS 3669-2:2007(E)	True			x	TBD	x	TBD	x	TBD			
4.9.1.2.2	Alternative flange sizes should be limited to a 100CF or 300CF flange	True			x	TBD	x	TBD	x	TBD			
4.9.1.3	**Standard bellow**												
4.9.1.3.1	The standard bellow shall be an edge-welded bellow according to a specification determined at a later release of this document.	True			x	TBD	x	TBD	x	TBD			
4.9.2	**Variant specific interfaces**												
4.10	**Beam monitors**												
5	**Installation variant selection**	**Specified value**	**Check**	**Method of verification (P1)**	**Check**	**Method of verification (P2)**	**Check**	**Method of verification (P3)**	**Check**	**Method of verification (P4)**	**Check**	**Method of verification (P5)**	**Comment**
5.1	**Variants selection process**												
5.1.1	The individual chopper assembly use-case (see 5.2) shall be determined by the system requirements and the architecture choice.	True	x	Design report review									
5.1.2	The instrument should use the endorsed variants if possible	True	x	Design report review									
5.1.3	The technical specifications should be used (together with this document) during the design, construction and installation of the chopper system.	True	x	Design report review	x	TBD	x	TBD	x	TBD	x	TBD	
5.2	**Use cases**												
5.2.1	**Single chopper assembly pit assemblies**												
5.2.2	**Multiple chopper assembly pit assemblies**												
5.3	**Selection matrix**												
5.3.1	**Placeholder models**												

5.3.1.1	The placeholder models should be used during phase 1 for establishing system architecture and general layout, unless more detailed models are available.	True	x	Drawing/Model check									
5.4	**Unendorsed variants**												
5.4.1	If an preferred or secondary installation variant is not selected, the instrument team shall contact the ESS chopper group for consultation.	True	x	Design report review									
5.4.2	An evaluation of optional variants shall be needed based on the requirements	True	x	Design report review									