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| Neutron Chopper Systems Questionnaire for Instrument Projects in Preliminary Design Phase |
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|  | **Name** | **Affiliation** |
| **Filled in by** | Erik Nilsson | Neutron Chopper Group, ESS |
| **Document Author** | Nikolaos Tsapatsaris | Neutron Chopper Group, ESS |
| **Reviewers** | Oliver Kirstein | Instrument Technologies, Head of Division, ESS |
| **Approver** | Gabor Laszlo | NSS Lead Instrument Engineer, ESS |

Distribution: <<add names>>

# Introduction

## Purpose of the document

The purpose of this document is the collection and verification of technical information related to neutron chopper systems before major instrument project checkpoints i.e. the scientific and technical advisory panel (STAP) meeting, the scope setting meeting and the Tollgate 2 (TG2) review, during the preliminary design phase (P1).

It is meant to ensure that both the Neutron Chopper Group (NCG) and instrument teams have considered and confirmed that the most important installation, operation, maintenance, safety and technical feasibility requirements have been met in accordance to the P1 process document ESS-0043330.

The information that is requested from the instrument teams is an expanded version of the “compliance matrices”, which are part of the neutron chopper systems requirements and specifications documents. The completion of this document with the instrument teams is not obligatory, however, it is encouraged, as it is expected that it will greatly expedite and simplify the Neutron Chopper System (NCS) review process.

## Process

The questionnaire is filled by the NCG and/or the instrument team in close collaboration. Please note that the completed questionnaire is not a necessary prerequisite for the successful passing of the tollgate review but it is nevertheless encouraged as it provides crucial detailed information which may shorten and simplify the NCG review process. The completed questionnaire and the instrument TG2 documentation is used as input to the NCG Review Summary Document (ESS-0060423), which contains the NCG recommendations with regards to technical and project schedule feasibility. The NCG Review Summary Document is communicated to the instrument team, the instrument class coordinator and the NSS management before the STAP, Scoping and TG2 meetingsor as deemed necessary.

# General Questionnaire

## Project questions

Unless otherwise stated, the possible answers to the questions of this questionnaire are Yes, No, Don’t know, N/A. Additional information can be provided in the space under each question.

### Maturity

#### Do you consider that your concept’s architecture is mature for review purposes?

If yes, would you please supply a schematic to your NCG contact, provide a disk sketch with dimensions and fill the basic chopper design parameters in the table below?

Table 2.1: BEER chopper system

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Chopper Assembly 1** | **Chopper Assembly 2** | **Chopper Assembly 3** | **Chopper Assembly 4** |
| **Type** | Single Disk Chopper | Single Disk Chopper | Single Disk Chopper | Double Disk Chopper |
| **Function** | Pulse shaping | Pulse shaping | Pulse shaping | Frame overlap |
| **Position (m)** | (PSC1)  6.450 | (PSC2)  Movable from  6.650 to 6.860 | (PSC3)  7.375 | (FC1a and FC1b)  8.280 and 8.330  (as in proposal) |
| **Arrangement** |  |  |  |  |
| **Installation variant** | Horizontal split (not confirmed) | Horizontal split (not confirmed) | Horizontal split (not confirmed) | Horizontal split  (N/A) |
| **Bearing/drive type** | Magnetic | Magnetic | Magnetic | Magnetic bearing |
| **Outer diameter (mm)** | 700 | 700 | 700 | 700 |
| **Operating Speed (Hz)** | 168 | 168 | 168 | FC1a: 7 or 14Hz  FC1b: 63 or 70 Hz  depending on the operation mode. |
| **Windows** | 1 | 1 | 1 | 1 each |
| **Window Height (mm), Angle (deg)** | 100mm,144° | 100mm,144° | 100mm,144° | FC1a: 100(mm),  70°  FC1b: 100(mm),  180° |
| **Absorber** | Left to supplier | Left to supplier | Left to supplier | Left to supplier |
| **Absorber Thickness (mm)** | Left to supplier | Left to supplier | Left to supplier | Left to supplier |
| **Note** | Slave and Master | Slave and Master | Slave and Master |  |
|  |  |  |  |  |
|  | **Chopper Assembly 5** | **Chopper Assembly 6** | **Chopper Assembly 7** |  |
| **Type** | Double Disk Chopper | Single Disk Chopper | Double Disk Chopper |  |
| **Function** | Modulation | Modulation | Frame overlap |  |
| **Position (m)** | (MCa and MCb)  9.300 and 9.350  (Shifted because of pillars. Exact position maybe needs to be customized) | (MCc)  9.873  (Shifted because of pillars. Exact position maybe needs to be customized) | (FC2a and Fc2b)  79.55 and 79.59  (as in proposal) |  |
| **Arrangement** |  |  |  |  |
| **Installation variant** | Horizontal split (N/A) | Horizontal split  (N/A) | Horizontal split  (N/A) |  |
| **Bearing/drive type** | Magnetic bearing | Magnetic bearing | Magnetic bearing |  |
| **Outer diameter (mm)** | 700 | 700 | 700 |  |
| **Operating Speed (Hz)** | MCa and MCb: 42-300  Vary from 42 to 300Hz depending on the desired resolution. | 42-70  Vary from 42 to 70 Hz depending on the resolution and experiment. | FC2a: 14  FC2b: 7 |  |
| **Windows** | MCa: 16 windows:  -Distributed equidistantly  -Slit distance 22.5°  MCb: 4 windows:  -Distributed equidistantly  -Slit distance 90° | 8 windows:  -Large window  (1x180°)  -followed by (7x4°) small windows. | 1 each |  |
| **Window Height (mm), Angle (deg)** | MCa and Mcb 100 mm,  4° | 100mm,  1\*180°/7\*4° | FC2a: 100 mm,  180°  FC2b: 100 mm, 90° |  |
| **Absorber** | Left to supplier | Left to supplier | Left to supplier |  |
| **Absorber Thickness (mm)** | Left to supplier | Left to supplier | Left to supplier |  |
| **Note** | Double disc chopper | Single disc chopper |  |  |
|  |  |  |  |  |

### Technical feasibility

#### Can you provide documentation pertaining the technical feasibility of your proposed chopper system? The documentation may include a manufacturer’s specification sheet, previous experience with similar system or manufacturer’s agreement to construct the proposed chopper system.

*If yes, would you please communicate this to your appointed NCG contact?*

|  |
| --- |
| Supplier (Airbus) has quoted the system. |

#### Have you identified potential suppliers for your chopper system?

If yes, would you please communicate them to your appointed NCG contact?

|  |
| --- |
| Airbus |

### Technical risks

#### Have you identified the principal technical risks in your chopper system ?

If yes, please provide the risk documentation and their mitigation to your NCG contact.

|  |
| --- |
| The system utilises the horizontal split variant. Remote handling access to the serpatining flange is a technical risk (currently handled by the ESS chopper group).  BEER integrates several choppers in a confined space. Integration of these choppers are a technical risk.  Some choppers operate over a large speed range. Operation at natural frequencies can be a technical risk. |

### Costing

#### Have you prepared a costing for a complete chopper system?

#### Can you provide a breakdown based on the chopper system PBS/WBS?

#### What are the sources of your costing estimate (NCG, supplier input) and what do you consider the accuracy of your costing to be?

|  |
| --- |
| Quote from supplier. Need to compare supplier scope with PBS according to ESS-0060400. |

### Schedule

#### Have you established a schedule for your chopper system?

If yes, would you please supply the project schedule to your NCG contact?

#### Has the lead-time for the manufacture of all chopper components been factored in?

#### Has additional time been allocated for expected developments?

|  |
| --- |
| No schedule has been considered yet. |

## Compatibility

#### Have you followed the guidelines, standards and requirements documents for the ESS neutron chopper systems?

If the answer to the question above is no, have these exceptions been discussed with the NCG?

|  |
| --- |
| Horizontal split variant is used (?)  Considerations to NCG Concept of operations has been taken. |

## Development

#### Is additional development anticipated for any aspects of the chopper system?

If yes, please list the affected systems.

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| Use of 3 choppers instead of 4. One of them is movable |

## Reliability

#### Can the reliability of each chopper assembly be shown to be >98% measured over the service interval of 5 years (ESS-0034248)? N/A

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| --- |
| Airbus contact bearing system?  Still in discussion with Airbus |

## Operations and Maintenance

#### Are the operational and maintenance aspects of your chopper systems in accordance with the chopper systems concept of operation (ESS-0034248)?

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| --- |
| N/A |

## Instrument space conflict

#### Have you considered interfaces to your neighboring instruments, the bunker and crane coverage in the placement of the choppers?

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| --- |
| This needs to be done. Potential conflict with 9m pillar in bunker.  Perhaps needs customization. Currently in discussion with ESS. |

# Neutronics Questions

## Chopper cascade concept

#### Have you defined your chopper cascade requirements (in terms of phase accuracy, timing and lambda)?

|  |
| --- |
| Yes with regards to timing and lambda.  Phase accuracy has not yet been considered. |

#### Have you optimized the final positions of your chopper cascade using acceptance diagrams, time of flight diagrams or Monte-Carlo simulations?

Would you please supply an instrument input file (Mcstas/Vitess) to your NCG contact?

|  |
| --- |
| No  Adaptation to bunker environment currently being worked on. |

#### Has the effect of jitter and phase accuracy to the instrument’s performance been considered in your simulation?

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| --- |
| No  ESS can provide expected jitter data |

#### Have you considered the impact of chopper system unit failure modes in your instrument functionality and performance? For instance, in the event of chopper disk malfunction.

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| --- |
| Yes. Alternative modes of operation is possible if broken systems are parked open. |

#### Have you considered beam inhomogeneity in the simulation of performance of your chopper cascade?

|  |
| --- |
| Uses the output of mcstas moderator model.  Could not see any major issues. |

## Chopper disk absorber

#### Have you analysed the suppression of unwanted neutrons by the chopper cascade considering the:

* Full ESS pulse width (2.86ms + tails),
* Current moderator design,
* At minimum neutrons originating from 6 subsequent ESS pulses,
* Guide dimensions and guide coating

|  |
| --- |
| 4 pulses have been used. No significant things detected.  During proposal a lot of work on FO was done.  New validation will be done once final position of choppers is complete. |

#### Have you considered the attenuation as a function of incident neutron energy when selecting chopper disk coating, and was this simulated?

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| --- |
| 100% attenuation assumed in the current simulations. |

#### In the case of high-speed applications, has the absorber weight been optimized?

|  |
| --- |
| Left to supplier |

## T0 Chopper

#### Have you determined the attenuation level required by the PPS?

If yes, would you please supply this information to your appointed contact?

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| --- |
| No (no need) |

#### Have you considered the influence of the chopper assembly’s inert gas on the instrument’s performance?

|  |
| --- |
| No |

#### Have you optimized the speed, and geometry of the absorber using analytical, Monte-Carlo and MCNPX calculations?

|  |
| --- |
| No |

#### Have you considered alternatives to using a PPS/T0 chopper, such as bending out of the line of sight or using crystal filters?

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| --- |
| No (according to the new design of the optics no need for PPS/T0) |

# Chopper Mechanical Integration (CHIM) P1 questions

## CHIM Guideline – ESS-0041170

Unless otherwise stated, the possible answers to the questions of this questionnaire are Yes, No, Don’t know, N/A. Additional information can be provided in the space under each question.

### Size and weight

#### Is the width of each chopper module less than 900mm ?

#### Is the height of each chopper module less than 1800mm ?

#### Is the length of each chopper module less than 2000mm ?

#### Is the total mass of an extractable assembly lower than 2000kg?

If the answer to any of these questions is no, have these exceptions been discussed with NCG?

#### Do you intend to use separate atmosphere for any of your chopper modules?

|  |
| --- |
| Sizes are ok.  All in common vacuum with optics in current concept. |

### Handling

#### Is the extraction of the chopper assembly possible without human presence within the shielding?

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| --- |
| Horizontal split version is used.  Need to work with ESS standard document (not yet released) and Airbus to get a good system. Once ESS horizontal split documentation is released Airbus will need to adopt their design. |

#### Is the extraction of all components within the bunker expected to be vertical?

If it is not known, have you contacted the NCG for assistance on this matter?

|  |
| --- |
| Yes |

### Cabling

#### How do you intend to route chopper cables within the bunker and elsewhere?

If it is not known, have you contacted the NCG for assistance on this matter?

|  |
| --- |
| Depending on the bunker design.  29.5m limit on Airbus cable lengths. Could be limiting. ESS chopper group is currently in discussion with Airbus. |

## CHIM Variants

#### Have only endorsed installation variants been selected?

#### If you are proposing to use an unendorsed variant has an evaluation of the proposed variant been carried out?

If yes, would you please communicate your evaluation documentation to your NCG contact?

|  |
| --- |
| Only horizontal split variant is used. |

### Placeholder models

#### Have the ESS NCG chopper placeholder models been used in your preliminary instrument design?

If not, would you please communicate the models that were used to the NCG?

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| --- |
| Mix between Airbus models and ESS placeholder models are used. |

## Pillar variant, small rotor, S1A – ESS-0041171

### Chopper base plate

#### Is the pit support anchored to the instrument base plate?

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| --- |
| N/A |

### Pillar assembly

#### Do you intend to use the design specified in ESS-0039340?

#### If using a design different from the ESS standard does your design comply with the interface dimensions in ESS-0054229?

#### Has the standard top-plate been used (ESS-0033150)?

|  |
| --- |
| N/A |

### Alignment

#### Do you intend to implement the standard three-point alignment system for your choppers?

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| --- |
| N/A |

## Chopper module variants

#### Do you intend to use any of the following chopper module variants from the NCG?

If yes please contact the NCG for the relevant documentation.

* Chopper module, integrated guide, M1A
* Chopper module, integrated guide, including PPSc, M1A
* Chopper module, large gap, M1B
* Chopper module, large gap, including PPSc, M1B
* Chopper module, large gap, translating choppers, M1B
* Horizontal split, integrated guide, M2B
* Horizontal split, integrated guide, including PPSc, M2B
* Horizontal split, cut-out guide, M2D

|  |
| --- |
| N/A |

## PPS Chopper module variants

### PPSc, integrated enclosure, unit extraction, S7A

#### Do you intend to use any of the PPSc module variants from the NCG?

If yes please contact the NCG for the relevant documentation.

#### Will a single standard PPS unit be sufficient for your attenuation requirements?

If not how many?

#### Have you decoupled the PPS chopper from the surrounding components in order to dampen transmitted vibrations?

#### Is there a mitigation plan upon mechanical failure of the PPS operation?

|  |
| --- |
| N/A |

#### Will the PPS chopper be extracted in a single unit together with other disk choppers?

#### In a stand-alone PPS chopper assembly, is the guide gap larger than 500 mm?

|  |
| --- |
| N/A |

# Chopper CONTROL SYSTEMS Integration (CHIC) P1 questions

## CHIC Communications requirement document – ESS-0042906

Unless otherwise stated, the possible answers to the questions of this questionnaire are: Yes, No, Don’t know, N/A. Additional information can be provided in the space under each question.

#### What supplier do you intend to use for the supply of the chopper control system? If the answer is a established chopper supplier, then the chopper control questionnaire is complete.

If not, please provide the motor and controller details.

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| --- |
| System provided by Airbus |

#### Does the chopper drive require an external synchronization signal?

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| Yes |

#### Can the chopper drive provide a output for a TDC signal, between 0-5v TTL ?

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| --- |
| N/A |

#### Can the chopper drive output a phase lock signal, between 0-5v TTL ?

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| --- |
| N/A |

#### Does the chopper drive have a rotor parking functionality with a precision of at least ± 1 degree?

|  |
| --- |
| N/A(to be discussion with Airbus) |

#### Does chopper drive adhere to a 19’’ form factor, with a depth not exceeding 800mm?

|  |
| --- |
| N/A |

#### Can the drive output a rotation direction signal?

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| --- |
| N/A |

#### Will your selected choppers use magnetic bearings?

If yes, does the drive provide a levitation function?

If yes, does the drive have a levitation output signal?

|  |
| --- |
| Mixture of bearings (ball and magnetic).  Levitation function: N/A  Levitation output: N/A |

#### Does the drive permit access to motor and drive diagnostic parameters?

|  |
| --- |
| N/A (left to the supplier) |

#### If the answer to any of these questions is no, have these exceptions been discussed with the NCG ?

|  |
| --- |
| No (not all) |

# Definitions, acronyms and abbreviations

|  |  |
| --- | --- |
| Abbreviation | Explanation of abbreviation |
| Abbreviations | Explained in text |

# References

Preliminary instrument design (P1) process document – ESS-0043330

NCG Review Summary Document – ESS-0060423

Chopper concept of operations document (ConOps) – ESS-0034248

Definitions of terms document – ESS-0042914

CHIC Communications requirement document – ESS-0042906

CHIM Guideline – ESS-0041170

Pillar variant, small rotor, S1A – ESS-0041171

NCG instrument project confluence page: *https://ess-ics.atlassian.net/wiki/display/CG/Chopper+group+and+Instrument+projects*