**List of changes after TG2 of T-REX:**

The following changes have been applied to the documents, as requested by the TG2 review committee:

1. High Level Scientific Requirements:
   1. HLSR n. 6. “shall allow” has been changed to “should allow”
   2. HLSR n. 7. “XYZ” has been added and flipping ratio has been quantified
   3. HLSR n. 11 has been modified to be consistent (in wording) with n. 10
   4. HLSR n. 14: the number has been changed to n. 15. S/N has been quantified
   5. HLSR n. 12 has been added
2. Instrument layout:
   1. The instrument has been shortened by 3 m, so that the back wall of the cave is about 4.7 m from the wall of E01 and enough clearance is left on the back. This enables to fit in a get lost tube longer than 4 m, outside the detector vessel, but still inside the experimental cave, which is considered a safe assumption.
   2. The cave and hutches have been reshaped and repositioned so that the operational requirements are met. The access to sample area is allowed in a safe way for users, given that the fast chopper close to the sample position will be shielded. The detector vessel will be designed in phase 2 to enable the installation of more detectors, up to full detector coverage, as part of the upgrade path.
3. Risk analysis in the WPS document:
   1. Mitigation strategies for the budget risks have been described in more details
   2. The technical risk for T0 chopper has been removed
4. Shielding:

The calculations of shielding thickness for the experimental cave have been updated, in section 3.7.3 of PSD document and the model updated to cope with this. The new calculations assumed a full white beam on the sample, whereas previously a polychromatic beam was assumed.

1. Instrument model

An updated version of the instrument has been produced and sent to the Lead Engineer of NSS. Due to the fact that the neighbour instrument HEIMDAL do not have an updated model available, it is currently not possible to show figures of the two instruments together. The two teams are working together to ensure that there are no integration problems, especially inside the bunker, where the two instruments get closer.

1. Milestones and Early Procurements:
   1. The schedule has been updated so that it is aligned with the NSS project phases and milestones.
   2. Early procurements milestones have been added

Moreover, the instrument team is committed to consider during phase 2 all the issues raised during TG2 and in the corresponding TG2 report:

1. V-cavity as a polarizer for cold neutrons
2. Evaluate the possibility to move Bandwidth choppers into the bunker
3. Analysis of materials for the collimators of primary beam and alternative solutions to collimate the beam
4. Examine the safety case for the fast chopper close to the sample position in more detail
5. Separate the vacuum of the M chopper from the detector tank.

Moreover, the following changes are applied to cope with the requested changes from the NSS Lead Scientist, the WP coordinator for T-REX and the technology groups. The list includes the previously mentioned changes:

* **CONOPS**

2. High level scientific requirements: definition of project scope and full scope has been introduced

List of High Level Scientific Requirements:

5. beam size has been quantified

6. shall has been changed to should

7. XYZ has been added and flipping ratio quantified

8. energy resolution has been quantified

10. should has been changed to shall

11. modified to be consistent (in wording) to n.10

12. according to point e) in the report of TG2, another HLSR has been added.

14. number has been changed to n. 15. S/N has been quantified

Section 3.2 has been removed because the high level system requirements do not belong to ConOps, after discussion with NSS Lead Scientist and NSS Lead Engineer. Due to this, all subsequent sections have been re-numbered accordingly, here we follow the former numbering.

Section 3.3 life cycle

hot commissioning activities continue in parallel to user programme.

Figure 1 life cycle has been updated

Section 3.4.2

Collimation system is mentioned,

Section 3.4.3

reference to ESS-0052625 is added, thermal neutron capture is mentioned as a source of gammas

Section 3.4.4

“butterfly configuration” for choppers has been removed

Section 3.4.4.1

the sentence about the scattering of fast neutrons has been removed.

Section 3.4.4.2

Sentences have been rephrased to avoid confusion about final wavelengths and their relation to choppers repetition rate

Section 3.4.4.3

A sentence has been added to clarify that the guide design enables installation of T0 chopper

Page 16 line 2-3 “top loading” replaces “top down”

Sample to detector distance is mentioned in the first line.

Section 3.4.11

Title has been changed.

It is clarified that the list is about upgrades for which a provision is made.

At points I, II, III, IV a sentence is added to explain how the provision is included in project scope.

At point II dilution fridge is added.

Section 3.4.12

line 1: “need to be” replaced with “are”

Section 5.1

“target centreline” replaced with “neutron beam centreline”

Floor load values are updated.

Description of Startup operating mode has been changed as proposed by Ken Andersen in his review.

Section 5.2.2

The last sentence describes the strategy of continuous sample rotation in event mode.

Section 5.2.4

A sentence is added to address the issue concerning the plan to move the light shutter element under ESS central control, as requested at first bullet point, page 2 of TG2 report.

The last sentence describes needs for support for 3He spin filter cells.

Section 5.2.5

A sentence has been added to mention the occasional, but routinely used, practice of illumination of single crystals for sample alignment:

“It is relevant to mention here that it will a usual practice to illuminate samples with a white beam, with PC and MC stopped in open position, as required to align single crystals of unknown orientation.”

Section 5.3.3 bender fail safe position has been described.

* **SYSREQ**

Section 1.

Definitions of full scope and project scope has been added.

Section 2.

Scope setting meeting is now referred to as a past event.

Requirements:

2 “, with a start of the bandwidth chosen continuously from 0.7 Å” is added

3 “, with a rejection rate of 10-6” is added

6 “(WxH, full width x full Height)” is added

7 “continuously selectable size, from 5x5 mm2 to 10x30 mm2 (WxH)” is added

8 “, with 10% variation in intensity,” is added

9 “±1°” has been replaced with “±2° at 6.5 Å”

11 the requirement has been quantified, after discussion with Ken Andersen:

“The BTCS should transport from the moderator to the sample a beam with a divergence profile that is not zero for more than 0.01 deg, so that the divergence profile does not induce artificial modulation in the scattering pattern.”

15 “should” is replaced with “shall”

17 “should” is replaced with “shall”

19 the requirement has been changed adding “a time resolution ≤ 2μs at 40 m, 108 m and 163 m distance from the origin”

29 “shall” is replaced with “should”

30 title: “Positioning” was replaced with “Arrangement” ; “position” was changed into “arrange”; “at 3 m distance from the sample position,” is added

34 “should” is replaced with “shall”

54 and 55 have been rephrased

58 Title: “installation and” removed, text rephrased.

60 “within the guide hall H3” has been replaced with “in proximity of the experimental area”

80 “(complying with ref. [x])” has been removed

* **Work Package Specification**

Page 3 line 4

“estimated to be” was removed.

Section 1.4

Parts of the PBS assigned to other ESS sub-projects are mentioned:

“The insert in the monolith is outside the project scope and is assigned to the Target Division. Only the optical components inside the monolith insert are in the project scope.

Vacuum system and the respective control racks are assigned to Target Division.

Control racks for DMSC and respective integration are assigned to DMSC project.

Instrument Control Software and respective integration is assigned to ICS project.”

Section 3.1.3 has been changed removing the parts of PBS outside the project scope, previously assigned to ESS work unit.

Section 3.2.5 was added to mention all components not in project scope.

Section 4.2

Labeling of TG reviews has been assigned correctly.

Procurements have been added

Section 6.1

Risks about T0 chopper have been removed, because T0 is not in project scope.

“settlement of building”: mitigation actions “design for ease of realignment / design for insensitivity to misalignment” added

“Software may not meet requirements” removed, because software is not in project scope

“P chopper”, “bandwidth Choppers” and “FAN chopper” risks were added.

Mitigation strategy of cost risks has been changed to further describe mitigation actions.

Schedule risks associated with choppers, detectors, optics have now the same probability value (3).

Delay in neutron optics inside and outside bunker have been split in two items, because the effect would be different.

* **Initial Operations and Staging Plan**

Section 1.

‘(Phase 6)’ has been removed

Section 1.1.2

“For the polarizing components, the polarization efficiency will also be measured.” Moved to the 6th paragraph and rephrased.

Section 1.1.3

“the Laue scattering of the non-magnetic solid solution Ni0.89Cr0.11 or ZrTi. The diffuse scattering from these isotope incoherent scatterers should be purely non-spin flip and” has been rephrased so that the proposed sample for calibration is SiO2, which is considered a standard for this purpose:

“For the calibration of the PA setup, as a standard calibration sample we will use amorphous SiO2, which is an isotropic pure non-spin flip scatterer and provides a straightforward calibration data set for data correction.”

Section 1.1.4 paragraph 2

“(i.e. experienced)“ has been removed.

Section 2 paragraph 1

Reference [1] has been added.

Section 2 paragraph 4

“two T0 chopper” has been changed into “a T0 chopper”,

“A decision on the position of the T0 chopper has to be made during phase 2, so that design provision for its installation can be made.” Has been added.

Section 2 paragraph 5:

“is needed to polarize the 3He cells and renew the cells for PASTIS” has been added

* **Preliminary System Design Description**

Section 1.1

“and software are also” has been removed, since software is not within instrument scope.

Section 2

Paragraph 3, line 1: “project” has been added after “instrument”, for clarity.

Paragraph 3, line 3: “includes” has been replaced with “needs”

Section 2.2

Table of positions:

Title of second column changed into length/gap size,

Table has been updated with the new positions:

Monitor 1 position at 40.05

To shorten the instrument, the guide sections upstream and downstream the P chopper have been shortened accordingly, by 2 m and 1 m, respectively.

All components downstream P chopper, as a consequence, have been shifted back by 3 m.

Figure 2 NBPI:

reference to yellow has been removed, since the yellow is not enough visible.

Section 3.1.2.1:

the wavelength band has been changed to 1.7Å, according to the shorter instrument length,

page 9 second paragraph “The radius of curvature of the curved blades is 7.2 m.” has been added.

Section 3.1.2.2

Second paragraph “In the simulated model, the single guide elements were straight sections of 50 cm length.” Has been added.

Page 10 first paragraph: “Moreover, the simulation excludes most of the guide gaps and imperfections.”

Section 3.1.2.3

Third paragraph: description of the collimator assembly has been changed into “The two honeycomb collimators and the corresponding last portion of neutron guide are installed on a frame surrounded by the holding field assembly. The frame is mounted on a motorised exchanger”, to explain how the holding field is kept over the collimators.

Section 3.2

End of first paragraph: “At the moment of writing, the position inside the bunker is preferable, due to the uncertain implications on the concept of T0C and on the shielding surrounding the chopper assembly.” has been added to comply with comment from the ESS chopper group.

Table 1 page 13.

PC and MC positions have been updated

Chopper 6 parameters page 13: positions have been updated

Chopper 4 parameters page 14: positions have been updated

Section 3.2.2.4

“ “horizontal split module” chopper installation variant, described in ESS0041194” has been changed to “horizontal spilt variant DCSR according to ESS-0041176 – face to face, double disk”.

Section 3.2.3

Neutron bandwidth has been updated (the new one is 1.7Å)

The last sentence has been rephrased into:” In order to estimate the required absorber coating, we consider that neutrons outside the required band should cross four faces, two faces each chopper. Therefore, we chose a coating along the main neutron direction so that the first three layers are made of a 10B containing absorber, and the final layer of a Gd2O3 containing absorber.” to cope with comments from the ESS choppers group.

BW chopper parameters has been split into 2 lists.

Section 3.2.4

Line 2: “once operational” has been changed into “if operational”

First line after figure: “300 mm diameter disc” has been changed into “300 mm radius rotor”, since this is covered by the ESS T0 development.

Figure 9 has been rotated upside down, to cope with the horizontal split variant.

Fan chopper parameters: position has been updated, absorber per disc has been changed to make clear the position of absorbing layers.

Section 3.4.1

“placed just outside the monolith” has been changed into “placed after the LSS”

A sentence has been added at the end: “Otherwise we envisage the use of other permanent magnets which may be more radiation hard than NdFeB.”

Section 3.4.3

The first sentence has been changed adding “, other than an adiabatic fast passage (AFP),”.

Section 3.4.5

“C6” has been changed into “MC on T-REX”.

Section 3.7.3

At the end a description of the beam stop has been added:

“A beam stop will be installed after the detector in forward direction, at the end of a get-lost tube, which will start inside the detector vessel, at a position that will be chosen such to avoid to spray the small angle detectors with the transmitted beam. The final design will depend on presently not available information about the neutron spectrum. Materials and shape will be chosen so that it will absorb the direct beam of neutrons not scattered by sample and sample environment. MCNP calculations performed for the MAGIC diffractometer lead to estimate a thickness of attenuating materials of about 50 cm at the end of a get-lost tube of about 2 m length.”

Section 3.8

First sentence after figure 16: “, in any case at more than 1 m above the floor” has been removed, while “so that it will be accessible from the top of the SEE” has been added.

“active shielding” has been changed into “magnetic shielding”

A sentence has been added to clarify that the access to the chopper will be safe for operators:

“The safety case for the M chopper will be analysed in more details during phase 2, so that the final design of the cave will include a chopper case or shielding around the chopper, to avoid that mechanical failure of the chopper represents a safety risk for operators and users. Access to the chopper will be possible for maintenance purposes.”

section 3.9.1

“, which is included in the project scope.“ has been added after the sentence “This can be realized by the usage of a rotation sample stick on any SEE”.

The second last sentence has been changed into “For such cases the project scope includes a remote positioning of the sample inside the SEE.”.

section 3.10.1

“steel” has been replaced with “stainless steel”.

“Moreover the use of the PASTIS analyser requires non magnetic materials.” has been added at the end of first paragraph.

Last sentence: “collimators” has been changed into “collimator”

Section 3.10.3

The list of detectors requirements has been removed.

Section 3.10.5

The last sentence has been rephrased to clarify that the collimator covers the full detectorrange plus 5 deg excursion:

“The whole collimator has inner and outer radii of 50 and 70 cm respectively, while horizontally covers the angular range from -41° to +149°, since it continuously oscillates back and forth with an excursion of ±5°. The oscillation frequency is about 0.1 Hz (one complete oscillation in 10 seconds).”

Section 3.12

First two paragraphs have been removed, since the description of MCA Workpackages does not belong to PSD document. Therefore, they have been moved to WPS document in section 1.4

Section 3.13 and 3.14 have been removed, because the software is not within project scope, it belongs to DMSC project scope.

Section 6 has been significantly reshaped, so to describe the instrument performance, including brilliance transfer curves and flux values. Most of the text has been taken from the report on neutron optics, which was originally delivered as attachment to the main TG2 documents.