Work package specification for CSPEC, the cold chopper spectrometer of the ESS.

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Summary

The CSPEC Work Package will deliver a cold chopper spectrometer instrument ready for the hot commissioning with neutrons. The scope of the work is described along with the budget, schedule and project processes used. The total budget is 16 500 000€, including a 10% contingency. The CSPEC instrument is a collaborative project between two in-kind partners, the Technische Universität of München (TUM) and the Laboratoire Léon Brillouin (LLB), both sharing equally the budget.

1. Project organization

1.1 Project Goal

1.2 General Project Strategies

A neutron scattering instrument is a complex system consisting of different subsystems (optical system, detector system, etc) that in turn consist of technical components. All of these subsystems together must fulfil the functional requirements for the scientific performance as well as obey the maintainability and safety requirements.

The general strategy to achieve this is that the core instrument team (consisting of TUM and LLB staff) sets the requirements for various subsystems and provide technical solutions that fulfil these requirements in close collaboration with the ESS technical groups. The core instrument team designs, procures or fabricates, installs and tests the technical components of the instrument. Every step of this process will be communicated with the ESS to ensure the compliance of proposed technical solutions with the ESS requirements. The instrument infrastructure supports the technical components, provides the necessary utilities and shields against radiation. This infrastructure will be designed by the core instrument team with the input from the ESS technical groups. The procurement and installation will be coordinated within the instrument construction sub-project.

1.3 Governance Structure

CSPEC is part of the German Construction Project at ESS leading by the Technische Universität of München (TUM) and the French join research consortium between CEA and CNRS leaded by the Laboratoire Léon Brillouin (LLB). The Project organization includes the Instrument Consortium Executive Board (TUM, LLB and ESS) under which, the work package leader (lead instrument scientist) is responsible for coordinating the efforts between German and French contributions.

2. Project Scope

Instrument Overview

The instrument consists of three main technical subsystems: the beam transport and conditioning system (BTCS), the sample exposure system (SES) and the scattering characterization system (SCS). In addition, the instrument includes the structures that house and support these subsystems.

Beam transport and conditioning system (BTCS) (13.6.10.1)

The beam transport system transports a beam of neutrons from the moderator surface to the sample. The size, divergence and wavelength spectrum of the beam are tailored to the needs of the experiment.

Sample exposure system (SCS) (13.6.10.2)

The sample exposure system positions the sample in a beam of neutrons and controls the physical and chemical environment of the sample by utilizing various sample environment equipment (SEE). The choice of SEE is driven by the needs of the experiment.

Scattering characterization system (SCS) (13.6.10.3)

The purpose of this system is to detect scattered neutrons from a sample, so that meaningful experimental data can be produced.

Experimental cave (13.6.10.5)

The experimental cave hosts the beam defining elements of the BTCS and SES. It shields the surrounding hall from the radiation generated by these systems, as well as it protects the detector system from interference with an external radiation.

Control hutch (13.6.10.6)

The control hutch hosts the experimental control and data processing terminals. During an experiment the user team spends most of their time in the control hutch.

Sample preparation area (13.6.10.7)

The sample preparation area contains all the necessary equipment for the sample handling, mounting and storage between experiments. The clear separation between non- and irradiated sample storage will be imposed.

Utilities distribution (Infrastructure) (13.6.10.8)

The hall two, the guide hall and the hall three contains all the shielding, utilities, infrastructure and support systems for the BTCS elements within hall two, guide hall and hall three.

Support infrastructure (13.6.10.9)

The hall two, the guide hall and the hall three contains all the infrastructure and support systems for the instruments components within hall two, guide hall and hall three.

Control racks (13.6.10.10)

This system includes DAQ, DMSC, motion control, chopper control, vacuum control and PSS racks.

Integrated control and monitoring system (13.6.10.11)

The integrated control and monitoring system allows the user to control the experimental parameters and process the neutron data. It also contains the control and monitoring systems needed for the safe operation of the instrument.

3. Work Breakdown

3.1 Instrument Work Units

The Work Units are composed of all the deliverables with which a single responsible partner contributes to the instrument construction Work Package (WP). The deliverables that compose the Work Units are indicate in the Work Breakdown Structure (WBS). The work unit documentation will contain the technical and project information related to the included deliverables. In what follows, the deliverables are extracted from the instrument WBS and associated with each Work Unit.

There are three partners responsible for delivering the CSPEC instrument (PBS 13.6.10): TUM, LLB and ESS. In what follows, we describe deliverables for each Work Unit. We note, that in some occasions several partners contribute different sub-systems of the same system.

Throughout the document, note that although the higher level WBS numbers are given for clarity, the deliverable is always the level after 13.6.10.

3.1.1 TUM Work Unit

This Work Unit provides the TUM contribution (50% of the total CSPEC budget) to the CSPEC project and include:

Neutron Optics

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM
- 13.6.10.1.1 Beam extraction system
  - 13.6.10.1.1.1 Monolith insert
    - 13.6.10.1.1.1.1 Guide elements
- 13.6.10.1.2 Beam delivery system
  - 13.6.10.1.2.1 Neutron guide system
- 13.6.10.1.4 Beam geometry conditioning
  - 13.6.10.1.4.2 Slit collimation system

13.6.10.9 SUPPORT INFRASTRUCTURE
- 13.6.10.9.2.2 Hall D03
  - 13.6.10.9.2.2.1 Infrastructure connections for guide
  - 13.6.10.9.2.2.2 Infrastructure connections for choppers
- 13.6.10.9.2.3 Hall E02
  - 13.6.10.9.2.3.1 Infrastructure connections for guide
  - 13.6.10.9.2.3.2 Infrastructure connections for choppers

13.6.10.10 CONTROL RACKS
- 13.6.10.10.4 Hall E01
  - 13.6.10.10.4.3 Motion control rack
    - 13.6.10.4.3.1 Control Slit collimation system
    - 13.6.10.4.3.2 Control Guide end changing system

Chopper System

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM
- 13.6.10.1.3 Chopper system
  - 13.6.10.1.3.1 Bandwidth chopper 1
  - 13.6.10.1.3.2 Bandwidth chopper 2
  - 13.6.10.1.3.3 Pulsing chopper assembly
  - 13.6.10.1.3.4 Monochromating chopper assembly
    - 13.6.10.1.3.6.1 RRM chopper
    - 13.6.10.1.3.6.2 Monochromating chopper pair

13.6.10.8 UTILITIES DISTRIBUTION (INFRASTRUCTURE)
- 13.6.10.8.2 Hall D03
  - 13.6.10.8.2.1 Power distribution
  - 13.6.10.8.2.2 Chilled water distribution

13.6.10.8.3 Hall E02
13.6.10.8.3.1 Power distribution
13.6.10.8.3.2 Chilled water distribution
13.6.10.8.4 Hall E01
13.6.10.8.4.1 Power distribution
13.6.10.8.4.2 Chilled water distribution
13.6.10.10 CONTROL RACKS
13.6.10.10.2 Hall D03
13.6.10.10.2.4 Chopper control rack
13.6.10.10.2.4.1 Band width chopper 1
13.6.10.10.2.4.2 Band width chopper 2
13.6.10.10.2.6 Personnel safety rack

13.6.10.10.3 Hall E02
13.6.10.10.3.4 Chopper control rack
13.6.10.10.3.4.1 Chopper control rack Pulse shaping chopper assembly
13.6.10.10.3.6 Personnel safety rack

13.6.10.10.4 Hall E01
13.6.10.10.3.4.2 Chopper control rack Monochromating chopper assembly

Shutters

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM
13.6.10.1.8 Beam cut off
13.6.10.1.8.4 Secondary shutter

Shielding

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM
13.6.10.1.10 Shielding
13.6.10.1.10.1 In-bunker shielding
13.6.10.1.10.2 Beamline shielding

Detectors

13.6.10.3 SAMPLE CHARACTERIZATION SYSTEM
13.6.10.3.2 Neutron detector system*
13.6.10.3.2.1 Neutron detector (TUM, LLB, ESS)

*The responsibility of the neutron detector is shared between the three partners of this project, TUM, LLB and ESS.

Beam Monitoring

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM
13.6.10.1.6 Beam validation
13.6.10.1.6.1 Beam monitors

Instrument Control

Provided by the MCA and DMSC groups.

Personnel Safety System

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM

13.6.10.1.8 Beam Cut off

13.6.10.1.8.1 Personnel Safety system

13.6.10.9 SUPPORT INFRASTRUCTURE

13.6.10.9.2 Hall D03

13.6.10.9.2.5 Fire protection

13.6.10.9.2.6 O2 monitoring

13.6.10.9.2.7 H2O leakage

13.6.10.9.3 Hall E02

13.6.10.9.3.5 Fire protection

13.6.10.9.3.6 O2 monitoring

13.6.10.9.3.7 H2O leakage

13.6.10.9.4 Hall E01

13.6.10.9.4.5 Fire protection

13.6.10.9.4.6 O2 monitoring

13.6.10.9.4.7 H2O leakage

3.1.2 LLB Work Unit

This Work Unit provides the the LLB contribution (50% of total) to the CSPEC project and include:

Secondary Spectrometer

13.6.10.2 SAMPLE EXPOSURE SYSTEM

13.6.10.2.1 Sample Stage

13.6.10.2.2 Sample environment equipment

13.6.10.2.2.1 Cryofurnace

13.6.10.2.2.2 Sample rotation stage

13.6.10.2.2.3 Multiple sample changer

13.6.10.2.2.4 Goniometer

13.6.10.2.2.5 He3 insert

13.6.10.3 SCATTERING CHARACTERIZATION SYSTEM

13.6.10.3.3 Vacuum system

13.6.10.3.3.1 Detector vacuum vessel*

13.6.10.3.3.1.1 Sample environment pot

13.6.10.3.3.1.2 Isolation system between sample and flight chamber areas

13.6.10.3.3.1.3 Flight chamber

*excluding vacuum pumps and controls, which are responsibility of the ESS Work Unit.

13.6.10.3.3.1.4 Radial Collimator

13.6.10.3.2 Neutron detector system*

- 13.6.10.3.2.1 Neutron detector
- 13.6.10.3.2.4 Neutron detector mechanical support structure
- 13.6.10.3.2.5 High voltage supply
- 13.6.10.3.2.6 Low voltage supply
- 13.6.10.3.2.8 Detector gas supply

*The responsibility of the neutron detector is shared between the three partners of this project, TUM, LLB and ESS.

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM

- 13.6.10.1.8 Beam cut off
  - 13.6.10.1.8.1 Personnel Safety System
  - 13.6.10.1.8.7 Beam Stop

13.6.10.5 EXPERIMENTAL CAVE

- 13.6.10.5.2 Utilities Distribution
  - 13.6.10.5.2.1 Power distribution
  - 13.6.10.5.2.2 Chilled water distribution
  - 13.6.10.5.2.3 Compressed air distribution
  - 13.6.10.5.2.4 Gas distribution
    - 13.6.10.5.2.4.1 Argon detector gas
    - 13.6.10.5.2.4.2 Helium
    - 13.6.10.5.2.4.1 Nitrogen
- 13.6.10.5.3 Support infrastructure
  - 13.6.10.5.3.1 Power
  - 13.6.10.5.3.2 Network
  - 13.6.10.5.3.3 Lightning
  - 13.6.10.5.3.4 Ventilation
  - 13.6.10.5.3.5 Fire protection
  - 13.6.10.5.3.6 O2 monitoring
  - 13.6.10.5.3.7 H2O leakage
  - 13.6.10.5.3.10 Local crane
- 13.6.10.5.4 Cave Shielding
- 13.6.10.5.5 Cave structure
- 13.6.10.5.6 Sample environment utilities supply
  - 13.6.10.5.6.1 Power board
  - 13.6.10.5.6.2 Supply gasses board
    - 13.6.10.5.6.2.1 Argon
    - 13.6.10.5.6.2.2 Helium
    - 13.6.10.5.6.2.3 Nitrogen
  - 13.6.10.5.6.3 Chilled water board
  - 13.6.10.5.6.4 Compressed air
  - 13.6.10.5.6.5 Liquids supply system

13.6.10.5.6.5.1 Nitrogen
13.6.10.5.6.5.2 Helium

13.6.10.10 CONTROL RACKS
13.6.10.10.4 Hall E01
13.6.10.10.4.1 DAQ rack
13.6.10.10.4.3 Motion control rack
13.6.10.10.4.6 Personnel safety rack

Instrument Control

Provided by the MCA and DMSC groups.

Control Hutch and Sample Preparation area

13.6.10.6 CONTROL HUTCH
13.6.10.6.1 Support infrastructure
13.6.10.6.2 Hutch building
13.6.10.6.3 Control terminal
13.6.10.7 SAMPLE PREPARATION AREA
13.6.10.7.1 Utilities Distribution
13.6.10.7.2 Support infrastructure
13.6.10.7.3 Cabin building structure
13.6.10.7.4 Lab equipment and sample storage

3.1.3 ESS Work Unit

Despite all the major components of the instrument to be delivered by TUM and LLB, ESS is going to be involved into every step of the process. It is to ensure a compliance of the CSPEC instrument with the ESS regulations. At the same time, ESS technical groups will look into technical solutions of CSPEC whenever those solutions could be implemented on other instruments or become standard requirements.

The following contributions will be provided by the ESS:

13.6.10.1 BEAM TRANSPORT AND CONDITIONING SYSTEM

13.6.10.1.1 Beam extraction system

13.6.10.1.1.1 Monolith insert
13.6.10.1.1.1.2 Monolith insert structure
13.6.10.1.1.1.3 Insert alignment mechanism
13.6.10.1.1.1.4 Streaming shielding

13.6.10.1.1.2 Monolith window

13.6.10.1.8 Beam cut off

13.6.10.1.8.2 Light shutter

13.6.10.1.9 Vacuum system

13.6.10.1.9.1 Beam delivery vacuum system
13.6.10.1.9.2 Chopper vacuum system

<u>13.6.10.3. SCATTERING CHARACTERIZATION SYSTEM</u>

13.6.10.3.3 Vacuum system*

*ESS will provide vacuum pumps and controls

<u>13.6.10.5 EXPERIMENTAL CAVE</u>

13.6.10.5.7 Sample environment control box

<u>13.6.10.10 CONTROL RACKS</u>

13.6.10.10.2 D03
13.6.10.10.2.5 Vacuum control rack
13.6.10.10.3 Hall E02
13.6.10.10.3.5 Vacuum control rack
13.6.10.10.4 Hall E01
13.6.10.10.4.2 DMSC rack
13.6.10.10.4.5 Vacuum control rack

<u>13.6.10.11. INTEGRATED CONTROL AND MONITORING</u>

13.6.10.11.1 Instrument control Integration
13.6.10.11.2 Personnel safety system integration
13.6.10.11.3 DMSC integration

3.2 Deliverables excluded from Work Units

All deliverables not explicitly mentioned in the Work Units description are excluded from the WP. Some exclusions that are nonetheless essential for the functionality and operation of the instrument are described below. These will be delivered by other parts of the ESS Programme, where the budget for these items are allocated.

3.2.1 Vacuum system

The ESS vacuum group will deliver the integration of hardware and software to operate the instrument components under vacuum and to control the vacuum components through the integrated control system. Apart from that, ESS is responsible for delivering and maintaining the vacuum pumps, excluding sample station.

3.2.2 Data Acquisition, instrument control and data processing

The data acquisition, instrument control and data processing are excluded from the formal scope and hence of the WP. It will deliver the control software necessary to control different components of the instrument and to conduct experiments. The software solutions for data processing and reduction will be provided by ESS in a close collaboration with the CSPEC team. In addition, ESS will provide the hardware and software to collect, store and analyse the data from the detectors and beam monitors.

3.2.3 Supporting laboratories and sample environment

Any sample environment equipment that is part of the ESS sample environment pool is excluded from the WP. The Scientific Activities Division (SAD) will provide a standard panel and mechanical interface that allows sample environment equipment from the ESS pool to be used at the instrument. Despite the sample preparation lab is part of LLB WP, we do expect to use the General User Lab in E03, particularly during the hot commissioning phase. The general user lab is however excluded from the WP.

3.2.4 Conventional facilities (CF)

That includes all civil construction activities not explicitly mentioned in the Work Units descriptions. This will be a part of the CF WP, i.e. supply of cooling/sprinkler water, electricity and gases up to the distribution points in the installation galleries.

3.3 Deliverables

In this section the deliverables for parties involved into the CSPEC project are summarized in a simplified manner.

There are two partners responsible for delivering the CSPEC instrument (PBS 13.6.10): TUM and LLB. Deliverables excluded from the Work Units that are nonetheless essential for the functionality and operation of CSPEC are listed in section 3.2. These deliverables will be provided by other parts of the ESS Programme and are not included in the costing. In what follows, we describe deliverables for each Work Unit.

Deliverables	Partner responsible	Cost k€
Neutron Optics	TUM	3180
Chopper System	TUM	1550
Shutters	TUM	20
Shielding	TUM	1130
Detectors	LLB, TUM, ESS	
	LLB	3462
	TUM	366
Secondary spectrometer excluding detectors	LLB	
Sample environment	LLB	350
Detector vessel	LLB	1426
Experimental cave	LLB	767
Control Hutch and Sample Preparation area	LLB	100
Beam Monitoring	TUM	70
Personnel Safety System	TUM, LLB	100

4. Project schedule

4.1 Time Schedule

The schedule of the WP is organized in four phases: Preliminary Design (Phase 1), Engineering Design (Phase 2), Procurement and Start of Installation (Phase 3) and Cold Commissioning (Phase 4). While the activities may overlap in time, the overall schedule is structured by the Tollgates (TG) reviews that mark the nominal end of each phase. The schedule presented here will be refined and adapted as the project progresses, but the major milestones (sections 4.2) serve as a basis for reporting.

4.2 Milestone Plan

The major milestones in the WP are divided into external milestones – that are out of control of the instrument team, but yet have a major impact – and progress milestones that are used to track progress and report to the Instrument Construction Sub-Project.

ID	External milestones	Projected date
1	Instrument Baseplate design freeze	15-Oct-17
2	Monolith insert delivered to ESS site	Nov-18
3	Monolith insert ready for installation	Mar-19
4	Full Access E01	Apr-19
5	Partial access E02 - Area 1	Apr-19
6	Partial access E02 – Area 2	Oct-19
7	Access to D03 bunker	Nov-19
9	Partial access D03	Nov-19
10	First Proton on Target	Oct-20

ID	Progress milestones	Projected date
1	In bunker Neutron Optic design frozen	Oct-17
2	Guide design frozen	Oct-17
3	Chopper system design frozen	Dec-17
4	Detector vessel design frozen	Dec-17
5	In Monolith Neutron Optic Procurement	Jan-18
6	Experimental Cave design frozen	Mar-18

7	TG3 (Phase 3)	Mar-18
8	In Bunker Neutron Optic Procurement	May-18
9	Chopper procurement	Jun-18
10	Guide procurement	Jul-18
11	Detector vessel procurement	Jul-18
12	Detector procurement	Jul-18
13	Monolith insert delivered to the ESS site	Nov-18
14	Radial Collimator procurement	Jan-19
15	Shielding delivered at the ESS	Mar-19
16	Shielding Pre installed in E01	Apr-19
17	Shielding Pre installed in E02 Area 1	Jun-19
18	Experimental cave procurement	Sep-19
19	Shielding Pre installed in E02 Area 2	Nov-19
20	In bunker guide delivered at the ESS	Nov-19
21	BW choppers delivered at the ESS	Nov-19
22	Start in-bunker installation	Nov-19
23	BW Choppers installed	Jan-20
24	Shielding Pre installed in D03	Feb-20
25	In-bunker installation done	May-20
26	TG4 (Phase 4)	May-20
27	Guide delivered at the ESS	May-20
28	Guide installed in E01	May-20
29	Guide installed in E02-D03	Jun-20
30	High speed choppers delivered at the ESS	Jul-20
31	Radial collimator delivered at the ESS	Aug-20
32	High speed choppers installed	Sep-20
33	Shielding installed	Nov-20

34	Detector delivered at the ESS	Feb-21
35	Detector vessel delivered at the ESS	Feb-21
36	Radial collimator installed	Mar-21
37	Detectors installed	May-21
38	Experimental Cave installed	Jun-21
39	Detector Cave shielding installed	Sep-21
40	Hot Commissioning Start	Dec-21

5. Project budget and financial reporting

5.1 Project budget

Below is the project budget divided according the CSPEC subsystems for 4 phases, all the prices are in k€.

	01 Preliminary Design	02 Engineering design	03 Procurement & Start of Installation	04 Installation and Start of Cold Commissioning	Total
01 Shielding	0	0	1129	0	1129
02 Neutron Optics	0	0	3097	99	3196
03 Choppers	0	0	1480	0	1480
04 Sample Environment	0	0	375	0	375
05 Detector (B10)	0	300	4979	0	5279
05.1 Detector set (33m²)	0	0	3853	0	3853
05.2 Detector Tank and Beam Monitors	0	300	1126	0	1426
06 Data Acquisition and Analysis	0	0	0	0	0
07 Motion Control and Automation	0	48	33	19	101
08 Instrument Team	484	936	528	375	2323
09 Instrument Infrastructure (Cave and Shielding)	0	0	867	0	867
10 Vacuum	0	0	0	0	0
11 PSS	0	33	33	33	100
Total (without contingency)	484	1318	12521	527	14850
12 Contingency					1650
Total (with contingency)					**16500**

The budget of each Work Unit is presented below (the contingency and the VAT are not included).

Work Unit	Preliminary design (k€)	Final Design (k€)	Procurement (k€)	Cold commissioning (k€)	Total (without contingency) (k€)	Contingency (k€)	Total	%
TUM	272	495	6366	292	7425	825	8250	50
LLB	212	823	6155	235	7425	825	8250	50
Total (k€)	484	1318	12521	527	14850	1650	16500	100

6. Project risk management

The risk analysis was divided into three different categories: technical, cost and schedule related. The probability was assigned to each potential event. The risk level then was calculated by multiplying probability by estimated effect. As a result, the high, medium and low risk levels were identified.

6.1 Risk list

Low (1-4)
Medium (5-6)
High (7-15)

Technical

Technical				
Risk	Probability	Effect	Mitigation	Risk level
B10 multigrid detectors do not perform as expected	2	5	Detector technical group is following an action plan and schedule for delivery to CSPEC of B10 detectors. Identify the factors that can be changed to improve the performance of the detectors by doing tests on similar spectrometers. Responsible : CSPEC team, NSS Detector group	10
Parasitic scattering in the detector tank	2	4	Design with parasitic scattering in mind. Plan for additional work during hot commissioning. Plan tests with multiple modules to identify multiple scattering effects that could occur. Responsible : CSPEC team	8
Shielding design is not adequate	2	3	Design to the scientific specifications. Follow the progress of the design and project schedule. Plan for additional work during hot commissioning. Responsible : CSPEC team	6
T0 Chopper needed to improve the instrument	2	2	During the design, ensure space for a future installation of a T0 chopper Responsible : CSPEC team	4
Difficulty to access the BW chopper in the bunker	2	2	Follow the bunker design process and ensure adequate interaction with bunker team Responsible : CSPEC team, NSS Bunker group, NSS Management	4

Cost

Cost				
Risk	Probability	Effect	Mitigation	Risk level
Detector tank cost estimates are exceeded	5	3	Use the previous design of similar projects to identify the key parameters that strongly influence the cost of the detector tank. Resolve them before the call for tender. Check the cost difference between the different manufacturers. Carefully follow the price of the raw material before signing the contract. Responsible : CSPEC team	15
Detector cost estimates are exceeded	3	3	Work together with the Detector technical group to identify the cost parameters. Start the work on day one with reduced angular coverage. Check the price of all the subcontractor and the impact of other solutions. Responsible : CSPEC team	9
Manpower required exceeds what is scheduled	2	3	Follow the project schedule quarterly with all the CSPEC team. Anticipate the incoming events and how it match in the project schedule Ensure timely intervention. Responsible : CSPEC team	6
Scope creep increase the manpower needed	2	3	Follow the project schedule. Freezing design concepts with finalised in a timely manner. Responsible : CSPEC team	6
VAT has to be paid by CSPEC team	1	5	TUM and NSS should work together in order to find a solution. Responsible : TUM, NSS Management	5

Schedule

Schedule				
Risk	Probability	Effect	Mitigation	Risk level
Delay in detector tank delivery	3	3	Identify the elements that could slow down the manufacturer. Check the time difference between the different manufacturers. Early procurement, select reliable vendor. Responsible : LLB team	9
Delay in detector delivery	3	3	Work with the Detector technical group to identify the parameters that influence the schedule. Fill the detector bank with the modules constructed and add the others later on. Early procurement. Follow the project in all the phase and plan visits to the selected manufacturer every three months. Responsible : NSS Detector group, CSPEC team	9
Delay in chopper delivery	3	3	Select reliable vendors, early procurement Responsible : TUM team	9
Delay in neutron optics delivery	2	3	Work in collaboration with the TUM to manufacture the guide in-house. Early procurement of all pieces that cannot be manufactured in house. Responsible : TUM team	6
General procurement delays	2	3	Early procurement of the critical items. Responsible : CSPEC team	6
Late arrival and installation of components during the time allocated for the bunker opening	2	2	Close collaboration with bunker team. Ensure timely procurement of components. Responsible : TUM team, NSS Bunker group	4

Further detail how we will cope with high level risks:

B10 multigrid detectors do not perform as expected

Tests will be made on 4SEASONS or SEQUOIA with at least 2 detector modules installed. The Al window in front of the detector boxes will be designed to hold the vacuum in a case very similar to CSPEC. During the manufacturing, the CSPEC team will carefully work with the detector technical group to ensure that the detector specifications will be obtained.

Parasitic scattering in the detector tank

Allocate time during the hot commissioning for the work required. Limit the material in the direct beam. Have a neutron absorbing material on the inner face of the detector tank. Optimise the radial oscillating collimator. Employ absorbing vanes between each detector modules so that they cannot see each other.

Detector tank cost estimates are exceeded

Start the writing of the tender as soon as possible and plan for an early procurement. Plan regular meetings with the manufacturers. Engage the tender with as many subcontractors as possible to ensure that the market is not dominated by only one subcontractor. Use the knowledge of previous projects to identify the key factors. One of the key factor is the possibility to deliver the tank in a single piece rather than in smaller pieces. The CSPEC team must work with the ESS to find a solution on how to install it in E01 Hall.

Detector cost estimates are exceeded

Start the work on day one with a reduced coverage of the electronics. Start the hot commissioning with a reduced horizontal coverage of the detectors and plan to add the missing module in the upgrade program of the ESS. Accept a longer time for the manufacturing in exchange of a lower price. Subcontract some of the work to in-kind contributors (BrightnESS).

Delay in detector tank delivery

Start the writing of the tender as soon as possible and plan for an early procurement of the vessel. Use the knowledge of previous projects to identify the factors that could influence the schedule. Follow the project in all the phases and plan visits to the selected manufacturer every three months. When the contract has been signed, plan a meeting with the installation, logistic and security groups of the ESS.

Delay in detector delivery

Separate the Work Package in several units with separate delivery time. Install the modules as soon as they are delivered. Start with less detector coverage and add the other when they are delivered.

Delay in chopper delivery

Start as soon as possible the writing of the tender and plan for an early procurement on the high speed and the BW choppers. Select the reliable vendors that can deliver the choppers on schedule. When the contract has been signed, plan a meeting with the installation, logistic and bunker groups of the ESS.