

**Description**

Document No

1.0

Date

Wednesday 7th Nov, 2012

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## Neutron Optics Group Charter

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## 1. DOCUMENT VALIDATION OF VERSION 1.0

Date	Name	Signature
23rd August, 2012	P. Bentley	
23rd August, 2012	R. Hall-Wilton	
23rd August, 2012	I. Sutton	
23rd August, 2012	A. Hiess	
23rd August, 2012	K. Andersen	
23rd August, 2012	R. Connatser	
23rd August, 2012	O. Kirstein	

## 2. DOCUMENT REVISION HISTORY

Version	Reason for revision	Date
0.0	First Draft	15th June 2012
0.1	Approval from stakeholders, circulation for management comments and/or approval	23rd August, 2012
1.0	Document Published to Chess	November, 2012

### 3. EXECUTIVE SUMMARY

The European Spallation Source ESS AB will design, build and operate a multi-disciplinary, large-scale research infrastructure based on the world's most powerful neutron source. ESS will provide scientists with unique and powerful neutron scattering instruments for the study of a large range of materials – from polymers and pharmaceuticals to membranes and molecules. The ESS project is partnered by 16 European countries, and hosted by Sweden and Denmark. The ESS will be built in Lund, Sweden, by a collaboration of European scientists and engineers. ESS is planned to produce the first neutrons by 2019. When the facility is in full operation 2025, ESS will have around 450 employees.

The Neutron Optics group is part of the Neutron Technology Division under the Science Directorate. The Neutron Technology Division provides the technological tools required for the design, construction and operation of the neutron instruments at the ESS. The Neutron Optics Group in the Neutron Technology Division will undertake development work to ensure that the instruments are equipped to perform world-leading science, in a close dialogue with the instrument scientists.

Staff in the Neutron Optics group will develop and design neutron optics solutions for the ESS instruments, such as beam extraction, guides & beam delivery, focusing and polarisation devices, as well as maintenance and shielding of these systems with each instrument project.

### 4. DOCUMENT OBJECTIVE

The purpose of this document is to define the mission, objectives and responsibilities of the neutron optics group and to outline the groups' interactions within the structure of the ESS organisation.

The document is intended to be written by the principal stakeholders in the group and to bring together all information fundamental to the establishment and subsequent running of the group. The document will be validated by the facilities directors.

### 5. DOCUMENT SCOPE

The document concerns the establishment, and running of, the neutron optics group within the Neutron Technology Division. All aspects of the groups functions and responsibilities within the organisation are addressed.

### 6. NOMENCLATURE

In this document, the following terminology is used.

**Beam extraction system:** all non-mechanical apertures, neutron guides, neutron mirrors, neutron filters, neutron guide windows, neutron guide mountings & supports, neutron guide shielding (excluding the monolith shielding) and neutron guide alignment systems within the target monolith structure, up to the containment barrier window and membrane of the target monolith (at the time of writing, six metres from the moderator central axis).

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**Beam delivery system:** all non-mechanical apertures, neutron guides, neutron mirrors, neutron filters, neutron guide environment control, neutron guide supports, neutron guide alignment devices, neutron guide shielding, neutron guide shimming & lining, from the outer boundary of the beam extraction systems until the final aperture nearest to the instrument sample position.

**Neutron beam system:** both the beam extraction system and the beam delivery system.

Neutron optical system: the neutron beam system and any specialised conditioning devices that manipulate the spatial dimensions of the beam, the divergence of the beam, the neutron spin polarisation of the beam, or diffractive devices that alter the wavelength distribution of the beam. Neutron optical systems exclude mechanical devices such as choppers and velocity selectors. Unlike the neutron beam system, which stops at the entrance to the neutron instrument, the neutron optical system may include elements beyond the sample position.

**Neutron Guide Shimming:** additional material added to the neutron guide assembly between the guide and the surrounding shielding that reduces the unwanted neutron beam current outside of the neutron guide, sometimes called "streaming neutrons" at other facilities. Shimming can be in the form of thin plates and wedges of an appropriate material with good neutron and gamma attenuating suppression.

## 7. REQUIREMENTS

ESS is planned to produce the first neutrons by 2019, at which date it will operate an initial suite of seven scientific instruments. The full suite of instruments will be realised in 2025, comprising 22 instruments. The reference instrument suite, which the ESS is using for costing and planning purposes until the instrument concepts are selected, suggests a total length of 2000 m of shielded neutron guide systems, with numerous geometrical shapes being likely depending on the transport distances and the specifications of the beams in question.

In addition to the beams, the neutron optics group will supply spin-polarised helium 3 at the same time as the first neutrons, and the ability to manufacture polarising supermirrors at the same time as the first neutrons.

The need for the group to obtain the ability to manipulate crystal monochromators, or possibly manufacture crystal monochromators, will be assessed in 2013 and onwards as the instrument concepts are developed.

## 8. MISSION STATEMENT

The group will develop, in collaboration with European research laboratories, and implement technical solutions for the neutron optical system requirements of the ESS instruments.

The group will be responsible for ensuring all systems meet stated requirements for neutronic performance, serviceability, safety and cost throughout their operating life.

To this end the group will be responsible for the management and achievement of all stages of system development, design, procurement, acceptance, installation, commissioning and

maintenance of all neutron optical systems at the ESS in support of, and in collaboration with, the Lead Instrument Scientists.

To be a centre of excellence, both through in-house efforts and collaborative/in-kind partners, in the development of novel neutron optical and shielding technology to be able to provide optimal performance for neutron optical systems for ESS instruments.

To contribute to the scientific and intellectual output and reputation of ESS, through developments directly or indirectly relating to neutron instrumentation technologies.

The Neutron Optics Group will provide the expertise and resources to realise all of these objectives.

## **9. STAKEHOLDERS**

### **9.1. Decision Makers**

- ESS General Director
- Director of Science Directorate at ESS
- Head of Neutron Technology Division
- Head of Instrument division

### **9.2 Clients**

- Lead Instrument Scientists
- Instrument support projects
- Operational instruments

### **9.3 Influencers**

#### **9.3.1 ESS Internal Groups**

- Head of Design Office
- Chief Instrument Project Engineer

#### **9.3.2 ESS External**

- Scientific partners
- Work unit managers
- Technical partners
- TAP and or STAP

## **9.4 Observers**

- Technical Partners
- Scientific Community
- General Public

## **9.5 Suppliers and Partners**

### **9.5.1 Internal to the ESS**

- Design Office
  - Drafting Services
  - Structural simulation
  - Structural calculation
  - Engineering services
- Target group
  - Simulation services
- Conventional Facilities
- Instrument Construction Office
  - Scheduling/Planning
  - Construction & Installation services
- On site workshops
- Computing services
- Data management
- Software supply
- Procurement
- Contracts
- Financial Services
- Administration Services

### **9.5.2 External to the ESS**

- System suppliers



- Component suppliers
- Engineering firms
- Technical partners (collaborating universities and facilities)

## 10. SPONSORS

**Neutron Technology Division, Science Directorate**, on behalf of the board of the ESS, will fund the group's running costs, investment programmes and cost associated with the strategic development programs.

**Instrument Projects** will fund direct development, production and installation costs for systems ordered. Instrument projects may participate in the funding of development in areas of specific interest.

**Facility Operations** will contribute to the cost of operating and maintaining installed equipment.

## 11. SCOPE

The group will implement technical solutions for all the neutron optical requirements of the ESS instruments. In the course of this mission the group will manage and/or execute tasks related to optical system design, development, procurement, manufacture, assembly, testing installation, maintenance and repair.

In order to maintain the highest possible levels of performance and service, the group will conduct research and development into appropriate technologies to increase performance.

These activities may be performed in-kind, in-house, through collaborative work or through commercial partners, but the management responsibility will lie in the optics group.

### 11.1 Principle Responsibilities

#### 11.1.1 Research And Development

1. Design, construction and management of an **ESS test beam line**, in collaboration with the instrumentation division and detector group.
2. **Research** into general, non-instrument-specific technologies that enable the manipulation of neutron beams in novel ways that may be of future use to the facility and other neutron science centres, in collaboration with ESS staff and external academic staff.

#### 11.1.2 Design Phase

3. **Design, assembly, validation, installation, commissioning** and **maintenance** of the **beam extraction systems** of the neutron instruments in collaboration with instrument project leaders. Participation in the designs of optical systems for beam monitors, choppers, velocity selectors and shutters.

4. **Heat load estimation** on the models of the guides to estimate longevity.
5. **Radiation fluence estimation** on the guides to estimate longevity.
6. **Design, assembly, validation, installation, commissioning** and **maintenance** of the **beam delivery systems** in collaboration with Lead Instrument Scientists.
7. **Participation** in **cross functional working groups** related to neutron optics, instrument design, and review panels such as **STAPs** and **TAPs**.
8. **Participation** in the compilation of the performance **specifications** and **quality controls** on neutron optical systems for instrument teams.
9. **Estimation** of the **dose rates** and **emittance rates** provided by the shielding solutions outside the monolith, for both radiation protection and instrument background.
10. **Participation** in **risk analysis** associated with neutron optics, beam delivery and shielding, both at an individual instrument level and at a site level as a result of cross-talk and total influence of all systems.
11. **Improvements** to the shielding where necessary due to "hotspots" and discrepancies between numerical models and actual emittance.
12. **Definition** of appropriate **standards** and **metrics** to be able to achieve the mission and to be able to compare competitive optical technologies in an objective fashion.

### 11.1.3 Procurement

13. The **procurement** of neutron optical systems and associated tools and spare components, or in-house **manufacturing** as appropriate.
14. The collection and production of the required **technical documentation**, as required, for the manufacture and acceptance testing of components and systems. Documents may include technical specifications, systems engineering documents, verification and validation protocols, test procedures, installation & operation manuals.
15. The **technical discussion** with suppliers prior to order placement and during production as required.
16. The **selection** and **validation** of potential equipment suppliers.
17. **Technical validation** of procurement proposals and supplier tenders prior to order placement.
18. The responsibility for **inspection** and **quality control** functions, as required, throughout the procurement process.
19. **Validation, benchmarking, characterisation** and **long term monitoring** of the entire moderator, beam extraction systems and beam delivery systems assembly after deployment to aid in diagnostics and performance evaluation with regard to upgrades, improvements and future instrumentation.

20. Identification of paths to **further improvement** of optical systems, and execution of improvements if requested, in partnership with other groups in the ESS, for both instrument performance and safety, as new technology and methodology emerges.
21. Supply of **helium 3 polarisation service** to the instrument suite of appropriate capacity.
22. Subsequent expansion or reduction of helium 3 production capacity as required, subject to strategic review of requirements by the ESS management as the facility evolves.
23. Supply of **supermirror polarisation devices** to the instrument suite after first neutrons in 2019.
24. Development and supply of **other neutron optical technologies** as they emerge and are identified as key technologies for the ESS.

#### **11.1.4 Assembly, Test & Inspection**

Group activities will include:

25. The establishment of **assembly, test and inspection facilities** as required to conduct the agreed test program.
26. The conduct of inspection and test functions throughout procurements operations as required to ensure conformity of equipment with specified values. Inspection may include the control of components at suppliers premises and the conducting of 'factory' and 'customer' acceptance testing.
27. **Verification** and **validation** of all aspects of equipment **performance**, to specified values, of all new or modified optical systems or components.
28. **Verification** and **validation** of system **safety** requirements and compliance to the national and international standards in rigour.
29. The **authorisation** of equipment and components as 'fit for installation'. Responsibility for design and implementation features and/or procedures to ensure the safe operation of equipment and the interdiction of operation in unsafe modes or configurations.
30. The **validation** of systems' **endurance** and serviceability through the conduct of equipment 'endurance testing'.
31. The **manufacture** and testing of **prototypes** for the purposes of research and development.

#### **11.1.5 Commissioning**

Group responsibilities will include:

32. **Commissioning** of the optics and associated equipment so that they perform to agreed specifications.
33. Provision of **diagnostic tools** and consultation (e.g. for spectroscopy and flux measurements of slow, epithermal fast neutrons, gamma, and other particles), including

validating neutronic performance, background determination, validation and reduction. This will be done in collaboration with the instrument groups and others in the Neutron Technology Division.

34. Other **consultation** with associated groups, as needed during the commissioning phase.

### 11.1.6 Decommissioning

35. **Consultation** on decommissioning and disposal of neutron optical systems at the end of their lifetimes, in terms of the documented material contents of the systems and their expected activations and phases.

## 12. SCOPE – EXCLUSIONS

1. High-end tools for virtual experiments in order to plan, optimize and model measurements (already covered by DMSC, although initial design work in the neutron optics group could be a useful starting point to feed into DMSC instrument modelling projects).
2. Project management.
3. Instrument design.
4. Shielding requirements for the target monolith.
5. Choppers and velocity selectors.
6. Beam monitors.
7. Shutters.
8. During normal operations, the responsibilities of the neutron optics group will be restricted to inspection, minor maintenance activities and consultation on best practice and optimising performance at the request of the instrument scientists. (Please refer to the next section for details on maintenance and repair).
9. Containment safety barriers on target building.
10. Decommissioning and disposal of irradiated and activated systems.
11. Supply of supermirror polarisation devices to instruments prior to 2019.

## 13. DELIVERABLES

### 13.1 Tangible

1. **TDR input** representing best available current knowledge on neutron optics.
2. **Baseline performance figures** for reference instrument beamlines using baseline source characteristics.

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3. **Design report** on reference systems.
4. **Refined performance** figures for each specific beam line after each instrument is selected for construction.
5. **Design report** for each of the optical systems at each stage of the instrument construction project.
6. **7 aligned, commissioned neutron beams on day 1**, optimised for the instruments they serve and striking an appropriate balance of performance, risk, cost, and deployment schedule as determined by the ESS management and steering committee.
7. High performance **helium 3 polarisation service** available on day 1.
8. High performance **supermirror polariser manufacture** available on day 1.

## 13.2 Intangible

9. **Coordination of optics efforts** via CFWG, STAP / TAP participation and review.

### 13.2.1 Services to clients

10. **Development:** the group will develop technical solutions and methods to continually improve the performance, lifetime costs and reliability of installed and future systems.
11. **Installation:** the group will carry out the installation, on site, of all optical systems and associated support equipment, and the set up and testing of all systems during commissioning.
12. **Commissioning:** commissioning of optical systems to bring them to their specified performance. Consultation, as requested, to help aid diagnosis of neutronic and background performance of instruments.
13. **Operations:** Consultation as requested by operational groups.
14. **Maintenance:** The group will conduct inspections and minor preventative maintenance where necessary in order to ensure the reliable, safe and cost effective functioning of all systems.
15. **Repair:** The group will conduct repair of all non-mechanical optical systems or components having suffered breakdown or having been subjected to accidental damage.
16. **Science profile:** Contribute to the scientific output and reputation of ESS, through developments and technical training, directly or indirectly relating to optics technology;
17. **Contributions to facilities design:** in the course of its duties the group will participate in and contribute to the design and optimisation of ESS facilities associated with or annex to optical systems including shielding, safety, electronics, data acquisition, integrated control systems as appropriate and required.

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**14. ASSUMPTIONS**

The neutron optics group will be provided the resources by the ESS, or provided the means of obtaining the resources, that are required to deliver the stated objectives with sufficient time to achieve the agreed scope by the agreed delivery date.

The neutron optics group will be involved in, and kept informed of, developments and discussions relevant to the optical systems within the ESS in order to meet the agreed objectives.

The performance of the neutron beam systems, in terms of the layout of the facility and the construction of the overall ESS site, the safety of the facility and the usability of the systems will be the top priorities over any aesthetic, artistic or cosmetic factors, including the placement of walls, gardens, plants, and also over the supply of utilities not essential to the workings of the ESS target, neutron optical systems, and instrument systems.

**15. SCHEDULE**

The schedule will be described in more detail in separate documents.

**16. BUDGET**

The budget will be defined with the ESS Management in 2013, and defined in detail in a separate document.

**17. AUTHORISATION****18. Group Authorisation**

Management agreement is hereby given with all points of the charter presented. Management support is pledged to the execution of the project towards these agreed objectives.

**19. Group Leader Authorisation**

Authorisation is hereby given to the group leader, by the direction of the ESS, to execute the project with the responsibilities defined in this document.