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| Service Level Framework AgreementIntegrated Control Systems – Neutron Scattering Systems |
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# Summary

This documents is intended to provide a high level overview of different interfaces between:

* Integrated Control Systems (ICS) Construction project (Jan 1, 2013 – Jun 30, 2019),
* ICS Initial Operations project (Jul 1, 2019 – Dec 31, 2025) on one side

and

* Neutron Scattering Systems (NSS) Construction project (Jan 1, 2013 – Dec 31, 2025) on the other side.

This includes technical and organisational matters as well as an agreement on the funding of the different activities and the installed material. The contents of this document describes to a suitable level of details the following:

* Definition of the modular control concept for Neutron Scattering Instruments at ESS
* Description of the single systems and responsibilities for technology development
* General description of interfaces between the systems
* Assigned system ownership and interfaces responsibilities for the construction phase
* Intended responsibilities for the operations phase
* Agreed budget allocations in P6 for the funding of hardware and manpower
* Applied standards, processes, procedures, guidelines etc.

This documents and the information contained should serve as basis of reference to:

* Single Service Level Agreements (SSLA) encapsulating the work, effort and structure related to one or more interfaces and
* Interface Control Documents (ICD) defining to a greater extent the technical details of the appropriated interface

This document is formally limited to the ESS construction / Initial Operation phase in the time limits described above (Jan 1, 2013 to Dec 31, 2025). Although there is a mutual under­standing that this framework agreement and the distribution of responsibilities listed should continue in the same way into the operations phase.

## Goal and scope of the document

The goal of this document is to describe to an understandable level of details all interfaces currently identified between the projects ICS and NSS within the ESS project. The level of details should be such that it can be used as basis for reference by SSLAs and ICDs. Further interfaces and services can be agreed upon and added in future versions of the document within the limits of chapter 8 and 10.

This document will define the different systems involved in the control of ESS Neutron Instruments, the distribution of responsibilities for the technology development of the systems between the projects ICS and NSS as well as the workflow on the resulting interfaces during construction. The intention is to continue with the distribution of responsibility into the operations phase of ESS.

Both projects ICS and NSS, in this document agree upon their budget allocations in Primavera P6 for the funding of equipment and manpower necessary to achieve the committed service levels.

# Modular Instrument control concept

## Systems overview

ESS will use EPICS as a global control system for instruments, machine (accelerator, target), central infrastructure and part of conventional facilities. It acts as a horizontal device layer and backbone for data exchange within a Neutron Instrument, between instruments and with other parts of the facility. The main signal flow for instrument control and operation will be between the systems (local control + instruments hardware) below and the software layer for instrument control and user interface on top (Figure 1, left part) and thus going vertically through the EPICS layer. All ESS hardware links to the EPICS layer by means of standardised input/output systems (control boxes).



Figure 1: Instrument control layers

The dashed blue line is separating areas of responsibility between ICS and NSS: ICS is providing the EPICS layer, the control boxes and for the rest of the facility also the other hard and software layer (Figure 1, right part). The Technical Groups of NSS are responsible for the systems of the Neutron Instruments. The Data Management and Software Centre (DMSC) as part of NSS provide software layers on top of EPICS.

Figure 2 gives a detailed view of the control concept breaking down the layers into single systems with lines representing control and data flows. The color code refers to different groups responsibilities for the control technology summarised in chapter 2.3. Direct single interfaces are represented by the red ellipsoid on the dashed blue line; described in detail in the following chapters. Interfaces represented by a dashed red ellipsoid are indirect or secondary interfaces representing a data exchange within the area of ICS responsibility. The range of data needs to be specified by NSS.



Figure 2: Overview of interfacing systems

## System scopes and functionalities

### Motion Control

Motion Control is the local control system for the motorisation of movements of instruments components. Most of the applications are covered by a generic motion control system, complex application use a dedicated and specialised control system. All systems are connected to the control and timing interfaces of the control box.

The responsibility for technology development is in the Motion Control & Automation Group (NSS).

### PLC + Rack Management

PLC is the local system to connect different actors and sensors necessary for the automation of the instrument. This could be solenoid valves for pneumatic actuators, temperature sensors or flow meters. Major part of the system will be dedicated to the management and monitoring of racks and cabinets. (Electrical) Motion Control, Vacuum Control, Cooling Control and Power Monitoring are excluded. It is connected to the control and timing interfaces of the control box.

The responsibility for technology development is in the Motion Control & Automation Group (NSS).

### Sample Environment

Sample Environment is the local control system for equipment temporary or permanently installed on an instrument close to the sample position and (often) comprising the sample. This includes control of the various physical quantities like temperature, magnetic field, electric field, pressure etc. Applications are covered by generic sample environment control systems, complex application use a dedicated and specialised control system. All systems are connected to the control and timing interfaces of the control box.

Depending on the data rate some equipment might also be linked to the Bulk Data Interface; this part is not subject of this agreement.

The responsibility for technology development is in the Scientific Activities Division (NSS).

### Chopper Control

Chopper Control is the local control system for the Neutron Choppers on the instrument. It consists of the motor controller, the magnetics bearings controller (if applicable) and a standardised Chopper Integration Controller (CHIC) to adapt the controller of different chopper manufacturers to a unified control interface. All systems are connected to the control and timing interfaces of the control box.

Depending on the data rate some equipment like condition monitoring systems might also be linked to the Bulk Data Interface; this part is not subject of this agreement.

The responsibility for technology development is in the Neutron Chopper Group (NSS).

### Detector Slow Control

Detector Slow Control is the local system for the control and time stamping of the different parameter of the detector and neutron beam monitors and it’s electronic like high voltage, low voltage, gas flow, gas bottle monitoring etc. All systems are connected to the control and timing interfaces of the control box.

The responsibility for technology development is in the Detector Group (NSS).

### Detector Readout

Detector Readout is the local system for the time stamping and readout of the neutron detectors and neutron beam monitors. All systems are connected to the control and timing interfaces of the control box.

The responsibility for technology development is in the Detector Group (NSS).

### Bulk Data Interface

Bulk Data Interface is the local system to collect fast data. Control of the system parameters includes selection of data source, current data rate, system status or other statistics etc. All systems are connected to the control and timing interfaces of the control box.

The bulk data interface provides direct interfaces for fast data from the Detector Readout but possibly also from Chopper and Sample Environment to DMSC, which all of them are NSS-internal interfaces and therefore not subject of this agreement.

The responsibility for technology development is in the Detector Group (NSS).

### Cooling Control

Cooling Control is the local control system for the cooling equipment installed on the instrument. Most of the applications are covered by a generic cooling control system on PLC basis; complex applications use a dedicated and specialised control system. All systems are connected to the control and timing interfaces of the control box.

The responsibility for technology development is within ICS.

### Power Monitoring

Power Monitoring is the local control system for the monitoring and time stamping of the different physical quantities in the power distribution of the instruments. Typical values to be monitored are voltage, current, power, grid quality, switching status of fuse breakers and main switches etc. The systems follow the standards already set in place by ICS and CF for the installations in the experimental halls and power substations. All systems are connected to the control and timing interfaces of the control box.

The responsibility for technology development is within ICS.

### Vacuum Control

Vacuum Control is the local control system for the vacuum equipment installed on the instrument. Most of the applications are covered by a generic vacuum control system on PLC basis integrating the different sensors, pumps and their appropriated control units; complex applications use a dedicated and specialised control system. All systems are connected to the control and timing interfaces of the control box.

The responsibility for technology development is within ICS.

### Personnel Safety Systems

This system is supervising the different areas of a Neutron Instrument ensuring the protection of personnel against hazards that might occur during the use of the instrument. It includes access control of the different instruments areas and shut down of neutron or proton beam in case of beam exposure in the supervised areas. It will be designed and implemented according to standard IEC 61508.

The system is connected to the control and timing interfaces of the control box for the time stamped status readings only; no control commands are possible over EPICS.

The responsibility for technology development is within PSS (ICS).

### Machine (Accelerator & Target)

This system represents all the data from accelerator and target that should be available at the instruments GUI or on the diagnostics user interfaces. They should be read in at the control box of the source, transported through the EPICS layer and displayed on the user screens.

The responsibility for technology development is within ICS.

### Building Management System

This system represents all the data from the building management system that should be available at the instruments GUI or on the diagnostics user interface. They should be read in at the control box of the source, transported through the EPICS layer and displayed on the user screens.

The responsibility for technology development is within ICS.

### Control Room

This system represents all the data or derivatives of the data from the different local control systems of the instrument that should be visible in the control room. They should be read in at the control box of the source, transported through the EPICS layer and displayed on the screens of the control room.

The responsibility for technology development is within ICS.

### Diagnostics User Interface

The diagnostic interface should serve technical personnel from ICS and NSS as an engineering interface to understand the control and data flow of the NSS hardware inside the EPICS network. It should directly interrogate the EPICS layer, cover all signal data available and might be limited to a pure monitoring functionality.

The responsibility for technology development is within ICS.

### Timing System

ESS is using a centralised absolute timing system. A generator is distributing the clock of a master oscillator and the absolute facility time to a number of timing receivers through a dedicated optical fibre network. A timing receiver is generally attached to a control box and provides a number of dedicated synchronous strobe signals according to the requirements of the local control units. The absolute time can be transferred through a communication interface.

The responsibility for technology development is within ICS.

### Control Box (CB)

The control box is a standardised input/output system to link the local control units to the EPICS network. It includes as functionalities the different hardware drivers (IOCs), the connectivity to the EPICS network and to the local control devices and in most cases the timing generator.

The responsibility for technology development is within ICS.

### EPICS

EPICS is the network connecting the different control boxes of an instrument with the rest of the facility. It could be organised physically in subnets on instruments level. It provides also a gateway to the DMSC network.

The responsibility for technology development is within ICS.

### Event Builder

The event builder system builds fast data into neutron events as required by the data aggregator.

It connects to the Bulk Data Interface of the Detector Group, which is an NSS-internal interface and therefore not subject of this agreement.

The responsibility for technology development is shared between DMSC and Detector Group (NSS) and defined by a separate agreement.

### Data Aggregation + Instrument Control

These systems represent the upper software layers on top of EPICS. The Instrument Control takes the commands from the user interface, interprets and sends them through the EPICS layer to the local control systems. The Data Aggregation is handling the stream of metadata from the different local control systems coming through the EPICS layer and transfers them to the user interface and to different storage media.

Data Aggregation collects also neutron data from the Event Builder, which is an NSS-internal interface and therefore not subject of this agreement.

The responsibility for technology development is within DMSC (NSS).

### User Interface

The User Interface provides the instruments users access to the different control systems of the instrument. It includes an Experts User Interface with the highest level of detail that should serve technical personnel from NSS as engineering interface to understand the data available in the DMSC software layer and to have full access to all control parameters.

The User Interface connects to the other software layers of the DMSC only and is therefore a DMSC (NSS) internal interface and not subject of this agreement. It is included in the graphics in Figure 2 for a better overall understanding of the concept only.

The responsibility for technology development is within DMSC (NSS)

## Control technology responsibilities

The table below gives a color-coded (s. Figure 2) overview of the responsibility for the evaluation, development and deployment of different control technologies used at ESS Neutron Instruments. As a general rule all technologies in ICS responsibility are deployed ESS wide, all technologies in NSS responsibility are used only in Neutron Instruments.

However it is agreed in this framework that the motion control technology will be used on all suitable ESS applications including accelerator and target. The Motion Control & Automation Group (MCAG) of NSS is responsible to collect requirements from all ESS applications and deploy a generic motion control system accordingly. The integration of that technology into accelerator and target application is in the responsibility of the ICS.

ICS is in charge to collect requirements from NSS for technologies in their responsibility and include them either directly in the development or deploy dedicated and adapted solutions for NSS applications. Hardware shall adhere to the standards listed in chapter 9.

Table 3: List of responsibilities for different control technologies

|  |  |
| --- | --- |
| **System** | **Technology Responsibility** |
| Motion Control (for whole ESS) | Motion Control & Automation Group (NSS) |
| PLC + Rack Management | Motion Control & Automation Group (NSS) |
| Sample Environment | Scientific Activities Division (NSS); Science Support Systems / Mechatronics and Software Integration Platform (SSS/MESI) |
| Chopper Control | Neutron Chopper Group (NSS) |
| Detector Slow Control | Detector Group (NSS) |
| Detector Readout | Detector Group (NSS) |
| Bulk Data Interface  | Detector Group (NSS) |
| Cooling Control | ICS |
| Power Monitoring | ICS |
| Vacuum Control | ICS |
| Personnel Safety Systems | PSS (ICS) |
| Machine (Accelerator & Target) | ICS |
| Building Management Systems | ICS |
| Diagnostics User Interface | ICS |
| Timing System | ICS |
| Control Box | ICS |
| EPICS | ICS |
| Event Builder | DMSC + Detector Group (NSS) |
| Data Aggregation | DMSC (NSS) |
| Instrument Control | DMSC (NSS) |
| User Interface | DMSC (NSS) |

There is a mutual understanding that the distribution of technology responsibilities should continue in the same way into the operations phase. This will cover service, maintenance, support in further development of applications and active obsolescence management of the respective control technologies. For accelerator and target applications the MCAG will cover support and obsolescence management activities only.

## Main interface types



4.

3.

1.

2.

Figure 3: Main interface types

The interfaces between ICS and NSS could be grouped into four different types (Figure 3):

1. Interfaces between ICS control box and local controls under NSS responsibility (including timing interfaces) – Chapter 3 + 6
2. Interfaces between control systems under ICS responsibility and NSS instruments hardware – Chapter 4
3. Software interfaces between EPICS and the DMSC layer – Chapter 5
4. Software interfaces within the EPICS layer – Chapter 5

A detailed description is given in the following chapters.

# Control and data flows (NSS Technology)

Control and data flows (NSS technology) represent the exchange of commands, status change requests, configuration changes, measurements and other non-experimental data between instruments devices under NSS responsibility and EPICS. This is usually done over a communication bus connecting to the control box (CB) representing the interface between ICS and NSS. These interfaces compose the group 1 defined in chapter 2.4. In Figure 2, they are represented with the following symbol:

## Control Box <-> Motion control

### NSS

1. Mechanical design and procurement of devices
2. Design and implementation of local protection for devices
3. Design and implementation of local control for devices
4. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices
5. Definition of functional specifications for devices

### ICS

1. Definition of requirements for Control Box (CB)
2. Procurement and installation of CB

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements for logical interfaces
3. Integration of devices into EPICS (deploying IOC)
4. Definition and implementation of device specific logic in EPICS
5. Definition and implementation of diagnostics user interfaces and applications

## Control Box <-> PLC + Rack Management

### NSS

1. Mechanical design and procurement of devices
2. Design and implementation of local protection for devices
3. Design and implementation of local control for devices
4. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices
5. Definition of functional specifications for devices

### ICS

1. Definition of requirements for CB
2. Procurement and installation of CB

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements for logical interfaces
3. Integration of devices into EPICS (deploying IOC)
4. Definition and implementation of device specific logic in EPICS
5. Definition and implementation of diagnostics user interfaces and applications

## Control Box <-> Sample Environment

### NSS

1. Mechanical design and procurement of devices
2. Design and implementation of local protection for devices
3. Design and implementation of local control for devices
4. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices
5. Definition of functional specifications for devices

### ICS

1. Definition of requirements for CB
2. Procurement and installation of CB

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements of logical interfaces
3. Integration of devices into EPICS (deploying IOC)
4. Definition and implementation of device specific logic in EPICS
5. Definition and implementation of diagnostics user interfaces and applications

## Control Box <-> Choppers

### NSS

1. Mechanical design and procurement of devices
2. Design and implementation of local protection for devices
3. Design and implementation of local control for devices
4. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices
5. Definition of functional specifications for devices

### ICS

1. Definition of requirements for CB
2. Procurement and installation of CB
3. Integration of devices into EPICS (deploying IOC)
4. Definition and implementation of device specific logic in EPICS
5. Definition and implementation of diagnostics user interfaces and applications

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements for logical interfaces

## Control Box <-> Detector Slow Control

### NSS

1. Mechanical design and procurement of devices
2. Design and implementation of local protection for devices
3. Design and implementation of local control for devices
4. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices
5. Definition of functional specifications for devices

### ICS

1. Definition of requirements for CB
2. Procurement and installation of CB
3. Integration of devices into EPICS (deploying IOC)
4. Definition and implementation of device specific logic in EPICS
5. Definition and implementation of diagnostics user interfaces and applications

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements for logical interfaces

## Control Box <-> Detector Readout

### NSS

1. Mechanical design and procurement of devices
2. Design and implementation of local protection for devices
3. Design and implementation of local control for devices
4. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices
5. Definition of functional specifications for devices

### ICS

1. Definition of requirements for CB
2. Procurement and installation of CB
3. Integration of devices into EPICS (deploying IOC)
4. Definition and implementation of device specific logic in EPICS
5. Definition and implementation of diagnostics user interfaces and applications

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements for logical interfaces

## Control Box <-> Bulk Data Interface Control

### NSS

1. Mechanical design and procurement of devices
2. Design and implementation of local protection for devices
3. Design and implementation of local control for devices
4. Definition of control, synchronization, diagnostics interface and data flow requirements for devices
5. Definition of functional specifications for devices

### ICS

1. Definition of requirements for CB
2. Procurement and installation of CB
3. Integration of devices into EPICS (deploying IOC)
4. Definition and implementation of device specific logic in EPICS
5. Definition and implementation of diagnostics user interfaces and applications

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements for logical interfaces

# Control and data flows (ICS Technology)

Control and data flows (ICS technology) represent the exchange of commands, status change requests, configuration changes, measurements and other non-experimental data between instruments devices with local control under ICS responsibility and EPICS. This is usually done over a communication bus connecting to the control box (CB) representing an ICS internal interface. The interface between ICS and NSS is the mechanical and logical integration of the device into the instruments. These interfaces compose the group 2 defined in chapter 2.4. In Figure 2, they are represented with the following symbol:

## Control Box <-> Cooling control

### NSS

1. Definition of functional specifications for devices
2. Definition and requirements for interfaces to instruments mechanics
3. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices

### ICS

1. Design and implementation of local protection for devices
2. Design and implementation of local control for devices
3. Definition of requirements for CB
4. Definition and requirements for interfaces between CB and local control
5. Procurement and installation of CB
6. Integration of devices into EPICS (deploying IOC)
7. Definition and implementation of device specific logic in EPICS
8. Definition and implementation of diagnostics user interfaces and applications

### Cooling Group (via ICS)

1. Mechanical design, procurement and installation of devices
2. Input into design of local control

## Control Box <-> Power Monitoring

### NSS

1. Definition of functional specifications for devices
2. Definition and requirements for interfaces to instruments mechanics
3. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices

### ICS

1. Design and implementation of local protection for devices
2. Design and implementation of local control for devices
3. Definition of requirements for CB
4. Definition and requirements for interfaces between CB and local control
5. Procurement and installation of CB
6. Integration of devices into EPICS (deploying IOC)
7. Definition and implementation of device specific logic in EPICS
8. Definition and implementation of diagnostics user interfaces and applications

### CF (via ICS)

1. Mechanical design, procurement and installation of devices
2. Input into design of local control

## Control Box <-> Vacuum control

### NSS

1. Definition of functional specifications for devices
2. Definition and requirements for interfaces to instruments mechanics
3. Definition of control, synchronization, diagnostics user interface and data flow requirements for devices

### ICS

1. Design and implementation of local protection for devices
2. Design and implementation of local control for devices
3. Definition of requirements for CB
4. Definition and requirements for interfaces between CB and local control
5. Procurement and installation of CB
6. Integration of devices into EPICS (deploying IOC)
7. Definition and implementation of device specific logic in EPICS
8. Definition and implementation of diagnostics user interfaces and applications

### Vacuum Group (via ICS)

1. Mechanical design, procurement and installation of devices
2. Input into design of local control

## Personnel Safety System -> Control Box

### NSS

1. Definition of workflow, access and operation modes of an instrument
2. Definition of interfaces to other control systems
3. Definition of status readings and monitoring through EPICS

### ICS

1. Support instruments design and construction
2. Design and implementation of safety system functionality
3. Definition of requirements for CB
4. Definition and requirements for interfaces between CB and system
5. Procurement and installation of CB
6. Definition and implementation of device specific logic into EPICS
7. Definition and implementation of user interfaces and applications

### Joint Responsibility

1. Mechanical design and procurement of devices
2. Definition and requirements for mechanical interfaces
3. Definition of functional specifications for safety system

# Data flows

Data flows are software interfaces. They represent the exchange of status information, measurements, configuration data and other non-experimental data between EPICS and the DMSC layer amd within the facility wide EPICS layer. The last-mentioned are secondary interfaces within the responsibilty of ICS. They are only defined by additional data reqirements on the interfaces in chapter 3, 5.1 and 5.2. These interfaces compose the groups 3 and 4 defined in chapter 2.4. In Figure 2, they are represented with the following symbol:

## EPICS -> DMSC Data Aggregator

### NSS

1. Definition of which data (meta data) should be delivered by the EPICS layer

### ICS

1. Delivery of data as specified

### Joint Responsibility

1. Definition and requirements for mechanical and logical interface

## DMSC Instrument Control -> EPICS

### NSS

1. Definition of which data (commands) should be delivered to the EPICS layer

### ICS

1. Receive data and transport them to the local control units as specified

### Joint Responsibility

1. Definition and requirements for mechanical and logical interface

## Machine (Accelerator & Target) <-> EPICS

### NSS

1. Definition of data to be acquired from accelerator and target

### ICS

1. Delivery of data as specified

## Building Management System (BMS) -> EPICS

### NSS

1. Definition of data to be acquired from BMS

### ICS

1. Delivery of data as specified

## EPICS -> Control Room

### NSS

1. Definition of instruments data to be sent to the control room

### ICS

1. Delivery of data as specified
2. Implementation of data display in the control room

### Joint Responsibility

1. Definition of how the data should be displayed

## Diagnostic User Interface <-> EPICS

### NSS

1. Definition of functional specifications
2. Definition of data to be displayed

### ICS

1. Definition of requirements
2. Implementation of the user interface

### Joint Responsibility

1. Definition and requirements for logical interfaces

# Timing Signals

Timing Signals represent the unidirectional exchange of timing data, events and triggers from the Timing Receiver to a device or a system over dedicated signal lines and/or a communication bus. In Figure 2, they are represented with the following symbol:

### NSS

1. Definition of data, events and synchronization triggers for devices
2. Definition of functional specifications for devices

### ICS

1. Definition of requirements for timing receiver
2. Procurement and installation of timing receiver
3. Definition and implementation of device specific logic into EPICS
4. Definition and implementation of user interfaces and applications

### Joint Responsibility

1. Definition and requirements for mechanical interfaces
2. Definition and requirements for logical interfaces

# System owners

A system owner is the liaison person for a device / system responsible for providing all the required information and other deliverables as required by the split of responsibilities. This table is representing the current state and is intended to be a living document during the lifetime of the project.

Table 4: List of system owners

|  |  |  |
| --- | --- | --- |
| **System** | **Owner (NSS)** | **Contact (ICS)** |
| Motion Control | Thomas Gahl | Klemen Strnisa ? |
| PLC + Rack Management | Thomas Gahl | Daniel? |
| Sample Environment | Anders Pettersson |  |
| Chopper Control | Iain Sutton |  |
| Detector Slow Control | Richard Hall-Wilton |  |
| Detector Readout | Scott Kolya |  |
| Bulk Data Interface | Scott Kolya |  |
| Cooling Control | Iain Sutton, Thomas Gahl, Anders Pettersson |  |
| Power Monitoring | Thomas Gahl |  |
| Vacuum Control | Iain Sutton, Thomas Gahl, Anders Pettersson |  |
| Personnel Safety Systems | Iain Sutton, Thomas Gahl, Anders Pettersson |  |
| Machine (Accelerator,Target) | TBD |  |
| Building Management System | TBD |  |
| Control Room | TBD |  |
| Diagnostics User Interface | Iain Sutton, Scott Kolya, Torsten Bögershausen, Anders Pettersson |  |
| Timing System | Iain Sutton, Scott Kolya, Thomas Gahl, Anders Pettersson |  |
| Control Box | Iain Sutton, Scott Kolya, Thomas Gahl, Anders Pettersson |  |
| EPICS | Torsten Bögershausen, Anders Pettersson |  |
| Data Aggregation | Tobias Richter |  |
| Instrument Control | Jonathan Taylor |  |

# Funding + Budget

Both projects ICS and NSS, in this chapter agree upon their budget allocations in Primavera P6 for the funding of equipment and manpower necessary to achieve the committed service levels. Unless agreed otherwise in the single SLAs, pinciple of funding is that activities in the responsibility of each of the project should be covered by their own appropriated budget. The budget numbers given below are final numbers and have to cover also all future interfaces not (yet) identified in this document.

## Hardware

ICS will support the instruments construction by supplying (=procure and finance), installing and connecting the hardware necessary for the EPICS infrastructure on all instruments of the NSS project. NSS will procure all local control systems on instruments budget.

### ICS Control Infrastructure Hardware

Hardware delivered and installed by ICS includes control boxes, timing receiver, network, switches etc.). The control boxes shall provide the following functional components:

* Enclosure, housing & power
* Operating system & EPICS IOC
* Timing synchronization (timing receiver) functionality
* Control network (EPICS) connectivity
* Fieldbus and device connectivity

However the total value of the delivered hardware is limited to the budget number in P6.

**WBS 14.6.12** Equipment (Control Boxes, network, switches etc.) **840 kEUR**

The budget is allocated in the construction projects budget of ICS. The procurement of all hardware within this value should be finished by June 30, 2019. The delivery of all hardware within this value should be finished December 31, 2025.

### ICS Vacuum Control

Budget for hardware of high-level vacuum control (PLCs) is allocated under WBS 14.6.x of the construction budget and ICS plans to cover instruments projects with this as well, however a fixed value for NSS cannot be guaranteed at this given point in time.

### NSS Local Control Systems

NSS will deliver all local control systems in their responsibility, financed by the instruments budgets. Hardware for personnel safety systems, cooling control and power monitoring is in the instruments budget as well. Control for sample environment pool equipment will come out of the Science Support Systems budget of NSS.

### NSS Motion Control Development

For the development of motion control technology, the characterisation of motion control components in harsh environment and prototyping of control technology NSS has budgeted as equipment:

**WBS 13.5.3.3** Motion Control & Automation / Generic Motion Control System **850 kEUR**

## Manpower

The allocated budget for manpower covers all work performed under “ICS” resp. “NSS“ responsibility and the respective parts of “Joint responsibility” work.

### ICS Manpower

ICS manpower estimates listed below is dedicated to technology development, competence building and integration of 16 instruments into the EPICS control structure.

#### Activities listed in the ICS Construction budget

ICS has in Construction project budgeted for NSS specific activities:

**WBS 14.12** Instruments integration support  **3 200 kEUR**

A part of the budget will be used to cover all activities in the framework of a common NSS-ICS EPICS integration exercise (2014 to 2016). Another part of the budget is intended to cover generic hardware evaluation and integration efforts as a part of supporting NSS technical group activities. The rest is dedicated to integrate all Neutron Instrumentation (16 instruments) into the control system. This includes also activities on the software interfaces with DMSC.

#### Activities listed in the ICS Initial Operations budget

ICS has in Initial Operations project budgeted for NSS specific activities:

**WBS 14.12** Instruments integration support **2 800 kEUR**

The budget is dedicated to continue integrating the suite of 16 Neutron Instruments into the control system. This includes also activities on the software interface with DMSC.

### NSS Manpower

NSS manpower estimates listed below covers the development of motion control technologies as well as the generic interface definition works for the different technologies and the integration of the interfaces into the 16 Neutron Instruments projects. It is part of the NSS Construction budget.

**WBS 13.5.3.3** Motion Control & Automation / Generic Motion Control System **1 391 kEUR**

**WBS 13.5.3.6** Motion Control & Automation / Embedded Software Engineering **716 kEUR**

**WBS 13.3.4** Science Support Systems / Mechatronics + Software Integration **1 224 kEUR**

**WBS 13.5.1.x** Chopper Systems / Control Systems Integration **560 kEUR**

**WBS 13.5.4.8** Detectors / Instruments projects  **1 218 kEUR**

**WBS 13.6.3 ff.** Manpower for the instruments integration will be financed by the budgets of the 16 Neutron Instruments work packages.

## Project Planning

Fixing collaborative project and budget planning necessary. Set up a coordination group with members from ICS and NSS.

### Budget Breakdown

Project and budget details for the identified interfaces have to be defined in appropriated single SLAs. Currently SLAs :

1. NSS-ICS EPICS integration exercise (2014 to 2016)
2. Neutron Chopper Integration

The Coordination Group needs to

### Yearly Planning Update

The Coordination Group will agree

### Budget Review

The Coordination Group will review the overall budgeted ICS equipment and manpower for the NSS project and the progress of use at the end of the budget year. Potential surplus from the technology development will benefit the instruments projects.

# Applied processes, procedures, guidelines etc.

All systems described above and the interfaces listed in the document shall adhere to the following ESS processes, procedures, guidelines and other applicable standards and entities:

* Hardware standards approved by the ESS Electronics Hardware Harmonization committee (E2H2C)
* Technical standards issued by the different technical groups of NSS
* Technical standards issued by ICS
* Relevant technical standards issued by other groups of the ESS

# Limitations

## Exclusion of Software Interfaces to Machine Protection System (MPS)

At the moment we don’t see any general interface definition necessary between the Machine Protection System (MPS) of the accelerator and the NSS instruments installation. MPS related matters will be evaluated on a system by system basis during the interface definition in the interface control documents. A single SLA will be issued if necessary.

## Future Interfaces

This document reflects current technical concepts and project planning.

## Limitation to ESS Construction / Initial Operations Phase

This document is formally limited to the ESS construction / initial operation phase from Jan 1, 2013 to December 31, 2025 as reflected by the limits of the current planning periods for the ESS project. There is a mutual understanding that the framework agreement and its distribution of responsibilities should continue into the operations phase, once an appropriated funding is established.

This reflects an important rationale of the ESS instruments construction: Ensuring a high level of availability and serviceability of the installed material by personal continuity from development to installation and operation.

# ANNEX

## Glossary of terms

|  |  |  |
| --- | --- | --- |
| **Term** | **Definition** | **Examples** |
| Device | A physical object performing a certain function | Vacuum pumpVacuum pump controllerMotorMotion controllerPower supply |
| System | A collection of devices;Per definition a system belongs to one technology | Proton source |
| Control Technology |  | Vacuum control, chopper control, personnel safety system |
| Control Box | Hardware and software interface between device / system and ICS (EPICS) | Proton source control box |
| Local Control | Control and monitor functionality specific and local to a device / system | Vacuum pump controller running the vacuum pumpMotion controller driving the motor |
| Local Protection | Control and monitor functionality specific and local to a device / system preventing the device / system from damaging itself.Local protection system can but is not required (unless specified otherwise) to provide inputs to MPS systems | End switches for motorsRF spark and arc detection systems |
| Mechanical Design | Self explanatory |  |
| Mechanical interface | Physical interface | Ethernet cable |
| Logical interface | Communication protocol | TCP/IPRS-232 |
| Expert user interface | User interface intended for the device / system owner |  |
| System Owner | Liaison person for a device / system responsible for providing all the required information and other deliverables as required by the split of responsibilities |  |
| Technology responsible | Group at ESS responsible for evaluation, development and deployment of that single control technology at ESS (or Instruments only) |  |
| Integration | Design, installation and commissioning of control technology on the different instruments projects | Chopper control on Instrument LOKI |

## List of Abbreviations

| Abbreviation | Definition |
| --- | --- |
| ICS | Integrated Control Systems |
| NSS | Neutron Scattering Systems |
| DMSC | Data Management & Software Center (NSS) |
| MCAG | Motion Control & Automation Group (NSS) |
| NCG | Neutron Chopper Group (NSS) |
| DG | Detector Group (NSS) |
| SAD | Scientific Activities Division (NSS) |
| SSLA | Single Service Level Agreement |
| ICD | Interface Control Document |
| ESS | European Spallation Source ESS AB |
| TS | Timing System |
| EPICS | Experimental Physics and Industrial Control System |
| CB | Control Box |
| IOC | Input Output Controller |
| BMS | Building Management System |
| P6 | Primavera (ESS Project Management System) |
| CF | Conventional Facilities Division |
| GUI | Graphical User Interface |
| PLC | Programmable Logic Controller |
|  |  |
|  |  |