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Document Title	Order Specification – Neutron Dose Rate Monitor (NDM)
Description	This document serves as an Order Specification for the NDM for PAS in FAIR
Division/Organization	SRP – GSI
Field of Application	Project “FAIR Accelerator and Experiments”

Document History

Version	Created, date	Reason for modification
V004	Dennis Gaßmann	Initial version after internal Review
V005	Dennis Gaßmann	Technical options modified and cable options refined

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Abstract

This order specification explains the design requirements on a system to be used as a stationary monitoring device for radiation monitoring of neutron dose rate for radiation protection areas within the Personnel Access System (PAS) and the interlock system at FAIR.

The system described here will be called "Neutron Dose Rate Monitor" (NDM).

The AID of the Neutron Dose Rate Monitor is AID: 0003896 "SRP Neutron Dose Rate Monitor".


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1. Purpose and Classification of the Document

This document explains the functional and technical requirements for an NDM (AID: 0003896) to be used as a stationary monitoring device for radiation monitoring of neutron dose rate.

In this document FAIR GmbH and GSI GmbH are referred to as the “Company” and the supplier is referred to as the “Contractor”.

All commercial and organizational conditions are specified in the commercial part of the contract.

2. Abbreviations, Terms and Definitions

Abbreviations and Terms	Definition
GSI	Helmholtzzentrum für Schwerionenforschung GmbH
FAIR	Facility for Antiproton and Ion Research
NE Areas	Radiation protection zones in particle accelerator where certain tasks are performed
PAS	Personnel Access System
NDM	Neutron Dose Rate Monitor
AID	Article Identifier
CID	Component Identifier

Table 1 Abbreviations and Terms of PAS

3. Scope of the Technical System

3.1. System Overview


Currently the international accelerator facility FAIR, one of the largest research projects worldwide, is being built in Darmstadt, Germany. A drawing of the GSI/FAIR complex is presented in Figure 1.

During the operation of heavy ion particle accelerators, radioactive radiation is produced due to unavoidable particle losses, especially a high neutron flux. Therefore, access to those parts of the accelerator complex where beam or remnant activation is present is strictly prohibited. The complex is divided into different areas. Depending on the experiments being executed, some areas will be exposed to radiation.

At the boundaries of these exposed areas and outside of the buildings on company premises the dose rate has to be monitored to ensure a low level of dose rate acceptable for working without any constraints of radiation.

Nevertheless a few NDMs will also be placed in high dose rate environments while beam operation or in areas with high remnant dose rates due to the specific layout of the facility.

For this purpose, the NDMs are needed.

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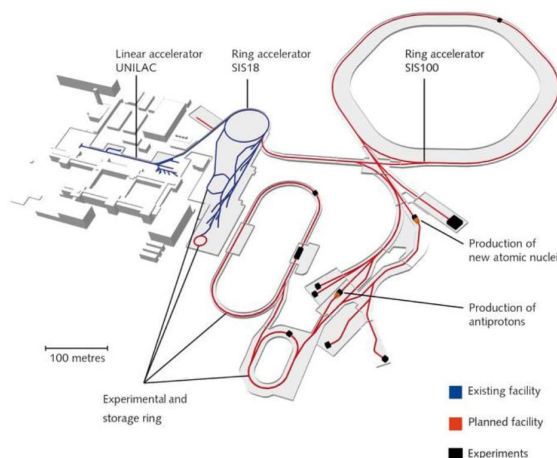


Figure 1 GSI/FAIR complex

3.2. Scope of Delivery

The scope of delivery comprises the delivery of a series of NDMs (**63 pcs** fix + 7 pcs as option A and further 8 pcs as option B or option C) in combination with a mechanical mounting option to place the NDMs on a wall or mounting plate and together with the necessary documentation. After the tender decision, a contract will be closed in order to provide the total amount of NDMs for FAIR. The precise amount of NDMs to be delivered for FAIR and other regulations will be specified in that contract.

Appropriate cables for the connection of a NDM with a control unit (described below), have to be offered optional. Due to space limitations on site the positions between a NDM and its control unit will vary. Therefore, different lengths of cables are required. The estimated total length of cables is given in Chapter 4.1).

CE conformity has to be declared.

Availability of spare parts and a service readiness must be guaranteed through the contractor for at least 10 years.


3.3. Spare Parts

The contractor has to provide a list of reasonable spare parts inclusive prices together with his offer, if applicable.

4. System Specification

4.1. Technical Requirements for System Components


All NDMs are identical therefore they have the same AID:0003896. The AID should be mentioned on the title page of each Document from chapter 6, if possible. Further the NDMs require a Component Identifier (CID) according to [2]. The CIDs to be used are listed in Table 2. The QR-code with the CID has to be placed on a **sticker**/label which will be delivered **separately** with the NDMs but not yet placed on them. The information of the QR-code on the sticker/label has to be read like this, e.g.: CID:50000005468

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The plain text, e.g.: CID:50000005468, has to be mentioned on the sticker as well.

Table 2 List of CIDs

AKS (Internal Number)	CID	AID
MB204.NE010.BR103	CID:50000005468	AID:0003896
MB204.NE010.BR113	CID:50000005536	AID:0003896
MB204.NE020.BR103	CID:50000005147	AID:0003896
MB204.NE020.BR113	CID:50000005680	AID:0003896
MB204.NE110.BR103	CID:50000005352	AID:0003896
MB206.NE110.BR103	CID:50000005895	AID:0003896
MB206.NE110.BR113	CID:50000005192	AID:0003896
MB206.NE110.BR123	CID:50000005642	AID:0003896
MB214.NE130.BR103	CID:50000005291	AID:0003896
MB214.NE140.BR103	CID:50000005345	AID:0003896
MB214.NE140.BR113	CID:50000005673	AID:0003896
MB217.NE110.BR103	CID:50000005178	AID:0003896
MB217.NE110.BR113	CID:50000005338	AID:0003896
MB217.NE110.BR123	CID:50000005857	AID:0003896
MB217.NE130.BR113	CID:50000005277	AID:0003896
MB218.NE110.BR103	CID:50000005048	AID:0003896
MB218.NE110.BR113	CID:50000005031	AID:0003896
MB218.NE110.BR123	CID:50000005611	AID:0003896
MB218.NE110.BR153	CID:50000005703	AID:0003896
MB218.NE110.BR173	CID:50000005321	AID:0003896
MB218.NE120.BR103	CID:50000005567	AID:0003896
MB218.NE120.BR113	CID:50000005543	AID:0003896
MB218.NE130.BR103	CID:50000005413	AID:0003896
MB218.NE130.BR113	CID:50000005246	AID:0003896
MB218.NE130.BR123	CID:50000005253	AID:0003896
MB267.NE110.BR103	CID:50000005444	AID:0003896
MB267.NE115.BR103	CID:50000005796	AID:0003896
MB274.NE110.BR103	CID:50000005710	AID:0003896
MB274.NE110.BR113	CID:50000005079	AID:0003896
MB274.NE110.BR123	CID:50000005208	AID:0003896
MB274.NE115.BR103	CID:50000005765	AID:0003896
MB276.NE110.BR103	CID:50000005314	AID:0003896
MB276.NE110.BR123	CID:50000005789	AID:0003896
MB276.NE120.BR103	CID:50000005802	AID:0003896
MB286.NE110.BR103	CID:50000005499	AID:0003896
MB303.NE110.BR103	CID:50000005918	AID:0003896
MB303.NE110.BR113	CID:50000005604	AID:0003896
MB310.NE020.BR103	CID:50000005406	AID:0003896
MB310.NE020.BR113	CID:50000005826	AID:0003896

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MB310.NE020.BR123	CID:50000005758	AID:0003896
MB310.NE020.BR133	CID:50000005383	AID:0003896
MB310.NE020.BR153	CID:50000005154	AID:0003896
MB310.NE030.BR103	CID:50000005451	AID:0003896
MB310.NE030.BR113	CID:50000005833	AID:0003896
MB310.NE030.BR123	CID:50000005512	AID:0003896
MB310.NE030.BR133	CID:50000005437	AID:0003896
MB310.NE030.BR143	CID:50000005420	AID:0003896
MB310.NE030.BR153	CID:50000005086	AID:0003896
MB310.NE030.BR163	CID:50000005062	AID:0003896
MB310.NE030.BR173	CID:50000005222	AID:0003896
MB310.NE030.BR183	CID:50000005505	AID:0003896
MB310.NE030.BR193	CID:50000005659	AID:0003896
MB310.NE030.BR203	CID:50000005390	AID:0003896
MB310.NE030.BR213	CID:50000005529	AID:0003896
MB310.NE030.BR223	CID:50000005574	AID:0003896
MB310.NE030.BR233	CID:50000005116	AID:0003896
MB313.NE110.BR103	CID:50000005109	AID:0003896
MB411.NE999.BR123	CID:50000005260	AID:0003896
MB411.NE999.BR133	CID:50000005475	AID:0003896
MB411.NE999.BR153	CID:50000005055	AID:0003896
MB411.NE999.BR163	CID:50000005284	AID:0003896
MB411.NE999.BR173	CID:50000005819	AID:0003896
MB412.NE999.BR103	CID:50000005161	AID:0003896
Option B or C		
MB412.NE999.BR203	CID:50000005666	AID:0003896
MB412.NE999.BR243	CID:50000005581	AID:0003896
MB412.NE999.BR263	CID:50000005901	AID:0003896
MB412.NE999.BR303	CID:50000005369	AID:0003896
MB412.NE999.BR333	CID:50000005215	AID:0003896
MB412.NE999.BR343	CID:50000005925	AID:0003896
MB412.NE999.BR353	CID:50000005772	AID:0003896
MB412.NE999.BR363	CID:50000005840	AID:0003896
Option A		
MB218.NE110.BR143	CID:50000005550	AID:0003896
MB218.NE110.BR133	CID:50000005697	AID:0003896
MB218.NE110.BR163	CID:50000005871	AID:0003896
MB412.NE999.BR293	CID:50000005017	AID:0003896
MB412.NE999.BR273	CID:50000005864	AID:0003896
MB412.NE999.BR323	CID:50000005093	AID:0003896
MB276.NE110.BR113	CID:50000005482	AID:0003896

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For details on the interface see chapter 4.3 “Interface”.

For the connection of the NDM and its control unit a cable is necessary which varies in length in principle for each single position of the NDMs due to space limitations. Nevertheless, it will be possible to define, together with the contractor, a few groups of cable lengths to standardize the cable orders, if necessary.

The offer for the cables should therefore be variable in terms of length to fit the space requirements.

The cables are defined as **option D** and should be offered separately as price per meter.

Option D:

Cable length for connection with the control unit	Estimated total amount
Price per meter	500 m

4.2. Functional Requirements

The chamber wall material has to be a non-metal material due to potential activation issues and better moderation, e. g. polyethylene.

For a better acceptance a dense material layer has to be used inside the chamber. Preferable not lead due to its toxicity, alternatively e. g. tungsten. Tungsten is providing an effective photon rejection.

A gas filled detector with He-3 counting tube is required. No BF3 gas due its toxicity and the lower acceptance in low energy neutron ranges.

The gas tube has to be cylindrical and requires a cylindrical polyethylene moderator at an equal distance from the tube to achieve angle independence from the neutron radiation.

The measurement range has to cover at least: 10 nSv/h up to 100 mSv/h.

The neutron fluence-to-ambient dose conversion of the neutron dosimeter should correspond to H*(10) values according to ICRP 74 and cover neutron energies from the thermal range up to 5 GeV.

NDMs have to be equipped with a preamplifier that provides a TTL output for connection to analysis or processing electronics.


4.3. Interfaces

The following interfaces must be provided by the system to guarantee a wired remote evaluation of the measurements and a sufficient power supply.

The NDMs have to be electrically and functionally compatible with the probe (Sonde) interface of the FHT6020 electronics system of Thermo Fisher Scientific which is part of the Companies equipment already. This allows direct connection, control, and data acquisition without the need for additional protocol converters, interface hardware, or custom software drivers compatible with the control unit.

The FHT6020 comprises of the main control and processing electronics for the NDMs which receives the signals from the NDM and converts it into digital RS232 or RS485 signals. It also generates the required voltage for biasing the counting tube, various alarm signals and also interlock signals.

A TTL output is required.

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The following options for communication interface are advantageous but not mandatory.

- 8 NDM-units should be provided with a different interface called **option C**, if available. These 8 units shall be equipped with a Sub-D 9-pin connector providing direct communication via an RS-485 interface. The communication protocol shall be the BEL protocol, enabling standalone operation and direct integration with NetView (Thermo Fisher Scientific) and NeuGamm software.

In case option C can be realized, it should be offered with a separate price.

In case option C is not available the 8 units have to be with the standard interface identical to the 63 units and is then called **option B**.

4.4. System Environment and Constraints


The NDMs will as well be installed in the inside of buildings and at least in parts in a high dose rate environment of controlled areas as also outside of the buildings.

Therefore, the typical range of temperature will be within -10 °C to +40 °C and the relative humidity will be up to 90 %. In most cases with no condensation expected due to controlled ventilation conditions.

Because of space limitations the NDM must not exceed the following dimensions.

- Height: 350 mm
- Diameter: 250 mm

The weight of the NDM should not exceed 15 kg to be easy moveable and transportable by hand.

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5. Quality Assurance, Tests and Acceptance

5.1 Quality Assurance System of the Contractor

The contractor has to follow the standards named in the chapters before in order to guarantee that the company is able to achieve the necessary functions. The contractor's quality assurance system shall comply with chapter 5 "Quality Assurance" of the General Specification [1].

Therefore, as part of the evaluation process during the public tender the contractor has to explain the details of his own quality assurance system in order to document his suitability.

FAT:

Each NDM has to be tested. The test results have to be documented in a quality protocol that is based on the quality plan for each individual CID and connected to the serial number of the NDMs. The quality protocol has to be submitted and released by the Company. The released FAT protocol gives the Contractor the permission for shipment.

SAT Aa:

After delivery to GSI a visual inspection will be done by the Company for each individual CID. The Company will provide a SAT Aa protocol to the Contractor, if requested.

SAT Ab:

Electrical tests and calibration will be done by the Company while installation. For each CID test and calibration results have to be documented by the Company. The Company provides a SAT Ab Protocol to the Contractor, if requested.

6. Documentation

- CE declaration of conformity and CE marking
- User manual
- Mechanical and electrical datasheet
- Mechanical drawings and 3D model (.pdf and .stp)
- Assembly instruction
- Risk assessment (if possible)
- Quality/test protocol for FAT
- Quality plan (if possible)

7. Related Documents

MANDATORY:

- [1] General Specification,
F-GS-PMO-en-General_Specification,
EDMS-ID: 1365092
- [2] FAIR Technical Guideline,
F-TG-B-05e_Component-ID_Barcode_System,
EDMS-ID: 1229368