



Document Title

Common Specification Beam Diagnostics for FAIR

Document Name

F-CS-BD-01e_Beam Diagnosticsv3.1.pdf

Date

2012-11-27

Abstract

This document describes the **Common Specifications** for all Parts and Components of the **Beam Diagnostic** system for the **FAIR facility**.

Table of Contents

1.	Purpose and classification of the document.....	4
2.	Scope of the Technical System	4
2.1.	System Overview.....	4
2.1.1.	BD Components.....	4
2.1.2.	Five Layer Structure of a BD Component.....	5
2.1.3.	BD Device Classes	7
2.1.4.	BD Sub-Systems.....	8
2.1.5.	Data Acquisition Software	9
2.1.6.	Slow Controls Software.....	9
2.2.	Limits of the System and Environment.....	9
2.2.1.	Constituents of BD Components / Scope of Delivery.....	9
2.2.2.	Interfaces to other Technical Systems.....	10
2.2.3.	Interfaces to Buildings / Civil Construction.....	10
2.3.	Basic Concept.....	11
3.	Responsibilities	11
4.	Technical Specifications	12
4.1.	Specifications for Mechanical Components.....	12
4.1.1.	Mechanical Parts of BD Components.....	12
4.1.2.	Mechanical Construction	12
4.1.3.	Assembly	13
4.1.4.	Detector Mechanics	14
4.1.5.	Vacuum Chambers	14
4.1.6.	Alignment.....	14
4.1.7.	Pneumatic Actuators	15
4.1.8.	Stepping-Motor Actuator	15
4.1.9.	Supply of Detector Gas	15
4.1.10.	Water cooling	16
4.2.	Specifications for Electrical Components	16
4.2.1.	Racks.....	16
4.2.1.1.	Racks in Electronic Rooms	17
4.2.1.2.	Racks at beam lines.....	17
4.2.2.	Cables.....	17
4.2.3.	Long cables.....	17
4.2.4.	Short cables	18
4.2.5.	Cable Terminals	18
4.2.6.	Clean Power Network	18
4.2.7.	Electronics in the Electronics Room	18
4.2.8.	Beam line Electronics.....	18
4.3.	Specifications for DAQ Software.....	19
4.3.1.	Beam-Pulse-bound Triggering and Data Acquisition	19
4.3.2.	Timing	20
4.3.3.	Slow Control.....	20
5.	Quality Assurance, Tests and Acceptance.....	20
5.1.	Mechanical Parts	20
5.1.1.	Mechanical Construction.....	21
5.1.2.	Production of Mechanical Parts.....	21
5.1.3.	Required Functional Tests	22
5.1.4.	Requirements for Factory Acceptance Tests (FAT).....	23
5.1.5.	Requirements for Site Acceptance Tests (SAT)	24
5.1.6.	Complete Acceptance Procedure.....	24
5.2.	Electronic Parts.....	25
5.2.1.	Electronic Circuit Plans	26
5.2.2.	Requirements for Factory Acceptance Tests (FAT).....	26

Document Title: Common Specification Beam Diagnostics

5.2.3.	Requirements for Site Acceptance Tests (SAT)	27
5.3.	Software	27
5.3.1.	Required Software Test Functions	28
5.3.2.	Requirements for Factory Acceptance Tests (FAT).....	28
5.3.3.	Requirements for Site Acceptance Tests (SAT)	28
6.	Documentation	29
7.	Warranty.....	30
I.	Attached Documents	31
II.	Related Documentation	31
III.	Document Information	33
III.1.	Document History	33
IV.	Abbreviations.....	33

List of Tables:

Table 1: Five-level breakdown for the electronic part of beam diagnostic components.	6
Table 2: BD Device Classes	7
Table 3: BD Sub-Systems.....	8
Table 4: Functional Tests.....	22

List of Figures:

Figure 1: Schematic representation of BD components.....	5
Figure 2: Device classes of BD components	7

1. Purpose and classification of the document

The purpose of this document is to specify the general technical requirements of all parts and components of the Beam Diagnostic (BD) system for FAIR. It is the central document in the hierarchy of beam diagnostic documentation and summarizes common aspects of the planned technical realization of this technical system. More detailed information on BD devices, like e.g. geometrical and functional parameters, can be found in the related detailed specifications. Wherever requirements are specified in the General Specifications (GS), Technical Guidelines (TG) or Detailed Specifications (DS) they are only referenced in this document. The related Documents are listed in Appendix II.

No legal or contractual conditions are treated in this document; all related information is given in the General Specifications [1].

2. Scope of the Technical System

2.1. System Overview

The Beam Diagnostic (BD) system of FAIR is a self-contained part of each section, i.e. accelerator, target, separator or beam line of the FAIR complex. The task of beam diagnostics is to deliver precise information on all relevant beam parameters to the overall accelerator control system and thus to the machine operators. The BD system of FAIR is an integral part of the FAIR control system with many interfaces to various subsystems (slow controls, interlocks, feedback, logging for QA and machine tuning etc.). A BD component comprises mechanical parts (e.g. pneumatic drive), analogue electronics (e.g. pre-amp), data acquisition hard- and software, as well as related subsystems (e.g. pneumatic actuator control).

The following sections present an overview of the BD system as such and define more closely its building blocks and their interrelations.

2.1.1. BD Components

Beam diagnostic equipment is generally located in two locations:

- a) inside or in the vicinity of the beam line, i.e. inside the accelerator tunnel and/or
- b) in the electronics/supply room.

In addition, for SIS100 special niches are foreseen inside the walls of the accelerator tunnel to supply radiation shielding for beam line electronics.

The general idea is to have as few electronic components as possible inside the accelerator tunnel, because here access is restricted during machine operation due to radiation safety and special care has to be taken concerning radiation hardness of e.g. electronic equipment. Only in cases where the installation of

Document Title: Common Specification Beam Diagnostics

active electronics inside the tunnel is unavoidable, e.g. due to restrictions concerning cable length, exceptions are possible. Figure 1 presents a schematic view of a beam diagnostic component with its various constituents.

Schematic for Beam Diagnostic Components

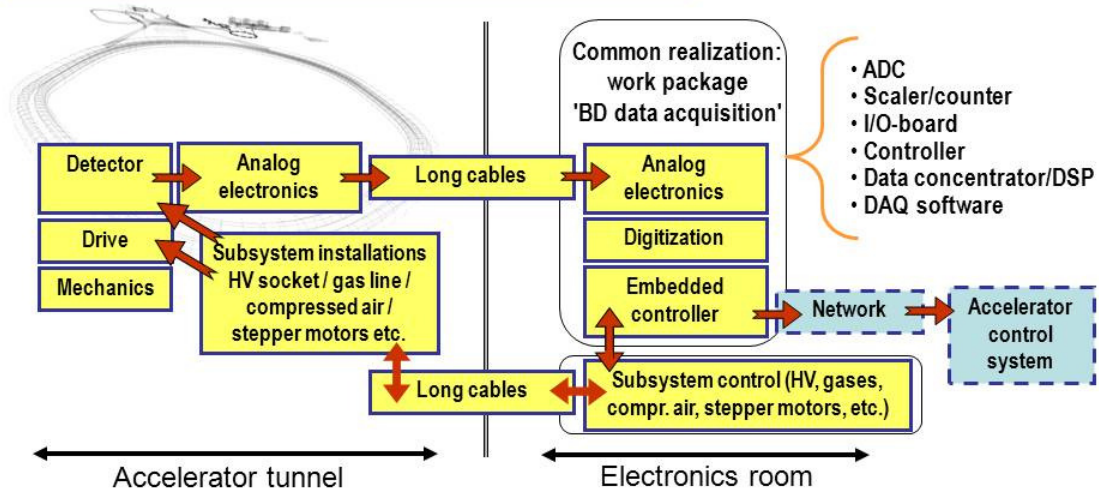


Figure 1: Schematic representation of BD components

Following this scheme a beam diagnostic component can principally be subdivided into five functional layers.

2.1.2. Five Layer Structure of a BD Component

The notion 'beam diagnostic component' in this document is defined as a complete measurement system, including the following constituents:

- the detector/ sensor,
- related mechanics (pneumatic drives, stepping motors, vacuum chambers, alignment consoles),
- all necessary subsystems (HV-supplies, pressurized air controllers and hoses, stepping motor controllers, detector gas pipes),
- analogue and digital electronics,
- the data acquisition system (now a separate building block, see following paragraph) and,
- complete cabling.

Because of the wide variety of beam diagnostic instruments the detailed composition and interfaces of an individual "beam diagnostic component" have to be defined in far more detailed specifications. Generally, the electronic part of each beam diagnostic component can be subdivided into five levels, as described in Table 1. In this simplified scheme the beam diagnostic component consists of a detector and related electronics at the beam line (1st level), long cables and driver electronics for signal transmission (2nd level) and the data acquisition electronics in the electronics room (3rd level). Additionally some of the beam diagnostic components require a data concentrator for pre-processing

Document Title: Common Specification Beam Diagnostics

of individually digitized data channels, which is implemented in the 4th level of the schematic breakdown. The 5th level includes all technical subsystems necessary to supply the technical infrastructure for the detectors ('slow controls'), like control of pneumatic actuators, stepping motors, high-voltage supplies etc. However, due to the large diversity of diagnostic components and their various requirements for signal treatment, no common intersection of the "sensor", "transmission" and "DAQ" segments is feasible and the population of the five levels with subcomponents varies significantly. As a consequence the separation has to be discussed for each system individually. Details concerning the subcomponents and their interfaces are described in the dedicated Detailed Specifications.

Table 1: Five-level breakdown for the electronic part of beam diagnostic components.

Level	Data Acquisition Task	Electronic Subcomponents	Segment Name
1	Physical signal detection and conditioning	detector, pre-amplifier	Sensor
2	Signal transport	converters, long cables	Transmission
3	Digitization, data buffering and transmission	ADC, Scaler, embedded controller	DAQ
4	Data accumulation, Network communication	Network adapter, Server, Data concentrator	Network
5	Motion, control of technical infrastructure	Controllers for: pneumatic actuators, stepping motors, HV-supplies, detector gases	Slow Controls

2.1.3. BD Device Classes

The complete set of all BD components, the 'BD system', is structured by device classes. A device class is defined by BD components that record similar physical properties of the ion beam, e.g. ac beam current or beam position, and that have, as a consequence, similar timing requirements. From the hardware point of view device classes consist of BD components sharing the same, or similar, data acquisition and infrastructural subsystems, as depicted in Figure 2.

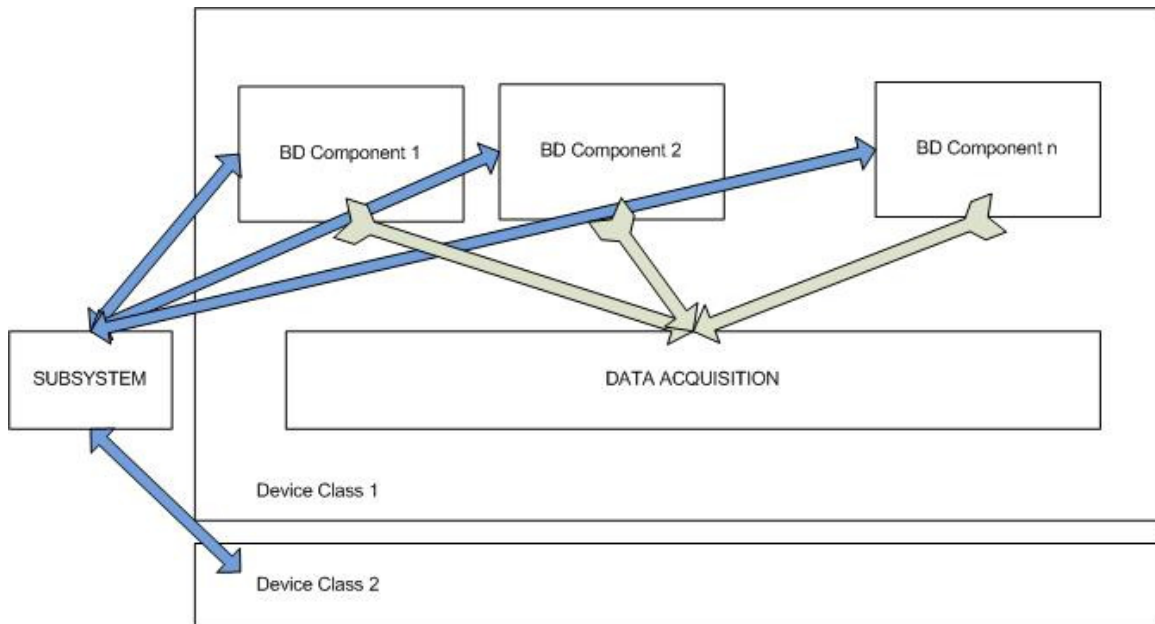


Figure 2: Device classes of BD components

The following table lists all presently defined BD device classes, the list may be extended in the future. More details on the device classes can be found – in a later stage of the project- in the Detailed Specification of the related device class.

Table 2: BD Device Classes

Device Class	BD Components	Acronym	Related Documents
Beam Position	Beam Position Monitor	BPM	[39], [40], [41], [42]
Beam Current	Pulse Current Transformer Resonant Transformer Fast Current Transformer Faraday-cup DC Current Transformer Novel DC Current Transformer Cryogenic Current Transformer	ACT RT FCT FC DCT NDCCT CCC	[24], [26], [22], [23], [20], [27], [28], [25]
Beam Profile	SEM grid Multi-Wire Proportional	GRID MWPC	[29], [30], [31], [32]

Document Title: Common Specification Beam Diagnostics

	Chamber		
Optical Diagnostics	Scintillating Screens Beam Induced Fluorescence Monitors Ionization Profile Monitors	SCR BIF IPM	[33], [34], [35], [36], [37], [38]
Particle Detection	Particle Detector Combination (IC, SEM, SC) Ionization Chambers Secondary Electron Monitor Scintillators Beam-loss Monitors	PDC IC SEM SC BLM	[43][44]
Special BD Systems	Beam Stopper Scraper Slit pairs Iris Bunch structure monitor Closed Orbit Feedback Tune Measurement Schottky Measurement	STP SCP SLIT IRIS BSM COFB TUNE STKY	[21] [46] [48] [47] [49] [45] [50] [50]

2.1.4. BD Sub-Systems

BD sub-systems are common infrastructure, needed for various device classes, like e.g. pneumatic actuator control or HV supply. As stated above, the notion 'beam diagnostic component' comprises also all required channels of the sub-systems needed for proper operation of the BD device.

The following table lists all BD sub-systems:

Table 3: BD Sub-Systems

Sub-System	BD Components	Related Document
HV-Supply	MWPC, IC, PDC, FC, IPM, BLM (GRID)	[57]
Detector Gas	MWPC, IC	[59]
Optical Iris Control	BIF, SCR	[36]
Pneumatic Control	FC, SCR, GRID, MWPC, PDC	[58]
Stepper Motor Control	SCP, SLIT, IRIS, STP	[52]
Gas valve & gauge	BIF	[53]
Local Cryogenics	CCC	[56]

Even though the required functionality of a sub-system is an important part of the BD components, the complete sub-system itself is treated separately as stand-alone support infrastructure and the related control software is part of the 'slow controls' of FAIR (see below). Nevertheless, the supplier of BD components has

Document Title: Common Specification Beam Diagnostics

to take care for and has to deliver slow controls software needed to operate the BD component.

2.1.5. Data Acquisition Software

Regarding the software necessary for data acquisition the CERN-built FESA system [51] has been chosen as standard platform for all beam diagnostic software developments. More details are given in section 4.3.

2.1.6. Slow Controls Software

The control of the devices for which timing is not a critical factor (HV power supply, gas supply, stepper motor and compressed air drives, etc.) shall be implemented with FESA and FESA-supported hardware, or with a software interface by means of a standardized SCADA system e.g. UNICOS.

Definition of the FAIR-wide standard solution will be communicated in the course of the project. The specifications can be found in the Common Specifications for FAIR Controls [A 8].

2.2. Limits of the System and Environment

2.2.1. Constituents of BD Components / Scope of Delivery

Within the work package beam diagnostics the notion 'BD component' is defined to consist of the following constituents:

- BD vacuum chamber (containing the sensor), support, alignment consoles (exception: BD components of S-FRS)
- detector / sensor
- mechanics / actuator / feed-through (attached to the vacuum chamber)
- analogue and front-end electronics (where required in the accelerator tunnel and in the electronics room)
- cabling (inside the electronics room)
- 'long cables' (from detector to electronics room)
- relevant sub-systems (e.g. HV supply, pressurized air control etc.)
- electronics for data acquisition
- data acquisition software (including manual control software)

Therefore, the delivery of a 'beam diagnostic component' (as listed e.g. in the FAIR costbook) is expected to consist of the entire set of the above mentioned parts.

Relevant components that are **not in the scope** of the work package Beam Diagnostics are:

- vacuum infrastructure (pumps, pressure gauges etc.)
- controls infrastructure (Ethernet, timing distribution etc.)
- technical infrastructure (electricity, pressurized air distribution etc.)

- infrastructure for survey and alignment of the components (fiducial axes etc.)
- final graphical user interfaces (GUI) for routine machine operation as part of the accelerator control system

2.2.2. Interfaces to other Technical Systems

In addition to the main task of providing relevant information of actual beam parameters to the operating staff, some dedicated BD components may act as:

- source of interlock signals for machine protection (e.g. signals of pneumatic drive positions, or, as an upgrade, signals from beam-loss monitors)
- source of logging information for the accelerator control system (e.g. online transmission monitoring)
- source of special input signals (e.g. BPM signal for RF system)
- drain for machine settings of the control system (e.g. for automated pre-amp gain settings)
- drain for interlock signals of the machine protection system (e.g. interlock-triggered movement of Faraday-cups and/or beam stoppers)
- drain for timing signals of the FAIR-wide timing system

A complete list of all input/output signals will be prepared in the course of the FAIR implementation. More details are described in [20]-[59].

2.2.3. Interfaces to Buildings / Civil Construction

The facility-wide beam diagnostic system is strongly interrelated with the building infrastructure, the geographical layout of the FAIR facility (e.g. due to cable paths and lengths) and has a number of interfaces to civil construction issues.

Some special issues concerning the accelerator tunnel refer to radiation hardness of electronic equipment and accessibility of the accelerator sections during beam operation. For example, restricted access to certain accelerator sections demands for remote test and reset functionalities, or electronic verification of cable plugs etc.

All relevant information concerning electronic rooms (names, places, installation locations etc.) can be supplied on request from the FAIR Machine Project Leaders. For initial contact see section 3.

This covers also the connection to building equipment via slow controls (e.g. temperature surveillance in electronic rooms or control of the detector gas system) and the requirements for each electronic component concerning uninterruptible power supply (UPS).

2.3. Basic Concept

In general the BD system consists of a wide variety of detectors, electronic and mechanical parts, but in order to facilitate service and maintenance a general strategy is to have standardized hardware components wherever applicable. E.g. the data acquisition for beam position monitors of the Collector Ring (CR) or the High Energy Storage Ring (HESR) is planned to be almost identical to the BPM DAQ of SIS100.

As a second important directive, commercial products ('commercial off-the-shelf', COTS) are preferred above purpose-built solutions, again to reduce workload for device development and to optimize maintenance efforts. Wherever applicable, identical COTS products shall be used for diagnostic devices of the same type at the various accelerators and beam lines.

In addition, the use of COTS products together with the strategy of facility-wide standardization significantly reduces the required spares inventory.

Of course the aim for FAIR-wide standardization has to be balanced for each component with the varying requirements of the different accelerators and beam line sections.

With regard to the data acquisition software, FESA is used as the standard platform. Each device addressable by the FAIR control system needs to be represented by a dedicated FESA class.

As a general strategy all BD components shall:

- be standardized to maximum extent, i.e. wherever possible identical BD components are planned for installation in the different machines
- composed of COTS products wherever applicable
- use FESA for data acquisition
- be reliable and failsafe
- inherently safe, especially with regard to moving parts
- compliant with EU and German laws and regulations

3. Responsibilities

The responsibilities with respect to changes and modifications of the present document are entirely in the hands of the Beam Diagnostics Department of the GSI Helmholtz Centre for Heavy Ion Research GmbH (GSI) Darmstadt.

For initial information please contact the administration of GSI Beam Diagnostics Department

Dr. Marcus Schwickert, m.schwickert@gsi.de
Dr. Peter Forck, p.forck@gsi.de

Further information on the BD organizational chart, names of responsible persons and task leaders, as well as the agreed document release and approval procedure is summarized in the organizational note 'FAIR-BD Project Structure' [2].

4. Technical Specifications

This chapter contains the common technical specifications which are valid for all beam diagnostic components. Requirements, parameters and functionalities of individual BD components are given in the Detailed Specifications [20]-[59]. A complete list of available Detailed Specifications is given in Appendix II 'Related Documentation' and in Annex 3 to the FAIR In-Kind contract. In addition each BD component has to abide by the relevant Technical Guidelines that are referenced in this document.

This chapter is divided into sections for mechanics, electronic components and data acquisition. Each section starts with general points, highlights Technical Guidelines and contains an individual subsection for safety issues concerned.

4.1. Specifications for Mechanical Components

It is foreseen that the contractor for BD components completes the design of the mechanical construction in close collaboration with and coordinated by GSI BD department, performs complete assembly of the component, delivers the BD component to the FAIR site, takes care of the installation into the beam lines and is responsible for the commissioning without beam, as described in the General Specifications [1]. For all steps of this process FAIR Technical Guidelines have been compiled that have to be applied.

Relevant GSI Technical standards for UHV components, which are summarized in the related Common Specifications shall be complied with during the production of all mechanical parts. Additionally, the rules, regulations and processes as given in the Technical Guidelines [100] - [149] have to be applied. Standard components have to be selected in such a way that a long-term availability is guaranteed.

4.1.1. Mechanical Parts of BD Components

In general a BD component consists of the following mechanical parts (not in all cases all constituents are involved):

- detector
- pneumatic or stepping motor driven actuator
- vacuum flange with electrical feed-through
- vacuum chamber
- support for vacuum chamber and alignment console

4.1.2. Mechanical Design

The mechanical design works have to be performed in close collaboration with and coordinated by GSI BD department. All mechanical construction works have to comply with the relevant Technical Guidelines of FAIR.

Document Title: Common Specification Beam Diagnostics

For important key components complete sets of drawings will be supplied by GSI/ FAIR.

Relevant Technical Guidelines for mechanical design:

- „Konstruktionsrichtlinien“ as given by GSI-ZT (available on request from GSI Construction Office)
- 'Terms and Conditions for the Exchange of Mechanical Engineering Data' [A 7]

Vacuum chambers for the diagnostic equipment have to be generally designed in such a way that mechanical collisions of beam diagnostic components with fixed or movable equipment is mechanically prevented. Deviations from this rule have to be explicitly agreed upon in written form and appropriate security measures have to be applied.

The technical construction drawings have to be numbered in a pre-defined way. For this purpose the numbering system of GSI/FAIR has to be applied. The numbers concerned are allocated by the GSI/FAIR (ZT or BD).

In addition each BD component requires a distinct type number (not necessarily connected to the numbering system for drawings), as well as a device unique serial number. These numbers will be supplied by GSI BD department in the course of production.

The mechanical construction has to abide by the following standards:

- compliance with CE-relevant guidelines (as given in [1])
- drawings have to be prepared by the contributor and mutually agreed upon in writing with the BD project leader at GSI/ FAIR well in advance of the production process
- drawings have to be prepared electronically using CATIA V5, only in exceptional cases the supply of STEP-Files is sufficing
- all drawings have to be supplied digitally and in hardcopy form

Further the exchange of drawings has to abide by the rules defined in the 'Terms and Conditions for the Exchange of Mechanical Engineering Data' [A 7].

The rules for mechanical construction process and fabrication of mechanical components are given in chapter 5 (Quality assurance) of this document.

4.1.3. Assembly

All BD components have to be readily assembled for the usage on site. If necessary the contributor has to foresee security installations for proper transport of fragile or delicate BD components to the FAIR site (see General Specifications and references therein).

E.g. all protective installations for shipping of the components have to be removed by the contributor after reception of the device on the FAIR site to prepare the SAT.

4.1.4. Detector Mechanics

The notion 'detector mechanics' in general refers to the mechanical parts of a BD component installed inside the vacuum system. For the large variety of detector types different regulations concerning leak rate, allowed materials and feed-throughs do exist which are given in the Detailed Specifications for the related BD component.

As a general rule all detectors mounted on a mechanical drive have to be constructed in such a way that mechanical collisions are prevented. Any exception of this general rule has to be negotiated in detail and agreed upon between the contributor and GSI/FAIR.

It is foreseen to have a standard flange size of the detector part for each accelerator or beam line section of FAIR.

In contrast a few detector systems are installed outside the vacuum system, like e.g. beam-loss monitors or transformers. In these cases special support structures belong to the detector mechanics part.

4.1.5. Vacuum Chambers

As described in section 2.2 **vacuum chambers are explicitly included in the scope of the individual BD component (exception: special BD components of S-FRS, e.g. different detectors on common target ladder).**

Thus the vacuum chambers are a part of the delivery of BD components. There will be several different types of vacuum chamber for the BD components. They differ in aperture, insertion length and in the number and direction of flanges. Some special vacuum chambers, mainly inside or in close vicinity to synchrotrons or storage rings, have to be bakeable.

The diagnostic chambers of a given accelerator or beam line section will have a standard flange size for mounting of the BD component. The relevant flange sizes are given in the Detailed Specification for BD vacuum chambers [55].

Many BD vacuum chambers are commonly used for pumping and include a designated pumping flange.

Further specifications are found in the Detailed Specifications dedicated to vacuum chambers for beam diagnostic components [55].

4.1.6. Alignment

All beam diagnostic components fixed inside a vacuum chamber or mounted on mechanical drives need to have reference points for alignment.

Document Title: Common Specification Beam Diagnostics

For the various BD components different alignment procedures are necessary. There are components without alignment (e.g. current transformers), components with fine alignment (e.g. profile grids) and components which need a transfer measurement of the inner detector with regard to the outer reference points, like e.g. beam profile monitors.

The alignment procedure for each component has to be clarified with the supplier prior to delivery. Details of the alignment procedure as required by the contributor will be discussed and resolved in the course of project realisation.

4.1.7. Pneumatic Actuators

All pneumatic actuators for BD components shall be designed for an operating pressure of min. 7 bar. All drives have to be oil-free in vacuum. The velocity of movements has to be fast enough for operations and slow enough to avoid damage of the detectors. The drives need to have a position indication for 'in' and 'out' position. There will be a standard cylinder for all types of air drives.

The following BD components are generally equipped with pneumatic actuators (some exceptions do exist, e.g. Faraday-cup at p-Linac beam dump):

- SEM grid
- Scintillating screen
- MWPC
- Particle Detector Combination
- Faraday-Cup
- Beam Stopper

There are different types of pneumatic actuators to be specified for different beam diagnostic components. Therefore their description is given in the Detailed Specifications for mechanical drives [54].

4.1.8. Stepping-Motor Actuator

All stepping-motor actuators have to be equipped with 5-phase motors (incl. electro-magnetic brake). The following BD components include stepping motor drives:

- Slit pair
- Scraper
- Iris

Technical details for stepping-motor actuators are part of the Detailed Specifications for mechanical Drives[54].

4.1.9. Supply of Detector Gas

For the Multi-Wire Proportional Chambers and Ionization Chambers installed in the HEBT section a supply of detector gases is required as infrastructure.

Document Title: Common Specification Beam Diagnostics

All technical parameters and interfaces have been compiled in the Technical Guideline for Detector Gas Supply [320].

4.1.10. Water cooling

For intercepting beam diagnostic components installed at locations with high beam power, like e.g. the Faraday-cup in the p-Linac section, water cooling is foreseen.

The requirements for the cooling water are given in the Detailed Specifications of the related BD components.

4.2. Specifications for Electrical Components

All electrical components have to abide by the following standards (as given in the General Specifications [1]):

- compliance with CE-relevant guidelines
- compliance with EMC-relevant guidelines
- Technical Guideline Electrical Engineering

For all purpose-built electronic devices the realization of a detector self-test function is mandatory. For the self-testing mechanisms of all detector systems, the test signals must be fed in at the detector itself or as close to the detector as possible in order to allow the entire signal path to be examined.

All electronic components have to be sufficiently cooled (in most cases air cooling).

Specific demands for the individual electrical devices are given in the dedicated Detailed Specifications of the related BD component.

4.2.1. Racks

Wherever possible standard racks for the beam diagnostic equipment must be used. Related electrical standards and technical parameters are defined in [300].

Maximum height of the racks is 43 units (2.1 m plus a socket of max. 0.2 m) and the maximum area per rack is 0.96 m² for racks installed in a row, and 1 m² for a stand-alone rack

To date (Sep. 2012) 2 types of standard racks are foreseen (w x d):

- a) 0.8 m x 0.8 m and
- b) 0.8 m x 1.2 m (for HV supplies, server pc etc.).

Wherever possible the racks must have doors. In any case all racks must be accessible also from the backside.

Document Title: Common Specification Beam Diagnostics

With regard to their power consumption all beam diagnostic racks have to follow the regulations given in [300].

In case interfaces to civil construction are touched (e.g. compliance with an external cooling system and/or air condition) the regulations of the relevant specifications of FAIR-Site&Buildings are mandatory.

4.2.1.1. Racks in Electronic Rooms

In all electronic rooms of the technical system beam diagnostic facility-wide standard racks are foreseen. For all electronic rooms the racks have to be compliant to the local air condition system, i.e. sufficient cooling is required to keep the electronic devices below 25° C.

4.2.1.2. Racks at beam lines

Racks at beam lines have to be equipped with cooling fans. As a standard mini-racks (e.g. 25 units, height: 1.2 m) are foreseen, but where applicable, also rack installations in wall niches are planned (20 units, height: 0.96 m). Here special care has to be taken to allow for sufficient cooling.

4.2.2. Cables

The cables for beam diagnostics may be subdivided into 'long cables' connecting the electronic rooms with the accelerator tunnel and beam lines, and 'short cables' for the interconnection of devices inside a single room or accelerator tunnel.

All cables of the technical system beam diagnostics belong to the category 'signal cables' of highest sensitivity. These cables must be able to transfer very low signals and by a proper choice of the cables and cable paths EMI influences have to be kept at an absolute minimum.

Generally a color code will be applied for the different cable classes (signal, HV-, control cables).

Details are specified in the Technical Note on BD-Cables [A 1].

4.2.3. Long cables

The planning and implementation of the cable system (including cable trays and cable channels) between the detectors and the electronic rooms ('long cables'), including assembly, is the task of the building equipment suppliers, unless the individual specifications stipulate otherwise.

The signal cables have to be guided separated from any cables and equipment which introduces noise on the signal. This means individual cable trays and cable channels. Details are specified in [A 1].

4.2.4. Short cables

Also for short cables standards do apply as described in [A 1]. All signal cables should preserve the signal quality in an appropriate manner. For analogue signals standard connectors are mandatory, like e.g. BNC, SMA, N-type or LEMO, cf. [A 1].

4.2.5. Cable Terminals

A number of cable terminals are foreseen for each machine and beam line section of FAIR. Cable terminals are planned to bridge the distance between the accelerator sections and the electronic rooms, between two electronic rooms and between the electronic rooms and the main control room. Details are specified in [A 2].

4.2.6. Clean Power Network

The general aspects of the power network for FAIR are described in the Technical Guideline 'Electrical Design Rules and Regulations' [300].

For all precise measurement devices in the accelerator facility, like beam diagnostics equipment, or vacuum sensors, a separate electricity supply, the 'Clean Power System' (CPS), is available. This network is separated especially from the energy supply for the network devices and RF supply. No other electricity supply must be used by BD components. The power network is specified in the Technical Note 'Clean Power Supply for Beam Diagnostics' [A 3]. The power plugs of the dedicated measurement power network must be specially indicated.

4.2.7. Electronics in the Electronics Room

For electronic equipment in the electronic rooms local control functions are required. The complete device functionality must be accessible by simple means (switches, human-machine interfaces etc.) in the electronic rooms.

For dedicated electronic devices, like e.g. controller boards or embedded PCs, an uninterruptible power-supply will be available in the electronic rooms.

4.2.8. Beam line Electronics

In some cases installation of electronics near the beam line, and thus in radiative areas, is unavoidable. For these electronic devices special requirements have to

Document Title: Common Specification Beam Diagnostics

be fulfilled concerning radiation hardness. Due to the restricted access to these areas the possibility for remote cable tests as well as remote control of all functions of the BD equipment is required.

4.3. Specifications for DAQ Software

The beam diagnostics measurement systems can be divided into two categories, i.e. the 'beam-pulse-bound' and the 'beam-pulse-independent' or 'slow control' systems (see the separate description of this subsystem in the Common Specification for the Accelerator Control System [920]), which must be integrated into the FAIR control system in different ways.

All details about the work package 'beam diagnostic data acquisition' are compiled in the Detailed Specification 'Data Acquisition for Beam-Diagnostics at FAIR' [51].

4.3.1. Beam-Pulse-bound Triggering and Data Acquisition

To measure the pulse-bound beam parameters (e.g. beam current, energy, etc.), the most beam diagnostic DAQ systems must be synchronized to the dedicated beam pulses. The various actions within such a measurement sequence must take place at exact times (e.g. corresponding to the processes during an acceleration cycle) and within exact time gates. The acquired data must be subsequently characterized with specific triggers, with time stamps and cycle identification, allocated by the central process controls. Afterwards the data set must be transmitted to the control system.

This type of data acquisition at the front-end level requires a real-time operating system such as Linux with RT patches. Open source software is preferred. Commercially available software like LynxOS is only accepted, when there is no technical alternative.

For the creation of the DAQ software (e.g. read out of data acquisition hardware such as ADCs, counters etc.) and as a common interface to the control system, the framework FESA must be used. FESA supports INTEL and PowerPC processors on standard bus systems such as VME, cPCI/PXI, PCI/PCIe. Wherever possible, commercially available CPUs and data acquisition modules must be used. For the reasons listed above, the following applies to pulse-bound beam diagnostics systems:

- All DAQ boards must be in accordance with a common industry standard bus system, such as VME, PCI, PCIe, μ TCA.
- Provision of driver unit software for all modules for current real-time operating systems.
- Selection of the bus system, crate controllers and DAQ modules in close cooperation with the control system- and beam diagnostic departments, 19" rack installable.
- Usage of GSI/ FAIR network and timing infrastructure and timing receiver boards.
- Commercial stand-alone systems, like e.g. oscilloscopes or network analyser must be equipped with an Ethernet interface and related software for remote control.

4.3.2. Timing

Presently two facility wide timing systems are foreseen for FAIR:

- a) the new FAIR timing system based on the White Rabbit protocol [A 4], [A 5] and
- b) the BuTIS-timing [A 6] for the high-precision adjustment of the RF accelerating cavities.

The final layout of the timing distribution system, as well as the design of the timing receiver boards in various form factors will be defined in the course of the project.

4.3.3. Slow Control

The adjustments of the devices for which timing is not a critical factor (HV power supply, gas supply, stepper motor and compressed air (pneumatic) drive, etc.) should be implemented with FESA and the supported hardware or with the software interface by means of a standardized SCADA system e.g. UNICOS. The specifications can be found in [920].

5. Quality Assurance, Tests and Acceptance

The following sections describe the quality assurance procedures for the delivery of mechanical, electronic and software components. In order to assure the demanded quality and to gain a common understanding of the components the following procedures have to be applied. The relevant specifications are listed in chapter 2.1.

The following sections focus on the delivery of purpose-built devices, in contrast to the purchase of commercially available products.

For COTS products as part of a delivery, a reduced set of quality assurance measures may be applied after negotiation and mutual agreement in writing between the contributor and GSI/FAIR.

5.1. Mechanical Parts

The mechanical parts of a beam diagnostic component can be subdivided into the following groups:

- vacuum chambers
- detector
- pneumatic actuators
- stepping motor actuators
- alignment consoles

For each of these groups the following sections describe the demanded QA measures.

5.1.1. Mechanical Design

This work package includes the following steps:

- preparation of a constructive sketch consisting of a 3d-model (STEP-file) and a 2d-sketch with dimensions and measures for the interfaces
- preparation of detailed drawings for components (3d), assembly groups and composition drawings
- preparation of detailed production drawings and production assembly drawings (2d)
- preparation of the complete drawing documentation with assembly drawings and part lists
- full documentation (including assembly instructions and manual)
- After each step a formal approval by GSI/FAIR in the context of a conceptual design review (CDR) is required.
- The process is finalized with the formal approval by GSI/FAIR in the frame of a final design review (FDR)

For the installation of beam diagnostic components into the diagnostic chamber for each individual chamber (with nomenclature) an assembly drawing (3d/2d) with part lists of the components has to be prepared and a collision test has to be performed.

As a general rule all mechanical construction works have to be performed in close collaboration with GSI BD department, the digital mock-up team (DMU), GSI Design Office and the relevant machine project leader.

5.1.2. Production of Mechanical Parts

The production process has to be performed in certain steps to assure optimal results and to avoid that single units of a series of components differ significantly in functionality, resolution or mechanical parts.

- Production and assembly of a pre-series model outside of the scope of delivery (see General Specs).
- Production and assembly of a small batch series (components as part of the delivery)
- Production and assembly of a complete series
- After each step the components have to be evaluated and tested by GSI/FAIR.

5.1.3. Required Functional Tests

The following dedicated tests have to be performed for the different components:

Table 4: Functional Tests

BD-Component	Tests						
	Visual examination	Leakage	Vacuum	adv. Vacuum	Electrical	Mechanical	Material certificate
Profile Grid (not bakeable)	X	-	X	-	X	-	X
Profile Grid (bakeable)	X	-	-	X	X	-	X
Actuator with vacuum feed-through (not bakeable)	X	X	X	-	X	X	X
Actuator with vacuum feed-through (bakeable)	X	X	-	X	X	X	X
Scintillating Screen (bakeable)	X	-	-	X	-	-	X
BIF	X	X	X	-	-	-	X
CCC	X	X	X	-	-	-	X
PDC	X	-	-	-	X	X	-
MWPC	X	-	-	-	X	X	-
Diagnostic Vacuum Chamber (bakeable)	X	X	-	X	-	-	X
Diagnostic Vacuum Chamber (not bakeable)	X	X	X	-	-	-	X
BLM	X	-	-	-	X	-	-
BPM (SIS100)	X	X	-	Adv. Test for cryo-equipm.	-	-	X
BPM (HEBT, non-bakeable)	X	X	X	-	-	-	X
BPM (HEBT, bakeable)	X	X	-	X	-	-	X
BPM (CR)	X	X	-	X	-	-	X
ACT	X	X	X	-	-	-	X
RT (bakeable)	X	X	-	X	-	-	X
RT (non-bakeable)	X	X	X	-	-	-	X
FCT (bakeable)	X	X	-	X	-	-	X
FCT (non-bakeable)	X	X	X	-	-	-	X
IPM	X	X	-	X	-	-	X
STP	X	X	-	X	X	X	X
SCP	X	X	-	X	X	X	X
SLIT, IRIS	X	X	X	-	X	X	X
STKY / BTF-Exciter	X	X	-	X	-	-	X

The following list gives a general description of the required functional tests.

Visual Examination

As a first step every component has to pass a visual examination to control e.g. completeness of delivery and general functionality.

Leakage Test

For each mechanical BD component a leakage test is mandatory before installation in the accelerator vacuum system and related test protocols are required. Information on the maximum leak rate etc. is given in [136] and [137].

Vacuum Test

For vacuum testing the components have to be installed on a vacuum test bench under controlled conditions and for each component a test protocol is required. This vacuum test is mandatory for all BD components with installation locations in the standard vacuum sections, where no bake-out is required [136].

Advanced Vacuum Test

For BD components to be installed inside the UHV or even XHV sections, in addition an advanced vacuum test including bake-out is required, again with detailed documentation for each individual unit. For these tests the regulations of the GSI UHV department apply, as given in [137].

Electrical Test

Electrical tests are required for all components mounted on mechanical drives, e.g. to test the correct function of end switches, and/or for components that include electrical feed-throughs. The electrical tests have to be summarized in individual test protocols.

Mechanical Test

Mechanical tests are necessary for all BD components mounted on mechanic drives and have to be documented in test protocols.

Material Certificate

Material certificate are needed for stainless steel vacuum components as specified in [134].

5.1.4. Requirements for Factory Acceptance Tests (FAT)

In order to prepare for a successful Factory Acceptance Test the following tasks have to be fulfilled:

- availability of detailed specifications
- description of the technical design
- preparation of detailed construction drawings
- production and assembly of a prototype
- execution of functional tests against all required system parameters as given in sections 4.3 and 10 of the related detailed specifications [20]-[59]
- availability of test results about first functional tests
- preparation of changes with evaluation until approval for small batch production

Document Title: Common Specification Beam Diagnostics

- production and assembly of a defined small batch for testing issues and, in the end, final installation in the facility

The fulfilment of the conditions for the performance of a FAT has to be indicated by the contributor to GSI/ FAIR well in advance of the FAT date.

The FAT will be attended by the responsible persons of the GSI BD department.

5.1.5. Requirements for Site Acceptance Tests (SAT)

A successful FAT is an important pre-requisite for the announcement of a SAT. In addition to the FAT conditions listed in the previous section the following tasks are necessary for a SAT:

- preparation of changes with evaluation until approval for serial production
- production and assembly of all components
- successful tests of the series as demanded in the related specifications, especially sections 4.3 and 10
- delivery of the components to the FAIR site
- installation in accelerators and beam lines
- commissioning of all components without beam
- availability of complete documentation
- training of the GSI/ FAIR staff

The fulfilment of the conditions for the performance of a SAT has to be indicated by the contributor to GSI/ FAIR well in advance of the SAT date.

The SAT will be attended by the responsible persons of the GSI BD department.

5.1.6. Complete Acceptance Procedure

In order to guarantee a mechanical production on the basis of the FAIR standard for mechanical components each contributor has to abide by the following acceptance procedure.

- preparation of a detailed specification with the following information: Function, demands (physical properties, vacuum techniques and mechanical parameters), interfaces and test instructions
- preparation of a technical design in close collaboration with the technically responsible person at GSI/ FAIR
- approval of the design by GSI/ FAIR
- preparation of detailed construction drawings consisting of production drawings, part lists and composition drawings according to the specifications of GSI department ZT ("Konstruktions-Richtlinie")
- evaluation of the construction by the technically responsible person
- preparation of changes with evaluation until approval of a pre-series model

Document Title: Common Specification Beam Diagnostics

- production and assembly of a pre-series model for testing issues
- functional test of the pre-series model with documentation
- preparation of changes with evaluation until approval for small batch production
- production and assembly of a defined small batch for testing issues and, in the end, final installation in the facility
- FAT
- preparation of changes with evaluation until approval for serial production
- production and assembly of all components
- tests of the series as demanded in the related specifications
- delivery of the components to the FAIR site
- hand-over of documents for declaration of conformity as per EC machinery directive or documents for 'incomplete machine'
- installation in accelerators and beam lines
- commissioning of all components without beam
- availability of complete documentation
- training of the GSI/ FAIR staff
- SAT

In general after successful SAT all partners shall attend and actively support the subsequent phase of commissioning with beam of the diagnostic device. Required changes or upgrades resulting from these beam tests have to be applied before the device under test can be finally approved.

Any change of this acceptance procedure has to be mutually agreed in writing with the responsible persons at GSI/ FAIR.

5.2. Electronic Parts

For the delivery of electronic parts, like e.g. drive controllers or DAQ components, certain QA measures are required that are described in the following sections. In general BD components include, as sub-components, the following electronic parts cover:

- Detector (e.g. ccd camera)
- Pre-amplifier
- Analog electronics (e.g. for signal shaping, fan in/fan out)
- Connector boxes (for signal level and connector adaptations...)
- purpose-built electronic devices (e.g. FPGA boards for fast signal processing)
- commercial DAQ products (controller, ADC board etc.)
- electronic sub-systems (e.g. pressurized air control, HV control, optical iris control etc.)

In general all electronic equipment delivered to FAIR beam diagnostics has to abide by the rules and regulations as given in the General Specifications [1] and Technical Guideline [300].

Whenever installation of electronic devices is foreseen at the beam line inside areas with increased radiation level components should withstand a total energy

Document Title: Common Specification Beam Diagnostics

dose of 1 kGy. Each contributor shall clarify the final installation location of the delivery and related boundary conditions before pre-series model development.

Acoustic noise level of electronic equipment shall be reasonably low, i.e. maximum noise emission of 45 dB(A) is tolerable.

Different regulations hold for a) commercially available electronic products, and b) purpose-built electronic devices realized by the contributor.

For commercially available electronics the goal is to collect the maximum amount of technical information on the device. In this frame **open hardware standards are absolutely preferred before propriety solutions.**

Whenever the usage of commercial electronics is planned as part of the BD delivery the choice for a special product has to be negotiated with the responsible persons at GSI beam diagnostic department.

While the next sections describe the acceptance procedure for electronic devices built by the contributor, the regulations should give a guideline also for the procurement of commercial products.

5.2.1. Electronic Circuit Plans

To guarantee a streamline production process of all electronic parts close contact between the supplier and GSI/ FAIR is necessary.

For each purpose-built electronic component as part of the BD equipment detailed electronic circuit plans and, if possible, PCB layouts, pinnings etc. are required.

If the electronic device contains FPGAs also a hardcopy of the VHDL code (with annotations) is mandatory.

5.2.2. Requirements for Factory Acceptance Tests (FAT)

For a successful Factory Acceptance Test the following tasks have to be fulfilled:

- availability of detailed specifications
- description of the technical design
- preparation of detailed electronic circuit plans
- production and assembly of a pre-series model
- execution of functional tests against all required system parameters as given in sections 4.3 and 10 of the related detailed specifications [20]-[59]
- availability of test results about first functional tests
- preparation of changes with evaluation until approval for small batch production

The FAT will be attended by the responsible persons of the GSI BD department.

During the whole production process close contact between the contributor and the responsible persons at GSI beam diagnostics department is required.

5.2.3. Requirements for Site Acceptance Tests (SAT)

A successful FAT is an important pre-requisite for the announcement of a SAT. In addition to the FAT conditions listed in the previous section the following tasks are necessary for a SAT:

- preparation of changes with evaluation until approval for serial production
- production of the series
- successful tests of the series as demanded in the related specifications [20]-[59], especially sections 4.3 and 10
- delivery of the components to the FAIR site
- installation in accelerators and beam lines
- commissioning of all components without beam
- availability of complete documentation
- training of the GSI/FAIR staff

The fulfilment of the conditions for the performance of a SAT has to be indicated by the contributor to GSI/ FAIR well in advance of the SAT date.

The SAT will be attended by the responsible persons of the GSI BD department.

In general after successful SAT all partners shall attend and actively support the subsequent phase of commissioning with beam of the diagnostic device. Required changes or upgrades resulting from these beam tests have to be applied before the device under test can be finally approved.

5.3. Software

As stated in section 3.3 the BD delivery also comprises software for data acquisition and slow control.

For each electronic component of the DAQ system the contributor has to supply all device drivers necessary for full control of the device.

In addition, if the scope is to deliver complete DAQ systems, the related FESA classes for full control of the systems are an important part of the delivery.

All software has to be delivered with complete source code. Any deviation from this general rule has to be clearly indicated by the contributor and may only be allowed for usage after acceptance in writing by the responsible persons at GSI beam diagnostic department.

For all external partners contributing to BD software a software repository and versioning system hosted by GSI is foreseen.

5.3.1. Required Software Test Functions

All software for device control has to include extensive test functions for manual control of the device, system tuning and troubleshooting.

With each DAQ and slow controls unit a 'manual control software' has to be delivered, allowing to modify each set value and to display any get value.

If dedicated calibration sequences are necessary for the correct setup of the electronic device (e.g. calibration of stepping motor drives) a piece of software is required to allow swift handling.

Each part of the software has to implement well-documented self test functions for commissioning and troubleshooting.

5.3.2. Requirements for Factory Acceptance Tests (FAT)

The 'Factory Acceptance Test' of software requires fulfilment of the following tasks:

- availability of detailed specifications
- description of the software design (joint creation of requirements specification)
- settlement of all system interfaces
- implementation of pre-series software
- availability of source code with annotations
- execution of functional tests against all required system parameters as given in sections 4.3 and 10 of the related detailed specifications [20]-[59]
- availability of test results about first functional tests

5.3.3. Requirements for Site Acceptance Tests (SAT)

After a successful FAT the following tasks are required for the SAT:

- code review of the pre-series software
- tests of the series as demanded in the related specifications
- installation of the production version on site
- successful tests without beam as demanded in the related specifications [20]-[59], especially sections 4.3 and 10, including timing
- availability of complete documentation
- training of the GSI/FAIR staff

The fulfilment of the conditions for the performance of a SAT has to be indicated by the contributor to GSI/FAIR well in advance of the SAT date.

The SAT will be attended by the responsible persons of the GSI BD department.

In general after successful SAT all partners shall attend and actively support the subsequent phase of commissioning with beam of the diagnostic device.

Document Title: Common Specification Beam Diagnostics

Required changes or upgrades resulting from these beam tests have to be applied before the device under test can be finally approved.

6. Documentation

The following documents are included in the scope of service:

Mechanic Parts

- I. Requirements specification
- II. Final specifications
- III. Detailed construction drawings (in paper and digital, 2d and 3d)
- IV. In the case of purchased parts: necessary documentation provided by the manufacturer as a part of delivery
- V. Parameter and unit lists
- VI. User manual
- VII. Material certificates
- VIII. Protocols of test procedures
- IX. Documentation of change management
- X. Safety procedures
- XI. Training notes
- XII. Environmental condition

Electronic Devices

- I. Requirements specification
- II. Final specifications
- III. Detailed current and layout diagrams of analogue and digital electronics, circuit diagrams
- IV. In the case of purchased parts: entire documentation provided by the manufacturer as a part of delivery
- V. Parameter and unit lists
- VI. User manual
- VII. Material certificates
- VIII. Protocols of test procedures
- IX. Documentation of change management
- X. Safety procedures
- XI. Training notes
- XII. Environmental condition

Software

- I. Requirements specification
- II. Final specifications
- III. Complete source code with detailed annotations
- IV. In the case of purchased software: entire documentation provided by the manufacturer as a part of delivery

Document Title: Common Specification Beam Diagnostics

- V. Parameter lists
- VI. User manual
- VII. Protocols of test procedures
- VIII. Documentation of change management
- IX. Safety procedures
- X. Training notes

All other documents shall simply be provided in printed form as part of the delivery, and shall additionally be delivered as MS Word and/or PDF files on a CD ROM or DVD.

Before the components are produced, the production documentation must be submitted to the FAIR / FAIR@GSI project managers for technical approval and countersigning.

7. Warranty

No special warranty requirements apply apart from the regulations given in the General Specifications and the contract for delivery.

I. Attached Documents

No documents attached.

II. Related Documentation

The references below represent a complete set of documents describing the accelerator part of the FAIR project as well as its installations and rules. Significant to this actual specification are only the documents referenced in the text.

The first paragraph contains all design reports and the General and Common Specifications of FAIR and the GSI-BD-department. The second paragraph is devoted to the Detailed Specifications of the Beam Diagnostics work package, whereas paragraph four to six list all relevant Technical Guidelines. Paragraph seven contains documents that are specific for the present Detailed Specification.

General Documents [1..19]

- [1] FAIR-XXXX-EF_General_Specifications_20110531.doc
- [2] Note on FAIR-BD Project Structure

Detailed Specifications Beam Diagnostics [20..99]

- [20] F-DS-BD-02e AC+FC_PL.pdf
- [21] F-DS-BD-03e AC+BS_CR.pdf
- [22] F-DS-BD-04e AC+FCT_T.pdf
- [23] F-DS-BD-05e AC+FCT_1S+CR.pdf
- [24] F-DS-BD-06e AC+ACT_PL+PT.pdf
- [25] F-DS-BD-08e AC+CCC_T+CR.pdf
- [26] F-DS-BD-09e AC+RT_T+PT+F.pdf
- [27] F-DS-BD-10e DC+DCT_1S+CR.pdf
- [28] F-DS-BD-11e DC+NDCCT_1S.pdf
- [29] F-DS-BD-12e ElecProfile+MWPC_T.pdf
- [30] F-DS-BD-13e ElecProfile+SEM_PL+T+PT.pdf
- [31] F-DS-BD-14e ElecProfile+SEM_1S.pdf
- [32] F-DS-BD-15e ElecProfile+SEM_CR.pdf
- [33] F-DS-BD-16e OptProfile+SCR_T+PT+F.pdf
- [34] F-DS-BD-17e OptProfile+SCR_1S.pdf
- [35] F-DS-BD-18e OptProfile+SCR_CR.pdf
- [36] F-DS-BD-19e OptProfile+BIF_PL+T+F.pdf
- [37] F-DS-BD-20e OptProfile+IPM_1S.pdf
- [38] F-DS-BD-21e OptProfile+IPM_CR.pdf
- [39] F-DS-BD-22e POS+BPM_1S.pdf
- [40] F-DS-BD-23e POS+BPM_T+PT+F.pdf
- [41] F-DS-BD-24e POS+BPM_CR.pdf
- [42] F-DS-BD-25e POS+PHP+TOF+BPM_PL.pdf
- [43] F-DS-BD-26e PD+BLM_T_1S_CR_PT.pdf
- [44] F-DS-BD-27e PD+PDC_T.pdf
- [45] F-DS-BD-29e Special+ClosedOrbitFeedback_1S.pdf
- [46] F-DS-BD-30e Special+Scraper_CR.pdf
- [47] F-DS-BD-31e Special+Iris_PL.pdf
- [48] F-DS-BD-32e Special+SlitPair_PL.pdf
- [49] F-DS-BD-33e Special+BunchStructureMonitor_PL.pdf
- [50] F-DS-BD-34e Special+SchottkyPickUp+Tune_1S+CR.pdf
- [51] F-DS-BD-40e DAQ.pdf

Document Title: Common Specification Beam Diagnostics

- [52] F-DS-BD-41e SubSys+StepperMotor.pdf
- [53] F-DS-BD-42e GasValveGauge+BIF.pdf
- [54] F-DS-BD-43e Mech+MechanicalDrives.pdf
- [55] F-DS-BD-44e Mech+VacuumChambers.pdf
- [56] F-DS-BD-45e Cryo+LocalCryoCCC.pdf
- [57] F-DS-BD-46e SubSys+HighVoltage.pdf
- [58] F-DS-BD-47e SubSys+PneumaticDrive.pdf
- [59] F-DS-BD-48e SubSys+DetectorGasFlow.pdf

Accelerator Technical Guidelines Vacuum [100 - 199]

- [100] F-TG-V-13.1e Assembly Instructions for Knife-Edge UHV Flanges 20100414.pdf
- [101] F-TG-V-2.19e Additives for TIG Welding of Stainless Steel 20100512.pdf
- [102] F-TG-V-2.1e Stainless Steel for Beam Vacuum Chambers 20101012.pdf
- [103] F-TG-V-2.23e Bolts_Studs_Nuts_Washers for bakeable UHV Components 20100624.pdf
- [104] F-TG-V-2.24e Materials in UHV 20100512.pdf
- [105] F-TG-V-2.25e Forged Blanks for Vacuum Applications Mat. 1.4429_ESU 20100512.pdf
- [106] F-TG-V-2.26e Forged Blanks for Vacuum Applications Mat. 1.4435_ESU 20100512.pdf
- [107] F-TG-V-2.28e Stainless Steel for Beam Vacuum Chambers at Cryogenic Temp. 20100614.pdf
- [108] F-TG-V-2.36e Bolts_Studs_Nuts_Washers for non-bakeable UHV Components 20101013.pdf
- [109] F-TG-V-2.37e Bolts_Studs_Nuts_Washers for Cryogenic UHV Components 20101012.pdf
- [110] F-TG-V-2.3e Copper for Vacuum Applications 20100512.pdf
- [111] F-TG-V-2.5e Vacuum Firing 20101012.pdf
- [112] F-TG-V-2.6e Material for bakeable CF-Flanges 20100512.pdf
- [113] F-TG-V-2.7e Ceramics for Vacuum Applications 20100624.pdf
- [114] F-TG-V-3.11e Bolts for Use in Vacuum 20100512.pdf
- [115] F-TG-V-3.17e Design of Thick-Walled Vacuum Chambers 20101013.pdf
- [116] F-TG-V-3.1e Constructive Design of Welding Seams for Vacuum Chambers 20101012.pdf
- [117] F-TG-V-3.30e Dimensions for Standard Bellows 20100621.pdf
- [118] F-TG-V-3.3e Design of O-Ring Grooves 20100624.pdf
- [119] F-TG-V-3.41e Construction and Mounting of COF gaskets 20101012.pdf
- [120] F-TG-V-3.42e Copper Gaskets for ConFlat Flanges 20101012.pdf
- [121] F-TG-V-3.4e Manufacturing of CF-Knife Edge Flanges 20110706.pdf
- [122] F-TG-V-3.9e Welding of CF-Flanges on Tubes 20101012.pdf
- [123] F-TG-V-4.1e Bakeout Equipment 20101012.pdf
- [124] F-TG-V-5.1e Surface Conditions of Vacuum Chambers 20101012.pdf
- [125] F-TG-V-6.10e Cleaning Assemblies and Sub-Assemblies in Vacuum 20100511.pdf
- [126] F-TG-V-6.1e Cleaning of UHV Components Stainless Steel 20100707.pdf
- [127] F-TG-V-6.2e Cleaning of Vacuum Components 20100510.pdf
- [128] F-TG-V-6.3e Cleaning Procedure for Bellows 20100512.pdf
- [129] F-TG-V-6.4e Cleaning of Ceramics for Use in UHV 20100510.pdf
- [130] F-TG-V-6.5e Cleaning of Aluminum Components 20101012.pdf
- [131] F-TG-V-6.8e Cleaning of Copper Components 20101012.pdf
- [132] F-TG-V-6.9e Bakeout Cycle 20101012.pdf
- [133] F-TG-V-7.15e Record for FAT Vacuum Components 20100512.pdf
- [134] F-TG-V-7.1e Mechanical Acceptance Test for UHV Components 20100512.pdf
- [135] F-TG-V-7.25e Vac. Prop. Acceptance Tests for Cryo Beam Vacuum Comp. 20101012.pdf
- [136] F-TG-V-7.2e Vacuum Properties Acceptance Test without Bakeout 20101012.pdf
- [137] F-TG-V-7.3e Vacuum Properties Acceptance Test with Bakeout 20101012.pdf
- [138] F-TG-V-8.10e Recom. Data Reconciliation of Internals in Vacuum Tanks 20101012.pdf
- [139] F-TG-V-8.14e Recom. Guidelines f. Purchase of Beam Vacuum Chamb. SuperFRS 20101012.pdf
- [140] F-TG-V-8.15e Recom. Guidelines f. Purchase of Beam Vacuum Chamb. SIS100 20101013.pdf
- [141] F-TG-V-8.16e Recom. Guidelines f. Purchase of Beam Vacuum Chamb. PL 20100630.pdf
- [142] F-TG-V-8.17e Recom. Guidelines f. Purchase of Beam Vacuum Chamb. HEBT 20101012.pdf
- [143] F-TG-V-8.18e Recom. Guidelines f. Purchase of Beam Vacuum Chamb. CR 20110124.pdf
- [144] F-TG-V-8.1e Recom. Guidelines f. Purchase of Ceramic Chamb. wo Bakeout 20100624.pdf
- [145] F-TG-V-8.2e Recom. Guidelines f. Purchase of Beam Vacuum Chamb. wo Bakeout 20100624.pdf
- [146] F-TG-V-8.3e Recom. Guidelines f. Purchase of Beam Vacuum Chamb. with Bakeout 20100624.pdf
- [147] F-TG-V-8.6e Recommendation Data Reconciliation of Vacuum Chambers 20100707.pdf
- [148] F-TG-V-8.19e Recom. Guidelines f. Purchase of Ceramic Chamb. with Bakeout 20110124.pdf
- [149] F-TG-V-9.1e Transport and Packaging of Vacuum Components 20100624.pdf

Accelerator Technical Guidelines Electrical Standards [300 - 319]

- [300] F-TG-ET-01e Electrical Design Rules and Regulations 20110415.pdf

Document Title: Common Specification Beam Diagnostics

Accelerator Technical Guidelines Infrastructure [320 - 349]

[320] F-TG-BD-01e Detector Gas supply v1.1.pdf

FAIR Common Specifications Various [920 - 999]

[920] F-CS-LS-01e Common Specification for the Accelerator Control System

Special Documents and Technical Notes [A 1 ...]

- [A 1] Technical Note 'Requirements for Beam Diagnostic Cables'
- [A 2] Technical Note 'Cable Terminals for Beam Diagnostic Systems'
- [A 3] Technical Note 'Clean Power Supply for Beam Diagnostics'
- [A 4] F-DS-C-05e_Timing-System.pdf
- [A 5] F-DS-C-06e_Timing-Receivers.pdf
- [A 6] P.Moritz, "BuTiS – Development of a Bunchpase Timing System", GSI Scientific Report 2006.
- [A 7] Terms and Conditions for the Exchange of Mechanical Engineering Data, to be prepared.
- [A 8] F-CS-LS-01e Common Specification 'FAIR Control System'

III. Document Information

III.1. Document History

Version	Date	Description	Author	Review / Approval
1.00	2011-10-28	Finalized for submission	M. Schwickert	Approved for submission
2.00	2012-07-27	Comments F. Gabriel	G. Schepers	
2.01	2012-08-09	Small changes, ch. 4.2.1	M. Schwickert	Ready for GSI-Approval
2.02	2012-09-10	Small changes/additions ch. 2.1.6, 5.1.6, 5.2, 5.2.3	M. Schwickert	
2.03	2012-10-01	Various corrected versions merged, minor changes	M. Schwickert	
3.00	2012-11-06	Insertion of test requirements for FAT, SAT, ch. 5.1.4, 5.1.5, 5.2.2, 5.2.3, 5.3.2, 5.3.3	M. Schwickert	Final approved version
3.1	2012-12-06	Comments of P. Forck, P. Spiller	M. Schwickert	Ready for re- approval by GSI

IV. Abbreviations

ABLASS	A Beam Loss measurement And Scaling System
AC	Alternating Current
ACT	Pulse Current Transformer for AC currents

Document Title: Common Specification Beam Diagnostics

ADC	Analog-to-Digital Converter
BD	Beam Diagnostic
BIF	Beam Induced Fluorescence Monitor
BLM	Beam Loss Monitor
BPM	Beam Position Monitor
BSM	Bunch Structure Monitor
BuTIS	Bunch Phase Timing System
CATIA	Computer Aided Three dimensional Interface Application
CCC	Cryogenic Current Comparator
CDR	Conceptual Design Review
CD ROM	Compact Disc (Read-only memory)
CE	Comunidad Europea
CERN	Conseil Européen pour la Recherche Nucléair (European Organization for Nuclear Resaerch)
cPCI	Compact PCI
CR	Collector Ring
COFB	Closed-Orbit Feedback
COTS	Commercial (available) Off-The-Shelf
CPU	Central Processing Unit
DAQ	Data Acquisition
DC	Direct Current
DCCT	DC-Current Transformer
DS	Detailed Specification
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
EU	European Union
FAIR	Facility for Antiproton and Ion Research
FAIR-CC	FAIR Civil Construction
FAT	Factory Acceptance Test
FC	Faraday-Cup
FCT	Fast Current Transformer
FDR	Final Design Review
FEC	Front-End Control
FESA	Front-End Software Architecture
FPGA	Field Programmable Gate Array
FRS	Fragment Separator
(SEM-)GRID	Secondary Electron Emission Grid
GS	General Specifications
GSI	GSI Helmholtzzentrum für Schwerionenforschung GmbH
HEBT	High Energy Beam Transport
HESR	High Energy Storage Ring
HV	High Voltage
IC	Ionization Chamber
I/O	Input/Output
IPM	Ionization Profile Monitor
IRIS	Iris
μ TCA	Micro Telecom Computing Architecture
MWPC	Multi-Wire Proportional Chamber
NDCCT	Novel DC-Current Transformer
OS	Operating System

Document Title: Common Specification Beam Diagnostics

PC	Personal Computer
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect Express
PDC	Particle Detector Combination
PDF	Portable Data Format
p-Linac	Proton Linac
PXI	PCI eXtension for Instrumentation
QA	Quality Assurance
RF	Radio Frequency
ROM	Read-Only memory
RT	Resonant Transformer or Real Time
SAT	Site Acceptance Test
SC	Scintillator
SCADA	Supervisory Control and Data Acquisition
SCP	Scraper
SCR	Scintillating Screen
SEM	Secondary Electron Emission
S-FRS	Super-Fragment Separator
SIS100	Heavy Ion Synchrotron with maximum bending power of 100Tm
SLIT	Slit pair
STEP	STandard for the Exchange of Product model data
STP	Beam Stopper
STKY	Schottky-Diagnostics
TG	Technical Guideline
TTL	Transistor-Transistor Logic
TUNE	Tune measurement
UHV	Ultra High Vacuum
UPS	Uninterruptable Power Supply
UNICOS	Unified Industrial Control System
VGA	Variable Gain Amplifier
VHDL	Very high speed integration circuit Hardware Description Language
VME	Versa Module Eurocard
XHV	Extreme high vacuum
ZT	Zentrale Technik