Contents

1. Abbreviations 1
2. Scope 1
3. Definitions 1
   3.1. Component Identification (CID) 1
   3.2. 2D – Barcode System 2
   3.3. Label 2
   3.4. What is a Component and should be tagged 2
4. Information on the Label 2
   4.1. Information in Plain Text 3
   4.2. Information embedded on QR-Code 3
5. Labelling in practice 4
6. References 6

1. Abbreviations

Abbreviation	Description
2D-Barcode	Two dimensional Barcode for Information Storage (Numbers, Text, etc.)
CDB	Component Data Base
CID	FAIR Serial number
DPI	dot per inch
MPL	Machine Project Leader
PCCM	Configuration Management
PLM	Product-Lifecycle-Management
QR-Code	Quick Response Code (2D-Barcode Trademark of the Company Denso Wave)
TG	**T**echnical **G**uideline

2. Scope

According to General Specification F-GS-F-01e components of the FAIR accelerator must be identified clearly and unambiguously by CID numbers. This identification is required in particular for product lifecycle management.
This TG defines the structure and the elements of CID numbers.
This TG determines the use of 2D-Barcode to guarantee the machine-readability of CID with scanners and mobile devices.
This TG defines also the format of the information stored in the 2D-Barcode.
To provide an informative basis for labelling, diverse marking methods are recommended according to the field of application.
This TG does not determine the layout or design of the label.

3. Definitions

3.1. Component Identification (CID)

CIDs may be created only by an authorized user of each Department. This authorization is granted by the Department PCCM. For the creation of CIDs the CDB interface provides a “CID generator”.

The CID is an 11 digit unique identifier. It is used as a serial number for identifying components of the FAIR accelerator. To avoid errors with similar characters (like 0, O or 1, l, I), only digits are used. The first two digits describe to which technical system a component belongs.
Main part of the CID is the eight digits in the middle. They describe a group of associated components and a consecutive number. The group can use three to seven digits.
Groups are defined on request and assigned by the central CID authority. Accordingly the consecutive number can be one to five digits long (see **Table 1**).

Table 1: CID digits description

z1	z2	-	z3	z4	z5	z6	-	z7	z8	z9	z10	-	z11
technical system e.g. Magnets			Group that contains up to 10000 single components					consecutive number from 0000 to 9999					check digit

The last digit of the CID is a check digit that is calculated according to ISBN-11:

$$z11 = (10 - ((z1 + z3 + z5 + z7 + z9 + 3 \bullet (z2 + z4 + z6 + z8 + z10)) \bmod 10)) \bmod 10$$

3.2. 2D – Barcode System

2D-Barcodes allows storing information in optical form. This information can be read-out by diverse scanners and mobile devices.
To ensure the machine readability of the CID on-site the components must be provided with a 2D-Barcode.
Therefore the QR code system based on ISO/IEC 18004 was chosen.

3.3. Label

The label or type plate contains important Information for commissioning or maintenance.
Type plates of particular components are defined by TG in **Table 2**.)

Table 2: Excerpt of technical guidelines for labelling

Component	**Technical guideline**
Cables and tubes on superconducting magnets	F-TG-MT-8.0e.
Steering magnets	F-TG-S-10.18e
Cryostats	F-TG-K-10.7e
Dipole magnets	F-TG-MT-10.4e
Quadrupole magnets	F-TG-S-10.6e

3.4. What is a Component and should be tagged

A component is an assembly or a part of the Fair accelerator, which has to be traced individually in its life cycle.

4. Information on the Label

Each label must contain these fundamental elements:

- the CID in plain text and
- the QR-code containing the CID.

Additional information may be placed on the label. This information and the label's design is responsibility of department.

4.1. Information in Plain Text

For better reading, the four groups of the CID should be separated by a hyphen.
The plain text has to be readable without optical aid. The font has to be without serifs. E.g.:

CID:02-12345-123-3

4.2. Information embedded on QR-Code

If information should be processed automatically it has to be stored on the barcode and needs an identifier tag (see **Table 3**).

Table 3: Excerpt of identifier tags

Identifier tag	Name	Example	Description
CID	Component Identification	CID:02123451233	unique number
SN	Serial number	SN:0815-4711-abc	SN assigned by manufacturer
TYP	Device type	TYP:Dipole	short description of device type
INV	inventory number	INV:88774	number for property of FAIR/GSI

Identifier tag and values are separated by a colon and each of these pairs is separated by a blank space. E.g. a character string stored in a QR-Code shall have the following format:

CID:02123451233 SN:0815-4711-abc TYP:Dipole INV:88774

Each square on a QR code, called module, has to be larger than 0.21 mm x 0.21 mm.
The larger a module becomes the easier and faster to read a QR code is. Then again a larger QR code requires a larger printing area and especially for interface cards this space is limited.
A QR codes has to be surrounded by blank area the "quiet zone". This margin has to be at least 4 modules wide at all sides [1]. It is important that there is a high contrast between for- and background.
To ensure the readability of damaged barcodes, QR code provides four level of error correction:

Level of error correction: correction capability [%]
L : 7% M : 15% Q : 25% H : 30%

Because of long lifetime (> 30 years) of tagged components level Q ≥ 25% correction capability has to be used. The minimum requirements for marking with QR-Codes are given in **Table 4**.

Table 4: Minimum requirements for QR-Codes

	QR-Code
Version	Version 6 (41 x 41 Module)
correction capability	25% Level Q
minimum printout area	9,53 x 9,53 mm
maximum printout area	100 x 100 mm
minimum „quiet zone“	4 module wide
minimum DPI	480 (18 point/mm)
minimum scanner resolution	5 Megapixel
maximum storage	178 digits or 108 alphanumeric characters

Figure 1 illustrates the basic elements of a label and the requirements for the QR-Code.

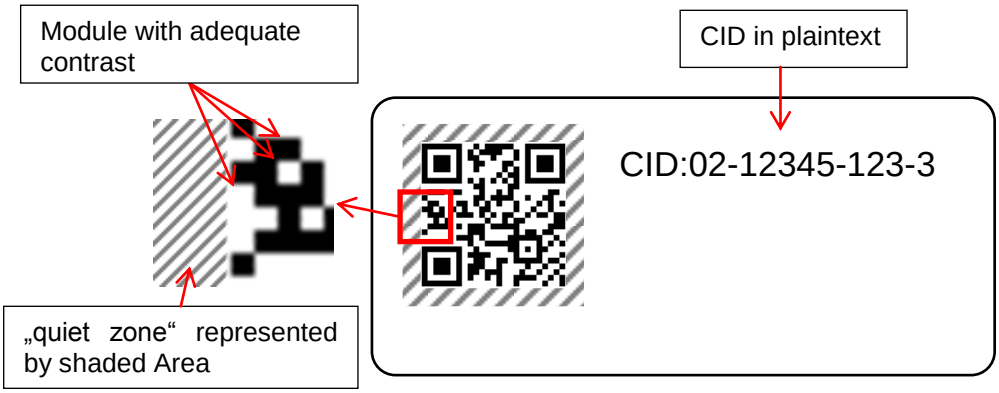

Figure 1: Basic elements of a label

5. Labelling in practice

Several options exist like mechanical, electrical or laser engraving. The marking methods can be divided in two main groups:

1. **Direct marking**
   The information (QR-Code, Text etc.) is burnt, etched or engraved directly on the surface of the component. In most cases a mechanical or chemical alteration of the surfaces occurs.
2. **non-direct marking**
   The information is stamped or printed on the label and then the label is bounded to the component by means of glue, lashes or grooved pins.

Direct marking is always preferred. If there is no possibility for direct marking, a label can be bonded on the component.
If the component holds a manufacturer type plate (e.g. pumps, valves etc.) the label shall be placed on in the immediate proximity of the type plate. The label with QR-code and CID do not replace the type plate. **Labels shall not be placed on top of the type plates!**

The recommended marking methods are listed after field of application **Table 5**. The contractor must ensure and proof that the label has adequate contrast and is scanable.

Table 5: Recommended marking methods

	Method	Material						Field									Surface						coating				
		Steel	Steinless steel	Aluminium	Plastic	Ceramic	Kapton	atmosphere	radioactiv	vaccum	humid	dry	aggressive	fluid flow	cryo	>250°	flat	concav	convex	milled	turned	polish	painted	zinked	coppered	anodize	burnished
direct marking	Laser marking	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X
	Dot peen marking	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X
	electrolytic etching	X	X	X				X	X	X	X	X	X	X	X	X	X			X		X					
	Stamping / embossing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X		X				X	X
	Tampon printing				X			X				X		X			X	X	X	X	X	X	X	X	X	X	X
non-direct marking	Adhesive label	X	X	X	X	X	X	X				X					X	X	X	X	X	X	X	X	X	X	X
	labelplate with grooved pins	X	X	X	X			X	X		X	X	X	X			X	X	X	X	X	X	X	X	X	X	X

Small objects like cables can be marked using a label-plate with a printable area of 12 x 12 (similar to F-TG-MT-8.0e). The label plates can be fixed by straps or lashes to the object like shown in Figure 2.



Figure 2: Example of cable labelling

When using labels (e.g. label plates) the material of the labels and grooved pins, lashes or bonding material must also comply to the requirements of the component. E.g.:

- magnetic permeability
- temperature
- thermal elongation

- radiation
- chemical environment

On vacuum chambers and cavities the labelling should be done directly on the surface on an area visible also when the chambers are installed, preferable on a rotating flange.

6. References

[1] Denso Wave: QR Code, http://www.qrcode.com/en/qrgene3.html, 12.06.2012