



# HL-LHC QA/QC – WP4

**H. Garcia Gavela on behalf of the HL Quality Office and WP4**



HL-LHC Collaboration Meeting Uppsalla – 21<sup>st</sup> September 2022

# Outline

1. HL-LHC Quality Plan
2. WP4 Approach and Requirements
3. EDMS and MTF
4. Quality during Series production
5. Conclusions

# Outline

- 1. HL-LHC Quality Plan**
2. WP4 Approach and Requirements
3. EDMS and MTF
4. Quality during Series production
5. Conclusions

# HL-LHC Quality Plan



The LHC Quality Assurance Plan



[Foreword - LHC Project Leader](#) (pdf file)



Policy



Definitions



Procedures



Standards



Templates



Instructions



Links



CD-ROM

[LHC Quality Assurance Plan presentation](#) (pdf file)

## Chapter 100 - Quality Assurance Policy

Definition of the quality assurance requirements for the LHC Project activities  
(Click the link in "Number" to load the pdf file)

Number	Rev.	Status	Date	Title
<a href="#">LHC-PM-QA-100.00</a>	1.4	Released	2003-04-02	Quality Assurance Policy and Project Organisation
<a href="#">LHC-PM-QA-101.00</a>	1.4	Released	2003-04-28	Quality Assurance Plan Contents and Status

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## Chapter 200 - Definitions

Definition of various common conventions in use throughout the Project  
(Click the link in "Number" to load the pdf file)

Number	Rev.	Status	Date	Title
<a href="#">LHC-PM-QA-201.00</a>	1.0	Released	1998-06-25	Quality Assurance Categories
<a href="#">LHC-PM-QA-202.00</a>	1.2	Released	2003-04-03	Document Types and Naming Conventions
<a href="#">LHC-PM-QA-203.00</a>	1.0	Released	1999-06-16	Glossary, Acronyms, Abbreviations
<a href="#">LHC-PM-QA-204.00</a>	1.1	Released	2003-04-03	Equipment Naming Conventions
<a href="#">LHC-PM-QA-205.00</a>	-	In-work	-	LHC Engineering Vocabulary
<a href="#">LHC-PM-QA-206.00</a>	1.1	Released	1999-11-09	LHC Part Identification
<a href="#">LHC-PM-QA-207.00</a>	1.0	Released	1999-11-16	Naming Conventions for Buildings and Civil Engineering Works

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## Chapter 300 - Procedures

Description of the required course of actions to implement the Project QA policies  
(Click the link in "Number" to load the pdf file)

Number	Rev.	Status	Date	Title
<a href="#">LHC-PM-QA-300.00</a>	-	Planned	-	Product Breakdown Structure Process and Control

- HL-LHC is an upgrade of an existing machine
- There are some rules and guidelines that we need to comply with (LHC requirements)

# HL-LHC Quality Plan



### HiLumi collaboration : a higher luminosity for greater discoveries !



A globe is shown with lines connecting to various international collaboration logos. The logos include: INFN, ILL, LAC, CERN, Uppsala University, KEK, DESY, SLAC, FNAL, ATLAS, CMS, LHCb, ALICE, STAR, PHENIX, CBM, EIC, RHIC, STFC, UNILIN, UNILIV, SOROT, UNIMAN, and HiLumi. The HiLumi logo is at the bottom right with the URL [hilumi.web.cern.ch](http://hilumi.web.cern.ch).

# HL-LHC Quality Plan

External contributors are governed by the quality management plans of their home institute, however **all HL-LHC deliverables shall be compatible with the HL-LHC Quality plan**

- Hardware baseline documentation stored in **EDMS**
- Fabrication records in **MTF**
- Project information accessible to all “Hilumiers”
- Corporate image when representing the project

# HL-LHC Quality Plan

		EDMS NO. 1513591	REV. 2.0	VALIDITY VALID
REFERENCE : LHC -QA-0001				
<b>PLAN</b>				
<b>HL-LHC QUALITY PLAN</b>				
<b>Abstract</b> The HL-LHC project is committed to be a project of excellence respecting the best practises in project and quality management. The adoption of a quality management system is a strategic decision that aims to improve overall performance and provide a sound basis for sustainable development initiatives.  This document provides an overview of the processes and procedures implemented on the HL-LHC Quality Management System (QMS).				
<b>TRACEABILITY</b>				
<b>Prepared by:</b> I. Bejar Alonso		<b>Date:</b> 2018-02-28		
<b>Verified by:</b> H. Garcia Gavela, Project Office		<b>Date:</b> 2018-03-14		
<b>Approved by:</b> I. Bejar Alonso, L. Rossi, Department Heads, F. Bordry		<b>Date:</b> 2018-04-20		
<b>Distribution:</b> Public				
Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)		
2.0	2018-04-20	Version post FP7 replacing version 1 and the EU deliverable [1]		
<small>This document is uncontrolled when printed. Check the EDMS to verify that this is the correct version before use</small>				

## 2 SCOPE

The quality policies, procedures, guidelines, plans and templates (also referred to as quality documentation hereafter) outlined in this document apply to all phases of the HL-LHC project and its systems, from R&D to preparation for dismantling of the future facility—in this context, as future facility it is understood the LHC equipment under the scope of the HL-LHC project-. This applies as well to documentation produced by third parties under the scope of the project.

External contributors are governed by the quality management systems of their home institution. However all HL-LHC project deliverables shall be compatible with what is stated in this Quality Manual.

The quality documentation presented in this Quality Manual complements/replaces the LHC Project Quality Assurance Plan [2].

### 4.3.2 Control of Documents

The procedures [11] and [12] describe how to handle HL-LHC documentation within the HL-LHC project.

EDMS is the tool used for the control of engineering documents and presentations. CDS is the tool used for the control of scientific documents and graphic records.

### 4.3.3 Control of Records

The HL-LHC Records Management [13] procedure describes how to handle the records established to provide evidence of compliance with the requirements and the effective operation of the quality management system.

All records related to Fabrication, Assembly and Verification of equipment belonging to HL-LHC, as well as those related to Installation and Commissioning, shall be stored by default until the dismantling phase. MTF is the tool used for the control of records.

HL-LHC Quality Plan:

<https://edms.cern.ch/document/1513591>

# HL-LHC Quality – Some pillars

## HL Quality Plan

TRACEABILITY	
Issue Date	2018-01-08
Issue Date	2018-02-04
Issue Date	2018-04-23

## Doc. Management & Control

It provides the procedures to be used and it explains how quality is managed for HL-LHC

**Non Baseline**  
Documents required for the well functioning of the project but which storage will not be critical after decommissioning.  
Peer review process is generally managed by the author.  
Do not require special labelling.  
Stored in SharePoint or EDMS.

**Baseline**  
Documents that will have to be stored in the baseline of the LHC.  
Concerning one Workpackage or one project.

Ref. of documentation

## Baseline Documents

- On top of the Quality Plan, guidelines, procedures and tools, the most important is the commitment and engagement of the people for these activities

Documents that need to be issued and stored up to the dismantling of the machine

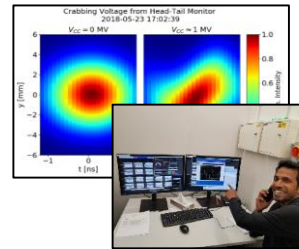
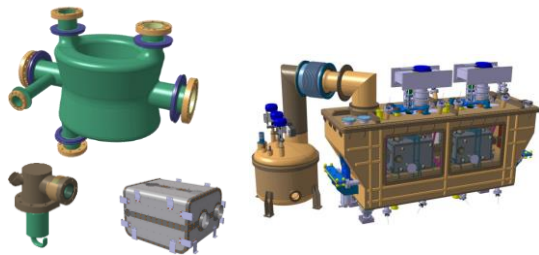
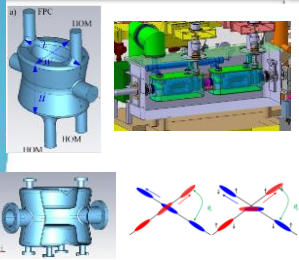
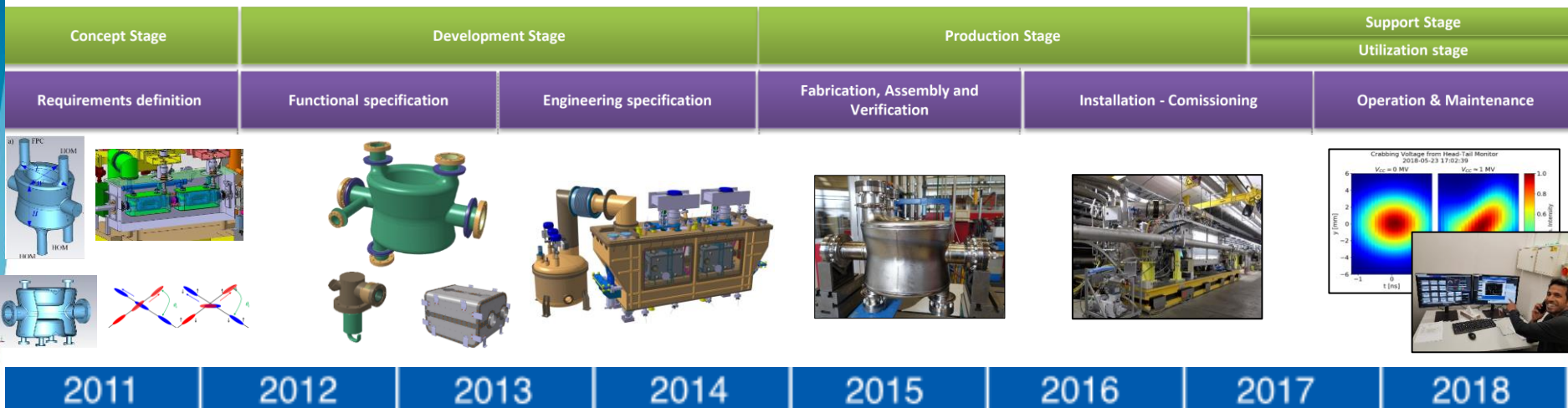
## Tools for HL



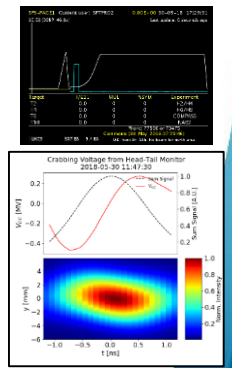
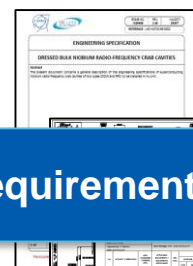
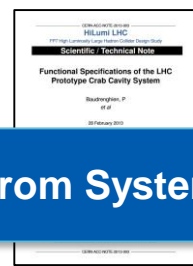
Tools at CERN to manage the documentation



# When – The full HL-LHC life-cycle



**From Systems Requirements to Technical Solutions & Products**



# Outline

1. HL-LHC Quality Plan
- 2. WP4 Approach and Requirements**
3. EDMS and MTF
4. Quality during Series production
5. Conclusions

# Requirements



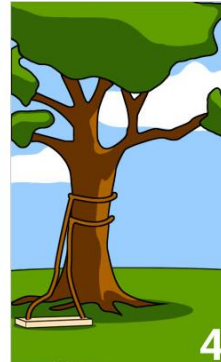
How the customer explained it



How the project leader understood it



How the analyst designed it



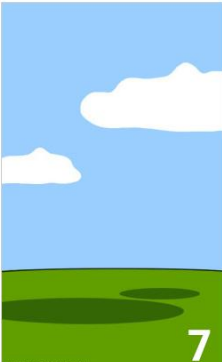
How the programmer wrote it



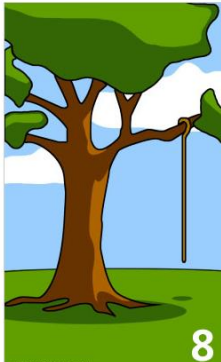
What the beta testers received



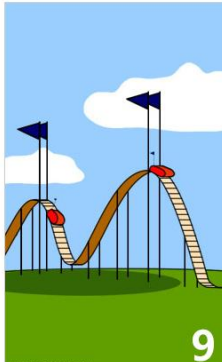
How the business consultant described it



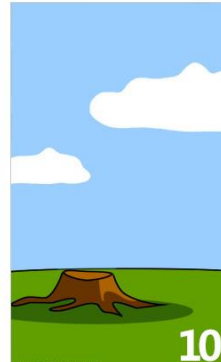
How the project was documented



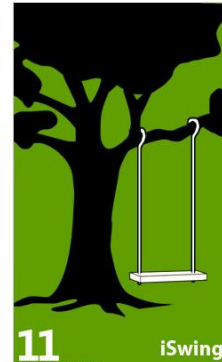
What operations installed



How the customer was billed



How it was supported





iSwing



What the customer really needed

# Requirements

## See Marco's presentation about the status of each engineering specification

EDMS NO. 2043014	REV. 1.0	VALIDITY VALID
REFERENCE: LHC-ACF_A-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES: CRYMODULES FOR CRAB CAVITIES

**Abstract**  
This engineering specification concerns the supply of cryomodules for dressed bulk niobium RF cavities of two types (DQW and RFD) for the High Lumosity Large Hadron Collider project.

**Prepared by:** L. Dassa **Date:** 2021-04-26



**Verified by:** G. Arduini, I. Bejar Alonso, K. Artoos, V. Baglin, K. Brodzinski, G. Burt, T. Capelli, S. Claudet, P. Fessia, C. Gaigriant, M. Garlasche, M. Garcia Gavela, R.T. Garcia, J. Gascon, F. Gerigk, T. Jones, S. Marsh, E. Montesinos, R. Laxdal, H. Mainaud Durand, E. Montesino, T. Otto, C. Pasquino, D. Perini, G. Bregliozzi, V. Rude, M. Sosin, L. Tavian, M. Therasse, K. Turaj, G. Vandoni, N. Valverde Alonso, O. Williams, M. Zerlauth **Date:** 2021-04-27

**Approved by:** F. Bertinelli, R. Calaga, O. Capatina, F. Gerigk, O. Bruning **Date:** 2021-05-19

**Distribution:** NA

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	2020-06-22	1 <sup>st</sup> version
0.2	2020-07-01	2 <sup>nd</sup> version: cryogenic / alignment / survey / metrology sections updated
0.3	2020-12-07	3 <sup>rd</sup> version: vacuum sections updated / general review / T. Jones comments integrated
0.4	2021-02-19	4 <sup>th</sup> version: integration of comments received during circulation within the WP4 (see EDMS related pages where comments are stored)
0.5	2021-04-26	5 <sup>th</sup> version: integration of comments received by V. Baglin, C. Pasquino, N. Valverde Alonso
1.0	2021-05-19	1 <sup>st</sup> Release Version of the document

Page 1 of 85 Template EDMS No.: 1372960

EDMS NO. 1389669	REV. 2.6	VALIDITY VALID
REFERENCE: LHC-ACFDC-ES-0002		

### ENGINEERING SPECIFICATION

#### DRESSED BULK NIOBIUM RADIO-FREQUENCY CRAB CAVITIES

**Abstract**  
The present document concerns a general description of the engineering specifications of superconducting niobium radio-frequency crab cavities of two types (DQW and RFD) to be installed in HL-LHC.

**Prepared by:** L. Alberty, S. Athie, L. Dassa, G. Favre, P. Freijeido Menendez, M. Garlasche, C. Farenz, N. Valverde, C. Zanoni **Date:** 2021-11-19



**Verified by:** G. Arduini, I. Bejar Alonso, K. Brodzinski, G. Burt, O. Capatina, S. Claudet, P. Fessia, H. Garcia Gavela, J. Gascon, F. Gerigk, T. Jones, R. Laxdal, H. Mainaud Durand, E. Montesinos, T. Otto, D. Perini, L. Ristori, L. Tavian, D. Wollmann **Date:** 2021-11-30

**Approved by:** Said Athie, O. Bruning, R. Calaga, K. Foraz, F. Gerigk, B. Goddard **Date:** 2021-12-08

**Distribution:** HL-LUMI-LHC-WP4-MEMBERS

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
1.0	05/06/2014	First version
2.0	22/06/2015	Updated version to include requirements for helium vessels and other items (these last, only for information)
2.1	19/06/2016	Updated version with the latest information for all items
2.2	31/10/2018	Luca Dassa - Major reorganization of the content to make it better readable. Integration of the Technical Specification for Titanium bellows.
2.3	27/11/2018	Rama Calaga, Luca Dassa - Functional Specification for cavities included. Acceptance criteria for cavities included
2.49	11/02/2019	Luca Dassa: integration of comments to the 2.4 version, after US-AUP revision
2.5	15/07/2019	Released
2.51	23/03/2020	New version with modifications issued by the experience with DQW proto
2.55	10/06/2020	Comments after circulation of 2.51 integrated (M. Garlasche, L. A. Santillana, A. G. Terricabras, S. V. Andres, E. Montesinos, M. Therasse, N. V. Alonso, K. Artoos)
2.56	04/11/2020	Comments after circulation of 2.55 integrated (Y. Papaphilippou, R. Garcia Tomas, G. Arduini, B. Sakant, R. De Maria) CMS specification rewritten + minor changes List of modifications in a separate file at the same EDMS node
2.57	22/09/2021	Comments after circulation of 2.56 integrated (M. Garlasche) / List of modifications in a separate file at the same EDMS node/
2.58	19/11/2021	Comments after circulation of 2.57 integrated
2.59	20/12/2021	Modifications required by J. A. Mitchell
2.6	22/03/2022	Rev. 2.6 set to Valid

This document is uncontrolled when printed. Check the EDMS to verify that this is the correct version before use

EDMS NO. 14070	REV. 1.0	VALIDITY VALID
REFERENCE: LHC-ACFDC-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES CRYMODULE CRYOGENIC LINES

**Abstract**  
The present document concerns the engineering specifications of thermal shield for the cryomodules to be installed in the QWS Family cryomodules installed in the HL-LHC superconducting niobium radio-frequency crab cavities (two types: DQW and RFD) installed in the HL-LHC ring for the HL-LHC project.

**Prepared by:** I. Bejar Alonso (HL-LHC), M. Garcia Gavela (HL-LHC) **Date:** 18-05-2008



**Verified by:** A. Bortone (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC) **Date:** 27-11-2008

**Approved by:** R. Calaga (HL-LHC), M. Garcia Gavela (HL-LHC), L. Capatina (HL-LHC) **Date:** 18-05-2008

**Distribution:** L. Capatina (HL-LHC), D. Williams (HL-LHC), L. Mainaud Durand (HL-LHC)

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	18/05/2008	First Draft
0.2	04/06/2008	Second Draft: Reorganization of the content of the technical specification for the cryomodules and the cryogenic lines. New figures for the Mainaud Durand List of DQW-Module Assembly-related data for DQW-Modules.
0.3	04/07/2008	Comments provided by M. Garcia Gavela
0.4	10/08/2008	Comments provided by R. Terricabras
1.0	18/05/2008	Comments provided by D. Capatina included. Final technical specification. (Approved by: D. Capatina, Y. Papaphilippou)

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EDMS NO. 14070	REV. 1.0	VALIDITY VALID
REFERENCE: LHC-ACFDC-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES WARM MAGNETIC SHIELD FOR CRAB CRYMODULES

**Abstract**  
The present document concerns the engineering specifications of warm shields (MS) to be installed in the superconducting niobium radio-frequency crab cavities (two types: DQW and RFD) installed in the HL-LHC.

**Prepared by:** I. Bejar Alonso, A. Garcia Terricabras, M. Garcia Gavela **Date:** 2020-05-06



**Verified by:** A. Bortone, L. Capatina, L. Capatina, L. Capatina, L. Capatina, L. Capatina **Date:** 2020-05-06

**Approved by:** R. Calaga, L. Capatina **Date:** 2020-05-06

**Distribution:** HL-LHC LHC CRAB CAVITIES

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	04/05/2020	First Draft
0.2	04/05/2020	Integration of comments received by L. Montesinos and M. Garcia Gavela
0.3	24/05/2020	Integration of comments received by L. Montesinos. Clarification for fabrication
1.0	04/05/2020	Integration of comments after integration and approval of the MS for MS

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EDMS NO. 14070	REV. 1.0	VALIDITY VALID
REFERENCE: LHC-ACFDC-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES THERMAL SHIELD FOR CRAB CRYMODULE

**Abstract**  
The present document is listing the engineering specifications of thermal shield for the cryomodules to be installed in the QWS Family cryomodules installed in the HL-LHC superconducting niobium radio-frequency crab cavities (two types: DQW and RFD) installed in the HL-LHC ring for the HL-LHC project.

**Prepared by:** I. Bejar Alonso (HL-LHC), M. Garcia Gavela (HL-LHC) **Date:** 13/01/2008



**Verified by:** A. Bortone (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC) **Date:** 05/06/2008

**Approved by:** R. Calaga (HL-LHC), M. Garcia Gavela (HL-LHC), L. Capatina (HL-LHC) **Date:** 13/01/2008

**Distribution:** L. Capatina (HL-LHC), D. Williams (HL-LHC), L. Mainaud Durand (HL-LHC)

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	13/01/2008	First Draft
0.2	04/06/2008	Comments by M. Garcia Gavela integrated
0.3	04/07/2008	HL Engineering Check
0.4	24/05/2020	1 <sup>st</sup> HL Engineering Check
0.7	24/05/2020	New version to implement modifications required by manufacturing of QWS. Revised for fabrication and operation modified. Drawing, lists and requirements modified. List of the non-conformances found. Soldered joints for thermocouples removed. New BORE-2000

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EDMS NO. 14070	REV. 1.0	VALIDITY VALID
REFERENCE: LHC-ACFDC-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES RF LINES FOR CRAB CRYMODULE

**Abstract**  
The present document is listing the engineering specifications of RF lines to be installed in the superconducting niobium radio-frequency crab cavities (two types: DQW and RFD) installed in the HL-LHC.

**Prepared by:** I. Bejar Alonso (HL-LHC), L. A. Mitchell (HL-LHC), M. Garcia Gavela (HL-LHC) **Date:** 26/01/2008



**Verified by:** M. Garcia Gavela (HL-LHC) **Date:** 26/01/2008

**Approved by:** M. Garcia Gavela (HL-LHC) **Date:** 26/01/2008

**Distribution:** M. Garcia Gavela (HL-LHC)

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	06/02/2008	First Draft
0.2	06/02/2008	Integration of comments received by L. Montesinos and M. Garcia Gavela
0.3	24/05/2020	Integration of comments received by L. Montesinos. Clarification for fabrication
1.0	04/05/2020	Integration of comments after integration and approval of the RF for RF

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EDMS NO. 14070	REV. 1.0	VALIDITY VALID
REFERENCE: LHC-ACFDC-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES VACUUM VESSEL

**Abstract**  
The present document is listing the engineering specifications of the vacuum vessel for the production of the second period that will be used in the HL-LHC Crab Cavities.

**Prepared by:** I. Bejar Alonso (HL-LHC), M. Garcia Gavela (HL-LHC) **Date:** 05/06/2008



**Verified by:** A. Bortone (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC) **Date:** 05/06/2008

**Approved by:** R. Calaga (HL-LHC), M. Garcia Gavela (HL-LHC), L. Capatina (HL-LHC) **Date:** 05/06/2008

**Distribution:** L. Capatina (HL-LHC), D. Williams (HL-LHC), L. Mainaud Durand (HL-LHC)

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	05/06/2008	First version
0.2	05/06/2008	Second version
0.3	18/05/2008	Third version
0.4	18/05/2008	Final version. Clarification for approval
0.5	18/05/2008	Final version. Clarification for approval
1.0	04/05/2020	1 <sup>st</sup> Release version of the document

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EDMS NO. 14070	REV. 1.0	VALIDITY VALID
REFERENCE: LHC-ACFDC-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES FUNDAMENTAL POWER COUPLER FOR CRAB CRYMODULES

**Abstract**  
The present document concerns the engineering specifications of fundamental power couplers (FPC) to be installed in the superconducting niobium radio-frequency crab cavities (two types: DQW and RFD) installed in the HL-LHC.

**Prepared by:** I. Bejar Alonso (HL-LHC), M. Garcia Gavela (HL-LHC) **Date:** 05/06/2008

**Verified by:** A. Bortone (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC), L. Capatina (HL-LHC) **Date:** 05/06/2008

**Approved by:** R. Calaga (HL-LHC), M. Garcia Gavela (HL-LHC), L. Capatina (HL-LHC) **Date:** 05/06/2008



**Distribution:** L. Capatina (HL-LHC)

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	05/06/2008	First Draft
0.2	05/06/2008	Integration of comments received by L. Montesinos and M. Garcia Gavela
0.3	18/05/2008	Integration of comments received by L. Montesinos. Clarification for approval
0.4	18/05/2008	Integration of comments received by L. Montesinos. Clarification for approval
1.0	04/05/2020	Integration of comments received by M. Garcia Gavela

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# WP4 Requirements

- ❑ The Engineering specifications are the result of many years of intense work (Major effort driven by Luca Dassa)
- ❑ It provides the requirements for the design, procurement, construction, testing and acceptance of each equipment
- ❑ It contains technical and functional requirements as well as acceptance criteria
- ❑ It contains the documentation that is expected to be delivered
- ❑ Feedback and lessons learned are also implemented

EDMS NO. 2043024	REV. 1.0	VALIDITY VALID
REFERENCE : LHC-ACF_A-ES-0001		

### ENGINEERING SPECIFICATION

#### HL-LHC LHC CRAB CAVITIES: CRYMODULES FOR CRAB CAVITIES

**Abstract**  
This engineering specification concerns the supply of cryomodules for dressed bulk niobium RF cavities of two types (DQW and RFD) for the High Luminosity Large Hadron Collider project.



#### TRACEABILITY

<b>Prepared by:</b> L. Dassa	<b>Date:</b> 2021-04-26
<b>Verified by:</b> G. Arduini, I. Bejar Alonso, K. Artoos, V. Baglin, K. Brodzinski, G. Burt, T. Capelli, S. Claudet, P. Fessia, C. Gaigant, M. Garlasche, H. Garcia Gavela, R.T. Garcia, J. Gascon, F. Gerigk, T. Jones, S. March, E. Montesinos, R. Landai, H. Mainaud Durand, E. Montesinos, T. Otto, C. Pasquino, D. Perini, G. Bregliozzi, V. Rude, M. Sosin, L. Tavlian, M. Therasse, K. Turaj, G. Vandoni, N. Valverde Alonso, O. Williams, M. Zerlauth	<b>Date:</b> 2021-04-27
<b>Approved by:</b> F. Bertinelli, R. Calaga, O. Capatina, F. Gerigk, O. Bruning	<b>Date:</b> 2021-05-19

**Distribution:** NA

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	2020-06-22	1 <sup>st</sup> version
0.2	2020-07-01	2 <sup>nd</sup> version: cryogenic / alignment / survey / metrology sections updated
0.3	2020-12-07	3 <sup>rd</sup> version: vacuum sections updated / general review / T. Jones comments integrated
0.4	2021-02-19	4 <sup>th</sup> version: integration of comments received during circulation within the WP4 (see EDMS related pages where comments are stored)
0.5	2021-04-26	5 <sup>th</sup> version: integration of comments received by V. Baglin, C. Pasquino, N. Valverde Alonso
1.0	2021-05-19	1 <sup>st</sup> Release Version of the document

Page 1 of 85 Template EDMS No. : 1372869

EDMS NO. 1389669	REV. 2.6	VALIDITY VALID
REFERENCE : LHC-ACFDC-ES-0002		

### ENGINEERING SPECIFICATION

#### DRESSED BULK NIOBIUM RADIO-FREQUENCY CRAB CAVITIES

**Abstract**  
The present document concerns a general description of the engineering specifications of superconducting niobium radio-frequency crab cavities of two types (DQW and RFD) to be installed in HL-LHC.

#### TRACEABILITY

**Prepared by:** L. Alberty, S. Atieh, L. Dassa, G. Favre, P. Frejedo Menendez, M. Garlasche, C. Parente, N. Valverde, C. Zanoni **Date:** 2021-11-19

**Verified by:** G. Arduini, I. Bejar Alonso, K. Brodzinski, G. Burt, O. Capatina, S. Claudet, P. Fessia, H. Garcia Gavela, J. Gascon, F. Gerigk, T. Jones, R. Landai, H. Mainaud Durand, E. Montesinos, T. Otto, D. Perini, L. Rastori, L. Tavlian, D. Wollmann **Date:** 2021-11-30

**Approved by:** Said Atieh, O. Bruning, R. Calaga, K. Foraz, F. Gerigk, B. Goddard **Date:** 2021-12-08

**Distribution:** HL-LUMI-LHC-WP4-MEMBERS

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
1.0	05/06/2014	First version
2.0	22/06/2015	Updated version to include requirements for helium vessels and other items (these last, only for information)
2.1	19/06/2016	Updated version with the latest information for all items
2.2	31/10/2018	Luca Dassa - Major reorganization of the content to make it better readable. Integration of the Technical Specification for Titanium bellows.
2.3	27/11/2018	Rama Calaga, Luca Dassa - Functional Specification for cavities included. Acceptance criteria for cavities included
2.49	11/02/2019	Luca Dassa: integration of comments to the 2.4 version, after US-AUP revision
2.5	15/07/2019	Released
2.51	23/03/2020	New version with modifications issued by the experience with DQW proto
2.55	10/06/2020	Comments after circulation of 2.51 integrated (M. Garlasche, I. A. Santillana, A. G. Terricabras, S. V. Andres, E. Montesinos, M. Therasse, N. V. Alonso, K. Artoos)
2.56	04/11/2020	Comments after circulation of 2.55 integrated (Y. Pappalippou, R. Garcia Tomas, G. Arduini, B. Salvant, R. De Maria) CMS specification rewritten - minor changes List of modifications in a separate file at the same EDMS node
2.57	22/09/2021	Comments after circulation of 2.56 integrated (M. Garlasche) / List of modifications in a separate file at the same EDMS node/
2.58	19/11/2021	Comments after circulation of 2.57 integrated
2.59	20/12/2021	Modifications required by J. A. Mitchell
2.6	22/03/2022	Rev. 2.6 set to Valid

This document is uncontrolled when printed. Check the EDMS to verify that this is the correct version before use

# HL-LHC Quality Plan – Traceability of Changes

Document	Purpose	Reference	EDMS Docs
<b>Engineering Change Request</b>	<p>Modification of the current Project Baseline:</p> <ul style="list-style-type: none"> <li>There is a modification on the scope defined in the technical baseline (TDR)</li> <li>There is a need of extra funds to pay for an object that was in the baseline and can not be funded by internal reorganization of the budget for the same equipment (Budget ECR)</li> </ul> <p>If the modification affects the present <b>LHC</b> machine an <b>ECR</b> is submitted using the normal <b>LHC ECR circuit</b></p>	<p><b>TDR</b> – <a href="#">Scope Baseline</a>  <b>PBS</b> – <a href="#">Project Breakdown Structure</a>  <b>MTP</b> – Cost Baseline</p>	<p><b>Process</b>  <a href="#">2429904</a>  <b>Template</b>  <b>HL-LHC ECRs</b>  <a href="#">1508429</a>  <b>LHC ECRs</b>  <a href="#">Link</a></p>
<b>Schedule Change Request</b>	<p>Trace and record relevant variances in the Master Schedule wrt. the one endorsed and approved in the last Cost &amp; Schedule Review (CSR).  For deliverables related to LHC installation or IT String installation:</p> <ul style="list-style-type: none"> <li>If the shift is &gt; 6 months (LHC installation) : An SCR shall be issued.</li> <li>If the shift is &gt; 2 months (IT String): An SCR shall be issued.</li> </ul>	<p><b>MS</b> – Master Schedule</p>	<p><b>Process</b>  <a href="#">2735444</a>  <b>Template</b>  <a href="#">2725175</a></p>
<b>Decision Management Reports</b>	<p>Trace managerial decisions without modifying the Project Baseline.</p> <ul style="list-style-type: none"> <li>Formalize a technical decision between several options or sharing of managerial decisions</li> <li>Internal re-scheduling w/o affecting the baseline</li> <li>Revaluation of the cost</li> </ul>		<p><b>Template</b>  <a href="#">1501719</a></p>
<b>Deviation Requests</b>	<p>Request to do something different from an established requirement for a limited number of components, for a brief period, or for a specific use</p>	<p><b>Engineering Specifications</b>  <b>Design/Manufacturing files</b>  <b>Technical Specifications</b></p>	<p><b>Process</b>  <a href="#">1506723</a>  <b>Template</b>  <a href="#">1506726</a></p>
<b>Safety Request</b>	<p>In case the <b>deviation</b> concerns exclusively a safety requirement. If so, it is not necessary to create a deviation request on the top of the Safety request.</p>	<p><b>Safety Requirements</b>  <b>Technical Specifications</b>  <b>Engineering Specifications</b></p>	<p><b>Template</b>  <a href="#">1770077</a></p>
<b>Nonconformity</b>	<p>Non fulfilment of an established requirement (they are more production oriented)</p>	<p><b>Engineering Specifications</b>  <b>Design/Manufacturing files</b>  <b>Technical Specifications</b></p>	<p><b>Process</b>  <a href="#">1499015</a>  <b>Template</b>  <a href="#">1501109</a></p>

# Deviation Requests vs Nonconformities

- **Nonconformities  $\neq$  Deviation Requests**
  - **Nonconformity** – A deviation from an established requirement is detected. During the verification of the equipment, it is found something that is not complying the specifications
  - **Deviation Request** – Request to do something different from an established requirement – The requirements are not changing but a derogation is granted in case that is accepted – If you already know that there are requirements that cannot be met, a deviation request is to issued

# Outline

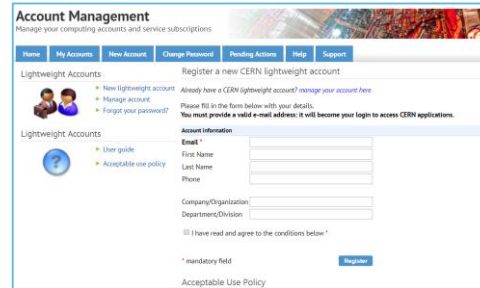
1. HL-LHC Quality Plan
2. WP4 Approach and Requirements
3. **EDMS and MTF**
4. Quality during Series production
5. Conclusions



# EDMS – Requirements to access

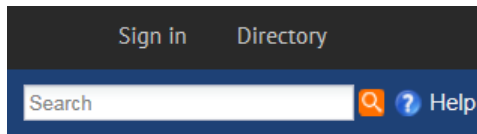
- **CERN Lightweight account** is required ([Link to create one](#)) to access to **EDMS** (Engineering & Equipment Data Management Service)

1. Follow the link to register your account

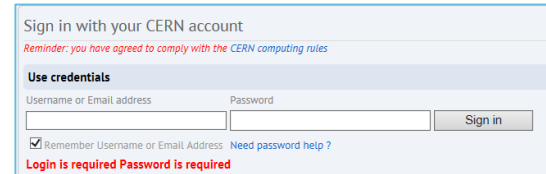


The screenshot shows the 'Account Management' page with a navigation bar (Home, My Accounts, New Account, Change Password, Pending Actions, Help, Support). The main content area is titled 'Lightweight Accounts' and includes a 'Register a new CERN lightweight account' section. It contains a form with fields for 'First Name', 'Last Name', and 'Phone'. Below the form, there are checkboxes for 'I have read and agree to the conditions below\*' and 'Acceptable Use Policy'. A 'Register' button is located at the bottom right of the form.

2. Go to [EDMS](#) and Log in with this account



The screenshot shows a dark blue search bar with the text 'Sign in Directory' at the top. Below the search bar, there is a search input field with a magnifying glass icon and a 'Help' button with a question mark icon.



The screenshot shows the 'Sign in with your CERN account' page. It includes a reminder: 'Reminder: you have agreed to comply with the CERN computing rules'. Below this, there is a 'Use credentials' section with input fields for 'Username or Email address' and 'Password'. A 'Sign in' button is located to the right of the password field. There is also a checkbox for 'Remember Username or Email Address' and a link for 'Need password help?'. At the bottom, there are red error messages: 'Login is required' and 'Password is required'.

3. You will then have access to the Documentation of the Project (after adding you to the corresponding E-Group)

# EDMS – Requirements to access

- If you are going to use **MTF (Equipment Management Folder)**, then a CERN Nice Account is required
- Please contact [HL-LHC.Secretariat@cern.ch](mailto:HL-LHC.Secretariat@cern.ch) (Michela Lancellotti) in order to proceed  
She will send you the details, the application form to be filled in and the documentation to be provided

**Registration under the heading "EXTERNAL"**

<b>Person concerned</b>			
Name		Surname _____ First name(s) _____ (as on passport)	
Gender	<input type="radio"/> female <input type="radio"/> male	e-mail	_____
Nationality	_____ Date of birth _____		
Employer's address <sup>1</sup>			
Name _____			
Address _____			
Tel. _____ Fax _____ e-mail _____			
<input type="radio"/> I certify that I am in compliance with all laws applicable to my presence and activity at CERN, including the laws on work and residence permits. <input type="radio"/> I also certify that I am in compliance with applicable laws concerning social insurance and that in any event, I have health insurance cover against the financial consequences of illness and accident, at levels adequate in Switzerland and France.			
Signature	_____		
Date	_____		
<b>Period of association with CERN</b>			
Starting date	Day _____ Month _____ Year _____	Scheduled end date	Day _____ Month _____ Year _____
<b>Reason for registration</b>			
<input type="radio"/> Person accompanying a member of the personnel or a beneficiary of the Pension Fund who requires assistance with mobility	ACCO	Registration exclusively by	Registration Service 1 year
<input type="radio"/> Member of an official CERN committees	COMT	Secretary of Council, scientific committees and Pension Fund	Mandate
<input type="radio"/> Lecturer or external participant in conferences... organised by CERN	CONF		4 weeks
<input type="radio"/> External participant in activities or projects, exclusively teleworking	DIST		1 year
<input type="radio"/> External participant in an EU project	EU/PR	Project's secretariat	1 year
<input type="radio"/> External participant in training courses organised by CERN	FORM	Training Service	1 year
<input type="radio"/> CERN Guide with dosimeter	GUID	Visits Service	1 year
<input type="radio"/> Honorary member	HONO	HR Department	= Invitation
<input type="radio"/> Host state's authorities (e.g. labour inspector, works doctor)	HOST	Host States Relations Service	2 years
<input type="radio"/> Industrial Liaison Officer	ILOF	IFT Department	= Mandate
<input type="radio"/> Child attending the CERN Kindergarten or the accompanying person not member of personnel	KIND	Staff Association or HR Department	1 year
<input type="radio"/> External participant in a project or specific activity (according to the exhaustive list available in the procedure)	PROJ	Service responsible for the project-activity	1 year
<input type="radio"/> Scientific activities of pensioners from institutes who have been previously USER	SCIE	DAO office of the EP Department	1 year
<input type="radio"/> Trainee invited directly by a department for an internship/job shadowing or participant in CERN's programs for highschool students	STAG		4 weeks
<input type="radio"/> Professional visitor	VISI	Registration Service	3 days
<b>CERN Guarantor</b>			
Name		Surname _____ First name(s) _____	
CERN ID	_____ Department _____		
By signing below, the guarantor engages his department's responsibility for the person concerned.			
Signature	_____		
Date	_____		

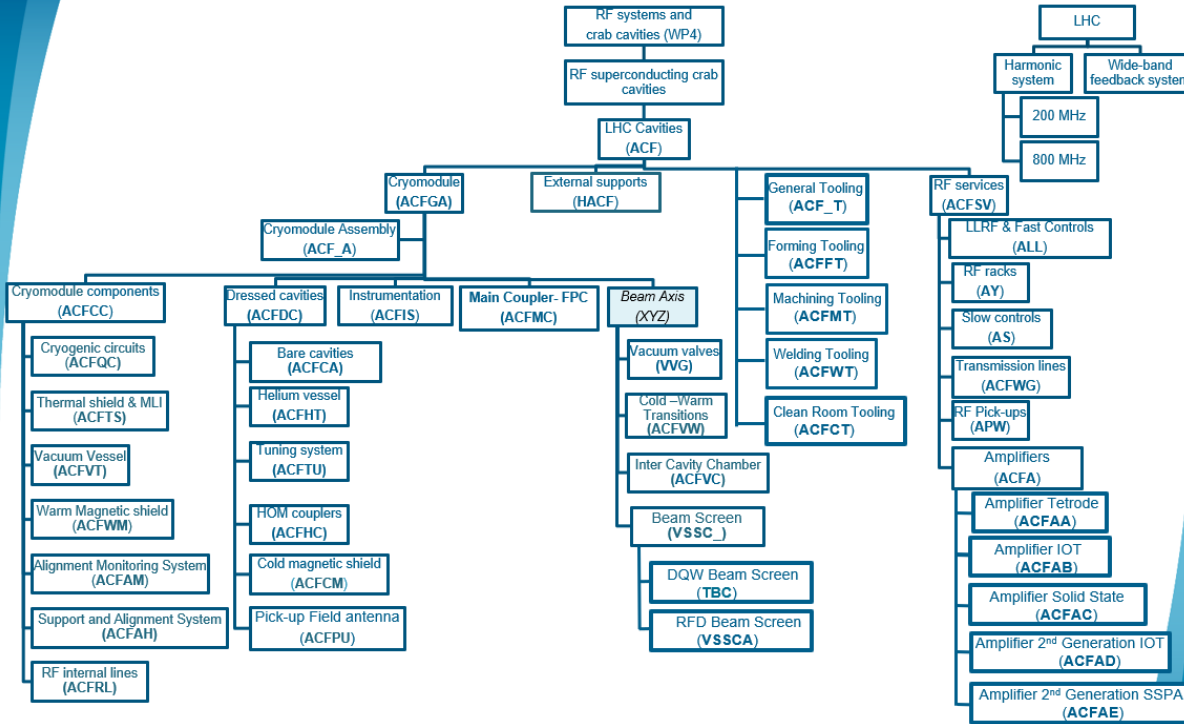
<sup>1</sup> It is compulsory to state your employer's address if you require a dosimeter or for registration with the reason VISI.  
FSP-DND-TP-19.10.2020

# From system architecture to EDMS Structure

[...]

## Crab Cavities & RF (WP4)

- ▶ Deliverables
- ▶ Milestones
- ▶ Activity Reports
- ▶ Other
- ▶ Internal doc (temp)
- ▶ Minutes
- ▶ Presentations
- ▶ Administration
- ▶ RF Parameters
- ▶ Links for the collabo
- ▶ LHC Crab Cavities (
- ▶ SPS Test Crab Cavi
- ▶ Hardware Baseline
- ▶ SPS Test Stand
- ▶ SM18
- ▶ Safety WP4
- ▶ Engineering drafts & notes
  - ▶ DQW Crab Cavities Cryomodule (SPS Test)
  - ▶ RFD Crab Cavities Cryomodule (SPS Test)
    - ▶ RFD Cryomodule Assembly
    - ▶ RFD Cryomodule Components
      - ▶ RFD Cryogenic circuits
      - ▶ RFD Thermal Shield & MLI
      - ▶ RFD Vacuum Vessel
      - ▶ RFD Warm Magnetic Shield
      - ▶ RFD Alignment Monitoring System
      - ▶ RFD Support and Alignment System
      - ▶ RFD RF Internal Lines
    - ▶ RFD Dressed Cavities
      - ▶ RFD Dressed Cavities Assembly
      - ▶ RFD Bare cavities
      - ▶ RFD Helium tank
      - ▶ RFD H-HOM Suppressors (Variant #3)
      - ▶ RFD V-HOM Suppressors (Variant #4)
      - ▶ RFD Cold Magnetic Shield
      - ▶ RFD Tuning System
      - ▶ RFD Pickup Field Antenna
    - ▶ RFD FPC Main Coupler
    - ▶ RFD Instrumentation
    - ▶ RFD Beam Axis
      - ▶ RFD Vacuum valves
      - ▶ RFD Beam Screen
      - ▶ RFD Plug In Modules
      - ▶ RFD Extremity Vacuum Chamber
      - ▶ RFD Vacuum Ancillaries



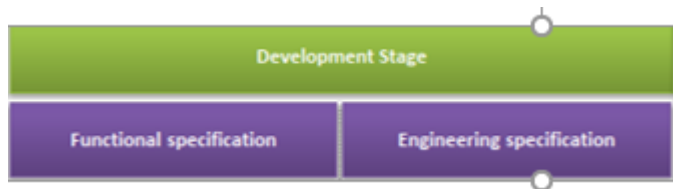
# EDMS Engineering node

## Engineering drafts & notes

- DQW Crab Cavities Cryomodule (SPS Test)
- RFD Crab Cavities Cryomodule (SPS Test)
  - RFD Cryomodule Assembly
    - RFD Cryomodule Components
      - RFD Cryogenic circuits
      - RFD Thermal Shield & MLI
      - RFD Vacuum Vessel
      - RFD Warm Magnetic Shield
      - RFD Alignment Monitoring System
      - RFD Support and Alignment System
      - RFD RF Internal Lines
    - RFD Dressed Cavities
      - RFD Dressed Cavities Assembly
      - RFD Bare cavities
      - RFD Helium tank
      - RFD H-HOM Suppressors (Variant #3)
      - RFD V-HOM Suppressors (Variant #4)
      - RFD Cold Magnetic Shield
      - RFD Tuning System
      - RFD Pickup Field Antenna
    - RFD FPC Main Coupler
    - RFD Instrumentation
      - RFD Beam Axis
      - RFD Vacuum valves
      - RFD Beam Screen
      - RFD Plug In Modules
      - RFD Extremity Vacuum Chamber
      - RFD Vacuum Ancillaries

## Engineering drafts & notes

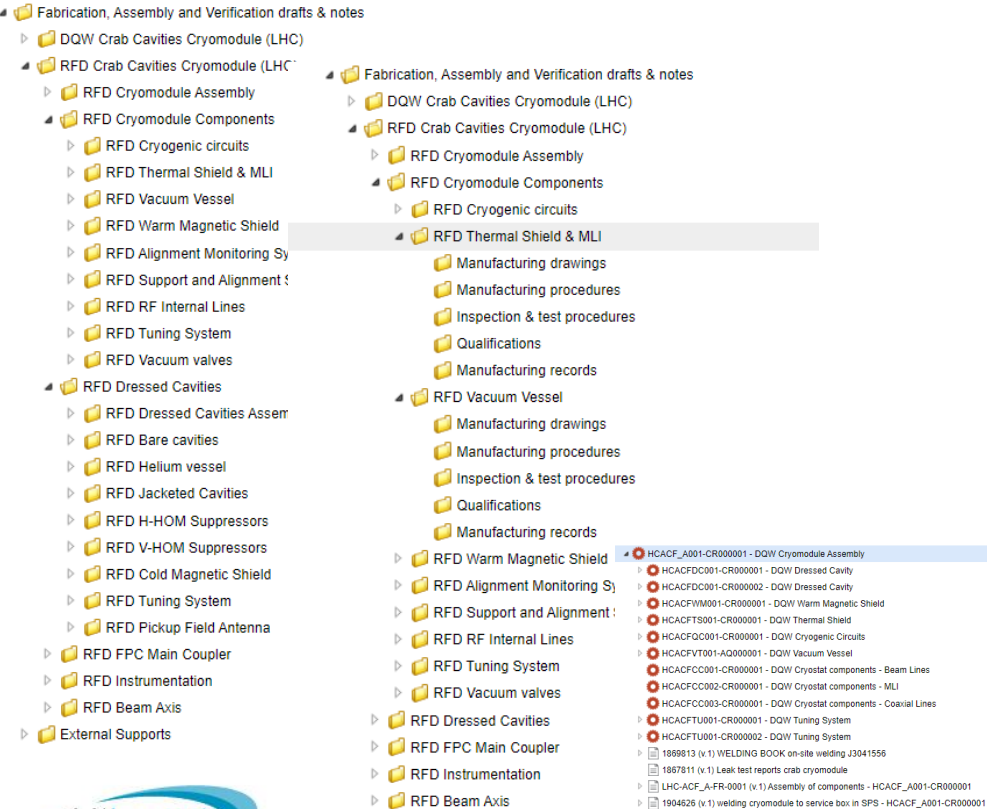
- DQW Crab Cavities Cryomodule (LHC)
- RFD Crab Cavities Cryomodule (LHC)
  - RFD Cryomodule Assembly
    - RFD Cryomodule Components
      - RFD Cryogenic circuits
        - RFD Thermal Shield & MLI
          - Specifications
          - Engineering calculations & Tests
          - Functional Drawings & models
        - RFD Vacuum Vessel
          - Specifications
          - Engineering calculations & Tests
          - Functional Drawings & models
        - RFD Warm Magnetic Shield
        - RFD Alignment Monitoring System
        - RFD Support and Alignment System
        - RFD RF Internal Lines
        - RFD Tuning System
      - RFD Dressed Cavities
      - RFD FPC Main Coupler
      - RFD Instrumentation
        - RFD Beam Axis
          - RFD Vacuum valves
          - RFD Inter Cavity Chamber
          - RFD Beam Screen
          - RFD Cold-Warm Transitions



## Documentation during this phase

- Specifications
- Drawings
- Calculations
- Simulations
- Engineering notes
- Bill of Materials, List of Materials

# EDMS Fabrication, Assembly, Verification node



Documentation during this phase

- Manufacturing Procedures
- Test Procedures
- Assembly Procedures
- Manufacturing and Inspection Plans
- Qualifications
- Manufacturing Records – **MTF**

# Manufacturing Records in MTF



- ▶ HCACF\_A001-CR000001 - DQW Cryomodule Assembly
  - ▶ HCACFDC001-CR000001 - DQW Dressed Cavity
  - ▶ HCACFDC001-CR000002 - DQW Dressed Cavity
  - ▶ HCACFWM001-CR000001 - DQW Warm Magnetic Shield
  - ▶ HCACFTS001-CR000001 - DQW Thermal Shield
  - ▶ HCACFQC001-CR000001 - DQW Cryogenic Circuits
  - ▶ HCACFVT001-AQ000001 - DQW Vacuum Vessel
    - HCACFCC001-CR000001 - DQW Cryostat components - Beam Lines
    - HCACFCC002-CR000001 - DQW Cryostat components - MLI
    - HCACFCC003-CR000001 - DQW Cryostat components - Coaxial Lines
  - ▶ HCACFTU001-CR000001 - DQW Tuning System
  - ▶ HCACFTU001-CR000002 - DQW Tuning System
  - ▶ 1869813 (v.1) WELDING BOOK on-site welding J3041556
    - 1867811 (v.1) Leak test reports crab cryomodule
  - ▶ LHC-ACF\_A-FR-0001 (v.1) Assembly of components - HCACF\_A001-CR000001
  - ▶ 1904626 (v.1) welding cryomodule to service box in SPS - HCACF\_A001-CR000001

- MTF is an integral part of EDMS.
- This tool is used to store the manufacturing data during production and grant traceability (what goes where)
- Workflow (more or less complex) shall be integrated following the Manufacturing & Inspection Plan (MIP)
- Manufacturing reports shall be provided to CERN along the production (including Nonconformities)

# Outline

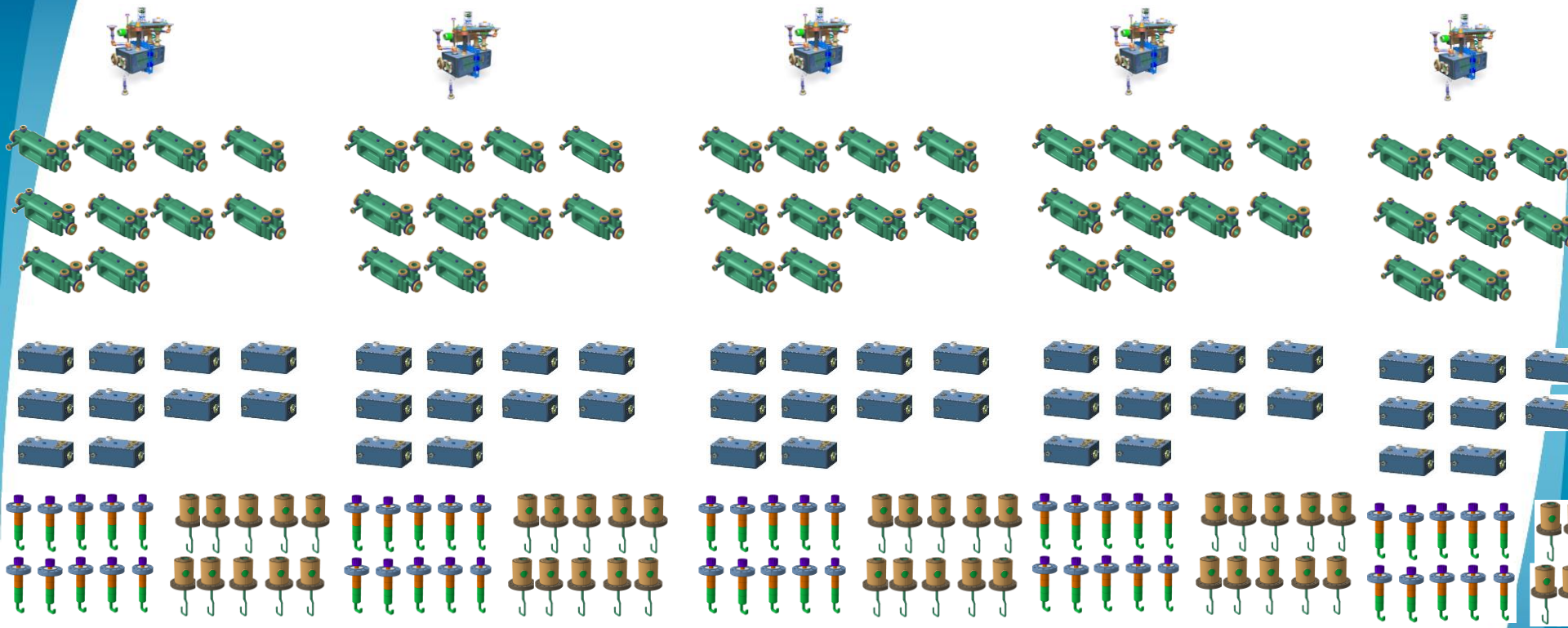
1. HL-LHC Quality Plan
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- 4. Quality during Series production**
5. Conclusions

# Series production

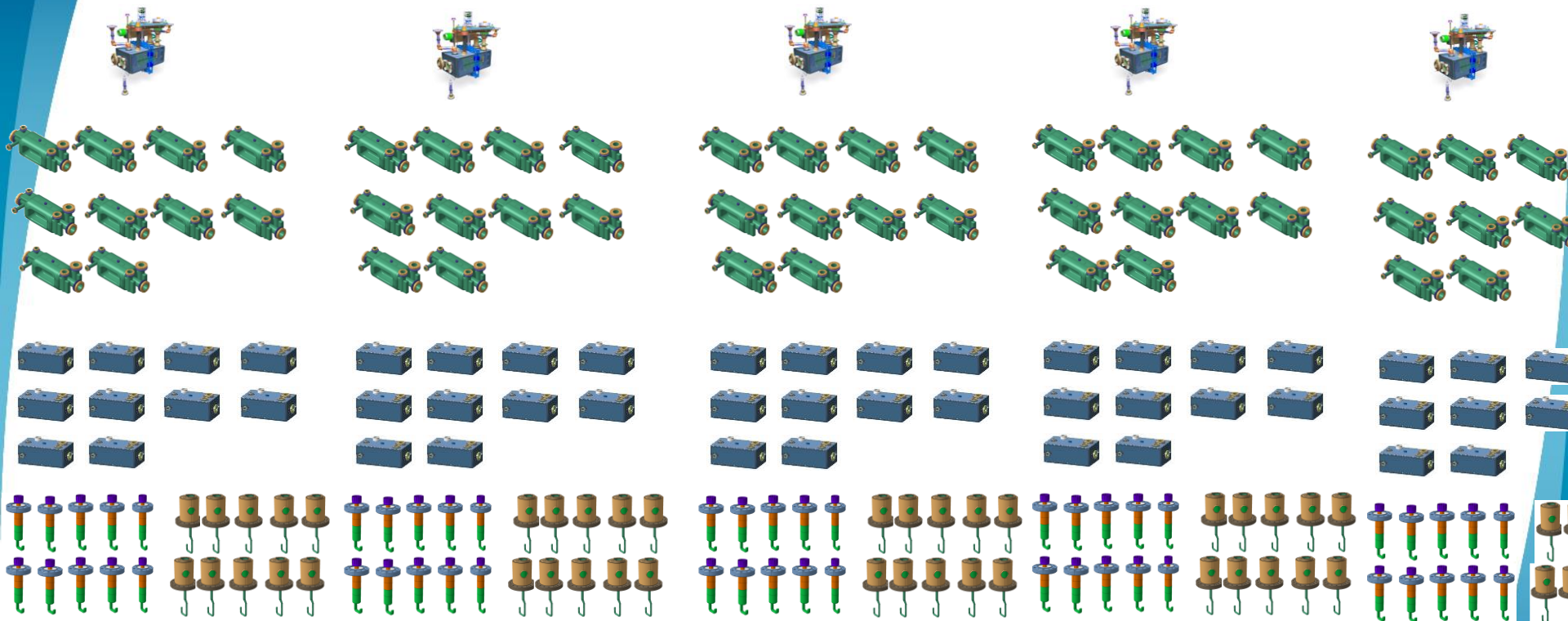
- We are now moving to Series production for cryomodules (for the Cavities, it was already the case)
- The equipment will be installed in the LHC machine so we need to have proper traceability in terms of components and documentation
- The approach is the the same as for the prototypes, but it will be more demanding as there will be several items built in parallel
- Quality activities should go in line with production



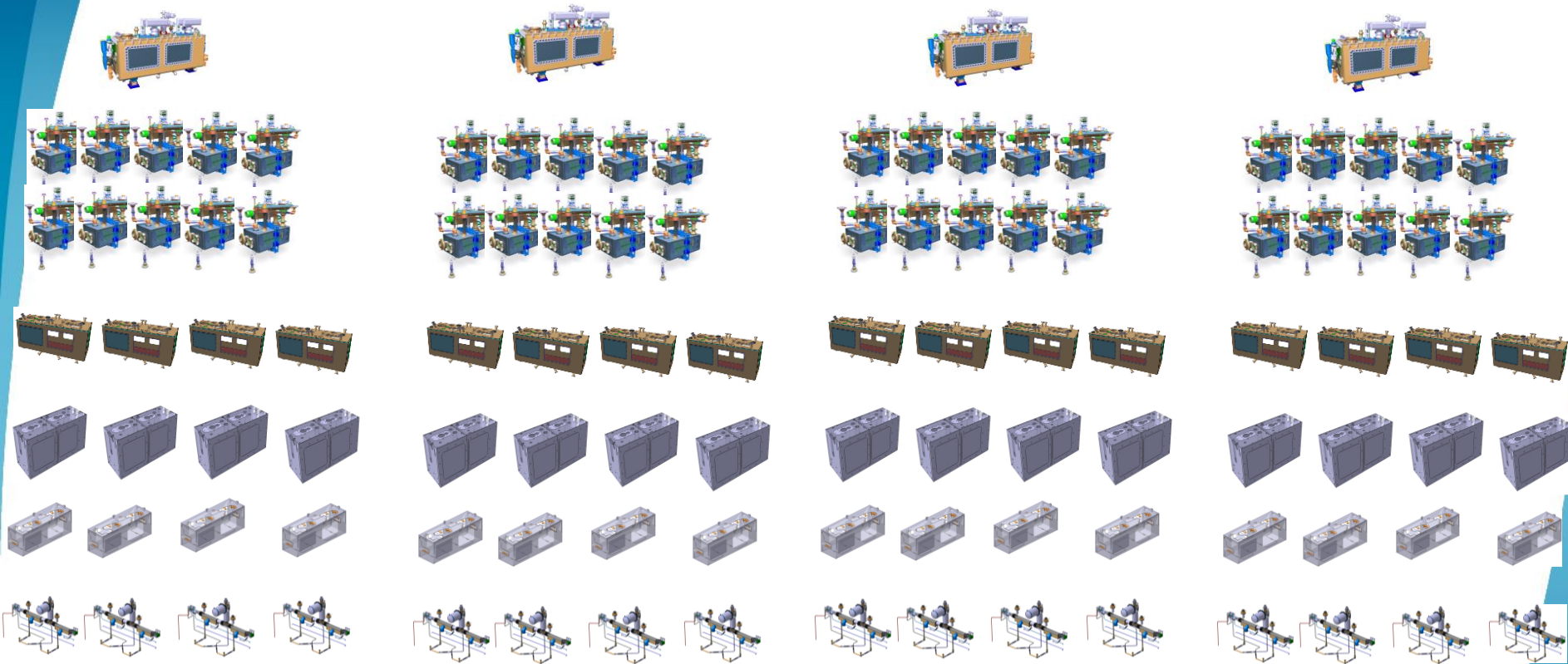
# What goes where



# What goes where

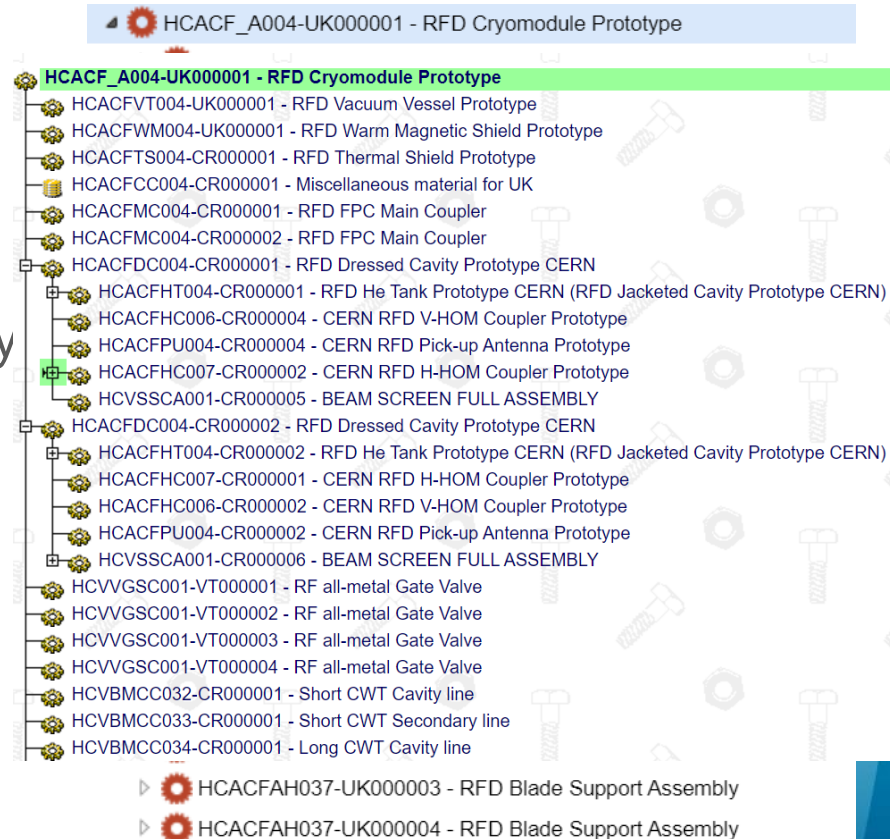


# What goes where



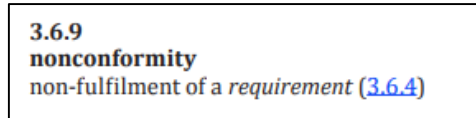
# What goes where

- MTF used to grant the traceability of the equipment and sub-equipment (Serial numbers)
- People on site should provide the inputs in terms of components usability
- Documentation to be attached to the corresponding asset
- Documentation/manufacturing data is to be provided on regular bases and not at the end of production



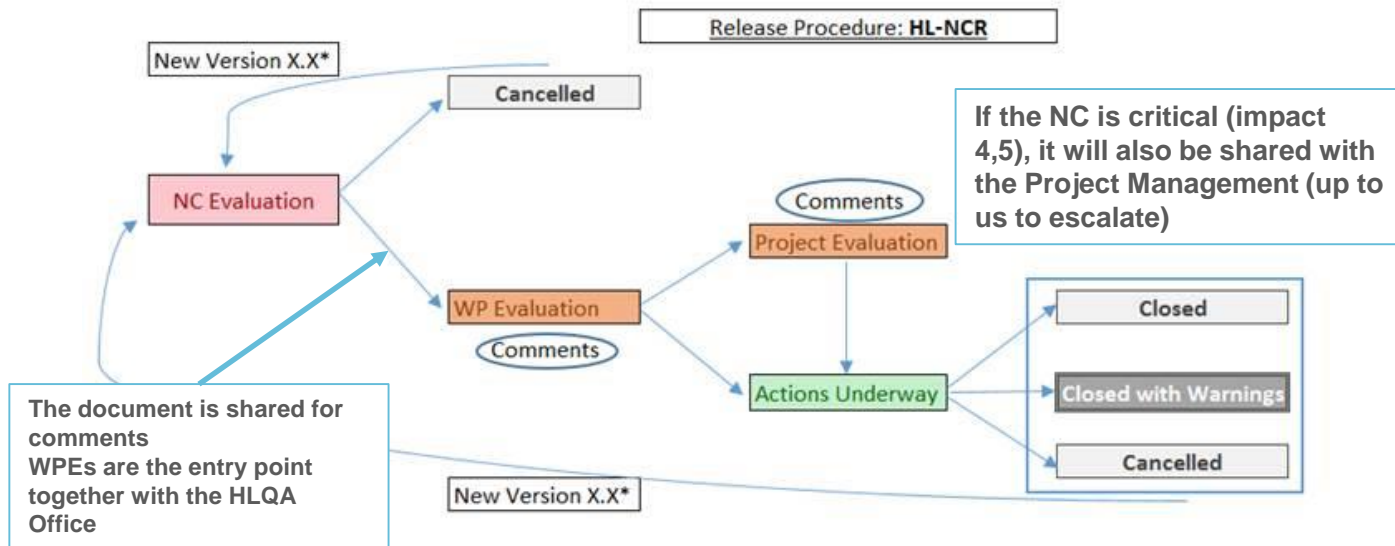
# HL-LHC Nonconformities

- **Nonconformity** → Non fulfilling of a **requirement** (of any kind)



- Requirements are specified in the **Engineering Specifications**, including their annexes (Drawings, Procedures) or are coming from the **normative (standards, rules, etc)**
- HL Nonconformity Process for Collaborations [EDMS 2149457](#)
- Full process on Launching a Nonconformity using EDMS is explained in [EDMS 1908145](#)
- NCRs will follow the [HL-LHC Template](#) to communicate with CERN in order to comply with HL-LHC NC Policy (class, criticality, decision, corrective/preventive actions...)
- **CERN** will provide support in the **preparation of the NCRs** as well with the **evaluation**. Nevertheless we expect **Collaborations** **pre-filled the template** with the **related info** as well as with a **first assessment**

# Document life-cycle (Share with CERN)



\*Create a new version when you have a new file to be uploaded.

# NC Description

NC Evaluation

HL-LHC Nonconformity Report			
Title of the Nonconformity			
NC Description			
<b>Work Package</b>	WP to which Equipment belongs	<b>Equipment</b>	Code of the equipment (asset)
<b>Collaboration</b>	Put the name (ex. INFN, F712 or Sandvik, 180-Team)	<b>Process</b>	Activity carried when the NC was identified
<b>Contract</b>		<b>Inspector</b>	Who identifies the nonconformity
<b>Team</b>	Put as many as applicable		

*[Instructions available on EDMS for CERN (1499015) and for the Collaborations (impact 3 or higher) EDMS:2149457]*

Description of the NC should contain:

- → Description of the NCR
- → Requirements that are not met
- → References to specification, procedures, applicable standards
- → Attached pictures if required
- → If there are pictures, include a red circle on the NC or an arrow so that it is easier to identify what the reader should look at. If possible include photos of the "OK" state as well with green circles and arrows to see how the object, part... should look like not to be a NC.

*[Be factual and objective. The cause of the NC will be described in the next section.]*

*[Upload the NCR in EDMS as soon as possible, never more than 3 days after the occurrence of the NC, and Share it with the WPL and CERN WPE. You will be able to create a new version with more details later but it is important that you communicate this first assessment.]*

- Provide all the available information about the Nonconformity (Description, requirement/s not met, etc.) – **What, Where, When, Who**
- Be **factual** and **objective**. **We are not assessing the causes and the impact yet**. First we need to know what went wrong. The **root cause** of the NC as well as the **consequences** will be described in the next section (**NC Evaluation**)
- **Add** references to **reports** and **other documentation** to be used as reference and **supportive documentation** of the Nonconformity
- Provide **pictures** and/or any other **relevant material** that can be useful for the analysis

NC-Evaluation
The Evaluation of the NC should contain the result of the Root-cause analysis with the reference of further analysis and tests <i>Analyse the NC with the team involved in the NC and experts that can support you in the investigation. Add their name to the analysis so that can be contacted back if necessary. You can start with a simple root-cause analysis tool. You can use an Ishikawa diagram, 5W... if the collaboration does not have any quality support you can contact the Project Quality team. Once arrived to a consensus on the cause of the NC discuss the preventive and corrective actions.</i> <i>The WPL could designate a person that will contribute to the NC investigation.</i>
<b>Documents used as reference</b> List of documents used as reference. Please use always hyperlinks
<b>Evaluation team:</b> N. Surname...

- The root cause of the Nonconformity is herein detailed – **Why, How**
- A **method statement** can be proposed to the evaluation team (if Repair is required)
- The **impact** of the Nonconformity is to be explained (technical and project level)
- **Corrective actions** to close this NC and **Preventive actions** to avoid recurrence are herein proposed. These actions shall be assessed and confirmed during the follow step (**WP Evaluation**). A new version of the document might be required depending on the decision (more information is requested for completeness, different method statement...)



# Handling and Sharing of Nonconformities

The NC Class triggers how it is to be communicated -> WPEs are your entry point

Impact assessment	Assessment scale	Financial loss	Reputation	Alignment with Business Objectives (WP Deliverables)	Who I shall inform in the project	When
Catastrophic / Extreme	5	Requiring resources outside the collaboration that can not be covered by the project	Large media (or scientific media) coverage - International coverage	Occurrence of the risk will significantly deter the achievement of all the objectives (ex, delay of the full project, not delivery of a component fully under the responsibility of the collaboration, ...)	PL, WPL, WPE	As soon as detected
Major	4	Requiring resources outside the collaboration that can be covered by the project	Host MS press coverage - Scientific media - Escalating community activism	Occurrence of the risk will significantly hamper the achievement of the objectives (ex, delay beyond the collaboration margin but not yet the WP margin, request of a permanent deviation permit for a component, engineering change request affecting the WP, ...)	PL, WPL, WPE	As soon as detected
Moderate	3	Requiring resources outside the collaboration but that can be covered inside the WP	Local press coverage - Neighbourhood reputation (public, suppliers, etc.)	Occurrence will have some adverse effect on the achievement of the objectives (ex, delay eliminating at the margin, request of a deviation permit for a component, engineering change request, ...)	WPL, WPE	In the 3 days
Minor	2		No one has heard of the occurrence of risk outside CERN; Problem dealt with at CERN's management level.	Occurrence of the risk will have minimal impact on the achievement of the entity's business objectives (magnet, cold mass, cryoassembly)	WPE	During periodic feedback
Negligible	1		No one has heard of the occurrence of the risk outside the department who owned the risk; problem dealt at department management level	Occurrence of the risk will have very little or no impact on the achievement of the entity's business objectives (magnet, cold mass, cryoassembly)	WPE	During periodic feedback

The NC will be assessed by the Collaboration with the team involved in the NC (Production, inspection ...). The first check shall be how this NC affects the project (Impact). If the NC has a relevant impact on the project (delays beyond the margin, additional means beyond the collaboration, damage to the image of the project, etc.), then the WPL shall be informed. The Collaborations Impact matrix ([EDMS 1863763](#)) can be used to evaluate the NC but, in case of doubt, the NC shall be always escalated to the next project level (Share with us!)

# WP Evaluation (CERN Assessment and feedback)

- Once the document is shared with **WP4\_COORD\_CRYOMODULE**, we will provide Feedback via EDMS

Decision				
Critical (Impact 4,5) <input type="checkbox"/>		Non-Critical (Impact 1,2 or 3) <input type="checkbox"/>		
Repair <input type="checkbox"/>	Regrade <input type="checkbox"/>	Scrap <input type="checkbox"/>	Return <input type="checkbox"/>	Concession <input type="checkbox"/>
<i>Collaboration manager /WPE/WPL/PL</i>		<i>N. Surname</i>	<i>Date</i>	20YY-MM-DD

- Based on the previous income CERN will assess the information and provide a decision (Full process is traced through EDMS).
- The decision about the Nonconformity shall be integrated in the document

Repair <input type="checkbox"/>	Regrade <input type="checkbox"/>	Scrap <input type="checkbox"/>	Return <input type="checkbox"/>	Concession <input type="checkbox"/>
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- Repair:** Action on a nonconforming product in order to make it acceptable for the intended use
- Regrade:** Alteration of the grade of a nonconforming product in order to make it conform to requirements differing from the initial ones
- Scrap:** Action on a nonconforming product to preclude its originally intended use (Recycling, destruction).
- Return:** Action on a nonconforming product to send back to the supplier's facilities
- Concession:** Permission to use or release a product that does not conform to specified requirements (Use as it is)

# NC Closure

Closed
Closed with Warnings
Cancelled

NCR Closure			
<i>Date of re-inspection</i>	20YY-MM-DD	<i>Inspector</i>	N. Surname
Indicate if the preventive and corrective actions have been completed and if there is any remark to be taken in consideration			
Agreed measurements have been successfully implemented: Yes <input type="checkbox"/> No <input type="checkbox"/>			
Non Conformity Closed: Yes <input type="checkbox"/> Yes with remarks <input type="checkbox"/>		<i>Date Closure</i>	20YY-MM-DD
<i>Inspector</i>	<i>Supplier</i>	<i>Collaboration manager/WPE/WPL/PL</i>	
<i>N. Surname person who closes the NCR</i>	<i>N. Surname of the supplier's representative</i>	<i>N. Surname of the Collaboration manager WPE, CERN WPE, WPL or PL</i>	

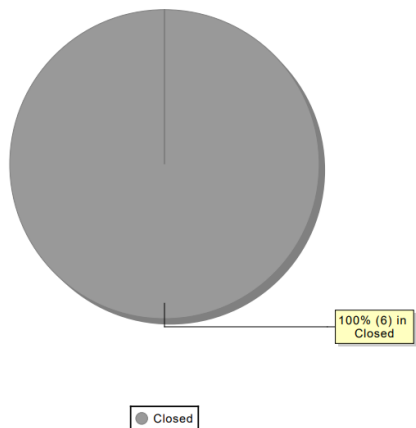
Page 1 of 1

Template EDMS No.: 1501109

- Once the Nonconformity is solved, the document shall be updated (new version to be issued). **The reference to the report(s)** that proves the Nonconformity is closed is to be added in MTF (additional MTF Step if needed) and the Status of the Nonconformity is changed to Closed or Closed with Warnings
- No measurable actions = No closure of the NC

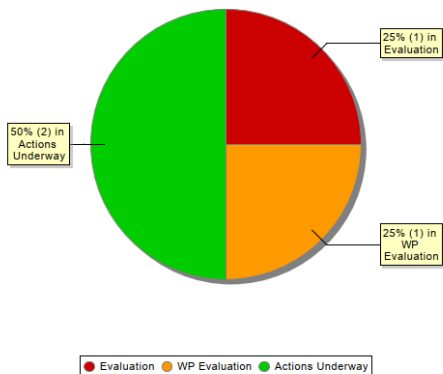
# NCRs Cryomodules and Cavities

Non critical: **6** (100%)



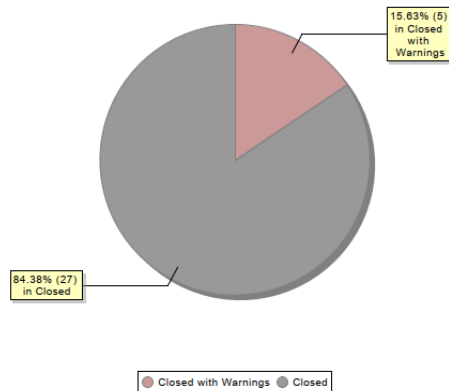
Total NCRs: **4**

Non critical: **1** (25%)  
 \_EMPTY: **3** (75%)



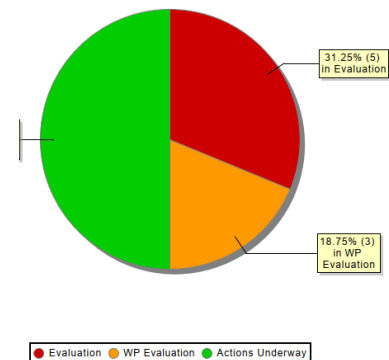
Total NCRs: **32**

Critical: **5** (15.63%)  
 Non critical: **16** (50%)  
 \_EMPTY: **11** (34.38%)



Total NCRs: **16**

Critical: **2** (12.5%)  
 Non critical: **7** (43.75%)  
 \_EMPTY: **7** (43.75%)



# Outline

1. HL-LHC Quality Plan
2. WP4 Approach and Requirements
3. Quality during Series production
4. EDMS and MTF
5. **Conclusions**

# Conclusions

- We are moving to Series production, and we need to be even more attentive to the QA/QC activities (more demanding than building just one cryomodule)
- You already know the approach and the main requirements in terms of QA/QC – Training has been given to Collaborations and more sessions will be scheduled in the near future (feel free to propose dates)
- Proper traceability is a must – What goes where / What is the equipment made of
- Regular reporting during production including NCRs (which should be taken as a learning process and improvement)

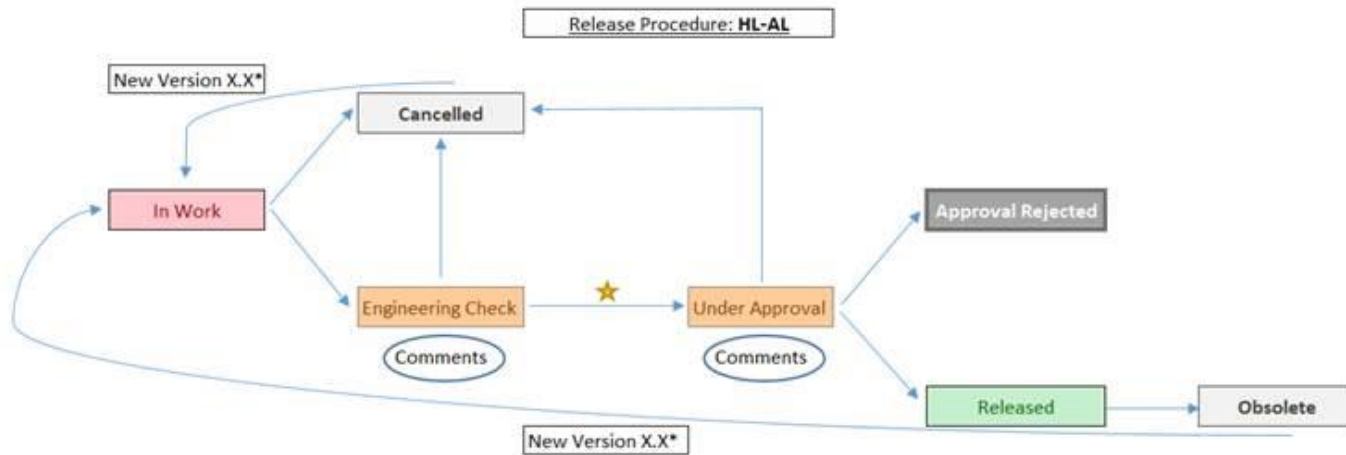


***Thank you for your attention***

***Special Thanks to my colleagues fom the HLQA  
Office and Luca Dassa for his inputs and efforts  
towards these activities within WP4***



# EDMS Release Procedures

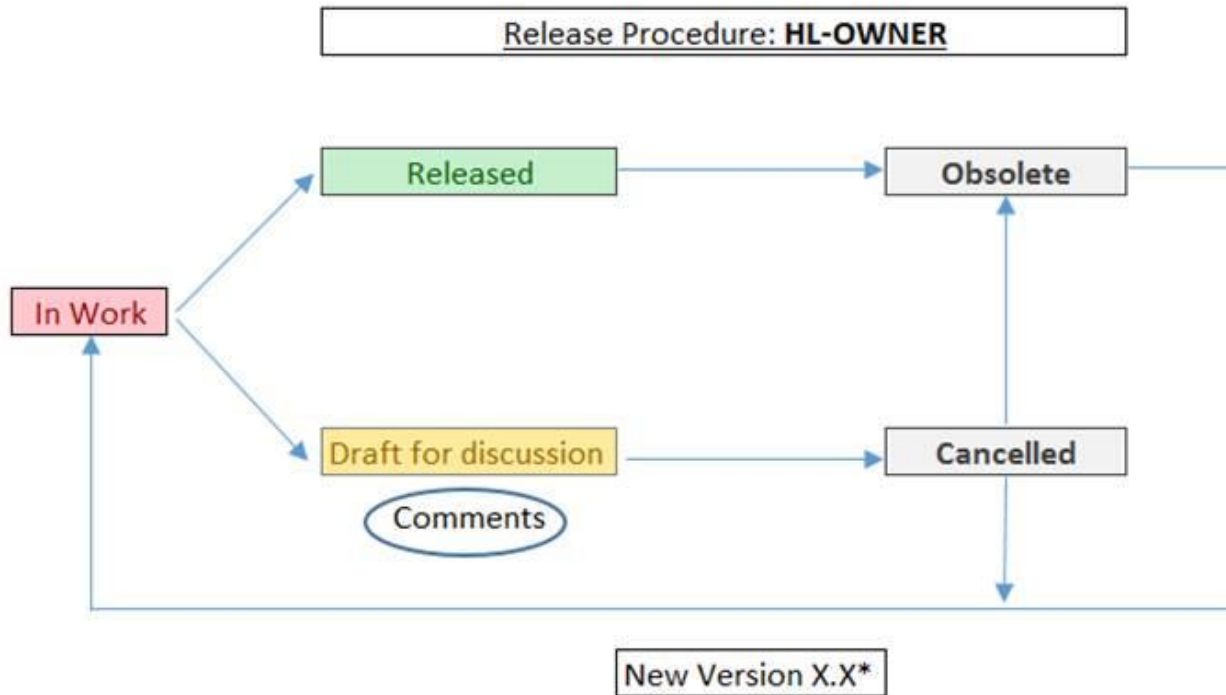


\*Create a new version everytime you have a new file to be uploaded

★ Only a few people can do it

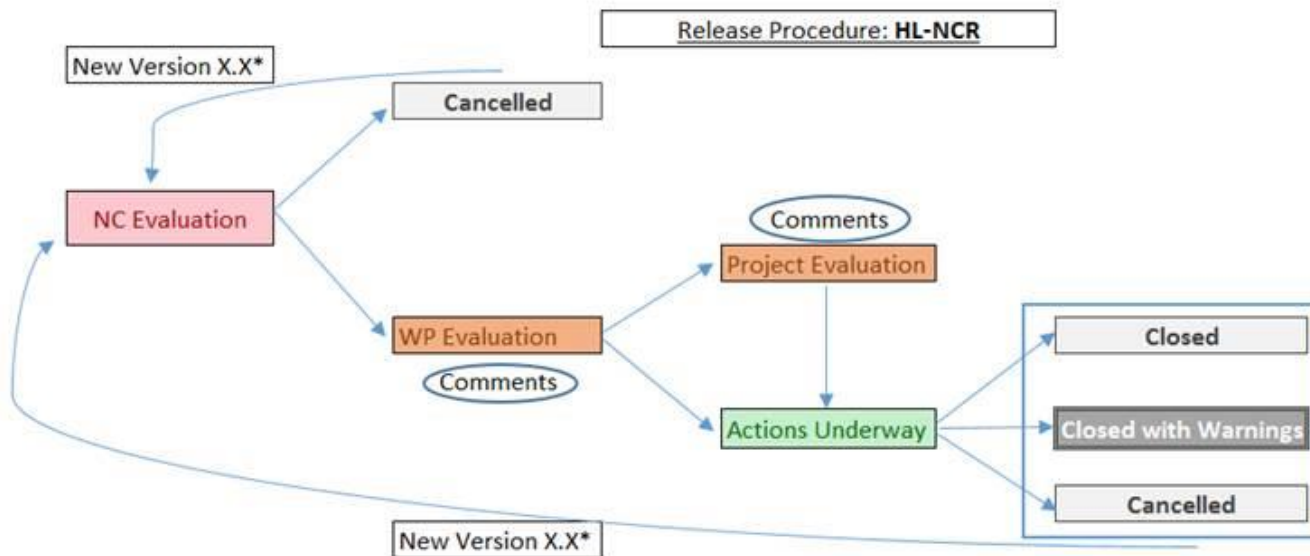


# EDMS Release Procedures



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