



Documentation plan for the HL-LHC IT String

N. Heredia García, CERN, TE-MPE-SF

On behalf of WP16

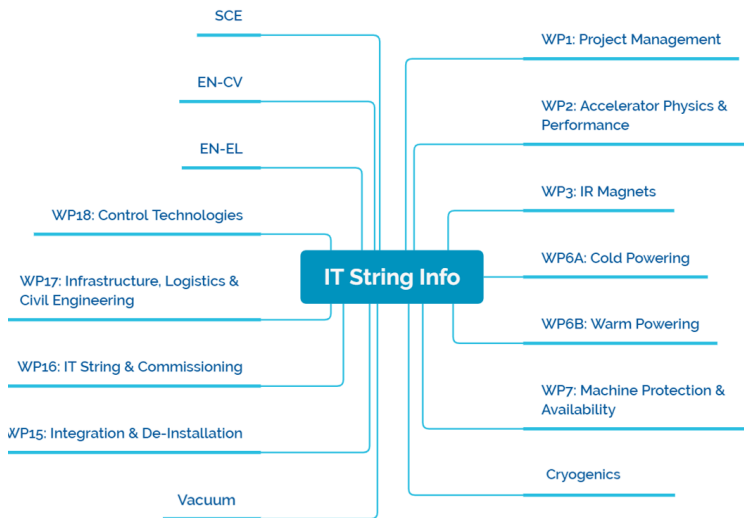
12th HL-LHC Collaboration Meeting – Uppsala (Sweden) – 19-22 September 2022

Scope of the talk

- Introduction
 - Information in the IT String
 - Repositories of information
- Documentation
 - Documentation overview
 - Planning baselines & Schedule Change Requests
 - Contribution & Interface documents
 - Integration & Installation
 - Validation program
 - Safety
 - Communication
- Conclusions

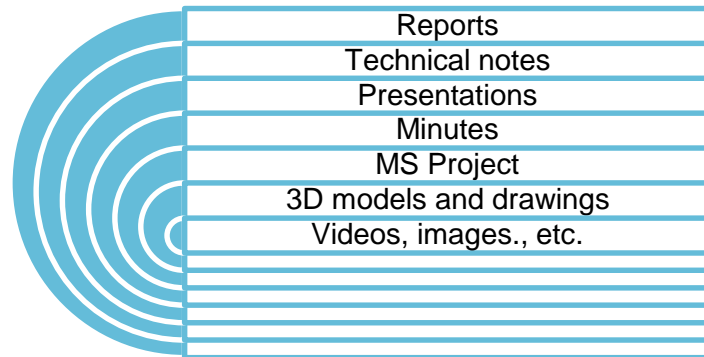
Introduction: Information in the IT String

- There are many **stakeholders** in the IT String:

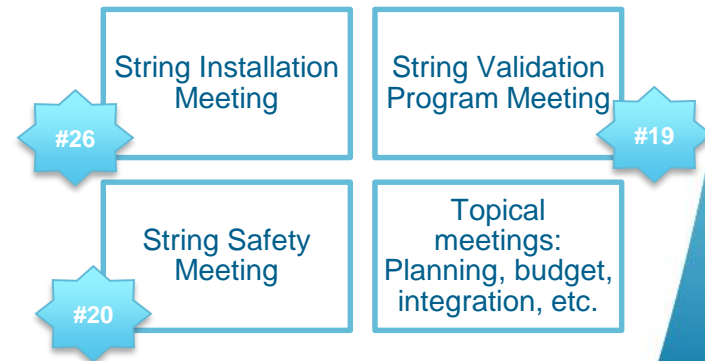


- Each **contribution** should be documented:
 - Scope
 - Technical specifications
 - Planning and resources
 - Test results

- Information gathered in **different formats**...

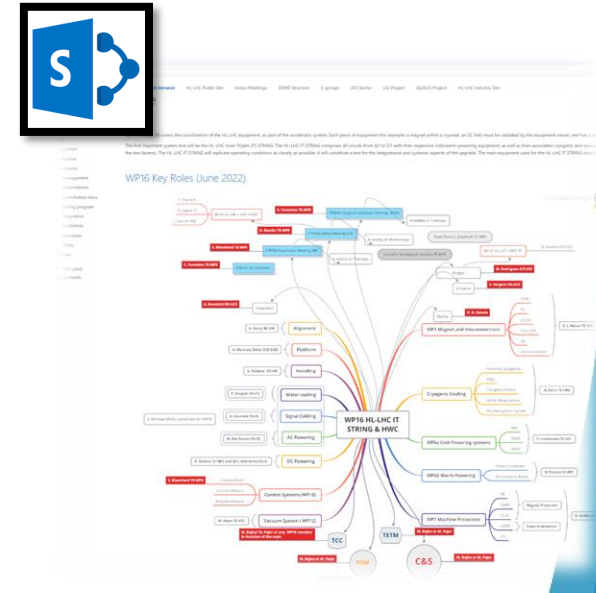
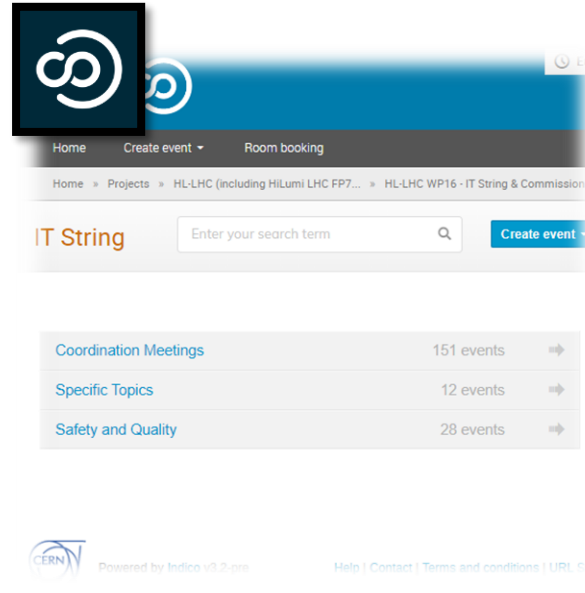
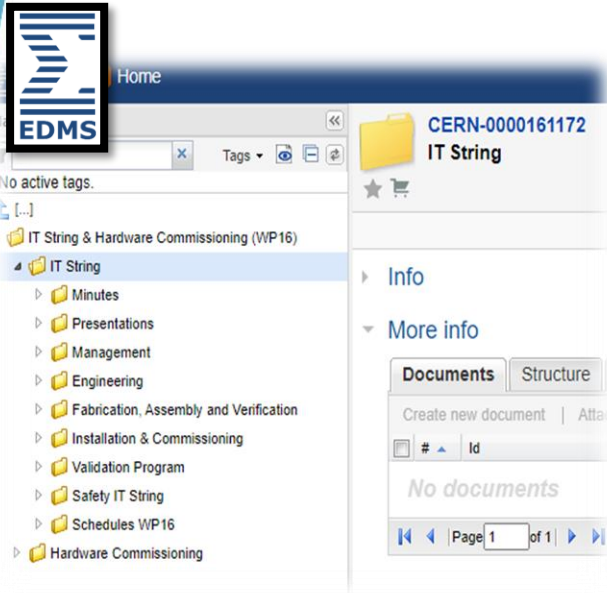


- ...And presented in different **meetings**



Introduction: Repositories of information

- Different **repositories** are used in the IT String to store and communicate information:



Introduction: Repositories of information

- Different **repositories** are used in the IT String to store and communicate information:



HL-LHC IT STRING

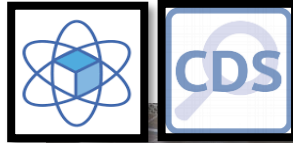
- Controls >
- Installation drawings >
- IMPACTS, VIC and On-site Meetings >
- Preparation activities actions >
- Installation Jira tickets >
- Circuits and Power Converter >
- Machine Protection >
- Equipment and integration >
- Infrastructures >
- Cryogenics >
- Cold Powering >
- Magnets >
- Vacuum >
- Alignment >
- Section report >
- IT Services >
- String Areas >
- Glossary >
- Who's who >
- Installation Meeting >
- Safety >
- Validation program >

Daily Calendar

Source: XLS in Sharepoint

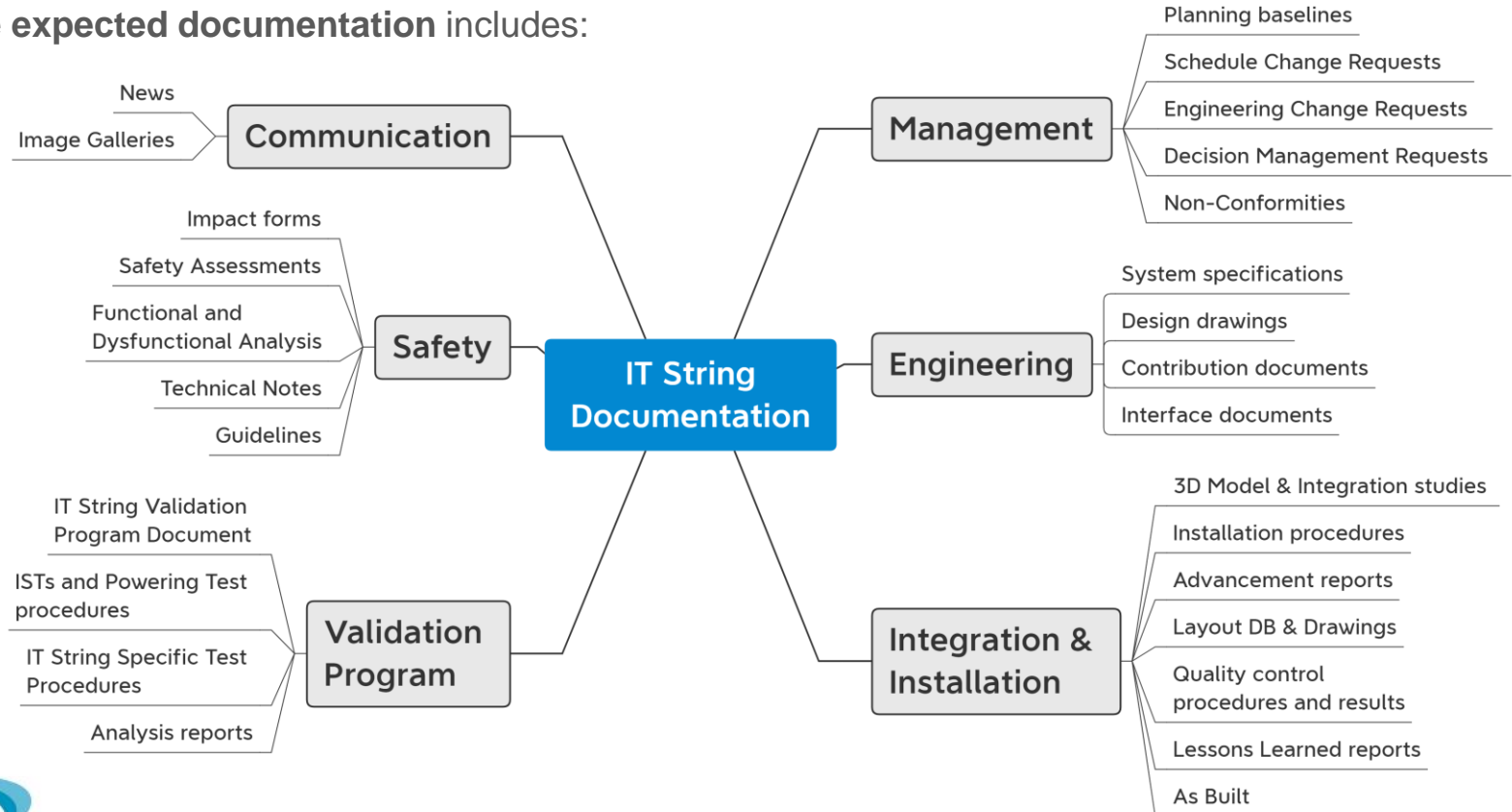
Alerts Impact	IN RACKS	PLATFORM	MANAGEMENT UNIT	EXT. STRING	Alerts Impact	IN RACKS	PLATFORM	MANAGEMENT UNIT	EXT. STRING	Alerts Impact	IN RACKS	PLATFORM	MANAGEMENT UNIT	EXT. STRING
Ma 8					Ma 22					Ma 5				
Tu 9					Tu 23					We 6				
We 10					We 24					Th 7				
Th 11					Th 25					Fr 8				
Fr 12					Fr 26					Sa 9				
Sa 13					Sa 27					Su 10				
Su 14					Su 28					Ma 15				
Ma 15					Ma 29					We 16				
We 16					We 30					Th 17				
Th 17					Th 1					Fr 18				
Fr 18					Fr 2					Sa 19				
Sa 19					Sa 3					Su 20				

Alerts Impact	IN RACKS	PLATFORM	MANAGEMENT UNIT	EXT. STRING	Alerts Impact	IN RACKS	PLATFORM	MANAGEMENT UNIT	EXT. STRING	Alerts Impact	IN RACKS	PLATFORM	MANAGEMENT UNIT	EXT. STRING
Ma 19					Ma 3					Ma 17				
We 20					We 4					We 18				
Th 21					Th 5					Fr 19				
Fr 22					Fr 6					Sa 20				
Sa 23					Sa 7					Su 21				



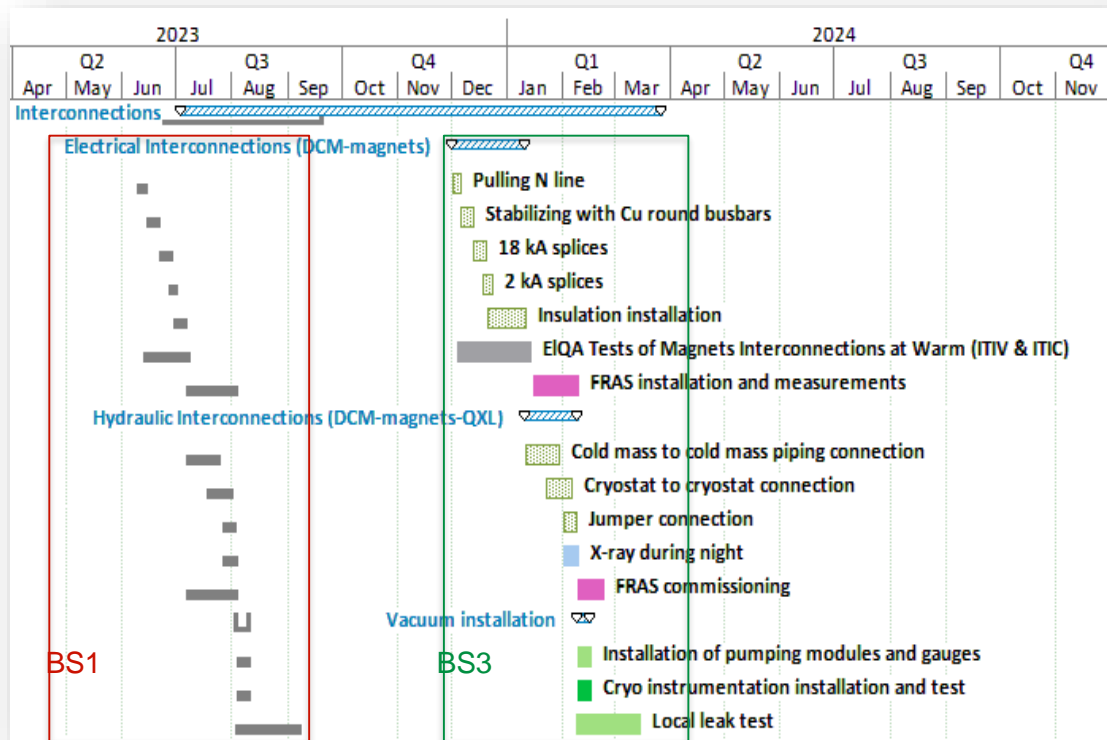
Documentation overview

- The **expected documentation** includes:





Documentation: Planning Baselines

- To track changes, **baselines** are established in the String detailed planning.
 - BS1: Installation Meeting No. 4
 - BS2: C&S Review 2021
 - BS3: WP16 PSM 230
- Summary report: EDMS [2583817](#).



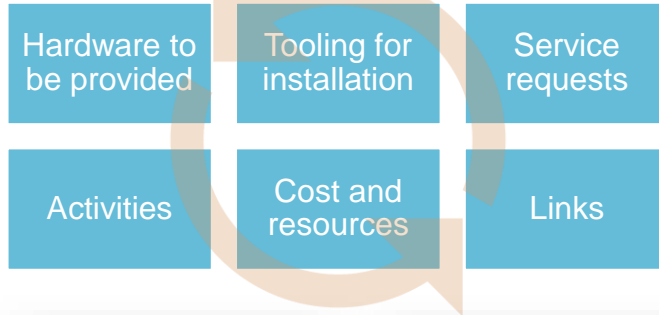
Documentation: Schedule Change Requests

- Schedule Change Request** documents to inform of new dates for component deliveries to the String.
 - EDMS [2740898](#): HL-LHC SCR – WP3. Delivery Dates of Magnets from WP3
 - EDMS [2746191](#): HL-LHC SCR - WP7. Delivery dates of WP7 deliverables to the IT String
 - EDMS [2747986](#): HL-LHC SCR – WP6A. Delivery dates of WP6A deliverables

 		EDMS NO. 2740898	REV. 1.0	VALIDITY VALID
REFERENCE : LHC-L-EC-0004				
HL – LHC Schedule Change Request WP3 DELIVERY DATES – APRIL 2022				
SCR DESCRIPTION				
WP Originator	WP3	Baseline affected	Schedule	
Equipment	WP3 Equipment	Date of Issue	2022-05-18	
Drawing	N/A	CI responsible	E. Todisco	
Document	WP3 master plan	Reference Document	EDMS 2649533	
WPs Affected	WP12, WP15, WP15.4, WP16			
Detailed Description				
This SCR updates the delivery dates of magnets from WP3 as follows:				
New dates for cryomagnets to be installed in the IT String (delivery to SM18 for installation):				
<ul style="list-style-type: none"> Q1: September 2023; Q2a: July 2023; Q2b: October 2023; Q3: September 2023; CP: September 2023; D1: July 2023 DCM: May 2023. 				
New dates for last cryomagnet to be installed in HL-LHC (delivery to vacuum for beam screen installation):				
<ul style="list-style-type: none"> Q1/Q3: September 2025; Q2: July 2026; CP: February 2025; D1: August 2025; D2: May 2025. 				
Reasons for the request				
Delays for IT string:				
<ul style="list-style-type: none"> Q1 (+5 months): delay induced by longer time needed to develop the welding of the cold mass; Q3 (+5 months): delay induced by joint decision to use MQXFAG5 in an endurance test, coupled with the issues in BNI test station that limit the quenching capacity; First Q2 (+4 months) and second Q2 for the string (+5 months): delay induced by the longer time needed to develop the fixed point for the cold mass; D1 (+ 5 months): delay is induced by the length of the activities related to the cold mass construction in Hitachi. Initially estimated to 3 months, they will take 10 months for the prototype due to no previous experience of the firms, validation of weldings, etc; CP (+4 months): delay is induced by the slower pace of manufacturing of coils of MCBXFA, mainly due to coactivities in CIEMAT collaboration between manufacturing of MCBXFA prototype coils in house, and technology transfer to EYET for the MCBXFB. All activities related to the HO correctors assembly in the cold mass have been already carried out in building 180 to reduce the delay. 				
Delays for last magnet to be installed in HL-LHC:				
Page 1 of 4				
Template EDMS No.: 2725175				

Documentation: Contribution documents

- The **contribution documents** describe the scope of each WP/Group for the IT String:





EDMS No.		REV.	VALIDITY
2188576		0.0	DRAFT
REFERENCE: LHC-KMS-01-0021			
CONTRIBUTION DOCUMENT			
WP16: HL-LHC IT STRING & HARDWARE COMMISSIONING			
SUMMARY OF WP3 (INTERACTION REGION CRYOMAGNETS) CONTRIBUTION TO WP16			
Abstract			
<p>This document summarises the contribution of WP3 to the HL-LHC IT String. It describes the scope of the contribution, in terms of hardware to be provided, activities to be performed and specific needs requested by the contributor. Furthermore, it gives an overview of the activity procedures as well as the associated timeline for their execution. Finally, it clarifies the needs of resources and the budget to finance the contribution.</p>			
TRACEABILITY			
Prepared by: N. Havelin Garcia	Date: 2022-07-23		
Verified by: F. Priu, D. Duarte Ramos	Date: 2022-09-30		
Approved by: A. David, F. Rodriguez Malton, C. Tolosa, M. Bujko	Date: 2023-03-09		
Distribution: All TE-MPE-01 members, M. Zanetti			
Rev. No.	Date	Description of Changes (major changes only, minor changes on EDMS)	
0.1	23-03-2023	First Issue	
0.2	20-09-2022	Revision and update by WP16.	
0.3	14-06-2022	Revision and update by WP3 leader.	
0.4	10-07-2022	Update: Split of TE-MSC and WP3 contribution in separate documents.	
0.5	11-07-2022	Revision and update by WP3 leader.	
0.6	16-09-2022	Implementation of comments received during Engineering Check	

EDMS No.		REV.	VALIDITY
2188604		0.0	DRAFT
REFERENCE: LHC-KMS-01-0021			
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WP/Group	EDMS No.	Status
WP3	2188576	Under Approval
TE-MSC	2755342	In Work
WP6A	2188577	In Work
WP6B/SY-EPC	2188575	In Work
WP7/TE-MPE	2188604	Draft for Discussion
TE-CRG	2188605	Draft for Discussion
WP12/TE-VSC	2602179	In Work
WP15.4/BE-GM	2324040	Draft for Discussion
EN-EL	2509609	Released
EN-CV	2621778	HL Engineering Check

Documentation: Interface documents

- The **interface documents** describe physical interfaces between equipment and boundaries of responsibilities.
 - WP6A general interface document: [EDMS 2087862](#) →
- Interfaces requiring clarification: meetings and related notes ([EDMS 228152](#))

EDMS NO. 2087862	REV. 0.1	VALIDITY DRAFT
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REFERENCE : LHC-EGCD-XX-XXXXX

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Prepared by: S. Fer
 Verified by: N. Herr
 Approved by: A. Ba
 Distribution: TE-MP

Rev. No.	Date
0.1	2022

This document is under review

Page 2 of 18 Template EDMS No.: 1311208

EDMS NO. 228152	REV. 1.1	VALIDITY Release
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NOTES

STRING INTERFACES COLD POWERING INSTRUMENTATION AND GAS LINES

Abstract
 This document is the notes relative to the "Cold Powering instrumentation and He Recovery lines interface" discussed during a meeting held the 2022-05-19.

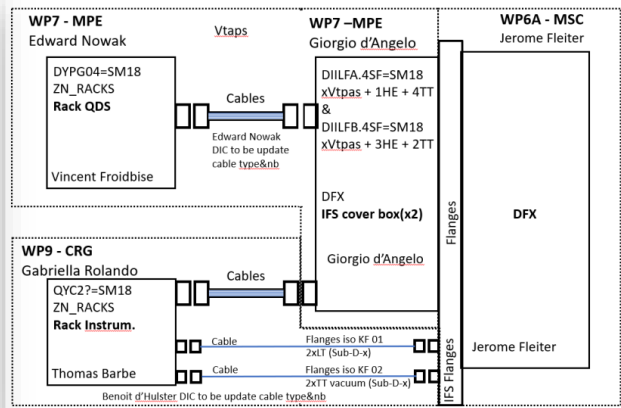
TRACEABILITY

Prepared by: Sebastien Blanchard (TE-MPE)	Date: 2022-05-30
Checked by: Not Applicable	Date: N/A
Approved by: Not Applicable	Date: N/A


Distribution: Renee Drees (TE-MPE); Jerome Fleiter (TE-MSC); Vincent Froidbise (TE-MPE); Giorgio d'Angelo (TE-MPE); Edward Nowak (TE-MPE); Sameer Yamin (TE-MPE); Davide Bozzini (TE-MPE); Milan Zivkovic (TE-MPE); Nicola Houda (TE-MPE); Gabriella Rolando (TE-CRG); Vanessa Gabler (TE-CRG); Thomas Barbe (TE-CRG); Analia Raffaele (TE-MSC); Daniel Wolmann (TE-MPE); Paul Czuchra (TE-VSC); Antonio Pires (TE-CRG); Maria Rajko (TE-MPE); to-ftp-ep@cern.ch

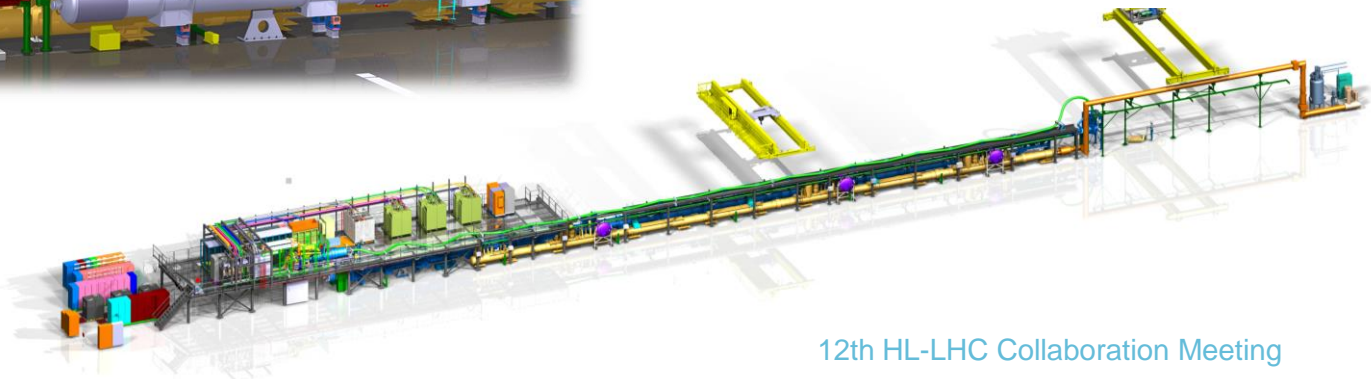
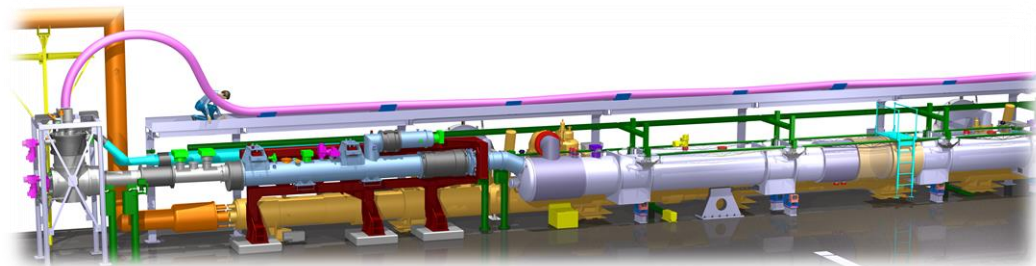
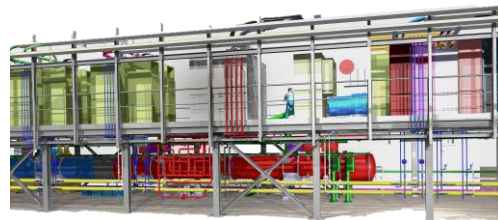
Web: string-sm18.web.cern.ch/oid-pro/stringsM228152

Rev. No.	Date	Descriptions of the changes
1.0	1202-05-30	Creation
1.1	2021-06-09	Review from GR: interface between CRG and WPS, scope is at the GMS interface like in the F2 test bench.



Documentation: Integration & Installation

- **3D Model** for the IT String  90%
- Integration Evolution: EDMS [1582348](#)
- Pending integration studies ([link](#))
- Installation drawings to be produced



Documentation: Integration & Installation

- **Installation procedures** definition is in progress. Advances: Installation meetings and topical meetings.
 - SQXL ([EDMS 2735208](#))
 - Jacks ([EDMS 2776178](#))
 - Magnets ([EDMS 2420321](#))
 - Interconnections ([EDMS 2776216](#))
 - Cold Powering ([EDMS 2776217](#), [EDMS 2776222](#))
- **Quality control** procedures and results
 - Ongoing work: Interconnections
 - Test results & Non-Conformities documentation strategy: under discussion with HL-LHC Quality Office.
- **Lessons learned** reports and **As-Built** document to be drafted
 - Example: SQXL lessons learned - [EDMS 2768428](#)

Works, Step 6 – Control & Jacks light tightening - ASG

- A final control of height and roll angle is done
- Main bolts on the floor are light tightened
- Once done, a sticker is placed on the jacks



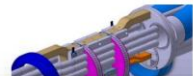
Installation below the mezzanine (Q1 and Q2A)
Longitudinal transfer on rolling equipment with tow tractor



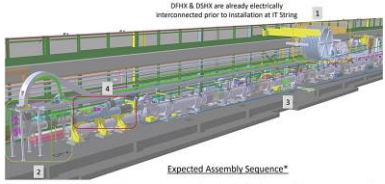
The longitudinal transfer of the magnet is performed with the magnet already at the final height from the ground

Activity : Q1 to D1 connection

- Installation of fixe points
- Eccobond injection
 - QC (visual inspection)
- EIQA test before sleep



Overview of Cold Powering Installation Sequence



DFHX & DSHX are already electrically interconnected prior to installation at IT String

* Magnets can be installed before any of the cold powering equipment


Share of WP6a team installation activities:

Expected Assembly Sequence*	
1) DFHX-DSHX	- lifting to platform, fixation of DFHX, unspooling of Sc link ~ 10%
2) DFX	- Sc link insertion, DFX assembly (up to Nb-Ti/Nb-Ti interconnect) ~ 60%
3) Triplets & D1	- magnet installation including busbar insertion into line N
4) DCM	- installation
2') DFX	- NbTi/NbTi connection, closure of DFX interconnect ~ 30%

DFHX to DCM is the only electrical interconnection work required at IT String for the cold powering system

Documentation: Validation Program

- Drafting of detailed **test procedures** is **ongoing**
 - ISTs and Short-Circuit Tests
 - Interconnection Tests: Magnet & Cold Powering
 - Circuit Commissioning Tests
 - String-Specific Tests
- **Analysis reports** during operation:
 - Automatic reports via Swan Notebook
 - Manual reports for specific tests



EDMS NO. 2746522	REV. 0.9	VALIDITY DRAFT
REFERENCE: LHC-XMS-CP-0003		

HARDWARE COMMISSIONING PROCEDURE

HL-LHC INNER TRIPLET STRING SHORT CIRCUIT TESTS

Abstract
The tests described in the present hardware commissioning procedure are meant to validate the normal conducting part of the electrical circuits powering the superconducting magnets, including the 400 V electrical network, the power converters, the water-cooled cables, Energy Extraction System, air-cooled cables, the circuit disconnector boxes and the room temperature high current bus bars before their connection to the DFHX in the HL-LHC inner Triplet String test facility.

TRACEABILITY

Prepared by: S. Sehadri	Date: 2022-06-07
Verified by: A. Antoine, D. Bozzi, J. Fleiter, B. Panev, M. Silva Marreiros, H. Thiesen and S. Yammine	Date: 2022-07-19
Approved by: M. Bajko, A. Ballarino, P. Cruckshank, M. Martino, V. Montabonnet, M. Poger, F. Rodriguez-Mateo and M. Zorlato	Date: 2023-MM-DD

Distribution: SVMF Members and HL-LHC PD

Rev. No.	Date	Description of Changes (major changes only, minor changes in EDMS)
0.1	2022-06-07	Draft version for engineering check

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

Analysis of a PNO.c6 HWC Test in an IPD Circuit

Subcontracting beam association classes of four different tests are required in the Experimental Insertions (E1, 2, 3 and 4) and the RF insertion (E5). Single aperture devices (E1, E2, E3, E4) and twin apertures (E5) are also required in the Experimental Insertions. They bring the two beams of the LHC into collision at four separate points then separate the beams again beyond the collision point in the RF Insertions two types of twin aperture devices, each type with two different aperture spacings are used (D1 and D2) and (D3 and D4) magnets increase the separation of the beams in E1, from the nominal spacing 194 mm to 430 mm. D3 and D4 are the twin apertures magnets with common iron core for both apertures, D2 is a twin apertures magnet with independent iron cores for each aperture.

The MFRIC optic consists of two individually powered apertures assembled in a common yoke structure:

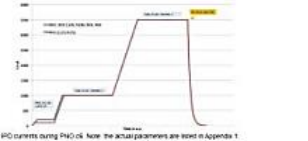
- MFRIC - D1
Single aperture of the magnet powered with one power supply
- MFRIC - D2
• MFRIC - D4
Apertures E1 and E2 of the magnet are powered in series with one power supply
- MFRIC - D3
Apertures E1 and E2 of the magnet are powered in series with one power supply but series connection done in the CFSM.

Magnets in the Circuit	Temperature	Position	General Information
MFRIC (D1)	4.9 K	RD1 D2 RD1 RB	Nominal: 5000A, L_Upper: 6700A I, V: 24 VPM 1 per aperture 26 VPM Inch: 18 147 Au
MFRIC (D2)	4.5 K	RD2 L1, RD2 R1, RD2 L3, RD2 R3	Nominal: 4000A, L_Upper: 4670A Nominal: 5000A, L_Upper: 6000A I, V: 18 VPM 1 per aperture 26 VPM Inch: 18 147 Au
MFRIC (D3)	4.9 K	RD3 L4, RD3 R4	Nominal: 5000A, L_Upper: 6000A I, V: 24 VPM 1 per aperture 26 VPM Inch: 18 147 Au
MFRIC (D4)	4.5 K	RD4 L4, RD4 R4	Nominal: 5000A, L_Upper: 6000A I, V: 24 VPM 1 per aperture 26 VPM Inch: 18 147 Au

This section is a copy of a document created by Alexandre Evdokimov https://cds.cern.ch/record/2816303/files/HL-LHC_IPD_ShortCircuit_Testing.pdf

PNO.C6 - FAST POWER ABORT AT NOMINAL CURRENT AND LEAD TEST

The aim of this test is to verify the correct performance of the current leads at operational current and evaluate the converter and magnet performance after a fast power abort from nominal current.

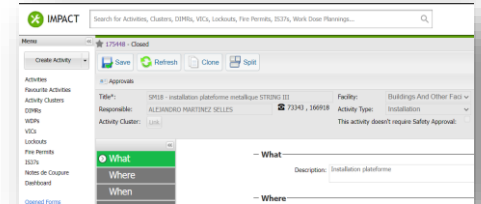


IPD currents during PNO.C6. Note: the actual parameters are listed in Appendix 1

Offline analysis are listed below:

Documentation: Safety

- **Impact forms** to document safety measures during on-site activities
- **System Safety Assessments (SSAs)** to be released before IT String operation. String specific Master SSAs:

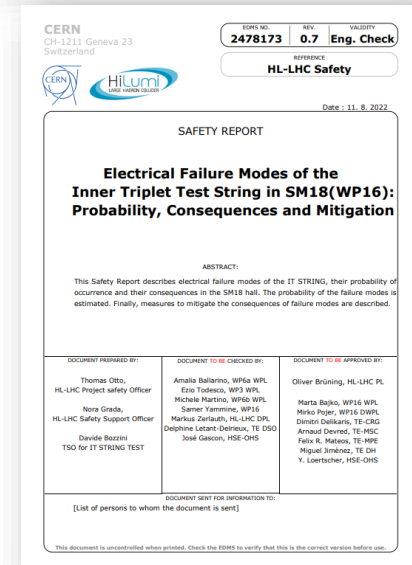


Test String in SM18
[EDMS 2568287](#)

Cryogenics for Test String
[EDMS 2366342](#)

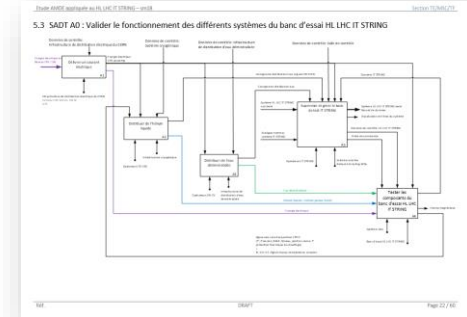
Electrical failure modes of the IT String
[EDMS 2478173](#)

Inner Triplet and Cold Powering in Test String
[EDMS 2575427](#)



Documentation: Safety

- **Functional and Dysfunctional analysis of the IT String to be completed** ([EDMS 2276420](#))
- **Technical notes**
 - AUG Requirements for HL-LHC IT String ([EDMS 2706599](#))
 - UPS Supply for HL-LHC IT-String ([EDMS 2718284](#))
 - Fix fencing for HL-LHC IT-String
 - ...
- **During Operation**
 - **Safety document** containing general safety aspects to be applied
 - **Guidelines** concerning safety during tests to be included in the procedures



5.3 SADT AD: Valider le fonctionnement des différents systèmes du banc d'essai HL LHC IT STRING

Should deviations from the baseline occur, the ELGA tests shall be executed in following cases:

- Abnormal temperature excursion of any coil component of the superconducting circuits above 30K
- Warm-up
- Intervention on components connected to the superconducting circuits

5 SPECIFIC ELGA SAFETY CONSIDERATIONS

The personnel executing the qualification tests as mentioned in this document, must have followed the electrical safety courses according to the IEC 618-510 [1] and be in possession of a B2 or B3 certification. The teams are led by a "chargé de travaux" in possession of a B2 certification.

The areas where the tests will be done and all the areas where circuits or elements directly connected to them are energized or could be energized due to a fault shall be duly signposted and specific protection shall be put in place.

According to the IEC 618-510 sub [1], all power converters powering the IT string facility under test have to be locked out. All switch header across supplies to the IT string facility have to be switched off. Any other electrical test or electrical intervention are forbidden on an IT string facility where ELGA tests are carried out.

Before starting the tests the ELGA engineer in charge will verify that all the preparatory works and installations are in place.


Qualification tests are always executed by a minimum of 2 ELGA team members. If the energized areas are multiple, the necessary personnel for the control will be provided by the ELGA team.

During the execution of the tests any person requesting an access to the area shall contact the ELGA engineer in charge and ask the permission for entering or crossing the area under test.

After the tests all circuits will be discharged and will be left grounded.

6 GENERAL SAFETY ASPECTS

6.1 In case of accident or emergency call cern fire brigade

 **RED Telephone**
CERN Telephone 74444

6.2 Safety policy and safety training

Each person working at CERN must respect the CERN Safety Policy and Safety Rules
<http://psp.cern.ch/content/safety-rules>

Each person involved in activities, which requires access to the LHC tunnel and to the IT string facility, must follow the mandatory safety training on the CERN Learning Web: <http://lhc.cern.ch>

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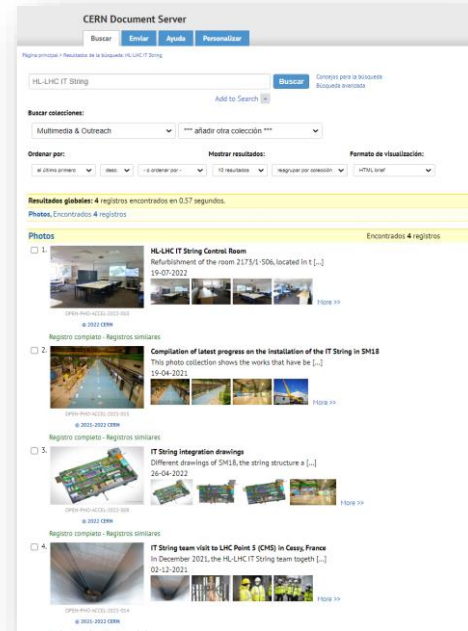
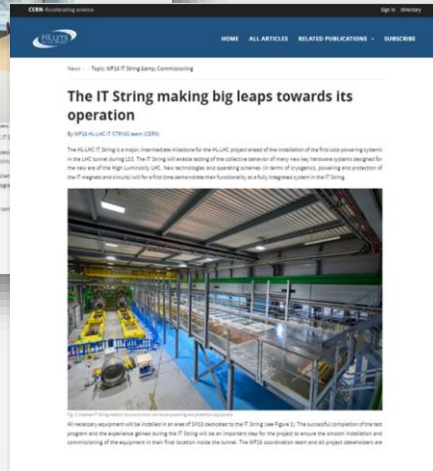
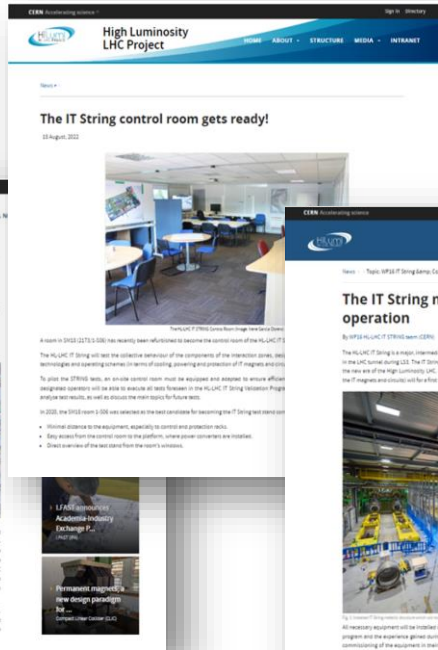
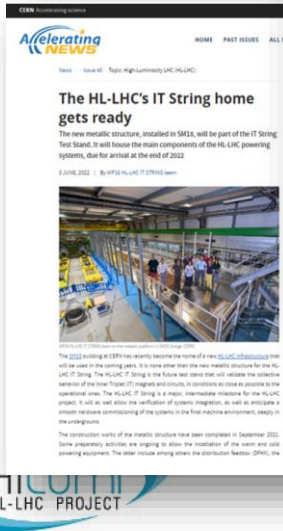


Communication

- In close collaboration with the HL-LHC Communication Office:

News on latest advancements

Image galleries of IT String activities



Conclusions

Clear vision of the documentation needed

IT String advancement extensively documented

Challenges

- Complete documents in time for operation
- Standardise level of detail documents of same category



***Special thanks to all collaborators for
their efforts***

Thank you for your attention

Questions, remarks...