HL-LHC IT String:
Planning and Validation Program

M. Bajko TE-MPE-SF/HL-LHC WP16

HL-LHC Collaboration Meeting, Uppsala September 2022

Outline

- STRING Validation Program
  - The HL-LHC IT STRING Motivation
  - The IT STRING Scope
  - The IT STRING: a test stand
  - The IT String Validation Program organisation
  - The Validation Program Drivers
  - The IT String Validation Program
- Planning
  - Remarks on the schedule
  - Tools for planning
- Status
- Summary

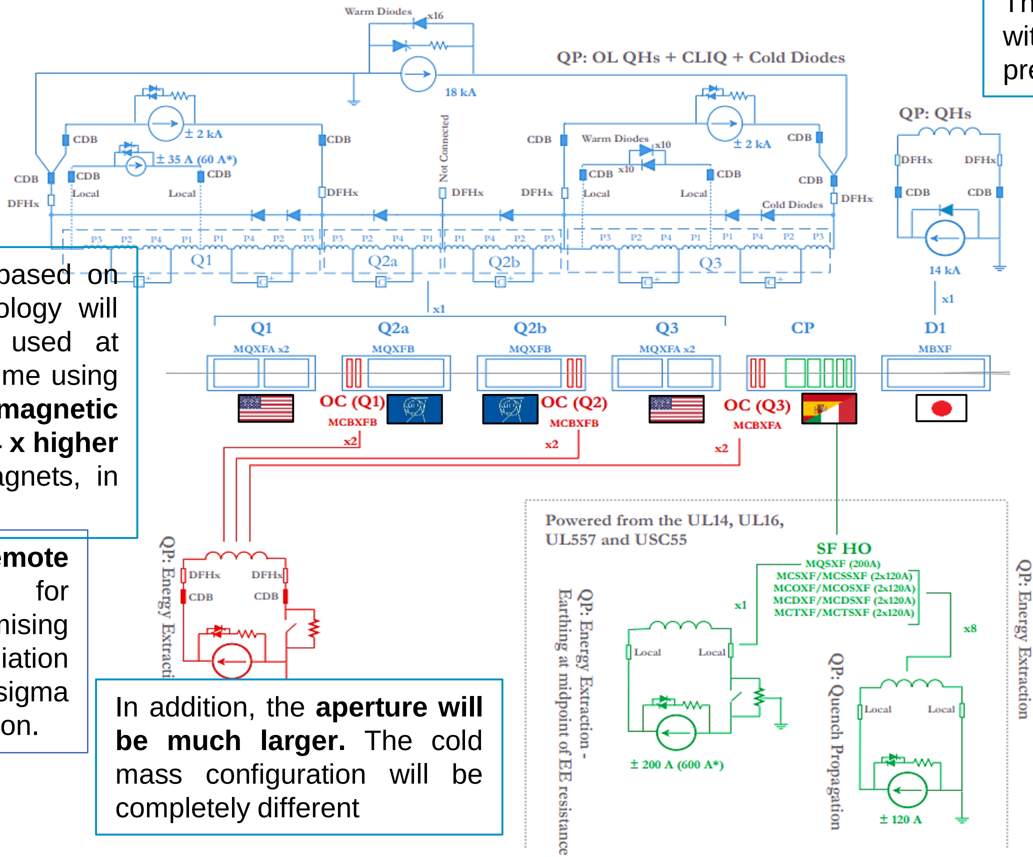
The HL-LHC IT STRING MOTIVATION

In the HL-LHC configuration, the present LHC's Inner Triplet (IT) regions of IR1 and IR5 <u>**will be heavily modified**</u> <u>**will be heavily modified**</u>.

The IT quadrupoles (Q1-Q3) will use **Nb_3Sn** instead of the **Nb-Ti** used by the present ones.

The **protection** of magnets based on Nb_3Sn superconductor technology will be **different** from what is used at present. This will be the first time using the CLIQ and QHs. **Higher magnetic energy stored (1.2 MJ/m, 2-4 x higher than in the LHC)** in the magnets, in operational conditions.

New **continuous and remote alignment** system (**FRAS**) for aperture optimisation, minimising corrector strength and radiation exposure of personnel. At1 sigma the target is ±0.100 mm precision.



The magnets will be powered with a **higher current** than the present LHC IR magnets

and will be fed via a **superconducting link and new a generation of superconducting current leads**

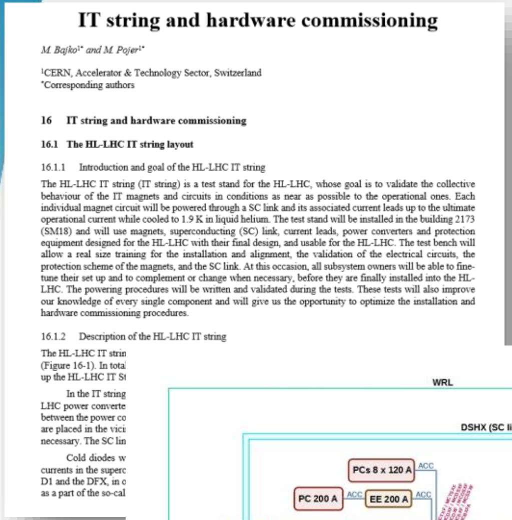
The D1 magnet will be made of **superconductor** instead of normal conductors as is in today's LHC.

The **corrector package** will be **substantially modified** as configuration and technology too.

In addition, the **aperture will be much larger.** The cold mass configuration will be completely different

Train teams and validate procedures for LS3 and HL LHC HWC.

The IT STRING Scope



IT string and hardware commissioning

M. Bajko[1*] and M. Pojer[1*]

[1]CERN, Accelerator & Technology Sector, Switzerland
*Corresponding authors

16 IT string and hardware commissioning

16.1 The HL-LHC IT string layout

16.1.1 Introduction and goal of the HL-LHC IT string

The HL-LHC IT string (IT string) is a test stand for the HL-LHC, whose goal is to validate the collective behaviour of the IT magnets and circuits in conditions as near as possible to the operational ones. Each individual magnet circuit will be powered through a SC link and its associated current leads up to the ultimate operational current while cooled to 1.9 K in liquid helium. The test stand will be installed in the building 2173 (SM18) and will use magnets, superconducting (SC) link, current leads, power converters and protection equipment designed for the HL-LHC with their final design, and usable for the HL-LHC. The test bench will allow a real size training for the installation and alignment, the validation of the electrical circuits, the protection scheme of the magnets, and the SC link. At this occasion, all subsystem owners will be able to fine-tune their set up and to complement or change when necessary, before they are finally installed into the HL-LHC. The powering procedures will be written and validated during the tests. These tests will also improve our knowledge of every single component and will give us the opportunity to optimize the installation and hardware commissioning procedures.

16.1.2 Description of the HL-LHC IT string

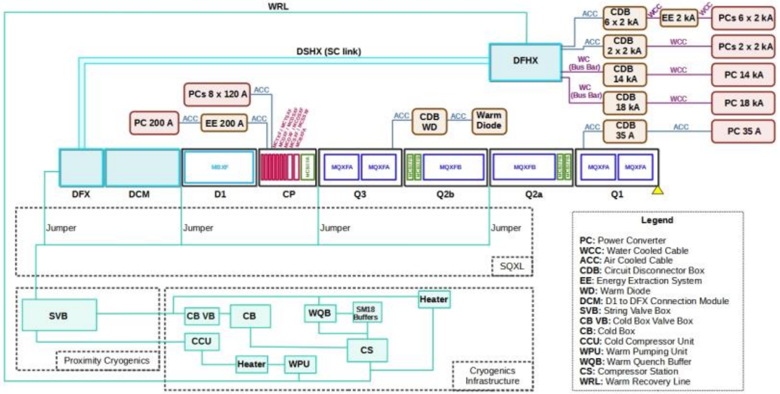
The HL-LHC IT strin… (Figure 16-1). In total… up the HL-LHC IT S…

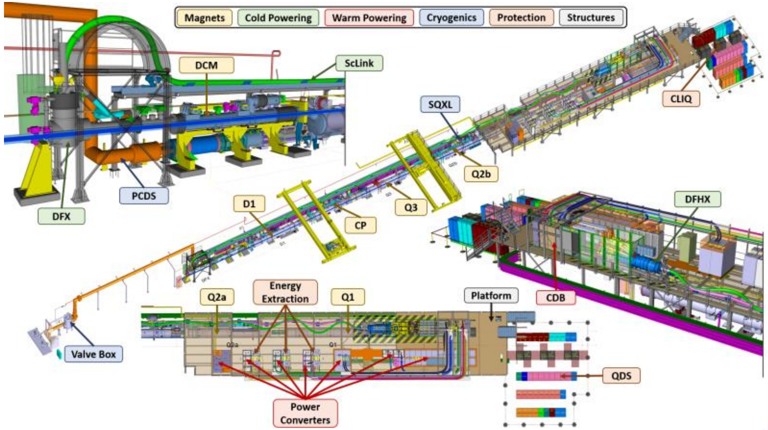
In the IT string… LHC power converte… between the power co… are placed in the vici… necessary. The SC lin…

Cold diodes w… currents in the superc… D1 and the DFX, in c… as a part of the so-cal…

The ***scope*** of the IT STRING is to represent, as best as reasonably achievable in a surface building, the various operation modes to **STUDY and VALIDATE the COLLECTIVE BEHAVIOUR** of the different systems of the HL-LHC's IT zone (magnets, magnet protection, cryogenics of the magnets andof the superconducting link, magnet powering, vacuum, alignment, interconnections between magnets, and the superconducting link itself).

Ref. HL-LHC IT STRING Scope https://edms.cern.ch/document/1693312/1





The IT **STRING** will deliver **the first complete experience** of installing and operating the IT zone

The HL-LHC IT STRING: a test stand

The HL-LHC IT STRING will serve as a test bed for matters or conditions that either

- **a** — cannot be fully tested as a part of the component acceptance and characterisation program
  - Splices
  - Lambda Plate
- **b** — depend on the response of the integrated system
  - Interconnections
  - Circuits
  - Alignment

The STRING test takes place TOO LATE in the project to be used FOR QUALIFICATION of COMPONENTS and « known unknowns » must be addressed at the level of the design.

We rather look for VALIDATION AND « unknown unknowns » of the INTEGRATED SYSTEM during its installation, operation and dismounting.

Drivers of the String Validation Program

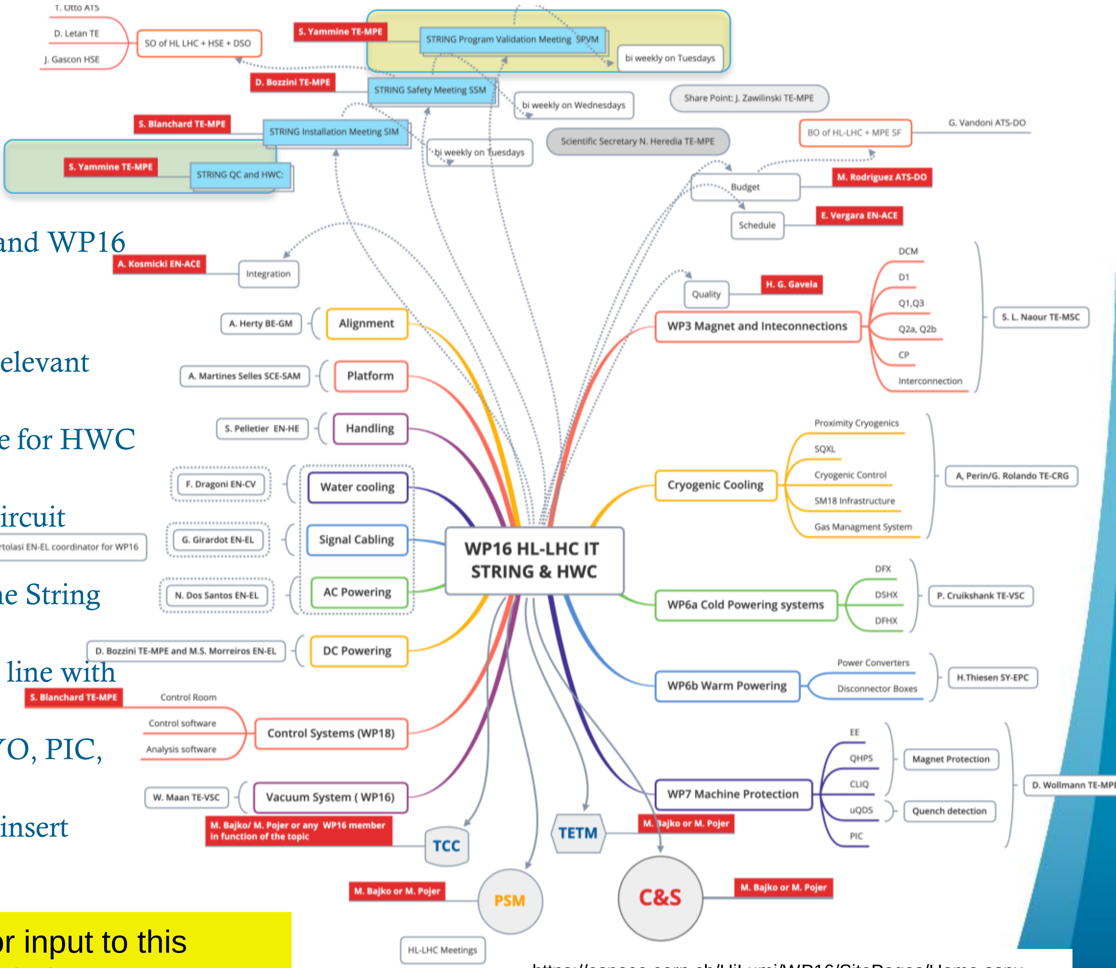
STRING Validation Program

- Alignment and repeatability
- Quench protection and Circuit
- Compatibility of Control layers
- Beam operation cycles
- Cryogenic operation scenarios
- Quench detection thresholds
- Power Convertre's accuracy, precision and control
- Tooling and methods for Interconnections
- Validation of the collective behaviour
- Training teams
- Validate procedures

HL-LHC IT STRING organisation for validation program

WP2, WP3, WP6a, WP6b, WP7, WP9, WP12, WP15/15.4 and WP16 are represented

- Objective of the Meetings:
  - Define the validation program of the string with the relevant WPs
  - Coordinate with equipment owners the test procedure for HWC and QC tests (ElQA, leak, pressure tests, etc.)
  - Produce the powering procedure for HWC tests per circuit family and for combined powering
  - Define the additional string-specific tests desired in the String Validation Program
  - Ensure the definition of the control layer and tools in line with the LHC tools
  - Ensure the adaptability of the supervision tools (CRYO, PIC, QPS, etc.) to the IT String
  - Identify QA/QC steps in the assembly sequence and insert them, when necessary all along the String lifetime



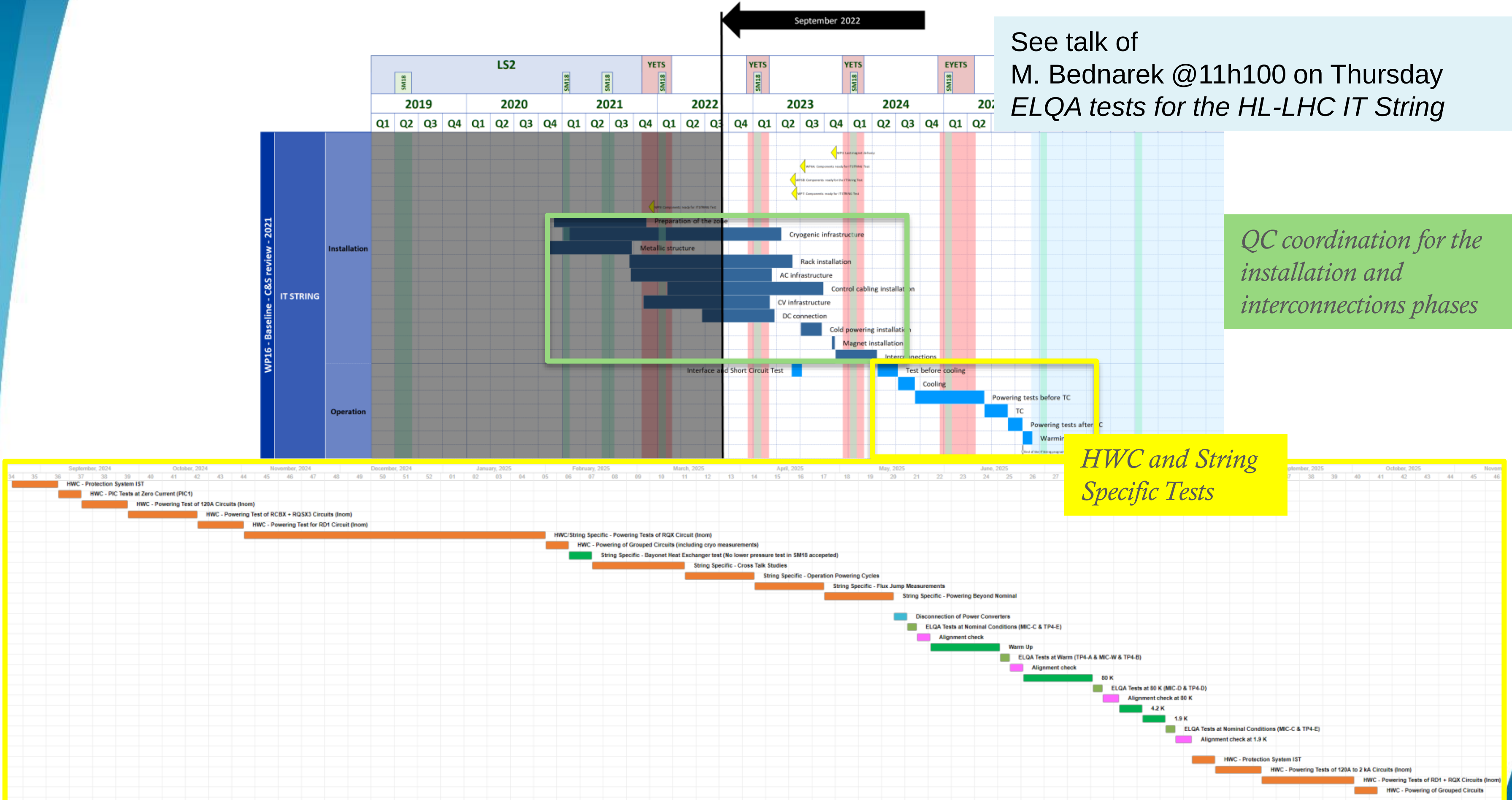
https://espace.cern.ch/HiLumi/WP16/SitePages/Home.aspx

Particular thanks for S. Yammine for input to this presentation specifically for the Validation Program.

HiLumi HL-LHC PROJECT

String Validation Program and QC Planning

See talk of
M. Bednarek @11h100 on Thursday
ELQA tests for the HL-LHC IT String

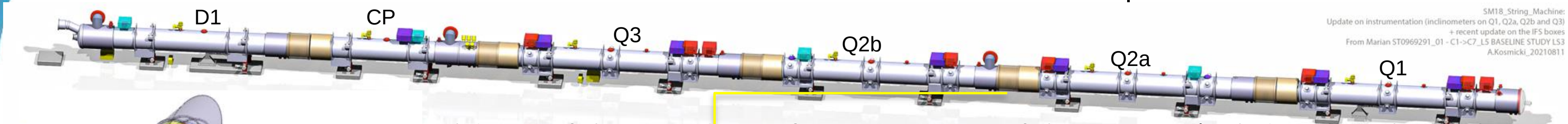


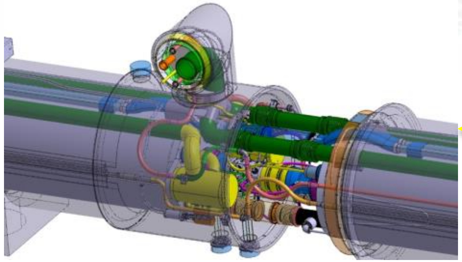
QC coordination for the installation and interconnections phases

HWC and String Specific Tests

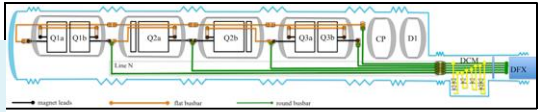
What will we learn during installation?

This is the first time that the individually-tested magnets will be interconnected, following the procedures which h had been defined for the new HL-LHC inner triplet



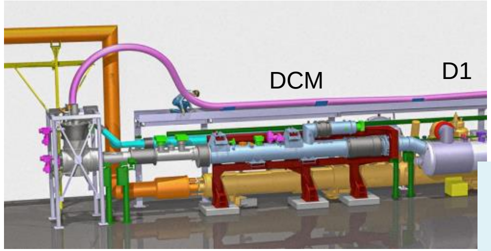


Validation of the **procedures of interconnection** of the **magnets** (including the splices), **the QXL and the N line.**



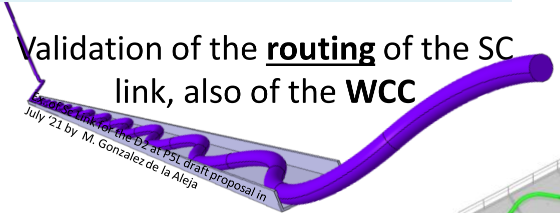
See talk of
R. Principe @10h50 on Thursday
Magnet splicing and interconnection in the IT String

Validation of the **handling and assembly procedures** of the Cold powering system.

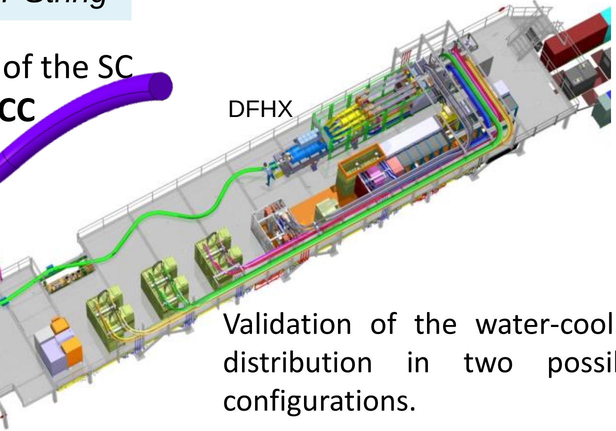


DFX

Validation of the **routing** of the SC link, also of the **WCC**



DFHX



Validation of the water-cooling distribution in two possible configurations.

See talk of
P. Cruikshank @11h30 on Thursday
Installation strategy of the SC Link system in the HL-LHC IT String

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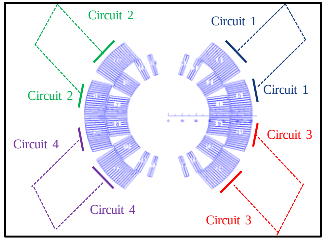
CERN

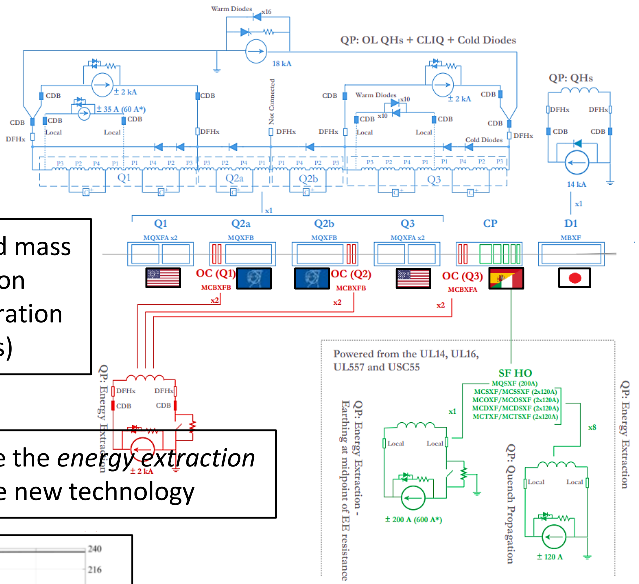
What will we learn during STRING HWC and operation?

Ex. Validation of the new **POWERING AND PROTECTION STRATEGIES**

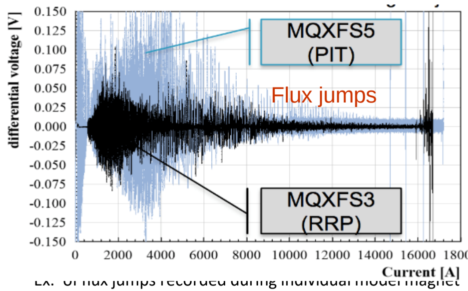
VALIDATE the new powering scheme: ex. new decoupling algorithm parameters for the circuit nested control and the new FGC parameters for the HL-LHC IT circuits.



Ground to Cold mass transfer function validation (vibration measurements)



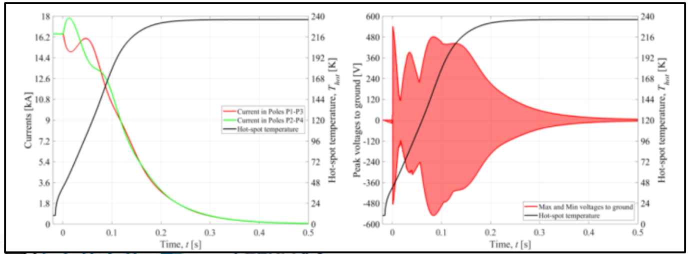
Define *thresholds* and validate the *quench detection* considering cross-talk among circuits and flux jumps, in order to increase the availability and reduce the amount of false triggers in both HWC and in the operation while keeping a suitable quench detection scheme.



Ex. of flux jumps recorded during individual model magnet test

Validate the *protection* strategy combining *CLIQ and QH*

Validate the *energy extraction* with the new technology

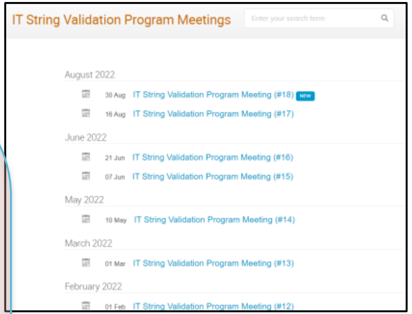


Check how the *SYSTEMS TOGETHER* can be commissioned…(also including WCC performance, CV circuitry, *cryogenics* etc

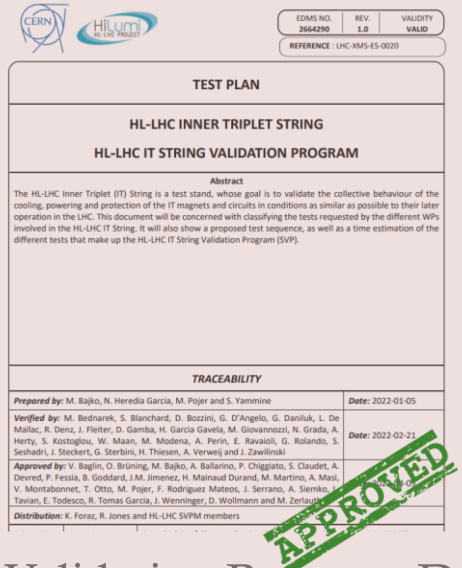
Validate the *Interlock system* for machine protection.

Validate the new hardware, software and procedure for the HL-LHC *ElQA*

Documentation Plan

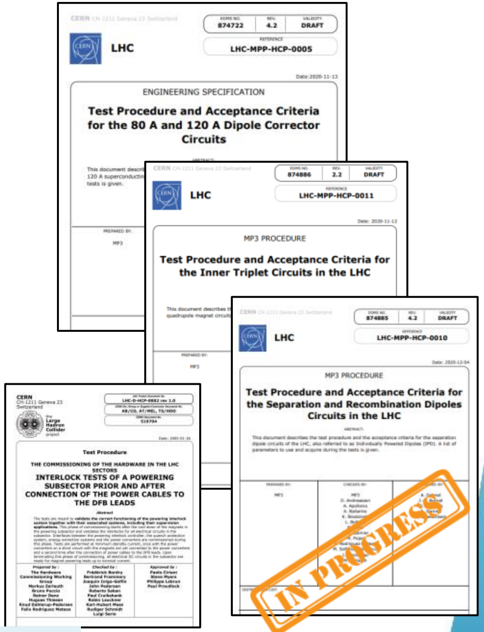


String Validation Program Meetings



Validation Program Document
(Goals and Methods)
LHC-XMS-ES-0020, EDMS no. 2664290

See talk of
N. Heredia Garcia @12h10 on Thursday
Documentation plan for the HL-LHC IT String



Test Procedures

String Validation Program Document

To the test sequence

Table 5 – Test sequence during and after the thermal cycle

No.	Test Name	Covered WP requirements	HWC or String Specific	Duration
1	ElQA Tests at Nominal Conditions	WP3-1, WP6a-1, WP7-4	N/A	1 w
2	Alignment Checks	WP15.4-1	N/A	2 d
3	Warm-up till Room Temperature	N/A	N/A	2 w
4	Global Leak Tests of Insulation Vacuum	WP12-1, WP12-2	N/A	3 w
5	Alignment Tests at Warm	WP15.4-1, WP15.4-2, WP15.4-4, WP15.4-5	N/A	2 d
6	ElQA Tests at Warm	WP3-1, WP6a-1, WP7-4	N/A	3 d
7	Cooling till 80 K	N/A	N/A	1 w
8	ElQA Tests at 80 K	WP3-1, WP6a-1, WP7-4	N/A	3 d
7	Alignment Tests at 80 K	WP15.4-1	N/A	3 d
8	Cooling till NOC (1.9 K in magnets)	N/A	N/A	1 w
9	ElQA at Nominal Conditions	WP3-1, WP6a-1, WP7-4	HWC	3 d
10	Alignment Tests at Nominal Conditions	WP2-2, WP15.4-1, WP15.4-3	HWC	3 d
11	Protection System IST	WP7-1	HWC	1 w
12	Powering Tests for 120 A to 2 kA Circuits	WP3-2, WP6a-3, WP16-1, WP16-2	HWC	2 w
13	Powering Tests for RD1 and RQX Circuits (2 w powering and 2 w training)	WP3-2, WP6a-3, WP16-1, WP16-2	HWC	4 w
14	Powering of Grouped Circuits	WP16-1, WP16-2	HWC	1 w
15	ElQA Tests at Nominal Conditions	WP3-1, WP6a-1, WP7-4	N/A	1 w
16	Alignment Checks	WP15.4-1	N/A	2 d
17	Warm-up till 80 K	N/A	N/A	1 w
18	ElQA Tests at 80 K	WP3-1, WP6a-1, WP7-4	N/A	3 d
19	Warm-up till Room Temperature	N/A	N/A	1 w
20	ElQA Tests at Warm	WP3-1, WP6a-1, WP7-4	N/A	3 d
21	De-Interconnection	WP15-2	N/A	-
	Total effective duration of test sequence during and after the thermal cycle			24 w

Requirement ID	Requirement Name	Items to Test	Goal of the Test	Magnets: Warm or Cold?
WP15.4-4	Remote Measurements Train	FRAS measurements	Simulate and validate a remote measurement "train" to prepare tunnel measurements of intermediary components.	W
WP15.4-5	FRAS Access and Maintenance Mock-up Tests	Maintenance of alignment/adjustment systems on all components	Test and optimise the FRAS system maintenance procedures (access and duration) for ALARA requirements.	W
WP16				
WP16-1	HWC	HWC Procedures	Validate HWC procedures for HL-LHC circuits.	C
WP16-2	HWC	HWC Software	Validate HWC software (AccTesting, Swan Notebook, Post Mortem, etc.) for HL-LHC circuits.	W & C
WP18				
WP18-1	Control Systems Tests	Control Systems	Validate the various systems that rely on the HL-LHC controls provided by WP18.	W & C

From the requirements by the different WPs

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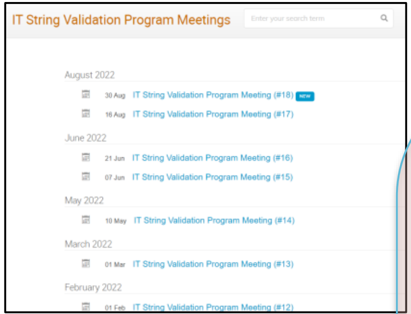
LHC-XMS-ES-0020, EDMS no. 2664290

Documentation Plan



IT String Validation Program Meetings

August 2022

30 Aug IT String Validation Program Meeting (#18) NEW

16 Aug IT String Validation Program Meeting (#17)

June 2022

21 Jun IT String Validation Program Meeting (#16)

07 Jun IT String Validation Program Meeting (#15)

May 2022

10 May IT String Validation Program Meeting (#14)

March 2022

01 Mar IT String Validation Program Meeting (#13)

February 2022

01 Feb IT String Validation Program Meeting (#12)

String Validation Program Meetings

EDMS NO.	REV.	VALIDITY
2664290	1.0	VALID

REFERENCE : LHC-XMS-ES-0020

TEST PLAN

HL-LHC INNER TRIPLET STRING

HL-LHC IT STRING VALIDATION PROGRAM

Abstract

The HL-LHC Inner Triplet (IT) String is a test stand, whose goal is to validate the collective behaviour of the cooling, powering and protection of the IT magnets and circuits in conditions as similar as possible to their later operation in the LHC. This document will be concerned with classifying the tests requested by the different WPs involved in the HL-LHC IT String. It will also show a proposed test sequence, as well as a time estimation of the different tests that make up the HL-LHC IT String Validation Program (SVP).

TRACEABILITY

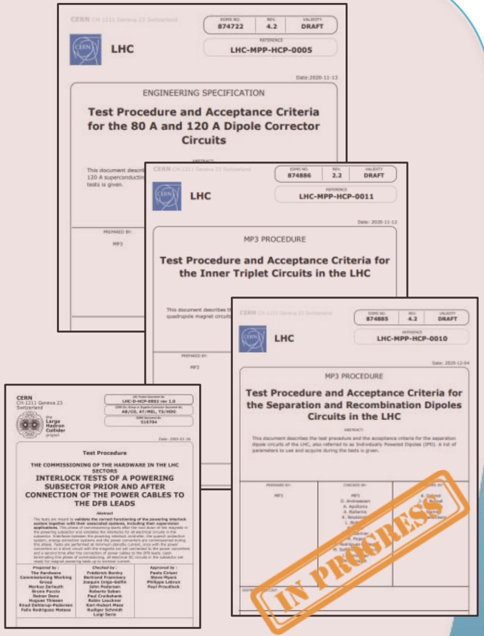
Prepared by: M. Bajko, N. Heredia Garcia, M. Pojer and S. Yammine	*Date:* 2022-01-05
Verified by: M. Bednarek, S. Blanchard, D. Bozzini, G. D'Angelo, G. Daniluk, L. De Mallac, R. Denz, J. Fleiter, D. Gamba, H. Garcia Gavela, M. Giovannozzi, N. Grada, A. Herty, S. Kostoglou, W. Maan, M. Modena, A. Perin, E. Ravaioli, G. Rolando, S. Seshadri, J. Steckert, G. Sterbini, H. Thiesen, A. Verweij and J. Zawilinski	*Date:* 2022-02-21
Approved by: V. Baglin, O. Brüning, M. Bajko, A. Ballarino, P. Chiggiato, S. Claudet, A. Devred, P. Fessia, B. Goddard, J.M. Jimenez, H. Mainaud Durand, M. Martino, A. Masi, V. Montabonnet, T. Otto, M. Pojer, F. Rodriguez Mateos, J. Serrano, A. Siemko, I. Tavian, E. Todesco, R. Tomas Garcia, J. Wenninger, D. Wollmann and M. Zerlauth	
Distribution: K. Foraz, R. Jones and HL-LHC SVPM members	

APPROVED

Validation Program Document

(Goals and Methods)

LHC-XMS-ES-0020, EDMS no. 2664290



Test Procedures

Powering Tests for Hardware Commissioning

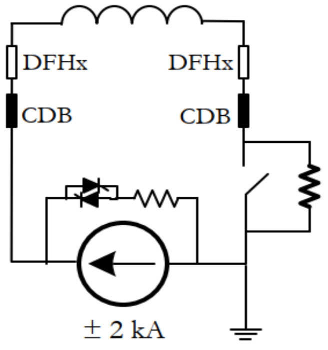
LHC 600 A (Reference)	Step for HL-LHC IT String	Test Description
PCC	PCC	Power Converter Configuration
PIC2	PIC2	PIC tests
PCS	PLI1.s1	Splice Mapping @ 500 A
PLI3.b1	PLI1.b1	EE from QDS @ 500 A
	PLI1.d1	Powering Failure @ 500 A
	PLI1.e1	SPA @ 500 A
	PLI2.s1	Splice Mapping @ 1 kA
	PLI2.c1	FPA @ 1 kA
	PLI2.d1	Powering Failure @ 1 kA
	PLI2.e1	SPA @ 1 kA
PNO.d3	PNO.d1	Training and Powering Failure
PNO.b1	PNO.b1	EE from QDS @ ±I_PNO
PNO.a3	PNO.a1	Bipolar Cycle @ ±I_PNO
PNO.x1	PNO.x3	Combined Powering

HL-LHC IT String Circuit Commissioning Tests

- LHC-XMS-OP-0004 (v.0.1) ELQA QUALIFICATION OF SUPERCONDUCTING CIRCUITS IN THE HL-LHC IT STRING
- LHC-MPP-HCP-0005 (v.4.2) Test Procedure and Acceptance Criteria for the 80 A and 120 A Dipole Corrector Circuits
- LHC-MPP-HCP-0003 (v.5.4) Test Procedure and Acceptance Criteria for the 600 A Circuits
- LHC-XMS-OP-0006 (v.0.1) Test Procedure and Acceptance Criteria for the 2 kA Corrector Circuits (RCBX) in the HL-LHC IT String
- LHC-XMS-OP-0007 (v.0.1) Test Procedure and Acceptance Criteria for the Separation Dipole Circuit (RD1) in the HL-LHC IT String
- LHC-XMS-OP-0008 (v.0.1) Test Procedure and Acceptance Criteria for the Inner Triplet Circuit (RQX) in the HL-LHC IT String
- LHC-XMS-OP-0009 (v.0.1) Parameters for the HL-LHC IT String Circuit Powering Tests

IN PROGRESS

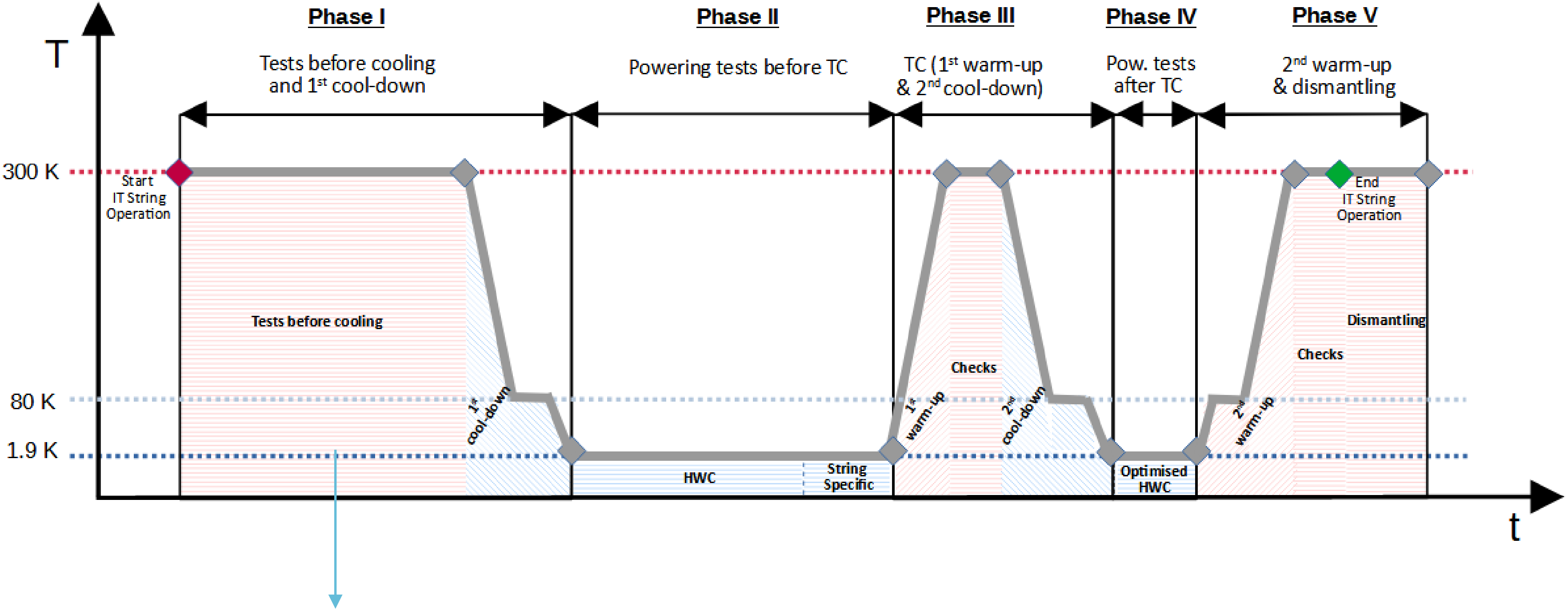
IT Orbit Corrector
(MCBXFA/B)



Example : Steps for 2 kA Circuits

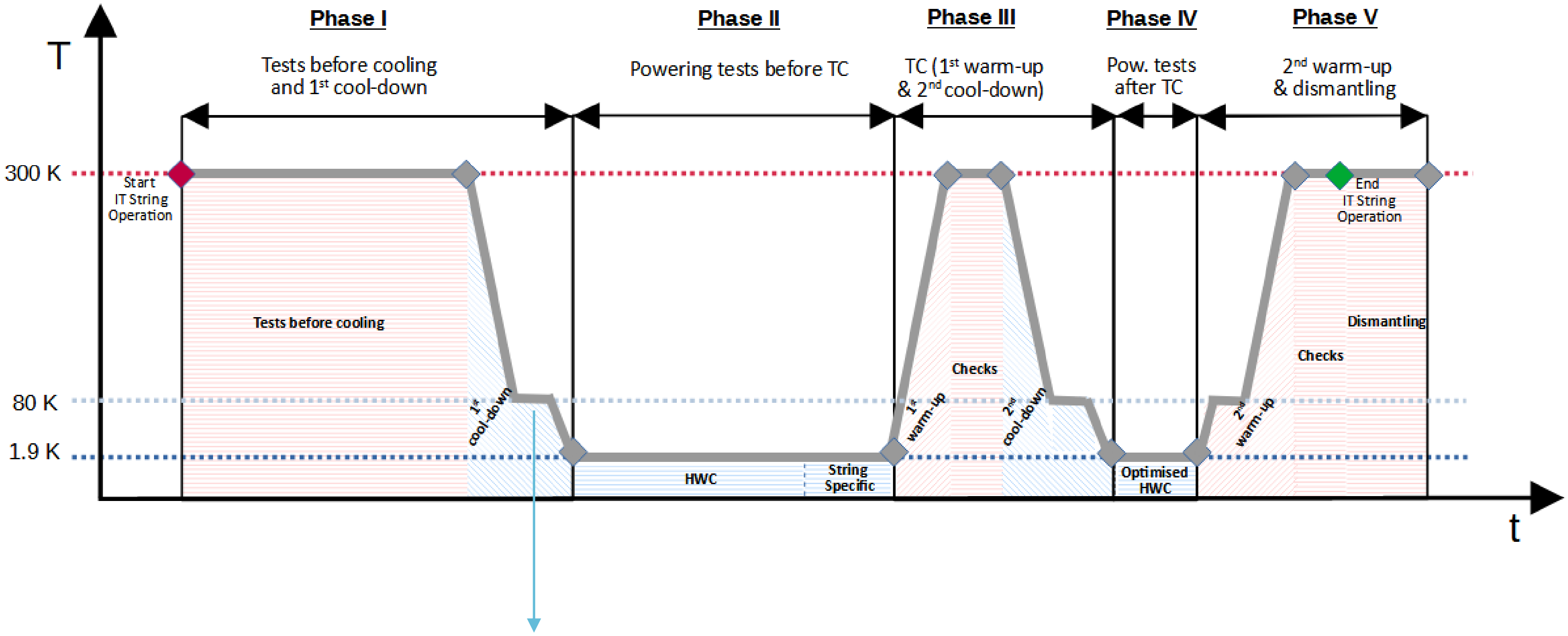
Special thanks for MP3 members participating in the procedure redaction

String Validation Program Phases



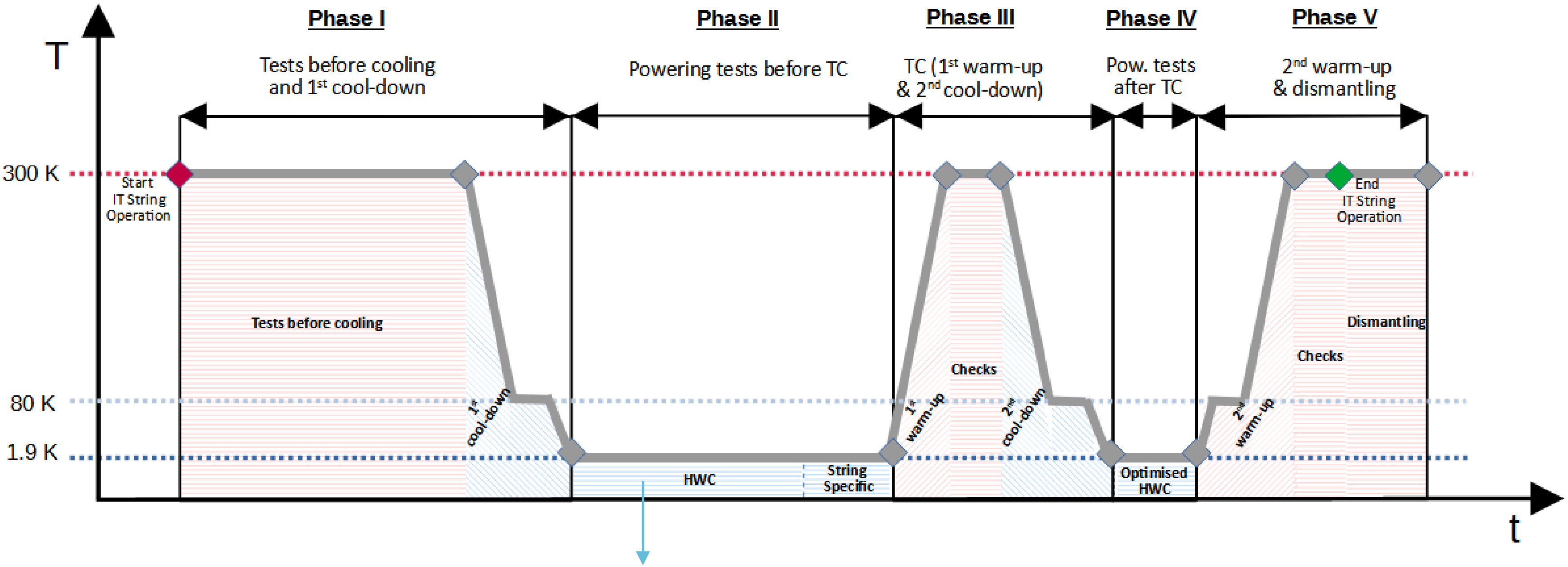
Pumping and Global Leak Tests for the Magnet and Cold Powering Vacuum	5 w
Cryogenics Pressure and Leak Tests and Insulation Vacuum Check	2 w
ElQA and Alignment Tests at Room Temperature	2 w

String Validation Program Phases



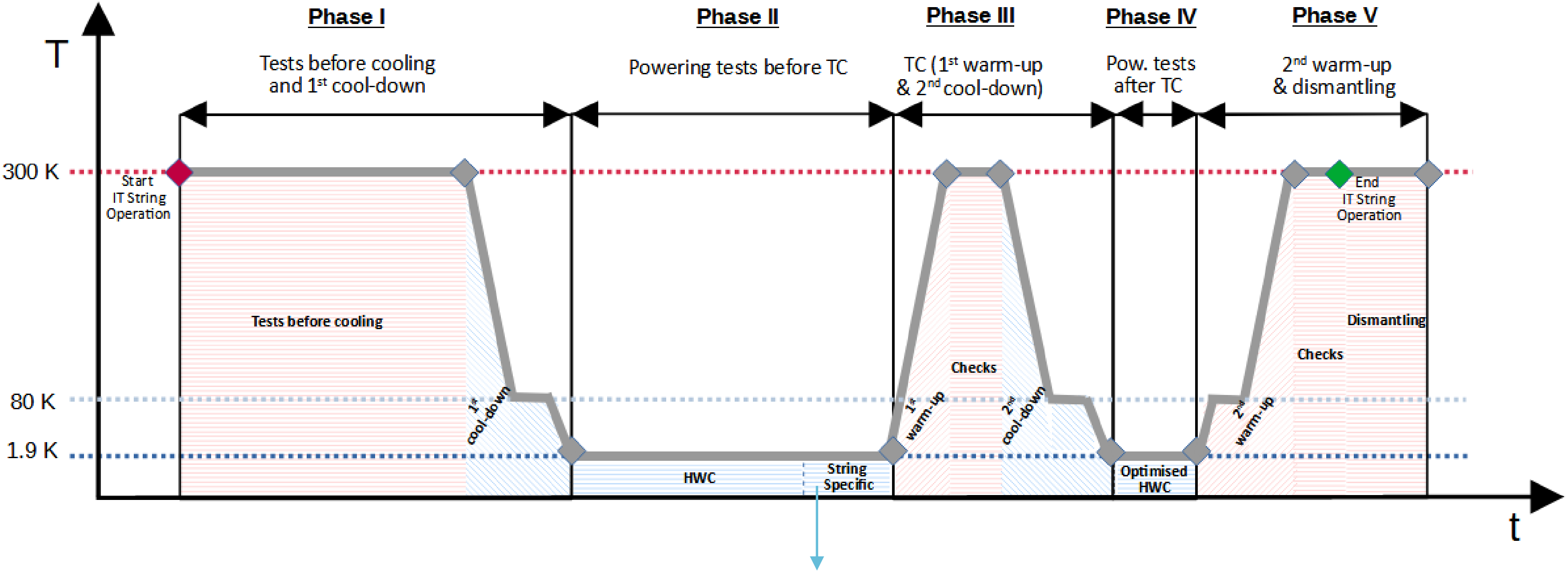
ElQA and Alignment Tests at 80 K	1 w

String Validation Program Phases



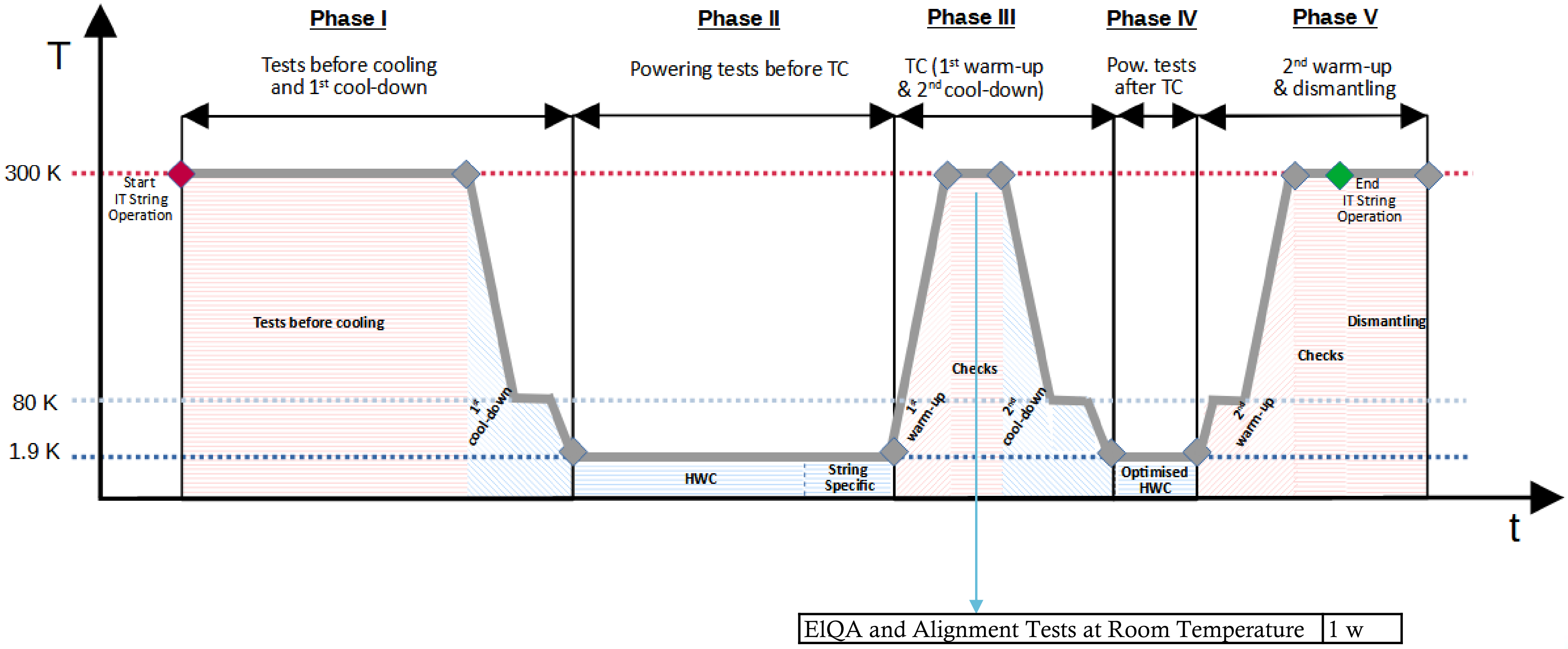
Static Cryogenics Measurements and Controls Tuning	4 w
ElQA and Alignment Tests at Nominal Conditions	1 w
Protection System IST and PIC Tests (PIC1)	3 w
Powering Tests for 120A + 200A Circuits (I_{nom})	2 w
Powering Tests for RCBX -2 kA- Circuits (I_{nom})	3 w
Powering Tests for RD1 -14 kA- Circuit (I_{nom})	2 w
Powering Tests for RQX -18 kA- Circuit (I_{nom})	11 w
Powering of Grouped Circuits	1 w

String Validation Program Phases

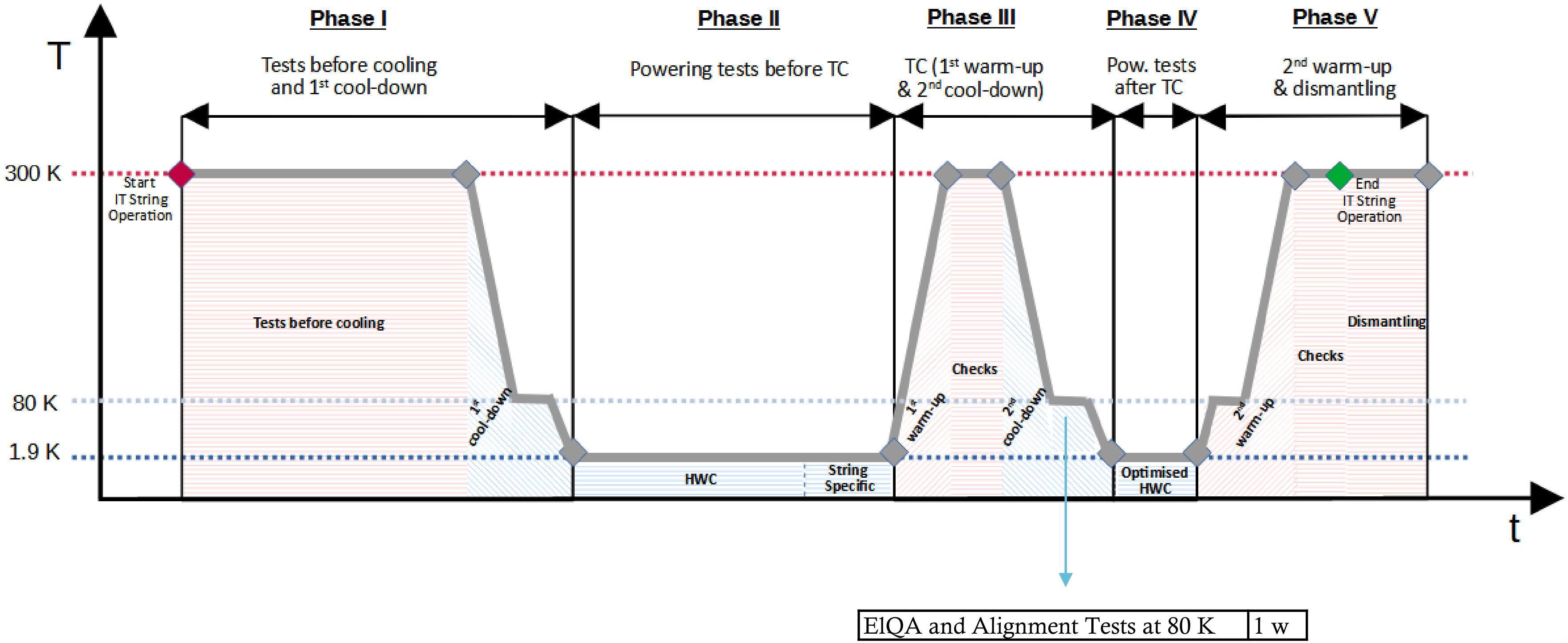


Bayonet Heat Exchanger Test	1 w
Cross Talk Studies	4 w
Operation Powering Cycles and Noise Measurements	3 w
Flux Jump Measurements	3 w
Powering Cycle Endurance Test	3 w
Powering beyond Nominal (Place Holder)	3 w

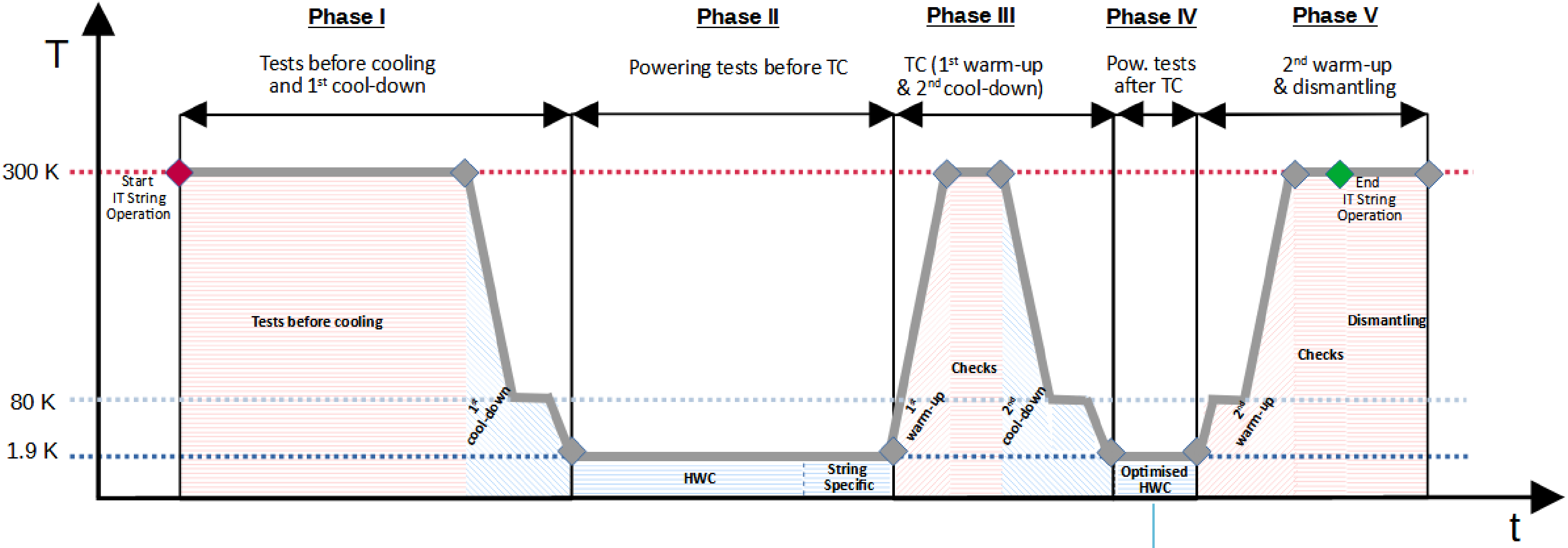
String Validation Program Phases



String Validation Program Phases

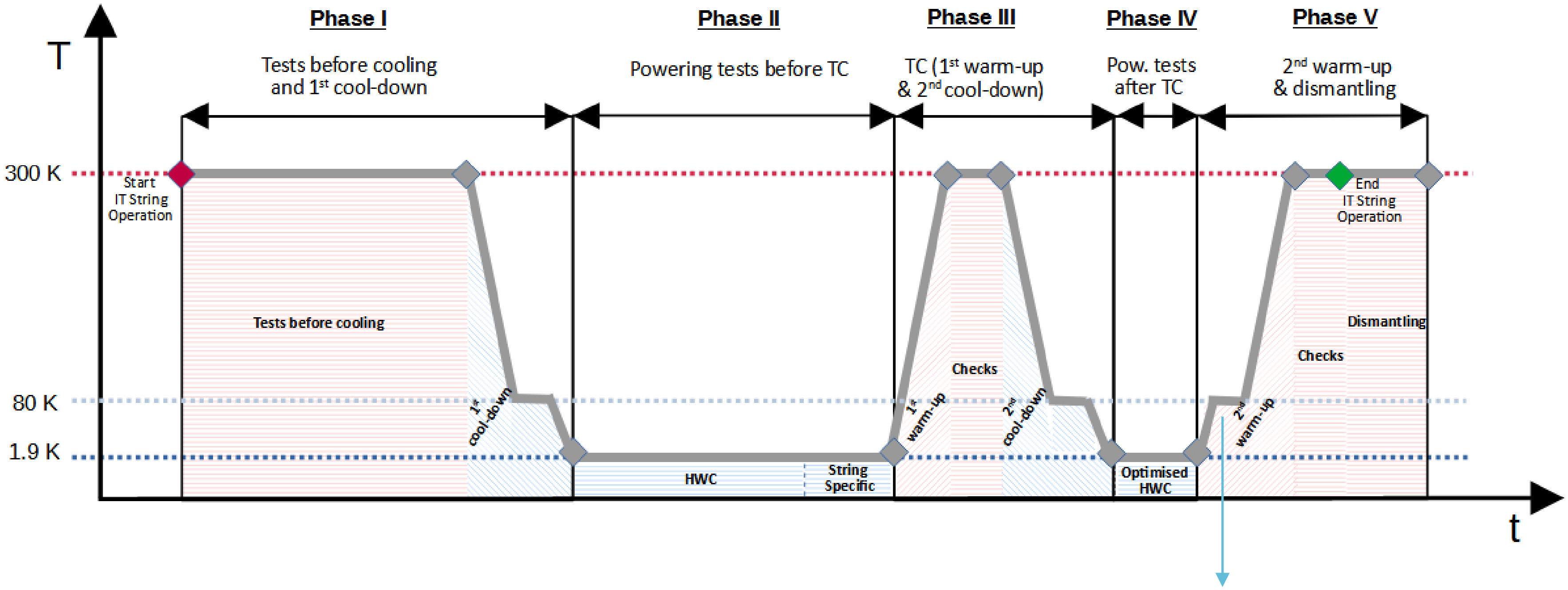


String Validation Program Phases



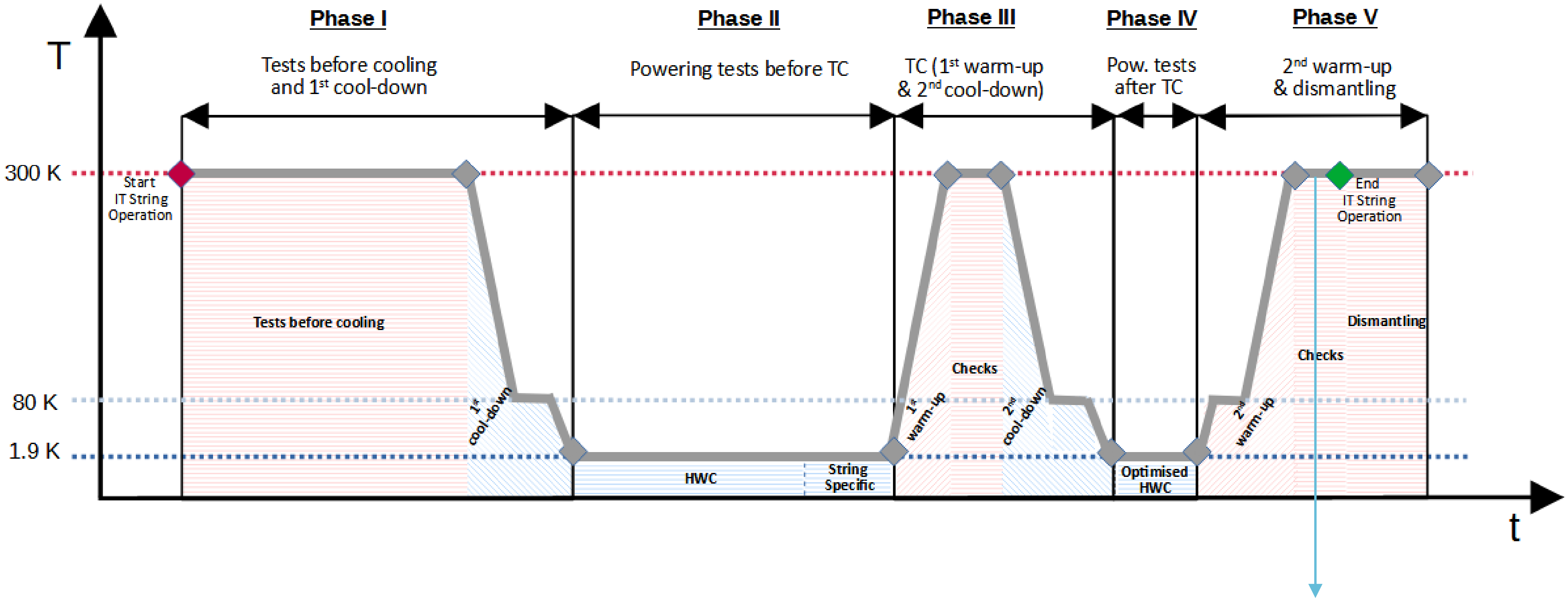
Protection System IST and PIC Tests at Zero Current (PIC1)	3 w
Powering Tests for 120A + 200A Circuits (I_{nom})	1 w
Powering Tests for RCBX -2 kA- Circuits (I_{nom})	1 w
Powering Tests for RD1 -14 kA- Circuit (I_{nom})	1 w
Powering Tests for RQX -18 kA- Circuit (I_{nom})	4 w
Powering of Grouped Circuits	1 w
Final ELQA Tests at Nominal Conditions	1 w

String Validation Program Phases



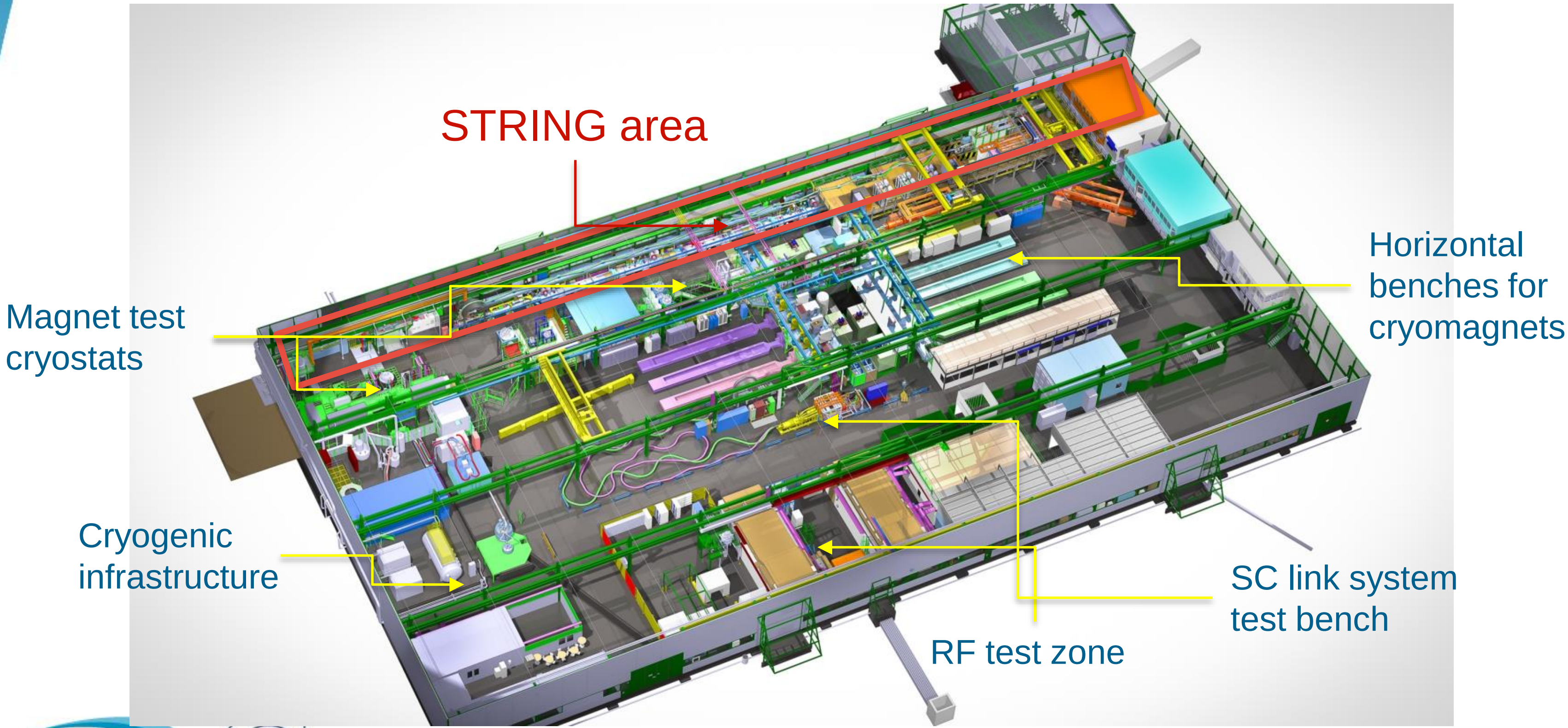
ElQA and Alignment Tests at 80 K	1 w

String Validation Program Phases



ElQA and Alignment Tests at Room Temperature	1 w

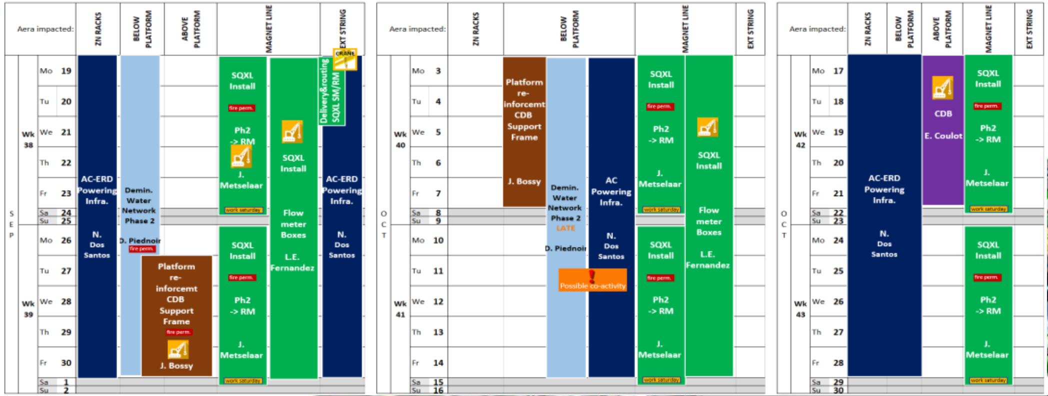
HL-LHC IT STRING in the SM18: activity planification

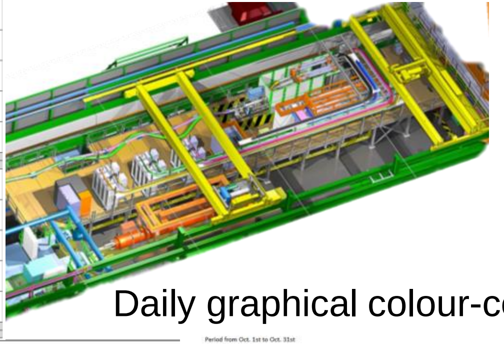


Integration work by A. Kosmicki

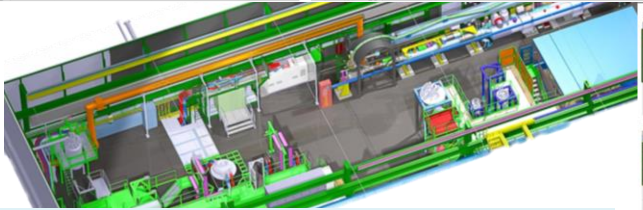
HL-LHC IT STRING in the SM18: activity planification

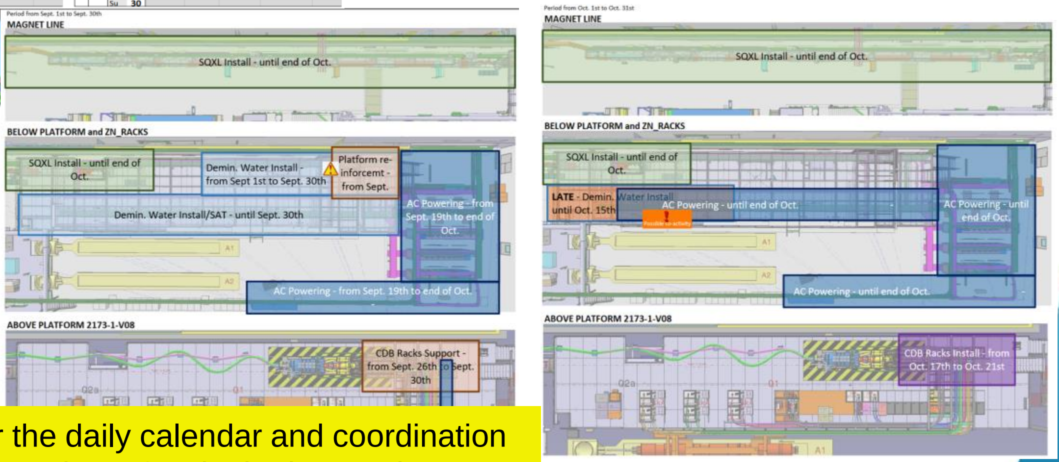
Short-term planning: daily calendar by zones





Daily graphical colour-coded calendar





See talk of
D. Bozzini @11h50 on Thursday
Safety considerations for the HL-LHC IT String

https://string-sm18.web.cern.ch/

Special thanks for S. Blanchard for the daily calendar and coordination work in Sm18; for D. Bozzini to insure the safety in the installation.

Component responsibilities and impact on the schedule

WP16 team do not master the delivery

Re -usable in the HL-LHC (prototypes/ pre-series)

Responsibility of OTHER WPs or Groups
- Magnets
- Cold powering
- Power Converters
- Magnet Protection
- Quench detection
- Machine Interlock
- Alignement system
- Disconnector Boxes

Component responsibility in the HL-LHC IT STRING

WP16 team master the delivery times

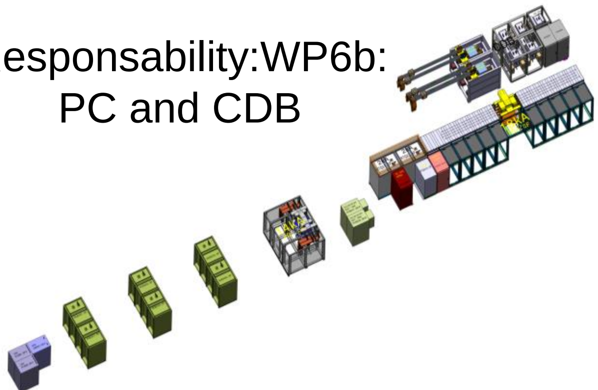
Responsability of WP16
- Water Cooled Cables
- Metallic Structure
- Control Cabling
- AC Powering
- Control Room
- Cryogenic system
- Demineralised Water distribution
- Handling infrastructure

STRING specific

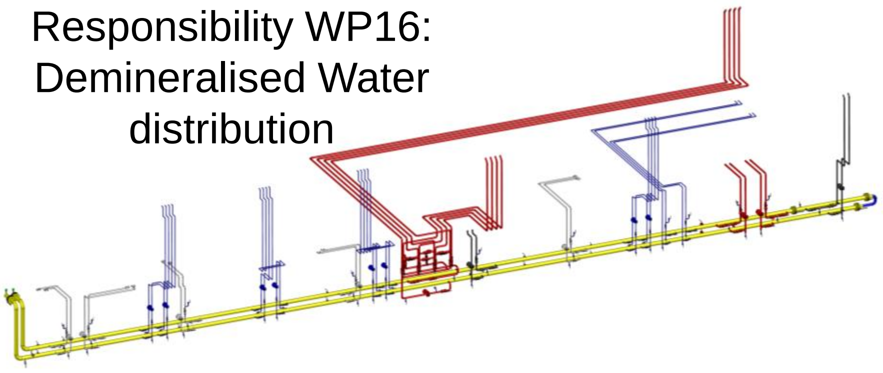
QA/QC
- ELQA
- Leak detection
- Alignment
- Any other method

As in HL-LHC

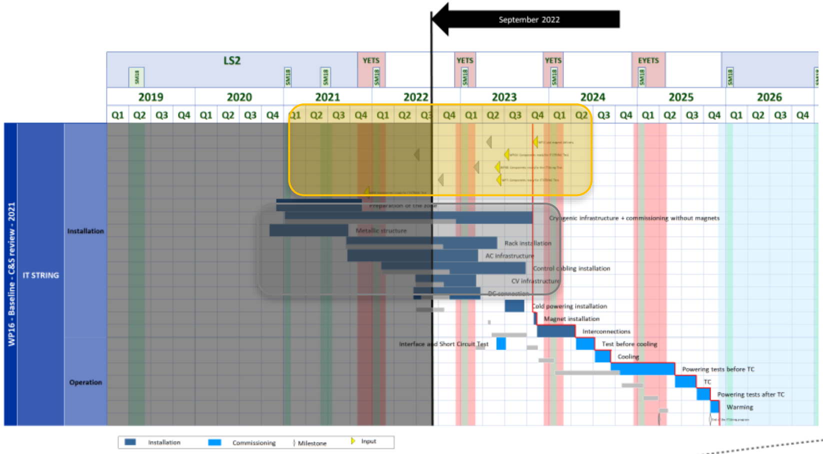
Responsability:WP6b: PC and CDB



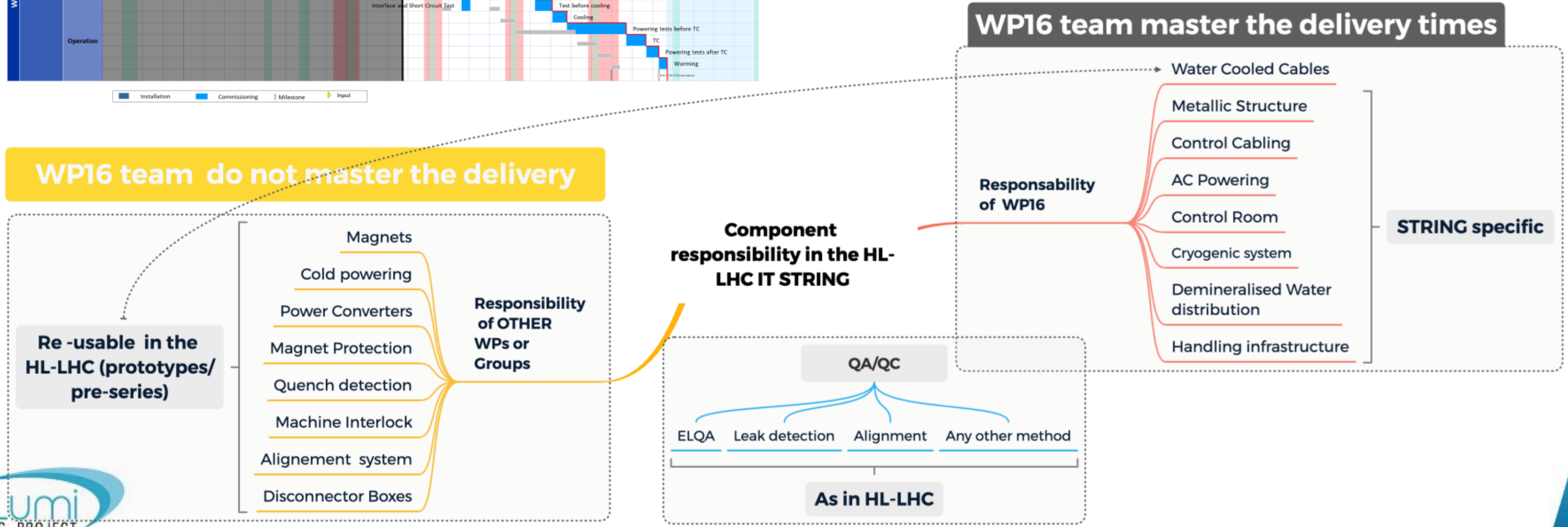
Responsibility WP16: Demineralised Water distribution



Component responsibilities and impact on the schedule

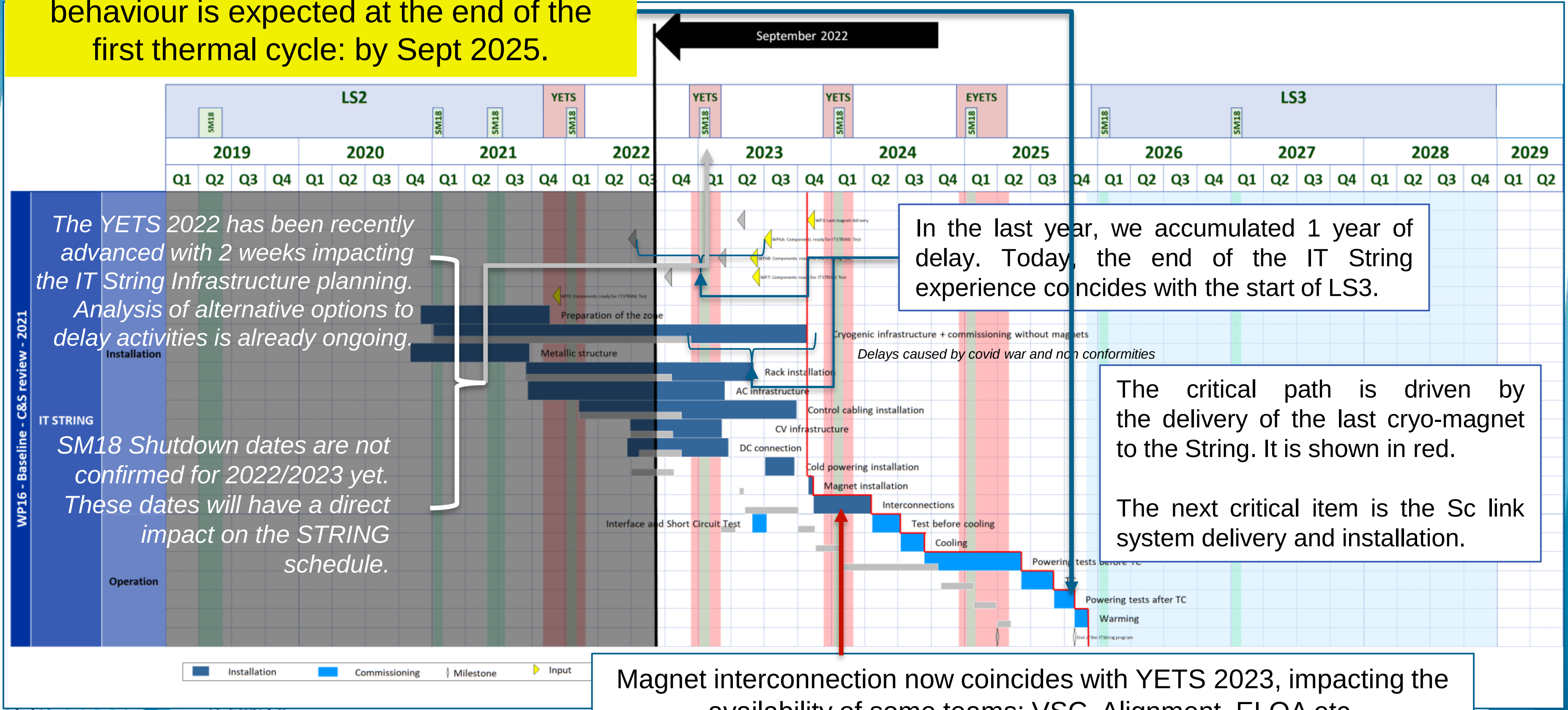


The interfaces fall the responsibility of the WPs. The String - being an early activity mirroring the installation of the HL-HLC - facilitates the discovery of grey zones (ex. GMS).



Schedule

The first important results on the collective behaviour is expected at the end of the first thermal cycle: by Sept 2025.



The YETS 2022 has been recently advanced with 2 weeks impacting the IT String Infrastructure planning. Analysis of alternative options to delay activities is already ongoing.

SM18 Shutdown dates are not confirmed for 2022/2023 yet. These dates will have a direct impact on the STRING schedule.

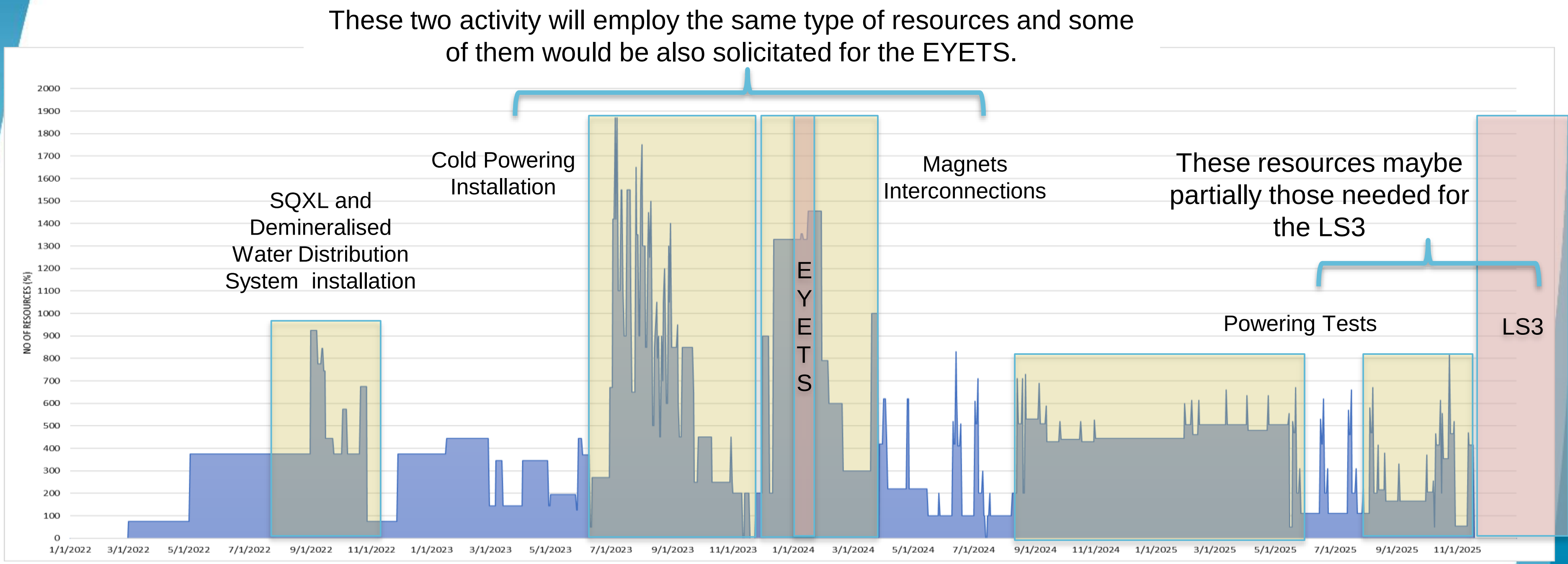
In the last year, we accumulated 1 year of delay. Today, the end of the IT String experience coincides with the start of LS3.

The critical path is driven by the delivery of the last cryo-magnet to the String. It is shown in red.

The next critical item is the Sc link system delivery and installation.

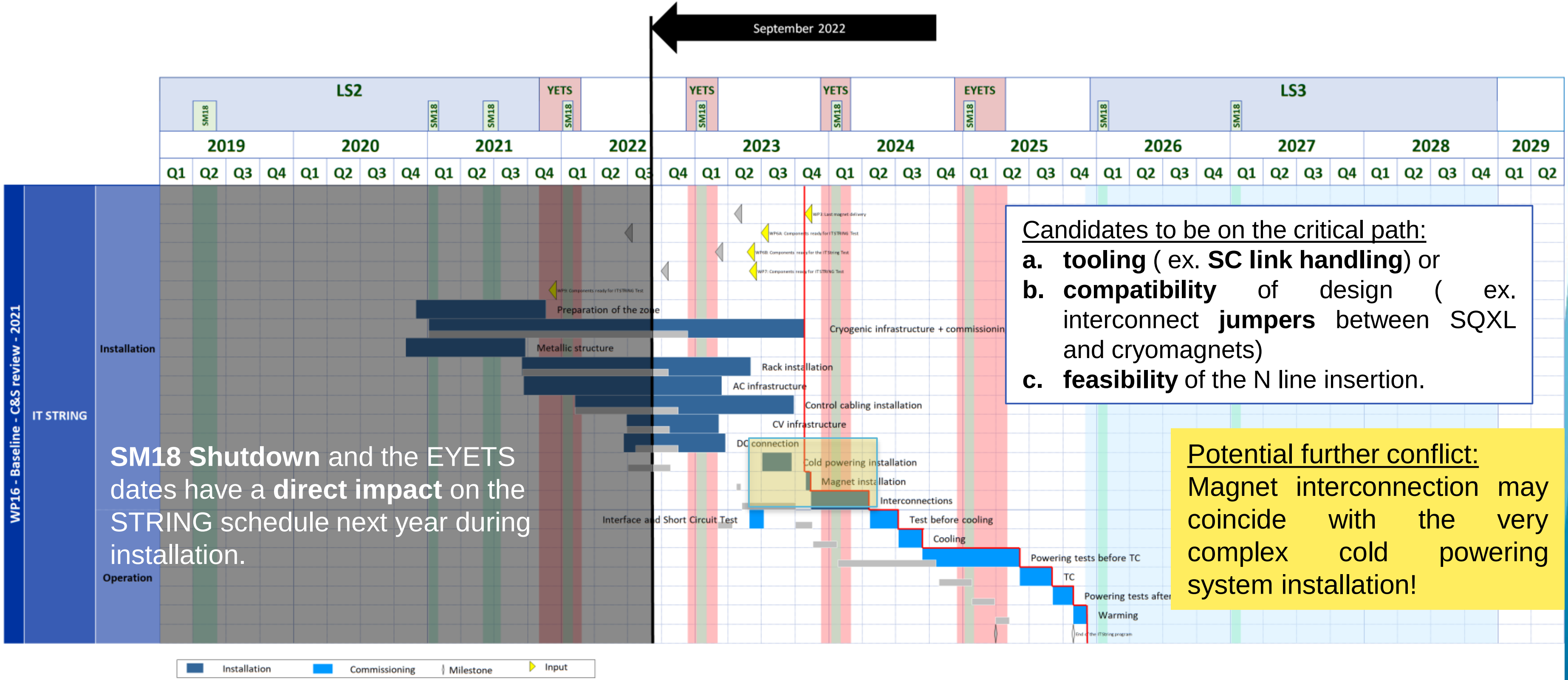
Magnet interconnection now coincides with YETS 2023, impacting the availability of some teams: VSC, Alignment, ELQA etc.

Resources & resource distribution in time



Particular thanks for N. Heredia Garcia and E. Vergara for input to this presentation specifically for the schedule and resource loaded planning + related tools preparation.

Potential candidates for the critical path and further conflicts



SM18 Shutdown and the EYETS dates have a **direct impact** on the STRING schedule next year during installation.

Candidates to be on the critical path:

a. **tooling** (ex. **SC link handling**) or
b. **compatibility** of design (ex. interconnect **jumpers** between SQXL and cryomagnets)
c. **feasibility** of the N line insertion.

Potential further conflict:

Magnet interconnection may coincide with the very complex cold powering system installation!

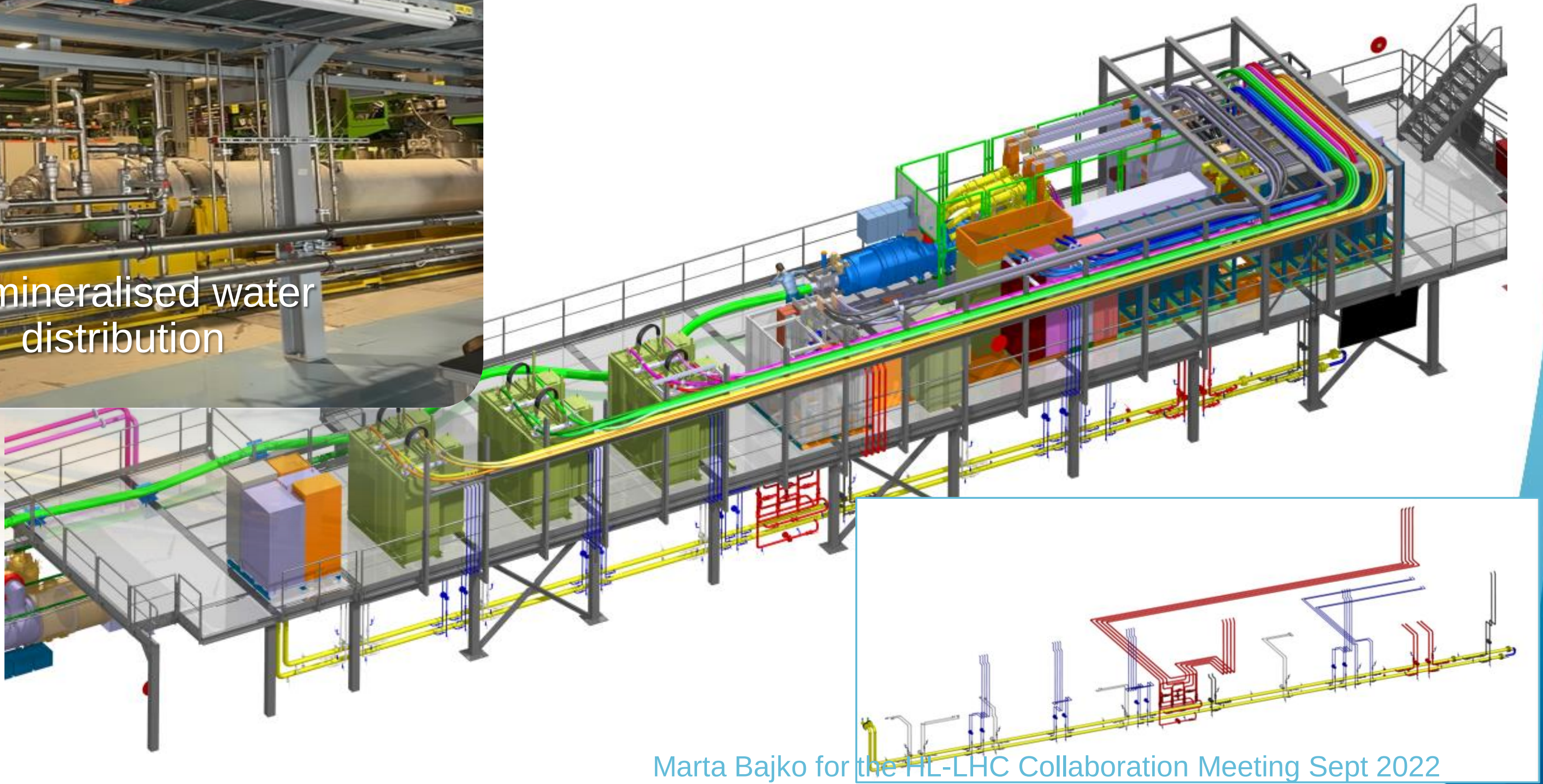
Status in pictures

Status in pictures

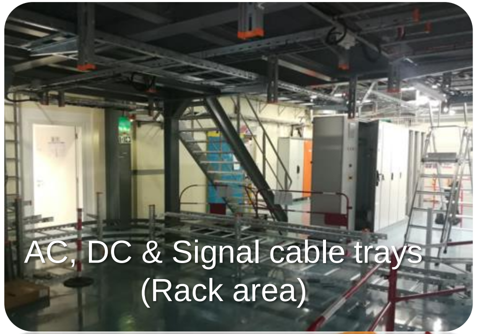
Status in pictures

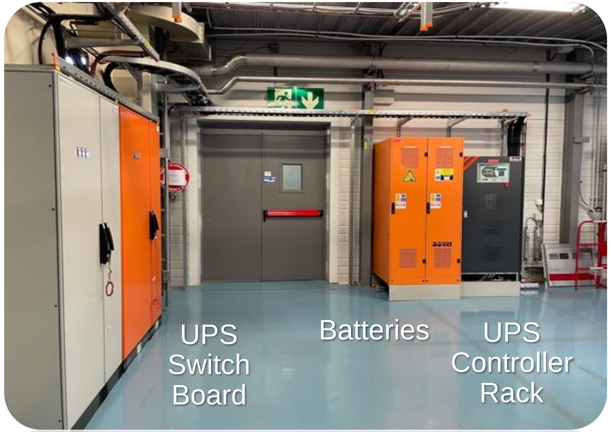
See talk of A. Perin @10h30 on Thursday
Status of the cryogenics system of the HL-LHC IT String

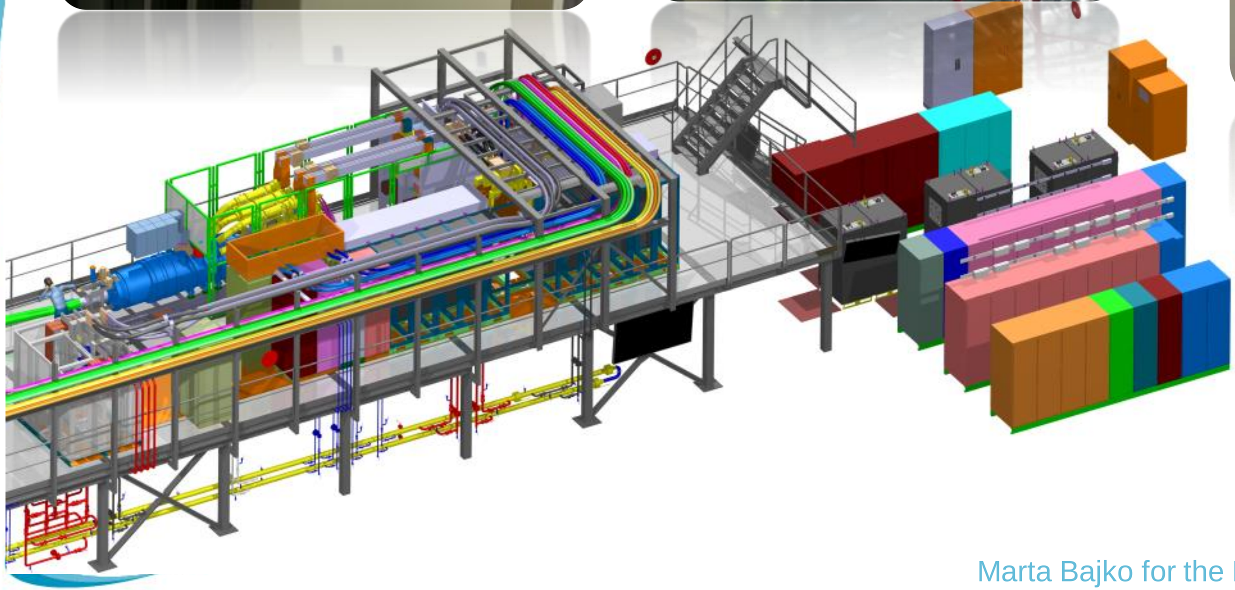
Status in pictures



Status in pictures







Status In pictures

We are ready to perform the IT STRING Validation Program.
Control layers strategy is made and work is planned for 2023.

Summary

1. **INTEGRATION**- and **INFRASTRUCTURE** are well-advanced. At this stage change in dimensions of objects have a large repercussion on schedule.
2. **VALIDATION PROGRAM** has been set up and approved ; test procedures are under revision. While writing the HWC procedures for STRING, we prepare the work for the HWC of the HL-LHC itself.
3. Gymnastics are needed to adjust to **SCHEDULE CHANGES** (e.g.:. Sc link installation first then the converters- or vice versa; changes of SM18 shutdown schedule affecting the CRG equipment HWC) and to avoid (E)YETS or other possible co-activities (e.g.. delay in magnet delivery implying the coactivity with YETS and thus maybe a lack of personnel for QC as VSC and ElQA). Unfortunately we continue accumulating important delays from major components that already define the critical path. In todays Master Plan, the ***STRING program will end at the beginning of the LS3 with a very first feed back on the collective behavior is expected for September 2025.***
4. **INSTALLATION SEQUENCE** definition with the required QA/QC has been started in dedicated regular meetings since May. This is our most important work right now: after the summer we made important advancements. The new information-both in sequence, time and in resources - are introduced step by step into the IT STRING planning implying the risk of further delays as we still need to analyze. Handling tools to be still designed maybe also on the critical path.
5. The **COACTIVITY IN SM18** is quite important. Major component installation In parallel maybe not possible; The annual SM18 cryogenic shut down will have a direct impact on the planning of the STRING from early 2023.
6. **DISMANTELING** of the STRING is not yet completed; we just watch out for spare components needed to be recovered for the installation of the machine itself. PCs of 2kA are expected to be needed the most quickly; dismantling planned for March 2026.

HL-LHC IT String Infrastructure team

General Integration: Antoine Kosmicki, Alparslan Tursun (EN-ACE), Philippe Orlandi (EN-EL)
Civil Engineering: Alejandro Martinez Selles, Wolfgang Bastien (SCE)
AC Powering: Nuno Dos Santos, Mathieu Rigollet (EN-EL)
Control Cables: Gael Girardot (EN-EL)
DC Cables: Matheus Silva (EN-EL)
IT Infrastructure: Maryse Da Costa (IT-CS)
CV infrastructure: Francesco Dragoni, Dominique Piednoir (EN-CV)
Cryogenic infrastructure: Gabriella Rolando, Jeremy Mouleyre, Jos Metselaar, Andrew Lees, Luis Fernandez, Benoit D'Hulster (TE-CRG)
Transport: Serge Pelletier, Erik Richards, Antonio Jorge-Costa (EN-HE)
Design and drawing: Robin Betemps, Oussama Id Bahmane, Hector Perez (EN-MME)
Alignment: Andreas Herty, Jean-Frederic Fuchs, Kacper Widuch (BE-GM)
Mechanical works: Jordi Bossy, Pascal Catherine (EN-ACE)
Control HW infrastructure: Benjamin Ninet (BE-CEM), Enzo Genuardi (BE-CSS)
…

HL-LHC IT String Validation Program team

Work Packages	WP Leader	DWP Leader	GL	SVPM Members
WP2/BE-ABP	Rogelio Tomas Garcia	Elias Metral	Yannis Papaphilippou	Davide Gamba
WP3/TE-MSC	Ezio Todesco	Delio Duarte Ramos	Arnaud Devred	Ezio Todesco and Sandrine Le Naour
WP6a/TE-MSC	Amalia Ballarino	Paul Cruikshank	Arnaud Devred	Amalia Ballarino, Paul Cruikshank and Jerome Fleiter
WP6b/SY-EPC	Michele Martino	Valerie Montabonnet	Valerie Montabonnet	Louis de Mallac, Hugues Thiesen and Shruti Seshadri
WP7/TE-MPE	Daniel Wollmann	Reiner Denz	Felix Rodriguez Mateos	Daniel Wollmann and Jens Steckert
WP9/TE-CRG	Serge Claudet	Antonio Perin	Dimitri Delikaris	Antonio Perin and Gabriella Rolando
WP12/TE-VSC	Vincent Baglin	Giuseppe Bregliozzi	Paolo Chiggiato	Willemjan Maan
WP15/BE-GM	Paolo Fessia	Michele Modena	Helene Mainaud Durand	Michele Modena and Andreas Herty
WP16 (HWC)	Marta Bajko - Mirko Pojer		Felix Rodriguez Mateos	Marta Bajko and Mirko Pojer
WP18	Javier Serrano	Greg Daniluk	Alessandro Masi	Greg Daniluk and Odd Oyvind Andreassen

- A. Verweij, E. Ravaioli for MP3
- M. Giovannozzi, Riccardo De Maria for WGA
- M. Zerlauth for the Project Office
- S. Blanchard for IT String Installation
- D. Bozzini for IT String Safety Coordinator
- J. Zawilinski for IT String Tools Coordinator

- M. Guinchard for Mechanical TF Measurements
- M. Jakub Bednarek for ElQA tests
- S. Yammine (Chair)
- N. Heredia Garcia (Scientific Secretary)
- Others for specific topics (software, control layers, protection equipment, etc.)

Thank you very much for your attention

String Day 2-15th of September

https://indico.cern.ch/event/1183794/timetable/