



# HL-LHC industrialization and procurement

## Lessons learnt

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HL-LHC Sourcing Officer

ICHEP 2018 - Seoul



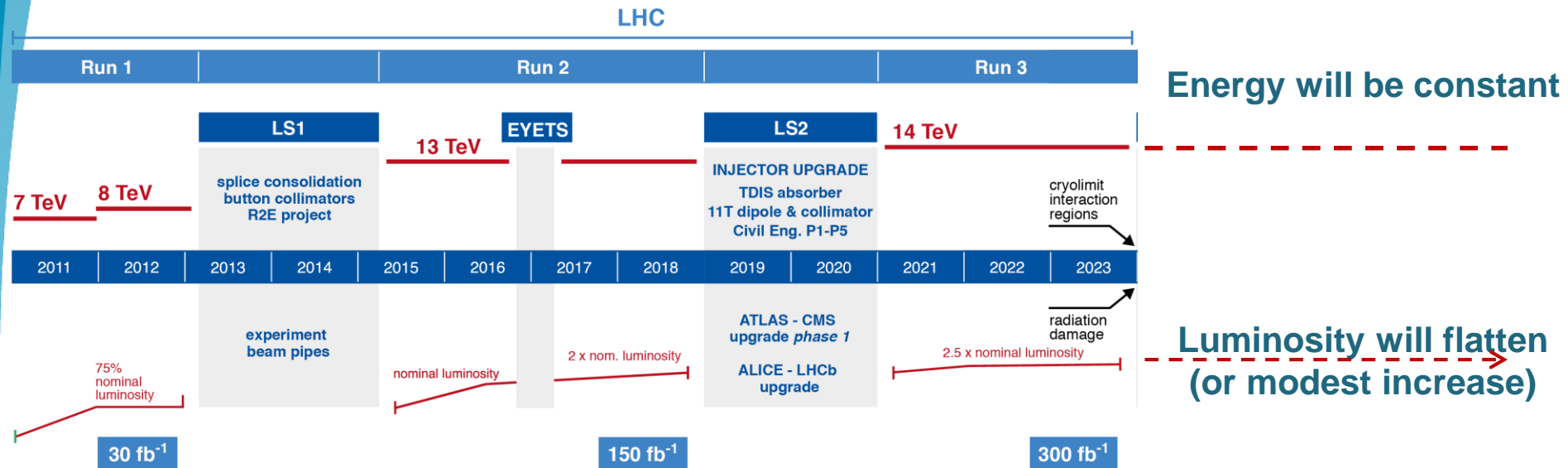
# The HL-LHC Project

Why, what, when & by whom?

# LHC Today: Energy and Luminosity Increase



## LHC / HL-LHC Plan

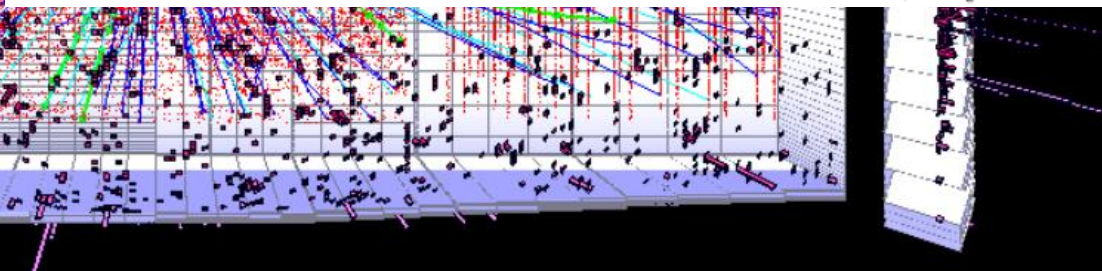
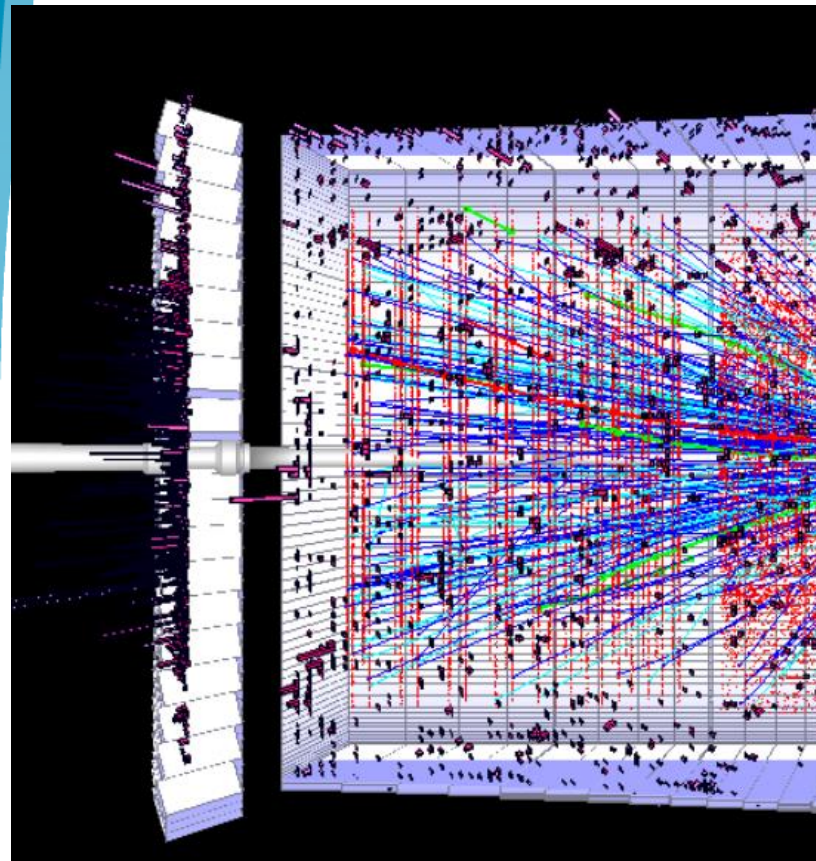
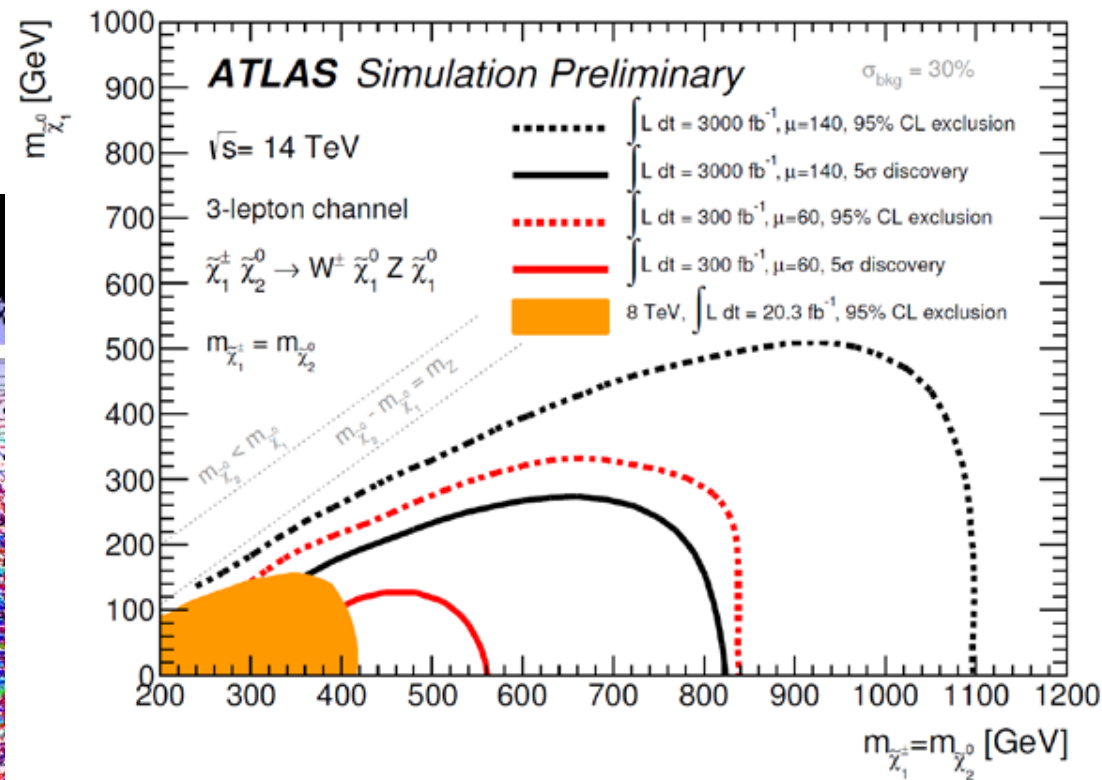


Around 2024 we need to change important parts of Collider and of Detectors Cryolimit LHC, Pile up ATLAS&CMS), Radiation limits (both LHC& Detectors), We need to use of «pit-stop» to improve the physics reach of LHC complex!

To keep it attractive for our partners and exploit at best the LHC investment!



# More Luminosity, more physics



# Goal of High Luminosity LHC (HL-LHC) as fixed in November 2010

From FP7 HiLumi LHC Design Study application

The main objective of HiLumi LHC Design Study is to determine a hardware configuration and a set of beam parameters that will allow the LHC to reach the following targets:

A peak luminosity of  $L_{\text{peak}} = 5 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$  **with levelling**, allowing:

An integrated luminosity of **250 fb<sup>-1</sup> per year**, enabling the goal of  $L_{\text{int}} = 3000 \text{ fb}^{-1}$  twelve years after the upgrade.

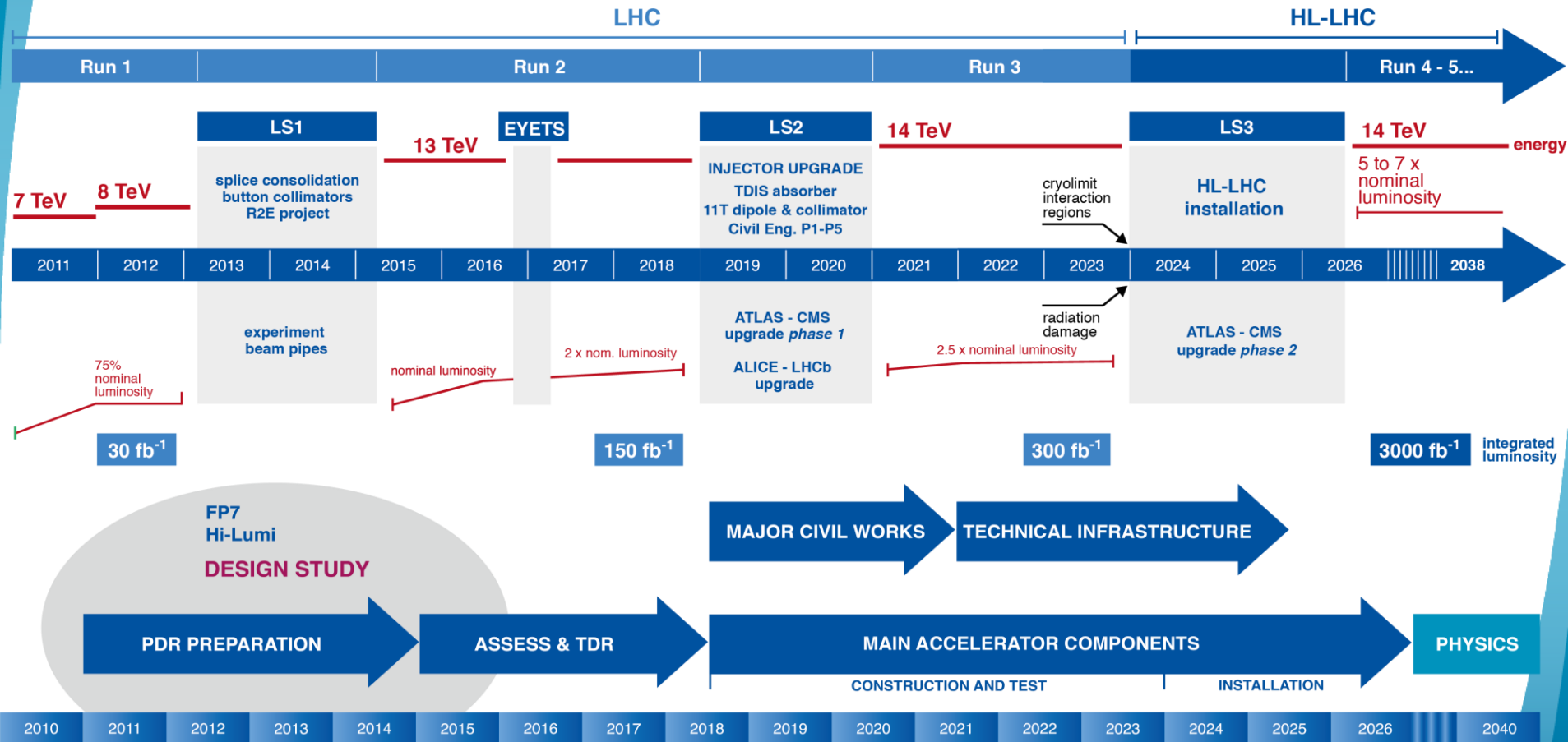
This luminosity is more than ten times the luminosity reach of the first 10 years of the LHC lifetime.

**Ultimate** performance established 2015-2016: with same hardware and same beam parameters: use of **engineering margins**:

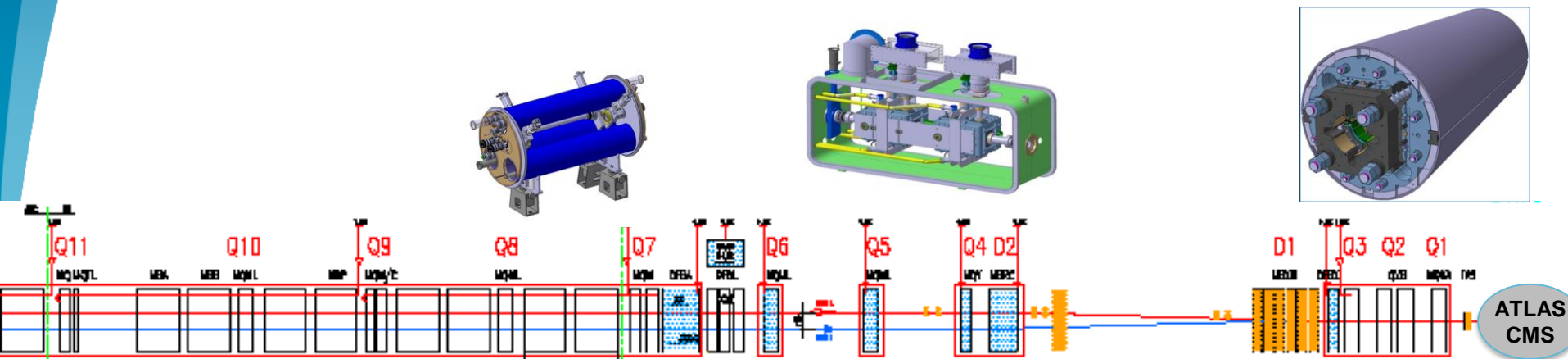
$L_{\text{peak ult}} \cong 7.5 \cdot 10^{34} \text{ cm}^{-2}\text{s}^{-1}$  and **Ultimate Integrated**  $L_{\text{int ult}} \sim 4000 \text{ fb}^{-1}$   
LHC should not be the limit, would Physics require more...

# Our roadmap

## LHC / HL-LHC Plan



# The largest HEP accelerator in construction



## Dispersion Suppressor (DS) in P7

### Modifications

1. In IP2: new DS collim. in C.Cryost.
2. In IP7 new DS collimation with 11 T

Cryogenics, Protection, Interface, Vacuum, Diagnostics, Inj/Extr... extension of infrastr.

## Matching Section (MS)

### Change/new lay-out

1. TAXN
2. D2
3. CC
4. Q4
5. Correctors
6. Q5
7. Q5@1.9K in P6
8. New collimators

## Interaction Region (ITR)

### Complete change and new lay-out

1. TAXS
2. Q1-Q2a-Q2b-Q3
3. D1
4. All Correctors Magnets
5. Heavy shielding (W)

> 1.2 km of LHC !!

# Global collaboration



BNL

Brookhaven National Laboratory



CEA

Commissariat à l'Énergie Atomique



CIEMAT

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas



CERN

Conseil Européen pour la Recherche Nucléaire



CI

Cockcroft Institute



SOTON

University of Southampton



UNIUPP

Uppsala University



USDOE

United States Department of Energy



STFC

Science & Technology Facilities Council



FNAL

Fermilab



INFN

Istituto Nazionale Fisica Nucleare



KEK

KEK Japan



ULAN

University of Lancaster



LBLN

Lawrence Berkeley National Laboratory



UNILIV

University of Liverpool



UNIMAN

University of Manchester



RHUL

Royal Holloway University



SLAC

National Accelerator Laboratory



BINP

Budker Institute of Nuclear Physics



UDUN

University of Dundee



EPFL

École Polytechnique Fédérale De Lausanne



UHUD

University of Huddersfield



IHEP

Institute of High Energy Physics



JLAB

Jefferson Lab



JINR

Joint Institute for Nuclear Research



LAPIN AMK

Lapland University of Applied Sciences



NCBJ

National Centre for Nuclear Research



ODU

Old Dominion University



TRIUMF



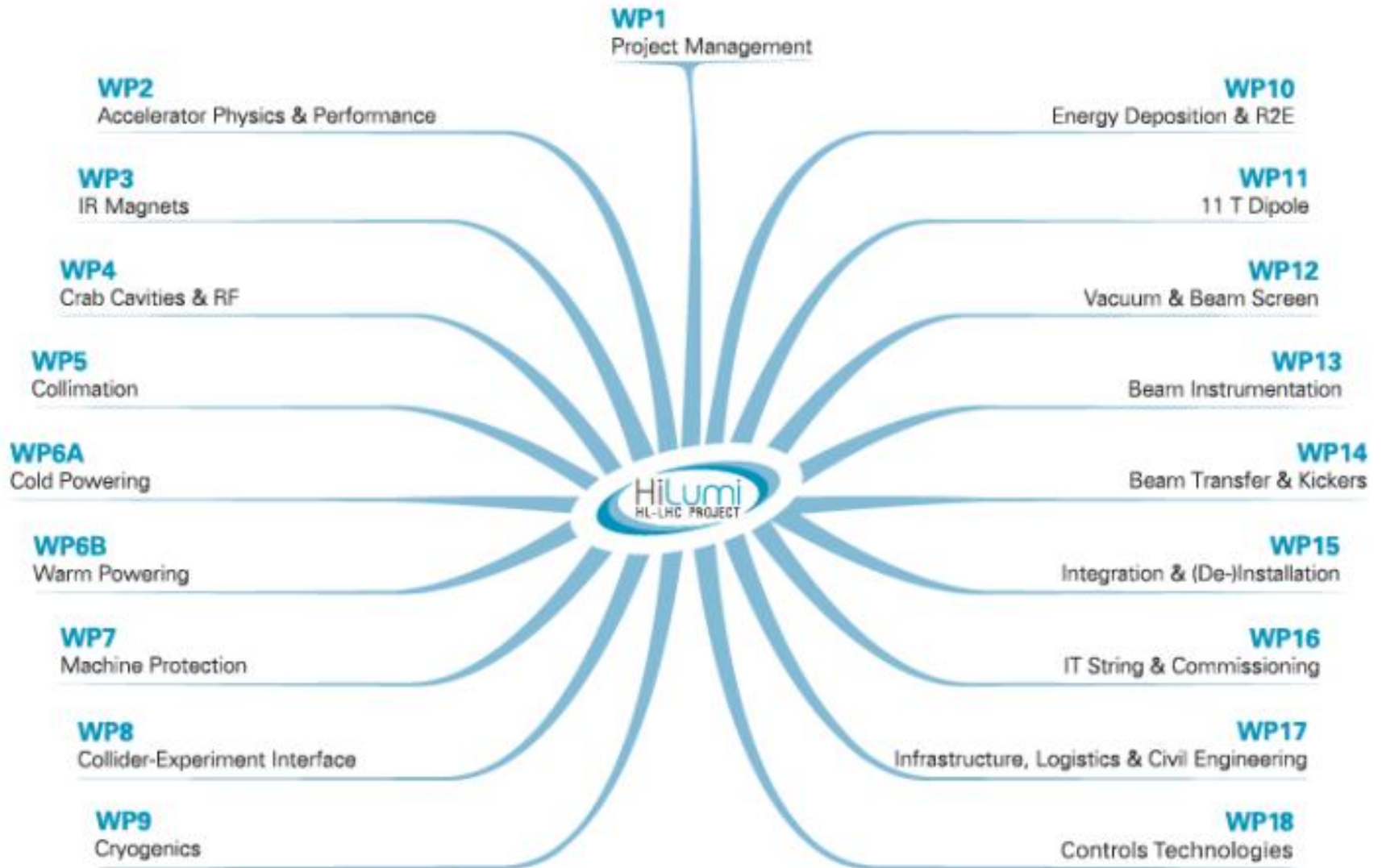
Isabel Bejar Alonso - HL-LHC Sourcing Officer



# The HL-LHC Project

Organization, technology & cost

# Project structure



# Technology driven



**CIVIL ENGINEERING**  
2 new caverns and two new 300-metre service galleries, two new large shafts;  
10 new technical buildings on surface in P1 and P5 (ATLAS and CMS)



**"CRAB" CAVITIES**  
8 superconducting "crab" cavities for each of the ATLAS and CMS experiments to tilt the beams before collisions.

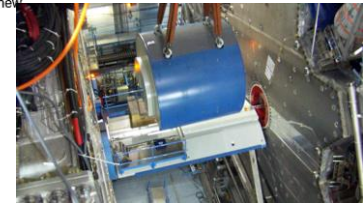
**LHC TUNNEL**



**BENDING MAGNETS**  
2 pairs of shorter and more powerful dipole bending magnets to free up space for the new collimators.



**FOCUSING MAGNETS**  
12 more powerful quadrupole magnets for each of the ATLAS and CMS experiments, designed to increase the concentration of the beams before collisions.



**CRYOGENICS**  
2 new large 1.9 K helium refrigerators for HL-LHC near ATLAS and CMS

ALICE

ATLAS

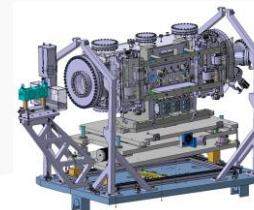
LHCb



**COLLIMATORS**  
10 new collimators and 60 replacement collimators to reinforce machine protection.



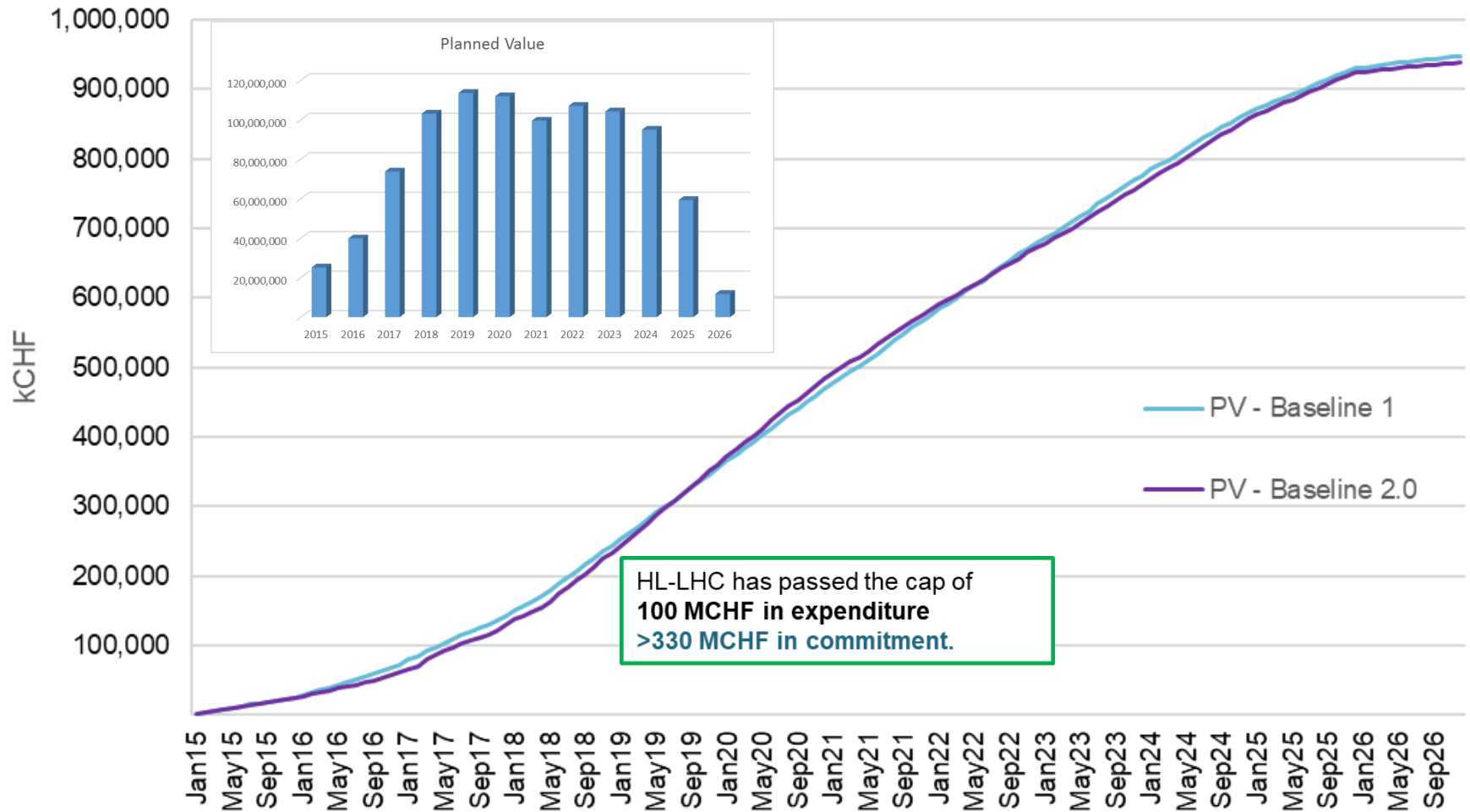
**SUPERCONDUCTING LINKS**  
Electrical transmission lines based on a high-temperature superconductor to carry current to the magnets from the new service galleries to the LHC tunnel.



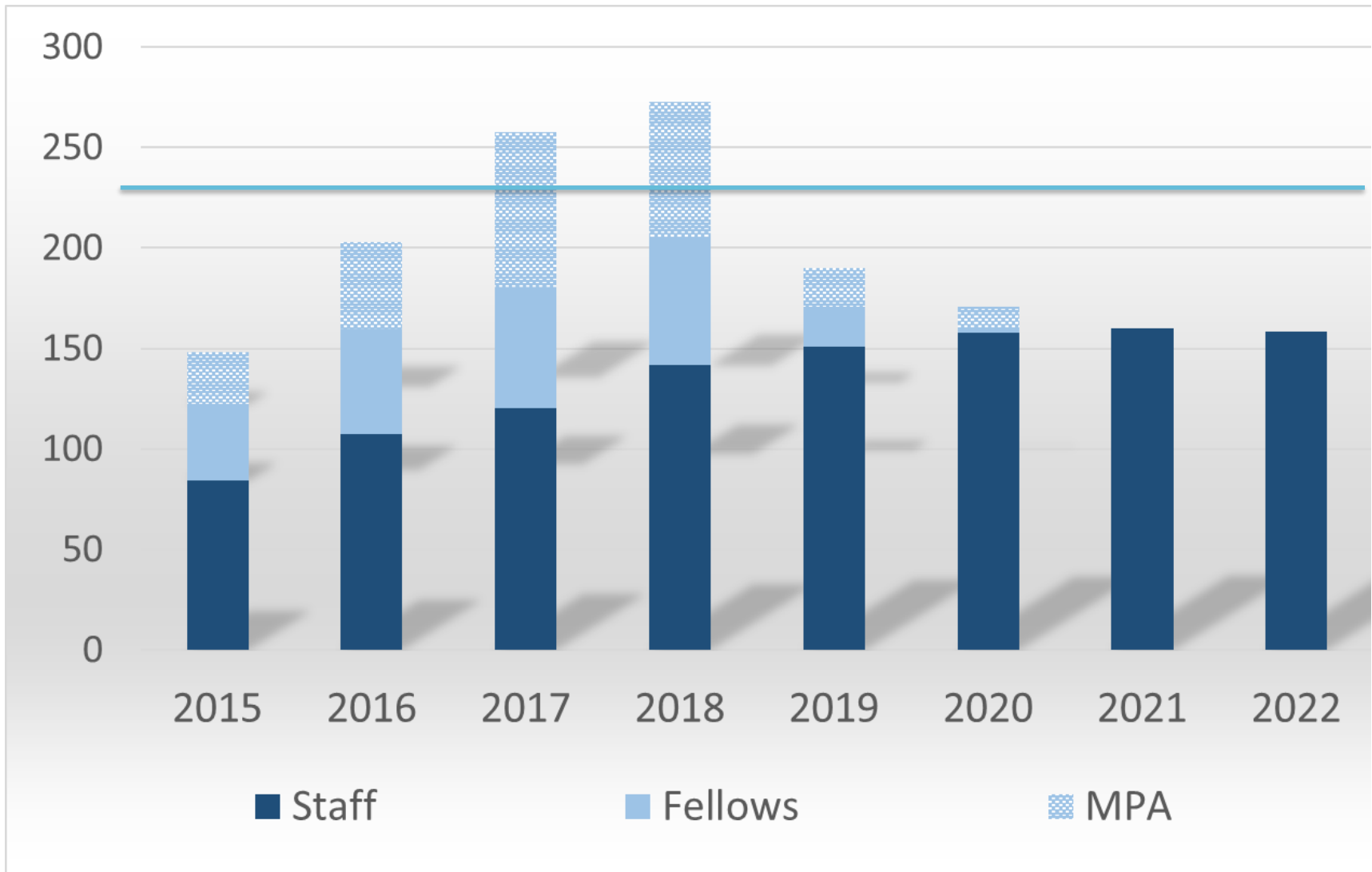
Isabel Bejar Alonso - HL-LHC Sourcing Officer



# COST: 950 MCHF for material



# Man Power



# The HL-LHC Project

## Main challenges

# Challenges

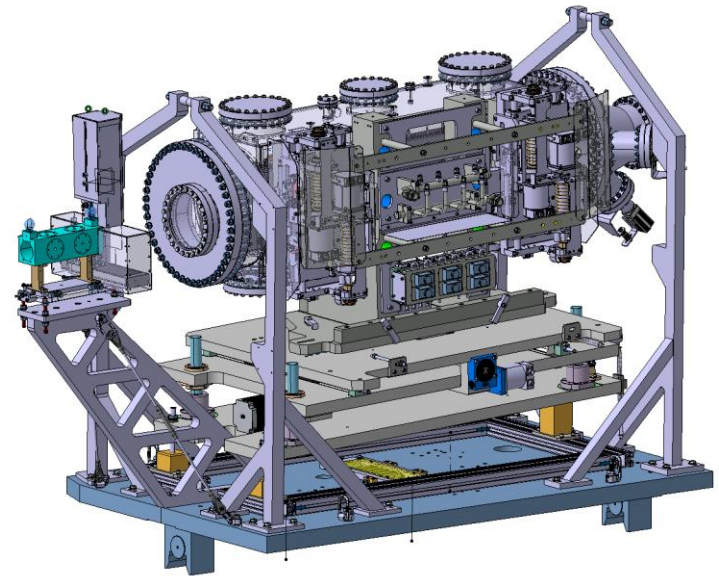
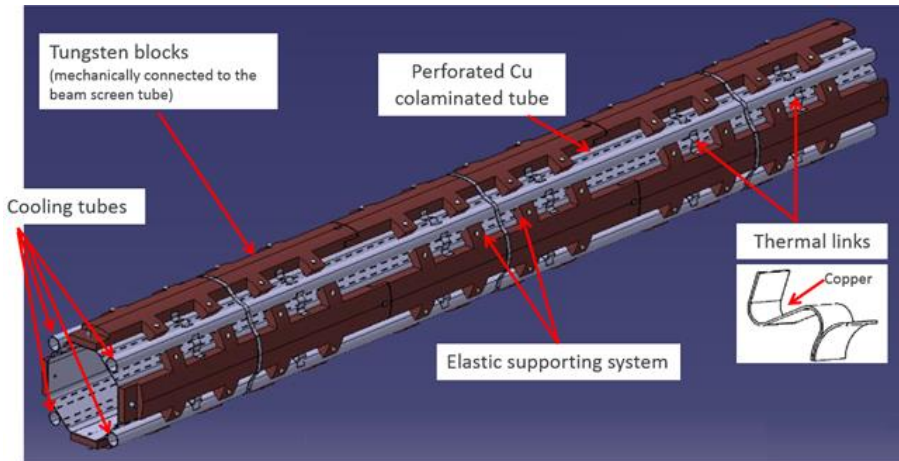
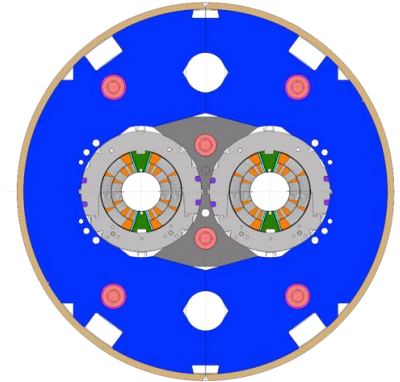
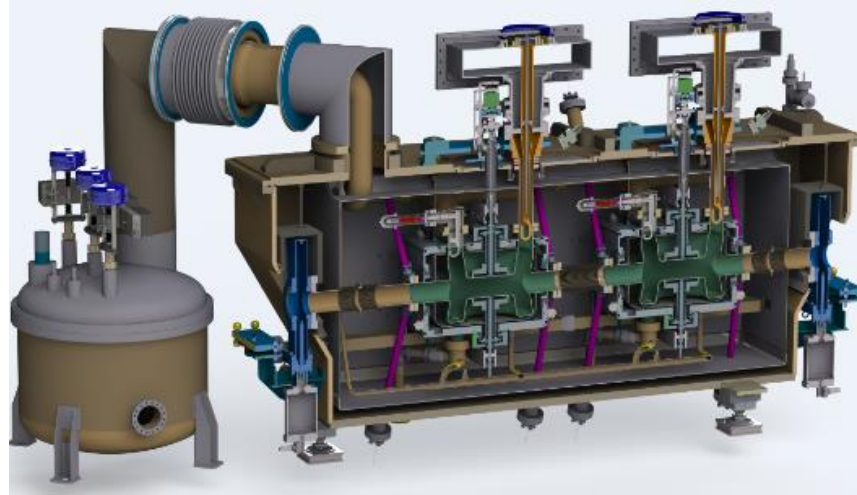
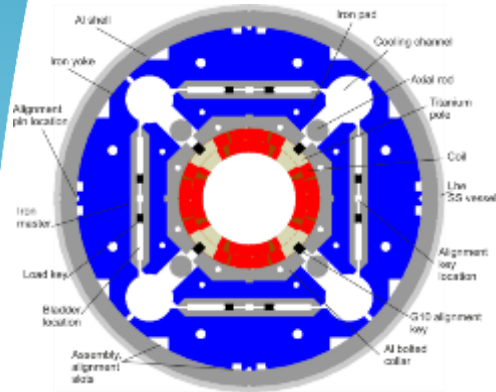
- Less than 6 years from concept to prototype
  - Magnets in Nb<sub>3</sub>Sn
  - Crab cavities for protons
  - Links on MgB<sub>2</sub>
  - New materials for collimators ...
- Extremely short series. Tens and not hundreds or thousands of identical components, consequently, lack of interest from industry
- Massive in-kind contributions some for subassemblies with interfaces and interlinked schedules
- Less than 10% of the personnel will work for the full length of the project

# The working axis

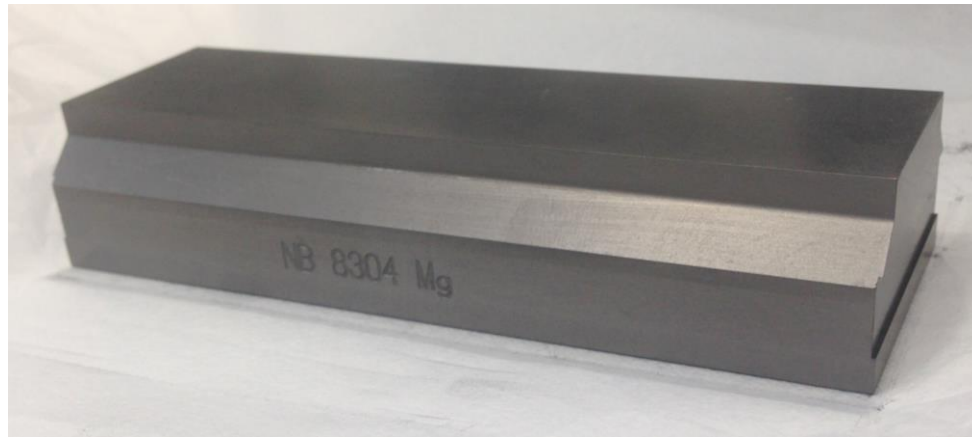
- Integration of several research teams with competitive designs
- Involvement of the industry from the earliest moment for the most critical materials/components
- Strong motivation campaigns with industry (general and national)
- Make or buy process
- Refurbishment of infrastructures and tooling to cope with in house production in case of failure to produce in industry or to make steps not possible in the industry
- Search for double production lines for all components that could be in the critical path
- Documentation handling structured and imposed for design and manufacturing independently of the origin of the supply
- Enlargement of programs to obtained skilled engineers and technician from partner labs and universities



# Design & prototypes: Competition - Cooperation



# Industry – Early involvement



# Motivation campaigns



**HL-LHC Industry**

Industry Relations and Procurement Website for the HL-LHC project

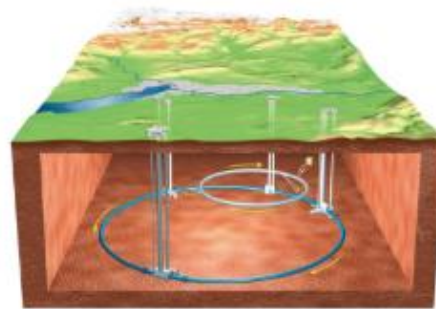
- Home
- General Info
- Procurement Overview
- Tendering
- Acquisition Timeline
- Events
- Contact

## Building the HL-LHC with the Industry

The HL-LHC Industry Website has been specially designed for all those firms that wish to participate in this ambitious project. We want to share all the relevant information related to the procurement that will be required to accomplish this major upgrade of the LHC.

The industry will have a crucial role and will be heavily involved within the HL-LHC Project since it will be the main source to provide the technologies and equipment that are required to successfully achieve the goals of this upgrade of the LHC.

The HL-LHC will collaborate with many types of industries and businesses to pursue its goals. Knowledge and technology to be developed during the HL-LHC project will make a lasting impact on society.



ILOS  
[ILOS Portal](#)

HIGHLIGHTS

12 June 2017

[BIG SCIENCE BUSINESS FORUM](#)

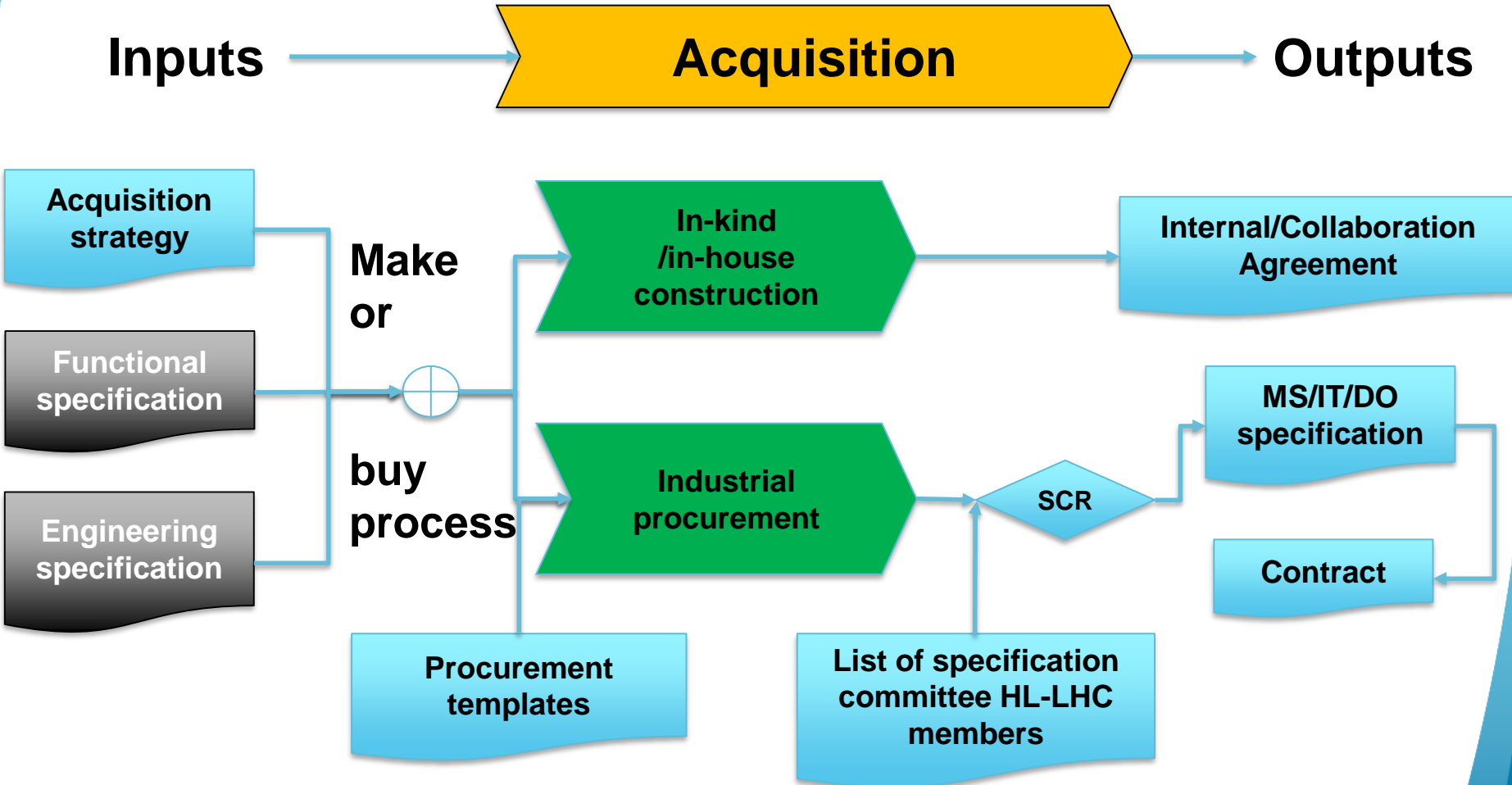
### Big Science Business Forum 2018

Big Science Business Forum 2018 will be the first one-stop-shop for European companies and other stakeholders to learn about Europe's Big Science organisations' future investments and procurements. CERN event will at this major event that will be held at Copenhagen on 27 and 28 February 2018.

[Read more](#)



# Make or buy?



## What and When

### MAKE OR BUY PLAN

Name	Engineering specification	Fabrication	Assembly	Verification	Installation	Commissioning
Warm Powering - 18kA Converters	CERN	New procurement contract	New procurement contract	CERN	CERN	CERN
Warm Powering - 13kA Converters	CERN	New procurement contract	New procurement contract	CERN	CERN	CERN
Warm Powering - 6kA Converters	CERN	New procurement contract	New procurement contract	CERN	CERN	CERN
Warm Powering - 4-quadrant converters	CERN	New procurement contract	New procurement contract	CERN	CERN	CERN
Warm Powering - Power converters - Measurement&controls	CERN	New procurement contract	New procurement contract	CERN	CERN	CERN

Mid 2018

### Looking for (short term)

- Potential suppliers from MS for DCCTs (Direct Current Current Transformers) – before end 2017

### Contacts & more info

[HL-LHC\\_Knowledge\\_and\\_Industry@cern.ch](mailto:HL-LHC_Knowledge_and_Industry@cern.ch)  
[WWW: HL-LHC Knowledge & Industry](http://WWW:HL-LHC_Knowledge_&_Industry)

Industry & Knowledge WP6B



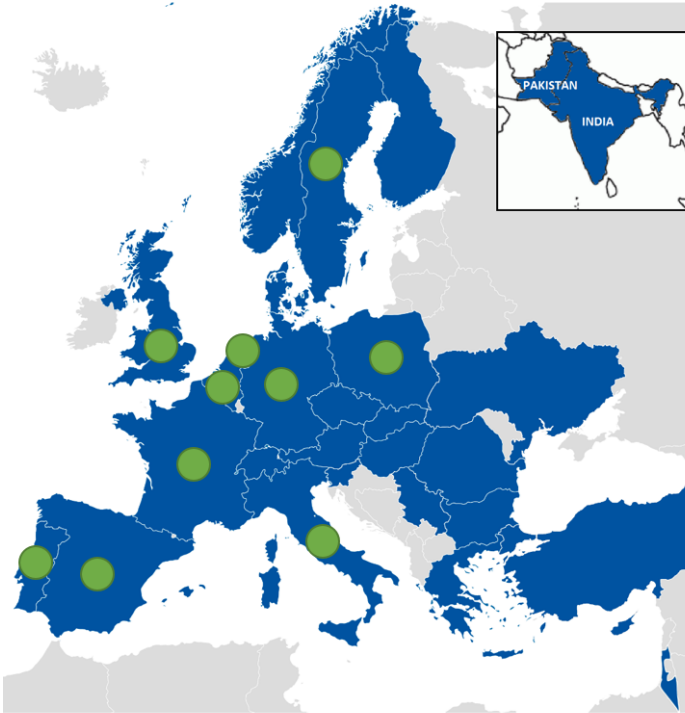
# Refurbishment of infrastructures



# Diversifying suppliers

## Domains of Activity

### Magnets Cryostat



## Presently identified as potential suppliers

MS	Firms	MS	Firms
AT		IT	SIMIC, Criotec, Zanon, Alca Tech, Fantini, CSC
BE	Amos, Ortman	NL	Cryoworld, Cryovat
BG		NO	
CZ		PK	
CH		PL	SFUP
CY		PT	Arsopi
DE	Raff+Grund, Butting, NTG, Pink	RO	
DK		RS	
ES	Cadinox, Vacuum Projects, Asturfeito, Nortemecanica	SE	Ornalp Unozon, Ekstroem
FI		SI	
FR	Allia	SK	
GR		TR	
HU		UA	
IL		UK	Metacraft
IN			

## Looking for...

- Metal works for cryostat manufacturing
- Suppliers of full cryostat or components as per CERN specifications and requirements (build)

## Identification of fields where we need suppliers

LIST OF FORESEEN DEPARTMENTAL REQUESTS (DRs) FOR THE NEXT TWO YEARS							
Item	Package Name	Work Package Reference	Detailed Description	Foreseen Cost Range	Foreseen Date for Purchasing Process	Domains Of Activity 1	Domains Of Activity 2 (if any)
1	Q2 Series - heat exchanger tube	WP03	Heat exchanger tube for the Q2 and for the 2nd prototype	50k-100k	May 18	Magnets components and assemblies	N/A
2	Q2 - strand for series	WP03	Strand for the manufacturing of the Q2 series Q2 magnets, P17 wire	c-750k	Jul-17	Electrical Equipment, electronics and instrumentation for accelerators	N/A
3	Q2 - strand for series	WP03	Strand for the manufacturing of the Q2 series Q2 magnets, RFP wire	c-750k	Jul-17	Electrical Equipment, electronics and instrumentation for accelerators	N/A
4	Q2 - strand for series	WP03	Strand for the manufacturing of the Q2 series Q2 magnets, RFP or P17 wire, not yet decided	c-750k	Dec-17	Electrical Equipment, electronics and instrumentation for accelerators	N/A
5	Q2-Q4 Connector series	WP03	A series of 4-rod connector magnets for Q4 and Q2 - 180-70 ribbon cable	c-750k	Jan-18	Magnets components and assemblies	N/A
6	46 Connectors	WP03	Series of 46 connectors, plus 9 spares, of 3 different type, based on 180-70 wire, superflex	c-750k	Jan-18	Magnets components and assemblies	N/A
7	MS2000 - Single Aperture Connector Package	WP03	Series of 46 long connectors (2.2 m long) plus 9 short connectors (0.2 m long) based on 180-70 ribbon cable	c-750k	Jan-18	Magnets components and assemblies	N/A
8	Q2 Series - Coil production	WP03	Fabrication of 2 coils and assembly in one CERN prototype. Fabrication of 40 series coils and assembly of 4 new magnets including procurement of tools for assembly and coil manufacturing. Insulated cable, and all coil and structure components provided by CERN	c-750k	Aug-18	Magnets components and assemblies	N/A
9	Q2 - Supporting Structure	WP03	Series of supporting structure for the new superconducting magnets (MS2000) including the yoke, load post and collar structure. CERN intends to place a contract for the supporting structure of the new superconducting magnets (MS2000), including the thick coils, load posts and yokes. The coils are 20 mm thick and with outer radius of 238 mm separated in four segments. These coils are assembled together with the thick laminations are 10 mm thick, 20 mm wide and 1000 mm tall. These and thick laminations will be assembled together with the thick laminations 3.8 mm thick to form a full length stack of about 7.1 m. The coils are 20 mm thick laminations with an inner radius of 134 mm and a width of about 20 mm. The geometries require high precision milling and EDM machining.	c-750k	Feb-17	Magnets components and assemblies	High precision assembling and manufacturing technologies
10	Q2 Series - Park gap making for assembly		Supply of ARACID raw material needed for the fabrication of the main supporting component (yoke, loadposts, spacers, and plates) of the new superconducting magnets				

EDM NO.	REV.	VALIDITY
STR001	1.2	VALID
ACQUISITION		PUBLIC



# Design documentation under a common umbrella

CERN Accelerating science

EDMS Home Favourites + Inbox

Navigator

- 1606329 v.1 In Work Public acc
- Chemical polishing CRAB DQW by [User]
- Created on [Date]
- Manual / Guideline Technic Last Modified on [Date]

Info

Description: This document describes the chemical polishing procedure of C cavities, namely the DOI, done in building 118.

Details

Associated Web Link: List of Administrators

Local administrators: TE-DEP-VSC-OWNER

Context: Documents relative to 1 (with simple release process)

This page: <https://edms.cern.ch/doc/1606329>

Files

Name
BCP_CRAB.docx



- HL-LHC High Luminosity LHC Project
  - Project Governance
  - Project Management
  - Work Package Workspace
    - Project Management and Technical Coordination (WP1)
    - Accelerator Physics and Performance (WP2)
    - Magnets Design (WP3)
    - Crab Cavities & RF (WP4)
    - Collimation (WP5)
    - Cold Powering (WP6)
    - Machine Protection (WP7)
    - Collider-Experiment interface (WP8)
    - Cryogenics (WP9)
    - Energy Deposition and Absorber (WP10)
    - 11T Dipole Two in One for DS (WP11)
    - Vacuum (WP12)
    - Beam Diagnostics (WP13)
    - Beam Transfer & Kickers (WP14)
    - Integration & De-installation (WP15)
    - IT String & Hardware Commissioning (WP16)
    - Technical Infrastructure (WP17)
    - Safetv



- HL-LHC High Luminosity LHC Project
  - Project Governance
  - Project Management
  - Work Package Workspace
    - HL-LHC Nodes in the LHC Hardware Baseline
      - HL-LHC Layout & Integration
      - IR magnets (WP3)
      - Crab Cavities & Radiofrequency System (WP4)
      - Collimation (WP5)
        - HL-LHC IR cleaning
          - HL-LHC IR cleaning - Incoming
            - HCTCTPM001 (v.0) Tertiary Collimator with Pick-Up Metallic [TCTPM]
          - HL-LHC IR cleaning - Outgoing
            - HCTCL00001 (v.0) HL-LHC Long Collimator [TCL]
            - HCTCLM0001 (v.0) HL-LHC Target Collimator Long Mask [TCLM]
        - HL-LHC DS collimation
        - HL-LHC Halo cleaning
        - Present system
        - Cold Powering (WP6A)
        - Warm Powering (WP6B)
        - Machine Protection (WP7)
        - Collider Experiment Interface (WP8)
        - Cryogenics (WP9)
        - Energy Deposition & R2E (WP10)
        - 11T Dipole (WP11)
        - Vacuum & Beam Screen (WP12)
        - Beam Instrumentation (WP13)
        - Beam Transfer & Kickers (WP14)
        - Integration & (De-)Installation (WP15)
        - IT String & Commissioning (WP16)
        - Infrastructure, Logistics & Civil Engineering (WP17)

CERN Accelerating science

Collaboration Workspaces

BROWSE PAGE

WP17 WP17.1 CE WP17.2 EL WP17.3 CV WP17.4 ASE WP17.6 SU WP17.7 HE HL Sharey

**HiLumi**  
HL-LHC PROJECT

## WP17.1 Civil Engineering

SubWorkpackage Leader: Pieter Mattelaer

Link to the EDMS folders for the HL LHC civil engineering consultancy services Tender

Link to the EDMS folder for the site investigation

Link to the egroups WP17 members WP17.1 members subWPLeaders

Link to the Drawings reviewing tasks

Link to WP17.1 Indico meetings

Tasks review c

15 October

Review: 12/20 - 1





# Complete follow up of production

**HL-LHC: Quality Manufacturing and Inspection Plan**

Approved by: [Signature] Date: 2015-07-26

Approved by: [Signature] Date: 2016-07-26

IN	ACTIVITY / OPERATION	APPL. EQUIPMENT / TOOLS	APPLICABLE DOCUMENTS / PROCEDURES	DEL. DEL.	SUPPLIER / CONTRACT	QUEST / VERIFICATION	APPROVED / APPROVED	REVISION / REVISION	NOTE / COMMENTS
1	Final inspection								
2	Final inspection								
3	Final inspection								
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26	Final inspection								
27	Final inspection								
28	Final inspection								



**Equipment Identifier: HCACFA004-CR000001**  
**Other Identifier: CERN-DQW-ACFA001**  
**Description: DQW Bare Cavity (variant #1)**

Main | Made of | Equipment data | Manufacturing | Operation | Non-conformities | Documents | History | Map

Actions: Edit | View summary

**Physical**  
 Manufacturer: CERN  
 Resp. Technique: Manufacturing  
 Status: Other Identifier: CERN-DQW-ACFA001  
 Parent Equipment: Parent Slot  
 Location: State: Good

**Safety**  
 RP Classification

**Comments**

**Design**  
 Item in ABS: DQW Bare Cavity (variant #1) (ver.0)

**Audit**  
 Created on: 2015-07-26 by: [Signature]  
 Last modified on: 2016-07-26 by: EDMS group  
 EDMS owner: HGACIAG

Main | Made of | Equipment data | Manufacturing | Operation | Non-conformities | Documents | History | Map

Actions: Add extra step

Workflow Diagram: No workflow diagram is defined for this equipment.

**Workflow Steps**

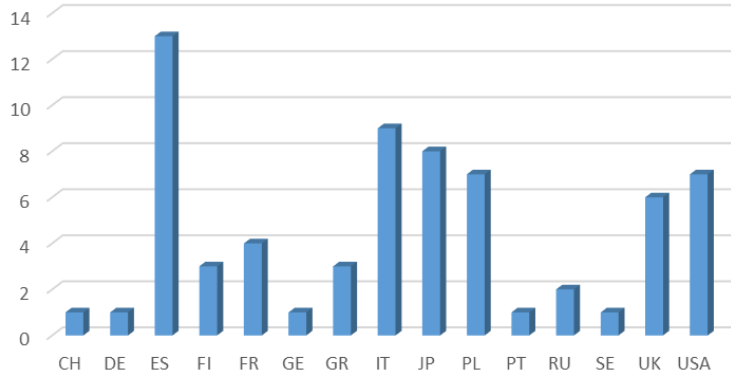
Step ID	R/E	Other name	Description	Status	Result	INC
1	0		Final inspection of materials - Main Body	Accepted	OK	
2	0		Cutting and bending - Main Body	Accepted	OK	
3	0		E-beam Welding longitudinal W01A/B - Main Body (*)	Accepted	OK	
3.1	0		Visual Inspection W01A/B (*)	Accepted	OK	
3.2	0		Radiographic examination W01A/B (*)	Accepted	OK	
4	0		Dimensional check before forming (*)	Accepted	OK	
4.1	0		Forming - Main Body	Accepted	OK	
5	0		Visual inspection after forming	Accepted	OK	
5.1	0		Metrology control after forming (*)	Accepted	OK	
5.2	0		Machining holes plus extrusion steps plus machining	Accepted	OK	
6	0		Metrology control final - Main Body (*)	Accepted	OK	
7	0		Forming - Bowl	Accepted	OK	
8	0		Visual inspection	Accepted	OK	
8.1	0		Metrology control final (*)	Accepted	OK	
8.2	0		Machining - Bowl	Accepted	OK	
9	0		Metrology control (*)	Accepted	OK	
9.1	0		Cutting and machining - Harlots & Pin	Accepted	OK	
10	0		E-beam Welding longitudinal W02A/B/C & W29 - Lunette (*)	Accepted	OK	
11	0		Visual Inspection W02A/B/C & W29 (*)	Accepted	OK	
11.1	0		Radiographic examination W02A/B/C & W29 (*)	Accepted	OK	
11.2	0		Forming - Lunette (*)	Accepted	OK	
12	0		Metrology Control (*)	Accepted	OK	
12.1	0		E-beam Welding circumferential W03A/B/C & W31 - Lunette (*)	Accepted	OK	
13	0		Visual Inspection W03A/B/C & W31 (*)	Accepted	OK	
13.1	0		Deep drawing & Calibration Extrusion - Lunette	Accepted	OK	
13.2	0		Metrology Control (*)	Accepted	OK	
14	0		Visual inspection after machining of lunette (*)	Accepted	OK	
14.1	0		E-beam Welding circumferential W04A/W04B - Diabolo Subassemblies (*)	Accepted	OK	
15	0		Visual Inspection W04A/W04B (*)	Accepted	OK	
16	0		Radiographic examination W04A/W04B (*)	Accepted	OK	
16.1	0		E-beam Welding circumferential W05 - Pin up (*)	Accepted	OK	
17	0		E-beam Welding circumferential W07A/W07B - Diabolo Subassemblies (*)	Accepted	OK	
18	0		Visual Inspection W07A/W07B & W07B (*)	Accepted	OK	
18.1	0		Radiographic examination W07A & W07B	Accepted	OK	
18.2	0		Visual Inspection W08A/B & W10A - Bowl Subassemblies (*)	Accepted	OK	
19	0		Visual Inspection W08A/B & W10A - Bowl Subassemblies (*)	Accepted	OK	
19.1	0		Visual Inspection W09A/B & W10A - Bowl Subassemblies (*)	Accepted	OK	
19.2	0		Metrology Flatness and profile (*)	Accepted	OK	
20	0		E-beam Welding W09A/B/C & W24 - Extremities (*)	Accepted	OK	
20.1	0		Visual Inspection W09A/B/C & W24 (*)	Accepted	OK	
20.2	0		Radiographic examination W09A/B/C & W24 (*)	Accepted	OK	
20.3	0		Machining internal ring (*)	Done	Not OK	
20.4	0		Machining internal ring	Accepted	OK	
21	0		Leak Test	Cancelled	Cancelled	
22	0		E-beam Welding W02A/B - Bowl	Accepted	OK	
22.1	0		Visual Inspection W02A/B (*)	Accepted	OK	
22.2	0		Radiographic examination W02A/B (*)	Accepted	OK	
22.3	0		Metrology Control (*)	Accepted	OK	
22.4	0		RF Trimming	Accepted	OK	
22.5	0		Metrology Control	Accepted	OK	
23	0		E-beam Welding W01A - Final Assembly	Accepted	OK	
23.1	0		Visual Inspection W01A	Accepted	OK	
23.2	0		Visual Inspection W03A Radiographic examination W03A	Accepted	OK	
23.3	0			Accepted	OK	
24	0			Accepted	OK	
24.1	0			Accepted	OK	
24.2	0			Accepted	OK	
24.3	0			Accepted	OK	
24.4	0			Accepted	OK	
25	0			Accepted	OK	
25.1	0			Accepted	OK	
25.2	0			Accepted	OK	
26	0			Accepted	OK	
27	0			Accepted	OK	
28	0			Accepted	OK	

HL-LHC-ACFA001



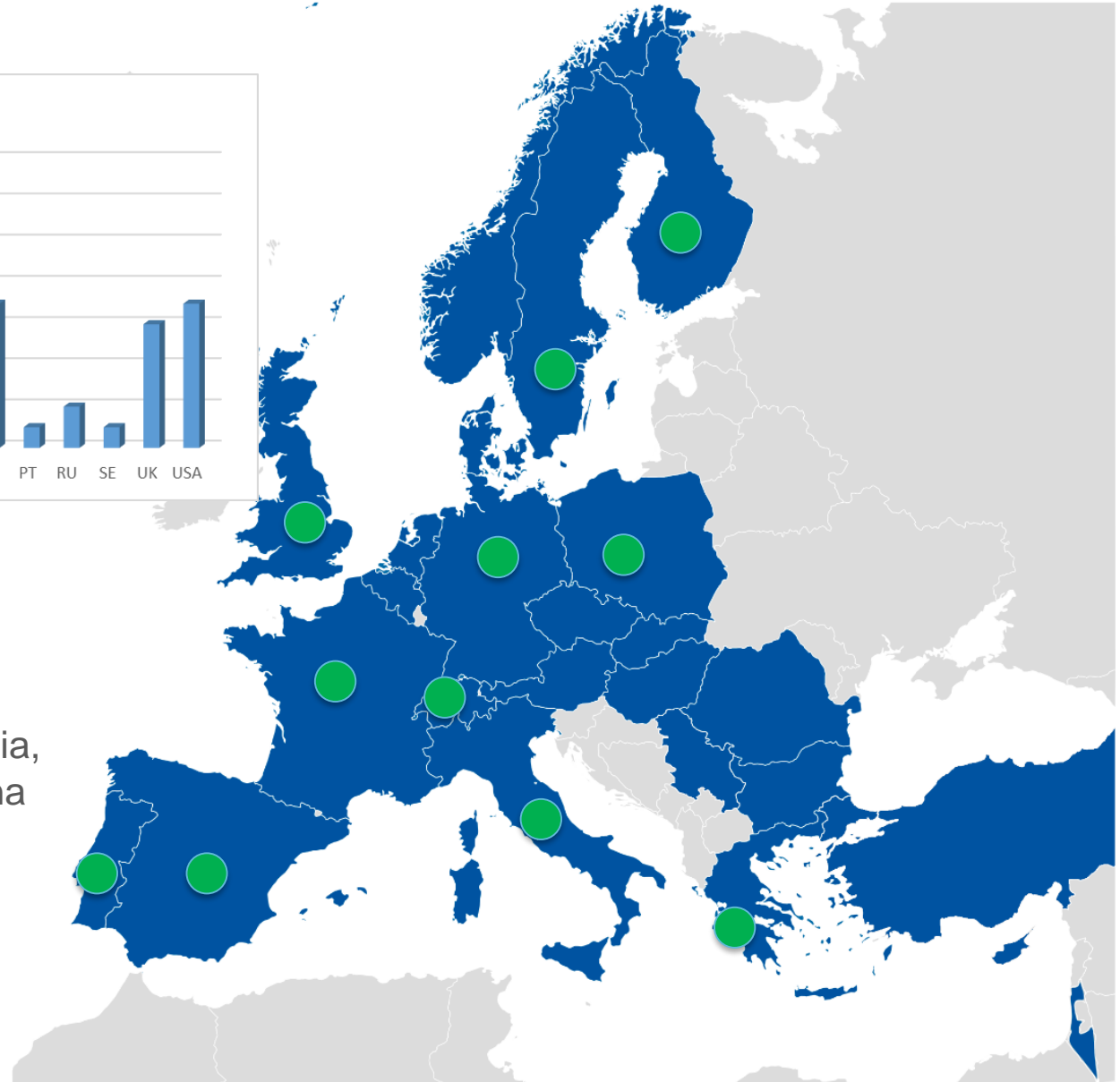
# Skilled Engineers & technicians

Agreements



● HL-LHC Existing collaborations

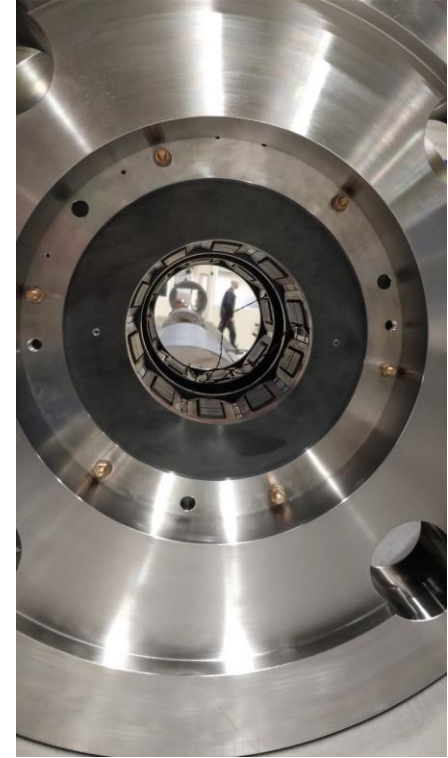
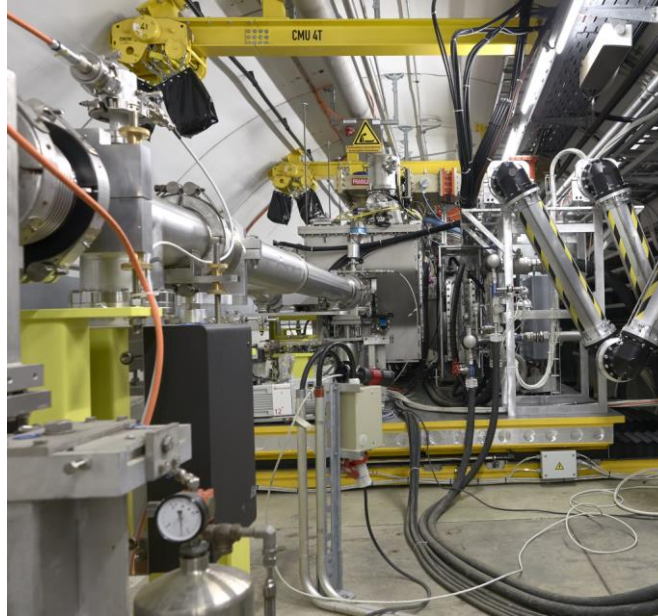
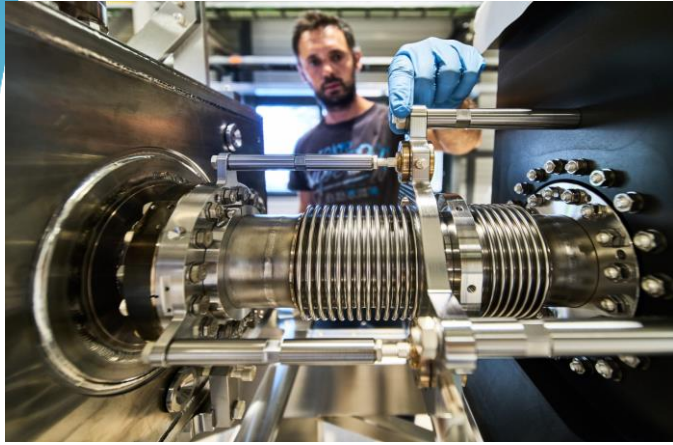
+Georgia, Japan, Russia, USA, Canada and China



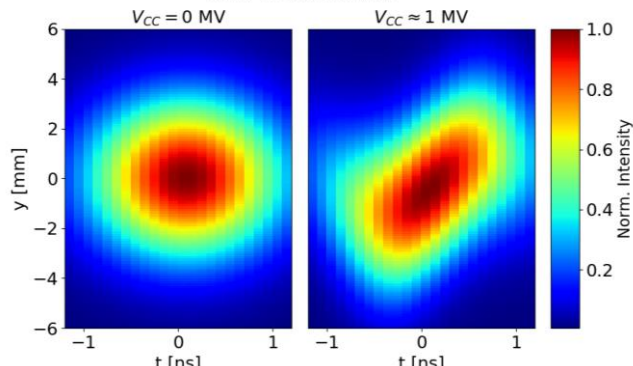
# The HL-LHC Project

How well he have done up to  
now

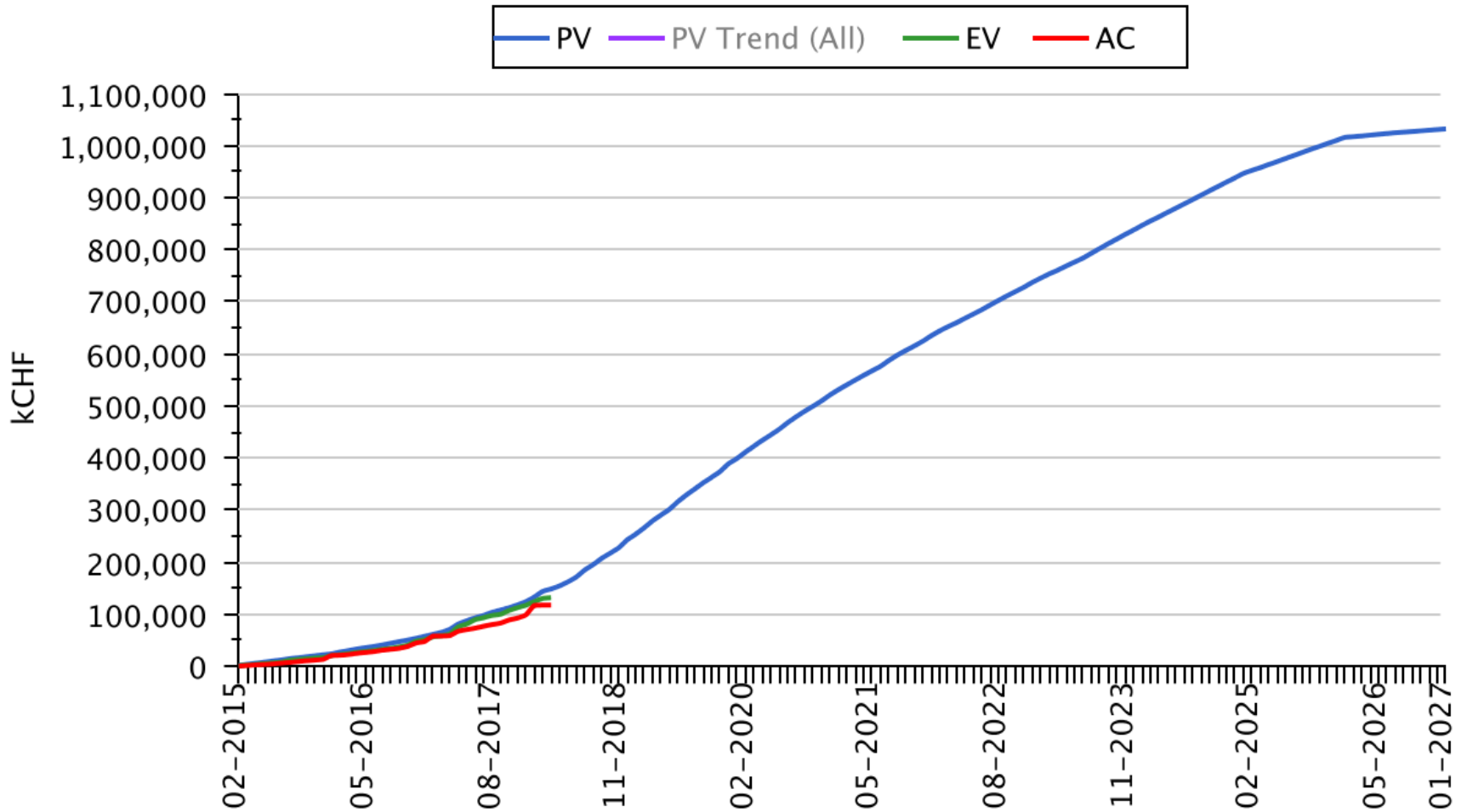
# 2018–2024: Construction and test of hardware components



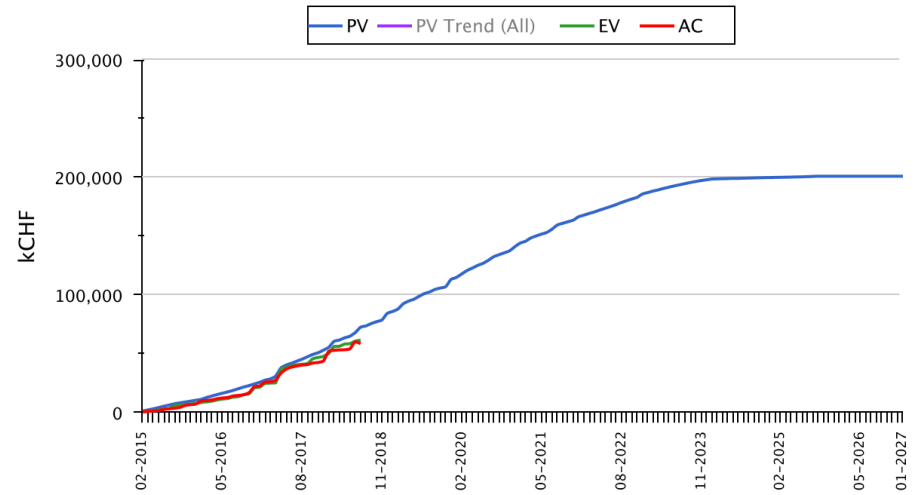
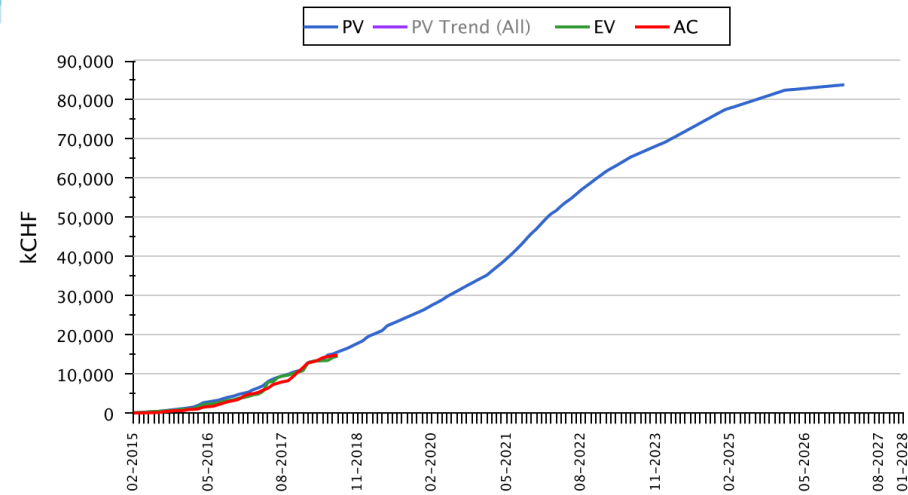
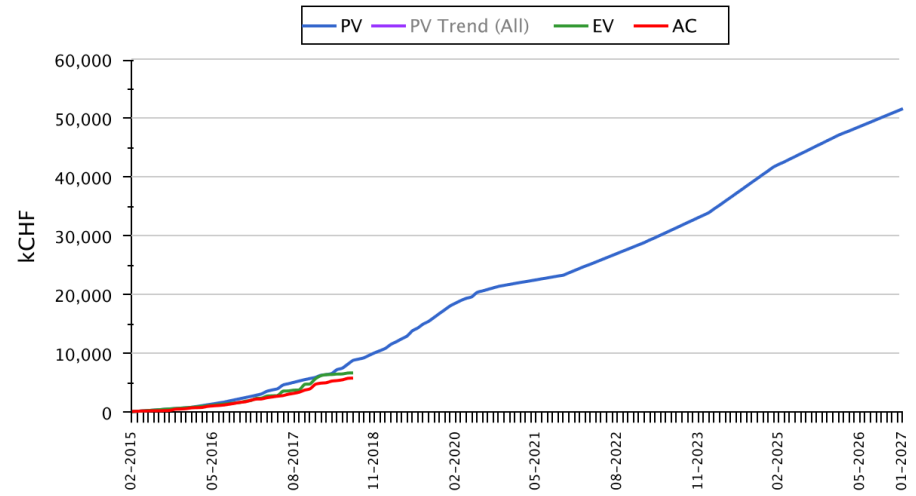
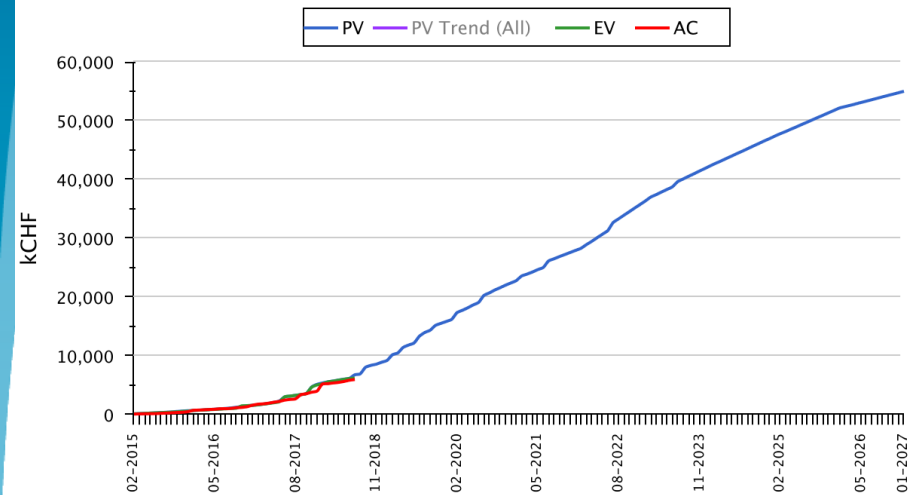
Crabbing Voltage from Head-Tail Monitor  
2018-05-23 17:02:39



# How we are doing? (Plan versus Actual)

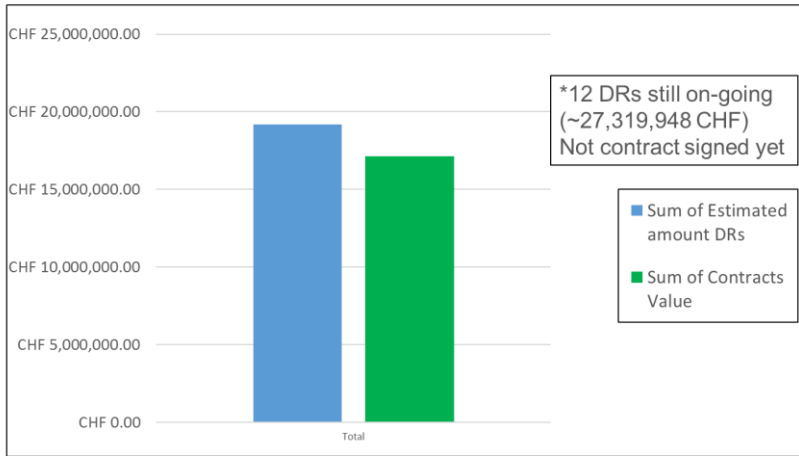


# On track for all WPs



# Under cost for most part of components

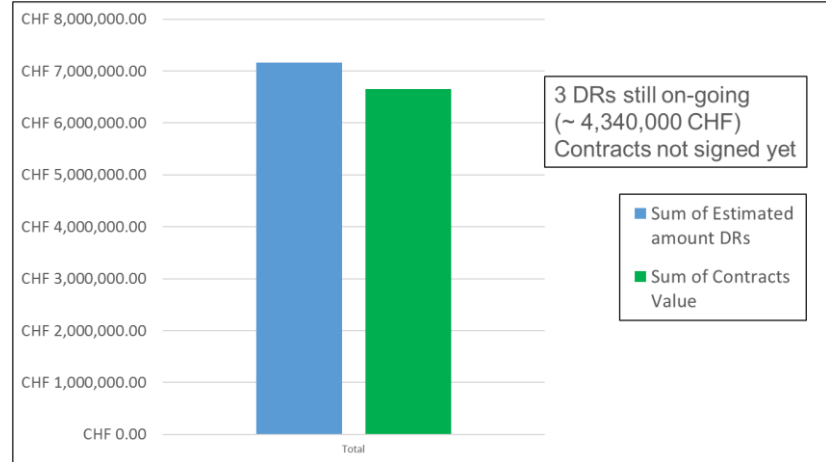
N° DRs issued: 34\*  
 Estimated value (CHF): 19,834,600.00  
 N° contracts placed: 22  
 Actual value (CHF): 17,782,275.12  
 $\Delta$  (CHF): **2,052,324.88**



N° DRs issued: 26  
 Estimated value (CHF): 7,161,105

N° contracts placed: 23  
 Actual value (CHF): 6,872,318.86

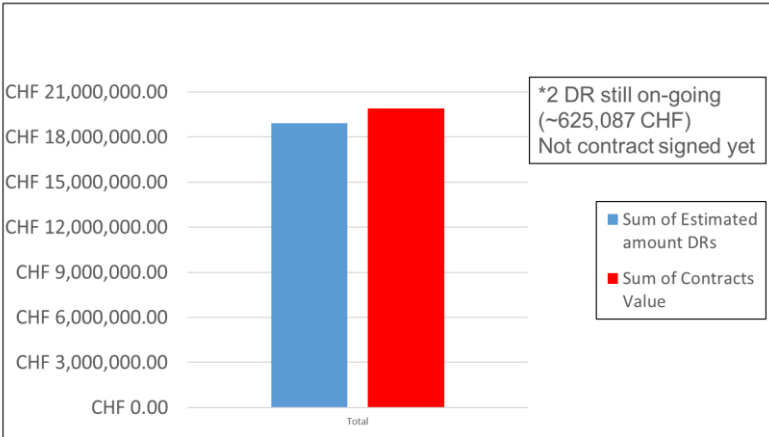
$\Delta$  (CHF): **288,786.14**



N° DRs issued: 37  
 Estimated value (CHF): 18,930,382

N° contracts placed: 35  
 Actual value (CHF): 19,889,912.9

$\Delta$  (CHF): **-959,530.9**



## WP1-WP16



Estimation DRs\*:  
 79,865,614 CHF  
 Actual Value Contracts:  
 77,419,837 CHF  
 $\Delta$  (CHF): **2,445,776.33 CHF**  
 \*DRs of contracts already awarded

Sum of Estimated amount DRs  
 Sum of Contracts Value



# Civil engineering and infrastructures

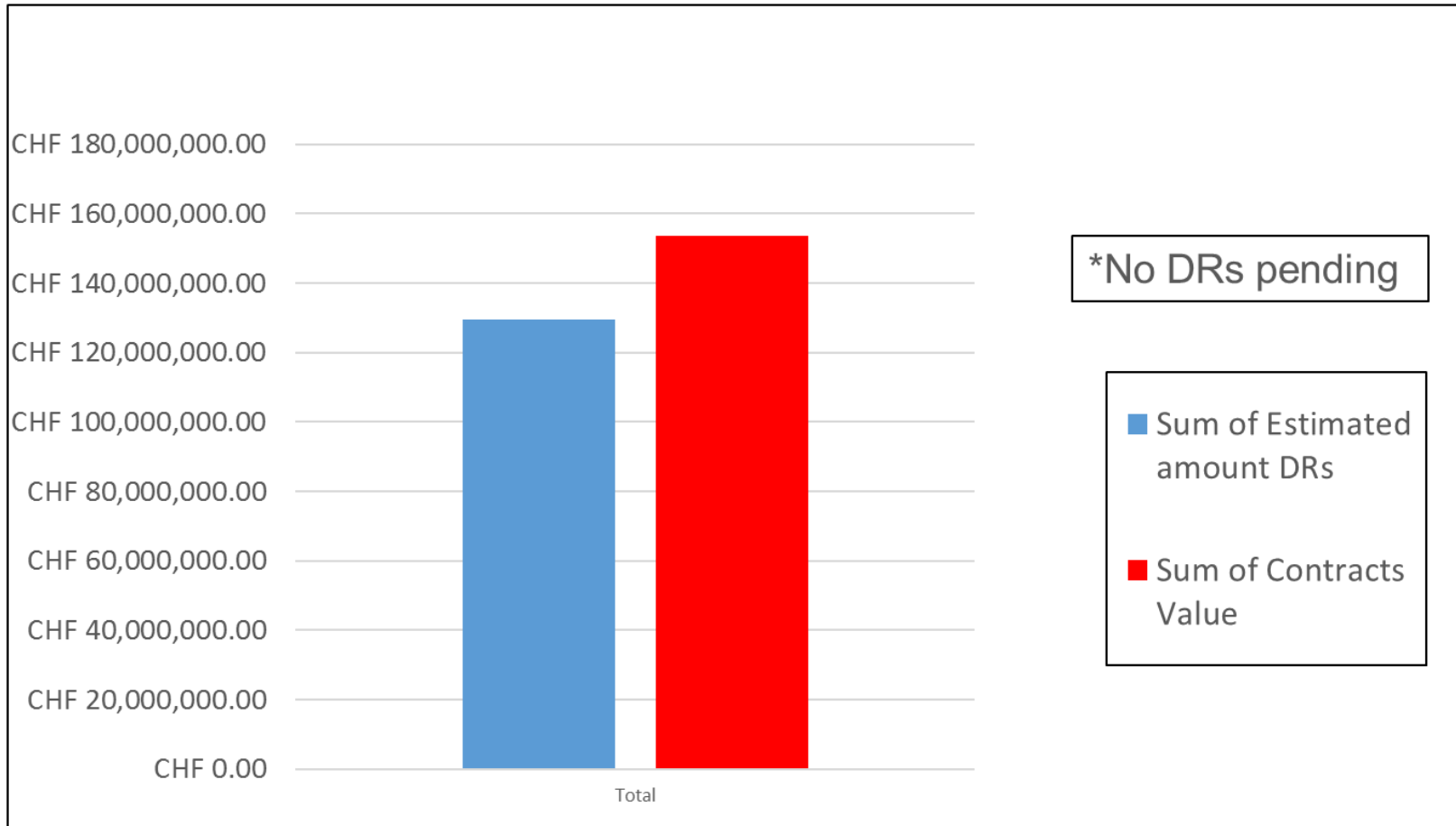
N° DRs issued: 8

Estimated value (CHF): 129,561,500

N° contracts placed: 8

Actual value (CHF): 153,498,143.6

$\Delta$  (CHF): **-23,936,643.62**

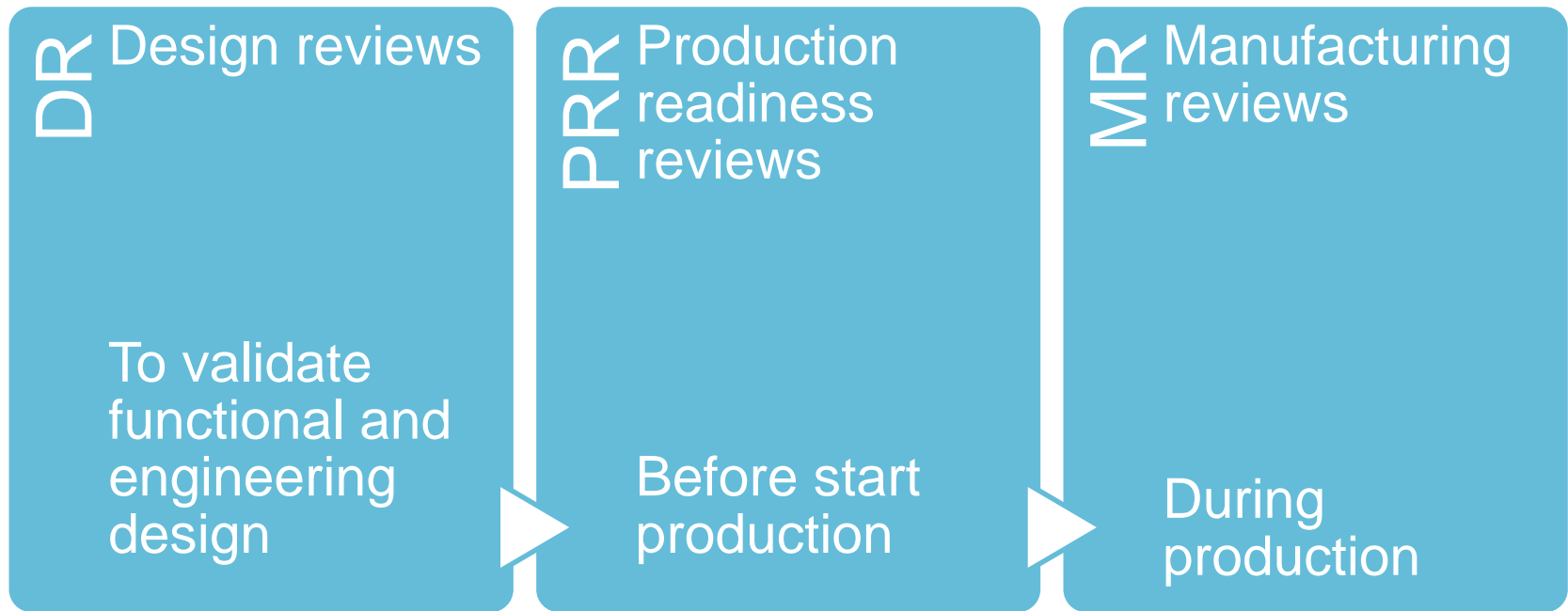




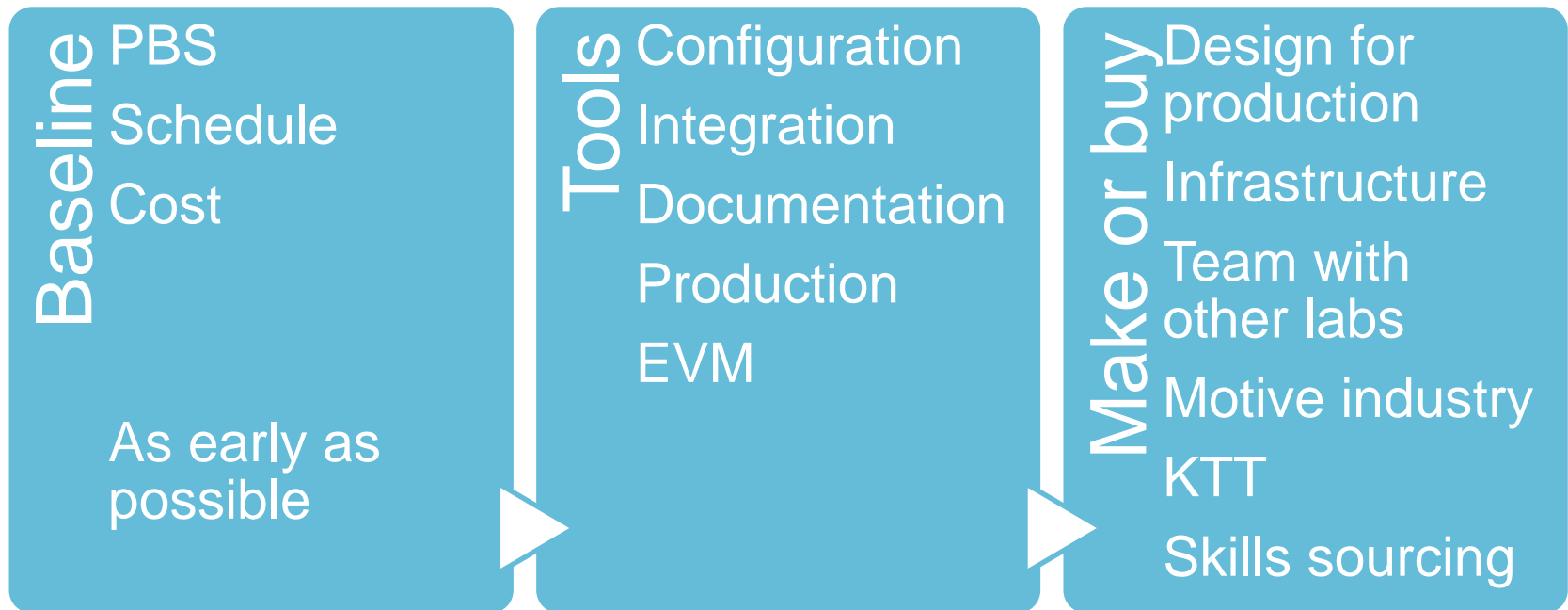
# Looking back ... would you do the same?

- Integration of several research teams with competitive designs
- Involvement of the industry from the earliest moment for the most critical materials/components
- Strong motivation campaigns with industry (general and national)
- Make or buy process
- Refurbishment of infrastructures and tooling to cope with in house production in case of failure on production in industry or to make steps not possible in the industry
- Search for double production line for all components that could be in the critical path
- Documentation handling structured and imposed for design and manufacturing independently of the origin of the supply
- Enlargement of programs to obtained skilled engineers and technician from partner labs and universities

# Review, review, review ... ahead of time



# Something more?



# Will we manage to finish on budget? On time?





***Thank you very much for your  
attention***

***Questions more than welcome***



Done on behalf of the HL-LHC Project Team