HL-LHC industrialization and procurement

Lessons learnt

Isabel Bejar Alonso

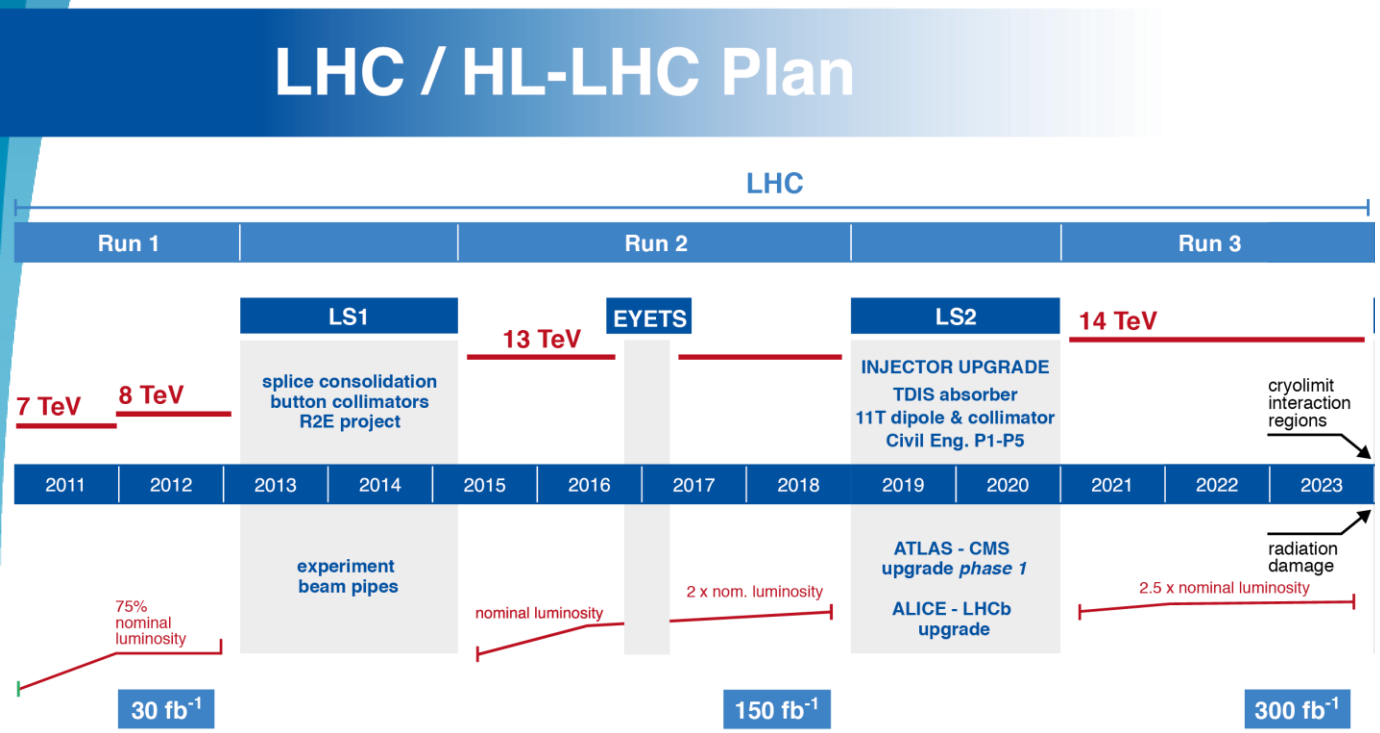
HL-LHC Sourcing Officer

ICHEP 2018 - Seoul

The HL-LHC Project

Why, what, when & by whom?

LHC Today: Energy and Luminosity Increase



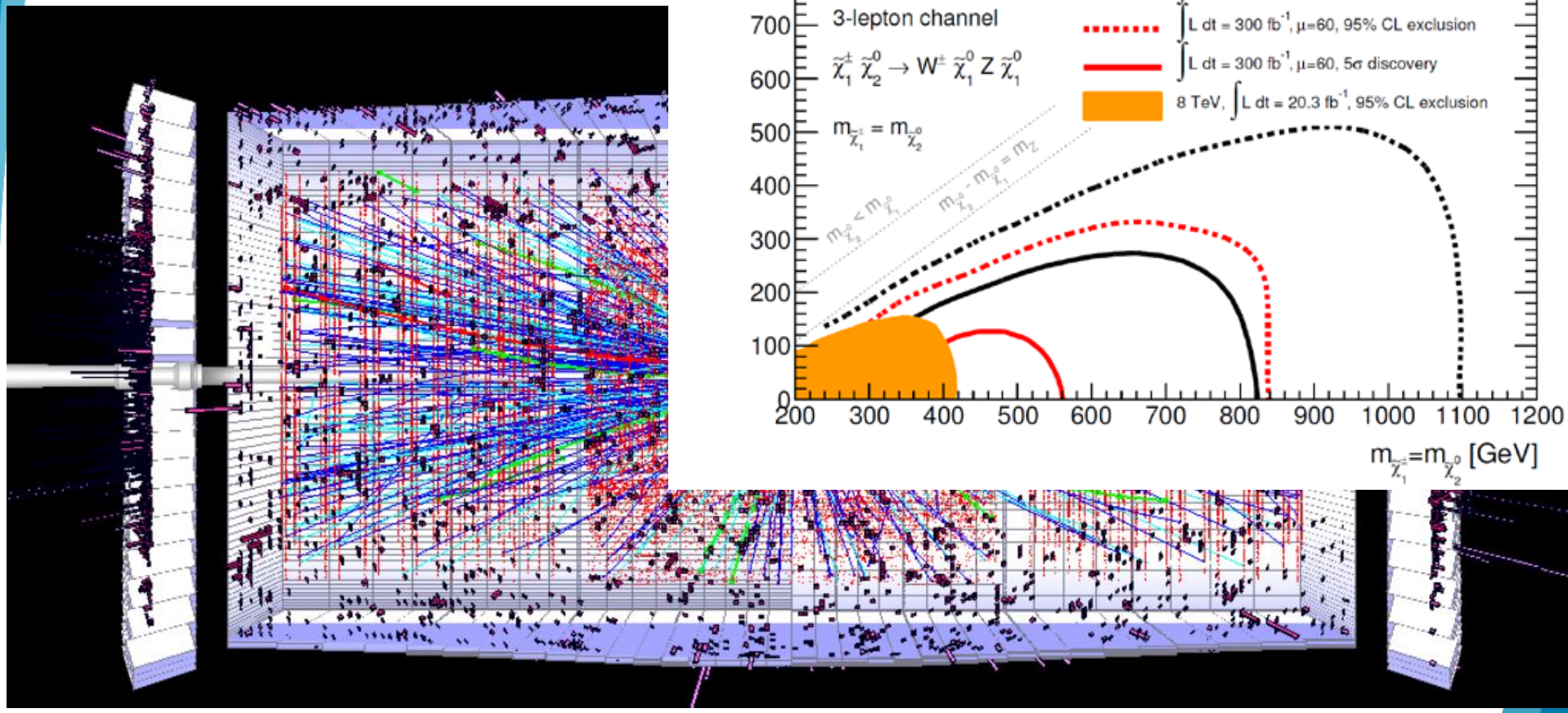
Energy will be constant

Luminosity will flatten (or modest increase)

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

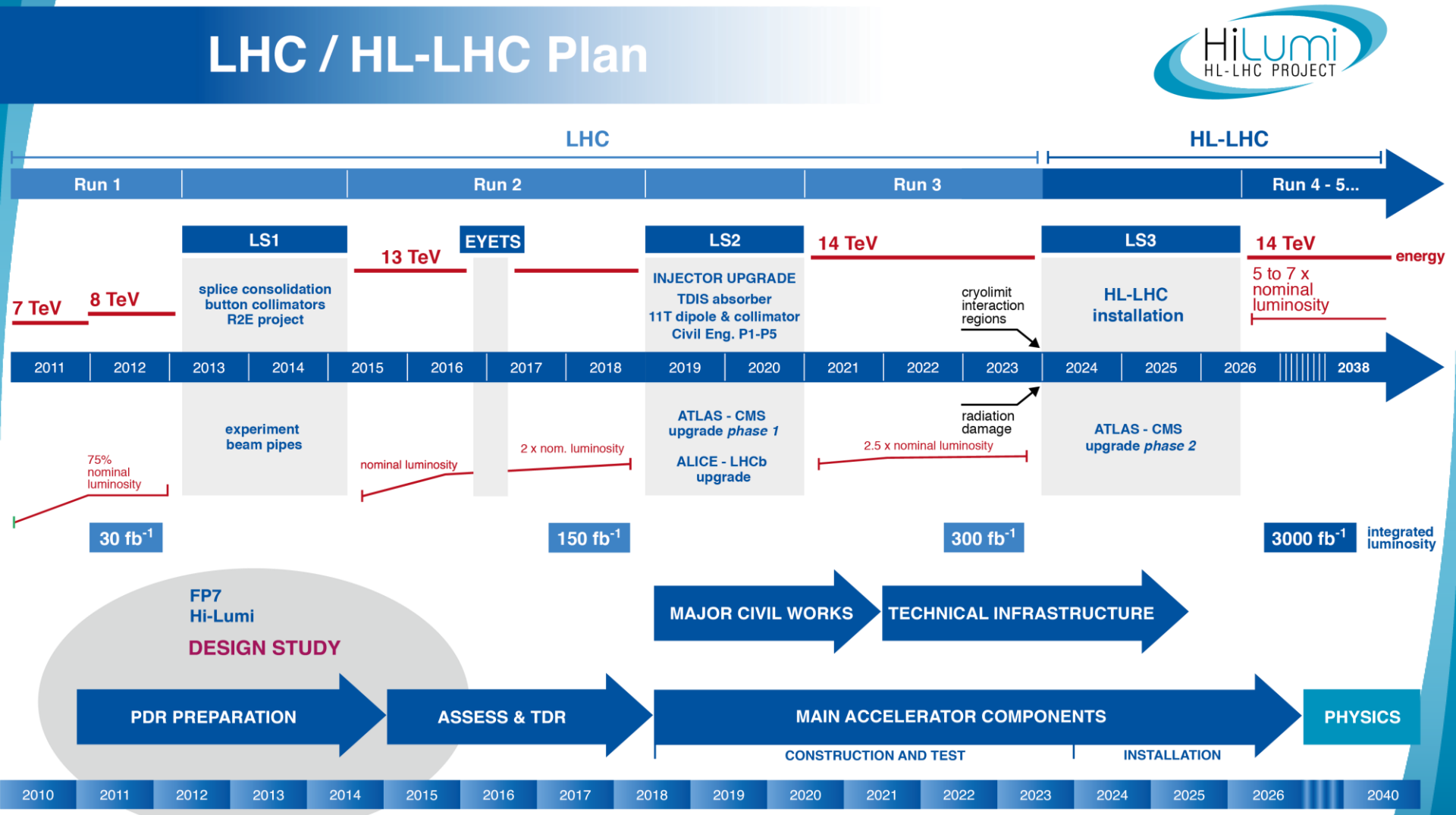
The main objective of HiLumi LHC Design Study is to determine a hardware configuration and a set of beam parameters that will allow the LHC to reach the following targets:

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

An integrated luminosity of **250 fb^{-1} per year**, enabling the goal of **L_{int} = 3000 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:**
$L_{peak\ ult} \cong 7.5\ 10^{34}$ $cm^{-2}s^{-1}$ and **Ultimate Integrated $L_{int\ ult} \sim 4000$ fb^{-1}**
LHC should not be the limit, would Physics require more…

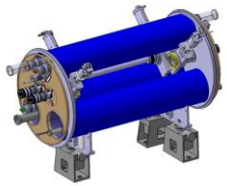
Our roadmap

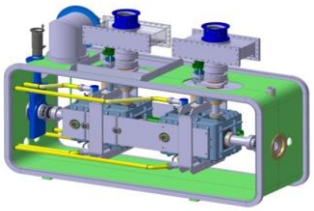


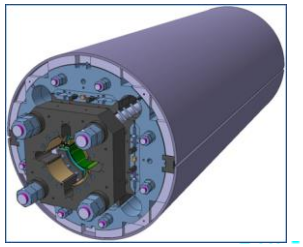
HiLumi HL-LHC PROJECT

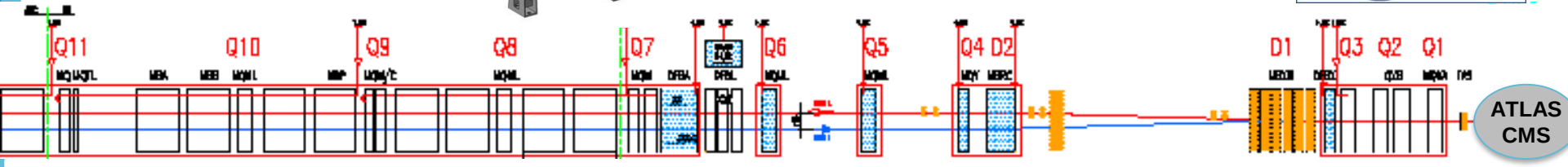
CERN

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)

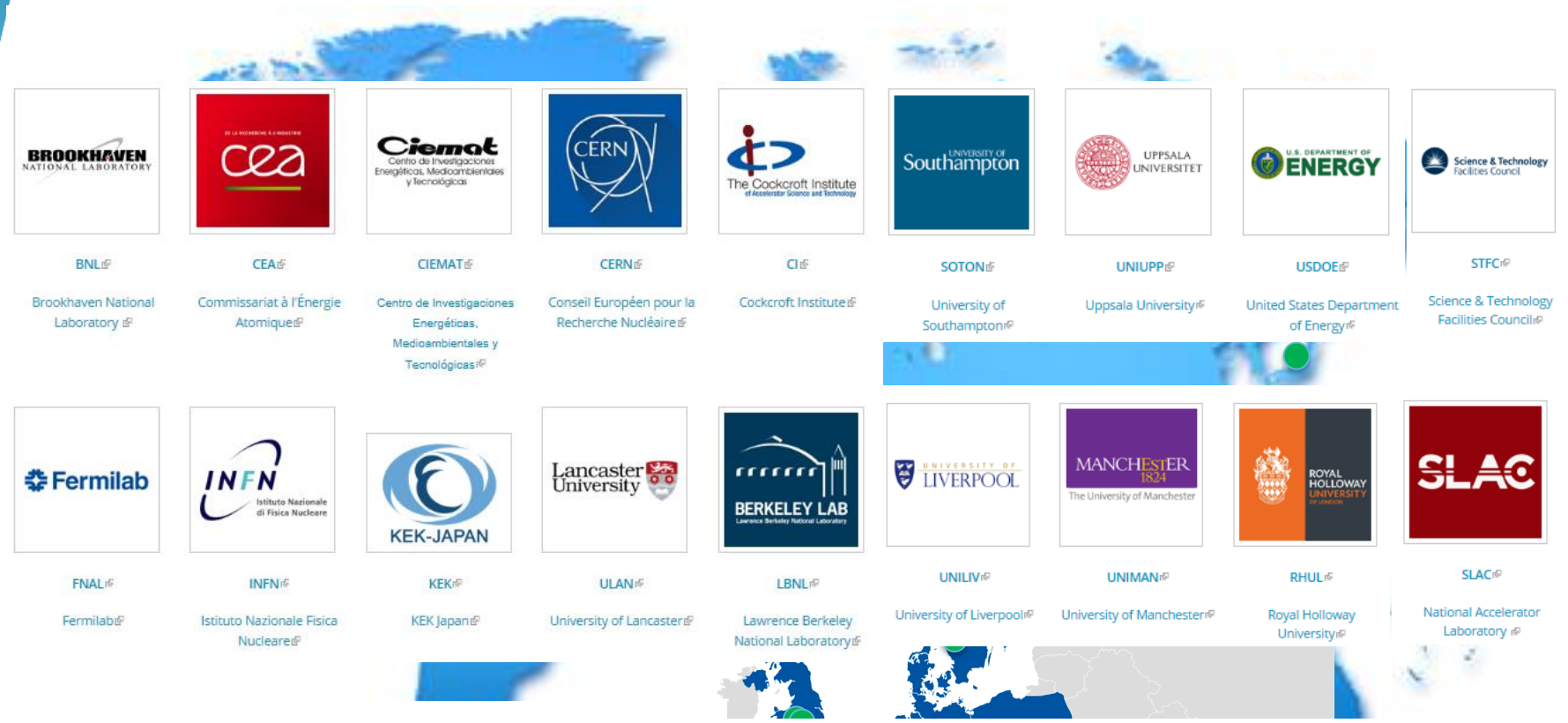
Change/new lay-out
1. TAXN
2. D2
3. CC
4. Q4
5. Correctors
6. Q5
7. Q5@1.9K in P6
8. New collimators

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

LBNL — 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

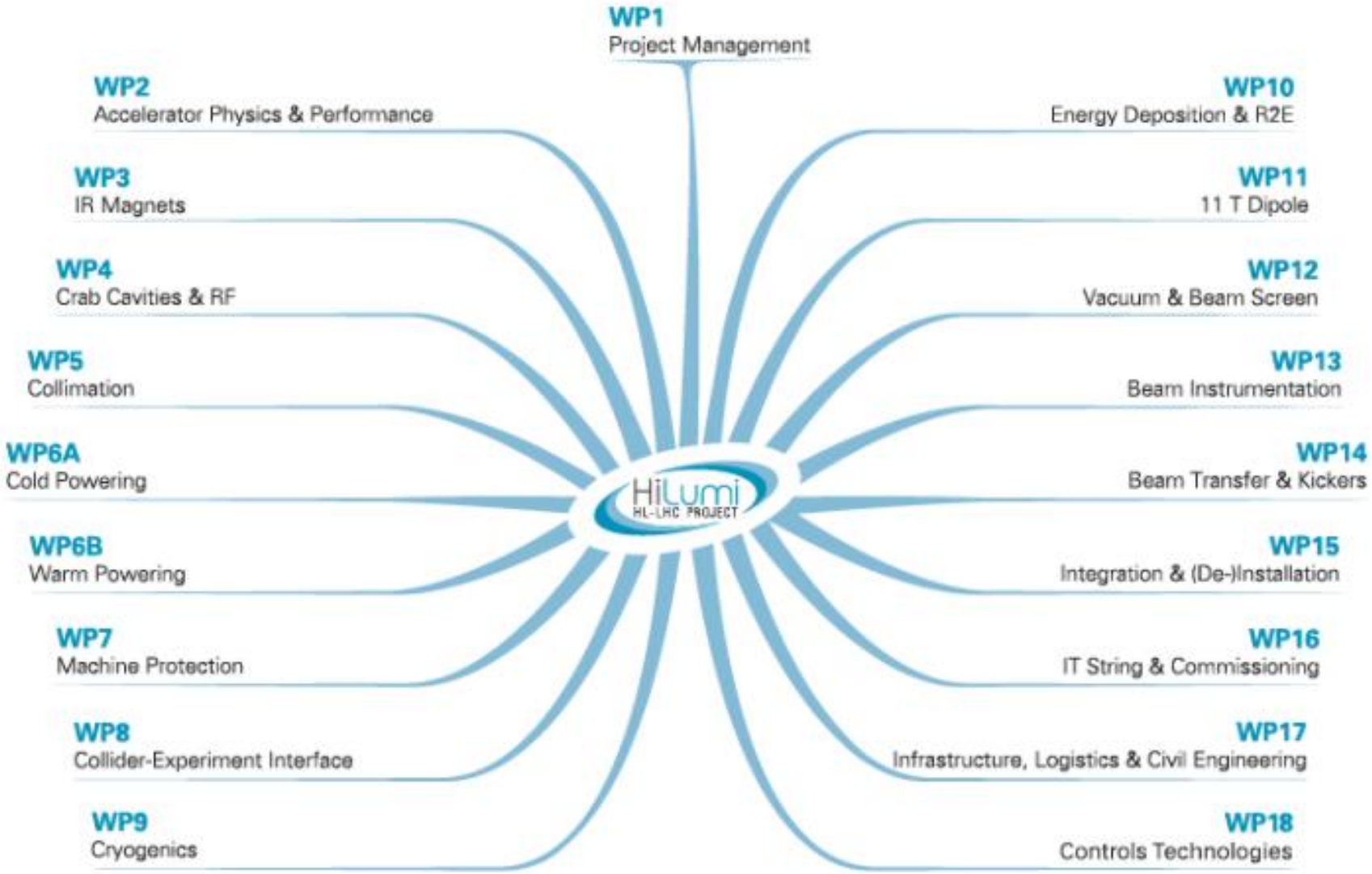
ODU — Old Dominion University

TRIUMF

The HL-LHC Project

Organization, technology & cost

Project structure

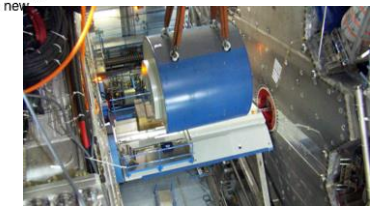


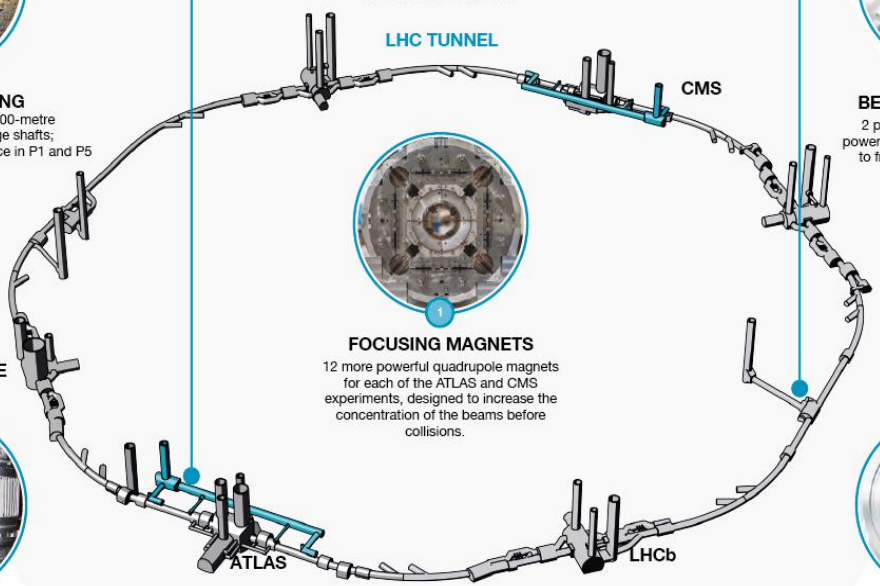
Technology driven

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

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)

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

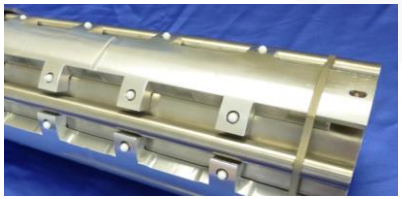




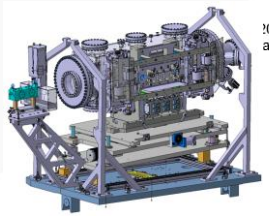
FOCUSING MAGNETS
12 more powerful quadrupole magnets for each of the ATLAS and CMS experiments, designed to increase the concentration of the beams before collisions.

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

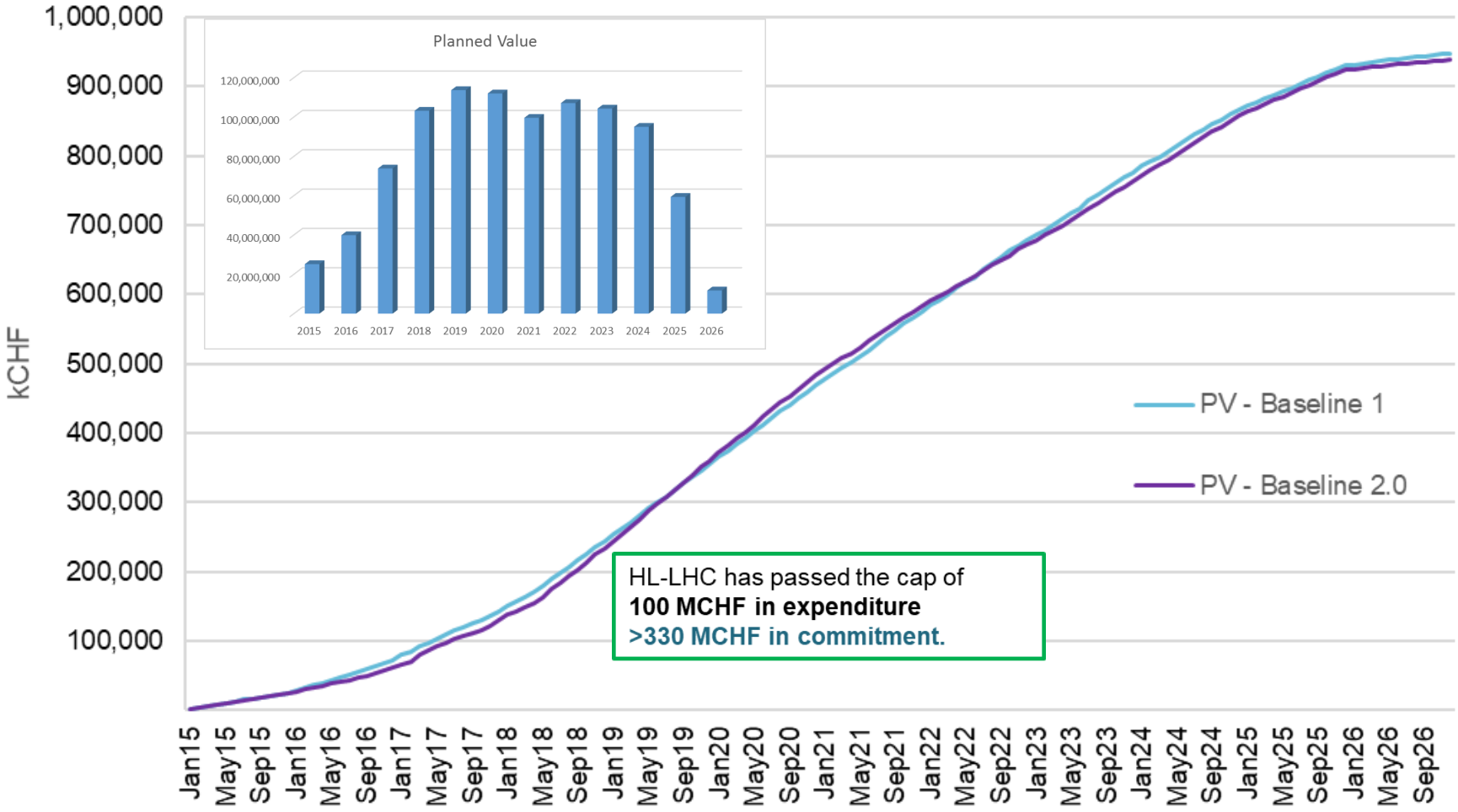
COLLIMATORS
20 new collimators and 60 replacement ators to reinforce machine protection.



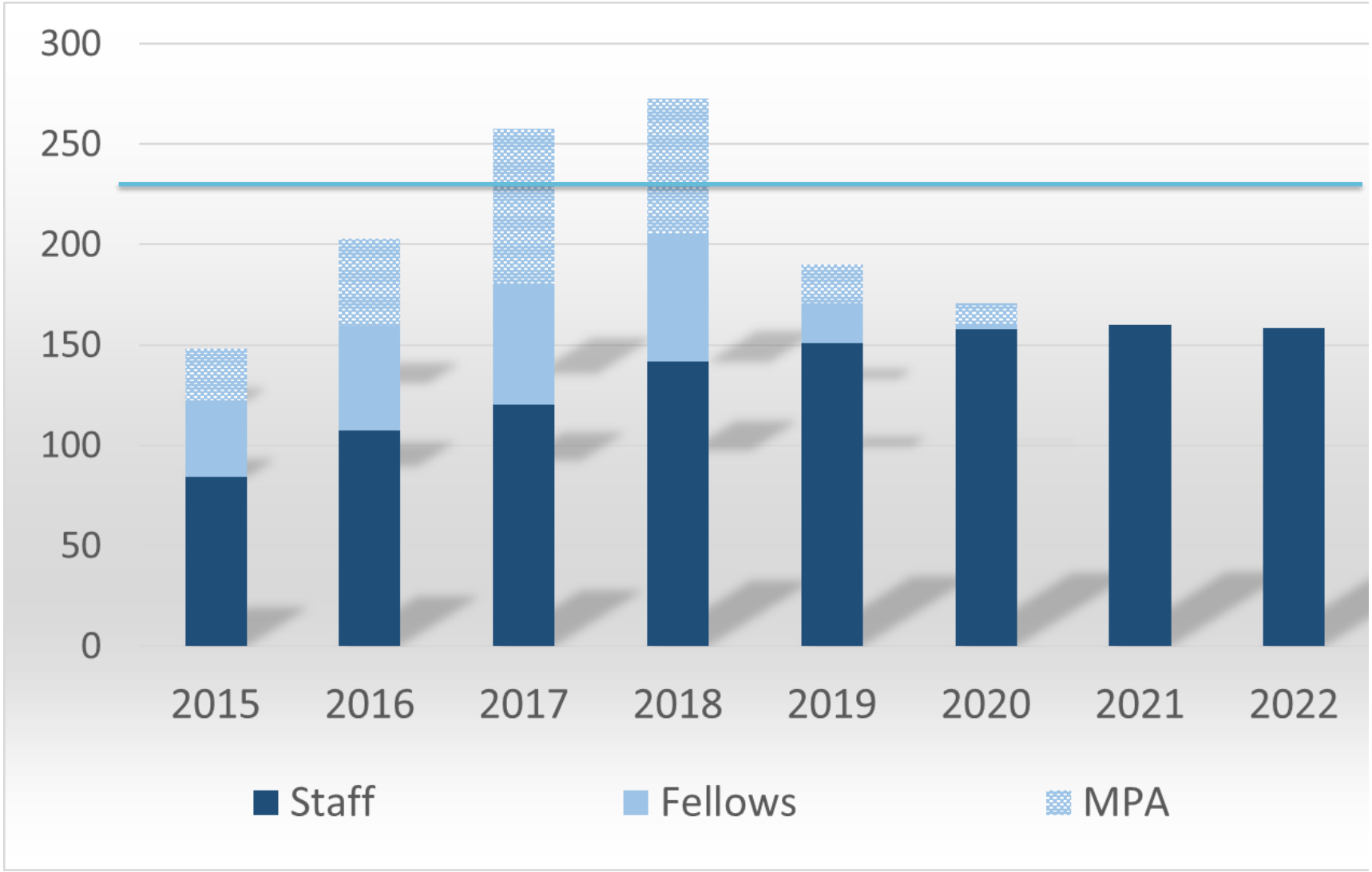
SUPERCONDUCTING LINKS
Electrical transmission lines based on a high-temperature superconductor to carry current to the magnets from the new service galleries to the LHC tunnel.



COST: 950 MCHF for material



Man Power


300
250
200
150
100
50
0
2015
2016
2017
2018
2019
2020
2021
2022
Staff
Fellows
MPA

The HL-LHC Project

Main challenges

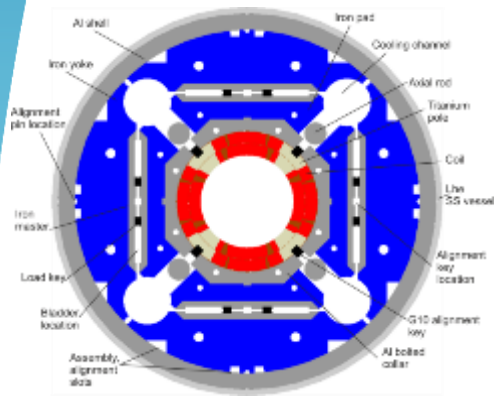
Challenges

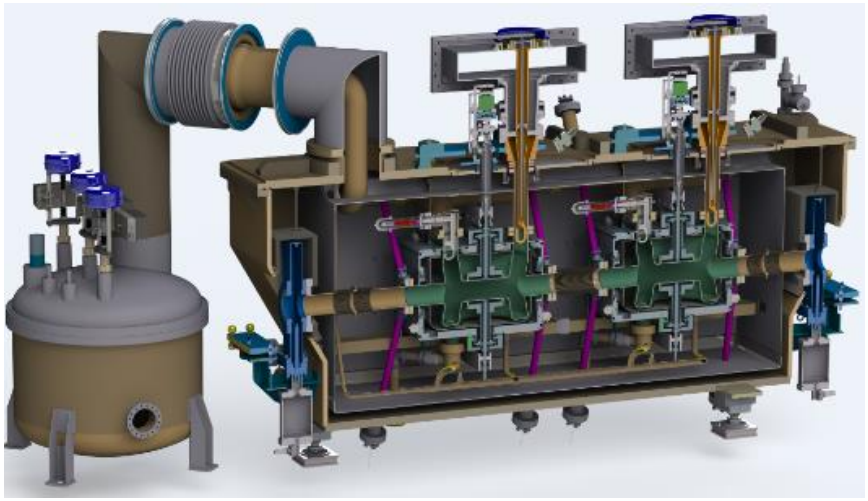
- Less than 6 years from concept to prototype
  - Magnets in Nb_3Sn
  - Crab cavities for protons
  - Links on MgB_2
  - New materials for collimators …
- Extremely short series. Tens and not hundreds or thousands of identical components, consequently, lack of interest from industry
- Massive in-kind contributions some for subassemblies with interfaces and interlinked schedules
- Less than 10% of the personnel will work for the full length of the project

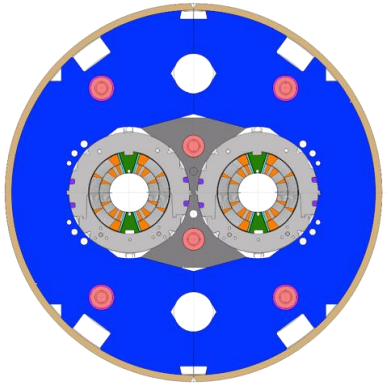
The working axis

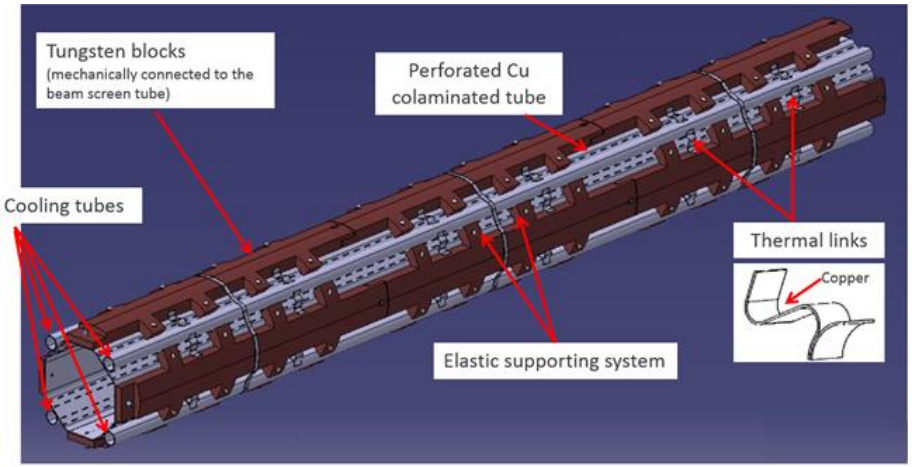
- Integration of several research teams with competitive designs
- Involvement of the industry from the earliest moment for the most critical materials/components
- Strong motivation campaigns with industry (general and national
- Make or buy process
- Refurbishment of infrastructures and tooling to 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

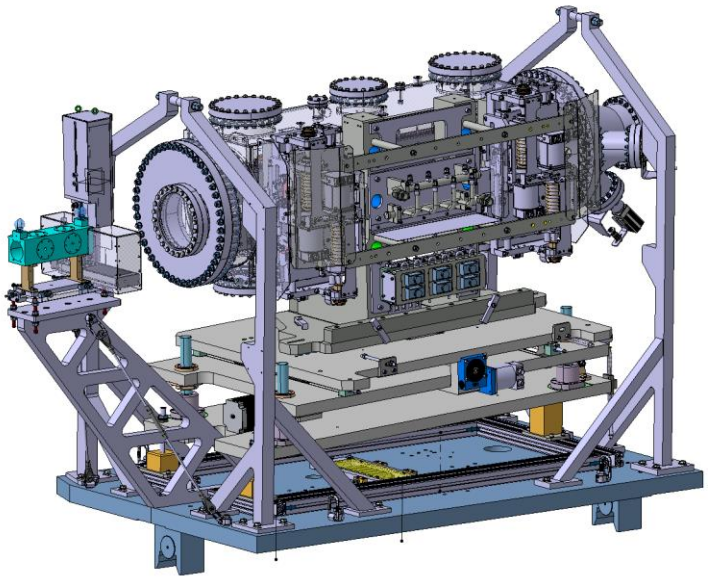
Design & prototypes: Competition - Cooperation



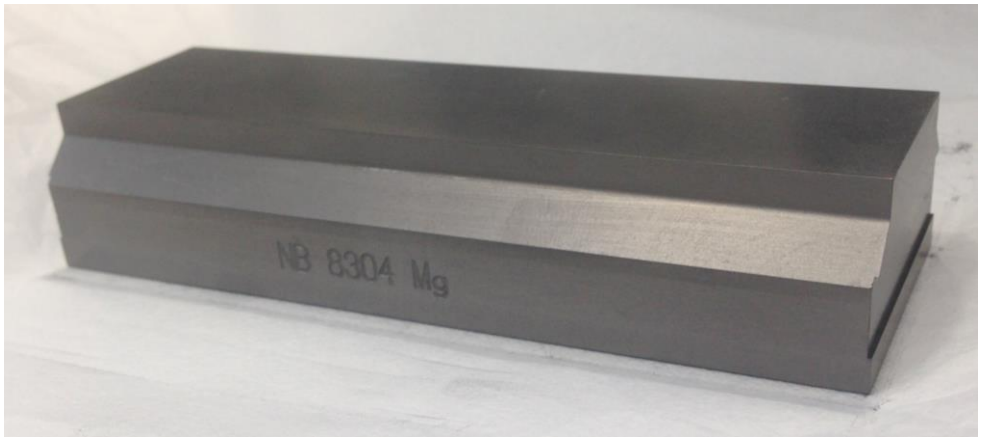


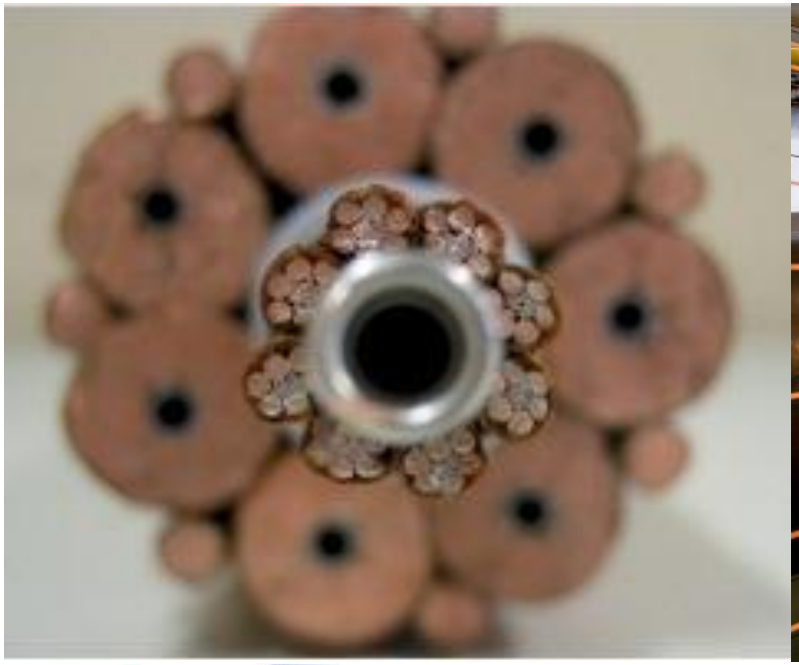


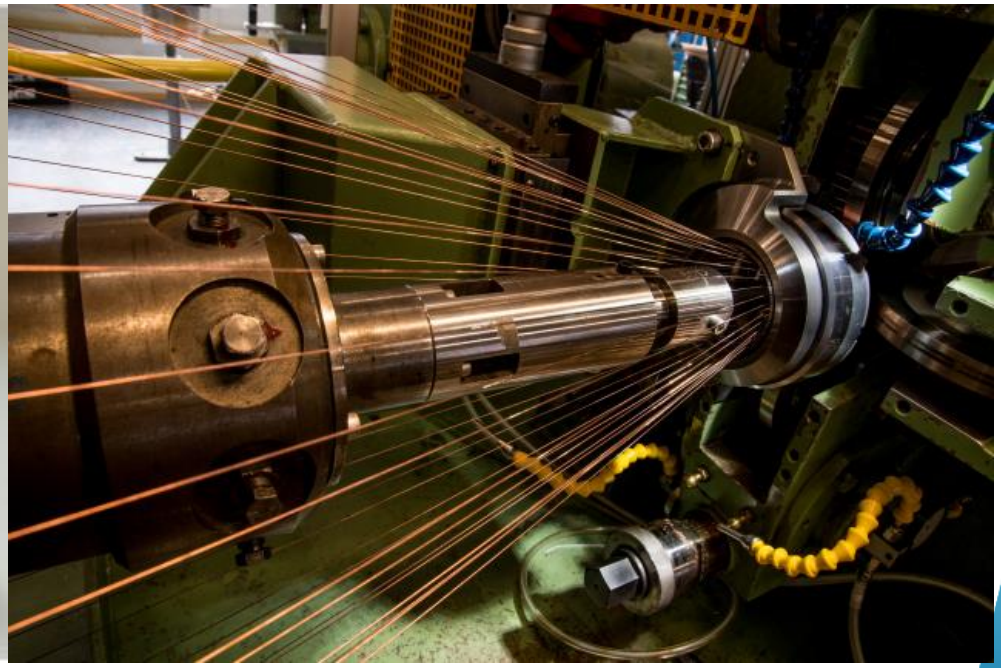




Industry – Early involvement







Motivation campaigns

HL-LHC Industry

Industry Relations and Procurement Website for the HL-LHC project

Search this site | Search

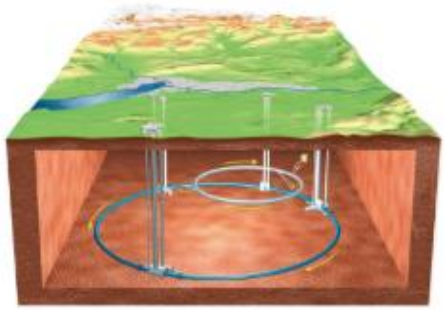
Home | General Info | Procurement Overview | Tendering | Acquisition Timeline | Events | Contact

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

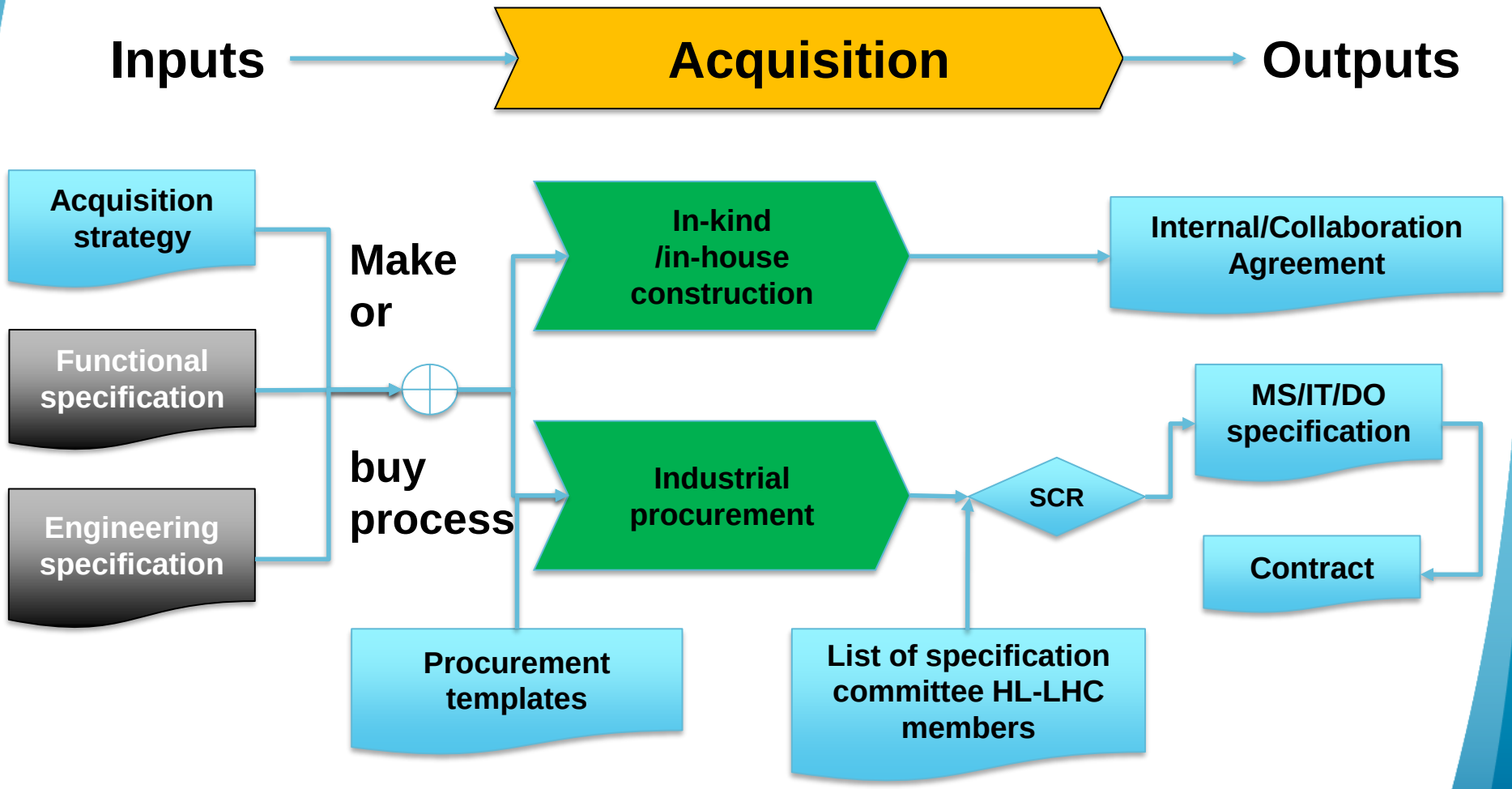
BIG SCIENCE BUSINESS FORUM

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 thie major event that will be held at Copenhagen on 27 and 28 February 2018.

Read more

Make or buy?



SCR: Specification Committee Rev

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
WWW: HL-LHC Knowledge & Industry

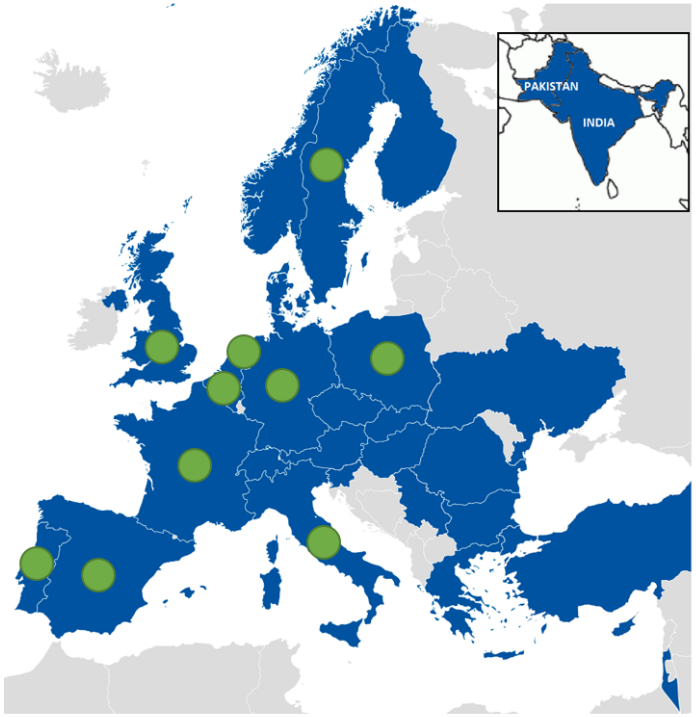
Industry & Knowledge WP6B

Refurbishment of infrastructures

Diversifying suppliers

Domains of Activity

Magnets Cryostat

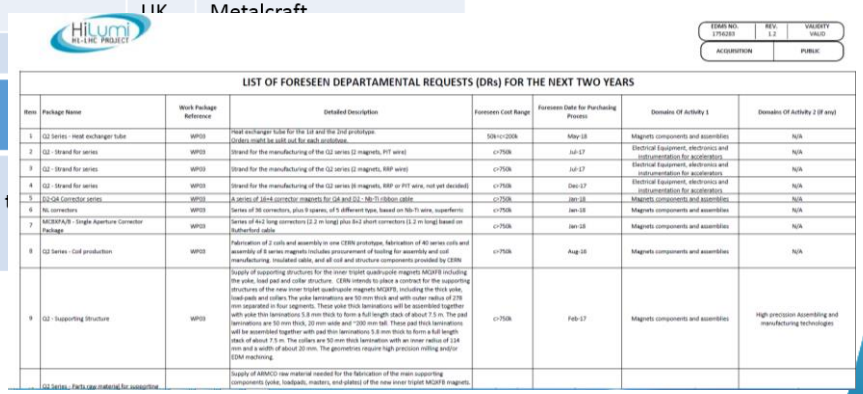


Presently identified as potential suppliers

MS	Firms	MS	Firms
AT		IT	SIMIC, Criotec, Zanon, Alca Tech, Fantini, CSC
BE	Amos, Ortmans	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	Metalcraft
IN			

Looking for…

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



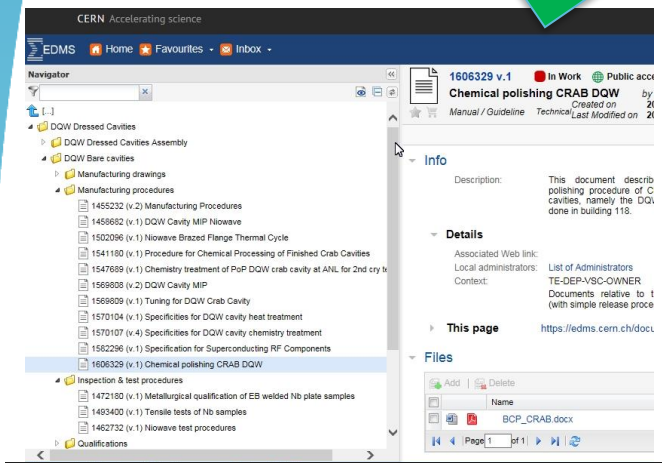
LIST OF FORESEEN DEPARTAMENTAL REQUESTS (DRs) FOR THE NEXT TWO YEARS

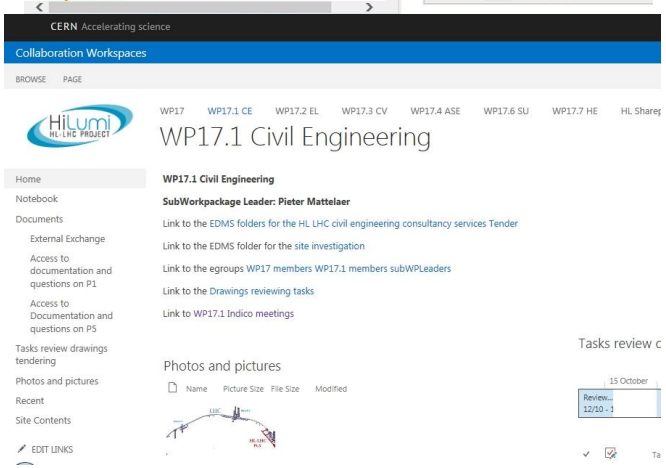
Item	Package Name	Work Package Reference	Detailed Description	Foreseen Cost Range	Foreseen Date for Purchasing Process	Domains Of Activity 1	Domains Of Activity 2 (if any)
1	Q2 Series - Heat exchanger tube	WP03	Heat exchanger tube for the 1st and the 2nd prototype. Orders might be split out for each prototype.	50k<c<200k	May-18	Magnets components and assemblies	N/A
2	Q2 - Strand for series	WP03	Strand for the manufacturing of the Q2 series (2 magnets, PIT 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 (2 magnets, RRP 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 (6 magnets, RRP or PIT wire, not yet decided)	c>750k	Dec-17	Electrical Equipment, electronics and instrumentation for accelerators	N/A
5	Q2-Q4 Corrector series	WP03	A series of 16+4 corrector magnets for Q4 and Q2 - Nb-Ti ribbon cable	c>750k	Jan-18	Magnets components and assemblies	N/A
6	NL correctors	WP03	Series of 36 correctors, plus 9 spares, of 5 different type, based on Nb-Ti wire, superferric	c>750k	Jan-18	Magnets components and assemblies	N/A
7	MCBXFA/B - Single Aperture Corrector Package	WP03	Series of 4+2 long correctors (2.2 m long) plus 8+2 short correctors (1.2 m long) based on Rutherford 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 8 series magnets includes procurement of tooling for assembly and coil manufacturing. Insulated cable, and all coil and structure components provided by CERN	c>750k	Aug-16	Magnets components and assemblies	N/A
9	Q2 - Supporting Structure	WP03	Supply of supporting structures for the inner triplet quadrupole magnets MQXFB including the yoke, load pad and collar structure. CERN intends to place a contract for the supporting structures of the new inner triplet quadrupole magnets MQXFB, including the thick yoke, load pads and collars.The yoke laminations are 50 mm thick and with outer radius of 278 mm separated in four segments. These yoke thick laminations will be assembled together with yoke thin laminations 5.8 mm thick to form a full length stack of about 7.5 m. The pad laminations are 50 mm thick, 20 mm wide and ~200 mm tall. These pad thick laminations will be assembled together with pad thin laminations 5.8 mm thick to form a full length stack of about 7.5 m. The collars are 50 mm thick lamination with an inner radius of 124 mm and a width of about 20 mm. The geometries require high precision milling and/or EDM machining.	c>750k	Feb-17	Magnets components and assemblies	High precision Assembling and manufacturing technologies
	Q2 Series - Parts raw material for supporting		Supply of ARMCO raw material needed for the fabrication of the main supporting components (yoke, loadpads, masters, end-plates) of the new inner triplet MQXFB magnets				

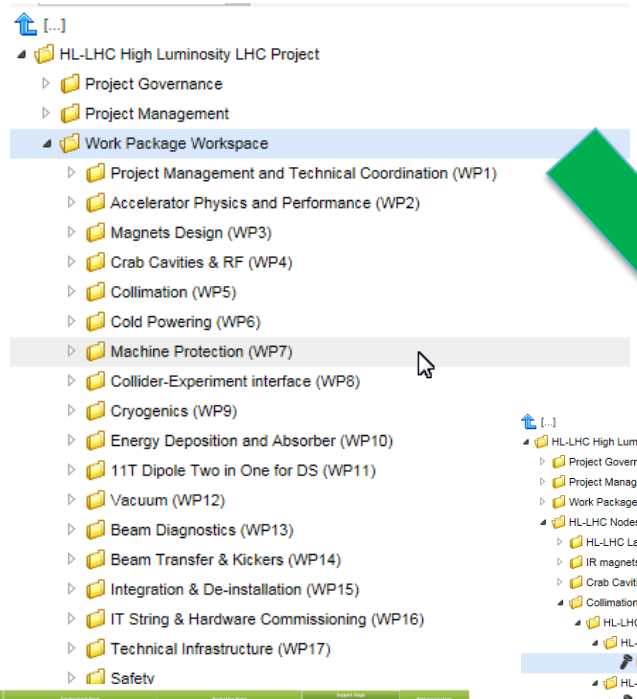
Identification of fields where we need suppliers

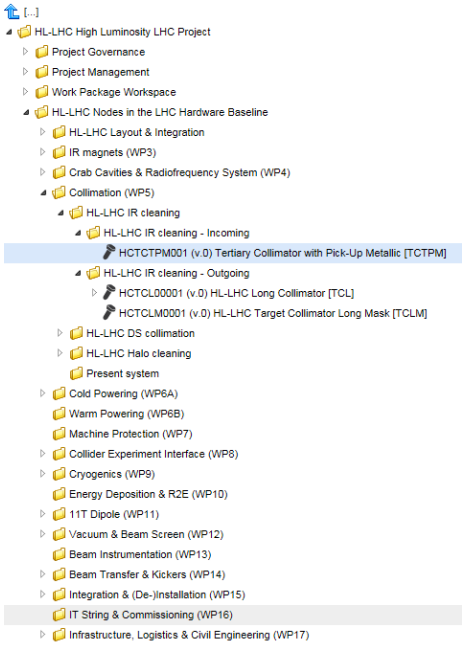
Isabel Bejar Alonso - HL-LHC Sourcing Officer

Design documentation under a common umbrella









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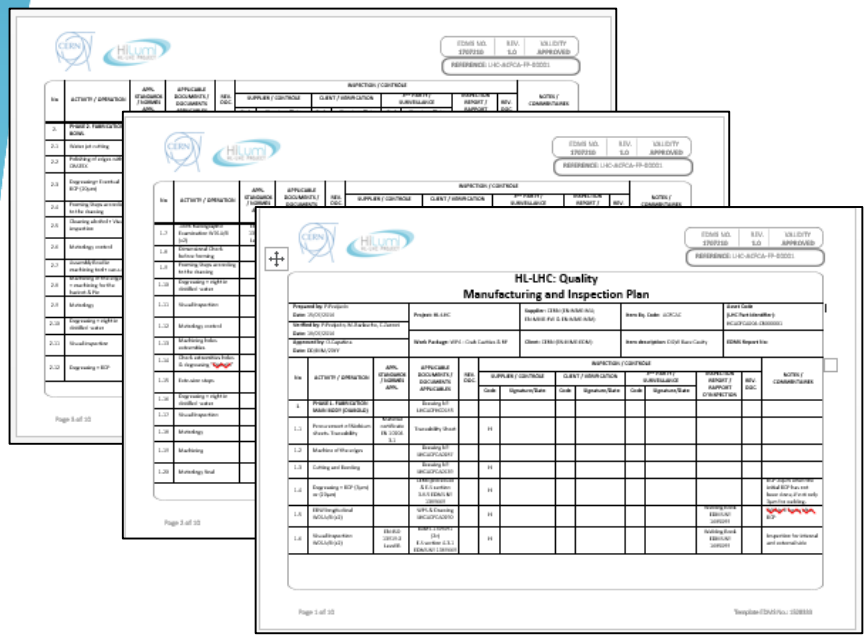
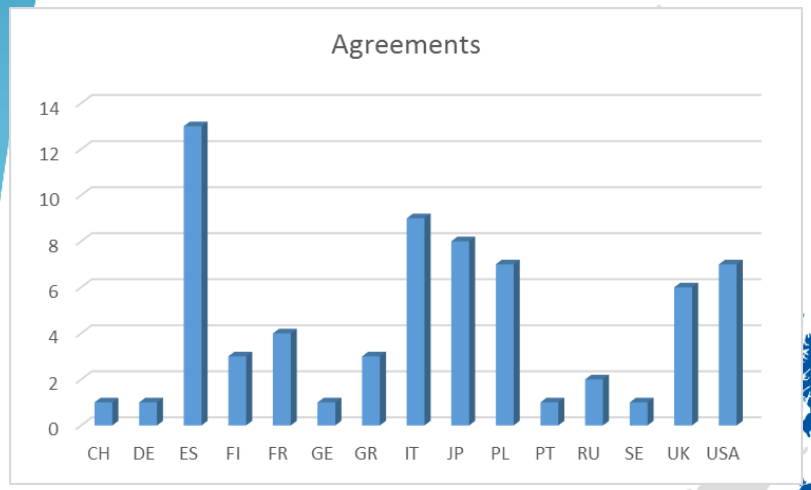
Complete follow up of production

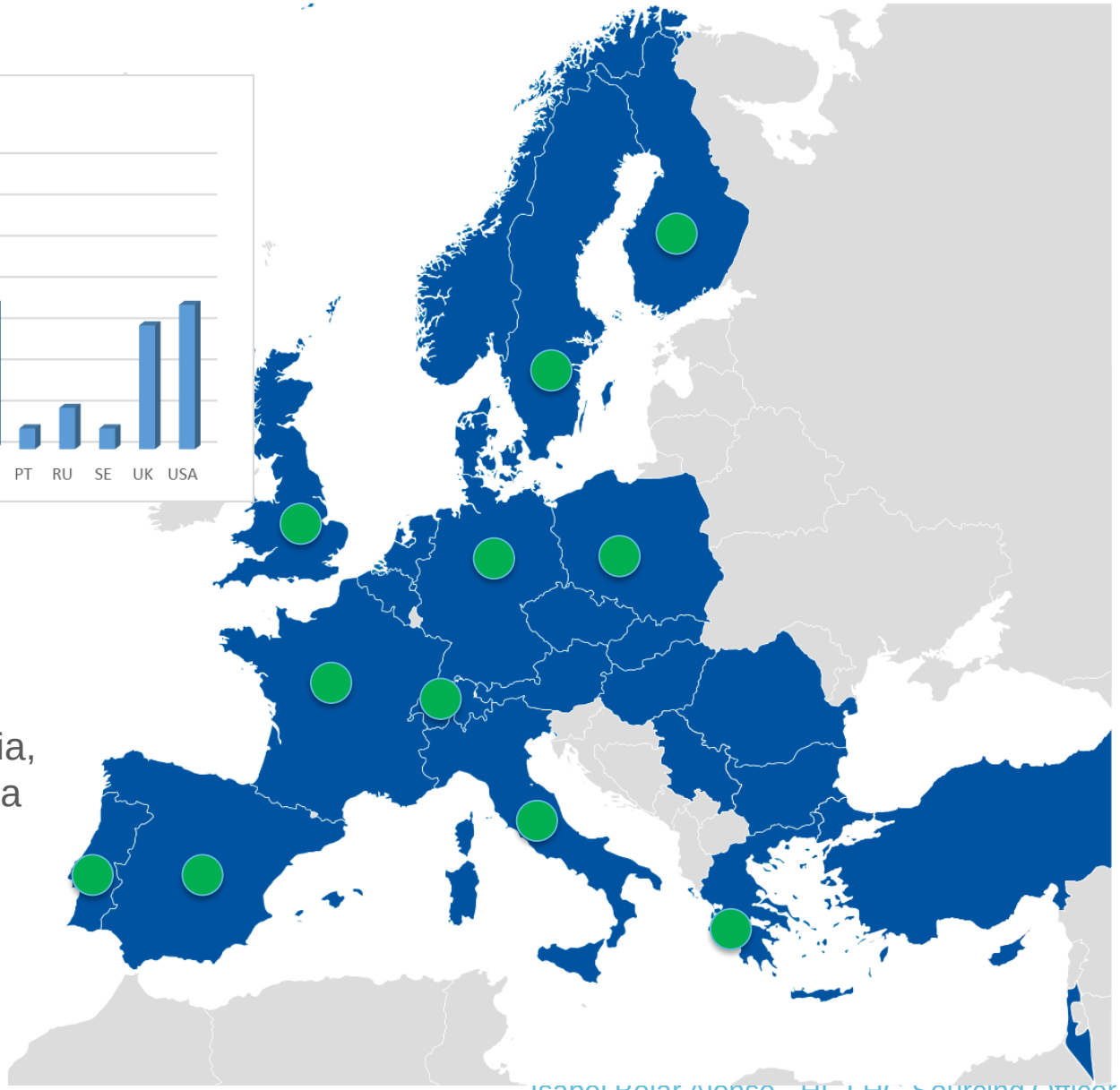


Skilled Engineers & technicians



HL-LHC Existing collaborations

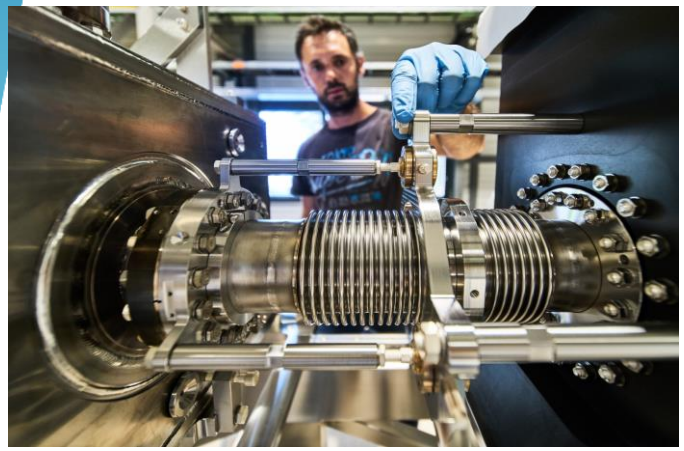
+Georgia, Japan, Russia, USA, Canada and China

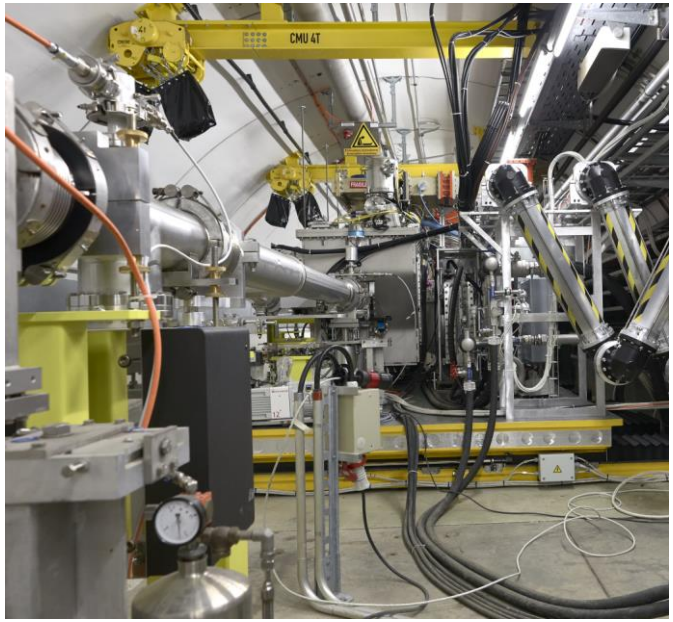


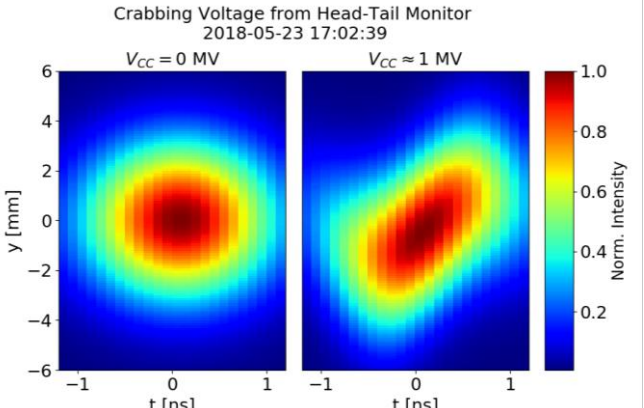
The HL-LHC Project

How well he have done up to now

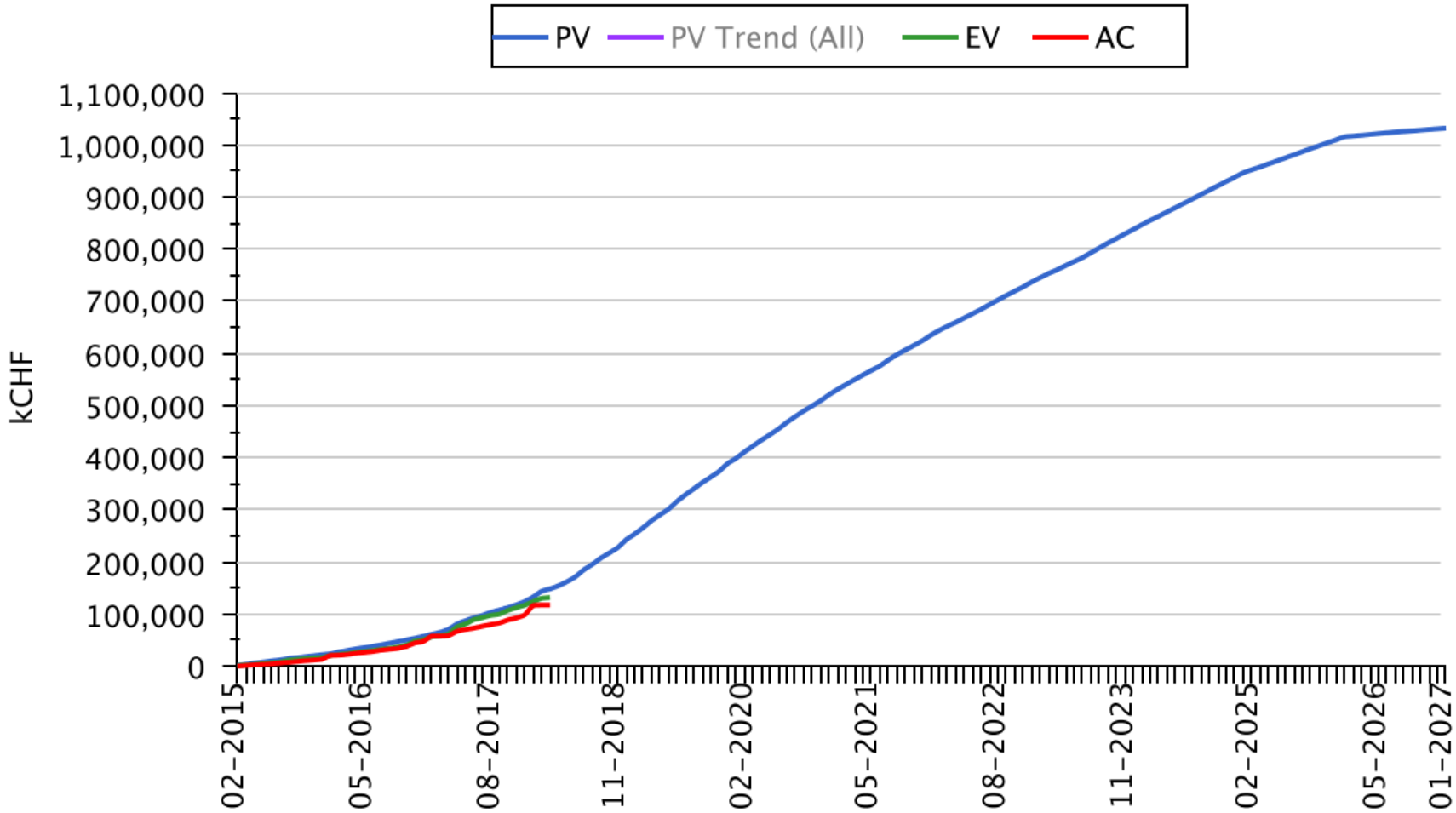
2018–2024: Construction and test of hardware components



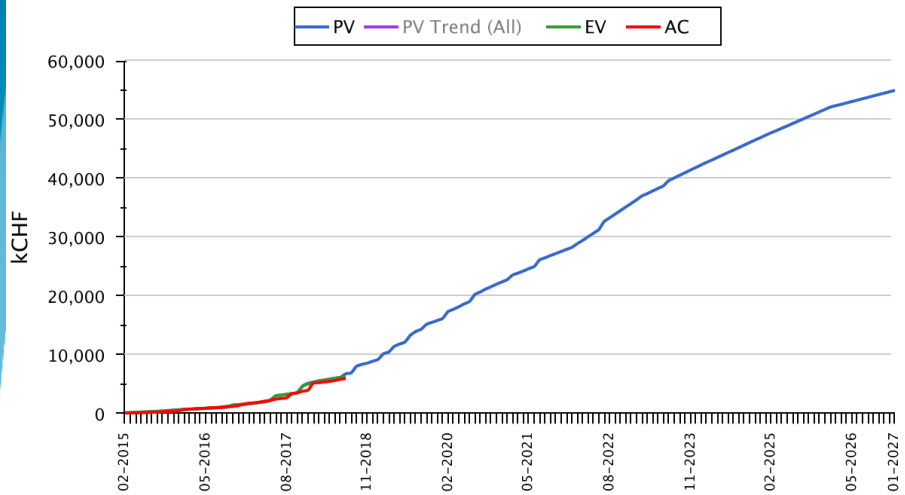


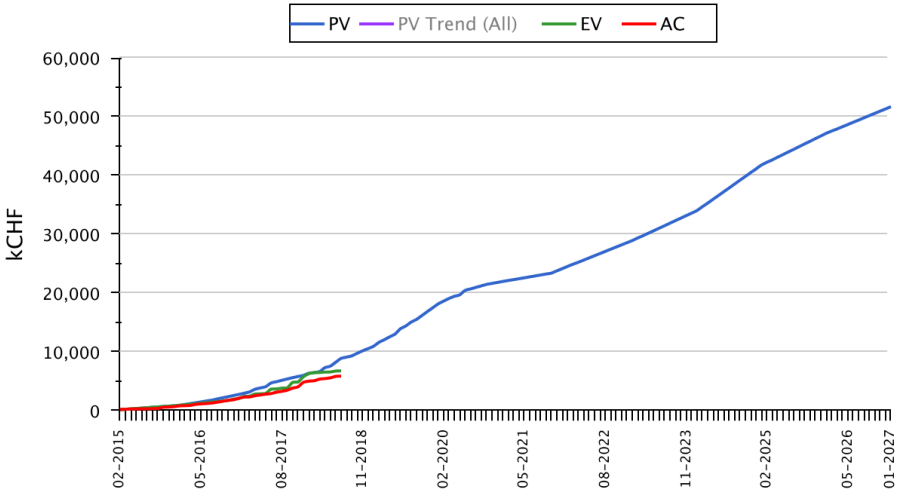


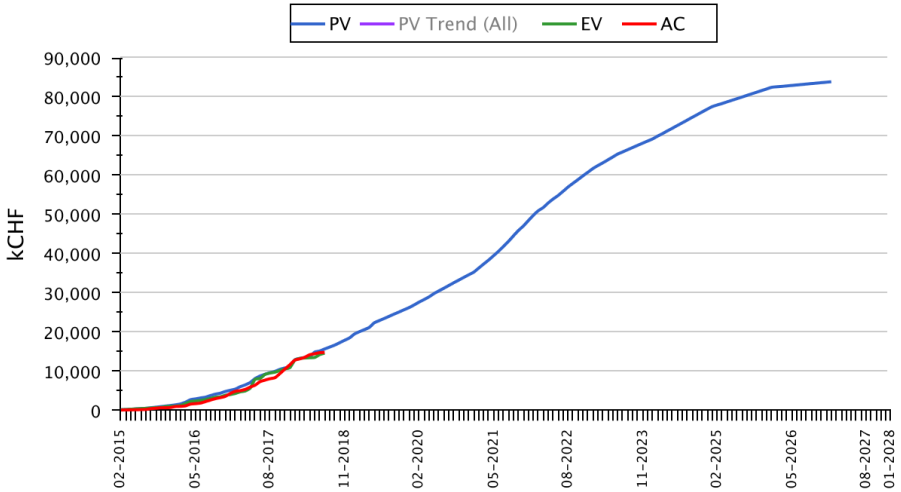
How we are doing? (Plan versus Actual)

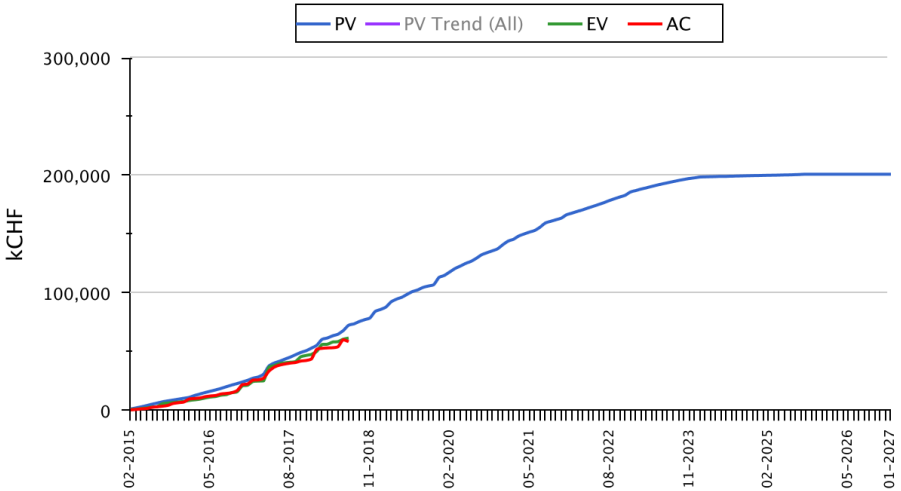


On track for all WPs







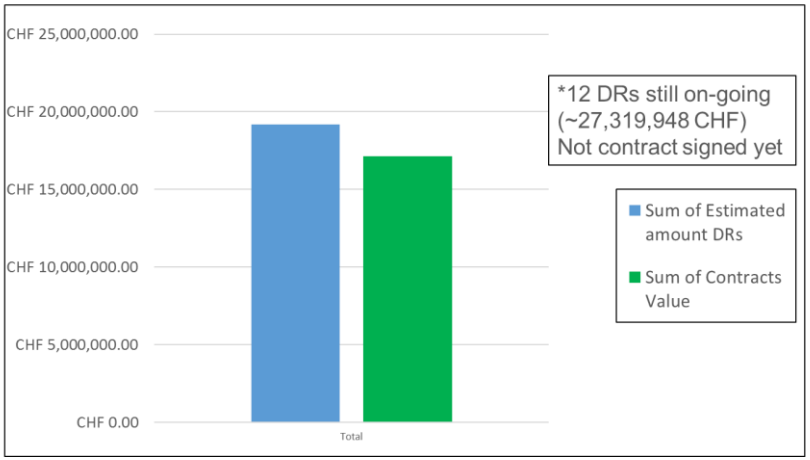


Under cost for most part of components

N° DRs issued: 34*
Estimated value (CHF): 19,834,600.00

N° contracts placed: 22
Actual value (CHF): 17,782,275.12

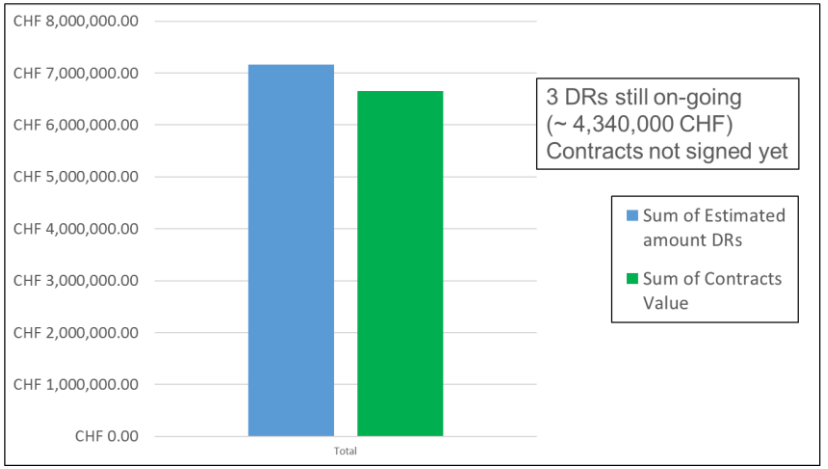
Δ (CHF): **2,052,324.88**



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

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

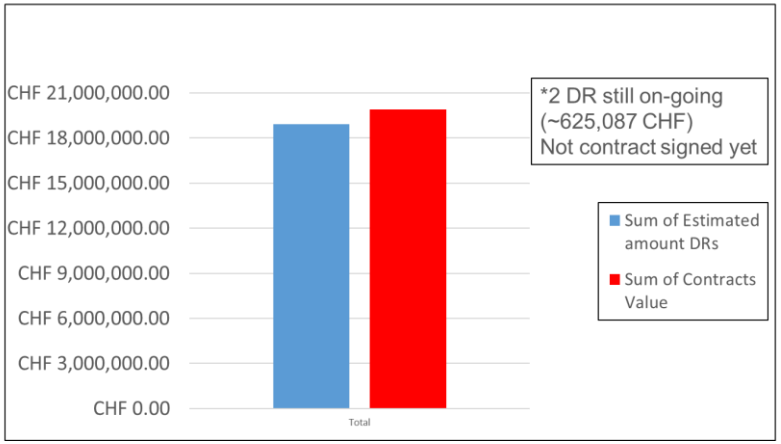
Δ (CHF): **288,786.14**

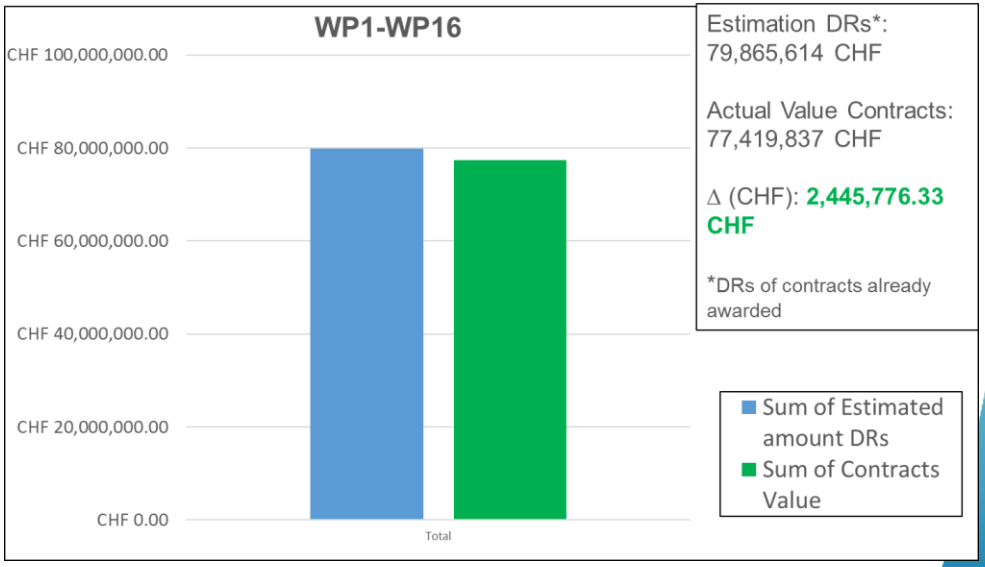


N° DRs issued: 37
Estimated value (CHF): 18,930,382

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

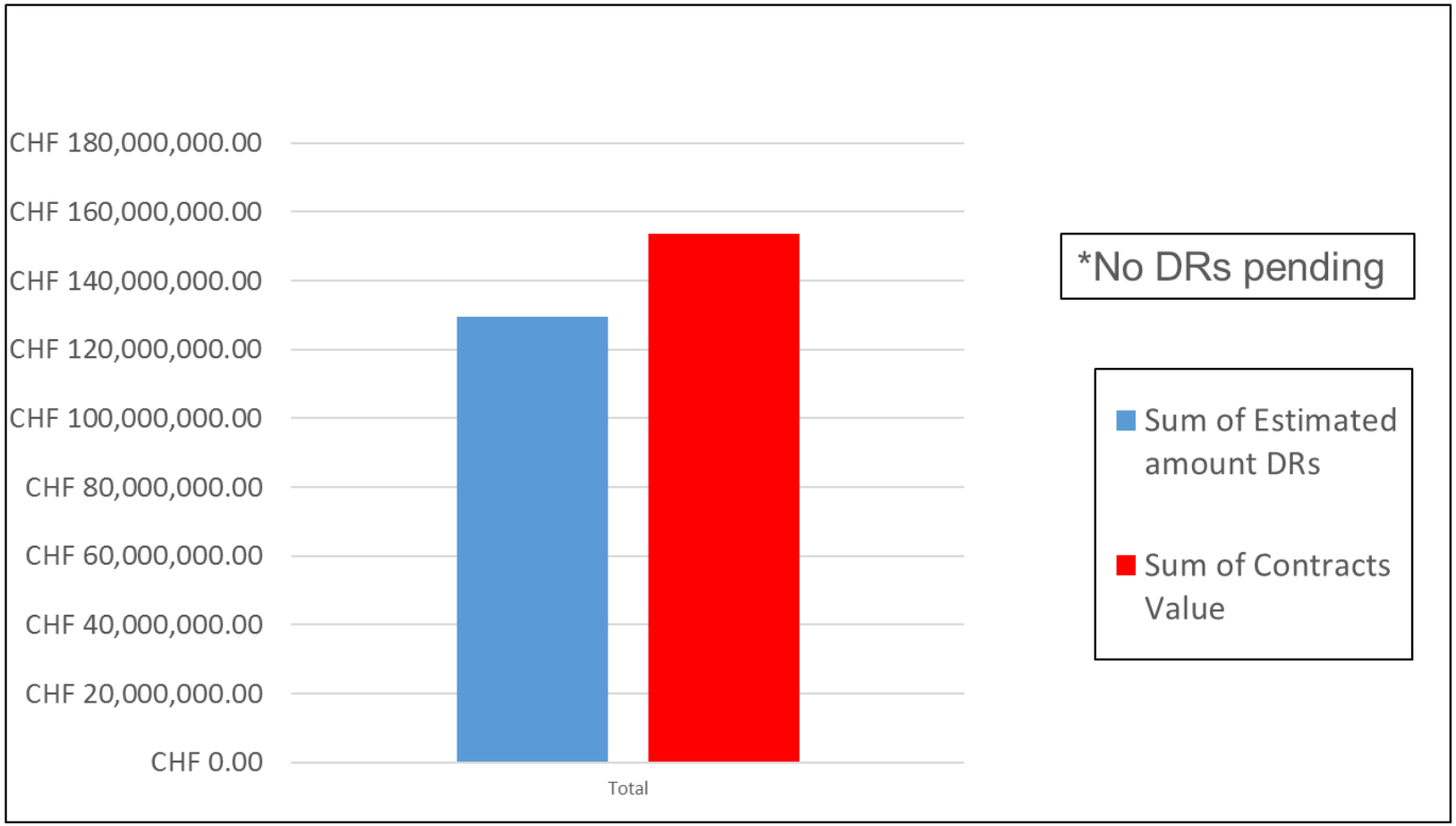
Δ (CHF): **-959,530.9**





Civil engineering and infrastructures

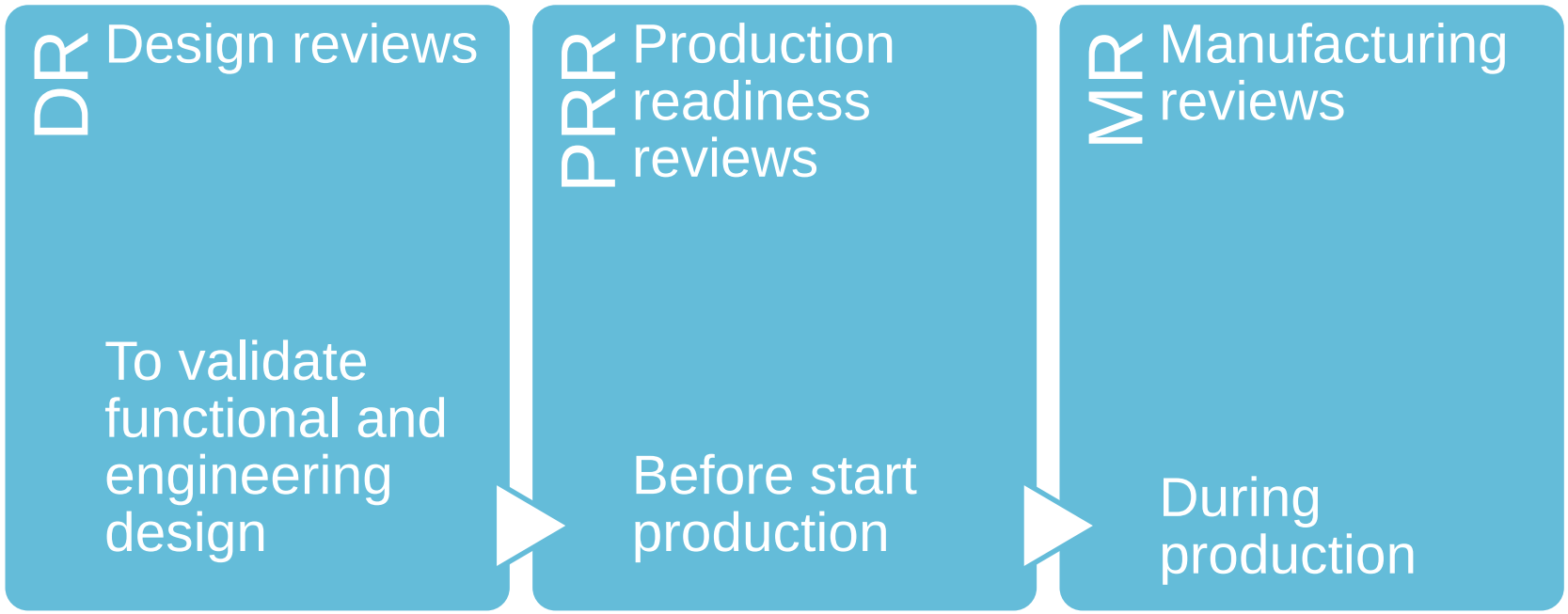
N° DRs issued: 8 Estimated value (CHF): 129,561,500	N° contracts placed: 8 Actual value (CHF): 153,498,143.6	Δ (CHF): **-23,936,643.62**



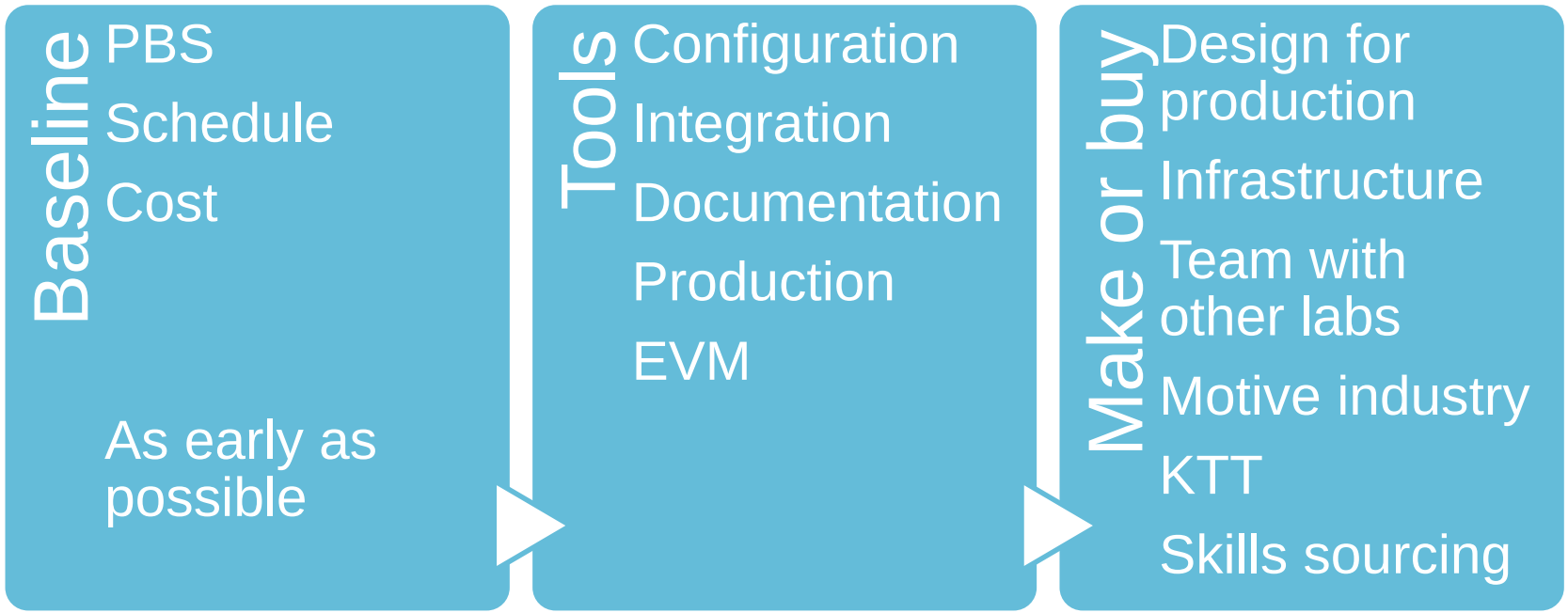
Looking back … would you do the same?

- 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