



HL-LHC (High Luminosity LHC)

Technical needs

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HL-LHC Configuration, Quality & Resources Officer

On behalf of the HL-LHC Project team

Norway@CERN, CERN, May 2017

The HL-LHC Project

What, when, where, by whom?

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⁻¹ 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.

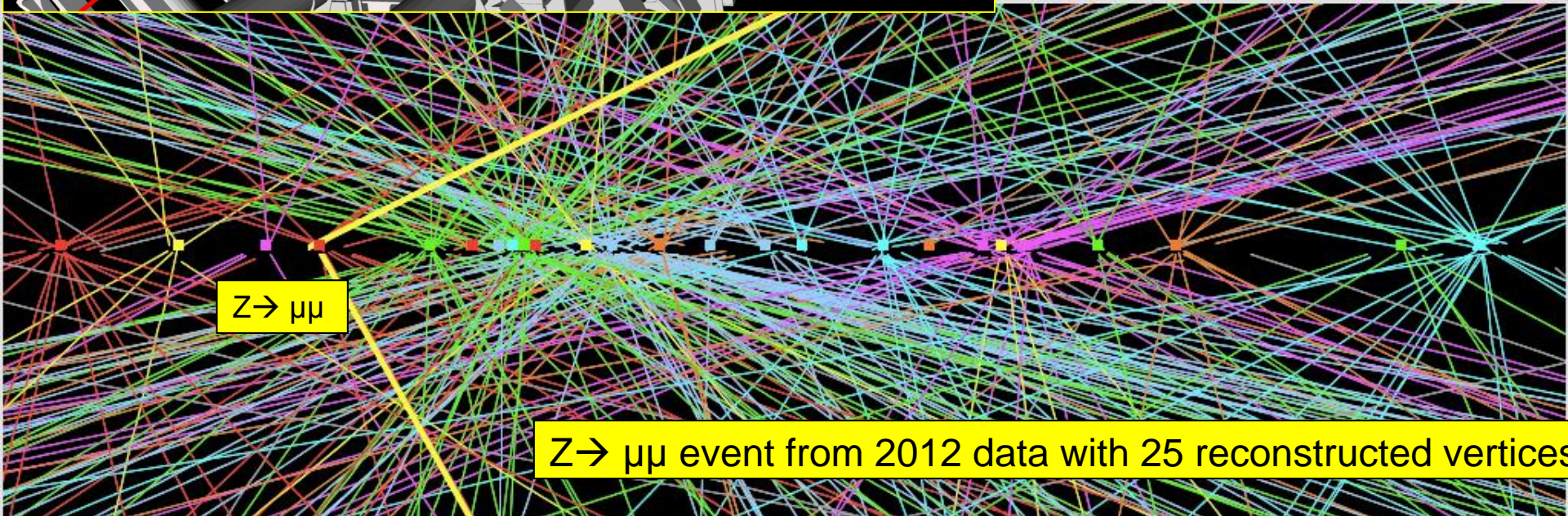
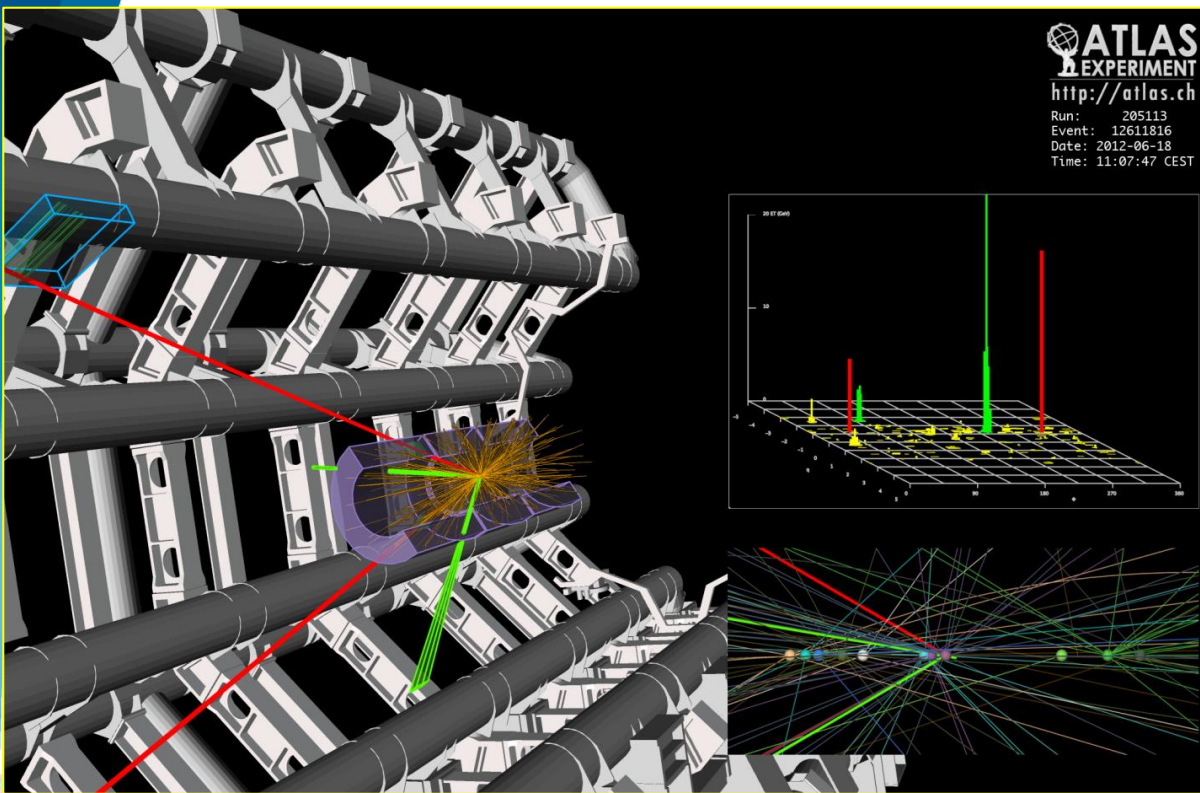
Ultimate performance established 2015-2016: with same hardware and same beam parameters: use of **engineering margins**:

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

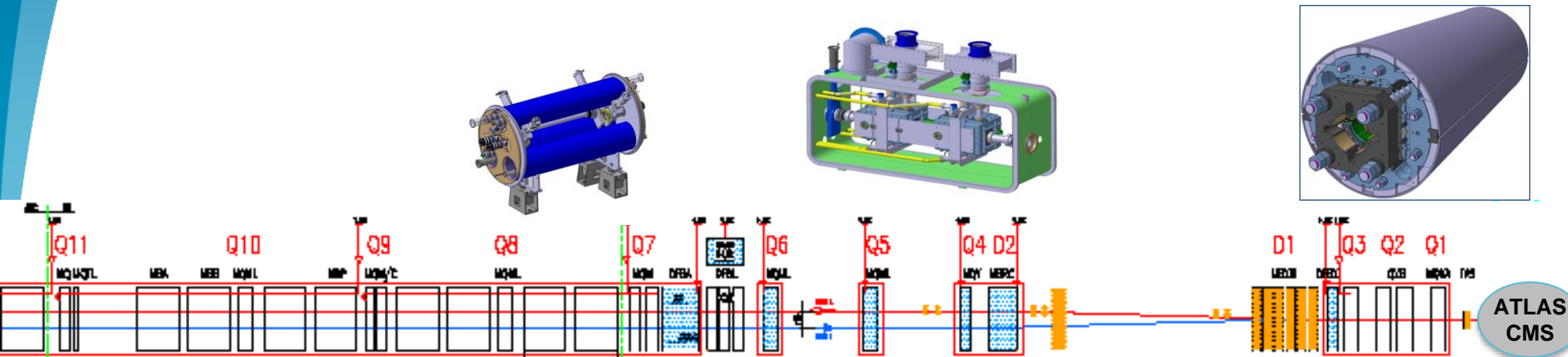
More luminosity
⇒ higher the
collision rate

Higgs: the needle in
the haystack

Picture repeated 40
millions times each
second



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 !!

How it could look like in point 5 (after HL)

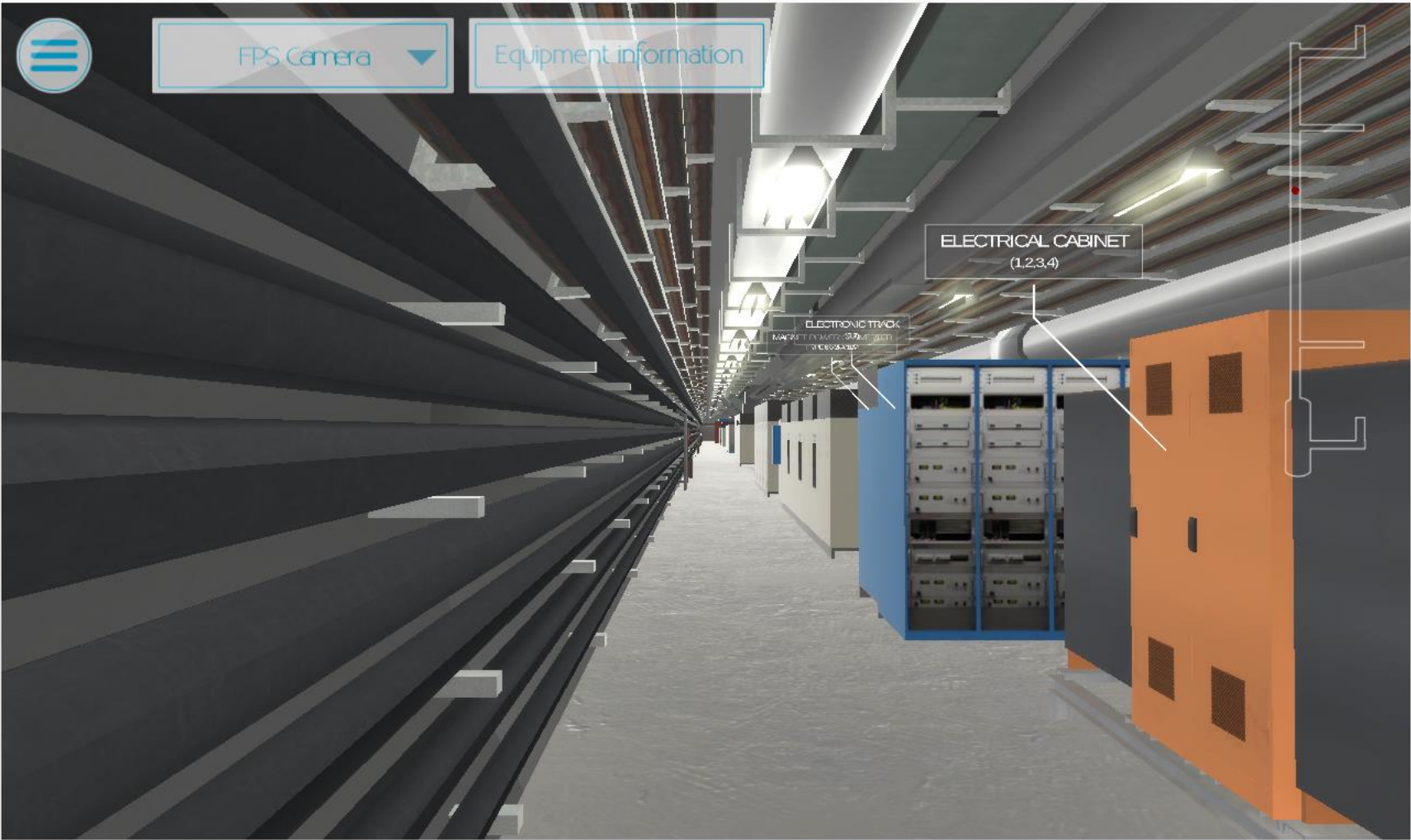


unity WebGL

HiLumi3D

- <https://play.google.com/store/search?q=hilumi3d>

On the new HL-LHC infrastructures

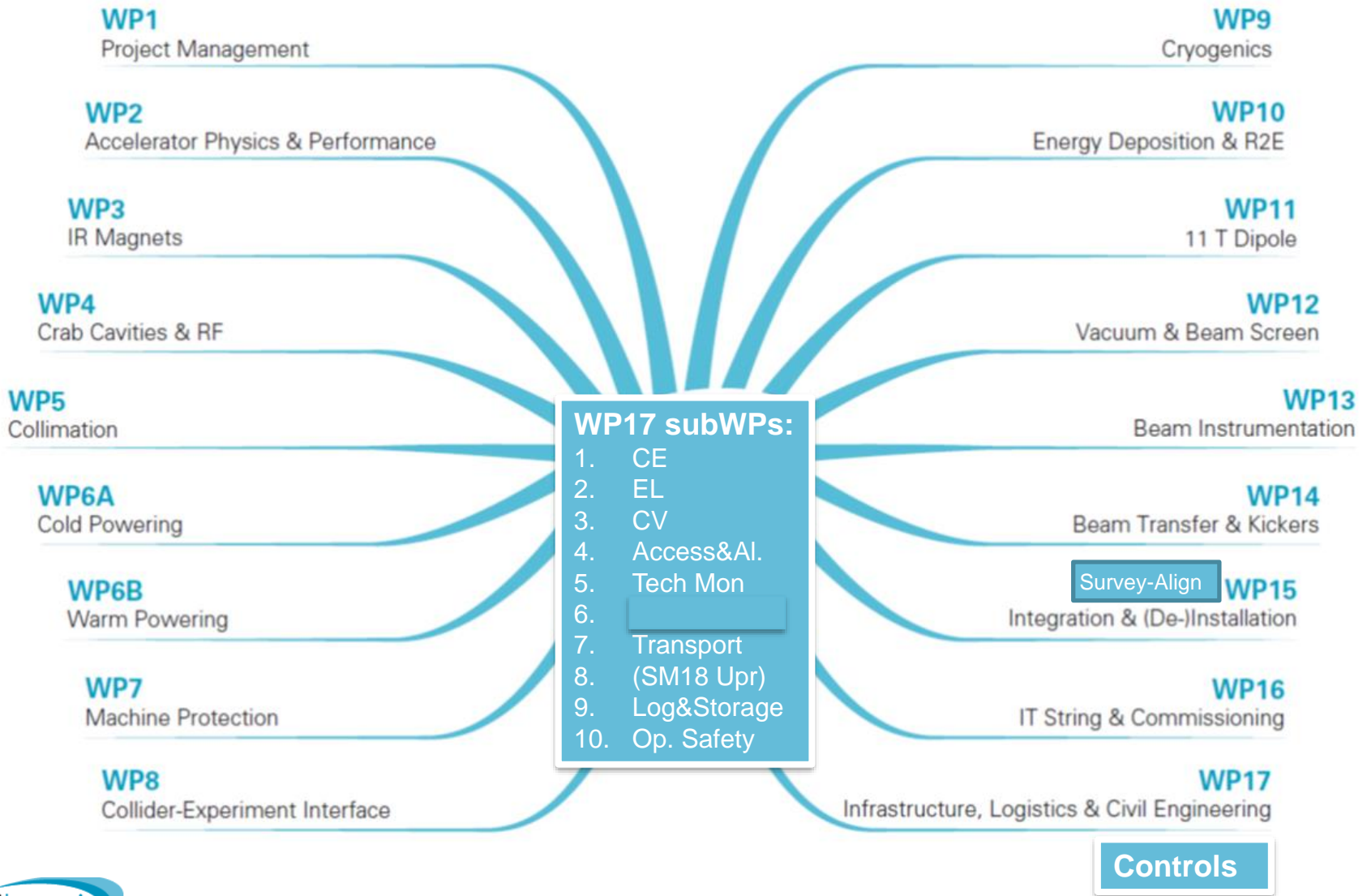


unity WebGL

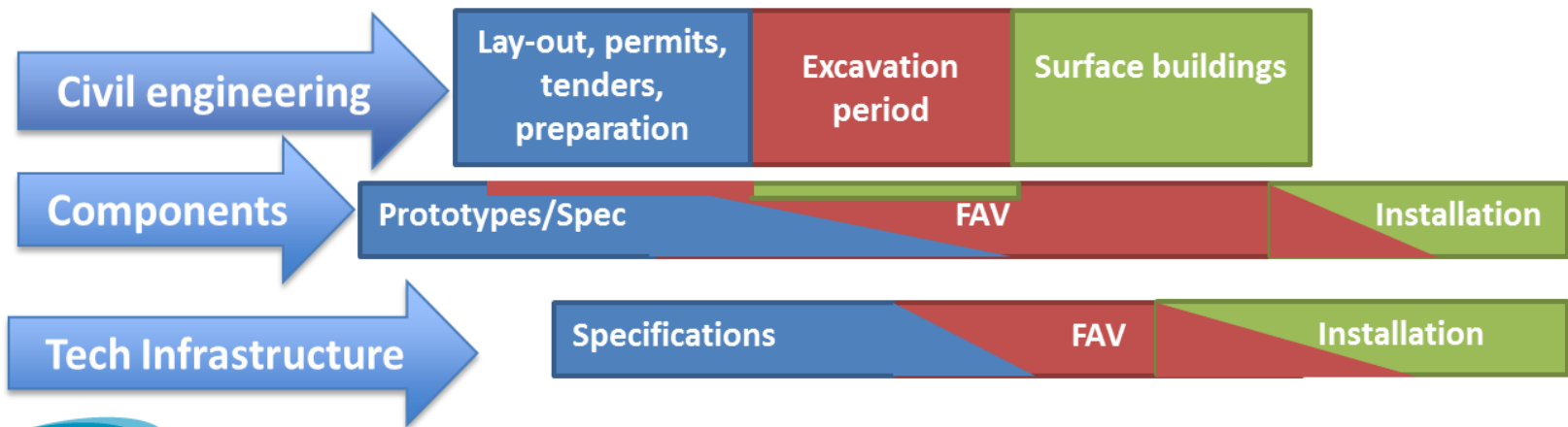
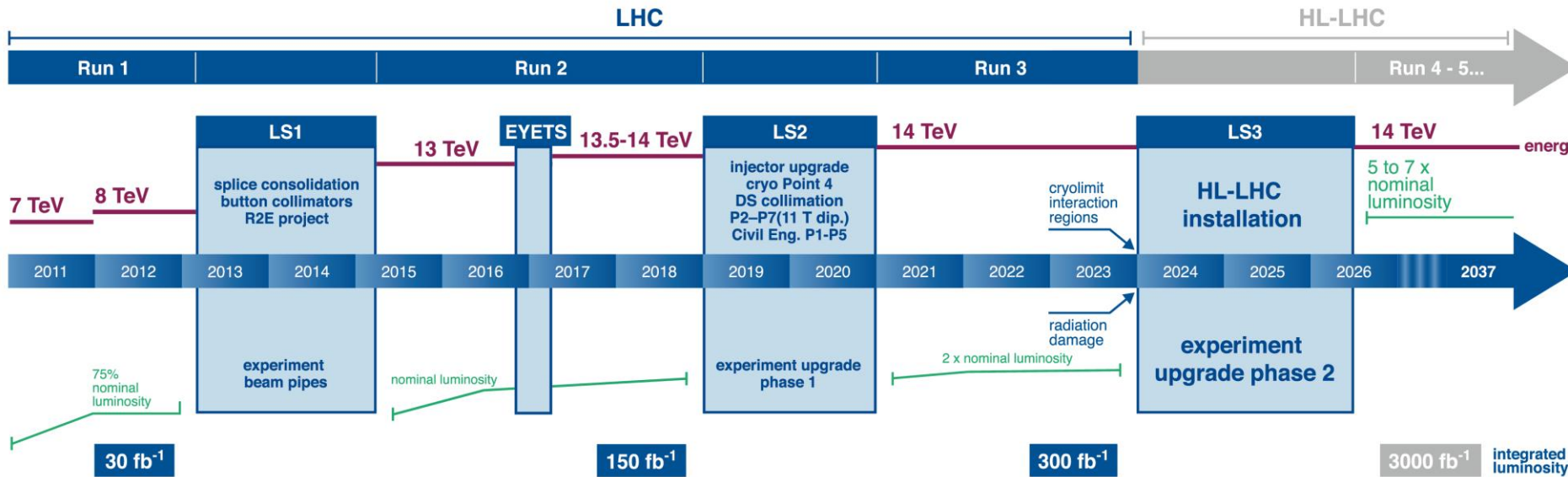
HiLumi3D



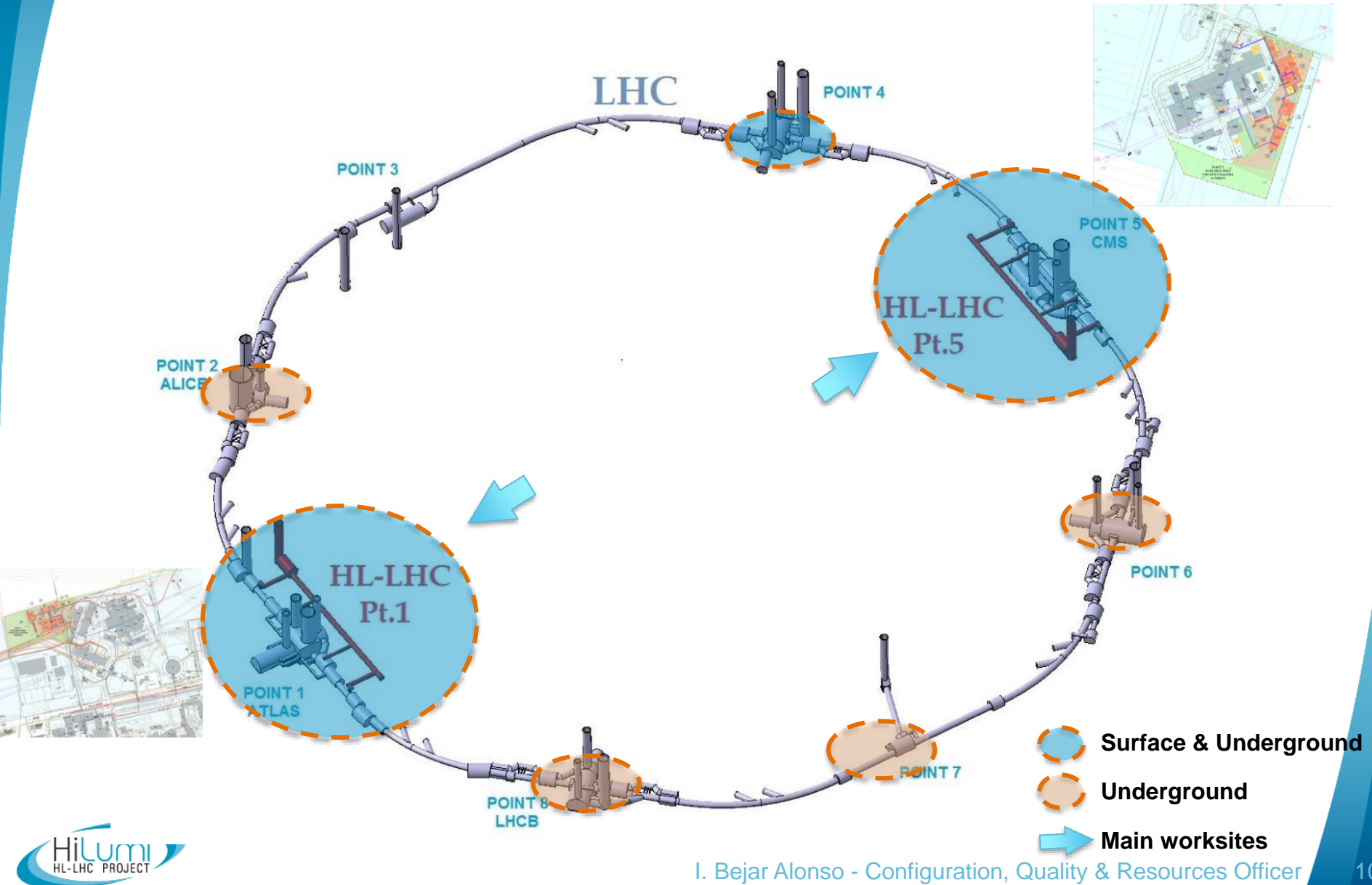
Project structure



LHC / HL-LHC Plan



Many points around the ring



The HL-LHC Project



High Luminosity LHC Participants



HL-LHC needs your industry

- 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

We have to find the right industrial partners all around our member states on time and having the best added value

HL-LHC needs your industry

Our work axis

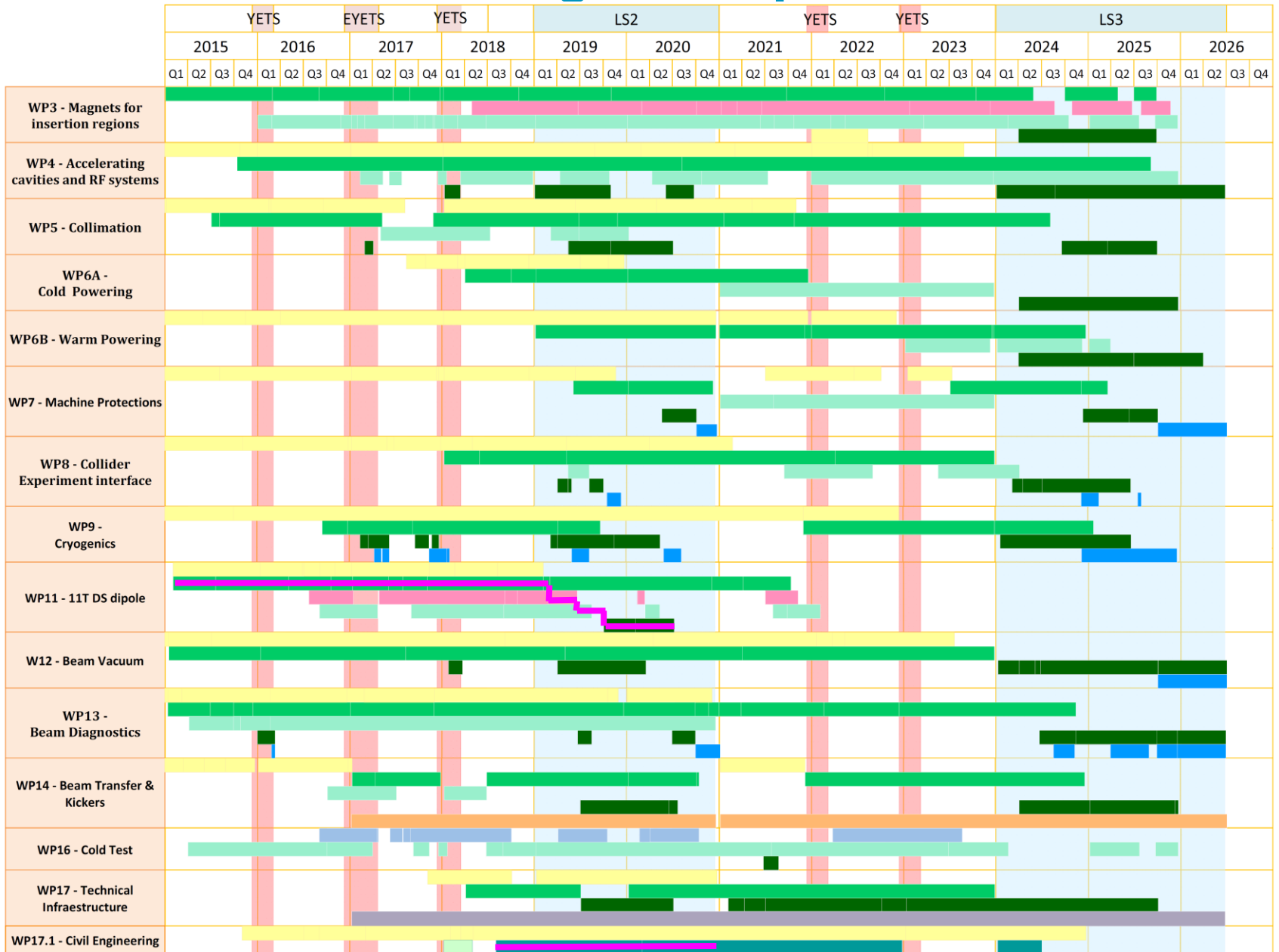
Provide you timely information of what we require and for when

Clear list of what we will need, their main characteristics and when the tendering process will start with easy access to the documents

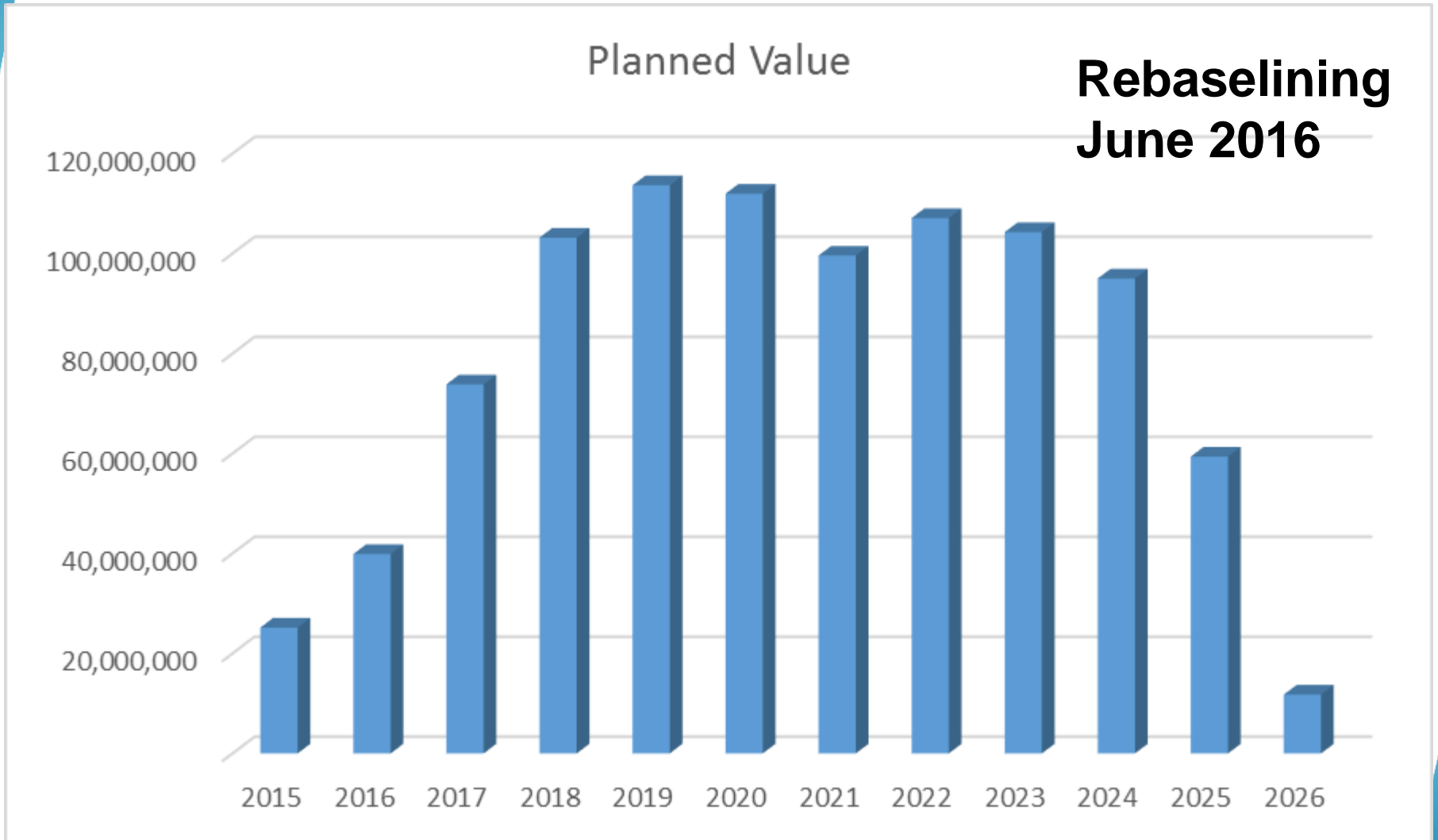
Industry

Procurement for HL-LHC

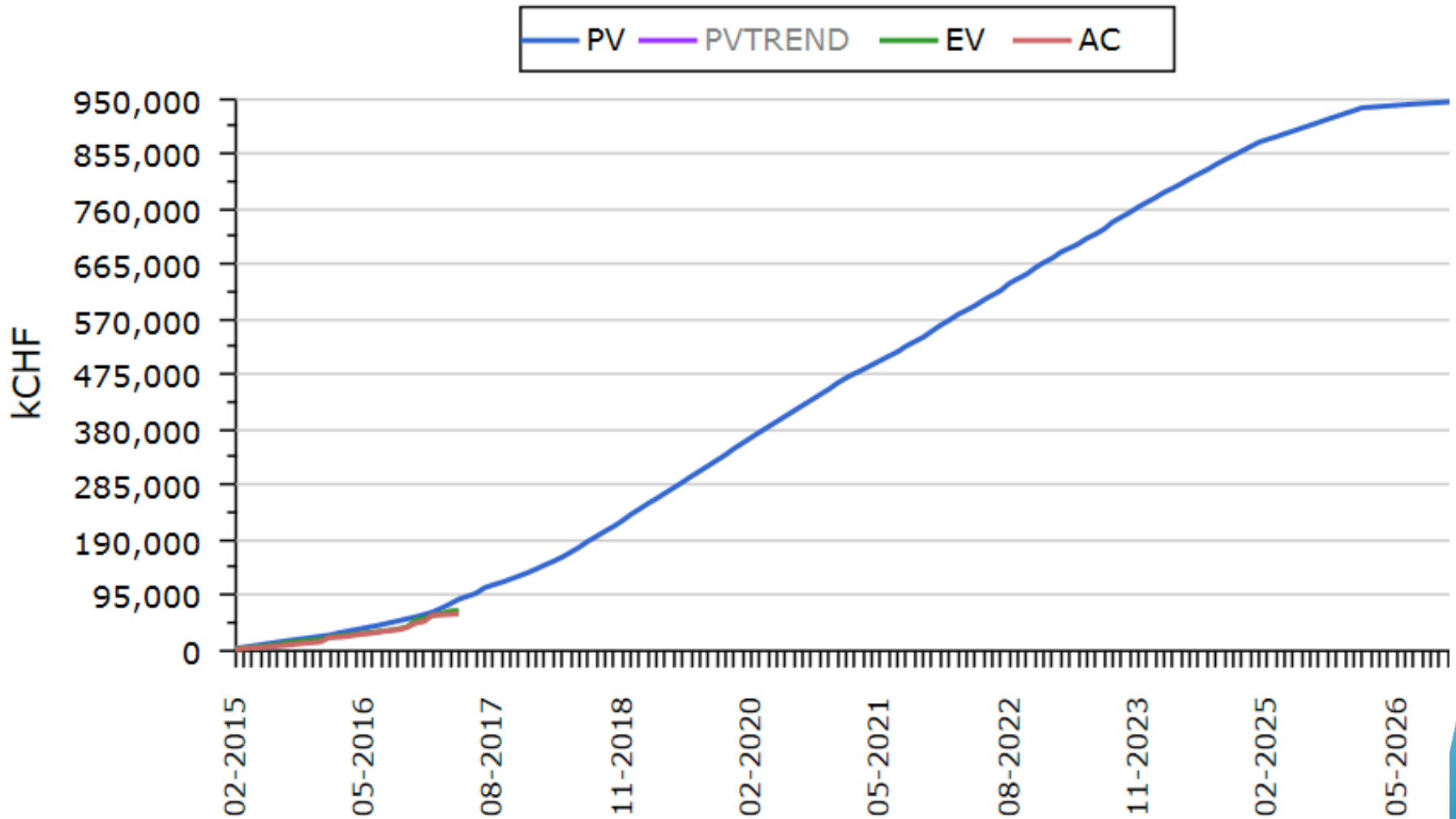
Detailed general plan



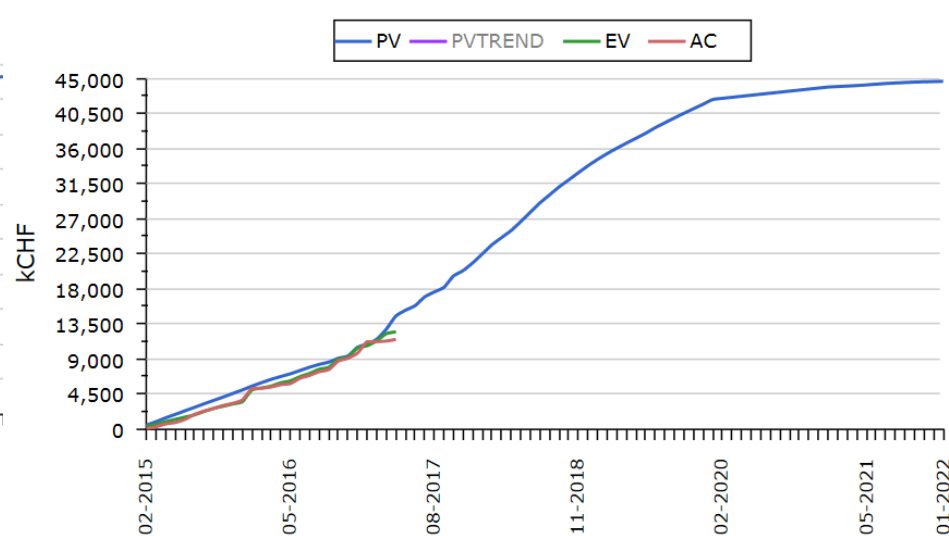
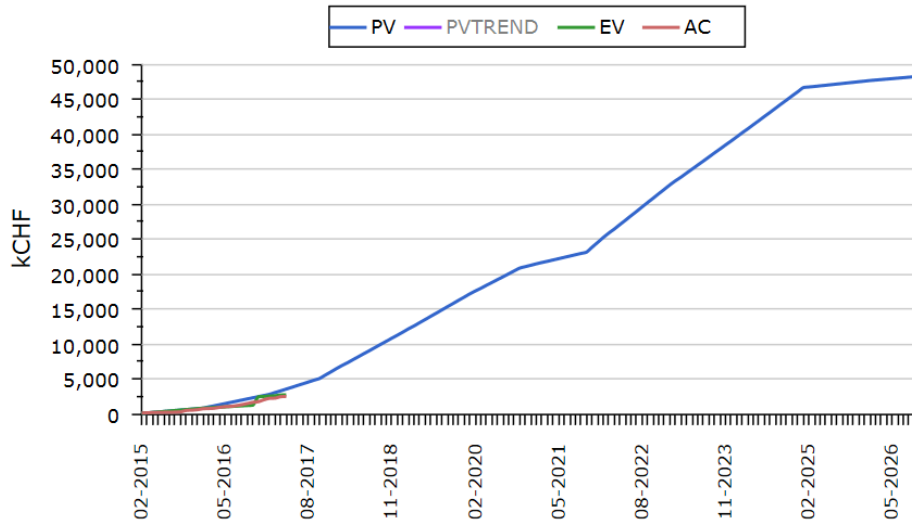
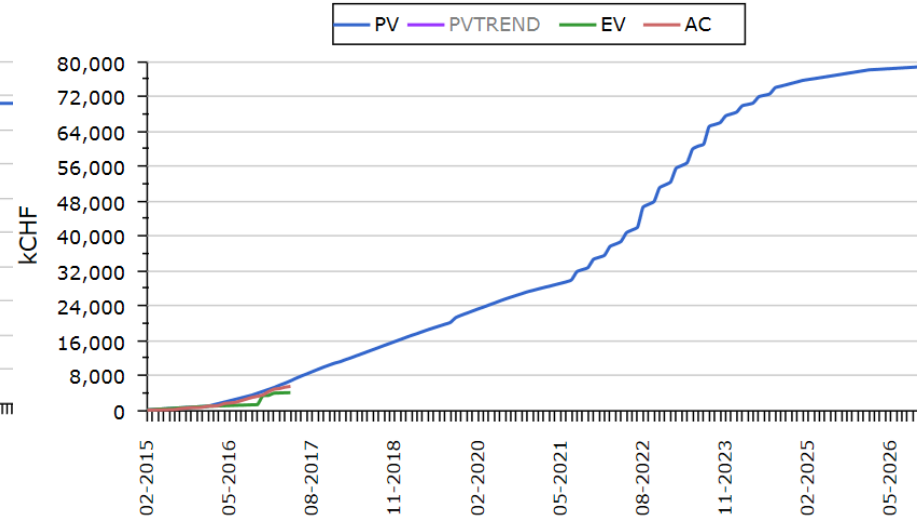
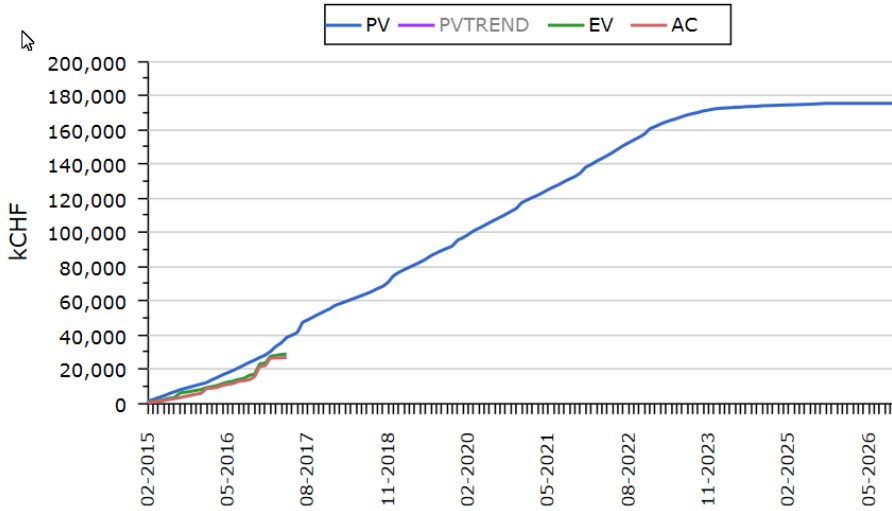
New post 2016 Cost & Schedule review



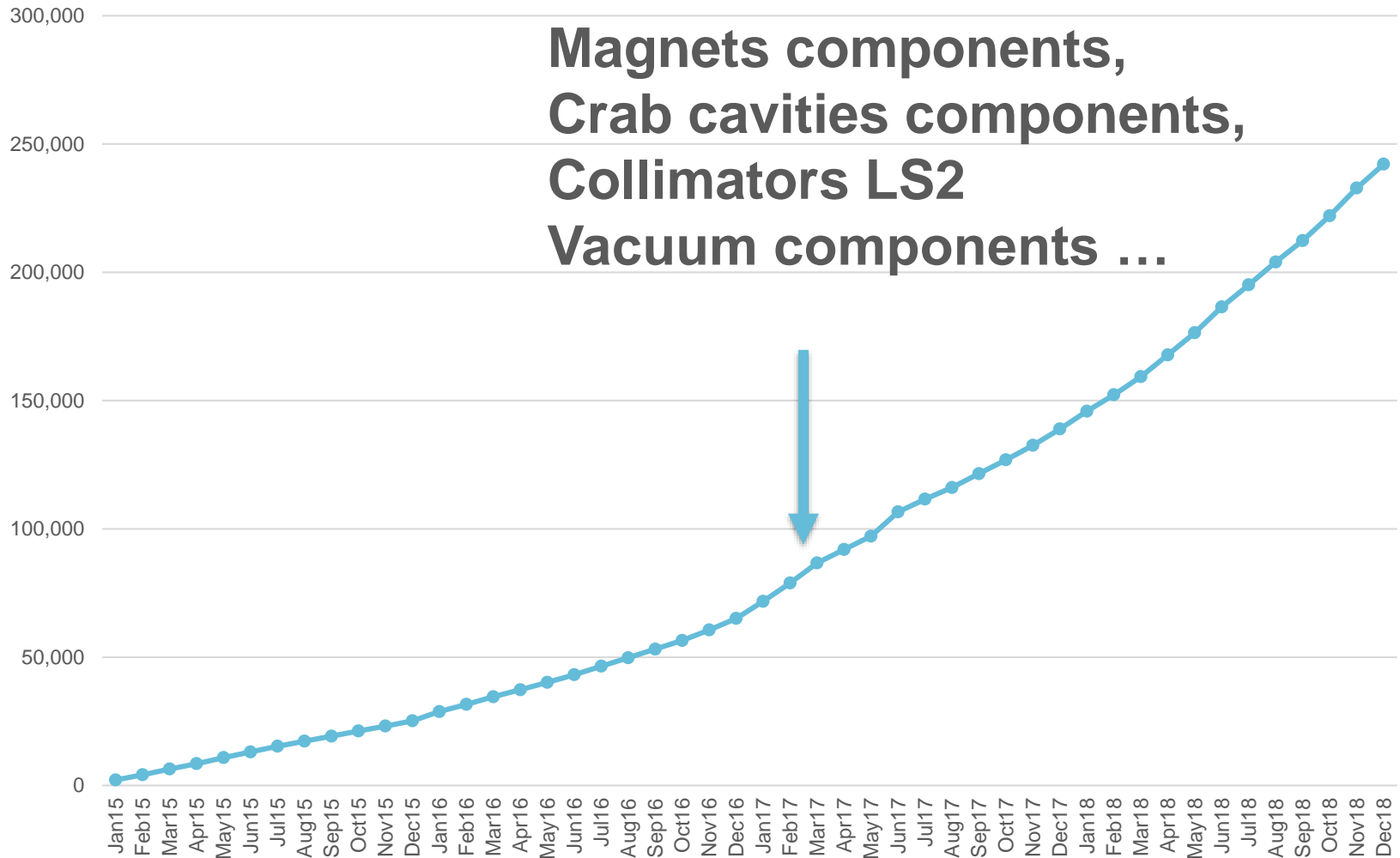
How we are doing? (Plan versus Actual)



On track for all WPs



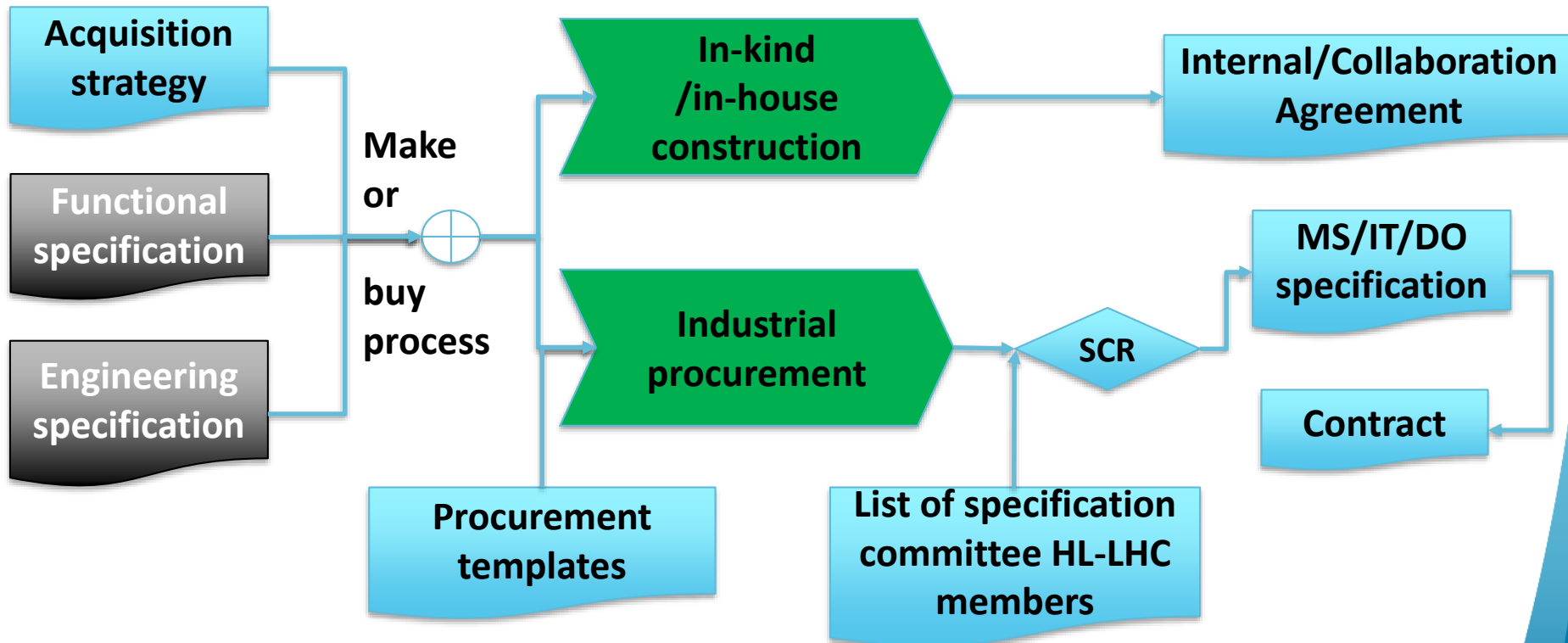
Ramping up!



Industry

Make or buy process

Acquisition process



SCR: Specification Committee Review

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](http://WWW:HL-LHC_Knowledge_&_Industry)

Industry & Knowledge WP6B



Example of procurement lists/suppliers

Domains of Activity	Presently identified as potential suppliers			
Magnets Cryostat	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)

CDMS NO. STRATEGY REV. 1.2 VALIDITY VALUE ACQUISITION PUBLIC

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	<175k	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	<175k	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	<175k	Dec-17	Electrical Equipment, electronics and instrumentation for accelerators	N/A
5	Q2-Q4 Connector series	WP03	A series of 4-lead connector magnets for Q4 and Q2 - 160-70 ribbon cable	<175k	Jan-18	Magnets components and assemblies	N/A
6	MC connectors	WP03	Series of 36 connectors, plus 9 spares, of 3 different type, based on 160-70 wire, superflex	<175k	Jan-18	Magnets components and assemblies	N/A
7	MCSTRAP - Single Aperture Connector Package	WP03	Series of 60 long connectors (2.2 m long) plus 60 short connectors (0.2 m long) based on 160-70 ribbon cable	<175k	Jan-18	Magnets components and assemblies	N/A
8	Q2 Series - Coil production	WP03	Fabrication of 2 coils and assembly in one CEBS 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. Heavy of supporting structure for the inner triplet quadrupole magnets MQ2P3 including the yoke, lead pad and collar structure. CERN intends to place a contract for the supporting structure of the new inner triplet quadrupole magnets MQ2P3, including the thick yoke, lead pads and coils. The pole laminations are 20 mm thick and with outer radius of 238 mm separated in four segments. These pole thick laminations will be assembled together with pole thin laminations 5.0 mm thick to form a full length stack of about 7.1 m. The pole laminations are 10 mm thick, 20 mm wide and 1200 mm tall. These pole thick laminations will be assembled together with pole thin laminations 5.0 mm thick to form a full length stack of about 7.1 m. The coils are 30 mm thick laminations with an inner radius of 134 mm and a width of about 20 mm. The geometries require high precision rolling and EDM machining.	<175k	Aug-18	Magnets components and assemblies	N/A
9	Q2 - Supporting Structure	WP03	Supply of ARABCO raw material needed for the fabrication of the main supporting components (yoke, leadpads, magnets, and plates) of the new inner triplet MQ2P3 magnets	<175k	Feb-17	Magnets components and assemblies	High precision assembling and manufacturing technologies
10	Q2 Series - Parts case making for assembly						

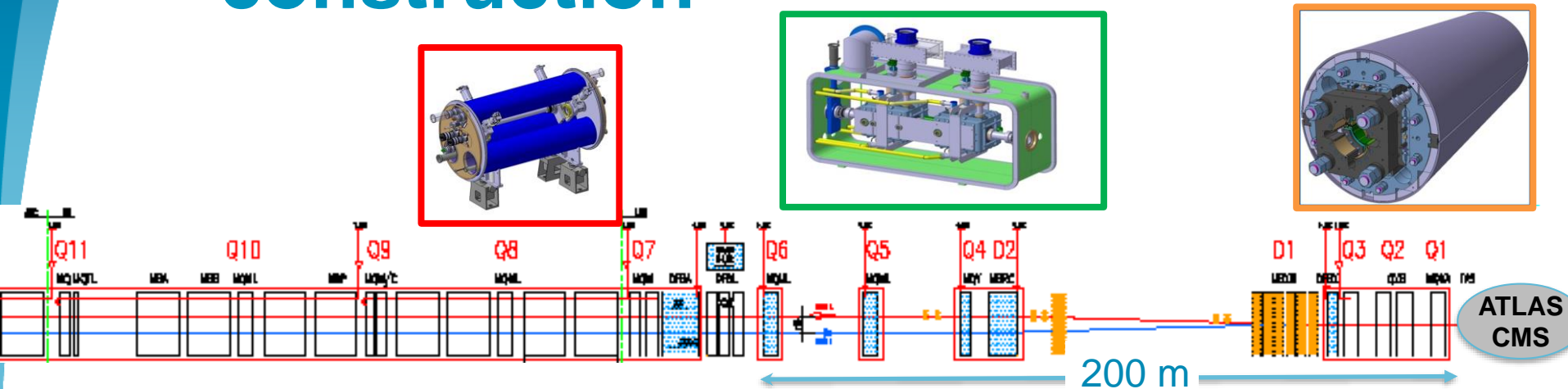
Identification of fields where we need suppliers



The HL-LHC Project

Main components, technical services and infrastructure

The largest HEP accelerator in construction



Dispersion Suppressor (DS)

Modifications

1. In IP2: new DS collimation in c. Cryostat
2. In IP7 new DS collimation with 11 T

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

Matching Section (MS)

Complete change and new lay-out

1. TAN
2. D2
3. CC
4. Q4
5. All correctors
6. Q5
7. New MQ in P6
8. New collimators

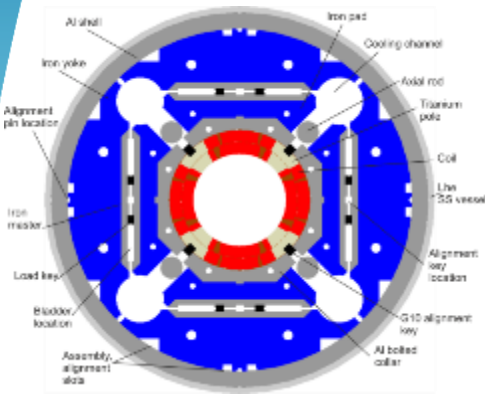
Interaction Region (ITR)

Complete change and new lay-out

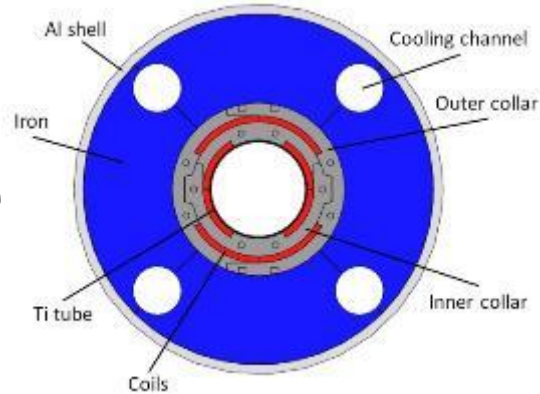
1. TAXS
2. Q1-Q2-Q3
3. D1
4. All correctors
5. Heavy shielding (W)

> 1.2 km of LHC

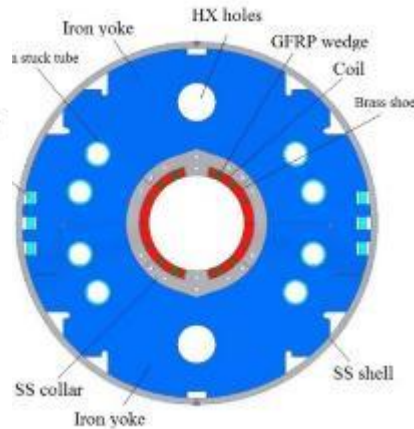
HiLumi LHC magnet zoo



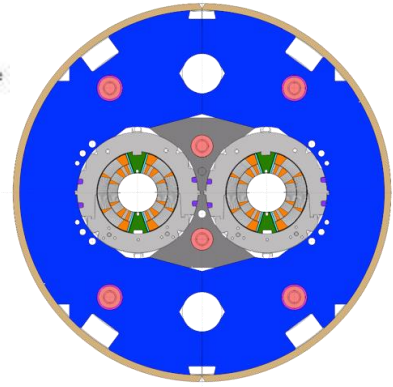
Triplet QXF (LARP and CERN)



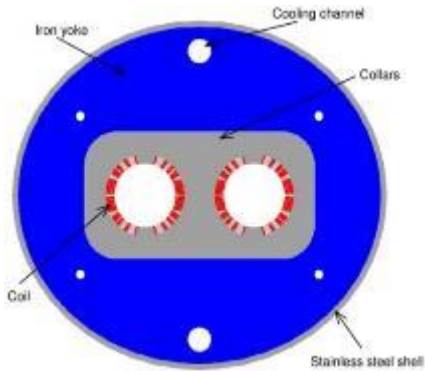
Orbit corrector (CIEMAT)



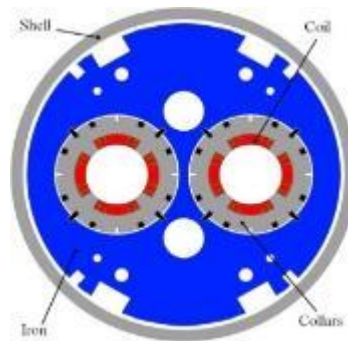
Separation dipole D1 (KEK)



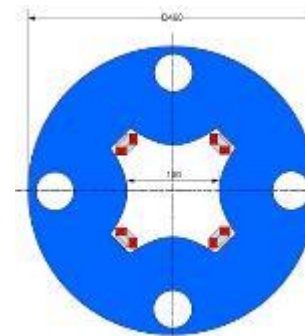
11 T dipole (CERN)



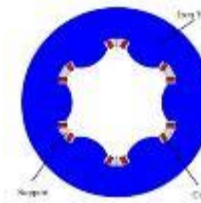
Recombination dipole D2 (INFN)



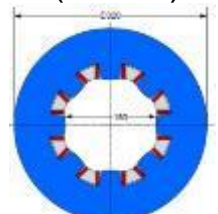
Q4 (CEA)



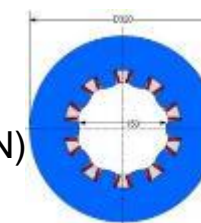
Skew quadrupole (INFN)



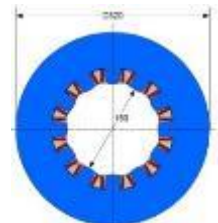
Sextupole (INFN)



Octupole (INFN)



Decapole (INFN)

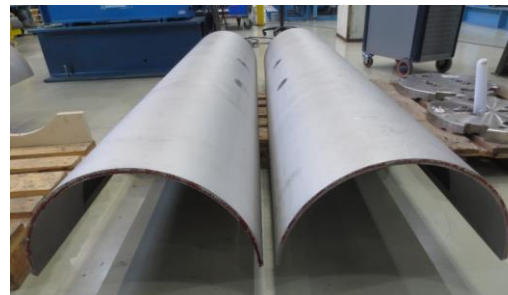
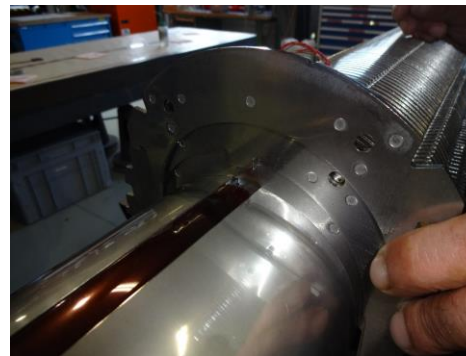
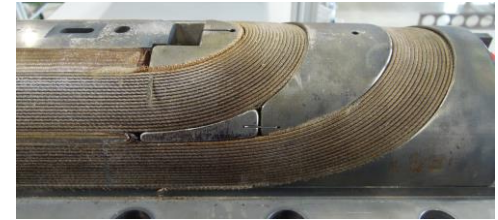
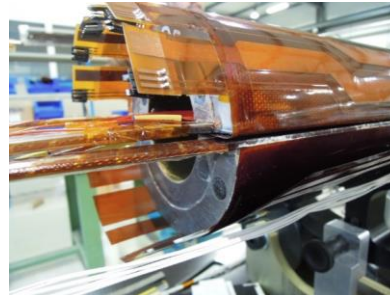


Dodecapole (INFN)

Overall, about 150 magnets are needed

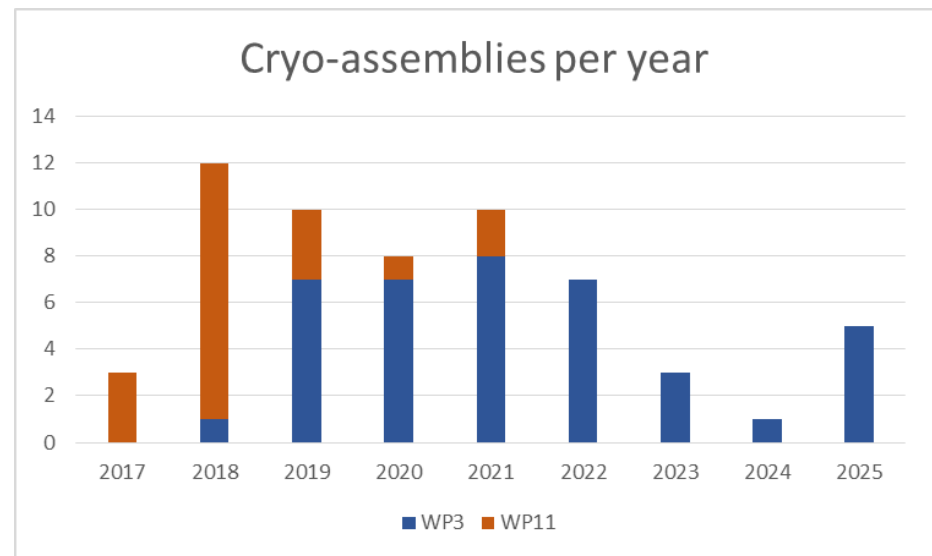
Magnets components and assemblies

- Non exhaustive list of components
 - Coil:
 - Impregnation resin
 - Winding poles
 - End spacers
 - Wedges
 - Quench heaters
 - Magnet:
 - Collars
 - Yoke laminations
 - Cold mass:
 - End domes
 - SS half shells



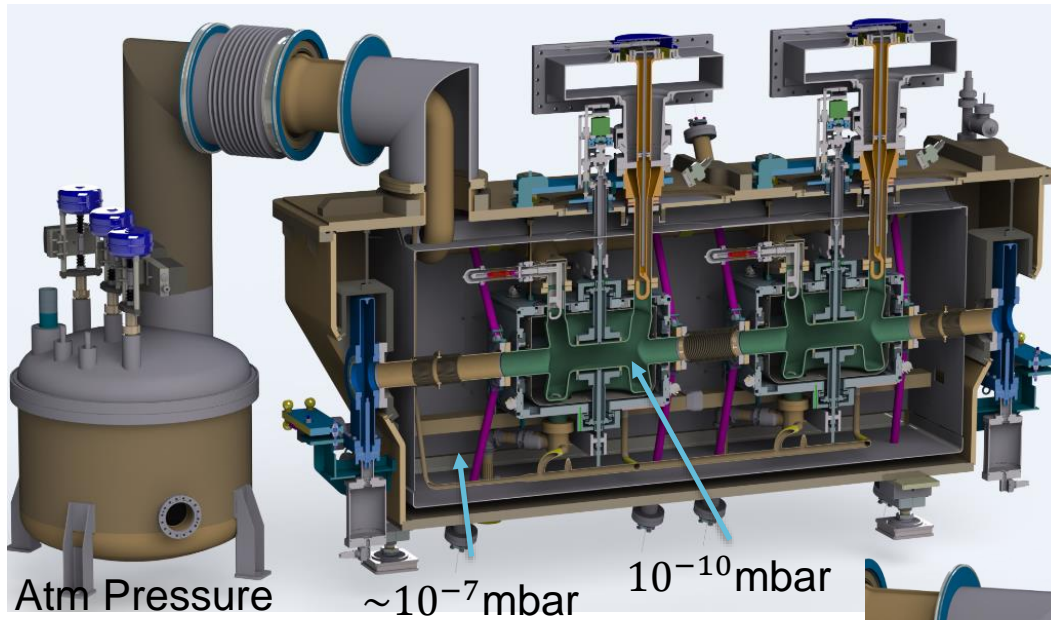
Magnets components and assemblies

- 77 cryostat units | 70 procured by CERN, incl. prototypes and spares
- Diameter ~1 m
- Unit lengths vary from 2 m up to 15 m
- Roughly 500 m of new cryostats to be installed in the LHC
- Carbon steel, stainless steel, aluminium, glass fiber composites...
- Production from now until 2025

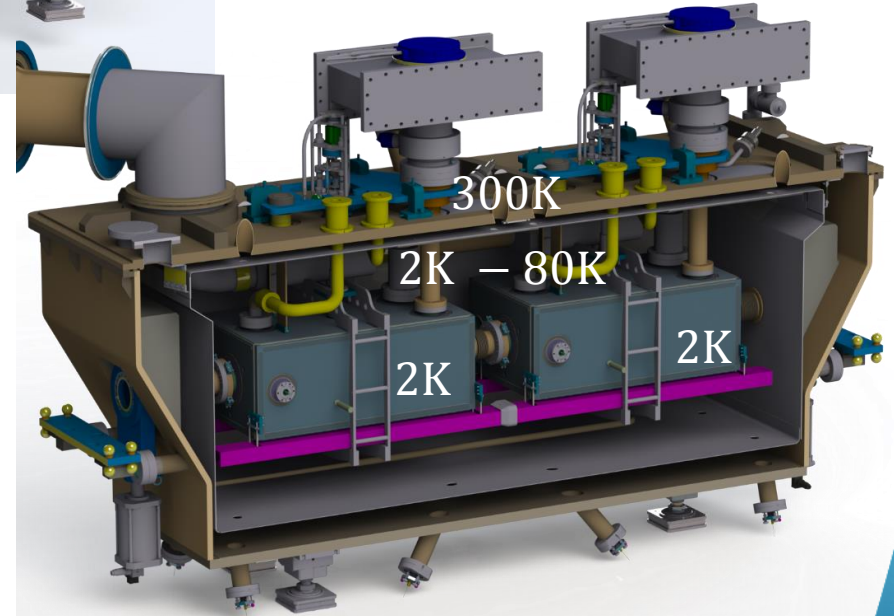


Assembly schedule at CERN

High precision assembling and manufacturing technologies



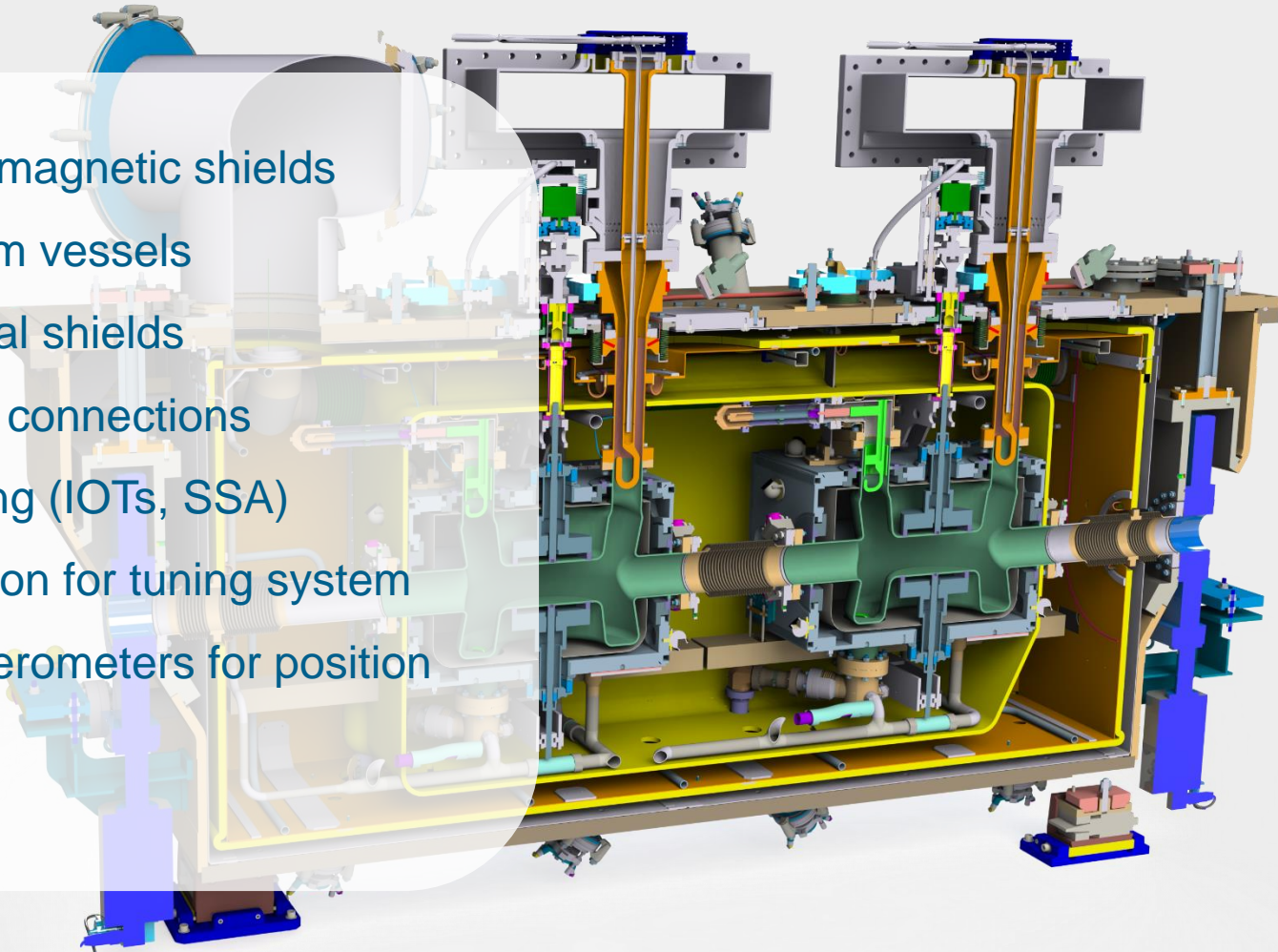
Crab cavities (DQW)
Vertical crossing for
ATLAS experiments



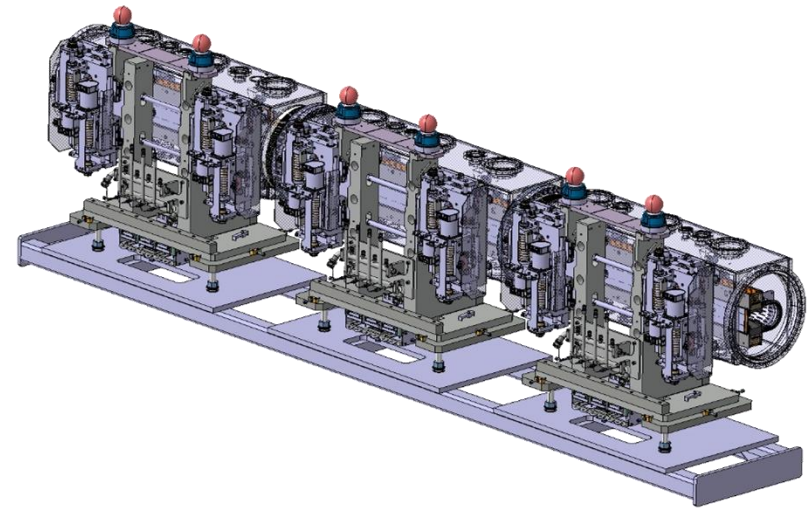
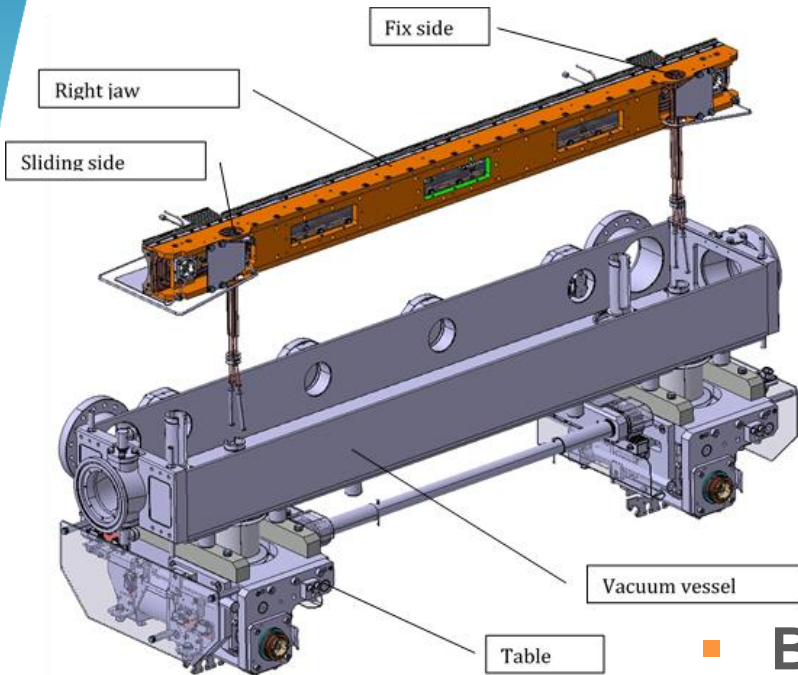
Crab cavities (RFD)
Horizontal crossing for
CMS experiment

Cryomodule

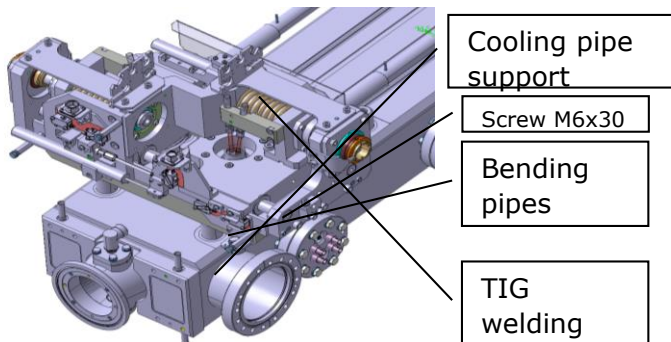
- 10x Warm magnetic shields
- 10x Vacuum vessels
- 10x Thermal shields
- 100x Coax connections
- RF powering (IOTs, SSA)
- 20x Actuation for tuning system
- 120x interferometers for position monitoring



Collimators & new material for high temperatures



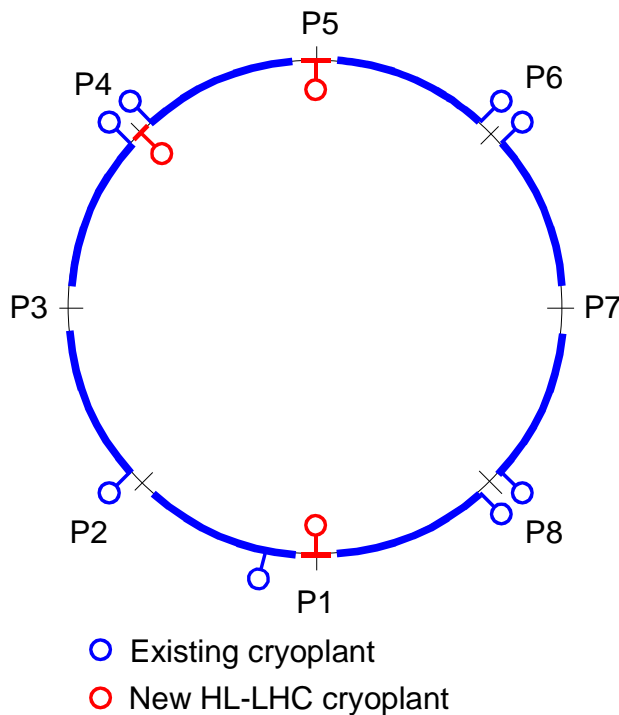
- **Beam Intercepting Devices** with the main functions of:



- Cleaning the beam by removing stray particles which would induce quenches in the SC magnets
- Protect the downstream machine elements by shielding them from beam orbit errors

Cryogenics systems

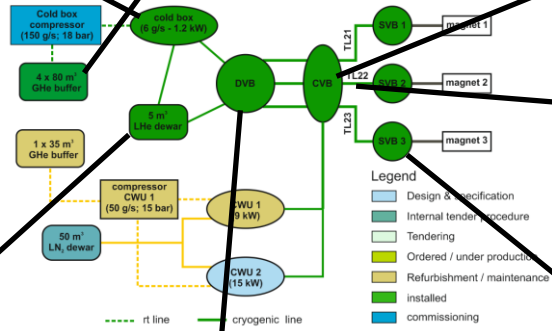
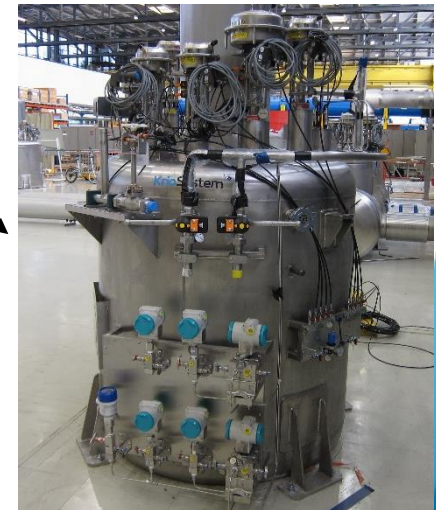
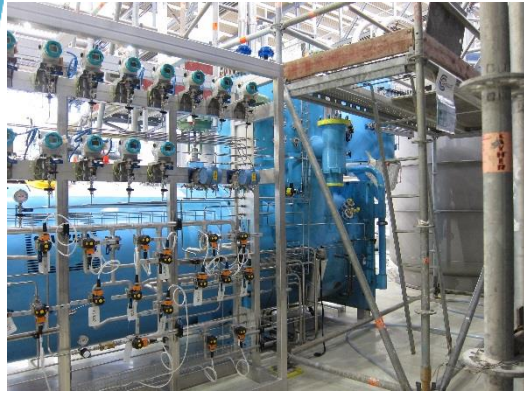
- New cryogenic demands for HL-LHC project.
- Magnets (WP3, WP11), Crab Cavities (WP4) and SC Links (WP6A) will be the main consumers.



- 2 new cryoplants (~ 18 kW @ 4.5 K incl. ~ 3 kW @ 1.8 K) at P1 and P5 for high-luminosity insertions
- 1 new cryoplant (~ 4 kW @ 4.5 K) at P4 for SRF cryomodules. (Alternative under study: upgrade of 1 existing LHC cryoplant and distribution)
- 11T + Q5@P6
- SRF test facility with beam at SPS-BA6 primarily for Crab-Cavities

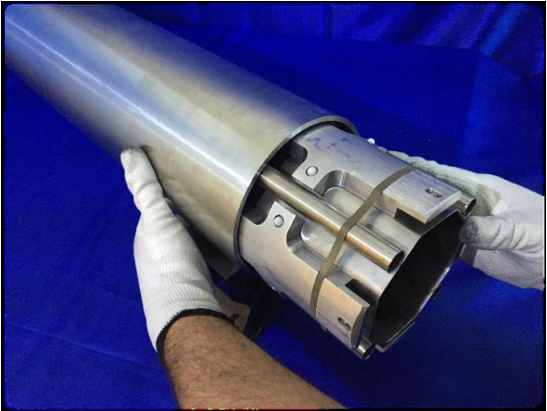
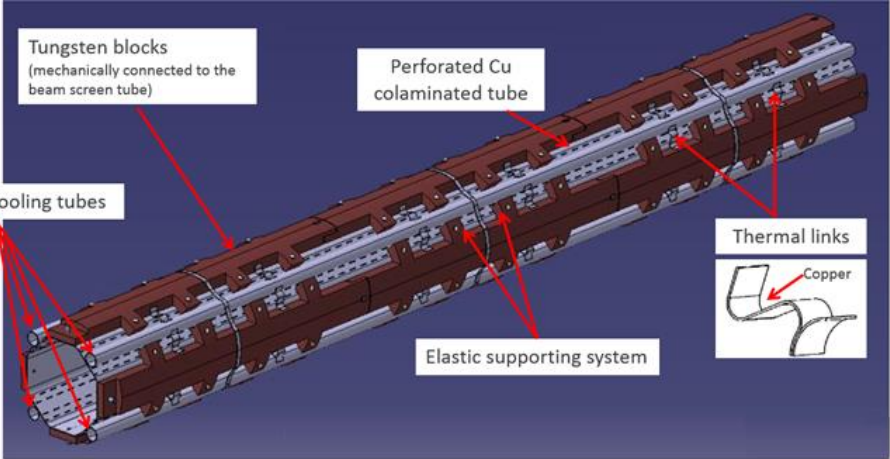
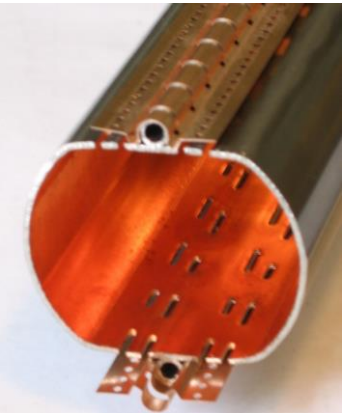
Test areas: Cold Box & Cryogenic Distribution System (B180)

All deliveries according to planning and installed.

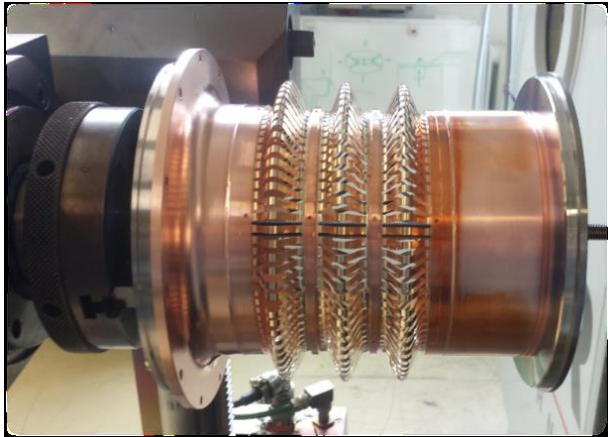
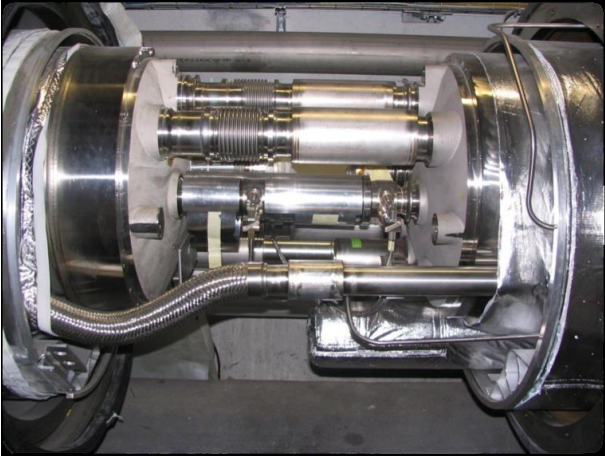


Ultra High Vacuum components and systems

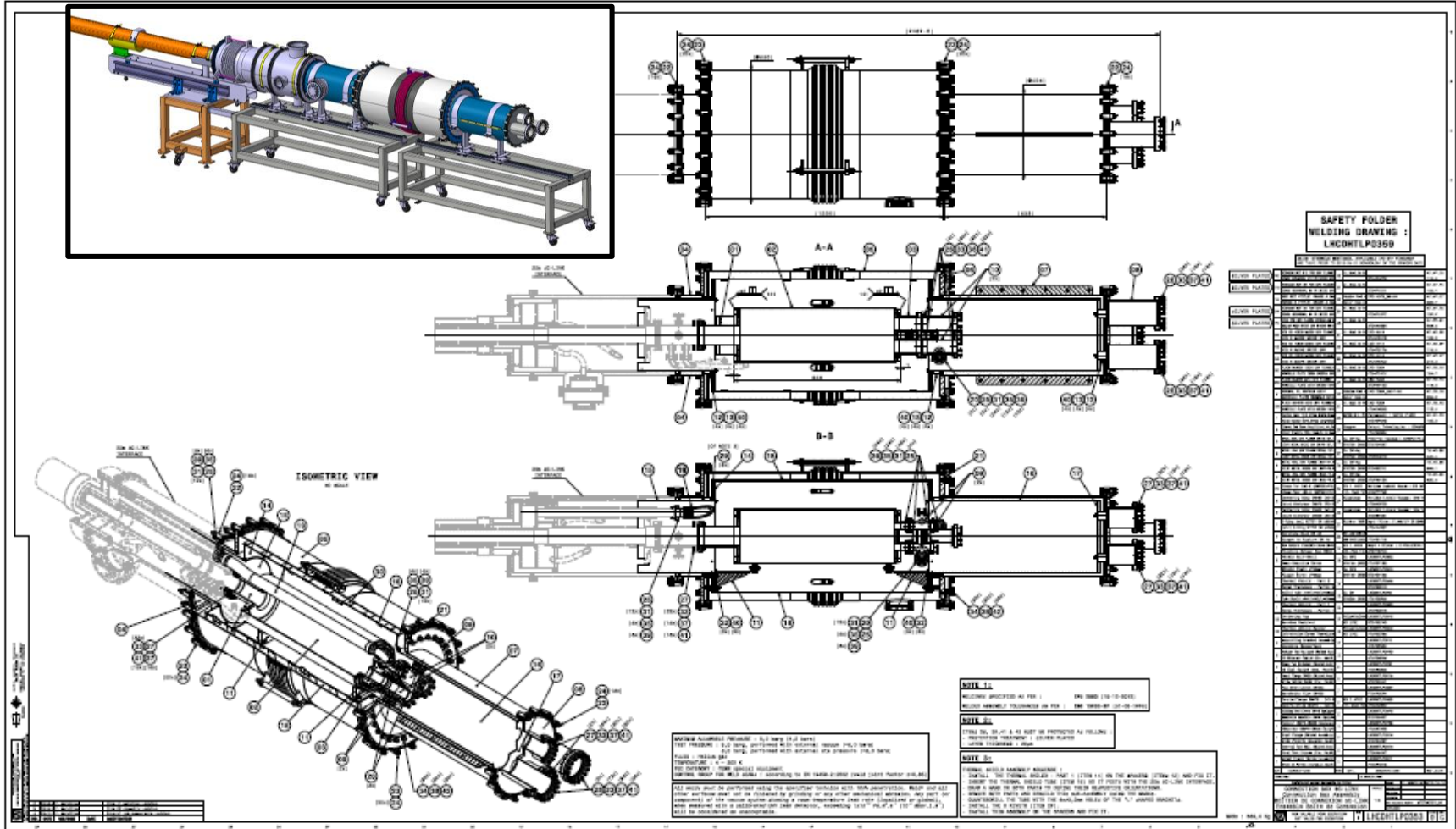
- New BS designs for HiLumi (New a-C coating, shielded BS)



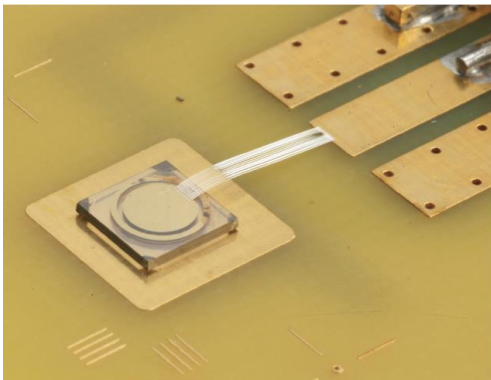
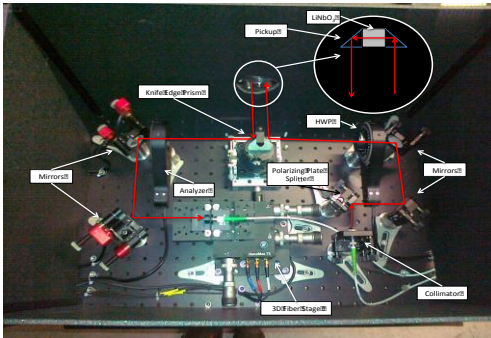
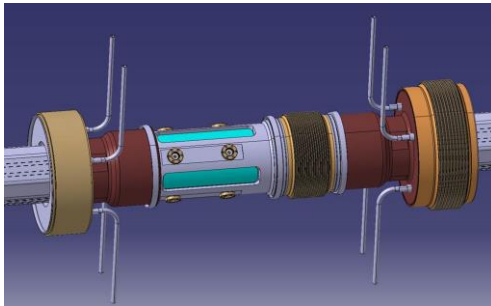
- New interconnection, plug-in modules



Superconducting links



Beam Instrumentation

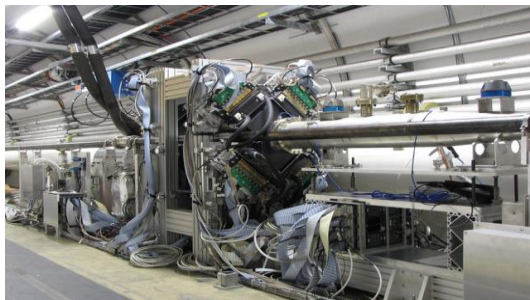
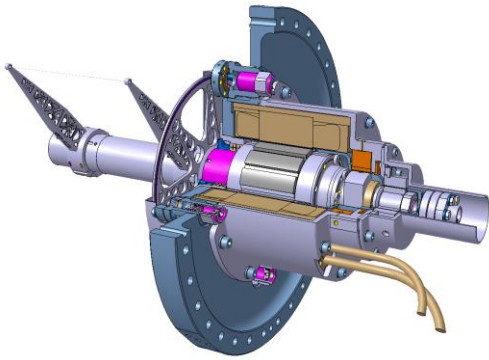


- Beam Position Monitors (BPMs) to measure beam positions as they approach collision, means sub-micron beam orbit resolution
- 48 BPMs to be installed in HL-LHC triplet magnets

- High Bandwidth BPMs for intra-bunch diagnostics
- Bandwidth > 10 GHz

- Cryogenic Beam Loss Monitors (BLMs) will allow fast localisation of beam losses in critical areas
- 32 detectors planned for installation

Beam Instrumentation



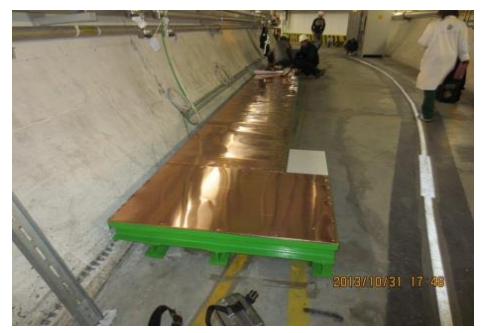
- Wire Scanners will give beam profile measurements to optimise machine performance
- 30 instruments for 2019 with more later
- Beam Halo Monitoring (BHM) to handle the high-intensity HL-Beams
- High dynamic range cameras with state-of-the-art range
- Beam Gas Vertex Detector (BGV) for non-destructive beam size measurement at high energy
- Precision mechanics as one of the main requirements

Other HL-LHC equipment

Power Converters

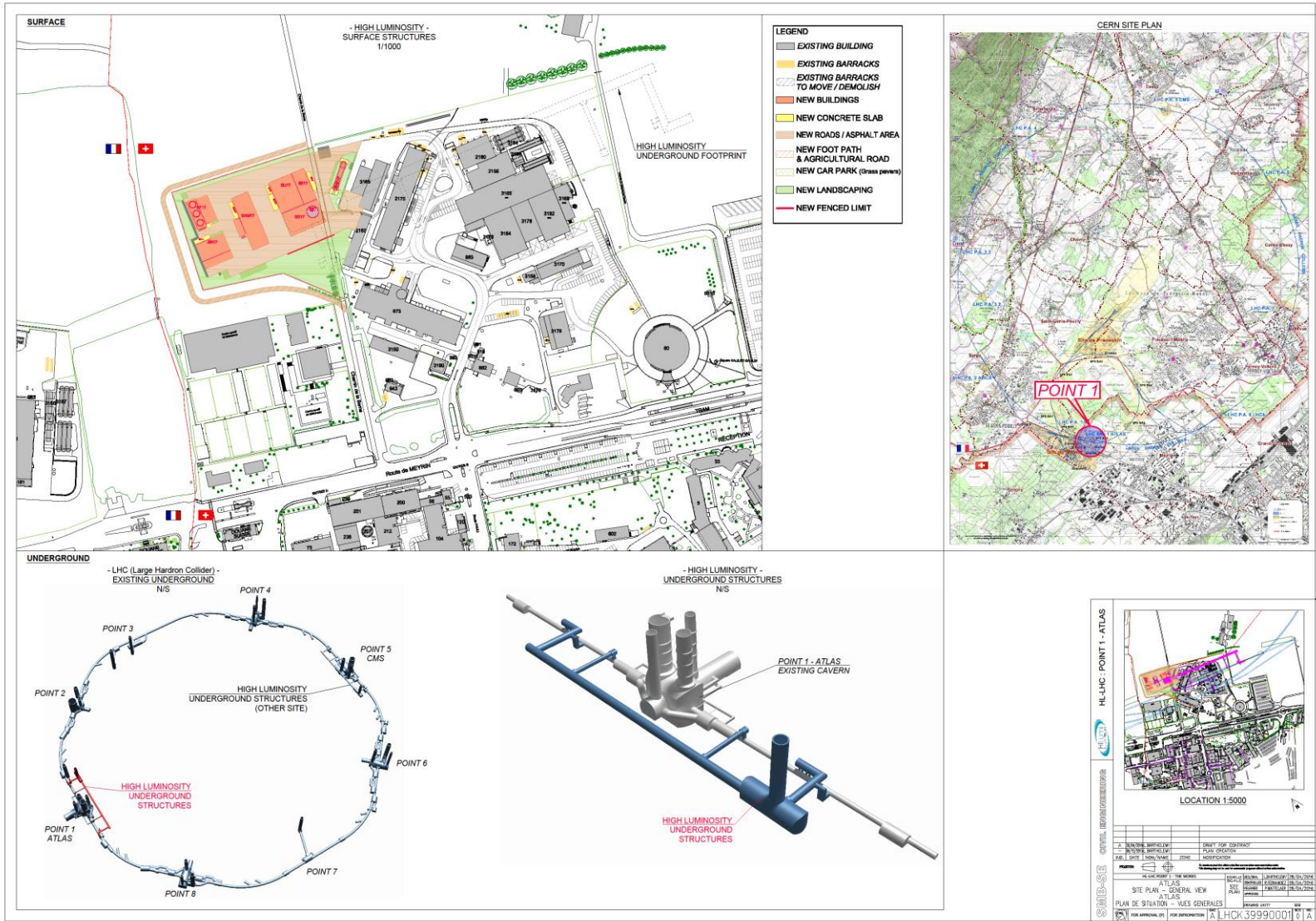
Power Converters needed for the powering of the HL-LHC circuits in IP1 and IP5

- R&D activities from 2016 to 2020
- Production 2021-2023
- Testing for overall quality assurance 2023-2024 Installation and commissioning in 2025



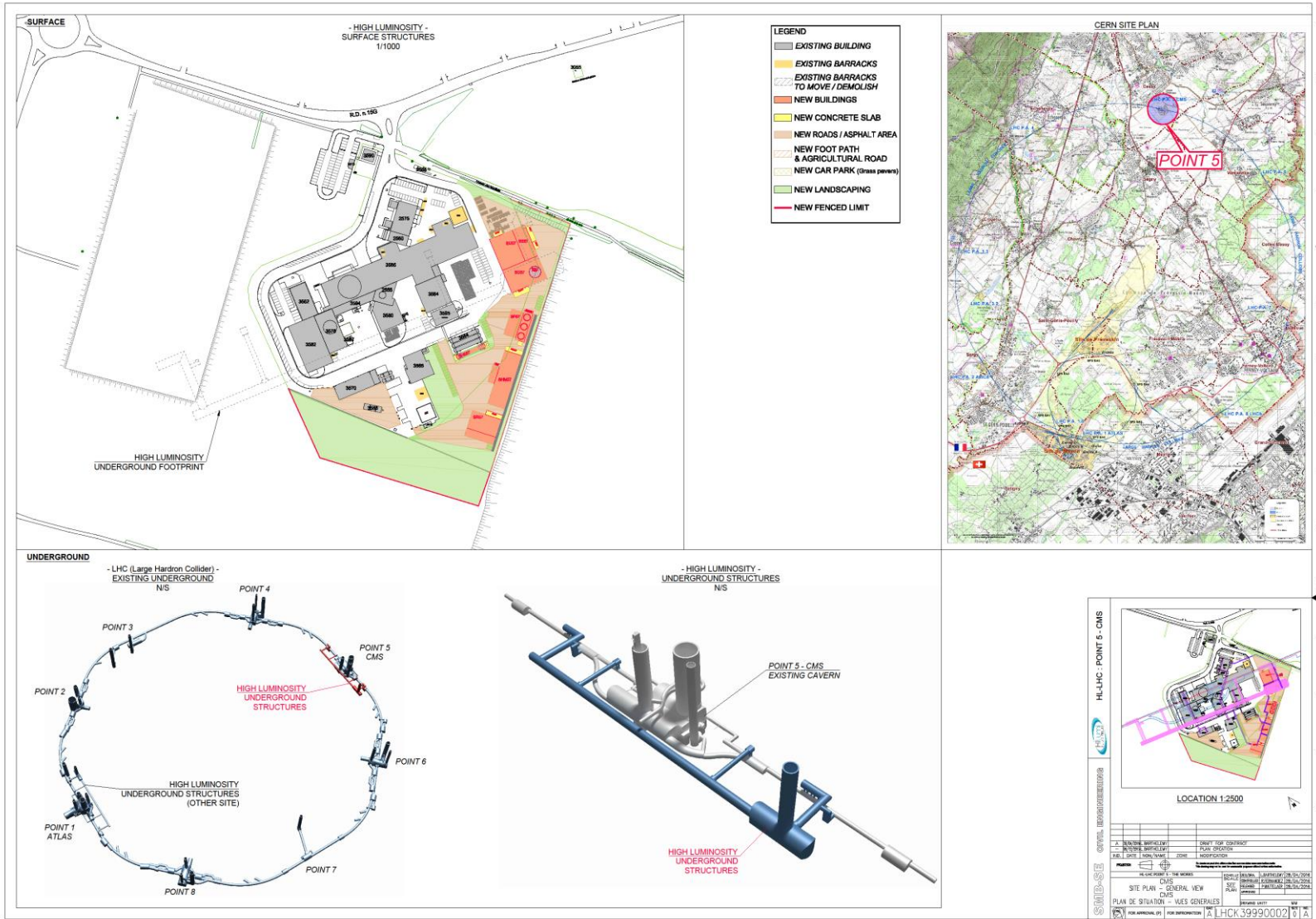
Civil Engineering & Technical Infrastructures

POINT 1 - ATLAS



Civil Engineering & Technical Infrastructures

POINT 5 - CMS



Industry

Tools to communicate and to get informed

Information must be dynamic ...

<https://project-hl-lhc-industry.web.cern.ch/>

HiLumi
HL-LHC PROJECT

HL-LHC Industry
Industry Relations and Procurement Website for the HL-LHC project

Search this site Search

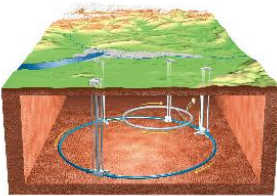
Home General Info Procurement Overview Tendering Acquisition Timeline Events Contact

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 in terms of 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.



The Large Hadron Collider (LHC) at [CERN](#) at the Franco-Swiss border near Geneva, is the largest scientific instrument ever designed and built for scientific research. It has been exploring the new high-energy frontier since 2010, attracting a global user-community of more than 7,000 scientists spanning more than 60 countries.

After only a little more than one year of operation, on 4th July 2012 the LHC experiments, [ATLAS](#) and [CMS](#), could announce the first major discovery: the long-sought Higgs boson, the cornerstone of the Standard Model (SM) of particle physics. This announcement, heralded by scientists as well as by the media as a giant leap in the understanding of our world and the origin of universe.

ILOS
[ILOs Portal](#)

HIGHLIGHTS

10 Mar 2016
[HL-LHC is now part of the ESFRI Roadmap](#)
The 2016 Roadmap highlights the strong socio-economic impact of research infrastructures as well as their potential to generate innovation through collaboration with industrial partners.
[More information on the ESFRI Roadmap 2016](#)

8 Feb 2016
[QUACO Open Market Consultation](#)
CERN, as member of the European pre-competitive procurement (PCP) Instrument QUACO, is pleased to invite you to the Open Market Consultation (OMC) that will take place on 30th March 2016.
[Read more](#)

1 Nov 2015
[High-Luminosity LHC moves to the next phase](#)
HL-LHC project moves from the design study to the machine construction phase.

3rd Industry Day

3RD HI-LUMI Industry Day

22-23

May 2017

The Park Royal

Warrington

UNITED KINGDOM

Registration before 31 March 2017

<https://indico.cern.ch/event/607165/>

More information on HL-LHC and future needs

<https://project-hl-lhc-industry.web.cern.ch>

**AN EVENT FOR
COMPANIES WILLING
TO TAKE ON THE HL-LHC
TECHNICAL CHALLENGES**



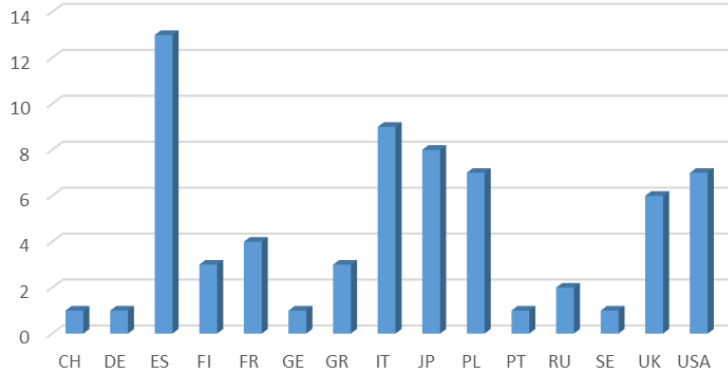
Science & Technology
Facilities Council

Fully booked!



Collaboration agreements

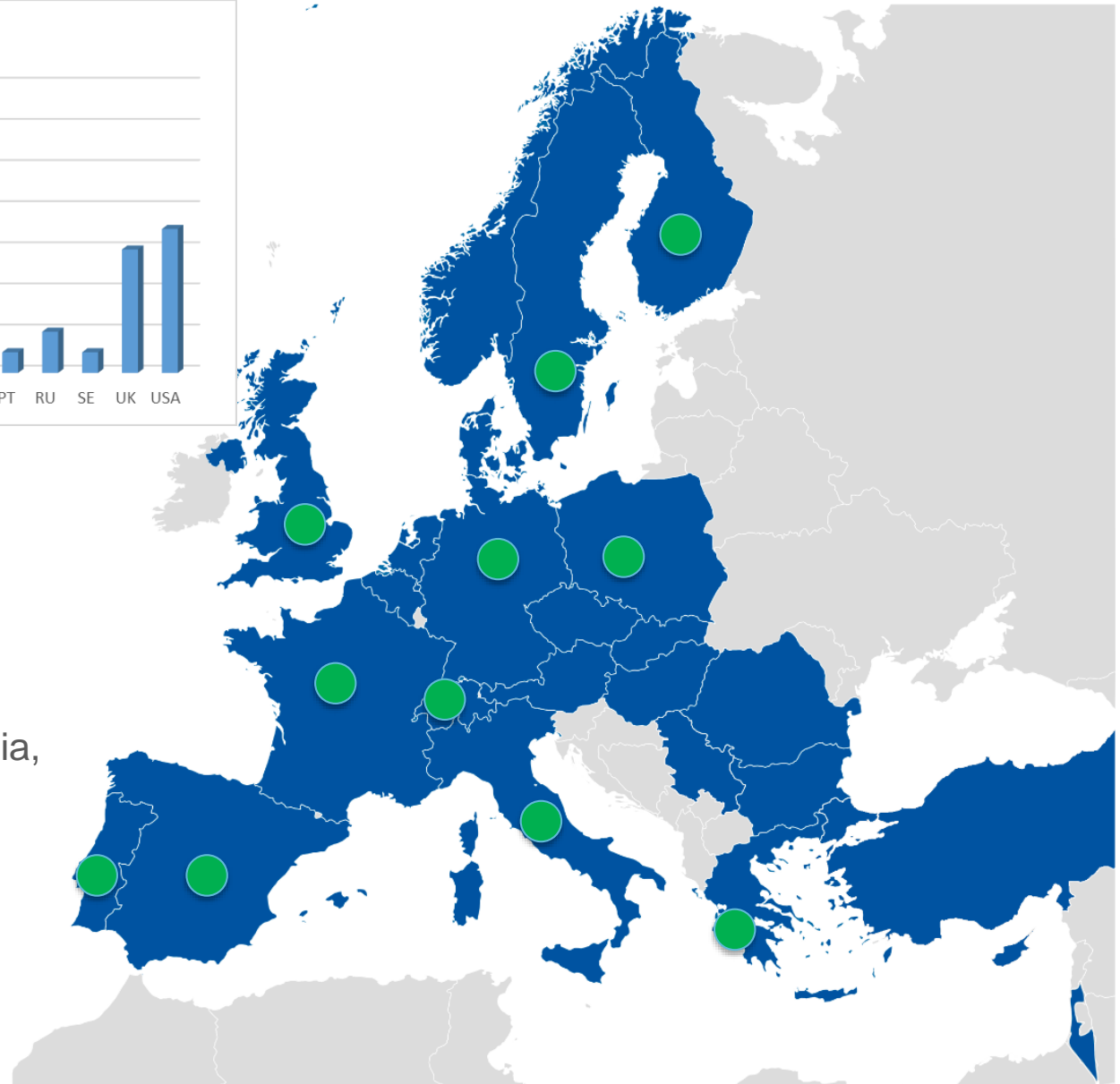
Agreements



● HL-LHC Existing collaborations

+Georgia, Japan, Russia, USA

Under discussion with Canada and China



Our objective

- The High Luminosity project seeks industrial suppliers and collaborations to start the construction phase and make the High Luminosity upgrade.
- CERN aims at fostering R&D collaborations and knowledge exchange also with SMEs, a perfect opportunity to match their capacity with the requirements of HiLumi.
- Next 3 years there will be intensive prototyping and the production of some of the first series of components.
- Understanding our needs is the first step to tender successfully.
- Understanding your capabilities and the know how that could come from industry is the best way to specify equipment that can be built by industry

Ready for the challenge?

Become a CERN supplier to built future accelerators

Visit us on

<https://project-hl-lhc-industry.web.cern.ch>



Thank you for your attention

Special Thanks to all HL-LHC WP Leaders

