The Technology (TE) Department and its activities

V. Mertens

3.9.2019

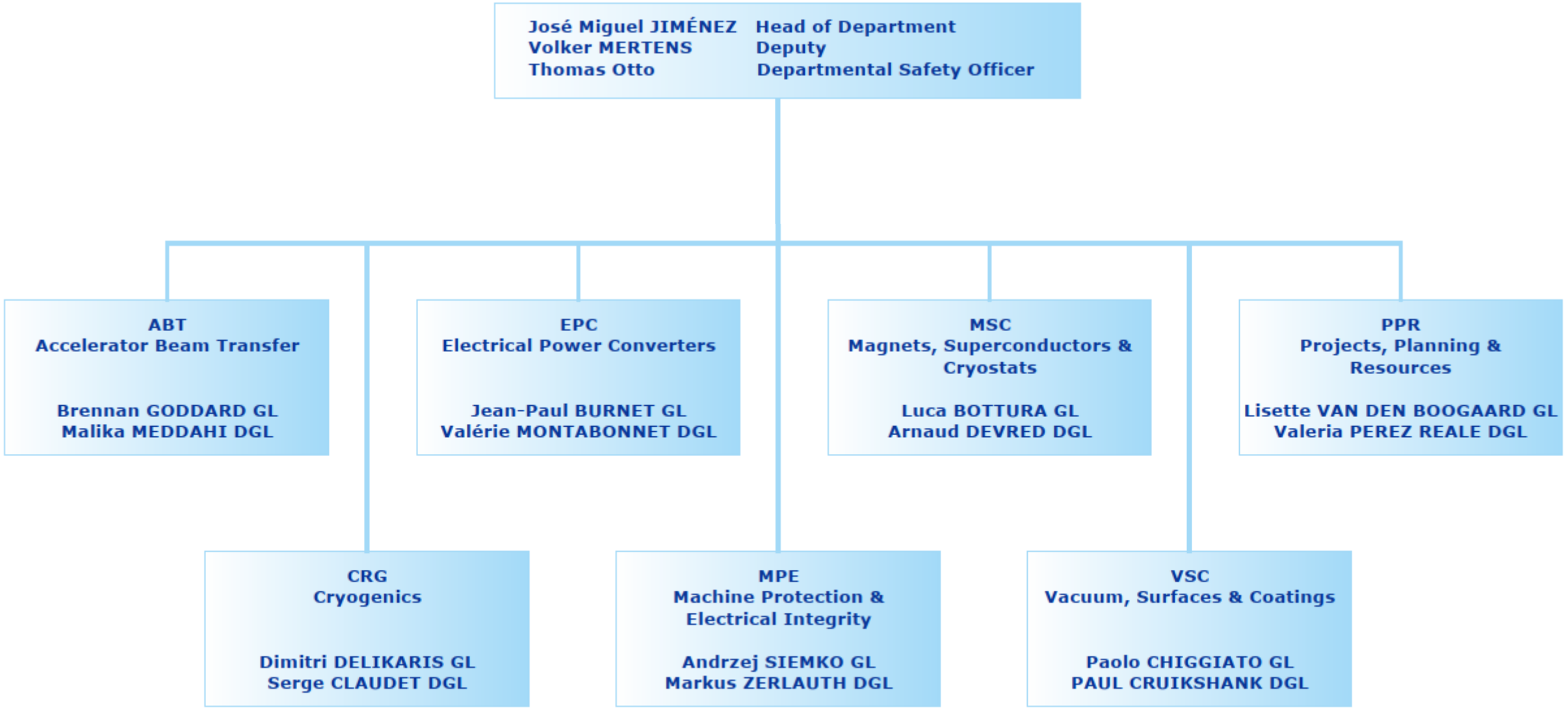
Outline:
Organisation
Infrastructures
Contributions

CERN internal organisation

Accelerators and Technology Sector

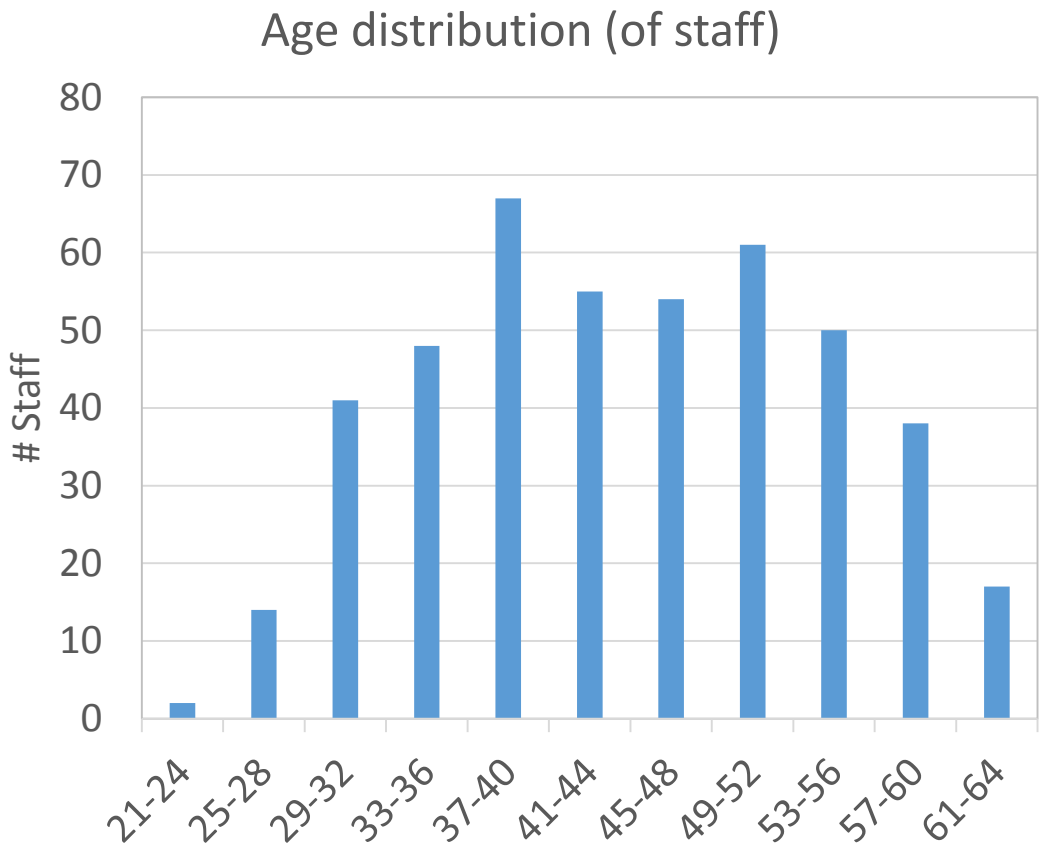
Director-General	***Fabiola Gianotti***
DG Units (DG): Translation, Minutes and Council Support, Internal Audit, Legal Service	
Occupational Health & Safety and Environmental Protection Unit (HSE)	Doris Forkel-Wirth
Director for Accelerators and Technology	***Frédérick Bordry***
Beams (BE)	Paul Collier
Engineering (EN)	Roberto Losito
Technology (TE)	José Miguel Jiménez
Director for Finance and Human Resources	***Martin Steinacher***
Finance and Administrative Processes (FAP)	Florian Sonnemann
Human Resources (HR)	James Purvis
Industry, Procurement and Knowledge Transfer (IPT)	Thierry Lagrange
Site Management and Buildings (SMB)	Lluis Miralles
Director for International Relations	***Charlotte Warakaulle***
Stakeholder relations (IR-REL): Host States, Member States, Associate & Non-Member States, International Organisations, Partnerships & Fundraising Strategic Planning & Evaluation, Protocol Education, Communications and Outreach (IR-ECO)	Ana Godinho
Director for Research and Computing	***Eckhard Elsen***
Scientific Information Services (RCS-SIS)	
Experimental Physics (EP)	Manfred Krammer
Information Technology (IT)	Frédéric Hemmer
Theoretical Physics (TH)	Gian Giudice

TE Department structure

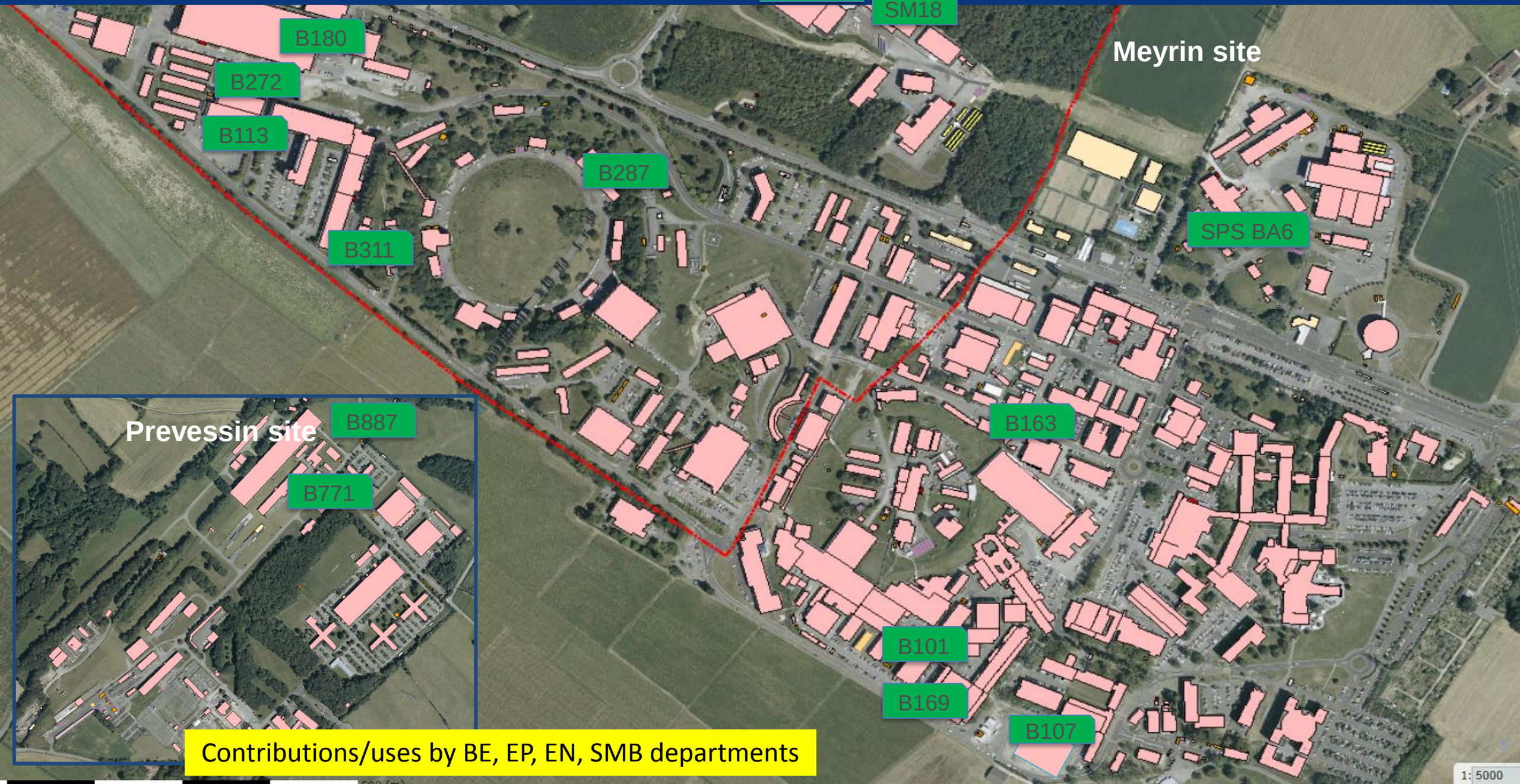


TE in numbers

TE members of personnel	Number (2016)	Number (2017)	Number (9.12.2018)
Employed personnel			
Staff	445	447	447
Fellows	130	133	145
Total	**577**	**580**	**592**
International collaboration			
Cooperation			
Associates	66	54	53
Project Associates	26	36	69
Total	**92**	**90**	**122**
Exchange of scientists			
Scientific Associates	0	0	2
Visiting Scientists	9	8	6
Guest Professors	1	0	0
Total	**10**	**8**	**8**
Training programs			
Students (Doct, Tech Admin)	74	74	59
Apprentices	0	19	18
Trainees	40	31	32
Total	**114**	**124**	**109**
Grand Total	**793**	**802**	**831**

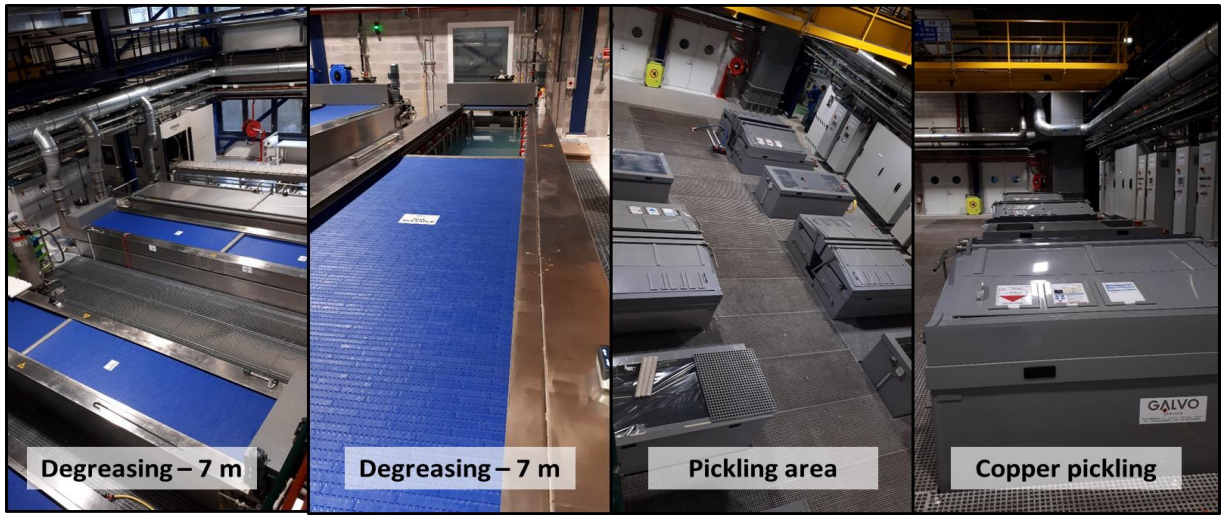


Technical infrastructures by TE (selection)



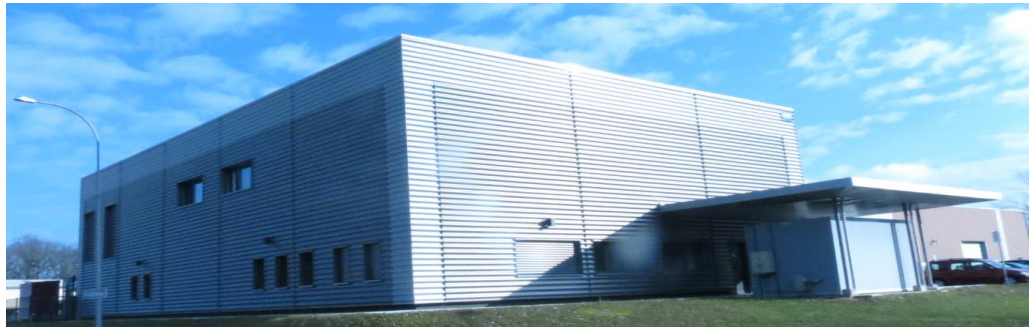
Chemical surface finishing and PCB production

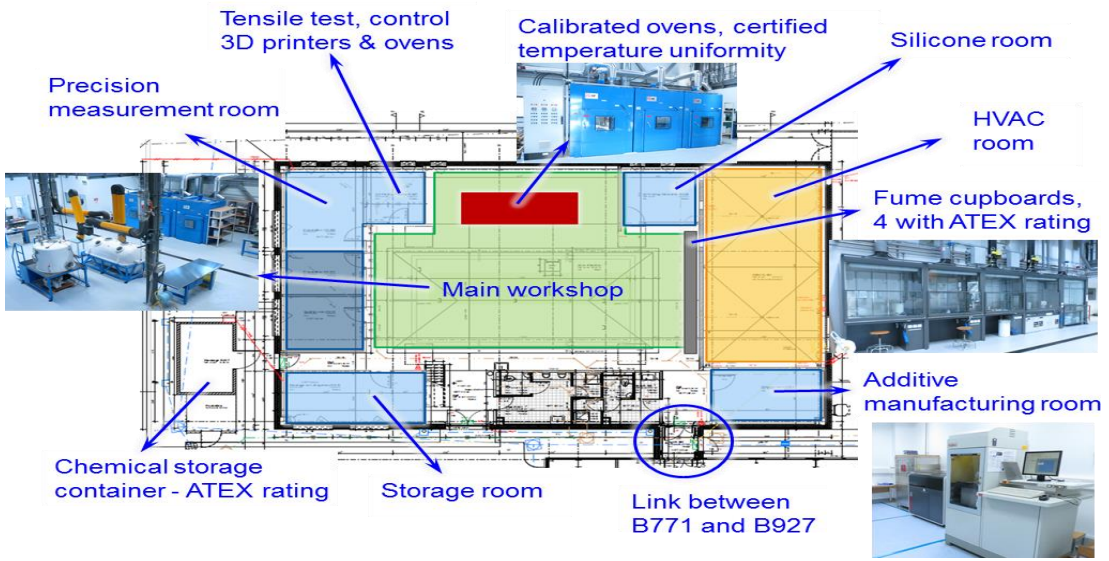
B107



Polymer laboratory

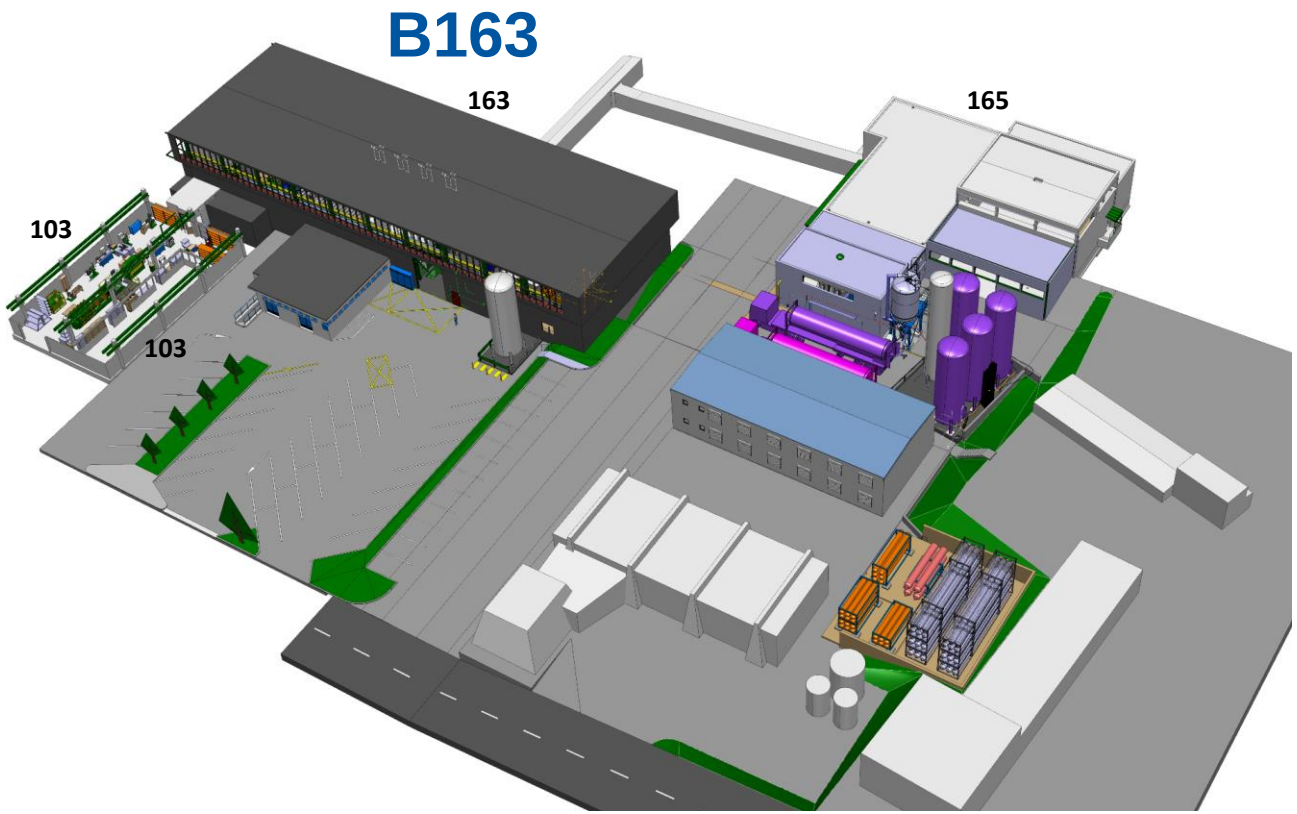
B771

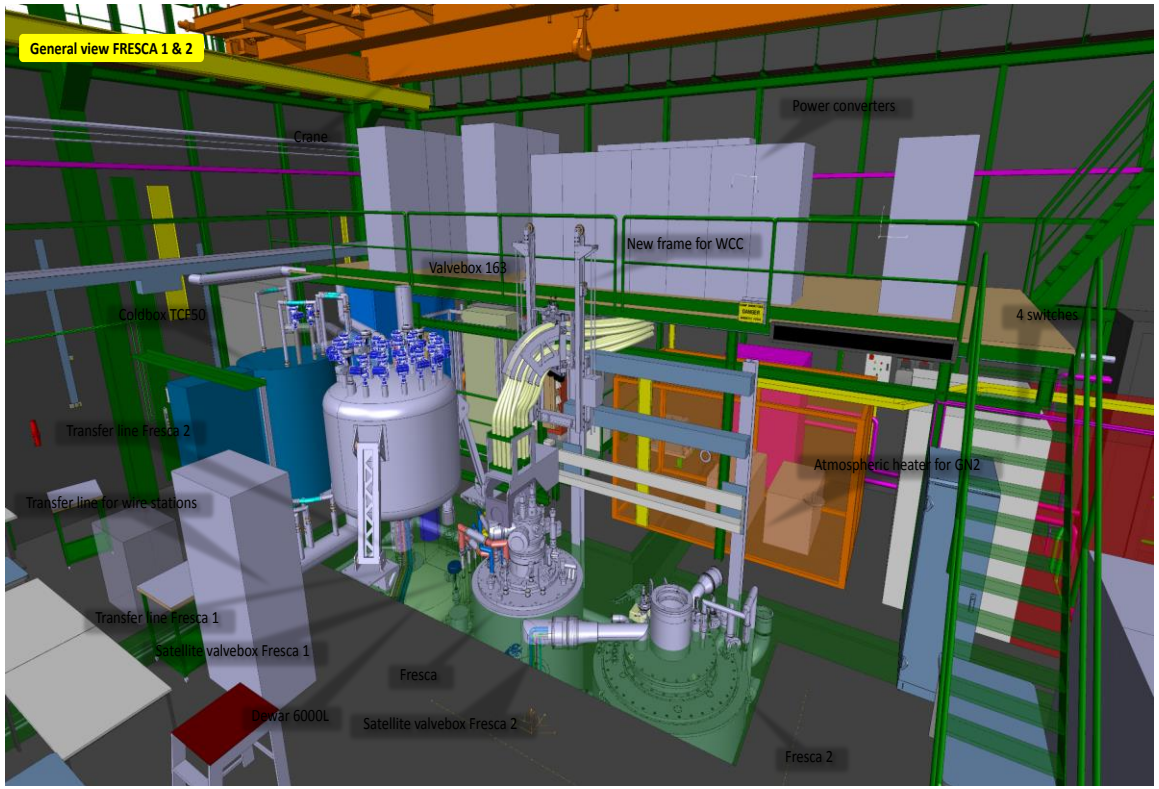




Superconducting cables manufacturing and qualification

FRESCA2 - Facility for the REception of Superconducting CAbles





Ready for operation: Q1/2020

Superconducting magnets fabrication

B180

coil winding

coil splicing

coil dimensions

coil reaction

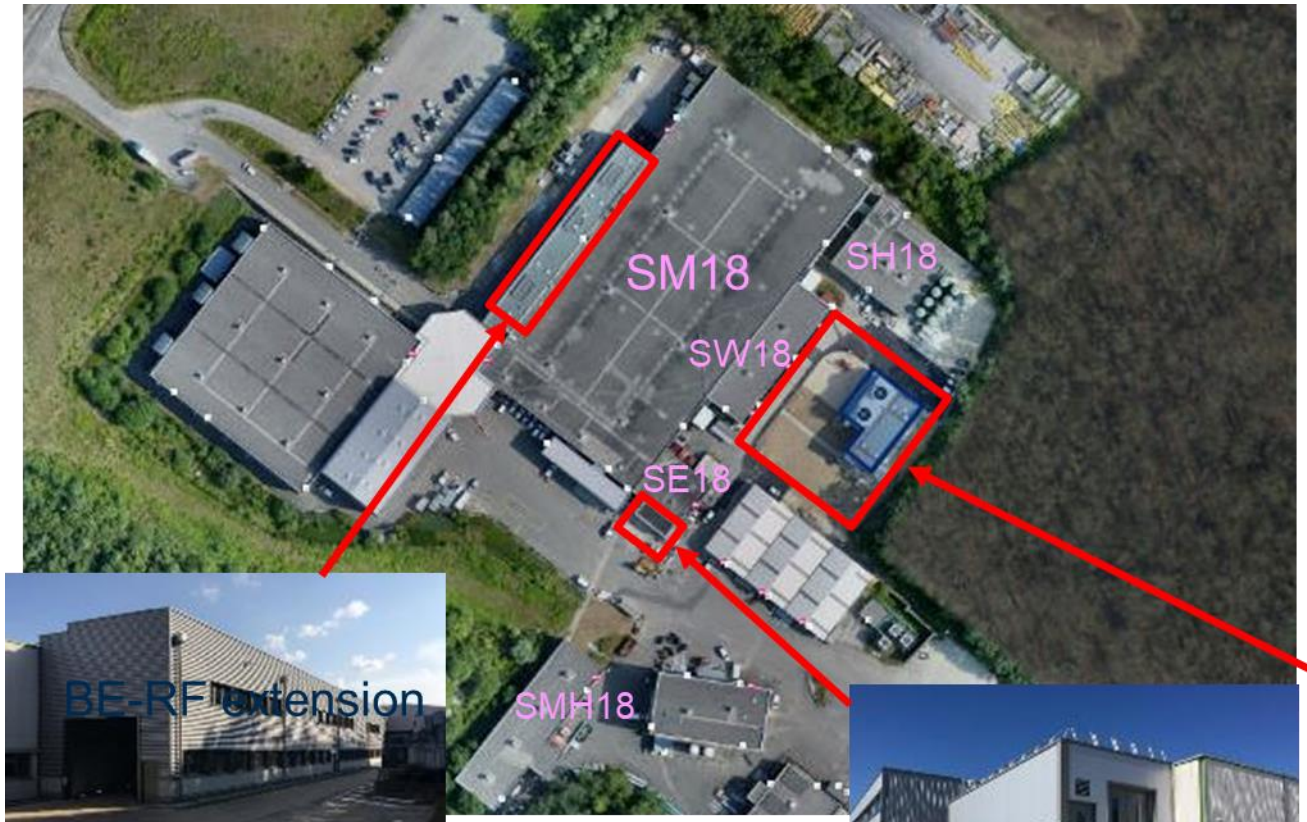
coil impregnation

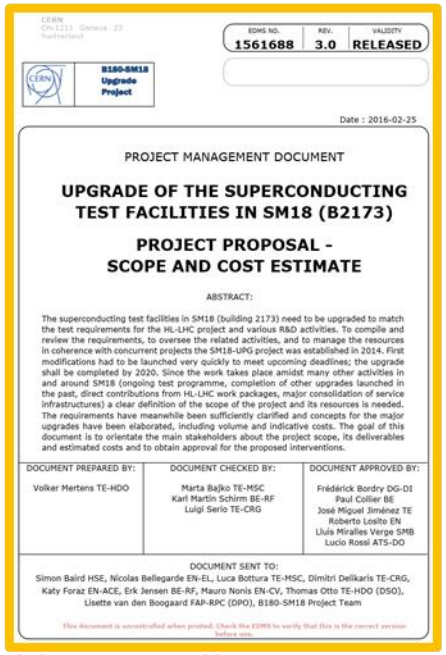
preparation for collaring

Superconducting test centre

SM18

For magnets, powering links, RF equipment





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B180-SM18 Upgrade Project

Date : 2016-02-25

PROJECT MANAGEMENT DOCUMENT

UPGRADE OF THE SUPERCONDUCTING TEST FACILITIES IN SM18 (B2173)

PROJECT PROPOSAL - SCOPE AND COST ESTIMATE

ABSTRACT:

The superconducting test facilities in SM18 (building 2173) need to be upgraded to match the test requirements for the HL-LHC project and various R&D activities. To compile and review the requirements, to oversee the related activities, and to manage the resources in coherence with concurrent projects the SM18-UPG project was established in 2014. First modifications had to be launched very quickly to meet upcoming deadlines; the upgrade shall be completed by 2020. Since the work takes place amidst many other activities in and around SM18 (ongoing test programme, completion of other upgrades launched in the past, direct contributions from HL-LHC work packages, major consolidation of service infrastructures) a clear definition of the scope of the project and its resources is needed. The requirements have meanwhile been sufficiently clarified and concepts for the major upgrades have been elaborated, including volume and indicative costs. The goal of this document is to orientate the main stakeholders about the project scope, its deliverables and estimated costs and to obtain approval for the proposed interventions.

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Upgrades by BE, EN, SMB, TE departments

Magnetic measurements

B311 For normal conducting magnets

Vacuum laboratory

B113

A reference for accelerator beam vacuum

Surface coating

B101

Leadership for coating technologies and associated R&D

CERN roadmap

Three main scientific pillars

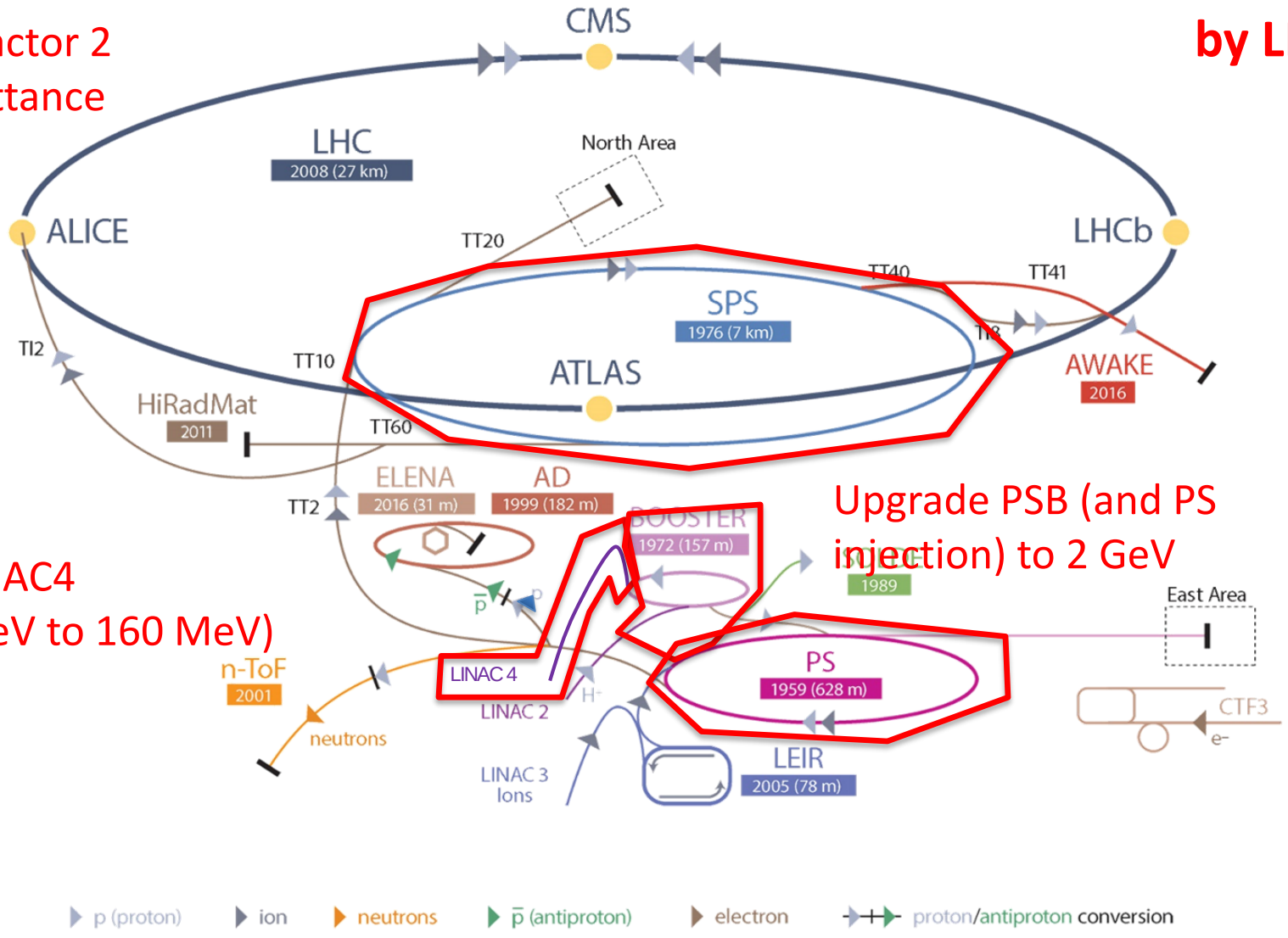
- **Full exploitation of the LHC**:
  - successful Run 2, LS2, and Run 3 start-up.
  - Upgrade of LHC Injectors; on-track construction of HL-LHC.
- **Scientific diversity programme** serving a broad community:
  - ongoing experiments and facilities at Booster, PS, SPS and their upgrades.
  - participation in accelerator-based neutrino through CERN Neutrino Platform.
- **Preparation of CERN future**:
  - vibrant accelerator R&D programme exploiting CERN strengths and uniqueness.
  - design studies for future accelerators: CLIC, FCC (includes HE-LHC).
  - future opportunities of diversity programme: “Physics Beyond Colliders”.

2019-2020: update of the European Strategy for Particle Physics (ESPP)

Accelerator complex

Modifications by LIU project

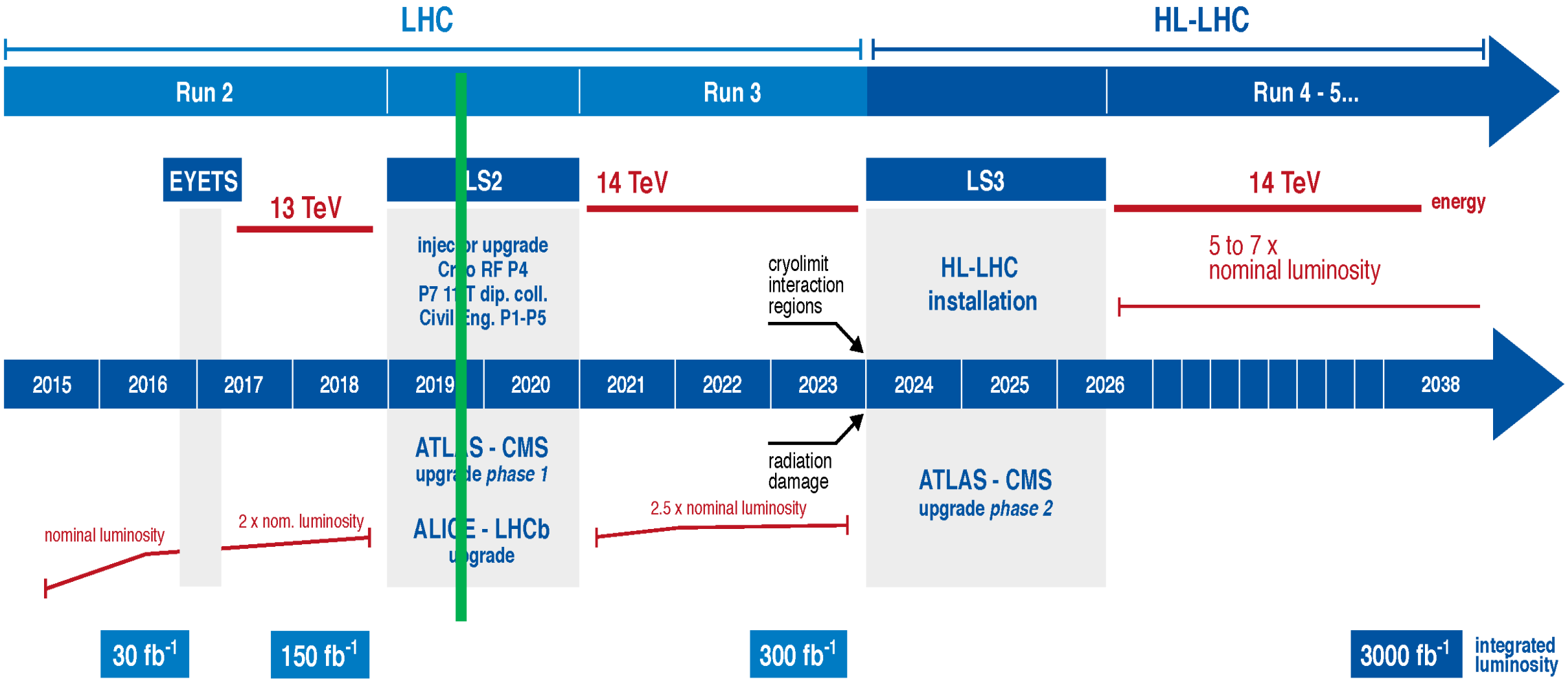
Increase beam intensity by a factor 2 (PS, SPS) with the present emittance



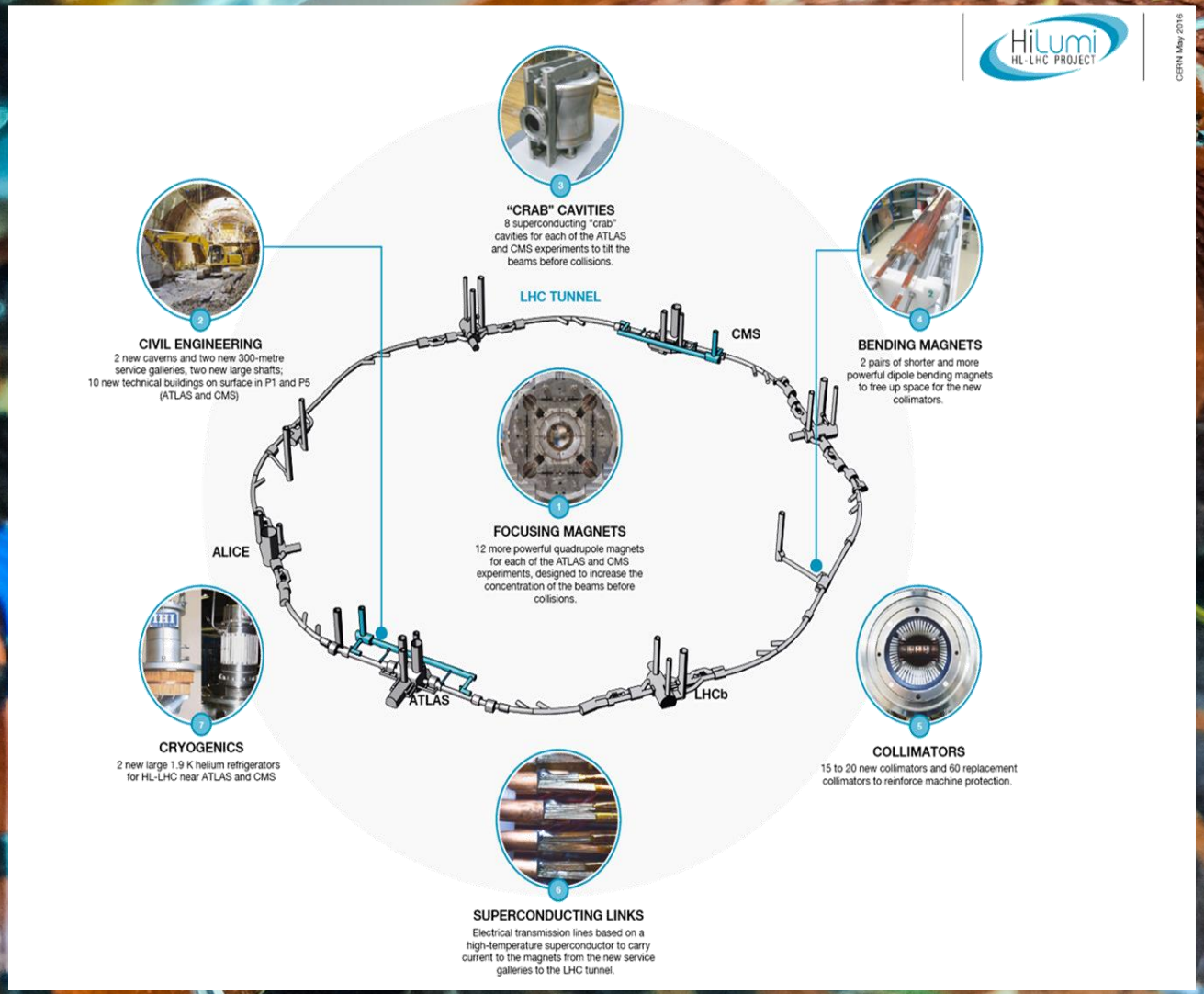
Upgrade PSB (and PS injection) to 2 GeV

Connect LINAC4 (from 50 MeV to 160 MeV)

CERN roadmap (LHC, HL-LHC)

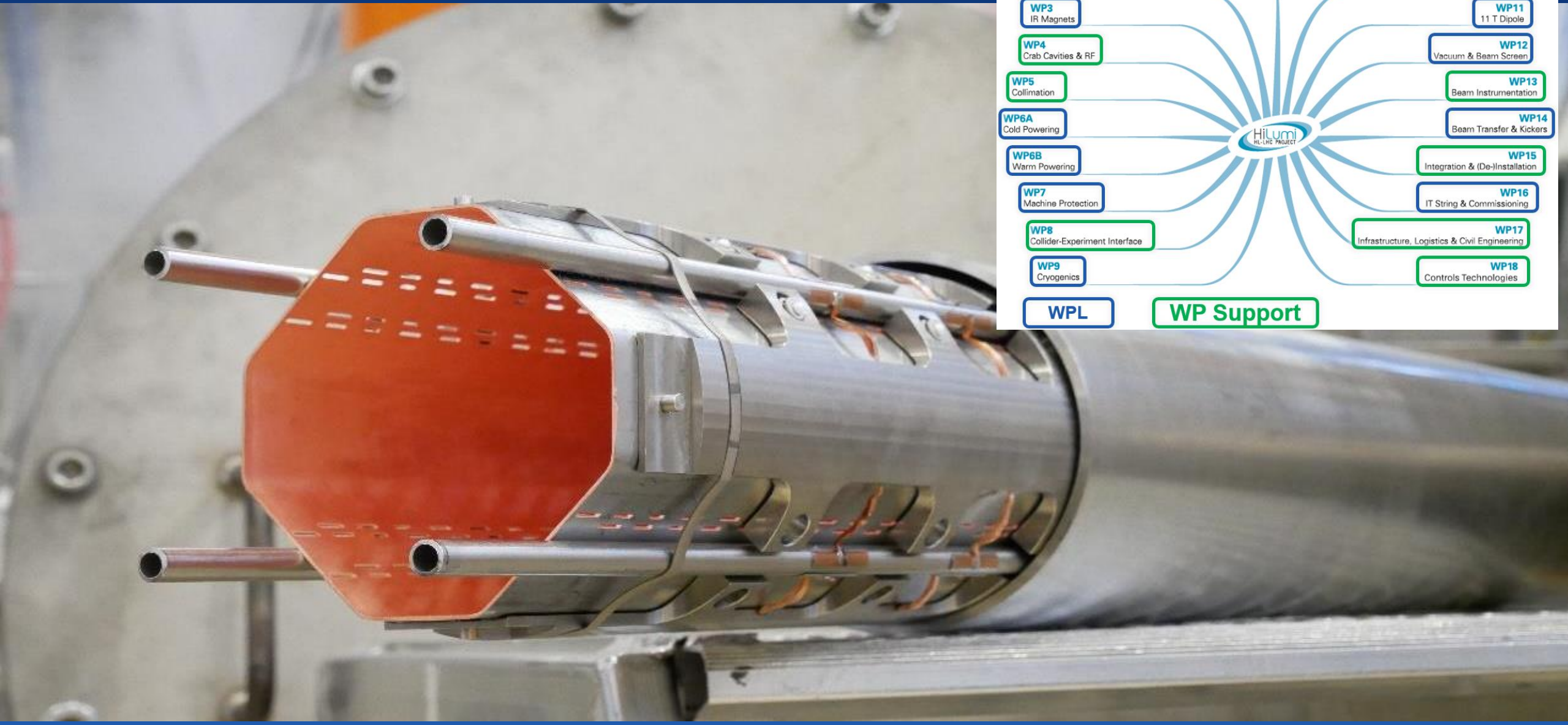


CERN roadmap – Full exploitation of the LHC (incl. HL-LHC)



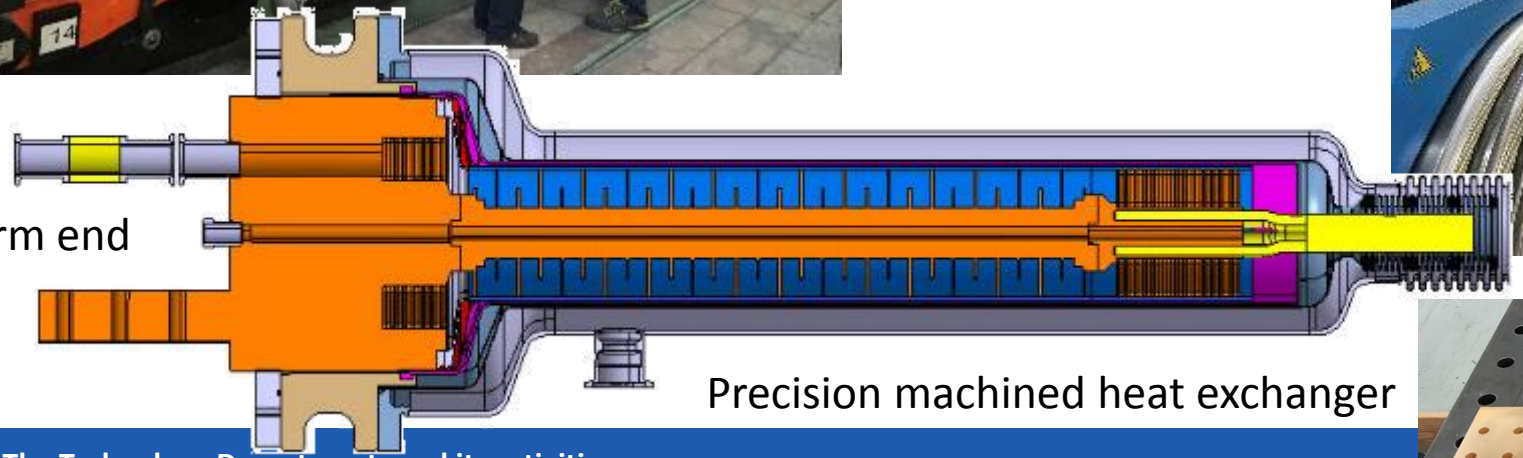
- 10 times more luminosity
  - Beam brightness
  - Proton density
  - Crossing angle
- Technology demonstrator
  - High magnetic field ~11 T
  - High current ~100 kA
  - Mitigation of beam effects
  - New collimators
- Worldwide approach
  - CERN Member States and International Collaborations

HL-LHC – TE contributions

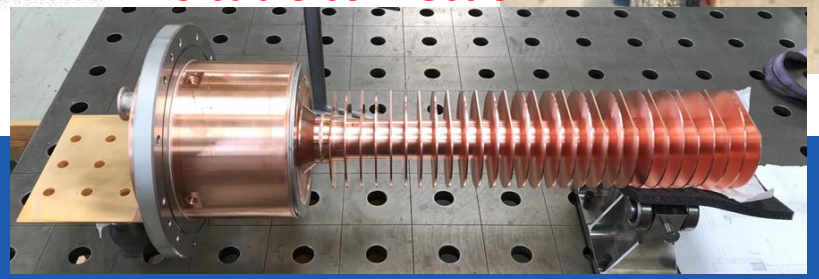


HL-LHC – TE contributions

WP6A - Superconducting links and current leads



HTS cable connection



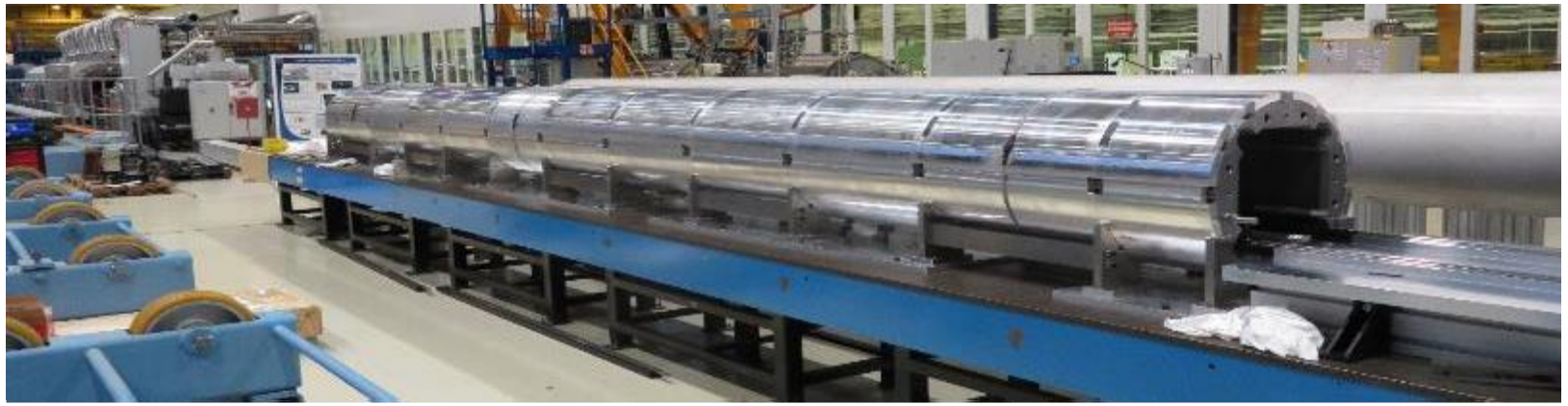
HL-LHC – TE contributions

WP3 – interaction region quadrupoles and correctors

Al alloy shells

coil winding

coil pack assembly



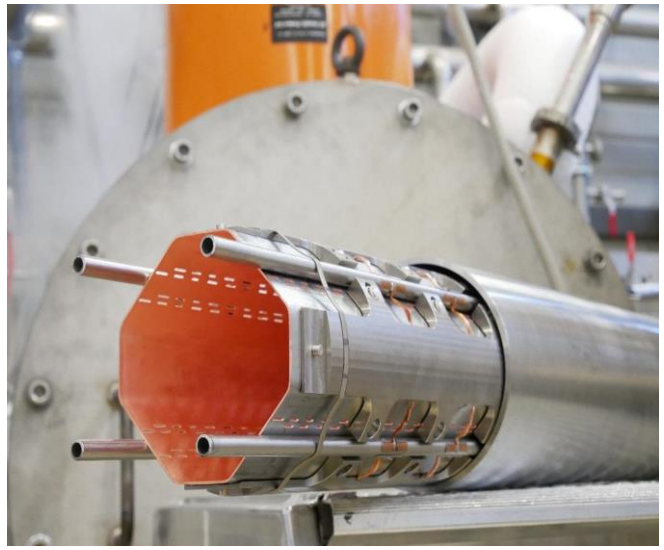
prototype structure

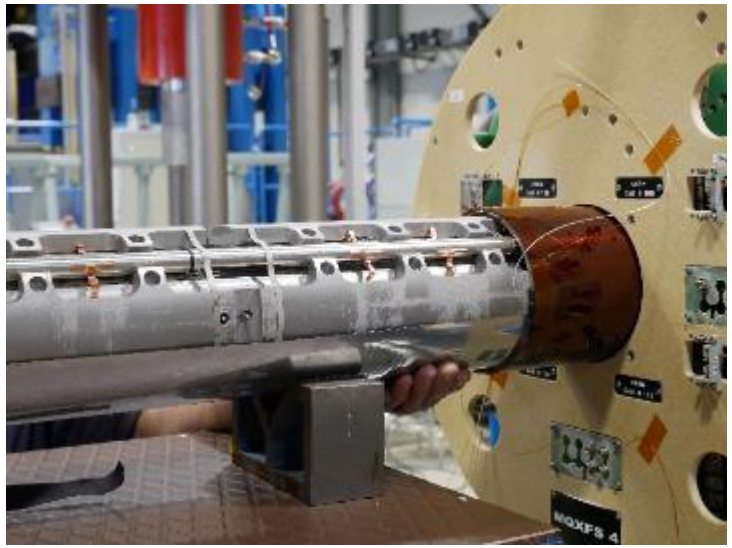
HL-LHC – TE contributions

WP11 – 11 T dipoles

HL-LHC – TE contributions

WP12 – vacuum



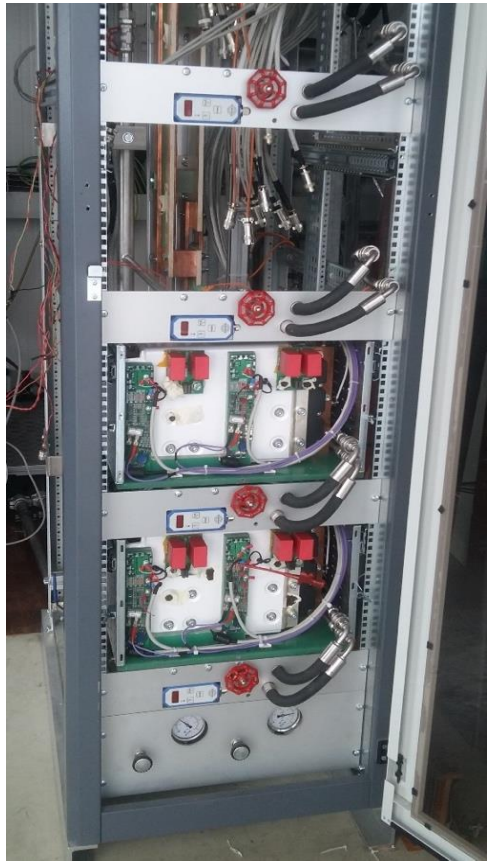


Thermal mechanical validation of the shielded beam screens

Prototyping and mechanical and RF tests of the deformable RF bridge

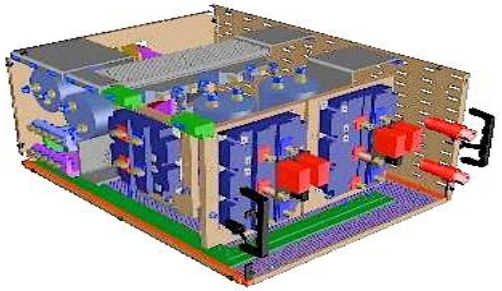
HL-LHC – TE contributions

WP7 – Machine Protection
Quench Detection & Protection
Energy extraction



EE systems based on IGBTs

- Two prototype switch modules for 1kA tested
- 2 kA bipolar prototype under construction



1 kA modules

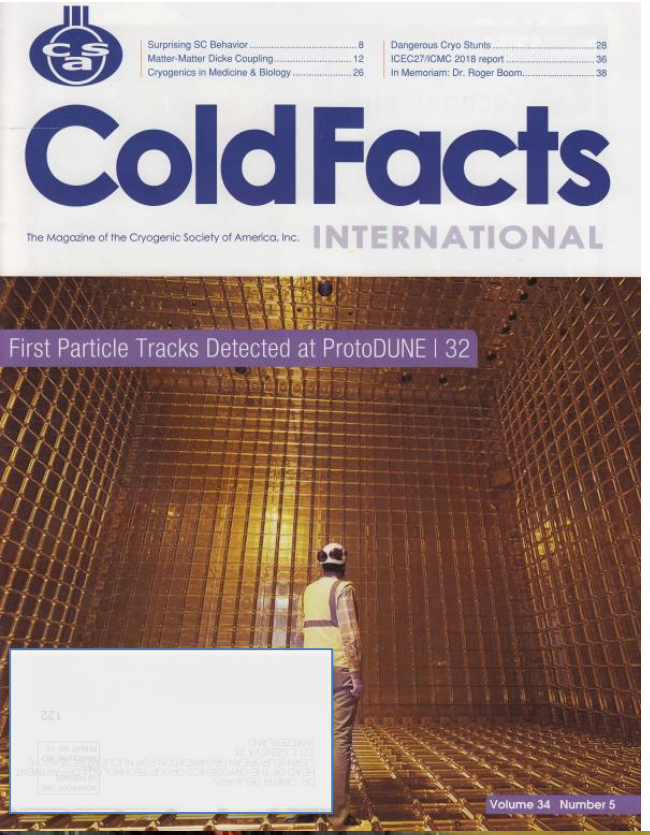
EE systems based on vacuum switches

- 2 kA EE system prototype fully tested
- Type tests for 600 A systems ongoing

Vacuum switch

2 x 600 A system

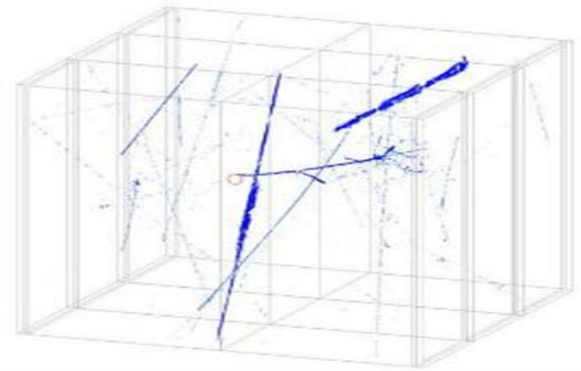
CERN roadmap – scientific diversity



600 m³ , 7'500 tons of LAr

180 tons warm gas filtered

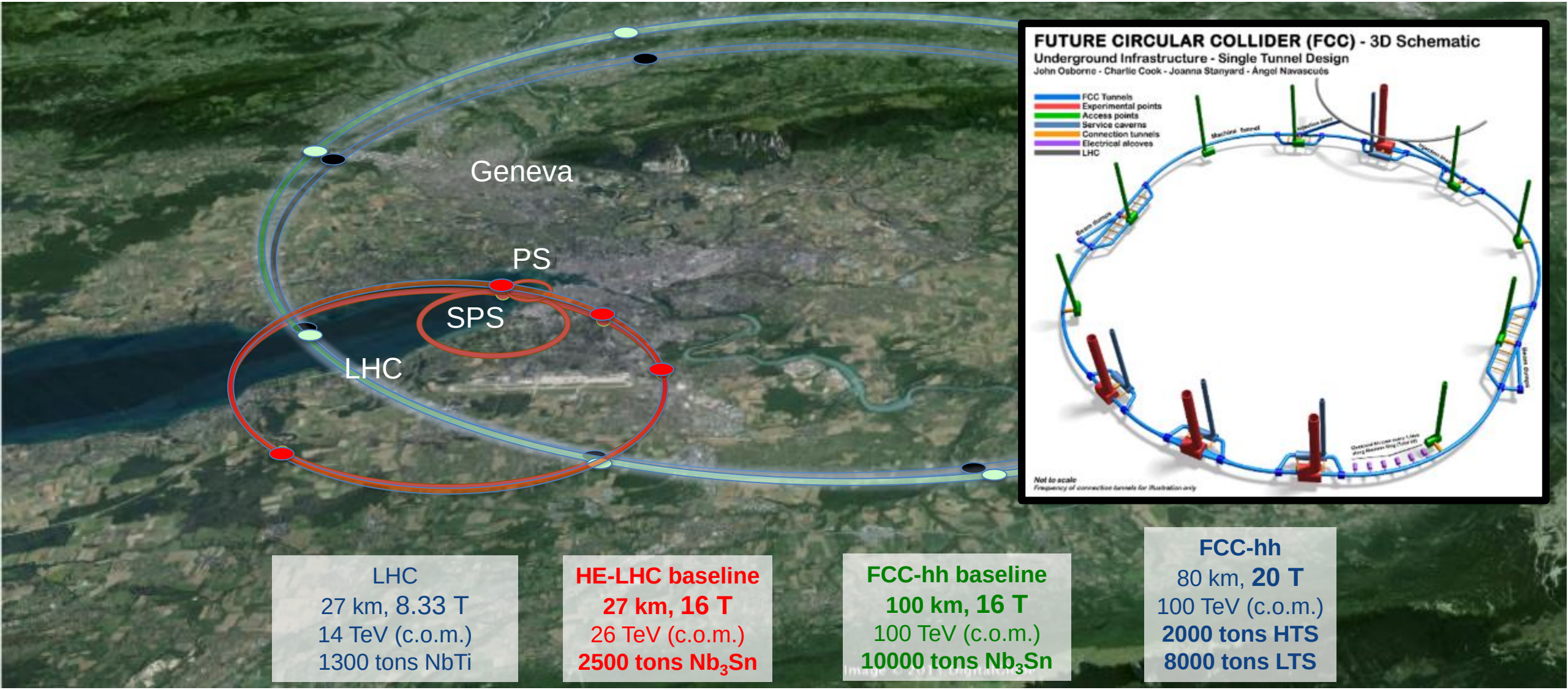
P < 50 ppt O_2 eq. ($50/10^{12}$)



Tracks in NP04 LAr volume

LAr cryoplant for neutrino platform in SPS North experimental area

CERN roadmap – High Energy Frontier (FCC, CLIC)



LHC
27 km, 8.33 T
14 TeV (c.o.m.)
1300 tons NbTi

HE-LHC baseline
27 km, 16 T
26 TeV (c.o.m.)
2500 tons Nb_3Sn

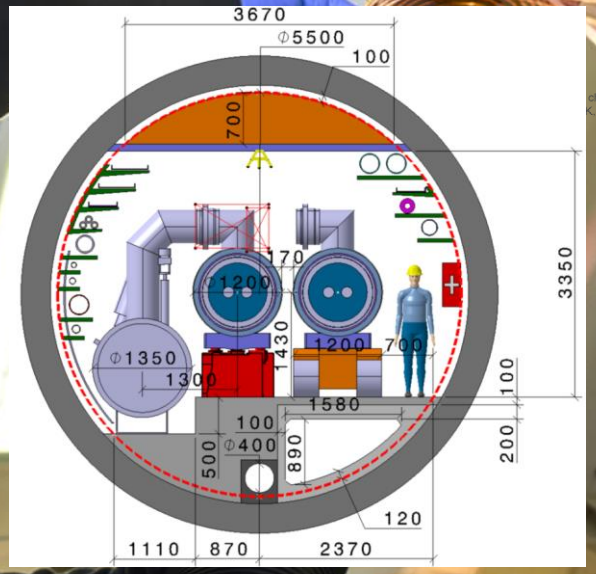
FCC-hh baseline
100 km, 16 T
100 TeV (c.o.m.)
10000 tons Nb_3Sn

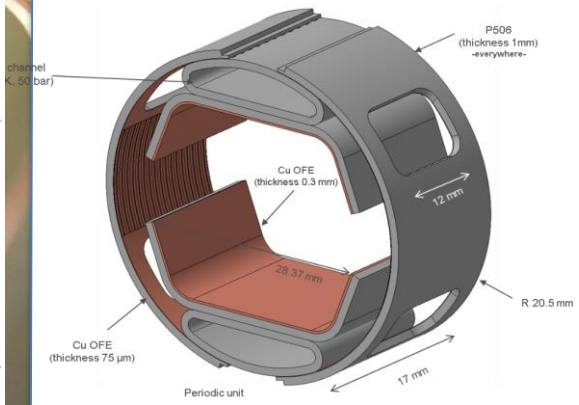
FCC-hh
80 km, **20 T**
100 TeV (c.o.m.)
2000 tons HTS
8000 tons LTS

FCC – TE contributions

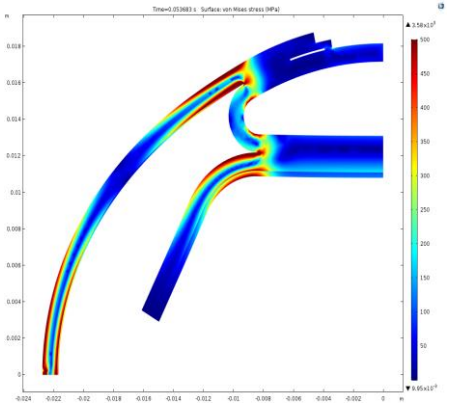
Comprising a wide range of topics …

- Geology & civil engineering
- Integration
- Electricity distribution
- Cryogenics
- Cooling & ventilation
- Transport & handling
- Installation
- Planning & coordination
- Geodesy, survey & alignment
- Controls
- Computing
- Communications & networks
- General safety
- Access control
- Radiation protection
- Environmental protection
- Power/energy consumption
- Energy efficiency
- Operation & maintenance concepts
- Availability & reliability
- …



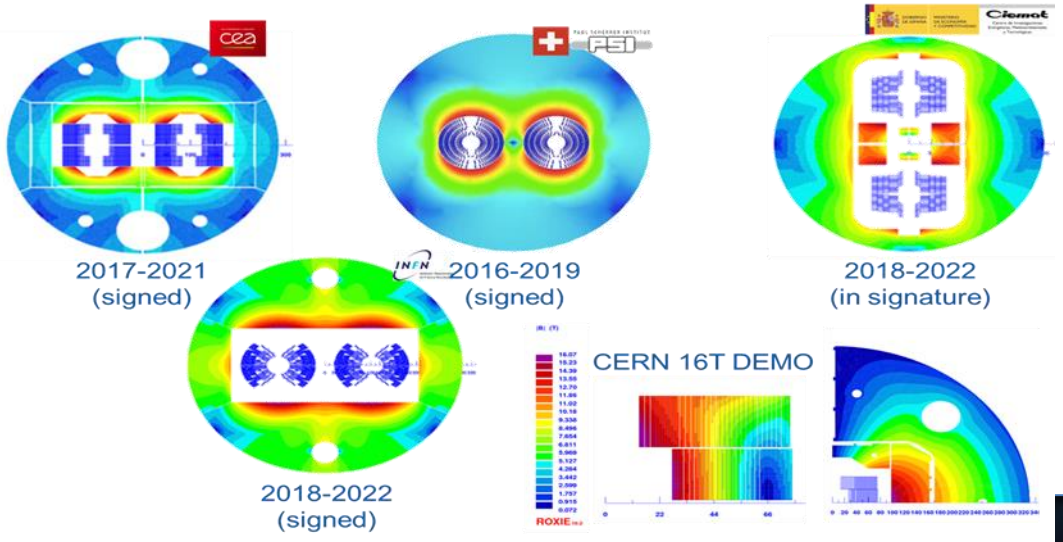


FCC-hh beam screen design



Stress profile during a quench

High Field Magnet program

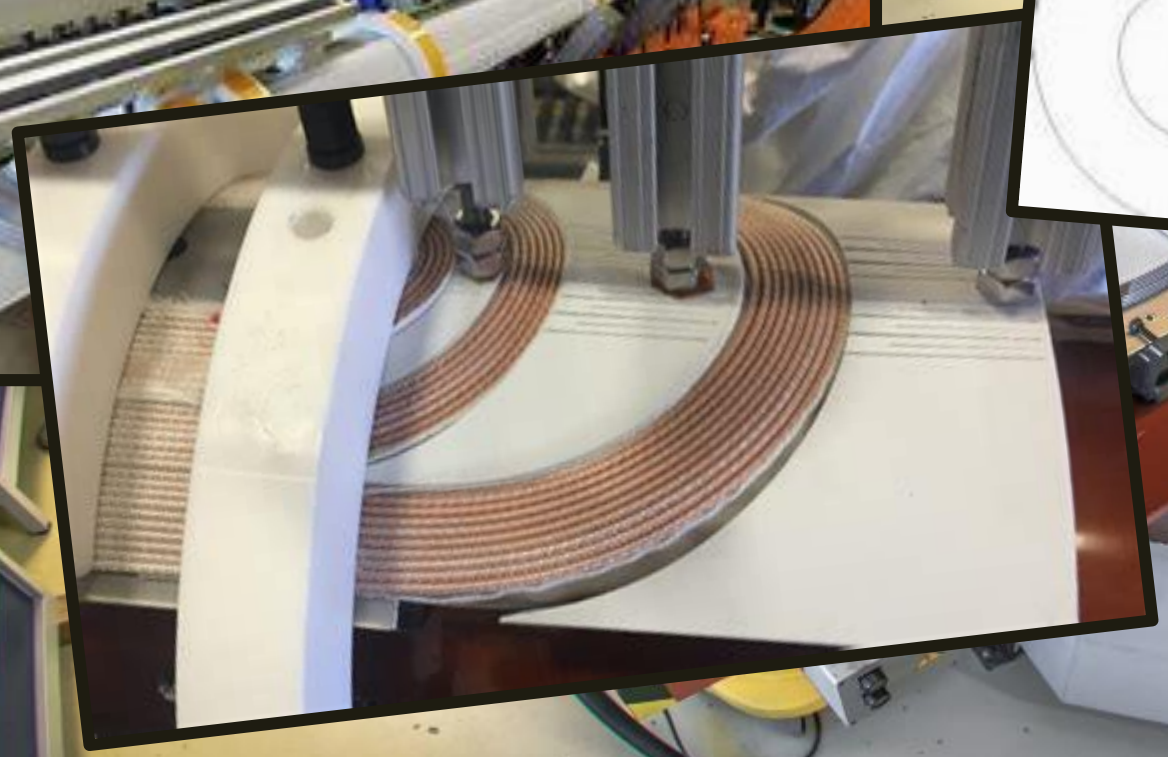


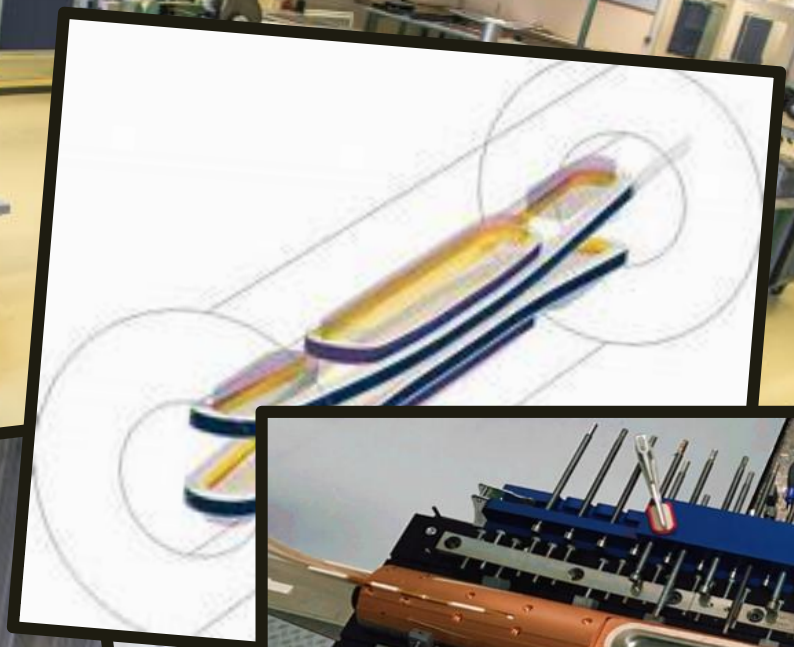
Quadrupole outer chamber

Dipole inner chamber

FCC – TE contributions

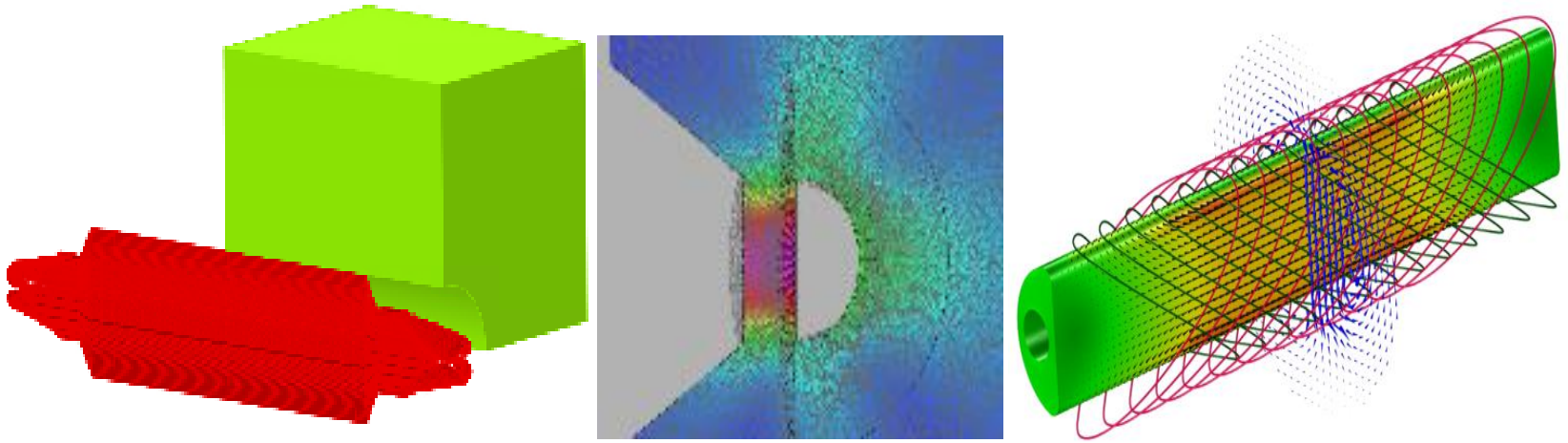
High field magnets (HTS)



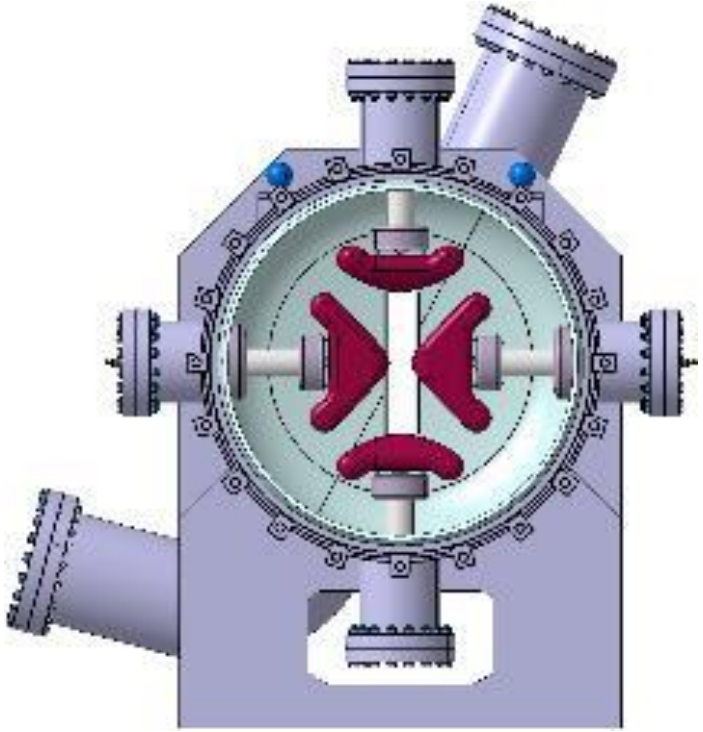


FCC – TE contributions

Special electrostatic and magnetic devices



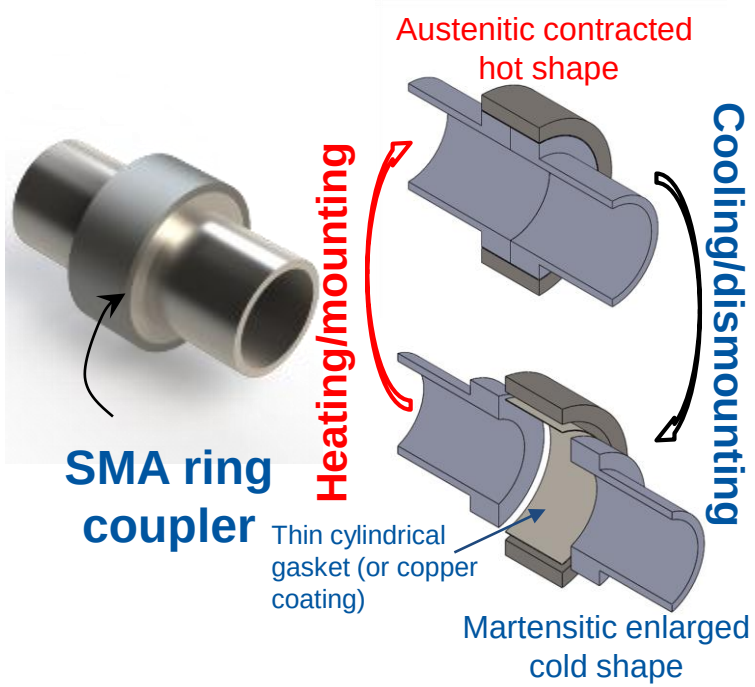
Superconducting septa developments for the FCC: Truncated Cosine Theta (TCT, left, middle) and Super conducting Shield (SuShi, right) topologies.



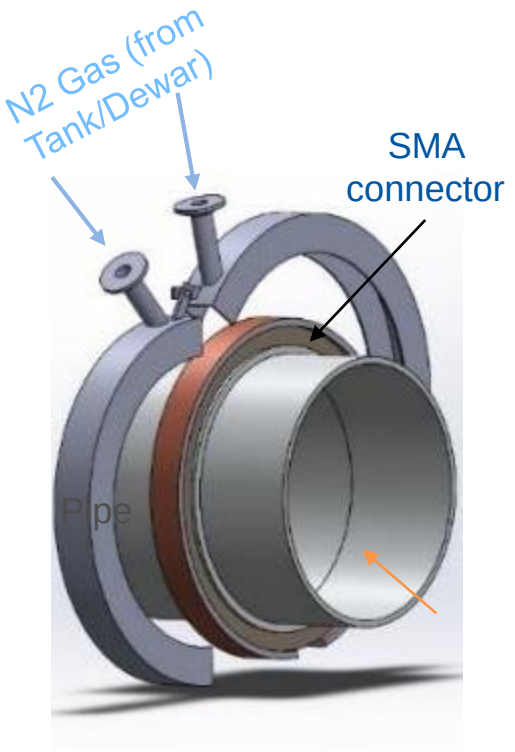
Electrostatic quadrupole concept

FCC – TE contributions

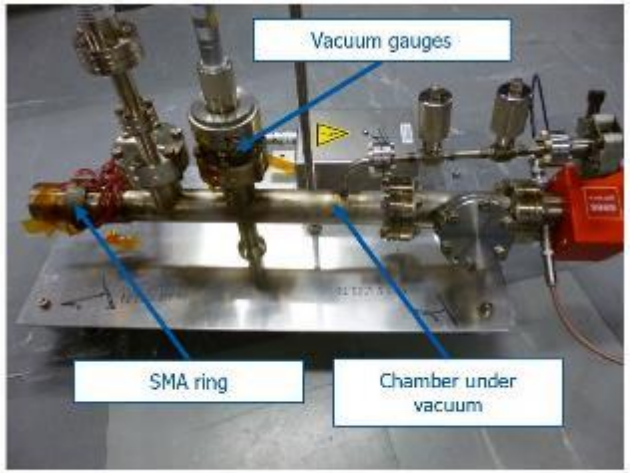
Shape memory allows: from feasibility study to implementation



Soft/hard materials + temperature control



Integrated heating/cooling collars (remote clamping/unclamping)



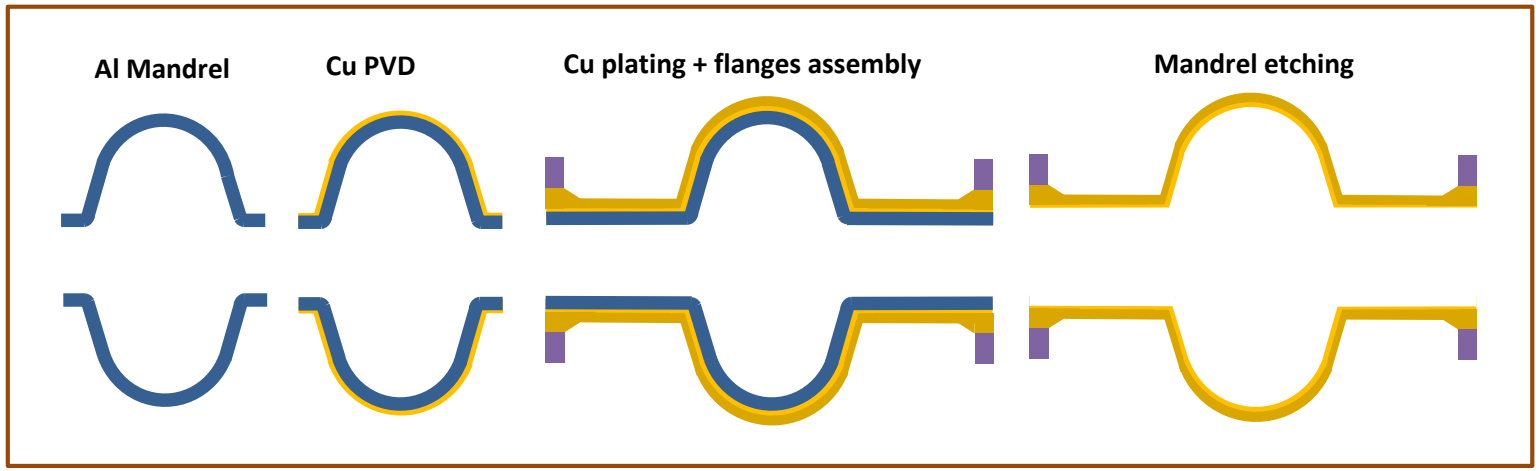
SMA vacuum set-ups in TDC2 (SPS North Area)

FCC – TE contributions

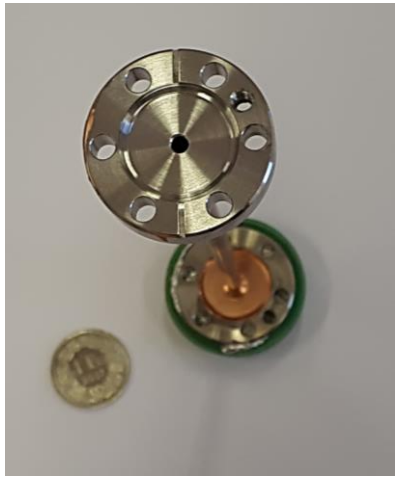
Small beam pipes and SC RF cavities by electroforming

Can we use the technology of reverse NEG chambers to manufacture a cavity?

- **Surface state controlled by mandrel**
- **No e-beam welding required**



Small Beampipe
SR Facilities



Upcoming needs for industrial procurement

TE-ABT:

- Capacitor charging power supplies for the LHC beam dumping system, 35 kV / 10 mA – 20 kV / 10mA, 2023-2025, high precision & high stability
- Digitiser for acquisition of pulse signals, 100 MS/s 14 bits, 2023-2025, PCIe form factor with Linux driver
- High voltage DC generators for electrostatic septa powering, 270 kV / 2 mA, 2022-2023, without SF6 as insulating medium

TE-CRG:

- Supply of 40'000 t of liquid nitrogen for the operational period 2019-2023 (renewal)
- Supply of 240 t of liquid helium for the operational period 2021-2025 (renewal)
- Industrial support services for cryogenics maintenance and operation for the period 2022-2026 (renewal)
- Two 18 kW @ 4.5 K cryogenic plants and cold compressors units
- 1.5 km cryogenic distribution infrastructure (multiple lines)

Will be presented and discussed in dedicated discussions this afternoon.

TE-EPC:

- Power converters (supplies) based mainly on commercial components (t b integrated in EPC‘s power racks + controls archit.)
- Power converters built to specification, or built to print (CERN design; based on manufacturing folder, 5 ... 150 units), e.g. for HL-LHC: 5 units of 10 V / 18 kA, 10 units of 8 V / 14 kA, 100 units of 10 V / 120 A, ...
- Components to be used in power converters (power semiconductors, magnetics, racks, capacitors, DCCT, ...)

Upcoming needs for industrial procurement

TE-MPE:

- CLIQ (Coupling Loss Induced Quenches) quench protection system (pre-series for the IT String test in SM18 + series);
  primarily electromechanical components, i.e. capacitors, switching devices/thyristors, charging units
  control electronics crates, mechanics (+ assembly)
- Quench Heater Power Supplies (DQHDS); e.g. electrolytic capacitors, charging circuits and controls electronics,
  cables and mechanics (+ assembly). Capacitor lifetime particularly critical.
- Energy Extraction Systems for 600 A and 2 kA magnet/circuits of HL-LHC insertion region and triplet;
  capacitors, triggering circuits, copper bus bars and machining, vacuum switches, controls electronics,
  cables and mechanics (+ assembly), dump resistors. Development based on vacuum switch technology.

Will be presented and discussed in dedicated discussions this afternoon.

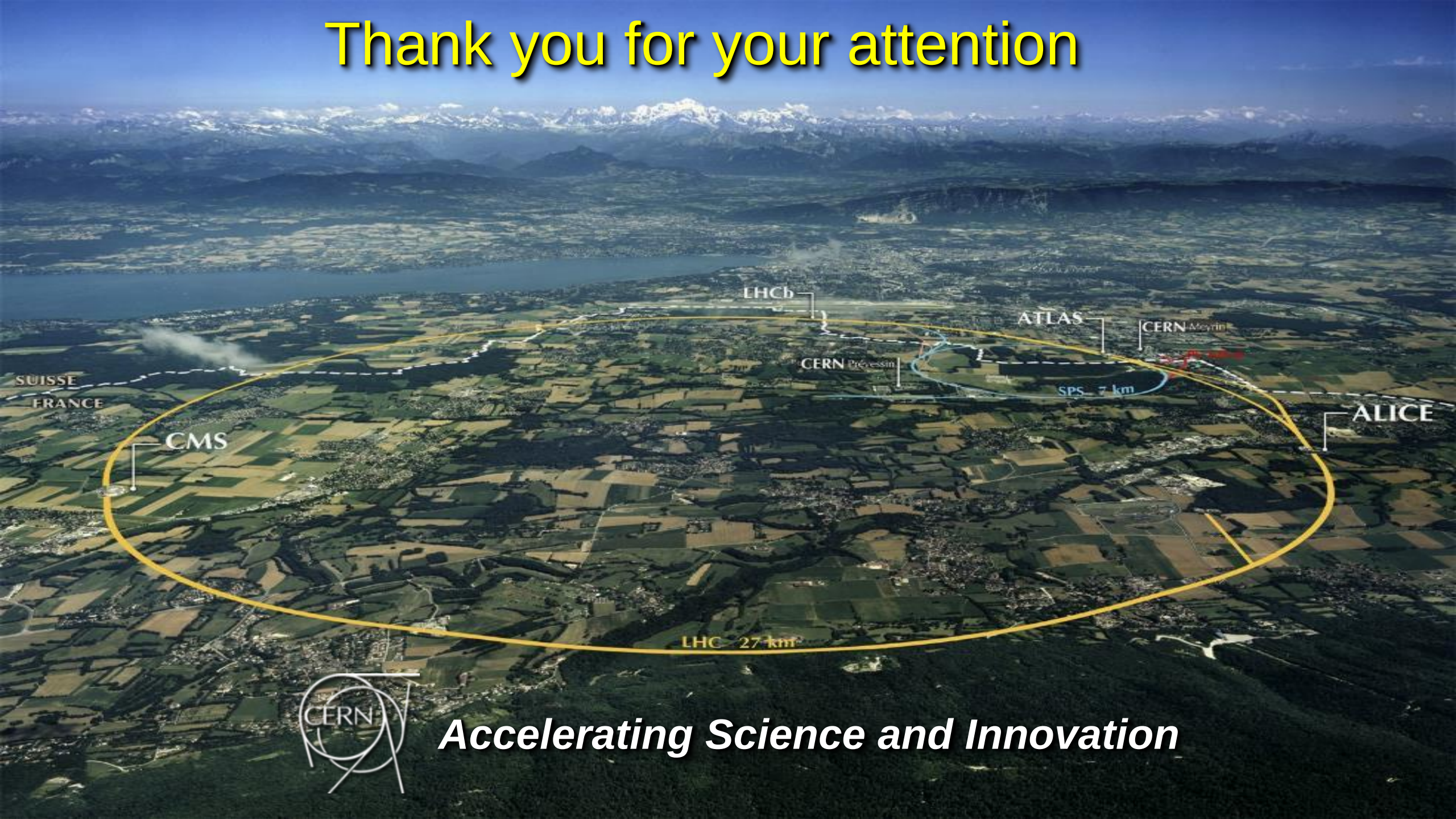
TE-MSC:

Will be presented and discussed in dedicated discussions this afternoon.

TE-VSC:

- Vacuum components (handled through main workshop – EN-MME)
- *Collaborations with Universities (Minho, IST Lisbon, Leiria)*

Thank you for your attention



Accelerating Science and Innovation

CERN roadmap (injectors, LHC/HL-LHC)