

**BIG SCIENCE
SWEDEN
CONFERENCE**
2019



Vacuum Technology @ CERN



Hector Garcia Gavela
HL-LHC Project Engineer

PARALLEL SESSIONS - Business Opportunities and Collaboration – DAY 1 - 26th Nov.

Description of short term need from the research facility – Business and Competence

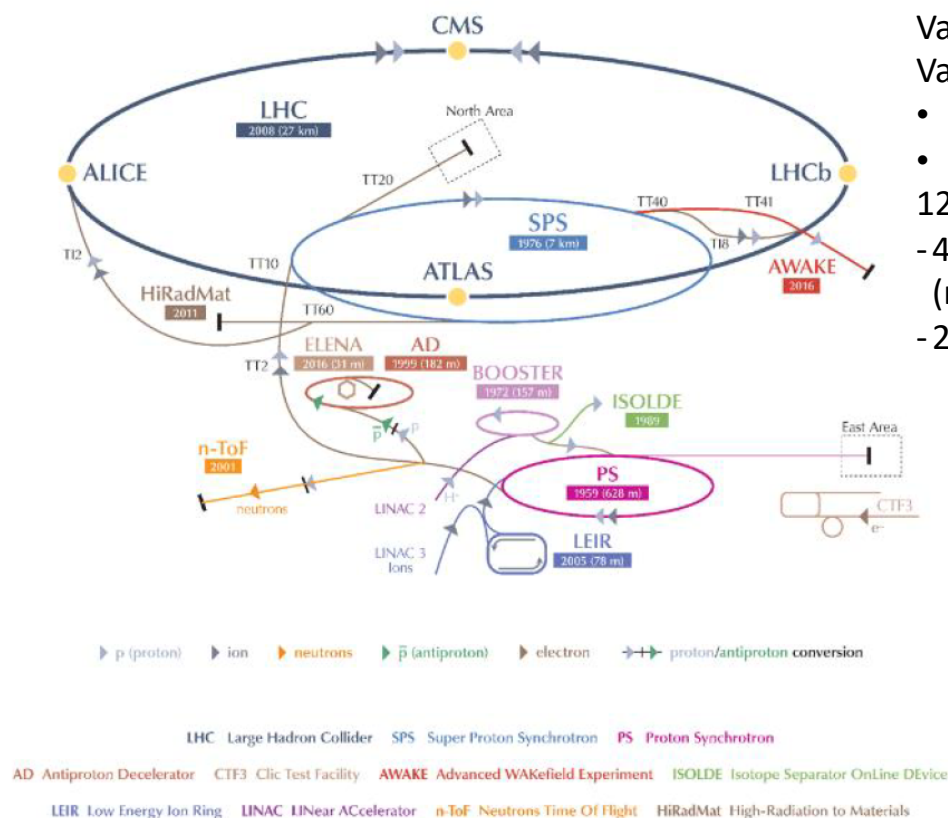
13.00-14.00	1. Advanced materials & Production methods NOTE: 13:00-14:15 Material classes and advanced production methods, Steel, Tungsten, Ceramics, Niobium, Copper, 3D-Printing, Hiping, Advanced Plastics, Surface treatment/coatings.	2. Electronics (Hardware) MictoTCA.4, PLC, Cables, FPGAs, Digitizers, Flexi boards, Detectors..	3. Technology Integration, consortia and sub-contracting How do we form successful consortia? How can Sweden successfully deliver projects within Big Science. This session is aiming at discussing together with system integrators.	4. Remote handling and robotics Maintenance and operations in complex, hazardous and routine work environments. Robotics and Co-robotics. Solutions for industry and RI.	
14.30-15.30	5. Vacuum, Cryogenics & Magnets Manufacturing companies - vacuum standards, vacuum companies, materials for room temperature and cryogenic temperature. Manufacturing methods, Gas companies, Ultra high vacuum. Magnets and superconducting Magnets.	6. AI, Control Systems, Data Acquisition, Big Data AI, Machine learning, Timing, data storage , EPICS, TANGO, PLC, Software.	7. Power Supplies & RF systems Power supplies, Power electronics, High voltages, RF generators and distribution.	8. Virtual reality and Augmented reality Solutions for industry, maintenance in advanced environment, training for advanced tasks.	9. Safety and Quality Safety analysis, Fire safety, Radiation protection, Electrical safety, Occupational safety, QA & QC, testing and verification.



Instructions for your presentation

- Vacuum Technologies at CERN
- Upcoming challenges
- Needed competences and capabilities of suppliers
- Upcoming procurements
- Summary

Vacuum Technology at CERN



Vacuum is a key technology for the performance of the accelerators

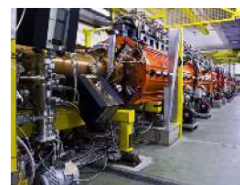
Vacuum to reduce interactions with residual gas molecules in the beam pipes

- maximise beam life-time (100 h: $1 \cdot 10^{-8}$ mbar)
- minimise background noise to the experiments ($1 \cdot 10^{-11}$ mbar)

120 km of vacuum chamber (of which 100 km in LHC alone)

-4x 23 km of LHC are Cold (1.9 or 4.5 K): 2 beam pipes + 2 insulation volumes (magnets + QRL)

-2x 4 km of LHC are at Room Temperature (RT): 1 or 2 beam pipes + no insulation



Linac2 $< 2 \cdot 10^{-6}$ mbar*



PSB $< 5 \cdot 10^{-8}$ mbar*



PS $< 2 \cdot 10^{-8}$ mbar*



ELENA $< 4 \cdot 10^{-12}$ mbar



* After 24 h pumpdown

SPS LSS $< 10^{-7}$ mbar*



LHC arcs $< 10^{-8}$ mbar



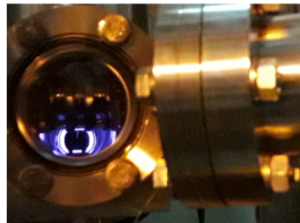
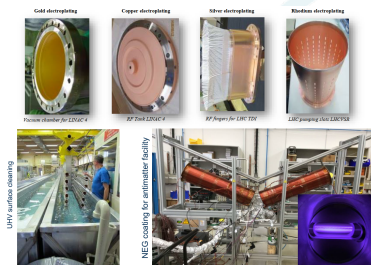
LHC LSS $< 10^{-10}$ mbar

Unbaked systems
TMP, ion pumps, Ti sublimators

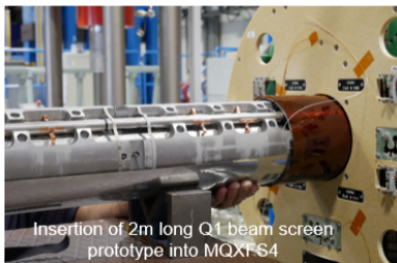
Cryogenic systems
Cryopumping

Baked systems
Ion pumps, NEG coating

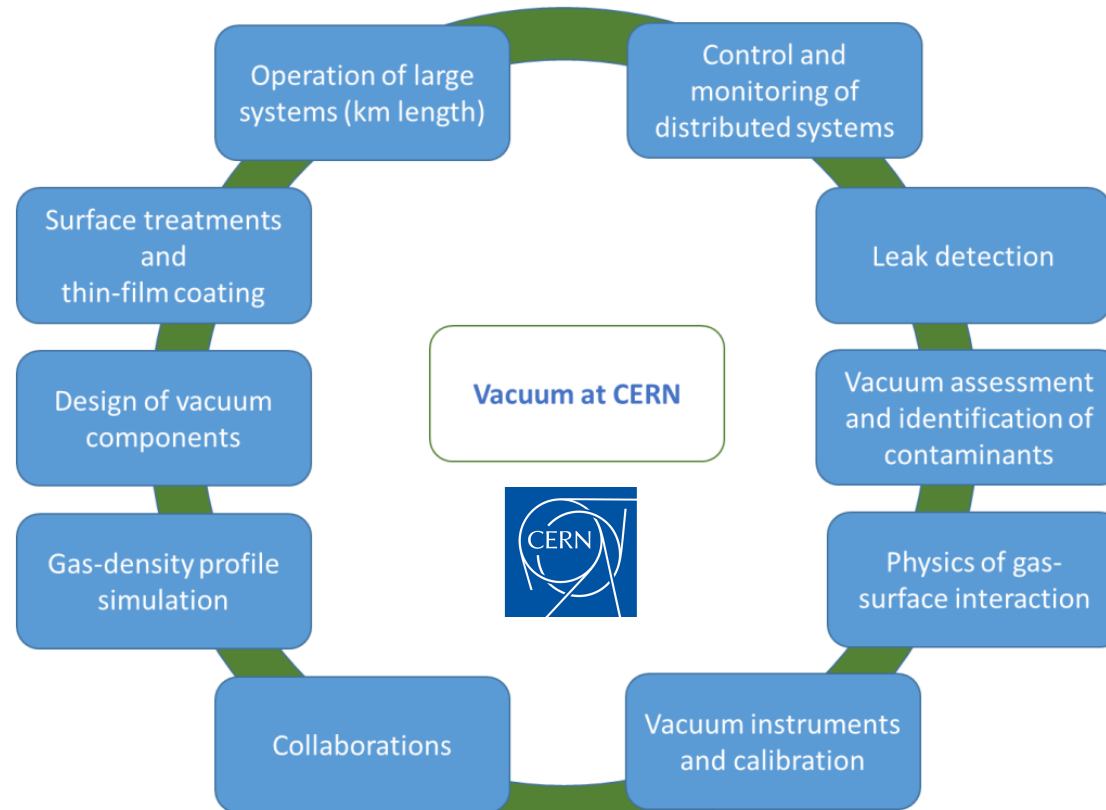
Vacuum Technology at CERN – Multidisciplinary Approach



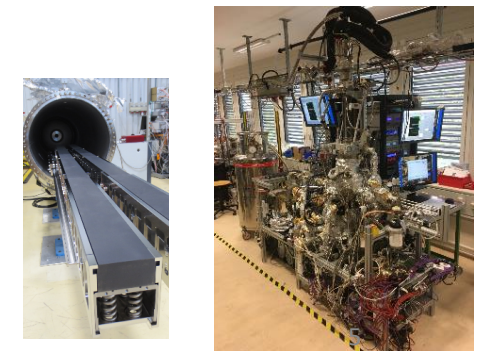
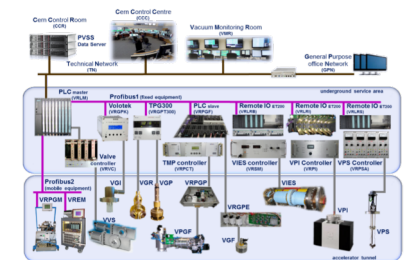
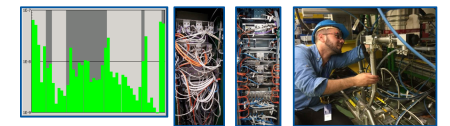
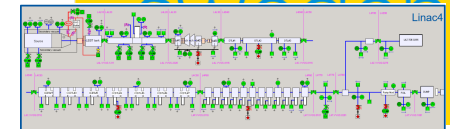
a-C coating Q5L8, October 2019



Insertion of 2m long Q1 beam screen prototype into MQXF S4



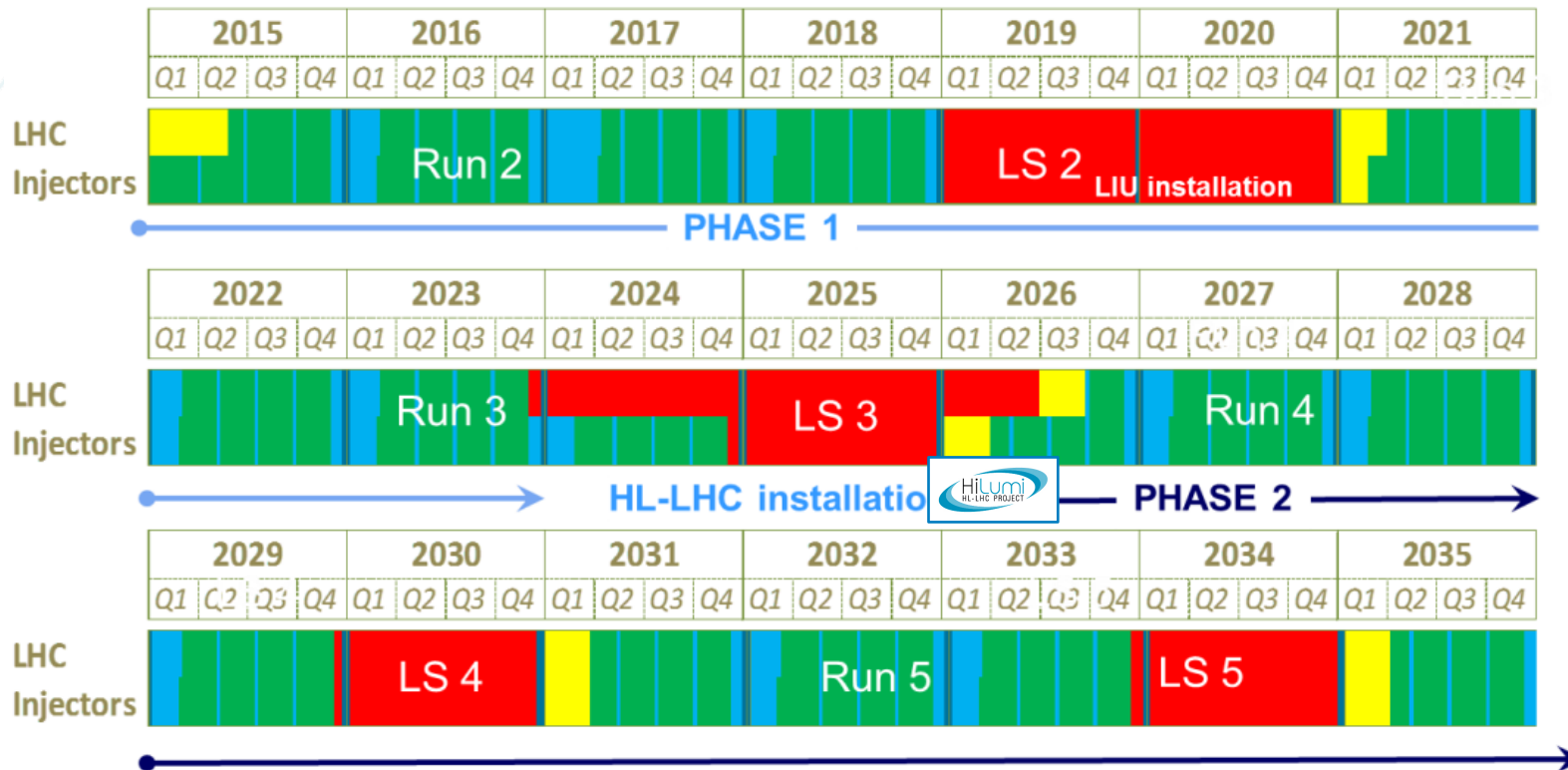
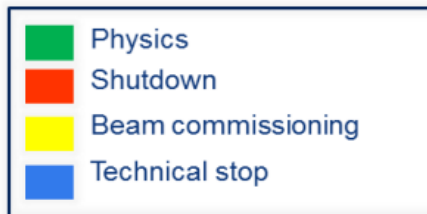
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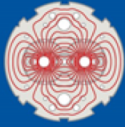


CERN Roadmap

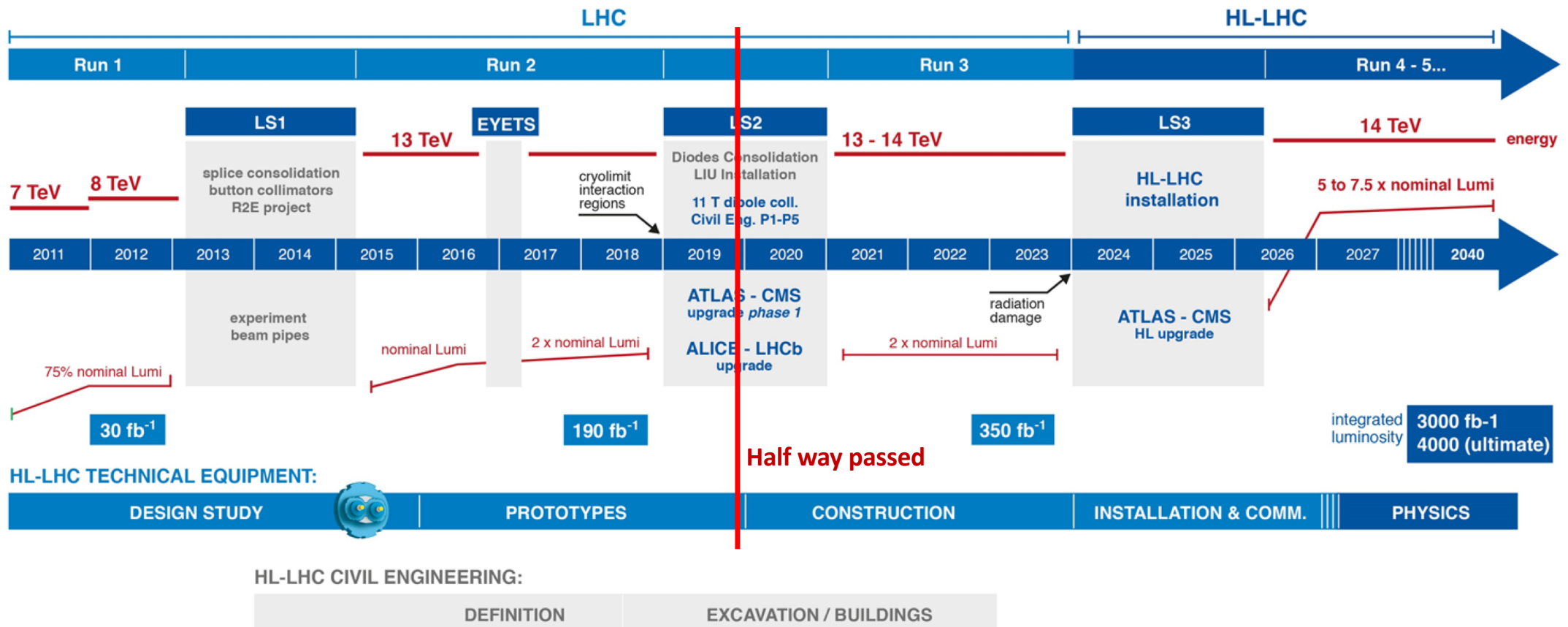


LS2 starting in 2019 => 24 months + 3 months BC
 LS3 LHC: starting in 2024 => 30 months + 3 months BC
 Injectors: in 2025 => 13 months + 3 months BC





LHC / HL-LHC Plan



Upcoming challenges (main pillars)

1. Full exploitation of the LHC:

- Successful Run 2, LS2*, and Run 3 start-up.
- Upgrade of LHC Injectors; on-track construction of HL-LHC.



2. 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.



3. Preparation of CERN's future:

- vibrant accelerator R&D programme exploiting CERN's strengths and uniqueness.
- design studies for future accelerators: CLIC, FCC (includes HE-LHC).
- future opportunities of diversity programme: "Physics Beyond Colliders".



Needed competences and capabilities of suppliers

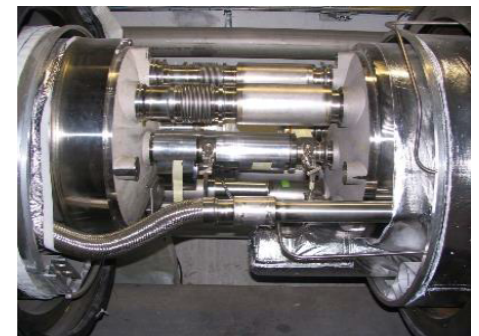
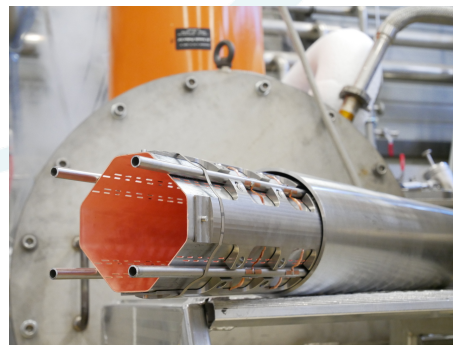
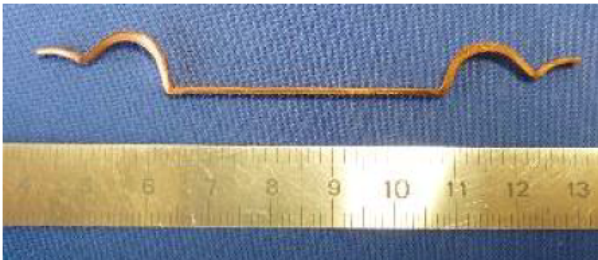


For the coming years, it will be required both hardware and engineering services/maintenance work.

- Standard vacuum components are mostly procured by blanket contracts:
 - Pumps covering all vacuum grades.
 - Leak detectors
 - Valves.
 - Quadrupole gas analysers.
 - Vacuum gauges.
- Vacuum chambers of different shapes are either manufactured in house or in the Industry.
- A part of maintenance and field activities are ensured by industrial support, presently a consortium

Upcoming procurements

- HL-LHC Thermal Links for Beam Screens (by 2020)
- HL-LHC Brazing of thermal Links for Beam Screens (by 2020)
- HL-LHC Machined Stainless Steel Studs for Beam Screens
- HL-LHC Interconnections, Cold-Warm Transitions (from 2020 onwards)
- Blanked Contract for Sputter Ion Pumps (by 2020)
- Service Contracts for Vacuum Activities during LS3



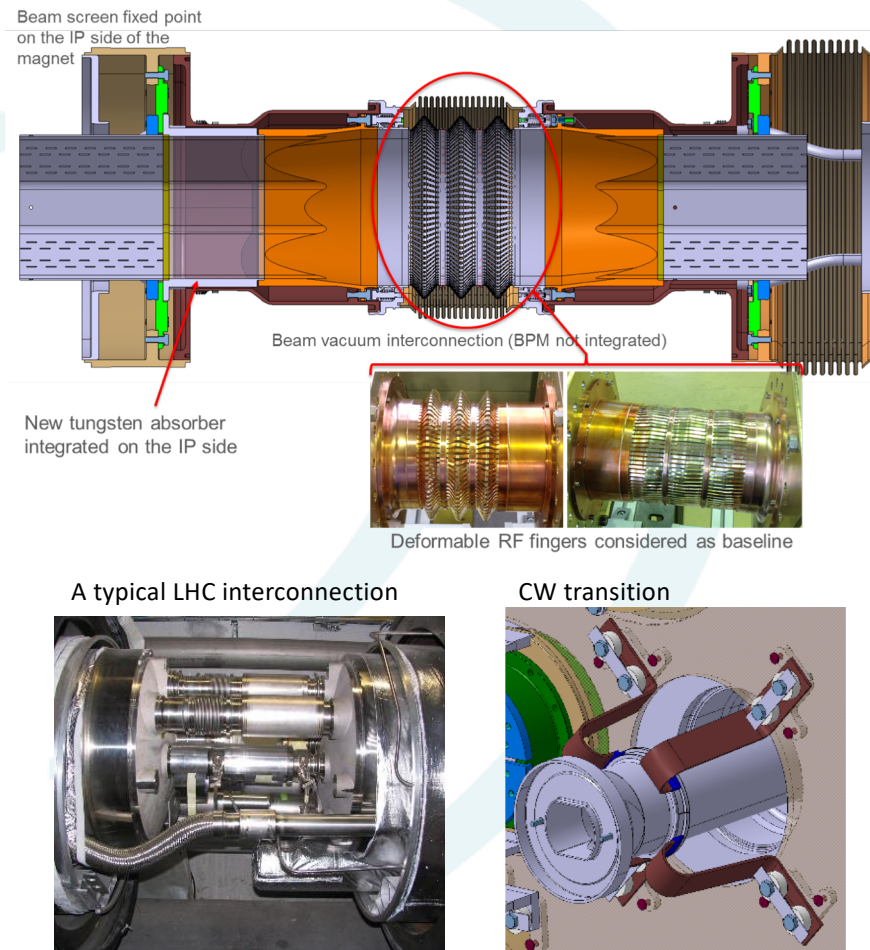
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Upcoming procurements



Beam Pipe Interconnects:

- Similar or different diameter or shape (aperture matching)
- Dedicated Plug-in Modules to assure RF screening and low impedance: Cu plated stainless steel
- Connections for different temperature (Cold-Warm Transition)
- Can house BPMs



About **50** new interconnections are needed

- 20 @ LS2
- 30 @ LS3

About **60** CW transitions are needed

- 20 @ LS2
- 40 @ LS3

Upcoming procurements

Vacuum Chambers:

- Cu, stainless steel, aluminium, beryllium
- Circular, elliptical, and transitions
- Specific shapes e.g. Y chamber
- Various diameters: 80, 91, 212.7, 250 mm
- Including chamber supports



Upcoming procurements

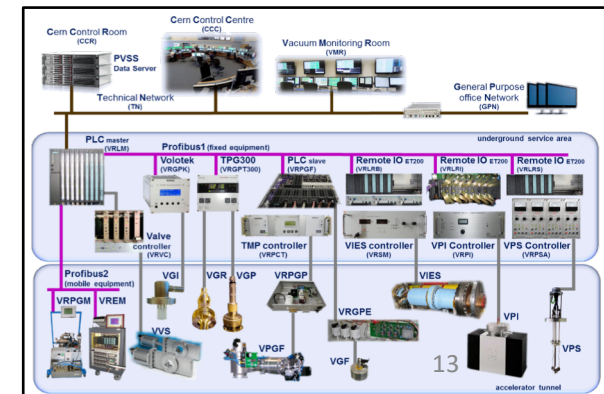
Bake-out Equipment

- Collars
- Thermocouplers
- Bake-out jackets
- Bake-out racks
- Heating tapes



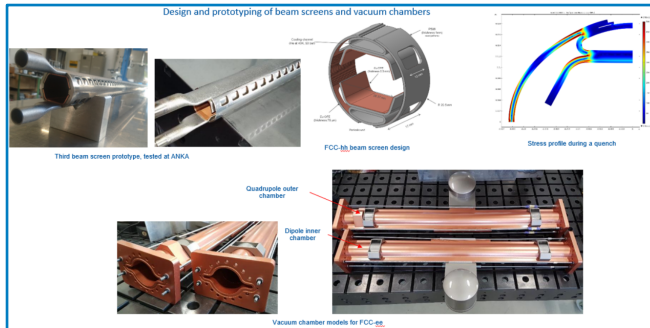
Vacuum Controls

- Redesign of some electronics (front-end & controllers)
- Adding new instruments/devices (remotely controlled and interlocked)
- Evolution of software frameworks (DB, PLC, SCADA)

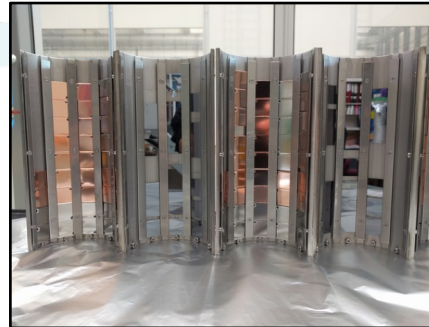


Medium-long-term needs

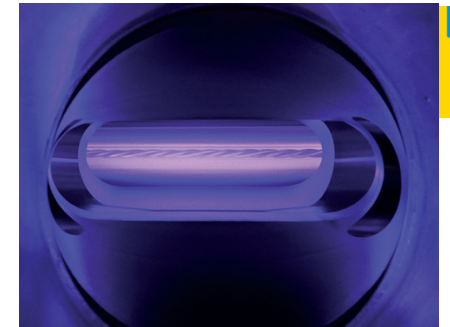
Vacuum technologies are, and will be present, in all the R&D Studies and future Projects (any size) of CERN



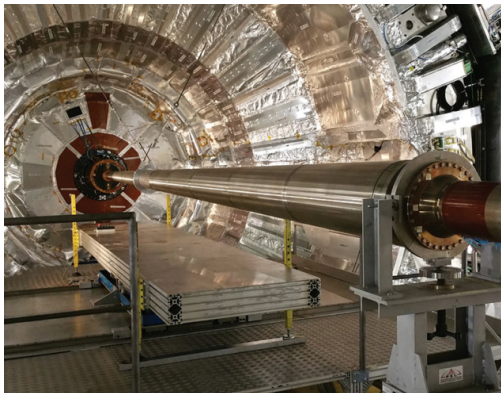
Design and prototyping of beam screens and vacuum chambers for FCC



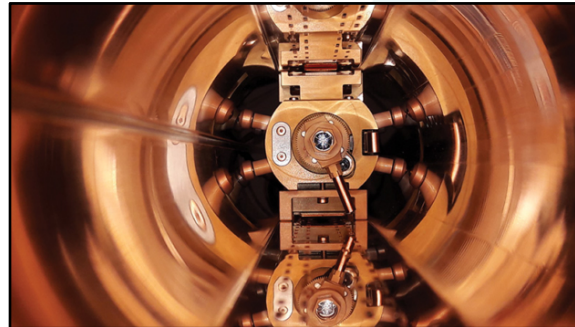
Thin NEG coating materials research for FCC-ee and hh



NEG thin-film coating of the ELENA vacuum chambers at CERN's Antiproton Decelerator



Central beam pipe of CMS is entirely coated with NEG materials on the inside



Miniature robot for in situ surface treatments of LHC beam screens, pictured inside the 74 mm-aperture beam screen of a superconducting magnet



Material irradiation tests

Main Technical Contacts Vacuum at CERN



		Contact Person	E-mail
Vacuum at CERN	TE-VSC Group Leader	Paolo Chiggiato	Paolo.Chiggiatto@cern.ch
HL-LHC Vacuum Systems	HL-LHC Work Package 12 Leader and Vacuum Studies and Measurements Section Leader	Vincent Baglin	Vincent.Baglin@cern.ch
HL-LHC Vacuum Systems	HL-LHC Deputy Work Package 12 Leader & TE-VSC Group Coordinator	Germana Riddone	Germana.Riddone@cern.ch
Design, Logistics and Methods Section	TE-VSC-DLM Section Leader	Cedric Garion	Cedrid.Garion@cern.ch
Interlocks, Controls and Monitoring	TE-VSC-ICM Section Leader	Gregory Pigny	Gregory.Pigny@cern.ch

See Presentation from J. Pierlot (CERN IPT): Doing business with CERN, Who to contact at CERN and in your country (ILO)



Summary

- There are several ways to access to the organisation, and in particular the TE-VSC group. Your Industrial Liaison Officer is the main door.
- The best success stories are those in which a small or medium size company accepted to extend its production to a higher quality standard, or to unusual tolerances and shapes.
- The learning process has profited CERN and the company itself; the latter has obtained new orientations in the market and the benefit of having CERN in its client portfolio
- Consolidation/Maintenance of the accelerators and HL-LHC Project are today the main activities within TE-VSC Group. Decision about European Strategy for Particle Physics (by 2020) will define the future needs of CERN

Many Thanks for your attention

Thanks a lot to CERN TE-VSC Group for their contributions, their infinite knowledge in the field and all the material for this presentation.

I'll be glad to discuss with you further details during this event