Vacuum for HILUMI

Paulo GOMES
on behalf of TE-VSC Group
(WP12 Leader : Vincent BAGLIN)

Introduction

Cryo Temperature sectors of the LSSs

Room Temperature sectors of the LSSs

Controls & Robotics for Vacuum

Summary

Vacuum in accelerators

vacuum for beams & for cryogenics

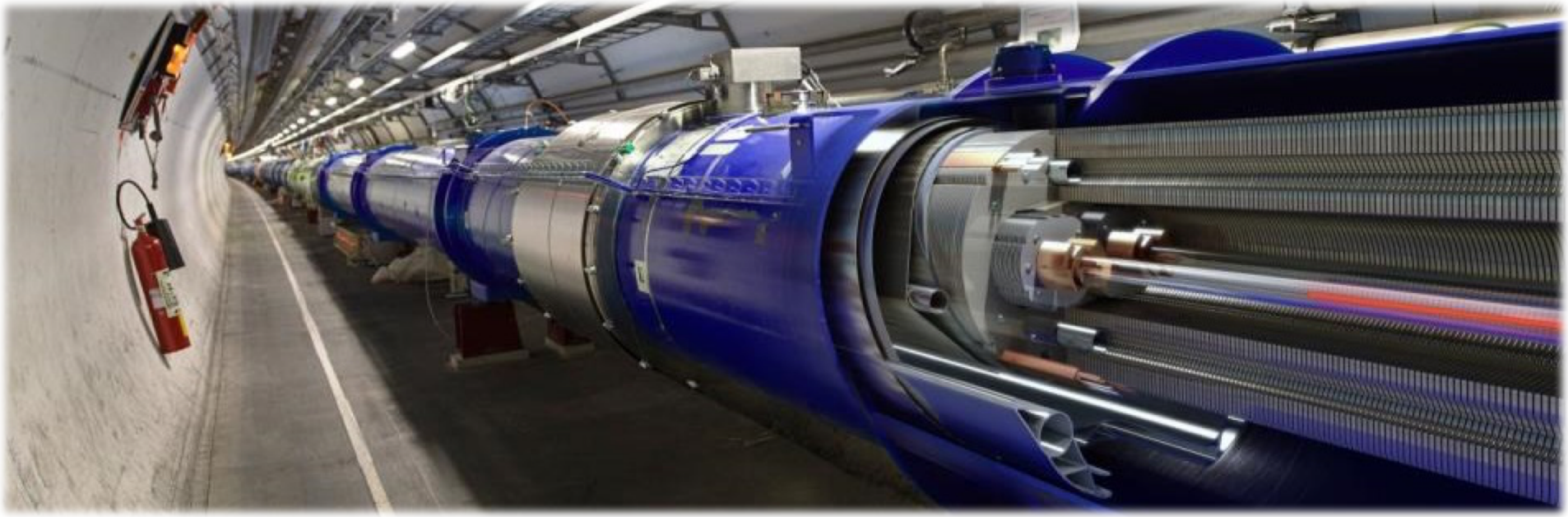
any accelerator: vacuum to reduce interactions with residual gas molecules in the **beam pipes**

maximise beam life-time (100h : 1e-8 mbar)

minimise background noise to the experiments (1e-11 mbar)

LHC needs cryogenics for superconducting magnets & accelerating cavities

vacuum is needed for **thermal isolation** (no heat exchange by convection below 1e-5 mbar)



@ cern : 120 km of vacuum vessels, of which 100 km in LHC alone

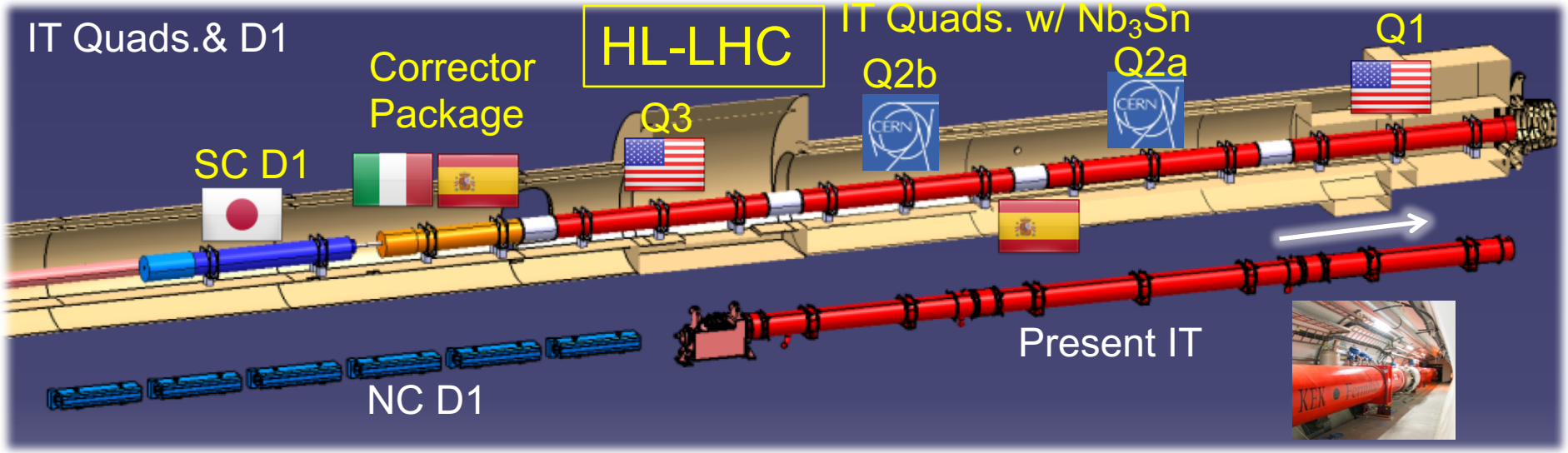
4x 23 km of **LHC** are cold (1.9 or 4.5 K): 2 **beam** pipes + 2 **insulation** volumes (magn + QRL)

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

Vacuum for HILUMI - LHC

will need modifications / upgrades on significant portions (>1.2 km) of LHC vacuum

no changes in the eight ARC sections
some modification of layout in all eight LSS (long straight sections)
completely new accelerator layout near ATLAS & CMS (LSS1 & LSS5)
- new Beam Screens (shielded, non-shielded)
- new a-C coating of Beam Screens
- new interconnects & cold-warm transitions
- increased magnet aperture (new beam pipes)



many components need to be designed and procured
- now preparing for first batch @ **LS2** (2019 – 2020)
- major works @ **LS3** (2024 – 2026)

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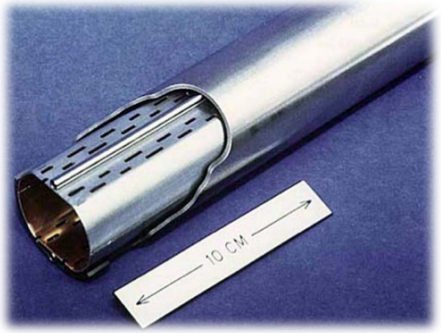
Beam Screens (BS)



current LHC baseline

Perforated BS are maintained at a controlled temperature (@ 5-20 K)

to intercept the heat induced by the beam (synchrotron radiation + electron cloud)
before it reaches the beam pipe (@1.9 K)

to intercept the particles produced by the beam (ions, electrons, photons etc.)
before they provoke molecular desorption from the beam pipe wall

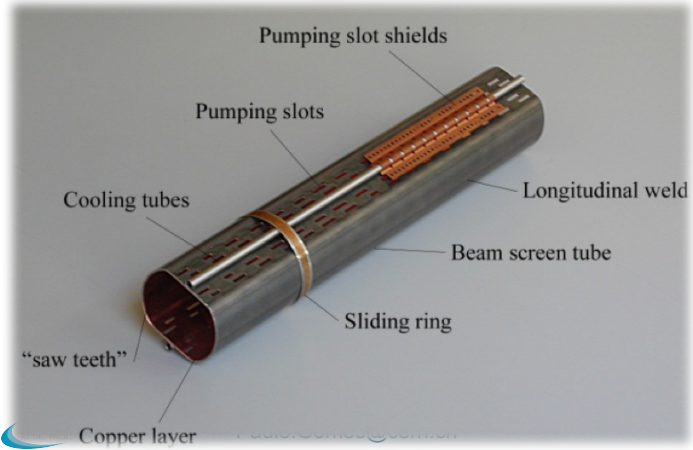
racetrack shape

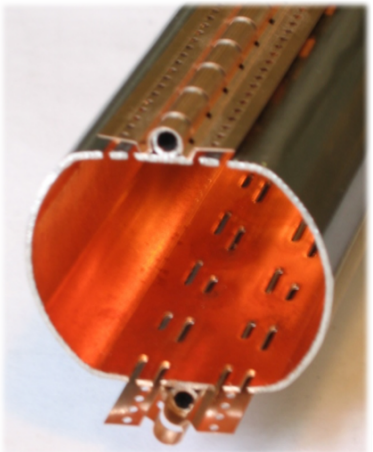
made of P506 non-magnetic stainless steel

with copper co-lamination (80 um), on the inner surface, for reduced electrical impedance

perforated to allow pumping of residual molecules into the wall of the beam pipe

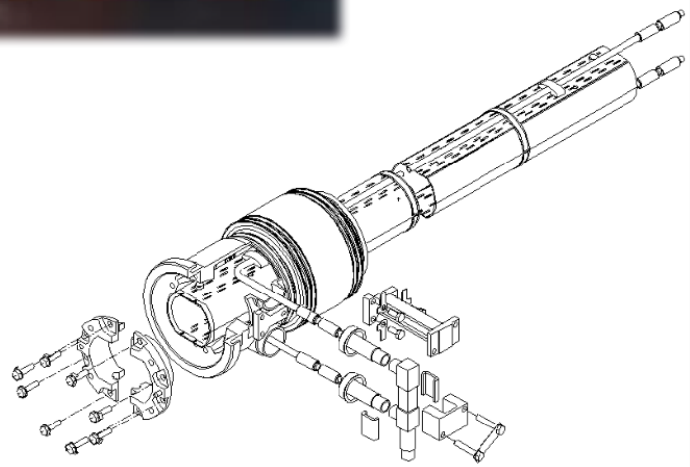
BS are not needed in Room Temperature beam pipes; which must be bakeable





Beam Screens' zoo

Wide variety of apertures (diameters) and end-finishing parts



New BS designs for HILUMI

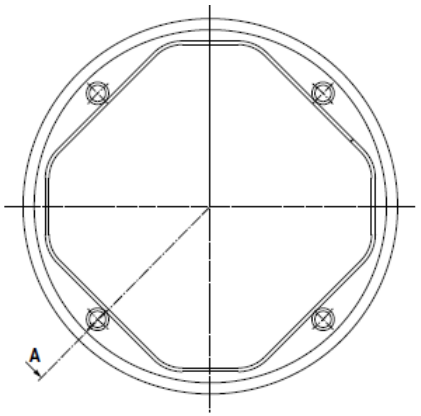
new BS designs for HILUMI are under way :

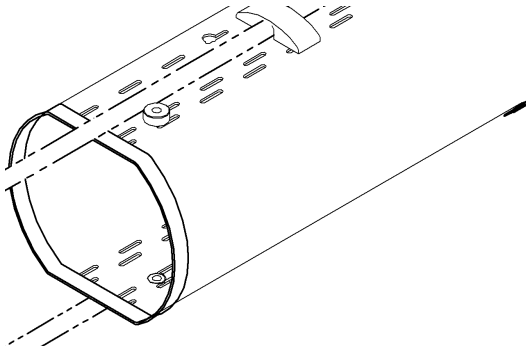
octagonal or racetrack shape

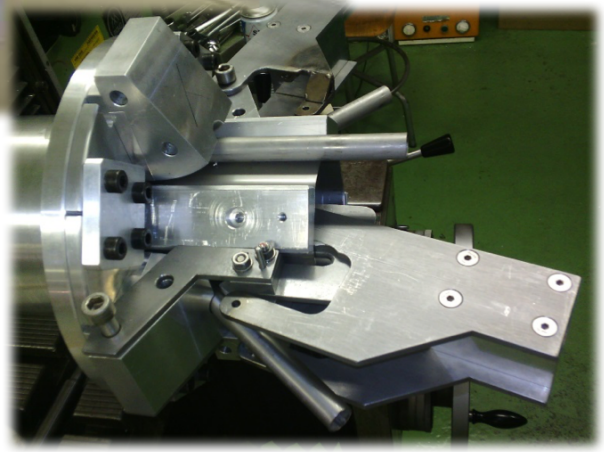
amorphous-Carbon (a-C) coating (100 nm) of inner surface of BS, to minimize electron cloud

withstand cumulated radiation 1e8 Gy

new laser welding tool at CERN

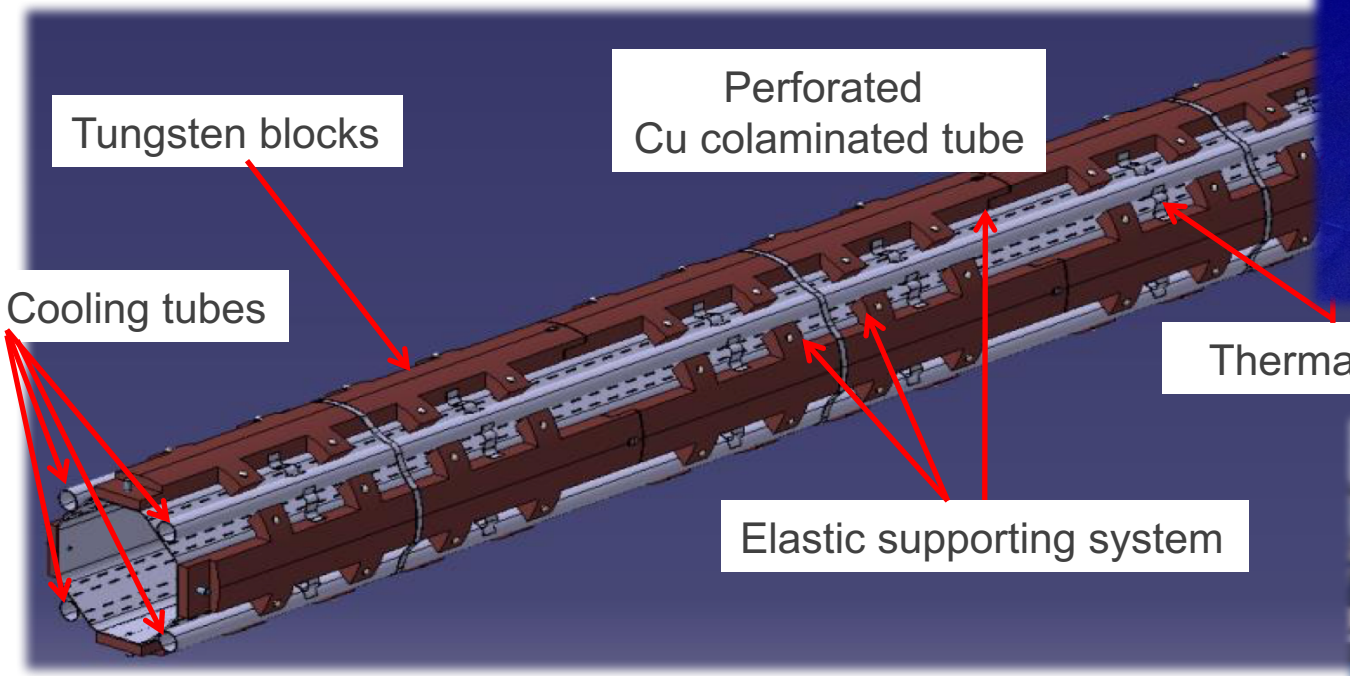


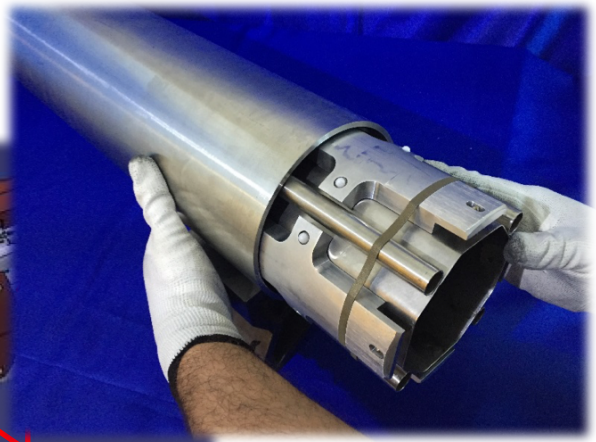


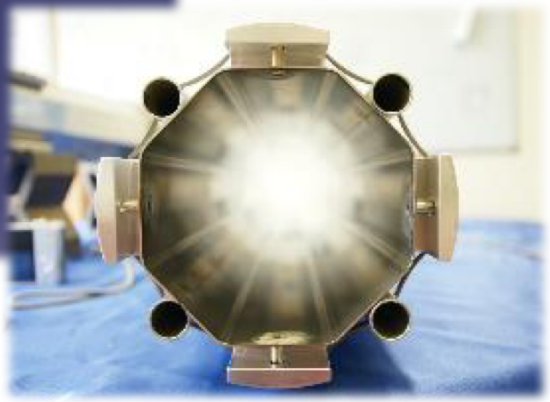


New shielded BS

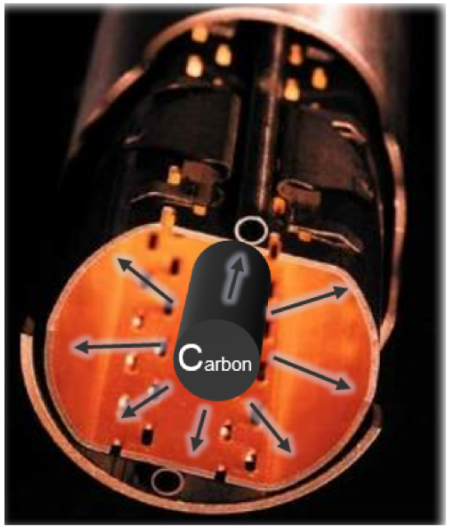
To shield the magnet coils, by intercepting particle debris produced by the experiments
40 cm absorber blocks of Tungsten (Inermet-180), 6 or 16 mm thick
4 cooling tubes stainless steel (40-60 K)
for each quadrupole magnet : 10 m, 500 kg







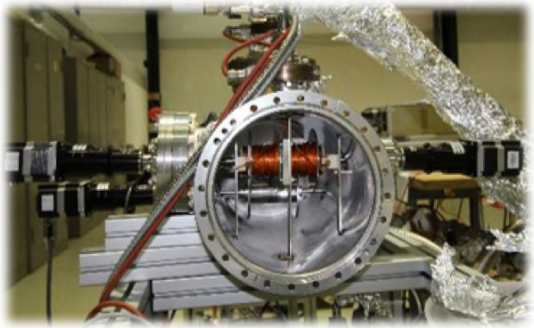
New a-C coating of BS

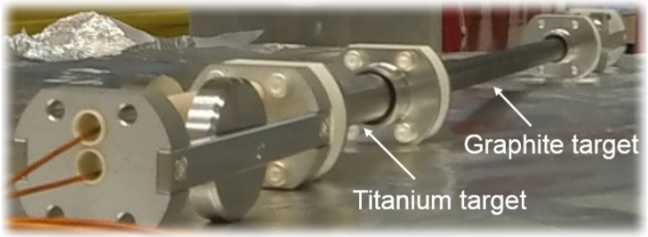


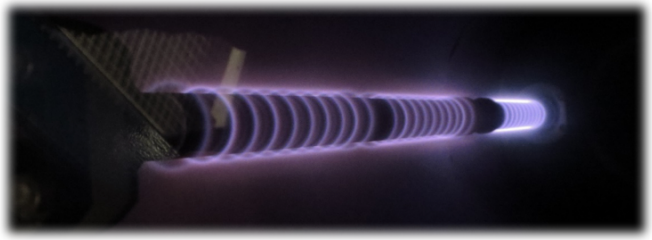
to limit the development of electron clouds
- reduce the heat-load on the BS
- reduce the background to experiments

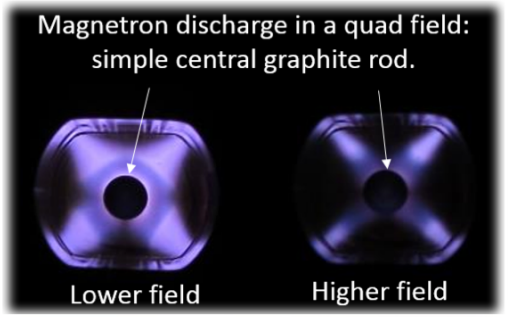
principle is under evaluation at cryogenic temperature

modular sputtering source being developed
- inserted in a 15 cm slot, and travel inside BS along 45 m
- for LSS2 and LSS8





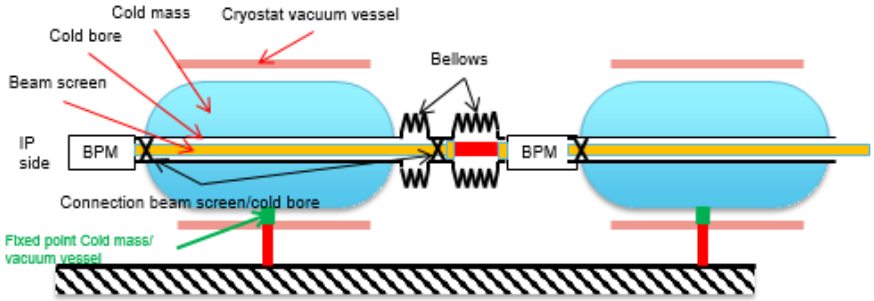


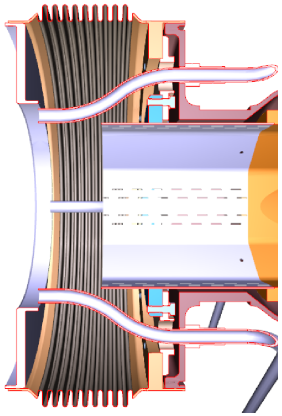


LS2 (2019 – 2020)
- in-situ a-C coating (for LSS2, LSS8) , because magnets will not be replaced
- start production of Beam Screens (for LSS1, LSS5)

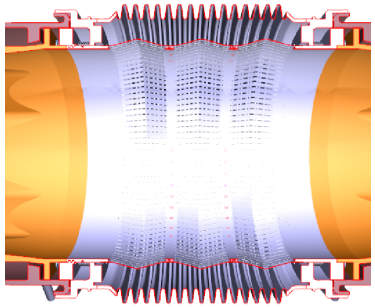
LS3 (2024 – 2026)
- Install new Beam Screens (for LSS1, LSS5) , with the new magnets

Beam pipe interconnects

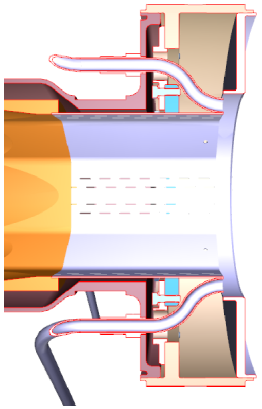




Sliding point

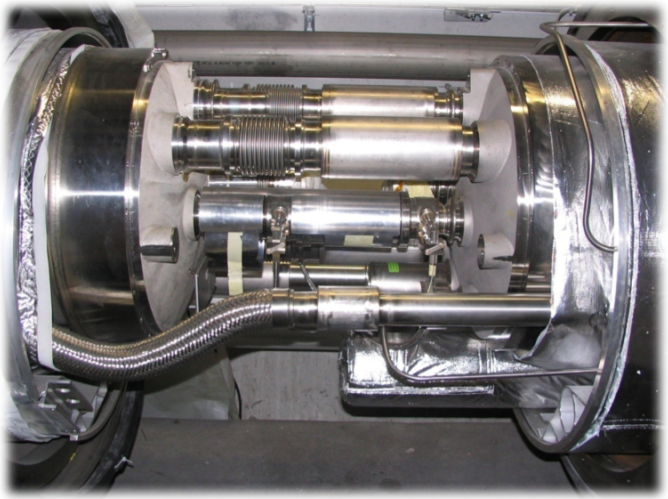


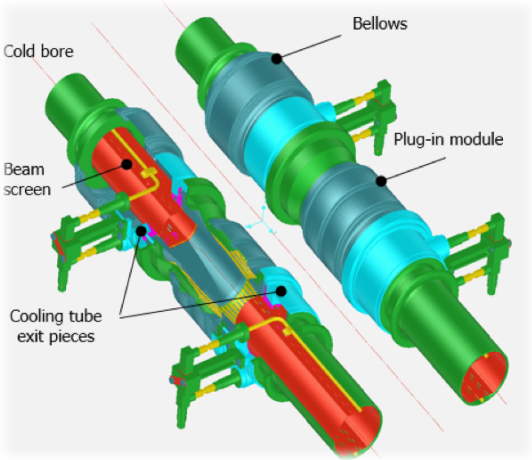
Plug-In module

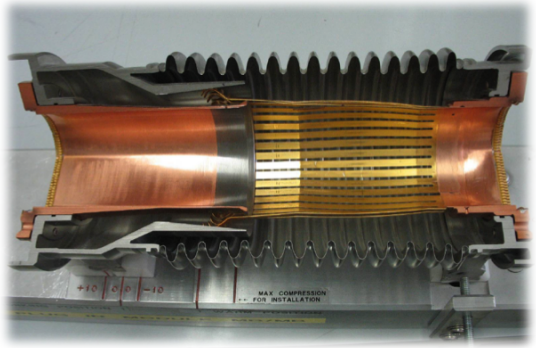


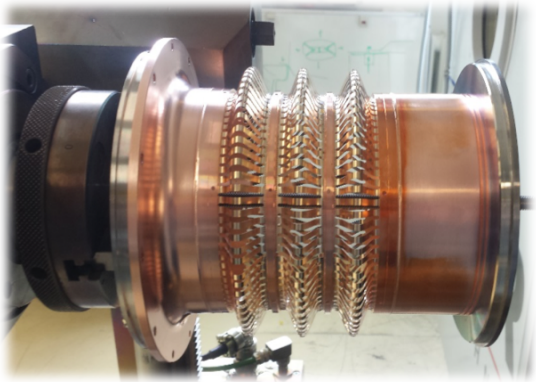
Fixed point

between beam pipes of consecutive cold masses
Similar or different diameter or shape (aperture matching)
Dedicated **Plug-in Modules** assure RF screening and low impedance









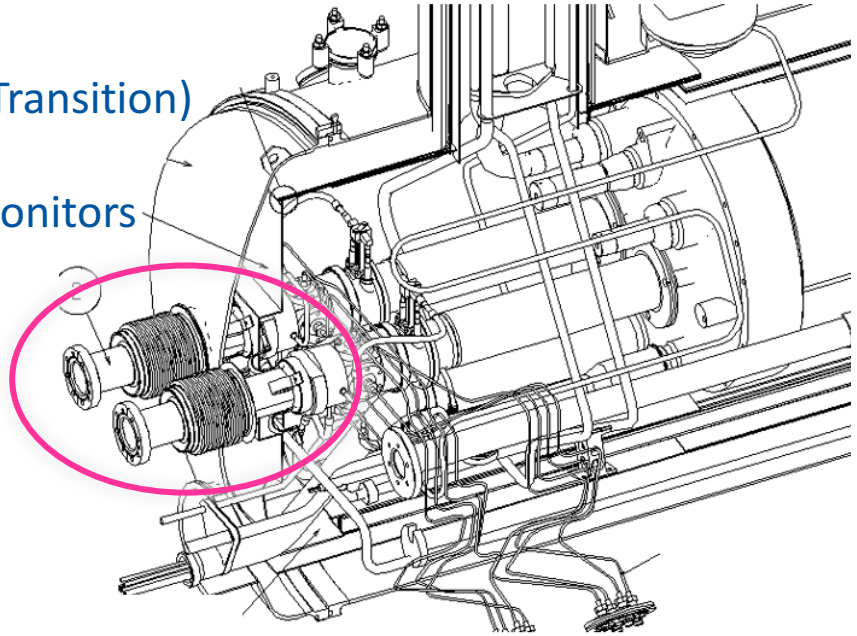
Beam pipe interconnects

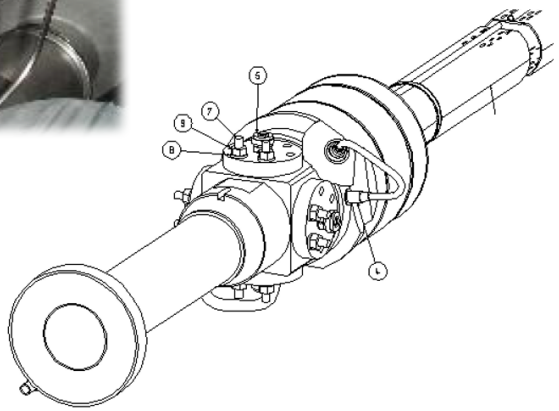
Connections for different temperature (Cold-Warm Transition)

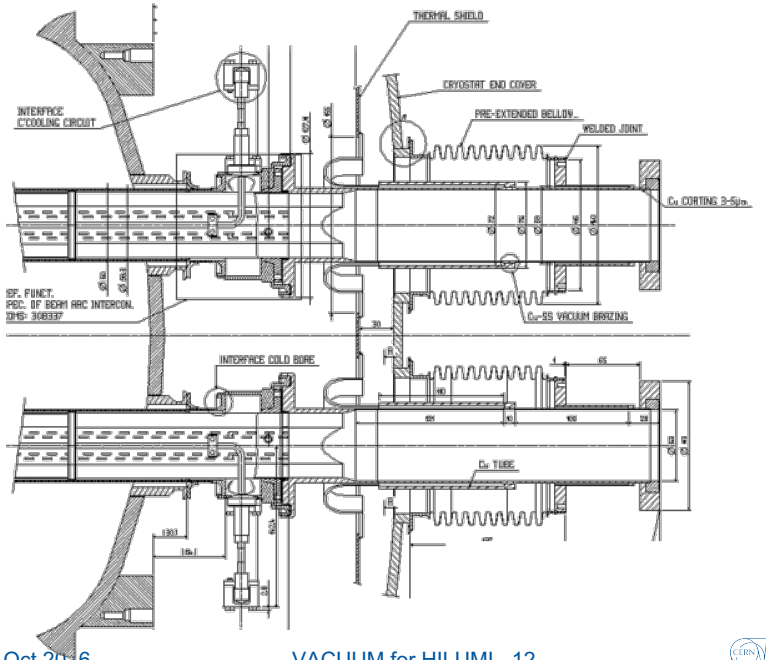
Some interconnects have to house Beam-Position Monitors

Many interconnects are still being designed

- Prototypes : 2016-17
- Procurement : 2017-19
- Assembly : 2018-22







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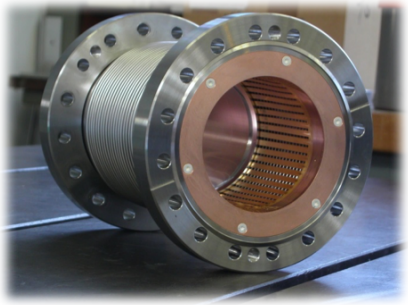
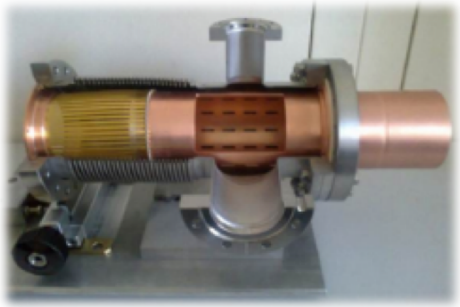
Summary

Layout modifications

the modifications in layout in the LSS (Long Straight Sections) will require the production of

- vacuum chambers (beam pipes)
  - many shapes (circular, elliptical, Y, transitions)
  - various diameters
  - in copper (find manufacturers) or Cu-plated stainless steel
  - NEG coated (@CERN)
- chamber supports
- RF bridges
- Rhodium coated inserts





Many still to finish design; then to be produced

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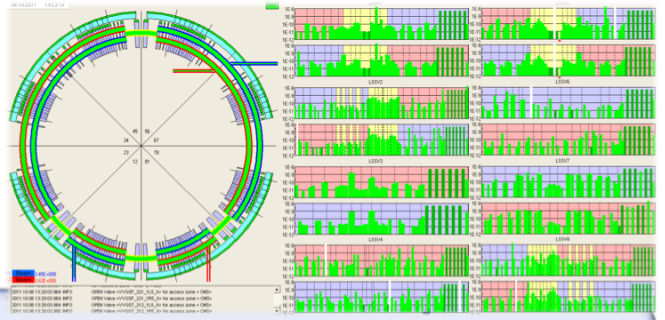
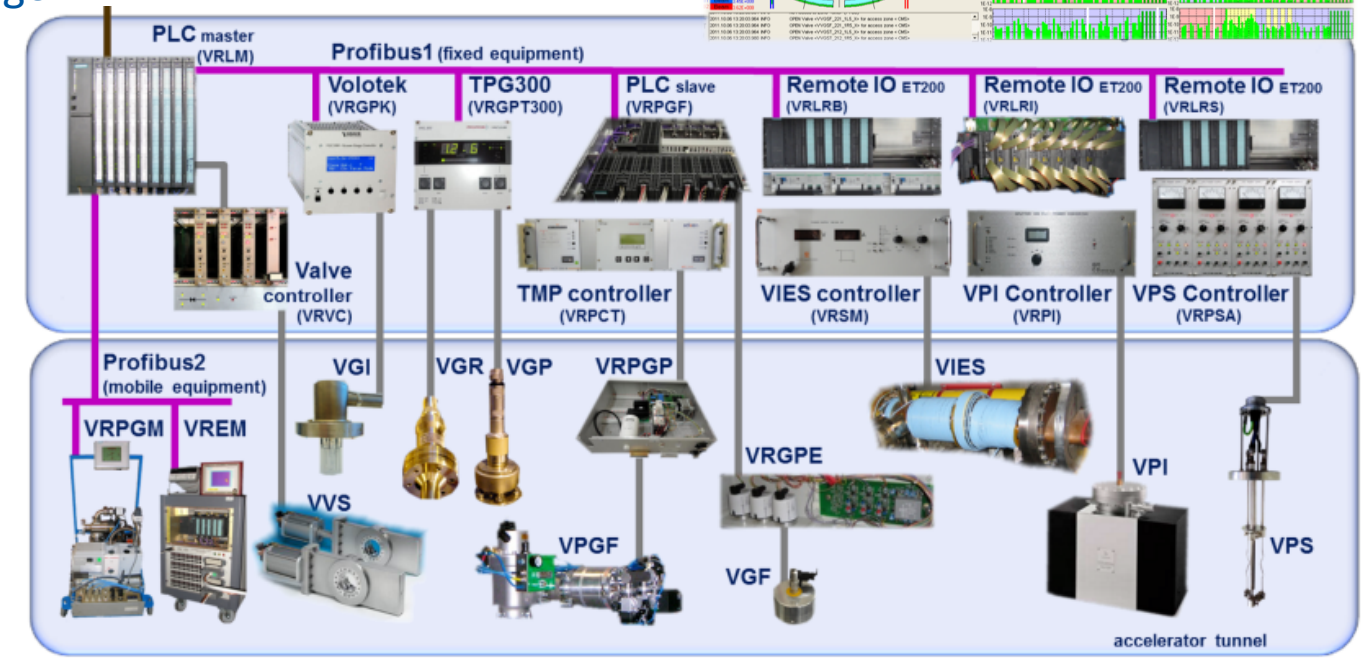
Controls



Redesign of some electronics (front-end & controllers) for

- Improved availability /measurement accuracy
- Extended dynamic range
- Radiation tolerance
- Obsolescence



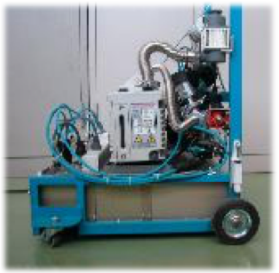
Adding new instruments (devices) implies: more readout, control, and interlocks

Evolution of software frameworks (DB, PLC, SCADA)

Implementation of methods and tools

- for asset management & tracking,
- for monitoring, prediction and surveillance of specific process

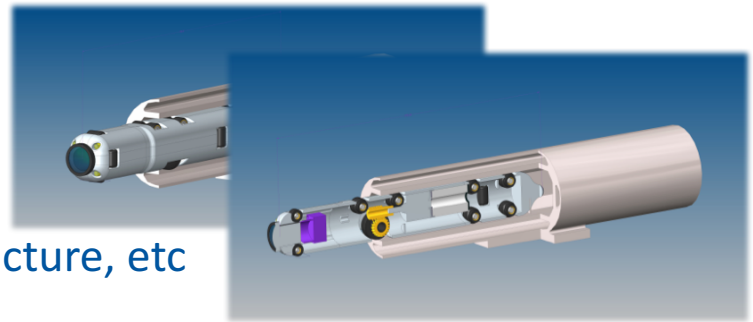
thus improving efficiency of intervention/repair and machine availability

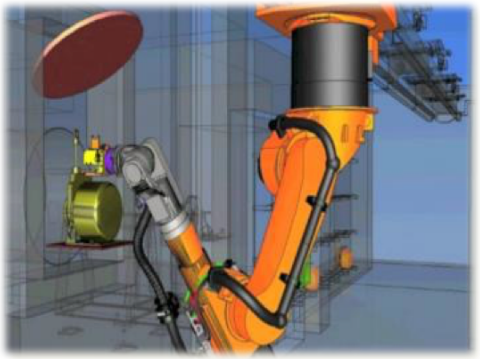


Robotics

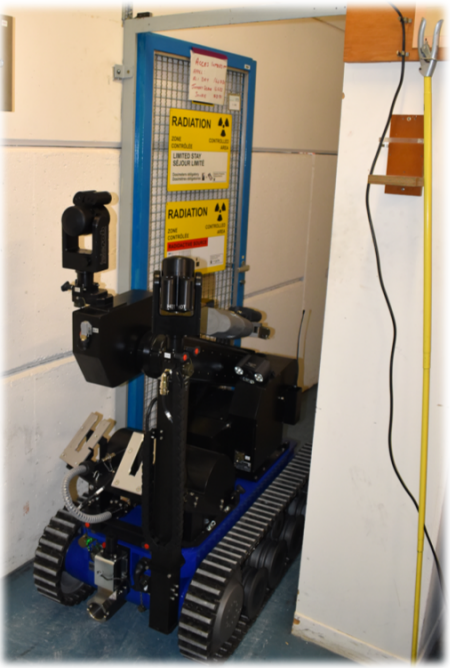
the level of radioactivity from activated materials, in the accelerators, will require new tools for
remote manipulation, enhanced reality, supervision, in order to
minimize the radiation doses for people, during interventions, when
replacing/servicing collimators, magnets, vacuum components, instruments, cables, etc,

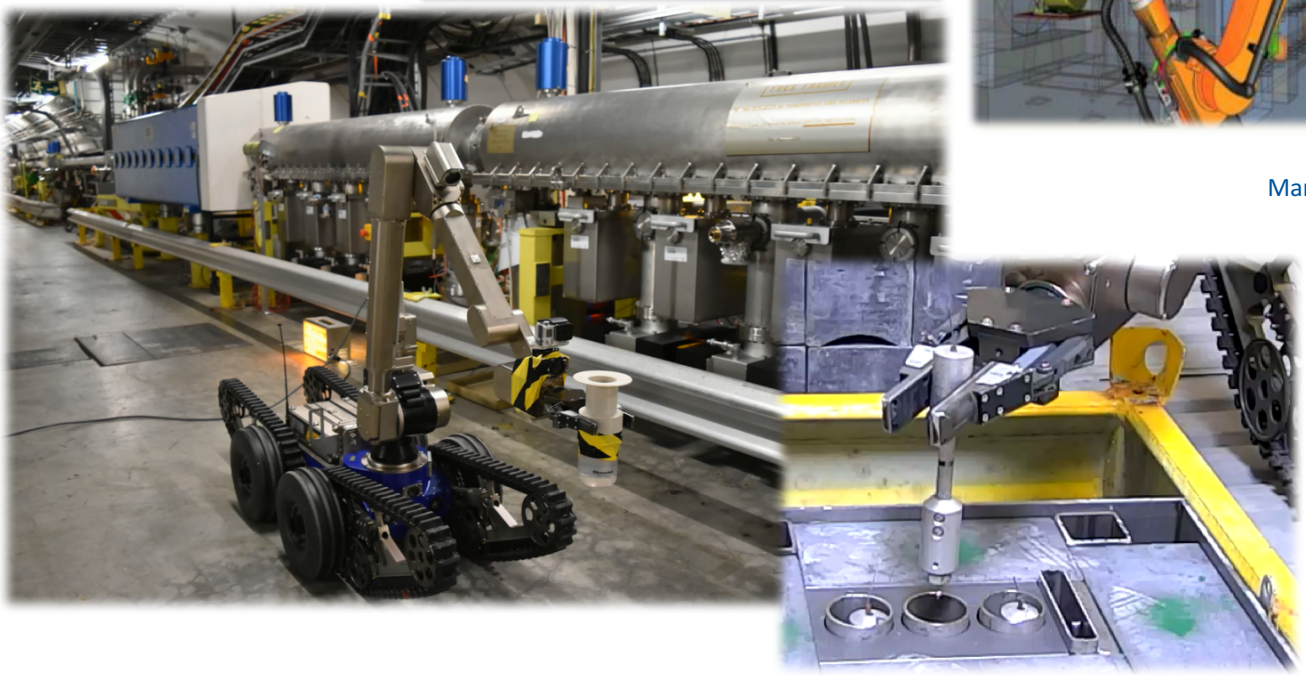
Several developments
done, ongoing, foreseen
will need
R&D collaborations, manufacture, etc





Courtesy of
Mario di Castro
(EN-STI)





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Ongoing studies

- a-C coating, design of beam screens, interconnects, vacuum layout

Cryogenic temperature vacuum system

- Design underway
- Prototyping to starting
- Procurement to start by 2017

Room temperature vacuum system

- Design initiated
- Procurement to start by 2018-19

Will need

- bakeout systems
- machining and assembly o UHV components
- raw materials (W alloy, Al alloy, SS, …)
- beam screens
- belows for UHV
- supports
- elctronics & controllers

Later in the day we will be glad to

- discuss any details with you
- and help you identifying common interests

Paulo GOMES:3 , Nicolaas KOS:4, Jaime PEREZ:14