

The remote positioning of the LHC low beta triplets

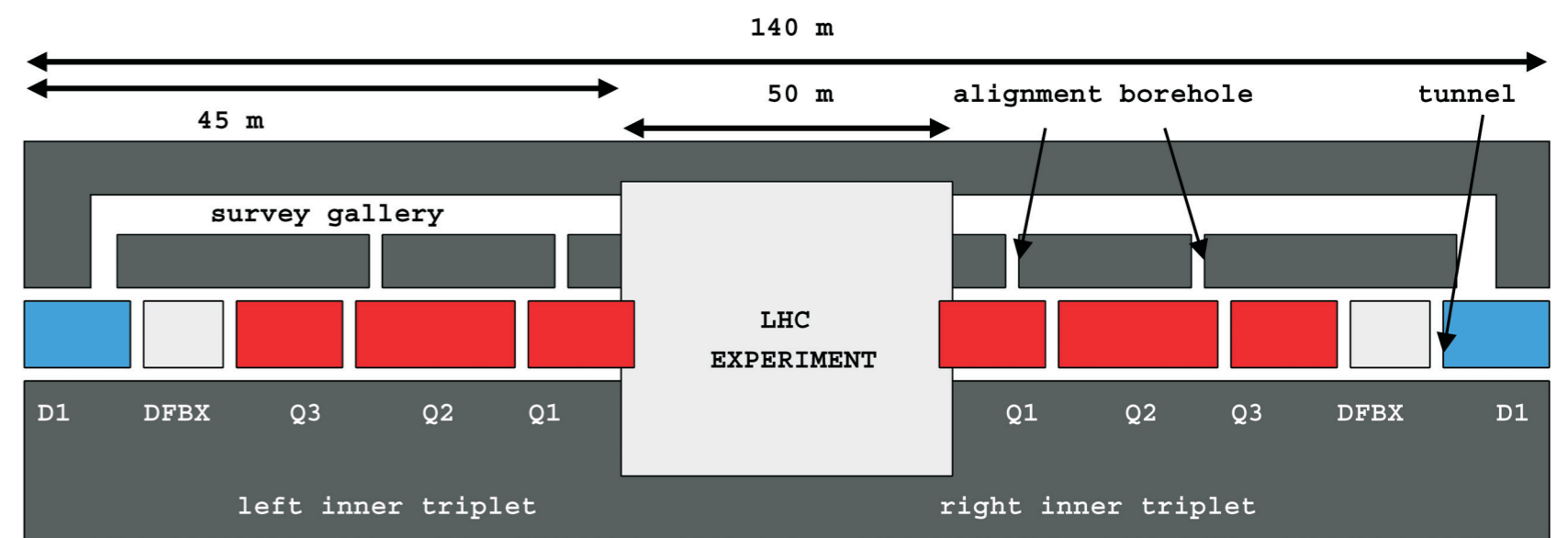
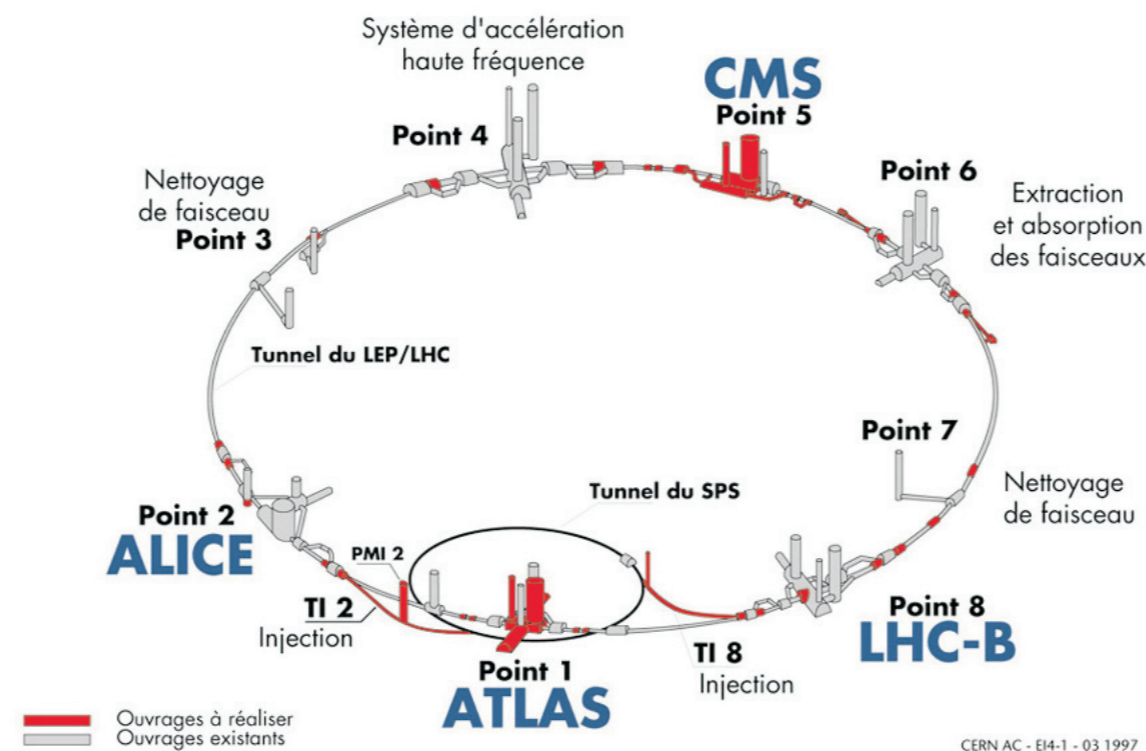
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Abstract

Because of tight alignment tolerances and severe environment (high radiation fluxes and magnetic fields), the LHC low beta quadrupoles are equipped with permanent instrumentation and are supported by motorized jacks, allowing their remote positioning thanks to the sensors' readings.

This poster describes the alignment systems, the motorized jacks as well as the first results obtained.

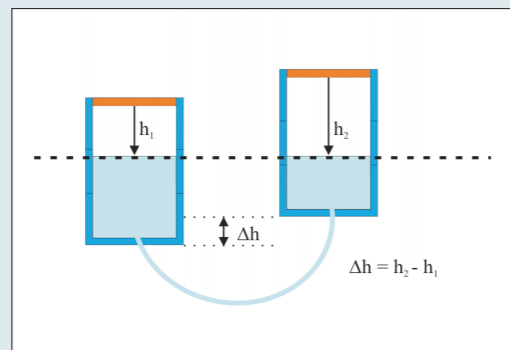


Alignment tolerances for the LHC low beta triplets:
 - positioning of one triplet w.r.t. the other: ± 0.3 mm (3 sigma)
 - stability of one quadrupole inside its triplet: a few microns

Monitoring and Repositioning Systems

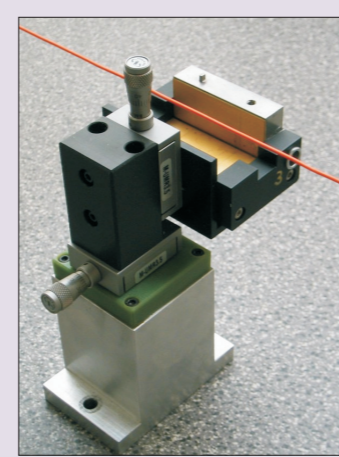
Hydrostatic Levelling System (HLS)

- based on the principle of communicating vessels
- reference surface is the water network
- a sensor is fitted to each vessel
- measurement of distance to the free surface of water

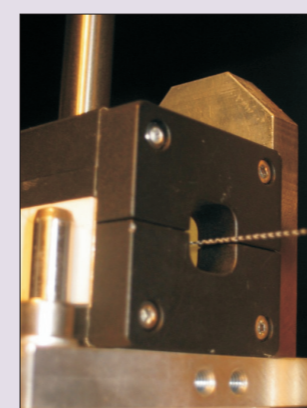


- ⊙ resolution: 0.1 micron
- ⊙ range: 5 mm
- ⊙ repeatability: 1 micron
- ⊙ bandwidth: up to 10 Hz

Wire Positioning System (WPS)

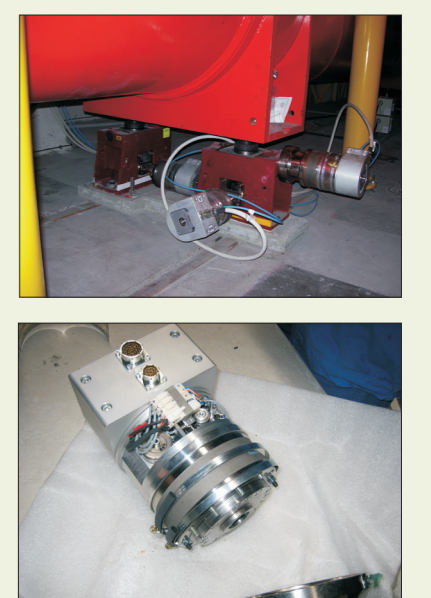
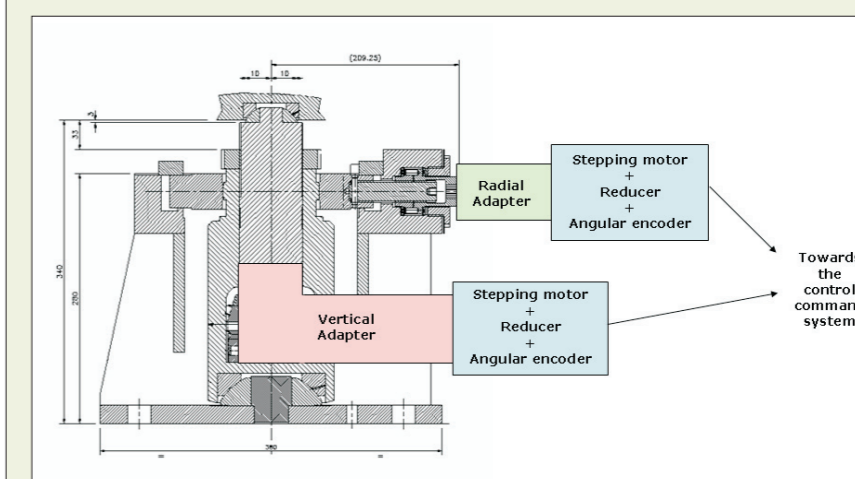


- reference frame is a stretched wire
- bi-axial measurement device
- horizontal plane: wire is a straight line
- vertical plane: wire follows a catenary curve



- ⊙ resolution: 0.2 micron
- ⊙ range: 10 mm x 10 mm
- ⊙ repeatability: 1 micron
- ⊙ bandwidth: up to 10 Hz

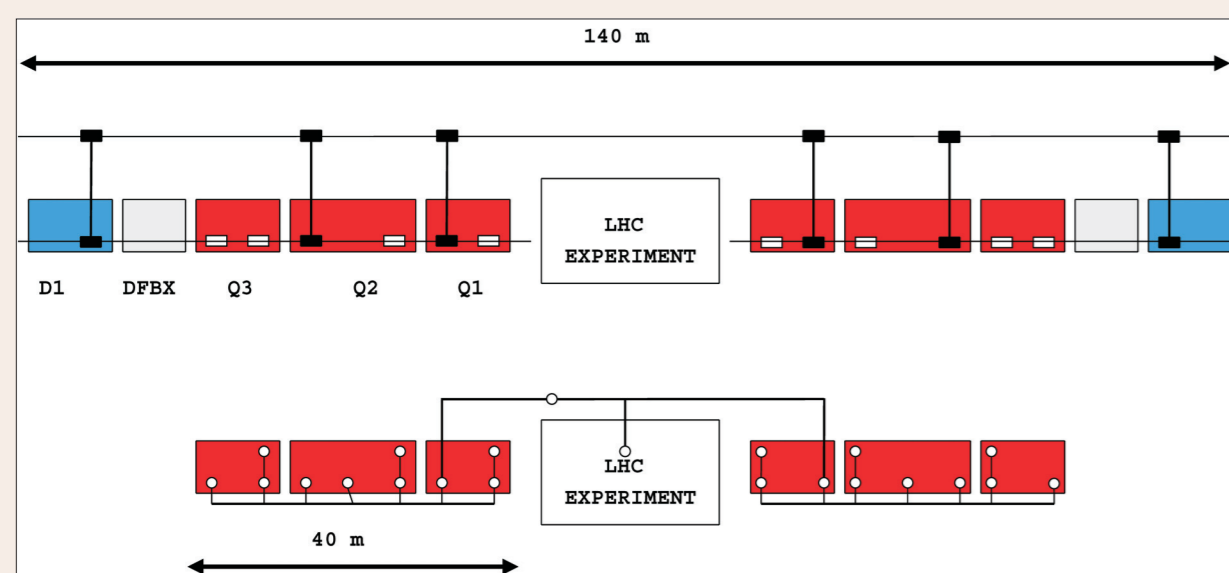
Motorized Jacks



- modified LHC cryo-magnets jacks, with two mechanical interfaces (traverse and vertical adaptors)
- minimum effective movement 10 micron, range ± 2 mm
- motor mounting time less than 15 minutes

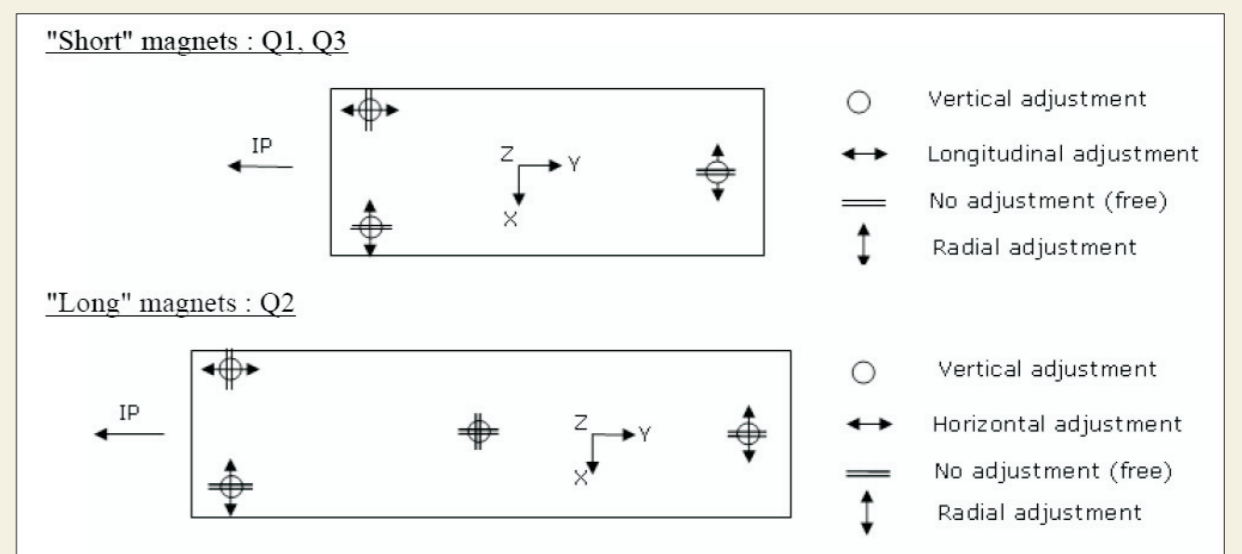
Configuration

Alignment systems (HLS + WPS)



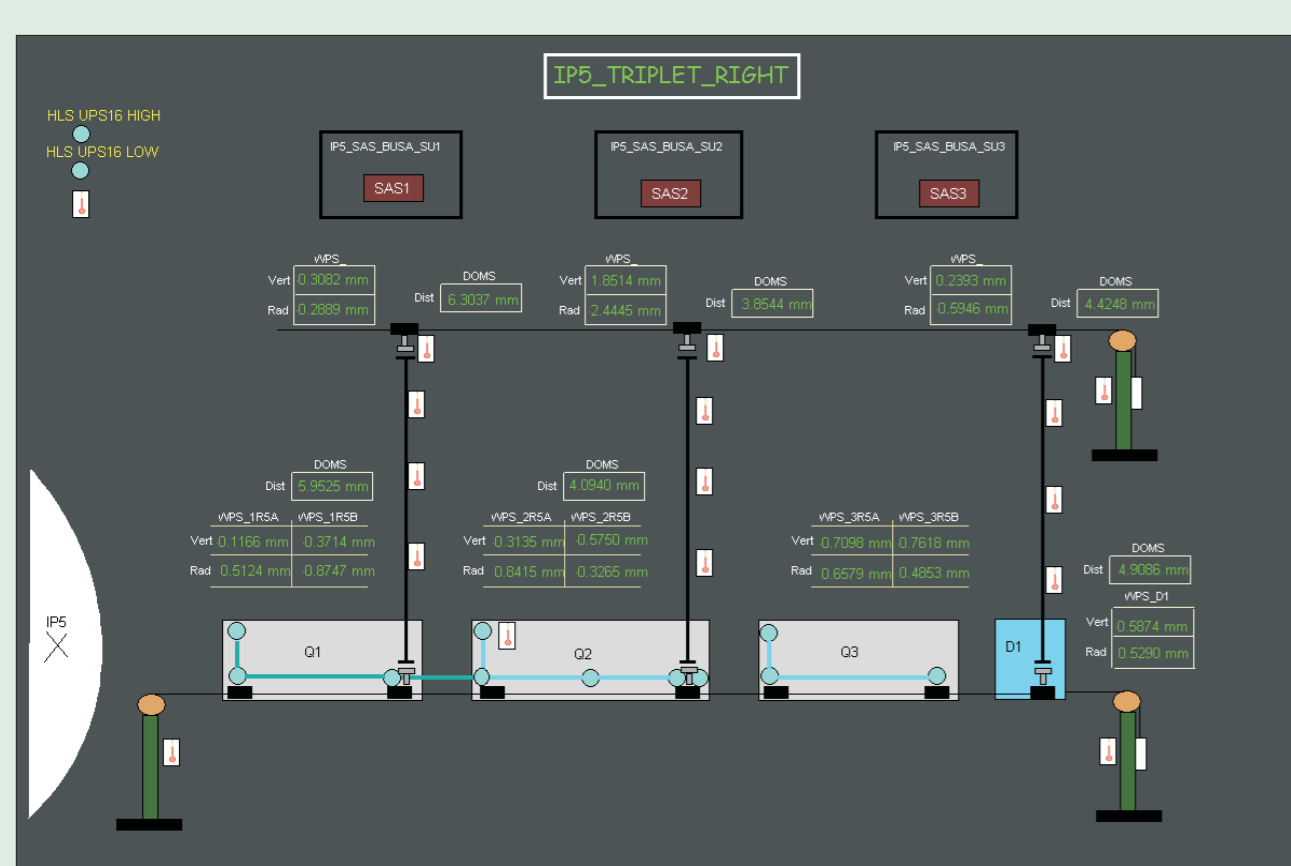
- Total number of sensors:
- 100 hydrostatic levelling sensors (HLS)
 - 68 wire position sensors (WPS)
 - 24 distance measurement sensors (DOMS)
 - 128 temperature probes (PT-100)

Motorized Jacks



- 80 motorized jacks with
 - 48 transverse adaptors
 - 80 vertical adaptors

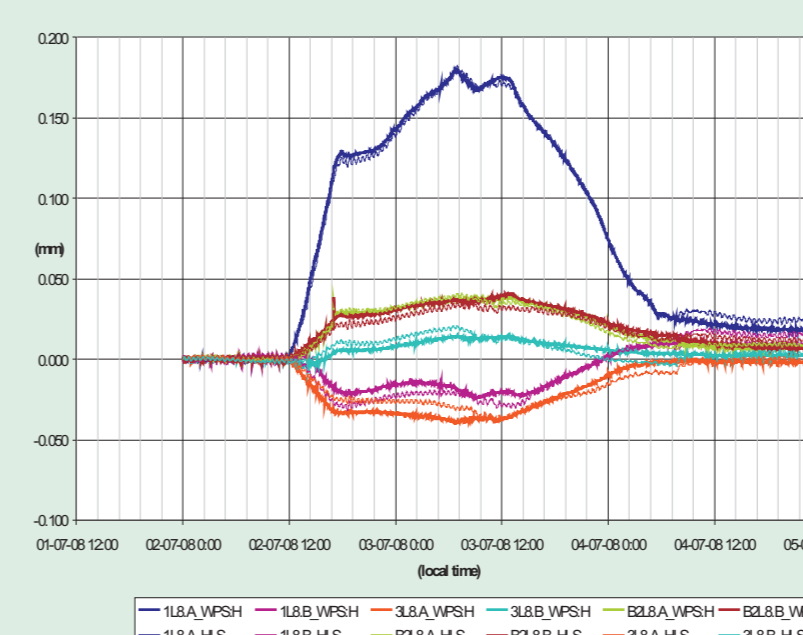
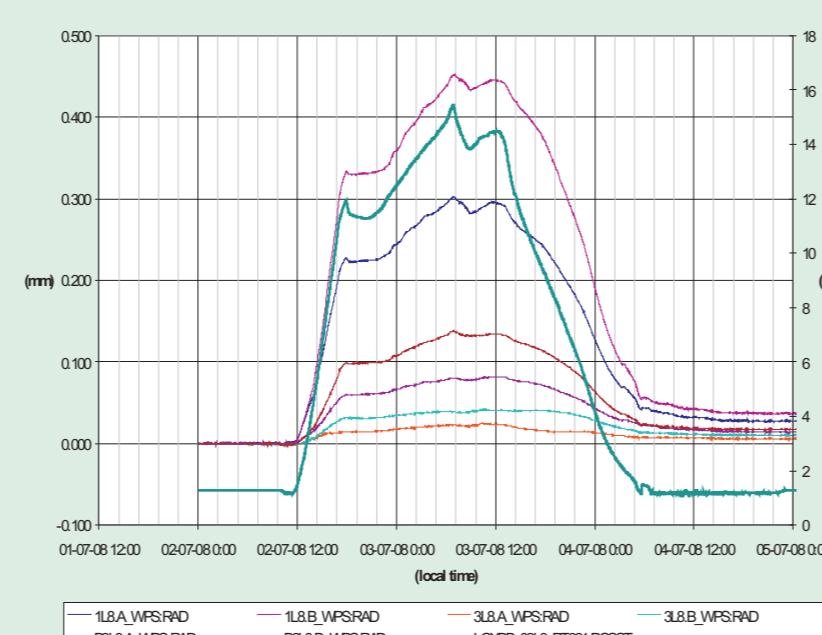
Results



PVSS data visualization

Monitoring of low beta magnets

displacement due to variation of magnet's internal pressure



during accelerator operation (beam on)

