Jacks requirements and motorization strategy

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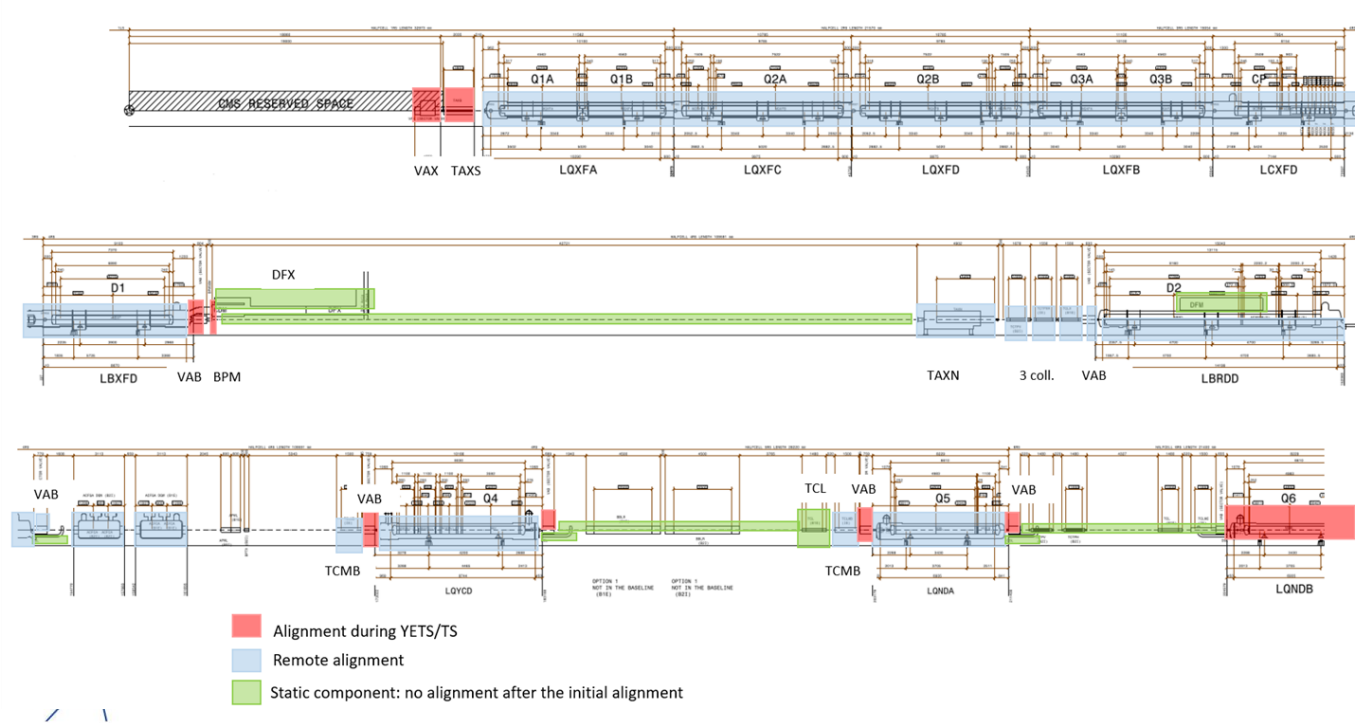
Review of HL-LHC Alignment and Internal Metrology (WP15.4)

Outline

- Jacks requirements and configuration
- Solution proposed and open points
- Strategy of the motorization of the jacks

Jacks requirements

- All components with a weight above 2t from Q1 to Q5 will be supported by motorized jacks.

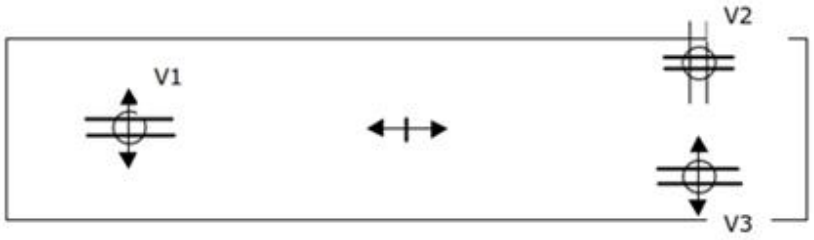


Jacks requirements

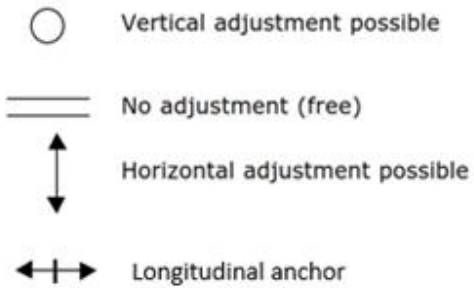
Component	WP owner	Number of jacks	Central jack
LQXFA (Q1)	WP 3	3	
LQXFC (Q2a)	WP 3	3	
LQXFD (Q2b)	WP 3	3	
LQXFB (Q3)	WP 3	3	
LCXFD (CP)	WP 3	3	
LBXFD (D1)	WP 3	3	
TAXN	WP 8	3	
LBRDD (D2)	WP 3	3	1
ACFGA001	WP 4	3	
ACFGA002	WP 4	3	
LQYGD (Q4)	WP 3	3	
LQYHD (Q5)	WP 3	3	

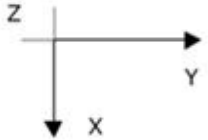
- 36 jacks per IP side + 1 central jack
- A total of 144 jacks + 4 central jacks

Jacks configuration



The functions of each jack are given on the drawing.





- ✓ Anchor for Q1 and D1

Jacks requirements

Requirements for the motorized jacks	
Maximum loads on jacks: Fz (vertical) Fx (radial)	150 kN 20 kN
Adjustable range in horizontal directions In vertical direction	≥ ±10 mm ≥ ±15 mm
Setting resolution for manual adjustments	0.05 mm
Long-term stability of position	≤ 0.1 mm/year
Nominal operating torque	➢ 60 N.m
Gap between cryostat and floor	340 mm
Total Integrated Dose (TID)	≥ 2MGy
Possibility to insert easily and quickly (less than 3 minutes) a motor assembly to perform remote adjustment on radial and vertical axes	
Shall provide a high stiffness to the cryostat support, with the first frequencies as high as possible	
Shall provide a high stiffness in transverse directions to allow minimum effective displacements	
Backlash in radial and vertical directions below 20 µm over the range	
All degrees of freedom motorized except the longitudinal translation	
Vertical / radial displacement range	± 5 mm
Vertical / radial resolution	< 10 µm
Possibility to equip jacks with safety transducers (load sensors)(to control vertical forces on the jack	
Free of maintenance over HL-LHC life time	
Maximum distance to the control / command system	300 m
Control/command system located in a non-radioactive area	

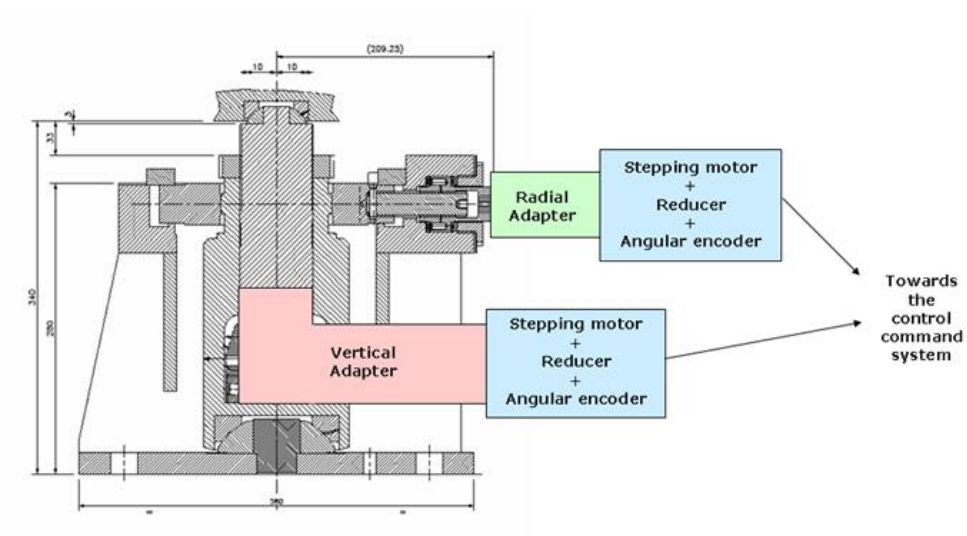
Jacks solution proposed

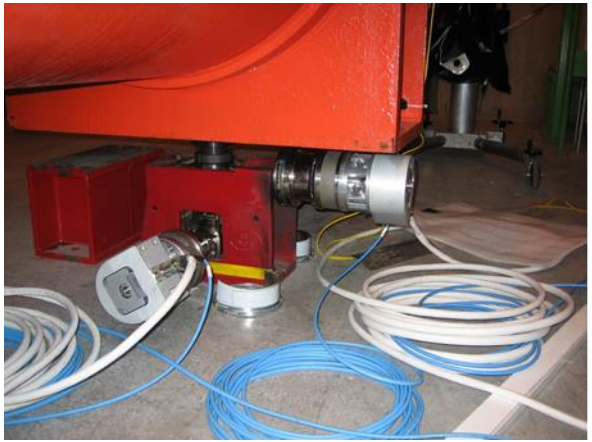
- Currently under study: the possibility to use LHC jacks for HL-LHC
- Some issues were met below the low beta quadrupoles and are under study on a test facility in building 181.

Problems of motorized jacks met in the LHC :

- Motorized jacks located under low beta quadrupoles are used in the limits of what was specified initially:forces and constraints applied are not those specified initially, and we are at the limit of loads on some jacks.
- Some of the jacks are in the limits of their longitudinal range → creating slip/stick effects
- This led to an unpredictable behavior of the triplet during remote adjustment
- With as consequences: loss of weight on jacks and no possibility in some cases to displace the jacks transversally (in radial or vertical) remotely.
- A string consisting of the spares low beta quadrupoles was proposed to study and have a better understanding of the behavior of jacks.
- No specific tests on motorized jacks were achieved on the low beta string test in 2005.

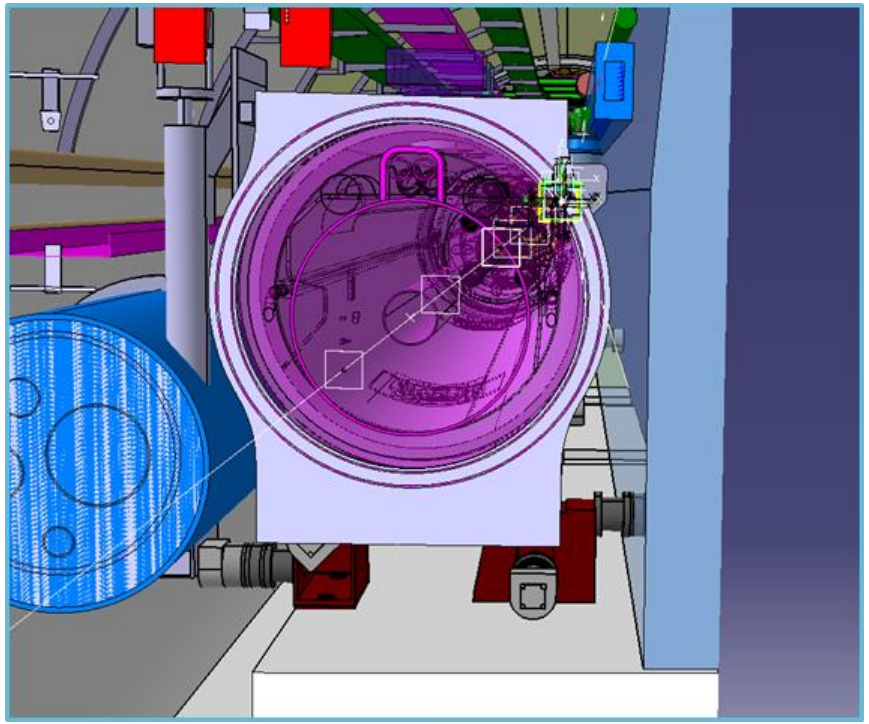
LHC solution

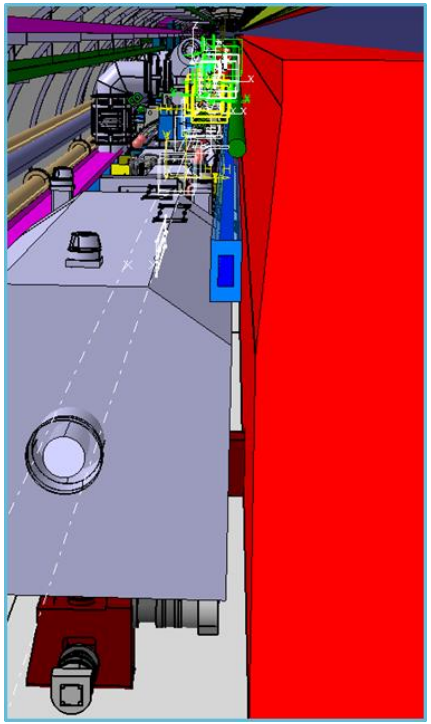




Upgrades proposed

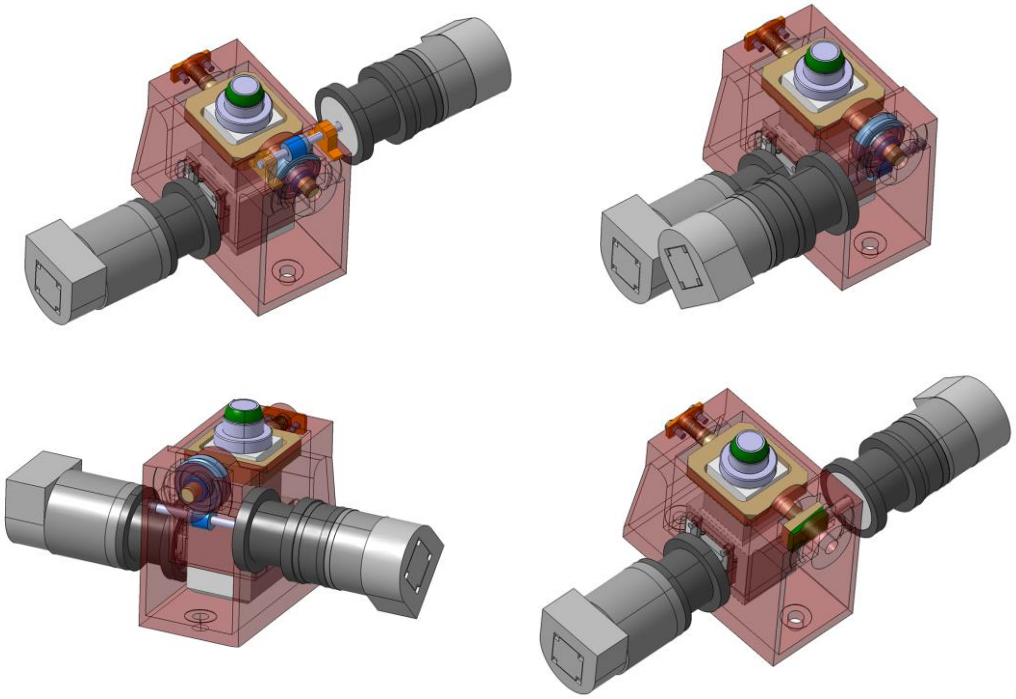
- Interference with the transport area of the motor assembly (if kept the same as in the LHC)





Upgrades proposed

Alternative location of motorized axes



Additional diagnostic tools:

- Permanent load cells (even on radial axes)
- Position sensor

Motorisation

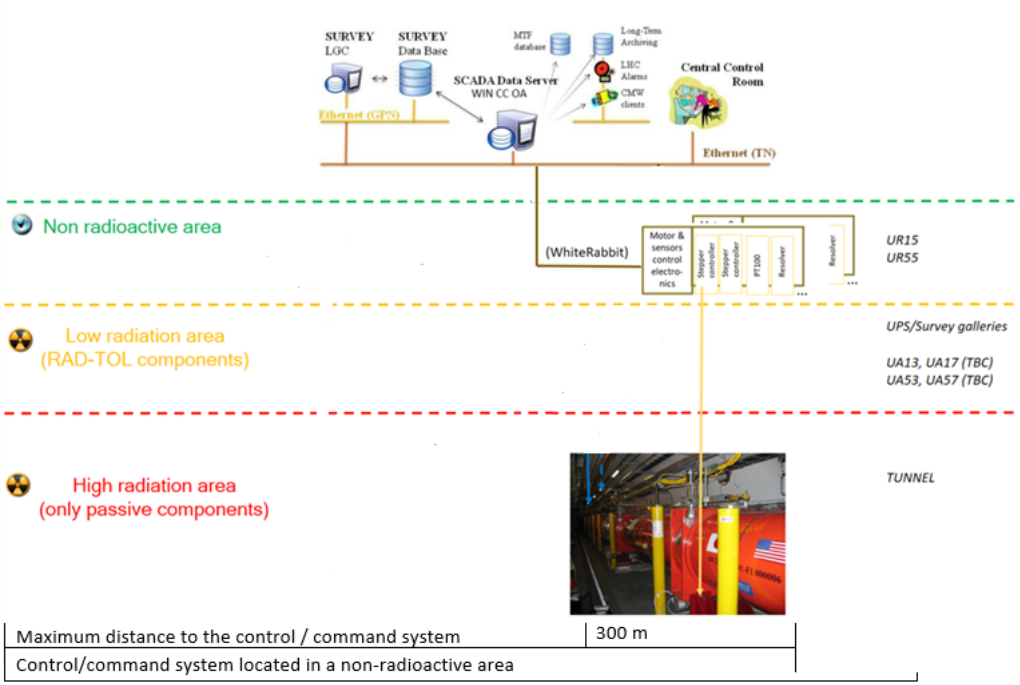
- Each axis to be remotely displaced will be equipped with a motor assembly including:
  - A mechanical interface (with the possibility to integrate a load cell)
  - A gearbox
  - A motor
  - A resolver.
  - A load cell (TBC)
  - A position sensor (TBC)
- The motors shall be standardized when possible between motorized jacks, platforms and collimators, to ease their maintenance
- A similar control/command and associated software between the different applications named Sambuca.

Motorisation

Number of motor assemblies: 244 (not considering the spares)

Component	Total number
Motors	244
Limit switches	732
Resolvers	244
Vertical load cell (TBC)	144
Radial load cell (TBC)	96

Control/command layout



Maximum distance to the control / command system	300 m
Control/command system located in a non-radioactive area	

Summary

- LHC jacks fulfil the requirements of HL-LHC motorized jacks; a full understanding of the issues met in the LHC with these jacks is under investigation.
- Jacks design not finalized yet;
- As soon as a decision has been taken concerning the jacks design, the study of motor assembly can start.
- Strategy of motorization: to use the same motors as for the collimators, already tested and validated in a harsh environment and very reliable.

Thank you very much