

DAE-CERN collaboration. To validate this complex model, dedicated experiments at CERN were carried out.

The tuned FE model gives out a relationship between the individual jack movement and cold mass positions (fig. A.2.1). The results are being used during the installation phase of LHC (fig. A.2.2).

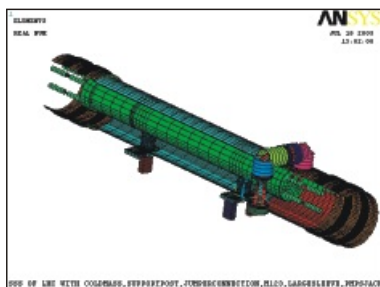


Fig. A.2.1 Finite Element Model of SSS



Fig. A.2.2 A picture of SSS in string-2 of LHC

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A.3 Motorizable high precision motion adaptors and jacks for inner triplets of LHC

After successful development and supply of compound motion alignment jacks for LHC arc magnets, CERN and CAT agreed to extend the work for the inner triplets of the LHC under DAE-CERN collaboration. The inner triplet system provides the final focusing of the proton beams before collision at four locations in the machine. Each inner triplet consists of 3 quadrupole optical elements. The quadrupoles of the inner triplet focus the beams to small spot sizes, about 0.016 mm. The alignment resolution (horizontal / vertical axis) required is less than 0.01 mm for these 18 ton magnets. In addition, the alignment has to be done remotely during small beam-on maintenance intervals.

The added requirements for the inner triplets jacks were the higher setting resolution of 0.01 mm, development of adaptors for motorization of jacks in vertical and transverse

directions, and short mounting and dismounting time for the adaptors due to high radiation environment.

The work done includes enhancing the setting resolution of 0.05 mm of the arc jacks to the inner triplet requirement of 0.01 mm, development of a compact mechanical adaptors and developing the interfaces for motorization.

The vertical adaptors are extremely compact precision lifting devices having a high load capacity of 10 tons and setting resolution better than 0.01 mm. Three different concepts based on wedges-on-rollers, screw driven by gear train and using a polyurethane block as hydraulic fluid were developed. A pre-series of eight adaptors were made after thorough testing of adaptors based on different concepts and selection of polyurethane based concept for implementation. These adaptors are assembled with the jacks, and two-stepper motors- one each for vertical and transverse movement- is coupled to these adaptors. Three such jacks support each magnet. The integrated alignment system consisting of jacks, pre-series vertical & transverse adaptors (supplied by CAT, and motors and its control unit provided by CERN), was successfully tested on a dedicated test set-up under a CAT-CERN joint test campaign in June 2005 at CERN.

A total of 74 of the 80 modified jacks required for the inner triplets have been supplied to CERN (fig. A.3.1- A.3.2). Series adaptors, numbering 130 units will be sent by the end of November 2005 to CERN.

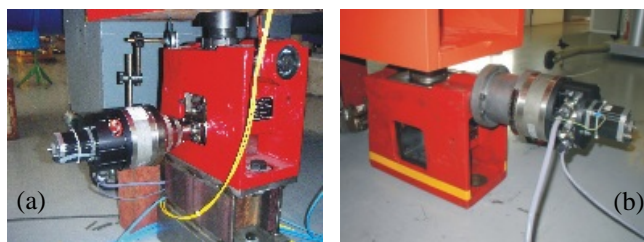


Fig. A.3.1 Vertical (a) and transverse (b) motorized jack with adaptor, under the triplet magnet during testing



Fig. A.3.3 Inner triplet magnet Q3 on its jacks

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