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3D calculation for the alignment of LHC Low-Beta quadrupoles

The low beta triplets quadrupoles magnets of the Large Hadron Collider (LHC) are located on both sides of the ATLAS, CMS, ALICE and LHCb experiments. The alignment tolerances of these components are particularly stringent (+/-0.5 mm at 3σ) and are tracked by an alignment system consisting of micrometric sensors and motorized jacks used for components remote displacements. The system has been installed in 2008 with the purpose to monitor the triplets relative displacements with respect to their nominal position. After the development of appropriate calibration benches, the first absolute calibrations of the sensors have been performed in 2016, allowing a determination of the magnet positions in an absolute reference frame. The radial and vertical (plus roll) data were separated in 2 different calculations steps.
During the LHC Long Shut-down 2 (LS2, 2019-2021), consolidation works have been carried out on all triplets allowing to perform absolute calculation in 3D and significantly increase the position determination accuracy. This paper gives an overview of the 3D calculations used currently for the LHC accelerator and summarizes the low beta triplets position change since LS2.

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