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Analysis and Modelling of the effect of tides on the Hydrostatic Levelling Systems at CERN

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Since the creation of CERN (European Organization for Nuclear Research) in 1954, the complex of particle accelerators has been in constant evolution. The latest arrival is the LHC (the Large Hadron Collider) which was run for the first time on the 10th September, 2008. To take care of the large scale metrology of the accelerators, CERN relies on the Survey section, and this section has had to develop and adapt new instrumentation in order to meet the ever increasing alignment accuracy requirements.

For the LHC, some essential remote vertical alignment is now possible thanks to a number of HLSs (Hydrostatic Leveling Systems), which are based on the principle of communicating vessels. Each HLS capacitive sensor measures the vertical distance to a common reference, materialized by a surface of water, and the submicrometric accuracy means that the measurements are affected by the tides in the same way as an inclinometer. An alignment accuracy of 10μm over 200m is required according to studies of the next generation of accelerator, so these effects need to be modelled.

The current HLS installations in the LHC, and in a special test area in an old unused transfer tunnel (TT1), are presented, together with the analyses of the optimal way to model the tides on the CERN site in order to remove their effect on the recorded observations. Several phenomena contribute to these tides : some have the same frequency (oceanic load); some a long wavelength having no significant effect on the relative alignment of the accelerator elements (earth tides); while others have a short wavelength and could have an effect on the alignment (cavity effect). The magnitude of these effects and the separation of them are being analyzed. The current state of these investigations is presented in this poster.