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Challenges for Mobile Hydrostatic Levelling Systems applied in accelerator environments

The research for automated measurement solutions for the Large Hadron Collider (LHC) is a key point for future developments and from extreme importance for even bigger machines like the Future Circular Collider (FCC) where manual measurements are almost excluded due to the very large scale of the future machine. The developments for transversal measurements using close-range photogrammetry are making good progress and first results should be available from the High-Luminosity IT-String test in 2026 where a HL-LHC Triplet section will be fully tested on the surface. The R&D for the vertical measurements are still in the beginning and will combine close-range photogrammetry with mobile Hydrostatic Levelling System (HLS) measurements.
Hydrostatic Levelling systems are commonly used in the field of high precision measurements or long-term monitoring of vertical displacements. The basic principle is quite robust and directly linked to an equipotential surface. There are several working principles available ranging from tactile, capacitive, or optical sensors to ultrasonic sensors in different configurations. For a mobile application, a particularly suitable system is the ultrasonic system with the transducer submerged in the water. A small number of critical aspects need to be solved to be usable in the Large Hadron Collider environment. The tunnel slope and system stabilization, the temperature gradient and atmospheric pressure differences due to tunnel ventilation needed to be considered in the design of the mobile system.
This paper describes the principle of the system along with some specific mitigation measures and validations for the mobile application.

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