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Development of a new levelling process integrated into a 3D global calculation

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CERN surveyors have been performing the smoothing of beamlines for decades using the 2D + 1 measurement and calculation process, where computing the planimetric (XY) and altimetric (H) data is performed independently and separately. Direct leveling (1D) is still recognized today as the most efficient method to allows accurate vertical determination over long distances.
CERN practices are continuously reviewed and optimized to adapt to new constraints and technological developments. With the High Luminosity upgrade of the Large Hadron Collider scheduled to take place from 2026-2029, data from hundreds of new sensors will be available in 3D. A new strategy is therefore needed to integrate the leveling measurements into a global 3D calculation.
A new leveling observation model, named *DLEV, has been developed for the CERN in-house least squares adjustment software, LGC (Logiciel Général de Compensation).
This new function integrates a geoid model and geo-referenced leveling stations that must be well determined especially in the longitudinal direction. It can also estimate the collimation error. The positions of digital leveling stations must be determined through multilateration measurements with a robust adjustment method and specific initial values due to the linear geometry of the network. Optical leveling stations require the new observations to be geo-referenced, and alternative input to be provided. This paper will review the new leveling process and compare the results of 3D and 2D+1 calculations using a practical case study.

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