

## Geodetic and Astronomic Measurements at the GMO

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Research projects at the Geomagnetic Observatory (GMO) demand very precise knowledge of the spatial parameters, especially the exact position, height and astronomical orientation of experimental set-ups. The Federal Office of Metrology and Surveying established a precise geodetic network in and above the adits at GMO. To achieve the required accuracy several geodetic techniques were used and multiple measurements were carried out. Stabilizing of benchmarks and geodetic measurements for the determination of their spatial coordinates took place in 2013 and 2014.

To set up the geodetic network in the adits, physical benchmarks had to be mounted (see figure 1). This geodetic network consists of 50 fillister headed aluminium benchmarks set into the floor, 9 target boards at the end of each gallery for orientation purposes and last but not least of 16 concrete pillars (see figure 2).

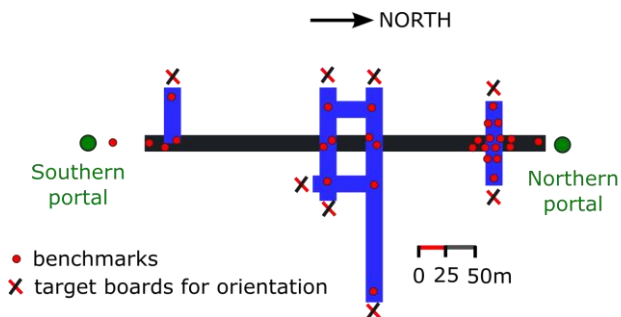


Figure 1: overview of the geodetic network and mounting of benchmarks

After the geodetic network was physically mounted, geodetic measurements were used for the determination of the spatial coordinates of the benchmarks. The following geodetic techniques were applied: astronomical measurements to Polaris to orientate the geodetic network (upper left picture in figure 2), GNSS (global navigation satellite system) measurements to obtain the spatial position with respect to the Earth and terrestrial

measurements by using a high performance tachymeter (figure 2, upper right) to connect several benchmarks with each other. The height information was derived from the precise levelling network of the BEV by levelling.

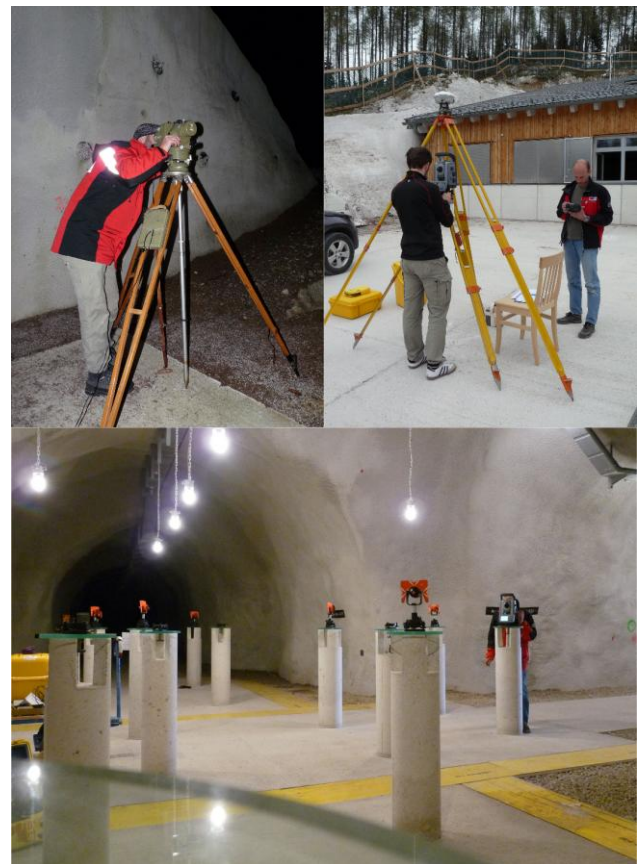


Figure 2: impressions of geodetic work

All these measurements were put together in a geodetic adjustment to compute the most reliable and accurate coordinates within the range of 1-2 millimetres.

This first determination of the geodetic network can be repeated in a few years. With the measurements from several epochs an evaluation of the stability of the gallery system at GMO will be possible.

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