First steps toward the calibration of observatory magnetometers

Ramon Egli, Roman Leonhardt

Modern observatory magnetometers measure variations of the geomagnetic field vector with a resolution of ~1 ppm and a rate of 1-10 measurements/s. Instrument calibration is essential for obtaining a reliable record of field variations. The extremely quiet magnetic environment of the Conrad Observatory offers a unique location for the setup of a calibration system for precisely investigating the response of magnetometers to static and dynamic magnetic fields.

Special magnetometers are used in magnetic observatories for more than 150 years to obtain a continuous and accurate record of the Earth's magnetic field and its variations over time. More recently, similar magnetometers have been employed onboard of satellites (e.g. CHAMP, SWARM). Observatories measure slow geomagnetic field changes due to processes in the Earth core (so-called secular variations) and rapid changes related to interactions with the solar wind and the ionosphere.

Observatory magnetometers must meet most stringent requirements in term of sensitivity, accuracy, and long-term stability. Fulfilment of these requirements must be tested under controlled conditions in a magnetically quiet environment, far from nowadays ubiquitous disturbances produced by human activities. Furthermore, temperature variations must be avoided as far as possible.

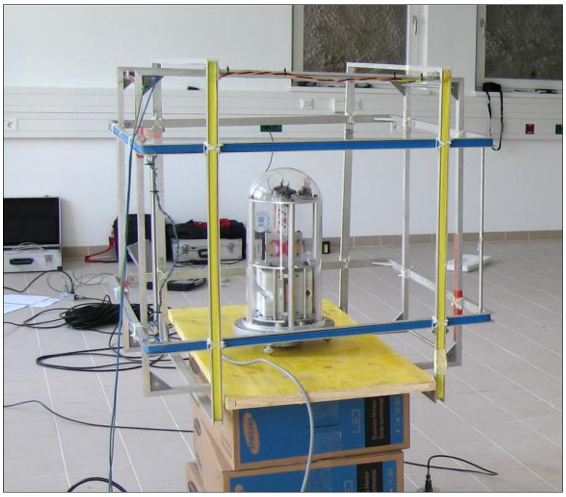

Figure 1: FGE fluxgate magnetometer placed at the centre of three pairs Helmholtz coils during a frequency response test.

Our Geomagnetic Observatory (GMO) offers ideal conditions that satisfy these requirements in large rooms that can host several equipments at the same time. Daily temperature variations in GMO tunnels, for instance, do not exceed 0.05°C.

For this reason, we are setting up a testing and calibration facility where precisely controlled, homogeneous magnetic fields are generated with a set of special coils. A first prototype is shown in Fig. 1. This prototype has been used to test the responses of a Caesium scalar magnetometer (Geometrics G823) and a FGE fluxgate magnetometer (DTU Space) to the following field conditions: (1) a sharp step occurring at a precisely known time, and (2) sinusoidal magnetic field variations in the 0.1-100 Hz frequency range.

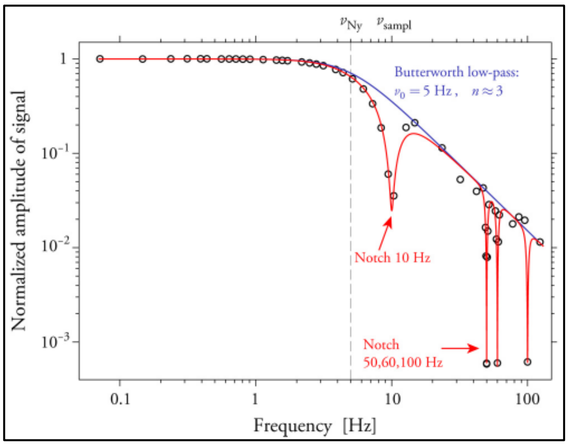

Figure 2: Frequency response of a Geometrics G823 Caesium magnetometer, measured with a sampling rate of 10 Hz (dots: measured, red: best fit model). The effects of analogue filters for the suppression of aliasing effects and disturbances at power supply frequencies (50 and 60 Hz) are clearly visible.

Sinusoidal field variations with ~200 nT amplitude have been used to probe the frequency response of the Cesium magnetometer, which is shown in Fig. 2.

Author:
R. Egli[1], R. Leonhardt[1]
1) Central Institute for Meteorology and Geodynamics, Vienna, Austria

Corresponding author:
Ramon Egli
Central Institute for Meteorology and Geodynamics
Hohe Warte 38, 1190 Vienna, Austria
Tel.: +43 (1) 36026 2503
e-mail: r.egli@zamg.ac.at.at