Observatory & Earth Monitoring

Precise Magnetic Field Monitoring Solutions for Observatory Calibration, Volcano and Natural Hazard Research

Since 1980

Leading the World of Magnetics

GEM Systems is the number one global leader in the manufacture and sale of high precision magnetometers.

GEM is the only commercial manufacturer of Overhauser magnetometers, that are accepted and used at Magnetic Observatories over the world.

Our Potassium Magnetometers are the most precise magnetometers in the world.

Our Proton sensors are considered the most practical and robust magnetometers for general field use.

Proven reliability based on R+D since 1980.

We deliver fully integrated systems with GPS and additional survey capability with VLF-EM for convenience and high productivity

Today we are creating the absolute best in airborne sensors and are leading the way in super sensitive potassium sensors specially designed for highly sensitive studies with super large sensors for research of Natural Hazards globally and now smaller and lighter sensors for practical UAV applications.

Our Leadership and Success in the World of Magnetics is **Your key to success** in applications from Archeology, Volcanology and UXO detection to Exploration and Magnetic Observation **Globally.**

GEM Systems Magnetometers for Earth Observation include;

Continuous reading SCALAR Total Field magnetometer for calibration - GEM Systems Robust Overhauser (GSM-90).

High Precision suspended coil (dIdD) VECTOR Magnetometer for evaluation of the x, y, z components of the field and monitoring changes in the Declination & Inclination.

Overhauser (GSM-90) Scalar Magnetometer

The GSM-90 is a scalar magnetometer of high absolute accuracy (0.1 nT) and low long term drift (0.05 nT /year). It is optimized for use in magnetic observatories, long term monitoring arrays in volcanology and where the following are essential:

* long term stability and high accuracy;
* high resolution and low noise (0.022 nT).

The GSM-90 is deployed in many installations globally, notably in observatories and on Mt. Etna, where dedicated scientists from the Instituto Nazionale di Geofisica e Vulcanologia (INGV) are using the system as a cornerstone of their research into the periodic eruptions of Europe's active volcano.

Canadian Observatories use the GSM-90 as secondary standard for the Earth's magnetic field. Sanikiluaq (SNK) Magnetic Observatory, Quebec Canada

Operating Principles

The GSM-90 is based on GEM Systems Overhauser Effect technology. The GSM-90 sensor has a free radical added in contrast to standard proton magnetometer's sensors, which only use a proton-rich liquid to produce precession signals. The free radical contributes free, unbound electrons that couple with protons producing a 2-spin system.

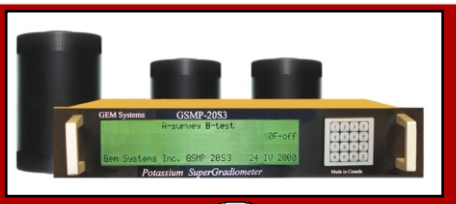
A strong RF magnetic field is used to disturb the electron-proton coupling. By saturating free electron spin resonance (ESR) lines, the polarization of protons in the sensor liquid is strongly increased.

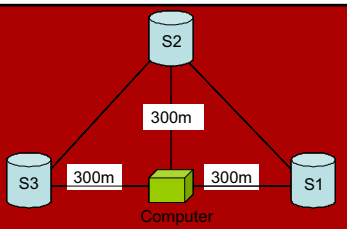
Therefore, the Overhauser Effect offers a superior method of proton polarization - delivering stronger signals from smaller sensors and with less power (i.e. 2Ws per reading)

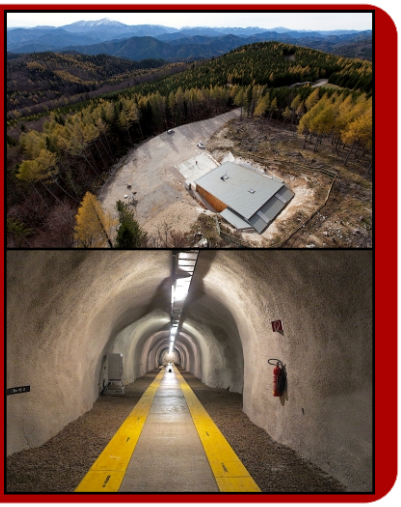
GSM-90 electronics are packaged in a thick, waterproof aluminum box specially designed to operate reliably in harsh environments It is also microprocessor-based with full remote control capability. Results are made available in serial form (RS-232C interface) for collection by data acquisition systems.

GEM Systems, Inc.
135 Spy Court Markham, ON Canada L3R 5H6
Phone: 1 905 752 2202 • Fax: 1 905 752 2205
Email: info@gemsystems.ca • Web: www.gemsystems.ca

Our World is **Magnetics.**







SuperGradiometer installed at Conrad Earth Observatory, Austria. (.02 pT sensitivity @ 1 Hz with <1pT noise level)

Suspended dIdD Vector Magnetometer for Observatories

GEM introduced the dIdD (delta Inclination / delta Declination, X, Y, Z) vector system for higher precision results. The Suspended system provides stability for the alignment coils and includes a small diameter (250 mm), spherical Overhauser sensor (or Potassium sensor).

Simplifying Observatory Measurements

The Suspended dIdD can provide improved accuracy and sensitivity and simplify the set-up of magnetic observatory installations by eliminating the need for fluxgate magnetometers and thermally insulated structures. The dIdD Vector Magnetometer minimizes ongoing system calibrations. These important new benefits are achieved through system design:

- Temperature coefficients that reduce drift to less than 0.1 nT / °C (compared with 0.5 nT / °C for high-end fluxgate magnetometers)
- Physical suspension of the Overhauser or Potassium sensor (shown experimentally to contribute to reduced drift)
- Long term drifts that are less than 2 nT/ year matching or exceeding the best component measurement at any observatory

The dIdD vector system also exceeds specifications set by Intermagnet - the global network of observatories monitoring the Earth's magnetic field (www.intermagnet.org).

SuperGrad - Observations and Earthquake Research

GEM's new SuperGradiometer is designed to provide precise gradient measurements of the Earth's magnetic field and to improve detection of subtle responses and potentially lower the threshold of detectable earthquakes.

The GSMP-20S3 was developed with the Russian research group of Dr. E. Alexandrov in response to the **United State Geological Survey's (USGS)** requirement for an ultra-high sensitivity magnetic gradiometer. It is the highest sensitivity total field measuring device ever developed with less than 0.05 pT root-mean-square (rms) sensitivity at a sampling rate of 20 Hz (averaged over a 1 sec. interval). This ultra-high sensitivity is well over an order-of-magnitude more sensitive than any other system.

For solid earth physics research, the GSMP-20S3 can achieve gradient sensitivities of 0.6 fT/m (10^{-15}T/m) with a sensor spacing of 50m - a major advantage over traditional long-baseline measurements (i.e. total field with reference station for removal of diurnals) which have sensitivities on the order of 1nT. The GSMP-20S3 also minimizes cultural noise from nearby infrastructure and 1 / f noise that typically degrades results from other types of measurements (ex. Electromagnetic). Note that f is the frequency of the measured magnetic signal from the event.

The GSMP-20S3 System is comprised of a dedicated data acquisition receiver and 3 very large high precision Potassium sensors configured to measure gradients across variable distances in different directions.

Magnetometer Specifications

GSM-90 Scalar Magnetometer

Sensitivity: 0.022 nT / √Hz
Resolution: 0.01 nT (gamma)
Absolute Accuracy: 0.1 nT
Dynamic range: 20,000 - 120,000 nT
Long term stability: <0.05 nT/year
Sampling: GSM90: 1 sample /3 sec.
GSM-90F1: 1 sample /1 sec. GSM-90F5: 5 samples / 1 sec.
Sensor size: 70mm dia. X 150mm
Power: 12V 200mA max., 40mA average
RS232C parameters: programmable
* For the ultimate in low power operation, consider our GSM-90L requiring only 100mW for 1 reading in 5 seconds or 300mW for 1 reading per second.

dIdD Vector Magnetometer

Sensitivity: 0.180 nT @ .2 sec reading interval
Resolution: 0.01 nT
Absolute Accuracy: 0.2 nT
Range: 20,000 to 120,000 nT
Gradient Tolerance: over 10,000 nT/m
Operating Temperature: -40°C to +45°C
Power Consumption: 1.5 W at 12V
Reading: X, Y, Z, dI and dD
0.5 sec per interval, 2.5 sec full cycle
0.4 sec per interval, 2 sec full cycle
0.2 sec per interval, 1.0 sec full cycle
5 measurements acquired during each full cycle
At 2.5 Sec Cycle
dI uncertainty <= to 1 arcsec rms
dD uncertainty <=to 2 arcsec rms
for I_O <= to 45°

SuperGRAD and SuperGRAD Mini

SuperGrad Sensitivity: 0.02 pT @ 1Hz
Gradient sensitivity: 0.6 fT/m, with 50m sensor spacing
SuperGrad Mini Sensitivity: 0.05 pT @ 1Hz
Gradient sensitivity: 1.0 fT/m, with 50m sensor spacing

Resolution: 0.001 pT for up to 20 readings /sec.
Absolute Accuracy: 0.1 nT
Time Base Stability: 0.01 ppm over -40°C to +55°C
Long Term Stability: better than 10 pT / year
Dynamic Range: 20,000 to 100,000 nT
Operating Temperature: -40°C to +55°C
Power Consumption: 22-60 V
80 W average, 250 W maximum
Tuning: wideband system no tuning
Sensor Orientation: 45 +/- 35 degrees off the magnetic field direction
Sampling rate: 1 to 20 samples / second

GEM Systems provide an industry leading 3 year Warranty

GEM SYSTEMS
ADVANCED MAGNETOMETERS

GEM Systems, Inc.
135 Spy Court Markham, ON Canada L3R 5H6
Phone: 1 905 752 2202 • Fax: 1 905 752 2205
Email: info@gemsystems.ca • Web: www.gemsystems.ca