Sensitivity of GEM Product Family

GEM takes pride in ensuring that its magnetometers are tested according to high sensitivity standards. That's why each magnetic sensor is put through a rigorous process that ensures the system meets published sensitivities. Sensitivity is determined by the signal-to-noise ratio from the sensor, spectral line width, and gyromagnetic constant

Sensitivity is a statistical value indicating the *relative uncertainty of repetitive readings of the same magnetic field intensity*. Formally, it is the root-mean-square (r.m.s.) value per square root of a unit of bandwidth ($Hz^{1/2}$). For example, a sensitivity of 1 pT / $Hz^{1/2}$ equals 1 pT r.m.s. (i.e. 3 - 4 pT peak-to-peak) with readings scattered about an "etalon" (fixed value) of the applied magnetic field per 1 Hz of measurement bandwidth.

GEM's sensitivity tests are conducted by assembling magnetometer sensors in a gradient configuration. Data are then acquired continuously for a sufficient period to ensure that the sensor meets design criteria.

Some of the factors that affect the testing measuring period are the presence of anomalous magnetic fields (i.e. sunspot or high atmospheric activity) and system cycling time.

In this short technical note, we show data from a set of Overhauser sensors operating at 1 second and 4 second cycle times.

For interest purposes, we also show an example from the world's most sensitive commercial gradiometer, the SuperGrad.

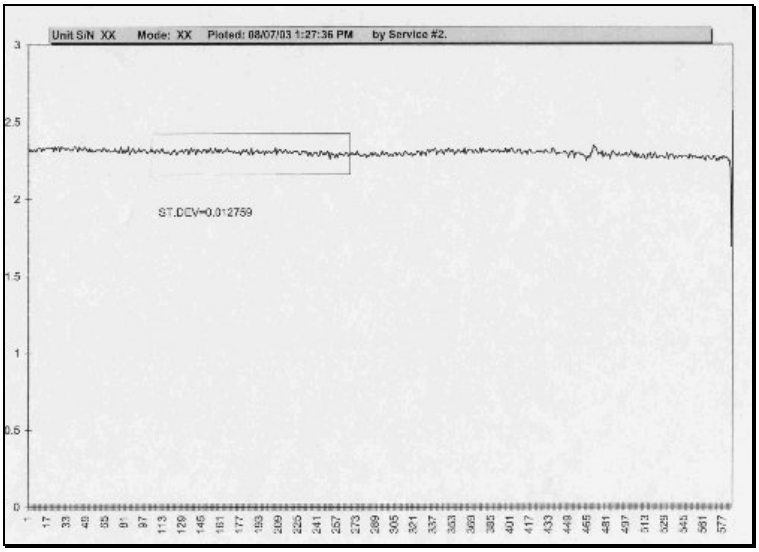


Figure 1: 1 second sampled Overhauser gradiometer data with a standard deviation (i.e. r.m.s. sensitivity) of 0.023 nT. Values range between 0.016 & 0.023 in routine 1 sec tests.

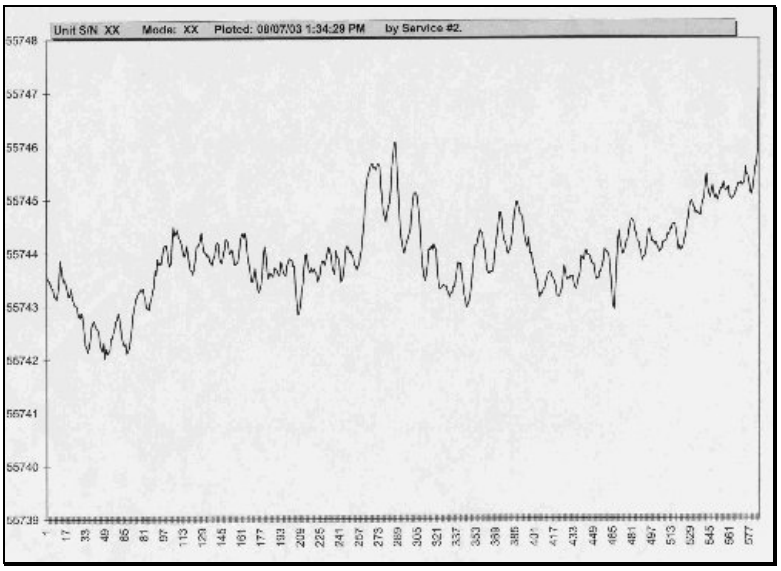


Figure 2: 1 second sampled Overhauser magnetometer data obtained with data in Figure 1. This data is from the lower sensor. Variability reflects diurnal and sensor noise.

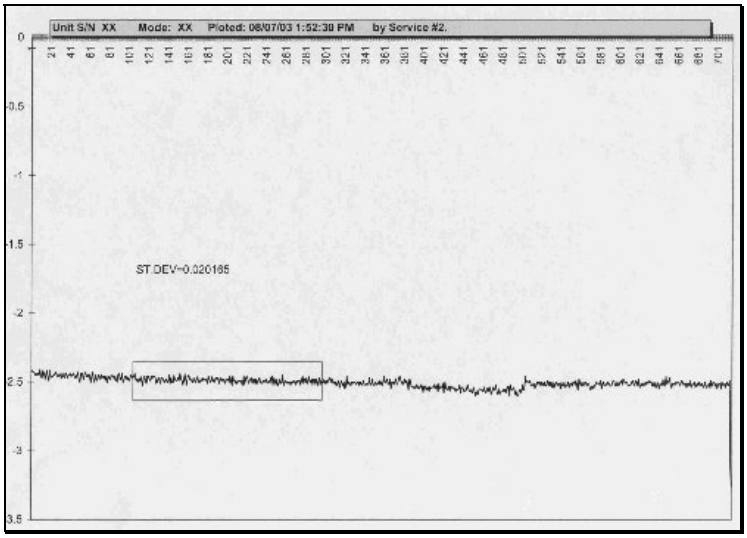


Figure 3: 4 second sampled Overhauser gradiometer data with a standard deviation (i.e. r.m.s. sensitivity) of 0.02. Values range between 0.02 & 0.04 in routine 4 sec tests.

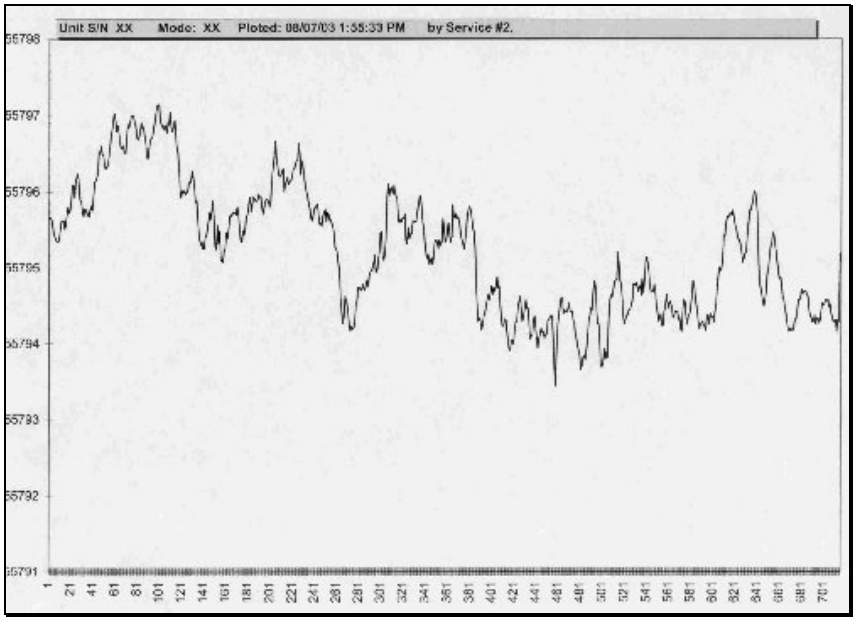


Figure : 4 second sampled Overhauser magnetometer data obtained with data in Figure 1. This data is from the lower sensor. Variability reflects diurnal and sensor noise.

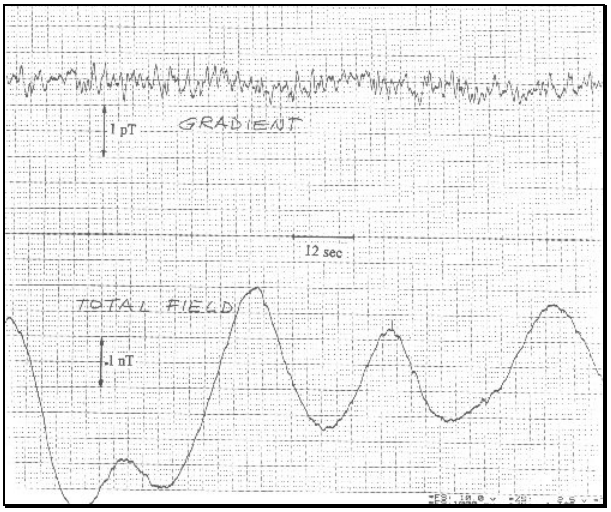
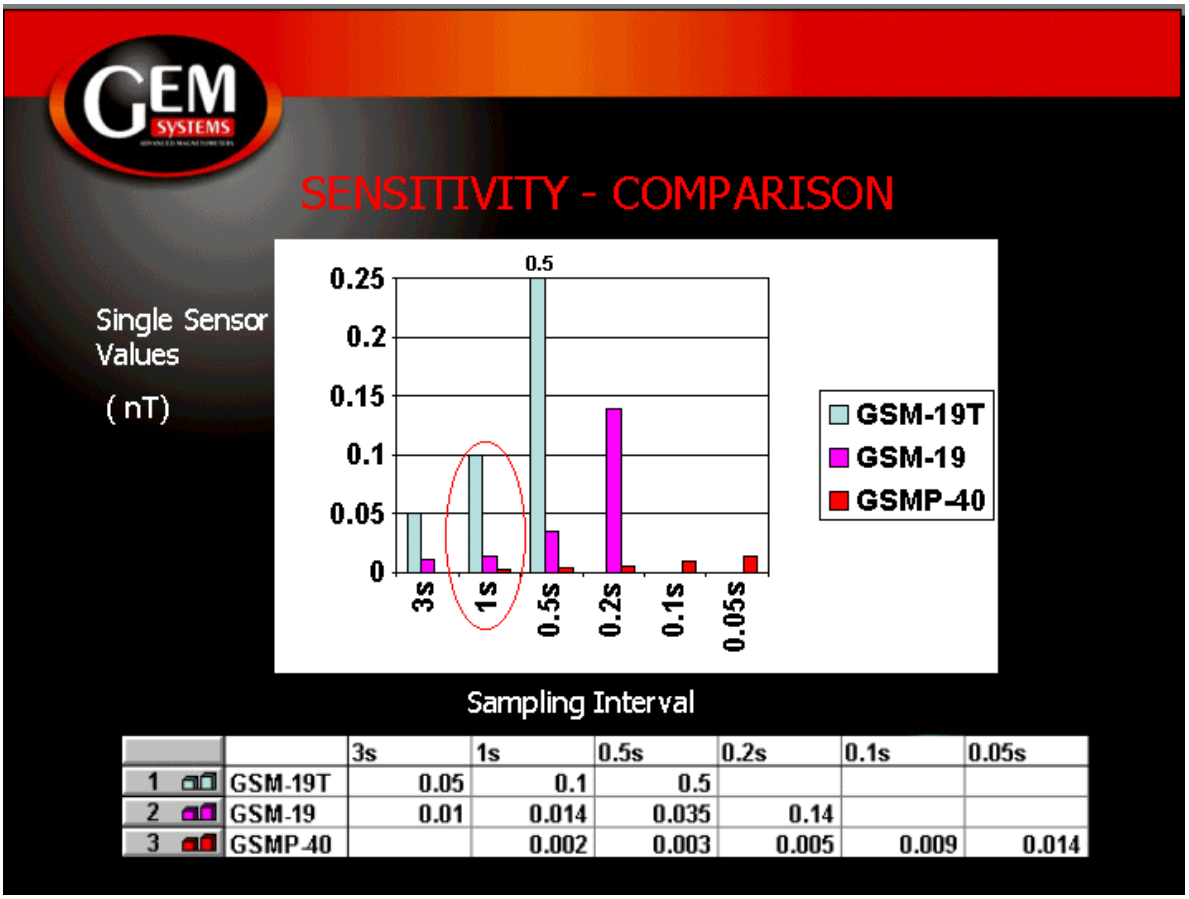


Figure 5: SuperGrad data. Peak-to-peak noise is 0.5 pT, making SuperGrad the most sensitive commercial gradiometer available today.

Comparison of System Signal Quality

GEM delivers three families of magnetometers, namely optically pumped Potassium, Overhauser and Proton Precession. Each of these systems leads its class in terms of sensitivity (i.e. high signal-to-noise.

The following graph shows results obtained from each of the three product families. Proton Precession has the lowest sensitivity followed by Overhauser and Potassium. These characteristics are important to keep in mind when selecting a magnetometer system.



		3s	1s	0.5s	0.2s	0.1s	0.05s
1	GSM-19T	0.05	0.1	0.5			
2	GSM-19	0.01	0.014	0.035	0.14		
3	GSMP-40		0.002	0.003	0.005	0.009	0.014

Figure 6: Comparison of sensitivities for different GEM families calculated by determining standard deviations and then dividing by the square root of 2. GEM's optically pumped **Potassium** is ideal for very high sensitivity work. 20 x per second sampling also provides the sampling needed for efficient vehicular work. The **Overhauser** (GSM-19) is a high sensitivity instrument suitable for portable and some vehicular applications. GEM's **Proton Precession** (GSM-19T) family combines the latest technology available in a Proton Precession system with classic value.