Reply to the comments

The orthogonality of the coil system is not mentioned in the manuscript. It is essential to know the angles between the coils, if good calibration of magnetometer sensors should be made. It is quite worrying that this point is'nt mentioned. So please add details about this.

Another point not mentioned in the manuscript is the influence from the environment. What is the 'noise' from the environment day and night? Has the temperature and humidity any influence on the coil constants?

Reply 1: The coil system had been manufactured by Department of PRAHA, Czechoslovakia (known from the few scanned pages available with the authors) and we believe that these angles were calculated during the commissioning of the set up, however these details are not mentioned in the said document.

For repeat experiments conducted on any random day the repeatability of the results is observed and and hence the influence from the environment is ruled out.

Detailed comments:

"A Tri Axial Square Helmholtz Coil system . . . was .. commissioned.." Page 1 line 2 Which company build the original coil system back in 1985?

Reply 2: The coil system had been manufactured by Department of PRAHA, Czechoslovakia.

"Square coils . . . provides a wider uniform field . . ." Page 1 line 17 How much bigger is the uniform field from a square Helmholtz coil compared to a circular Helmholtz coil?

Reply 3: This system yields a working space volume of approx. 5 liters (considering a cubic sensor of 17 cubic cm).

"All technical parameters of the system were re-calculated". Page 2 line 15 Please specify how with formulas and results: coil constants, coil resistance, etc.

Reply 4: Tabulated below

Parameter	H	D	Z
Coil Constant (nT/mA)	76.44	85.55	68.44
Coil Dimension (mm)	2200	1900	2500
Coil Resistance (Ω)	45	39	62
Coil Inductance (mH)	95	80	157
Coil Turns	2 × 105	2 × 105	2 × 105
Working space volume	Approx. 5 litres		

“This system generates uniform, accurate and precise magnetic fields” Page 2 line 16 What is the definition of uniform? Is it 0.1 o/oo of the ambient field? What is the definition of Accurate? Is it 1 nT or 100 nT? Please show some time plots of the measured field with ambient field added”.

Reply 5: This system yields a working space volume of approx. 5 liters (considering a cubic sensor of 17 cubic cm). It is accurate to 1 nT.

“The Helmholtz condition of the second-order field” page 3 line 4 Please specify the formula.

Reply 6: This line we will strike off as we have not dervied the formula.

“Working space volume . . . with max +-2 nT homogenity deviation” page 3 line 7 This depends on the field generated in the coil, so it should be stated like ‘0.2 o/oo of the added field’ or similar.

Reply 7: Yes Sir. We agree to to your comment.

“The coefficient of thermal expansion of aluminium is less than page 3 line 12 that of borosilicate glass” I do not think this is correct. Please check this.

Reply 8: The necessary reference has been provided.

“Larger magnetic fields are generated by smaller coils..” page 5 line 6 This is correct with same current and number of windings, but it also has a smaller uniform volume, so a large field will give higher deviation. Please mention this in the paper.

Reply 9: Yes Sir. We agree to your comment and we will mention it in the paper.

“The CCS is designed to provide current at a stability and resolution page 6 line 1 of 10 uA” It can supply a maximum of 1 A .. which can produce enough magnetic field .. with the range of nT to mT” From this I will deduce that the coil constant will be something like 1 mT/1A ~ 1000 nT/mA. With this coil constant the stability and resolution will be 10 uA * 1000 nT/mA = 10 nT. Is this correct? Please add such details to the description.

Reply 10: The CCS used in the system can provide a stable constant current of 1 mA to 1 A with steps of 10 uA. From the coil constants, constant magnetic field of 76.44/85.55/68.440 uT per ampere of current can be generated in respective coils. With these coil constants and current parameters stability and resolution will be 10uA*76.44nT/mA= 0.07nT (theoretical).

“LTC1657 is a . . . 16 bit . . . DAC” page 6 line 4 16 bit gives 65k steps. What are the steps in nT for each coil?

Reply 11: The DAC used in current source is LTC 1657 which is a 16 bit DAC and used with a reference voltage of 2.048V. The output of DAC is amplified by 2 with the internal gain setting of DAC. Thus minimum output resolution achieved by the DAC is 6.250 uV. Current feeding to the coil from the CCS is referenced to a high precision power resister of 10 ohm hence the minimum current resolution achieved 6.2 uA. Considering noise

performance of the DAC and the PCB board we have achieved up to 10 uA stable output current step to the coil.

"The sensor is mounted so that sensor axes are aligned along H, D and page 7 line 12 Z directions. . . ." This method only gives the coil constant for each axis of the tested sensor, and only if the Helmholtz cage is well calibrated. What are the angles between the coil axes? If the coil system should be used for calibrating magnetometers considering both coil constants, offsets and orthogonality, it is essential that all coil constants and angles between the 3 axes are well documented.

Reply 12: Please refer to the Reply No. 1.

"o/p" page 7 line 19 What does this mean?

Reply 13: Output

"These results confirm that the field measured . . . is in agreement page 7 line 28 with the input current (input field) . . . increasing to < 100 nT at higher inputs" As I can see at the figures, the differences in field at 500 mA are up to several thousand nT, so I do not think there are an agreement. The constants seems to be 5-10 % off, which is a lot. This point is important and must be more clearly documented.

Reply 14: Typo error. Approximately 1000 nT.

"The similar trend is seen in 3 more sensors" page 7 line 30 Either the alignment of the test stand is poor, or the coil constants are wrong. Or all sensors are bad? Again, this is worrying. More details must be given and the adequate function of the system must be demonstrated.

Reply 15: It is an alignment issue.

Figure 6, 7 and 8: page 8, 9 and 10 From figure 6, H-coil constant seems to be 34000 nT/400 mA = 85 nT/mA and H-offset = 0. From figure 7, D-coil constant seems to be the same: 85 nT/mA and D-offset=0. From figure 8, Z-coil constant seems to be 28000 nT/400 mA = 70 nT/mA and Z-offset = -22000 nT. How can H-offset be zero? Shouldn't it be something like 38000 nT? D-offset and Z-offset seems more correct. Are H-coil constant and D-col constant both 85 nT/mA? All 3 coil constants are much smaller than 1000 nT/mA, according to my earlier deductions.

Reply 16: The same coil was used as H and D by changing the sensor orientation.