

Interactive comment on “Tri Axial Square Helmholtz Coil system at the Alibag Magnetic Observatory: Upgraded to Magnetic Sensor calibration facility” by Prasanna Mahavarkar et al.

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Comments on manuscript: Tri axial square helmholtz coil system at the Alibag Magnetic Observatory: Upgraded to magnetic sensor calibration facility.

By Prasanna Mahavarkar et al.

General comments: It is very difficult to understand the setup of the coil system, since there are very few facts given about the coils. Please make a table with all information for all 3 coils: coil constant, coil resistance, coil windings, angles between the 3 axis (orthogonality). Also information on how they are measured. The orthogonality of

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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 not 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?

Useful information on how to measure the coil constants and the orthogonality of the coil system can be found in this article: “Determining the orthogonality error of coil systems by means of a scalar magnetometer: Application to dIdD magnetometers” by B Heilig, 2012 And in this thesis: “Magnetic calibration by using non-linear optimization method” by Ales Zikmund. 2014.

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?

“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?

“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.

“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.

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

“Working space volume ... with max +-2 nT homogeneity 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

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added field' or similar.

"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.

"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.

"The CCS is designed to provide current at a stability and resolution page 6 line 1 of 10 μA " 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 $1 \text{ mT}/1\text{A} \sim 1000 \text{ nT}/\text{mA}$. With this coil constant the stability and resolution will be $10 \mu\text{A} * 1000 \text{ nT}/\text{mA} = 10 \text{ nT}$. Is this correct? Please add such details to the description.

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

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

"These results confirm that the field measured ... is in agreement page 7 line 28 with the input current (input field) ... increasing to $< 100 \text{ nT}$ 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.

"The similar trend is seen in 3 more sensors" page 7 line 30 Either the alignment of the

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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.

Figure 6, 7 and 8: page 8, 9 and 10 From figure 6, H-coil constant seems to be $34000 \text{ nT}/400 \text{ mA} = 85 \text{ nT}/\text{mA}$ and H-offset = 0. From figure 7, D-coil constant seems to be the same: $85 \text{ nT}/\text{mA}$ and D-offset=0. From figure 8, Z-coil constant seems to be $28000 \text{ nT}/400 \text{ mA} = 70 \text{ nT}/\text{mA}$ 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 $85 \text{ nT}/\text{mA}$? All 3 coil constants are much smaller than $1000 \text{ nT}/\text{mA}$, according to my earlier deductions.

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