



EGUsphere, referee comment RC2
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Comment on egusphere-2022-220

Hans-Ulrich Auster (Referee)

Referee comment on "Tesseract – a high-stability, low-noise fluxgate sensor designed for constellation applications" by Kenton Greene et al., EGU sphere,
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The authors present a vector compensated fluxgate magnetometer based on six racetracks inside a three axes coil system. The design is unique and the demonstrated performance is excellent. Thus, the paper is worth to publish.

Features of magnetic field experiments on constellation mission are discussed in the introduction. Please add a brief statement, why particularly these applications are used as reference for the new developed magnetometer. An argument could be, that these missions are representative for almost all space born magnetometers; wide range is required (low field at apogee, high field at perigee), exposed to radiation, temperature changes due to eclipse crossings ..

The comparison is made disordered, some parameters are listed for the one, others for the second type of magnetometers. This should be harmonised, may be supported in a table format. Noise, mass, scale value and axis stability vs. temperature shall be given for all of them.

The paper attention turns to stability of the sensors and to the advantages of the vector compensated system. All constellation missions mentioned in this paper (Themis, MMS,

SWARM) are since many years in space. Long period data for offset and axis stability should be available from inflight calibration. Contact magnetometer PI's for these data (if not published) and include the inflight measured drifts into your comparison.

The presented sensor design is impressive. In contrast to the straight forward OERSTEDT/SWARM design (feedback system over three single ringcores) and the more compact THEMIS design (feedback system over crossed ringcores) the cores (racetracks) are accommodated symmetric and identical for all three components. It is made similar to the very innovative Xavier Lalanne design from the 1990th. He placed six ringcores at the six planes of a cube. Please refer to it.

Chapter 3 has to be rewritten. Promoting the presented sensor is ok, however, the comparison with a user defined ringcore sensor, which should imply that the presented sensor is much better than ringcore sensors in general is not acceptable. The comparison has to be made with the vector compensated ringcore sensors you have studied in the introduction.

Quantities are mixed up. It shall be clearly distinguished between stability of offsets, scale values and orthogonality. The vector compensation stabilises the orientation of the magnetic axis while the offset stability depends on core properties only. Thus for scale value and axes stability it is fully unimportant which type and geometry of magnetic material is used as core.

The analysis of the uniformity of the feedback coils has been intensively discussed. No question, high homogeneity is better than low homogeneity, however in case you want to underline the importance of the uniformity, you have to quantify it. What is the impact on offset, scale value, linearity and orthogonality behaviour really? Particularly racetracks with a significant length/diameter ratio might disturb the uniformity you have hardly achieved by the sophisticated feedback coil design.

The discussion of thermal expansion of the feedback system is not as simple. A high scale value stability of $<10\text{ppm/K}$, achieved by a combination of materials with different expansion coefficients must not be better than a scale value stability of 20ppm/K , if this one is linear over the whole temperature range and has a lower hysteresis. Thus linearity, the reaction on fast temperature changes (e.g. during eclipse) and the hysteresis are criteria which have to be discussed and compared, not the number itself.

The authors present a nice sensor with an excellent performance. The demonstration of its parameter doesn't need to be underlined by an artificial comparison with an arbitrary sensor. Only drawback is the mass, may be a little bit too heavy for constellation missions or small satellites. However, with respect to the mass of boom and harness, a few 100g should be acceptable for the most important part of a magnetic field experiment, the sensor.