## Observation of an unexplained event from a magnetic monopole detector

IN a recent article Caplin *et al.*[1] reported an event, event-160. They rejected many possible terrestrial causes for event-160 and offered the event as a candidate magnetic monopole sighting. Here I demonstrate that although the precise cause of event-160 remains unknown the experimental record of the event contains enough evidence to discount any connection with a magnetic monopole.

The design of this experiment intentionally sacrificed uniqueness of signal size and full coincidence for maximum detection area. As a result the only check against fast, spurious single-channel events was the simultaneous records of four sensors that monitored the mechanical and electromagnetic environment. The experimental method was to reject any event whose record contained a real anomaly in just one of these monitors even though a definite causal connection between monitor feature and SQUID offset was not always found[2]. The record event 160 contains a complicated and rare anomaly in the radiofrequency (r.f.) monitor. In this experiment the choice between artefact and serious candidate hinges on our understanding of this monitor.

Caplin *et al.* correctly pointed out that the r.f. signal was dominated by the stray radiation associated with data transmissions to and from the computer. They suggested that the r.f. anomaly was a direct consequence of the change in sign in the numbers transmitted by the SQUID event channel. A careful analysis of the data shows that the r.f. anomaly was composed of three parts, two of which clearly precede the SQUID offset. About 40 s before the event the mean signal level began a gradual rise. About 0.4 s before the offset the variance of the signal dropped abruptly to its lowest level in the entire record. At this instant the mean level began a more rapid rise that persisted across the time of the SQUID offset. Caplin *et al.* restricted their attention to this last component.

A statistical analysis of 40 preserved records each consisting of $8000 \times 7$ data points was made. Only two other records were found to contain the features seen in event-160. These were readily explained and were not associated with any sign change. The same survey showed that sign changes in at least one channel were the norm and that there was no evidence for any associated r.f. feature.

In a long series of experimental tests square-wave input signals were used to simulate large, fast offsets in all three SQUID channels. The system was subjected to $>100$ trials at different times of day and with different test amplitudes. Of these only one batch of $\sim 15$ trials produced any response at all on r.f. In this batch the effect had the wrong sign to explain event-160: it was clearly visible on other channels and was subsequently traced to amplifier saturation caused by an excessively large input signal. The magnitude of event-160 was two orders of magnitude too small to saturate its amplifier.

A later investigation of the r.f. channel itself revealed that amplifier slew rate and pulse distortion made it impossible for r.f. to contain any information about any bit pattern being transmitted by any channel. The same study provided enough information to permit the reproduction at will of the main features of variance and mean shift seen in event-160 using changes in computer speed and antenna coupling. These last tests showed that quite significant changes were required to produce any effect on r.f.

It is very unlikely that two very rare features should occur within 0.4 s in the same record by chance. I have shown that the r.f. anomaly preceded the offset. I have shown that the r.f. anomaly could not have been generated without a significant change either in the computer or the environment of the apparatus. I therefore conclude that such a change was responsible for both recorded features.

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1. Caplin, A. D., Hardiman, M., Koratzinos, M. & Schouten, J. *Nature* **321**, 402–406 (1986).
2. Caplin, A. D., Guy, C. N., Hardiman, M., Park, J. G. & Schouten, J. *Nature* **317**, 234–236 (1985).

CAPLIN *ET AL.* REPLY—The r.f. feature alluded to by Dr Guy in connection with event-160 is not unique; indeed, during the year of normal operation of the detector, several similar features were seen.

Most of the 170 offsets recorded by our detector[1] were small, but the mechanism probably responsible for these r.f. features (see below) is likely to be operative only with fast offsets that are larger than peak-to-peak noise. Further, external noisy r.f. sources could obscure the effect. The susceptible category of offsets is therefore a small fraction of the total.

Of the 40 putative events surveyed by Guy, which are those for which the full 20-Hz data on floppy disk have been retained, only 5 (event-0 caused by mechanical shock, events-47, 50 and 75 caused by an intermittent electronic fault in a SQUID control unit, and the unexplained event-160) fall into the susceptible category, apart from a few offsets that were so large as to saturate amplifiers in the data acquisition system. Events-47 and 50 show r.f. shifts of 2 and 0.7 V respectively, which should be compared with the 0.1 V r.f. shift associated with event-160 (the mean value of the r.f. level is typically 5 V, with fluctuations of 2 V peak-to-peak).

Of the other 130 putative events, the causes were sufficiently well identified and lacking in interest that the floppy disks were erased; even so, some sections of the detailed record were usually retained in printed form. Susceptible events for which relevant printed records are available are events-1 (mechanical shock) and 84, 85 and 90 (intermittent electronic fault in a SQUID control unit). Events-1 and 90 show r.f. shifts of about 0.5 and 0.3 V respectively.

Thus the experimental evidence is that in normal operation, about half of the large and sudden offsets in a detector channel are accompanied by features in the r.f. record. The computer-controlled data acquisition system provides the likely mechanism for this coupling[1]; under quiet conditions it is responsible for 90% of the recorded r.f. interference. A large change in one of the input channels can therefore affect the radiated r.f., through an interaction at the hardware level, through a perturbation of the rhythm of program execution, or both.

We do not understand in detail why, even under the more or less constant conditions of normal operation, the form and amplitude of the r.f. feature should be so variable; perhaps the computer speed and antenna coupling referred to by Guy are important. The attempted simulations that he describes were made after the cryostat had been warmed to room temperature and the detector dismantled; the results obtained under those very different conditions are of limited relevance to behaviour in normal operation.

Guy's conclusion that the r.f. feature and event-160 were generated by a (unidentified) 'significant change either in the computer or the environment of the apparatus' not only fails to identify a causative mechanism, but ignores the ample experimental evidence showing that the r.f. feature is likely to be a mere artefact of the event.

Other mechanisms that could have generated event-160, and which are physically reasonable, were discussed in detail in our article[1].

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1. Caplin, A. D., Hardiman, M., Koratzinos, M. & Schouten, J. C. *Nature* **321**, 402–406 (1986).