B-field generated by single-axis probe

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I have looked for a possible magnetic field generated by the single-axis cryogenic probe. I reduce the ambient magnetic field by performing the search inside a three layer magnetic shield. The residual magnetic field inside these shields is below a 200 μG. A single axis probe sits inside the shields while a dummy is scanned around it. Data is recorded as a function of position of the dummy probe using a 6.5 digit voltmeter.

Figures 1 and 2 show the experimental data with the single-axis fluxgates under a magnetic field of 5 mG and 10 mG, respectively. The magnetic field has the same orientation as the probes. The vertical axis is the magnetic field measured; the horizontal axis is the distance from the probe in the vertical direction. The scans were performed in the z direction with the y and x directions are fixed.

I fit the data to a magnetic dipole field considering that the dipole points along the long axis of the probe. The fit has four paramaters : the size of the dipole (m_0), an offset (B_0), the center of the peak (z_0), and the distance perpendicular to the probe (y_0). Fig. 3 shows the magnetic field when the dummy probe is operating (turned on) while a magnetic field of 5 mG is on. Fig. 4 has a similar plot in a magnetic field of around 7 mG. Fig. 5 has the "sanity check" scan with no dummy probe.

Similar data was taken with the bias field off. Figs. 6 and 7 show two such measurements. In between the measurements the dummy probe was turned on and off. It appears that the history of the probe affects in which direction the magnetization points to as well as the size of the magnetic dipole. Table 1 sumerizes the values of the magnetic dipoles as a function of the bias magnetic field.

I looked also for any radiation coming from the single axis fluxgate. For this purpose i positioned and aligned the single axis fluxgate as close as possible to a single probe of the three axis fluxgate. A single axis fluxgate could not be used for this purpose since its roll-off starts at 10 Hz. A frequency component at 1 kHz was observed (see Figs. 8 and 9).

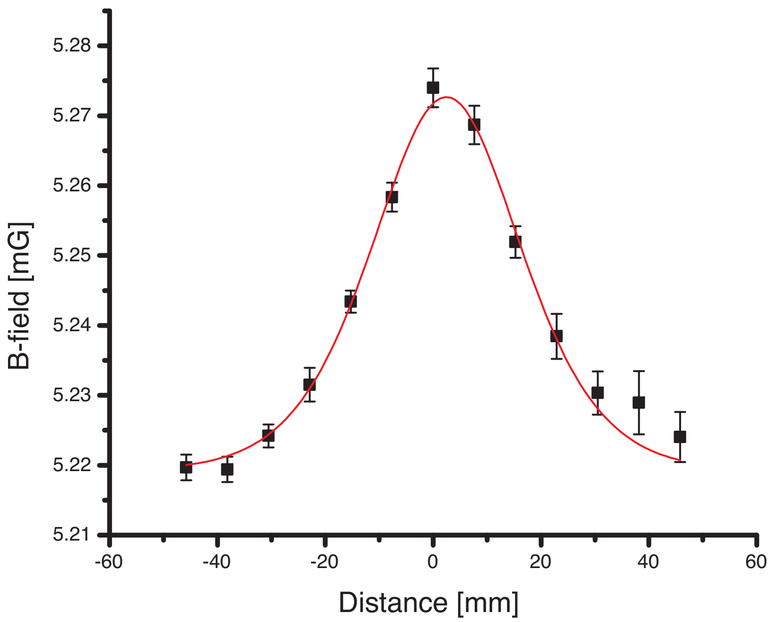

Figure 1: Magnetic field close to the single axis cryogenic probe as a function of position while the dummy probe is off under a magnetic field of 5 mG.

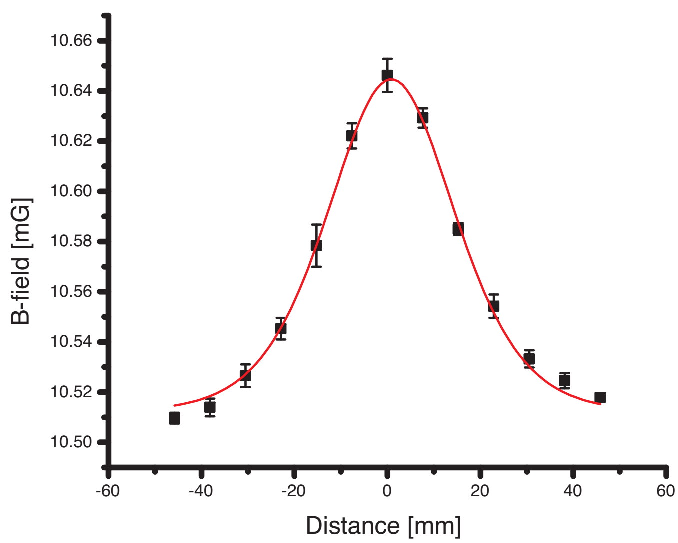

Figure 2: Magnetic field close to the single axis cryogenic probe as a function of position while the dummy probe is off under a magnetic field of 10 mG.

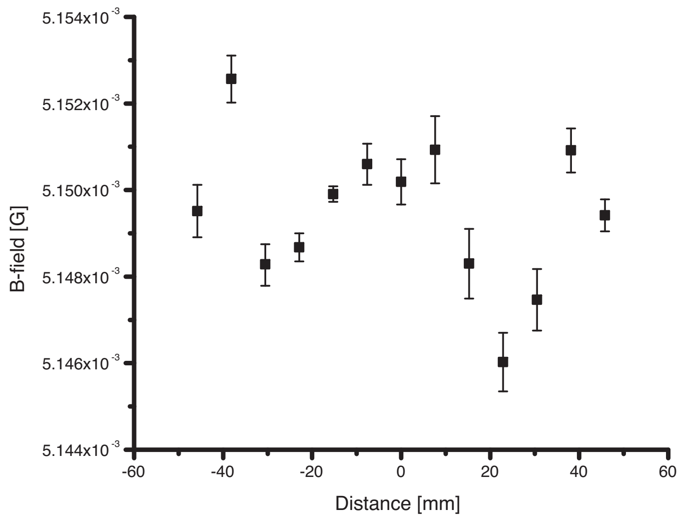

Figure 3: Magnetic field close to the single axis cryogenic probe as a function of position while the dummy probe is turned on under a magnetic field of 5 mG.

Bias B-field [mG]	Magnetic dipole [$A \cdot mm^2$]
.150	-0.22(12)
.150	0.06(2)
5	0.84(11)
10	2.03 (29)

Table 1: Size of magnetic dipole under different magnetic fields.

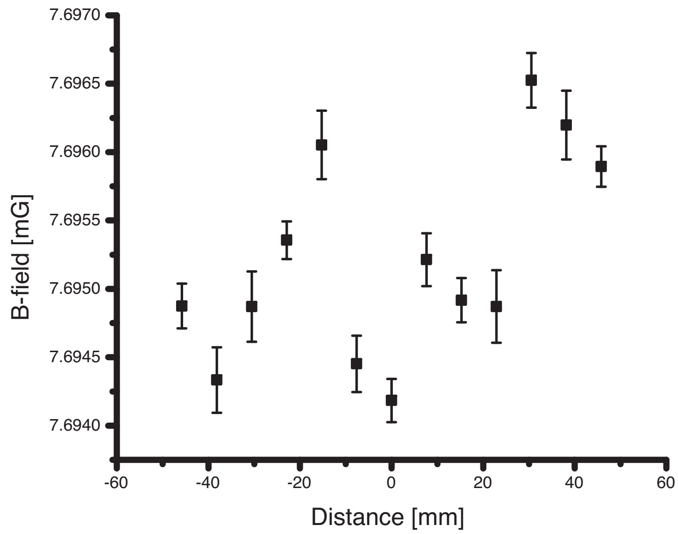

Figure 4: Magnetic field close to the single axis cryogenic probe as a function of position while the dummy probe is turned on under a magnetic field of 7 mG.

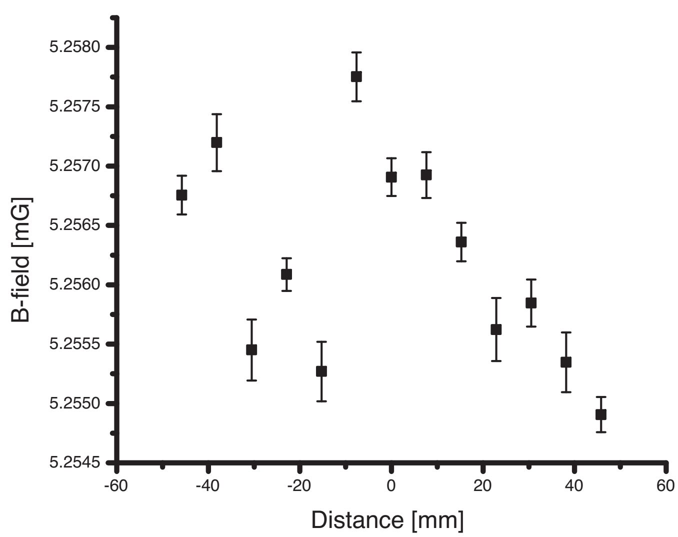

Figure 5: Magnetic field close to the single axis cryogenic probe as a function of position with no probe.

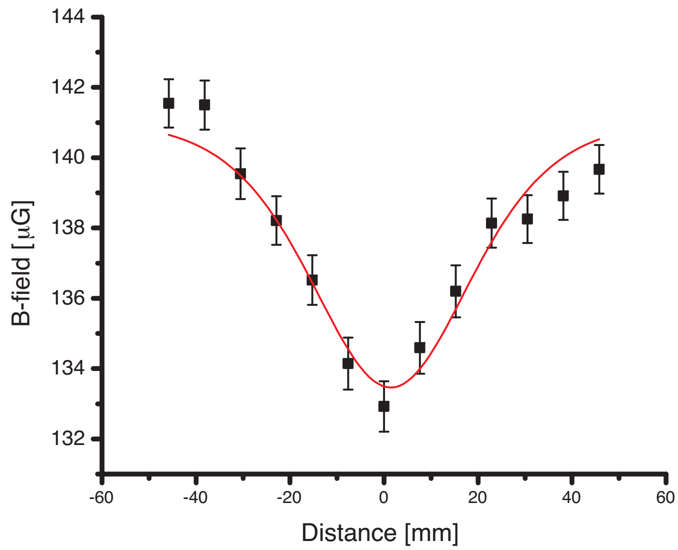

Figure 6: Magnetic field close to the single axis cryogenic probe as a function of position while the dummy probe is off at a low value of magnetic field (around 150 μG).

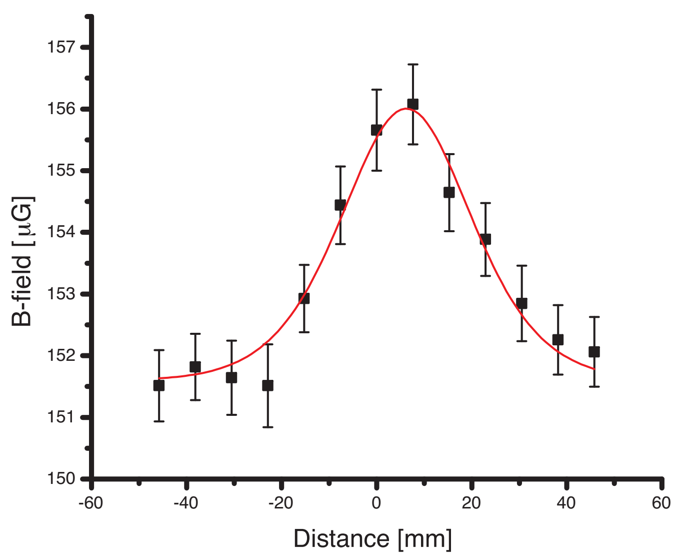

Figure 7: Magnetic field close to the single axis cryogenic probe as a function of position while the dummy probe is off after it probe has been turned on and off.

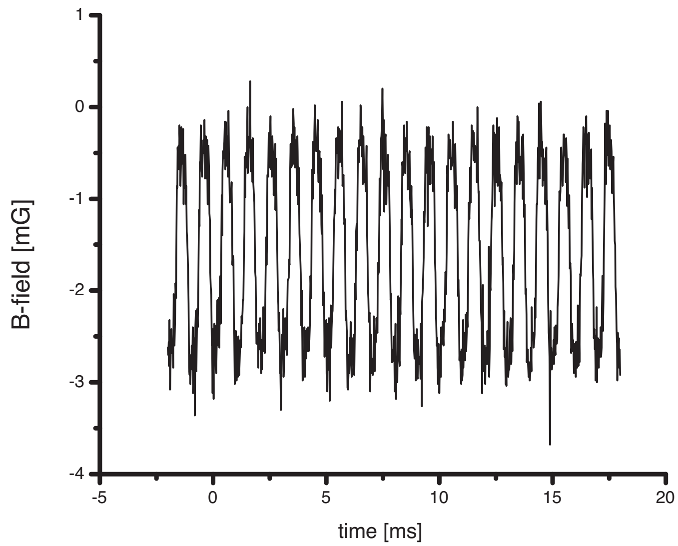

Figure 8: Behavior of the single axis fluxgate as measured with the three axis fluxgate.

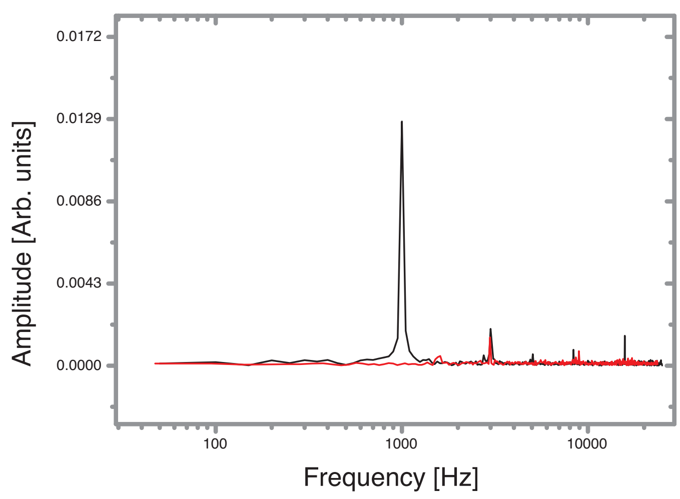

Figure 9: FFT of the radiation emanating from the single axis fluxgate. The black line has the response of the fluxgate when it is on and the red line when it is turned off.