GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

VERIFICATION OF SMD AC ATTENUATION FACTOR

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Approvals:

Program Responsibility	Signature	Date
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NOTES:
Level of QA required during performance of this procedure:
___Stanford QA Representative
___Government QA Representative

All redlines must be approved by QA

Revision Record:

Rev	Rev Date	ECO #	Summary Description

Acronyms and Abbreviations:

Acronym / Abbreviation	Meaning
f.s.	full scale
QC	quick connect
QD	Quantum Design (SQUID system manufacturer)
R	$(X^2 + Y^2)^{1/2}$ (instantaneous magnitude of signal voltage phasor referred to lock-in input
RCM	Rotating Coil Magnetometer
SMD	Science Mission Dewar
TC	time constant
X	Instantaneous in-phase voltage component referred to input of lock-in (when not referring to Science Mission coordinate system)
Y	Instantaneous quadrature-phase (lagging X by 90 degrees) voltage component referred to input of lock-in (when not referring to Science Mission coordinate system)

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A Scope

This is a procedure to measure the ac attenuation of external longitudinal (axial, Z direction) magnetic fields into the interior of the SMD Well. The external field is applied by a fixed 12-ft. diameter hexagonal field coil set in the Helmholtz configuration, and the internal field is measured by a SQUID-based Rotating Coil Magnetometer (RCM) configured to sense a specified component of the field on the axis of the dewar Well. In order to distinguish an externally generated leakage field from fixed internal fields, the external field will be applied at a frequencies between 5 and 100 mHz. (The nominal roll frequency is 5.55 mHz. It is advantageous, however, to use as high a frequency as possible in order to minimize SQUID noise. Since the attenuation factor can be frequency-dependent because of eddy current fields, the procedure is written in a way to determine the highest frequency that is predictive of the 5 mHz result.) Because an external axial field is very strongly attenuated by a superconducting cylindrical shield with one open end (over a factor of 2000 for every diameter of penetration), it is expected that any readily-observed leakage field in the gyro region will be due to defects (holes, tears) in the lead shield or other non-ideal behavior such as cross coupling between longitudinal and transverse modes. It is anticipated that the data obtained in this procedure can be used in combination with analysis to verify the transverse attenuation as well.

B Requirements Verification

B.1 Requirements Cross Reference: Payload Spec. 3.7.5.3.3

B.2 Expected Data for verification per requirement: Current Payload Spec. calls for a combined Cryoperm and Lead Bag longitudinal shielding factor of 2×10^{-11} (0.2 for the Cryoperm and 10^{-10} for the lead bag). However, it is anticipated that the Spec. will be revised to require that both transverse and longitudinal attenuation factors be <= 2×10^{-9} for the lead bag/cryoperm combination.

C Configuration Requirements

The RCM has been installed in the Well of the SMD and has been positioned with the center of the rotating coil located at the station number that gyro #1 would occupy when the Probe is inserted. The internal temporary Cryoperm shield (used during lead bag installation and dc field measurement) should not be installed. It is assumed that the DC Field Verification Procedure (P0191) has been completed and that the field at the gyro1 position has been determined to be <= 1 microgauss. In addition, the 12-ft. diameter hexagonal field coil set has been installed around the SMD per engineering instruction.

C.1 General requirements:

C.1.1 Clean room gloves shall be worn by all persons working on hardware to be inserted into the well. For any work performed at the level of the dewar opening clean room shoes shall be worn in addition

C.1.2 During operations with the Well the pressure should remain positive to avoid air incursion into the well. Pressure in the Well will be limited by relief valves, but in general, it is desirable to not exceed 5 oz/in^2.

D **Hardware Required**

D.1 Commercial test equipment

Manufacturer / Descrip.	Model	Serial Number	Calibr. Exp. Date
Quantum Design dc SQUID controller	5000	DC0113	NR
SHE/BTi current source	CCS	220232-02	9/11/99
HP Function Generator	33120A	US34002995	NR
Kepco Bipolar Operational Power Supply / Amplifier	BOP 50-8M	E125174	NR
HP multimeter	34401A	3146A35192	7/16/99
Applied Physics System Fluxgate Magnetometer	APS 520A	-	10/5/99
Stanford Research Systems DSP Lock-in Amplifier	SRS850	26416	11/14/99
HP Dynamic Signal Analyzer	35607A	3431A01463	NR
Soltec Chart Recorder (opt.)	DS6404	24116	NR

D.2 Mechanical/Electrical Special test equipment

Description	Part No.	Rev. no.	Serial No.	Certification Date
12' dia. hexagonal vertical-field Helmholtz coil set	–	–	–	
RCM (with support and adapter hardware to interface with the SMD and crane)	-	-	-	-

D.3 Tools

Description	No. Req'd
Tape measure	1

D.4 Expendables: None

E **Software Required**

E.1 Test Support Software: none

F **Procedures Required**

None

G **Equipment Pretest Requirements**

Equipment	Serial No.	Test Required	Proc. No.	Test Performed Date	Test Performed By
Hexagonal lower coil	-	field/current ratio	Op #903a	11/17/98	D. Murray
Hexagonal upper coil	-	field/current ratio	Op #910	11/24/98	D. Murray

H Personnel Requirements

This test to be conducted only by certified personnel. Any portion of this test can be conducted by any two of the following individuals: J. Mester , M. Taber, D. Murray.

I Safety Requirements

I.1 Emergencies: In case of medical emergency or fire, **CALL 9-911**

I.2 Refer to FIST Emergency Procedures SU/GPB P0141 for other types of emergency situations which may occur in the FIST Lab. A copy of this document can be found in the SMD Operations binder. Refer also to the GP-B (FIST) Safety Plan, LMSC F-314447 and the GP-B (FIST) Preliminary Hazards Analysis, LMSC F- 314446 for details concerning hazards and safe operation of Lockheed-supplied equipment.

I.3 Crane operations: The FIST Crane may be operated only by a certified operator who shall verify that the crane has been inspected for proper operation within the previous seven days. Particular care should be taken to make sure that there is freedom of movement before the RCM is moved in the vertical direction with the crane. Failure to check for freedom of motion may result in damage to the RCM with possible contamination of the SMD Well.

J General Instructions

J.1 Redlines can be initiated by J. Mester, M. Taber, or D. Murray and must be reviewed and approved by QA.

J.2 Any nonconformance or test anomaly should be reported by a Discrepancy Report. Refer to the Quality Plan, P0108, for guidance. Do not alter or break test configuration if a test failure occurs; notify quality assurance.

J.3 Only the following persons have the authority to exit/terminate this test or perform a retest: J. Mester, M. Taber, D. Murray.

K References and Applicable Documents: None

L **Operations**

Date:
Time:

L.1 Verifying liquid helium levels:

L.1.1 If required in order to maintain adequate liquid helium level in the well (above STA 200) throughout the measurement sequence, perform internal tank to well transfer per Procedure P210.

Op No._________

L.1.2 Record helium levels.

Tank _________ %

Well _________ %

Axial Lock _________ %

L.2 Before connection of the power supply to the field coils, perform the following power supply setup to prevent the application of excessive current and verify proper programming:

L.2.1 Connect the power supply output terminal to the current (I) input of the multimeter and the power supply common terminal to the multimeter LO input. (The multimeter current input will effectively short the power supply.).

L.2.2 Place the Mode switch into the current programming mode (to the right).

L.2.3 Set the current programming control pot to zero output (5.00 on the turns counting dial).

L.2.4 Plug in and turn on the power supply and multimeter.

L.2.5 Turn on the current control switch (on the right side of the panel) and turn up the current control pot until the multimeter reads +3.0 A. (Note: This is the maximum current rating for the multimeter.)

L.2.6 Using a small screwdriver, adjust the positive current limiting pot downward until the current limit indicator lights.

L.2.7 Turn the current control pot downward until the panel ammeter reads -3.0 A.

L.2.8 Adjust the negative current limiting pot upward until the current limit indicator lights.

L.2.9 Turn the current control pot up and down once more to verify that the current is limited at ±3.0 amps.

L.2.10 Set the current control pot to center (5.00) and turn off the current control switch.

L.2.11 Turn off the power supply.

L.2.12 Connect the HP function generator output to the current programming terminals of the power supply. (Note: the programming ratio is approximatey -0.806 A/V.)

L.2.13 Turn on the function generator, select the square wave function, and set the frequency to 0.05 Hz.

L.2.14 Turn on the power supply.

NOTE:

In using the HP 33120A Function Generator, be aware of two idiosyncrasies: 1) The numbers displayed with units "V_{PP}" are really the peak amplitude volts. 2) The offset voltage is in reality twice the voltage displayed.

L.2.15 Set the function generator ac amplitude to 1.072 V_{PP} and the dc offset to -0.690 V. (This corresponds to a dc voltage of 1.38 V.) Verify that the output current varies between +0.24 and +1.98 A. Make adjustments as necessary to the offset voltage such that the average current is 1.11 A (corresponding to a dc field of 0.320 G needed to cancel the vertical component of the earth's field) and adjustments in the ac amplitude until the ac current amplitude (one-half of the peak-to-peak difference) is 0.87 A (corresponding to a peak amplitude of 0.25 G).

L.2.16 When satisfied with the offset and amplitude, change from a square to a sine waveform and increase the frequency to 0.1 Hz. Verify that the offset and amplitude have not been accidentally changed.

L.2.17 Store the function generator setup parameters as record 1. These setup parameters may be recalled even after the power to the function generator has been cycled.

L.2.18 In case the record the function generator becomes altered record the ac amplitude:______________V_{pp}, and dc offset:_______________V.

L.2.19 Turn off the function generator and the power supply.

L.3 Field coil setup:

L.3.1 Verify that the two halves of the hexagonal Helmholtz are connected in series so that the current will be flowing in the same direction in each coil. (This will be reverified below.)

L.3.2 Connect the coil set, operational power supply, digital multimeter, and function generator per Fig. 1. Note: The output shunting capacitor is necessary to prevent oscillation of the power supply when connect to the field coils.

L.3.3 Verify that the power supply mode switch is set to the current programming mode and that the current programming pot is set to zero output (5.00).

L.3.4 Turn on the digital multimeter and the power supply.

L.3.5 Turn on the current control switch and turn up the current control pot to +2 amps.

L.3.6 Verify that both coils are producing field in the same direction by holding the fluxgate probe a few inches inside each coil.

L.3.7 Note the direction of the field for a positive current.

L.3.8 Turn the current programming pot to zero output, turn off the current control switch, and turn off the power supply. If the field direction was determined to be downward for a positive current, reverse the leads to the field coils.

L.3.9 Mount the fluxgate magnetometer probe midway between the coils and 3" from the OD of the dewar with the fluxgate +Z axis aligned with the SMD +Z axis. At this location (1.15 m from the center), the field is 0.88 of the central field value. (Central field is .289 G/A and .254 G/A at the fluxgate.)

L.3.10 Verify calibration of the APS Fluxgate magnetometer: calibration date:__________; calibration due date:____________ QA:__________

L.3.11 Turn on the power supply and function generator. Restore the function generator parameters stored in section L.2. Verify that the fluxgate Z axis readout alternates between -0.22 and +0.22 gauss to within ~10%. If necessary, temporarily reduce the function generator frequency to allow the peak field levels to be easily read. If the average of the applied field is more than 0.05 G adjust the offset voltage and record: __________V.

L.3.12 Set/verify set the function generator to 0.1 Hz with a sine waveform. If the offset has been changed, store the function generator setup parameters as record 1.

L.3.13 Turn off the power supply and the function generator.

L.4 Magnetometer setup:

L.4.1 Verify that the vertical position of the magnetometer is at gyro 1 location (pickup coil at STA 153.3; see Fig. 2). If not perform the following:

L.4.2 Change vertical position to gyro 1:

L.4.2.1 Verify that the crane has been inspected for proper operation within the previous seven days.

L.4.2.2 Using the compliance device with the alarm, connect the crane to the RCM lifting eye.

L.4.2.3 Loosen the 2" QC ring completely and pull o-ring away from the QC body.

L.4.2.4 Using the crane, move the RCM to a position slightly above the new position, making sure that the 3" protection housing does not move. Guide the equalization hose and electrical cables to prevent snagging.

L.4.2.5 Loosen the yoke from the guide rods and the 2" RCM housing and raise until it is in the desired location as given in Fig. 2. Reclamp onto the guide rods.

L.4.2.6 Orient the RCM to the correct azimuth and lower onto the yoke. Retighten the yoke to the RCM as necessary.

L.4.2.7 Retighten the 2" QC.

L.4.2.8 Lower and detach the crane from the lifting eye.

L.4.3 Connect the internal Helmholtz calibration coil (9-pin D subminiature connector with filter unit on the RCM) to the 9-pin connector at the back of the breakout box on the RCM instrument rack. (Note: pins 1, 6 are the only active pins.)

L.4.4 Connect the Quantum Design (QD) SQUID cable. (The connector at the RCM end of the QD cable contains the preamplifier for the SQUID.) The SQUID cable should be connected to the right-hand SQUID plug-in module at the back of the controller box next to the module with the connectors labeled "analog out", and "level sensor".

L.4.5 Verify that the motor drive cable is disconnected and that the turns counting dial on the drive shaft housing reads ~005. Note: Turns counting dial advances 100 counts per revolution; it will read ~ 113 after one revolution, the extra counts accounting for backlash.

L.4.6 Turn on power to the SQUID controller.

L.5 SQUID set up and health check:

L.5.1 SQUID controller shows the status display for channel 1 on power-up. Push the **Setup: tune** button to access the tune function for channel 1.

L.5.2 If it is thought useful, the heater cycle may be used. Push the **+/-** button to specify a heat cycle as part of the tune sequence, then push either the **tune** or **enter** buttons to initiate the tune process. Verify that the display indicates a good tune. After tuning, the display will again show the status display for channel 1.

L.5.3 Press the **setup: config** button to access the configuration menu. Using the arrow buttons, move the arrow cursor to item 3, "Individual channel configuration", then press **enter** to configure channel 1**.** Again use the cursor arrow to go to the "select" option and by pressing the **incr** or **decr** buttons select "1 K" (1 kHz low pass filter).

L.5.4 While still viewing the channel 1 configuration menu, move the arrow cursor to the "range" option. Use the **incr** or **decr** buttons to select "5s". Note: The range roughly specifies the number of flux quanta full scale. The options are nominally ±5, ±50, ±500 ϕ_0 full scale (The 5s option is also 5 ϕ_0 full scale, but with a slow feedback to reduce the tendency to flux jump In response to impulsive noise.) In actuality, the number of full scale flux quanta is approximately 70% of these numbers. Since the maximum output voltage is ±5 V, these ranges represent ~0.7, 7, 70 ϕ_0/V.

L.5.5 Verify calibration of the CCS current source: calibration date:__________;
calibration due date:____________ QA:__________

L.5.6 Connect the constant current supply to jacks 1 and 6 of the breakout box.

L.5.7 Set the current pot to zero, select the 1 mA range, and turn on the constant current supply. A current of 100 µA (one turn) should produce a change of ~03.6 V at the SQUID output, assuming the 5 range, x1 gain. The output voltage is displayed at the top of the channel 1 configuration menu. Note: If it is desired to reset the SQUID so that the output is nulled for a given circumstance, this may be accomplished by navigating to the "reset" option in the channel 1 configuration menu and toggling the reset on and then off. Also note: <u>A calibration table can be found on the back of the constant current source.</u>

L.5.8 Verify that the pickup coil is properly oriented by manually dithering the current source and varying the coil orientation to achieve a maximum response. Note: To minimize the effect of hysteresis, always approach the final setting while proceeding in the positive direction.

L.5.9 Record the measured value of output voltage / calibration current:_________V/100 µA

Calibration note: The central field produced by the Helmholtz calibration coil is calculated to be 0.283 Gauss/Amp in free space and by numerically correcting for the shielding currents is found to be 0.278 G/A in a 10" shield (a 1.8% reduction).

Using this gauss/amp value, record the approximate magnetometer calibration factor: applied B field / output voltage = __________µG/V (range 5 / gain X10). Note: This result is to verify that the magnetometer is functioning properly. It should be within 10% of the value obtained in the dc Field Measurement Procedure (P0191), 0.718 µG/V, which will be used in this procedure.

L.5.10 Turn the current pot to zero and turn off and disconnect the current source.

L.6 Lock-in amplifier setup:

L.6.1 Turn on the lock-in amplifier and configure as indicated. (Note: NR denotes not relevant; AR denotes as required. The significant AR parameters will be recorded in the data table.)

L.6.1.1 Input / filters menu:

L.6.1.1.1 Source: A

L.6.1.1.2 Grounding: ground (either the Lock-in or the HP spectrum analyzer can be grounded)

L.6.1.1.3 Coupling: DC

L.6.1.1.4 Line notches: both

L.6.1.2 Ref / phase menu:

L.6.1.2.1 Ref. phase: 0.000 deg.

L.6.1.2.2 Ref. source: external

L.6.1.2.3 Ref. slope: [positive]

L.6.1.2.4 Harmonic #: 1

L.6.1.2.5 Sine output: NR

L.6.1.3 Gain / TC menu:

L.6.1.3.1 Sens.: AR

L.6.1.3.2 Reserve: max.

L.6.1.3.3 T.C.: AR

L.6.1.3.4 Filter: 24 dB/oct.

L.6.1.3.5 Synchonous: <200 Hz

L.6.1.4 Output / offset menu:

L.6.1.4.1 Front panel: CH 1

L.6.1.4.2 Source: R

L.6.1.4.3 Offset & expand: for X, Y, R: offset: 0.00%, expand 1.0

L.6.1.5 Trace / scan menu:

L.6.1.5.1 Trace 1: (X*1)/1; store

L.6.1.5.2 Trace 2: (Y*1)/1; store

L.6.1.5.3 Trace 3: (R*1)/1; store

L.6.1.5.4 Trace 4: (θ*1)/1; store

L.6.1.5.5 Sample rate: 0.5 Hz

L.6.1.5.5.1 Scan length 16000 (~4 hrs. 27 min)

L.6.1.5.6 1 shot / loop: loop

L.6.1.6 Initial Display / scale menu:

(Note: The Display / scale setup may be changed as required for various operations.)

L.6.1.6.1 Format: up/down

L.6.1.6.2 Monitor: settings

L.6.1.6.3 Display scale: For the top display:

L.6.1.6.3.1 Type: chart

L.6.1.6.3.2 Trace: 3

L.6.1.6.3.3 ±: AR

L.6.1.6.3.4 @: same as above so that the bottom of the chart is zero

L.6.1.6.4 Display scale: For the bottom display:

L.6.1.6.4.1 Type: Chart

L.6.1.6.4.2 Trace: 4

L.6.1.6.4.3 ±: 180

L.6.1.6.4.4 @: 0.0

L.6.2 Connect the Lock-in amplifier, SQUID magnetometer, Signal Analyzer, and Function Generator as shown in Fig. 3. If desired, connect the output of CH 1 of the Lock-in to one of the Soltec chart recorder channels with the gain set to 10 V f.s. The Signal Analyzer is useful for diagnostics (e.g. harmonic generation, signal / noise estimation) and for verifying the Lock-in results.

L.7 Initial measurement at the Gyro 1 position:

L.7.1 Turn on / verify turned on all electronics except the power supply. Reset the SQUID to eliminate dc offset.

L.7.2 Turn on the power supply and verify operation with the fluxgate as observed in L.3.11

NOTE:

Any significant dc offset from the SQUID is undesirable because it reduces dynamic reserve. Be sure to reset the SQUID before starting any measurements. If a flux jump occurs during a measurement, the SQUID should be reset and the settling process should be started over again.

L.7.3 Set the lock-in TC to 100 sec. or less and adjust the sensitivity to achieve a mid-scale reading. <u>Do not allow the input, output, or reserve overload annuciators to illuminate</u>. Adjust the SQUID gain, or Lock-in sensitivity as necessary to avoid overload.

L.7.4 Increase the lock-in TC to a level necessary to achieve a "signal-to-noise ratio" in excess of 3:1 or to the longest practicable duration (generally 10 ks). As a rough guide, a signal-to-noise of 3:1 or more will be such that the R trace virtually never goes to zero.

L.7.5 When a satisfactory setup has been found, enter the setup information into the first page of Table 1.

L.7.6 Wait for a settling time of at least 2.5 x TC. This will assure that the lock-in dc outputs are within 10% of their steady-state values. Using a chart recorder as suggested in L.6.2 is also useful to confirm that a steady-state condition has been reached.

L.7.7 After the settling period has elapsed, press the Pause/Reset control key twice (to clear the data buffers), and change the scan mode to one-shot (in the Trace / Scan menu). Press the Start/Cont control key and enter the data acquisition start time on the second page of Table 1. Wait for 4:30 hrs. for the trace buffers to be filled with approximately steady -state data. (This is the period of time to fill the data buffers with four traces of 16,000 points each. The amount of time needed to fill the data buffers is determined by the sampling rate on the Trace / Scan menu. <u>In the case of a relatively short TC, the sampling rate may be increased from the 0.5 Hz rate specified previously.</u>)

L.7.8 After the data buffers have been filled, the Done annunciator will light. Using the Active Display control key make Trace 4 (θ) the active display.

L.7.9 Using the Math menu key, select the Stats submenu and press the Do Stats soft key. Record the values of Δt and $\langle\theta\rangle$ in Table 1.

L.7.10 Return to the normal display and use the Display / Scan menu key to make the bottom display Trace 1. Using the Active Display control key, make the bottom display the active display. Using the Math menu key, select the Stats submenu and press the Do Stats soft key. Record the values of $\langle X\rangle$ and σ_X in Table 1.

L.7.11 Using the Disk menu key, select the the Save Data soft key. Enter a file name using the ALT key to activate the alternate keypad. Use the filename extension of ".XDA" to signify the X trace (Trace 1). Press the Data:Save softkey to save the active display and the machine setup parameters. (Do not save data as an ASCII file.) Use the Catalog On/Off key to verify that the file has been saved.

L.7.12 Return to the normal display and use the Display / Scan menu key to make the bottom display Trace 2 (Y). Make the bottom display the active display . Using the Math menu key, select the Stats submenu and press the Do Stats soft key. Record the value of ⟨Y⟩ in Table 1.

L.7.13 Using the Disk menu key, select the the Save Data soft key. Enter a file name using the ALT key to activate the alternate keypad. Use the filename extension of ".YDA" to signify the Y trace (Trace 2). Press the Data:Save softkey to save the active display and the machine setup parameters. Use the Catalog On/Off key to verify that the file has been saved.

L.7.14 Estimate the desired signal amplitude by calculating the expression $[\langle X\rangle^2 + \langle Y\rangle^2]^{1/2}$. In order to estimate the field attenuation, multiply this number by √2 (to change from rms to peak amplitude) and by 0.718 µG/V to convert to magnetic flux density, and finally divide by the amplitude of the external field, 0.25 G.

L.8 Attenuation frequency dependence and attenuation measurements at gyros 2-4

L.8.1 Repeat the above measurements (L.7.1-L.7.14) for ac field frequencies of 30, 10, 5 mHz.

L.8.2 Return the function generator frequency to 100 mHz, and turn off the power supply by switching the mode switch to the voltage mode.

L.8.3 Change vertical position to gyro 2 by repeating steps L.4.2.1-L.4.2.8.

L.8.4 Repeat the measurements in section L.4.2.1-L.4.2.8 with a frequency of 100 mHz.

L.8.5 Repeat the measurements in L.7.1-L.7.14 with a frequency of 5 mHz. Verify that the ratio of attenuations between 100 and 5 mHz is the same (to within 10%) as that that was obtained at the Gyro 1 position. If this does not turn out to be the case, repeat L.7.1-L.7.14 at 30 and 10 mHz to determine the highest frequency that reliably predicts the 5 mHz attenuation to within 10%.

L.8.6 Change vertical position to gyro 3 by repeating steps L.4.2.1-L.4.2.8.

L.8.7 Repeat L.7.1-L.7.14 at the frequency determined in L.8.5.

L.8.8 Change vertical position to gyro 4 by repeating steps L.4.2.1-L.4.2.8.

L.8.9 Repeat L.7.1-L.7.14 at the frequency determined in L.8.5.

L.9 Measurement of ac transverse field components at gyros 1-4:

L.9.1 Change vertical position to gyro 1 by repeating steps L.4.2.1-L.4.2.8.

L.9.2 Orient the RCM pickup coil to measure transverse fields:

L.9.2.1 Connect the constant current supply to jacks 1 and 6 of the breakout box.

L.9.2.2 Manually adjust the pickup coil orientation to approximately 90° (such that the coil is sensing the transverse field). While varying the current supply up and down, slowly adjust the coil orientation until no response is seen in the magnetometer. This will ensure that the pickup coil sensing direction is transverse to the RCM vertical axis.

L.9.2.3 Turn the current pot to zero and turn off and disconnect the current source.

L.9.3 Orient / verify oriented the RCM azimuth along the +X axis.

L.9.4 Repeat L.7.1-L.7.14 at the frequency determined in L.8.5. while sensing the +X component of the field.

L.9.5 If the previous step was not performed at 5 mHz, repeat L.8.1 (while sensing the +X component) for any frequencies listed which are below the frequency determined in L.8.5.

L.9.6 Change vertical position to gyro 2 by repeating steps L.4.2.1-L.4.2.8.

L.9.7 Repeat L.7.1-L.7.14 at the frequency determined in L.8.5. while sensing the +X component of the field.

L.9.8 If the previous step was not performed at 5 mHz, change the frequency to 5 mHz and repeat the measurement. If it is verified that the ratio of attenuations between the frequency determined in L.8.5. and 5 mHz is the same (to within 10%) as that that was obtained at the Gyro 1 position, then continue to use this frequency for all subsequent transverse ac field measurements. If this does not turn out to be the case, repeat L.9.5 to determine the highest frequency that reliably predicts the 5 mHz attenuation to within 10%.

L.9.9 Change vertical position to gyro 3 by repeating steps L.4.2.1-L.4.2.8.

L.9.10 Repeat L.7.1-L.7.14 at the frequency determined in L.9.8. while sensing the +X component of the field.

L.9.11 Change vertical position to gyro 4 by repeating steps L.4.2.1-L.4.2.8.

L.9.12 Repeat L.7.1-L.7.14 at the frequency determined in L.9.8. while sensing the +X component of the field.

L.9.13 Change vertical position to gyro 1 by repeating steps L.4.2.1-L.4.2.8.

L.9.14 Change the RCM azimuth to the +Y direction.

L.9.15 Repeat L.7.1-L.7.14 at the frequency determined in L.9.8. while sensing the +Y component of the field.

L.9.16 If the frequency used in L.9.15 was not 5 mHz, repeat L.7.1-L.7.14 at 5 mHz while sensing the +Y component of the field.

L.9.17 Change vertical position to gyro 2 by repeating steps L.4.2.1-L.4.2.8.

L.9.18 Repeat L.7.1-L.7.14 at the frequency determined in L.9.8. while sensing the +Y component of the field.

L.9.19 Change vertical position to gyro 3 by repeating steps L.4.2.1-L.4.2.8.

L.9.20 Repeat L.7.1-L.7.14 at the frequency determined in L.9.8. while sensing the +Y component of the field.

L.9.21 Change vertical position to gyro 4 by repeating steps L.4.2.1-L.4.2.8.

L.9.22 Repeat L.7.1-L.7.14 at the frequency determined in L.9.8. while sensing the +Y component of the field.

L.10 Termination of ac attenuation measurements

L.10.1 Review the data taken in the previous steps for plausibility.

L.10.2 Repeat any measurements that are questionable.

L.10.3 Copy all data files to a server. Data file name and directory path: ____

L.10.4 Shut down and disconnect all electronic instrumentation.

Test completed.

Completed by: ___________________
Witnessed by: ___________________
Date: ___________________
Time: ___________________

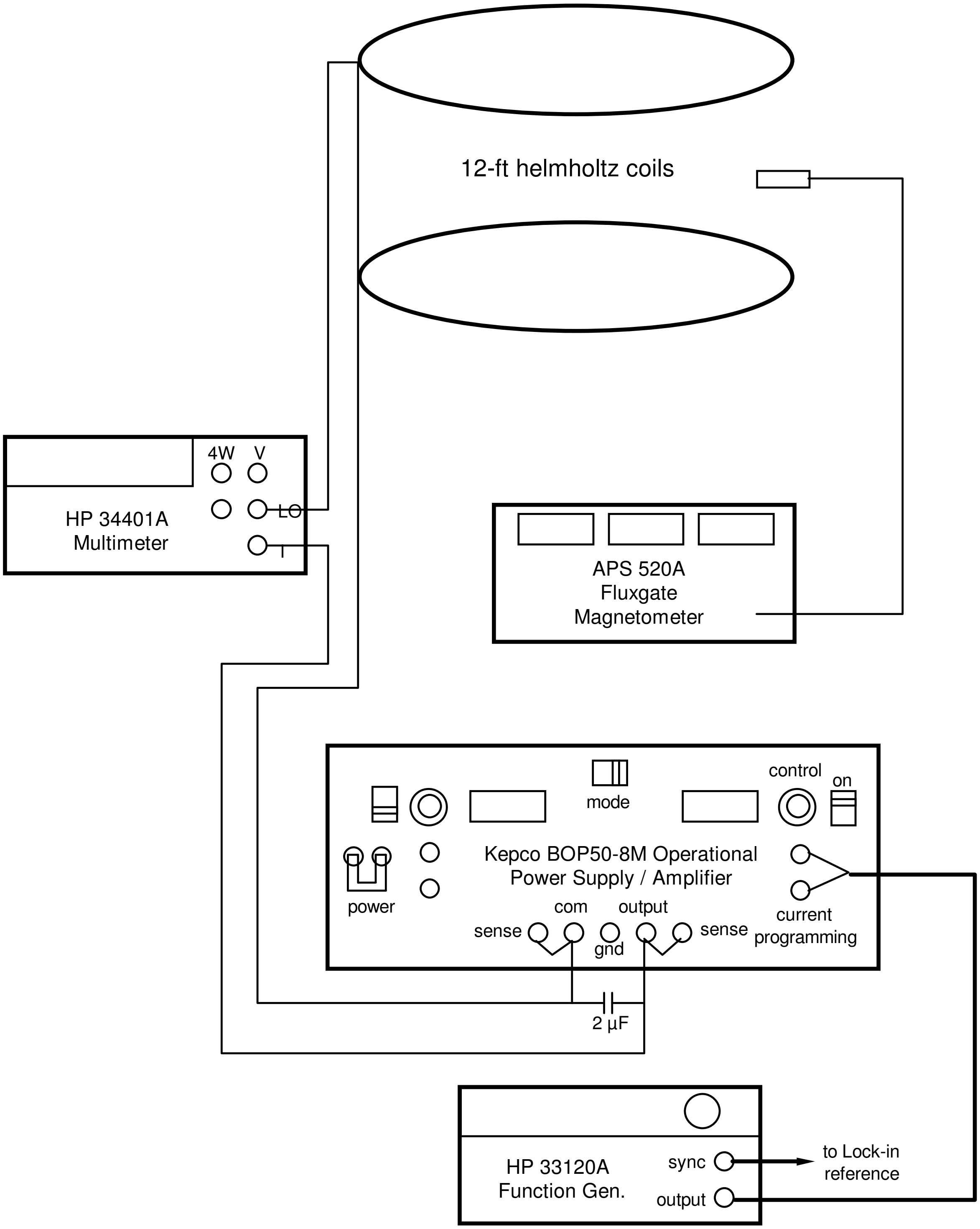

Fig. 1 Field Coil setup.

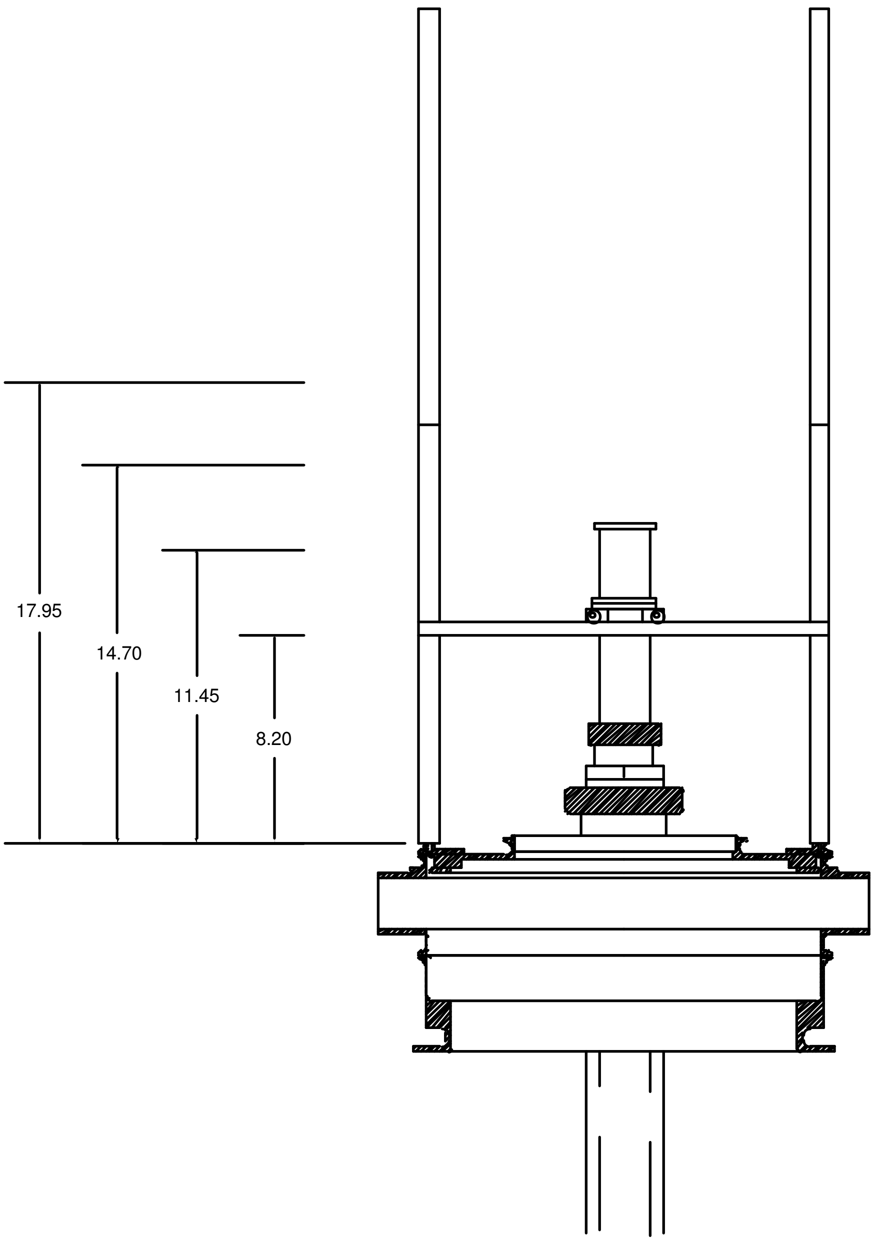

Fig. 2 RCM position reference. The dimensions shown are the height of the bottom of the cross brace above the split clamp ring. The highest position places the rotating coil at the position of gyro 1 (STA 153.3), the second position, gyro 2 (STA 150.1), third, gyro 3 (STA 146.8), and lowest, gyro 4 (STA 143.6).

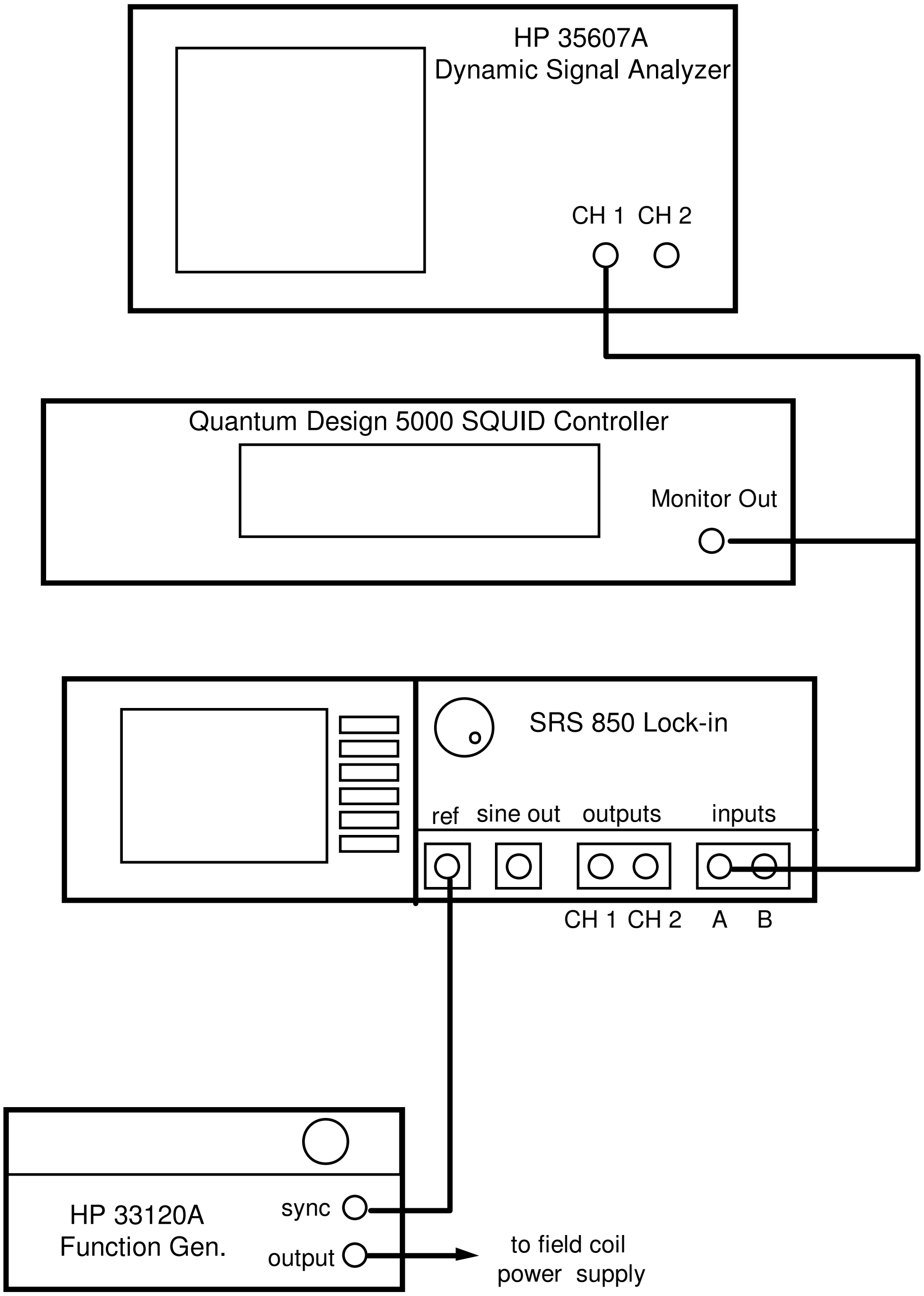

Fig. 3 Instrumentation block diagram.

Table 1

Setup parameters									
	Start of settling period		Oscillator	Magnetometer				Lock-in	
			frequency	coil location	coil sense	Range	Gain	sensitivity	time const.
Record No.	time	date	(mHz)	(STA No.)	(x,y,z)			(volts f.s.)	(sec)

Table 1 (cont'd)

Data Parameters								
Start data acquisition			Lock-in Data (stats from Math menu)					
			Δt	$\langle\theta\rangle$	$\langle X\rangle$	σ_X	$\langle Y\rangle$	
Rec. #	Time	Date	(sec)	(degr.)	(V)	(V)	(V)	Comments and datafile name*

* Omit the file name extension. The file names for all traces should be the same except for the file name extension: ".RDA" for the R trace, ".TDA" for the angle trace, ".XDA" for the X trace, and ".YDA" for the Y trace (optional).