

U.S. DEPARTMENT OF THE INTERIOR  
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**ABSOLUTE GRAVIMETRY IN ANTARCTICA: 1995 OBSERVATIONS  
AT MCMURDO STATION AND TERRA NOVA BAY STATION**

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Explanatory Text

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## **Absolute Gravimetry in Antarctica: 1995 Observations at McMurdo Station and Terra Nova Bay Station**

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*Abstract:* Between 11 November and 1 December, 1995, absolute gravity observations were conducted at McMurdo Station (S 77° 50' 49", E 166° 40' 5") and Terra Nova Bay (S 74° 41' 36", E 164° 5' 59"). The observed gravity value at 1 meter elevation above the station surface is  $9.829727596 \pm (2.1 \times 10^{-8}) \text{ ms}^{-2}$  for McMurdo Station; the observed local vertical gravity gradient is  $3.28 \pm 0.03 \text{ } \mu\text{Gal cm}^{-1}$ . The observed gravity value at Terra Nova Bay is  $9.828656429 \pm (2.1 \times 10^{-8}) \text{ ms}^{-2}$ ; the measured vertical gravity gradient is  $3.12 \pm 0.03 \text{ } \mu\text{Gal cm}^{-1}$ .

### **Introduction**

The FG5/102 system was deployed to Antarctica in the fall of 1995 in order to establish new high accuracy absolute gravity measurements in the Antarctic continent. Primary goals included the determination of the local geoid and ellipsoid separation, as well as providing absolute values for gravity base stations; future studies of tectonic motion and other high precision geodetic studies will also benefit from the experiences of this experiment. The program is a cooperative research venture between the National Oceanic and Atmospheric Administration/National Ocean Service/Geosciences Laboratory and the United States Geological Survey/National Mapping Discipline. USGS acted as the principal investigator during this experiment; funding was provided by the National Science Foundation under the United States Antarctic Program.

Relative gravity measurements have long been conducted in the Antarctic continent as a key component of geophysical and geodetic research. However, laser interferometric absolute gravimeters have been introduced quite recently. The reports of previous expeditions may be

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found in Nakagawa and others (1994). To the best of our knowledge, this is the first American deployment of modern absolute gravimeters in Antarctica.

## **Equipment Utilized**

The absolute gravimeter used is the FG5/102 system with a WEO iodine laser, serial number 112. Data collection software used is the NOAA variant OLIVE41, with modification for DAS-8 data acquisition software. The system is based at the GeoSciences Laboratory-Table Mountain Gravity Observatory (TMGO) in Colorado. Instrument design details and an error budget are found in Niebauer and others (1995) and in the Sasagawa and others (1995) report on the observed instrument repeatability.

Vertical gravity gradient and station transfer observations were collected with a LaCoste-Romberg relative gravimeter (unit D-17), utilizing analog electrostatic feedback to null the gravimeter beam. A TurboRouge GPS receiver was used to determine preliminary site coordinates. The first author served as the principal operator of the gravity equipment.

Equipment transport from the United States was handled through the National Science Foundation's U.S. Antarctic Program (USAP). The system was deployed at Godley Head, New Zealand, prior to air shipment to McMurdo Station. This measurement served as a instrument performance test and additionally provided base station data for the New Zealand Department of Survey and Land Information. Details of the Godley Head observations may be found in a technical report which can be obtained from the first author.

## **Observation Sequence**

Upon arrival in Antarctica, the FG5 system was unpacked and assessed in the Crary Science and Engineering Center (CSEC), McMurdo Station. No anomalies were uncovered; the SuperSpring seismic isolator required adjustment to account for the expected high gravity level (nominally  $9.82 \text{ ms}^{-2}$ ). The chosen site, Building 58 (the "Gravity Hut"), required modification to accommodate the FG5 system. The site electrical power was re-connected and an additional pier was installed to fit the FG5 instrument footprint; all work was conducted by Antarctic Support Associates (ASA) support personnel.

The FG5 system was moved to Building 58 on 4 November 1995 and set up over the monument, labeled "SATGRAV". Due to site constraints, the observation is offset from the mark center by 3.7 cm. The building is quite small and space for the instrument and operator was limited; however, initial setup and measurements proceeded nominally.

During the night of 4 November 1995, the building electrical heater controller failed; the heaters did not cycle off and the ambient temperature approached  $41^\circ \text{C}$ . This thermal excursion caused the dropping chamber servo system to fail, initiating its fail-safe mode. The computer system locked up and the vacuum chamber pressure was extremely high due to outgassing. The

iodine laser uses Peltier thermoelectric elements to thermally control the gain cavity; these elements saturated and the laser frequency lock failed. The system was allowed to cool slowly for the next 12 hours and all systems returned to normal operation. Measurements then proceeded normally.

Except for the previously mentioned problem, all measurements proceeded well. Difficulty was encountered in maintaining the beam vertical; this is suspected to be caused by thermal distortions of the optical mounts as the system attained temperature equilibrium. The FG5 system experienced large temperature changes during transport from the CSEC, and the previously mentioned building heater failure. The scatter of the measured gravity values were quite low, despite the proximity of the vehicle shop, automotive traffic, and the helicopter pad.

Upon observation completion, the system was repacked and prepared for the next station. On 10 November 1995, the system and operator were transported via Twin Otter to Terra Nova Bay Station, managed by the Italian Antarctic Program. It was hoped that the FG5 could occupy the absolute gravity station using the station code IRGS stamped on the mark that was established by Ceruti and others (1992); however, the pier size was too small for the FS5 system and modifications could not be accomplished in the time allotted. A second absolute gravity station was established in the vehicle hanger bay. The building itself is set on a substantial concrete floor poured onto bedrock. Observations and setup proceeded normally, with a short interruption due to a station AC power failure. Relative gravity ties were also established between the new station of the International Absolute Gravity Base Station Network (IAGBN) and the previously established IRGS Monument.

Measurements were also attempted in Bull Pass, in the Dry Valleys (S 77° 31' 3", E 161° 51' 6"). The measurement was conducted on a rock outcrop, with a Scott polar tent for cover. A number of equipment failures were encountered, including failure of the computer disk drive controller, dropper servo anomalies, and failure of the iodine laser frequency lock; the last item proved to be the most critical. The tent walls flapped in the wind and generated acoustic noise and large air pressure changes which perturbed the Invar cavity. The laser cavity length must be maintained to within a small fraction of the optical wavelength if the servo is to work. At this point, it was decided to abort this measurement.

Upon return to McMurdo Station, the FG5/102 system was repaired and set up again at the SatGrav site, for an observation conducted on 1 December 1995. All operations were nominal. After the observations were completed, the computer experienced a catastrophic power supply failure; fortunately, no data was lost. The system was shipped back to the United States. Measurements at TMGO during January 1996 showed no unusual shifts or changes in the instrument from its last measurement in Colorado.

## **Analysis and Results**

The results of the two McMurdo occupations (11 November 1995 and 1 December 1995) are  $9.82\ 972\ 759\ 9 \pm (2.1 \times 10^{-8})\ \text{ms}^{-2}$  and  $9.79\ 972\ 758\ 0 \pm (2.2 \times 10^{-8})$  respectively, at a datum height

of 1 meter above the monument surface. The agreement between the two occupations, separated by 3 weeks, is  $1.9 \pm 3.0 \mu\text{Gal}$ . The average standard deviation of the gravity values is of order  $10 \mu\text{Gal}$ ; this is an indication of an exceptionally quiet site. Given these conditions, it is expected that the McMurdo site can serve as a very stable gravity base station. McMurdo Station is located on Ross Island and much of the exposed surface is volcanic cinder; such material is generally considered unstable for high precision geodetic stations. The subsurface, however, is frozen fast. Whether or not the monument itself is stable will require future observations over extended periods of time.

Nakagawa and others (1983) describe relative gravity transfers to McMurdo station as part of a refinement of the International Gravity Standardization Net (IGSN71). The transferred gravity value was  $9.82\,973\,381 \text{ ms}^{-2}$  at the level of the floor, with presumed uncertainty of order  $30 \mu\text{Gal}$ . The FG5/102 absolute gravity measurement, transferred to the floor, is  $9.82\,973\,087 \text{ ms}^{-2}$ . All Lacoste-Romerg G-meter observations done in Antarctica are at the extreme ends of the instrument range and thus scale factor calibration and non-linearity problems tend to dominate. The discrepancy should not be considered as indicative of a problem; indeed, Nakagawa and others (1983) recommend that absolute observations be conducted in Antarctica.

Observations at Terra Nova Bay on 13 November 1995 yielded a gravity value of  $9.82\,865\,642\,9 \pm (2.1 \times 10^{-8}) \text{ ms}^{-2}$  at a height of 1 meter above the floor. Again, the average standard deviations were of order  $10 \mu\text{Gal}$ . The gravity time series exhibited large tidal frequency signals due to unmodelled ocean loading terms. The ocean loading perturbation phasor amplitudes for K1 and O1 were empirically adjusted to minimize these signals; the original and adjusted phasor parameters are listed in Table 1. A more rigorous analysis, utilizing satellite altimetry data, will be conducted.

Sasagawa and others (1995) and Niebauer and others (1995) describe the post-processing procedures used and the uncertainly estimate for the measurements. For the purposes of this report, the uncertainty estimate can be described as having several components: an instrumental error assessment ( $1.6 \mu\text{Gal}$ ), uncertainties in modelling time varying gravity signals such as tides and ocean loading contributions ( $1.5 \mu\text{Gal}$ ), uncertainties in transferring the results from the observation level of 1.3 m to a standard datum level of 1 m ( $1 \mu\text{Gal}$ ), and the formal statistical error of the data set itself (of order  $0.2 \mu\text{Gal}$ ). These components are assumed to act as independent uncorrelated random variables, and the finally uncertainty estimate is the square root of the sum of the squares of the individual components.

The gravity difference between the Terra Nova Bay AB site and the IRGS site was also measured, with an observed gravity difference of  $-2040.9 \pm 12.4 \mu\text{Gal}$  and a transferred absolute value of  $9.82\,863\,914 \pm (13 \times 10^{-8}) \text{ ms}^{-2}$ . In comparison, the transferred value of Ceruti and others (1992) estimates an IRGS absolute value of  $9.82\,863\,890 \pm (33 \times 10^{-8}) \text{ ms}^{-2}$ ; the two estimates are in statistical agreement. The Italian expedition also performed a tie between the IRGS site and the Scott Base gravity mark, Gravity Station Scott Base 1 (GSSB). The absolute gravity value at Scott Base, as transferred from IRGS, is  $9.82\,976\,860 \pm (51 \times 10^{-8}) \text{ ms}^{-2}$ . A relative tie between the McMurdo SatGrav site was also performed to GSSB on 4 December

1995; the transferred absolute gravity value is  $9.82\ 977\ 007 \pm (7 \times 10^{-8})\ \text{ms}^{-2}$ . The discrepancy is  $47 \pm 51\ \mu\text{Gal}$ , within the measurement uncertainty limits. This recent estimate of the GSSB gravity value should be more accurate, because the relative tie performed is smaller in both range and duration. The relative data as a whole provides confirmation (but not validation) of the absolute results, albeit at a significantly lower level of precision.

The Bull Pass attempt was disappointing. It should be noted that the first two sites were in established camps, inside permanent structures. The FG5 system encountered multiple failures, of which the laser problems were the most crucial. If the attempt were to be repeated, a more substantial shelter or a more robust gravimeter design are required. As for the laser itself, its frequency stabilization method is inherently fragile due to the nature of the absorption lines used. New experimental laser designs utilize diode lasers which lock on slightly different wavelengths, which allows use of iodine transitions with greater absorption and consequently higher signal to noise ratios. In turn, such single pass, modulation free transfer spectroscopy systems should be more robust.

A reconnaissance observation and relative gravity reading at Cape Roberts was also conducted (S  $77^\circ\ 2'\ 77''$ , E  $163^\circ\ 10'\ 45''$ ). This site proved to be adequate for future absolute observations planned for the 1997 field season. A major crustal drilling effort at the site should be helpful in providing support facilities; however, any absolute gravity observations should avoid periods in which vibrations from active drilling would increase the observed noise levels.

Single tie relative observations were also conducted between Cape Roberts and McMurdo and Bull Pass and McMurdo; helicopter flight constraints precluded multiple observations. The transferred absolute results are thus far from optimum. The estimated absolute gravity value at Cape Roberts is  $9.82\ 905\ 904 \pm (19 \times 10^{-8})\ \text{ms}^{-2}$ ; the value at Bull Pass is  $9.82\ 802\ 779 \pm (50 \times 10^{-8})\ \text{ms}^{-2}$ . The uncertainty estimates should be considered highly optimistic and the values themselves are of unknown reliability.

Given accuracy and precision estimates of order  $2\ \mu\text{Gal}$ , future re-occupations of these sites will be capable of detecting sub-centimeter vertical deformation. The correlation between gravity changes and vertical deformation depend critically upon the dynamics of the relevant deformation process. However, the ratio of gravity to elevation change is typically of the same magnitude as the free air gradient,  $-3.08\ \mu\text{Gal}\ \text{cm}^{-1}$ . Thus,  $2\ \mu\text{Gal}$  measurements are commensurate with 6 mm precision in detecting vertical motion. Again, the deformation process itself is crucial to determining this ratio. Combined gravity and geometric measurements, such as GPS, provide an optimum means to resolve deformation processes and to robustly detect vertical motions.

## Conclusions

Absolute gravity measurements at McMurdo Station and Terra Nova Bay proved to be successful, with estimated accuracies of order  $\pm 2 \mu\text{Gal}$ . The FG5 system performed as expected; repeat measurements at McMurdo and at TMGO show no instrument offsets or anomalies. Relative observations also agreed with the absolute results. Observations in the Dry Valleys could not be accomplished, due to instrument limitations and a tent design that, while a proven Antarctic field shelter, could not adequately protect the instrument.

As with all Antarctic operations, logistical concerns are paramount. The FG5/102 system performed well under most of the conditions encountered. Instrument and support system improvements will be needed to overcome field operations limits. Further, the overall size and weight of the system did place significant burdens on antarctic transport and support systems. New absolute gravimeter designs are being developed which should be significantly more robust and smaller. In turn, the logistical burdens of future deployments should be reduced.

These first epoch measurements provide valuable geodetic information on the geoidellipsoid separation, as well as highly accurate base station data for relative gravimeter networks. Future reoccupations with absolute instruments of similar or superior accuracy will also allow the detection of  $\mu\text{Gal}$  level gravity changes and/or vertical changes of order 6 mm. Applications of such results include detection of sea level change, tectonic motion, volcanic processes, and visco-elastic deformation due to time varying ice load history.

## Attachments

Field Notes  
Site Sketch  
Set Processing Log  
Time Series Plot  
Relative Gravimeter Data and Post Processing  
Processed Data - DOS 3.5" diskette

## References

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## Appendix 1 - Event Log

- 28 Sep 1995: FG5/102 shipped from Boulder to Port Hueneme
- 14-20 Oct 1995: Sasagawa arrives in Christchurch; measurements with DoSLI initiated.
- 20 Oct 1995: FG5/102 returned to USAP staging yard for shipment to McMurdo.
- 24 Oct 1995: Mullins, Meunier, Sasagawa depart on USN Flight XD-07 for McMurdo.
- 25 Oct 1995: Arrive MCM at 0200L. FG5/102 en-route.
- 26 Oct 1995: Awaiting FG5/102 shipment. Examine site, Bldg 58, and request that electrical power be restored.
- 27 Oct 1995: Mullins, Sasagawa attend mandatory snowcraft survival school.
- 28 Oct 1995: FG5/102 arrives at McMurdo.
- 29 Oct 1995: Set up and pump down FG5/102. Test accessible subsystems.
- 30 Oct 1995: Full up test of FG5/102 in CSEC. Noisy data but no unexpected behavior. Superspring coarse adjustment screw reset. Submit work request for Bldg. 58 mods to accommodate FG5 — pier is too small.
- 3 Nov 1995: Perform vertical gradient measurements at SatGrav site.
- 4 Nov 1995: Move FG5 to SatGrav site. Begin setup and instrument operation,
- 5 Nov 1995: Heater failed in "on" position at 0200L, causing system to fail. System shut down and allowed to cool. All systems came back on line. Note that thermal beam steering or perhaps pier tilt (unlikely) continued for up to 12 hours after cooldown.
- 6 Nov 1995: Normal operations, no anomalies detected. One seismic event was recorded, possibly a 6.3 Mb event in Sumatra.
- 7 Nov 1995: Normal operations. Initiated a flight request to Terra Nova Bay.
- 8 Nov 1995: Shut down at 1300L. Move system back to CSEC.
- 9 Nov 1995: Gradient Measurements, all day.
- 10 Nov 1995: Flight to TNB rescheduled — weather poor.
- 13 Nov 1995: Aircraft departs 0945L, arrive TNB 1130L. Find IAGS site is unsuitable due to pier size. Setup in Hanger bay, south side. Normal setup.
- 14 Nov 1995: Normal operations. Conducting tie from offset point to IRGS station. 15
- 15 Nov 1995: Normal operations. Dropper servo required adjustments twice to both velocity servo lead and sphere gain and damping. Suspect colder operating temperatures.
- 16 Nov 1995: Main electrical power failure at 0805L. Restored in 15 minutes. Normal operations otherwise.
- 17 Nov 1995: Shutdown absolute observations at 0830L. Normal operations. Conduct vertical gradient measurements between ground level/130 cm and ground level/100 cm.
- 18 Nov 1995: Helicopter flight back to McMurdo, arrive 1600L.
- 19 Nov 1995: Prepare for Bull Pass.
- 22 Nov 1995: Depart for Bull Pass site via helicopter. Arrive at site and begin site prep and instrument setup. Multiple failures encountered.
- 23 Nov 1995: Continue to diagnose multiple failures, decide to abandon the site and repair

the instrument.

24 Nov 1995: Return to McMurdo Station.

25-28 Nov 1995: Repairs conducted on FG5/102 system.

29 Nov 1995: Repairs completed, tests run in CSEC.

1 Dec 1995: Repeat occupation at SatGrav site.

2 Dec 1995: Continue observations.

3 Dec 1995: Complete observations.

4 Dec 1995: Reconnaissance flight to Cape Roberts station.

5 Dec 1995: Relative ties conducted to Scott Base gravity base station.

6 Dec 1995: Pack FG5/102 for return shipment.

12 Dec 1995: Personnel depart for Christchurch, New Zealand.

**Appendix 2 - Ocean Loading Parameters**

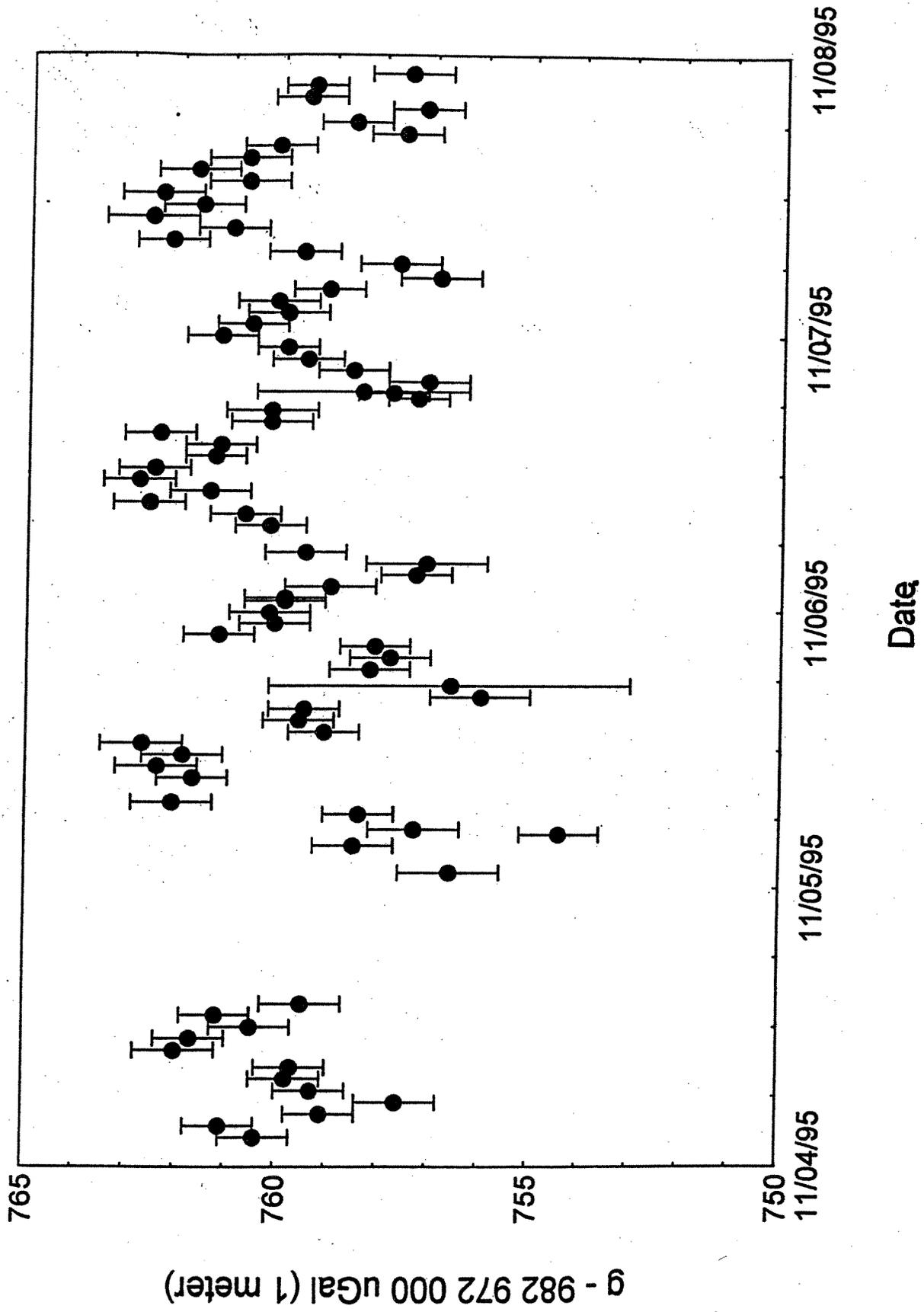
**McMurdo SatGrav Ocean Loading Perturbation Phasors**

| Tidal Component | Schwiderski Model |             |
|-----------------|-------------------|-------------|
|                 | Amplitude         | Local Phase |
|                 | $\mu\text{Gal}$   | Degrees     |
| M2              | 0.70              | 76.576      |
| S2              | 0.70              | 33.267      |
| K1              | 3.4               | 347.0       |
| O1              | 2.0               | 336.088     |
| N2              | 0.4               | 64.331      |
| P1              | 0.4               | 347.178     |
| K2              | 0.2               | 15.149      |
| Q1              | 0.2               | 327.402     |

**Terra Nova Bay Ocean Loading Perturbation Phasors**

| Tidal Component | Computed Schwiderski Ocean Loading Model |             | Modified Ocean loading Model |
|-----------------|--|-------------|------------------------------|
|                 | Amplitude                                | Local Phase | Amplitude                    |
|                 | $\mu\text{Gal}$                          | Degrees     | $\mu\text{Gal}$              |
| M2              | 0.51                                     | 49.09       | 0.51                         |
| S2              | 0.543                                    | 21.06       | 0.543                        |
| K1              | 2.101                                    | 336.0       | 1.1                          |
| O1              | 1.705                                    | 329.0       | 0.7                          |
| N2              | 0.304                                    | 51.43       | 0.304                        |
| P1              | 0.307                                    | 333.05      | 0.307                        |
| K2              | 0.205                                    | 14.04       | 0.205                        |
| Q1              | 0.109                                    | 353.33      | 0.109                        |

# McMurdo SatGrav



cmurdo\_satgrav\_95/11/04

Location --- McMurdo/Antarctica

LAT: -77-50-49  
LON: 193-19-55  
LEV.: 30.0 m

Instrument used: FG5-102i

Observed gradient : 3.280 +/- .030 uGal/cm  
Observation height : 132.26 cm

System response correction (avg) : -0.9 uGal  
Solar motion correction : -0.1 uGal  
Water table correction : 0.0 uGal  
User temperature correction : 0.0 uGal  
User drift correction : 0.0 uGal  
Miscellaneous corrections : 0.0 uGal

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SET SUMMARY  
GRAVITY IS FULLY CORRECTED AND TRANSFERED TO 1 METER

| ST | MODE | DROPS | TIMETAG      | GRAVITY     | ST ERROR | LS TIDE | ATM  | OL   |
|----|------|-------|--------------|-------------|----------|---------|------|------|
| 1  | I    | 109   | 951104022715 | 982972760.4 | 0.7      | -71.1   | -9.6 | 1.6  |
| 2  | I    | 110   | 951104032715 | 982972761.1 | 0.7      | -75.6   | -9.7 | 0.8  |
| 3  | I    | 109   | 951104042715 | 982972759.1 | 0.7      | -79.9   | -9.6 | 0.0  |
| 4  | I    | 110   | 951104052715 | 982972757.6 | 0.8      | -83.4   | -9.6 | -0.6 |
| 5  | I    | 110   | 951104062715 | 982972759.3 | 0.7      | -85.8   | -9.6 | -0.9 |
| 6  | I    | 109   | 951104072715 | 982972759.8 | 0.7      | -87.2   | -9.6 | -1.0 |
| 7  | I    | 110   | 951104082715 | 982972759.7 | 0.7      | -87.9   | -9.5 | -0.8 |
| 8  | I    | 104   | 951104095715 | 982972762.0 | 0.8      | -88.3   | -9.4 | -0.4 |
| 9  | I    | 109   | 951104105715 | 982972761.7 | 0.7      | -88.7   | -9.3 | -0.3 |
| 10 | I    | 104   | 951104115715 | 982972760.5 | 0.8      | -89.4   | -9.3 | -0.3 |
| 11 | I    | 108   | 951104125715 | 982972761.2 | 0.7      | -90.1   | -9.5 | -0.6 |
| 12 | I    | 107   | 951104135715 | 982972759.5 | 0.8      | -90.4   | -9.5 | -1.0 |
| 13 | I    | 110   | 951105011715 | 982972756.6 | 1.0      | -60.6   | -9.5 | 2.2  |
| 14 | I    | 103   | 951105033715 | 982972758.5 | 0.8      | -68.4   | -9.5 | 0.8  |
| 15 | I    | 107   | 951105043715 | 982972754.4 | 0.8      | -74.3   | -9.4 | -0.3 |
| 16 | I    | 107   | 951105050215 | 982972757.3 | 0.9      | -81.4   | -9.5 | -1.4 |
| 17 | I    | 105   | 951105062215 | 982972758.4 | 0.7      | -85.8   | -9.6 | -1.9 |
| 18 | I    | 109   | 951105072215 | 982972762.1 | 0.8      | -87.6   | -9.6 | -1.9 |
| 19 | I    | 109   | 951105093215 | 982972761.7 | 0.7      | -88.6   | -9.6 | -1.6 |
| 20 | I    | 109   | 951105103215 | 982972762.4 | 0.8      | -88.9   | -9.6 | -1.2 |
| 21 | I    | 110   | 951105113215 | 982972761.9 | 0.8      | -89.0   | -9.6 | -0.9 |
| 22 | I    | 109   | 951105123215 | 982972762.7 | 0.8      | -89.1   | -9.6 | -0.9 |
| 23 | I    | 110   | 951105133215 | 982972759.1 | 0.7      | -89.1   | -9.6 | -1.0 |
| 24 | I    | 109   | 951105143215 | 982972759.6 | 0.7      | -88.5   | -9.7 | -1.2 |
| 25 | I    | 110   | 951105153215 | 982972759.5 | 0.7      | -87.0   | -9.6 | -1.5 |
| 26 | I    | 107   | 951105163215 | 982972756.0 | 1.0      | -84.0   | -9.7 | -1.6 |
| 27 | I    | 105   | 951105173215 | 982972756.6 | 3.6      | -79.5   | -9.7 | -1.4 |
| 28 | I    | 108   | 951105185715 | 982972758.2 | 0.8      | -70.6   | -9.7 | -0.4 |
| 29 | I    | 110   | 951105195715 | 982972757.8 | 0.8      | -63.3   | -9.7 | 0.6  |
| 30 | I    | 108   | 951105205715 | 982972758.1 | 0.7      | -55.9   | -9.6 | 1.7  |
| 31 | I    | 109   | 951105215715 | 982972761.2 | 0.7      | -49.6   | -9.5 | 2.8  |

|    |   |     |              |             |     |       |      |      |
|----|---|-----|--------------|-------------|-----|-------|------|------|
| 32 | I | 110 | 951105225715 | 982972760.1 | 0.7 | -45.2 | -9.2 | 3.5  |
| 33 | I | 110 | 951105235715 | 982972760.2 | 0.8 | -43.4 | -9.2 | 4.0  |
| 34 | I | 109 | 951106005715 | 982972759.9 | 0.8 | -44.3 | -9.2 | 3.9  |
| 35 | I | 109 | 951106011215 | 982972759.9 | 0.8 | -49.1 | -9.2 | 2.9  |
| 36 | I | 109 | 951106021215 | 982972759.0 | 0.9 | -55.2 | -9.1 | 1.8  |
| 37 | I | 109 | 951106031215 | 982972757.3 | 0.7 | -62.2 | -9.1 | 0.4  |
| 38 | I | 108 | 951106041215 | 982972757.1 | 1.2 | -69.3 | -9.1 | -0.8 |
| 39 | I | 106 | 951106051215 | 982972759.5 | 0.8 | -75.5 | -9.0 | -1.9 |
| 40 | I | 110 | 951106073415 | 982972760.2 | 0.7 | -82.0 | -9.0 | -2.6 |
| 41 | I | 107 | 951106083415 | 982972760.7 | 0.7 | -85.0 | -8.9 | -2.7 |
| 42 | I | 110 | 951106093415 | 982972762.6 | 0.7 | -86.7 | -8.8 | -2.6 |
| 43 | I | 110 | 951106103415 | 982972761.4 | 0.8 | -87.5 | -8.9 | -2.2 |
| 44 | I | 110 | 951106113415 | 982972762.8 | 0.7 | -87.7 | -8.8 | -1.8 |
| 45 | I | 110 | 951106123415 | 982972762.5 | 0.7 | -87.6 | -8.8 | -1.5 |
| 46 | I | 110 | 951106133415 | 982972761.3 | 0.6 | -87.3 | -8.6 | -1.5 |
| 47 | I | 110 | 951106143415 | 982972761.2 | 0.7 | -86.4 | -8.6 | -1.5 |
| 48 | I | 109 | 951106153415 | 982972762.4 | 0.7 | -84.6 | -8.6 | -1.5 |
| 49 | I | 110 | 951106163415 | 982972760.2 | 0.8 | -81.5 | -8.5 | -1.4 |
| 50 | I | 110 | 951106173415 | 982972760.2 | 0.9 | -76.9 | -8.4 | -1.1 |
| 51 | I | 109 | 951106183415 | 982972757.3 | 0.6 | -70.6 | -8.4 | -0.5 |
| 52 | I | 14  | 951106191015 | 982972758.4 | 2.1 | -66.2 | -8.3 | 0.0  |
| 53 | I | 110 | 951106190215 | 982972757.8 | 0.7 | -59.2 | -8.3 | 0.9  |
| 54 | I | 109 | 951106200215 | 982972757.1 | 0.8 | -51.1 | -8.3 | 2.1  |
| 55 | I | 109 | 951106210215 | 982972758.6 | 0.7 | -43.8 | -8.3 | 3.3  |
| 56 | I | 110 | 951106220215 | 982972759.5 | 0.7 | -38.3 | -8.2 | 4.2  |
| 57 | I | 110 | 951106230215 | 982972759.9 | 0.6 | -35.2 | -8.1 | 4.6  |
| 58 | I | 109 | 951107000215 | 982972761.2 | 0.7 | -35.1 | -8.0 | 4.5  |
| 59 | I | 110 | 951107010215 | 982972760.6 | 0.7 | -37.9 | -8.1 | 3.9  |
| 60 | I | 110 | 951107020215 | 982972759.9 | 0.8 | -43.2 | -8.0 | 2.7  |
| 61 | I | 109 | 951107030215 | 982972760.1 | 0.8 | -50.3 | -7.9 | 1.3  |
| 62 | I | 110 | 951107040215 | 982972759.1 | 0.7 | -58.1 | -7.9 | -0.2 |
| 63 | I | 110 | 951107050215 | 982972756.9 | 0.8 | -65.7 | -7.9 | -1.6 |
| 64 | I | 109 | 951107061315 | 982972757.7 | 0.8 | -73.5 | -7.8 | -2.8 |
| 65 | I | 110 | 951107071315 | 982972759.6 | 0.7 | -78.6 | -7.8 | -3.4 |
| 66 | I | 109 | 951107081315 | 982972762.2 | 0.7 | -82.0 | -7.8 | -3.5 |
| 67 | I | 110 | 951107091315 | 982972761.0 | 0.7 | -84.0 | -7.9 | -3.3 |
| 68 | I | 110 | 951107101315 | 982972762.6 | 0.9 | -85.2 | -8.0 | -2.9 |
| 69 | I | 110 | 951107111315 | 982972761.6 | 0.8 | -85.5 | -8.1 | -2.5 |
| 70 | I | 110 | 951107121315 | 982972762.4 | 0.8 | -85.3 | -8.1 | -2.2 |
| 71 | I | 105 | 951107131315 | 982972760.7 | 0.8 | -84.6 | -8.1 | -1.9 |
| 72 | I | 110 | 951107141315 | 982972761.7 | 0.8 | -83.2 | -8.2 | -1.8 |
| 73 | I | 110 | 951107151315 | 982972760.7 | 0.8 | -80.7 | -8.2 | -1.6 |
| 74 | I | 109 | 951107161315 | 982972760.1 | 0.7 | -76.9 | -8.2 | -1.2 |
| 75 | I | 110 | 951107171315 | 982972757.6 | 0.7 | -71.4 | -8.2 | -0.7 |
| 76 | I | 109 | 951107181315 | 982972758.6 | 0.7 | -64.2 | -8.3 | 0.2  |
| 77 | I | 110 | 951107192215 | 982972757.2 | 0.7 | -54.8 | -8.3 | 1.5  |
| 78 | I | 108 | 951107202215 | 982972759.5 | 0.7 | -46.2 | -8.3 | 2.7  |
| 79 | I | 110 | 951107212215 | 982972759.4 | 0.6 | -38.5 | -8.4 | 3.9  |
| 80 | I | 109 | 951107222215 | 982972757.5 | 0.8 | -32.4 | -8.5 | 4.8  |

---

MEANS (weighted g)                      982972759.9                      0.8                      -71.7                      -8.9                      -0.1

---

standard deviation of the set mean values : 1.9 uGal  
total number of drops used . . . . . : 8616 drops  
separation of laser modes ( red - blue ) : NA

ERROR SOURCES:

|                            |   |          |
|----------------------------|---|----------|
| data scatter (se) . . .    | : | 0.2 uGal |
| instrument error budget    | : | 1.6 uGal |
| environmental models .     | : | 1.5 uGal |
| vertical transfer . . .    | : | 1.0 uGal |
|                            |   | -----    |
| occupation RMS error . . . | : | 2.1 uGal |

reason for misc. corr. ---

comments:

( 162 pts ) ( t0 = 34ms ) Processed on 1/11/96.

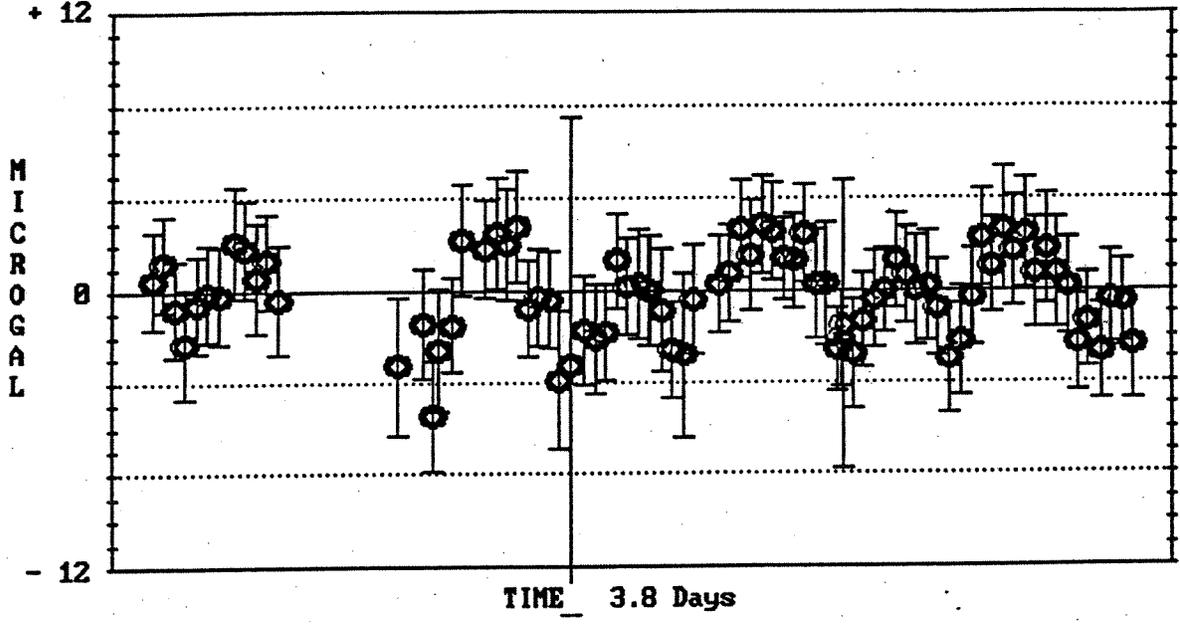
#####

McMurdo\_Satgrav\_95/11/84

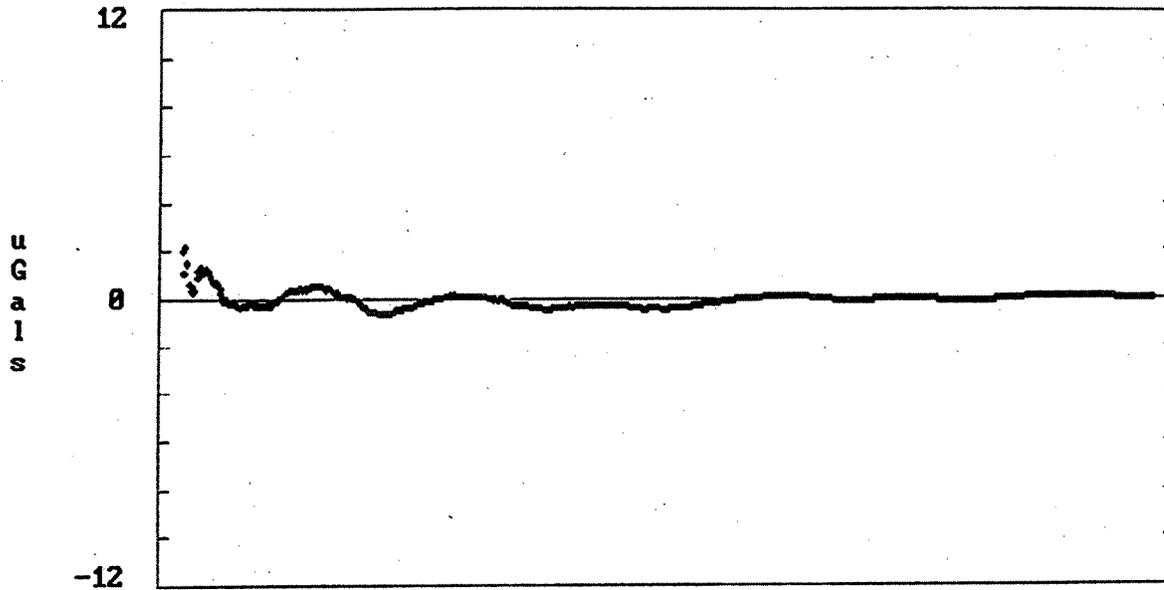
Gravity Average = 982972759.9

● RED MODE

⊙ BLUE MODE



DROP RUNNING AVERAGE  
mcsg1



total ( 8610 drops )

PM = -0.1  
HT = 132.26

Station: *Mc56 - McMurdo Sat Env*

Lat: *77.847 S* Elev: *3012.1*

Lon: *166.668 E* Grad: *3.28*

S/N: *102*

Page 1 of

FG5 SYSTEM CHECK LOG  
REV 04/95

| Date (UT) | Time (UT) | Superseding Status |            |        | Dropping Chamber |       | Fringe Amplitude |            | Cart Reference Heights |                     | Weather Data |          | ISL Laser    |               | Ion Pump Pressure uTorr | OPS ID |        |      |             |
|-----------|-----------|--------------------|------------|--------|------------------|-------|------------------|------------|------------------------|---------------------|--------------|----------|--------------|---------------|-------------------------|--------|--------|------|-------------|
|           |           | End Level          | Side Level | SP (m) | SP (m)           | Vert  | End Level        | Side Level | V <sub>m</sub> (mV)    | V <sub>m</sub> (mV) | Start (M)    | Hold (M) | Air Temp (C) | Pressure (mB) |                         |        | DC (M) | Body | Peak Select |
| 4 Nov     | 0140      | ✓                  | ✓          | -22    | -                | ✓     | ✓                | 220        | -                      | 10.00               | -8.05        | 26       | 978          | 5.34          | -                       | -      | E      | 0.6  | 65          |
| 4 Nov     | 0905      | ✓                  | ✓          | -40    | -                | 1/3   | ✓                | 247        | 247                    | 10.00               | -8.05        | 21.5     | 978          | 5.31          | -                       | -      | F      | 0.7  | 65          |
| 4 Nov     | 2340      | ✓                  | ✓          | +10    | -                | ✓     | ✓                | 247        | -                      | 10.00               | -8.04        | 24       | 979          | 6.12          | -                       | -      | F      | 1.1  | 65          |
| 5 Nov     | 0250      | ✓                  | ✓          | -98    | -5               | 1 1/3 | ✓                | 237        | 246                    | 10.00               | -8.04        | 23.9     | 978.3        | 6.08          | -                       | -      | F      | 0.8  | 65          |
| 5 Nov     | 0510      | ✓                  | ✓          | -120   | +27              | 1 1/2 | ✓                | 237        | 234                    | 10.00               | -8.04        | 19       | 979          | 6.09          | -                       | -      | F      | 0.4  | 65          |
| 5 Nov     | 0625      | ✓                  | ✓          | -23    | +9               | 1     | ✓                | 241        | 241                    | 10.00               | -8.07        | 17 1/2   | -            | 6.09          | -                       | -      | F      | 0.4  | 65          |
| 5 Nov     | 0900      | ✓                  | ✓          | 24     | -                | ✓     | ✓                | 265        | 265                    | 10.00               | -8.06        | 19       | -            | 5.98          | -                       | -      | F      | 0.6  | 65          |
| 5 Nov     | 1800      | ✓                  | ✓          | 35     | -                | 1/2   | ✓                | 226        | 245                    | 10.00               | -8.06        | 22       | 978          | 6.16          | -                       | -      | F      | 0.4  | 65          |
| 5 Nov     | 2230      | ✓                  | ✓          | 17     | -                | -     | ✓                | -          | -                      | -                   | -            | 21       | 979.5        | 6.01          | -                       | -      | F      | 0.5  | 65          |
| 5 Nov     | 0130      | ✓                  | ✓          | 31     | -                | ✓     | ✓                | 249        | 249                    | 10.00               | -8.07        | 22       | 979.1        | 6.12          | -                       | -      | F      | 0.4  | 65          |

SYSTEM NOTES

04 Nov 1976 Header read auto temp = 40°C - system worked at 1408 UT -  
 dropped window - dryer will not cycle - hot air on left - controls down - best result  
 temp down to 23°C - dryer in box - open the door to see - decide to reset  
 assembly - 2 air = 517 mm (max read) & 1 above 1100, we say to take reset  
 4 the rest 517 to 516.5 mm ± 1 mm  
 5 Nov 0510 517 - 6.6 of difficulty setting material - ions to keep moving:



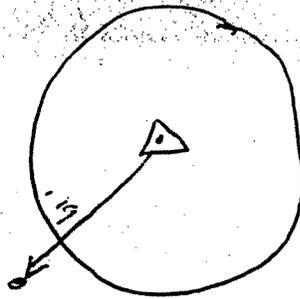
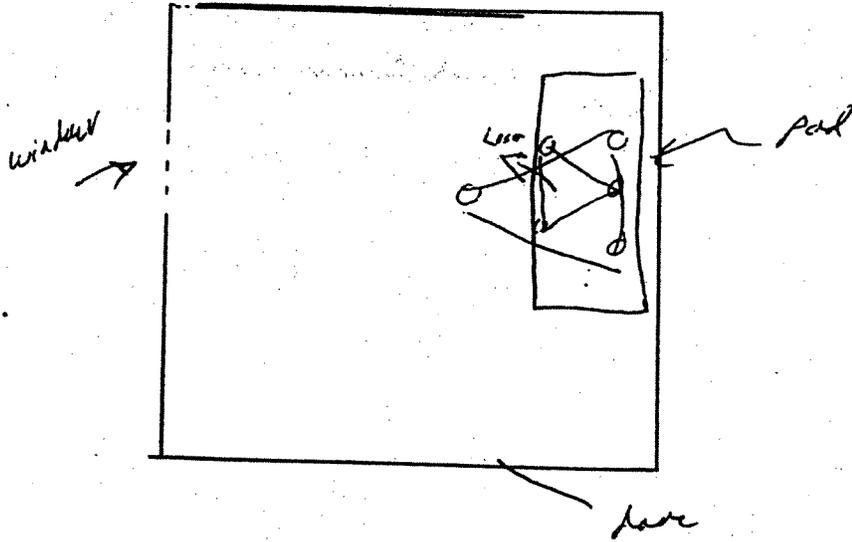
| Site: <i>ML56 - McMurdo Set Env</i> |                   | Unit: <i>102</i>    |              | FGS INITIAL SYSTEM CHECK LOG<br>Rev 10/93 |  |
|-------------------------------------|-------------------|---------------------|--------------|---|--|
| Date: <i>3 Nov 3 AM</i>             |                   | Operator: <i>ES</i> |              |   |  |
| Check Item                          |                   | Initial Value       | Final Value  | Nominal Value                             |  |
| <b>Site Arrival Time Sequence</b>   |                   |                     |              |   |  |
| Site Entry                          | Date/Time UT      | <i>3 Nov 2100</i>   | N/A          | N/A                                       |  |
| Laser OnLine                        | Date/Time UT      | <i>3 Nov 2200</i>   | N/A          | N/A                                       |  |
| Electronics OnLine                  | Date/Time UT      | <i>3 Nov 2200</i>   | N/A          | N/A                                       |  |
| Ion Pump On-line                    | Date/Time UT      | <i>NA</i>           | N/A          | N/A                                       |  |
| <b>Dropping Chamber</b>             |                   |                     |              |   |  |
| Hover Height                        | Volts             | <i>4.07 v</i>       |              | 5-6 V                                     |  |
| Hover Time                          | msecs             | <i>182</i>          |              | 220 ms                                    |  |
| Start Position                      | Volts             | <i>10.00</i>        |              | +10.0 V                                   |  |
| Hold Position                       | Volts             | <i>8.05</i>         |              | -8.0 V                                    |  |
| <b>SuperSpring</b>                  |                   |                     |              |   |  |
| Sphere Position                     | mV                | <i>15</i>           |              | < ± 100 mV                                |  |
| Coil Current Amplitude              | mV <sub>pp</sub>  | <i>-</i>            |              | < 20 mV                                   |  |
| <b>Interferometer</b>               |                   |                     |              |   |  |
| Dipstick Reference Height           | cm                | <i>517</i>          | <i>517</i>   | 49-52 cm                                  |  |
| Ring Reference Height               | rings             | <i>1.17</i>         | <i>1.114</i> | 0-3 rings                                 |  |
| Mean Collimation Noise              | dia               | <i>2.1</i>          |              | Site Dependent                            |  |
| I2 Laser DC Power                   | V                 | <i>5.3</i>          |              | 25 μW/V; 75-100 μW                        |  |
| NI-1 Null test                      | mV                | <i>NA</i>           |              | < 10 mV                                   |  |
| TTL Amplitude                       | V <sub>peak</sub> |                     |              | 3 V                                       |  |
| <b>Electronics</b>                  |                   |                     |              |   |  |
| Computer Boot Error Messages        |                   | <i>✓</i>            |              | NONE                                      |  |
| SRS 620 Self Test Errors            |                   | <i>✓</i>            |              | NONE                                      |  |
| Rubidium Frequency Lock             |                   | <i>✓</i>            |              | ON in 5-15 minutes                        |  |

Start Height = (Dipstick) + (Ring Height) + (48.62 cm) + [ΔV (0.5666 V/cm)]  
1 mV = 0.018 mm

ABSOLUTE GRAVITY STATION ORIENTATION DIAGRAM

STATION:

DATE:



37 mm

STATION CONTACT:

## COMMENTS \_\_\_\_\_

Unusable - Site at Aldy 57 required modification to accommodate F653. Existing pipe is a 11.5 cm x 71 cm. A <sup>1/2</sup> inch 129 pipe is needed. Request made through NSF Polar Programs director & general assistance program.

4th Nov - Morning gear from cargo led to site. Rather cold, extremely cramped. Dust everywhere. Normal setups, normal ops. SS was received in cargo lab - Nominal  $q = 9.82 \text{ } 9.77 \text{ m/s}^2$  - 2200L - all well.

5 Nov - 0800 L. Thermostat in bldg 57 heater failed - Temp at  $41^\circ\text{C}$ . Fan blk logs show maximum occurred at 0200L. Shut down system, allow slow cooling. Dropper failed / +increas

1200L - 1700L. Reset & re-align system. Data dropouts observed, large residuals. Tried to tweak H&D servo due to hold time also reset setup. Finally decided could be related to temp. excessive in dropper. Note that laser temp was nailed 101 reads at  $20 \times 10^{-6}$  torr. PC ran functional at 0800L.

Prepared By: WINESTER / BERSTIS

Organization: NOAA/NOS/OOES/GL





McMurdo RELATIVE DATA - Measured 11/95

METER 17 EFU Scale Factor = .98521 Dial Scale Factor = 1

| Time (elapsed minutes) | Location | Gravity (uGal) |
|------------------------|----------|----------------|
| 0.0                    | 1        | 314.68         |
| 5.8                    | 2        | -0.61          |
| 12.1                   | 1        | 319.39         |
| 17.9                   | 2        | 0.13           |
| 24.2                   | 1        | 320.20         |
| 30.0                   | 2        | 0.91           |
| 35.8                   | 1        | 334.77         |
| 42.1                   | 2        | -1.34          |
| 46.8                   | 1        | 325.80         |
| 54.2                   | 2        | 3.24           |
| 58.9                   | 1        | 333.31         |
| 65.2                   | 2        | -2.88          |
| 71.0                   | 1        | 321.06         |
| 76.8                   | 2        | 0.56           |
| 83.1                   | 1        | 329.35         |

| Time (elapsed minutes) | Tares | Tare Correction (uGal) |
|------------------------|-------|------------------------|
| 12.0                   |       | -8.00                  |
| 77.0                   |       | -7.00                  |

| LOCATION | AVG READING (uGal) | STD DEV (uGal) | STD ERR (uGal) | #PTS |
|----------|--------------------|----------------|----------------|------|
| 1 floor  | 324.82             | 7.18           | 2.54           | 8    |
| 2 100cm  | 0.00               | 1.92           | 0.72           | 7    |

*f = 37.8  
42.6*

McMurdo RELATIVE DATA - Measured 11/95

METER 17 EFU Scale Factor = .98521 Dial Scale Factor = 1

| Time (elapsed minutes) | Location | Gravity (uGal) |
|------------------------|----------|----------------|
| 0.0                    | 1        | 418.45         |
| 6.8                    | 3        | 0.40           |
| 13.1                   | 1        | 422.74         |
| 20.0                   | 3        | 1.66           |
| 25.8                   | 1        | 446.61         |
| 32.1                   | 3        | -3.05          |
| 37.9                   | 1        | 425.96         |
| 44.2                   | 3        | -1.10          |
| 50.0                   | 1        | 445.70         |
| 55.8                   | 3        | -0.11          |
| 62.1                   | 1        | 424.96         |
| 67.8                   | 3        | 4.71           |
| 74.2                   | 1        | 430.71         |
| 81.0                   | 3        | -2.50          |
| 86.3                   | 1        | 434.40         |

| Time (elapsed minutes) | Tares | Tare Correction (uGal) |
|------------------------|-------|------------------------|
| 44.0                   |       | -15.00                 |
| 38.0                   |       | -15.00                 |

| LOCATION | AVG READING | STD DEV | STD ERR | #PTS |
|----------|-------------|---------|---------|------|
|----------|-------------|---------|---------|------|

1 floor  
3 130cm

(uGal)  
431.19  
0.00

$\approx 2.8$

(uGal)  
10.41  
2.64

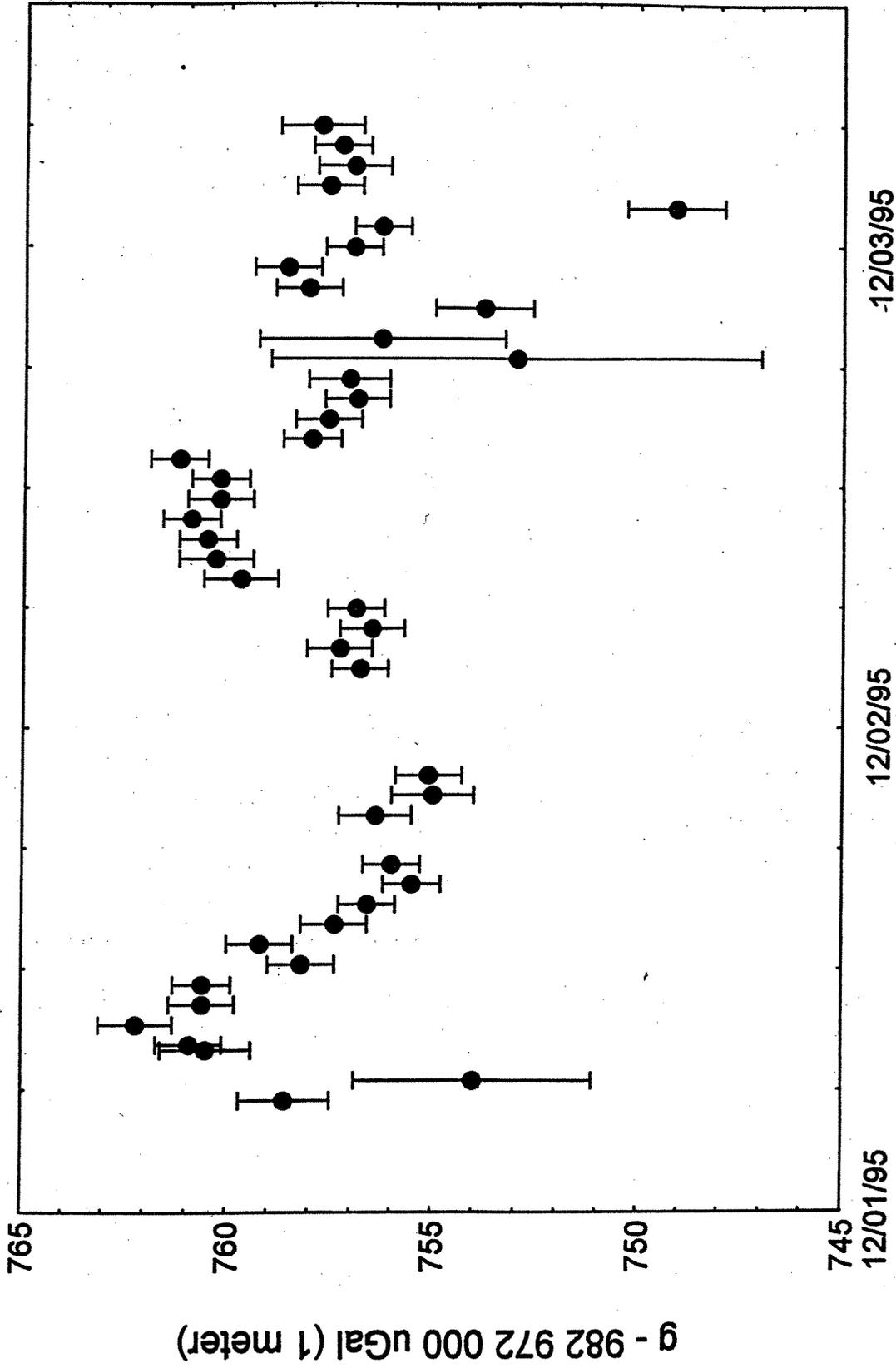
(uGal)  
3.68  
1.00

8  
7

$\gamma = 331.7 \quad \approx 2.8$

$3.28 \times 10^{-3}$

# McMurdo SatGrav



cmurdo\_satgrav\_95/12/01

ocation --- McMurdo/Antarctica

LAT: -77-50-49  
LON: 193-19-55  
LEV.: 30.0 m

nstrument used: FG5-102i

bserved gradient : 3.280 +/- .030 uGal/cm  
bservation height : 132.35 cm

ystem response correction (avg) : -1.1 uGal  
olar motion correction : 0.6 uGal  
ater table correction : 0.0 uGal  
aser temperature correction : 0.0 uGal  
aser drift correction : 0.0 uGal  
iscellaneous corrections : 0.0 uGal

-----  
SET SUMMARY  
GRAVITY IS FULLY CORRECTED AND TRANSFERED TO 1 METER

| ST | MODE | DROPS | TIMETAG      | GRAVITY     | ST ERROR | LS TIDE | ATM  | OL   |
|----|------|-------|--------------|-------------|----------|---------|------|------|
| 1  | I    | 109   | 951201052730 | 982972758.6 | 1.1      | -75.2   | -6.4 | -0.3 |
| 2  | I    | 109   | 951201062730 | 982972754.0 | 2.9      | -77.5   | -6.5 | -0.5 |
| 3  | I    | 107   | 951201075715 | 982972760.5 | 1.1      | -80.9   | -6.5 | -0.7 |
| 4  | I    | 110   | 951201081215 | 982972760.9 | 0.8      | -83.6   | -6.6 | -0.8 |
| 5  | I    | 110   | 951201091230 | 982972762.2 | 0.9      | -85.8   | -6.6 | -0.9 |
| 6  | I    | 110   | 951201101215 | 982972760.6 | 0.8      | -87.6   | -6.6 | -1.2 |
| 7  | I    | 110   | 951201111230 | 982972760.6 | 0.7      | -88.8   | -6.5 | -1.4 |
| 8  | I    | 110   | 951201121230 | 982972758.2 | 0.8      | -88.8   | -6.5 | -1.6 |
| 9  | I    | 110   | 951201131230 | 982972759.2 | 0.8      | -87.6   | -6.5 | -1.7 |
| 10 | I    | 110   | 951201141215 | 982972757.4 | 0.8      | -84.9   | -6.4 | -1.7 |
| 11 | I    | 110   | 951201151215 | 982972756.6 | 0.7      | -80.5   | -6.4 | -1.5 |
| 12 | I    | 110   | 951201161230 | 982972755.5 | 0.7      | -75.0   | -6.4 | -0.9 |
| 13 | I    | 108   | 951201171215 | 982972756.0 | 0.7      | -68.9   | -6.4 | -0.2 |
| 14 | I    | 110   | 951201193715 | 982972756.4 | 0.9      | -60.4   | -6.3 | 1.1  |
| 15 | I    | 110   | 951201203815 | 982972755.0 | 1.0      | -55.4   | -6.3 | 1.9  |
| 16 | I    | 110   | 951201213730 | 982972755.1 | 0.8      | -52.1   | -6.3 | 2.5  |
| 17 | I    | 110   | 951202025715 | 982972756.8 | 0.7      | -63.7   | -6.2 | 0.6  |
| 18 | I    | 109   | 951202035715 | 982972757.3 | 0.8      | -68.2   | -6.3 | -0.3 |
| 19 | I    | 109   | 951202045715 | 982972756.5 | 0.8      | -72.5   | -6.4 | -0.9 |
| 20 | I    | 110   | 951202055715 | 982972756.9 | 0.7      | -76.2   | -6.3 | -1.4 |
| 21 | I    | 110   | 951202072715 | 982972759.7 | 0.9      | -80.4   | -6.3 | -1.7 |
| 22 | I    | 110   | 951202082715 | 982972760.3 | 0.9      | -82.5   | -6.4 | -1.7 |
| 23 | I    | 109   | 951202092715 | 982972760.5 | 0.7      | -84.3   | -6.4 | -1.5 |
| 24 | I    | 110   | 951202102730 | 982972760.9 | 0.7      | -85.7   | -6.4 | -1.4 |
| 25 | I    | 110   | 951202112730 | 982972760.2 | 0.8      | -86.7   | -6.5 | -1.3 |
| 26 | I    | 109   | 951202122715 | 982972760.2 | 0.7      | -86.9   | -6.5 | -1.4 |
| 27 | I    | 110   | 951202132730 | 982972761.2 | 0.7      | -86.3   | -6.5 | -1.4 |
| 28 | I    | 109   | 951202142715 | 982972758.0 | 0.7      | -84.3   | -6.7 | -1.4 |
| 29 | I    | 110   | 951202152715 | 982972757.6 | 0.8      | -80.7   | -6.8 | -1.2 |
| 30 | I    | 110   | 951202162715 | 982972756.9 | 0.8      | -75.6   | -6.7 | -0.9 |
| 31 | I    | 105   | 951202172715 | 982972757.1 | 1.0      | -69.2   | -6.7 | -0.4 |

|    |   |     |              |             |     |       |      |      |
|----|---|-----|--------------|-------------|-----|-------|------|------|
| 32 | I | 109 | 951202182715 | 982972753.0 | 6.0 | -62.0 | -6.8 | 0.5  |
| 33 | I | 107 | 951202192715 | 982972756.3 | 3.0 | -54.7 | -6.7 | 1.4  |
| 34 | I | 108 | 951202205715 | 982972753.8 | 1.2 | -45.7 | -6.9 | 2.7  |
| 35 | I | 110 | 951202215730 | 982972758.1 | 0.8 | -41.8 | -6.9 | 3.3  |
| 36 | I | 110 | 951202225715 | 982972758.6 | 0.8 | -40.3 | -7.0 | 3.6  |
| 37 | I | 110 | 951202235715 | 982972757.0 | 0.7 | -41.3 | -7.0 | 3.3  |
| 38 | I | 110 | 951203005715 | 982972756.3 | 0.7 | -44.5 | -7.1 | 2.8  |
| 39 | I | 87  | 951203015130 | 982972749.1 | 1.2 | -49.0 | -7.2 | 1.9  |
| 40 | I | 110 | 951203025715 | 982972757.6 | 0.8 | -55.5 | -7.3 | 0.7  |
| 41 | I | 110 | 951203035715 | 982972757.0 | 0.9 | -61.8 | -7.3 | -0.5 |
| 42 | I | 109 | 951203045715 | 982972757.3 | 0.7 | -67.8 | -7.3 | -1.6 |
| 43 | I | 110 | 951203055715 | 982972757.8 | 1.0 | -73.0 | -7.4 | -2.2 |

---

MEANS (weighted g)                    982972758.0            1.0            -71.0            -6.6            -0.2

---

Standard deviation of the set mean values : 2.6 uGal

Total number of drops used . . . . . : 4683 drops

Separation of laser modes ( red - blue ) : NA

ERROR SOURCES:

|                           |          |
|---------------------------|----------|
| data scatter (se) . . . : | 0.4 uGal |
| instrument error budget : | 1.6 uGal |
| environmental models . :  | 1.5 uGal |
| vertical transfer . . :   | 1.0 uGal |
|                           | -----    |
| occupation RMS error :    | 2.2 uGal |

Reason for misc. corr. ---

Comments:

( 162 pts ) ( t0 = 34ms ) Processed on 1/30/96.  
Sets 17-20 removed due to verticality error.

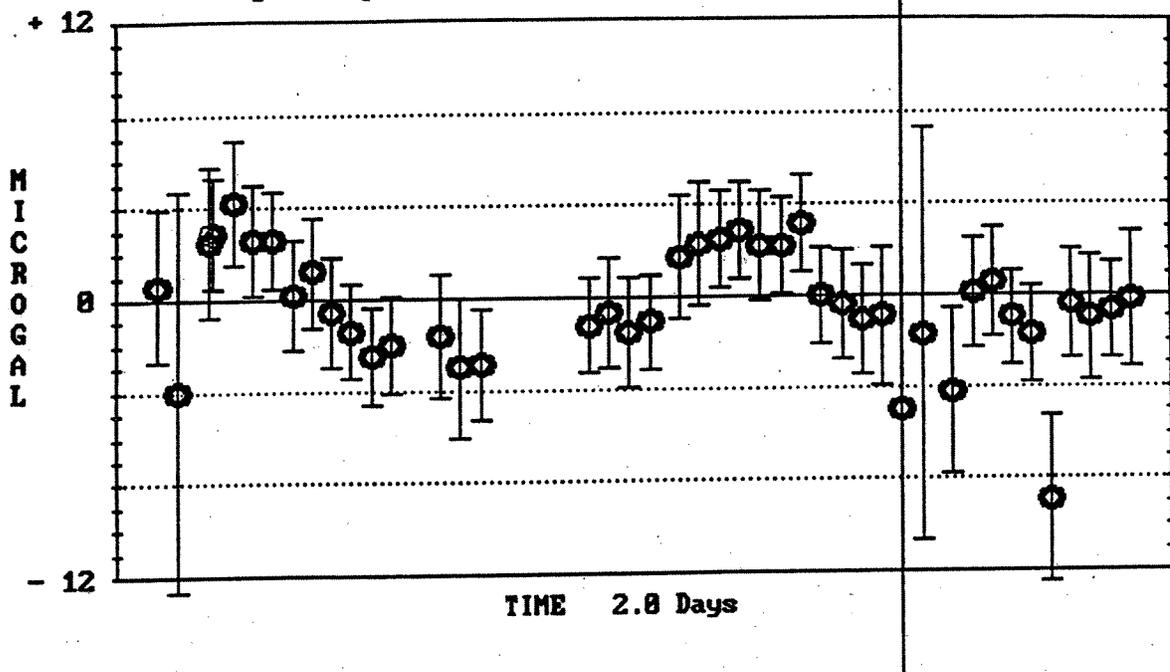
#####

McMurdo\_Satgrav\_95/12/81

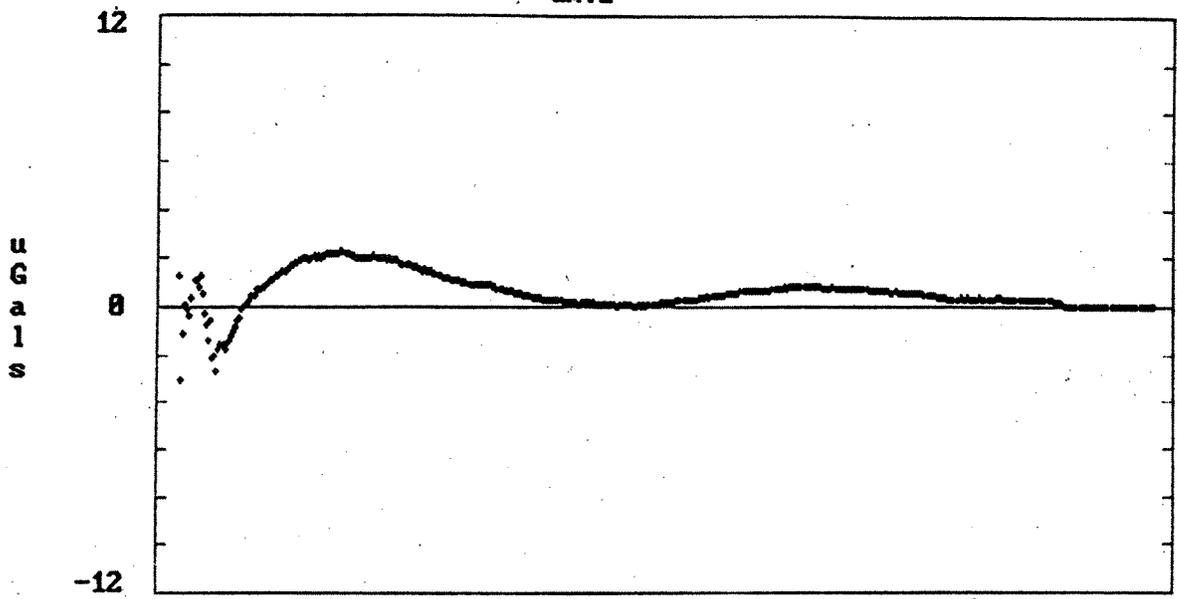
Gravity Average = 982972758

● RED MODE

⊙ BLUE MODE



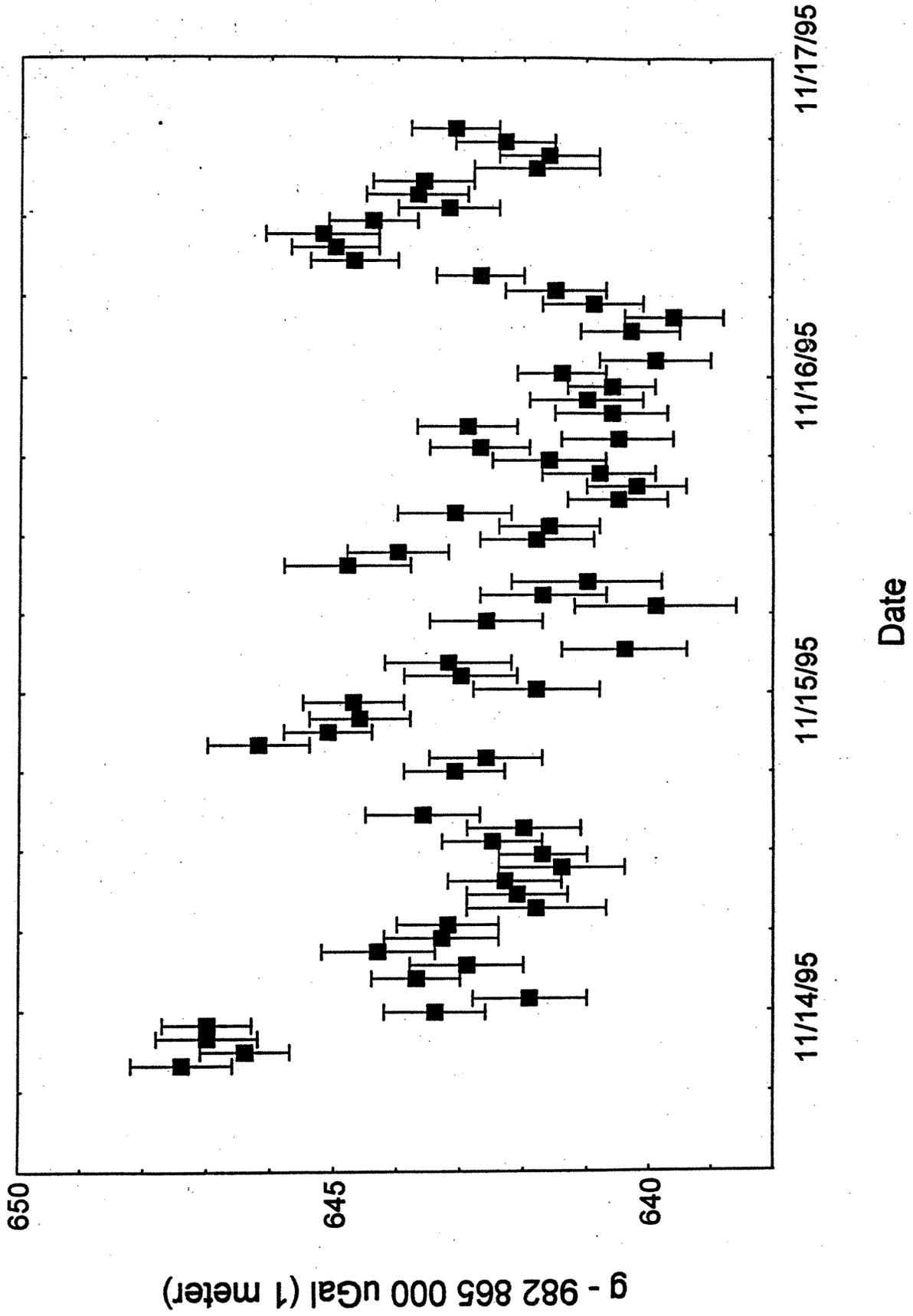
DROP RUNNING AVERAGE  
an.1



total ( 4680 drops )



# Terra Nova Bay AB



erra\_Nova\_AB\_95/11/13

ocation --- Terra\_Nova/Antarctica

LAT: -74-41-36  
LON: 195-54-01  
LEV.: 30.0 m

Instrument used: FG5-102i

Observed gradient : 3.120 +/- .030 uGal/cm  
Observation height : 131.30 cm

System response correction (avg) : -0.3 uGal  
Solar motion correction : -0.9 uGal  
Water table correction : 0.0 uGal  
Sensor temperature correction : 0.0 uGal  
Sensor drift correction : 0.0 uGal  
Miscellaneous corrections :-12.5 uGal

-----  
SET SUMMARY  
GRAVITY IS FULLY CORRECTED AND TRANSFERED TO 1 METER

| T  | MODE | DROPS | TIMETAG      | GRAVITY     | ST ERROR | LS TIDE | ATM   | OL   |
|----|------|-------|--------------|-------------|----------|---------|-------|------|
| 1  | I    | 110   | 951113195745 | 982865647.4 | 0.8      | -72.0   | -10.4 | -0.4 |
| 2  | I    | 106   | 951113205715 | 982865646.4 | 0.7      | -67.3   | -10.4 | 0.4  |
| 3  | I    | 109   | 951113215715 | 982865647.0 | 0.8      | -61.9   | -10.3 | 1.2  |
| 4  | I    | 108   | 951113225715 | 982865647.0 | 0.7      | -55.9   | -10.3 | 2.0  |
| 5  | I    | 109   | 951113235730 | 982865643.4 | 0.8      | -49.6   | -10.3 | 2.5  |
| 6  | I    | 91    | 951114005715 | 982865641.9 | 0.9      | -44.1   | -10.4 | 3.0  |
| 7  | I    | 108   | 951114022730 | 982865643.7 | 0.7      | -36.9   | -10.4 | 3.3  |
| 8  | I    | 109   | 951114032745 | 982865642.9 | 0.9      | -34.2   | -10.6 | 3.3  |
| 9  | I    | 105   | 951114042800 | 982865644.3 | 0.9      | -33.6   | -10.6 | 2.9  |
| 10 | I    | 109   | 951114052715 | 982865643.3 | 0.9      | -35.2   | -10.5 | 2.4  |
| 11 | I    | 108   | 951114062730 | 982865643.2 | 0.8      | -38.9   | -10.7 | 1.7  |
| 12 | I    | 101   | 951114074230 | 982865641.8 | 1.1      | -45.9   | -10.6 | 0.7  |
| 13 | I    | 110   | 951114084215 | 982865642.1 | 0.8      | -52.9   | -10.7 | -0.1 |
| 14 | I    | 110   | 951114094215 | 982865642.3 | 0.9      | -60.3   | -10.6 | -1.0 |
| 15 | I    | 110   | 951114104230 | 982865641.4 | 1.0      | -67.4   | -10.7 | -1.6 |
| 16 | I    | 109   | 951114114215 | 982865641.7 | 0.7      | -73.7   | -10.6 | -2.2 |
| 17 | I    | 109   | 951114124215 | 982865642.5 | 0.8      | -78.6   | -10.5 | -2.7 |
| 18 | I    | 105   | 951114134230 | 982865642.0 | 0.9      | -82.0   | -10.5 | -2.9 |
| 19 | I    | 101   | 951114144230 | 982865643.6 | 0.9      | -83.6   | -10.3 | -3.0 |
| 20 | I    | 103   | 951114180230 | 982865643.1 | 0.8      | -76.5   | -10.2 | -1.2 |
| 21 | I    | 106   | 951114190215 | 982865642.6 | 0.9      | -73.0   | -10.0 | -0.6 |
| 22 | I    | 106   | 951114200215 | 982865646.2 | 0.8      | -69.0   | -10.0 | 0.1  |
| 23 | I    | 110   | 951114210215 | 982865645.1 | 0.7      | -65.0   | -9.9  | 0.8  |
| 24 | I    | 109   | 951114220215 | 982865644.6 | 0.8      | -60.7   | -9.9  | 1.4  |
| 25 | I    | 110   | 951114231730 | 982865644.7 | 0.8      | -55.3   | -9.8  | 2.0  |
| 26 | I    | 109   | 951115001715 | 982865641.8 | 1.0      | -51.4   | -9.7  | 2.3  |
| 27 | I    | 108   | 951115011715 | 982865643.0 | 0.9      | -47.8   | -9.7  | 2.5  |
| 28 | I    | 104   | 951115021730 | 982865643.2 | 1.0      | -45.3   | -9.6  | 2.5  |
| 29 | I    | 83    | 951115031715 | 982865640.4 | 1.0      | -43.9   | -9.5  | 2.4  |
| 30 | I    | 101   | 951115052715 | 982865642.6 | 0.9      | -44.3   | -9.3  | 2.2  |
| 31 | I    | 71    | 951115063515 | 982865639.9 | 1.3      | -46.8   | -9.3  | 1.4  |

|    |   |     |              |             |     |       |      |      |
|----|---|-----|--------------|-------------|-----|-------|------|------|
| 32 | I | 92  | 951115072700 | 982865641.7 | 1.0 | -50.1 | -9.1 | 1.3  |
| 33 | I | 75  | 951115082715 | 982865641.0 | 1.2 | -55.1 | -8.9 | 0.7  |
| 34 | I | 110 | 951115094245 | 982865644.8 | 1.0 | -63.1 | -8.6 | -0.1 |
| 35 | I | 110 | 951115104215 | 982865644.0 | 0.8 | -69.3 | -8.4 | -0.9 |
| 36 | I | 110 | 951115114215 | 982865641.8 | 0.9 | -75.4 | -8.2 | -1.5 |
| 37 | I | 110 | 951115124215 | 982865641.6 | 0.8 | -80.3 | -8.0 | -2.1 |
| 38 | I | 110 | 951115134215 | 982865643.1 | 0.9 | -83.9 | -7.8 | -2.3 |
| 39 | I | 109 | 951115144215 | 982865640.5 | 0.8 | -85.5 | -7.6 | -2.6 |
| 40 | I | 109 | 951115154215 | 982865640.2 | 0.8 | -85.5 | -7.3 | -2.6 |
| 41 | I | 110 | 951115164215 | 982865640.8 | 0.9 | -84.0 | -7.2 | -2.3 |
| 42 | I | 110 | 951115174215 | 982865641.6 | 0.9 | -81.3 | -6.9 | -1.9 |
| 43 | I | 104 | 951115184045 | 982865642.7 | 0.8 | -77.9 | -6.8 | -1.3 |
| 44 | I | 108 | 951115191730 | 982865640.5 | 0.9 | -72.1 | -6.5 | -0.4 |
| 45 | I | 108 | 951115201730 | 982865642.9 | 0.8 | -68.7 | -6.3 | 0.1  |
| 46 | I | 109 | 951115211715 | 982865640.6 | 0.9 | -65.7 | -6.3 | 0.7  |
| 47 | I | 109 | 951115221730 | 982865641.0 | 0.9 | -63.2 | -6.2 | 1.0  |
| 48 | I | 110 | 951115231715 | 982865640.6 | 0.7 | -61.0 | -6.2 | 1.2  |
| 49 | I | 108 | 951116001730 | 982865641.4 | 0.7 | -59.1 | -6.2 | 1.4  |
| 50 | I | 102 | 951116011715 | 982865639.9 | 0.9 | -57.4 | -6.3 | 1.5  |
| 51 | I | 110 | 951116032715 | 982865640.3 | 0.8 | -55.9 | -6.4 | 1.6  |
| 52 | I | 110 | 951116042715 | 982865639.6 | 0.8 | -55.1 | -6.5 | 1.6  |
| 53 | I | 110 | 951116052715 | 982865640.9 | 0.8 | -55.1 | -6.6 | 1.7  |
| 54 | I | 110 | 951116062715 | 982865641.5 | 0.8 | -56.2 | -6.6 | 1.5  |
| 55 | I | 110 | 951116073445 | 982865642.7 | 0.7 | -59.2 | -6.6 | 1.2  |
| 56 | I | 110 | 951116084215 | 982865644.7 | 0.7 | -63.1 | -6.7 | 0.8  |
| 57 | I | 110 | 951116094215 | 982865645.0 | 0.7 | -67.8 | -6.8 | 0.4  |
| 58 | I | 110 | 951116104215 | 982865645.2 | 0.9 | -73.2 | -6.8 | -0.1 |
| 59 | I | 109 | 951116114215 | 982865644.4 | 0.7 | -78.5 | -6.9 | -0.7 |
| 60 | I | 110 | 951116124215 | 982865643.2 | 0.8 | -83.1 | -7.0 | -1.3 |
| 61 | I | 110 | 951116134230 | 982865643.7 | 0.8 | -86.4 | -7.0 | -1.7 |
| 62 | I | 110 | 951116144215 | 982865643.6 | 0.8 | -88.0 | -7.0 | -2.0 |
| 63 | I | 75  | 951116154215 | 982865641.8 | 1.0 | -87.4 | -7.1 | -2.0 |
| 64 | I | 110 | 951116164215 | 982865641.6 | 0.8 | -85.4 | -7.0 | -1.8 |
| 65 | I | 110 | 951116174215 | 982865642.3 | 0.8 | -81.9 | -7.0 | -1.4 |
| 66 | I | 110 | 951116184215 | 982865643.1 | 0.7 | -77.5 | -6.8 | -1.0 |

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|                    |             |     |       |      |     |
|--------------------|-------------|-----|-------|------|-----|
| MEANS (weighted g) | 982865642.9 | 0.9 | -64.3 | -8.5 | 0.2 |
|--------------------|-------------|-----|-------|------|-----|

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tandard deviation of the set mean values : 1.9 uGal

otal number of drops used . . . . . : 6984 drops

eparation of laser modes ( red - blue ) : NA

RROR SOURCES:

|                         |   |          |
|-------------------------|---|----------|
| data scatter (se) . . . | : | 0.2 uGal |
| instrument error budget | : | 1.6 uGal |
| environmental models .  | : | 1.5 uGal |
| vertical transfer . .   | : | 0.9 uGal |
| -----                   |   |          |
| occupation RMS error    | : | 2.1 uGal |

Reason for misc. corr. --- 686 comparitor at 200mv.

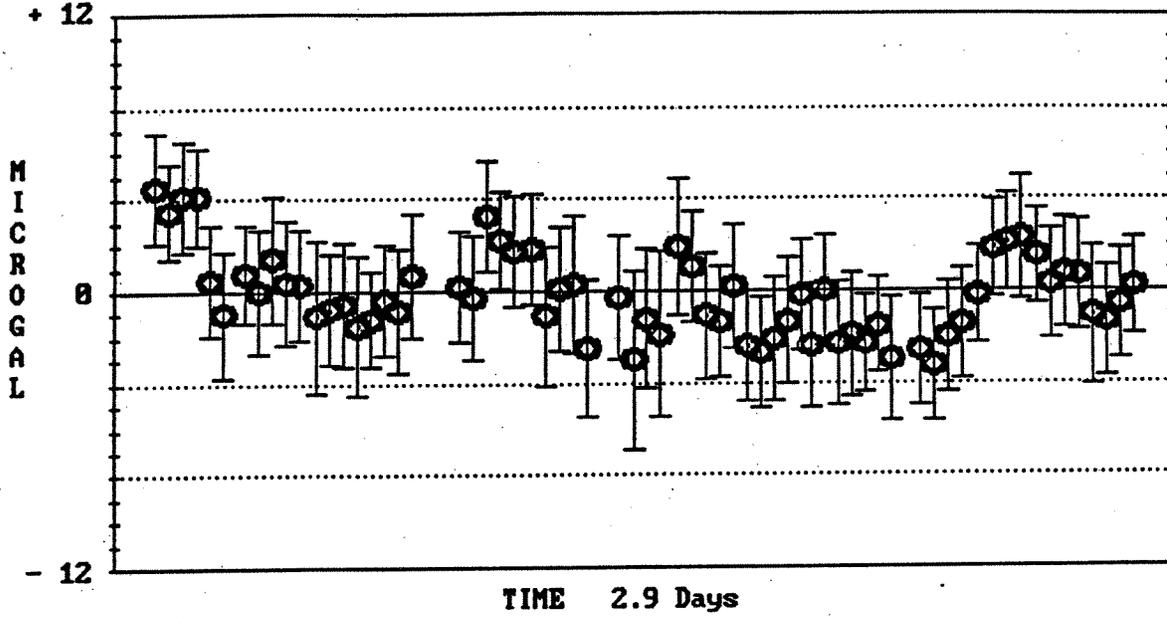
omments:  
 ( 162 pts ) ( t0 = 34ms ) Processed on 1/24/96.  
 Sets 1-9 removed due to verticality error.

Terra\_Nova\_AB\_95/11/13

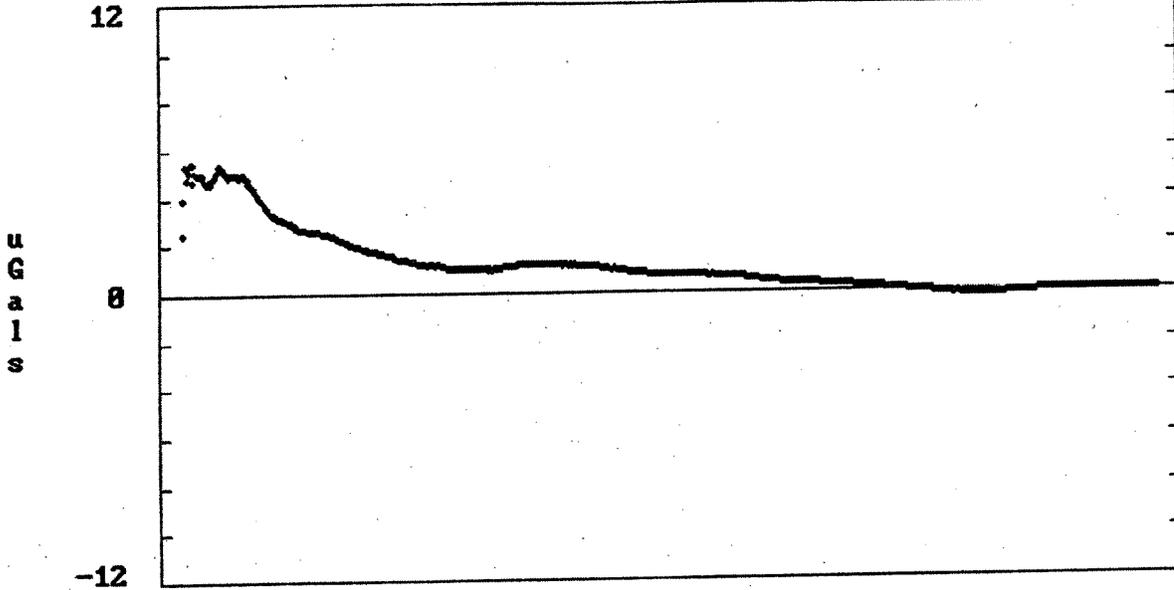
Gravity Average = 982865642.9

● RED MODE

⊙ BLUE MODE



DROP RUNNING AVERAGE  
a2



total ( 6980 drops )



FG5 SYSTEM CHECK LOG  
REV 04/95

Station: *Terra Nova Bay AB*  
 Lat: *-77.6934* Elev: *3.086 pm/m*  
 Lon: *164.0998* Grad

S/N *102i*

| Date<br>(UT) | Time<br>(UT) | Superspring Status |            |         | Dropping Chamber |                      | Fringe Amplitude     |           | Cart Reference Heights |              | Weather Data  |        | ISL Laser |             | Ion Pump Pressure<br>uTorr | OPS ID |     |    |
|--------------|--------------|--------------------|------------|---------|------------------|----------------------|----------------------|-----------|------------------------|--------------|---------------|--------|-----------|-------------|----------------------------|--------|-----|----|
|              |              | End Level          | Side Level | SP (mV) | SP (mV)          | V <sub>sp</sub> (mV) | V <sub>sp</sub> (mV) | Start (M) | Hold (M)               | Air Temp (C) | Pressure (mb) | DC (M) | Body      | Peak Select |                            |        |     |    |
| 15 Nov       | 2045         | ✓                  | ✓          | -15     | -                | ✓                    | ✓                    | -         | -                      | 10.00        | -8.09         | 12.7   | 990       | 5.40        | -                          | E      | 0.2 | 65 |
| 16 Nov       | 0245         | ✓                  | ✓          | -12     | -                | ✓                    | ✓                    | 255       | 255                    | 10.00        | -8.07         | 15.4   | 989.2     | 5.34        | -                          | E      | 0.2 | 65 |
| 16 Nov       | 0650         | ✓                  | ✓          | +9      | -                | ✓                    | ✓                    | 260       | 260                    | 10.00        | -8.07         | 14.8   | 988.5     | 5.28        | -                          | E      | 0.2 | 65 |
| 16 Nov       | 1910         | ✓                  | ✓          | 21      | -                | ✓                    | ✓                    | 257       | -                      | 10.00        | -8.10         | 13.9   | 988       | 5.39        | -                          | E      | 0.2 | 65 |

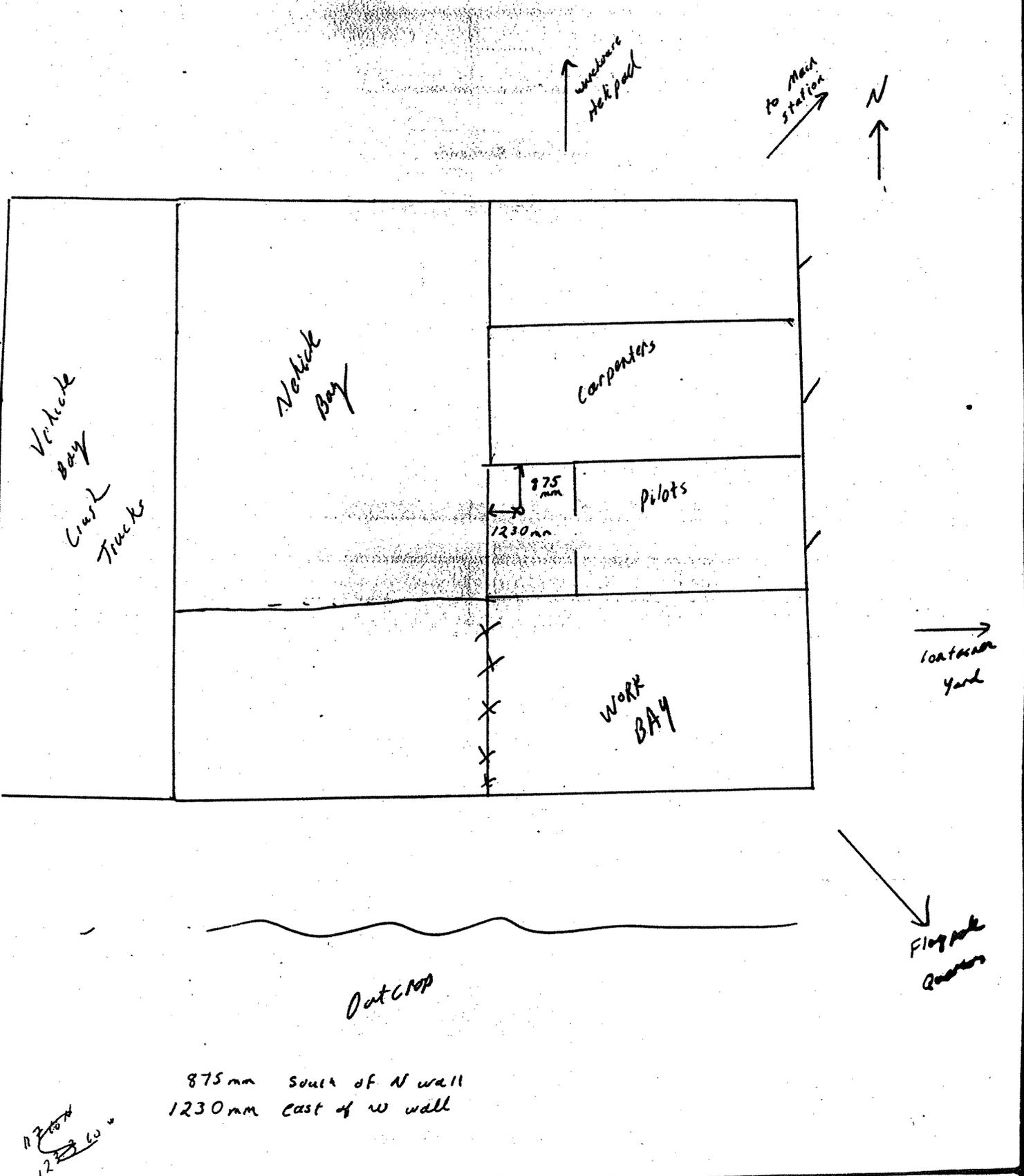
SYSTEM NOTES

16 Nov 0650 Clock slow -15. riser. Vertical adjusted  
 16 Nov 1910 Clock slow -15. Dipstick at 50hr.2 min + 1 min

ABSOLUTE GRAVITY STATION ORIENTATION DIAGRAM

STATION: *Terra Nova Bay*

DATE: *15 Nov 95*



↑  
uncovered  
Helipad

→  
to Main  
station

N  
↑

Vehicle  
Bay  
Crew  
Trucks

Natick  
Bay

Carpenters

Pilots

875 mm  
1230 mm

Work  
Bay

→  
ice storage  
yard

↓  
Flag pole  
quarters

Outcrop

875 mm South of N wall  
1230 mm East of W wall

875 mm  
1230 mm

STATION CONTACT:

| Site: <i>Terra Nova Bay AB</i>    | Unit: <i>102i</i>   | FG5 INITIAL SYSTEM CHECK LOG<br>Rev 10/93 |                    |
|-----------------------------------|---------------------|---|--------------------|
| Date: <i>13 Nov 95</i>            | Operator: <i>GS</i> |   |                    |
| Check Item                        | Initial Value       | Final Value                               | Nominal Value      |
| <b>Site Arrival Time Sequence</b> |                     |   |                    |
| Site Entry                        | Date/Time UT        | <i>11/13/95 0200</i>                      | N/A                |
| Laser OnLine                      | Date/Time UT        | <i>11/13/95 0530</i>                      | N/A                |
| Electronics OnLine                | Date/Time UT        | <i>11/13/95 0600</i>                      | N/A                |
| Ion Pump On-line                  | Date/Time UT        | <i>11/13/95 0500</i>                      | N/A                |
| <b>Dropping Chamber</b>           |                     |   |                    |
| Hover Height                      | Volts               | <i>6.3</i>                                | 5-6 V              |
| Hover Time                        | msecs               | <i>1.62</i>                               | 220 ms             |
| Start Position                    | Volts               | <i>10.00</i>                              | +10.0 V            |
| Hold Position                     | Volts               | <i>-8.07</i>                              | -8.0 V             |
| <b>SuperSpring</b>                |                     |   |                    |
| Sphere Position                   | mV                  |   | < ± 100 mV         |
| Coil Current Amplitude            | mV <sub>pp</sub>    |   | < 20 mV            |
| <b>Interferometer</b>             |                     |   |                    |
| Dipstick Reference Height         | cm                  | <i>506.2 mm</i>                           | 49-52 cm           |
| Ring Reference Height             | rings               | <i>1 ring</i>                             | 0-3 rings          |
| Mean Collimation Noise            | dia                 | <i>2 1/12</i>                             | Site Dependent     |
| I2 Laser DC Power                 | V                   | <i>5.18 0709 11/13</i>                    | 25 μW/V; 75-100 μW |
| NI-1 Null test                    | mV                  | <i>NA</i>                                 | < 10 mV            |
| TIL Amplitude                     | V <sub>peak</sub>   |   | 3 V                |
| <b>Electronics</b>                |                     |   |                    |
| Computer Boot Error Messages      |                     | <i>OK</i>                                 | NONE               |
| SRS 620 Self Test Errors          |                     | <i>OK - Pass #6</i><br><i>SRS-check</i>   | NONE               |
| Rubidium Frequency Lock           |                     | <i>OK</i>                                 | ON in 5-15 minutes |

Start Height = (Dipstick) + (Ring Height) + (48.62 cm) + [ΔV (0.5666 V/cm)]  
1 mV = 0.018 mm

STATION \_\_\_\_\_

PAGE 1 OF \_\_\_\_\_

## COMMENTS \_\_\_\_\_

13 Nov - Arrived on station. IAES station cannot be started due to pipe dimensions. Using longer bag instead. Nominal setup. Temp control now -  $+24^{\circ}\text{C}$ . Noisy during day due to staging activities.

14 Nov - System nominal - Drifts are perhaps worsened. Could be system is facing long thermal extremes than ever before.

15 Nov - Nominal ops @ 0002Z

15 Nov 0810Z - 1910Z - Nails power failure,  
1915Z Power restored

Prepared By WINESTER BERSTISOrganization NOAA/NOS/OOES/GL

TNB\_AB RELATIVE DATA - Measured 11/95

METER 17 EFU Scale Factor = .98521 Dial Scale Factor = 1.3665

| Time (elapsed minutes) | Location | Gravity (uGal) |
|------------------------|----------|----------------|
| 0.0                    | 2        | -2089.62       |
| 11.0                   | 1        | 1.74           |
| 22.1                   | 2        | -2068.25       |
| 34.2                   | 1        | -20.11         |
| 45.8                   | 2        | -2053.55       |
| 57.9                   | 1        | -3.48          |
| 71.0                   | 2        | -2062.43       |
| 81.0                   | 1        | -16.68         |
| 94.1                   | 2        | -2049.11       |
| 105.2                  | 1        | 5.58           |
| 116.8                  | 2        | -2035.99       |
| 127.8                  | 1        | 45.19          |
| 274.0                  | 2        | -1998.03       |
| 285.1                  | 1        | 2.37           |
| 295.1                  | 2        | -2012.90       |
| 315.1                  | 1        | -7.50          |
| 334.0                  | 2        | -1998.21       |
| 345.0                  | 1        | -7.11          |

No Tares

| LOCATION      | AVG READING (uGal) | STD DEV (uGal) | STD ERR (uGal) | #PTS |
|---------------|--------------------|----------------|----------------|------|
| 1 TNBAB_floor | 0.00               | 18.99          | 6.33           | 9    |
| 2 TNBAB_IRG   | -2040.90           | 32.17          | 10.72          | 9    |

TNB AB  $g @ 1m = 982, 865, 6 \pm 2.9 \pm 2.1$

$g = 3.12 \pm 0.03 \text{ uGal/cm} \Delta g \text{ to floor} +312.0 \pm 3.0$

Transfer  $-2040.9 \pm 12.4$

126  $g$   $982, 863, 914.0 \pm 12.9$

TNB\_AB RELATIVE DATA - Measured 11/95

METER 17 EFU Scale Factor = .98521 Dial Scale Factor = 1

| Time (elapsed minutes) | Location | Gravity (uGal) |
|------------------------|----------|----------------|
| 0.0                    | 1        | -3.33          |
| 5.8                    | 2        | -337.37        |
| 12.1                   | 1        | -6.38          |
| 17.9                   | 2        | -338.45        |
| 24.2                   | 1        | 16.17          |
| 30.0                   | 2        | -342.49        |
| 35.8                   | 1        | 2.29           |
| 42.1                   | 2        | -343.57        |
| 47.9                   | 1        | -3.86          |
| 54.2                   | 2        | -337.89        |
| 60.0                   | 1        | -11.85         |
| 65.7                   | 2        | -342.92        |
| 72.1                   | 1        | 12.68          |
| 77.8                   | 2        | -337.12        |
| 84.2                   | 1        | -7.14          |
| 89.9                   | 2        | -333.31        |
| 96.3                   | 1        | 2.59           |
| 102.0                  | 2        | -331.48        |
| 107.8                  | 1        | -6.42          |
| 114.1                  | 2        | -329.65        |
| 119.9                  | 1        | 5.24           |

Tares

| Time (elapsed minutes) | Tare Correction (uGal) |
|------------------------|------------------------|
| 48.0                   | -9.00                  |

| LOCATION      | AVG READING (uGal) | STD DEV (uGal) | STD ERR (uGal) | #PTS |
|---------------|--------------------|----------------|----------------|------|
| 1 TNBAB_floor | -0.00              | 8.72           | 2.63           | 11   |
| 2 TNBAB_100cm | -337.42            | 4.81           | 1.52           | 10   |

*Handwritten notes:*  
 = 3374  
 1.000

TNB\_AB RELATIVE DATA - Measured 11/95

METER 17 EFU Scale Factor = .98521 Dial Scale Factor = 1

| Time (elapsed minutes) | Location | Gravity (uGal) |
|------------------------|----------|----------------|
| 0.0                    | 1        | 19.31          |
| 5.8                    | 3        | -405.75        |
| 12.1                   | 1        | -11.17         |
| 17.9                   | 3        | -396.84        |
| 24.2                   | 1        | -8.20          |
| 30.0                   | 3        | -395.86        |
| 35.8                   | 1        | -3.23          |
| 42.1                   | 3        | -407.70        |
| 47.9                   | 1        | 0.66           |
| 54.2                   | 3        | -395.95        |
| 60.0                   | 1        | -11.24         |
| 65.7                   | 3        | -416.68        |
| 72.1                   | 1        | 7.38           |
| 77.8                   | 3        | -406.94        |
| 84.2                   | 1        | 1.35           |
| 89.9                   | 3        | -412.00        |
| 96.3                   | 1        | 5.14           |

|       |   |         |
|-------|---|---------|
| 102.0 | 3 | -409.20 |
| 107.8 | 1 | 4.03    |
| 114.1 | 3 | -408.39 |
| 119.9 | 1 | -4.03   |

No Tares

| LOCATION      | AVG READING<br>(uGal) | STD DEV<br>(uGal) | STD ERR<br>(uGal) | #PTS |
|---------------|-----------------------|-------------------|-------------------|------|
| 1 TNBAB_floor | 0.00                  | 9.04              | 2.73              | 11   |
| 3 TNBAB_131cm | -405.53               | 2.11              | 2.25              | 10   |

$$y = 3.119$$

$$x = .027$$

### Relative Gravity Meter Log Sheet

Meter # 017

Operator 655

Survey Notes Vertical Gradient at Terra Nova Bay, 5000

EFU = 0.98521

| Site Name | Date   | Time (UT) | Dial Reading | EFU    | g | Tide | Corr. g |
|-----------|--------|-----------|--------------|--------|---|------|---------|
| TNA-AB-0  | 16 Nov | 2100      | 95.690       | +0.159 |   |      |         |
| 130       |        | 2106      |              | -0.272 |   |      |         |
| 0         |        | 2112      |              | +0.129 |   |      |         |
| 130       |        | 2118      |              | -0.262 |   |      |         |
| 0         |        | 2124      |              | +0.133 |   |      |         |
| 130       |        | 2130      |              | -0.260 |   |      |         |
| 0         |        | 2136      |              | +0.139 |   |      |         |
| 130       |        | 2142      |              | -0.271 |   |      |         |
| 0         |        | 2148      |              | +0.144 |   |      |         |
| 130       |        | 2154      |              | -0.258 |   |      |         |
| 0         |        | 2200      |              | +0.133 |   |      |         |
| 130       |        | 2206      |              | -0.278 |   |      |         |
| 0         |        | 2212      |              | +0.153 |   |      |         |
| 130       |        | 2218      |              | -0.267 |   |      |         |
| 0         |        | 2224      |              | +0.148 |   |      |         |
| 130       |        | 2230      |              | -0.271 |   |      |         |
| 0         |        | 2236      |              | +0.153 |   |      |         |
| 130       |        | 2242      |              | -0.267 |   |      |         |
| 0         |        | 2248      |              | +0.153 |   |      |         |
| 130       |        | 2254      |              | -0.265 |   |      |         |
| 0         |        | 2300      |              | +0.146 |   |      |         |

200 L)

100 L)

1200 L)

### Relative Gravity Meter Log Sheet

Meter # D-17

Operator \_\_\_\_\_

Survey Notes \_\_\_\_\_

*Vertical Control*

*AB' is 0.63 m east of AB*

| Site Name | Date   | Time (UT) | Dial Reading | EFU    | g | Tide | Corr. g |
|-----------|--------|-----------|--------------|--------|---|------|---------|
| TND-AB-0  | 17 Nov | 0136      | 95.690       | 0.140  |   |      |         |
| 100       |        | 0142      |              | -0.199 |   |      |         |
| 0         |        | 0148      |              | +0.137 |   |      |         |
| 100       |        | 0154      |              | -0.200 |   |      |         |
| 0         |        | 0200      |              | +0.160 |   |      |         |
| 100       |        | 0206      |              | -0.204 |   |      |         |
| 0         |        | 0212      |              | 0.146  |   |      |         |
| 100       |        | 0218      |              | -0.205 |   |      |         |
| 0         |        | 0224      |              | +0.149 |   |      |         |
| 100       |        | 0230      |              | -0.190 |   |      |         |
| 0         |        | 0236      |              | +0.141 |   |      |         |
| 100       |        | 0242      |              | -0.195 |   |      |         |
| 0         |        | 0248      |              | +0.160 |   |      |         |
| 100       |        | 0254      |              | -0.189 |   |      |         |
| 0         |        | 0300      |              | +0.146 |   |      |         |
| 100       |        | 0306      |              | -0.185 |   |      |         |
| 0         |        | 0312      |              | +0.156 |   |      |         |
| 100       |        | 0318      |              | -0.183 |   |      |         |
| 0         |        | 0324      |              | +0.147 |   |      |         |
| 100       |        | 0330      |              | -0.181 |   |      |         |
| 0         |        | 0336      |              | +0.159 |   |      |         |

15.00L  
14500-L

### Relative Gravity Meter Log Sheet

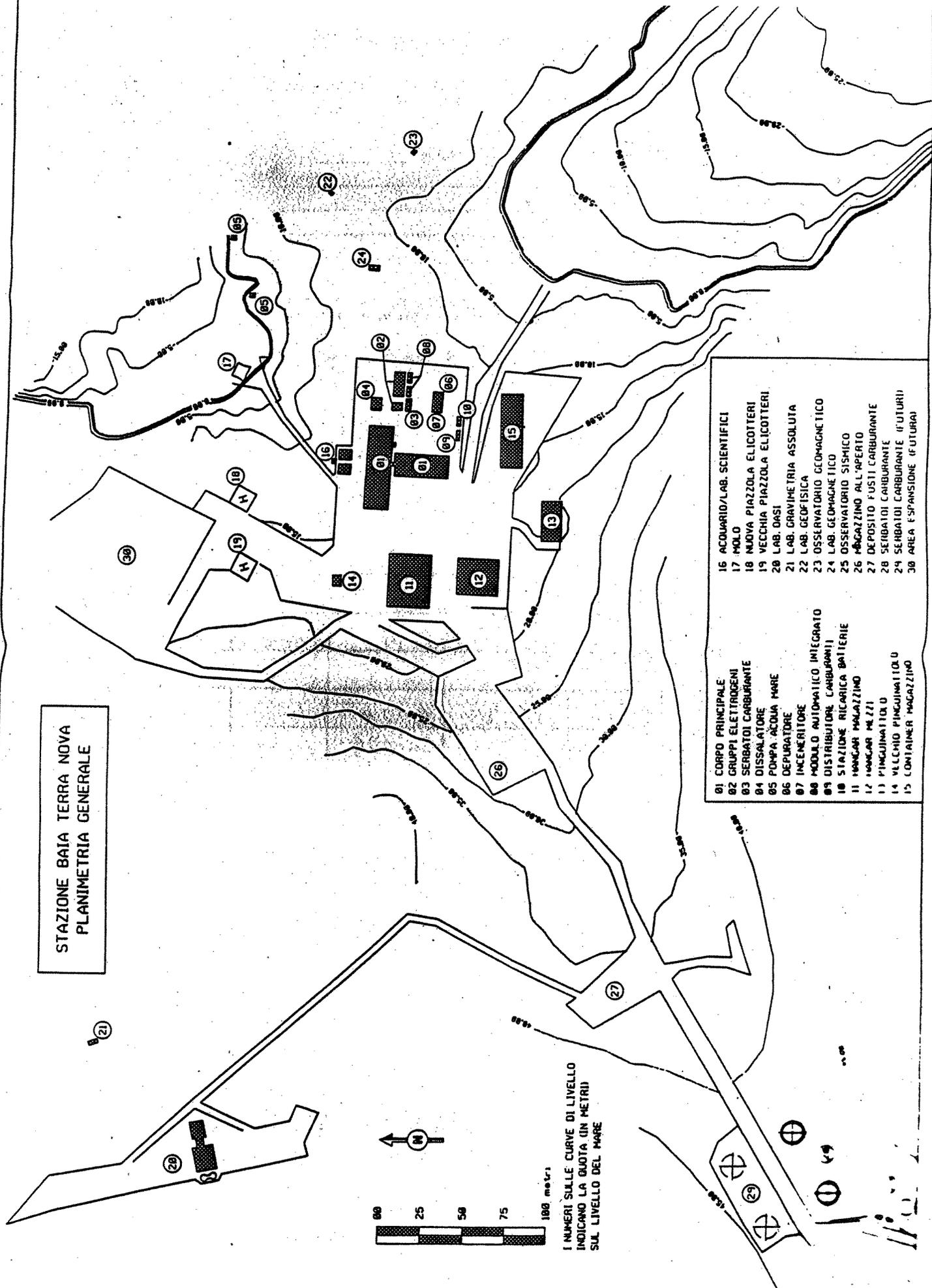
Meter # D-17  
 Survey Notes \_\_\_\_\_

Operator \_\_\_\_\_

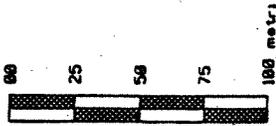
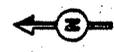
| Site Name                             | Date   | Time (UT) | Dial Reading | EFU    | g | Tide | Corr. g |
|---------------------------------------|--------|-----------|--------------|--------|---|------|---------|
| TNB-AB'                               | 13 Nov | 2125      | 95.700       | +0.084 |   |      |         |
| IRGS                                  |        | 2140      | 94.230       | +0.012 |   |      |         |
| TNB-AB'                               |        | 2151      | 95.700       | 0.154  |   |      |         |
| IRGS                                  |        | 2202      | 94.230       | 0.090  |   |      |         |
| TNB-AB'                               |        | 2214      | 95.700       | 0.128  |   |      |         |
| IRGS                                  |        | 2231      | 94.230       | 0.101  |   |      |         |
| TNB-AB'                               |        | 2238      | 95.700       | 0.141  |   |      |         |
| <del>IRGS</del><br><del>TNB-AB'</del> |        | 2251      | 94.230       | 0.098  |   |      |         |
| TNB-AB'                               |        | 2301      | 95.700       | 0.124  |   |      |         |
| IRGS                                  |        | 2314      | 94.230       | 0.095  |   |      |         |
| TNB-AB'                               |        | 2325      | 95.700       | 0.143  |   |      |         |
| IRGS                                  |        | 2337      | 94.230       | 0.103  |   |      |         |
| TNB-AB'                               |        | 2348      | 95.700       | 0.180  |   |      |         |
| TNB-AB'                               |        | 0159      | 95.700       | 0.160  |   |      |         |
| IRGS                                  |        | 0214      | 94.230       | 0.131  |   |      |         |
| TNB-AB'                               |        | 0225      | 95.700       | 0.122  |   |      |         |
| IRGS                                  |        | 0235      | 94.230       | 0.115  |   |      |         |
| TNB-AB'                               |        | 0255      | 95.700       | 0.111  |   |      |         |
| IRGS                                  |        | 0314      | 94.230       | 0.127  |   |      |         |
| TNB-AB'                               |        | 0325      | 95.700       | 0.144  |   |      |         |

*note  
 survey*

STAZIONE BAIÀ TERRA NOVA  
PLANIMETRIA GENERALE



STAZIONE BAIÀ TERRA NOVA  
PLANIMETRIA GENERALE



I NUMERI SULLE CURVE DI LIVELLO  
INDICANO LA QUOTA (IN METRI)  
SUL LIVELLO DEL MARE

- |    |                             |    |                              |
|----|-----------------------------|----|------------------------------|
| 01 | CORPO PRINCIPALE            | 16 | ACQUARIO/LAB. SCIENTIFICI    |
| 02 | GRUPPI ELETTROGENI          | 17 | MOLO                         |
| 03 | SERBATOI CARBURANTE         | 18 | NUOVA PIAZZOLA ELICOTTERI    |
| 04 | DISSALATORE                 | 19 | VECCHIA PIAZZOLA ELICOTTERI  |
| 05 | POMPA ACQUA MARE            | 20 | LAB. OASI                    |
| 06 | DEPURATORE                  | 21 | LAB. GRAVIMETRIA ASSOLUTA    |
| 07 | INCENERITORE                | 22 | LAB. GEOFISICA               |
| 08 | MODULO AUTOMATICO INTEGRATO | 23 | OSSERVATORIO GEOMAGNETICO    |
| 09 | DISTRIBUZIONE CARBURANTI    | 24 | LAB. GEOMAGNETICO            |
| 10 | STAZIONE RICARICA BATTERIE  | 25 | OSSERVATORIO SISMICO         |
| 11 | MANGIAR MALAZZINO           | 26 | MAGAZZINO ALL'APERTO         |
| 12 | MANGIAR MEZZI               | 27 | DEPOSITO FUSTI CARBURANTE    |
| 13 | PINGUINATOIO                | 28 | SERBATOI CARBURANTE          |
| 14 | VELECHIO PINGUINATOIO       | 29 | SERBATOI CARBURANTE (FUTURI) |
| 15 | CONTAINER MAGAZZINO         | 30 | AREA ESPANSIONE (FUTURA)     |