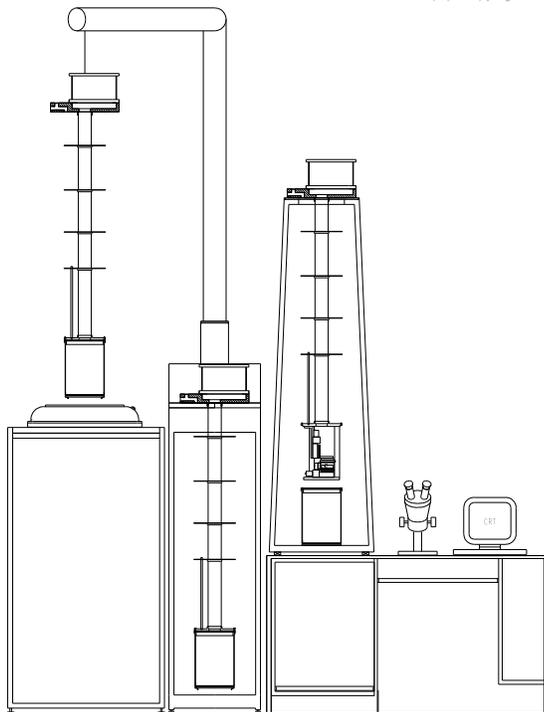


Scanning Magnetic Microscope 1000

**Computer Controlled
3 Channel Magnetometer System**

SMM 1000 System *Version 2.0*
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TRISTAN TECHNOLOGIES

SAN DIEGO, CALIFORNIA U.S.A.

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Date	Revision	Description
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Any questions or comments in regard to this product and other products from Tristan, please contact:

<p><i>Tristan Technologies, Inc.</i> 6191 Cornerstone Court E, Ste 107 San Diego, CA 92121 U. S. A.</p> <p><i>phone:</i> (619) 550 - 2700 <i>fax:</i> (619) 550 - 2799</p>
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WARRANTY

WARRANTY

Tristan Technologies warrants its products to be free from defects in material and workmanship. Obligations under this warranty shall be limited to replacing, repairing, or giving credit for the purchase price, at Tristan's option, of any instrument returned, shipment prepaid, to its factory for that purpose within one year of delivery to the original purchaser, provided prior authorization for such return has been given by an authorized Tristan representative.

This warranty shall not apply to any instrument which Tristan's inspection discloses to have become defective or unworkable due to abuse, mishandling, misuse, accident, alteration, negligence, improper installation, or other causes. This warranty shall not apply to any instrument or component not manufactured by Tristan. When products manufactured by others are included in Tristan's equipment, the original manufacturer's warranty, if any, is extended to purchaser to the extent permitted by that manufacturer.

Tristan reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

There are no warranties which extend beyond the description herein.

This warranty is in lieu of, and excludes any and all other warranties or representations, expressed, implied or statutory, including merchantability and fitness for purpose as well as any and all other obligations or liabilities of seller, including, but not limited to, special or consequential damages. No person, firm or corporation is authorized to assume for Tristan any additional obligation or liability not expressly provided for herein.

Chapter 1: Introduction

1.1. SYSTEM OVERVIEW

The main components of the system are:

- Liquid Helium Dewar
- Three-Channel Scanning SQUID Magnetometer Probe
- Computer Control and Data Acquisition System
- Pump Down and Warm Up Station
- Probe Crane
- Probe Stand
- Control Console
- Miscellaneous Accessories
 - Optical Microscope /w stand
 - Lab Jack
 - Motor Cable
 - Position Sensor Cable
 - X-Y Stage Extension Cable
 - One GPIB cable (6')
 - Level Meter Cable 15'

These components are shown in Figures 1-1 & 1-3.

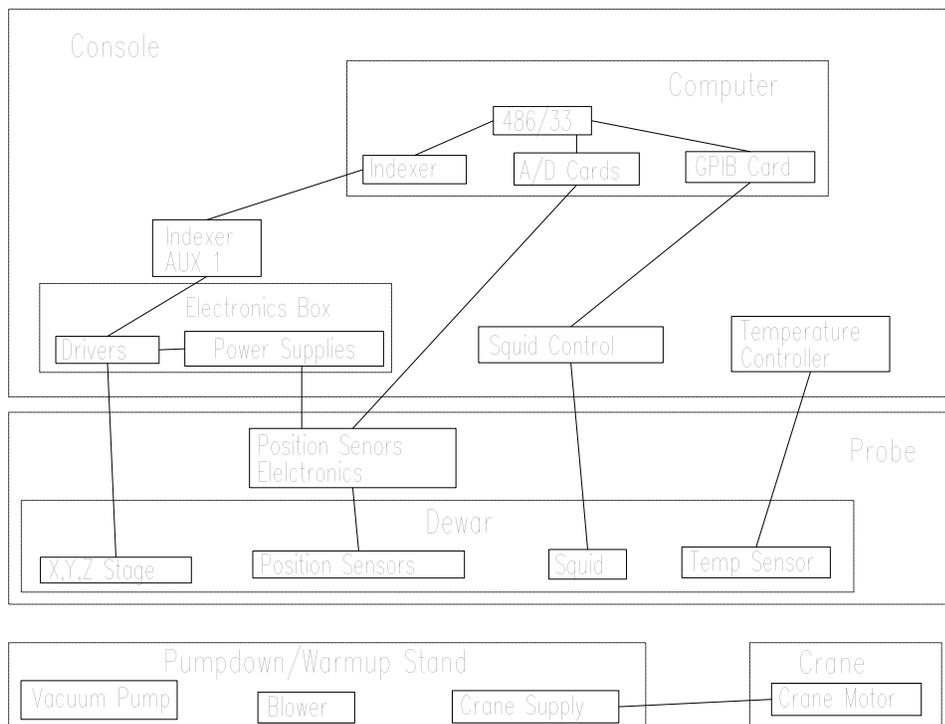


Figure 1-1: System block diagram

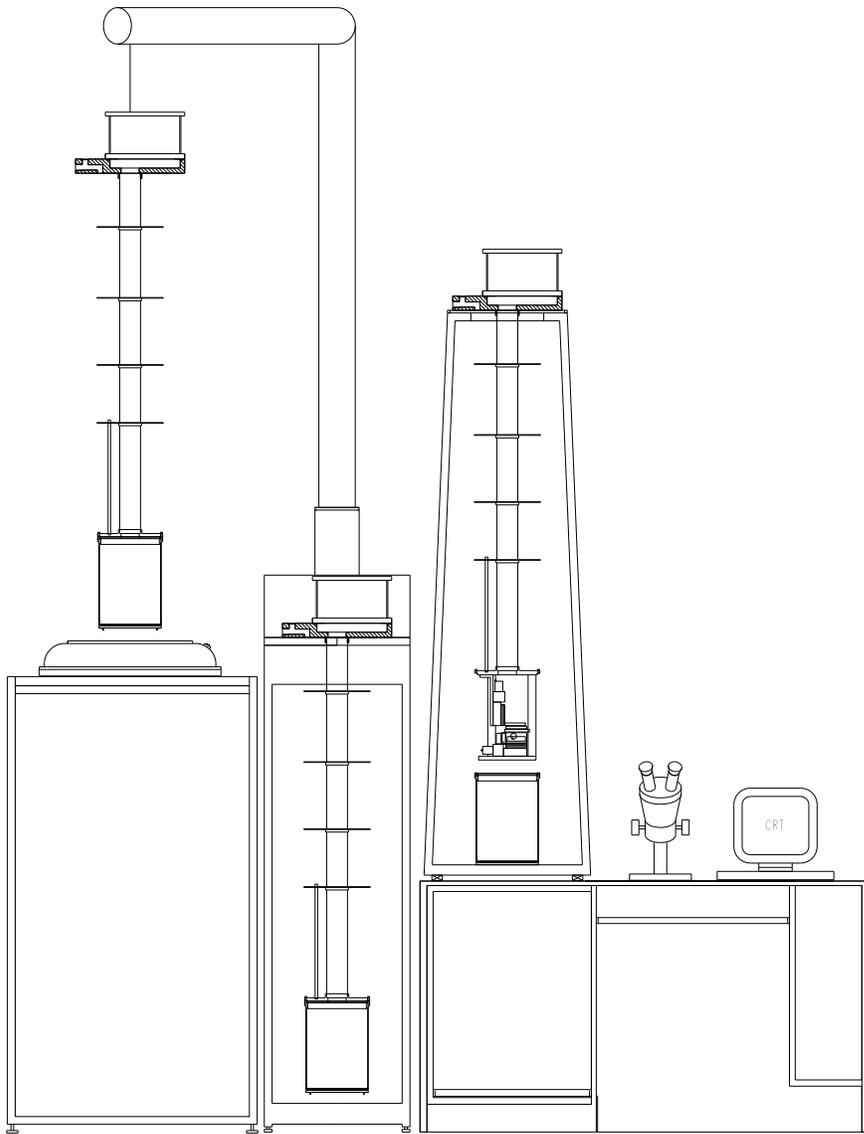


Figure 1-2: System Front View

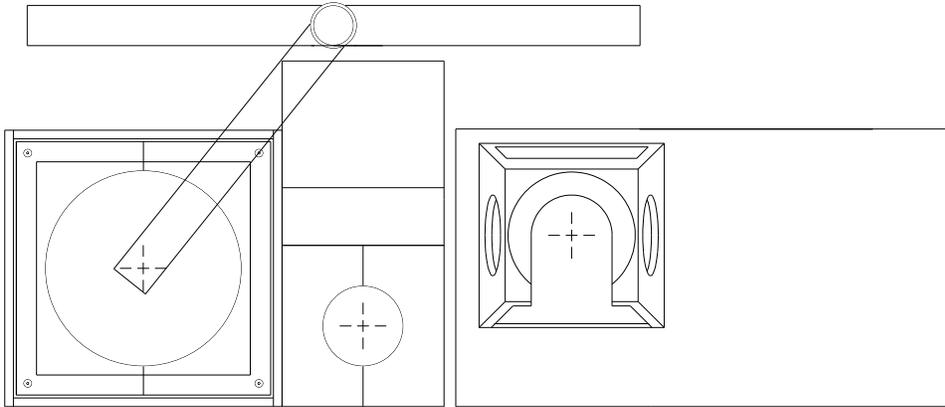


Figure 1-3: System Floor Plan.

1.1 CRYOGENIC SQUID CHIP

The SQUID chip has nine integrated SQUIDs. Each SQUID has a detection loop $14\mu\text{m} \times 14\mu\text{m}$, which is set away from the SQUID junctions. The detection loops are in a linear array, with a spacing of $50\mu\text{m}$.

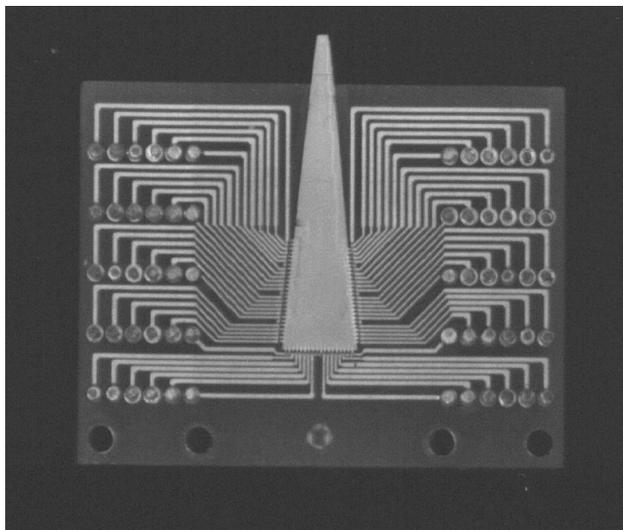


Figure 1-4: SQUID Chip.

1.2. COMPUTER CONTROL AND DATA ACQUISITION

1.2.1. Computer Hardware

The system is controlled by an IBM-AT compatible computer system including:

- 80486 microprocessor (33 MHz)
- 14" color monitor (1024x768 resolution capability with appropriate software, .28mm dot pitch)
- mouse and keyboard
- 8 MByte memory, expandable to 32 MByte
- 210 MByte hard disk
- one 5.25" floppy (1.2 MByte)
- one 3.5" floppy (1.44 MByte)
- two digital I/O cards with two, 20 bit A/D inputs
- IEEE-488 compatible digital communication port
- two, RS-232 communication ports
- one, Centronics compatible, 8 bit parallel port
- one, cartridge tape back up (120 MByte compressed capacity)
- MS DOS 5.0 operating system
- Custom Software for control of all critical system components (see below)
- Miscellaneous software utilities for debugging, graphing, memory management, and communication.

1.2.2. Custom Software

Custom software is supplied that is capable of controlling all critical system components, acquiring data from all SQUID channels, and analyzing the data to determine the magnetic properties of the sample being tested. AC and DC field control requires optional hardware.

Specific features include:

1.2.2.1. -- AC Field Control

Both amplitude and frequency of the sinusoidal, ac field applied to the sample are computer controlled. The field is automatically turned on and off as required during specific measurements.

1.2.2.2. -- DC Field Control

The dc field amplitude and ramp rate is computer controlled. A fully automated routine operates the heat switches and ramp the field as required. (The operator is required to turn the main power on to the magnet power supply).

1.2.2.3. -- SQUID Control

All necessary functions of the SQUID system are under computer control via the IEEE-488 bus. Utilities are provided to allow direct operator control of:

- GAIN
- SQUID RESET
- RANGE
- SQUID Heaters

These, and many other SQUID control functions, are automatically controlled as required to perform various sample measurements. In particular, all necessary data acquisition parameters are automatically set by the computer prior to a sample measurement.

1.2.2.4. -- Heater Control

The magnet persistent switch heater, SQUID heater, and pick up coil heaters are operable from the computer console. These heaters are also automatically switched on and off as required for various sample measurement procedures.

1.2.2.5. -- Interface to Automated Motion Control

The system is interfaced to an automated magnetometer positioning mechanism (a remote positioning mechanism). Communication between the remote positioning mechanism and the data acquisition computer will coordinate the motion of the remote positioning mechanism to the acquisition of data. Position information will be entered into the computer by a format described in the **POSFIL.EXE** in chapter 5.

1.2.2.6. -- AC Signal Nulling

Complete control of the AC Field Nulling Circuit allows the operator to manually null the in-phase and quadrature signal from the ac magnet that is detected by each SQUID channel. An automated procedure is also supplied that automatically nulls the signal from all channels by issuing a single command prior to data acquisition.

1.2.2.7. -- Automated Data Acquisition Procedures

Three classes of automated data acquisition procedures are supplied:

- ◆ manual trigger mode,
- ◆ timed mode,
- ◆ remote trigger mode.

In each of these, the operator is prompted to specify:

- channels from which data is to be acquired,
- data acquisition rate (samples/sec),
- number of data points to be acquired in a single burst,
- ac field amplitude and frequency.

If the operator desires and the acquisition rate is slow enough to allow for it, the operator is able to view the acquired data in real time on the CRT monitor.

Manual Trigger Mode -- In the manual mode, the operator may trigger each burst of data using the mouse. Multiple bursts will be stored in a single file.

Timed Mode -- In the timed mode, each burst of data will begin after a predetermined delay time until all bursts specified have been acquired. Multiple bursts are stored in a single file

Remote Trigger Mode -- In the remote mode, each burst of data may be triggered by a remote signal. This will usually be used to synchronize data Acquisition with the scanning device (the remote positioning mechanism).

1.2.2.8. -- Data Analysis Functions

After the data has been acquired and stored in a file, the operator is able to process the data using a variety of data analysis functions.

All data that is acquired is stored in a standard format that will include a header file describing all of the important data acquisition parameters. A new file will be created by the data analysis function that has the same format as the original file. The header file will be modified to indicate that the data has been processed by the specified data analysis function. See chapter 5 for more details.

The data analysis functions supplied includes:

Decimate -- This will reduce the number of data points stored in the file by rejecting a specified percentage of the data points. A specified number of points at the beginning and end of each data burst can also be rejected.

FFT -- A fast Fourier transform will be applied to each burst of data.

Average -- This will average the data over a specified parameter, e.g. the data from all bursts in the file could be averaged together or multiple FFT's could be averaged together.

Slope -- Calculate the ratio of change in magnetometer output to change in applied field. This ratio can be calculated for each cycle of applied ac field or for the average of all cycles of applied field during the data burst.

Area -- Calculate the area of the B/H loop. This can be done for each cycle of applied field or for the average of all cycles.

Amplitude -- Calculate the peak-to-peak amplitude of the magnetometer output (or any other measured output) during a single cycle of applied ac field or during a single burst of data.

Filter -- This will apply a low-pass, high-pass, or band pass digital filter to the data.

Other -- Tools will be provided to simplify the addition of other data acquisition procedures as may be required. For example, these tools will read and write the standard data file formats.

1.2.2.9. -- Data Plotting Functions

A variety of data plotting functions is supplied that can operate on the standard data format. This will allow any data file to be plotted in any of the following formats (some of these formats may not be meaningful for some of the data files).

Time Series -- Plots the data amplitude versus data point

X-Y Plot -- Plots the amplitude of one magnetometer function versus AC current.

Contour Plot -- Plots the amplitude as a contour plot versus X-Y position.

3-D Contour Plot -- Plots the amplitude of a data set versus X-Y position.

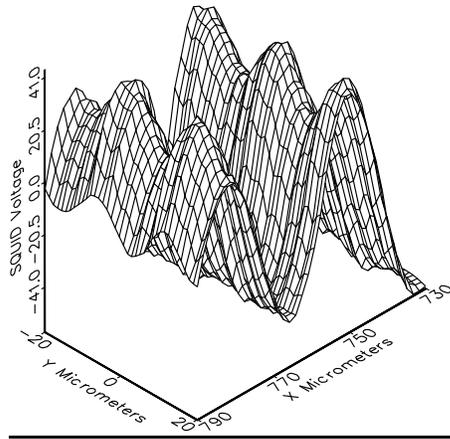


Figure 1-5: Sample surface plot from a scan of a magnetic disk.

1.3. MAGNETIC FIELD SYSTEM

1.3.1. DC Field

The superconducting magnet on the magnetometer probe is capable of applying a dc magnetic field to a sample. The dc magnet operates in a persistent field mode.

The dc magnet is 0.99 cm in diameter and .38 cm long with 250 turns. The measured field profile from this magnet is shown in Figure 1-6. The distance from the magnet center line to the Squid chip is about 2.5 cm.

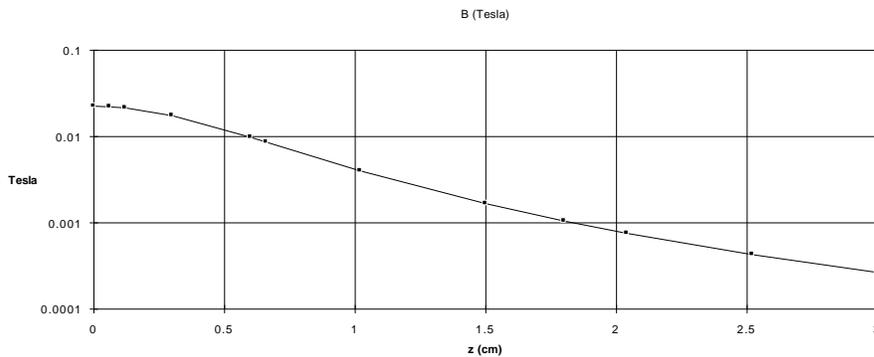


Figure 1-6: Magnetic Field at 1 Amp as a function of distance along the axis.

The circuit used in the superconducting magnet circuit is shown in Figure 1-7. The switch heater is activated via an external power supply. See the appendix for the pin connections.

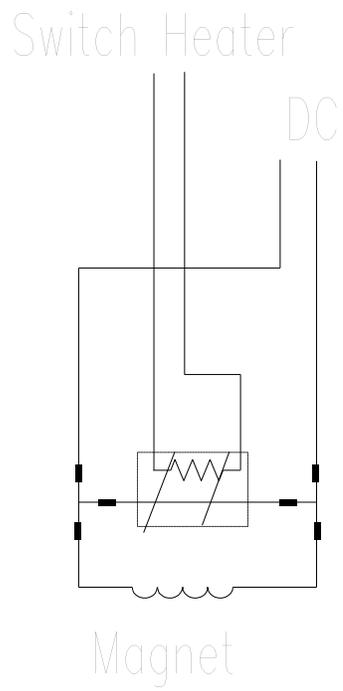


Figure 1-7: Superconducting magnetic field circuit.

1.4. Control Console

Major part of the system electronics and the computer control system are housed in a custom-fabricated control console. This console is desk-like in nature and is approximately 1.5 m wide by 0.6 m deep by 0.7 m tall.

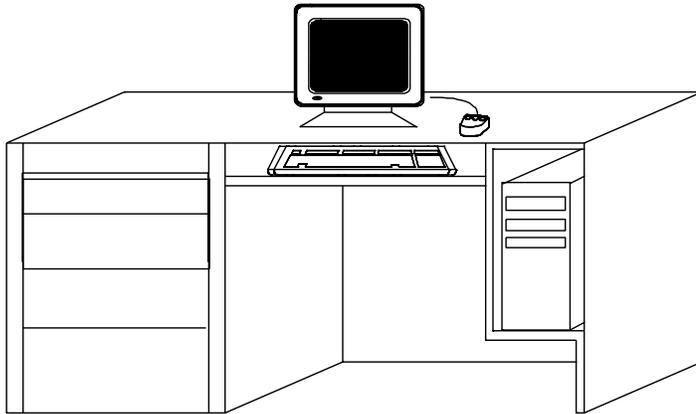


Figure 1-8: Control Console

1.7. MEASURED PARAMETERS AND FACTORY TEST DATA

The following parameters were measured at Tristan prior to shipment. Dimensions and weights are approximate and are given for reference only. Performance data is the result of testing done at Tristan. Under ideal conditions, you should expect to achieve similar performance in your laboratory, but small differences are to be expected.

1.7.1. System details

Helium Dewar

Dewar Capacity	21 L
Equilibrium Helium Consumption	~ 5 L/day
Suggested Operating Time Between Refills	3 days
Dimensions:	
Overall Height	46 inches
Maximum Diameter	17½ inches
Weight (empty)	≈ 50 lb
Construction:	
All Al dewar with fiberglass neck. Superinsulated.	
Helium Level Sensor: Superconducting Wire with 10½" active length	
Volts at 0%	8.3 Volts

Noise	SQ 1	SQ 2	SQ 3
T/V x10 ⁸ Calculated	56	56	56
SQUID $\mu\phi_0$ /Hz	3	3	3
effective area x 10 ⁻¹² m ²	196	196	196
V/ ϕ_0	19	19	19
fT/###Hz	1X10 ⁻¹⁰	1X10 ⁻¹⁰	1X10 ⁻¹⁰

all above on range 5

TUNE	SQ 1	SQ 2	SQ 3
BIAS (%)			
SKEW			
V (pp mon)			
TUNE VOLTS (Panel)			

Chapter 2: SAFETY PRECAUTIONS

2.1. SAFETY PRECAUTIONS FOR HANDLING LIQUID HELIUM AND LIQUID NITROGEN

The potential hazards of handling liquid helium stem mainly from the following properties:

WARNING
1. THE LIQUID IS <u>EXTREMELY</u> COLD (HELIUM IS THE COLDEST OF ALL CRYOGENIC LIQUIDS).
2. THE ULTRA-LOW TEMPERATURE OF LIQUID HELIUM CAN CONDENSE AND SOLIDIFY AIR.
3. VERY SMALL AMOUNTS OF LIQUID HELIUM ARE CONVERTED INTO LARGE VOLUMES OF GAS.
4. HELIUM IS NOT LIFE SUPPORTING.

2.2. Extreme Cold-- Cover Eyes and Exposed Skin

Accidental contact of liquid helium or the cold gas that results from its rapid evaporation may cause a freezing injury similar to a burn. Protect your eyes and cover the skin where the possibility of contact exists. Eye protection should always be worn when transferring liquid helium.

2.3. Keep Air and Other Gases Away from Liquid Helium

The low temperature of liquid helium or cold gaseous helium can solidify another gas. Solidified gasses and liquid, particularly solidified air, can plug pressure-relief passages and fowl relief valves. Plugged passages are hazardous because of the continual need to vent the helium gas which evolves as the liquid continuously evaporates. Therefore, always store and handle liquid helium under positive pressure and in closed systems to prevent the infiltration and solidification of air or other gases. Do not permit condensed air on transfer tubes to run down into the container opening.

2.4. Keep Exterior Surfaces Clean to Prevent Combustion

Atmospheric air will condense on exposed helium-cooled piping. Nitrogen, having a lower boiling point than oxygen, will evaporate first from condensed air, leaving an oxygen-enriched liquid that may drip or flow to nearby surfaces. Areas and surfaces upon which oxygen-enriched liquid can form, or come in contact with, must be cleaned to oxygen-clean standards to prevent possible ignition of grease, oil, or other combustible substances. Leak-testing solutions should be selected carefully to avoid mixtures which can leave a residue that is combustible. When combustible type foam insulations are used, they should be carefully applied to reduce the possibility of exposure to oxygen-enriched liquid which could, upon impact, cause explosive burning of the foam.

2.5. Pressure-Relief Devices Must Be Adequately Sized

While most cryogenic liquids require considerable heat for evaporation, liquid helium has a very low latent heat of vaporization. Consequently, it evaporates very rapidly when heat is introduced or

when liquid helium is first transferred into warm or partially-cooled equipment. The quenching of a superconducting solenoid or even minor deterioration of the vacuum in the helium container can result in significant evaporation. Pressure relief devices for liquid helium equipment must, therefore, be of adequate capacity to release helium vapor resulting from such heat inputs, and thus, prevent hazard due to excessive pressure. This system has been designed to safely vent the evolving helium gas in the event of any reasonable failure mode.

WARNING
DO NOT MAKE ANY MODIFICATIONS TO THIS SYSTEM WHICH MIGHT AFFECT ITS ABILITY TO VENT HELIUM GAS IN THE EVENT OF AN EMERGENCY SUCH AS LOSS OF VACUUM IN THE DEWAR VACUUM SPACE.

If transfer lines can be closed off at both ends so that a cryogenic liquid or the related cold gas can become trapped between the closed ends, a pressure-relief device must be provided in that line to prevent excessive pressure build-up.

2.6. Keep Equipment Area Well Ventilated

Although helium is nontoxic, it can cause asphyxiation in a confined area without adequate ventilation. Any atmosphere which does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Helium, being colorless, odorless, and tasteless cannot be detected by the human senses and will be inhaled normally as if it were air. Without adequate ventilation, the expanding helium can displace air and result in an atmosphere that is not life-supporting. The cloudy vapor that appears when liquid helium is exposed to the air is condensed moisture, not the gas itself. The issuing helium gas is invisible. Liquid containers should be stored in large, well ventilated areas.

If a person becomes groggy or loses consciousness when working around helium, get them to a well ventilated area immediately. If breathing has stopped, apply artificial respiration. If a person loses consciousness, summon a physician immediately.

Chapter 3: INSTALLATION

3.1 INITIAL INSPECTION

All Tristan instruments and equipment are carefully inspected and packaged at Tristan prior to shipment. However, if a unit is received mechanically damaged, notify the carrier and the nearest Tristan representative, or the factory in San Diego, California. Keep the shipping container and packing material for the carrier and insurance inspections.

If the unit does not appear to be damaged but does not operate to specifications, contact the nearest Tristan representative or the Tristan factory and describe the problem in detail. Please be prepared to discuss all surrounding circumstances, including installation and connection detail. After obtaining authorization from the Tristan representative, return the unit for repair along with a tag to it identifying yourself as the owner. Please enclose a letter describing the problem in as much detail as possible.

3.2 REPACKING FOR RETURN SHIPMENT

If it is necessary to return the system, you should repack the unit in its original container (if available). For this reason, it is advisable to save the original crate sent by Tristan; however, if this is not possible, use the following instructions for repacking.

1. Wrap the unit in either bubble wrap or foam rubber.
2. Cover the bottom of a sturdy container with at least 3 inches of Styrofoam pellets or shredded paper.
3. Set the unit down onto the packing material and fill the rest of the container with Styrofoam or shredded paper. The unit must be completely protected by at least 3 inches of packing material on all sides.

3.3 SYSTEM COMPONENTS

The following components are included with this system. Please check carefully when unpacking the equipment to verify that everything is located. We recommend that you save the shipping crates for possible future use in case the system has been damaged and needs to be repaired.

Quantity	Description
1	Custom Designed SQUID Magnetometer Probe
1	Custom Designed Liquid Helium Dewar
1	MODEL 5000 dc SQUID CONTROL (Quantum Design) ¹
3	MODEL 500 dc SQUID multiCARD ¹ (installed in MODEL 5000)
3	microPREAMP™ ¹ with cable to connect MODEL 5000 to Probe
1	Miscellaneous Accessories
1	System Instruction Manual
1	DC SQUID Electronics Instruction Manual (Quantum Design ¹)
1	Indexer and Driver Manuals
1	A/D Board Manual
1	Philtec Specifications
1	Control Console
1	Pump Down and Warm Up Station
1	Probe Crane
1	Probe Stand
1	Optical Microscope /w stand
1	Lab Jack
1	Position Sensor Cable
1	Motor Cable
1	X-Y Stage Extension Cable
1	GPIB cable (6')
1	Level Meter Cable 15'
1	486 PC (ref. 1.2.1)

3.4 System Assembly

Dewar:

Dewar is mounted in the dewar stand via the rubber shock cords provided. The support rings on the dewar are aligned normal to each side of the dewar stand. A shock cord attaches from each middle support ring to the two adjacent eye-bolts in the upper corners of the dewar stand. Four additional shock cords are stretched between the lower eye-bolts on the dewar stand and attached to the lower dewar support rings via S hooks. The turn buckles are adjusted to center, level, and raise the dewar.

Crane:

The crane should be positioned as shown in figure 3.5.1, so that the probe cable is centered on the dewar and the warmup stand. Once the position is determined the crane should be bolted to the floor.

Warmup/Pumpdown stand:

The vacuum pump is installed in the rear of the warmup stand on the metal bracket. The vacuum line is attached to the red hose using a hose clamp. Power is then connected (lines are coded). The warmup stand should be located adjacent to the dewar stand on the right hand side, with the front surface flush with the dewar stand. Once in place the crane power should be connected.

Console:

¹Quantum Design, San Diego, CA USA

Position the console to the right of the warmup stand. The console should not be touching the warmup stand. The AT6400 AUX1 should be mounted behind the computer. The temperature controller, SQUID controller, and electronics box are all mounted in the rack on the left hand side of the console.

After all components are positioned, cabling should be attached. Different connector types are used to insure proper installation.

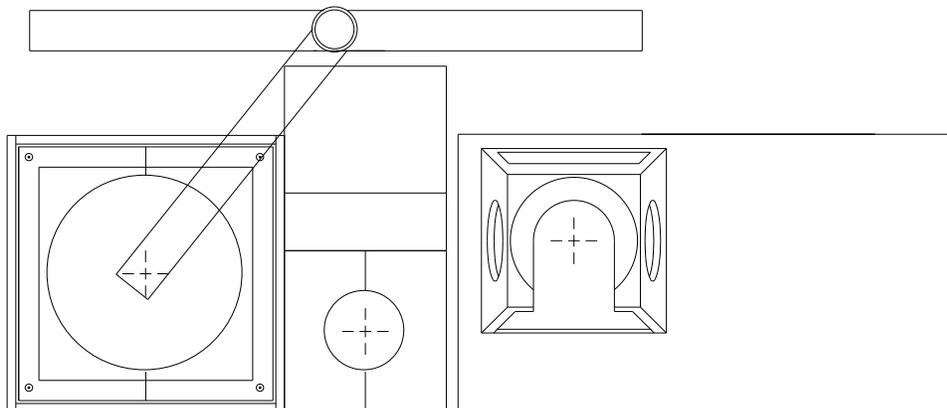


Figure 3.5.1: Floor Layout

Chapter 4: NORMAL OPERATION

4.1 REFILLING THE DEWAR WITH LIQUID HELIUM

After the initial liquid helium transfer, subsequent transfers will be required on a regular basis. The liquid helium should never be allowed to completely boil out of the helium reservoir. Always refill the dewar while there is still some liquid helium in the reservoir; a minimum level of 5 % is recommended. During normal use, this will require that the helium be refilled every 2 - 3 days.

To refill the dewar, first set up the Model 5000 SQUID Electronics to continuously monitor the helium level (see Model 5000 Operator's Manual for Instructions). You can transfer liquid helium into this system using standard techniques, but you will find it quite helpful to follow the following guidelines:

- ◆ Begin to transfer helium with the transfer tube OUTSIDE the magnetometer dewar. This will cool down the tube without evaporating liquid in the dewar. Do not insert the transfer tube into the magnetometer dewar until liquid helium can be seen coming out the end of the transfer tube (it will look like a plume of very cold gas about 5 cm long).
- ◆ Then insert your insulated transfer tube into the dewar a total distance of 24 cm from the top plate.
- ◆ Transfer at a moderate rate using an approximate pressure in your storage dewar of 10 kilopascal
- ◆ Stop the transfer by venting the storage dewar when the magnetometer dewar reaches about 95%.
- ◆ When the storage dewar has been vented back to atmospheric pressure, remove the transfer tube and replace the plug in the top of the dewar.

4.2 Mounting Sample

- Use four 00-90 screws to mount chip holder to stage.
- Connect leads to chip holder
- Verify all lines below surface.
- Visually check for flatness and surface cleanliness.
- Verify that z stage is fully retracted.
- Using lab jack, slowly raise x-y stages until seated in support legs.

CAUTION: Watch for x-y sensors hitting tilt stage, wires pinching under support legs, and sample hitting squid chip.

- Snap spring latches in place
- Connect x-y motor and sample lines
- Remove lab jack

2. Verify x,y,z Motion and Sensors

- Connect motor and position sensor lines at top of probe
- Down load AT6400 operating system (ATSTART)
- Start NDE software and enter manual table move under utilities
- move x + 1 mm, while moving raise squid chip (via spring attachment) x motor should shut off. Repeat test for -x,+y,-y,+z motions.

3. Leveling:

- Move stages (x,y) to positive limit.
- Define position as 3175,3175 mm
- Move to 0,0
- Move z down slowly until z - sensor is on front side of optical peak and reading ~ 3v
- Define position as z = 0
- Move to ± 2 mm, 0, 0 and 0, ± 2 mm, 0
Record z position voltage @ each location * (Both axis)
- Calculate $\Delta V_x = V(+X) - V(-X)$
 $\Delta V_y = V(+Y) - V(-Y)$
- Calculate $\Delta Z = \Delta V * 11.3 \mu\text{m}/\text{v}$
- ### Calculate turns #turns = 1018.9 * $\Delta Z/\Delta X$
- Move Z to -1 mm
- Adjust tilt,
- Repeat until ΔZ approximately 1 μm

*** If unable to use Z sensor the sample may be leveled via the following procedure:**

Move to ± 2 mm,0,0 and 0, ± 2 mm,0
@ each position move z in plus direction until shut off.
Record z height, move back ~100 μm

4. Vacuum Can Assembly:

- Remove any old Indium
- Grease with M grease Vacuum Can and top of can sealing surfaces
- Grease with M grease New Indium o-ring
- Install o-ring in Vacuum Can
- Carefully install Vacuum Can, making sure o-ring is not disturbed
- Tighten all 12 nuts in circular pattern

5. Pump down / He purge

- Move probe to pump down station
- Install valve and bellows
- With probe valve closed start Vacuum pump
- Open Vacuum line on pump stand and verify Vacuum to approximately < 200 m
- Open probe valve and verify pressure increase
- When pressure reads approximately < 500 m, backfill with He until over pressured (poppet valves pop). Repeat twice more
- Close Vacuum valve @ probe (with it backfilled) and remove Vacuum line

6. Cool Down

The cool down procedure described below assumes the probe is being lowered into liquid He. If possible it is preferable to lower into the dewar with LN₂ as this will save He. The procedure is the same, though one must be careful to remove all LN₂ before transferring He. The dewar can be pressurized to remove the LN₂.

- Raise the probe slightly, and install the plexiglass shield around the probe. Connect the shield to the counterweighted shield cable.
- Lift probe and shield with crane until probe will clear the top of dewar.
- Insure that all clamps on the dewar are aligned outward to allow the shield to clear.
- Remove dewar plug and quickly position probe over dewar. Lower probe until shield is in place.
- Taking care that the probe is centered and not stuck, slowly lower into the dewar.
- When probe is down all the way lift the shield and remove the probe cable. The shield may then be placed in the warmup stand.
- Rotate probe to desired orientation, and tighten the six probe clamps.

- Connect all cables to the top of the probe. These cable are:
 1. Level meter (4 pin)
 2. Motor lines (26 pin)
 3. Position sensor lines (8 pin)
 4. Three SQUID connectors (9 pin)
 5. Thermometer (10 pin)
 6. Sample lines (10 pin)
 7. Magnet lines (10 pin)

- Transfer He as required. (See 4.1)

Comment [RLZ1]: Page: 3

7. Warm Up

- Move SQUID chip more than 1 mm away from sample.
- Remove all cables from the top of the probe.
- Position shield above probe, and attach the probe cable.
- Loosen all six clamps and rotate to clear shield
- Lower shield into position.
- Holding shield in place, raise probe slowly.
- Once probe is above the dewar, position it over the warmup stand. Replace dewar plug.
- Lower probe and shield into warmup stand until probe is just above the top. Drop shield down into the stand, and replace the stand top plates.
- Lower probe onto top plates.
- Start blower.

CAUTION:
Probe should not be opened until the stages are at room temperature.

4.3 TUNING THE SQUID AND OPERATING THE CONTROL ELECTRONICS

Comprehensive instructions for tuning and operating the SQUID electronics may be found in the MODEL 5000 DC SQUID CONTROLLER OPERATOR'S MANUAL which has been included with this system. For expedient sake, we are providing the following section as a quick setup procedure. Any questions and detail operations, please refer back to the Squid Controller operator's manual.

The basic procedure steps are:

Turn the power on for the SQUID controller; do the autotuning of the Squids; and verify the variable setups. (The SQUID controller variables should all have the proper settings as it did from the manufacturer. Users should still verify them to make sure it suits their particular test environment.)

1. Turn Power ON by pressing the white **POWER** button.

It will go through power on self test.

Once finished, it will be in the Status Display screen.

2. Push **TUNE** key 2 times

If the tuned value is "Good", it will proceed back to the Status Display screen. If the Tuned value is "Bad", it will stay in that screen. (Value between 20 to 50 are still ok).

3. Make sure the initial settings are correct.

Range = 500,

Gain = 1x, and

Filter = 1k, and

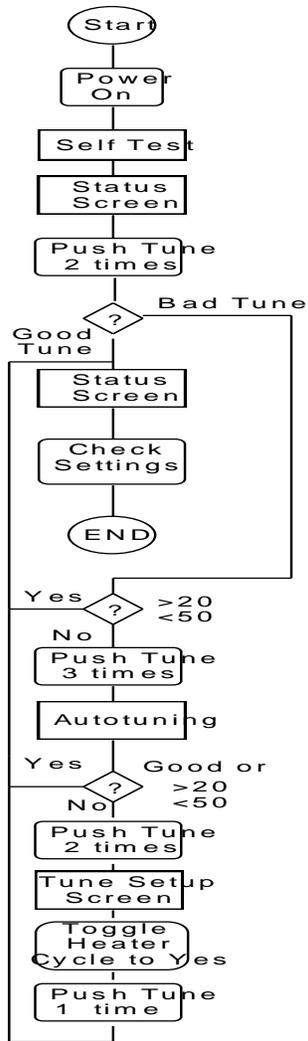
Monitor Filter : None

 see footnote on Helium level

 The **up/down/left/right** cursor keys can toggle the channels.

 The **decr/incr** keys can toggle the monitor filter field.

4. For "Bad" tune results, if the value shown is between 20 and 50, it can generally be used. If you choose to ignore it, just proceed by pressing **ESC** key.
5. Otherwise, Push **TUNE** key three times. It will repeat the auto tune process.
6. If the tuned result is good, proceed to 3.
7. Push **TUNE** key two times to go to the Tune Setup Screen. Use the [+/-] key to toggle the Heater cycle to YES.
8. Push **TUNE** key one time to go through the heating of SQUID to heat (remove trapped flux) and tuning the SQUID.



Make sure the Helium level is OK.

Check the Helium Level Sensor screen settings to be the following:

Helium Level Sensor

HE Monitor: **Disable**

HE Display: **ENABLE**

CALCULATED LEVEL: --%(Volts at 0%: 8.23) or as specified in system.tti

Error! Bookmark not defined. **Chapter 5: USER INTERFACE**

5.1. BASIC DESCRIPTION

The user interface is the graphical human interaction portion of the program "NDE.EXE". This user interface is comprised of a collection of objects such as menu bars, panels, pop-up panels, and controls. Please see the Lab Windows "User Interface Library Reference Manual" for a complete description of the user interface objects and operation.

<p style="text-align: center;">IMPORTANT!</p> <p>Any data entry must be followed by a <RETURN> or the values will not be used even though the values are shown on the screen. This is a limitation of the LAB WINDOWS environment.</p> <p>The DC fields are limited by 20 Amps. The AC by 5 Amps. The maximum SQUID sample rate is about 250 Hz. The slowest continuous SQUID sample rate is about 10 Hz. The AC magnet maximum frequency is about 200 Hz. Please note a 200 Hz AC magnet frequency is a gross under sample of AC data with a SQUID sample rate of 300 Hz.. NDE software warns the user if fewer than 10 samples per AC magnet frequencies are sampled. The maximum field that can be acquired, plotted, or analyzed has a limitation of 8000 entries per burst. The entire data file may have more than 8000 samples. The file size is only limited to the size of the hard disk.</p>
--

5.2. MENU BARS AND HARDWARE CONFIGURATION

Figures 5.1 and 5.2 illustrate the menu bars associated with the program "NDE". Subsequent to the program's initialization, a menu bar appears on the screen. If initialization with hardware is selected, PC communication to the system hardware configuration is established. Current software supported hardware configuration options include:

<p>1.) SQUID controller 2.) Tristan Noise Cancellation Unit (NCU) 3.) Wavetek function generator 4.) AT6400 indexer for table scanner movement 5.) Lawson 20-bit AD position transducer for position read</p> <p style="text-align: center;">Hardware Configurations Options supported by the NDE software</p>

Each NDE system has a subset of the hardware configuration described above. The configuration is established at the factory prior to shipment. If the hardware configuration is changed at a time subsequent to shipment, the NDE software may easily be re-configured in the field to support any of the above listed hardware configurations. Subsequent to hardware initialization, the menu bar in Figure 5.1 appears on the computer screen.

System Setup	Data Acquisition	Data Analysis	Utilities	Quit!	Help!
---------------------	-------------------------	----------------------	------------------	--------------	--------------

Figure 5.1: Menu Bar with hardware installed.

NOTE

THE PC'S MEASUREMENT COMPUTER PROGRAM REQUIRES THE CORRECT INSTALLATION OF INTERFACE CABLES AND POWER ON FOR HARDWARE INITIALIZATION OF THE CONFIGURED DEVICES.

If the user desires to execute the program without hardware installed, a subset of hardware initialization menu bar appears on the screen, as illustrated in Figure 5.2.

System Setup	Data Analysis	Utilities	Quit!	Help!
---------------------	----------------------	------------------	--------------	--------------

Figure 5.2: Menu Bar without hardware installed.

5.3. PULL-DOWN MENUS AND PANELS

The menu bars titles allow access to pull down menus. Figure 5.3 illustrates all of the pull-down menus for executing the program with hardware installed. The pull down menu associated with no hardware installed are a subset of the pull down menu associated with hardware installed. The following ntt\manualment describes the pull down menu for hardware initialization, the functioning and title of the "no hardware" pull down menus are the same as that of the hardware installed pull down menu.

Selecting a title on a pull-down menu causes an panel to appear on the screen or the computer to perform some action. Controls on the panels initiate some action by the computer.

WARNING

NUMERIC ENTRIES FOR CONTROL BOXES REQUIRE THE KEYBOARD'S ENTER KEY TO BE PUSHED. PARAMETERS TYPED IN THESE CONTROL BOXES DO NOT UPDATE UNTIL THE ENTER KEY IS PUSHED.

All of the panels accessed by the program are illustrated below. The remainder of this chapter discusses each one of the pull-down menu titles.

System Setup	Data Acquisition	Data Analysis	Utilities	Quit!	Help!
---------------------	-------------------------	----------------------	------------------	--------------	--------------

AC Field Setup DC Magnet Ramp SQUID Control System Parameter	AC Field Null Data Acquisition Auto Position Acq High Speed Acq	Manipulate Data XY Plot 3d Plot	SQUID Control Status GPIB Help Heater+Relay Control Function Gen Control Helium Level Check PC Memory Conv File to ASCII Conv Header to ASCII Conv ASCII to File Dummy Output File Create Position File Manual Table Move Conv File to Spread
---	--	---------------------------------------	---

Figure 5.3: Pull-Down Menus.

5.4. DESCRIPTION OF PULL-DOWN MENU TITLES

The pull-down menu titles consist of AC field setup, DC Magnet Ramp, SQUID Control, System Parameter, AC Field Null, Data Acquisition, Auto Position Acq, Manipulate Data, High Speed Acquisition, XY Plot, 3-D Plot, SQUID Control Status, GPIB Help, Heater+Relay Control, Function Generator Control, Helium Level, Save System State, Check PC Memory, Convert File to ASCII,

Convert Header to ASCII, Convert ASCII to File, Dummy Output File, Create Position File, Manual Table Move, and Convert File to Spreadsheet. Selecting one of these titles causes the computer to perform some action directly or display a panel. Most of descriptions below ntt\manualument the user interface portion of NDE, with the exception of the Manipulate Data section that describes each analysis algorithm used in processing NDE data.

5.4.1. AC Field Setup PULL-DOWN MENU

Selecting the AC Field Setup pull-down menu causes the computer to display the panel illustrated in Figure 5.4.1. This menu only applies to systems with an AC magnet. The AC Magnet signal may be generated by the Tristan NCU. The control boxes on this panel allow the user to set the electric current, the frequency, and to turn on or off the AC magnetic field during data acquisition. The panel's "AC Magnet Control" control does not instantly turn on the AC magnet, this switch only sets a flag in the program indicating that the AC magnet is on during data acquisition. When the AC magnet is "turned on", the AC field is automatically acquired and written to the output data file.

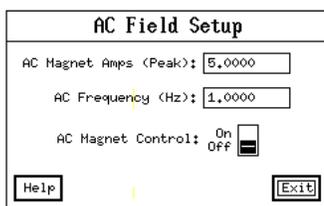


Figure 5.4.1 AC Field Setup Menu

5.4.2. DC Magnet Ramp PULL-DOWN MENU

Selecting the DC FIELD Ramp pull-down menu causes the computer to display the panel illustrated in Figure 5.4.2.1.

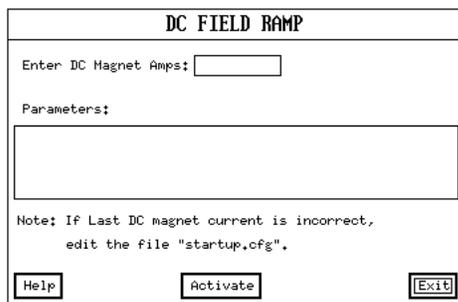


Figure 5.4.2.1 DC Field Ramp Menu

Please see figure 5.4.2.2 for an illustration of the DC Magnet Ramp algorithm.

Figure 5.4.2.2 DC Ramp Algorithm Illustration

The user sets the "Enter DC Magnet Amps" field and then selects "Activate". The DC Magnet Ramp algorithm consists of ramping the DC magnet from zero amps to the last applied amps, ramping from the last applied amps to the "Enter DC Magnet Amps", and then ramping to zero amps. Heater switches are also turned on and off during this ramping process. The panel's "Parameters" field displays the last DC magnet amps and the time and date of the last update. The last DC magnet amps and other DC Magnet Ramp parameters as illustrated in figure 6.2 are stored in the "**STARTUP.CFG**" input file. This value is read when the program is initially loaded into memory and is written to the input file at the end of the "DC FIELD Ramp" process. The new value stored as the last DC magnet amps in the input file is the "Enter DC Magnet Amps".

5.4.3. SQUID Control PULL-DOWN MENU

Selecting the SQUID Control pull-down menu causes the computer to display the panel illustrated in Figure 5.4.3. Each control corresponds to a setting on the SQUID controller. Please see the SQUID controller manual for a more complete description of the control titles.

Range: Sets the sensitivity of the measurement in terms of flux quanta. The range indicates the maximum flux quanta the SQUID channel can measure.

Gain: Sets the gain on amplifiers that feed the anti-alias filters.

Null Mode: This command allows the user when to activate the null algorithm. The null algorithm consists of "nulling" the output of the channel to zero volts by use of the offset D/A converter after a momentary reset. The possible Null Modes are OFF, MAN, and AUTO. If MANUAL is selected, the null algorithm is activated after a SQUID reset. If AUTO is selected, the null algorithm is activated subsequent to a SQUID reset or when the voltage exceeds the discriminator voltage.

Null Activate: The null algorithm is activated for the selected channel.

% Offset: Offsets the current injected into the channel.

Tune Activate: Adjusts the maximum BIAS current of the SQUID sensor to obtain a maximum amplitude of response from an input signal.

% Bias: Sets the level of the bias current in the SQUID sensor.

SQUID Triangles: Helps to check the quality of the measurement SQUIDs by inputting an AC signal into all of the installed SQUID channels. The user then connects an oscilloscope to the "Analog Output" port on the front of the SQUID controller and looks for a triangular shaped waveform. Each channel may be checked by selecting the appropriate "Monitor Channel".

GPIB SQUID command: This control is reserved for factory use.

Sample Rate(Hz): This control allows the user to set the acquisition rate when acquiring IEEE format data. IEEE format data is automatically acquired when using the "Data Acquisition" or "Auto Position Acq" menus. The sample rate is set in the SQUID controller by:

- 1.) Setting the SQUID controller's A/D converter rate i.e. 6kHz, 12kHz, 24kHz, or 48kHz. The A/D converter collects the real SQUID data for a single channel. The A/D converter is multiplexed for all the SQUID channels.
- 2.) Setting the SQUID controller's REPF. The REPF (repeat factor) is the number of times the channel list is repeated in the SQUID controller's measurement buffer.
- 3.) The SQUID controller then averages the measured data in the buffer for each channel. The averaged data is then downloaded to the PC via the GPIB interface.

Monitor Filter: The filtering applied to the "analog output" port of the SQUID controller.

Output Voltage: Displays the value of each SQUID channel's output voltage. Please note: "Sample Output Voltage" must be selected to update the display.

Reset SQUIDS: Resets all the installed SQUID channels.

Heat SQUIDS: Turns on the heaters for all the installed SQUIDS. The heaters are left on for 10 seconds then turned off.

Sample Output Voltage: Samples the output voltage for all the installed SQUIDS and displays the voltage in the "Output Voltage" controls.

Monitor Channel: Selects the SQUID channel output to the SQUID controller's "Analog output" port.

SQUID Control									
SQUID #	1	2	3	4	5	6	7	8	ALL
Range	<input type="button" value="5s"/>	<input type="button" value="5s"/>	<input type="button" value="5s"/>	<input type="button" value="5s"/>	<input type="button" value="5s"/>	<input type="button" value="5s"/>	<input type="button" value="5s"/>	<input type="button" value="5s"/>	<input type="button" value="Mixed"/>
Gain	<input type="button" value="1x"/>	<input type="button" value="1x"/>	<input type="button" value="1x"/>	<input type="button" value="1x"/>	<input type="button" value="1x"/>	<input type="button" value="1x"/>	<input type="button" value="1x"/>	<input type="button" value="1x"/>	<input type="button" value="Mixed"/>
Null Mode	<input type="button" value="Off"/>	<input type="button" value="Off"/>	<input type="button" value="Off"/>	<input type="button" value="Off"/>	<input type="button" value="Off"/>	<input type="button" value="Off"/>	<input type="button" value="Off"/>	<input type="button" value="Off"/>	<input type="button" value="Mixed"/>
Null Activate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
% Offset	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>
Tune Activate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
% Bias	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>	<input type="text" value="10.00"/>
SQUID Triangles: <input type="checkbox"/>									
GPIB SQUID Command: <input type="text"/>									
<input type="text"/>									
Sample Rate(Hz):	<input type="text" value="0.00000"/>	Monitor Channel:		<input type="button" value="1"/>	Monitor Filter:		<input type="button" value="NONE"/>		
Output Voltage	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>
<input type="button" value="Help"/>	<input type="button" value="Reset SQUIDS"/>	<input type="button" value="Heat SQUIDS"/>	<input type="button" value="Sample Output Voltage"/>		<input type="button" value="Exit"/>				

Figure 5.4.3 SQUID Control Menu

5.4.4. System Parameter PULL-DOWN MENU

Selecting the System Parameter pull-down menu causes the computer to display the panel illustrated in Figure 5.4.4. The input file "**STARTUP.CFG**" is read by the computer program when the program is initially loaded into the computer's memory. Selecting the "Display Current Parameters" control displays another panel containing those system parameters stored in the input file. Selecting "Restore Default Parameter File" causes the program to load the default input file "**STARTUP.CFG**" into the current parameters. This file load erases any system parameters the user might have changed via the user interface. When the user selects "Save Params as Default Parameter File", the current system parameters are stored in the "**STARTUP.CFG**" file. When "Restore User Parameter File" is selected, the user is asked to type in a file name. After

the file name is typed in, that file is used as the "input file" and read into the computer's system parameter's. When "Save Params in a User Parameter File" is selected, the user is asked to type in a file name. The current system parameters are then stored in that user selected file.

Figure 5.4.4 System Parameter Menu

5.4.5. AC Field Null PULL-DOWN MENU

Selecting the AC Field Null pull-down menu causes the computer to display the panel illustrated in Figure 5.4.5.

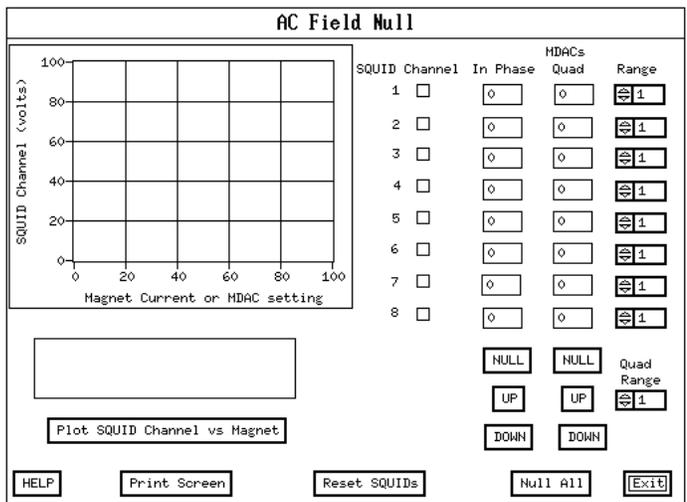


Figure 5.4.5 AC Field Null MENU

This menu aids in manual AC Field Null and allows for AC Field Null with one control selection. The MDAC's affect how much AC flux is introduced into the SQUID input circuit to cancel the AC signal from the magnet. The In Phase MDAC controls the amplitude of the AC flux and the QUAD is the out of phase AC flux. Selecting "Null All" causes the AC null algorithm to be executed for all installed SQUID channels. Selecting "SQUID Reset" immediately causes all installed SQUID channels accessed through the SQUID controller to go into reset for 1 second.

A SQUID channel is selected by choosing the appropriate radio button control. The "NULL", "UP", and "DOWN" controls for the IN Phase or Quad MDAC apply to the selected SQUID channel. Only one SQUID channel may be selected for a "NULL", "UP", or "DOWN" control. The User Interface does not allow selection of channels that are not installed in the system.

Selecting "NULL" causes the AC null algorithm to be executed for the SQUID channel and MDAC selected. After the "NULL" of the AC field, Volts RMS of the SQUID channel vs MDAC settings is then plotted to the SQUID channel plot window. Selecting "UP" causes the MDAC setting in the Tristan NCU box to be incremented until "UP" is selected again. Selected "DOWN" causes the MDAC setting to be decrement until the same "DOWN" is pushed again. The MDAC settings may be explicitly set by typing a value into the displayed control numeric window for each MDAC. These numeric windows also contains the current settings for all the MDAC's.

Selecting the "Plot SQUID channel vs Magnet" control causes the following to occur:

- 1.) The computer acquires data for one cycle of AC magnet and SQUID data for the channel selected.
- 2.) The least squares linear regression fit of the SQUID channel versus the AC magnet volts is then calculated.
- 3.) The best linear fit data and raw data are then plotted in the SQUID Channel plot window.
- 4.) The text box window displays the slope, offset, and error terms from the linear regression.

5.4.6. Data Acquisition PULL-DOWN MENU

Selecting the Data Acquisition pull-down menu causes the computer to display the panel illustrated in Figure 5.4.6. This panel is displayed during data acquisition.

+

Figure 5.4.6.1 Data Acquisition Only Scan MENU

Selecting a SQUID channels radio control button chooses that channel for data acquisition. Only SQUID channels may be selected from the channels installed on the system. Subsequent to selecting "Begin Acquisition" data is acquired for the SQUID channels and if selected, the AC magnet channel.

Selecting "Change Time Delays" causes the computer to display the "Enter Timing Parameters" pop-up panel discussed in the section 5.4.7 of this manual. The "Samples/Burst" control is the number of samples in a "Burst" of data. The "Bursts/File" control is the number of "Bursts" for a File of data. The "Sample Rate(Hz)" control is the acquisition rate for each sample of data.

The "Unselect Position File" control allows for a data acquisition file write without position information stored in the file and by "unselecting" the position file the user has manual control of the "Bursts/File" parameter.

There are three data acquisition trigger modes supported. There are the Mouse mode, the Remote mode and the Timed mode. The "Trigger Mode" controls how the data is acquired between "Bursts". With the Trigger Mode on "Mouse", subsequent Bursts of data are triggered by a click of the mouse button on the "Begin Acquisition" control. With the Trigger Mode on "Remote", subsequent bursts are triggered by a remote signal to the computer. This is for systems with a position control system. With the Trigger Mode on "Timed", subsequent bursts are automatically trigger with a delay of "burst interval" between each "Burst".

The "AC Magnet indicator" control is a "light" indicating if the AC magnet is on or off. When the "light" is colored red, the AC magnet is on, and no color indicated the AC magnet is off.

Selecting "AC Null" causes the AC null algorithm for all installed SQUID channels to be executed.

Selecting "SQUID Reset" causes all installed SQUID controller channels to go into reset for 1 second.

Selecting the "Interburst Reset SQUID's" to the "ON" resets the SQUID controller by issuing the GPIB command "RSET" for 500 milli-seconds between subsequent bursts of data. By turning OFF the "Init SQUID Reset" control, the SQUID reset prior to the AC magnet activation is shut off. The "Status" control displays the current state of the system. If the user interface is active, the Status control displays "Idle", and when acquireing data the Status control displays "Acquireing Data for burst: #".

NOTE

TO ABORT THE DATA ACQUISITION, PRESS "ENTER" ON THE KEYBOARD DURING DATA ACQUISITION. THE MOUSE IS SHUT OFF DURING DATA ACQUISITION.

Selecting the "Real -Time Display" control displays a graphing panel above this panel. When a burst of data is acquired, the graphing panel then graphically displays the acquired data.

Selecting the "Select File" control causes the "Select Files" pop-up panel (Section 5.4.9) to be displayed. The program does not allow any data to be acquired without first selecting a data file name. If no position file is selected, the position file is automatically selected by using the last position file selected. That position information is stored in the data file as the data is acquired. The position file contains (X,Y) coordinates of the probe tail position relative to the sample being tested. The position file selection sets the Samples/Bursts parameter to the number positions in the position file.

NOTE

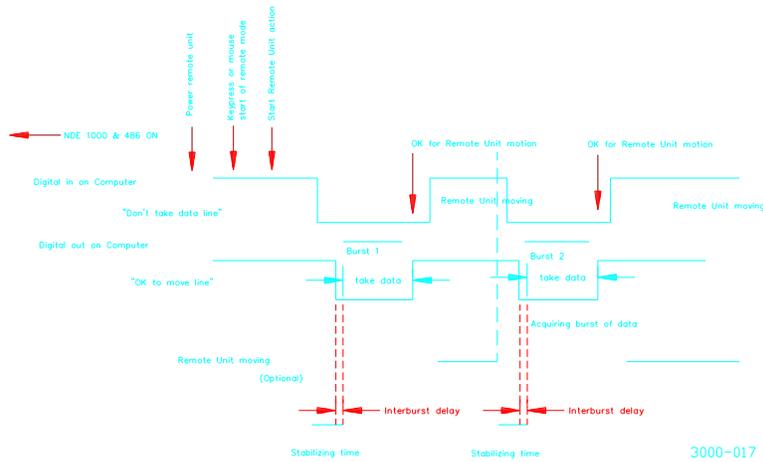
THE USER MAY SELECT "MANUAL TABLE MOVE" FROM THE "UTILITY" PULL DOWN MENU FOR CONTROL OF THE TABLE SCANNER.

Subsequent to Data Acquisition, the user interface parameter control boxes are locked out until the acquisition has been completed or aborted.

Remote mode AC data acquisition user interface selections (suggested):

For those systems supporting a position control system, the computer can connect to this position system via a digital input/output signals through the PC Lab module. The digital signals will remotely control the position stage according to the position file set up. The sequence to use the remote mode is as follow:

- 1.) Set the appropriate AC magnet frequency, AC magnet amplitude, and SQUID controller ranges. These controls are all accessed by using the "System Setup" pull-down menus.
- 2.) Turn on the position system. Activate the position system digital lines to the acquisition computer and move to the starting acquisition position.
- 3.) Perform an AC null by selecting "AC null" from the AC null pull-down menu.
- 4.) Select the "Data Acquisition" pull-down menu. Set the trigger mode to "Remote". Choose the "Select Files" control. From the "Select Files" menu select:
 - a.) Create a position file that contains the same position information as the position system programmed movement.
 - b.) Select that created position file.
 - c.) Select the data file name to store the acquired data and position coordinates.
- 5.) Set the appropriate time delays by selecting "Change Time Delays". The time delay occurs after the OK to move digital output line is set "LOW" by the acquisition computer and before data acquisition.
- 6.) Select "Begin Acquisition".



Remote Mode Acquisition Timing Diagram

Figure 5.4.6.2 Remote mode timing illustration

5.4.7 Enter Timing Parameters MENU

Selecting the Enter Timing Parameters menu causes the computer to display the panel illustrated in Figure 5.4.7. The "Burst Interval" control allows the user to select an additional amount of time in seconds between subsequent bursts of data. The "Initial Delay" control is the time in seconds between the initial turning on of the AC magnet and the acquisition of data. If the AC magnet is off, the "Initial Delay" is the time in seconds between the selection of "Begin Acquisition" and data acquisition. The Initial Delay parameter applies to all trigger modes and Auto Position acquisition. The initial delay applies only to the first burst or position. The Interburst Delay parameter is used by timed and remote trigger modes and by Auto Position Acquisition.

NOTE

THE TIMING PARAMETERS HAVE A RESOLUTION OF 55 MILLI-SECONDS. THE DELAY MUST BE GREATER THAN 55 MILLI-SECONDS. THE TIMER DELAYS IN STEPS OF 55 MILLI-SECONDS.

Figure 5.4.7 Enter Timed Mode Parameters MENU

5.4.8. Auto Position Acq PULL-DOWN MENU

The Auto Position Acq menu illustrated in figure 5.4.8 is similar to the Data Acquisition menu. The following user interface controls work in the same way as discussed in the Data Acquisition menu section 5.4.6; Channel SQUID, Channel A/D IN, AC magnet indicator, Real-Time Display, Sample/Rate, Change Time Delays, AC null, Reset SQUID's, Select Files, and Begin Acquisition. The Auto Position Samples/Position control has the same functionality as the Data Acquisition Samples/Burst control. The Auto Position Interposition Reset SQUIDs control has the same functionality as the Data Acquisition Interburst Reset Control. Selecting "Manual Table Control" activates the Manual Scanner Control Pop-Up Menu described in section 5.4.25. The binary switch, "Init SQUID Reset" controls the state of the SQUID reset prior to data being acquired. The "Status" control is used to indicate current data acquisition, motor movement, plotting, disk write, or idle. For example if data is being acquired, the "Status" control displays "Acquiring Data, Position: 1".

The Auto Position Acq menu is used when a scanning table is present. Manual control of the scanner table is available by using this menu. The position file is used to store coordinates and control the position of the XY table scanner. The position data is automatically stored in the data file, and may be used to plot magnetic field versus position in the XY plane.

WARNING

AUTO POSITION ACQUISITION IS USED TO INTERFACE WITH THE XY TABLE SCANNER SYSTEM. THE SYSTEM WILL LOCK BY ATTEMPTING DATA ACQUISITION WITH NO XY TABLE SCANNER PRESENT. PLEASE USE THE DATA ACQUISITION MENU FOR ACQUISITION WITHOUT AN XY TABLE SCANNER.

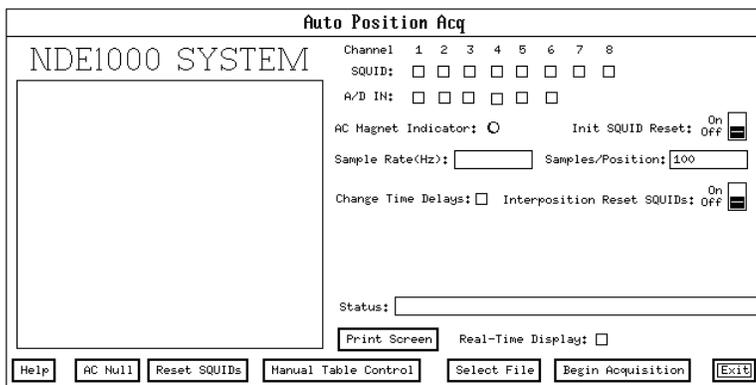


Figure 5.4.8 Auto Position Scan MENU

5.4.9. Select Files Pop-up MENU

The Select Files menu is illustrated in figure 5.4.9. The Select Files Pop-up menu is accessed by selecting "Select Files" from the Auto Position Scan, Data Acquisition, or XY plot menu. For Auto Position Acquisition access, the user selects "Select Position File" and "Select Data File" prior to data acquisition. For Data Acquisition access, the user "Selects Data File" and the "Select Position File" is optional. If the position file is not selected, a position file is automatically selected by using the last position file. For XY plot access, the user selects a data file, and the position file selection is optional. If a position file is selected, the XY plotter uses the selected position file during an X trace plot. Selecting "Create Position File" activates the Create Position File Pop-Up Panel described in section 5.4.10.

Figure 5.4.9 Select Files MENU

5.4.10. Create Position File Pop-up MENU and PULL-DOWN MENU

The position file create menu is a panel accessed by selecting "Create Position File" from the Select Files Menu or by selecting the "Create Position File" from the main menu bar. This menu

aids the user in the creation of a position file used in 3-D plotting and defining positions for the table scanner. The position file contains the XY plane position information. See the illustration on Figure 5.4.10 for the menu screen associated with the position file create utility.

Definition of menu screen control parameters:

X start - The initial "X" starting position of the table scanner.

X inc - The increment distance of "X" as the table scanner moves. This parameter may be positive or negative.

Num of X - The number of increments the table scanner moves in the "X" direction.

Y start - The initial "Y" starting position of the table scanner.

Y inc - The increment distance of "Y" as the Table scanner head moves. This parameter may be positive or negative.

Num of Y - The number of increments the Table scanner moves in the "Y" direction.

Num of Positions - This is a read only control. The number of positions is gotten by multiplying the Num of Y * Num of X.

Sweep Mode - The manner in which the table scanner moves. A "Serpentine" movement resembles a "back and forth" sort of movement. A raster movement resembles the movement of the CRT gun. For a demonstration of these movements, try each sweep setting.

Units - The distance units used by the table scanner. This control selects which unit gets written to the position file comment line. Adding the units to the comment provide the user a way of record keeping his units and are not used by the NDE in any other way.

Step Plot - Plots one position at a time for the entire number of positions.

Create Position File - Creates the parameterized position file.

Read Position File - Reads a user selected file into the plot window and loads the controls X start, Ystart, Num of X, Num of Y, X inc, Yinc, and rotation angle with the appropriate values.

Rotation Angle - The trace is rotated by this angle with respect to the starting point.

The normal sequence of control parameter selection for writing a position file is:

- 1.) Choose the appropriate X start, X inc, Num of X, Y start, Y inc, and Num of Y control parameters.
- 2.) Choose the appropriate Sweep Mode. The sweep mode refers to motion pattern of the table scanner head. For most cases, the default, "Serpentine" expresses the Table scanners head type of movement.
- 3.) Check the user input control parameters by selecting "Step plot".
- 4.) After the parameters are correct, for the desired Table scanner movement, select "Write Position File".

The Table scanner moves in a square or rectangular grid. This utility expresses the Table scanner movement in terms of an "XY" plane. All movement is incremented in the "X" direction for a "row" then in the "Y" direction for the next "row". The movement then fills in a grid by incrementing all "Y" for each row.

Each point on the grid corresponds to a measurement by the TRISTAN NDE system. This measurement must be at a single position. Normally, during data acquisition, many samples of data are collected at a single position. The data is processed by using one of the computer program "NDE's" burst analysis functions. An example of a "burst" analysis function is "slope". The slope of the SQUID data vs the AC magnet data is calculated at each position or burst. The file generated by the burst analysis function, serves as a file used by the TRISTAN 3d plot utility. This create position file utility helps the user to generate a position file used by the 3d plot utility and defines the table scanner positions.

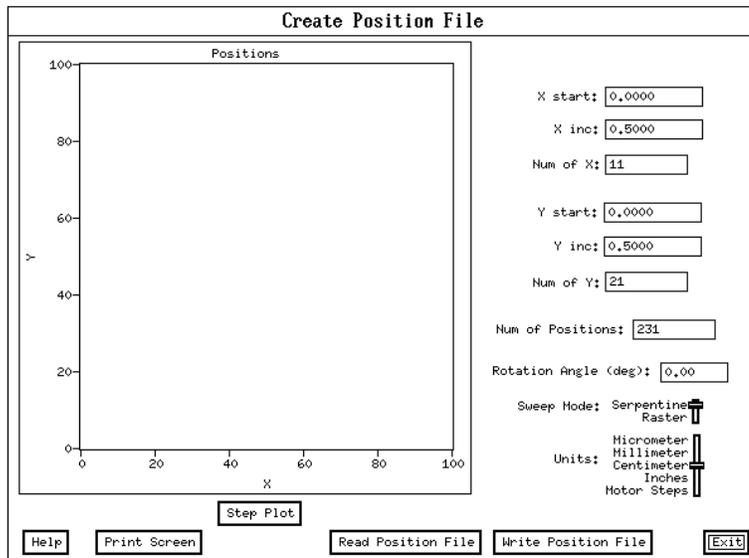


Figure 5.4.10 Create Position File Pop-up MENU

5.4.11. Manipulate Data PULL-DOWN MENU

Selecting the Manipulate Data pull-down menu causes the computer to display the panel illustrated in Figure 5.4.11. The Manipulate data controls allow the user to post process a raw data acquisition or a previously post processed data acquisition file. Selecting the "Select File" control, causes a user to be prompted for a file name. The file associated with the file name typed in by the user should be a valid file for a desired post processed operation. The type of post process operations are selected by mouse clicking next to the appropriate operation. The post processing operations consist of P-P Amplitude (Peak-to-Peak Amplitude), B/H Area (SQUID channel vs AC magnet), B/H Slope (SQUID channel vs AC magnet), Average, Decimate Data, FFT, Running Average, Digital Filter, Multiply, Offset, and Volts to Tesla. Once the appropriate post processing operations are selected, "Activate Analysis" is selected and the post processing operations are executed. For every operation selected, a file is written. This file contains the processed data and can be plotted by the XY plot algorithm.

AC data is data collected with the AC Magnet "ON". DC data is data collected with the AC magnet "OFF".

Figure 5.4.11 Manipulate Data MENU

NOTE
FOR DATA COLLECTED WITH NO AC MAGNET, THE "ANALYSIS SET" CONTROL MUST BE SET TO " ENTIRE BURST" FOR ACCESS TO ANY ANALYSIS FUNCTIONS.

● Analysis Algorithm Summary

Type	Algorithm	AC Impact
P-P Amplitude	Processes SQUID data only for a Burst or Cycle. For each Burst or Cycle the computer finds the greatest and least SQUID reading. The P-P Amplitude = (Greatest SQUID reading - Least SQUID reading). The P-P Amplitude is then written to the output analysis file.	AC may be "ON" or "OFF". The AC data is not processed by the P-P Amplitude algorithm. If AC is "ON", the written analysis file contains the P-P amplitude of the AC magnet.
B/H Area	For a cycle or burst calculates the area of the SQUID data vs AC magnet curve. Please note the SQUID data is in units of volts and the AC magnet data is in units of amperes.	AC must be "ON". The written analysis file contains a dummy entry for the AC magnet. Data not completing a AC magnet cycle is not processed. The burst area calculation is the total area of all the cycles with incomplete AC cycle data not included in the calculation.
B/H Slope	For a cycle or burst calculates the slope of the SQUID data vs AC magnet best fit line. Please note the SQUID data is in units of volts and the AC magnet data is in units of amperes. The Lab Windows analysis library "LinFit" function call is used.	AC must be "ON". The written analysis file contains a dummy entry for the AC magnet.
Average	For a burst or cycle, it averages the SQUID data. The samples in a cycle or burst are added up then divided by the number of samples in a cycle or burst, respectively.	AC may be "ON" or "OFF". The AC data is not processed by the Average algorithm. If AC is "ON", the written analysis file contains a the average for the AC magnet data.
Decimate	Operates on the entire data set. The burst data is truncated at the end of the burst if there are insufficient samples in a burst to define a group of samples for decimation. The decimate data operation is performed on the SQUID and AC magnet data. The user specifies SAVE 1 out of <user specified> data samples. The user specified number of data samples indicates the denominator of the fraction of data to save. The numerator of the fraction of data samples to save is always 1. For example, the user specifies SAVE 1 out of 3 data samples. This means for each 3 data samples 1 data sample is saved to the output analysis file. This SAVE 1 out of 3 data samples effectively reduces the amount of data by a factor of 1/3.	May operate on both SQUID and AC data. AC may be "OFF". The AC data written to the analysis file is real decimated data.
FFT	Each FFT is performed on each subsequent burst of data for number of points specified by the user. The number of points (n) for the FFT must satisfy the condition: $n = 2^i$, i is an integer. Operates on both SQUID and AC magnet data. The FFT algorithm uses the Lab Windows analysis functions BkmanWin and Spectrum.	May operate on both SQUID and AC data. AC may be "OFF". The AC data written to the analysis file is real FFT data.

Running Average	Operates on the entire data set. The burst data is truncated at the end of the burst if there are insufficient samples in a burst to define a group of samples for averaging. The user specifies the number of points to average. The average operation is performed on the SQUID data only. The SQUID data is added up for the user specified number of samples then divided by the user specified number of samples.	AC may be "ON" or "OFF". The AC data is not processed by the running average algorithm. If the AC is "ON", the written analysis file contains a dummy entry for the AC magnet.
Filter	Performs the filter on each burst of data. Only SQUID data is processed by this algorithm. All filters, Low Pass, High Pass, Band Pass, and Band Stop, use the Lab Windows Butter worth analysis functions Bw_LPF, Bw_HPF, Bw_BPF, and Bw_BSF, respectively. The user inputs high cutoff frequency, low cutoff frequency, and filter order appropriately for each filter.	AC may be "ON" or "OFF". The AC data is not processed by the Filter algorithm. If the AC is "ON", the written analysis file contains the same data as in the raw data file.
Multiply	Multiplies each SQUID sample of data by a user input number for the entire file. AC data is not processed.	AC may be "ON" or "OFF". The AC data is not processed by the multiply algorithm. If the AC is "ON", the written analysis file has the same AC data as the raw data file.
Offset	Adds an offset to each SQUID sample of data for the entire file. The user specifies the offset. AC data is not processed.	AC may be "ON" or "OFF". The AC data is not processed by the offset algorithm. If the AC is "ON", the written analysis file contains the same AC data as the raw data file.
Volts to Tesla	Multiplies the each SQUID channel by volt to tesla conversion factor stored in the data file by each SQUID sample of data for the entire file. The AC data is not processed.	AC may be "ON" or "OFF". If the AC is "ON", the written analysis file contains the same AC data as in the raw data file.

● **Filename extensions**

DATA Set	CYCLE	BURST	FILE
RAW DATA	N/A	N/A	.DAT
Peak to peak amp	.AMC	.AMB	N/A
Area	.ARC	.ARB	N/A
Slope	.SPC	.SPB	N/A
Average	.AVC	.AVB	N/A
Decimate	N/A	.DEC	N/A
FFT	N/A	.FFT	N/A
Running Average	N/A	.RUN	N/A
Band Pass Filter	N/A	.BBP	N/A
Band Stop Filter	N/A	.BBS	N/A
High Pass Filter	N/A	.BHP	N/A
Low Pass Filter	N/A	.BLP	N/A
Multiply	N/A	N/A	.MLF
Offset	N/A	N/A	.OSF
Volt to Tesla	N/A	N/A	.TES
ASCII file	N/A	N/A	.ASC
Binary file	N/A	N/A	.BIN
Position	N/A	N/A	.XYZ

5.4.12. XY Plot PULL-DOWN MENU

Selecting the XY Plot pull-down menu causes the computer to display the panel illustrated in Figure 5.4.12. The user must first "Select File" to be plotted. Subsequent to selecting a file, the relevant system parameters contained in the file are displayed in the "File Info" window. All plots are displayed in the "Channel" plot window. A display of the plot is activated by selecting "Plot Next Data Set". Generally, the user selects the appropriate controls or plot "parameter" before selecting "Plot Next Data Set". Selecting a "Plot Parameter" does not cause a plot to be displayed, only by selecting "Plot Next Data Set" is the plot window activated. The "Restart" control allows the user to rewind the currently "Selected File" to the beginning of the data set. This control is provided for as a convenience for the user. The "Select File" control has the same affect as the "Restart", but the "Select File" requires the user type in a file name.

The following describe each control on the XY plot menu:

X Axis Linear Log :

Selecting "Log" takes the log base 10 of the AC magnet data before plotting on the X axis. Please note the X Axis AC Magnet control must be selected for Log plot. Selecting Linear, plots the data directly from the file with no Log taken.

Y Axis Linear Log :

Selecting "LOG" takes the Log10 of the data before plotting. Selecting "LINEAR" causes the data to be plotting without log10 taken.

AC Magnet :

selection causes the AC Magnet data to be plotted on the X axis.

Teslas|Volt :

If "Tesla" is selected, the data is multiplied by the testla to volts conversion number stored in the data file. The data is assumed to be in stored in volts.

WARNING:
THE DATA FILE MAY BE CONVERTED TO "TESLA" BY SELECTING "VOLTS TO TESLA" IN THE MANIPULATE DATA MENU. THE USER MAY SELECT "TESLA" IN THE XY PLOT MENU AND THE DATA IS ALREADY CONVERTED TO TESLA THE PLOTTED DATA IS WRONG. DO NOT SELECT "TESLA" IN THE XY PLOT IF THE DATA HAS ALREADY BEEN CONVERTED TO TESLA.

Data Set :

The data is plotted by cycle, burst, file, trace, or position file. If trace, data may be plotted vs. the position information in the data file or the position file.

One Cycle :

A cycle of data corresponds to data collected during one AC magnet cycle. For plotting, the AC magnet must be "ON", the file is of raw data, and there must be more than one AC magnet cycle per burst.

One Burst :

Data collected at one position. The file can be raw data or an analysis file, and there must be more than one data point per burst.

Entire File :

The entire data set in a file is plotted without regard to cycle or burst.

One X Trace :

Plots SQUID channel or AC magnet vs position. Position is one X trace of the table. Each trace is plotted by selecting "Plot Next Data Set".

Position File:

Allows the user to plot a position file. The position file name is prompted for and then plotted to the "Channel" plot window.

Restart :

Allows the same selected file to be plotted from the beginning of the data set.

Plot Next Data Set :

activates the plotting for the next data set.

Channel :

Selects the SQUIDs or AC magnet plot channels.

Offset :

Adds this value onto the channel data before plotting.

Reverse Polarity :

multiplies the plotted data by -1.

Modify Scaling :

Allows the user to set the axis scaling by inputting maximum and minimum values for the "X" and "Y" axis. Selection of this control causes the computer to display the menu illustrated in figure 5.4.27 with the appropriate controls for manual scaling.

Modify Labels :

Allows the user to modify the axis labels. Selection of this control causes the computer to display the menu illustrated in figure 5.24.26.

Print Scale :

90% prints on 90% of the page. "Full" uses the entire page.

Grid :

allow the user to put a grid on the plot screen.

Zoom In :

Allows the user to "zoom" in on the plotted data. The zoom in parameters are defined by the mouse cursors visible in "gray" on the plot screen.

Zoom Out :

Zooms out to the parameters previously defined by "Zoom In". This option may not be used to make the plot window larger than the data. To make the plot window larger than the data, use manual scaling accessed by selecting "Modify scaling" and re-plot the data set.

Print Screen :

dumps the entire XY plot menu to the LASER printer.

Print Graph :

print the graph only in an enhanced format.

XY PLOT ORDER OF OPERATIONS:

During plotting several plotting options may be selected. If the plotting options are selected, the sequential order of those operations are:

- 1.) Volt to Tesla Conversion.
- 2.) Take Log10 of the absolute value of the data.
- 3.) Offset (add offset to data).
- 4.) Polarity (multiply data by -1).
- 5.) Clip for manual scaling. A clip consists of setting data greater than the user specified maximum or minimum to the user specified maximum or minimum.
- 6.) Plot.

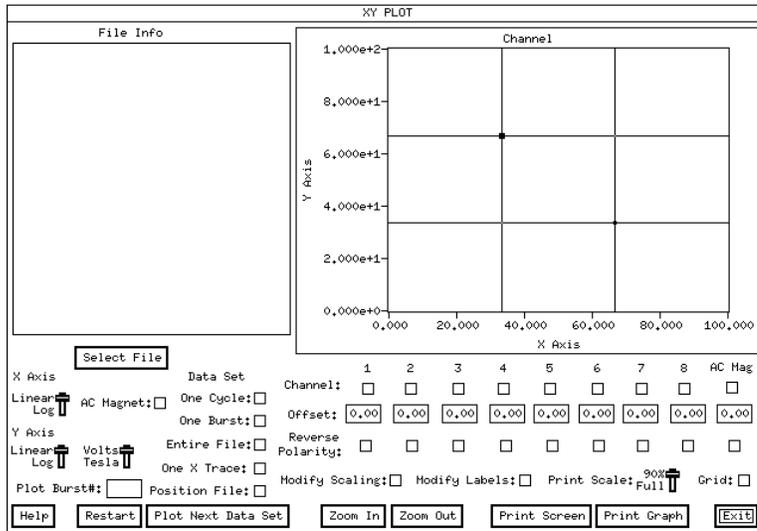


Figure 5.4.12 XY Plot MENU

5.4.13. SQUID Control Status PULL-DOWN MENU

Selecting the SQUID Control Status pull-down menu causes the computer to display the panel illustrated in Figure 5.4.13, SQUID controller GPIB Query command, and responses from the SQUID controller. These GPIB commands are ntt\manualumented in the SQUID controller manual.

Figure 5.4.13 Parameters MENU

5.4.14. GPIB Help PULL-DOWN MENU

Selecting the GPIB Help pull-down menu causes the computer to display the panel illustrated in Figure 5.4.14.

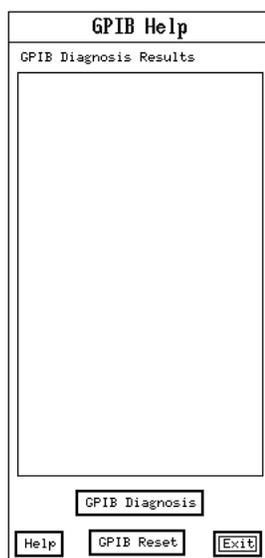


Figure 5.4.14 GPIB Help MENU

By selecting the control "GPIB Diagnosis" the GPIB Diagnosis Results window displays the contents of the variable "ibsta", "iberr", and the state of the GPIB interface hardware lines. Activating the "GPIB reset" control issues the two GPIB commands "ibsic" and "ibcmd". These GPIB commands are used to issue a bus reset. Issuing a bus reset should not harm any of the GPIB devices or GPIB controller card. The National Instruments NI-488.2 MS-DOS Software Reference manual contains the definition for the ib-- terms used above.

5.4.15. Heater and Relay Control PULL-DOWN MENU

Selecting the Heater/Relay Control pull-down menu causes the computer to display the panel illustrated in Figure 5.4.15. None of the Heaters are activated until the "Activate" control is selected. The user selects the heaters to be activated by selecting from the Other Heaters and SQUID Sensor Heaters controls. The heaters accessed via the SQUID controller correspond to the SQUID Sensor heater controls. The heaters accessed via the NCU correspond to the Other Heaters controls. The NCU Relays are accessed via the Relay section of this menu. The "Seconds Active" numeric control corresponds to the number of seconds the heater switches are "On" after the "Activate" control is selected. The "CLEAR ALL HEATERS" clears the user interface control by shutting off the displayed activated controls. Please note, the "CLEAR ALL HEATERS" control does not shut off the heaters, this control only clears the user interface.

Figure 5.4.15 Heater and Relay Control MENU

5.4.16. Function Generator Control PULL-DOWN MENU

Selecting the Function Generator Control pull-down menu causes the computer to display the panel illustrated in Figure 5.4.16. The "AC Magnet Indicator" "light" indicates the current state of the NCU oscillator - on or off. The following describe the user interface controls:

AC ON: Turns on the AC magnet. The TRISTAN NCU AC magnet relay is turned on. If the NDE system is configured with a Wavetek function generator, the the appropriate sinusoidal frequency and amplitude are set, and the waveform is executed. If the system is configured with the NCU oscillator instead of the Wavetek, the appropriate sinusoidal frequency and amplitude in the NCU is set and executed.

AC OFF: Turns off the AC magnet. The TRISTAN NCU AC magnet relay is turned off. If the NDE system is configured with a Wavetek function generator, the function generator is set of 0 volts DC.

NCU AC OFF: Turns off the AC magnet relay in the TRISTAN NCU. The AC magnet is shut off by using this control. The Wavetek or NCU onboard oscillator are not affected by this control.

Freq(Hz): The frequency of the AC magnet. For a frequency change to take affect, the control "AC off" then "AC on" must be selected. If the system is configured with a Wavetek, frequencies are continuos. If the system is configured with a NCU oscillator, the frequencies are discrete. In this NCU oscillator case the user interface control allows for only discrete frequency settings.

Amps (peak): Sets the amplitude of the AC magnet. For a amplitude change to take affect, the control "AC off" then "AC on" must be selected.

WARNING
Selecting AC ON turns ON the AC magnet and burns helium. The AC magnet may accidentally be left ON when exiting this menu.

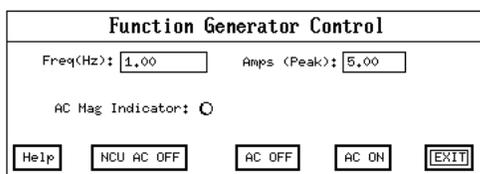


Figure 5.4.16 Function Generator Control MENU

5.4.17. Helium Level PULL-DOWN MENU

Selecting the Helium Level pull-down menu causes the computer to display the panel illustrated in Figure 5.4.17. Selecting the "Read Helium Level" control causes the computer to activate the SQUID controller helium level meter for 5 seconds and then display the value in the "Helium % " control. A continuous read of the Helium level in the SQUID controller may be executed by selecting the "Continuous Helium Check" control. Each check of "continuous check" takes approximately 5 seconds of metering time. The "Fill Rate" control is a measure of how fast the helium level is changing. The Fill Rate is useful when filling the probe with helium.

WARNING
To shut OFF the "Continuous Check" control, click the mouse on "continuous check Off" for at least 5 seconds.

Figure 5.4.17 Helium Level MENU

5.4.18. Check PC Memory PULL-DOWN MENU

Check the amount of RAM memory available to the program for dynamic memory allocation and displays.

5.4.19. Convert File to ASCII PULL-DOWN MENU

Selecting the Convert File to ASCII causes the computer to prompt the user for a data acquisition or analysis file name. The file with the file name type in by the user is then converted from file "binary" mode to a readable "ASCII" or text mode file. The measurement system stores all of its data files in binary. This utility provides a means for the user to easily see the processed or raw data in text mode.

WARNING

LARGE FILES TAKE LONG TIME PERIODS TO CONVERT TO ASCII. ALSO, LARGE DATA FILES CONVERT TO MUCH LARGER ASCII FILES. DISK SPACE IS A CONSIDERATION WHEN CONVERTING A FILE TO ASCII. FILE CONVERSION MAY TAKE PLACE OVERNIGHT.

5.4.20. Convert Header to ASCII PULL-DOWN MENU

This utility has the same affect as the one described in 5.4.19, except only the information in the header of the data file is converted to ASCII.

5.4.21. Convert ASCII to File PULL-DOWN MENU

This utility converts the file written by executing the utility in 5.4.19, back to binary form.

5.4.22. Dummy Output File PULL-DOWN MENU

This utility writes a dummy data acquisition data file by using an artificial AC magnet. No data acquisition takes place. This utility may be executed without any hardware or SQUIDs on the measurement system.

5.4.23. Manual Scanner Control Pop-Up MENU

The Manual Scanner Control Pop-Up Menu is accessed by selecting the Pull-down menu "Manual Table Move". This menu may be selected while accessing the AC null, Data Acquisition, Auto Position Acq, or the High Speed acquisition menu's.

Current Motor Position(Indexer): A real time display of the current motor position as reported from the AT6400 indexer card.

Current Motor Position(Encoder): A real time display of the LAWSON position transducer read of position.

User Coord: The coordinate system for the LAWSON position transducer read. The choices include user coord, stage coord, and volts.

Absolute: The coordinate system used in table movement. The choices include relative and absolute. The default is absolute.

Move Coord: The user desired coordinate for table movement.

WARNING

THE TABLE MOVEMENTS WHILE ACQUIRING DATA ARE IN RELATIVE COORDINATES IF RELATIVE IS SELECTED IN THE MANUAL SCANNER CONTROL MENU. RELATIVE COORDINATES USE NO HOME, EACH MOVE IS RELATIVE TO THE LAST. IF ABSOLUTE COORDINATES ARE DESIRED, PLEASE SELECT ABSOLUTE BEFORE EXITING THE MENU FOR DATA ACQUISITION.

Move to Origin: Selecting this control causes the table scanner to move to [0,0], or the user defined home.

Move: Activates the table scanner for movement to the coordinates defined in the Move Coordinates control boxes.

STOP MOTION: The emergency stop button to kill table movement.

Indexer Command: This control is reserved for factory use.

Define Current Position as Origin: The current table scanner position is defined at the new origin [0,0] or home.

Move Hardware Home and Set as Origin: Moves the table scanner to the Hardware Home defined by Limit switches on the table. This control applies only to systems installed with home limit switches.

Units: Defines the units for table movement.

WARNING

DATA ACQUISITION MOVEMENT IS DEFINED BY UNIT INFORMATION CONTAINED IN THE POSITION FILE. IF THE UNITS ARE DIFFERENT IN THE MANUAL SCANNER CONTROL, THE MANUAL SCANNER CONTROL USES THE UNITS DISPLAYED IN ITS OWN MENU. DATA ACQUISITION WILL ALWAYS MOVE IN UNITS OBTAINED FROM THE POSITION FILE.

Define Current Position with Coordinates: If selected, the user is presented with another panel allowing for the defining of the current position.

Optical Peak Voltage: This control is active only for system with the LAWSON position transducer card. The optical peak voltage allows the user to set a peak voltage used in the interpolation the z position user coordinate. The peak voltage is set by:

- 1.) Installing the sample in the probe

2.) Moving the Z stage until the peak voltage the found. The Z position voltage is read by changing the encoder from User Coord to volts.

3.) Input that peak voltage into the "Optical Peak Voltage" control.

Define Acquisition Rotation Angle: This control is currently not available.

Figure 5.4.23 Manual Scanner Control Pop-Up Menu

5.4.24. XY Plot Labels Pop-Up MENU

The XY Plot Labels Pop-Up Menu is accessed by selecting XY Plot Pull-Down Menu and then the "Modify Labels" control. The controls on the Labels Menu illustrated in figure 5.4.24 are used when plotting data from the XY plot menu. The following describe each control:

- Plot Title :** The label at the top of the plot.
- Label :** The label parallel to each axis, X or Y.
- Number Digits Right of Decimal Point :** The graph numeric axis labels format.
- Number of Divisions :** The number of numeric labels appearing on each axis.
- Fixed Point/ Scientific Notation :** The format of the numeric axis labels.
- Asterisk Data :** Each data point is Asterisked.
- Label Plot with Channel Number :** Print the channel number on the plot.
- Restore Defaults :** Restores the most commonly used labels.

Figure 5.4.24 XY Plot Labels Pop-Up Menu

5.4.25. XY Plot Manual Scaling Pop-Up MENU

The XY Plot Manual Scaling Pop-Up Menu is accessed by selecting XY Plot Pull-Down Menu and then the "Modify Scaling" control. The controls on the Manual Scaling illustrated in figure 5.4.25 are used when plotting data from the XY plot menu. For the following description, the control applies to the appropriately selected X or Y axis.

Manual Scale N Axis :

By selecting this control, the manual scaling parameter are used during plotting instead of auto scaling. The manual scaling parameters are modified by selecting "Modify Manual Scale for N Axis."

Modify Manual Scale for N Axis :

Selecting this control causes the Enter Manual Scaling Menu illustrated in figure 5.4.25 to appear.

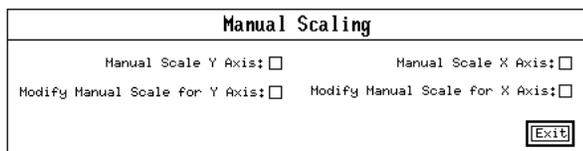


Figure 5.4.25 XY Plot Manual Scaling Pop-Up Menu

5.4.26. XY Plot Enter Manual Scaling Pop-Up MENU

The XY Plot Enter Manual Scaling Pop-Up Menu is accessed by selecting XY Plot Pull-Down Menu, the "Modify Scaling" control, and then the "Modify Manual Scale for N Axis". The controls on the Enter Manual Scaling illustrated in figure 5.4.26 are used when "Modify Manual Scale for N Axis" is selected from the "Manual Scaling" menu illustrated in figure 5.4.25. For the following description, the control applies to the appropriately selected X or Y axis.

Max : The maximum numeric value used in plotting. The data is clipped for data greater than the "max" value. Note: max must be greater than min.

Min : The minimum numeric value used in plotting. The data is clipped for data less than the "min" value.

Figure 5.4.26 XY Plot Enter Manual Scaling Pop-Up Menu

5.4.27. High Speed Acquisition PULL-DOWN MENU

The High Speed Acquisition is illustrated in figure 5.4.27. Many of the High Speed Acquisition controls have the same meaning as in the Data Acquisition and Auto Position Acq Menu controls. The following defines User Interface Controls:

SQUID Channels: Allows the user to select the acquired SQUID channels.

SQUID Converter Rate(Hz): This is how fast the A/D converter rate is operating in the SQUID controller. The possible A/D converter rate settings are 6kHz, 12kHz, 24kHz, and 48kHz. The fastest possible SQUID acquisition rate is:

Fastest Acquisition Rate=SQUID Converter Rate / number of SQUID channels

Sample Rate/Channel (Hz): This is the actual data acquisition rate per SQUID channel. This data is stored on disk and displayed on the plots if "Activate Real Time Display" is activated. If the GPIB Sample Rate is less than the SQUID A/D Converter Rate, some of the data is Decimated. The decimation factor may be calculated by:

Decimation Factor = (SQUID A/D converter rate/GPIB Sample Rate)

The Decimation factor is the number of points per SQUID channel to use for a decimation. For example, if the GPIB sample rate is 100 Hz and the A/D converter rate is 6 kHz, and one SQUID channel is active.

Decimation Factor = 6000/100 = 60

Therefore for every 60 samples in the buffer, 59 samples are thrown away.

This algorithm chooses the first sample in the buffer to save.

Sample/Burst: The number of samples for each SQUID channel per Burst. These samples are stored on disk and plotted if "Activate Real Time Display" is selected.

Bursts/Scan: The number of bursts collected per file.

Begin Acquisition: Starts Data Acquisition. Please note that a file must be selected to begin acquisition.

SQUID Reset: Resets all the SQUID channels.

Select File: Allows the user to select a data file and position file.

Preview Acquisition: Acquires data without writing to a file for one burst.

Begin Acquisition: Starts the process of acquiring data and writing to a file.

Change Time Delays: Selecting this control display the panel illustrated in figure 5.4.7.

Trigger Mode: The choices are Motor and Timed. If Motor is selected, the at6400 stepper motor stopping movement triggers a data acquisition. If Timed is selected, data acquisition is continuous with only the termination of a interburst delays triggering subsequent data acquisitions.

Notes on High Speed Acquisition:

High Speed Acquisition uses "binary" mode in the SQUID controller. Binary mode is associated with raw data from the SQUID controller's A/D converter. The triggering mode is always "Timed". "Timed" has the same meaning as that triggering mode for "Data Acquisition Only Scan". The GPIB Rate is the rate for a download of each buffer from the SQUID controller. This rate is fixed at 100 Hz for high speed acquisition. If the AC Magnet is on for data acquisition, the NDE obtains the AC magnet data from the SQUID controller. The AC Magnet SQUID channel is defined in the system.tti file, and becomes active when entering the High Speed Acquisition Menu. The High Speed acquisition requires the installation of a special Tristan SQUID controller card.

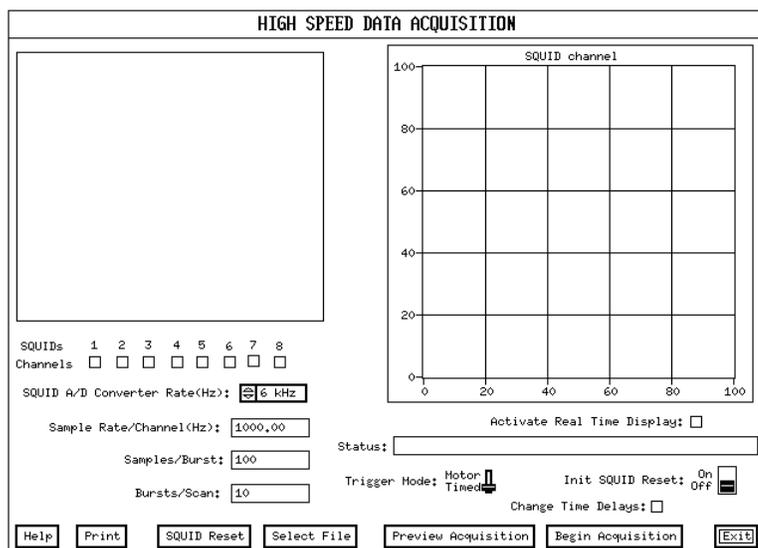


Figure 5.4.27 High Speed Acquisition Pull-Down Menu

5.4.28. Convert File to Spreadsheet PULL-DOWN MENU

Convert File to Spreadsheet illustrated in figure 5.4.28 is accessed by selecting "Conv File to Spread" from the utility pull-down menu. Convert File to Spreadsheet is normally used to convert a binary data or analysis file to an ASCII format that is readable by other spreadsheet or plotting programs. For example, Microsoft's Excel can read the spreadsheet file created by using this menu. Excel's 3d plotting option easily plots the spreadsheet file created with the "Matrix" option of this menu.

Select File: By selecting this control, the user is prompted for a data or analysis file name in binary format.

Status: A display is the current status of the conversion process. Please note, if no file conversion is taking place, the Status control displays "Idle".

Channels: Allows the user to select which SQUID channels to convert.

Indexer: Allows the user to select the AT6400 indexer channels to convert.

Encoder: Allows the user to select the LAWSON position read channels to convert.

Delimiter: The separator used for subsequent data in the converted file.

Format: The options include Matrix or Column. If Matrix is chosen the data is written in the following format:

- 1.) The X indexer positions are in the first row.
- 2.) The Y indexer positions are in the first column.
- 3.) The channel data is written in matrix format corresponding to entries that match the position in the appropriate row and column.
- 4.) There is one file written for each channel or encoder position.

If Column is chosen, the data is written in the following format:

- 1.) Each channel of data is written in a column. Channels of data include SQUID channels, indexer channel, or encoder channels.
- 2.) There is one file written for all the channels.
- 3.) Each column is labeled with the appropriate channel number.

One File per Channel: Currently not available.

Convert: Activates the process of converting the selected file and options to a spreadsheet file.

Figure 5.4.28 Convert File to Spreadsheet Pull-Down Menu

5.5. 3d (3 Dimensional) GraphiC program

5.5.1. 3d (3 Dimensional) PLOT PROGRAM

The 3d plot utility is executed by selecting option 2 from the NDE System Batch File Menu utility or executing the program "3drt.exe". The 3d plot utility contains SURFACE and CONTOUR plots that operate directly on NDE system data and position files. The 3d user interface is illustrated in figures 5.5.1.1 and 5.5.1.2. 3d provides for a hard copy using the HP Laser Jet printer. Section 5.5.4 discusses the various hard copy options. The 3d SURFACE and CONTOUR plots use the Scientific Endeavors "GraphiC" libraries. The 3d user interface use the National Instruments real mode User Interface Library. The following sections discuss operation of the user interface and shows examples SURFACE and CONTOUR plots. All plots use data in the form of (X,Y,Z) data points plotted to a right handed rectangular coordinate system.

The following lists the steps the user may do to create his own SURFACE or CONTOUR plot using the 3d plot utility:

- 1.) Acquire data with position information using NDE.
- 2.) Analyze the data with a burst analysis function using NDE. This analysis is accessed via the "manipulate data" menu, and must be analyzed with "burst" selected on the control "Analysis Set". The analysis file is used as the data file for the 3d plot.
- 3.) Execute 3d, select appropriate controls in the user interface, and plot.

5.5.1.1. 3d Plotting Inputs MENU

The user activates figure 5.5.1.1 on the computer by executing the program "3d". The following describe each control on the "3d Plotting Inputs" Menu.

Squid Channel:

Allows the user to select which SQUID channels are plotted. The user must select a file before the SQUID channels can be selected. The SQUID channels selected controls are limited to those SQUID channels acquired and stored in the NDE data file.

AC:

Allows the user to select the AC magnet data for plotting.

Change Plot Parameters:

Activating this control causes the computer to display the "Manual Scaling" menu illustrated in figure 5.5.1.2.

Change Axis Labels:

Activating this control causes the computer to display the "Axis Labels" menu illustrated in figure 5.5.1.2.

Surface/Contour:

Selects the SURFACE or CONTOUR plotter.

Help:

Displays the help menu associated with the 3d Plotting Inputs Menu.

Select Data File:

Allows the user to select a data file for plotting. The SQUID channels data, AC magnet data, and position coordinates are stored in the data file. Each channel is mapped to a Z coordinate on the surface plot and the contour levels for the contour plot.

Select Position File:

Allows the user to select a position file that is used with the data file when plotting. Normally, the data file contains position information, and the position file is not selected. The user may select a position file, and that file is used for the X and Y coordinates no matter if the data file contains position information.

WARNING

Position and data file names follow the standard DOS convention. The prefix must be no more than 8 characters and the extension must be no more than 3 characters. A file name must also have a '.'.

Example of good file names : "MY_data1.xyz" for a position file and "MY_data1.avb" for a data file.

- Plot:**
Activates the Surface or Contour plotter with channel auto scaling for the selected channels.
- Quit:**
Quits the 3d program.

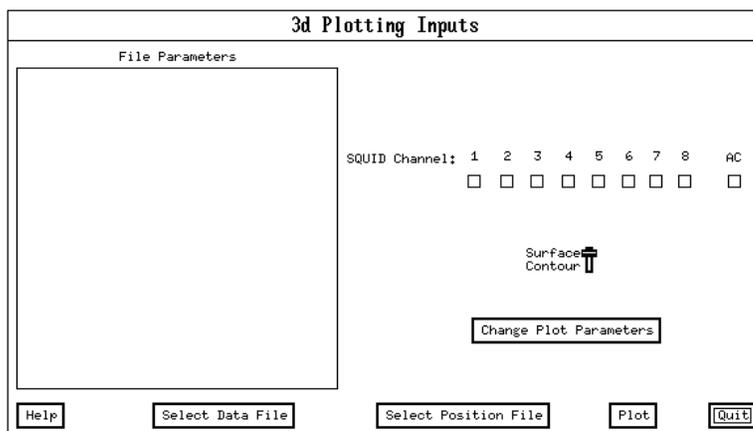


Figure 5.5.1.1 3d Plotting Inputs MENU

5.5.1.2 3d Plot Parameters MENU

Selection of "Change Plot Parameters" control from the 3d Plotting Inputs Menu displays the 3d Plot Parameters menu illustrated in figure 5.5.1.2.

Definition of User Interface Controls:

Axis Start:

The displayed axis starting value on the contour or surface plot. These parameter are used during manual scaling only. The start and end values can be used to exclude and include data on the surface or contour plot.

Axis End:

The displayed axis ending value on the contour or surface plot. These parameter are used during manual scaling only.

Axis Step:

The displayed axis step value on the contour or surface plot. The step value determines the number of displayed divisions on the X and Y axis. These parameter are used during manual scaling and when the On/Off switch is "ON".

User Eye:

X, Y, and Z position of the user eyeball position for viewing the displayed surface.

Label:

The labels that are displayed on each axis and the plot title label. If the data has a comment, that comment is always displayed as one of the titles. An additional title may be displayed by entering that title in the Plot Label control.

Number of Grids:

This applies to both the X and Y direction. This number is used by the surface or contour interpolator. For best results, a data point should be spaced every 2 to 20 grid cells. Too many data points confuse the interpolator and too few result in bad estimates of z interpolated values.

Perspective:

The size of the Z axis as compared to the X and Y axis. A "High" perspective displays might display more fluctuations in the data. A "Low" perspective might display less fluctuations but the data appears in perspective to the X and Y axis.

Multiplier:

The data multiplier. The data multiplier is used most often when plotting Tesla data. The multiplier improves the format of the Z axis labels.

Number of Divisions:

The number of divisions on the "Z" axis. This control only appears for a surface plot.

Number of Contours:

The number of contours on a contour plot. This control only appears for a contour plot.

Tolerance:

The precision used for the surface and contour plotter. The larger the tolerance the less the precision. If GraphiC displays the error message "Too few data points, try a coarser grid", try to reduce the precision by inputting a larger tolerance.

Significant Digits:

The number of significant digits to the right of the decimal point used for axis labels.

Label Size:

The size of the axis labels in inches. Most plots have appropriate label size of 0.1 to 0.3.

Scaling:**Manual :**

uses the axis parameters that include start, step, and end from the controls displayed.

Channel Auto :

Each channel is auto scaled as plotting occurs.

Global Auto :

All the channels use the same scaling. The scaling is set by using the channel with the smallest minimum and largest maximum.

File Information and Time:

Display the file name, file size, date and time of file creation, current date and time on the plot.

Save Scaling to User File:

Allows the user to save the current plotting parameters to a file.

Restore Scaling from a User File:

Allows the user to restore a plotting parameter file to the current parameters.

Plot:

3d plots using the scaling parameters selected

WARNING concerning a SURFACE plot:

The (X User Eye, Y User Eye, Z User Eye) position must be outside the surface plotted. The surface size does not appear larger or smaller with an eyeball position further away or closer to the surface. The eyeball position only yields a vector direction to the surface.

Figure 5.5.1.2 3d Plot Parameters MENU

5.5.2 CONTOUR PLOT EXAMPLE

Figure 5.5.2 illustrates an example contour plot obtained by using the TRISTAN 3d plot utility.

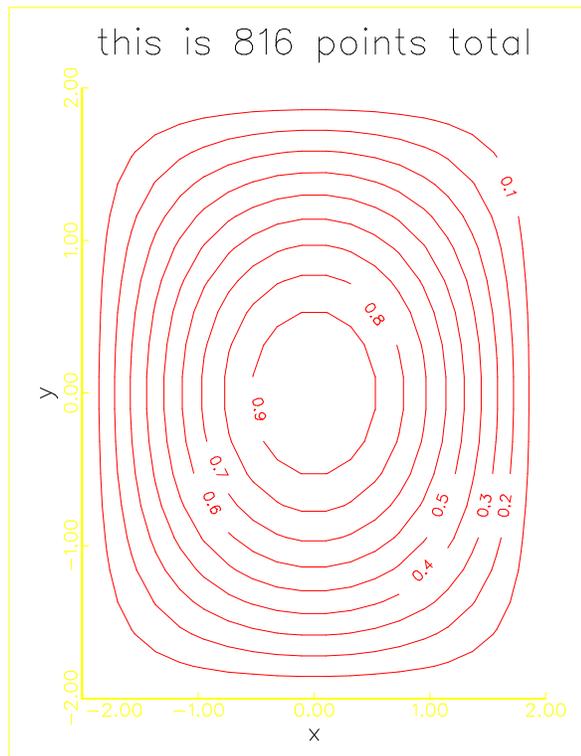


Figure 5.5.2 Sample Contour Plot

5.5.3 SURFACE PLOT EXAMPLE

Figure 5.5.3 illustrates an example SURFACE plot obtained by using the TRISTAN 3d plot utility.

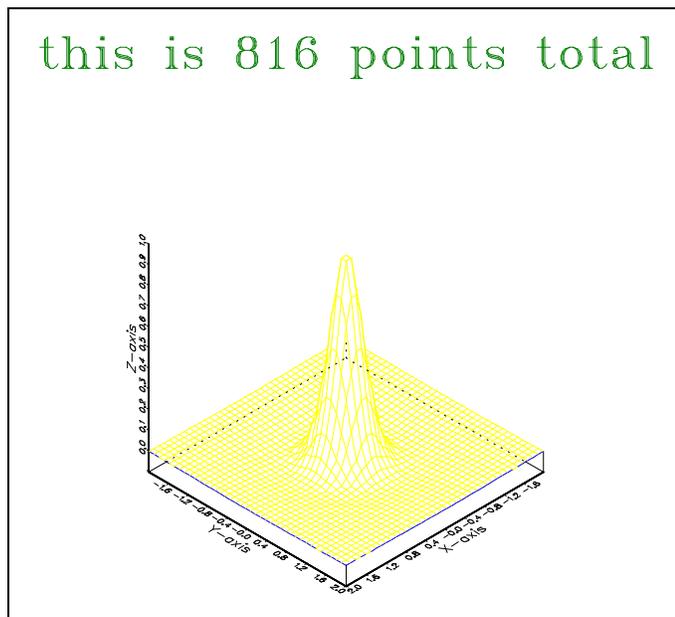


Figure 5.5.3 Sample Surface Plot

5.5.4 3D HARD COPY OPTIONS

The 3d plot utility is configured to obtain a high resolution HP Laser Jet print out. For a complete listing of the printing capabilities please see the Scientific Endeavors GraphiC manual. This manual presents a condensed procedure to obtain a hard copy. The following procedure lists an easy method to obtain a hard copy:

- 1.) Execute 3d in the usual manner. (option 2 from batch file system)
- 2.) Select a data and position file.
- 3.) Select the appropriate scaling options.
- 4.) Select Plot
- 5.) Once the data is plotted to the screen the following options are available by typing the selected key:

Key Typed	Action
c	Convert TKF file to another format
f	Redirect the printer output to a file
L	Make a full-page high-resolution print
l	Make a full-page medium-resolution print
M	Make a half-page high-resolution print
m	Make a half-page medium resolution print
p	Choose a different printer
q	Exit the program and abort print

s	Make a color separation
v	Vary Postscript fonts and line widths
w	Reduce and position plot
z	Enter zoom mode
space bar	Redraw the picture
enter	Exit back to 3d user interface
any key not listed	display hard copy options menu

5.6. EXTERNAL "DOS" PROGRAMS

5.6.1. NDE System Batch File Menu Utility

Description:

A helpful utility "menu.bat" organizes execution of NDE system computer programs. With the "menu.bat" installed on the NDE system computer, operation of the programs is more user friendly and resembles that of a turnkey system. The programs NDE, 3d, DOS's Chkdsk, DOS's DIR of the NDE data, and the TAPE utility may all be executed through continuous menu selection.

Menu Appearance:

The "menu.bat" menu appears to the user as follows:

Welcome to TRISTAN's NDE system!

- 1. Run NDE.**
- 2. Run 3d Plot.**
- 3. Check the Hard Disk.**
- 4. Check Data Directory.**
- 5. Run TAPE Backup utility.**
- 6. Read Read.me file.**
- 7. Exit to DOS.**

Type the number you want and press ENTER:

Files Required:

The following files are required:

- 1.) c:\Menu.bat
- 2.) c:\1.bat
- 3.) c:\2.bat
- 4.) c:\3.bat
- 5.) c:\4.bat
- 6.) c:\5.bat
- 7.) c:\6.bat
- 8.) c:\7.bat
- 10.) c:\nde\nde.bat
- 11.) c:\nde\3d.bat
- 12.) c:\autoexec.bat

Contents of Files:

Menu.bat

```
echo off
cls
echo.
echo.
echo Welcome to TRISTAN's NDE system! echo.
```

```
echo.  
echo 1. Run NDE.  
echo 2. Run 3d Plot.  
echo 3. Check the hard disk.  
echo 4. Check data Directory.  
echo 5. Run TAPE backup utility.  
echo 6. Read Read.me file.  
echo 7. Exit to DOS.  
echo.  
echo Type the number you want and press ENTER:
```

```
1.bat  
echo off  
cls  
cd nde  
call nde  
cd ..  
menu
```

```
2.bat  
echo off  
cls  
cd nde  
call 3d  
cd ..  
menu
```

```
3.bat  
echo off  
cls  
chkdsk /f  
pause  
menu
```

```
4.bat  
echo off  
cls  
dir c:\nde\ndedata /w /p  
pause  
menu
```

```
5.bat  
echo off  
cls  
cd \tape  
tape  
cd \  
menu
```

```
6.bat  
echo off  
cls  
type c:\nde\read.me |more  
pause  
menu
```

```
7.bat
```

```

echo off
cls
prompt=$p $t$h$h$h$h$h$h$h $d$h$h$h$h$h$h$h$g

```

5.7. TYPICAL AC ACQUISITION AND ANALYSIS MENU SELECTION

- 1.) AC Field Setup - set the desired frequency and amplitude of the AC magnet. Turn the "AC magnet control" on.
- 2.) DC Magnet Ramp - if a different field is desired in the DC magnet.
- 3.) SQUID Setup - set the sample frequency in the SQUID controller.
- 4.) AC Field Null - null the AC field.
- 5.) Data Acquisition - setting the proper number of samples, bursts, and trigger mode.
- 6.) Manipulate Data - execute the desired analysis on the acquired data.
- 7.) XY plot - plot the analyzed or raw data.
- 8.) 3-D plot - create an XY position file and plot with the an analysis file having one sample per burst.

The following illustrates some of the lengths of time for total data acquisition for typical data sets.

SAMPLE OF DATA SETUPS:

SQUID sample rate (Hz)	Samples	TOTAL TIME	AC @ 1 HZ (#/AC cycle)	# cycles @ 1 HZ in burst	AC @ 2 HZ (#/AC cycle)	# cycles @ 2 HZ in burst
1000	2500	2.5 sec	1000	2.5	500	5
200	2500	10 sec	200	20	100	40
100	2500	25 sec	100	25	50	50
20	2500	125 sec	20	125	25	250
12.5	2500	200 sec	12.5	200	6.25	400

```

fast:  = .005 * 2500 = 12.5 sec
med   = .01  * 2500 = 25  sec
slow  = .08  * 2500 = 200 sec

```

Chapter 6: FILE STRUCTURE & MAINTENANCE

6.1 DIRECTORY STRUCTURE AND EXAMPLE DATA FILE

Section 6.1.1 discusses the directory structure necessary for executing the program **NDE**. The directory structure listing contains the sub-directory name and the sub-directory file names. The listed files and directory structure are necessary to execute the program.

Section 6.1.2 describes the NDE file structure. An important part of program operation is understanding the file structure.

Section 6.1.3 lists an example output raw data acquisition file listing. The listing includes a header, comments, and some raw data. This file is a ASCII representation of the data file. The ASCII representation is created by first executing **NDE**'s menu option "Acquire Data" and then converting the acquired raw data file to ASCII by executing the menu option "Convert File to ASCII".

6.1.1 (NDE) DIRECTORY STRUCTURE

```
Directory PATH listing for Volume MS-DOS_5
Volume Serial Number is 1872-746A
C:\NDE
| NDE.bat           !Batch file for executing NDE
| 3d.bat           !Batch file for executing 3d
| read.me          !Readme file
|
+---NDECODE
| | NDELW.EXE
| |
| |
+---3DCODE
| | CONTOUR.PLT
| | SURFACE.PLT
| | CONTOUR.INP
| | SURFACE.INP
| | 3DRT.EXE
| | 3D.CFG
| | +---GPC
| | | CONFIG.GPC
| | | EQUIP.EXE
| | | PRINTER1.PRN
| | | *.FNT
| | | *.DRV
| | | *.DAT
| | | *.TAB
| |
+---COMMON
| |
| | +---INCLUDE
| | | DISPLAY.UIR
| | | *.HLP
| | | PLOT.UIR
| |
+---NDEDATA
| |
+---PARAMS
| | STARTUP.CFG
| | SYSTEM.TTI
```

6.1.2 FILE STRUCTURE DESCRIPTION

Basic Description:

An important aspect of the NDE data measurement system are files stored on the acquisition computer's hard disk. The computer program "nde" uses these files to define important information. Prior and during data acquisition, important information stored in files includes hardware and software initialization parameters, parameters important to an individual's experiment, system state, and system configuration. These files used to define the system information prior and during data acquisition are referred to as "input" files. During data acquisition, important system information and data acquired are stored in the "raw" file. A "raw" data file that is processed by one of "nde's" analysis function's is referred to as an "analysis" file.

Organization of Files:

Contents of "input", "raw", and "analysis" files include parameter and comments. Parameters are organized into "classes", "sub-classes", and "fields". "Classes", "sub-classes" and "fields" are merely concepts used to help organize the parameters and are not used as parameter's in the measurement system. A "class" is a group of parameters that have a common function, for example "DC magnet information". A "sub-class" is a sub-group of information within a "class", such as sub-classes "DC magnet number 1" and "DC magnet number 2". A "field" is one parameter within a "sub-class", such as the field "magnitude of the last electric current in DC magnet number 1". Information about number of "classes", "sub-classes", and "fields" are stored within each file. This information is necessary to make the future file format compatible with the current file format.

Future file formats will use the same organization of information into "classes", "sub-classes", and "fields". The future file formats will contain the currently specified parameters, and will add additional parameters. By using "classes", "sub-classes", and "fields" "raw" and "analysis" files created with the current measurement system can be used by future revisions of the program "nde". Additionally, "raw" and "analysis" files created with future revisions of "nde" may be used by the current versions of "nde". However, current "input" files may be read by future versions of the program, but are not guaranteed to initialize the measurement system in the same way. Additionally, future "input files" may be read by the current program, but are not guaranteed to initialize the system in the same way.

Parsing Classes:

Subsequent classes are marked for the parser with a "\$". This "\$" informs the parser that the next character read is the beginning of a class definition. The "\$" must be in the 1st column on the text page. Comment lines may be added to files by the "\$\$". This "\$\$" informs the parser that the subsequent information in the file are comments. The parser does not assume any additional classes in the file until the next "\$" is parsed.

Input Files Basic Description:

Two input files are required by the program "nde". These files must be named "startup.cfg" and "system.tti" and be in the proper file format. When the program is first loaded into the computer's memory, these two input files are read from the hard disk. Initially, the file "startup.cfg" contains factory default parameters. These default parameters are used by the measurement system, except when the parameter's are changed via "nde's" user interface. Startup.cfg is written to the hard disk with the current system parameters whenever:

1. The user "saves startup file".
2. The DC field has been ramped.
3. An Autozero is completed. The updated MDAC values are then stored.

The file "system.tti" contains information specific to the measurement system hardware configuration, and is normally not changed from the factory settings.

An third file may be used by the program "nde". This third file is not required by the program, but is provided for as a convenience for the user to define a system configuration for his own experiment. The experiment file name is user selected and this name should not be "startup.cfg" or "system.tti". This "experiment.cfg" file contains the same parameters and has the same file format as the file "startup.cfg". When this file is used by "nde", the "startup.cfg" file parameters are not used by the measurement system. There are two methods for writing the "experiment.cfg" file to the hard disk . The first method consists of reading the "startup.cfg" file into an ASCII editor such as DOS 5's "edit", modifying the appropriate parameter's in that file, and then saving that file to a name other than "startup.cfg". The sequence of events for the second method of writing an experiment file consists of executing the program "nde", modifying the appropriate parameters via the program's menu screens, selecting the program's "system parameters" menu option, and then the user types in a file name for storing those modified parameters. For the program "nde" to use the "experiment.cfg" file's stored parameter 's , the following menu options are selected, "system parameter", "read user file", and then the user types in the appropriate experiment file name.

WARNING:

Several of the important parameters in the "startup.cfg" and "experiment.cfg" file include:

- 1.) The peak amplitude in ampere's of the last DC field stored in the DC magnet
- 2.) The SQUID Tesla/Volt ranges
- 3.) The MDAC settings for AC null.

The "startup.cfg" file always gets updated with these important parameters. The "experiment.cfg" file only gets updated with the parameters when the user explicitly saves the system parameters to a file. The program's System Parameter menu can be used to save the system parameters to a experiment file. If an "experiment.cfg" file is read by "nde" as the "input" file, the value for the important parameters in the file may not be correct. During "nde's" process of reading in an "experiment.cfg" file the user is asked if the program should use the important parameters in the "experiment.cfg" file or the "startup.cfg" file. For most user's, the parameters stored in the "startup.cfg" file are the correct ones.

Raw and Analysis File Format

These files are in written in DOS binary mode. Binary mode files are used to preserve disk space. Binary mode files can not be read into a word processor or text editor. When the DOS "type" command is issued with a binary file, the characters display on the screen are not readable. The measurement program has a utility that converts raw and analysis files to a readable standard text mode. The measurement program's XY plot, manipulate data , and surface modules require the binary mode raw or analysis file. These modules do not read a raw and analysis files that have been converted to text mode.

Raw and analysis files contain a header and data. The header contains system parameter information that is pertinent during the data acquisition. This header information is similar to the information stored in the "startup.cfg" and "system.tti" files. For a raw file, the data are the numerical values obtained during the data acquisition. For a data acquisition with the AC magnet on, the data consists of the SQUID box measurements and the AC magnet amps during each SQUID box measurement. For data acquisition with DC only, the data consists of the SQUID box measurement for all of the active channels. The analysis file contains the processed acquisition data in the same file format as in the raw file.

One additional class in the raw and analysis file, not in the input files, is the Last Operation Performed Class. The Last Operation Performed Class contains information about what operations were last performed on the file. The file may have been post processed several times. The history of the post processing operations are contained in this class. For example, raw data is acquired, the data is decimated, the data has a P-P amplitude performed on each cycle, and then the data is averaged for each burst. Each one of these operation's has a file associated with it. The last entry in the Last Operation Performed Class corresponds to the last operation performed on that file. For this example, the file last written with averaged data would contain the following entries in the Last Operation Performed Class; RAW DATA, DECIMATED DATA, P-P AMPLITUDE/CYCLE, and AVERAGE/BURST. In the above described manner, the Last Operation Performed Class has another entry added every time a post processing operation is completed. A maximum of 7 post processing operations are supported.

6.1.3 EXAMPLE "SYSTEM.TTI" FILE

```

TRISTAN_SYS_FILE          !Tristan id
2.1                      !Version number

$Service History          ! Descriptor for the first class
This area in the file is reserved for a service history of the system. Any
modification or service to the system hardware must be logged here. Please
type in all text before the next "$" and use a standard text editor such as
DOS "EDIT". This history gets written to the data files. Data files have
gone to version 2.1. The Service History class is limited to 50 lines and
80 characters per line.
DATE:                    DESCRIPTION:
nde code comments
29-June-92                System startup and initialization
29-March-93              More service history

$$ Line required to end Service history

$General
32                        !Number of parameters
NDE                       !Customer Name
6-AUG-93                  !Ship Date
6-AUG-93                  !SYSTEM.TTI file write date
13:07                     !SYSTEM.TTI file write time
xxxxxx                   !Serial Number
33                        !Computer clock speed
5                         !Mouse interrupt number
0                         !The Max Analog in Channels
12.0                      !Helium Cal number !7.5
13                        !number of classes
WAVETEK                   !AC magnet oscillator source NCU or WAVETEK
NEW                       !Use OLD or NEW NCU commands
30000                     !bytes in software cash, 40 to 64k
0.0                       !sample time fudge factor
0.001                     !plotting sample time fudge factor/channel
1.9                       !burst time fudge factor
7                         !SQUID controller Binary Acquisition Channel
NONE                      !AT6400 or NONE motor driver
NONE                      !NONE or FIELDTEK encoder
YES                        !NCU installed YES or NO
YES                       !Wavetek installed
YES                       !Lab-PC installed
YES                       !Kepco installed
DC5000                    !DC5000 or NONE , SQUID box
YES                       !GPIB installed
5.2                       !acquisition re-do railed value
35.0                      !Helium level min for DC ramp
5.0                       !AC max Amps
10.0                     !DC max Amps
FACTORY                   !USER or FACTORY VERSION
NO                        !Shut SQUID box display off during acquisition
NO                        !ARE THERE CALIBRATION TABLES for fieldtek

$DC Magnets
1,2,3                    !Number of magnets in this system

```

```

18          !Number of parameters per magnet
25.1        !Amp/volt conversion for mag 1
0.04025    !Resistance conversion for mag 1
0.0159     !Volt/Tesla at tail mag 1
1.0        !The error volts for mag 1
1.0        !Ramp rate 1 amps/sec
1.0        !Ramp rate 2
1.0        !Ramp rate 3
2.0        !Time delay 1
2.0        !Time delay 2
2.0        !Time delay 3
2.0        !Time delay 4
7.0        !Time delay 5
7.0        !Time delay 6
1          !Lab-PC board number mag 1
2          !Lab-PC analog in KEPCO on/off sense
3          !Lab-PC analog in amps sense for KEPCO
10         !Lab_PC analog out KEPCO driver
1          !NCU Heater channels of DC magnet 1
25.1      !Amp/volt conversion for mag 2
0.04025   !Resistance conversion for mag 2
0.00167   !Volt/Tesla at tail mag 2
1.0       !The error volts for mag 2
0.0       !dummy
1         !Lab-PC board number mag 2
2         !Lab-PC analog in KEPCO on/off sense
3         !Lab-PC analog in amps sense for KEPCO
10        !Lab_PC analog out KEPCO driver
7         !NCU Heater channels of DC magnet 2
25.1     !Amp/volt conversion for mag 3
0.04025  !Resistance conversion for mag 3
0.00272  !Volt/Tesla at tail mag 3
1.0      !The error volts for mag 3
0.0      !dummy
1         !Lab-PC board number mag 3
2         !Lab-PC analog in KEPCO on/off sense
3         !Lab-PC analog in amps sense for KEPCO
10        !Lab_PC analog out KEPCO driver
8         !NCU Heater channels of DC magnet 3

$AC Magnets
1          !The Number of AC Magnets
4          !The Number of parameter/mag
0          !LAB-PC Analog in channel
0.5       !The AMP/Volt conversion factor mag 1
1.00     !Resistance conversion factor mag 1
0.0000175 !Volts/Tesla at tail

$SQUIDS
1,2,3,4,5,6 !MAX SQUID channels, please define below
5           !Number of SQUID parameters/channel
SQUID1-1cm_axial_-AC !Descriptor SQUID 1
6.7e-9     !Volts/Tesla Low SQUID 1
1.0e-6     !Volts/Tesla Medium SQUID 1
1.0e-6     !Volts/Tesla High SQUID 1
1.0        !acquisition multiplier 1
SQUID2 1.5_mm_mag !Descriptor SQUID 2
5.62e-8    !Volts/Tesla Low SQUID 2
1.0e-6     !Volts/Tesla Medium SQUID 2
1.0e-6     !Volts/Tesla High SQUID 2

```

```

1.0 !acquisition multiplier 2
SQUID3_3mm_axial_-AC !Descriptor SQUID 3
1.88e-7 !Volts/Tesla Low SQUID 3
1.0e-6 !Volts/Tesla Medium SQUID 3
3.1e-5 !Volts/Tesla High SQUID 3
1.0 !acquisition multiplier 3
SQUID4_3mm_axial !Descriptor SQUID 4
3.07e-8 !Volts/Tesla Low SQUID 4
1.0e-6 !Volts/Tesla Medium SQUID 4
1.0e-6 !Volts/Tesla High SQUID 4
1.0 !acquisition multiplier 4
SQUID5_3mm_axial_-AC !Descriptor SQUID 5
1.7e-7 !Volts/Tesla Low SQUID 5
1.0e-6 !Volts/Tesla Medium SQUID 5
1.0e-6 !Volts/Tesla High SQUID 5
1.0 !acquisition multiplier 5
SQUID6_3mm_axial !Descriptor SQUID 6
3.7e-8 !Volts/Tesla Low SQUID 6
1.0e-6 !Volts/Tesla Medium SQUID 6
1.0e-6 !Volts/Tesla High SQUID 6
1.0 !acquisition multiplier 6

$HEATER REFERENCE
1,2,3,4,5,6,7,8 !NCU heaters on system
1 !number of parameters
DC_Magnet_#1 !channel 1 descriptor
Circuit_#1_SQUID_#1 !channel 2 descriptor
Circuit_#2_SQUID_#3 !channel 3 descriptor
Circuit_#3_SQUID_#5 !channel 4 descriptor
Circuit_#4_AC_relay_#1 !channel 5 descriptor
Circuit_#5 !channel 6 descriptor
DC_Magnet_#2 !channel 7
DC_Magnet_#3 !channel 8

$MDAC
1,2,3 !MAX MDAC on system
1 !number of parameters
1 !SQUID channel for list MDAC 1
3 !SQUID channel for list MDAC 2
5 !SQUID channel for list MDAC 3

$POSITION INFO
12 !position info in data file
!number of parameters
FLOAT !data type of coordinates (FLOAT,DOUBLE,INT)
LOW !(LOW or HIGH) Indexer limit switches level
AUX1 !(AUX1) Indexer Board type
NO !YES or NO, turn indexer off
768 !Indexer address in Decimal
3 !Movement Mode 1=SINGLE AXIS,2=ALL AXIS,3=X-SQUID
+ !Mode 1 and 2, X positive move
+ !Mode 1 and 2, Y positive move
+- !Mode 3, A motor sign move
++ !Mode 3, B motor sign move
1 !Mode 3, A motor AT6400 axis
2 !Mode 3, B motor AT6400 axis

$SCANNER INFO
6 !number of parameter on axis
2 !number of axis on system
0.2 !distance per revolution in inches axis 1
25000 !steps per revolution axis 1
1.0 !velocity axis 1
1.0 !acceleration axis 1
0.3 !pulse width axis 1
1.0 !deceleration axis 1
0.2 !distance per revolution in inches axis 2
25000 !steps per revolution axis 2
1.0 !velocity axis 2
1.0 !acceleration axis 2
0.3 !pulse width axis 2
1.0 !deceleration axis 2

$COIL INFO
0 !number of parameters

$DEWAR INFO

```

```

0                                !number of parameters

$RELAY REFERENCE
1,2,3,4,5,6                        !Relays
1                                !Parameters
DC_Magnet_#1                       !Descriptor relay 1
DC_Magnet_#1                       !Descriptor relay 1
DC_Magnet_#2                       !Descriptor relay 1
DC_Magnet_#2                       !Descriptor relay 1
DC_Magnet_#3                       !Descriptor relay 1
DC_Magnet_#3                       !Descriptor relay 1

$POSITION READ
3                                !Number of Channels
5                                !Number of parameters per channel
600                               !base address 1
0                                !card channel 1
128                               !mode 1
0.57                             !sample time 1
1                                ! axis map 1
560                               !base address 2
0                                !card channel 2
128                               !mode 2
0.57                             !sample time 2
2                                ! axis map 2
600                               !base address 3
1                                !card channel 3
128                               !mode 3
0.57                             !sample time 3
3                                ! axis map 3

```

6.1.4 EXAMPLE "STARTUP.CFG" FILE

```

TRISTAN_CFG_FILE                   !TRISTAN id
2.1                               !Version num

$GENERAL INFORMATION               !class one
5                                !number of parameters
dummy                             !user comment
..\params\startup.cfg             !File Name
09-28-1993                        !file creation date
10:33:31                          !file creation time
9                                  !Number of Classes

$GENERAL ACQUISITION              !class two
9                                !number of parameters
1,2,3                             !SQUID channels on
0                                  !Analog in channels on
Timed                             !Acquisition Mode
2                                  !Samples/Burst
5                                  !number of bursts/file
0.00000000                        !time between bursts
0.00000000                        !initial delay
100.0                             !squid box sample freq
2                                  !Raw data Samples/Burst

$DC MAGNETS                       !class three
1,2,3                             !DC magnets defined
2                                  !number of parameters
0.0                               !current(amps)
07-15-1993,11:12:39              !date and time of DC field
0.0                               !current(amps)
07-15-1993,11:12:39              !date and time of DC field
0.0                               !current(amps)
07-15-1993,11:12:39              !date and time of DC field

$AC MAGNETS                       !class four
1                                  !AC magnets defined
3                                  !number of parameters
0.1                               !current (peak amps)
2.0                               !AC freq
ON                                !AC mag state

```

```

$MDAC globals          !class five
2                      !number of parameters
21                     !number of MDAC samples
7                      !MDAC global QUAD range

$MDAC channels        !class six
1,2,3,4,5,6,7,8      !MDAC channels defined
3                      !number of parameters
884                   !in Phase channel 1
2999                  !QUAD channel 1
6                     !Summation Range channel 1
1781                  !in Phase channel 2
2242                  !QUAD channel 2
6                     !Summation Range channel 2
1707                  !in Phase channel 3
2298                  !QUAD channel 3
6                     !Summation Range channel 3
2048                  !in Phase channel 4
2048                  !QUAD channel 4
7                     !Summation Range channel 4
2048                  !in Phase channel 5
0                     !QUAD channel 5
7                     !Summation Range channel 5
2048                  !in Phase channel 6
2048                  !QUAD channel 6
0                     !Summation Range channel 6
2048                  !in Phase channel 7
2048                  !QUAD channel 7
1                     !Summation Range channel 7
2048                  !in Phase channel 8
2048                  !QUAD channel 8
1                     !Summation Range channel 8

$$SQUID channels      !class seven
1,2,3,4,5,6,7,8      !SQUID channels defined
4                      !number of parameters
L                      !Tesla/Volt channel 1
4                      !Range 1=5s,2=5,3=50,4=500 1
1                      !Gain 1=1x,2=2x,3=5x,4=10x 1
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense
L                      !Tesla/Volt channel 2
4                      !Range 1=5s,2=5,3=50,4=500 2
1                      !Gain 1=1x,2=2x,3=5x,4=10x 2
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense
H                      !Tesla/Volt channel 3
4                      !Range 1=5s,2=5,3=50,4=500 3
1                      !Gain 1=1x,2=2x,3=5x,4=10x 3
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense
L                      !Tesla/Volt channel 4
4                      !Range 1=5s,2=5,3=50,4=500 4
1                      !Gain 1=1x,2=2x,3=5x,4=10x 4
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense
L                      !Tesla/Volt channel 5
4                      !Range 1=5s,2=5,3=50,4=500 5
1                      !Gain 1=1x,2=2x,3=5x,4=10x 5
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense
L                      !Tesla/Volt channel 6
4                      !Range 1=5s,2=5,3=50,4=500 6
1                      !Gain 1=1x,2=2x,3=5x,4=10x 6
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense
L                      !Tesla/Volt channel 7
4                      !Range 1=5s,2=5,3=50,4=500 7
1                      !Gain 1=1x,2=2x,3=5x,4=10x 7
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense
L                      !Tesla/Volt channel 8
3                      !Range 1=5s,2=5,3=50,4=500 8
1                      !Gain 1=1x,2=2x,3=5x,4=10x 8
1                      !SELS 1=1k,2=2k,3=4k,4=16k,5=N0,6=Dect,7=Tune,8=Sense

$$SQUID globals      !class eight
8                      !number of parameters
0                      !SQUID box (REPF)
1                      !SQUID box AD converter rate(ADCR)
0                      !SQUID box decimation factor
3                      !SQUID box data type(DTYPE)
0                      !SQUID box digital filter mode

```

```

0          !SQUID box (BWRf)
1          !SQUID box monitor channel (CHAN)
1          !SQUID box monitor filter(MONF)

$POSITION INFO      !class
8              !number of parameters
C:\NDEWORK\NDEDATA\DUM.xyz!position file name
Centimeters        !position units
Hello              !comment
NONE               !store pos file coordinates(NONE or X,Y)
NONE               !store transducer coordinates
10                !number of X trace positions
0.00000000        !XY trace angle of rotation
5.00000000        !Optical peak volts

```

6.1.5 EXAMPLE RAW DATA ACQUISITION FILE

```

TRISTAN_OUTPUT_FILE !TRISTAN ID
2.1                 !VERSION NUMBER
$GENERAL INFORMATION !class one
32                  !(SYS)number of parameters
C:\NDEWORK\NDEDATA\DUM.dat!data file name
09-28-1993          !current date
10:33:31            !current time
C:\NDEWORK\NDEDATA\DUM.dat!raw file name
19                  !total number of classes
example data file   !user comment
NDE                 !SYS customer name
6-AUG-93            !SYS ship date
xxxxx              !SYS serial number
1                   !OSC 1=WAVETEK,0=NCU
0                   !SYS max analog in
33                  !SYS computer clock speed
5                   !SYS mouse interrupt
12.0                !SYS Helium Cal
30000               !software cash size
0.00000000          !sample time fudge
0.00100000          !plot sample time fudge
1.90000000          !burst time fudge
7                   !SQUID Controller Binary Acq Channel
NONE                !AT6400 or NONE motor driver
NONE                !NONE encoder
YES                 !NCU installed
YES                 !Wavetek installed
YES                 !LAB-PC installed
YES                 !KEPCO installed
DC5000              !SQUID controller
YES                 !GPIB installed
5.2                 !acquisition railed err value
35.00000000         !helium level min for DC ramp
5.00000000          !Maximum AC magnet current
10.00000000         !Maximum DC magnet current
FACTORY              !USER or FACTORY program
NO                  !SQUID box off during acquis
NO                  !CAL tables for POSITION transducer

$GENERAL ACQUISITION !class
9                   !CFG number of parameters
1,2,3               !CFG SQUID flag
0                   !CFG analog in flag
Timed               !CFG acquisition mode
2                   !CFG samples/burst
5                   !CFG number of bursts
0.00000000          !CFG burst interval
0.00000000          !CFG initial delay
100.0               !CFG Squid frequency
2                   !raw file samples/burst

$DC MAGNET          !class
1,2,3               !SYS DC magnets available
18                  !SYS number of available parameters
1,2,3               !CFG DC magnets defined
2                   !CFG number of defined parameters
0.0                 !CFG DC magnet amps

```

```

07-15-1993,11:12:39 !CFG Time of last DC field change
25.1 !SYS amps/volts conversion
0.0159 !SYS Tesla/volts at tail
0.04025 !SYS resistance conversion
1.0 !SYS error volts for DC ramp
1.0 !SYS DC ramp rate
1.0 !SYS DC ramp rate
1.0 !SYS DC ramp rate
2.0 !SYS DC ramp time delay
7.0 !SYS DC ramp time delay
7.0 !SYS DC ramp time delay
1 !SYS LABPC board number
10 !SYS LABPC to Kepco on sense
3 !SYS LABPC to Kepco amps sense
10 !SYS LABPC to Kepco driver
1 !SYS DC magnet heater channels
0.0 !CFG DC magnet amps
07-15-1993,11:12:39 !CFG Time of last DC field change
25.1 !SYS amps/volts conversion
0.00167 !SYS Tesla/volts at tail
0.04025 !SYS resistance conversion
1.0 !SYS error volts for DC ramp
0.0 !SYS DC ramp rate
0.0 !SYS DC ramp rate
0.0 !SYS DC ramp rate
0.0 !SYS DC ramp time delay
1 !SYS LABPC board number
10 !SYS LABPC to Kepco on sense
3 !SYS LABPC to Kepco amps sense
10 !SYS LABPC to Kepco driver
7 !SYS DC magnet heater channels
0.0 !CFG DC magnet amps
07-15-1993,11:12:39 !CFG Time of last DC field change
25.1 !SYS amps/volts conversion
0.00272 !SYS Tesla/volts at tail
0.04025 !SYS resistance conversion
1.0 !SYS error volts for DC ramp
0.0 !SYS DC ramp rate
0.0 !SYS DC ramp rate
0.0 !SYS DC ramp rate
0.0 !SYS DC ramp time delay
1 !SYS LABPC board number
10 !SYS LABPC to Kepco on sense
3 !SYS LABPC to Kepco amps sense
10 !SYS LABPC to Kepco driver
8 !SYS DC magnet heater channels

$AC MAGNET !class
1 !SYS AC magnets available
4 !SYS number of available parameters
1 !CFG AC magnets defined
3 !CFG number of defined parameters
0.1 !CFG AC amps
2.0 !CFG AC freq
1 !CFG AC ON/OFF flag
0 !SYS Lab-Pc card pin
0.5 !SYS Amp/Volt conversion
1.0 !SYS Resistance conversion
1.75e-005 !SYS Tesla Volts at tail

$MDAC GLOBALS !class
2 !CFG number of parameters
7 !CFG global range

```

```

21                !CFG AC null number of samples

$MDAC CHANNELS    !class
1,2,3             !SYS MDAC channels available
1,2,3,4,5,6,7,8 !CFG MDAC channels defined
884              !CFG in Phase 1
2999             !CFG Quad 1
6                !CFG Range 1
1781             !CFG in Phase 2
2242             !CFG Quad 2
6                !CFG Range 2
1707            !CFG in Phase 3
2298            !CFG Quad 3
6                !CFG Range 3

$$SQUID CHANNELS !class
1,2,3,4,5,6,7,8 !CFG SQUID channels defined
4                !CFG number of parameters
1,2,3,4,5,6     !SYS MAX SQUIDS
5                !SYS number of parameters
SQUID1-1cm_axial_-AC !SYS SQUID Descriptor 1
6.7e-009        !SYS SQUID Descriptor 1 Low Wire
1.0e-006        !SYS SQUID Descriptor 1 Medium Wire
1.0e-006        !SYS SQUID Descriptor 1 High Wire
1.0             !SQUID acquisition multiplier
0               !CFG Volts/Tesla Range 1
4               !CFG SQUID Box Range 1
1               !CFG SQUID box Gain 1
1               !CFG SQUID box PPL filter 1
SQUID2 1.5_mm_mag !SYS SQUID Descriptor 2
5.62e-008       !SYS SQUID Descriptor 2 Low Wire
1.0e-006        !SYS SQUID Descriptor 2 Medium Wire
1.0e-006        !SYS SQUID Descriptor 2 High Wire
1.0             !SQUID acquisition multiplier
0               !CFG Volts/Tesla Range 2
4               !CFG SQUID Box Range 2
1               !CFG SQUID box Gain 2
1               !CFG SQUID box PPL filter 2
SQUID3 3mm_axial_-AC !SYS SQUID Descriptor 3
1.88e-007       !SYS SQUID Descriptor 3 Low Wire
1.0e-006        !SYS SQUID Descriptor 3 Medium Wire
3.1e-005        !SYS SQUID Descriptor 3 High Wire
1.0             !SQUID acquisition multiplier
2               !CFG Volts/Tesla Range 3
4               !CFG SQUID Box Range 3
1               !CFG SQUID box Gain 3
1               !CFG SQUID box PPL filter 3
SQUID4 3mm_axial !SYS SQUID Descriptor 4
3.07e-008       !SYS SQUID Descriptor 4 Low Wire
1.0e-006        !SYS SQUID Descriptor 4 Medium Wire
1.0e-006        !SYS SQUID Descriptor 4 High Wire
1.0             !SQUID acquisition multiplier
0               !CFG Volts/Tesla Range 4
4               !CFG SQUID Box Range 4
1               !CFG SQUID box Gain 4
1               !CFG SQUID box PPL filter 4
SQUID5 3mm_axial_-AC !SYS SQUID Descriptor 5
1.7e-007        !SYS SQUID Descriptor 5 Low Wire
1.0e-006        !SYS SQUID Descriptor 5 Medium Wire
1.0e-006        !SYS SQUID Descriptor 5 High Wire
1.0             !SQUID acquisition multiplier
0               !CFG Volts/Tesla Range 5
4               !CFG SQUID Box Range 5
1               !CFG SQUID box Gain 5
1               !CFG SQUID box PPL filter 5
SQUID6 3mm_axial !SYS SQUID Descriptor 6
3.7e-008        !SYS SQUID Descriptor 6 Low Wire
1.0e-006        !SYS SQUID Descriptor 6 Medium Wire
1.0e-006        !SYS SQUID Descriptor 6 High Wire
1.0             !SQUID acquisition multiplier
0               !CFG Volts/Tesla Range 6
4               !CFG SQUID Box Range 6
1               !CFG SQUID box Gain 6
1               !CFG SQUID box PPL filter 6
0               !CFG Volts/Tesla Range 7
4               !CFG SQUID Box Range 7

```

```

1          !CFG SQUID box Gain 7
1          !CFG SQUID box PPL filter 7
0          !CFG Volts/Tesla Range 8
3          !CFG SQUID Box Range 8
1          !CFG SQUID box Gain 8
1          !CFG SQUID box PPL filter 8

$SQUID GLOBALS      !class
8          !CFG number of parameters
0          !CFG REP factor
1          !CFG AD converter rate
0          !CFG Decimation factor
3          !CFG data type
0          !CFG digital filter mode
0          !CFG bandwidth reduction
1          !CFG display channel
1          !CFG monitor filter

$SERVICE HISTORY   !class (from SYS File)
This area in the file is reserved for a service history of the system. Any
modification or service to the system hardware must be logged here. Please
type in all text before the next "$" and use a standard text editor such as
DOS "EDIT". This history gets written to the data files. Data files have
gone to version 2.1. The Service History class is limited to 50 lines and
80 characters per line.
DATE:              DESCRIPTION:
nde code comments
29-June-92         System startup and initialization
29-March-93       More service history

$$ Line required to end Service history

$HEATER REFERENCE  !class
1,2,3,4,5,6,7,8   !SYS Heater channels
1                 !number of heater params
DC_Magnet_#1      Heater Description
Circuit_#1_SQUID_#1 Heater Description
Circuit_#2_SQUID_#3 Heater Description
Circuit_#3_SQUID_#5 Heater Description
Circuit_#4_AC_relay_#1 Heater Description
Circuit_#5        Heater Description
DC_Magnet_#2      Heater Description
DC_Magnet_#3      Heater Description

$MDAC MAP          !class
1,2,3             !MDAC channels installed
1                 !number of MDAC params
1                 !SQUID channel for MDAC
3                 !SQUID channel for MDAC
5                 !SQUID channel for MDAC

$LAST OPERATION    !class
DUMMY-RAW-DATA
EOS

$DATA DESCRIPTOR   !class
18                !number of parameters
SQUID-CHANNEL-1   !data type
FLOAT
SQUID-CHANNEL-2   !data type
FLOAT
SQUID-CHANNEL-3   !data type
FLOAT
SQUID-CHANNEL-4   !data type
FLOAT
SQUID-CHANNEL-5   !data type
FLOAT
SQUID-CHANNEL-6   !data type
FLOAT
SQUID-CHANNEL-7   !data type
FLOAT
SQUID-CHANNEL-8   !data type
FLOAT
AC-Magnet-1       !data type
DOUBLE

```

```

$POSITION INFO          !class
12                     !SYS number of parameters
FLOAT                  !coordinate data type
HIGH                   !SYS Indexer default level
AUX1                   !SYS Indexer board type
NO                     !Indexer Driver on always
768                    !Indexer Address
3                      !move mode 1=1 axis,2=all axis,3=X-SQUID
+                      !mode 1 and 2, X positive move
+                      !mode 1 and 2, Y positive move
++                     !mode 3, X positive move
+-                     !mode 3, X negative move
1                      !A motor axis number
2                      !B motor axis number
8                      !CFG number of parameters
C:\NDEWORK\NDEDATA\DUM.xyz!pos file name
Centimeters           !position units
Hello                  !comment
NONE                   !store position file?(NONE or X,Y)
NONE                   !store transducer?(NONE or X,Y)
10                     !number of X traces
0.00000000            !XY trace rotation angle
5.00000000            !Fieldtek optical peak

$SCANNER INFO          !class
6                      !number of parameters
2                      !number of axis
0.20000000            !inches per revolution
25000                  !steps per revolution
1.00000000            !velocity
1.00000000            !acceleration
0.30000000            !pulse width
1.00000000            !deceleration
0.20000000            !inches per revolution
25000                  !steps per revolution
1.00000000            !velocity
1.00000000            !acceleration
0.30000000            !pulse width
1.00000000            !deceleration

$COIL INFO             !class
0                      !number of parameters

$DEWAR INFO            !class
0                      !number of parameters

$RELAY REFERENCE      !class
1,2,3,4,5,6           !SYS Heater channels
1                      !number of relay params
DC_Magnet_#1          Relay Description
DC_Magnet_#1          Relay Description
DC_Magnet_#2          Relay Description
DC_Magnet_#2          Relay Description
DC_Magnet_#3          Relay Description
DC_Magnet_#3          Relay Description

$POSITION READ         !class
3                      !number of channels
5                      !number of parameters
600                    !base address decimal
0                      !card channels address
128                    !mode 0=unipolar, 128=bipolar
0.57000000            !sample time
1                      !axis map 1=x,2=y,3=z
560                    !base address decimal
0                      !card channels address
128                    !mode 0=unipolar, 128=bipolar
0.57000000            !sample time
2                      !axis map 1=x,2=y,3=z
600                    !base address decimal
1                      !card channels address
128                    !mode 0=unipolar, 128=bipolar
0.57000000            !sample time
3                      !axis map 1=x,2=y,3=z

Time (sec)   Squid Data for each Channel   AC mag

```

3.799132e+004			
0.000000e+000	1.099542e-001	2.862883e+000	0.000000e+000
1.503999e-001	3.844757e-001	3.225469e+000	6.141329e-001
3.799132e+004			
2.984279e-001	6.529338e-001	3.537187e+000	1.218581e+000
4.417495e-001	9.110948e-001	3.793122e+000	1.803810e+000
3.799132e+004			
5.781045e-001	1.154887e+000	3.989237e+000	2.360593e+000
7.053424e-001	1.380466e+000	4.122439e+000	2.880148e+000
3.799132e+004			
8.214566e-001	1.584275e+000	4.190629e+000	3.354281e+000
9.246160e-001	1.763098e+000	4.192729e+000	3.775515e+000
3.799132e+004			
1.013194e+000	1.914117e+000	4.128707e+000	4.137207e+000
1.085793e+000	2.034948e+000	3.999574e+000	4.433653e+000

6.1.7 NDE PRINTER CONFIGURATION

The NDE printer configuration menu may be accessed by typing the following DOS commands:

- 1.) c> **cd ndecode**
- 2.) c\ndecode> **ndelw -config**

The NDE printer configuration menu then appears. The user may then change the printer type by selecting "Configure Output". For higher quality outputs, users may choose to use PostScript printers.

6.1.8 3D PRINTER CONFIGURATION

The 3D software may be configured by executing the program "EQUIP" from the c:\nde\3dcode\gpc directory. The EQUIP program then prompts the user for the desired printer.

6.1.9 DATA ACQUISITION ERROR LOGGING

If a Data acquisition error occurs during a burst or at a position, the number of that burst or position is logged to a file. The file name is c:\nde\ndecode\NDEERR.LOG. Every time a data acquisition occurs the NDEERR.log file is erased and re-written. The nature of the Data acquisition errors are with data transmission or data manipulation in the SQUID controller.

6.2 NDE Software Modifications

6.2.2 Accessing NDE Data Files

NDE data and analysis files are written in Microsoft binary format. These binary files include a header and data. The header and data are in a format specific to the NDE program. No other computer program, such as Microsoft Excel, can directly read a NDE binary file. This section discusses methods for accessing NDE data and analysis files by hard copy output, or with other PC programs, or on other computer platforms.

The methods of accessing NDE files written during data acquisition include:

- 1.) Using the XY plot feature in the NDE program.
- 2.) Using the 3d plot in the 3d program.
- 3.) Using the NDE's "Conv File to ASCII" and then post processing the ASCII file. Post processing includes porting that ASCII file to another computer or using that file by a PC program such as Microsoft Excel. If the ASCII file is ported to another computer, a program could be written to process that file on that platform.

- 4.) Porting that binary data or analysis file to another platform and then writing code to read that file. An NDE binary file has a smaller size than the ASCII file containing the same information. If disk space or porting time is important, processing files in binary format is a better choice than processing ASCII files.

Reading NDE Binary Files with a Computer Program

NDE Binary Files contain a header and data. The header contains NDE system parameter and configuration information pertinent to the data in the file. Examples of information stored in the header include the magnitude of the AC and DC field, the SQUID sample frequency, the number of bursts of data, the number of samples per burst of data, etc.

Those parameters are stored on a byte by byte basis according to the data type. The data type and the number of bytes are also stored for each parameter. The file may be read into the computers memory by reading the number of classes, the number of parameters for each class, the data type, and number of bytes for each parameter. Please see section 6.1.2 "File Structure Description" for definitions of terms used in this section. The following illustrates the source code for reading a NDE binary file header and data file:

```
static int (*read_func[NUM_OUT_CLASSES])(int handle) = {
    &read_GEN_INFO,
    &read_GEN_ACQ,
    &read_DC,
    &read_AC,
    &read_MDAC_global,
    &read_MDAC_chan,
    &read_SQUID_chan,
    &read_SQUID_global,
    &read_SERVICE_HISTORY,
    &read_HEATER_REF,
    &read_MDAC_MAP,
    &read_LAST_OP,
    &read_DATA_Descriptor,
    &read_POSITION,
    &read_SCANNER,
    &read_COIL,
    &read_DEWAR,
    &read_RELAY
};

int read_DATA_file_header(int handle)
{
    int i, read_classes;
    char str[100];

    asc_to_bin_flag = FALSE;
    if (BINARY_read(handle, (void*)str, STRING_TYPE) != NO_ERR) return (ERR_REPORTED);
    if (strcmp(str, TRISTAN_OUT_id) != 0)
    {
        ERROR_handle(FILE_READ_ID_ERR, NO_ADD_ERR);
        return (ERR_REPORTED);
    }
    BINARY_read(handle, (void*)data_file_ver_num, STRING_TYPE); /* version num */
    DataFileVerNum10 = (int)((atof(data_file_ver_num) + .0001) * 10.);
    if (strcmp(data_file_ver_num, version_num) != 0)
        ERROR_handle(FILE_DATA_VER_ERR, NO_ADD_ERR);
    if (read_GEN_INFO(handle) != NO_ERR) return (ERR_REPORTED);

    if (NUM_OUT_CLASSES < num_read_classes) read_classes = NUM_OUT_CLASSES;
    else read_classes = num_read_classes;

    for (i = 1; i < read_classes; i++)
    {
        if ((*read_func[i])(handle) != NO_ERR) return (ERR_REPORTED);
    }
    if (num_read_classes > NUM_OUT_CLASSES)
    {
        for (i = NUM_OUT_CLASSES; i < num_read_classes; i++)
        {
            if (read_DUMMY_class(handle) != NO_ERR) return (ERR_REPORTED);
        }
    }
}
```

```

    }
}
return(NO_ERR);
} /* end function */

static int read_DUMMY_class(int handle)
{
    int num_params,i;
    char str[100];

    if(BINARY_read(handle, (void*)&num_params, INT_TYPE) !=
NO_ERR) return(ERR_REPORTED);
    for(i=0;i<num_params;i++)
        if(BINARY_read(handle, (void*) str, STRING_TYPE) !=NO_ERR) return (ERR_REPORTED);
    return(NO_ERR);
} /* end function */

static int read_GEN_INFO(int handle)
{
    char str[100];
    long dummy;

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$GENERAL INFORMATION")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    if(BINARY_read(handle, (void*)&SYS.GEN.num_fields, INT_TYPE)!=NO_ERR)
        return(ERR_REPORTED); /*number of parameters*/
    if(BINARY_read(handle, (void*)data_fname, STRING_TYPE) !=NO_ERR)
        return(ERR_REPORTED); /*read data filename*/
    if(BINARY_read(handle, (void*)SYS.GEN.fdate, STRING_TYPE) !=NO_ERR)
        return(ERR_REPORTED); /* read date */
    if(BINARY_read(handle, (void*)SYS.GEN.ftime, STRING_TYPE) !=NO_ERR)
        return(ERR_REPORTED); /* read time*/
    BINARY_read(handle, (void*)raw_fname, STRING_TYPE); /*read raw file name*/
    BINARY_read(handle, (void*)&num_read_classes, INT_TYPE); /*total number of
classes*/
    BINARY_read(handle, (void*)user_comment, STRING_TYPE); /* user comment*/
    BINARY_read(handle, (void*)SYS.GEN.cust_name, STRING_TYPE); /* cust name*/
    BINARY_read(handle, (void*)SYS.GEN.ship_date, STRING_TYPE);
    BINARY_read(handle, (void*)SYS.GEN.serial_num, STRING_TYPE);
    BINARY_read(handle, (void*)&SYS.GEN.OSC, INT_TYPE); /*oscillator source*/
    BINARY_read(handle, (void*)&SYS.GEN.MDA, INT_TYPE); /*MAX ANALOG IN*/
    BINARY_read(handle, (void*)&SYS.GEN.CS, INT_TYPE); /*clock speed*/
    BINARY_read(handle, (void*)&SYS.GEN.MOUSEINT, INT_TYPE); /*mouse interrupt*/
    if(BINARY_read(handle, (void*)&SYS.GEN.Hcal, INT_TYPE) !=NO_ERR)
        return(ERR_REPORTED); /*Helium Cal*/
    if(SYS.GEN.num_fields>12)
        BINARY_read(handle, (void*)&dummy, LONG_TYPE);
    if(SYS.GEN.num_fields>13)
        BINARY_read(handle, (void*)&SYS.GEN.sample_time_fudge, DOUBLE_TYPE);
    if(SYS.GEN.num_fields>14)
        BINARY_read(handle, (void*)&SYS.GEN.plot_sample_time_fudge, DOUBLE_TYPE);
    if(SYS.GEN.num_fields>15)
        BINARY_read(handle, (void*)&SYS.GEN.burst_time_fudge, DOUBLE_TYPE);
    if(SYS.GEN.num_fields>16)
        BINARY_read(handle, (void*)&SYS.GEN.bin_chan, INT_TYPE); /*oscillator source*/
    if(SYS.GEN.num_fields>17)
        BINARY_read(handle, (void*)SYS.GEN.motor_driver, STRING_TYPE);
    if(SYS.GEN.num_fields>18)
        BINARY_read(handle, (void*)SYS.GEN.encoder, STRING_TYPE);
    if(SYS.GEN.num_fields>19)
        BINARY_read(handle, (void*)&SYS.GEN.NCUIN, INT_TYPE);
    if(SYS.GEN.num_fields>20)
        BINARY_read(handle, (void*)&SYS.GEN.WAVETEKIN, INT_TYPE);
    if(SYS.GEN.num_fields>21)
        BINARY_read(handle, (void*)&SYS.GEN.LABPCIN, INT_TYPE);
    if(SYS.GEN.num_fields>22)
        BINARY_read(handle, (void*)&SYS.GEN.KEPCOIN, INT_TYPE);
    file_advance_extra_params(SYS.GEN.num_fields,23,handle);
    return(NO_ERR);
} /* end function */

static int read_GEN_ACQ(int handle)

```

```

{
    char str[100];

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$GENERAL ACQUISITION")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    BINARY_read(handle,(void*)&CFG.ACQ.num_fields,INT_TYPE);
    if(BINARY_read(handle,(void*)&CFG.ACQ.Sfl,INT_TYPE)!=NO_ERR)
        return(ERR_REPORTED);/* SQUID flag*/
    BINARY_read(handle,(void*)&CFG.ACQ.Adf1,INT_TYPE);/*Analog in flag*/
    BINARY_read(handle,(void*)CFG.ACQ.MODE,STRING_TYPE); /*acquisition mode*/
    BINARY_read(handle,(void*)&CFG.ACQ.ndat,LONG_TYPE); /*num of samples*/
    BINARY_read(handle,(void*)&CFG.ACQ.nburst,LONG_TYPE);/*num of bursts*/
    BINARY_read(handle,(void*)&CFG.ACQ.bint,DOUBLE_TYPE);/*burst interval*/
    BINARY_read(handle,(void*)&CFG.ACQ.indel,DOUBLE_TYPE);/*initial delay*/
    if(BINARY_read(handle,(void*)&CFG.ACQ.sfreq,FLOAT_TYPE)!=NO_ERR)
        return(ERR_REPORTED);/*SQUID sample freq*/
    if(CFG.ACQ.num_fields>8)
        BINARY_read(handle,(void*)&CFG.ACQ.raw_ndat,LONG_TYPE); /*num of
samples*/
    file_advance_extra_params(CFG.ACQ.num_fields,9,handle);
    return(NO_ERR);
} /* end function */

static int read_DC(int handle)
{
    int num_chan,i,j;
    char str[100];

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$DC MAGNET")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    if(BINARY_read(handle,(void*)&SYS.GEN.DC_mag_fl,INT_TYPE)!=NO_ERR)
        return(ERR_REPORTED);
    BINARY_read(handle,(void*)&SYS.GEN.DCfields,INT_TYPE);
    BINARY_read(handle,(void*)&CFG.GEN.DCfl,INT_TYPE);
    BINARY_read(handle,(void*)&CFG.GEN.DCfields,INT_TYPE);
    num_chan = count_channels(SYS.GEN.DC_mag_fl);
    for(i=0;i<num_chan;i++)
    {
        BINARY_read(handle,(void*)&CFG.DC[i].AMP,FLOAT_TYPE);
        BINARY_read(handle,(void*)CFG.DC[i].AMPtd,STRING_TYPE);
        file_advance_extra_params(CFG.GEN.DCfields,2,handle);
        BINARY_read(handle,(void*)&SYS.DC[i].AV,FLOAT_TYPE);
        BINARY_read(handle,(void*)&SYS.DC[i].TV,FLOAT_TYPE);
        BINARY_read(handle,(void*)&SYS.DC[i].R,FLOAT_TYPE);
        BINARY_read(handle,(void*)&SYS.DC[i].E,FLOAT_TYPE);
        for(j=0;j<3;j++)
            BINARY_read(handle,(void*)&SYS.DC[i].Rate[j],FLOAT_TYPE);
        for(j=0;j<6;j++)
        {
            if(BINARY_read(handle,(void*)&SYS.DC[i].Time[j],FLOAT_TYPE)!=NO_ERR)
                return(ERR_REPORTED);
        }
        if(SYS.GEN.DCfields>13)
        {
            BINARY_read(handle,(void*)&SYS.DC[i].LAB_PC_BOARD,INT_TYPE);
            BINARY_read(handle,(void*)&SYS.DC[i].LAB_PC_KEPON,INT_TYPE);
            BINARY_read(handle,(void*)&SYS.DC[i].LAB_PC_AMPSENSE,INT_TYPE);
            BINARY_read(handle,(void*)&SYS.DC[i].LAB_PC_KEPON,INT_TYPE);
            BINARY_read(handle,(void*)&SYS.DC[i].HEAT_ON_NCU,INT_TYPE);
        }
        file_advance_extra_params(SYS.GEN.DCfields,18,handle);
    } /* end for */
    return(NO_ERR);
} /* end function */

static int read_AC(int handle)
{
    int bit_check,i,num_chan;

```

```

char str[100];

advance_DATA_file_to_class(handle,str);
if(strcmp(str,"$AC_MAGNET")!=0)
{
    ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
    return(ERR_REPORTED);
}
if(BINARY_read(handle,(void*)&SYS.GEN.AC_mag_fl,INT_TYPE)!=NO_ERR)
    return(ERR_REPORTED);
BINARY_read(handle,(void*)&SYS.GEN.ACfields,INT_TYPE);
BINARY_read(handle,(void*)&CFG.GEN.ACfl,INT_TYPE);
BINARY_read(handle,(void*)&CFG.GEN.ACfields,INT_TYPE);
num_chan = count_channels(SYS.GEN.AC_mag_fl);
bit_check = 0x0001;
for(i=0;i<num_chan;i++)
{
    if((CFG.GEN.ACfl&bit_check)==bit_check)
    {
        BINARY_read(handle,(void*)&CFG.AC[i].AMP,FLOAT_TYPE);
        BINARY_read(handle,(void*)&CFG.AC[i].freq,FLOAT_TYPE);
        BINARY_read(handle,(void*)&CFG.AC[i].IS_ON,INT_TYPE);
        file_advance_extra_params(CFG.GEN.ACfields,3,handle);
    }/* end if */
    if((SYS.GEN.AC_mag_fl&bit_check)==bit_check)
    {
        BINARY_read(handle,(void*)&SYS.AC[i].LAB_PC_CHAN,INT_TYPE);
        BINARY_read(handle,(void*)&SYS.AC[i].AV,FLOAT_TYPE);
        BINARY_read(handle,(void*)&SYS.AC[i].R,FLOAT_TYPE);
        if(BINARY_read(handle,(void*)&SYS.AC[i].TV,FLOAT_TYPE)!=NO_ERR)
            return(ERR_REPORTED);
        file_advance_extra_params(SYS.GEN.ACfields,4,handle);
    }/* end if */
    bit_check<<=1;
} /* end for */
return(NO_ERR);
} /* end function */

static int read_MDAC_global(int handle)
{
    char str[100];

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$MDAC_GLOBALS")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    BINARY_read(handle,(void*)&CFG.Mgl.num_fields,INT_TYPE);
    BINARY_read(handle,(void*)&CFG.Mgl.Ran,INT_TYPE);
    if(BINARY_read(handle,(void*)&CFG.Mgl.ndat,INT_TYPE)!=NO_ERR)
        return(ERR_REPORTED);
    file_advance_extra_params(CFG.Mgl.num_fields,2,handle);
    return(NO_ERR);
} /* end function */

static int read_MDAC_chan(int handle)
{
    int num_chan,i,bit_check;
    char str[100];

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$MDAC_CHANNELS")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    BINARY_read(handle,(void*)&SYS.GEN.MDAC_fl,INT_TYPE);
    BINARY_read(handle,(void*)&CFG.GEN.MDACfl,INT_TYPE);
    num_chan = count_channels(SYS.GEN.MDAC_fl);
    bit_check = 0x0001;
    for(i=0;i<num_chan;i++)
    {
        if((CFG.GEN.MDACfl&bit_check)==bit_check)
        {
            BINARY_read(handle,(void*)&CFG.Mch[i].inP,UNSIGNED_INT_TYPE);

```

```

        BINARY_read(handle, (void*)&CFG.Mch[i].Q, UNSIGNED_INT_TYPE);
        if (BINARY_read(handle, (void*)&CFG.Mch[i].Ran, INT_TYPE) != NO_ERR)
            return (ERR_REPORTED);
        /* end if */
        bit_check<=1;
    } /* end for */
    return (NO_ERR);
} /* end function */

static int read_SQUID_chan(int handle)
{
    int i, bit_check, j, num_chan;
    char str[100];

    advance_DATA_file_to_class(handle, str);
    if (strcmp(str, "$SQUID CHANNELS") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return (ERR_REPORTED);
    }
    BINARY_read(handle, (void*)&CFG.GEN.S_def_fl, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.GEN.Sfields, INT_TYPE);
    BINARY_read(handle, (void*)&SYS.GEN.MS, INT_TYPE);
    BINARY_read(handle, (void*)&SYS.GEN.Sfields, INT_TYPE);
    bit_check = 0x0001;
    num_chan = count_channels(CFG.GEN.S_def_fl);
    for (i=0; i<num_chan; i++)
    {
        if ((SYS.GEN.MS & bit_check) == bit_check)
        {
            BINARY_read(handle, SYS.Squid[i].des, STRING_TYPE); /* Description for each
squid*/
            for (j=0; j<3; j++)
                BINARY_read(handle, &SYS.Squid[i].VT[j], FLOAT_TYPE); /* Volt Tesla for L, M, H
range*/
            BINARY_read(handle, &SYS.Squid[i].mult, FLOAT_TYPE); /* multiplier*/
            file_advance_extra_params(SYS.GEN.Sfields, 5, handle);
        }
        if ((CFG.GEN.S_def_fl & bit_check) == bit_check)
        {
            BINARY_read(handle, (void*)&CFG.Sch[i].VTR, INT_TYPE);
            BINARY_read(handle, (void*)&CFG.Sch[i].Ran, INT_TYPE);
            BINARY_read(handle, (void*)&CFG.Sch[i].Gain, INT_TYPE);
            if (BINARY_read(handle, (void*)&CFG.Sch[i].PLL, INT_TYPE) != NO_ERR)
                return (ERR_REPORTED);
            file_advance_extra_params(CFG.GEN.Sfields, 4, handle);
        } /* end if */
        bit_check<=1;
    } /* end for */
    return (NO_ERR);
} /* end function */

static int read_SQUID_global(int handle)
{
    char str[100];

    advance_DATA_file_to_class(handle, str);
    if (strcmp(str, "$SQUID GLOBALS") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return (ERR_REPORTED);
    }
    BINARY_read(handle, (void*)&CFG.Sgl.num_fields, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.Sgl.REPF, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.Sgl.ADCR, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.Sgl.DECF, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.Sgl.DTYPE, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.Sgl.DFMD, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.Sgl.BWRF, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.Sgl.CHAN, INT_TYPE);
    if (BINARY_read(handle, (void*)&CFG.Sgl.MONF, INT_TYPE) != NO_ERR)
        return (ERR_REPORTED);
    file_advance_extra_params(CFG.Sgl.num_fields, 8, handle);
    return (NO_ERR);
} /* end function */

```

```

static int read_SERVICE_HISTORY(int handle)
{
    char str[100];

    advance_DATA_file_to_class(handle, str);
    if(strcmp(str, "$SERVICE HISTORY") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    str[0] = '\0';
    SYS.SER_HIS.num_lines = 0;

    while(str[0] != '$')
    {
        if(BINARY_read(handle, str, STRING_TYPE) != NO_ERR) return(ERR_REPORTED);
        if((SYS.SER_HIS.use == TRUE) && (SYS.SER_HIS.num_lines < 50))
            strcpy(SYS.SER_HIS.buffer[SYS.SER_HIS.num_lines++], str);
    }
    is_class_found = FALSE;
    strcpy(class_name, "no_class");
    return(NO_ERR);
} /* end function */

static int read_HEATER_REF(int handle)
{
    char str[100];
    int i, num_heaters, j;

    advance_DATA_file_to_class(handle, str);
    if(strcmp(str, "$HEATER REFERENCE") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    if(BINARY_read(handle, (void*) &SYS.GEN.Heat_f1, INT_TYPE) != NO_ERR)
        return(ERR_REPORTED);
    if(is_class_found == FALSE)
    {
        BINARY_read(handle, &SYS.GEN.Hfields, INT_TYPE); /* read the num of params */
        if((SYS.GEN.Hfields > 0) && (is_class_found == FALSE))
        {
            num_heaters = count_channels(SYS.GEN.Heat_f1);
            for(i=0; i < num_heaters; i++)
            {

if(BINARY_read(handle, (void*) SYS.Heat[i].descr, STRING_TYPE) != NO_ERR) return(ERR_REP
ORTED); /* */
                for(j=1; j < SYS.GEN.Hfields; j++)

if(BINARY_read(handle, (void*) str, STRING_TYPE) != NO_ERR) return(ERR_REPORTED); /* read
extra parameters */
            }
        }
        return(NO_ERR);
    } /* end function */

static int read_MDAC_MAP(int handle)
{
    char str[100];
    int i, j, num_chan;

    advance_DATA_file_to_class(handle, str);
    if(strcmp(str, "$MDAC MAP") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    if(BINARY_read(handle, (void*) &SYS.GEN.MDAC_f1, INT_TYPE) != NO_ERR)
        return(ERR_REPORTED);
    num_chan = count_channels(SYS.GEN.MDAC_f1);
    if(is_class_found == FALSE)
    {
        BINARY_read(handle, &SYS.GEN.Mfields, INT_TYPE); /* read the num of params */
        if((SYS.GEN.Mfields > 0) && (is_class_found == FALSE))

```

```

        {
            for(j=0;j<num_chan;j++)
            {
                BINARY_read(handle,&SYS.MDAC[j].SQUID_chan,INT_TYPE);
                for(i=1;i<SYS.GEN.Mfields;i++)
                    BINARY_read(handle,str,STRING_TYPE);/* read extra parameters */
            }
        }
    }
    return(NO_ERR);
} /* end function */

static int read_LAST_OP(int handle)
{
    int i;
    char str[100];

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$LAST OPERATION")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    if(BINARY_read(handle,(void*)LAST_OP[0],STRING_TYPE)!=NO_ERR)
        return(ERR_REPORTED);
    for(i=1;(i<7) && (strcmp(LAST_OP[i-1],"EOS")!=0));i++)
        if(BINARY_read(handle,(void*)LAST_OP[i],STRING_TYPE)!=NO_ERR)
            return(ERR_REPORTED);
    return(NO_ERR);
} /* end function */

static int read_DATA_Descriptor(int handle)
{
    int i;
    char str[100];

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$DATA DESCRIPTOR")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    BINARY_read(handle,(void*)&CFG.DATA.num_fields,INT_TYPE);
    for(i=0;i<nS_chan;i++)
    {
        BINARY_read(handle,(void*)&CFG.DATA.SQUID_des[i],STRING_TYPE);
        BINARY_read(handle,(void*)&CFG.DATA.SQUID_dtype[i],INT_TYPE);
    }
    for(i=0;i<nAC_chan;i++)
    {
        BINARY_read(handle,(void*)&CFG.DATA.AC_des[i],STRING_TYPE);
        if(BINARY_read(handle,(void*)&CFG.DATA.AC_dtype[i],INT_TYPE)!=NO_ERR)
            return(ERR_REPORTED);
    }
    return(NO_ERR);
} /* end function */

static int read_POSITION(int handle)
{
    char str[100];

    if(DataFileVerNum10>20)
    {
        advance_DATA_file_to_class(handle,str);
        if(strcmp(str,"$POSITION INFO")!=0)
        {
            ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
            return(ERR_REPORTED);
        }
        BINARY_read(handle,(void*)&SYS.POS.num_params,INT_TYPE);
        BINARY_read(handle,(void*)&SYS.POS.data_type,INT_TYPE);
        if(SYS.POS.num_params>1)
            BINARY_read(handle,(void*)&SYS.POS.default_level,INT_TYPE);
        if(SYS.POS.num_params>2)
            BINARY_read(handle,(void*)SYS.POS.board_type,STRING_TYPE);
        file_advance_extra_params(SYS.POS.num_params,3,handle);
    }
}

```

```

    BINARY_read(handle, (void*)&CFG.POS.num_params, INT_TYPE);
    BINARY_read(handle, (void*)&CFG.POS.pos_fname, STRING_TYPE);
    BINARY_read(handle, (void*)&CFG.POS.pos_units, STRING_TYPE);
    BINARY_read(handle, (void*)&CFG.POS.comment, STRING_TYPE);

    BINARY_read(handle, (void*)str, STRING_TYPE);
    CFG.POS.store_pos_file_fl = decode_pos_file_string(str, 20);
    BINARY_read(handle, (void*)str, STRING_TYPE);
    CFG.POS.store_trans_fl = decode_trans_string(str, 20);
    BINARY_read(handle, (void*)&CFG.POS.num_traces, INT_TYPE);
    file_advance_extra_params(CFG.POS.num_params, 6, handle);
}
else
    CFG.POS.store_pos_file_fl = CFG.POS.store_trans_fl = 0;
return(NO_ERR);
} /* end function */

static int read_SCANNER(int handle)
{
    char str[100];
    int j;

    advance_DATA_file_to_class(handle, str);
    if(strcmp(str, "$SCANNER INFO") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    BINARY_read(handle, (void*)&SYS.SCAN.num_params, INT_TYPE);
    if(SYS.SCAN.num_params > 0)
    {
        BINARY_read(handle, (void*)&SYS.SCAN.num_axis, INT_TYPE);
        for(j=0; j<SYS.SCAN.num_axis; j++)
        {
            BINARY_read(handle, (void*)&SYS.SCAN.inch_rev[j], DOUBLE_TYPE);
            BINARY_read(handle, (void*)&SYS.SCAN.steps_rev[j], LONG_TYPE);
            BINARY_read(handle, (void*)&SYS.SCAN.velocity[j], DOUBLE_TYPE);
            BINARY_read(handle, (void*)&SYS.SCAN.accel[j], DOUBLE_TYPE);
            BINARY_read(handle, (void*)&SYS.SCAN.pulse_width[j], DOUBLE_TYPE);
        }
        file_advance_extra_params(SYS.SCAN.num_params, 5, handle);
    }
    return(NO_ERR);
} /* end function */

static int read_COIL(int handle)
{
    char str[100];

    advance_DATA_file_to_class(handle, str);
    if(strcmp(str, "$COIL INFO") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    BINARY_read(handle, (void*)&SYS.COIL.num_params, INT_TYPE);
    file_advance_extra_params(SYS.COIL.num_params, 0, handle);
    return(NO_ERR);
} /* end function */

static int read_DEWAR(int handle)
{
    char str[100];

    advance_DATA_file_to_class(handle, str);
    if(strcmp(str, "$DEWAR INFO") != 0)
    {
        ERROR_handle(FILE_READ_ERR, NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    BINARY_read(handle, (void*)&SYS.DEWAR.num_params, INT_TYPE);
    file_advance_extra_params(SYS.DEWAR.num_params, 0, handle);
    return(NO_ERR);
} /* end function */

static int read_RELAY(int handle)

```

```

{
    char str[100];
    int i,num_heaters,j;

    advance_DATA_file_to_class(handle,str);
    if(strcmp(str,"$RELAY REFERENCE")!=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    if(BINARY_read(handle,(void*)&SYS.GEN.Relay_fl,INT_TYPE)!=NO_ERR)
        return(ERR_REPORTED);
    BINARY_read(handle,&SYS.GEN.Rfields,INT_TYPE);/* read the num of params */
    if(SYS.GEN.Rfields>0)
    {
        num_heaters = count_channels(SYS.GEN.Relay_fl);
        for(i=0;i<num_heaters;i++)
        {

if(BINARY_read(handle,(void*)SYS.Relay[i].descr,STRING_TYPE)!=NO_ERR) return(ERR_RE
PORTED);/* */
                for(j=1;j<SYS.GEN.Rfields;j++)

if(BINARY_read(handle,(void*)str,STRING_TYPE)!=NO_ERR) return(ERR_REPORTED);/* read
extra parameters */
        }
        return(NO_ERR);
    } /* end function */

int advance_DATA_file_to_class(int handle,char *str1)
{
    char str[100];
    str[0] = '\0';
    if(is_$class_found==FALSE)
    {
        while(str[0]!='$')
        {
            if(BINARY_read(handle,str,STRING_TYPE)!=NO_ERR) return(ERR_REPORTED);
            if(str[0] == '$' && str[1] == '$') str[0] = '\0';
        }
        strcpy(str1,str);
    }
    else
        strcpy(str1,class_name);
    is_$class_found = TRUE;
    return(NO_ERR);
} /*end function */

int BINARY_read(int handle,void *val,int data_type)
{
    int TAG,num_bytes;
    char *str;
    char str_storage[150];

    /* read the tag, the number of bytes to read is stored in the tag */
    is_$class_found=FALSE;
    strcpy(class_name,"no_class");

    if(ReadFile(handle,&TAG,2)<=0)
    {
        ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
        return(ERR_REPORTED);
    }
    if( TAG == INT_TYPE ||
        TAG == UNSIGNED_INT_TYPE ||
        TAG == BINARY_QD_TYPE)
        ReadFile(handle,val,2);
    else if( TAG == FLOAT_TYPE ||
            TAG == LONG_TYPE ||
            TAG == UNSIGNED_LONG_TYPE ||
            TAG == FLOAT_IEEE_TYPE)
        ReadFile(handle,val,4);
    else if ( TAG == DOUBLE_TYPE)
        ReadFile(handle,val,8);
    else if ((TAG&0x00ff)==STRING_TYPE) /* string type */

```

```

{
  num_bytes=TAG>>8;
  num_bytes&=0x00ff;
  TAG&=0x00ff;
  if(data_type== STRING_TYPE)
  {
    ReadFile(handle,val,num_bytes);
    str = val;
    str[num_bytes] = '\0';
    if(str[0]=='$')
    {
      is_$class_found=TRUE;
      strcpy(class_name,str);
    }
  }
  else
  {
    ReadFile(handle,str_storage,num_bytes);
    str_storage[num_bytes] = '\0';
    if(str_storage[0]=='$')
    {
      is_$class_found=TRUE;
      strcpy(class_name,str_storage);
    }
  }
}
else
{
  ERROR_handle(FILE_READ_ERR,NO_ADD_ERR);
  return(ERR_REPORTED);
}
return(NO_ERR);
} /* end function */

```

Chapter 7: MAINTENANCE

7.1 DEWAR VACUUM

Because there is some diffusion of helium through warm fiberglass, helium gas should not be allowed to remain in a warm dewar for extended periods. There is also a small amount of helium diffusion that occurs during normal operation through the warm, upper portion of the neck tube. Large quantities of air, water, and other gasses are also outgassed from the warm, interior surfaces of the dewar vacuum space. However, there is a getter in the vacuum space which absorbs large amounts of gas when the dewar is cold. Therefore, the vacuum space should not require any maintenance for over a year of normal operation. Eventually, the vacuum space of the dewar will need to be re-evacuated. This will become obvious in one of two ways:

- ◆ The helium evaporation rate will increase during normal operation. If the evaporation rate has increased by more than 30%, you should consider repumping the vacuum space.
- ◆ You will be unable to transfer liquid helium. All of the helium transferred into the dewar will immediately evaporate. If the vacuum is extremely poor, the outside of the dewar may get cold and even condense water, especially along the tail.

CAUTION
CARE MUST BE TAKEN IN THE USE OF THE CRYOLAB DEWAR VALVE. IT IS VERY DIFFICULT TO TELL IF THE VALVE IS DISENGAGED OR NOT. IT IS BEST TO PULL THE BODY UPPER OFF WHILE KEEPING THE PISTON EXTENDED (I.E. CLOSED) BEFORE REMOVING THE VALVE BODY.

If you suspect a poor vacuum, use the following procedure to check and pump on the vacuum:

CAUTION
EXTREME CAUTION MUST BE USED WHEN EXAMINING THE VACUUM. THERE ARE MANY FINE LAYERS OF SUPERINSULATION IN THE VACUUM SPACE. RAPID CHANGES IN PRESSURE MAY CAUSE RUPTURING OF THE SUPERINSULATION. THEREFORE, NEVER ABRUPTLY OPEN THE DEWAR VACUUM SPACE TO ATMOSPHERIC PRESSURE; THE DEWAR VACUUM SHOULD BE SLOWLY VENTED OVER A PERIOD OF ABOUT 15 MINUTES. THE HELIUM RESERVOIR MUST ALWAYS BE AT ROOM TEMPERATURE WHEN GAS IS ADMITTED TO THE VACUUM SPACE OR WHEN IT IS BEING PUMPED.

The dewar is equipped with a vacuum space evacuation valve mounted on the dewar top. Before opening this valve, a leak-tight connection should be made to it and the pumping line to the valve should be evacuated using a leak detector or a pumping station equipped with a diffusion pump and cold trap (or other pumping system with equivalent capability). The cold trap is necessary to prevent back-streaming of pump oil into the vacuum space after it has reached a low, static pressure.

OPEN THE VALVE VERY SLOWLY AND OBSERVE THE PRESSURE IN THE DEWAR. DO NOT BEGIN PUMPING UNTIL YOU OBSERVE THE PRESSURE.

If you observe a high pressure (more than a few Torr), you should pump the vacuum space very slowly by opening the valve as little as possible.

A satisfactory vacuum is about 100-200 millitorr when the whole dewar is at room temperature. If it is higher than 500 millitorr, it should be reevacuated. Depending on the pressure, this may take up to 24 hours to obtain a satisfactory pressure.

WARNING
DO NOT LEAVE THE DEWAR PUMPING UNATTENDED

Since most of the time required is for outgassing of the surfaces in the dewar, it is better to pump the dewar for 15 minutes every few hours. There is little advantage to leave the pump connected continuously.

If your leak detector indicates a high level of helium gas, it may be advantageous to flush the vacuum space once with nitrogen gas. Slowly fill the vacuum space with 10 Torr of nitrogen gas (this should not be done at a rate faster than 1 Torr per minute). It should then be re-evacuated as described above. This procedure may be repeated several times until the helium level is low.

WARNING
THE PRESSURE IN THE VACUUM SPACE MUST NEVER BE ALLOWED TO CHANGE QUICKLY. RAPID PRESSURE CHANGES WILL CAUSE PERMANENT DAMAGE TO THE THERMAL SHIELD AND SUPERINSULATION.

If the dewar does not perform well after pumping the vacuum, or if it requires pumping at intervals more frequent than once a year, there may be a leak in the dewar. If you suspect this problem, contact your Tristan representative for assistance.

APPENDIX A: ADDITIONAL INFORMATION

A.1 SETUP

A.2 COMPUTER HARDWARE SETUP

● Interrupts and addresses

	IEEE address	I/O PORT	IRQ	DMA
GPIB card	0	0x2C0h	11	5
QD SQUID Controller	15	N/A	N/A	N/A
COM1 - NCU	N/A	0x3F8h	4	N/A
COM2	N/A	0x2F8h	3	N/A
LPT1	N/A	0x378h	7	N/A
BUS MOUSE	N/A	N/A	5	N/A
Compumotor AT6400	N/A	0x300h	Disabled	N/A

IEEE address & setup (v2.1.1):

	PRIMARY	QD	WAVETEK
Pri address	0	15	9
Sec address	none	none	none
Timeout setting	1 Sec	1 Sec	1 Sec
Terminate read on EOS	no	no	no
Set EOI with EOS on Writes	no	no	no
Type of compare on EOS	7-bit	7-bit	7-bit
EOS byte	00H	00H	00H
Send EOI with last byte of write	yes	yes	yes
System controller	yes	no	no
Assert REN swahn SC	no	N/A	N/A
Enable Auto serial poll	no	N/A	N/A
Bus timing	2 µsec	N/A	N/A
Parelle Poll Duration	default	N/A	N/A
Use this GPIB Interface	yes	N/A	N/A
Base I/O Address	0x2C0h	N/A	N/A
DMA Channel	5	N/A	N/A
Interrupt Level	11	N/A	N/A

QD SQUID controller IEEE 488 Setup page:

IEEE 488 Setup	
Binary Check Sum: Enable	Send EOI: Yes
Output Buffer Mode: Overwrite	Send EOS: No
	EOS Val: 10

*Lawson Labs A/D Cards

Address 1	230H
Address 2	238H
Settling time	568ms
Pin 4	GND
Pin 6	Channel 0+
Pin 8	Channel 1+
Pin 13	Channel 0-
Pin 15	Channel 1-

Contents of PC BIOS

BIOS SETUP PROGRAM - STANDARD CMOS SETUP (C)1990 American Megatrends Inc., All Rights Reserved

```
Date (mn/date/year)      : Fri, Jun 18 1993          Base memory : 640 KB
Time (hour/min/sec)     : 09:34:38          Ext. memory : 7168 KB
Daylight saving         : Disabled          Cyln      Head      WPcom  LZone      Sect      Size
Hard disk C: type      : 47 = USER TYPE   683       16       0       0         38       203MB
Hard disk D: type      : Not Installed
Floppy dxive A:        : 1.2 MB, 5 1/4"
Floppy drive B:        : 1.44 MB, 3 1/2"
Primary display        : VGA/PGA/EGA
Keyboard               : Installed
```

BIOS SETUP PROGRAM - ADVANCED CMOS SETUP (C)1990 American Megatrends Inc., All Riiehts Reserved

```
Typematic Rate Programming : Disabled
Typematic Rate Delay (msec): 500
Typematic Rate CCharseSec) : 15
Above 1 MR Memory Test    : Enabled
Memory Test Tick Sound    : Enabled
Memory Parity Error Check : Enabled
Hit <DEL> Message Display : Enabled
Hard Disk Type 47 RAM Area: 0:300
Wait For <Fl> If Any Error: Enabled
System Boot Up Nun Lock   : On
Weitek Processor          : Absent
Floppy Drive Seek At Boot : Enabled
System Boot Up Sequence   : A:, C:
System Boot Up CPU Speed  : High
Fast Gate A20 Option      : Enabled
Password Checking option  : Disabled
Shadow RAM Option        : Disabled
```

BIOS SETUP PROGRKM - ADVANCED CHIPSET SETUP (c)1990 American Megatrends Inc., All Right~ Reserved

```
On Board Serial Port 1   : Disabled
On Board Serial Port 2   : 2fB
On Board Parallel Port   : 378

on Board Floppy Controller : Enabled
On Board IDE Controller   : Enabled
8-bit DMA Active Clocks  : 2 CLKs
16-bit DMA Active Clocks : 2 CLKs
DMA Clock                 : SCLK/2
Command Delay, 8-bit Cycle : No
Command Delay, 16-bit Cycle: No
8-bit I/O Wait States    : 4 W/S
16-bit I/O Wait States    : 0 W/S
```

Contents of 386max.pro, config.sys, autoexec.bat Files:

```
386max.pro=
  RAM=B800-C900 ;exclude video area
  RAM=F000-10000

config.sys=
  Device=C:\386MAX\386MAX.SYS pro=c:\386max.pro
  DOS=HIGH,UMB
  devicehigh=c:\newgpib\gpib.com
  files=30
  buffers=20,8
  stacks=9,256
  devicehigh=c:\mouse\mouse.sys
  shell=c:\command.com c:\ /E:1024 /p /f

autoexec.bat=
  set echo off
  prompt=$p $t$h$h$h$h$h$h$h $d$h$h$h$h$h$h$h$g
  PATH \DOS;
  numlock
  SET TMP=c:\tmp
  set TEMP=c:\temp
  set GPC=C:\nde\3dcode\gpc
  echo off
  cls
  echo.
  echo.
  echo Welcome to TRISTAN's NDE system!
  echo.
  echo.
  echo 1. Run NDE.
  echo 2. Run 3d Plot.
  echo 3. Check the hard disk.
  echo 4. Check data Directory.
  echo 5. Run TAPE backup utility.
  echo 6. Read Read.me file.
  echo 7. Exit to DOS.
  echo.
  prompt Type the number you want and press ENTER:
```

Files needed to execute NDE:

```
c:\autoexec.bat
c:\config.sys
c:\386max.pro
c:\command.com
c:\menu.bat
c:\1.bat .. 2.bat .. 3.bat .. 4.bat .. 5.bat .. 6.bat .. 7.bat
c:\atbrds.cfg
c:\386max\*. *
c:\dos\*. *
c:\at-gpib\*. *
c:\mouse\*. *
c:\nde\3d.bat
```

c:\nde\nde.bat
c:\nde\test\ndelw.exe
c:\nde\params\startup.cfg
c:\nde\params\system.tti
c:\nde\3dcode\3drt.exe
c:\nde\3dcode\3d.cfg
c:\nde\3dcode\gpc*. *
c:\nde\ndedata (just the directory)
c:\nde\common\include\display.uir
c:\nde\common\include\plot.uir
c:\nde\common\include*.hlp (NDE runs without the *.hlp files, but requires them for help in NDE.)

Software Versions and Serial Numbers:

Software Packages	Vesion Number	Serial Number
386Max		
NI GPIB 422186-55	2.1.1	35733
NI DAQ for DOS/Windows		
NI DAQ for Lab Windows		
MS DOS	version 5.0	1801C102-035-71
Mouse Driver	6.2	MBAL038366-F620
Tape 0148	3.03	25221435
	or	1004-0337

Hardware Serial Numbers

Hardware	Serial Number		
486 PC			
Mother Board	5004513355		
Video Card (Orchid Technology)	830-0071-2/810		
Mouse Card (Logitech Bus Mouse)	0780120		
Serial I/F Card			
Monitor	SR279128		
Keyboard	HY199181		
NI GPIB	59406		
AT6400	921118000088		
SQUID Controller	DC0083		
Magnetometer			
SQUIDs	PreAmps		MultiCards
1	MP159		
2	MP146		
3	MP179		

A.3. Probe Top Wiring

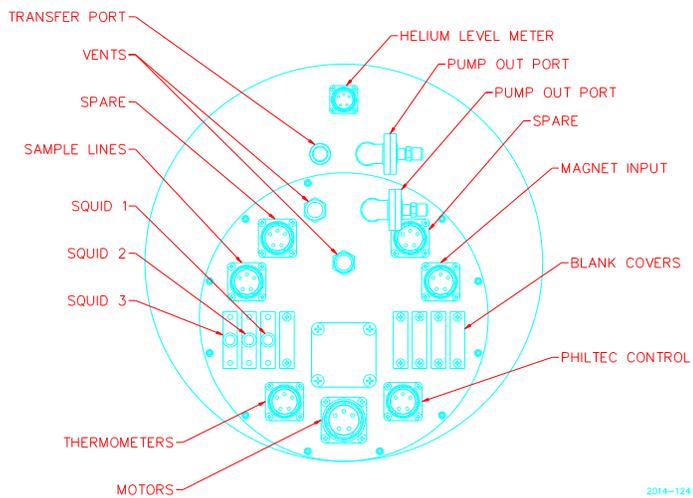


Figure A-3.1: Probe Top

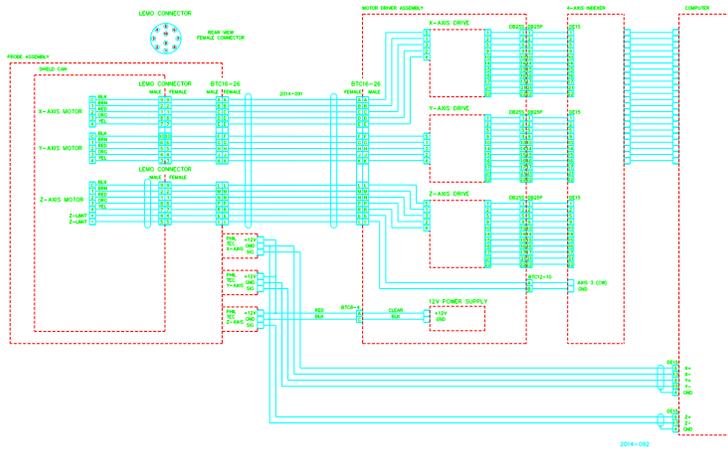


Figure A-3.2: Probe Wiring Diagram #1

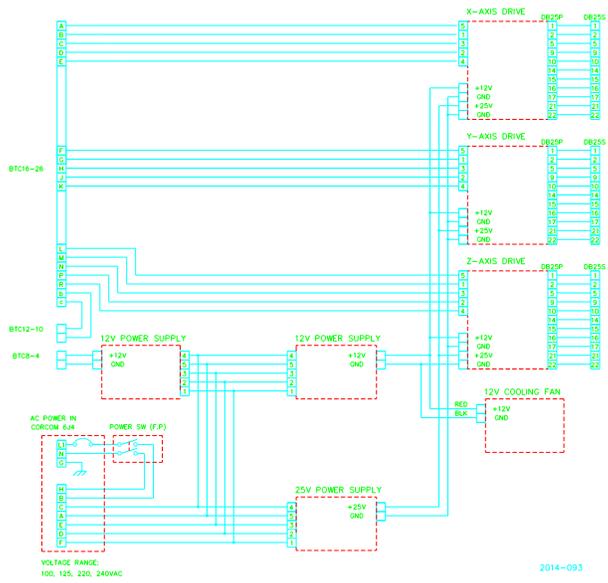


Figure A-3.3: Probe Wiring Diagram #2

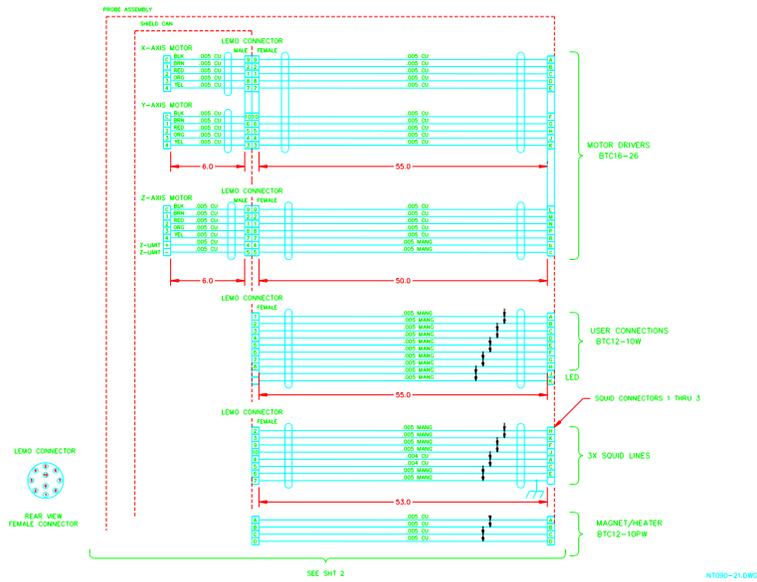


Figure A-3.4: Probe Wiring Diagram #3

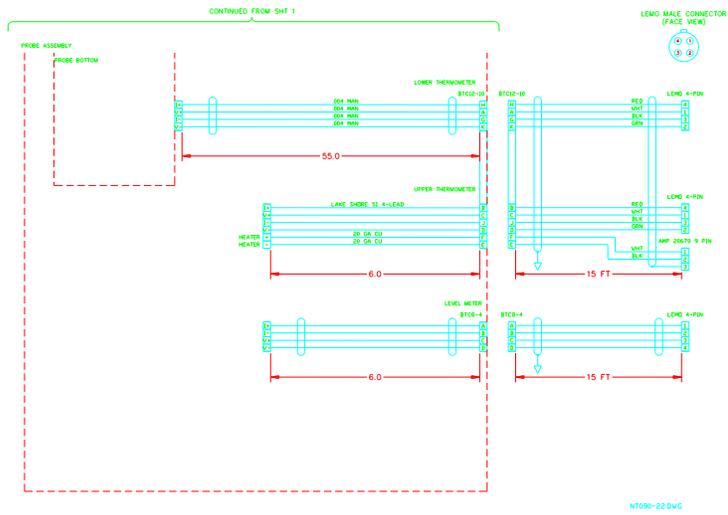


Figure A-3.5: Probe Wiring Diagram #4

A.4 SMM Installation