

**OM-7942
OPERATING MANUAL
FOR VERSION 4.5
OF THE
CASIUS SYSTEM

ISSUE A
REVISION 2**

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C O N T E N T S

1. INTRODUCTION	1-1
1.1 General.....	1-1
1.2 Impact of VRU Errors.....	1-1
1.3 Impact of Gyro Compass Errors.....	1-3
2. CASIUS V4.5 SETUP	2-1
2.1 Requirements.....	2-1
2.2 Differences from Previous Versions of CASIUS	2-1
3. (L)USBL NAVIGATION PROCESSOR SET UP FOR CASIUS	3-1
3.1 Acoustic Transceiver Set-up	3-1
3.2 DGPS Set-Up	3-2
3.3 Attitude Corrections	3-3
3.4 I/O Port Allocation and Set-Up	3-5
3.5 Final (L)USBL System Checks before Starting CASIUS.....	3-6
4. DATA COLLECTION METHODS.....	4-1
4.1 Manoeuvring Guidelines.....	4-1
4.2 Stationary Data Collection on a DP Vessel	4-2
4.3 Data Collection on a Constantly Moving Vessel – “run lines”	4-3
4.4 Stationary Data Collection on a DP Vessel with a 30° tilted Transceiver.....	4-4
5. LOGGING OF DATA FOR CASIUS V4.5.....	5-1
5.1 Method 1 – Recommended.....	5-1
5.2 Method 2 – Output of Survey Data to the PC	5-2
5.3 Using an Alternative Terminal Emulator Program to Capture Data on a PC	5-4
5.4 Additional Checks on Logged Data	5-4
5.5 Extracting CASIUS Data from a Fusion USBL System	5-4
6. CASIUS V4.5 OPERATION	6-1
6.1 Installing CASIUS.....	6-1
6.2 Start-up Data Entry in CASIUS.....	6-2
6.3 Loading of Logged Data into CASIUS.....	6-6
6.4 Processing of Logged Data by CASIUS.....	6-9
6.5 Re-Loading of the CASIUS Calculations and Data.	6-9
6.6 A the Corrections Computed by CASIUS to the (L)USBL System.....	6-9
6.7 Apply the Corrections Computed by CASIUS to the Fusion USBL System	6-9

LIST OF APPENDICES

(L)USBL I/O PORT ALLOCATIONS

CONVERGENCE CONVENTION

LIST OF FIGURES

FIG 1.1	ROLL ERROR IMPACT	1-2
FIG 1.2	HEADING ERROR IMPACT	1-3
FIG 1.3	ONE TENTH DEGREE POSITION ERROR	1-3
FIG 3.1	NAVIGATION SETUP PAGE	3-1
FIG 3.2	VEHICLE SUMMARY SETUP PAGE	3-1
FIG 3.3	GEODETTIC PARAMETERS	3-2
FIG 3.4	ATTITUDE CORRECTIONS.....	3-3
FIG 3.5	USBL TOP LEVEL MENU	3-6
FIG 4.1	EXAMPLE OF VESSEL MANOEUVRING TO COLLECT DATA	4-2
FIG 5.1	SETING UP TERMINAL	5-2
FIG 5.2	TERMINAL FUNCTION KEYS	5-3
FIG 6.1	THE START UP SCREEN	6-1
FIG 6.2	THE CASIUS MENU	6-6
FIG 6.3	LOADING CSV FILES INTO CASIUS	6-7
FIG 6.4	CASIUS VESSEL TRACK	6-8

AMENDMENT RECORD

All amendments and additions will be issued with a new copy of this sheet,
recording the history of amendments.

Issue	Revision	Date	Comments	Section	Page
A	0	30/08/01	Initial Issue	All	All
A	1	03/09/01	Updated for CASIUS V4.4	All	All
A	2	25/07/03	Reference to Figure 16 deleted Reference to Section 4.4 changed to 4.3 List of Figures added to the Contents Page numbering modified	6.26 4.2	p27 p17 p3
			Updated for CASIUS V4.5 - CN 7886	All	All

SECTION 1

1. INTRODUCTION

1.1 GENERAL

CASIUS is a Microsoft Excel Spreadsheet Add-in.

CASIUS is a mnemonic which stands for the Calibration of Attitude Sensors In the USBL acoustic positioning System manufactured by Sonardyne International Ltd.

By manoeuvring near a stationary beacon deployed on the seabed and recording DGPS positions and acoustic positions relative to the beacon it is possible to solve for:-

- ❑ the position of the beacon (BOXIN position)
- ❑ the prevailing sound velocity (through the water column)
- ❑ the Acoustic Transceiver offsets from the DGPS antenna.
- ❑ the pitch, roll & heading corrections that should be applied within the (L)USBL system.

In general pitch and roll errors will have greater effect on beacons directly under a vessel (especially in deep water) and that heading errors will have a greater effect at horizontal offsets from a beacon.

Pitch, roll and gyro used by the (L)USBL system will all need calibration when initially installed to maximise their benefits.

The correction values obtained for pitch, roll and heading by performing a CASIUS calibration will significantly improve positioning of acoustic beacons and it is strongly recommended that a calibration be performed on a regular basis to counteract any long term drift in gyro and VRU sensors.

1.2 IMPACT OF VRU ERRORS

Errors in the VRU outputs (ship's attitude) will lead to errors in the (L)USBL computation of beacon position. In practice, VRU roll output errors will lead to x co-ordinate errors in beacon position and VRU pitch output errors will lead to y co-ordinate errors. The position error is similar in form for both roll and pitch cases and the roll case is examined in detail below as an example.

It should be noted that this is a simplified analysis. In practice, the situation is complicated by the interaction of roll, pitch and heading acting together.

Fig 1.1 illustrates a ship with an angle of list, σ , and a beacon at range, R .

It can be shown that the seabed x co-ordinate error (Δ_{XB} in Fig 1.1) is a function of the depth of the beacon on the seabed, D , and the angular error in roll, $\delta\sigma$.

The full expression for the seabed x co-ordinate error is complex if the ship's angle of list, σ , is large. However, for small angles of list, a simplified expression may be used. From Fig 1.1:-

$$R = \frac{D}{\cos \sigma}$$

$$\text{Roll error } \Delta_r = R \delta\sigma = \frac{D \delta\sigma}{\cos \alpha}$$

where $\delta\sigma$ is in radians

$$\text{and, since angle } \alpha = \text{angle } \sigma, \Delta_r = \frac{D \delta\sigma}{\cos \sigma}$$

$$\begin{aligned} \text{Seabed x error, } \Delta_{XB} &= \frac{\Delta_r}{\cos \alpha} = \frac{\Delta_r}{\cos \sigma} \\ &= \frac{D \delta\sigma}{\cos^2 \sigma} \end{aligned}$$

and, for small values of σ , this simplifies to:-

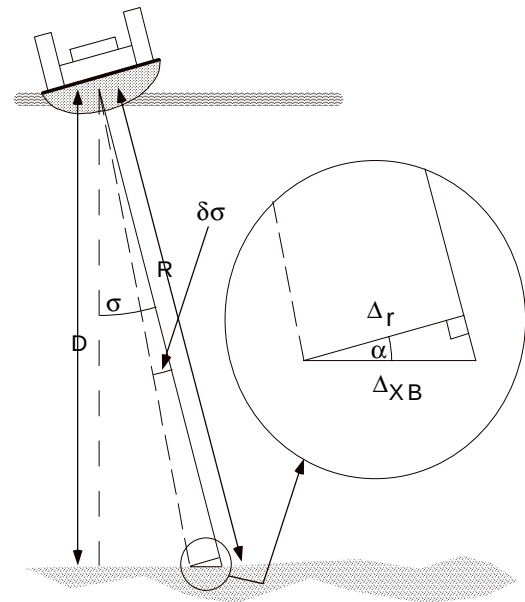
$$\Delta_{XB} = D \delta\sigma$$

A similar argument for the VRU pitch output leads to the following expression for the seabed y co-ordinate error, Δ_{YB} , attributable to a VRU pitch error, $\delta\theta$, as follows -

$$\Delta_{YB} = D \delta\theta$$

A graphical representation of these equations, given in Fig 1.3 which follows, simplifies the task of estimating position errors attributable to VRU roll and pitch errors.

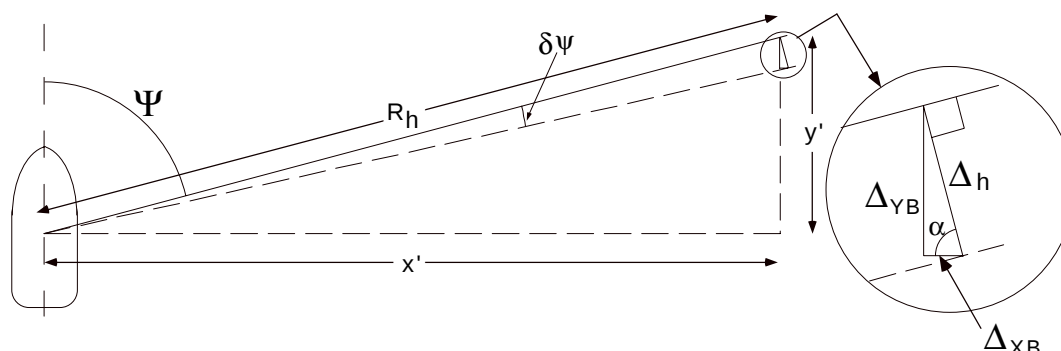
FIG 1.1 ROLL ERROR IMPACT



1.3 IMPACT OF GYRO COMPASS ERRORS

In the case of a gyro compass error, there is an impact on computation of beacon position in both x and y-axes. In Fig 1.2 below, Ψ is the ship's heading angle, $\delta\psi$ is the error in that angle and x' and y' are the seabed x, y co-ordinates of the beacon position from the ship.

FIG 1.2 HEADING ERROR IMPACT



From Fig 1.2:-

$$\sin \Psi = \frac{x'}{R_h}$$

$$\text{and } \cos \Psi = \frac{y'}{R_h}$$

$$\text{also, } \Delta_h = R_h \delta\psi - \text{where } \delta\psi \text{ is in radians}$$

$$\text{since } \alpha = \Psi, \Delta_{XB} = \Delta_h \cos \alpha = \Delta_h \cos \Psi$$

$$= R_h \delta\psi \frac{y'}{R_h}$$

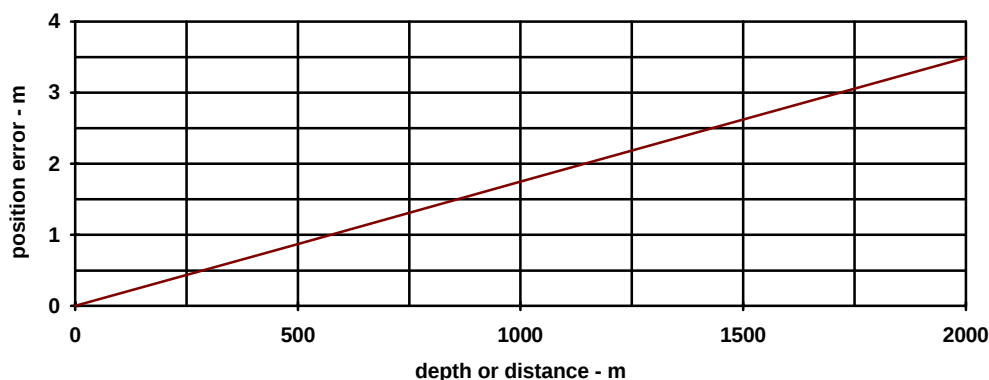
$$\therefore \Delta_{XB} = y' \delta\psi$$

A similar argument for the y co-ordinate leads to the following result for Δ_{YB} :

$$\Delta_{YB} = x' \delta\psi$$

Fig 1.3 illustrates the position error arising in the appropriate seabed co-ordinate (Δ_{XB} and/or Δ_{YB}) for each 0.1° error in attitude angle (roll, pitch or heading) over a range of depths (D) or distances (x' or y').

FIG 1.3 ONE TENTH DEGREE POSITION ERROR



SECTION 2

2. CASIUS V4.5 SETUP

2.1 REQUIREMENTS

- ❑ Sonardyne LUSBL/USBL system installed on vessel.
- ❑ Vertical Reference Unit giving instantaneous pitch & roll of vessel interfaced to the LUSBL system.
- ❑ Gyrocompass giving the heading of the vessel interfaced into the LUSBL system.
- ❑ The Navigation Processor should ideally have a serial card to accommodate the DGPS input. It is possible to carry out the calibration using either a port on the serial card or the DP output port on the CPU card for the DGPS interface (if this port is not required by the DP desk during the calibration).
- ❑ DGPS system with NMEA 0183 GGA or UKOOA ASCII outputs of Quality & HDOP to be connected to the Navigation.

The Northings & Eastings should have a resolution in minutes of a minimum of 4 places of decimals.

- ❑ The data may be collected in the system log files or using the survey output from the serial card.
- ❑ The convergence between the UTM grid at the operational site and True North (gyro will read true north) must be known. Convergence will have a larger effect the farther from the equator you are operating and so it is important not to forget about this parameter during calibrations.
- ❑ 200MHz IBM compatible PC with a minimum of 32 Mbytes of RAM.
- ❑ Excel version 8 (Excel 97) software installed on PC for use with CASIUS software.

2.2 DIFFERENCES FROM PREVIOUS VERSIONS OF CASIUS

This manual is written for the latest generation of CASIUS software version 4.5, the fundamental differences between this version and previous versions of software are outlined below -

- ❑ A dongle is required to run this version of CASIUS software.
- ❑ There is no longer a limit on the number of points to be logged since CASIUS 4.5 is written for Excel 97 (Excel 8) as opposed to Excel 5 used previously.
- ❑ CASIUS V4.5 is compatible with Fusion USBL and Version 6.xx (L)USBL software as well as being backward compatible with version 5.xx (L)USBL s/w. This manual is written with both operating versions of the (L)USBL software in mind but primarily using references to Fusion and Version 6 software menus.

While there are obvious differences between the versions of (L)USBL s/w the principal is generally the same for the setup of the system and the logging of information required by CASIUS.

- Previously logging of data to be processed by CASIUS has used Windows Terminal 3.x software, which was set up with specially programmed functions to remotely turn on and off data streams from the USBL system. The Windows terminal 3.x program was run on a PC interfaced directly to the V5.xx USBL system via the serial card.

For this version of CASIUS it is strongly recommended that data is archived via the (L)USBL floppy drive instead of logged via the serial port using the surveyors output.

The main reason for logging to the hard drive and archiving data to a floppy drive is the introduction of multiple transceiver and multiple beacon data to be processed by CASIUS 4.5 for version 6 (L)USBL software.

It is now possible for CASIUS to calibrate two or more transceivers connected to the V6 (L)USBL system and more than one beacon on the seabed simultaneously. When data is logged to the hard drive CASIUS 4.5 has the ability to extract data for individual transceivers and individual beacons from the mass of raw data. Calibration of transceivers can therefore be speeded up because all data can be logged at one time and the amount of vessel manoeuvres reduced.

When data is logged via the serial port as has been done previously it is not so easy to extract the required information in the multi beacon scenario. This may be changed in a later release of CASIUS

Both methods of logging data are explained later in detail.

SECTION 3

3. (L)USBL NAVIGATION PROCESSOR SET UP FOR CASIUS

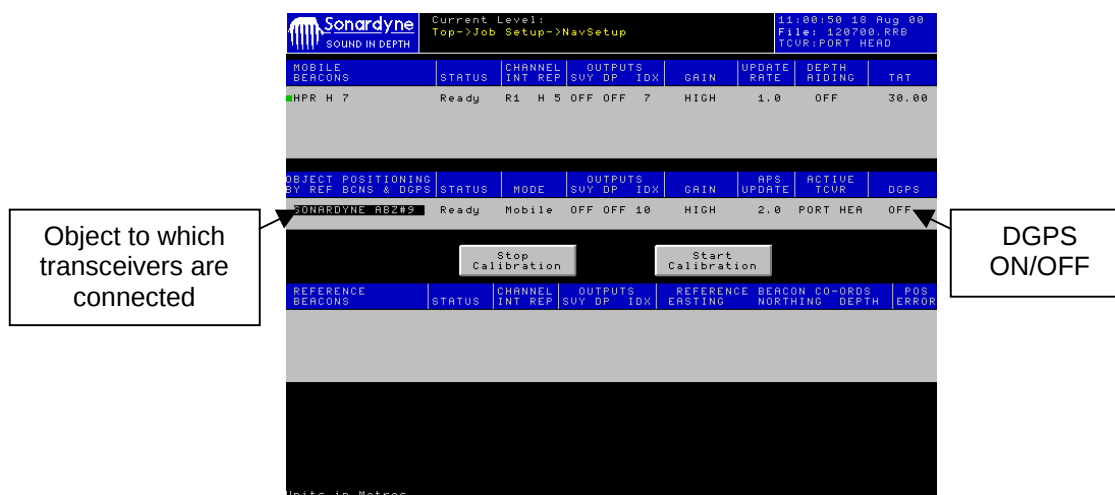
3.1 ACOUSTIC TRANSCIVER SET-UP

Version 5 - Check the 'Top->Installation->Acoustic Transceivers' Page and confirm and record the current offsets from the vessel datum - these will be required for CASIUS.

If there is more than one Transceiver entered in the system ensure that the offsets are recorded for the active transceiver, that will be used when collecting CASIUS data, as specified in the 'Top->Job Setup->NavSetup' page

Version 6 – Check the 'Top->Job Setup->Navigation Setup' page and record the transceiver offsets (highlight the object used for positioning and press return – all transceivers connected to the object positioned will be displayed along with their associated offsets). If more than one transceiver is online ensure they are set to LUSBL TX/RX (see [Fig 3.2](#)).

FIG 3.1 NAVIGATION SETUP PAGE



(Positive is Transceiver to Starboard, Forward or below the vessel datum)

FIG 3.2 VEHICLE SUMMARY SETUP PAGE



Sonardyne

SOUND IN DEPTH

Current Level:

Top->Job Setup->NavSetup->

Object Setup

10:49:35 18 Aug 00

File: 120700.RR8

TCUR:PORT HEAD

Object Name	Depth Aiding	Object Colour	Gain	OUTPUTS SUV DP IDX	APS Update	DGPS	DGPS Acc
SONARDYNE ABZ#9	0.0		HIGH	OFF OFF 10	2.0	OFF	5.0

Shape Name	Rotation	Shape Starboard	Shape Forward	Shape Scale X	Shape Scale Y
SHIP	0.00	0.00	0.00	20.00	80.00

Acoustic Devices	Offsets Starboard	Offsets Forward	From Object Datum Depth	Transmit / Receive Settings	Transducer
PORT HEAD	-10.00	80.00	10.00	Failed	(L)USBL
STBD HEAD	0.00	0.00	0.00	Failed	(L)USBL

DGPS	Antenna Stbd	Antenna Fwd	Antenna Height	Attached Gyros	Active Gyro	Attached URUs	Active URU
DGPS1	2.00	-5.00	27.00	GYR01	GYR01	URU1	URU1

Fixed Beeping

None

3.2 DGPS SET-UP3.2.1 Offsets

(See Section 3.4 first if no DGPS is interfaced.)

Version 5 - Check the 'Top->Installation->DGPS' Page and confirm and record the current antenna X, Y, Z offsets from the vessel datum - these will be required for CASIUS.

Version 6 - Check the 'Top->Job Setup->Navigation Setup' page for the DGPS offsets (highlight the object used for positioning as before for acoustic transceivers and press return –the DGPS connected to the object positioned will be displayed along with the associated offsets). See Fig 3.1 and Fig 3.2 above.

Also ensure DGPS is set to ON in this page.

(Positive is Transceiver to Starboard, Forward or below the vessel datum point).

If DGPS has not previously been connected then the antenna offsets may have to be obtained from the vessel drawings or from a survey.

3.2.2 Geodetic Parameters

Ensure that the correct definition of the UTM grid being used is entered into (L)USBL (e.g. for Plymouth -3.0, 0.0, 500000.0, 0.0, 0.9996).

N.B. When South of the Equator the False North value should be ten million [10000000]

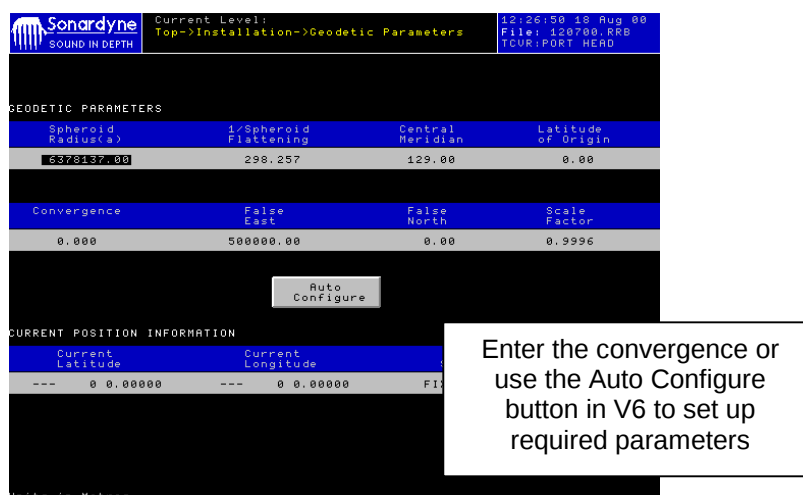
Ensure that the correct spheroid parameters are entered into (L)USBL for the DGPS (e.g. WGS84 is 6378137.00, 298.257).

Enter the convergence. This is the angular offset of UTM Grid North east of True North at the position of the CASIUS Beacon. **The convergence required for entry in the (L)USBL system may be obtained by using the Sonardyne convergence calculating program "sconver.exe" if required.**

Version 5 - Check the 'Top->Installation->DGPS' Page as before to edit the settings.

Version 6 – Check the 'Top->Installation->Geodetic Parameters' as below in Fig 3.3.

FIG 3.3 GEODETIC PARAMETERS



3.3 ATTITUDE CORRECTIONS

In the pitch / roll / heading corrections page in both version 5 and version 6 (L)USBL software there are different sets of corrections which many people have found confusing so a brief explanation may be helpful.

3.3.1 TCVR Factory Corrections

This set of corrections is taken from the label on the housing of the transceiver. Basically it is the mounting offset of the internal pitch and roll sensors in the transceiver itself and these readings are obtained from a calibration procedure carried out on a stable surface (i.e. not on a ship/rig) when the unit is initially built. There should not be any cause to change these and if they are unknown should be assumed to be negligible – set to zero (especially for newer transceivers due to improvements in manufacturing tolerances).

3.3.2 VRU/Ship Pitch and Roll Correction AND Gyro/Ship Heading Correction

These corrections are the mounting offsets of the VRU and gyro to the ship's planes of reference. The procedure for obtaining these corrections cannot be done if the vessel is pitching, rolling or yawing excessively.

The Sonardyne VRU/ship correction procedure requires the (L)USBL transceiver to be placed on a horizontal plane of the vessel aligned with vessel north before running the 'VRU/ship correction procedure' from the attitude sensors page on V6 software. This procedure would be done when tied up alongside a quay with the vessel in a neutral attitude i.e. not during ballasting operations (See application manual for V6 software).

The gyro correction procedure is also to be carried out alongside a quay (with a known bearing). The procedure involves taking measurements of the physical relationship of the ship / rig to a measured baseline on the quayside while recording gyro readings at the same instants. This procedure should only be carried out by qualified survey personnel or may be obtained from installation records for the gyro. (Gyro's can drift so beware of using very old figures).

Unless you can carry out the procedures properly, it is generally recommended that these figures be left as zero (thus assuming the VRU and gyro are correctly on the ship's planes of reference). See (L)USBL application manual for further information.

FIG 3.4 ATTITUDE CORRECTIONS

Tcvr Name	Device Ser No.	Tcvr Factory Corrections Pitch	Tcvr Factory Corrections Roll	Tcvr Ship Grid Corrections Pitch	Tcvr Ship Grid Corrections Roll	Tcvr to Ship Grid Heading
PORT HEAD	1258	0.00	0.00	0.00	0.00	0.00
STBD HEAD	1259	0.00	0.00	0.00	0.00	0.00

VRU Name	Port Number	Degrees	Linear Scaling	Invert Pitch	Invert Roll	VRU/Ship Corrections Pitch	VRU/Ship Corrections Roll
VRU1	1	10.0	YES	NO	NO	0.00	0.00

Gyro Name	Gyro to Ship Grid Heading Correction	Degrees
GYRO1	0.00	0.00

3.3.3 Transceiver/Ship Pitch and Roll Corrections AND Transceiver/Ship Heading Correction

These are the mounting corrections of the transceivers installed on the vessel relative to the ships' planes of reference and are the figures that will be obtained from a CASIUS calibration.

When they are determined by CASIUS they should be entered in the location as shown above in [Fig 3.4](#).

These pitch and roll corrections may also be derived less accurately than by CASIUS by pressing the 'Tcvt to ship corrections' button seen in [Fig 3.4](#) above. This must only be done with the transceiver fully deployed to its working location and a transceiver to ship grid heading already entered (see application manual). This can be used as a comparison to any CASIUS derived values.

Version 5 - In the 'Top->Installation->Attitude Sensors->Corrections' page ensure that 'VRU/ship Grid Corrections' and 'Gyro to Ship Grid Corrections' are zero unless you have carried out the appropriate procedures when alongside a quay or have the figures from recent installation records.

Record the 'Transceiver / ship corrections' entered for pitch, roll and heading (these may have come from a previous CASIUS calibration or from running selection 3 of the attitude sensor set up in the (L)USBL installation page).

Version 6 – In the 'Top->Installation->Attitude Sensors' page, **shown in [Fig 3.4](#) above**, ensure that the 'VRU/ship grid corrections' and 'Gyro to ship Grid heading correction' are zero unless you have carried out the appropriate procedures when alongside a quay or have the figures from recent installation records.

N.B. Version 6 (L)USBL software allows for the connection of more than one VRU or gyro and each one will have its own installation corrections to the ships reference planes.

Often in the scenario where definitive corrections for gyro/ship or VRU/ship are unavailable and there is more than one unit, it is advisable to set one gyro and VRU as the master unit and align the other VRU's and gyro's to the master. This is done by keeping the corrections for the master zero and inserting corrections for the others units so that they read the same as the master – this makes it possible to switch between VRUs /gyros without changing Transceiver / ship corrections.

From V6.03 the USBL has a utility which measures (and sets) the offsets of VRUs relative to the chosen master.

Ensure that the active / master VRU and gyro are correctly selected on the 'Top-> Job setup ->Navigation Setup Page' as **can be seen in [Fig 3.2](#)**.

Record the 'Transceiver / Ship corrections' of pitch, roll and heading for each active transceiver (these may have come from a previous CASIUS calibration or from pressing the 'Tcvt to Ship Corrections' button **shown in [Fig 3.4](#) above**).

3.4 I/O PORT ALLOCATION AND SET-UP

Check the 'Top->Installation->I/O Port allocation and Setup' page. Ports need to be set up to input the DGPS data (and output the survey data from the Navigation Processor – not recommended).

On the serial i/o card use ports 4,5 or 6 for interfacing since ports 1 and 2 are reserved transceiver mapping and port 3 is used for interconnection between processors when a dual redundant system is installed:-

Set up:-

- a. A serial port for input from the DGPS set as 'NMEA GGA, 9600, 8,1, None, None' using port 4,5,or 6.
- b. A serial port for data output to PC set as 'Survey output, CSV, 9600, 8,1, None, None' again using port 4,5 or 6.

(This is only required if using the Windows terminal 3.x software to control the logging of data from the (L)USBL system – it is not recommended that terminal 3.x software is used with the new CASIUS software at present.)

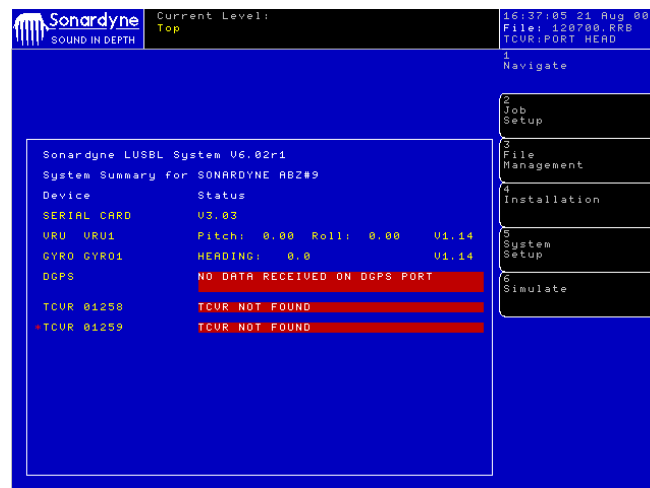
Alternatively, if there is no serial card in the system, Serial port 1 (the DP output port) on the CPU card can be used to collect DGPS data, if it is not required for the acoustic DP output. If the port has been configured for DP current loop operation it will need re-configuring to RS232 {see SM7707 Appendix J pages 8 to 10 CPU spreader jumper configurations}. When only the CPU card is used the data will have to be extracted from the Navigation Processor's log files recorded during normal operation by archiving the logging files.

Appendix A gives further guidance to the I/O port settings on the Sonardyne USBL system.

3.5 FINAL (L)USBL SYSTEM CHECKS BEFORE STARTING CASIUS

- a. Reboot the Navigation Processor to make any changes made in 3.4 above active.
- b. Check that USBL transceiver communication, DGPS, Gyro & VRU data are all displayed on the 'Top' level menu Page of USBL software. Note that earlier releases of V5 USBL software do not monitor the DGPS input.

FIG 3.5 USBL TOP LEVEL MENU



- c. Go to the online navigation screen, set up a mobile beacon to be used and test interrogation.
- d. On the 'Navigation Setup' page in the 'OBJECT POSITIONING' line ensure that the 'DGPS' is set to ON. See [Fig 3.1](#).
- e. To check that the DGPS is operating correctly, select a data box to show the ship position data and select seabed frame with either gyro north up or grid north up. The data box should then show the WGS84 UTM co-ordinates (If Ship frame is selected then the data box always shows 0, 0 for the vessel position).
- f. **Check and record the sound velocity used in the (L)USBL system this will be required by CASIUS.**
- g. **Record the approximate position of the beacon from the navigation page by selecting it to be displayed in a data box while using seabed frame – this will be required by CASIUS.**
- h. **Record the beacon depth from the navigation page – this will also be required by CASIUS.**

SECTION 4

4. DATA COLLECTION METHODS

4.1 MANOEUVRING GUIDELINES

There is no specific manoeuvre required but data collected should conform to the following guidelines –

- a. Some of the data needs to be taken with the vessel above or nearly above the Beacon, in order to maximise the effects of pitch & roll offsets.
- b. Some of the data needs to be taken with the vessel at some distance from the Beacon in order to maximise the effect of gyro offset.
- c. Data needs to be taken at opposite headings in order to maximise information used to determine the antenna offsets.
- d. Ideally data needs to be taken with the Beacon through the full range of azimuth directions.
- e. Data should be collected no further than the water depth from the Beacon position, **or a maximum of 500 metres from the Beacon position, which ever is the smaller.**
- f. Ideally, the manoeuvres done while collecting data should reflect the way the vessel will be used operationally. So if the vessel is expected to be largely stationary during operation then it should be stationary for each data collection phase. Similarly if the vessel will be moving past the Beacon operationally then the data should be collected while moving. If it is not a DP vessel, then it will be difficult to keep the vessel stationary, so the latter method will almost inevitably be used.
- g. Heading changes are known to cause some VRU units to misread. Refer to the VRU handbook for details of how long the VRU takes to settle down after various rates of turn. Because of this and because data is needed at more than one heading, the vessel manoeuvring may be broken up into a series of constant heading data collection passes or phases. A constant heading should be maintained for a short time prior to and during each pass.
- h. **An important decision to be made is whether the data will be collected while moving or stationary. It is preferable to be stationary if possible as this minimises any DGPS lag problems. If the vessel has no DP then this will not be a realistic option and in this case data should be collected during a series of straight run-lines over and to the side of the beacon.**

4.2 STATIONARY DATA COLLECTION ON A DP VESSEL

A DP vessel is able to move in any direction while on a constant heading. It is suggested that the pattern in [Fig 4.1](#) below is followed, pausing at each of the cardinal points and also directly above the beacon.

CASIUS data is collected while stationary

Data can also be collected for the transits between cardinal points if heading is maintained (this is the same data that would be obtained for the constantly moving vessel collecting data as explained in [Section 4.3 below](#)).

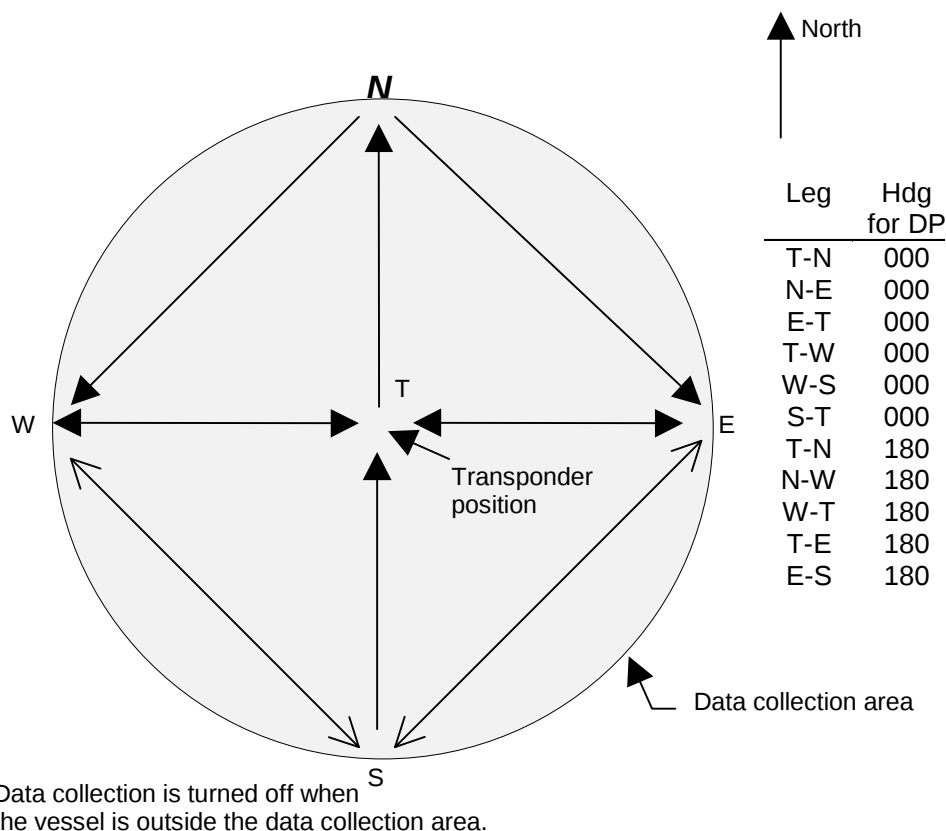
It is suggested separate log files are used for each section of data logging to aid processing later and that an equal amount of data is collected at each cardinal point to avoid skewing the data.

Note that a reciprocal heading is used for the second half of the data collection.

The radius of the circle centred on the Beacon defines the data collection area. This would normally be equal to half of the water depth, or a maximum of 500 hundred metres. The data collection points are then at 90 degrees to one another at equal distance from the beacon as well as immediately above the beacon.

The pattern may be rotated in any direction to accommodate wind or currents.

FIG 4.1 EXAMPLE OF VESSEL MANOEUVRING TO COLLECT DATA



4.3 DATA COLLECTION ON A CONSTANTLY MOVING VESSEL – “RUN LINES”

This data collection method is very similar to the one outlined above for stationary collection of data except that the vessel is not expected to stop at the cardinal points to log the data but only to collect data on the transits between cardinal points whilst maintaining good heading.

12 lines are to be run in all – 8 transits between adjacent cardinal points (in both directions), [i.e North-West, West-South, South-East, East-North, North-East, East-South, South-West, West-North] along with a run line across the top of the beacon each direction.

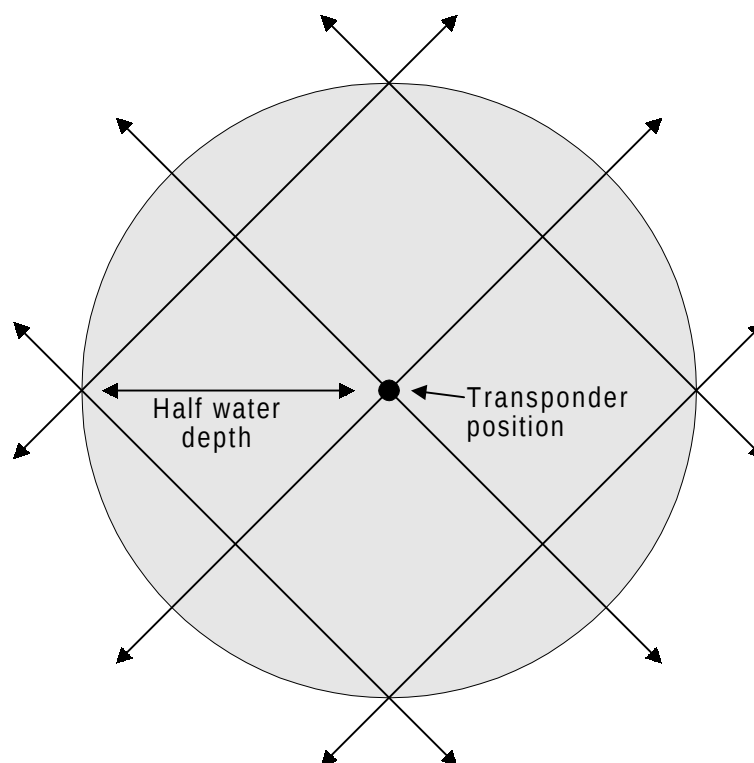
As before, the example in [Fig 4.1](#) can be rotated to allow for current and wind directions where required. The length of the “run” lines that are to be followed by the ship are dependent on the water depth as before for stationary data collection.

The radius of the circle centred on the beacon defines the data collection area. This would normally be equal to half of the water depth, or a maximum of 500 hundred metres.

It is suggested that these lines are extended by an appropriated distance to ensure that the vessel has a chance to stabilise its heading before beginning the data collection within the area as shown in [Fig 4.1](#).

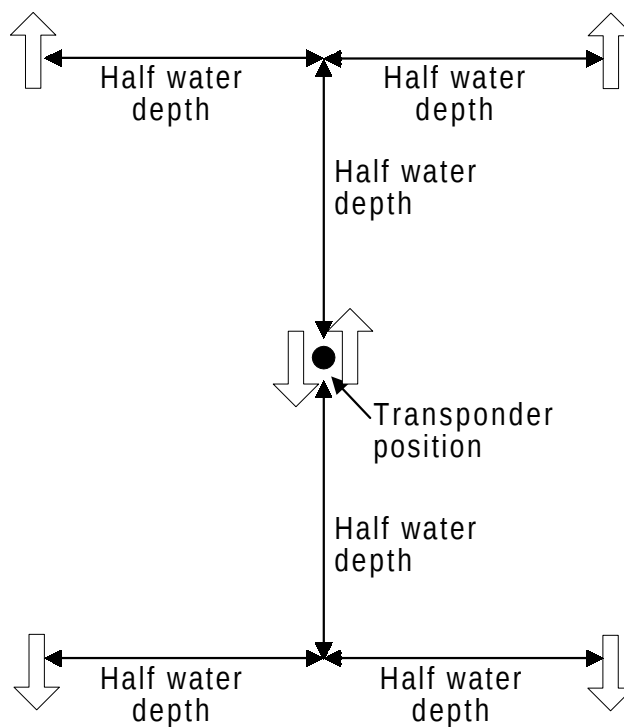
To keep the lines straight in the data collection area, the vessel may turn outside the area between the runs. In addition before starting to collect data, the heading should have been constant for a minute, although this time will depend on the VRU & the rate of heading change prior to this.

Passes between the points and the Beacon at centre of the circle are also made, slowing as much as possible each time over the Beacon to get more readings there, although maintaining speed at the outer end of the run lines.



4.4 STATIONARY DATA COLLECTION ON A DP VESSEL WITH 30° TILTED TRANSCEIVER

The data collection process is the same as for a non-tilted transceiver, except the points where the data is collected need to be moved by 30° when collecting data with a tilted transceiver. The following diagram shows a suggested data collection pattern and the heading of the vessel at each position, (assuming the transceiver is tilted backwards).



SECTION 5

5. LOGGING OF DATA FOR CASIUS V4.5

5.1 METHOD 1 – RECOMMENDED

Archiving of Data Logged on the Navigation Processor

The DGPS and USBL data may be obtained in .CSV form by archiving the data that is continuously logged on the Navigation processor itself.

The procedure for this is as follows -

- a. When happy with the acoustics and position of the vessel select Job Set-up, Archive Log Files, Delete All Log Files from the online navigation page.
- b. Start timing at this point. Required logging time in seconds = no of fixes required * beacon update rate. (Remember to log equal amounts of data in each area to avoid skewing results). One hundred points in each location is a rough guide for sufficient data – this would be five minutes of logging at 3sec interrogation rate. If data is being collected for more than one transceiver in V6, it will be necessary to multiply this time by the number of on line transceivers. e.g. this would be 10 minutes for 2 transceivers.
- c. When the required amount of time has passed, i.e. when you are happy that enough data has been logged at this point, Select Job Set-up, Archive Log Files, Archive New Log Files with a floppy disc in the drive, and the data recorded will be copied across from the hard drive to the floppy. (You may prefer to Exit Navigation to speed up the archiving of the data to PC.)
- d. Put the disc in to a PC and check that there is data there – both acoustic and DGPS ship position. DGPS records will start "POSITION". In the ACOUSTIC records, "node" information indicates the transceiver and transponder used for the collection in the form {tt,b,tt}. The transceiver tt will be indicated by its index 11,12,13.... etc depending on the number of transceivers. Beacon b will be indicated with a 1,2,3 etc depending on how many beacons are online.
- e. Copy the data to a directory on the PC.
- f. Move the vessel to the next location for data logging and start from step one again.
- g. Continue until all logging at collection points has been completed.

5.2 METHOD 2 – OUTPUT OF SURVEY Data TO THE PC

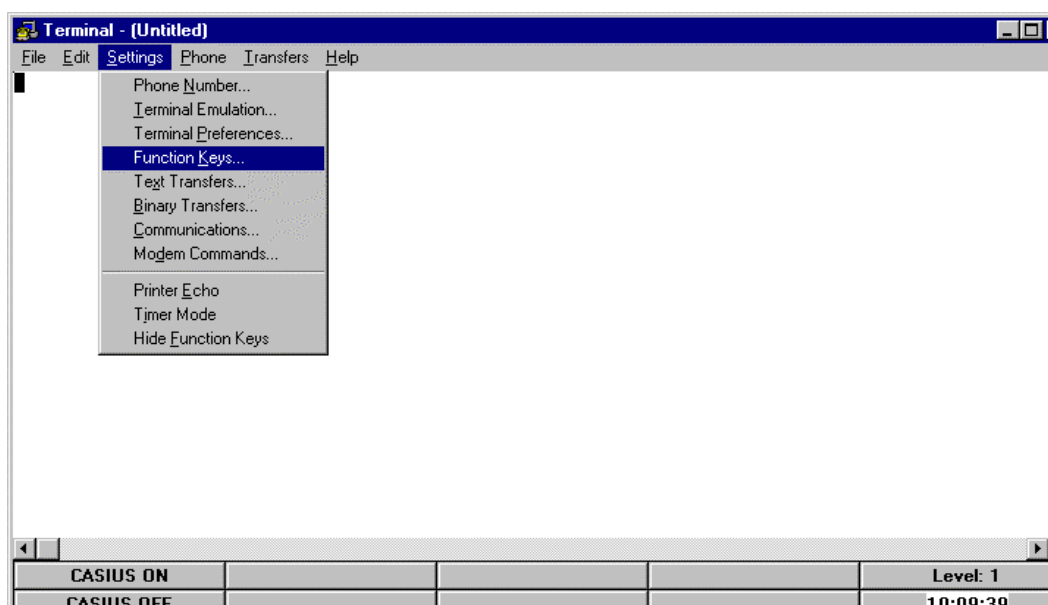
Enter the terminal program on the PC.

Version 5 (L)USBL is compatible with the “surv_cas.trm” file for terminal 3.x used previously.

Version 6 (L)USBL software requires different function keys from version 5 (L)USBL s/w to be set up on two of the soft keys for the terminal 3.x program. V6CASIUS.trm will enable the sending of the correct character sequences to turn on and off the CASIUS messages from the Navigation processor in V6.

Both sets of commands are outlined below:-

FIG 5.1 SETING UP TERMINAL



Version 6:-

Type in the following functions as shown in Fig 5.2 which follows:-

F1=CASIUS ON Command = select,6,1,all^mselect,6,2,all^m

F2=CASIUS OFF Command = select,6,1,^mselect,6,2,^m

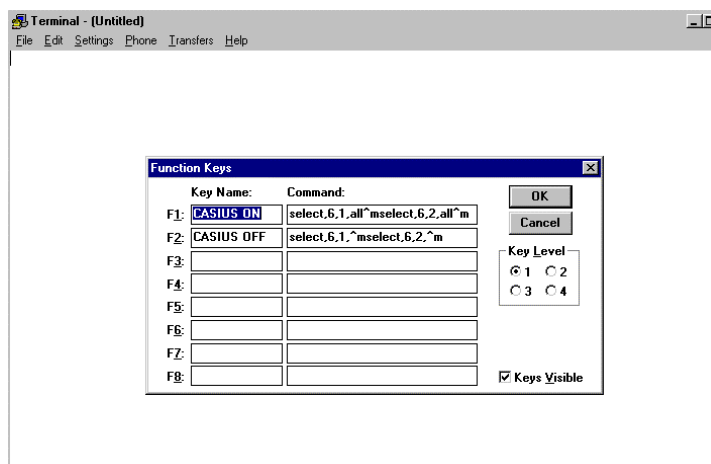
Version 5:-

Type in the following functions:-

F1=CASIUS ON Command = select,1,all^mselect,11,all^m

F2=CASIUS OFF Command = select,1,^mselect,11,^m

Ensure that “keys visible” is also selected on this page so that the function keys are displayed on the bottom of the terminal 3.x screen.

FIG 5.2 TERMINAL FUNCTION KEYS

Check the communication settings in the terminal program which should be 9600,8,n,1 to correspond with the port that has been set up in the (L)USBL system for the survey output.

Once all above is set, save the file for use in the future – this will create a terminal file (*.TRM) which can be loaded every time the settings for comms and function keys need to be recalled.

To check the serial link before going any further ensure the navigation processor is online and turn on the serial messages on by pressing the 'CASIUS Msgs ON' function key.

It is wise to check that DGPS and acoustic data are present before proceeding as for the internal logging of data method outlined in Section 5.1 above.

Once all is confirmed OK and the vessel is on the first location for logging proceed as follows:-

- a. **Ensure CASIUS messages are off before beginning.**
- b. **Start logging data on the PC using the CASIUS terminal.** In Windows 3.1 terminal program this is done by selecting Transfers, Receive Text File and giving the file an extension of .CSV. The '.CSV' extension is necessary so that Excel will automatically interpret the file as a Comma Separated Variable file and so enter the variables into consecutive columns of the active sheet, as is required by CASIUS.
- c. **Turn on the output of CASIUS messages from the survey interface** port by sending the required character string to the Navigation processor. In Windows 3.1 terminal program this is done by clicking on the function key 'CASIUS Msgs ON'.
- d. Start timing at this point. Required logging time in seconds = no of fixes required * beacon update rate. (Remember to log equal amounts of data in each area to avoid skewing results). One hundred points in each location is a rough guide for sufficient data – this would be five minutes of logging at 3 sec interrogation rate. If data is being collected for more than one transceiver in V6, it will be necessary to multiply this time by the number of on line transceivers. e.g. this would be 10 minutes for 2 transceivers.
- e. Stop the CASIUS messages from the survey output by sending the required character string to the Navigation processor **and then stop the logging of data on the PC.** This is done by clicking the key 'CASIUS Msgs OFF' key and then clicking the 'STOP'
- f. Move the vessel to the next location for data logging and start from step one again.
- g. Continue until all logging at collection points has been completed.

5.3 USING AN Alternative Terminal Emulator Program to Capture Data ON A PC

If the windows terminal program is not available (e.g. recording data under DOS), then another terminal emulator, such as PCPLUS may be used.

In the case of PCPLUS two macro keys need to be set up to turn CASIUS messages from the survey output port on & off.

These will be the same as the functions set up above for Version 5 and Version 6 (L)USBL systems.

For more details see Appendix G section entitled "Use of terminal emulator to extract survey output" of the USBL system manual SM_7707. (Issue B onwards).

5.4 ADDITIONAL CHECKS ON LOGGED DATA

On completion of logging you should have a series of *.csv files logged and transferred to a directory on the PC.

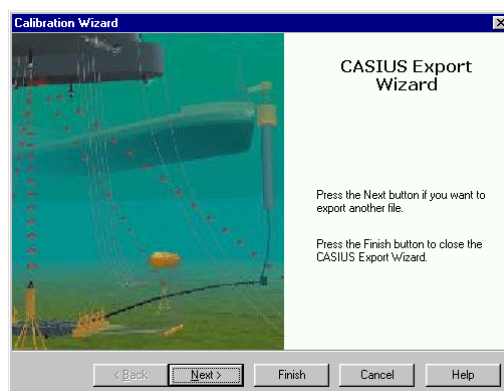
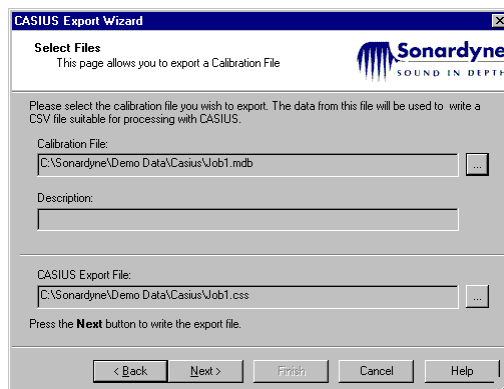
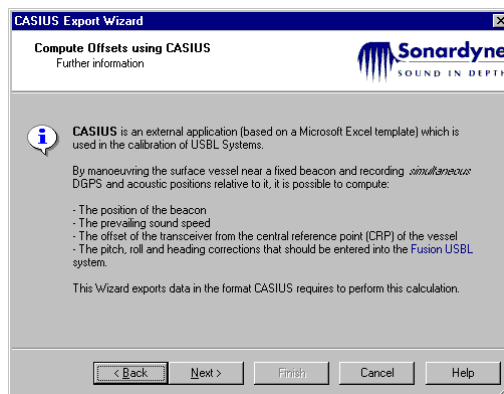
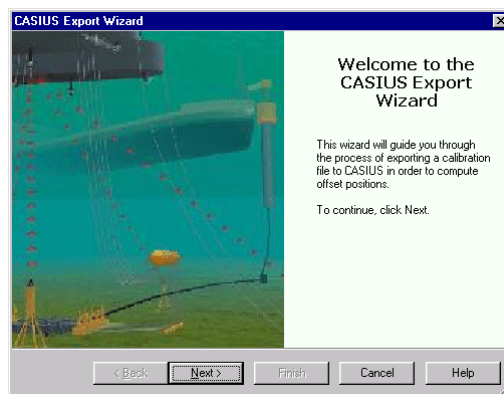
It is possible to check the data before proceeding with CASIUS processing as follows –

- a. Use the utility Plot_csv.xlm provided on Installation Disk 3 of the USBL system software to generate a chart of DGPS track. Ensure data is present and reasonably consistent.
- b. Use the same technique to chart Beacon X & Y against time and pitch, roll & heading (labelled 'bearing') against time to check the quality of the acoustic & attitude sensor data.
- c. Beware of manually editing the logged data file(s) in EXCEL. If this is done then these must be saved as normal worksheets (XLS type) rather than a CSV type files. This is because Excel (even version 8!) does not store the complete data in the file when saved in .CSV format but for some data types only stores the information visible on the screen at the time of saving. This means that DGPS precision could be lost and more seriously the date of the file records is corrupted. Alternatively the data can be edited by use of a text editor such as Windows Write, provided "No Conversion" is selected when the file is opened, it may then be re-saved as a CSV file.

5.5 EXTRACTING CASIUS DATA FROM A FUSION USBL SYSTEM

The CASIUS Export Wizard guides you through the process of exporting a calibration file to CASIUS. The wizard is opened by selecting **CASIUS Export Wizard** from the **Tools** menu.

The Select files page allows the name and location of the calibration file to be exported and the name and location of the .CSV export file and .CSS CASIUS start sheet to be selected. A message box is displayed when the calibration file chosen for export may not be suitable for use by CASIUS.



SECTION 6

6. CASIUS V4.5 OPERATION

6.1 INSTALLING CASIUS

CASIUS V4.5 will be installed automatically from a CD ROM when inserted in the drive unless the auto-detect function has been turned off in Windows - in which case it will be necessary to run the setup program using Windows Explorer.

Follow the instructions on screen and CASIUS will be installed by default in the C:\Program Files \ Sonardyne \ CASIUS directory.

Driver files will also be installed.

An Icon will be put onto the Desktop. The program will also be accessible from the "start menu" as follows:-

Start / Programs / Sonardyne / CASIUS.

Once installed, run CASIUS and be sure to "Enable Macro's" when Excel prompts you if you wish to use them or not.

The initial CASIUS screen will look like this:-

FIG 6.1 THE START UP SCREEN

Microsoft Excel - Book2

File Edit View Insert Format Tools Data Window CASIUS Help

Arial 10

R1C1

Casius Version 4.5a Excel 8.0e

Report comments Enter specific information about this CASIUS calibration here.....

CASIUS for L/USBL
For use with Excel 97

Sonardyne
SOUND IN DEPTH

The values below are not needed for 'Box In' only

Transceiver & beacons (V6 only)	
Transceiver Index	11
Beacon Name	
Beacon Turn Around Time	125

Depth aiding for "TcvtAttitude"	
Boresight angle limit	22
Depth difference limit	1

Estimated values for "Boxin"	
Beacon Eastings	400010
Beacon Northings	5000010
Beacon Depth	1000
USBL Sound Velocity	1485
Observed Sound Velocity	1485
Transceiver starboard offset	0
Transceiver forward offset	0
Transceiver depth offset	5
Transceiver Depth	5
Antenna starboard offset	0
Antenna forward offset	0
Antenna height offset	15

Errors in estimates for "Boxin"	
Beacon position	30
Beacon depth	5
Sound velocity	50
DGPS lags USBL by (secs)	0.0
Transceiver depth	0.5
Antenna offset	1
Range measurement	0.2
Range gate	1

"TcvtAttitude" calculation inputs	
Angle gate (% slant range)	2
Is heading correction known? Yes/No	No
Value of known heading correction	0

Values used by USBL during data collection	
Transceiver to Ship Pitch correction	0
Transceiver to Ship Roll correction	0
Transceiver to Ship Heading correction	0

"BeaconPositions" scatter plots	
Size of plot area (default = depth / 20)	10
Number of categories (default = 30)	30
Use default values of these? Yes/No	Yes

StartUp / csv / Report /

Ready

If the screen does not appear and Excel stops running then the dongle is probably not installed in the parallel port of the PC.

6.2 START-UP DATA ENTRY IN CASIUS

Referring to [Fig 5.2](#) above the following data is to be entered to enable CASIUS to carry out the calculations required. Note: if you have a Fusion USBL System some of these values can be imported, see Section [6.2.8](#))

6.2.1 Estimated Values For Boxin

- a. **Beacon Eastings , beacon Northings and beacon depth** – this is the trial position for the beacon which should have been obtained from the (L)USBL navigation display when the beacon was initially deployed. (See Section [3.5](#)).
- b. **USBL Sound Velocity** – this is the water column sound velocity that was entered in the USBL system during data collection.
- c. **Observed Sound Velocity** – If there is a better estimate of the sound velocity available (from a TS dip, previous CASIUS calibration etc) then it should be entered here. If there is no better estimate then enter the same as the USBL sound velocity as above.
- d. **Transceiver Offsets** – Enter the value of the transceiver offsets as taken from the (L)USBL system here.
- e. **Version 5** (L)USBL ensure that offsets are entered for active transceiver as selected in the (L)USBL system.
- f. **Version 6** (L)USBL enter the offsets for the transceiver you wish to calibrate (if more than one transceiver was online during data collection then selection of transceiver data can be controlled by entering 11,12,13 etc in the “Transceiver index” box. This will correspond to the order in which transceivers are entered in the (L)USBL ‘Top->Job setup->NavSetup->Object Setup’ page as described in Section [3.1](#)).
- g. **Transceiver depth** – Enter the depth below sea level of the transceiver face. This may be different from the transceiver depth entered in the offsets above since that offset is from the datum point of the vessel which may not be at sea level. If unsure use the same as above.
- h. **Antenna offsets** – Enter the offsets for the DGPS antenna as described in Section [3.2](#) here.

6.2.2 Errors In Estimates For Boxin

The accuracy’s given for the observations should be realistic, but if in doubt err on the high side.

- a. **Beacon position** – Enter a value of 1% of the water depth or the radius of the back plot display of the Beacon position on the USBL which ever is the greater. If a previously calculated or known position for the Beacon is available, then a much smaller error value may be entered.

If this is the calculation of pitch & roll offsets overhead the Beacon and a previous CASIUS calculation has been done to 'box in' the Beacon, then the Beacon position accuracy's will be high, otherwise the position accuracy's will be typically tens to hundreds of metres.

- b. **Beacon Depth** - The beacon depth accuracy is dependent upon how it was obtained. If a pressure sensor fitted to the beacon has been used, then the resolution of the sensor and the offset between the pressure sensor and the acoustic transducer, and the surface offset need to be taken into account in determining how many metres in error the measurement could be. If the depth is based on the acoustic measurement taken when directly overhead the beacon then the water column sound velocity accuracy needs to be taken into account and the depth of the USBL transceiver needs to be correctly accounted for.

If CASIUS is being performed in a highly tidal area then this will also effect the depth error.

If this is the calculation of pitch & roll offsets overhead the beacon and a previous CASIUS calculation has been done to box in the Beacon, then the beacon depth accuracy will be high. Otherwise the depth accuracy will typically be tens of metres.

- c. **Sound Velocity** - The sound velocity value is for the accuracy of the observed sound velocity through the water column. If the values come from a velocity profiler then the velocity error will be small say within 3
- d. **DGPS Lag** – Depending on how the data has been collected this factor could be important. It is recommended that the lag of the DGPS UTC clock behind the USBL processor clock is determined as closely as possible and the value entered. This lag becomes more critical as the vessel motion increases and needs to be known to 100 ms for a vessel moving at 3 knots to keep the resulting rotational correction errors below 1/10th of a degree. If the data is collected while stationary, this lag is less critical, and if such is the case, or the lag is unknown enter 0 in this box. CASIUS will assume there are equivalent lags between validity and internal logging of the acoustic & DGPS.
- e. **Transceiver Depth** - The Transceiver depth accuracy relates to the amount of heave and the ballasted condition of the vessel. On a vessel such as a Semi-sub there is generally not as much heave as that experienced on a ship, however the range of depths that a Semi-sub can be ballasted through is generally much greater than for a ship. Therefore the ballasted state and the heave need to be taken into account when entering this value.
- f. **Antenna Offset** - The DGPS antenna offset values from the vessel datum in X, Y and Z will probably be known to within 0.5-1.0 metres on a permanent installation as they will probably have been surveyed during construction. On a temporary installation only a tape measure to the edges of hatches and other structural items may have been used, and measurements may not have been taken parallel with the vessels frame. However in both cases the gyros angular offset from the vessels frame also needs to be allowed for as this will cause changes in the X and Y values.
- g. **Range Measurement** – The range measurement accuracy relates to the range jitter and will depend on the acoustic signal to noise ratio experienced at the transceiver face. It cannot be less than 0.1 metres and 0.2 metres is a normal figure.

- h. **Range Gate** – relates to how much the acoustic ranges need to disagree with those calculated via DGPS before being weighted against. This will normally reflect the expected range accuracy and because DGPS usually has a position accuracy of 2 to 5 metres it should be set to this sort of value.

6.2.3 Depth Aiding For Transceiver Attitude

(These inputs are only required if you wish CASIUS to calculate transceiver attitude corrections.)

- a. **Depth Aiding** – The USBL's ability to measure the angle off boresight is not as good as measuring azimuth or range. When the range and depth are accurately known it can be beneficial to use depth aiding.

The depth aiding works on the principle that the depth of the Transceiver is known from start-up data, the depth of the Beacon is known from the 'Box In' calculation and the acoustic range is known. This means the 2-D range of the beacon from the Transceiver can be calculated as the square root of the differences of the Range squared and the Depth squared. The X & Y components of the 2D range can then be apportioned in the same ratio as in the original acoustic observation.

Depth aiding will only occur for fixes when the calculated angle off boresight is greater than the Boresight Angle Limit in the Start Up page AND the Depth Difference Limit is exceeded.

- b. **Boresight Angle Limit** – The user is asked for the boresight angle above which Pythagorean depth aiding will be done, it is normal to set this to between 10 and 20°. If none is required then enter 90 degrees.
- c. **Depth Difference Limit** - In most cases this should be kept within 0.5% of the water depth.
If the difference between the USBL depth and the beacon depth calculated from the "box in" is greater than the depth difference limit then the fix is a candidate for depth fixing. If this difference is more than 100 times the Depth Difference Limit, then the fix is ignored in the Tcvt attitude correction calculation.

6.2.4 Transceiver Attitude calculation inputs

(These inputs are only required if you wish CASIUS to calculate transceiver attitude corrections.)

- a. **Angle Gate (% of slant range)** – The Angle Gate is the equivalent of Range gate but in direction. This is used to reduce the weight given to fixes where the acoustic direction differs from that predicted using the DGPS data by the gate value. This is similar to the use of the range gate in the Box In calculation. 1 to 2% of slant range is a normal value, but increases as the range reduces.
- b. **Is Heading Correction Known** – if a heading correction for the transceiver has already been calculated (as is the case when calculating just the pitch & roll offsets from data gathered while overhead the beacon), enter “yes” otherwise enter “no” and CASIUS will calculate the transceiver heading correction from the data gathered.
- c. **Value Of Known Heading Correction** – If you have entered “yes” in the cell for “Is the heading correction known?” then enter the value of the known correction here. Otherwise the value in the cell is ignored.

6.2.5 Values Used By USBL During Data Collection

(These inputs are only necessary if you wish CASIUS to calculate transceiver attitude corrections.)

Enter the values for the transceiver to ship pitch / roll / heading corrections which were used by the (L)USBL system during data collection. (See Section 3.3.3 and Fig 3.4.)

6.2.6 Beacon Position Scatter Plot

These figures will be used to control the size of the plots when the data has been processed by CASIUS. It is best to leave these as default initially, as the plots can be re-done afterwards if required.

6.2.7 Transceiver and beacon (V6 Only)

This is an addition to CASIUS and will only be relevant to Version 6 (L)USBL systems which have more than one transceiver online while data collection is carried out and/or more than one subsea beacon interrogated during data collection.

- a. **Transceiver Index** – This will only be important if more than one transceiver is online and used to collect data. The entry in this field depends on the order in which the transceivers are entered in the (L)USBL ‘Top->Job Setup->Navigation Setup->Object Setup’ page. The first transceiver entered in this page will be allocated an index of 11, the next will be allocated 12,13, etc (See Fig 3.2).
- b. **Beacon Name** - It will not be possible to enter the beacon name until the data to be processed has been loaded. This field will only matter if more than one beacon is being interrogated during the data collection phase. More detail will be shown on this later in Section 6.3.

At this point the start up data can be saved as an .XLS file if required by selecting “SAVE START UP AND DATA” from the CASIUS menu on the toolbar (see Fig 6.2).

6.2.8 Importing Startup Values from Fusion USBL

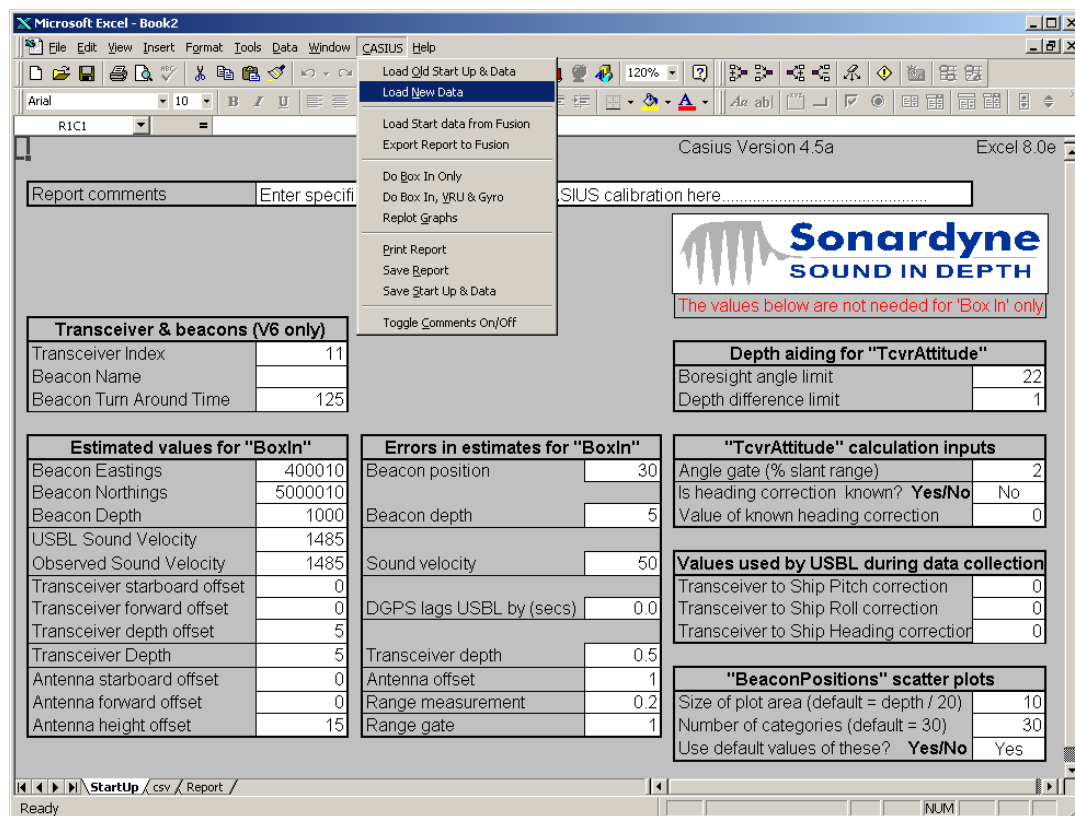
If you are using a Fusion USBL System, then you can import the Estimated values directly from Fusion USBL. Export the CASIUS Start Sheet values from Fusion, as a .CSS file, using the CASIUS wizard in Fusion. In CASIUS, Select ‘Load Start Data from Fusion’ from the CASIUS menu. Select the file you wish to import and click ‘Open’.

Note: the Error estimates still need to be decided upon and manually entered. See above.

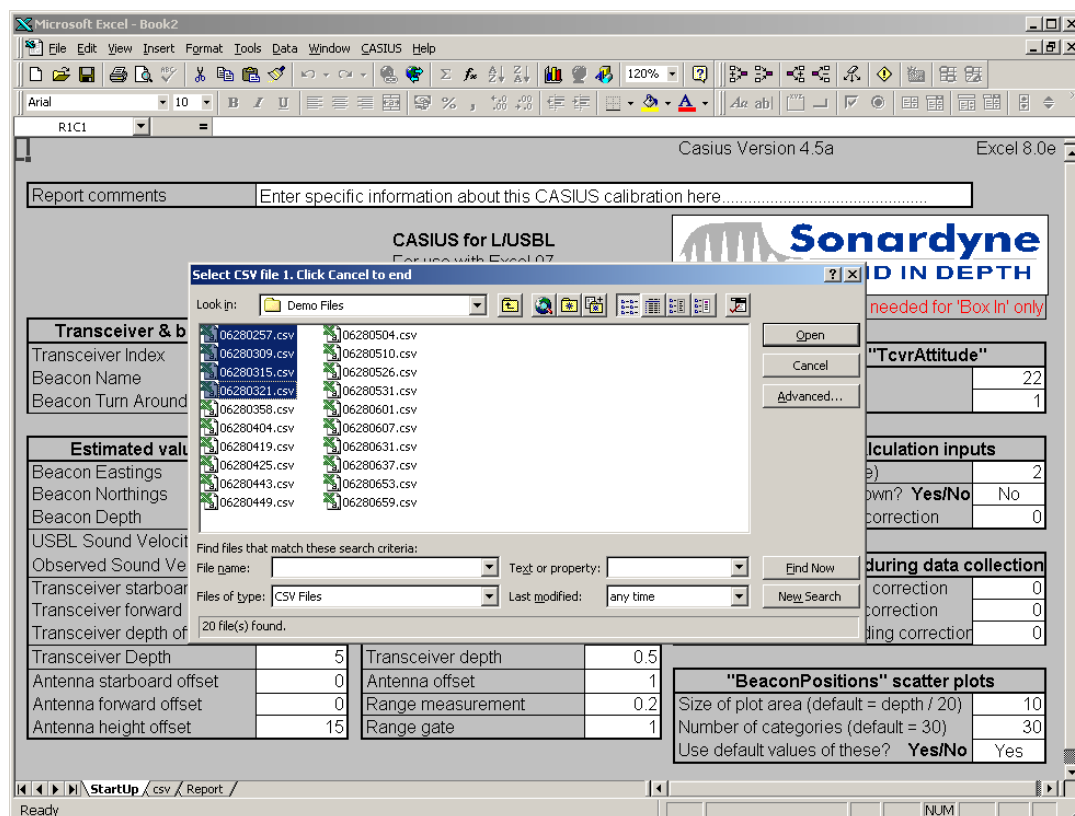
6.3 LOADING OF LOGGED DATA INTO CASIUS

Once the cell values have been set up as required the next stage of the process is to load the logged data by selecting "LOAD NEW DATA" from the CASIUS menu on the toolbar as shown below:-

FIG 6.2 THE CASIUS MENU



CASIUS will now request the successive logging files used. It is possible to select several files at the same time, by holding down shift / ctrl.

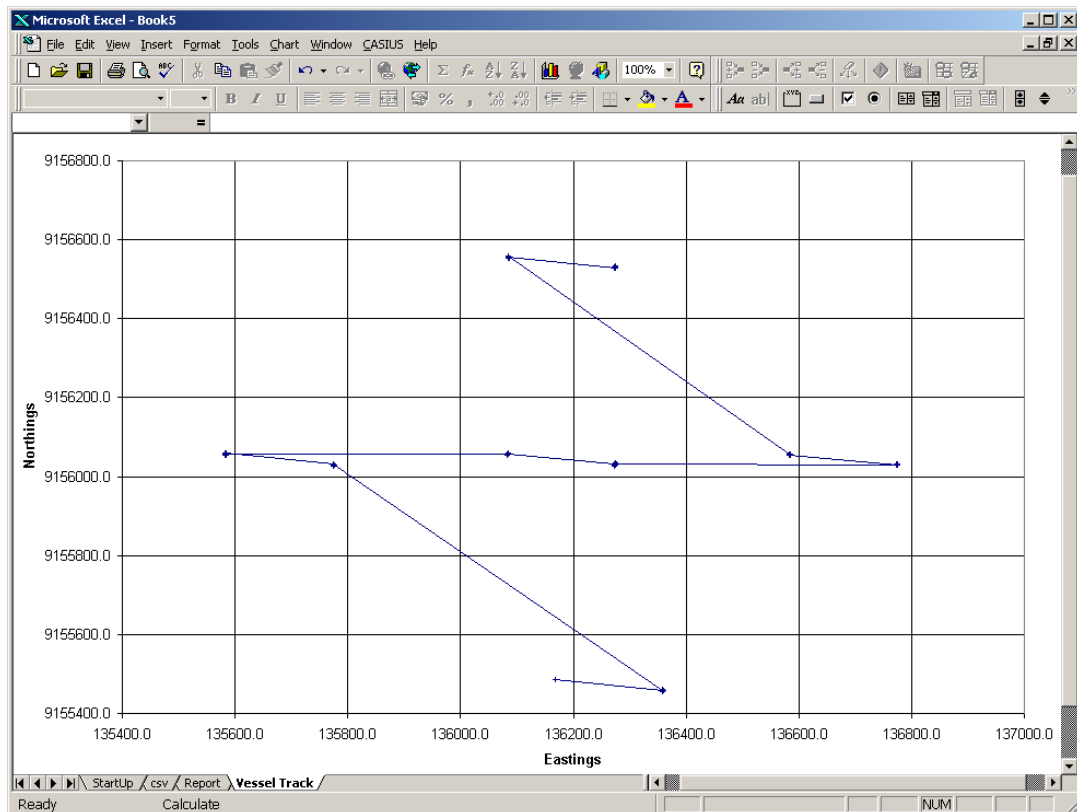
FIG 6.3 LOADING CSV FILES INTO CASIUS

When all the files have been input the 'Cancel' button is used to indicate that there are no more input files.

At this point the files will be joined together, redundant records removed and the resultant joined file including the start up data can be saved as an .XLS file if required by selecting "SAVE START UP AND DATA" from the CASIUS menu on the toolbar if desired (see [Fig 6.2](#)).

Once this has been done or if the data to be processed by CASIUS already exists as a single file it is not necessary to join any files and the selection of "LOAD OLD START UP AND DATA" can be selected from the CASIUS menu on the toolbar.

The status of the data extraction will be shown on the bottom of the screen and you will see messages such as "parsing input data", "extracting data", "fill in box in sheet" and "drawing vessel track" before the data extraction is finished.

FIG 6.4 CASIUS VESSEL TRACK

Once the data has been loaded as above then it is possible to now select the beacon name by highlighting this cell in the start up sheet and pulling down the box. All beacons available in the logged data will be shown. This is only of interest to Version 6 (L)USBL users with more than one beacon active, (see Section 6.2.7b and Fig 6.4). It is also only available if the data was collected using log files. It is not possible using data collected using the Surveyor's Output.

6.4 PROCESSING OF LOGGED DATA BY CASIUS

There are two options for processing of data in CASIUS and these are –

- a. Do Box In Only
- b. Do Box In, VRU and Gyro

These processing options are **available through the CASIUS menu** and the selection will depend on the data that has been collected. For a “box in” only there is no requirement to have data logged from directly above the beacon provided that either the beacon depth or the sound velocity is known accurately. To resolve unknowns in both beacon depth and sound velocity or for the pitch, roll and azimuth corrections to be calculated, it is necessary to go over the beacon.

In the ‘box in’ calculation the beacon position, depth, sound velocity & antenna offsets are determined. These values are then used in the ‘Tcvt Attitude’ calculation to determine the pitch, roll & heading corrections. Both calculations are based on a least squares adjustment using the variation of co-ordinates method.

After the calculations are complete the following results of the adjustment are displayed in dialogue boxes of the report sheet –

- a. Beacon East, North & Depth.
- b. Sound velocity.
- c. X & Y Transceiver offsets from the vessel datum.
- d. The calculated values of the (L)USBL transceiver/ship pitch, roll & heading corrections.
- e. The percentages of the beacon positions corresponding to each fix falling within various radii of the calculated Beacon position after the CASIUS adjustments and the number of acoustic fixes used.

6.5 RE-LOADING OF THE CASIUS CALCULATIONS AND DATA.

The CASIUS start up values and extracted data may be loaded (if previously saved) at a later stage by opening the file from the CASIUS toolbar menu (“load old start up and data”)

The results may be viewed, calculation re-done, with changed inputs if required, and the 3D scatter plots recomputed with various box sizes and plot areas.

Printing and saving of the results is as from the original workbook.

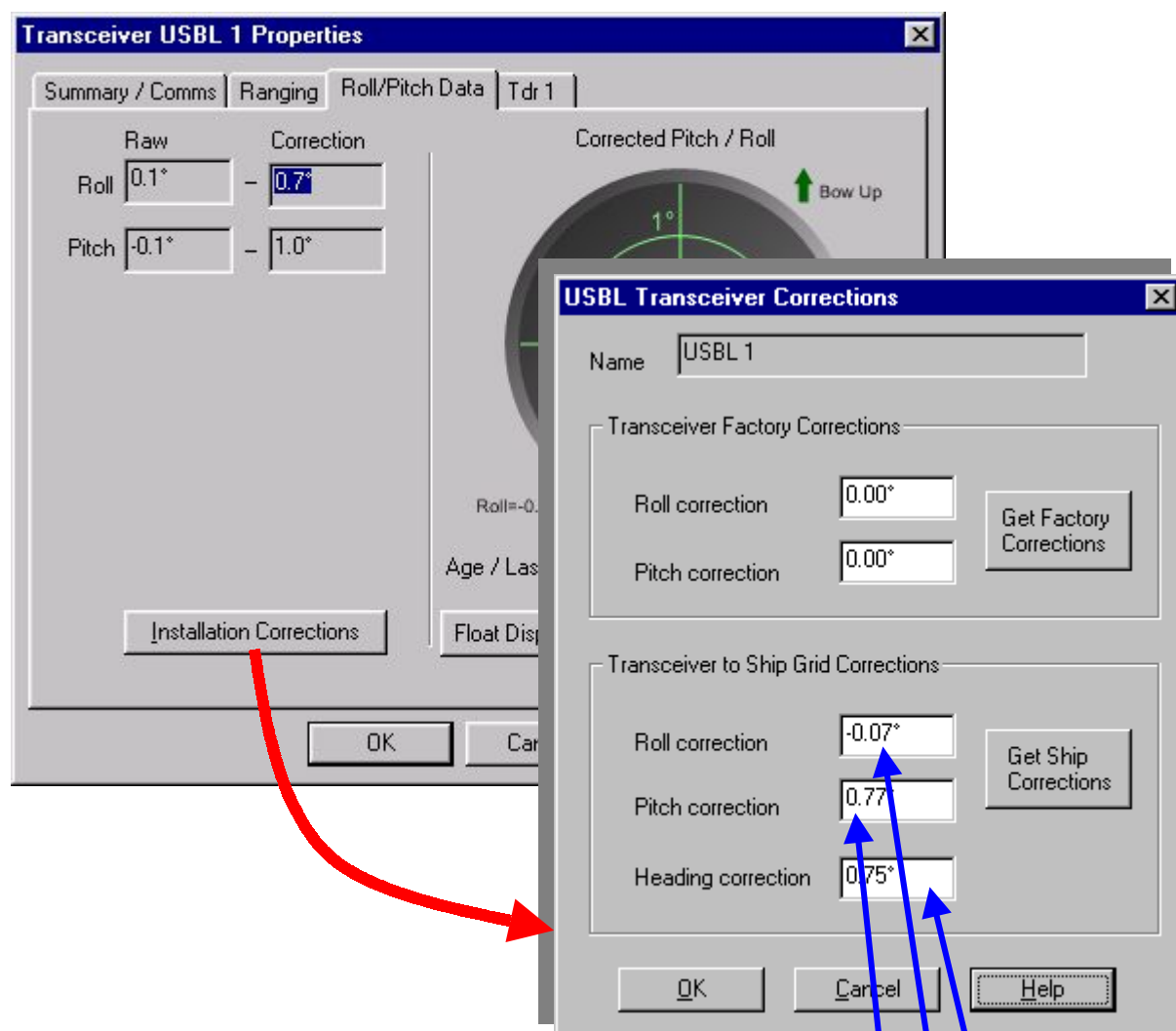
Note that the main workbook may be saved at any stage for further processing and that the report file may be saved at any stage after the calculation has been done.

6.6 A THE CORRECTIONS COMPUTED BY CASIUS TO THE (L)USBL SYSTEM

Replace the Transceiver/ship corrections on the USBL attitude corrections page with the corrections computed by CASIUS, (see Section 3.3 and Fig 3.4.).

6.7 APPLY THE CORRECTIONS COMPUTED BY CASIUS TO THE FUSION USBL SYSTEM

Alignment corrections between the USBL transceiver and the vessel / ship grid are to be entered manually into the Fusion USBL software. These are to be entered into the **USBL Transceiver Corrections** pages as detailed below. This page is accessed via the **Installation Corrections** button on the Roll/Pitch data tab for the USBL transceiver.



CASIU DEMO		CASIU calibration report			Casius Version 4.5a		Excel 9.0		LUSBL version 6	
Comments: Demo Casius										
data file: 06280257.csv				Path:						
report file:				log end: 28 Jun 2000 07:03				duration: 04:05		
log start: 28 Jun 2000 02:57										
INPUTS:										
Used by USBL	-----	-----	-----	1,497.8	-----	-----	-0.65	-0.19	2.02	
Initial Estimates	136,210.0	9,156,040.0	1,280.0	1,497.8	-10.20	5.60	-----	-----	-----	
Estimate accuracy	30.0	30.0	5.0	1.0	1.0	1.0	-----	-----	-----	
Distance units are metres										
Range gate	3.0	angle gate	2.0	% slant range						
Range accy	0.2			Ant Stbd Offset	13.6	Tcwr Index			11	
Tcwr Depth Offset	10.90			Ant Fwd Offset	81.6	Beacon Name				
Tcwr depth	10.90	accuracy	0.5	Ant Height Offset	27.20	Turn Around Time			125 ms	
Depth aid angle limit	15.0	depth limit	1.0			DGPS lags USBL by			0 seconds	
DGPS protocol NMEA 0183 GGA										
OUTPUTS:										
Calculated	136,208.8	9,156,042.8	1,374.4	1,490.1	-9.38	7.42	0.77	-0.07	0.75	
Calc accuracy	0.52	0.59	0.92	0.59	0.53	0.45	0.00	0.00	0.00	
Before CASIU After CASIU										
39.4% Tpdtr posns. (1 sigma)	35.2		3.0	No. of iterations		7	4	Box In Tcwr Attitude		
50.0% Tpdtr posns. (CEP)	37.0		3.5	No. Depth aided			543			
63.2% Tpdtr posns. (1 Drms)	39.0		4.3	No. of fixes used		692	692			
86.5% Tpdtr posns. (2 sigma)	42.2		6.1	Average weighted residuals		0.87	0.58			
98.2% Tpdtr posns. (2 Drms)	46.2		11.1							
N.B. The Pitch, Roll & Heading corrections are to be entered as the USBL tcwr/ship grid corrections.										

APPENDIX A

(L)USBL I/O PORT ALLOCATIONS

CPU Serial port 1 for DP Telegram	Protocol as required by the vessel. This is the only port configurable for Current Loop operation by jumper settings.
CPU Serial port 2 for LUSBL	Acoustic Transceiver 38400, 8,1,None,None (If the Transceiver is to be driven from the CPU, otherwise set to None).
CPU printer	Printer, Bit Map (Print picture screens to the floppy disc with the file name 'mmdhmm.bmp'. The file name is the month, day, hour and minute at which the capture started. When renaming the file on a PC use the Extension '.BMP' so as to keep the file type association)..
SYNC I.O. VRU 1	Analogue VRU (typical settings for a TSS VRU are:- VRU port: 1, type: Scaling: 50, Linear: Yes, Invert Roll: No, Invert pitch: No.) (typical settings for a Datawell VRU are:- VRU port: 1, type: Scaling: 90, Linear: No, Invert Roll: No, Invert pitch: Yes.)
SYNC I.O. Sync Dig *	Synchro Gyro (This is for a Synchro Gyro otherwise select None.)
SYNC I.O. Serial *	None This would be used for a Gyro connected serially; the normal settings are:- Robertson 9600, 8,1, None, None, or NMEA 4800, 8, 1, None, None).
Serial IO: Ser 1	Acoustic Transceiver 38400, 8,1,None,None (serial port for the Acoustic transceiver, If the Transceiver is driven from the CPU this should be set to None).
Serial IO: Ser 2	Acoustic Transceiver 38400, 8,1,None, None (serial port for a second Acoustic Transceiver, otherwise set to None).
Serial IO: Ser 3	Nav Processor, 38400, 8,1,None, None (serial port for comms to a second Navigation Processor, otherwise set to None).
Serial IO: Ser 4	None, 9600, 8,1, None, Xon/Xoff (Default settings for a unassigned serial port).
Serial IO: Ser 5	DGPS, NMEA CGA, 9600, 8,1, None, Xon/Xoff (serial port set for input from DGPS).
Serial IO: Ser 6	Survey output, CSV, 9600, 8,1, None, Xon/Xoff (serial port for data output to PC).

Note: *Only one of the synchro inputs can be set-up at a time hence one of the selections must read None.

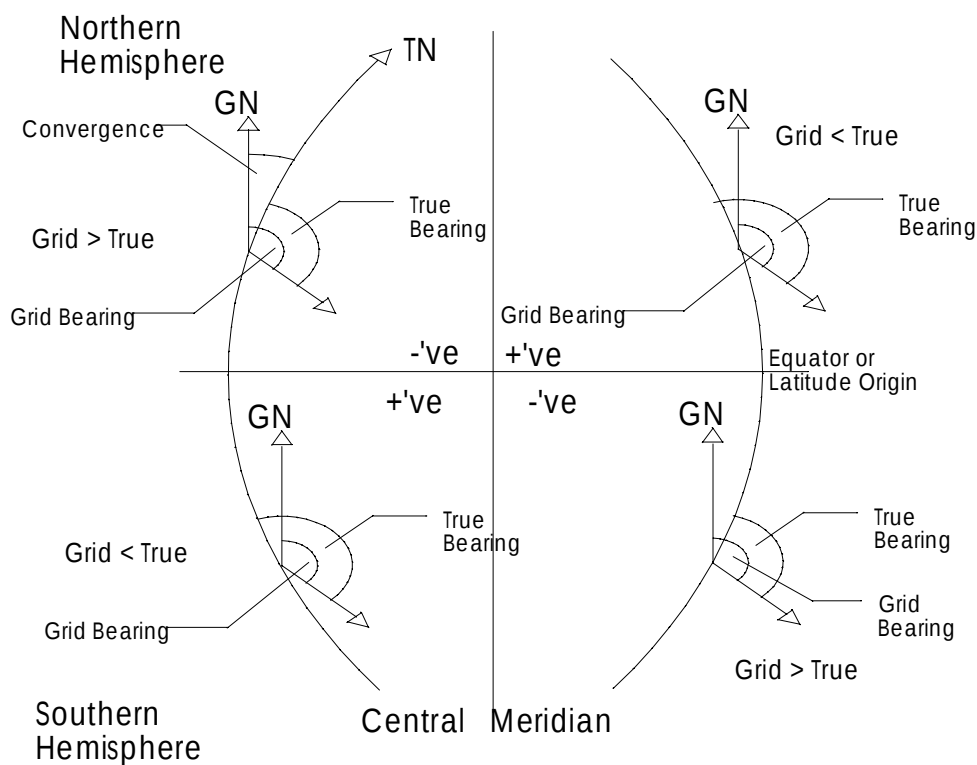
Note: Serial ports 1 - 3 support RS232 and RS485 communications. The USBL Transceiver is normally driven through internal wiring in the Navigation Processor with port jumpers set for RS485. However the ports can also drive a Transceiver through the back panel connectors provided an external power source for the Transceiver is available, again the jumpers need to be set to the RS485 position.

APPENDIX B

CONVERGENCE CONVENTION

Sonardyne follow the Bomford convention illustrated below.

Convergence - Bomford Convention



$$\text{Grid} = \text{True} - (+/- \text{Convergence})$$

Bomford's Definition of Convergence:

At any point the *convergence* is the angle between the meridian as represented on the plane and the N grid line. It is positive when Grid North lies east of True North. *Convergence*, clockwise from meridian to N axis.

A convergence calculator is available that will not only calculate the magnitude of convergence but display it in the correct sign to be entered into the USBL system.