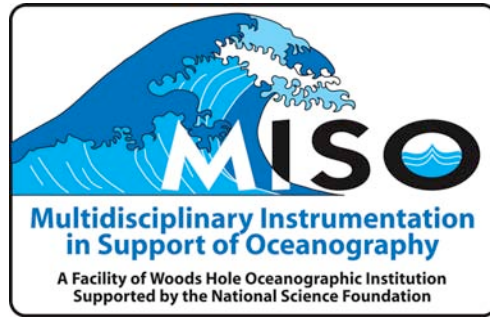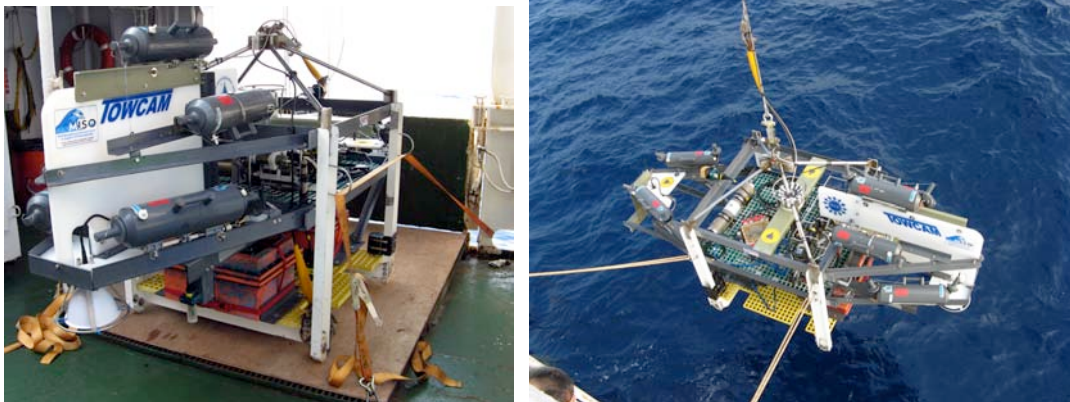# WHOI MISO TowCam

System Manual, Operational Guidelines and Data Processing For National Taiwan University (NTU) TowCam System

拖曳式高解析攝影機TOWCAM

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1. NTU TowCam System Specifications and Description

       The WHOI MISO TowCam built for National Taiwan University (NTU) (Appendix A) provides three primary types of data. They are: CTD water properties data (including camera depth and altitude) derived from the SeaBird SBE25 CTD, digital photographs produced by the DSPL DigiSeaCam digital deep-sea camera, and bottom water samples collected by the seven (7) 5-liter Niskin bottles mounted on the frame and triggered via the SBE32 pylon.

Figure 1. NTU TowCam on main deck of OR-1 at deployment door on starboard side.

Figure 2. Port (left) and starboard side views of TowCam fully rigged for deployment on CTD platform of OR-1, midship starboard side.
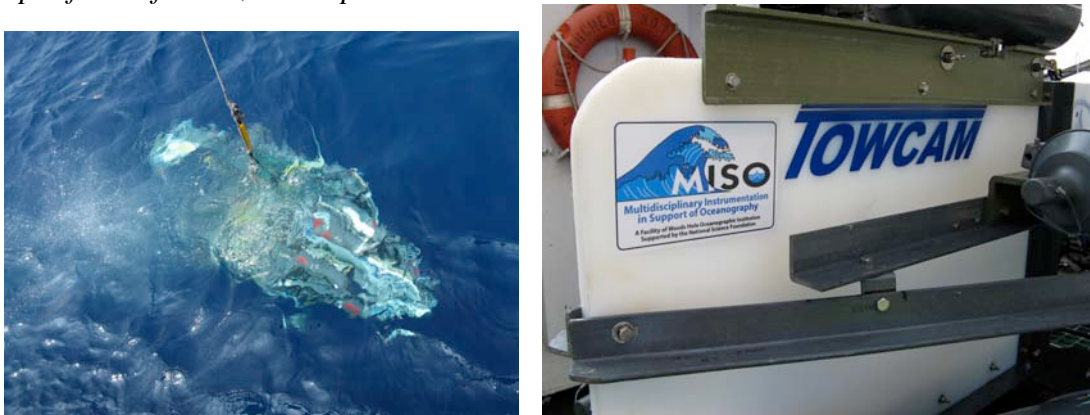

Figure 3. (left) TowCam deployed, (right) TowCam tail showing Niskin mounting brackets.

1.1. System Specifications

Frame - Aluminum, fiberglass and stainless steel (lifting bale is 316 stainless), with nylon standoff isolation between aluminum vertical struts, bolts and other frame elements. All bolt fasteners are 316 stainless.

Camera- DeepSea Power&Light (DSPL) style Digiseacam (s/n 6003B) (WHOI built to DSPL specs) including Deck Box (s/n 6005) and (1) set of Deck Box cables.

Power- three (3) DSPL SeaBatteries each providing 24VDC at 42 amp/hr.

Battery Chargers- (4) MajorPower 'smart' chargers (110VAC in, 24VDC out at 8 amps).

Strobes- (1) Benthos 383 electronics (600 watt/sec capacity) with (2) Benthos 386 strobe heads.

Cables, Connectors and Dummy Plugs- various styles for different components. All manufactured by Impulse Enterprise, Inc. Main cables are 16-pin camera to Jbox cable, 4-pin strobe to Jbox cable, and 4-pin strobe to strobe-heads Y cable.

Junction Box- (1) WHOI designed and built to distribute power from batteries to camera and strobes and provide synchronization line from camera to strobes.

Flashbird- (1) WHOI designed and built to provide confirmation of strobe/camera function.

Computers- (2) One Dell Precision dual processor PC laptop and one Apple MacbookPro laptop.

CTD- (currently on loan from WHOI-MISO) Seabird SBE25 CTD system -s/n 346.

Water Bottle Release System- (1) SeaBird Pylon CRM - SBE32 - s/n 3229598-0489 (Part 90409.1).

Niskin Bottles- (7) total, 5-liter volume with internal springs, user supplied.

Weaklink- (1) Scripps style dredge weak link using 5500# (tested) brass bolts.

Hardware and Tools- various hardware - all English units with hand tools including wrenches, screwdrivers, portable battery powered drill, and specialty tools for servicing camera.

Total system weight in air ~1000 pounds, 455 kg
Total system weight in water ~700 pounds, 320 kg
Rated Depth - 6000 m

2. Equipment List, Spare Parts and Contact Information

2.1. NTU TowCam Equipment (see Appendix A)

Major System Components
(1) WHOI-MISO TowCam frame, mechanical supplies, compensating oils and tools
(1) DigiSeaCam deep-sea digital camera system (including Deck Box) and cables
(1 set) Subsea cables and connectors
(1) 600 watt/sec - double head strobe system
(1) SeaBird Water Bottle Release CRM Pylon - SBE32
(4) Deep-sea batteries 24VDC/ 42 amp/hr
(1) Deep-sea Junction Box (Jbox)
(2) laptop computers
(4) Battery Chargers and Cables
(1) Flashbird

On loan from WHOI MISO:
(1) SeaBird SBE25 CTD system with cables for down and forward altimeters, flashbird, turbidity sensor, and standard temperature, depth and conductivity sensors.

2.2. NTU TowCam Spares

2.2.1. Frame Components
Assorted fiberglass angles and 316 stainless bolts, nuts, washers etc, are provided.

2.2.2. Deep-Sea Digital Camera

A spare Nikon995 camera module is provided along with one spare 2 GB CompactFlash card, and one Digisnap2300 controller board (Appendix A). One spare 5-pin dummy plug for camera housing end cap connector is provided. Spare Orings for camera connectors (bulkhead and cable) are provided along with Oring insertion tool used for putting Orings into 16-pin bulkhead connector on camera and Jbox. Lubrication (DC4 and DC111) for Orings and sealing surfaces is provided along with wooden handled cotton swabs, and 3 boxes of Precision Wipes to be used to clean the camera lens with 70% isopropyl alcohol. A spare set of stainless shoulder bolts used to mount the camera in the mounting bracket on the TowCam are also provided.

2.2.3. Strobe

Spare fuses for the Benthos 383 strobe electronics chassis are provided as are spare Orings for the endcap seals. 1 spare stainless steel 386 strobe head frame and 2 spare conical reflectors are provided. Assorted ¼-28 316 stainless hardware is provided for strobes heads.

2.2.4. SeaBattery

(1) spare DSPL SeaBattery is provided, and (2) additional SeaBatteries are on loan from WHOI MISO. ~4 liters of compensating oil (mineral oil) is provided.

2.2.5. Charger

One spare MajorPower battery charger is provided.

2.2.6. Dummy Plugs

At least 2-3 spare dummy plugs are provided for each type of connector used on the Jbox and batteries.

2.2.7. Jbox

~1 liter of silicon compensating oil (DC20). NB - Jbox compensating oil and battery compensating oil is NOT COMPATIBLE and cannot be substituted for each other.

2.2.8. SeaBird Water Bottle Release Pylon - SBE32

Spare 300#-test monofilament and bottle release hooks are provided.

2.3. Contact Information

If there are any questions about the NTU TowCam system, or these guidelines and processing steps please call or email Dan Fornari at: dfornari@whoi.edu, telephone – 508-289-2857 (office), 508-428-5895 (home), 508-728-9050 (mobile). Shipping address is: Dr. D. J. Fornari, Woods Hole Oceanographic Institution, 266 Woods Hole Rd., Woods Hole, MA 02543 USA.

3. Planning TowCam Traverses and Towing Operations

Plans for the TowCam traverses should be typed up and provided to: 1) the Bridge, 2) Shipboard Technician and 3) the Chief Scientist at least 6-8 hours prior to the start of the camera tow. The information should include waypoint positions that you want the bridge to steer the ship through and a launch and end position. Avoid sharp bends in the trackline as this will complicate towing operations. By providing a plan early, everyone involved with the operations will know what to expect. Please provide the TowCam technician with ~12-

24 hours advance warning for when you expect to do a towed camera survey so they have time to properly set up the system.

Plan each tow carefully paying attention to properly orienting the traverse with respect to prevailing weather conditions and the especially the terrain. Be certain not to drive over the wire. Orient the tows so as to steam into the seas and wind if possible so as to not go too fast during the traverse. Optimal speed during TowCam surveys is 0.3-0.5 kts depending on the terrain to be surveyed. The steeper the terrain the slower the tow speed.

In gently sloping terrain, speeds of ~1/2 knot provide good coverage. Taking photos at 10 sec interval you can cover ~ 2 nm (3.6 km) of seafloor on a single tow with some overlap between images**.**

Traverses should be oriented parallel or somewhat oblique to the bathymetric contours. **Do not tow the system up steep slopes- it is NOT an ROV or submersible!** If you have steep terrain to investigate you can consider going DOWN slope obliquely, but it is suggested that you avoid extreme terrain and if there are steep slopes tow parallel to the contours. The forward-looking altimeter (yellow trace on CTD real-time display screen) provides good advance warning when steeper slopes or obstacles are in front of the camera. This capability allows you to fly up gentle slopes or scarps that are 10-20 m high because the response time and speed of the CTD winch allows you to reel up 10-20 m of wire in <1 minute.

Optimal tow altitude for good photography and for optimizing coverage is expected to be ~4-5 meters. See Table 1 that provides camera 'field of view' for frame coverage based on altitude. If after the first tow you see that the bottom water is turbid (this should also show up on the CTD turbidity sensor) then you may need to fly at lower altitude, and perhaps slower speed (~ 1/3 knot).

Remember that for a tow speed (speed over ground- "SOG") of ~1/2 kt at ~ 1200 m depth, the layback of the camera behind the ship will be ~200 meters. A tabular listing of layback versus depth and wire out for SOG of ~ 1/2 knot is also provided in the TowCam documentation and appended to this document.

The GPS position of the ship should be used to determine the approximate TowCam location in real-time during each tow. Watch standers should be plotting ship and estimated TowCam position every 5 min during the tow. Processing of the ship's navigation data should be performed so as to produce layback navigation for the TowCam that subtracts the calculated layback in a direction of 180° from the ship's Course Over Ground (COG). Writing down the camera depth and wire out every 5 minutes will permit you to calculate what the layback of the camera is behind the ship using a simple Pythagoras formula.

Launch position for the TowCam should be ~1/4 mile 'upstream' from where the bottom traverse is to begin. This is so that the camera can be lowered while the ship is steaming at ~1/4 knot. Lowering while towing the system slowly ensures that there is sufficient drag on the system to not 'unload' the cable while paying out wire at ~ 20-30 m/min rates. Follow instructions from the shipboard techs and engineers regarding speed on the CTD winch. Once you have ~500 m of wire out you can increase the speed to ~30-35m/min if the weather is good. If it is rough slower speeds may be needed to avoid

unloading the cable during lowering. Hauling in can usually be done at speeds of ~40m/min up to 200 m from the surface.

The CTD altimeter on the TowCam will start receiving good signals from the bottom about 30-50 m above the seafloor. Make sure to get a reading from the ship's fathometer so you know the approximate seafloor depth where you will begin the bottom traverse. **Approach the bottom slowly – at 50 m above the bottom depth slow to 10 m/min and make sure altimeter readings are decreasing normally as you approach the bottom.** Stop the winch at 6-7 m above the bottom and let the camera settle for a few minutes, then proceed to 4-5 m towing altitude.

Keep a real-time bathymetry map, at small scale (1: 5000 or 1: 10000) with 5-10 m contours and plot the ship and camera positions every 5 minutes during the tow so that you can be aware of when the bottom will be rising or falling in front of the ship, or when slope changes are expected. For going up steps in a slope, watch for the forward altimeter signal to alert you to upcoming slopes or scarps.

The science party is expected to provide 3 watch standers for each TowCam lowering. There will be: 1 flyer, 1 Navigation Plotter, and 1 Log Keeper – who will also calculate the real time layback using the TowCam depth from the CTD data and the wire out from the winch reading.

4. Pre-Tow set up of SBE-25CTD system, Deep-sea Digital Camera, and Niskin Bottles
The NTU TowCam does not use the 'Winch' connector on the power Jbox (Figure 4), hence the 'Winch' normal (black) dummy plug (center one) will always be inserted in the power JBox of the NTU TowCam. Only two 'shorted' (RED) dummy plugs will be used for each lowering - they are for the strobe and the camera. **Always plug in the strobe red, shorted dummy FIRST –and listen for the high-pitched sound from the strobe electronics that verifies that the strobe capacitors are charging.**
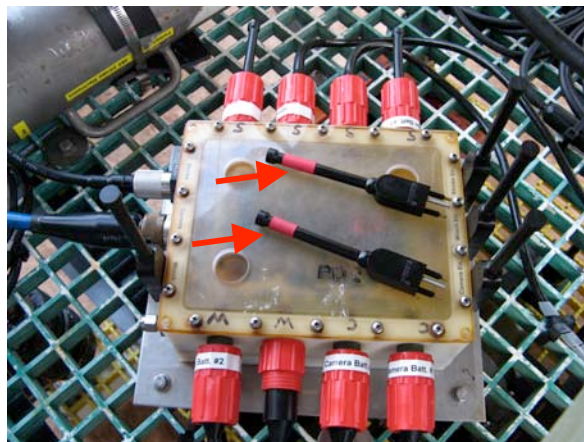

Figure 4. Power Jbox showing shorted dummies with red bands (by red arrows) on top of Jbox, and black, normal dummies inserted into strobe and camera connectors. Shorted dummy plugs are used to 'turn on' the strobe and camera.

Plug the red, shorted dummy for the camera in LAST. The camera will take its first flash after about 20 seconds from plugging in the camera shorted dummy. If you don't see a flash after ~20 sec., unplug the camera dummy, wait 5 sec, and plug it back in. The camera should

then start. Because these are consumer Nikon 995 cameras in the housing, with a Digisnap interface board, sometime the 'power-up' to the camera is not acknowledged. However, once the camera does power up, it will accept the delay and start up as programmed.

4.1. Digital Camera Set-up

During a cruise the deepsea digital camera should be powered up using the DSPL deck box (Figure 5) in the lab every 4-5 days if it has not been used for a lowering. This helps to put power to the camera's internal battery so that the settings remain in memory. The camera also has a separate power supply, using 3 AA lithium batteries, so that it keeps the setting and time. But it is a good idea to power up the camera with the DSPL deck box and hook up the video monitor so you can monitor the camera's display, and take photos of the LED clock on the Apple Macbook computer that is set to GMT. Let the camera run for 4-5 hours taking photos of the clock. This will also give you experience in using the camera, downloading images and converting them to have the date/time.jpg stamp.

Prior to each camera tow the following should be done to the camera:
NB- never power up the deck box unless you have already plugged the 16pin cable into the DSPL camera bulkhead connector

4.1.1. Erase all the photos on the camera's compact flash (CF) Card

This is done by connecting camera to the DSPL Deck Box **with toggle switch in 'LOAD' (**see Figures 5-6). Wait 30 sec for camera to power up, then take the USB cable from the Deck Box and connect to the Apple laptop. The camera's CF card will appear as a *'No Name'* disk icon on the laptop screen. Double click on the icon to open it. Go to the Folder called: 'DCIM' in that folder there will be multiple folders called '100Nikon', '101Nikon', etc. The individual images are in there, you can delete the '100Nikon' folders by dragging them to the trash, or highlighting them and clicking on the apple key and delete- that moves them to the trash. **YOU MUST THEN EMPTY THE TRASH SO THAT THEY ARE DELETED FROM THE CF CARD.** To empty the trash on the iBook go to the Desktop menu and click on the Finder menu – the 'Empty Trash' command is in that list. *Do not use the 'Secure Empty Trash' it takes much longer.* After you have ejected the 'No Name' CF card icon and it disappears from the desktop, unplug the USB camera cable from the iBook, then power off the camera (Figures 5-7).
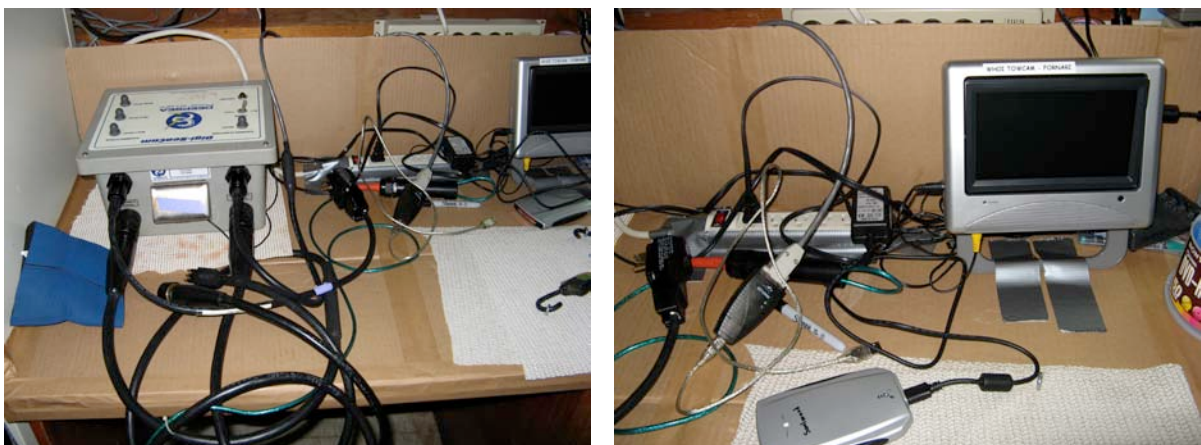

Figure 5. Set-up for bench testing deep sea digital camera. (left) DSPL deck box with cables and monitor (right) that displays camera settings when camera is on.

Figure 6. Deck box (left) and cables (right) used to connect DSPL Deck Box to DSPL Camera and iBook computer. (right photo) A- Camera 16 pin connector, B- USB cable for downloading photos from the camera, C- power cord and switch/plug for DSPL Deck Box (white button on the plug is the 'ON' button). First connect 16-pin connector to the camera. Then plug in the power cord (C). Be sure toggle switch is in proper setting (ie L-load or R-run). If downloading images, the toggle switch (A) is in 'Load' after ~ 20 seconds after turning power on, plug in the USB connector (B) to the port on the laptop. The Compact Flash card in the DSPL camera will appear as a 'No Name' disk icon (see Figure 8).

Figure 7. Digital camera showing 16 pin connector and 2 key pins on the male connector from the cable (red arrow- left photo). GREAT CARE SHOULD ALWAYS BE TAKEN WHEN MATING THESE CONNECTORS AS THE PINS ARE SMALL AND CAN BE BROKEN EASILY. Be sure to carefully match the guide pins before pushing gently to seat the connector and to screw the brass ring on carefully so it does not cross-thread. Be sure to insert 5-pin dummy (yellow arrow, middle photo) into other connector on end cap prior to launch.
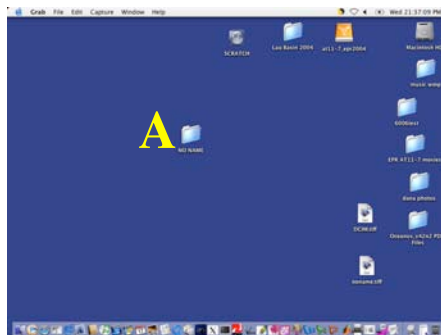

Figure 8. Apple laptop screen showing 'No Name' icon (to the right of yellow 'A') which is the mounted, 2 Gbyte Compact Flash Card of the DSPL camera. To unmount the card, drag the 'No Name' disk icon to the trash, or click on it and press the and E keys to eject it.
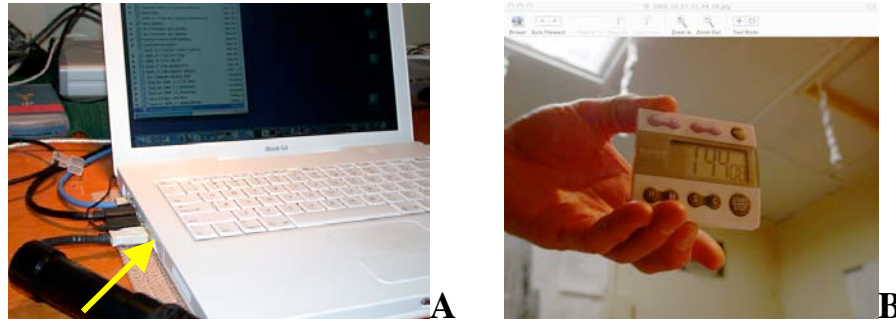
Figure 9.   A) Apple laptop showing USB connectors on the left side of CPU – white connector (yellow arrow) is USB plug from DSPL deck box. B) Screen shot of the LED clock that displays GMT time as it appears in one of the DSPL camera photos taken prior to a lowering. For the NTU system, digital alarm clock software is provided on both laptops so that photos of the computer screen clock can be used to register time on the first images of each tow.
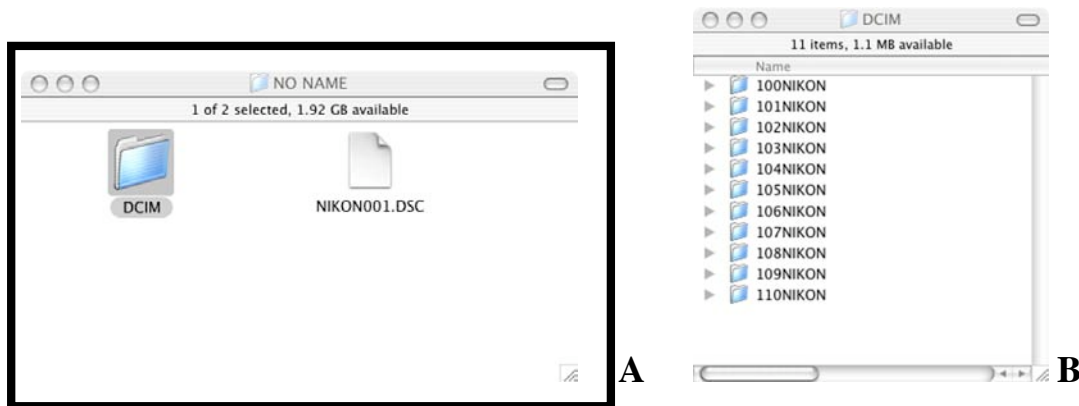

Figure 10. A) Screen shot of 'No Name' DSPL camera CF card icon as it will appear on laptop screen when the icon is opened (double clicked on). DO NOT ERASE THESE TWO ITEMS. All the photographs will be written to the 'DCIM' folder. Double click on that folder and you will see the subdirectories labeled '100Nikon', '101Nikon', etc. -Figure 10B. Those are the folders that you will copy over to the laptop desktop when downloading images from the camera following a lowering. Figure 10 B. Window of digital camera CF card opened in laptop to show the various folders where the images are saved. Copy all of these folders to the folder you have made on the laptop's desktop with the tow name (i.e., "OR1-810-tow1raw"). That will be your 'raw' data. You will then copy this to 2 places using the firewire drives provided to be sure you have it saved, then you will 'process' the images to have the file names tagged with time/date using the ImageTime.pl program.

4.1.2.Verify the Camera Settings & Take Photos of GMT Clock & Setting the Delay Interval
        With the camera connected to the DSPL Deck Box **and the toggle switch in 'RUN'** power up the camera (Figure 11). Be sure to have the small monitor connected via the RCA cable to the deck box so you can see the DSPL camera monitor display (Figure 5). Verify that the camera settings are OK and that the CF card is empty – you can tell this if the number of photos at the lower right of the camera's display screen reads a number like"1283" (Figure 12). (Note - the 2 Gbyte CF card is empty when the number at lower right reads '1283'– the camera can actually take about 1800 frames per lowering, but the Nikon995's software was designed before 2 GB cards were available, so it can't count that high…). If you turn on the camera in 'Run' and video monitor display reads "Out of

Memory", that means that the DSPL camera's CF card is full and you need to erase the photos from the previous lowering.
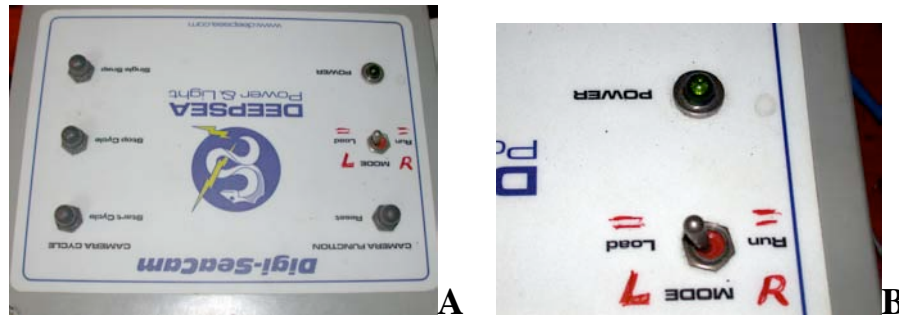

Figure 11. A) DSPL Deck Box used to communicate with the DSPL Camera. Note toggle switch on right side of box (see close-up in Figure 11B). 'L' setting allows you to down load photos or to set the delay. 'R' setting allows you to 'RUN' the camera and take photos.

Figure 12. DSPL camera display as seen on the monitor of the video camera. Note that the monitor should look like this when the settings are properly set in the camera. The "0.5 m" at the upper right identifies the focal length at infinity for camera to ensure that the photos will be in focus using the water corrected lens on the DSPL camera. That focus setting is also printed on the end cap of the digital camera.

Figure 13. Recording time in the digital camera prior to a tow using the digital alarm clock on the Apple laptop. Small video monitor (red arrow) allows you to ensure you have the clock number in the image frame.

Prior to each tow, take 3-4 photos of the digital clock on the laptop screen (figure 13) (positioning it using the video camera display so you can easily read the clock) so that you have the accurate GMT time and can then relate that to the time stamp of each image based on the DSPL Camera's time, which may be off by a few seconds to a few tens of seconds. Having these photos at the beginning of each tow allows you to correct the time of the images using a Perl script written by Adam Soule (ImageTime.pl) that runs on the Apple laptop (see Data Processing section below).

4.1.3. Shut Down the Camera and Clean Lens with Precision Wipe and Alcohol

Turn off the camera by pressing the black button on the switch attached to the AC power cord. Remember to replace the 5-pin dummy connector if it was taken off, and to put the brass dummy plug on the 16-pin connector after ensuring it is clean and the connector is clean.

The only thing that should touch the DSPL camera lens is a Precision Wipe – no other type of cloth or wipe please. Several boxes of precision wipes have been provided to use for this purpose. Put a small a squirt of isopropyl alcohol on the precision wipe and gently clean the lens, then take a dry precision wipe and make sure the lens is dry. The camera is now ready for installation on the TowCam frame. At all other times the DSPL camera lens should be protected by the blue neoprene cover.

4.1.4. Installing the Digital Camera on the TowCam and Connecting the Blue Camera Cable and Testing the Camera on the TowCam

After the DSPL camera lens is cleaned, carefully carry the camera to the TowCam, protecting the lens. The camera is mounted by inserting it into the guide slots in the black square plastic plate in the center-base of the frame (Figure 14). The curved latch is then brought over the back of the camera and the wing-nut is tightened firmly to latch the camera in place. **MAKE SURE THE 'TOP OF IMAGE' LABEL ON THE CAMERA HOUSING POINTS TOWARDS THE FRONT OF THE TowCam.**

Figure 14. (left) camera mount on lower deck of TowCam (red arrow). Blue camera cable is shown by blue arrow. (right) Camera (red arrow) mounted on TowCam and down-looking altimeter installed (yellow arrow).

Then the blue camera cable (Figure 14) is ready to be plugged into the camera. Remove the brass bulkhead connector from the camera and spray lightly with silicon spray. Remove the stainless dummy plug from the cable connector – **CHECK TO BE SURE THAT THE SMALL O-RING IN THE CABLE CONNECTOR IS PROPERLY**

SEATED – THIS IS CRITICALLY IMPORTANT. Check that the mating surfaces are clean, wipe with a precision wipe if needed, then spray lightly with silicon spray. Carefully insert the cable end into the camera bulkhead, making sure that you have the guide pins oriented correctly so that they match the guide slots in the camera bulkhead connector. Tighten down HARD on the connector by hand, using a cloth to grip the connector. Mate the two dummy connectors (cable and camera bulkhead) and store in plastic container. Keep them clean!
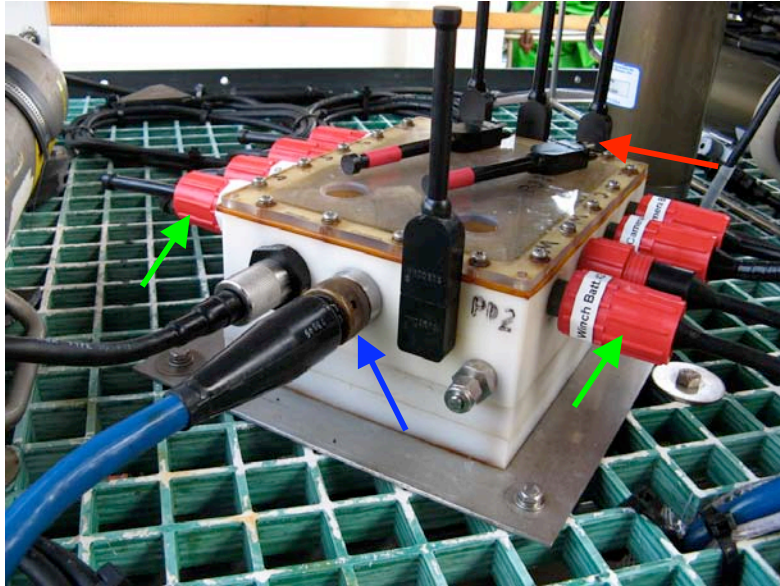

Figure 15. Power Jbox on TowCam. Blue camera cable connector shown by blue arrow in middle of side of Jbox. Red arrow points to the 3 dummy plugs – the center one is for the winches and is NOT used on NTU TowCam. Green arrows point to the battery plugs. Two batteries are used for strobe power and one battery is used for camera power. In order to turn on the strobe and camera, the outer two plugs are removed and replaced by shorted dummies which are resting on top of the Jbox (red bands around the stem of the plug identifies it as a 'shorted' dummy) (see also Figure 4).

After you are sure the cable is properly connected and screwed down you are ready to test the camera through the TowCam's battery power. Go to the power J-box at the back of the TowCam and, using 2 shorted dummies (NB the shorted dummies are the 'ON' switches for the camera and strobe- they are marked by a RED band), **insert the STROBE shorted dummy into the J-box connector labeled 'Strobe' FIRST**, then put your ear by the strobe electronics housing and you will hear it whining, that is the capacitors in the electronics charging up – it's a sign that the strobe will work properly. **After ~ 10 seconds, insert the other shorted dummy into the J-box connector labeled 'Camera'** (Figure 15). Count slowly to 15 and by that time the camera should have started up and it will fire the first of 5 test flashes. If the strobes do not fire once after waiting about 20 seconds, unplug the camera shorted dummy, wait 10 seconds and reinsert the plug- that sometimes is necessary, but once the camera fires the test shots it is very reliable at starting after the delay period that has been programmed in.

About 15 minutes prior to the lowering, with the camera installed on the TowCam, test the camera and strobe functionality by energizing the strobe and camera. Let the camera take 2 photos, then pull the plug on the strobe, and 5 seconds after the flash, pull the camera plug. This sequence ensures that you don't interrupt the saving of the last photo in the

Nikon995 in the housing to the CF card. Reinsert the black dummies into the Jbox until you are ready to launch the camera.

4.2. TowCam's SeaBird SBE25 CTD and SBE32 Bottle Release Pylon Set-up

The TowCam's Seabird SBE25 CTD (Figure 16) provides real-time depth, altitude, forward-looking obstacle avoidance, temperature, turbidity, salinity and indication of flash. The most important sensors are the down-looking altimeter - so you can fly 3-5 meters above bottom, the camera depth- needed to match against the wire out and determine the layback, and the forward-looking altimeter - so that you can avoid crashing into steep slopes or objects in front of the TowCam. All CTD data is updated and recorded at 1 Hz (1 second) in real time.

*Figure 16A. (left) bottom of SBE25 CTD unit on TowCam upper deck. Red arrow points to the syringe tubing where distilled water is pumped to keep the temperature sensor wet while TowCam is on deck in between tows. **THE SYRINGE MUST BE REMOVED PRIOR TO LAUNCH**. ON/OFF slide switch for CTD is under the cabling on the CTD housing (pink arrow). (right) Side view of TowCam showing placement of SBE25 CTD (red arrow), SBE32 pylon (blue arrow), and strobe electronics housing (yellow arrow).*
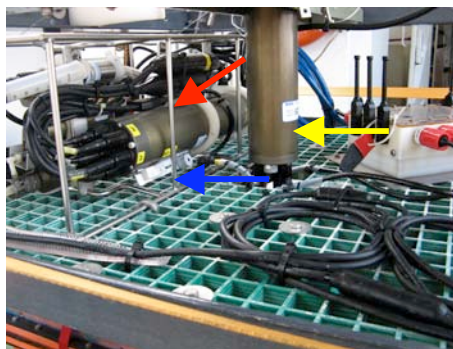

Figure 16B. SBVE25 CTD on top deck of NTU TowCam (red arrow). Blue arrow points to On/Off switch. Yellow arrow points to electronics housing for SBE32 pylon

The detailed documentation for the SeaBird SBE25 CTD is provided in the SeaBird manual for the system provided in Appendix B. The CTD seacable is connected to the SeaBird 32 water bottle release pylon (Figures 16-17). Detailed information on the SBE32 is provided in the SeaBird manual - Appendix C. The SBED25 CTD is connected to the SBE32 pylon via a 2-pin Impulse cable. The CTD is powered through the sea cable when in normal operating mode during a TowCam lowering.
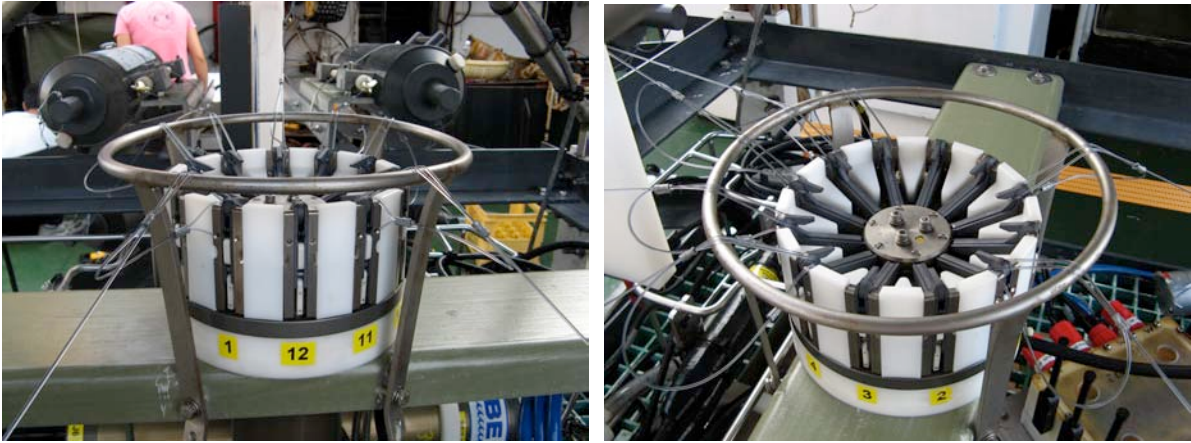
Figure 17A. SeaBird SBE32 water bottle release pylon on top of TowCam. (left) side view. (right) top view showing monofilament lanyards rigged on the release hooks. For NTU TowCam, pylon release positions 1, 4, 5, 6, 7, 8 and 11 are used.


Figure 17B. Detail of hook-up to lanyard release system for water bottle release using the SBE32 pylon.

Detailed documentation for the SeaBird SBE25 CTD is provided in the SeaBird manual for the SBE25 system provided in Appendix B. The CTD sea cable is connected to the SeaBird 32 water bottle release pylon (Figure 17A). Detailed information on the SBE32 is provided in the SeaBird SBE32 manual - Appendix C. The CTD is powered through the sea cable during a TowCam lowering.

The SBE25 CTD has 9 alkaline 'D'-cell batteries which provide back up power to the CGTD and a small lithium battery inside the SBE25. These keep the CPU inside the CTD properly configured. During normal use, the SBE25 CTD is powered by the SBE32 pylon, which is itself powered by the SBE33 deck unit through the sea cable.

Figure 18. TowCam operations set up on OR1 in winch control 'dog house'. The PC laptop has plastic over the keyboard to protect from salt spray. The SeaBird SBE33 deck box is located on the shelf behind the PC laptop (red arrow).
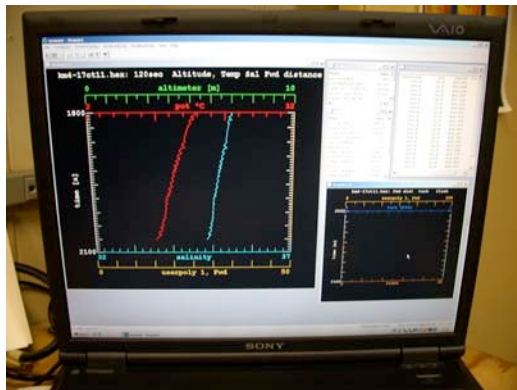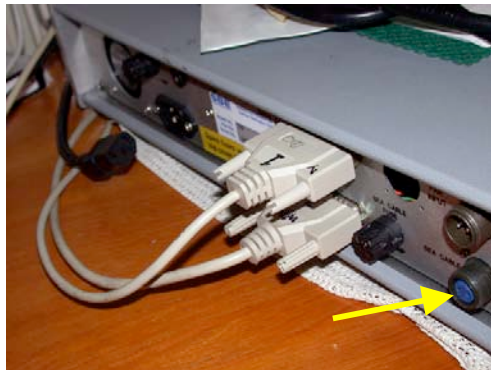

Figure 19. A) PC laptop real-time display of TowCam CTD data. B) USB to serial converter box that is plugged into the laptop's USB port on the left side of the CPU. C) SeaBird SBE33 Deck Box, used to communicate with the SBE25 CTD on the TowCam. D) Rear of the SBE33 Deck Unit showing two serial cables (#1 and #2) connected to the USB/Serial box. Connector #1 is on top and #2 is bottom. The 2-pin sea cable connects to the Deck Box via the female plug at lower right (yellow arrow).

4.2.1. PreTow SBE25 CTD Test

About 1 hour prior to the TowCam lowering, test the CTD to be sure all is OK. With the exception of removing the syringe filled with de-ionized water (Figure 16), this is exactly what you need to do prior to launching the TowCam. Below is the sequence for launching the CTD data acquisition.

a) Be sure that the USB/Serial converter box is plugged into the PC laptop's USB port,
b) Turn on the PC laptop, the Admin. Password is noted on the keyboard ('towcam')
c) Go out to the TowCam and remove the red neoprene wedge from the SBE25's switch andslide the switch to 'ON'- **this turns on the CTD** (Figure 16).
d) When the computer is booted up, double click on the SBE Acquisition icon "**SBE Acq**" on the Desktop. The SeaBird CTD acquisition screen (Figure 20) configured for TowCam operations pops up. You then need to enter a file name for the lowering and 'start' acquisition.
e) Go to the top menu bar and click on "RealTimeData", scroll down and click on "Start Acquisition". A window will open where you have a choice of entering an output file name (center of window – see Figure 21A). Enter a file name for the test – e.g., 'test1', you don't need to add the .hex suffix as that is already there. For a lowering you should use the convention "ct**X**" where **X= 1, 2,** etc. the incremental tow#.
f) Make sure the power cord is plugged into the SBE33 Deck Box and that all serial and USB cables are properly connected. **Turn on the SBE33** using the red push button at the right side of the box (Figure 19C). The red LED lights will cycle through all the numbers and then the yellow light will flash momentarily and then the green, middle status light will start flashing every second, meaning that the Deck Box is communicating with the CTD on the TowCam.
g) Go to the window where you entered the file name for the upcoming tow (Figure 21B) and click on the 'Start Acquire' button (blue arrow in Figure 21B).
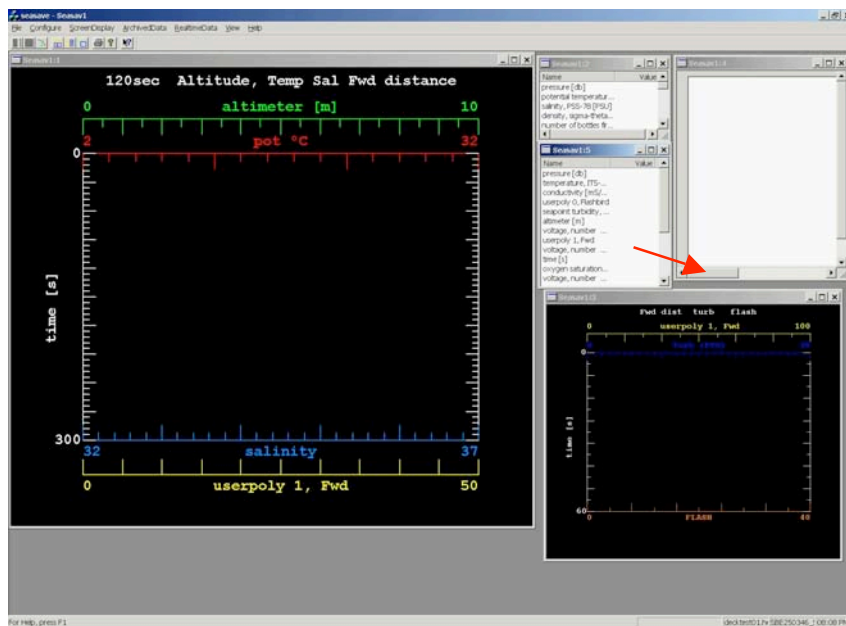

Figure 20. SeaBird CTD Acquisition Screen as configured for TowCam operations when it first pops up on starting the SBE Acquisition program. Large left screen displays real-time down-looking altimeter data 0-10 m range (green line), temperature (red line) and 0-50 m range of forward looking altimeter (yellow line). The total length of the window is 5 minutes (300 seconds). Upper right window is where real time numbers for Depth, Altitude and

Forward-looking altimeter are displayed at 1 Hz. Note that horizontal scroll bar (red arrow) must be slid to the right to display scrolling numbers. Lower right screen displays the 'Flashbird' that is a light sensor on the TowCam's SBE25 CTD that registers when the flashes go off. The signal is displayed as a square wave that comes from the left vertical axis of the window. Because the DSPL camera triggers the strobe, the functionality of the camera is confirmed if the strobe flash is operational. The other data displayed in this window is turbidity (blue line).

h) After you click the button, two small dialog boxes will appear that confirm serial data is being acquired; then the Acquisition Screen (Figure 20) will appear with real-time data being displayed. Move the horizontal slider bar (red arrow in Figure 20) in the upper right window where the altitude, depth, and forward-looking altimeter data scrolls down so that you can see the numbers scrolling. That is your primary data window for flying the TowCam, along with the graphical display in the main window where the altitude data is shown by a green line, and the forward looking obstacle avoidance sonar is shown by a yellow line. See Figure 22 for an example and a description, and the QuickTime movies provided as examples of real-time towing operations.

i) You are now recording CTD data from the TowCam. **The above steps (a-i) should be followed when starting a camera lowering.** The one additional step is to remove the syringe from the temperature sensor (see Figure 11B). **Start TowCam's CTD recording about 5-10 minutes prior to launching the TowCam.**
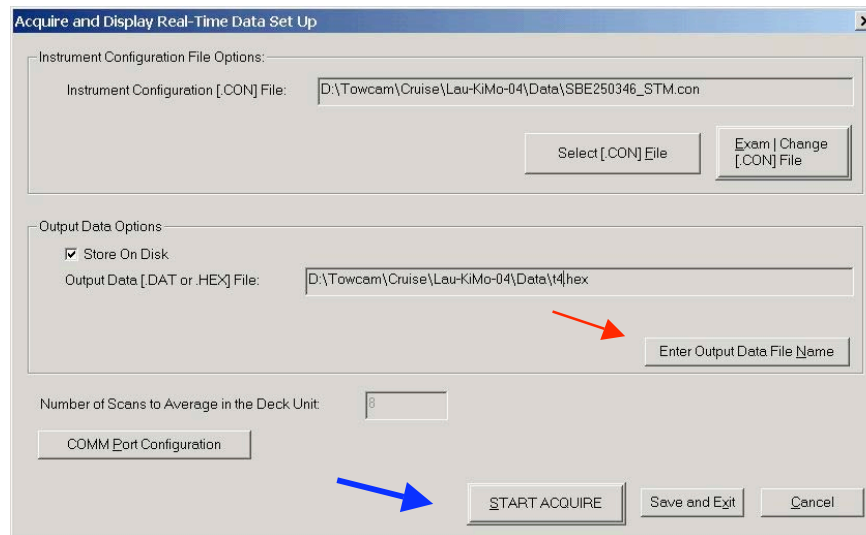

*Figure 21A. Entering output name of the CTD file is done by clicking on the RealTime Data menu in the Acquisition Screen (Figure 20) and scrolling to Start Acquisition. That pulls up the dialog box shown in Figure 21B where you can enter the file name for the lowering. Click on the 'Enter Output File Name' button and the window shown in Figure 16B will appear. Use a convention of: "**ct1**" for the file name. Be sure to keep the '.hex' suffix. Blue arrow points to the 'Start Acquire' button which you click on after the SBE33 Deck Box is ON and the green status light is flashing – which confirms that serial data is being sent to the laptop. This will start the CTD data acquisition. Note the time in the log.*
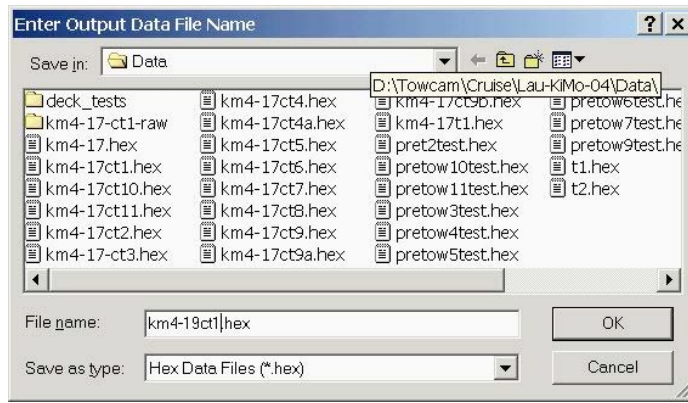
Figure 21B. The PC laptop window where you enter the file name for the camera lowering. The directory path is shown at upper right.
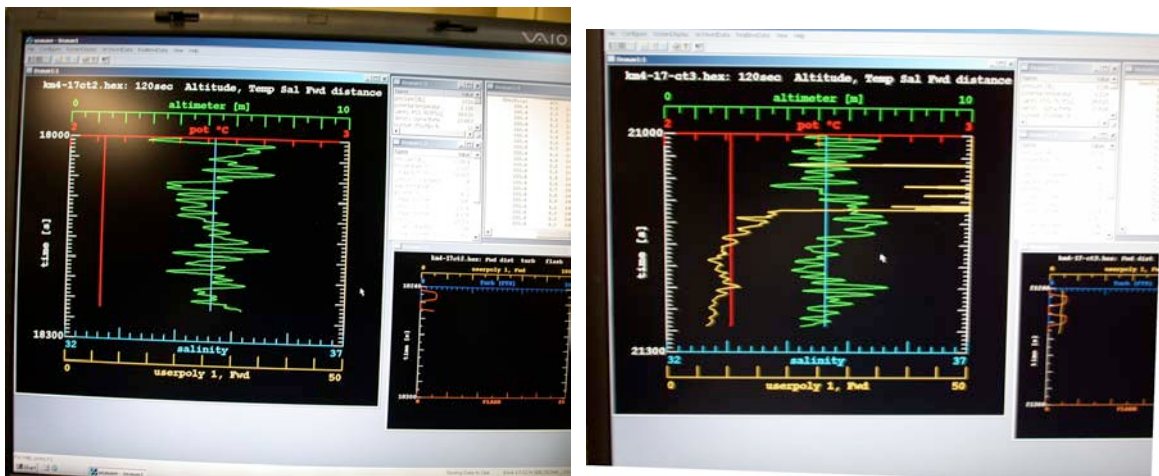

Figure 22. (left) TowCam's SeaBird CTD data acquisition screen during a camera tow. Green line in large window at left is the altitude that is varying between 7-4 meters. The ~2 m periodic variation is due to the sea surface swell that gets translated down the CTD cable. Red line shows ambient near-bottom temperature. The upper right window shows the scrolling text data updated at 1 Hz for the Depth, down-looking altimeter and the forward-looking altimeter. The lower right window shows the Flashbird – the strobe monitor signal that is the brown square waves along the left edge of the frame. (right) CTD screen during period when the forward altimeter (yellow line on large left screen) is registering a contact approximately 10 m in front of the TowCam.

4.3. 'Burping' the Batteries and Securing the Valves

It is essential for the DSPL batteries on the TowCam to be vented while the system is on deck and not in use and covered by a tarp. This will keep direct sunlight off the components and cables and will help prevent overheating of the components.

The small valve caps are stored in small Tupperware container tucked into the top of one of the battery cases (Figure 23). **THE VALVE CAPS MUST BE SCREWED DOWN FIRMLY PRIOR TO LAUNCHING THE TOWCAM.** Before screwing down the valve caps, the batteries must be 'burped' to eliminate most but not all of the air bubble in the top of the bladder. First- check to see that each valve cap has a small black or red O-ring seated at the bottom of the cap. Then, get someone to help you 'burp' the batteries, as 2 pairs of hands make the job easier. While one person gently pushes on one end of the bladder, and with you holding the valve cap ready to be screwed on, gently push on the other end of the

bladder forcing the air bubble to escape through the valve stem leaving an air bubble about 3-5 cm diameter. When the air bubble is that size, screw down the cap FIRMLY by hand. Use one of the red towels to get a firm grip on the cap and screw down tightly – do not use any pliers – just hand tightened – but firmly done.
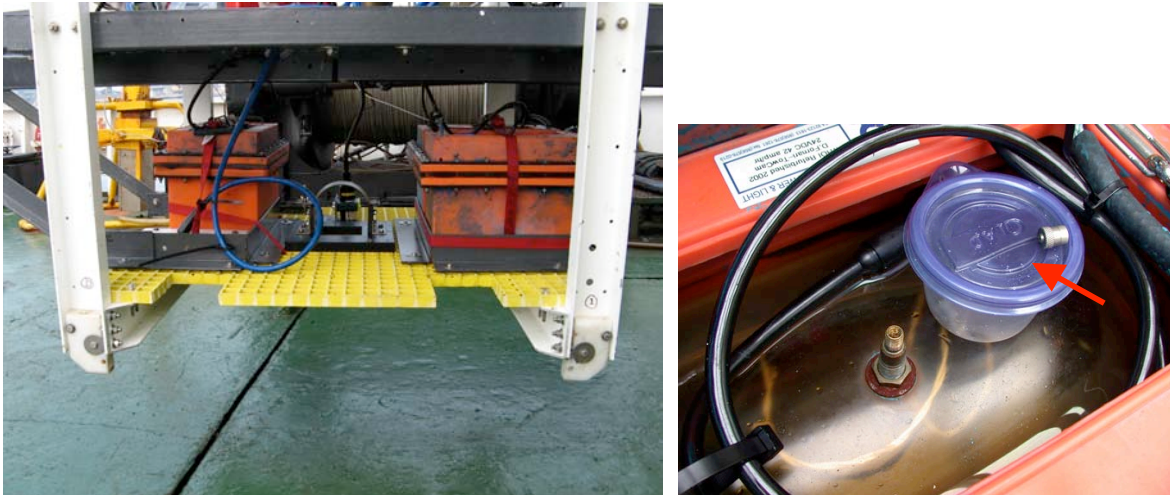

Figure 23. (left) Lower deck of TowCam showing DSPL batteries. (right) Valve stem of the DSPL battery on the TowCam (red arrow). There are 3 batteries on the NTU TowCam. The batteries are filled with Carnation mineral oil as compensation fluid. The air bubble beneath the bladder in each battery must be squeezed out to where it is the approximately 3-5 cm diameter, and the cap is then firmly tightened down by hand. When the TowCam is on deck, the valves should be left open and the caps stored in the small Tupperware container provided – which should be tucked into the top well of one of the batteries.

5. Deployment and Recovery of TowCam
5.1. Initializing the TowCam and Deployment

Turning on the SBE25 CTD, powering on the SBE33 deck box and starting the acquisition software on the PC laptop and ensuring that the data is being recorded, and starting the camera by inserting the shorted (red-banded) dummy plugs into the strobe and camera connectors (Figure 4) are the steps necessary to initializing the TowCam camera and CTD system prior to launch.

To reiterate – follow the steps listed above (Sec. 2.4.) for preparing the DSPL camera and CTD.

a) Start the CTD recording 5-10 minutes prior to launching the camera, and check that all battery valve caps have been properly installed.
b) Be sure the tag lines are properly rigged and the CTD cable slack has been pulled so the cable is tight and ready for launch.
c) Start the camera only after the Bridge confirms that you are on station and ready for launch.
Insert the shorted dummy into the STROBE connector FIRST. Listen for the whining in the electronics housing of the strobe, then insert the CAMERA shorted dummy.
d) After 15 seconds the camera will start taking the initial 5 photos at 20 sec. interval to confirm it is properly programmed for the delay. (If the camera/strobes do not start, unplug the camera connector, wait 5-10 sec., then plug it back in).
e) The camera will take 5 photos spaces ~ 20 seconds apart. This confirms that the camera is working properly.   After the 5th flash – the camera will start its PRESET DELAY

PERIOD of either 30 minutes (1500 m operating range), or 60 minutes (2500 m operating range). RECORD THE TIME OF THE LAST FLASH ON DECK IN THE LOG BOOK.

f) After the 5th flash, and waiting another 30 seconds to be sure the camera does not flash again, you give the OK to the shipboard technician to launch the camera (Figure 24).

Figure 24A. (left) Launching the TowCam from the R/V OR1's starboard mid-ship's door. (right) Two restraining lines are always used to launch and recover the camera. They are fair-leaded through cleats in the deck. The lines can be slipped once the TowCam is over the side and close to the sea surface. The shipboard technician directs the launch and recovery operations, giving signals to the crane and winch operators located on the 01 deck just above the launch pad.
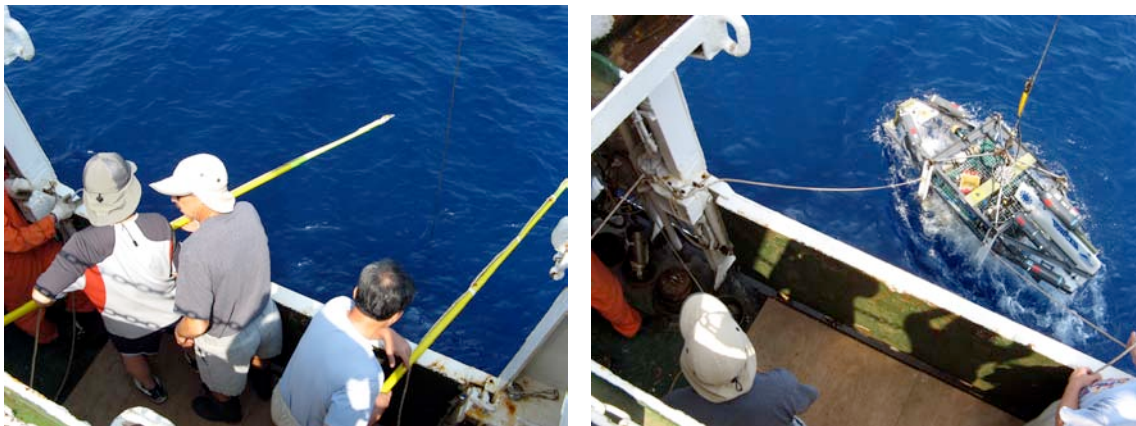

Figure 24B. (left) Recovery poles prepared for TowCam recovery. (right) TowCam being recovered after two tag lines have been attached using the recovery poles.

5.2. Recovering TowCam and Preparing for Data Downloading

The TowCam is recovered using the two, long extendable recovery poles to secure tag lines while the frame is just out of the water (Figure 24B). The shipboard technician directs the operations. 4 people are needed – 2 to hook the tag lines, and 2 to clear the long recovery poles and help bring in the TowCam to the landing pad (Figure 24A). The following is the sequence of tasks to be done after the TowCam is on deck after a lowering

a) Once the TowCam is on deck **secure the tag lines** to the cleat so that the TowCam is secure. Strap down to deck using cargo straps.

b) **Remove the strobe and camera shorted dummies and replace with the black un-shorted dummies - spray with silicon spray to displace any water - inspect to make sure they are clean and free of any dirt/dust.**

c) **Turn OFF the SBE25 CTD SLIDE SWITCH** and re-insert the red neoprene stop

d) Go inside winch house and **stop the CTD acquisition** by pulling down the 'RealTimeData' menu and clicking on "Stop Acquisition". When asked if you want to 'Save the Configurations to Disk' SAY NO. Then click on the "X" at the upper right corner of the window and the program will quit.

e) **Turn OFF THE SBE33 Deck Unit**.

f) **Wash down the TowCam and component thoroughly with a strong spray of freshwater. Be sure to flood the battery wells so that you replace the seawater trapped in them with fresh water.** The water will drain from the small bleed holes in the side of the wells. Wash all the cabling and strobe heads, altimeters, Flashbird, etc. Flood the SBE32 pylon with fresh water. If it is sunny, let it dry for an hour, then cover with the blue tarp.

g) Immediately after the wash down and after the battery wells have partially drained below the level of the valve stem, **remove the valve caps and put them in the Tupperware container**.

h) **Unscrew the blue camera cable from the camera.** Replace the stainless dummy on the cable end – SCREW THE DUMMY, NOT THE CONNECTOR-THIS HELPS TO NOT DISTURB THE O-RING. **Check the O-ring in the cable.** Spray with Silicon spray. Spray the camera bulkhead connector with Silicon spray and replace the brass dummy onto the camera connector.

i) Remove the DSPL camera from the frame, carry it into the lab carefully and wash with freshwater in the lab sink always protecting the lens. Dry the housing with towels – **dry the lens only with a precision wipe.**

j) Put the camera on the bench in the computer lab and connect the DSPL Deck Box 16-pin cable to the camera. **You are now ready to download images. You should start the download (see Section 4.1.2.) before going out and putting the TowCam batteries on charge.**

5.3. TowCam Battery Charging

a. Vent batteries, put vent caps in Tupperware container.

b. If needed, put a tarp over TowCam to keep the sun and salt spray off of it.

c. Measure voltage on all batteries using special lead that has a male 4 pin battery connector on the end of it and note in a log that has the TowCam ID, date, battery number, time, etc. along with other comments.

d. **Make sure battery chargers (Figure 24C) are DISCONNECTED from AC Power,** then connect charging cables to batteries, put dummies on power J-box while charging is in progress. **MAKE SURE BATTERIES ARE VENTED.**

e. Turn on chargers. Monitor charge periodically over the next few hours by looking at the light indicators on the chargers, normally the batteries will charge fully in about 2-4 hours. The chargers are 'smart' and they will not overcharge the batteries. Disconnect when the green 'ready' light is on all the chargers. Strobe batteries take about twice as long to charge as the camera batteries

f. After charging is completed, reconnect batteries to the power J-box on TowCam, spraying the connectors with silicon spray and wiping w/precision wipes as needed to be sure the contacts and sealing surfaces are clean. Be sure to screw red safety sleeves back on.

g. Allow the batteries to vent with caps off in between tows. Tap the battery bladders to ensure that any trapped gases come to the surface.

h. **Remember to install and tighten the vent caps on the batteries before deploying the TowCam**- **VERY IMPORTANT.**

Figure 24C. TowCam battery chargers and cables. ***DO NOT PLUG CHARGERS INTO AC POWER UNLESS YOU ARE CONNECTED TO A BATTERY ON THE TOWCAM!***

5.4. Post-Tow Inspection of TowCam Frame and Equipment

Check the TowCam frame for any damage. Check the entire frame, towpoint, termination and weak link (Appendix A) each time to be sure all bolts and shackles are well tightened and cotter pins are in place and no frame elements are broken. Check cabling for loose wires, chafing or problems with connectors. Check the strobe head bulbs to see if there is excessive 'cloudiness' or if it looks like there is cracking in the dome.

6. Real-Time Towing Operations
6.1. Towing Speed, Track Orientation, Waypoints

This information has largely been provided in Section 3, above. The key points to remember are to plan your camera tows carefully considering the seafloor topography and by making a good multibeam map prior to the tow. A large plot of the intended track area should be printed and available for plotting the position of the camera in real time to assist the camera flyer to know when they will need to haul in or pay out line when going over key features in the terrain. Also, be sure to give the Bridge waypoints for the traverse well in advance of the camera run, and try to keep the waypoints in a line to avoid sharp course changes when possible as that will facilitate calculating layback. Try to keep the speed constant during the tow to control speed and course over ground. Plan your surveys keeping in mind sea and wind conditions. Remember to plan the end waypoint for your traverse so you go beyond the feature you are interested in. At ~1/2 knot towing speed, the TowCam layback will be ~ 200 m behind the ship for water depths of ~1200 m.

6.2. Monitoring Altitude Above Bottom

The TowCam altitude is monitored using the down-looking altimeter on the SBE25 CTD. The transducer is positioned at the same level as the camera lens, so that altitude data also provide the ability to scale the images (see Table 1). Altitude data is displayed graphically as a green line in the main data window (Figure 17). Because normal swell height will be 1-3 m the altitude of the TowCam will vary periodically with the swell. One

can minimize the heave of the system by timing **very small haul-ins and pay-outs** of the wire with downswings and upswings, respectively- **Do this ONLY if you are confident about your flying abilities!** The small window at upper right of the PC laptop screen during CTD acquisition provides numerical updates of the altitude, depth and forward-looking altimeter at 1 Hz, but it is usually much easier to fly using the graphical display of the data.

Try to keep the TowCam at ~4-5 m altitude for optimal imaging and coverage. As Table 1 shows, photographs at 5 m altitude cover an area ~ 6 m across by 4.5 m in the along track direction. If bottom conditions offshore Taiwan are murky, you may have to fly at 3-4 m altitude.

The TowCam Flyer must be at the winch controls at all times to respond to changes in seafloor depth. If you touch down or hit the bottom, monitor the wire tension carefully to be sure you are not hung up.

Table 1. Field of view in seawater for DSPL DigiSeaCam.

Altitude above Bottom	3 meters	5 meters	7 meters
Field of View in Seawater	3.49mx2.62m	6.06x4.54m	8.03x6.02
Pixels/Meter	586	338	255

6.2.1. Down-Looking Altimeter Locking Up – What to Notice When This Happens and How to Fix it

Occasionally, the down-looking altimeter may 'lock' onto something in the water column and begin giving incorrect altitude readings. This is most noticeable when it begins incrementing the altitude readings by 0.1 m, either up or down. This is easily seen in both the graphical display of altitude or the numerical waterfall display. When it happens, try to pull up 5 meters quickly to see if that 'wakes up' the altimeter. If it does not, come up ~ 20-30 meters quickly, at 20-30 m/minute, then re-approach the bottom and you will see that at ~ 10-15 m altitude it will re-lock onto the bottom and give correct altitude readings.

6.3. Monitoring Forward-Looking Altimeter

The forward-looking altimeter provides critical obstacle avoidance capability for TowCam traverses. The sensor is exactly the same as the down-looking altimeter – 200 kHz frequency, but it is pointed forward at the nose of the TowCam. Figure 25 provides an example of the real-time trace. The main data window shows the forward-looking altimeter when the range is <20 m. The smaller lower right window shows the forward-looking altimeter over its full 100 m range.

When an obstacle is detected and it is less than 50 m range from TowCam, pull up the TowCam 1-2 meters to see if the obstacle disappears. That will allow you to determine its relative altitude with respect to the TowCam's flying altitude. If you see the trace gradually decreasing in range, it means you are probably approaching a slope, so be prepared to haul in. In general, because you will be traversing at moderate speeds – 10-15 m/min (1/3 to 1/2 knot), you will have time to haul in quickly if the forward-looking altimeter shows a strong return and short range to the obstacle. The CTD winch can haul in quickly at 20-30 m/min – do not hesitate to haul in quickly when in doubt… you can always go back to the normal flying altitude within a few minutes.

6.4. Water Properties Data

Water properties data are displayed in real time on the SeaBird acquisition screen. In general the bottom water temperature (red trace in main window) and turbidity (blue trace in the small window at lower right) provide the best indicators of water properties.
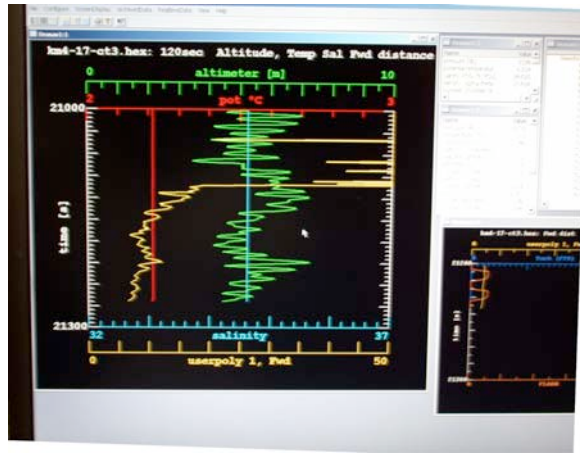

Figure 25. Example of TowCam's CTD real-time display showing altitude (green line) and an obstacle (probably a scarp) that the TowCam is approaching. The tick marks on the yellow scale at the bottom of the window for the forward-looking altimeter (called "userpoly 1" in the SeaBird software) are every 5 m. The forward-looking altimeter also displays on the small window at lower right at a scale of 0-100 m. Only when the obstacle comes closer than 50 m does it appear in the large display window so that you can easily monitor the approaching obstacle along with the TowCam altitude above bottom.

7. Post-Tow CTD and Camera Data Downloading and Processing
7.1. CTD Data Processing

CTD data processing is a 3-step process that normally takes only a few minutes owing to MatLab and Perl processing scripts that have been set up on the PC laptop. The first step involves averaging the data and converting from SeaBird hexidecimal format to ascii text. The second step parses the data so that 3 separate text files are created – one for 1 Hz CTD data, one for CTD data at each strobe flash so that the data can be correlated with each image, and the last file is a 'bottle' file that provides CTD data for each Niskin water sample. The third step involves synchronizing the GMT time between the CTD's GMT time and GMT recorded in the digital images.

To begin the processing first go to the 'Run' menu under the 'Start' tab at lower left corner of the Vaio screen (Figure 19). A window will pop up (see Figure 19) where you can run a programming script that exists in the /Data directory for the current cruise. **All that needs to be entered is the file name (NB- do not add the .hex suffix of the file – e.g. type only the tow name you entered in the SeaBird software when you started acquisition "ct01")**. Figure 26 shows the directory paths required – the ones for the OR1-810 cruise will be similar but specific to the directory structure that the TowCam engineer will set up for you.

Clicking on the 'Start' menu at lower left of the main screen allows you to pop up the "Run" menu dialog box shown in Figure 26. This runs an executable program that batch processes the SeaBird hexidecimal file to produce the 'XXXavg.cnv' files needed to do the

second CTD data processing steps that provide 1 Hz CTD data, CTD data for each flash, and data for each Niskin bottle when fired.
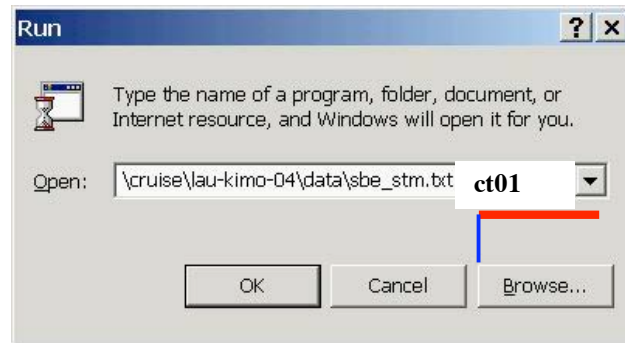

Figure 26. Run window where you enter the file name you gave to the lowering (e.g. "ct01", just above the red line. This executes a command script that will batch process the hexidecimal data through the SeaBird software. There is a space between the directory path and the file name (vertical blue line).
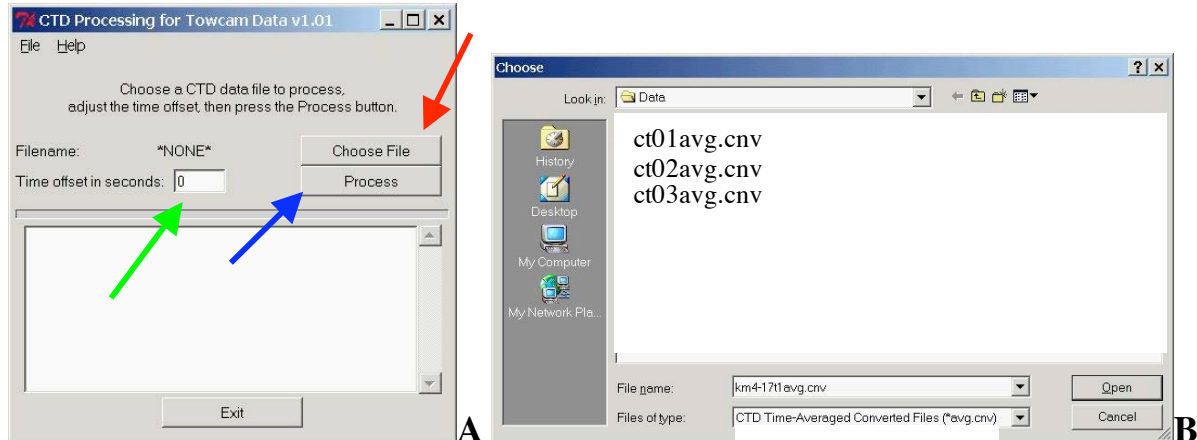

Figure 27. CTD Processing step #2 is done by clicking on the CTD processing icon on the PC's desktop. The window shown in A pops up. The red arrow points to the 'Choose File' button where you can select the avg.cnv file created by step 1 described above. Blue arrow points to the 'Process' button that executes the processing. The green arrow points to the time-offset entry window where you adjust the CTD time to match the DSPL camera time of the first image after the delay period. The second step of the processing will parse the CTD and flash data to delimited text files within the data directory- giving them the lowering number (e.g. "ct1") but with a 'ctd.txt' or 'flash.txt' ending). Clicking on the Choose File button will open the dialog box shown in B. The avg.cnv files are all in that directory, and the one just created for the lowering your are processing should be in there for you to click on and then click 'Open'.

CTD processing step #2 is performed by the MatLab and Perl scripts running behind the window shown in Figure 27. Select the lowering file by clicking on 'Choose File' (red arrow in Figure 27A) and clicking on the lowering file in the Data directory that appears in the window that opens (Figure 27B). Once you have selected the correct 'avg.cnv' file you click on the 'Process' button in the program window (blue arrow in Figure 27A). The processing only takes a few seconds. If you then go into the /Data directory for the cruise you will see that new .txt files have been created for the CTD and Flash for that lowering.

The third step in the CTD processing involves co-registering the GMT time in the CTD files to the GMT time registered by the DSPL camera after it has been corrected by comparing the first 3-4 images taken of the GMT clock at the beginning of the tow.   In order to do this, open the 'Flash.txt' file for the lowering in the PC's text editor (just double click on the file and it will open automatically in the text editor). Look at the top of the file to see the time of the first flash. This will be the first record after the delay interval, so it will be obvious which entry it is as you'll see several lines of data and then a delay interval and then the line with the CTD data at the first flash in water. **Note that time and compare it to the corrected image time.**

After you have completed the camera processing steps in Section 5.2, below, use the corrected time stamp of the first image file after the delay as your reference time (i.e., 'the camera's first flash in water'. Match the CTD time so that the first flash in the 'Flash.txt' file matches the image time recorded by the first photograph after the delay period.   In the processing screen in Step 2, above, you can add or subtract time, in seconds, to the CTD data. Once you have determined the number of seconds to be added (just type the number, no '+' is needed), or subtracted (use a minus sign before the number of seconds), enter that number in the window at the left margin of the Step 2 processing screen (Figure 20A, green arrow).

After you have corrected the CTD data for the time offset, use a USB thumb drive to copy ALL the CTD files for the tow from the PC to the USB drive so that you can provide them to the science party and put them on the Apple laptop as a backup. Include ALL the files for that lowering – the raw hexidecimal file, all the cnv and avgcnv files, etc., and the .CON file which is essential if further processing is done on the data by the science party post cruise.

7.2. DSPL DigiSeaCam Digital Photo Data Processing – Time-Tagging Images and Archiving Data

Downloading images follows the same steps as listed in Section 4.1.1. However, in this case you are COPYING THE IMAGES TO THE Apple laptop from the DSPL camera rather than deleting them.

Use the following steps to download, archive and process images from the DSPL Camera. It is critical that you archive the raw and processed images in two (2) places to ensure that the data are not lost.

a) Have the Apple laptop powered on and the Firewire drive labeled 'Saulwood - TowCam Backup' connected and mounted as a disk icon. Note that when using Firewire drives on Apple computers **you must drag the firewire drive icon into the trash to Un-mount it**. DO NOT UNPLUG THE DRIVE UNLESS YOU HAVE DRAGGED IT TO THE TRASH TO UNMOUNT IT. The firewire drive is used as a backup to archive the TowCam data – both images and CTD data. **Make sure no other programs are running on the laptop.**

b) Connecting the camera to the DSPL Deck Box **with the toggle switch in 'LOAD'** (see Figures 5-6). **Wait 30 sec for camera to power up** then take the USB cable from the Deck Box and connect to the Apple laptop.

c) The camera's CF card will appear as a *'No Name'* disk icon on the Apple laptop screen (Figure 10). Double click on the icon to open it. In 'No Name' go to the folder called 'DCIM' (Figure 10) in there will be multiple folders called '100Nikon', '101Nikon', etc. The individual images are in that folder.

d) Create a folder on the laptop desktop or the firewire drive called: 'ct1raw', this will be the folder where the raw images are kept. You need to have the name be short and with no spaces or hyphens in order to process the images to stamp them with Date/Time.

e) Open the 'ct1raw' folder you just created, then open the 'DCIM' folder of the camera's CF card.

f) Select 'ALL' the '100Nikon', '101Nikon', etc. folders in the DCIM folder and drag them to the 'ct1raw' folder – this will start the copying process. Copying a full camera lowering of ~ 1800 images (about 8-9 folders in the DCIM), usually takes about 40 minutes. (Figure 28) **DO NOT INTERRUPT THIS PROCESS**.

g) After the raw images are copied to the Apple laptop or firewire drive, copy the folder to the Firewire drive. That will give you a copy of the raw images as an archive.

h) Once the raw images are copied to the Firewire drive, rename the folder containing the raw images on the Desktop to be 'ct1processed'. You rename folders on a Mac by clicking once on the file name, after a few seconds the name will be highlighted and you will be able to type in new name. Then click outside the icon and the name will be preserved. **YOU MUST ONLY USE LETTERS OR NUMBERS IN THE FOLDER NAME AND NO SPACES OR OTHER CHARACTERS OR THE ImageTime.pl PROGRAM WILL NOT WORK.**

i) The next step involves dragging all the images out of the 'Nikon' folders to use the Imagetime.pl script that converts the 'DSCNXXXX.JPG' raw file names to the date/time tagged image names. Click on the folder in the middle column and the files appear in the right most column. Click the and 'A' key (select ALL) in the column with the file names and then drag them to the middle column – that will place them at the top level in the 'ct1processed' folder. Do that for all the Nikon folders until all the images are in the top level of the 'ct1processed' folder. Delete the empty Nikon folders, then close the window (Figure 28).

j) Open the Terminal Window on the iBook. This is done by going to the Dock at the bottom of the screen. It is located in the middle of the Apple laptop Dock and looks like a black monitor screen .

k) You are now ready to run the Imagetime.pl script to rename the images with date/time in the format: "yyyy-mm-dd-hh:mm:ss.jpg". At the > prompt type: "**Imagetime.pl**", then hit 'Return'. This command opens a GUI (Figure 30) with a Perl script behind it that has been written to convert the native Nikon formatted image names to be Date/Time with the .jpg suffix preserved.

l) In the Imagetime window, first chose the location of the folder where the images are located; in the example case on the Desktop in the 'ct1processed' folder, by clicking on the 'Choose' button (Figure 23). NEXT, YOU MUST CLICK ON THE BOX - "Revert to original time stamp" WHEN DOING THE FIRST RENAMING (red arrow in Figure 30B). Once you have selected the folder where the raw images are located**, and clicked on the 'Revert' box**, Click 'OK' and the images will all be renamed. This usually takes about 3-4 minutes for a full 1800 image lowering.

m) Once the images are date/time stamped, go into the folder and look at the first few images so you determine which is the first image taken after the delay period. Write down the time shown in that file name. Then go to the first few images and look at an image with the LED clock to determine the offset between GMT

displayed on the clock in the image, and the time stamp of that image. It will usually be 10-20 seconds slow, meaning you will have to ADD time the next time your run the Imagetime.pl script.

n) Once you have determined the time offset, go back into the Imagetime.pl GUI and re-execute the program inserting the correct number of seconds to add or subtract (to subtract use the minus key before the number). **DO NOT CLICK ON THE REVERT BOX THIS TIME**.

o) Once you have re-run the script, check to see that the file name matches the time on the LED clock. The images are now correctly processed.

p) **BACK UP THE PROCESSED IMAGE FOLDER TO THE FIREWIRE DRIVE.**

q) Provide the images to the science party ASAP after the processing is completed by copying them to their firewire drives or writing DVDs. The Apple has a DVD writer software to write the DVDs). This should be given to the Chief Scientist.

r) After you have backed up the raw and processed images you can erase the raw images from the DSPL camera's CF card – I usually do this just prior to the next lowering.
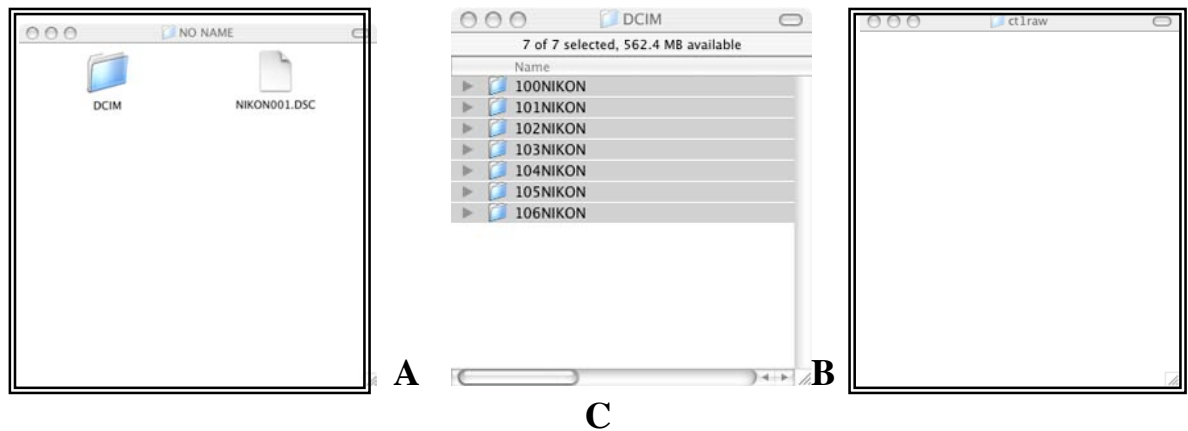
Figure 28. DSPL camera 'No Name' folders as they will appear on the Apple laptop screen when the camera is mounted in order to download images. A) Shows opened 'No Name' CF card icon. B) Shows opened 'DCIM' folder containing all the Nikon folders where the acquired images are stored. C) Shows the opened folder you created on the Desktop of the iBook where you will write the 'raw' images by dragging the folders from the camera's DCIM folder to the 'ct1raw' folder.
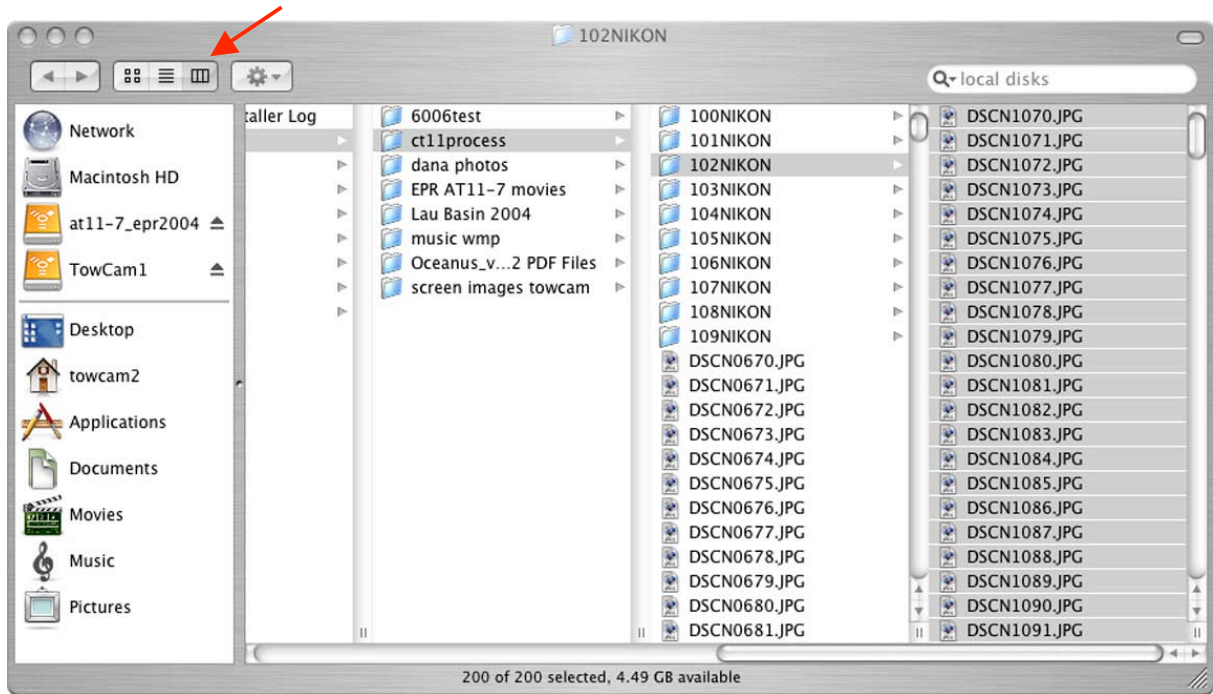
Figure 29. Apple laptop window showing the folder and file listing in the 'Nikon' folders. To change the view in the window, click on the 3 different views in the 2ⁿᵈ box from left at the top of window (red arrow) that provide icon, list, or column views of the folder(s). You have to drag all the images out of the 'Nikon' folders to use the Imagetime.pl script that converts the 'DSCNXXXX.JPG' raw file names to the date/time tagged image names. Click on the folder in the middle column and the files appear in the right-most column. Click the and 'A' key (select ALL) in the column with the file names and then drag them to the middle column – that will place them in the 'ct1processed' folder. Do that for all the Nikon folders until all the images are in the 'ct1processed' folder. Delete the empty Nikon folders, then close the window.

A   **B**
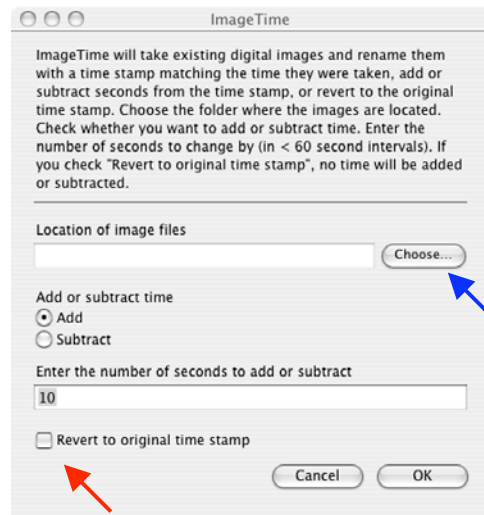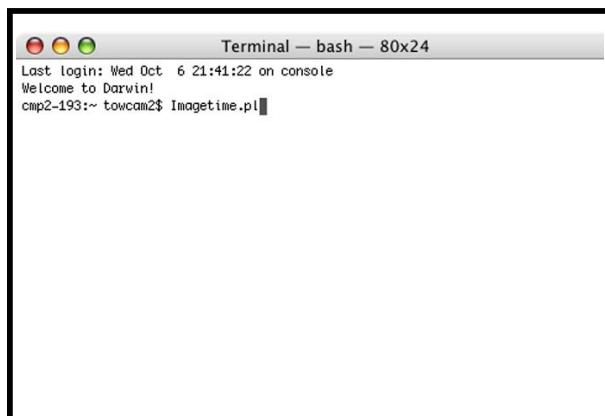
Figure 30. A) Terminal window opened and the command: 'Imagetime.pl' typed in in order to bring up the Perl script GUI that will execute the renaming of the files to date/time. B) the Perl script GUI window. You first chose the location of the folder where the images are located, in the example case on the Desktop in the 'ct1processed' folder, by clicking on the 'Choose' button (blue arrow). YOU MUST CLICK ON THE BOX - "Revert to original time stamp" (red arrow) WHEN DOING THE FIRST RENAMING. Once you have selected the

folder where the raw images are located, <u>and clicked on the 'Revert' box</u>, Click 'OK' and the images will all be renamed. This usually takes about 3-4 minutes for a full 1800 image lowering.

8. Post-Cruise Maintenance of TowCam System

After each cruise the following routine maintenance should be done on the TowCam and system components (Appendix A).

a. Wash down entire system with fresh water and dish detergent making sure to get all salt water off the components and the cables. Rinse well with fresh water and allow the system to dry

b. Remove camera and rinse with fresh water and dry. Open the housing and service the endcap Orings and seals, lightly grease with DC4 only. Replace end cap and purge air from housing using purified canned air. If long term storage is expected, replace 3 AA lithium batteries with new ones.

c. Remove end cap of strobe electronics housing and service Orings and seals, lightly grease. Reconnect cables once they have been serviced.

d. Remove strobe heads, wash with fresh water and dry thoroughly and inspect. Blow out air from all threaded holes. Spray strobe head housing (not glass) with silicon spray. Put protectors on connectors and pack carefully.

e. Service all connectors on Jbox and cables. Lightly grease and install dummy plugs or cover with plastic bags and rubber bands. Reconnect cables once they have been serviced.

f. Charge batteries and leave un-capped (vented). Put valve caps in small plastic container and tuck into one of the battery wells so they are not lost. If TowCam is to be transported, install valve caps and then remove once it arrives at the storage facility.

g. Remove SBE25 CTD and SBE32 CRM pylon and service all connectors. Service seal and Orings on the SBE25 CTD end cap and lightly grease. Put both units back on TowCam and secure.

h. Remove Niskin bottles and store separately.

i. Inspect weak link, spray with silicon spray, tie-wrap to the bail so it does not bang on the frame.

j. Inspect frame for any damage or broken fiberglass pieces and replace as necessary.

k. After system is dry and all components serviced, cover with tarp.

9. Long-Term Storage of TowCam System

The TowCam system should be stored in a secure, cool, dry location, out of sunlight.

Every 4 months, the batteries should be charged and the voltages logged. Inspect cables and components to be sure there is no damage or corrosion.

Note that neoprene cables will deteriorate from exposure to ozone in air, sunlight or chemicals. Never use chemical cleaners on cables. If cables show cracks in insulation, install replacements and order new spares.

10. Appendices (as separate PDF files on NTU TowCam System CD)

Appendix A - TowCam System photographs
Appendix B - SeaBird SBE25 CTD Manual
Appendix C - SeaBird SBE32 Water Bottle Release manual
Appendix D - MajorPower Battery Charger Manual
Appendix E - Benthos Strobe Manual
Appendix F - DSPL Digital Camera Manual
Appendix G - Digisnap Set-Up Instructions
Appendix H - Nikon995 Camera Manual
Appendix I - DSPL Deck Box Manual
Appendix J - Impulse Enterprise Connector Catalog
Appendix K - DSPL SeaBattery Manual
Appendix L - US Dept. of Commerce Export License
Appendix M - CTD Data Processing Notes
Appendix N - Navigation Processing Notes

Appendix A
TowCam System Photographs

Figure A1. Mobilization of TowCam and equipment at CGS in Taipei.

Figure A2. NTU TowCam on launch platform of OR1. Note how it is secured to the deck using the yellow cargo straps. Note plywood used to cover landing platform so that TowCam can easily be slid during launch and recovery.

Figure A3. NTU TowCam, side view with camera mounted (red arrow).

Figure A4. View of rear of NTU TowCam with 5-liter Niskin bottles mounted.
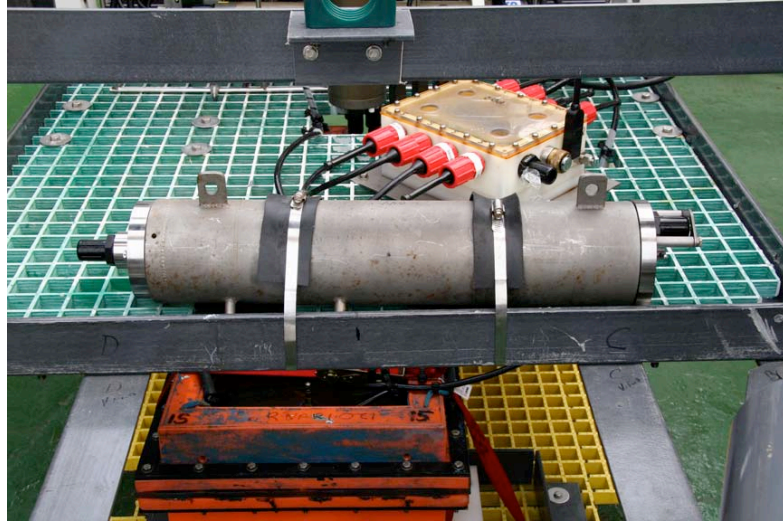
Figure A5. Benthos 383 strobe electronics housing on upper deck of NTU TowCam. Power junction box (Jbox) is behind it. One of the DSPL batteries (orange housing) can be seen in lower part of photograph, on lower deck of TowCam.

Figure A6. Mounting the Benthos 386 strobe heads on the NTU TowCam. 316 stainless ¼-28 hardware is used to mount strobes. A small nylon washer is used to slightly tilt the strobe head for optimal lighting at 4-5 m altitude. Note lock washers go on bolts just below heads to secure the bolt when tightened.
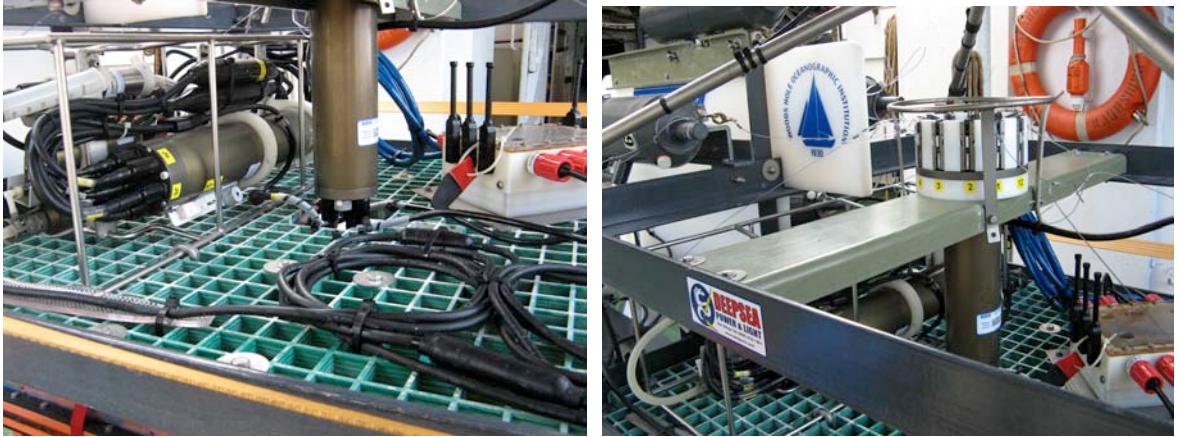
Figure A7. SBE25 CTD system (left) (on loan from WHOI MISO Facility) and SBE32 CRM pylon water bottle release system (right).
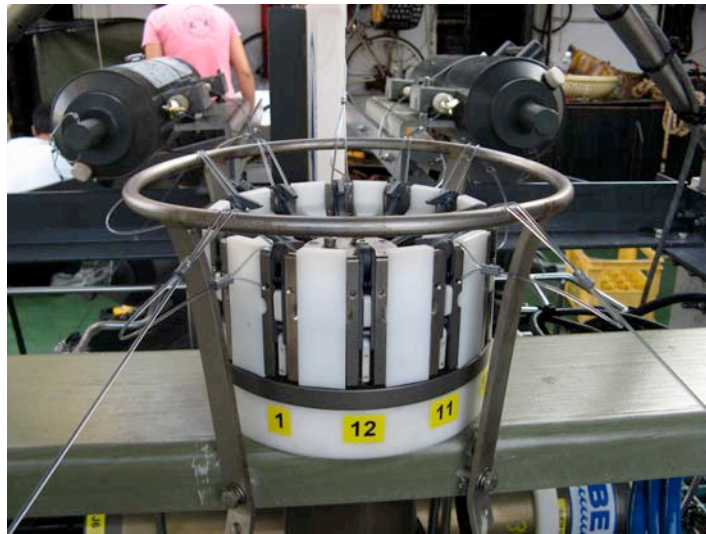
Figure A8. Top of SBE32 pylon showing monofilament lanyards from the Niskin bottles.
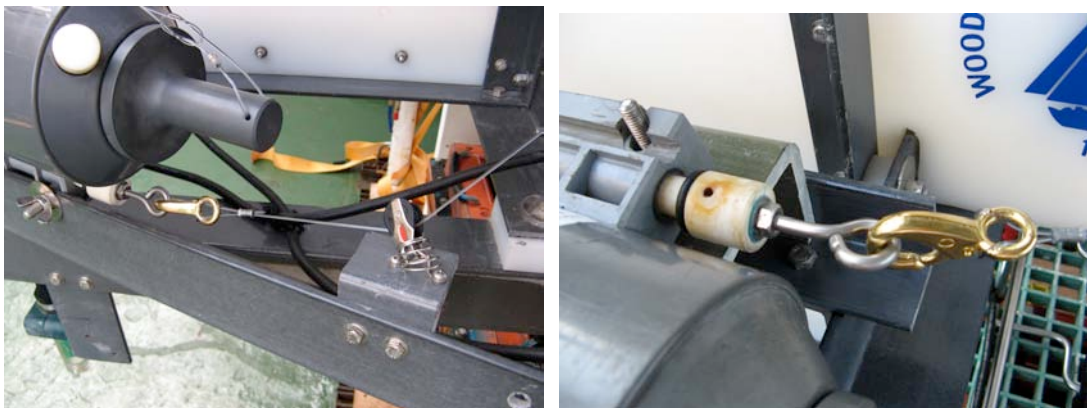
Figure A9. Details of monofilament lanyards and rigging of water bottle releases.
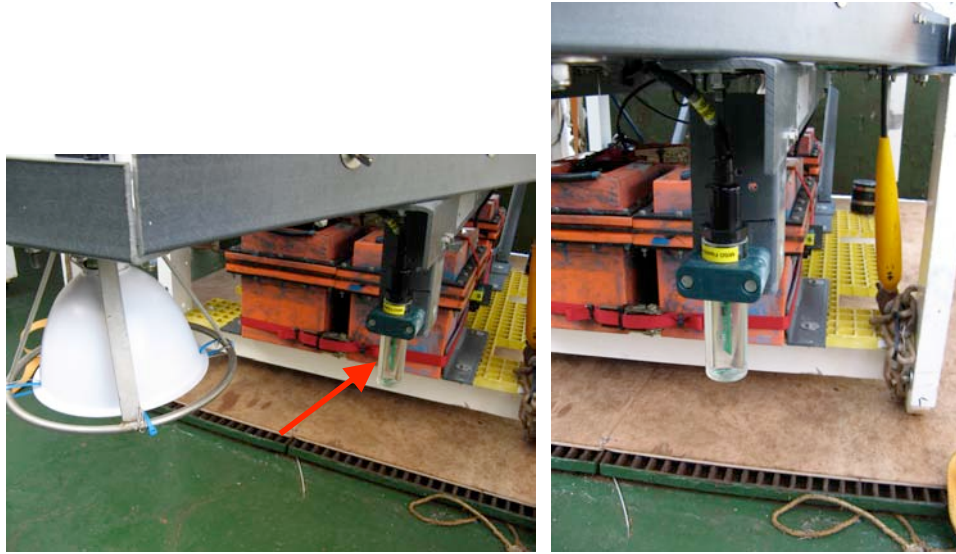
Figure A10. Rear Benthos 386 strobe head inside conical reflector and stainless protector cage, and flashbird (red arrow). (right) close up of Flashbird.

Figure A11. Down-looking altimeter (red arrow) on lower deck of TowCam.
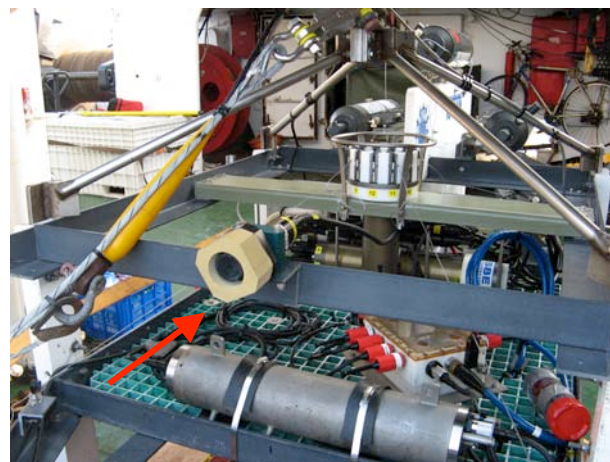
Figure A12. Forward altimeter for obstacle avoidance (red arrow). Beige foam block is a syntactic foam collar that helps reduce side-lobe acoustic energy from the altimeter.
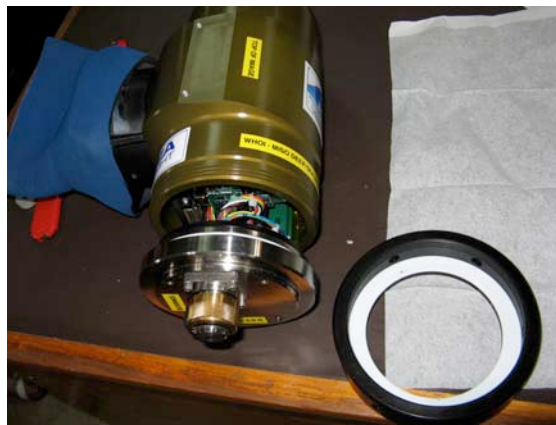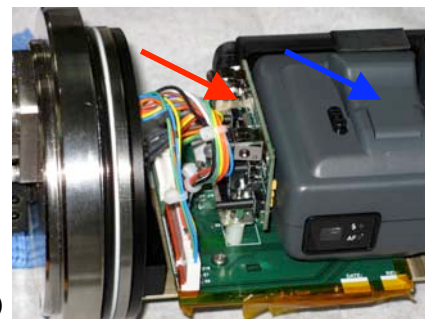
Figure A13. NTU digital deep-sea camera (s/n6003B). A) Camera and specialty tools for opening housing and tightening connectors on Jbox. B) Camera end cap and yellow removal handle. 5-pin dummy plug shown at right of handle. C) Camera housing partly opened with Delrin retaining ring at right. D) Camera chassis removed from housing. E) Detail of Digisnap card installed on camera's mother board (red arrow), blue arrow points to Nikon995 camera module.

Figure A14. Spare parts boxes for NTU digital deep-sea camera (s/n6003B). (red arrow) Camera and strobe spares Orings, CF card, fuses, etc., (yellow arrow) spare dummies.

Figure A15. (left) Spare parts boxes for NTU digital deep-sea camera (s/n6003B) showing spare Nikon995 camera (red arrow). (right) Detail of camera cable connector Orings and Oring insertion tool (red arrow).
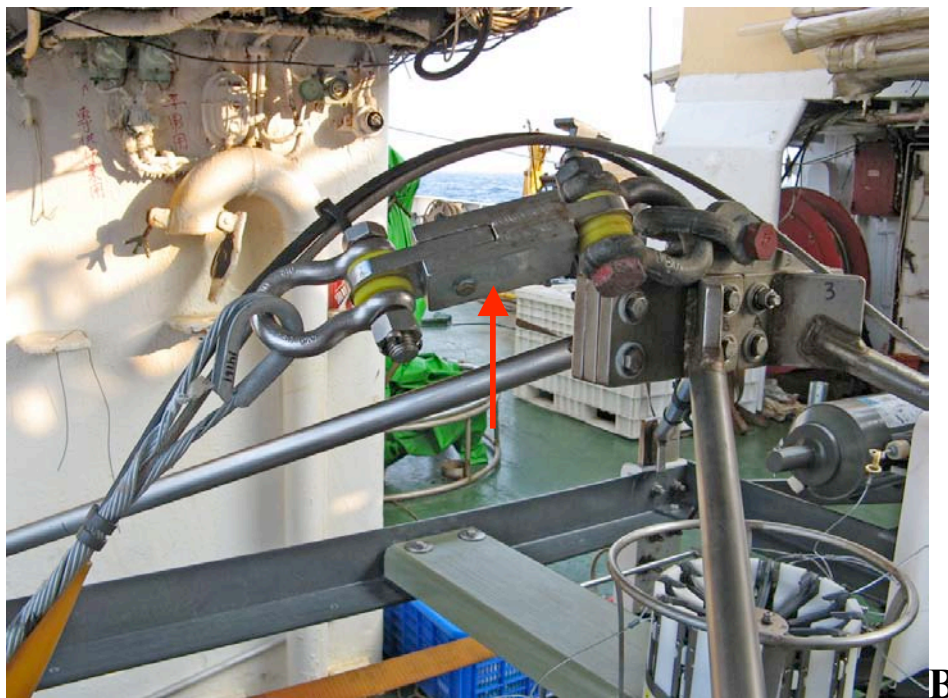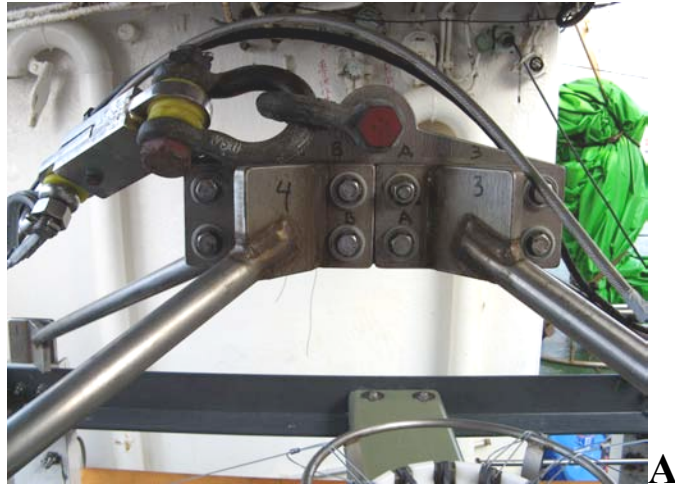
Figure A16. (A) Lifting bail on NTU TowCam. Always check to be sure bolts are tight and no cracks are appearing along welds. (B) Weak link (red arrow). Weak link brass bolt will shear at 5500# tension. If that happens, the safety line that is rigged above the weak link and connected to the lower frame of the TowCam will remain attached and the system will be hauled up by that line so that it is not lost. ALWAYS CAREFULLY MONITOR THE WIRE TENSION DURING A TOW TO BE SURE IT IS NORMAL. IF YOU GET HUNG UP AND NOTICE TENSION INCREASING SHARPLY. PAY OUT LINE TO DECREASE TENSION AND IMMEDIATELY STOP THE SHIP. TRY TO REVERSE COURSE SLOWLY, ALWAYS KEEPING TENSION LOWER THAN 4000A#. TRY TO GET UN-STUCK BY SLOWLY HAVING SHIP REVERSE DIRECTION OR PULL IN ANOTHER DIRECTION. KEEP TRACK OF THE WIRE OUT AND TENSION AND SHIP POSITION DURING THIS OPERATION.

Figure A17. Flying the TowCam from the winch 'dog house'. PC laptop computer with CTD display is on shelf (red arrow). SBE33 deck unit is behind laptop (blue arrow).

Figure A18. Battery chargers and cables for TowCam DSPL SeaBatteries.
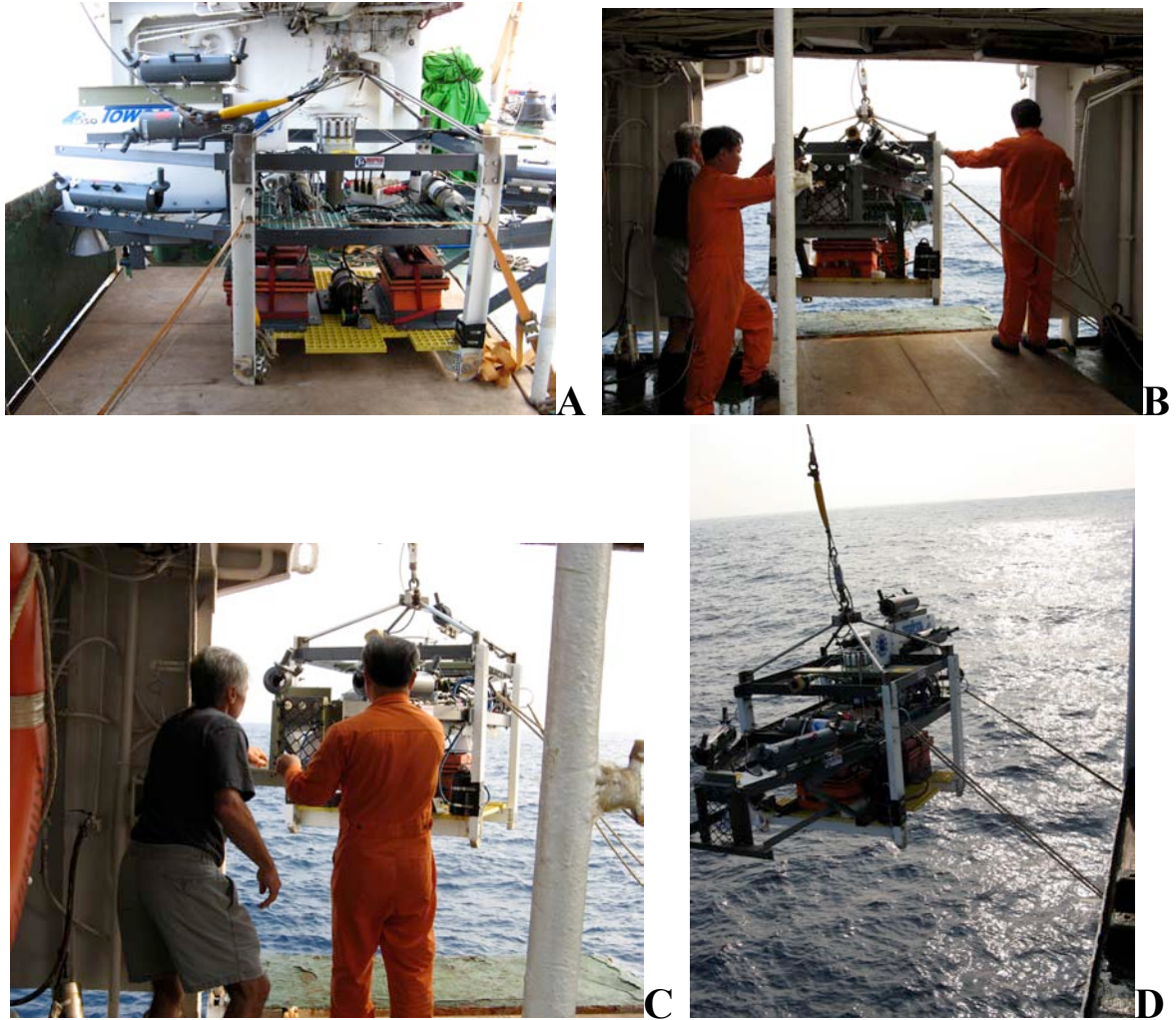
Figure A19. Deploying NTU TowCam from ORI side door on main deck, starboard side. TowCam is launched tail first (A) to avoid problems with low overhang on deck above platform. TowCam should be secured during launch using 3 tag lines (2 aft and 1 forward) to keep it from swinging (B). Once the frame has cleared the side of the ship (C), it must be turned, bow forward and the lines switched so that the port side of TowCam is secured by two tag lines as shown in (D) above. Lower slowly into water and zero the winch meter. Descend to 10 m and hold for several minutes to let the CTD pump purge any trapped air and so you see the altimeters registering numbers in the PC laptop screen. Then pay out wire at ~0.2m/sec (12 m/min) until ~300 m, then you can increase winch speed to ~0.3-0.4 m/sec (18-24 m/min) until 700 m. After 700 m you can descend at 0.5 m/sec (30 m/min). Lowering speeds may vary depending on sea state. DO NOT LET THE WIRE BOUNCE OR SNAP LOAD AS THIS CAN DAMAGE THE TERMINATION AND MAY TRIGGER THE WEAK LINK IF THE FORCES ARE GREAT ENOUGH.
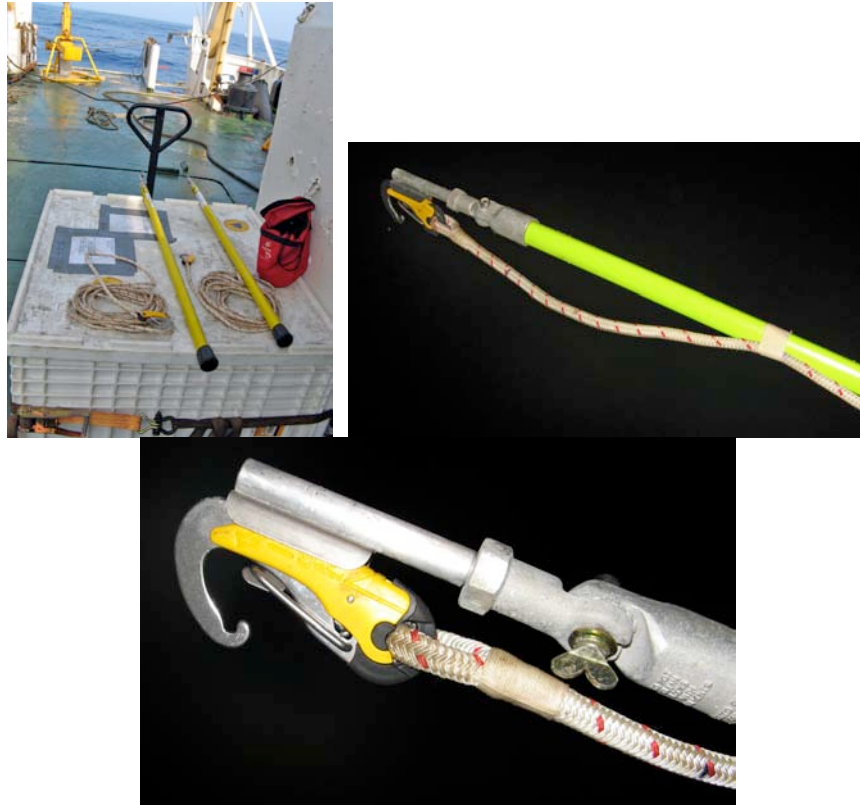
Figure A20. TowCam recovery poles showing detail of the snap hook engaged in the tip of the pole and rigged for recovery. Use only 2 wraps of masking tape to fix the line onto the poles.
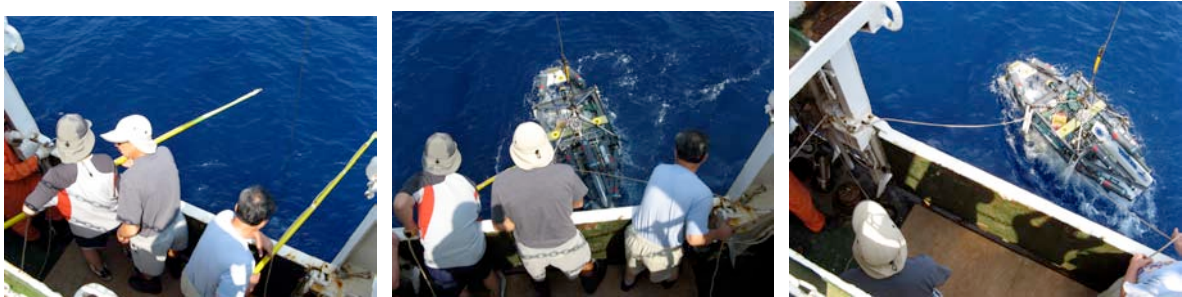

Figure A21. Recovering the NTU TowCam from starboard platform door on OR1. Have recovery poles and lines ready. Keep the TowCam top deck just above the surface but not fully out of the water in order to dampen the swing of the system. Hook into TowCam U-bolts ASAP when it reaches the surface. Cleat-off the lines to keep tension so that it does not swing. Once both lines are attached raise the system and guide it into the platform.