A Seafloor Sediment MultiCorer With MISO Real-Time Camera & Telemetry Systems for Multidisciplinary Oceanographic Research

User Guidelines

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1. Motivation for MISO Instrumented Multicorer Development

Multicoring is a routine method for acquiring undisturbed, spatially co-located upper sediment and sediment-water interface core samples in a range of water depths for ecological, geological, geochemical, and biogeochemical studies. Having a real-time camera and sensors to monitor water properties and depth/altitude on a multicorer greatly increases the chances of successful coring operations. The use of an anti-pretrip collar that can be remotely triggered via telemetry from the surface also helps to ensure reliable core recovery and can save valuable ship time by avoiding pre-trip occurrences. Additional advantages of using a real-time camera on a multicorer include locating sampling areas with specific, active biological or chemical processes and performing controlled penetration of the seafloor to achieve optimal sample recovery. The motivation for developing an instrumented multicorer system grew from the extensive experience with deep-sea camera and sampling systems over the past decade's operation of the Multidisciplinary Instrumentation in Support of Oceanography (MISO) Facility at Woods Hole Oceanographic Institution (WHOI), an NSF-funded facility that provides deep-sea imaging and related instrumentation to the US and international oceanographic community (http://www.whoi.edu/main/instruments/miso). We approached this problem over the past few years through a combination of sea trials and utilization of the MISO systems on multicorers, funded through an NSF-OCE-Ocean Instrumentation grant (OCE-1435042) to accomplish field research objectives in a variety of settings (e.g., offshore US east coast, Gulf of Mexico, California boarderland, Bering Sea, and Norwegian Arctic).

Enhancing multicoring operations with real-time imaging capabilities for both sample-site selection and acquisition parameters (e.g., assessing slope and bottom conditions, distribution of microbial or other biological or chemical deposits, and depth/altitude to better control landing the multicorer) was a logical application of MISO imaging/sensing systems. To date, the MISO imaging and telemetry systems have been installed on MC-800 and MC-400 multicorers on 8 UNOLS cruises (*RV Atlantis, RV Sally Ride, RV Sikuliaq, RV Thompson, RV Pelican*, *RV Kilo Moana*), and on 2 cruises using a square, German-made multicorerwith colleagues at U. Tromsø, CAGE Group, Norway for work offshore Svalbard at ~79°N (*RV H. Hanssen*).

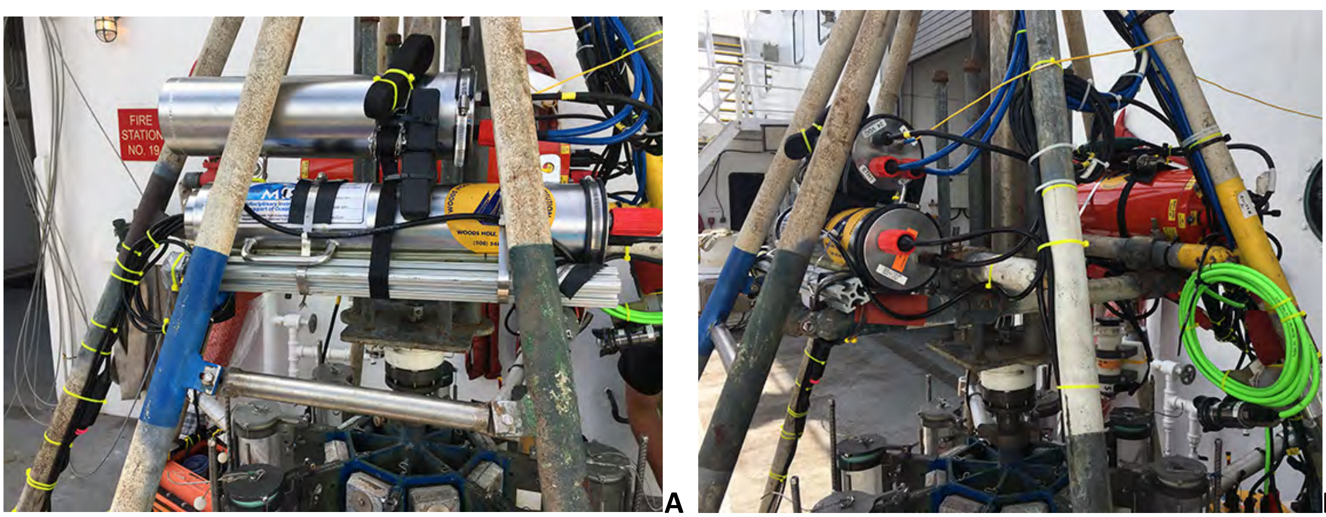
2. MISO Imaging and Telemetry Systems on MC-800 Multicorer

MISO imaging and systems are mounted on specially designed attachment fixtures and platforms within the MC800 frame that were designed and fabricated at WHOI (**Figure 1a-c**). The inventory of MISO systems configured for the U. Hawaii MC800 multicorer on this cruise consists of the following instruments (shown in Figures 1-3): 24MP OIS digital still camera, 300 watt/sec strobe w/2 heads, MISO HD video system and 1 LED light for monitoring the anti-pretrip collar function, Valeport 500P altimeter/depth sensor recorded at 1 Hz update rate, MISO DataLink telemetry system with Ethernet and serial data comms., MISO fiber-optic to Ethernet converter system, MISO anti-pretrip collar to prevent accidental pre-trips of the multicorer spyder due to heave during launch and descent, one (1) MISO deep-sea battery (40 amp/hr capacity), MISO power Junction Box and subsea cabling.

Figure 1. (A) 24MP OIS digital still camera mounted on platform on MC-800, top of image points towards center of core assembly. (B) Overall view of MC-800 with MISO imaging and data systems mounted. (C) Deep-sea battery mounted on platform (orange case) and one of the two strobe reflectors at lower left. (D) Anti-pretrip collar rigged. Brass clip (red arrow) attaches to the pull-loop (yellow arrow), the clip is attached to the monofilament line (green arrow) which runs to the winch motor that is triggered via the DataLink telemetry to remove the collar prior to landing the corer on the seafloor.

A B

Figure 2. (A) MISO HD video recording system (large yellow housing, red arrow in B image) mounted on MC-800 platform, with power Junction Box (white box in middle of photo, yellow arrow in B image), and Valeport 500P altimeter/depth sensor (small, silver cylinder just to right of J-box). (B) Overall view of MC-800 with MISO equipment mounted – large orange housing on upper-right part of frame is the DataLink telemetry, smaller silver housing on left side is the strobe electronics (see Fig. 3).



A B

Figure 3. (A) Lower silver housing in middle of image is the 300 watt/sec strobe electronics, upper silver housing is the fiber optic to Ethernet converter electronics where the fiber connection from the cable is made with the two Ethernet ports providing connectivity to both the video system and the DataLink telemetry so that one can control the video on/off and LED light, as well as view the 24MP digital still camera r/t image and the depth/altitude 1 Hz data stream. (B) Side view on connector end of the strobe and fiber-to-Ethernet housings. Green cable at right edge is HD camera cable, just below the cable is the Deep-Sea Power & Light FlexLink HD camera.

3. Multicoring Operations Guidelines with MISO Imaging & Telemetry Systems

All mechanical connections/linkages and rigging on the MC-800 multicorer (MC) and around the core tubes and sealing shoes should be carefully checked by the shipboard techs and the MISO engineers well prior to deployment. Check that the main shackle attachment has been seized with a cotter pin, and that the wire service loop in the main cable is free to move down when the corer will land on the seafloor, and that it will not catch on any part of the MC-800 frame. Check that all MISO equipment cables are well out of the way of any of the sealing shoes when they will rotate down to close off the bottom of the cores after the spyder pushes the core tubes into the sediment.

Lowering speeds for the traction winch should be discussed with the Chief Engineer and the shipboard technicians. In general, and depending on weather - wind/wave conditions, the system should initially be lowered at ~15-20 m/min until ~500 m of wire is out. After that, the speed can be increased gradually to ~30-35 m/min. It is recommended to briefly view the movement on the spyder using the MISO HD video system to ensure that the spyder is not moving up/down excessively during descent.

Once you are sure that the system is stable and not subject to excessive surface induced heave, you may remove the anti-pretrip collar.

On the first lowering to ~5000 m on the 0.681 fiberoptic cable, it is recommended to set the MISO 24MP OIS digital camera to flash every 15 sec and to give the system a ~15 min delay to allow for overboarding. **Do not set a long delay** so that you can monitor the system performance during descent to make sure all sensors and cables are fully operational at depth. Once you are certain that the full system works at depth, you can set a ~2hr delay in the digital camera/strobe system to preserve power and reset the digital still camera interval to 10 sec.

Be sure that the battery is fully charged and topped off prior to the lowering. Keep the battery on charge until ~2 hrs prior to the deployment to ensure full charge. Keep battery vented and shaded during charging. Remember purge most of the air below the battery bladder - ‘burp’ battery – and to install battery valve cap tightly by hand.

Fully test the video system and LED light control (switch #2) and the winch motor control (switch #1) prior to deployment, as well as the still camera/strobe system and altimeter/depth sensor.

Make sure the anti-pre-trip collar is fully rigged and correctly restrained with the plastic snap ring and the clipped rubber band, and that the line between the winch and the collar is just slightly slack so that when the winch is started it immediately will start to pull off the collar.

REMEMBER NEVER TO PUT THE CURSOR OVER THE *SWITCH 1* ENABLE BUTTON IN THE ‘TOWCAM’ APP ON THE MAC, UNTIL YOU ARE READY TO REMOVE THE COLLAR AT DEPTH.

Once you have reached ~2000-3000 m, it is likely that the system will not be experiencing much heave, but check this on the first lowering to be sure.

When you are ready to remove the anti-pretrip collar, be sure to time the winch start to when you see a small, upward movement (e.g., heave surge) that would release pressure on the collar. If the system is stable and not experiencing much or any heave this may not be visible. **The time it takes to remove the collar is usually only a few seconds,** and remember that you may not see all of the movement as it is happening. Monitor the video r/t image, but have your cursor on the OFF button on SWITCH #1 for the winch motor so you do not overload the motor or break the line. Remember that the collar is UHMW plastic so it will float up out of the way of the core tubes.

During the lowering, turn on the video recording at ~500 m intervals for ~30 sec at each interval to record a clip and turn on the light during descent. **Remember that you can view the real-time video by positioning the cursor over the Aja-KiPro screen display.** The video clip recording controls are provided in the Teradek screen. Refer to the MISO HD video manual for more detailed instructions.

When you have locked onto the bottom with the altimeter at ~70-80 m above bottom, slow the descent speed to ~20 m / min. Stop the winch when you are 15 m above bottom. Let the MC sit for 3-4 min before you slowly pay out at ~5-7 m /min until you are ~4-5 m above the bottom – at which point you will be able to view the sediment surface in the digital still camera low-res images. Hover above the bottom at 3-5 m altitude until you are confident that you have a suitable bottom to core. Take the time to acquire ~10-15 min of imagery of the bottom. If you need to reposition the ship, do so at ~20-40 m intervals in DP, this may take 30-40 min to do because of the large amount of wire out (~5000+ meters).

Be sure to monitor the tension when you are hovering above the bottom as that will give you your 'normal' tension to compare to any pull-out tension you may experience. Be sure to log this information. Rochester 0.681 Fiberoptic cable weighs 0.905 kg/meter (0.608 lb/ft) so you will have ~6000 kg of static weight at ~5000 m depth between the weight of the wire and the ~1500 lb. weight of the multicorer. Once you have determined you are in a suitable position to: 1) conduct the multicorer landing, and 2) you have taken sufficient digital still images to document the terrain, and 3) you have removed the anti-pretrip collar, you are ready to proceed with landing the MC and core the seafloor. **At 10 m/min, RAISE the multicorer to ~10-12 m above the seafloor.** *Let the instrument sit for 2 min.* **Lower the multicorer at 10 m/min, carefully noting the altimeter reading and monitoring the tension readout, AND the meters of wire out.** You will see the landing of the MC on the camera image (lots of billowing sediment), and the altimeter will be pegged at ~1 m, and the tension will decrease. **NOTE THE WIRE OUT WHEN YOU LAND ON THE BOTTOM, <u>AND ONLY LET OUT ~3 M OF EXTRA WIRE.</u> LET THE MC SIT ON THE BOTTOM FOR ~1-2 MIN. THEN SLOWLY – AT 5-10 M / MIN, PULL IN ON THE WIRE TO PULL OUT THE CORES.**

Raise the MC to 3-5 m above the seafloor and wait a minute or two to see if the sediment clears and you can get an image of the core holes. After a few minutes, gradually increase the speed of ascent to 30 m/min, once you are 100 m above the seafloor, increase the pull-in speed to 40-45 m/min, if approved by the Chief Engineer. At 300 m from the surface, stop the winch and prepare for recovery by readying the hooker poles in order to control the MC recovery and landing on deck.

Remember to note all tensions above bottom, pull out tensions, max wire out, and number of successful cores per lowering. Take photos of the cores on deck and select good, example photos