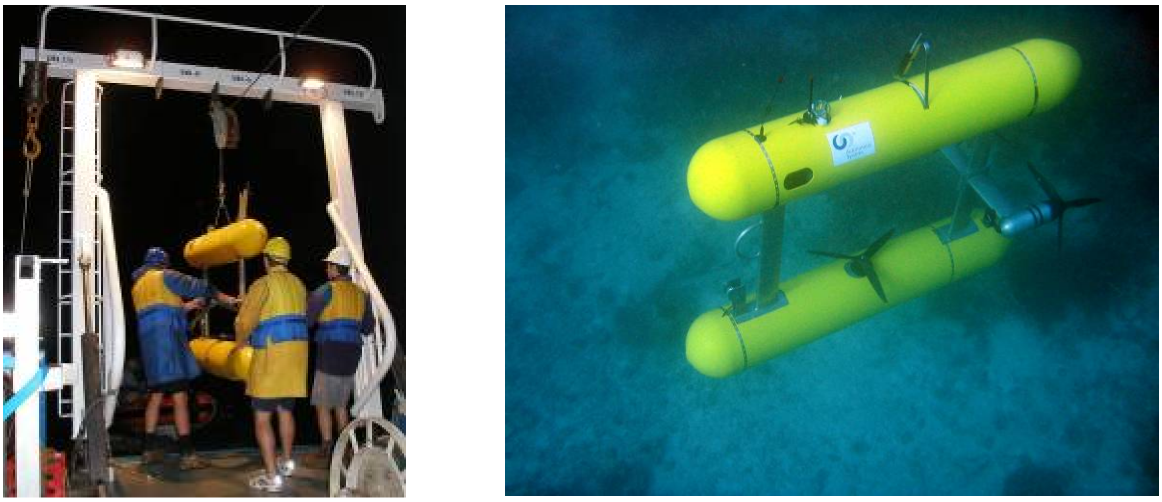
# IMOS AUV Facility

The University of Sydney's Australian Centre for Field Robotics (ACFR) is leading the IMOS AUV Facility and has an ocean going Autonomous Underwater Vehicle (AUV) called *Sirius* capable of undertaking high resolution survey work (see Figure 1). This platform is a modified version of a mid-size robotic vehicle called Seabed built at the Woods Hole Oceanographic Institution. The submersible is equipped with a full suite of oceanographic instruments, including a high resolution stereo camera pair and strobes, a multibeam sonar, depth and conductivity/temperature sensors, Doppler Velocity Log (DVL) including a compass with integrated roll and pitch sensors, Ultra Short Baseline Acoustic Positioning System (USBL) and forward looking obstacle avoidance sonar. As part of IMOS, the vehicle will be enhanced with a Wetlabs Eco Puck, measuring chlorophyll-a, CDOM and scattering (red), and an Aanderaa Optode, measuring dissolved oxygen concentrations. Requests for additional sensor payloads will be considered and may be supported with IMOS funds allocated for sensor acquisition.

As part of the establishment of the AUV Facility, IMOS will support deployment of the *Sirius* AUV which will be made available to scientists on a competitive basis in order to assist marine projects in Australia. IMOS will cover the costs of AUV calibration, preparation, insurance, transport within Australia, and access to and storage of the data. Ship-time for the deployment, tracking and recovery of the AUV are the responsibility of the local node requesting the deployment. The use of the AUV must comply with IMOS' objective to "*offer open access to data arising from research infrastructure provided through the IMOS to the national and international marine research communities*".

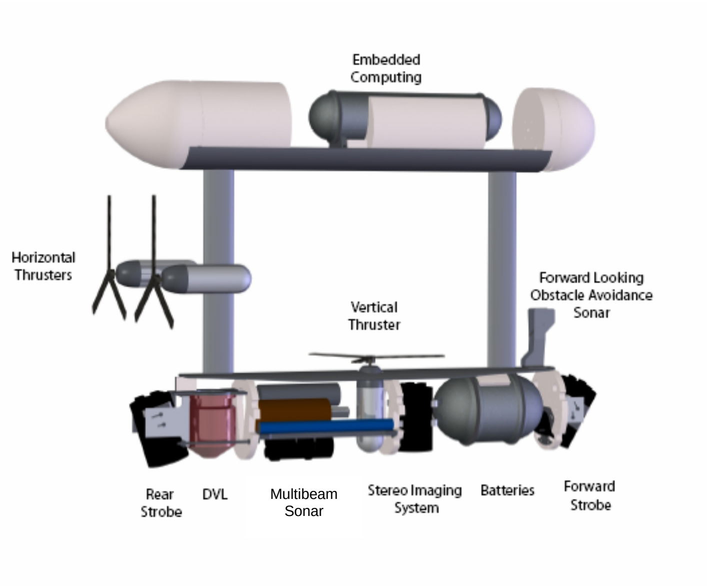


(a) (b)

**Figure 1 - (a) The AUV on-board the AIMS ship R/V Cape Ferguson being deployed off the coast at Exmouth, WA (b) the AUV during earlier deployment on the Great Barrier Reef, Qld**

| Vehicle Specifications | |
|---|---|
| Depth rating | 700m |
| Size | 2.0 m(L) x 1.5 m(H) x 1.5 m(W) |
| Mass | 200kg |
| Maximum Speed | 1.2 *m/s* |
| Batteries | 1.5 kWh Li-ion pack |
| Propulsion | 3x150 W brushless DC thrusters |
| **Navigation** | |
| Attitude/Heading | Tilt (±*0.5*°), Compass (±2°) |
| Depth | Paroscientific pressure sensor, (0.01 %) |
| Velocity | RDI Navigator ADCP (1-2*mm/s)* |
| Altitude | RDI Navigator |
| USBL | TrackLink 1500 HA (0.2m range, 0.25°) |
| GPS | Ashtech A12 |
| **Optical Sensing** | |
| Camera | Stereo Proslica 12bit 1360x1024 CCD |
| Lighting | 2 x 2.8 J strobe |
| Separation | ~1 m between camera and light |
| **Acoustic Sensing** | |
| Multibeam sonar | Imagenex DeltaT 837 Profiling 260kHz |
| Imaging sonar | Tritech Seaking (optional) |
| Obstacle Avoidance | Imagenex 852 Echo Sounder |
| **Other Sensors** | |
| CTD | Seabird 37SBI |
| Fluorometers | Wetlabs Ecopuck (chlorophyll-a, CDOM, scattering red) |
| **Communications** | |
| Radio Frequency | Freewave 900kHz radio + ethernet |
| Acoustic Modem | TrackLink 1500 HA modem |

(a)




(b)

**Figure 2 - Specifications and sensor placement on the AUV *Sirius***

The vehicle is typically deployed from a surface vessel which tracks the vehicle while it is underway. As there is no tether connecting the AUV to the surface, the vehicle is programmed with a mission prior to deployment. Mission profiles include transiting to a particular location, following a linear transect and undertaking lawnmower style grids. The vehicle is capable of automatically tracking the seafloor or operating at a constant depth, with a maximum depth rating of 700m. When undertaking visual surveys, the vehicle typically flies 2m above the seafloor. Sensor data is stored locally on the vehicle and can be synchronized with the mission profiles such that the stereo cameras, for example, are used only when in close proximity to the seafloor.

We have operated the AUV on board the AIMS R/V Cape Ferguson on two cruises. A series of trials were undertaken to assess benthic habitats off the Ningaloo Reef, WA. These trials were aimed at evaluating the effectiveness of using an AUV for conducting biodiversity assessment in waters beyond diver depths. The particular focus of these deployments was on documenting sponge habitats in 40m to 80m depths and in exploring canyons in depths up to 250m. Sample mosaics from one of these dives at a depth of 80m are shown in Figure 4.

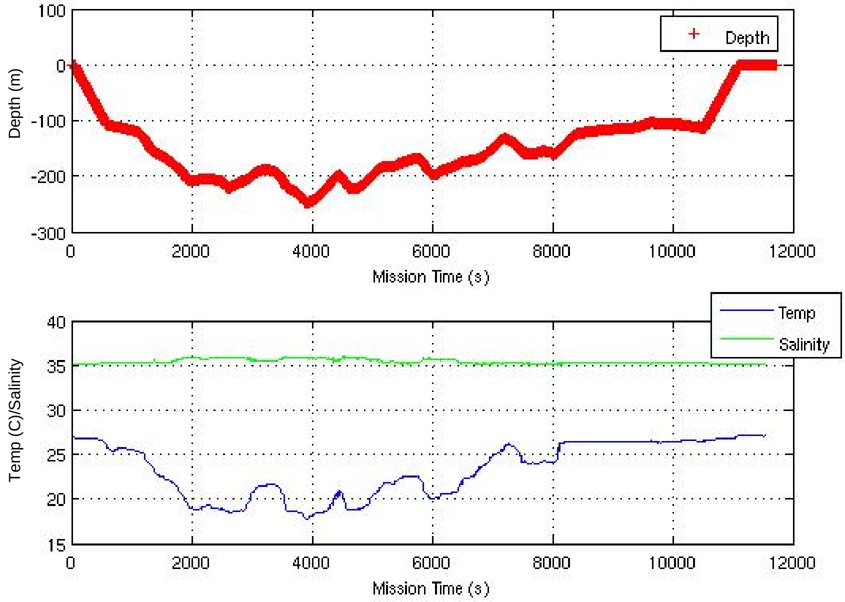



**Figure 3 - Temperature and salinity measurements taken during a dive into a canyon to a depth of 250m.**

More recently, the AUV was part of a three week research cruise aboard the R/V Southern Surveyor documenting drowned shelf edge reefs at multiple sites in four areas along the Great Barrier Reef. Sample reconstructions from this cruise are shown in Figure 5.

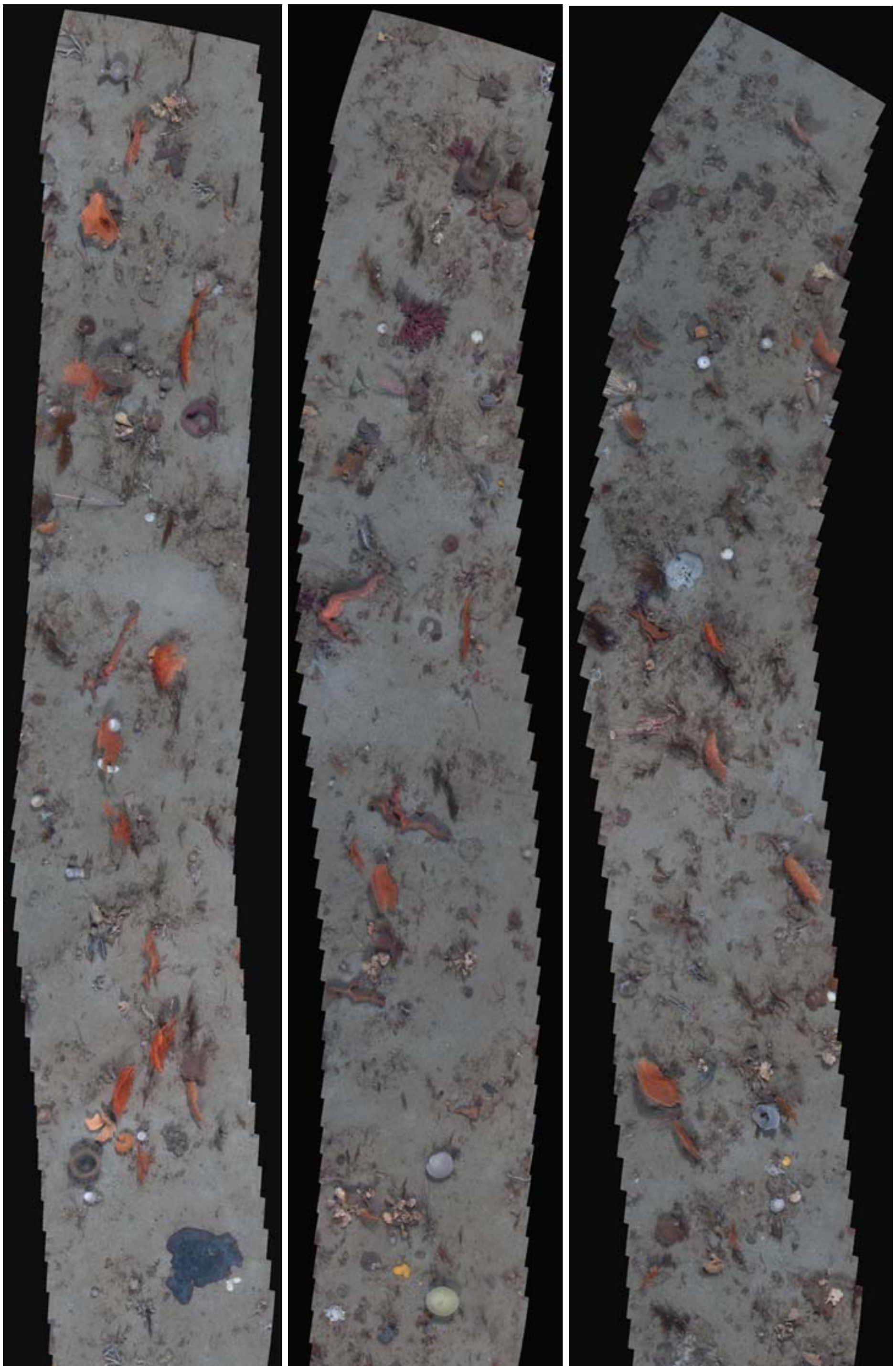
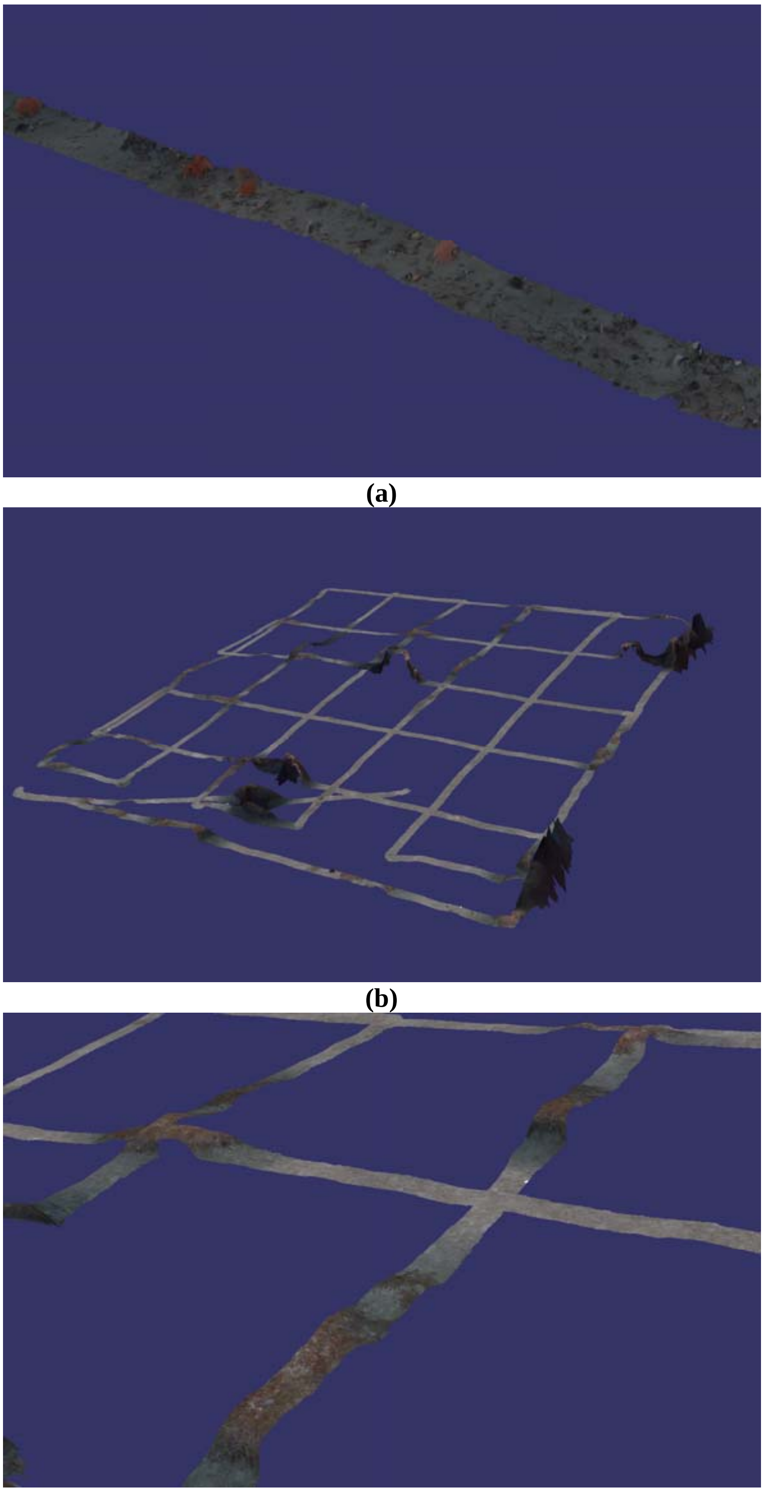


**Figure 4 - Sample Mosaics from Ningaloo showing sponge beds in 80m of water. The images were acquired from an altitude of 2m. The mosaics each represent 40 consecutive images taken at 2Hz while travelling at a forward speed of 1knot (0.5m/s). The resulting transects are each 10m in length with a width of approximately 1.5m. These mosaics were taken from a deployment that included over 1.5km of linear travel and are meant to illustrate the quality and resolution of the imagery.**



**(a)**

**(b)**

**(c)**

**Figure 5 – (a) A portion of a stereo reconstruction of the seafloor taken during the Ningaloo cruise. This particular portion of the reconstruction is from the same deployment as shown in Figure 4 and was part a 1km East West transect, a transit to the South of 500m and a return leg of 1km. (b) An example of grid surveys undertaken on the Great Barrier Reef. This grid survey was 100m x 100m and was taken during a dive at 50m. The dark areas correspond to areas where the vehicle has negotiated over coral bommies (c) Detail taken from this same survey showing some of the local hard substrate supporting hard coral and halimeda amongst sandy sediment.**

This document has presented the Autonomous Underwater Vehicle *Sirius* available as part of the NCRIS IMOS AUV Facility. Current work has been focused on integrating a comprehensive suite of sensors onto the Autonomous Underwater Vehicles and the development of terrain aided navigation algorithms suitable for deployment in unstructured underwater environments. Managing the data and transforming it into data products will be a key challenge as we continue to work with marine scientists on documenting benthic habitats. We are very keen to engage with the end user community in exploring the application of these technologies to help in understanding Australia's unique marine resources.

## ACKNOWLEDGEMENTS

The authors wish to acknowledge the support provided under the NCRIS IMOS program and the ARC Centre of Excellence Program by the Australian Research Council and the New South Wales government. We would also like to thank AIMS, CSIRO, DSTO, BAe Systems' Advanced Technology Centre and the Great Barrier Reef Research foundation for their on-going support of this program.