



# GAVIA

THE GREAT NORTHERN DIVER



## A NEW DIMENSION

GAVIA - 200

**GAVIA** - THE GREAT NORTHERN DIVER is a fully modular AUV with user changeable modules that can be replaced in minutes, allowing rapid sensor reconfiguration and battery replacement.

GAVIA -500

The small size and the deep-water rating combined with an almost limitless adaptability make GAVIA an ideal tool for any application where autonomy, cost, and ease of deployment matter.

GAVIA - 1000

Gavia is available in depth ratings from 200 to 2000 meters. The different versions differ in the materials used. There is no difference in size or weight. Every Gavia vehicle is tank tested at the rated pressure.

GAVIA - 2000

- FULLY MODULAR
- 2000-METER DEPTH RATING
- SHROUDED PROPELLER AND CONTROL SURFACES
- A SELECTION OF SENSORS AVAILABLE
- INS AND LBL NAVIGATION OPTIONS
- OVER-THE-HORIZON OPERATION AND SERVICING
- EXPANDABLE CONTROL SOFTWARE
- CHART-BASED GRAPHICAL MISSION PLANNING
- SIMPLE TO OPERATE
- LOW OPERATING COST

### BENEFITS OF MODULARITY

- HIGHLY PORTABLE
- RECONFIGURABLE
- RAPID BATTERY REPLACEMENT
- INCREASE RANGE WITH EXTRA BATTERY MODULE
- EASY ACCOMMODATION OF NEW TECHNOLOGIES
- CUSTOM CONFIGURABLE
- REDUCED MAINTENANCE COSTS



# THE GAVIA AUV SYSTEM



## RUGGED, RELIABLE DESIGN

The Gavia hull is precision-machined from corrosion-resistant aluminum alloys to achieve depth ratings from 200 to 2000 meters. For further protection the metal surfaces are hard anodized in a golden color that aids visual detection at sea.

The propeller and control surfaces are protected by the propeller nozzle thereby greatly reducing the risk of accidental damage and snagging on kelp or ropes.

Extensive hull profile development has brought Gavia the characteristics of low drag and low power consumption for maximum speed, range, and endurance.

## MODULAR SYSTEM

The Gavia modules that make up the vehicle are assembled and locked in place by means of the unique Gavia QuickLock™ mechanism. Double O-rings provide sealing at module joints to form a single pressure hull, while individual modules are splash-proof to facilitate on-deck assembly and module replacement. Circular military connectors provide power and fast Ethernet connectivity across the length of the vehicle. Each module is a stand-alone unit that can be operated outside of the vehicle for charging, data access etc.

## OVER-THE-HORIZON COMMUNICATION

Gavia is equipped with two surface communication links: a high-speed

wireless LAN and a global Iridium satellite link. Acoustic underwater communication options are available for deep and shallow water operation. Remote mission control and monitoring is available through all communication channels. Missions can be temporarily halted or aborted and missions can be modified and uploaded to the vehicle mid-mission.

Data accumulated during operation is stored on hard disks for straightforward browsing by means of Gavia's on-board web-server. Browsing and secure file transfer is available over all communication links. Remote position reporting over the Iridium satellite link simplifies recovery and ensures that Gavia will not be lost even though visual contact might be.

## BUOY-FREE NAVIGATION

For navigation under water there is a choice between a high-precision DVL-aided inertial navigation system, providing buoy-free navigation, and an acoustic LBL buoy system. A satellite-augmented GPS receiver is provided as standard for accurate positioning on the surface. An acoustic USBL tracking system is further available for enhanced positioning during deep-water descent. For applications where accurate positioning is not of importance, the base vehicle provides basic dead-reckoning using a magnetic compass and estimated speed.

## OPERATIONAL ENDURANCE

The Gavia can be operated with one or more battery modules depending on the endurance required for a particular mission. Battery modules are available for two different cell types: cost-efficient rechargeable Lilon cells and single-use Lithium primary cells that offer greater endurance. The selected cruising speed, equipment duty-cycle and type and number of battery modules determine the range and endurance of the vehicle in a particular operation.

Spare battery modules can be charged out of the vehicle, and battery modules are readily replaced on deck for rapid turn-around. This enables the use of high survey speeds without downtime loss. With a spare battery module, Gavia effectively has the operational

capabilities of two AUVs that must be alternately taken out of the water to recharge batteries. The battery module has built-in battery charge circuits, simplifying external support needs in the field.

## TRANSPORT, LAUNCH AND RECOVERY

One of the greatest benefits of the Gavia design is the small size, which readily enables her to be transported and operated by one or two persons. Gavia can be deployed and recovered from the shore, from a small boat, or lowered with a small crane or boom from a vessel of opportunity. It has been a design goal for Gavia to be operated in the field by relatively inexperienced operators.

## RANGE OF SENSORS

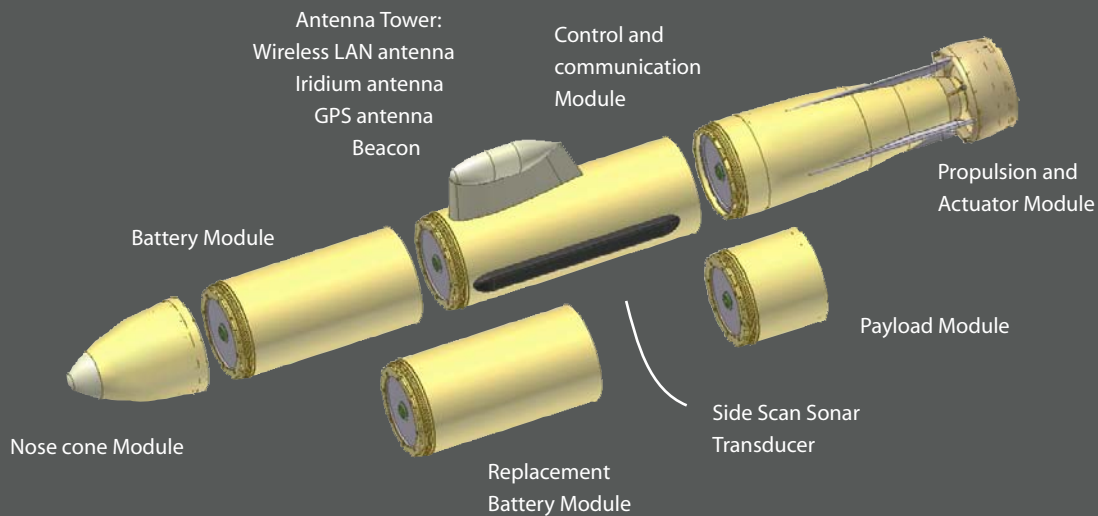
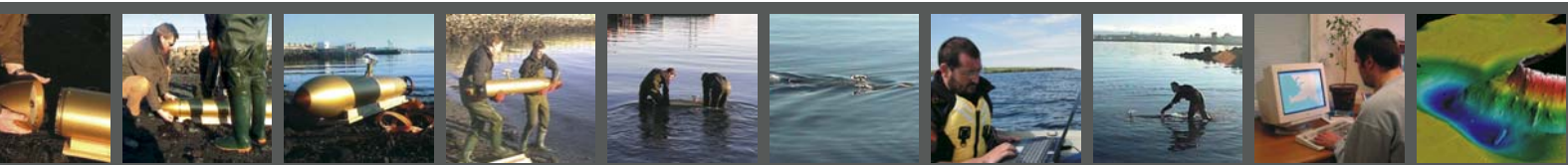
Gavia can be equipped with a range of sensors to accomplish a wide range of AUV missions. The sensor options include single and dual frequency side-scan sonars, high definition digital cameras, oceanographic CTD sensors and ADCP current profilers, and a Swath Bathymetry Sonar for efficient IHO standard hydrographic surveys. A great benefit of Gavia is that as new technologies and sensors emerge, they can be rapidly incorporated into the Gavia system in the form of sensor modules.

## FLEXIBLE VEHICLE CONTROL

Vehicle control is passed over to the "Intelligent Artificial Crew" during autonomous operation. A standard crew is common to all vehicles while specialist crew members are added to operate particular sensors or otherwise extend the capabilities of the vehicle.

A chart-based graphical interface is provided for easy mission planning and control.

The time and geo-referenced data accumulated during the mission are stored in open standard formats for maximum inter operability with third party data-analysis software and GIS systems.



# THE GAVIA MODULAR SYSTEM

The starting point for any Gavia AUV is the base vehicle consisting of Nose Cone, Battery, Control and Communication, and Propulsion modules, and is offered as a common platform serving a variety of AUV applications. Application specific capabilities are added to the base system in the form of optional Gavia modules. In time a Gavia AUV system can be expanded by adding further Gavia modules as requirements evolve and new modules become available.



## NOSE CONE PAYLOAD MODULE

Can be equipped with a digital camera with or without a local PC. The Nose cone and camera can be rotated in 45° steps. Alternatively the Nose cone can be equipped with a customer supplied payload. A collision avoidance sonar is also available.



## DVL-AIDED INERTIAL NAVIGATION SYSTEM MODULE

The high precision DVL aided INS is capable of navigational accuracies in the range of 3m/hour, giving the Gavia the benefit of buoy-free navigation when transponder reliance is not mission compatible.



## BATTERY MODULES

Lilon rechargeable batteries with on-board chargers (voltage for chargers supplied by external DC source, 2-wires). A module with single use Lithium primary batteries can also be used for increased endurance. Multiple battery modules are possible to use at one time.



## PROPULSION AND ACTUATOR MODULE

The propeller and 4 independent control planes are protected by the propeller nozzle. Oil-filled brush-less motors are pressure compensated to eliminate the leakage potential and friction loss associated with pressurized shaft seals and ensure low maintenance.



## CONTROL AND COMMUNICATION MODULE

Contains main PC, control electronics, GPS receiver, pressure sensor, Iridium satellite modem, antenna tower with GPS antenna, Iridium satellite antenna, wireless LAN antenna, and emergency strobe beacon. Options include Side scan sonar, acoustic modem, and altimeter.



## PAYLOAD MODULE

The payload module can be designed and equipped to customer specifications or built by the customer.



## ADCP MODULE

An up/down looking Acoustic Doppler Current Profiler .



## ACOUSTIC MODEM MODULE

The acoustic modem module can accommodate a range of acoustic modems and can be used in a USB/USBL system.



## SCANNING SONAR MODULE

Contains a 360° sector scan sonar with variable frequency. Comes with pilots for obstacle avoidance.

## ADDITIONAL SENSORS

Further sensor options are available, including an oceanographic **CTD METER** and an IHO standard **SWATH BATHYMETRY SONAR**.



# INTELLIGENT ARTIFICIAL CREW



The Gavia autonomous vehicle control software is organized in a unique distributed architecture modeled on the division of responsibilities amongst the hands of a marine vessel. The Gavia Intelligent Artificial Crew (IAC) comprises a full crew responsible for the safe navigation of the vessel together with project personnel responsible for meeting the goals of the mission.

**The Captain** has the same responsibilities as on board any other ship. He oversees the operation of the vessel and decides on actions in response to exceptional or critical circumstances.

**The Mission Commander** is responsible for the aims of the mission as laid down in the mission plan.

**The Navigator** maintains a best estimate of the vehicle position at any given time, making use of all available instrumentation.

**The Engineer** oversees the operation of the hardware, such as power system, motors etc. and reports to the captain in case there is a need for action.

## MISSION SPECIFIC CREW MEMBERS

A specialist **Instrument Operator** accompanies each instrument on board the vessel, such as the side-scan sonar, digital camera etc. The Instrument Operator works the instrument, logs data and monitors its health.

**Data Analysts** are hired as required for a particular mission. They process sensor data in real-time for use in reactive behaviors.

There are a number of **Pilots** on board this vessel and specialist Pilots can be easily added for particular tasks. Each adds a particular skill: one knows how to track the seabed, another how to avoid obstacles etc.

## GRAPHICAL MISSION PLANNING AND CONTROL

The Gavia Control Center is a chart-based graphical interface for easy mission planning, mission control, and post-mission play-back. Gavia mission plans can contain both fixed geo-referenced paths as well as dynamic paths to be determined in real-time by an on-board data analyst. Throughout the mission sensors may be switched on and off as required.



## GAVIA - THE IDEAL AUV PLATFORM





### DESIGN YOUR OWN PAYLOAD MODULE

A payload module can be designed by the customer based on a generic Gavia payload module. The payload module supplies power, serial and Ethernet connectivity to the vehicle crew and to the outside world.

A custom module can also contain a PC computer to accommodate customer supplied crew members with particular operating system or processing needs.

### DESIGN YOUR OWN CREW MEMBER

Assemble a crew from available Gavia crew members and add your own crew member with special capabilities required for a particular application. Crew members can be coded on any number of platforms supporting industry standard CORBA communications. A software development kit is available for these purposes.

-  - Pick a Pilot
-  - an Instrument Operator
-  - a Data Analyst
-  - or design your own crew-member

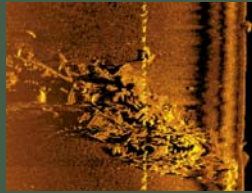
## MAIN SPECIFICATIONS

Construction ..... fully modular with Gavia QuickLock™ system  
 Material ..... Aluminum alloy, plastic, stainless steel  
 Finish ..... Hard anodized in golden color  
 Depth rating ..... 200, 500, 1000, 2000 m  
 Length ..... from 1.7 m  
 Width ..... cylindrical 0.2 m  
 Weight ..... from 44 kg  
 Cruising speed ..... > 3 m/s (6 knots)  
 Seabed tracking ..... from 1 m  
 Turning radius ..... < 3 m  
 Operating temperature range ..... -2.0°C to +35°C  
 (Extended operating temperature range available)  
 Storage temperature range ..... -20°C to +60°C

Communications ..... Wireless LAN  
 Iridium satellite link  
 Two-way acoustic link (optional)  
 Navigation ..... GPS receiver (SBAS enabled)  
 Magneto-inductive electronic compass and tilt sensors  
 3-axis rate gyros  
 Pressure sensor  
 Doppler Velocity Log (DVL) (optional)  
 DVL & GPS-aided Inertial Navigation System (INS) (optional)  
 Long Baseline Navigation System (LBL) (optional)  
 Ultra Short Baseline Tracking System (USBL) (optional)  
 Navigational Sonar (OAS) (optional)

Note: All specifications are subject to change without prior notice.

This side scan sonar image shows the wreck of a ship that exploded on the surface a few years ago.



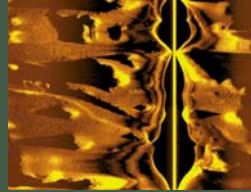
A crab, *Hyas araneus*, posing for Gavia at close range (detail from photo shot with 4 Mpixel digital camera and strobe)

The view from the nose cone of Gavia. (Shot with a digital video camera and ambient illumination).



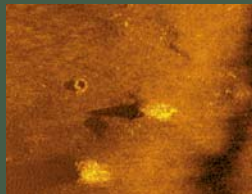
A digital video camera can be mounted in the nose cone or at the front of the antenna tower for a higher vantage point when Gavia is surfaced.

*Cucumaria frondosa* lurching on the bottom.



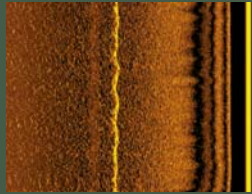
Dramatic features on the seabed as imaged by the Marine Sonic 600 kHz side scan sonar, range 30 m.

Detail of a side scan sonar image showing a car tire lying on the seabed. (Marine Sonic 600 kHz side scan sonar)



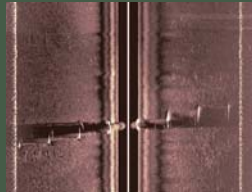
Debris on the seabed photographed by Gavia (shot with 4 Mpixel digital camera and strobe).

Side scan sonar image (detail) of the sandy bottom of fjord Thistilfjordur. Compare texture to simultaneous photograph right



The seabed of fjord Thistilfjordur in Iceland, which has a high population of scallops. Picture taken during a mission by the Marine Research Institute of Iceland in 2002.

A sewage pipe imaged on the 600 kHz Marine Sonic side scan sonar, set at a range of 30 m.



A photographic detail of the sewage pipe shown left. Photo shot by Gavia in 2002 using a 4 Mpixel digital camera; ambient illumination).

## LOCAL REPRESENTATIVE:

## QUALITY ASSURANCE

Every Gavia vehicle is tested in a pressure tank for full functionality at the rated pressure. In addition Gavia is run-in and tested rigorously both on the bench and in the water prior to client delivery in accordance with Hafmynd's Quality Assurance Program.

## WARRANTY

Gavia and all subsystems carry a two-year warranty on materials and workmanship.



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