## Underwater Mass Spectrometer

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### Description

SRI International and the University of South Florida have developed underwater membrane introduction mass spectrometry (MIMS) systems capable of in-situ detection and quantification of dissolved gases and volatile organic compounds (VOCs). The instruments are based on a 200-amu (atomic mass unit) linear quadrupole mass analyzer with a closed ion source (Transpector CPM-200 Residual Gas Analyzer, Inficon, Inc., Syracuse, NY). Introduction of analytes into the mass spectrometer occurs through a high-pressure polydimethlyl siloxane (PDMS) membrane introduction system that has been pressure tested to a depth of 2000 meters. The membrane interface used in these systems provides parts-per-billion (ppb) level detection of many VOCs and sub parts-per-million (ppm) detection limits for many dissolved light stable gases.

### Operational status

The underwater MIMS systems have been deployed on a wide variety of platforms for a number of applications in coastal oceanographic, estuarine and freshwater research. Types of deployments include shallow-water monitoring for pollutants (VOCs) in tethered/moored scenarios, as well as onboard autonomous and remotely controlled unmanned vehicles. By recording the position of the vehicle/MS system using global positioning system (GPS) technology, and time matching to concurrent MS data, we have demonstrated that chemical maps can be created to show spatial chemical concentration variations with unprecedented resolution. Underwater MS systems have also been deployed on a remotely operated vehicle (ROV) in Yellowstone Lake, WY for studies of hydrothermal vent gases. The UMS was also towed in the Santa Barbara basin for detection and mapping of methane and other oil related hydrocarbons. In addition, the 200-amu systems have been used, e.g., in depth profile studies of dissolved gases in Saanich Inlet, BC (200 m depth) and the Gulf of Mexico ( 900m depth).

Future goals include development of an in situ mass spectrometer capable of long-duration deployment, further miniaturization of MS systems and development of new sampling interfaces. Several innovations and improvements relative to current underwater MS technology are required to meet these goals. We believe that providing the capability to make stable measurements (with in-situ recalibration or minimal drift from calibration) over periods of weeks to many months, will immensely expand the utility of in-situ mass spectrometry technology.

**Specifications**

| | |
|---|---|
| Mass Analyzer Type | Linear Quadrupole Mass Filter |
| Mass Range | 1-200 amu |
| Inlet System | Membrane Introduction (PDMS) |
| Power Consumption | 100 - 130 Watts |
| Operation Voltage | 24 VDC or 120 VAC |
| Maximum Deployment Time | 10-14 Days (exhaust limited) |
| Dimensions | 1: Diameter 19 cm, Length 114 cm<br>2: Diameter 25 cm, Length 104 cm |
| Weight | 1: 41.5 kg<br>2: 59.5 kg |
| Depth Capability | 1: 1200 m<br>2: 1500 m |

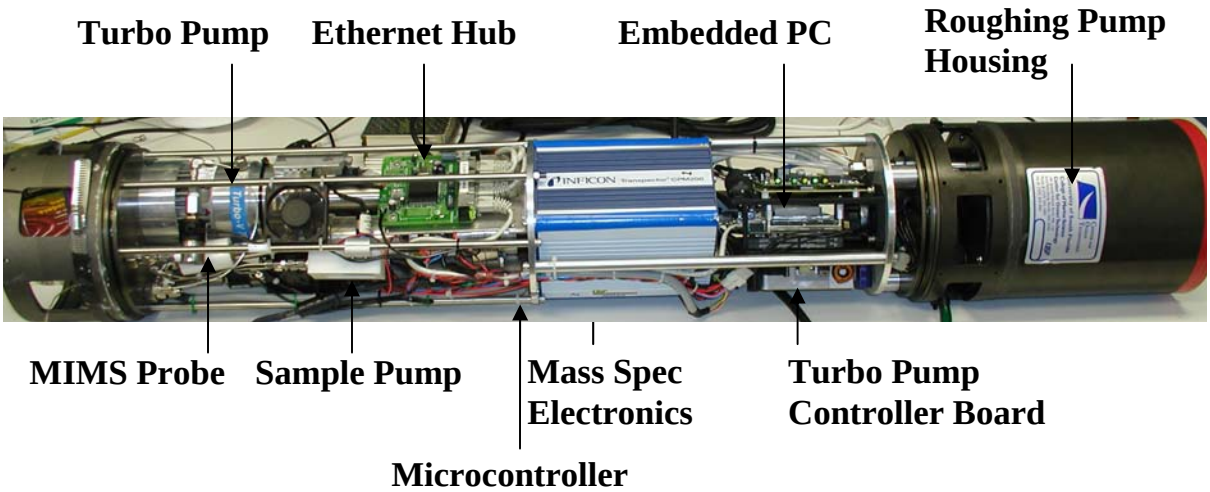


Figure 1. Underwater MS 1 without main pressure housing.