



CEROS Project Description

Project: *AQUASENSE¹: an in situ, low-power, portable mass spectrometer system*

Contractor: Pace Tech (Pacific Environmental Technologies LLC), Honolulu HI

Summary: Pace Tech proposed to design, build, and test a field-capable, low-powered, miniature mass spectrometer that would allow automated, quasi-continuous, *in situ* monitoring of chemical pollutants (hydrocarbons, dissolved gases, nutrient solutes, etc.) and microbial populations (via protein profiling) in fresh and salt waters.

Description: This contract (as well as two predecessor CEROS-funded efforts²) have adapted mass spectrometry, traditionally a laboratory-based analytical method, to a submersible field instrument contained in a pressure hull. *In situ* measurements avoid analyte contamination due to sample collection and sample handling, and also allow for time-series data to be collected. A miniaturized mass spectrometer with data logging or telemetry capabilities could be utilized in an autonomous underwater vehicle (AUV) or profiling sonde. An operational system could be valuable to DoD as a sensitive detector for weapons of mass destruction (chemical or biological agents), or as a AUV-mounted shallow water surveillance tool.

The earlier CEROS contracts resulted in the Mass SURFER prototype (*Figure 1*), a 6½-inch diameter by 5½-foot long cylinder that saw several test deployments at sea (*Figure 2*, for example). The AQUASENSE instrument being developed under the current contract is an adaptation of the earlier design that will:

1. Lower the detection limits from part-per-billion to parts-per-trillion range by adding a channel electron multiplier (CEM) detector to the existing Faraday cup ion collector.
2. Encase the instrument in a smaller pressure hull of anodized aluminum with a depth rating of 100 bars pressure (1000m depth).

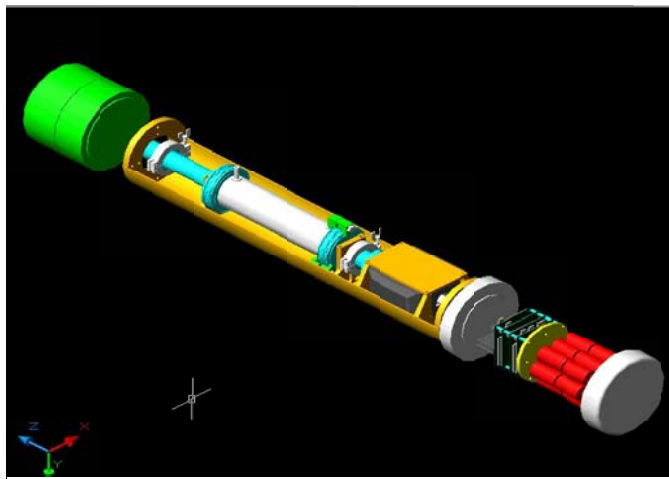


Figure 1. Mass SURFER design, with sample inlet assembly in the green endcap, RFMS (blue), and electronics and battery module (right end).

¹ CEROS FY03 contract 51228, entitled "*AQUASENSE¹: a low-power, portable mass spectrometer system for in situ measurement of dissolved gas and solutes in natural waters, atmospheric gases and aerosols, and large organic compound identification*"

² CEROS FY99 contract 45291 and FY00 contract 46821

3. Isolate all metal surfaces (by Teflon coating, for example) and replacement of existing sampler-exposed metal surfaces with titanium or quartz glass components in order to aid sensitivity by eliminating corrosion and the introduction of foreign materials.

4. Possibly add heating elements at choke points in the sample distribution subsystem to prevent induced freezing of freshwater samples.

Both the Mass SURFER and AQUASENSE instruments use modifications of the quadrupole Rotating Field Mass Spectrometer (RFMS) developed at Caltech's Jet Propulsion Laboratory (JPL, Pace Tech's subcontractor for this effort) as the mass analyzer. A recently miniaturized prototype of the RFMS is shown in Figure 3; it is about 4 inches in length. Samples to be analyzed are ionized by nano-electrospray (nano-ESI) assemblies at the upstream end of the RFMS. Channel electron multiplier (CEM) detectors were added to the Faraday cup ion collector at the downstream end to enhance detection of ions; circuitry has been built to amplify the signals for subsequent processing.

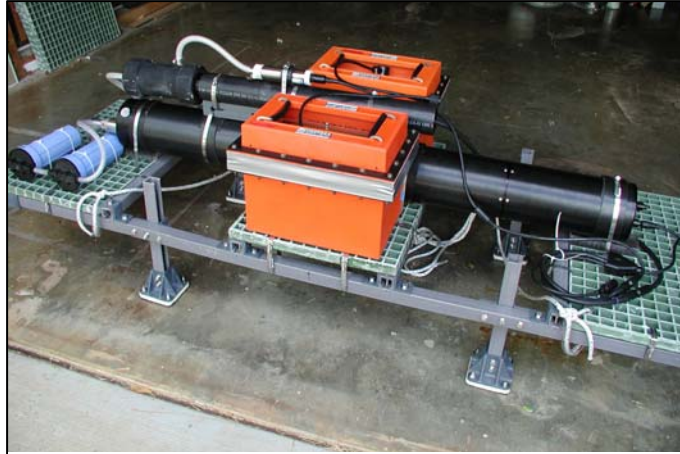


Figure 2. An example of a Mass SURFER field deployment, with a CTD, sample filtration cartridges (blue), and battery packs (orange).



Figure 3. JPL RFMS prototype of August 2004; the unit is 4 inches long.

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