Development of the Hyperbolic Horn Helical Mass Spectrometer

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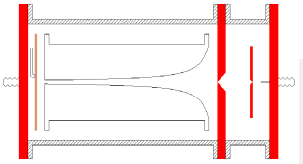
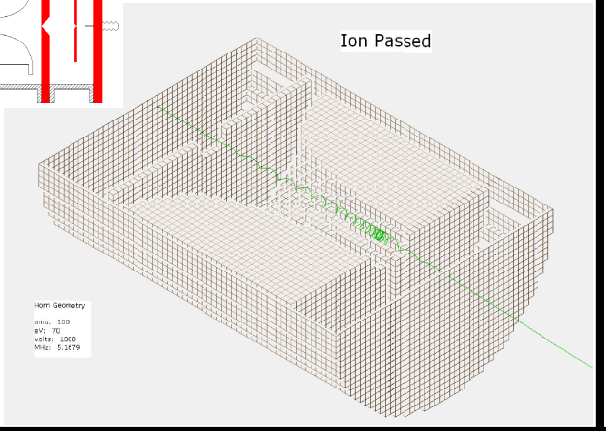


Small, Rugged & High-Mass Detection



Key Discriminators

Operational Capability

There is a wide variety of mass spectrometers, each usually with some distinct advantage over other designs. All share the ability to perform rapid, multi-component analysis of gases, liquids and solids, with relatively great sensitivity (ppm to ppb detection is common). We have focused upon the well-known, compact quadrupole mass spectrometers to learn the best system designs for field applications and we have explored the extended mass range capabilities of the Rotating Electric Field Ion Mass Spectrometer (REFIMS) because these types allow much higher mass detection (to >100,000 atomic mass units or amu) than is possible using a quadrupole MS (usually <300 amu). The REFIMS thus allows detection of large organics such as proteins and DNA. While working with various REFIMS designs, our engineering team invented a new, improved type of mass spectrometer, called the Hyperbolic Horn Helical Mass Spectrometer (H^3MS). The main advantages of this new design over previous REFIMS designs are a >100-fold increase in sensitivity by use of improved ion focus geometry, compact, "in-line" geometry, and the ability to detect ions in two dimensions. The H^3MS-based instruments we propose to develop will augment technical expertise in Department of Navy applications, Department of Defense applications, and in medical practice/research and environmental studies important to Hawaii and the rest of the country. The proposed instrument will be robust and compact; it will also be extremely sensitive over an extended mass range.

Problem/Readiness/Champions

Problem Being Addressed

For most field applications, the primary advantages of quadrupole and REFIMS-type sensors over more traditional magnetic MS sensors are compact size and robust design. In our previous work, REFIMS devices have been successfully shock-tested to nearly 2000 G. The REFIMS and the new H^3MS also have large organic molecular detection capability, which is of keen interest to anti-terrorism and force protection commands. Besides potentially greater sensitivity, the advantages of the H^3MS 2-d detector will allow for rapid, sensitive analysis of airborne plumes in a battlefield scenario (e.g., in sounding rockets), for multi-component and large organics surveillance of air and waters (from airborne craft to deep-sea vehicles, buoys), of soil gases (in penetrators), and in situ surveillance of groundwater within well bores. Using similar technology, we foresee applications for in situ environmental monitoring (an upcoming research area) and in the medical and pharmaceutical industries (e.g., protein biomarker discovery).

Technology Readiness Level

This technology has completed level 1.

Champions

A collaborating research group (S. Anderson, PI) at the Hawaii Institute of Geophysics & Planetology at the University of Hawaii has independently confirmed some of our modeling results for the REFIMS.

Milestones/Deliverable/Date/Status

Milestones	Deliverable	Date	Status
REFIMS-3HMS modeling	Compiled data on model results	2/1/06	Completed
3HMS-based instrument development	In progress	-/-/--	Future
REFIMS & 3HMS high-vacuum tests			
Improve Gen. 3 electronics for 3HMS			
Final 3HMS field tests & demonstration			
Commercialization of 3HMS prototype			

Prepared by: Dr. Gary McMurtry
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