Lonestar VOC Analyzer

The Lonestar VOC Analyzer is a research and analysis tool for infectious disease, cancers and inflammatory disease. Using cutting-edge FAIMS technology, Lonestar allows clinicians and researchers to analyze breath and bodily fluids to find VOC biomarkers of disease.

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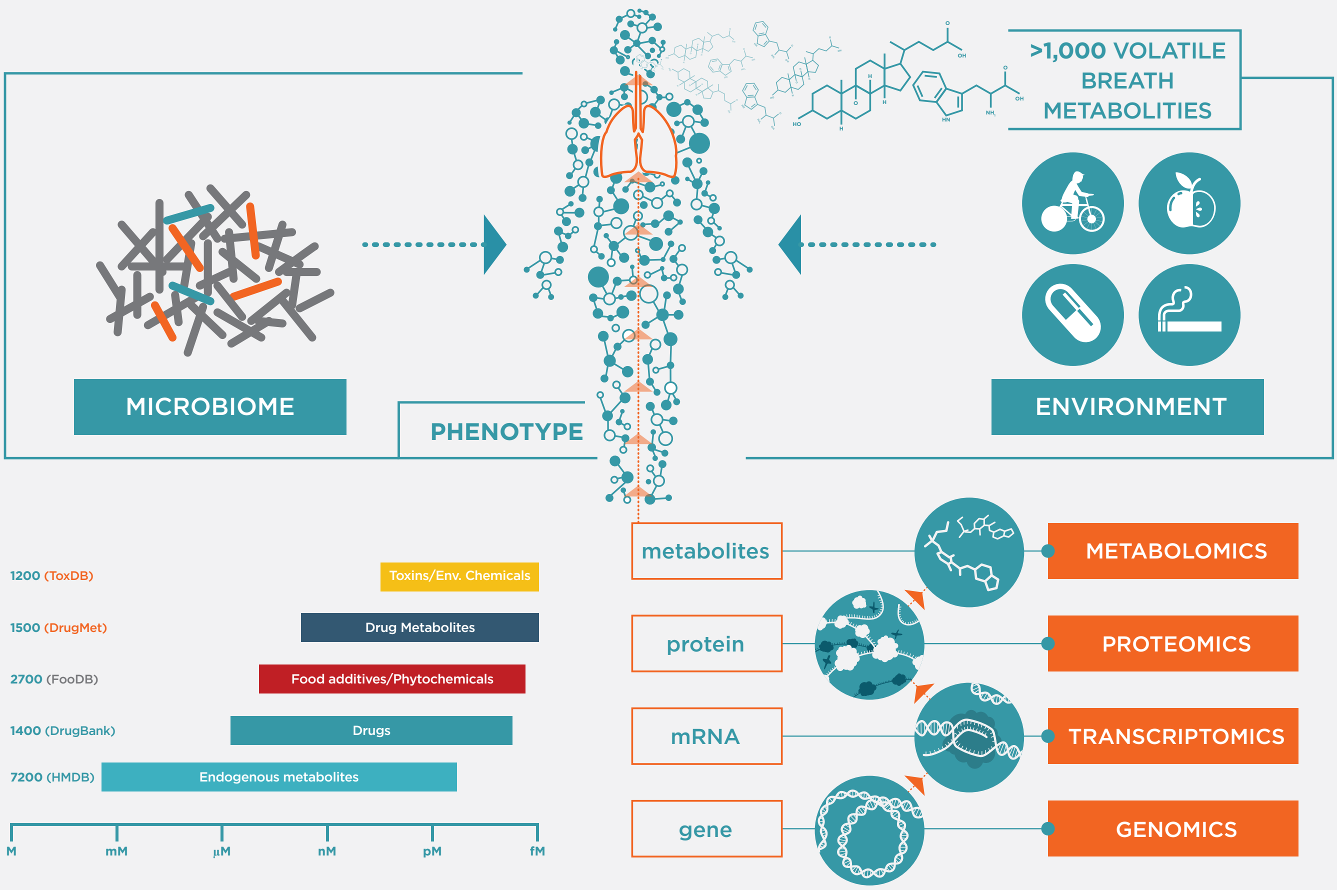
Biomarker Analysis

The body produces a wide range of volatile organic compounds (VOCs) that reflect cellular activity. These compounds are altered by disease, making them potential biomarkers. VOCs may be detected within a range of media, including breath, blood, urine, feces, sputum and sweat. Biomarkers of this kind have the potential to revolutionize medicine by allowing diagnosis of a broad range of diseases through a simple, non-invasive test for their presence.

Researchers are currently engaged in two parallel streams of work relating to these biomarkers; firstly, to identify robust biomarkers of different diseases, and secondly, to determine the most viable technology to use to detect these chemical biomarkers in a point-of-care setting.

Up to this point, the main options available have been GC-MS (Gas Chromatography - Mass Spectrometry) systems, or electronic nose type systems. GC-MS is the gold standard in terms of analytical power, but has a number of significant disadvantages when it comes to clinical settings. GC-MS systems are expensive, and require significant training and expertise to operate. They are also physically large, and as such are unlikely to ever be feasible as a point of care tool.



Electronic nose systems, which generally consist of an array of discrete sensors that undergo chemical interactions when they come into contact with VOCs, have shown more promise for deployment in a clinical setting. They are generally cheap to produce, small in size and portable, allowing them to be easily used outside a laboratory. However, they have a number of weaknesses that have prevented that promise from becoming a reality; they suffer from poor intra- and inter-device repeatability, with the same compounds producing different readings on different

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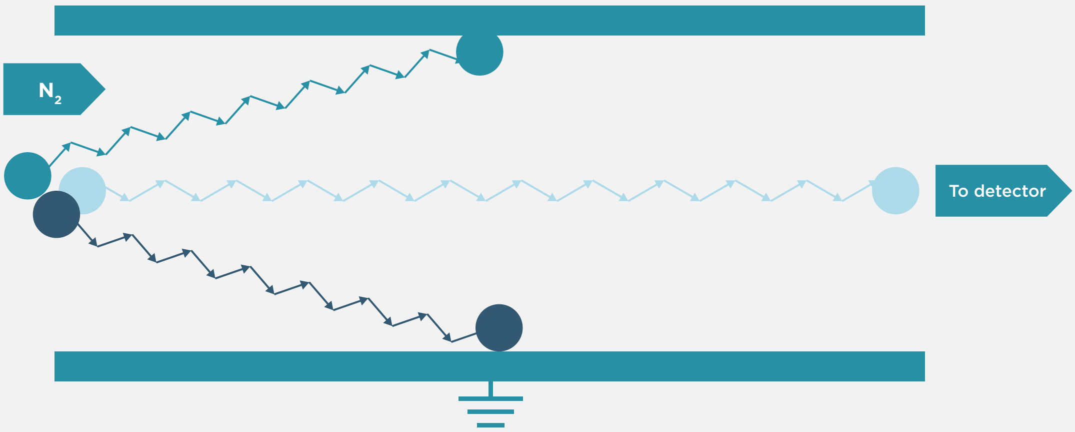
devices, and even on the same device at different times. The chemical reactions undergone by elements of the array are also not unique to particular VOCs, meaning that there may be frequent false alarms and poor selectivity.

Field-asymmetric ion mobility spectrometry (FAIMS), which is used by Lonestar, promises to bridge the gap between these two techniques. The system produces an information- rich chemical spectrum, with unique features associated with each VOC, but in a much smaller, less expensive and more user-friendly package than the GC-MS.

How Does FAIMS Work?

Ion Mobility Spectrometry separates molecules according to the speed at which they move through a gas under the influence of an electric field. This depends in turn upon the collision cross-section (i.e. the size) of the molecules. FAIMS uses an asymmetric alternating voltage to separate molecules according to how their shape changes in high electric fields. Unlike mass spectrometry, FAIMS does not require molecules to move through a vacuum, avoiding the need for a vacuum generator, and allowing a smaller system footprint. A detailed technical outline of FAIMS may be found at **www.owlstonemedical.com/science-technology/faims-technology**



More information is available at
www.owlstonemedical.com/products/reciva

Sample Collection

For solid and liquid samples (urine, blood, stool etc), sample collection is relatively straightforward - Lonestar will generally require a sample volume of around 5 or 10ml, although the exact volume needed will vary with both the sample medium and disease under investigation. This sample can be collected in any inert sampling vessel. Breath sampling is a slightly more challenging proposition, with a more complex system required to capture the VOCs present in a patient's breath so that they can be analysed using Lonestar. An international consortium of breath researchers has produced an open source breath sampling system designed to overcome these challenges.

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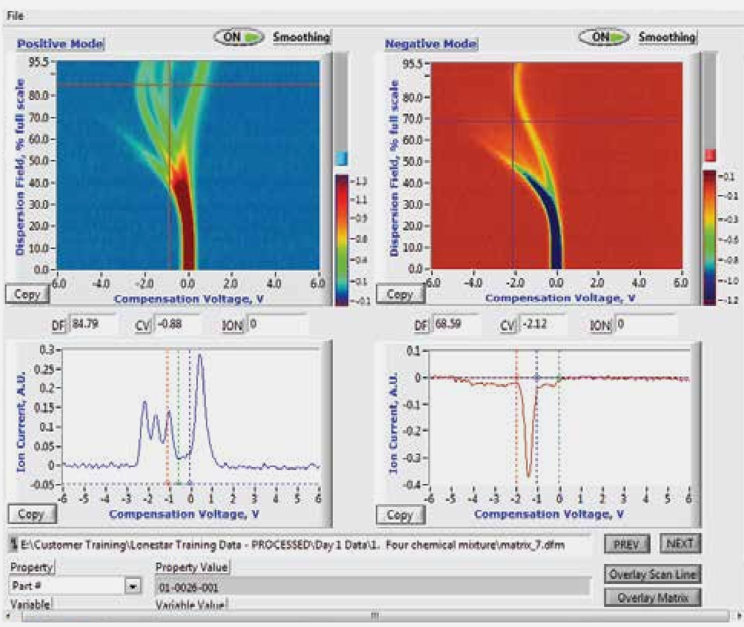
Sample Processing

Lonestar analyses VOCs in the gas-phase, which means that for solid and liquid samples, the spectrum is generated by the volatile compounds that evaporate into the headspace above the sample. The rate at which this happens depends on temperature and pressure, so for solid and liquid samples, Lonestar has an optional headspace sampling system, ATLAS, which provides accurate control of the temperature and the flow rate of the gas taking VOCs from the headspace into the instrument.

www.owlstonemedical.com/products/atlas/

Data Analysis

The output from the sample processing phase will be raw FAIMS spectra for patients with and without the disease of interest. The task then is to identify features present only in the spectra of diseased patients. FAIMS data are multi-dimensional in terms of the features present in each spectrum, and so it will usually be necessary to carry out some form of compression or data reduction (such as discrete wavelet transforms or principal component analysis) first. After this step, a classifications algorithm is developed and applied to the reduced data set. This algorithm will test relevant features of the data, and assign each sample to the disease or disease-free category. The form of the classifier will depend upon the data-set, but random forest, sparse logistic regression and support vector machines have all been successfully deployed. The classifier will then ideally be tested on a new set of samples, to externally validate the sensitivity and specificity.



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Results and Potential

Research teams around the world have already discovered the unique potential of FAIMS. Published studies cover the spectrum from cancer (bowel/colorectal) to inflammatory diseases (such as IBD and Celiac disease) to infectious diseases (C. difficile). The use of a novel technology such as FAIMS has aided the process of getting these papers published. However, a huge range of diseases with the potential to be diagnosed using VOC signatures remains unexplored. Using Lonestar, your research group can be at the forefront of this emerging diagnostic field.

Case Studies

Inflammatory Disease: Asthma

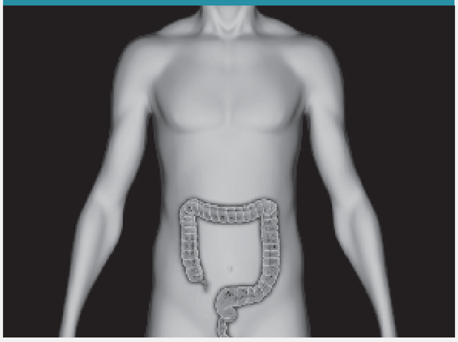
Using the Lonestar system in conjunction with three eNose-type sensors, Brinkman et al were able to successfully differentiate breath samples given by severe asthma sufferers from those of healthy control patients. They have also shown that the system has the potential to distinguish eosinophilic from non-eosinophilic asthma, allowing drug therapies to be more effectively targeted for individuals.

www.owlstonemedical.com/science-technology/research-case-studies/asthma

Cancer: Colorectal Cancer

Initial studies by Arasaradnam et al have found that FAIMS can be used to differentiate between patients with colorectal cancer and healthy controls, with a sensitivity of 88% and specificity of 60%, by comparing the spectrum of volatile organic compounds (VOCs) in urine. These initial results suggest that FAIMS could potentially prove valuable as part of a screening program for early-stage bowel cancer.

www.owlstonemedical.com/science-technology/research-case-studies/colorectal-cancer/



Infectious Disease: Tuberculosis

A team from the Pulmonology Department at the Academic Medical Centre, University of Amsterdam, used Owlstone's Lonestar as part of an eNose array to conduct a proof-of-concept study showing that tuberculosis can be diagnosed via chemical markers in exhaled breath. Notably, this is true even in TB cases where the sputum ZN-smear gives a negative result, which currently cause significant diagnostic problems.

www.owlstonemedical.com/science-technology/research-case-studies/tuberculosis

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TECHNICAL SPECIFICATION:

Technology	**Field Asymmetric Ion Mobility Spectrometry**
Detection Mode	**Positive and negative ions**
Sample Input	**Ambient, Headspace**
Inlet / Outlet	**1/8" Swagelok compression fittings**
Analyte Range	**Volatile Organic Compounds**
Dynamic Range	**User adjustable inlet dilution for ppb - %**
Required Gas Supply	**Clean, dry air (there is an integrated, replaceable scrubber)**
Max Heater Temperature	**70°C**
Humidity Range	**0% - 95%**
Instrument Sensors	**Temperature, humidity, flow and pressure**
Inputs	**Inbuilt tracker ball**
Output	**Real-time chemical spectra and stored data**
Computer	**Inbuilt PC running Windows XP**
Memory	**4gb internal**
Comms	**USB, RJ45**
Software	**Custom online control software**
AC Inputs	**120/240V AC**
Dimensions	**383 x 262 x 195 mm**
Weight	**7.8kg**

www.owlstonemedical.com

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