

# Chemical Detection Intelligence™

Better Science For Better Lives

Owlstone delivers its patented chemical detection technology for commercial and military applications, including health and safety, drug testing, environmental monitoring, air quality, and more.



SCANNING... Analyzing Data...

Sector: 8 ● Water Quality

Grid: 12 ● Chemical Detected



# Chemical Intelligence

## Sensing a Safer World

Sensors are revolutionizing our lives. They're making vehicles smarter, homes safer, and factories more efficient. Owlstone delivers an electronic sense of smell to everyday life, so that we can monitor the chemical world around us.

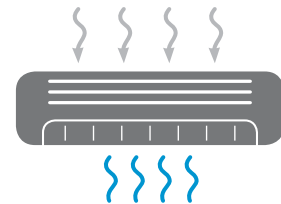
### What if...



**...your smoke alarm**  
could smell fire  
before there is smoke?



**...your refrigerator**  
could tell you food  
is about to spoil?



**...your HVAC system**  
could ensure the air in your  
home is safe to breathe?

While it may sound like science fiction, Owlstone's future is to enable these things and more.

The revolutionary technology that is the foundation of our military and medical products is now being developed with a form factor and at a cost that allows more ubiquitous deployment.

Owlstone's technology is designed to make people chemically smarter by sensing the environment around them. From facilities to fencelines, aviation to automotive, stadiums to transport hubs, this increase in intelligence and awareness will make vehicles, plants, buildings, and devices safer and more efficient.





**Military & Defense**



**Health & Safety**



**Environmental Monitoring**



**Quality Control**



**Leak Monitoring**



**Narcotics Testing**





# Better Science

## As Proven by the World's Most Demanding Industries

Some of the most demanding chemical detection applications are in the defense and medical markets.

The environments on a battlefield are harsh, and accuracy and reliability could literally mean life or death. Delivering non-invasive breath diagnostics for the early detection of cancer and other diseases is profound in its complexity and no small challenge. Owlstone is transforming chemical detection in both domains.



### Owlstone Medical

Owlstone Medical has developed a breathalyzer for rapid, non-invasive disease detection. Owlstone Medical's ReCIVA Breath Sampler and chemical sensor technology have introduced breath as a new diagnostic modality.

The Breath Biopsy™ platform detects and identifies disease-specific volatile biomarkers and has numerous applications in clinical diagnostics and precision medicine. Highly sensitive and selective, the Breath Biopsy™ platform allows for early diagnosis when treatments are more effective and more lives can be saved.

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*“Work so pioneering that it was recently labeled as the next ‘Unicorn’ coming out of the global tech industry.”*

– Professor Chris Toumazou,

FREng, Regius Professor at Imperial College London

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## Just breathe

Exhaled breath contains over 1,000 volatile organic compounds (VOCs) derived from the blood due to efficient exchange of chemicals between the pulmonary and circulatory systems. A blood cell takes approximately 1 minute to circulate around the entire body. Every minute, VOCs originating from sources all throughout the body reach the alveoli in the lungs where they pass efficiently from the blood into the alveolar air and are then exhaled. By continuously sampling breath over a few minutes, the profile of VOCs originating from throughout the body can be accessed in a way that is completely non-invasive and is preferable for patients over uncomfortable and potentially unpleasant diagnostic procedures.

## The world's largest breath-based clinical trials

Owlstone technology, along with the ReCIVA Breath Sampler, is being used in large clinical trials relating to lung cancer (LuCID), colorectal cancer (InTERCEPT) and asthma (STRATa). Research into precision medicine applications include inflammatory disease (e.g., inflammatory bowel disease, asthma, COPD), liver disease (e.g., hepatic encephalopathy), and infectious disease (e.g., tuberculosis).



ReCIVA Breath Sampler

***“[This] amazing technology will save millions of lives in the next decade.”***

“This work is so pioneering that it was recently labeled as the next ‘Unicorn’ coming out of the global tech industry. [Owlstone] has focused for years on deploying this technology, very successfully, in major hospitals and working with many companies and institutions. [This] amazing technology will save millions of lives in the next decade.”

**Professor Chris Toumazou**

FREng, Regius Professor at Imperial College London

*Owlstone Medical Ltd., a diagnostics company, was spun out of its parent company, Owlstone Inc., in April 2016 to develop and commercialize a breathalyzer for use in clinical diagnostics and precision medicine with applications in cancer, inflammatory disease and infectious disease. The company raised \$7M in seed financing. Since then, 67M has been raised in Series A & B financing.*



# Better Science



## Owlstone Defense

Owlstone is the only chemical detection technology selected for the 3 most significant development programs this decade.

Protecting soldiers and battlefield infrastructure from exposure to chemical threats is a core priority for Owlstone. The development of our technology for the detection of chemical warfare agents has been funded by the US Defense Threat Reduction Agency, the US DOD's Joint Program Executive Office for Chemical and Biological Defense, the Dept. of Homeland Security, and the UK Ministry of Defence.

Our technology detects and identifies nerve agents, blister agents, blood agents, and toxic industrial chemicals. Owlstone develops products in collaboration with some of the most respected names in chemical detection and analysis.



### US Department of Defense (DOD)

#### ▶ *Next Generation Chemical Detector (NGCD)*

Owlstone was one of three companies funded by the DOD to develop their Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD)'s advanced handheld chemical warfare agent detector, NGCD. In this multimillion-dollar, multiyear, three-phase contract, Owlstone developed its advanced chemical detection (CD) platform to deliver broadband detection, reprogrammability, light weight, and rapid response time.



### US Department of Homeland Security (DHS)

#### ▶ *Next Generation Explosive Detector (NGED)*

Owlstone was the sole technology chosen by the DHS for development of an advanced portable explosives detection system. Owlstone will develop the explosives detector in partnership with UTC Aerospace Systems, a unit of United Technologies Corp. As DHS's only contract to develop a new handheld explosives detector, the system is projected to be a critical tool in delivering advanced detection capability against the new generation of threats and enable new deployment scenarios as a result of its portability.



### UK Ministry of Defence (MOD)

Owlstone was awarded one of only two contracts from the UK MOD to fund continued research and technology improvements of our CD platform. This effort will maximize the performance and improve the overall sensitivity and selectivity of the sensor. The award is indicative of the MOD's confidence in the potential of our proprietary technology. The R&D will lead to improvements in the system for future products and deployment.



## Explore what our partners are building with Owlstone



### **FLIR Systems**

Owlstone in partnership with FLIR Systems, Inc. is launching the world's most advanced battlefield chemical detector. This product, the C401, has been designed to meet the stringent requirements of the US NGCD program.



### **United Technologies Corp.**

Owlstone in partnership with prime defense contractor, United Technologies, is developing the advanced explosives detector for use across all agencies within the Department of Homeland Security.



### **Kylink Communications**

Owlstone in partnership with Kylink Communications delivered more than 800 systems (OwlSens-T chemical detectors) to an international military force. The deployed battlefield product detects chemical warfare agents and TICs.





# Introducing Spark Owlstone's New C

## > Current Generation

Owlstone's current platform delivers the highest sensitivity, selectivity, and reprogrammability available in a man-portable, military-grade system.

For too long, the deployment of handheld chemical detection lacked scalable, cost-effective solutions that also delivered the required level of performance.

With \$41 M in capital investment and \$25 M in engineering grants, Owlstone developed a platform technology that set a new standard in man-portable chemical detection. We are now taking the next step in our evolution.



*Current state-of-the-art Owlstone platform*

## The Owlstone chemical detection advantage

### The state of the art

Owlstone technology offers extreme sensitivity and selectivity with field reprogrammability, enabling continuous improvement and training for new compounds after deployment. The technology detects chemicals against complex matrices within a few seconds, delivering specific identification and quantification capability.

### Validated

Owlstone science brought disruptive innovation to medical diagnostics and military chemical defense. The Owlstone sensor drives the ground-breaking Breath Biopsy® platform in medicine (see p.2). Owlstone is the only company selected for the three most significant defense development programs over the past decade (see p. 4).

### De-risked

Owlstone technology has already driven disruptive innovation in the chemical detection marketplace. We have brought game-changing field deployable spectrometry to chemical sensing, without beginning to tap into the potential for reduced form factors and lower cost of ownership. The engineering required to deliver the promise of Spark is already utilized in consumer electronics devices and poses minimal technical risk.



# Generation Platform

## Potential Applications:

- › Hazardous Materials Accident
- › Equipment Leak
- › Terrorist Incident

› **New Generation** The natural evolution of a platform built on better science.

Spark is Owlstone's newest chemical detector platform, optimized for industrial and security applications, delivering unmatched performance with a reduction in size and cost.

We're taking our technology where it wants to go – smaller, cheaper, and better – all enabled by the science of small. The step change from current systems is a new generation product, Spark, designed for more affordable and ubiquitous deployment.

## Meeting the expanding needs of chemical detection

Spark is a compact device for chemical detection in the field. State-of-the-art performance in a small ruggedized form factor opens the door to faster, more robust, low-cost chemical sensing.

*Spark – Owlstone's new chemical detector platform*



## Empowering technology

- Speed** › Real-time results (<1 sec analysis time) allow immediate, appropriate action
- Performance** › Extreme sensitivity and selectivity (ppb) identify toxic compounds on the spot
- Ease of use** › Designed to be used by non-specialist operators
- Portability** › Light weight and small form factor
- Ease of integration** › Integration with front-end sampling, 3rd party systems, and other sensor networks
- Low cost** › Quick ROI
- Customizable** › Tailor the sensor for specific applications
- Reprogrammable** › Detect new chemicals even after deployment

## Accelerating what's next by reducing:

...total COGS by

**80%**

Lower cost to build

...assembly time by

**85%**

Modular and easy to service

...parts count by

**90%**

Optimized for volume manufacture

...overall size by

**50%**

Easy to use and portable



# A High-Growth Strategy in the Industrial Sector

## Proven technology

Owlstone's proven chemical detection technology has been in development since 2004 and shipped to hundreds of customers. Our proprietary platform has raised the bar permanently in defense threat detection and in medical diagnostics.

Owlstone sensors deliver significant advancements in chemical sensing that form the basis for future high-performance sensing applications.

The Spark platform further optimizes the science behind our IP. With a reduced form factor, better performance, faster speed and lower cost, the new platform is being engineered for industrial and consumer market disruption.

## What can Owlstone technology do for your business?

Explore leveraging Owlstone's technology through several different models. Owlstone is currently licensing its IP, pursuing joint ventures, and developing its own products for external distribution.

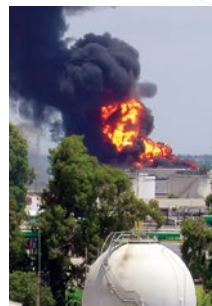
Contact us to learn more.



Military & Defense



Health & Safety



Environmental  
Monitoring



Quality Control



Leak Monitoring



Narcotics Testing



# Owlstone Technology Licensing

## Build Your Next Sensing Solution Using the Most Advanced Chemical Detection Technology

At Owlstone, we license and partner with companies around the world to design, develop, manufacture and sell products built on our industry-leading chemical detection technology. With each chemical sensing solution discovered and each product developed, the world becomes safer and healthier.

### Imagine how we can solve the next problem together.

Owlstone's proven technology is uniquely positioned to solve industrial and consumer chemical detection needs, large and small. Our technology licensing process covers every stage from ideation and product/application development through to manufacture of end systems, and if desired, sales and marketing assistance.

Whether you are an industry leader with complex monitoring and manufacturing challenges or just starting out with a big idea, Owlstone can provide the chemical detection technology to bring your ideas to market with industry-leading features and profitability.

### We advance strategic goals.

**We work with market leaders, small businesses and start-ups to deliver ground-breaking chemical detection products.**

If you want to build cutting-edge solutions that incorporate smart, small, fast, and cost-effective chemical detection, Owlstone will provide this technology for your market. The Owlstone chemical sensor can be integrated into an array of systems and controlled by front-end electronics to address virtually any application.



Contact us to learn more about how Owlstone's technologies can help you take your product or sensing solutions to the next level.

### Stages of tech licensing:



Deal structure



Engineering validation



Spinoff

### Partnership scenarios:



OEM/purpose built



Licensing for in-plant



Licensing for in-system



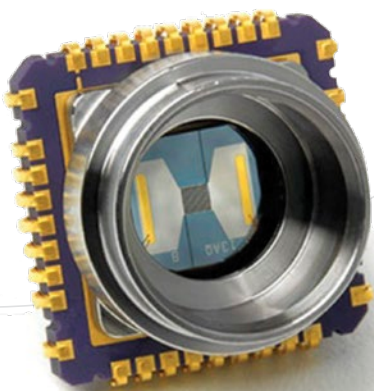
Custom solution with solid phase sampling required.



# How Owlstone's Technology is Transforming Chemical Detection

## Better science

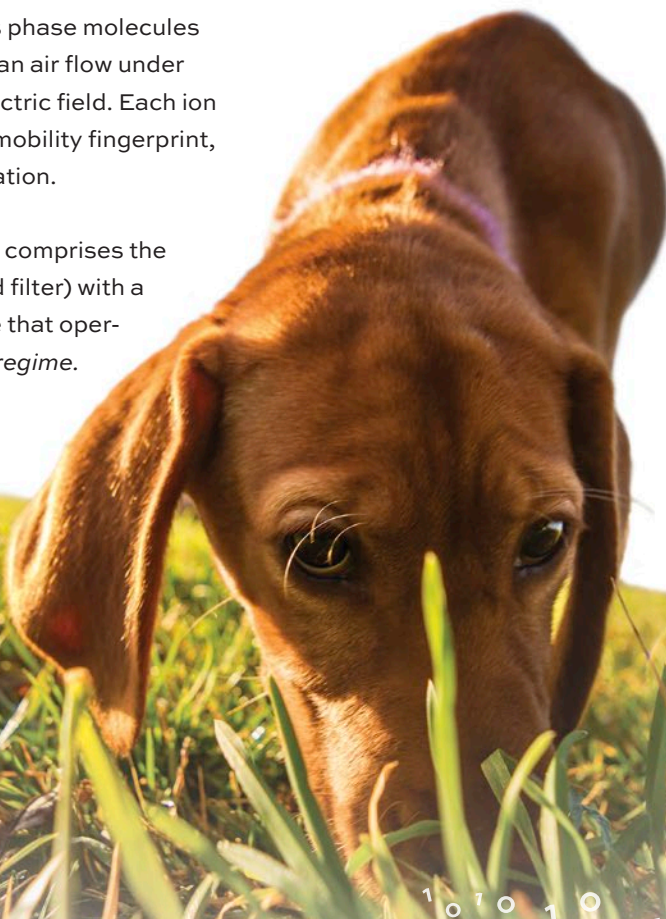
The heart of the chemical detection (CD) platform is a tiny micro-fabricated sensor – the most sensitive and selective chemical detection technology ever designed for field deployed systems. Owlstone invented a novel approach to analyze chemicals, which exploits the radically increased spectral information possible when ions derived from a chemical sample are subjected to extreme electric fields. Simply put – it's better science. Beyond mass spectrometry-based systems and conventional ion mobility spectrometry – it yields more data. And, its ripe for improvements as the channel widths, airflow, temperature, substrate dimensions, etc., all can be optimized, to deliver tailored systems for specific applications.



## Putting the sense of smell in a sensor

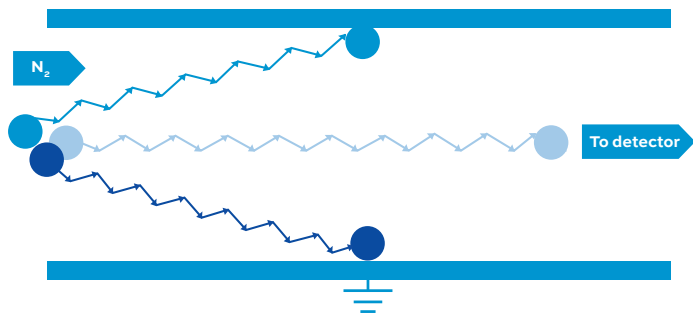
Owlstone technology distinguishes charged gas phase molecules (ions) according to differences in the mobility in an air flow under the influence of an extremely high oscillating electric field. Each ion derived from the chemical sample has a unique mobility fingerprint, allowing highly selective detection and identification.

The Owlstone micro-fabricated sensor topology comprises the multiple micron gap ion separator (interdigitated filter) with a novel high-frequency separation waveform drive that operates in a previously uncharted *ultra-high field regime*.



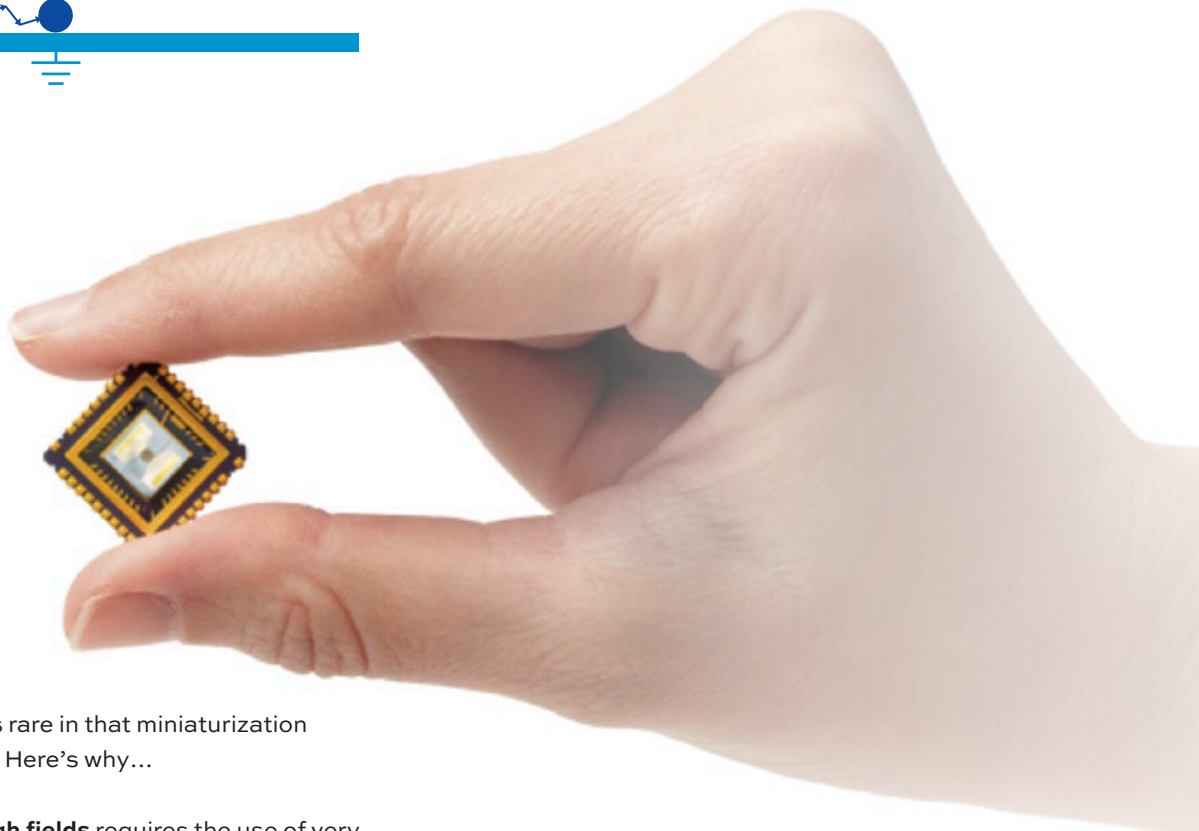


## Ion Drift in an Oscillating Electric Field



For more info, see Wilks et al., *Characterization of a miniature, ultra-high-field, ion mobility spectrometer*. *Int. J. Ion Mobil. Spectrom.* 15, 2012, 199–222.

Visit: <https://www.owlstoneinc.com/media/uploads/files/Characterization-miniature-ultra-high-field-ion-mobility-spectrometer.pdf>



## The science of small

Owlstone technology is rare in that miniaturization improves performance. Here's why...

- › **Operation at ultra-high fields** requires the use of very narrow-gap (micron scale) ion separators to enable waveform driver design.
- › **Minimizing this gap** enables higher fields to be generated with lower voltage and smaller form factor waveform drivers.
- › **The combination of** high frequency waveforms and short ion separation channels means ion-molecule collisions are minimized leading to profound effects on the ion chemistry, since separation timescales become more comparable to natural ion-neutral collision frequencies at atmospheric pressure.
- › **The electronics** is more optimally integrated, reducing systems noise and enabling more sensitive ion detection.

## Ultra-high electric fields yield exponentially richer data

In other words, unlike traditional models for linear field dependence of ion mobility at lower electric fields, the separation principles operating in ultra-high fields, given the nonlinear relationships, are unique. Ultimately, the kinetics and thermodynamics of ions within the separation region are fundamental drivers in the separation and identification process. The principles and differentiators associated with ultra-high field operation define the unique mode of operation.

*Ultimately, the small size of the sensor helps to maximize its performance*



# Better Science Through Innovation

Owlstone was built on the spirit of science and innovation. We know good science can solve big problems. Just look at how our sister company, Owlstone Medical, is changing medicine. Imagine – breathe into a breathalyzer for 10 min and know if you have early stage disease – or not.

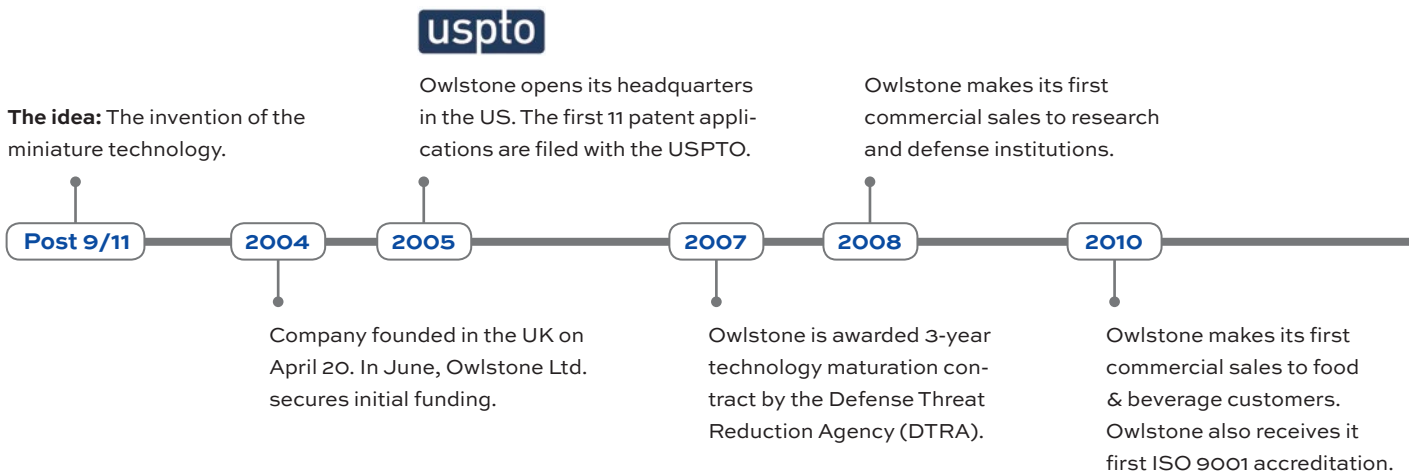
At Owlstone, we believe more heads are better than one. That’s why we share and collaborate. Our chemical sensor is the foundation of amazing advancements in chemical detection across sectors from medicine to defense to oil & gas. Each day we are inspired by the possibilities of what is next for Owlstone technology.

## Owlstone’s Origins > The idea for a miniature chemical sensor

It was the years after 9/11. An American PhD student at Cambridge University, Andrew Koehl, with his engineering buddies Billy Boyle and David Ruiz-Alonso, dreamed up the idea of a miniaturized sensor for chemical detection in homeland security. Koehl, an electronics engineer, found a way to miniaturize ion mobility spectrometry through micro-fabrication techniques.

## A History of Innovation

From the beginning, Owlstone has been a leader in chemical detection technology. See some of the biggest accomplishments that contribute to our company timeline.





# Our business model is simple.

## Invent, collaborate, solve.

*At the end of the journey,  
we're always disruptive.*

*Right: Celebrating the founding of Owlstone*



Owlstone makes its first commercial sales to major oil & gas customers, BP, Chevron, Baker Hughes, Statoil, and Shell.

Contract awarded to Owlstone from the U.K. National Health Service for the development of the LuCID Lung Cancer Identification system.

Owlstone in partnership with United Technologies wins the only award for handheld advanced explosives detector development by DHS.

Owlstone enters partnership agreement with FLIR Systems to develop the C401 battle-field chemical detector and to submit a proposal to the US military for the purchase of 63,000 systems in the EMD phase of NGCD.



Owlstone wins one of only three contracts awarded by the US Dept. of Defense for the development of the Advanced Battlefield Detector.

Owlstone develops chemical detectors for an international military force. 800 units delivered to date.

Owlstone spins out first division to shareholders.

Defense procurement expands further. Owlstone is awarded one of two contracts for development of an Advanced Chemical Detector from the U.K. Ministry of Defence.

38 patents are issued and pending.



[www.owlstoneinc.com](http://www.owlstoneinc.com)

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