



# **CIA *Advantage***



**Cryogen-free automation for high-performance analysis of canister air and gas**

# CIA Advantage™



## CIA Advantage – The next generation of automated canister analyser

CIA Advantage is an advanced system for automated analysis of VOCs in canister samples. With capacity for up to 27 canisters and cryogen-free operation, it is the ultimate solution for laboratories wanting a robust, high-throughput system for canister air monitoring.

CIA Advantage offers flexibility and productivity enhancements for air-monitoring laboratories that cannot be obtained with other systems. Electrically-cooled focusing eliminates the expense and

inherent problems of using liquid cryogen, while heated internal lines and uniquely efficient purge steps eliminate carryover and optimise productivity.

At the same time, CIA Advantage provides both excellent analytical performance and unmatched application versatility. Gas-loop and MFC-controlled sampling options combined with quantitative sample splitting allow compatibility with the widest possible sample concentration range, and the method-compliant tube desorption capability integral to every CIA Advantage allows compatibility with TO-17 air toxics and SVOCs.

## Canister analysis technology from an award-winning company

## CIA Advantage – The key benefits for canister users



### Economy and productivity

- No need for liquid cryogen means savings of thousands of dollars per annum per instrument
- Up to 27 channels allows round-the-clock automated operation for maximum productivity
- Heated internal lines (up to 200°C) and uniquely efficient purging combine to eliminate carryover. This means fewer blanks and more samples, allowing you to generate higher revenue
- High- and low-concentration samples can be accommodated in the same sequence. Pre-screening of uncharacterised samples can be carried out automatically with no need for dedicated equipment
- Robust modular design optimises uptime and enhances serviceability, thus minimising maintenance costs
- Easy water management

### Analytical excellence

- Peerless analytical performance, including splitless desorption for optimum sensitivity
- Simple but sophisticated, single-stage trapping with an optimised combination of sorbents and electrical cooling provides the ultimate VOC pre-concentration capability. Even ultra-volatiles and polar species can be quantitatively retained, while interferents such as CO<sub>2</sub> and water are selectively eliminated

### Flexible and future-proof

- Electronic splitting capability (2–500 mL/min) and the option of small-volume sampling *via* gas-loop further enhance compatibility with high-concentration samples. This eliminates the need for time-consuming sample preparation steps such as canister dilution
- Compatible with both canister/bag analysis and method-compliant analysis of sorbent tubes, allowing you to satisfy a wider range of applications, such as TO-17 air toxics, SVOCs and passive sampling



Indoor air quality



Soil gas



Fugitive industrial emissions



Urban/ambient air

## The CIA Advantage range

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The CIA Advantage range comprises two systems:

### CIA Advantage-T™

A dedicated system for analysis of trace-level components, e.g. in ambient air or process gas streams. This system introduces sample volumes from each canister in the range 10 mL to 1 L (depending on canister size).

The CIA Advantage-T accommodates up to four canisters with the standard model, or 17 when used with the optional CIA Satellite™ module.

### CIA Advantage-HL™

A versatile system for analysis of both high- and low-concentration samples and for screening unknowns, incorporating gas-loop sampling in addition to the standard mass flow control. This system introduces sample volumes from each canister in the range 0.5 mL to 1 L (depending on canister size).

The CIA Advantage-HL accommodates up to fourteen canisters with the standard model, or 27 when used with the optional CIA Satellite module.



### Gas-loop sampling

For the analysis of high-concentration samples, or those of unknown concentration, gas-loop sampling (available in the CIA Advantage-HL model) has distinct benefits over mass flow control. The gas loop introduces a precise volume of sample (0.5 mL), allowing high-concentration samples to be analysed in the same automated run as trace-level samples. When running a range of sample types, or analysing unknowns, this saves both time and money, without the risk of contamination.

## Innovation and excellence in air-monitoring technology from Markes International

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Since 1997, Markes International has grown to become the world's leading supplier of sampling and analytical solutions for monitoring trace toxic and odorous chemicals in air, gas and materials. Serving fast-growing markets from environmental research to routine air monitoring and stack emission analysis, Markes' global customer base includes major industry, government agencies, academia and the service laboratory sector.

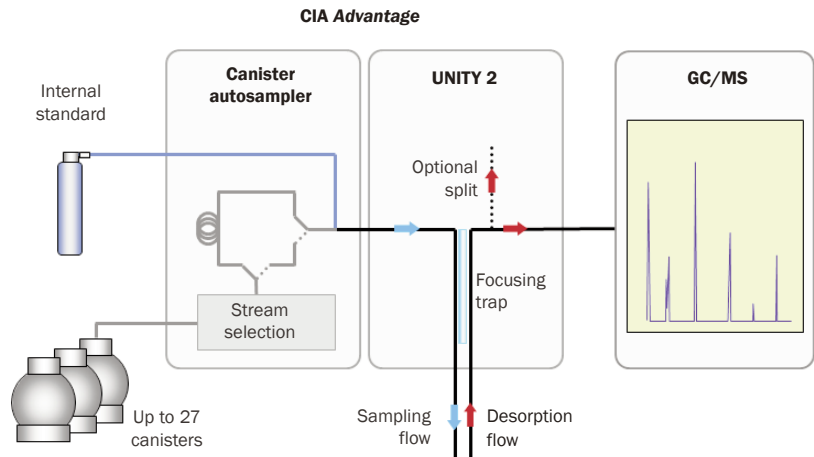
The CIA Advantage builds on these achievements, allowing canister users to benefit from the analytical excellence of Markes' world-class air-monitoring technologies.

# Capacity for up to 27 canisters

## Overview of operation

Metered by gas loop or mass flow controller, each air/gas sample is introduced directly into the electrically-cooled, sorbent-packed focusing trap. Sorbents and trapping temperatures are optimised for retention of organic components and simple/effective elimination of water and CO<sub>2</sub>. The trap then heats rapidly in a reverse stream of carrier gas to transfer the retained compounds into the analytical system. This transfer can be performed splitless for maximum sensitivity.

Flow path heating to 200 °C and uniquely effective line purging between samples eliminates carryover. This minimises the requirement for blanks and boosts productivity.



Schematic of CIA Advantage operation

## Performance characteristics

- Detection limits: <0.1 ppb (1 L sample, quad full scan)  
<10 ppt (1 L sample, quad SIM mode)
- Carryover: Typically <0.2 ng absolute (<0.04%)
- Precision: Target air toxic compounds: typically 1–10% RSD
- Internal standards: 1–4% RSD
- Linear conc. range: Up to 5 orders of magnitude, harnessing split versatility

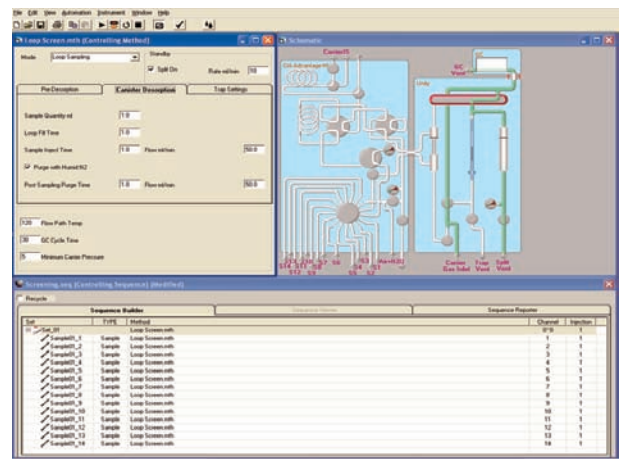
## Simple user interface

Sequence building is a clear and simple process with Markes' intuitive software. Each channel can be identified as sample, calibrant or blank, and associated with the appropriate analytical method.

## Full sequence reporting

All analytical parameters are automatically recorded, enabling quick confirmation of a successful run. Any sequence failure triggers the GC(MS) system to start a blank run to keep the analyser in step with the canister autosampler.

Simple user interface – instrument parameters, flow schematic and sample sequence in one simple, easy-to-follow layout



# The perfect solution for US EPA Method TO-14/15

## Full compliance with US EPA Method TO-14/15

Monitoring the volatile organic hazardous air pollutants specified in US EPA Method TO-14/15 for air toxics is a key canister application. CIA *Advantage* offers full compatibility with this method, while providing the productivity and analytical excellence that comes as standard with all Markes systems.

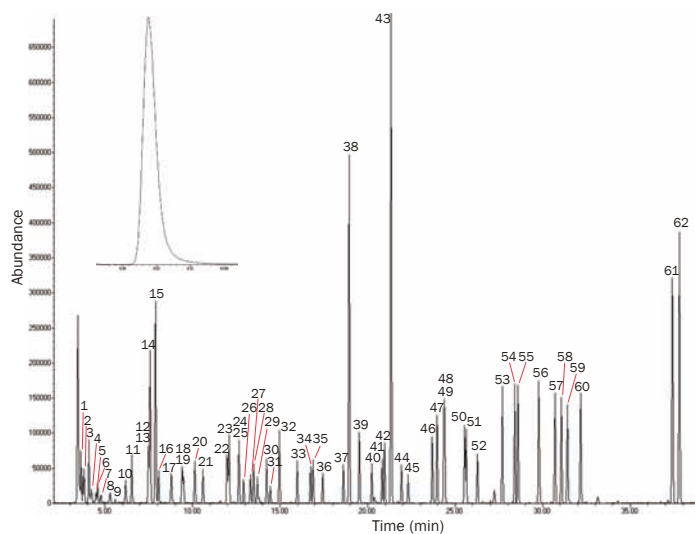
Routine TO-14/15 analysis benefits hugely from the peerless analytical performance of the CIA *Advantage* coupled with low-cost, cryogen-free operation. Internal standard addition capability is included as standard for optimum reproducibility.

Negligible carryover and the inherent concentration flexibility of the CIA *Advantage* also mean that ambient air samples can be directly calibrated with small volumes of relatively inexpensive higher-concentration standards if required. (Alternatively, Markes' diluter can be used to generate low-level standards from ppm-level calibration gases.)



Compound	RSD (%)
1,3-Difluorobenzene	2.02
Chlorobenzene-d <sub>5</sub>	2.32
Bromochloromethane	2.00
4-Bromofluorobenzene	3.41

Standard deviations for the peak areas for 10 runs of four internal standards, showing the precision of the instrumentation



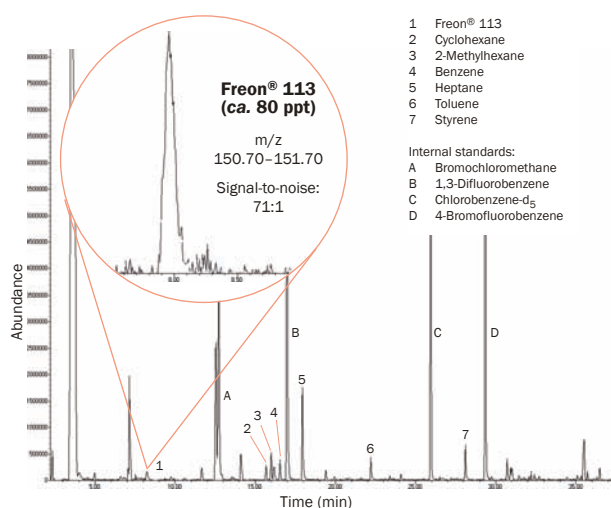
- |    |   |    |                           |
|----|---|----|---------------------------|
| 1  | Propene   | 31 | Benzene                   |
| 2  | Dichlorodifluoromethane                             | 32 | n-Heptane                 |
| 3  | 1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon® 114) | 33 | Trichloroethene           |
| 4  | Chloromethane                                       | 34 | 1,2-Dichloropropane       |
| 5  | Chloroethane  | 35 | 1,4-Dioxane               |
| 6  | 1,3-Butadiene                                       | 36 | Bromodichloromethane      |
| 7  | Vinyl chloride                                      | 37 | cis-1,3-Dichloropropene   |
| 8  | Bromomethane  | 38 | 4-Methylpentan-2-one      |
| 9  | 1,2-Dichloroethane                                  | 39 | Toluene                   |
| 10 | 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon® 113)  | 40 | trans-1,3-Dichloropropene |
| 11 | Ethanol   | 41 | 1,1,2-Trichloroethane     |
| 12 | 1,1-Dichloroethene                                  | 42 | Tetrachloroethene         |
| 13 | Trichlorofluoromethane                              | 43 | Hexan-2-one               |
| 14 | Acetone   | 44 | Dibromochloromethane      |
| 15 | Carbon disulfide                                    | 45 | 1,2-Dibromoethane         |
| 16 | Isopropanol   | 46 | Chlorobenzene             |
| 17 | Dichloromethane                                     | 47 |                           |
| 18 | Methyl tert-butyl ether                             | 48 | o-, m-, p-Xylene +        |
| 19 | cis-1,2-Dichloroethene                              | 49 | Ethylbenzene              |
| 20 | n-Hexane  | 50 |                           |
| 21 | 1,1-Dichloroethane                                  | 51 | Styrene                   |
| 22 | Vinyl acetate                                       | 52 | Bromoform                 |
| 23 | trans-1,2-Dichloroethene                            | 53 | 1,1,2,2-Tetrachloroethane |
| 24 | Butan-2-one   | 54 | Trimethylbenzene          |
| 25 | Ethyl acetate                                       | 55 | Trimethylbenzene          |
| 26 | Tetrahydrofuran                                     | 56 | 1-Ethyl-4-methylbenzene   |
| 27 | Chloroform  | 57 | Dichlorobenzene           |
| 28 | 1,1,1-Trichloroethane                               | 58 | Dichlorobenzene           |
| 29 | Cyclohexane   | 59 | α-Chlorotoluene           |
| 30 | Carbon tetrachloride                                | 60 | Dichlorobenzene           |
|    |   | 61 | 1,2,4-Trichlorobenzene    |
|    |   | 62 | Hexachloro-1,3-butadiene  |

1 L of a 1 ppb 'air toxics' mix analysed splitless, cryogen-free and in full-scan mode using TD-GC/MS (quad) according to US EPA Method TO-15. The inset shows the excellent Gaussian peak shape for 1 ppb isopropanol analysed splitless using extracted mass ion 45

## Analytical excellence

### Optimum sensitivity

Highly efficient trapping and desorption, even under splitless conditions, makes for optimum sensitivity and resolution. This enhances identification of target analytes, even at trace levels and against the most complex backgrounds.



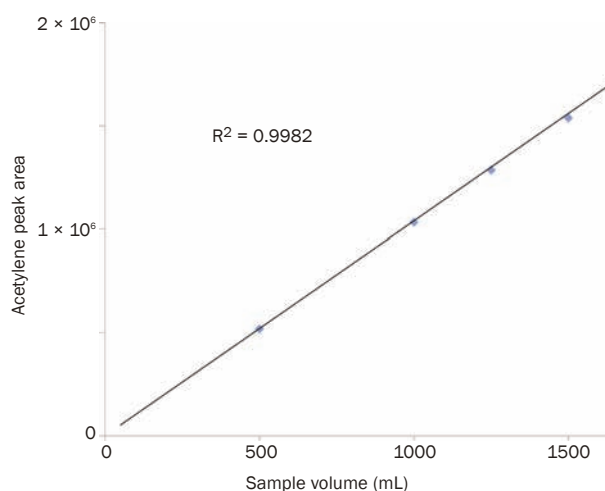
**Total ion chromatogram showing splitless analysis of only 10 mL of semi-rural air using the CIA Advantage in combination with GC/TOF MS. Inset: Extracted-ion chromatogram for a characteristic fragment ion of Freon® 113 (present in the atmosphere at ca. 80 ppt), showing the remarkably high sensitivity of this system**

### Negligible carryover

For a system to be capable of analysing samples covering a wide concentration range within a single sequence, it must have exceptionally low sample carryover. By combining a heated low-volume flow path (operating to up 200 °C) and stringent purging steps, the CIA Advantage completely eliminates the risk of analyte condensation and carryover.

## Uniquely efficient trapping

High-performance analysis of highly volatile hydrocarbons is straightforward with the CIA Advantage. The efficient design of the UNITY 2 focusing trap, integrated into every CIA Advantage system, even allows quantitative retention of acetylene using sample volumes up to 1.5 L. Moreover, Markes' technology achieves this without the need for liquid cryogen.



**Plot of peak area against sample volume of a 4 ppb acetylene standard sampled using the CIA Advantage, demonstrating outstanding linearity**



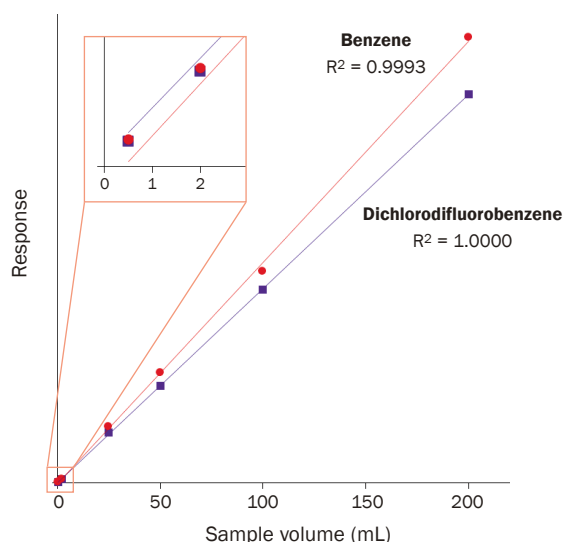
# The most reliable and versatile system for canisters available

## Flexible and future-proof

### Wide concentration range

Gas loop and mass flow control sampling options accommodate sample volumes ranging from 0.5 mL to 1 L (depending on the canister size and which CIA Advantage model is chosen).

Negligible carryover and electronically-controlled sample splitting (2–500 mL/min) further enhance the dynamic range, allowing both high- and low-concentration samples to be analysed in the same sequence without the need for dilution. Excellent linearity is obtained across the range.



Responses for loop sampling (at 0.5 and 2 mL), and MFC sampling (at 25, 50, 100 and 200 mL) for selected compounds from the TO-15 standard, showing that a single curve can be fitted to both sampling methods

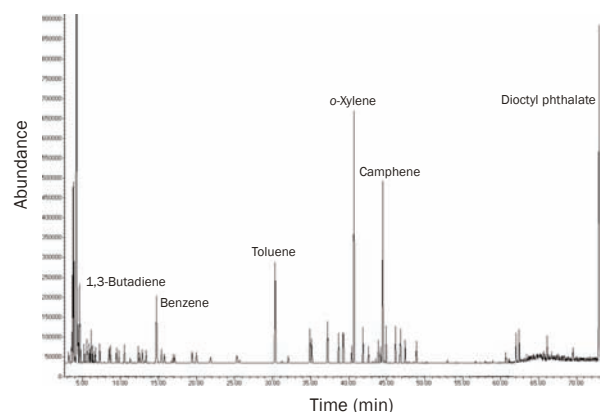
### Tube desorption

Sorbent tubes complement canisters, offering compatibility with SVOCs as well as conventional VOC air toxics. Tube desorption capability also facilitates passive sampling for unobtrusive personal monitoring and cost-effective deployment of large

numbers of samplers during major field studies. Every CIA Advantage offers Markes' world-leading manual tube desorption capability featuring SecureTD-Q™ – quantitative sample re-collection for repeat analysis. Tube desorption can also be fully automated, allowing you to adapt your CIA Advantage to any future requirement.

### Maximum volatility range

The design and efficiency of the electrically-cooled UNITY 2 focusing trap, integrated into every CIA Advantage system, gives optimum performance for the widest possible range of analytes. Ultra-volatile species such as freons and C<sub>2</sub> hydrocarbons can be analysed quantitatively, together with the highest-boiling compounds that can be reliably recovered from canisters or ambient-temperature air/gas streams.



Sorbent tube desorption of a standard mixture of compounds relevant to materials emissions testing, showing the ability of the CIA Advantage to handle compounds with a wide range of volatility

### Suitable for fixed and mobile laboratories

Cryogen-free operation means the CIA Advantage is ideal for installation in unattended field monitoring stations (on-line mode) or mobile labs, as well as the traditional laboratory environment.





## Economy and productivity

### No liquid cryogen

The efficient electrically-cooled trapping used in the CIA Advantage eliminates many of the costs and complexities associated with cryo-cooled systems. This means no topping-up with coolant, fewer interruptions to automated sequences, and simplified water management. Electrical cooling is also fully compliant with US EPA Methods TO-15 and TO-17.

### High-throughput operation

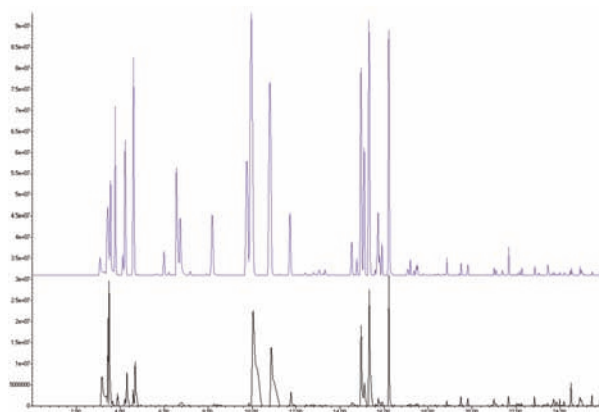
With up to 27 channels available, the CIA Advantage allows round-the-clock operation. In addition, a range of sample volumes and widely differing concentrations can be accommodated in the same sequence. This increases the efficiency of workflow and means that uncharacterised samples can be prescreened automatically with no need for dedicated equipment.

### Sample integrity – no cross-contamination

Heated internal lines (up to 200°C) and uniquely efficient purging combine to eliminate carryover. This means fewer blanks and more samples, allowing you to generate higher revenue. Even two fewer blanks per day could result in an extra \$400, generating up to \$100,000 extra income every year (based on a 5-day working week).

## Advanced water management

The CIA Advantage deals effectively with even the most humid of samples. Selective purging of water, sophisticated sample splitting and optional in-line dryers reduce water accumulation and maximise up-time. Other air interferences such as CO<sub>2</sub> are also selectively purged before analysis.



**Analysis of humid air sample using the CIA Advantage. The top panel shows the effect of optimised water management using the CIA Advantage, while the bottom panel shows the lower response and poor peak shape that result when water is not selectively eliminated prior to analysis**

## Easy maintenance and high uptime

The robust modular design of the CIA Advantage minimises maintenance costs and maximises uptime. Systems are backed-up by Markes' experienced technical support team, and feature advanced functions for sample security. Internal standard addition and an integrated leak test ensure quantitative sample transfer and reliable data time after time.

# Eliminates the cost of liquid cryogen

# Full range of accessories and consumables

## Options and accessories

### CIA Satellite

Both the 4-channel CIA Advantage-T and the 14-channel CIA Advantage-HL can be used in conjunction with the CIA Satellite.

This module increases automation by 13 channels in each case, providing extra capacity for canister processing.



### Canisters and bags

Markes provides a selection of canisters optimised for US EPA method TO-14/15 and ASTM D5466. The canisters (electropolished or inert coated) contain high-quality metal-to-metal seals and a stainless steel diaphragm valve.



### Diluter

Markes' diluter makes possible the accurate dilution of a standard gas, allowing the creation of multiple different calibration levels from a single original standard.

### Canister racks

Markes' canister racks hold up to 15 canisters (14 samples and one internal standard). The bench-mounted model holds canisters up to 1 L, and the floor-mounted model holds canisters up to 6 L in size.



### Pump

An optional pump is available to assist in the introduction of samples from non-pressurised sources.

### Dryer kit

To assist with the removal of water from humid apolar samples (e.g. C<sub>2</sub> to C<sub>10</sub> ozone precursors), Markes can provide an optional Nafion® dryer kit.

### Canister cleaner

The TO-14/15-compliant TO-Clean canister conditioning system can be adapted for different canister sizes from 12 x 6 L to 48 x mini-cans. The system is fully automated, allowing the user to start a cleaning cycle and walk away. Using the touch-screen controller, up to ten custom cleaning methods can be defined and loaded as needed. The system also comes with an automated leak-check method, ensuring consistently high performance.



## Tube desorption

The *CIA Advantage* features US EPA Method TO-17-compliant desorption of industry-standard tubes as well as automated canister analysis. Sorbent tubes extend the airborne analyte range beyond the limitations of canisters and other whole-air containers, to include critical semi-volatile pollutants such as middle-distillate fuels, PAHs, phthalates, chemical agents and PCBs. Complete recovery of the vapour fraction of compounds boiling up to n-C<sub>40</sub> is possible.

A wide range of sorbent tubes and associated sampling accessories is available from Markes, to allow you to take full advantage of this capability. Key options include method-compliant tubes in stainless steel, glass or inert-coated steel, packed with up to three sorbents arranged in discrete sorbent beds. A range of pumped and passive sampling accessories is also available – see Markes' comprehensive catalogue for details.

The optional addition of Markes' ULTRA™ autosampler to your *CIA Advantage* system allows up to 100 sorbent tubes to be processed automatically.

In summary, with *CIA Advantage* technology, laboratories are equipped to offer the widest range of air-monitoring services.

## Trademarks

*CIA Advantage*™, *CIA Advantage-T*™, *CIA Advantage-HL*™, *CIA Satellite*™, *UNITY 2*™, *SecureTD-Q*™ and *ULTRA*™ are trademarks of Markes International Ltd, UK.

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## System upgrades

Upgrading an existing *UNITY 2* to a *CIA Advantage* is straightforward due to the modular nature of all Markes systems. Simply contact us for further details.



**The *CIA Advantage* system configured with the ULTRA for automated analysis of tubes and canisters**



**Consult our catalogue for Markes' comprehensive range of thermal desorption and air monitoring accessories**

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