

Scientific/Metrology Instruments  
Direct Analysis in Real Time  
Time-of-Flight Mass Spectrometer

## AccuTOF-DART



# Rapid, Accurate Open Air Analysis



## Direct Analysis with Time-of-Flight MS

AccuTOF-DART® is the perfect union of a time-of-flight mass spectrometer and an open air ion source.

The DART ion source fully utilizes the speed and accuracy of the AccuTOF for small molecule analysis, producing clean, reproducible, easy-to-interpret data.

## Real Time Analysis

AccuTOF-DART has completely changed the field of mass spectrometry. Now you can immediately determine chemical composition of knowns and unknowns, and produce high-resolution, accurate mass spectra by simply placing a sample, in its native form, between the DART ion source and the AccuTOF mass spectrometer inlet.

## Wide Analytical Range

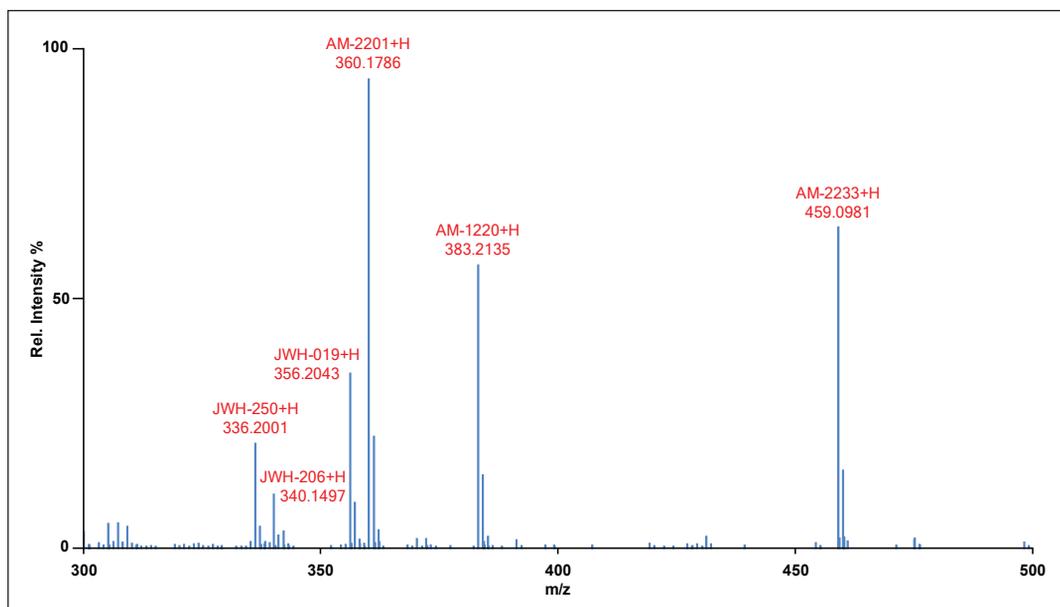
No interface is required between the DART and the MS, therefore the AccuTOF-DART is able to detect a wider range of polar and nonpolar compounds than any other ambient mass spec system.

## Award-winning Technology

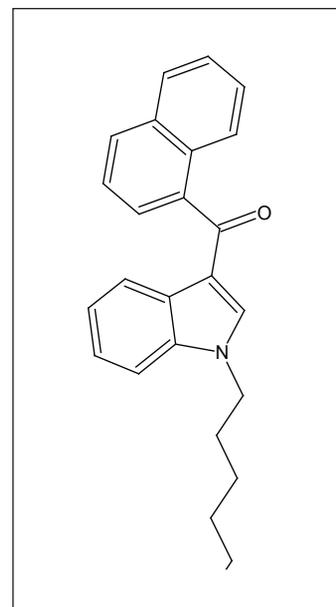
JEOL introduced the DART ion source in 2005, and the technology quickly gained recognition, winning both the Pittcon Editor's Gold Award and the R&D 100 Award. Since that time nearly 400 papers have been published by chemists using the AccuTOF-DART.

The introduction of DART made it possible for the first time to carry out atmospheric pressure ionization for analysis of samples in open air.

## Designer drugs: spice – bath salts – K2



## AM-2201



# Fast Answers for Tough Problems

## Rapid Analysis Minus the Chromatography

DART reduces or eliminates the need for any special sample preparation or solvents. The DART source ionizes almost anything put in front of it, including solutions straight from the synthetic reaction pot, crude extracts, unknown pills or powders, sticky liquids, vapors, TLC plates, and more. It rapidly acquires data for mixtures and complete unknowns without sample carryover, and the resulting spectra yield unambiguous assignments, isotopic ratios and elemental compositions.

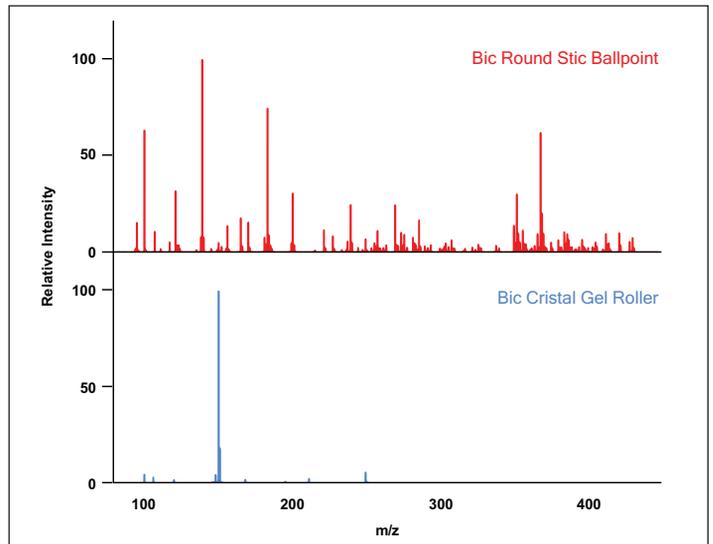
The AccuTOF-DART will exponentially improve your MS workflow – it is the only high-performance mass spectrometer system that works as fast as you think.



## AccuTOF-DART for:

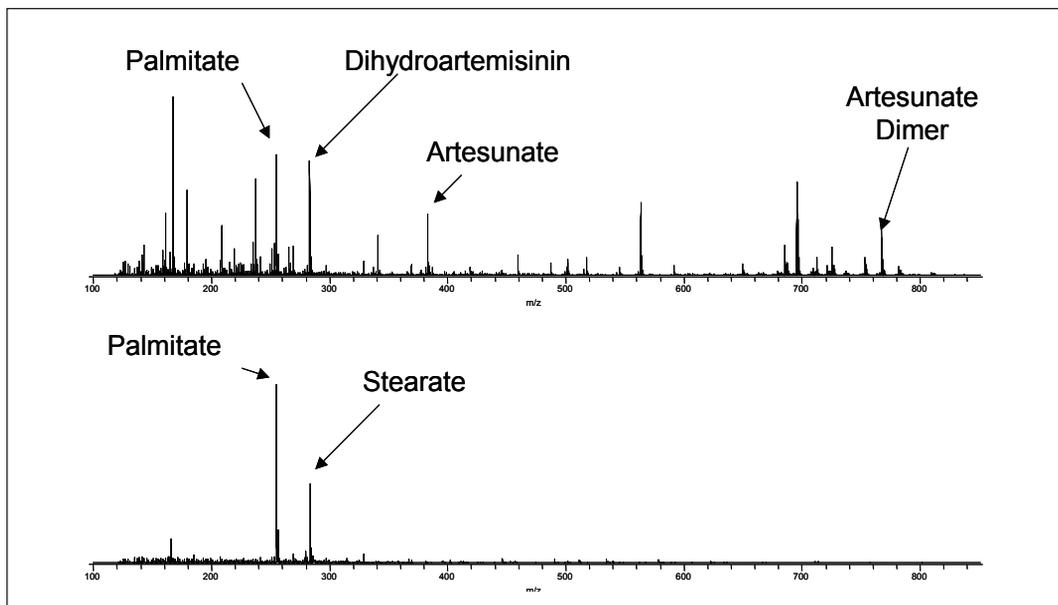
- Food, Flavors, Fragrances
- Forensic Evidence
- Homeland Security Threats
- Industrial Materials
- Organic Synthesis
- Liquids, Powders, Vapors
- Residue on Any Material
- Biological Fluids
- Trace Evidence
- Questioned Documents
- Illicit Drugs
- Counterfeit Drugs
- Fingerprints
- White Powders
- Materials
- Pesticides
- Art Conservation
- Explosives
- Reaction Monitoring
- And much more

*without the need for sample preparation in most cases*



*Ink analyzed directly from paper samples*

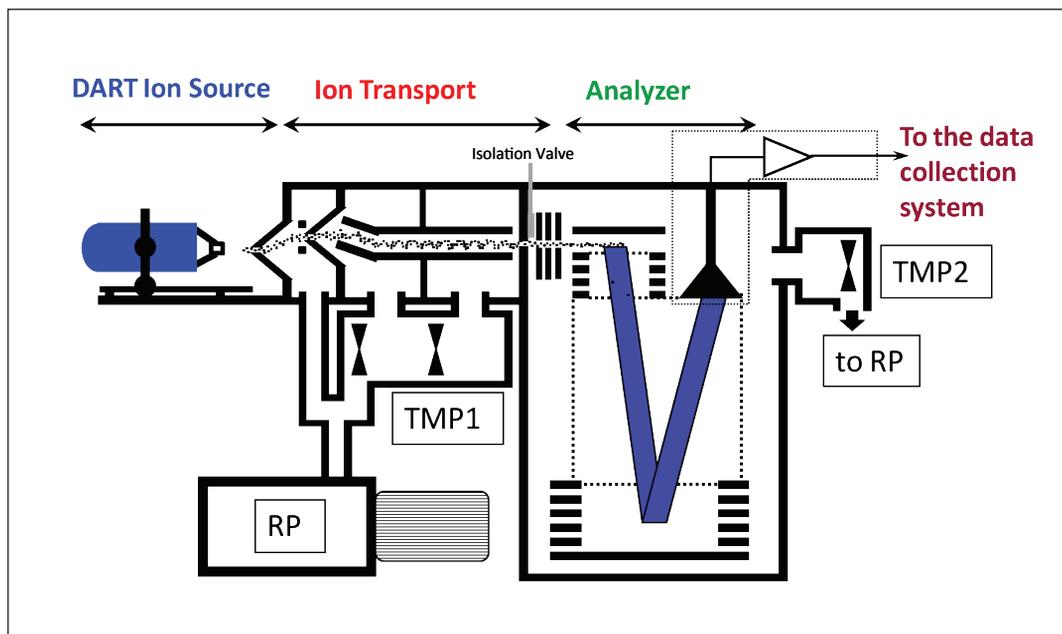
Jones, McClelland (Iowa State University)



*Detecting Counterfeits:  
antimalarial tablet (top)  
and fake tablet (bottom)*

Facundo Fernandez,  
(Georgia Institute of Technology)

# Robust Combination



## The AccuTOF Advantage

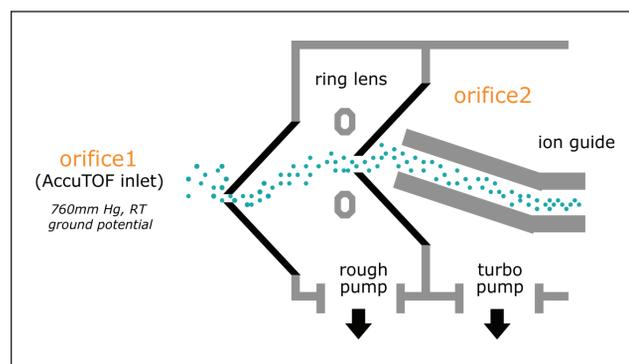
The DART was developed for the JEOL AccuTOF mass spectrometer. The AccuTOF has a rugged, simple, contamination-resistant interface that is a perfect match for the wide variety of samples that can be analyzed by DART. As a result, the user can analyze a far wider range of samples that would not be possible with any other mass spectrometer.

The AccuTOF does not require an interface between the DART and the mass spectrometer. An interface can cause a loss of signal for some compound types. The speed and accuracy of the AccuTOF ensure that you obtain the maximum information from a sample analysis.

The AccuTOF-DART is capable of analyzing polar and non-polar compounds. The DART can be positioned within 1 cm of the MS sampling orifice. This helps to detect "difficult" compounds such as saturated hydrocarbons, alcohols, and other non-polar analytes and oxygen adducts  $[M + O_2]^-$ .

The AccuTOF flight tube is maintained at a constant temperature, ensuring stable mass accuracy.

*For even more sampling versatility, the standard configuration also includes an orthogonal electrospray (ESI) source.*



## Robust, Clean Chemistry

Analyze any number of samples, even the dirtiest, without cross-sample contamination. The AccuTOF-DART stands up to:

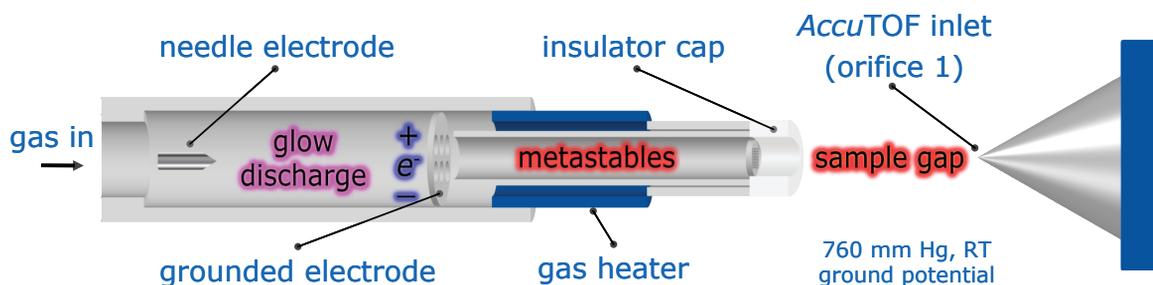
- mud
- blood
- peanut butter
- crude oil
- olive oil
- residues on fabrics
- and much more

in any order, with only the occasional need for cleaning the inlet.

### Isolation Valve

The isolation valve between the ion guide and the TOF analyzer makes it possible to retain high vacuum in the analyzer whenever the ion transport system is undergoing cleaning or maintenance.

# DART Ionization

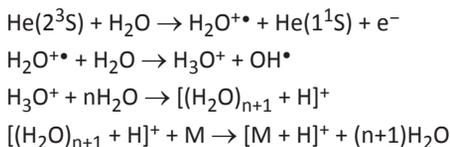


## How DART Works

A gas (usually helium) is passed into a chamber around a needle electrode held at a high potential. A glow discharge is produced between the needle and a grounded electrode, creating both charged particles and excited-state species. Afterwards, the gas flows into a heater region that is used to control the overall temperature of the gas stream. This temperature is adjusted to facilitate thermal desorption and/or pyrolysis of the samples placed in the sample gap. The metastables leave the heater region, and pass through an exit grid biased electrode, then a ceramic insulator cap. The gas stream ionizes the samples placed in the sample gap (in open air). The sample ions formed in this region (either positive or negative) are then carried into the AccuTOF mass spectrometer inlet.

## Positive Ion

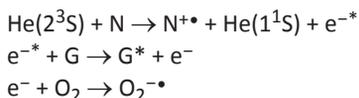
The metastable helium atoms formed in the DART source react with atmospheric water to produce ionized water clusters. These protonated water clusters can then react with the analyte (M) to form protonated cations:



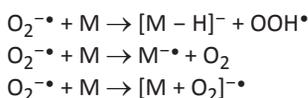
The  $\text{He}(2^3\text{S})$  electronic excited state has an energy of 19.8 eV and a reaction cross-section of  $100\text{\AA}$  for water ionization, which is optimal for promoting the above reaction scheme.

## Negative Ion

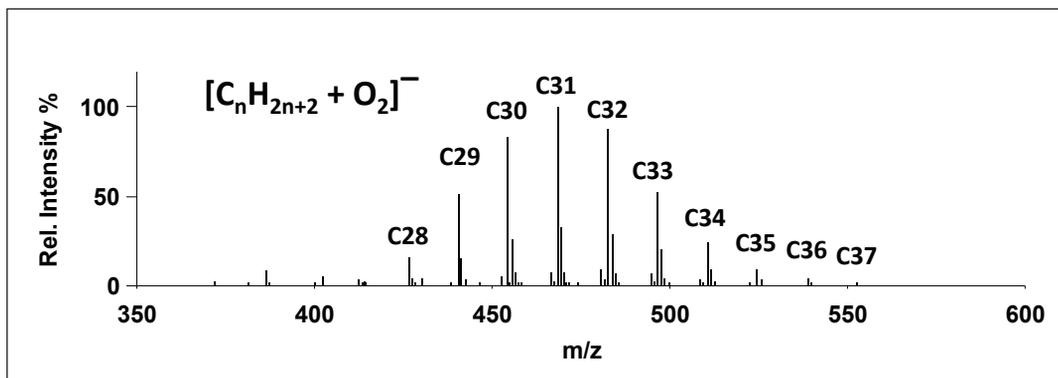
Metastable helium atoms can react with a neutral (N), such as the exit grid electrode, or another neutral species to form electrons through Penning ionization. The electrons formed are rapidly thermalized by collisions with atmospheric gases (G) and then react with gaseous oxygen to produce oxygen anions:



These oxygen anions can then react with sample molecules (M) to produce analyte anions:



## Negative Ion Advantage



Negative ion: saturated hydrocarbons (Parafilm)

For a complete discussion of the DART technique and its ionization mechanisms, please consult *Anal. Chem.* 2005, 77, p. 2297-2302, or our website at [www.jeolusa.com](http://www.jeolusa.com).

## Rapid Screening And Reproducibility



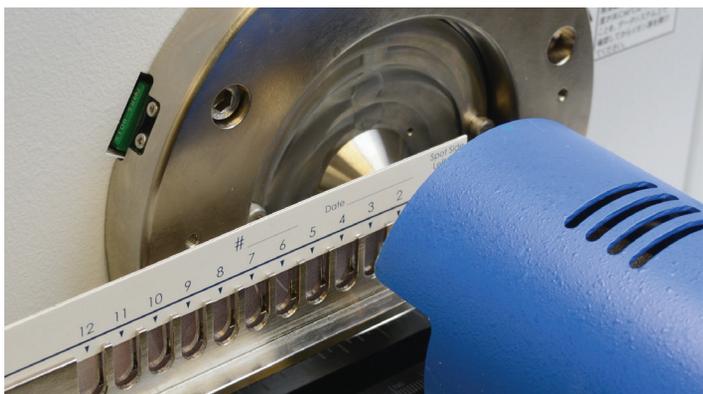
### Direct Capillary Insert

To increase sample reproducibility and accuracy, the DART ion source can be outfitted with an optional Direct Capillary Insertion Module. Apply the sample to the end of a standard size melting-point capillary, place it in the module, secure it using the magnetic lock, and start your DART analysis.



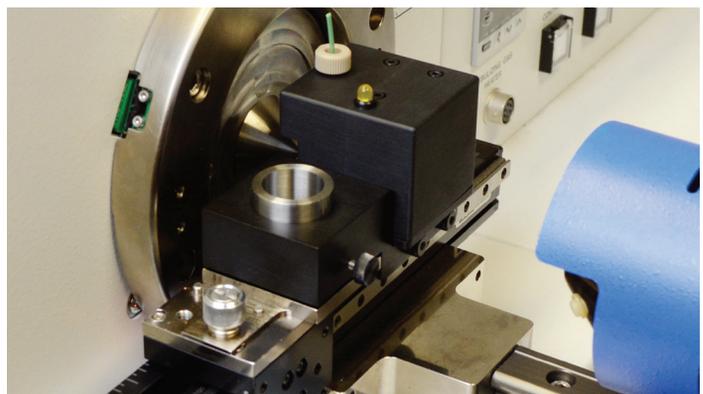
### 12-Sample Microtiter Row

The 12 DIP-it<sup>®</sup> sampler automates the analysis of up to 12 liquid samples at a time, facilitating rapid qualitative and quantitative analysis. The module easily attaches and detaches in seconds.



### Quick Strip Module

In transmission mode, the DART gas flows through a disposable mesh onto which samples are deposited. The Quick Strip Module improves signal reproducibility for quantitative analysis (included with all DART units equipped with linear rail).



### PaperSpray<sup>®</sup> Attachment (Optional)

PaperSpray allows spotting a sample on a disposable paper triangle to obtain electrospray ionization mass spectra without the complication of pumps or plumbing. PaperSpray can even be used for ambient inorganic analysis. A PaperSpray attachment can be mounted onto the linear rail of the AccuTOF-DART to permit PaperSpray analysis on the sample platform as DART without any hardware modifications.

PaperSpray<sup>®</sup> is a registered trademark of the Purdue Research Foundation and is used under license.



### Electrospray (ESI) Source

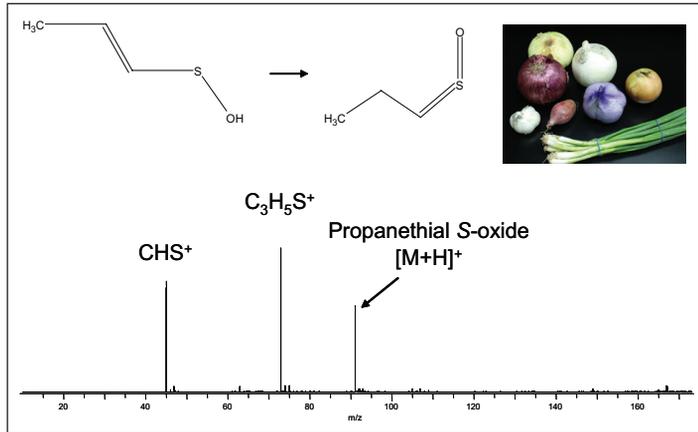
The instrument is also supplied with an Electrospray (ESI) source for LC/MS applications. Other LC/MS interfaces are optionally available.

# Analyze Samples in their Native Form

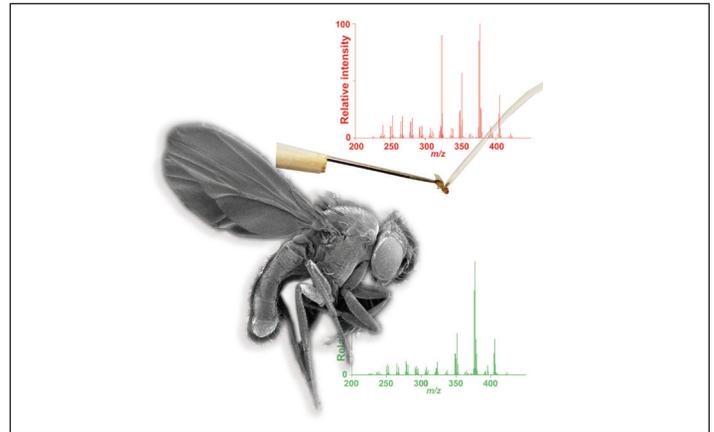
## Analyze Samples in Their Native Form

What can you do with an AccuTOF-DART? Analyze virtually anything at hand, with little or no preparation of the sample and without damaging the sample. JEOL opened the door for a new, fast, reliable type of mass analysis that expands the horizon for never-before-attempted experiments. This ability to capture data from a split second in time makes AccuTOF-DART ideal for measuring reactive compounds and transient intermediates.

### Unstable compounds: garlic and chives

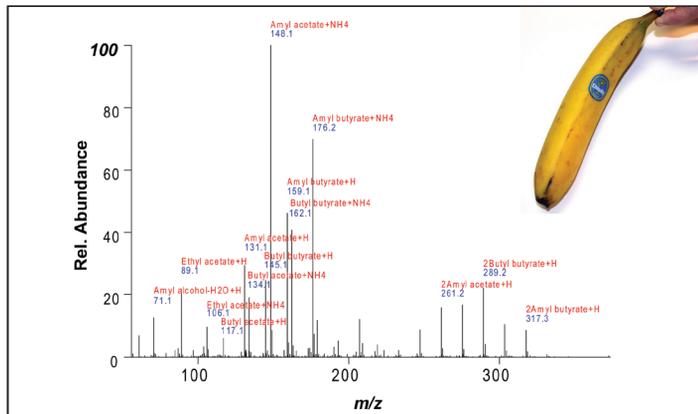


### Fruit fly pheromones

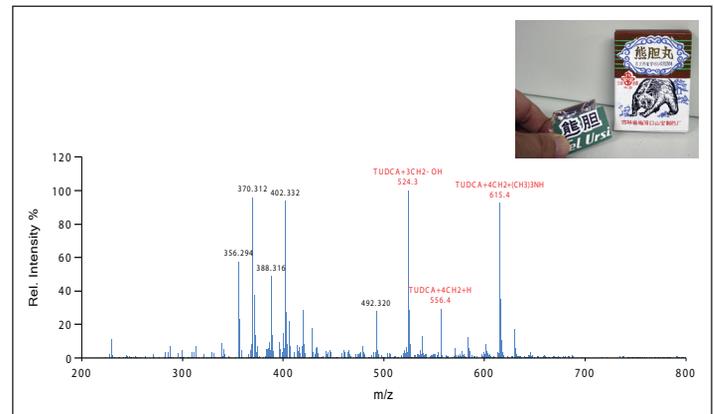


Joanne Yew (Temasek Life Sciences Laboratory, Singapore – previously Harvard Medical School)

### Solid-Phase Microextraction (SPME)

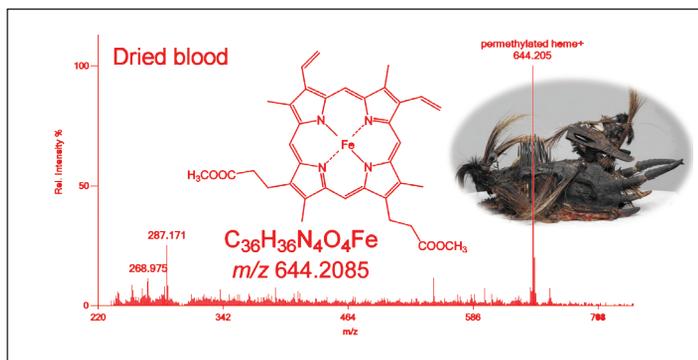


### Contraband: bear bile (UDCA)



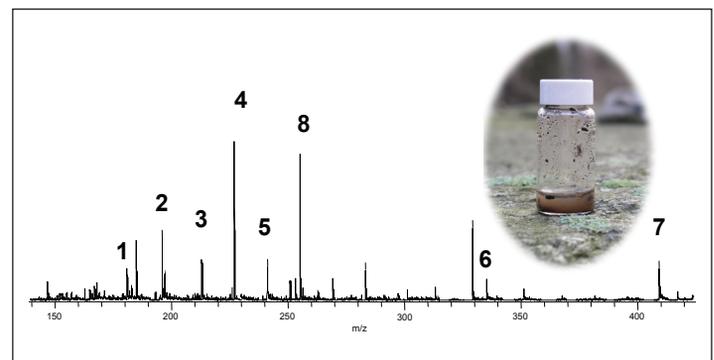
National Fish and Wildlife Forensic Laboratory

### Art conservation and validation

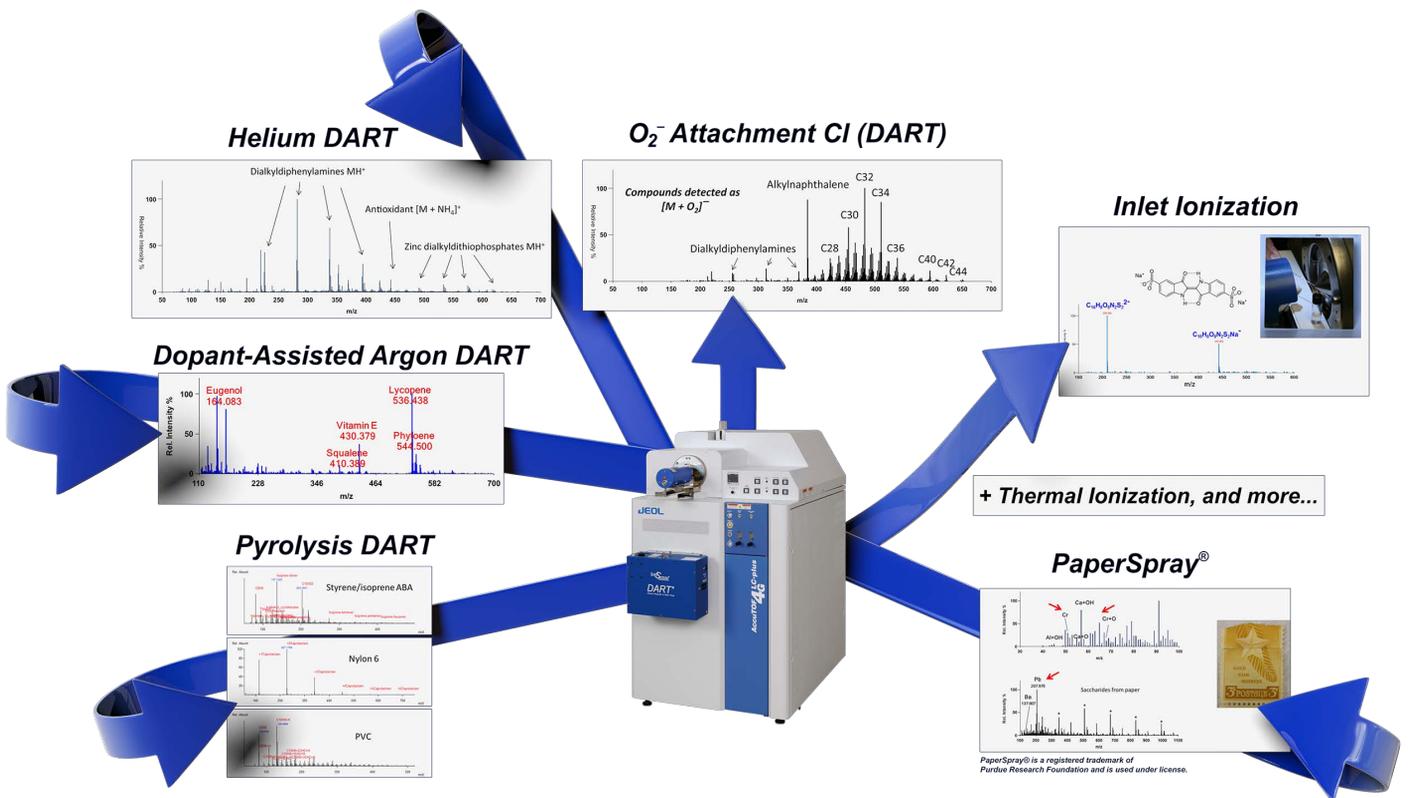


African Komo Mask (Detroit Institute of Arts)  
Ruth Ann Armitage (Eastern Michigan University) and Daniel Fraser (Lourdes University)

### Explosives: 8 detected in muddy water



# AccuTOF-DART: The Ambient Ionization Toolbox™



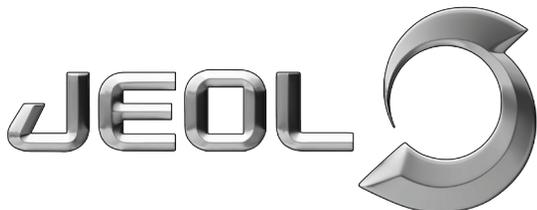
## Proven Performance and Dependability

The AccuTOF-DART revolutionized mass spectrometry in 2005 and has been the topic of nearly 400 peer reviewed research papers written by users of this technology.

AccuTOF-DART has played a vital role in analysis and has streamlined the way analysis can be done. It has been used for a variety of applications including detection of counterfeit anti-malarial drugs, toxic materials in food and building supplies, screening for the presence of concealed drugs, metabolic analysis, food safety, authentication of art and historical artifacts, explosives detection, identification of unknown materials and contaminants, forensic analysis, and much more.

JEOL Applications Notes, published papers, and a full bibliography are available on the JEOL USA website at [www.jeolusa.com](http://www.jeolusa.com).

JEOL is renowned for its support and commitment to customer satisfaction. Our excellence in scientific instrumentation is well-known throughout the world.



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