Comprehensive Drug Screening for Forensic Toxicology

Overcome Evolving Toxicology Screening Challenges with High Resolution Mass Spectrometry (HRMS)

Waters™

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Introduction: Today's Challenges

The last 20 years has seen the rapid emergence of novel psychoactive substances (NPS)

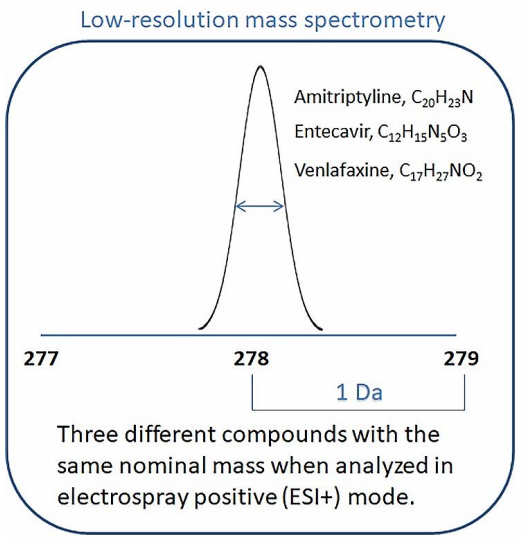
Hundreds of NPS have emerged and the NPS landscape is constantly evolving which means that traditional screening methods will not be able detect and identify them.

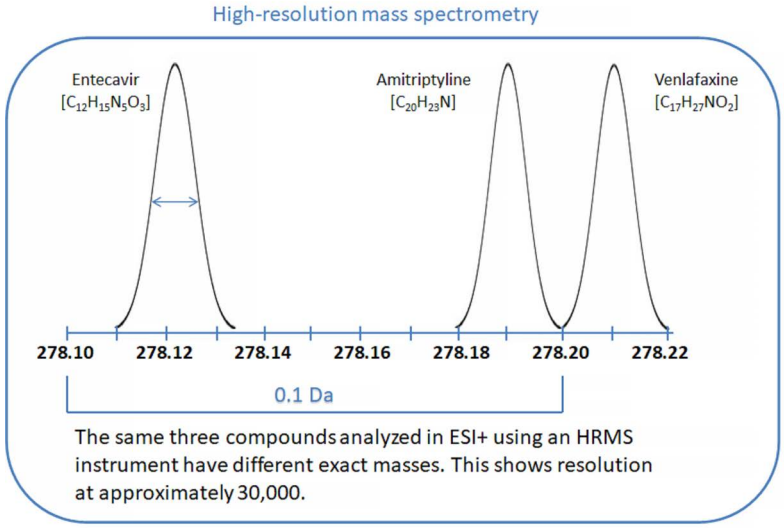
Challenges faced by forensic toxicology laboratories include:

- Large number of drugs to screen for, including known illicit, pharmaceutical, and newly emerging NPS
- Constantly evolving drug landscape with new drugs and analogs emerging
- Standard/reference materials not always available for method development
- Retrospective analysis not possible with immunoassay or tandem quad MRM methods
- Current screening methods face challenges when identifying drug metabolites

These challenges and more have led many forensic toxicology laboratories to implement high resolution mass spectrometry (HRMS).

Photo: © 2021 Securetec Detektions-Systeme AG



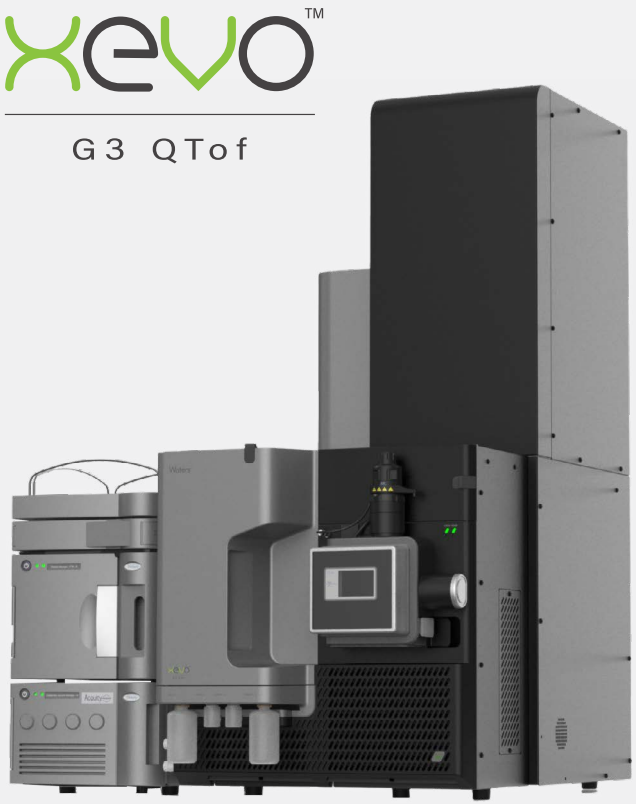


Benefits of HRMS and Accurate Mass

Using HRMS with the power of accurate mass data enables laboratories to confidently identify a comprehensive list of drugs and toxicants, investigate and identify new emerging drugs. With Waters HRMS LC-MS solutions , forensic laboratories can routinely perform the following tasks:

- **Comprehensive screening** – Search confidently against a library of 2000+ drugs, therefore screen for a much larger number of drugs than is possible with multiple reaction monitoring (MRM) methods on tandem quadrupole systems.
- **Confident known and "unknown" drug identification** – Accurately identify known drugs by comparison with library data and "unknown" NPS with accurate mass measurement of precursor and fragment ions utilizing in silico fragmentation and on-line databases
- **Identify compounds without reference material** – Reference materials are not essential for HRMS screening methods – unlike screening methods using tandem quadrupole systems.
- **Retrospective data analysis** – Waters HRMS systems acquire data using non-targeted acquisition, meaning that data on all ions are collected and stored. Unidentified peaks can be investigated later as new data on emerging NPS becomes available.

Read this primer to learn more about mass accuracy and resolution with high resolution mass spectrometry.



Waters Xevo G3 QTof System brings the power of accurate mass to the routine forensic toxicology laboratory.

A Complete System Solution for Toxicology Screening

Adopting HRMS in your forensic toxicology lab can be a challenge, but it's easier with a trusted partner and a proven solution. The Waters HRMS screening solution builds in three generations of Xevo QTof innovation and provides a complete solution for comprehensive toxicology screening.

The system includes the latest performance-leading ACQUITY UPLC, Xevo G3 QTof mass spectrometer and waters_connect informatics. This current HRMS screening platform builds on more than 15 years of successful operation in customer laboratories worldwide. The Waters HRMS screening solution offers:

- **A complete system solution** including liquid chromatography (LC), mass spectrometry (MS), informatics, and a proven method – all supported by Waters industry-leading technical support
- **Proven LC/MS method and data processing**, avoiding valuable time spent developing methods
- **A trusted solution** in toxicology laboratories worldwide
- **Library of more than 2000** toxicologically relevant compounds
- **Dedicated informatics for toxicology screening** with both targeted and non-targeted workflows

Read this article about how Waters HRMS can improve toxicology screening in a forensic toxicology laboratory.

A Comprehensive Portfolio of Forensic Toxicology

The Xevo G3 QTof accurate mass screening system is just one component of Waters extensive portfolio of systems for seized drugs analysis and forensic toxicology.

Waters forensic solutions can help with many analytical challenges, whether that's identifying seized drugs or new psychoactive substances, presenting reliable forensic data in court, monitoring illicit drug use, or analyzing prohibited substances in a sports doping investigation.

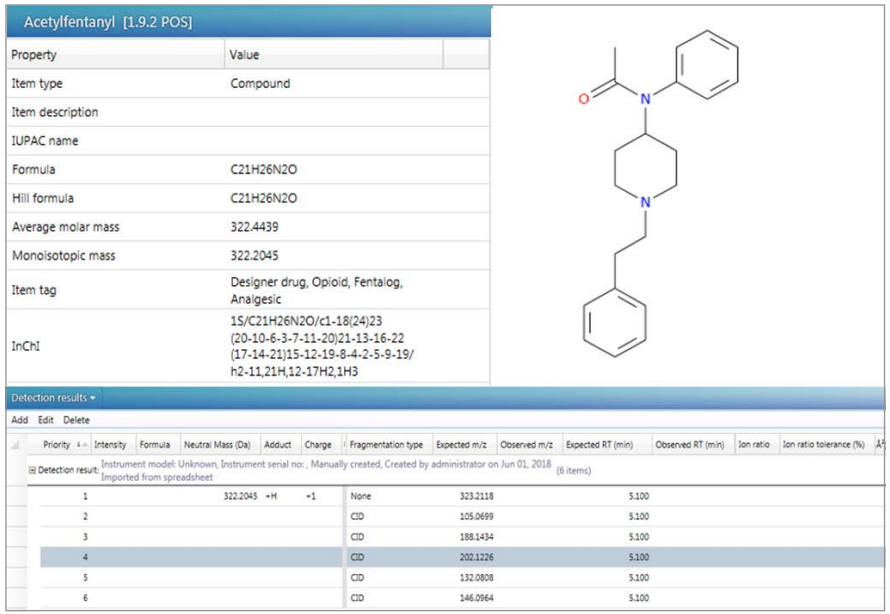
Waters forensic solutions can help your lab with key workflows like:

- **Seized drugs analysis** and rapid selective drug screening
- **Drug testing**, including urine, blood, hair, and oral fluid
- **Forensic toxicology**, including post-mortem toxicology, Driving Under the Influence of Drugs (DUID), and Drug-Facilitated Crime (DFC)

Explore the brochure to learn about the entire Waters portfolio of systems for seized drugs analysis and forensic toxicology.

Improve real-time seized drug analysis workflows and reduce sample backlogs using direct ionization mass spectrometry (MS) with RADIAN ASAP or ACQUITY Rda Detector.

The Xevo TQ-S micro tandem quadrupole in combination with the ACQUITY I-Class PLUS System is ideal for targeted screening and quantitative analysis of opiates, benzodiazepines, amphetamines, NPS, cannabinoids, synthetic cannabinoids, and many other drugs and metabolites. For the most demanding high sensitivity applications, Waters offers the Xevo TQ Absolute.



Rigorous checks have been performed to ensure the data in the library will result in identifications you can trust.

Accurate Mass Forensic Toxicology Library

At the heart of Waters HRMS screening solution is a comprehensive forensic toxicology library containing more than 2000 compounds.

Real-time information provided in the library includes: compound name, Chemical Abstracts Service (CAS) number, empirical formula, exact precursor mass, exact masses of multiple fragment ions, and retention time (RT). A Molfile is included for semi-targeted screening and automated in-silico fragmentation investigations.

Reliable and confident identification are dependent on the quality of libraries, not the quantity. Waters accurate mass library has been developed using a rigorous procedure to ensure data accuracy, with a comprehensive approach for independent data verification. With this approach, we ensure that all fragment data is thoroughly checked before being added to the Waters forensic toxicology library.

For added confidence, sample data can also be compared to third-party commercial and custom-built libraries.

Read this white paper to learn more about how the Waters accurate mass library has been produced and checked and recently enhanced to contain more than 2000 compounds.

2,000+
Toxicologically relevant compounds

97%+
Include Molfiles for semi-targeted analysis

200+
Fentanyl analogs/ metabolites

Informatics: waters_connect™

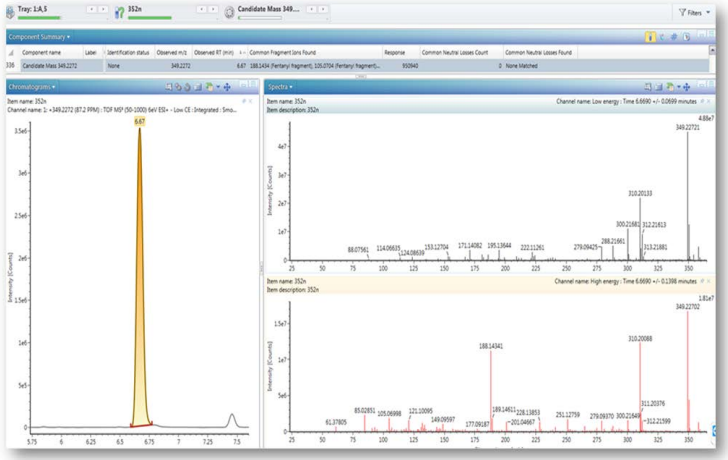
Informatics is critical when it comes to acquiring and processing HRMS data. The UNIFI toxicology screening application integrated in the waters_connect informatics platform makes toxicology screening a seamless process, resulting in simple LC-MS setup, operation, and confident drug identification.

The waters_connect platform brings a wealth of new features via an intuitive modern user interface. From instrument control to sample analysis and data processing, waters_connect with UNIFI enables users to confidently screen for known drugs of abuse and emerging NPS in a secure environment ensuring data integrity.

With waters_connect and UNIFI screening application, you only have to process the sample data once to perform several different tasks:

- **Identify known drugs of abuse and toxicants** by comparison with an accurate mass library utilizing mass spectra and retention time data
- **Quantify components of interest** in the sample
- **Look for drug metabolites**, characteristic fragments and ions
- **Compare one sample** to another
- **Investigate and identify components** that are not in the library
- **Utilize Molfiles** to investigate the presence of compounds
- **Search against on-line databases** with derived elemental composition and in-silico fragmentation

waters_connect with UNIFI toxicology screening application.

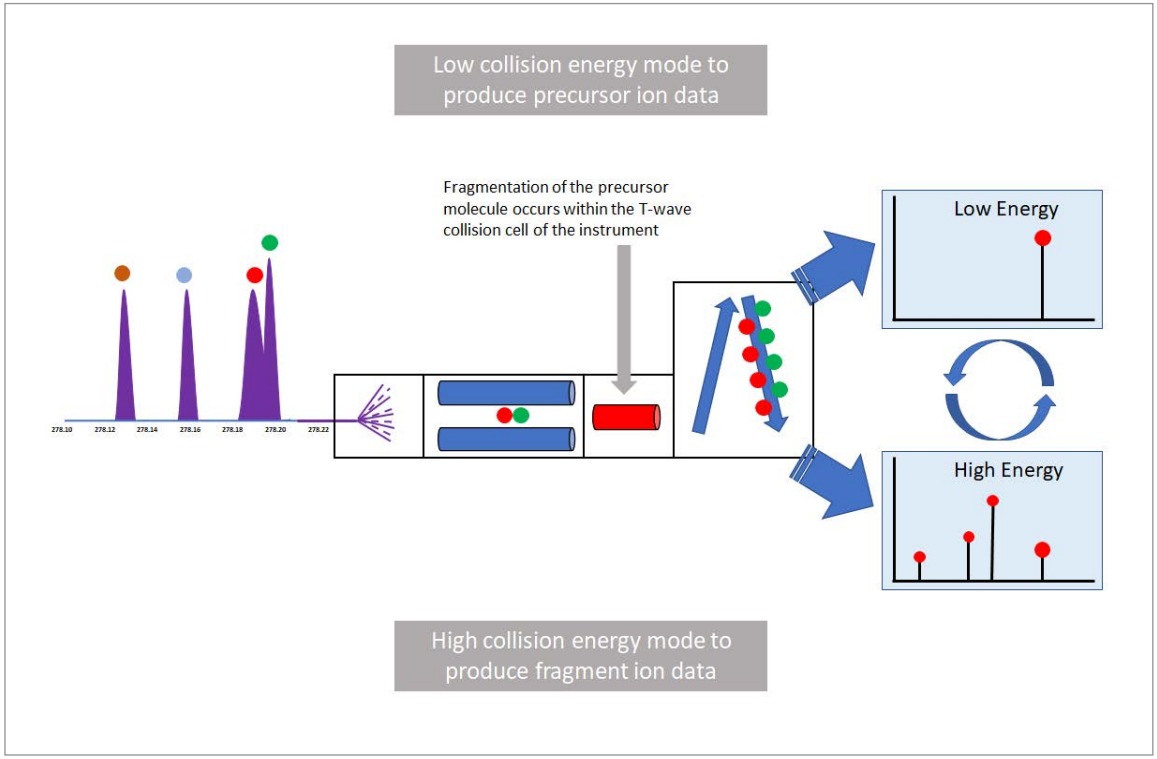


waters_connect presents data clearly in a browser format – for simple and intuitive visualization of chromatographic and mass spec data.

Data-Independent Acquisition Using MS^E

Data can be acquired in a number of ways with the Waters Xevo G3 QTof, including data directed acquisition (DDA), data independent acquisition (DIA), and Tof-MRM.

Waters uses DIA for toxicology screening. Acquiring data with the proven and patented MS^E DIA method ensures that **retention time aligned precursor ion and fragment accurate mass** data are acquired for all compounds present in the samples. All of the data is collected all of the time, enabling comprehensive screening against library data, identification of unknowns, and retrospective analysis of your samples.



With MS^E data acquisition, time aligned mass spec data is collected on precursor and fragment ions for every component in the sample. A unique 3D peak detection algorithm then associates each ion detected with a component based on the retention time data, accurate mass measurement of ions and intensities.

Read this application note to learn how Time-of-Flight instruments and UPLC/MS^E can help perform broad screening techniques on complex biological samples to identify drugs of abuse and other toxicants.

Read this white paper on how waters_connect associates precursor and fragment ions to components with 3D peak identification.

Pre-Configured Data Processing Workflows

With HRMS and DIA, you can confidently identify known drugs of abuse, look for new emerging NPS in your samples, and investigate ''unknown'' compounds. Waters provides pre-configured data processing workflows to analyze your sample for known and unknown compounds.

- **Targeted:** Compare to the toxicology library with more than 2000 characterized drugs and metabolites, with compounds identified using retention time, precursor ions, and diagnostic fragment ions.
- **Semi-targeted:** Use Molfiles to search for expected precursor ions in the low and expected fragment ions. In-silico fragmentation is automatically performed to yield fragment ions which are then identified in high-energy MS data.
- **Non-targeted:** A submission of an ''unknown peak'' to the discovery tool set automates the determination of elemental formula and searching of external libraries for possible matches. In-silico fragmentation is used to compare the theoretical fragments for potential compounds in the high energy mass data.

UNIFI browser showing chromatographs of precursor ion, fragment ions and high and low energy mass spectra acquired using MS^E from a sample containing Fentanyl.

Read this white paper to learn how compounds not present in libraries can be identified using automated discovery workflows.

Waters Support for Forensic Laboratories

You have a challenging job to do, whether that's identifying seized drugs or new psychoactive substances, presenting reliable forensic data in court, monitoring illicit drug use, or analyzing prohibited substances in a sports doping investigation.

With Waters as your partner, you're never alone in overcoming your analytical challenges. We're committed to advancing forensic toxicology and forensic science in partnership with our customers, and we love to prove it. You can get the critical data you need with our extensive forensic solutions portfolio, including industry-leading liquid chromatography, mass spectrometry, informatics, chemistries, and comprehensive support.

Waters has a deep knowledge of forensic applications gained from decades of developing instrumentation and methods. We have dedicated application development, service and support teams to ensure your success, and research and development teams to help you keep current with constantly evolving forensic analytical challenges. Our mission is to help provide data you can trust.

Let's get started. Together.

LEARN MORE
waters.com/forensics

Resources

Forensics Solutions Brochure

Forensics Applications Notebook

Application Notes /Posters

Screening for Synthetic Cannabinoids Using Tof MRM

Analysis of Plant Alkaloids Using Discovery Workflows

Tof-MRM for the Confirmation of Fentanyl Analogues

Screening for Diuretics in Urine

Screening for Cannabinoids using UNIFI screening application

White Papers

The Utility of MS^E Data for Toxicology Screening

3D Peak Detection and Componentization

Accurate Mass Libraries - Quality over Quantity

The Use of Ion Ratios as Additional Confirmation

Webinars /Videos

NICC Webinar - HRMS for Toxicology Screening

HRMS in Forensic Toxicology – Prof. Tom Rosano

Validation of HRMS Toxicology Screening Method

Find out what Waters forensics solutions can do in your lab. Contact us today.

#DataUCanTrust

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