



### K18 Direct Analysis in Real Time (DART<sup>®</sup>) Analysis With a Modified GC/MS System for Rapid Drug Screening

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After attending this presentation, attendees will learn about complete rapid screening for drugs of abuse using Direct Analysis In Real Time (DART<sup>®</sup>) screening capability with their Gas Chromatograph/Mass Spectrometry (GC/MS). This is important since traditionally the DART<sup>®</sup> technology has required a more complex Liquid Chromatography/Mass Spectrometry (LC/MS) for operation.

This presentation will impact the forensic science community by enabling more rapid screening of samples with existing GC/MS systems that are prevalent in the community. This technology can speed identification of drugs of abuse, reduce turn-around-time, and reduce sample backlogs.

DART<sup>®</sup> is an ambient ionization method that provides rapid determination of sample composition with little sample preparation. Samples are directly sampled and ionized merely by placing the material in the flow of heated ionizing gas. Solids or liquids are readily analyzed, often without any manipulation or purification of the sample. The ionization usually occurs by the excited helium atoms reacting with ambient water to form protonated water clusters. These water clusters attach a proton onto the molecule of interest, producing a spectrum that is very simple and often composed of one peak per compound. This leads to the facile interpretation of the spectra and the ability to analyze mixtures without the complexity of many fragment ions.

Several major forensics laboratories including FBI, Secret Service, the FDA Forensic Chemistry Center, and the Virginia Department of Forensic Science, have utilized DART<sup>®</sup> for rapid detection and characterization of unknowns. Published papers show analysis of gamma-hydroxybutyric acid, synthetic cannabinoids, analysis of sexual assault evidence, alprazolam tablets, methamphetamine, bank security device and pepper spray components, explosives trace detection, ricin activity assay, iodine and red phosphorus, and chemical warfare agents.<sup>1-10</sup>

However, this time-saving ambient ionization technology has not gained a wider audience in the forensic community for several reasons. A major reason is the fact that the DART<sup>®</sup> source requires a mass spectrometer equipped with an Atmospheric Pressure Inlet (API) typically supplied with an LC/MS system. Since this technology is limited to more specialized laboratories, the analysts cannot readily access the current DART<sup>®</sup> technology. In this current effort, an API has been integrated into an Agilent Mass Selective Detector (MSD), which is widely used in state and federal laboratories for trace forensic analysis. Secondly, the sampling process has been left to the analyst, allowing for flexibility, but also encumbering the analysts with additional method development. The sample preparation process has been simplified with a new device composed of a card-containing metal screen that holds the liquid or solid sample. The sample is placed on the screen, the card is inserted into the source, and the spectrum acquired in less than 10 seconds.

Facilitating DART<sup>®</sup> analysis with the low cost Agilent mass analyzer should enable more laboratories to add this capability, speeding analysis and reducing backlogs. This presentation will demonstrate the application of this modified DART<sup>®</sup>-MSD for determination of the presence of drugs in urine with a simple solid phase extraction for sample preparation. This reduces analysis time of 30 – 60 min to less than one minute. Additionally, the direct analysis of solid dosage forms of drugs of abuse will be illustrated, showing how DART<sup>®</sup> can identify these materials in seconds.

#### References:

1. M. J. Bennett and R. R. Steiner, "Detection of Gamma- Hydroxybutyric Acid in Various Drink Matrices via AccuTOF<sup>™</sup> - DART<sup>®</sup>," *Journal of Forensic Sciences*, vol. 54, no. 2, pp. 370 – 375, 2009.
2. L. Huang, M. Veltri, R. B. Cody, A. J. Dane, A. Rivera, M. A. Marino, and W. J. Kim, "Where is the next high? - Rapid identification of synthetic cannabinoids in 'Spice' products," *Forensic Science International*, vol. submitted, 2012.
3. R. A. Musah, R. B. Cody, A. J. Dane, A. L. Vuong, and J. R. E. Shepard, "Direct analysis in real time mass spectrometry for analysis of sexual assault evidence," *Rapid Commun. Mass Spectrom.*, vol. 26, no. 9, pp. 1039 – 1046, 2012.
4. W. C. Samms, Y. J. Jiang, M. D. Dixon, S. S. Houck, and A. Mozayani, "Analysis of Alprazolam by DART<sup>®</sup>-TOF Mass Spectrometry in Counterfeit and Routine Drug Identification Cases," *Journal of Forensic Sciences*, vol. 56, no. 4, pp. 993 – 998, 2011.
5. H. Grange and G. W. Sovocool, "Detection of illicit drugs on surfaces using direct analysis in real time (DART<sup>®</sup>) time-of-flight mass spectrometry," *Rapid Commun. Mass Spectrom.*, vol. 25, no. 9, pp. 1271 – 1281, 2011.
6. M. Pfaff and R. R. Steiner, "Development and validation of AccuTOF<sup>™</sup>-DART<sup>®</sup> as a screening method for analysis of bank security device and pepper spray components," *Forensic Science International*, vol. 206, no. 1 – 3, pp. 62 – 70, 2011.



## Toxicology Section - 2013

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7. J. M. Nilles, T. R. Connell, S. T. Stokes, and H. Dupont Durst, "Explosives Detection Using Direct Analysis in Real Time (DART<sup>®</sup>) Mass Spectrometry," *Propellants, Explosives, Pyrotechnics*, vol. 35, no. 5, pp. 446 – 451, 2010.
  8. V. L. H. Bevilacqua, J. M. Nilles, J. S. Rice, T. R. Connell, A. M. Schenning, L. M. Reilly, and H. D. Durst, "Ricin Activity Assay by Direct Analysis in Real Time Mass Spectrometry Detection of Adenine Release," *Analytical Chemistry*, vol. 82, no. 3, pp. 798 – 800, 2010.
  9. R. R. Steiner, "A Rapid Technique for the Confirmation of Iodine and Red Phosphorus Using Direct Analysis in Real Time and Accurate Mass Spectrometry," *Microgram J*, vol. 7, no. 1, pp. 3 – 6, 2010.
  10. J. M. Nilles, T. R. Connell, and H. D. Durst, "Quantitation of Chemical Warfare Agents Using the Direct Analysis in Real Time (DART<sup>®</sup>) Technique," *Analytical Chemistry*, vol. 81, no. 16, pp. 6744 – 6749, 2009.
- Drugs of Abuse, DART<sup>®</sup>, Mass Spectrometry**