



The CBRNE Threat

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CBRNE

Chemical

Biological

Radiological

Nuclear

Explosive

ICx Technologies



ICx Technologies is a leader in the development and integration of advanced sensor technologies for homeland security, force protection and commercial applications. Our proprietary sensors detect and identify chemical, biological, radiological, nuclear and explosive (CBRNE) threats, and deliver superior awareness and actionable intelligence for wide area surveillance, intrusion detection and facility security. ICx pioneers the integration of these advanced sensors into effective security and commercial solutions.



BioCapture®

Most widely deployed portable air sampler for detection of biowarfare agents; enables first-stage bio-detection; battery powered; stand-alone or incorporated as front-end for range of bio-analytical systems.



Griffin 450 Mobile GC/MS with Air Sampling

The Griffin 450 is another mobile member of the Griffin family of products. The Griffin 450 utilizes CIT technology, employs shock mounts and is placed in a reinforced ruggedized aluminum cube. The ruggedized instrument is capable of direct air sampling and comes with a handheld air sampler with thermal desorption capabilities.



Fido® XT

At less than three pounds, the Fido Portable Explosives Detector is the world's most sensitive explosives detection system.



identiFINDER

The identiFINDER is a complete, handheld, digital gamma spectrometer and dose rate system.



Technology in Writing

As a scientist, I appreciate writers using terminology correctly with the appropriate use of acronyms.

MS	Mass Spectrometry
GC	Gas Chromatography
LC	Liquid Chromatography
IED	Improvised Explosive Device
CBRNE	Chemical Biological Radiation Nuclear Explosive
CWA	Chemical Warfare Agent
BWA	Biological Warfare Agent
ESI	Electrospray Ionization
DART	Direct Analysis in Real Time
DESI	Desorption Electrospray Ionization
FBO	Federal Business Opportunities
DHS	Department of Homeland Security
DOD	Department of Defense

Types of CWAs

- Defoliants that destroy vegetation, but are not immediately toxic to human beings. Some batches of Agent Orange, for instance, used by the United States in Vietnam, contained dioxins as manufacturing impurities. Dioxins, rather than Agent Orange itself, have long-term cancer effects and for causing genetic damage leading to serious birth deformities.
- Incendiary or explosive chemicals (such as napalm, extensively used by the United States in Vietnam, or dynamite) because their destructive effects are primarily due to fire or explosive force, and not direct chemical action.
- Viruses, bacteria, or other organisms. Their use is classified as biological warfare. Toxins produced by living organisms are considered chemical weapons, although the boundary is blurry. Toxins are covered by the Biological Weapons Convention.

Designations

Most chemical weapons are assigned a one- to three-letter "NATO weapon designation" in addition to, or in place of, a common name. Binary munitions, in which precursors for chemical warfare agents are automatically mixed in shell to produce the agent just prior to its use, are indicated by a "-2" following the agent's designation (for example, GB-2 and VX-2).

Blood agents:	Vesicants:
•Cyanogen chloride: CK •Hydrogen cyanide:AC	•Lewisite: L •Sulfur mustard: H, HD, HS, HT
Pulmonary agents:	Incapacitating agents:
•Phosgene: CG	•Quinuclidinyl benzilate: BZ
Lachrymatory agents:	Nerve agents:
•Pepper spray: OC •Tear gas: CN, CS, CR	•Sarin: GB •VE, VG, VM, VX

Class of agent	Agent Names	Mode of Action	Signs and Symptoms	Rate of action	Persistency
Nerve	<ul style="list-style-type: none"> •Cyclosarin (GF) •Sarin (GB) •Soman (GD) •Tabun (GA) •VX •VR •Some insecticides •Novichok agents 	Inactivates enzyme acetylcholinesterase, preventing the breakdown of the neurotransmitter acetylcholine in the victim's synapses and causing both muscarinic and nicotinic effects	<ul style="list-style-type: none"> •Miosis (pinpoint pupils) •Blurred/dim vision •Headache •Nausea, vomiting, diarrhea •Copious secretions/sweating •Muscle twitching/fasciculations •Dyspnea •Seizures •Loss of consciousness 	<ul style="list-style-type: none"> •Vapors: seconds to minutes; •Skin: 2 to 18 hours 	VX is persistent and a contact hazard; other agents are non-persistent and present mostly inhalation hazards.
Asphyxiant/Blood	<ul style="list-style-type: none"> •Most Arsines •Cyanogen chloride •Hydrogen cyanide 	<ul style="list-style-type: none"> •Arsine: Causes intravascular hemolysis that may lead to renal failure. •Cyanogen chloride/hydrogen cyanide: Cyanide directly prevents cells from using oxygen. The cells then uses anaerobic respiration, creating excess lactic acid and metabolic acidosis. 	<ul style="list-style-type: none"> •Possible cherry-red skin •Possible cyanosis •Confusion •Nausea •Patients may gasp for air •Seizures prior to death •Metabolic acidosis 	Immediate onset	Non-persistent and an inhalation hazard.
Vesicant/Blister	<ul style="list-style-type: none"> •Sulfur mustard (HD, H) •Nitrogen mustard (HN-1, HN-2, HN-3) •Lewisite (L) •Phosgene oxime (CX) 	Agents are acid-forming compounds that damages skin and respiratory system, resulting burns and respiratory problems.	<ul style="list-style-type: none"> •Severe skin, eye and mucosal pain and irritation •Skin erythema with large fluid blisters that heal slowly and may become infected •Tearing, conjunctivitis, corneal damage •Mild respiratory distress to marked airway damage 	<ul style="list-style-type: none"> •Mustards: Vapors: 4 to 6 hours, eyes and lungs affected more rapidly; Skin: 2 to 48 hours •Lewisite: Immediate 	Persistent and a contact hazard.
Choking/Pulmonary	<ul style="list-style-type: none"> •Chlorine •Hydrogen chloride •Nitrogen oxides •Phosgene 	Similar mechanism to <i>blister agents</i> in that the compounds are acids or acid-forming, but action is more pronounced in respiratory system, flooding it and resulting in suffocation; survivors often suffer chronic breathing problems.	<ul style="list-style-type: none"> •Airway irritation •Eye and skin irritation •Dyspnea, cough •Sore throat •Chest tightness •Wheezing •Bronchospasm 	Immediate to 3 hours	Non-persistent and an inhalation hazard.
Lachrymatory agent	<ul style="list-style-type: none"> •Tear gas •Pepper spray 	Causes severe stinging of the eyes and temporary blindness.	Powerful eye irritation	Immediate	Non-persistent and an inhalation hazard.
Incapacitating	<ul style="list-style-type: none"> •Agent 15 (BZ) 	Causes atropine-like inhibition of acetylcholine in subject. Causes peripheral nervous system effects that are the opposite of those seen in nerve agent poisoning.	<ul style="list-style-type: none"> •May appear as mass drug intoxication with erratic behaviors, shared realistic and distinct hallucinations, disrobing and confusion •Hyperthermia •Ataxia (lack of coordination) •Mydriasis (dilated pupils) 	<ul style="list-style-type: none"> •Inhaled: 30 minutes to 20 hours; •Skin: Up to 36 hours after skin exposure to BZ. Duration is typically 72 to 96 hours. 	Extremely persistent in soil and water and on most surfaces; contact hazard.

20th Century CWA History

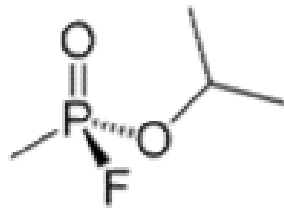
	Agents	Dissemination	Protection	Detection
1900s	Chlorine Chloropicrin Phosgene Mustard gas	Wind dispersal	Gas masks, urinated-on gauze	Smell
1910s	Lewisite	Chemical shells	Gas mask Rosin oil clothing	
1920s		Projectiles w/ central bursters	CC-2 clothing	
1930s	G-series nerve agents	Aircraft bombs		Blister agent detectors Color change paper
1940s		Missile warheads Spray tanks	Protective ointment (mustard) Collective protection Gas mask w/ Whetlerite	
1950s				
1960s	V-series nerve agents	Aerodynamic	Gas mask w/ water supply	Nerve gas alarm
1970s				
1980s		Binary munitions	Improved gas masks (protection, fit, comfort)	Laser detection
1990s	<u>Novichok nerve agents</u>	Fine powder		

Sarin (GB)

Discovered in Germany in 1939 while trying to develop better pesticides

Produced by the U.S.S.R. and the U.S.A. for military purposes

UN banned the production and stockpiling of Sarin and called for the destruction of specified stockpiles of chemical weapons

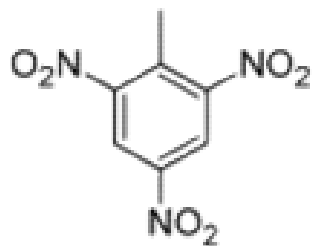


Sarin Gas Attack on the Tokyo Subway

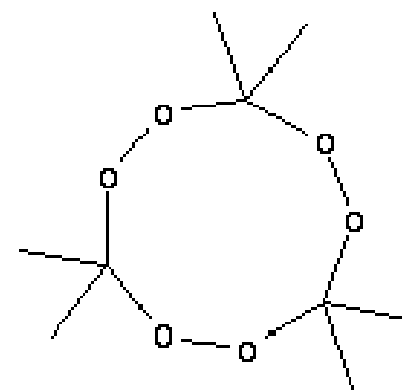
1995 incident when members of AUM Shinrikyo released sarin gas on several lines of the Tokyo Subway in an act of domestic terrorism. 12 people died and some 6000 were injured as a result of the attack.

Explosives

An explosive is defined as a material (chemical or nuclear) that can be initiated to undergo very rapid, self-propagating decomposition that results in the formation of more stable material, the liberation of heat, or the development of a sudden pressure effect through the action of heat on produced or adjacent gases. All of these outcomes produce energy; a weapon's effectiveness is measured by the quantity of energy - or damage potential - it delivers to the target. (Global Security.org)



TNT
2,4,6-Trinitrotoluene



TATP
Triacetone Triperoxide

Improvised Explosive Devices (IEDs)

IEDs are homemade devices to cause injury or death and can be combined with biological, chemical, radiological substances

IEDs may be carried by people, placed in vehicles, or buried by the roadside

IEDs are extremely difficult to detect and are the cause of many deaths

Fido deployed
on a robot

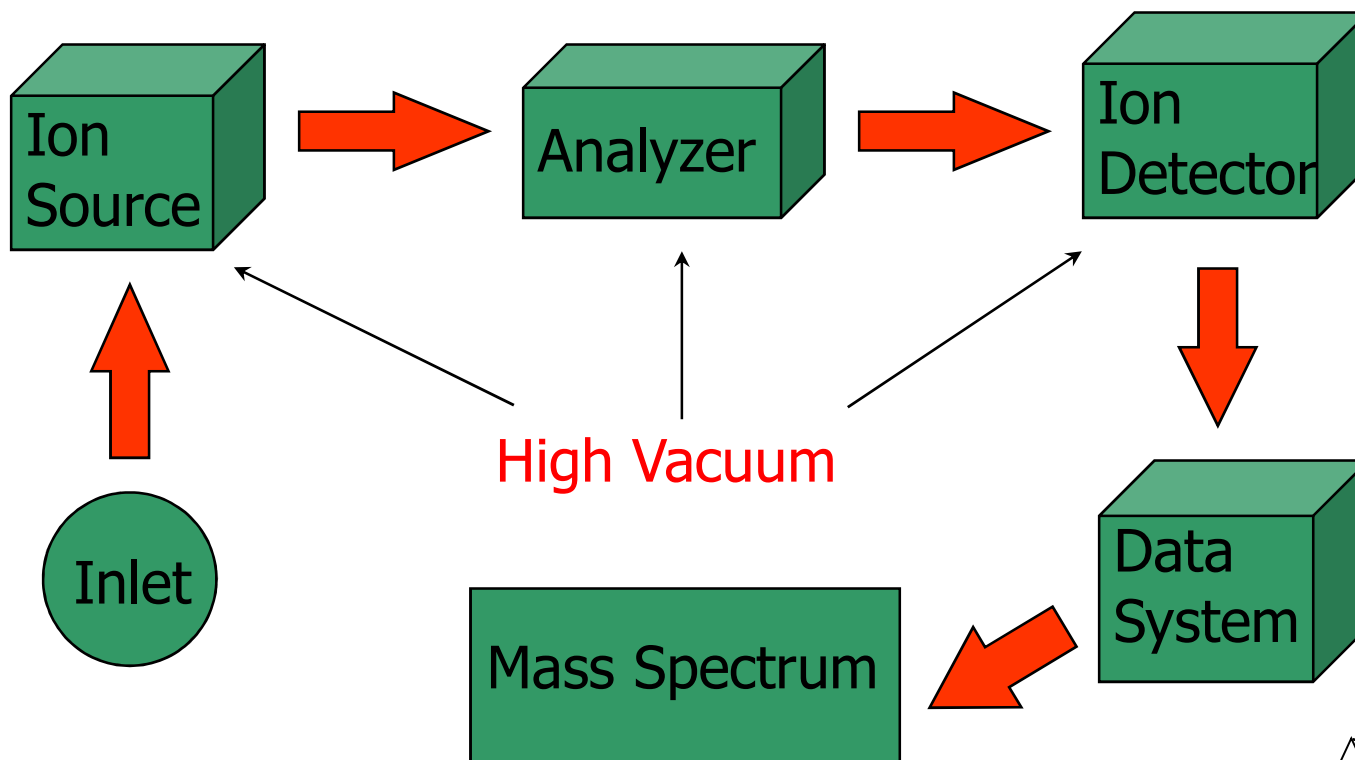


Stryker after a roadside
IED explosion

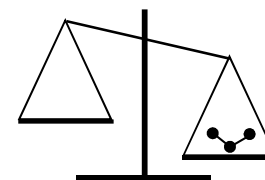


Soldiers use robots to
dispose of IEDs

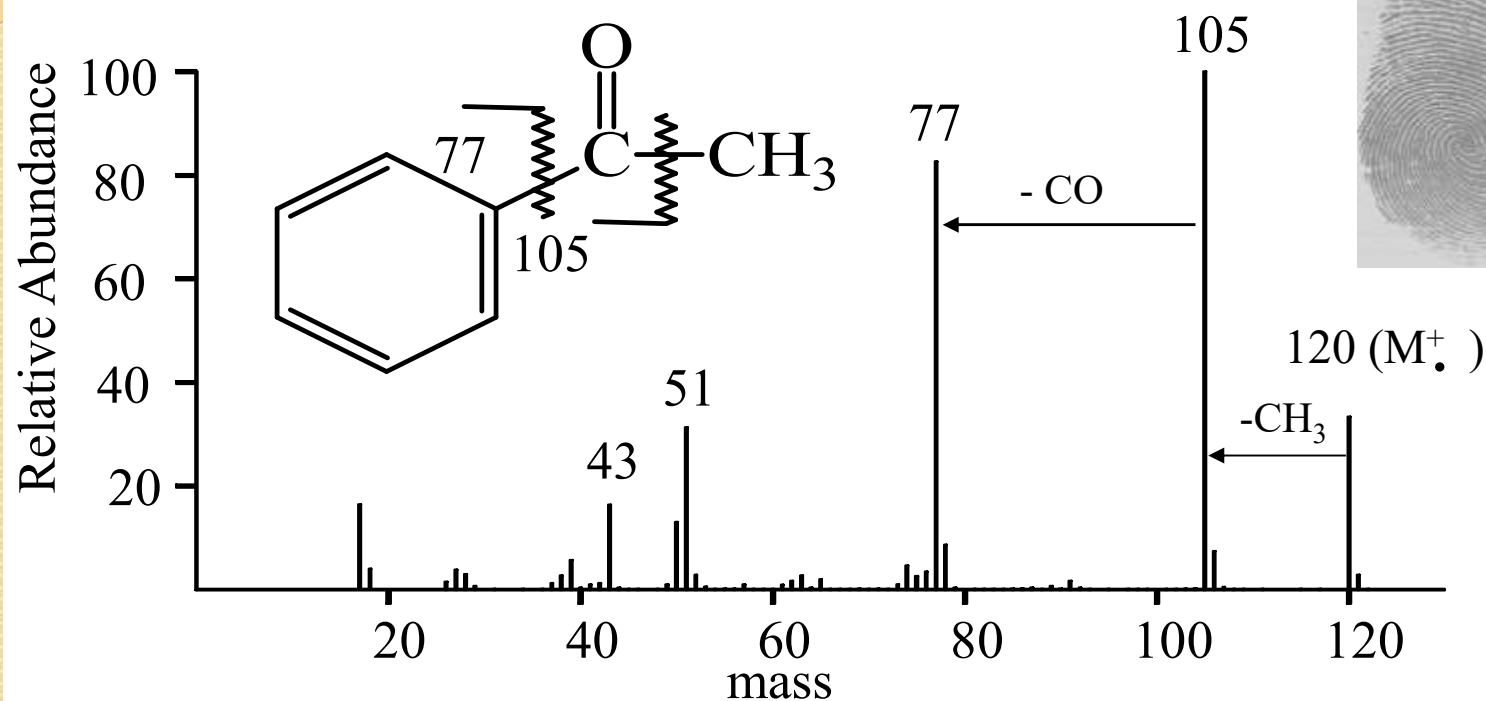
What is Mass Spectrometry?



Samples: gases, liquids, and solids



What Is Mass Spectrometry?



- Qualitative (What is in the sample?)
- Quantitative (How much is in the sample?)



Mass Analyzers

Time of Flight (ToF)

Quadrupole

Triple quadrupole

Guided Ion Beam

Ion Trap

Cylindrical Ion Trap

Linear Ion Trap

Rectilinear Ion Trap

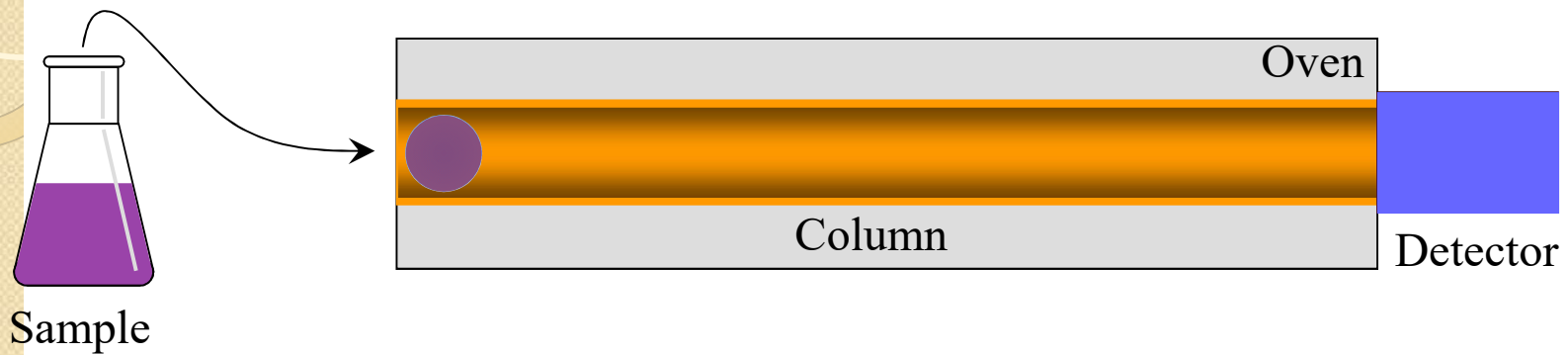
Sector Instrument

Electric

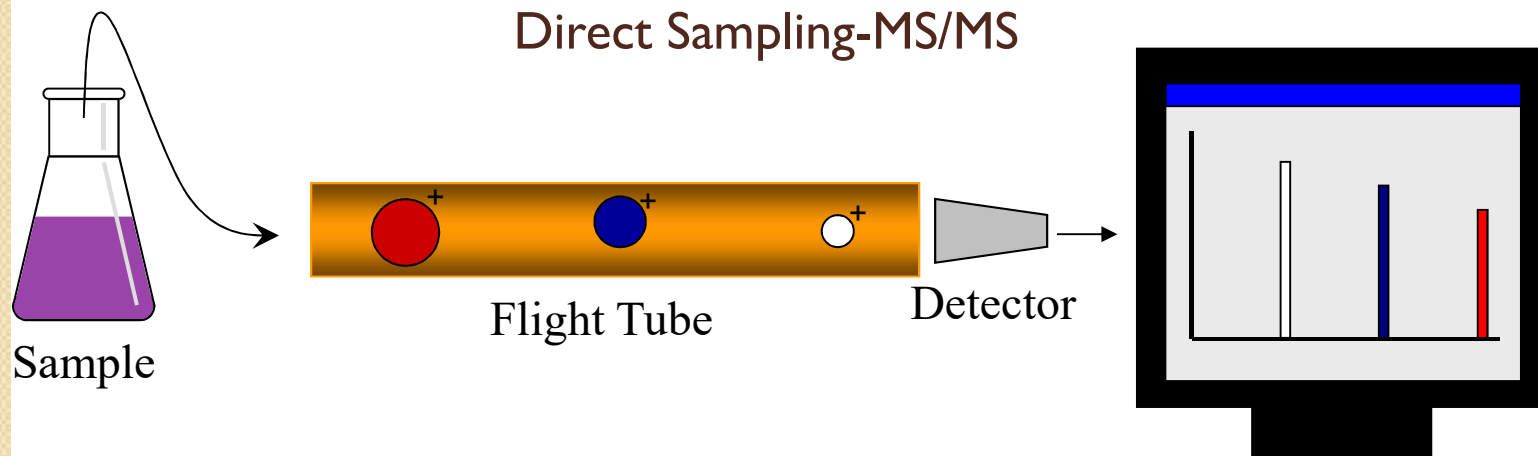
Magnetic

Technology

GC/MS/MS



Direct Sampling-MS/MS





Forensic GC-MS

Premium technique for the detection and identification of unknown chemicals

Can access the NIST database (100,000s of chemicals)

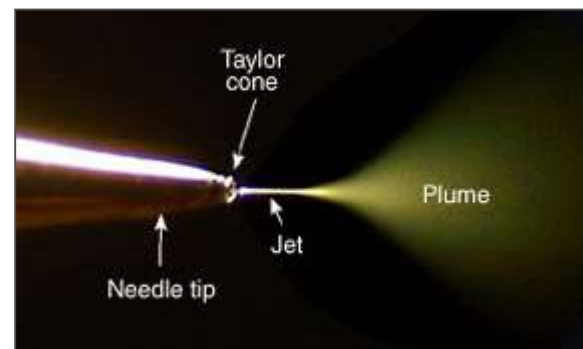
Amenable to gas and liquid analysis

Defensible in court

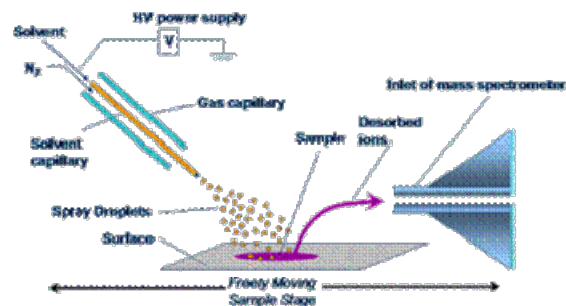
Atmospheric Ionization

External Ionization -
Atmospheric Ionization
Alternative to GC for sample
introduction to the MS
Direct sampling and ionization of
components in liquids, on
surfaces, etc.
Chemical and explosives
detection applications
Premium class on-site
bioanalytical applications
Requires an AI interface for the
MS

Electrospray ionization (ESI)



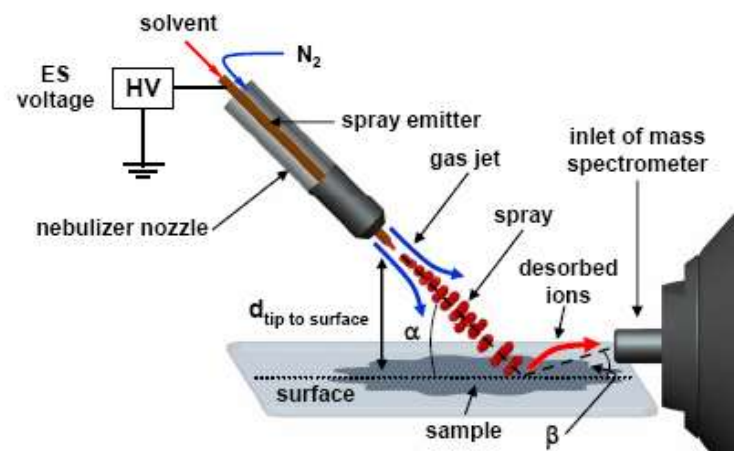
DESI



DART

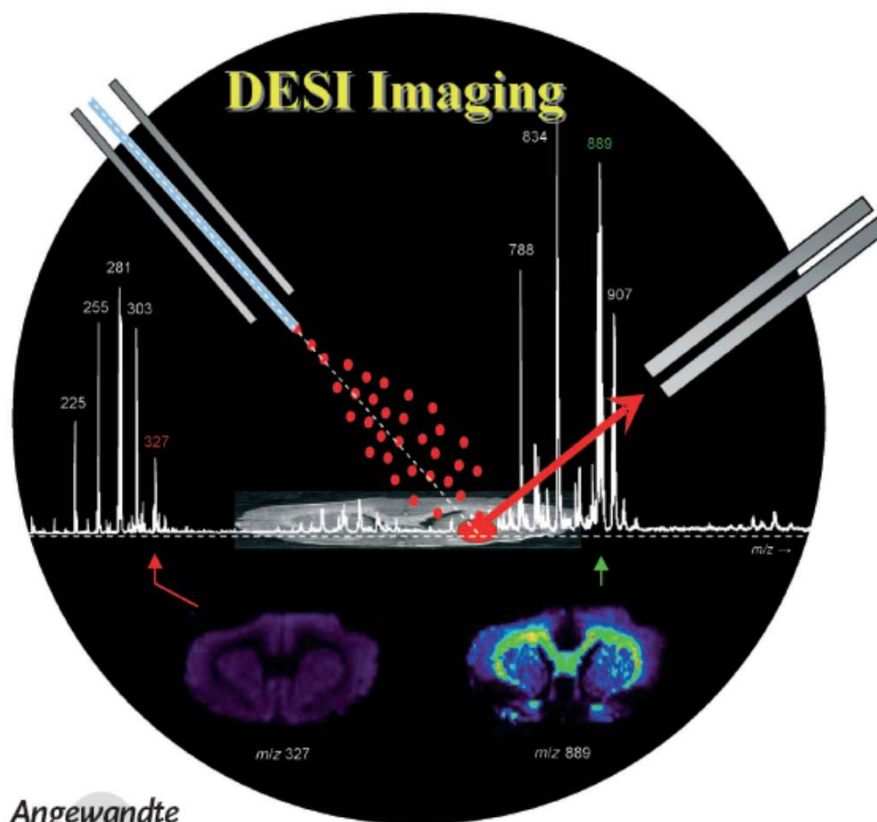


Desorption Electrospray Ionization



DESI is able to analyze solid samples present on a surface with minimal to no sample preparation by spraying fast-moving charged solvent droplets onto sample surfaces. The analytes present on the surface are extracted and carried by the offspring droplets into the atmospheric pressure interface of the mass spectrometer where ions are produced through electrospray ionization mechanisms.

DESI and Imaging Samples



Angewandte
Chemie

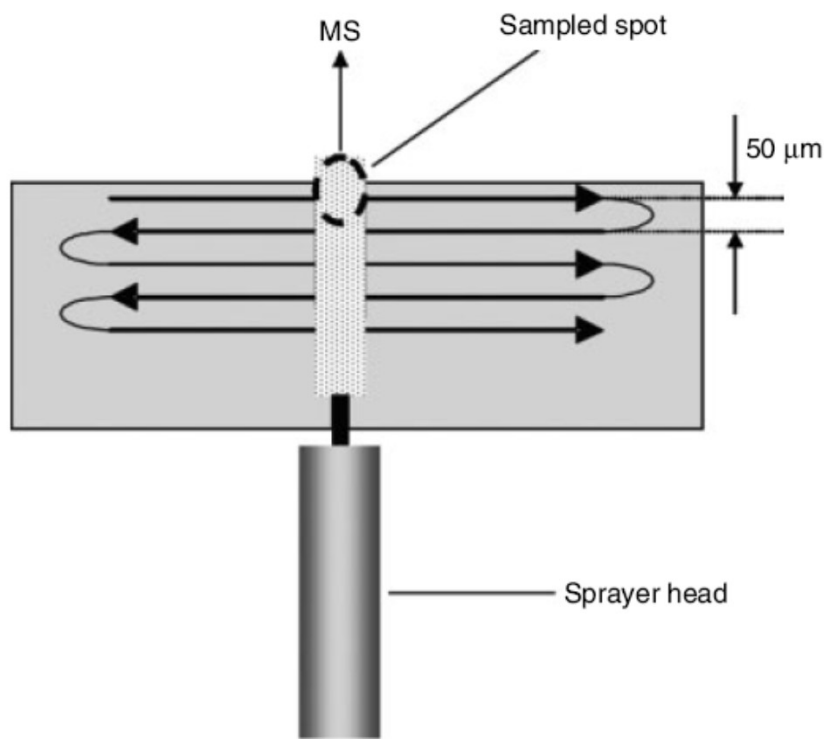
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Angew. Chem. Int. Ed. 2006, 45, 7188–7192

DESI and Imaging Samples



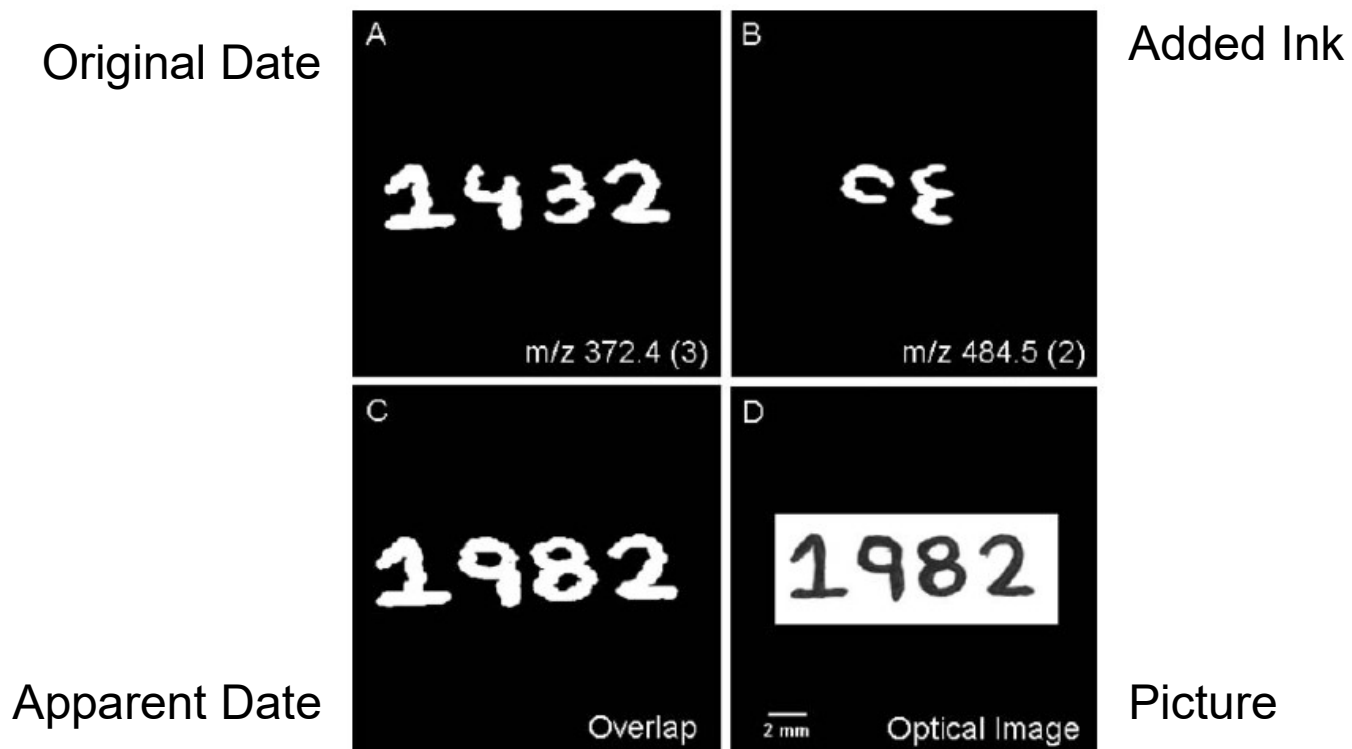
Imaging surfaces is accomplished by rastering across the surface

Samples amenable to imaging include biological tissue samples, polymers, narcotics, CWAs, etc. on a large variety of surfaces

DESI and Ink Analysis

DESI can differentiate between different types of inks based on their chemical composition.

Unless a forger uses the exact same type of ink composition, this is detectable by DESI



DESI on Television

Purdue Technology to be Featured on "CSI: Miami"

InsideIndianaBusiness.com Report

Purdue University's forensic technology will debut on the hit CBS television series "CSI: Miami." The November 24th episode, titled "Power Trip," will feature a fingerprint analysis tool developed by Purdue Professor R. Graham Cooks. The device reads a fingerprint's chemical signature and can unearth fingerprints buried beneath others or reveal what a person recently handled. It can also create an image of the fingerprint for identity searches.

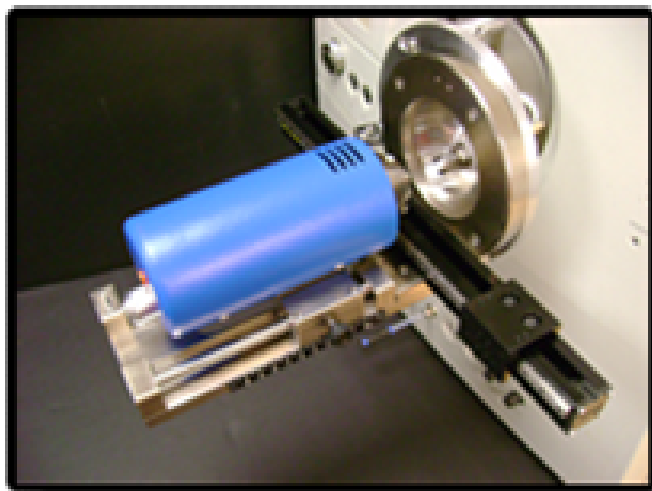
When a young co-ed is found electrocuted with her pupils fully dilated, making her blinded by light and unable to fight back, the team suspects it's the work of a killer from a year ago. Suspicion falls on the ophthalmologist who was the lead suspect in the first murder case, but when the detective, Reggie Mastow, who worked the first case and has since been put on restrictive duty for assaulting the ophthalmologist, becomes hell-bent on pinning the murder on the ophthalmologist and interferes with the team's investigation, the team questions if he's trying to deter the case because he's the killer. In order to prove who the real killer is, the team uses technology on overlapping prints that didn't exist a year ago when the first murder took place.

DESI on CNN

CNN Video

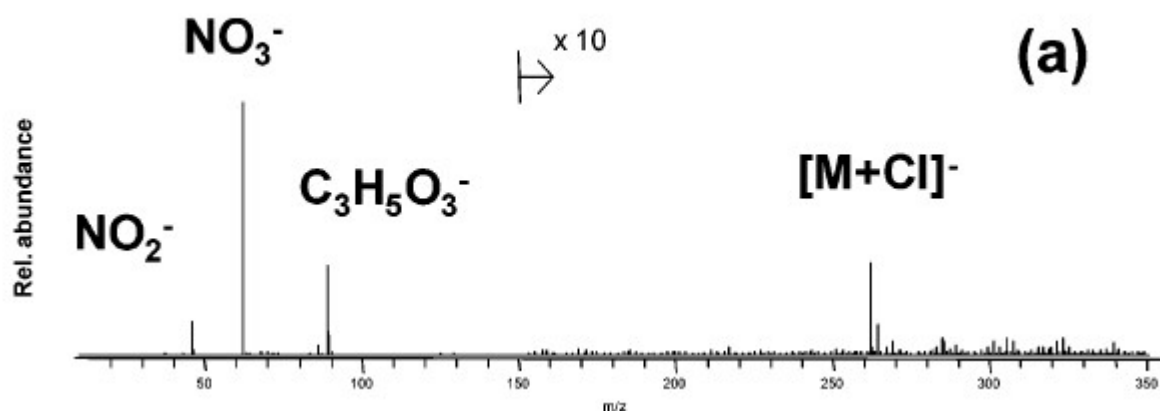
<http://www.cnn.com/video/?/video/tech/2008/10/14/fingerprint.science.cnn>

Direct Analysis in Real Time



IonSense Inc.

An electrical discharge creates a plasma as inert gas flows through the DART chamber. The plasma contains ions, electrons, and excited neutral atoms and molecules. A heater coil increases the temperature of the gas as it travels towards the exit orifice of the source. The heated gas containing neutral but highly energetic atoms and molecules exits the source heading towards the inlet of the atmospheric pressure ionization mass spectrometer.



Cody, R.B., Laramée, J.A., Durst, H.D., *Anal. Chem.*, **2005**.



DART on Television

Primetime crime drama meets reality in forensic research taking place at the Midwest Forensics Resource Center at Iowa State University.

Ames Laboratory scientists are using the new Direct Analysis in Real Time mass spectrometry interface, which has made a guest appearance on the popular crime show "CSI: New York," to build a library of ink mass spectra using samples from the US Secret Service. The mass spectra library will help identify inks on fraudulent documents and other crime evidence.

Dancing with the Fishes



Proposal Writing and Submission

The Government publishes their funding opportunities on the grants.gov or the FBO website.

FBO = Federal Business Opportunities

These requests range from Sole Source requests for widgets to large development opportunities through agencies like DARPA.

FBO Searching Options Include:

- Opportunity/Procurement Type (9 options)
- NAICS – North American Industry Classification System (1287 options)
- Classification Code (102 options)
- Agency
- Date
- Solicitation Number

Government Funding

The U.S. Government is highly interested in funding the research and development of technologies to protect the armed forces and our country.



**Homeland
Security**

www.dhs.gov

Science & Technology

Homeland Security harnesses our nation's scientific and technological resources to provide federal, state, and local officials with the technology and capabilities to protect the homeland. One area of focus for the Department is catastrophic terrorism--threats to the security of our homeland that could result in large-scale loss of life and major economic impact. Science and Technology is designed to counter threats to the homeland, both by evolutionary improvements to current capabilities and development of revolutionary, new capabilities.

Focus Areas Include:

- Borders and Maritime Security
- Chemical and Biological
- Command, Control, and Interoperability
- Explosives
- Human Factors Behavioral Sciences
- Infrastructure and Geophysical
- Radiological/Nuclear

Government Funding



Defense Agencies

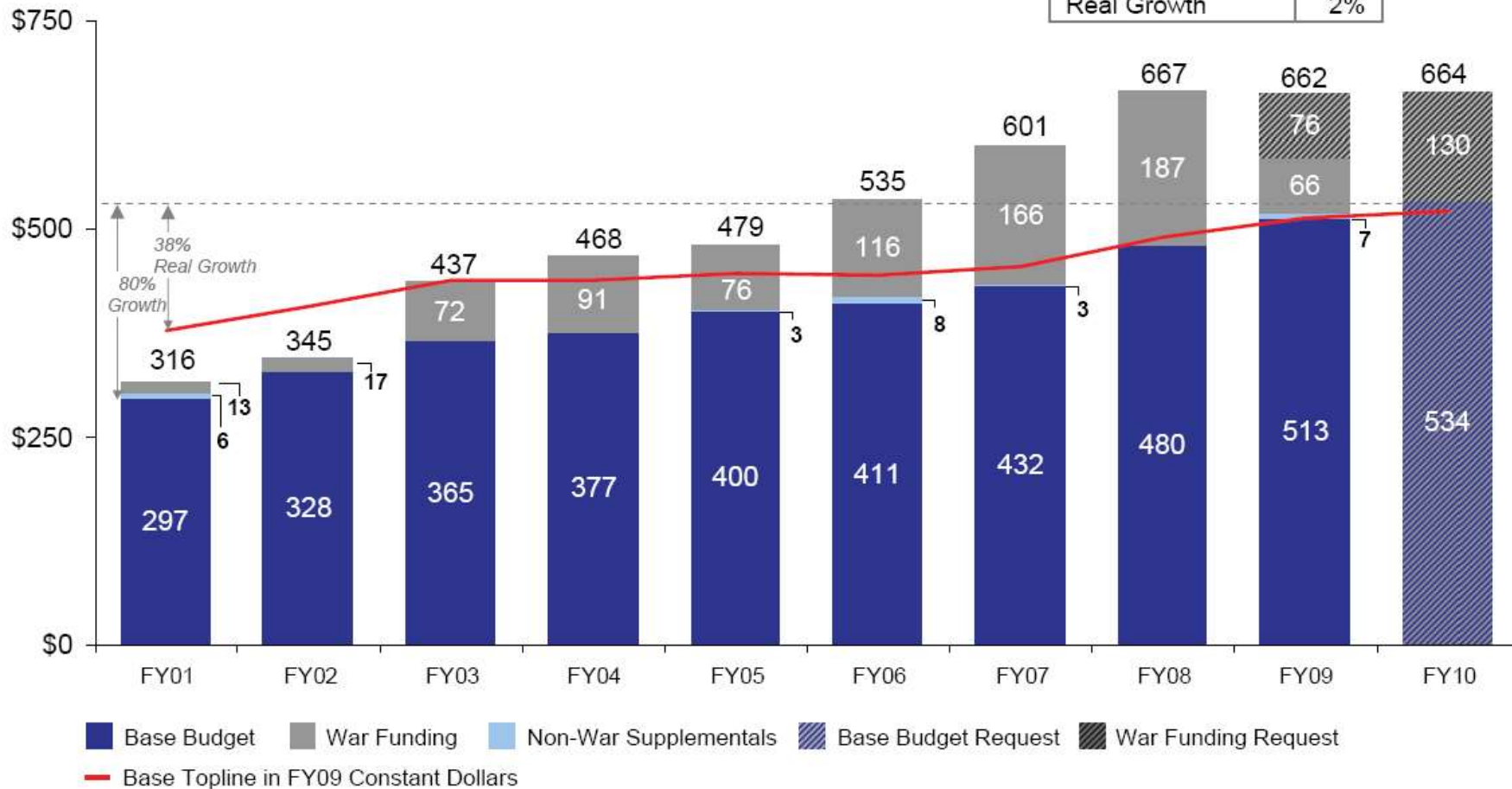
Business Transformation Agency (BTA)
Defense Advanced Research Projects Agency (DARPA)
Defense Commissary Agency (DECA)
Defense Contract Audit Agency (DCAA)
Defense Contract Management Agency (DCMA)
Defense Finance and Accounting Service (DFAS)
Defense Information Systems Agency (DISA)
Defense Intelligence Agency (DIA)
Defense Legal Services Agency (DLSA)
Defense Logistics Agency (DLA)
Defense Security Cooperation Agency (DSCA)
Defense Security Service (DSS)
Defense Threat Reduction Agency (DTRA)
Missile Defense Agency (MDA)
National Geospatial-Intelligence Agency (NGA)
National Security Agency (NSA)
Pentagon Force Protection Agency (PFPA)

Department of Defense Topline

FY 2001 – FY 2010

(Dollars in Billions)

FY 2009 – FY 2010 Base Growth	
Nominal Growth	4%
Real Growth	2%



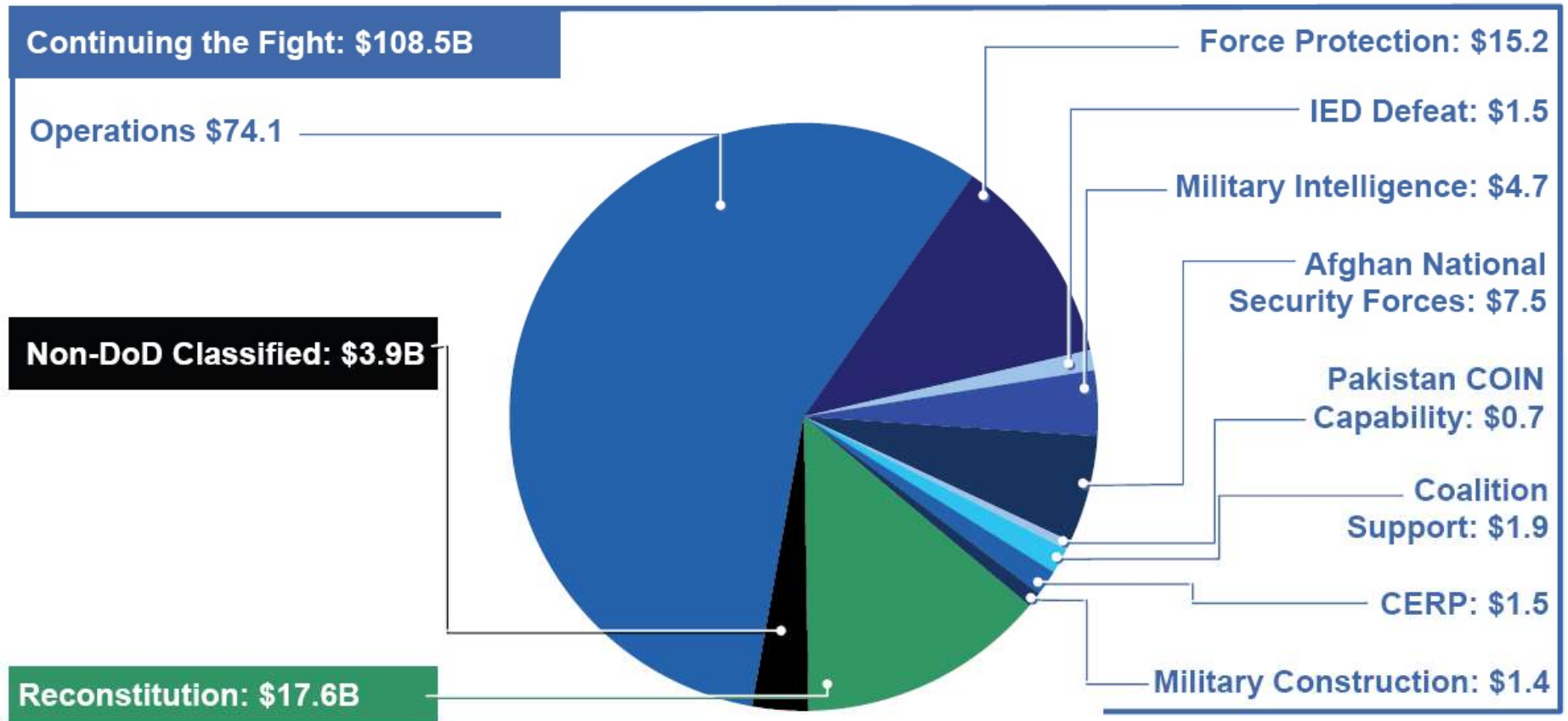
Note: FY 2009 Non-War Supplemental is appropriated through American Recovery and Reinvestment Act of 2009

Source: Defense Appropriation Acts FY 2001 – FY 2009, National Defense Budget Estimates for FY 2009, OMB Historical Tables FY 2009

Support the Troops in the Field

FY 2010 Overseas Contingency Operations

(Dollars in Billions)



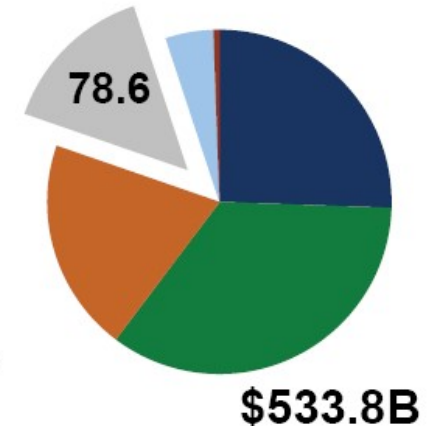
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Numbers may not add due to rounding

RDT&E

(Dollars in Billions)

	FY 2009	FY 2010	Δ FY 2009 – FY 2010
RDT&E	79.5	78.6	-1.1%



- **Highlights:**

- Funds robust science and technology program, particularly basic research (6.1)
- Fully funds Joint Strike Fighter (F-35) development
- While reducing total missile defense spending, robustly fund R&D to improve capability against long-range rogue missile threats
- Restructure the Future Combat System to retain and accelerate the spin out technology enhancements to combat brigades