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Surface Wipe Sampling for Trace Narcotics and Explosives Collection

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Applications of Wipe Sampling (Collection of Contaminants from Surfaces)

- Environmental sampling

  Heavy metals, beryllium, pesticides, molds, etc.
- Industrial/occupational/residential hygiene

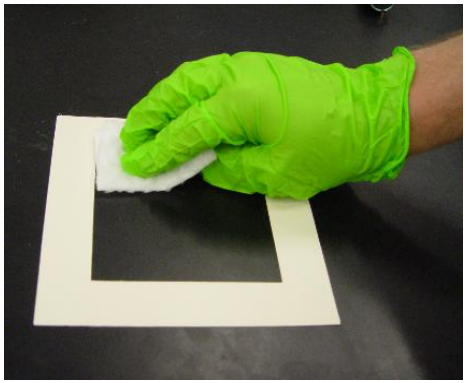
  Work and home place exposure
- Post-remediation/decontamination

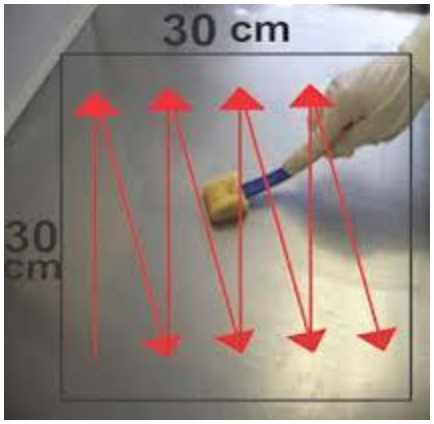
  Clandestine methamphetamine laboratories
- **Security/forensics**

  Trace detection of explosives, controlled substances, biohazards, nuclear material

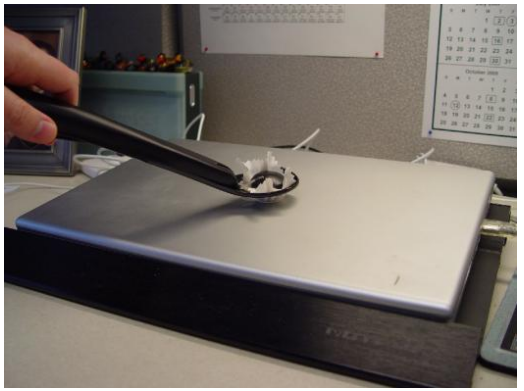
Wipe Sampling Materials

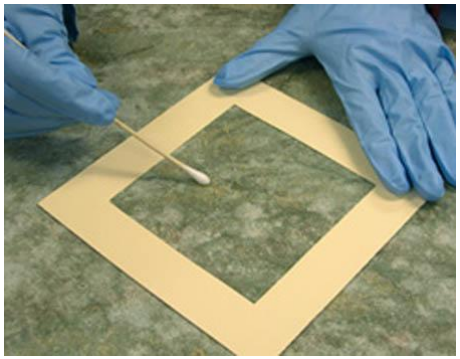
Gauze, cotton, polyester, nylon, PVA, paper, cellulose sponge, foam swab, clean room wipes, glass fiber filters .....





http://www.inspection.gc.ca





http://www.industrysearch.com.au

http://www.cdc.gov

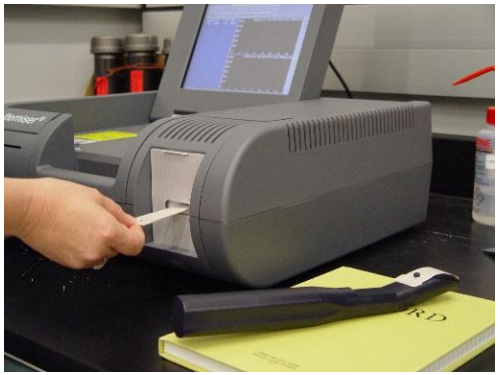
Agency use of Trace Detection

- Transportation Security Administration – airport explosives screening
- US ARMY Criminal Investigation Laboratory – forensics analysis of explosives and narcotics
- Department of State –US Embassy trace explosives screening
- Federal Protective Services – federal building trace explosives screening
- Customs and Border Protection – drug screening at borders
- Arizona Department of Corrections – drug interdiction
- Bureau of Prisons – prisoner/mail drug screening
- USSS – mobile trace explosives detection

Wipe Sampling for Trace Detection

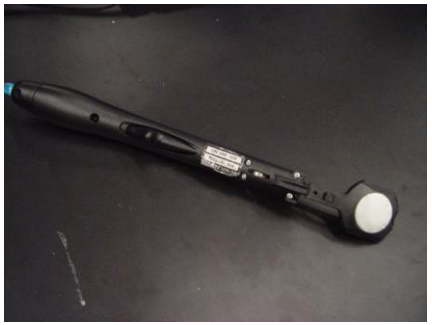
Direct Introduction of Sample Wipe to Explosive (or Narcotic) Trace Detector (ETD)

dry collection, wipe heated to ~ 200°C, sample confined to specific area



Teflon-coated fiberglass

cotton



Nomex (aramid polymer)

Current State-of-Knowledge: Wipe Sample Collection

In general, no overwhelming consensus can be drawn from the current literature on how to collect a wipe sample ..... EPA/600/R-11/079 January 2007

- Factors

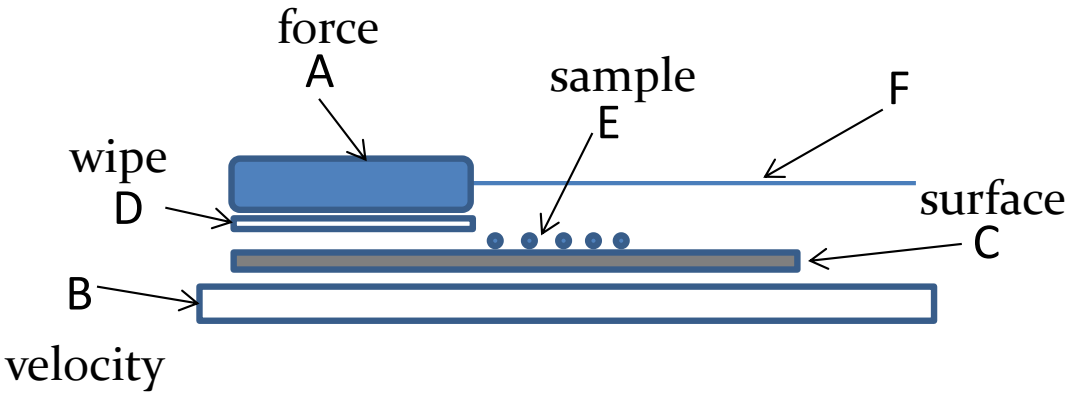
  Wipe material, solvent, applied force, sampled area, surface characteristics, physical/chemical nature of contaminant

- Goal

  Maximum - or at least repeatable - collection efficiency

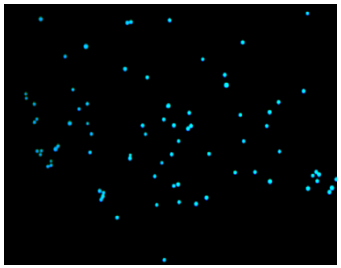
Collection Efficiency of Sampling Wipes: Method

Standard Practice in development ASTM E54.01 With Jayne Morrow and Sandra Da Silva (NIST)

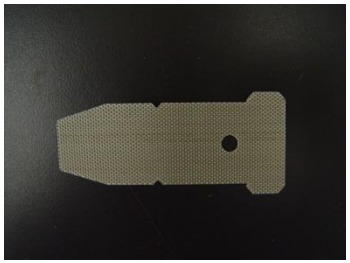


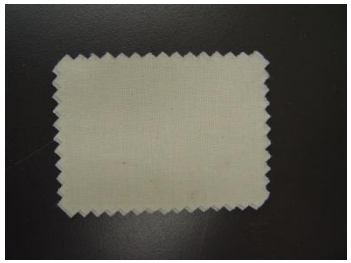
A. Sled
B. Plane
C. Sampling surface
D. Wipe
E. Particulate sample
F. Tow line

Particle Counting Fluorescent Microspheres

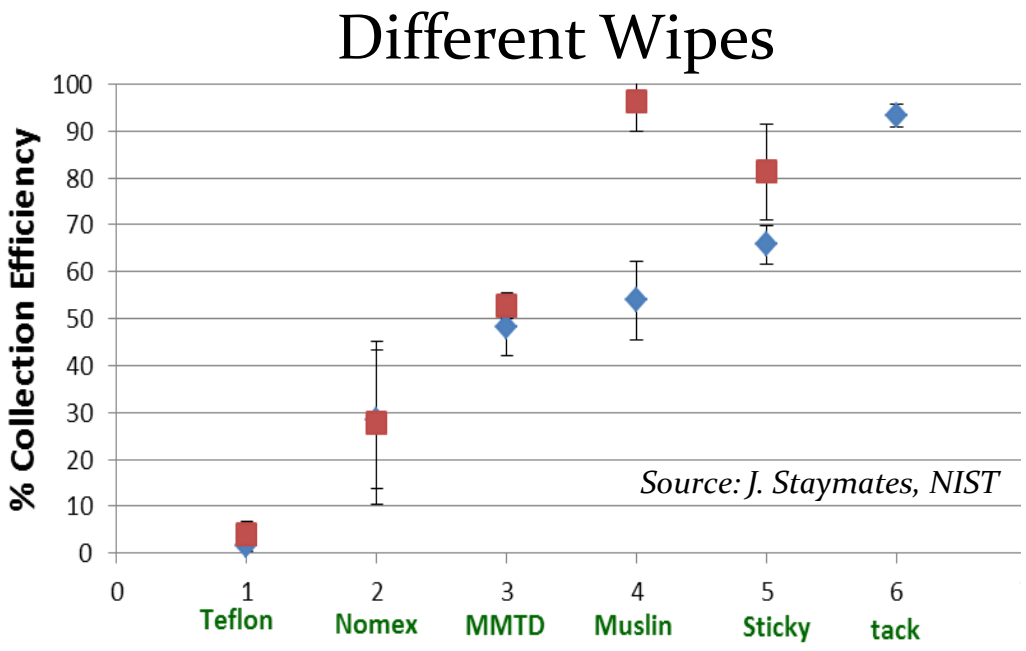


Wipe Comparison

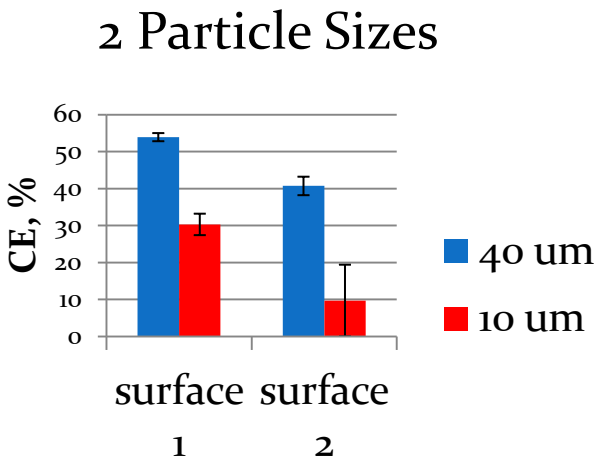


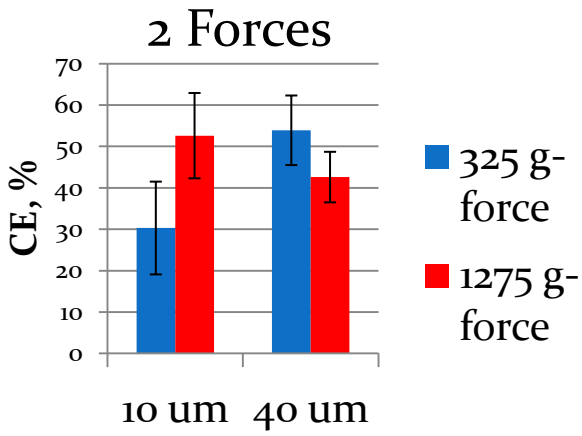


Collection Efficiency of Wipes: Results



Wipe material, surface characteristics, particle size, applied force - all significant factors



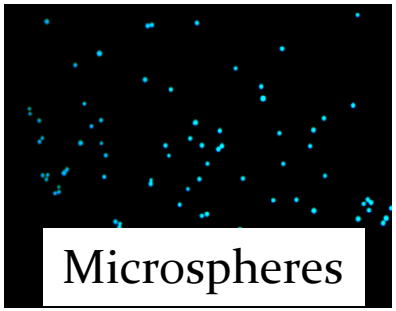


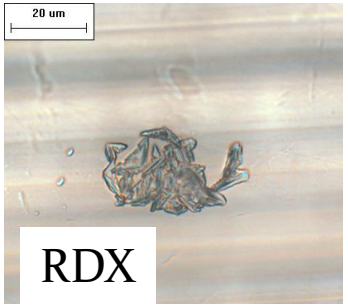
Source: Verkouteren et. al (2008) Meas. Sci. Technol, 19, 115101.

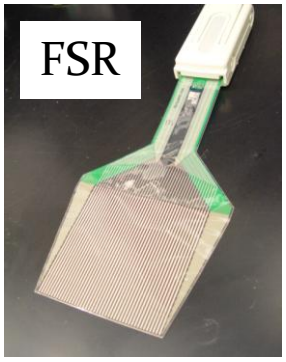
Development of Standard Sampling Method

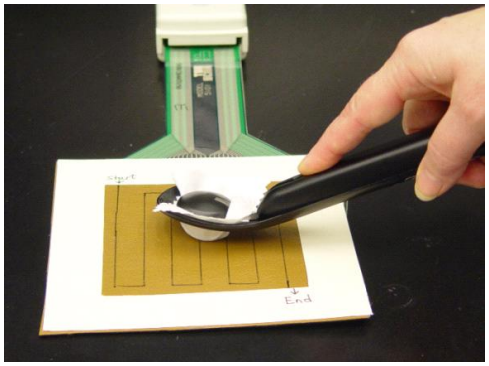
Factors

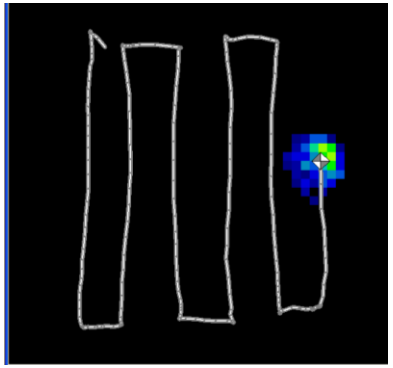
- Force (Force Sensitive Resistors – FSRs)
- Area (sampling path)
- Surface
- Particles
- Wet wipe vs dry

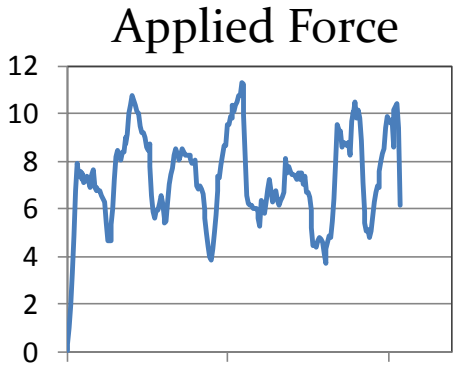






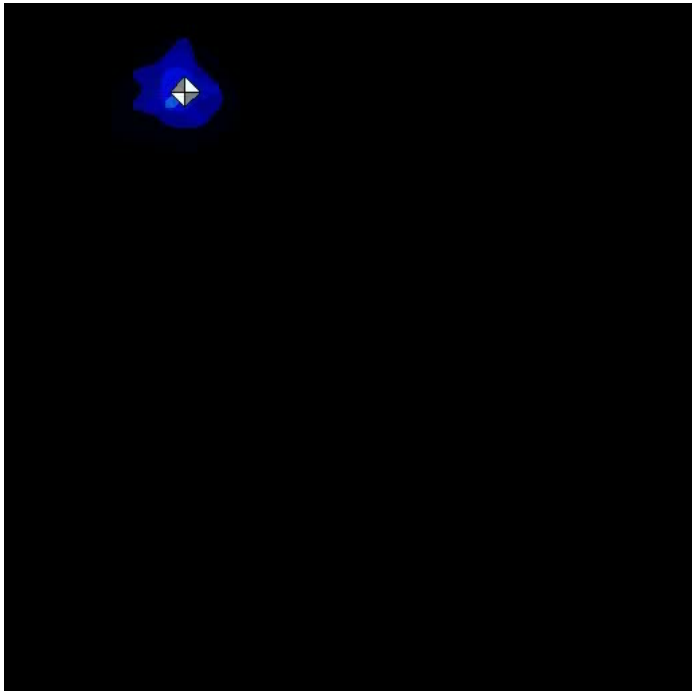






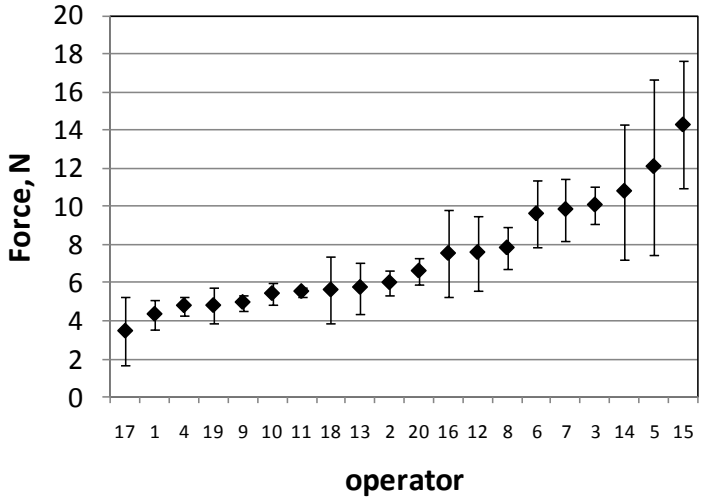
FSR Measurements of Operator Performance

Population size: 20
Sample with “firm” force
Follow sampling pattern

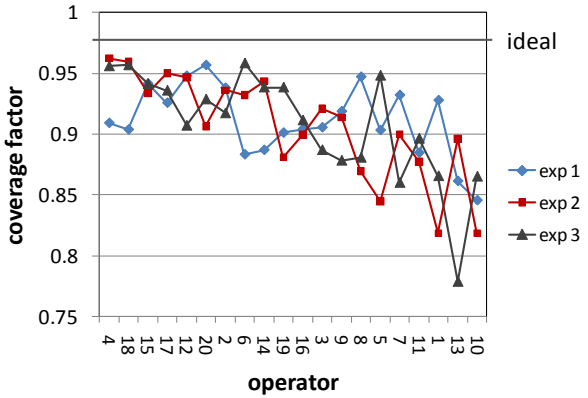


Significant Inter-operator Variability

Average “firm” force = 7 N (1.5 lb)



Area Coverage 80% to 98%



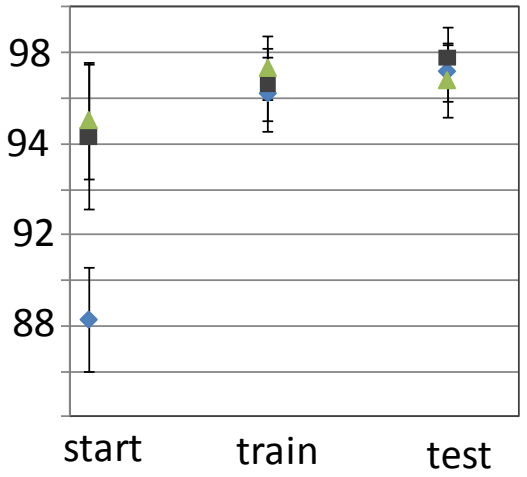
In Press: Verkouteren et al. Environmental Science: Processes & Impacts, DOI: 10.1039/c2em30644a

FSR Use for Operator Training

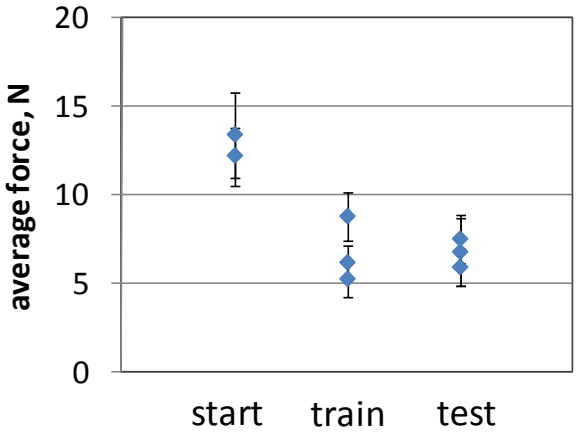
Currently training NIST Physical Security (NIST Test Bed)

Technology transfer to Transportation Security Administrations for airport screener training

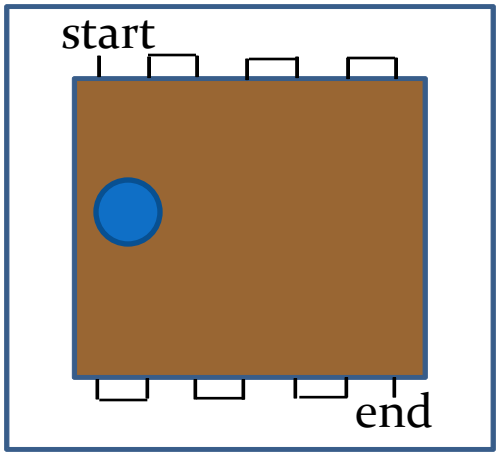
Train for >95% coverage



Train for 7 N



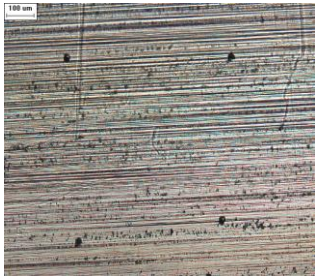
Particle Collection Efficiency: Method



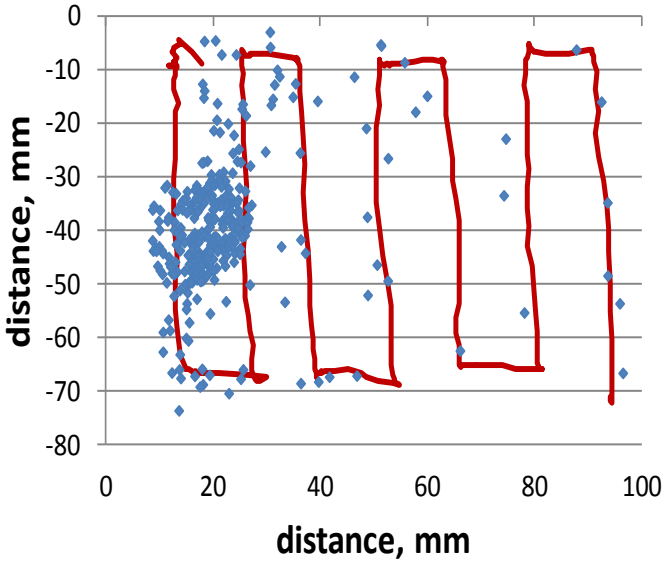
Particle Test Materials

10 μm fluorescent microspheres

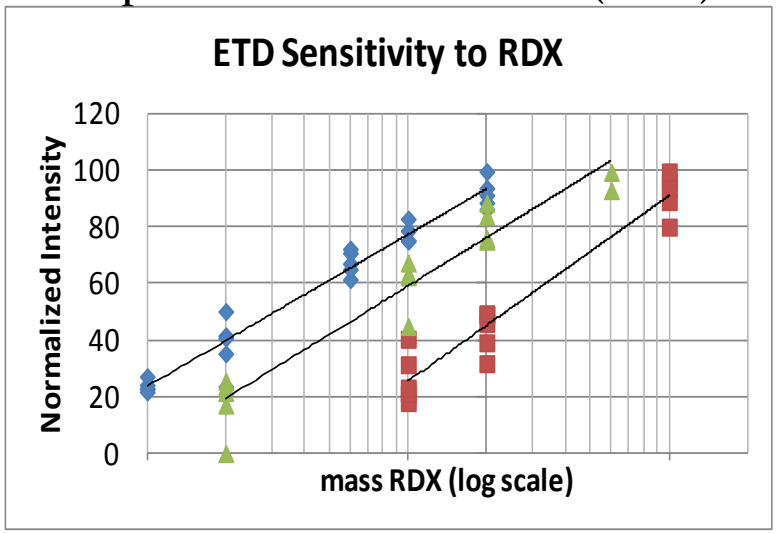
"dry transfer" RDX particles ~ 20 μm diameter



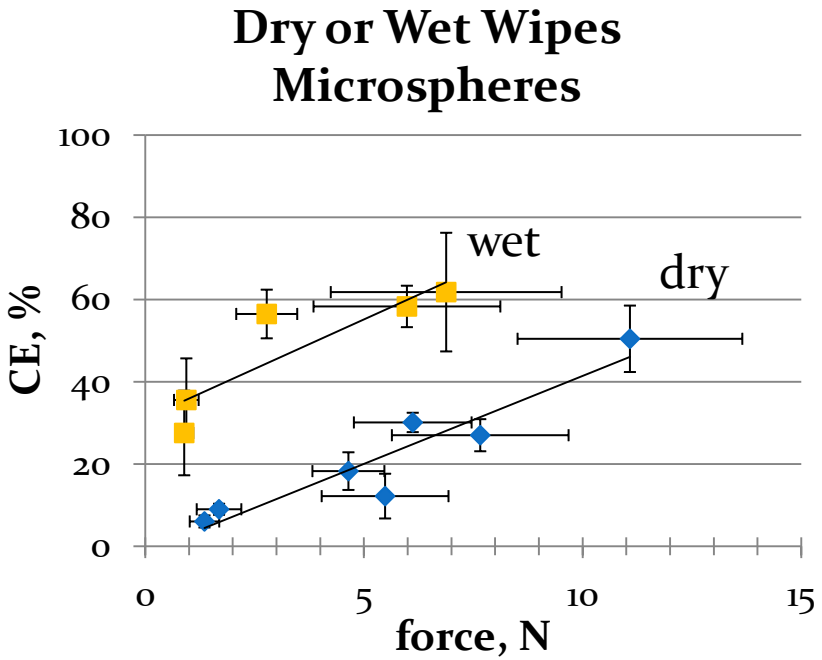
Count Microspheres

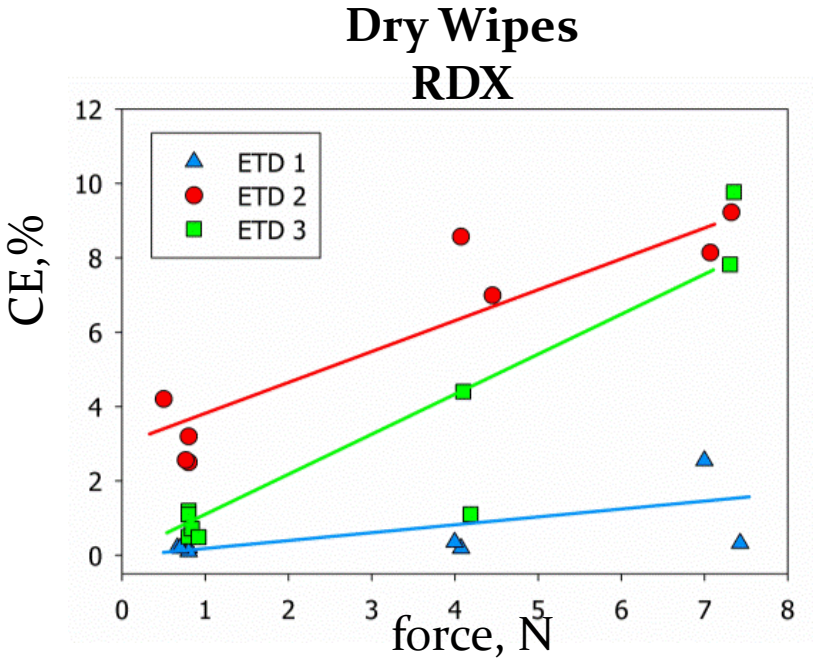


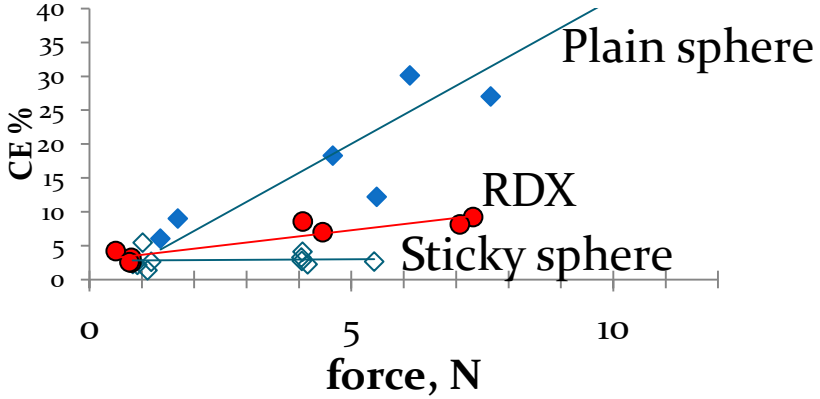
Explosive Trace Detector (ETD)



Particle Collection Efficiency: Results



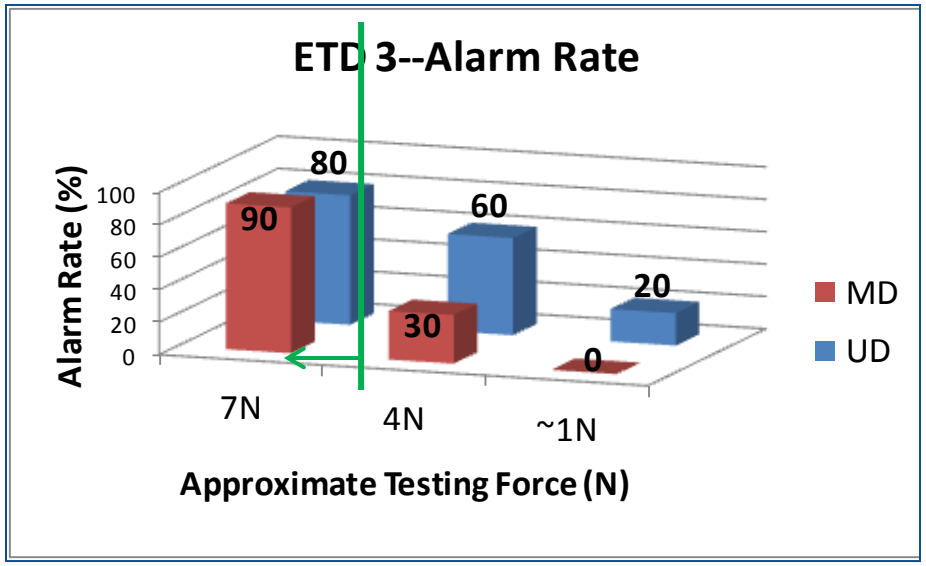




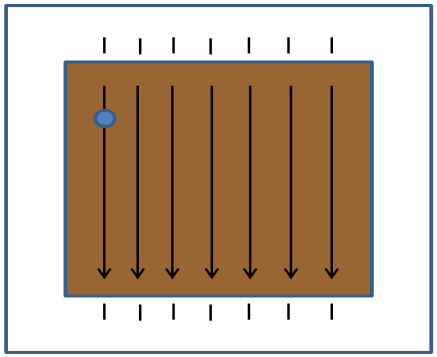
- modify microsphere adhesion
  better simulant for explosive particles

- Increase force
- Use wet wipes (maybe in future)

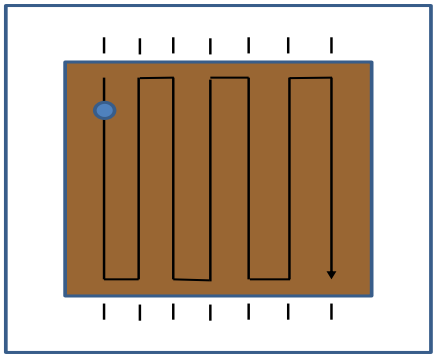
Field Testing using ETD Alarm Rate



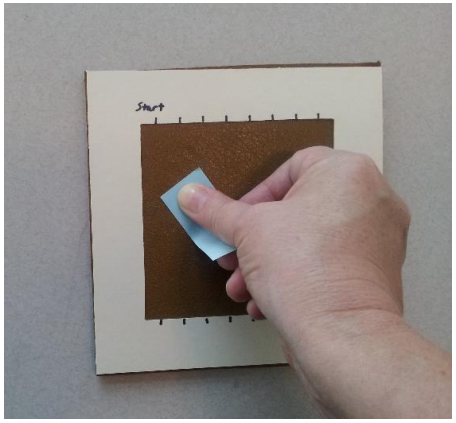
Unidirectional (UD)



Multidirectional (MD)



No FSR

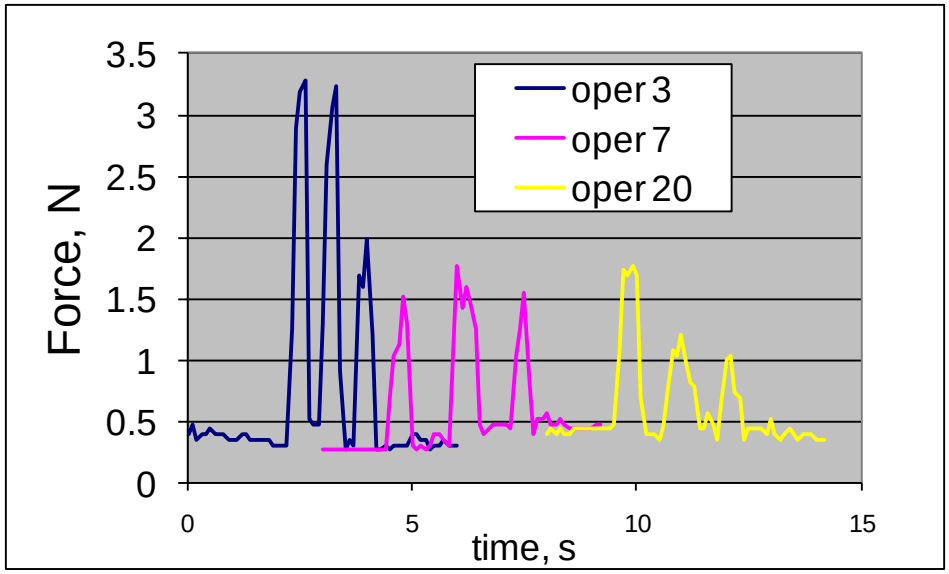


Success measure for correct sampling:
ETD Alarm rate > 67 % (2/3 trials)

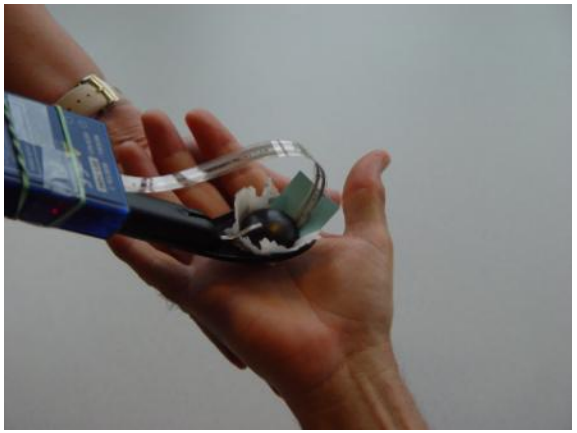
3 Trials
Apply Dry Transfer Material
Sample at force > 4 N

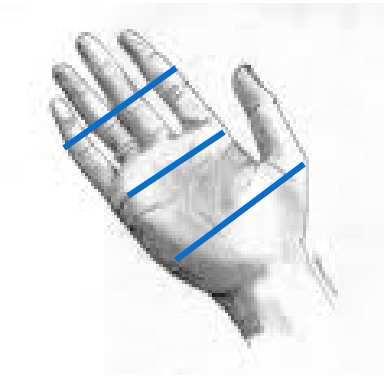
Applied Force Depends on the Scenario

Dermal Sampling



operator	flat surface	hand
	force, N	force, N
3	10.5 (±1.4)	2.3 (max 3.3)
7	11.4 (±2.4)	1.3 (max 1.8)
20	7.4 (±1.8)	1.2 (max 1.8)

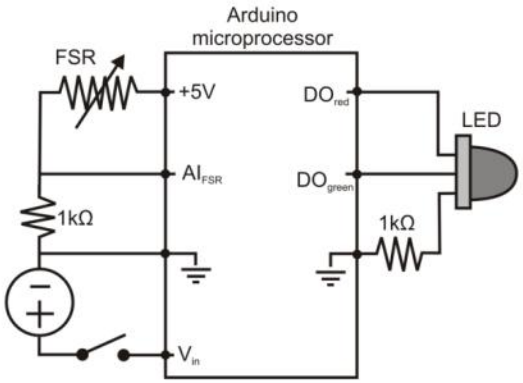


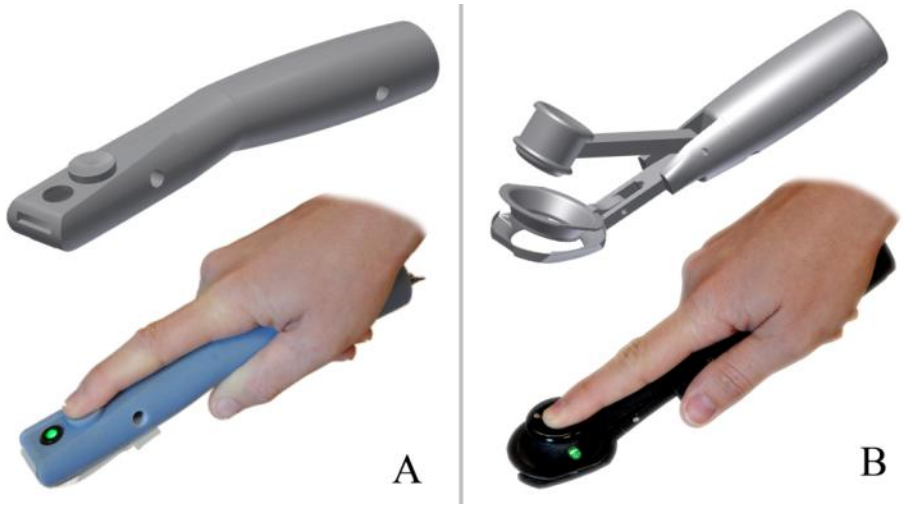


Reduction in force for wiping hands compared to wiping flat surface of 80% or more

Field Use of FSR-Integrated Wands

Test ability to achieve required force in operational environment





Green light when force threshold exceeded

Force threshold set at 6 N

Source: M. Staymates, NIST

Conclusions

- Standard practice for evaluating wipes
  - Controls wipe, force, particle size, surface
- Development of standard sampling method
  - FSR based
  - Control of same factors, and area coverage and path
  - Determine best practices for wide range of contaminants
- Training of operators to reduce variability
  - Average 7 N force
  - >95% area coverage
- Integration of FSR in wand