

NIST TRACE EXPLOSIVES TEST BED

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Who is a target?



C-4: Blast effects from Bali, Indonesia nightclub bombing



C-4: Damaged hull of U.S.S. Cole in Yemeni port



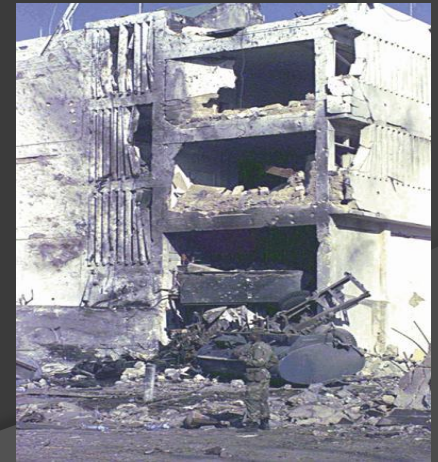
Semtex: Pan Am Flight 103



ANFO (4K lbs): Oklahoma City Murrah Building



TNT: U.S. embassy in Nairobi, Kenya



TNT: U.S. embassy in Tanzania

Detection Technology

- Explosive Trace Detectors (ETDs) are widely deployed to rapidly screen vehicles, people, and their belongings for trace contraband residue
- Locard's Exchange Principle: "Every contact leaves a trace...."*
 - the perpetrator of a crime will bring something into the crime scene and leave with something of it
- What are we looking for?
 - Microscopic evidence or indication of the past presence or existence of contraband



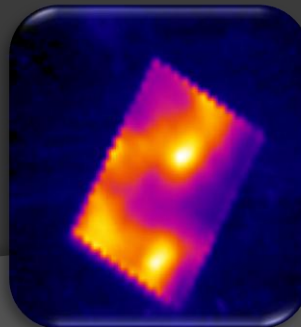
Trace Detection

Trace Residue



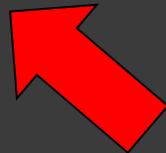
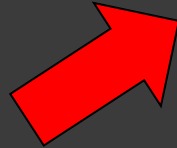
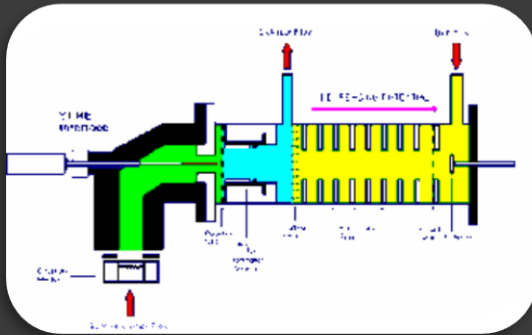
Sample Collection

Operational User



Sample Analysis

Chemical Analyzer/
Detection



Law Enforcement Needs



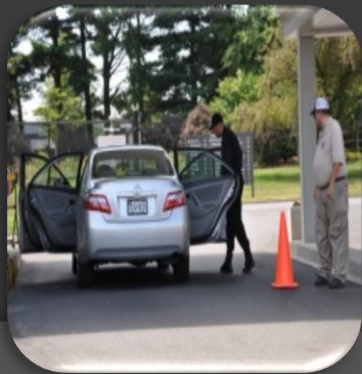
- Need: To protect federal agencies/infrastructure from potential terrorist threats

- How do we know if our detector is working?
- What should my detection requirements be?
- SOPs and best practices for screeners
- Considerations for setting operational parameters
 - false alarm rate, contamination issues, the effect of environmental conditions, sample throughput etc



What is the Test Bed?

- A unique partnership between law enforcement (end-users) and researchers
 - Physical location: NIST campus entry-points
 - ETDs complement canine detection team
- Benefits:
 - Researchers: Evaluate NIST laboratory findings in real-world field conditions
 - End-users: Explosives trace materials (no cost) and specialized screener training



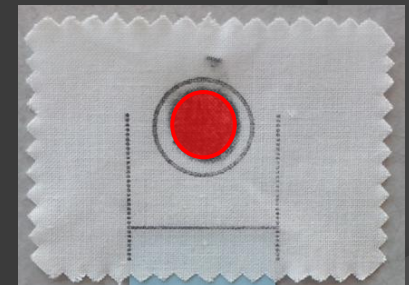
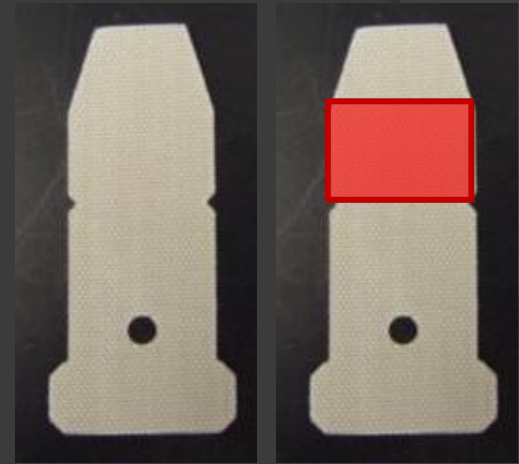
Operator Training

- Characterization of the threat
 - visual, chemical, thermal characteristics
 - particle size distribution
 - contamination: how much to expect, where to look (“hot spots”), fingerprints, dirt, etc.



Operator Training

- Sample collection
 - Wipes and particle collection efficiency (PCE)
 - “sweet spot”
 - Best practices for swiping
 - Direction
 - Force
 - Wands
 - Design and optimization



Operator Training

- Instrument operation
 - How does the instrument work?
 - Optimization of parameters
 - Verifying instrument performance
 - **Test materials**



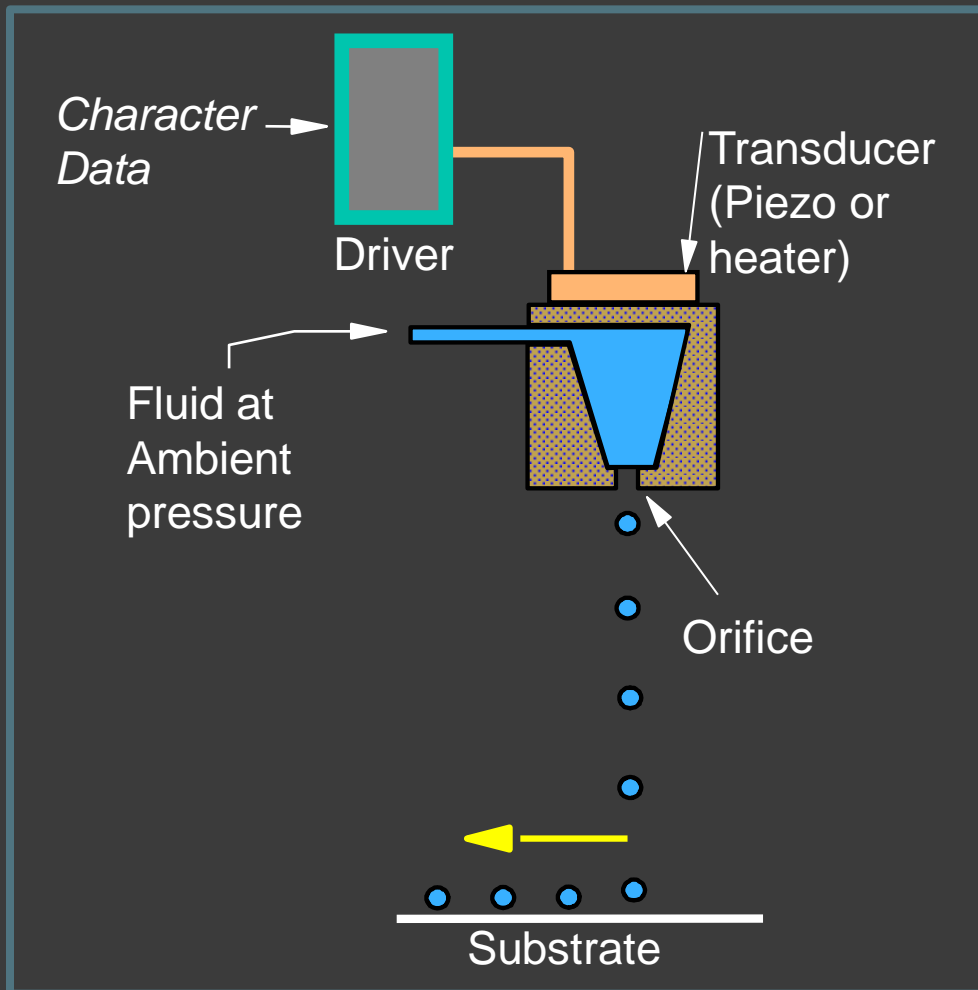
Test Materials (TMs)

- ⦿ Explosives test materials are standards with a known amount of explosive

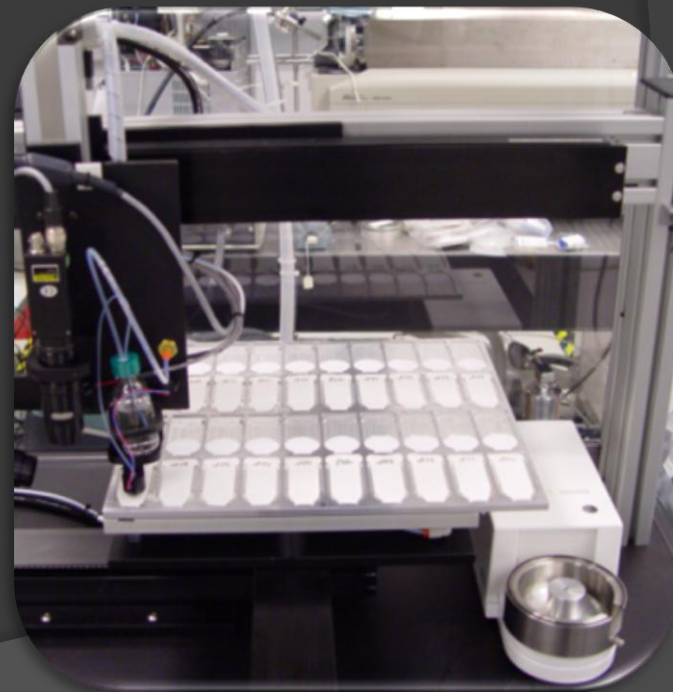
Test materials applications:

- Daily instrument performance check
- Evaluate screener performance
- Support “red team” operations
- Evaluate instrument variability
 - False alarms
 - Limit of detection
- Lab vs field instrument response comparison
- Monitor instrument drift (environment)
- Define detection requirements
- Define limit of detection (LOD)
- Assess return from service

Inkjet Printing Technology

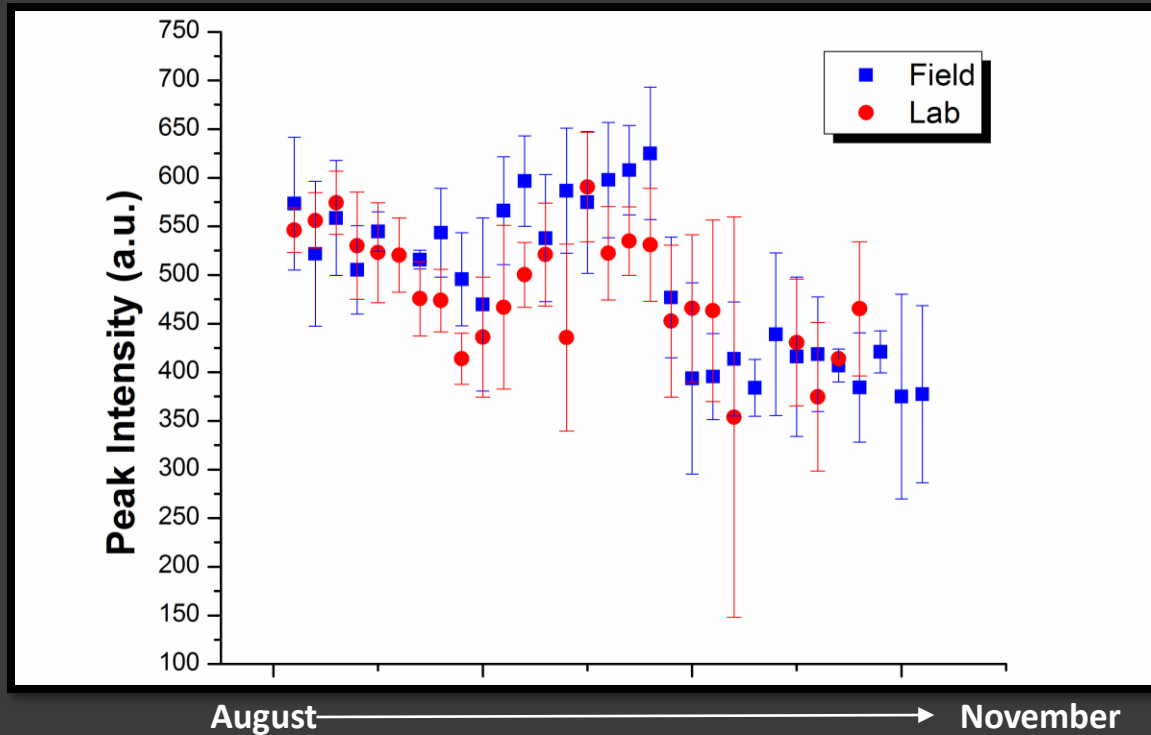


- Mass production
- Large dynamic range
- Wide range of threats
- Repeatable, traceable
- Flexibility
- Low cost and easy to use



1. Verkouteren et al., *Anal. Chem.*, **2009**, 81 (20), pp 8577-8584
2. Windsor et al., *Anal. Chem.*, **2010**, 82 (20), pp 8519-8524
3. Verkouteren et al., *Langmuir.*, **2011**, 27 (15), pp 9644-9653

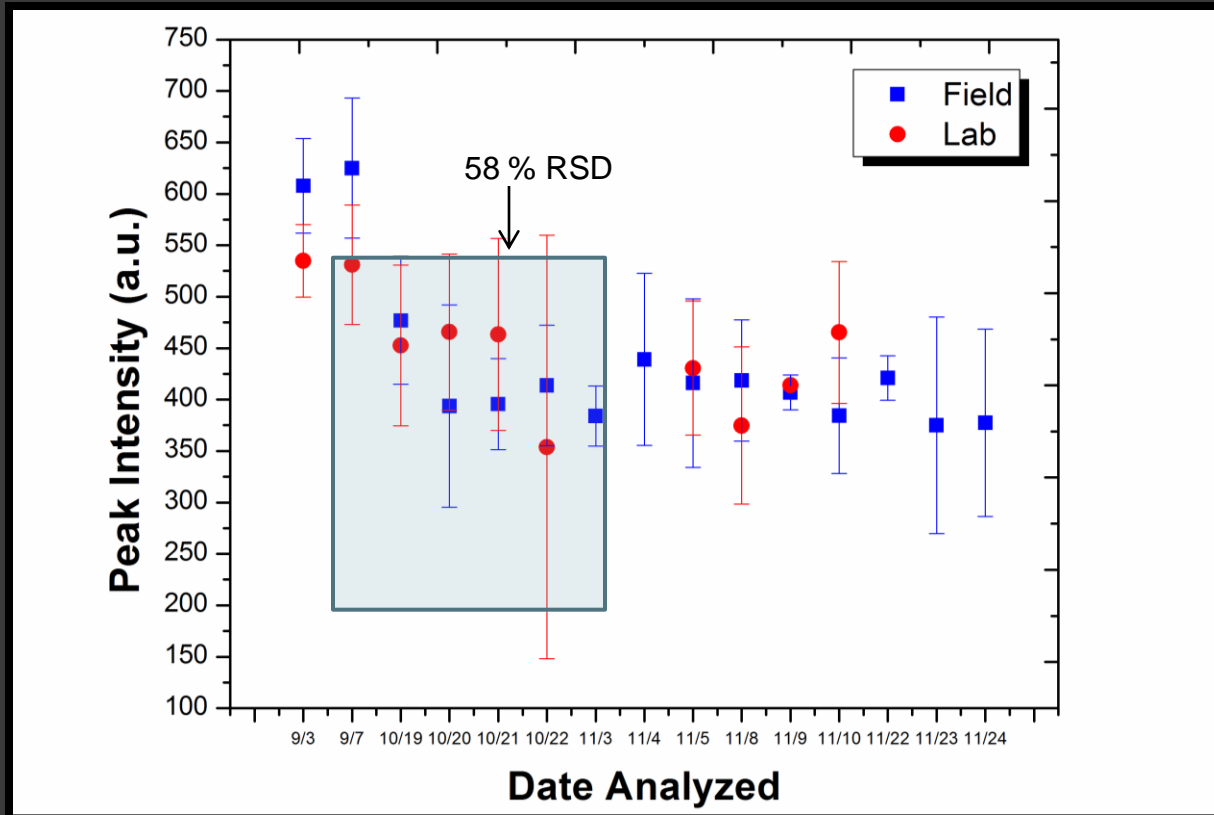
Laboratory vs Field Response



$n = 5$
~10 % RSD

- Test materials were stable during testing period
- Showed subtle changes in instrument performance
- All samples produced a 100 % alarm rate
- Good sample shelf-life (+85 days)

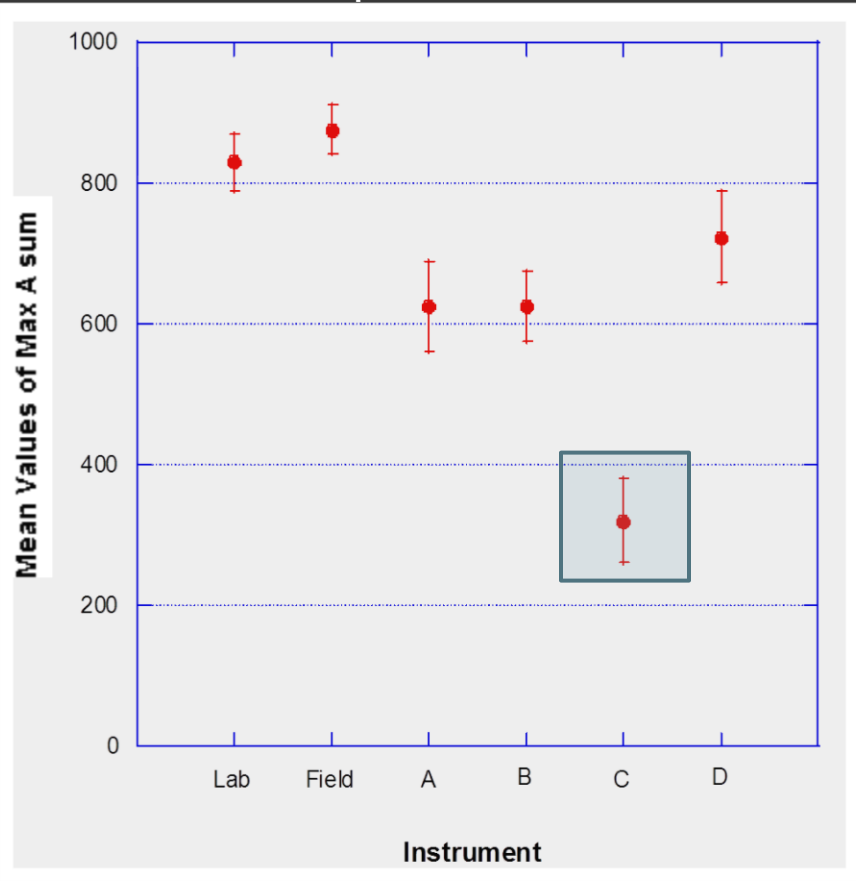
Instrument Drift



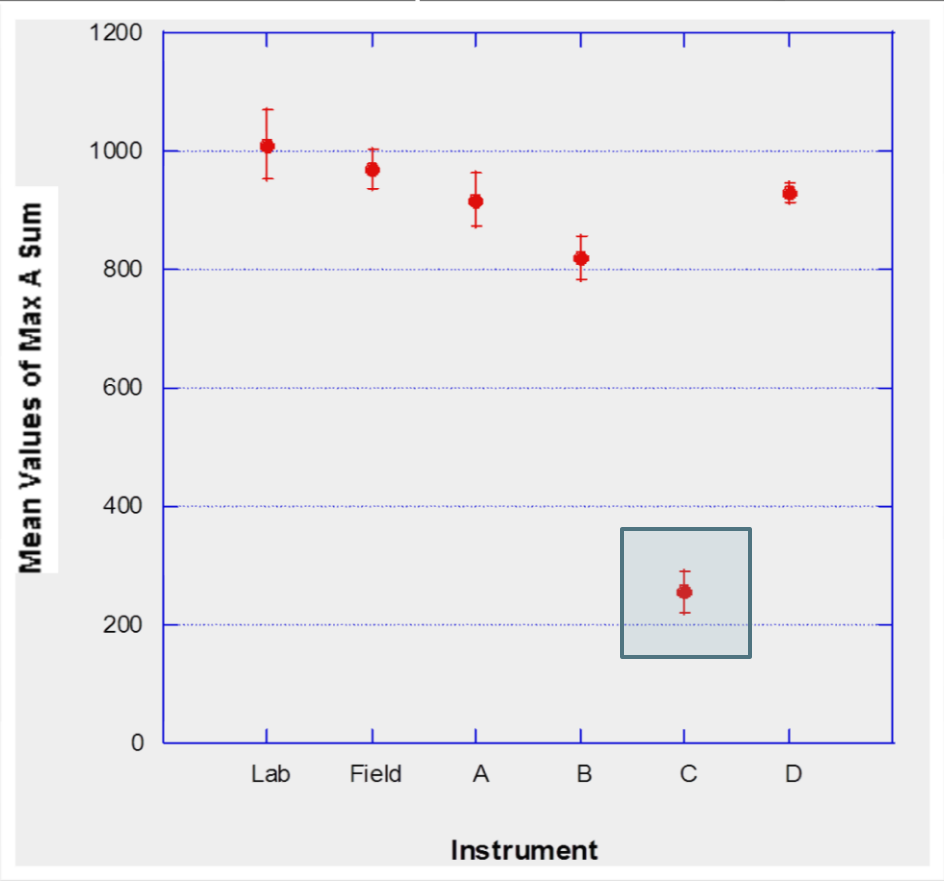
- The average field temperature during this testing period was 16 °C and 41 % relative humidity
- High TM variability alerted of a need for preventative maintenance: bakeout cycles and replacing the O-ring of the sample flange

Instrument Response Comparison

Explosive X

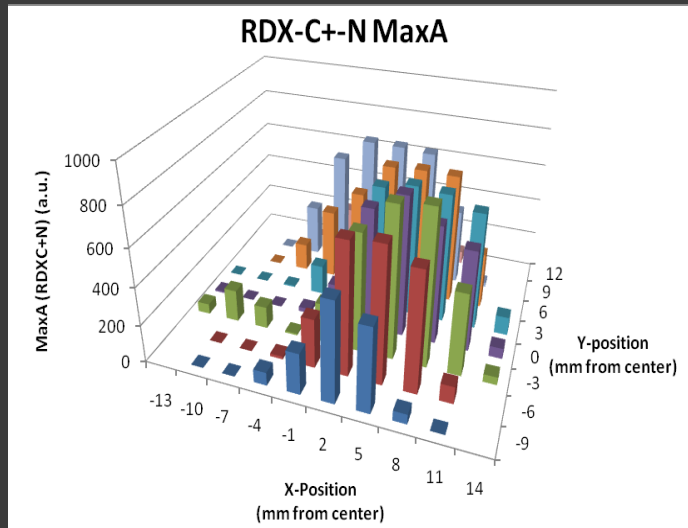


Explosive Y

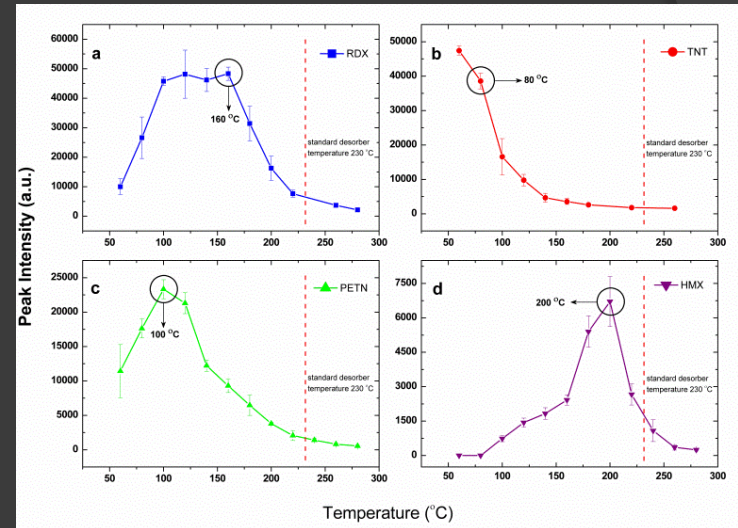


- Uncertainty is the standard deviation of the 10 measurement data set
- There was no operational indication or warning that “C” was performing with lower sensitivity than the other instruments

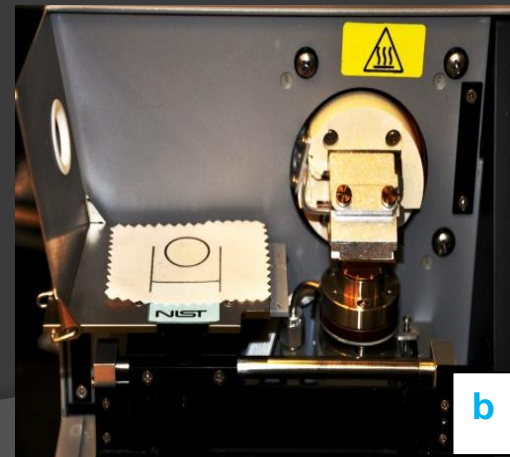
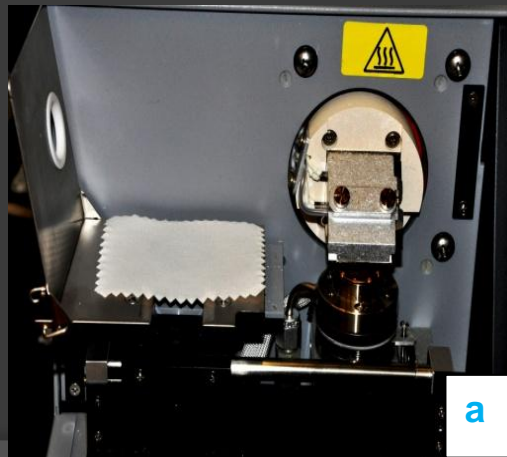
Operational Improvement Recommendation (OIRs)



Optimizing instrument design



Optimizing operational conditions



Optimizing sampling

Conclusions

- ◎ Test Bed was developed to bridge the gap between the laboratory and the field
 - Assess value of research findings to the end-user in the field
 - Address the needs and requirements of the trace detection community
- ◎ Operator training is critical to ensure the reliability of the trace detection analysis chain
- ◎ Fundamental research in the lab and field studies at the NIST explosives test bed confirm the critical need for **measurements and standards** for the trace detection community

Future Goals

- Develop an inter-agency program with federal, state, and local law enforcement agencies interested in using test materials
- Provide scientific documentation to support educational/training programs for screeners
- Develop test materials for the narcotics detection community (dual mode ETDs)



Acknowledgments

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Questions?

Thank you for your time and attention!

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*Certain commercial equipment, instruments or materials are identified in this paper to specify adequately the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.