Towards a Comprehensive Counter-IED Program: Detection and Deterrence

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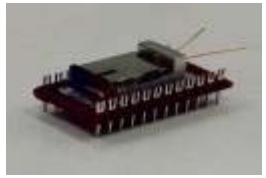
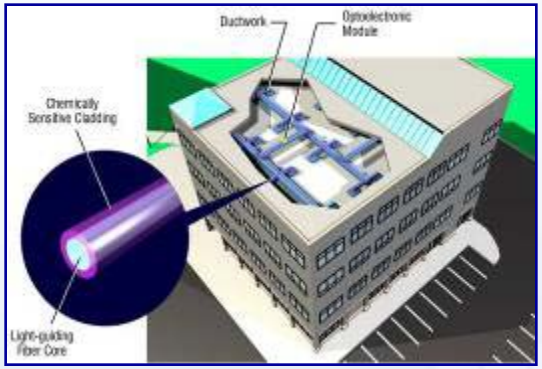
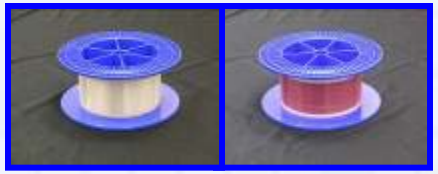
- **Founded in 1998**
- **Focus: practical application of optical technology and devices.**
- **Main thrusts:**
  - Optical sensors: physical, chemical, biochemical diagnostics
  - Advanced light sources
  - Advanced signal and image processing
- **Diversified research and development**
- **Interdisciplinary: physicists, chemists, biotechnologists, computer scientists, engineers**







Detection and Deterrence:
Key events "on the left of the boom"

- Detection
  - Identification of threatening individuals
  - Identification of threatening materials
- Deterrence
  - Passive measures
  - Active deterrence

OBJECTIVE: REAL-TIME THREAT TRACKING

False color imaging will be used identify, classify, and track threat

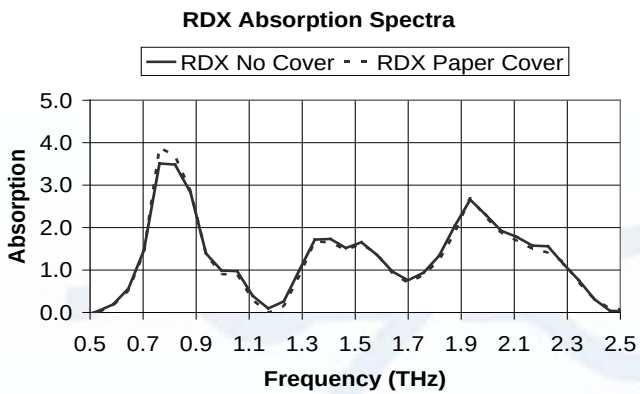
Detection

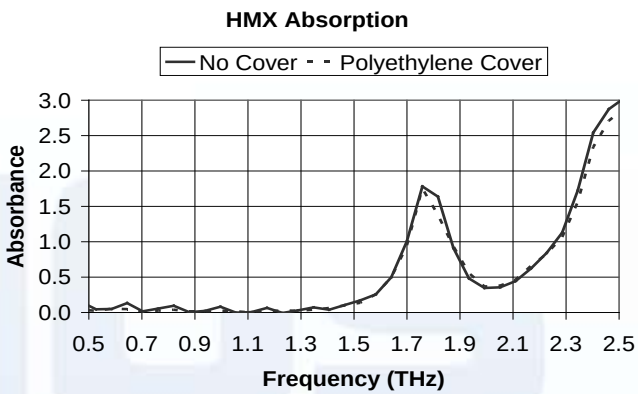
- Approach: Combine recognition of individuals with recognition of threat materials

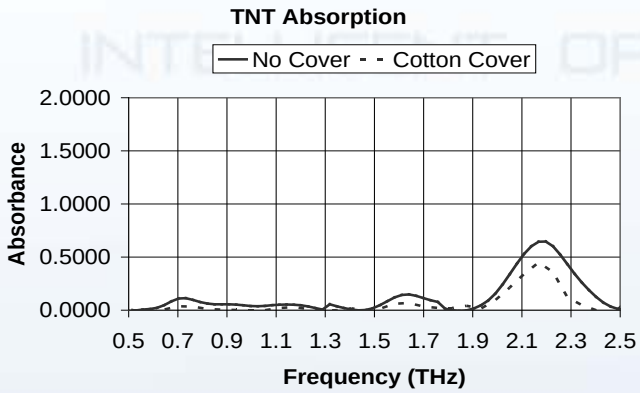
THz Spectroscopy for Standoff Detection of Explosives and Weapons

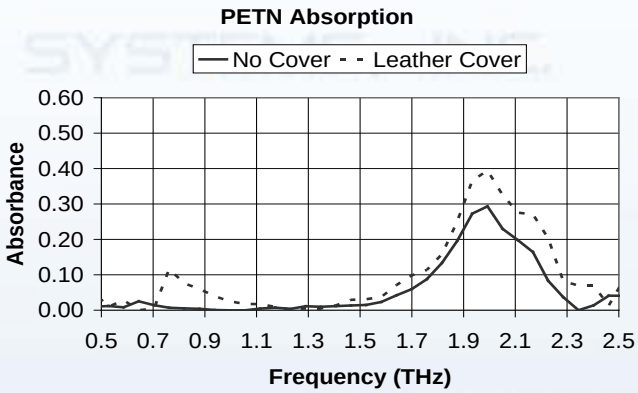
- THz radiation is safe to humans
- Frequency dependence of absorbed or reflected THz radiation is indicative of explosives and other dielectric materials
  - Stand off spectroscopic analyzer
- Efficient reflection over broad wavelength regions is indicative of metals and ceramics
  - Potential weapons detection
- THz radiation is minimally absorbed by paper, leather, plastic, cardboard, clothing
- THz radiation can be transmitted through the atmosphere within a window of 0.1 to 3 THz, with the exception of numerous water absorption lines

ABSORBANCE SPECTRA OF EXPLOSIVES



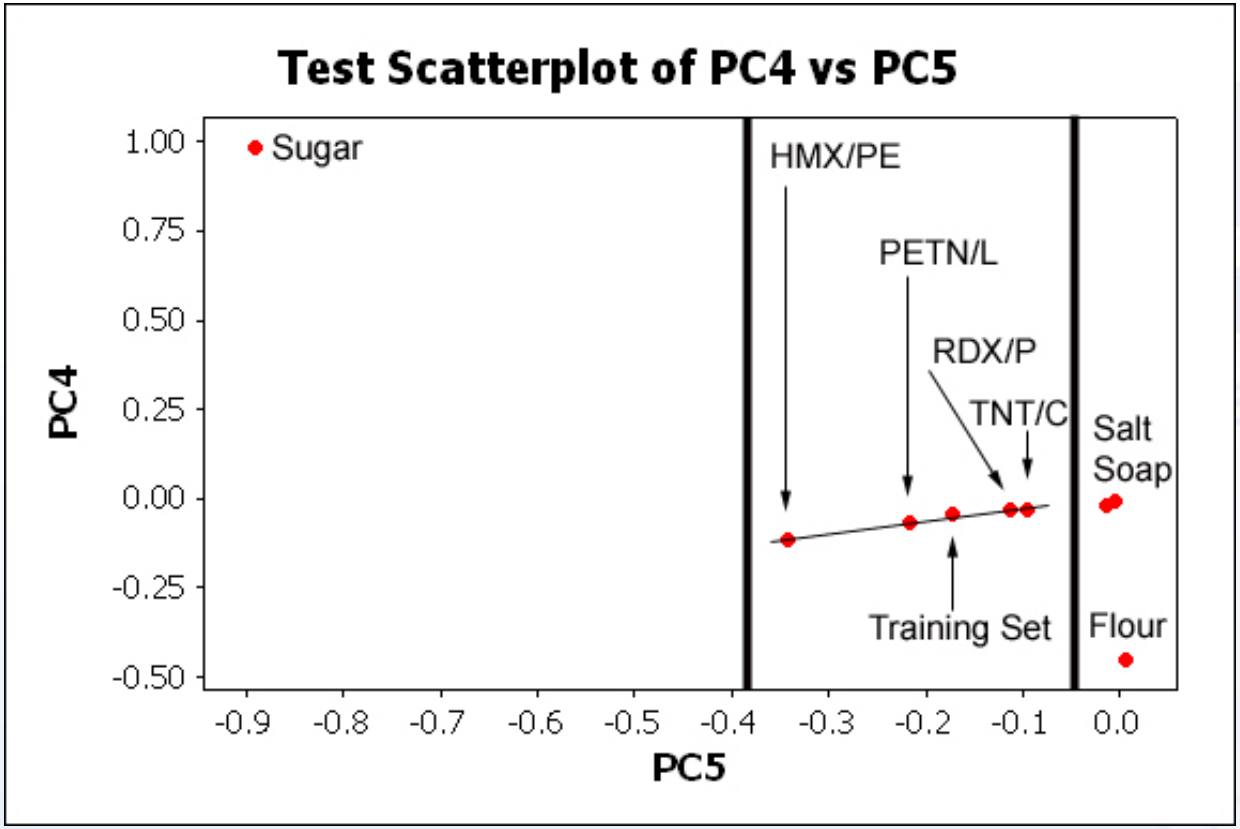




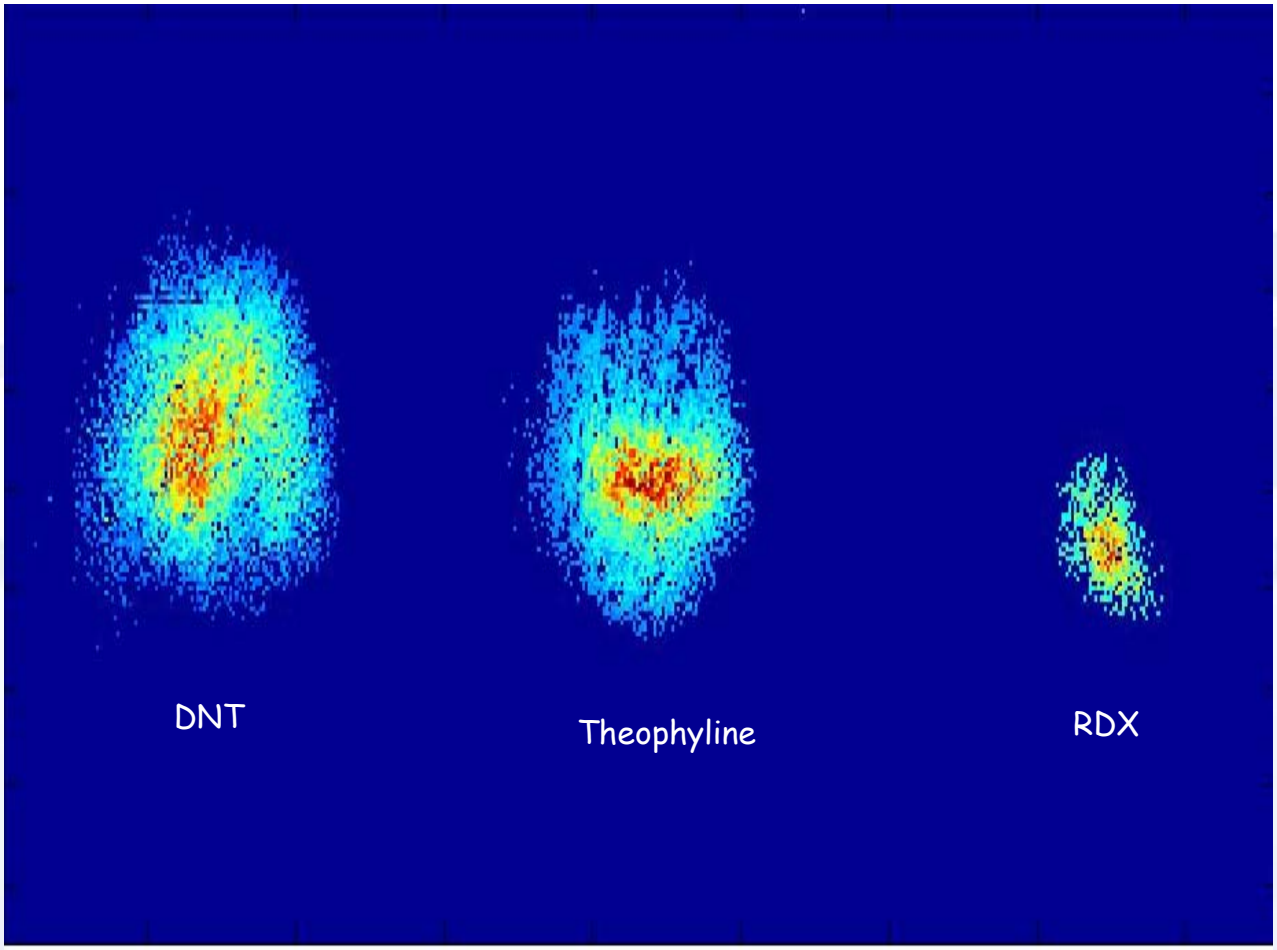


CLASSIFICATION VIA Principal Components Analysis

- Used spectra of four covered explosives and 4 non-explosives as test set
- Used five signature frequencies

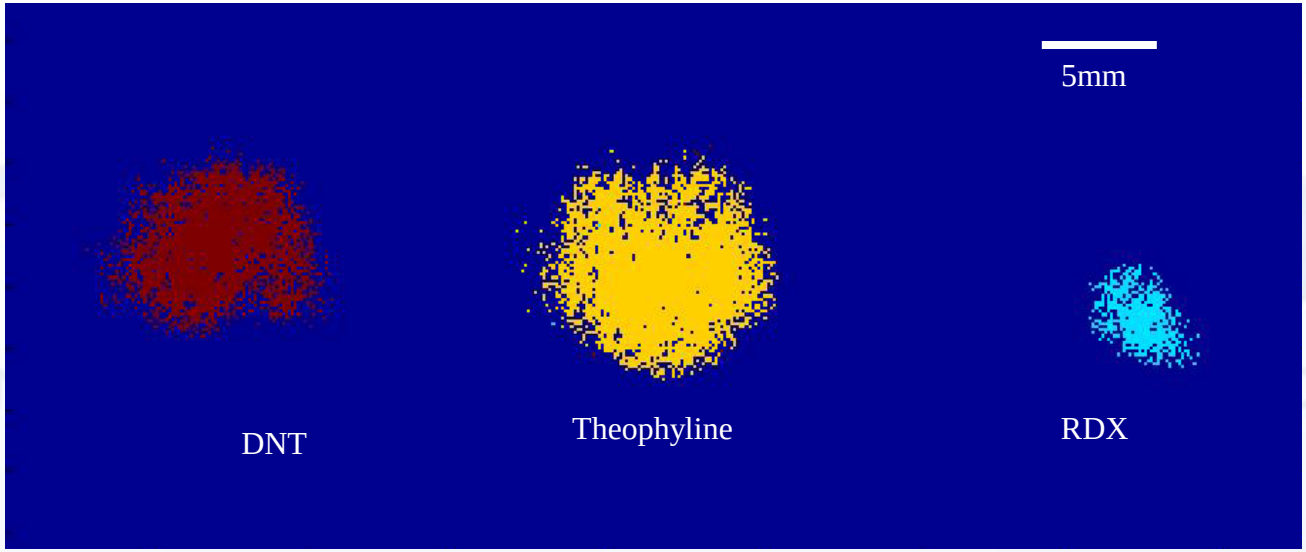


BROADBAND REFLECTION IMAGES



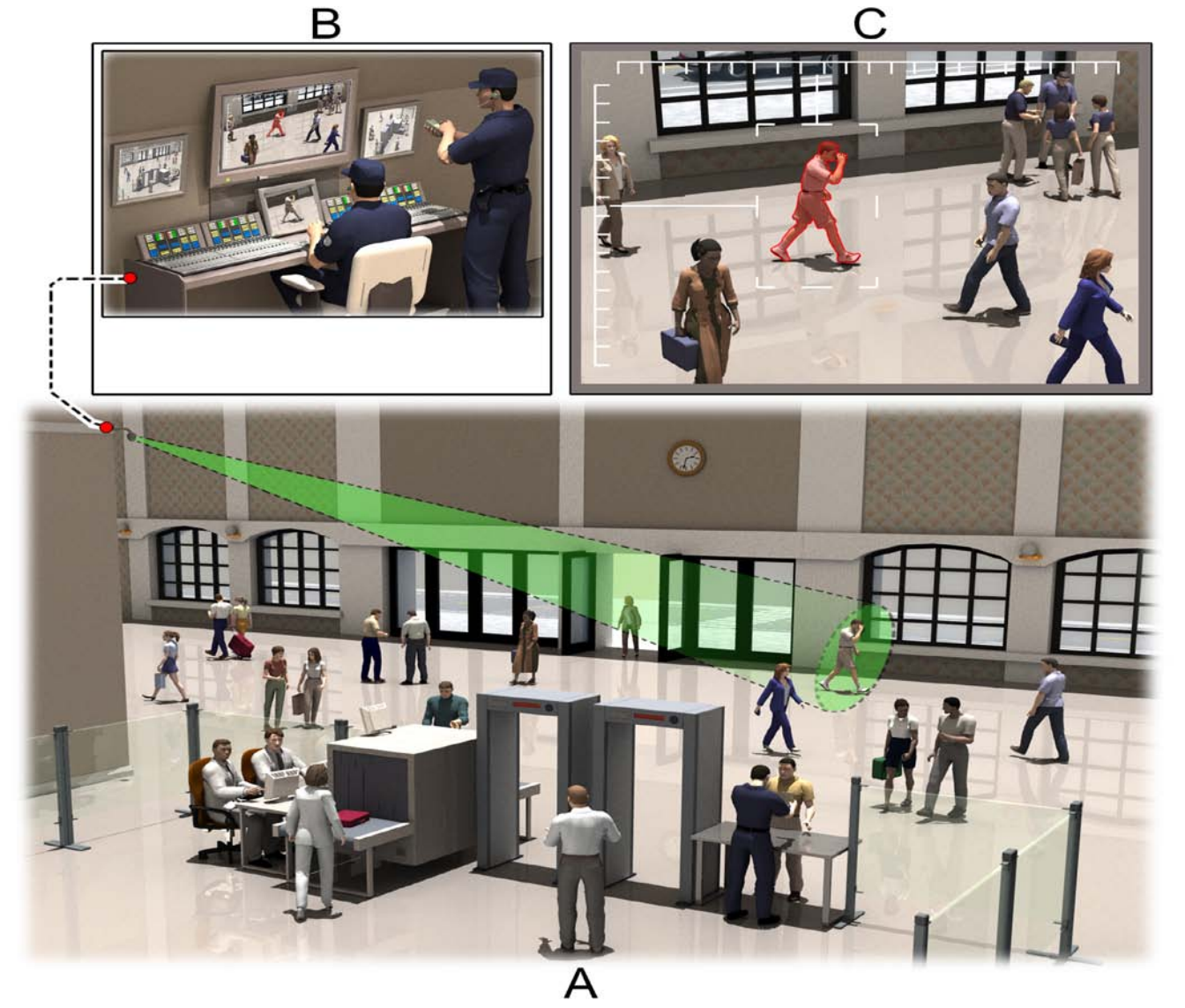
Amplitudes of peak time domain reflections, no classification

CLASSIFICATION VIA PCA



100% classification using 28 features of principal component analysis of 80 frequencies of relative reflectance spectra

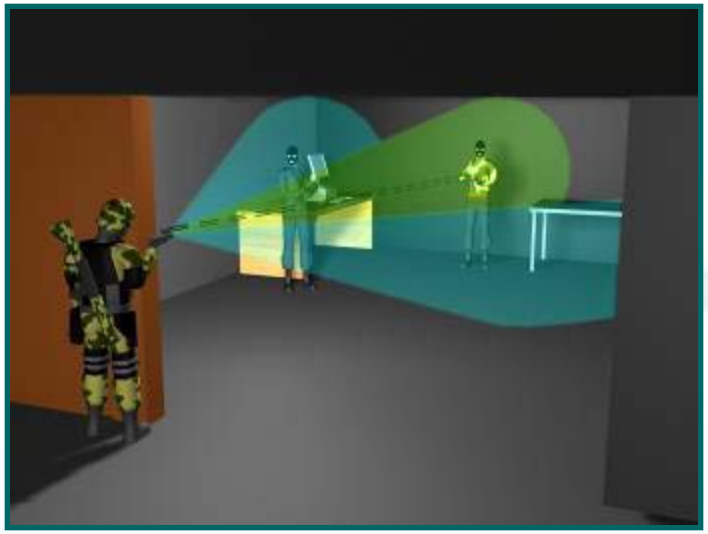
STANDOFF DETECTION AND TRACKING



Deterrance

- Approach: Nonlethal “discriminator” and incapacitator

Less-lethal Eye-safe LED Incapacitator



- Funded by DHS
- Highly disorienting, pulsed intense light with varying colors and frequency patterns
- Ultra bright, highly efficient LED clusters
- Eye safe operation at all distances

Second Generation LEDI™ Prototypes: Developed and Delivered in SBIR Phase II

- Flashlight shape - 4.5″ or 6″ head
- Calculated irradiance at 7 feet:
  - 5.6 mW/cm^2 for 4.5″ provides 3.6 - 5.6 mW/cm^2 irradiance
  - 8.9 mW/cm^2 for 6″ provides 5 – 6 mW/cm^2 irradiance
- Light concentrated in 5º angle with microsructured lens
- Dual mode operation
- Three colors strobe at 5-7Hz frequency
- Random frequency strobe light
  - Incorporated white light
- 169 color and 18 white LEDs cluster in 6″ unit
- 91 color and 18 white LEDs in 4.5″ unit
- Rechargeable battery
- Application: police, security

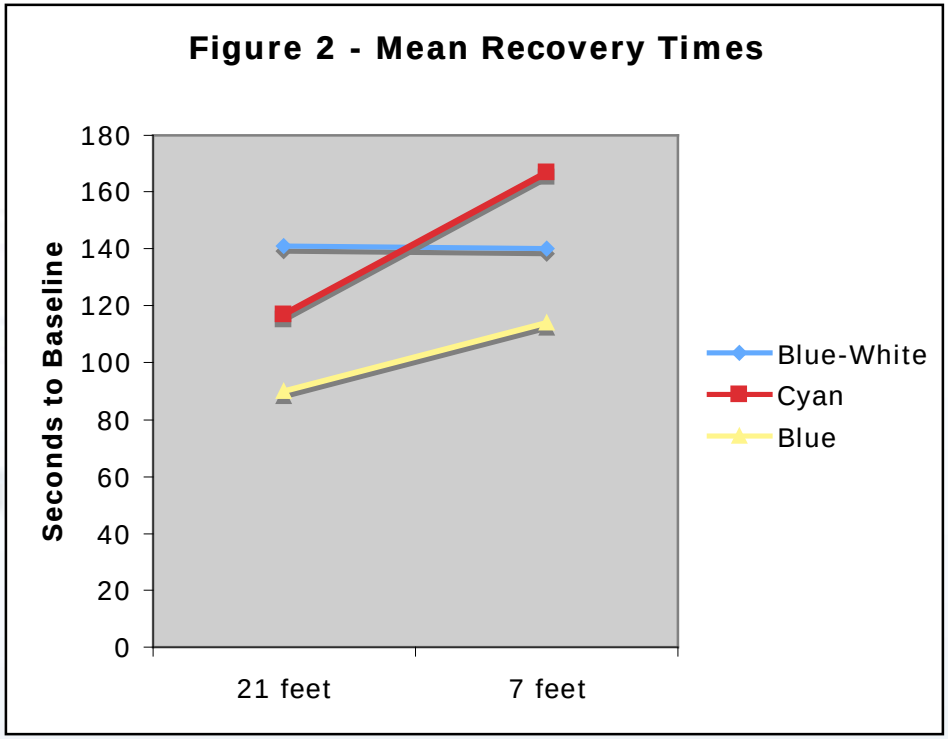
Affects as Reported by Subjects

- One-third to one-half of subjects reported glare and flash-blindness in most conditions
- All subjects reported afterimages
- No subjects, in any trial, reported experiencing:
  - Vertigo
  - Nausea
- This is not a “puke ray”
  - Despite some of the LEDI™ stories found on the web

DATA is NOT to be released without the express written permission of IOS

Results Show Effect on Visual Acuity

- Visual acuity affected by all wavelength options
- Cyan had the most impact for close range operations
  - Useful for cell extractions and other close in situations
- Cyan and blue similar in affect at 21 feet



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Gross Motor Skills Test Environment

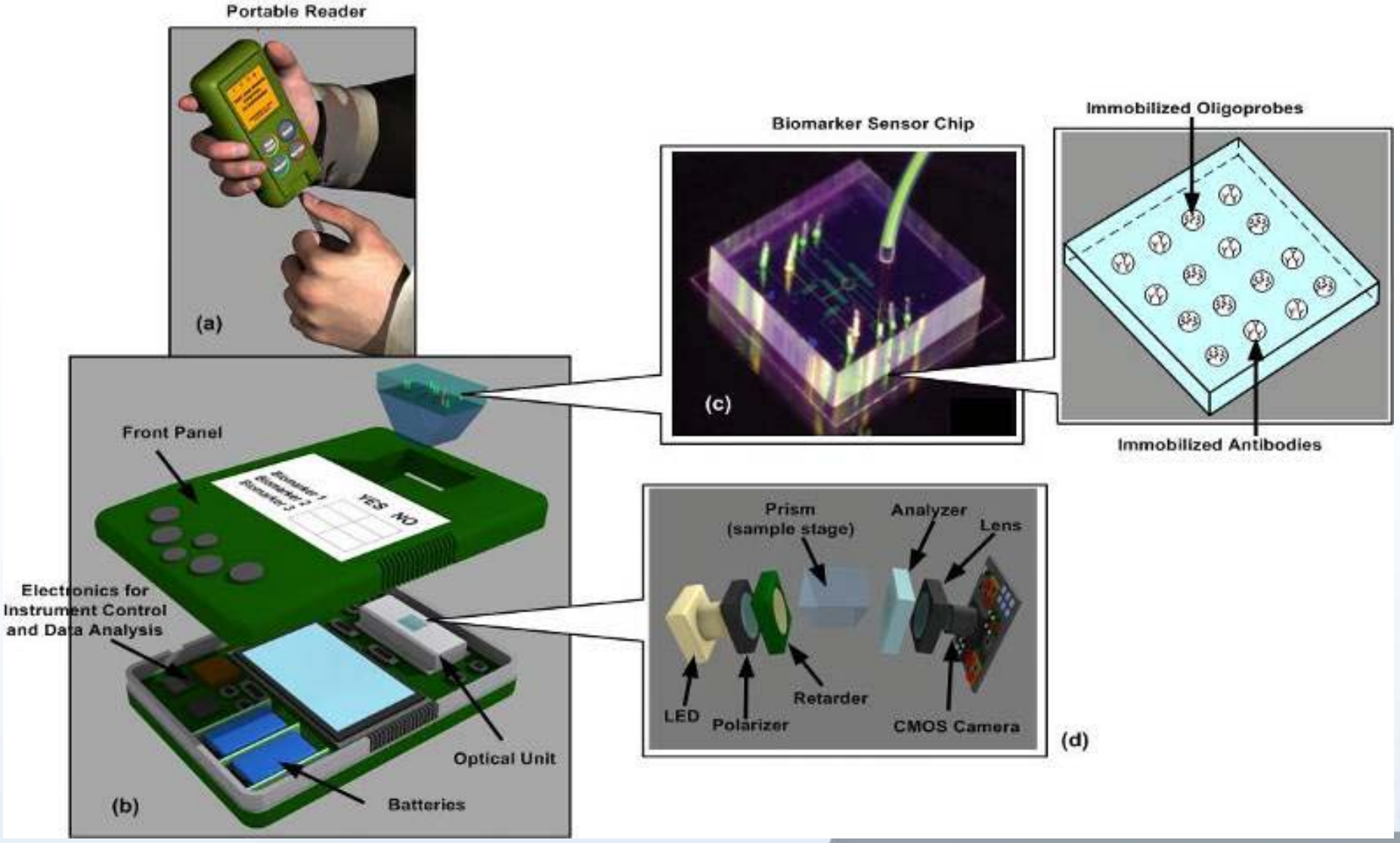
- Subjects positioned 21 feet away from light source in a darkened room
  - Instructed to move toward light after 5 seconds exposure and hit target with marker mounted on 5-foot stylus.
  - Light continued to flash until they hit the target
- Time to target and accuracy (distance in cm from the marked center of the target) recorded

LEDI™-3 Product Prototypes: RTAP Brings LEDI™ to the Field

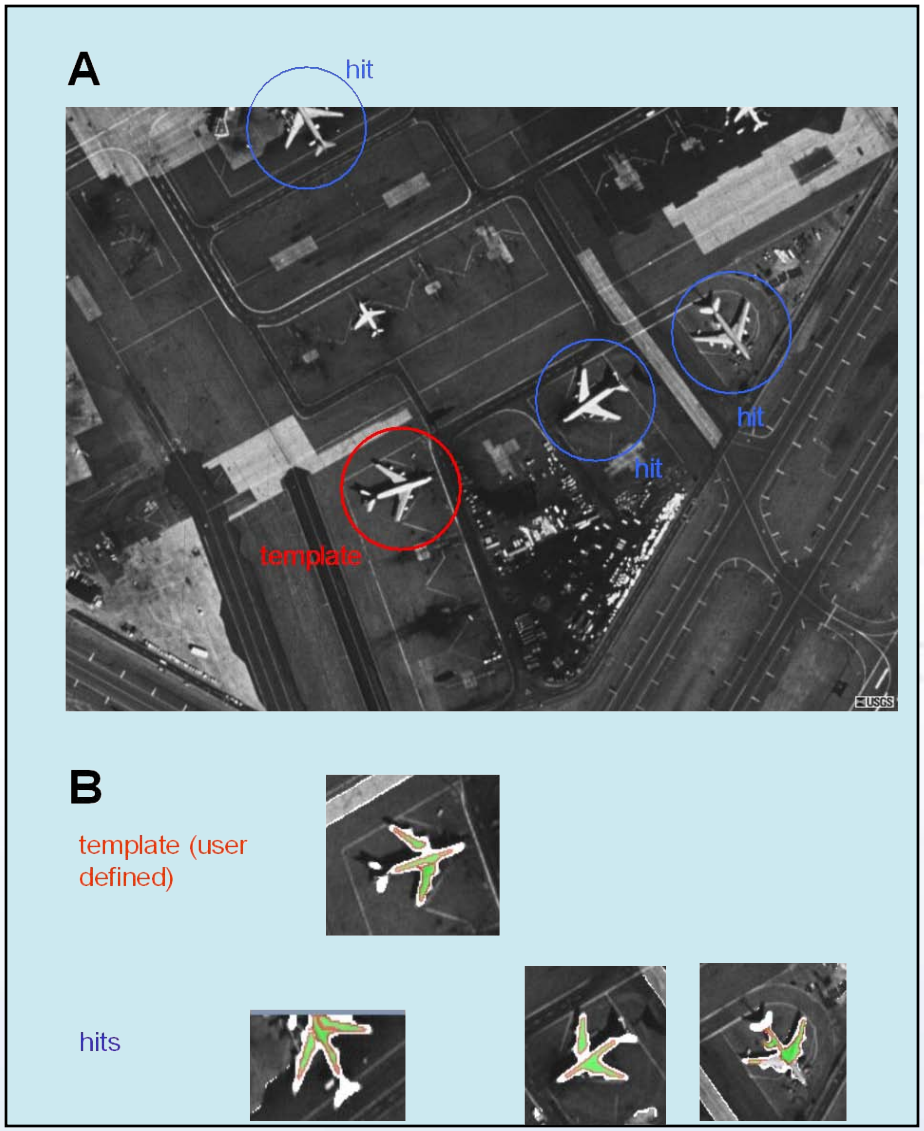
Distributed Chemical Sensor Systems

DICAST®: The cable *is* the sensor

Field-Portable Biomarker Detector



Singularity Modeling Enhances Target Recognition



A The template airplane (red circle) was defined by the user. The algorithms detected three airplanes of similar size (blue circles).

B Segmentation for template (top, 3 segments) and hits (bottom, 3, 2, and 2 segments). The user defined the three segments of the template airplane.

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