Aerosol Triggers

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New England Bioterrorism Preparedness Workshop

3-4 April 2002

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<td>Workshop paper from the New England Bioterrorism Preparedness Workshop held 3-4 April 2002 at MIT Lincoln Laboratory, Lexington, MA, The original document contains color images.</td>
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Biosensor Architecture

- **Trigger (< 60 s)**
  - Continuous operation
  - Alert of potential threat aerosol
- **Collector (5 min)**
  - Activated by trigger
  - Provide sample of aerosol particles

- **Identification (15 min)**
  - Preliminary identification of agent

- **Confirmation (4 – 24 hr)**
  - Final identification of agent
  - “Gold Standard” tests
  - Performed in laboratory (TAML)
Bio-Aerosol Triggers

• Raw Particle Counters
  – Small, low cost
  – Nondiscriminatory - very high false trigger rates

• Fluorescent Particle Counters
  – Ultra Violet Aerodynamic Particle Sizer (UVAPS)
    Trigger for Biological Integrated Detection System (BIDS)
    Manufactured by TSI Inc. (St. Paul, MN)
  – Fluorescence Aerodynamic Particle Sizer (FLAPS)
    Different trigger algorithm than UVAPS
    Trigger for Canadian Integrated Biological Agent Detection System (CIBADS)

  – Biological Agent Detection Sensor (BAWS)
    Trigger for Joint Biological Point Detection System
    Manufactured by Intellitec (Deland, FL)
Biological Agent Warning Sensor (BAWS)

- Army Advanced Technology Demonstration
  - Began BAWS development in 1996

- Four design generations developed

- Extensively tested
  - Performance
  - Environmental

- Integrated into the Joint Biological Point Detection System
  - Development transitioned to JBPDS in 1999.

**BAWS III**

- Size: 0.8 ft³
- Weight: 19 lbs
- Power: 35 W
BAWS Concept

Pulsed Ultraviolet Laser

Fluorescence Emission and Elastic Scattering

Agent Containing Particle

Detected Signals

UV
Visible
Elastic

Time

Particle Emission Spectrum

Relative Signal

Elastic Scattering
Fluorescence
Tryptophan
NADH
Flavins

UV - Visible

266 330 450 560

Wavelength (nm)

UV - Elastic

Dirt
Agent

Particle Discrimination
Joint Biological Point Detection System

- Automated suite of sensors for detection and identification of biological attacks
  - Trigger – BAWS
  - Collector – Wetted Wall Cyclone
  - Identifier – Immunoassay
  - Confirmatory Samples
The Atmospheric Aerosol Composition

Aerosol Size Distribution


Composition of Coarse (>1 micron) Aerosol

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<thead>
<tr>
<th>Organic Aerosols</th>
<th>Particles per Liter</th>
<th>Inorganic Aerosols</th>
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<tr>
<td>Man Made</td>
<td>0 – 2000</td>
<td>100 – 10,000</td>
</tr>
<tr>
<td>Fungi</td>
<td>0 – 100</td>
<td>Clays, Sands, Composites</td>
</tr>
<tr>
<td>Bacteria (culturable)</td>
<td>0 – 1</td>
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<tr>
<td>Pollen</td>
<td>0 – 1</td>
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Total vs. Fluorescent Particles

- Most sand particles do not fluoresce and are “invisible” to BAWS
Field Trials

27Oct99 - 9Nov99
BAWS/JBPDS Mini Field Trials

BAWS ROC Curve

Detection Probability

False Alarm Rate
Response of BAWS Array to Agent Aerosol

- **East End of Grid**: JFT-4
  - Alarm On

- **Center of Grid**: Truth Data

- **West End of Grid**: Truth Data

Time: 21:35 to 22:10
Response of BAWS to Interferent and Agent Aerosol

Sensor at East End of Grid

Sensor Signal

Time (H:M:S)

Agent Signal
Truth
Particle Concentration

Sensor Alarm Period

Agent Signal
Truth
Particle Concentration

Sensor Alarm Period

Bioterrorism Workshop-11
THJ 4/22/2002
Live Agent Tests of BAWS

- Comparison of BAWS response to real agents and simulant agents
  - Simulant Agents: BG, *Erwinia herbicola*, Ovalbumin, MS2
  - Three Real agents

Results: BAWS detects live agents as well as, or better than, simulant agents
  - Equivalent sensitivity
  - Equivalent discrimination
BAWS Performance Testing

- **Joint Field Trials**
  - JFT 3, Dugway Fall ‘96
  - JFT 4, Dugway Fall ‘97
  - JFT 4.5, Dugway Spring ‘98
  - JFT 6, DRES Canada Fall ‘00
- **Army ATD Field Trials** Spring ‘99
- **Joint Biological Point Detection System Field Trials**
  - Mini Field Trials Fall ‘99
  - Gamma-Killed Bio-Agents Spring ‘99
  - PPQT Spring ‘00
  - Live Agents Summer ‘00
  - Porton Down, UK Fall ‘00
  - Ambient Breeze Tunnel, Battelle Spring ‘01
  - Operational Assessment 2 Fall ‘01
- **Background Measurements**
  - USA tour ’98 – ‘99
  - Kuwait Spring ‘99
  - Altitude study Fall ‘00
  - Salt Lake City Spring ‘01
  - Hawaii Summer ‘01
Simulation of BAWS Response to Agent Attacks in Different Environments

Background Measurement Data (1 week at each site)

Alarm Algorithm

BAWS III Sensor Response to BG

False Trigger Rate (per day)

Kuwait
Dugway UT
Atlanta GA
Cambridge MA
Fort Leonard Wood MO

Counts (Hz)

Time (min)

UV-Elastic

UV-Vis

Sensitivity (ACPLA)

False Trigger Rate (per day)
Detector Position vs. False Trigger Rate

- **England (Sep ‘00)**
  - One week of measurements
  - 21 agent simulant challenges
  - 8 interferent challenges
- **Sensor Performance vs. sensor height**
  - BAWS at 2-m and 13-m height
  - Ten times fewer false triggers at 13-m height
Summary

- **BAWS developed for early warning of a biological agent attack**
  - continuously operating point detector
  - small size, low weight, low power consumption

- **Generic detection (not identification) of threat aerosol**
  - Individual detection of aerosol particles
  - Discrimination of threat particles from non-threat particles
  - Sensitive, low false alarm rate, fast response

- **Subjected to extensive testing**
  - Performance
  - Environmental

- **BAWS integrated into JBPDS**