



# ***NDIA Small Arms Symposium***

## ***Multi-Sensory Deprivation “Land Mine”***

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# Multi-Sensory Deprivation Device (MSDD)



- **Concept of Operation:** Develop an acoustic device that can be used for distracting, and delaying individuals.
- **Scenario:** Provide a NL alternative capability for protection of Anti-Tank (AT) mines
- **Technologies:** Multi-Sensory Deprivation utilizing aversive sound and light. Rapidly emplace minefield for high reliability acoustic aversive device for delay of threat

Sized to  
M139 Volcano Dispensed Munition  
&  
M16A2 Hand Emplaced “Bouncing Betty”

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# Outline

- Objectives
  - Background
  - Leveraging
  - Approach
  - Modeling / Simulations
  - Operational Capabilities
  - Effects (Candidate Aversive) Sounds
  - Human Effects
  - Program Summary
  - Future Efforts
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# Objectives

- **Program Objectives:** To demonstrate the scalability of multi-sensory deprivation technology for application in a single Volcano and M16A2 hand-emplaced mine configuration.
- **Technical Objectives:**
  - Identify aversive sounds & aversive sound qualities
  - Quantify aversiveness & neurobehavioral impact
  - Assess combined effects of light and sound across scenarios
- **Performance Objective:**
  - Fabricate a breadboard to support concept demo

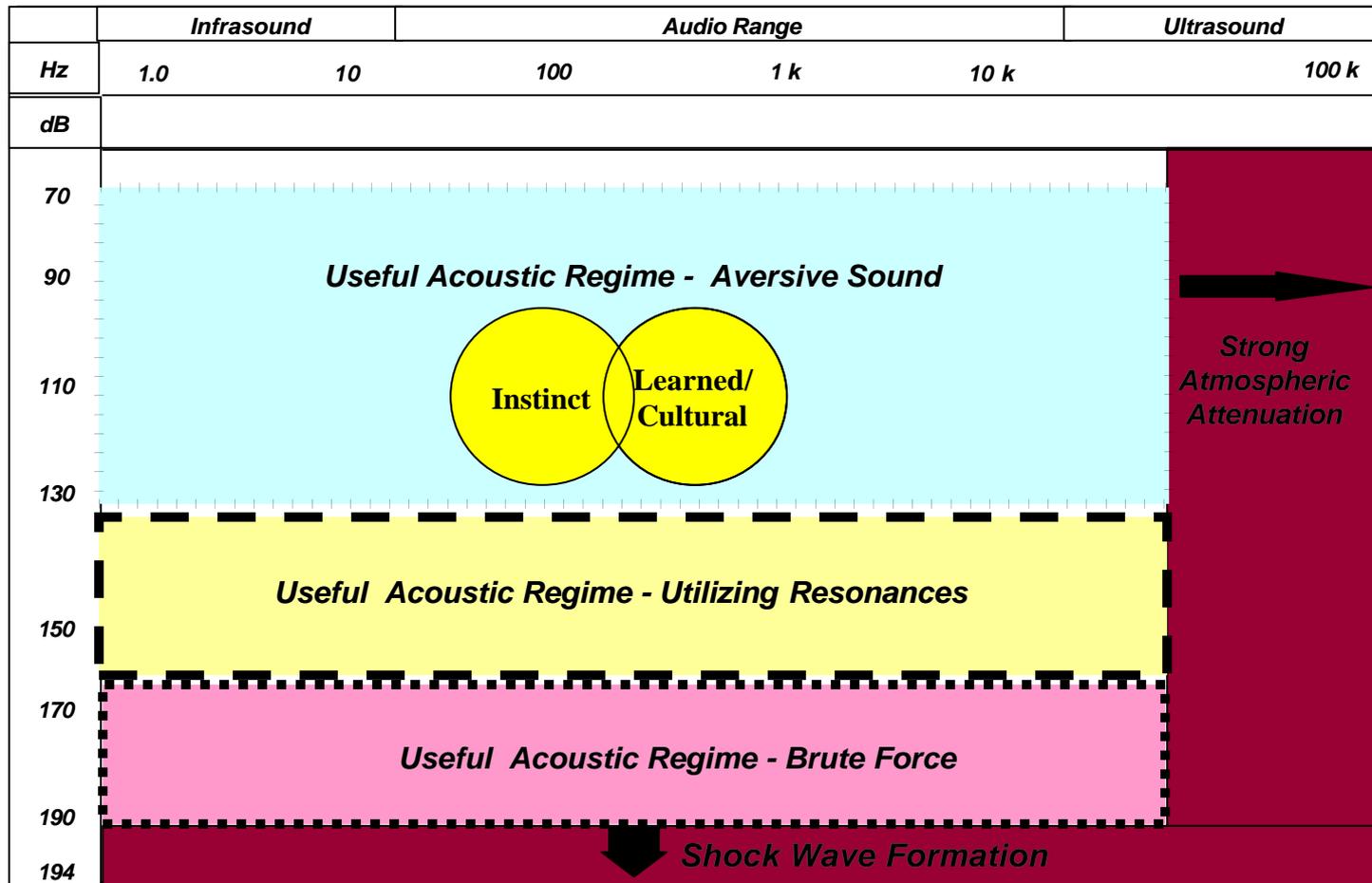


# Background

- Leveraging from multiple efforts & APLA Track III
  - Previous NL programs (e.g., Bounding NL Munition)
  - **CONCEPT:** Focus on combined Acoustic & Light technology
  - **WHY ACOUSTICS?**
    - Focus on *minimizing* probability of lethal effects
    - Capability to *tune* acoustic approaches to non-lethal levels while still maintaining a *high probability* of adverse effects generating functional delay
    - Availability of designs with *reasonable* size and power requirements for potential weapon solutions
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# Useful Acoustic Regime



**Intensity (dB)**

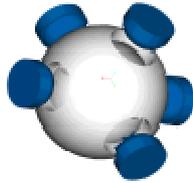
**Omnidirectional**

**Directional**



# Approach

- Adapted Audible Aversive Acoustic Device (A3D or Gayl Blaster) concept for Anti-Personnel Landmine Alternative
- Body designed in Pro-E and produced with stereo lithography



- Breadboard system uses a rack mounted signal source to provide flexibility
  - Pure tones with adjustable frequency, amplitude, modulation
  - Complex User/Computer generated waves





# Approach (cont'd)

- Original Concept Investigated only Acoustics
  - In an effort to maximize effectiveness, it was determined that multiple sensory deprivation would significantly improve battlefield performance, within same weight and cube
  - Effects
    - Audible and visible light Ranges
    - Non-Injurious Effects
    - Behavior Modification
    - Effects not Intensity Based
  - Countermeasures
    - Audible - Hearing protection not effective
    - Light: Auto closing visor may be effective, but would significantly reduce threat capability(s)
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# Approach (cont'd)

- Extensive literature search performed, investigating any (anecdotal and proven) information available on the subject of the 'human auditory response'.
  - Identified the characteristics of sound that can be manipulated.
  - Obtained mandatory Internal Review Board approval to begin auditory response testing.
  - Assembled an in-house sound lab, which allowed the researchers to personally explore and exploit these 'dimensions' of sound via customized sound file creation.
  - Secured testing equipment and developed test plans tailored to gauge the 'human auditory response' to given auditory stimuli.
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# System Simulations

## System simulations for typical mission scenarios

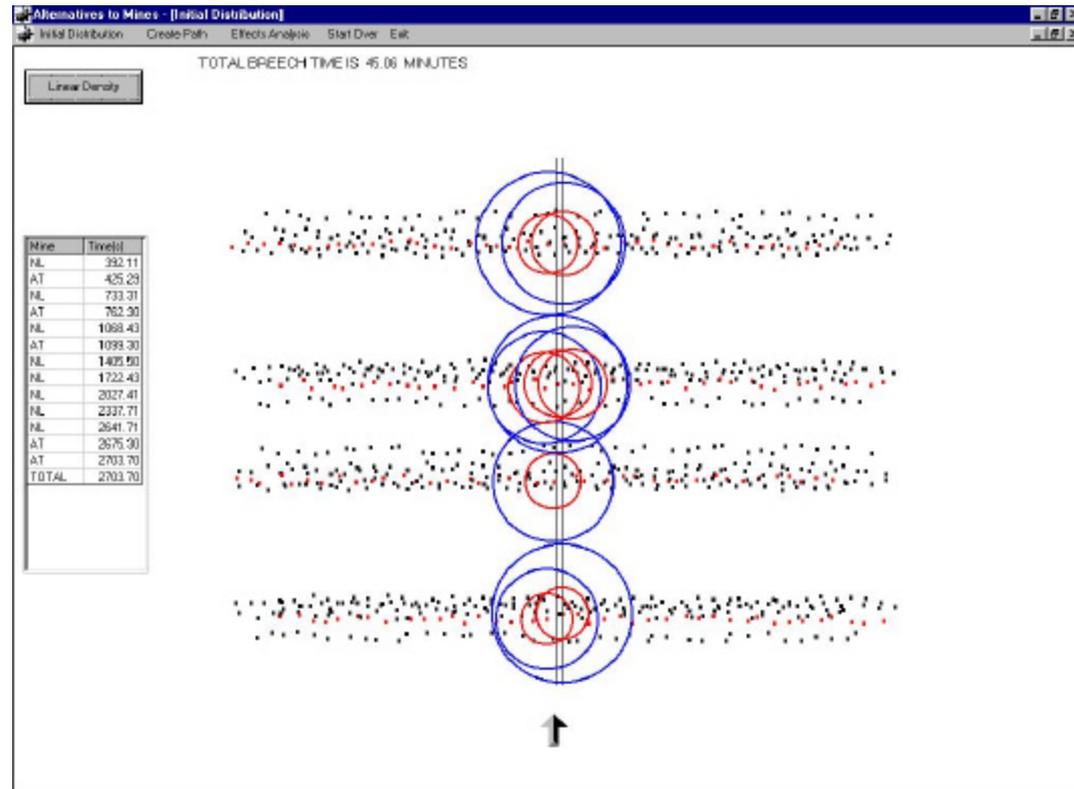
- Goal of simulations:
    - Evaluate the effectiveness of technologies
    - Define requirements for the acoustic source
      - *Number of sources*
      - *Placement density*
      - *Source frequency*
      - *Intensity*
      - *Duty cycle*
      - *Lifetime*
    - Screen candidate concepts
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# Modeling & Simulation



- **Developed preliminary design tool** **Non-Lethal Technology Analysis Tool (NLTAT)**  
(leveraged from SHM)
- **Visual based tool investigates**
  - **Dispensing Schemes**
  - **Countermine Effectiveness**
  - **Acoustic Range Effects**
- **Example inputs include**
  - **VOLCANO**
  - **Fraction of NL Devices**
  - **Effective Radius, Duration and Trip Wire Extent**
- **Tool utilized to perform simple performance trades**

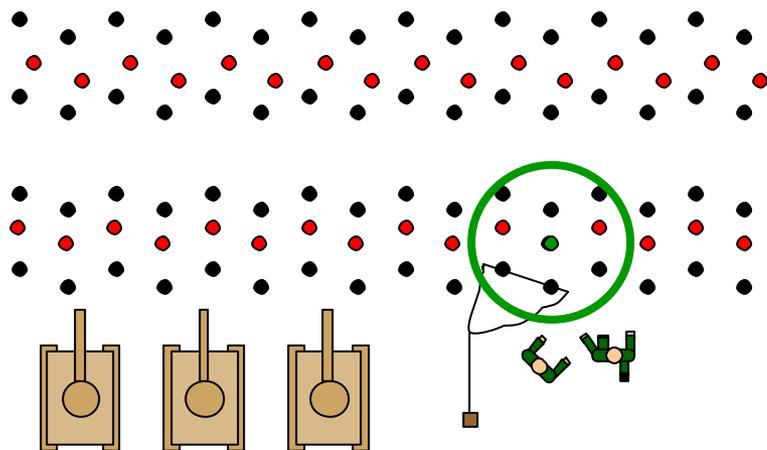




# Modeling & Simulation

## Preliminary Performance Trades

● AT Mine ● NL Mine ● Activated NL Mine



### Baseline Parameters

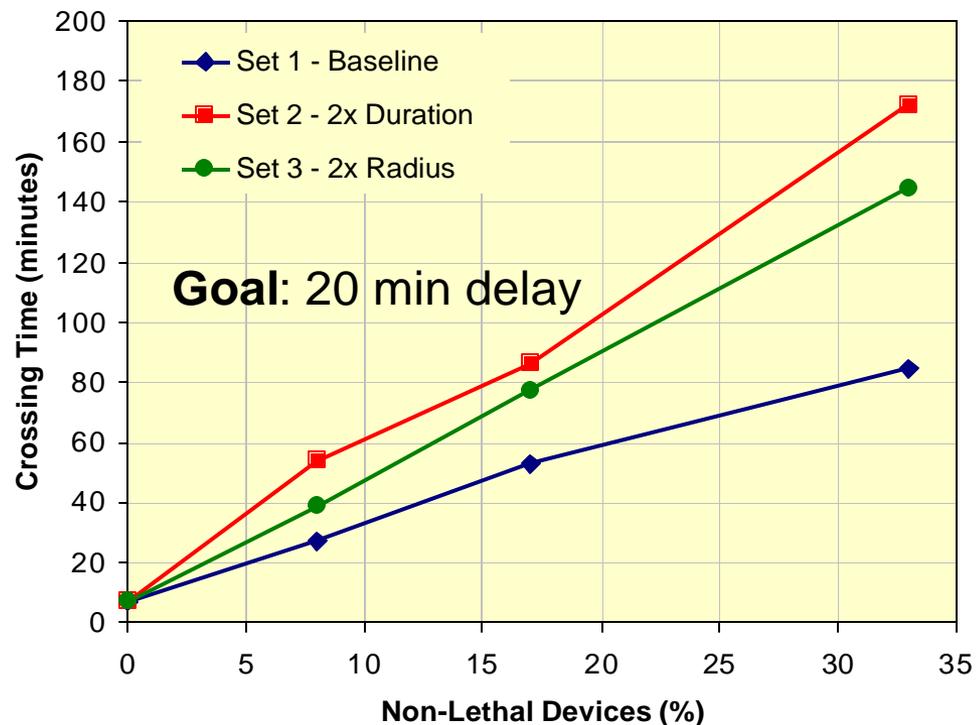
Effects Duration: 5 minutes

Effective Radius:  $25 \pm 5$  m

Trip Radius:  $10 \pm 2$  m

Traverse Speed: 3 m/s

AT Disable Time: 30 s



- Trade Between Effects Duration and Number of NL Devices
- Trade Between Effective Radius and Number of NL Devices



# Operational Capabilities



- **Primary:**
    - Disrupt Task Performance Resulting in Delay
  - **Secondary:**
    - Increased Comfort Zone Between Friendly Forces/Equipment and Threat
    - Potential to Contain/Reduce Escalation Factor
    - Provides Force Protection
    - Non-combatant Dissuasion
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# Multi-Sensory Deprivation Device

- Assembled using modified off-the-shelf piezo's and strobe
  - Approximately 20 watts to generate  $112 \text{ dB}_{\text{RMS}}$  @ 1 meter with 8-piezo system
- Assembled a 4-piezo systems with integral signal source
  - Generates  $93 \text{ dB}_{\text{RMS}}$  @ 1-meter using two 9-Volt Batteries





# Human Effects

- In General – there are documented cases of light and sound phenomena, they are scenario/application specific
- Current literature review, indicates that little if any applications have utilized both light and sound in combination
  - Most importantly, not for this type of application





# Program Summary

- Program objectives accomplished:
    - Scalability of Technology Demonstrated
    - Generation of the Combined Effects of Sound and Light
  - Modeling
  - Established Technology Assessment Matrix
  - Issue: Bio-effects testing is deficient/non-existent specifically investigating behavior modification
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# Future Efforts

- Candidate sounds for future investigation:
    - **Aversive sounds**
    - **Sound and light which simulate special effects**
      - **Gun shots, rockets/missiles, mines/explosives detonating**
    - **Recognizable sounds**
      - **Normal communications or commands**
        - **In English or in language of RED troops**
      - **Screams, warbles**
  - **More efficient acoustic drivers**
    - **Explore HyperSonicSound (HSS™) Technology**
  - **Electrically and/or mechanically rotate or direct sound**
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# Future Efforts

- Integration / Development of Activation Sensor (or Fuze)
    - Hand emplaced
    - Platform launched / dispensed
  - Volumetric Concerns (Power Needs vs Volume Limits)
  - Integration of Self Righting Technology
  - System Integration
  - Prototype fabrication and testing against established performance parameters & effects determination
  - Bottom Line: Additional funding would be required to continue the weaponization of this technology
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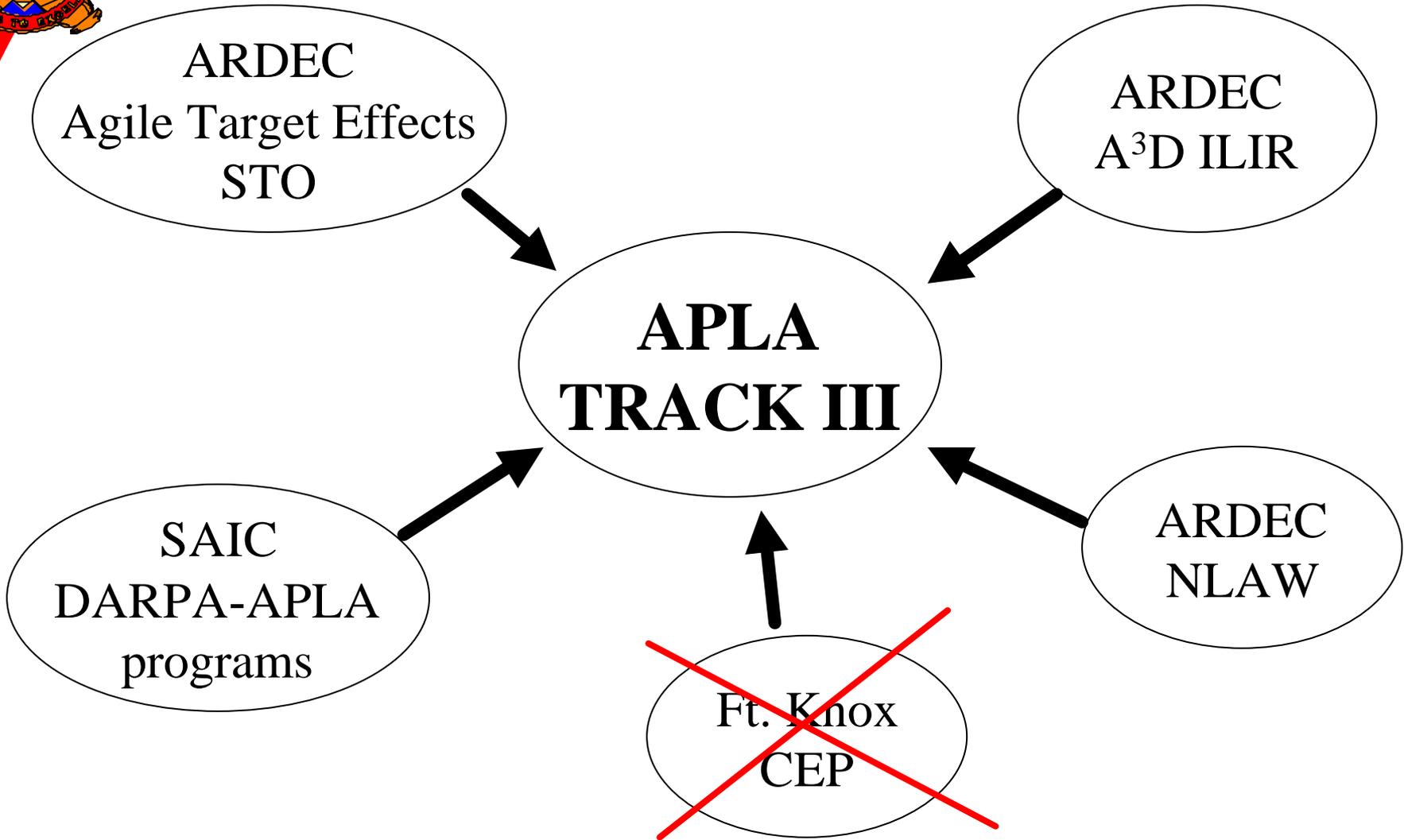


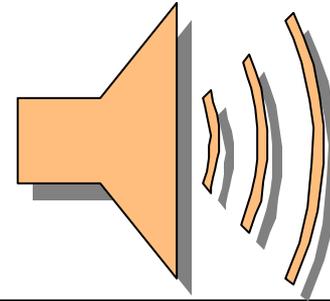
# Back-Up Slides





# Program Leveraging





# Acoustics Primer

How does acoustics work?

- Acoustic energy/power is generated by compressing a medium (in this case air) to create a pressure wave
- Acoustics are similar to mm/microwaves in many areas





# Advantages of Acoustics

- Can be directional, depending upon frequency
  - Naturally provides area coverage, and hence area denial
  - Can provide tunable target effects
    - Anti-personnel/anti-materiel
  - Weather conditions
    - High relative humidity improves performance – not required
  - Countermeasures
    - Non-aural target effects have few if any countermeasures
  - Non-polluting
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# Disadvantages of Acoustics

- Frequency
    - High frequency
      - Increased atmospheric attenuation
    - Low frequency
      - Reduced directionality to omni-directional
        - Potential for increased fratricide
      - More energy/power from source which increases system weight/volume and logistics burden
  - Effects data – mostly anecdotal
    - On-going efforts to gather data
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# Types of Sound Generation Sources

- **Piezo - Electric**

- *High Performance Speakers & Ceramics*
- *Smallest Volume Package*
- *Promising, Additional Work Needed*
- *Shortest Range against Single/Few Targets*



- **Compressed Air Driven**

- *Sirens*
- *Cover Larger Area*
- *Brassboard Available*
- *Can Be Made Directional*



- **Combustion Driven**

- *Pulser, Siren, Flame Tube Vortex, Detonation Tubes*
- *Cover Larger Area*
- *Brassboard Available*
- *Can Be Made Directional*

