



Missile Defense Technology (Can BMD Systems Work?)

Eric D. Evans
MIT Lincoln Laboratory

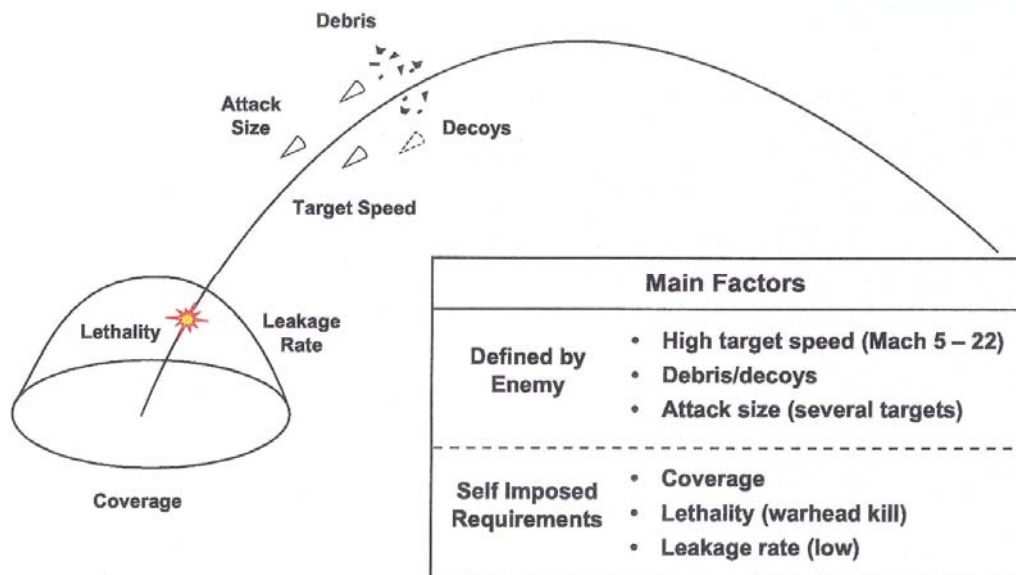
Mini DTS Course

10 December 1999



What Makes Ballistic Missile Defense Difficult?

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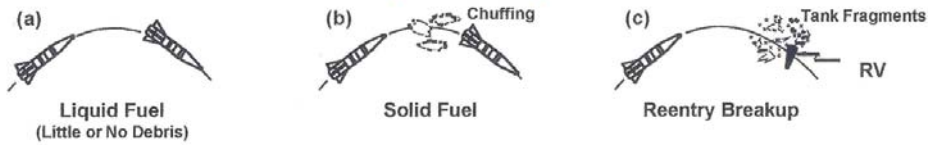
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Potential Sources of TBM Natural/Countermeasure Debris

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I. Non-Separated Payloads



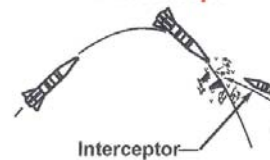
II. Separated Payloads



III. Intentional Exo Tank Breakup



IV. Intercept



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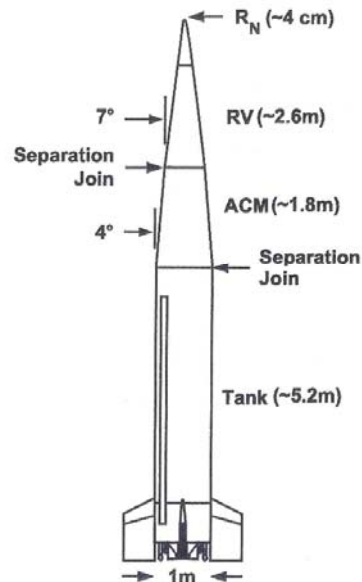
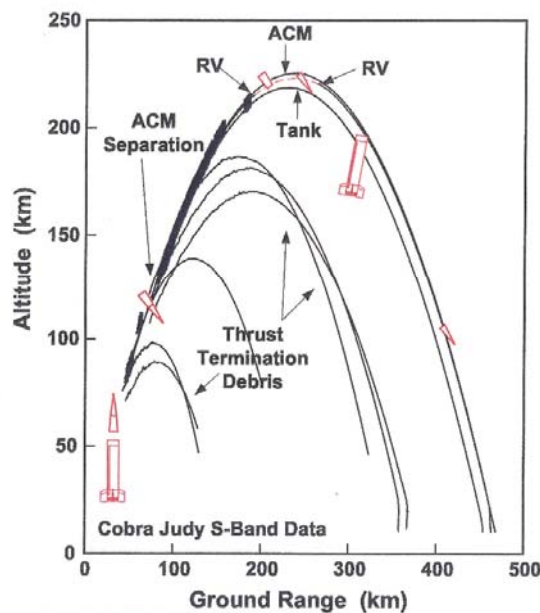
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Target Complex Trajectories

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TMD Countermeasure Concepts

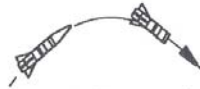
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Tumbling target
Missile or RV



Multiple objects
Frag/Segmentation, CSOs



Orientation control
RV pointing or spin-up



Anti-cueing tactics
Depl. stage disposal



Maneuvers
Evasive corkscrew, etc.



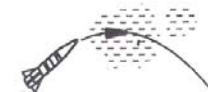
Submunitions
Early Release, CW, BW



Signature control
Low RCS, IR coatings



Enveloping structure(s)
Extended targets...



Masking
Chaff, Flares, Corner Cubes



Decoys
Radar, IR



Jammers
Escort, barrage, repeaters



Other
Suites, ARMs, EMP...

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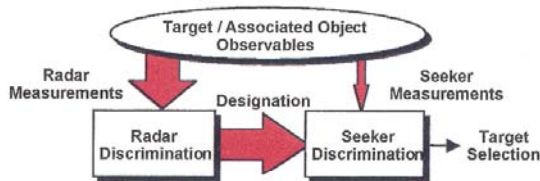
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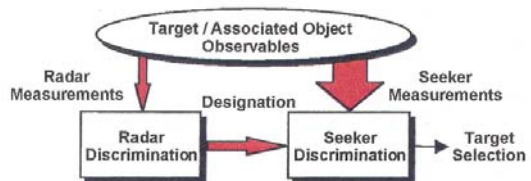
System Discrimination Options

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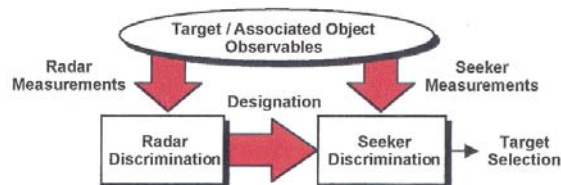
Option 1: Radar Sensor Has Main Discrimination Capability



Option 2: Seeker Has Main Discrimination Capability



Option 3: Radar and Seeker Have Significant Discrimination Capability



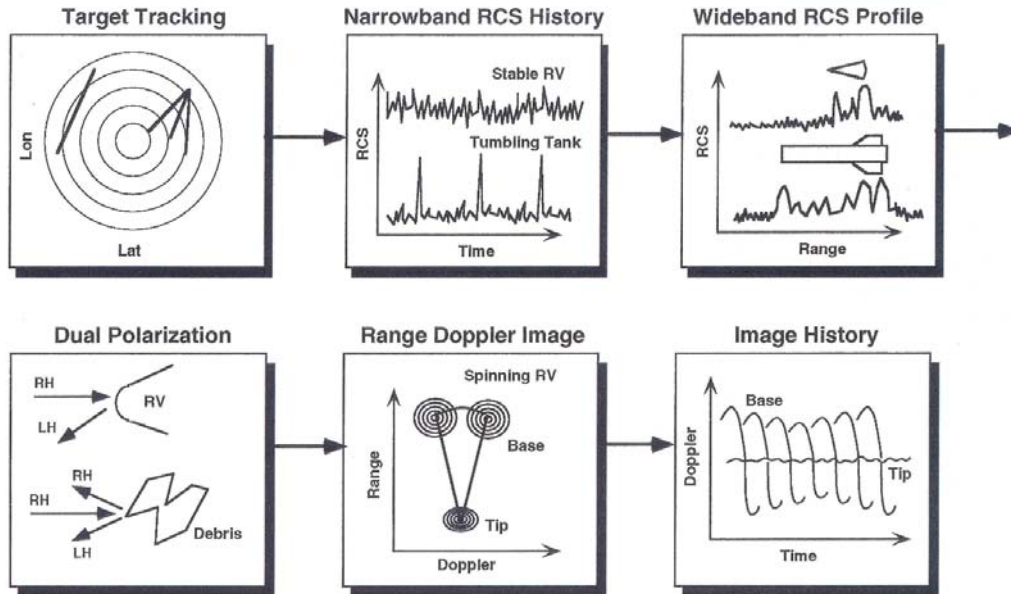
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Radar Discrimination Technique Evolution

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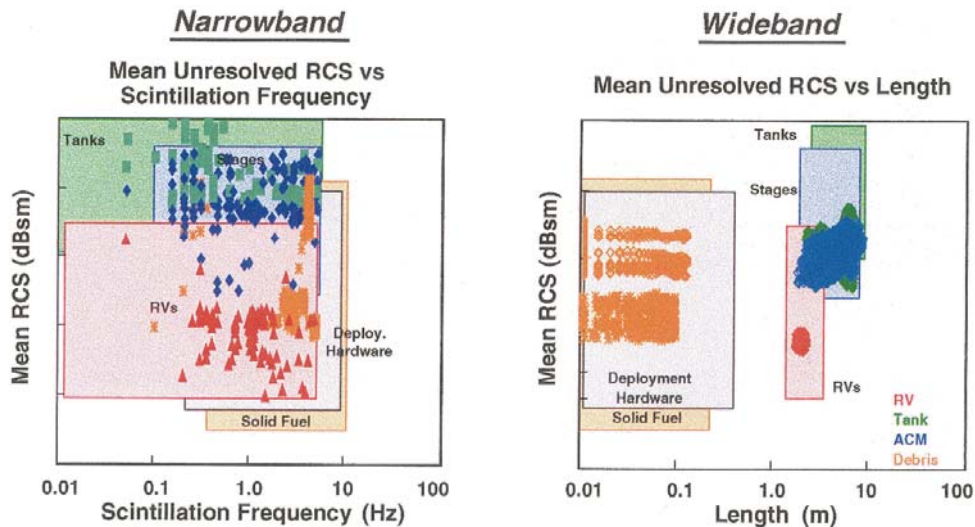
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Radar Discrimination Capabilities

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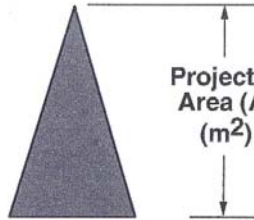
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Physical Components of Target IR Signature

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Temperature (T)
(°K)



Projected Area (A)
(m²)



Spectral Radiant Intensity (J (λ))
(W/sr/μm)

Planck's Equation

$$J(\lambda) = \frac{\epsilon A}{4\pi} \frac{2\pi hc^2}{\lambda^5} \frac{1}{e^{hc/k\lambda T} - 1}$$

λ = Wavelength

h = Planck's Constant

k = Boltzman's Constant

c = Speed of Light

Emissivity (ε): Ratio of radiant emittance to that of black body at same temperature

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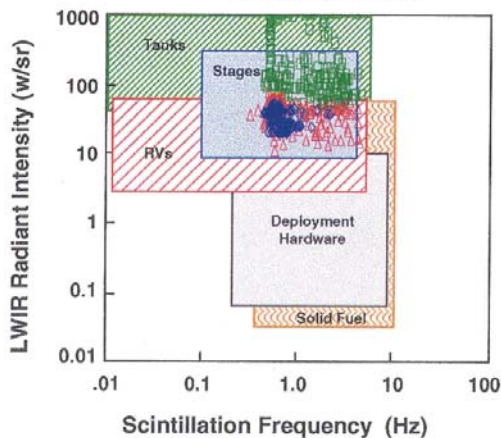


IR Seeker Discrimination Capabilities

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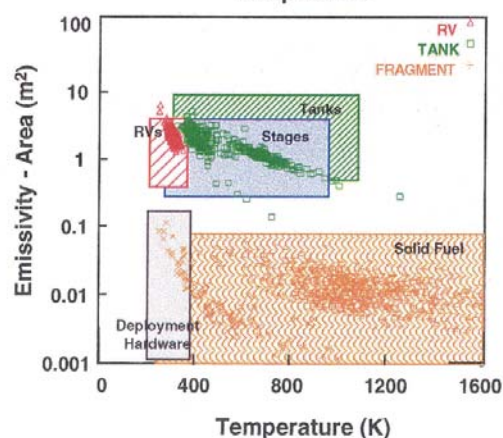
One - Color IR Seeker

Metrics: Mean IR Signature
Scintillation Rate



Two - Color IR Seeker

Metrics: Emissivity - Area
Temperature



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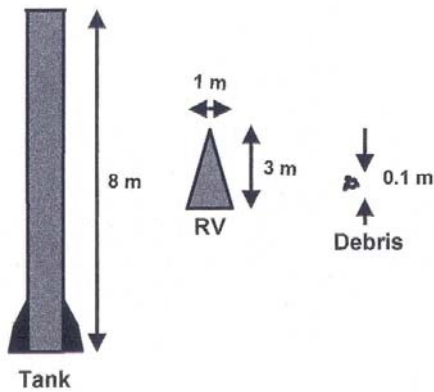
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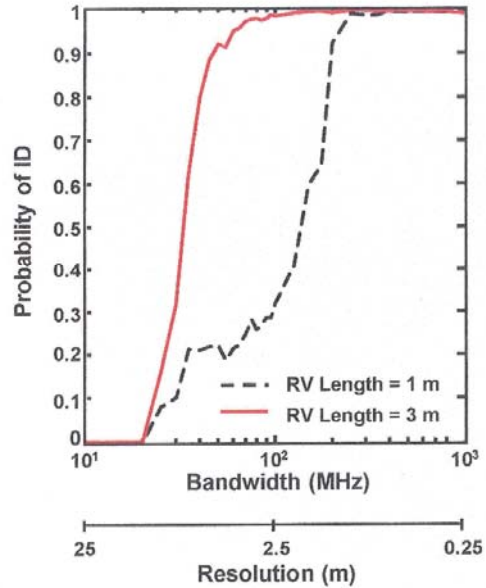


Bandwidth Requirements for TBM Length Discrimination

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300 MHz Bandwidth (1 m resolution)
Required Against Near-Term Threat



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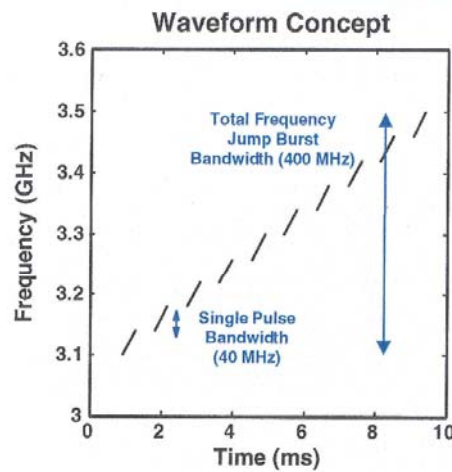


Wideband Waveform Processing

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System	Frequency	Processing	Year Implemented
Range Measurement Radars	VHF-K _s -Bands	Non Real-Time	1960
TRADEX	S-Band	Non Real-Time	1974
RSTER	UHF	Non Real-Time	1995
Patriot	C-Band	Real-Time	1995

The Frequency Jump Burst (FJB)
Type of Wideband Waveform
Is a Demonstrated Technology



Wideband Waveform
Concept for AN/SPY-1 Radar

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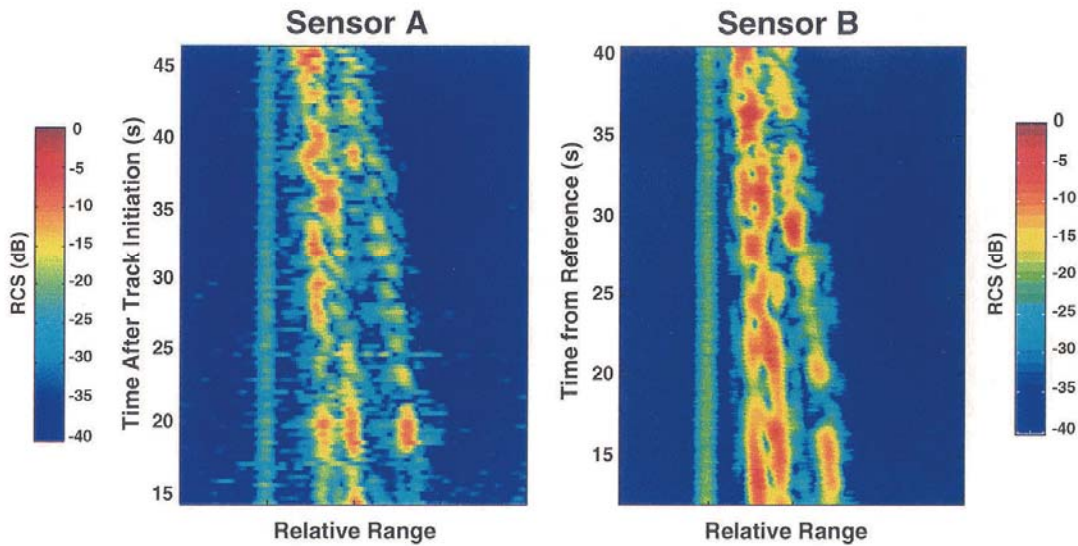
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Comparison of Wideband RTIs Test Data

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$T_0 = 45518$ s GMT

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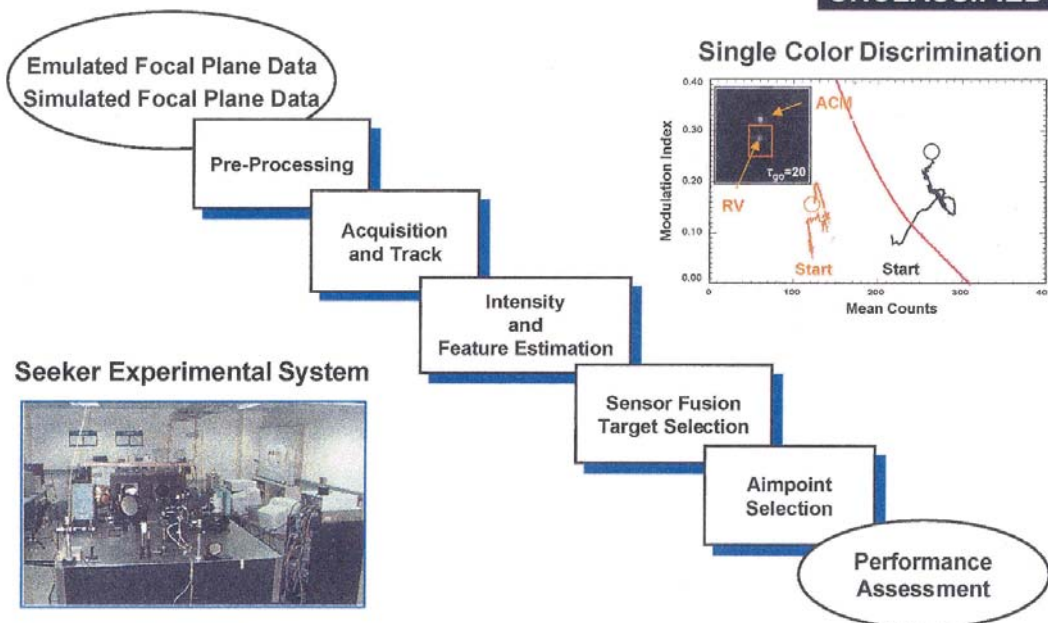
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Single Color Seeker Processing Chain

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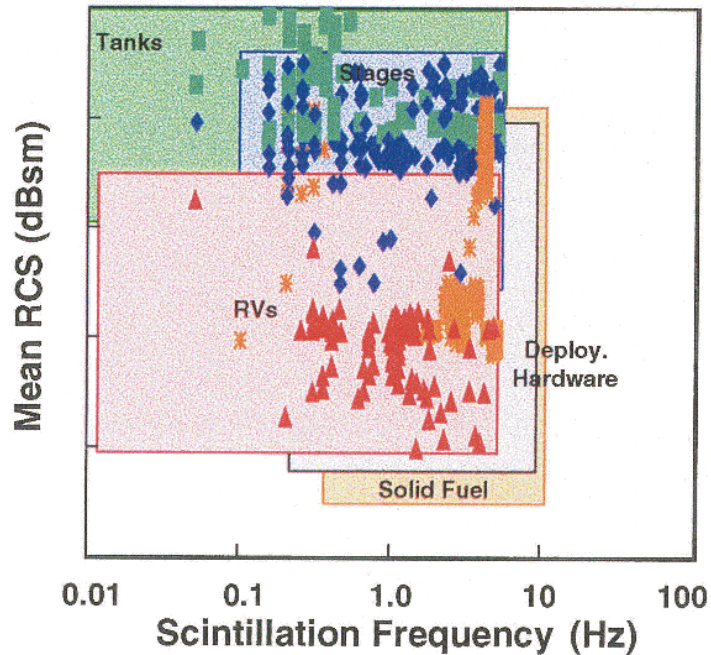


Radar Discrimination Capabilities

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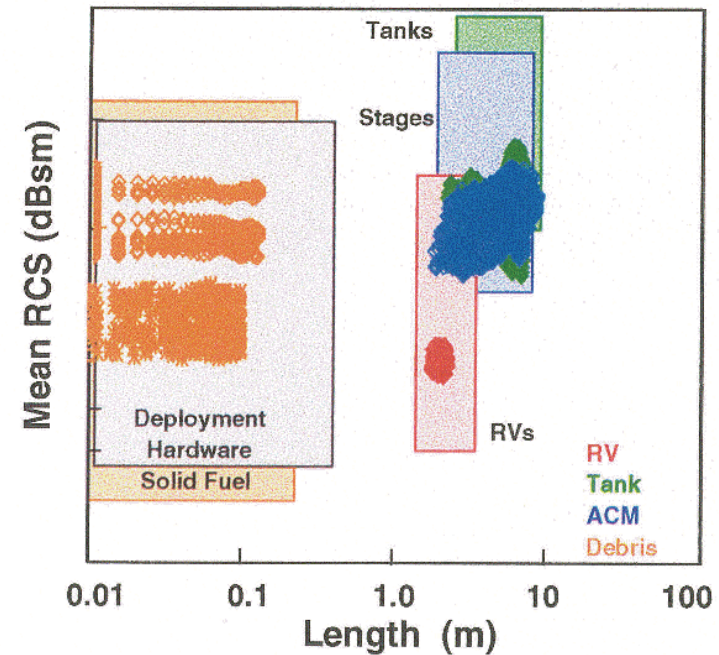
Narrowband

Mean Unresolved RCS vs Scintillation Frequency



Wideband

Mean Unresolved RCS vs Length



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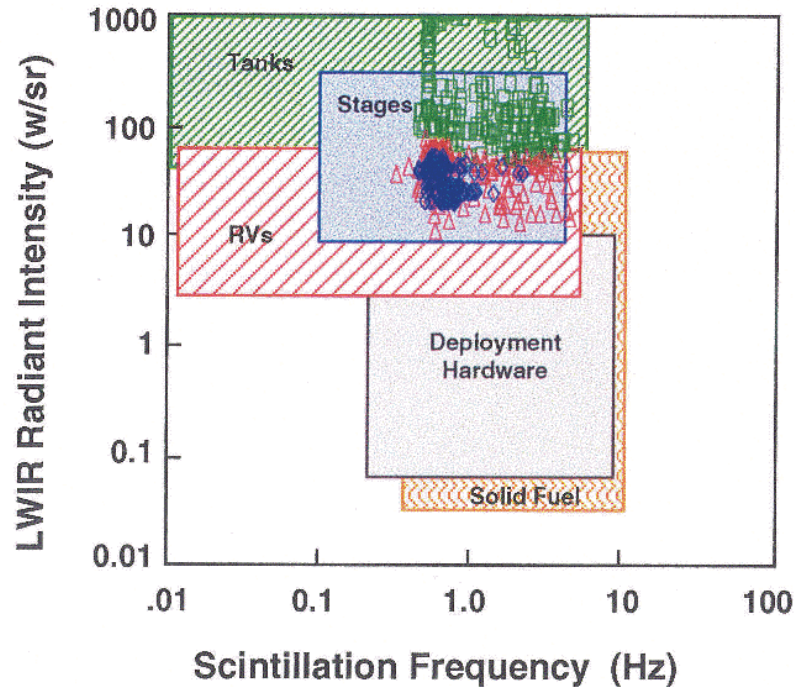


IR Seeker Discrimination Capabilities

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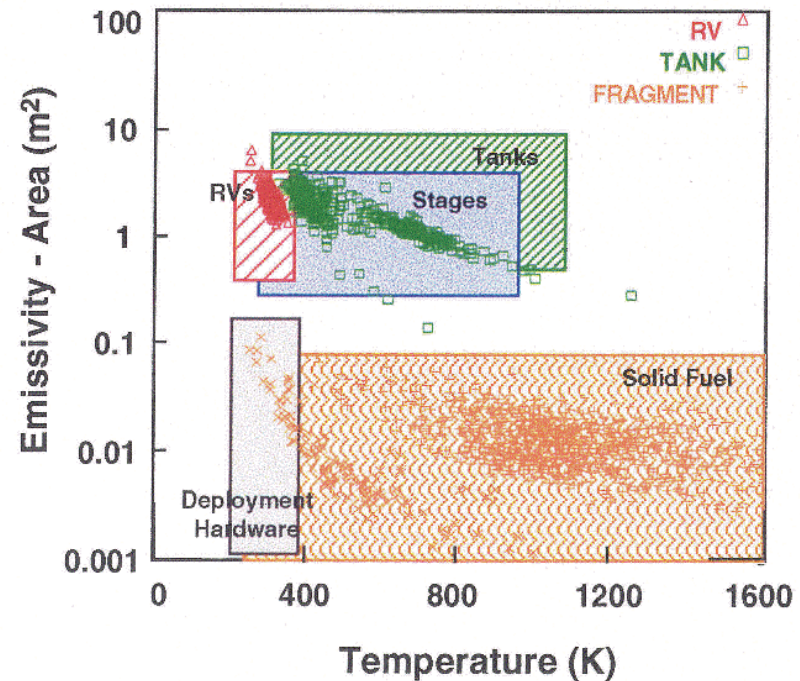
One - Color IR Seeker

Metrics: Mean IR Signature
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Two - Color IR Seeker

Metrics: Emissivity - Area
Temperature



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