Joint Gun Effectiveness Model (JGEM)

"Navy Accredited Minor/Medium Caliber Operational Tool"

The

Direct Fire

Analysis

Solution

National Defense Industrial Association
Gun and Missile Systems Conference & Exhibition
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Outline

- Model Description
- Model History
- Methodology Overview
- Input / Output
- Future Enhancements (Air Bursting Methodology, Graphics)

JGEM Description

Operational tool for direct fire evaluation of minor/medium caliber gun systems firing against single and multiple targets.

PURPOSE:

- Predicts effectiveness for direct fire engagements
- Analyze system sensitivities
- Tool for system concept and trade studies

FEATURES:

- Monte Carlo Simulation
- Models Direct Fire Engagements
- Adaptability to various Gun Weapon Systems
- Error Budget-based System Accuracy
- 3-D Target & Shooter Path (position data)
- Range Table Ballistics
- Single & Multiple Target Capability
- Statistical Output
- User-Friendly Graphical User Interface (GUI)
- JTCG/ME Accredited Model (Dec 2001)

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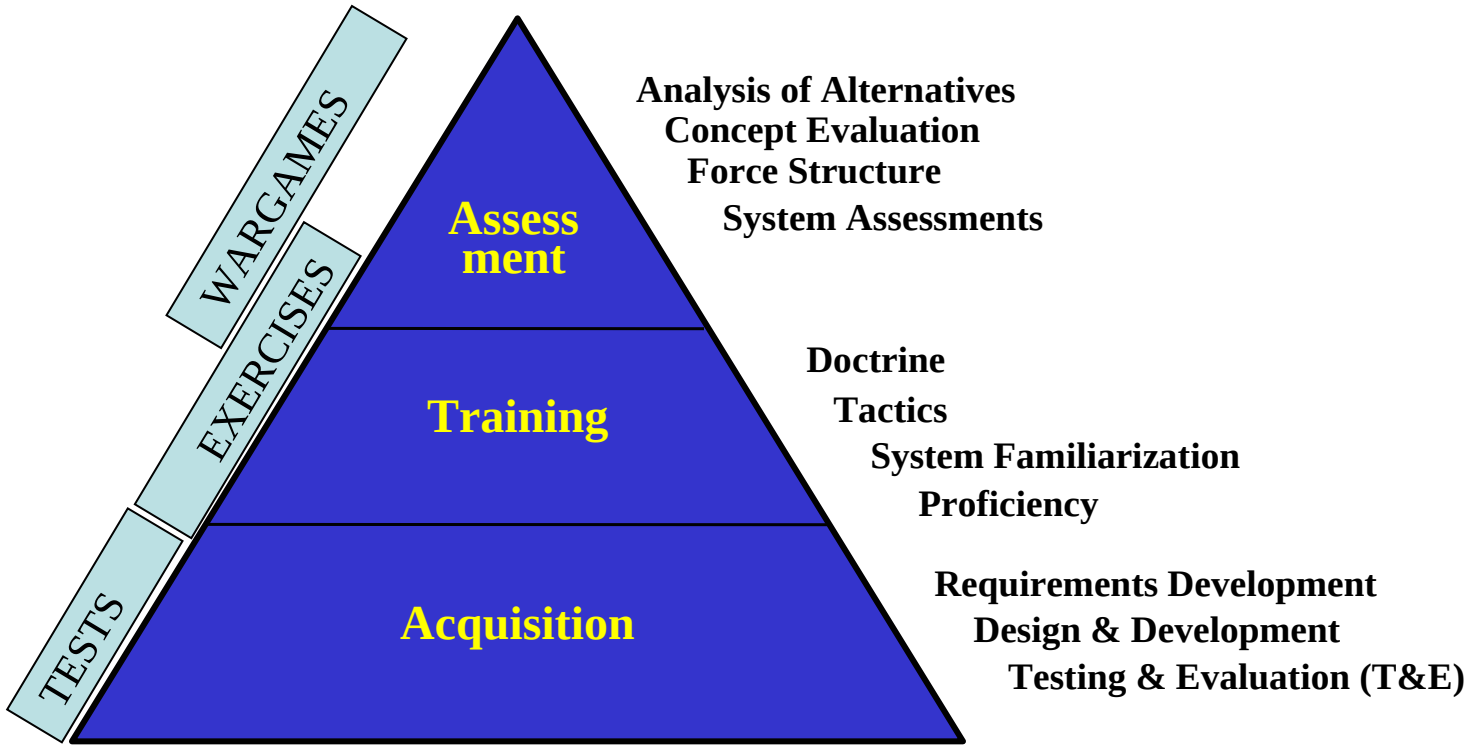
M&S Applications Hierarchy



JGEM Development History

1982	1984	1993	1999	2000	2001	2001 – 2006	
Original MGEM Developed by the Army Materiel Systems Analysis Activity (AMSAA) written to provide a computerized model to quantify the advantages of developing new air defense guns.	MGEM Released and studied the effectiveness of that class of air defense guns whose design was based on Modern Control Theory	AMCGS/SWPS COEA Used modified version of MGEM for calculating gun system effectiveness	MGEM changes Made For 2000 Compliance with JWES 2.0 Requirements Document and Procedures for Acceptance of Software by JTCG/ME.	Verification Completed by UDLP. Graphical Users Interface Started Documentation For Users Guide Completed.	JGEM, Re-engineered version Approved for Accreditation by JTCG/ME Dec. 2001	Conduct SUW studies: Deep Water, LPD17, N76, LHAR, LCS	Incorporate Airbursting Methodology

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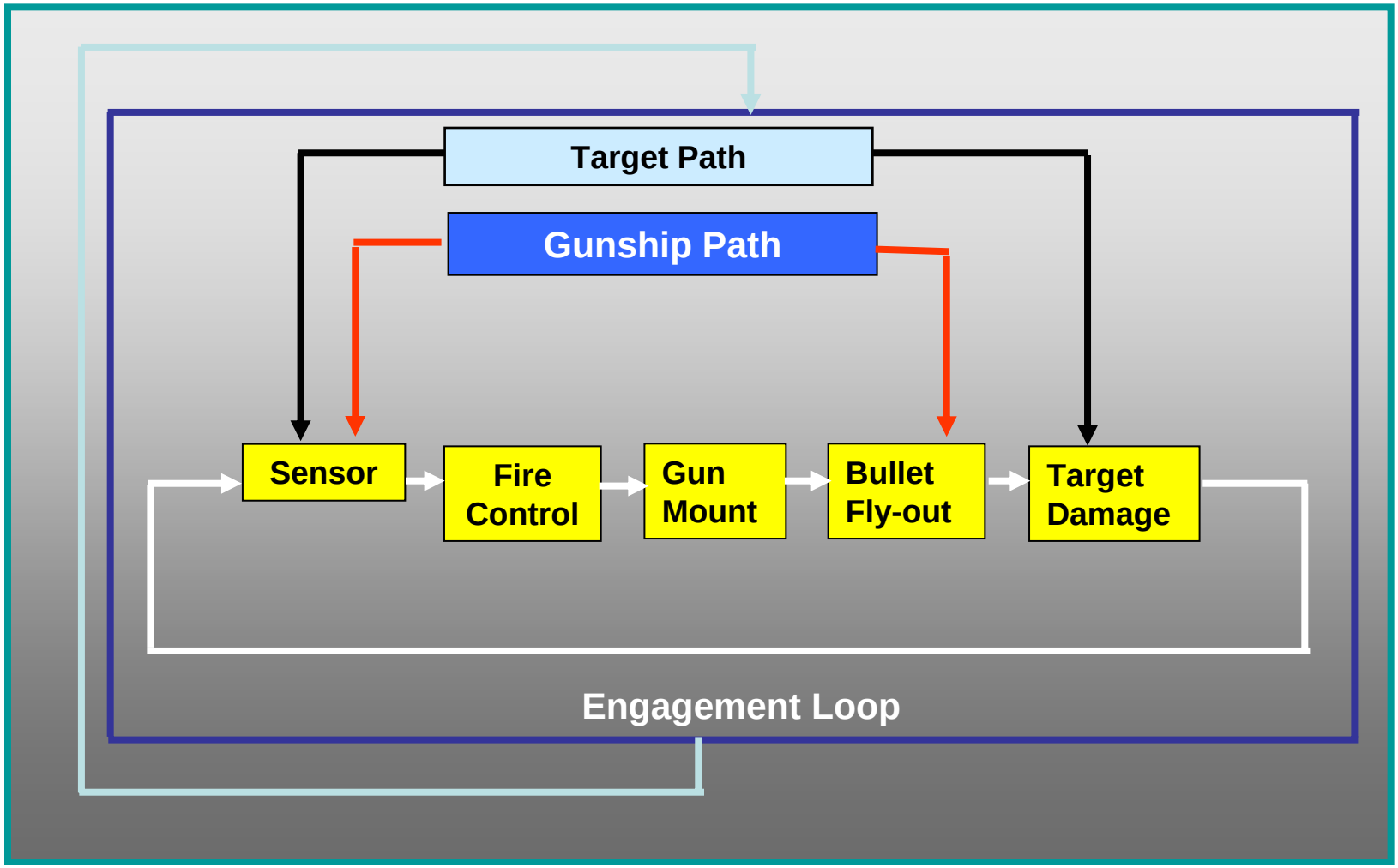
JGEM Methodology Overview



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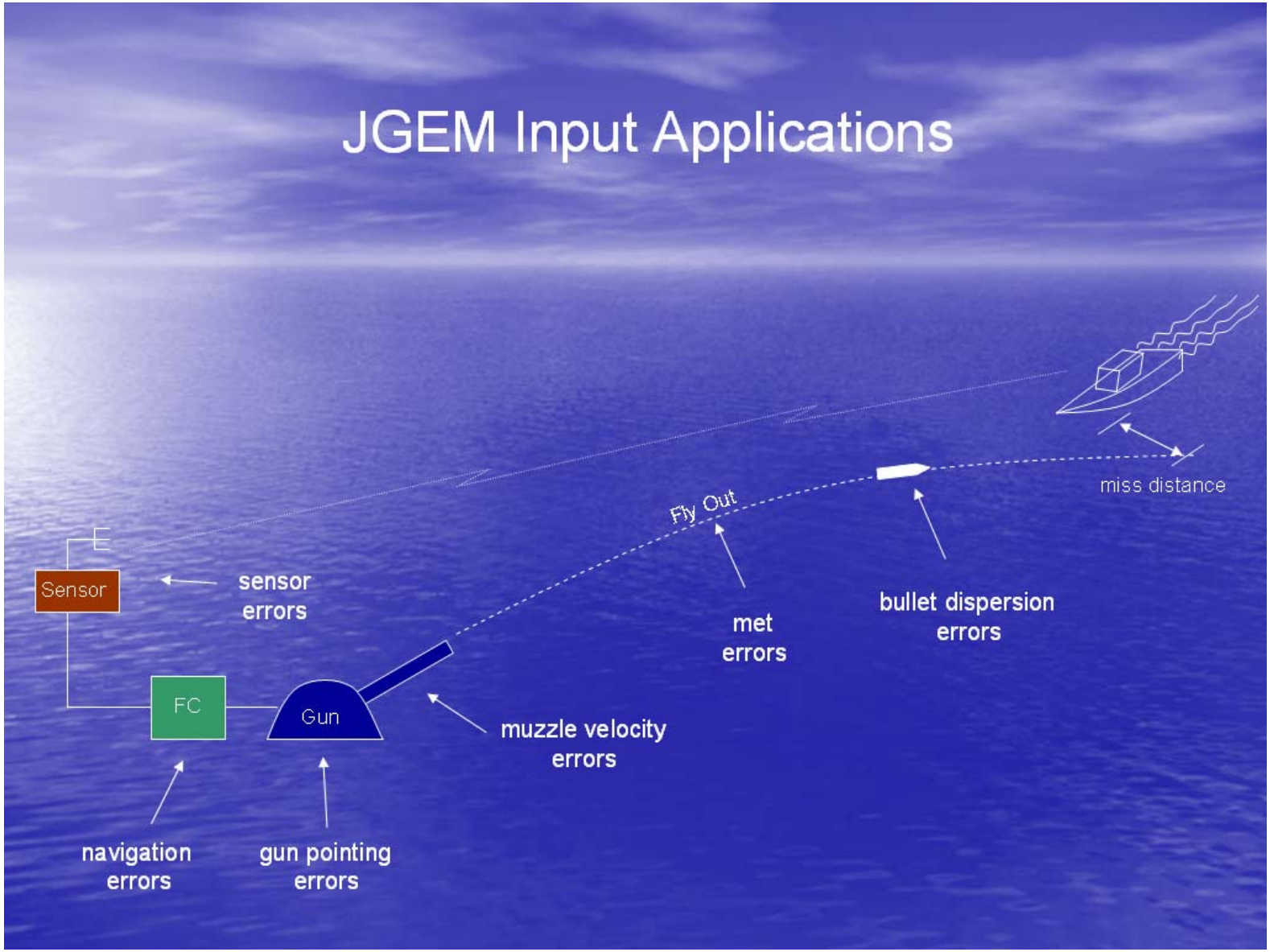
JGEM Methodology



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JGEM Input Error Budget

AMMUNITION	Range Table	Muzzle Velocity (m/s)	Reference(s)
Round 1	Yes	1000	1
Round 2	Yes	1020	1

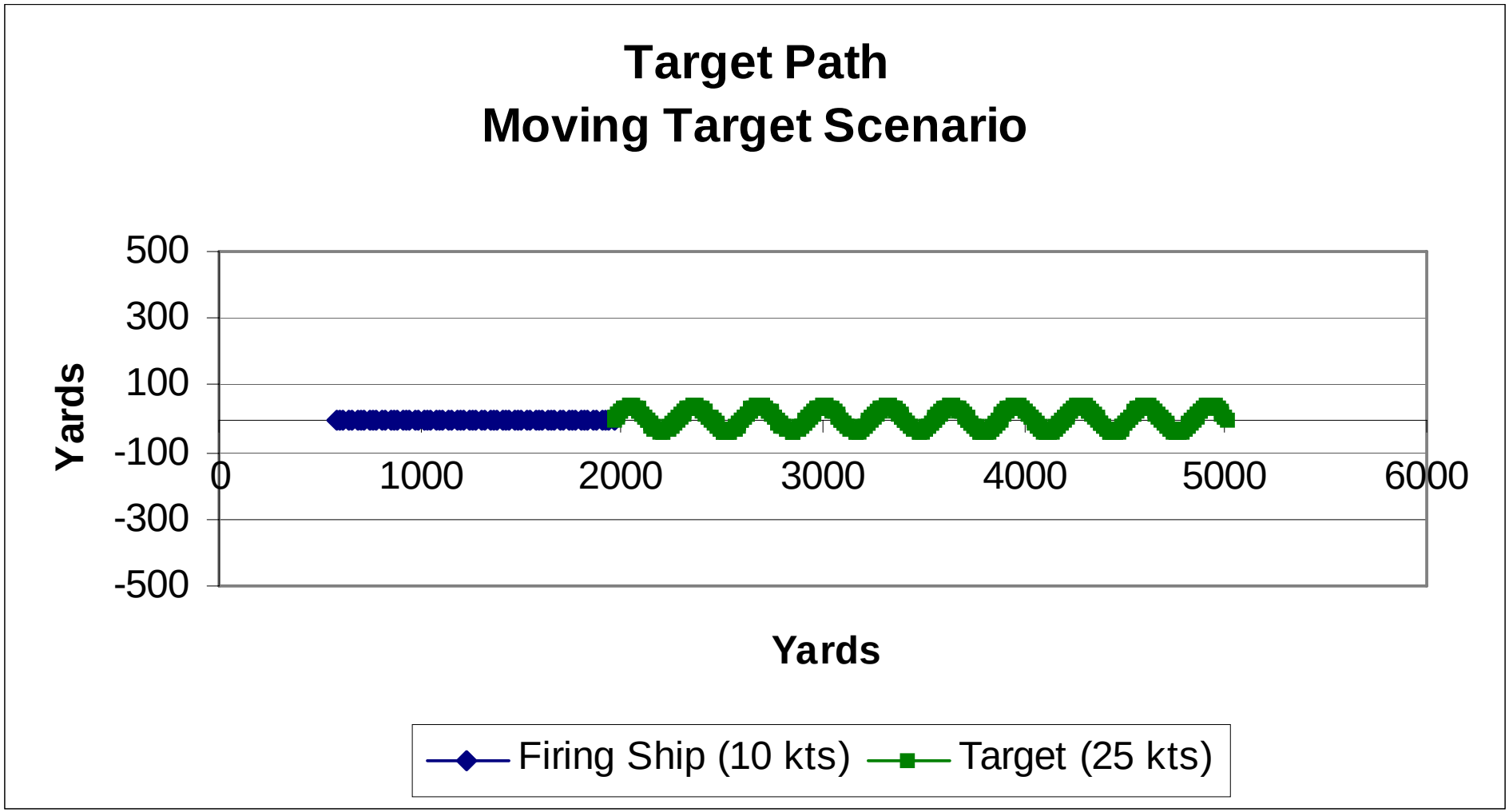
SENSOR	Rnd-Rnd Error	MPI	
Range	2 meters	5 meters	2, 6
Azimuth	0.2 mils	0.2 mils	2, 6
Elevation	0.1 mils	0.1 mils	2, 6

GUN POINTING	Rnd-Rnd Error	MPI	
Azimuth	0.5 mils	0.5 mils	3, 4, 5
Elevation	0.3 mils	0.2 mils	3, 4, 5

AMMUNITION DATA	IV Error (m/s)		
	MPI	Rnd-Rnd	
Round 1	5	3	7, 8
Round 2	5	3	7, 8

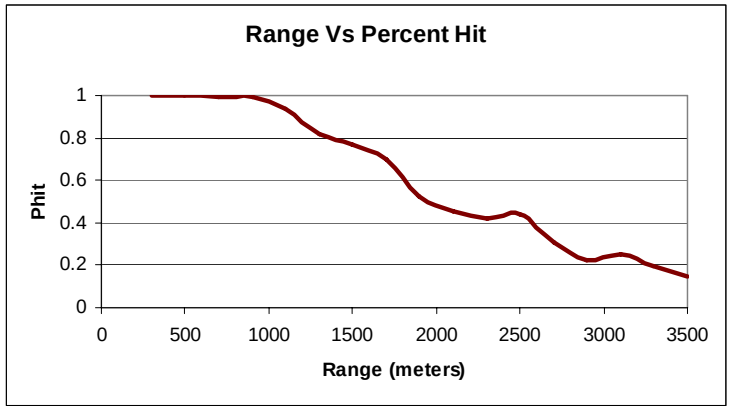
Other JGEM Inputs Required:		
Fire Control Cycling Time:	0.05 seconds	4
Track Settling Time:	1 seconds	4
Magazine Capacity:	300 rounds	4
Rate of Fire:	200 rpm	4
Burst Size:	5 rounds	4
Kill Assessment Time	5 seconds	4
Target Acquisition Time	5 seconds	4

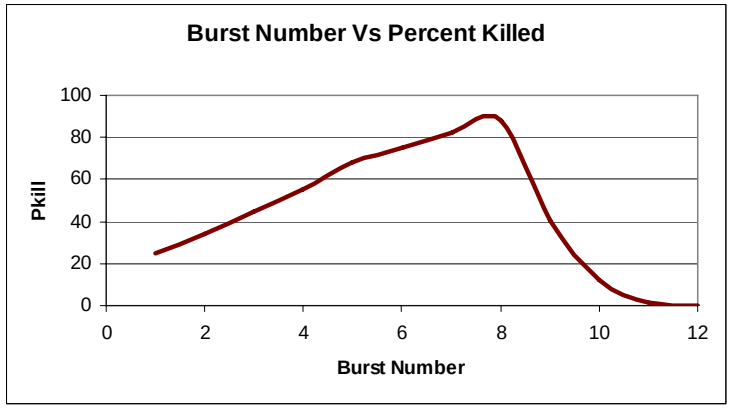
JGEM Input
Target Path/Firing Ship Path

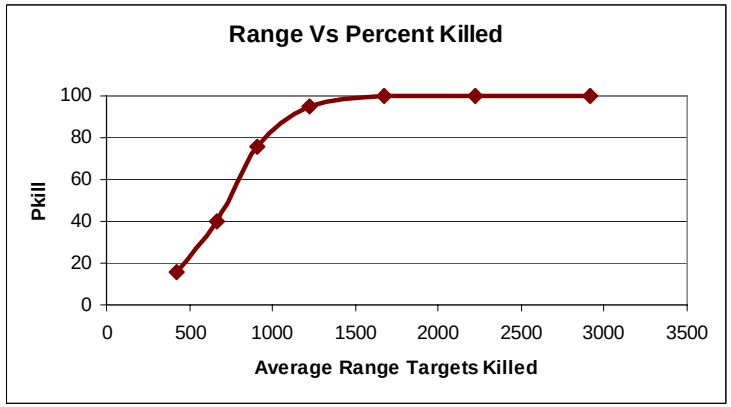


JGEM Output

- Range
- Burst
- Target





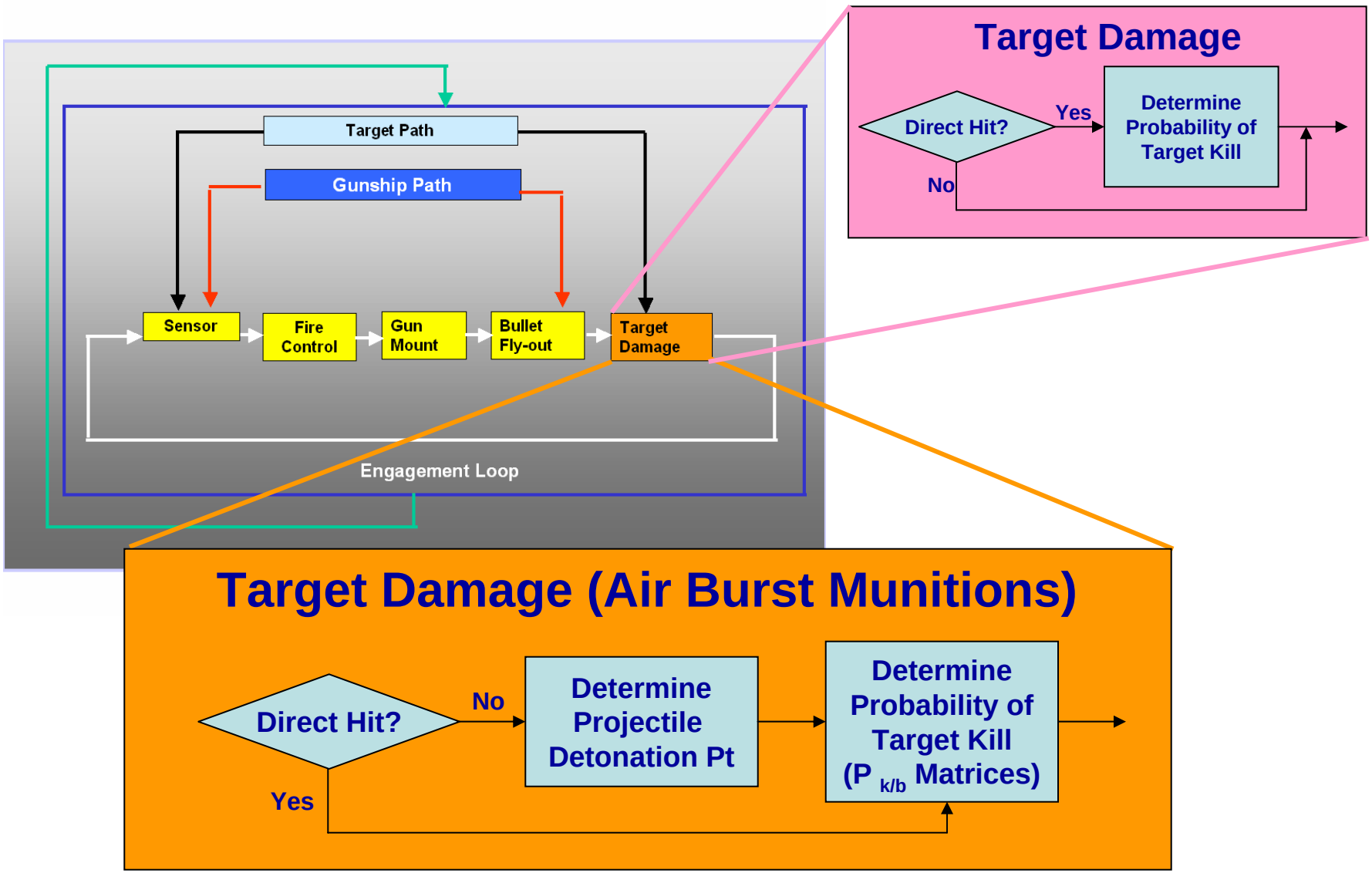


Open Fire Range: 4000 yards

Expected Number of Targets Killed: 5.26

The Graph represents the probability of defeating each target when engaged in sequential order starting with Target 1 on the far right to the left.

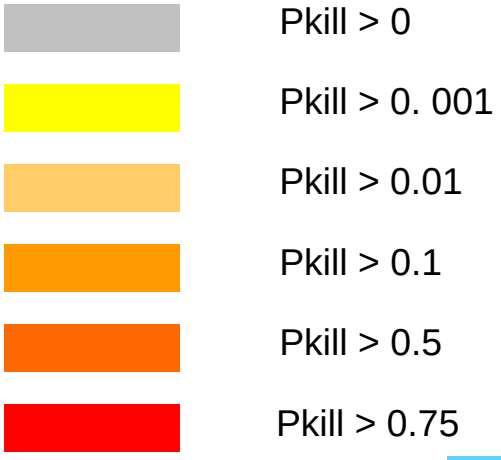
Evaluation of Air Burst Munitions - Methodology Overview



JMAE Probability of Kill Data

Sample Pk/b matrix

6.5 x 6.5 ft cells
Deflection = 40 cells wide
Range = 80 cells long



Pkill > 0

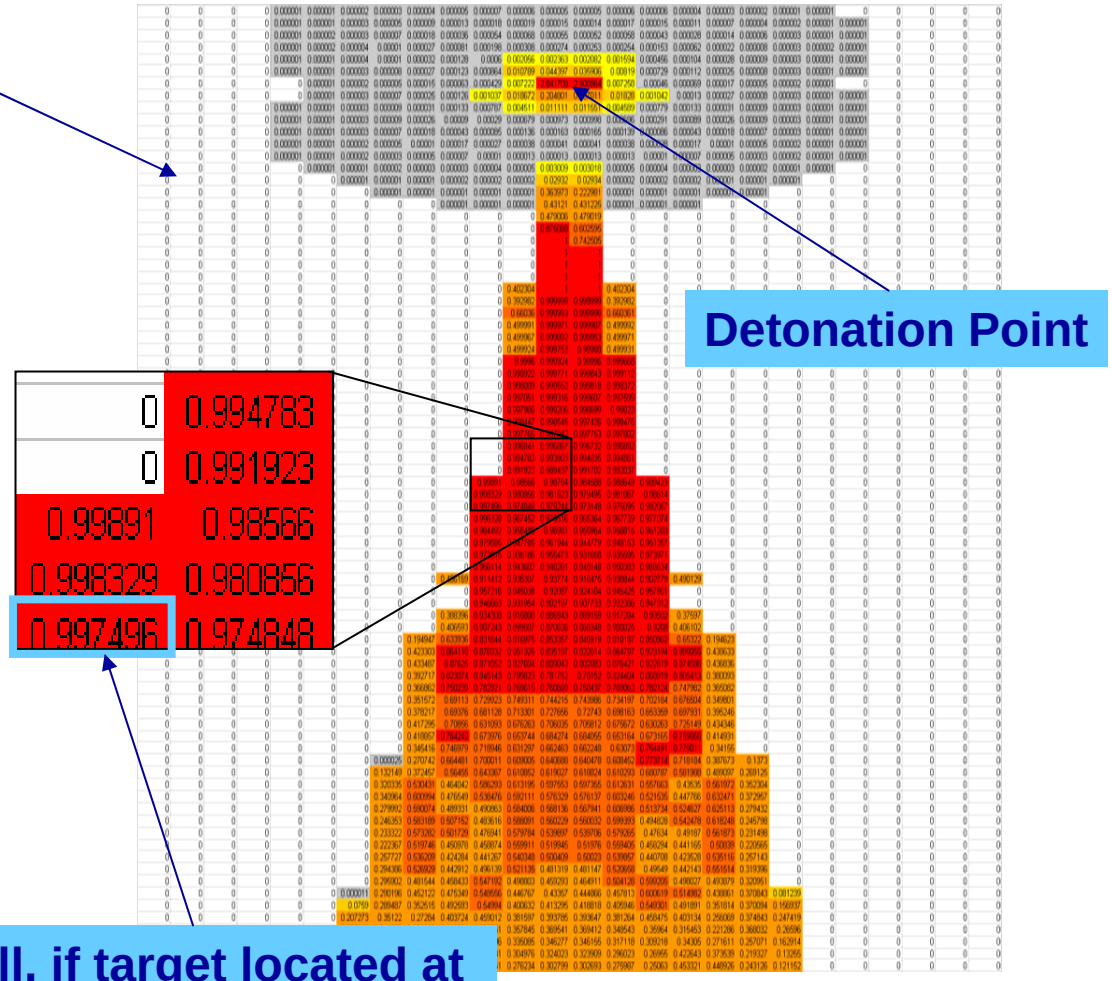
Pkill > 0. 001

Pkill > 0.01

Pkill > 0.1

Pkill > 0.5

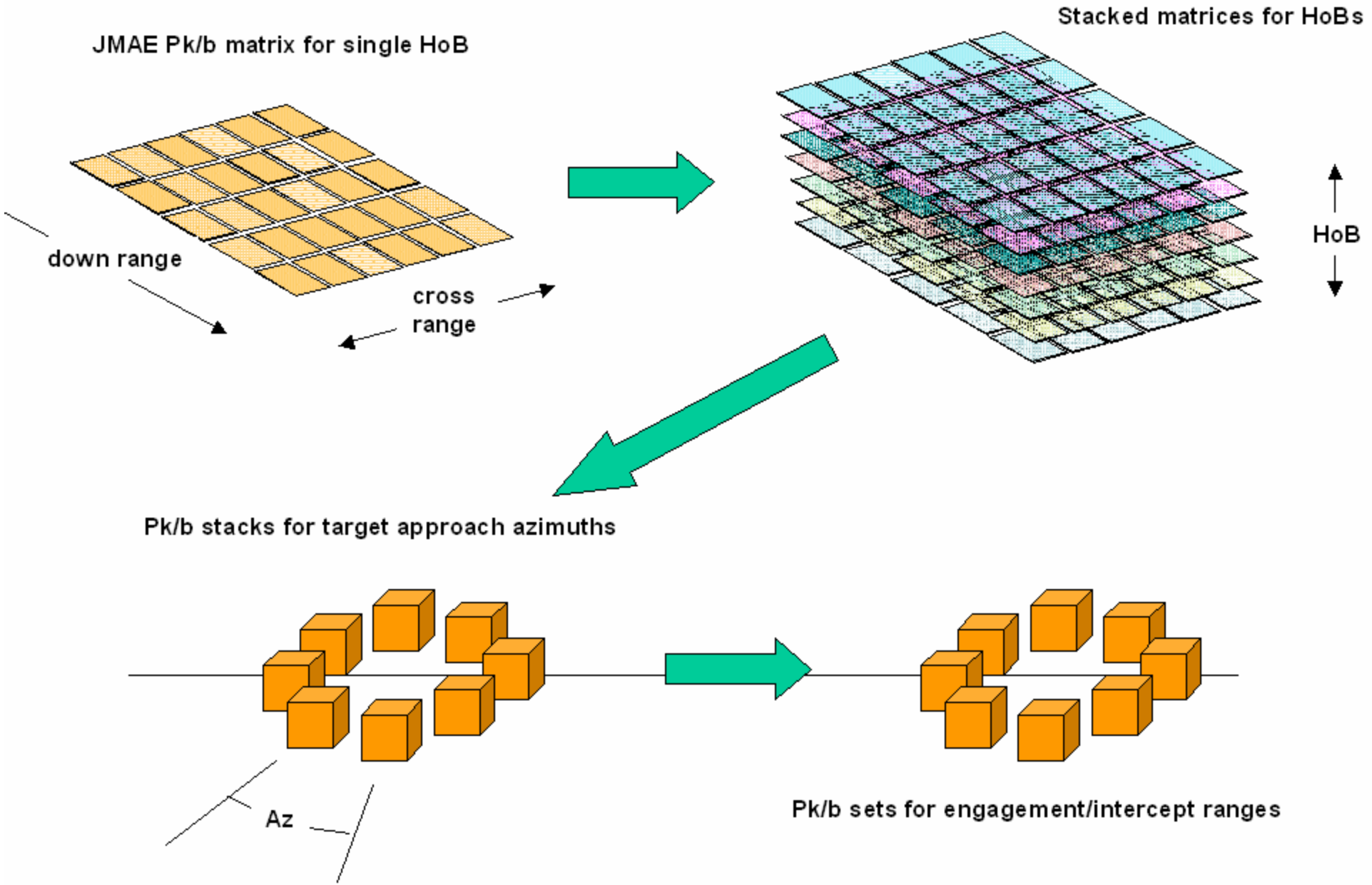
Pkill > 0.75



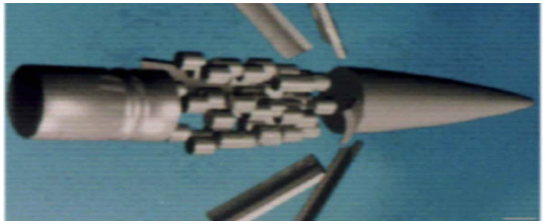
Detonation Point

Pkill, if target located at position “b” in relation to projectile detonation point.

JGEM/JMAE $P_{k/b}$ Matrix Design



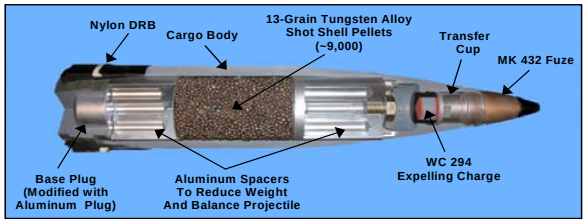
AIR BURSTING MUNITIONS



30mm AHEAD

Controlled Detonation Munitions

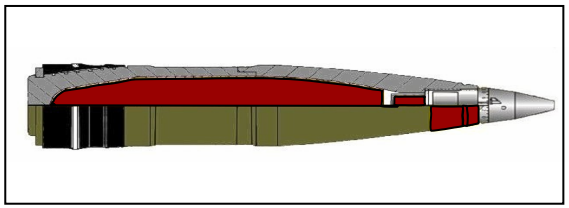
Pre-formed pellets dispersed in a pre-determined pattern prior to projectile impact on target



5-Inch KE-ET

Kinetic Energy Rounds

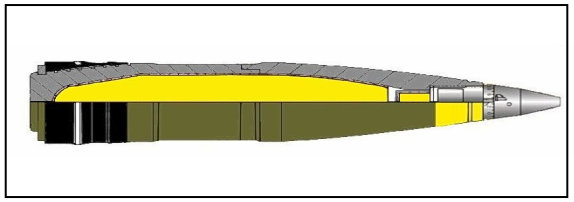
Pre-formed spherical pellets expelled by low impulse detonation charge and radial dispersion achieved via projectile spin momentum



5-Inch HE-ET, HE-CVT, HE-MFF

High Explosive Rounds

Blast-fragmentation munitions which eject naturally forming shell casing fragments at high velocities



Future Air Burst Munitions Types

Methodology will allow accurate effectiveness assessments of all types of air bursting munitions.

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FUZING IN JGEM

- **Timed Fuzes**
  - CVT Fuzes
  - ET Fuzes
  - Multi-Function Fuzes with ET operating modes

Timing of detonation is varied via a standard deviation time error which has been determined from test data.

- **Proximity Fuzes**
  - RF fuzes
  - Laser fuzes
  - IR Fuzes
  - Multi-Function Fuzes with proximity modes of operation

Fuze characterized in terms of cone angle and cone edge length.

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Animation of JGEM Engagements

- 3-D Animation using SIMDIS
  - Will allow display of JGEM engagement actions
    - Firing ship movements
    - Threat boat movements
    - Projectile impacts and/or detonations
  - Allows extensive manipulation of developed images
- NSWCDD fragmentation visualization tool
  - Program can be modified to display JGEM engagement actions
    - Firing ship movements
    - Threat boat movements
    - Projectile impacts and/or detonations
- Exploring use of other pre-existing visualization tools

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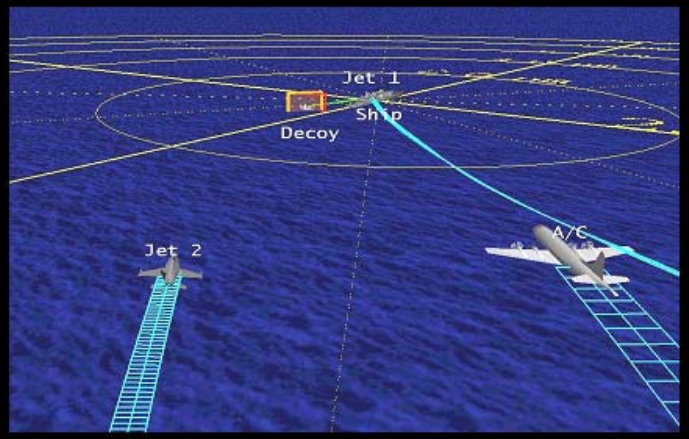
Animation With SIMDIS

NRL | SIMDIS Analysis and Display

SIMDIS – Visual Analysis and Display



- SIMDIS is a set of GOTS software tools in use by DoD Ranges and Systems Centers to support 3D analysis and visualization of test and training missions for air, sea, and undersea warfare areas
- SIMDIS allows an integrated real-time view of time-space position information (TSPI), system telemetry data, and other real-time data sources . It is used to provide live and post event understanding and insights into complex system interactions.