Bursting Munition Fuzing for Individual and Crew Served Systems

15 August 2001

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
15Aug2001	N/A	-

Title and Subtitle Bursting Munition Fuzing for Individual and Crew Served Systems	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Broden, David; Timmerman, John; Tomes, Mark; Becker, Bob; Gilles, Pete	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) ATK Weapon Systems	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) NDIA (National Defense Industrial Association) 211 Wilson Blvd, STE. 400 Arlington, VA 22201-3061	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)

Distribution/Availability Statement
Approved for public release, distribution unlimited

Supplementary Notes
Proceedings from the 2001 Joint Services Small Arms Symposium, Exhibition & Firing Demonstration 13-16 August 2001 Sponsored by NDIA, The original document contains color images.

Abstract

Subject Terms

Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU

Number of Pages
28

Presenter

Dave Broden
ATK
Weapon Systems
Technical Director

Prepared by:

John Timmerman
ATK
Ammunition Technology Director

Mark Tomes
ATK
Bursting Munition Fuzing
Development Engineer

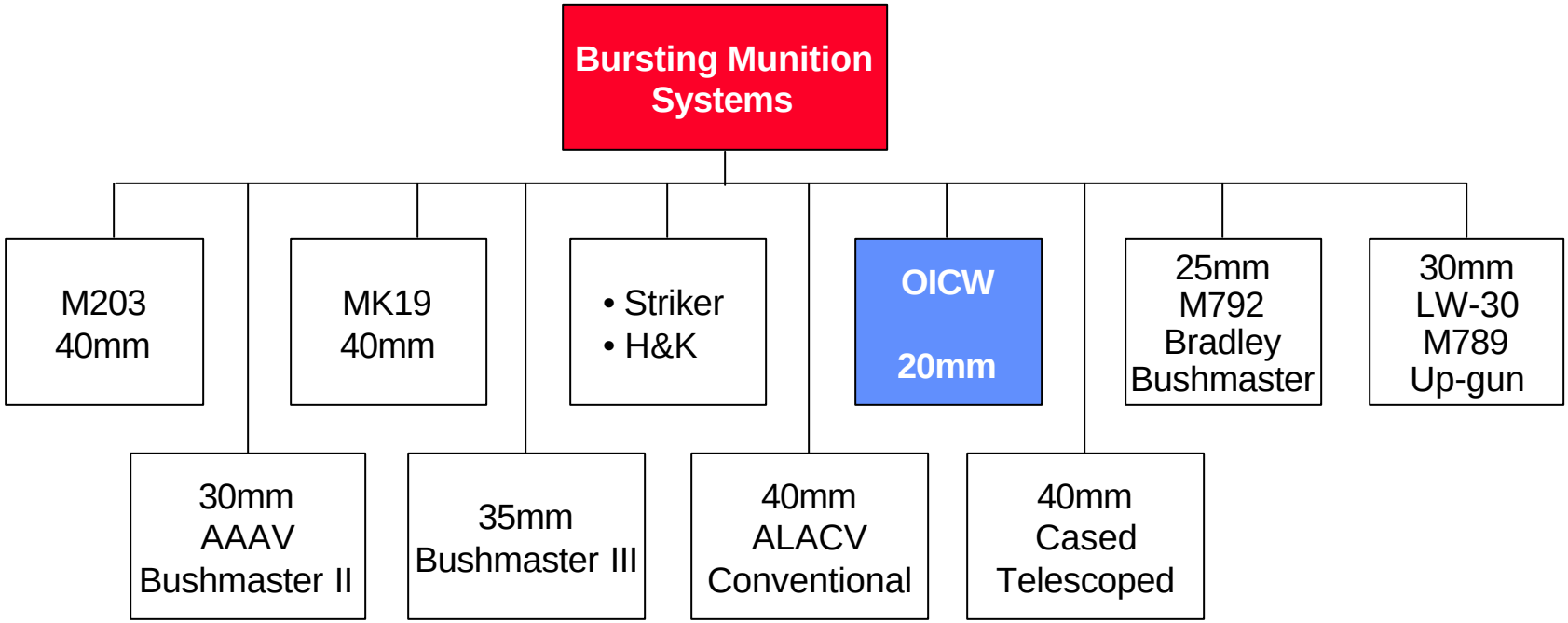
Bob Becker
ATK
Engineering Fellow
Aeroballistics and Dynamics

Pete Gilles
ATK
System Analyst

Objective: Confirm Bursting Munition Capability Readiness for Individual and Crew Served Weapon Systems

- System effectiveness
- Requirement assessment
- System integration
- Technology
- Performance
- Safety
- Training
- Commonality
- Affordability

“Bursting Munition” Applications



Establishing a Commonality of Systems
- Integration
- Technology
- Performance

Ensure Affordability

Bursting Munitions Fuzing Applications/Commonality

- OICW — 20mm → Design focus ensures application to other calibers
  → Maximizes warhead capability
  → Establishes commonality
  → Address producibility/affordability

Cannon Caliber System

- 30mm AAAV
- 25mm M790 family
- 35mm
- 40mm high velocity — cannon application(s)

Individual and Crew Systems

- 40mm grenade
  - Low velocity → M203 M406/M433
  - High velocity → MK19 M383, M385, M430, M918
  - Improved low and high velocity ammunition

Bursting Munition System

Bursting Munition Capability is an Integrated System

- Operational capability
- Weapon system integration
- Fire control system
  - Aiming
  - Adjusted aim point/ballistic computer
  - Ranging
  - Fuze setter
- Setter interface
- Ammunition
  - Ballistics
  - Warhead
- Fuzing
- Training
- Supportability

Leveraging OICW Total System Approach Ensures Integration

Bursting Munition System Drivers

- System effectiveness
- Ergonomics
- Error budget management
- Weight
- Compact profile
- Adaptable/modular
- Long operational life/low power
- Ruggedness
- Reliability
- Safety
- Supportability
- Affordability

System Characteristics Critical to Individual and Crew Served Systems

OICW Evolution Address Technology Readiness

System Integration

- System physical integration
- Fire control system
  - Laser range finder
  - Adjusted aimpoint
    - Optical
    - Alignment indicator
  - Ballistic computer
  - Setter
- System setter
  - Weapon interface
  - Inductive
  - Contact

Bursting Munition Fuze Integration is Adaptable to Multiple Weapon System Applications

ATK Bursting Munitions Fuzing Elements

- System error budget management
- System effectiveness
- Ballistic solution/algorithm
- Fuze design and performance
- Fuze setter design and integration
  - Inductive
  - Contact (alternate)
- Functions
  - Air burst
  - Point detonating — super quick
  - Point detonating — delay
  - Window
  - Point detonating — backup
  - Self destruct
  - Self neutralize
- Safing and arming — meet MIL-STD-1316E

Requirements Established to Meet Specific Application

System Effectiveness

Objective: Enhance Individual and Crew Served Capability with Precision Delivery of Lethality to Target

- Extend battlefield
- Battlefield safety
- Defilade target(s)
- Functional alternatives
  - Air burst
  - Point detonating
  - Window
- Achieving capability through rigorous error budget management

Fuze Precision Requirement Dictates Fuze Range Precision Algorithm

Systems Effectiveness / Error Budget
System Performance Model

CASRED Output

Pk Grids
Lethal Area

System Errors

Man-in-the-Loop

- Aiming Errors
- Laser Accuracy
- Laser Ranging

System Errors

Environment
- Temperature
- Pressure
- Wind

Weapon / Fire Control
- Site Angle
- Cant Angle
- Boresight
- Aimpoint Accuracy

Ammuntion
- Muzzle Velocity
- Drag Coefficient
- Spin Damping Coeff.
- Cm_alpha, Cn_alpha
- Mass, Ixx, Dref
- Muzzle Twist
- Dispersion

Aeroballistic / Turns Count Fuze Model

FBAR Inputs

Occasion-to-Occasion Errors
- Down Range
- Cross Range

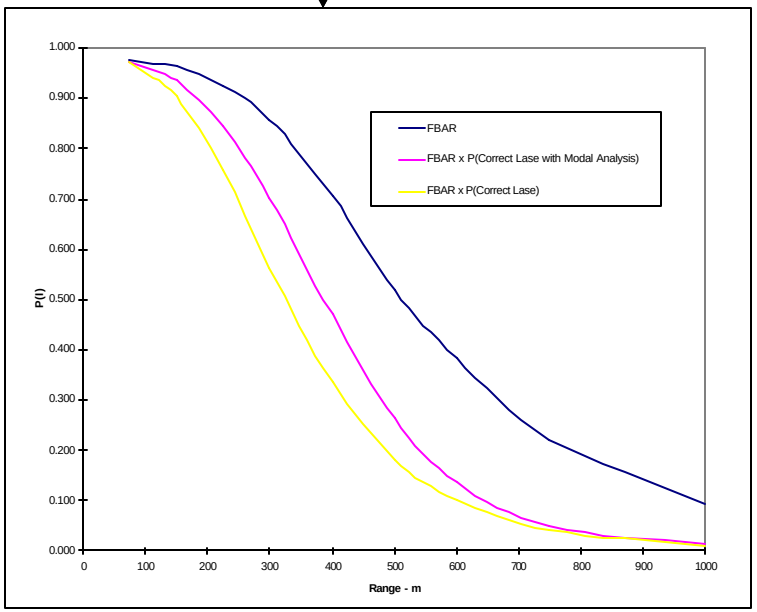
Random Errors
- Down Range
- Cross Range

Terminal Velocity

Angle of Fall

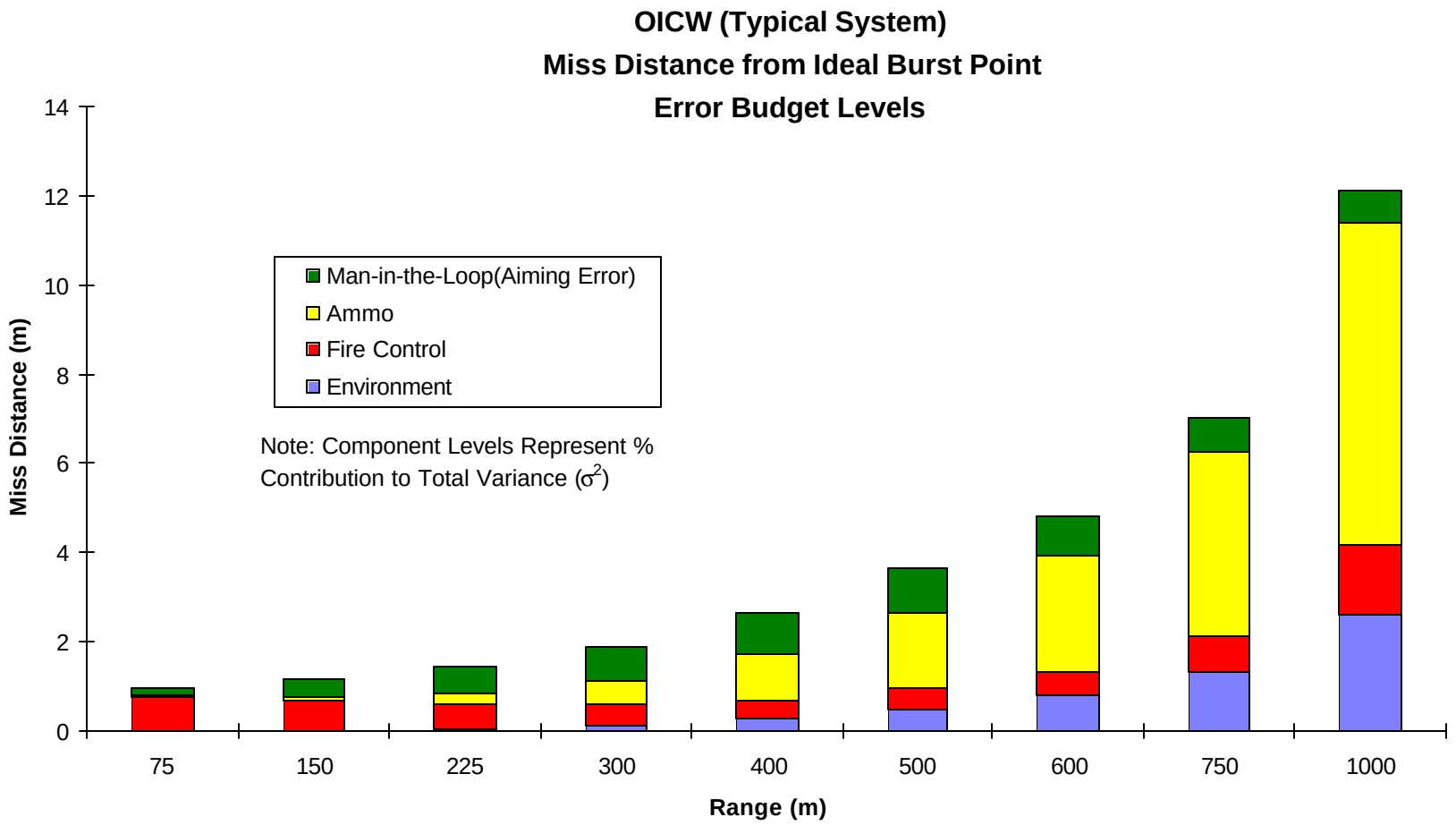
Fuze Timing Error

FBAR



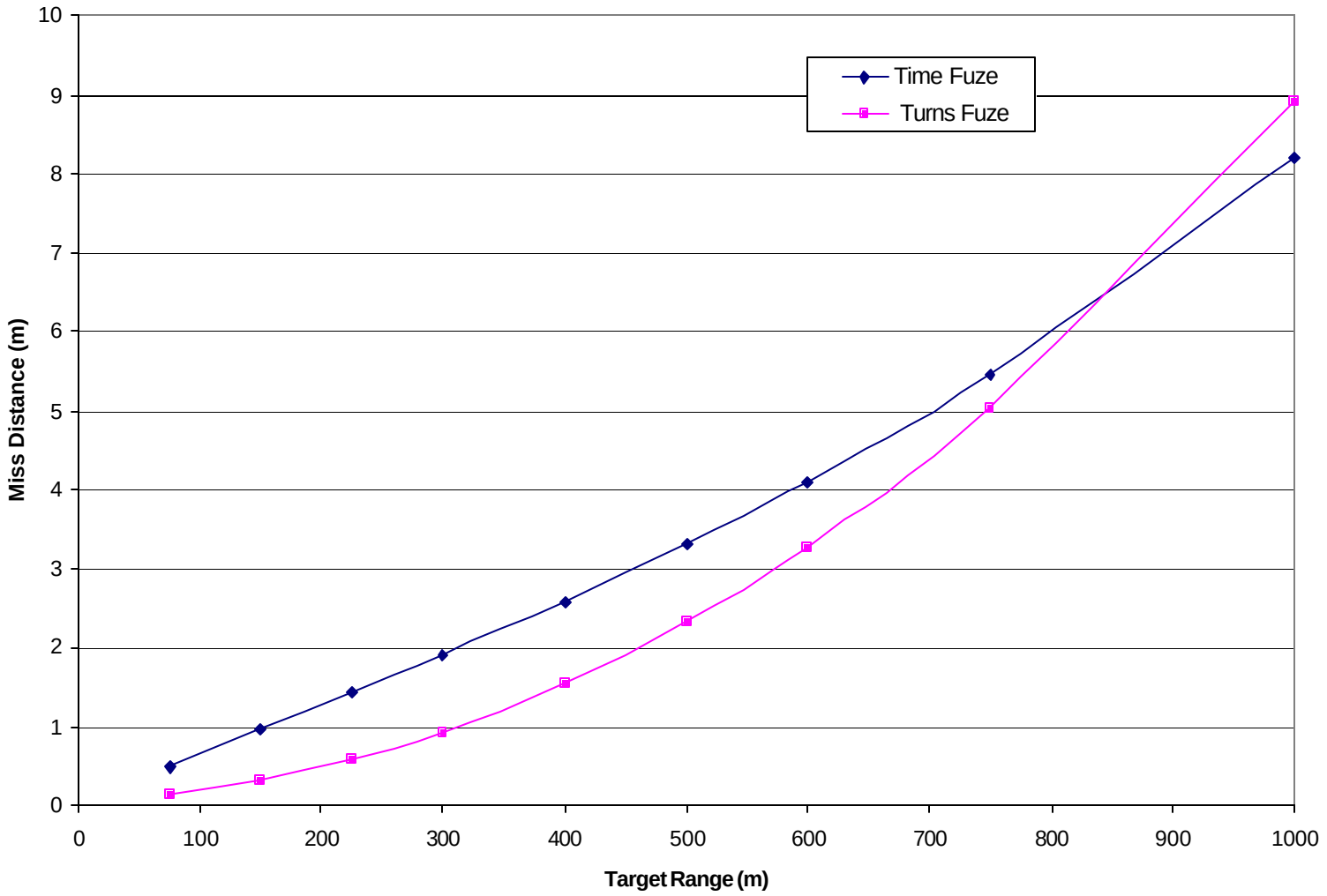
Integrated Approach to Requirements Assessment Ensures Priority

ATK ALLIANT TECHSYSTEMS


OICW (Typical System)
Miss Distance from Ideal Burst Point
Error Budget Levels
Miss Distance (m)
14
12
10
8
6
4
2
0
Man-in-the-Loop(Aiming Error)
Ammo
Fire Control
Environment
Note: Component Levels Represent % Contribution to Total Variance (σ²)
75
150
225
300
400
500
600
750
1000
Range (m)

Fuze Type Algorithm Assessment

Turns Count System Minimizes Miss Distance



2–3 pages on 40mm

Aeroballistics/Miss Distance

and

Turns vs. Time

to be added

on Friday a.m.

Bursting Munition Fuze Algorithm Alternatives

Alternatives

- Time
- Closed loop time compensation
- Turns
- Turns/time hybrid
- Above with accelerometer compensation

Selection Criteria

- Muzzle velocity
- Aeroballistics
- System integration
- Precision
- Application range

Preferred Approach: Turns or turns/time provides assured precision without compensation link

Bursting Munition Fuzing Capability

- Focus on system integration ensuring enhanced effectiveness

  Error Budget Management

- Ensure repeatable and precise fuze function

  Fuze Compensation Addressing Error Parameters

- Safety compliance

  MIL-STD-1316E and System Integration Interface

- Affordability

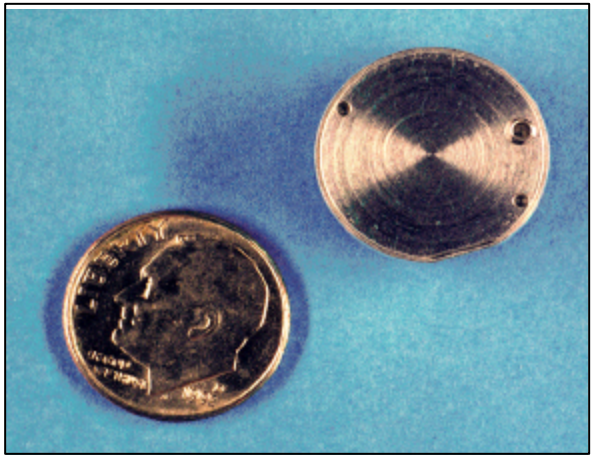
  Technology Selection, Technology Insertion, Commonality, Adoptability

Miniaturization

- Design focus to 20mm OICW: Volume ≤ 0.45 in^3
  - Reduction in volume evolving
- Adaptable to MEMs S&A as MEM matures
  - Fuze integraion
  - Mechanical configuration
  - Explosive train
- Electronic packaging
  - Alternatives addressed
    - Power
    - Packaging
- Power source
  - Application dependent
  - Power source affordability addressed

Safing and Arming (S&A) Mechanism

- Volume ≤ 0.1 in^3
- Command arm system
  - Arming distance options
    - Normal
    - MOUT
  - Overhead safety (option)
- MIL-STD-1316E compliant
- Weapon launch compatible to over 100K g's
- Adaptable to multiple caliber and launch conditions
- Explosive train component compatible and rugged
- Tailor to initiation direction
  - Dual: Forward and rearward
  - Single: Rearward
- Demonstrated to meet MIL-STD-331 selected criteria
- Reviewed by Fuze Safety Board
- Ruggedization in process



Bursting Munition Demonstrated Performance

- High fuze setter reliability
- Command arm S&A function dual environment demonstrated
- Repeatable burst point precision
- Integrated compensation — reduces error
- Turns count precision
- Turns/time hybrid precision enhancement
- Functional modes
  - Air burst
  - Point detonating
  - Point detonating delay
  - Point detonating — backup
  - Window
  - Self destruct

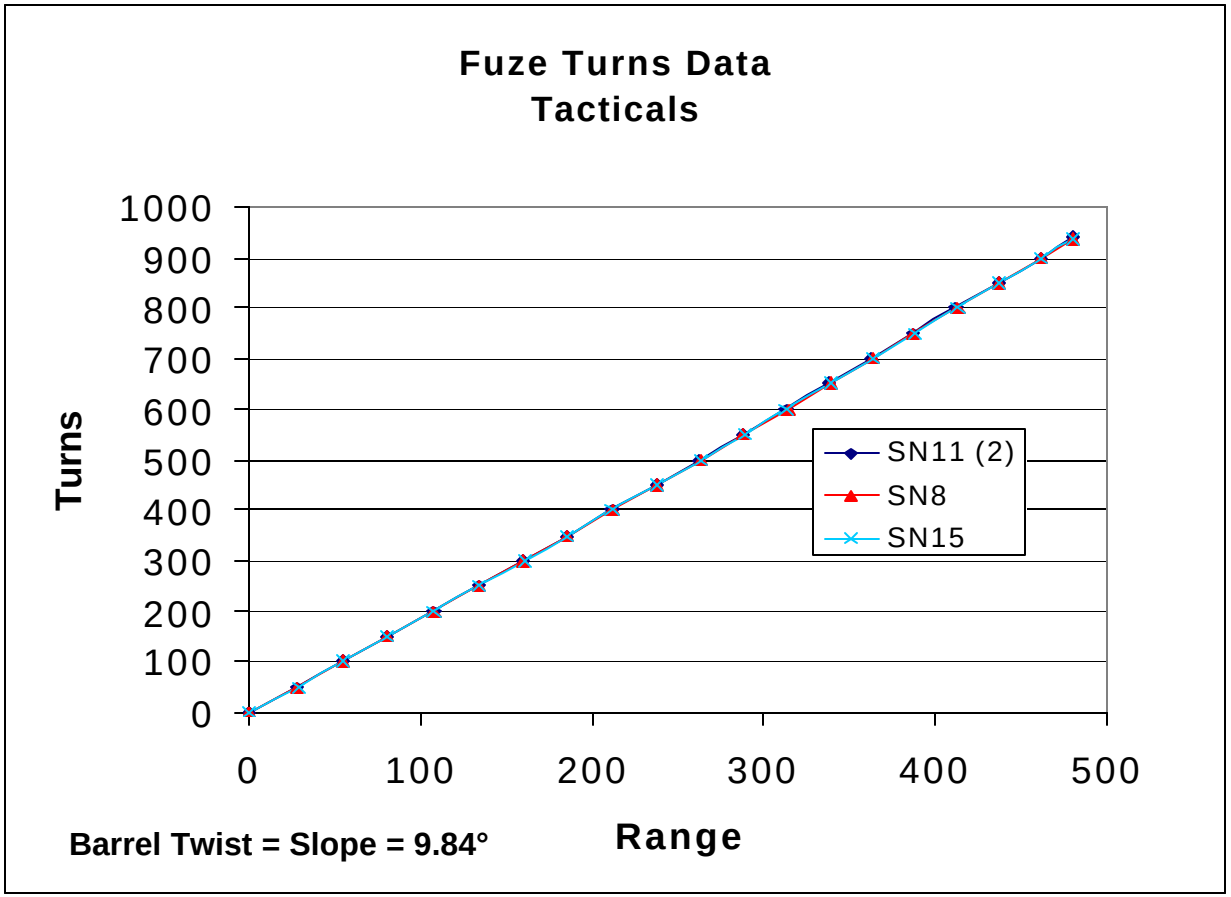
Key Operational Feature Confirmed — Adaptable to Other Applications

Demonstrated Performance

	20mm	40mm	30mm Cannon Caliber
System Integration	√	In process	In process
Fire Control Interface	√		√
Fuze Setter	√	In process	√
Power Source	√	Applies	√
Safing and Arming	√	Applies	√
Command Arm	√		√
Electronic Function	√	Applies	√
Compensation	√	Analysis in process	√
Function			
• Air burst	√	Applicable from 20mm without change	√
• Point detonating	√		√
• Point detonating delay	√		
• Window	√		
• Self destruct	√		
Self Neutralized	√		

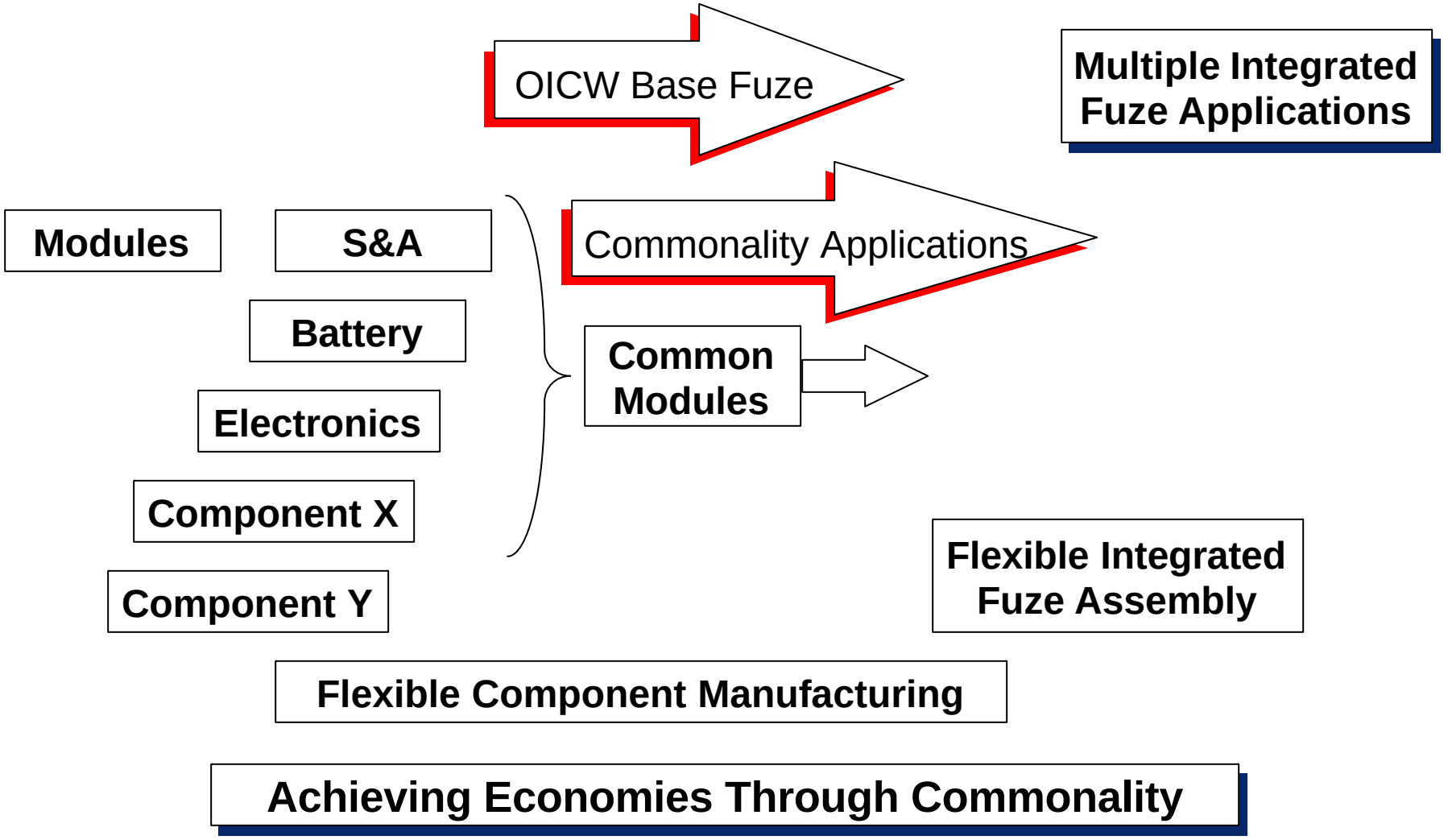
Precision Performance

- Turns data is repeatable from round to round



Turns/Time Hybrid Demonstrated Precision

OICW Fuze Commonality

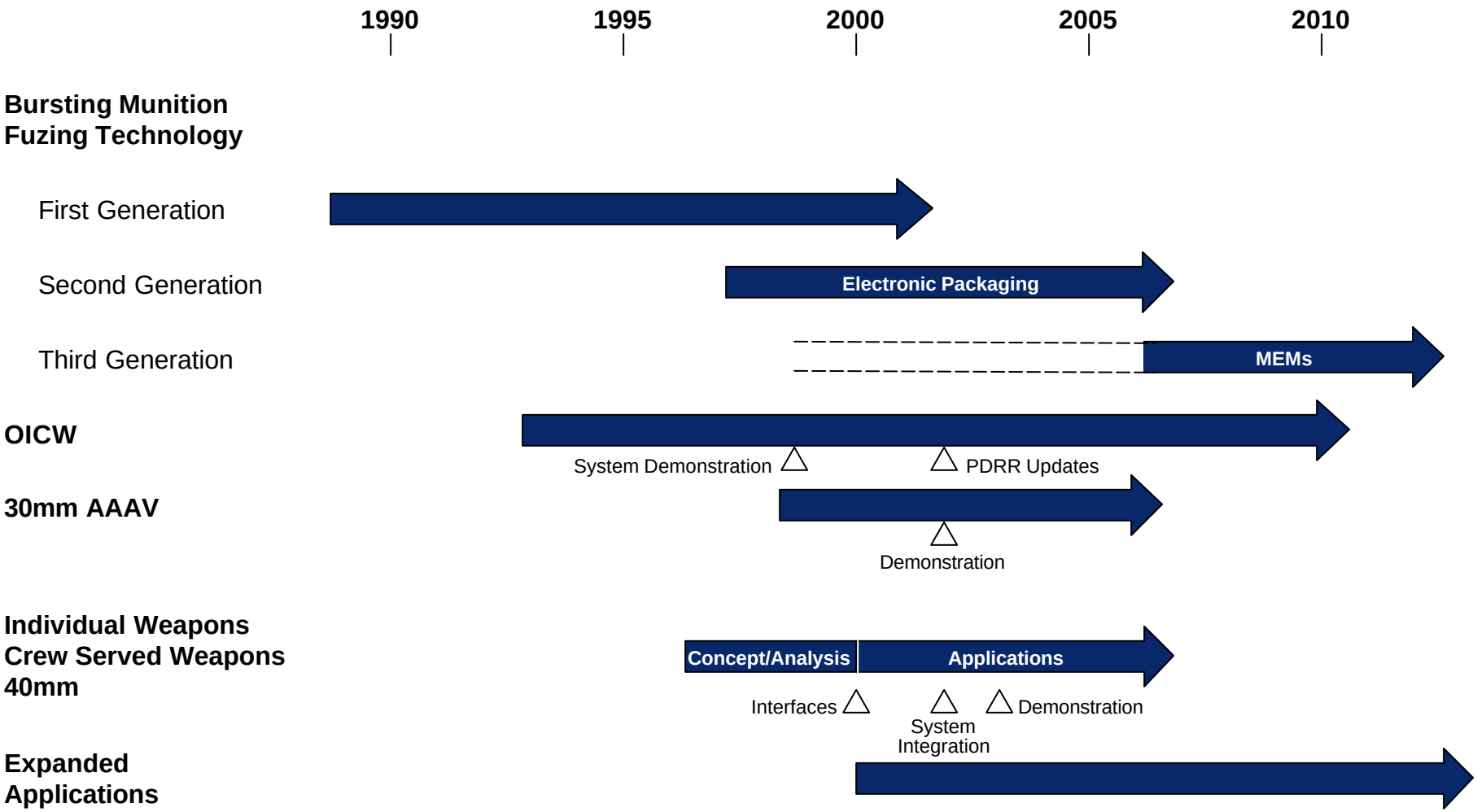


ATK Bursting Munition Highlights

• Bursting munition technology and applications	1985	Present
• OICW applications and demonstrations	1995	Present
– 1998 system demonstration confirmed integration and performance		
• Safety and ruggedness enhancement	1999	Present
• 30mm cannon caliber integration	1999	Present
• 40mm applications — designs, performance, and integration	1998	Present
– Integration	2001	– 2005
– Introduction	2005	– 2007

Individual and Crew Served Bursting Munition Systems Offer Near Term Capability Enhancements

Bursting Munition System Evolution



Bursting Munition Capability – Realizing the Benefits

Requirements

- Enhanced system effectiveness
- System integration
- Affordability

Integration and Technology

- Established and demonstrated
- Application from related systems
  - Weight
  - Power
  - Volume

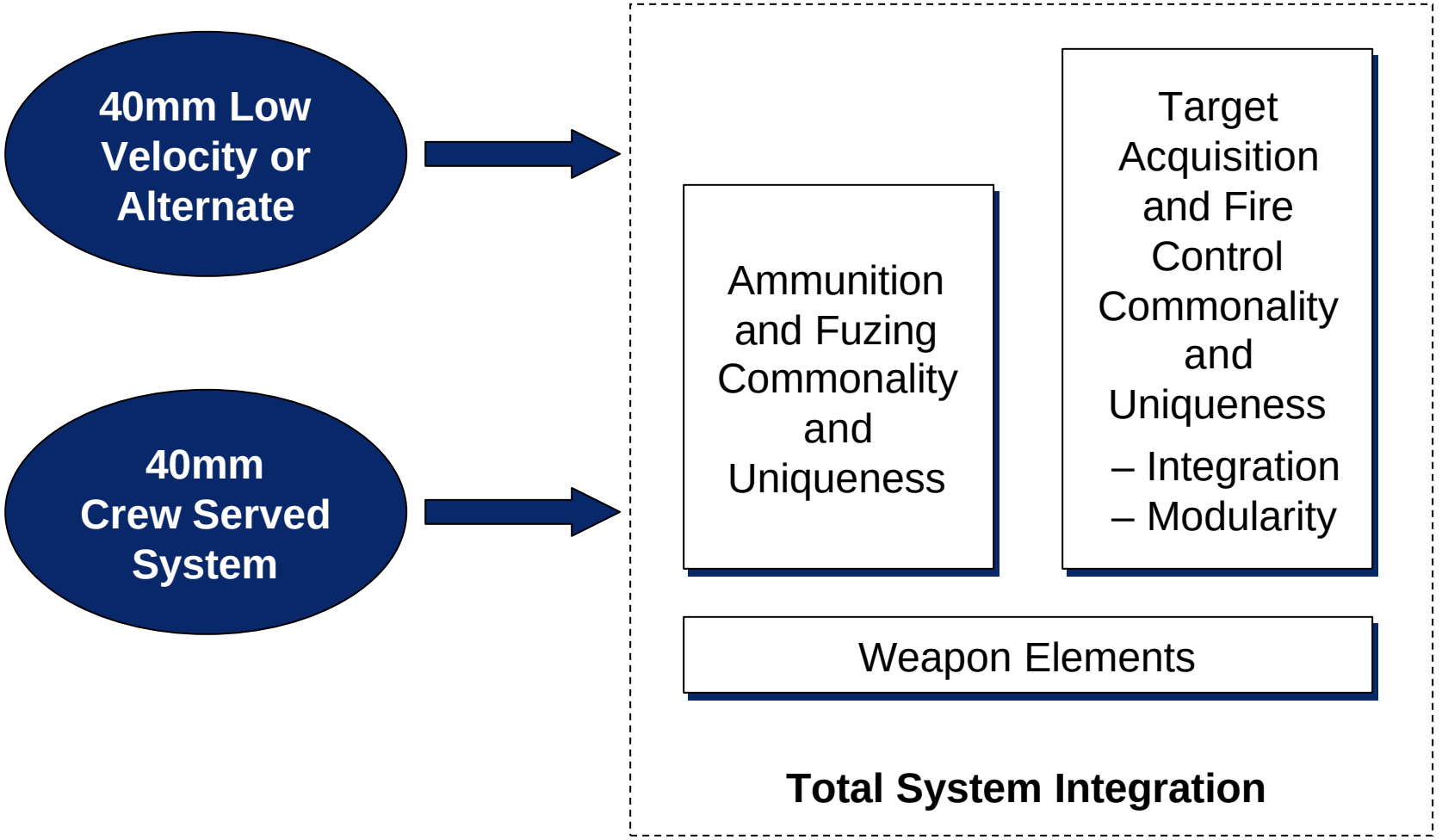
  } Reductions realized
- Technology is available

Affordability

- Achieved through commonality and flexibility

Achieving Affordability Through Commonality and Modularity

Small Arms
NDIA
2001



Extend Legacy System Life Through Leveraging and Commonality

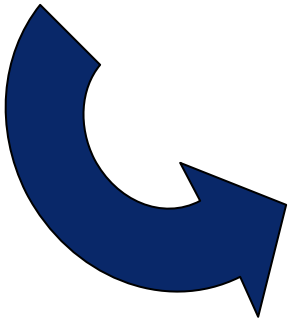
ATK ALLIANT TECHSYSTEMS

Conclusion

- Bursting munition fuzing utilizing turns and/or turns/time algorithm offer unique capability
  - Simplicity
  - Precision
  - Functional variations
  - Commonality/adoptability
- Total system approach ensures system interface capability
  - Setter
  - Fire control
  - Weapon integration
- Leveraging OICW system and fuzing technology and integration provides efficiency
  - Development
  - Commonality in technology
  - Training uniformity
  - Affordability

Individual and Crew Served Weapon Bursting Munition Benefits

- Enhances system effectiveness
- Extends life of Legacy Systems
- Provides for modular block mod changes
- Affordable



Provides Affordable and Effective Link to Objective Force Capability