Air Bursting Ammunition Technology

John Timmerman - ATK Ordnance & Ground Systems Co.
Bob Becker - ATK Ordnance & Ground Systems Co.
Mike Hiebel - ATK Ordnance & Ground Systems Co.

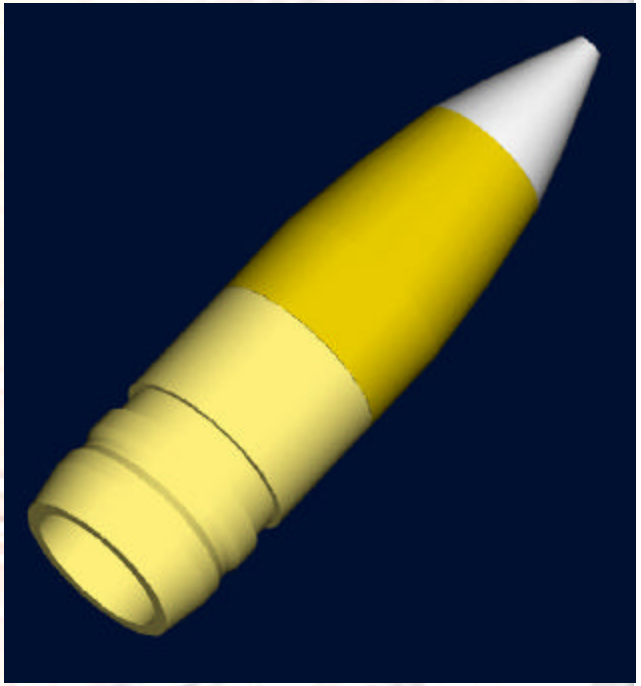
April 10, 2003

ATK
ALLIANT TECHSYSTEMS

ATK Air Burst Initiatives

20mm HEAB Grenade

40mm HEAB Projectile

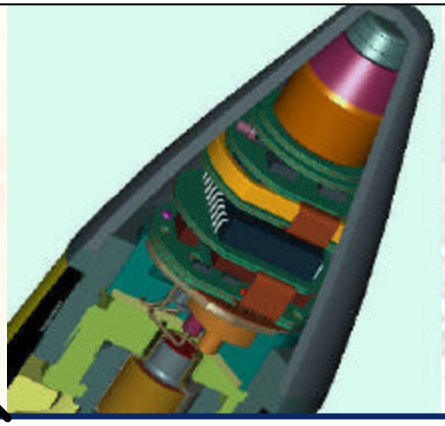


30mm HEAB Cartridge

ATK
ALLIANT TECHSYSTEMS

Air Burst Munitions

ATK's bursting ammunition fuze is completely self contained requiring no external velocity correction



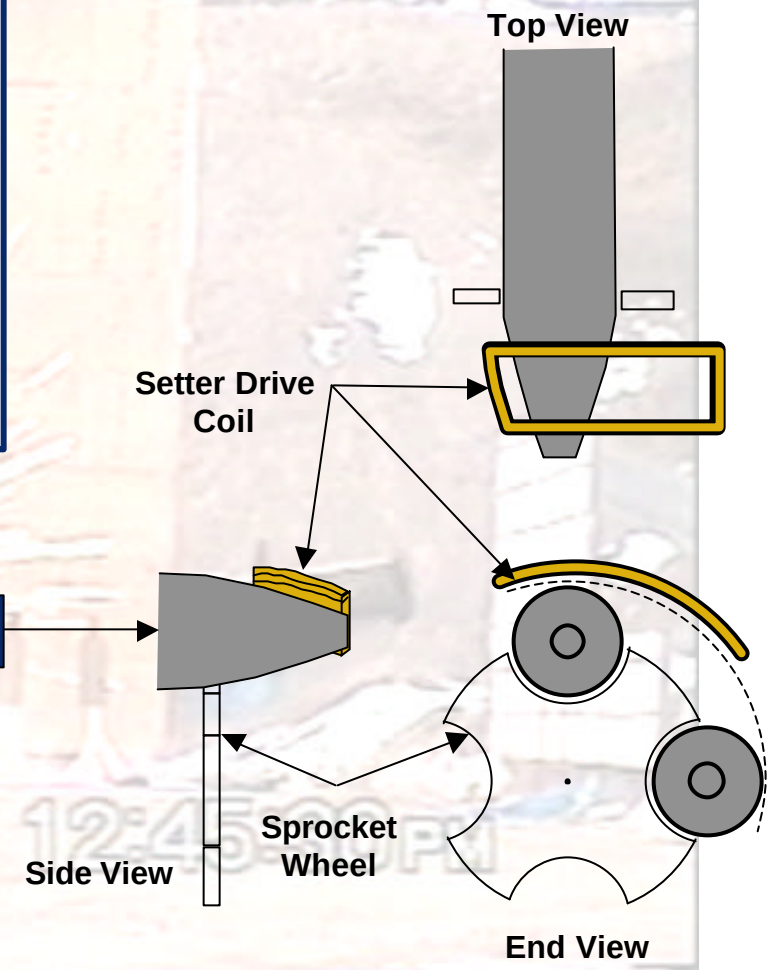
- **Bursting ammunition**
  - **Turns counting fuze**
- **Flexibility**
  - **Programmable**
    - **Mode**
    - **Range**

ATK
ALLIANT TECHSYSTEMS

Air Burst Munitions

- Inductively transmit data to the fuze
  - Power
  - Mode, range
- High rate capable
- Robust relative to position

Inductive Fuze Setter



Marine Airburst Demonstration (05-2002)

Gun Environment – 30mm Mann barrel, hardstand

Ammunition - 30mm x173mm nose fuzed HEAB round

Firing mode – Single shot from 1500 meters

Results:

– All 9 rounds within the 10 m deep by 50m wide target area

– Average muzzle velocity – 1094 m/sec

- 1 sigma = 3.8m/sec

– Average Range error – 0.03m

- 1 sigma = 3.6m

Every round engages the target

ATK ALLIANT TECHSYSTEMS

PM-MAS Airburst Demonstration (11-2002)

Gun Environment – 30mm MK44 mounted on a Bradley FV

Ammunition - 30mm x173mm nose fuzed HEAB round

Firing mode – Single shot and 3 round bursts from 1500 meters

Results:

- 14 rounds fired
  - 12 functioned airburst
  - 2 functioned PD due to premature ground impact
- Average muzzle velocity – 1094.4 m/sec
  - 1 sigma = 3.9m/sec
- Average Range error – 0.1m (.01m - 3 round bursts)
  - 1 sigma = 5.6m (3.8m - 3 round bursts)

Accuracy is not affected in automatic fire mode

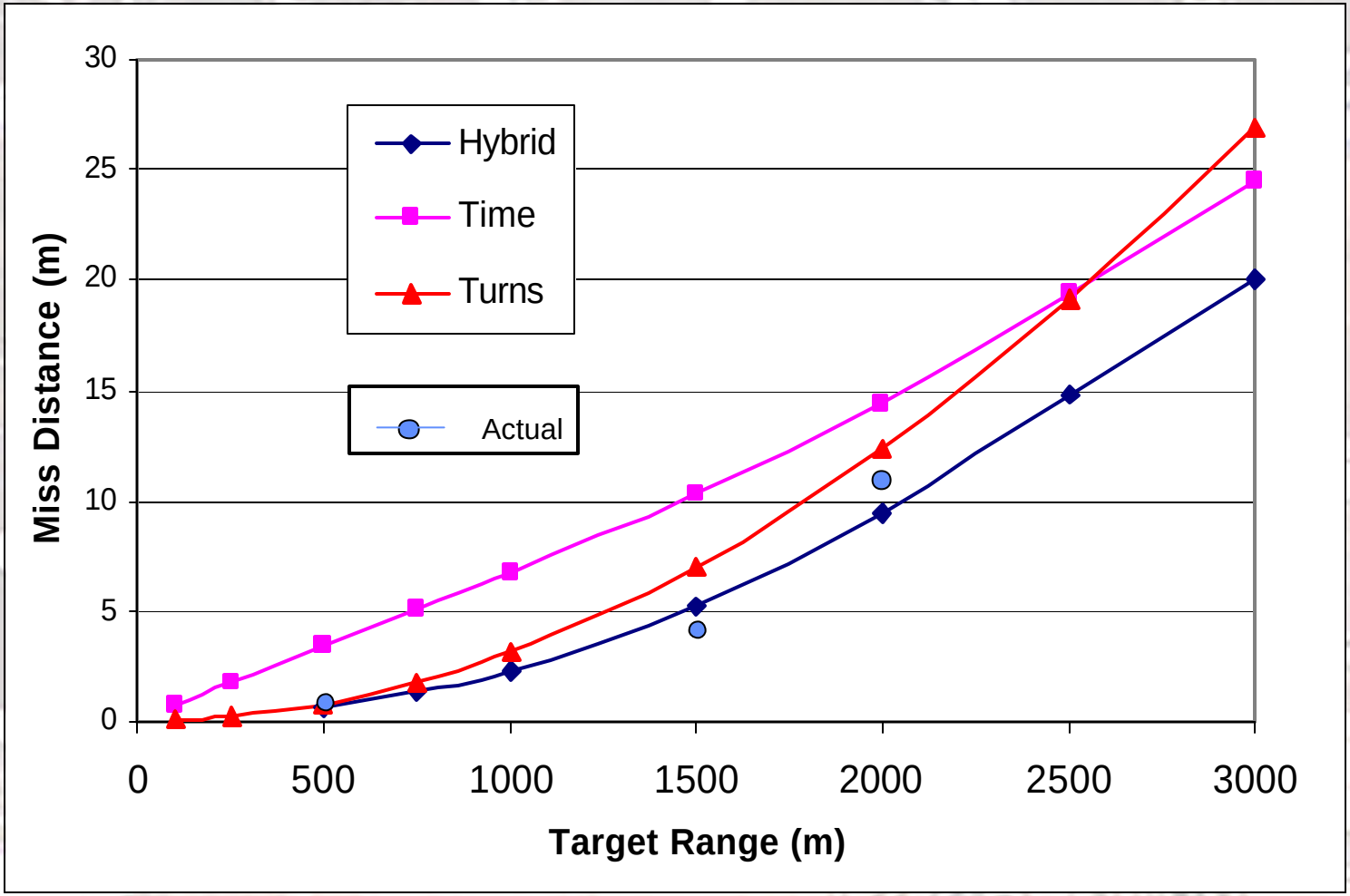
ATK ALLIANT TECHSYSTEMS

Air Bursting Algorithms

- Fundamental Challenge of Air Burst: Target no longer “events” Round
- First Order Methods: Timer or Turns Counter estimates when desired range to burst is reached. Assuming accurate Range and MET Data, Random (round-to-round) Errors will define accuracy.
- Second Order: Reduce round-to-round Muzzle Velocity error
  - External Measurement
  - “Hybrid” Utilize on-board timer and turns counter - No need for Gun Muzzle modifications
- Third Order: Direct Range estimate (1-D IMU)
  - Integrate Axial accelerometer twice on the fly
  - Requires higher CPU capabilities, accelerometer must survive Set-back g’s with no zero shift and be accurate to the 0.1 g level

ATK ALLIANT TECHSYSTEMS

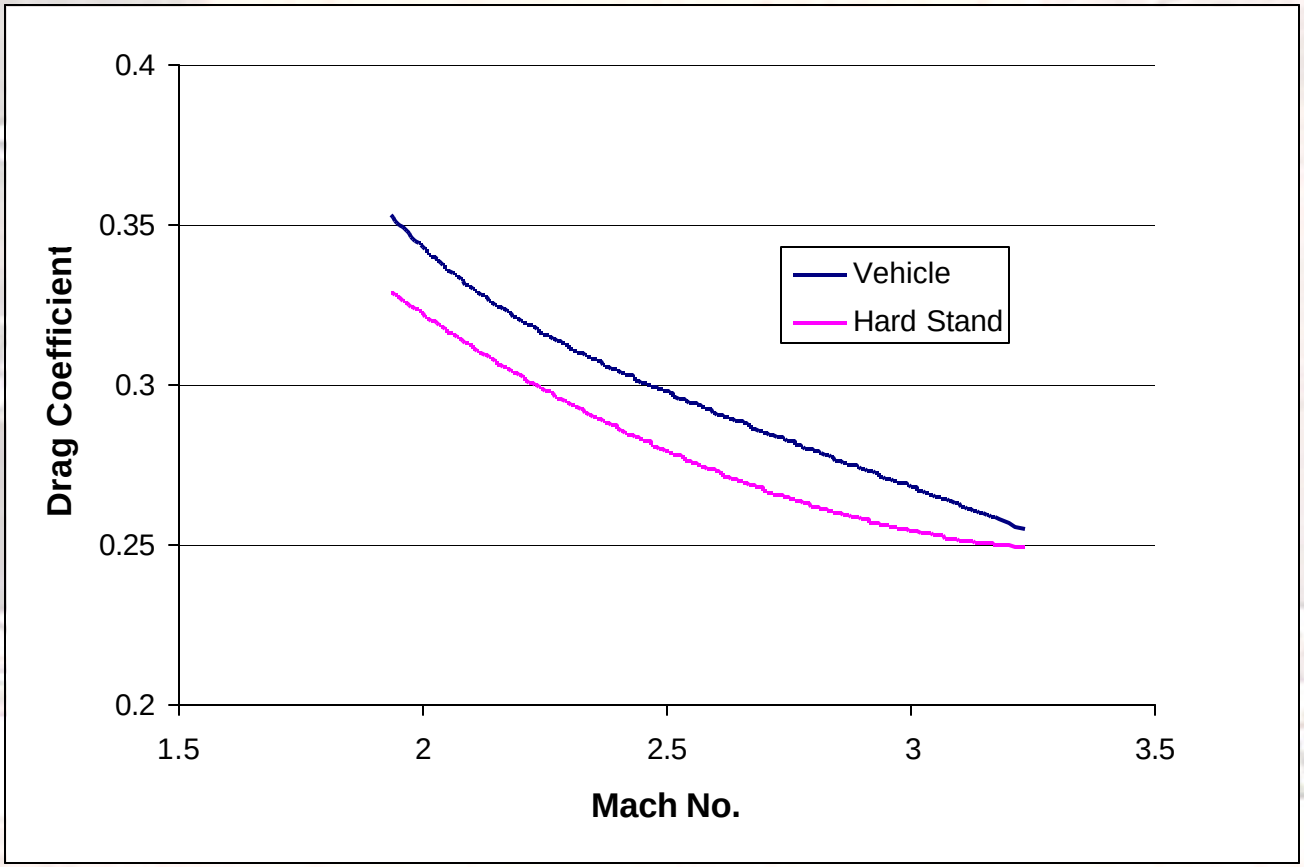
Miss Distances for Typical Error Budget



OBR, HE Tests confirms analytical results - simple Turns Counter effective close-in (<1500 m), Hybrid will improve accuracy at greater ranges

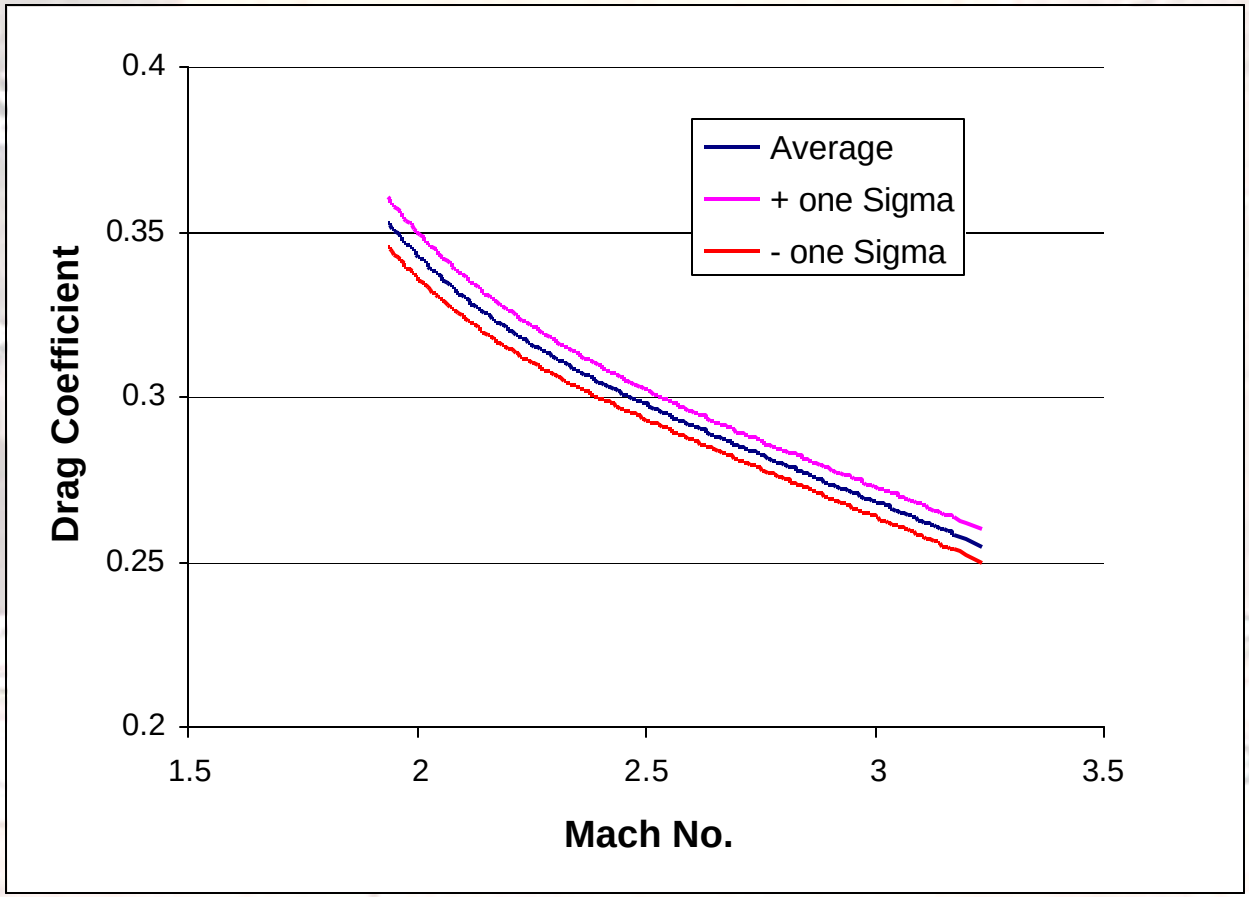
Primary Range Error Sources 30mm

- **Average Drag is higher (» 6%) out of Bradley mounted system (increased barrel whip, mount effects and higher angle of attack levels in pitch/yaw motion) as compared to Hard-Stand Systems.**



Primary Range Error Sources 30mm

- **Shot-to-Shot Variation at 1.6% one Sigma Level (Matches levels seen in Hard Stand Testing)**



Primary Range Error Sources 30mm

Single-Source Range Error Estimates at 1500 meters nominal burst point

- **Drag 1.6% One Sigma**
  - **Turns: 5.9m**
  - **Time: 5.7m**
  - **Hybrid: 5.7m**
- **Velocity 4.0 m/s One Sigma (Nominal Muzzle Velocity of 1095 m/s)**
  - **Turns: 0.5m**
  - **Time: 4.6m (Without Muzzle Velocity Compensation)**
  - **Hybrid: 0.0m**
- **Head Wind 3.55 m/s One Sigma**
  - **Turns: 1.9m**
  - **Time: 2.0m**
  - **Hybrid: 1.9m**

ATK ALLIANT TECHSYSTEMS

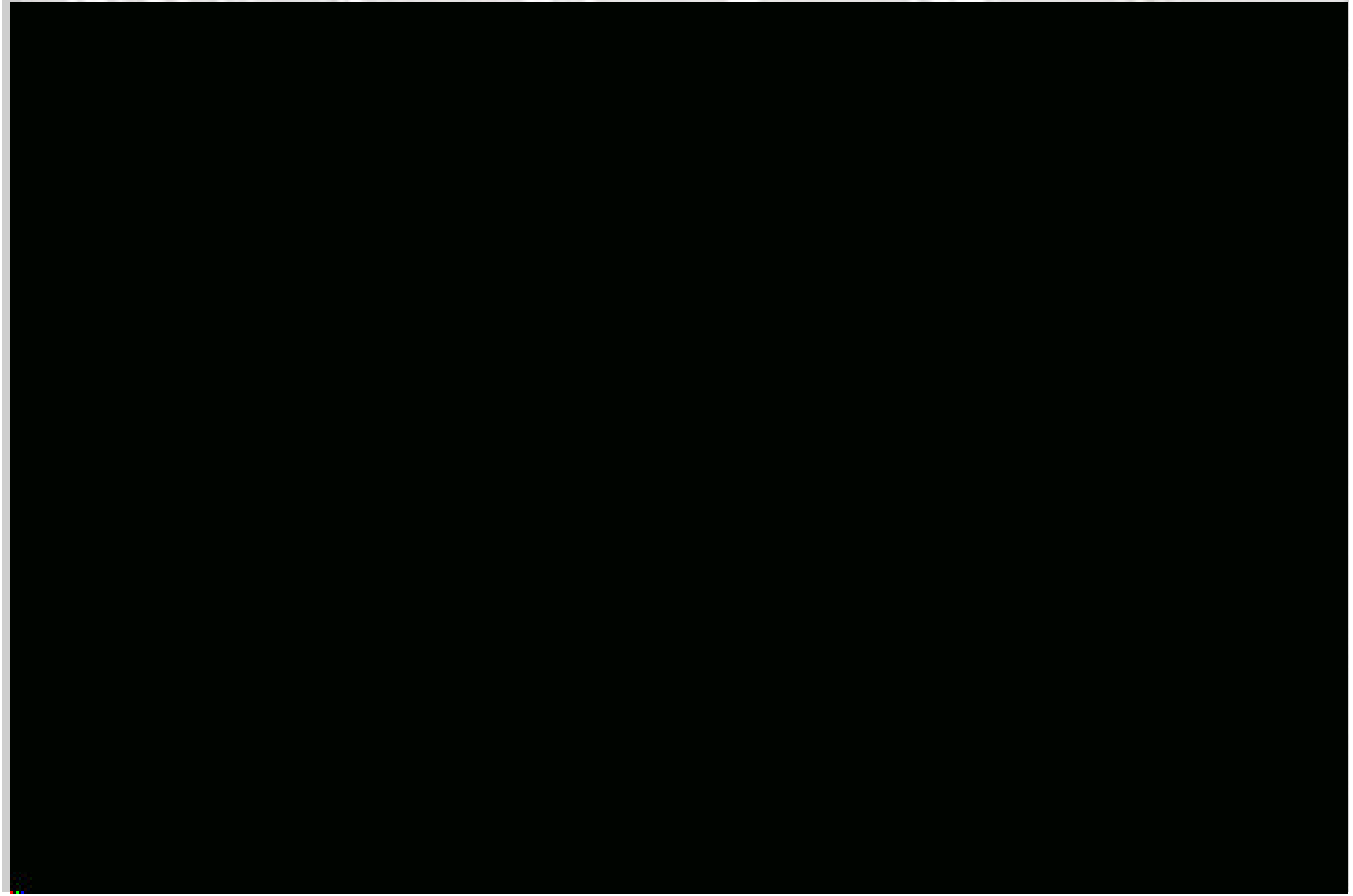
Next Generation On-Board Accel

- **Still require on-board time/turns count for initial muzzle velocity estimate**
- **Single-Axis Integration**
  - **Minimizes onboard computation (but will require floating point arithmetic)**
  - **Muzzle transients, coning motion, yaw-to-repose introduce errors related to projectile and velocity axes alignment**
- **Inherent accuracy along primary axis after impulsive set back loading of » 100,000 g's (Dynamic shift)**
- **Wind Effects**
- **Cost**

Will Improvement in Accuracy and Rounds/Kill be worth the cost for Medium Caliber Systems?

ATK ALLIANT TECHSYSTEMS

Air Burst Demonstration Video



ATK
ALLIANT TECHSYSTEMS