

Telemetry-Based Instrumentation for Mortar Systems

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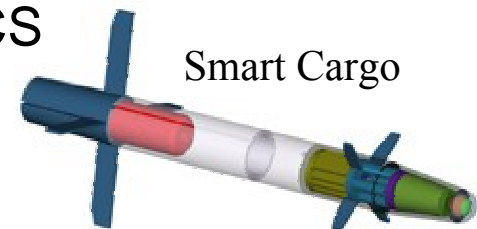
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Purpose

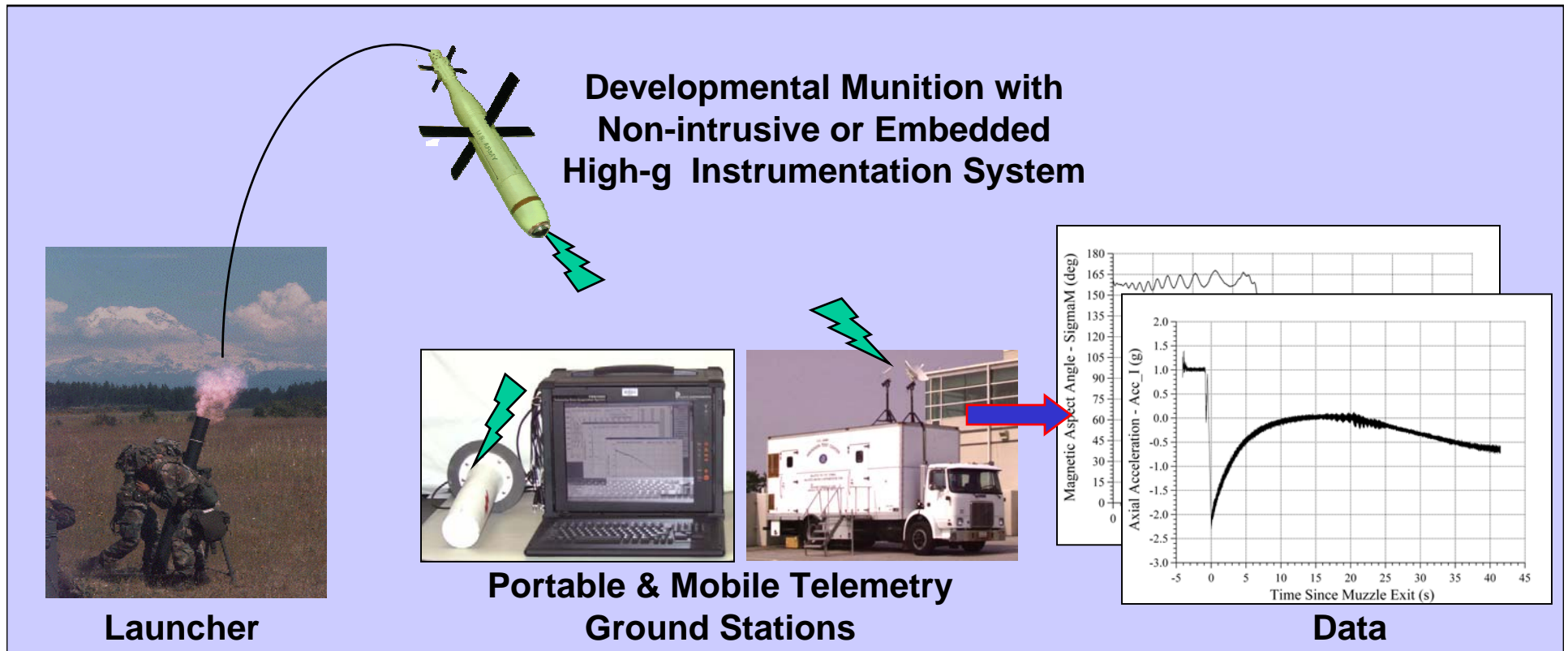
Army, Navy, and Air Force munitions require telemetry-based technologies utilizing modern electronics for data acquisition during all phases of Test and Development.

- Provide an Overview of Today's Telemetry-Based Instrumentation.
- Show how they are helping in Developmental and FCS Small Arms, Artillery, and Tank programs.
- Show TM instrumentation for Developmental and FCS Mortar Systems.





Telemetry-Based Instrumentation



- PMs & Developers are using to Rapidly “Redesign and Retest.”
- Verifies Airframe Performance, Validates Aerodynamics, and Measures Maneuver Authority.
- Adds Critical Measurement Capability, Reduces Hardware and Range Costs, and Saves Substantial Time to reach Technology Readiness Levels.



Aeroballistic Diagnostic Fuze (DFuze)



- NATO-Compatible Artillery Shape
- Tested to > 30,000 g's
- Various form Factors, Shapes, & Sizes
- 16 Channel Capability
- 1 hour Battery

ARL Diagnostic Fuze, US Patent 6,349,652

155-mm Army XM982 Excaliber



5-inch Navy EX171 ERGM



14-inch NASA T-Lynx Sounding Rocket



Applications

- On-Board Functions
- Roll, Pitch, Yaw, and Attitude
- Accelerations/Vibrations
- Time Space Position Information
- Maneuver Reference and Control
- Custom Measurements

Recent DFuze Customer Programs

XM982 EXCALIBUR	PM-ARMS
FCS Block I - Mid Range Munition (MRM)	PM-MAS
FCS Block II - MRAAS - SMART CARGO	PM-MAS
Autonomous Naval Support Round (ANSR)	NSWC
Counter Mine Counter Obstacle (CMCO)	NSWC
ANSR Tactical GEU and 2-D GIF Fuze	NSWC
DD-X Advanced Gun System (AGS)	SAIC/ Raytheon
Extended Range Guided Munitions (ERGM)	NSWC
PGMM Proposal Support	ATK
NSROC	NASA



Hardened Subminiature Telemetry and Sensor System (HSTSS) Program



PRODUCTS DELIVERED

SENSORS



ENCODERS



BATTERIES



TRANSMITTERS



ANTENNAES



PACKAGED SYSTEMS



DESCRIPTION

- HSTSS is a set of instrumentation “Building Blocks”. Component level products, modular in design, and with multi-configuration adaptability.
- Micro-miniature systems able to withstand high shock (100,000 g’s desired) & high acceleration.
- Low cost and expendable instrumentation.
- Can be embedded test instrumentation crossing the lines for operational tests, training, and tactical.

FUNDING

- HSTSS is Tri-Service program with Joint DoD and Army Funding
 - Central Test & Evaluation Investment Program (CTEIP)
 - PEO-STRI/TECOM D984 Funding
- PEO-STRI is the Project Manager, ARL is the Technical Lead
- Developers – Research Labs, RDE Centers, and Industry

\$M	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
CTEIP	0.4	1.1	5.4	5.0	3.5	1.5	0	0
D984	2.0	1.9	4.9	5.5	3.5	3.9	4.3	0
ERGM						1.2	2.4	1.4

\$48M

USERS / CUSTOMERS

Multi-service

ATIRCM (small missiles) - Battery & inertial sensors for tracking/attitude

• ARMY

PM ARMS - XM982 Projectile Imbedded Measurement Systems
 PM MAS - Tank Extended Range Munition (TERM)
 PM MLRS - Stock Pile Monitoring
 PM Mortar - Mortar Fuze TM Replacement

• Air Force

Scramjet - Telemetry Solution

• Navy

Extended Range Guided Munition (ERGM)
 Barrage Round Program
 Advanced Gun System (AGS)
 Autonomous Naval Support Round (ANSR)

• Private Industry HSTSS Users

Alliant-Tech Systems - advanced KE system measurements, ANSR
 SAIC - AGS,CMCO
 Lockheed Martin - AGS, PGMM

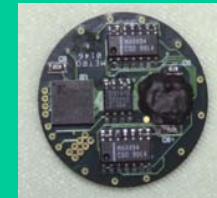


G-Hardened Data Acquisition Products



Pulse Code Modulated (PCM) Encoders

- HSTSS/ARL FPGA and CPLD encoders developed
- 8 and 16 channels at 12-bit resolution
- Randomization is supported
- Time delay/In-bore recording feature
- Several different frame formats implemented



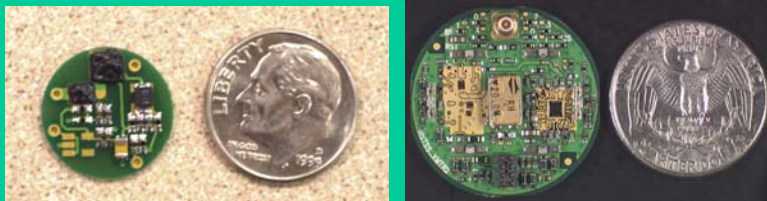
- HSTSS/ARL 29mm 8-channel
- Up to 5-Mbps
 - 65 mA @ 5 V

Transmitters

- HSTSS/MACOM/ARL X-mitters
- L and S-bands (w/ tunable freqs)
- Up to 20 Mbps
- 10mW to 2W power, low voltage operation

HSTSS/ARL 15mm

HSTSS/MACOM 29mm



Antennas

- Application specific patch and wrap-around antennas developed

HSTSS/NAWC 29mm
S-band Patch Antenna





G-Hardened Products Available

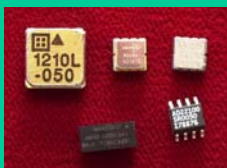


Sensors

- Utilize Commercial Technology
- Leverage Government Investments (DARPA/Labs/RDECs)
- HSTSS develops those truly unique



COTS Magnetometers, Accelerometers, Gyroscopes, Temperature Sensors



Endevco Model 73 (6, 20, 60 kg range)

3- Axis Gyro Chip



DRAPER High-G IMU on a chip

3- Axis Accelerometer Chip



HSTSS/ ARL 29mm 8-channel ISS

Batteries

- Several COTS batteries available
- Repackaged and High-G qualified
- Configurable

Commercial Lithium Batteries

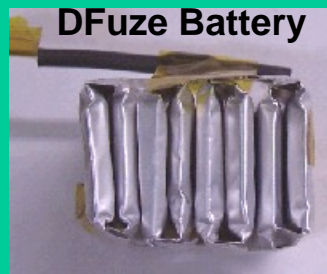


Primary CR2 Photo Battery Rechargeable Lilon



HSTSS Primary Li/MnO₂ Pouch Cell Batteries

DFuze Battery

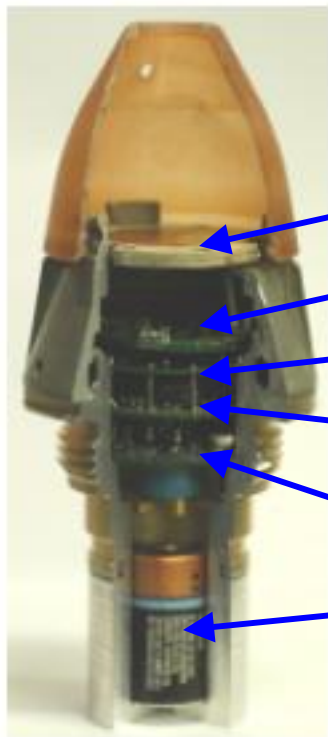


Nominal Voltage: 24V
Dimensions: 0.98" x 0.98" x 1.12"
Typical Discharge Current: 250mA

Battery Work courtesy Ed Bukowsk (DSI)



Mortar Diagnostic Fuze (MDFuze)



ANTENNA
TRANSMITTER
ENCODER
SENSORS
POWER
REGULATION
BATTERY



60mm M721 mortar round

- Recently developed for 60, 81, and 120mm Mortars.
- M734 fuze body components used for standard form, fit, and aerodynamics.

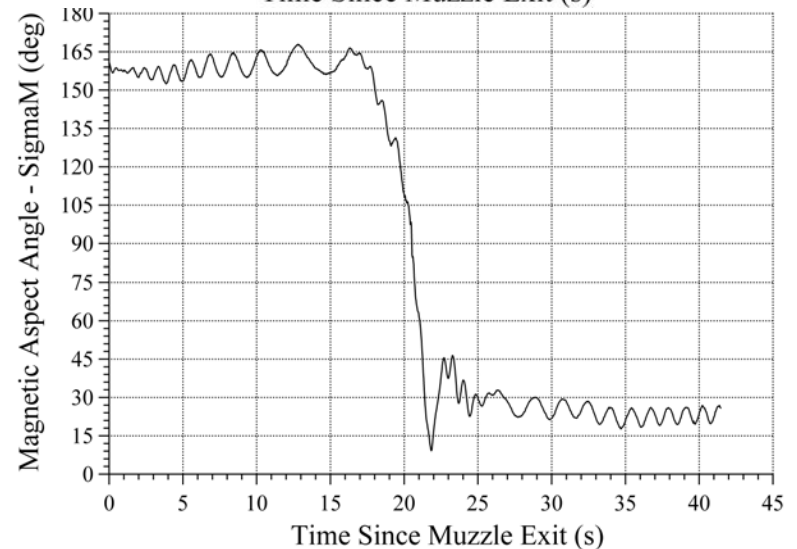
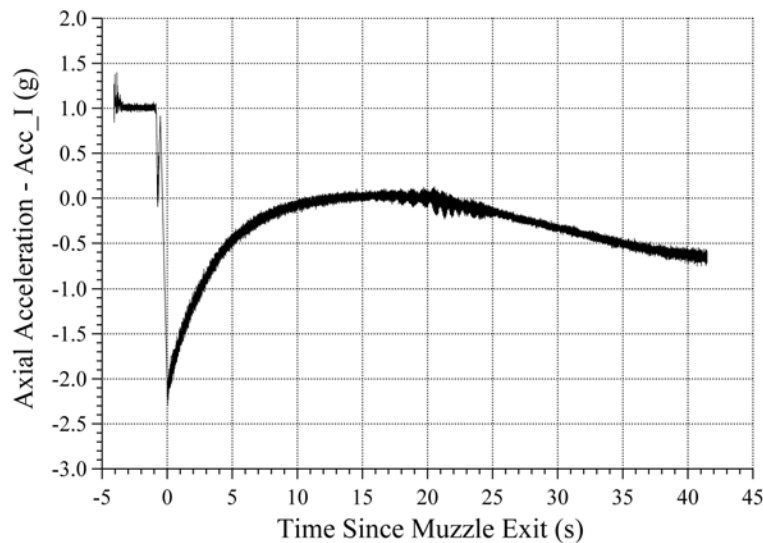
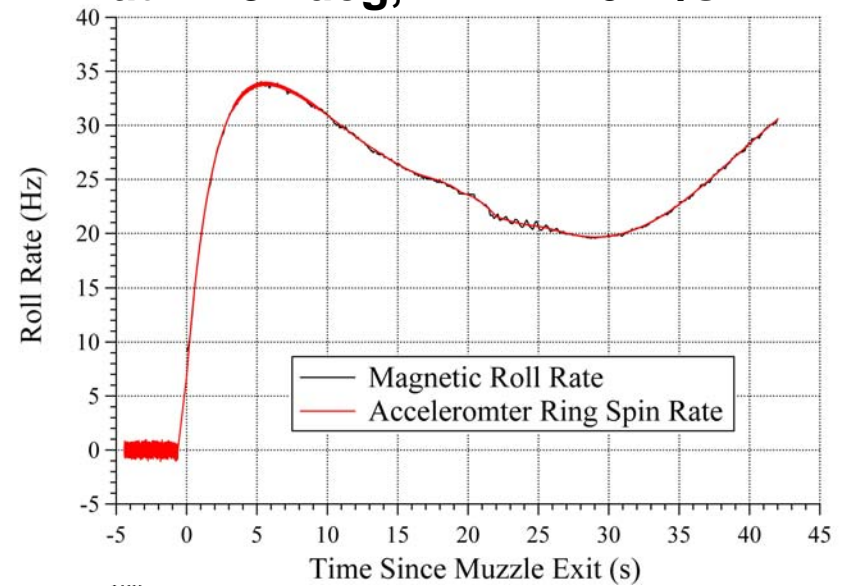
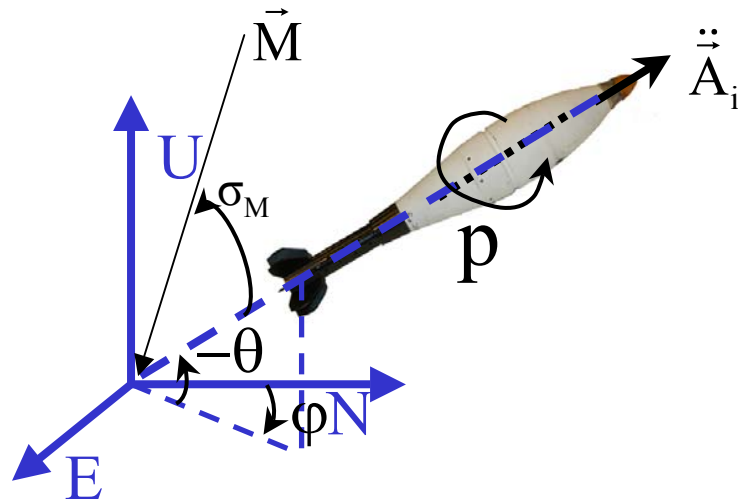
- 2 MDFuzes flight-tested during TACOM-ARDEC Fuze development program at APG-EA
- Successfully transmitted in-flight.
- Flight data Included
 - Axial and Radial accelerations
 - Velocity
 - Roll Rate
 - Angle to Magnetic Field
- Recovered and operational.



MDFuze M721 Flight Data



Launch Conditions QE = 89 deg, Azimuth = 82 deg, MV = 270 m/s





XM395 Precision Guided Mortar Munition (PGMM)



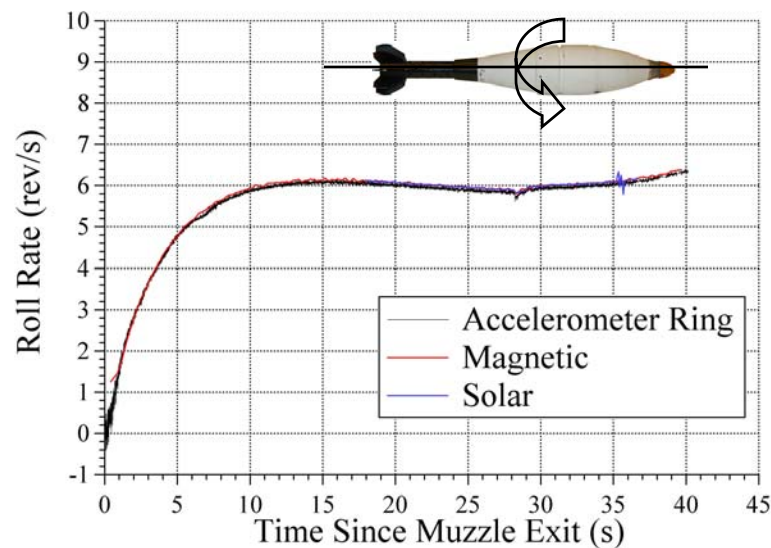
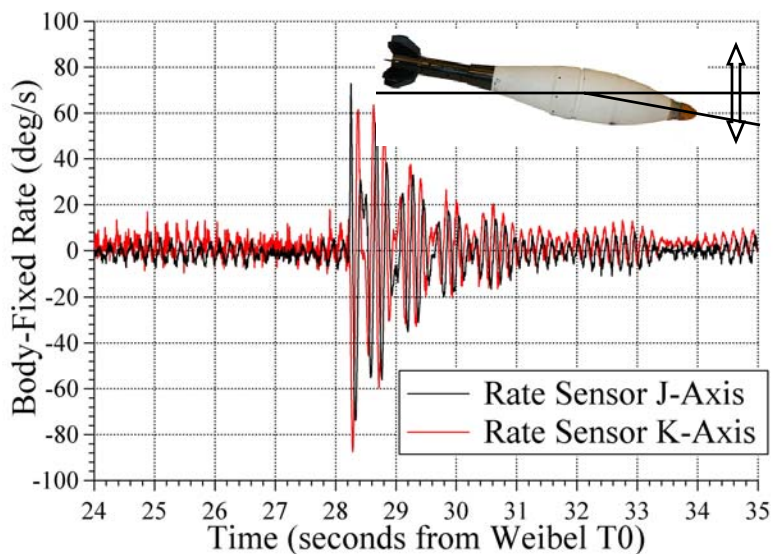
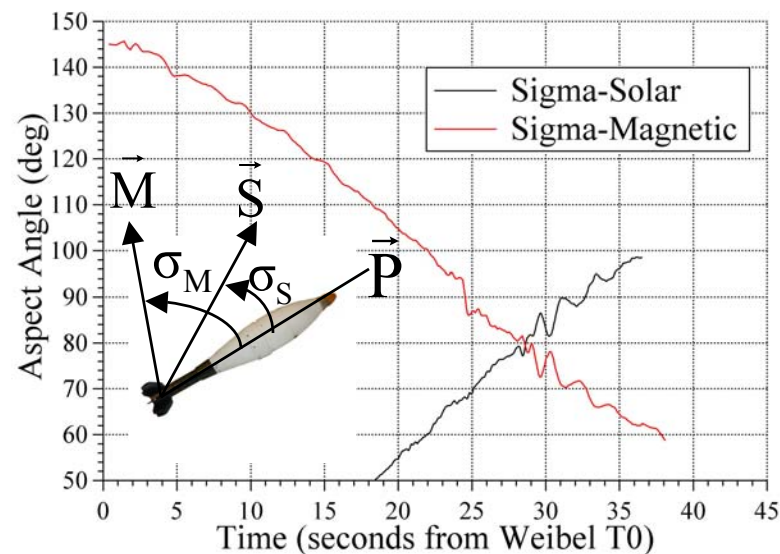
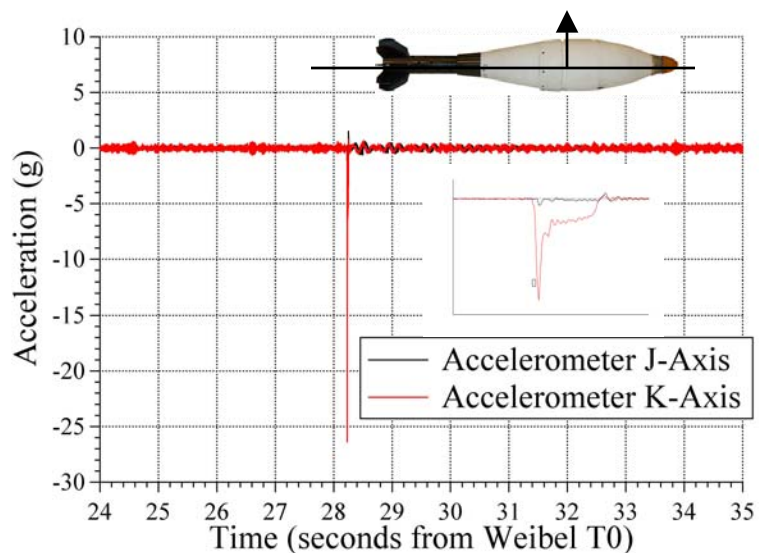
DFuze



- ATK's PGMM Airframe/Maneuver Demo utilized maneuver thrusters controlled by a processor for guidance
- 3 were demonstrated at ATC, APG, MD with 16-channel DFuze.
- All survived 10Kg-launch & successfully transmitted.
- In-bore/In-flight data provided included:
Roll, Pitch, and Yaw rates, Accelerations, Temperature, Battery Voltage, as well as 4 channels of ATK Flight Processor Data.
- DFuze was instrumental in defining maneuver authority, assessing airframe stability, aerodynamics.



ATK PGMM Demo Flight Data



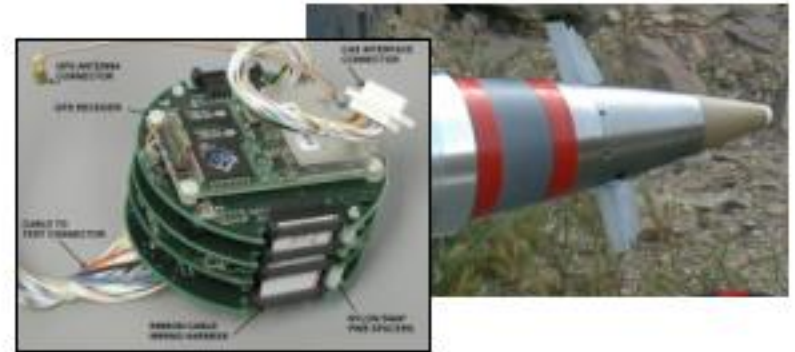


Technology Insertions



- Advanced G-Hardened Electronics Technologies (Sensors, Packaging, and Processing) are being transitioned from ARL's SMART Munitons Work Package
- HSTSS is transitioning telemetry systems into production projectiles

ARL is providing sensor modules, Supporting ATDs, and collecting flight data.



Early Demonstration Guidance Electronics Unit For Autonomous Naval Support Round

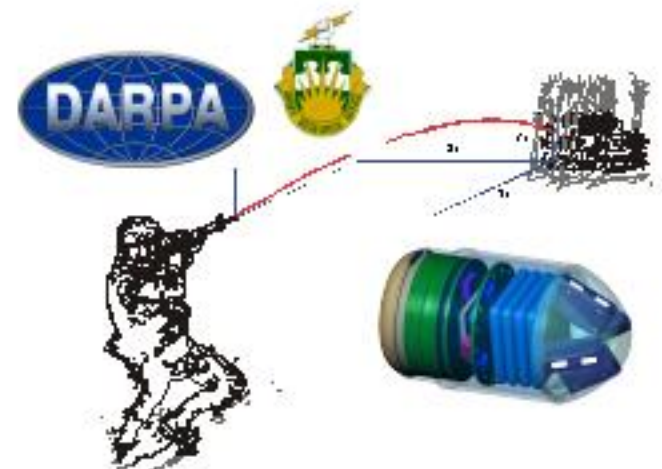
HSTSS/ARL developed TM systems that enable downlink of critical performance parameters during live firings.

- Modular Form Factor
- High Power/High Efficiency
- Digital/Analog Inputs

AGS (FIU) Telemetry system



ERGM (TTM) Telemetry system



Guided medium caliber munition using Micro-Adaptive Flow Control (MAFC).



Continue Mortar Support & Establish Insertion Opportunities

- FY04 Improvements – add GPS, DSP, micro-controllers
- Systems available now can provide critical measurements required for Legacy, Interim, and Objective Mortar Systems
 - **FCS NLOS Mortar, PGMM, new Mortar Fuzes**
- Systems need to be Embedded to Support Life-Cycle use: Development Test, Operational Test, Training, and Tactical.
 - **Provides a key technology for FCS vision of information collection, processing, distribution, & presentation**
 - **PGMM Test & Evaluation Master Plan (TEMP) calls for Hundreds of rounds for Effectiveness (Performance/Firing Tables) and Suitability (Environmental) Tests**

