Telemetry-Based Instrumentation for Mortar Systems

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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.
• 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.

Unclassified/Unlimited Distribution
Aeroballistic Diagnostic Fuze (DFuze)

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

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

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**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
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

Transmitters

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

Antennas

- Application specific patch and wrap-around antennas developed

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

DARPA 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

Rechargable LiIon

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)

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

Unclassified/Unlimited Distribution
Technology Insertions

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

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

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

Early Demonstration Guidance Electronics Unit For Autonomous Naval Support Round

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