A Real-time RF/Bluetooth Application for Low Cost Fuze Test Telemetry Collection

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Problem Statements

- Data recovery is difficult from a damaged device
  - Sensor wires are easily broken in environmental/high-g impact
  - Imbedded Data Recorder may not survive the test

- Centrifuge is typically required for acceleration testing
  - Slip rings, lead time for Test Fixtures, balancing, etc…
  - Troubleshooting an issue with an electromechanical device under dynamic forces is problematic

Projects & Goals

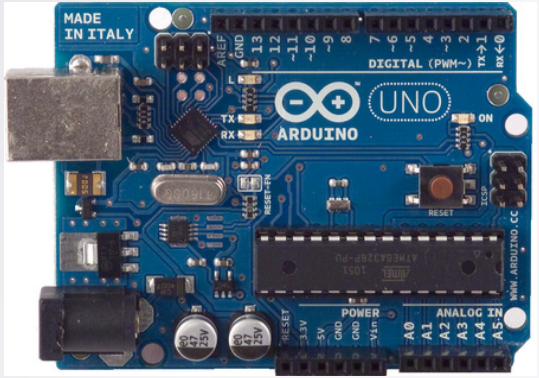
- 3 similar projects related to wireless data acquisition
  - Wireless data transmission during high-g event
    - Basic prototype, Proof of concept testing
  - Non-centrifuge acceleration test bed development
    - On board data record, and wireless transmission
    - Build a new test bed
  - Wireless Centrifuge transmission options
    - Project currently in testing phase

Wireless High-g Project Goals

- Pick a wireless technology for testing
  - Needed to stream an analog and digital signal
  - Desire to stream data as fast as possible
- Build a prototype for impact testing
  - A platform for on board devices, with wireless streaming of test signals.
- Subject the article to a high-g impact
  - See if the device survives and continues to function

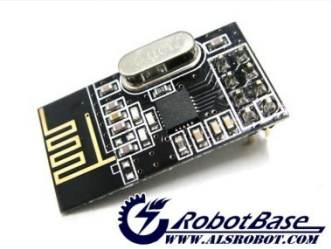
High-g Project: Controller Selection

- Needed to transmit as fast as possible
- Transmit analog data (accelerometer), and digital (impact switch closure)
- Internal Memory not required/desired
- Decided to convert the analog data to digital using a microcontroller (Arduino Uno) before transmitting



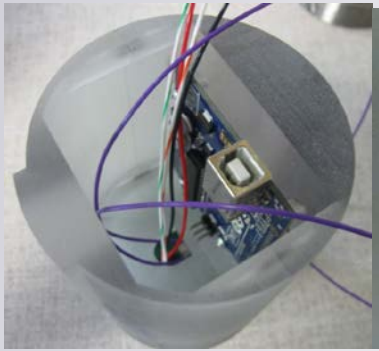
High-g Project: Method of Data Transmission

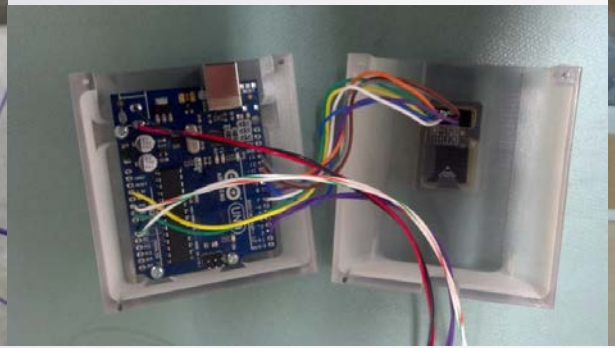
- Transmitter Options:
  - Bluetooth
    - Arduino compatible adaptors (“Shields”) available
    - Large packet sizes
  - Wifi Shield (802.11, 2.4GHz WLAN)
    - Wireless network required
    - Transmission speed
    - Stability of connection
  - XBee Transmitters (required Xbee Shield)
    - Nodal network platform for plant equipment continuous monitoring
    - Extensive features for cloud data collection, remote monitoring.
  - RF Transceiver
    - Cheap ~$3
    - Simple
    - Small packet sizes
    - Small board, < 1 in^2

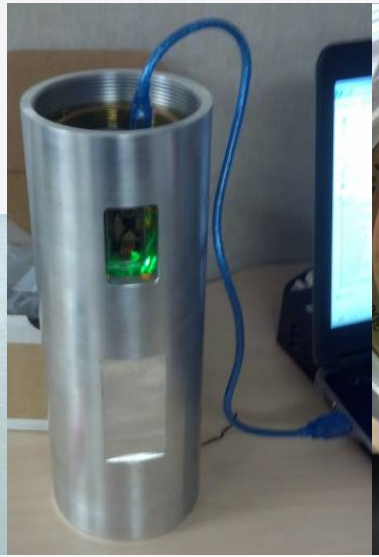


High-g Project: Prototype Build

- Electronics Packaging
  - 3D printed housings
  - Microcontroller & Sensor in separate housings
  - Supporting material added

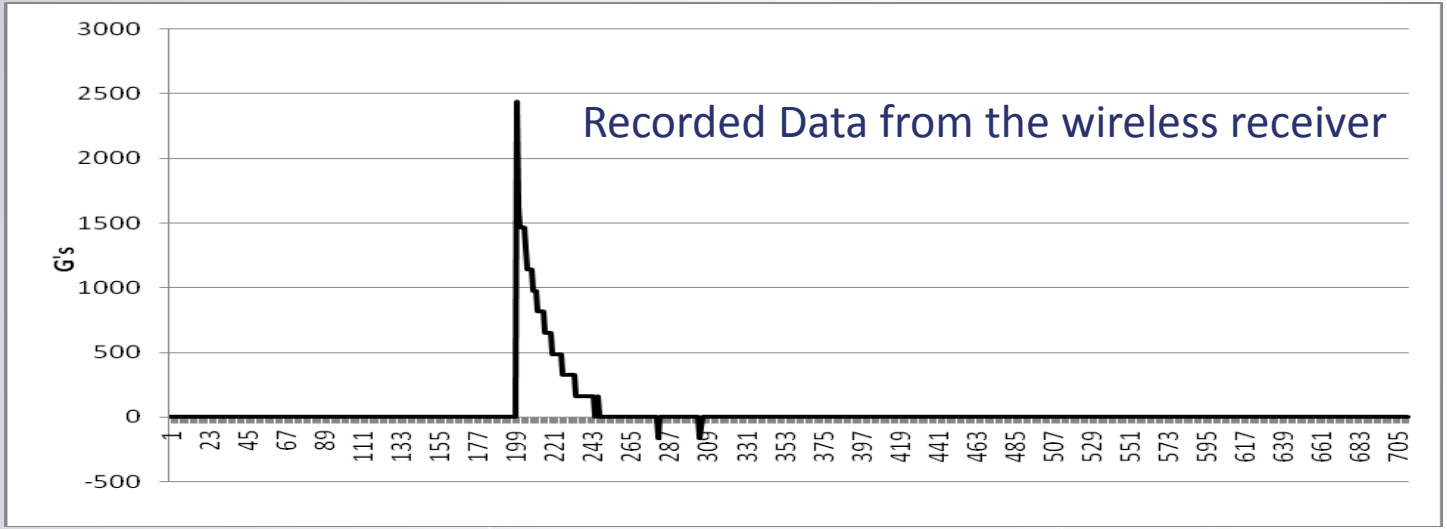






High-g Project: Test Shot & Results

- Known velocity and mass of Bird resulted in ~5,000g impact
- Article measured the event, survived impact, and continued to transmit throughout the event



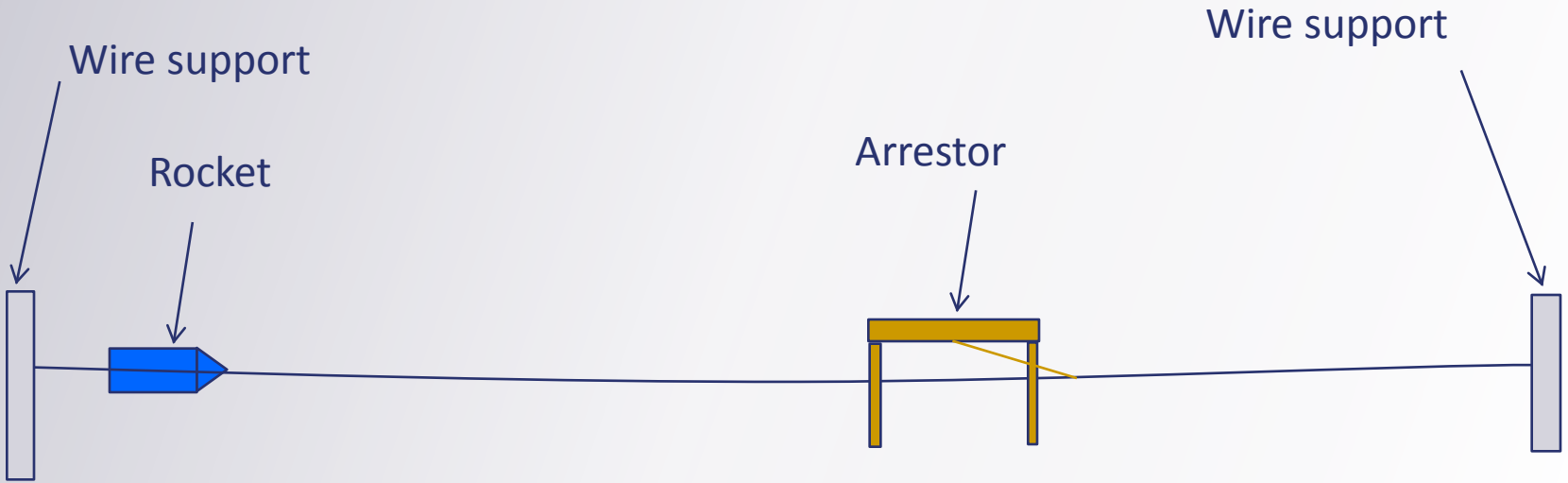
High-g Project: Test Shot & Results

- Limitations with the Initial Prototype
  - Sampling Rate
    - Limitation with the microcontroller
  - Range of transmission
    - Improved antenna
    - RF transceiver can handle a faster transmission rate
- Proof of Concept test provided confidence
  - Implemented into a dynamic acceleration test bed project
  - Potential for a wireless centrifuge

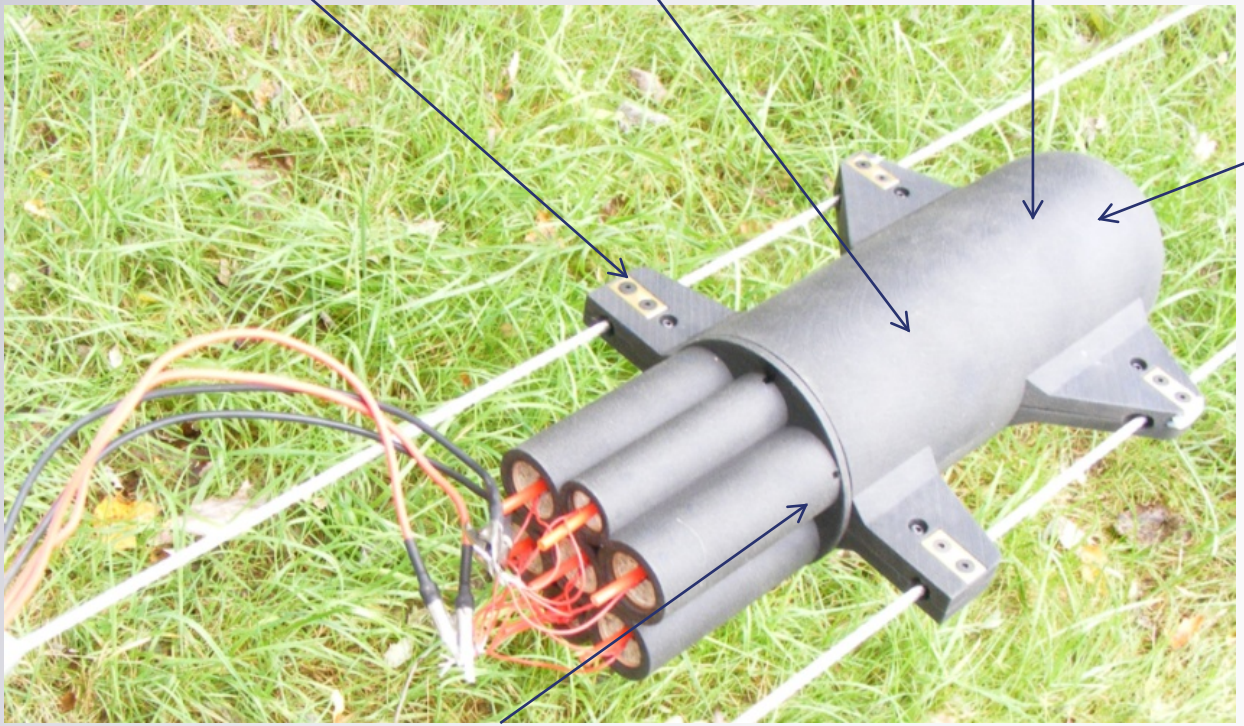
Non-Centrifuge Acceleration Test Bed Project

- L-3 FOS developed a Rocket on a Rope (ROR) test facility for special test purposes
  - Test bed for wireless and on board instrumentation, no slip rings/centrifuge needed
  - Allows for higher fidelity simulation of actual rocket motor acceleration environment
  - Can support quick turn evaluation of concepts once a particular acceleration setup has been established
  - The facility was based on similar methods used to test rocket launched systems
  - Onboard data recording in parallel with wireless streaming.

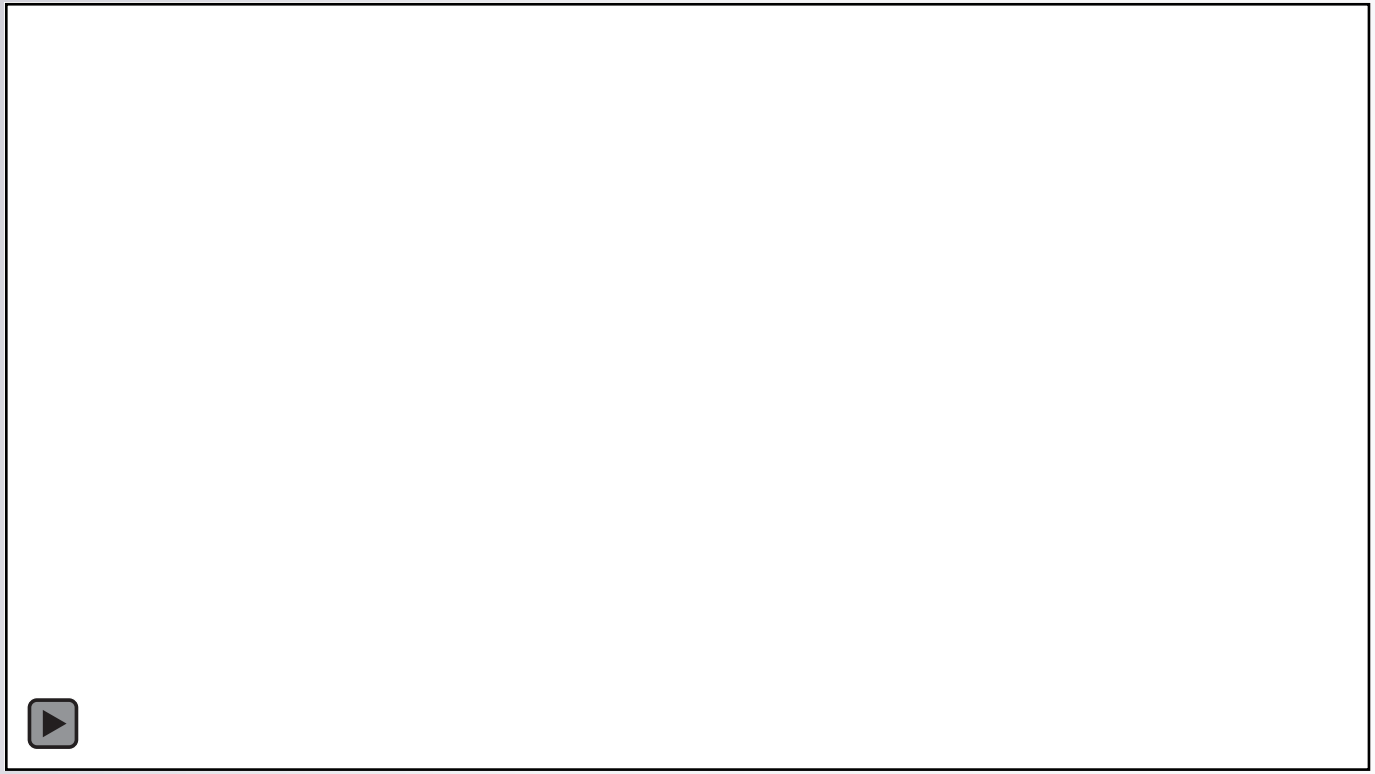
Rocket on a Rope: Test Stand



Rocket on a Rope: Hardware Overview

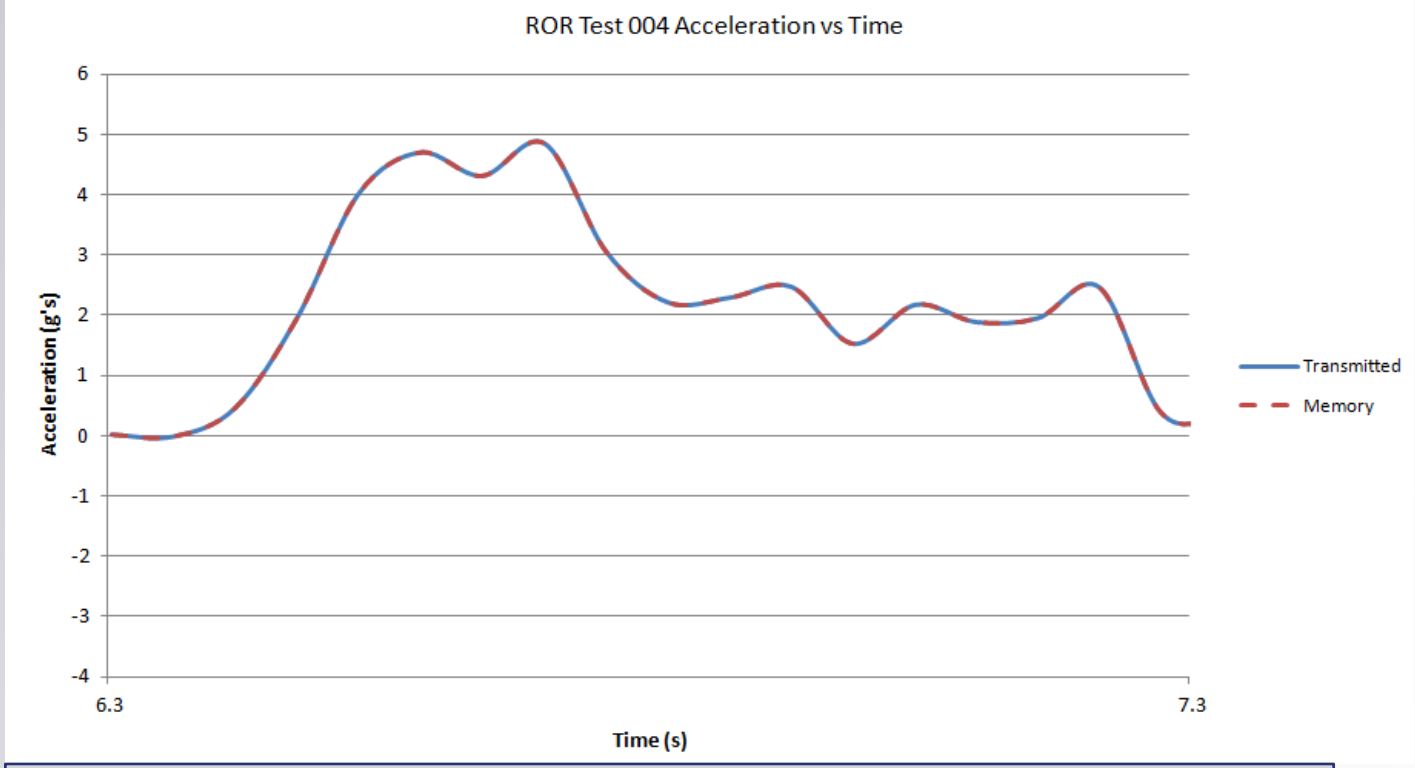


Rocket on a Rope: Video



Rocket on a Rope

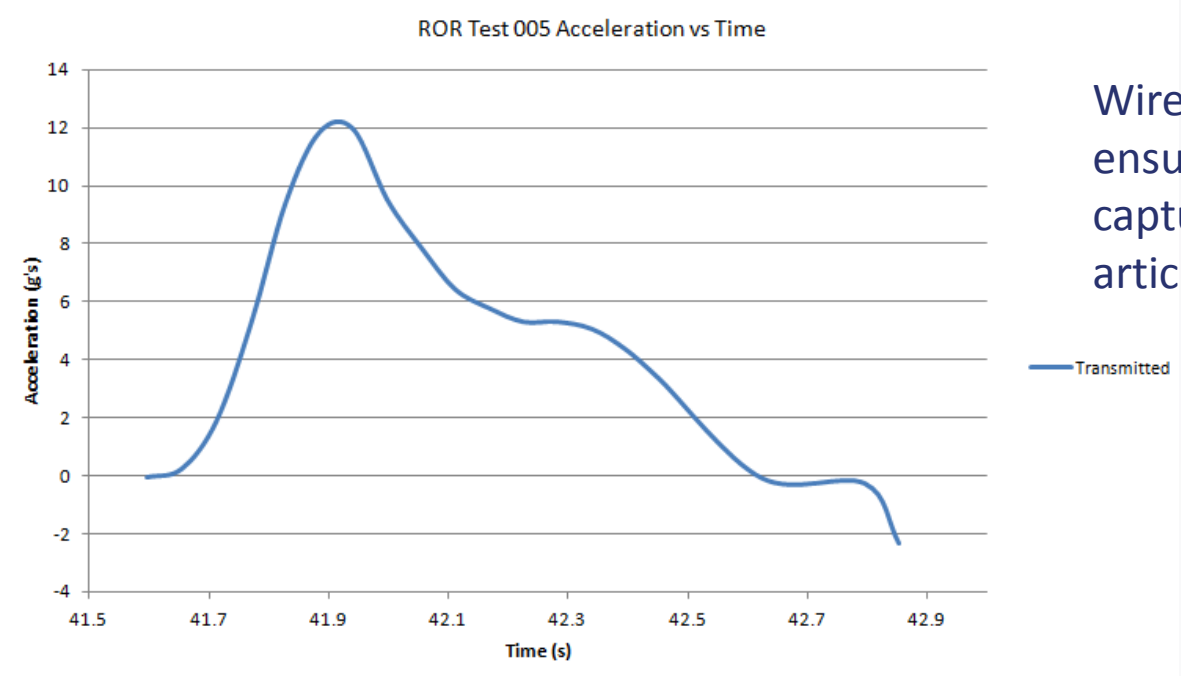
- Transmitted and on board data captured



Transmitted and on board data identical

Rocket on a Rope Test

- Transmitted data was captured successfully
  - Test article on board data recorder destroyed as part of test and data was not recovered



Wireless transmittal ensures data capture despite test article destruction

Portion of impact acceleration transmitted

Wireless Data Recorder Next Steps

- Secondary velocity measurement
  - Photo eyes, Radar, High speed camera?
- Data capture/programming
  - Optimization of transmission speed
  - Robustness of transmission
  - Develop interface that uses “standard” type high g accelerometers for use in high g applications

Future Projects

- Centrifuge with wireless signal transmission
  - No need for slip rings
  - Prototype can be accomplished at fraction of the cost of current test methods
  - Troubleshooting issues simplified
    - Plug in more wires to transmitter, receiver sees no changes

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