Data Recorders: JABS Bomb Drop

Casey Birmingham
NAWCWD
China Lake, CA
Funded by ONR

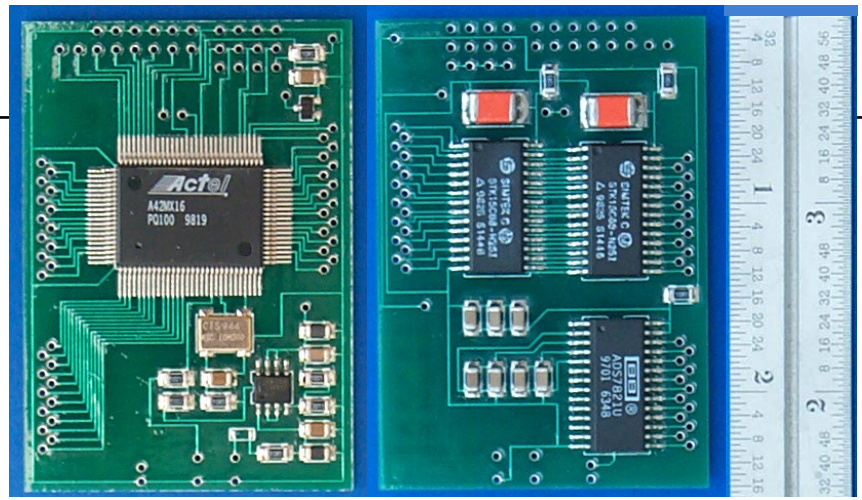
Purpose of JDAM JABS

- Joint Direct Attack Munitions (JDAM) Assault Breaching System (JABS)
  - To clear mines and obstacles to support amphibious assault
- Two Environments: Surf and Beach Zones
- System was effective in Beach Zones, and at up to 3 meters of water
- Extended to include “VSW” Zone (Very Shallow Water)
  - Water depth of 10 to 40 feet
- Investigation into what combination of warhead and fuzes was most effective

What and How

- What is needed for High Effectiveness in VSW
  - The acceleration levels seen by the bomb on impact into water and sand
- How to find these acceleration levels
  - Install data recorders that will survive impact and monitor all crucial components
    - Accelerometers
    - Impact Switches

Brief History:
The Beginning
1997

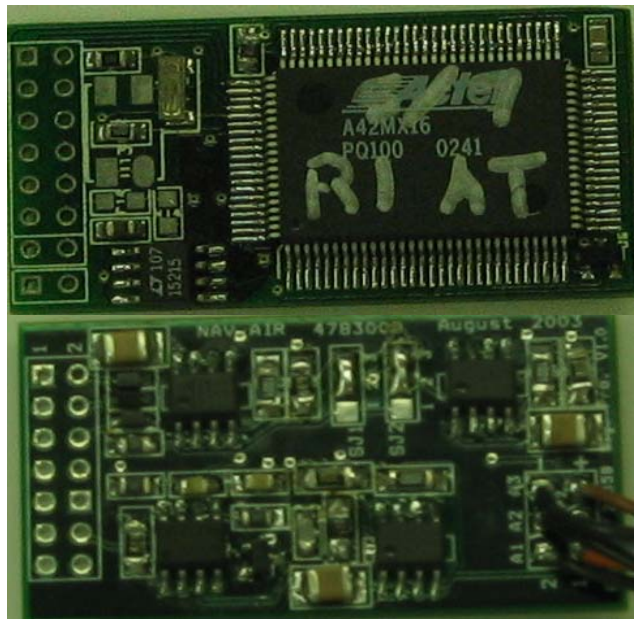


- Single channel 16 bit x 32k memory Data Recorder
- Memory stored on SRAM, as power is lost, the data is transferred to EEPROM

2005

- 3 channel 16 bit x 32k memory
- Same FPGA Package
- Memory stored in FRAM memory chips
  - 45 year storage life
- Two wire trigger
  - Write Mode/Read Mode
  - Save pre-trigger data, write remaining data

Design Includes Shock Hardened Capacitors so recorder has power throughout impact regardless of power supply



Objective of JABS Drop Tests

- 1. Record the accelerations acting on fuzes inside fuzewell of a 2000 lb. JDAM during impact

- 2. Record Impact Switch Closures during impact, compare to accelerations

JABS Flight Drop test: Requirements

Redundancy

- Two Recorders per Bomb
- Two Accelerometers per Recorder

Shock Hardened Recorder Pre-flight Confidence Testing

- Temperature cycling
- Flight vibration
- Shock
- Simulated FZU-48 power enable

Recorder Features

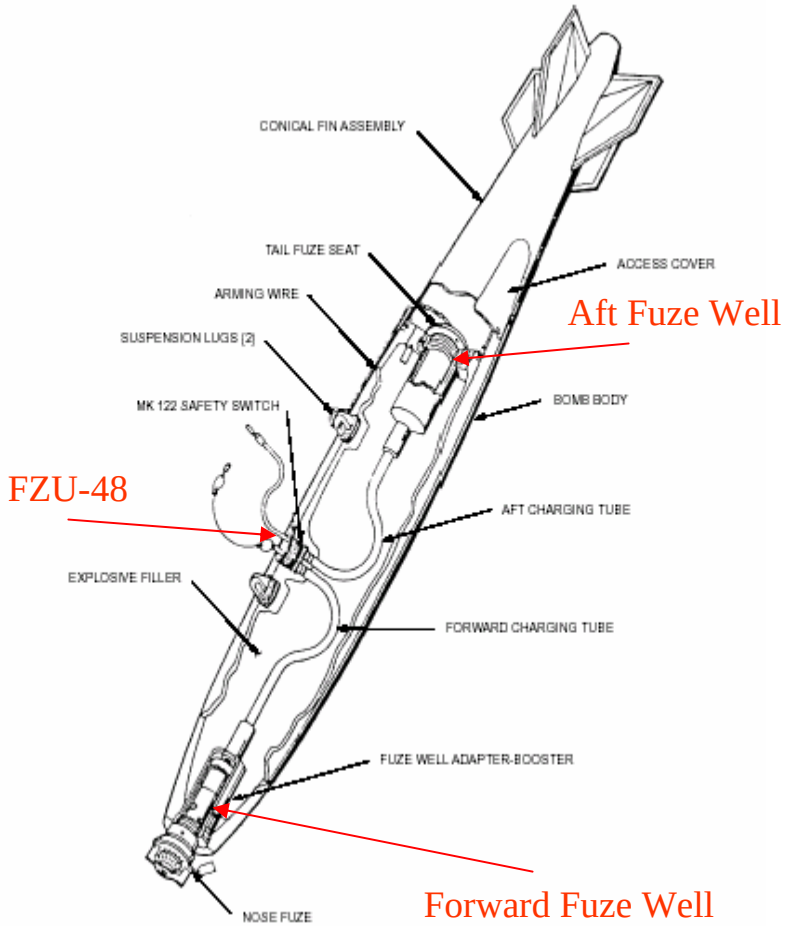
- Non-Volatile Memory
- 100 milliseconds of Pre-trigger Data
- 200 milliseconds of Post-trigger Data

* Funded by ONR

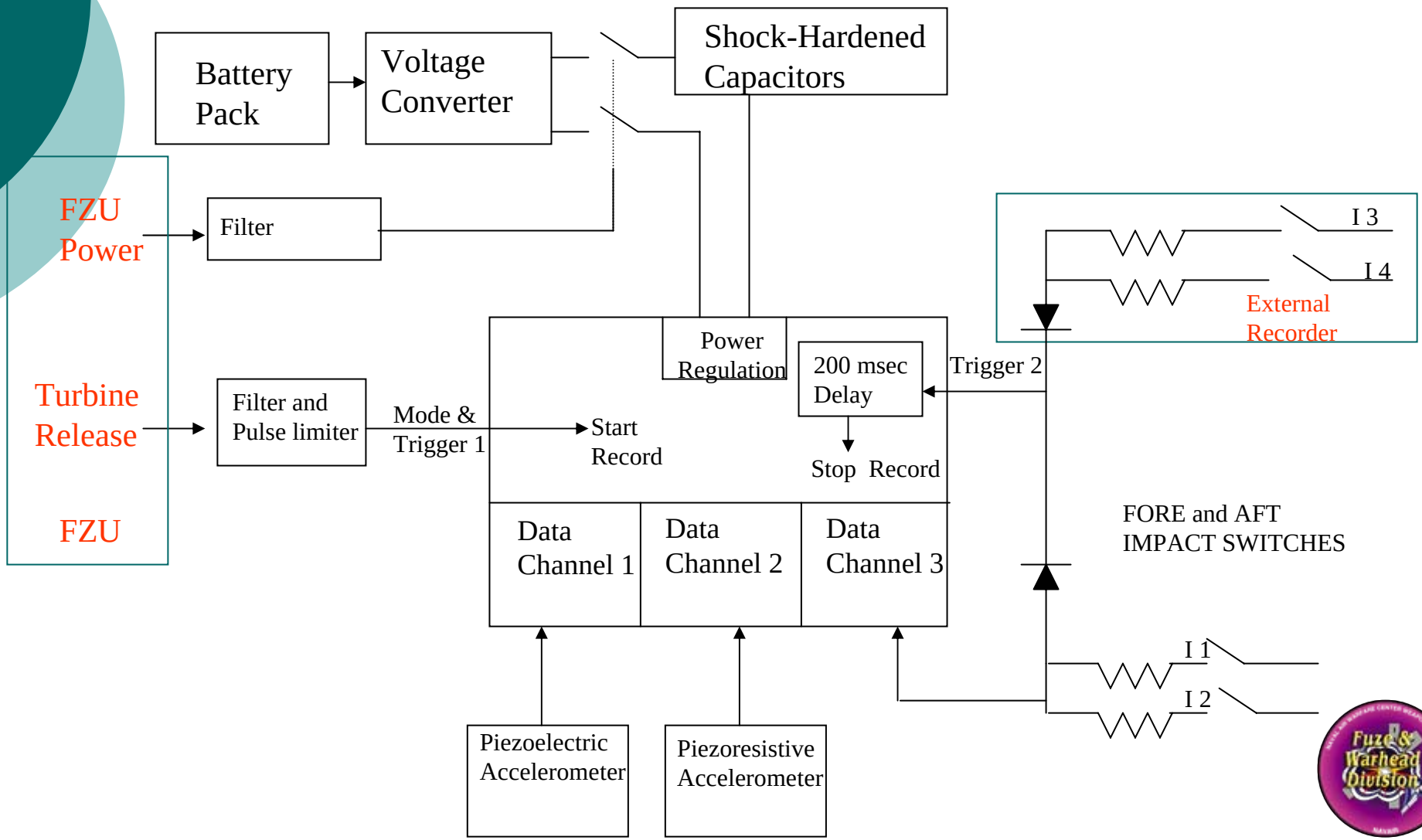
Drop Environments

- First flight drop into simulated Beach Zone
- Second flight drop into simulated Surf Zone
  - 10 feet of water, then sand

Placement of Recorders



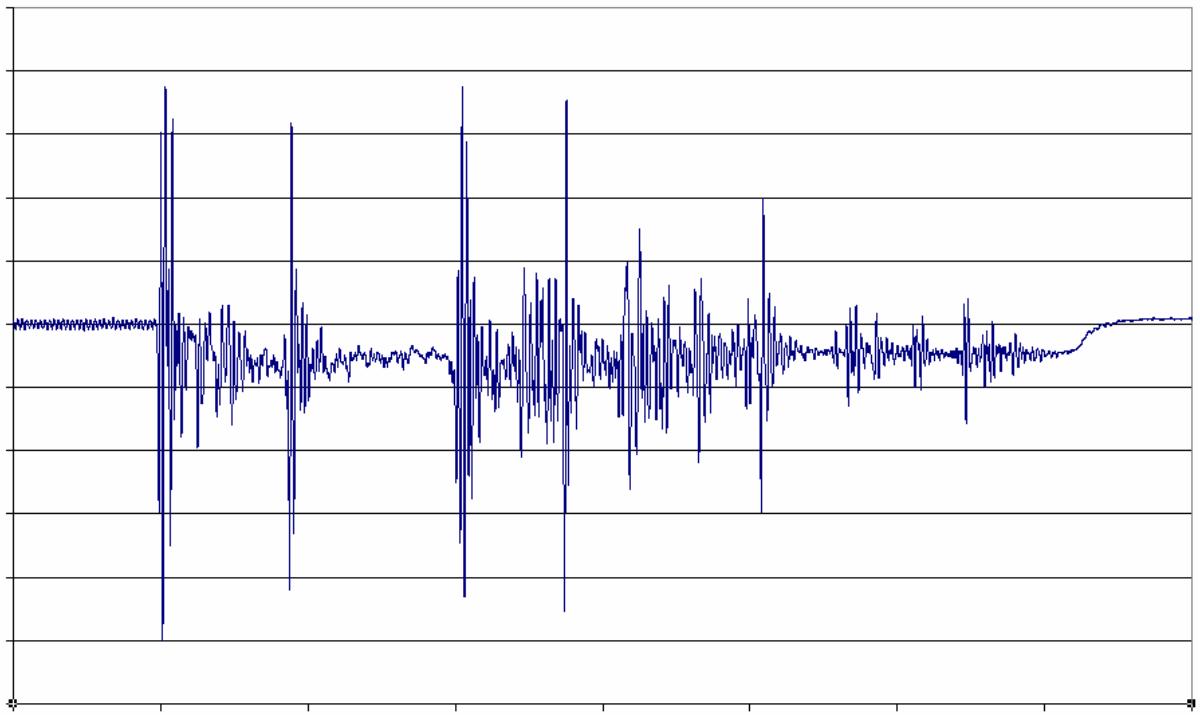
JABS DATA RECORDER
BZ Block Diagram



Results from Beach Zone

- Mixed Bag
  - Some positive indicators, some recorder anomalies

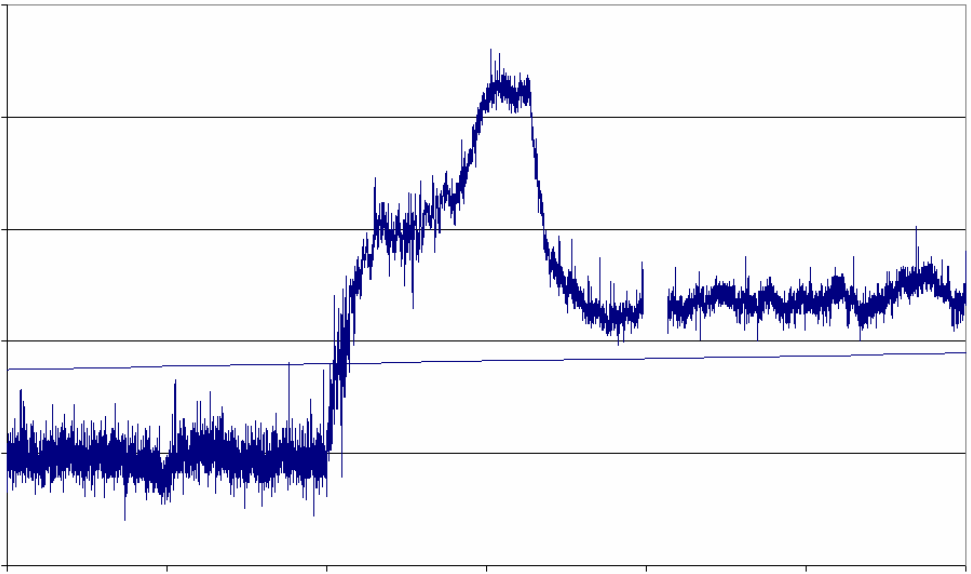
Reasonable acceleration Characterization



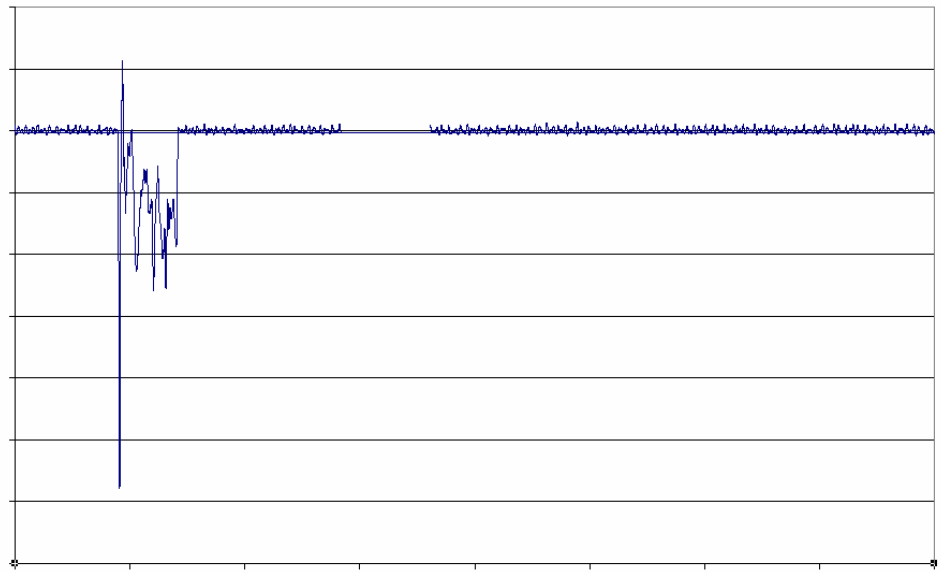
Results from Beach Zone

- The negative results included:
  - Unusable Impact Switch closure data
  - Broken wire causing an accelerometer malfunction
  - Power loss or reset on one recorder
  - Non-trigger on one recorder

Accelerometer Malfunctioning



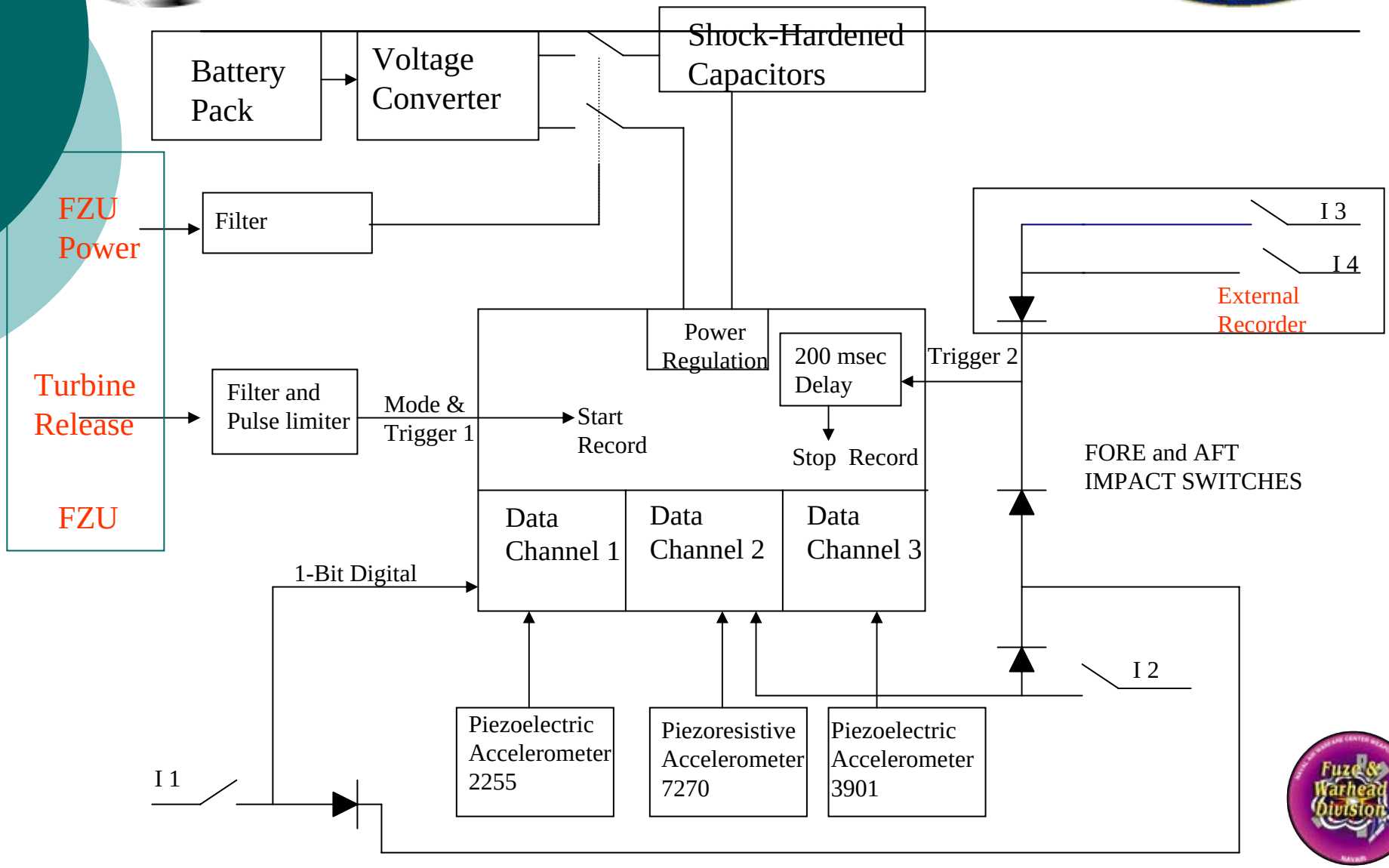
Power Loss or Reset to the recorder



Changes to recorder from Beach Zone to Surf Zone

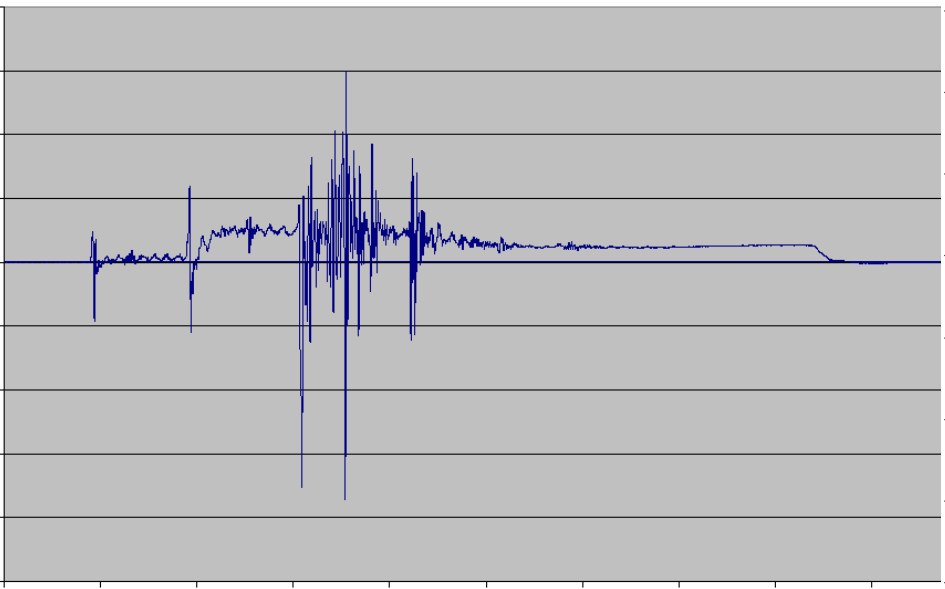
- Unusable Impact Switch Data:
  - Changed from a resistor divider, to 1 bit digital signal, monitored each line individually.
- Recorder No-Trigger:
  - Mass from solder and thick wire gauge resulted in a broken connector
  - Fixed by reducing wire gauge and using less solder. Changed testing procedure to test the connector.
- Broken Accelerometer Wire:
  - Fixed by increasing the diameter of thru-hole mount on PCB board. Glued strain relief to mounting structure.
- Power Loss or Reset:
  - Could not recreate in lab, redrew printed circuit board layouts to make sure no existing electrical lead problem would occur again. Team concluded that it was a unique event that would most likely not happen again.

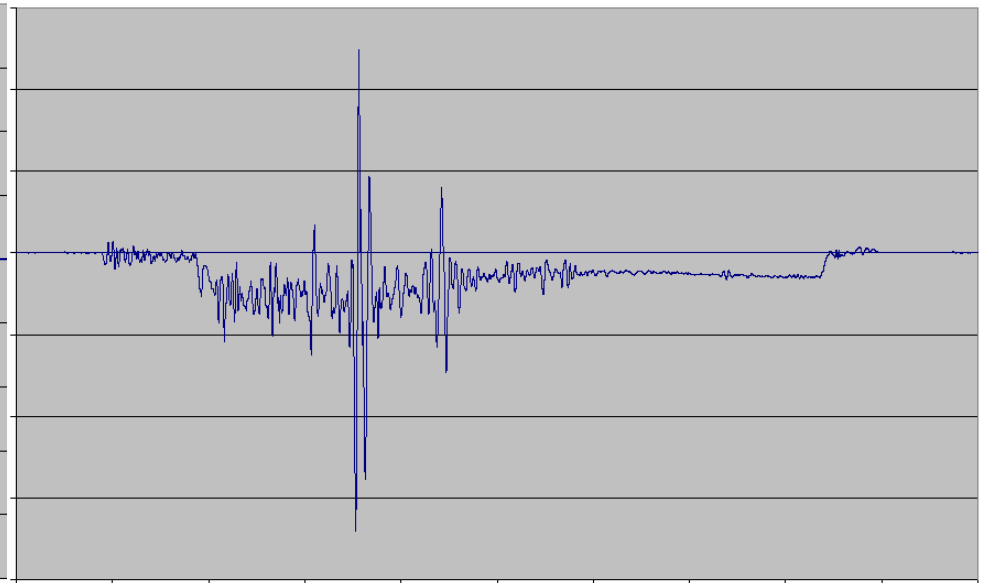
JABS DATA RECORDER
BZ Block Diagram



Results from Surf Zone

- Accurate Acceleration Data
  - All accelerometer records stored similar data and recorded like events





Results from Surf Zone

- Some anomalies did occur:
  - Protection diodes for Impact Switch record lines shorted. Voltage on trigger line was recorded instead of switch closure.
  - Common trigger line between Nose and Tail recorders on Bomb 1 failed. Recorders triggered independently of each other.
  - Both recorders on Bomb 2 reset around 15 ms after trigger. Impact event was captured, however this reset event was obviously no longer considered unique.

Final Conclusions of Flight Test

- First Objective: Record Acceleration Levels
  - Acceleration records were accurate
  - Good for Modeling and Simulation
- Second Objective: Record Impact Switch Closure
  - Difficulty interpreting results from BZ drop
  - Protection diode failure on SZ drop