Metrozet Broadband Sensors

Introduction to Metrozet

Antelope User Group Meeting

February 23-24th, 2012

Stephen Manion

Metrozet, LLC.

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Metrozet Overview

- Metrozet mission focused ONLY on the development of high-performance seismic sensors
- Ex - JPL Sensor Development Group
  - Steve Manion
  - Tom VanZandt
  - Eric Canuteson (UCSD)
- Metrozet products include
  - TSA-100S: low noise strong motion accelerometer
  - M2166-VBB: very broadband seismometer, 360 seconds to 15 Hz
    - STS-1 VBB replacement
    - Meets or exceed original specifications while introducing new concepts and technology
  - PBB-200S: broadband seismometer, 120 seconds to 50 Hz
    - Design derived from M2166-VBB, but much smaller and lighter
  - STS2.5 in gimbaled package for boreholes / OBS
  - STS1-E300: replacement electronics for STS1-VBB

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Metrozet Overview

- Metrozet/Streckeisen/Quanterra Development
  - STS 2.5 Borehole and OBS packaging
    - Gimbal with 5 degree range
    - Designed to meet or exceed original specifications while introducing new concepts and technology
    - First commercial installation
      - OBS: June 2012

Fig. Full package, upside down, with bottom cap installed (being vacuum tested)

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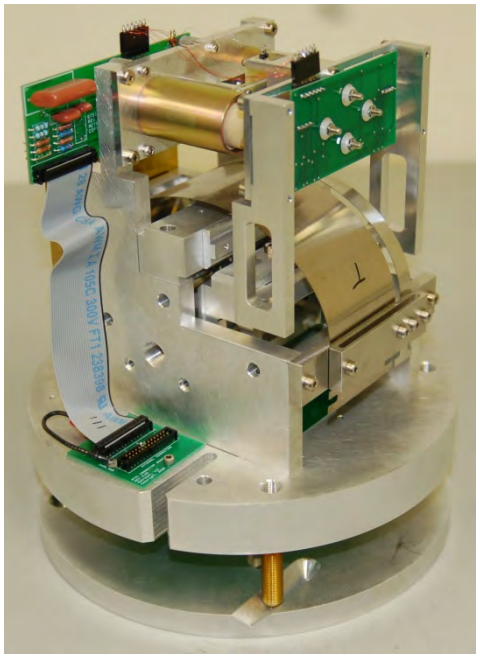
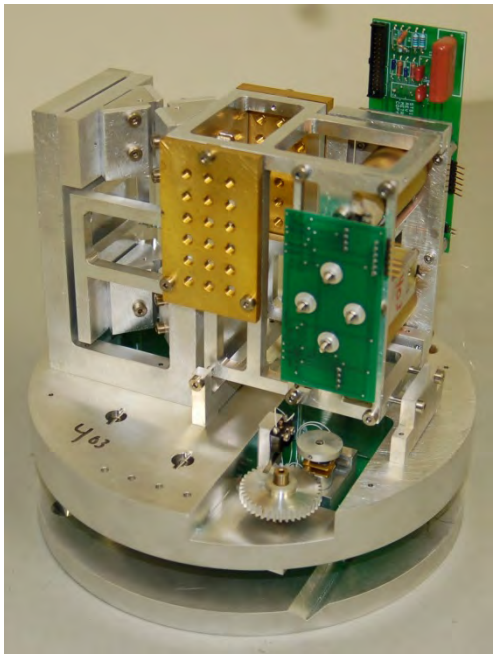
M2166-VBB

Lowest noise broadband sensor available today

- 360 second to 15 Hz passband
- Non-Galperin design, based on separate horizontal and vertical designs
  - Cross axis rejection is by design, not by summing
  - No magnetic field effects in horizontal sensors
  - Glitches affect only one axis
- Magnetic shielding for vertical sensor



Vertical Sensor module



Horizontal Sensor module

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M2166-VBB

Integrated Sensor

- Sensor modules mounted kinematically on monolithic baseplate for near perfect alignment
- Implements Wielandt / ASL warpless baseplate
- Sensor self noise at or below the NLNM to beyond 1000 second period

M2166-VBB is currently shipping

Initial shipments to USGS completed in 2011

Financial support provided by IRIS and NSF
Additional support provided by E. Wielandt, UC Berkeley, and ASL

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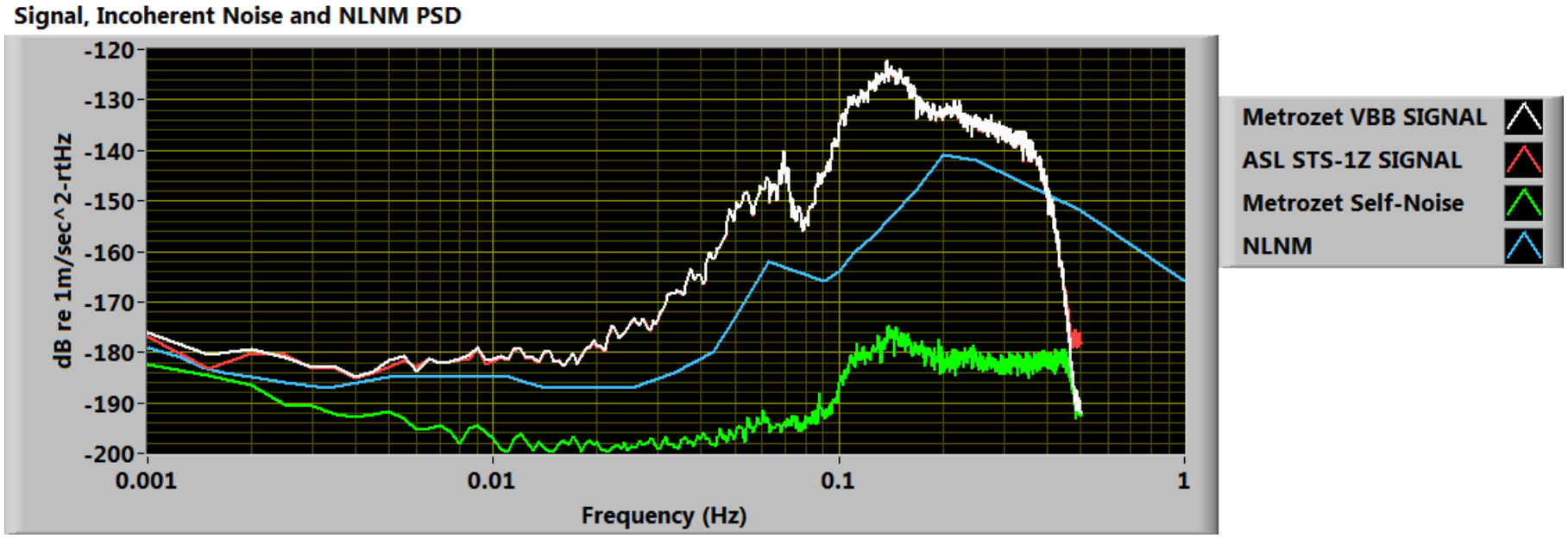
M2166-VBB Self Noise Measurements

Signal and Noise power spectral densities measured at ASL.



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PBB-200 Overview

Design Goals:

- Smaller, less expensive, and more portable broadband sensor than the industry leading M2166-VBB
- Appropriate for most seismic networks and transportable deployments (aka PASSCAL environmental)
- Robustness for reliability when transported
  - meets US MIL-STD-810G (air & truck transport)
- Sensor self-noise below the NLNM model from 40 seconds up to 8 Hz
- Compatible with existing networks
- Good performance under less than optimal conditions, because that's what we find at most vaults
  - Minimal magnetic field dependence
  - Minimal temperature dependence
  - Minimal pressure dependence

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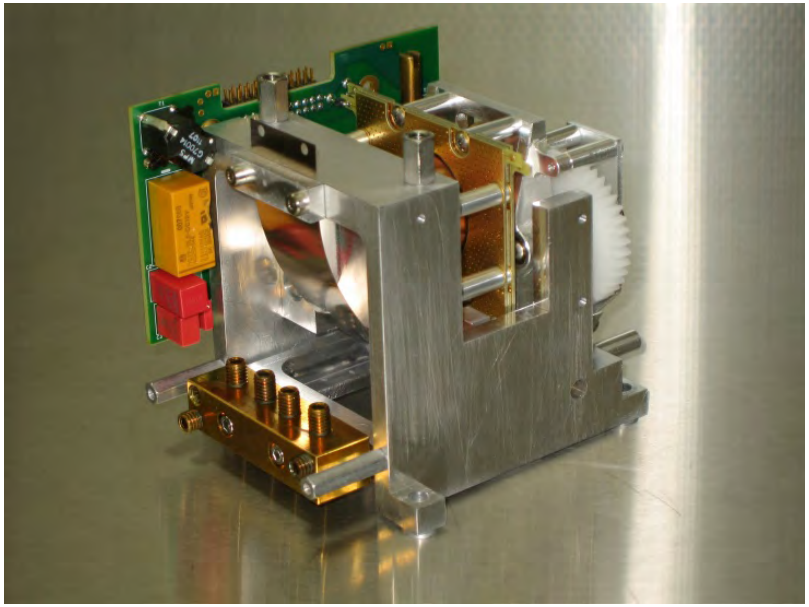
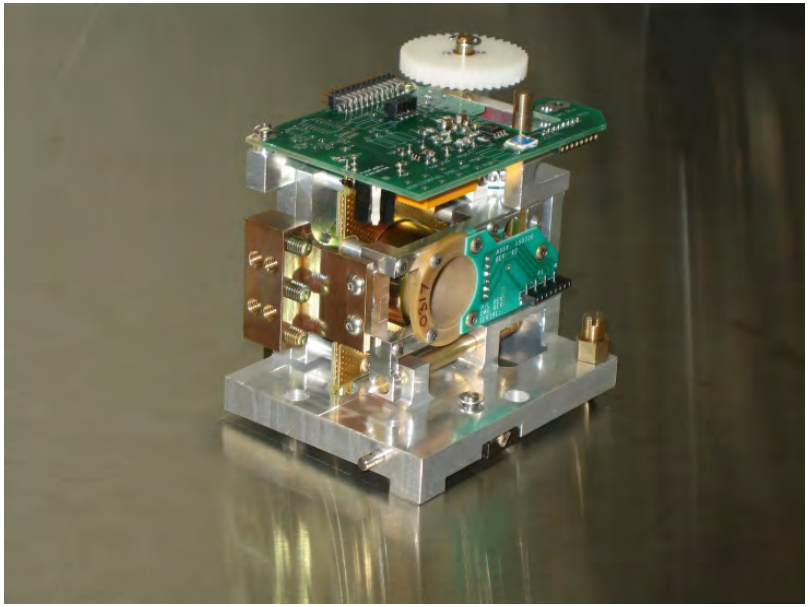
PBB-200S Sensor Design Approach

Non-Galperin design based on the M2166-VBB



Vertical sensor with mu metal shield removed



Horizontal sensor

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Sensor Design Details

- Non-Galperin Design
  - Horizontal axis are insensitive to magnetic field disturbances by design
  - Reduced glitch rate
  - Improved reliability
  - Improved orthogonality
- Mechanical sensor lock provides minimum 50 g shock tolerance
- Built in magnetic shield on vertical sensor
- Ni-Span-C springs to reduce temperature dependence

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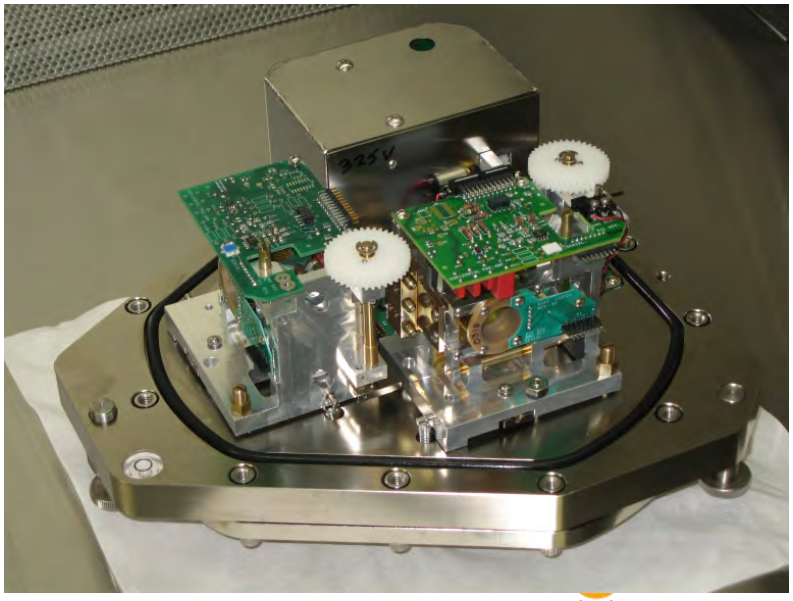
Packaging Design Details

- Sensors are mounted on a warpless baseplate to minimize the effects of external pressure variations
  - PBB 200S has the best performance in its class of sensors
- Sensors are mounted to the baseplate using kinematic features to preserve alignment accuracy
- Sensor electronics contained mostly in separate host box
- Control interface compatible with the STS-2, allowing immediate integration into existing data networks



Sensor Performance Details

- Sensor elements trimmed individually for cross axis rejection, typically less than 0.2 degrees misalignment
- Sensor elements individually trimmed for 1500 V/m/sec
- Bandwidth 120 seconds to 50 Hz
- STS-2 standard interface
  - ±20 V velocity output
  - ±10 V mass position output
  - Mass center and calibration control under digitizer control
  - Mass center also available through host box push button

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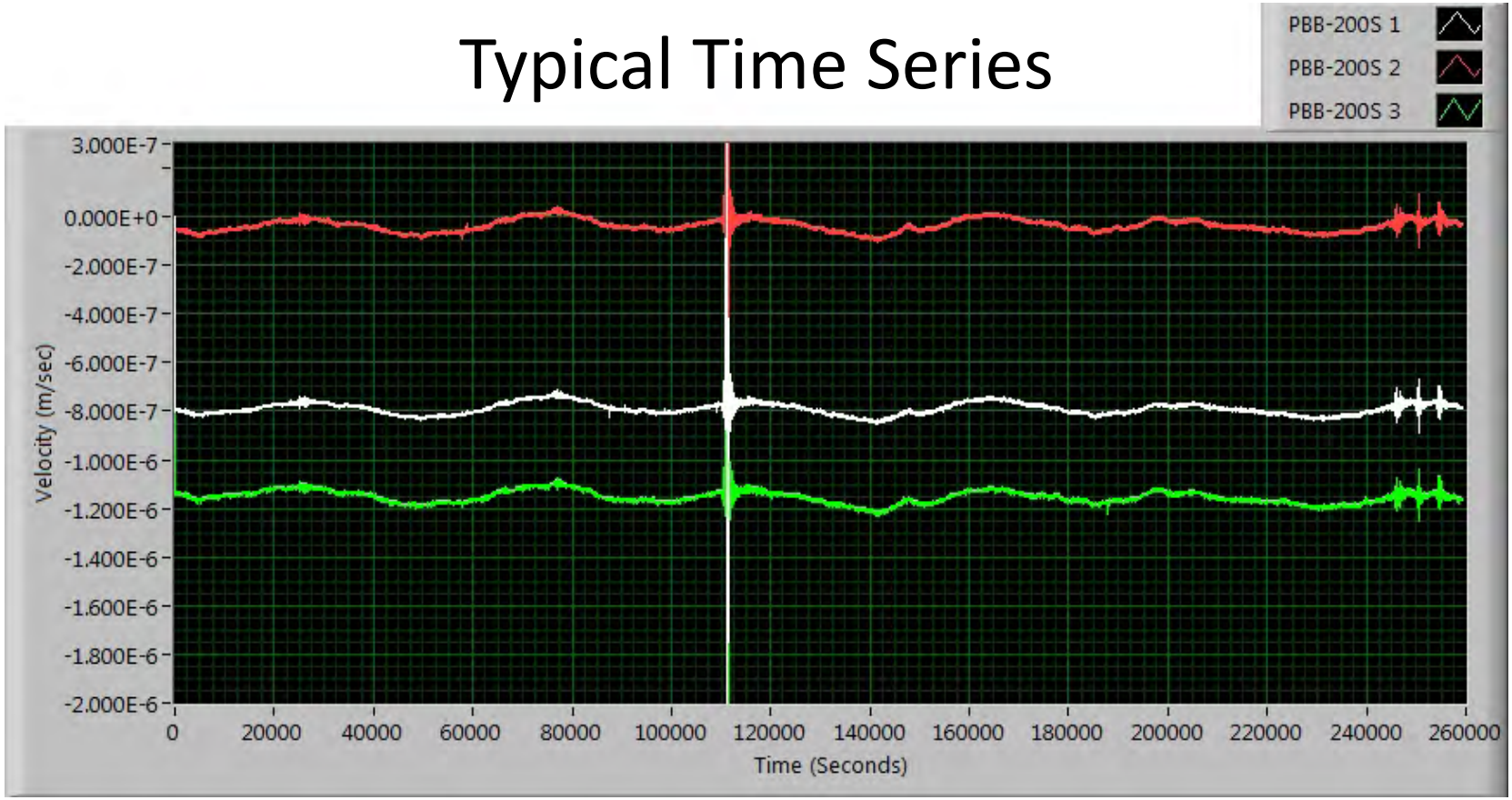
Typical Time Series



Three day time series from three vertical sensors, low pass filtered at 40 seconds, data offset for clarity. Multiple earthquakes are visible in these records.

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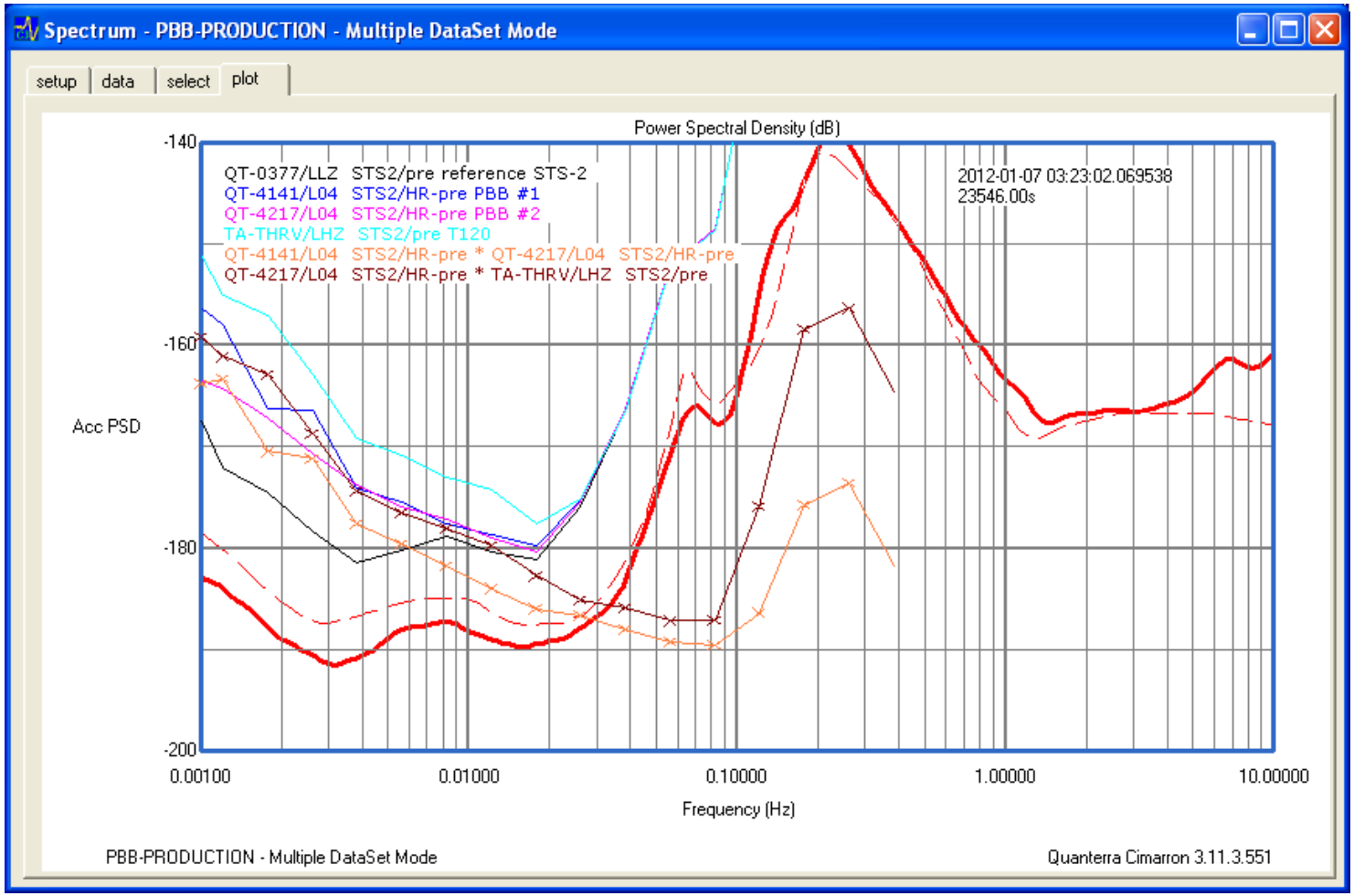
Sensor Noise Data



Incoherent Noise Comparison, PBB-200 vs T-120

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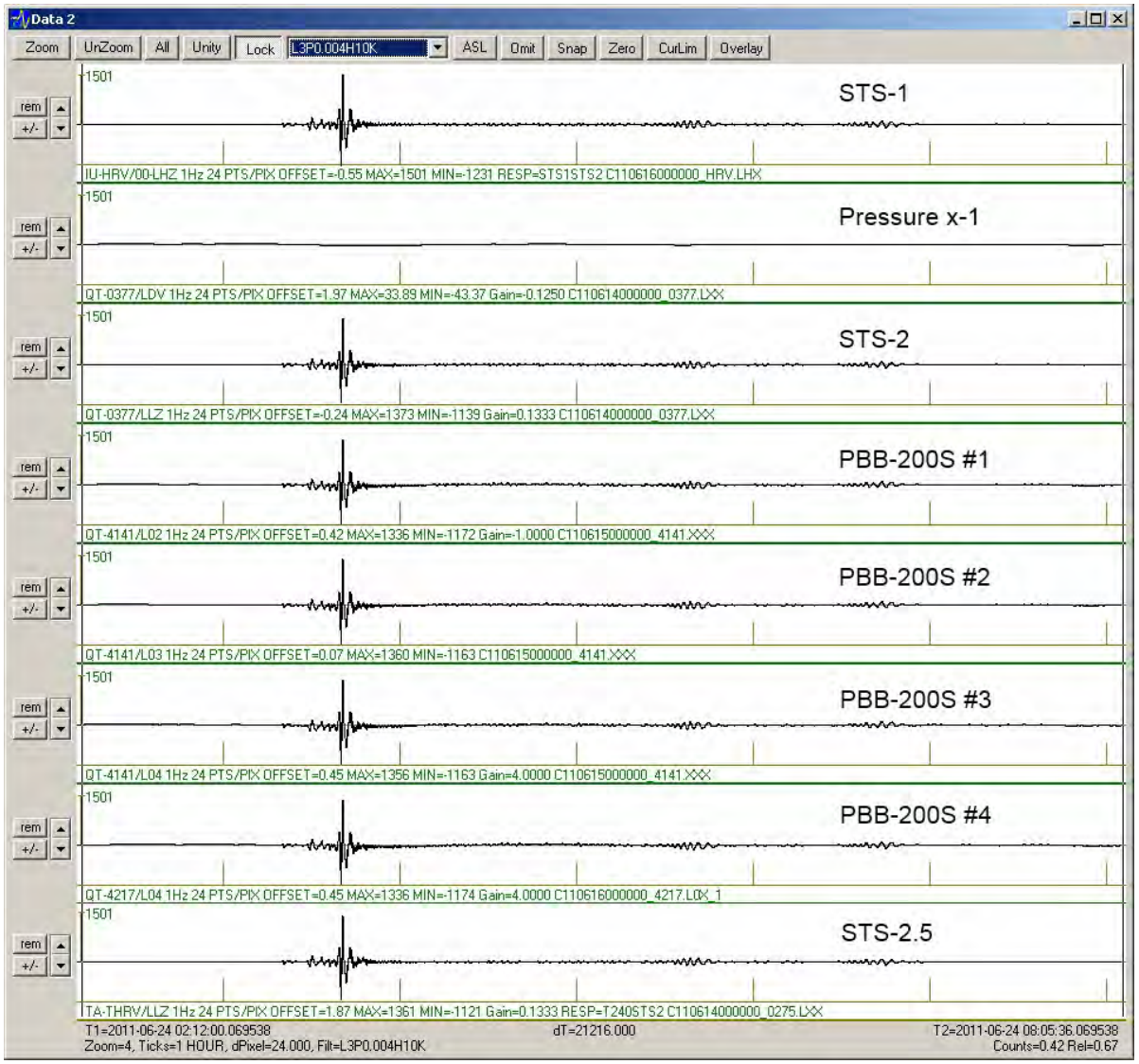
PBB-200S Response to Remote Earthquake



Comparison of PBB-200S long period response to that of STS sensors

Magnitude 7.2

June 24, 2011

03:09:40 UTC

Aleutian Islands

Sensors at HRV

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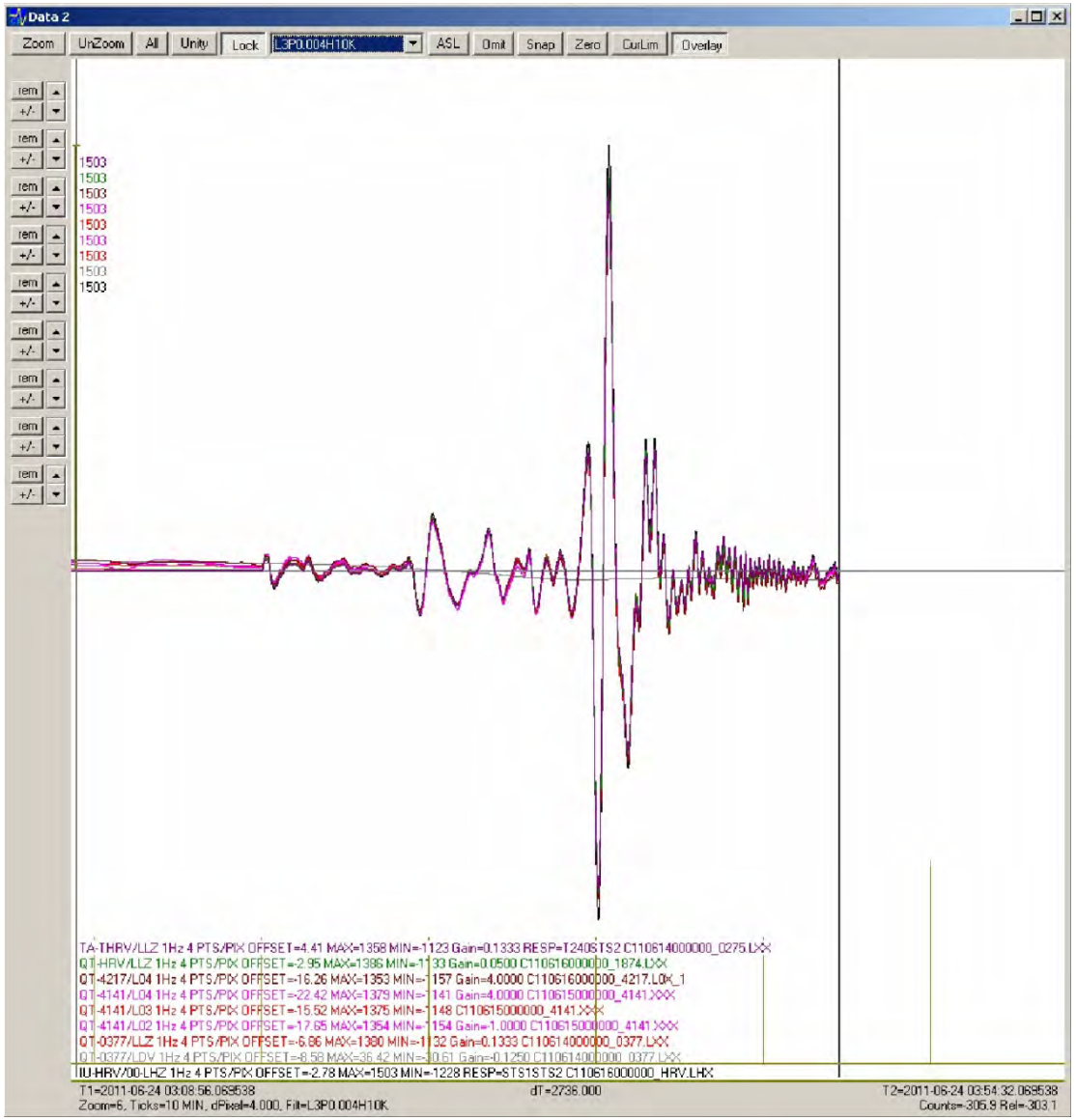
PBB-200S Response to Remote Earthquake



Overlay of sensor output from Aleutian Islands, AK Earthquake.

STS-1, STS-2, STS-2.5 and four PBB-200S vertical sensors. All sensors located at HRV, Boston, MA

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PBB-200 Summary

- High performance sensor
  - Self noise typically below the NLNM from 40 sec. to 8 Hz
  - Integrated magnetic shielding
    - ✓ Best in class
  - High shock tolerance
    - ✓ Best in class
  - Low pressure sensitivity
    - ✓ Best performer in class
  - Exceptional Thermal Isolation

- Compatible with existing networks and digitizers
- Production units available now
- Borehole version of this sensor
  - Q4 2012

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