

# High Channel Count Data Acquisition for Transducer Applications

May xx 2010  
Transducer Workshop



**CAL-BAY SYSTEMS**

Solutions for Test, Measurement, & Automation

Lowering Your Risk in Functional Test

# WHO IS CAL-BAY SYSTEMS?

- Cal-Bay Systems is a worldwide solution provider for Test & Measurement systems, with operations in 7 cities.
  - Founded in 1992
  - **National Instruments Select Partner**
  - Agilent Channel Partner
  
- Prize-winning projects and innovative products
  - Over 100 User Solutions
  - Web-based marketplaces like justTESTx.com
  - Platform products like the FlexATE, IntraStage and vibDaq



# The Application

Engineering measurements on military weapons and munitions for the U.S. Army Yuma Proving Grounds



# The Application

## Use Cases

- Testing of gun designs
- Testing of projectile designs
- Flight characterization
  - Time of flight
  - Trajectory
  - Velocity vs. time
- Human factors
  - Blast pressures (for soft tissue damage)
  - Sound levels for hearing protection
- Equipment life characterization
  - Fatigue
  - Stress/strain

## Signal Types

- Transient internal pressures
- Projectile velocities (by radar)
- Recoil displacements
- Structural strains
- Accelerations
- Noise levels
- Pressure impulses
- Event times (at gun and downrange)



# Solution:

## Integrated Ballistics Data System

- Goals for next generation system
  - Enable much faster setup, reduce errors and checking needed in enormously complex system
  - Radar, positioners, signal conditioning, digitizers, etc.
  - Coordinate many signals including weapon firing and signal generation for complementary systems
  - Integrate transducer channels end to end with all needed information
  - Self test to detect setup errors, faulty equipment, etc.
  - Automated calibration
  - Synchronized timing of everything
- How did we do it? Solution presented . .



# Instruments



GPS Synchronized IRIG B Time Code Generator,  
Instrument Technology Systems 6115G-TSM, (ITS)



Three axis positioners from  
Directed Perception Inc.



Specialty signal conditioners from  
Precision Filters Inc. (PFI)



Radar instruments from Weibel  
Scientific and Infitation Inc (shown).



PC with MXI-4 Kit  
PXI-1045 14 slot chassis (3)  
PXI-6120 Simultaneous Sampling MIO Card  
(32)  
PXI-6653/6651 Timing and Synchronization  
Modules  
PXI-6602 for digital trigger outputs

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# Key Benefit: Analog Channel Setup and Self Test

- Greatly reduces complexity and opportunities for errors
- Saves time setting up for mission
- Precision Filters 28000 signal conditioners integrated with NI PXI digitizers with setup screen handling everything from transducer to triggering—128 channels
- Self test, auto-balance and shunt calibration to find and fix errors before firing the “million dollar bullet”
- Imports setup files that can be built by offline engineers in mission planning







# How did we do it?

- Careful software architecture/design process
- Extensive involvement with end users to develop user interfaces, flowcharts
- Professional QA approach throughout project to manage very large LabVIEW application development



# Software Architecture

# Key Benefit: Synchronization of DAQ Across All Equipment

1. Between channels on a single DAQ card
  2. Between channels on different DAQ cards
  3. Between channels on different PXI chassis
  4. Between DAQ data and data from other instruments such as
    - Radar data
    - Down range time of flight sensors
    - Video data
- Eliminates need to manually line up the data timing later!



# Synchronization: Within a PXI Chassis

- PXI-6653 Timing and Synchronization Module
  - Drives the PXI Star Trigger lines
  - 50 ppb accuracy vs. 25 ppm for PXI backplane
- Instead of PXI 6653 reference clock we use a 10 MHz output from ITS
  - <2.5 ppm if no GPS lock since power up
  - <500 ppb if previously locked since power up
  - <+/- 100 ns when locked



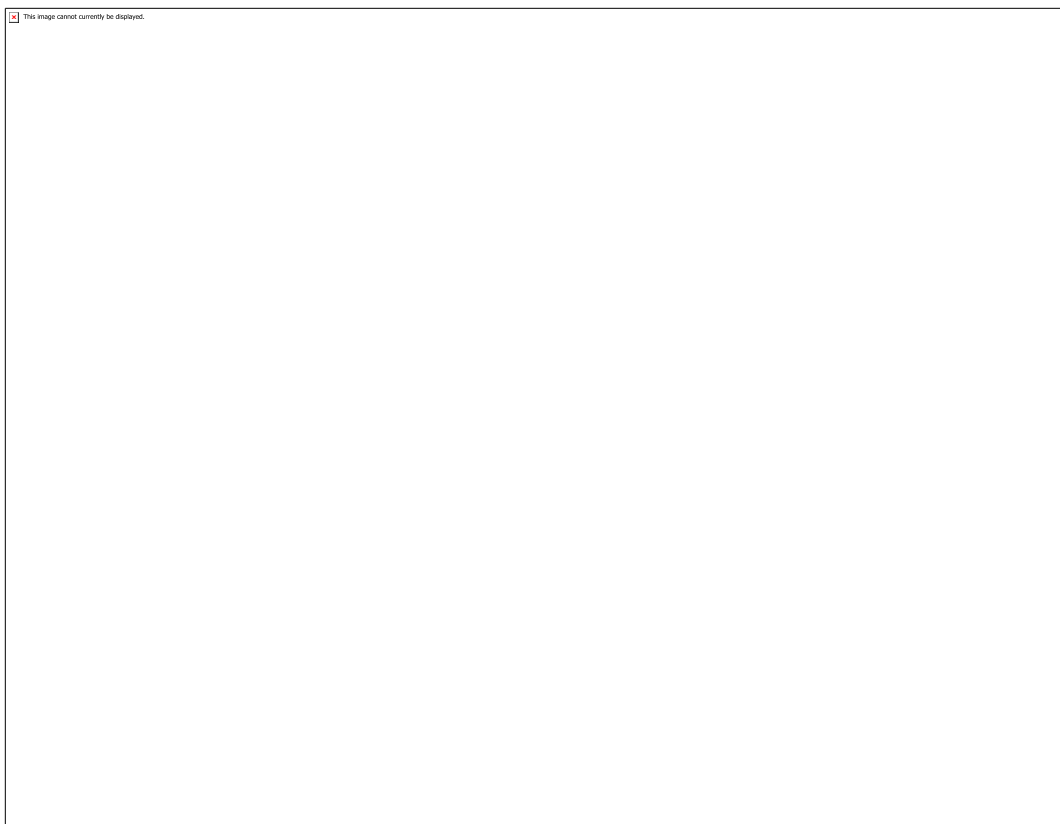
# Synchronization: Between PXI Chassis

- PXI-665x Timing and Synchronization Modules
- PXI-6653 is the master
- PXI-6651 are the slave(s)
- The key is to route the clock signals such that the trace length from the clock source to the star trigger of each PXI chassis' is the same



# Synchronization: Between PXI Chassis

- All Cables shown are the same length
- Clock output from master routed to:
  - Slave 1
  - Slave 2
  - Itself
- Trigger routing ensures all cards receive AIStart at same time



# Synchronization:

Between DAQ Data and  
Data from Other Instruments

- ITS features six event trigger inputs
  - Digital events routed to both ITS and PXI-6120 trigger inputs
  - DAQ trigger can be correlated to an absolute time reference
- Other data may be collected by
  - The IBDS (e.g. radar)
  - Separate test teams



GPS Synchronized IRIG B Time Code Generator,  
Instrument Technology Systems 6115G-TSM, (ITS)

# Summary—Mission Accomplished!

- Customer is happy with the system
- Multi-Year support and development contract has been awarded
- Cal-Bay will continue to work with YPG to build more capabilities into the system and keep it running as new versions of Windows roll out
- Questions and Discussion Welcome!





**Q & A?**

**Thank you for your time!**

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