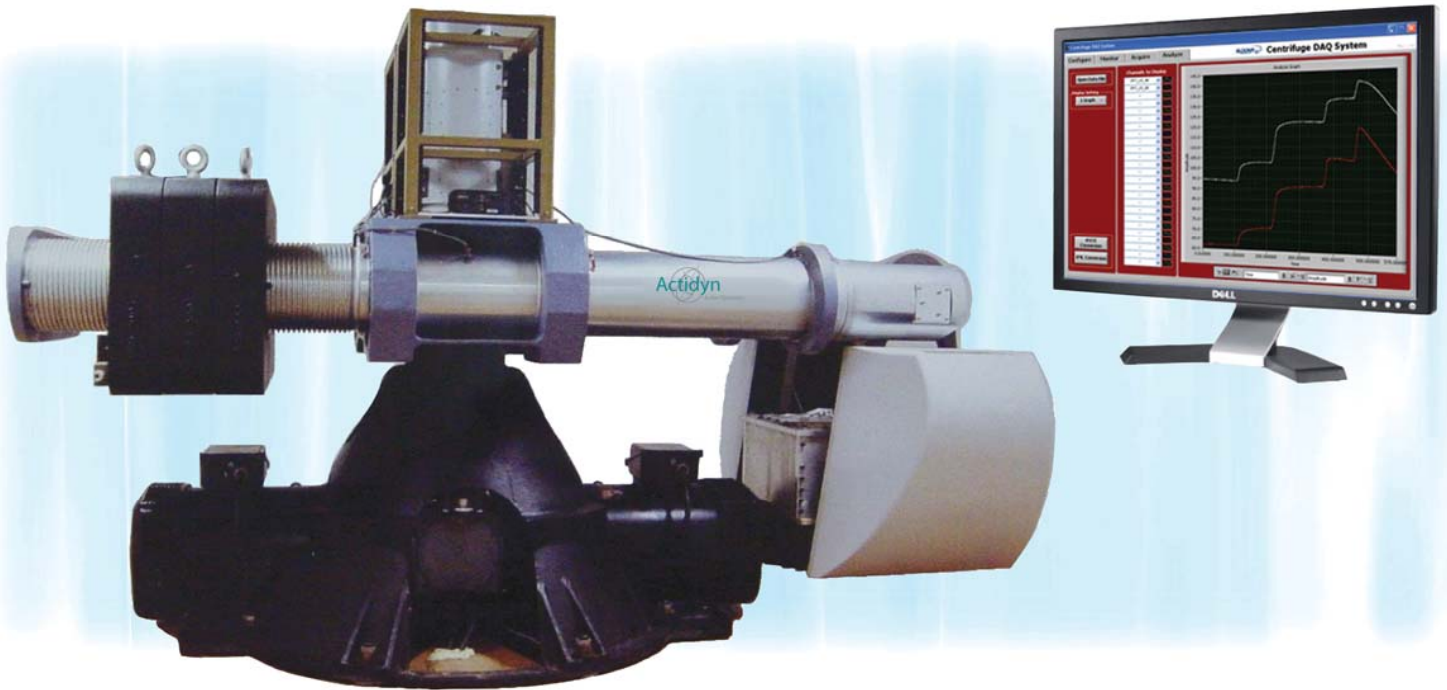


# Centrifuge Data Acquisition System

## Geotechnical Material and Structural Modeling



### Overview

Centrifuges are commonly used for modeling the response of geotechnical material or structures such as soil, dams, and foundations to natural and manmade hazards such as earthquakes, floods, and explosions. As the behavior of soil is stress dependant, it is crucial in studying the performance of a geotechnical system to ensure that the correct stresses are applied to each element in the specimen. In a centrifuge a model at a scale of  $1/N$  can be subjected to a steady acceleration field equivalent to  $N$  times earth's gravity. In this state, the same stress conditions that exist in the field can be effectively reproduced at all points in the model. By applying appropriate data acquisition techniques, these stresses can be verified throughout the model during centrifuge testing. Moreover, detailed information can be collected on the response of a geotechnical system including measurements in the ground at different locations, the movement of a structure, and video imagery of a sequence of events leading to a seismic event.

The **Bloomy Controls' Centrifuge Data Acquisition System** is a highly configurable, high-performance data acquisition system for geotechnical centrifuge measurements which has been adopted by research facilities around the world because it is powerful, detailed, flexible, and easy to use. Key features and benefits include:

- Highly configurable hardware and software supports a wide range of test requirements
- Synchronized acquisition maintains the proper time scale of compressed geological events
- Sample rate is adjustable on the fly from 1 to more than 10,000 samples/sec/channel
- Multipurpose relays facilitate geological event simulation such as flooding
- Analog outputs control shaker and high-speed camera synchronously with acquisition of sensor data
- Meta data recording of sensor configuration, test information, user notes and observations
- Web server interface facilitates remote observation over the Internet
- Easy to use and adopted by research institutions around the world

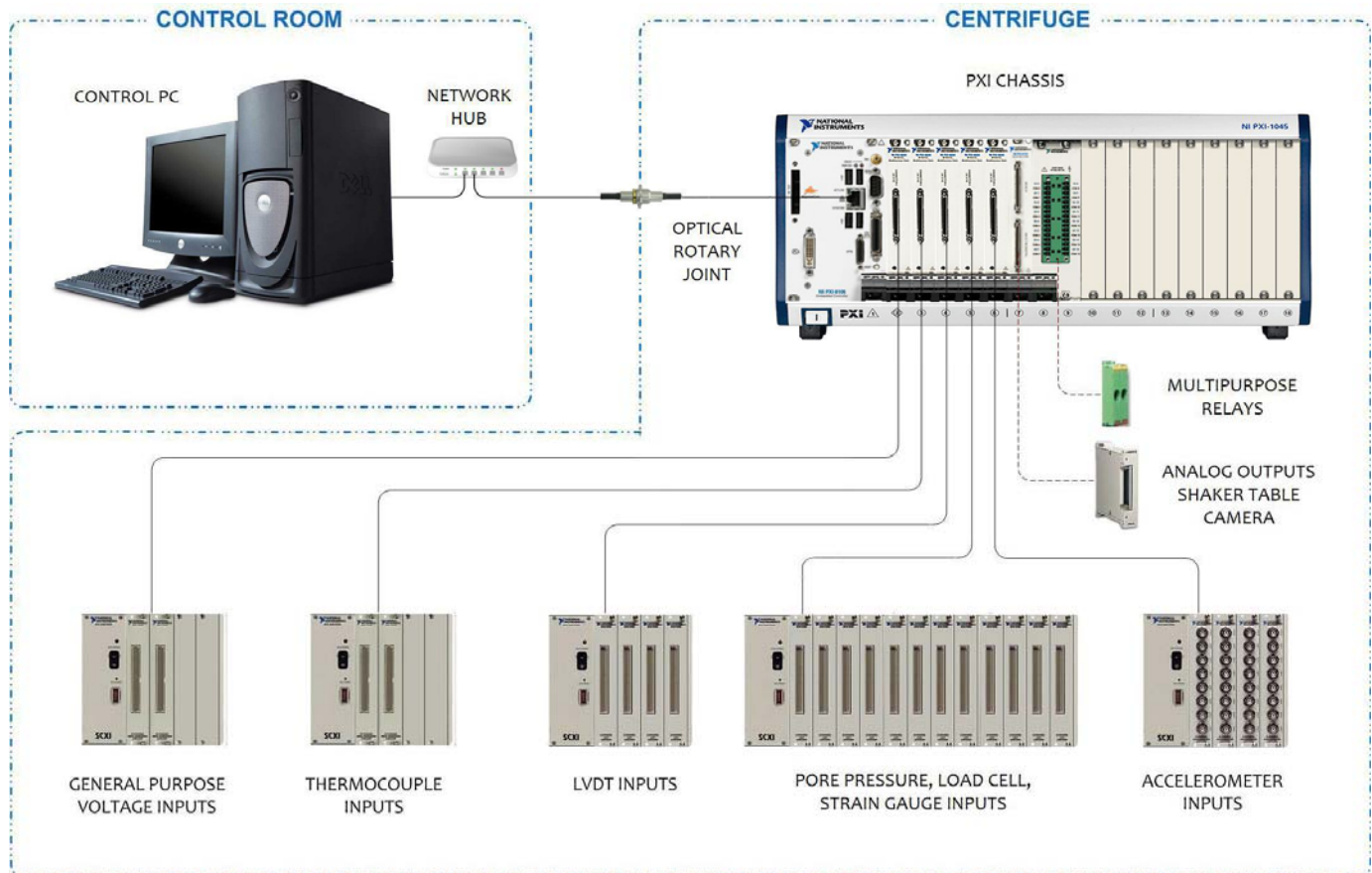


*Increase Productivity. Improve Quality. Reduce Cost.*

## Centrifuge Data Acquisition Hardware

Bloomy Controls' Centrifuge Data Acquisition System utilizes National Instruments PXI and SCXI hardware to condition signals from a wide variety of sensor types and to ensure precise timing and synchronization. The PXI hardware consists of a PXI chassis, PXI-8110 quad-core embedded controller, five PXIe-6341 X-Series data acquisition modules, a PXI-6733 analog output module, and a PXI-2565 relay module. The controller runs Bloomy Controls' Centrifuge DAQ application software, and is connected to a control room PC and local area network via an optical fiber running through a rotary optical coupling. Each PXIe-6341 data acquisition module is cabled to a SCXI signal conditioning chassis. Any combination of SCXI-1000 4-slot chassis and SCXI-1001 12-slot chassis may be used. Common signal conditioning modules include the SCXI-1102x, SCXI-1520, SCXI-1531, and SCXI-1540. Supported sensors include accelerometers; quarter, half, and full bridge strain gages; pore pressure sensors; LVDTs; thermocouples; and analog voltages. Any SCXI module can be installed in any slot of any SCXI chassis. The PXIe-6341 modules perform high-speed analog-to-digital conversion of the conditioned signals. The PXI-6733 analog output module and PXI-2565 relay module control a variety of equipment such as shaker tables, cameras, pumps, and valves.

The PXI chassis is typically mounted in a cabinet at the center of the centrifuge. For a small centrifuge, the SCXI chassis is also located in the center. For a larger centrifuge, the SCXI chassis are mounted in the centrifuge basket to minimize wire length and signal attenuation between sensors inside the model and the SCXI chassis. A geotechnical model can be instrumented with only a few sensors for a simple test to more than 200 sensors and actuators for an advanced model.



Centrifuge Data Acquisition System Hardware Architecture



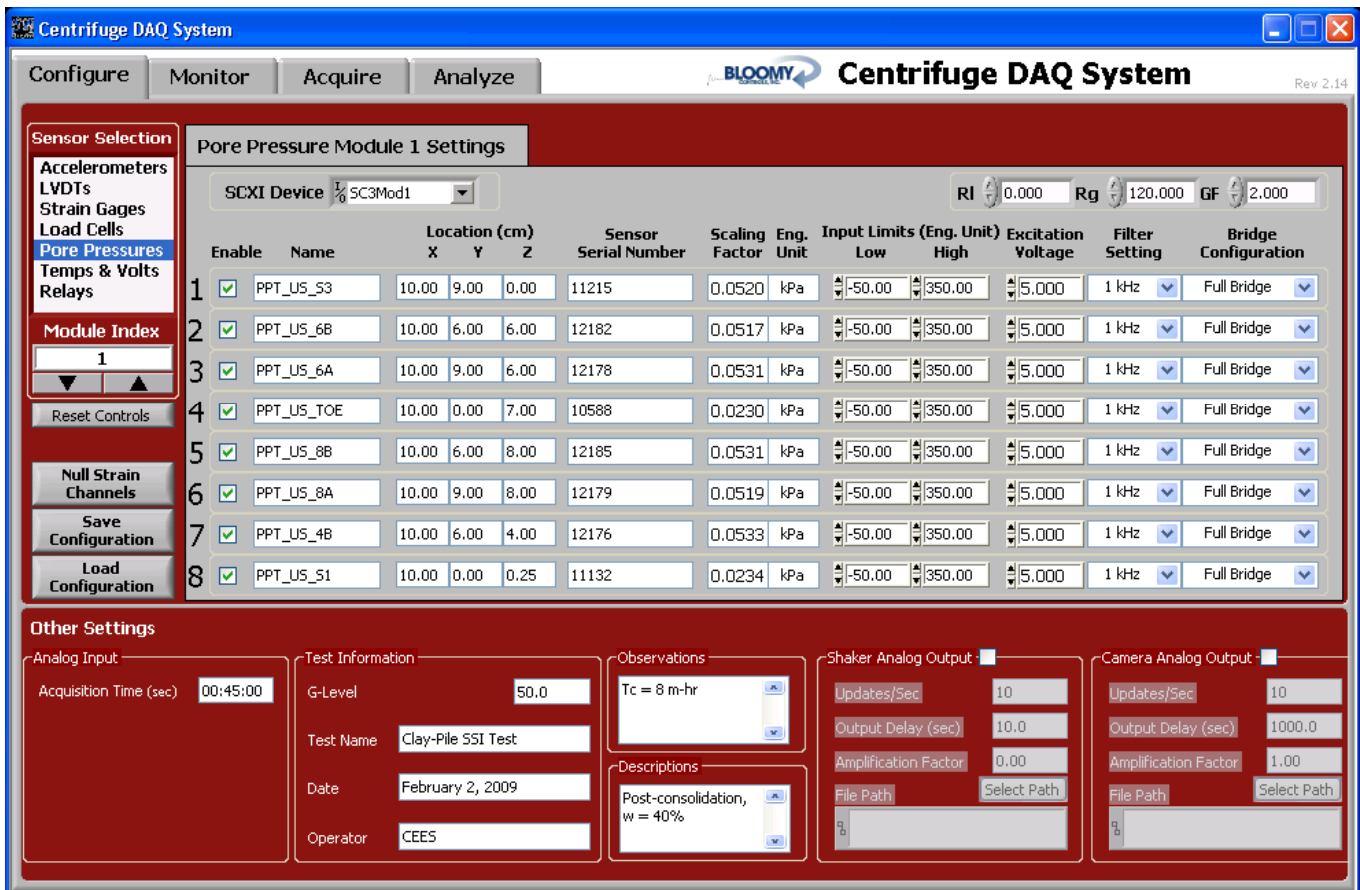
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# Centrifuge Data Acquisition Software

The Centrifuge Data Acquisition Software is designed to manage a wide range of sensor and hardware configurations while helping users to prepare the centrifuge model, monitor specific channels of interest, interactively control the model, modify acquisition rates and on the fly, and analyze the data when a test is complete. It is very highly configurable to meet a wide range of test requirements, yet very easy to use. The functionality is organized into separate display pages or tabs labeled Configure, Monitor, Acquire, and Analyze.

## Configure

The **Configure** tab is used to configure the sensors and data acquisition hardware used for a specific test, as shown below. The user selects the type of sensors to configure using the **Sensor Selection** control. Each sensor selection has a corresponding form that allows the user to choose the SCXI chassis and module location using the **SCXI Device** control, and configure the channels of the selected module based on the parameters applicable to the selected sensor type. For pore pressures, load cells, and strain gages, the bridge completion, excitation voltage, and filter setting may be individually selected for each channel; and the lead resistance ( $R_L$ ), nominal resistance ( $R_G$ ), and gage factor (GF) may be selected for each SCXI module. Additionally, the channel name, location within the model, sensor serial number, scaling factor, and engineering units are settings applicable to all sensor types. Each configuration can be saved to file and then loaded, edited, and saved to a new file at a later date. Therefore, new configurations can be created by simply loading and editing the configurations for similar tests run previously.



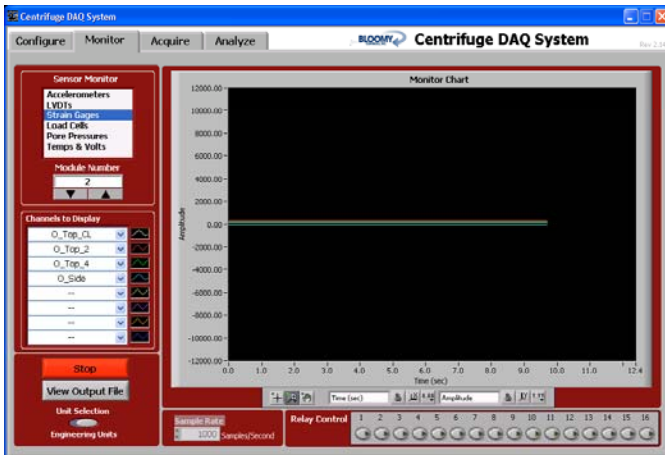
Centrifuge Data Acquisition Software **Configure** Tab with Pore Pressure Configuration Parameters



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## Monitor

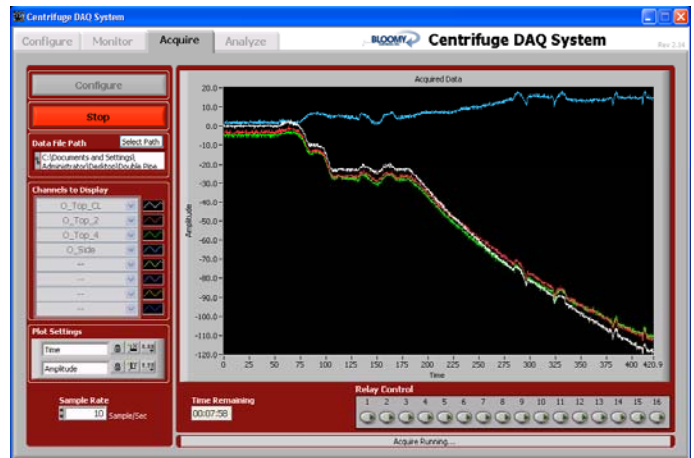
The **Monitor** tab displays a waveform chart of live data from the active sensors connected to any SCXI module. This feature assists the user with preparation of the model and identification of any problems with the sensors during centrifuge spin up.



Centrifuge Data Acquisition Software View: **Monitor**

## Acquire

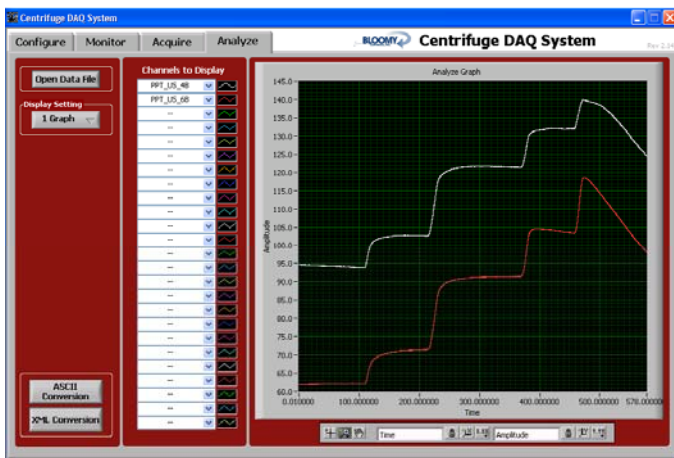
The **Acquire** tab is used during testing to control acquisition, relays, and graphically monitor any user-selected channels in finished engineering units. Data acquisition is initiated via the **Start** button, and ended either manually via the **Stop** button, or automatically based on completion of the **Acquisition Time (sec)** interval specified on the Configure tab. The sample rate is adjustable on-the-fly via the **Sample Rate** control. Also, a row of buttons allows the user to interactively control pumps and valves simulating geological events such as flooding.



Centrifuge Data Acquisition Software View: **Acquire**

## Analyze

The **Analyze** tab is used after testing to open any data file, view user-selected channels on one graph or on separate graphs by sensor type, and convert the data from binary to text files or XML. The figure below shows a graph of two pore pressures responding to increasing water level of a levee.



Centrifuge Data Acquisition Software View: **Analyze**

**Please contact Bloomy Controls to discuss your Centrifuge Data Acquisition Requirements.**

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