The CICENNS DAQ System

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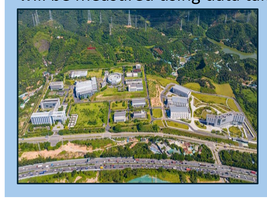
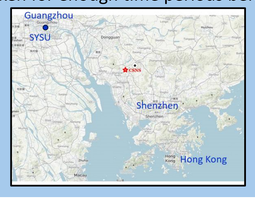
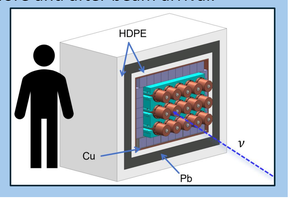
Abstract

A CsI Detector for Coherent Elastic Neutrino-Nucleus Scattering (**CICENNS**) experiment is under preparation for a high-precision CEvNS research using neutrinos produced by the China Spallation Neutron Source (**CSNS**). Utilizing a total of 300kg CsI(Na) crystal scintillator, it aims to deliver precisely measured CEvNS cross-section and explore new physics beyond the Standard Model.

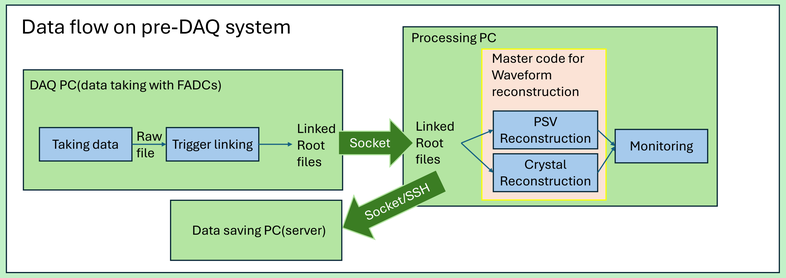
To manage both beam-on and -off data with high event rates, an advanced Data Acquisition **(DAQ)** system is under development by optimizing maximum throughput. The hardware integrates two distinct types of Flash Analog-to-Digital Converters (**FADC**s), dedicated to signal waveform processing for 15 20-kg crystal neutrino targets and 32 plastic scintillation veto modules surrounding them, to ensure a wide dynamic range and maintain signal integrity.
On the software level, the DAQ framework employs a multi-threaded architecture that enables parallel processing of raw PMT signals and seamless data streaming. A steady-state background will be measured using data taken for enough time periods before and after beam arrival.

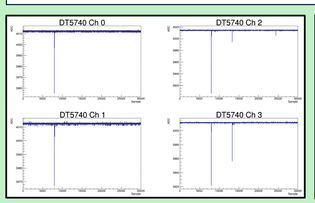


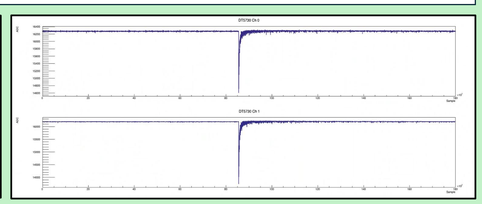




Recent status of CICENNS DAQ



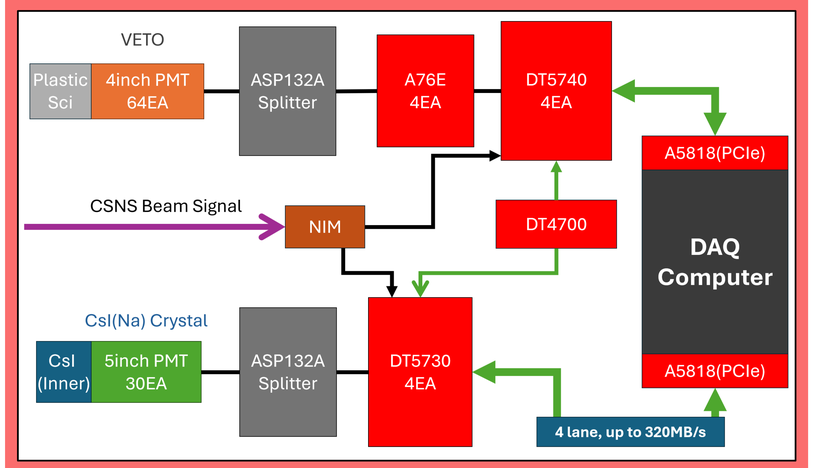




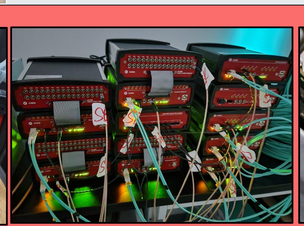
- From the beginning, We desired an event window of the maximum possible length.
  - Given the high-speed file transfer requirements of our DAQ system, it was essential to maximize system efficiency through rigorous optimization.
    - To achieve the above goal, the latest CAEN library was applied.
    - By migrating the existing single-threaded implementation to a multi-threaded architecture, we have optimized CPU usage and significantly lowered overhead.
    - Additionally, by utilizing a lower-level communication protocol and a highly compressed file system, we have achieved higher effective bandwidth.
- During our visit in early June, the DAQ system demonstrated stable and promising performance during preliminary testing at CSNS.

➢ **The completed DAQ system will take data with 25Hz!**

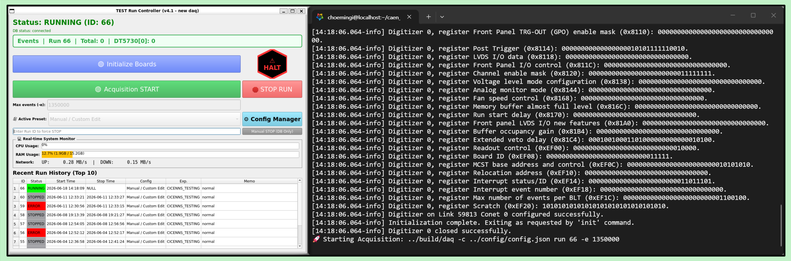
DAQ System at Glance



Model Name	Picture	Description
NNVT N2041		4-inch PMT. For VETO
Hamamastu R877-100		5-inch PMT. For Inner Detector
CAEN A5818		PCIe Gen 3 x8 CAEN CONET2 Controller. Link to FADC with optical links via <CAEN CONET 2>
CAEN DT4700		Clock Generator. Using for Time Synchronization between FADCs DT5730 and DT5740
CAEN DT5730		8 Channel 14 bit 500 MS/s Digitizer. FADC for CsI(Na) crystal, Inner-Detector
CAEN DT5740		32 Channel 12 bit 62.5MS/s Digitizer. FADC for VETO
CAEN A746E		Patch panel 32 Channel LEMO 00 female to 1.27 68-pin ERNI SMC female. Attach to DT5740
ASP132A		Analog Splitter. Copy the PMT Analog Signal



DAQ Run Controller

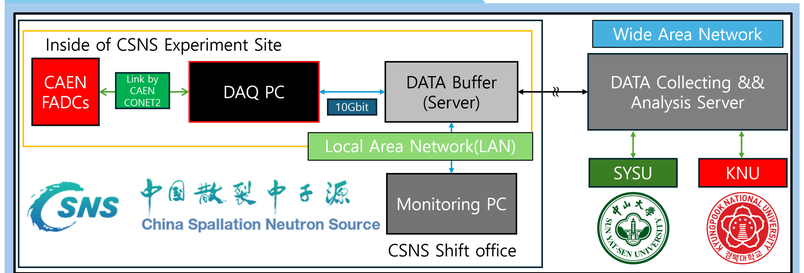


❖ This is a preview of DAQ Run Controller in development

- Numerous people have a **shift** to facilitate the smooth and continuous data collection
  - Since experts from numerous fields take turns working shifts in a single experiment, the **DAQ system** must be operated with a degree of **user-friendliness** in mind.
  - Currently developing a real-time monitoring system for the FADC status.
  - Added features to monitor the capacity, transfer speed, and other metrics of the data storage server.
- The **DAQ Run Controller** must first be able to initialize the **FADC** and command data acquisition, and it should also be able to record when data collection needs to be restarted due to issues.
  - Therefore, we are currently developing that part using **Python** with using **MySQL** for **Database(DB)** management.
  - Each function must be sufficiently **independent**, so using **subprocesses**.
  - In addition, we are receiving feedback for further feature additions and are planning to incorporate as many features as possible.

➢ The RunController currently under development has been running for over a week in a laboratory environment without any issues, and we are prioritizing system stability above all else.

Plan



- Due to the immense volume of data, discussions are currently underway regarding the possibility of utilizing CSNS server resources.
- Our goal is to commence the experiment at CSNS through continuous consultation and verification of other components as well.

The full detector will be Commissioned at CSNS in 2026!