

A Plugin-Based Software Framework for Data Acquisition and Processing

Shaoshuai Fan

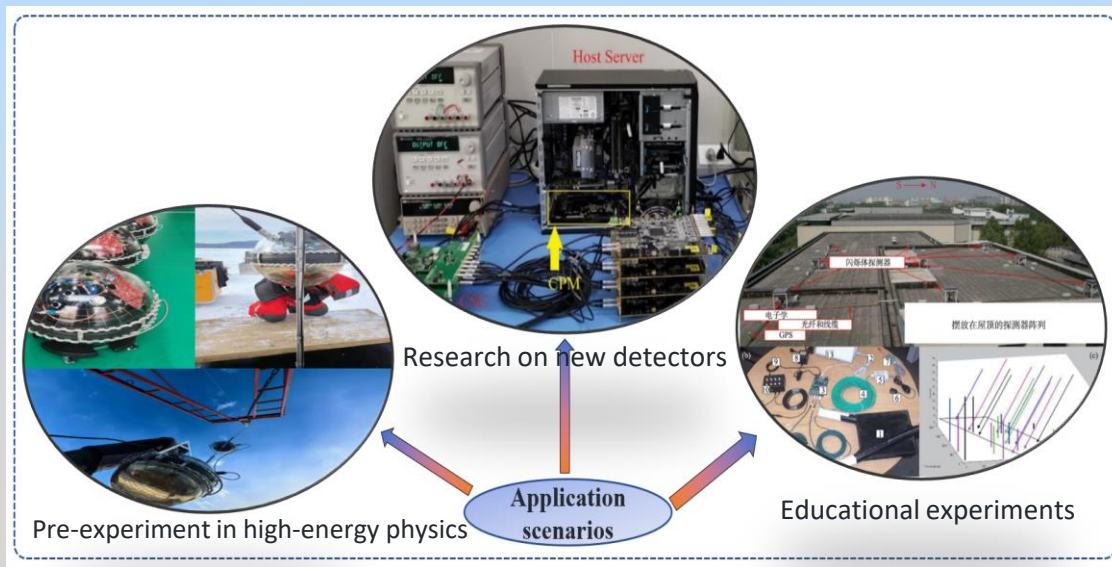


Figure 1. Framework application scenarios

- To address the above scenarios, we propose a plugin-based software framework—ExpDAQ.
- Adapt to different electronic readout interfaces
- Reusable processing algorithms
- Online configuration to generate different dynamic data streams

- In order to facilitate the design of data flows, we have developed an online flow design tool to assist in generating configuration files!

Application characteristics

- › Smaller data volumes
- › Greater variety of front-end electronics readout
- › Different data processing algorithms

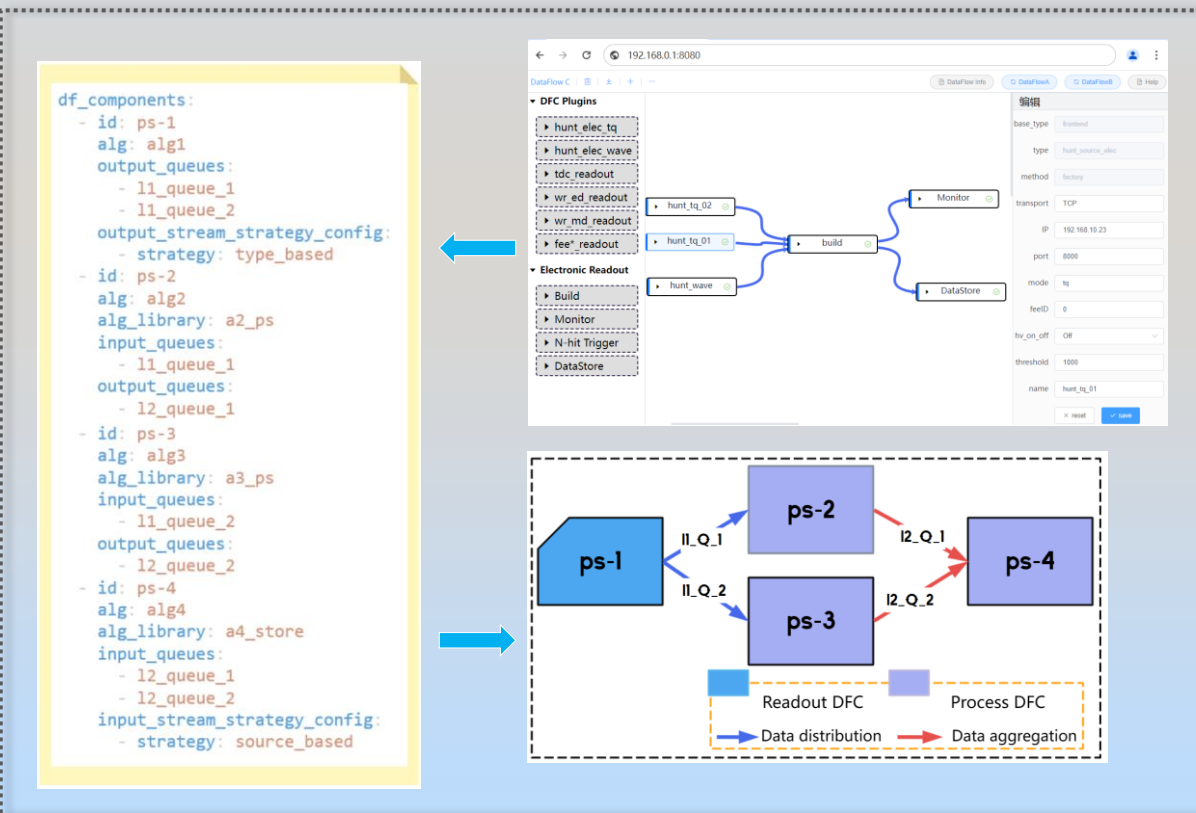


Figure 2. Online configuration for generating dynamic data streams

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Welcome to Discuss~

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A Plugin-Based Software Framework for Data Acquisition and Processing

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INTRODUCTION

Compared to the data acquisition system(DAQ) of large-scale high-energy physics experiments, small-scale experiments, such as preliminary research experiments for large-scale experiments, educational instruction, engineering development, and medical applications, have the following characteristics: They have smaller data volumes and face a greater variety of front-end electronics readout and data processing needs. To meet the requirements of the above scenarios, we have proposed a DAQ framework—ExpDAQ, which offers flexibility in data flow and reusability of processing algorithms.

FEATURES

- In the ExpDAQ framework, the data flow process is scalable.
 - A C++ plugin manager has been designed to manage different plugins, allowing for the addition of modules and system scalability.
 - The data flow can dynamically change based on the configuration file, enabling dynamic variations in the processing flow.
 - Define a standard data header format to label data fragments, enabling data aggregation and routing of fragments to specific processing modules.
- In the ExpDAQ framework, traditional state machines have been replaced. Plugins now manage their states independently by receiving commands.

METHOD

- Data Flow Component (DFC): A fundamental processing unit capable of being utilized to form various data streams.
- Composition of DFC
 - StreamInput
 - StreamOutput
 - Data Process
- The basic processing unit DFC's IO
 - StreamOutput: Distribute data into the next DFC based on different strategies
 - StreamInput: Aggregate data from different DFCs based on different strategies

APPLICATION

The framework has been applied in multiple experiments.

- Huge Underwater high-energy Neutrino Telescope prototype experiments
- LHAASO-ED detector testing
- Campus Cosmic-ray Observation Collaboration
- Time-to-Digital Converter Experiment

DESIGN & IMPLEMENTATION

- Architecture of ExpDAQ framework
- The ExpDAQ comprises two layers: the plugin layer and the framework layer.
- Different functionalities of DFC call Stream IO and strategies to achieve the transfer of data packets between DFCs.
- The plugin layer includes two types of DFC with different functionalities:
 - Readout: Electronic configuration, readout, and data packetization, serving as the data source
 - Process: The fundamental unit for data processing
- Online Info & API: Monitor info publish & Control
- Plugin Manager
 - Inherited from a same base class "Object"
 - Object class can inject the required dependencies based on configuration information
 - Dynamic loading and dependency injection of C++ base plugins.

EXAMPLE

- The ExpDAQ framework implements the following functions
 - Dynamically load processing plugins based on configuration file
 - Stream IO distributes or aggregates data based on strategy plugins

In order to facilitate the design of data flows, we have developed an online flow design tool to assist in generating configuration files!

SUMMARY

The ExpDAQ framework allows processing units to freely combine processing flows through configuration files, providing a more convenient solution for data acquisition and online data processing in high-energy physics experiments.

Scenarios

Features

Method

Architecture

Example

Summary

Application

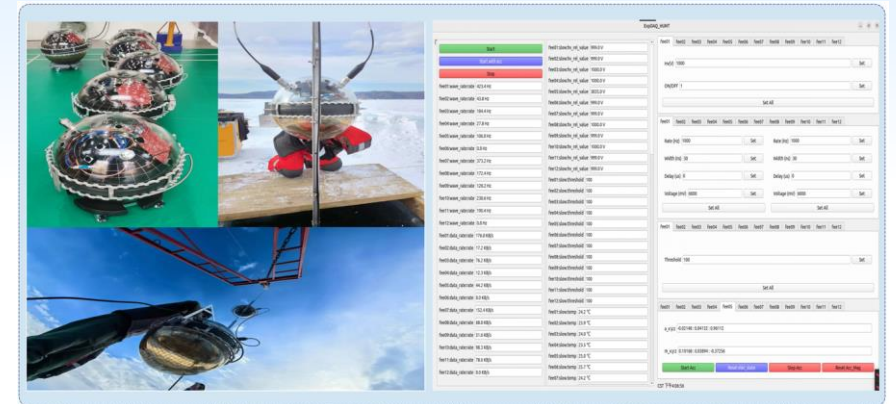


Figure 3. The HUNT Baikal prototype experiment and its DAQ UI interface

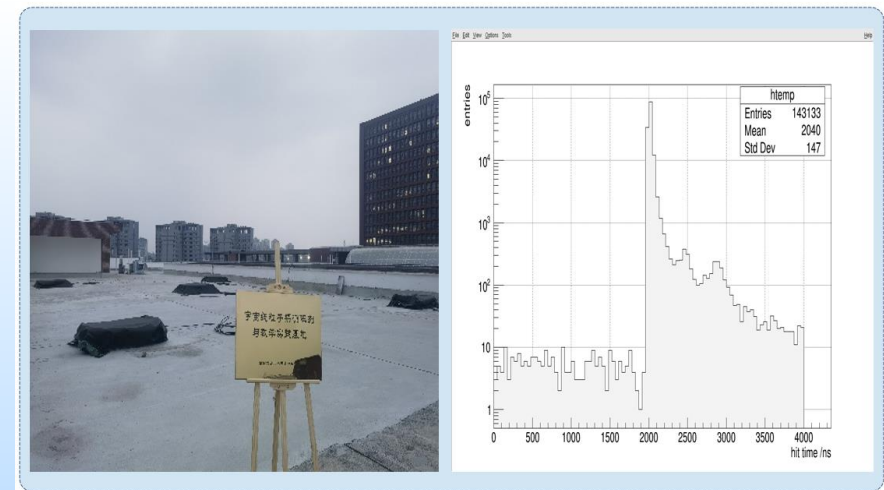


Figure 4. Cosmic-ray particle detection array at Southwest Jiaotong University