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A ROOT-based General Online Data Visualization System

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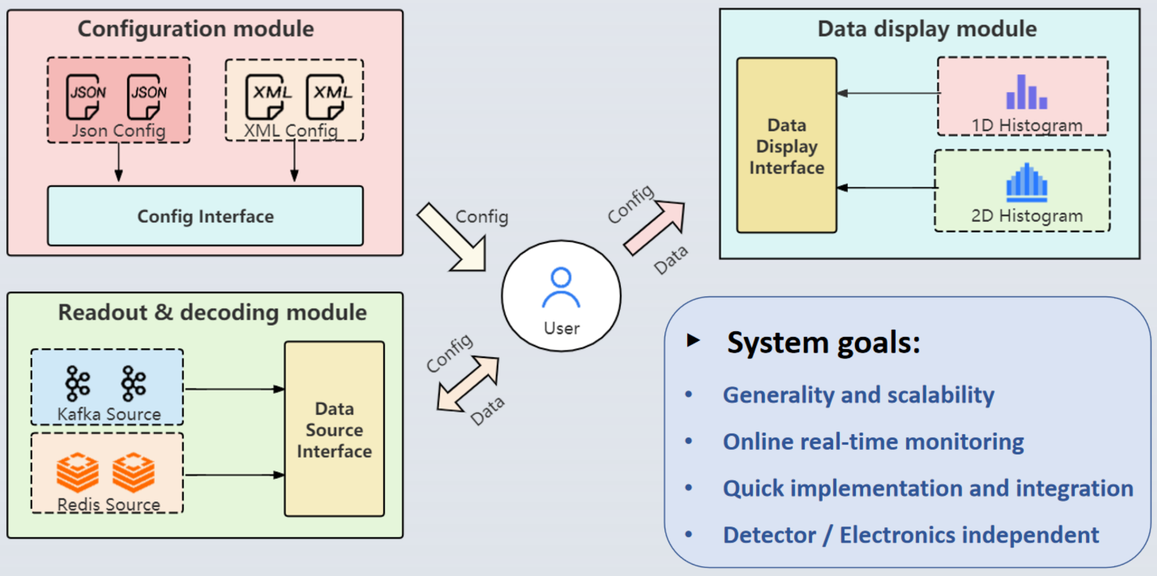
Introduction

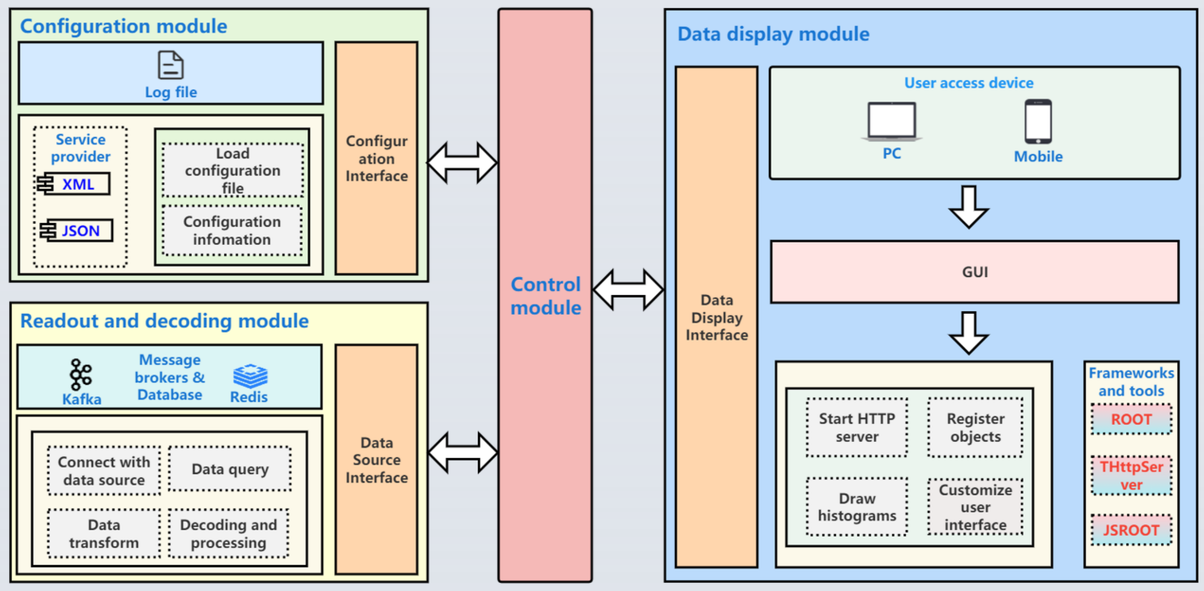
The online data visualization system is an essential component of the data acquisition system, delivering swift, efficient, and comprehensive real-time monitoring for detectors and readout electronics. Simultaneously, ROOT, an open-source software framework for data analysis in high-energy physics, provides a variety of data analysis tools. Utilizing ROOT-based online histogram monitoring, researchers can efficiently analyze data in real-time and promptly detect potential anomalies. To minimize development costs and enhance deployment efficiency, a ROOT-based general online data visualization system **called ROBOT** has been designed and implemented.

Architecture Design



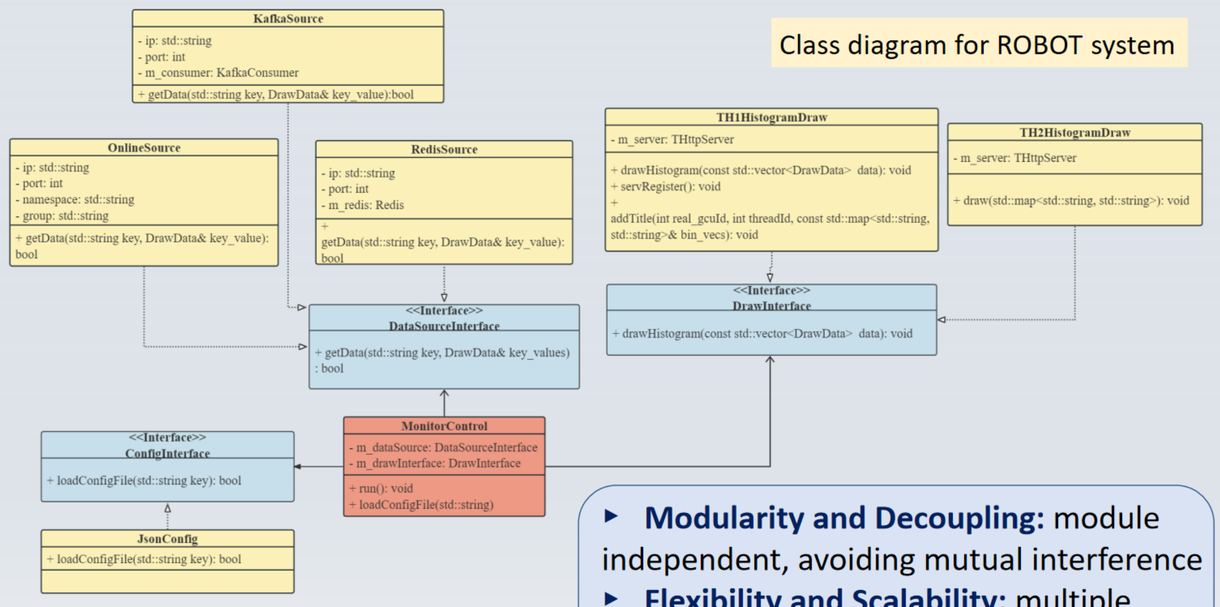
Design architecture for ROBOT system

System Implementation



Implementation for ROBOT system

- **Configuration module**: Providing parameter information required for image display
- **Readout & decoding module:** Acquiring data and decoding based on the specified format.
- **Data display module:** Drawing the histogram based on the configuration information.



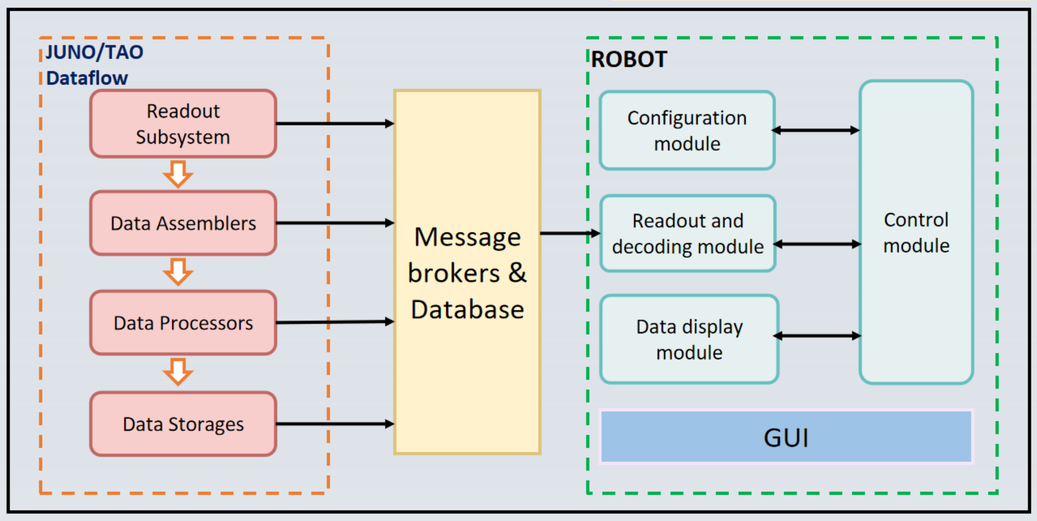
Class diagram for ROBOT system

- **Modularity and Decoupling:** module independent, avoiding mutual interference
- **Flexibility and Scalability:** multiple interfaces provided to support different experiments integration

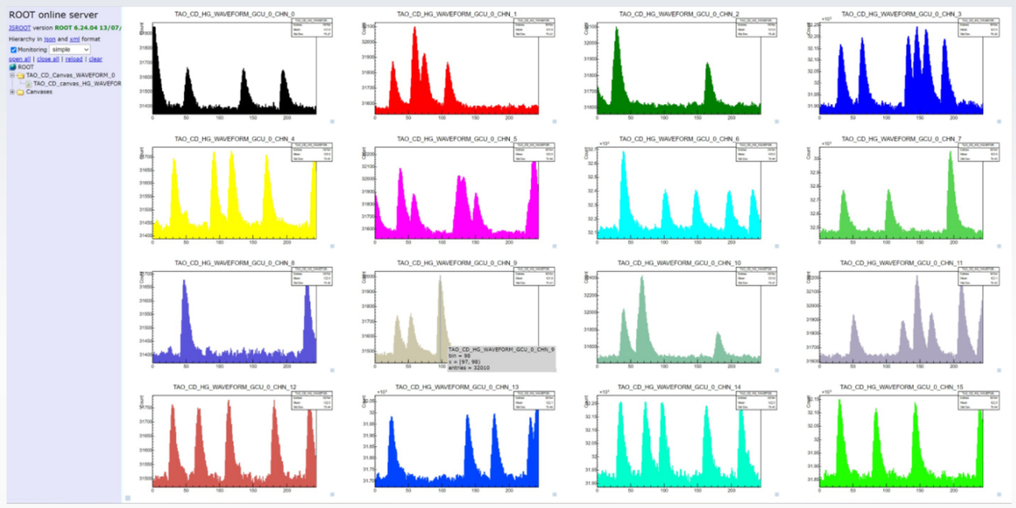
Results

- **Integrate with different experiments**

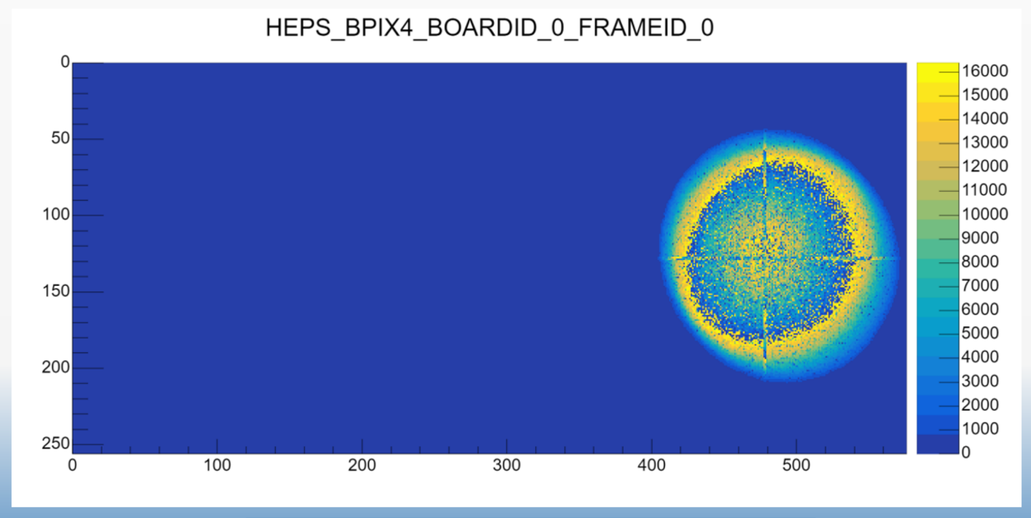
Take JUNO and TAO as examples



- **System deployment**

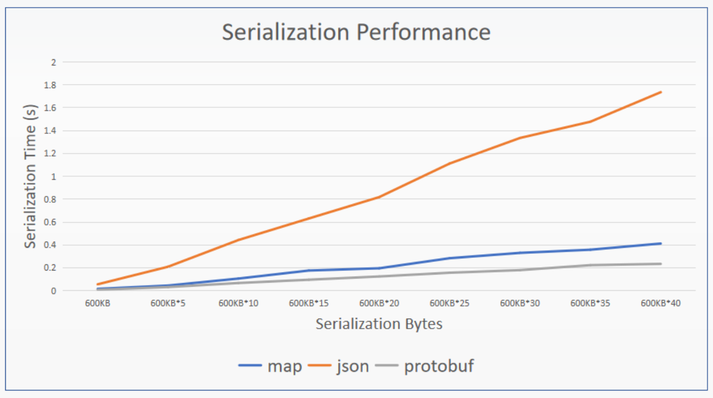


TH1D applications in JUNO-TAO experiment



TH2D applications in HEPS-BPIX4 experiment

Performance Study



- **JSON:**
  - Easy to parse
  - Lightweight
- **Protobuf:**
  - Efficient serialization
  - Binary encoding

Conclusions

The system has completed the architecture design and main modules implementation, and has been successfully applied to integration test for different experiments and the on-site installation of JUNO. In particular we performed:

1. **Easily integrate with different experiments:** file-based configuration management
2. **Multiple data source interfaces:** Redis & Kafka
3. **ROOT-based image visualization:** TH1D & TH2D