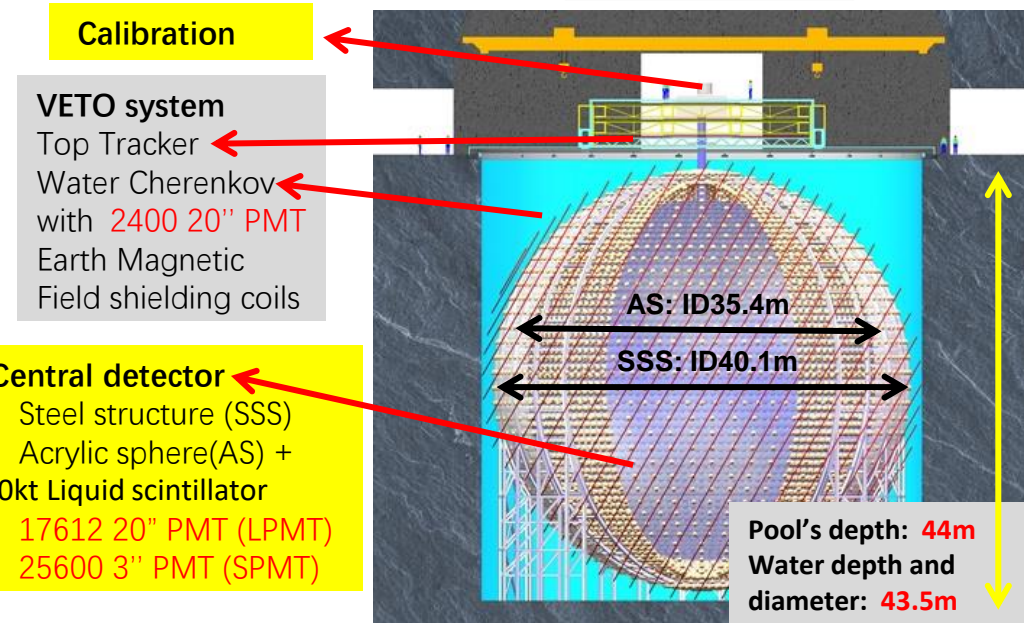


# Design and Development of JUNO DAQ Data Flow Software

Chao Chen, Yu Peng, Tingxuan Zeng, Shuihan Zhang, Yinhui Wu, Hangchang Zhang, Zezhong Yu, Xu Zhang, Minhao Gu, Xiaolu Ji, Fei Li, Kejun Zhu

## JUNO Detectors

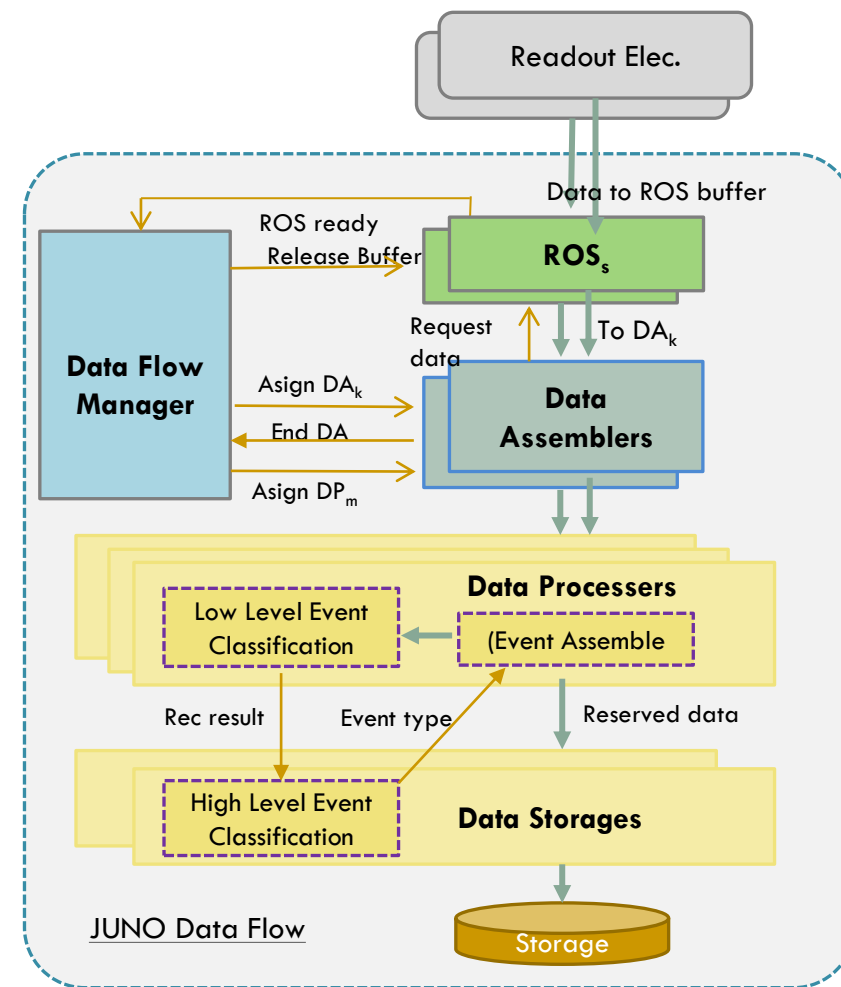


## JUNO Data Flow Software:

- Data Readout (ROS)
- Data Assembler (DA)
- Data Processor (DP)
- Data Storage (DS)
- Data Flow Manager (DFM)

## Plugin-based module design

- Different readout electronics use different readout modules
- Different online processing uses different algorithm modules



### 20" LPMT data

- 3 channels/UWB for LPMTs of CD and WP : ~6800 UWBs
- CD waveform data rate with hardware trigger:  
18000 \* 1GHz sample \* 2 Bytes \* 1us window \* 1kHz trigger rate = 36GB/s
- CD trigger-less TQ data rate: 18000 \* 30kHz dark rate \* 16 Bytes = 8.5GB/s

### 3" SPMT data

- 128 channels/UWB for SPMTs: 200 UWBs
- Trigger-less TQ data rate:  
500Hz dark rate \* 25000 \* 30 Bytes = 375MB/s

~7000 links, readout interface: 1 Gbps Ethernet + TCP protocol, ~40GB/s data rate

# Poster



中国科学院高能物理研究所  
Institute of High Energy Physics, Chinese Academy of Science

2024/04/22 - 2024/04/26 - ICSE, Quy Nhon, Vietnam

## Design and Development of JUNO DAQ Data Flow Software

Chao Chen<sup>(1,2,3)</sup> on behalf of the JUNO DAQ Group



(1) Institute of High Energy Physics, Beijing 100049, People's Republic of China  
(2) University of Chinese Academy of Sciences, Beijing 100049, People's Republic of China  
(3) State Key Laboratory of Particle Detection and Electronics, Beijing 100049, People's Republic of China

## Introduction and Motivation

### 1. INTRODUCTION

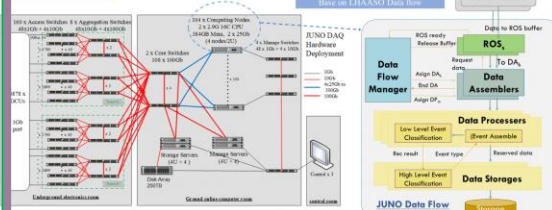
The Jiangmen Underground Neutrino Observatory (JUNO) is a neutrino experiment under construction with a broad physics program in southern China. The primary physics goal of JUNO is to measure the order of neutrino mass. The JUNO DAQ data flow software is responsible for the readout, online processing, and storage of more than 40GB/s raw data generated by the front-end electronics(FEE) in various formats.

### 2. Requirement

Detector	Channel	Data Size (Byte)	Rate	Data Volume
CD LPM1	17612	2032	1 MHz	35.8 GB/s
CD LPM1-T/Q	17612	16	30 MHz	8.5 GB/s
CD SPM1	25600	30	500 Hz	375 MB/s
CD Calibration	17612	2032	200 Hz	7.2 GB/s
WP LPM1	2400	2032	205 Hz	984 MB/s
WP Calibration	2400	2032	200 Hz	960 MB/s
TT				1 MB/s

### 3. Architecture



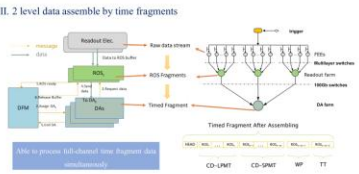
## Data flow Software Architecture Design and Implementation

### 4. Implementation

#### I. Pipeline architecture of ROS

- Readout threads:
  - Readout of all channel data
  - 1-thread to multi-channels
- Preprocess threads:
  - Data format check
  - Generate time fragment based on timestamps
- ROS builder threads:
  - Level-1 data assemble

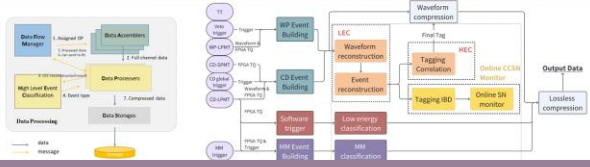
#### II. 2 level data assemble by time fragments



#### III. Processing of different types of data in DP

4 Event Stream: (online processing, in the same DP)

- Waveform event (hardware trigger)
  - CD-WP event assemble based on hardware triggers
  - Online Event Classification(OEC)
- Trigger-less T/Q (software trigger)
  - T/Q process flow for CCSN monitor
  - T/Q process flow for low energy event
- Multi-Message data stream (hardware trigger)



## Achieved Results

### 5. Performance

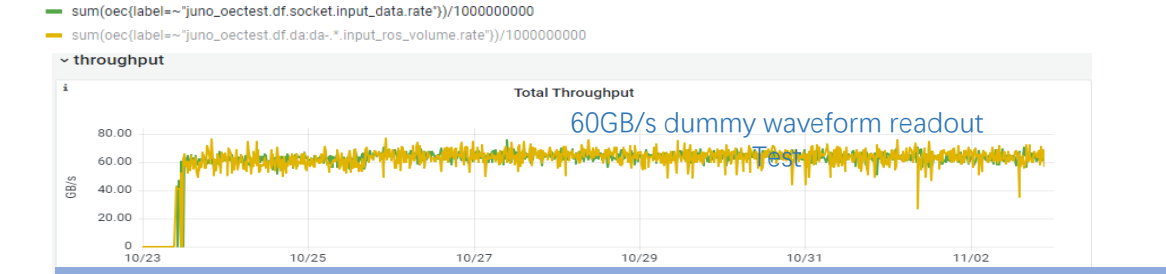
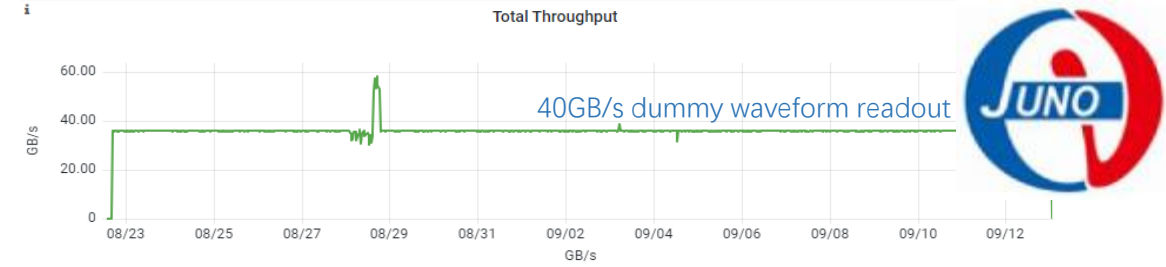
- Containerized running by K8s
- Dummy waveform data source test
- Mixed dummy data source test
- JUNO onsite test



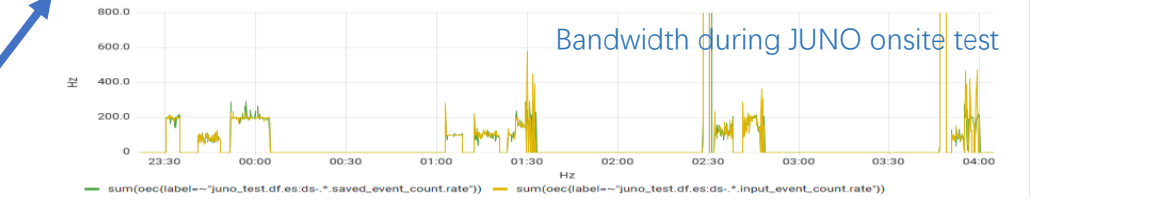
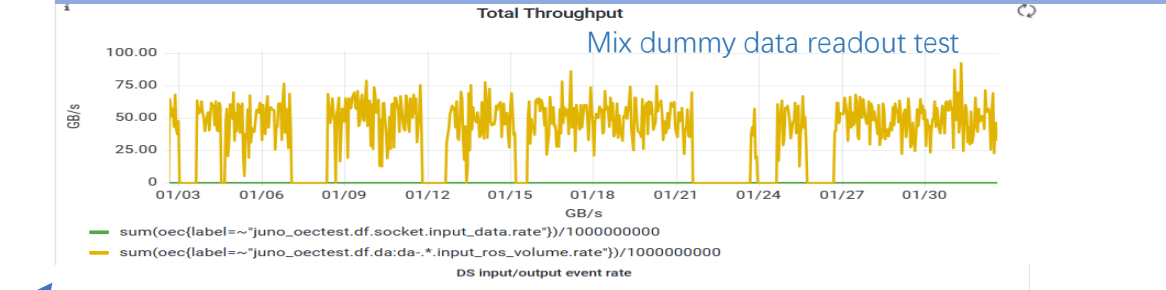
Total computing nodes: 27 (DA and DP run same nodes)

### 6. Conclusion

The current version of JUNO data flow software supports readout and processing of waveform and T/Q data for both CD and WP-detectors, as well as global trigger data. The on-site detector integration has begun, and the software is currently able to support trial operation. The main focus of the subsequent work is the upgrade of high availability for the data stream.

Meets the requirement for 40GB/s data acquisition and 50% redundancy performance



The current version of JUNO data flow software supports readout and processing of waveform and T/Q data for both CD and WP detectors, as well as global trigger data. The on-site detector integration has begun, and the software is currently able to support trial operation. The main focus of the subsequent work is the upgrade of high availability for the data stream.