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Data Quality Monitoring System for the JUNO Experiment

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In High Energy Physics experiments, Data Quality Monitoring (DQM) system is pivotal in ensuring the correct and smooth operation of the experimental apparatus during data taking. The DQM for the Jiangmen Underground Neutrino Observatory (JUNO) will reconstruct raw data directly from the JUNO Data Acquisition system and utilize event visualization tools to monitor and display the detector performances for high quality data taking. The strategy of the JUNO DQM, as well as its design will be presented.

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1. Introduction

The Jiangmen Underground Neutrino Observatory (JUNO) [1] is located in Guangdong Province, China. The primary scientific goal of JUNO is to determine the neutrino mass hierarchy. The detector consists of a Central Detector (CD), a water Cherenkov detector, and a Top Tracker (TT). A crucial component of the monitoring infrastructure for the JUNO experiment is the Data Quality Monitoring (DQM) system, which is essential for ensuring the proper operation of the detector, maintaining the efficiency of data collection. In the event of data quality problems, the DQM system can immediately alert shifters, ensuring the accuracy and reliability of the data [2–4]. In this paper, we present the design framework of the JUNO DQM system.

2. The architecture of DQM

The JUNO DQM system consists of the job server and the web server. The framework of DQM system is shown in Fig. 1.

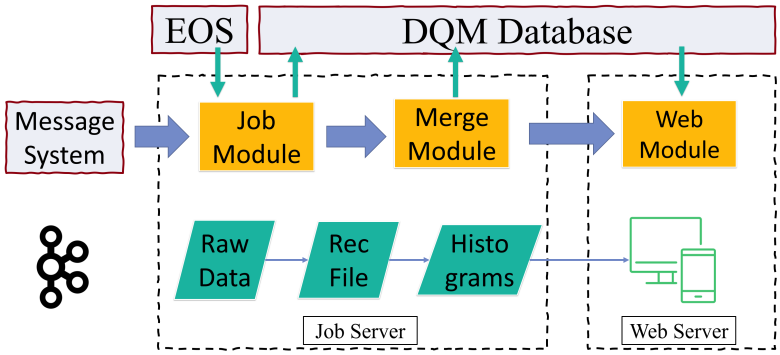

Figure 1: The framework of JUNO DQM system.

The job server consists of two modules: the job module and the merge module. The message system of job module receives messages from the Keep-up production system. The message information includes the file name, path, timestamps, status, checksum and so on. When receiving a message, the job module can create and submit a job based on the message information. The job always includes the calibration, reconstruction and creating histogram information [5, 6]. This process will take about one hour, depending on the design requirement of the DQM system. For the accuracy of file status recording, the job module will modify the file status information in the DQM database on the web server after completing specific steps. The DQM database, which is based on MySQL, is deployed on the web server, and the job server has access to the DQM database. The DQM database can record the necessary information of files, including the file name, reconstruction method, event number, file status, and some time information for reconstruction, merging, and update.

Since the job module of JUNO DQM processes each file individually, the merge module combines multiple files to get the run level information from the same run. After obtaining the run level histograms, the merge module will synchronize them to the web server for display on the website.

The JUNO DQM webpages can display detailed run information, including file numbers, event numbers, reconstructed histograms, and the Photomultiplier Tube (PMT) status for each sub-detector. The status of each PMT is classified as normal, hot, or dead, based on the number of hits the PMT receives during a run. To improve the examination of abnormal PMT information, we developed a method that allows users to click on each PMT to display detailed information, thereby facilitating the shifter's inspection process [7–9].

3. Summary

We present the JUNO DQM system, including the job server, web server, database, and the associated website. The system provides run-level histograms and essential information on web interfaces, enabling shifters to inspect potential problems during JUNO data taking.

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