

An Online Track Reconstruction and Monitoring System for MRPC Cosmic-Ray Detectors Based on CERN ROOT

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Abstract

We present an online monitoring and track reconstruction system developed for a multi-detector MRPC (Multi-gap Resistive Plate Chamber) cosmic-ray test platform. Built upon CERN ROOT and deployed in a Linux environment, the system enables simultaneous performance evaluation of multiple MRPC detectors. It performs real-time track fitting using hit information, allowing users to add or remove detector modules flexibly according to experimental configurations. The graphical interface displays hit positions on each detector, facilitating rapid diagnostics of detector status and data quality. The software employs a modular architecture that supports both continuous data acquisition and offline replay, with online histogram updates and alarm functions for abnormal channels. Tested with a telescope of four MRPCs, the system demonstrates stable operation over long runs. This tool significantly improves the efficiency of detector commissioning and cosmic-ray muon tracking, and it is readily adaptable to other resistive-plate chamber arrays for future RPC experiments.

ROOT-based processing chain

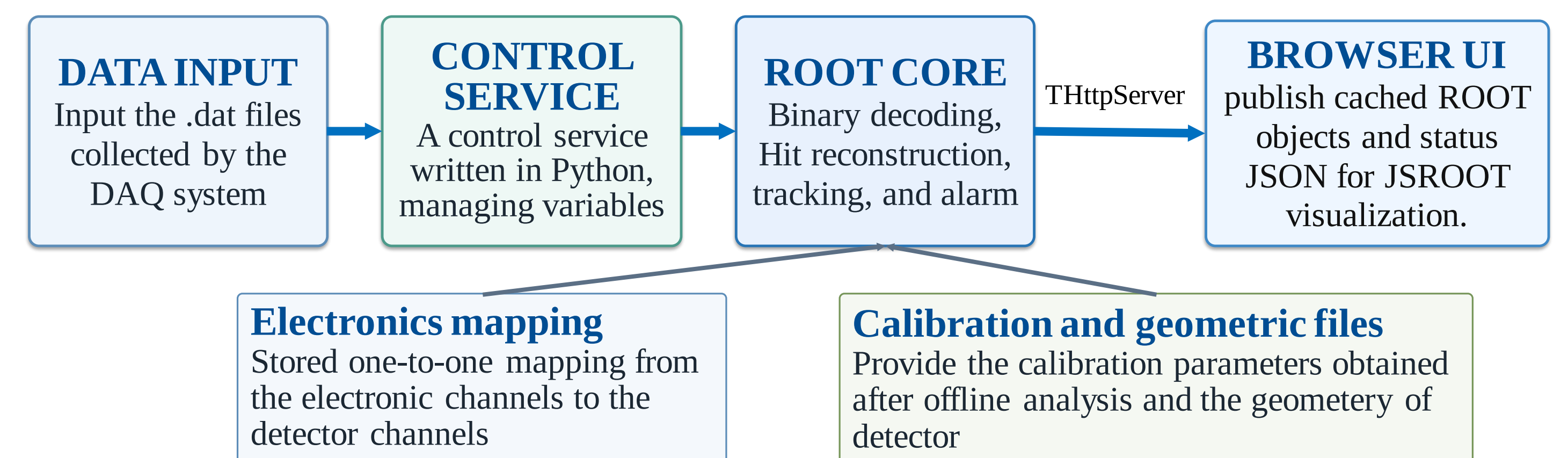
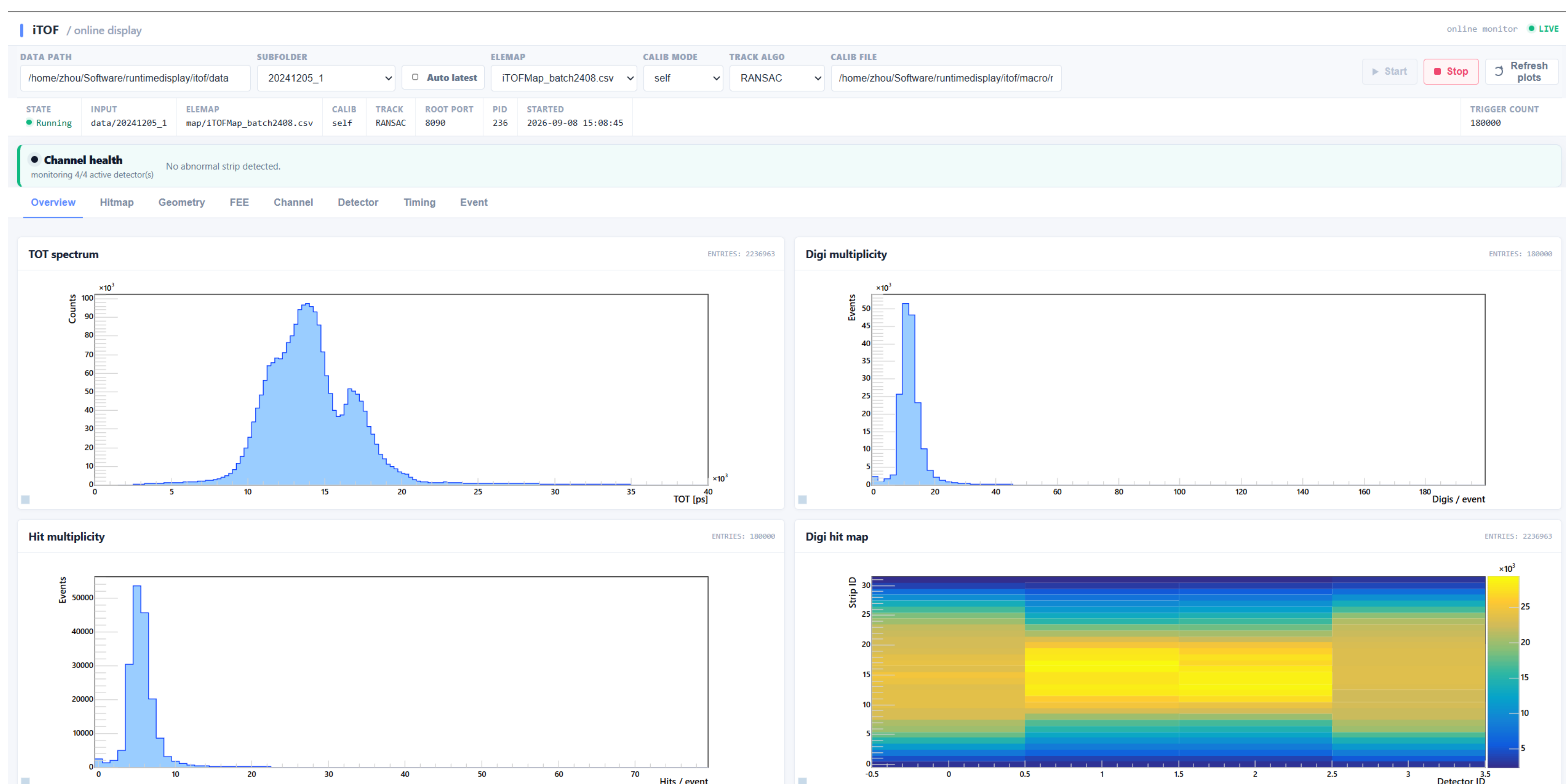


Figure 1. System architecture. The ROOT core decodes raw data, reconstructs hits and tracks, and updates monitoring objects. THttpServer [1] serves these objects over HTTP in JSON format, while JSROOT [2] renders them interactively in the browser. The same processing chain supports online monitoring and offline replay.

Main browser interface



Operators configure the run and inspect detector health from one browser page while the ROOT monitor continues processing in the background.

Figure 2. Main online interface. The control bar selects the data path, subfolder, electronics map, calibration mode, and tracking algorithm. The status row reports the active input, process state, ROOT port, start time, and trigger count. Tabs separate overview, hit-map, geometry, electronics, channel, timing, and event views; cached plots appear immediately and update during monitoring.

Electronics-map-driven configuration

The electronics map links each FEE channel to a detector, strip, and readout side. The software uses this correspondence to decode channel identities and organize detector-level monitoring. Raw signals are assigned to the corresponding detector strips and readout sides for hit reconstruction. Detector and channel views are generated from the selected map, keeping the displayed channels consistent with the configured setup. Selecting an updated map accommodates changes in cabling and detector configuration without manually redefining the corresponding monitoring views.

Online monitoring and channel alarms

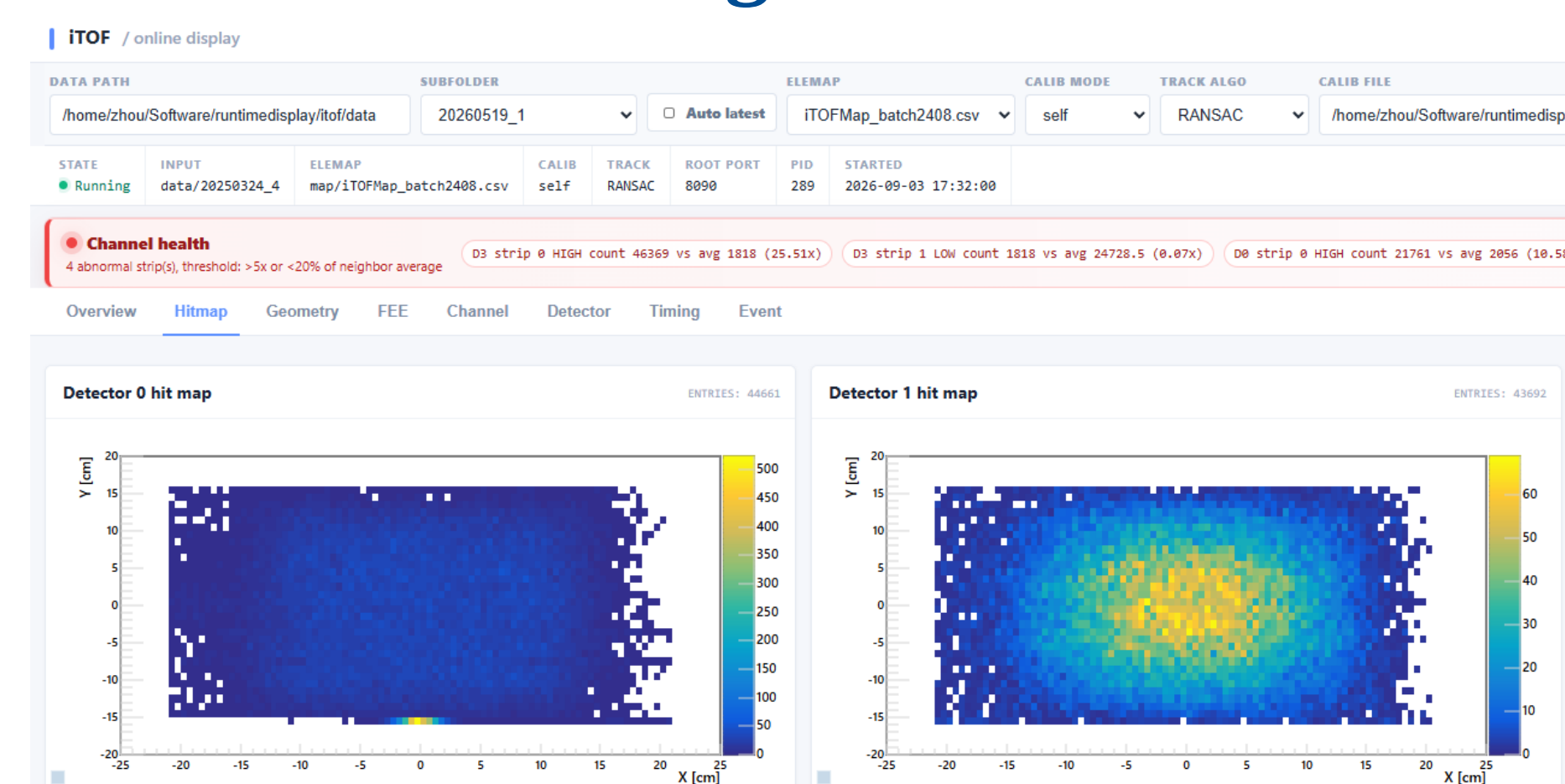


Figure 3. Detector monitoring. The interface creates detector and channel views from the selected electronics map. After a strip accumulates sufficient statistics, a neighbor-aware test flags persistent high or low occupancy. A flagged strip is excluded from the reference used to judge adjacent strips, preventing one abnormal channel from producing a chain of false alarms.

Event display and online tracking

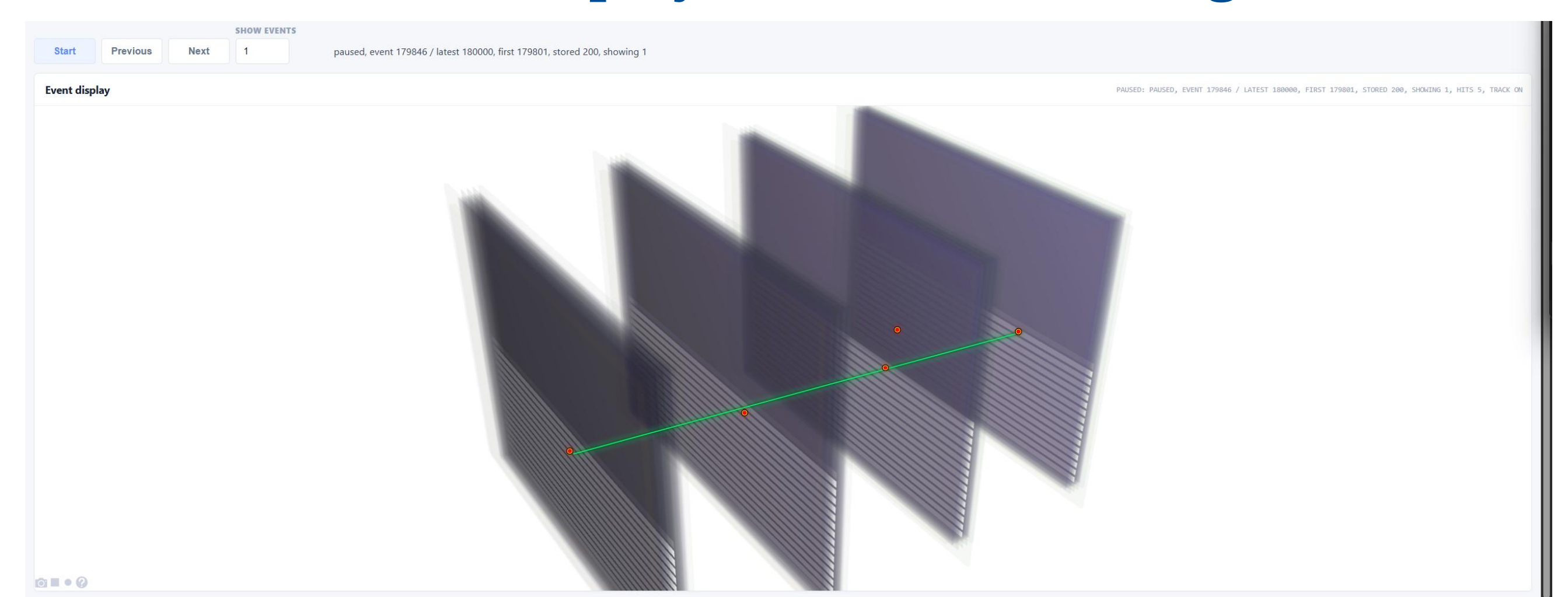


Figure 4. Hit and track visualization. Event navigation supports pause, previous/next selection, multi-event display. Two tracking reconstruction algorithms are provided for selection. Fast reconstruction gives low-latency online feedback, while RANSAC rejects outliers when at least three layers contribute hits.

Conclusions

A ROOT-based online monitoring and track reconstruction system has been developed and applied to a four-MRPC cosmic-ray telescope. It combines live detector monitoring, occupancy-based channel alarms, and interactive event visualization in a browser interface. Electronics-map-driven configuration supports changes in channel assignments and monitoring views, while online processing and offline replay provide a practical tool for MRPC commissioning and data-quality assessment. The software was developed with coding assistance from GPT-5.6-SOL, while the detector configuration, reconstruction algorithms and experimental validation were defined and reviewed by the research team.

REFERENCE

- [1] J. Adamczewski-Musch and S. Linev, “THttpServer class in ROOT,” J. Phys.: Conf. Ser. 664 (2015) 062032.
- [2] B. Bellenot and S. Linev, “JavaScript ROOT,” J. Phys.: Conf. Ser. 664 (2015) 062033.

