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DESIGN AND IMPLEMENTATION OF A WEB APPLICATION FOR CMS RPC STATE MONITORING [2]

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Abstract: *This work presents the design and implementation of the RPC State Tracker, a web application for monitoring and analyzing the performance of the Resistive Plate Chambers (RPCs) of the CMS experiment at CERN. The application was developed to facilitate systematic exploration of RPC efficiency data and to support comparative analysis across different operational periods. It provides an intuitive, web-based interface for interactive visualization of efficiency maps and derived performance metrics. Implemented with a Python (Flask) backend and a JSROOT-based frontend, the system integrates ROOT data processing, statistical analysis, and dynamic visualization within a unified and modular framework. The application enables quantitative efficiency comparisons and incorporates statistical significance testing, including the Z-test and the Wilcoxon signed-rank test, allowing users to assess performance variations in a consistent and reproducible manner. The backend architecture is designed to ensure efficient data handling and on-demand execution of statistical computations, while the frontend focuses on usability and clarity of data presentation. By combining established scientific data formats with modern web technologies, the RPC State Tracker enhances accessibility to complex performance data and demonstrates the potential of lightweight, data-driven web applications for monitoring and analysis tasks in large-scale physics experiments.*

Keywords: *RPC State Tracker, Resistive Plate Chambers (CMS), Performance Monitoring, Web Application, Data Visualization, Statistical Analysis, ROOT Data Processing.*

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REFERENCES

Brun, R., & Rademakers, F. (1997). ROOT – An object oriented data analysis framework. *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 389(1–2), 81–86.

CMS Collaboration (2008). The CMS experiment at the CERN LHC. *Journal of Instrumentation*, 3, S08004. https://doi.org/10.1088/1748-0221/3/08/S08004

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CMS Collaboration (2010). Performance study of the CMS barrel resistive plate chambers with cosmic rays. *Journal of Instrumentation*, 5, T03017. https://doi.org/10.1088/1748-0221/5/03/T03017

Copy, B., Bräger, M., Ehm, F., Lossent, A., & Mandilara, E. (2017). C2MON SCADA deployment on CERN cloud infrastructure. Paper presented at the *16th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS'17)*, October 2017, Barcelona.

JSROOT (2025). JSROOT: JavaScript ROOT. URL: https://root.cern/manual/jsroot/

(Accessed on 18.11.2025).

Montgomery, D. C., & Runger, G. C. (2010). *Applied statistics and probability for engineers*. Hoboken, NJ: John Wiley & Sons.

Arcidiacono, R., *et al.* (2005). CMS DCS design concepts. *Proceedings of the 10th International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS'05)*, Geneva.

Rey, D., & Neuhäuser, M. (2011). Wilcoxon signed-rank test. In Lovric, M. (ed.) (2011). *International encyclopedia of statistical science*. Berlin: Springer. https://doi.org/10.1007/978-3-642-04898-2_616