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CMS improved Resistive Plate Chambers (iRPC) upgrade Web-based automation for Quality Control

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Abstract

In the context of the CMS improved Resistive Plate Chambers (iRPC) upgrade, a strategy has developed that leverages cosmic muon triggers along with web-based automation for Quality Control (QC) steps. A key aspect of this approach was finding a way to bridge slow and fast control parameters, a crucial step towards achieving full automation. This integration not only enhances the efficiency and accuracy of the QC process for the iRPC system but also streamlines the workflow and significantly reduces the likelihood of human errors. This development is a valuable improvement in the CMS experiments upgrade efforts, contributing to more reliable and efficient operations in high-energy physics research.

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CMS improved Resistive Plate Chambers (iRPC) upgrade: Web-based automation for Quality Control

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In the context of the CMS improved Resistive Plate Chambers (iRPC) upgrade, we have developed a strategy that leverages cosmic muon triggers along with web-based automation for Quality Control (QC) steps. A key aspect of our approach was finding a way to bridge slow and fast control parameters, a crucial step towards achieving full automation. This integration not only enhances the efficiency and accuracy of the QC process for the iRPC system but also streamlines the workflow and significantly reduces the likelihood of human errors. This development is a valuable improvement in the CMS experiment's upgrade efforts, contributing to more reliable and efficient operations in high-energy physics research.

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1. Introduction

In order to cope with the high particle rate and challenging pileup environment of the HL-LHC [1], the CMS collaboration proposed the installation of new RPC. A total number of 72 improved RPC (iRPC) will be added to the 2 outer stations of the CMS endcap within $2.4 > |\eta| > 1.8$. The iRPC [2] chambers consist of double-gap detectors with gaps made of 1.4 mm low-resistivity High Pressure Laminate (HPL) electrodes. These electrodes are separated by a gas gap of the same thickness. The new layout reduces the amount of avalanche charge produced, thereby improving rate capability by reducing the charge collection time.

2. Quality Control

To ensure peak performance for the HL-LHC, a comprehensive Quality Control (QC) process was developed, rigorously testing every component of the iRPC chambers. The first phase, QC1, focuses on chamber components such as the High Pressure Laminate (HPL) under INFN Pavia (Italy) supervision, Strip Printed Circuit Boards (PCBs), and Front-End Boards (FEBs) at IP2I Lyon (France), as well as the cooling system at the Georgian technical university (Georgia).

In QC2, gap testing is performed to identify any potential gas leaks, ensure proper spacer bonding, and check the dark current scan and stability. At the assembly sites, additional tests are conducted to further assess gas leaks, spacer bonding quality, and the dark current stability.

QC3 covers the chamber tests performed at the assembly sites. QC3.1 focuses on chamber assembly tests, while QC3.2 involves chamber cosmic tests using a portable FEB to evaluate noise levels, efficiency, cluster size, and high voltage stability.

Finally, QC4 involves tests conducted at the R&D Laboratory in Building 904 at CERN. QC4.1 includes final chamber tests such as cooling leak tests, gas leak tests, and dark current scans, while QC4.2 ensures long-term high voltage stability. QC4.3 further subjects the chambers to cosmic tests using the final FEBs.

3. WebDCS for Quality Control

WebDCS is employed for both QC3.2 and QC4.3, providing a web-based automation approach that facilitates communication between detector slow control and data acquisition systems.

The idea of the QC3.2 on WebDCS is shown in a nutshell in Figure 1. Once the WebDCS start button pushed following items are followed.

- The high voltage is set, and dark current and HV values are monitored.
- Data acquisition starts, and data from the FEB is acquired and sent to the DAQ.
- WebDCS completes the cosmic trigger count, repeating the procedure for different HV points.
- This procedure continues until all the desired HV points are done.
- Then the Analyse button can be used to monitor data quality.

Such a system allow us to monitor both slow and fast control from the same panel at the same time keeping a database of all required information.

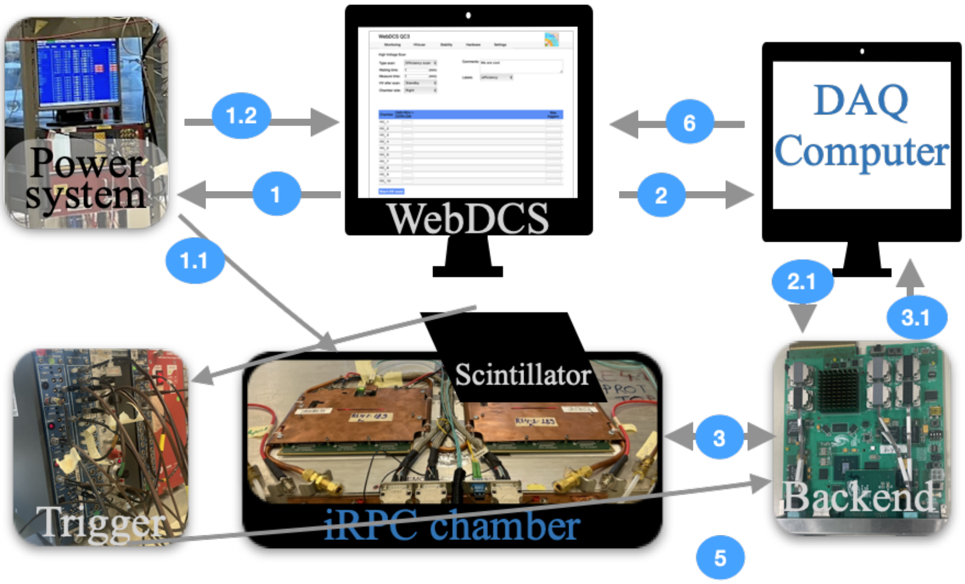

Figure 1: The conceptual overview of the Quality Control (QC3.2) system on the WebDCS platform, highlighting key components and functionalities at a glance.

4. Conclusion

62 out of 72 chambers have been assembled and passed QC1, QC2, and QC3.1. 58 of these chambers have passed QC3.2. The rigorous WebDCS-based QC system ensures comprehensive quality control.

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[1] CMS Collaboration, The Phase-2 Upgrade of the CMS Muon Detectors, *CERN-LHCC-2017-012* (2017).

[2] E. Asilar, *Performance of improved rpcs demonstrator for the cms at the hl-lhc*, *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* **1048** (2023) 167953.