Contribution ID: **209** Type: **Poster Presentation**

Real-Time Indoor Air Quality Monitoring and Adaptive Ventilation in Scientific Workspaces

Real-time monitoring and control are essential in particle physics environments, where experimental precision depends not only on instrumentation stability but also on the well-being of personnel. Technicians and physicists at CERN often work long hours on sensitive detector systems within confined spaces, where elevated CO_2 levels can impair cognitive function and reduce operational efficiency. Ensuring optimal indoor air quality in such high-performance settings is a critical aspect of experimental infrastructure.

To address this, the South African Consortium of Air Quality Monitoring (SACAQM) has developed an IoT-enabled Indoor air quality monitoring system. The network supports real-time sensing of particulate matter (PM1, PM2.5, PM5, PM10), volatile organic compounds (VOx), nitrogen oxides (NOx), and carbon dioxide (CO_2). A pilot deployment at Evotel offices has revealed clear links between CO_2 accumulation and occupancy patterns. In response, an adaptive ventilation system using automated fans has been introduced to maintain CO_2 levels within healthy limits. This low-cost feedback loop is currently under performance evaluation.

The aim of developing and validating this system in South Africa, is to demonstrate its applicability in research environments like CERN. Implementing real-time indoor air quality monitoring and adaptive ventilation in CERN's workspaces could support cognitive well-being, reduce fatigue, and maintain high operational standards.

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Session Classification: Poster Session

Track Classification: Track F - Applied Physics