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The gas systems for the detectors at the LHC experiments: overview of the performances and upgrade strategy in view of the High Luminosity LHC phase.

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Over the five experiments (ALICE, ATLAS, CMS, LHCb and TOTEM) taking data at the CERN Large Hadron Collider (LHC) 27 gas systems are delivering the proper gas mixture to the corresponding detectors. Each gas system is made of different functional modules which are distributed on average into about 10 Universal Euroracks. If we imagine to put one on the top of the other the 270 Euroracks used for the LHC gas systems, we reach a height (about 500 meters) higher than the tour Eiffel height.
The gas systems for the LHC experiments were built according to a common standard allowing minimizing manpower and costs for maintenance and operation.
A typical gas system is made of several modules: mixer, pre-distribution, distribution, circulation pump, purifier, gas analysis, etc. Gas systems extend from the surface building where the primary gas supply point is located to the service balcony on the experiment following a route few hundred meters long. Even if all functional modules are basically equal between different gas systems, they can be configured to satisfy the specific needs of every gaseous particle detector.
The statistic accumulated over the last years of LHC operation demonstrates how stable and reliable the gas systems for the LHC experiments are: on average a system was in stop for less than 1 hour per year, corresponding to an efficiency greater than 99.98%. Despite the excellent result, the activities are addressed to a careful planning of maintenance and consolidation/upgrade work to maintain and, possibly, improve the performances in the years to come.
Clear examples concern the gas system’ s flow regulators, the needs for an increase in the gas flow circulation in the detectors and the effort for reducing the consumption of expensive or greenhouse gases.
After several years of operation, the performance of specific flow regulators is currently under investigation. An extensive calibration/verification campaign is ongoing. It will allow optimizing the flow range for future operation and to understand the performance in relation with the specific gas used.
The circulation flow increase is needed to safely operate the detectors at the higher LHC luminosity foreseen in the years to come and/or to integrate new detectors installed during present or imminent upgrades. In addition, also the gas system needs reinforcements in order to maintain a certain redundancy ensuring a fast recovery in case of unexpected failures.
Given the large detector volume served by the gas systems and the use of relatively expensive or greenhouse gases components, for technical and economical reasons most of the detectors are operated in gas re-circulation mode. In addition, new systems, making use of different principles, have been developed for the recuperation of the gas mixture present inside the detectors. This operation is of particular relevance especially in preparation of the future LHC shutdowns. Some examples will be described in the present contribution.

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