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Upgrade of the LHC vacuum control system towards the High Luminosity LHC era

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The HL-LHC project has initiated a comprehensive upgrade of the LHC vacuum control system. Much of the vacuum control hardware, installed at the beginning of the LHC in 2008 or even dating back to the LEP era in the 1990s, was becoming obsolete and required modernization.
Additionally, the new HL-LHC operating conditions will induce higher radiation levels; therefore, new radiation-tolerant electronics are required in the arcs and dispersion suppressor areas, as well as radiation-hard equipment in the matching sections.
Moreover, during the third long shutdown (2026-2030), the matching sections around the ATLAS and CMS experiments will need to be extensively modified with the insertion of new systems. The vacuum control system will be relocated to new underground galleries, with a significant increase in vacuum control equipment.
This upgrade, progressively implemented during each year-end technical stop and long shutdown, spans from 2019 to 2030. Hundreds of controllers are involved, along with significant control software design and refactoring, while keeping the vacuum control system fully operational.
This paper provides an overview of the new designs and technological solutions chosen, the radiation hardness assurance applied, the evolution of the vacuum control system architecture, and the main control software upgrades to ensure decades of reliable operation. Furthermore, it presents the current progress, challenges, and outlines future activities planned until 2030.

Footnotes

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