



Contribution ID: 7 Contribution code: TUPD011

Type: **Poster Presentation**

Active magnetic bearings electronic system upgrade for CERN's (HL)-LHC cryogenic 1.8 K cold compressor units

Tuesday 23 September 2025 16:00 (1h 30m)

The Large Hadron Collider (LHC) at CERN relies on superfluid helium, supplied by eight large refrigeration units, each providing 2.4 kW at 1.8 K. These units, developed by specialized cryogenic industrial suppliers, consist of serial hydrodynamic cold compressors equipped with axial-centrifugal impellers and Active Magnetic Bearings (AMB), coupled with volumetric warm screw compressors. The AMB electronic units, delivered by suppliers, have been in reliable operation for over 20 years.

As part of the CERN consolidation project, the need to meet evolving LHC cryogenic operational requirements—along with the obsolescence of electronic components—has driven the upgrade of the entire electronic and electrical control system. A step-by-step analysis, beginning with an operational risk assessment, led to the design and development of a prototype. This effort was undertaken at CERN in collaboration with the French company SKF Magnetic Mechatronics.

The prototype underwent extensive testing, first in a dedicated CERN cold compressor test bench and later in real-system operation, where it was successfully validated. This paper presents the complete upgrade process, the positive test results obtained, and the outlook for full deployment during the LHC Long Shutdown 3 (2026–2029).

Footnotes

Funding Agency

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Session Classification: TUPD Posters

Track Classification: MC02: Control System Upgrades in Existing Facilities