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## Design, construction and commissioning of a 15 kW CO<sub>2</sub> evaporative cooling system for particle physics detectors: lessons learnt and perspectives for further development

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Since 2000, a few particle physics detectors have been using evaporative Carbon Dioxide (CO<sub>2</sub>) for their low temperature cooling systems, showing exceptional performances and stability in their full range of operation. The excellent physical, thermal and fluid dynamic properties of CO<sub>2</sub>, coupled to its radiation hardness, make it a very interesting option for the cooling systems of the next generation vertex and tracking detectors.

In order to match the requirements of the CMS Pixel Phase I upgrade, a 15 kW cooling system featuring evaporative CO<sub>2</sub> has been designed, constructed and commissioned in 2013, as a full-scale prototype of the final system.

This paper describes the challenges during the design and construction phases, highlights the performance achieved during commissioning, and describes the optimisation of the design for the final system. Results of the performance tests, including stability of the temperature regulation while power cycling are illustrated as well.

An outlook on further scaling up is given in view of designs for higher cooling power, as needed for the next generation of tracking detectors for the LHC experiments.

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