CO_2 evaporative cooling: the future for tracking detector thermal management

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Why evaporative cooling?

- ✓ Low flow and higher Heat Transfer Coefficient (HTC) : smaller pipes!
- ✓ Limited temperature excursion on the detector: isothermal evaporation

Why CO_2?

Significant saving on material budget

- ✓ large latent heat of evaporation
- ✓ low liquid viscosity
- ✓ higher Heat Transfer Coefficient than, e.g. C_3F_8
- ✓ high thermal stability due to the high pressure

Very practical fluid to work with

- ✓ Environmental friendly with respect to presently used fluorocarbons
- ✓ Radiation resistant
- ✓ Cheap

LHCb Velo
1 kW, -30 °C

ATLAS IBL
2 x 3 kW, -35 °C

CMS Pixel Phase I
2 x 15 kW, -25 °C

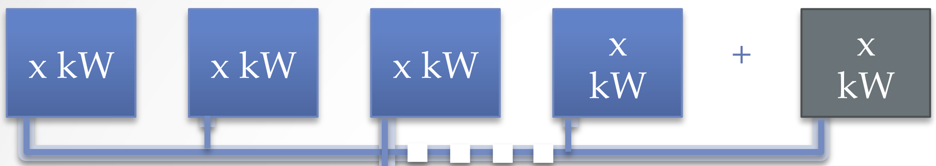
LHCb Velo II & UT
2 x 7 kW, -30 °C

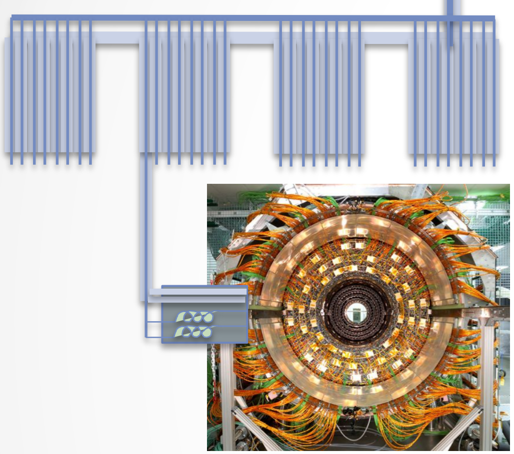
CMS Tk Upgrade
100 kW, - 30°C

ATLAS ITk Upgrade
140 kW, - 35°C

2003 — 2014 — 2015-17 — 2018-19 — 2023-24

Challenges to next generation of CO2 systems





Primary systems TO BE TESTED:
industrial CO2 chillers

- up to several hundred kWs
- small footprint
- Environmental friendly
- Good T range

CO2 storage & regulation of complex system
Alternative to 2PACL: design to allow surface storage (local pump and pressure control through pressure regulation valves)

High cooling power (several 100 kW)
Redundancy concept of N+1 plants: swap in operation, distribution, optimization of transfer lines. R&D needed for parallel operation!

Common concept being developed @ CERN for next generation CO_2 plants!

Conclusions

- R&D and conceptual development exploiting full synergies for Phase II detectors
- LHCb Upgrade profiting of the experience of both ATLAS and CMS on CO_2 cooling
- Common Demo system necessary on medium term to verify conceptual design
- CO_2 cooling is a complex system where on-detector and off-detector design shall be developed together: synergies and collaboration needed between detector experts and cooling team