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# LHC low beta quadrupole magnets: cryogenic refrigeration capacity and improved controls for luminosity optimization

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The LHC low-beta quadrupole magnets, also known as "Inner Triplets", are the final focusing magnets located on each side of the LHC interaction points. The design of the currently operated LHC Inner Triplets is based on NbTi superconducting technology. The magnets are operated in superfluid helium and use a longitudinal heat exchanger to extract the power deposited by the secondary particles coming from the proton collisions. The dynamic heat load in the Inner Triplet is proportional to the LHC luminosity and due to the recent upgrades of LHC and its injectors, the cryogenic capacity limit can be reached in ATLAS and CMS experiments where the luminosity can go slightly beyond the LHC ultimate values. This paper summarizes the history of the Inner Triplet cryogenics with the dedicated tests performed in the past to assess their cooling capacity. Then, it describes the optimization-oriented techniques implemented in the cryogenic process control system to handle the luminosity transients and finally presents a new process control interaction between the cryogenic system and the LHC levelling server, towards a high-level optimization of the achieved LHC luminosity without loss of the cryogenic conditions.

## Funding Agency

## Footnotes

## I have read and accept the Privacy Policy Statement

Yes

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