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Optimizing cavity detuning at high beam intensities in the LHC

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The increased beam intensity during the high luminosity LHC era is expected to impose tight margins on the operation of the LHC RF system. The larger momentum spread from the injectors together with twice the bunch charge requires a higher RF voltage at injection to avoid beam losses. However, the peak RF power due to the increased beam loading must be kept below the saturation level of the klystrons. Accurate optimization of RF parameters is therefore needed to maintain a sufficient RF voltage to capture and retain the injected beam. In the LHC, the beam-loading is partially compensated by detuning the RF cavities. This is achieved at injection by a pre-detuning scheme and throughout the injection plateau by applying half-detuning. During the 2024 run the pre-detuning was adjusted with beam to minimize the required peak power at injection. Furthermore, a new algorithm was developed to optimize the setup of the half-detuning scheme at a given bunch intensity. Both measures have been essential to accommodate higher beam intensities in the LHC.

Footnotes

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