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Stability survey of a double RF system with RF feedback loops for bunch lengthening in a low-emittance synchrotron ring

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Bunch lengthening with a double radio-frequency (rf) system combining fundamental and harmonic cavities (HCs) is essential in achieving extremely low emittance along with suitable lifetime as required for ring-based fourth-generation synchrotron light sources in the low-to-medium energy range.

Recent studies have pointed out that, in many cases, an unstable beam motion, as so-called "periodic transient beam loading effect*1*" or "*coupled-bunch mode=1 instability2*", prevents from reaching the optimum bunch lengthening condition. One effective way to raise the bunch lengthening limit is to reduce the total R/Q of the HCs. However, there is also a limit to the reduction of their R/Q due to the need for generating sufficient HC voltage for bunch lengthening.

We have then considered using active (powered) HCs with conventional rf feedback loops, coupled-bunch mode damper and direct rf feedback, which were modeled and introduced in the particle tracking code, mbtrack. The tracking results for the SOLEIL-II ring case show that the direct rf feedback is quite effective in suppressing the beam instabilities thanks to its ability of reducing the cavity impedance as seen by the beam. The features of the implemented rf feedback loops and the simulation results are reported.

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Footnotes

*1 T. He et al., Phys. Rev. Accel. Beams, 25, 024401, 2022.*2 M. Venturini, Phys. Rev. Accel. Beams, 21, 114404, 2018.

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