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## Study of longitudinal bunch-by-bunch feedback in an ultra-low-emittance ring in the presence of bunch lengthening cavities

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The SOLEIL II upgrade project aims to achieve ultra-low emittance and high beam current. In the SOLEIL II ring, there shall be new main RF cavities (MCs) and bunch lengthening harmonic cavities (HCs). Since the newly adopted MCs would have a non-negligible probability of exciting HOMs (Higher-Order Modes)-induced longitudinal coupled-bunch instabilities, it was decided to implement longitudinal bunch-by-bunch feedback (LFB) in addition to the transverse. In the longitudinal beam dynamics, however, there are some further complications, which are due to the introduction of HCs, which, along with the MCs, create the so-called flattened potential, which above all helps increasing the shortened beam lifetime. Despite its benefit, the bunch lengthening system creates effects that can be harmful to LFB, such as significant lowering of the synchrotron frequency, as well as longitudinal phase distortions between bunches in non-uniform beam fillings. This project develops a dedicated LFB system through advanced beam dynamics and electromagnetic field simulations and semi-analytical modelling. The goal is to ensure longitudinal beam stability and maximize the feedback performance.

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