Longitudinal beam dynamics in ultra-low emittance rings

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A key feature of ultra-low emittance storage rings is the need for bunch lengthening to prevent emittance degradation from intrabeam scattering and/or to improve the Touschek beam lifetime. This is typically solved using Landau cavities operating at a harmonic of the main RF. These may be actively powered through the use of additional RF transmitters or passively driven by the beam itself. Using the MAX IV 3 GeV ring as an example, the most important considerations in the design and operation of these double-RF systems are reviewed from a beam-dynamics perspective. Potential issues and possible mitigations are identified. Finally, the option of adding RF cavities at additional higher harmonics, with the goal of lengthening the bunches even further, is discussed.