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Landau damping with a transversely gaussian pulsed electron lens

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A pulsed electron lens produces a betatron tune shift
along a hadron bunch as a function of the longitudinal coordinates, which is a longitudinal detuning. An example of transverse detuning is the tune shifts due to octupole magnets. This paper considers a pulsed electron lens as a measure to mitigate the head-tail instabilities. A detailed analytical description within a Vlasov formalism presents the coherent properties of the longitudinal and transverse detuning.
The analytical predictions are compared with the results of the particle tracking simulations. A pulsed electron lens is demonstrated to be a source of tune spread with two components: a static one, leading to Landau damping; and a dynamic one, leading to an effective impedance modification, which we demonstrate analytically and in our particle tracking simulations. The effective impedance modification can be important for beam stability due to devices causing longitudinal detuning, especially for nonzero head-tail modes. The Vlasov formalism is extended to include the combination of longitudinal and
transverse detuning. As a possible application at the SIS100 heavy-ion synchrotron (FAIR at GSI Darmstadt, Germany), a combination of a pulsed electron lens with octupole magnets is considered.

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Footnotes

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