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Quadrupole pumping for bunch shortening in the Proton Synchrotron and Super Proton Synchrotron at CERN

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Quadrupole pumping is a longitudinal manipulation technique for bunch shortening, which works by modulating the RF voltage at twice the synchrotron frequency to excite bunch length oscillations. These controlled oscillations rotate the bunch in longitudinal phase space, with extraction set for when the bunch is shortest. Higher RF harmonics can also be used to linearise the synchrotron frequency distribution, reducing the formation of tails. Recently, quadrupole pumping has been proposed as a method for achieving ultra short bunches for proton-driven plasma wakefield accelerators such as the AWAKE experiment. In this contribution, we assess the performance of quadrupole pumping for the first time in the Proton Synchrotron (PS) and Super Proton Synchrotron (SPS) at CERN. Using simulations and beam measurements, we compare the effectiveness of this technique (without linearisation) against other bunch-shortening methods, including the unstable phase jump and the non-adiabatic voltage jump.

Footnotes

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