Can an Electron Be at Rest?

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http://kirkmcd.princeton.edu/examples/EM/romer_ajp_63_777_95.pdf

Classically a particle is at rest (in some frame) when its velocity and momentum vanish. In quantum mechanics, simply requiring the expectation value of momentum to be zero implies only that the particle's average velocity is zero. Something closer to the classical meaning of "rest" is achieved only when one requires that the expectation value of the square of the velocity be vanishingly small as well. As indicated in the statement of the Question, the uncertainty principle then tells us that this condition can only be achieved if the particle is in an arbitrarily large box.

Consider the recent example of trapped ^{87}Rb atoms that formed a Bose-Einstein condensate.[1] Those atoms were most nearly at rest for any particles studied to date. The trap size was about 0.1 mm so the corresponding r.m.s. atomic velocity was $\hbar/m\Delta x \approx 1$ cm/s. While this may see high by classical standards, it corresponds to a temperature of only a few $\times 10^{-7}$K and is a remarkable achievement.

[1]M.H. Anderson *et al.*, Science **269**, 198 (1995),
http://kirkmcd.princeton.edu/examples/QM/anderson_science_269_198_95.pdf