Wave-packet propagation in 1D chains

Consider a binary 1D chain described by the following tight binding Hamiltonian:

$$\mathcal{H} = -t_0 \sum_{i=0}^{L} (|i\rangle\langle i+1| + H.c.) + \sum_{i=0}^{L} V_i |i\rangle\langle i|,$$

where $V_i = V_i^0 + i * E/L$ is the potential energy with $V_i^0 = (-1)^i V_0$ describing the on-site energy and E an applied electric field. Such a Hamiltonian was used for describing Bloch-Zener oscillations in Ref.[1].
Solve the time-dependent problem of a wave-packet starting at $i = L/2$ by using the Chebyshev time-propagation scheme.

Tasks to complete by modifying the provided code:

- investigate how the "step size (dt)" affects the total running time of the code for a given propagation time
- study the effect of DC and AC(square pulses) electric fields on the motion and spread of the wave-packet
- study the interplay between the period of the Bloch oscillation, the frequency of the square AC pulse and the magnitude of the dimerization gap induced by the alternating on-site potential. Explore the different regimes that can be achieved in the spread of the wave-packet (see Ref [1]).
- repeat the calculation for a larger unit cell (e.g. 4 different atom types with different on-site energies)

[1] S Longhi, J. Phys. B: At. Mol. Opt. Phys. 45 225504 (2012)