Abstract. In the physics literature it is common to use “in cascade” the rotating wave approximation and the adiabatic approximation for chirped pulses of two-level quantum systems driven by one external field, in particular when the resonance frequency is not known precisely. Both approximations need relatively long time and are based on averaging theory of dynamical systems. Unfortunately, the two approximations cannot be done independently since, in a sense, the two time scales interact. We study how the cascade of the two approximations can be justified, while preserving the robustness of the adiabatic strategy. Our first result, based on high-order averaging techniques, gives a precise quantification of the uncertainty interval of the resonance frequency for which the population inversion works. As a by-product, we prove controllability of an ensemble of spin systems by a single real-valued control, providing an extension of a celebrated result with two controls by Khaneja and Li.