SUPPLEMENTARY INFORMATION

A nonlinear response as a consequence of Rabi oscillations for short pulses ($\tau \ll \Gamma$) can also be seen for exponential pulses. Figure 1(a) shows the atomic response for $\tau_e = 5\,\text{ns}$ and $\langle N \rangle \approx 1000$. During the rise, the Rabi frequency increases with time, leading to a more pronounced oscillatory behaviour in the population than in Figure 4 of the main article before the pulse turns off and the population decays exponentially.
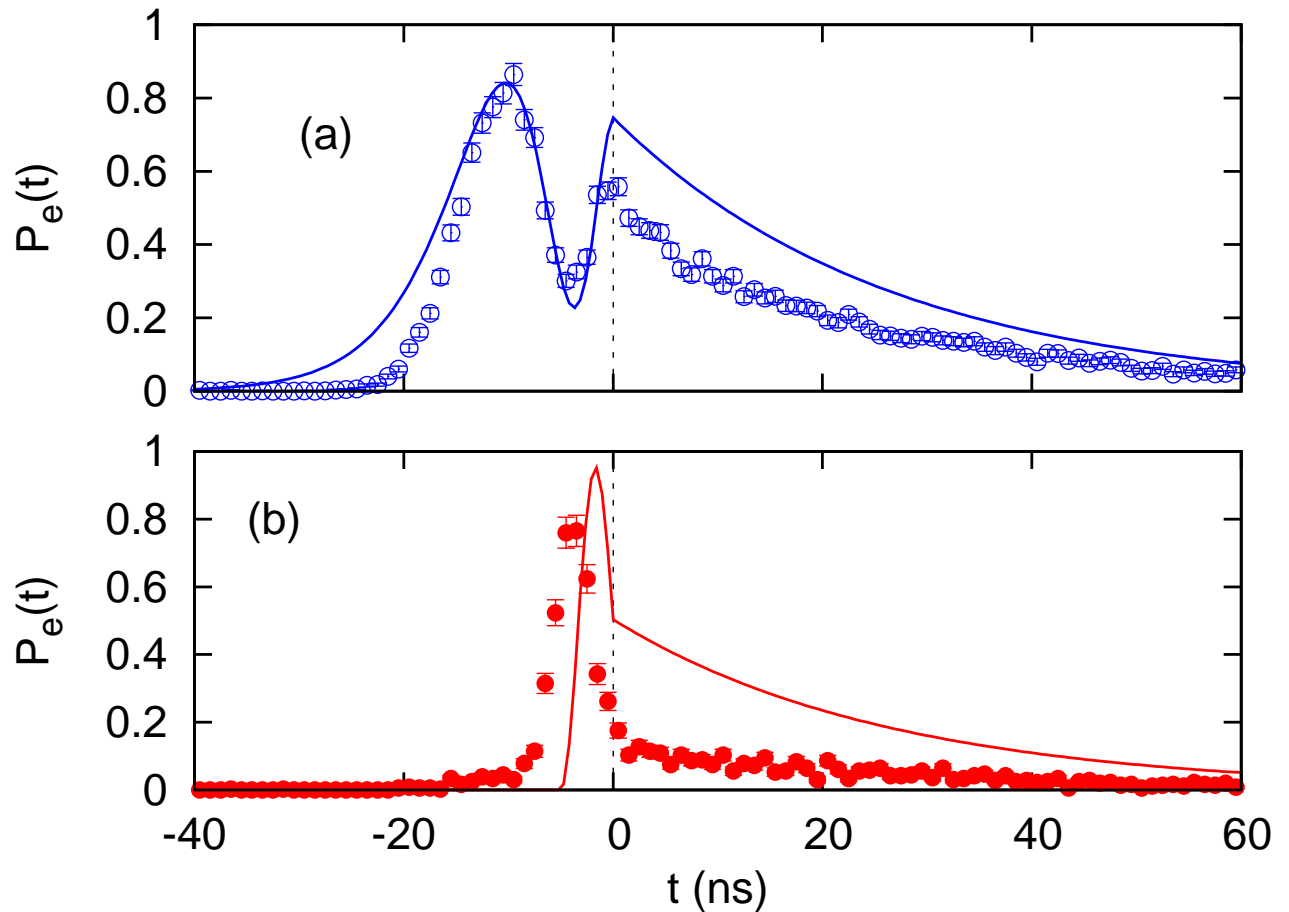

FIG. 1: (a) Excitation dynamics for an exponential pulse with $\tau_e = 5\,\text{ns}$. (b) For reference, the response to a square pulse with $\tau_{\text{sq}} = 5\,\text{ns}$. Respective average photon numbers are $\langle N_e \rangle = \langle N_s \rangle \approx 1000$. The solid lines shows predictions from the theoretical model.

The deviation from the theoretical model for the square pulse for this short pulse time is significant because rising and falling slopes make up a large fraction of the whole pulse.