Hyperpolarized $^1$H long lived states originating from Parahydrogen accessed by CW irradiation


In the main text we have introduced the sequence to access the pH$_2$ singlet state inside the observation field. The sequence is based on the application of a CW pulse with amplitude $\omega_1$ at a particular off-resonance frequency ($\Delta\omega$). In order to enable the singlet-triplet transition both quantities should satisfy the condition depicted in Eq. (14) in the paper.

The amount of singlet state converted into observable magnetization depends on the mentioned parameters ($\omega_1$ and $\Delta\omega$) as well as on the duration of the pulse ($d_{CW}$). These parameters were optimized by studying the amplitude of the vinyl peak after the singlet-triplet conversion, as shown in figure 1.

![Figure 1](image)

**Figure 1** Normalized signal integral of the hyperpolarized vinyl protons after a CW pulse depending on (a) the RF strength $\omega_1$ and (b) the CW pulse duration $d_{CW}$. In (b) the mean and the standard deviation values of four measurements are shown.

The sequence was tested for the following ($\Delta\omega$, $\omega_1$) combinations: (50 Hz, 677.9 Hz), (75 Hz, 1016.9 Hz), (100 Hz, 1355.8 Hz), (150 Hz, 2033.7 Hz) and (200 Hz, 711.6 Hz), using a CW pulse duration $d_{CW}$ of 5 s (Fig. 1 (a)). The signal integral increases fast until $\omega_1 = 1355.8$ Hz and reaches a plateau for higher values. Due to these results, the parameter combination (100 Hz, 1355.8 Hz) was used for further investigations.

In Fig. 1(b) the signal was analyzed for different pulse durations $d_{CW}$ using the combination (100 Hz, 1355.8 Hz). The maximum signal was found for a duration of 5 s, hence this value was chosen for the rest of the experiments. The decay of the signal for longer $d_{CW}$ values might be due to the spin lattice relaxation time of the vinyl protons, $T_1 \approx 10$ sec. The measurements were repeated for four times.