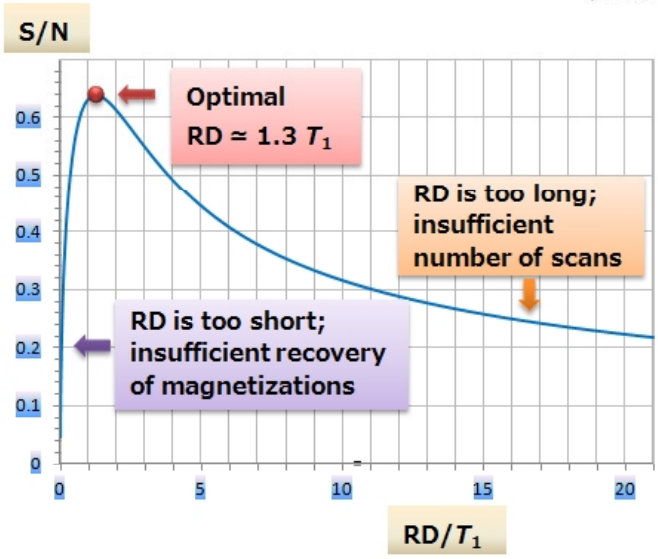
How to Set the Recycle Delay to Maximize the Sensitivity per Hour: Most Efficient Measurements

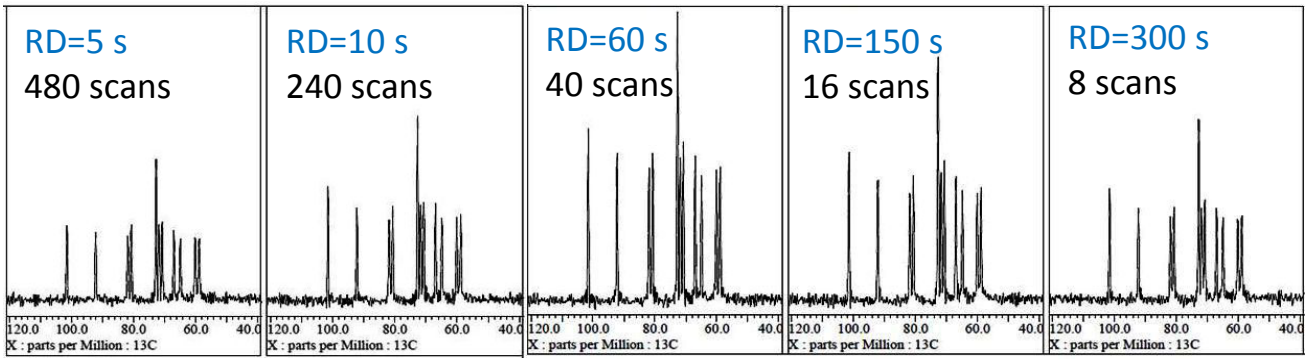
What should we do to obtain the maximum signal sensitivity in a given measurement time ? How about setting the recycle delay RD to be 3-5 times of the longitudinal relaxation time T_1 ? It is the case of quantitative NMR measuements. For the pulse sequences preparing transverse magnetizations, the S/N ratio per hour is given by the following equation:

$$S/N = \sqrt{\frac{T_1}{RD}}\left(1 - e^{-\frac{RD}{T_1}}\right)$$



The behavior of the function shown left clarifies that the signals can be most efficiently obtained when the recycle delay RD is set to be about 1.3 times of T_1. In contrast, too long RD decreases the number of scans per hour and so lowers the sensitivity. Also for too short RD, the sensitivity per hour becomes low since the magnetizations are not sufficiently recovered.

Figures shown below are a series of ^{13}C CPMAS spectra for sucrose ($T_1(^1H)$ = 50s) obtained in a given time of 2,400s. The most efficient measurement is realized for RD=60s.



References: 1. T. D. W. Claridge, "High-Resolution NMR Techniques in Organic Chemistry", Second Ed., Elsevier, 2009, pp99-102.

2. T. Nakai, New Glass, 28(2), 17-28 (2013).

JEOL RESONANCE