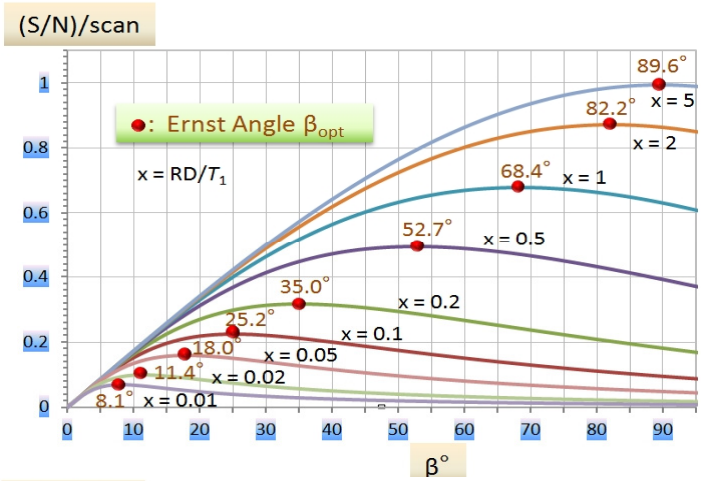
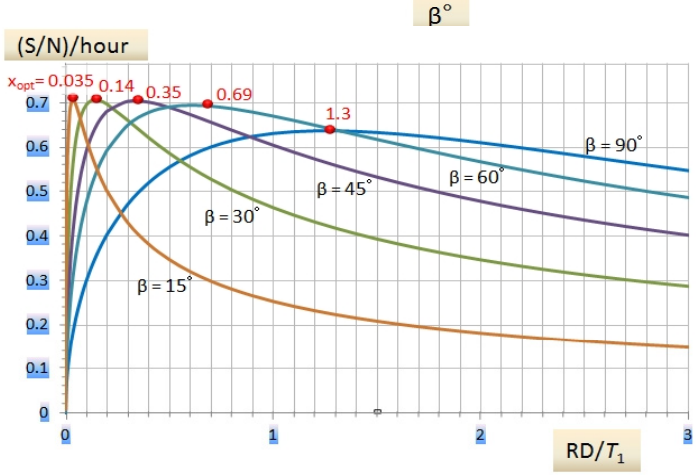
How to Set the Flip Angle to Maximize the Sensitivity per Hour: Meaning of Ernst Angle

A flip angle β smaller than 90 degree is often applied in the single-pulse measurements for long T_1 samples to accumulate the signals with a short recycle delay RD. Signal sensitivity per scan as a function of β shown below indicates maxima with smaller flip angles β_{opt} when T_1 becomes longer than RD, or when x=RD/T_1 becomes smaller. The angle β_{opt} is called Ernst angle and given by cos β_{opt} = exp(−RD/T_1) [1,2].





Some combinations of RD and β_{opt} to be set in the experiments are summarized below:

RD/T_1	β_{opt}
0.01	8.1°
0.02	11.4°
0.035	15°
0.05	18.0°
0.1	25.2°
0.14	30°
0.2	35.0°
0.35	45°
0.5	52.7°
0.69	60°
1	68.4°
2	82.2°
5	89.6°

As shown left, measurements with an appropriate combination of RD and β_{opt} may maximize the signal sensitivity per hour [3].

References: 1. R. R. Ernst, G. Bodenhausen, and A. Wokaun, "Principles of Nuclear Magnetic Resonance in One and Two Dimensions", Clarendon Press, 1987, pp124-125.

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

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

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