1) $T_2{}^* = 1/(\pi \times \Delta\upsilon_{1/2}) = 1/(\pi \times 2) = 0.16$ s $= T_2$ if line width is totally dictated by spin relaxation (no magnetic field inhomogeneity).

If 1Hz of the 2 Hz width is from inhomogeneity, $T_2{}^*$ is still 0.16 s, but T_2 is 0.32.

The FID decays with $T_2{}^*$ and multiplying with an exponential with a 1 s decay constant (T_e) adds to the decay constant: $\exp(-t/T_2{}^*)\times\exp(-t/T_e)=\exp(-t/T_2{}^*+-t/T_e)=$ $\exp(-t{}^*(T_2{}^*+T_e)/(T_2{}^*\times T_e))$, so, effective decay constant is $(T_2{}^*+T_e)/(T_2{}^*\times T_e)=0.138$, and line width becomes 2.3 Hz. These decay constants are often entered as line broadening (LB) or effective $1/T_2{}^* = 1/(\pi\times LB) + 1/0.16$. An LB of 1 Hz would add 1Hz to the line width.

2) a) acqusition time should be approximately $T_2{}^*$, or 0.3s
b) spectral width (Hz) for 200 ppm @ 50 MHz = 200 ppm × 50 Hz/ppm = 10,000 Hz
the dwell time should be 1/(2×spectral width) or 1/20000 = 5×10^{-5} s. For a 0.3 s acquisition one needs at least $0.3/(5\times10^{-5})$=6000 complex points.
c) the Ernst formula says optimal pulse angle = $\cos^{-1}[\exp(-aq/T_1)]$; optimum pulse angle is 20 degrees
d) none if signal to noise is to be optimized
e) line broadening should be about $1/(\pi\times T_2)$ or 1 Hz if signal to noise is to be optimized.

3) 4 minutes is long enough to reach steady state so S/N increases on averaging are well approximated by the square root of the length of time. Hence S/N after 100 min is 25:1 $(5\times\sqrt{100}/\sqrt{4})$.

4) $J_{P,H} = 21 \times \cos(\theta)^2$ - 2.25 = 18.8 for 180°, and 3.0 for 60°

Ideal Couplings

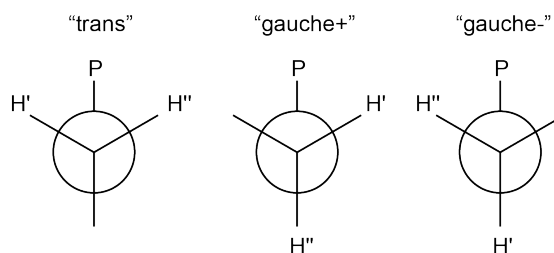|	Trans	Gauche-	Gauche+
$^3J_{PH'}$	3.0	18.8	3.0
$^3J_{PH''}$	3.0	3.0	18.8

Experimental
$^3J_{PH'} = f_T (3.0) + f_{G+} (3.0) + f_{G-} (18.8) = 6.0$
$^3J_{PH''} = f_T (3.0) + f_{G+} (18.8) + f_{G-} (3.0) = 8.0$
$f_T + f_{G+} + f_{G-} = 1.0$

Implies: $f_T = 0.5$, $f_{G+} = 0.3$, $f_{G-} = 0.2$

5) The carbonyl carbon uses an sp^2 hybrid orbital to bond to the nitrogen as opposed to an sp^3 orbital for the Cα carbon. Hence the s character ratio is 1/3 vs 1/4 and the coupling to the α carbon should be ¾ of 15 or about 11 Hz – this is approximately correct. If we consider the nitrogen of the C'-N bond to also use an sp^2 hybrid, the only difference from C=C in ethylene would come from the magnetogyric ratios and the C=C coupling in ethylene would be about 10/4 = 2.5 times larger – again approximately correct.