CPMG Guideline for Cryoprobes

History:

Index	Date	Changes	Initials
00	30.8.2012	Document created	SEY / RAK

1. Purpose

Safe operation of a NMR probe requires that the power and the durations of RF pulses do not exceed specified values. The “Typical pulses” document delivered with your probe contains this information for the most common application cases.

For CPMG T_2 or REX Type experiments on ^{13}C and ^{15}N it is of interest to know as well the limits for other working points, for example at a lower B_1 field but with longer decoupling time.

This document gives a guideline for such cases.

2. Scope

All 5 mm TCI H-C/N-D CryoProbes^{TM} from 500MHz to 950 MHz.

3. Reference to Documents

Please read the Document ZFCP0614 “5mm CryoProbe - Limitations” and

The “Typical Pulses” document belonging to your probe.

4. Implementation

4.1 Introduction

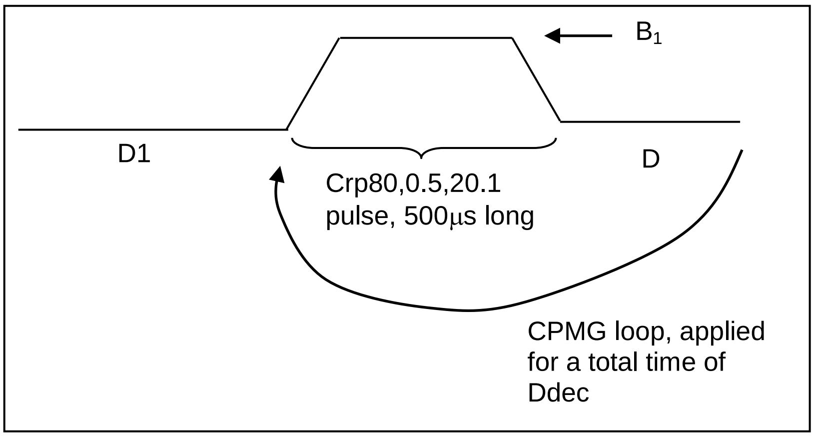
The graphs in the following sections present useful parameter ranges for cpmg type experiments. Remaining within the allowed range makes sure that the probe will not be damaged.

For the majority of applications working at the limits will still produce good spectra. Nevertheless, higher power loads in the allowed range usually result in a certain deshimming of the probe. The spectroscopic usefulness of the parameters has to be judged in accord with your spectroscopic needs. A deshimming might be tolerable to some extent for spectra with relatively broad lines whereas it is not for narrow lines.

First remedy when too much deshimming occurs would be to increase D1, increase dummy scans and adopt ‘Auto Shim’. Be careful to adopt correct parameters when using ‘Auto Shim’. A missetting might even give poorer results or produce artifacts.

4.2 Limits for 13C CPMG with adiabatic inversion pulses

Sequence:



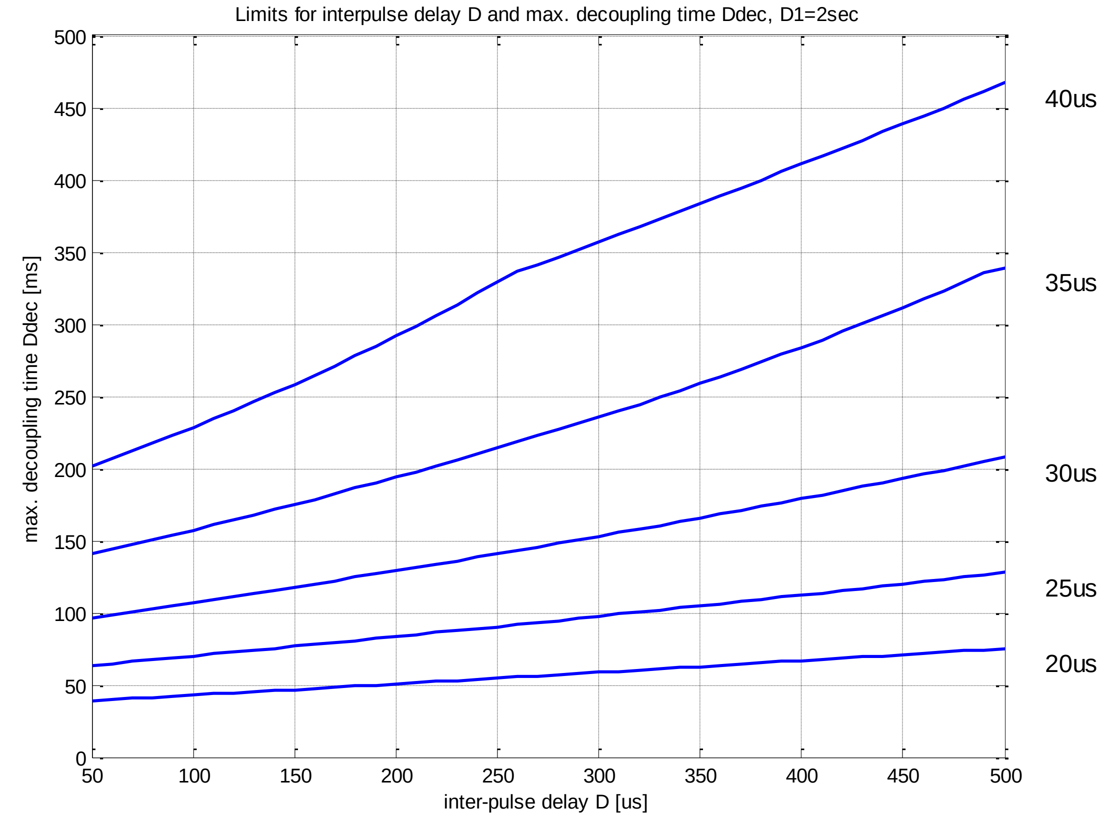
B_1 = maximum field strength of shaped pulse

D = interpulse delay

D1= recycle delay

In standard cpmg sequences the 'decoupling time' Ddec is the length of the CPMG element (d20) and the inter-pulse delay is defined by 2*D21.

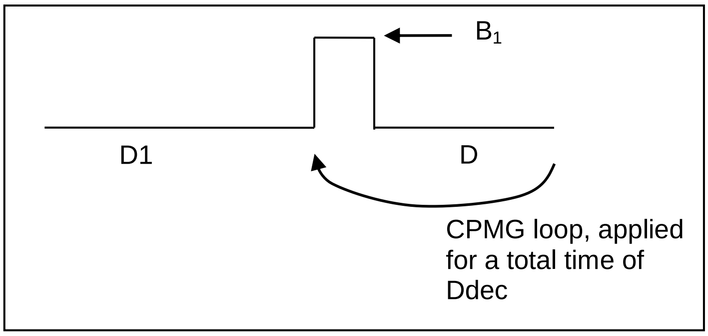
The limits can be read out from the following graph:



The traces show the maximum decoupling time for a given B_1 field strength (given as a 90° pulse angle (20µs…40µs), D1 is assumed 2.0 s
All values below a specific trace are possible

4.3 *Limits for 13C CPMG with hard inversion pulses*

Sequence:

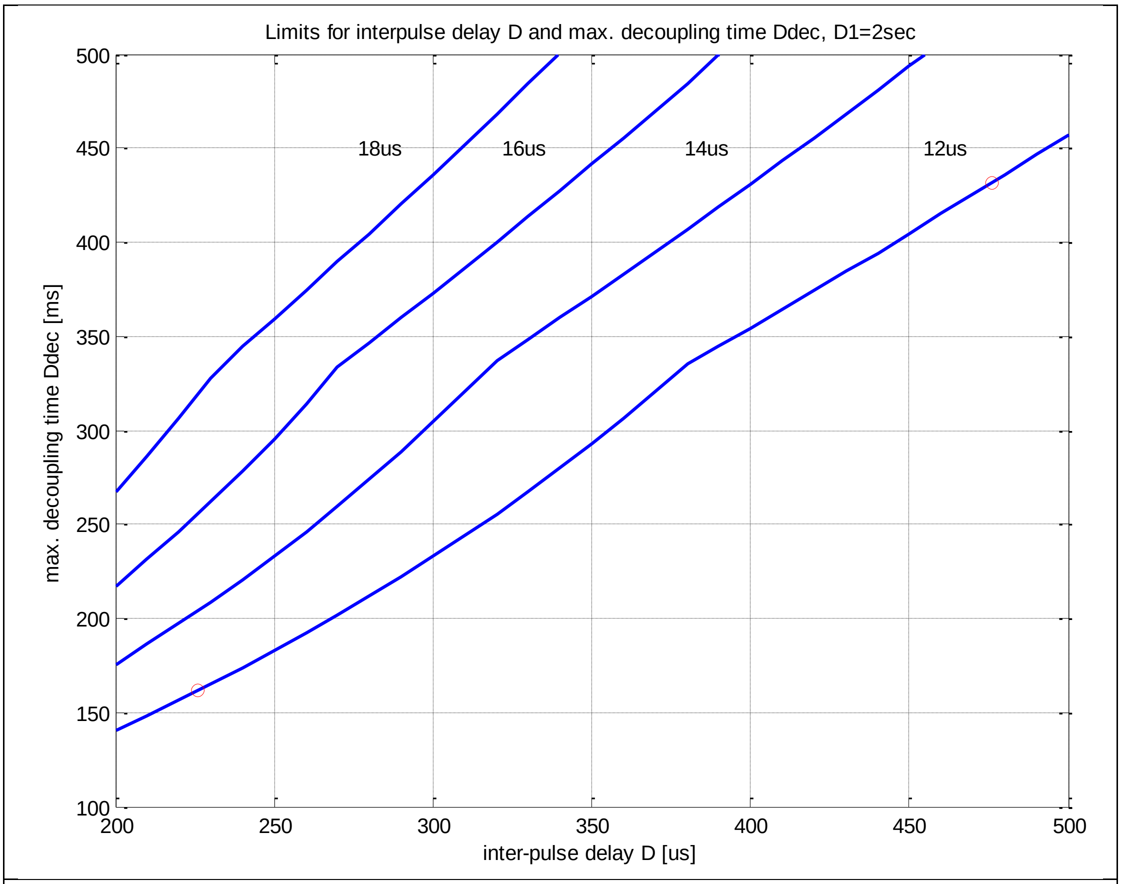


B_1 = maximum field strength of inversion pulse

D = interpulse delay

D1= recycle delay

In standard cpmg sequences the decoupling time is the length of the CPMG element (d20) and the inter-pulse delay is defined by 2*D21

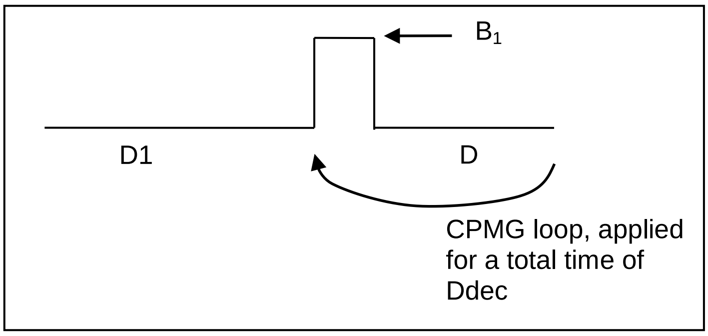


The traces show the maximum decoupling time for a given B_1 field strength (given as a 90° pulse angle (12μs…18μs), D1 is assumed 2.0s
All values below a specific trace are possible
The red circles denote limits for REX with 2kHz and 1kHz rotation frequency and 12μs 180° field strength (i.e. the pulse is 24μs long)

So, for a typical cpmg REX sequence with 2kHz and 12μs pulse strength, a maximum decoupling time of about 150ms is allowed. (which means 2* 75ms periods in the usual sequences)

4.4 Limits for 15N CPMG with hard inversion pulses

Sequence:

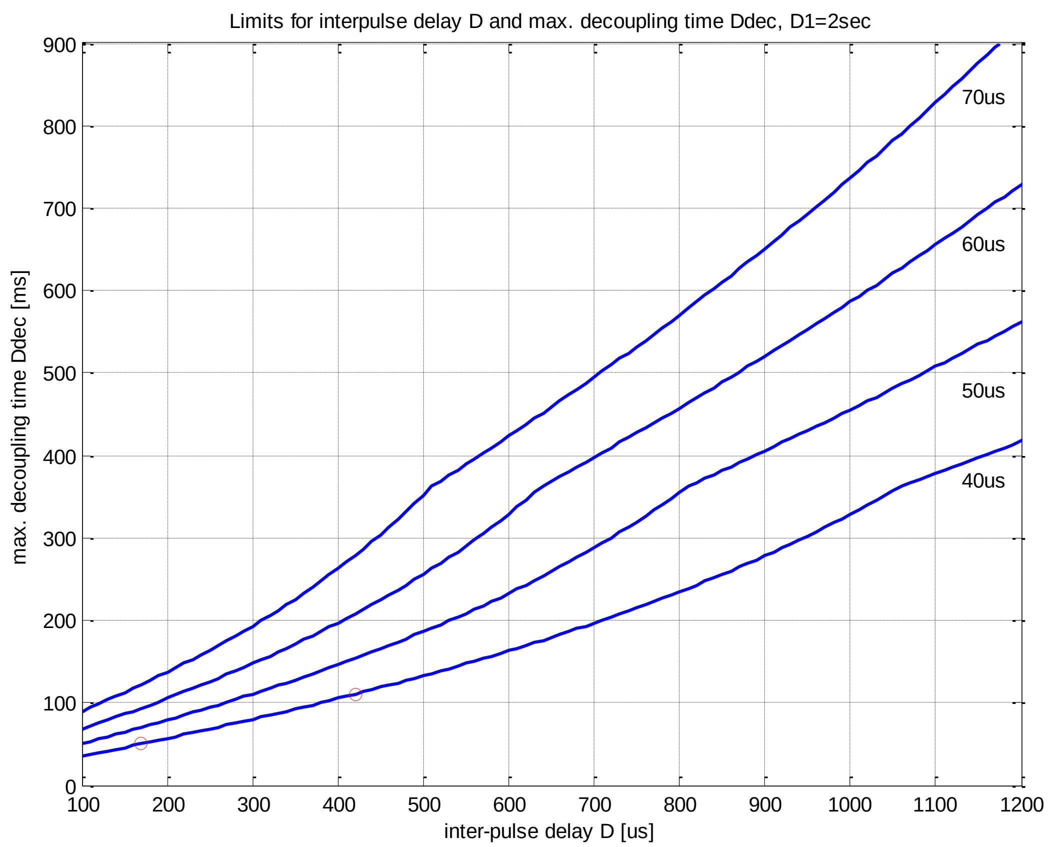


B_1 = maximum field strength of inversion pulse

D = interpulse delay

D1= recycle delay

In standard cpmg sequences the decoupling time is the length of the CPMG element (d20) and the inter-pulse delay is defined as 2*D21



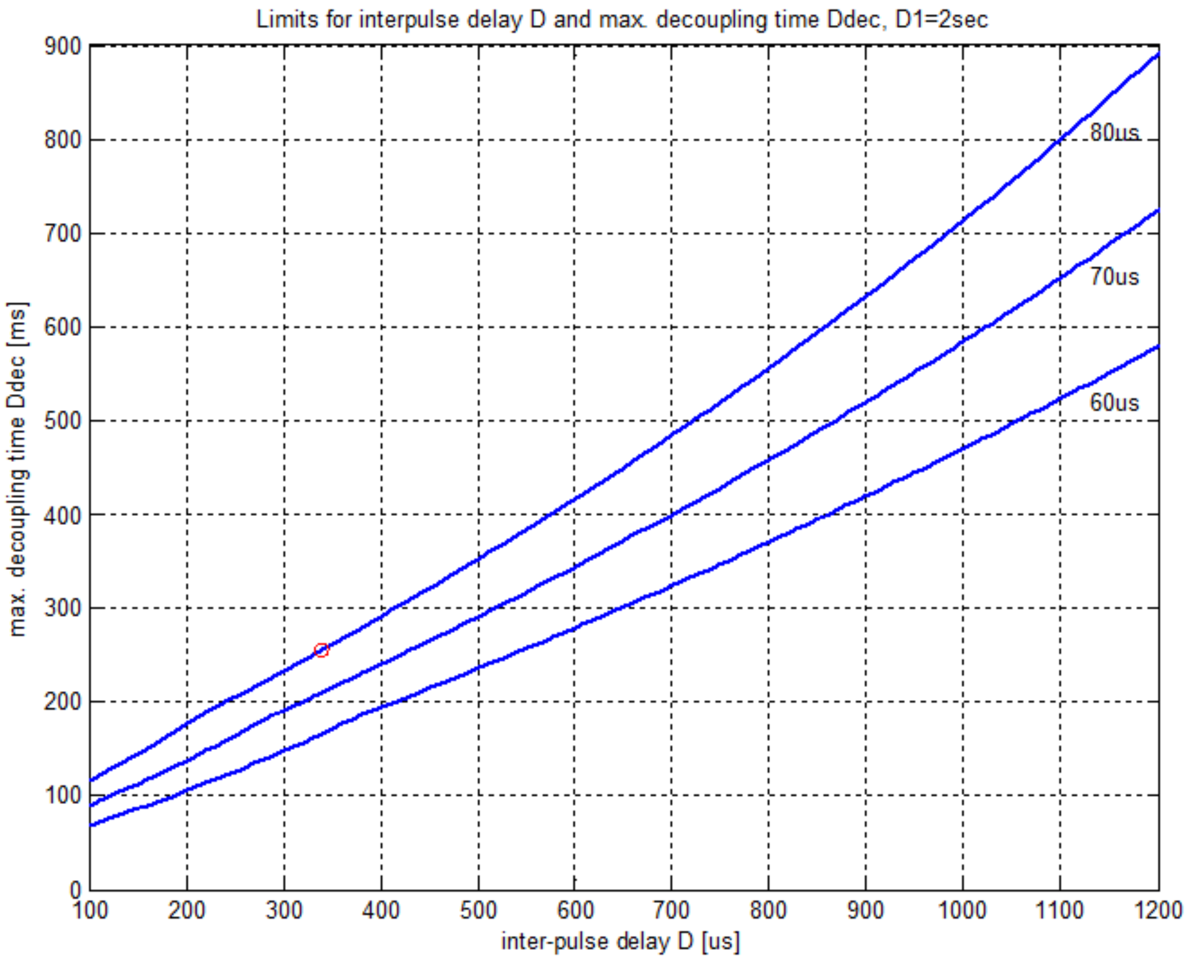
The traces show the maximum decoupling time for a given B_1 field strength (given as a 90° pulse angle (40µs…70µs), D1 is assumed 2.0s
All values below a specific trace are possible
The red circles denote limits for REX with 2kHz and 1kHz rotation frequency and 40µs 180° field strength (i.e. the pulse (usually p30) is 80µs long)

For a cpmg REX sequence with 2kHz and 40µs pulse strength, a maximum decoupling time of about 50ms is allowed. (which means 2* 25ms periods in the usual sequences).

Pulse Power on 800 CPTCI Probe 0018

5 mm CPTCI 1H-13C/15N/2H Z-GRD (Mar 2005) #Z44909-0018

This probe head requires about 70% more power to achieve the same pulse width compared to the current probes (2013). 180 degree inversion pulses shorter then 60us (90 dec pulse) should be avoided. The following graph gives a guidline of pulse length and durations.



Example:
The red dot represents the 1kHz spinlock for the Rex experiment. Using a 80us pulse (90deg), the inter-pulse delay between two 180 deg pulses should be about 350us and a maximum spinlock of 250ms cannot be exceeded. In any case, keep a close eye on the tuning!

Personal note R. Seydoux, 2/14/2014