^{205}Tl setup on INOVA-500

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Introduction

Thallium and ^{3}He are unique in having resonance frequencies that falls between ^{31}P and ^{19}F. On a 11.74 Tesla magnet:

Isotope	Spin	Natural Abund. %	Freq (MHz)
^{31}P	1/2	100	202.5
^{203}Tl	1/2	29.5	285.8
^{205}Tl	1/2	70.5	288.6
^{3}He	1/2	0	381.0
^{19}F	1/2	100	470.6
^{1}H	1/2	99.98	500.2

For electronic reasons, commercial spectrometers are built such that ^{31}P is the highest frequency ***X*** nucleus, and ^{19}F is the lowest of a narrow band providing for it and ^{1}H.

To observe ^{205}Tl (with ^{203}Tl obviously being very similar, only having a lower sensitivity due to its lower natural abundance), there are three broad areas of a commercial spectrometer that must be considered for potential modification:

A. A probe must tune to the ^{205}Tl frequency, 288.6 MHz for a 14T magnet. Commercial broadband probes typically will not tune on the ***X*** channel more than a few MHz above ^{31}P. We have taken an older broadband probe, and tuned the X channel up to 288.6 MHz. Modification of a triple resonance probe (with 3-channel spectrometer) would be required to enable $^{205}Tl\{^{31}P,^{1}H\}$ experiments.

B. The transmitter chain must generate high-power rf pulses at the ^{205}Tl frequency. Frequency synthesis is typically not a problem, but 220 or 250 MHz is often the limiting upper frequency for broadbanded power amplifiers. Fortunately, our INOVAs 1H cover 200-500 MHz, allowing ^{205}Tl rf to be generated. Filtering must be adjusted to allow ^{205}Tl, and reject other (e.g., decoupler) frequencies.

C. The receiver chain must have good low-noise preamplification at ^{205}Tl frequency, with demodulation at that frequency. Preamplifiers often cutoff around 250 MHz. The INOVA X preamp can handle the ^{205}Tl frequencies, but the transmitter and LO (for demodulation) must be properly routed; both cabling and software control must be properly setup.

Requirements for B and C will be console/hardware dependent. The next section describes changes that enable the experiment on our INOVA-500 spectrometer.

Implementation on the INOVA-500

Our hardware specifications are:

INOVA-500
Amp: AMT 3900A-12
Varian PN: 00-969441-03
ch A 200-500 MHz
ch B 6-220 MHz

1. Move 1H cables on 1H/19F preamp to the X preamp (check that all cables are properly labeled before doing this).
2. Move white (LO) cable from 1H/19F preamp to the X preamp. To get the cable to reach, unscrew and lift the X preamp off the mounting slide screws, and carefully lay the X preamp on the floor in reach of the 1H white cable.
3. Had to remove all bandpass filters, so X preamp cable went straight into the probe (we will have to look for a proper low-reject or bandpass when doing 31P decoupling; multiple serially in-line filters might work better if rejection is <60dB per filter).
4. Had to remove the high-pass filter off the proton xmitter cable at the back of the main (air-pneumatics/switching) box next to the magnet; this filter rejects everything < 350MHz.
5. create('amphbmin','real','global')
   amphbmin=280

pw90=22us at tpwr=63 on an old broadband probe.

Note that the probe will have a finite bandwidth, as will a reasonably sized pulse width. Assume < 200 kHz. A larger change while searching for the signal requires the probe be retuned to the new center frequency.

On the 500, Tl205 will be 2.8MHz downfield from Tl203.