Phosphorous MR Detection Using High Power RF Transmitter Protocol

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Introduction

There is a long-standing interest in measuring ATP synthesis rates *in vivo* through the use of ^{31}P magnetization transfer methods. Inorganic phosphate (P_i) - adenosine triphosphate (ATP) exchange may be sensitive to many metabolic abnormalities in cells, including cancerous changes. The possibility to detect ^{31}P MR signal was investigated using a high-power transmitter setting at 21.1 T. Such setting is required to cover a large chemical shift splitting of the phosphorous MR spectra.

Experimental

A double tuned ^{31}P/^{1}H volume RF coil was created earlier for *in vivo* phosphorous experiments. The new ^{31}P/^{1}H RF coil configuration files were created for both PV5.1 and PV6.01 Bruker MR imaging software. Now for the ^{31}P experiments the users can equally select a high-power X-transmitter of 1kW as well as X-Transmitter of 0.3 kW.

Results and Discussion

The calibration of the volume ^{31}P/^{1}H RF coil was performed with a load equivalent to a rat head load. The RF power of 10 W is needed to create a 90-degree pulse having duration of 1 ms. Thus, the 90° degree RF pulse with duration of 0.1 ms may need X-Transmitter RF power of 1kW. Such power is in the range of our hardware for the ^{31}P transmitter. The test ^{31}P spectrum using a new setting is presented on **Fig. 1**. However, the maximum power which can be safely applied to the current ^{31}P RF coil cannot be more than 0.4 kW. The higher RF power leads to the RF coil arcing.

The effect of the additional shielding was also tested for our phosphorus/proton RF probe. Such additional shielding is usually needed for many low gamma nuclei. The STD deviation of noise at a frequency of 363.6 MHz with extra shielding was usually only 1% less than without shielding. Thus, apparently, ^{31}P experiments can be conducted without extra shielding. However, from time to time, an intermittent noise may be present which affect the results. Thus, the shield placed between the MRI gradient coil and the RF probe is needed for phosphorous experiments at 21.1 T, as for other low gamma nuclei.

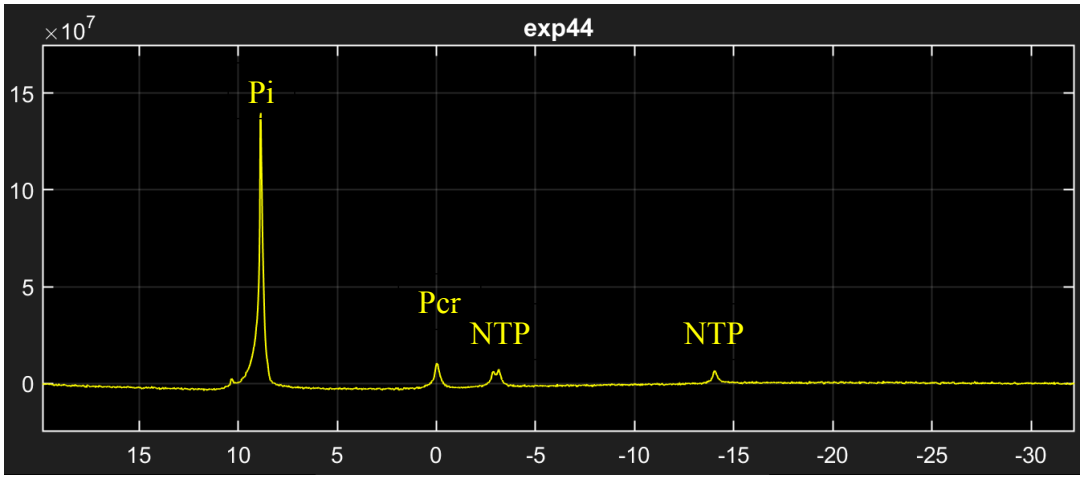

Fig. 1. ^{31}P NMR spectrum of the test sample (volume ~ 2 ml) using high power configuration setting. The duration of the excitation RF pulse was 60 μs (flip angle 30°). Scan time 3 min, number of accumulations, NA = 40.

Conclusions

The current double tuned ^{31}P-^{1}H volume RF coil for detection of MR ^{31}P signals has a power limitation. The surface coil can help in increasing the RF pulse amplitudes needed to detect a wide ^{31}P spectrum at 21.1 T. Additionally, the surface coil can boost MR sensitivity needed for detection of minor changes of phosphorous *in vivo* metabolites.

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