# Clinical Integration of a Phosphorus-31 Coil Insert into a System Head Coil at 3T

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## Introduction

In order to move multinuclear spectroscopy from the research to the clinical environment, scan time reduction and coil compatibility between the 1H and the X-nuclei must occur. A specific example is the need for volume P-31 chemical shift imaging and proper 1H registration required for imaging with both nuclei. This has been done in the past with double tuned coils [1,2], some being of a concentric geometry [3]. What is proposed here is a concentric P-31 insert coil (which could be tuned to any nuclei) that does not significantly alter the properties of surrounding head imaging coil on a 3T whole body MR system, currently making it suitable as an add on to a clinical sequence.

## Methods

The coil was designed to fit in the GE 3T head coil which has an i.d. of 28 cm so that the o.d. of the insert coil was set to 27.3 cm and the i.d. of the insert coil was 23.9 cm. Based on this the length of the coil was set at 23.7 cm to produce the highest SNR possible with reasonable homogeneity. The coil was constructed in the band-pass configuration by first tuning a trap in each leg to 127.75MHz, the proton frequency of 3T system (General Electric, SIGNA, Milwaukee, WI). These traps are used to decouple the insert coil from the outer coil and maintain the operating efficiency of the imaging coil. Once these traps were tuned, Birdcage Builder (Penn State) was used to calculate the proper capacitor needed in the end-ring. The coil was then tuned to 51.2MHz, the 31P frequency for the system. In the Figure 1, the effect of the blocking impedance is well illustrated. The signal-to-noise ratio loss has a tradeoff between head coil and P-31 insert as impedance varies.

## Results

Figures show T2 weighted fast spin echo images using GE standard head coil. The transmit gains (TG) are 165 and 154 for with (Fig. 2a) and without (Fig. 2b) P-31 coil insert. Using the series of axial brain images, the SNR's were estimated as 10.84±0.61 and 11.80±0.68, with and without P-31 coil insert, respectively. The homogeneity of the P-31 coil insert was also evaluated by phosphorus-31 imaging on the high molar phosphate phantom (14.7 M). P-31 spectra were also obtained from 14x14x2.5 cc axial brain slice (Fig. 3a) and from the gastrocnemius calf muscle (Fig. 3b)

## Discussion and Conclusions

The resonance trap circuit decouples P-31 coil from the surrounding proton head and/or body coil. However, about 1 dB increase in transmitter gain and 9% decrease in signal-to-noise ratio were observed. This confirms the calculations shown in Figure 1. More importantly, it has been shown that a P-31 resonator insert can be used without significant compromise of the image quality via SNR loss or induced artifacts. The effective region of interest is well extended for entire hemispheric examination by the efficient concentric geometry. This demonstration of the coil design facilitates the move to integrating the imaging and MNS pulse sequences for reduced scan time that is currently being pursued for MNS.

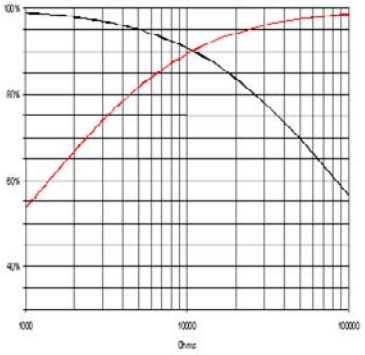
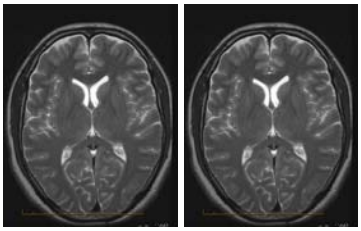
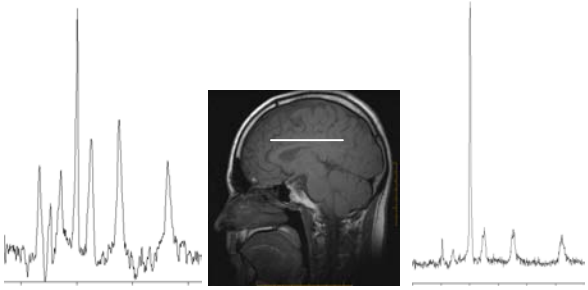


**Figure 1**. Tradeoff effect in SNR loss due to blocking impedance on insert. Black: P-31 coil SNR loss, Red: Head coil SNR loss as blocking impedance varies.



(a) (b)

**Figure 2**. T2 weighted fast spin echo images (85ms TE, 4s TR) using standard head coil with (a. left) and without (b. right) P-31 coil insert.



(a) (b)

**Figure 3**. P-31 spectrum (128 avg, 2s TR, fidcsi) from the 14x14x2 cc brain slice (a). P-31 spectrum from the gastrocnemius calf muscle (b). (128 avg, 3s TR, fidcsi)

## References

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