

## Calculation of the Sensitive Region of a U-shaped Permanent Magnet for a Single-Sided NMR Spectrometer

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### ABSTRACT

*With a conventional NMR (Nuclear Magnetic Resonance) spectrometer, the study sample is placed inside the magnet. In contrast, with a single-sided NMR spectrometer, the study sample is outside, but close to the magnet. Single-sided spectrometers can thus be used with a large sample and made portable. A high magnetic field can be achieved without the need for a high-current, DC power supply when using neodymium (NdFeB) magnets. The system is, therefore, relatively low cost, as well.*

*The U-shaped magnet developed here consists of two permanent magnets of size 50x50x25 mm<sup>3</sup> (with a measured surface magnetic field of 0.35 T) placed on a piece of thick steel with opposite poles upward, giving a magnetic field parallel to the surface of the magnets. The magnetic charge model was used to calculate the magnetic field in planes at different distances from the magnets' surface and the size of the NMR sensitive region with 10<sup>3</sup> ppm homogeneity was obtained. Calculated field values and values measured using a tesla meter allowed the values of the surface magnetic charge density  $\sigma_m$  to be determined. Magnets positioned with a gap of one-half the width of the magnet face produced the largest sensitive region. In this case, the sensitive region was 12 x 2.5 x 1 mm and located 15 mm above the magnet surface with a central field of 0.23 T.*

**Keywords:** Single-sided NMR, Mobile NMR, NMR spectrometers, U-shaped magnet, Magnetic charge model

### INTRODUCTION

Nuclear Magnetic Resonance (NMR) is a phenomenon whereby a nucleus with non-zero spin, and thus a magnetic moment, will absorb energy from an irradiating electromagnetic wave when placed in an external static magnetic field ( $B_0$ ). The specific frequency absorbed, known as the Larmor frequency ( $f_0$ ), is given by the simple relationship ( $f_0 = \gamma B_0 / 2\pi$ ) (Levitt, 2001). The constant  $\gamma$  is the gyromagnetic ratio for that particular nucleus. For example, a hydrogen nucleus ( $^1\text{H}$ ) or proton will resonate at 42.578 MHz in a field of 1 T. Experimentally, the radio frequency (RF) wave is applied by an RF-coil with its magnetic field