# Magnetic Resonance and Magnetic Resonance Imaging with a Variable Field Cryogen Free Superconducting Magnet

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**Introduction:** Magnetic Resonance of realistic materials and processes is often confounded by magnetic susceptibility mismatch effects which dramatically increase the MR linewidth. These magnetic susceptibility effects scale with the strength of the applied Bo field and these effects can be dramatic in porous materials, which comprise the majority of the systems we study.

**Control of Susceptibility Effects:** In an amenable material one wishes a high field strength for increased SNR, in a more challenging material with a strong susceptibility mismatch, a lower Bo field is essential. How to bridge this divide? For several years we have been employing a cryogen free magnet with an integrated magnet power supply which permits us to increase or decrease the static field as desired, controlling linewidth and susceptibility effects for relaxation and imaging studies. Essentially, we choose the highest available field consistent with the sample and measurement we wish to undertake.

**Changing the Nucleus:** There is however another, more profound, advantage of the variable field magnet approach to materials MR/MRI. If we are studying a system with a complicated apparatus (for example a battery or a system at high temperature and pressure) there is no reasonable prospect of a multi resonant RF probe for multi nuclear studies. Our approach to measuring nuclei in addition to 1H is to change the static field strength to compensate for a lower gyromagnetic ratio. The result is a constant Larmor frequency and a single RF probe with identical sensitivity and tuning despite a change of nucleus. For example, at 0.79 T the 1H frequency is 33 MHz. If the field is increased to 2.99 T we measure 23Na at 33 MHz and if we increase the field to 3.1 Tesla we measure 13C at 33 MHz. This approach to MR/MRI of materials with multiple nuclei opens many new possibilities for experimentation.

**Examples:** In this presentation we will outline measurements where we adjust the field to control susceptibility mismatch effects. We will also describe measurements in systems where we adopt the field changing approach to undertake 19F, 13C, 23Na and 7Li studies in conjunction with 1H.