

# FFC NMR relaxometer with improved magnetic field uniformity

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In this work, the flux density distribution in the sample's reference volume of a Fast Field Cycling Nuclear Magnetic Resonance (FFC-NMR) magnet was analysed at room temperature and under cryogenic conditions.

The optimized magnet with low volume and low power losses was powered by a power supply with a control system based on the feedback of the magnetic induction directly instead of the magnet current. In a fast field cycling relaxometry experiment, the main requirement is to produce the magnetic induction cycles between highly accurate magnetic induction levels with short transients in a stable and repetitive sequence.

The design of magnetic cores can be done optimizing different parameters in accordance with the application requirements. Typically, there are two types of FFC-NMR magnets: solenoid coils with air core and with ferromagnetic cores. Since FFC NMR apparatus require magnets with high magnetic field uniformity, in order to improve the flux density distribution, a magnet constituted by a ferromagnetic core, copper coils and superconducting blocks was designed having a main target a magnetic flux density of about 0.2 T and improved uniformity ( $\Delta B_0/B_0$ ) when compared with the same magnetic circuit without superconducting blocks.

The magnet structure was designed taking into account the coils and the current required to obtain the maximum magnetic field in the section where the sample is placed. The number of turns and the maximum current depend on the dimensions of the iron core. Unchanging the initial dimensions of the magnetic core, three pieces of superconducting (SC) blocks were added to the ferromagnetic structure, surrounding the sample's section.

The homogeneity of flux density distribution in the central air gap central with the active superconducting blocks improved, as expected.

The tests performed using the control system and the power supply developed show that magnet presents similar dynamic behavior under cryogenic conditions ( $\sim 77\text{K}$ ) and at the room temperature.

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