# CRAZED signal dependence on correlation distance and sample orientation in rat sciatic nerve

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Introduction: Conventional magnetic resonance imaging is typically limited to resolutions of 100's of microns in small animals and to millimeters in humans. No single conventional magnetic resonance method probes both the micron and millimeter distance scales or an intermediate scale (< 50–300 μm) between diffusion measures and direct imaging. The CRAZED [1] pulse sequence has a structural sensitivity determined by applied gradients. Specifically, the correlation distance dc = π/γGT dictates the distance scale of the signal sensitivity to magnetization variations (see Figure 1). In this work, we address the issues of CRAZED signal dependence on sample orientation and the gradient induced correlation distance in sciatic nerve and cylindrical phantoms with the goal of determining what size information can be obtained unambiguously from the CRAZED signal.

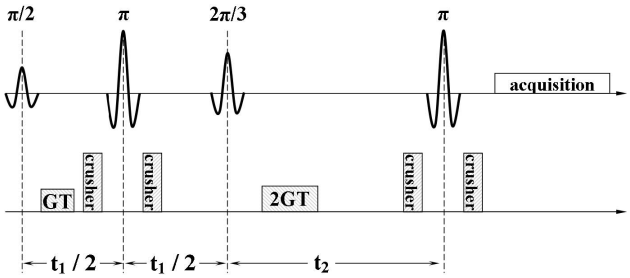


Figure 1: CRAZED pulse sequence

Methods: Two samples were measured: a cylinderical doped water sample and *ex vivo* rat sciatic nerve. A spectroscopic CRAZED sequence was implemented with dc = [4002 1199 359.7 107.9 32.30 9.786] μm. Both samples were rotated over a 90◦ arc in 10◦ steps. Histology and electron microscopy were performed to assess the underlying structures of the sciatic nerve and to determine the extent of degeneration during the CRAZED measurements. The measurements on the water sample signal were also numerically simulated.

Results: Figure 2 illustrates the histology results, indicating micro-anatomical structures at roughly the 10 μm and 300-400 μm scales, and that these structures are preserved during the measurement. Figure 3 plots the most important CRAZED results: that the signal dependence on sample orientation and gradient direction for a nerve when dc = 10 μm and 360 μm matches the simulations of a cylinder when dc = the cylinder diameter.

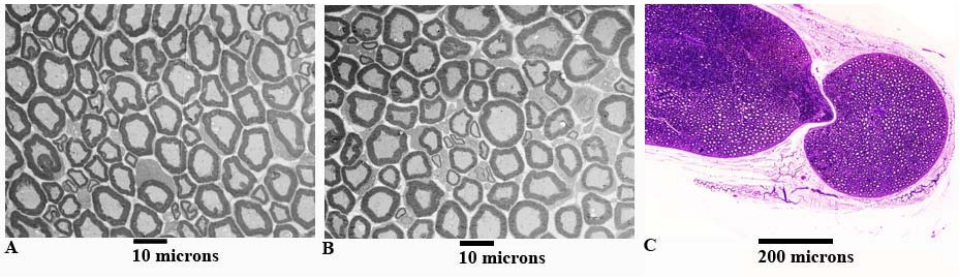


Figure 2: Histology of rat sciatic nerve cross sections. (a), (b) Electron micrographs reveal the 10 μm structures corresponding to myelinated axons. There is no discernible difference in fiber structures between (a) sciatic nerve fixed immediately upon dissection or (b) fixed after 3 hours post-excision. (c) Light microscopy of toluidene blue stained sciatic nerve show the peroneal (smaller) and tibial (larger) fascicles that make up the sciatic nerve.

Discussion: The results for the sciatic nerve have characteristics indicative of cylinders at both the ten and hundreds of micrometers distance scales, reflecting both axon and the tibial/peroneal fascicle structures that compose the nerve. These results support the view that CRAZED methods are able to probe a range of distance scales not available in other magnetic resonance methods.

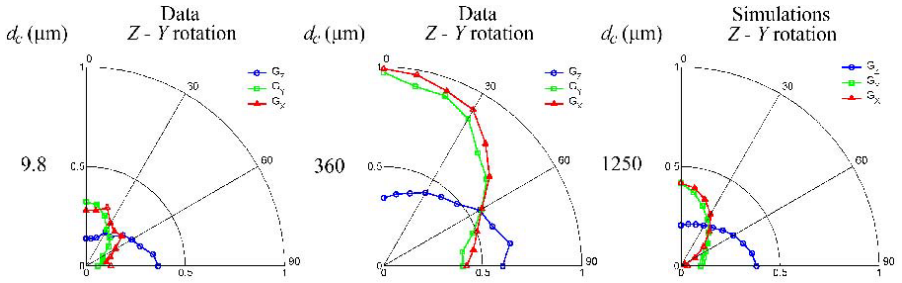


Figure 3: Nerve sample Z to Y rotation data for dc = 9.8 and 360 μm. For comparison a numerical simulation of a homogeneous cylinder of diameter 1250 μm and dc = 1250 μm is plotted as well. The similar shapes in all three cases indicates cylindrical structures in nerve with diameters of roughly 10 μm and 360 μm.

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References: 1. WS Warren et al., Science, 262:2005–2009, 1993.