This study uses high-field NMR to evaluate biochemical imbalances in the brain that develop during the onset and progression of a migraine. Small molecules involved in energetic neuroprotective and neurotransmitter action in the rat brain were evaluated with a frequency-selective magnetic resonance technique called relaxation-enhanced (RE) $^1$H spectroscopy in the MagLab’s unique 21.1T NMR/MRI magnet. Specific chemical signals were monitored in a (4mm)$^3$ volume in the brain via repeated acquisitions every 10 minutes over 3 hours before, during, and after the injection of nitroglycerine (NTG) to induce a migraine analog in the rat. This approach enabled the most complete detection and monitoring of temporal biochemical changes related to migraine.

By following, for example, increasing lactate and elevated taurine levels in the brain, energetic and protective chemical actions were found to occur in the brain even before the rats’ behavior indicates migraine-associated pain. This finding suggests that the onset of the NTG-induced central sensitization involves either more extensive metabolism or more likely conversion from aerobic to anaerobic metabolism, which would be consistent with an osmoregulatory impact if ionic distributions in the brain are disturbed.

Using MagLab-developed NMR pulse sequences (4 mm)$^3$ volumes in the rat cortex (pink boxes) are selected to acquire relaxation-enhanced (RE) $^1$H NMR spectra over 3 hours. Spectra were acquired after either a nitroglycerine injection to induce migraine or a sham saline injection. Lactate (Lac), N-acetyl Aspartate (NAA), Total Creatine ($tCr$), Choline (Cho), Aspartate (Asp), Taurine (Tau) were identified in the brain, along with Glutamine, Glutamate & GABA (together denoted Glx) and Glycine, Glutamine & Glutamate (together denoted Gly).