Flow Through Nuclear Magnetic Resonance

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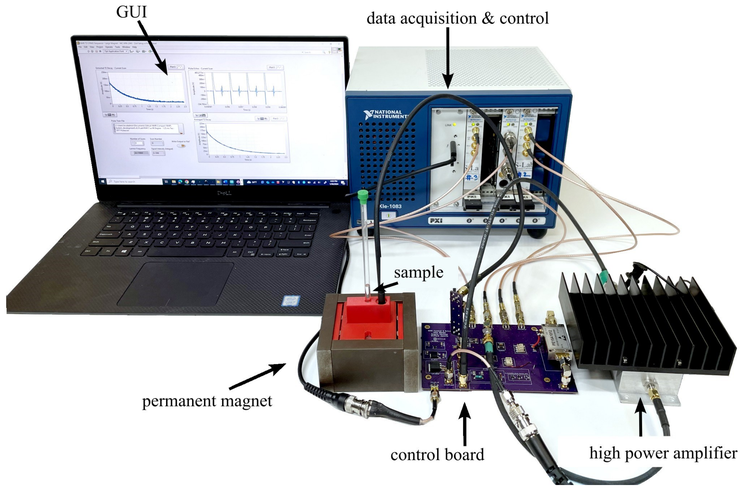
Background

- Water quality is a global problem that is constantly being fought. Containments end up in bodies of water through industrial processes, human product and natural disasters.
- Contaminants such as wildfire ash and different magnetic particles are difficult to detect and quantify usually requiring samples to be run through a lab using processes such as X-ray diffraction and magnetic separation.
- Nuclear Magnetic Resonance spectroscopy (NMR) is a commonly used methodology for determining the molecular structure of a substance.

Objective

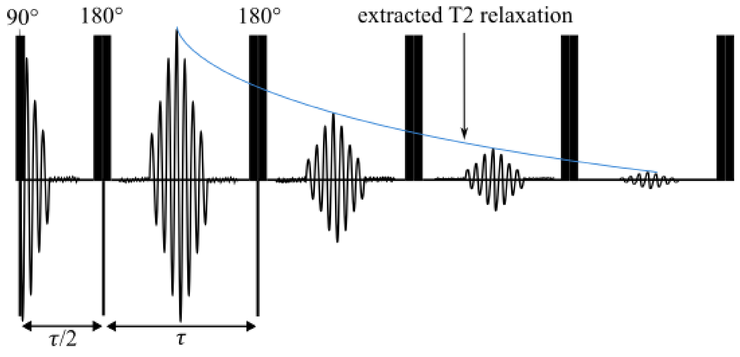
- Develop and improve an inexpensive, easily replicable and portable flow through system that can be used for environmental applications including testing for magnetic particles and other contaminants in water, algae, or other matter.



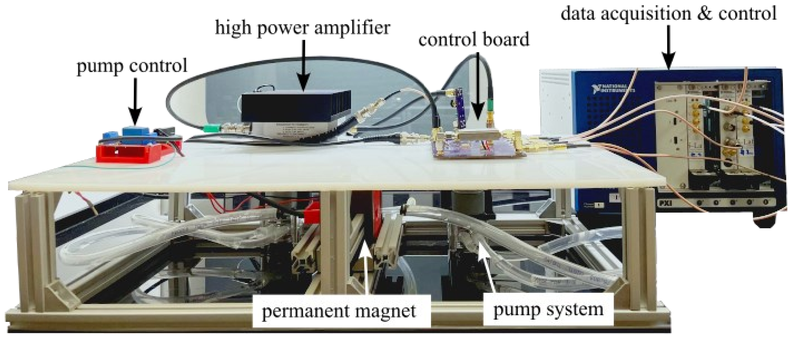
Base Compact NMR system

Methodology

- **T2 Relaxation:** Analyzes the resonation from the spins of the nuclei as they relax back to their original state.
- **CPMG sequence:** To plot T2, First a π/2 (or 90°) pulse is sent into the sample causing the magnetization to point in an orthogonal direction. Then a series of π (or 180°) pulses are sent causing the nuclei to realign while not affecting the decay rate. From this we can read of the peaks from each 180° pulse to plot the T2 curve.
- A pumping and controls system is implemented to continuously take new readings from water sources. To take a reading the water needs to be stationary requiring the NMR and pump control to by in sync.

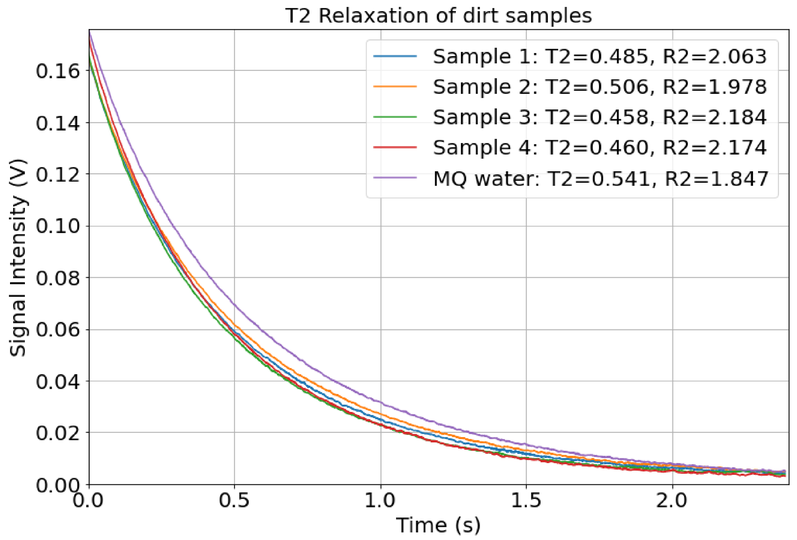


Visual representation of 90° and 180° pulses and plotted T2 Relaxation



Flowthrough NMR system

Results



T2 Relaxations of dirt suspended in water compared to MQ water.

- Some preliminary results of the current compact NMR are shown above. This data is from 4 different samples of dirt that were suspended in 20 mg of water.
- As seen the relaxation rates increase with the added particles compared to the mQ water demonstrating the ability to detect these particles.

References

[1] Jacob Martin, Austin R.J. Downey, Mohammed Baalousha, and Sang-Hee Wong. Measurement of magnetic particle on centrations in wildfire ash via compact NMR. In IEEE Sensors Conference, 2022

[2] Barbosa, Thaís. “Part 2 – T2 Relaxation: Definition, Measurement and Practical Implications!” *Nanalysis*, Nanalysis, 30 June 2020, https://www.nanalysis.com/nmready-blog/2020/6/1/part-2-t2-relaxation-definition-measurement-and-practical-implications-wps35.

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