

Spin Lattice Relaxation Times in Glycerine and Water

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Spin-Lattice Relaxation

- RF pulse rotates spins off equilibrium axis
- **Spin-Lattice Relaxation:** Spins return to thermal equilibrium
 - Dipole-dipole interactions
 - Chemical shift anisotropy
 - Spin-rotation interaction

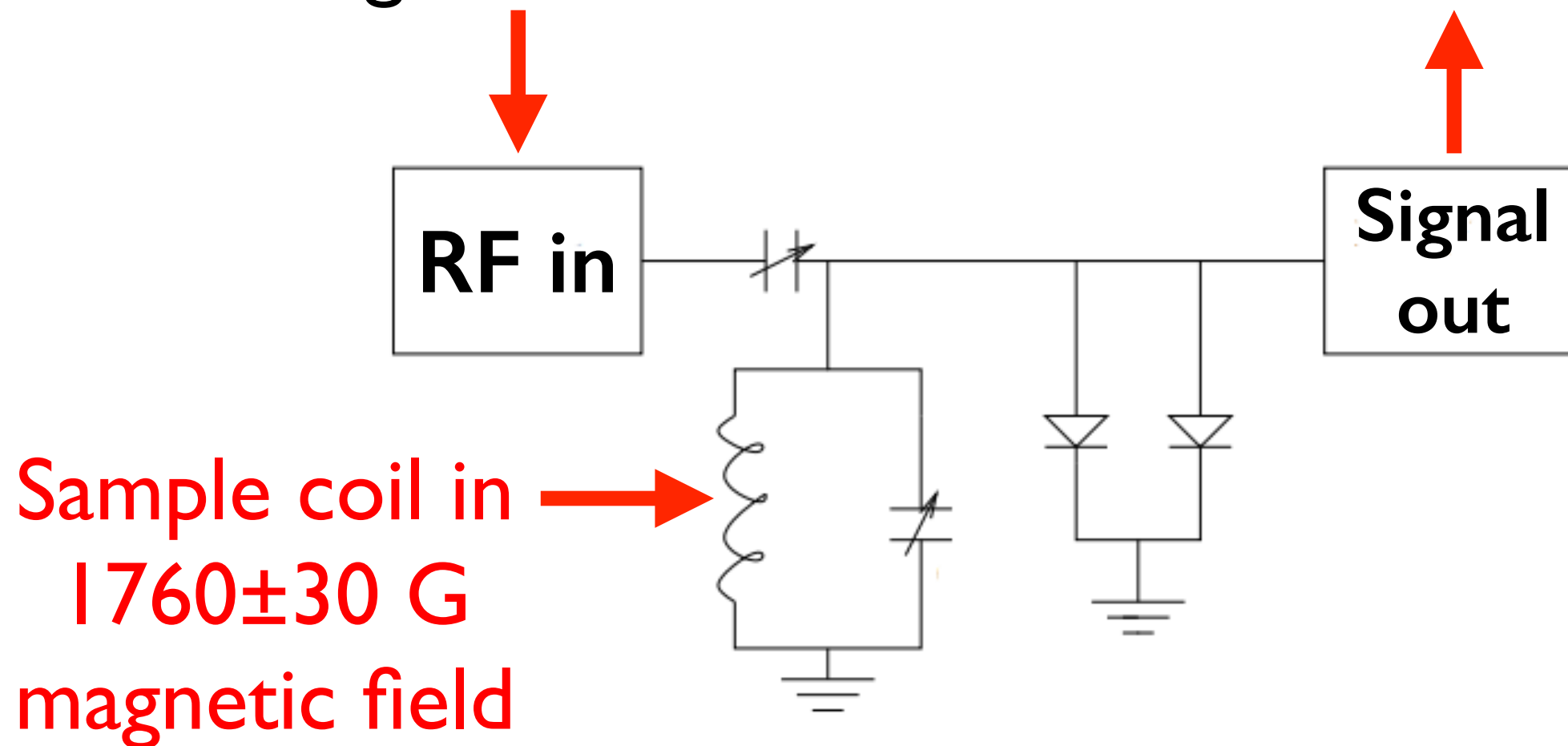
Dipole-Dipole Relaxation

- Nearby dipoles induce a fluctuating B-field
- Fluctuations near Larmor frequency dominate
- **High viscosity**: slower molecular motion, stronger relaxation
- Dissolved paramagnetic O_2 increases effect

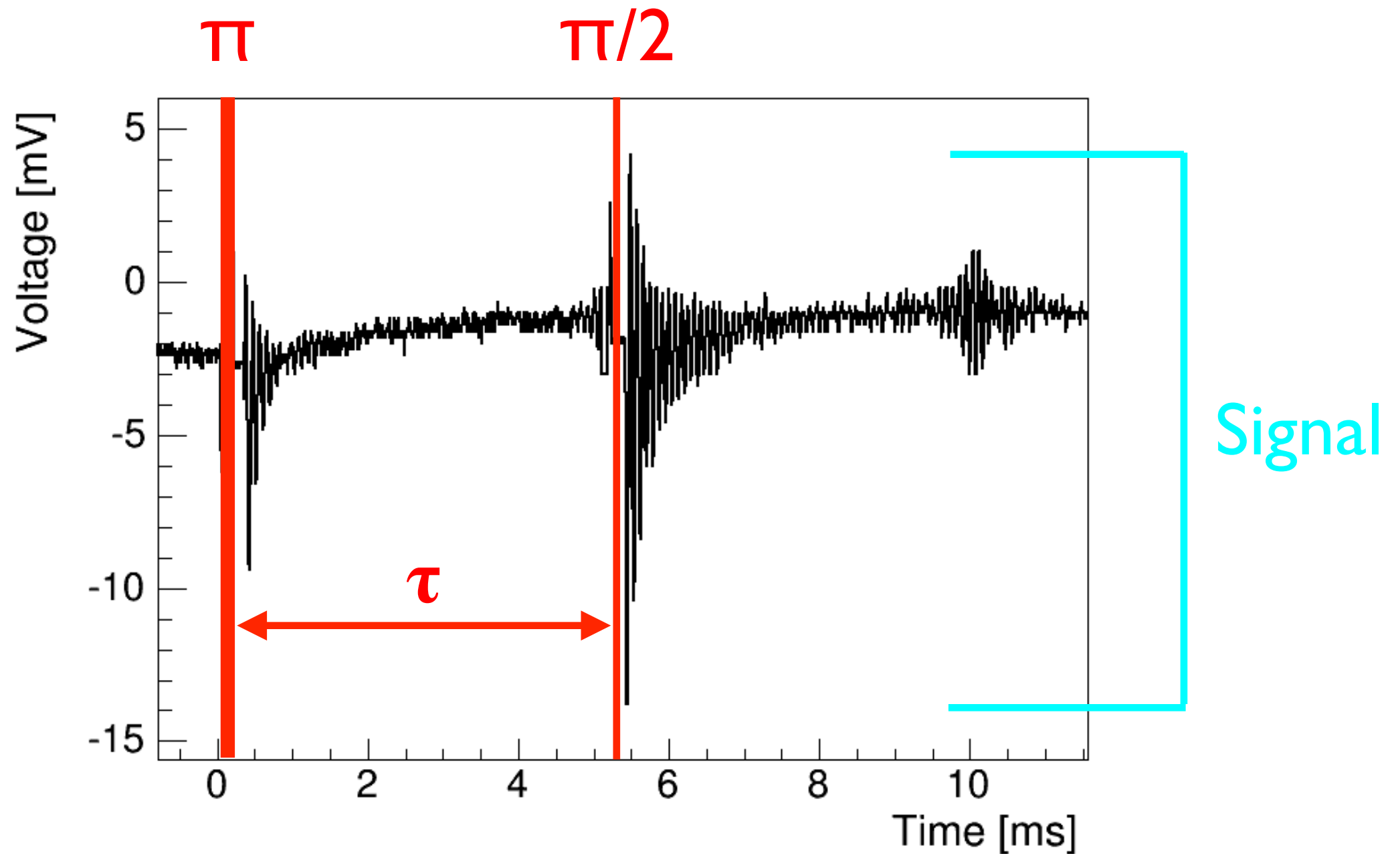
NMR Circuit

Pulse programmer,
generator

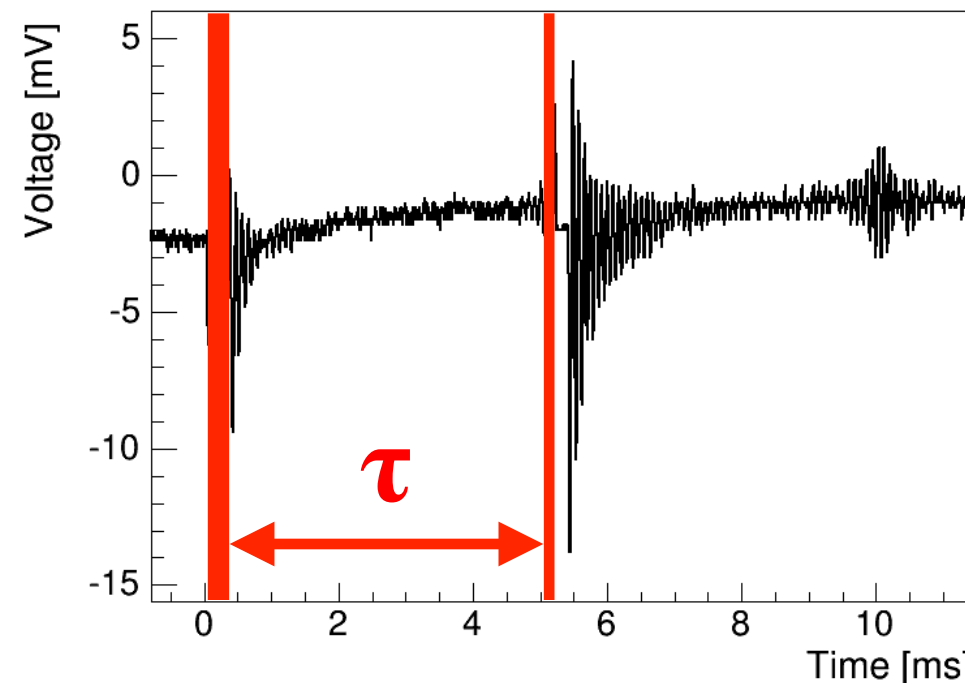
Phase detector,
filter, oscilloscope



T_1 Relaxation Measurement

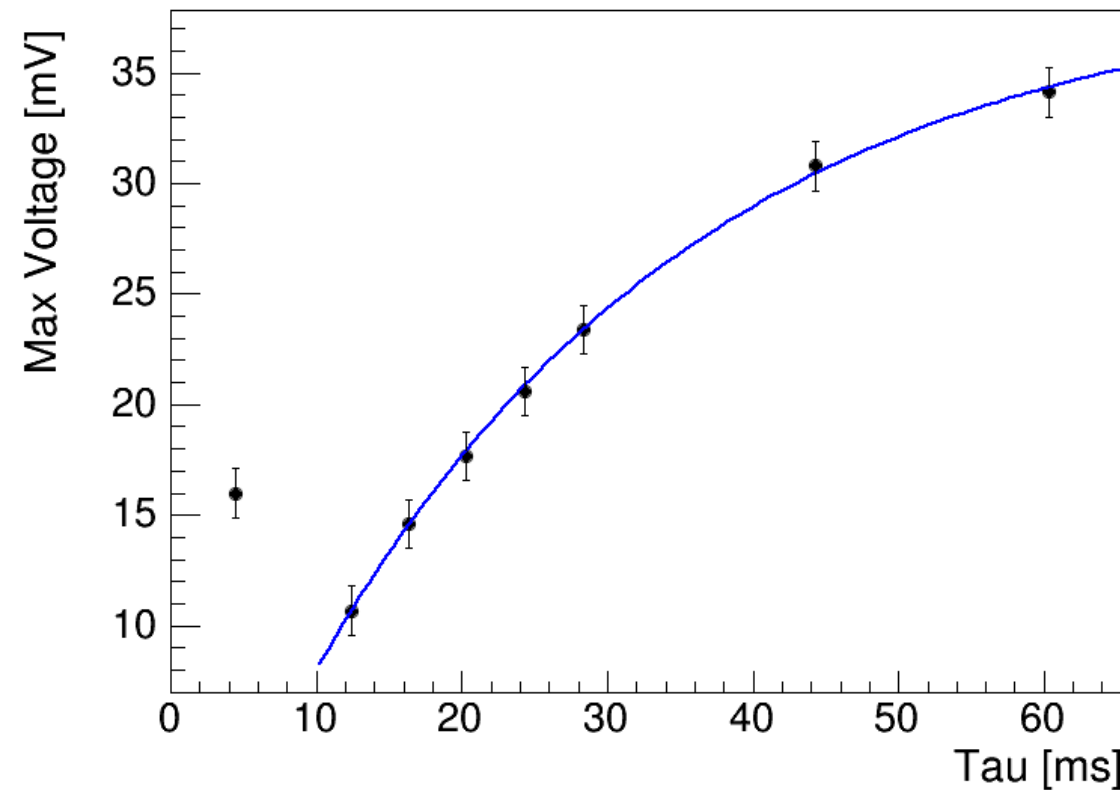


T_1 Relaxation Measurement



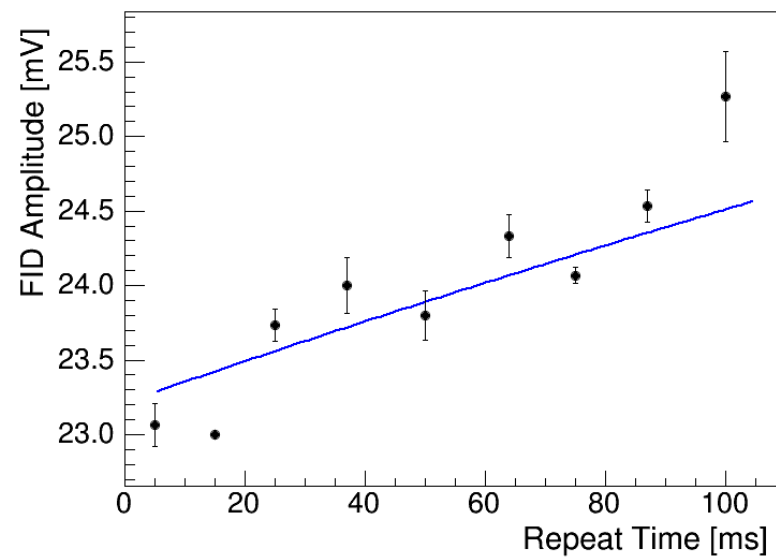
- Vary τ between π and $\pi/2$ pulses
- FID height after $\pi/2$ pulse starts at negative maxima, exponentially decays through zero back to positive maxima

T_1 Relaxation in Glycerine

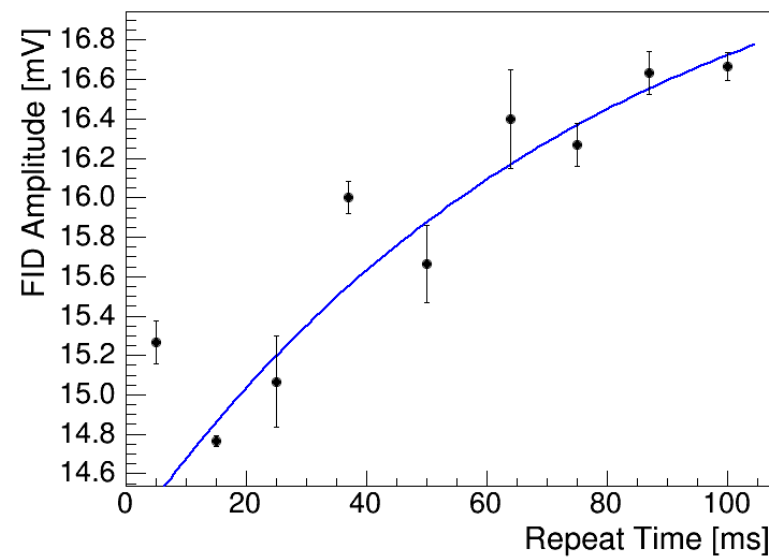


- $T_1 = 26.9 \pm 8.0$ ms
- Bloembergen: 20 ms

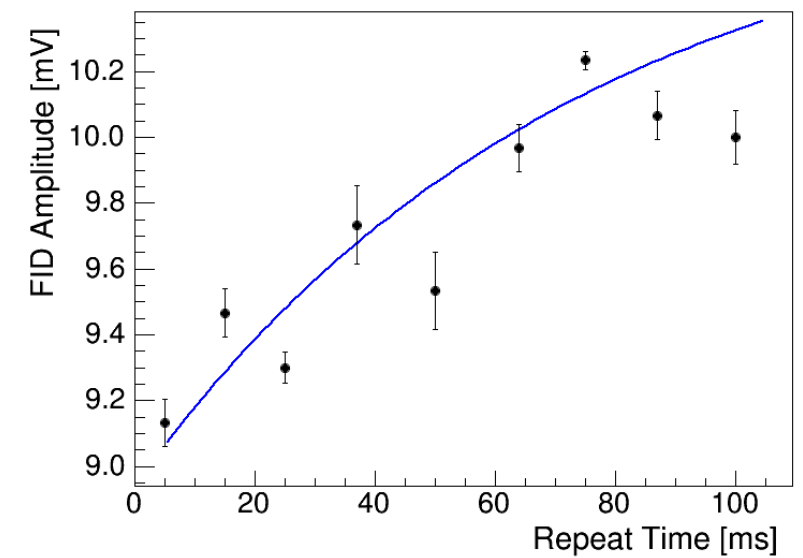
Glycerine Solutions



70%
 600 ± 1100 ms

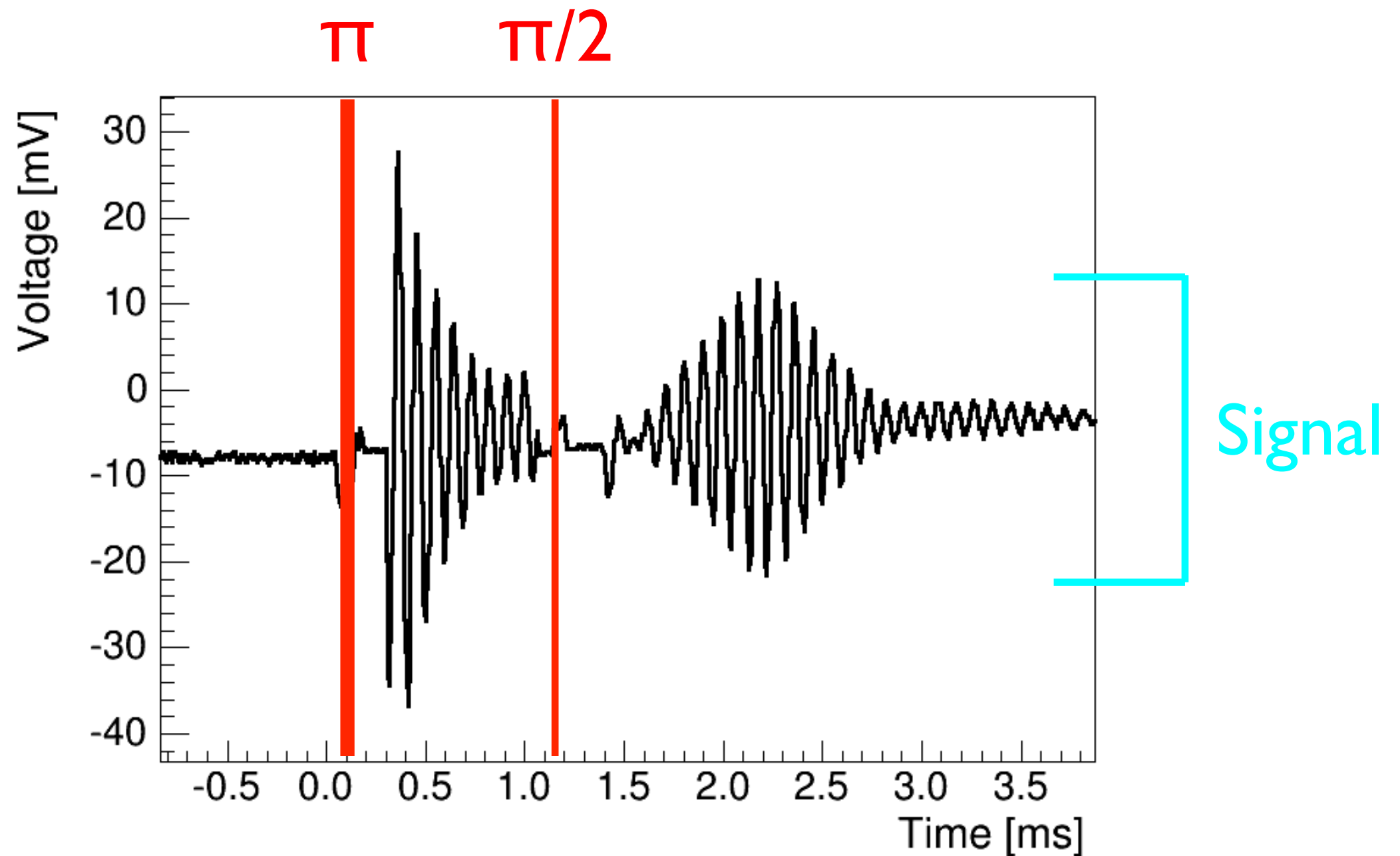


50%
 78.0 ± 26.7 ms

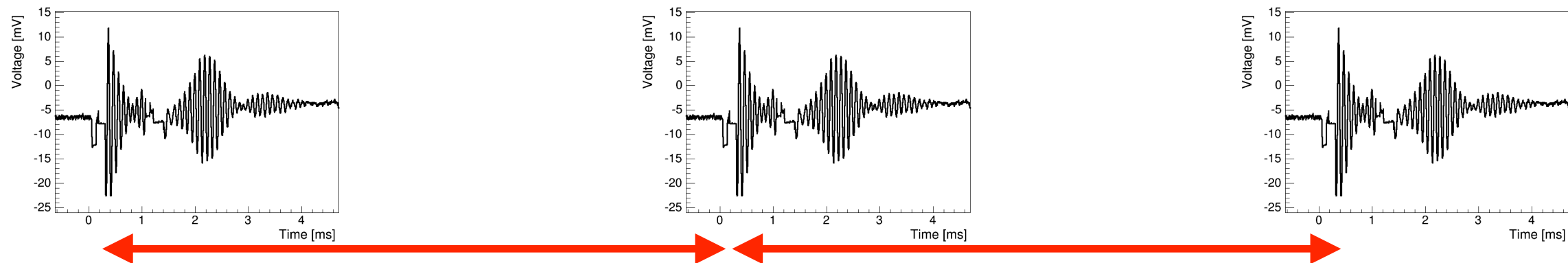


30%
 73.3 ± 30.6 ms

Long T_1 Relaxation Measurement

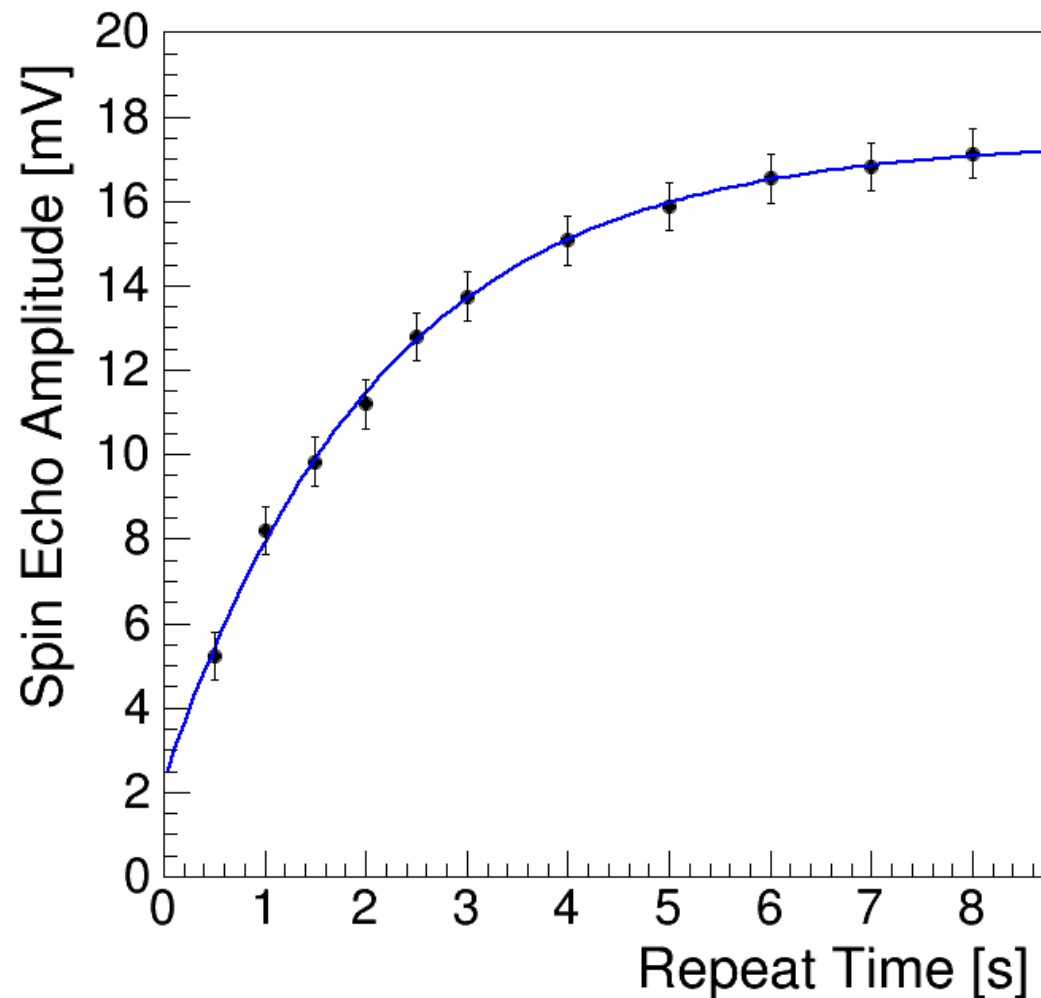


Long T_1 Relaxation Measurement



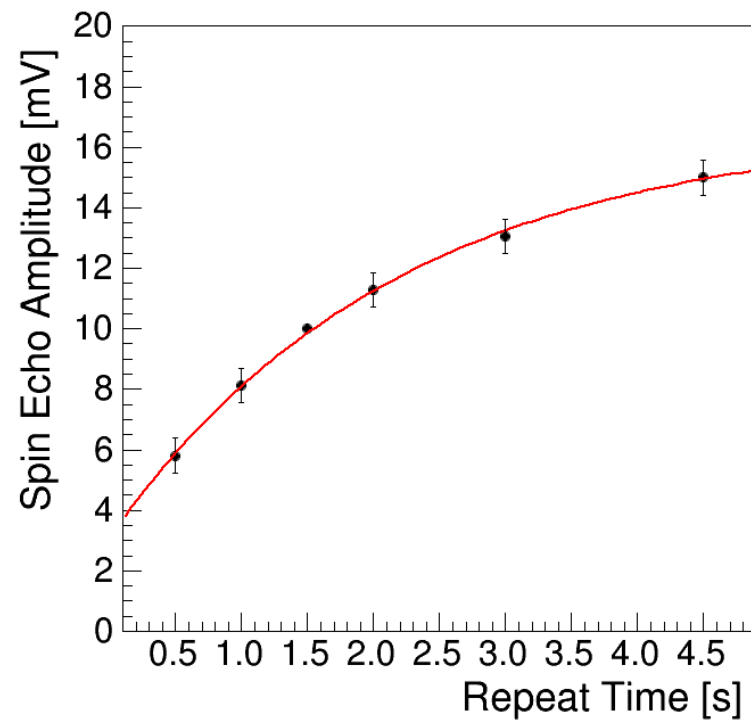
- Vary **repeat time** between pulse sequences
- Spin echo height recovers exponentially as repeat time increases

T_1 Relaxation in Water

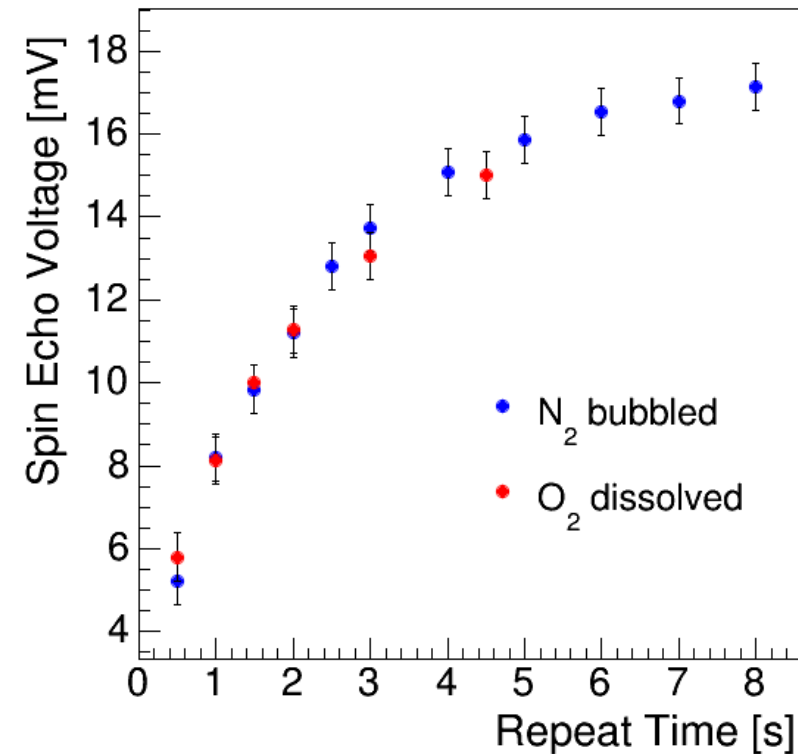


- Sample bubbled with N₂ to remove paramagnetic O₂
- $T_1 = 2.14 \pm 0.32$ s
- Bloembergen: 2.3 s

T_1 Relaxation in Water

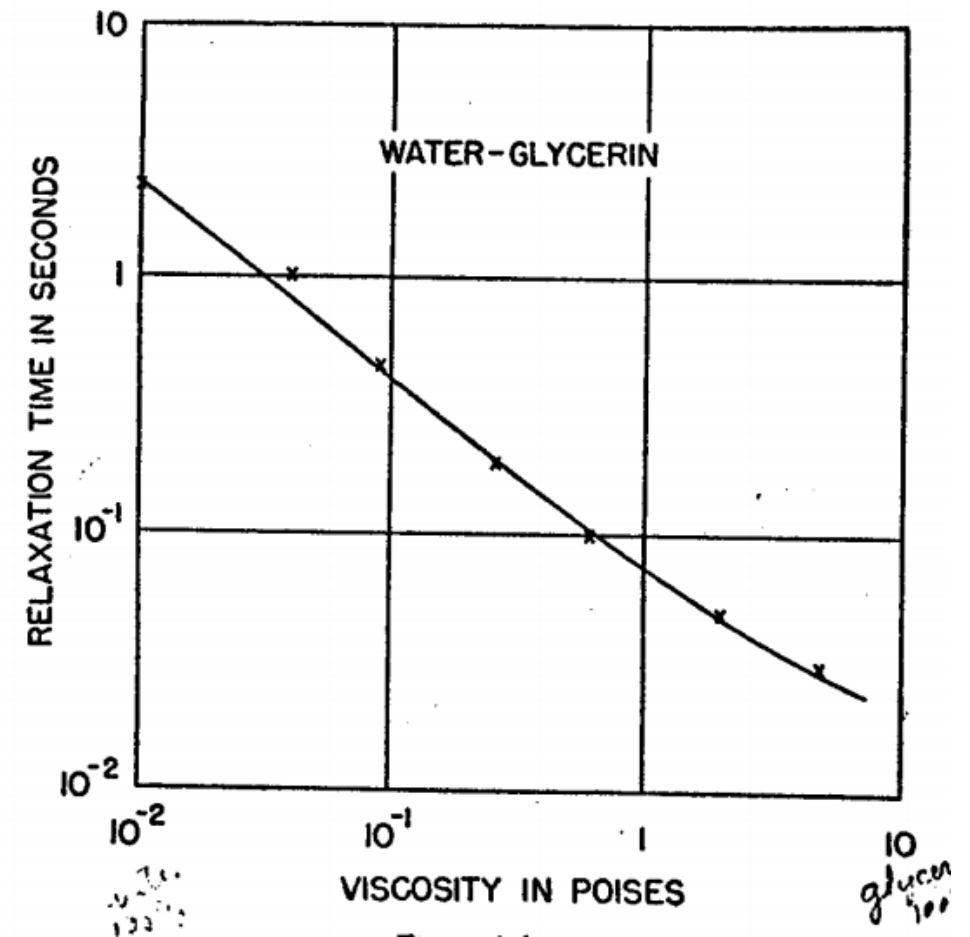
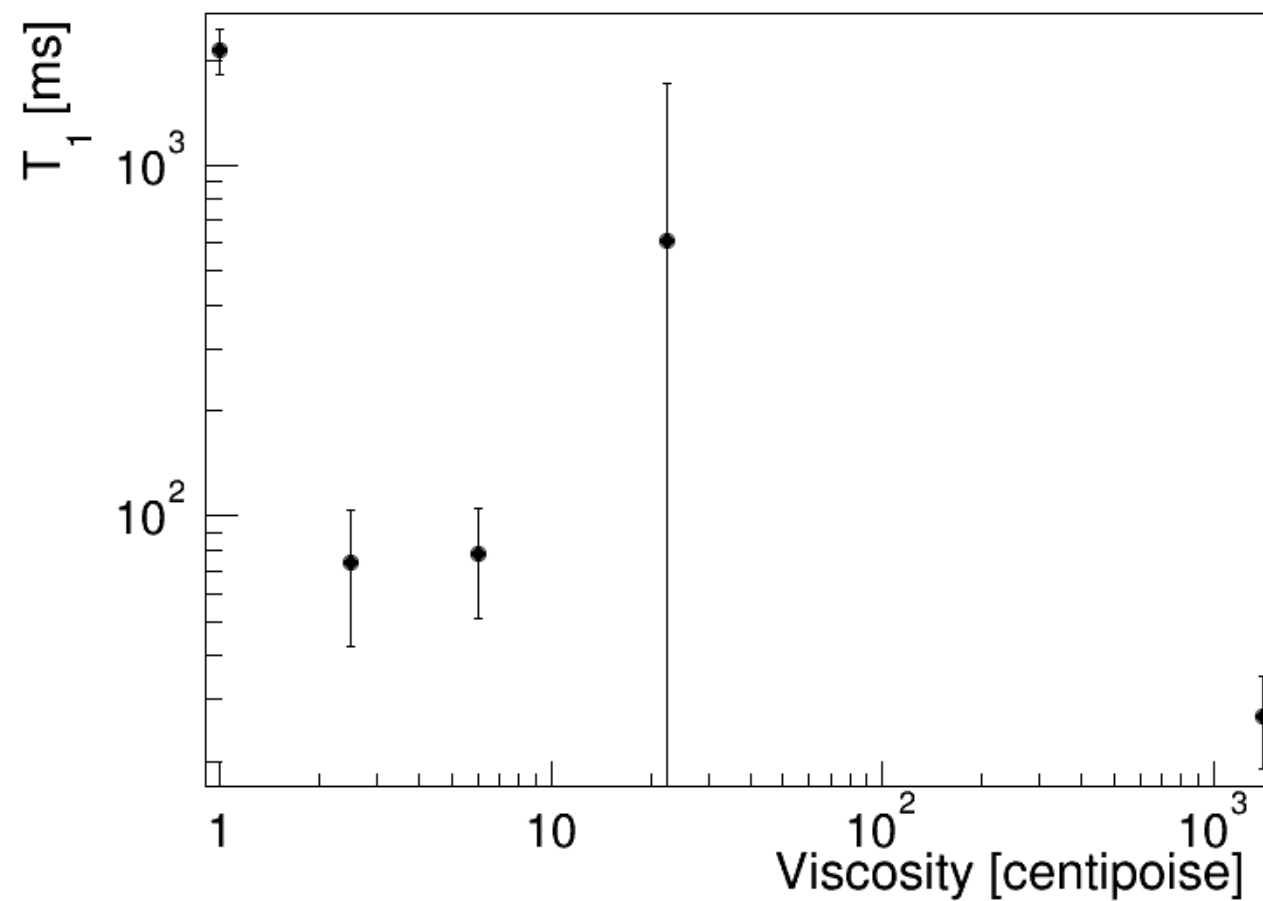


- $T_1 = 2.2 \pm 1.2$ s
in distilled water



- No significant difference between measured T_1 values

T_1 Relaxation and Viscosity



Bloembergen

Summary

- T_1 relaxation time observed to decrease with increasing viscosity
- No difference observed between water with dissolved N_2 or O_2
- T_1 of water measured as 2.14 ± 0.32 s, consistent with literature