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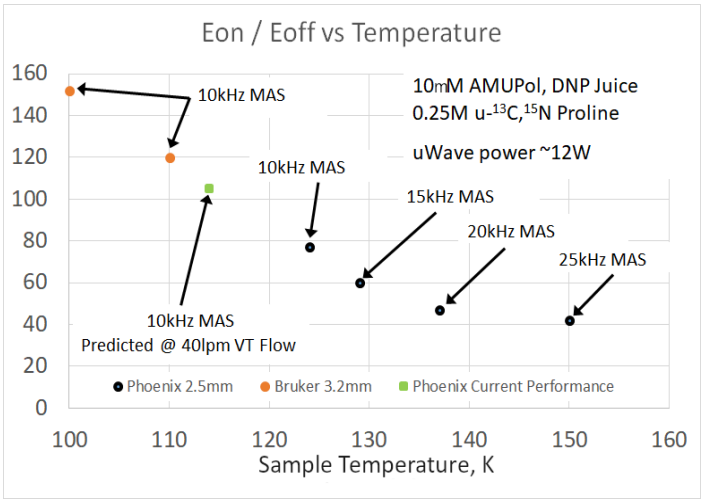
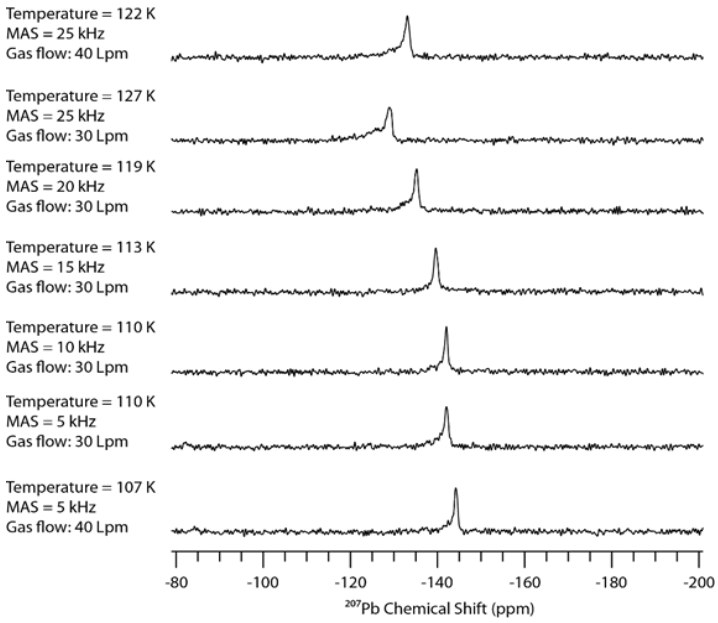
# PhoenixNMR Does DNP!

Introducing the PhoenixNMR 2.5 mm 18 µl sample volume 395 GHz / 600 MHz $^{1}H/^{19}F/(^{31}P\text{-}^{13}C)/(^{23}Na\text{-}^{15}N)$ quadruple resonance MAS-DNP NMR probe. Microwave power is transported through probe using a series of corrugated miter and straight sections connected to a focusing lens designed by Thorsten Maly[3] of Bridge12 Technologies. At a modest cost well below any other complete DNP probe system on the market, with greatly expanded operational capability including a low gamma box to reach all NMR accessible nuclei, this probe is a perfect addition to your existing DNP system (400-600 MHz for NMR) or simply add a Bridge12 gyrotron to an existing NMR system to have a full DNP system.

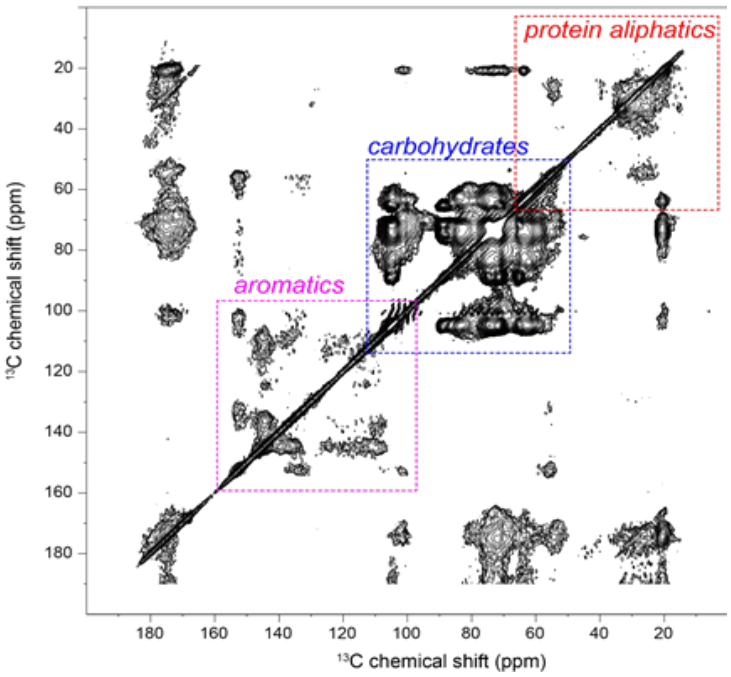



*DNP Enhancement versus sample temperature: The four round markers reflect the data collected on the PhoenixNMR 2.5 mm DNP probe utilizing the 395 GHz/600MHz DNP NMR system at the NHMFL[1], VT flow rate of 30 lpm, the two orange dots represent the performance of the Bruker 3.2 mm DNP probe on the same system with the same sample, the single green dots shows the expected performance based on recent improvements to the VT system of the PhoenixNMR probe at 40 lpm flow rate.*




*Sample temperature measurement at a set temperature of 90 K utilizing the chemical shift of $PbNO_3$. The central 5 spectra show the sample temperature as a function of spin rate at a VT flow rate of 30 lpm. The top and bottom most spectra show the effect of increasing the VT Flow from 30 lpm to 40 lpm.*

*$^{13}C$-$^{13}C$ 2D correlation of $^{13}C$ labeled intact plant stem (Sample and Data by Tuo Wang[2]) on the 600 MHz DNP system at the National High Magnetic Field Laboratory in Tallahassee, FL, in collaboration with Frederic Mentink-Vigier[1]. This spectrum was acquired with a spin rate of 22 kHz, a sample temperature of ~140 K (run at a conservative 20 lpm VT flow) exhibiting a DNP enhancement of 8:1.*



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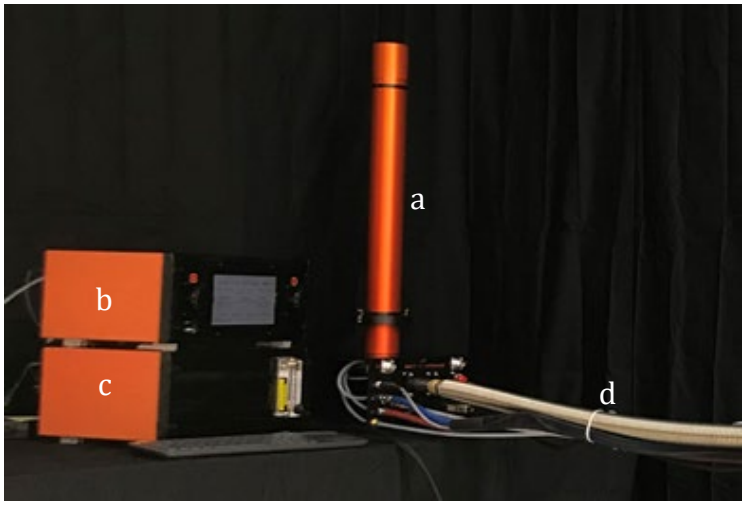
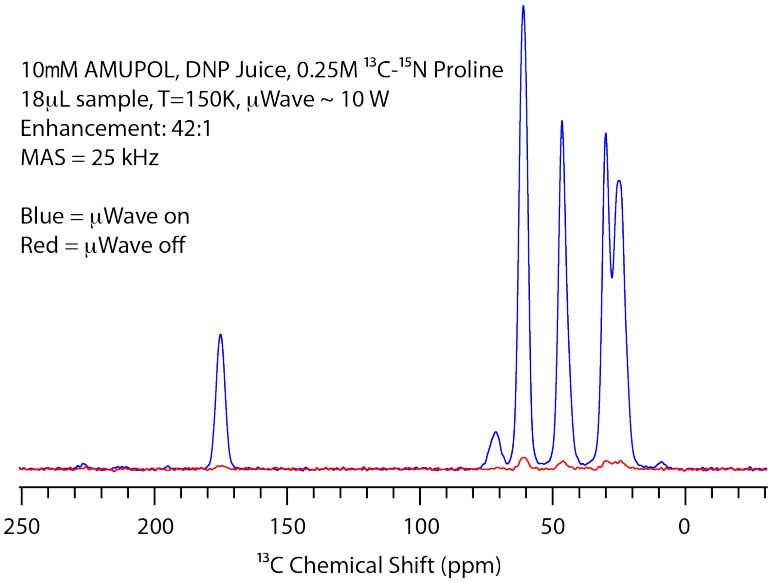



*The PhoenixNMR DNP probe system: The WB Quad Resonance HFXY probe (a), two control boxes (b,c) - MAS spinning, VT cryogenic control and sample insert/eject operation), cryogenic counter-flow heat exchanger (d), LN2 Dewar (not Shown). The 50-liter Dewar provides ~36 hours of 90 K operation and can be refilled at any time. The included counter-flow heat exchanger is manufactured by Bridge12 Technologies[3].*




**Tuning Range**

Quadruple Resonance Mode: **H:** $^{1}H$ and $^{19}F$ **X:** $^{31}P$ to $^{13}C$ **Y:** $^{23}Na$ to $^{15}N$
Triple Resonance Mode: **H:** $^{1}H$ and $^{19}F$ **X:** $^{31}P$ to $^{15}N$
Tuning on X can be lowered to ~15 MHz with an optional Low Gamma box.
Simultaneous H and F operation available as an option.

**Spinning Module**

Spin Rate: 5 kHz to 25 kHz @ 90 K to 373 K (set temperature)
Stability: +/- 5 Hz or +/- 0.2%, whichever is larger, over 24 hrs
Sample Volume: 18 μL Active sample volume used for all NMR tests
VT Range: 90 K to 373 K
90 K @ 5 kHz Spin Rate, Sample T = 115 K
90 K @ 25 kHz Spin Rate, Sample T = 130 K

**Resolution**

Adamantane ($^{13}C$): 0.05 ppm FWHM, 0.2 ppm @ 10%, 0.35 ppm @ 2%

**Signal to Noise** (Glycine, Matched filter, 32 acquisitions, 293 K)

HFCN Mode 150:1
HFC Mode 170:1

**RF Performance @ 90 K and 300 K:**

| Nucleus | pw90μs |
|---|---|
| $^{1}H/^{19}F$ | 2.5 μs (50 ms, 2% duty factor) |
| $^{1}H$ & $^{19}F$ | 2.8 μs (50 ms, 2% duty factor) |
| $^{13}C$ | 2.5 μs (10 ms, 2% duty factor) |
| $^{31}P$ | 2.5 μs (10 ms, 2% duty factor) |
| $^{15}N$ | 5.0 μs (10 ms, 2% duty factor) |

[1] Frederic Mentink-Vigier, *National High Magnetic Field Laboratory, Tallahassee, Florida 32310*, [2] Tuo Wang, *Department of Chemistry, Louisiana State University, Baton Rouge, Louisiana 70803*, [3] Thorsten Maly, *Bridge12 Technologies, Inc. Framingham Massachusetts 01702*

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