Technology Update:
Standard-Bore (SB) & 1.x GHz DNP

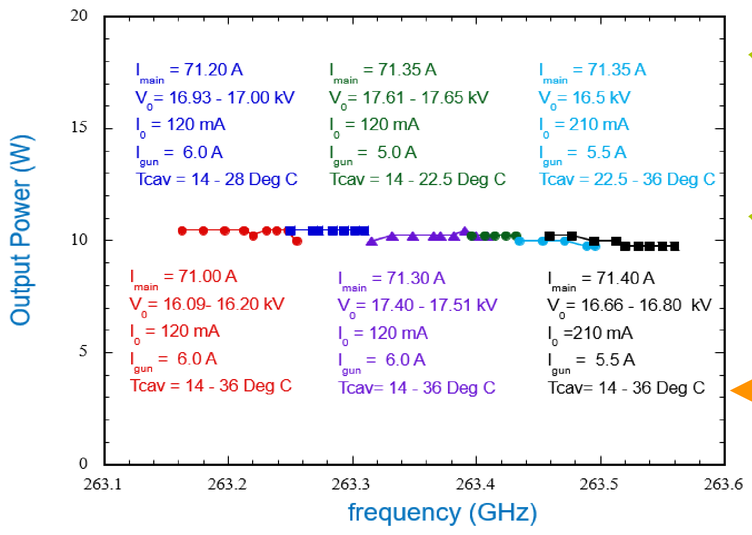
Hyperpolarization at Ultra-High Fields

1.x GHz NMR magnets offer unparalleled gains in both sensitivity and resolution. By combining these systems with DNP one can obtain an additional gain of ~660x in signal-to-noise compared to traditional CPMAS techniques. Current DNP microwave sources are limited to 593 GHz (900 MHz NMR), however, recent progress in gyrotron and standard-bore DNP probe development will enable DNP experiments at 1.0 GHz and above.

Next Gen. Gyrotrons (*in Development*)

The next generation of gyrotrons will enable high-power DNP experiments up to 790 GHz (1.2 GHz NMR). These systems will feature an extended frequency tuning range in place of an NMR sweep coil.

- ✓*Same footprint as current 400 – 900 MHz gyrotrons*
- ✓*High power output (> 35 W)*



- ✓*Large tuning range (1500 ppm)*
- ✓*No need for NMR sweep coil*

← Frequency tuning tests on 263 GHz gyrotron

Gyrotron Cavity Design

CPI Communications & Power Industries

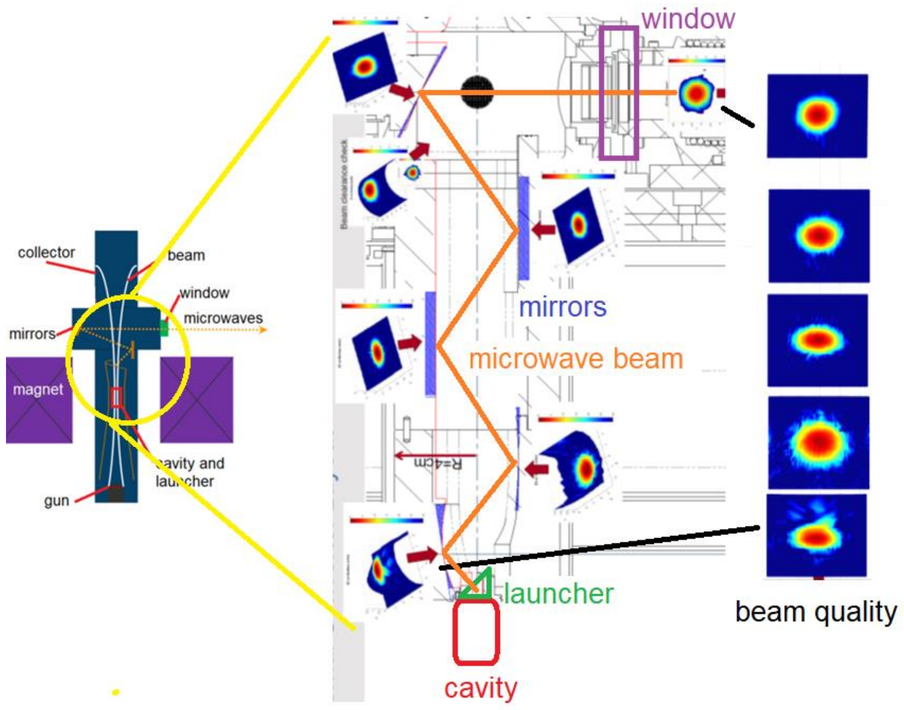
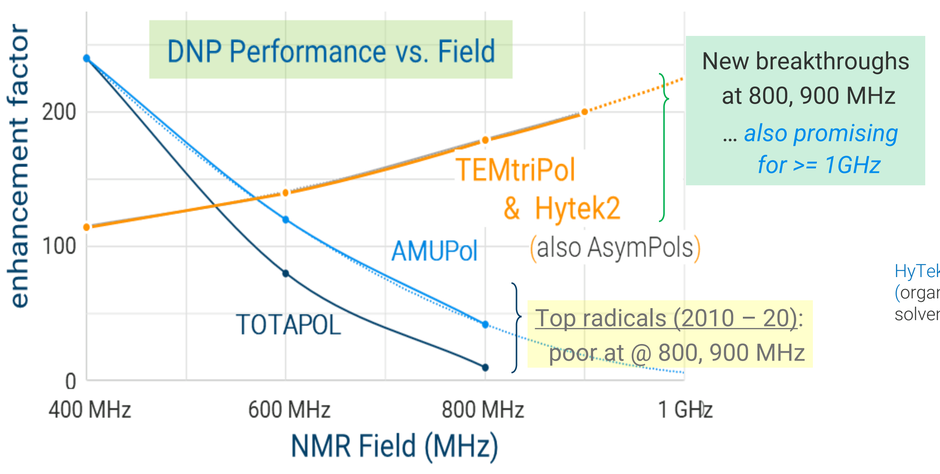
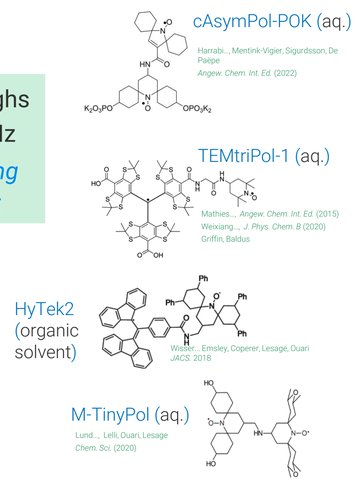


Fig.1 Cross-sectional view of 790 GHz gyrotron tube. Design by CPI (Palo Alto).

Radicals for High-Field DNP

The design of efficient radicals is a key step for the development of solid-state DNP applications at high magnetic field. Over the years, different series of radicals have been developed, with continuous progress for high field NMR magnets. The latest radical generation is composed of hybrid and nitroxides radicals, with unprecedented efficiency for NMR frequencies ≥ 800 MHz.





Standard-Bore DNP (≤ 1.3 mm MAS)

These probes open accessibility to DNP for customers with new or existing 600 – 800 MHz SB magnets, and pave the way for 1.x GHz DNP. HCN & HX configurations at 1.3 are 0.7 mm are in development for 600 MHz to 1.2 GHz NMR

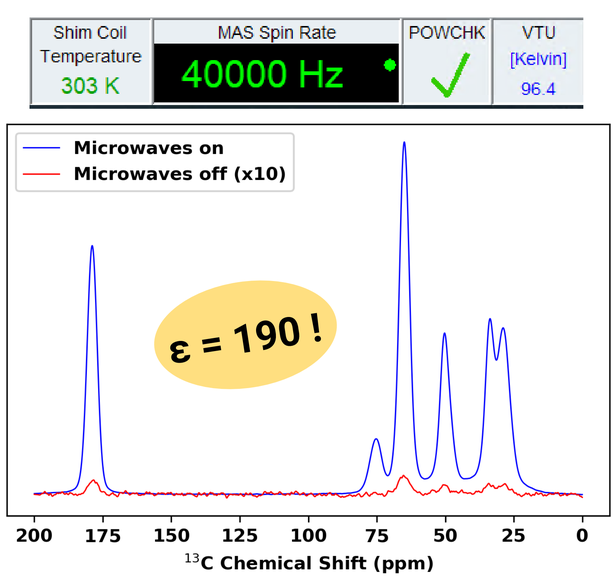


Fig.2 (left) Prototype SB DNP 1.3mm HXY 600 MHz probe.
(right) $^{1}H/^{13}C$ CP-MAS, with & without DNP at 96K. Sample = 0.25 M proline with 10 mM AMUPol in glycerol-d_8/D_2O/H_2O (60/30/10). DNP gain (on/off): 190.

Conclusion

- Recent advancements in gyrotron technology will enable DNP experiments at 1.0 GHz and above
- New radicals have been developed that substantially improve DNP performance at high magnetic fields
- SB DNP probes offer a way to perform DNP experiments on 1.x GHz NMR systems

TECHNOLOGY & APPLICATIONS