

Benchtop EPR for DNP Users

Magnettech ESR5000 – Strategic Role in DNP Workflows



- Prescreening Tool
 - ❖ Enables fast screening of polarizing agents before committing to long DNP experiments
- Quality Control
 - ❖ Ensures consistency and reliability of DNP samples over time
- Troubleshooting
 - ❖ Helps identify issues related to radical degradation or concentration changes

Value Proposition

Scientific and Technical Advantages



Rapid Assessment of Polarizing Agents

- ❖ Allows quick evaluation of radicals such as AMUPol, TEKPol, etc. This helps predict DNP efficiency and sample lifetime with minimal sample preparation

Spin Counting and Radical Concentration

- ❖ SpinCount module enables accurate measurement of radical concentration without external references. This is crucial for optimizing DNP conditions and monitoring radical degradation



Low Temperature Compatibility

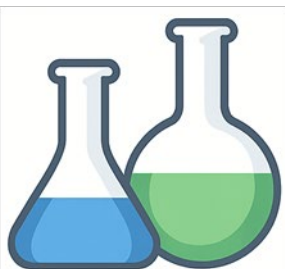
- ❖ Accessories enable measurements down to 77 K, simulating actual LT-MAS DNP conditions. This enables researchers to study radical behavior under cryogenic environments

■ $P_{1/2}$ Measurement

- ❖ Automatic power sweep and fitting capabilities help determine $P_{1/2}$, a key predictor of DNP performance

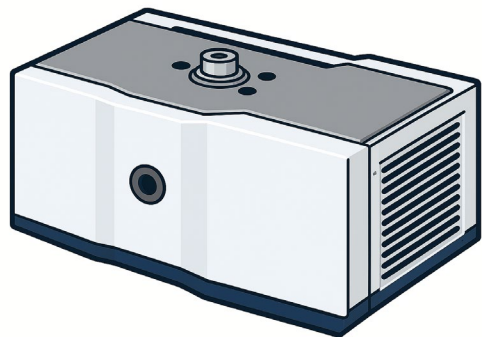
■ Versatile Sample Handling

- ❖ Compatible with various MAS rotors and solvents (aqueous and organic), making it suitable for a wide range of sample types



Value Proposition

Operational and Practical Benefits



- **Compact and Portable Design**

With dimensions around 40 × 28 × 19 cm and weighing ~45 kg, Magnettech ESR5000 is ideal for labs with limited space

40 × 28 × 19 cm



EASE OF USE

- **Ease of Use**

- ❖ Intuitive interfaces and streamlined ESRStudio software make these systems accessible to users without extensive EPR training



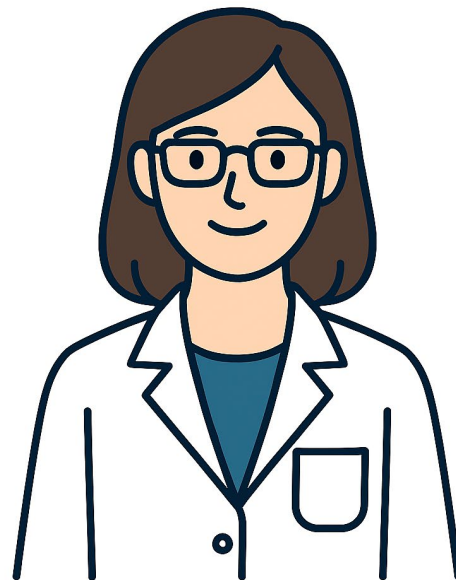
COST-EFFECTIVE

- **Cost-Effective**

- ❖ Compared to floor-standing EPR systems, benchtop models are significantly more affordable and require less maintenance, making them ideal for routine DNP support

Persona

- **Persona:** Dr. Elena Fischer – Cryogenic NMR Researcher
- **Role:** Senior Scientist in Solid-State NMR
Institution: National Center for Magnetic Resonance
Focus Area: Dynamic Nuclear Polarization (DNP) for biomolecular and materials research
- **Goals:** Maximize DNP efficiency for low-temperature MAS experiments. Rapidly screen and validate polarizing agents. Optimize sample preparation workflows with minimal downtime.



DR. ELENA FISCHER
Cryogenic NMR
Researcher

How ESR5000 Helps

- Provides **fast, reliable data** on radical concentration and behavior.
- Enables **routine QC** of DNP samples without disrupting NMR workflows.
- Offers **plug-and-play usability** for non-EPR experts.
- Supports **cryogenic studies** critical for LT-MAS DNP optimization.

Markets

Academic Research Laboratories (including DNP synthesis)

- **Fields:** Solid-state NMR, cryogenic spectroscopy, materials science, biochemistry
- **Use Case:** Synthesizing, screening and quantifying polarizing agents to predict DNP efficiency and sample lifetime
- **Value:** Enables fast, routine characterization without needing high-field EPR systems

Cryogenic NMR and DNP Specialists

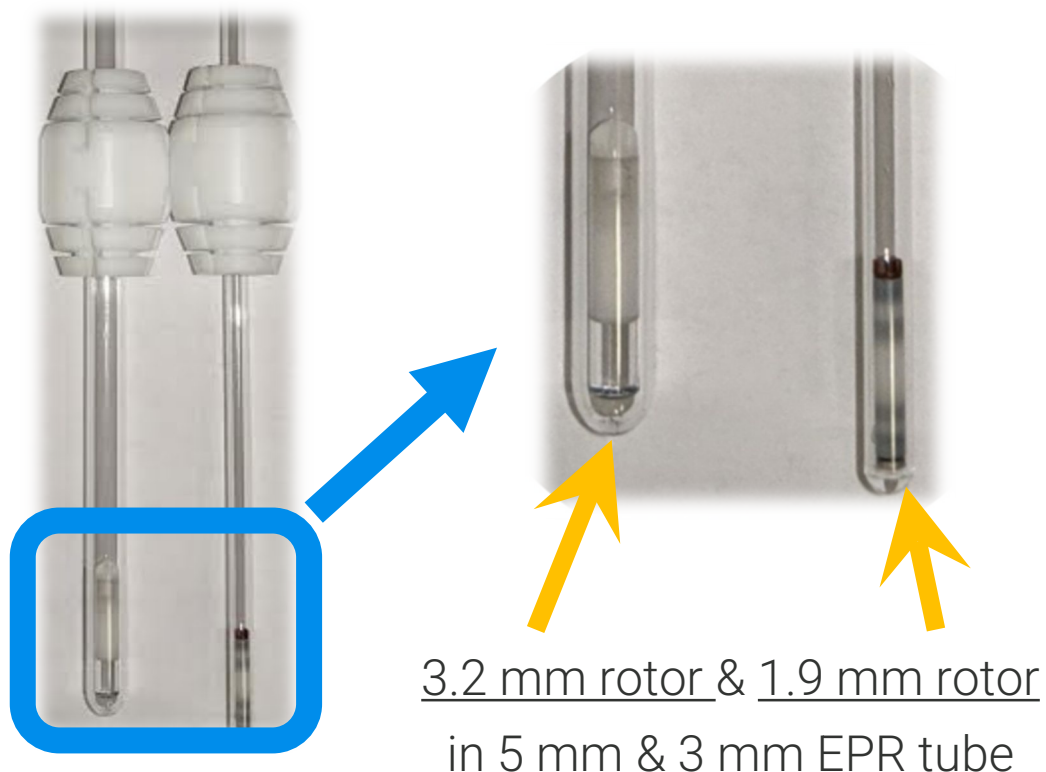
- **Fields:** LT-MAS DNP, dissolution DNP (d-DNP)
- **Use Case:** Simulating DNP conditions at temperatures down to 77 K, measuring $P_{1/2}$ and spin relaxation
- **Value:** Critical for optimizing DNP performance under realistic experimental conditions

Pharmaceutical and Biotech Companies

- **Fields:** Drug development, formulation stability, structural biology
- **Use Case:** Monitoring radical degradation and optimizing DNP sample prep for long-duration experiments
- **Value:** Supports quality control and reproducibility in DNP-enhanced NMR workflows



User-Friendly Rotor Loading Process



- **Precise Alignment:**
The cavity template ensures the MAS rotor is perfectly centered within the EPR tube, optimizing signal sensitivity and reproducibility
- **Rotor-to-Tube Compatibility:**
3.2 mm rotors fit smoothly into 5 mm EPR tubes, and 1.9 mm rotors into 3 mm tubes, with the template guiding correct depth and orientation
- **Sample Integrity Maintained:**
The rotor remains sealed, so there's no need to transfer the sample—reducing contamination risk
- **Tool-Free Loading:**
Most setups allow manual insertion without special tools, making the process quick and user-friendly
- **Cryo-Compatible:**
The tube-rotor combination is stable for low-temperature measurements, including down to 77 K

Polarizing Agent Analysis

■ DNP Gain Correlates with $P_{1/2}$

DNP efficiency is strongly linked to electron spin relaxation (T_{1e}), and shows a linear correlation with $P_{1/2}$, the microwave power at half saturation.

■ Fast $P_{1/2}$ Determination

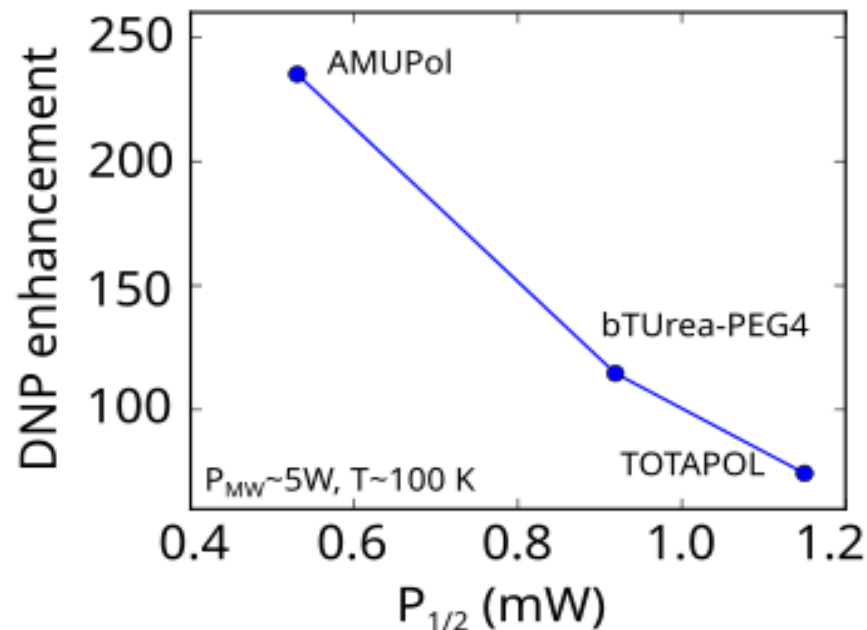
ESRStudio enables automatic power sweep and fitting to determine $P_{1/2}$, helping predict DNP performance in under an hour.

■ Radical Screening Made Easy

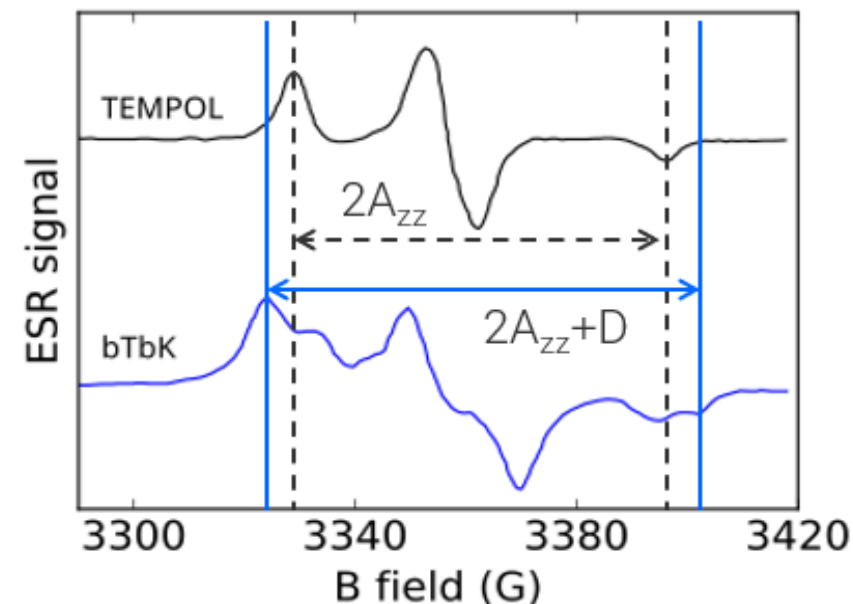
Quickly assess the suitability of new or endogenous polarizing agents (PAs) for DNP using ESRStudio's integrated modules.

■ Comprehensive Evaluation Tools

ESRStudio supports analysis of dipolar (D) and exchange coupling, which are key parameters for screening biradicals across different magnetic fields.



^1H DNP enhancement vs. $P_{1/2}$ for various radicals. Enhancements at 400 MHz using 5 W microwave power.



EPR spectra of nitroxide (TEMPOL) and bis-nitroxide (bTbK) DNP radicals.

Low-Temperature (LT) Accessories

Two Low-Temperature Options Available

- Variable temperature range from 93 K to 473 K using TCH04 VT controller
- Fixed 77 K via cold finger

Variable Temperature System (TCH04)

Includes a 50 L LN₂ dewar and temperature controller for flexible, in-line temperature control across a wide range.

Cold Finger Dewar

Offers a convenient and cost-effective solution for fixed low-temperature measurements

Relevance to DNP Conditions

Enables EPR measurements under conditions similar to DNP experiments, typically near 95–100 K

Enhanced Experimental Versatility

Supports both routine and advanced cryogenic studies, making it ideal for screening radicals under realistic DNP conditions



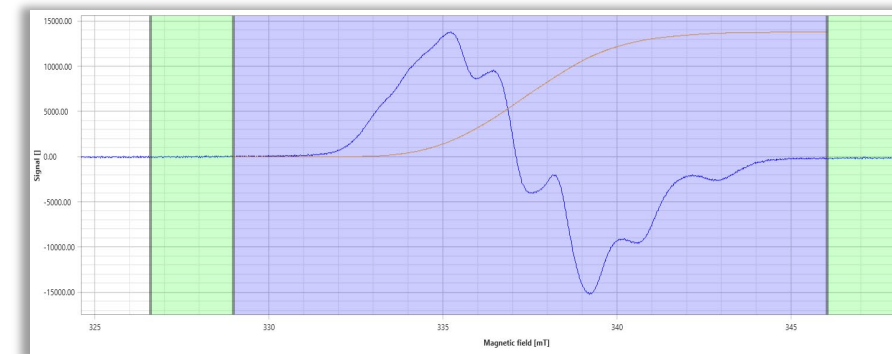
Spin Counting

Accurate electron spin concentrations are essential for:

- Optimizing DNP performance
- Monitoring radical degradation over time



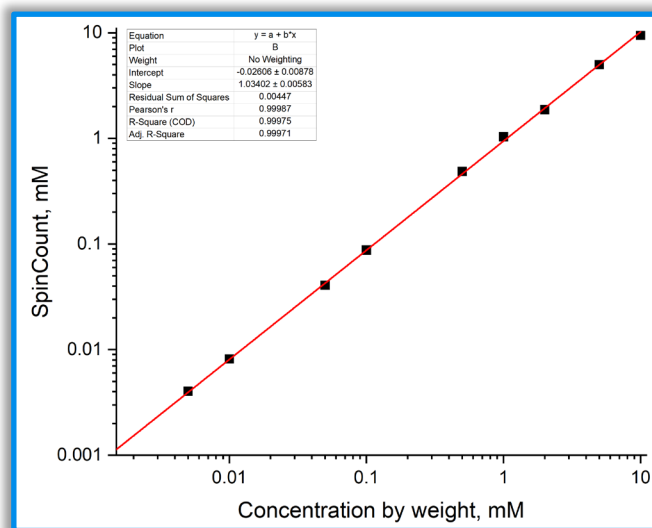
3.2 mm sapphire rotor



Improved double integration routine

The SpinCount module within ESRStudio offers:

- Easy and quick assessment of electron spin concentrations in DNP samples
- No need for an external reference



Excellent agreement with gravimetric analysis

SpinCount

Sample information

Height:

5.1 mm

Diameter:

2.17 mm

Mass:

1 mg

Electron spin:

1/2

Temperature:

32.2 °C

Result preview

Spins:

8.531e+016

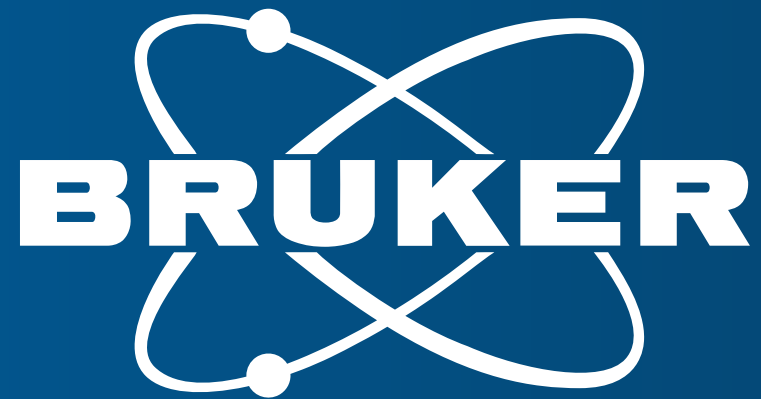
Spin conc.:

7.510e-003 M

Calculate

Close

SpinCount calculation to determine the concentration of AMUPol in DNP sample



Innovation with Integrity