Rapid Scan EPR

Since 1995, the very high level of sensitivity in Continuous Wave EPR (CW-EPR) has technologically reached its maximum. Recently a new method of acquiring the EPR signal, Rapid Scan EPR (RS-EPR), has been pioneered by the Eaton research lab at the University of Denver. RS-EPR is a revolutionary technique that can improve the signal to noise ratio and significantly decreases the acquisition time (down to milliseconds).

Fig. 1: RS-EPR Accessory (top) compatible with ELEXSYS and EMXplus (bottom)

The main difference between CW-EPR and RS-EPR is the size of the modulation amplitude and the sweep rate of the magnetic field. In RS-EPR the modulation amplitude is much larger than the EPR linewidth and the field is swept a million times faster (10 MG/s).

Continuous Wave EPR	Rapid Scan EPR
Field modulation, 1G /100 kHz	Direct detection
Derivative line shape	Absorption line shape
Modulation amplitude << line width	Scan width >> line width
Slow scan, G/sec	Rapid scan, 10 MG/sec
Unlimited sweep width	Sweep width ≤ 200 G per segment

Advantages in Rapid Scan EPR

The main advantage of RS-EPR comes from the later onset of signal saturation, allowing higher microwave powers to be used. This increases the signal amplitude relative to CW-EPR, leading to a much higher signal-to-noise ratio.

The short acquisition time in RS-EPR allows extensive signal averaging and very high time resolution. Compared to CW-EPR, RS-EPR delivers higher signal to noise in the same total experimental time. With sweep times as low as 10 microseconds, short lived EPR species can be observed and their changes can be followed with unprecedented time resolution.

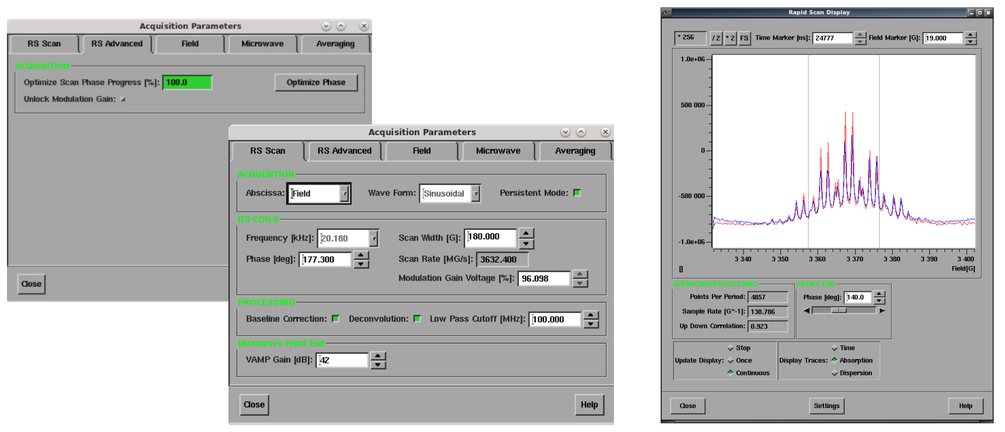

Fig. 2: Acquisition and Control Software : Real time display of time-domain data, on the fly spectrum reconstruction, software controlled wave form and frequency changes.

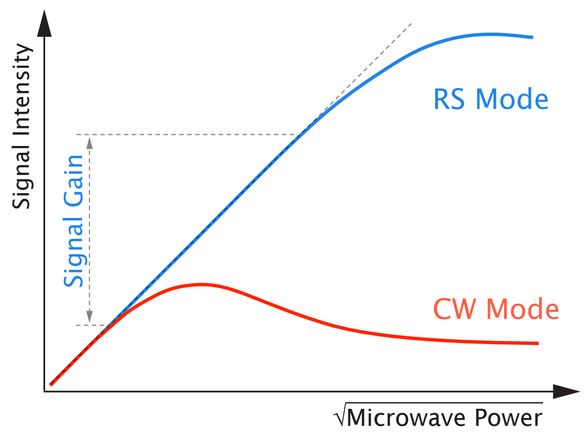

Fig. 3: EPR signal amplitude vs square root of power. In RS-EPR, the signal saturates at higher microwave powers, resulting in an EPR spectrum with much higher signal-to-noise.

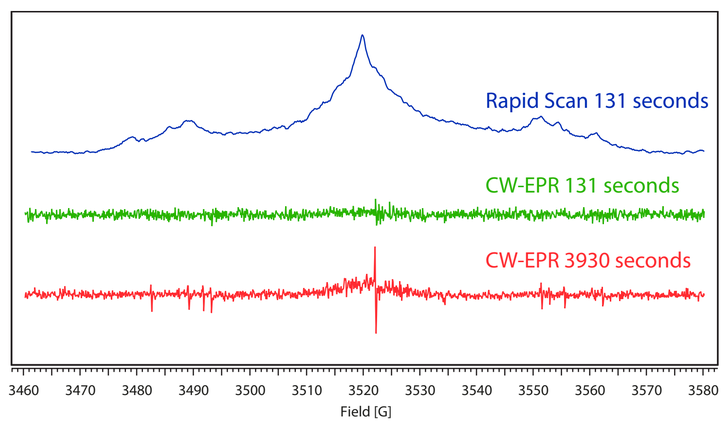

Fig. 4: RS-EPR and CW-EPR spectra of single nitrogen substitution center (P1) in diamond. RS-EPR yields a higher signal to noise in a shorter time compared to CW-EPR. For 131 seconds acquisition time, the diamond spectrum is clearly visible in RS-EPR while no clear spectrum is present in the CW-EPR spectrum. Only after averaging 30 times longer is the diamond spectrum obtained in CW-EPR with reasonable signal to noise.

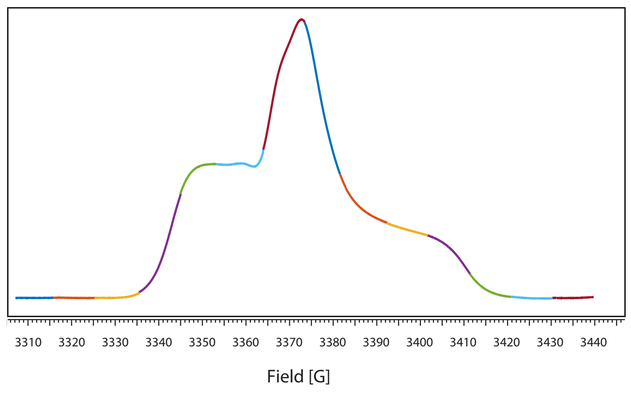

Fig.5: Nitroxide radical solid. 14 field segments of 26 G at 6.5 s per segment. Triangular Mode with Scan Frequency of 10 kHz.
For cases where the EPR spectra are greater than the maximum RS scan width, segmented acquisition is provided to acquire the full EPR spectrum.

Summary

- Impressive Signal-to-Noise gain vs CW-EPR.
- Reaction monitoring with unprecedented time resolution.
- Available as an accessory for EMXplus and ELEXSYS systems.
- Low temperature compatible (4K -300K).