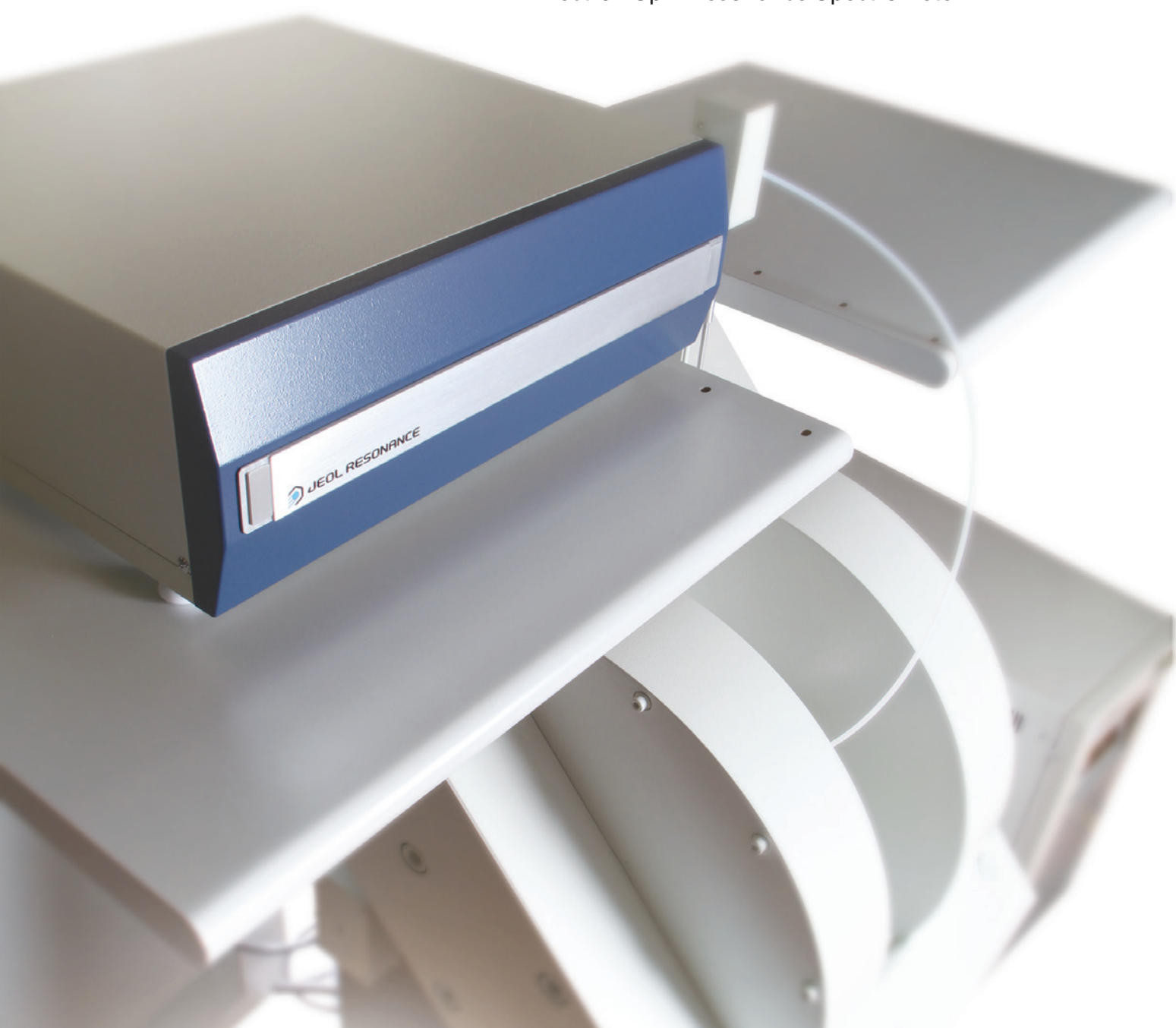


JES-X3 series

JES-X310 / JES-X320 / JES-X330

Electron Spin Resonance Spectrometer



ESR Spectrometer JES-

The ESR Spectrometer JES-X3 series has an improved low-noise Gunn oscillator sensitivity compared to previous models.

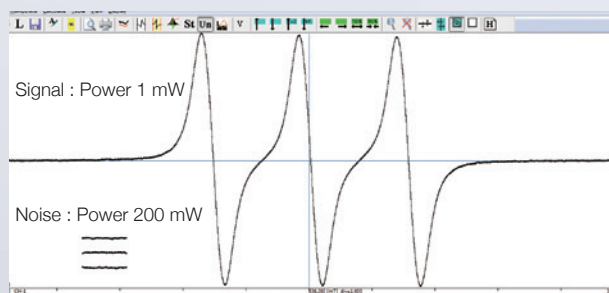
ESR is the only instrument for directly detecting paramagnetic species.

This supports a variety of applications in research, development, inspection and



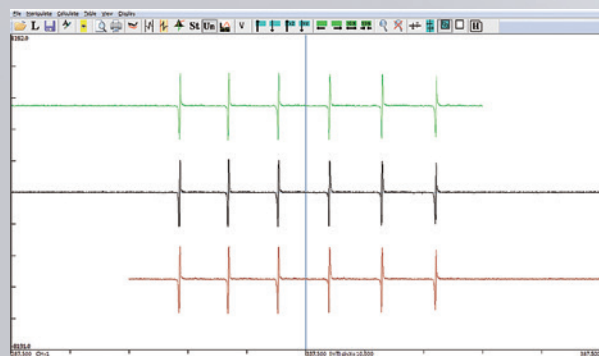
High sensitivity

The standard configuration includes a Gunn oscillator as the stable, low-noise microwave oscillation source, and a cylindrical (TE_{011}) cavity with an internal modulation method providing modulation with good uniformity and a high Q value, enabling high-sensitivity measurements. The data is the ESR signals for 1 μ M TEMPOL/benzene solution.



Magnetic field linearity

This figure shows the 6 ESR lines derived from Mn^{2+} measured by changing the center field by 20 mT for each spectrum. The coincidence of each peak position, even under different field setting, indicates the excellent field linearity of the magnet field.



X3 series

providing a 30% improvement in
evaluation.

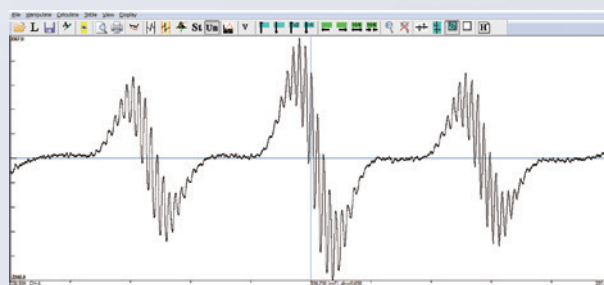


- Improved sensitivity with the ultra-low noise Gunn oscillator
- Built-in microwave frequency counter
- Intuitive user interface
- Various automatic measurement modes
- 3 types of magnets to suit the application
- Zero cross-field sweep function
- Wide variety of attachments



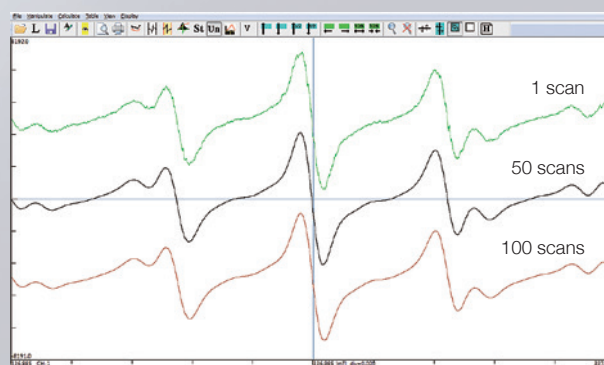
High resolution

High-purity materials are used for the magnet pole pieces and precisely engineered to provide a magnetic field with superior uniformity. The addition of ring shims to the pole piece surface makes it possible to obtain excellent uniformity over a wide range. The separation of the t-butyl group ($4.7 \mu\text{T}$) showing the smallest division of the galvinoxyl radical can be obtained.



Magnetic field stability

Data acquired near the center of the ESR signal for the perylene cation radical. Even with a signal exhibiting fine splitting, there is no spreading, demonstrating the exceptional stability of the magnetic field.





Intuitive User Interface (ESR measurements)

All the functions needed for ESR measurements are presented in 1 window that can be operated intuitively. Start the ESR system, adjust the microwaves from the Q-DIP window, set the acquisition conditions and

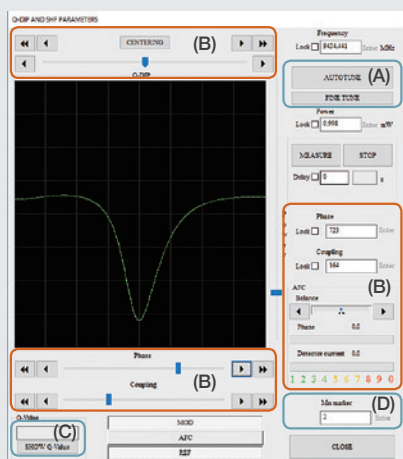
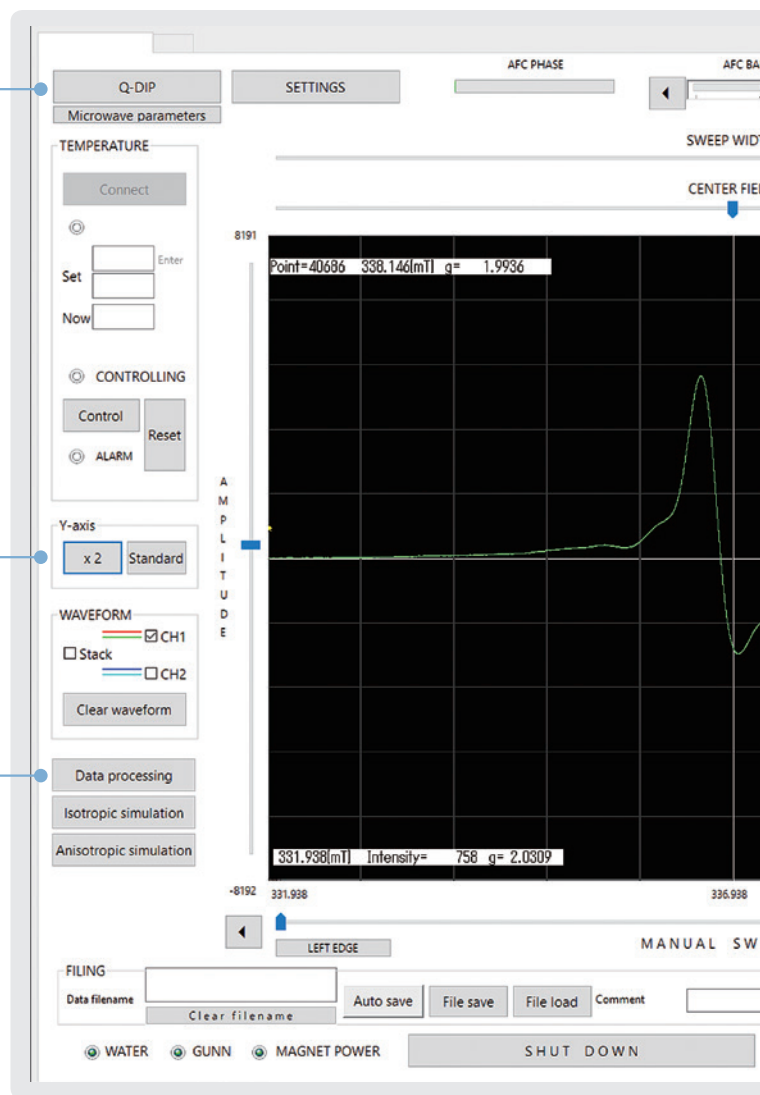
Q-DIP

Easily perform microwave adjustment.

Dynamic range

Switch between 5 settings.

Software for ESR analysis (P5)



■ Microwave adjustment functions

Microwave adjustment can be performed automatically using AUTOTUNE, or manually using various buttons.

(A) AUTOTUNE

Automatically optimizes the phase, coupling and detection of the resonance frequency of the microwaves.

(B) MANUAL TUNE

Manually adjust the phase and coupling while observing the Q-DIP waveform.

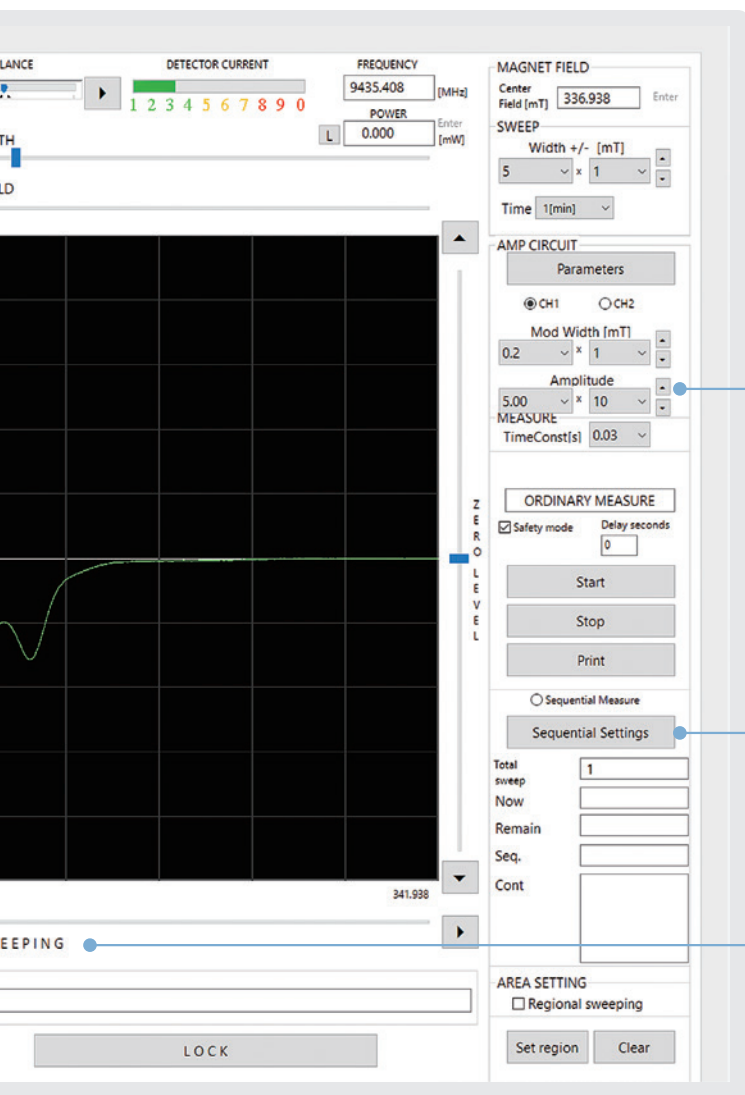
(C) Show Q-value

Displays the approximate Q value.

(D) Mn Marker

The insertion amount (0 to 1000) of the Mn marker can be adjusted.

start measurements.



ESR measurement

Sequential measurement

Automatic continuous measurement can be set.

Manual sweep

Check for presence of an ESR signal before measurement and set start position manually.

■ Sequential Measurement Mode

Various 2-dimensional measurements can be obtained by sequentially varying the ESR measurement parameters automatically.

Example of sequential measurement parameters

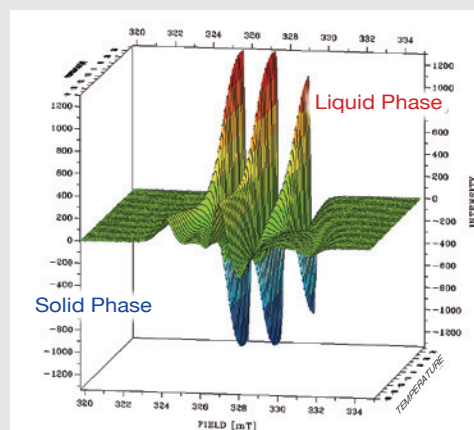
- ☐ Temperature
- ☐ Microwave power (saturation)
- ☐ Modulation width
- ☐ Detection phase
- ☐ Crystal axis (anisotropic tensor)
- ☐ Amplification

Parameter change increment

Arithmetic sequence Geometric sequence User-defined sequence

Other functions

Interval time Repeat measurement Integration
Data auto-save Save/Load parameter settings



ESR signal of the TEMPOL radical in glycerol
Temperature varied in 2 °C steps from - 35 °C to + 37 °C

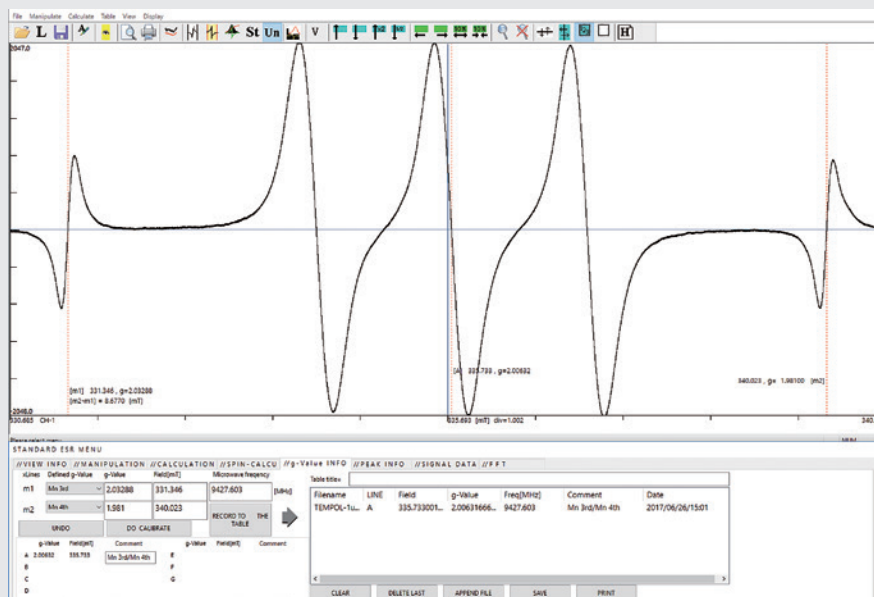


Data Processing for ESR Signal Analysis

The system is equipped with the tools required to obtain the information needed for ESR analysis (g-factor, A value, spin, linewidth, etc.) from the acquired measurement data.

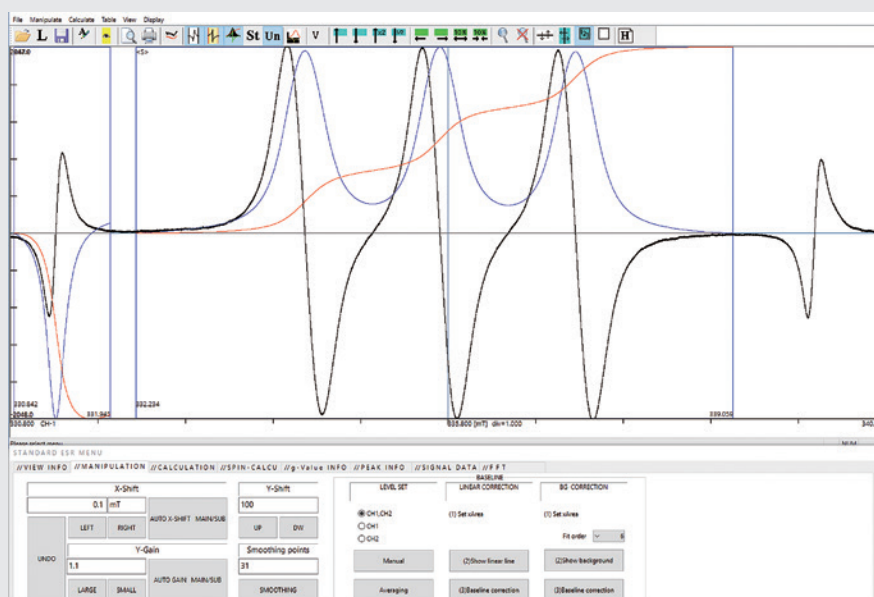
■ g-factor information

When a line is set on the ESR signal, the g-factor information can be extracted and a table of g-factors can be generated. The g-factor table can be saved in text format and processed using spreadsheet software. Highly-precise g-factors can be obtained by performing correction of the magnetic field using the Mn markers as a reference.



■ Spin calculation

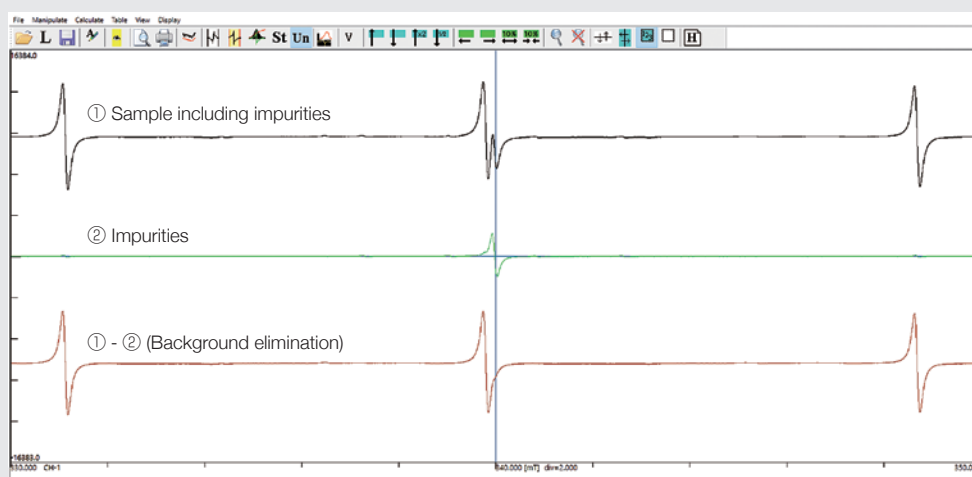
The number of spins (radical concentration) can be calculated with the results presented in a list. The number of spins is proportional to the doubly-integrated value (area) of the ESR signal. The number of spins for an unknown sample can be determined by comparing the doubly-integrated value obtained for unknown samples with the value for a standard sample, e.g. TEMPOL, with a known concentration. Sensitivity correction is applicable by doubly-integrating Mn^{2+} signal as well.



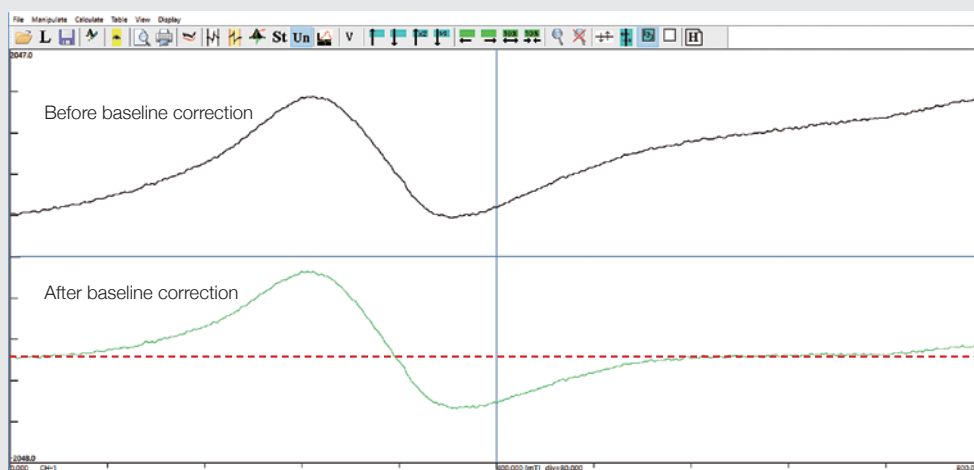
■ Waveform Processing

Available processing includes arithmetic operations on the signal, conversion to exponential and logarithmic forms, differentiation and integration, adjusting size and position for fitting signal, and baseline correction.

- **Arithmetic operations**
Arithmetic operations on waveforms.
- **Differentiation and integration**
Differential and integral processing of waveforms.
- **Spectrum separation**
If the conditions are matched, spectrum separation may be possible using subtraction.
- **Background elimination**
When there are known substances mixed into the sample, or when paramagnetic impurities are found in the sample tube, the arithmetic functions can be used to eliminate the background signal from the impurities.

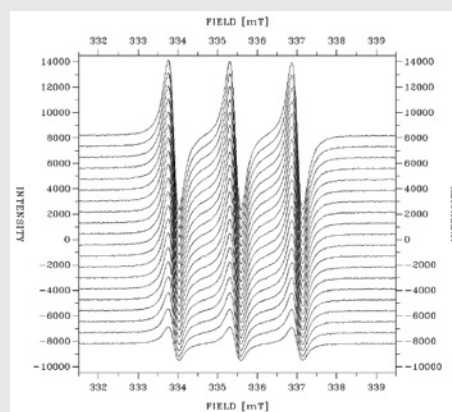
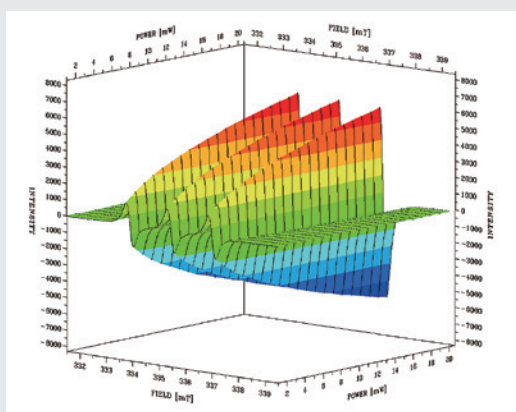


- **AUTO SHIFT · AUTO GAIN**
Signal position and intensity can be adjusted automatically.
- **X-Shift · Y-Shift**
Data can be freely manipulated, including moving the signal longitudinally or vertically, and varying the intensity.
- **Smoothing**
When power cannot be applied because the sample is easily saturated, or the concentration is low, a sufficient S/N might not be obtained. In such cases, smoothing can be used to reduce the noise components.
- **BASELINE correction**
Baseline correction can be performed by approximating the baseline components using a regression curve.
· Linear approximation · Regression curve (2nd to 11th order curve)



■ Various 2-Dimensional Displays

The display range can be set for signals and 2D data, and 2D data can be edited and created.



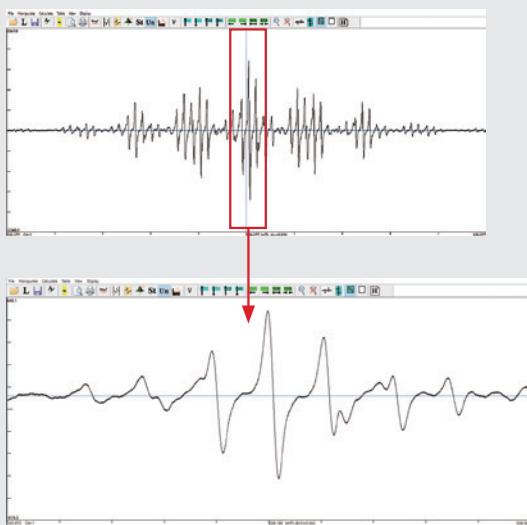
TEMPOL radical ESR signal
The microwave power range is varied in 1 mW steps from 1 to 20 mW

■ Peak information

By specifying an area on the ESR signal, it is possible to extract peak information (intensity, linewidth, intensity relative to the Mn marker) and generate a peak table. The peak table can be saved in text format and processed using spreadsheet software.

■ Other functions

● Partial signal zoom



● Batch conversion of multiple files into text format

The original spectrum data is a 64 K point binary format; but, it is possible to compress the number of points and convert the files into text format. All the data files contained in a folder can be converted into text files at one time.

XY axis data in text format

mT	Intensity
326.63682	33.50000
326.64415	35.50000
326.65148	39.25000
326.65881	42.25000
326.66613	44.50000
326.67346	48.50000
326.68079	51.00000
326.68812	53.00000
326.69544	56.50000
326.70277	58.25000
326.71010	64.00000
326.71743	65.50000
326.72476	69.75000
326.73208	73.25000
326.73941	77.25000
326.74674	82.50000
326.75407	85.50000
326.76139	93.25000
326.76872	94.75000
326.77605	100.75000
326.78338	105.25000
326.79071	108.75000
326.79803	115.25000
326.80536	120.50000
326.81269	127.50000
326.82002	133.00000
326.82734	138.50000



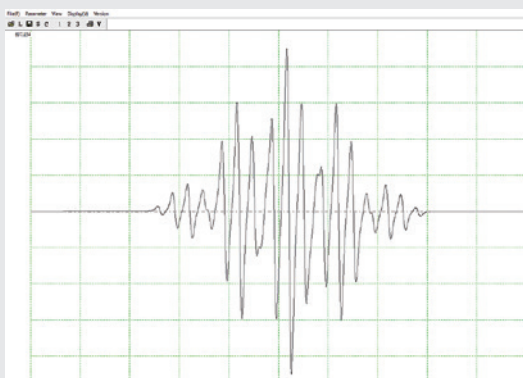
Simulation Assisting ESR Signal Analysis

■ Simulation software

Simulation of Isotropic and Anisotropic ESR signals is included in the standard configuration. In the simulation for an ESR signal for which the radical types can be estimated, the waveform is calculated from the signal-specific information, such as the splitting width, g-factor, and linewidth, in addition to the actual measurement conditions like resonance frequency, center magnetic field and sweep width.

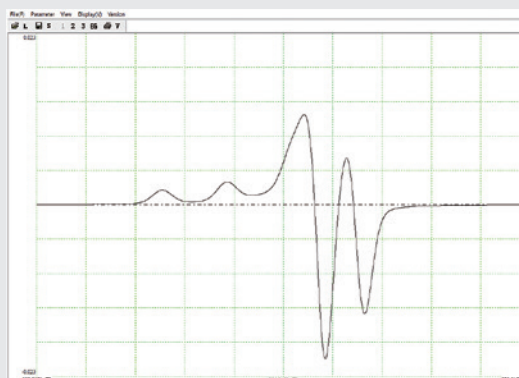
For the anisotropic simulation, the anisotropic parameters (g-factor anisotropy, A-value anisotropy, linewidth anisotropy) are used to calculate the waveform. Axial symmetry as well as rhombic anisotropy can be handled.

● Isotropic simulation



Simulation of ESR signal of the Anthraquinone radical anion

● Anisotropic simulation



Simulation of ESR signal for copper

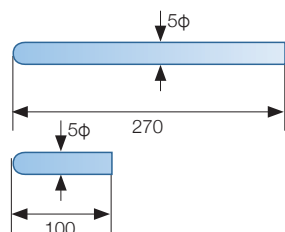
Sample Tubes

Sample tubes have an outer diameter of 2 to 5 mm, with the measurement section made from high-purity synthetic quartz. For samples with a large dielectric losses and liquid samples, sample tubes with a smaller diameter, capillary tubes or aqueous sample cells may be more suitable.

Unit:mm

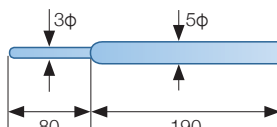
● Quartz For X-band 5 ϕ

270 Part No. : 780225392
100 Part No. : 820374083



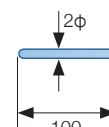
● For X-band (Quartz tip) 3 ϕ

Part No. : 422000272



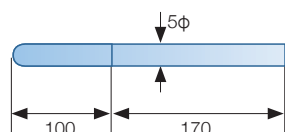
● Quartz For Q-band 2 ϕ

Part No. : 620007125



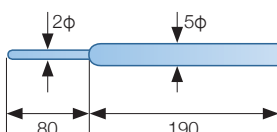
● For X-band (Quartz tip) 5 ϕ

Part No. : 422000281



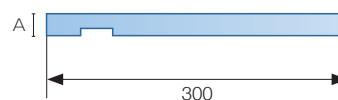
● For X-band (Quartz tip) 2 ϕ

Part No. : 422000990



● For sample rotation device

A=5 ϕ Part No. : 800310641
3 ϕ Part No. : 800310659



* The caps for sample tubes are sold separately.



Attachments Enabling a Variety of ESR Measurements

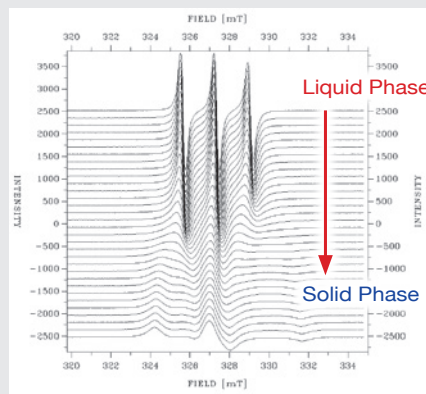
Variable Temperature Controller (ES-13060DVT5)

Features

- Variable temperature range: 103 to 473 K
- Temperature stability : ± 0.5 K
- USB connection
- Temperature control : Auto PID
- Compressor flow : 17 L/min (air)
- Dewar volume : 10 L
- (30 L Dewar also available as option)
- Variable temperature range : 113 to 473 K)

Composition

- Temperature controller
- Heating tube
- Dewar adapter
- Metal Dewar
- Variable temperature adapter
- Compressor



ESR signal of the TEMPOL radical in glycerol
Temperature varied in 2°C steps from -35 to +37 °C

* Separate consultation required for 400 °C VT.

Liquid He Variable Temperature Controller (ES-CT470)

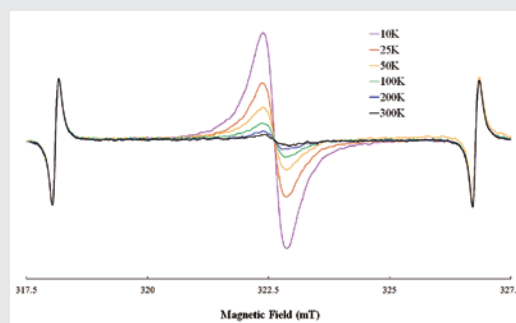
Features

- Variable temperature range : 2.5 to 470 K
- Easy set-up : Assembly time : about 20 min
- Rapid cooling : From room temperature to 4.2 K : 15 min
- Temperature stability : ± 0.5 K
- Can use both UV radiation and Mn markers
- Easy sample exchange
- Control using liquid nitrogen available
- (Variable temperature range : 80 to 470 K)

Composition

- Cryostat
- Transfer line
- Dewar adapter and spacer
- Flow meter
- Temperature sensor
- Temperature controller
- Parts for assembly and spare parts

* Additional rotary pump is needed for the experiments conducted below 4.2 K.



ESR signal of silicon dangling bond

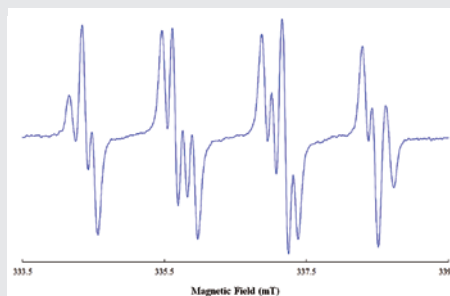
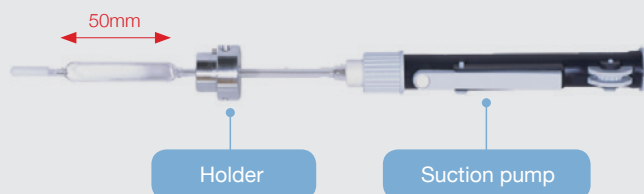
■ Aqueous Sample Cells (ES-LC12)

● Features

- Flat cell structure makes it possible to minimize reduction of sensitivity.

● Specifications

- Volume : 130 μL
- Sample tube outer shape (mm) : 12×1.5
- Sample tube inner shape (mm) : 10×0.25
- Permitted temperature range : Room temperature



ESR signal of DMPO spin adducts of superoxide anion radical

■ Sample Angular Rotation Device (ES-12010)

● Features

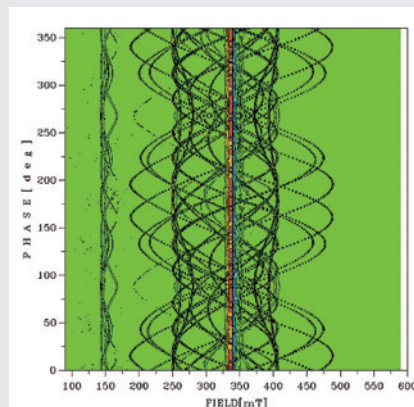
- Angle setting resolution : 0.06° (Rotation angle: 0 to 360°)
- Variable temperature controller (ES-13060DVT5) and the liquid helium variable temperature controller (ES-CT470) can be used concurrently.

● Compatible cavity

- ES-UCX2/ES-MCX3B

● Sample rod

- 1 each of 5 ϕ , 3 ϕ are provided



Angular rotation spectrum (1.2° increments) of diamond II a monocrystal irradiated with an electron beam

■ Q-Band Microwave Unit (ES-SQ5)

● Features

- Temperature variation can be performed by attaching the temperature control adapter (ES-UTQ3) to the variable temperature unit (ES-13060DVT5).
- High filling factor
- Only small sample volumes needed (a few μL)

● Composition

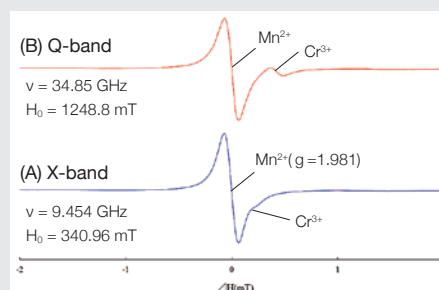
- Compatible ESR systems : JES-X320/JES-X330
- Q-Band cavity
- Q-Band microwave unit

● Sample tubes

- Q-Band dedicated sample tubes



Q-Band microwave unit configuration
(Left) Q-Band microwave unit
(Right) Q-Band cavity



ESR signal for Mn^{2+} containing Cr^{3+} as impurities is shown around the center field H_0 .
(A) X-band, (B) Q-band

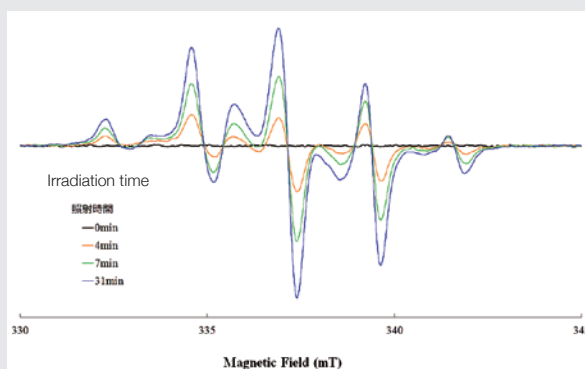


Attachments Generating Radicals by External Stimulation

■ Ultraviolet Irradiation Apparatus (ES-USH500 / USH500H / UXL500 / UXL500H)

● Features

- Variable temperature controller (ES-13060DVT5) and the liquid helium variable temperature controller (ES-CT470) can be used concurrently.
- Can choose a high-voltage mercury lamp or a xenon lamp.
- 2 types of irradiation models for each light source.
- The ultraviolet irradiation accessory kit (ES-UVAT1) and condenser lens (ES-UVLL/UVLS) are required options.
- Selectable irradiation wavelength using colored glass filters.



Variation in ESR signal intensity relative to the irradiation time of polymethacrylic resin (optical fiber)

- * A cart for moving the ultraviolet irradiation apparatus is not included.
- * Please inquire about irradiation apparatus using optical fiber if needed.

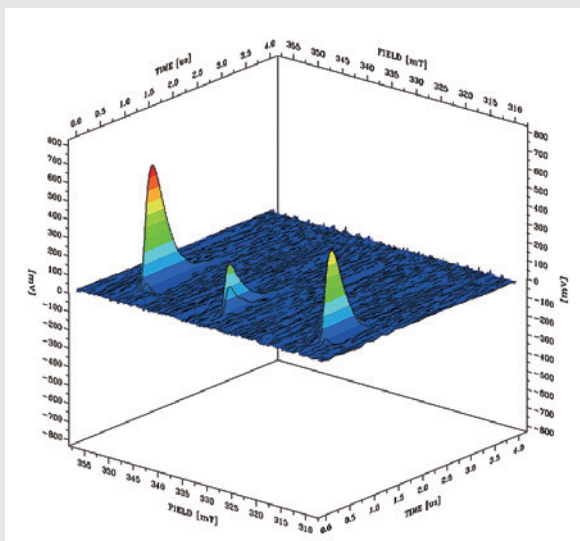
■ Time-Resolved ESR System (ES-CIDEP)

● Features

- Time resolution of several hundred ns

● Composition

- Wide-band pre-amplifier (ES-WBPA4)
- Digital oscilloscope
- Time-resolved ESR software
- Cables



Sample : TMDPO / benzene solution
YAG laser: 355 nm (3rd harmonic)

- * Laser light source and optical path not included.

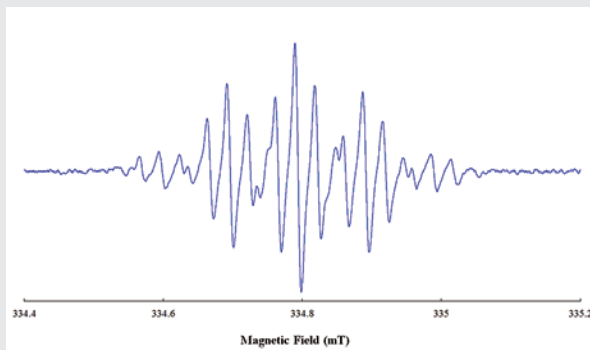
■ Helix Electrode Electrolytic Cell (ES-EL30)

● Features

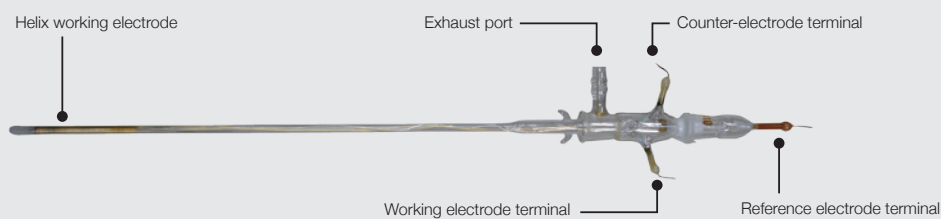
- Can use with the Variable temperature controller (ES-13060DVT5).
- Measurement possible for highly-polar organic solvents (DMSO, DMF, etc.) or with water as the solvent.

● Composition

- Electrolytic cell (glass vessel)
- Electrodes (Au),
Reference electrode (Ag)
- Sample tube (quartz)



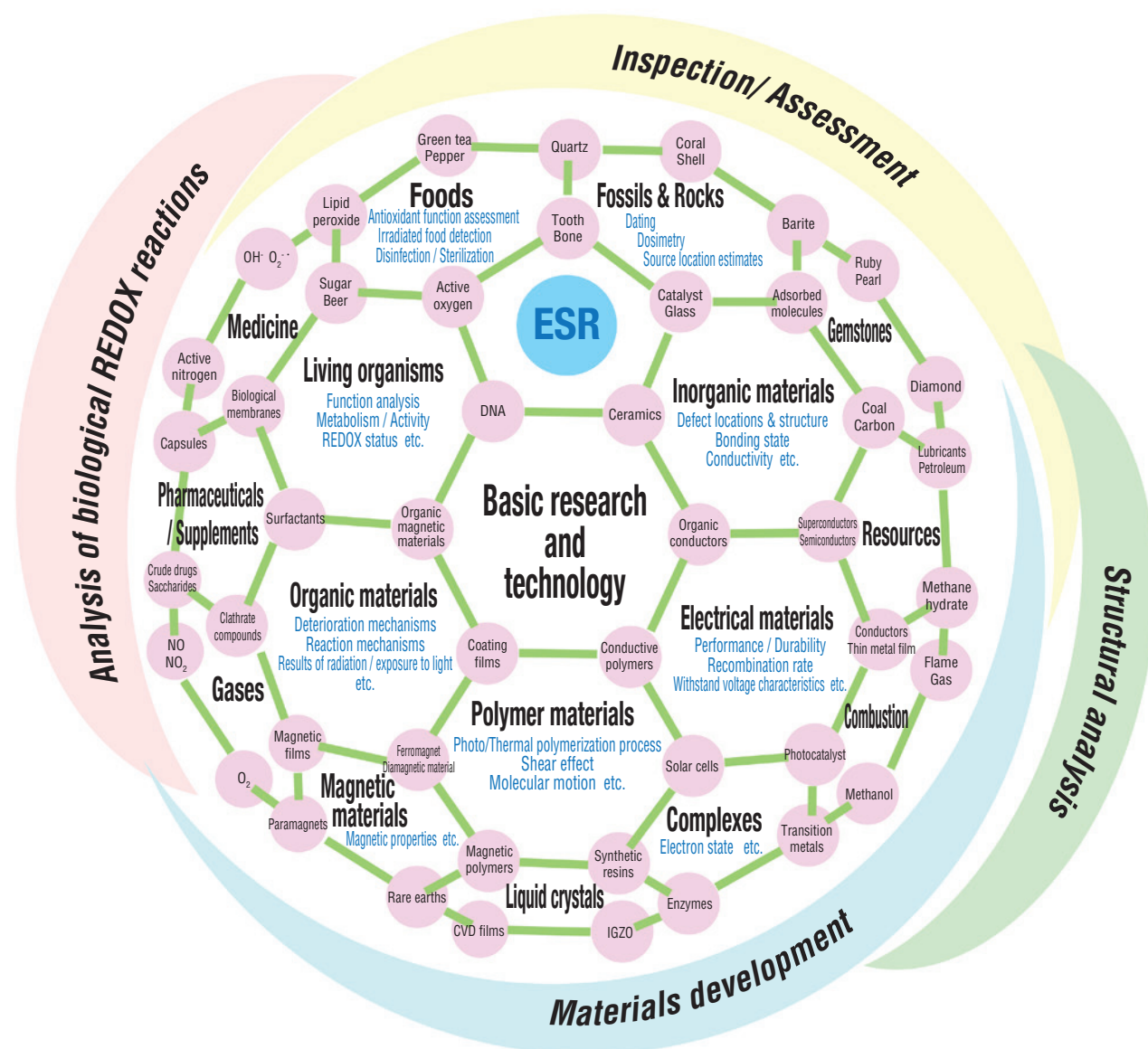
Anthraquinone anion radical ESR signal



Please see the attachment brochure for other options, such as insertion type Dewar, ODMR, EDMR, ESRET, ENDOR, and so forth.

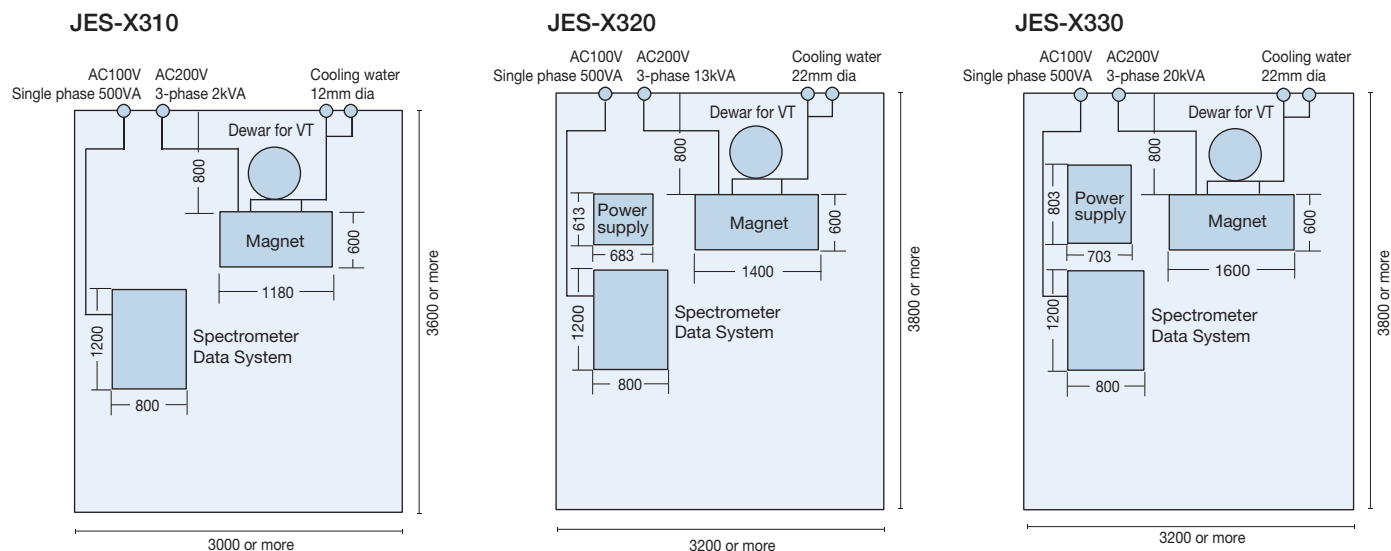


ESR Applications



Installation Example

Unit:mm



Main Specifications

	JES-X310	JES-X320	JES-X330
Electromagnet			
Maximum magnetic field (T)	~0.65	~1.3	~1.4
Sub-polepiece magnetic field (T)	-	~1.7	~2.0
Sweep width (mT)	±0.01 to 250	±0.01 to 500	
Magnetic field setting accuracy	±5μT or ±0.1% or less (whichever is larger)		
Long term stability	5×10 ⁻⁶		
Pole diameter (root)/Effective gap(mm)	150 / 60	240 / 60	360 / 75
Microwave unit			
Frequency range (GHz)	8.750 to 9.650		
Frequency count display	7 digits (std)		
Microwave output (mW)	0.0001 to 200		
Microwave tuning	Auto		
Cavity			
Resonance mode / Q value (no load)	Cylindrical TE ₀₁₁ / 18000 or more		
Mn marker	Auto / Motor control		
Data system			
OS	Windows® 10		
Spectrum resolution (bit)	16		
Analysis software/ Simulation	Standard		

Dimentions and Weight

External dimensions = Width × Depth × Height

	JES-X310	JES-X320	JES-X330
Electromagnet (Including SHF table)			
Dimensions (mm)	1,180×710×1,105	1,400×803×1,190	1,600×990×1,190
Weight kg	520	1,060	2,300
Spectrometer			
Dimensions (mm)	300×602×602 / 35		
Excitation power supply			
Dimensions (mm)	Included in magnetic chassis	683×613×895	703×803×1,114
Weight kg	-	300	500
Power requirements			
Spectrometer	1 ϕ 100 V, 500 VA		
Magnet (Breaker rating)	3 ϕ 200 V, 2 kV 30 A	3 ϕ 200 V, 13 kVA 60 A	3 ϕ 200 V, 20 kVA 100 A
Power supply fluctuation / grounding	± 5 % / Class D grounding		
Cooling water			
Water pressure (MPa)	0.05 to 0.2	0.15 to 0.3	
Flow rate (L/min) / Temperature (°C)	6 / 15 to 25	8 /15 to 16/25	16 /15 to 25
Faucet outer diameter (mm)	12	22	

* Appearance and specifications are subject to change without notice.

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