EB-TX210A / EB-TX220A

(FCC ID NWJ10A002A)

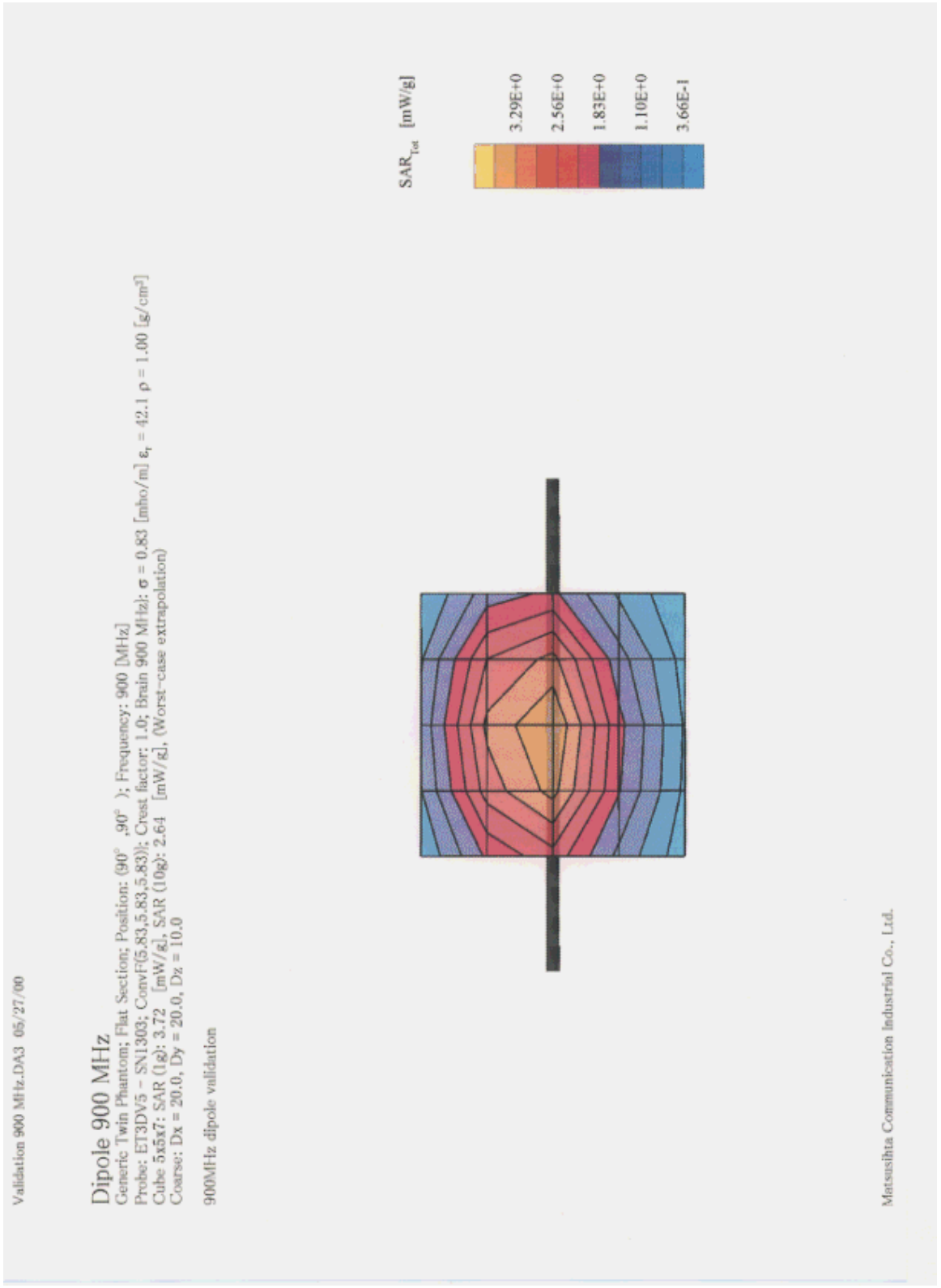
Dipole system validation

Table of Contents

1. Overview

Plot data in this report is validation of dipole antenna. Measurement is based on the document ('Dipole Validation Kit') attached.

2. 900MHz system validation



3. 1900MHz system validation

Schmid & Partner
Engineering AG

Staffelstrasse 8, 8045 Zurich, Switzerland, Telefon +41 1 280 08 60, Fax +41 1 280 08 64

DASY

Dipole Validation Kit

Type : D1800V2

Ser.: 205

Manufactured:	January 1997
Calibrated:	February 1997

1. Measurement Conditions

The measurements were performed with the the new generic twin phantom (shell thickness 2mm) filled with brain simulating sugar solution of the following electrical parameters at 1800 MHz:

Relative Dielectricity	**40.3**	± 5%
Conductivity	**1.69 mho/m**	± 10%

The DASY2 System (Software version 2.3d) with a dosimetric E-field probe ET3DV4 (SN:1025) was used for the measurements. The Conversion Factor (probe parameter) for the probe was 4.5.

With the Head Phantom, the dipole feedpoint was positioned below the ear hole marking. The dipole orientations used were in a horizontal plane parallel and normal to the body axis. The standard measuring distance was 20mm from dipole centre to the solution surface. The accurate distance positioning was done by using the included distance holder.
This measuring point is not very critical for SAR measurements. The measured variations are:

Horizontal shift from/to phantom nose	< 2% for 5mm shift
Horizontal shift to bottom/top of head	< 5% for 5mm shift
Positioning angle in horizontal plane	< 2% for ±10° shift

The repeatability of SAR-measurements with normally careful positioning should be better than 5%. The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. The variations from using different coarse grid orientations and spacings or from using the 4x4x7 fine cube were all within 3% of the assessed SAR-value.

2. SAR Measurement

Standard SAR-measurements were performed with the head phantom according to the measurement conditions described in section 1. The results (see figure) have been normalised to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

- SAR in flat phantom:

SAR at surface (extrapolated):	**25.0mW/g**
averaged over 1 cm^3 (1 g) of tissue:	**13.7 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**7.50 mW/g**

- Dipole normal to body axis (horizontal):

SAR at surface (extrapolated):	**28.5 mW/g**
averaged over 1 cm^3 (1 g) of tissue:	**14.6 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**8.37 mW/g**

- Dipole parallel to body axis (vertical):

SAR at surface (extrapolated):	**23.9 mW/g**
averaged over 1 cm^3 (1 g) of tissue:	**12.6 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**7.30 mW/g**

If the liquid parameters for validation are slightly different from the ones used for initial calibration, the SAR-values will be different as well. The estimated sensitivities of SAR-values and penetration depths to the liquid parameters are as follows (see also Application Note 4: SAR Sensitivities):

- SAR at the phantom surface:

$$\frac{dSAR / SAR}{d\varepsilon / \varepsilon} = -0.73 \qquad \frac{dSAR / SAR}{d\sigma / \sigma} = +0.90$$

- SAR averaged over a cube of $1cm^3$:

$$\frac{dSAR / SAR}{d\varepsilon / \varepsilon} = -0.54 \qquad \frac{dSAR / SAR}{d\sigma / \sigma} = +0.51$$

- SAR averaged over a cube of $10cm^3$:

$$\frac{dSAR / SAR}{d\varepsilon / \varepsilon} = -0.41 \qquad \frac{dSAR / SAR}{d\sigma / \sigma} = +0.23$$

- Penetration depth:

$$\frac{d\delta / \delta}{d\varepsilon / \varepsilon} = +0.46 \qquad \frac{d\delta / \delta}{d\sigma / \sigma} = -0.96$$

3. Dipole Impedances

The impedances were measured at the SMA-connector with a network analyser and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	**1.2394 ns**	(one direction)
Transmission factor:	**0.979**	(voltage transmission, one direction)

- Dipole impedance at Flat phantom:

Distance from solution [mm]	Re{Z} [Ω]	Im{Z} [Ω]	Return Loss [dB]
10	50.9	6.3	-24.5
15	49.2	-0.3	-41.3
20	55.3	0.9	-26.2
25	64.6	2.4	-18.2
30	74.3	1.1	-14.6
35	83.6	-3.5	-12.3
40	90.4	-9.0	-11.0
45	95.4	-18.2	-9.9
50	96.0	-26.5	-9.3

- Dipole impedance at Head phantom:

Distance from solution [mm]	Re{Z} [Ω]	Im{Z} [Ω]	Return Loss [dB]
10	42.7	-8.5	-18.7
15	44.1	-8.9	-19.3
20	51.6	-7.1	-23.3
25	59.7	-7.5	-19.4
30	68.3	-11.2	-15.3
35	74.8	-16.7	-12.9
40	78.8	-23.8	-11.3

• Dipole in free space	71.2	-30.0	-11.0

4. Handling

The dipole is made of standard semirigid coaxial cable. The centre conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

Do not apply excessive force to the dipole arms, because they might bend. If the dipole arms have to be bent back, take care to release stress to the soldered connections near the feedpoint; they might come off.

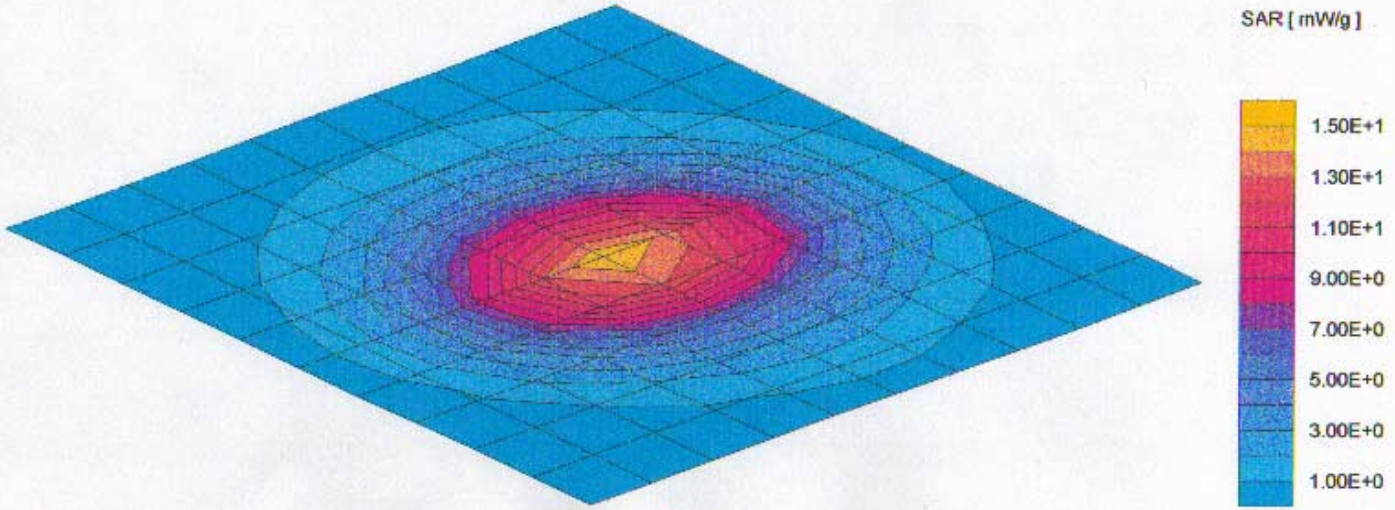
After prolonged use with 40W radiated power, only a very slight warming of the dipole near the feedpoint can be measured.

D1800V2 sn:205 / Flat Phantom / Pin = 1W / d = 20 mm

σ = 1.69 [mho/m] ε_r = 40.3 ρ = 1.00 [g/cm^3]

SAR [mW/g] Max: 15.1

SAR (1g): 13.7 [mW/g] SAR (10g): 7.50 [mW/g]



D1800V2 sn:205 / Head Phantom / horizontal / Pin = 1W / d = 20mm

σ = 1.69 [mho/m] ε_r = 40.3 ρ = 1.00 [g/cm^3]

SAR [mW/g] Max: 16.20

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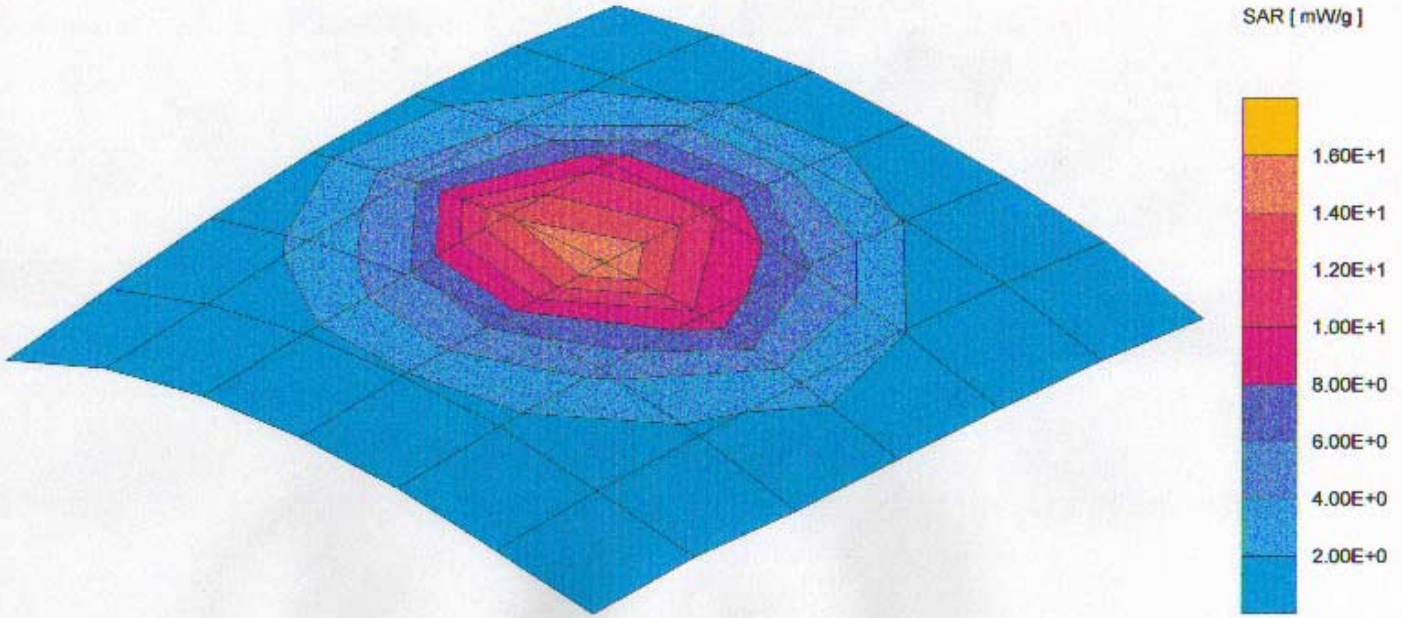

D1800V2 sn:205 / Head Phantom / vertical / Pin = 1W / d = 20mm

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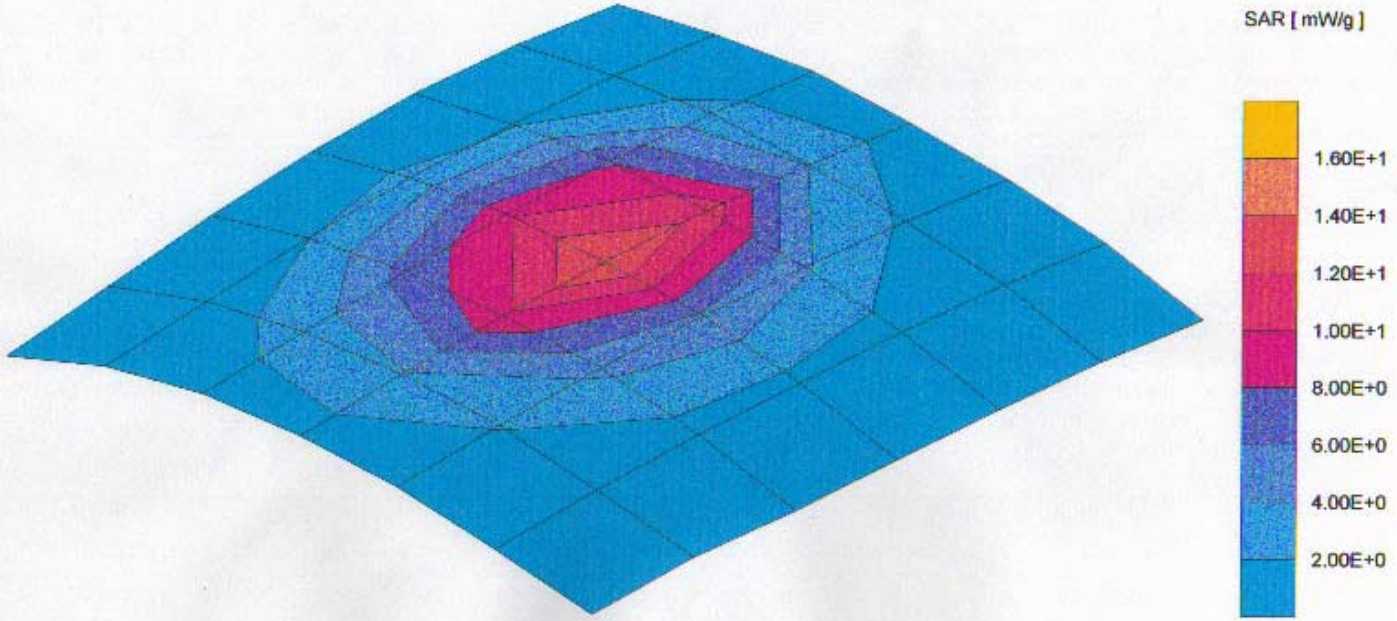
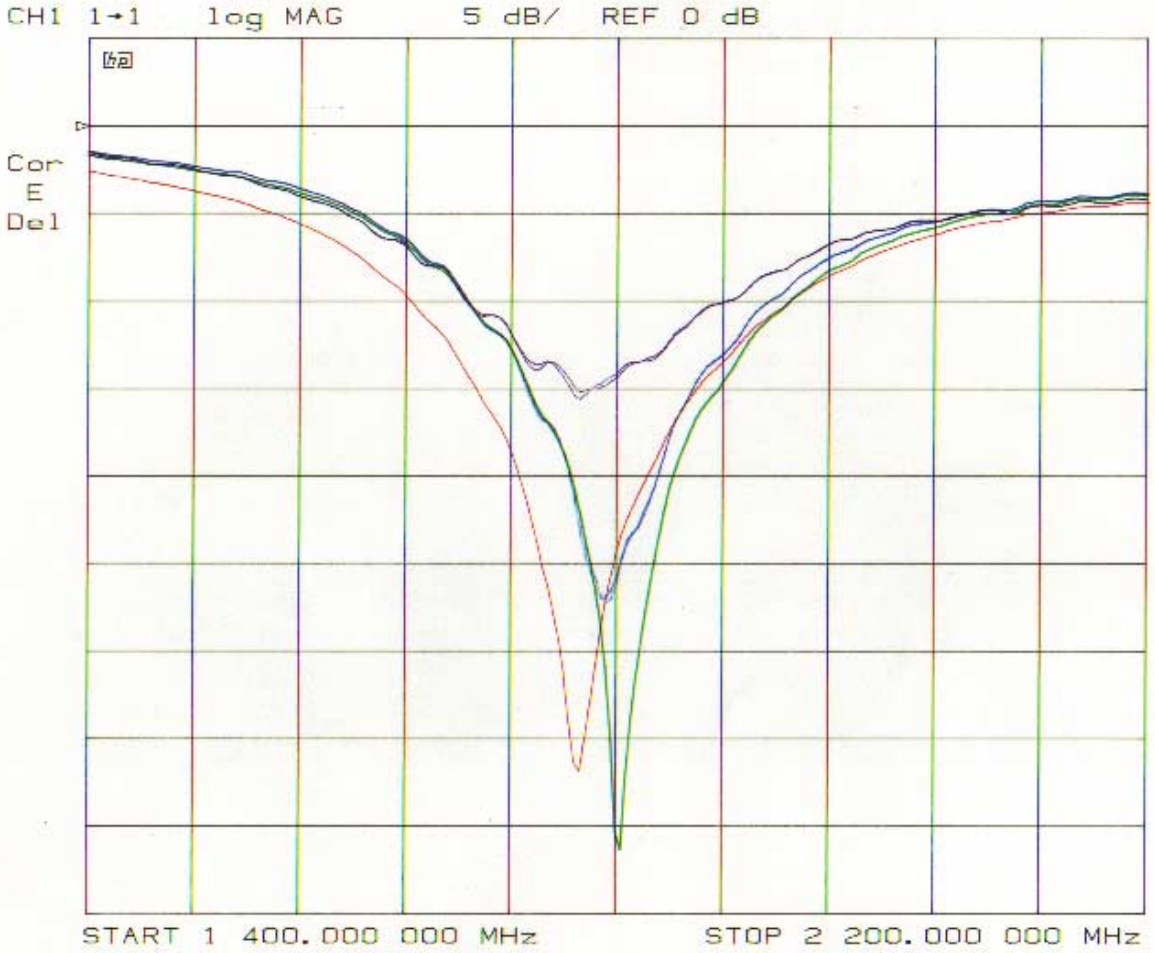




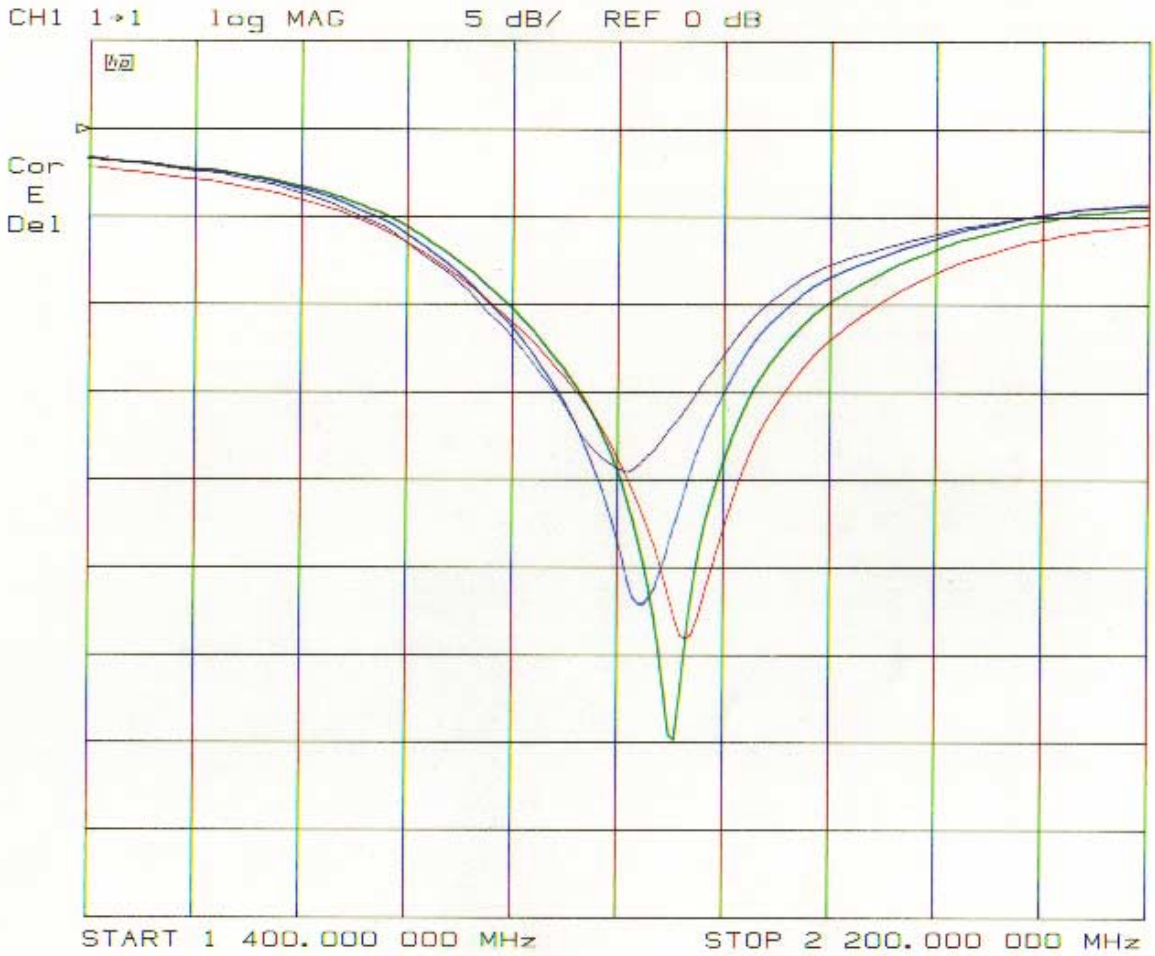
D1800V2 SN:205

S11

Flat phantom with brain simulating solution

1: d = 10mm (red)
2: d = 15mm (green)
3: d = 20mm (blue)
4: d = 30mm (violet)

d=distance from dipole center to solution



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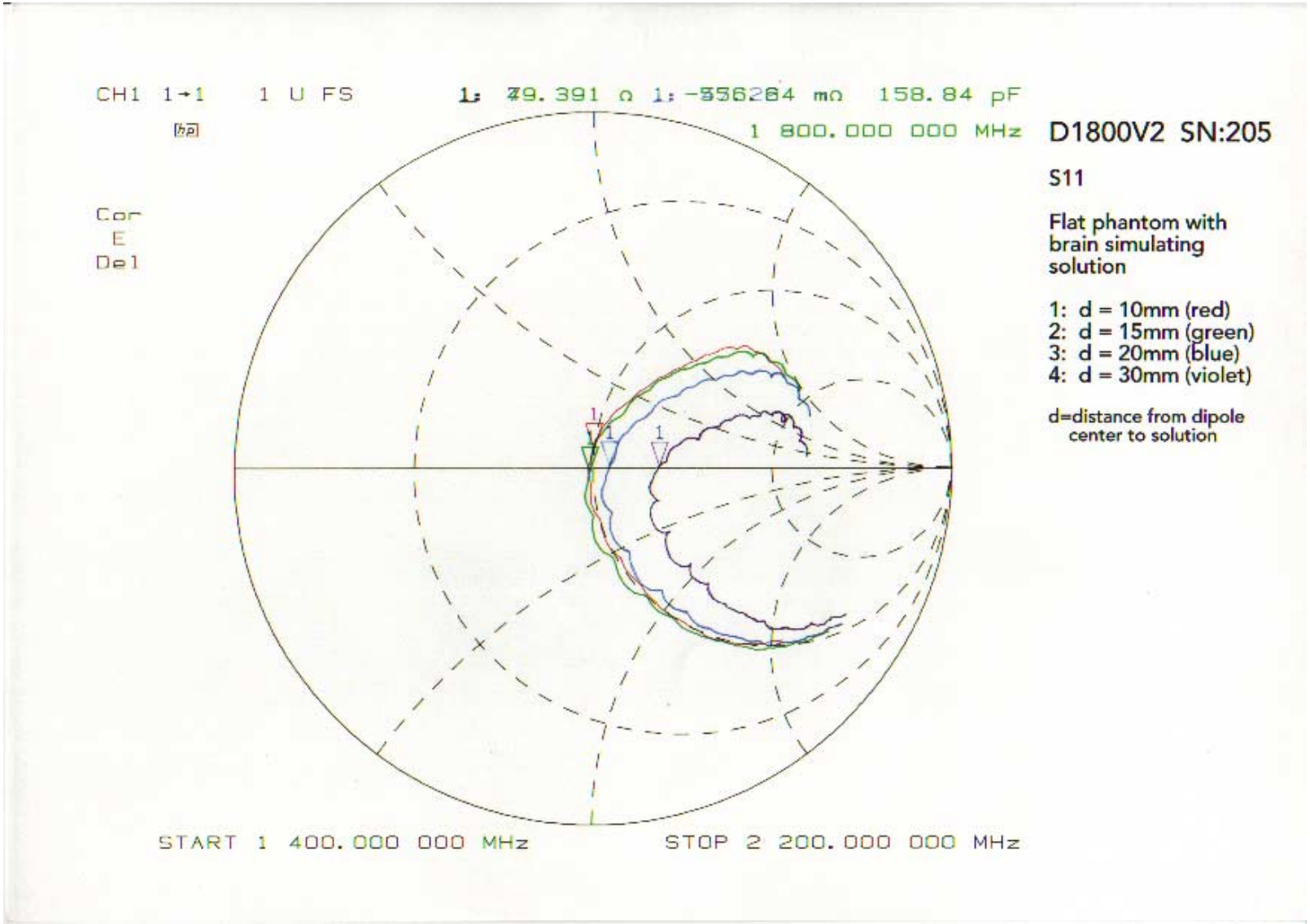

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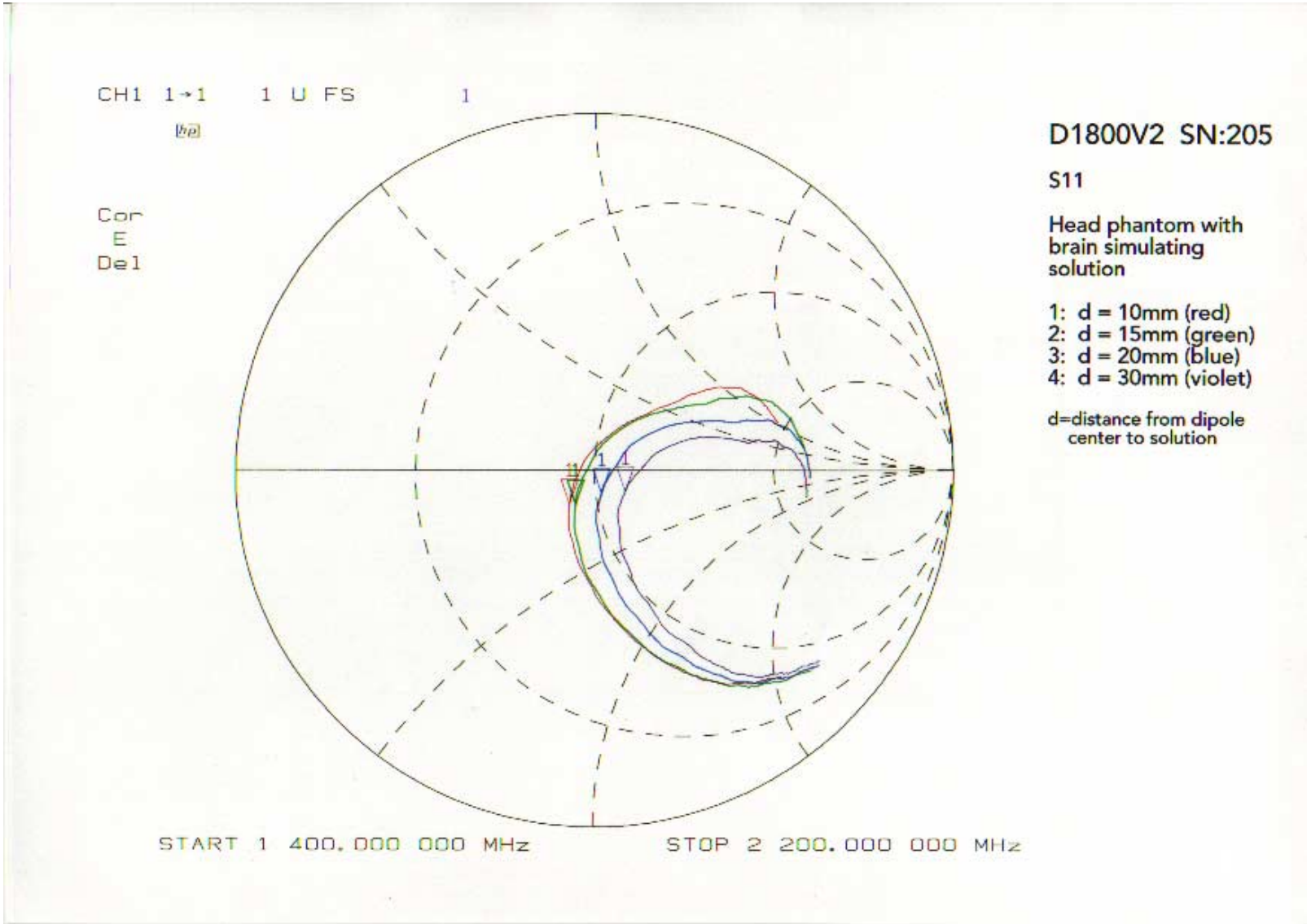

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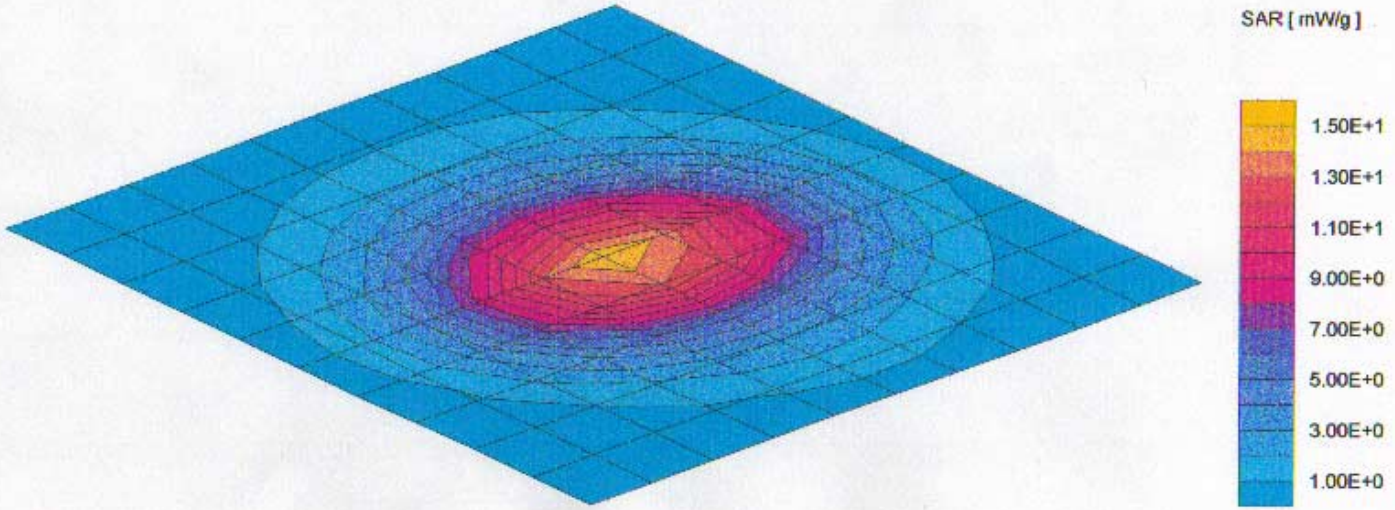

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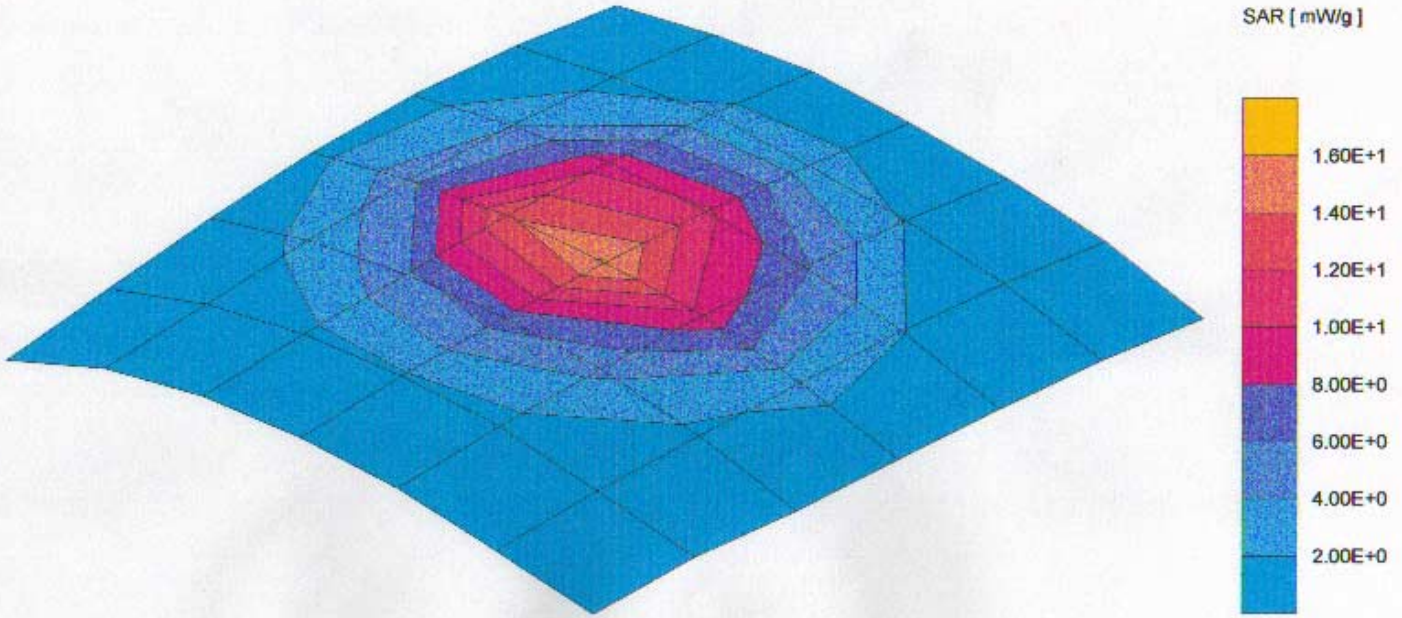

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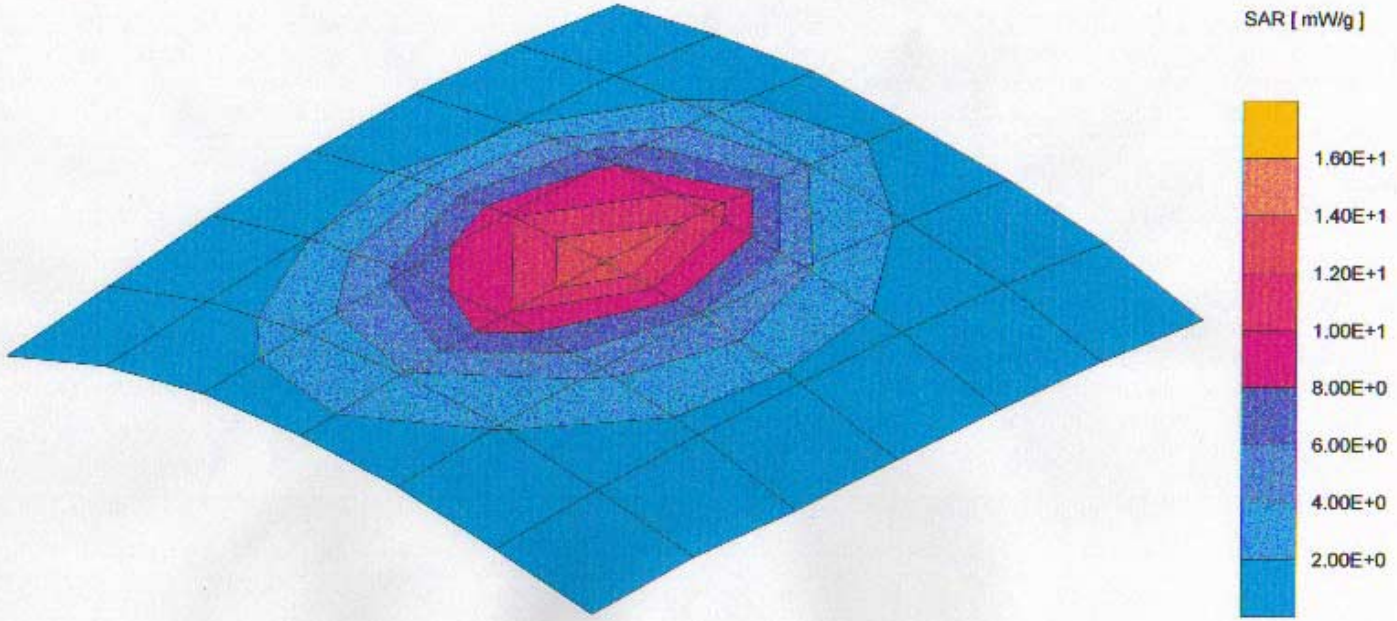

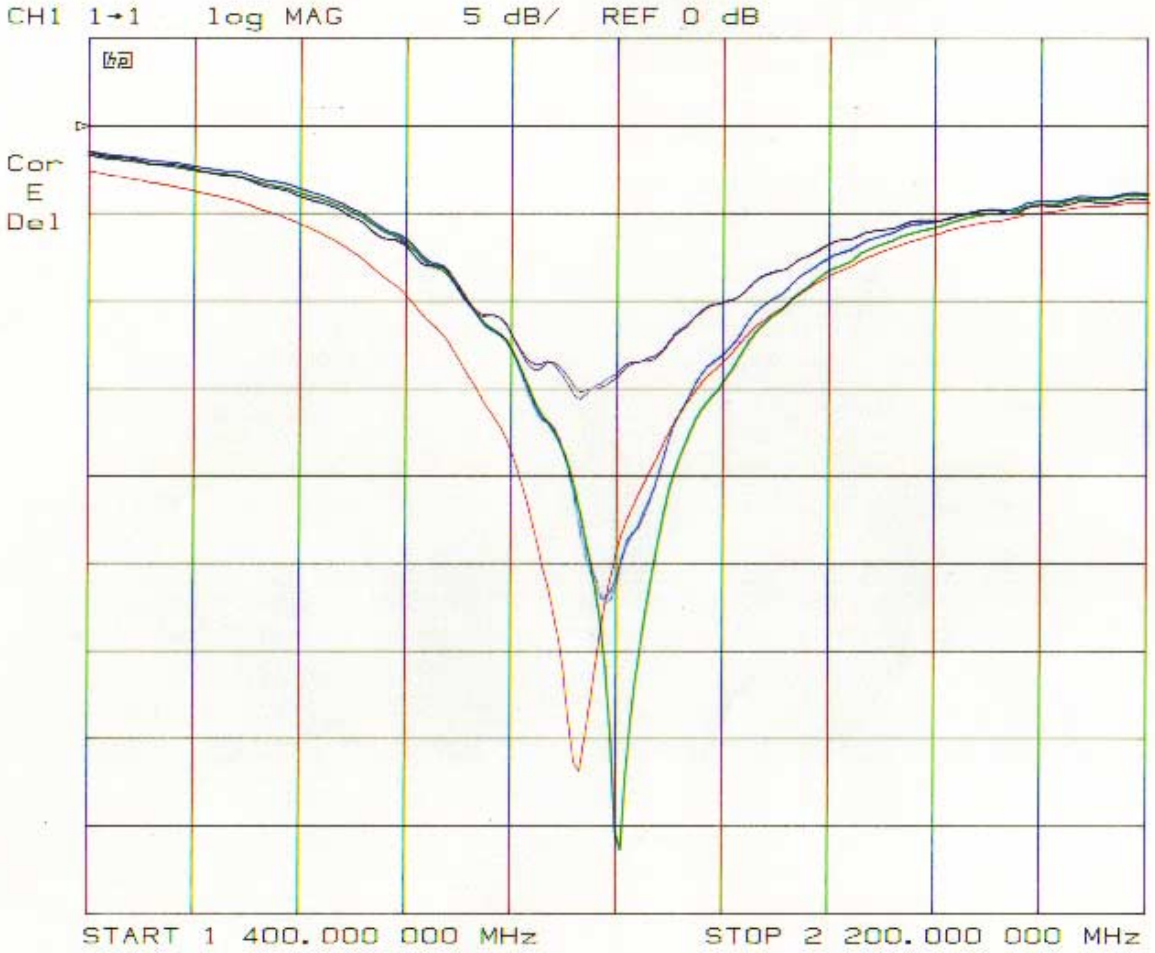

D1800V2 SN:205

S11

Flat phantom with brain simulating solution

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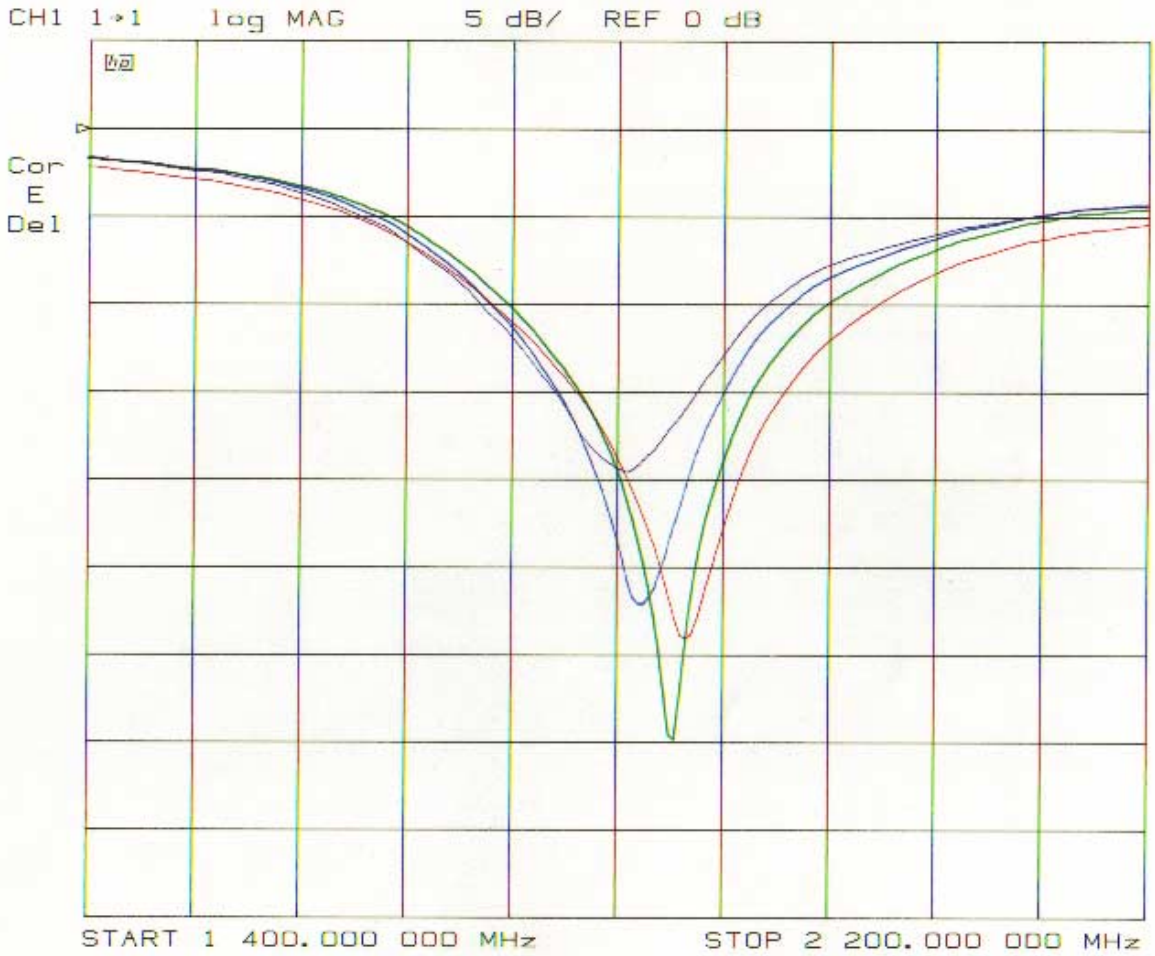

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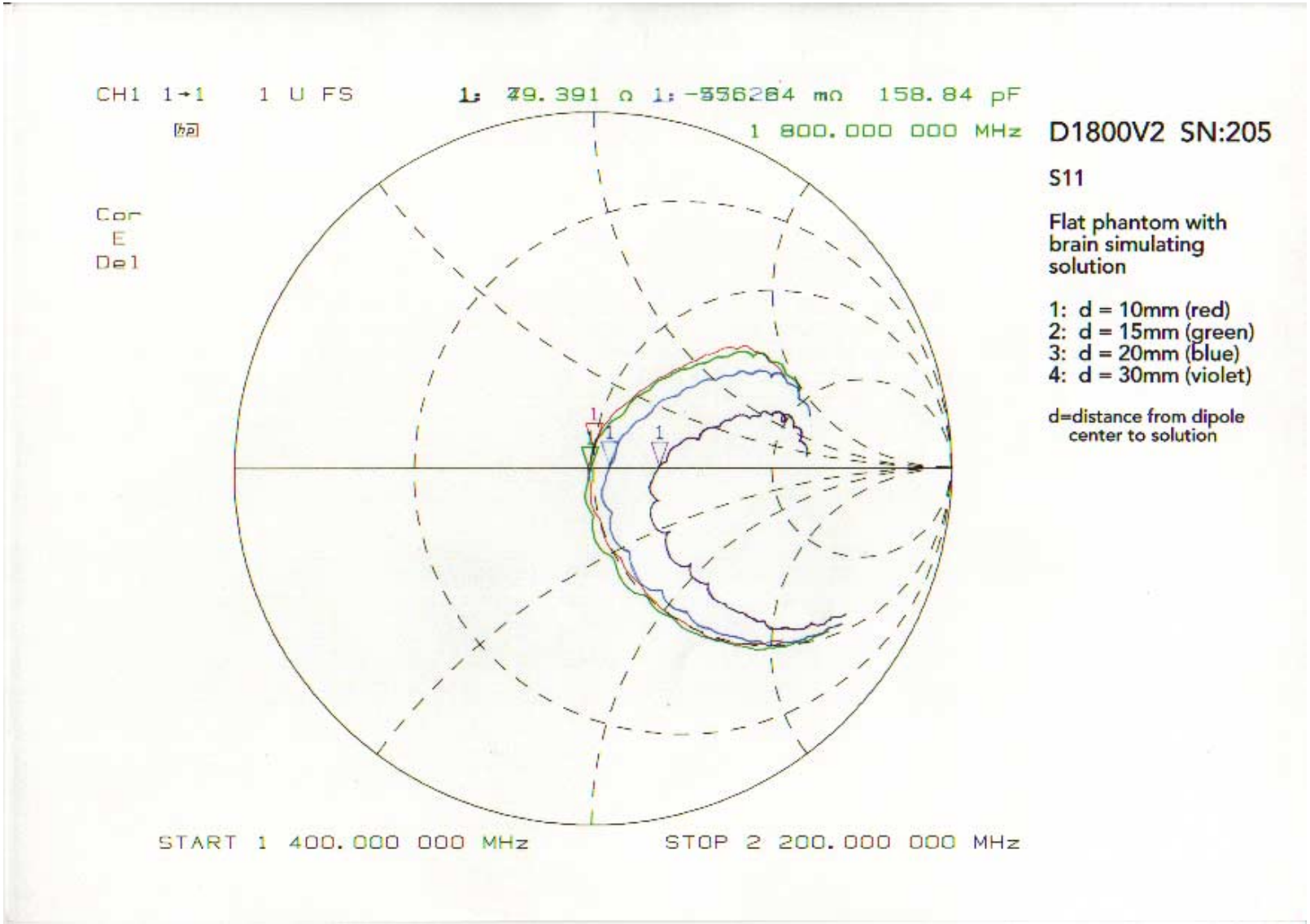

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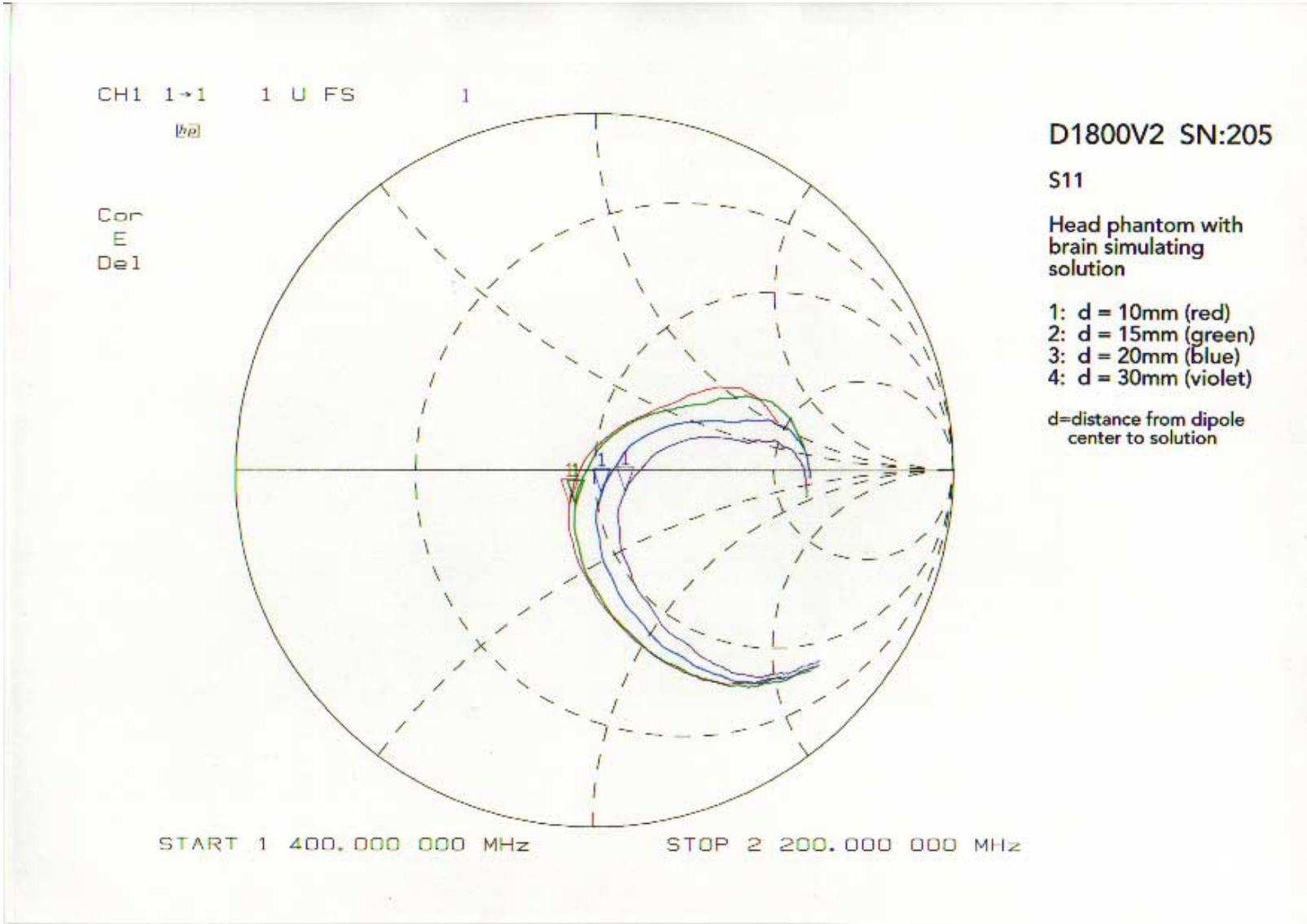

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Probe ET3DV5

SN:1303

Manufactured:	October 10, 1996
Last calibration:	October 15, 1998
Recalibrated:	February 1, 2000

Calibrated for System DASY2

DASY2 - Parameters of Probe: ET3DV5 SN:1303

Sensitivity in Free Space

Diode Compression

NormX	1.34 $\mu V/(V/m)^2$	DCP X	82 mV
NormY	1.26 $\mu V/(V/m)^2$	DCP Y	82 mV
NormZ	1.41 $\mu V/(V/m)^2$	DCP Z	82 mV

Sensitivity in Tissue Simulating Liquid

Brain **450 MHz** ε_r = 48 ± 5% σ = 0.50 ± 10% mho/m

ConvF X	6.17 extrapolated	Boundary effect:	
ConvF Y	6.17 extrapolated	Alpha	0.07
ConvF Z	6.17 extrapolated	Depth	5.42

Brain **900 MHz** ε_r = 42.5 ± 5% σ = 0.86 ± 10% mho/m

ConvF X	5.83 ± 7% (k=2)	Boundary effect:	
ConvF Y	5.83 ± 7% (k=2)	Alpha	0.22
ConvF Z	5.83 ± 7% (k=2)	Depth	4.33

Brain **1500 MHz** ε_r = 41 ± 5% σ = 1.32 ± 10% mho/m

ConvF X	5.37 interpolated	Boundary effect:	
ConvF Y	5.37 interpolated	Alpha	0.42
ConvF Z	5.37 interpolated	Depth	2.89

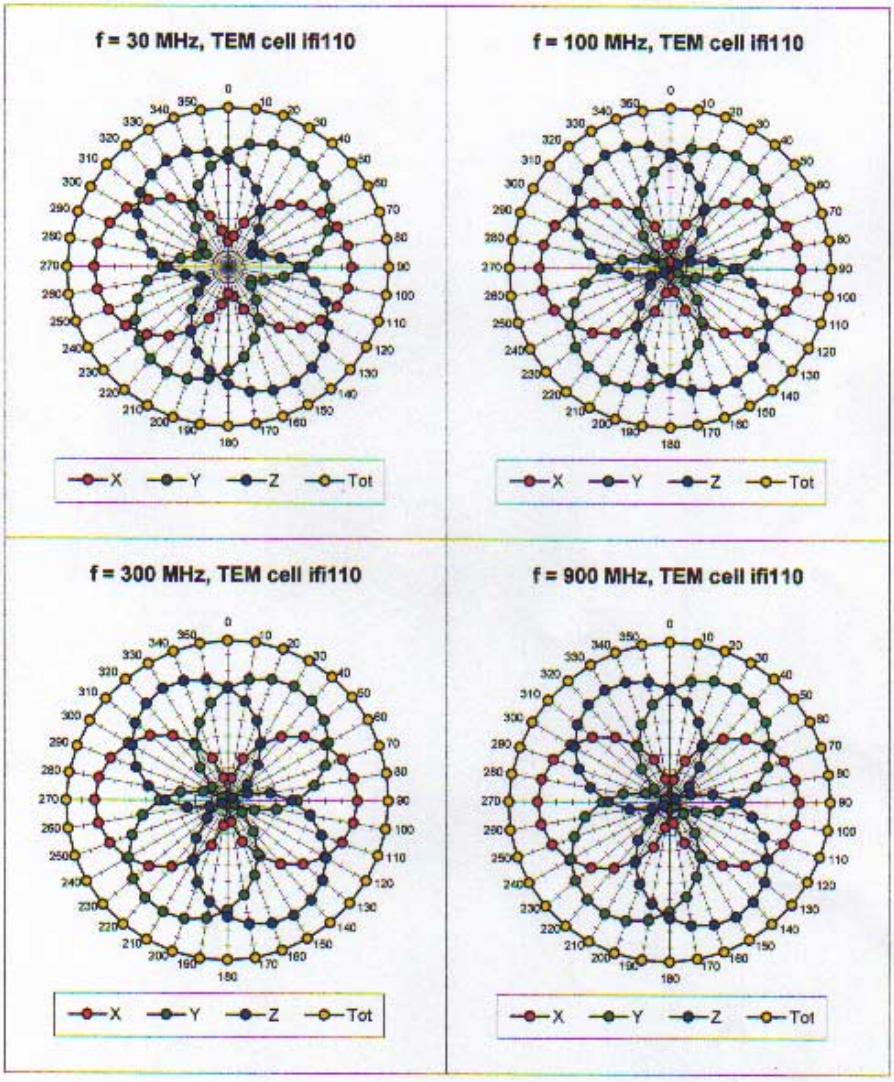
Brain **1800 MHz** ε_r = 41 ± 5% σ = 1.69 ± 10% mho/m

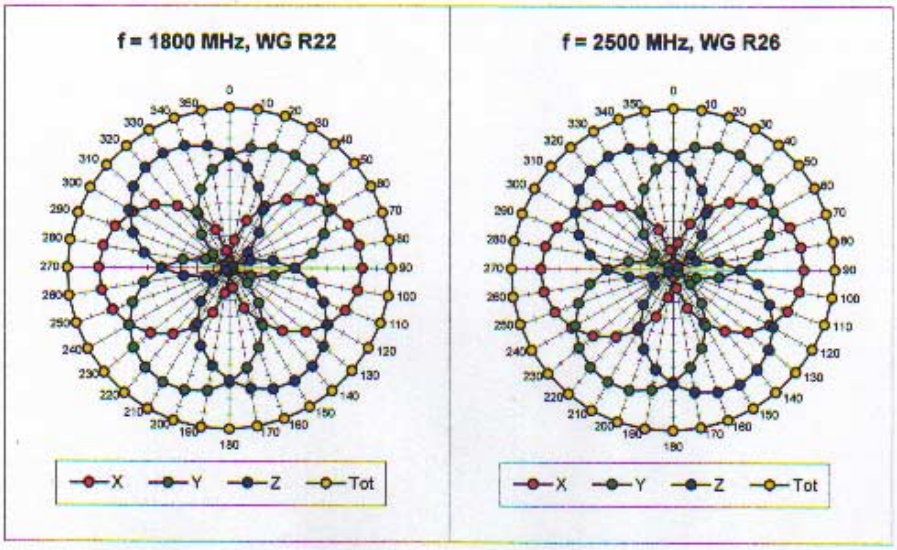
ConvF X	5.15 ± 7% (k=2)	Boundary effect:	
ConvF Y	5.15 ± 7% (k=2)	Alpha	0.52
ConvF Z	5.15 ± 7% (k=2)	Depth	2.16

Sensor Offset

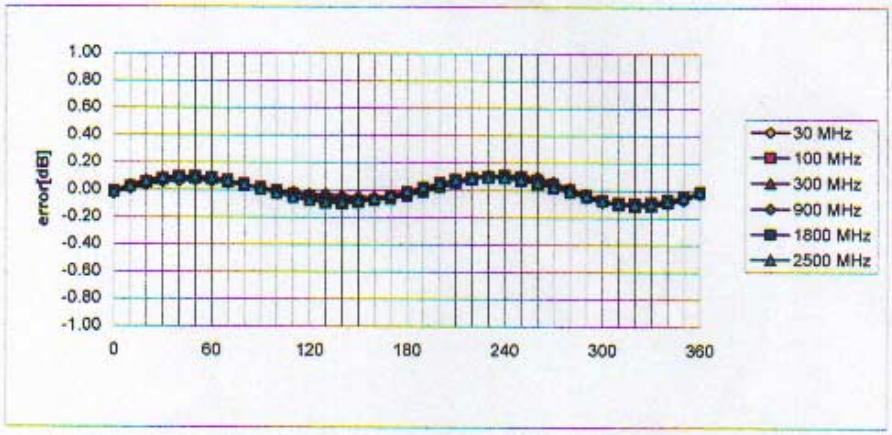
Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.95 ± 0.2	mm

Receiving Pattern (ϕ), θ = 0°



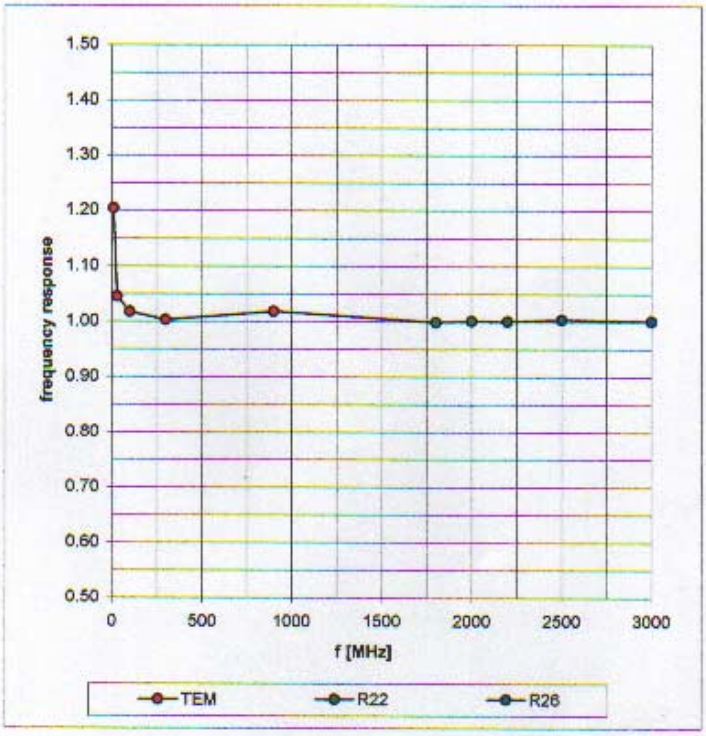


Isotropy Error (ϕ), θ = 0°



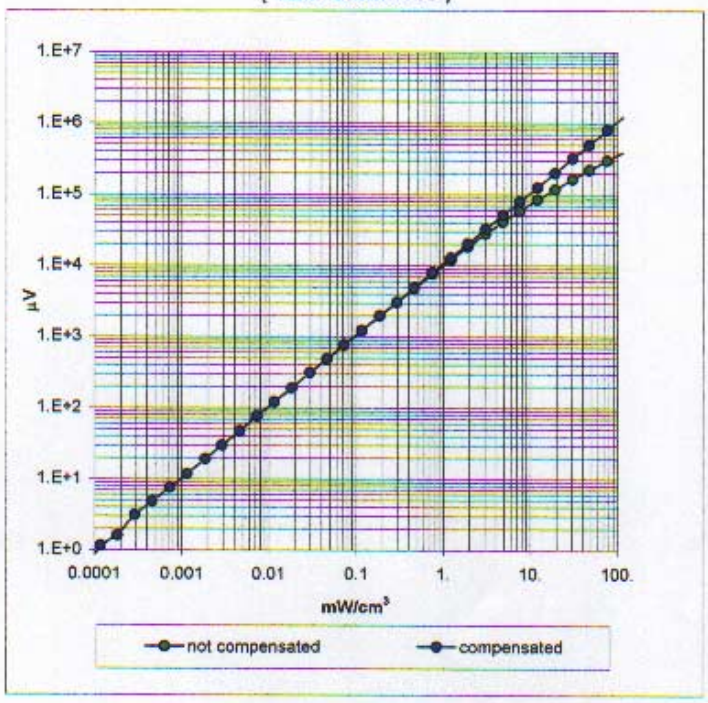
Frequency Response of E-Field

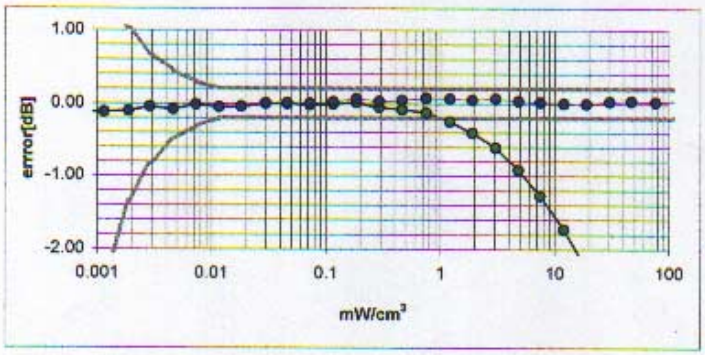
(TEM-Cell:ifi110, Waveguide R22, R26)



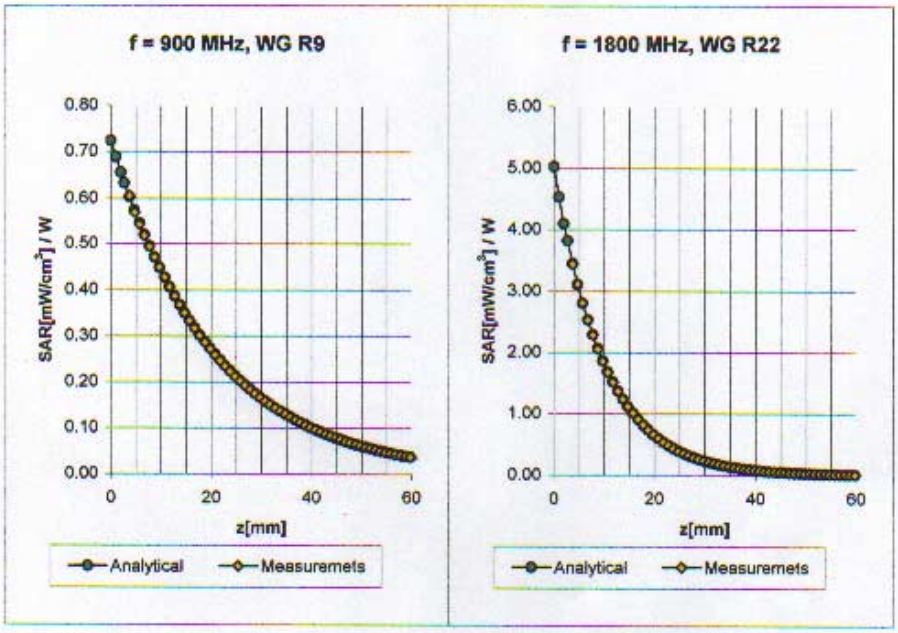
Dynamic Range f(SAR_{brain})

(TEM-Cell:ifi110)





Conversion Factor Assessment



Receiving Pattern (ϕ)

(in brain tissue, z = 5 mm)