

Client

Motorola MRO

CALIBRATION CERTIFICATE

Object(s)

ET3DV6R - SN 1501

Calibration procedure(s)

QA CAL-01.v2
Calibration procedure for dosimetric E-field probes

Calibration date:

April 16, 2003

Condition of the calibrated item

In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date	Scheduled Calibration
RF generator HP 8684C	US3642U01700	4-Aug-99 (in house check Aug-02)	In house check: Aug-05
Power sensor E4412A	MY41495277	2-Apr-03	Apr-04
Power sensor HP 8481A	MY41092180	18-Sep-02	Sep-03
Power meter EPM E4419B	GB41293874	13-Sep-02	Sep-03
Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03

Calibrated by:	Name	Function	Signature
	Nico Vetterli	Technician	

Approved by:	Katja Pokovic	Laboratory Director
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Date issued: April 16, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

DASY - Parameters of Probe: ET3DV6R SN:1501

Sensitivity in Free Space

NormX	2.08 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	2.09 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	2.14 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	96	mV
DCP Y	96	mV
DCP Z	96	mV

Sensitivity in Tissue Simulating Liquid

Head **900 MHz** $\epsilon_r = 41.5 \pm 5\%$ $\sigma = 0.97 \pm 5\% \text{ mho/m}$

Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to IEEE P1528-200X

ConvF X	6.4 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	6.4 $\pm 9.5\%$ (k=2)	Alpha 0.39
ConvF Z	6.4 $\pm 9.5\%$ (k=2)	Depth 2.31

Head **1800 MHz** $\epsilon_r = 40.0 \pm 5\%$ $\sigma = 1.40 \pm 5\% \text{ mho/m}$

Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to IEEE P1528-200X

ConvF X	5.0 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	5.0 $\pm 9.5\%$ (k=2)	Alpha 0.49
ConvF Z	5.0 $\pm 9.5\%$ (k=2)	Depth 2.55

Boundary Effect

Head **900 MHz** **Typical SAR gradient: 5 % per mm**

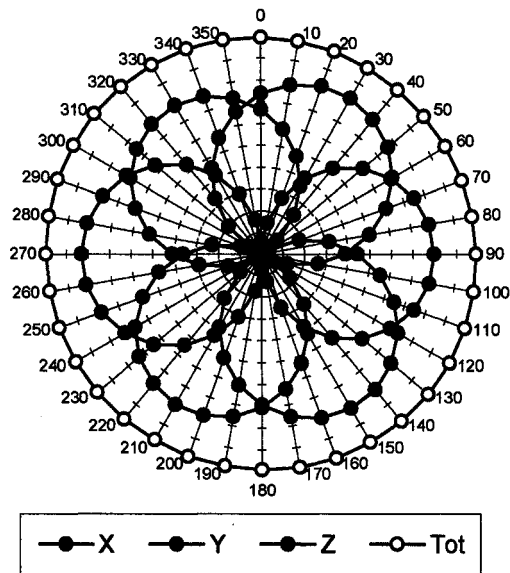
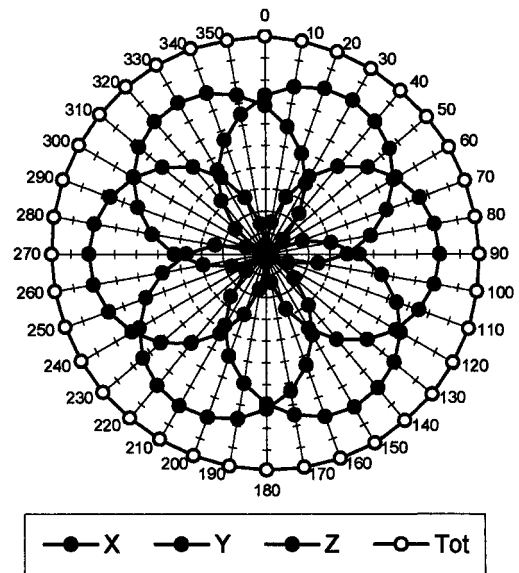
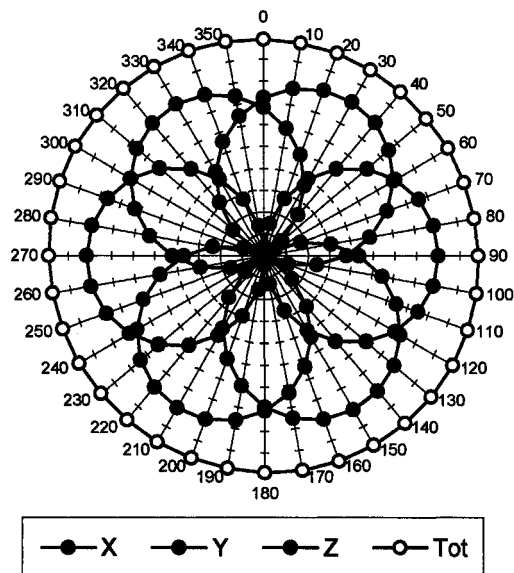
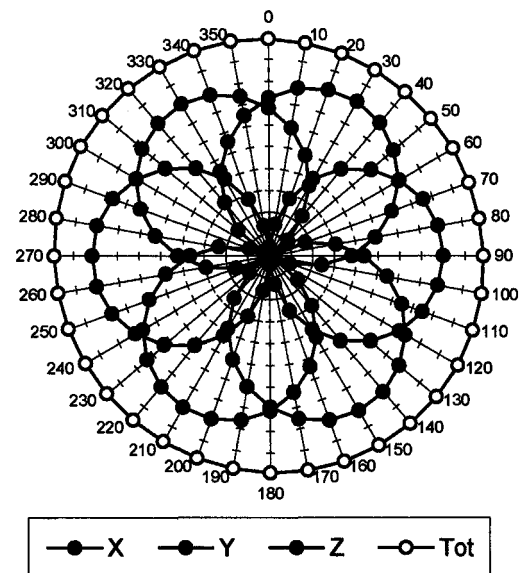
Probe Tip to Boundary	1 mm	2 mm
SAR _{be} [%] Without Correction Algorithm	8.9	4.9
SAR _{be} [%] With Correction Algorithm	0.3	0.5

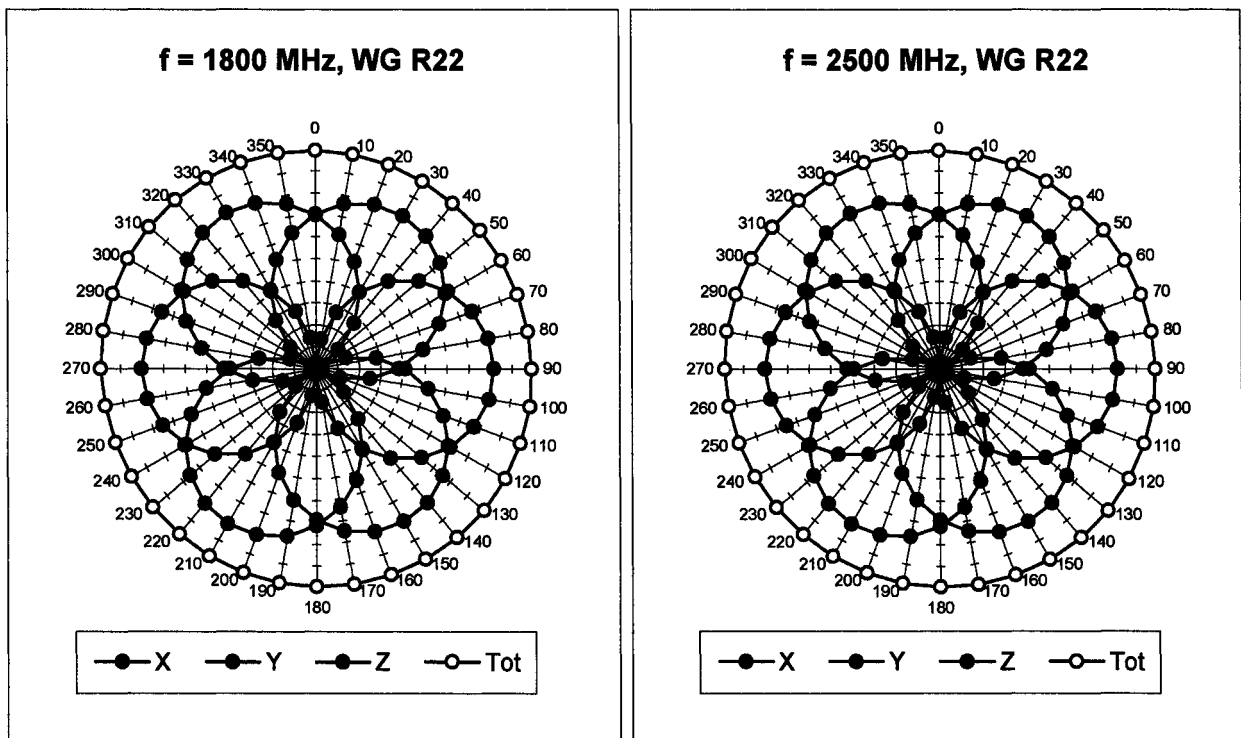
Head **1800 MHz** **Typical SAR gradient: 10 % per mm**

Probe Tip to Boundary	1 mm	2 mm
SAR _{be} [%] Without Correction Algorithm	12.8	8.6
SAR _{be} [%] With Correction Algorithm	0.2	0.2

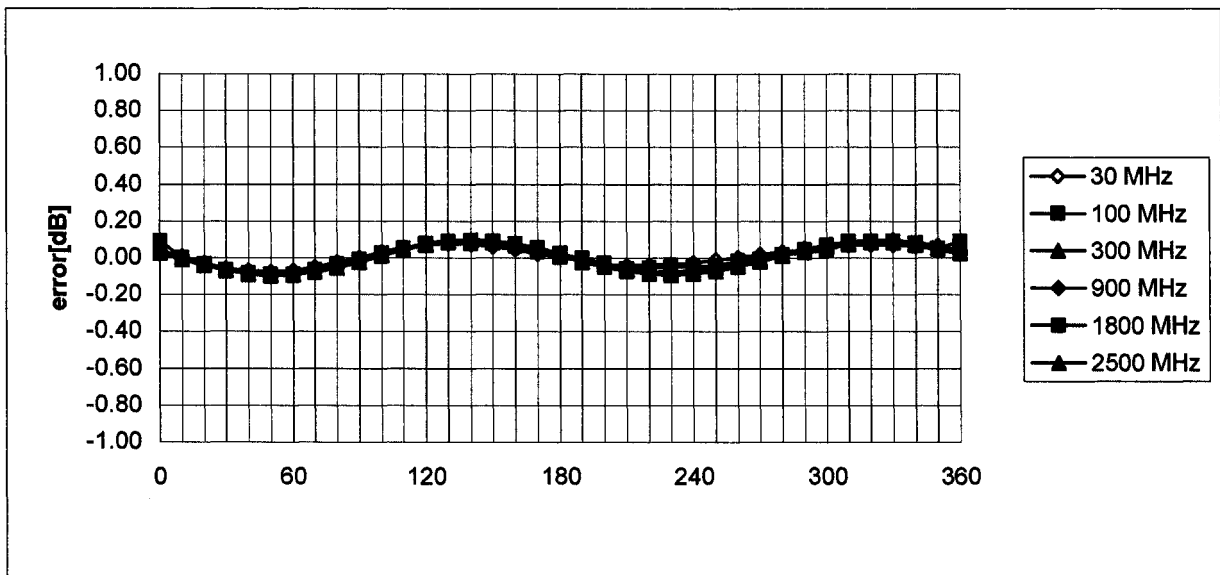
Sensor Offset

Probe Tip to Sensor Center	2.7	mm
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Receiving Pattern (ϕ , $\theta = 0^\circ$)**f = 30 MHz, TEM cell ifi110****f = 100 MHz, TEM cell ifi110****f = 300 MHz, TEM cell ifi110****f = 900 MHz, TEM cell ifi110**

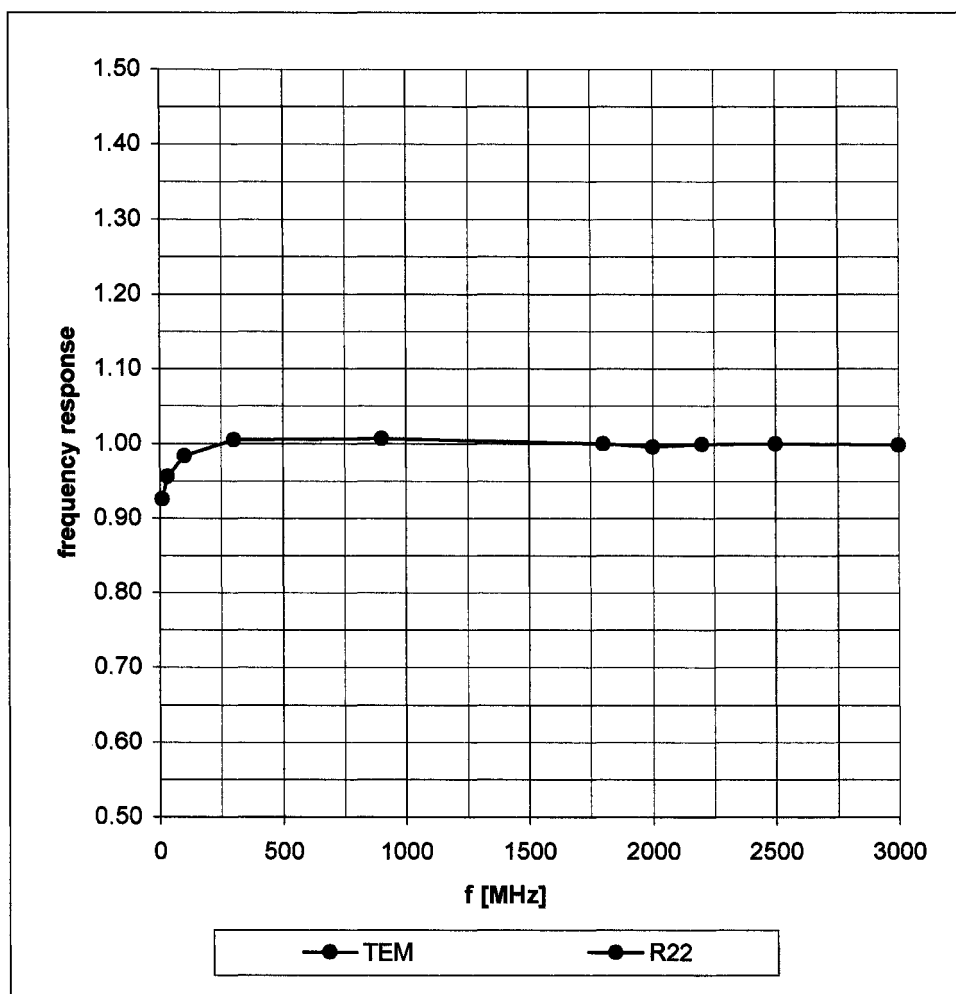


Isotropy Error (ϕ), $\theta = 0^\circ$

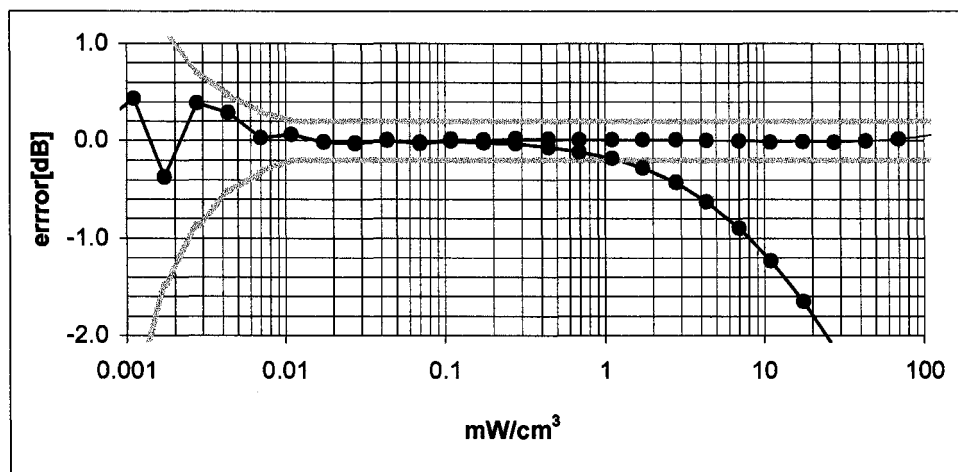
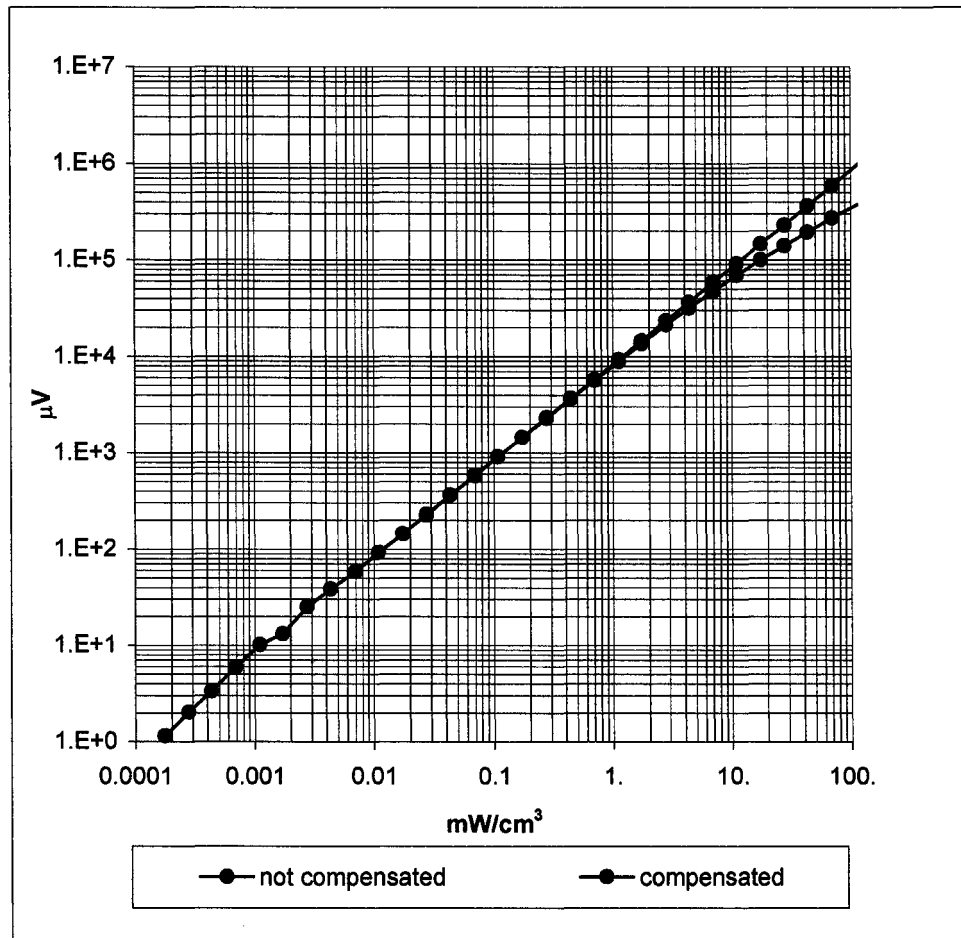


Frequency Response of E-Field

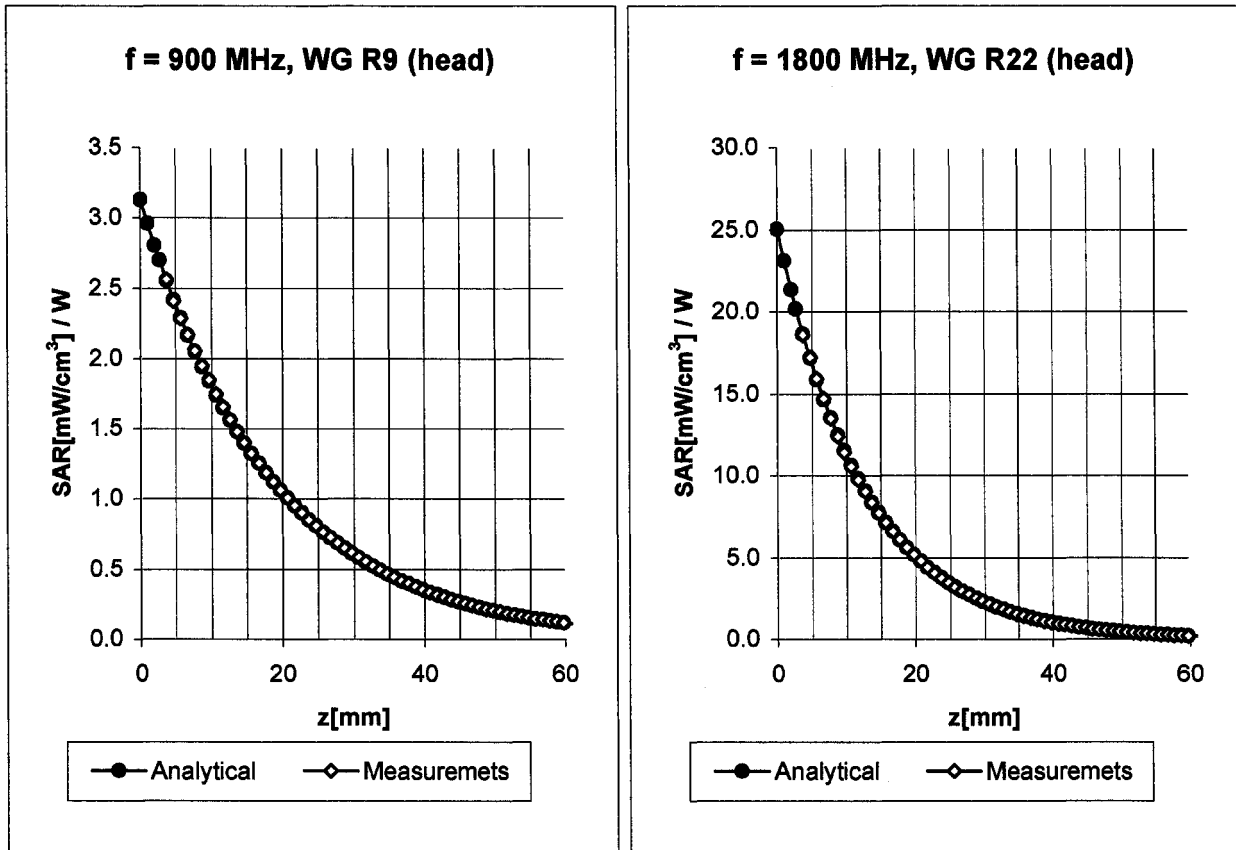
(TEM-Cell:ifi110, Waveguide R22)



Dynamic Range f(SAR_{brain}) (Waveguide R22)



Conversion Factor Assessment



Head 900 MHz $\epsilon_r = 41.5 \pm 5\%$ $\sigma = 0.97 \pm 5\%$ mho/m

Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to IEEE P1528-200X

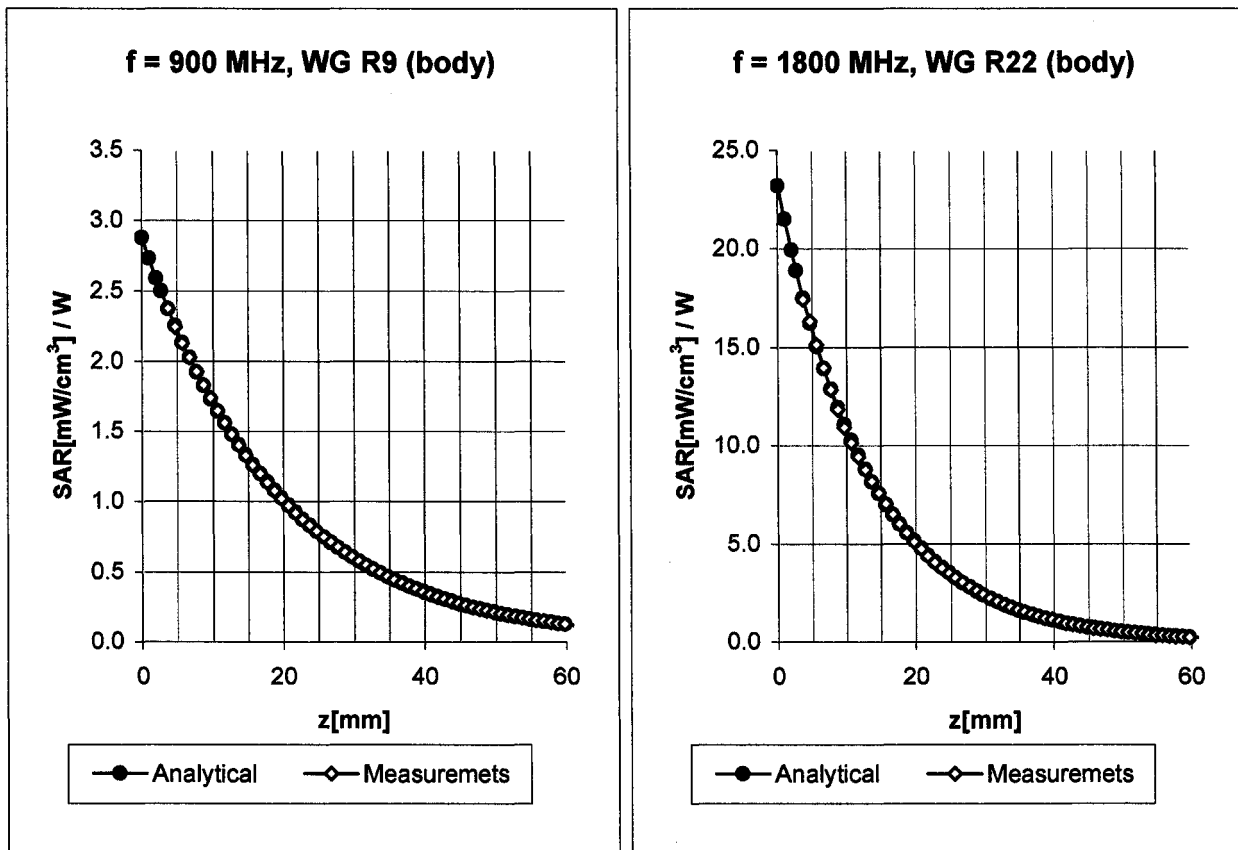
ConvF X	6.4 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	6.4 $\pm 9.5\%$ (k=2)	Alpha 0.39
ConvF Z	6.4 $\pm 9.5\%$ (k=2)	Depth 2.31

Head 1800 MHz $\epsilon_r = 40.0 \pm 5\%$ $\sigma = 1.40 \pm 5\%$ mho/m

Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to IEEE P1528-200X

ConvF X	5.0 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	5.0 $\pm 9.5\%$ (k=2)	Alpha 0.49
ConvF Z	5.0 $\pm 9.5\%$ (k=2)	Depth 2.55

Conversion Factor Assessment



Body **900 MHz** $\epsilon_r = 55.0 \pm 5\%$ $\sigma = 1.05 \pm 5\% \text{ mho/m}$

Valid for f=800-1000 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

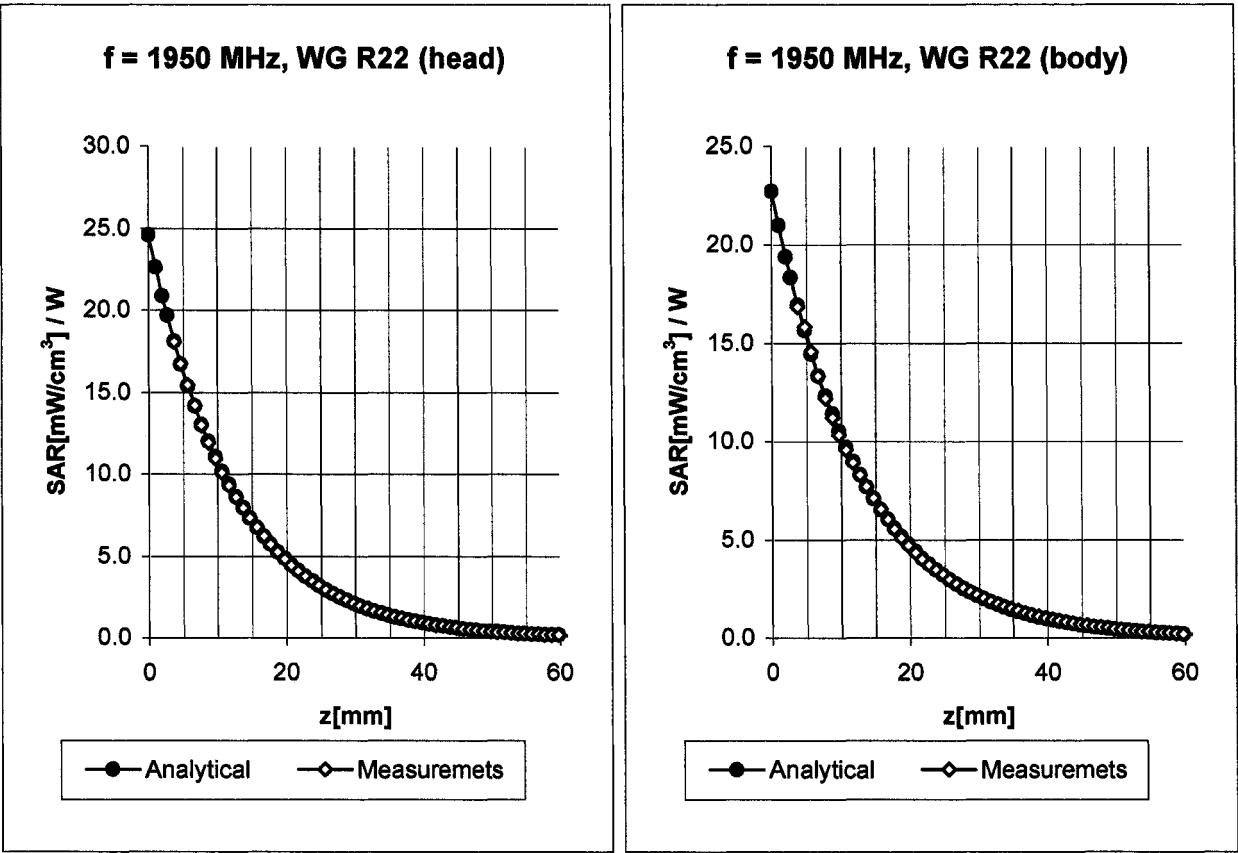
ConvF X	6.1 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	6.1 $\pm 9.5\%$ (k=2)	Alpha 0.40
ConvF Z	6.1 $\pm 9.5\%$ (k=2)	Depth 2.37

Body **1800 MHz** $\epsilon_r = 53.3 \pm 5\%$ $\sigma = 1.52 \pm 5\% \text{ mho/m}$

Valid for f=1710-1910 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	4.6 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	4.6 $\pm 9.5\%$ (k=2)	Alpha 0.55
ConvF Z	4.6 $\pm 9.5\%$ (k=2)	Depth 2.59

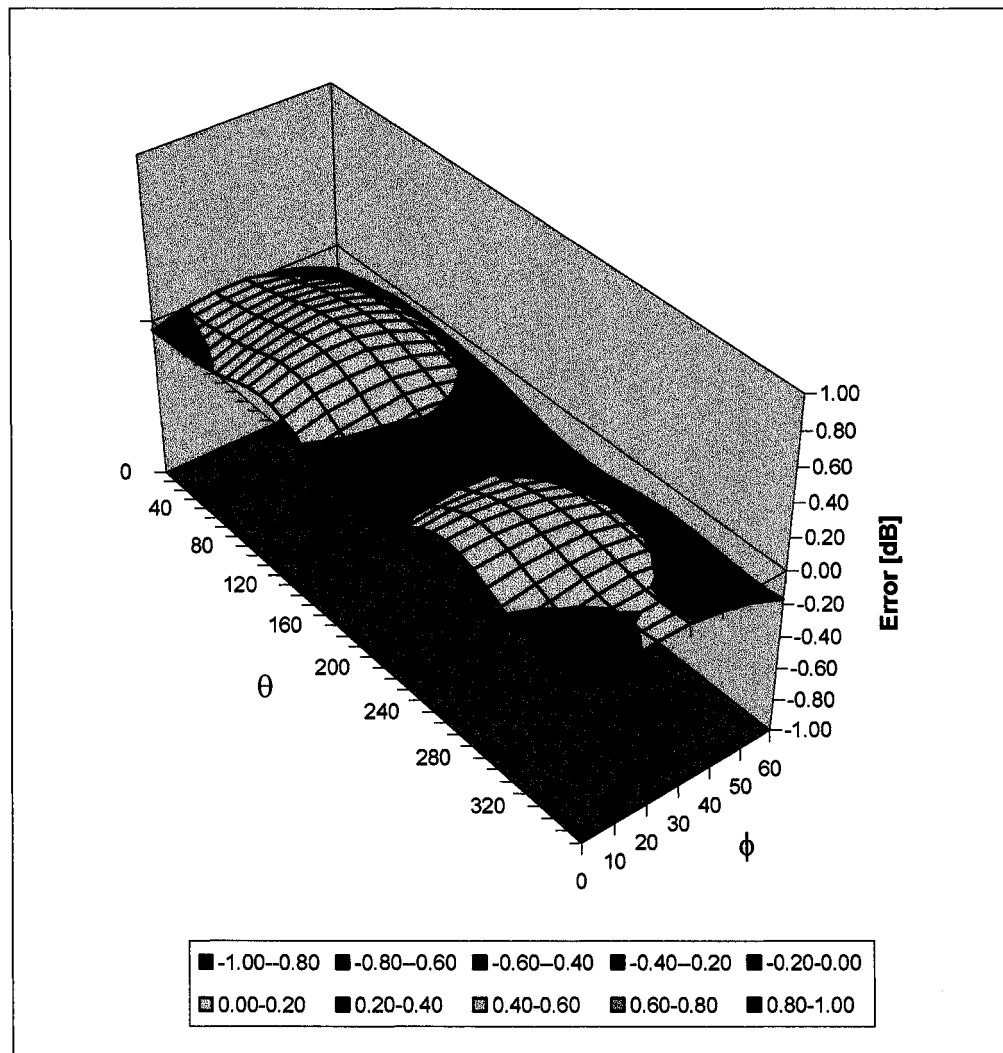
Conversion Factor Assessment



Head	1950	MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
	ConvF X	4.7 $\pm 8.9\%$ (k=2)	Boundary effect:	
	ConvF Y	4.7 $\pm 8.9\%$ (k=2)	Alpha	0.53
	ConvF Z	4.7 $\pm 8.9\%$ (k=2)	Depth	2.53
Body	1950	MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
	ConvF X	4.2 $\pm 8.9\%$ (k=2)	Boundary effect:	
	ConvF Y	4.2 $\pm 8.9\%$ (k=2)	Alpha	0.70
	ConvF Z	4.2 $\pm 8.9\%$ (k=2)	Depth	2.26

Deviation from Isotropy in HSL

Error ($\theta\phi$), $f = 900$ MHz



Calibration Certificate

Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1502

Place of Calibration:

Zurich

Date of Calibration:

September 27, 2002

Calibration Interval:

12 months

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by:

N. Vetter

Approved by:

Blaise Kitz

Probe ET3DV6

SN:1502

Manufactured:	October 24, 1999
Last calibration:	September 26, 2001
Recalibrated:	September 27, 2002

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1502

Sensitivity in Free Space

NormX	1.84 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	1.89 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	1.87 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	93	mV
DCP Y	93	mV
DCP Z	93	mV

Sensitivity in Tissue Simulating Liquid

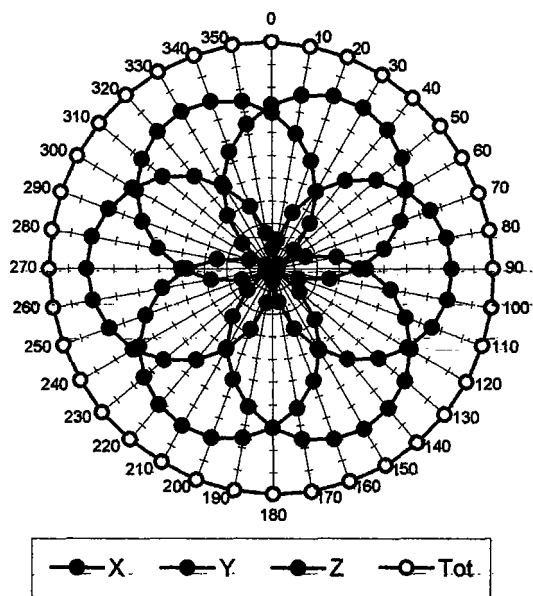
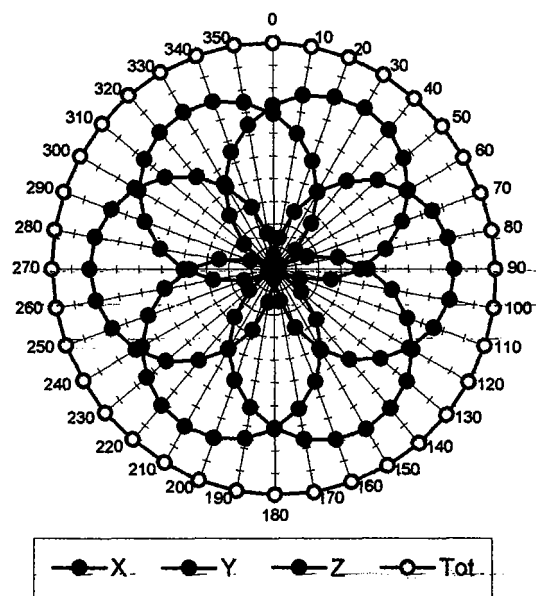
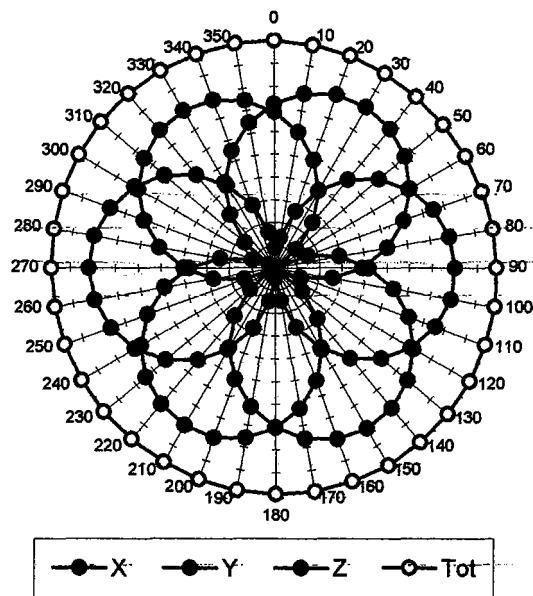
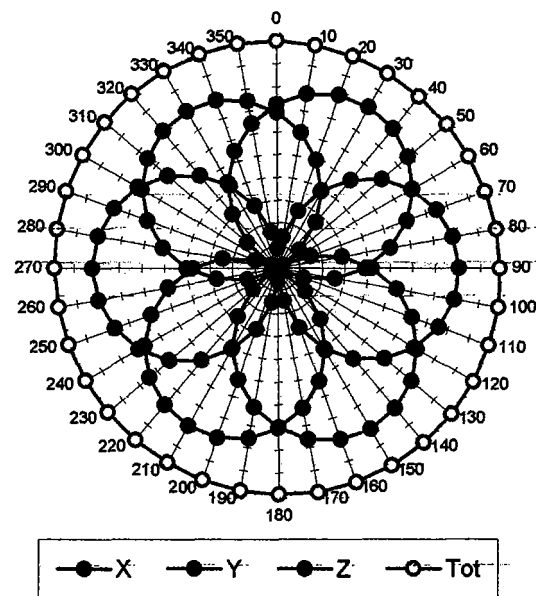
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\% \text{ mho/m}$
ConvF X	6.5 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	6.5 $\pm 9.5\%$ (k=2)	Alpha	0.46
ConvF Z	6.5 $\pm 9.5\%$ (k=2)	Depth	2.27
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
Head	1900 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
ConvF X	5.6 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	5.6 $\pm 9.5\%$ (k=2)	Alpha	0.56
ConvF Z	5.6 $\pm 9.5\%$ (k=2)	Depth	2.24

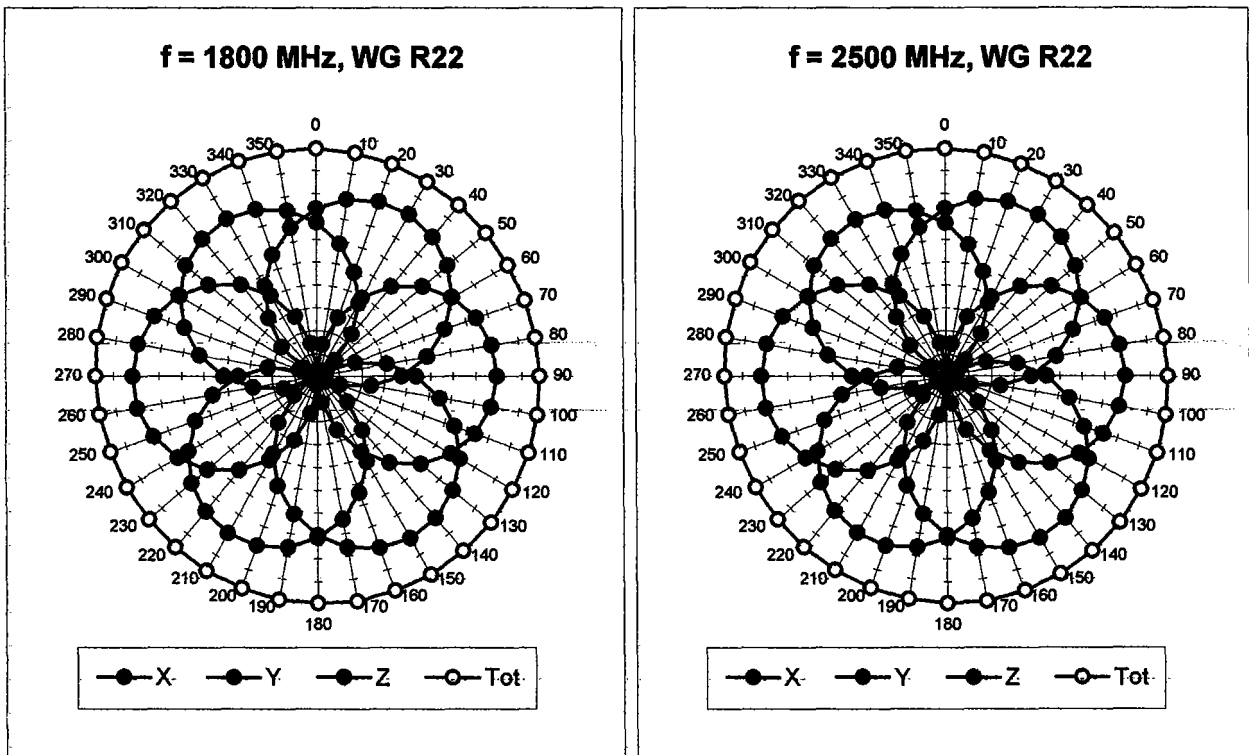
Boundary Effect

Head	900 MHz	Typical SAR gradient: 5 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%]	Without Correction Algorithm	10.2	5.7
SAR _{be} [%]	With Correction Algorithm	0.3	0.4
Head	1800 MHz	Typical SAR gradient: 10 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%]	Without Correction Algorithm	11.9	7.7
SAR _{be} [%]	With Correction Algorithm	0.1	0.3

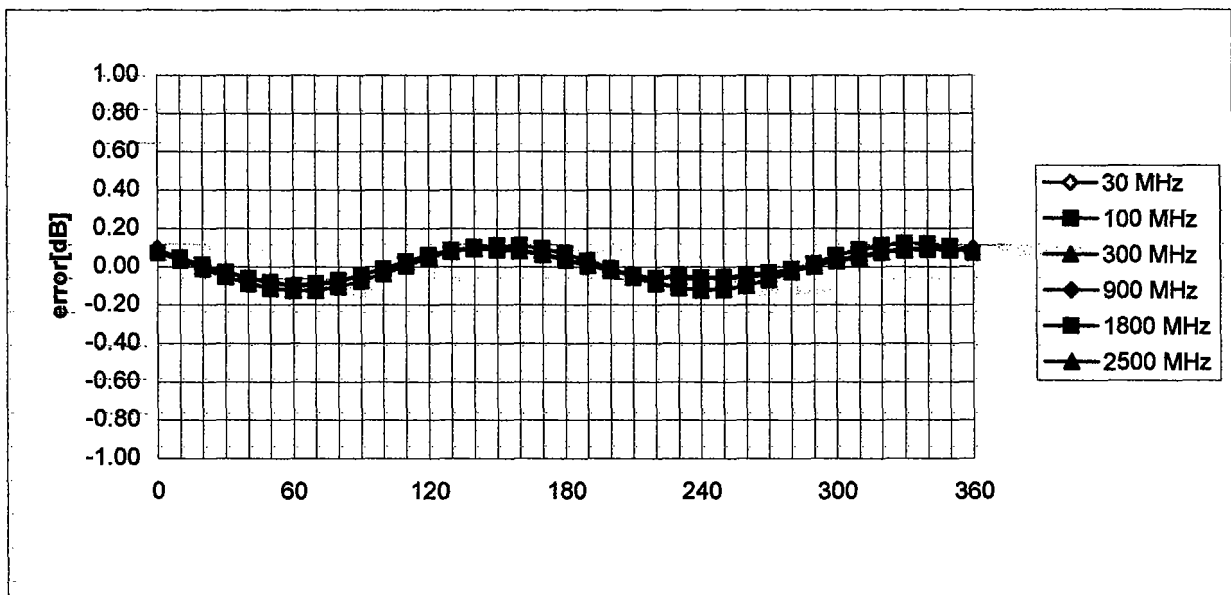
Sensor Offset

Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.4 $\pm$ 0.2	mm

Receiving Pattern (ϕ), $\theta = 0^\circ$ **f = 30 MHz, TEM cell ifi110****f = 100 MHz, TEM cell ifi110****f = 300 MHz, TEM cell ifi110****f = 900 MHz, TEM cell ifi110**

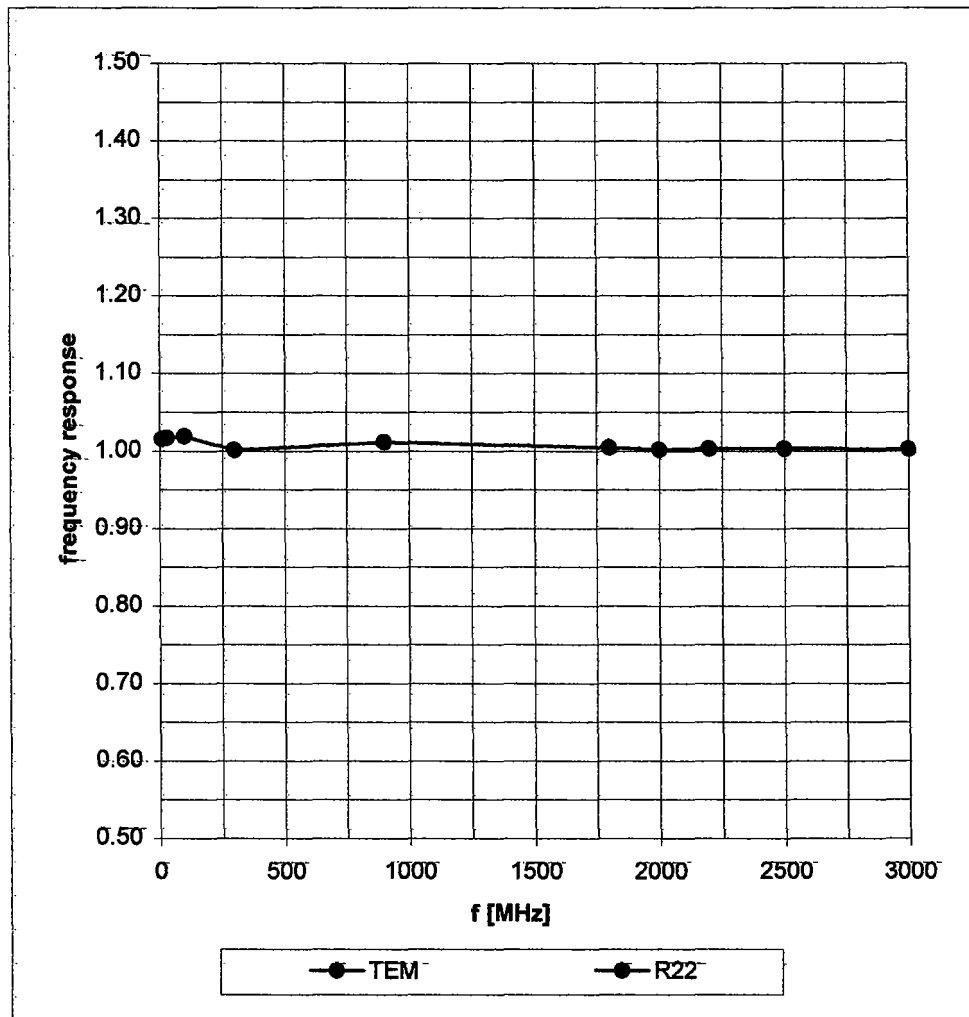


Isotropy Error (ϕ), $\theta = 0^\circ$

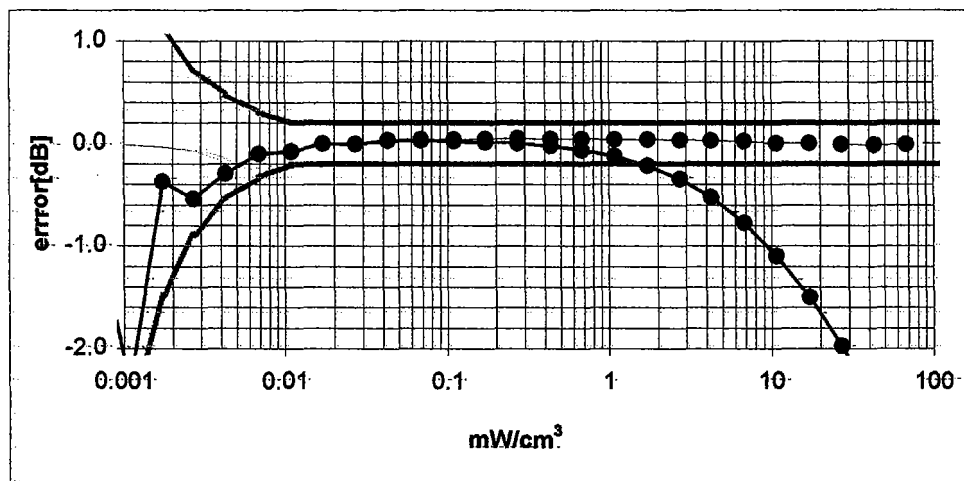
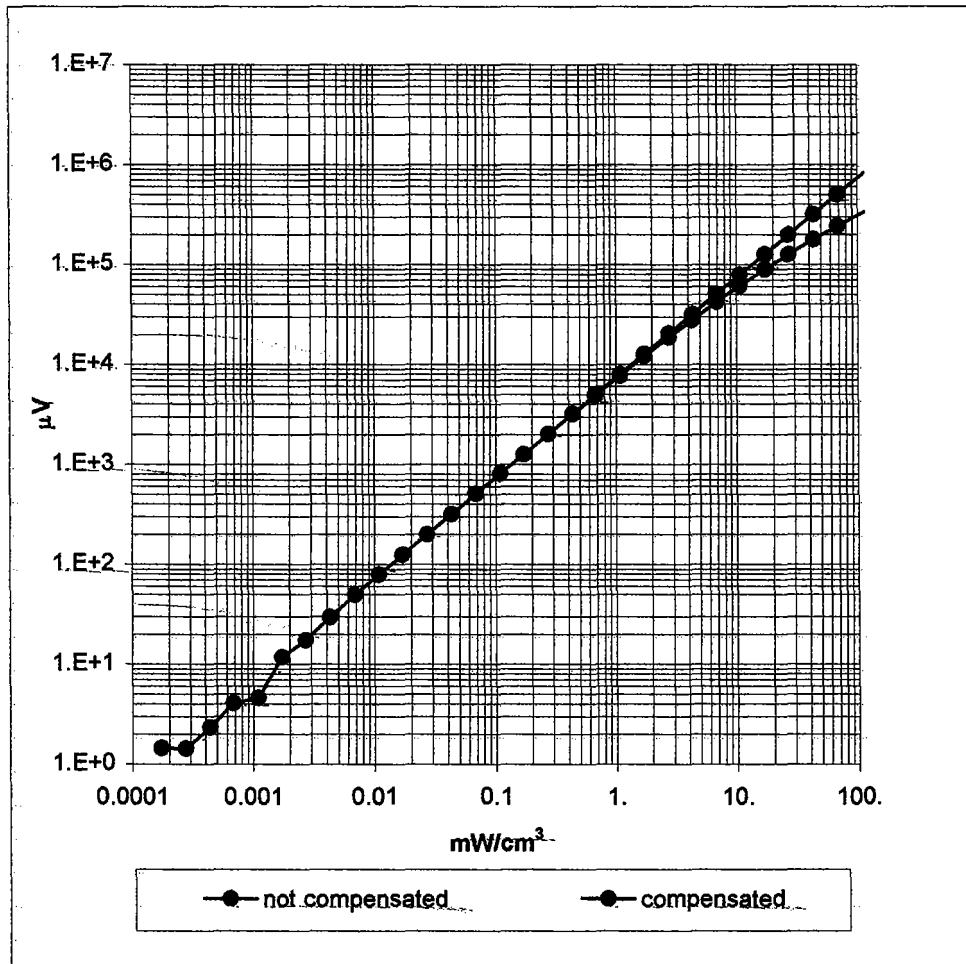


Frequency Response of E-Field

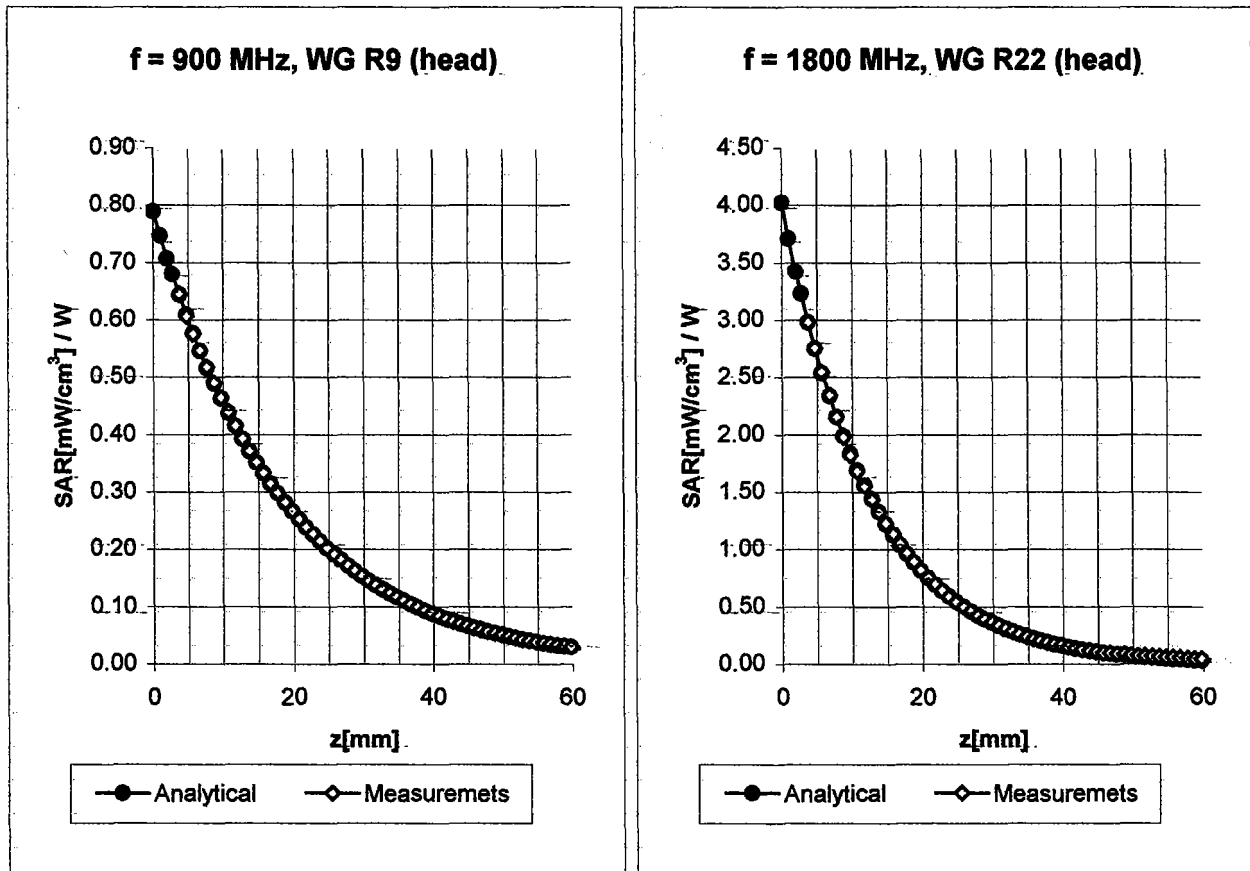
(TEM-Cell:ifi110, Waveguide R22)



Dynamic Range $f(\text{SAR}_{\text{brain}})$ (Waveguide R22)

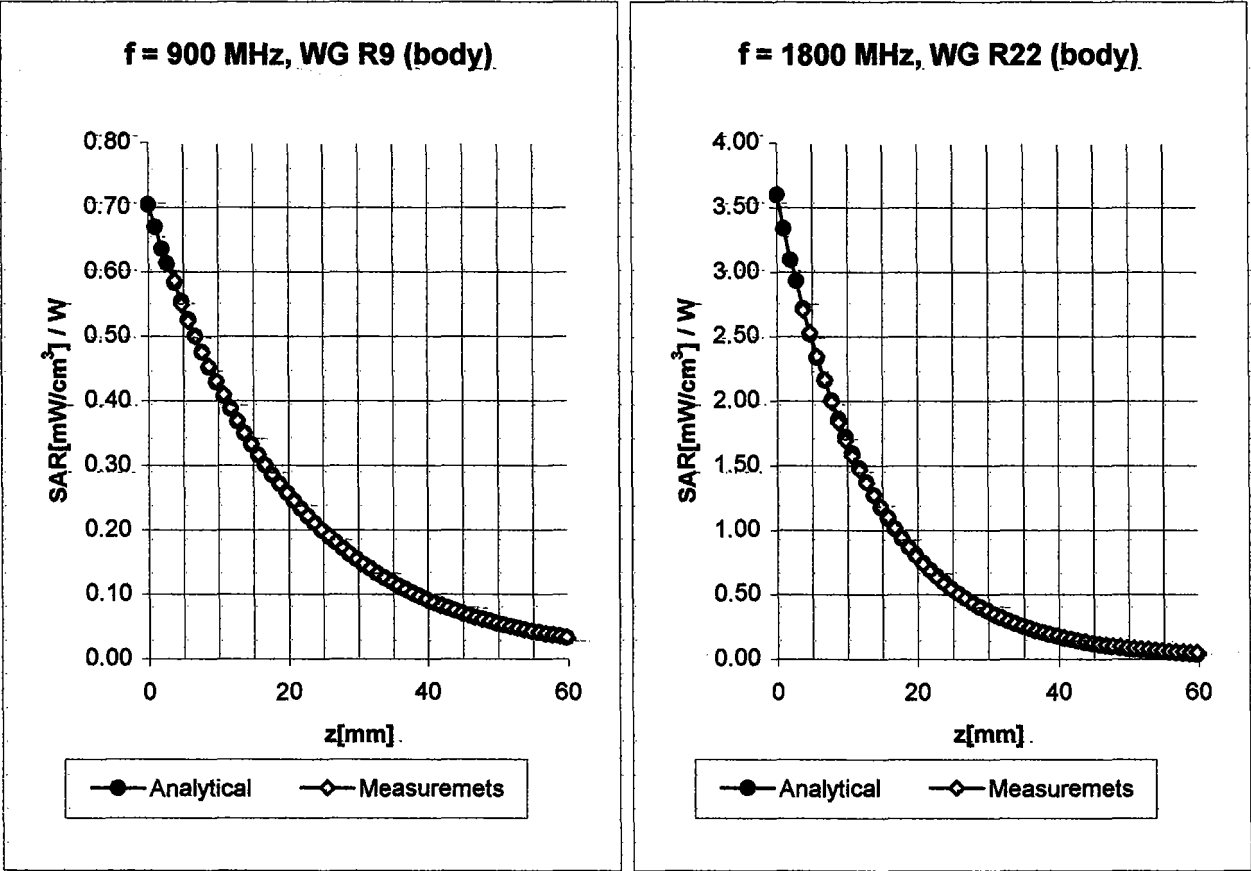


Conversion Factor Assessment



Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
	ConvF X	6.5 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	6.5 $\pm 9.5\%$ (k=2)	Alpha 0.46
	ConvF Z	6.5 $\pm 9.5\%$ (k=2)	Depth 2.27
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Head	1900 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
	ConvF X	5.6 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	5.6 $\pm 9.5\%$ (k=2)	Alpha 0.56
	ConvF Z	5.6 $\pm 9.5\%$ (k=2)	Depth 2.24

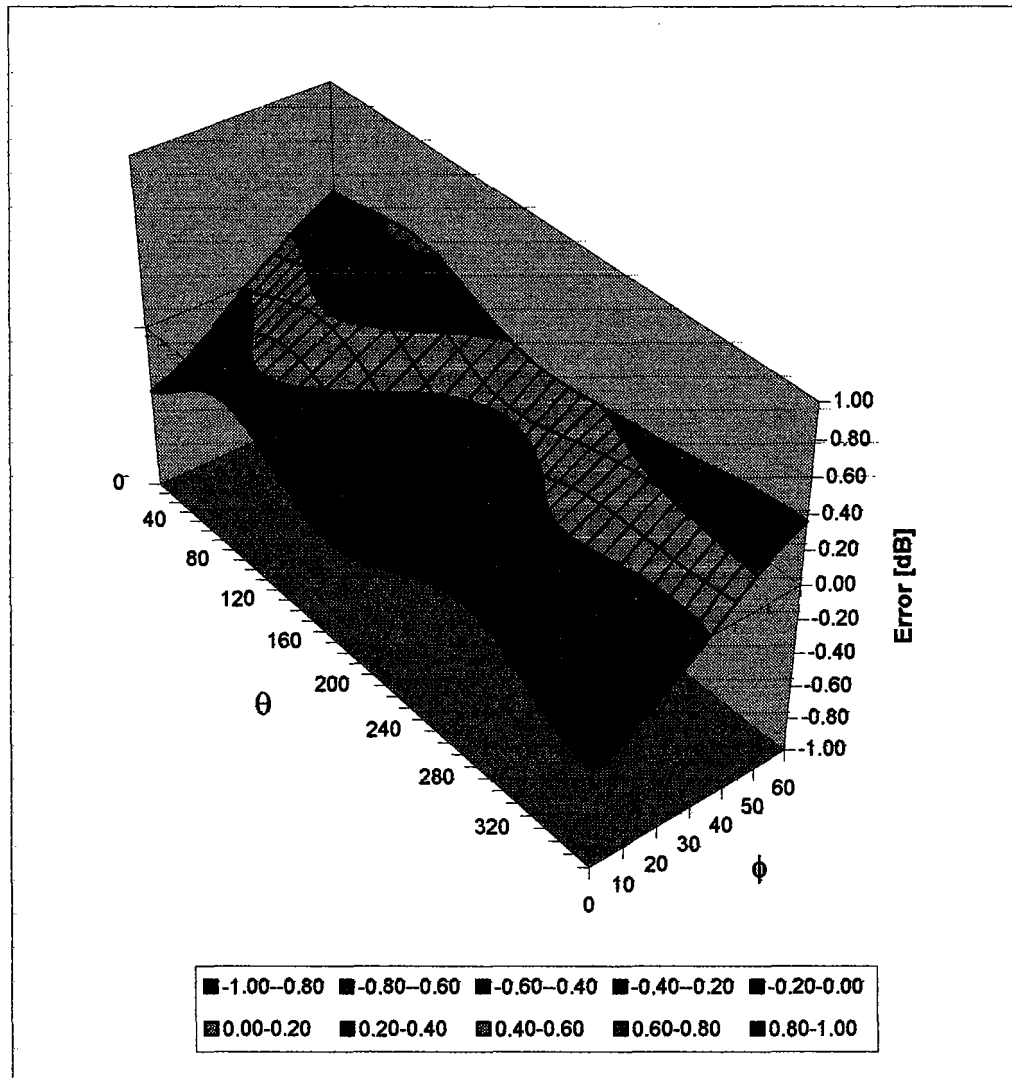
Conversion Factor Assessment



Body	900 MHz	$\epsilon_r = 55.0 \pm 5\%$	$\sigma = 1.05 \pm 5\% \text{ mho/m}$	
Body	835 MHz	$\epsilon_r = 55.2 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$	
	ConvF X	$6.3 \pm 9.5\% (k=2)$	Boundary effect:	
	ConvF Y	$6.3 \pm 9.5\% (k=2)$	Alpha	0.29
	ConvF Z	$6.3 \pm 9.5\% (k=2)$	Depth	3.55
Body	1800 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$	
Body	1900 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$	
	ConvF X	$5.3 \pm 9.5\% (k=2)$	Boundary effect:	
	ConvF Y	$5.3 \pm 9.5\% (k=2)$	Alpha	0.63
	ConvF Z	$5.3 \pm 9.5\% (k=2)$	Depth	2.34

Deviation from Isotropy in HSL

Error (θ, ϕ), $f = 900$ MHz



Client **Motorola MRO (Harvard)**

CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN 1513**

Calibration procedure(s) **QA CAL-01 v2
Calibration procedure for dosimetric E-field probes**

Calibration date: **January 17, 2003**

Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

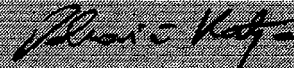
All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date	Scheduled Calibration
RF generator HP 8684C	US3642U01700	4-Aug-99 (in house check Aug-02)	In house check: Aug-05
Power sensor E4412A	MY41495277	8-Mar-02	Mar-03
Power sensor HP 8481A	MY41092180	18-Sep-02	Sep-03
Power meter EPM E4419B	GB41293874	13-Sep-02	Sep-03
Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03

Calibrated by:	Name	Function	Signature
	Nico Vetterli	Technician	

Approved by:	Name	Function
	Katja Pokovic	Laboratory Director



Date issued: January 17, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

Probe ET3DV6R

SN:1513

Manufactured:	May 3, 2002
Last calibration:	May 8, 2002
Repaired:	December 16, 2002
Recalibrated:	January 17, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6R SN:1513

Sensitivity in Free Space

NormX	2.21 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	2.00 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	2.02 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	94	mV
DCP Y	94	mV
DCP Z	94	mV

Sensitivity in Tissue Simulating Liquid

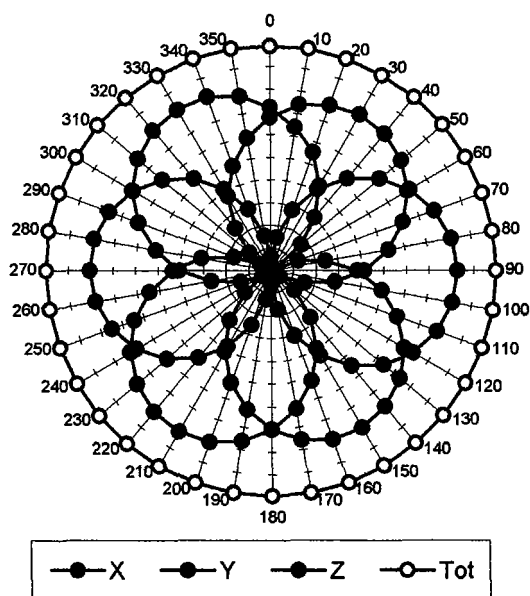
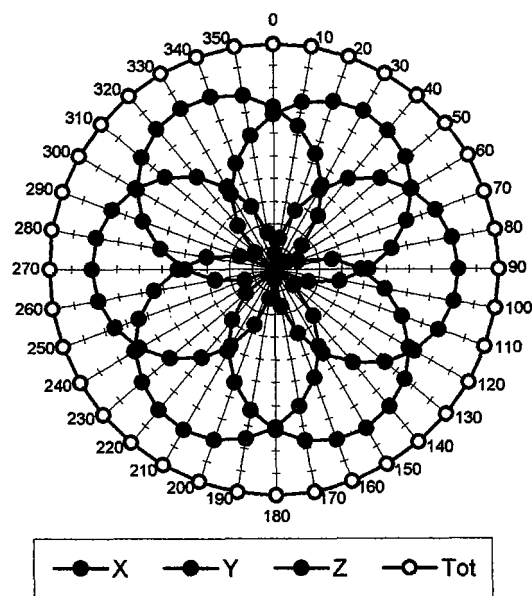
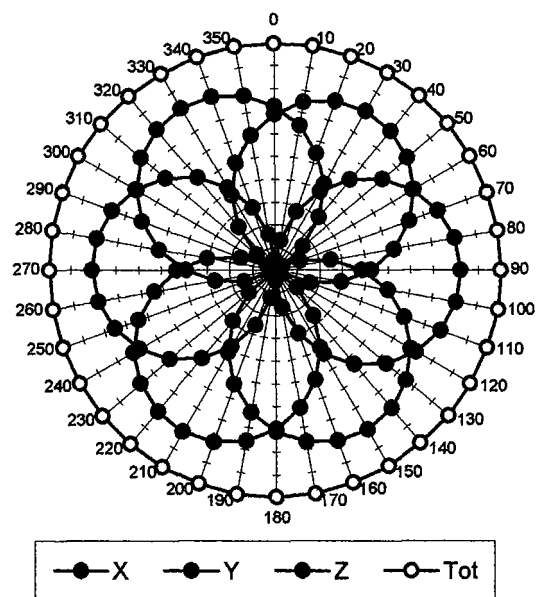
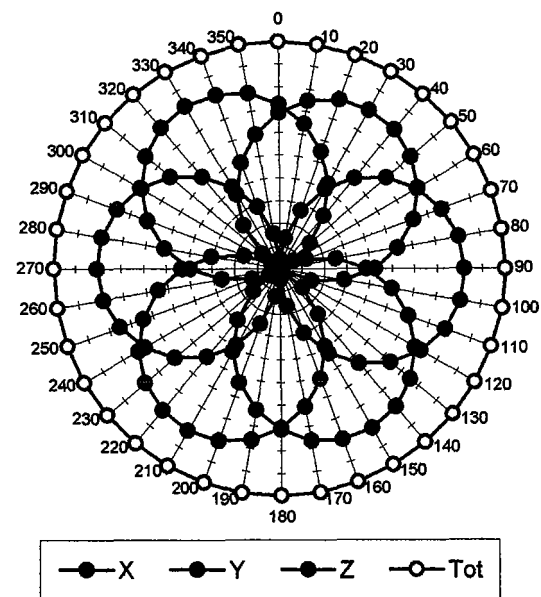
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\% \text{ mho/m}$
ConvF X	6.0 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	6.0 $\pm 9.5\%$ (k=2)	Alpha	0.56
ConvF Z	6.0 $\pm 9.5\%$ (k=2)	Depth	1.95
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
Head	1900 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
ConvF X	4.9 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	4.9 $\pm 9.5\%$ (k=2)	Alpha	0.50
ConvF Z	4.9 $\pm 9.5\%$ (k=2)	Depth	2.63

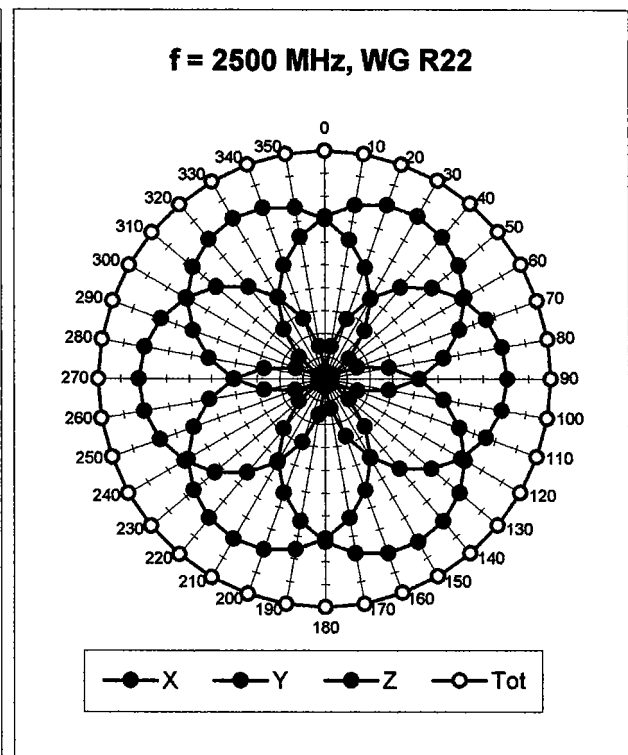
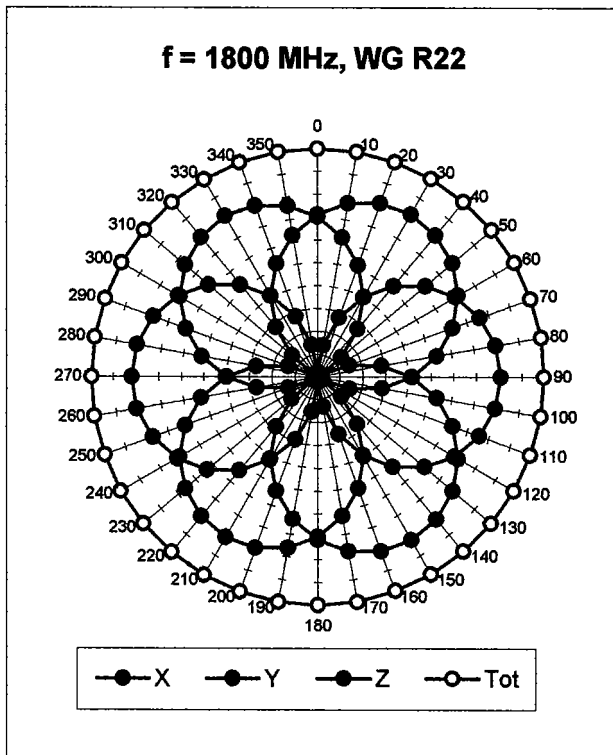
Boundary Effect

Head	900 MHz	Typical SAR gradient: 5 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%]	Without Correction Algorithm	9.3	4.9
SAR _{be} [%]	With Correction Algorithm	0.2	0.4
Head	1800 MHz	Typical SAR gradient: 10 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%]	Without Correction Algorithm	13.9	9.3
SAR _{be} [%]	With Correction Algorithm	0.2	0.1

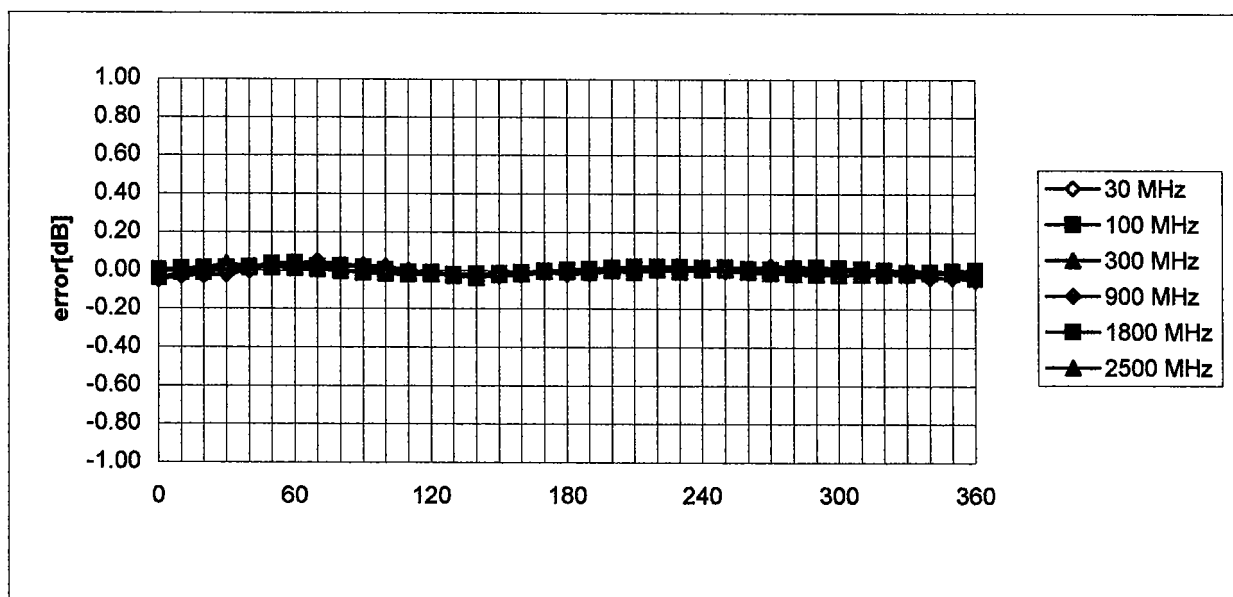
Sensor Offset

Probe Tip to Sensor Center	2.7	mm
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Receiving Pattern (ϕ), $\theta = 0^\circ$ **f = 30 MHz, TEM cell ifi110****f = 100 MHz, TEM cell ifi110****f = 300 MHz, TEM cell ifi110****f = 900 MHz, TEM cell ifi110**

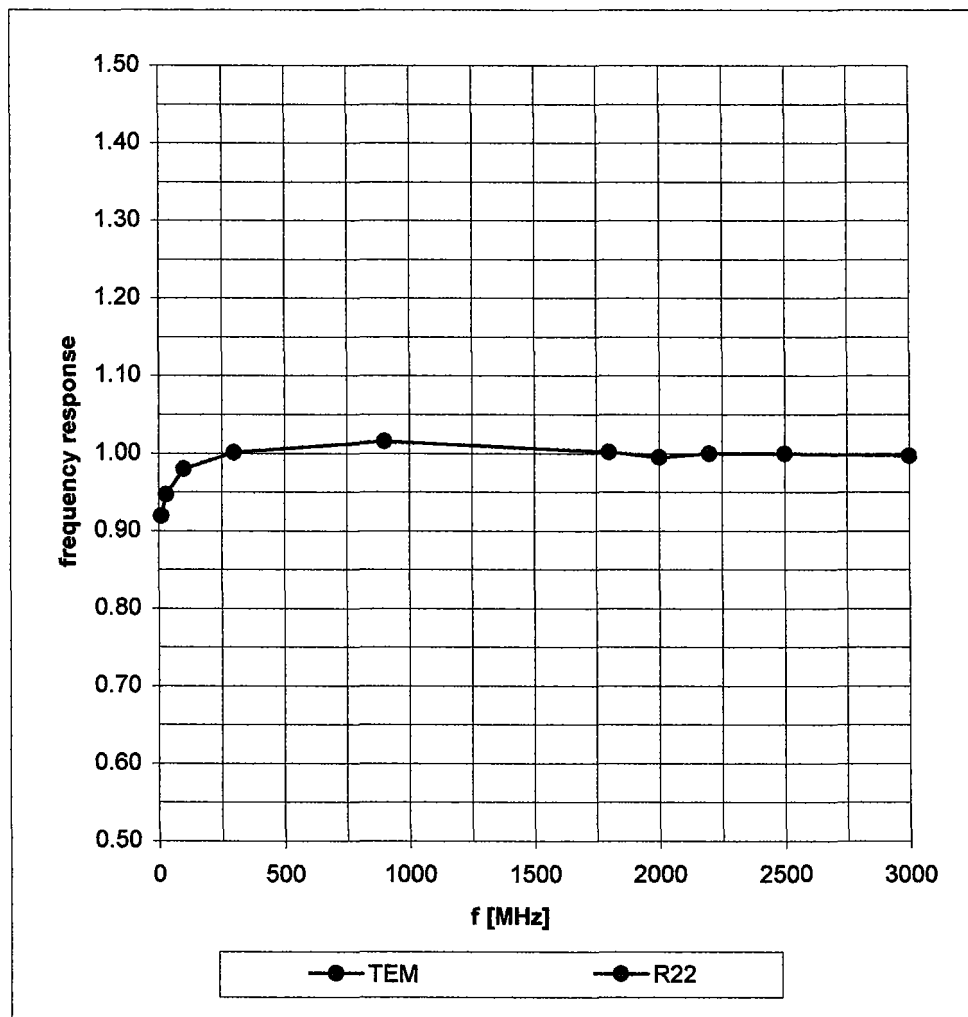


Isotropy Error (ϕ), $\theta = 0^\circ$

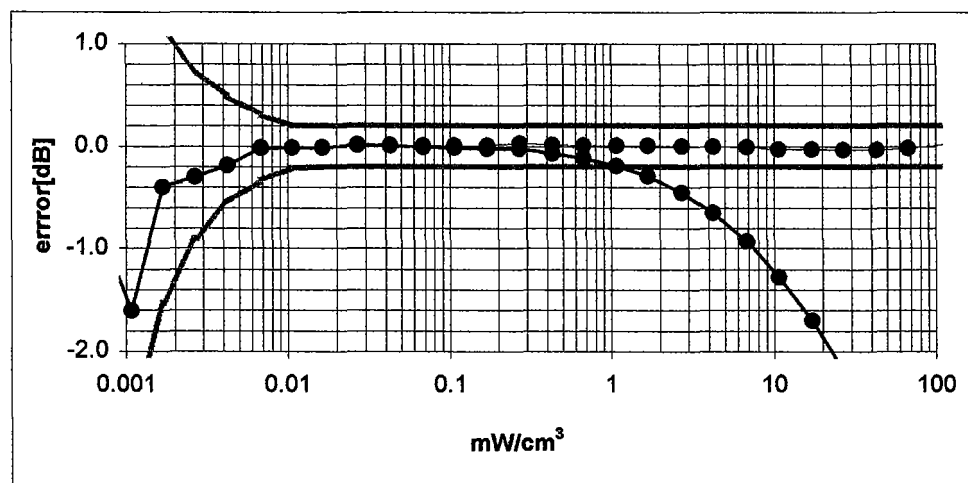
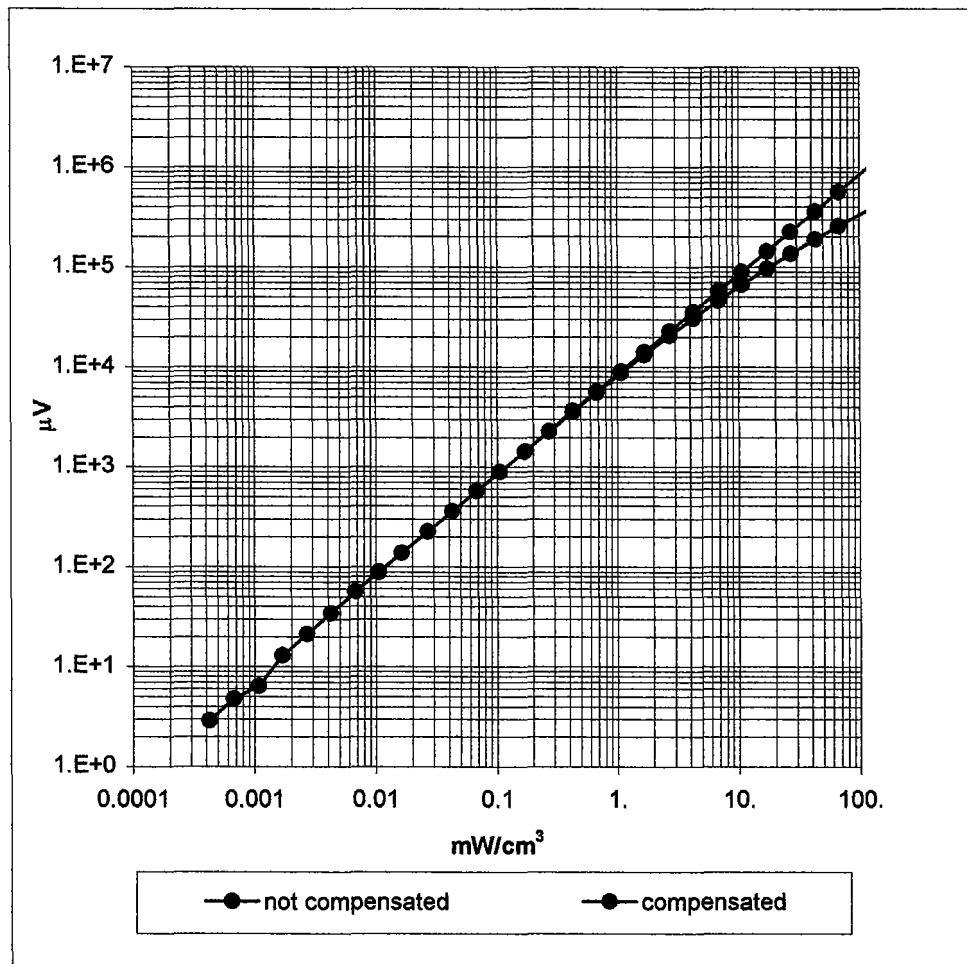


Frequency Response of E-Field

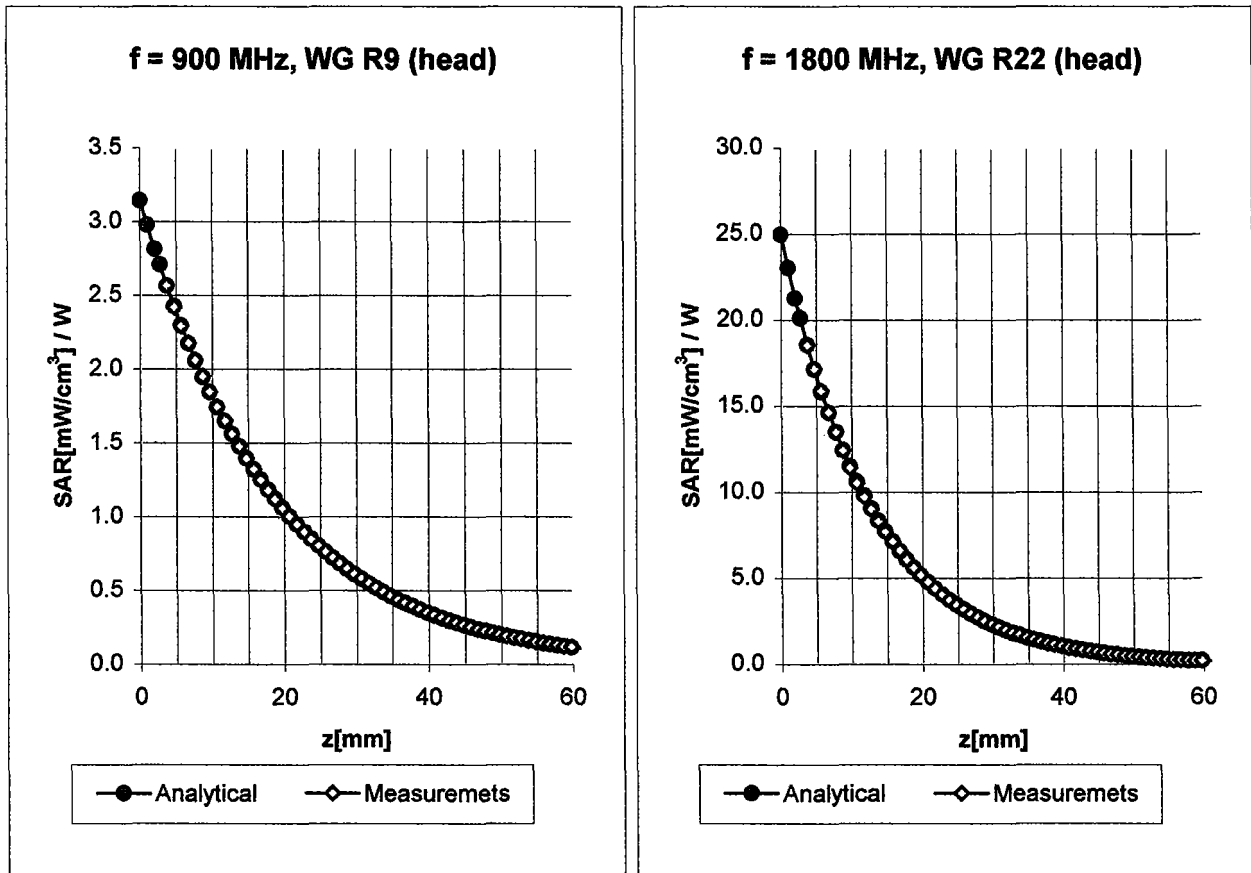
(TEM-Cell:ifi110, Waveguide R22)



Dynamic Range $f(\text{SAR}_{\text{brain}})$ (Waveguide R22)



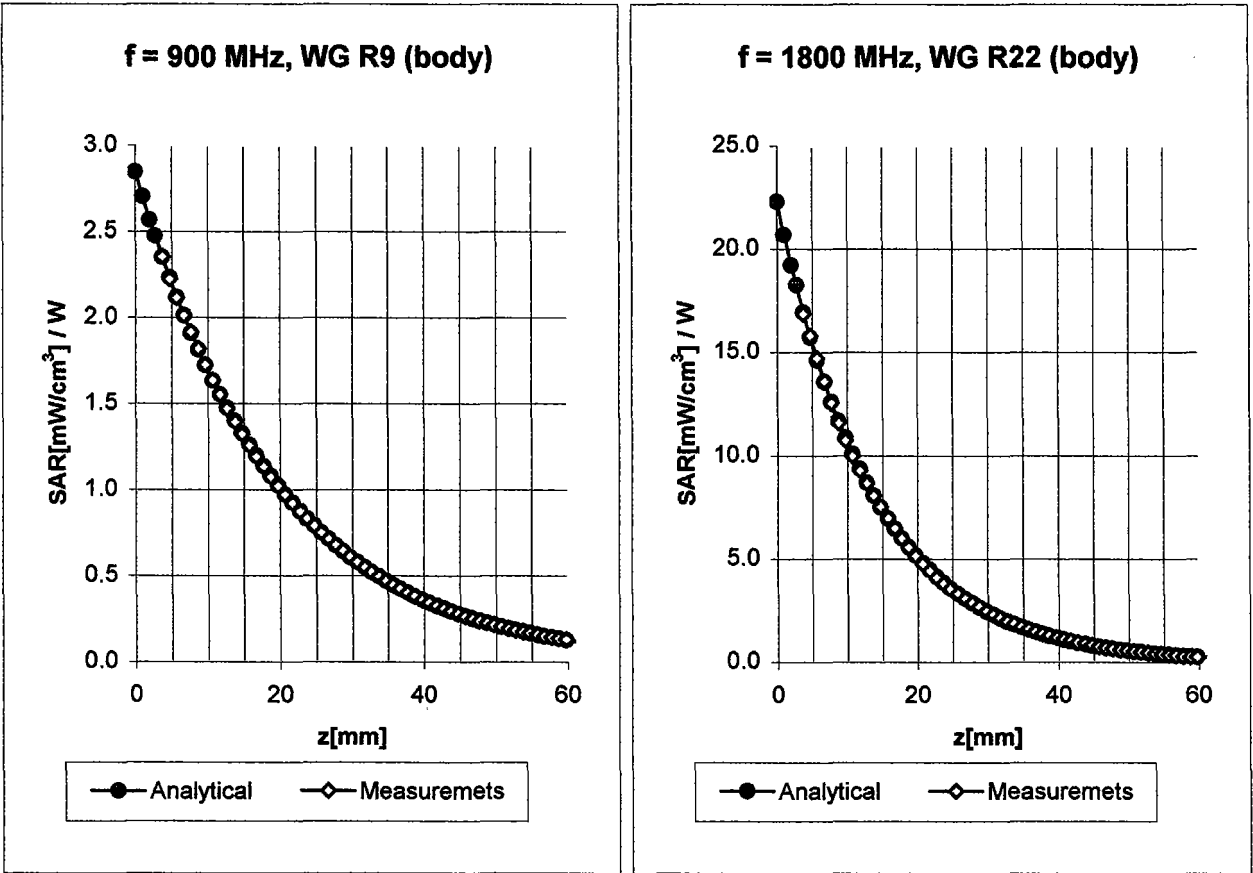
Conversion Factor Assessment



Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
ConvF X	6.0 $\pm 9.5\%$ (k=2)		Boundary effect:
ConvF Y	6.0 $\pm 9.5\%$ (k=2)		Alpha 0.56
ConvF Z	6.0 $\pm 9.5\%$ (k=2)		Depth 1.95

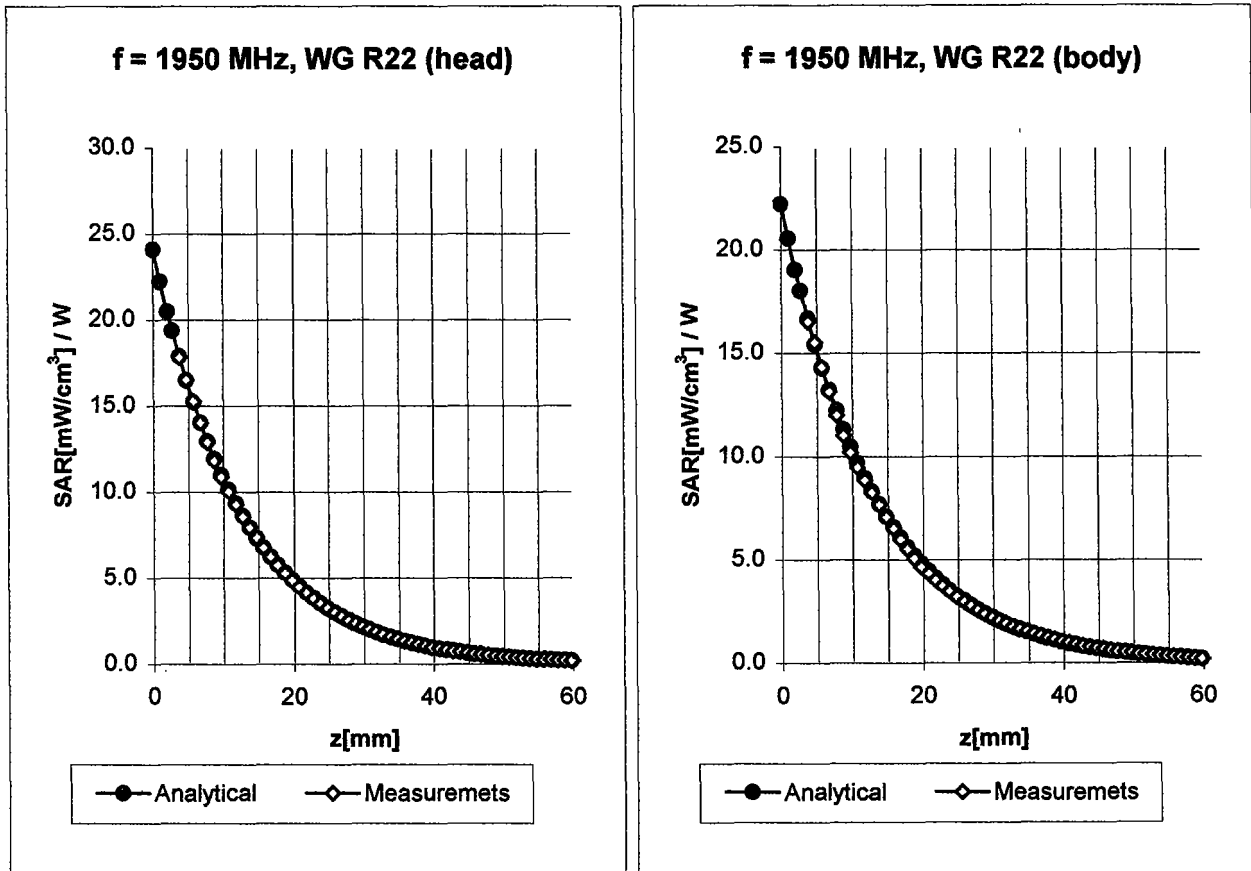
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m	
Head	1900 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m	
	ConvF X	4.9 $\pm 9.5\%$ (k=2)	Boundary effect:	
	ConvF Y	4.9 $\pm 9.5\%$ (k=2)	Alpha	0.50
	ConvF Z	4.9 $\pm 9.5\%$ (k=2)	Depth	2.63

Conversion Factor Assessment



Body	900 MHz	$\epsilon_r = 55.0 \pm 5\%$	$\sigma = 1.05 \pm 5\% \text{ mho/m}$
Body	835 MHz	$\epsilon_r = 55.2 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
	ConvF X	5.8 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	5.8 $\pm 9.5\%$ (k=2)	Alpha 0.45
	ConvF Z	5.8 $\pm 9.5\%$ (k=2)	Depth 2.35
Body	1800 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
Body	1900 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
	ConvF X	4.4 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	4.4 $\pm 9.5\%$ (k=2)	Alpha 0.57
	ConvF Z	4.4 $\pm 9.5\%$ (k=2)	Depth 2.66

Conversion Factor Assessment



Head 1950 MHz $\epsilon_r = 40.0 \pm 5\%$ $\sigma = 1.40 \pm 5\%$ mho/m

ConvF X **4.6** $\pm 8.9\%$ (k=2)

Boundary effect:

ConvF Y **4.6** $\pm 8.9\%$ (k=2)

Alpha **0.55**

ConvF Z **4.6** $\pm 8.9\%$ (k=2)

Depth **2.57**

Body 1950 MHz $\epsilon_r = 53.3 \pm 5\%$ $\sigma = 1.52 \pm 5\%$ mho/m

ConvF X **4.2** $\pm 8.9\%$ (k=2)

Boundary effect:

ConvF Y **4.2** $\pm 8.9\%$ (k=2)

Alpha **0.80**

ConvF Z **4.2** $\pm 8.9\%$ (k=2)

Depth **2.14**

Deviation from Isotropy in HSL

Error (θ, ϕ), $f = 900$ MHz

