

SAR Compliance Test Report

Test report no.:	03-SA-0100	Date of report:	8 th September, 2003
Number of pages:	52	Contact person:	Nerina Walton
		Responsible test engineer:	Nerina Walton

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Tested devices:	GMLNPB-1NB, Model 3390 BMC-2 Battery and HDE-2 Headset
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Supplement reports:	-
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Testing has been carried out in accordance with:	IEEE Std 1528-200X, Draft CBD 1.0 – April 4, 2002 Draft Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques FCC Supplement C Edition, 01-01 Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
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Documentation:	The documentation of the testing performed on the tested devices is archived for 15 years at Test & Certification Center (TCC) Dallas
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Test results:	The tested device complies with the requirements in respect of all parameters subject to the test. The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.
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Date and signatures:
For the contents:


Alan C. Ewing
TCC Line Manager

8th September, 2003


Nerina Walton
Test Engineer

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1. QUALITY SYSTEM

The quality system in place for TCC-Dallas conforms to ISO/IEC 17025 and has been audited to the standard by A2LA (American Association of Laboratory Accreditation). Appendix D of this report contains the scope of accreditation for A2LA. TCC – Dallas has also been audited using the ISO 9000 Quality System, as part of Nokia Mobile Phones, Inc., by ABS (American Bureau of Shipping) Quality Evaluations Inc.

TCC-Dallas is a recognized laboratory with the Federal Communications Commission in filing applications for Certification under Parts 15 and 18, Registration Number 100060, and Industry Canada, Registration Number IC 661.

2. SUMMARY FOR SAR TEST REPORT

Date of test	08 April - 09 April 2003
Contact person	Nerina Walton
Test plan referred to	-
FCC ID	GMLNPB-1NB
SN, HW, SW and Type of tested device	IMEI: 010072/72/290613/5, HW: 15.10, SW: 7.14, Type: NPB-1NB
Accessories used in testing	BMC-2 Battery, and HDE-2 Headset
Notes	-
Document code	03-SA-0100
Responsible test engineer	Nerina Walton
Measurement performed by	Elizabeth Parish / James Love

2.1 Maximum Results Found during SAR Evaluation

The equipment is deemed to fulfill the requirements if the measured values are less than or equal to the limit.

2.1.1 Head Configuration

Mode	Ch / f (MHz)	EIRP (dBm) ¹	Position	Limit (mW/g)	Measured (mW/g)	Result
GSM 1900	512 / 1850.20	28.48	Right Touch	1.6	0.73	PASSED

Note 1: An FCC accredited laboratory, TCC Dallas, performed the EIRP measurements.

2.1.2 Body Worn Configuration

Mode	Ch / f (MHz)	EIRP (dBm) ¹	Position	Limit (mW/g)	Measured (mW/g)	Result
GSM 1900	661 / 1880.00	28.8	Flat Position with 15mm Separation Distance	1.6	0.43	PASSED

Note 1: An FCC accredited laboratory, TCC Dallas, performed the EIRP measurements.

2.1.3 Measurement Uncertainty

Combined Standard Uncertainty	±14.5
Expanded Standard Uncertainty (k=2)	±29.1

3. DESCRIPTION OF TESTED DEVICE

Device category	Portable device
Exposure environment	Uncontrolled exposure
Unit type	Prototype unit
Case type	Fixed case
Mode of Operation	GSM 1900
Modulation Mode	Gaussian Minimum Shift Keying (GMSK)
Duty Cycle	1/8
Transmitter Frequency Range (MHz)	1850.20 – 1909.80

3.1 Picture of Device

The tested device, GMLNPB-1NB is shown below:



3.2 Description of the Antenna

Type	Internal Integrated Antenna
Location	Inside Back Cover, Near Top of the Device

3.3 Battery Options

There is one battery currently available for the tested device, a rechargeable Ni-MH battery, BMC-2.

3.4 Body Worn Operation

Body SAR was evaluated with a separation distance of 15mm and with the HDE-2 headset connected.

4. TEST CONDITIONS

4.1 Ambient Conditions

Ambient temperature (°C)	22±2
Tissue simulating liquid temperature (°C)	20±2
Humidity (%)	30-37

4.2 RF characteristics of the test site

Tests were performed in a fully enclosed RF shielded environment.

4.3 Test Signal, Frequencies, and Output Power

The device was controlled by using a radio tester. Communication between the device and the tester was established by air link.

Measurements were performed on the lowest, middle and highest channels of the operating band.

The phone was set to maximum power level during all tests and at the beginning of each test the battery was fully charged.

The DASY3 system measures power drift during SAR testing by comparing e-field in the same location at the beginning and at the end of measurement. These records were used to monitor stability of power output.

5. DESCRIPTION OF THE TEST EQUIPMENT

The measurements were performed with an automated near-field scanning system, DASY3, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland.

Test Equipment	Model	NMP #	Serial Number	Due Date
DASY3, Data Acquisition	DAE V1	2292	389	07/03
E-field Probe	ET3DV6	2954	1504	07/03
Dipole Validation Kit	D1900V2	3457	5D004	07/03

E-field probe and dipole validation kit calibration records are presented in Appendix D.

Additional equipment (required for validation).

Test Equipment	Model	NMP #	Serial Number	Due Date
Signal Generator	HP 8648C	0409	3836A04346	06/03
Amplifier	AR 5S1G4	0188	25583	-
Coupler	AR DC7144	2057	25304	-
Power Meter	Boonton 4232A	2996	64701	05/03
Power Sensor	Boonton 51015	2997	32187	05/03
Power Sensor	Boonton 51015	2998	32188	05/03
Thermometer	Omega CL27	3392	T-228448	06/03
Network Analyzer	HP 8720D	0455	US38431353	06/03
Dielectric Probe Kit	Agilent 85070C	3089	US99360172	-

The calibration interval on all items listed above can be obtained from the Engineering Services Group within NMP, Product Creation – Dallas. Where relevant, measuring equipment is subjected to in-service checks between testing. TCC – Dallas shall notify clients promptly, in writing, of identification of defective measuring equipment that casts doubt on the validity of results given in this report.

5.1 System Accuracy Verification

The manufacturer calibrates the probes annually. Dielectric parameters of the simulating liquids are measured using an Agilent 85070C dielectric probe kit and an HP 8720D network analyzer.

SAR measurements of the tested device were performed within 24 hours of system accuracy verification, which was done using the dipole validation kit.

The dipole antenna, which is manufactured by Schmid & Partner Engineering AG, is matched to be used near a flat phantom filled with tissue simulating solution. Length of the 1900MHz dipole is 68mm with an overall height of 300mm. A specific distance holder is used in the positioning to ensure correct spacing between the phantom and the dipole.

A power level of 250 mW was supplied to the dipole antenna placed under the flat section of the SAM phantom. Validation results are in the table below and a print out of the validation tests are presented in Appendix B. All the measured parameters were within specification.

5.1.1 Head Tissue

Tissue	f (MHz)	Description	SAR (W/kg), 1g	Dielectric Parameters		Temp (°C)
				ϵ_r	σ (S/m)	
Head	1900	Measured, 08-Apr-03	43.2	38.5	1.43	20.5
		Reference Result	44.0	39.8	1.46	N/A

5.1.2 Muscle Tissue

Tissue	f (MHz)	Description	SAR (W/kg), 1g	Dielectric Parameters		Temp (°C)
				ϵ_r	σ (S/m)	
Muscle	1900	Measured, 09-Apr-03	44.4	52.7	1.58	18.8
		Reference Result	44.0	54.4	1.57	N/A

5.2 Tissue Simulants

All dielectric parameters of tissue simulants were measured within 24 hours of SAR measurements. The depth of the tissue simulant in the ear reference point of the phantom was $15\text{cm} \pm 5\text{mm}$ during all tests. Volume for each tissue simulant was 27 litres.

5.2.1 Head Tissue Simulant

The composition of the brain tissue simulating liquid for 1900 MHz is: -

44.91% 2-(2-butoxyethoxy) Ethanol
54.88% De-ionized Water
0.21% Salt

f (MHz)	Description	Dielectric Parameters		Temp (°C)
		ϵ_r	σ (S/m)	
1880	Measured, 08-Apr-03	38.6	1.41	20.5
	Recommended Values	40.0	1.40	N/A

Recommended values are adopted from OET Bulletin 65 (97-01) Supplement C (01-01).

5.2.2 Muscle Tissue Simulant

The composition of the muscle tissue simulating liquid for 1900 MHz is: -

69.02% De-ionized Water
30.76% Diethylene Glycol Monobutyl Ether
0.22% Salt

f (MHz)	Description	Dielectric Parameters		Temp (°C)
		ϵ_r	σ (S/m)	
1880	Measured, 09-Apr-03	52.8	1.55	18.8
	Recommended Values	53.3	1.52	N/A

Recommended values are adopted from OET Bulletin 65 (97-01) Supplement C (01-01).

5.3 Phantoms

"SAM v4.0" phantom", manufactured by SPEAG, was used during the measurement. It has a fiberglass shell integrated into a wooden table. The shape of the shell corresponds to the phantom defined by SCC34-SC2. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. Reference markings on the phantom allow the complete set-up of all predefined phantom positions and measurement grids by manually teaching three points in the robot.



The thickness of phantom shell is 2 mm except for the ear, where an integrated ear spacer provides a 6 mm spacing from the tissue boundary. Manufacturer reports tolerance in shell thickness to be ± 0.1 mm.

5.4 Isotropic E-Field Probe ET3DV6

Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycol ether)
Calibration	Calibration certificate in Appendix D
Frequency	10 MHz to 3 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Optical Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic Range	5 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms



6. DESCRIPTION OF THE TEST PROCEDURE

6.1 Test Positions

The device was placed into a holder using a special positioning tool, which aligns the bottom of the device with the holder and ensures that holder contacts only to the sides of the device. After positioning is done, tool is removed. This method provides standard positioning and separation, and also ensures free space for antenna.

Device holder was provided by SPEAG together with DASY3.



6.1.1 Against Phantom Head

Measurements were made on both the "left hand" and "right hand" side of the phantom.

The device was positioned against phantom according to OET Bulletin 65 (97-01) Supplement C (01-01). Definitions of terms used in aligning the device to a head phantom are available in IEEE Draft Standard P1528-2001 "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"

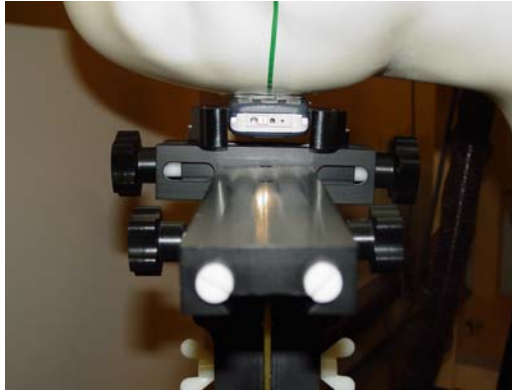
6.1.1.1 Initial Ear Position

The device was initially positioned with the earpiece region pressed against the ear spacer of a head phantom parallel to the "Neck-Front" line defined along the base of the ear spacer that contains the "ear reference point". The "test device reference point" is aligned to the "ear reference point" on the head phantom and the "vertical centerline" is aligned to the "phantom reference plane".

6.1.1.2 Touch Position

"Initial ear position" alignments are maintained and the device is brought toward the mouth of the head phantom by pivoting along the "Neck-Front" line until any point on the display, keypad or mouthpiece portions of the handset is in contact with the phantom or when any portion of a foldout, sliding or similar keypad cover opened to its intended self-adjusting normal use position is in contact with the cheek or mouth of the phantom.

The following picture show the tested device in the right touch position:



6.1.1.3 Tilt Position

In the "Touch Position", if the earpiece of the device is not in full contact with the phantom's ear spacer and the peak SAR location for the "touch position" is located at the ear spacer region or corresponds to the earpiece region of the handset, the device is returned to the "initial ear position" by rotating it away from the mouth until the earpiece is in full contact with the ear spacer. Otherwise, the device is moved away from the cheek perpendicular to the line passes through both "ear reference points" for approximate 2-3 cm. While it is in this position, the device is tilted away from the mouth with respect to the "test device reference point" by 15°. After the tilt, it is then moved back toward the head perpendicular to the line passes through both "ear reference points" until the device touches the phantom or the ear spacer. If the antenna touches the head first, the positioning process is repeated with a tilt angle less than 15° so that the device and its antenna would touch the phantom simultaneously.

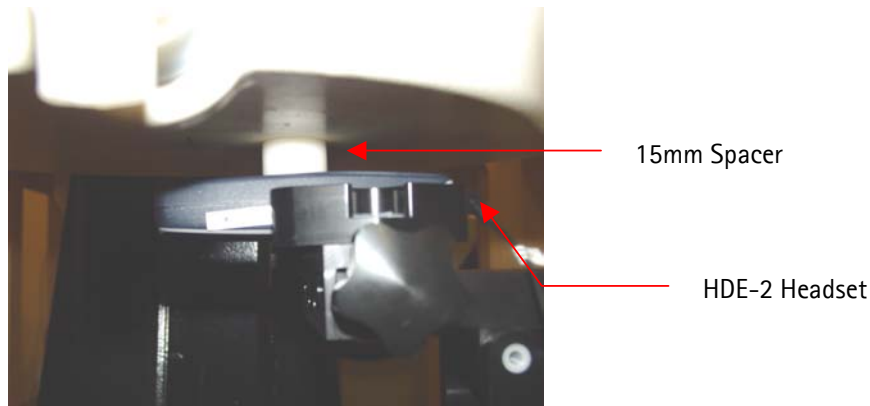
The following picture shows the tested device in the right tilt position:



6.1.2 Body Worn Configuration

Body SAR measurements were performed with the antenna facing towards the flat part of the phantom, with a separation distance of 15mm with the HDE-2 headset connected.

The following picture shows the tested device in the body test position: -



Note: the 15mm spacer was removed before the SAR measurement.

6.2 Scan Procedures

First coarse scans are used for quick determination of the field distribution. Next a cube scan, 5x5x7 points; spacing between each point 8x8x5 mm, is performed around the highest E-field value to determine the averaged SAR-distribution over 1g.

6.3 SAR Averaging Methods

The maximum SAR value is averaged over its volume using interpolation and extrapolation.

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot" -condition [W. Gander, Computermathematik, p. 141-150] (x, y and z -directions) [Numerical Recipes in C, Second Edition, p 123].

The extrapolation is based on least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 30 mm in all z-axis, polynomials of order four are calculated. This polynomial is then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1mm from one another.

7. MEASUREMENT UNCERTAINTY

7.1 Description of Individual Measurement Uncertainty

7.1.1 Assessment Uncertainty

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e = f(d,k)</i>	<i>F</i>	<i>h = c x f / e</i>	<i>k</i>
Uncertainty Component	Section in P1528.	Tol. (%)	Prob. Dist.	Div.	<i>c_i</i>	<i>u_i</i> (%)	<i>v_i</i>
Measurement System							
Probe Calibration	E2.1	±4.8	N	1	1	±4.8	∞
Axial Isotropy	E2.2	±4.7	R	√3	(1-cp) ^{1/2}	±1.9	∞
Hemispherical Isotropy	E2.2	±9.6	R	√3	√c _p	±3.9	∞
Boundary Effect	E2.3	±8.3	R	√3	1	±4.8	∞
Linearity	E2.4	±4.7	R	√3	1	±2.7	∞
System Detection Limits	E2.5	±1.0	R	√3	1	±0.6	∞
Readout Electronics	E2.6	±1.0	N	1	1	±1.0	∞
Response Time	E2.7	±0.8	R	√3	1	±0.5	∞
Integration Time	E2.8	±2.6	R	√3	1	±1.5	∞
RF Ambient Conditions - Noise	E6.1	±3.0	R	√3	1	±1.7	∞
RF Ambient Conditions - Reflections	E6.1	±3.0	R	√3	1	±1.7	∞
Probe Positioner Mechanical Tolerance	E6.2	±0.4	R	√3	1	±0.2	∞
Probe Positioning with respect to Phantom Shell	E6.3	±2.9	R	√3	1	±1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E5.2	±3.9	R	√3	1	±2.3	∞
Test sample Related							
Test Sample Positioning	E4.2.1	±6.0	N	1	1	±6.0	11
Device Holder Uncertainty	E4.1.1	±5.0	N	1	1	±5.0	7
Output Power Variation - SAR drift measurement	6.6.3	±10.0	R	√3	1	±5.8	∞
Phantom and Tissue Parameters							
Phantom Uncertainty (shape and thickness tolerances)	E3.1	±4.0	R	√3	1	±2.3	∞
Liquid Conductivity Target - tolerance	E3.2	±5.0	R	√3	0.64	±1.8	∞
Liquid Conductivity - measurement uncertainty	E3.3	±5.5	N	1	0.64	±3.5	5
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e =</i>	<i>F</i>	<i>h =</i>	<i>k</i>

				$f(d,k)$		$c \times f / e$	
Uncertainty Component	Section in P1528.	Tol. (%)	Prob. Dist.	Div.	c_i	u_i (%)	v_i
Measurement System							
Liquid Permittivity Target tolerance	E3.2	±5.0	R	√3	0.6	±1.7	∞
Liquid Permittivity – measurement uncertainty	E3.3	±2.9	N	1	0.6	±1.7	5
Combined Standard Uncertainty			RSS			±14.5	208
Expanded Uncertainty (95% CONFIDENCE INTERVAL)						±29.1	

8. RESULTS

Corresponding SAR distribution print outs of maximum results in every operating mode and position are shown in Appendix C; it also includes Z-plots of maximum measurement results in head and body worn configurations. The SAR distributions are substantially similar or equivalent to the plots submitted regardless of used channel in each mode and position, unless otherwise presented.

8.1 Head Configuration

Mode	Channel/ <i>f</i> (MHz)	EIRP (dBm) ¹	SAR, averaged over 1g (mW/g)			
			Left-hand		Right-hand	
			Touch	Tilt	Touch	Tilt
GSM 1900	512 / 1850.20	28.48	0.63	0.57	0.73	0.71
	661 / 1880.00	28.80	0.55	0.56	0.72	0.69
	810 / 1909.80	29.15	0.51	0.52	0.65	0.60

Note 1: An FCC accredited laboratory, TCC Dallas, performed the EIRP measurements.

8.2 Body Worn Configuration

Body SAR measurements were performed with the HDE-2 headset connected.

Mode	Channel/ <i>f</i> (MHz)	EIRP (dBm) ¹	SAR, averaged over 1g (mW/g)
			HDE-2
GSM 1900	512 / 1850.20	28.48	0.40
	661 / 1880.00	28.80	0.43
	810 / 1909.80	29.15	0.40

Note 1: An FCC accredited laboratory, TCC Dallas, performed the EIRP measurements.

APPENDIX A: SCOPE OF ACCREDITATION FOR A2LA

TCC-Dallas is accredited by the American Association for Laboratory Accreditation (A2LA) as shown in the scope below:



 American Association for Laboratory Accreditation	
<u>SCOPE OF ACCREDITATION TO ISO/IEC 17025:1999</u>	
NOKIA MOBILE PHONES TEST & CERTIFICATION CENTER - DALLAS 4621 Connection Drive Irving, TX 75039 Alan Ewing Phone: 972.894.4744	
ELECTRICAL	
Valid to: November 30, 2003 Certificate Number: 1819-01	
In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following Electromagnetic Compatibility (EMC), Specific Absorption Rate (SAR), and tests on wireless communications devices:	
Tests	Test Method
Wireless	
GSM (850/900/1800/1900 MHz)	3GPP TS 51.010-1, -2, -3 3GPP TS 11.10-4 P1CRB NAFRD .03
TDMA	CTIA TDMA/AMPS Test Plan (excluding Sections 7.3.3 & 7.3.4) TIA/EIA-136-270
Emissions	
Conducted and Radiated	CFR 47 Part 2, 15, 22, 24 CISPR 22; EN 55022 ICES-003; RSS-128, 132 and 133 3GPP TS 51.010-1 Section 12.2 ETSI EN 301 489-1; EN 301 489-7 (using ANSI C63.4 and RSS-212)
Specific Absorption Rate	IEEE 1528 EN 50360; EN 50361 CFR 47 Parts 2 and 24 OET Bulletin 65 and Supplement C RSS-102
Immunity	
Vehicular Immunity	ISO 7637-1; ETSI EN 301 489-1; EN 301 489-7
Electrostatic Discharge (ESD)	EN 61000-4-2; ETSI EN 301 489-1; EN 301 489-7
RF Radiated	EN 61000-4-3; ETSI EN 301 489-1; EN 301 489-7
Electrical Fast Transient/Burst	EN 61000-4-4; ETSI EN 301 489-1; EN 301 489-7
Surge	EN 61000-4-5; ETSI EN 301 489-1; EN 301 489-7
Conducted	EN 61000-4-6; ETSI EN 301 489-1; EN 301 489-7
Voltage Dips, Short Interruptions and Voltage Variations	EN 61000-4-11; ETSI EN 301 489-1; EN 301 489-7
<i>Peter Maye</i>	
(A2LA Cert. No. 1819.01) Revised 09/18/02 Page 1 of 2 5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8373 • Phone: 301-644 3248 • Fax: 301-662 2974	
<i>Peter Maye</i>	
(A2LA Cert. No. 1819.01) Revised 09/18/02 Page 2 of 2	

"This laboratory is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this report have been determined to be in accordance with the laboratory's terms of accreditation unless stated otherwise in the report."

Should this report contain any data for tests for which we are not accredited, such data would not be covered by this laboratory's A2LA accreditation.

APPENDIX B: VALIDATION TEST PRINTOUTS

Dipole 1900 MHz, Head Validation

SAM 3 (PCS - Brain / Muscle Tissue)

Frequency: 1900 MHz; Crest factor: 1.0

Validation 1900MHz - Brain Tissue: $\sigma = 1.43$ mho/m $\epsilon_r = 38.5$ $\rho = 1.00$ g/cm³

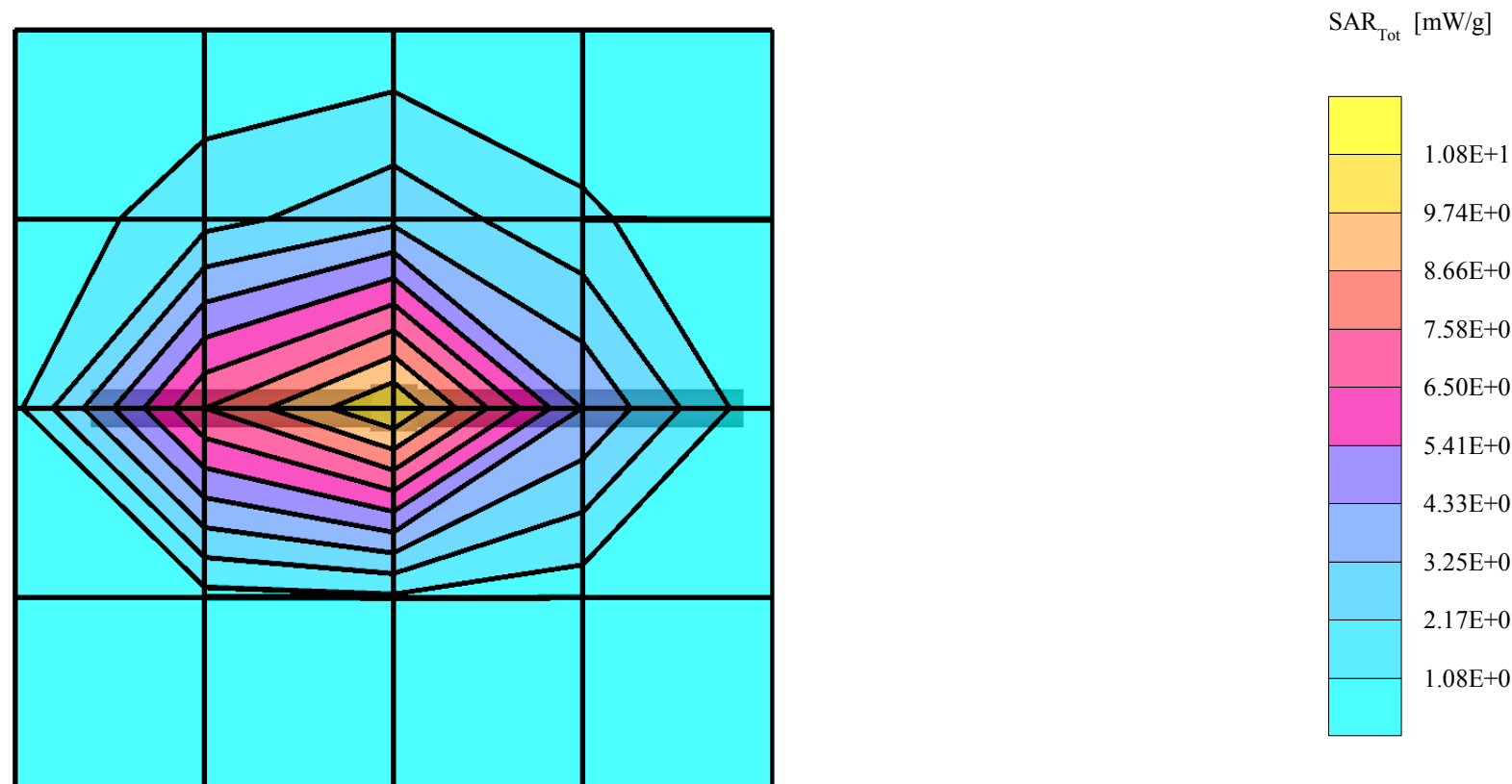
Probe: ET3DV6 - SN1504; ConvF(5.40,5.40,5.40)

Cubes (2): Peak: 20.4 mW/g ± 0.13 dB, SAR (1g): 10.8 mW/g ± 0.08 dB, SAR (10g): 5.53 mW/g ± 0.05 dB, (Worst-case extrapolation)

Penetration depth: 8.1 (7.7, 9.0) [mm]

Powerdrift: -0.32 dB

Liquid Temperature (°C): 20.5



Dipole 1900 MHz, Body Validation

SAM 3 (PCS - Brain / Muscle Tissue)

Frequency: 1900 MHz; Crest factor: 1.0

Validation 1900MHz - Muscle Tissue: $\sigma = 1.58$ mho/m $\epsilon_r = 52.7$ $\rho = 1.00$ g/cm³

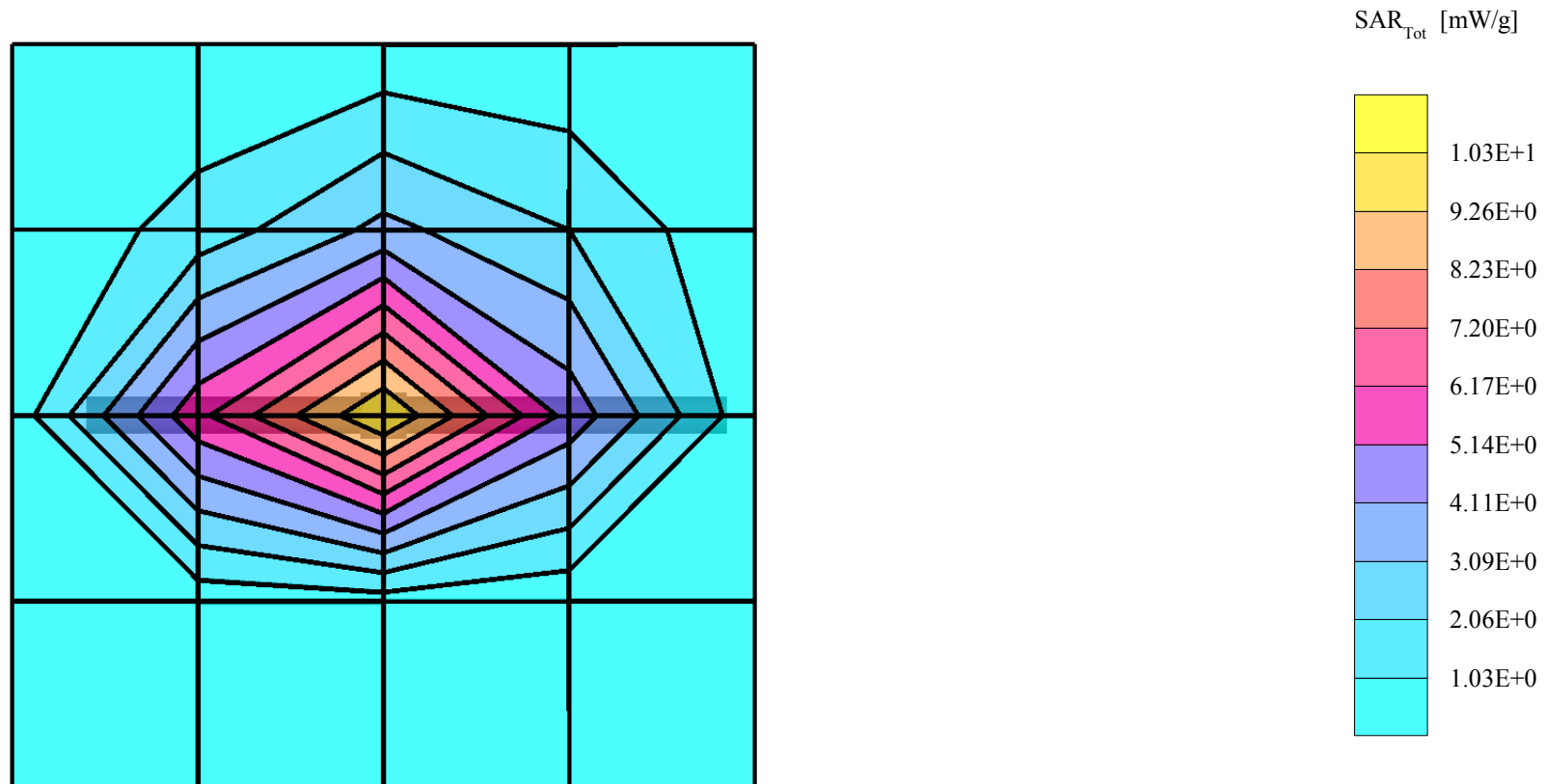
Probe: ET3DV6 - SN1504; ConvF(5.00,5.00,5.00)

Cubes (2): Peak: 21.0 mW/g ± 0.12 dB, SAR (1g): 11.1 mW/g ± 0.07 dB, SAR (10g): 5.70 mW/g ± 0.03 dB, (Worst-case extrapolation)

Penetration depth: 8.4 (7.8, 9.6) [mm]

Powerdrift: -0.22 dB

Liquid Temperature (°C): 18.8



APPENDIX C: SAR DISTRIBUTION PRINTOUTS

GMLNPB-1NB, GSM 1900, Channel 512, Left Touch Position

SAM 3 (PCS - Brain / Muscle Tissue) Phantom

Frequency: 1850 MHz; Crest factor: 8.0

PCS Band - Brain Tissue: $\sigma = 1.41$ mho/m $\epsilon_r = 38.6$ $\rho = 1.00$ g/cm³

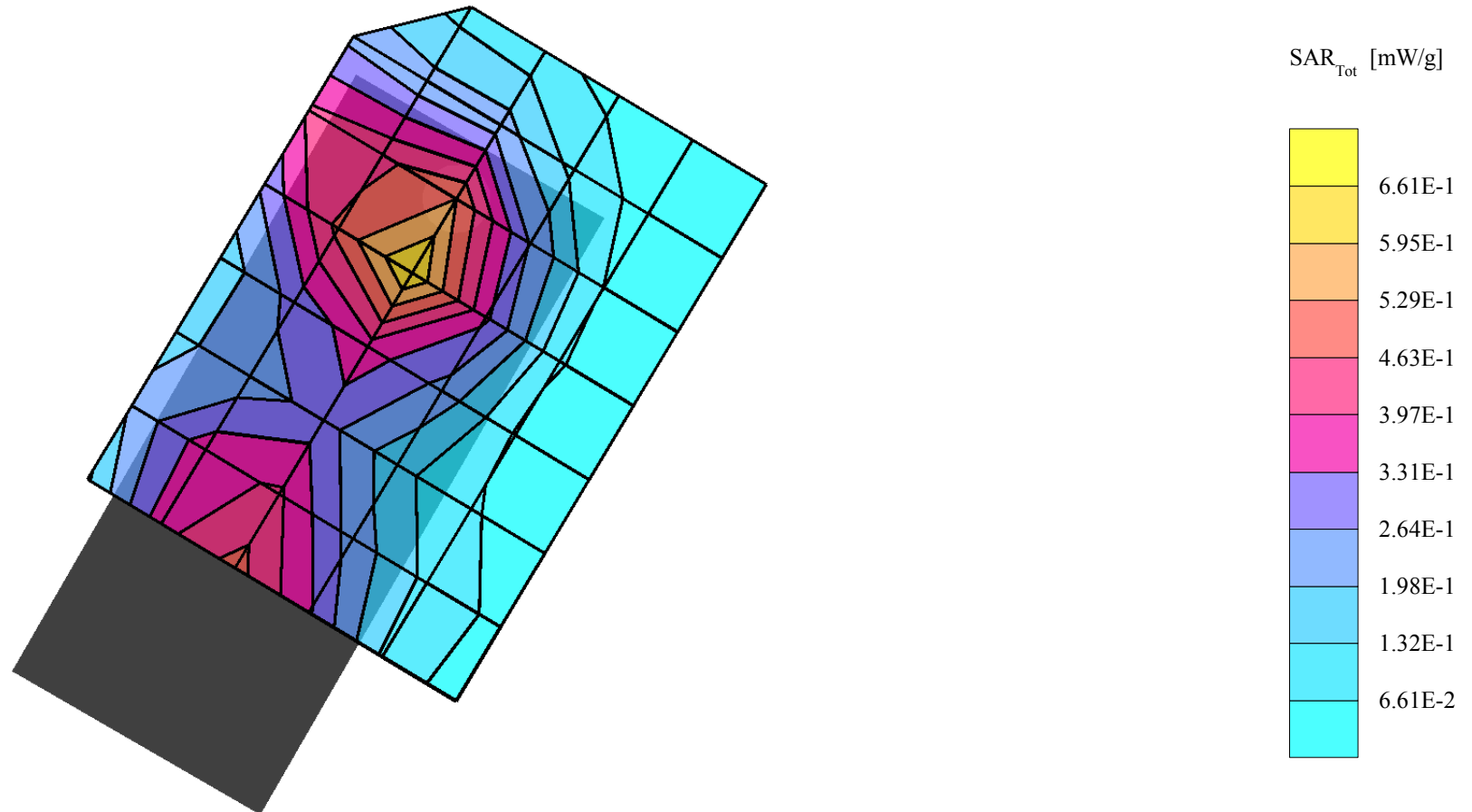
Probe: ET3DV6 - SN1504; ConvF(5.40,5.40,5.40)

Cube 5x5x7: SAR (1g): 0.625 mW/g, SAR (10g): 0.367 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0

Powerdrift: -0.09 dB

Liquid Temperature (°C): 20.5



GMLNPB-1NB, GSM 1900, Channel 512, Left Tilt Position

SAM 3 (PCS - Brain / Muscle Tissue) Phantom

Frequency: 1850 MHz; Crest factor: 8.0

PCS Band - Brain Tissue: $\sigma = 1.41$ mho/m $\epsilon_r = 38.6$ $\rho = 1.00$ g/cm³

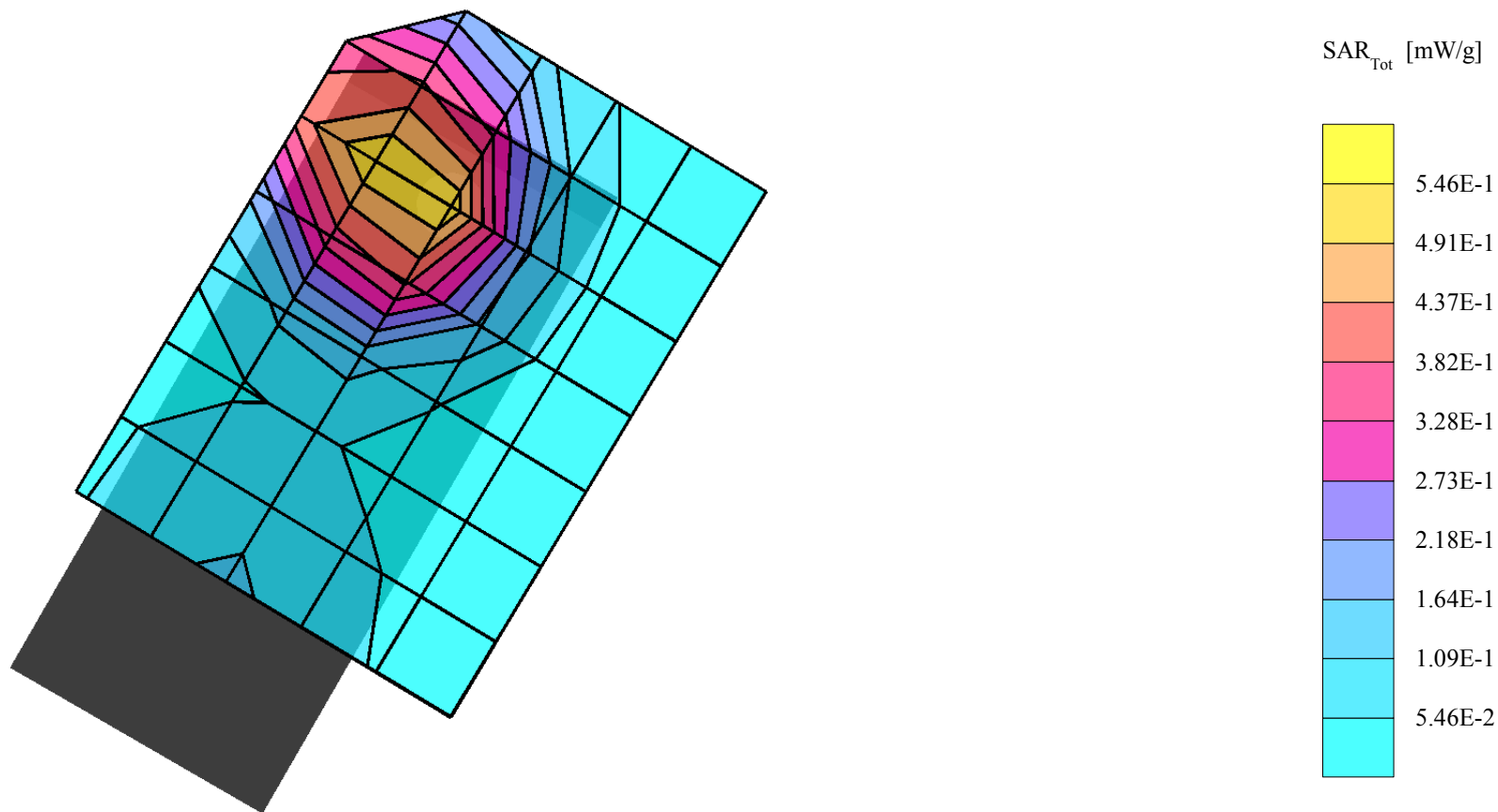
Probe: ET3DV6 - SN1504; ConvF(5.40,5.40,5.40)

Cube 5x5x7: SAR (1g): 0.565 mW/g, SAR (10g): 0.323 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0

Powerdrift: 0.11 dB

Liquid Temperature (°C): 20.5



GMLNPB-1NB, GSM 1900, Channel 512, Right Touch Position

SAM 3 (PCS - Brain / Muscle Tissue) Phantom

Frequency: 1850 MHz; Crest factor: 8.0

PCS Band - Brain Tissue: $\sigma = 1.41$ mho/m $\epsilon_r = 38.6$ $\rho = 1.00$ g/cm³

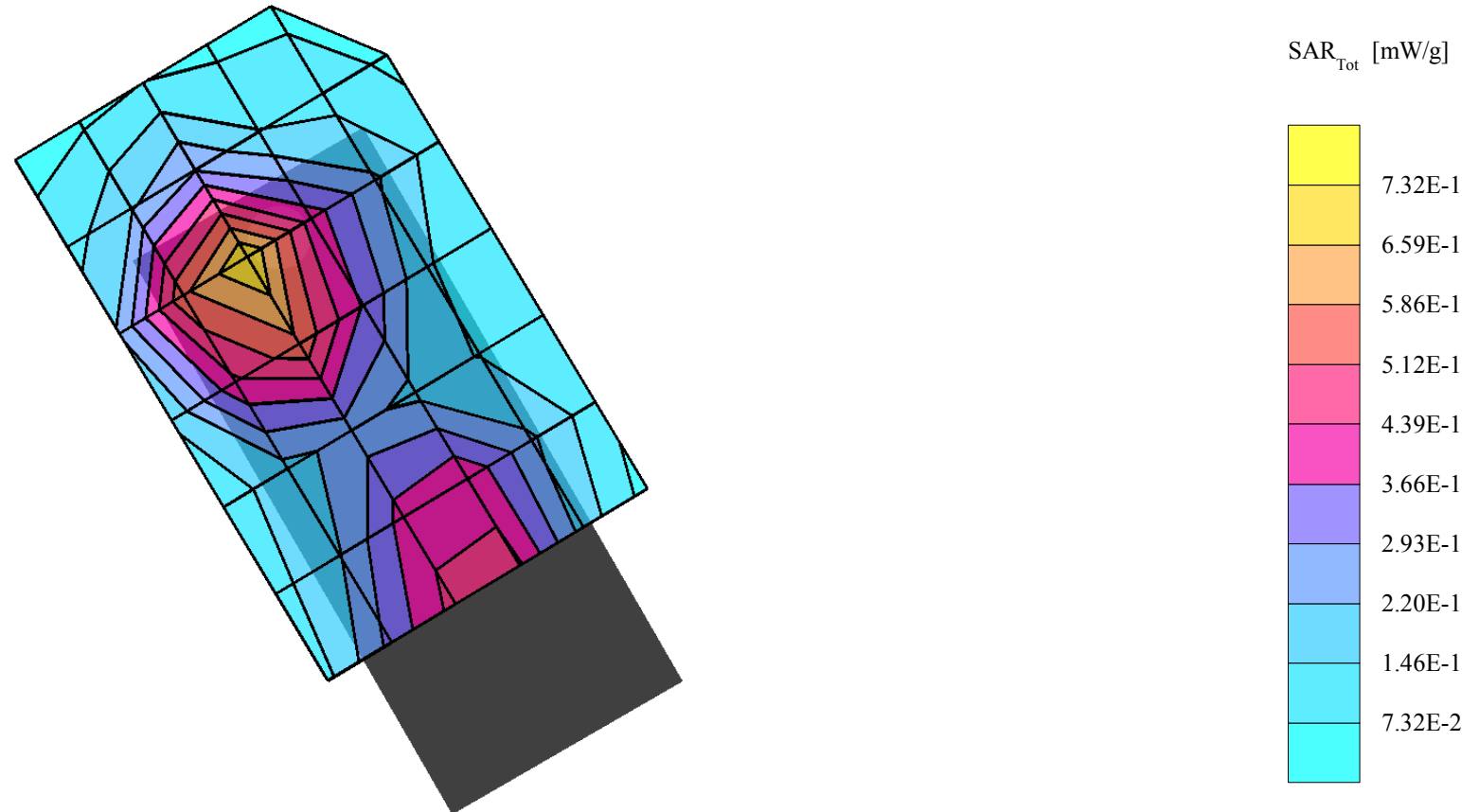
Probe: ET3DV6 - SN1504; ConvF(5.40,5.40,5.40)

Cube 5x5x7: SAR (1g): 0.729 mW/g, SAR (10g): 0.417 mW/g, (Worst-case extrapolation)

Coarse: Dx = 19.0, Dy = 14.0, Dz = 10.0

Powerdrift: -0.39 dB

Liquid Temperature (°C): 20.5



GMLNPB-1NB, GSM 1900, Channel 512, Right Tilt Position

SAM 3 (PCS - Brain / Muscle Tissue) Phantom

Frequency: 1850 MHz; Crest factor: 8.0

PCS Band - Brain Tissue: $\sigma = 1.41$ mho/m $\epsilon_r = 38.6$ $\rho = 1.00$ g/cm³

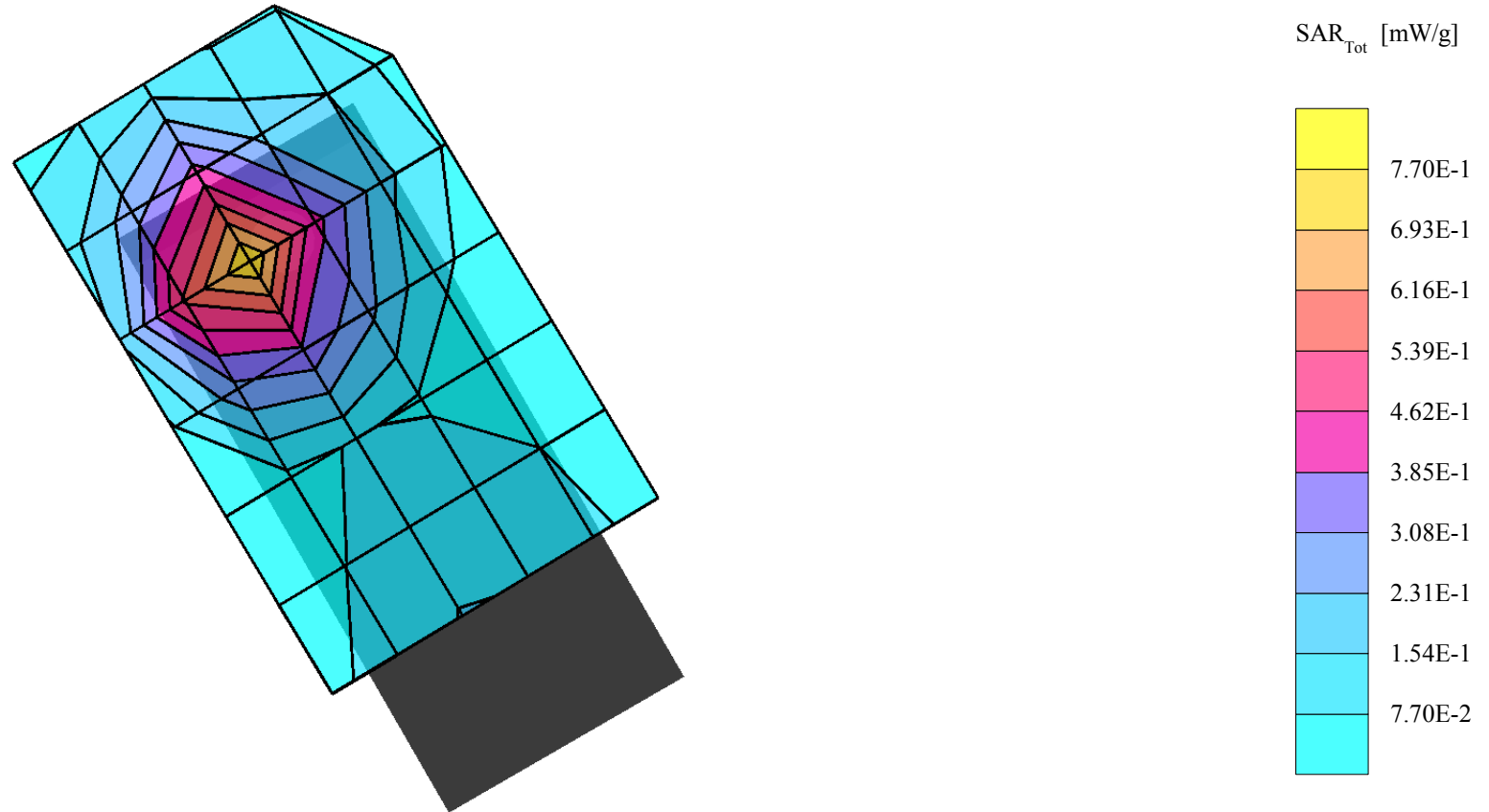
Probe: ET3DV6 - SN1504; ConvF(5.40,5.40,5.40)

Cube 5x5x7: SAR (1g): 0.710 mW/g, SAR (10g): 0.396 mW/g, (Worst-case extrapolation)

Coarse: Dx = 19.0, Dy = 14.0, Dz = 10.0

Powerdrift: -0.17 dB

Liquid Temperature (°C): 20.5



GMLNPB-1NB, GSM 1900, Channel 661, Flat Position - Back of Phone with 15mm Spacer and HDE-2 Headset

SAM 3 (PCS - Brain / Muscle Tissue) Phantom

Frequency: 1880 MHz; Crest factor: 8.0

PCS Band - Muscle Tissue: $\sigma = 1.55$ mho/m $\epsilon_r = 52.8$ $\rho = 1.00$ g/cm³

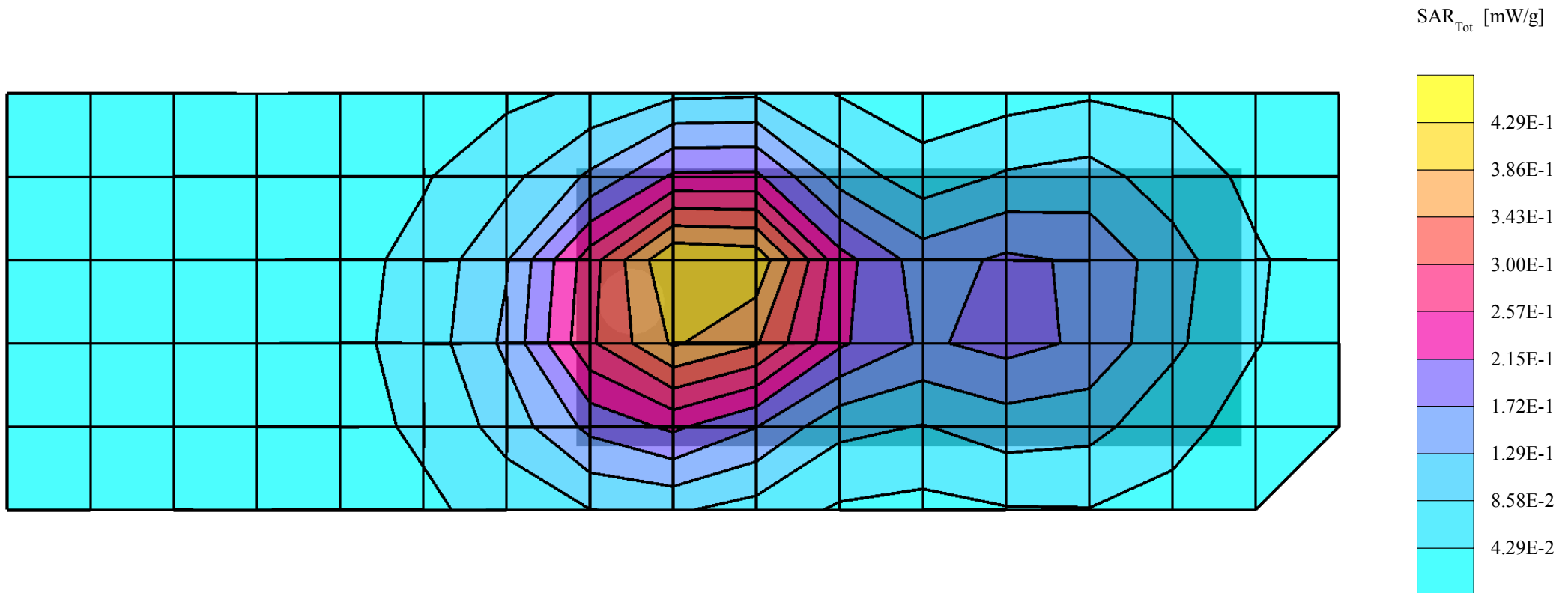
Probe: ET3DV6 - SN1504; ConvF(5.00,5.00,5.00)

Cube 5x5x7: SAR (1g): 0.427 mW/g, SAR (10g): 0.258 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 12.0

Powerdrift: -0.04 dB

Liquid Temperature (°C): 18.8



GMLNPB-1NB, GSM 1900, Channel 512, Right Touch Position

SAM 3 (PCS - Brain / Muscle Tissue) Phantom

Frequency: 1850 MHz; Crest factor: 8.0

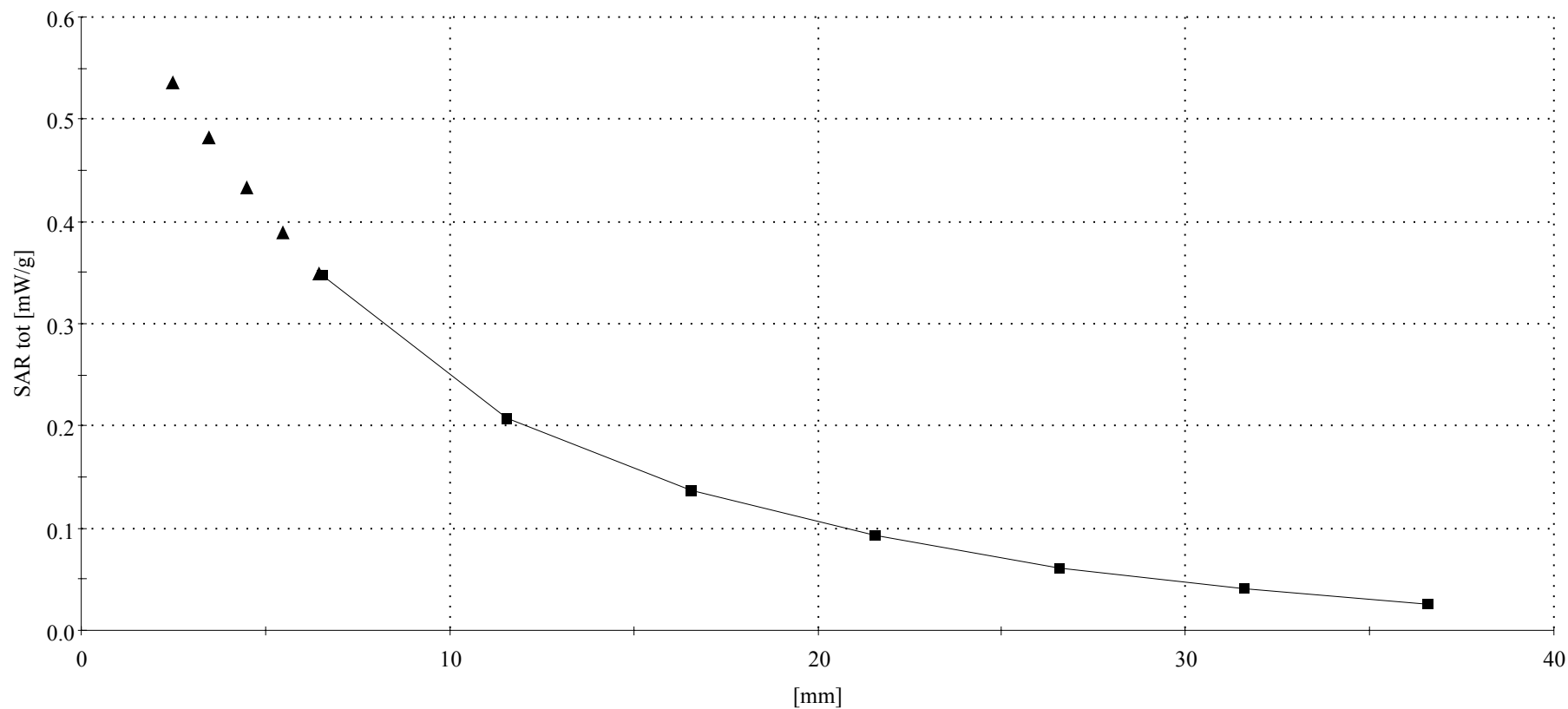
PCS Band - Brain Tissue: $\sigma = 1.41$ mho/m $\epsilon_r = 38.6$ $\rho = 1.00$ g/cm³

Probe: ET3DV6 - SN1504; ConvF(5.40,5.40,5.40)

Cube 5x5x7: SAR (1g): 0.729 mW/g, SAR (10g): 0.417 mW/g, (Worst-case extrapolation)

Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0

Liquid Temperature (°C): 20.5



GMLNPB-1NB, GSM 1900, Channel 661, Flat Position - Back of Phone with 15mm Spacer and HDE-2 Headset

SAM 3 (PCS - Brain / Muscle Tissue) Phantom

Frequency: 1880 MHz; Crest factor: 8.0

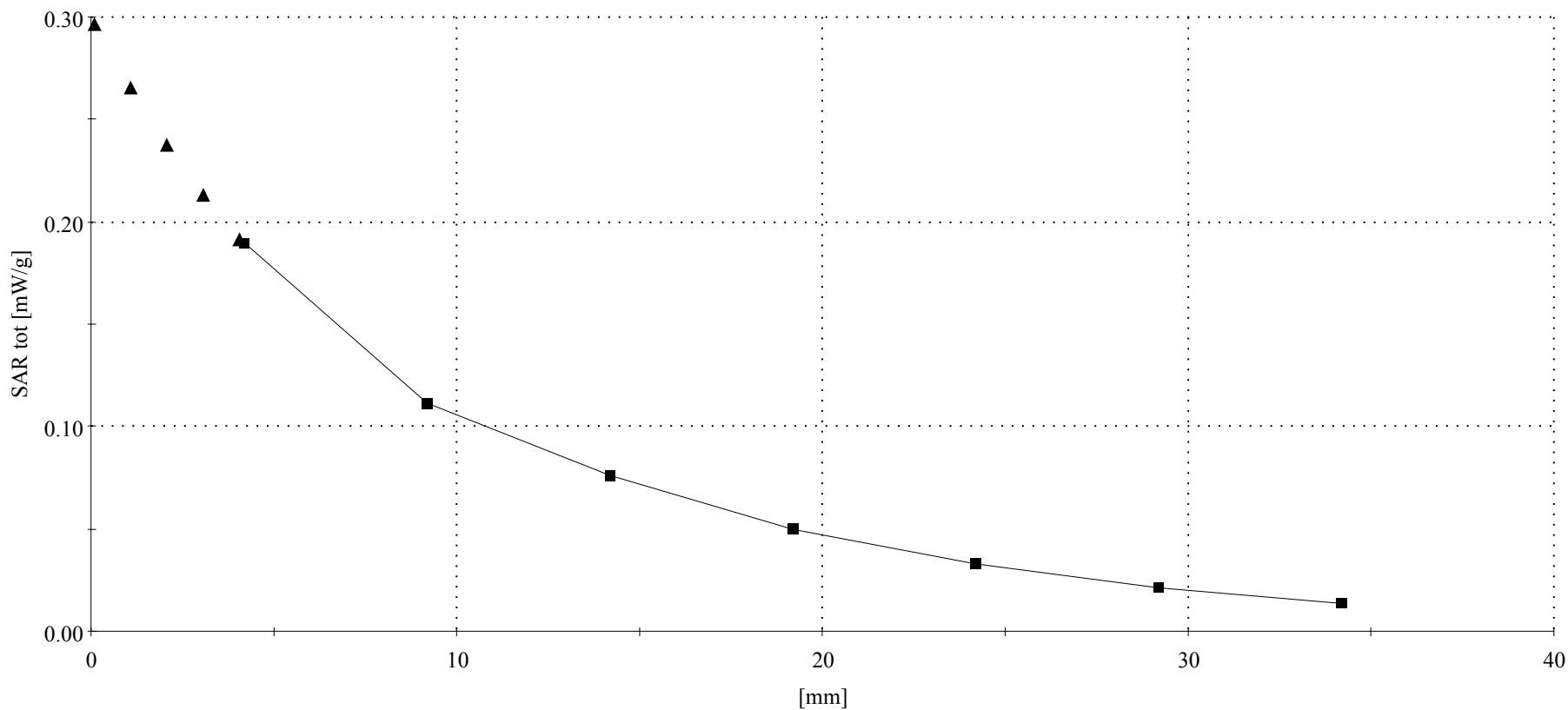
PCS Band - Muscle Tissue: $\sigma = 1.55$ mho/m $\epsilon_r = 52.8$ $\rho = 1.00$ g/cm³

Probe: ET3DV6 - SN1504; ConvF(5.00,5.00,5.00)

Cube 5x5x7: SAR (1g): 0.427 mW/g, SAR (10g): 0.258 mW/g, (Worst-case extrapolation)

Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0

Liquid Temperature (°C): 18.8



APPENDIX D: CALIBRATION CERTIFICATE (S)

Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Calibration Certificate

Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1504

Place of Calibration:

Zurich

Date of Calibration:

July 26, 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:

U. Vella

Approved by:

Philip Kutz

Probe ET3DV6

SN:1504

Manufactured:	October 24, 1999
Last calibration:	January 10, 2002
Recalibrated:	July 26, 2002

Calibrated for System DASY3

DASY3 - Parameters of Probe: ET3DV6 SN:1504

Sensitivity in Free Space

NormX	2.02 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	1.78 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	1.73 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	95	mV
DCP Y	95	mV
DCP Z	95	mV

Sensitivity in Tissue Simulating Liquid

Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
ConvF X	6.5 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	6.5 $\pm 9.5\%$ (k=2)	Alpha	0.39
ConvF Z	6.5 $\pm 9.5\%$ (k=2)	Depth	2.42
Head	1880 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
ConvF X	5.4 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	5.4 $\pm 9.5\%$ (k=2)	Alpha	0.53
ConvF Z	5.4 $\pm 9.5\%$ (k=2)	Depth	2.44

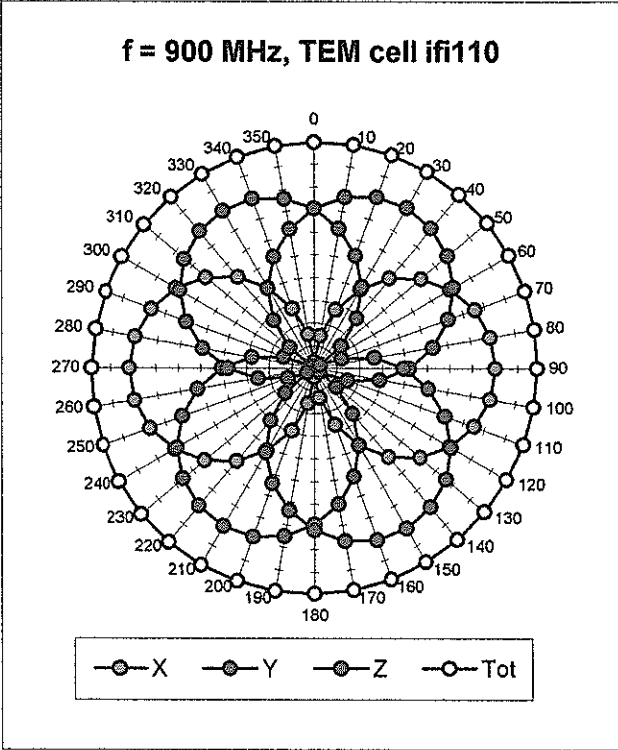
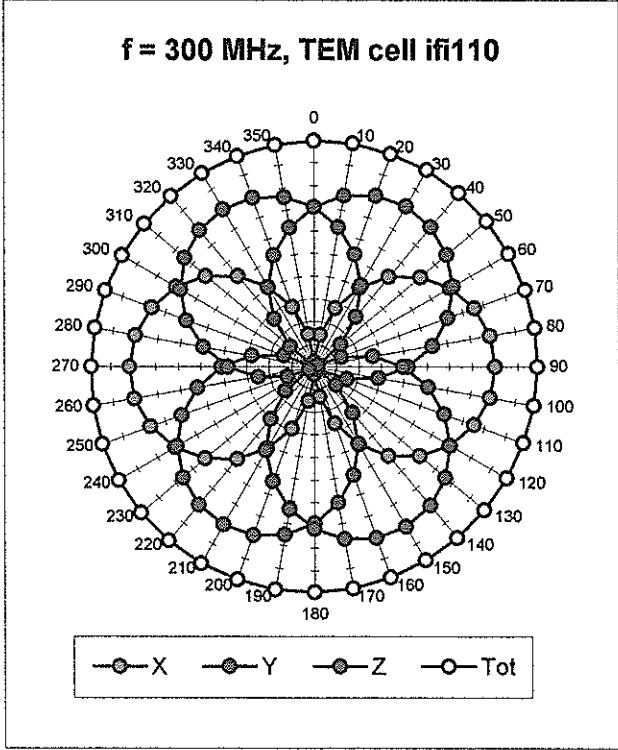
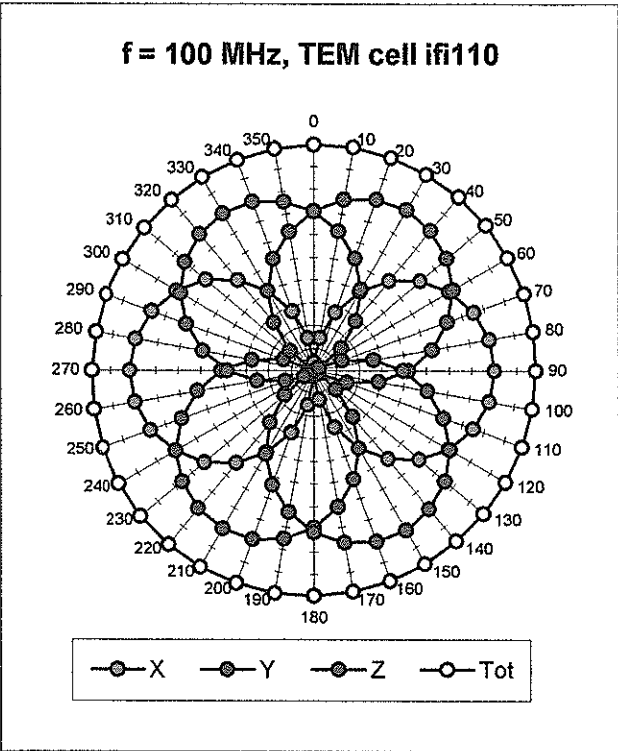
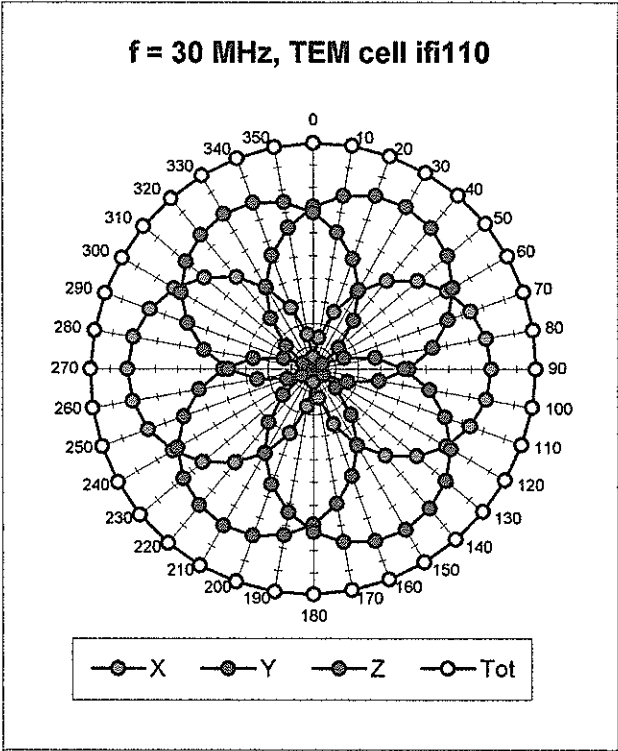
Boundary Effect

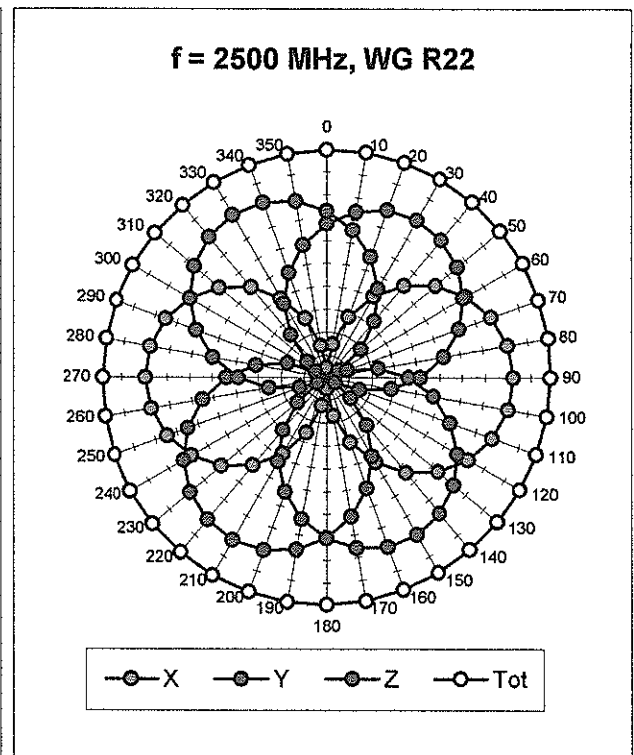
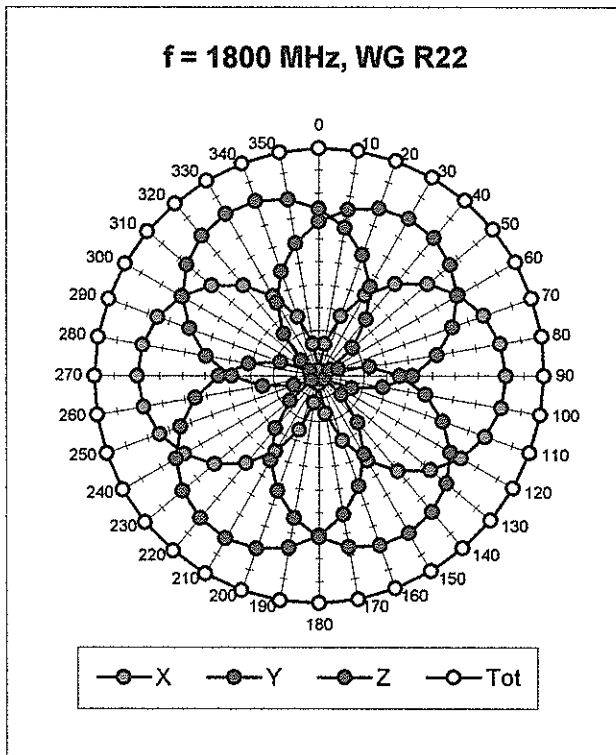
Head	835 MHz	Typical SAR gradient: 5 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%]	Without Correction Algorithm	9.6	5.3
SAR _{be} [%]	With Correction Algorithm	0.3	0.5
Head	1880 MHz	Typical SAR gradient: 10 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%]	Without Correction Algorithm	13.0	8.5
SAR _{be} [%]	With Correction Algorithm	0.2	0.2

Sensor Offset

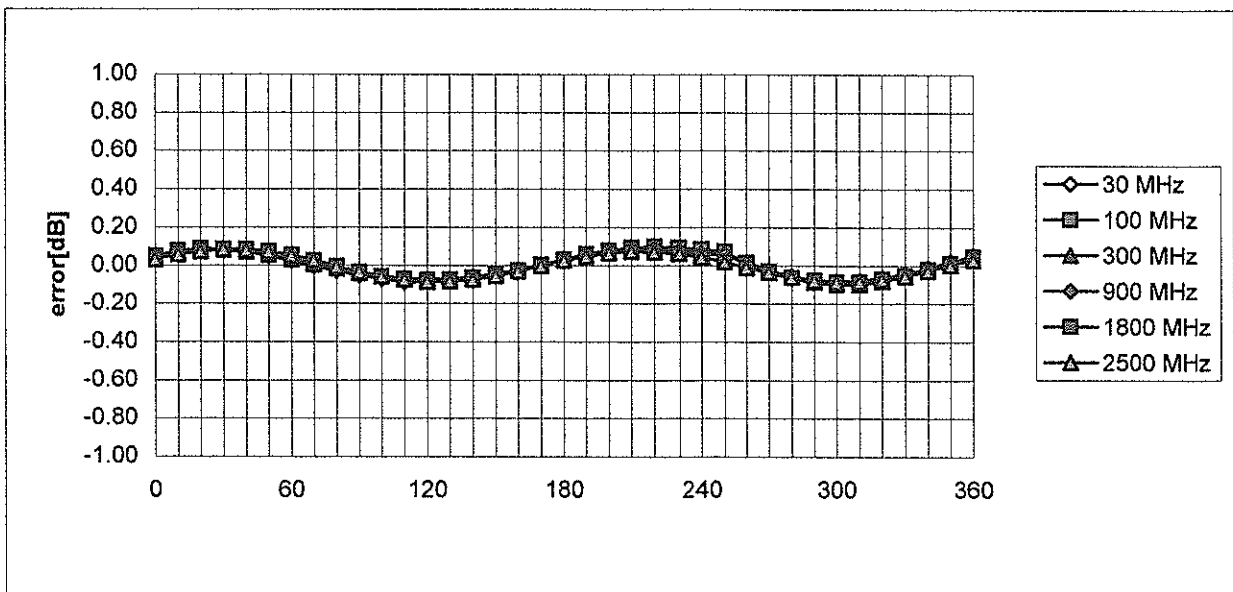
Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.4 $\pm$ 0.2	mm

Receiving Pattern (ϕ), $\theta = 0^\circ$



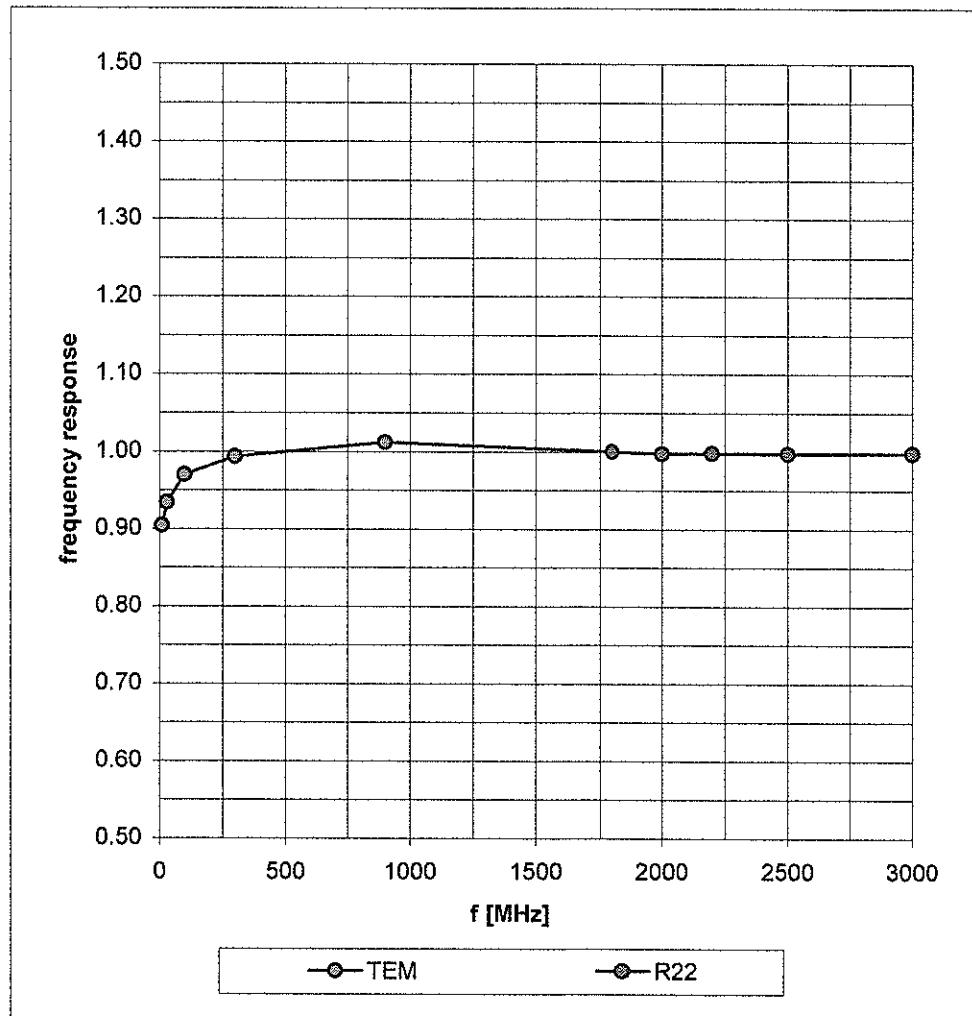


Isotropy Error (ϕ), $\theta = 0^\circ$

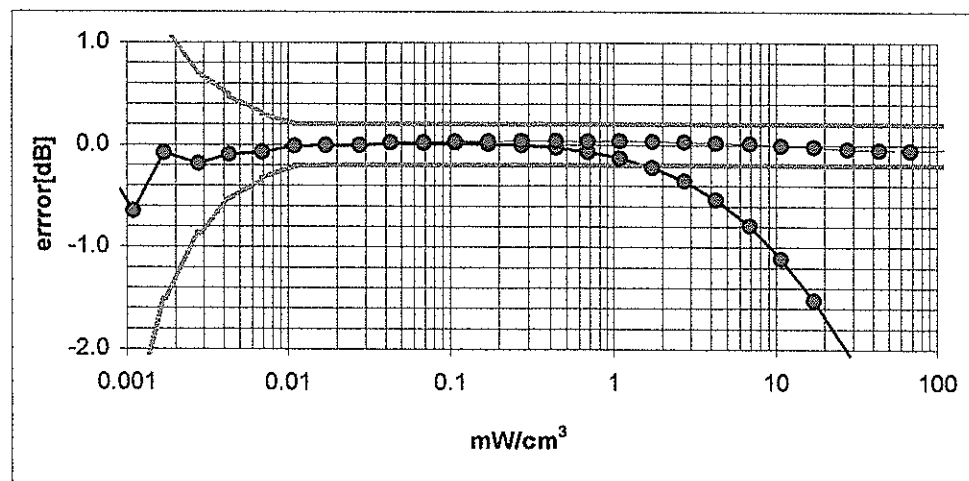
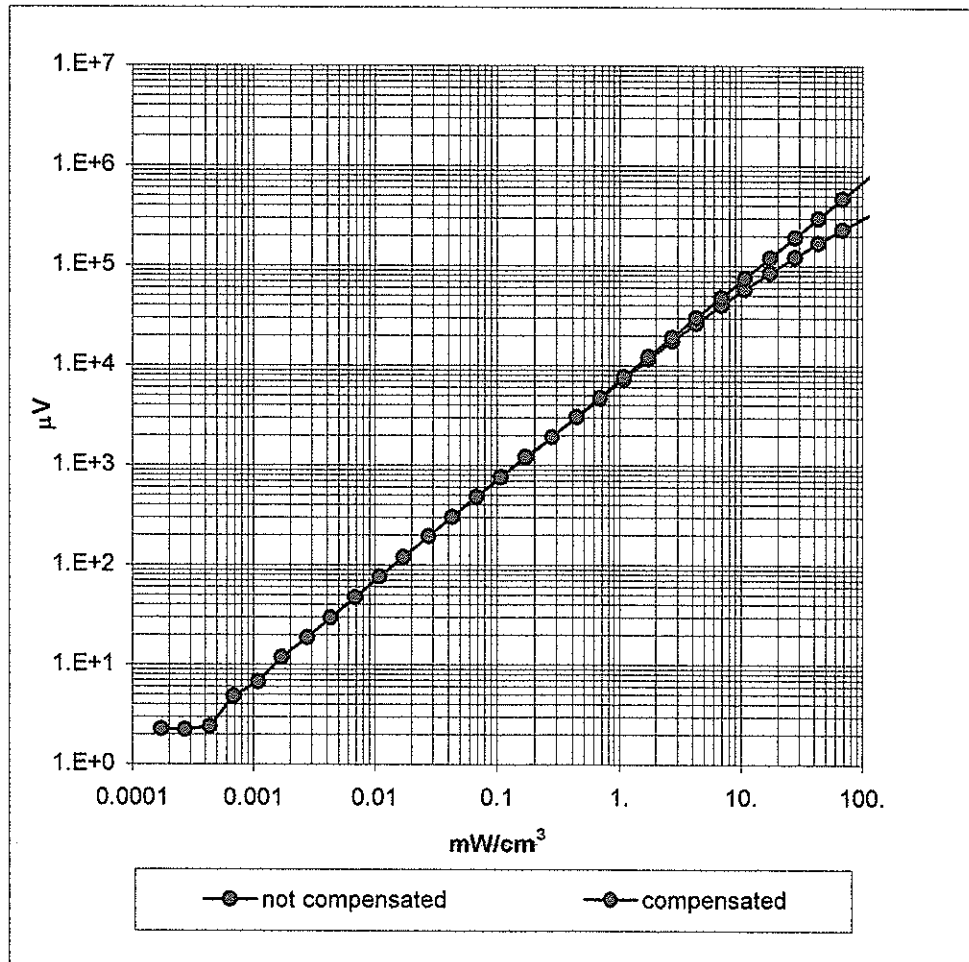


Frequency Response of E-Field

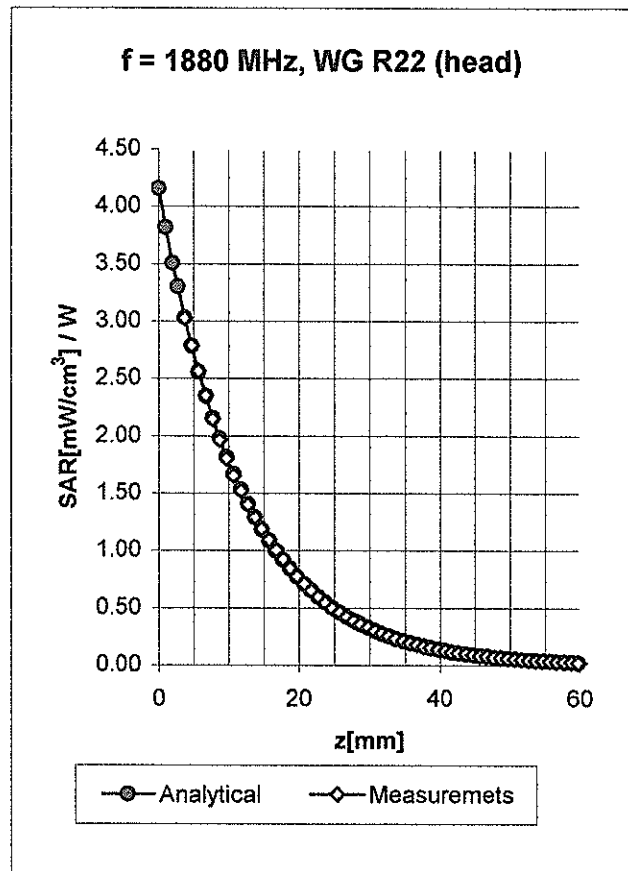
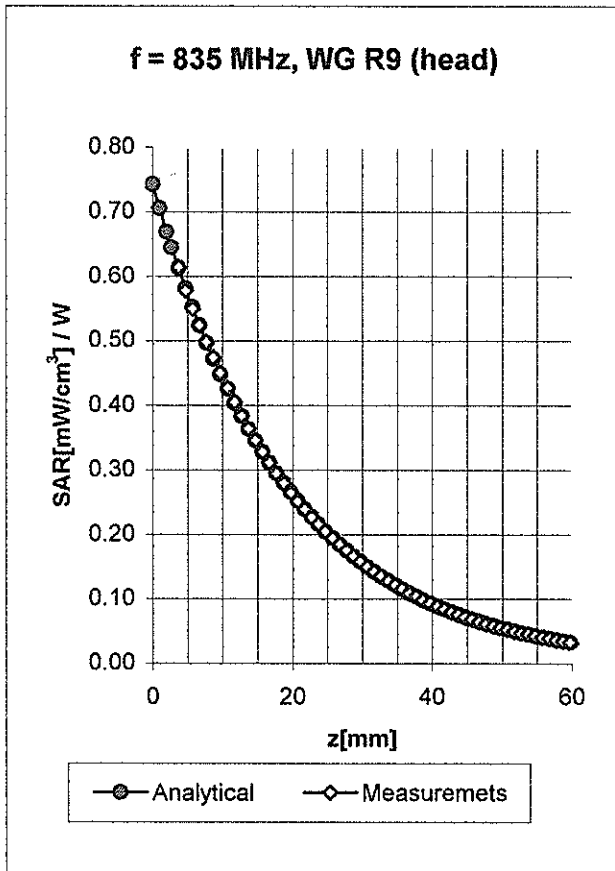
(TEM-Cell:ifi110, Waveguide R22)



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

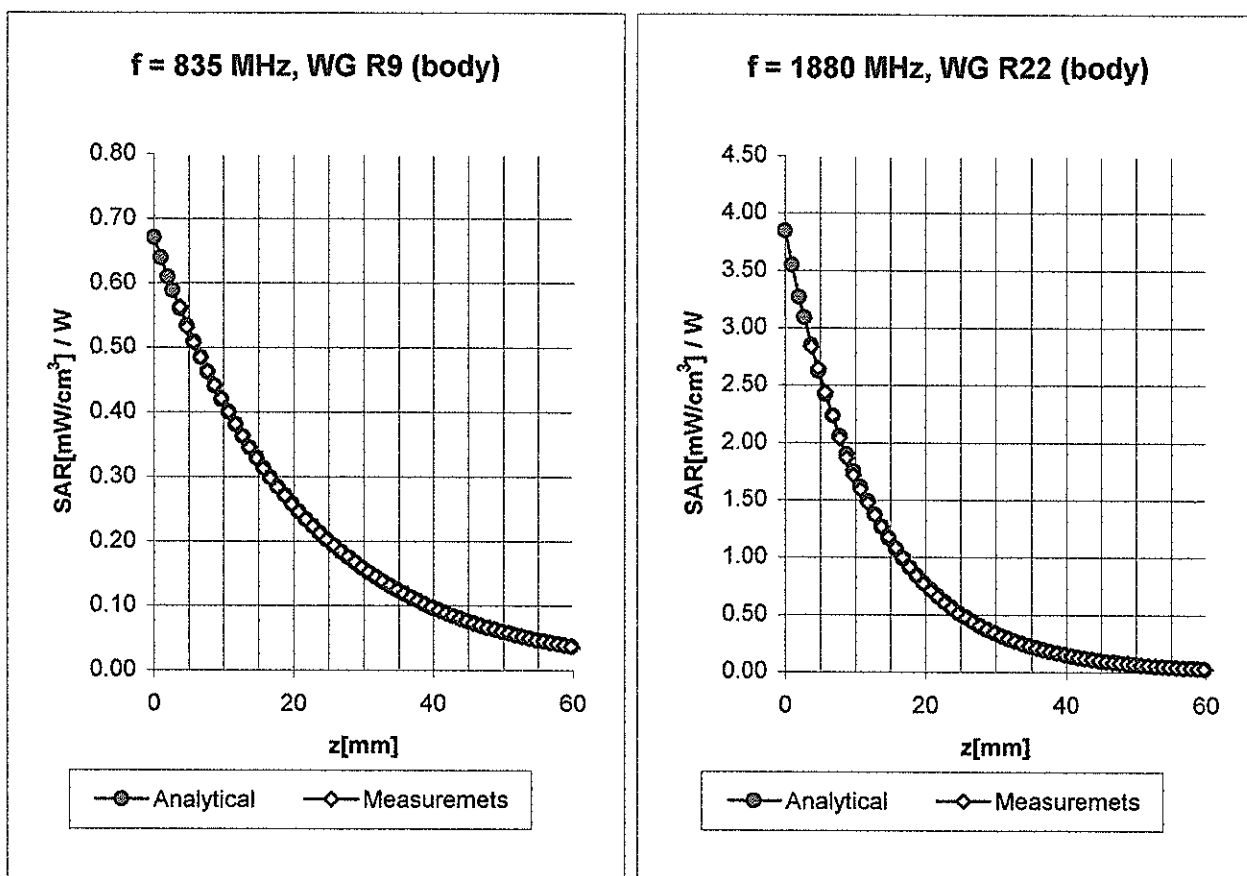


Conversion Factor Assessment



Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\% \text{ mho/m}$
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
	ConvF X	$6.5 \pm 9.5\% (k=2)$	Boundary effect:
	ConvF Y	$6.5 \pm 9.5\% (k=2)$	Alpha 0.39
	ConvF Z	$6.5 \pm 9.5\% (k=2)$	Depth 2.42
Head	1880 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
	ConvF X	$5.4 \pm 9.5\% (k=2)$	Boundary effect:
	ConvF Y	$5.4 \pm 9.5\% (k=2)$	Alpha 0.53
	ConvF Z	$5.4 \pm 9.5\% (k=2)$	Depth 2.44

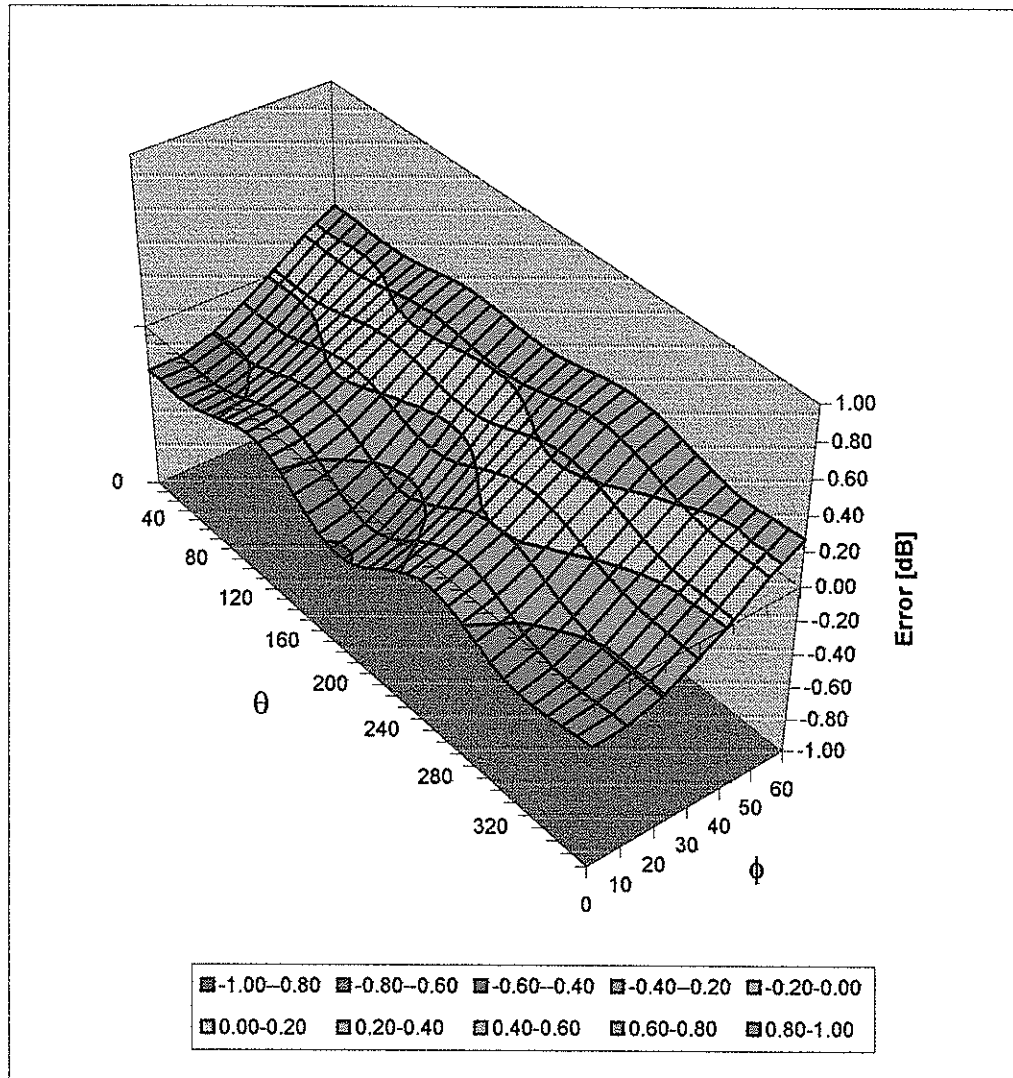
Conversion Factor Assessment



Body	835 MHz	$\epsilon_r = 55.2 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Body	900 MHz	$\epsilon_r = 55.0 \pm 5\%$	$\sigma = 1.05 \pm 5\%$ mho/m
	ConvF X	6.5 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	6.5 $\pm 9.5\%$ (k=2)	Alpha 0.42
	ConvF Z	6.5 $\pm 9.5\%$ (k=2)	Depth 2.38
Body	1880 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\%$ mho/m
Body	1800 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\%$ mho/m
	ConvF X	5.0 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	5.0 $\pm 9.5\%$ (k=2)	Alpha 0.74
	ConvF Z	5.0 $\pm 9.5\%$ (k=2)	Depth 2.06

Deviation from Isotropy in HSL

Error (θ, ϕ), $f = 900$ MHz



3457

Calibration Certificate

1900 MHz System Validation Dipole

Type:

D1900V2

Serial Number:

5d004

Place of Calibration:

Zurich

Date of Calibration:

July 17, 2002

Calibration Interval:

24 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:

D. Velled

Approved by:

Polonic Katya

DASY3

Dipole Validation Kit

Type: D1900V2

Serial: 5d004

Manufactured: February 14, 2002

Calibrated: July 17, 2002

1. Measurement Conditions

The measurements were performed in the flat section of the new SAM twin phantom filled with head simulating solution of the following electrical parameters at 1900 MHz:

Relative permittivity	39.8	$\pm 5\%$
Conductivity	1.46 mho/m	$\pm 10\%$

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.2 at 1900 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 20mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.

The dipole input power (forward power) was $250\text{mW} \pm 3\%$. The results are normalized to 1W input power.

2.1. SAR Measurement with DASY3 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the worst-case extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	44.0 mW/g
averaged over 10 cm^3 (10 g) of tissue:	22.7 mW/g

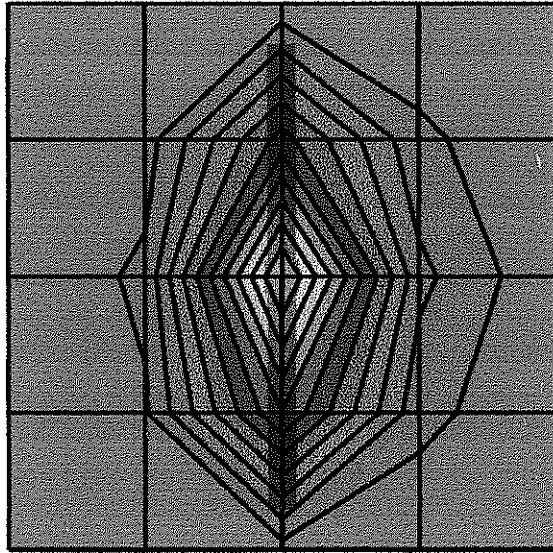
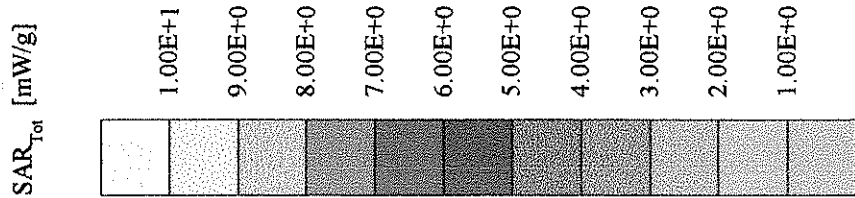
2.2 SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	40.4 mW/g
averaged over 10 cm^3 (10 g) of tissue:	21.3 mW/g

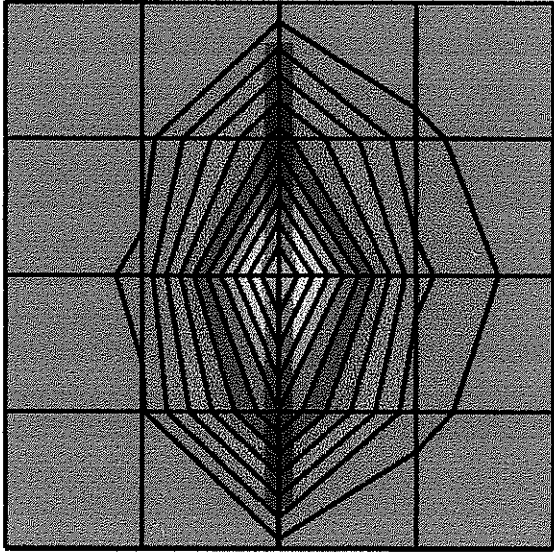
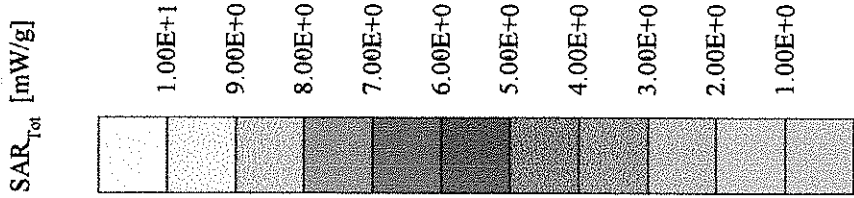
Validation Dipole D1900V2 SN5d004, d = 10 mm

Frequency: 1900 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.20,5.20,5.20) at 1900 MHz; IEEE1528 1900 MHz: $\sigma = 1.46 \text{ mho/m}$ $\epsilon_r = 39.8$ $\rho = 1.00 \text{ g/cm}^3$
Cubes (2): Peak: 20.5 mW/g $\pm 0.01 \text{ dB}$, SAR (1g): 11.0 mW/g $\pm 0.01 \text{ dB}$, SAR (10g): 5.68 mW/g $\pm 0.01 \text{ dB}$, (Worst-case extrapolation)
Penetration depth: 8.1 (7.8, 8.8) [mm]
Powerdrift: -0.01 dB



Validation Dipole D1900V2 SN5d004, d = 10 mm

Frequency: 1900 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.20,5.20,5.20) at 1900 MHz; IEEE1528 1900 MHz: $\sigma = 1.46 \text{ mho/m}$ $\epsilon_r = 39.8$ $\rho = 1.00 \text{ g/cm}^3$
Cubes (2): Peak: $17.7 \text{ mW/g} \pm 0.01 \text{ dB}$, SAR (1g): $10.1 \text{ mW/g} \pm 0.01 \text{ dB}$, SAR (10g): $5.32 \text{ mW/g} \pm 0.01 \text{ dB}$, (Advanced extrapolation)
Penetration depth: $8.7 (8.6, 8.9) [\text{mm}]$
Powerdrift: -0.01 dB



17 Jul 2002 09:51:09

CH1 S11 1 U FS

1: 50.549 Ω 3.5332 Ω 295.96 μ H

1 900.000 000 MHz

↑

Del

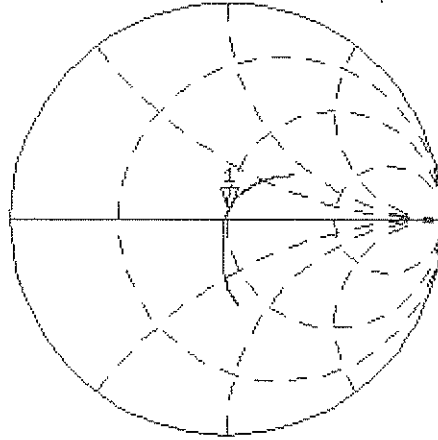
PRM

Cor

Avg

16

↑



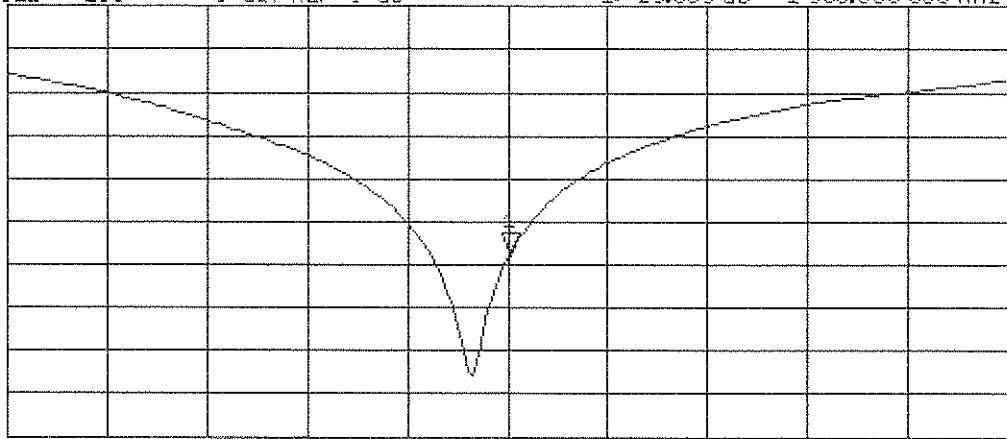
CH2 S11 LOG 5 dB/REF 0 dB

1: -29.069 dB 1 900.000 000 MHz

PRM

Cor

↑



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz

3. Dipole Impedance and Return Loss

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	1.179 ns	(one direction)
Transmission factor:	0.989	(voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 1900 MHz:	$\text{Re}\{Z\} = \mathbf{50.5\ \Omega}$
	$\text{Im}\{Z\} = \mathbf{3.5\ \Omega}$
Return Loss at 1900 MHz	- 29.1 dB

4. Measurement Conditions

The measurements were performed in the flat section of the new SAM twin phantom filled with body simulating solution of the following electrical parameters at 1900 MHz:

Relative permittivity	54.4	$\pm 5\%$
Conductivity	1.57 mho/m	$\pm 10\%$

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 4.9 at 1900 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 20mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.

The dipole input power (forward power) was 250mW $\pm 3\%$. The results are normalized to 1W input power.

5.1. SAR Measurement with DASY3 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the worst-case extrapolation are:

averaged over 1 cm³ (1 g) of tissue: **44.0 mW/g**

averaged over 10 cm³ (10 g) of tissue: **22.9 mW/g**

5.2 SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm³ (1 g) of tissue: **40.4 mW/g**

averaged over 10 cm³ (10 g) of tissue: **21.4 mW/g**

6. Dipole Impedance and Return Loss

The dipole was positioned at the flat phantom sections according to section 4 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 1900 MHz: **Re{Z} = 46.7 Ω**

Im {Z} = 3.6 Ω

Return Loss at 1900 MHz **- 25.9 dB**

7. Handling

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

8. Design

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

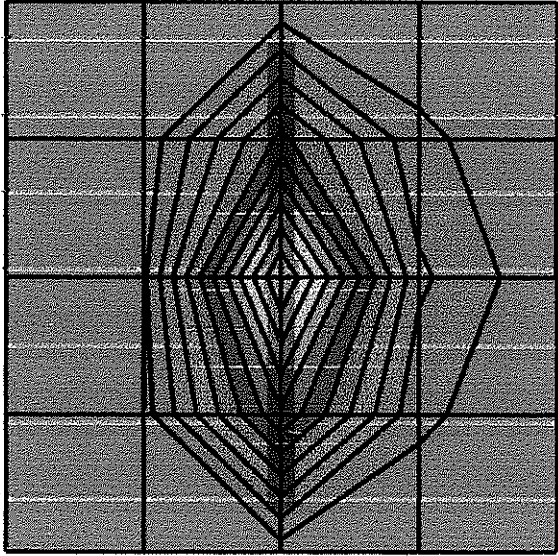
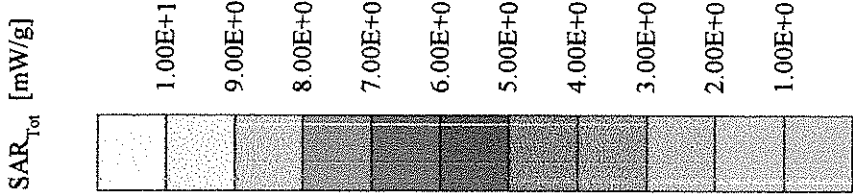
Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Section 1. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

9. Power Test

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

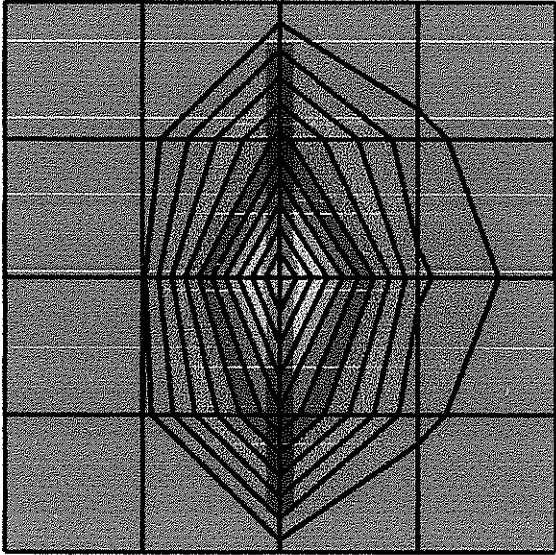
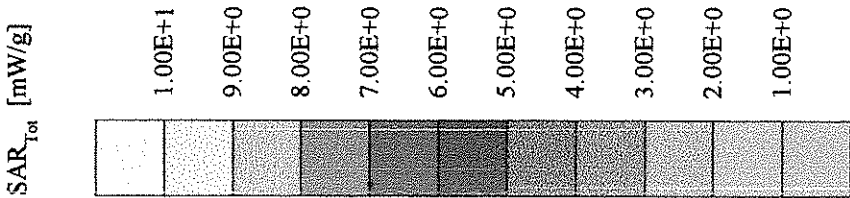
Validation Dipole D1900V2 SN5d004, d = 10 mm

Frequency: 1900 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(4.90,4.90,4.90) at 1900 MHz; IEEE1528 1900 MHz: $\sigma = 1.57 \text{ mho/m}$ $\epsilon_r = 54.4$ $\rho = 1.00 \text{ g/cm}^3$
Cubes (2): Peak: 20.4 mW/g $\pm 0.00 \text{ dB}$, SAR (1g): 11.0 mW/g $\pm 0.01 \text{ dB}$, SAR (10g): 5.73 mW/g $\pm 0.02 \text{ dB}$, (Worst-case extrapolation)
Penetration depth: 8.5 (8.0, 9.5) [mm]
Powerdrift: 0.00 dB



Validation Dipole D1900V2 SN5d004, d = 10 mm

Frequency: 1900 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(4.90,4.90,4.90) at 1900 MHz; IEEE1528 1900 MHz: $\sigma = 1.57 \text{ mho/m}$ $\epsilon_r = 54.4$ $\rho = 1.00 \text{ g/cm}^3$
Cubes (2): Peak: $17.5 \text{ mW/g} \pm 0.00 \text{ dB}$, SAR (1g): $10.1 \text{ mW/g} \pm 0.01 \text{ dB}$, SAR (10g): $5.36 \text{ mW/g} \pm 0.02 \text{ dB}$, (Advanced extrapolation)
Penetration depth: 9.3 (9.1, 9.6) [mm]
Powerdrift: 0.00 dB



16 Jul 2002 14:06:45

CH1 S11 1 U FS

1: 45.686 Ω 3.6289 Ω 303.98 μ H

1 900.000 000 MHz

γ

Mosde

Del

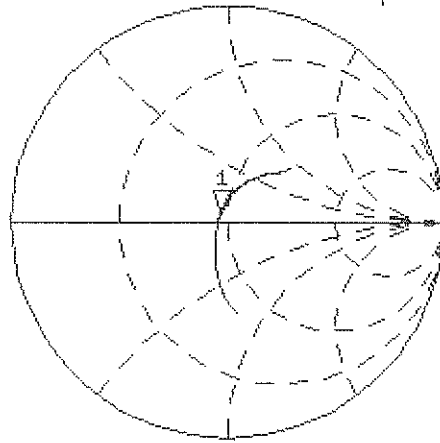
PRM

Cor

Avg

16

↑



CH2 S11 LOG 5 dB/REF 0 dB

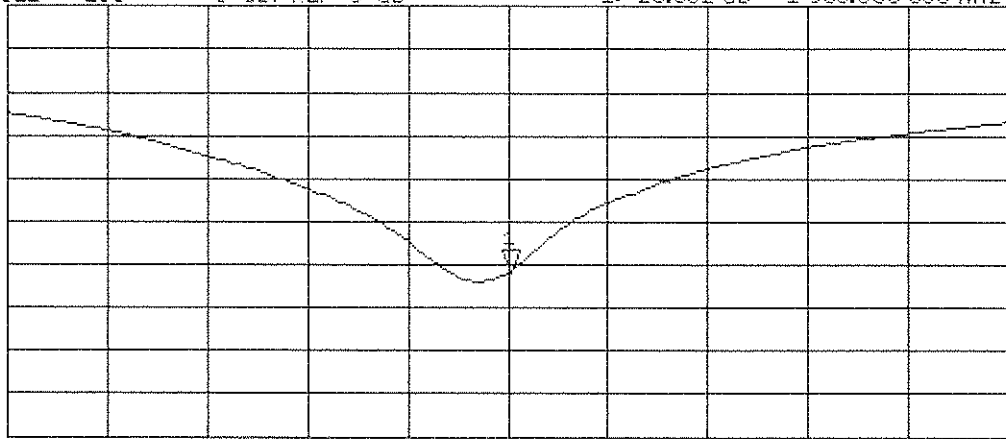
1: -25.882 dB

1 900.000 000 MHz

PRM

Cor

↑



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz