SAR Compliance Test Report

Test report no.:	Not numbered	**Date of report:**	2002-02-19
Number of pages:	50	**Contact person:**	Olli Kautio
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Tested devices:	**GMLNSD-5FX** CSL-28
Supplement reports:	-
Testing has been carried out in accordance with:	IEEE P1528-200X Draft 6.4 Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques
Documentation:	The documentation of the testing performed on the tested devices is archived for 15 years at PC Site Oulu
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.

Date and signatures: 2002-02-19

For the contents:

Pertti Mäkikyrö
Miia Nurkkala

Pertti Mäkikyrö
Engineering Manager, EMC

Miia Nurkkala
Test Engineer

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1. SUMMARY FOR SAR TEST REPORT

Date of test	2002-01-31 – 2002-02-01
Contact person	Olli Kautio
Test plan referred to	-
FCC ID	GMLNSD-5FX
SN, HW, and DUT numbers of tested device	SN:100/10747620 HW:B2.0 DUT:310102/5
Accessories used in testing	Headset HDC-5, battery BLB-2
Notes	-
Document code	DTX03852-EN
Responsible test engineer	Pertti Mäkikyrö
Measurement performed by	Miia Nurkkala

1.1 Maximum Results Found during SAR Evaluation

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

1.1.1 Head Configuration

Ch / *f* (MHz)	Power	Position	Limit	Measured	Result
1175/1908.75	23.7 dBm	Tilted	1.6 mW/g	1.17 mW/g	**PASSED**

1.1.2 Body Worn Configuration

Ch / *f* (MHz)	Power	Accessory	Limit	Measured	Result
25/1851.25	23.7 dBm	CSL-28	1.6 mW/g	0.49 mW/g	**PASSED**

1.1.3 Measurement Uncertainty

Combined Standard Uncertainty	**±13.6%**
Extended Standard Uncertainty (k=2)	**±27.1%**

2. DESCRIPTION OF TESTED DEVICE

Device category	Portable device
Exposure environment	Uncontrolled exposure
Unit type	Prototype unit
Case type	Fixed case
Modes of Operation	IS95A-1900
Modulation Mode	Quadrature Phase Shift Keying
Duty Cycle	1
Transmitter Frequency Range (MHz)	1851.25 – 1908.75

2.1 Picture of Phone

2.2 Description of the Antenna

Type	Internal integrated antenna
Location	Inside the back cover, near the top of the device

2.3 Battery Options

There is only one battery option available for tested device, Li-ion battery BLB-2.

2.4 Body Worn Accessories

Following body worn accessoy is available for GMLNSD-5FX:

- CSL-28

3. TEST CONDITIONS

3.1 Ambient Conditions

Ambient temperature (°C)	22±1
Tissue simulating liquid temperature (°C)	22±1
Humidity (%)	35

3.2 RF characteristics of the test site

Tests were performed in a fully enclosed RF shielded environment.

3.3 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.

In all operating bands the measurements were performed on lowest, middle and highest channels.

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

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.

4. 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	Serial Number	Due Date
DASY3 DAE V1	371	10/02
E-field Probe ET3DV6	1381	10/02
Dipole Validation Kit, D1900V2	511	02/03

E-field probe calibration records are presented in Appendix C.

Additional equipment needed in validation:

Test Equipment	Model	Serial Number	Due Date
Signal Generator	R&S SMIQ03B	100012	02/02
Amplifier	Amplifier Research 5S1G4	27573	-
Power Meter	R&S NRT	835065/049	05/02
Power Sensor	R&S NRT-Z44	835374/021	05/02
Thermometer	DO9416	1505985462	-
Vector Network Analyzer	Anritsu 37347A	992604	01/03
Transmission Line Dielectric Probe	Damaskos T1500	-	-

Equipment used to measure conducted power output:

Test Equipment	Model	Serial Number	Due Date
Power Meter	Agilent E4416A	GB41050565	07/02
Power Sensor	Agilent E9327A	US40440339	05/02

4.1 System Accuracy Verification

The probes are calibrated annually by the manufacturer. Dielectric parameters of the simulating liquids are measured using a Damaskos Inc. transmission line model T1500 and Anritsu 37347A vector network analyzer.

The SAR measurement of the DUT were done within 24 hours of system accuracy verification, which was done using the dipole validation kit. Power level of 250 mW was supplied to a dipole antenna placed under the flat section of SAM phantom. The antenna is matched for use near flat phantoms filled with tissue simulating solution. It is manufactured by Schmid & Partner Engineering AG. Length of the dipole is 68 mm with overall height of 300mm. A specific distance holder is used in the positioning of the antenna to ensure correct spacing between the phantom and the dipole. The validation results are in the table below and printout of the validation test is presented in Appendix A. Manufacturer's reference dipole data is presented in Appendix C. All the measured parameters were within the specification.

Tissue	*f* (MHz)	Description	SAR (W/kg), 1g	Dielectric Parameters ε_r	Dielectric Parameters σ (S/m)	Temp (°C)
Head	1900	Measured	11.4	38.0	1.44	22
		Reference Result	10.7	39.2	1.47	N/A
Muscle	1900	Measured	11.4	52.0	1.55	22
		Reference Result	10.6	53.5	1.46	N/A

4.2 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 15cm ± 5mm during all the tests.

4.2.1 Head Tissue Simulant

The composition of the brain tissue simulating liquid for 1900MHz

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	38.1	1.42	22
	Recommended Values	40.0	1.40	20-26

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

4.2.2 Muscle Tissue Simulant

The composition of the muscle tissue simulating liquid for 1900MHz

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	52.0	1.52	22
	Recommended Values	53.3	1.52	20-26

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

4.3 Phantoms

“SAM v4.0” phantom", manufactured by SPEAG, was used during the measurement. It has fiberglass shell integrated in 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 setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

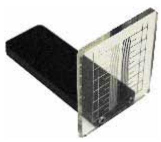
The thickness of phantom shell is 2 mm except for the ear, where an integrated ear spacer provides a 6 mm spacing from the tissue boundary. Manufacturer reports tolerance in shell thickness to be ±0.1mm.

4.4 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., glycolether)
Calibration	Calibration ceritifcate in Appendix C
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 µW/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

5. DESCRIPTION OF THE TEST PROCEDURE

5.1 Test Positions



The device was placed in holder using a special positioning tool, which aligns the bottom of the device with 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.

5.1.1 Against Phantom Head

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

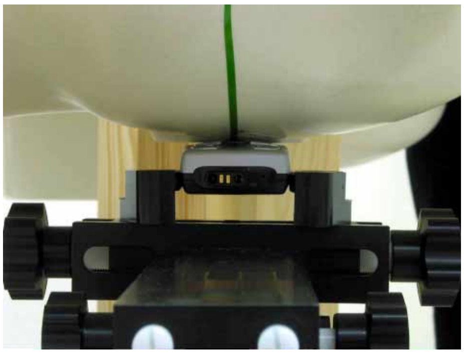
The device was positioned against phantom according to OET Bulletin 65 (97-01) Supplement C (01-01) . Definitions of terms used in aligning the device to a head phantom are available in IEEE Draft Standard P1528-2001 “Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR)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

5.1.1.1 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".

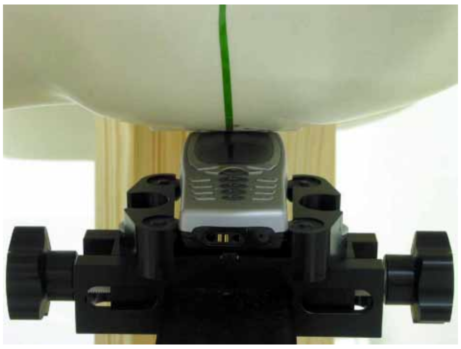
5.1.1.2 Cheek Position

"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.



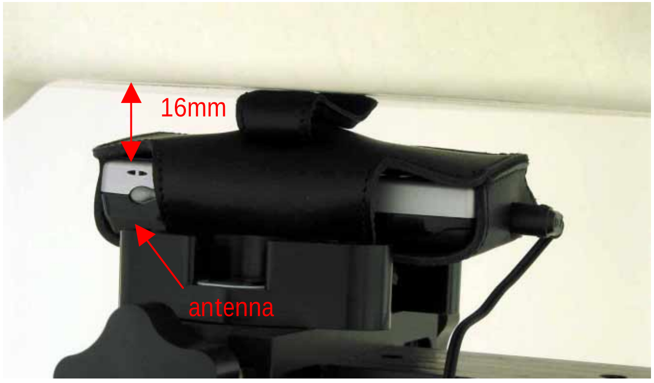
5.1.1.3 Tilt Position

In the "Cheek 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 "cheek 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.

5.1.2 Body Worn Configuration

Body worn accessory CSL-28 was tested for the FCC RF exposure compliance. The phone was positioned into carrying case and placed below of the flat phantom. Headset was connected during measurements. Since CSL-28 has opening for headset connector, headset can be connected only if the antenna of the DUT is facing away from the phantom.



5.2 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.

5.3 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.

6. MEASUREMENT UNCERTAINTY

6.1 Description of Individual Measurement Uncertainty

6.1.1 Assessment Uncertainty

Uncertainty description	Uncert. value %	Probability distribution	Div.	c_i[1]	Stand. uncert (1g) %	v_i[2] or v_{eff}
Measurement System						
Probe calibration	±4.4	normal	1	1	±4.4	∞
Axial isotropy of the probe	±4.7	rectangular	√3	$(1-c_p)^{1/2}$	±1.9	∞
Sph. Isotropy of the probe	±9.6	rectangular	√3	$(c_p)1^{/2}$	±3.9	∞
Spatial resolution	±0.0	rectangular	√3	1	±0.0	∞
Boundary effects	±5.5	rectangular	√3	1	±3.2	∞
Probe linearity	±4.7	rectangular	√3	1	±2.7	∞
Detection limit	±1.0	rectangular	√3	1	±0.6	∞
Readout electronics	±1.0	normal	1	1	±1.0	∞
Response time	±0.8	rectangular	√3	1	±0.5	∞
Integration time	±1.4	rectangular	√3	1	±0.8	∞
RF ambient conditions	±3.0	rectangular	√3	1	±1.7	∞
Mech. constrains of robot	±0.4	rectangular	√3	**1**	±0.2	∞
Probe positioning	±2.9	rectangular	√3	1	±1.7	∞
Extrap. and integration	±3.9	rectangular	√3	1	±2.3	∞
Test Sample Related						
Device positioning	±6.0	normal	0.89	1	±6.7	12
Device holder uncertainty	±5.0	normal	0.84	1	±5.9	8
Power drift	±5.0	rectangular	√3	1	±2.9	∞
Phantom and Setup						
Phantom uncertainty	±4.0	rectangular	√3	**1**	±2.3	∞
Liquid conductivity (target)	±5.0	rectangular	√3	**0.6**	±1.7	∞
Liquid conductivity (meas.)	±10.0	rectangular	√3	**0.6**	±3.5	∞
Liquid permittivity (target)	±5.0	rectangular	√3	**0.6**	±1.7	∞
Liquid permittivity (meas.)	±5.0	rectangular	√3	**0.6**	±1.7	∞
Combined Standard Uncertainty					±13.6	
Extended Standard Uncertainty (k=2)					±27.1	

7. RESULTS

Corresponding SAR distribution printouts of maximum results in tilted position and z-plots of the maximum results are shown in Appendix B. The SAR distributions are substantially similar or equivalent to the plots submitted regardless of used channel.

In the cheek position two almost equal SAR peaks were found and both were evaluated. Results of higher peaks are in the table. Secondary peak evaluation results are marked to the SAR plots and therefore all cheek position plots are included.

7.1 Head Configuration

Mode	Channel/ *f* (MHz)	Power (dBm)	SAR, averaged over 1g (mW/g)			
			Left-hand		Right-hand	
			Cheek	Tilted	Cheek	Tilted
CDMA 1900	25/1851.25	23.7	1.07	0.98	1.03	0.88
	600/1880.00	23.5	1.08	1.07	1.06	0.86
	1175/1908.75	23.7	1.16	1.17	1.09	1.16

7.2 Body Worn Configuration

Mode	Channel/ *f* (MHz)	Power (dBm)	SAR, averaged over 1g (mW/g)
			CSL-28
CDMA 1900	25/1851.25	23.7	0.49
	600/1880.00	23.5	0.41
	1175/1908.75	23.7	0.43

APPENDIX A.

Validation Test Printouts

Dipole 1900 MHz

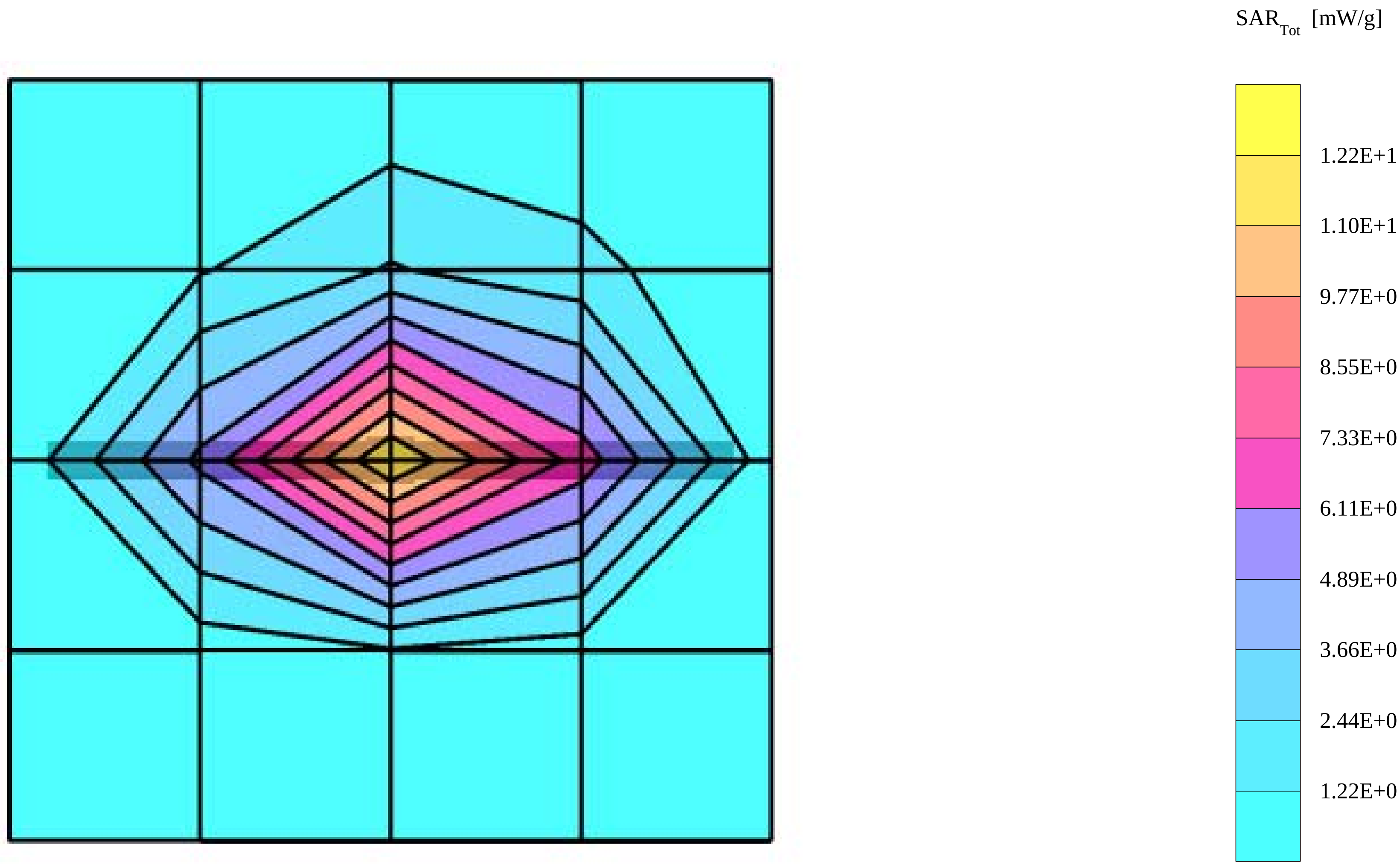
SAM 1; Flat

Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1900 MHz SCC34: σ = 1.44 mho/m ε = 38.0 ρ = 1.00 g/cm^3

Cubes (2): Peak: 21.9 mW/g ± 0.07 dB, SAR (1g): 11.4 mW/g ± 0.02 dB, SAR (10g): 5.78 mW/g ± 0.01 dB

Penetration depth: 7.9 (7.5, 8.8) [mm]

Powerdrift: -0.03 dB



Dipole 1900 MHz

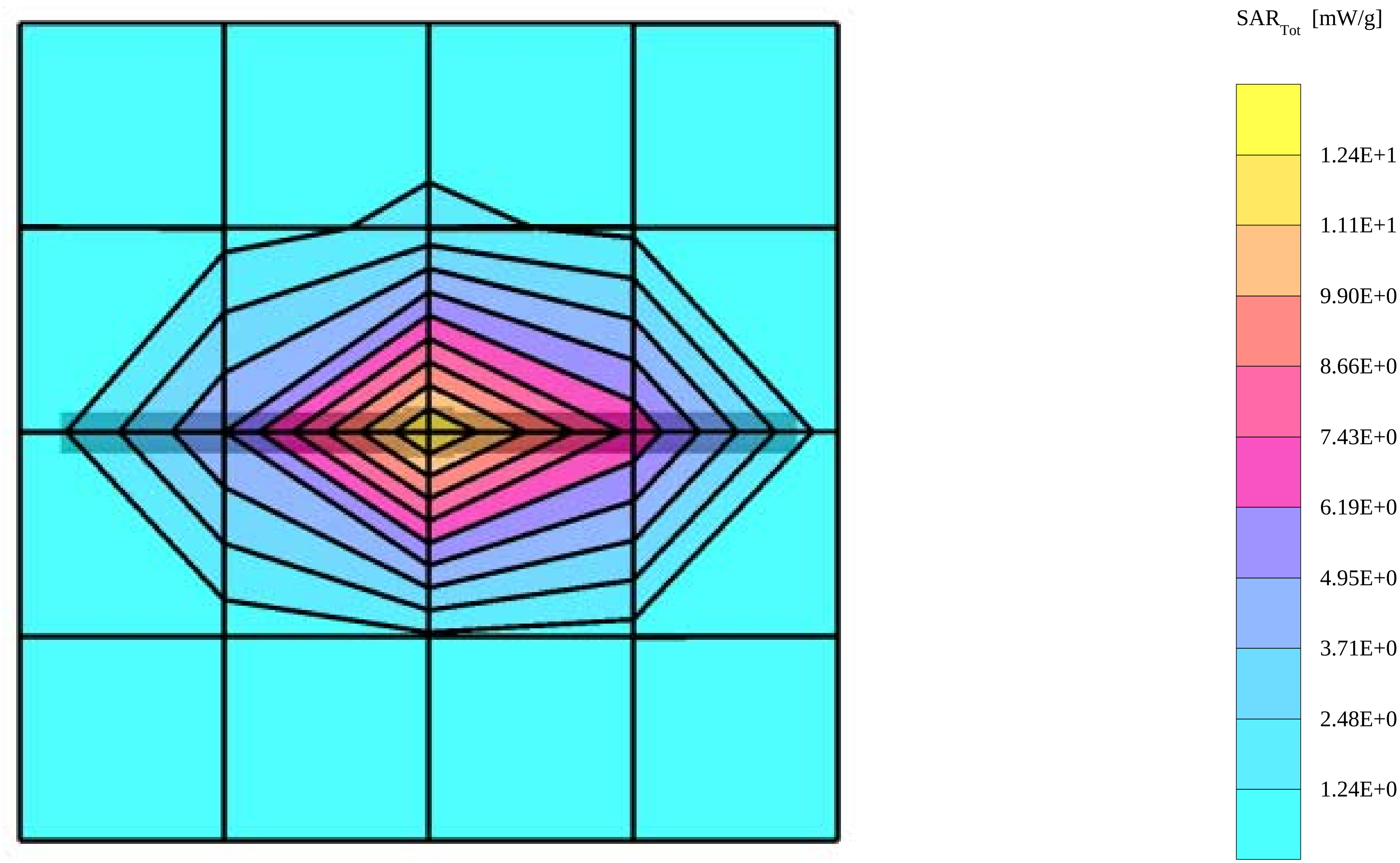
SAM 1; Flat

Probe: ET3DV6 - SN1381; ConvF(4.96,4.96,4.96); Crest factor: 1.0; Muscle 1900 MHz: σ = 1.55 mho/m ε = 52.0 ρ = 1.00 g/cm^3

Cubes (2): Peak: 21.8 mW/g ± 0.01 dB, SAR (1g): 11.4 mW/g ± 0.01 dB, SAR (10g): 5.72 mW/g ± 0.01 dB

Penetration depth: 8.3 (7.6, 9.6) [mm]

Powerdrift: -0.01 dB

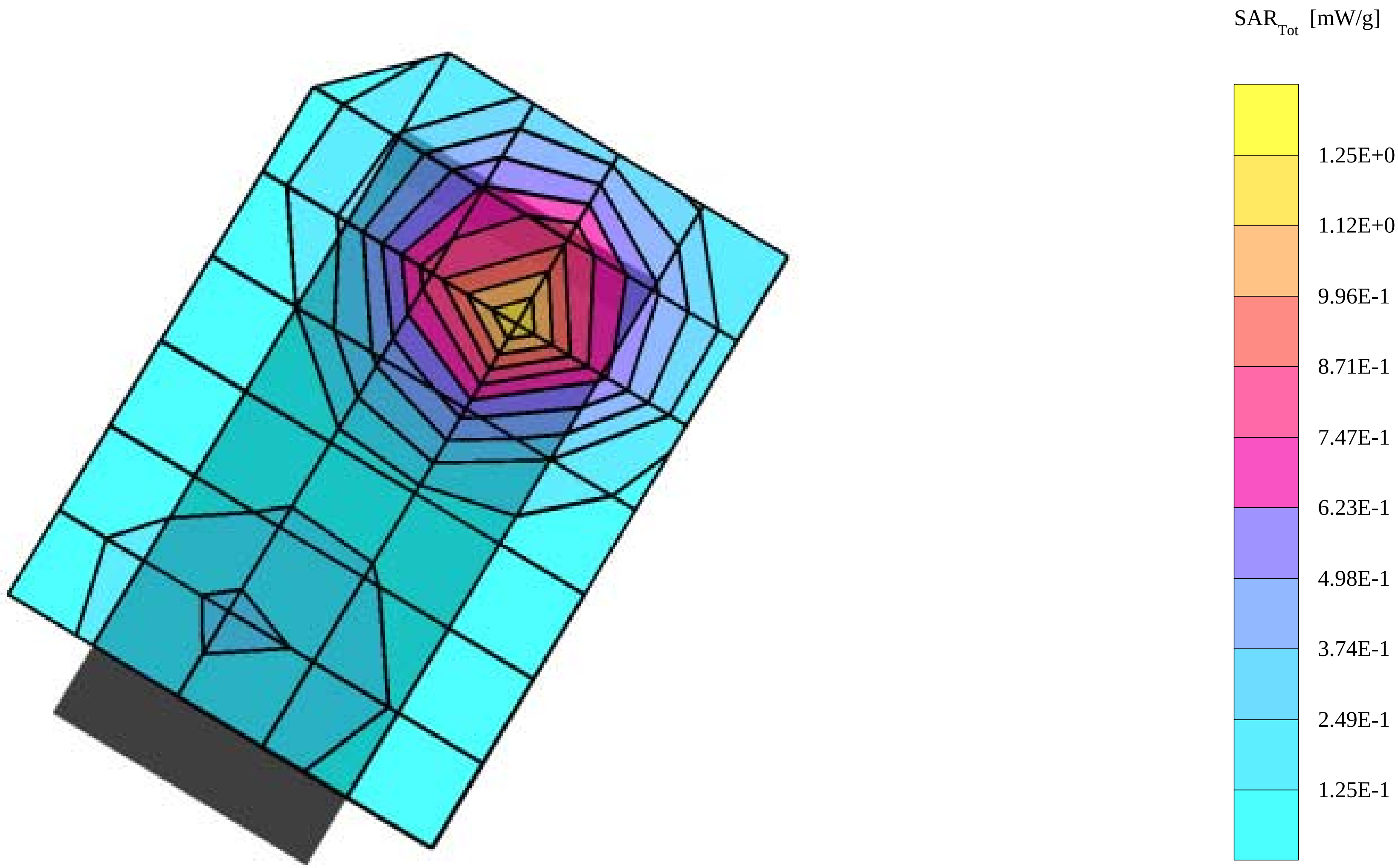


APPENDIX B.

SAR Distribution Printouts

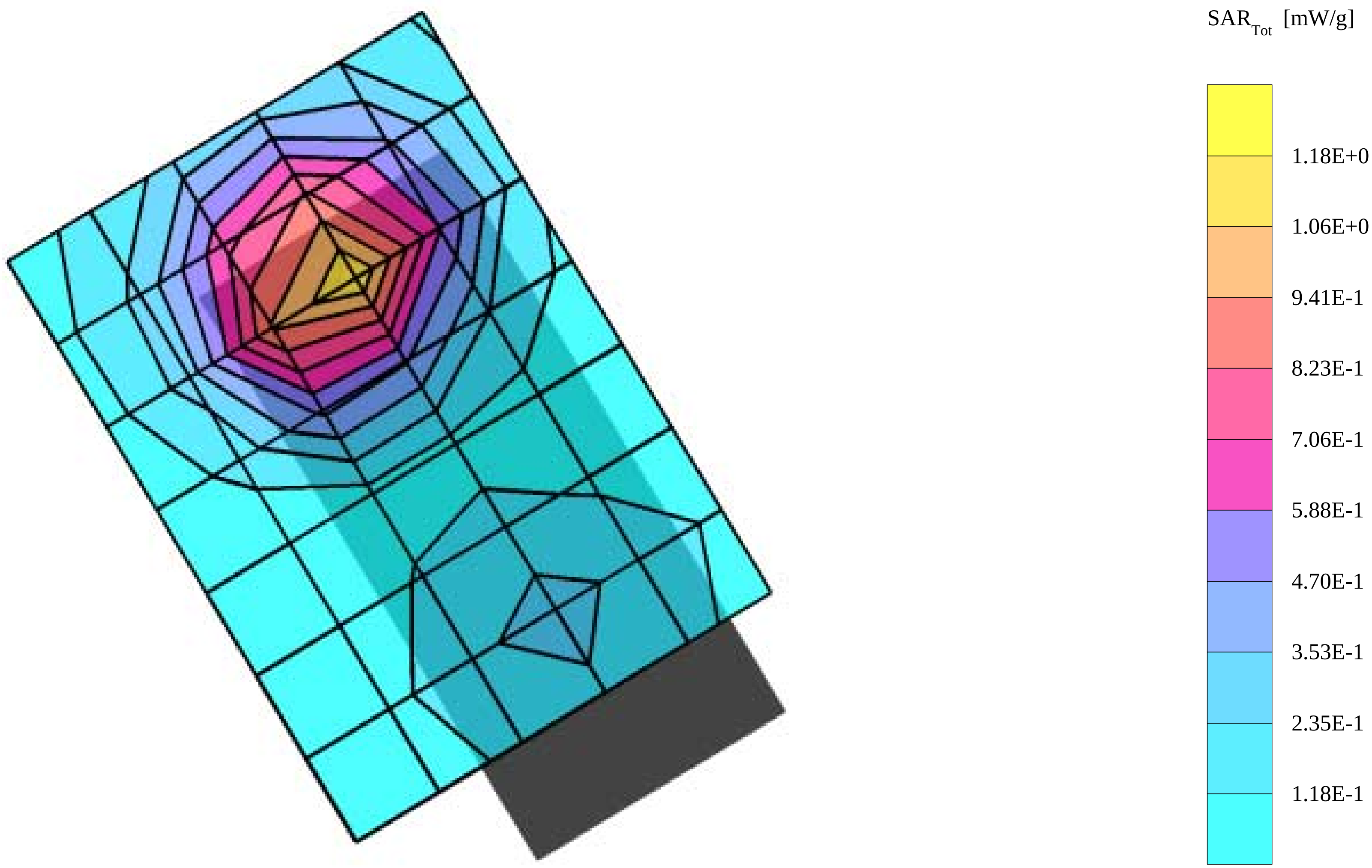
GMLNSD-5FX

SAM 1 Phantom; Left Hand Section; Position: tilted; Frequency: 1909 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 1.17 mW/g, SAR (10g): 0.661 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.00 dB



GMLNSD-5FX

SAM 1 Phantom; Righ Hand Section; Position: tilted; Frequency: 1909 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 1.16 mW/g, SAR (10g): 0.660 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.22 dB



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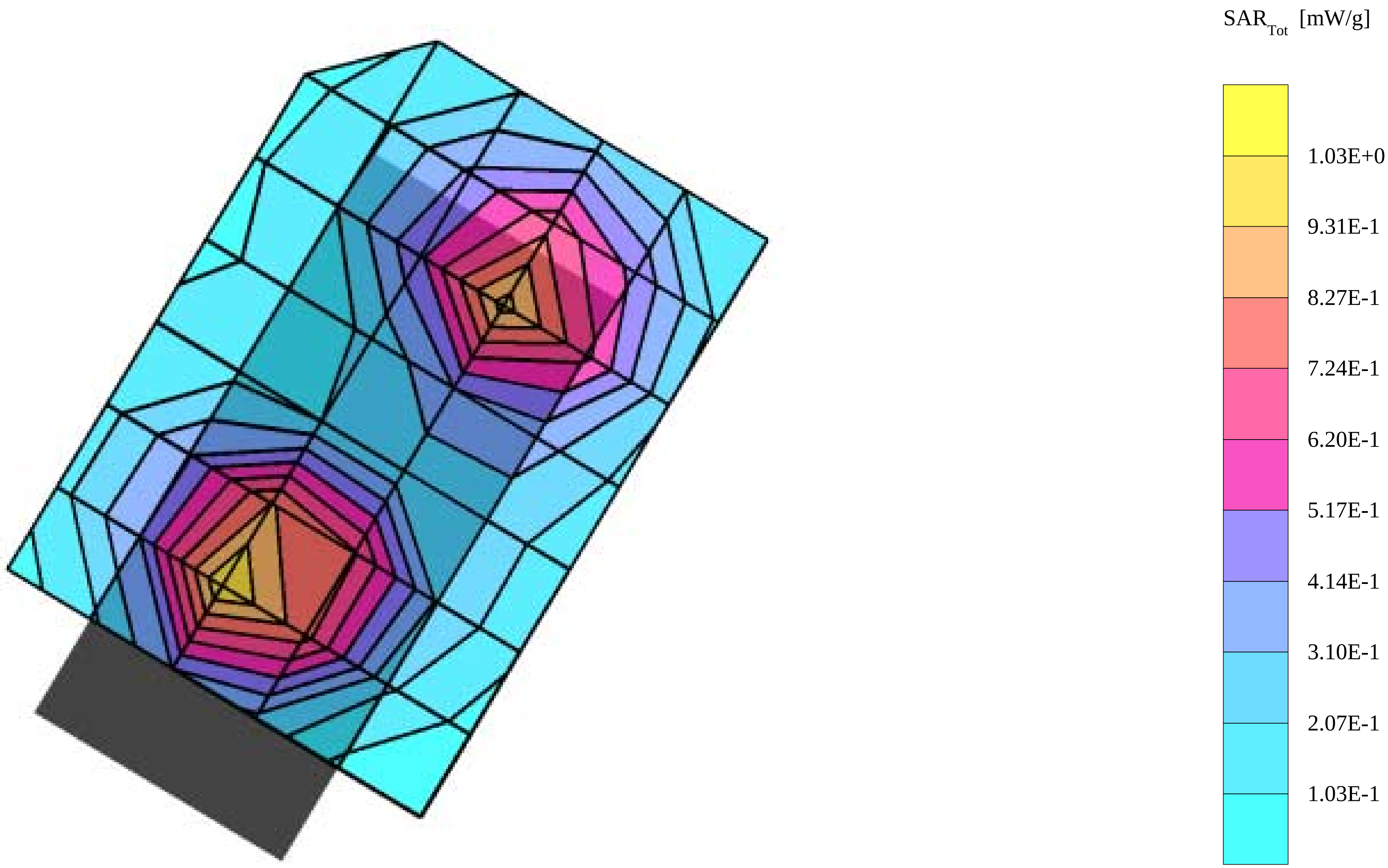
GMLNSD-5FX

SAM 1 Phantom; Left Hand Section; Position: cheek; Frequency: 1851 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm^3
Cube 5x5x7: cheek region peak: SAR (1g): 1.07 mW/g, SAR (10g): 0.632 mW/g, ear region peak: SAR (1g): 0.915mW/g, SAR (10g): 0.459 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.00 dB



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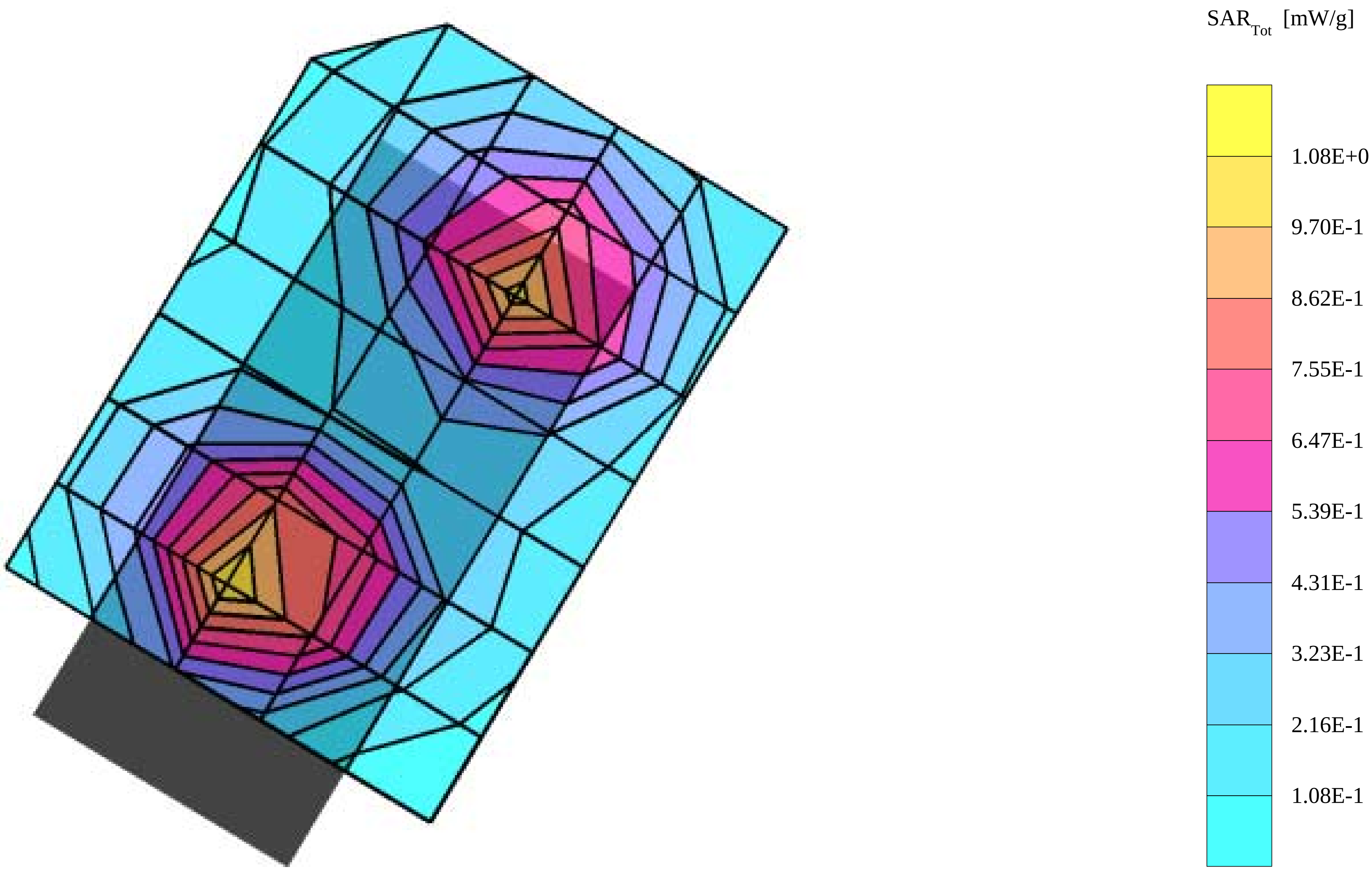
GMLNSD-5FX

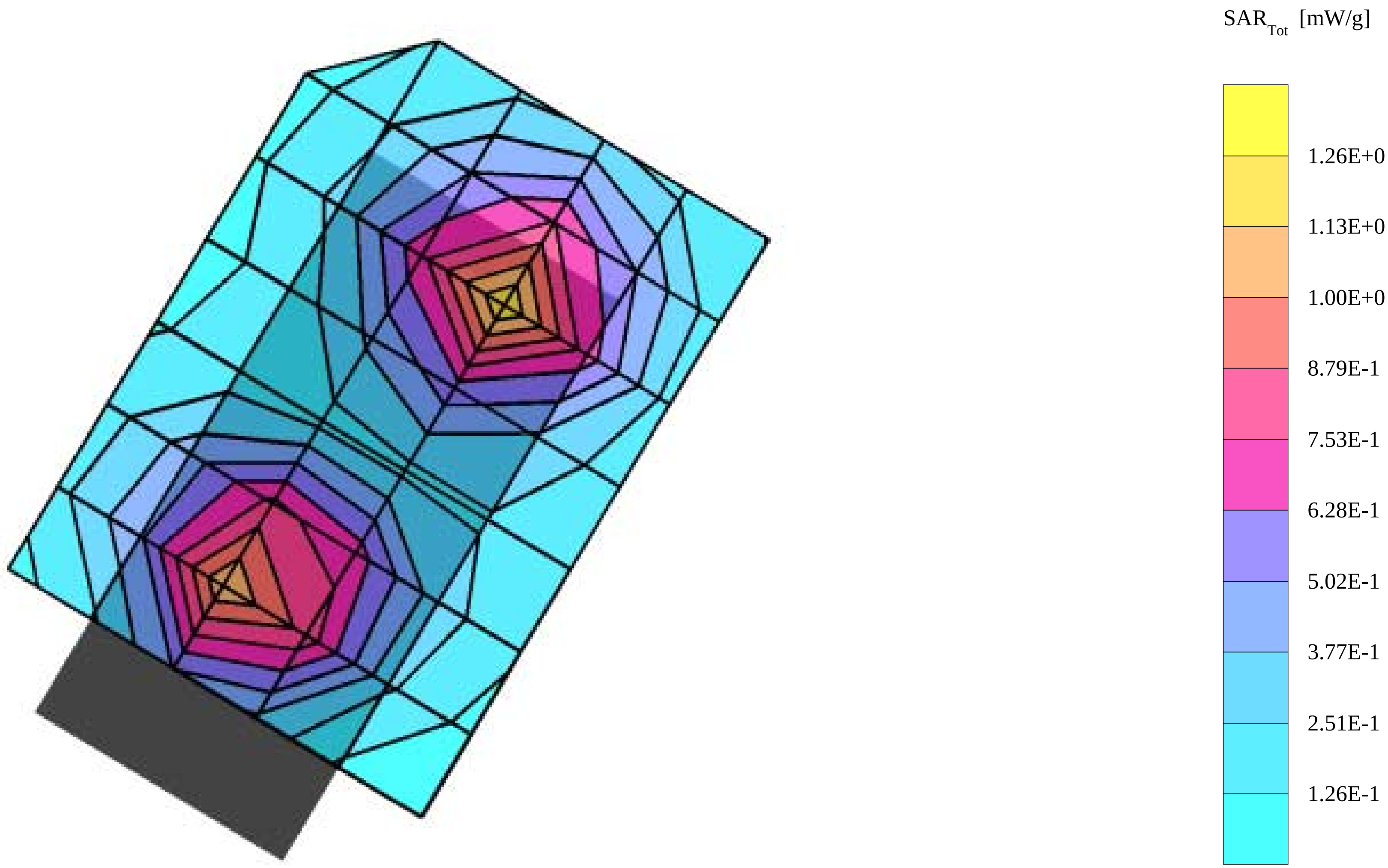
SAM 1 Phantom; Left Hand Section; Position: cheek; Frequency: 1880 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm³
Cube 5x5x7: cheek region peak: SAR (1g): 1.08 mW/g, SAR (10g): 0.639 mW/g, ear region peak: SAR (1g): 1.05 mW/g, SAR (10g): 0.527 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.14 dB



01/31/02

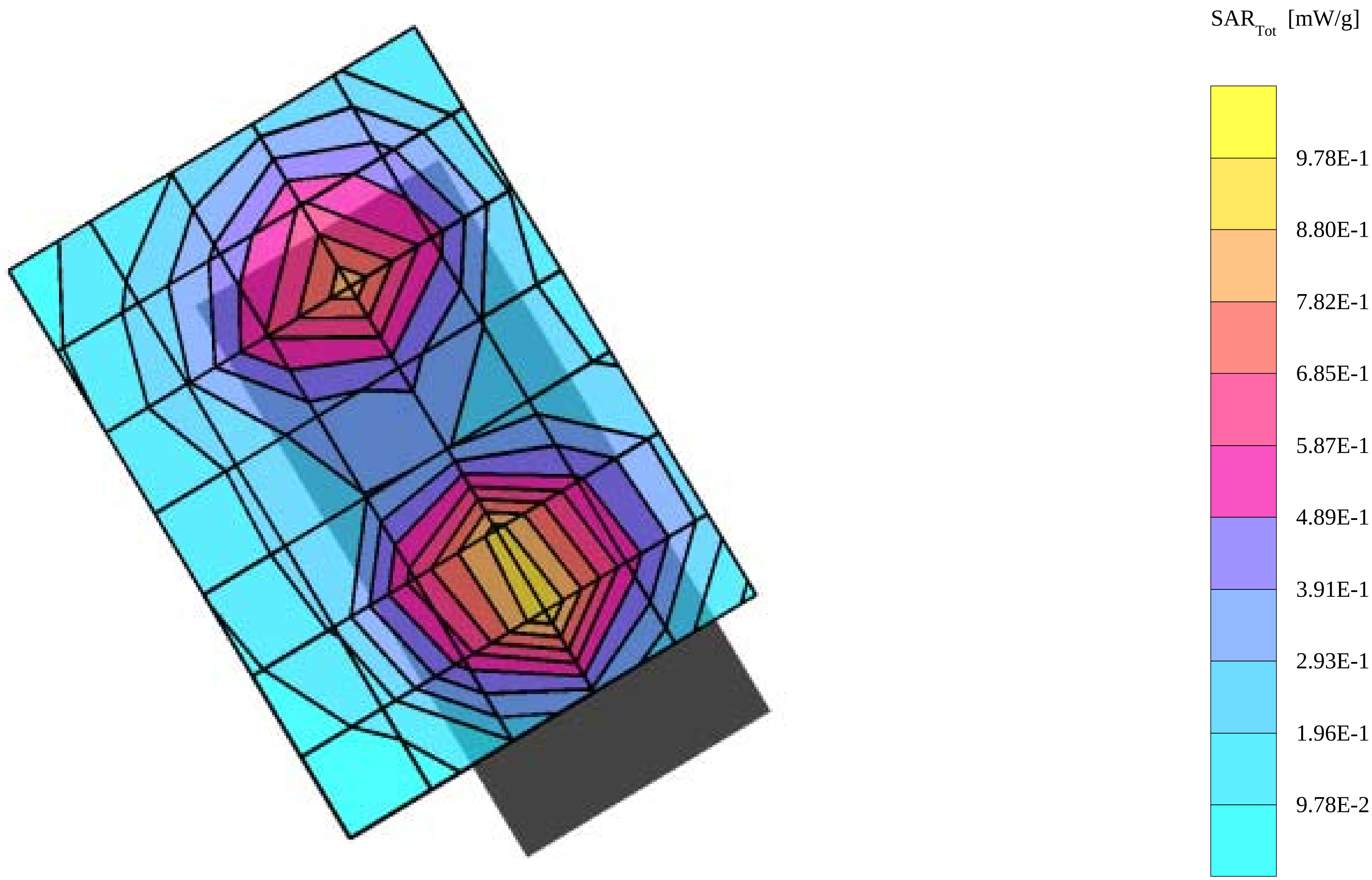
GMLNSD-5FX

SAM 1 Phantom; Left Hand Section; Position: cheek; Frequency: 1909 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm^3
Cube 5x5x7: ear region peak: SAR (1g): 1.16 mW/g, SAR (10g): 0.636 mW/g, cheek region peak: SAR(1g):1.11 mW/g, SAR(10g):0.661 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.08 dB



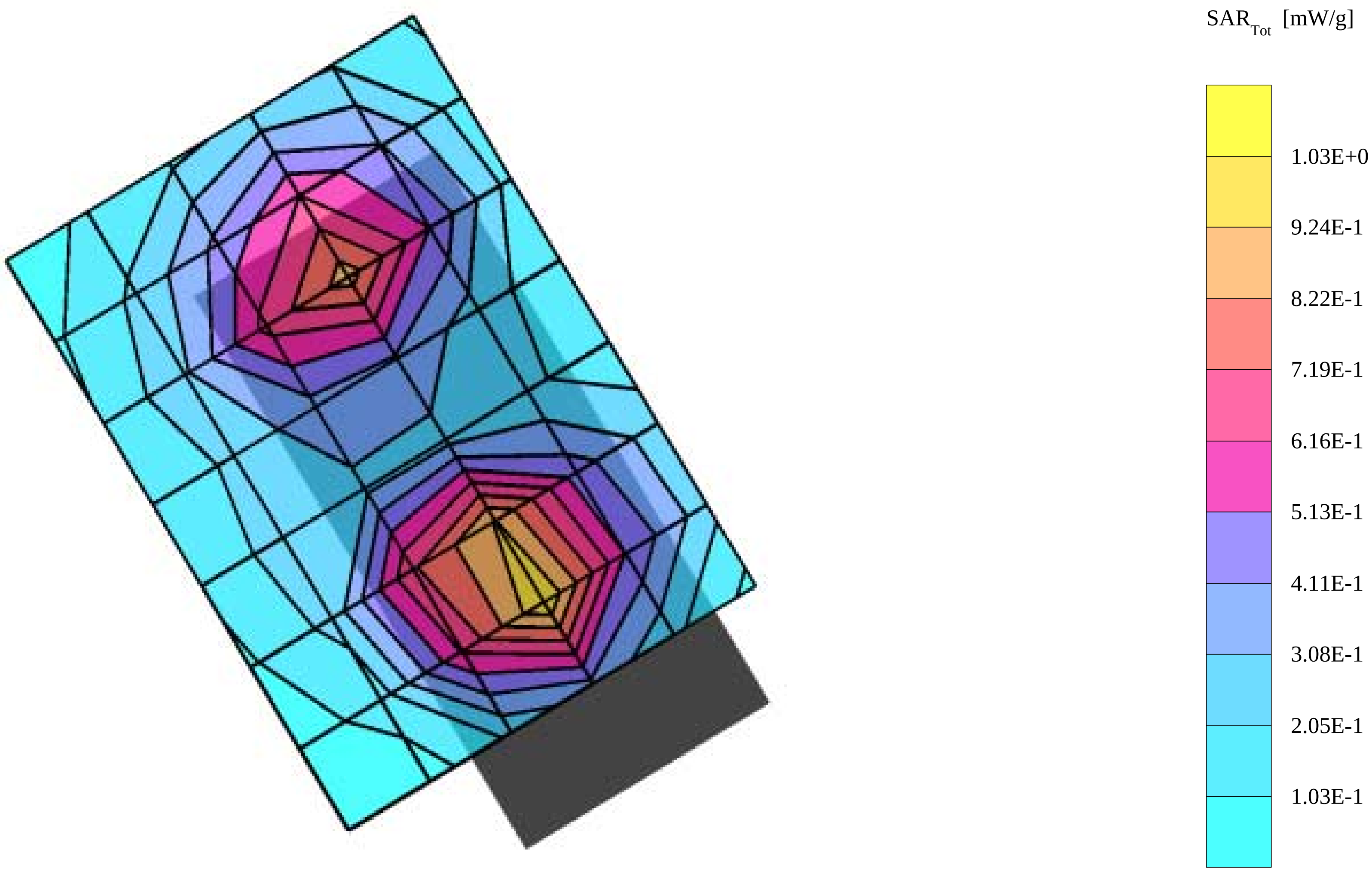
GMLNSD-5FX

SAM 1 Phantom; Righ Hand Section; Position: cheek; Frequency: 1851 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm^3
Cube 5x5x7: cheek region peak: SAR (1g): 1.03 mW/g, SAR (10g): 0.619 mW/g, ear region peak: SAR(1g): 0.893 mW/g, SAR(10g): 0.523 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.02 dB



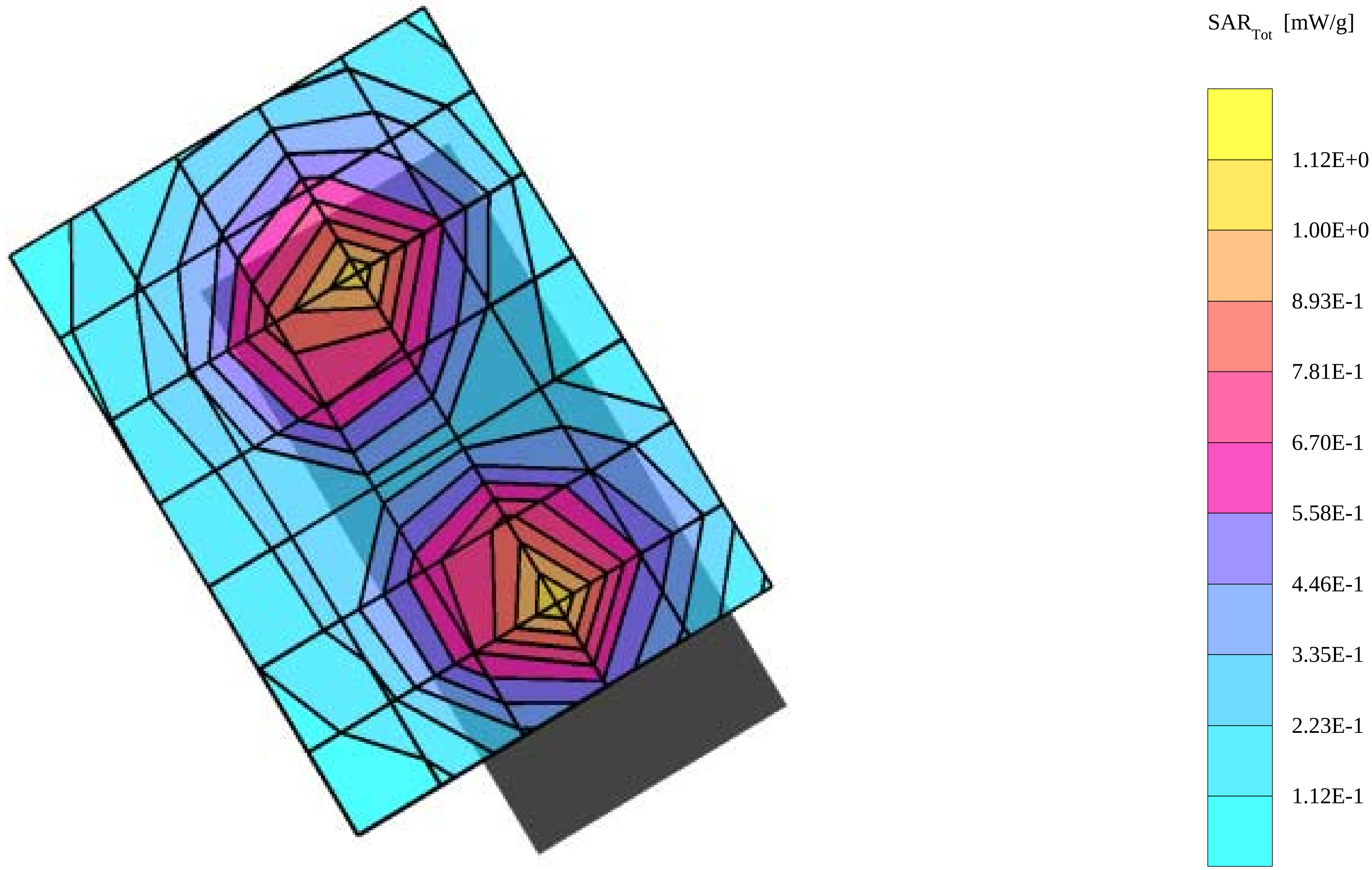
GMLNSD-5FX

SAM 1 Phantom; Righ Hand Section; Position: cheek; Frequency: 1880 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm³
Cube 5x5x7: cheek region peak: SAR (1g): 1.06 mW/g, SAR (10g): 0.628 mW/g, ear region peak: SAR (1g): 0.856 mW/g, SAR (10g): 0.469 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.05 dB



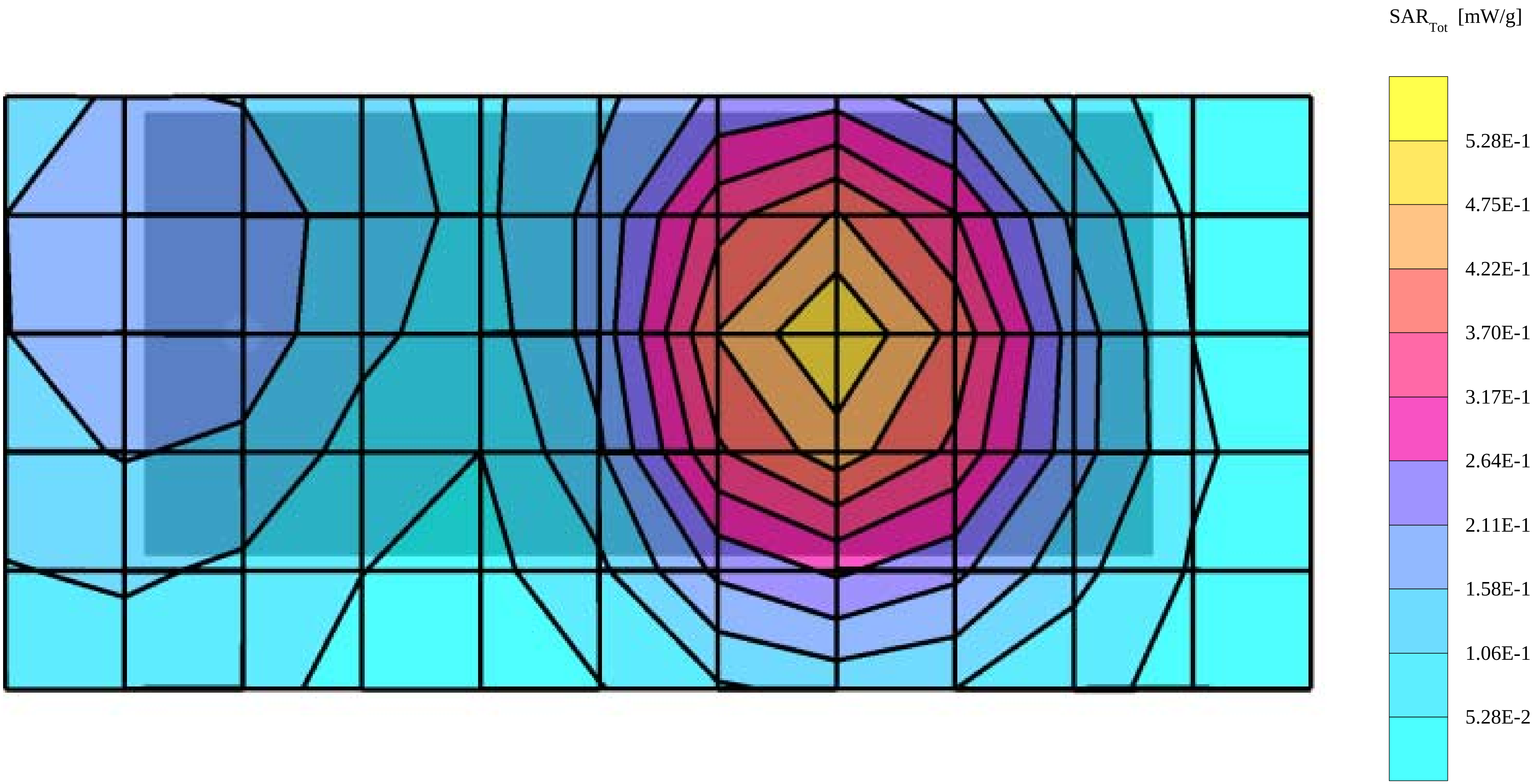
GMLNSD-5FX

SAM 1 Phantom; Righ Hand Section; Position: cheek; Frequency: 1909 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm³
Cube 5x5x7: cheek region peak: SAR (1g): 1.09 mW/g, SAR (10g): 0.649 mW/g, ear region peak: SAR (1g): 1.09 mW/g, SAR (10g): 0.632 mW/g
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.01 dB



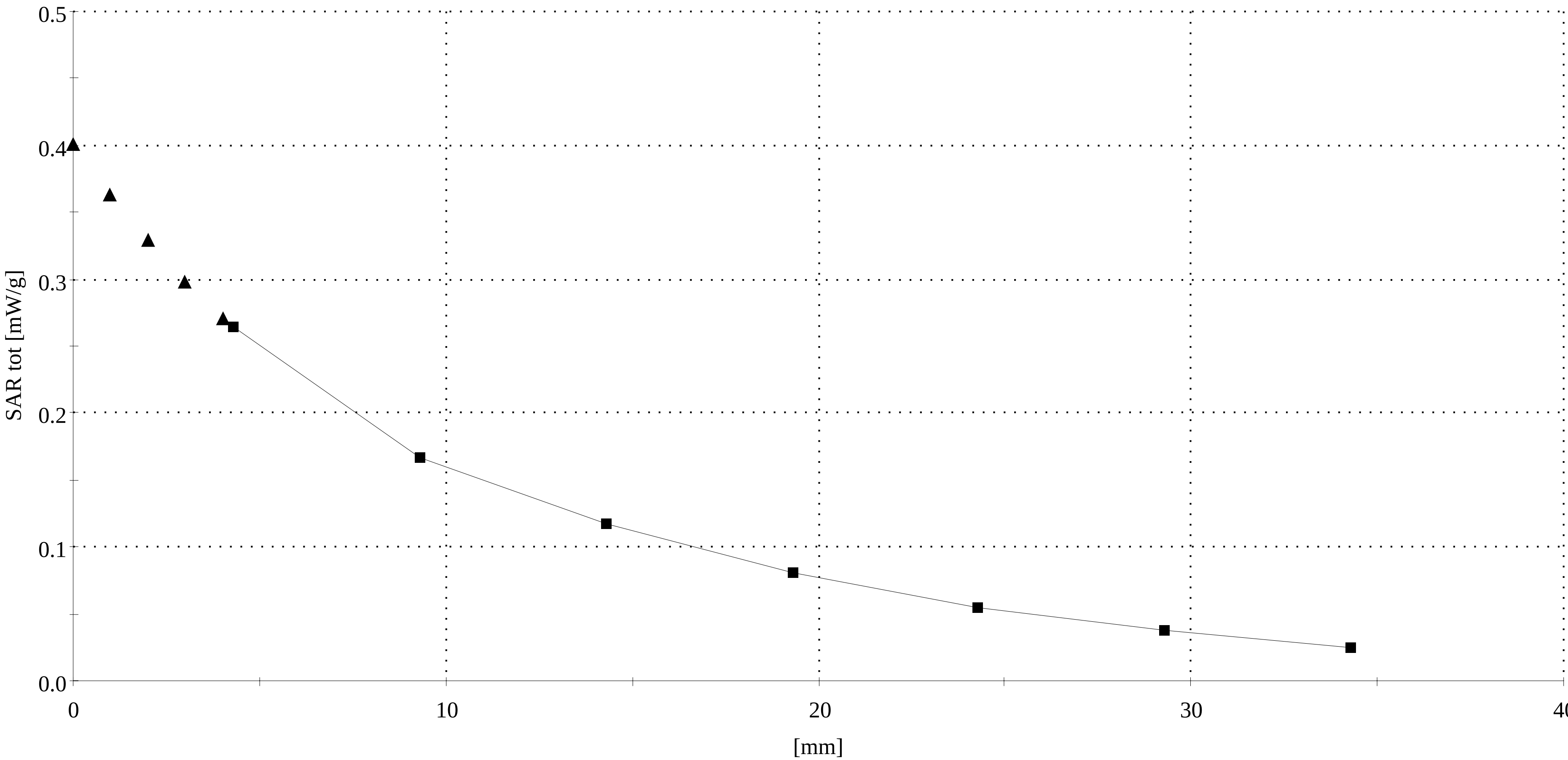
GMLNSD-5FX, CSL-28

SAM 1 Phantom; Flat Section; Position: body worn; Frequency: 1851 MHz
Probe: ET3DV6 - SN1381; ConvF(4.96,4.96,4.96); Crest factor: 1.0; Muscle 1880 MHz: σ = 1.52 mho/m ε = 52.0 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.485 mW/g, SAR (10g): 0.297 mW/g
Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0
Powerdrift: 0.14 dB



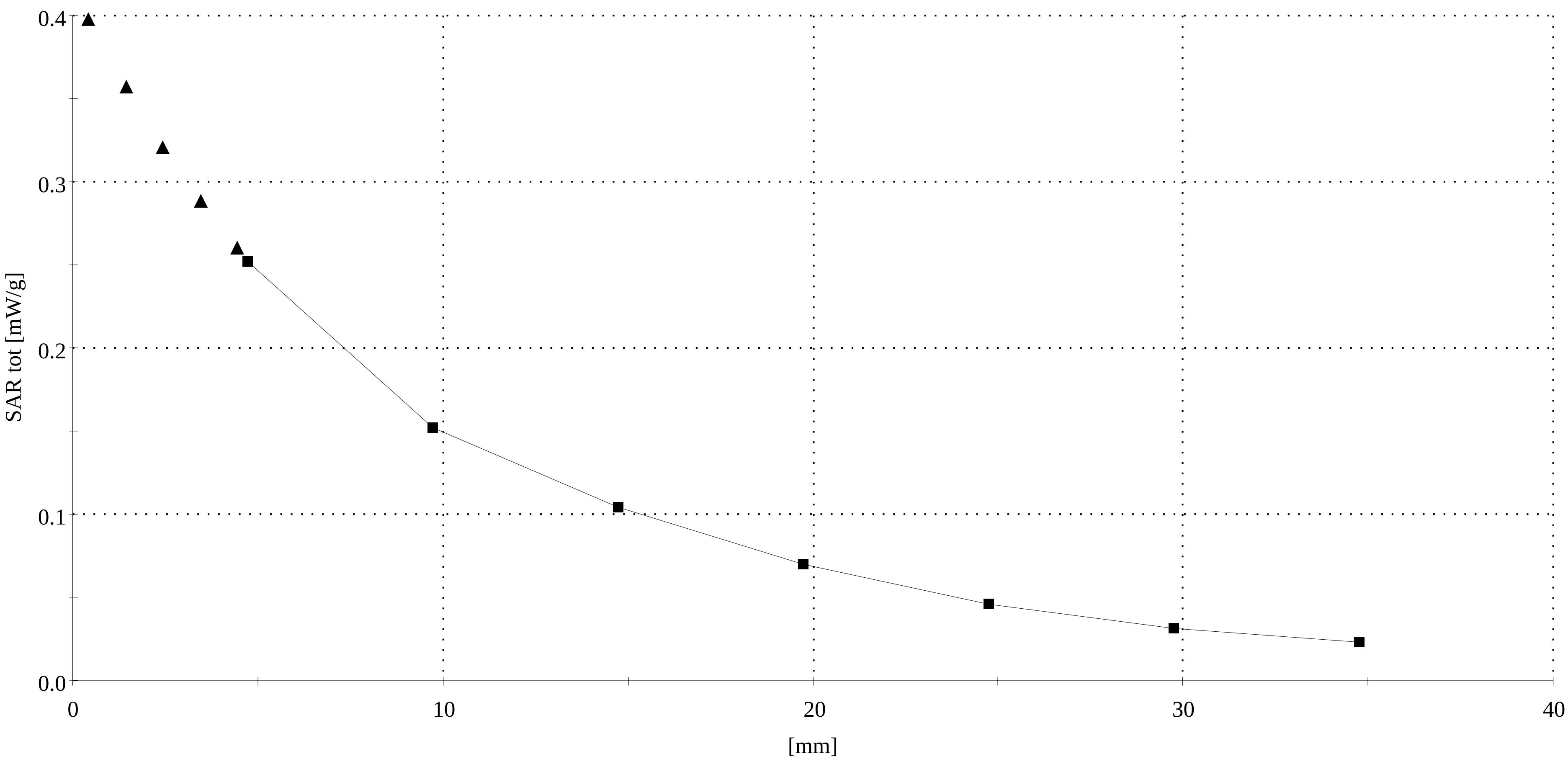
GMLNSD-5FX

SAM 1 Phantom; Left Hand Section; Position: tilted; Frequency: 1909 MHz
Probe: ET3DV6 - SN1381; ConvF(5.22,5.22,5.22); Crest factor: 1.0; Brain 1880 MHz SCC34: σ = 1.42 mho/m ε = 38.1 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 1.17 mW/g, SAR (10g): 0.661 mW/g
Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0



GMLNSD-5FX, CSL-28

SAM 1 Phantom; Flat Section; Position: body worn; Frequency: 1850 MHz
Probe: ET3DV6 - SN1381; ConvF(4.96,4.96,4.96); Crest factor: 1.0; Muscle 1880 MHz: σ = 1.52 mho/m ε = 52.0 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 0.485 mW/g, SAR (10g): 0.297 mW/g
Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0



APPENDIX C.

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:	**1381**
Place of Calibration:	**Zurich**
Date of Calibration:	**October 25, 2001**
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:	Nikoloski Neviana
Approved by:	Pokovic Katja

Probe ET3DV6

SN:1381

Manufactured:	September 18, 1999
Last calibration:	October 6, 2000
Recalibrated:	October 25, 2001

Calibrated for System DASY3

DASY3 - Parameters of Probe: ET3DV6 SN:1381

Sensitivity in Free Space

NormX	**1.57**	$\mu V/(V/m)^2$
NormY	**1.70**	$\mu V/(V/m)^2$
NormZ	**1.78**	$\mu V/(V/m)^2$

Diode Compression

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

Sensitivity in Tissue Simulating Liquid

Head **450 MHz** e_r = **43.5 ± 5%** s = **0.87 ± 10% mho/m**

ConvF X	**6.66**	extrapolated	Boundary effect:	
ConvF Y	**6.66**	extrapolated	Alpha	**0.29**
ConvF Z	**6.66**	extrapolated	Depth	**2.78**

Head **800 - 1000 MHz** e_r = **39.0 - 43.5** s = **0.80 - 1.10 mho/m**

ConvF X	**6.21**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.21**	± 9.5% (k=2)	Alpha	**0.40**
ConvF Z	**6.21**	± 9.5% (k=2)	Depth	**2.61**

Head **1500 MHz** e_r = **40.4 ± 5%** s = **1.23 ± 10% mho/m**

ConvF X	**5.61**	interpolated	Boundary effect:	
ConvF Y	**5.61**	interpolated	Alpha	**0.55**
ConvF Z	**5.61**	interpolated	Depth	**2.38**

Head **1700 - 1910 MHz** e_r = **39.5 - 41.0** s = **1.20 - 1.55 mho/m**

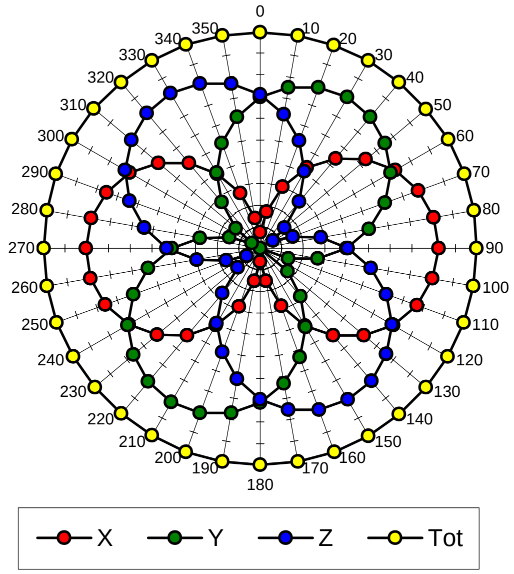
ConvF X	**5.31**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.31**	± 9.5% (k=2)	Alpha	**0.62**
ConvF Z	**5.31**	± 9.5% (k=2)	Depth	**2.27**

Sensor Offset

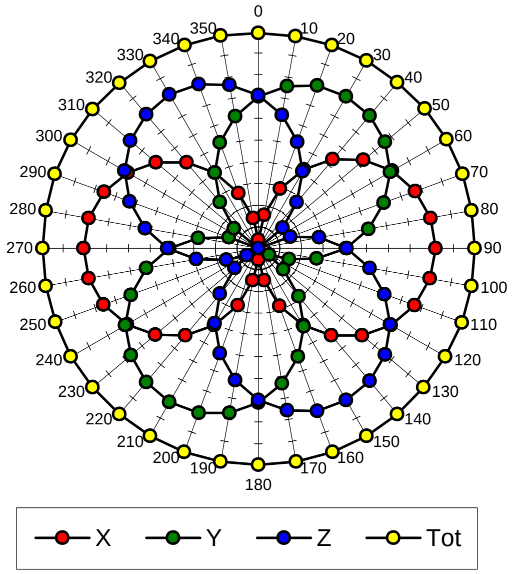
Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.6 ± 0.2**	mm

Receiving Pattern (f), q = 0°

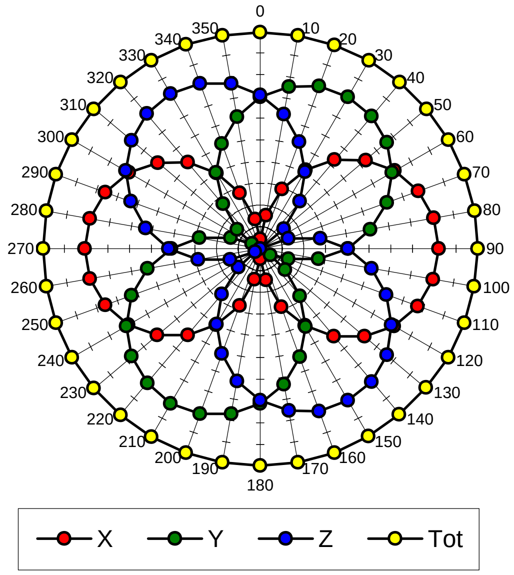
f = 30 MHz, TEM cell ifi110



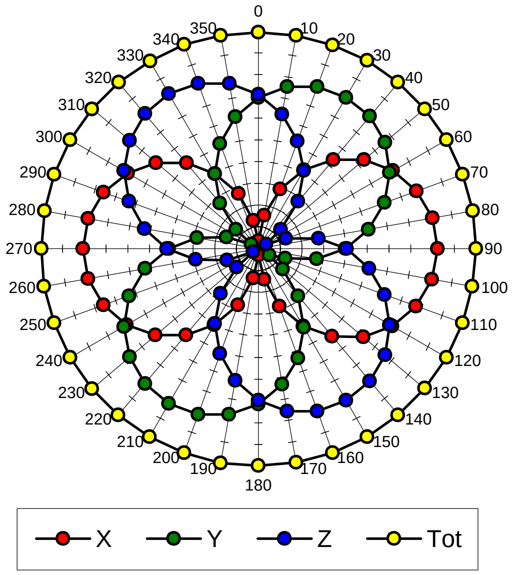
f = 100 MHz, TEM cell ifi110

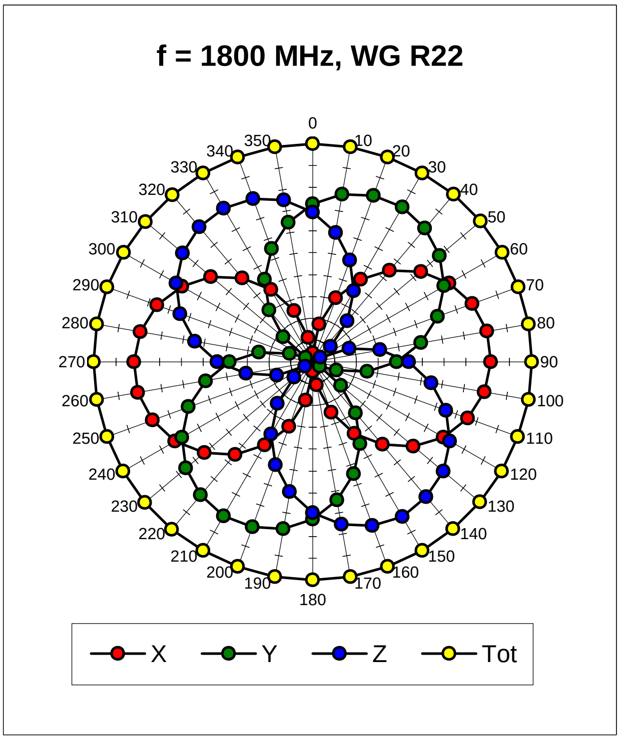


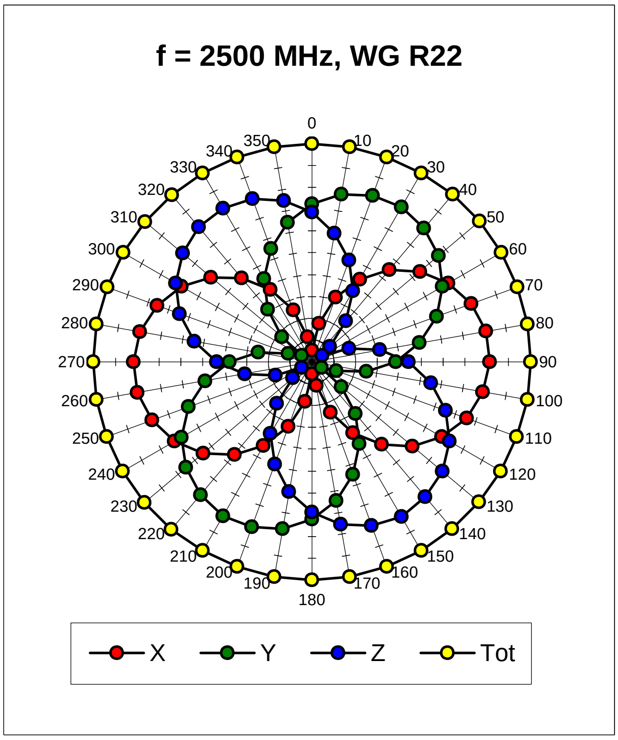
f = 300 MHz, TEM cell ifi110



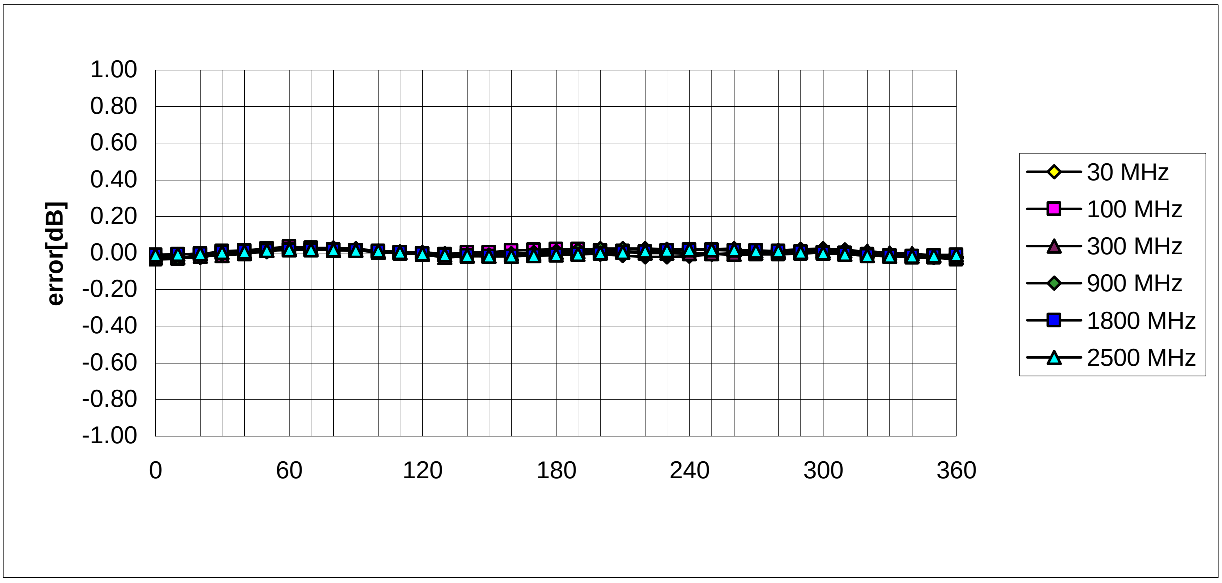
f = 900 MHz, TEM cell ifi110





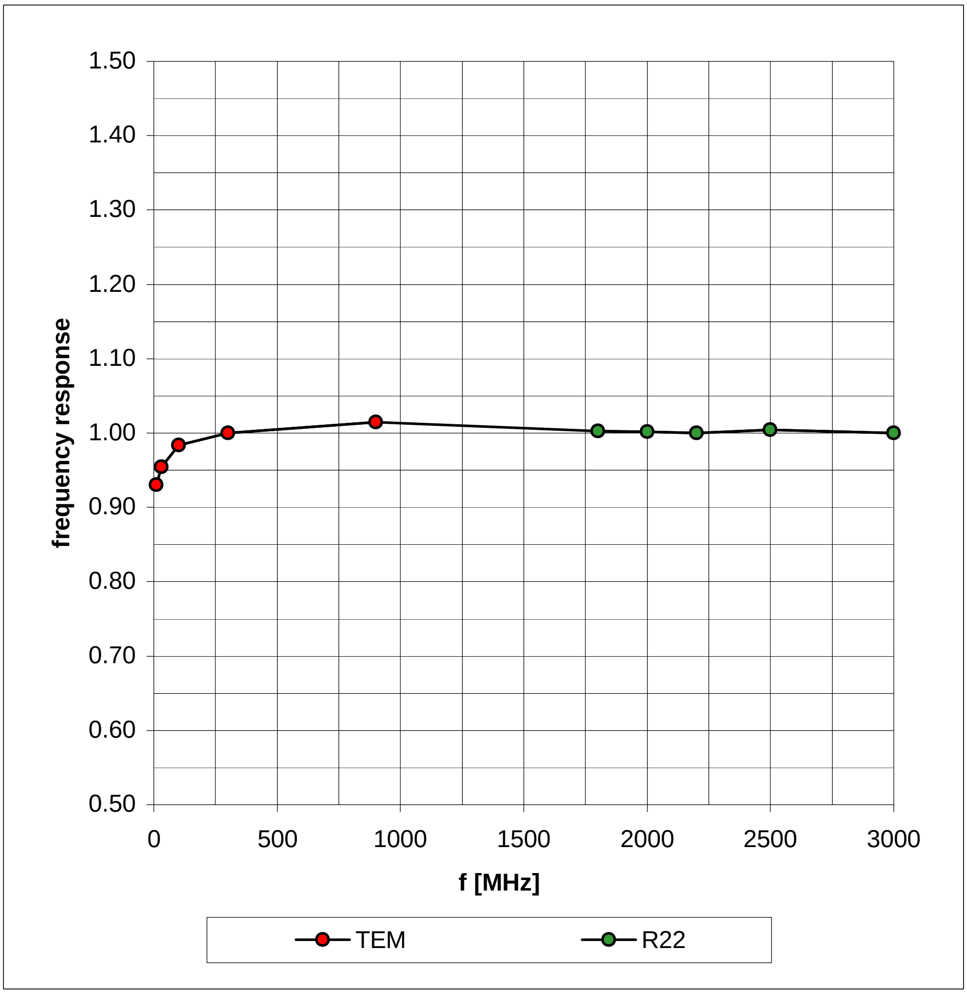


Isotropy Error (f), q = 0°



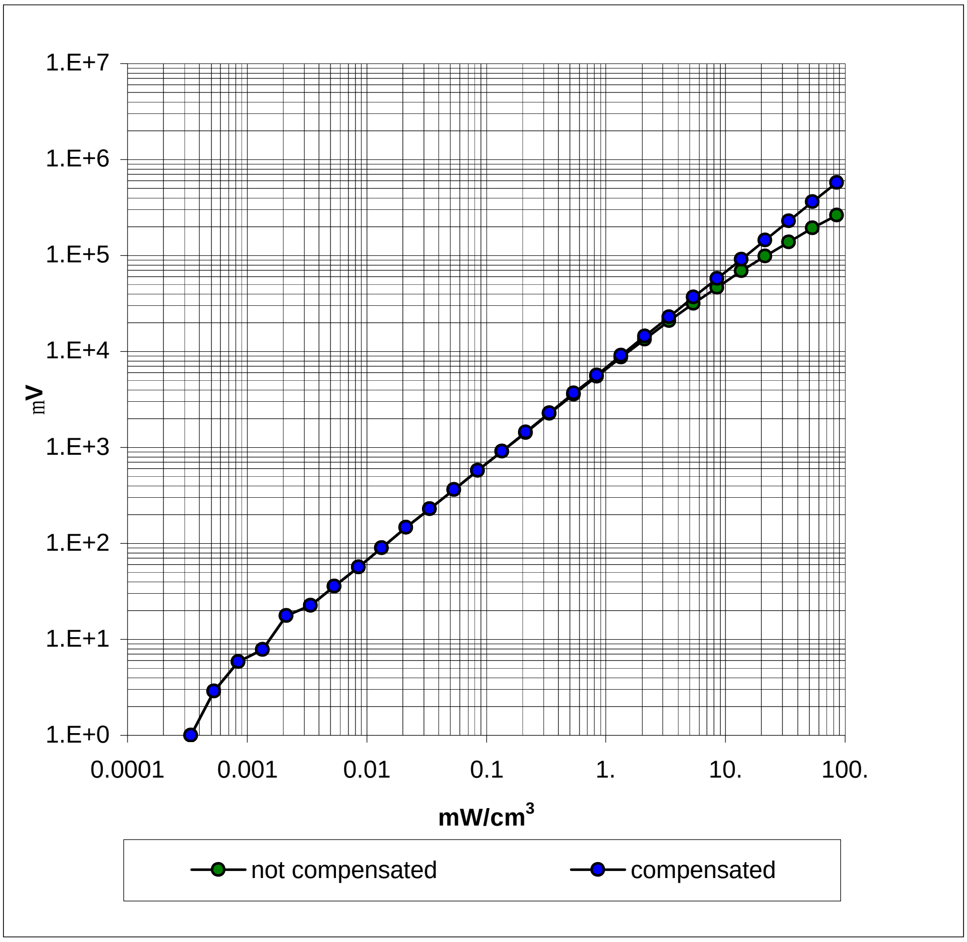
Frequency Response of E-Field

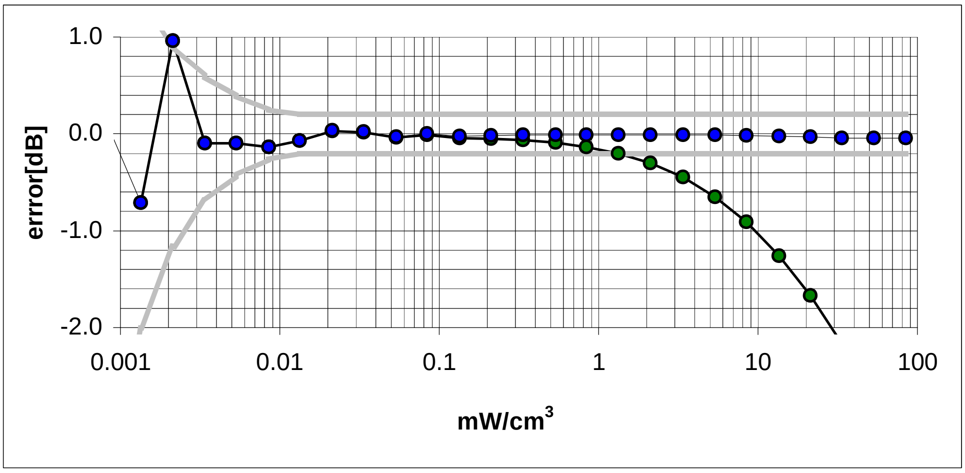
(TEM-Cell:ifi110, Waveguide R22)



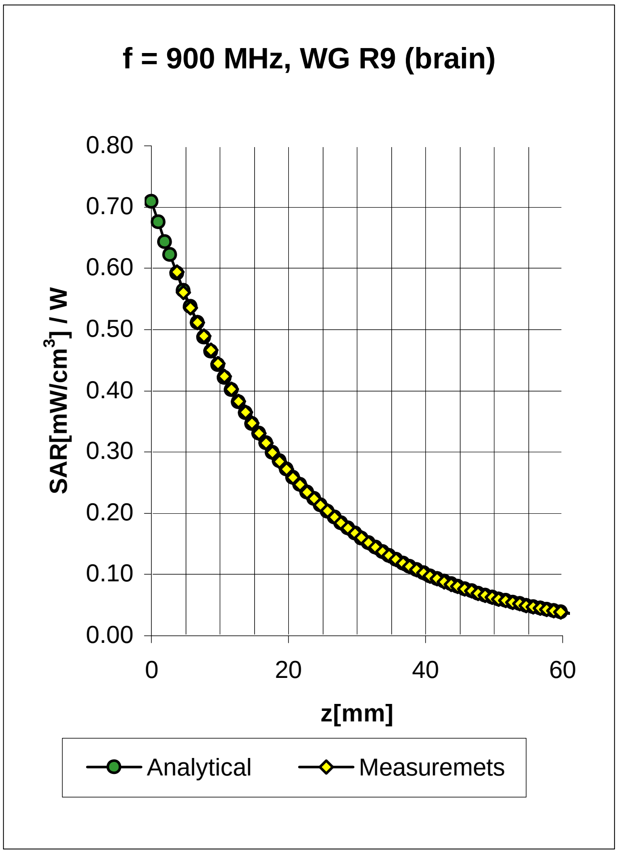
Dynamic Range f(SAR_{brain})

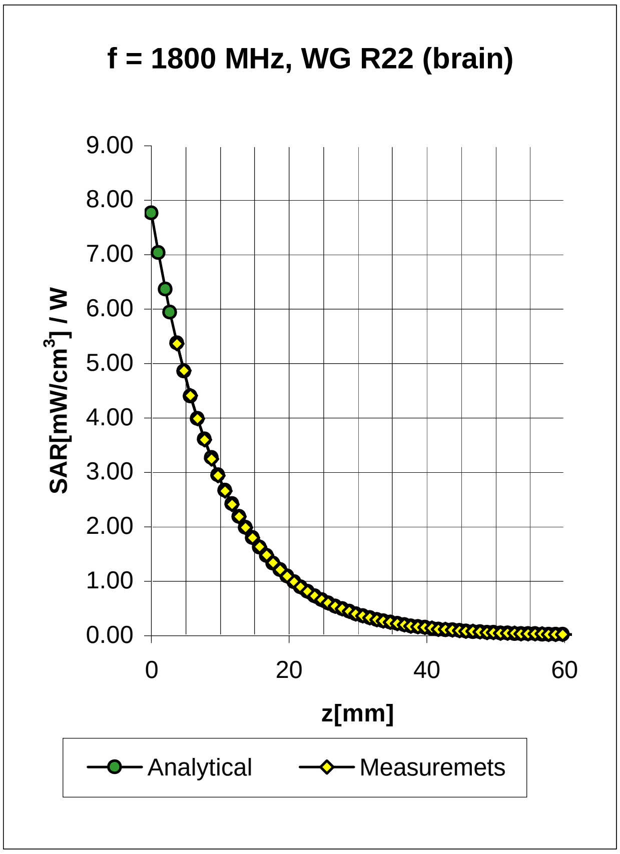
(Waveguide R22)





Conversion Factor Assessment

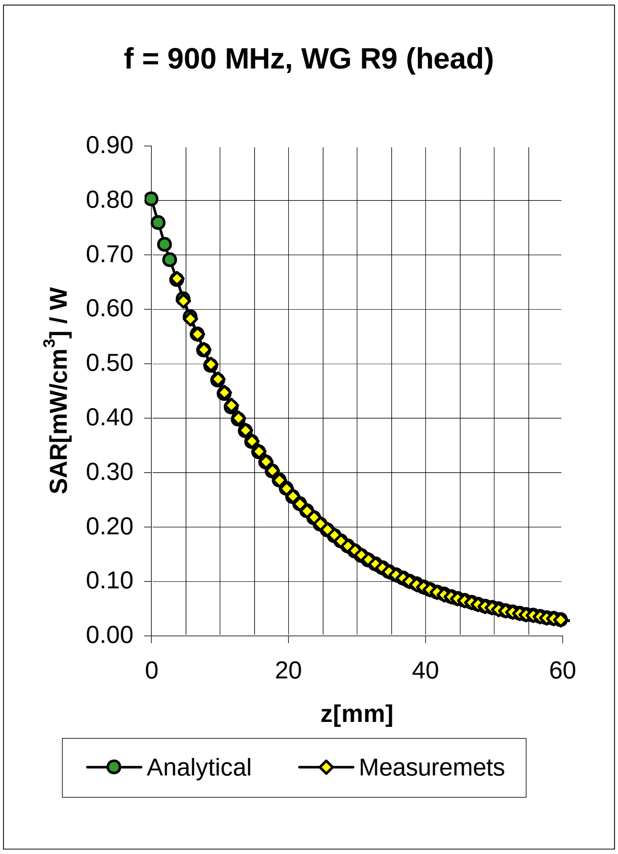


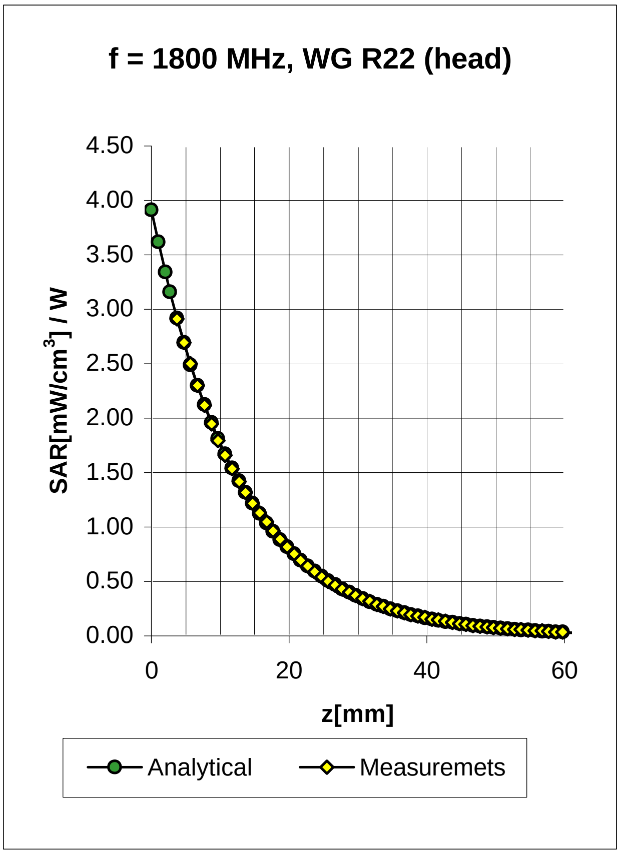


Brain	**800 - 1000 MHz**	e_r **= 39.3 - 43.0**	s **= 0.75 - 1.00 mho/m**	
	ConvF X	**6.13** ± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**6.13** ± 9.5% (k=2)	Alpha	**0.45**
	ConvF Z	**6.13** ± 9.5% (k=2)	Depth	**2.36**

Brain	**1700 - 1910 MHz**	e_r **= 39.3 - 41.6**	s **= 1.53 - 1.90 mho/m**	
	ConvF X	**5.53** ± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**5.53** ± 9.5% (k=2)	Alpha	**0.66**
	ConvF Z	**5.53** ± 9.5% (k=2)	Depth	**2.07**

Conversion Factor Assessment



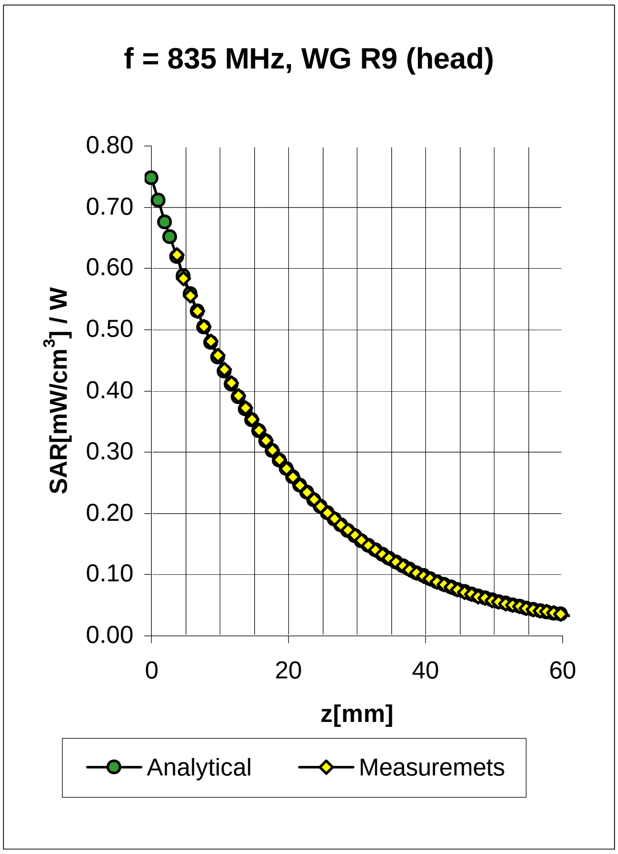


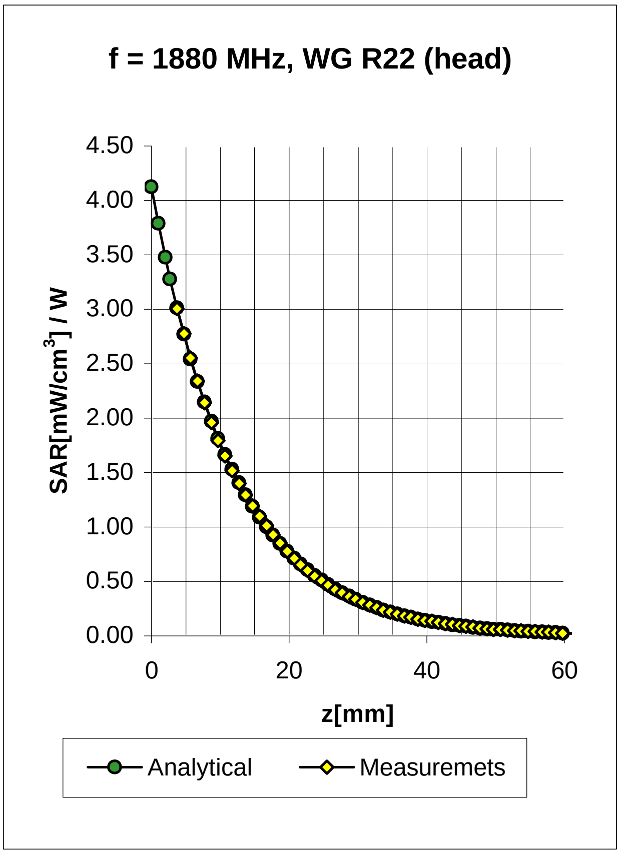
Head	**800 - 1000 MHz**		e_r = **39.0 - 43.5**	s = **0.80 - 1.10 mho/m**	
	ConvF X	**6.21**	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**6.21**	± 9.5% (k=2)	Alpha	**0.40**
	ConvF Z	**6.21**	± 9.5% (k=2)	Depth	**2.61**

Head	**1700 - 1910 MHz**		e_r = **39.5 - 41.0**	s = **1.20 - 1.55 mho/m**	
	ConvF X	**5.31**	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**5.31**	± 9.5% (k=2)	Alpha	**0.62**
	ConvF Z	**5.31**	± 9.5% (k=2)	Depth	**2.27**

ET3DV6 SN:1381

Conversion Factor Assessment





Head	**835 MHz**	e_r **= 41.5 ± 5%**	s **= 0.90 ± 5% mho/m**

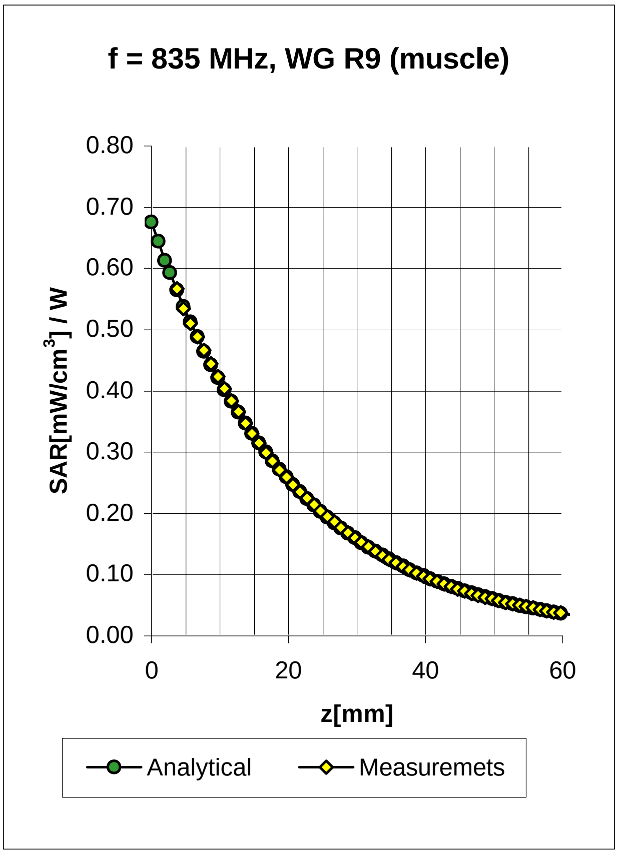
ConvF X	**6.20**	± 8.9% (k=2)	Boundary effect:	
ConvF Y	**6.20**	± 8.9% (k=2)	Alpha	**0.41**
ConvF Z	**6.20**	± 8.9% (k=2)	Depth	**2.58**

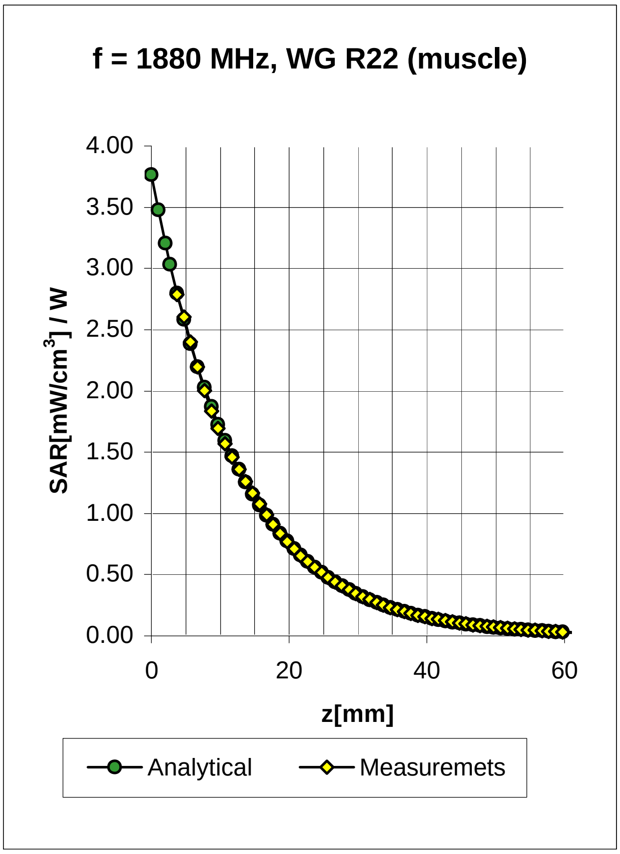
Head	**1880 MHz**	e_r **= 40.0 ± 5%**	s **= 1.540 ± 5% mho/m**

ConvF X	**5.22**	± 8.9% (k=2)	Boundary effect:	
ConvF Y	**5.22**	± 8.9% (k=2)	Alpha	**0.64**
ConvF Z	**5.22**	± 8.9% (k=2)	Depth	**2.23**

ET3DV6 SN:1381

Conversion Factor Assessment





Muscle	**835 MHz**	e_r **= 55.2 ± 5%**	s **= 0.97 ± 5% mho/m**

ConvF X	**6.04**	± 8.9% (k=2)	Boundary effect:	
ConvF Y	**6.04**	± 8.9% (k=2)	Alpha	**0.42**
ConvF Z	**6.04**	± 8.9% (k=2)	Depth	**2.73**

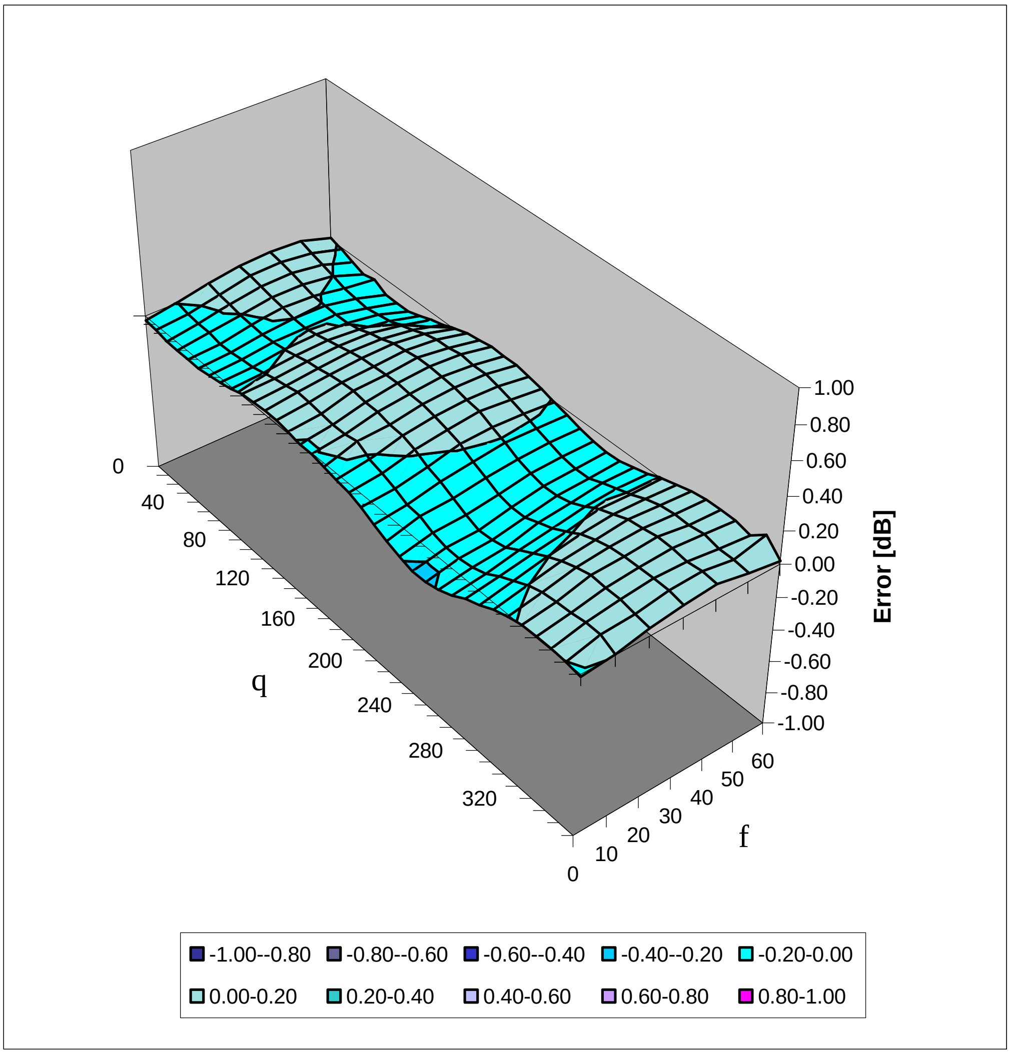
Muscle	**1880 MHz**	e_r **= 53.3 ± 5%**	s **= 1.52 ± 5% mho/m**

ConvF X	**4.96**	± 8.9% (k=2)	Boundary effect:	
ConvF Y	**4.96**	± 8.9% (k=2)	Alpha	**0.91**
ConvF Z	**4.96**	± 8.9% (k=2)	Depth	**1.88**

ET3DV6 SN:1381

Deviation from Isotropy in HSL

Error (q, f), f = 900 MHz



Schmid & Partner
Engineering AG

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

DASY3

Dipole Validation Kit

Type: D1900V2

Serial: 511

Manufactured: October 20, 1999
Calibrated: February 13, 2001

1. Measurement Conditions

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

Relative permitivity	**39.2**	± 5%
Conductivity	**1.47 mho/m**	± 10%

The DASY3 System (Software version 3.1c) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.57 at 1800 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 15mm 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 ± 3 %. The results are normalized to 1W input power.

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 normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

averaged over 1 cm^3 (1 g) of tissue:	**42.8 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**21.9 mW/g**

Note: 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 listed in the DASY Application Note 4: 'SAR Sensitivities'.

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:	**1.205 ns**	(one direction)
Transmission factor:	**0.983**	(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:	Re{Z} = **50.1 Ω**
	Im {Z} = **-1.5 Ω**
Return Loss at 1900 MHz	**- 34.9 dB**

4. Measurement Conditions

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

Relative permitivity	**53.5**	± 5%
Conductivity	**1.46 mho/m**	± 10%

The DASY3 System (Software version 3.1c) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 4.85 at 1800 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 15mm 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 ± 3 %. The results are normalized to 1W input power.

6. 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 normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

averaged over 1 cm^3 (1 g) of tissue:	**42.4 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**22.0 mW/g**

Note: If the liquid parameters for validation are slightly different from the ones used for initial calibration, the SAR-values will be different as well.

7. 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:	**1.205 ns**	(one direction)
Transmission factor:	**0.983**	(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:	**Re{Z} = 45.3 Ω**
	Im {Z} = -1.0 Ω
Return Loss at 1900 MHz	**- 25.6 dB**

8. Handling

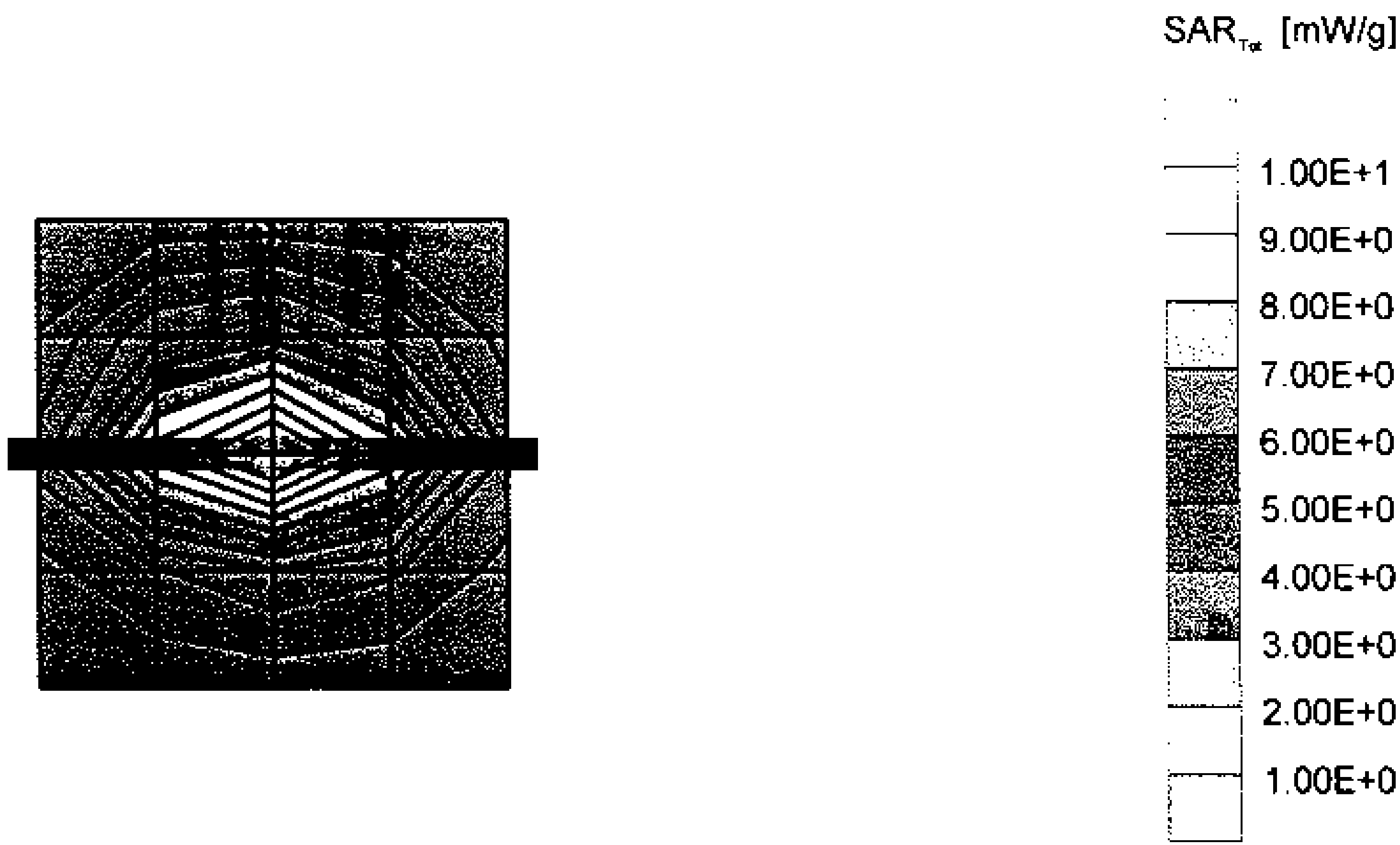
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

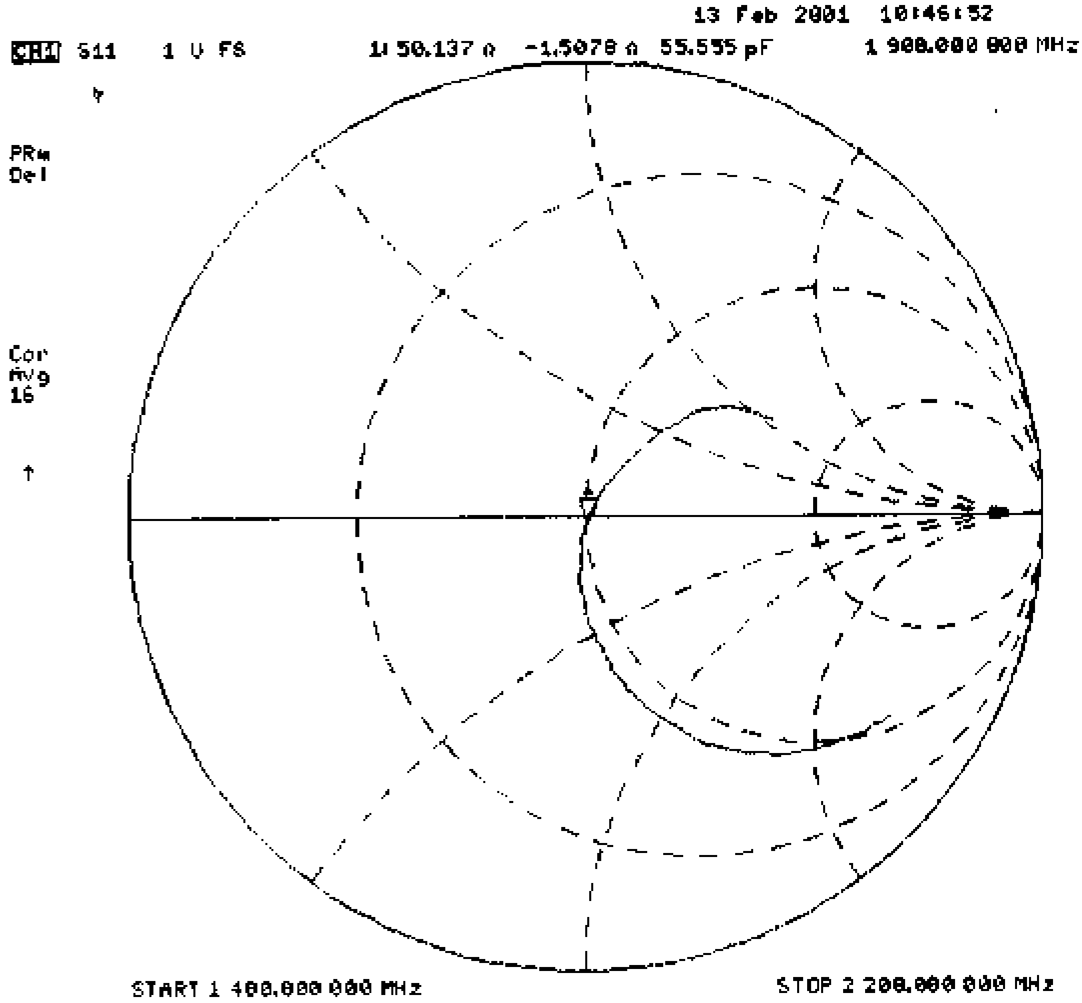
Do not apply excessive force to the dipole arms, because they might bend. If the dipole arms have to be bent back, take care to release stress to the soldered connections near the feedpoint; they might come off.

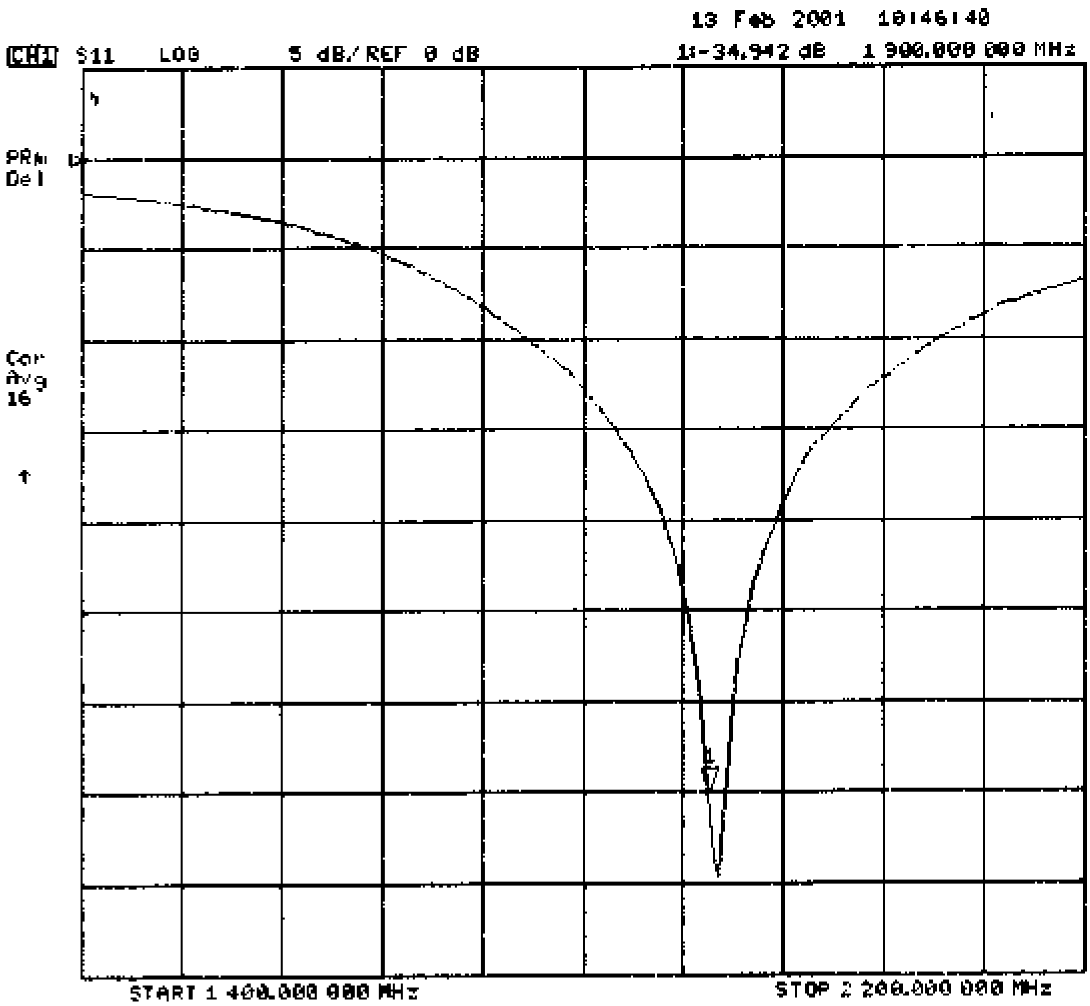
After prolonged use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

Validation Dipole D1900V2 SN:511, d = 10 mm

Frequency: 1900 MHz; Antenna Input Power: 250 [mW]
Generic Twin Phantom; Flat Section; Grid Spacing: Dx = 15.0, Dy = 15.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.57,5.57,5.57) at 1800 MHz: IEEE1528 1900 MHz ; σ = **1.47** mho/m ϵ_r = **39.2** ρ = 1.00 g/cm³
Cubes (2). Peak: 20.6 mW/g ± 0.02 dB, SAR (1g): **10.7** mW/g ± 0.03 dB, SAR (10g): 5.47 mW/g ± 0.03 dB, (Worst-case extrapolation)
Penetration depth. 7.9 (7.4, 9.1) [mm]
Powerdrift. 0.00 dB

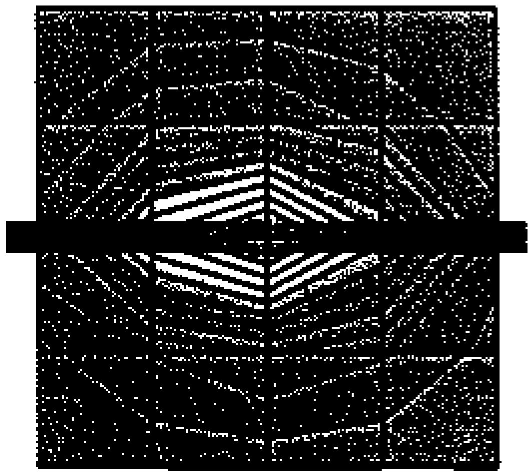


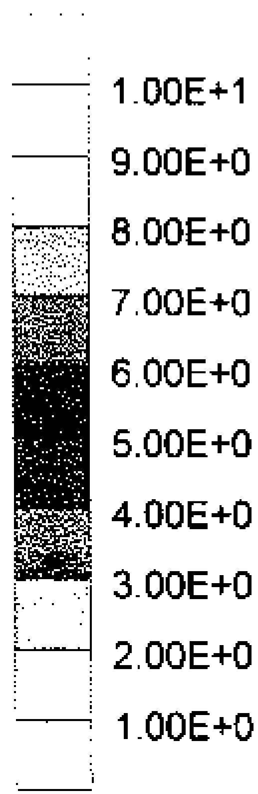

13 Feb 2001 10:46:52
CH1 S11 1 U FS
1: 50.137 Ω -1.5078 Ω 55.555 pF 1 900.000 000 MHz
PRm
Del
Cor
Avg
16
START 1 400.000 000 MHz
STOP 2 200.000 000 MHz

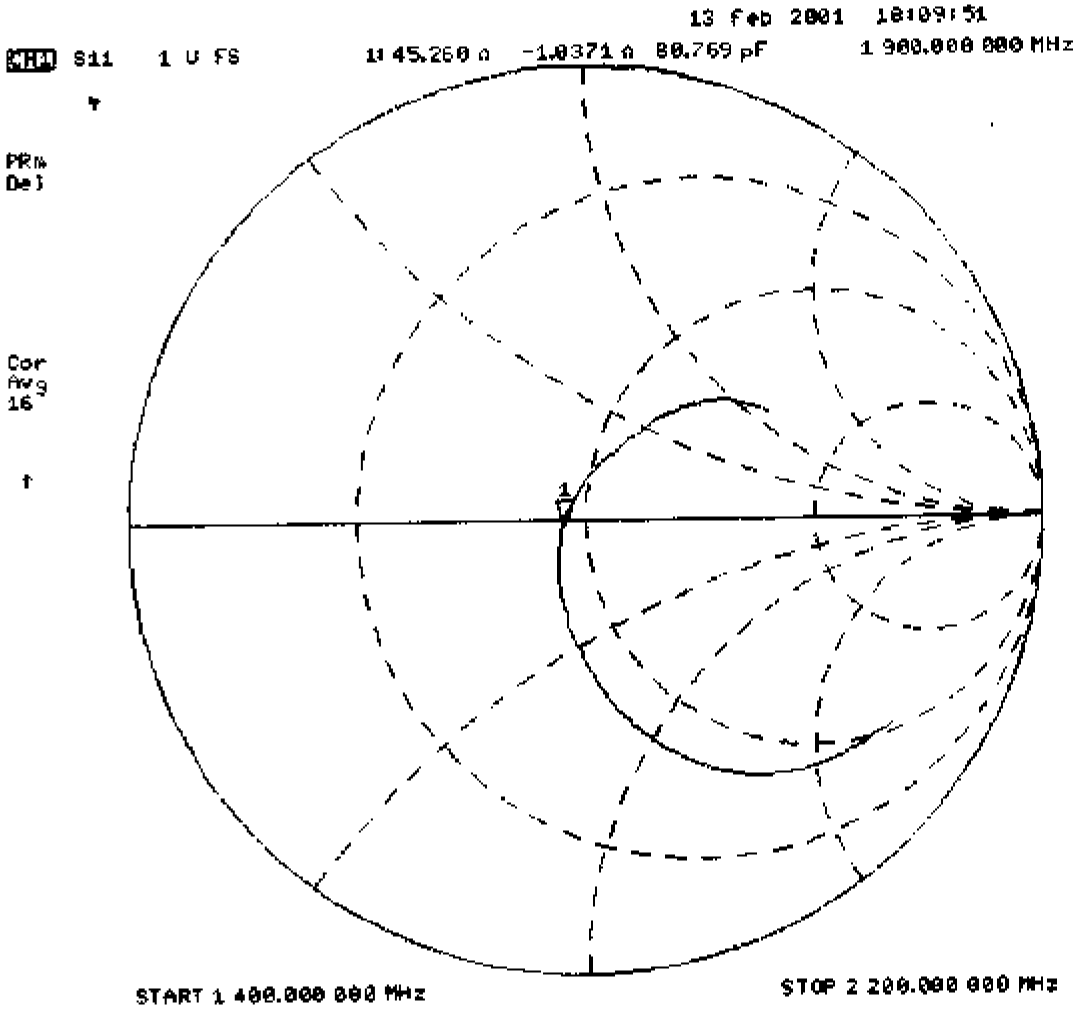

13 Feb 2001 10:46:40
CH1 S11 LOG 5 dB/ REF 0 dB
1:-34.942 dB 1 900.000 000 MHz
PRm
Del
Cor
Avg
16
1
START 1 400.000 000 MHz
STOP 2 200.000 000 MHz

Validation Dipole D1900V2 SN:511, d = 10 mm

Frequency: 1900 MHz; Antenna Input Power: 250 [mW]
Generic Twin Phantom; Flat Section; Grid Spacing: Dx = 15.0, Dy = 15.0, Dz = 10.0
Probe: ET3DV6 - SN1507: ConvF(4.85,4.85,4.85) at 1800 MHz; **Muscle 1900 MHz: σ = 1.46 mho/m ε_r = 53.5 ρ = 1.00 g/cm³**
Cubes (2): Peak: 20.0 mW/g ± 0.06 dB, SAR (1g): 10.6 mW/g ± 0.05 dB, SAR (10g): 5.49 mW/g ± 0.04 dB, (Worst-case extrapolation)
Penetration depth: 8.7 (7.9, 10.3) [mm]
Powerdrift: 0.01 dB






13 feb 2001 10:09:51
CH1 S11 1 U FS
1: 45.260 Ω -1.0371 Ω 80.769 pF 1 900.000 000 MHz
PRm
Del
Cor
Avg
16
1
START 1 400.000 000 MHz
STOP 2 200.000 000 MHz