



**MOTOROLA**

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SAR Test Report for Motorola portable cellular phone (FCC ID IHDT5ZR1).

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## 1. Introduction

The Motorola Personal Communications Sector Product Safety Laboratory has performed measurements of the maximum potential exposure to the user of portable cellular phone FCC ID IHDT5ZR1. The Specific Absorption Rate (SAR) of this product was measured. This report details the test setup and equipment as well as the results of those tests.

## 2. Applicable Regulations

Federal Communications Commission rule §2.1093(d)(2), the ANSI/IEEE C95.1 1992 and the NCRP Report Number 86 specify the maximum exposure limit of 1.6 W/kg as averaged over any 1 gram of tissue for portable devices being used within 20cm of the user in the uncontrolled environment.

## 3. Description of Test Sample

This phone is available in two different shaped products, the Talkabout™ phone and the V.™ phone. The two phone products are exactly the same except for the shape of the plastic housing. All electrical parameters are the same for both phone shapes. A prototype unit serial number FCF40015 was measured with the Talkabout™ phone housing. This unit is identical in physical construction, maximum radiated power levels and antenna structure to units that will be in production. It transmits in the frequency range of 824 to 849 MHz using AMPS mode and TDMA mode. The unit was tested at its maximum transmitter power. The antenna has a single operating position as shown in figure 1 and figure 2.



Figure 1. Front of Talkabout™  
Phone Housing



Figure 2. Side of Talkabout™  
Phone Housing

Figures 3 show the Talkabout™ phone test unit as it is placed onto the Motorola phantom. For the purposes of the actual SAR tests the Motorola phantom head is tilted on its side by 90 degrees so that a vertically oriented measurement probe can easily scan an area where the phone is in close contact with the phantom and the SAR will be the highest.



Figure 3. Talkabout™™ Housing against Left Side of Phantom Head

For the V.™ phone housing, a prototype unit serial number FCF4001E was measured. This unit is identical in physical construction, maximum radiated power levels and antenna structure to units that will be in production. It transmits in the frequency range of 824 to 849 MHz using AMPS mode and TDMA mode. The unit was tested at its maximum transmitter power. The antenna has a single operating position as shown in figure 4 and figure 5.



Figure 4. Front of V.™ Phone



Figure 5. Side of V.™ Phone

Figure 6 show the V.™ phone test unit as it is placed onto the Motorola phantom. For the purposes of the actual SAR tests the Motorola phantom head is tilted on its side by 90 degrees so that a vertically oriented measurement probe can easily scan an area where the phone is in close contact with the phantom and the SAR will be the highest.

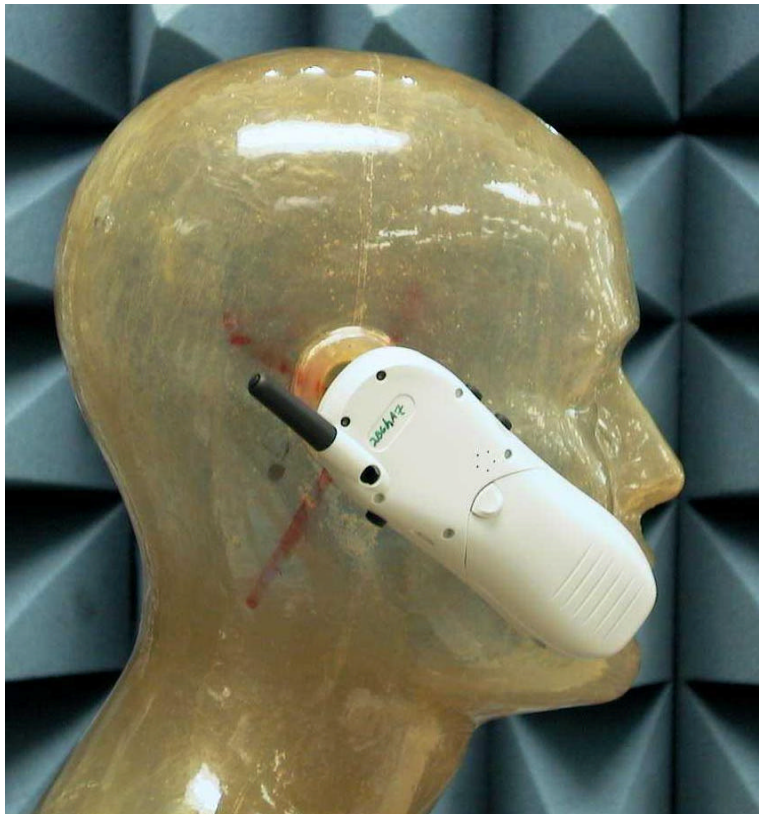


Figure 6. V.™ Phone Housing against Right side of Phantom Head

#### **4. SAR Test Facility**

The Motorola test facility utilized for the SAR testing of this product is the Personal Communications Sector Product Safety Laboratory, in Harvard Illinois. The laboratory utilizes a Dosimetric Assessment System (Dasy™) SAR measurement system manufactured by Schmid & Partner Engineering AG (SPEAG™), of Zurich Switzerland. This system utilizes a computer controlled six axis robot to move a measurement probe to measure the SAR. A photo of the Dasy™ system with the Motorola phantom is shown in figure 7.

Probe serial number 1103 was used for the measurements of the Talkabout™ phone. It was calibrated at SPEAG™, and has a calibration date of April 20,1999. Dipole Validation Kit type D835V2, serial number 414 was used to validate the system accuracy. The validation SAR value is 8.56 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.12 mW/g normalized to 1 Watt. This is within the required accuracy, and thus the measured SAR values are considered correct. See appendix E for printout of the validation test from the Dasy™ measurement system.

Probe serial number 1391 was used for the measurements of the V.™ phone. It was calibrated at SPEAG™, and has a calibration date of October 6,1999. Dipole Validation Kit type D835V2, serial number 414 was used to validate the system accuracy. The validation SAR value is 8.56 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.12 mW/g normalized to 1 Watt. This is within the required accuracy, and thus the measured SAR values are considered correct. See appendix E for printout of the validation test from the Dasy™ measurement system.

The measurement methodology is described in IEEE Transactions on Vehicular Technology, vol. 44, no. 3, August 1995, titled Electromagnetic Energy Exposure of Simulated users of Portable Cellular Telephones. The Dasy™ system is operated per the instructions in the Dasy™ Users Manual. The entire manual is available directly from SPEAG™.

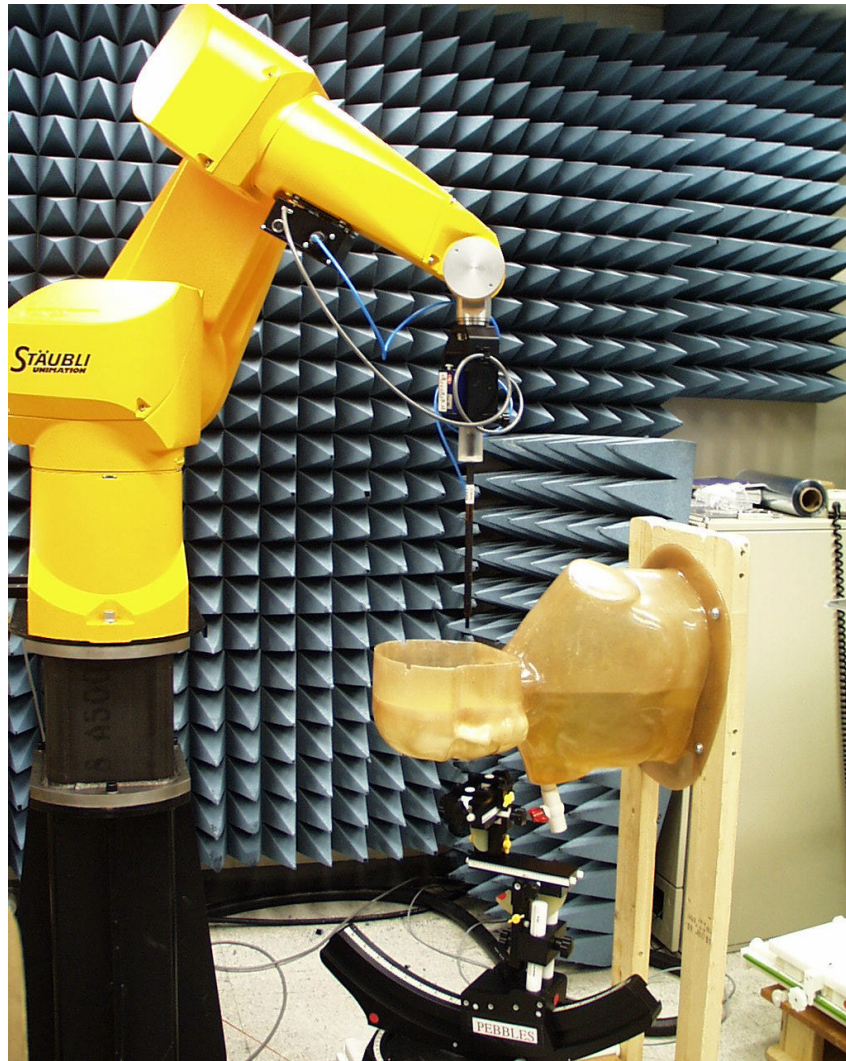


Figure 7. Dasy™ System

## 5. Test Sample Conditions

For the purposes of these tests the subject phones were positioned on the measurement phantom per the instructions in the Motorola users manual for the subject phone. The position used for the tests is the 3-point contact position. In this position the test sample contacts the phantom's ear and cheek and is positioned with a repeatability of better than  $\pm 6\%$ . Since the antenna is not located on the center of the phone, the SAR was measured with the phone on both the left and right side talk positions (See figures 3 and 6). Due to the construction of the phone, for both phone housings, the base of the antenna is 26 mm away from the phantom for the left side head, which is the closest.

The test samples are capable of operation in a test mode that allows control of the transmitter without the need to place actual phone calls. This guarantees that the unit does not change its transmitter power, and that the resultant SAR values will not be affected by external connections. For the purposes of this test the unit is commanded to test mode and manually set to the proper channel, transmitter power level and transmit mode of operation. The phone is then placed in the SAR measurement system with a fully charged battery. At the end of each

test the Dasy™ system measures the drift of the SAR at a fixed point in the phantom so as to ensure that the test sample has not changed in transmitter power. For the purposes of these tests, the transmitter was operated at the highest transmitter output and with the phone and module on both left and right side talk positions.

## 6. Method of Measurement

The system is instructed to scan as much of the face of the phone as is in close proximity to the phantom. Using the information gained about the general region of highest SAR, the system then automatically scans a smaller area centered around the location of peak spatial SAR. During this scan the system automatically measures the fall off of electric field strength as the measurement probe is moved away from the inner surface of the phantom in the direction of the local normal to the phantom surface. Using appropriate probe calibration techniques, the SAR in 1 gram of phantom tissue is then calculated.

For the Talkabout™ phone tests the phantom head, shown in figures 3 & 6, was filled with a liquid having relative dielectric constant equal to 46.8 and conductivity equal to 0.85 S/m. This mixture is a good dielectric equivalent of the human head. The composition of the liquid mixture is as follows: 42.5% water; 55.6.0% sugar; 0.8% salt, 1% HEC; and 0.1% bactericide.

For the V.™ phone tests the phantom head, shown in figures 3 & 6, was filled with a liquid having relative dielectric constant equal to 47.3 and conductivity equal to 0.875 S/m. This mixture is a good dielectric equivalent of the human head. The composition of the liquid mixture is as follows: 42.5% water; 55.6.0% sugar; 0.8% salt, 1% HEC; and 0.1% bactericide.

## 7. Measurement Uncertainty

The overall RSS uncertainty of the measurement system is ±12.0% (K=1). The breakdown of the individual uncertainties is as follows:

<b><u>Probe Uncertainty</u></b>	<b><u>±%</u></b>
Isotropy error	7.2
Calibration error	3.3
Spatial resolution	0.5
<b><u>SAR Evaluation</u></b>	<b><u>±%</u></b>
Conductivity measurement	5.0
Environmental errors	1.0
<b><u>Peak SAR Evaluation</u></b>	<b><u>±%</u></b>
Probe positioning	1.0
Volumetric averaging	4.2
Device positioning	6.0

## 8. SAR Test Results for the Talkabout™ Housing

Figure 8 shows the Talkabout™ phone housing overlaid with a typical contour plot. The phone is placed on the phantom's head with the center of the phone's speaker at the center of the

ear, and the center line of the phone extends downward to the center of the phantom's mouth. The same orientation and phone position are used for left and right side talk positions.

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT5ZR1) with the Talkabout™ phone housing is 1.1 W/kg and was found on the right side head. A full data set output of the test conditions with the highest SAR values from each side of the phantom head are included as appendix A. The test conditions included are indicated as bold numbers in the following table. All other test conditions measured lower SAR values than those included. Note that digital mode SAR data was measured only for the test conditions that resulted in the highest analog SAR values. This is because the only difference between analog and digital modes that can impact SAR is the average transmitter power.

Analog 800 Channel	Left side head	Right side head	Conducted Power (Watts)
991	<b>0.76</b>	0.67	0.32
384	0.34	0.33	0.33
799	0.75	<b>1.10</b>	0.33

Digital 800 Channel	Left side head	Right side head	Peak Conducted Power (Watts)
25	<b>0.35</b>		0.48
600			0.48
1175		<b>0.23</b>	0.46

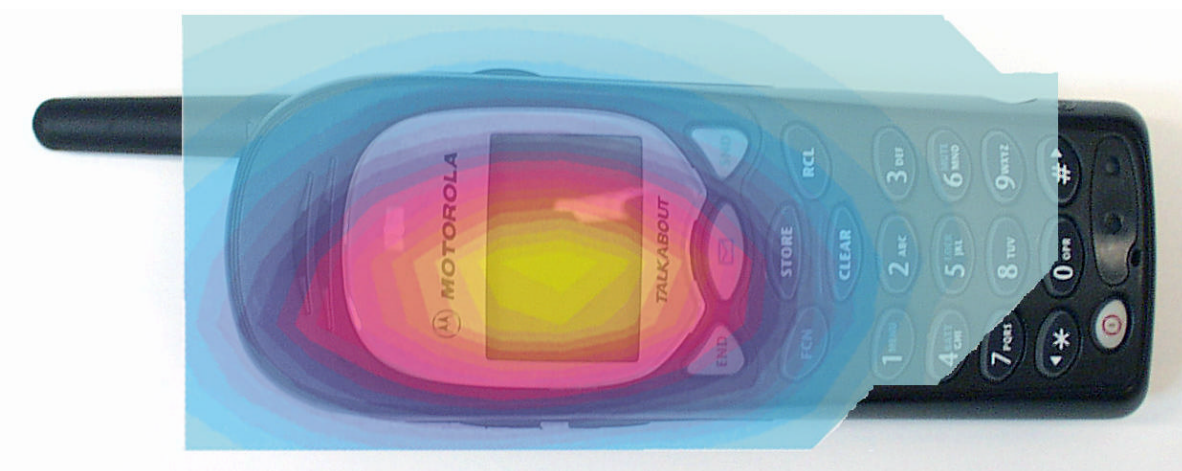


Figure 6. Contour Plot Overlaid on Face of Talkabout™ Phone Housing.

## 9. Body Worn Configuration for the Talkabout™ Phone Housing

The cellular phone (FCC ID IHDT5ZR1) with the Talkabout™ phone housing can be used in a body-worn configuration using the supplied belt clip. We have performed an evaluation to show RF exposure compliance when used with the belt clip. Figure 9 shows the test unit as it is placed onto the phantom.



Figure 9. Talkabout™ Phone Housing In Supplied Belt Clip Against Phantom

The phantom was filled with a liquid having relative dielectric constant equal to 51.87 and conductivity equal to 1.097 S/m. This mixture is a good dielectric equivalent of the human muscle. The composition of the liquid mixture is as follows: 53.5% water; 44.30% sugar; 1.1% salt, 1% HEC; and 0.1% bactericide.

The following table shows the SAR values for the body worn condition for analog mode. A full data set output of the test condition with the highest SAR values from the Dasy™ measurement system is included as appendix B. The test condition included is indicated as a bold number in the following table. All other test conditions measured lower SAR values than those included. The location of highest SAR was the area near the antenna.

Analog 800 Channel	Belt Clip
991	0.23
384	0.13
799	<b>0.33</b>

## 10. SAR Test Results for the V.™ Phone Housing

Figure 10 shows the V.™ phone housing overlaid with a typical contour plot. The phone is placed on the phantom's head with the center of the phone's speaker at the center of the ear, and the center line of the phone extends downward to the center of the phantom's mouth. The same orientation and phone position are used for left and right side talk positions.

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT5ZR1) with the V.™ phone housing is 0.74 W/kg and was found on the right side head. A full data set output of the test conditions with the highest SAR values from each side of the phantom head are included as appendix C. The test conditions included are indicated as bold numbers in the following table. All other test conditions measured lower SAR values than those included. Note

that digital mode SAR data was measured only for the test condition that resulted in the highest analog SAR value. This is because the only difference between analog and digital modes that can impact SAR is the average transmitter power.

Analog 800 Channel	Left side head	Right side head	Conducted Power (Watts)
991	0.68	0.56	0.32
384	0.41	0.41	0.33
799	<b>0.69</b>	<b>0.74</b>	0.33

Digital 800 Channel	Left side head	Right side head	Peak Conducted Power (Watts)
25			0.47
600			0.48
1175		<b>0.19</b>	0.42

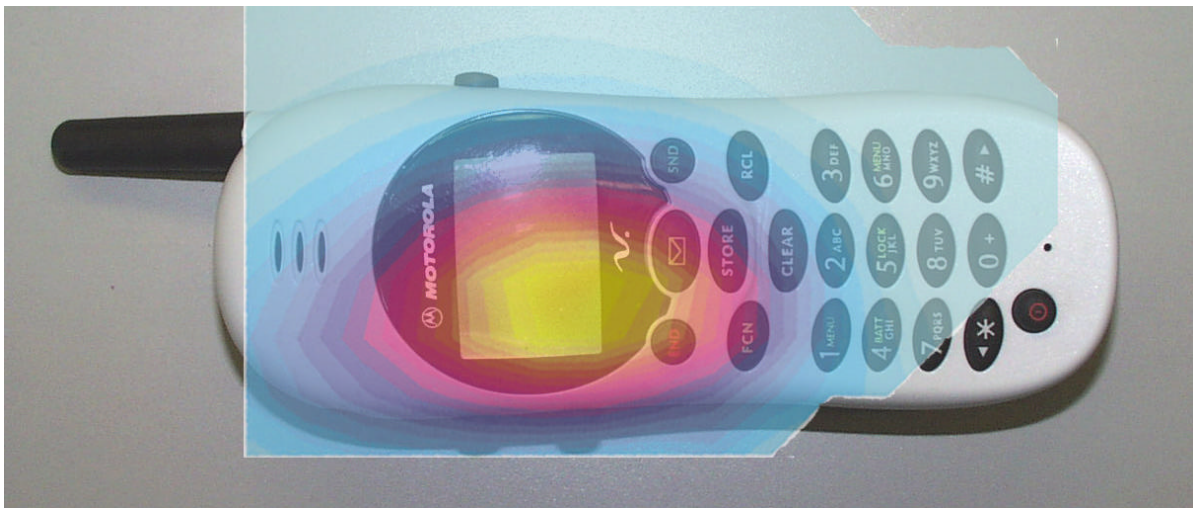


Figure 10. Contour Plot Overlaid on Face of V.™ phone Housing.

### 11. Body Worn Configuration for the V.™ Phone Housing

The cellular phone (FCC ID IHDT5ZR1) with the V.™ phone housing can be used in a body-worn configuration using the supplied belt clip. We have performed an evaluation to show RF exposure compliance when used with the belt clip. Figure 11 shows the test unit as it is placed onto the phantom.

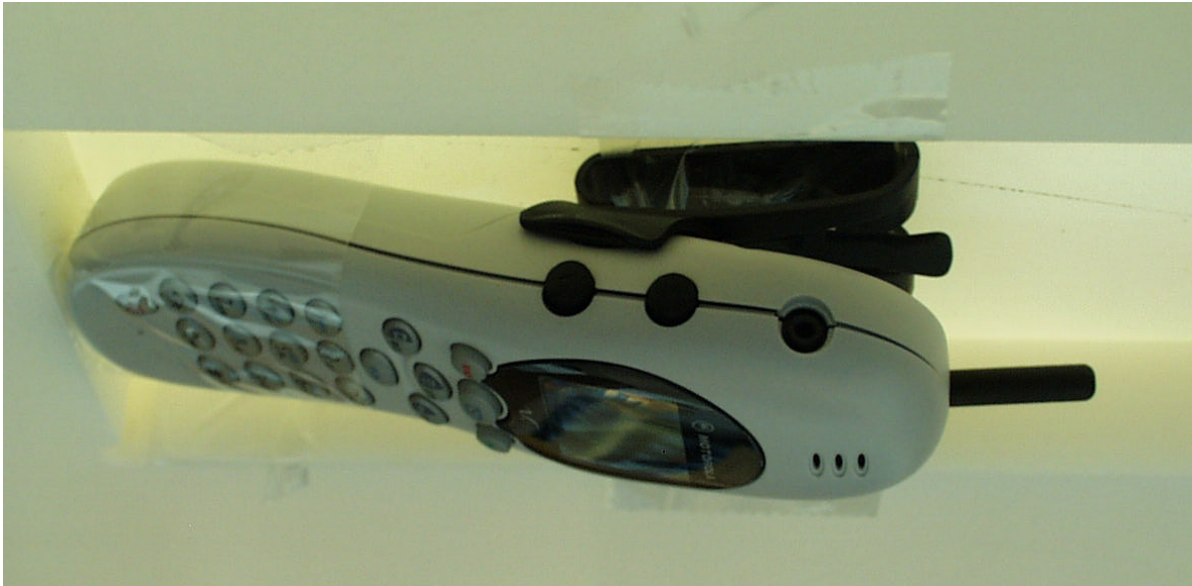


Figure 11. V.™ Phone Housing In Supplied Belt Clip Against Phantom

The phantom was filled with a liquid having relative dielectric constant equal to 51.87 and conductivity equal to 1.097 S/m. This mixture is a good dielectric equivalent of the human muscle. The composition of the liquid mixture is as follows: 53.5% water; 44.30% sugar; 1.1% salt, 1% HEC; and 0.1% bactericide.

The following table shows the SAR values for the body worn condition for analog mode. A full data set output of the test condition with the highest SAR values from the Dasy™ measurement system is included as appendix D. The test condition included is indicated as a bold number in the following table. All other test conditions measured lower SAR values than those included. The location of highest SAR was the area near the antenna.

Analog 800 Channel	Belt Clip
991	0.26
384	0.19
799	<b>0.35</b>

## 12. Battery Options

The cellular phone (FCC ID IHDT5ZR1) with both housings use only one battery model. This model was used for all testing. There are no other battery options for this cellular phone.

## 13. Summary

The SAR values found for the portable cellular phone (FCC ID IHDT5ZR1) are below the maximum recommended levels of 1.6 W/kg.

## Appendix A

The following pages are printouts from the Dasy™ measurement system of the data for the Talkabout™ Phone Housing against the Phantom Head as indicated.

### s/n FCF40015

Ch 799/ Pwr 2 / Modulation: AMPS

Thelma Lou(right) Phantom; Right Head Section; Position: (80°,180°); Frequency: 849 MHz

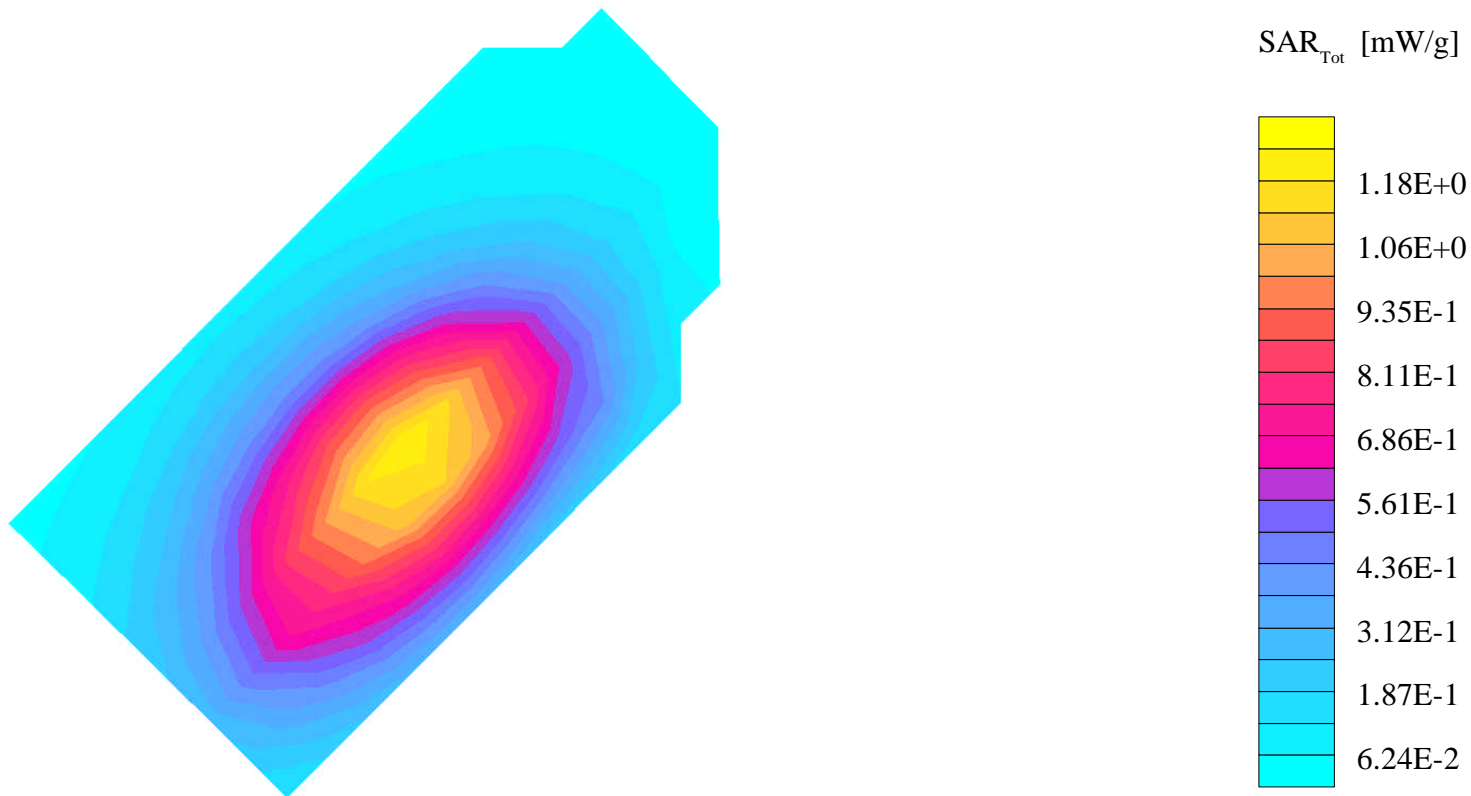
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 835MHz:  $\sigma = 0.85$  mho/m  $\epsilon_r = 46.8$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 1.10 mW/g, SAR (10g): 0.760 mW/g, (Worst-case extrapolation)

Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

Penetration depth: 16.9 (15.0, 18.6) [mm]

Powerdrift: -0.46 dB



### s/n FCF40015

Ch 991/ Pwr 2 Modulation: AMPS

Barney(left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 824 MHz

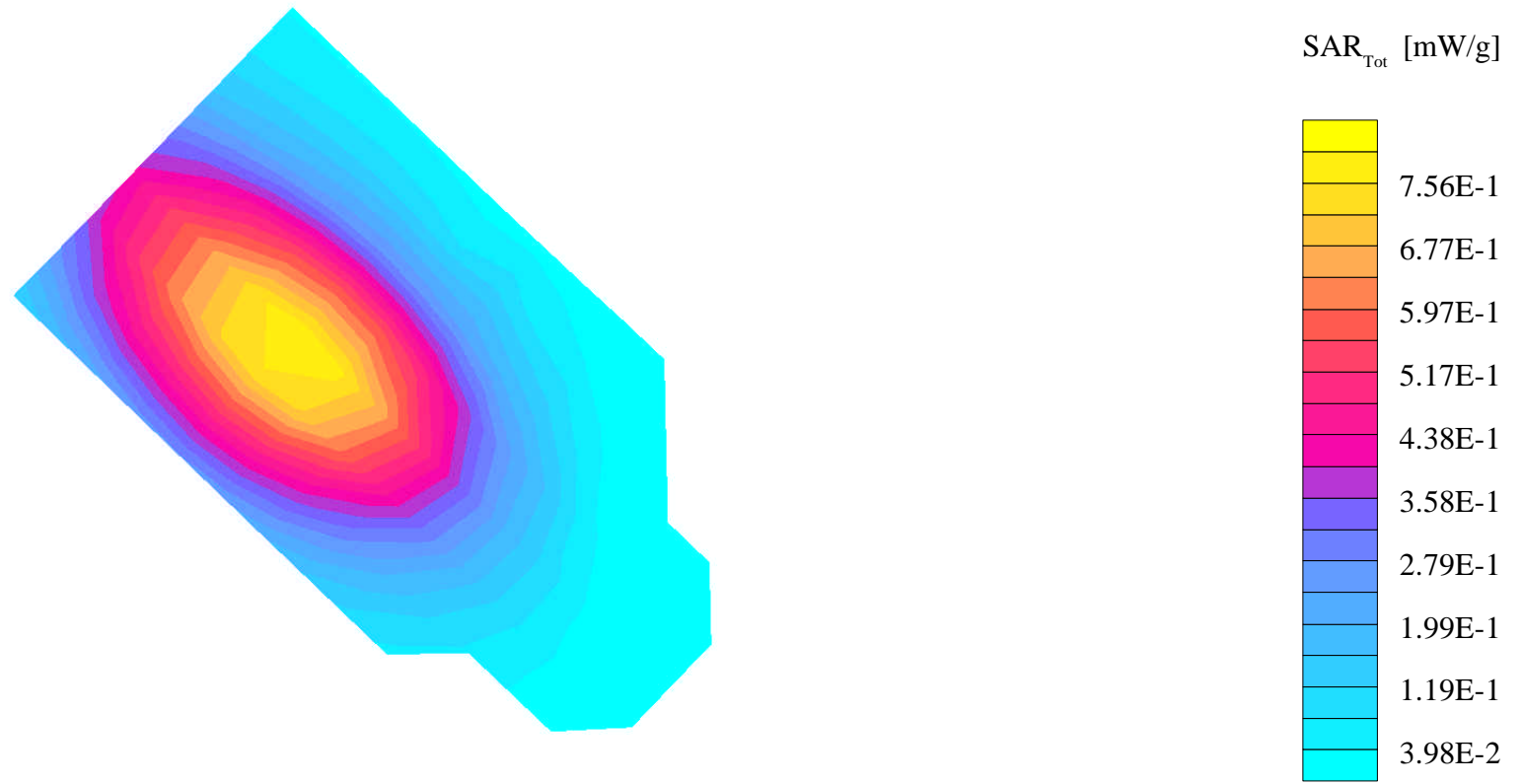
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 835MHz:  $\sigma = 0.85$  mho/m  $\epsilon_r = 45.4$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.758 mW/g, SAR (10g): 0.535 mW/g, (Worst-case extrapolation)

Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

Penetration depth: 17.2 (14.9, 19.6) [mm]

Powerdrift: -0.25 dB



### s/n FCF40015

Ch 799/ Pwr 2 / Modulation: AMPS

Thelma Lou(right) Phantom; Right Head Section; Position: (80°,180°); Frequency: 849 MHz

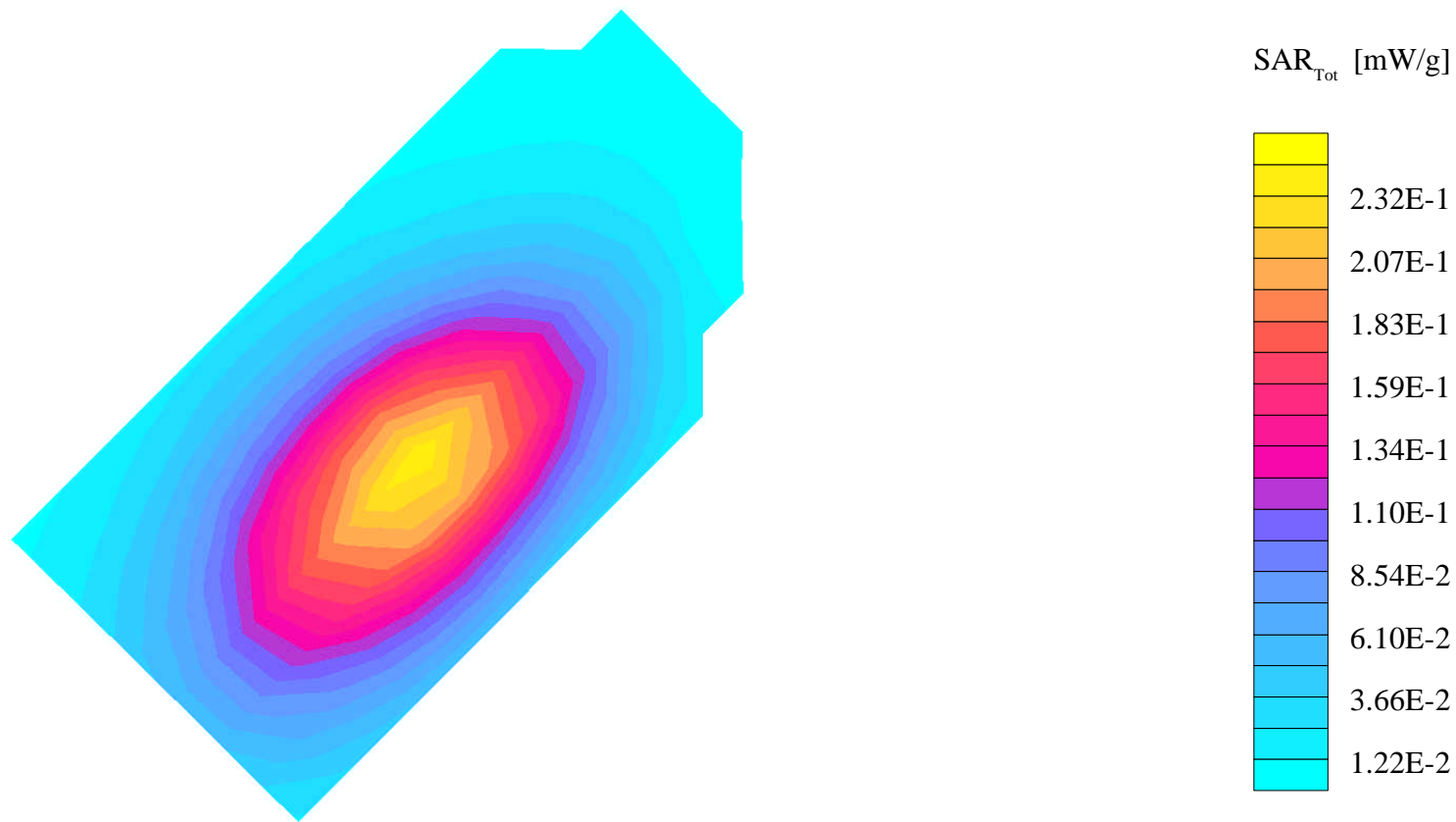
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 3.0; Brain 835MHz:  $\sigma = 0.85$  mho/m  $\epsilon_r = 46.8$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.226 mW/g, SAR (10g): 0.156 mW/g, (Worst-case extrapolation)

Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

Penetration depth: 16.9 (15.1, 18.6) [mm]

Powerdrift: -0.05 dB



### s/n FCF40015

Ch 991/ Pwr 2 / Modulation: TDMA

Barney(left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 824 MHz

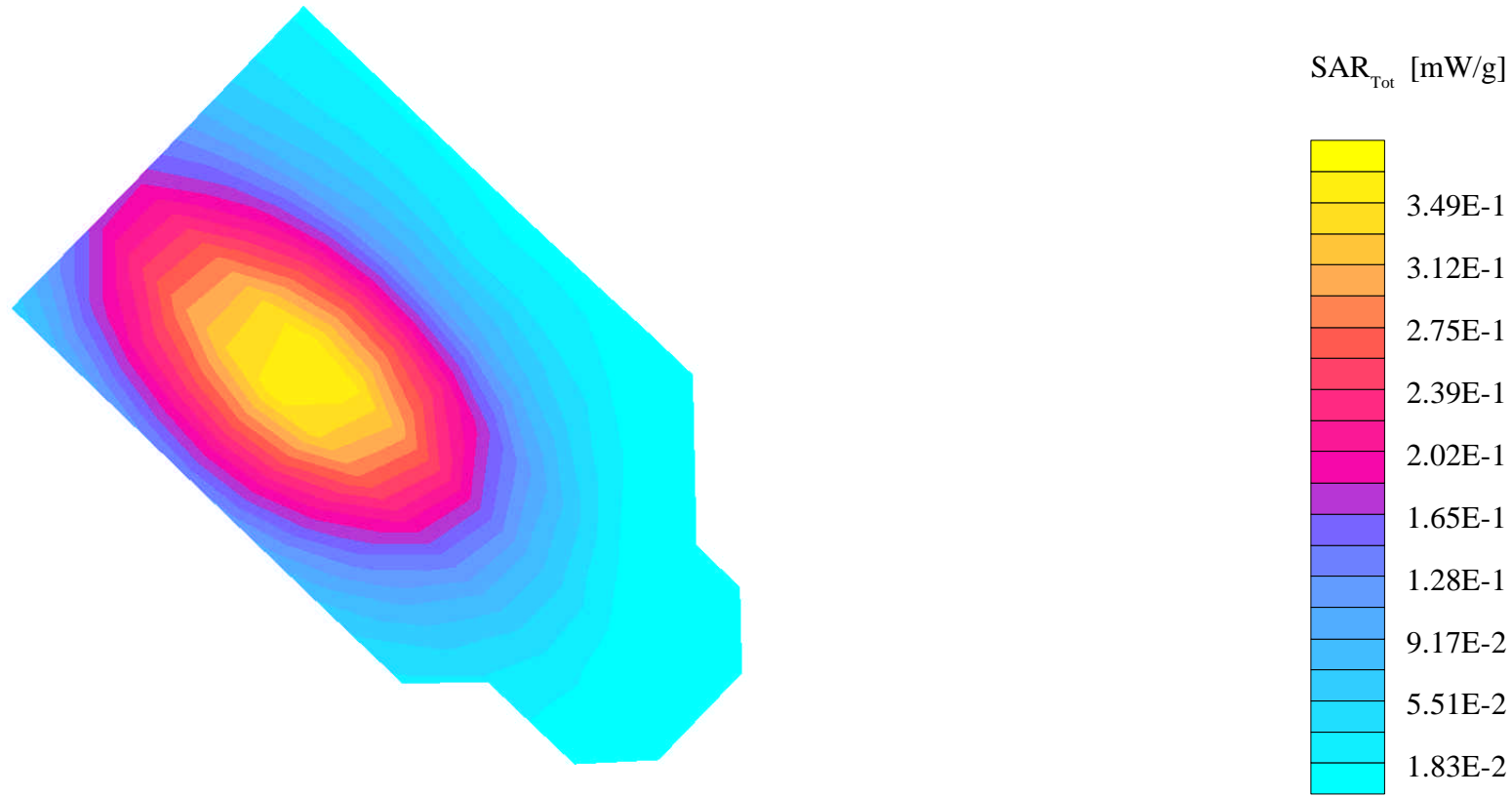
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 3.0; Brain 835MHz:  $\sigma = 0.85$  mho/m  $\epsilon_r = 45.4$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.349 mW/g, SAR (10g): 0.245 mW/g, (Worst-case extrapolation)

Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

Penetration depth: 17.2 (15.1, 19.3) [mm]

Powerdrift: -0.17 dB



## Appendix B

The following pages are printouts from the Dasy™ measurement system of the Talkabout™ Phone Housing Body-Worn Configuration data as indicated.

### s/n FCF40015

Ch 799/ Pwr 2 / Modulation: AMPS

Validation Chamber 1, Goofy Phantom; Flat Phantom Section; Position: (80°,220°); Frequency: 849 MHz

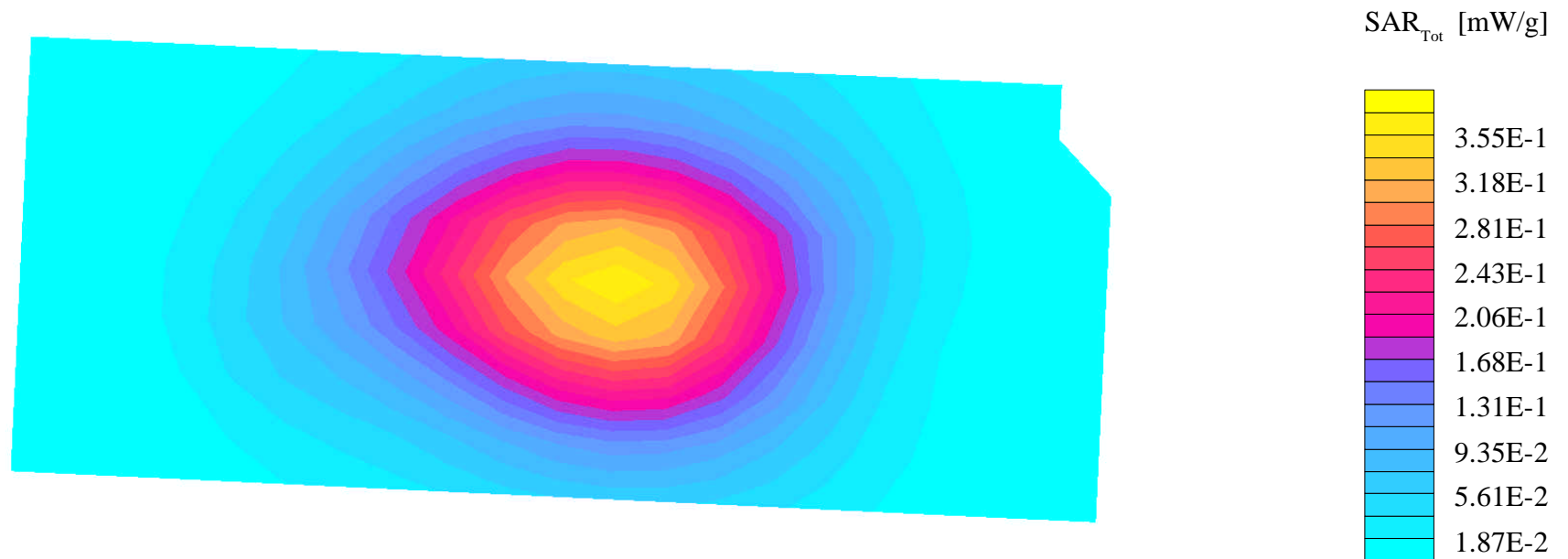
Probe: ET3DV6 - SN1391; ConvF(6.18,6.18,6.18); Crest factor: 1.0; Muscle 835 MHz:  $\sigma = 1.10$  mho/m  $\epsilon_r = 51.9$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.326 mW/g, SAR (10g): 0.226 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 12.0, Dz = 0.0

Penetration depth: 14.1 (12.3, 16.2) [mm]

Powerdrift: -1.12 dB



## Appendix C

The following pages are printouts from the Dasy™ measurement system of the data for the V.™ Phone Housing against the Phantom Head as indicated

### s/n FCF4001E

Ch 799 / Pwr 2 / Modulation: ANALOG

Mindy Right Head!!!! Phantom; Right Head Section; Position: (80°,180°); Frequency: 849 MHz

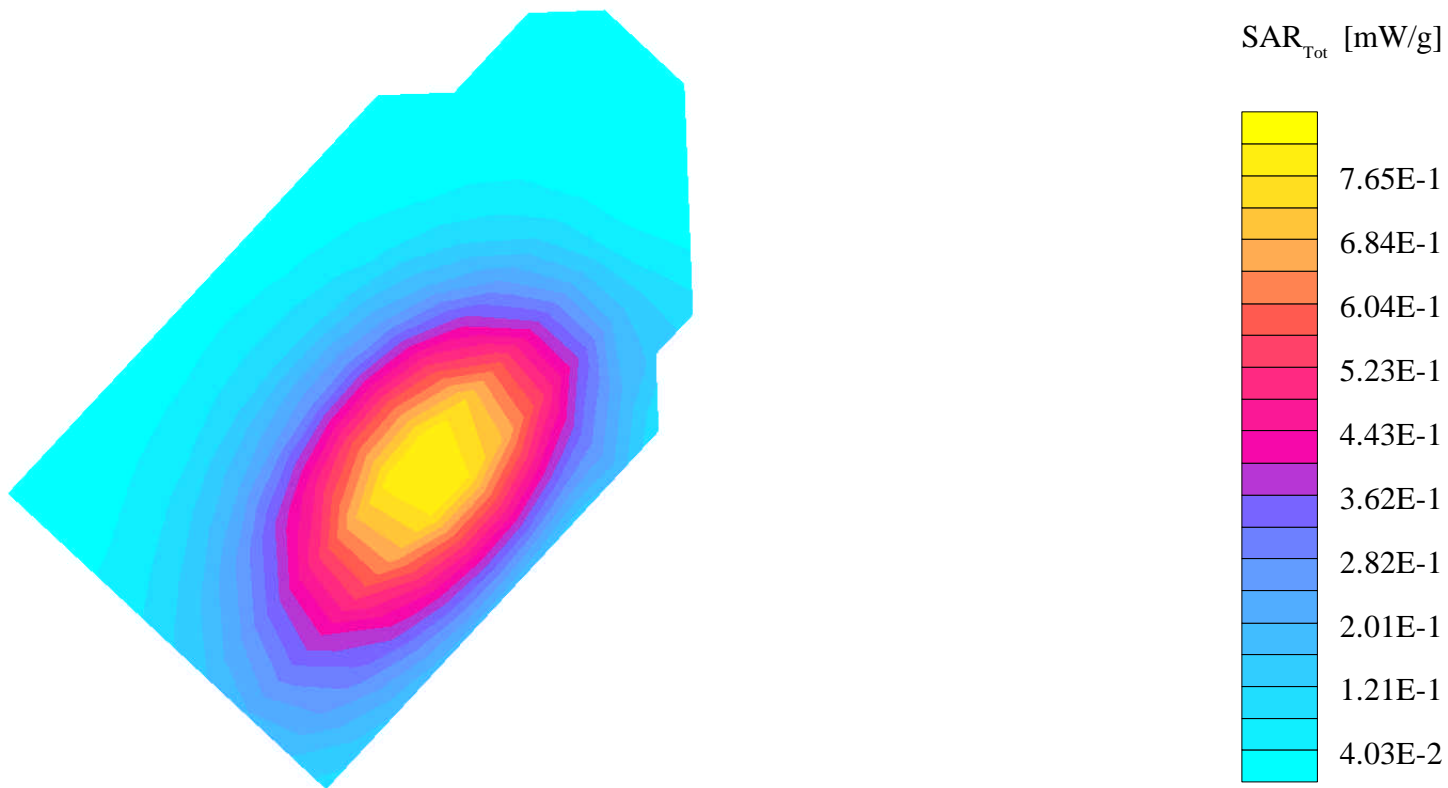
Probe: ET3DV6 - SN1391; ConvF(6.18,6.18,6.18); Crest factor: 1.0; Brain 835 MHz :  $\sigma = 0.88$  mho/m  $\epsilon_r = 47.3$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.742 mW/g, SAR (10g): 0.518 mW/g, (Worst-case extrapolation)

Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

Penetration depth: 17.3 (16.0, 18.5) [mm]

Powerdrift: -0.97 dB



### s/n FCF4001E

Ch 799 / Pwr 2 / Modulation: ANALOG

Mork(left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 849 MHz

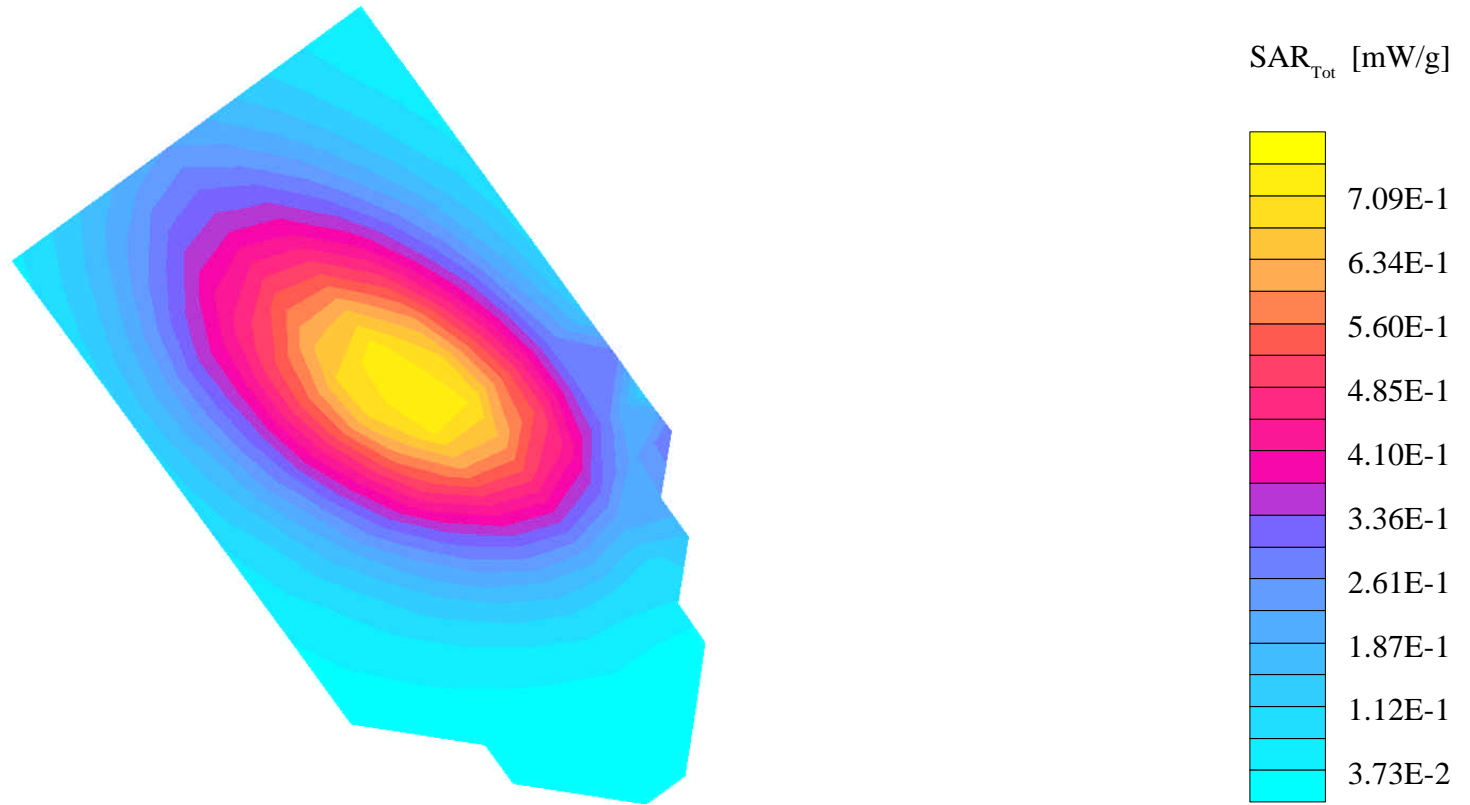
Probe: ET3DV6 - SN1391; ConvF(6.18,6.18,6.18); Crest factor: 1.0; Brain 835 MHz :  $\sigma = 0.88$  mho/m  $\epsilon_r = 41.6$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.690 mW/g, SAR (10g): 0.477 mW/g, (Worst-case extrapolation)

Coarse: Dx = 8.0, Dy = 8.0, Dz = 0.0

Penetration depth: 16.6 (14.8, 18.4) [mm]

Powerdrift: -0.58 dB



### s/n FCF4001E

Ch 799 / Pwr 2 / Modulation: TDMA

Mindy Right Head!!!! Phantom; Right Head Section; Position: (80°,180°); Frequency: 849 MHz

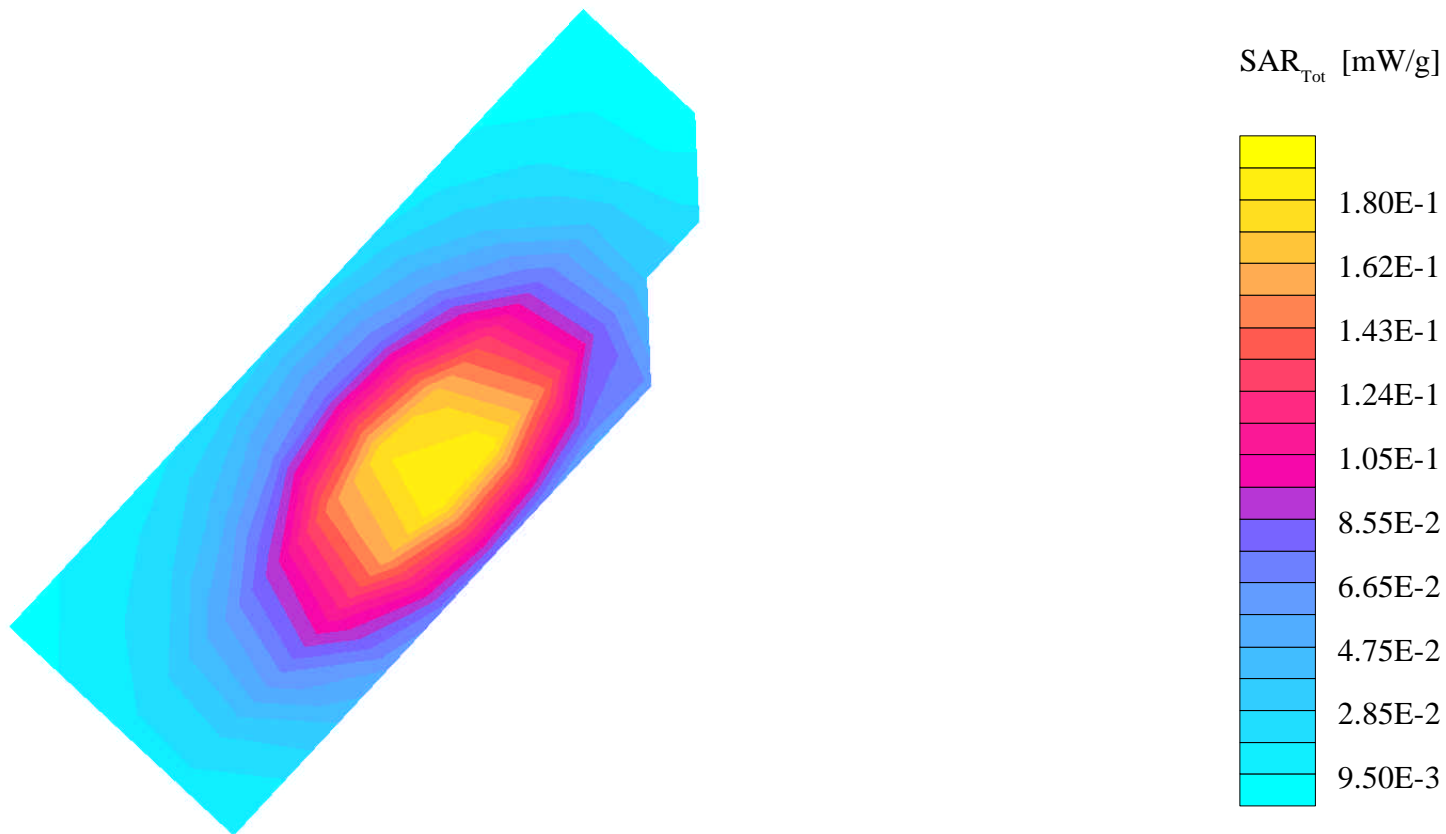
Probe: ET3DV6 - SN1391; ConvF(6.18,6.18,6.18); Crest factor: 1.0; Brain 836MHz :  $\sigma = 0.88$  mho/m  $\epsilon_r = 47.3$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.193 mW/g, SAR (10g): 0.135 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 0.0

Penetration depth: 17.4 (15.4, 19.2) [mm]

Powerdrift: -0.29 dB



## Appendix D

The following pages are printouts from the Dasy™ measurement system of the Talkabout™ Phone Housing Body-Worn Configuration data as indicated.

### s/n FCF4001E

Ch 799 / Pwr 2 / Modulation: ANALOG

Validation Chamber 1, Goofy Phantom; Flat Phantom Section; Position: (80°,180°); Frequency: 849 MHz

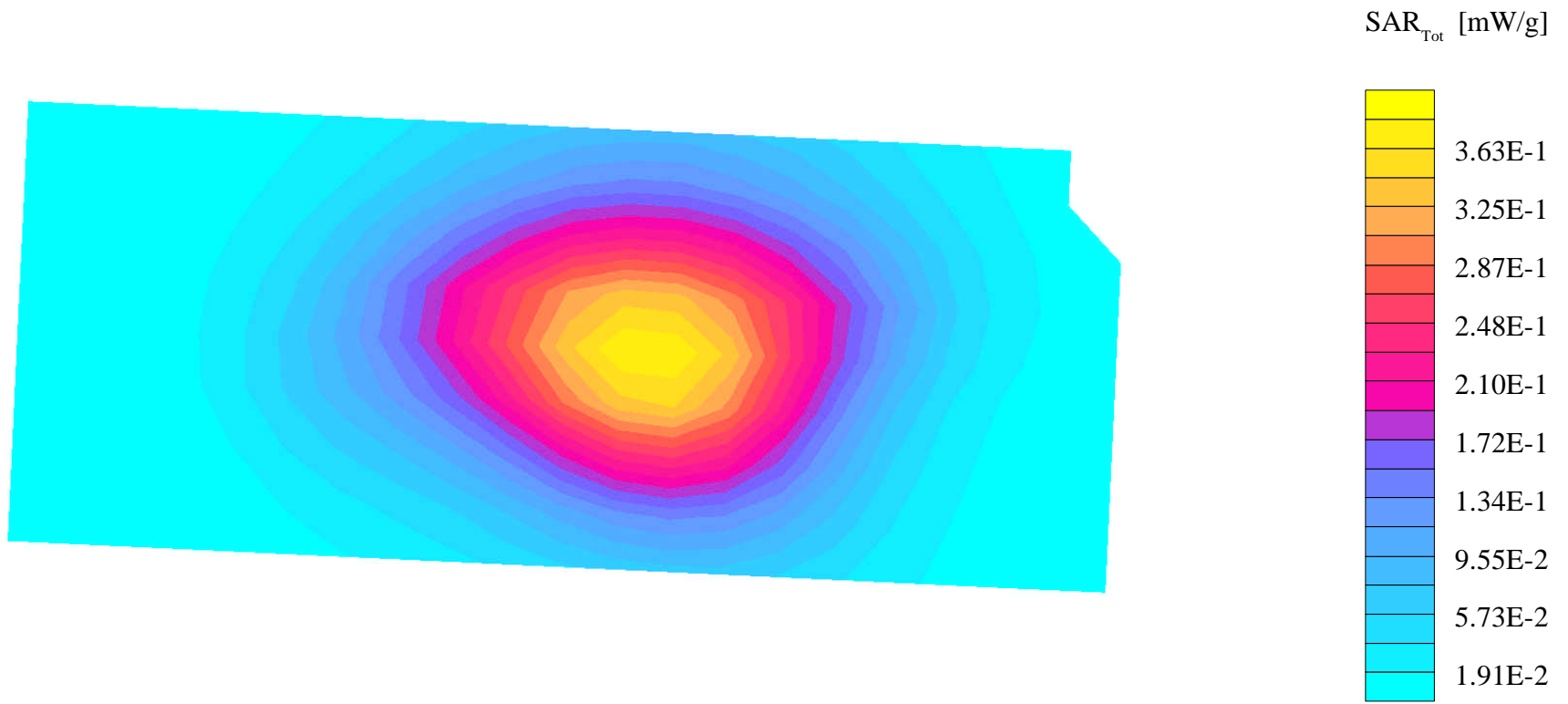
Probe: ET3DV6 - SN1391; ConvF(6.18,6.18,6.18); Crest factor: 1.0; Muscle 835 MHz:  $\sigma = 1.10$  mho/m  $\epsilon_r = 51.9$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.353 mW/g, SAR (10g): 0.243 mW/g \* Max outside, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 12.0, Dz = 0.0

Penetration depth: 14.3 (12.1, 16.8) [mm]

Powerdrift: -0.30 dB



## Appendix E

The following page is the printout from the Dasy™ measurement system validation tests.

## Dipole 835 MHz

835MHz Dipole Validation Dipole Sn# 414 / Input Power = 251mW

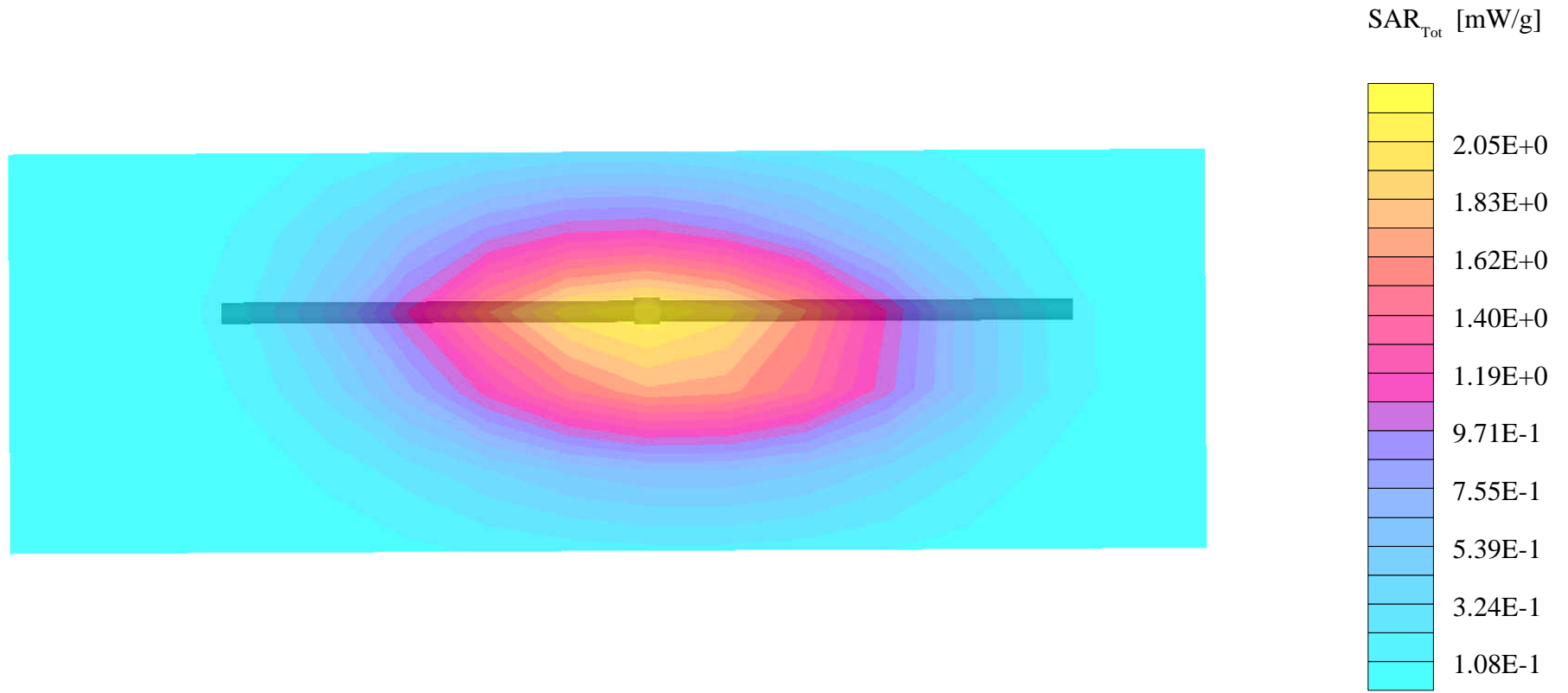
Validation Chamber 1 Pikachu; Flat Phantom

Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 835MHz:  $\sigma = 0.81$  mho/m  $\epsilon_r = 43.8$   $\rho = 1.00$  g/cm<sup>3</sup>

Cubes (2): Peak: 3.56 mW/g  $\pm 0.33$  dB, SAR (1g): 2.28 mW/g  $\pm 0.33$  dB, SAR (10g): 1.49 mW/g  $\pm 0.33$  dB, (Worst-case extrapolation)

Penetration depth: 12.6 (11.1, 14.6) [mm]

Powerdrift: 0.15 dB



## Dipole 835 Mhz

835MHz Dipole Validation Dipole Sn# 414 / Input Power = 249 mW

Validation Chamber 1, Goofy; Flat Phantom

Probe: ET3DV6 - SN1391; ConvF(6.18,6.18,6.18); Crest factor: 1.0; Brain 835 MHz :  $\sigma = 0.81$  mho/m  $\epsilon_r = 43.8$   $\rho = 1.00$  g/cm<sup>3</sup>

Cubes (2): Peak: 3.57 mW/g  $\pm 0.04$  dB, SAR (1g): 2.28 mW/g  $\pm 0.05$  dB, SAR (10g): 1.49 mW/g  $\pm 0.07$  dB, (Worst-case extrapolation)

Penetration depth: 12.8 (11.1, 15.1) [mm]

Powerdrift: 0.10 dB

