MOTOROLA

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SAR Test Report for Motorola portable cellular phone (FCC ID IHDT5ZW1).

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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 IHDT5ZW1. 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

A prototype unit serial number EDD1B346 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 CDMA mode. The unit was tested at its maximum transmitter power. The unit is equipped with a telescoping antenna that serves as both a receive and transmit antenna. The antenna has a retracted and an extended operating position as shown in figures 1 and 2 respectively.

Figure 1. Side of Phone with Antenna Retracted

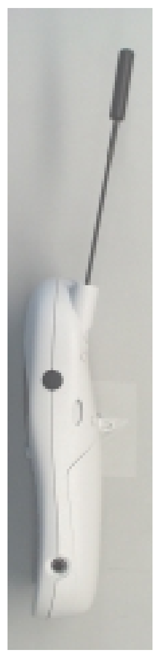


Figure 2. Side of Phone with Antenna Extended

Figures 3 and 4 show the 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. Phone against side of Phantom Head with Antenna Retracted

Figure 4. Phone against side of Phantom Head with Antenna Extended

## 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 Libertyville 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 5. Probe serial number 1508 was used for the measurements. It was calibrated at SPEAG™, and has a calibration date of October 28,1999. A copy of the calibration certificate is included as appendix C. Dipole Validation Kit type D900V2, serial number 063 was used to validate the system accuracy. The validation SAR value is 9.56 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.36 mW/g normalized to 1 Watt. This is within the required accuracy, and thus the measured SAR values are considered correct. See appendix C 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 5. Dasy™ System

## 5. Test Sample Conditions

For the purposes of these tests the subject phone was 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 ±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 4). Due to the construction of the phone, the base of the antenna is 26 mm away from the phantom for the left side head, which is the closest.

The test sample is 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 Analog mode tests the unit is commanded to test mode and manually set to the proper channel, transmitter power level and transmit mode of operation. For the purposes of the CDMA mode tests, the unit is placed in a phone call using an HP8924 and is commanded to the highest possible power by means of the “always up” command. 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. The phantom head, shown in figure 3, was filled with a liquid having relative dielectric constant equal to 43.7 and conductivity equal to 0.83 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:

| **Probe Uncertainty** | **±%** |
|---|---|
| Isotropy error | 7.2 |
| Calibration error | 3.3 |
| Spatial resolution | 0.5 |

| **SAR Evaluation** | **±%** |
|---|---|
| Conductivity measurement | 5.0 |
| Environmental errors | 1.0 |

| **Peak SAR Evaluation** | **±%** |
|---|---|
| Probe positioning | 1.0 |
| Volumetric averaging | 4.2 |
| Device positioning | 6.0 |

## 8. SAR Test Results

Figure 6 shows the phone 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 IHDT5ZW1) is 1.15 W/kg and was found on the right side head with the antenna retracted. 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.

| 800MHz Analog Channel | Left Side Head Ant Ext | Right Side Head Ant Ext | Conducted Power (Watts) |
|---|---|---|---|
| 991 | 0.38 | **0.64** | 0.47 |
| 384 | **0.43** | 0.62 | 0.49 |
| 799 | 0.27 | 0.40 | 0.47 |

| 800MHz Analog Channel | Left Side Head Ant Ret | Right Side Head Ant Ret | Conducted Power (Watts) |
|---|---|---|---|
| 991 | **0.97** | 1.12 | 0.20 |
| 384 | 0.63 | 0.88 | 0.21 |
| 799 | 0.92 | **1.15** | 0.21 |

| 800MHz CDMA Channel | Right Side Head Ant Ext | Conducted Power (Watts) |
|---|---|---|
| 1023 | 0.03 | 0.24 |
| 384 | | 0.23 |
| 779 | | 0.24 |

| 800MHz CDMA Channel | Right Side Head Ant Ret | Conducted Power (Watts) |
|---|---|---|
| 1023 | **0.19** | 0.08 |
| 384 | | 0.08 |
| 779 | | 0.08 |

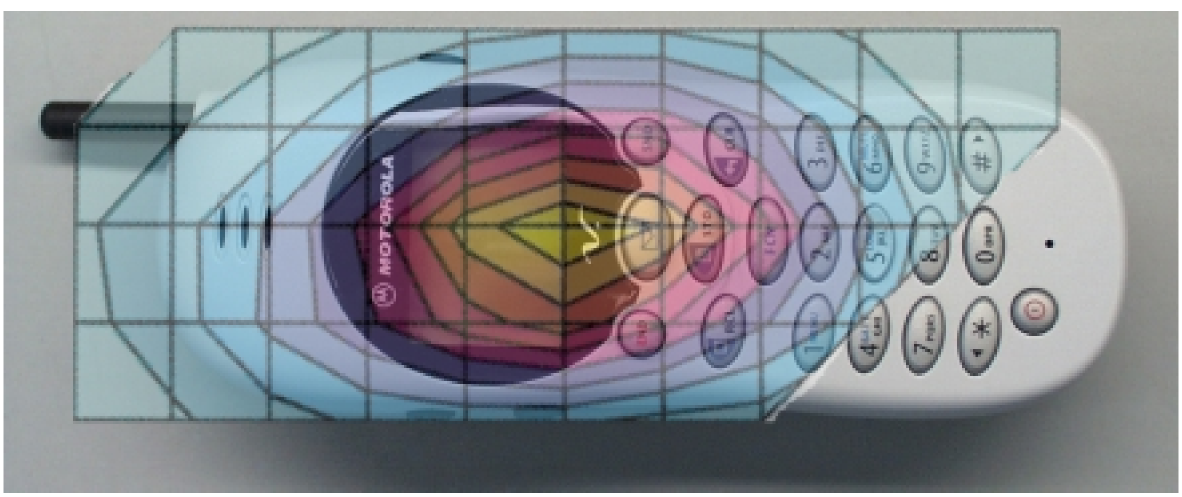



Figure 6. Contour Plot Overlaid on Face of Phone.

## 9. Body Worn Configuration

The cellular phone (FCC ID IHDT5ZW1) 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 7 shows the test unit as it is placed onto the phantom.

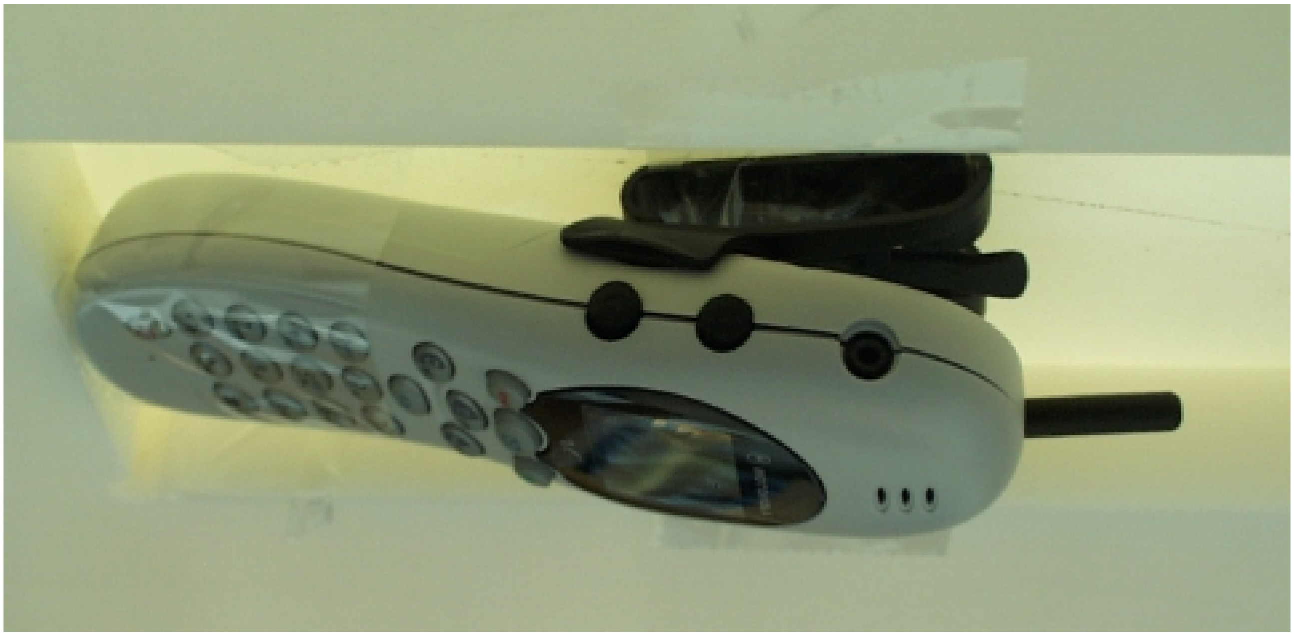


Figure 7. Phone In Supplied Belt Clip Against Phantom

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 conditions included are indicated as bold numbers 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.

| | Belt Clip | |
|---|---|---|
| Analog 800 Channel | Ant Ret | Ant Ext |
| 991 | 0.54 | **0.55** |
| 384 | 0.48 | 0.50 |
| 799 | **0.60** | 0.41 |

## 10. Battery Options

The cellular phone (FCC ID IHDT5ZW1) uses only one battery model. This model used for all testing. There are no other battery options for this cellular phone.

## 11. Summary

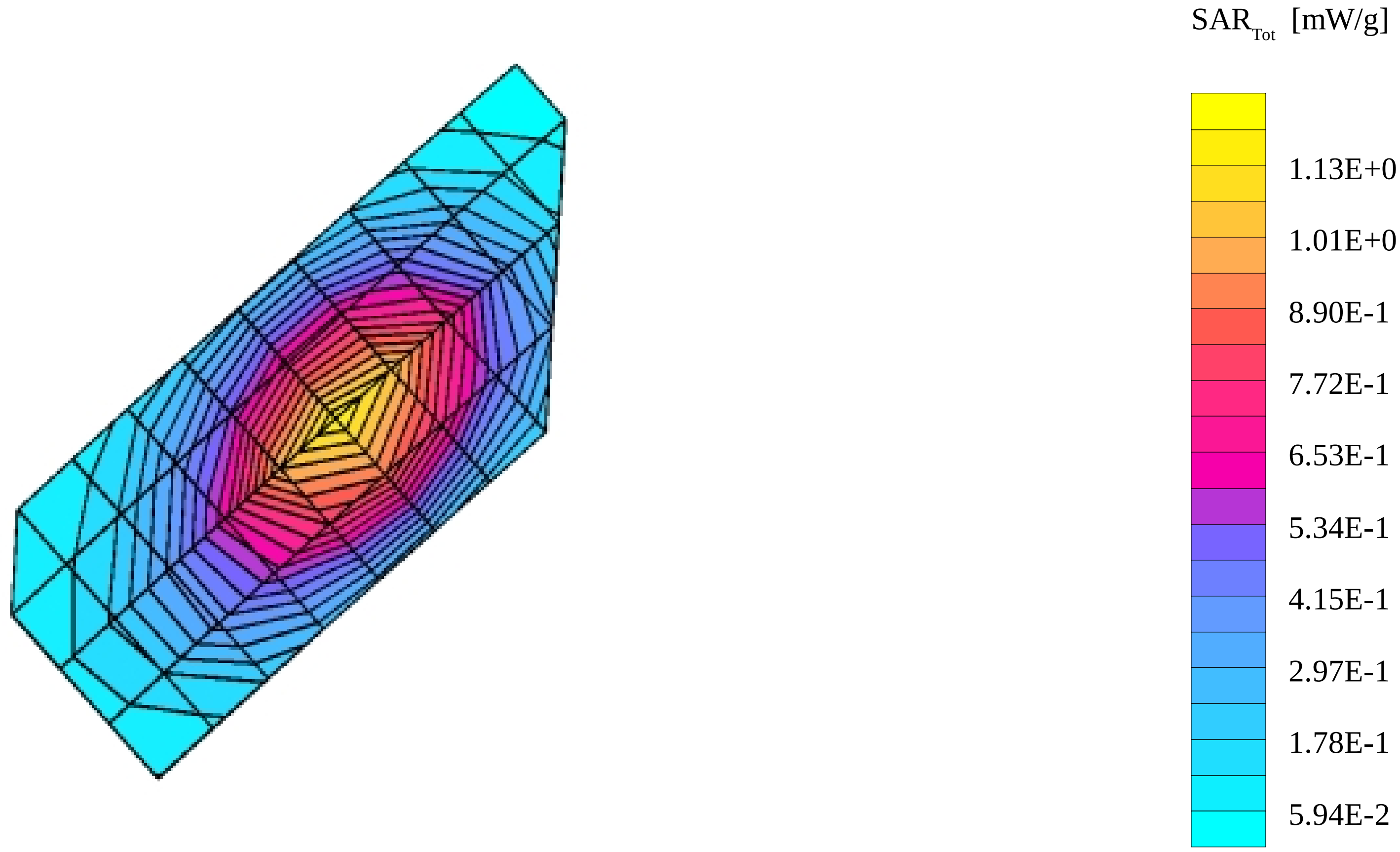
The SAR values found for the portable cellular phone (FCC ID IHDT5ZW1) are below the maximum recommended levels of 1.6 W/kg.

Appendix A

The following pages are printouts from the Dasy™ measurement system of the data as indicated.

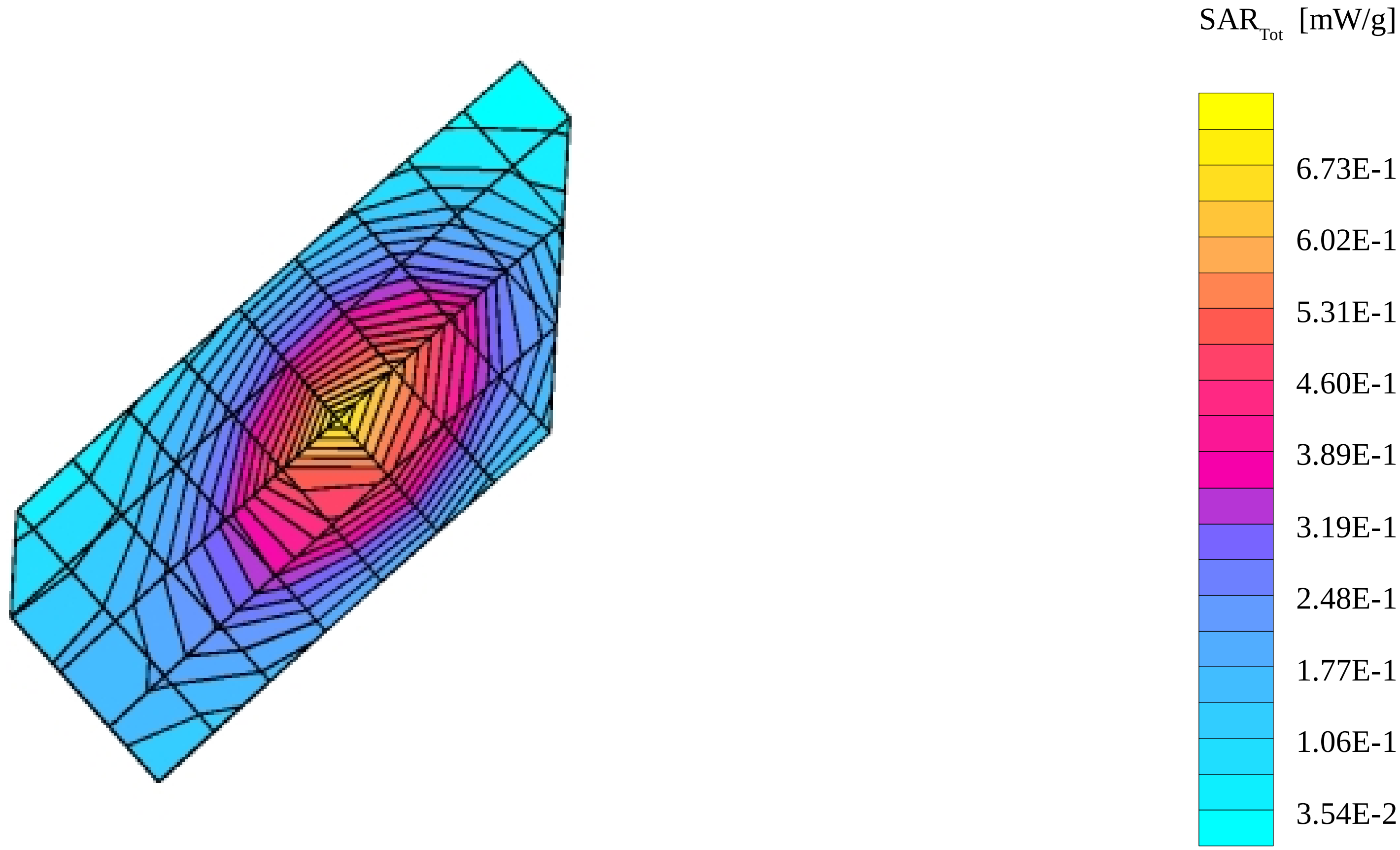
# s/n EDD1B346

Ch# 799/ Pwr 2 / Modulation: Analog / Ant: Ret
Leia Right Head Phantom; Right Head Section; Position: (80°,180°); Frequency: 824 MHz
Probe: ET3DV6 - SN1508; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Brain 835 MHz: $\sigma$ = 0.83 mho/m $\varepsilon_r$ = 43.7 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 1.15 mW/g, SAR (10g): 0.789 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Penetration depth: 16.1 (13.8, 18.6) [mm]
Powerdrift: -0.17 dB



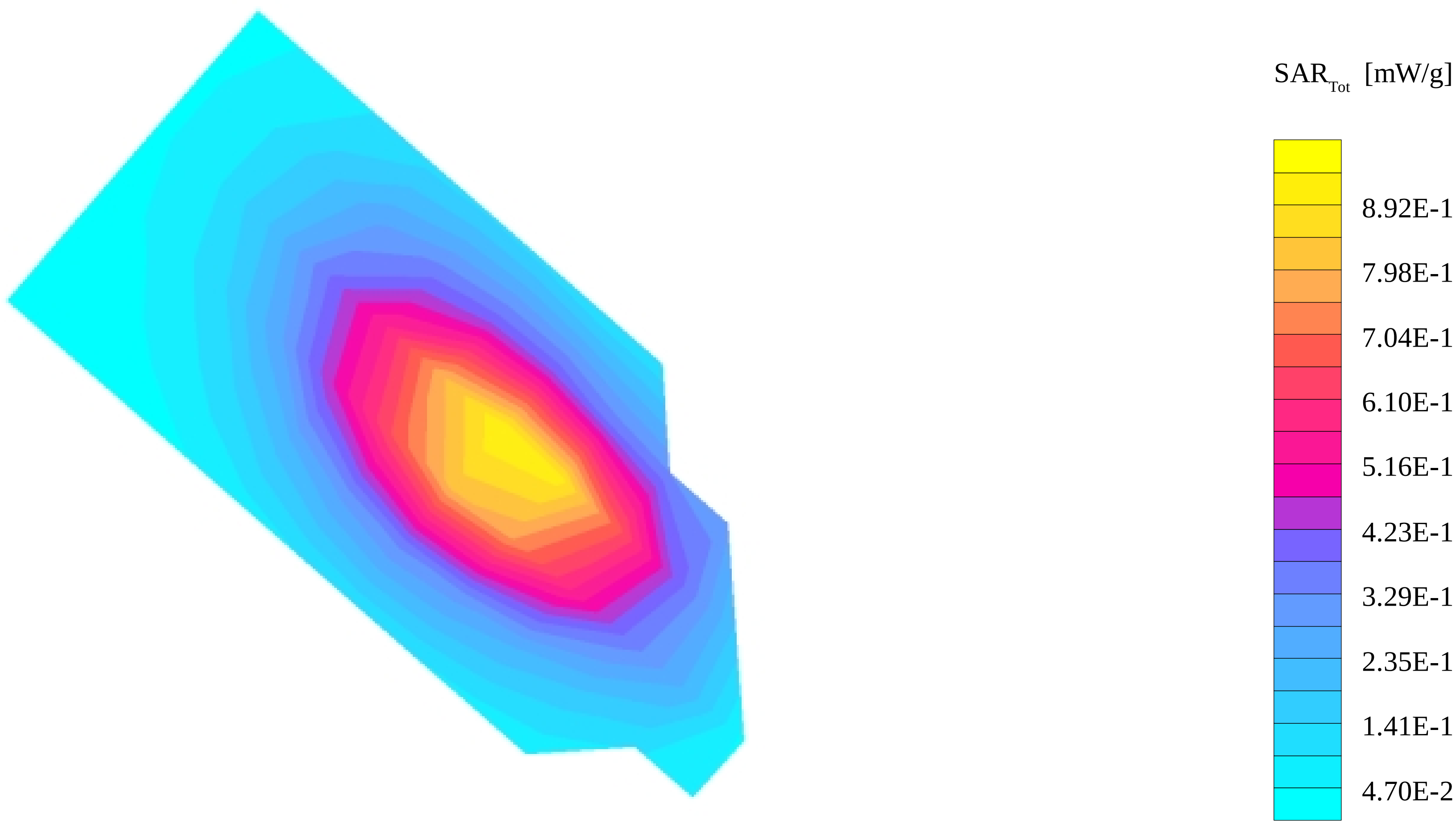
# s/n EDD1B346

Ch# 991/ Pwr 2 / Modulation: Analog / Ant: Ext
Leia Right Head Phantom; Right Head Section; Position: (80°,180°); Frequency: 824 MHz
Probe: ET3DV6 - SN1508; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Brain 835 MHz: $\sigma$ = 0.83 mho/m $\varepsilon_r$ = 43.7 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 0.636 mW/g, SAR (10g): 0.440 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Penetration depth: 16.5 (14.4, 18.7) [mm]
Powerdrift: -0.21 dB



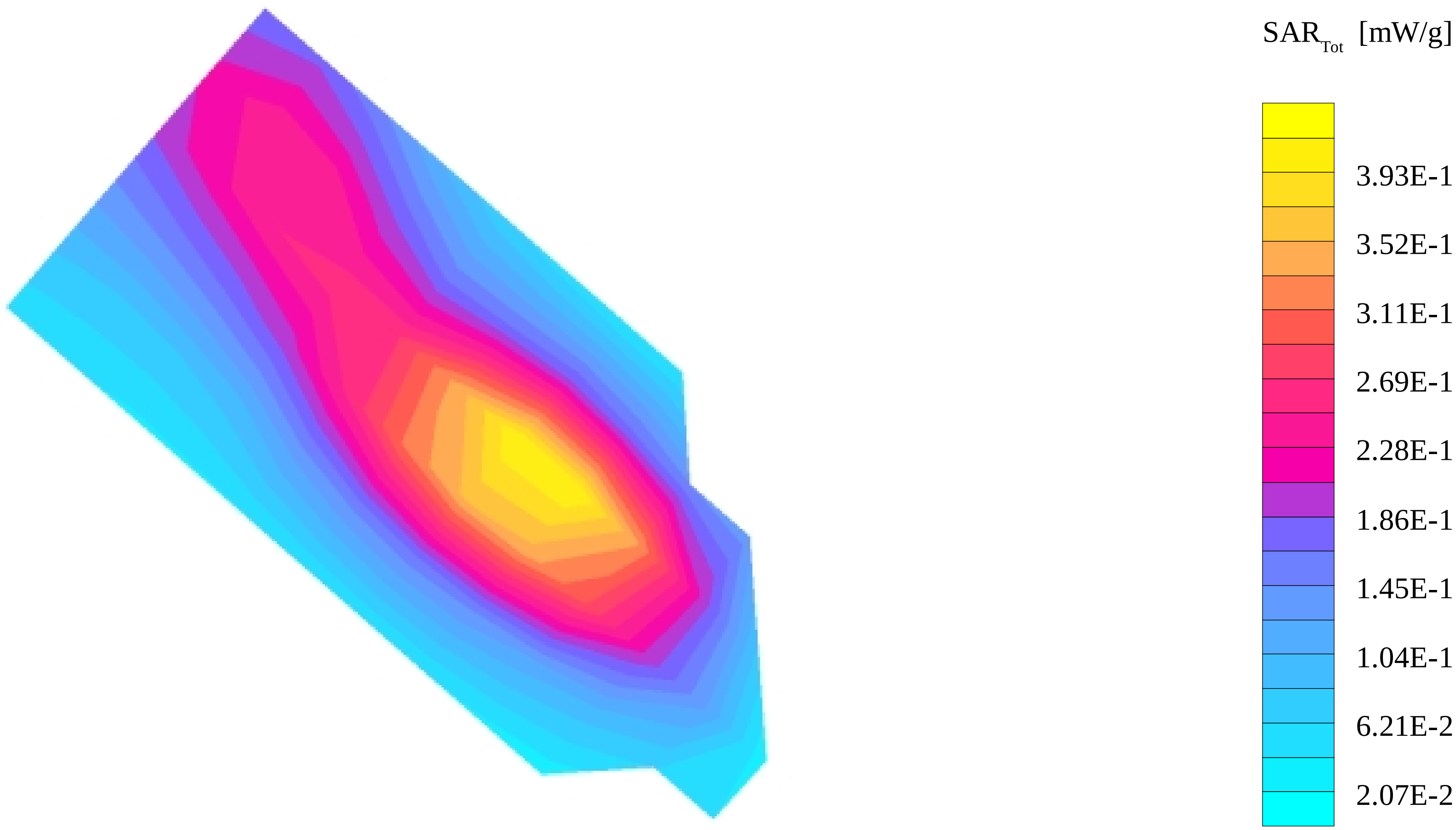
# s/n EDD1B346

Ch# 991/ Pwr 2 /Modulation: Analog / Ant: Ret
Luke Left Head Phantom; Left Head Section; Position: (80°,180°); Frequency: 824 MHz
Probe: ET3DV6 - SN1508; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Brain 835 MHz: $\sigma$ = 0.83 mho/m $\varepsilon_r$ = 43.7 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 0.971 mW/g, SAR (10g): 0.675 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 0.0
Penetration depth: 17.8 (14.8, 20.8) [mm]
Powerdrift: 0.04 dB



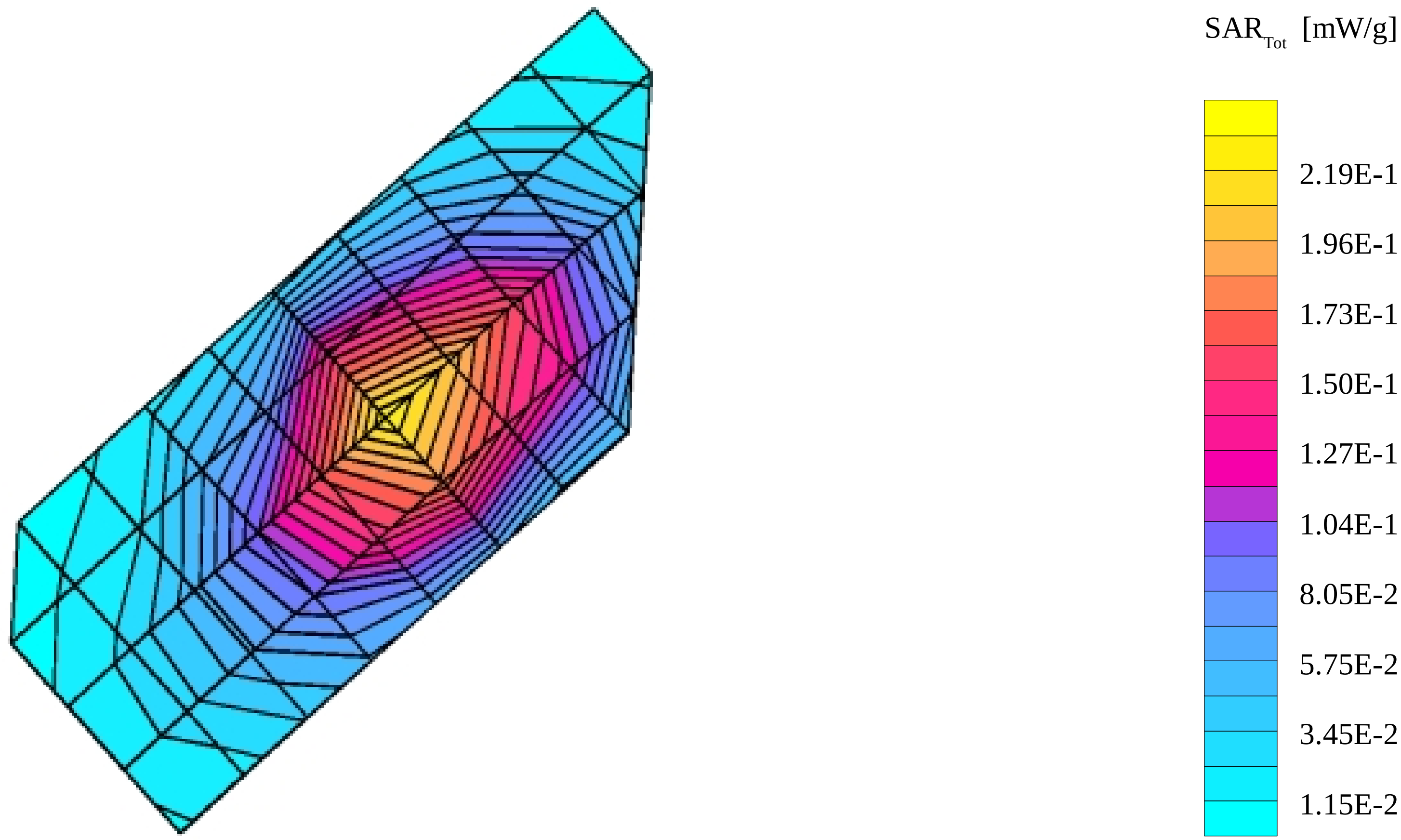
# s/n EDD1B346

Ch# 384/ Pwr 2 /Modulation: Analog / Ant: Ext
Luke Left Head Phantom; Left Head Section; Position: (80°,180°); Frequency: 824 MHz
Probe: ET3DV6 - SN1508; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Brain 835 MHz: $\sigma$ = 0.83 mho/m $\varepsilon_r$ = 43.7 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 0.428 mW/g, SAR (10g): 0.305 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 0.0
Penetration depth: 19.2 (15.2, 23.6) [mm]
Powerdrift: -0.05 dB



# s/n EDD1B346

Ch# 1023/ Pwr 2 / Modulation: Analog / Ant: Ret
Leia Right Head Phantom; Right Head Section; Position: (80°,180°); Frequency: 824 MHz
Probe: ET3DV6 - SN1508; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Brain 835 MHz: $\sigma$ = 0.83 mho/m $\varepsilon_r$ = 43.7 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 0.190 mW/g, SAR (10g): 0.127 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Penetration depth: 15.5 (14.8, 16.5) [mm]
Powerdrift: 0.04 dB



# Appendix B

The following pages are printouts from the Dasy™ measurement system of the data as indicated.

# s/n EDD1B346

Ch#799/ Pwr 2 / Modulation: Analog / ANT ret

Amy Twin Phantom Phantom; Section 1 Section; Position: (0°,0°); Frequency: 849 MHz

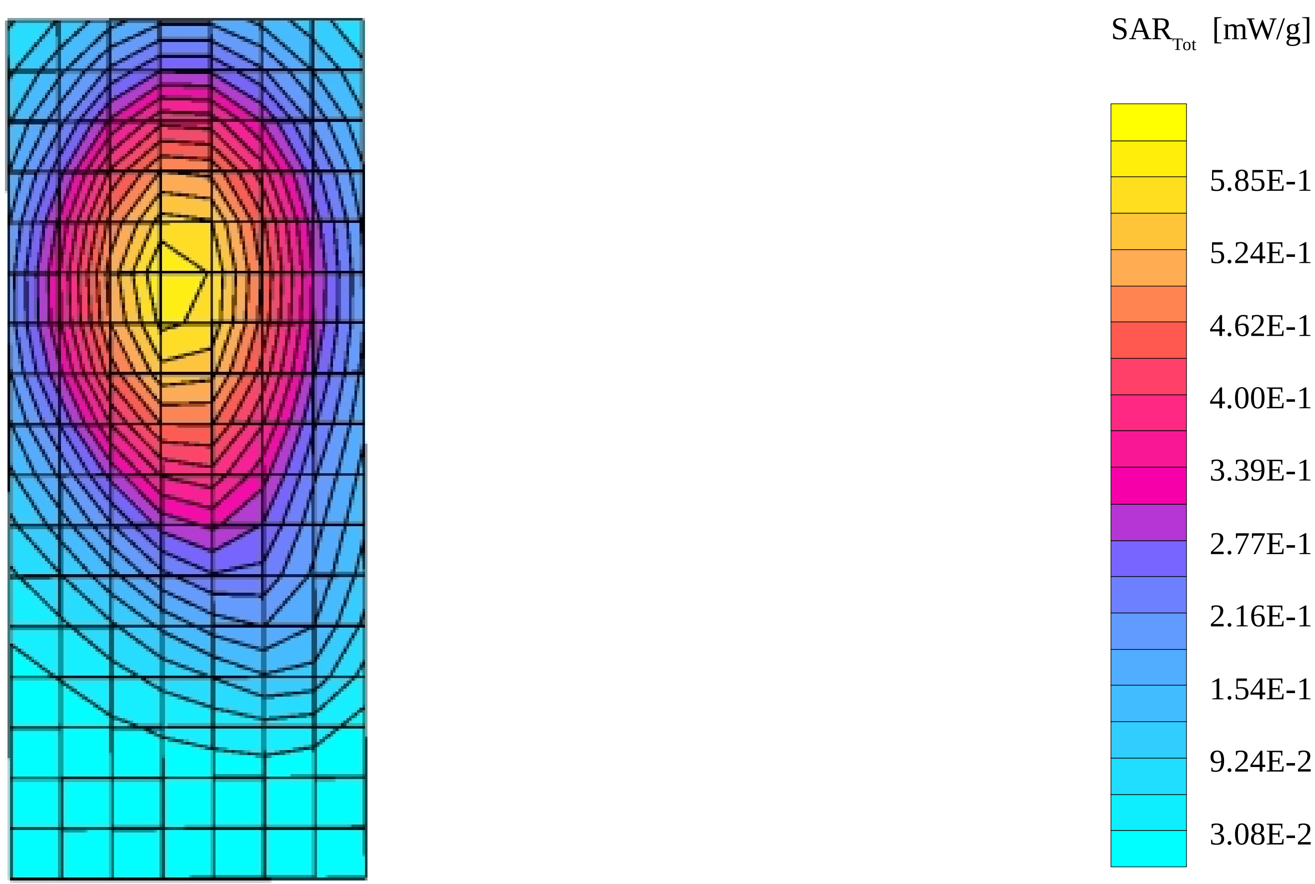
Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 1.0; Muscle 900 MHz: $\sigma$ = 1.18 mho/m $\varepsilon_r$ = 57.7 $\rho$ = 1.00 g/cm$^3$

Cube 5x5x7: SAR (1g): 0.596 mW/g, SAR (10g): 0.408 mW/g, (Worst-case extrapolation)

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

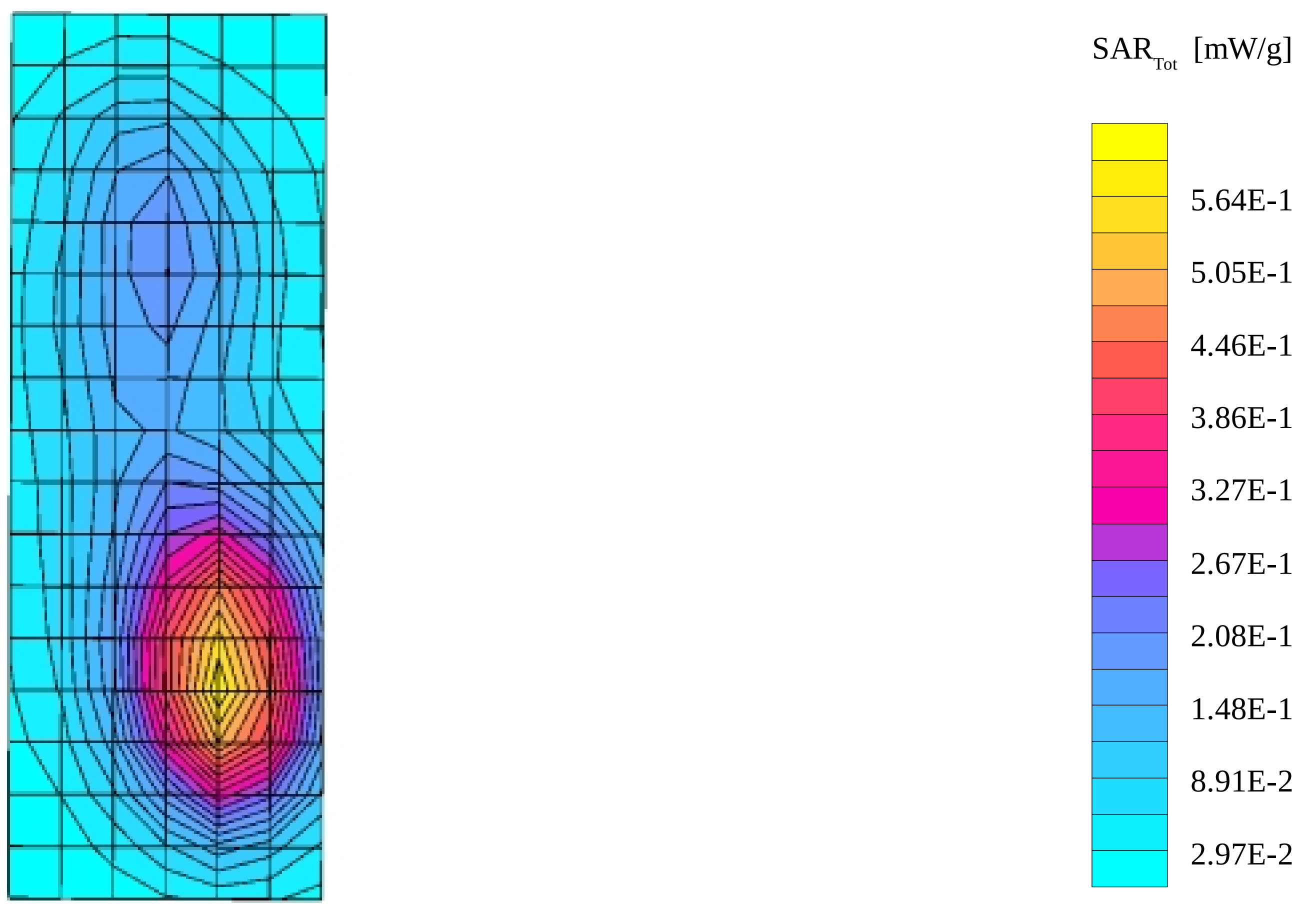
Penetration depth: 14.0 (12.1, 16.4) [mm]

Powerdrift: -0.11 dB



# s/n EDD1B346

Ch# 991/ Pwr 2 /Modulation: Analog / Ant: Ext
Amy Twin Phantom Phantom; Section2 Section; Position: (0°,0°); Frequency: 824 MHz
Probe: ET3DV6 - SN1508; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Muscle 900 MHz: $\sigma$ = 1.12 mho/m $\varepsilon_r$ = 54.3 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 0.549 mW/g, SAR (10g): 0.358 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Penetration depth: 12.1 (10.7, 14.0) [mm]
Powerdrift: -0.68 dB



# Appendix C

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

# Dipole 900 MHz

Amy Twin Phantom; Section2

Probe: ET3DV6 - SN1508; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Brain 900 MHz: $\sigma$ = 0.80 mho/m $\varepsilon_r$ = 47.2 $\rho$ = 1.00 g/cm$^3$

Cubes (2): Peak: 3.66 mW/g ± 0.16 dB, SAR (1g): 2.34 mW/g ± 0.07 dB, SAR (10g): 1.50 mW/g ± 0.01 dB, (Worst-case extrapolation)

Penetration depth: 12.9 (11.9, 14.2) [mm]

Powerdrift: 0.04 dB