**Kyocera Wireless Corp.**
**2119**

# SPECIFIC ABSORPTION RATE (SAR)

# REPORT

# CONTENTS

# 1 INTRODUCTION

This test report describes an environmental evaluation measurement of specific absorption rate (SAR) distribution in simulated human head tissues exposed to radio frequency (RF) radiation from a wireless portable device manufactured by Kyocera Wireless Corp. (KWC). These measurements were performed for compliance with the rules and regulations of the U.S. Federal Communications Commission (FCC). The testing was performed in August 2001 in the KWC SAR Test Facility. The wireless device is described as follows:

EUT Type: *CDMA(PCS), (Cellular) Phone*
Trade Name: *Kyocera Wireless Corp.*
Model: *2119*
**FCC ID:** *OVFKWC-2119*
Tx Frequency : *1851.25 – 1908.75 MHz*
Max. Output Power:
*26.67 dBm EIRP Digital (in PCS band)*
Modulation: *CDMA and Analog*
Antenna: *Retracting whip w/internal antenna*
FCC Classification: *Non-Broadcast Transmitter Held to Ear*
Application Type: *Certification*
Serial Number : *0120010194*
Place of Test: *KWC, San Diego, CA, USA*
Date of Test: *August , 2001*
FCC Rule Part:*47 CFR 2.1093; OET Bulletin 65, Sup. C; 47 CFR 24*

# 2 SAR TEST FACILITY

SAR tests were performed in the KWC SAR Test Facility located at the following address:

QCP Inc.
Building AA.
10290 Campus Point Drive
San Diego CA 92121-1522

# 3 APPLICABLE REGULATIONS

The 2119, FCC ID: OVFKWC-2119, is designed to comply with the specific absorption rate SAR limits for distances within 20 cm of the transmitting elements of the mobile phone, and with general public uncontrolled environment Maximum Permissible Exposure (MPE) limits at distances greater than 20 cm from the transmitting elements of the device, as required by Sections 1.1307 through 1.1310, 2.1091 and 2.1093 of the 47 C.F.R. (1997). These FCC RF safety limits, which are based on a hybrid combination of the SAR and MPE requirements from ANSI/IEEE C95.1-1992 and the National Council on Radiation Protection and Measurements (NCRP) report no. 86, are also consistent with the RF safety limits defined in the IRPA Guidelines on Protection Against Non-Ionizing Radiation which are reportedly in the process of being adopted in Europe, as codified in European Pre-Standard ENV 59166-2 approved by CENELEC (1994). This test report pertains specifically to the following limit from the Code of Federal Regulations 47, Part 2 "Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube)."

# 4 SAR TEST RESULTS SUMMARY

This device has been tested for localised specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1 ~ 1992 and has been tested in accordance with the measurement procedures specified in ANSI/IEEE Std. C95.3 ~ 1992 . Normal antenna operating positions were incorporated, with the device transmitting at frequencies consistent with normal usage of the device. The device has been shown to be capable of compliance for localised specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE std. C95.1-1992

# 5 TECHNICAL DESCRIPTION

The test sample consisted of a 2119, FCC ID: OVFKWC-2119. This model will operate in CDMA PCS, cellular mode. The CDMA PCS mode is designed to transmit in the 1851.25 – 1908.75 MHz band at a maximum EIRP of 26.67 dBm.

The 2119, FCC ID: OVFKWC-2119, is a PCS phone. The antenna is a standard retracting whip antenna tuned for dual frequency, with a helical antenna that is at the base of the whip which gets activated when the whip is retracted. Since either position is possible during use, both retracted and extended were tested, at the low, middle, and high frequencies of each band.

The 2119, FCC ID: OVFKWC-2119, has provision for headset and belt-clip to allow hands-free operation. The SAR for such operating condition was also measured at the low, middle, and high frequencies of each band.

## 5.1 DESCRIPTION OF KWC SAR TEST FACILITY

All tests were performed under the following environmental conditions:

| | |
|---|---|
| Temperature Range: | 15 - 35 Degrees C |
| Humidity Range: | 25 - 75 % |
| Pressure: | 860 - 1060 mbar |

The SAR tests were performed using the following facilities:

All KWC dosimetry equipment is operated within a shielded screen room manufactured by Lindgren RF Enclosures to provide isolation from external EM fields.

The E-field probes of the DASY 3 system are capable of detecting signals as low as 5μW/g in the liquid dielectric, and so external fields are minimised by the screen room, leaving the phone as the dominate radiation source. The floor of the screen room is reflective, so four two-foot square ferrite panels are placed beneath the phantom area of the DASY system to minimise reflected energy that would otherwise re-enter the phantom and combine constructively or destructively with the desired fields. These ferrite panels provide roughly 12 to 13 dB of attenuation in the frequency range of 900 MHz, and 7 to 8 dB of attenuation in the frequency range of 1.9 GHz. Space beneath the DASY system limits the absorber type to ferrite tiles, although this attenuation combined with scattering of the energy is sufficient to bring the system validation within the acceptable tolerance.

DOSIMETRY SYSTEM The dosimetry equipment consists of a complete DASY3 V1.0 dosimetry system manufactured and calibrated by Schmid & Partner Engineering AG of Zurich, Switzerland, it is currently a state of the art system and from our research, it appears to be the best available at this time. The DASY3 system consists of a six axis robot, a robot controller, a teach pendant, automation software on a Pentium 200 MHz computer, data acquisition system, isotropic e-field probe, and validation kit.

E-FIELD PROBE This test was performed using an E-field probe with conversion factors determined by Schmid & Partner (S & P). The probe is the most important part of the system, so will be discussed in section 5.2.

PHANTOM The phantom was the so called "generic phantom" supplied by S & P, and consists of a left and right side head for simulating phone usage on both sides of the head. The phantom is constructed of fibreglass with 2 +/- 0.1 mm shell thickness. The shape of the shell is based on data from an anatomical study of a group of 33 men and 19 women to determine the maximum exposure in approximately 90% of all users. The DASY system uses a homogeneous tissue phantom based on studies concerning energy absorption of the human head, and the different absorption rates between adults and children. These studies indicated that a homogeneous phantom should overestimate SAR by no more than 15% for 1 g averages and should not underestimate SAR. In similar studies, it was found that a typical ear thickness is approximately 4 mm, so a 4 mm rubber ring is attached to the phantom at the ear area.

LIQUID DIELECTRIC The tissue simulating liquid which fills the phantom is supplied by QCP Inc.. There are two separate formulas for the two frequencies 900 MHz and 1800 MHz. This is necessary because the water molecules raise the conductivity to approximately 1.65 +/- 10% at the 1800 MHz frequency, without the addition of salt, so no salt is needed. Before the test, the permitivity and conductivity were measured with an automated Hewlett Packard 85070B dielectric probe in conjunction with a HP 8752C network analyser to monitor permitivity change due to evaporation. The electromagnetic parameters of the liquid were maintained as shown in table 1. The target values were obtained from the FCC web page for Tissue Dielectric Properties with internet address www.fcc.gov/fcc-bin/dielec.sh . The 1800 MHz liquid prepared has no salt or any conductive additive (the chemical/physical properties of the water, preservative, and sugar molecules alone provide too much conductivity). It is impossible to lower the conductivity to 1.15 S/m without a new formula with different ingredients. In other words, we would have to locate an ingredient to replace the sugar/water/preservative ingredients with materials providing similar density, permitivity, and optical properties (for the optical surface detection) but having lower conductivity at 1800 MHz. It was determined that using the 1800 MHz fluid from Schmid & Partner would overestimate the SAR by a small margin, and maintain maximum confidence.

| FREQUENCY | PERMITIVITY | CONDUCTIVITY | DENSITY |
|---|---|---|---|
| 900 MHz | 41.8 +/- 5% | .82 +/- 10% mho/m | 1 $g/cm^3$ |
| 1800 MHz | 42.3 +/- 5% | 1.62 +/- 10% mho/m | 1 $g/cm^3$ |

Table 1

Schmid & Partner has supplied us with data that can be used to show the error in SAR caused by using higher conductivity. In general, higher conductivity over estimates measured SAR values. So by using a higher conductivity in the 1800 MHz band we were measuring SAR values higher than would exist in the human brain. This data is provided here in Table 2.

| ***Distance of radiator from liquid surface*** | ***Frequency MHz*** | *Avg. volume gram* | *Increase of SAR per Increase in conductivity* | *Relative. permitivity* | *Conductivity of liquid S/m* | *Density of liquid g/cm³* |
|---|---|---|---|---|---|---|
| 10 mm | 900 | 1 | + 0 .62 | 41.5 | 0.85 | 1 |
| 10 mm | 900 | 10 | + 0.39 | 41.5 | 0.85 | 1 |
| 15 mm | 900 | 1 | + 0.63 | 41.5 | 0.85 | 1 |
| 15 mm | 900 | 10 | + 0.39 | 41.5 | 0.85 | 1 |
| 30 mm | 900 | 1 | +0.63 | 41.5 | 0.85 | 1 |
| 30 mm | 900 | 10 | +0.39 | 41.5 | 0.85 | 1 |
| 10 mm | 1500 | 1 | + 0.55 | 40.5 | 1.2 | 1 |
| 10 mm | 1500 | 10 | + 0.27 | 40.5 | 1.2 | 1 |
| 15 mm | 1500 | 1 | + 0.55 | 40.5 | 1.2 | 1 |
| 15 mm | 1500 | 10 | + 0.27 | 40.5 | 1.2 | 1 |
| 30 mm | 1500 | 1 | + 0.54 | 40.5 | 1.2 | 1 |
| 30 mm | 1500 | 10 | + 0.26 | 40.5 | 1.2 | 1 |
| 10 mm | 1800 | 1 | + 0.43 | 40.0 | 1.65 | 1 |
| 10 mm | 1800 | 10 | + 0.13 | 40.0 | 1.65 | 1 |
| 15 mm | 1800 | 1 | +0. 42 | 40.0 | 1.65 | 1 |
| 15 mm | 1800 | 10 | + 0.13 | 40.0 | 1.65 | 1 |
| 30 mm | 1800 | 1 | + 0.41 | 40.0 | 1.65 | 1 |
| 30 mm | 1800 | 10 | + 0.12 | 40.0 | 1.65 | 1 |
| | | | | | | |

Table 2

The E-field probe is calibrated by the manufacturer in brain simulating tissue at frequencies of 900 MHz, and 1.8 GHz, accurate to +/- 8%. Linearity is said by the manufacturer to be +/- .2 dB from 30

MHz to 3 GHz. Dynamic range is said by the manufacturer to be 5 μW/gm to > 100 mW/g. The probe contains 3 small dipoles positioned symmetrically on a triangular core to provide for isotropic detection of the field. Each dipole contains a diode at the feed point that converts the RF signal to DC, which is conducted down a high impedance line to the data acquisition system.
The data acquisition system amplifies the signals, and converts them to digital values so that they may be sent to the computer. The inputs to the signal amplifiers are auto zeroed after every measurement to prevent charge build up on the lines, which could lead to errors.

## 5.2 SAR SYSTEM THEORY

The human body absorbs energy from a radiating cell phone by ionic motion and oscillation of polar molecules. The human head is in the near field of the device where polarisation and field intensity are very complex. Also the human head can cause large reflections and scattering, so it is more practical to measure the field absorbed inside the head, than to measure incident power before it enters the head. Inside the lossy brain tissue, the power per unit volume is given by (next page):

$$\mathbf{R}_v = \tfrac{1}{2}\ \mathbf{J} \bullet \mathbf{E}^* = \tfrac{1}{2}\ \mathbf{s}\ |\mathbf{E}|^2 \quad \mathrm{W/m^3}$$

where **J** is current density

**s** is conductivity of human tissue due to conductive and lossy displacement currents.

**E** is the electric field

But since SAR is the absorption of RF power per unit mass

$$\mathbf{R}_g = \tfrac{1}{2}\ \mathbf{s}/\boldsymbol{p}\ |\mathbf{E}|^2 \quad \mathrm{W/kg}$$

where ***p*** is density of the tissue in kilograms per cubic meter.

In this equation, σ is a function of frequency, and so it must be measured at the frequency of the test. It is measured in terms of the real and imaginary components of the complex permitivity;

$$\varepsilon = \varepsilon_0 (\varepsilon' - j\varepsilon'')$$

$$\sigma = 2\pi f \times (8.854 \times 10^{-12}) \times \varepsilon''$$

$$\textbf{Loss Tangent} \equiv \tan\delta = \varepsilon'' / \varepsilon'$$

In order to measure the E field strength without distorting the field, the E field probe(shown here) is made as described by Schmid, Egger, and Kuster in [3].

E-field Probe

A major concern is that secondary coupling of the EUT radiated fields to the feed lines of the probe are minimised. This is done by making the feed lines of high impedance “twin-line” transmission line, printed very close together. In the probe tip there are three orthogonal dipoles, electrically small to minimise field distortion from coupling. The electrically small dipoles have source impedance’s of 5 to 8 MΩ due to their small size, the high resistive feed lines, and the distributed filters on the lines. This high impedance makes them less sensitive so a sophisticated Data Acquisition Electronics (DAE) box is needed to amplify, multiplex, and digitize the signals. The DAE is installed on top of the robot arm. It also detects the proximity of the phantom surface with a fiber-optic cable. It provides for multiplexing between the three dipoles, and between 1X gain and 100X amplification, and it provides some filtering that will remove unwanted signals picked up by the probe. The DAE also provides a fast digital link to the robot for stopping in the event of a touch detection. It samples the probe output for 2600 complete E field measurements per dipole, per second. These samples are used to determine the amplification needed, 1X or 100X, and the magnitude determines what diode compression correction factor should be used. These factors as well as sensitivity factors of the specific probe, which are stored in the program, are used to determine the actual field strength for the test point.

The substrate on which the dipoles are printed, has been shaped to align each dipole with the E-field *after* the field lines are distorted by the permitivity of the substrate. In other words, since the substrate and the liquid dielectric have different permitivities, the E-field will diffract as it passes through the interface, and so the dipoles have been positioned to align with the fields *after* this distortion is accounted for.

The dipole elements in the probe are offset from the tip of the probe approximately 2.7 mm so unfortunately the field strength cannot be measured at the surface of the phantom, where it is likely to be maximum. The magnitude of the field at the surface must therefore be calculated with interpolation by using the data points stepped away from the surface and curve fitting, this is done automatically by the software.

# 6 TEST SAMPLE OPERATION

The wireless device was made to transmit maximum power that is allowed by the software (KWC phone control software, named phone_t) in the device. The software was used to force the device to transmit maximum power for the duration of the SAR tests. The DASY 3 system checks E field strength at a fixed location before and after each scan, and checks for drift due to draining of the battery or some other effect. This shows up as “drift” on the report and if it is too high the test is repeated.

*Power settings* –

The nominal manufacture power levels were used for EMC tests required in 47 CFR Part 24. For SAR test discussed in this RF exposure test report, the conducted power level was set 0.7 dB higher than the nominal power level to include the manufacture tolerance. The radiated power (EIRP) corresponding to the conducted power level used for SAR tests was measured in the antenna range (fully anechonic chamber). The measurement procedures and technique are described in the Part 24 test report.

The conducted power levels and corresponding EIRP for SAR test are listed in following tables.

**Table 3: Conducted power used for SAR test - PCS**

| | | RF output power (W) - PCS |
|---|---|---|
| carrier frequency (MHz) | channel | CDMA |
| | | Measured |
| 1851.25 | 25 | 0.1867W / 22.72 dBm |
| 1880 | 600 | 0.189 W / 22.76 dBm |
| 1908.75 | 1175 | 0.190 W / 22.78 dBm |
| Maximum Power over Band | | **22.78 dBm** |

**Table 4: Radiated power (EIRP) corresponding to Table 4 - PCS**

| | | RF output power EIRP (W or dBm) - PCS |
|---|---|---|
| carrier frequency (MHz) | channel | CDMA |
| | | measured |
| 1851.25 | 25 | 25.56 dBm |
| 1880 | 600 | 26.13 dBm |
| 1908.75 | 1175 | 26.67 dBm |
| Max power over band | | **26.67 dBm** |

# 7 SAR TEST SYSTEM VALIDATION

We performed the validation test by using a dipole before the SAR tests. The following plots are the results of validation tests. The muscle tissues were calibrated by using HP85070B dielectric measurement system. The data sheets are attached below. The original validation results provided by the system manufacturer for cellular and PCS band are attached as well.

**Manufacturer Validation Data**

**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: | **ET3DV5** |
| Serial Number: | **1353** |
| Place of Calibration: | **Zurich** |
| Date of Calibration: | **July 26, 2000** |
| 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: | Nikolos K. Neviana |
| Approved by: | Thomas Schmid |

Schmid & Partner
Engineering AG

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

# Probe ET3DV5

## SN:1353

Manufactured: August 14, 1998
Last calibration: August 28, 1998
Recalibrated: July 26, 2000

Calibrated for System DASY3

# DASY3 - Parameters of Probe: ET3DV5 SN:1353

## Sensitivity in Free Space

| | |
|---|---|
| NormX | **1.59** $\mu V/(V/m)^2$ |
| NormY | **1.47** $\mu V/(V/m)^2$ |
| NormZ | **1.75** $\mu V/(V/m)^2$ |

## Diode Compression

| | |
|---|---|
| DCP X | **102** mV |
| DCP Y | **102** mV |
| DCP Z | **102** mV |

## Sensitivity in Tissue Simulating Liquid

**Brain** **450 MHz** $\varepsilon_r$ **= 48 ± 5%** $\sigma$ **= 0.50 ± 10% mho/m**

| | | | | |
|---|---|---|---|---|
| ConvF X | **6.08** | extrapolated | Boundary effect: | |
| ConvF Y | **6.08** | extrapolated | Alpha | **0.07** |
| ConvF Z | **6.08** | extrapolated | Depth | **3.39** |

**Brain** **900 MHz** $\varepsilon_r$ **= 42.5 ± 5%** $\sigma$ **= 0.86 ± 10% mho/m**

| | | | | |
|---|---|---|---|---|
| ConvF X | **5.70** | ± 7% (k=2) | Boundary effect: | |
| ConvF Y | **5.70** | ± 7% (k=2) | Alpha | **0.33** |
| ConvF Z | **5.70** | ± 7% (k=2) | Depth | **2.82** |

**Brain** **1500 MHz** $\varepsilon_r$ **= 41 ± 5%** $\sigma$ **= 1.32 ± 10% mho/m**

| | | | | |
|---|---|---|---|---|
| ConvF X | **5.20** | interpolated | Boundary effect: | |
| ConvF Y | **5.20** | interpolated | Alpha | **0.68** |
| ConvF Z | **5.20** | interpolated | Depth | **2.06** |

**Brain** **1800 MHz** $\varepsilon_r$ **= 41 ± 5%** $\sigma$ **= 1.69 ± 10% mho/m**

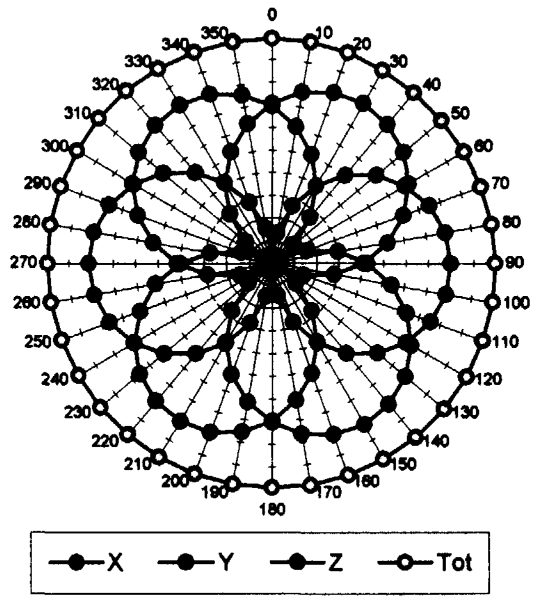
| | | | | |
|---|---|---|---|---|
| ConvF X | **4.94** | ± 7% (k=2) | Boundary effect: | |
| ConvF Y | **4.94** | ± 7% (k=2) | Alpha | **0.86** |
| ConvF Z | **4.94** | ± 7% (k=2) | Depth | **1.68** |

## Sensor Offset

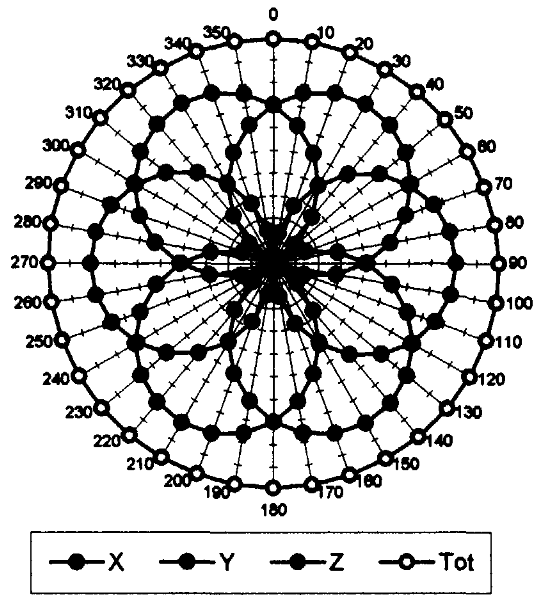
| | | |
|---|---|---|
| Probe Tip to Sensor Center | **2.7** | mm |
| Optical Surface Detection | **1.8 ± 0.2** | mm |

# Receiving Pattern (ϕ), θ = 0°

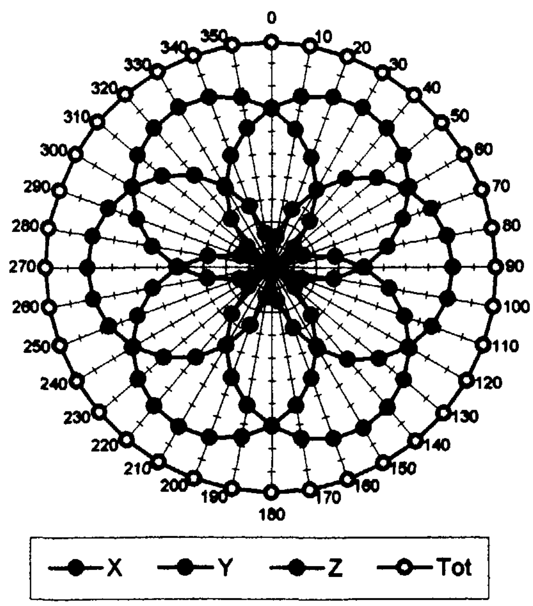
**f = 30 MHz, TEM cell ifi110**



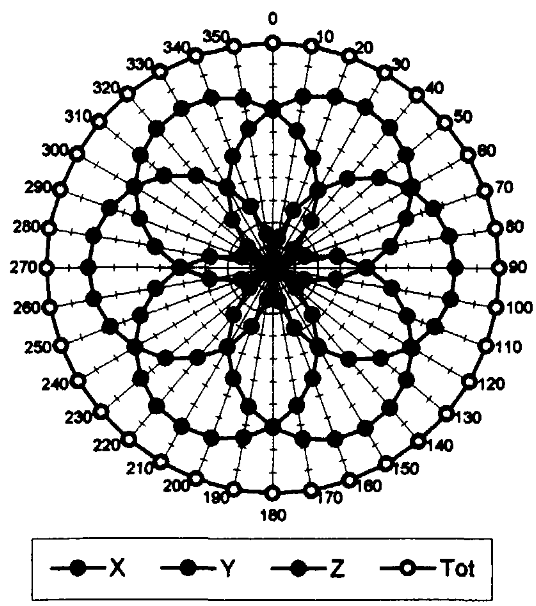

**f = 100 MHz, TEM cell ifi110**

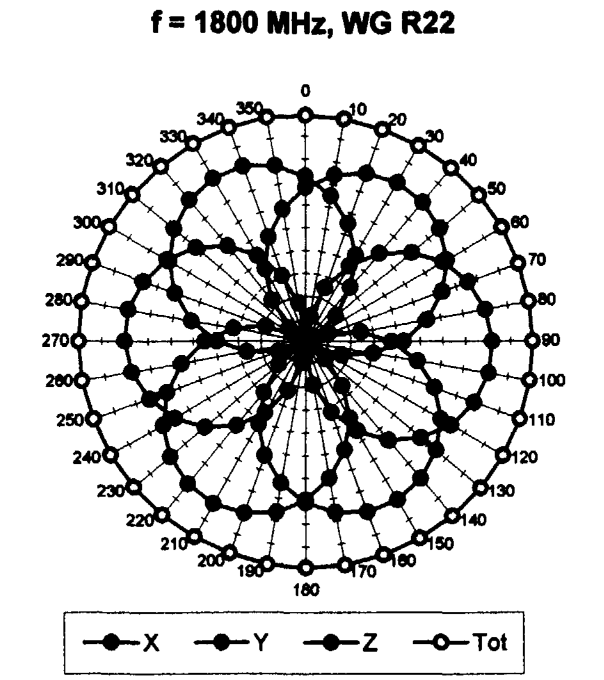


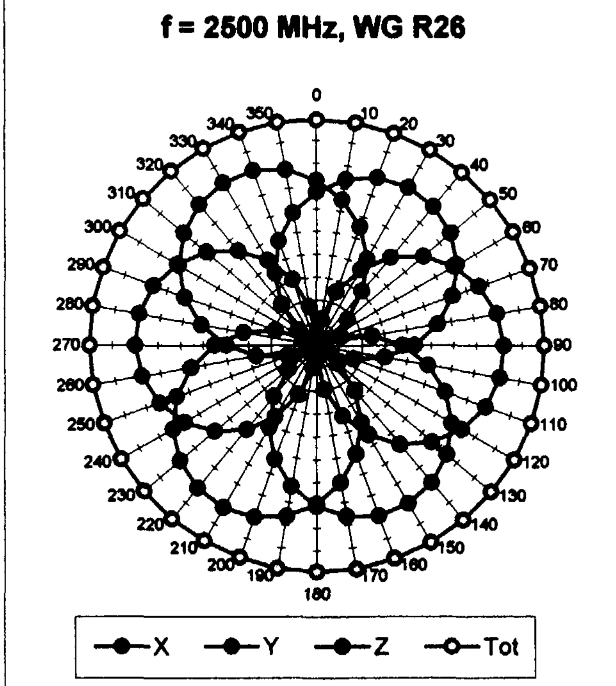

**f = 300 MHz, TEM cell ifi110**



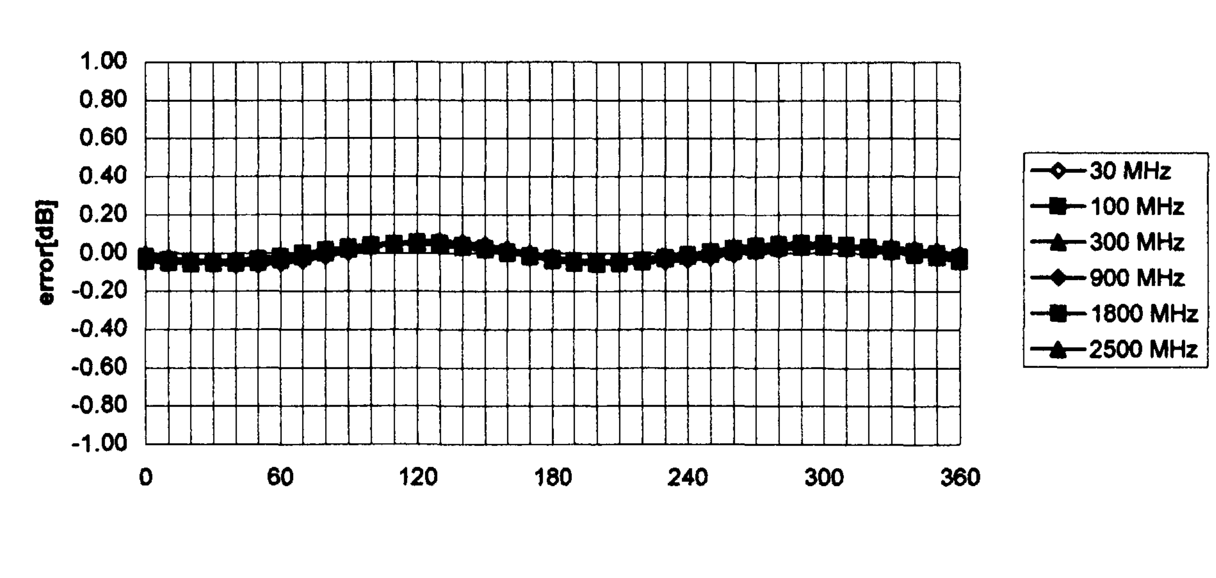

**f = 900 MHz, TEM cell ifi110**





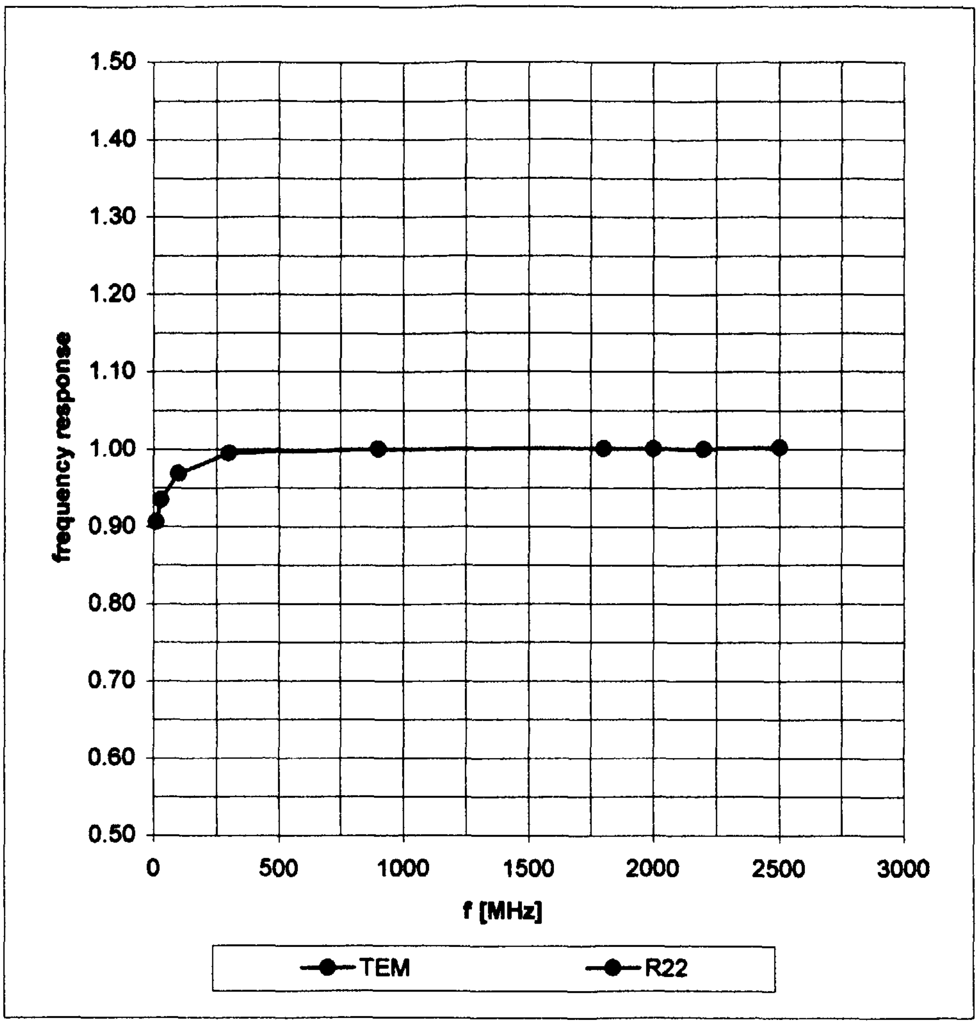




# Isotropy Error (φ), θ = 0°



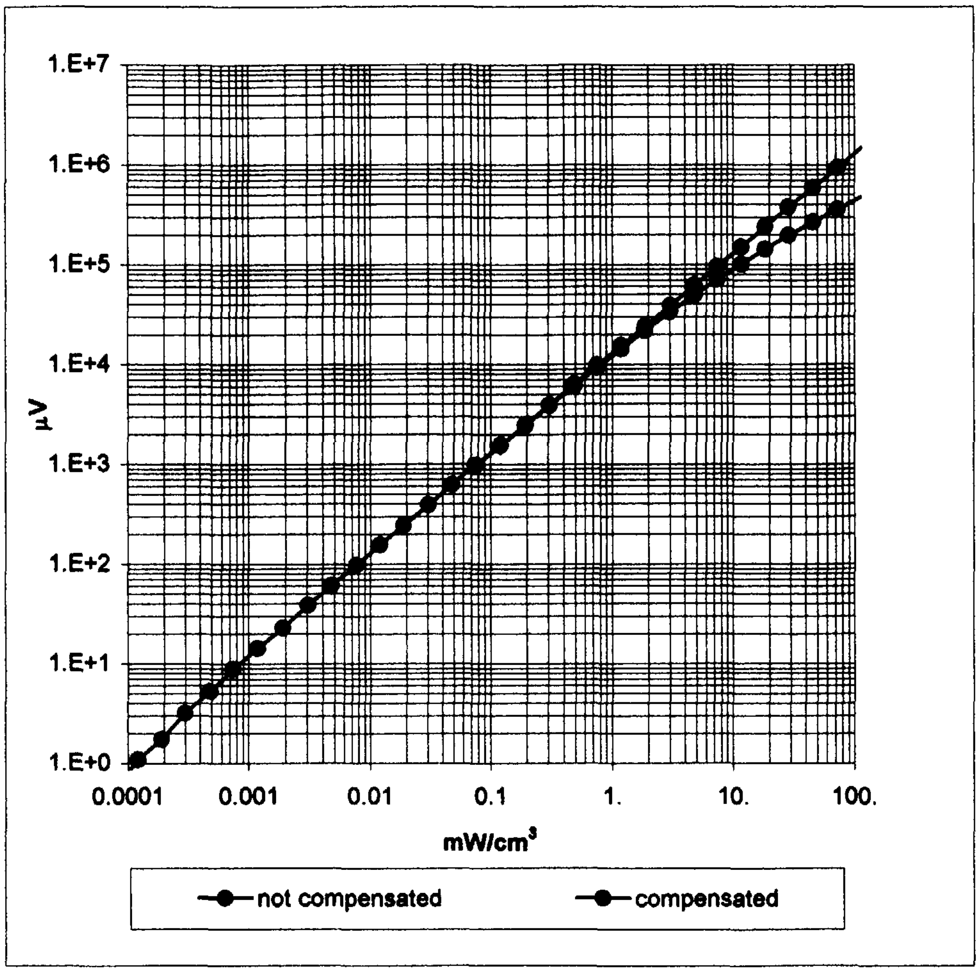
# Frequency Response of E-Field

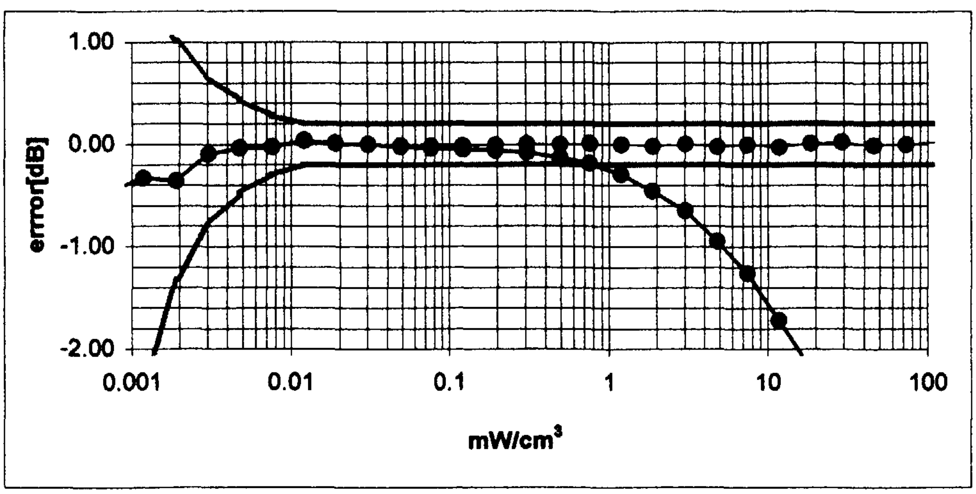
**( TEM-Cell:ifi110, Waveguide R22, R26 )**



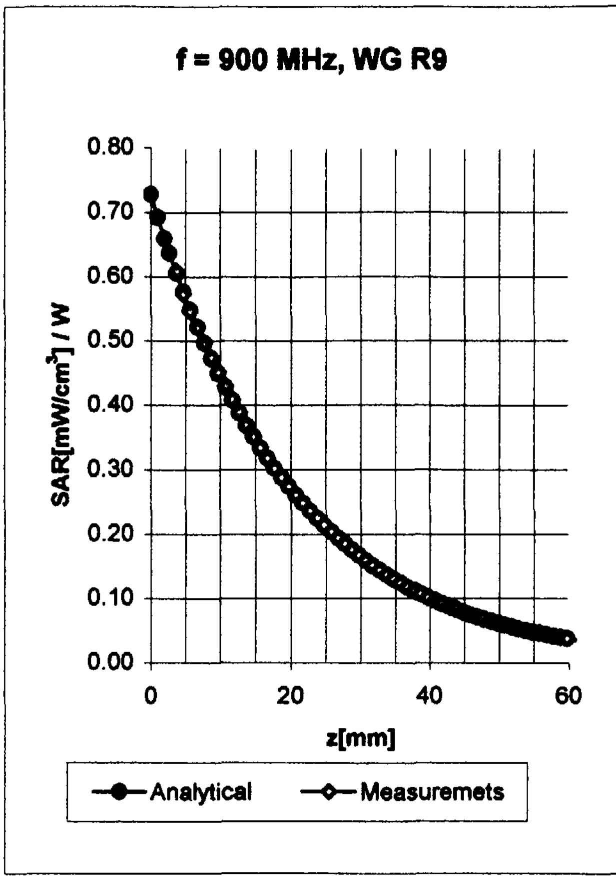
# Dynamic Range f(SAR$_{brain}$)

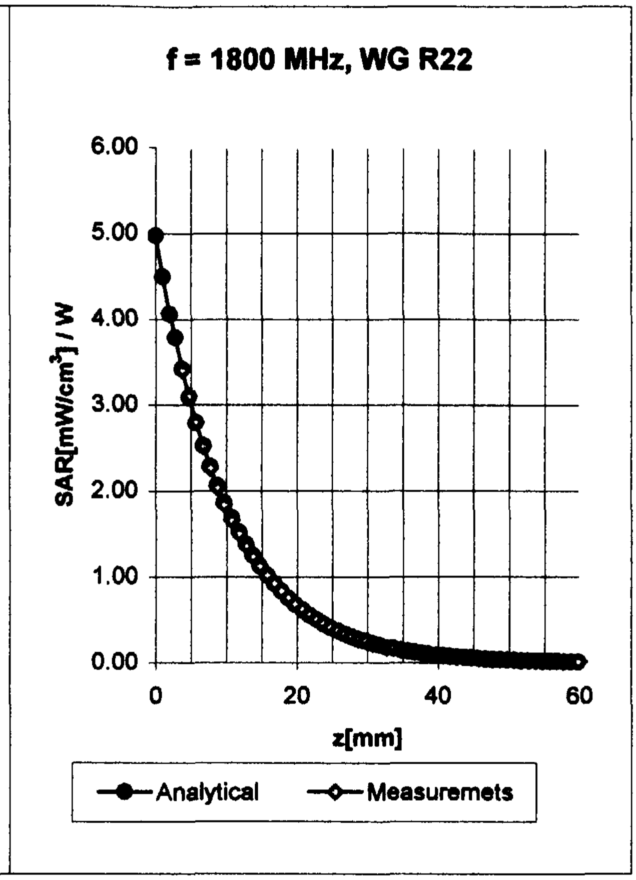
( TEM-Cell:ifi110 )



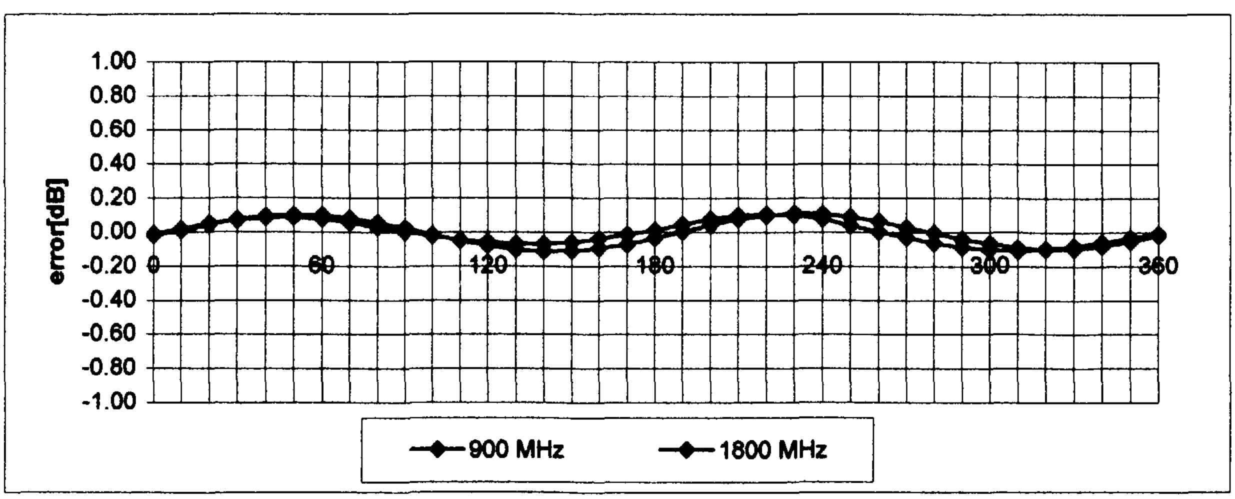
# Conversion Factor Assessment




# Receiving Pattern (ϕ)

**( in brain tissue, z = 5 mm )**



**Schmid & Partner**
**Engineering AG**

## DASY - DOSIMETRIC ASSESSMENT SYSTEM

# CALIBRATION REPORT

## DATA ACQUISITION ELECTRONICS

| | |
|---|---|
| **MODEL:** | **DAE3 V1** |
| **SERIAL NUMBER:** | **409** |

This Data Acquisition Unit was calibrated and tested using a FLUKE 702 Process Calibrator. Calibration and verification were performed at an ambient temperature of 23 ± 5 °C and a relative humidity of < 70%.

Measurements were performed using the standard DASY software for converting binary values, offset compensation and noise filtering. Software settings are indicated in the reports.

Results from this calibration relate only to the unit calibrated.

| | |
|---|---|
| **Calibrated by:** | **E. Meyer** |
| **Calibration Date:** | **Dec. 18, 2000** |
| **DASY Software Version:** | **DASY3 V3.1c** |

## 1. DC Voltage Measurement

DA - Converter Values from DAE

| | | | | |
|---|---|---|---|---|
| High Range: | 1LSB = | 6.1μV , | full range = | 400 mV |
| Low Range: | 1LSB = | 61nV , | full range = | 4 mV |

Software Set-up: Calibration time: 3 sec     Measuring time: 3 sec

| Setup | X | Y | Z |
|---|---|---|---|
| **High Range** | 404.688 | 404.222 | 403.891 |
| **Low Range** | 3.991 | 3.980 | 3.986 |
| **Connector Position** | 150 ° | | |

| High Range | Input | Reading in μV | % Error |
|---|---|---|---|
| **Channel X + Input** | 200mV | 199999.0 | 0.00 |
| | 20mV | 20004.8 | 0.02 |
| **Channel X - Input** | 20mV | -19998.1 | -0.01 |
| **Channel Y + Input** | 200mV | 200001.0 | 0.00 |
| | 20mV | 20002.2 | 0.01 |
| **Channel Y - Input** | 20mV | -19998.1 | -0.01 |
| **Channel Z + Input** | 200mV | 199999.0 | 0.00 |
| | 20mV | 20000.6 | 0.00 |
| **Channel Z - Input** | 20mV | -19997.7 | -0.01 |

| Low Range | Input | Reading in μV | % Error |
|---|---|---|---|
| **Channel X + Input** | 2mV | 2000.15 | 0.01 |
| | 0.2mV | 199.728 | -0.14 |
| **Channel X - Input** | 0.2mV | -200.188 | 0.09 |
| **Channel Y + Input** | 2mV | 1999.85 | -0.01 |
| | 0.2mV | 199.150 | -0.42 |
| **Channel Y - Input** | 0.2mV | -201.257 | 0.63 |
| **Channel Z + Input** | 2mV | 2000.17 | 0.01 |
| | 0.2mV | 199.254 | -0.37 |
| **Channel Z - Input** | 0.2mV | -201.436 | 0.72 |

## 2. Common mode sensitivity

Software Set-up
Calibration time: 3 sec, Measuring time: 3 sec
High/Low Range

| in µV | Common mode Input Voltage | High Range Reading | Low Range Reading |
|---|---|---|---|
| Channel X | 200mV | 13.45 | 13.17 |
| | - 200mV | -13.95 | -12.42 |
| Channel Y | 200mV | -0.17 | 0.57 |
| | - 200mV | -2.46 | -1.25 |
| Channel Z | 200mV | 1.74 | 3.24 |
| | - 200mV | -3.88 | -4.55 |

## 3. Channel separation

Software Set-up
Calibration time: 3 sec, Measuring time: 3 sec
High Range

| in µV | Input Voltage | Channel X | Channel Y | Channel Z |
|---|---|---|---|---|
| Channel X | 200mV | - | 2.098 | 0.630 |
| Channel Y | 200mV | 1.117 | - | 3.237 |
| Channel Z | 200mV | -1.468 | 0.411 | - |

## 4. AD-Converter Values with inputs shorted

| in LSB | Low Range | High Range |
|---|---|---|
| Channel X | 15551 | 15612 |
| Channel Y | 17285 | 16039 |
| Channel Z | 13368 | 15670 |

## 5. Input Offset Measurement

Measured after 15 min warm-up time of the Data Acquisition Electronic.
Every Measurement is preceded by a calibration cycle.

Software set-up:
- Calibration time: 3 sec
- Measuring time: 3 sec
- Number of measurements: 100, Low Range

Input 10MΩ

| in µV | Average | min. Offset | max. Offset | Std. Deviation |
|---|---|---|---|---|
| **Channel X** | 1.23 | 0.16 | 1.97 | 0.48 |
| **Channel Y** | -0.35 | -1.70 | 0.63 | 0.53 |
| **Channel Z** | -2.33 | -3.31 | -0.26 | 0.61 |

Input shorted

| in µV | Average | min. Offset | max. Offset | Std. Deviation |
|---|---|---|---|---|
| **Channel X** | 0.06 | -0.90 | 1.08 | 0.36 |
| **Channel Y** | -0.60 | -3.14 | 1.46 | 0.50 |
| **Channel Z** | -0.76 | -3.28 | 0.90 | 0.56 |

## 6. Input Offset Current

| in fA | Input Offset Current |
|---|---|
| **Channel X** | < 25 |
| **Channel Y** | < 25 |
| **Channel Z** | < 25 |

## 7. Input Resistance

| | Calibrating | Measuring |
|---|---|---|
| **Channel X** | 200.1 kΩ | 199.9 MΩ |
| **Channel Y** | 200.0 kΩ | 199.5 MΩ |
| **Channel Z** | 200.1 kΩ | 200.0 MΩ |

## 8. Low Battery Alarm Voltage

| in V | Alarm Level |
|---|---|
| Supply (+ Vcc) | 7.81 V |
| Supply (- Vcc) | -7.58 V |

## 9. Power Consumption

| in mA | Switched off | Stand by | Transmitting |
|---|---|---|---|
| Supply (+ Vcc) | 0.000 | 7.5 | 15.5 |
| Supply (- Vcc) | -0.012 | -7.59 | -8.75 |

## 10. Functional test

| | |
|---|---|
| Touch async pulse 1 | ok |
| Touch async pulse 2 | ok |
| Touch status bit 1 | ok |
| Touch status bit 2 | ok |
| Remote power off | ok |
| Remote analog Power control | ok |
| | |
| Modification Status | B - C |
| | |
| | |

**Date:** 18.12.2000 **Signature:** E. Meyer

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Engineering AG

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# DASY

## Dipole Validation Kit

## Type: D900V2

## Serial: 024

Manufactured: December 1997
Calibrated: January 1998

## 1. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom (shell thickness 2mm) filled with brain simulating sugar solution of the following electrical parameters at 900 MHz:

| | | |
|---|---|---|
| Relative Dielectricity | **42.3** | ± 5% |
| Conductivity | **0.85 mho/m** | ± 5% |

The DASY3 System (Software version 1.0a) with a dosimetric E-field probe ET3DV4 (SN:1302, Conversion factor 5.5) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the centre marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15mm from dipole centre 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 normalised to 1W input power.

## 2. SAR Measurement

Standard SAR-measurements were performed with the phantom according to the measurement conditions described in section 1. The results have been normalised to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

| | |
|---|---|
| averaged over 1 $cm^3$ (1 g) of tissue: | **9.44 mW/g** |
| averaged over 10 $cm^3$ (10 g) of tissue: | **6.16 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 analyser and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

| | | |
|---|---|---|
| Electrical delay: | **1.397 ns** | (one direction) |
| Transmission factor: | **0.988** | (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 900 MHz: | Re{Z} = **50.2 Ω** |
| | Im {Z} = **-0.0 Ω** |
| Return Loss at 900 MHz | **- 54.9 dB** |

## 4. Handling

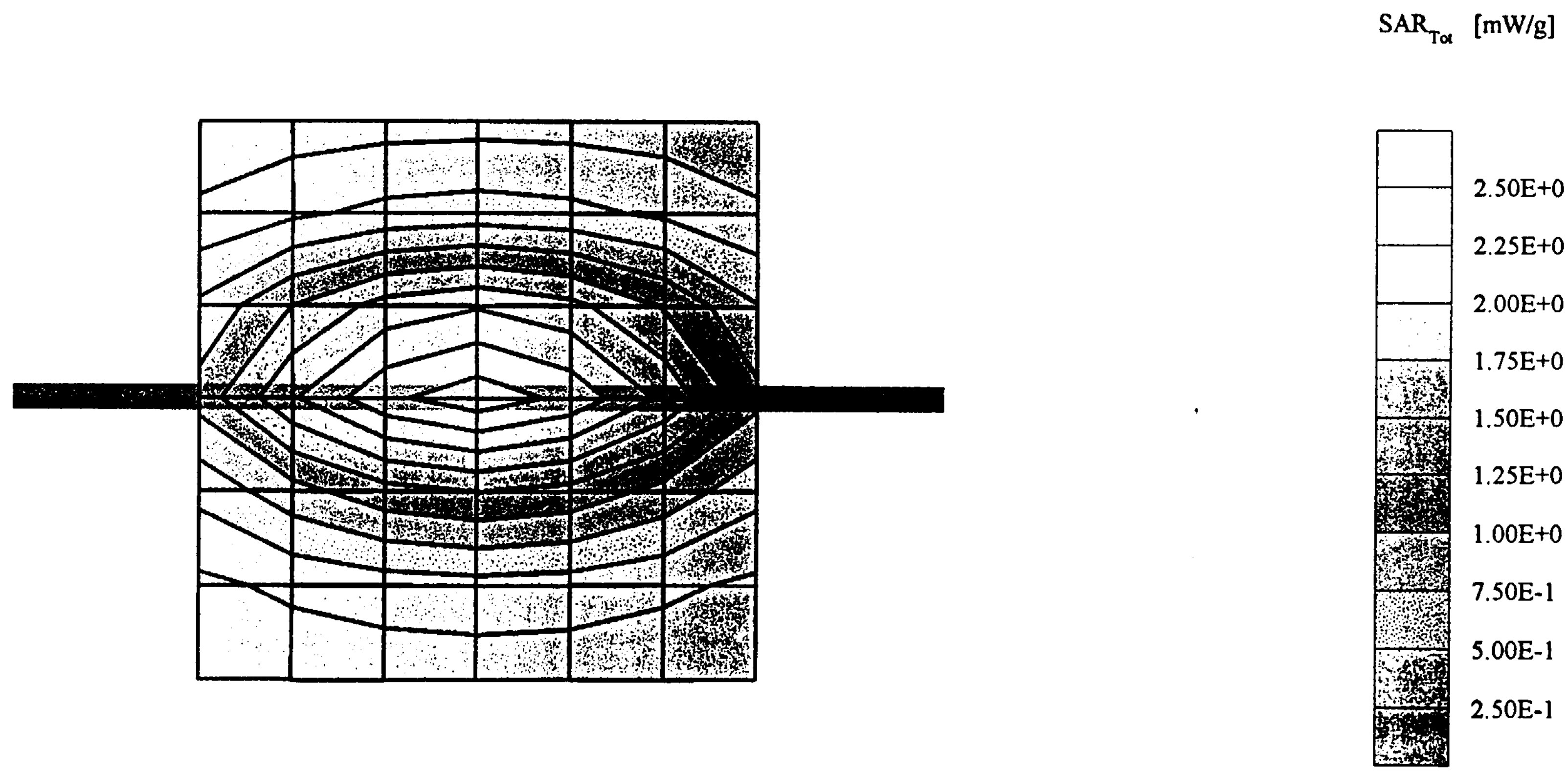
The dipole is made of standard semirigid coaxial cable. The centre conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

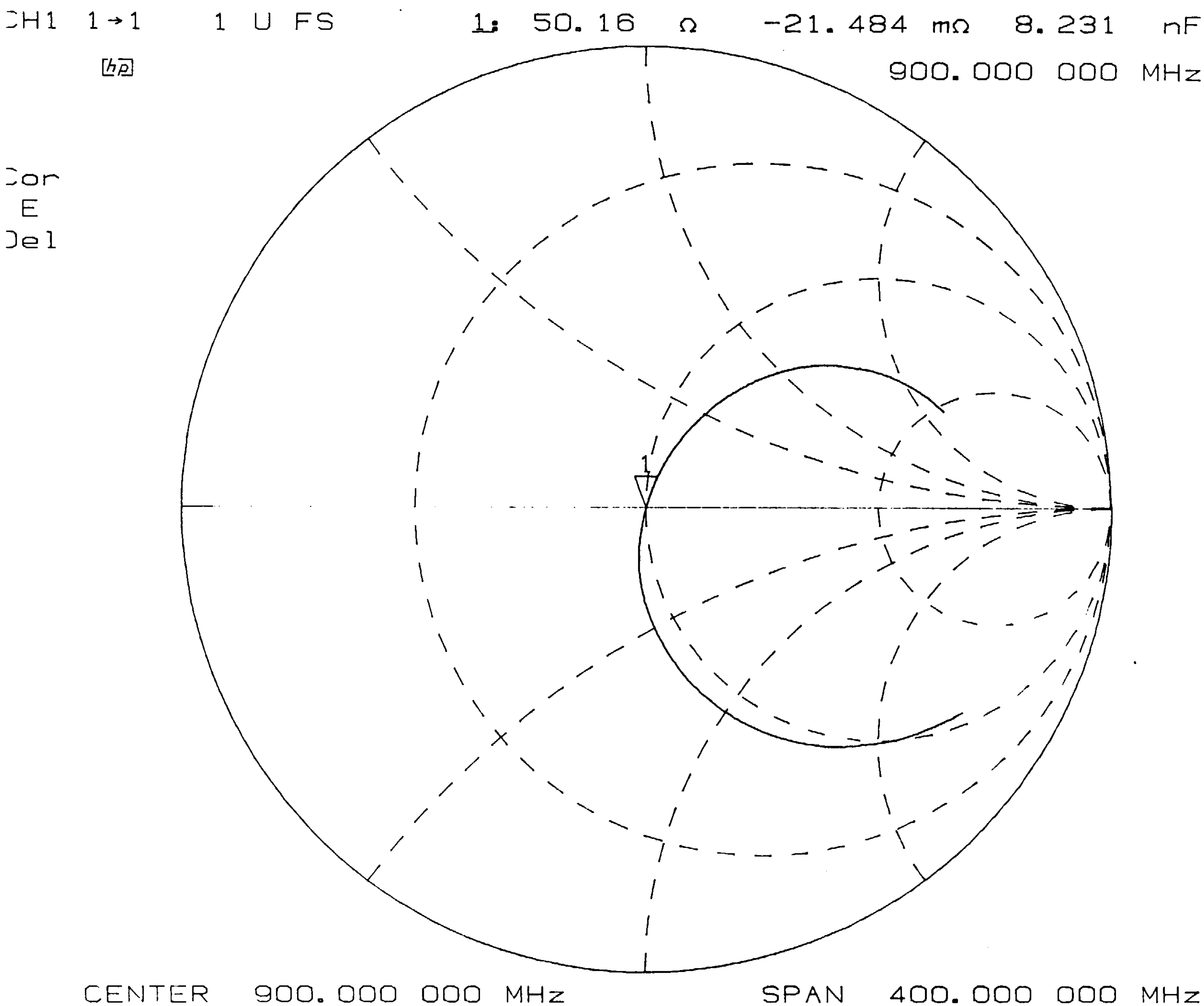
Do not apply excessive force to the dipole arms, because they might bend. If the dipole arms have to be bent back, take care to release stress to the soldered connections near the feedpoint; they might come off.

After prolonged use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

## alidation Dipole D900V2 SN:024, d = 15mm

:quency: 900 [MHz]; Antanna Input Power: 250 [mW]
neric Twin Phantom; Flat Section; Grid Spacing: Dx = 15.0, Dy = 15.0, Dz = 10.0 [mm]
›be: ET3DV5 - SN1302 DAE3; ConvF(5.40,5.40,5.40); Crest factor: 1.0; }: $\sigma$ = 0.85 [mho/m] $\varepsilon_r$ = 42.3 $\rho$ = 1.00 [g/cm³]
bes (2): Peak: 3.58 [mW/g] ± 0.06 dB, SAR (1g): 2.36 [mW/g] ± 0.05 dB, SAR (10g): 1.54 [mW/g] ± 0.04 dB, (Worst-case extrapolation)
ıetration depth: 13.1 (12.1, 14.4) [mm]
werdrift: 0.03 dB





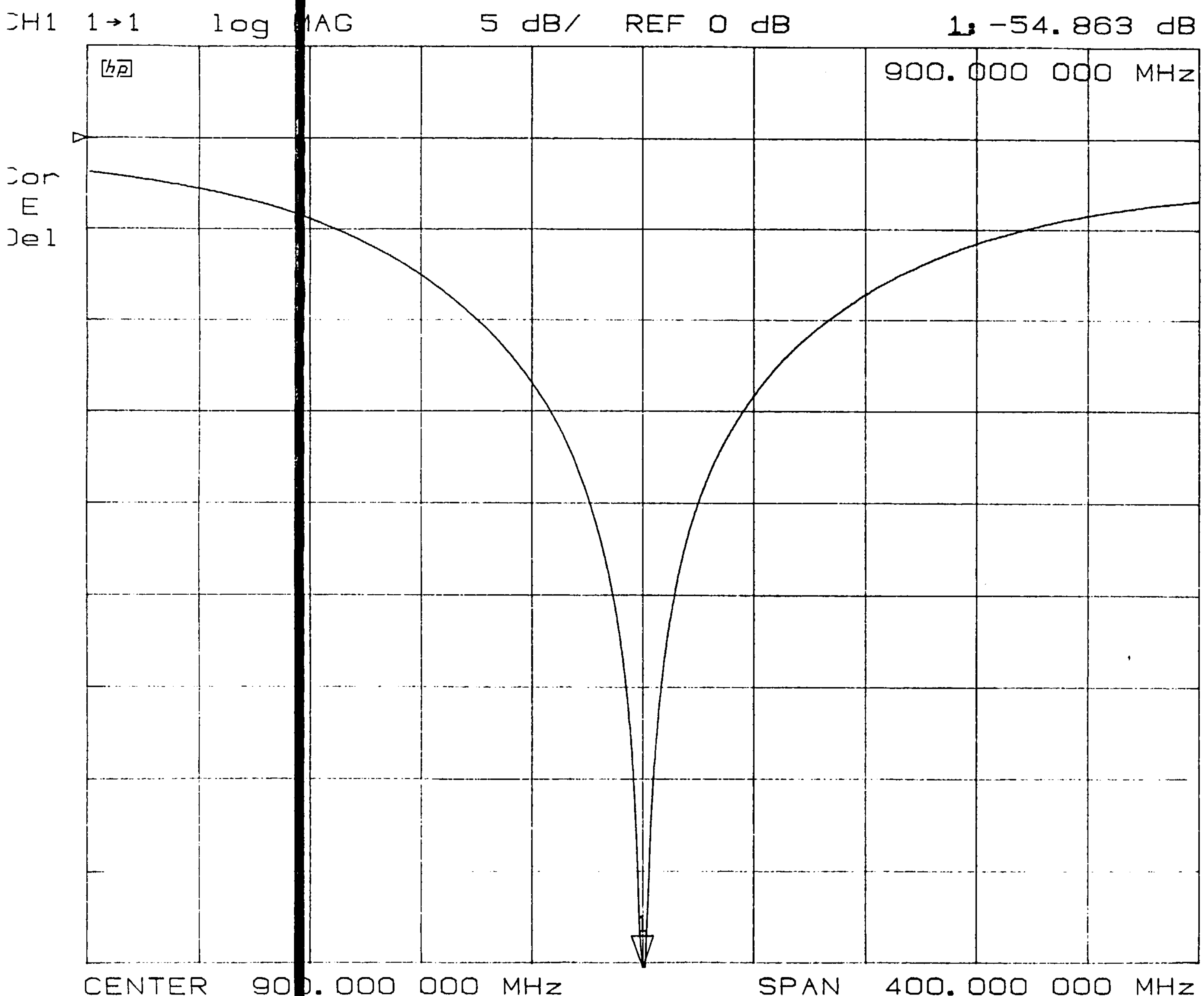

D900V2 SN: 024

S11

Flat phantom with brain simulating solution

d = 15mm

(distance from dipole center to solution)




D900V2 SN: 024

S11

Flat phantom with brain simulating solution

d = 15mm

(distance from dipole center to solution)

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# DASY3

## Dipole Validation Kit

## Type: D1800V2

## Serial: 220

Manufactured: December 1997
Calibrated: January 1998

## 1. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom (shell thickness 2mm) filled with brain simulating sugar solution of the following electrical parameters at 1800 MHz:

| | | |
|---|---|---|
| Relative Dielectricity | **39.5** | ± 5% |
| Conductivity | **1.70 mho/m** | ± 10% |

The DASY3 System (Software version 3.0b) with a dosimetric E-field probe ET3DV4 (SN:1302, conversion factor 4.6) was used for the measurements.

The dipole feedpoint was positioned below the centre marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole centre 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 normalised 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 normalised to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

| | |
|---|---|
| averaged over 1 $cm^3$ (1 g) of tissue: | **39.9 mW/g** |
| averaged over 10 $cm^3$ (10 g) of tissue: | **20.1 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 Impedanc and return loss

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

| | | |
|---|---|---|
| Electrical delay: | **1.178 ns** | (one direction) |
| Transmission factor: | **0.993** | (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 1800 MHz: | Re{Z} = **49.5 Ω** |
| | Im {Z} = **0.6 Ω** |
| Return Loss at 1800 MHz | **- 42.1 dB** |

## 4. Handling

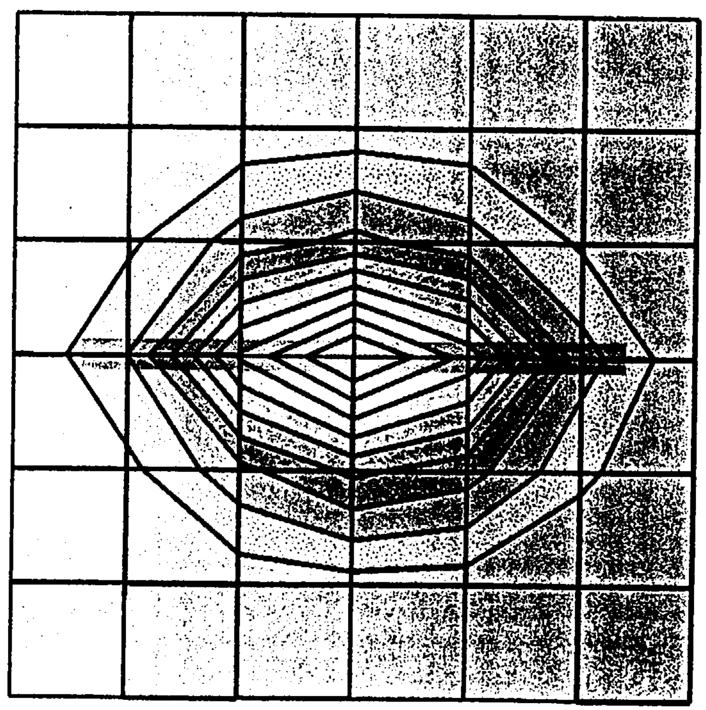
The dipole is made of standard semirigid coaxial cable. The centre conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

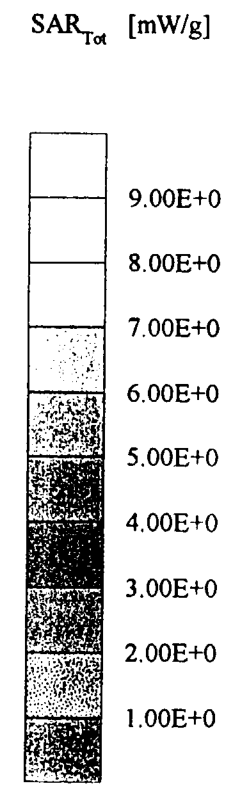
Do not apply excessive force to the dipole arms, because they might bend. If the dipole arms have to be bent back, take care to release stress to the soldered connections near the feedpoint; they might come off.

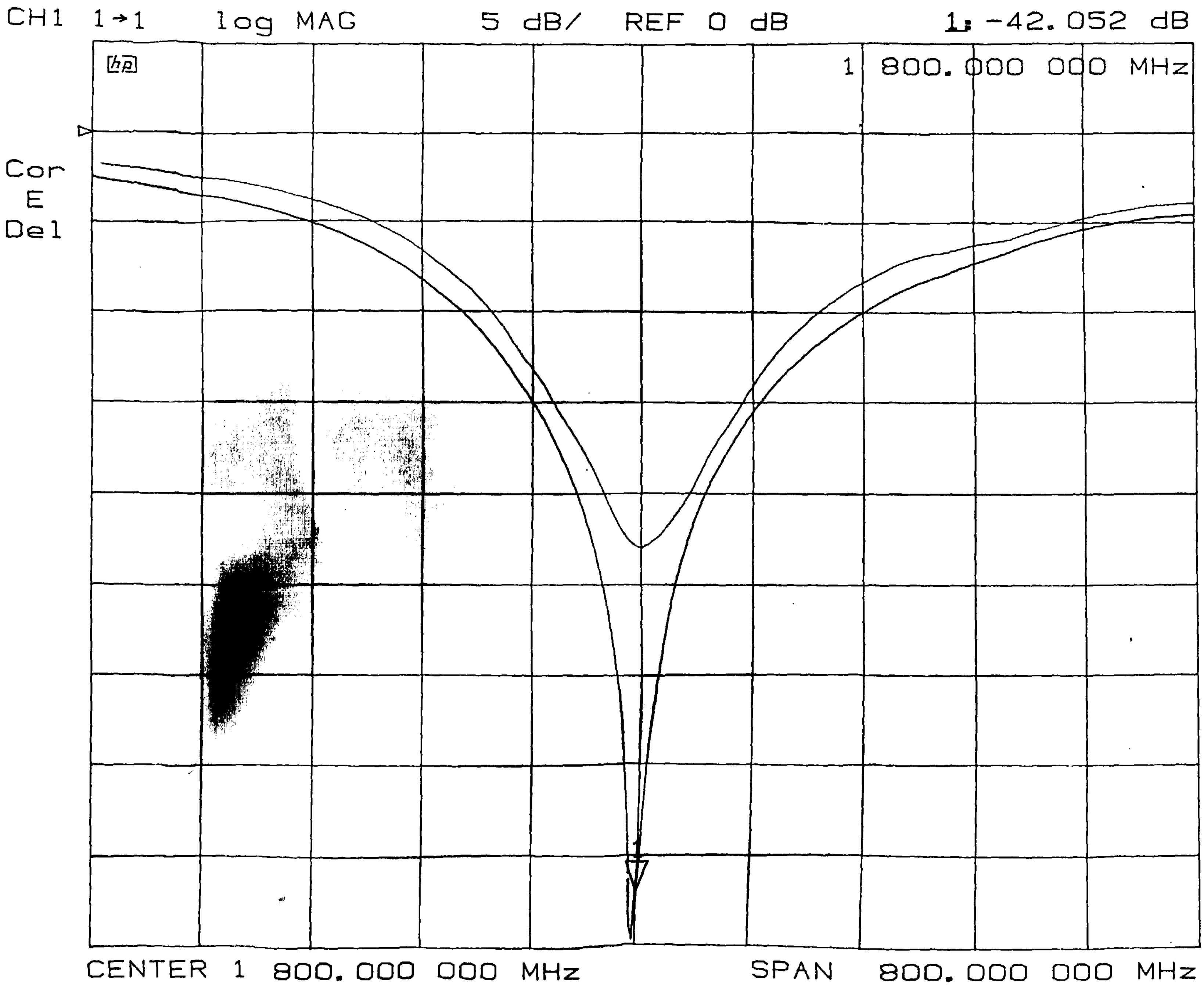
After prolonged use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

## Validation Dipole D1800V2 SN:220, d = 10mm

Frequency: 1800 [MHz]; Antanna Input Power: 250 [mW]
Generic Twin Phantom; Flat Section; Grid Spacing: Dx = 15.0, Dy = 15.0, Dz = 10.0 [mm]
Probe: ET3DV5 - SN1302 DAE3; ConvF(4.60,4.60,4.60); Crest factor: 1.0; }: $\sigma$ = 1.70 [mho/m] $\varepsilon_r$ = 39.5 $\rho$ = 1.00 [g/cm³]
Cubes (2): Peak: 19.2 [mW/g] ± 0.06 dB, SAR (1g): 9.97 [mW/g] ± 0.05 dB, SAR (10g): 5.02 [mW/g] ± 0.04 dB, (Worst-case extrapolation)
Penetration depth: 7.4 (7.2, 8.0) [mm]
Powerdrift: 0.03 dB








D1800V2 SN

S11

Flat phantom wi
brain simulating
solution

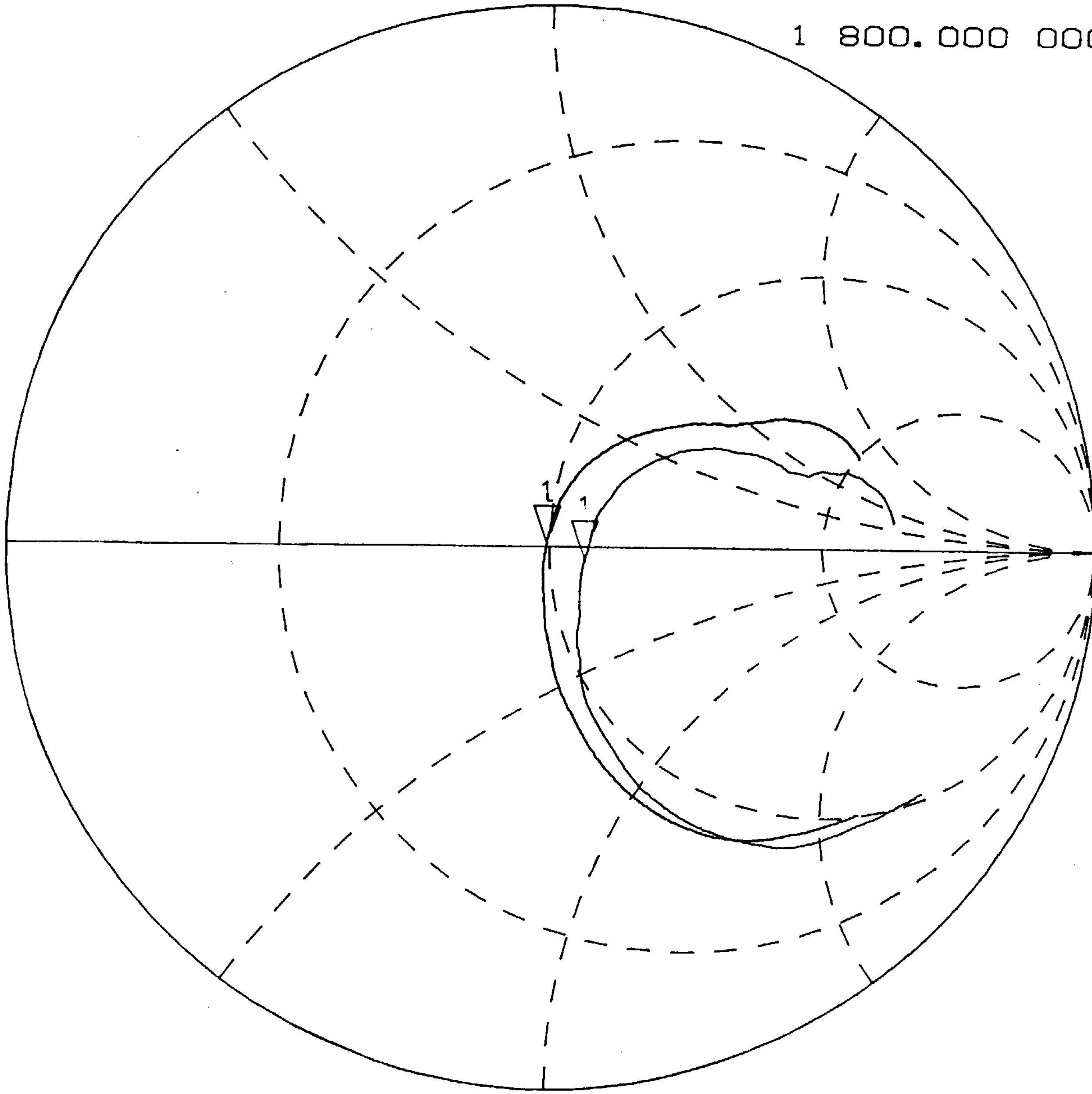
blk: d = 10mm
red: d = 20mm

(distance from dipo
center to solution)

CH1 1→1 1 U FS 1: 49.51 Ω 0.6289 Ω 55.608 pH

1 800.000 000 MHz

Cor
E
Del




CENTER 1 800.000 000 MHz SPAN 800.000 000 MHz

D1800V2 SN

S11

Flat phantom wi
brain simulating
solution

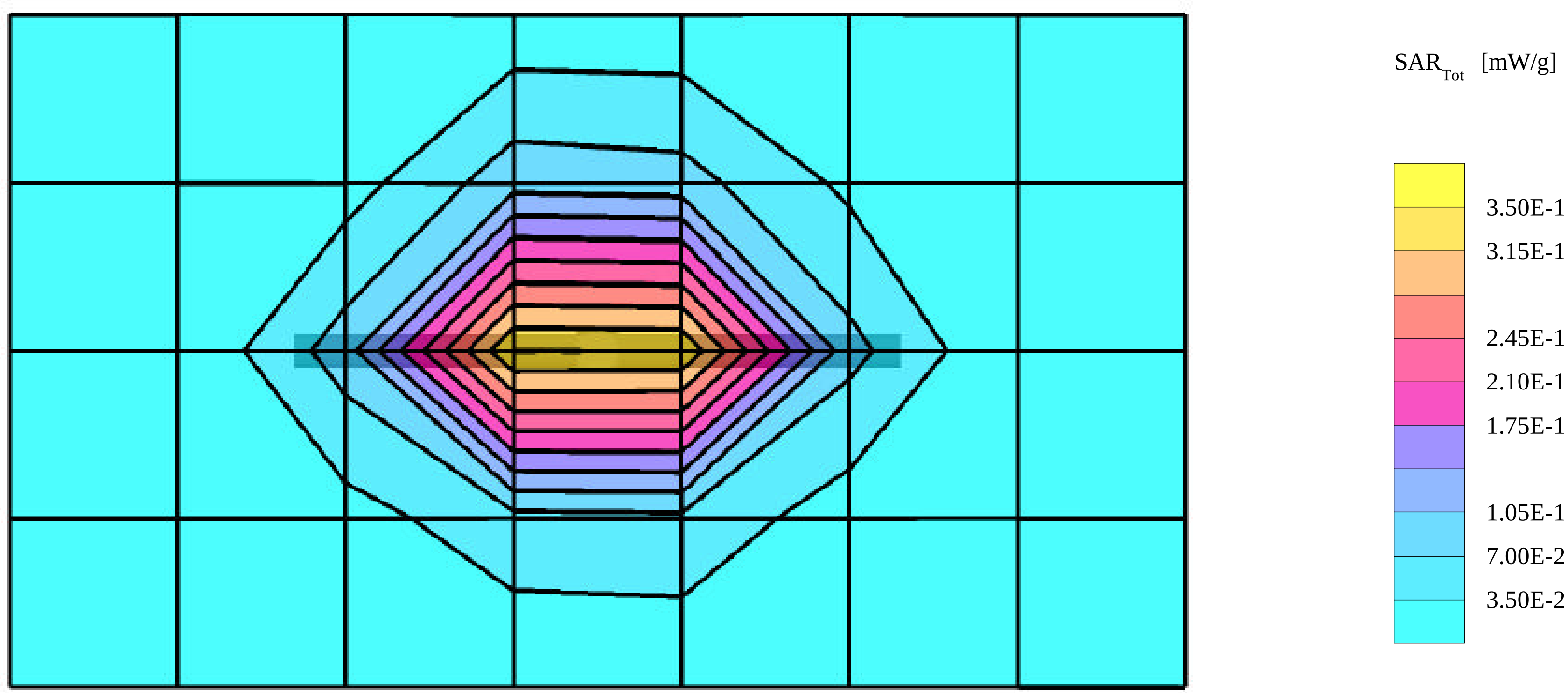
blk: d = 10mm
red: d = 20mm

(distance from dipo
center to solution)

**Brain Tissue Validation Test Results**

# 07-30-2001, 1800MHz Validation, Target=0.399mW/g

SAR (1g): 0.394 [mW/g] ± 0.05 dB, SAR (10g): 0.202 [mW/g] ± 0.05 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(5.00,5.00,5.00)
Brain 1800 MHz: $\sigma$ = 1.70 [mho/m] $\varepsilon_r$ = 40.6 $\rho$ = 1.00 [g/cm$^3$]
File Name: V1_FCC ValidationFlat 1800MHz 07-30-2001.DA3
Operator: DL



**Muscle Tissue Calibration Data Sheet**

Reference math : OFF    Title: vl **fcc** pcs only

MUSCLE 1800 MHz

| Pt# | Frequency (GHz) | Data real | -Data imag |
|---|---|---|---|
| 1 | 0.000030000 | 244.11 | -244.13 |
| 2 | 0.015029850 | 68.89 | 9.00 |
| 3 | 0.030029700 | 66.20 | 6.04 |
| 4 | 0.045029550 | 66.01 | 5.04 |
| 5 | 0.060029400 | 65.93 | 4.53 |
| 6 | 0.075029250 | 65.78 | 3.83 |
| 7 | 0.090029100 | 65.56 | 4.01 |
| 8 | 0.105028950 | 65.41 | 4.14 |
| 9 | 0.120028800 | 65.15 | 4.43 |
| 10 | 0.135028650 | 64.84 | 4.44 |
| 11 | 0.150028500 | 64.81 | 4.59 |
| 12 | 0.165028350 | 64.73 | 4.53 |
| 13 | 0.180028200 | 64.64 | 4.85 |
| 14 | 0.195028050 | 64.29 | 4.97 |
| 15 | 0.210027900 | 64.14 | 5.09 |
| 16 | 0.225027750 | 64.06 | 5.16 |
| 17 | 0.240027600 | 63.83 | 5.33 |
| 18 | 0.255027450 | 63.82 | 5.58 |
| 19 | 0.270027300 | 63.64 | 5.70 |
| 20 | 0.285027150 | 63.60 | 5.78 |
| 21 | 0.300027000 | 63.41 | 5.93 |
| 22 | 0.315026850 | 63.33 | 6.02 |
| 23 | 0.330026700 | 63.18 | 6.22 |
| 24 | 0.345026550 | 63.02 | 6.46 |
| 25 | 0.360026400 | 62.87 | 6.65 |
| 26 | 0.375026250 | 62.82 | 6.74 |
| 27 | 0.390026100 | 62.69 | 6.87 |
| 28 | 0.405025950 | 62.65 | 6.95 |
| 29 | 0.420025800 | 62.41 | 7.09 |
| 30 | 0.435025650 | 62.34 | 7.39 |
| 31 | 0.450025500 | 62.25 | 7.50 |
| 32 | 0.465025350 | 62.20 | 7.61 |
| 33 | 0.480025200 | 62.04 | 7.66 |
| 34 | 0.495025050 | 61.91 | 7.79 |
| 35 | 0.510024900 | 61.86 | 7.99 |
| 36 | 0.525024750 | 61.69 | 8.15 |
| 37 | 0.540024600 | 61.62 | 8.24 |
| 38 | 0.555024450 | 61.48 | 8.35 |
| 39 | 0.570024300 | 61.39 | 8.48 |
| 40 | 0.585024150 | 61.30 | 8.61 |
| 41 | 0.600024000 | 61.21 | 8.76 |
| 42 | 0.615023850 | 61.07 | 8.87 |
| 43 | 0.630023700 | 60.97 | 9.01 |
| 44 | 0.645023550 | 60.91 | 9.13 |
| 45 | 0.660023400 | 60.78 | 9.28 |
| 46 | 0.675023250 | 60.65 | 9.42 |
| 47 | 0.690023100 | 60.55 | 9.52 |
| 48 | 0.705022950 | 60.41 | 9.62 |
| 49 | 0.720022800 | 60.30 | 9.73 |
| 50 | 0.735022650 | 60.22 | 9.86 |
| 51 | 0.750022500 | 60.12 | 10.02 |
| 52 | 0.765022350 | 59.98 | 10.15 |
| 53 | 0.780022200 | 59.89 | 10.22 |
| 54 | 0.795022050 | 59.78 | 10.31 |
| 55 | 0.810021900 | 59.67 | 10.42 |
| 56 | 0.825021750 | 59.58 | 10.53 |
| 57 | 0.840021600 | 59.46 | 10.67 |
| 58 | 0.855021450 | 59.36 | 10.78 |
| 59 | 0.870021300 | 59.24 | 10.88 |
| 60 | 0.885021150 | 59.14 | 10.93 |
| 61 | 0.900021000 | 59.05 | 11.00 |
| 62 | 0.915020850 | 58.93 | 11.15 |
| 63 | 0.930020700 | 58.82 | 11.25 |
| 64 | 0.945020550 | 58.72 | 11.36 |
| 65 | 0.960020400 | 58.67 | 11.46 |
| 66 | 0.975020250 | 58.57 | 11.55 |
| 67 | 0.990020100 | 58.46 | 11.66 |
| 68 | 1.005019950 | 58.31 | 11.77 |
| 69 | 1.020019800 | 58.19 | 11.87 |
| 70 | 1.035019650 | 58.10 | 11.97 |

| | | | |
|---|---|---|---|
| 71 | 1.050019500 | 57.99 | 12.06 |
| 72 | 1.065019350 | 57.90 | 12.17 |
| 73 | 1.080019200 | 57.77 | 12.24 |
| 74 | 1.095019050 | 57.64 | 12.33 |
| 75 | 1.110018900 | 57.55 | 12.41 |
| 76 | 1.125018750 | 57.44 | 12.50 |
| 77 | 1.140018600 | 57.33 | 12.60 |
| 78 | 1.155018450 | 57.27 | 12.68 |
| 79 | 1.170018300 | 57.13 | 12.75 |
| 80 | 1.185018150 | 57.03 | 12.81 |
| 81 | 1.200018000 | 56.93 | 12.88 |
| 82 | 1.215017850 | 56.82 | 12.94 |
| 83 | 1.230017700 | 56.72 | 13.01 |
| 84 | 1.245017550 | 56.63 | 13.07 |
| 85 | 1.260017400 | 56.57 | 13.10 |
| 86 | 1.275017250 | 56.53 | 13.21 |
| 87 | 1.290017100 | 56.45 | 13.32 |
| 88 | 1.305016950 | 56.36 | 13.42 |
| 89 | 1.320016800 | 56.26 | 13.52 |
| 90 | 1.335016650 | 56.15 | 13.62 |
| 91 | 1.350016500 | 56.02 | 13.72 |
| 92 | 1.365016350 | 55.92 | 13.81 |
| 93 | 1.380016200 | 55.81 | 13.87 |
| 94 | 1.395016050 | 55.71 | 13.93 |
| 95 | 1.410015900 | 55.61 | 14.01 |
| 96 | 1.425015750 | 55.50 | 14.08 |
| 97 | 1.440015600 | 55.39 | 14.15 |
| 98 | 1.455015450 | 55.27 | 14.23 |
| 99 | 1.470015300 | 55.17 | 14.29 |
| 100 | 1.485015150 | 55.07 | 14.32 |
| 101 | 1.500015000 | 54.98 | 14.36 |
| 102 | 1.515014850 | 54.91 | 14.41 |
| 103 | 1.530014700 | 54.79 | 14.46 |
| 104 | 1.545014550 | 54.70 | 14.56 |
| 105 | 1.560014400 | 54.62 | 14.63 |
| 106 | 1.575014250 | 54.56 | 14.68 |
| 107 | 1.590014100 | 54.50 | 14.74 |
| 108 | 1.605013950 | 54.42 | 14.83 |
| 109 | 1.620013800 | 54.34 | 14.89 |
| 110 | 1.635013650 | 54.23 | 14.97 |
| 111 | 1.650013500 | 54.12 | 15.01 |
| 112 | 1.665013350 | 54.01 | 15.09 |
| 113 | 1.680013200 | 53.90 | 15.14 |
| 114 | 1.695013050 | 53.83 | 15.23 |
| 115 | 1.710012900 | 53.74 | 15.28 |
| 116 | 1.725012750 | 53.64 | 15.33 |
| 117 | 1.740012600 | 53.55 | 15.38 |
| 118 | 1.755012450 | 53.44 | 15.43 |
| 119 | 1.770012300 | 53.36 | 15.48 |
| 120 | 1.785012150 | 53.25 | 15.51 |
| 121 | 1.800012000 | 53.16 | 15.58 |
| 122 | 1.815011850 | 53.08 | 15.60 |
| 123 | 1.830011700 | 52.99 | 15.64 |
| 124 | 1.845011550 | 52.91 | 15.70 |
| 125 | 1.860011400 | 52.83 | 15.72 |
| 126 | 1.875011250 | 52.76 | 15.76 |
| 127 | 1.890011100 | 52.71 | 15.81 |
| 128 | 1.905010950 | 52.63 | 15.86 |
| 129 | 1.920010800 | 52.55 | 15.94 |
| 130 | 1.935010650 | 52.48 | 16.00 |
| 131 | 1.950010500 | 52.41 | 16.04 |
| 132 | 1.965010350 | 52.33 | 16.10 |
| 133 | 1.980010200 | 52.24 | 16.16 |
| 134 | 1.995010050 | 52.14 | 16.19 |
| 135 | 2.010009900 | 52.04 | 16.27 |
| 136 | 2.025009750 | 51.96 | 16.30 |
| 137 | 2.040009600 | 51.87 | 16.34 |
| 138 | 2.055009450 | 51.79 | 16.40 |
| 139 | 2.070009300 | 51.72 | 16.44 |
| 140 | 2.085009150 | 51.61 | 16.47 |
| 141 | 2.100009000 | 51.53 | 16.52 |
| 142 | 2.115008850 | 51.45 | 16.54 |
| 143 | 2.130008700 | 51.37 | 16.57 |
| 144 | 2.145008550 | 51.33 | 16.61 |

$\sigma$ = 1.56 mho/m

| | | | |
|---|---|---|---|
| 145 | 2.160008400 | 51.23 | 16.64 |
| 246 | 2.175008250 | 51.15 | 16.70 |
| 147 | 2.190008100 | 51.07 | 16.74 |
| 148 | 2.205007950 | 51.00 | 16.77 |
| 149 | 2.220007800 | 50.94 | 16.83 |
| 150 | 2.235007650 | 50.89 | 16.86 |
| 151 | 2.250007500 | 50.81 | 16.91 |
| 152 | 2.265007350 | 50.73 | 16.98 |
| 153 | 2.280007200 | 50.65 | 17.02 |
| 154 | 2.295007050 | 50.58 | 17.07 |
| 155 | 2.310006900 | 50.52 | 17.11 |
| 156 | 2.325006750 | 50.44 | 17.16 |
| 157 | 2.340006600 | 50.35 | 17.22 |
| 158 | 2.355006450 | 50.27 | 17.28 |
| 159 | 2.370006300 | 50.18 | 17.31 |
| 160 | 2.385006150 | 50.06 | 17.37 |
| 161 | 2.400006000 | 49.99 | 17.40 |
| 162 | 2.415005850 | 49.92 | 17.44 |
| 163 | 2.430005700 | 49.86 | 17.47 |
| 164 | 2.445005550 | 49.80 | 17.51 |
| 165 | 2.460005400 | 49.72 | 17.54 |
| 166 | 2.475005250 | 49.63 | 17.59 |
| 167 | 2.490005100 | 49.56 | 17.63 |
| 168 | 2.505004950 | 49.47 | 17.66 |
| 169 | 2.520004800 | 49.42 | 17.69 |
| 170 | 2.535004650 | 49.37 | 17.74 |
| 171 | 2.550004500 | 49.27 | 17.76 |
| 172 | 2.565004350 | 49.18 | 17.82 |
| 173 | 2.580004200 | 49.11 | 17.86 |
| 174 | 2.595004050 | 49.03 | 17.89 |
| 175 | 2.610003900 | 48.97 | 17.94 |
| 176 | 2.625003750 | 48.90 | 17.98 |
| 177 | 2.640003600 | 48.83 | 18.03 |
| 178 | 2.655003450 | 48.75 | 18.07 |
| 179 | 2.670003300 | 48.65 | 18.12 |
| 180 | 2.685003150 | 48.58 | 18.15 |
| 181 | 2.700003000 | 48.50 | 18.18 |
| 182 | 2.715002850 | 48.43 | 18.21 |
| 183 | 2.730002700 | 48.35 | 18.24 |
| 184 | 2.745002550 | 48.28 | 18.27 |
| 185 | 2.760002400 | 48.20 | 18.30 |
| 186 | 2.775002250 | 48.10 | 18.34 |
| 187 | 2.790002100 | 48.03 | 18.37 |
| 188 | 2.805001950 | 47.96 | 18.41 |
| 189 | 2.820001800 | 47.90 | 18.44 |
| 190 | 2.835001650 | 47.83 | 18.46 |
| 191 | 2.850001500 | 47.75 | 18.49 |
| 192 | 2.865001350 | 47.68 | 18.51 |
| 193 | 2.880001200 | 47.61 | 18.55 |
| 194 | 2.895001050 | 47.53 | 18.59 |
| 195 | 2.910000900 | 47.46 | 18.60 |
| 196 | 2.925000750 | 47.40 | 18.63 |
| 197 | 2.940000600 | 47.34 | 18.65 |
| 198 | 2.955000450 | 47.26 | 18.67 |
| 199 | 2.970000300 | 47.17 | 18.70 |
| 200 | 2.985000150 | 47.11 | 18.76 |
| 201 | 3.000000000 | 47.05 | 18.76 |

# 8 SAR MEASUREMENT PROCEDURE

**DEVICE POSITIONING** The phone was tested in the primary test position that is described by Supplement C of OET Bulletin 65 from the Office of Engineering & Technology, of the FCC. The procedure places the surface of the phone in contact with the phantom.

# 9 SAR MEASUREMENT UNCERTAINTY

The possible errors included in this measurement arise from device positioning uncertainty, device manufacturing uncertainty, liquid dielectric permitivity uncertainty, liquid dielectric conductivity uncertainty, uncertainty due to disturbance of the fields by the probe.

These will be discussed as they are of much importance to the final dosimetric assessment. Every attempt is made to reduce uncertainty, as well as to test for worst case SAR. These uncertainties are likely to be pessimistic, but they should be considered when comparing data taken from one lab to another. Thomas Schmid of Schmid and Partners has performed a study of SAR repeatability due to many different uncertainties, this is likely the most complete study of the topic so it is referred to here.

**Device positioning**; this uncertainty is due to different operators positioning the device on the phantom differently, it depends on the operators, the device design, the phantom, and the device holder. Repeatability for some devices in Schmid's study was as poor as +/- 30% for the "touch" position. For the "intended use" position the repeatability was approximately +/- 5%, depending on the device tested, overall a figure of +/- 6% was taken as typical device positioning uncertainty. One operator is used at the Kyocera lab, trained to place the phone as close as possible to phantom, and the test is performed after the position of maximum SAR is determined. This minimises device positioning error. Typically the phone is clamped in the holder in the horizontal position, and a short wooden dowel is placed in a small hole where the center of the ear speaker resides, this wooden dowel allows the operator to line up the speaker with the ear canal. Once aligned, the tooth pick is removed, and the phone is raised up until it touches the phantom on the ear. Then the cradle is rocked so the phone rocks toward the chin of the phantom, touching as closely as possible without depressing the keypad. This puts the phone as close as possible to the phantom, allowing maximum SAR to be measured, for most positions. In the event that this may not produce maximum SAR, the phone is placed in several other positions and a coarse scan is run for each position. The DASY system has a command called "move to max" which allows the probe to be sent to the point of max field intensity found with the coarse scan. This gives a visual indication of where the maximum surface currents may be, and allows the operator to position this point of the phone as close as possible to the phantom.

**Liquid dielectric permittivity and conductivity**; The average permittivity of a typical human head was determined by Dr. Gabriel and has been listed by the FCC (OET bulletin 65 supplement C) as 46.1 at 835 MHz and 43.4 at 1800 MHz. The lower permittivity generally gives a slightly higher SAR value, so slightly lower values were used for the test. Since SAR is defined as the time rate of absorption per unit of weight, only the macroscopic simulation of the tissue's permittivity, permeability, and conductivity are required. These electrical properties are obtained with a liquid which uses sugar to raise the permittivity, salt to raise the conductivity, and cellulose to hold the two in suspension. After installing the liquid it is measured with an HP 85070A dielectric probe kit. The achievable accuracy of this device is +/- 5% for the permittivity and +/- 10% for the conductivity. The liquid is also measured at the beginning of each SAR measurement day, to check for evaporation.

**FIELD DISTURBANCES** Errors due to disturbance of the fields by the probe; because the polarisation of the fields are unknown, the near field probe must measure all polarisation's without disturbing them by being present. Three orthogonal dipoles are located at the tip of a special dielectric support, with diodes at the feed points sensitive to fields as small as 5 microWatt/gm. To prevent secondary coupling of the fields to the feed lines, the lines are high resistance printed lines with distributed filters integrated in the lines, after the diode. Much research has been put into these probe designs, so their uncertainty is considered minimized. There are other uncertainties, such as laboratory setup uncertainty, the reader should refer to attachment 10 of the March 1998 minutes of the IEEE standards coordinating committee, by Thomas Schmid. Mr. Schmid's preliminary uncertainty figure is –12% to +52% for the SAR measurement. As stated before this is possible, but believed to be pessimistic because many of the sources of uncertainty have been reduced or eliminated, at considerable expense. All practical precautionary measures are taken to reduce these errors in the Kyocera Corp SAR lab.

**Surface Detection** The surface detection on the DASY system is mechanical and optical, it is checked and compared automatically to ensure correct operation. This can indicate that the optical surface detection is not in agreement with the mechanical, which might mean the liquid needs to be stirred. This process insures minimum distance from the surface of the phantom for measurements.

# 10 TEST DATA SUMMARY

The device, which was tested, is the final production model in both the analogue and digital modes. The SAR values measured indicate that the device produces SAR levels below the limit of 1.6 mW/g for the one gram average.

**Parameters of brain and muscle tissue**

| | **Frequency** | **Permittivity** | **Conductivity (S/m)** | **Notes** |
|---|---|---|---|---|
| Brain | 900 MHz | 42.7 | 0.86 | specified by DASY3-user manual |
| Muscle | 900 MHz | 55.9 | 0.94 | specified by OET bulletin 65, supplemental C and DASY3-user manual |
| | | | | |
| Brain | 1800 MHz | 40.4 | 1.68 | specified by DASY3-user manual |
| Muscle | 1800 MHz | 40.1 | 1.67 | specified by OET bulletin 65, supplemental C. |

| ANSI/IEEE C95.1 1992 – SAFETY LIMIT<br>Spatial Peak (Brain)<br>Uncontrolled Exposure/General Population | 1.6 W/kg (mW/g) |
|---|---|

**Brain SAR Test Results**

| FREQ. MHZ | CH.# | SERIAL NUMBER | MODULATION | ANTENNA POSITION | 1 GRAM AVG. SAR (MW/G) |
|---|---|---|---|---|---|
| 1851.25 | 25 | 0120010194 | PCS CDMA | Ext | 0.943 |
| 1851.25 | 25 | 0120010194 | PCS CDMA | Ret | 1.15 |
| 1880 | 600 | 0120010194 | PCS CDMA | Ext | 1.02 |
| 1880 | 600 | 0120010194 | PCS CDMA | Ret | 1.38 |
| 1908.75 | 1175 | 0120010194 | PCS CDMA | Ext | 1.04 |
| 1908.75 | 1175 | 0120010194 | PCS CDMA | Ret | 1.39 |

For the FCC ID: OVFKWC-2119 the highest SAR (at head) for the PCS band is 1.39 mw/g.

The 2119 has provision for headset and belt clip to allow hands-free operation. The SAR for such operating condition was measured. The following is the summary of the results.

**Body-worn SAR Test Results**

| FREQ. MHZ | CH.# | SERIAL NUMBER | MODULATION | ANTENNA POSITION | 1 GRAM AVG. SAR (MW/G) |
|---|---|---|---|---|---|
| 1851.25 | 25 | 0120010194 | PCS CDMA | Ext | 0.426 |
| 1851.25 | 25 | 0120010194 | PCS CDMA | Ret | 0.380 |
| 1880 | 600 | 0120010194 | PCS CDMA | Ext | 0.466 |
| 1880 | 600 | 0120010194 | PCS CDMA | Ret | 0.450 |
| 1908.75 | 1175 | 0120010194 | PCS CDMA | Ext | 0.644 |
| 1908.75 | 1175 | 0120010194 | PCS CDMA | Ret | 0.649 |

For the FCC ID: OVFKWC-2119 tested with a belt clip (provides 26.7 mm closet separation), the highest body-worn SAR is 0.649 mw/g.

The 2119 has provision for headset and belt clip to allow hands-free operation. The SAR for the operating condition with a space only of 26.7 mm closest separation to the body (no belt clip) was measured. The following is the summary of the results.

**Body-worn SAR Test Results (26.7 mm Space Only)**

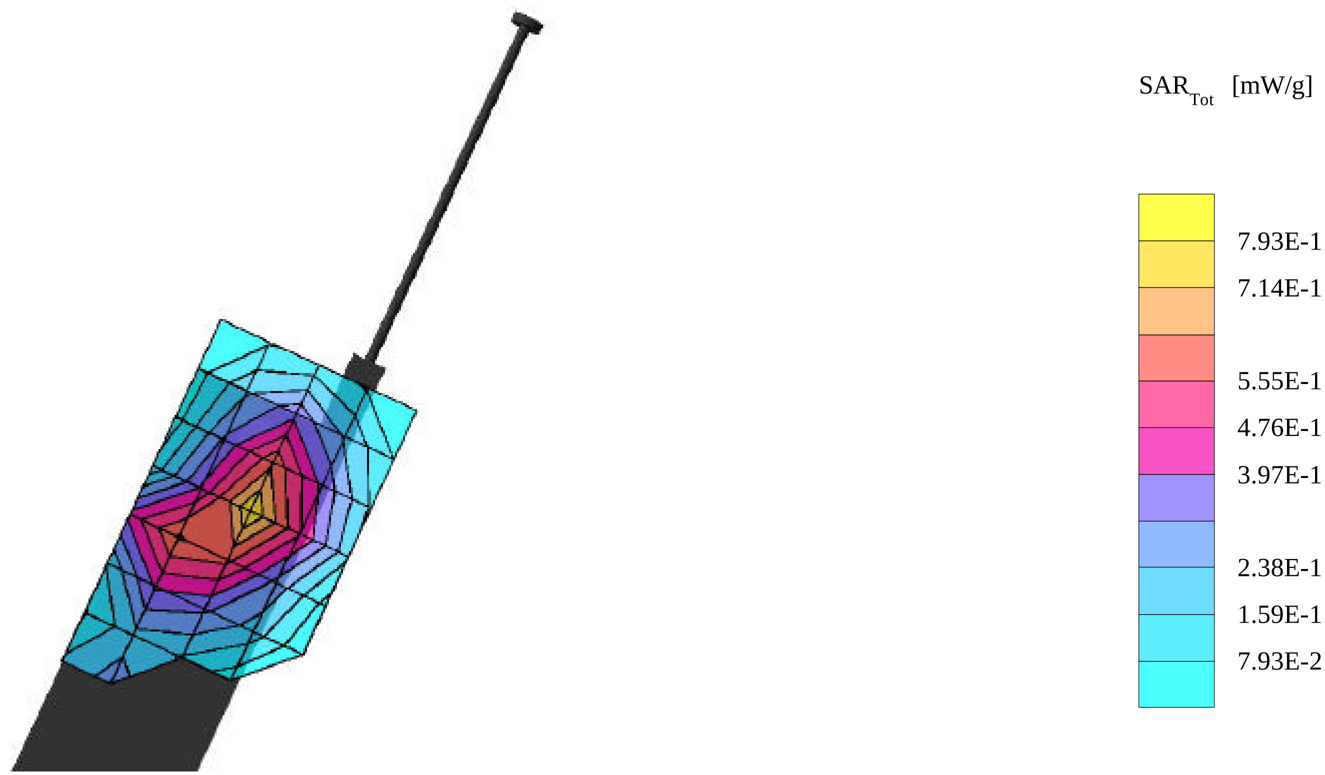
| FREQ. MHZ | CH.# | SERIAL NUMBER | MODULATION | ANTENNA POSITION | 1 GRAM AVG. SAR (MW/G) |
|---|---|---|---|---|---|
| 1851.25 | 25 | 0120010194 | PCS CDMA | Ext | 0.148 |
| 1851.25 | 25 | 0120010194 | PCS CDMA | Ret | 0.128 |
| 1880 | 600 | 0120010194 | PCS CDMA | Ext | 0.216 |
| 1880 | 600 | 0120010194 | PCS CDMA | Ret | 0.164 |
| 1908.75 | 1175 | 0120010194 | PCS CDMA | Ext | 0.199 |
| 1908.75 | 1175 | 0120010194 | PCS CDMA | Ret | 0.161 |

For the FCC ID: OVFKWC-2119 tested with a closest separation of 26.7mm (without a belt clip in place), the highest body-worn SAR is 0.216 mw/g.

# 11 SAR PLOTS

# KWC-V1 P1A, #0194 PCS Ch25, Conducted Power=22.70dBm, Hdet=42

SAR (1g): 0.943 [mW/g] ± 0.04 dB, SAR (10g): 0.461 [mW/g] ± 0.03 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Generic Twin Phantom; Left Hand Section
Probe: ET3DV5 - SN1353; ConvF(5.00,5.00,5.00)
Brain 1800 MHz: $\sigma$ = 1.70 [mho/m] $\varepsilon_r$ = 40.6 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch25, 07-30-01.da3
Operator: DL



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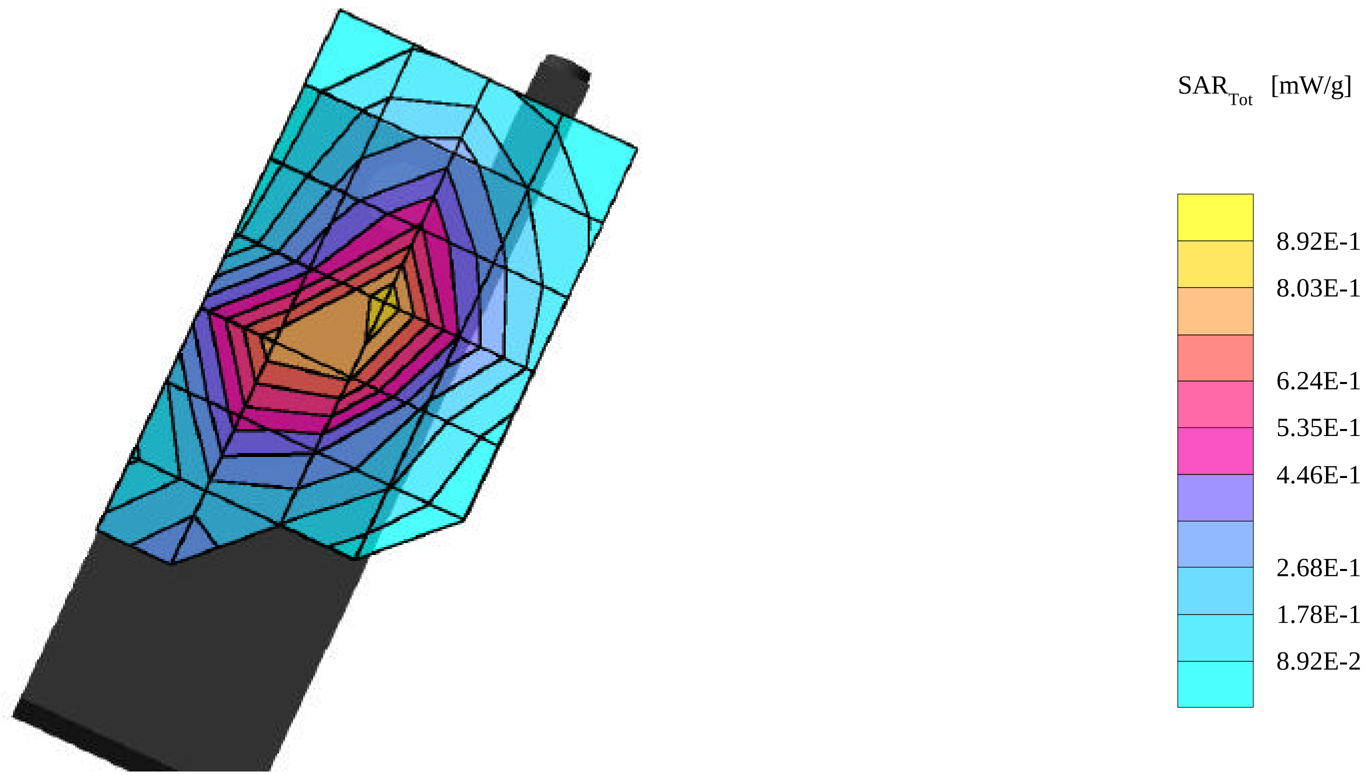
# KWC-V1 P1A, #0194 PCS Ch25, Conducted Power=22.70dBm, Hdet=42

SAR (1g): 1.15 [mW/g] ± 0.07 dB, SAR (10g): 0.542 [mW/g] ± 0.03 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Generic Twin Phantom; Left Hand Section
Probe: ET3DV5 - SN1353; ConvF(5.00,5.00,5.00)
Brain 1800 MHz: $\sigma$ = 1.70 [mho/m] $\varepsilon_r$ = 40.6 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch25, 07-30-01.da3
Operator: DL

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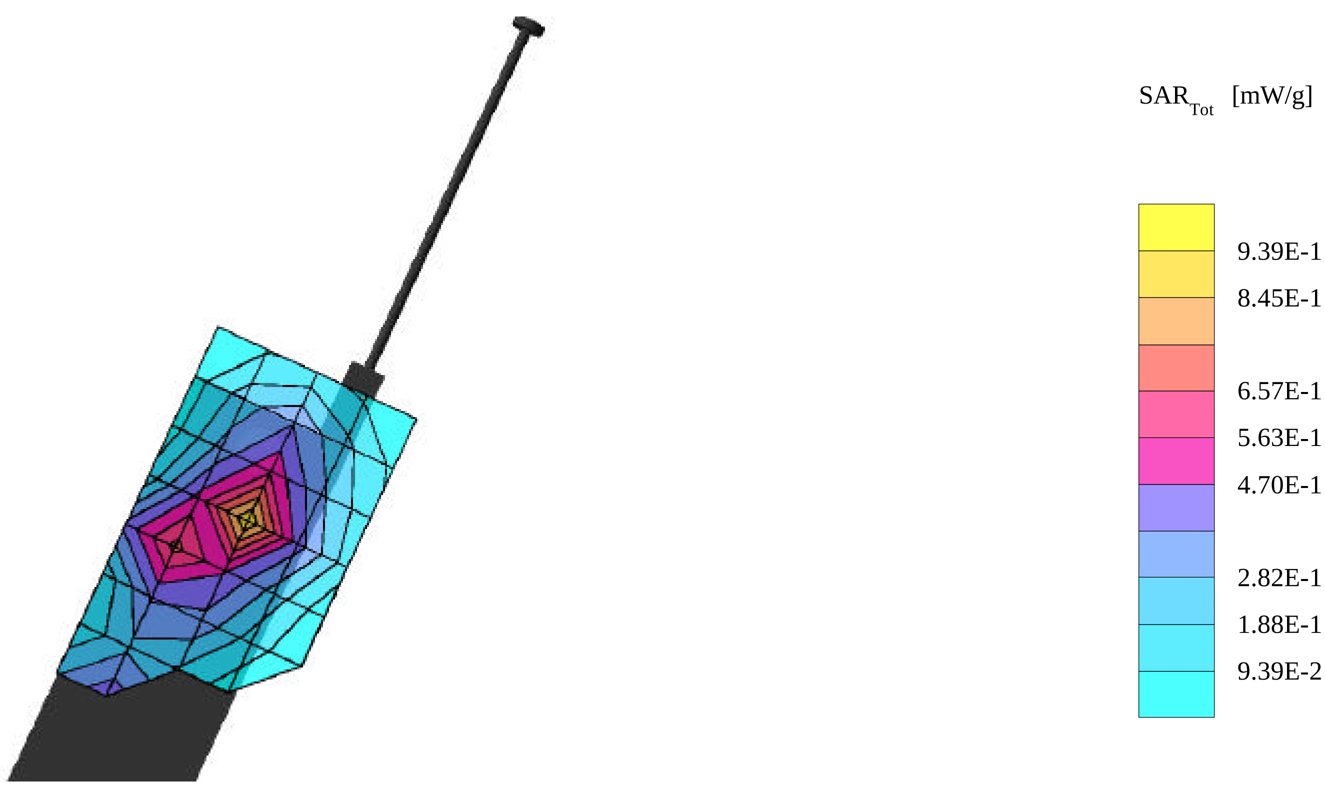
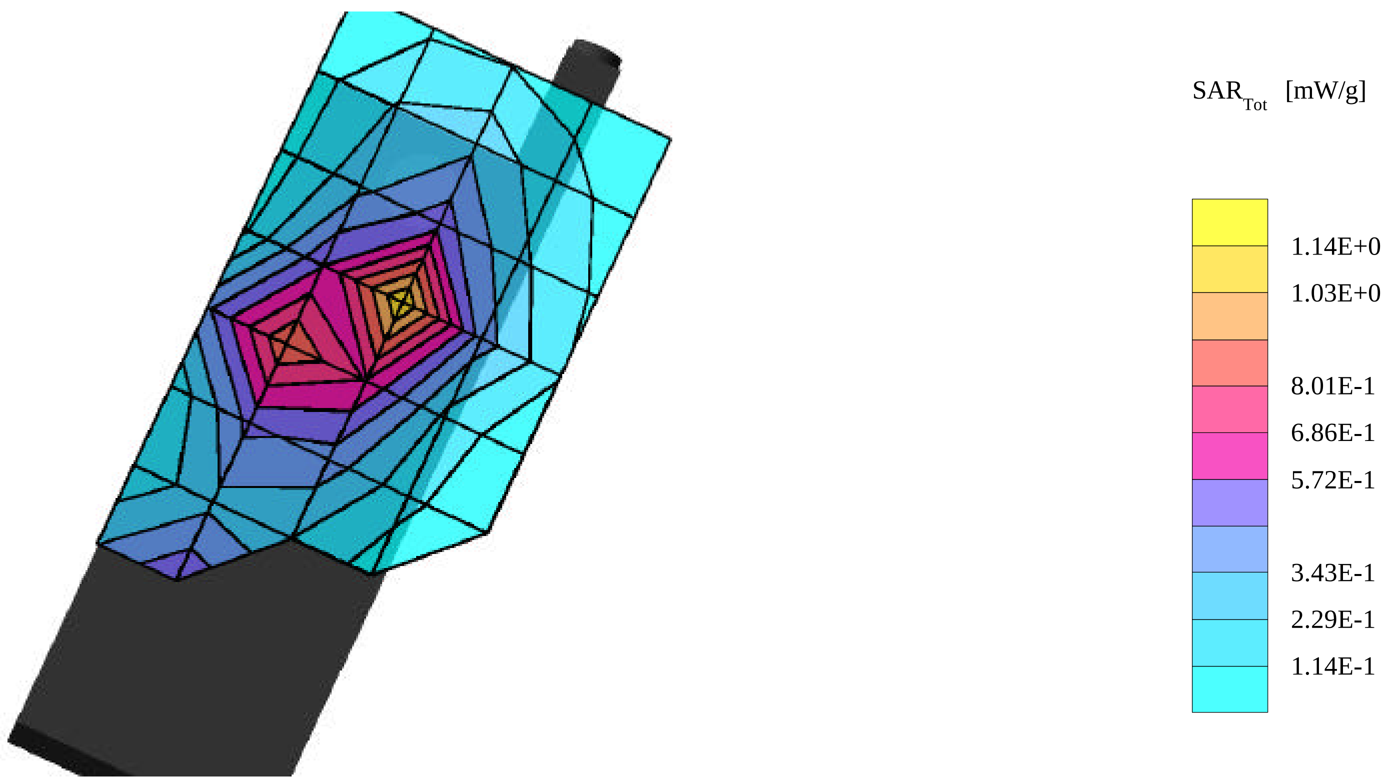
# KWC-V1 P1A, #0194 PCS Ch600, Conducted Power=22.70dBm, Hdet=43

SAR (1g): 1.02 [mW/g] ± 0.04 dB, SAR (10g): 0.484 [mW/g] ± 0.07 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Generic Twin Phantom; Left Hand Section
Probe: ET3DV5 - SN1353; ConvF(5.00,5.00,5.00)
Brain 1800 MHz: $\sigma$ = 1.70 [mho/m] $\varepsilon_r$ = 40.6 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch600, 07-30-01.da3
Operator: DL



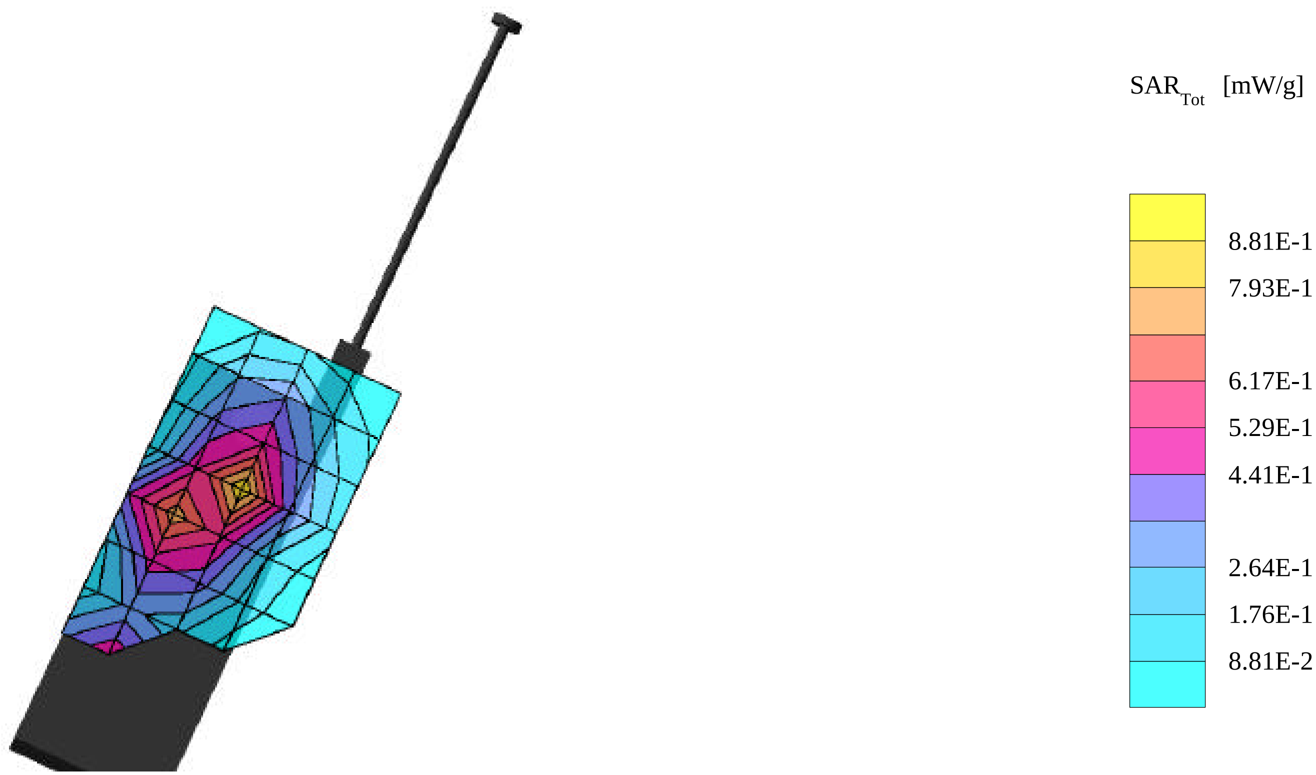
# KWC-V1 P1A, #0194 PCS Ch600, Conducted Power=22.70dBm, Hdet=43

SAR (1g): 1.38 [mW/g] ± 0.03 dB, SAR (10g): 0.635 [mW/g] ± 0.08 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Generic Twin Phantom; Left Hand Section
Probe: ET3DV5 - SN1353; ConvF(5.00,5.00,5.00)
Brain 1800 MHz: $\sigma$ = 1.70 [mho/m] $\varepsilon_r$ = 40.6 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch600, 07-30-01.da3
Operator: DL



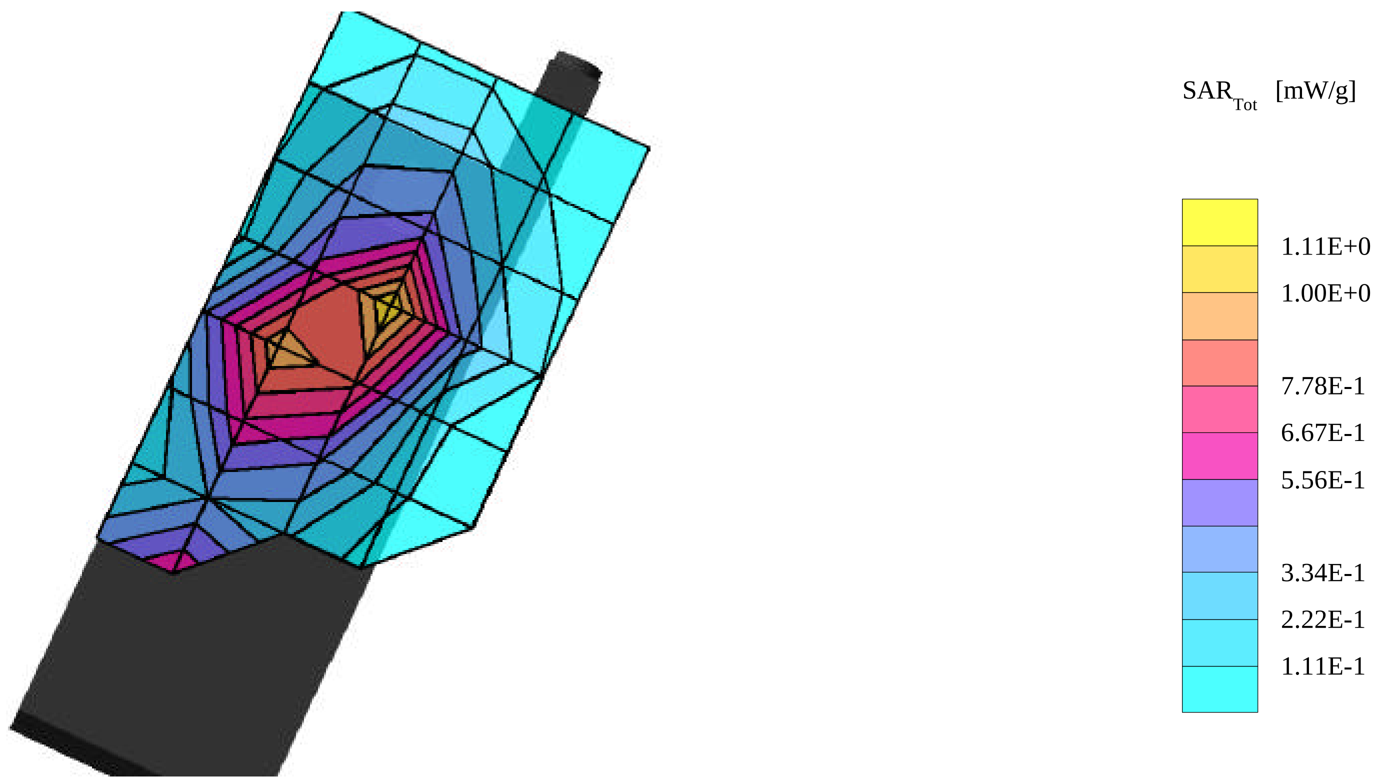
# KWC-V1 P1A, #0194 PCS Ch1175, Conducted Power=22.70dBm, Hdet=45

SAR (1g): 1.04 [mW/g] ± 0.02 dB, SAR (10g): 0.499 [mW/g] ± 0.01 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Generic Twin Phantom; Left Hand Section
Probe: ET3DV5 - SN1353; ConvF(5.00,5.00,5.00)
Brain 1800 MHz: σ = 1.70 [mho/m] $\varepsilon_r$ = 40.6 ρ = 1.00 [g/cm³]
File Name: KWC-V1 P1A #0194, PCS ch1175, 07-30-01.da3
Operator: DL



# KWC-V1 P1A, #0194 PCS Ch1175, Conducted Power=22.70dBm, Hdet=45

SAR (1g): 1.39 [mW/g] ± 0.02 dB, SAR (10g): 0.648 [mW/g] ± 0.05 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Generic Twin Phantom; Left Hand Section
Probe: ET3DV5 - SN1353; ConvF(5.00,5.00,5.00)
Brain 1800 MHz: $\sigma$ = 1.70 [mho/m] $\varepsilon_r$ = 40.6 $\rho$ = 1.00 [g/cm³]
File Name: KWC-V1 P1A #0194, PCS ch1175, 07-30-01.da3
Operator: DL



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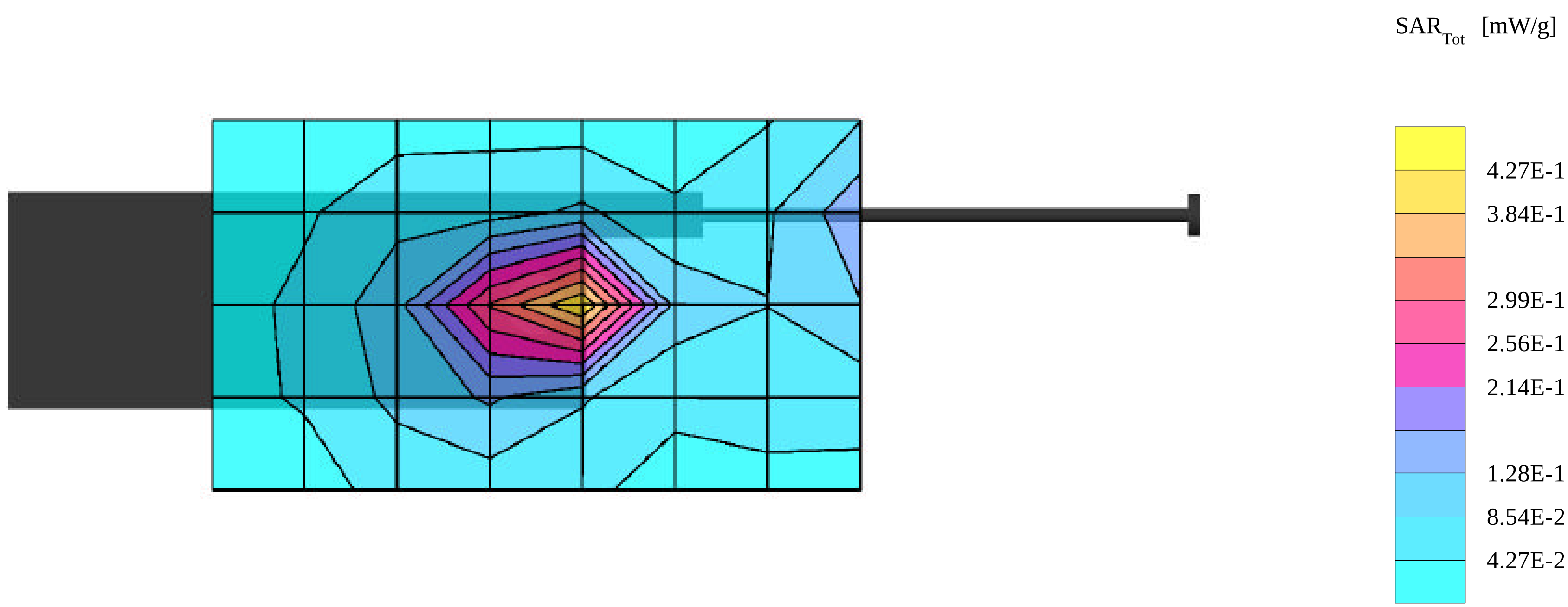
# KWC-V1 P1A, #0194 PCS Ch25 with beltclip, Conducted Power=22.70dBm, Hdet=42

SAR (1g): 0.426 [mW/g] ± 0.07 dB, SAR (10g): 0.223 [mW/g] ± 0.08 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch25 muscle with bc, 07-30-01.da3
Operator: DL

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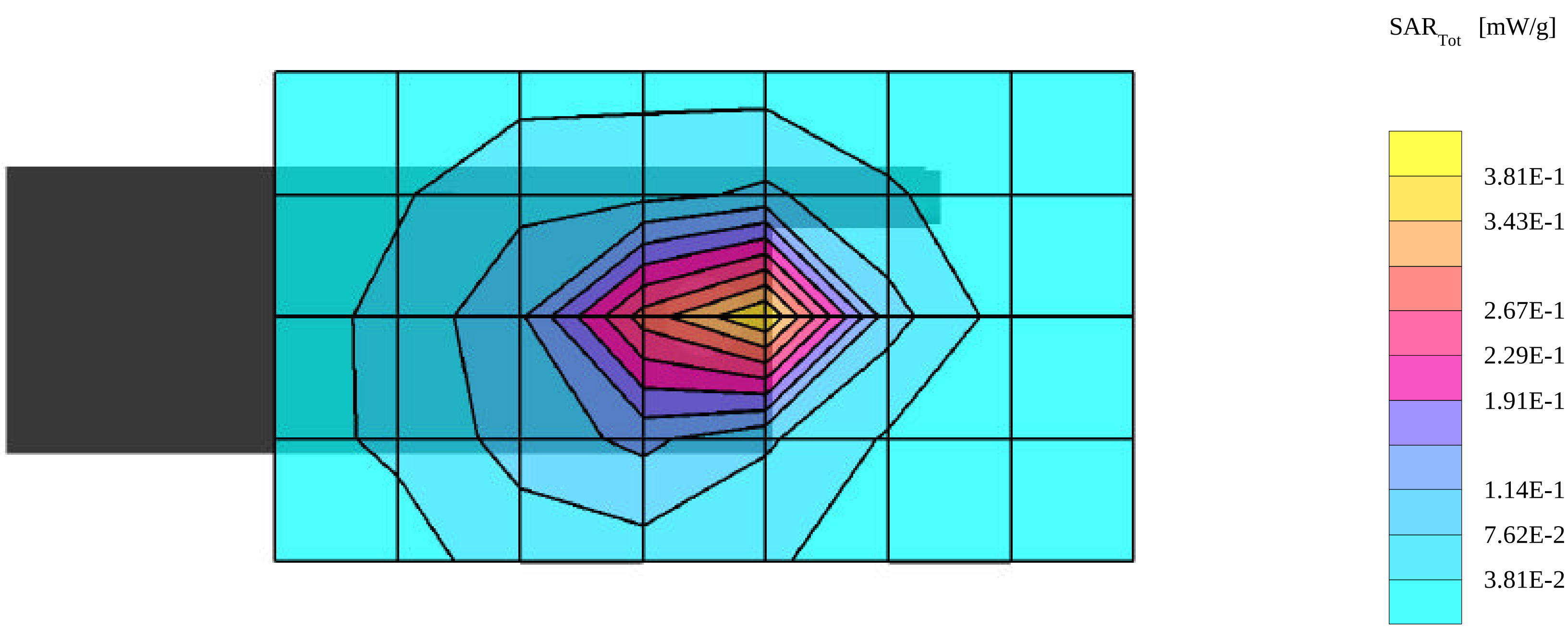
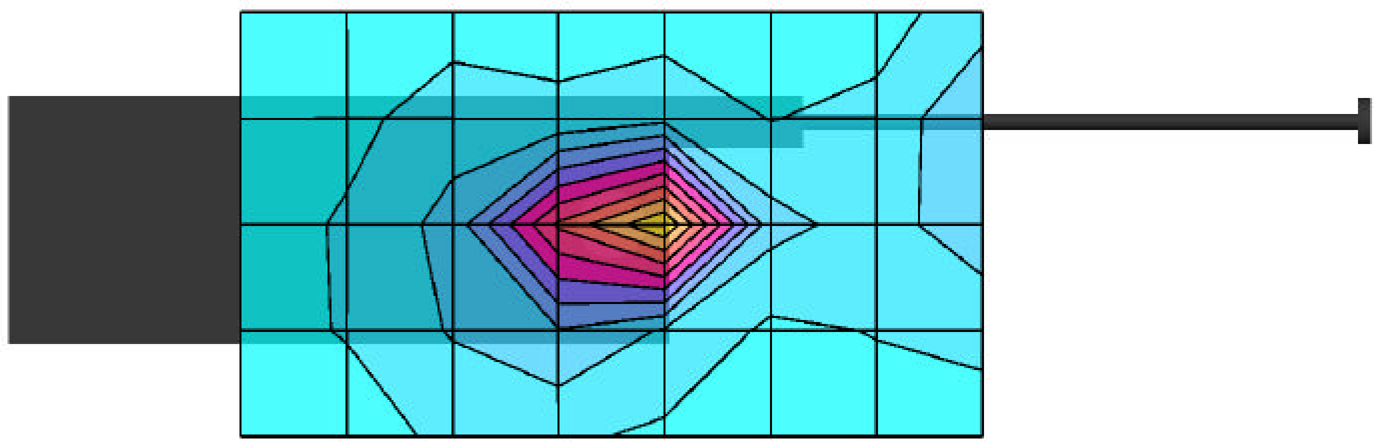
# KWC-V1 P1A, #0194 PCS Ch25 with beltclip, Conducted Power=22.70dBm, Hdet=42

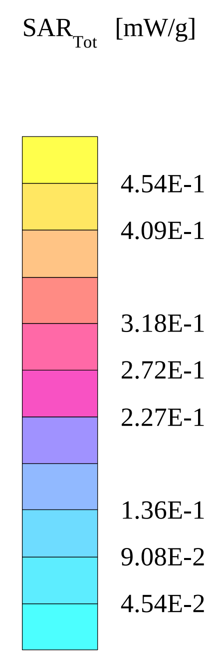
SAR (1g): 0.380 [mW/g] ± 0.14 dB, SAR (10g): 0.199 [mW/g] ± 0.11 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch25 muscle with bc, 07-30-01.da3
Operator: DL



# KWC-V1 P1A, #0194 PCS Ch600 with beltclip, Conducted Power=22.70dBm, Hdet=43

SAR (1g): 0.466 [mW/g] ± 0.01 dB, SAR (10g): 0.237 [mW/g] ± 0.03 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch600 muscle with bc, 07-30-01.da3
Operator: DL

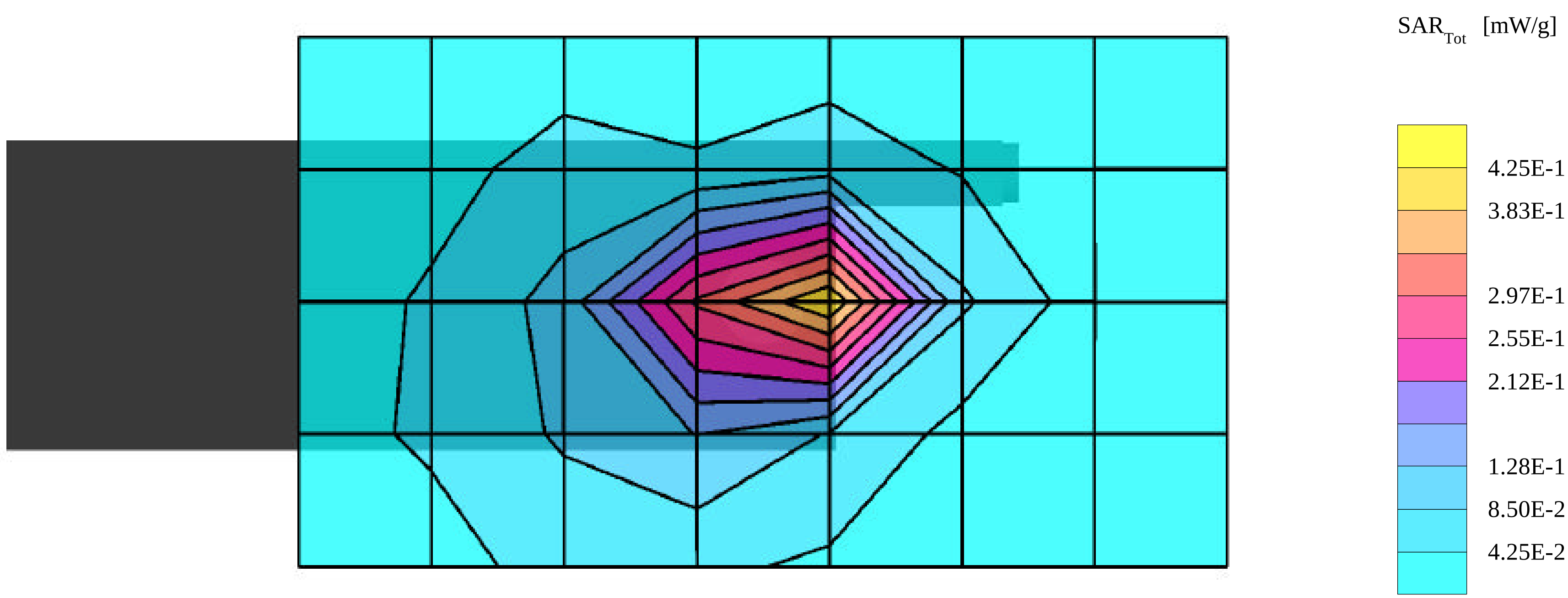




07/30/01

# KWC-V1 P1A, #0194 PCS Ch600 with beltclip, Conducted Power=22.70dBm, Hdet=43

SAR (1g): 0.450 [mW/g] ± 0.11 dB, SAR (10g): 0.228 [mW/g] ± 0.10 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch600 muscle with bc, 07-30-01.da3
Operator: DL

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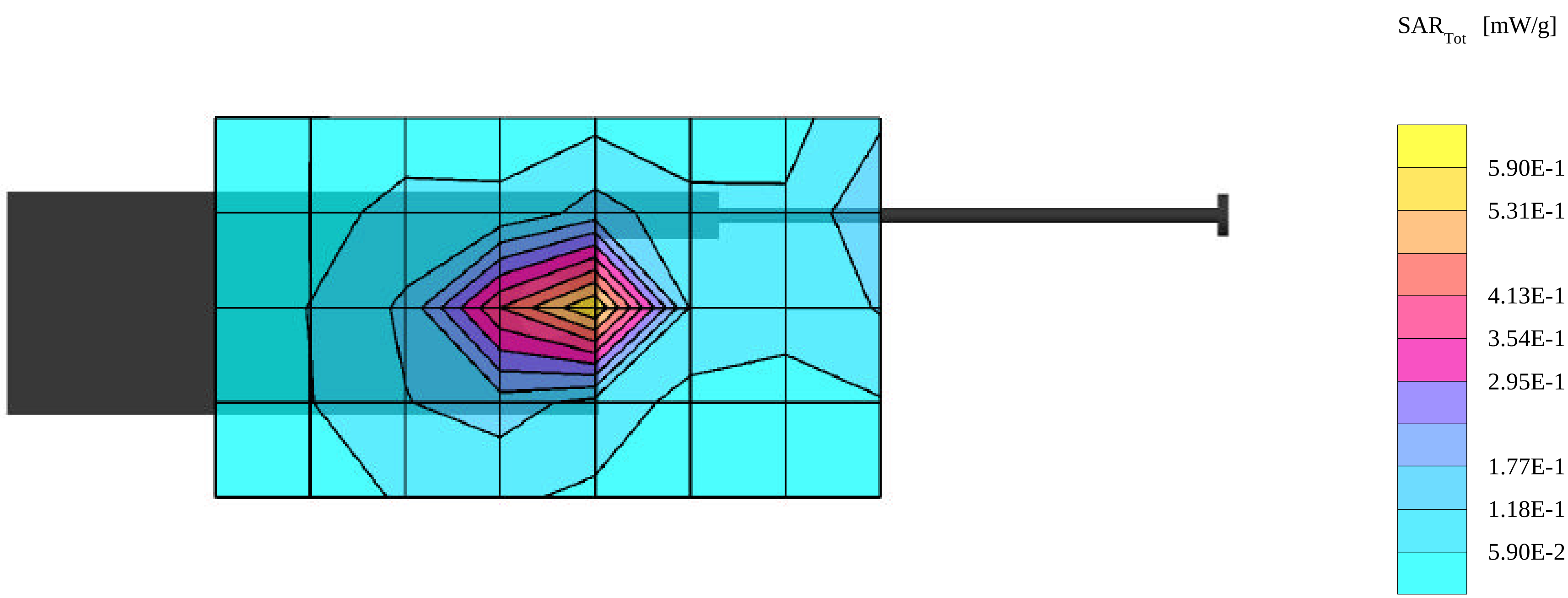
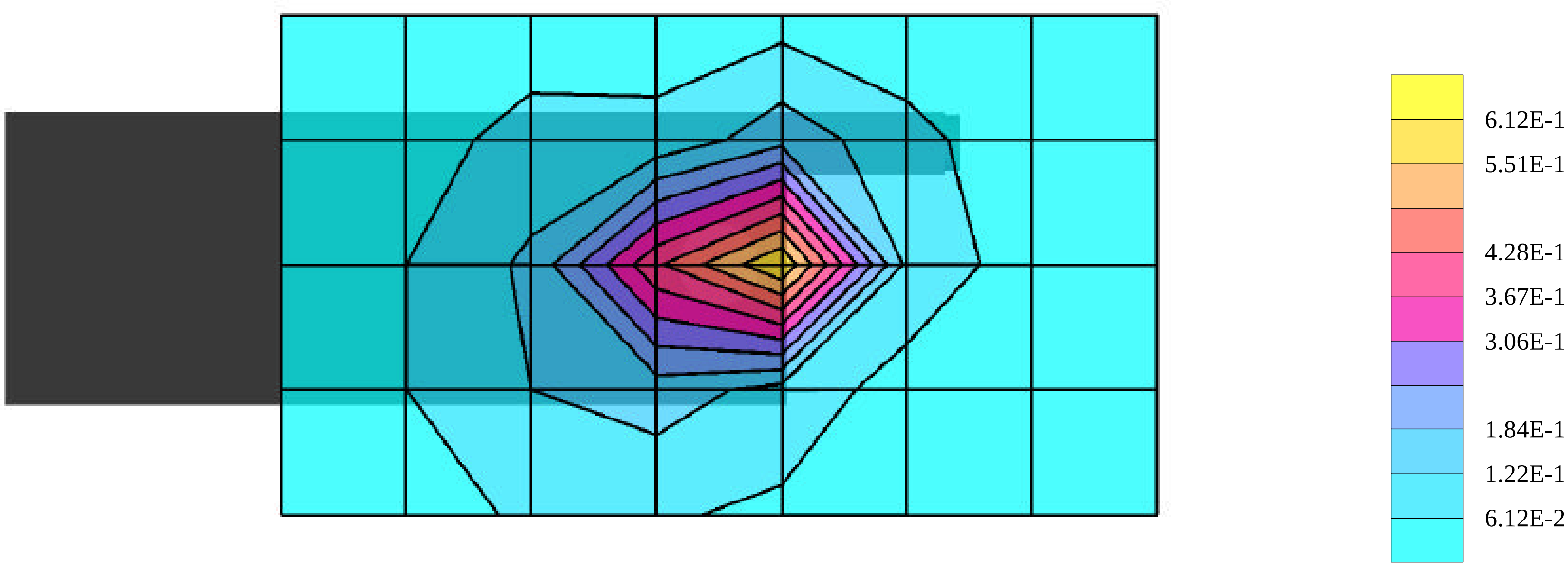
# KWC-V1 P1A, #0194 PCS Ch1175 with beltclip, Conducted Power=22.70dBm, Hdet=45

SAR (1g): 0.644 [mW/g] ± 0.05 dB, SAR (10g): 0.325 [mW/g] ± 0.05 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch1175 muscle with bc, 07-30-01.da3
Operator: DL



# KWC-V1 P1A, #0194 PCS Ch1175 with beltclip, Conducted Power=22.70dBm, Hdet=45

SAR (1g): 0.649 [mW/g] ± 0.08 dB, SAR (10g): 0.327 [mW/g] ± 0.12 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch1175 muscle with bc, 07-30-01.da3
Operator: DL



# KWC-V1 P1A, #0194 PCS Ch25 without beltclip, Conducted Power=22.70dBm, Hdet=42

SAR (1g): 0.148 [mW/g] ± 0.03 dB, SAR (10g): 0.0935 [mW/g] ± 0.00 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
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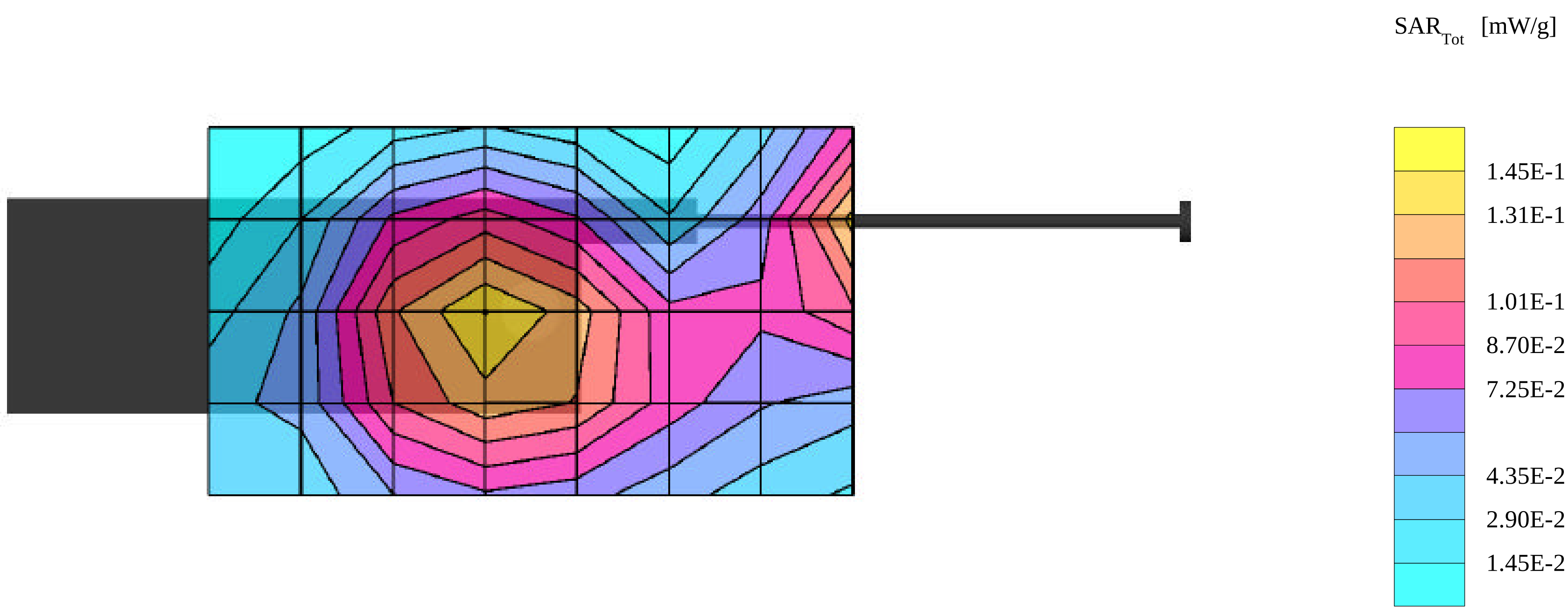
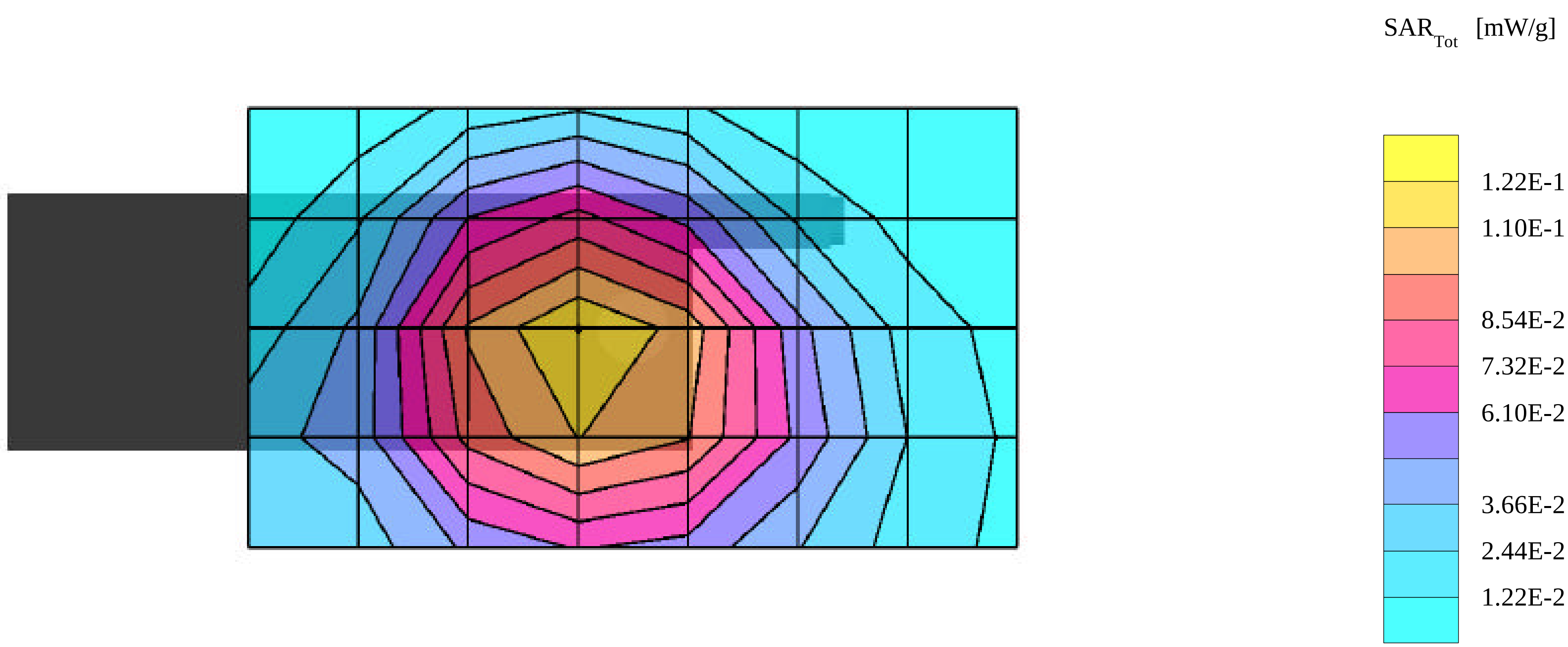
Operator: DL



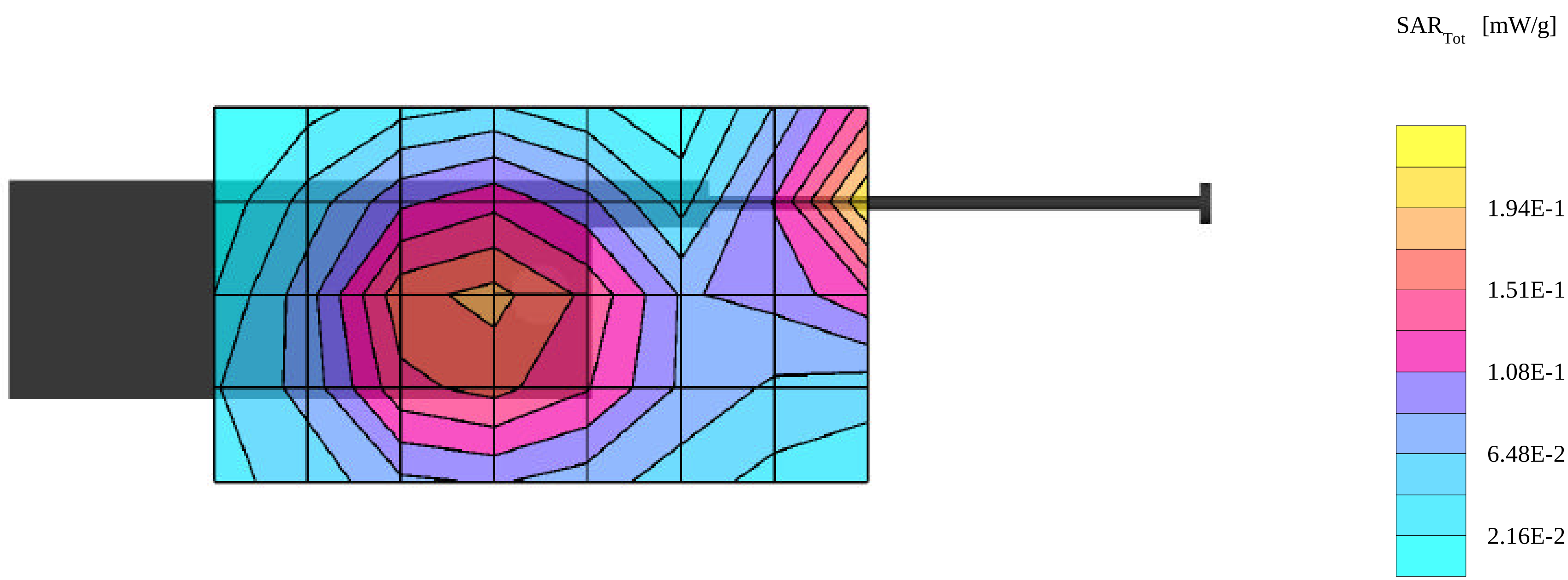
# KWC-V1 P1A, #0194 PCS Ch25 without beltclip, Conducted Power=22.70dBm, Hdet=42

SAR (1g): 0.128 [mW/g] ± 0.04 dB, SAR (10g): 0.0805 [mW/g] ± 0.03 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch25 muscle without bc, 26.7mm space, 07-30-01.da3
Operator: DL



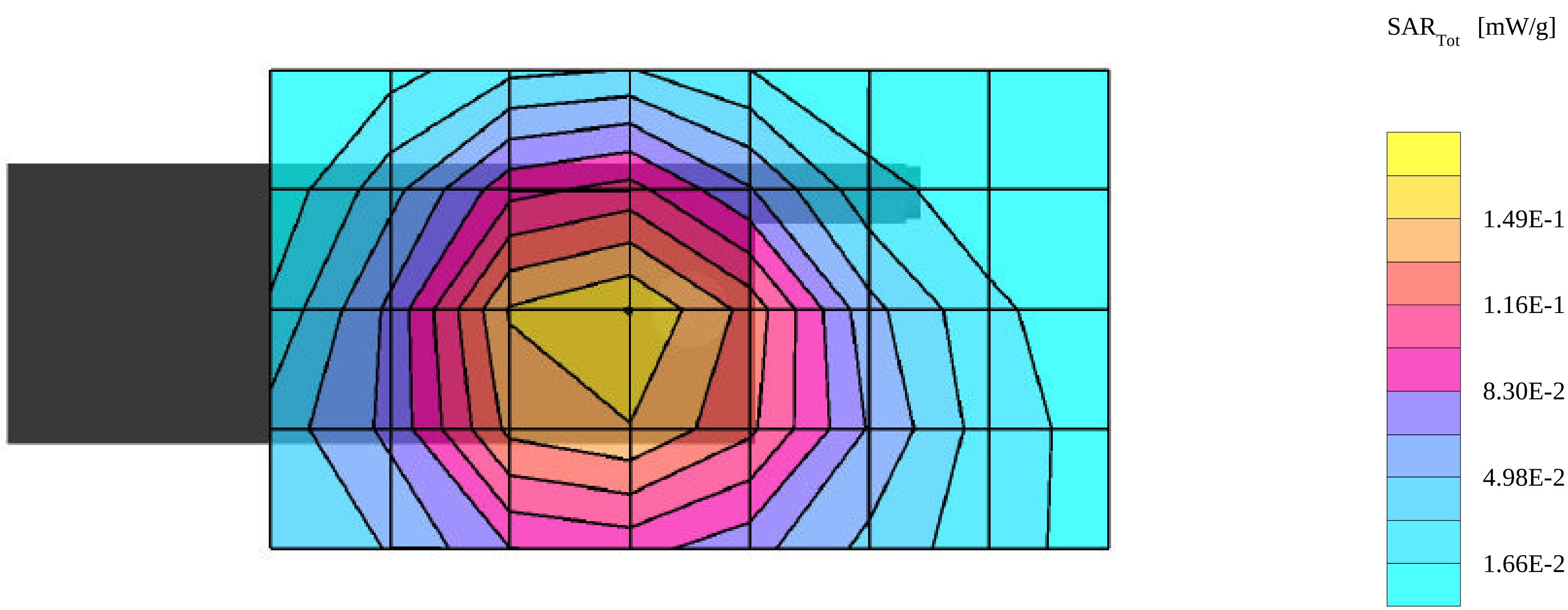
# KWC-V1 P1A, #0194 PCS Ch600 without beltclip, Conducted Power=22.70dBm, Hdet=43

SAR (1g): 0.216 [mW/g] ± 0.00 dB, SAR (10g): 0.128 [mW/g] ± 0.02 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch600 muscle without bc, 26.7mm space, 07-30-01.da3
Operator: DL



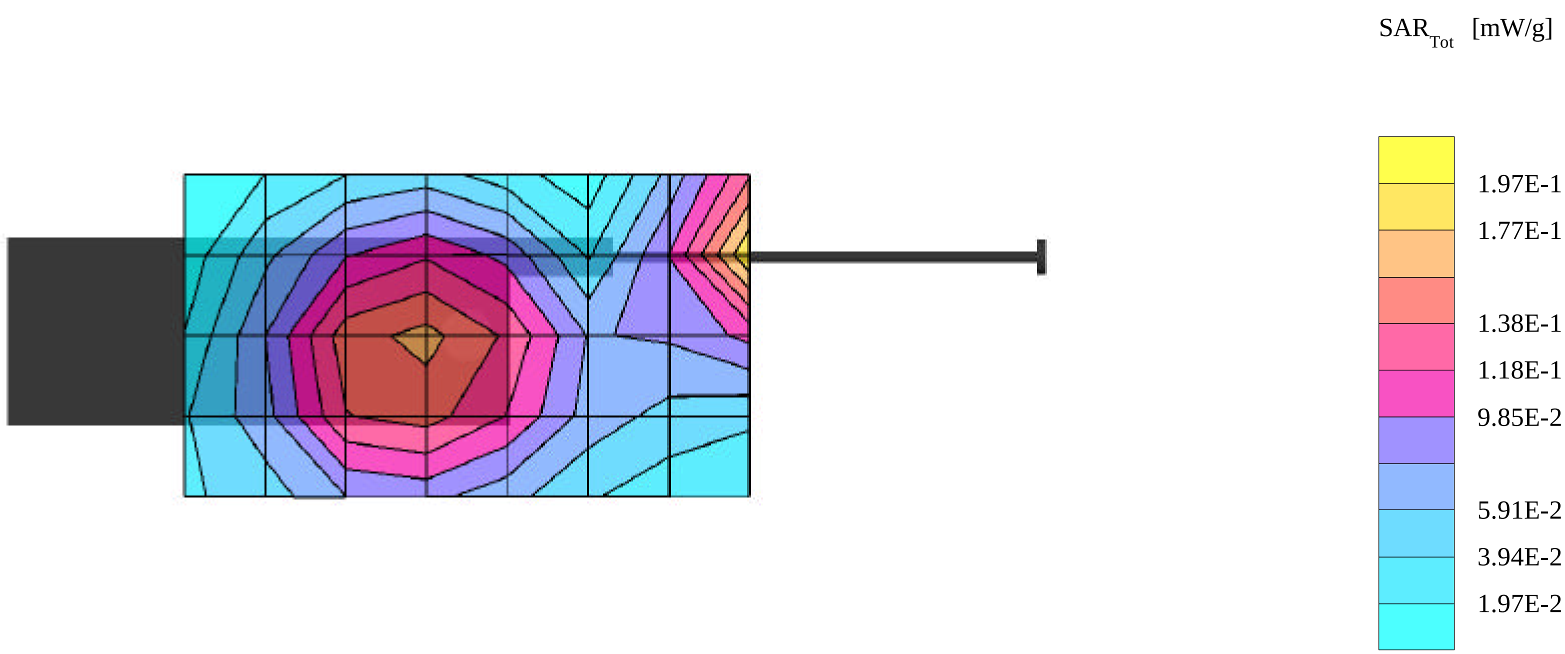
# KWC-V1 P1A, #0194 PCS Ch600 without beltclip, Conducted Power=22.70dBm, Hdet=43

SAR (1g): 0.164 [mW/g] ± 0.01 dB, SAR (10g): 0.103 [mW/g] ± 0.05 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch600 muscle without bc, 26.7mm space, 07-30-01.da3
Operator: DL



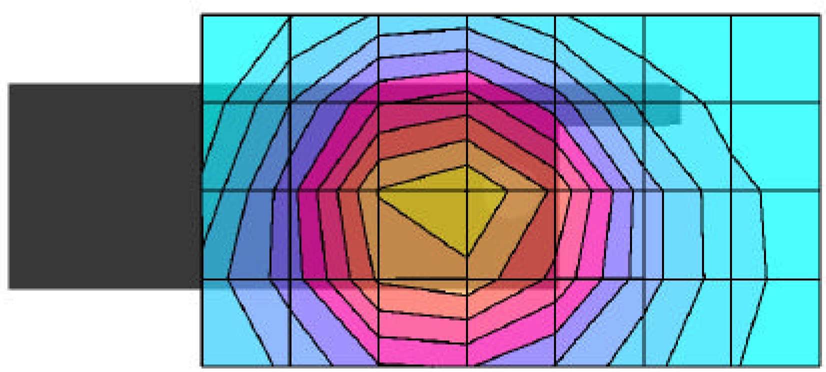
# KWC-V1 P1A, #0194 PCS Ch1175 without beltclip, Conducted Power=22.70dBm, Hdet=45

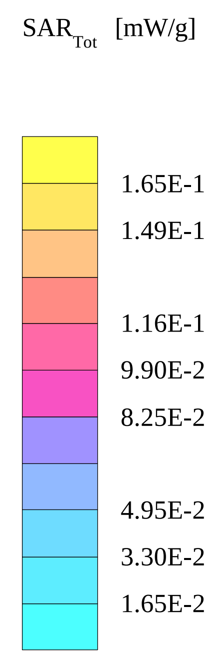
SAR (1g): 0.199 [mW/g] ± 0.02 dB, SAR (10g): 0.117 [mW/g] ± 0.02 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch1175 muscle without bc, 26.7mm space, 07-30-01.da3
Operator: DL



# KWC-V1 P1A, #0194 PCS Ch1175 without beltclip, Conducted Power=22.70dBm, Hdet=45

SAR (1g): 0.161 [mW/g] ± 0.02 dB, SAR (10g): 0.0997 [mW/g] ± 0.04 dB
Cubes (2) (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Generic Twin Phantom; Flat Section
Probe: ET3DV5 - SN1353; ConvF(4.50,4.50,4.50)
Muscle 1800 MHz: $\sigma$ = 1.56 [mho/m] $\varepsilon_r$ = 53.2 $\rho$ = 1.00 [g/cm$^3$]
File Name: KWC-V1 P1A #0194, PCS ch1175 muscle without bc, 26.7mm space, 07-30-01.da3
Operator: DL





## 12 PHOTOS

# References

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