NOKIA

NOKIA MOBILE PHONES
6000 Connection Dr.
Irving, TX 75039
972-894-5000
972-894-4988

May 22, 2001

Federal Communications Commission,
Authorization & Evaluation Division,
7435 Oakland Mills Road
Columbia, MD. 21046

Attention: Equipment Authorization Branch

We hereby certify that the transceiver FCC ID: GMLNSC-4 complies with ANSI/IEEE C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

Compliance was determined by testing appropriate parameters according to standard.

NOKIA MOBILE PHONES

Esa Posio
Product Program Manager, Dallas

# SAR Compliance Test Report

| | | | |
|---|---|---|---|
| **Test report no.:** | Not numbered | **Date of report:** | 8-Jun-2001 |
| **Number of pages:** | 21 | **Contact person:** | Olli Kautio |
| | | **Responsible test engineer:** | Pertti Mäkikyrö |
| **Testing laboratory:** | Nokia Mobile Phones<br>Elektroniikkatie 10<br>P.O. Box 50<br>FIN-90571 OULU<br>Finland<br>Tel. +358-10-5051<br>Fax. +358-10-505 7222 | **Client:** | Nokia Mobile Phones<br>6000 Connection Dr.<br>Mailstop 2:200<br>Irving Tx, 75039<br>USA<br>Tel. +1 972 894 5000<br>Fax. +1 972 894 4589 |

**Tested devices:** **GMLNSC-4, CSH-1**

**Supplement reports:** -

**Testing has been carried out in accordance with:**

ANSI/IEEE Std C95.1-1992
IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

ANSI/IEEE Std C95.3-1992
IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields-RF and Microwave

**Documentation:** The documentation of the testing performed on the tested devices is archived for 15 years at PC Site Oulu

**Test results:** **The tested device complies with the requirements in respect of all parameters subject to the test.**

The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.

**Date and signatures:** 8-Jun-2001

For the contents:

| | |
|---|---|
| **Pertti Mäkikyrö** | **Miia Nurkkala** |
| **Engineering Manager, EMC** | **Test Engineer** |

## CONTENTS

# 1. SUMMARY FOR SAR TEST REPORT

| | |
|---|---|
| Date of receipt | 23-May-2001 |
| Date of test | 24-May-2001 - 25-May-2001 |
| Contact person | Olli Kautio |
| Test plan referred to | - |
| Phone with SN, HW, SW and DUT numbers | SN:10604798727 HW:B6.4 SW:Vr06.11 DUT: A230501/23 |
| Accessories used in testing | CSH-1, BLB-3 |
| Notes | |
| Document code | DTX02655-EN |
| Responsible test engineer | Pertti Mäkikyrö |
| Measurement performed by | Miia Nurkkala |

## 1.1 Maximum Results Found during SAR Evaluation

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

### 1.1.1 Head Configuration

| Ch / *f* [MHz] | Position | Limit [mW/g] | Measured [mW/g] | Result |
|---|---|---|---|---|
| 799/848.97 | Cheek | 1.6 | 1.08 | **PASSED** |

### 1.1.2 Body Worn Configuration

| Ch / *f* [MHz] | Body Worn Accessory | Limit [mW/g] | Measured [mW/g] | Result |
|---|---|---|---|---|
| 991/824.04 | CSH-1 | 1.6 | 0.41 | **PASSED** |

### 1.1.3 Measurement Uncertainty

| | |
|---|---|
| **Combined Uncertainty (Assessment & Source)** | **± 12.2%** |
| **Extended Uncertainty (k=2) 95.5%** | **± 24%** |

## 2. DESCRIPTION OF TESTED DEVICE

| | |
|---|---|
| FCC ID | GMLNSC-4 |
| Modes of Operation | AMPS, IS136-800, |
| Modulation Mode(s) | $\pi/4$ Quadrature Phase Shift Keying |
| Duty Cycle(s) (=1/ Crest Factor) | 1, 1/3 |
| Transmitter Frequency Range | 824.04 - 848.97MHz |

### 2.1 Picture of Phone


### 2.2 Description of the Antenna

GMLNSC-4 has an internal integrated antenna.

### 2.3 Battery

Li-ion battery, BLB-3 was used in the measurements.

In body worn configuration it does not affect the separation distance between flat-phantom and tested device and thus should not affect the SAR values.

### 2.4 Body Worn Accessories

Following body worn accessory is available for GMLNSC-4:

Carry Sleeve CSH-1

# 3. TEST CONDITIONS

## 3.1 Environment

| | |
|---|---|
| Ambient temperature (°C). | 22°C ± 1°C |
| Tissue simulating liquid temperature (°C). | 22°C ± 0.5°C |

## 3.2 Test Signal, Frequencies, and Output Power

The phone was put into operation by using a radio tester, Rohde & Schwarz CMU 200. Communication between the phone and the tester was established by air link.

In both operating modes the measurements were performed on lowest, middle and highest channels.

The phone was set to maximum power level during all the tests and at the beginning of each test the battery was fully charged. Power output was measured by FCC accredited test laboratory, M.Flom Associates Inc. The same unit was used in SAR testing.

# 4. DESCRIPTION OF THE TEST EQUIPMENT

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

| Test Equipment | Serial Number | Due Date |
|---|---|---|
| DASY3 DAE V1 | 371 | 10/01 |
| E-field Probe ET3DV6 | 1379 | 02/02 |
| Dipole Validation Kit, D835V2 | 405 | 02/03 |

Additional equipment needed in validation

| Test Equipment | Model | Serial Number | Due Date |
|---|---|---|---|
| Signal Generator | R&S SMIQ 03B | 10012 | 02/02 |
| Amplifier | Amplifier Research 5S1G4 | 27573 | - |
| Power Meter | R&S NRT | 835065/049 | 05/02 |
| Power Sensor | R&S NRT-Z44 | 835374/021 | 05/02 |
| Thermometer | DO9416 | 1505985462 | - |
| Vector Network Analyzer | Anritsu 37347A | 992604 | 02/02 |
| Transmission Line Dielectric Probe | Damaskos T1500 | - | - |

## 4.1 System Accuracy Verification

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

The SAR measurements were validated using the dipole validation kit. Power level of 250 mW was supplied to the dipole antenna placed under the flat section of the generic twin phantom. The validation results are in the table below and printouts of the validation tests are shown in Appendix A. All the measured parameters were within the specification.

| *f* [MHz] | Description | SAR [W/kg], 1g | Dielectric Parameters $\varepsilon_r$ | Dielectric Parameters σ [S/m] | Temp [°C] |
|---|---|---|---|---|---|
| 835 | Measured | 2.46 | 39.5 | 0.90 | 22 |
| | Reference Result | 2.47 | 42.0 | 0.88 | N/A |
| 835 | Measured | 2.56 | 57.0 | 0.95 | 22 |
| | Reference Result | 2.53 | 56.6 | 0.93 | N/A |

## 4.2 Head Tissue Simulant

The composition of the brain tissue simulating liquid for 835MHz is

39.7% De-Ionized Water
58.35% Sugar
1.55% Salt
0.25% HEC
0.15% Bactericide

| *f* [MHz] | Description | Dielectric Parameters $\varepsilon_r$ | Dielectric Parameters σ [S/m] | Temp [°C] |
|---|---|---|---|---|
| 835 | Measured Value | 39.5 | 0.90 | 22 |
| | Recommended Value | 41.5 | 0.90 | 22 |

Recommended values are adopted from IEEE 1528-Draft 6.1 "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques".

## 4.3 Muscle Tissue Simulant

The composition of the muscle tissue simulating liquid for 835MHz is

56.0% De-Ionized Water
41.76% Sugar
1.21% HEC
0.76% Salt
0.27% Preservative

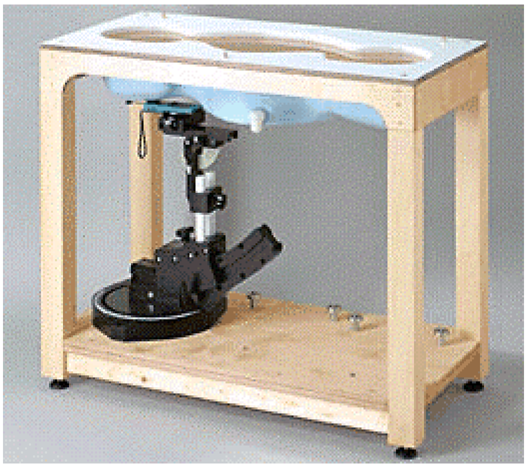
| *f* [MHz] | Description | Dielectric Parameters $\varepsilon_r$ | σ [S/m] | Temp [°C] |
|---|---|---|---|---|
| 835 | Measured Value | 57.0 | 0.95 | 22 |
| | Recommended Value | 56.1 | 0.95 | 22 |

Recommended values are adopted from FCC Tissue Dielectric Properties web page at http:// www.fcc.gov/fcc-bin/dielec.sh

## 4.4 Phantoms

Two phantoms, "Generic Twin Phantom", manufactured by SPEAG, were used during the measurements. One phantom was filled with 835 MHz head tissue-simulating liquid and the other with 835 MHz muscle tissue-simulating liquid.

The thickness of phantom shell is 2 mm except for the ear, where a 4 mm ear spacer provides a 6 mm spacing from the tissue boundary.



# 5. DESCRIPTION OF THE TEST PROCEDURE

## 5.1 Test Positions

### 5.1.1 Against Phantom Head

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

The phone was positioned against phantom according to IEEE 1528-Draft 6.1 "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques". This draft of IEEE Standard Document defines "cheek" position as follows:

1) Ready the handset for talk operation, if necessary. For example, for handsets with a flip piece, open the flip.
2) Define two imaginary lines on the handset: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width $w_t$ of the handset at the level of the acoustic output (point A on Figures 5.1a and 5.1b), and the midpoint of the width $w_b$ of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 5.1a). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 5.1b), especially for clamshell handsets, handsets with flip pieces, and other irregularly shaped handsets.
3) Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 5.2), such that the plane defined by the vertical center line and the horizontal center line is in a plane approximately parallel to the sagittal plane of the phantom.
4) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.
5) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is the plane normal to MB ("*mouth-back*") - NF ("*neck-front*") including the line MB (reference plane).
6) ("*We are unable to follow instructions in this paragraph (6) until the SAM phantom is available.*") Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF.
7) While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with the cheek of the phantom.

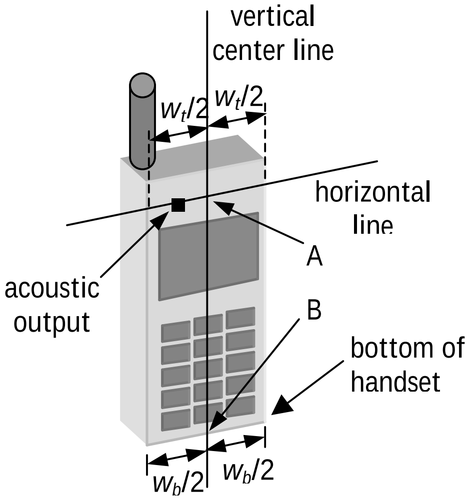



Figure 5.1a – Handset vertical and horizontal reference lines – fixed case

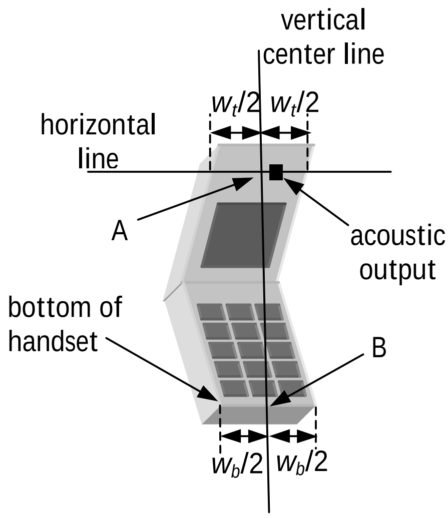



Figure 5.1b – Handset vertical and horizontal reference lines – “clam-shell”

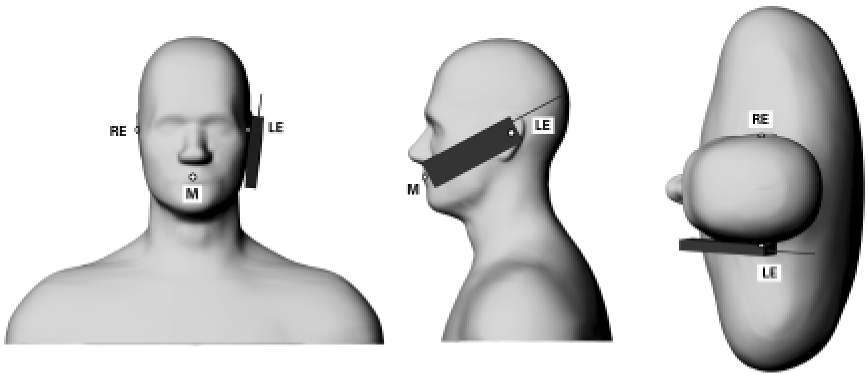



Figure 5.2 - "Cheek" position

The same draft document defines "tilted position" as

1) Repeat steps 1 to 7 of 5.4.1 (“*in this document 5.1.1*”) to place the device in the “cheek position.”
2) While maintaining the device in the reference plane (described above) and pivoting against the ear, move the device outward away from the mouth by an angle of 15degrees, or until the antenna touches the phantom.

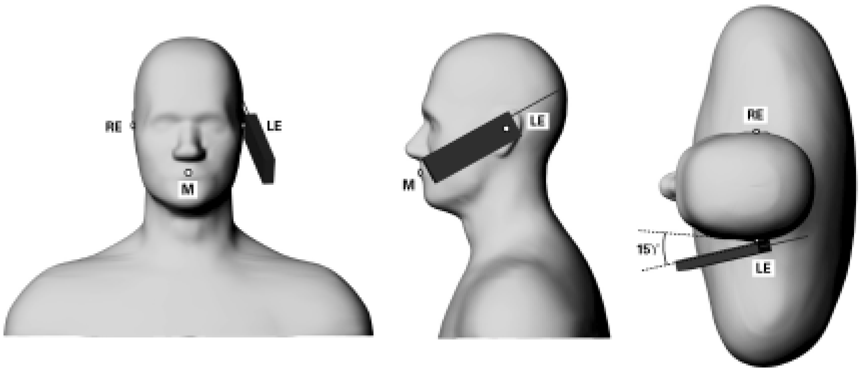


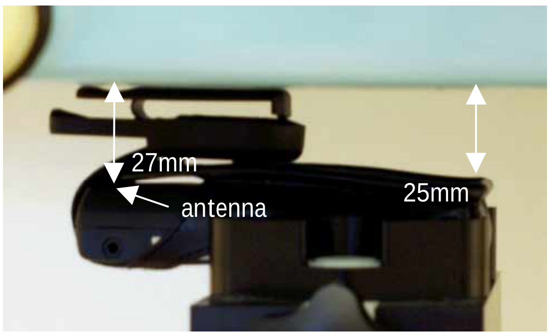

Figure 5.3 - "Tilted" position

Since GMLNSC-4 has a fixed case, the reference lines are defined in figure 5.1a.

5.1.2 Body Worn Configuration

Body worn accessory, CSH-1 was tested for the FCC RF exposure compliance. The phone was positioned into carry sleeve and placed below of the flat phantom. GMLNSC-4 can be positioned into CSH-1 only one way because CSH-1 has an opening for display and keypad.


GMLNSC-4
in carry sleeve CSH-1




Body worn
configuration setup

## 5.2 Scan Procedures

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

## 5.3 SAR Averaging Methods

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

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

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

# 6. MEASUREMENT UNCERTAINTY

## 6.1 Description of Individual Measurement Uncertainty

### 6.1.1 Assessment Uncertainty

| Uncertainty description | Error | Distrib. | Weight | St. Dev. |
|---|---|---|---|---|
| | | | | |
| **Probe Uncertainty** | | | | |
| - Axial Isotropy | ±0.2 dB | U-shape | 0.5 | ±2.4% |
| - Spherical Isotropy | ±0.4 dB | U-shape | 0.5 | ±4.8% |
| - Isotropy from Gradient | ±0.5 dB | U-shape | 0 | |
| - Spatial Resolution | ±0.5 % | Normal | 1 | ±0.5% |
| - Linearity Error | ±0.2 dB | Rectang. | 1 | ±2.7% |
| - Calibration Error | ±3.6 % | Normal | 1 | ±3.6% |
| | | | | |
| **Evaluation Uncertainty** | | | | |
| - Data Acquisition Error | ±1% | Rectang. | 1 | ±0.6% |
| - ELF and RF Disturbances | ±0.25% | Normal | 1 | ±0.25% |
| - Dielectric Parameters | ±10% | Rectang. | 1 | ±5.8% |
| | | | | |
| **Spatial Peak SAR Evaluation Uncertainty** | | | | |
| - Extrapolation | ±3% | Normal | 1 | ±3% |
| - Probe Positioning Error | ±0.1mm | Normal | 1 | ±1% |
| - Cube<br>- Orientation/Integration | ±3% | Normal | 1 | ±3% |
| - Cube Shape Inaccuracies | ±2% | Rectang. | 1 | ±1.2% |
| | | | | |
| **Total Measurement Uncertainty** | | | | **±10.2%** |

### 6.1.2 Source Uncertainty

| Uncertainty description | Error | Distrib. | Weight | St. Dev. |
|---|---|---|---|---|
| | | | | |
| - Device Positioning | ±6% | Normal | 1 | ±6% |
| - Laboratory Setup | ±3% | Normal | 1 | ±3% |
| | | | | |
| **Total Source Uncertainty** | | | | **±6.7%** |

### 6.1.3 Combined Uncertainty

| Uncertainty description | Uncertainty |
|---|---|
| | |
| **- Total Assessment Uncertainty** | ±10.2% |
| **- Total Source Uncertainty** | ±6.7% |
| | |
| **Combined Uncertainty (Assessment & Source)** | ±12.2% |
| **Extended Uncertainty (k=2)** | **±24%** |

## 7. RESULTS

Corresponding SAR distribution printouts of maximum results in each operating mode are shown in Appendix B.

### 7.1 Head Configuration

| Mode | Channel/ *f* [MHz] | Power ERP [dBm] | SAR, averaged over 1g [mW/g] | | | |
|---|---|---|---|---|---|---|
| | | | Left-hand | | Right-hand | |
| | | | Cheek | Tilted | Cheek | Tilted |
| AMPS 800 | 991/824.04 | 21.6 | 0.96 | 0.62 | 0.93 | 0.67 |
| | 383/836.49 | 21.3 | 1.04 | 0.73 | 0.99 | 0.69 |
| | 799/848.97 | 20.0 | **1.08** | 0.77 | 1.04 | 0.73 |
| TDMA 800 | 991/824.04 | 27.8 | 0.81 | 0.54 | 0.82 | 0.57 |
| | 383/836.49 | 27.6 | 0.92 | 0.62 | 0.90 | 0.58 |
| | 799/848.97 | 26.1 | 0.96 | 0.62 | **0.96** | 0.63 |

### 7.2 Body Worn Configuration

| Mode | Channel/ *f* [MHz] | Power ERP,[dBm] | SAR, averaged over 1g [mW/g] |
|---|---|---|---|
| | | | CSH-1 |
| AMPS 800 | 991/824.04 | 21.6 | **0.41** |
| | 383/836.49 | 21.3 | 0.35 |
| | 799/848.97 | 20.0 | 0.30 |
| TDMA 800 | 991/824.04 | 27.8 | **0.37** |
| | 383/836.49 | 27.6 | 0.34 |
| | 799/848.97 | 26.1 | 0.26 |

## APPENDIX A.

### Validation Test Printouts

# Dipole 835 MHz

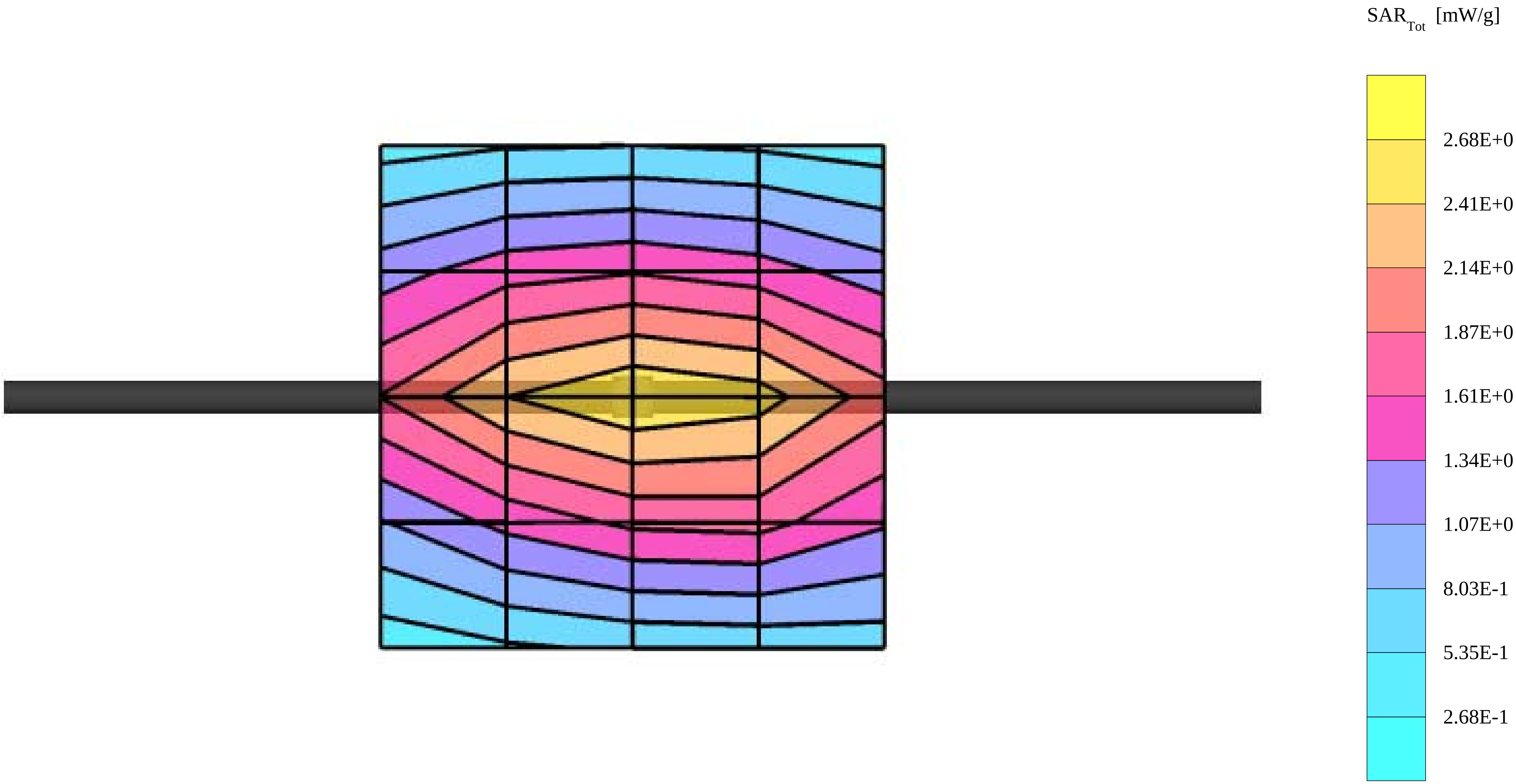
Generic Twin 1 new; Flat

Probe: ET3DV6 - SN1379; ConvF(6.24,6.24,6.24); Crest factor: 1.0; Brain 836 MHz SCC34: $\sigma$ = 0.90 mho/m $\varepsilon$ = 39.5 $\rho$ = 1.00 g/cm$^3$

Cubes (2): Peak: 3.87 mW/g ± 0.06 dB, SAR (1g): 2.46 mW/g ± 0.08 dB, SAR (10g): 1.59 mW/g ± 0.08 dB,

Penetration depth: 12.4 (11.3, 13.9) [mm]

Powerdrift: -0.21 dB



# Dipole 835 MHz

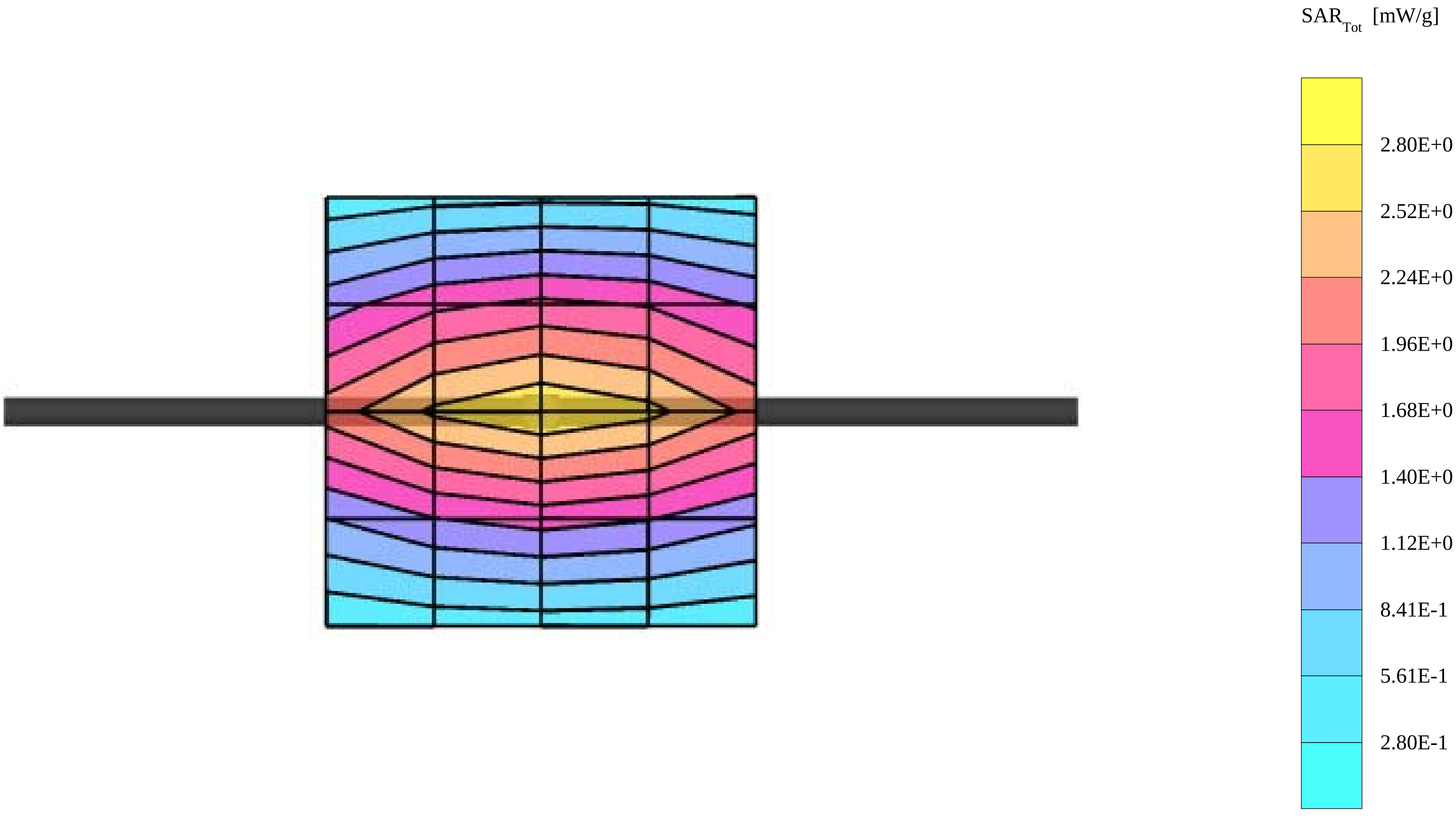
Generic Twin 2 new; Flat

Probe: ET3DV6 - SN1379; ConvF(5.91,5.91,5.91); Crest factor: 1.0; Muscle 836 MHz: $\sigma$ = 0.95 mho/m $\varepsilon$ = 57.0 $\rho$ = 1.00 g/cm$^3$

Cubes (2): Peak: 3.98 mW/g ± 0.04 dB, SAR (1g): 2.56 mW/g ± 0.05 dB, SAR (10g): 1.67 mW/g ± 0.06 dB,

Penetration depth: 13.0 (11.5, 14.9) [mm]

Powerdrift: -0.04 dB

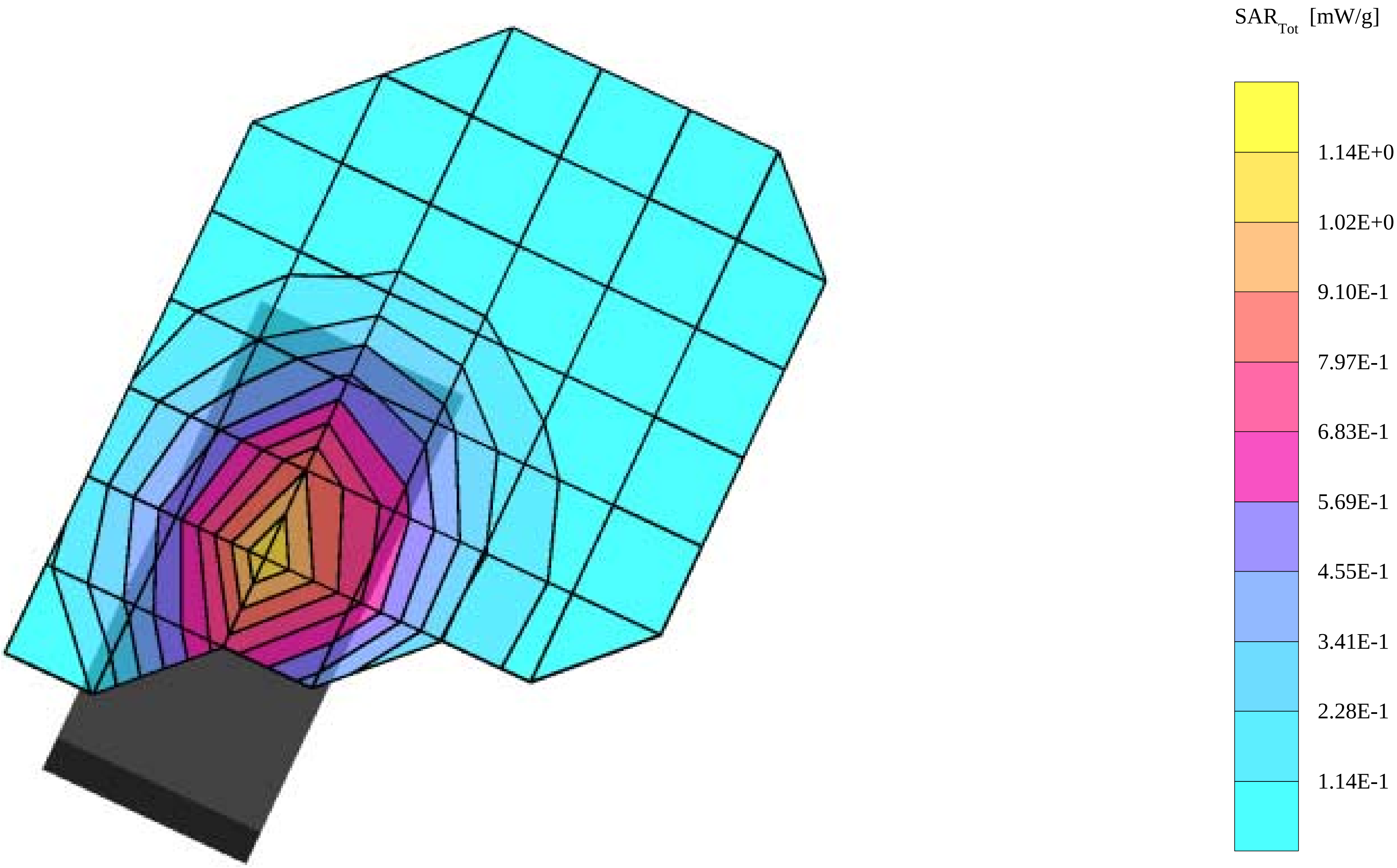


## APPENDIX B.

### SAR Distribution Printouts

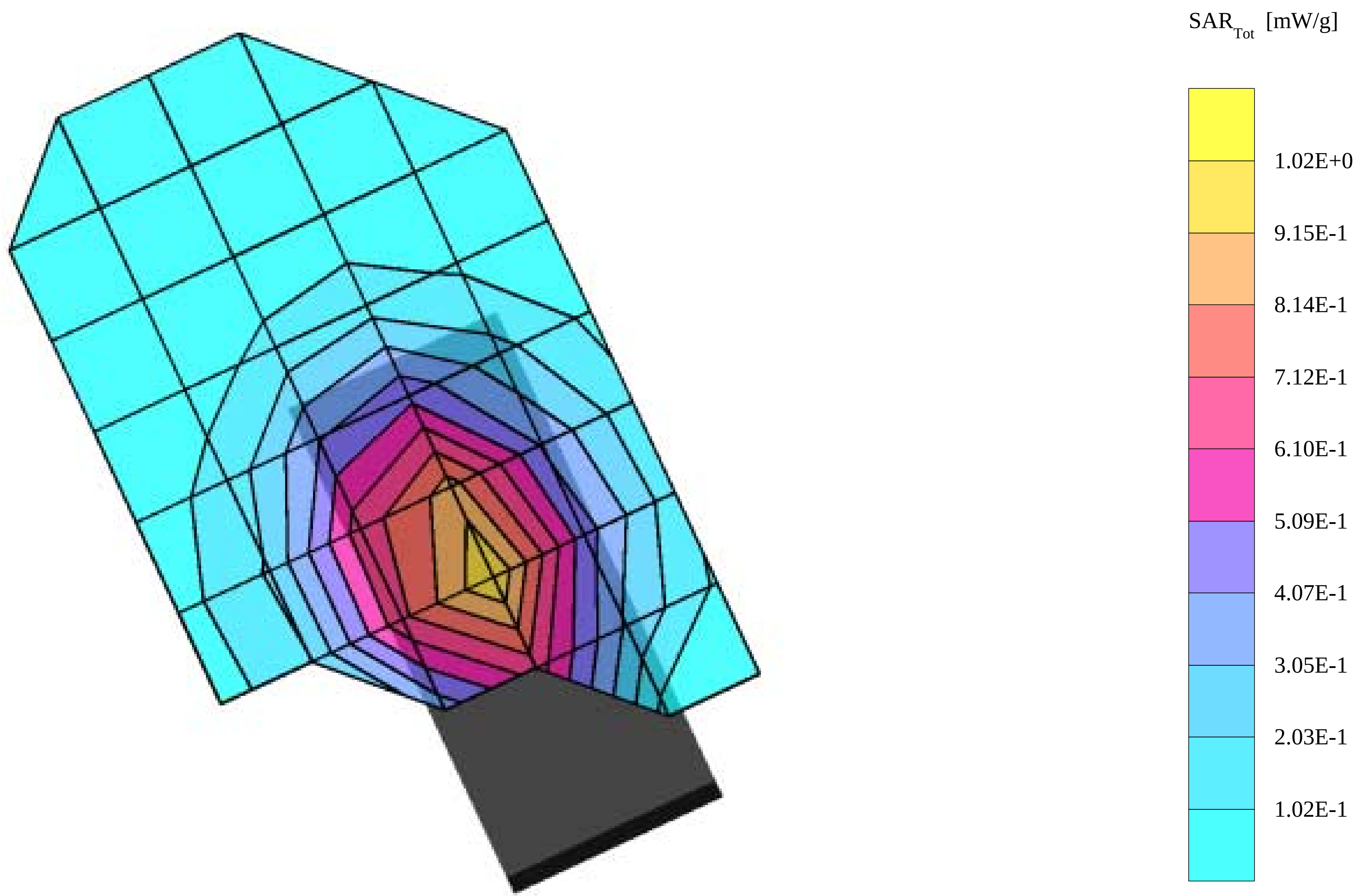
# GMLNSC-4

Generic Twin 1 new Phantom; Left Hand Section; Position: cheek ; Frequency: 849 MHz
Probe: ET3DV6 - SN1379; ConvF(6.24,6.24,6.24); Crest factor: 1.0; Brain 849 MHz SCC34: σ = 0.91 mho/m ε = 39.4 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 1.08 mW/g, SAR (10g): 0.736 mW/g
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.25 dB



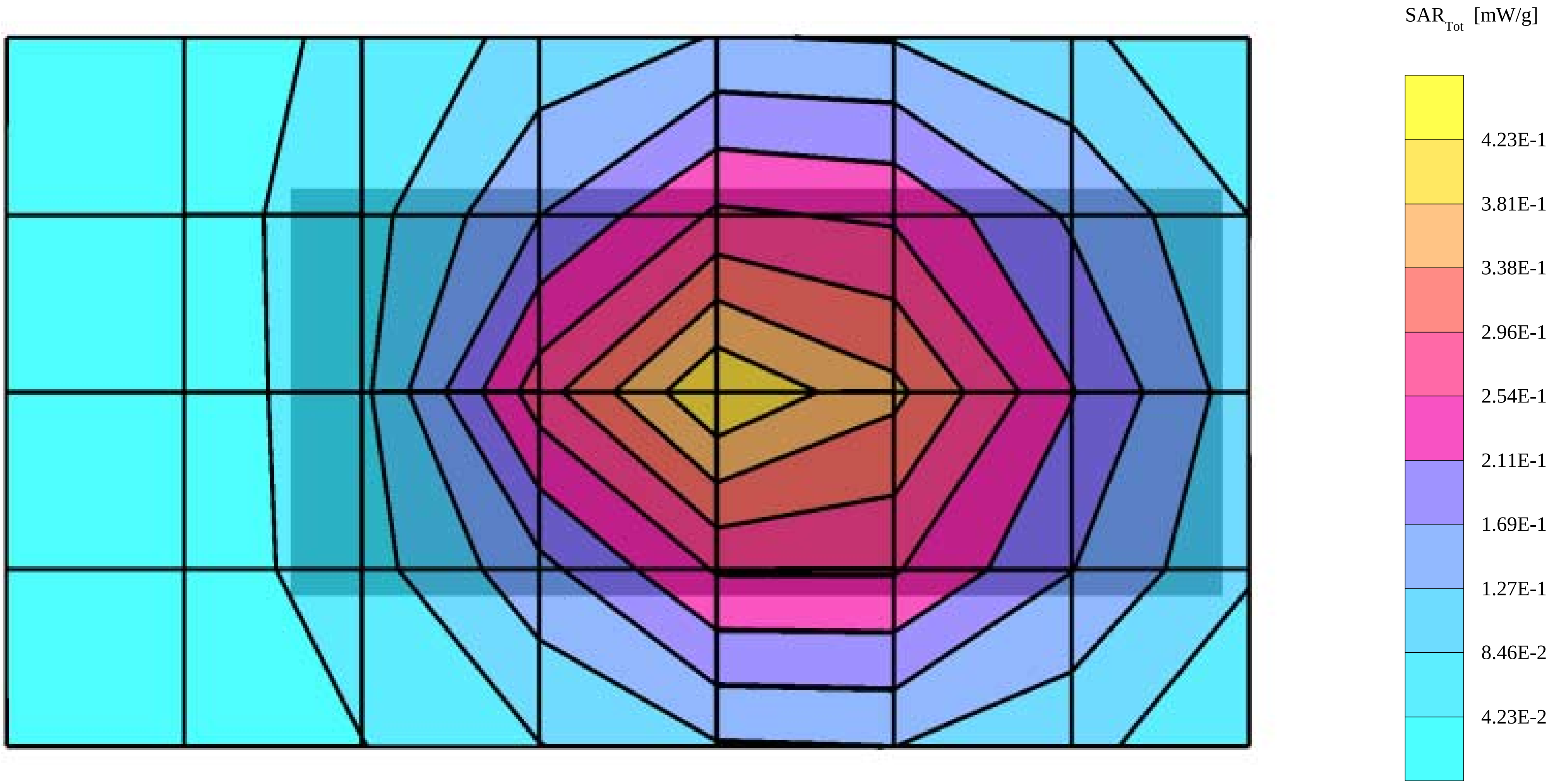
# GMLNSC-4

Generic Twin 1 new Phantom; Right Hand Section; Position: cheek; Frequency: 849 MHz
Probe: ET3DV6 - SN1379; ConvF(6.24,6.24,6.24); Crest factor: 3.0; Brain 849 MHz SCC34: $\sigma$ = 0.91 mho/m $\varepsilon$ = 39.4 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 0.964 mW/g, SAR (10g): 0.653 mW/g
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.30 dB



# GMLNSC-4 CSH-1

Generic Twin 2 new Phantom; Flat Section; Position: body worn; Frequency: 824 MHz
Probe: ET3DV6 - SN1379; ConvF(5.91,5.91,5.91); Crest factor: 1.0; Muscle 824 MHz: $\sigma$ = 0.93 mho/m $\varepsilon$ = 57.0 $\rho$ = 1.00 g/cm$^3$
Cube 5x5x7: SAR (1g): 0.407 mW/g, SAR (10g): 0.280 mW/g,
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.15 dB



# GMLNSC-4 CSH-1

Generic Twin 2 new Phantom; Flat Section; Position: body worn; Frequency: 824 MHz

Probe: ET3DV6 - SN1379; ConvF(5.91,5.91,5.91); Crest factor: 3.0; Muscle 824 MHz: $\sigma$ = 0.93 mho/m $\varepsilon$ = 57.0 $\rho$ = 1.00 g/cm$^3$

Cube 5x5x7: SAR (1g): 0.371 mW/g, SAR (10g): 0.256 mW/g,

Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0

Powerdrift: 0.00 dB