

## 17 MAIN TEST INSTRUMENTS

**Table 17.1: List of Main Instruments**

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	Agilent E5071C	MY46103759	2017-11-17	One year
02	Dielectric probe	85070E	MY44300317	/	
03	Amplifier	VTL5400	0404	/	
04	Signal Generator	E8257D	MY47461211	2017-06-06	One year
05	Power meter	NRP	102603	2018-01-04	One year
06	Power sensor	NRP-Z51	102211		
07	Power meter	NRP	101460	2018-02-05	One year
08	Power sensor	NRP-Z91	100553		
09	Signal Generator	E8257D	MY47461211	2017-06-06	One year
10	E-field Probe	SPEAG ES3DV3	3151	2017-12-13	One year
11	DAE	SPEAG DAE4	786	2017-11-22	One year
12	Dipole Validation Kit	SPEAG D835V2	4d057	2015-10-22	Three year
13	Dipole Validation Kit	SPEAG D1800V2	2d147	2015-11-03	Three year
14	Dipole Validation Kit	SPEAG D1900V2	5d088	2015-11-04	Three year
15	Dipole Validation Kit	SPEAG D2450V2	873	2015-10-30	Three year
16	Dipole Validation Kit	SPEAG D2550V2	1010	2015-07-24	Three year
17	BTS	E5515C	GB46110722	2018-02-19	One year
18	Radio Communication Analyzer	Anristu MT8820C	6201341853	2018-03-08	One year

\*\*\*END OF REPORT BODY\*\*\*

## ANNEX A Graph Results

### GSM850 Head

Date: 2018-3-10

Electronics: DAE4 Sn786

Medium: Head 835 MHz

Medium parameters used (interpolated):  $f = 836.6$  MHz;  $\sigma = 0.914$  S/m;  $\epsilon_r = 40.732$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.6°C      Liquid Temperature: 22.1°C

Communication System: UID 0, GSM (0) Frequency: 836.6 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (6.47, 6.47, 6.47);

**Left cheek Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.202 W/kg

**Left cheek Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 6.273 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.248 W/kg

**SAR(1 g) = 0.194 W/kg; SAR(10 g) = 0.144 W/kg**

Maximum value of SAR (measured) = 0.204 W/kg

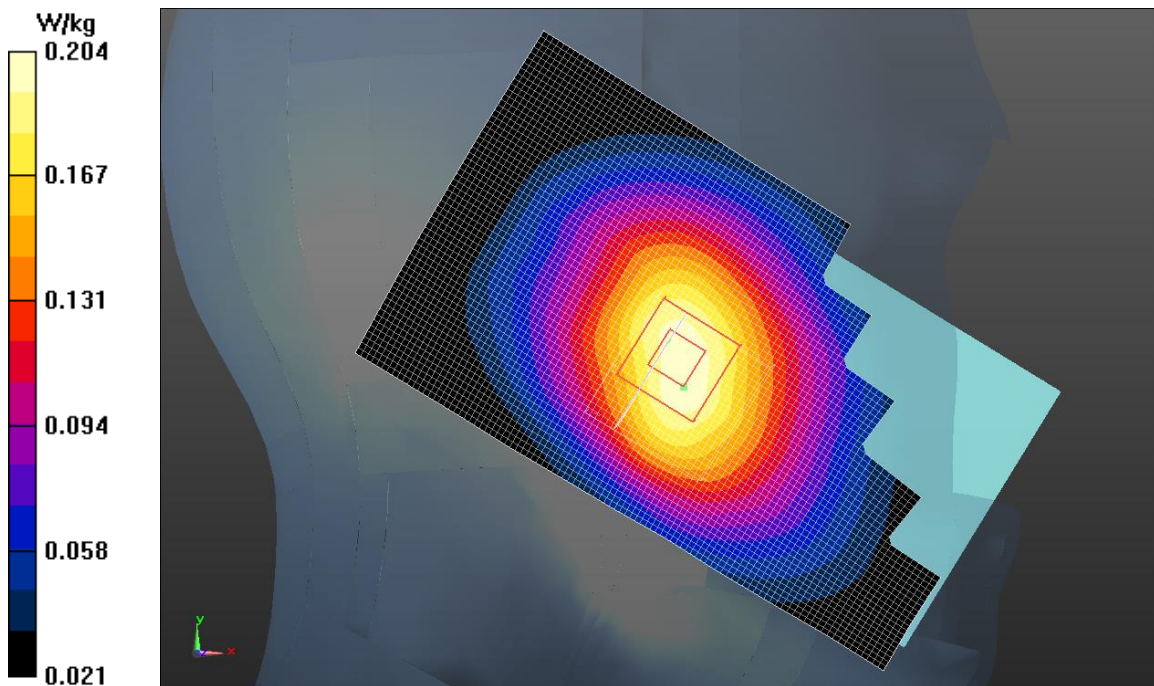


Fig.1 GSM 850MHz

## GSM850 Body

Date: 2018-3-12

Electronics: DAE4 Sn786

Medium: Body 835 MHz

Medium parameters used (interpolated):  $f = 836.6$  MHz;  $\sigma = 0.990$  S/m;  $\epsilon_r = 53.615$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.6°C      Liquid Temperature: 22.1°C

Communication System: UID 0, GPRS 3Txslot (0) Frequency: 836.6 MHz Duty Cycle: 1:2.67

Probe: ES3DV3 – SN3151 ConvF (6.38, 6.38, 6.38);

**Rear side Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.305 W/kg

**Rear side Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 17.61 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 0.371 W/kg

**SAR(1 g) = 0.344 W/kg; SAR(10 g) = 0.264 W/kg**

Maximum value of SAR (measured) = 0.365 W/kg

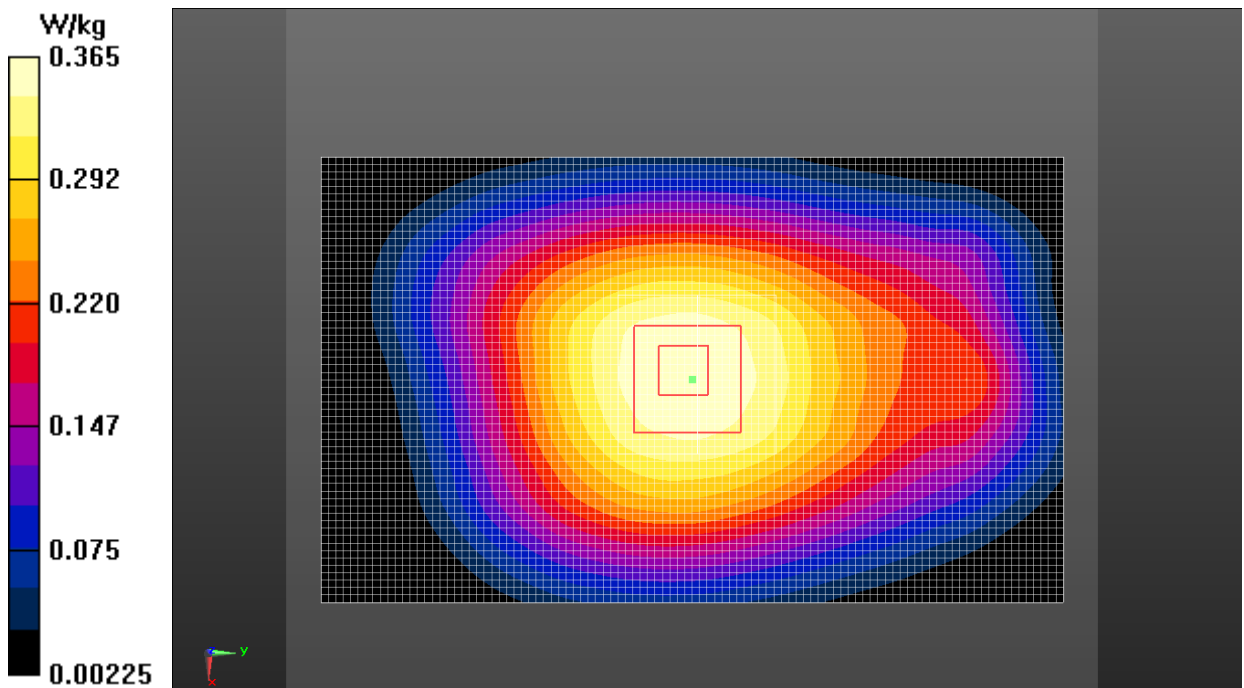


Fig.2 GSM 850 MHz

## GSM1900 Head

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.397$  S/m;  $\epsilon_r = 39.383$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.2°C      Liquid Temperature: 21.7°C

Communication System: UID 0, GSM (0) Frequency: 1880 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

**Right Cheek Middle/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.285 W/kg

**Right/Right Cheek Middle/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 2.189 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 0.519 W/kg

**SAR(1 g) = 0.148 W/kg; SAR(10 g) = 0.087 W/kg**

Maximum value of SAR (measured) = 0.307 W/kg

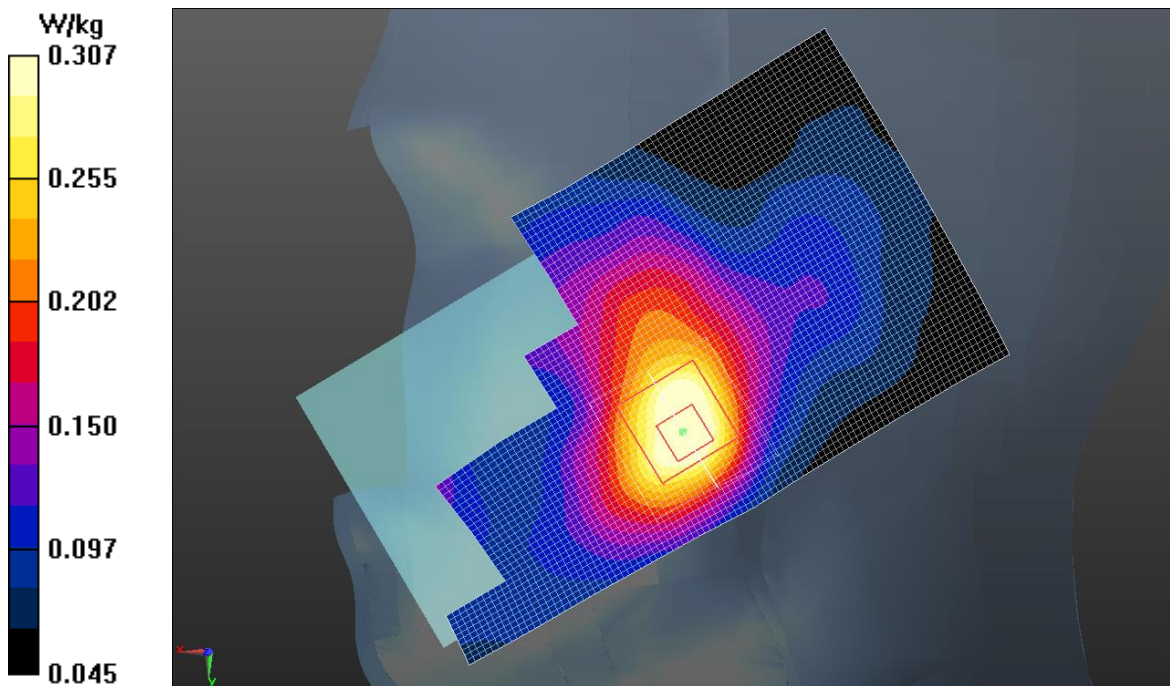


Fig.3 GSM 1900 MHz

## GSM1900 Body

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.539$  S/m;  $\epsilon_r = 51.795$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.2°C      Liquid Temperature: 21.7°C

Communication System: UID 0, GPRS 3Txslot (0) Frequency: 1880 MHz Duty Cycle: 1:2.67

Probe: ES3DV3 – SN3151 ConvF (4.89, 4.89, 4.89);

**Bottom side Mid/Area Scan (51x71x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.569 W/kg

**Bottom side Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 9.569 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 0.846 W/kg

**SAR(1 g) = 0.497 W/kg; SAR(10 g) = 0.260 W/kg**

Maximum value of SAR (measured) = 0.567 W/kg

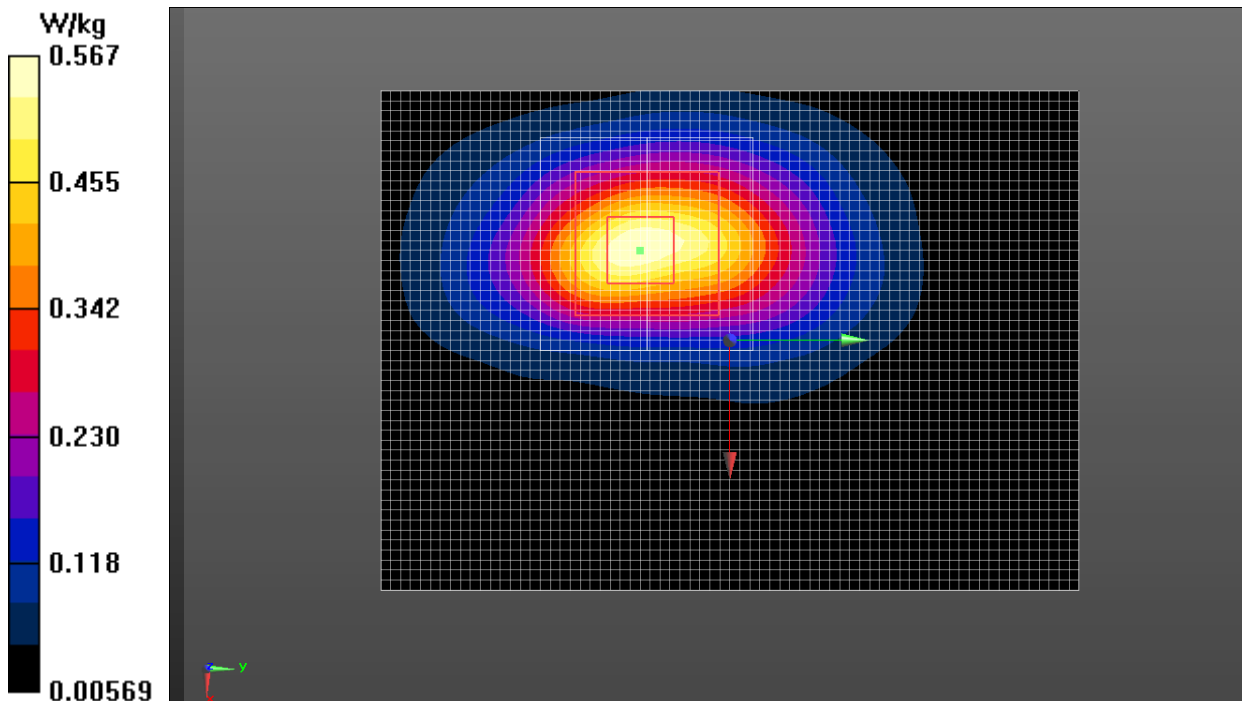


Fig.4 GSM 1900 MHz

## CDMA BC0 Head

Date: 2018-3-10

Electronics: DAE4 Sn786

Medium: Head 835 MHz

Medium parameters used (interpolated):  $f = 836.5$  MHz;  $\sigma = 0.914$  S/m;  $\epsilon_r = 40.764$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.4°C      Liquid Temperature: 21.9°C

Communication System: UID 0, CDMA (0) Frequency: 836.5 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.47, 6.47, 6.47);

**Left cheek Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.466 W/kg

**Left cheek Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 10.32 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 0.578 W/kg

**SAR(1 g) = 0.453 W/kg; SAR(10 g) = 0.337 W/kg**

Maximum value of SAR (measured) = 0.480 W/kg

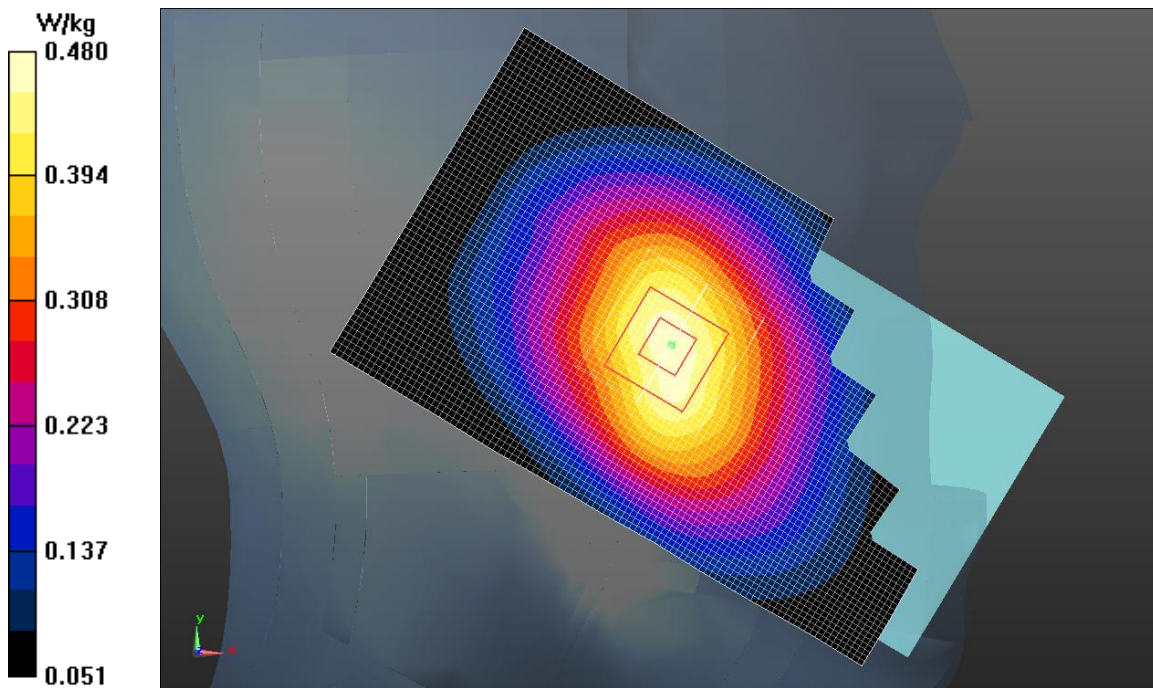


Fig.5 CDMA BC0

## CDMA BC0 Body

Date: 2018-3-12

Electronics: DAE4 Sn786

Medium: Body 835 MHz

Medium parameters used (interpolated):  $f = 836.5$  MHz;  $\sigma = 0.990$  S/m;  $\epsilon_r = 53.617$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.4°C      Liquid Temperature: 21.9°C

Communication System: UID 0, CDMA (0) Frequency: 836.5 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.38, 6.38, 6.38);

**Rear side Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.589 W/kg

**Rear side Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 24.64 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.702 W/kg

**SAR(1 g) = 0.559 W/kg; SAR(10 g) = 0.428 W/kg**

Maximum value of SAR (measured) = 0.584 W/kg

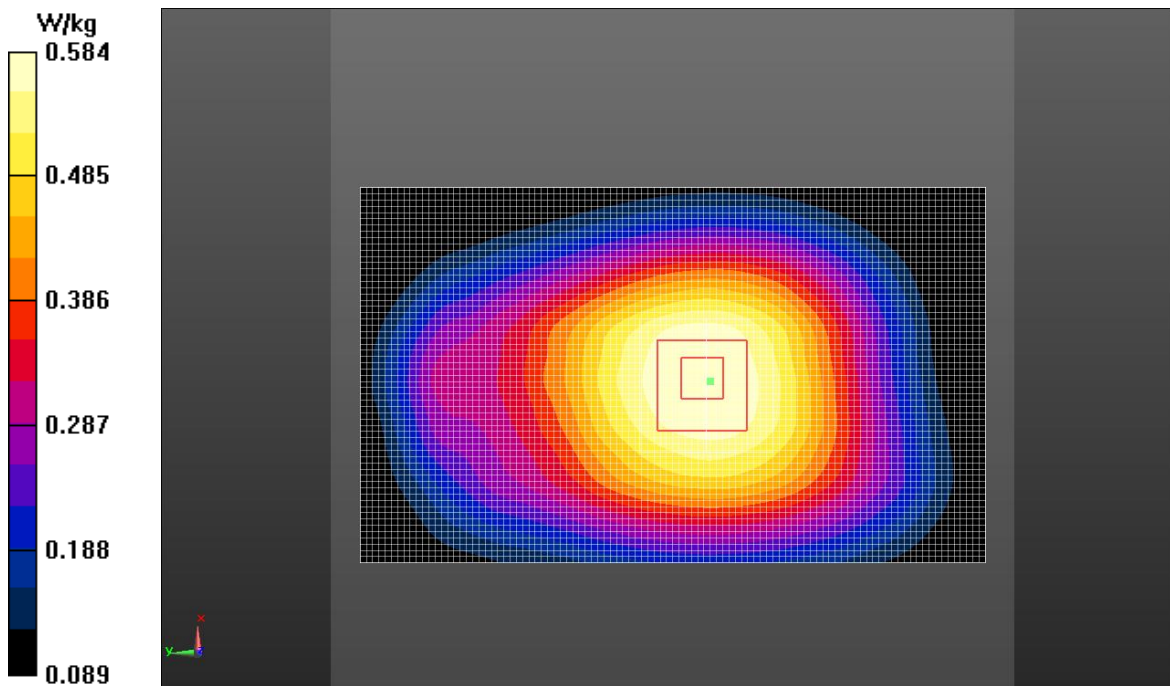


Fig.6 CDMA BC0

## WCDMA 850 Head

Date: 2018-3-10

Electronics: DAE4 Sn786

Medium: Head 835 MHz

Medium parameters used (interpolated):  $f = 836.4$  MHz;  $\sigma = 0.914$  S/m;  $\epsilon_r = 40.76$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.5°C      Liquid Temperature: 22.0°C

Communication System: UID 0, WCDMA (0) Frequency: 836.4 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.47, 6.47, 6.47);

**Left cheek Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.394 W/kg

**Left cheek Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 8.811 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 0.481 W/kg

**SAR(1 g) = 0.376 W/kg; SAR(10 g) = 0.281 W/kg**

Maximum value of SAR (measured) = 0.396 W/kg

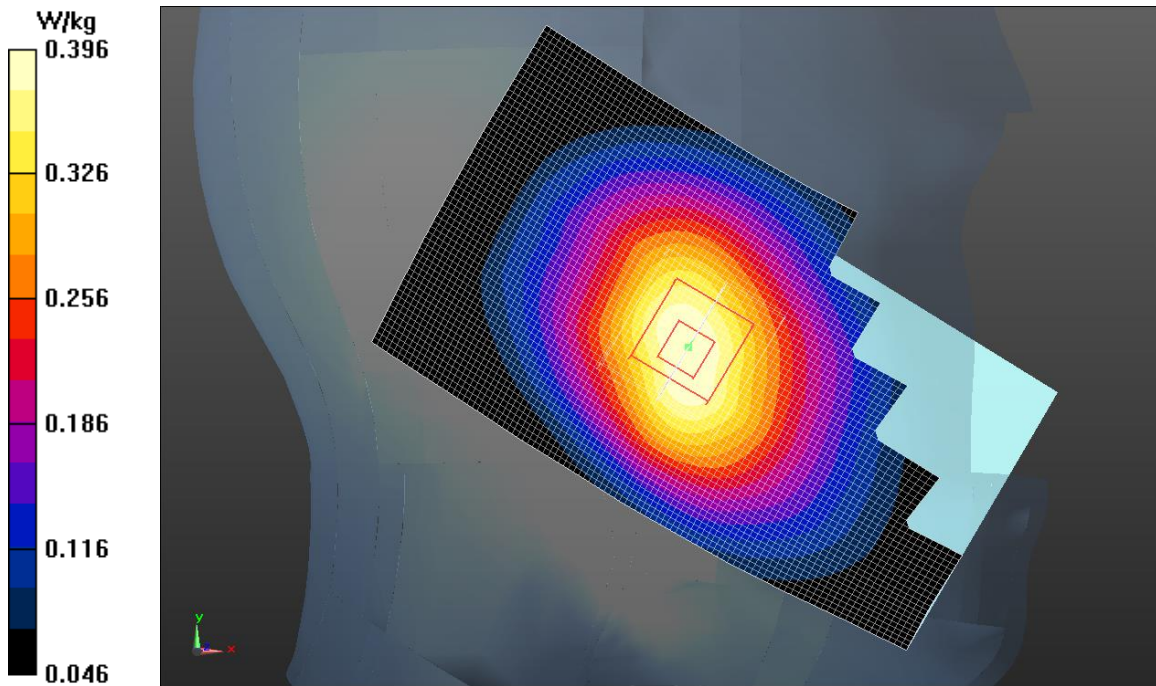


Fig.7 WCDMA 850



## WCDMA 850 Body

Date: 2018-3-12

Electronics: DAE4 Sn786

Medium: Body 835 MHz

Medium parameters used (interpolated):  $f = 836.4$  MHz;  $\sigma = 0.990$  S/m;  $\epsilon_r = 53.614$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.5°C      Liquid Temperature: 22.0°C

Communication System: UID 0, WCDMA (0) Frequency: 836.4 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.38, 6.38, 6.38);

**Rear side Mid/Area Scan (71x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.553 W/kg

**Rear side Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 23.10 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 0.657 W/kg

**SAR(1 g) = 0.523 W/kg; SAR(10 g) = 0.400 W/kg**

Maximum value of SAR (measured) = 0.547 W/kg

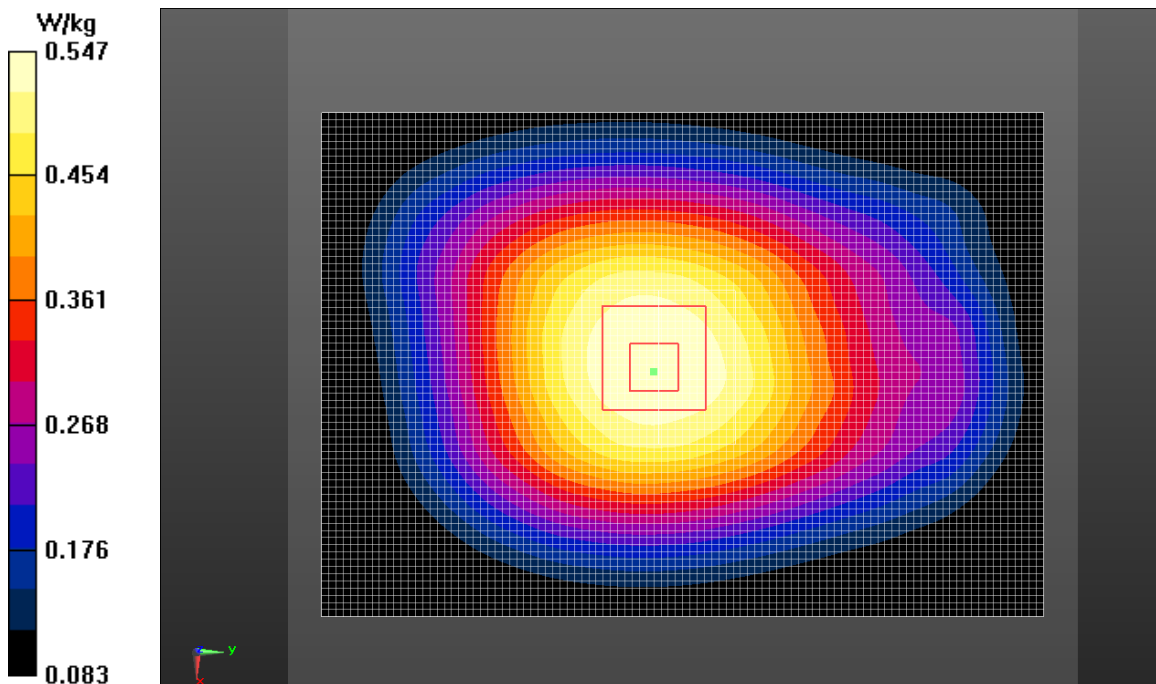


Fig.8 WCDMA 850

## WCDMA 1900 Head

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.397$  S/m;  $\epsilon_r = 39.383$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.8°C      Liquid Temperature: 21.3°C

Communication System: UID 0, WCDMA (0) Frequency: 1880 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

**Right Cheek Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.402 W/kg

**Right Cheek Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 2.870 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.543 W/kg

**SAR(1 g) = 0.305 W/kg; SAR(10 g) = 0.176 W/kg**

Maximum value of SAR (measured) = 0.494 W/kg

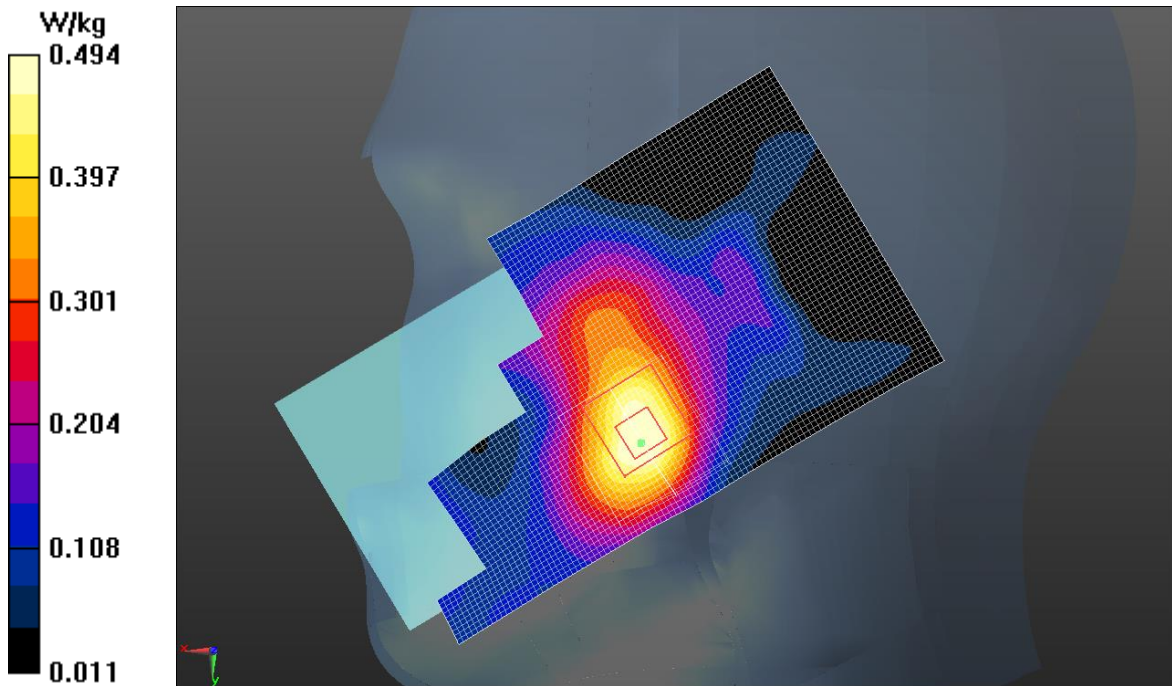


Fig.9 WCDMA 1900

## WCDMA 1900 Body

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.539$  S/m;  $\epsilon_r = 51.795$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3°C      Liquid Temperature: 21.8°C

Communication System: UID 0, WCDMA (0) Frequency: 1880 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.89, 4.89, 4.89);

**Bottom side Mid/Area Scan (41x71x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.562 W/kg

**Bottom side Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 11.97 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 0.893 W/kg

**SAR(1 g) = 0.516 W/kg; SAR(10 g) = 0.268 W/kg**

Maximum value of SAR (measured) = 0.583 W/kg

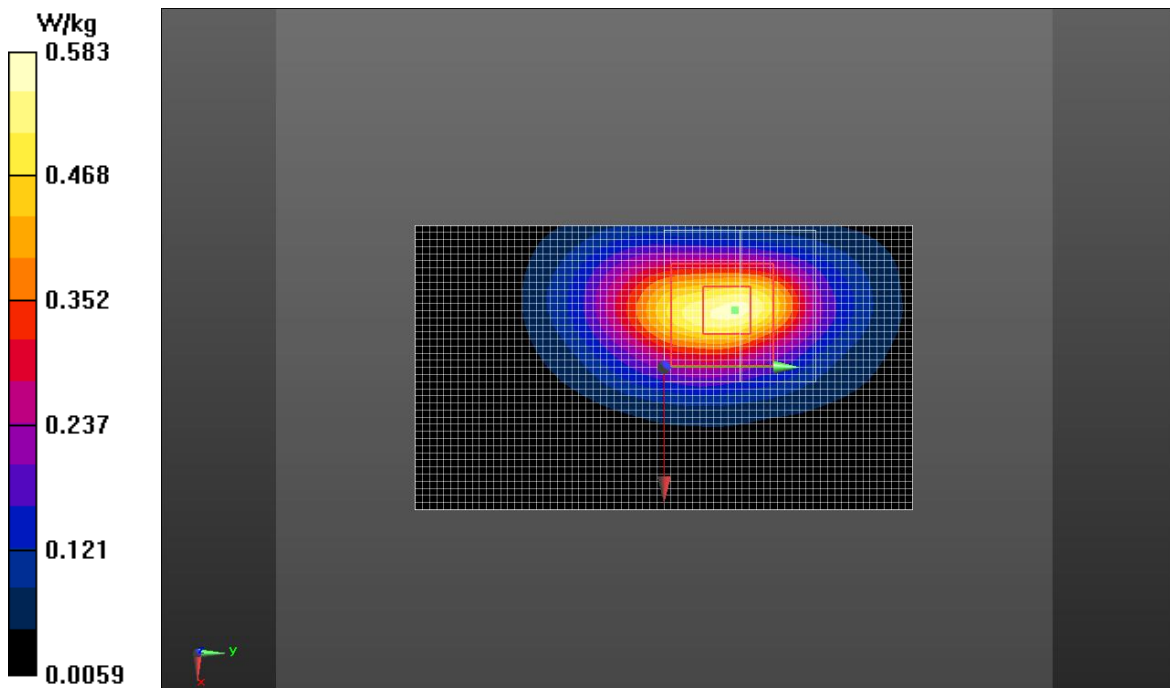


Fig.10 WCDMA 1900

## WCDMA 1700 Head

Date: 2018-3-2

Electronics: DAE4 Sn786

Medium: Head 1800 MHz

Medium parameters used (interpolated):  $f = 1732.6$  MHz;  $\sigma = 1.336$  S/m;  $\epsilon_r = 39.838$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.7°C      Liquid Temperature: 22.2°C

Communication System: UID 0, WCDMA (0) Frequency: 1732.6 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.27, 5.27, 5.27);

**Right Cheek Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.080 W/kg

**Right Cheek Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 0.4970 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 0.162 W/kg

**SAR(1 g) = 0.065 W/kg; SAR(10 g) = 0.039 W/kg**

Maximum value of SAR (measured) = 0.236 W/kg

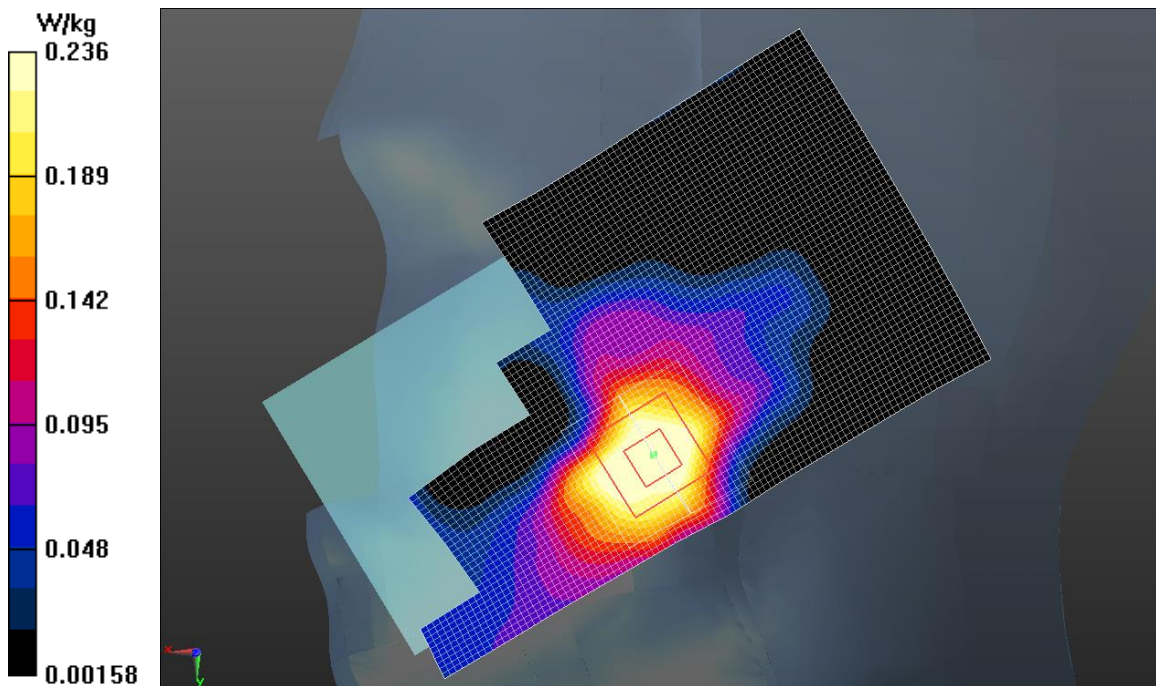


Fig.11 WCDMA 1700

## WCDMA 1700 Body

Date: 2018-3-2

Electronics: DAE4 Sn786

Medium: Body 1800 MHz

Medium parameters used (interpolated):  $f = 1712.4$  MHz;  $\sigma = 1.421$  S/m;  $\epsilon_r = 51.995$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.6°C      Liquid Temperature: 22.1°C

Communication System: UID 0, WCDMA (0) Frequency: 1712.4 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.11, 5.11, 5.11);

**Bottom side Low /Area Scan (41x71x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 1.36 W/kg

**Bottom side Low /Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 30.28 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 1.92 W/kg

**SAR(1 g) = 1.15 W/kg; SAR(10 g) = 0.624 W/kg**

Maximum value of SAR (measured) = 1.28 W/kg

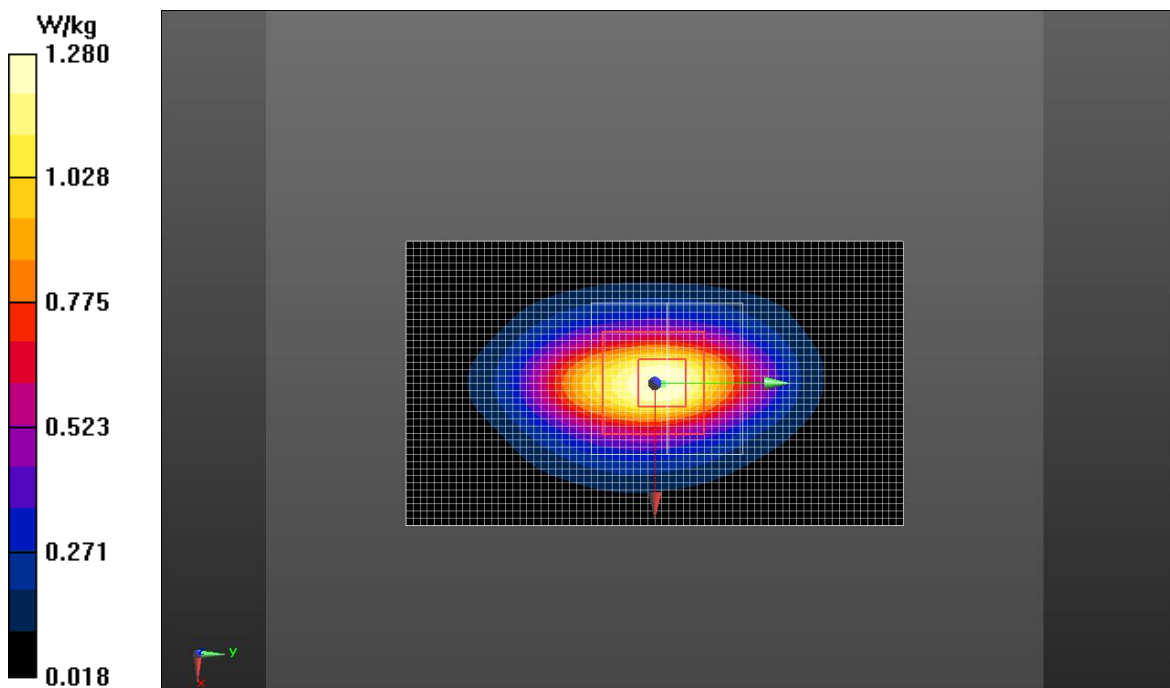


Fig.12 WCDMA 1700

## LTE Band 2 Head

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.397$  S/m;  $\epsilon_r = 39.383$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.5°C      Liquid Temperature: 21.0°C

Communication System: UID 0, LTE\_FDD (0) Frequency: 1880 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

**Right Cheek Mid 1RB\_Low/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.193 W/kg

**Right Cheek Mid 1RB\_Low/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 3.441 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.295 W/kg

**SAR(1 g) = 0.208 W/kg; SAR(10 g) = 0.118 W/kg**

Maximum value of SAR (measured) = 0.370 W/kg

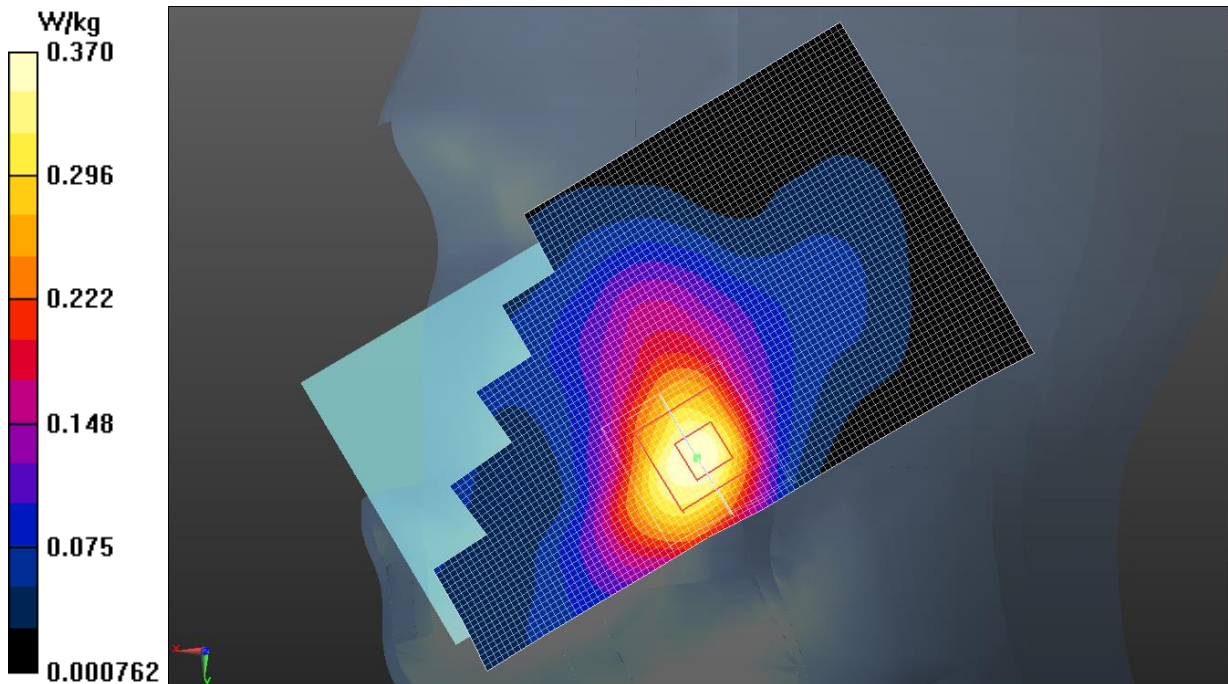


Fig.13 LTE Band 2

## LTE Band 2 Body

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.539$  S/m;  $\epsilon_r = 51.795$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.8°C      Liquid Temperature: 21.3°C

Communication System: UID 0, LTE\_FDD (0) Frequency: 1880 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.89, 4.89, 4.89);

**Rear side Mid 1RB\_Low/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.593 W/kg

**Rear side Mid 1RB\_Low/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 9.221 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 0.848 W/kg

**SAR(1 g) = 0.506 W/kg; SAR(10 g) = 0.275 W/kg**

Maximum value of SAR (measured) = 0.565 W/kg

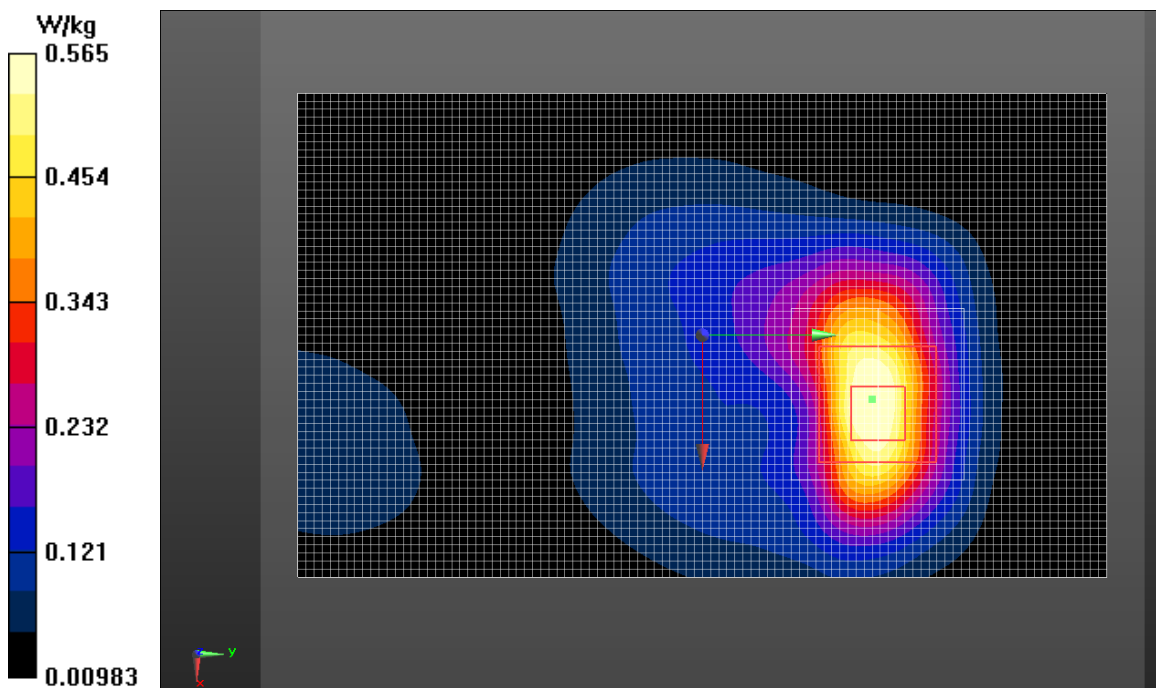


Fig.14 LTE Band 2

### LTE Band 4 Head

Date: 2018-3-2

Electronics: DAE4 Sn786

Medium: Head 1800 MHz

Medium parameters used (interpolated):  $f = 1732.5$  MHz;  $\sigma = 1.336$  S/m;  $\epsilon_r = 39.839$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.2°C      Liquid Temperature: 21.7°C

Communication System: UID 0, LTE\_FDD (0) Frequency: 1732.5 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.27, 5.27, 5.27);

**Right Cheek Mid 1RB\_Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm  
Maximum value of SAR (interpolated) = 0.089 W/kg

**Right Cheek Mid 1RB\_Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 2.159 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.155 W/kg

**SAR(1 g) = 0.068 W/kg; SAR(10 g) = 0.040 W/kg**

Maximum value of SAR (measured) = 0.081 W/kg

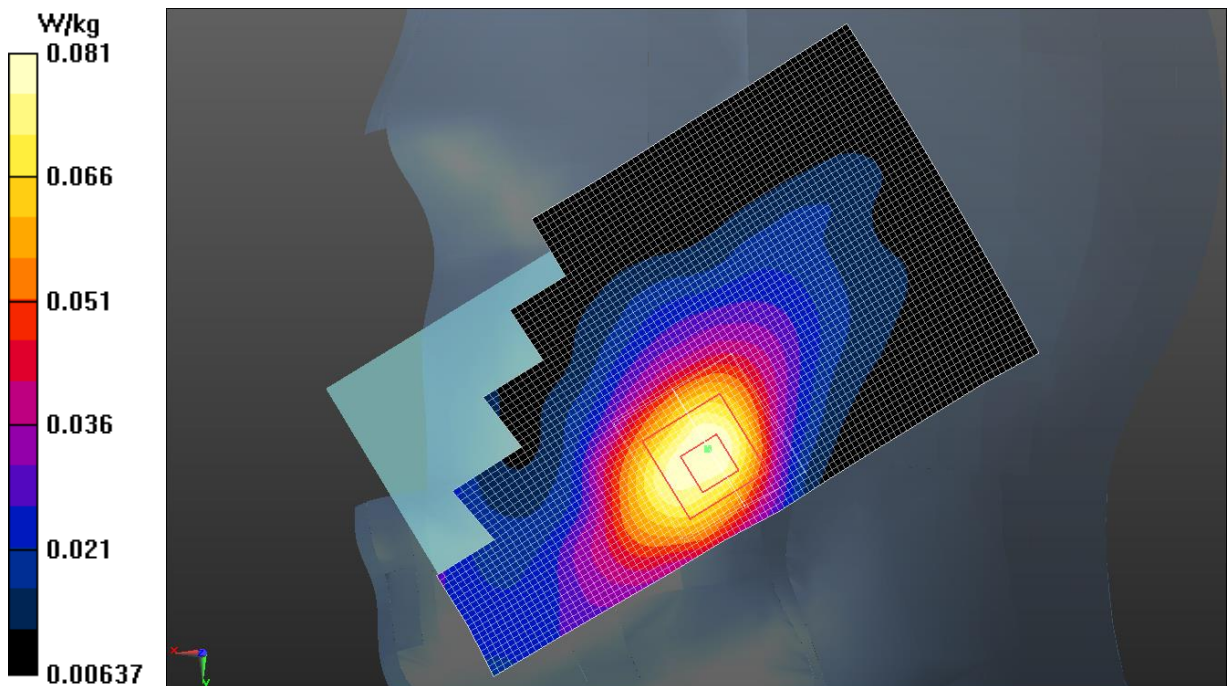


Fig.15 LTE Band 4



### LTE Band 4 Body

Date: 2018-3-2

Electronics: DAE4 Sn786

Medium: Body 1800 MHz

Medium parameters used:  $f = 1720$  MHz;  $\sigma = 1.429$  S/m;  $\epsilon_r = 52.072$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.8°C      Liquid Temperature: 21.3°C

Communication System: UID 0, LTE\_FDD (0) Frequency: 1720 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.11, 5.11, 5.11);

**Rear side Low 1RB\_Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 1.12 W/kg

**Rear side Low 1RB\_Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 6.401 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.68 W/kg

**SAR(1 g) = 1.09 W/kg; SAR(10 g) = 0.595 W/kg**

Maximum value of SAR (measured) = 1.22 W/kg

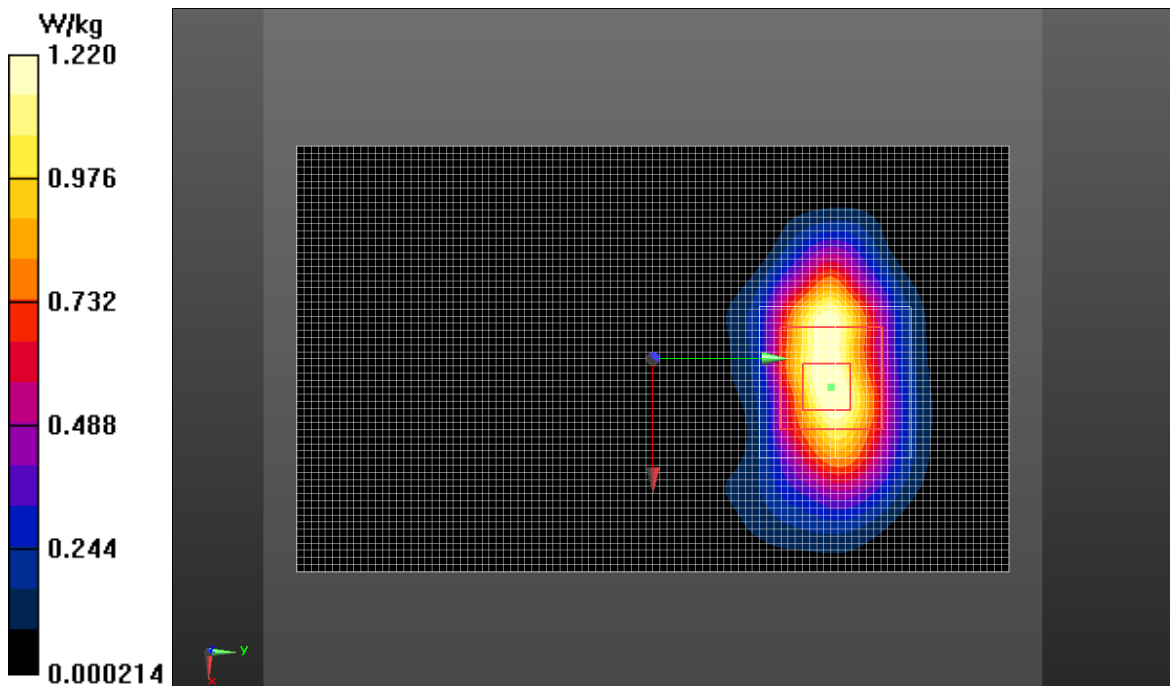


Fig.16 LTE Band 4

## LTE Band 5 Head

Date: 2018-3-10

Electronics: DAE4 Sn786

Medium: Head 835 MHz

Medium parameters used (interpolated):  $f = 836.5$  MHz;  $\sigma = 0.914$  S/m;  $\epsilon_r = 40.764$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.0°C      Liquid Temperature: 21.5°C

Communication System: UID 0, LTE\_FDD (0) Frequency: 836.5 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.47, 6.47, 6.47);

**Left cheek Mid 25RB\_High/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.402 W/kg

**Left cheek Mid 25RB\_High/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 7.284 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.498 W/kg

**SAR(1 g) = 0.373 W/kg; SAR(10 g) = 0.275 W/kg**

Maximum value of SAR (measured) = 0.394 W/kg

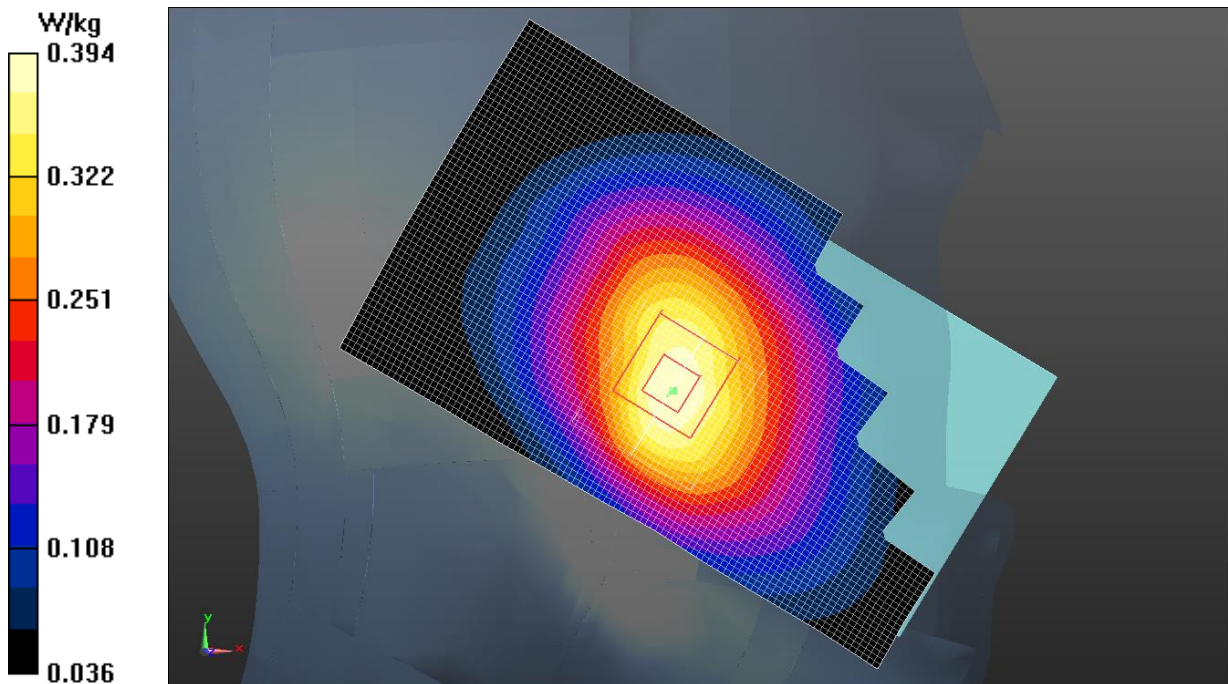


Fig.17 LTE Band 5

### LTE Band 5 Body

Date: 2018-3-12

Electronics: DAE4 Sn786

Medium: Body 835 MHz

Medium parameters used (interpolated):  $f = 836.5$  MHz;  $\sigma = 0.990$  S/m;  $\epsilon_r = 53.617$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.4°C      Liquid Temperature: 21.9°C

Communication System: UID 0, LTE\_FDD (0) Frequency: 836.5 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.38, 6.38, 6.38);

**Rear side Mid 25RB\_High /Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.477 W/kg

**Rear side Mid 25RB\_High /Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 21.72 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.564 W/kg

**SAR(1 g) = 0.451 W/kg; SAR(10 g) = 0.346 W/kg**

Maximum value of SAR (measured) = 0.471 W/kg

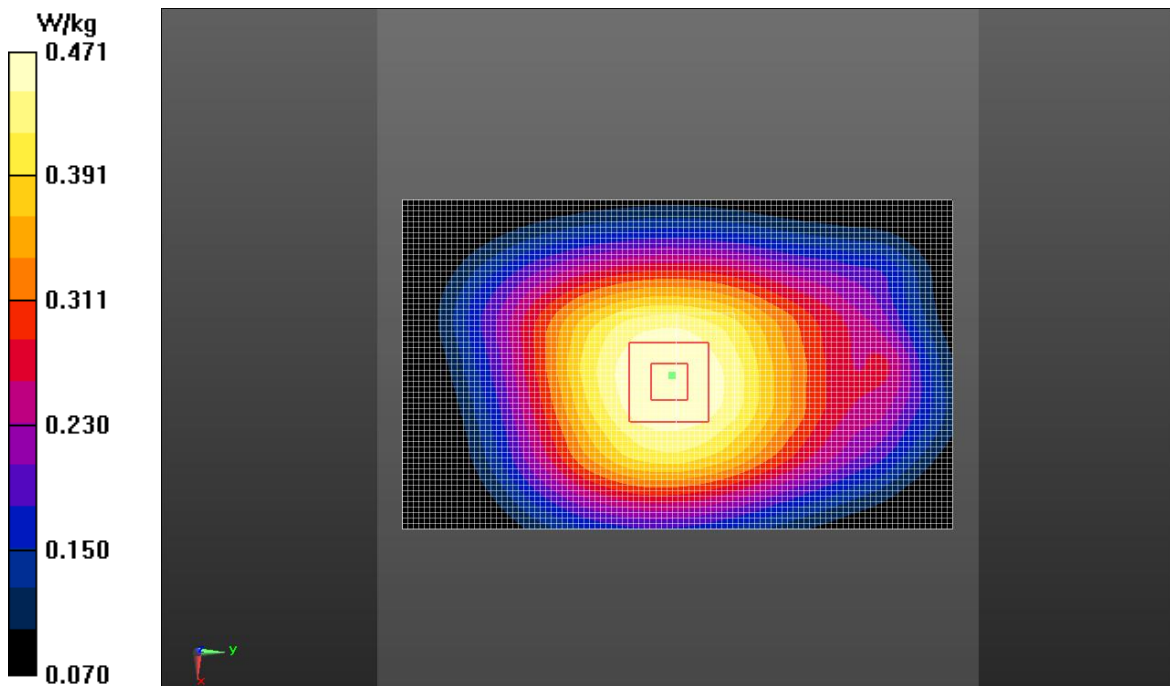


Fig.18 LTE Band 5

## LTE Band 7 Head

Date: 2018-2-26

Electronics: DAE4 Sn786

Medium: Head 2550 MHz

Medium parameters used (interpolated):  $f = 2535$  MHz;  $\sigma = 1.958$  S/m;  $\epsilon_r = 38.436$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3°C      Liquid Temperature: 21.8°C

Communication System: UID 0, LTE\_FDD (0) Frequency: 2535 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.53, 4.53, 4.53);

**Right Cheek Mid 1RB\_Mid /Area Scan (61x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.165 W/kg

**Right Cheek Mid 1RB\_Mid /Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 2.018 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.282 W/kg

**SAR(1 g) = 0.144 W/kg; SAR(10 g) = 0.071 W/kg**

Maximum value of SAR (measured) = 0.159 W/kg

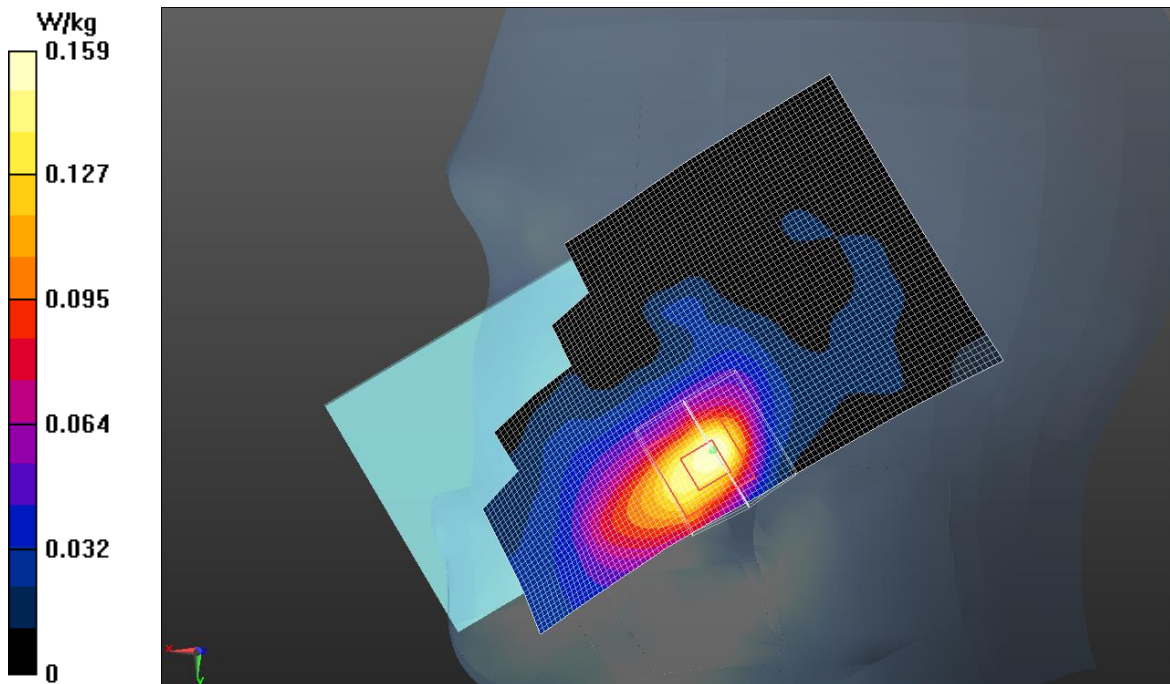


Fig.19 LTE Band 7

### LTE Band 7 Body

Date: 2018-2-26

Electronics: DAE4 Sn786

Medium: Body 2550 MHz

Medium parameters used (interpolated):  $f = 2535$  MHz;  $\sigma = 2.084$  S/m;  $\epsilon_r = 51.978$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.7°C      Liquid Temperature: 22.2°C

Communication System: UID 0, 4G\_LTE\_FDD (0) Frequency: 2535 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.24, 4.24, 4.24);

**Rear Side Mid 1RB\_ Mid/Area Scan (71x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.651 W/kg

**Rear Side Mid 1RB\_ Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 4.418 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.24 W/kg

**SAR(1 g) = 0.615 W/kg; SAR(10 g) = 0.276 W/kg**

Maximum value of SAR (measured) = 0.697 W/kg

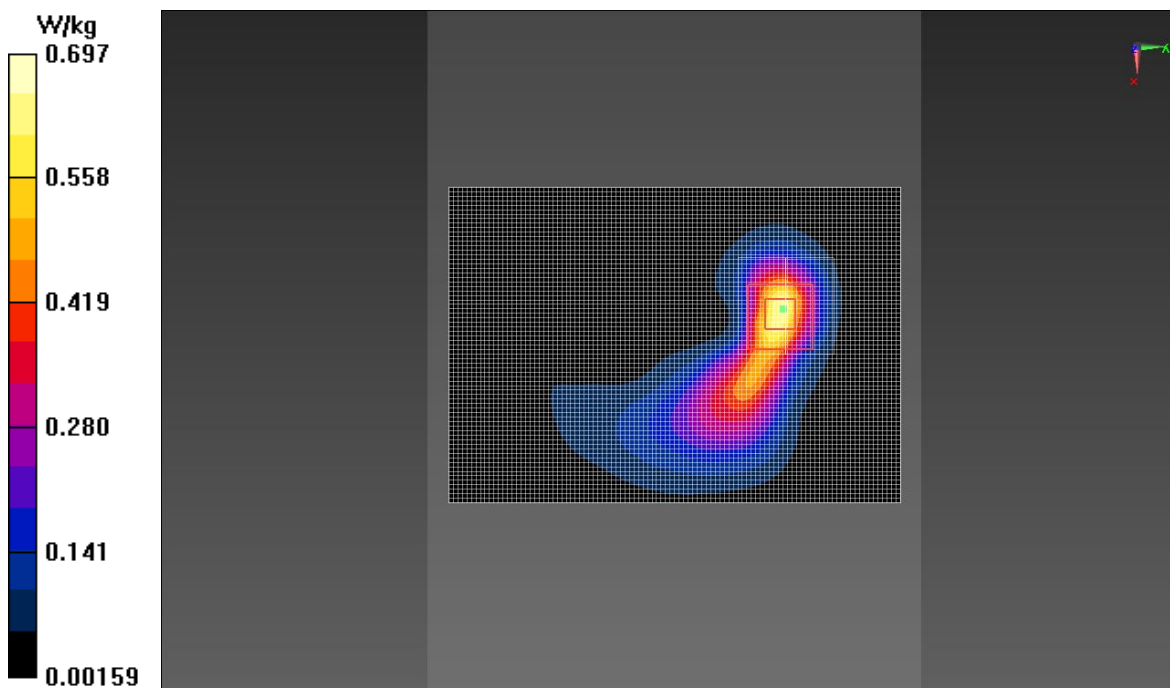


Fig.20 LTE Band 7

## Wi-Fi 2.4G Head

Date: 2018-3-14

Electronics: DAE4 Sn786

Medium: Head 2450 MHz

Medium parameters used (interpolated):  $f = 2437$  MHz;  $\sigma = 1.832$  S/m;  $\epsilon_r = 38.109$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.2°C      Liquid Temperature: 21.7°C

Communication System: UID 0, WiFi (0) Frequency: 2437 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.57, 4.57, 4.57);

**Left Cheek Mid/Area Scan (61x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.434 W/kg

**Left Cheek Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 6.775 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 0.818 W/kg

**SAR(1 g) = 0.400 W/kg; SAR(10 g) = 0.195 W/kg**

Maximum value of SAR (measured) = 0.406 W/kg

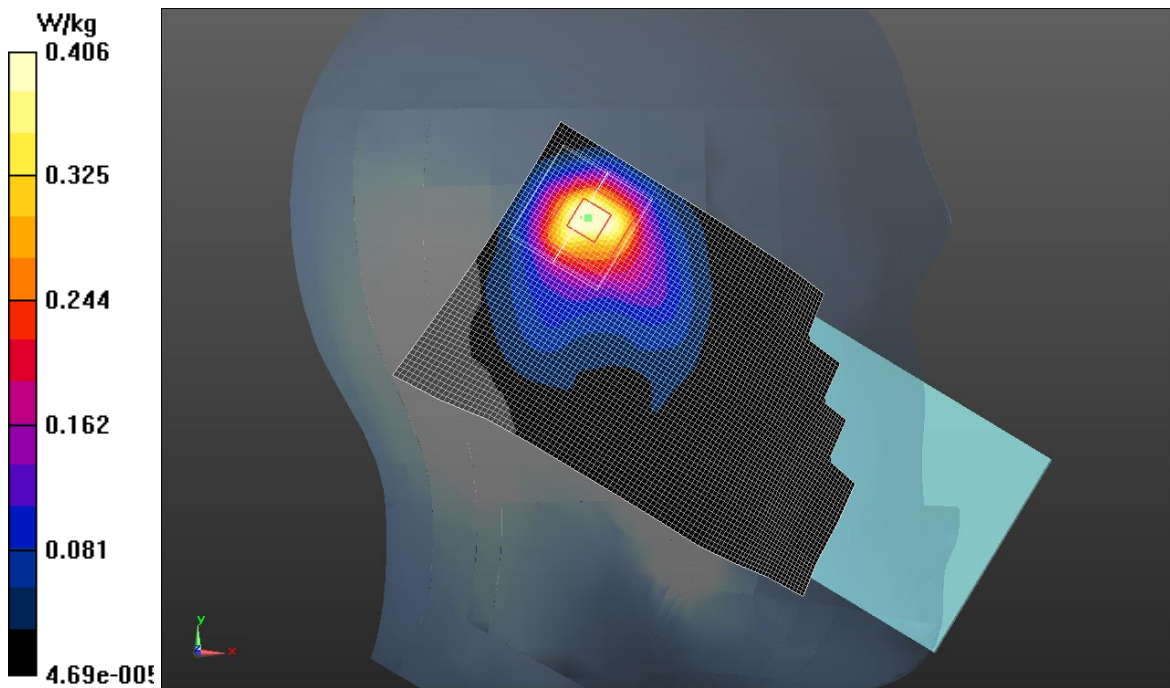


Fig.21 Wi-Fi 2.4G

## Wi-Fi 2.4G Body

Date: 2018-3-14

Electronics: DAE4 Sn786

Medium: Body 2450 MHz

Medium parameters used (interpolated):  $f = 2437$  MHz;  $\sigma = 1.961$  S/m;  $\epsilon_r = 52.234$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3°C      Liquid Temperature: 21.8°C

Communication System: UID 0, WiFi (0) Frequency: 2437 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.46, 4.46, 4.46);

**Rear Side Mid/Area Scan (71x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.124 W/kg

**Rear Side Mid/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 2.903 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.255 W/kg

**SAR(1 g) = 0.124 W/kg; SAR(10 g) = 0.060 W/kg**

Maximum value of SAR (measured) = 0.128 W/kg

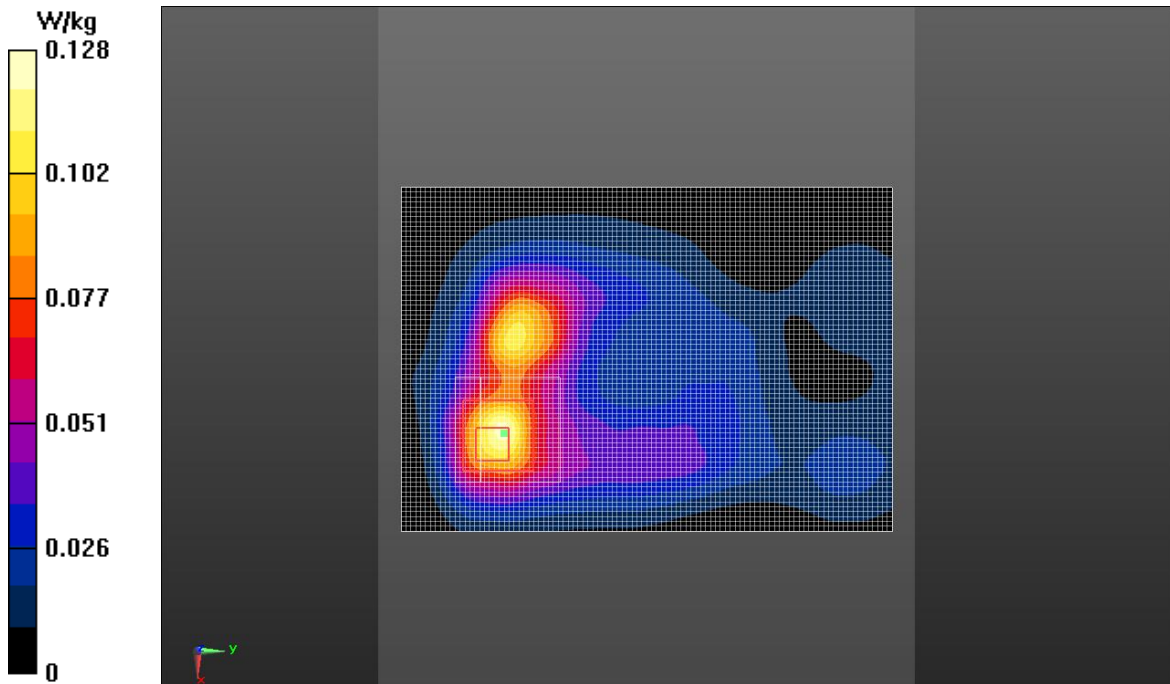


Fig.22 Wi-Fi 2.4G

## ANNEX B SystemVerification Results

### 835MHz

Date: 2018-3-10

Electronics: DAE4 Sn786

Medium: Head 835 MHz

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.912 \text{ S/m}$ ;  $\epsilon_r = 40.752$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.9^\circ\text{C}$       Liquid Temperature:  $22.5^\circ\text{C}$

Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.47, 6.47, 6.47);

**System Validation /Area Scan (81x161x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $54.784 \text{ V/m}$ ; Power Drift =  $0.05 \text{ dB}$

**Fast SAR: SAR(1 g) = 2.35 W/kg; SAR(10 g) = 1.50 W/kg**

Maximum value of SAR (interpolated) =  $2.52 \text{ W/kg}$

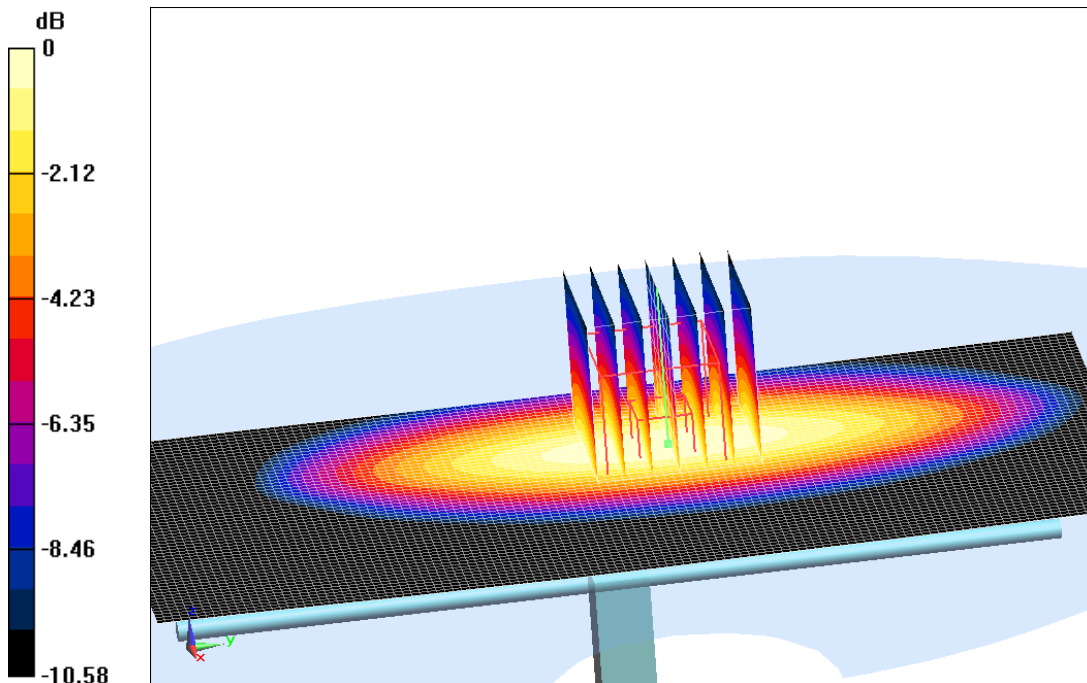
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $54.784 \text{ V/m}$ ; Power Drift =  $0.05 \text{ dB}$

Peak SAR (extrapolated) =  $3.38 \text{ W/kg}$

**SAR(1 g) = 2.37 W/kg; SAR(10 g) = 1.53 W/kg**

Maximum value of SAR (measured) =  $2.58 \text{ W/kg}$



0 dB =  $2.58 \text{ W/kg} = 4.12 \text{ dBW/kg}$

**Fig.B.1. Validation 835MHz 250mW**



## 835MHz

Date: 2018-3-12

Electronics: DAE4 Sn786

Medium: Body 835 MHz

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.988 \text{ S/m}$ ;  $\epsilon_r = 53.639$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.9^\circ\text{C}$       Liquid Temperature:  $22.5^\circ\text{C}$

Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.38, 6.38, 6.38);

**System Validation /Area Scan (81x171x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $56.427 \text{ V/m}$ ; Power Drift =  $0.08 \text{ dB}$

**Fast SAR: SAR(1 g) =  $2.41 \text{ W/kg}$ ; SAR(10 g) =  $1.55 \text{ W/kg}$**

Maximum value of SAR (interpolated) =  $2.59 \text{ W/kg}$

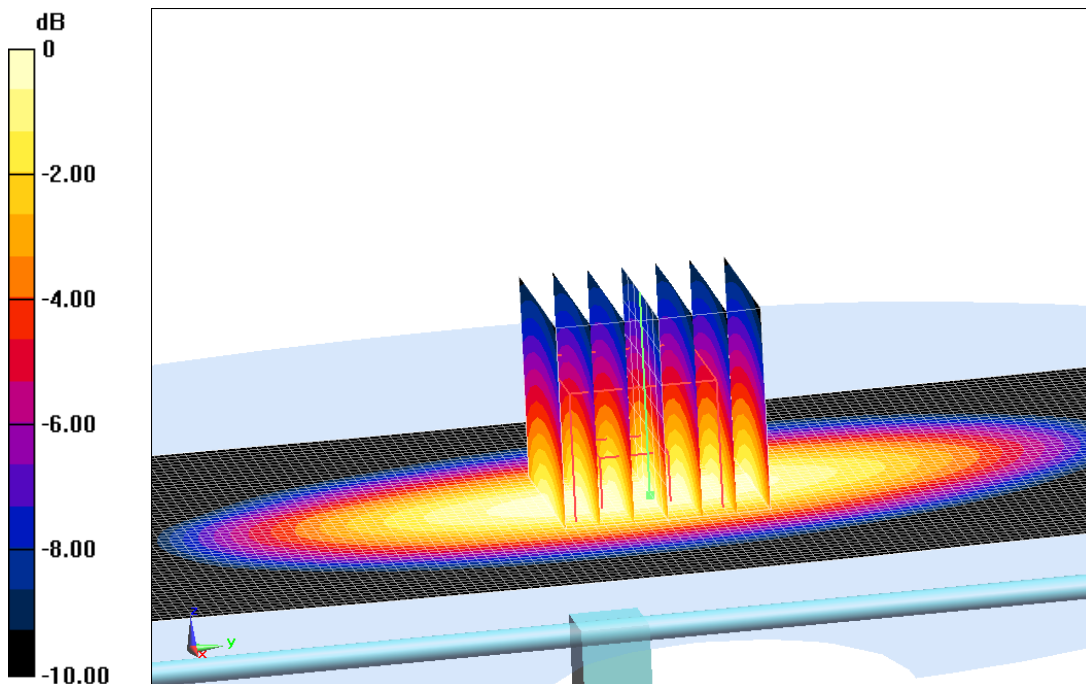
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $56.427 \text{ V/m}$ ; Power Drift =  $0.08 \text{ dB}$

Peak SAR (extrapolated) =  $3.68 \text{ W/kg}$

**SAR(1 g) =  $2.45 \text{ W/kg}$ ; SAR(10 g) =  $1.58 \text{ W/kg}$**

Maximum value of SAR (measured) =  $2.66 \text{ W/kg}$



0 dB =  $2.66 \text{ W/kg}$  =  $4.25 \text{ dBW/kg}$

**Fig.B.2. Validation 835MHz 250mW**

## 1800MHz

Date: 2018-3-2

Electronics: DAE4 Sn786

Medium: Head 1800 MHz

Medium parameters used:  $f = 1800 \text{ MHz}$ ;  $\sigma = 1.409 \text{ S/m}$ ;  $\epsilon_r = 39.653$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.0^\circ\text{C}$       Liquid Temperature:  $21.5^\circ\text{C}$

Communication System: CW Frequency: 1800 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.27, 5.27, 5.27);

**System Validation/Area Scan (61x121x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $80.268 \text{ V/m}$ ; Power Drift =  $0.03 \text{ dB}$

**Fast SAR: SAR(1 g) =  $9.84 \text{ W/kg}$ ; SAR(10 g) =  $5.18 \text{ W/kg}$**

Maximum value of SAR (interpolated) =  $11.6 \text{ W/kg}$

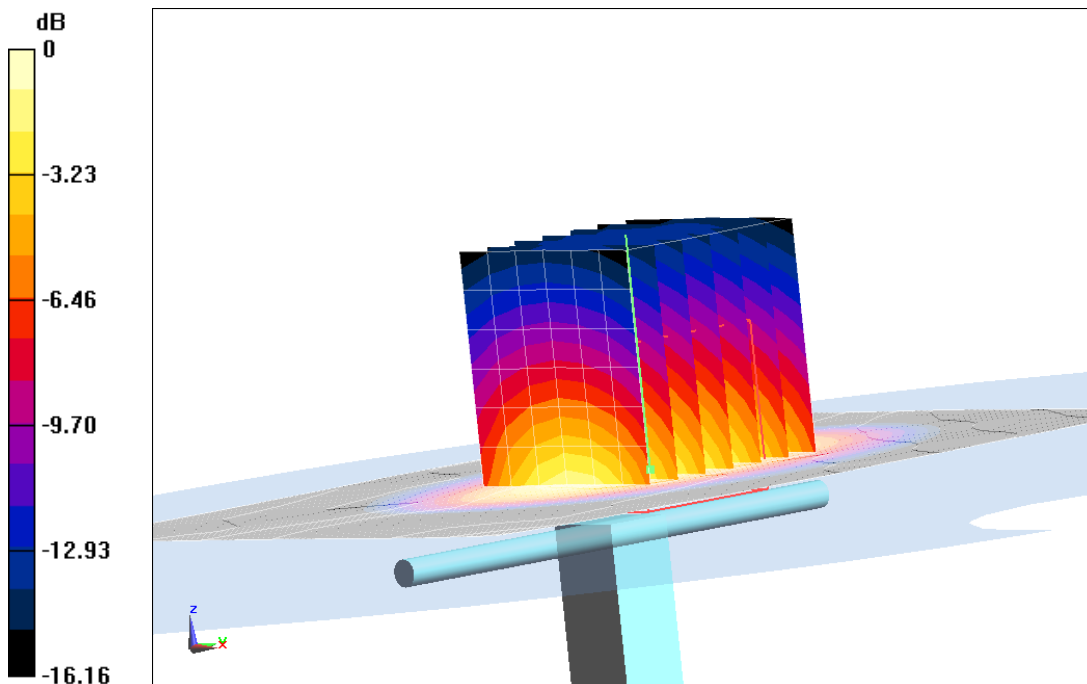
**System Validation/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $80.268 \text{ V/m}$ ; Power Drift =  $0.03 \text{ dB}$

Peak SAR (extrapolated) =  $19.5 \text{ W/kg}$

**SAR(1 g) =  $9.89 \text{ W/kg}$ ; SAR(10 g) =  $5.22 \text{ W/kg}$**

Maximum value of SAR (measured) =  $12.7 \text{ W/kg}$



0 dB =  $12.7 \text{ W/kg}$  =  $11.04 \text{ dBW/kg}$

**Fig.B.3. Validation 1800MHz 250mW**

## 1800MHz

Date: 2018-3-2

Electronics: DAE4 Sn786

Medium: Body 1800 MHz

Medium parameters used:  $f = 1800$  MHz;  $\sigma = 1.503$  S/m;  $\epsilon_r = 51.82$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.0°C      Liquid Temperature: 21.5°C

Communication System: CW Frequency: 1800 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.11, 5.11, 5.11);

**System Validation/Area Scan (61x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 78.182 V/m; Power Drift = -0.09 dB

**Fast SAR: SAR(1 g) = 9.80 W/kg; SAR(10 g) = 5.24 W/kg**

Maximum value of SAR (interpolated) = 12.0 W/kg

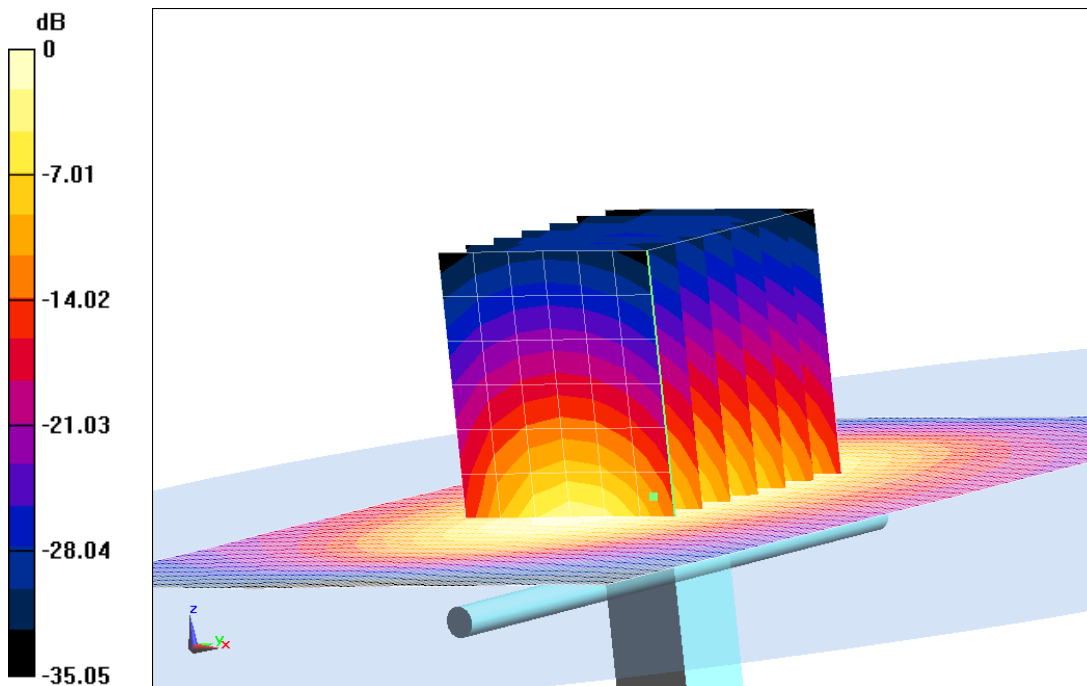
**System Validation/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 78.182 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 18.4 W/kg

**SAR(1 g) = 9.67 W/kg; SAR(10 g) = 5.19 W/kg**

Maximum value of SAR (measured) = 11.7 W/kg



0 dB = 11.7 W/kg = 10.68 dBW/kg

**Fig.B.4. Validation 1800MHz 250mW**

## 1900MHz

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.416 \text{ S/m}$ ;  $\epsilon_r = 39.288$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.9^\circ\text{C}$       Liquid Temperature:  $22.5^\circ\text{C}$

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

**System Validation /Area Scan (81x121x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $92.854 \text{ V/m}$ ; Power Drift =  $-0.06 \text{ dB}$

**Fast SAR: SAR(1 g) =  $10.6 \text{ W/kg}$ ; SAR(10 g) =  $5.36 \text{ W/kg}$**

Maximum value of SAR (interpolated) =  $13.1 \text{ W/kg}$

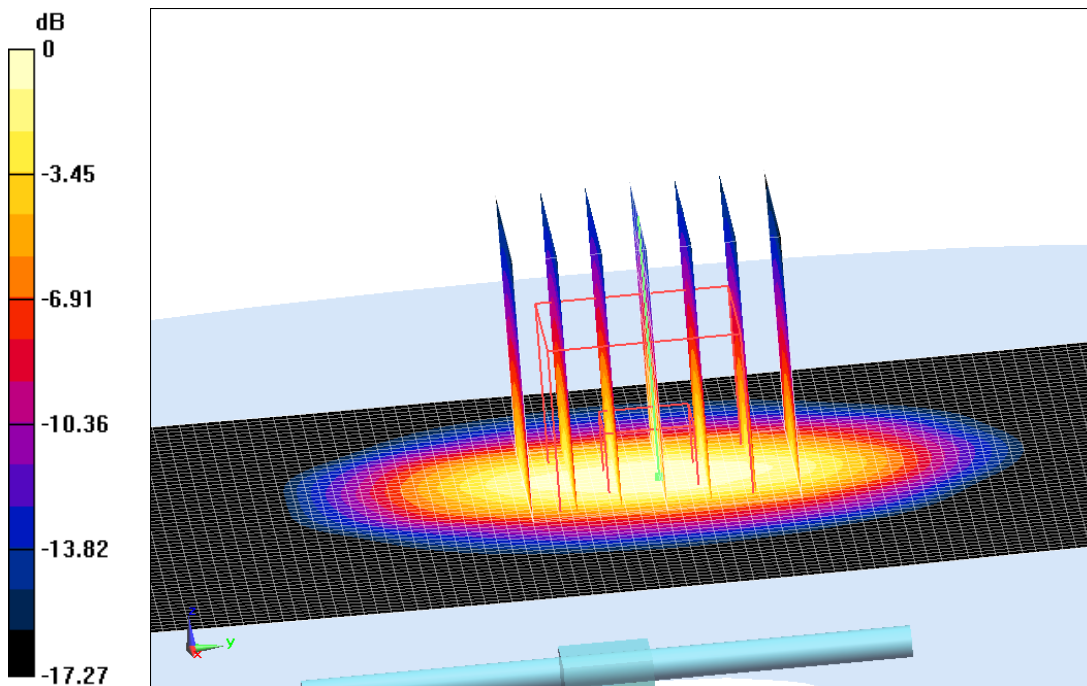
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $92.854 \text{ V/m}$ ; Power Drift =  $-0.06 \text{ dB}$

Peak SAR (extrapolated) =  $19.4 \text{ W/kg}$

**SAR(1 g) =  $10.4 \text{ W/kg}$ ; SAR(10 g) =  $5.31 \text{ W/kg}$**

Maximum value of SAR (measured) =  $12.9 \text{ W/kg}$



0 dB =  $12.9 \text{ W/kg}$  =  $11.11 \text{ dBW/kg}$

**Fig.B.5. Validation 1900MHz 250mW**

## 1900MHz

Date: 2018-3-5

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.554$  S/m;  $\epsilon_r = 51.747$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.9°C      Liquid Temperature: 22.5°C

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.89, 4.89, 4.89);

**System validation /Area Scan (81x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 75.847 V/m; Power Drift = 0.10 dB

**Fast SAR: SAR(1 g) = 10.5 W/kg; SAR(10 g) = 5.41 W/kg**

Maximum value of SAR (interpolated) = 12.6 W/kg

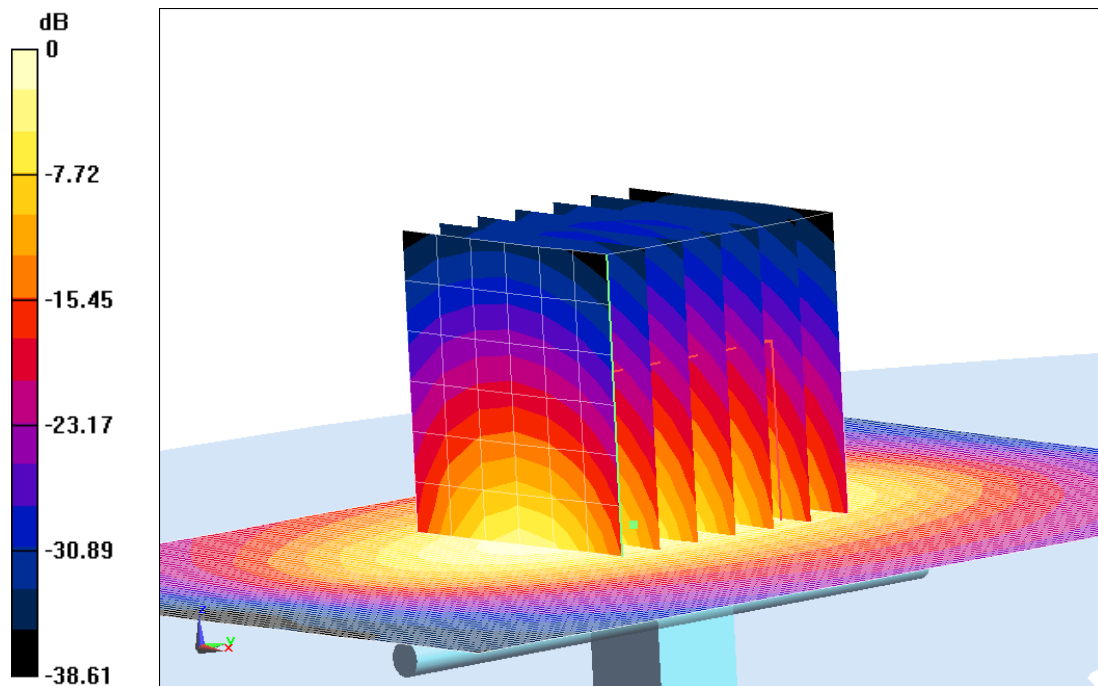
**System validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 75.847 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 20.2 W/kg

**SAR(1 g) = 10.6 W/kg; SAR(10 g) = 5.46 W/kg**

Maximum value of SAR (measured) = 13.2 W/kg



0 dB = 13.2 W/kg = 11.21 dBW/kg

**Fig.B.6. Validation 1900MHz 250mW**

## 2450MHz

Date: 2018-3-14

Electronics: DAE4 Sn786

Medium: Head 2450 MHz

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.847 \text{ S/m}$ ;  $\epsilon_r = 38.063$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.0^\circ\text{C}$       Liquid Temperature:  $21.6^\circ\text{C}$

Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.57, 4.57, 4.57);

**System Validation /Area Scan (61x81x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $86.622 \text{ V/m}$ ; Power Drift =  $-0.08 \text{ dB}$

**Fast SAR: SAR(1 g) =  $13.2 \text{ W/kg}$ ; SAR(10 g) =  $6.06 \text{ W/kg}$**

Maximum value of SAR (interpolated) =  $15.5 \text{ W/kg}$

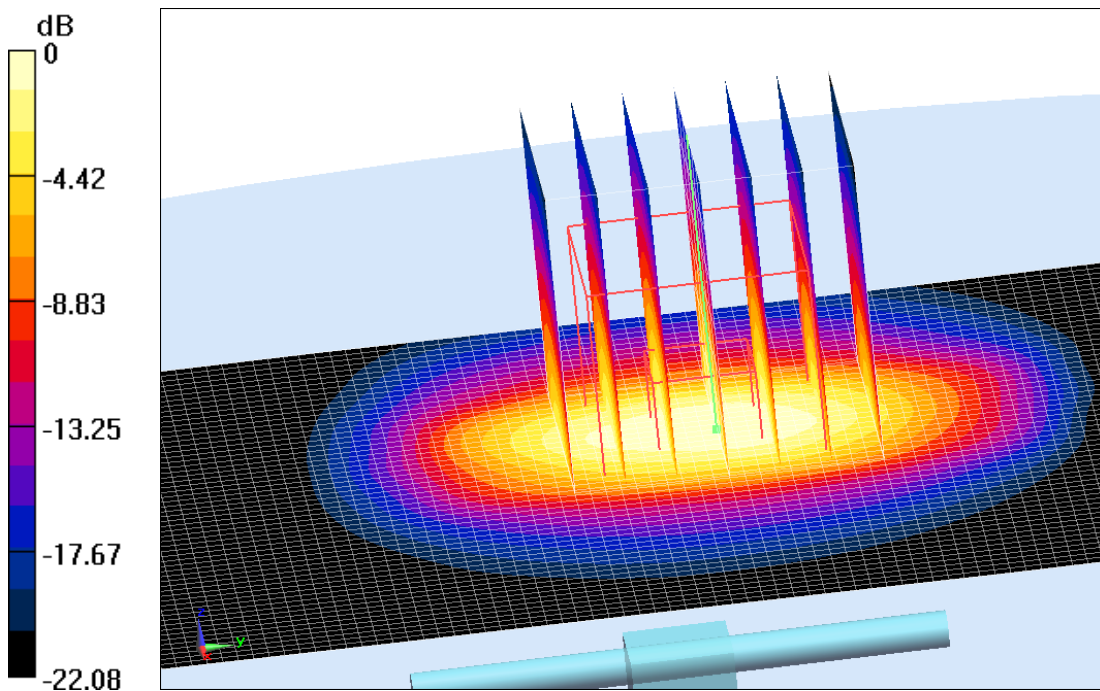
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $86.622 \text{ V/m}$ ; Power Drift =  $-0.08 \text{ dB}$

Peak SAR (extrapolated) =  $22.6 \text{ W/kg}$

**SAR(1 g) =  $12.9 \text{ W/kg}$ ; SAR(10 g) =  $5.98 \text{ W/kg}$**

Maximum value of SAR (measured) =  $15.0 \text{ W/kg}$



0 dB =  $15.0 \text{ W/kg}$  =  $11.76 \text{ dBW/kg}$

**Fig.B.7. Validation 2450MHz 250mW**

## 2450MHz

Date: 2018-3-14

Electronics: DAE4 Sn786

Medium: Body 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.976$  S/m;  $\epsilon_r = 52.19$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.0°C      Liquid Temperature: 21.6°C

Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.46, 4.46, 4.46);

**System Validation/Area Scan (81x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 88.591 V/m; Power Drift = 0.11 dB

**Fast SAR: SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.12 W/kg**

Maximum value of SAR (interpolated) = 15.7 W/kg

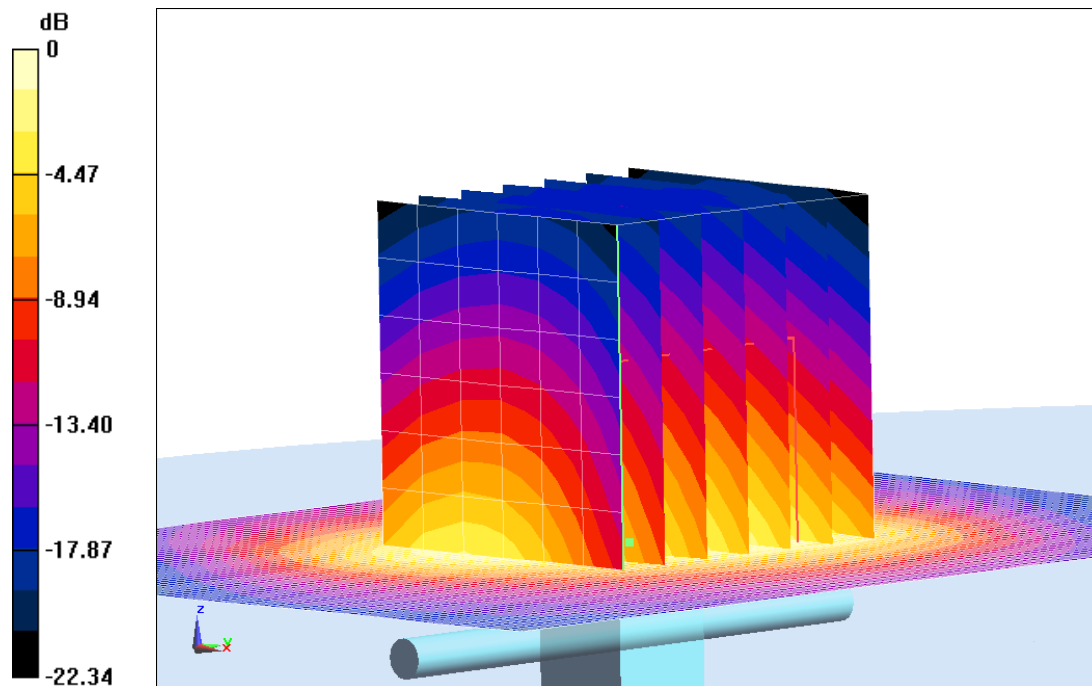
**System Validation/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 88.591 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 24.9 W/kg

**SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.18 W/kg**

Maximum value of SAR (measured) = 16.4 W/kg



0 dB = 16.4 W/kg = 12.15 dBW/kg

**Fig.B.8. Validation 2450MHz 250mW**

## 2550MHz

Date: 2018-2-26

Electronics: DAE4 Sn786

Medium: Head 2550 MHz

Medium parameters used:  $f = 2550 \text{ MHz}$ ;  $\sigma = 1.977 \text{ S/m}$ ;  $\epsilon_r = 38.374$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.0^\circ\text{C}$       Liquid Temperature:  $21.6^\circ\text{C}$

Communication System: CW Frequency: 2550 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.53, 4.53, 4.53);

**System Validation/Area Scan (81x101x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $92.738 \text{ V/m}$ ; Power Drift =  $0.02 \text{ dB}$

**Fast SAR: SAR(1 g) =  $14.5 \text{ W/kg}$ ; SAR(10 g) =  $6.61 \text{ W/kg}$**

Maximum value of SAR (interpolated) =  $15.8 \text{ W/kg}$

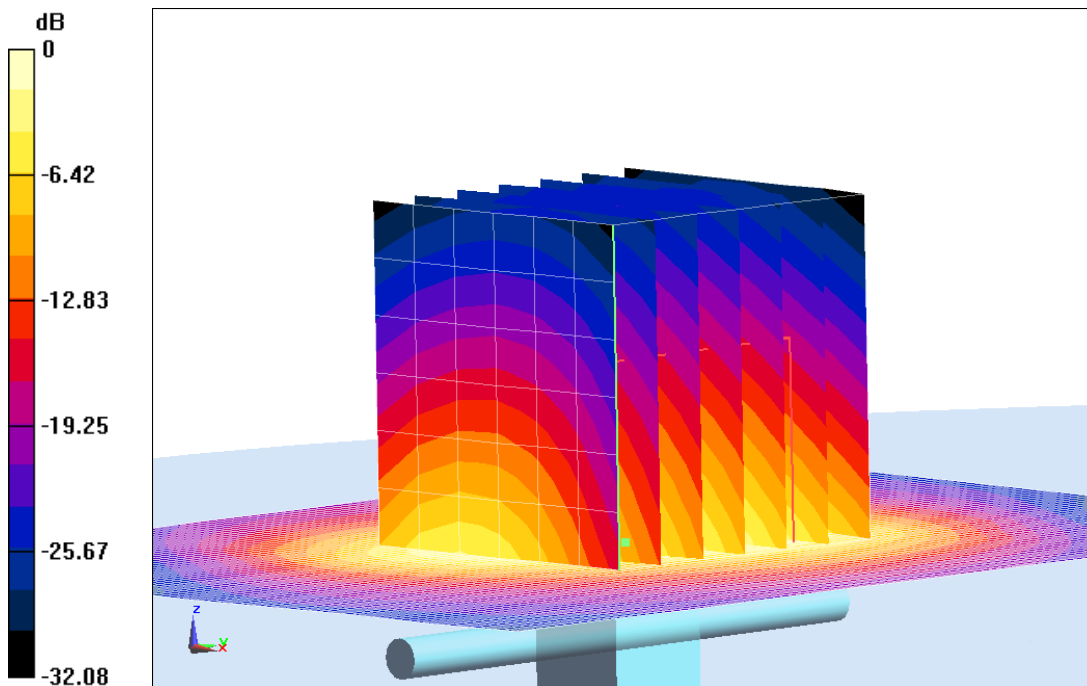
**System Validation/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $92.738 \text{ V/m}$ ; Power Drift =  $0.02 \text{ dB}$

Peak SAR (extrapolated) =  $28.8 \text{ W/kg}$

**SAR(1 g) =  $14.8 \text{ W/kg}$ ; SAR(10 g) =  $6.68 \text{ W/kg}$**

Maximum value of SAR (measured) =  $16.9 \text{ W/kg}$



0 dB =  $16.9 \text{ W/kg}$  =  $12.28 \text{ dBW/kg}$

**Fig.B.9. Validation 2550MHz 250mW**



## 2550MHz

Date: 2018-2-26

Electronics: DAE4 Sn786

Medium: Body 2550 MHz

Medium parameters used:  $f = 2550 \text{ MHz}$ ;  $\sigma = 2.105 \text{ S/m}$ ;  $\epsilon_r = 51.934$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.0^\circ\text{C}$       Liquid Temperature:  $21.6^\circ\text{C}$

Communication System: CW Frequency: 2550 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.24, 4.24, 4.24);

**System Validation/Area Scan (81x101x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $87.965 \text{ V/m}$ ; Power Drift =  $-0.01 \text{ dB}$

**Fast SAR: SAR(1 g) =  $13.5 \text{ W/kg}$ ; SAR(10 g) =  $6.23 \text{ W/kg}$**

Maximum value of SAR (interpolated) =  $15.2 \text{ W/kg}$

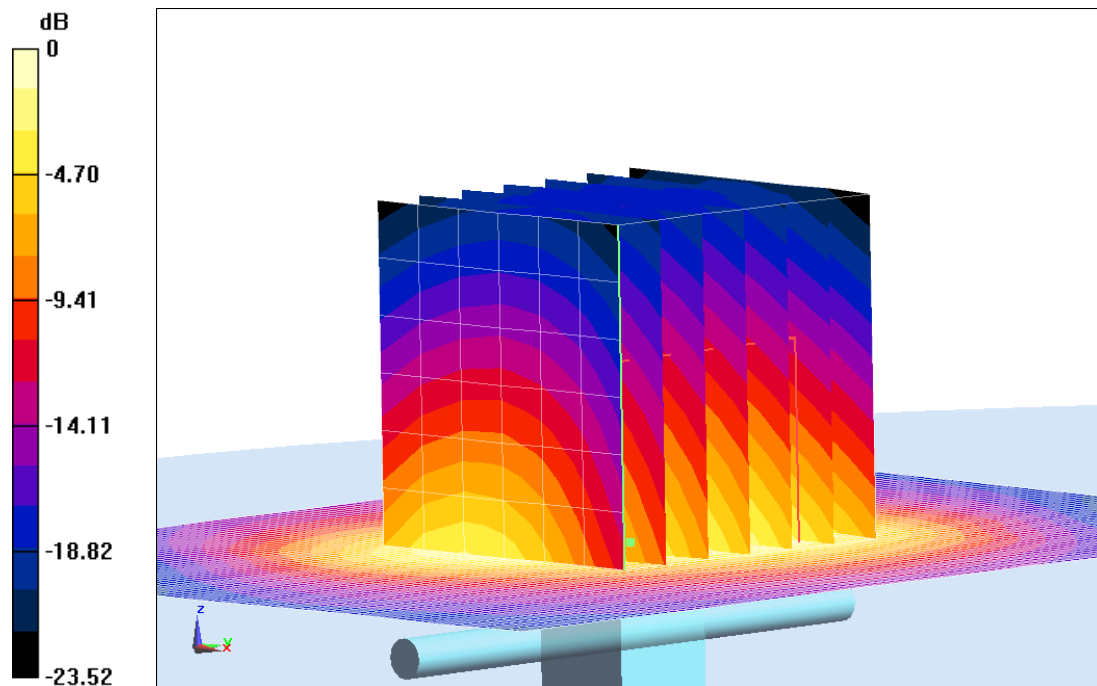
**System Validation/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $87.965 \text{ V/m}$ ; Power Drift =  $-0.01 \text{ dB}$

Peak SAR (extrapolated) =  $26.2 \text{ W/kg}$

**SAR(1 g) =  $13.3 \text{ W/kg}$ ; SAR(10 g) =  $6.16 \text{ W/kg}$**

Maximum value of SAR (measured) =  $14.7 \text{ W/kg}$



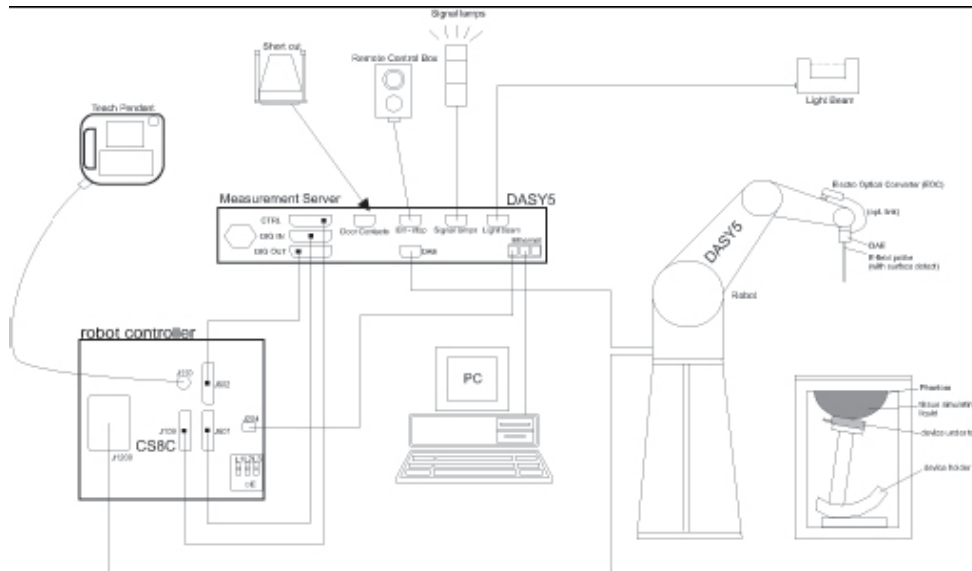
0 dB =  $14.7 \text{ W/kg}$  =  $11.67 \text{ dBW/kg}$

**Fig.B.10. Validation 2550MHz 250mW**

## ANNEX C SAR Measurement Setup

### C.1 Measurement Set-up

DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:



**Picture C.1 SAR Lab Test Measurement Set-up**

- A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as
- warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## C.2 DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection during a software approach and looks for the maximum using 2<sup>nd</sup> order curve fitting. The approach is stopped at reaching the maximum.

### Probe Specifications:

<b>Model:</b>	<b>ES3DV3, EX3DV4</b>
<b>Frequency</b>	<b>10MHz — 6.0GHz(EX3DV4)</b>
<b>Range:</b>	<b>10MHz — 4GHz(ES3DV3)</b>
<b>Calibration:</b>	<b>In head and body simulating tissue at Frequencies from 835 up to 5800MHz</b>
<b>Linearity:</b>	<b>± 0.2 dB(30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB(30 MHz to 4 GHz) for ES3DV3</b>
<b>Dynamic Range:</b>	<b>10 mW/kg — 100W/kg</b>
<b>Probe Length:</b>	<b>330 mm</b>
<b>Probe Tip</b>	
<b>Length:</b>	<b>20 mm</b>
<b>Body Diameter:</b>	<b>12 mm</b>
<b>Tip Diameter:</b>	<b>2.5 mm (3.9 mm for ES3DV3)</b>
<b>Tip-Center:</b>	<b>1 mm (2.0mm for ES3DV3)</b>
<b>Application:</b>	<b>SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields</b>



Picture C.2 Near-field Probe



Picture C.3 E-field Probe

## C.3 E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density ( $1 \text{ mW/cm}^2$ ) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed

in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ cm<sup>2</sup>:

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C \frac{\Delta T}{\Delta t}$$

Where:

$\Delta t$  = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

$\Delta T$  = Temperature increase due to RF exposure.

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

Where:

$\sigma$  = Simulated tissue conductivity,

$\rho$  = Tissue density (kg/m<sup>3</sup>).

## C.4 Other Test Equipment

### C.4.1 Data Acquisition Electronics (DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



PictureC.4: DAE

#### C.4.2 Robot

The SPEAG DASY system uses the high precision robots (DASY5: RX160L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)



**Picture C.5 DASY 5**

#### C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5:128MB), RAM (DASY5:128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.



**Picture C.6 Server for DASY 5**

#### C.4.4 Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of  $\pm 0.5\text{mm}$  would produce a SAR uncertainty of  $\pm 20\%$ . Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric

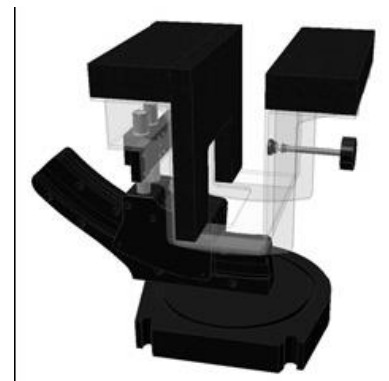
parameters: relative permittivity  $\epsilon = 3$  and loss tangent  $\delta = 0.02$ . The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.



Picture C.7-1: Device Holder



Picture C.7-2: Laptop Extension Kit

#### C.4.5 Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to

Represent the 90<sup>th</sup> percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

Shell Thickness:  $2 \pm 0.2$  mm  
Filling Volume: Approx. 25 liters  
Dimensions: 810 x 1000 x 500 mm (H x L x W)  
Available: Special

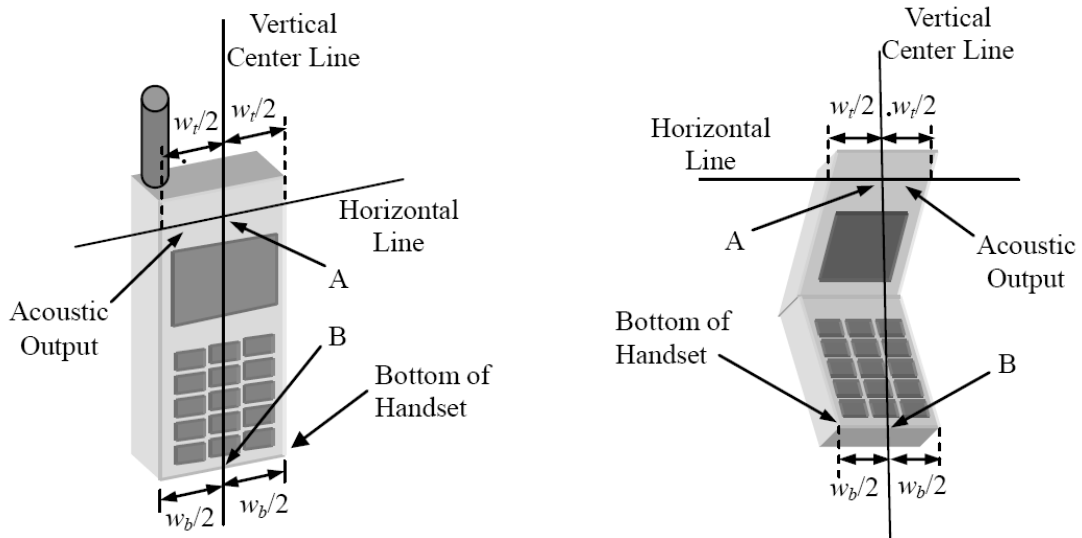


**Picture C.8: SAM Twin Phantom**

## ANNEX D Position of the wireless device in relation to the phantom

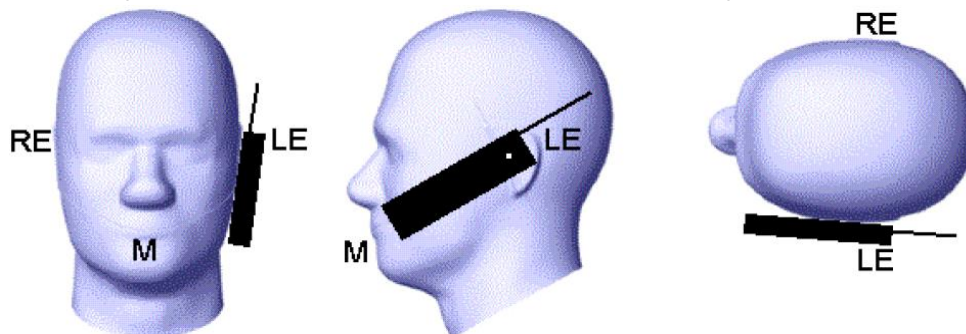
### D.1 General considerations

This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



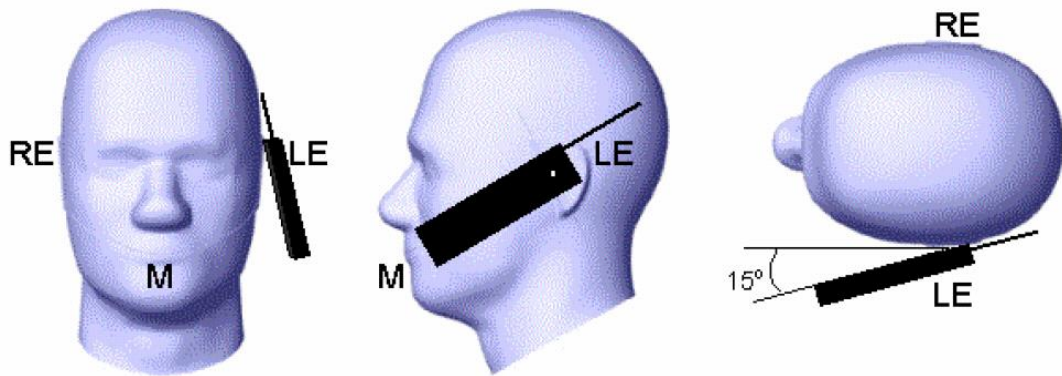
- $w_t$  Width of the handset at the level of the acoustic
- $w_b$  Width of the bottom of the handset
- A Midpoint of the width  $w_t$  of the handset at the level of the acoustic output
- B Midpoint of the width  $w_b$  of the bottom of the handset

Picture D.1-a Typical “fixed” case handset      Picture D.1-b Typical “clam-shell” case handset



Picture D.2 Cheek position of the wireless device on the left side of SAM

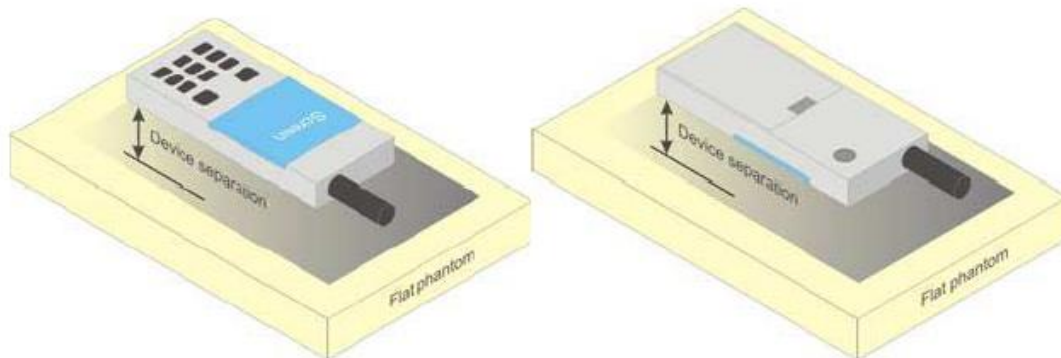




**Picture D.3 Tilt position of the wireless device on the left side of SAM**

## D.2 Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.

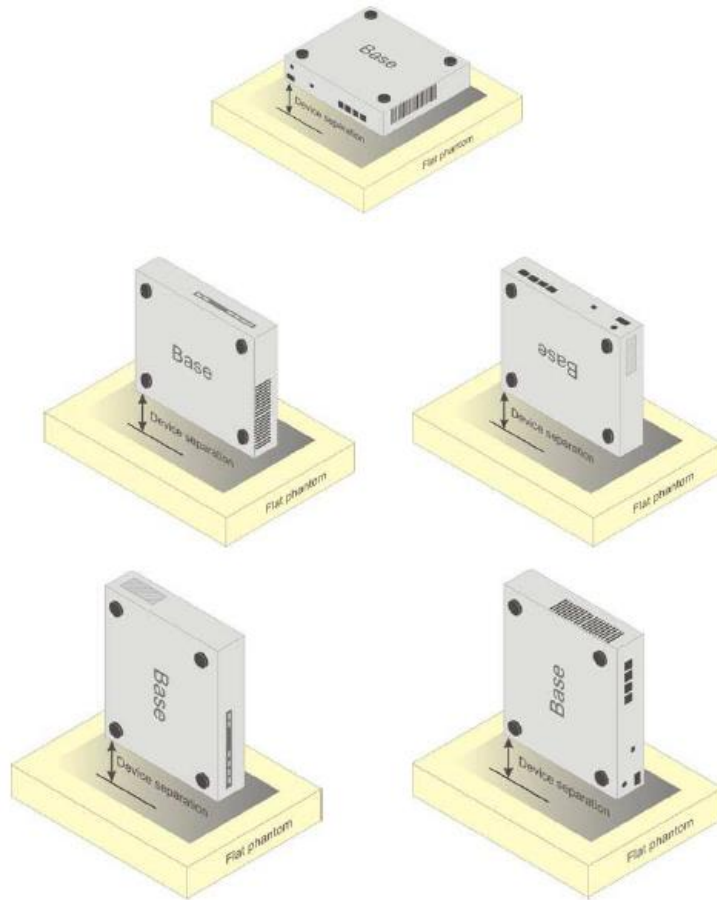


**Picture D.4 Test positions for body-worn devices**

## D.3 Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 8.5 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.



**Picture D.5 Test positions for desktop devices**

#### **D.4 DUT Setup Photos**



**Picture D.6**

## ANNEX E Equivalent Media Recipes

The liquid used for the frequency range of 700-6000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

**Table E.1: Composition of the Tissue Equivalent Matter**

Frequency (MHz)	835 Head	835 Body	1900 Head	1900 Body	2450 Head	2450 Body	5800 Head	5800 Body
Ingredients (% by weight)								
Water	41.45	52.5	55.242	69.91	58.79	72.60	65.53	65.53
Sugar	56.0	45.0	\	\	\	\	\	\
Salt	1.45	1.4	0.306	0.13	0.06	0.18	\	\
Preventol	0.1	0.1	\	\	\	\	\	\
Cellulose	1.0	1.0	\	\	\	\	\	\
Glycol Monobutyl	\	\	44.452	29.96	41.15	27.22	\	\
Diethylenglycol monohexylether	\	\	\	\	\	\	17.24	17.24
Triton X-100	\	\	\	\	\	\	17.24	17.24
Dielectric Parameters Target Value	$\epsilon=41.5$ $\sigma=0.90$	$\epsilon=55.2$ $\sigma=0.97$	$\epsilon=40.0$ $\sigma=1.40$	$\epsilon=53.3$ $\sigma=1.52$	$\epsilon=39.2$ $\sigma=1.80$	$\epsilon=52.7$ $\sigma=1.95$	$\epsilon=35.3$ $\sigma=5.27$	$\epsilon=48.2$ $\sigma=6.00$

**Note: There is a little adjustment respectively for 750, 1800, 2600, 5200, 5300, and 5600, based on the recipe of closest frequency in table E.1**

## ANNEX F System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

**Table F.1: System Validation**

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
3151	Head 750MHz	2017-12-17	750 MHz	OK
3151	Head 835MHz	2017-12-17	835 MHz	OK
3151	Head 1800MHz	2017-12-19	1800 MHz	OK
3151	Head 1900MHz	2017-12-19	1900 MHz	OK
3151	Head 2450MHz	2017-12-20	2450 MHz	OK
3151	Head 2550MHz	2017-12-20	2550 MHz	OK
3151	Body 750MHz	2017-12-17	750 MHz	OK
3151	Body 835MHz	2017-12-17	835 MHz	OK
3151	Body 1800MHz	2017-12-19	1800 MHz	OK
3151	Body 1900MHz	2017-12-19	1900 MHz	OK
3151	Body 2450MHz	2017-12-20	2450 MHz	OK
3151	Body 2550MHz	2017-12-20	5200 MHz	OK

## ANNEX G DAE Calibration Certificate

### DAE4 SN: 786 Calibration Certificate



Client : **CTTL(South Branch)**

Certificate No: **Z17-97239**

### CALIBRATION CERTIFICATE

Object: **DAE4 - SN: 786**

Calibration Procedure(s): **FF-Z11-002-01  
Calibration Procedure for the Data Acquisition Electronics (DAEx)**

Calibration date: **November 22, 2017**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	27-Jun-17 (CTTL, No.J17X05859)	June-18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: November 25, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
E-mail: cttl@chinattl.com Http://www.chinattl.cn

**Glossary:**

DAE data acquisition electronics  
Connector angle information used in DASYS system to align probe sensor X to the robot coordinate system.

**Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASYS system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.





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E-mail: ctfl@chinattl.com Http://www.chinattl.cn

**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec





Calibration Factors	X	Y	Z
High Range	404.138 ± 0.15% (k=2)	404.330 ± 0.15% (k=2)	404.714 ± 0.15% (k=2)
Low Range	3.97217 ± 0.7% (k=2)	3.97384 ± 0.7% (k=2)	3.95842 ± 0.7% (k=2)

**Connector Angle**

Connector Angle to be used in DASY system	229.5° ± 1 °
---	--------------

## ANNEX H Probe Calibration Certificate

### Probe ES3DV3-SN: 3151 Calibration Certificate


In Collaboration with  



中国认可  
国际互认  
校准  
CALIBRATION  
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

Client **CTTL(South Branch)** Certificate No: **Z17-97240**

### CALIBRATION CERTIFICATE

Object: **ES3DV3 - SN:3151**

Calibration Procedure(s): **FF-Z11-004-01  
Calibration Procedures for Dosimetric E-field Probes**

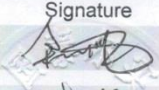
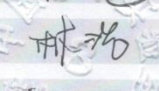
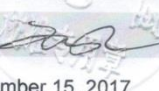
Calibration date: **December 13, 2017**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Power sensor NRP-Z91	101547	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Power sensor NRP-Z91	101548	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Reference10dBAttenuator	18N50W-10dB	13-Mar-16(CTTL,No.J16X01547)	Mar-18
Reference20dBAttenuator	18N50W-20dB	13-Mar-16(CTTL, No.J16X01548)	Mar-18
Reference Probe EX3DV4	SN 7464	12-Sep-17(SPEAG,No.EX3-7464_Sep17)	Sep-18
DAE4	SN 549	13-Dec-16(SPEAG, No.DAE4-549_Dec16)	Dec -17
DAE4	SN 1524	13-Sep-17(SPEAG, No.DAE4-1524_Sep17)	Sep -18
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	27-Jun-17 (CTTL, No.J17X05858)	Jun-18
Network Analyzer E5071C	MY46110673	13-Jan-17 (CTTL, No.J17X00285)	Jan -18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: December 15, 2017

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