LTE750-FDD13_CH23230 Rear

Date: 4/22/2018

Electronics: DAE4 Sn1525

Medium: Head 750 MHz

Medium parameters used: f = 782 MHz; σ = 0.985 mho/m; εr = 55.91; ρ = 1000 kg/m^3

Ambient Temperature: 22.5ºC,   Liquid Temperature: 22.3ºC

Communication System: LTE750-FDD13 782 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(10.63,10.63,10.63)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.363 W/kg

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

Reference Value = 17.63 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 0.543 W/kg

SAR(1 g) = 0.296 W/kg; SAR(10 g) = 0.162 W/kg

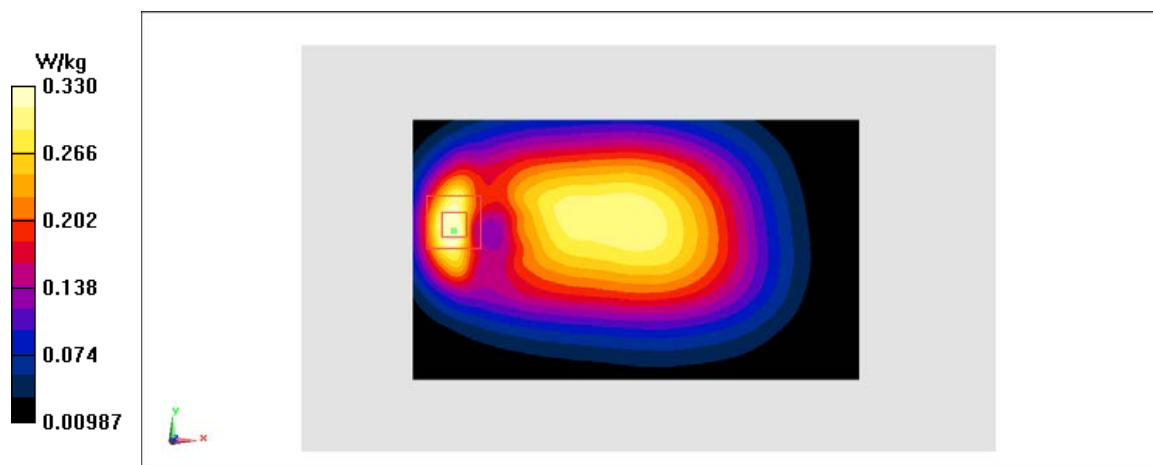Maximum value of SAR (measured) = 0.33 W/kg

Fig A.18

LTE1700-FDD66_CH132322 Left Cheek

Date: 4/24/2018

Electronics: DAE4 Sn1525

Medium: Head 1750 MHz

Medium parameters used: f = 782 MHz; σ = 0.457 mho/m; εr = 41.98; ρ = 1000 kg/m^3

Ambient Temperature: 22.5ºC,   Liquid Temperature: 22.3ºC

Communication System: LTE1700-FDD66 782 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(8.70,8.70,8.70)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.364 W/kg

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

Reference Value = 7.208 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 0.48 W/kg

SAR(1 g) = 0.303 W/kg; SAR(10 g) = 0.188 W/kg
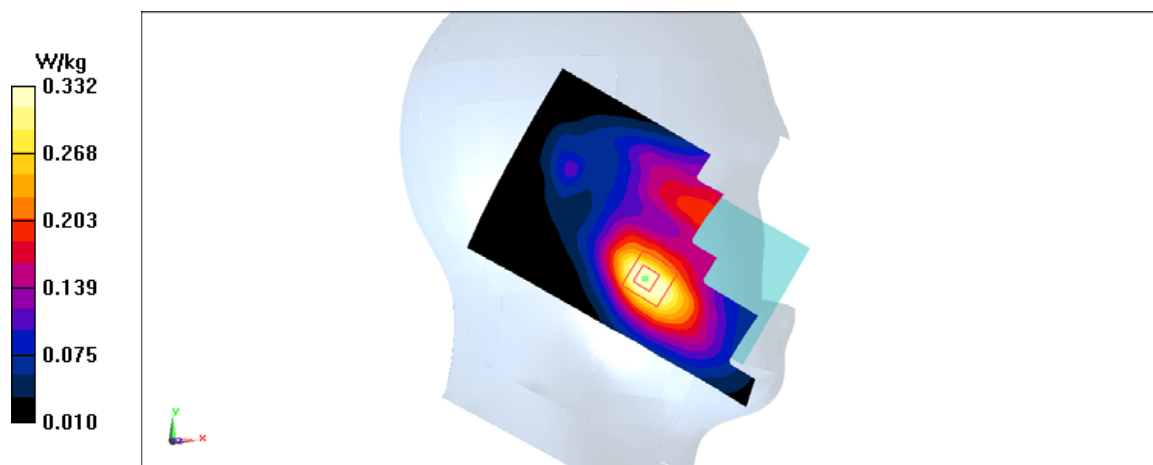
Maximum value of SAR (measured) = 0.332 W/kg

Fig A.19

LTE1700-FDD66_CH132072 Rear

Date: 4/24/2018

Electronics: DAE4 Sn1525

Medium: Head 1750 MHz

Medium parameters used: f = 782 MHz; σ = 0.565 mho/m; εr = 53.74; ρ = 1000 kg/m³

Ambient Temperature: 22.5ºC,   Liquid Temperature: 22.3ºC

Communication System: LTE1700-FDD66 782 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(8.60,8.60,8.60)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.851 W/kg

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

Reference Value = 8.728 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 1.22 W/kg

SAR(1 g) = 0.688 W/kg; SAR(10 g) = 0.378 W/kg

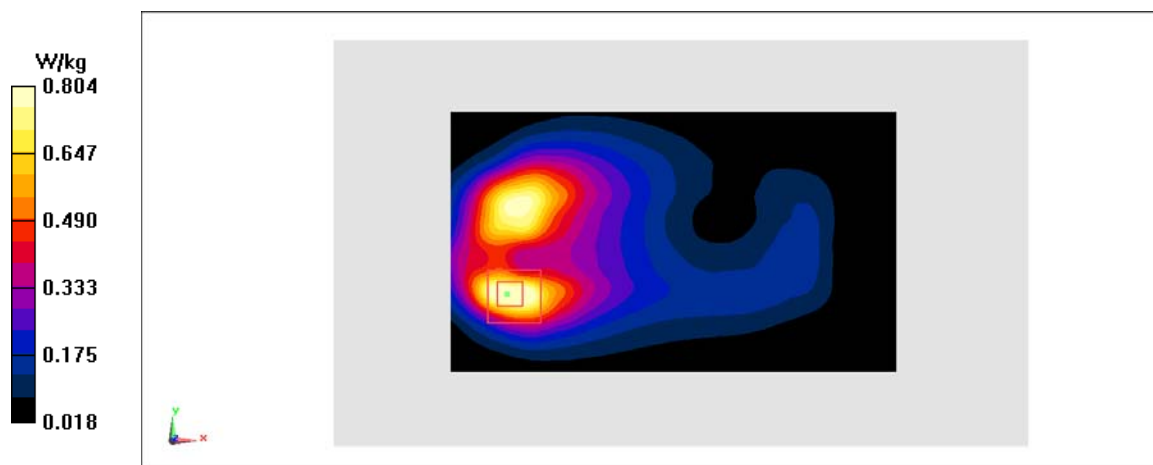Maximum value of SAR (measured) = 0.804 W/kg

Fig A.20

LTE700-FDD71_CH133222 Left Cheek

Date: 4/22/2018

Electronics: DAE4 Sn1525

Medium: Head 750 MHz

Medium parameters used: f = 782 MHz; σ = 0.918 mho/m; εr = 41.31; ρ = 1000 kg/m^3

Ambient Temperature: 22.5ºC,   Liquid Temperature: 22.3ºC

Communication System: LTE700-FDD71 782 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(10.57,10.57,10.57)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.303 W/kg

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

Reference Value = 7.081 V/m; Power Drift = -0.1 dB

Peak SAR (extrapolated) = 0.349 W/kg

SAR(1 g) = 0.272 W/kg; SAR(10 g) = 0.205 W/kg
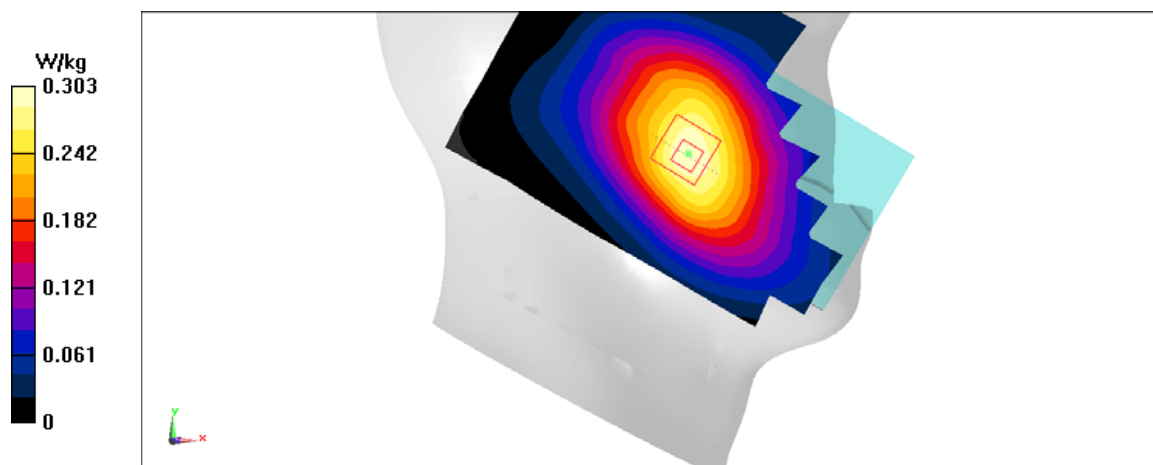
Maximum value of SAR (measured) = 0.301 W/kg

Fig A.21

LTE700-FDD71_CH133222 Rear

Date: 4/22/2018

Electronics: DAE4 Sn1525

Medium: Head 750 MHz

Medium parameters used: f = 782 MHz; σ = 0.985 mho/m; εr = 55.91; ρ = 1000 kg/m^3

Ambient Temperature: 22.5°C,   Liquid Temperature: 22.3°C

Communication System: LTE700-FDD71 782 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(10.63,10.63,10.63)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.43 W/kg

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

Reference Value = 20.64 V/m; Power Drift = -0.2 dB

Peak SAR (extrapolated) = 0.504 W/kg

SAR(1 g) = 0.388 W/kg; SAR(10 g) = 0.295 W/kg
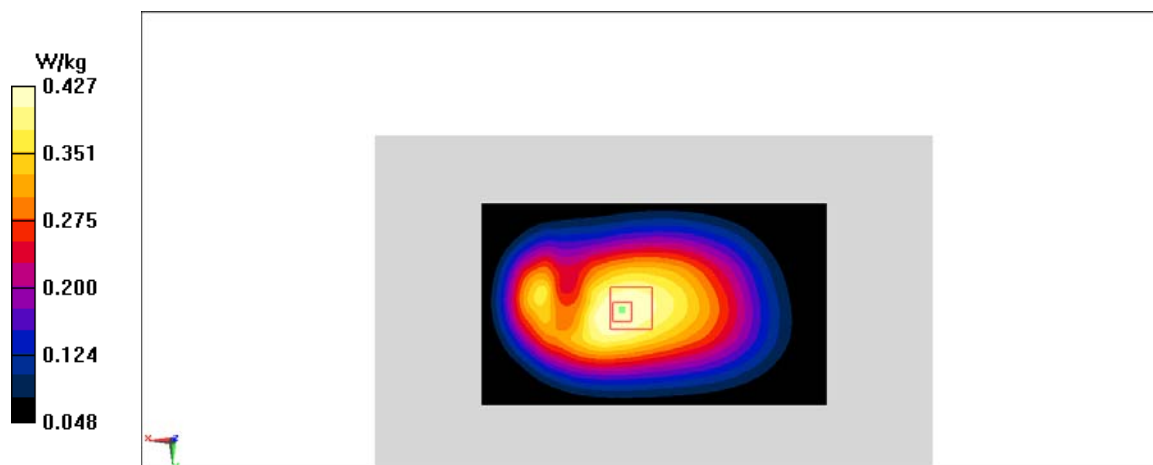
Maximum value of SAR (measured) = 0.427 W/kg

Fig A.22

WLAN2450_CH11 Left Cheek

Date: 4/26/2018

Electronics: DAE4 Sn1525

Medium: Head 2450 MHz

Medium parameters used: f = 2462 MHz; σ = 1.791 mho/m; εr = 38.98; ρ = 1000 kg/m³

Ambient Temperature: 22.5ºC,   Liquid Temperature: 22.3ºC

Communication System: WLAN2450 2462 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(7.89,7.89,7.89)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.597 W/kg

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

Reference Value = 9.145 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.02 W/kg

SAR(1 g) = 0.475 W/kg; SAR(10 g) = 0.219 W/kg

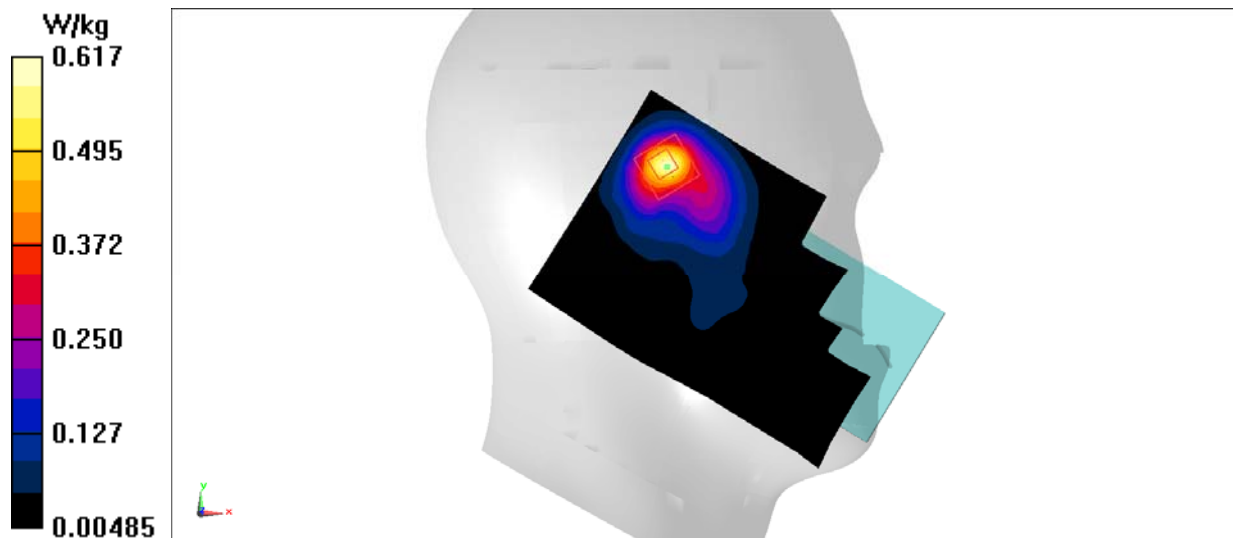Maximum value of SAR (measured) = 0.617 W/kg

Fig A.23

WLAN2450_CH11 Rear
Date: 4/26/2018
Electronics: DAE4 Sn1525
Medium: Head 2450 MHz
Medium parameters used: f = 2462 MHz; σ = 1.968 mho/m; εr = 53.48; ρ = 1000 kg/m³
Ambient Temperature: 22.5ºC,   Liquid Temperature: 22.3ºC
Communication System: WLAN2450 2462 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(8.09,8.09,8.09)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.231 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.187 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 0.357 W/kg
SAR(1 g) = 0.181 W/kg; SAR(10 g) = 0.0904 W/kg
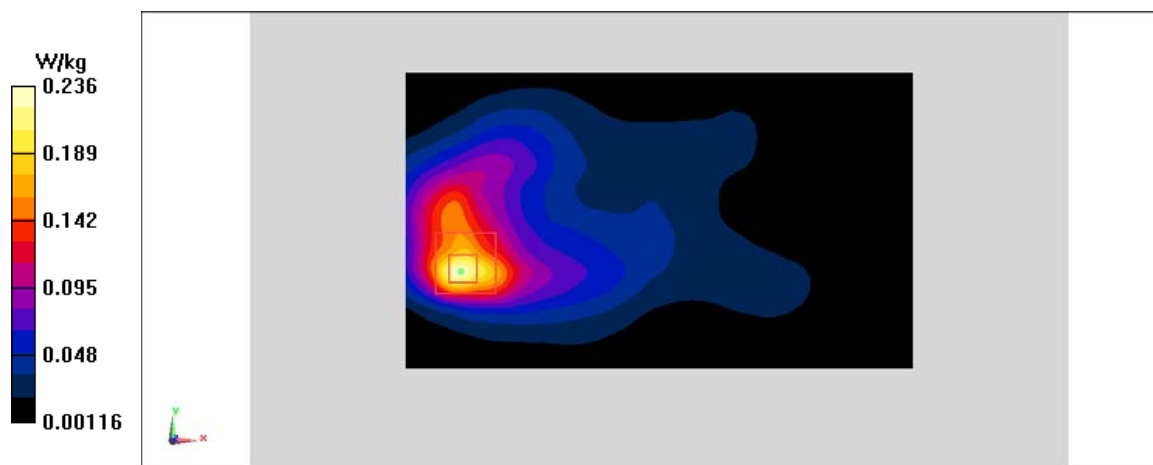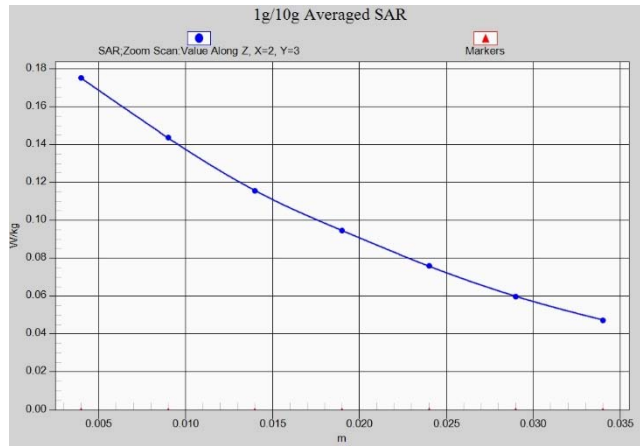Maximum value of SAR (measured) = 0.236 W/kg

Fig A.24

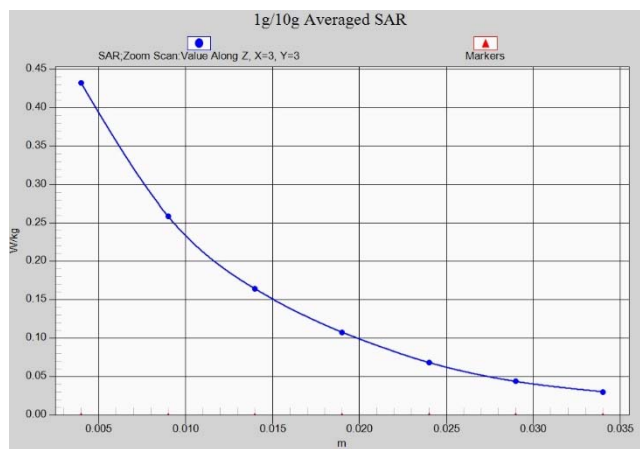**Fig.A.1- 1 Z-Scan at power reference point (GSM850)**

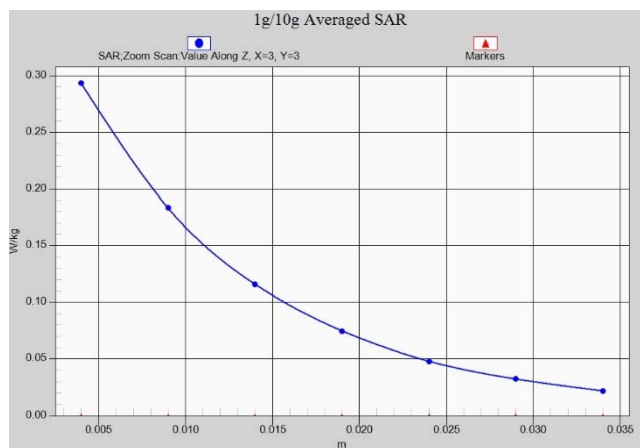**Fig.A.1- 2 Z-Scan at power reference point (GSM850)**

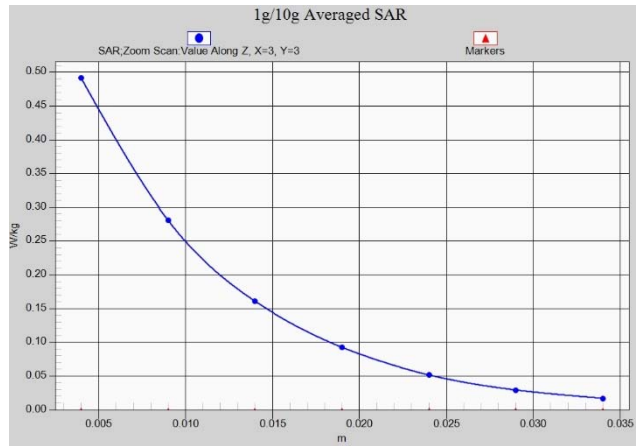**Fig.A.1- 3 Z-Scan at power reference point (PCS1900)**

Fig.A.1- 4 Z-Scan at power reference point (PCS1900)

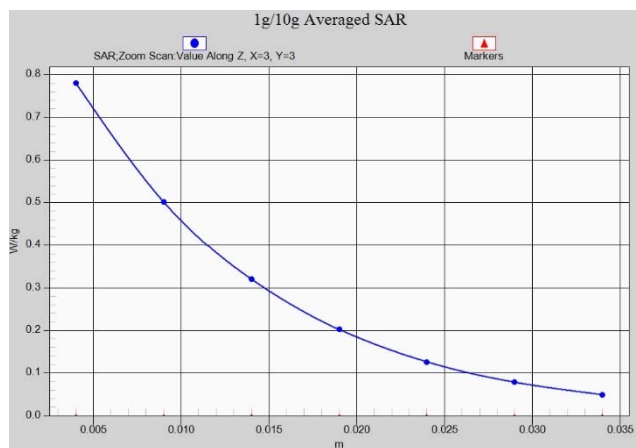**Fig.A.1- 5 Z-Scan at power reference point (W1900)**

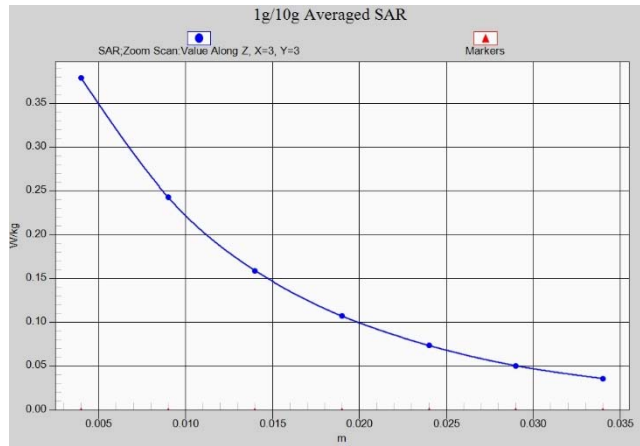**Fig.A.1- 6 Z-Scan at power reference point (W1900)**

Fig.A.1- 7 Z-Scan at power reference point (W1700)
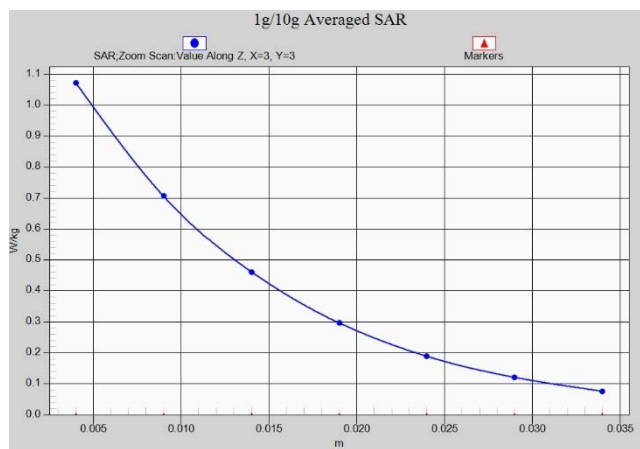
Fig.A.1- 8 Z-Scan at power reference point (W1700)
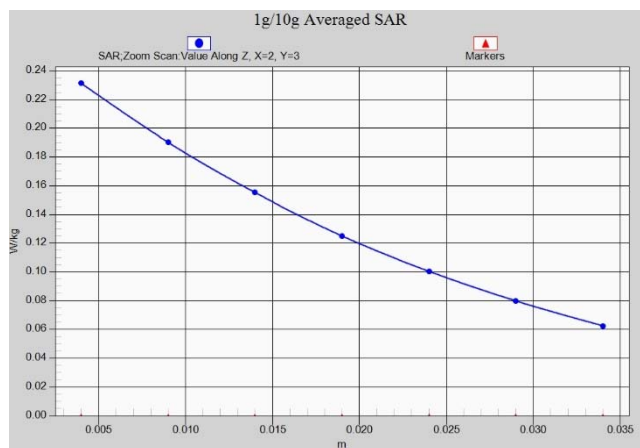
Fig.A.1- 9 Z-Scan at power reference point (W850)

Fig.A.1- 10 Z-Scan at power reference point (W850)

Fig.A.1- 11 Z-Scan at power reference point (LTE band2)

Fig.A.1- 12 Z-Scan at power reference point (LTE band2)

Fig.A.1- 13 Z-Scan at power reference point (LTE band5)

Fig.A.1- 14 Z-Scan at power reference point (LTE band5)

Fig.A.1- 15 Z-Scan at power reference point (LTE band12)
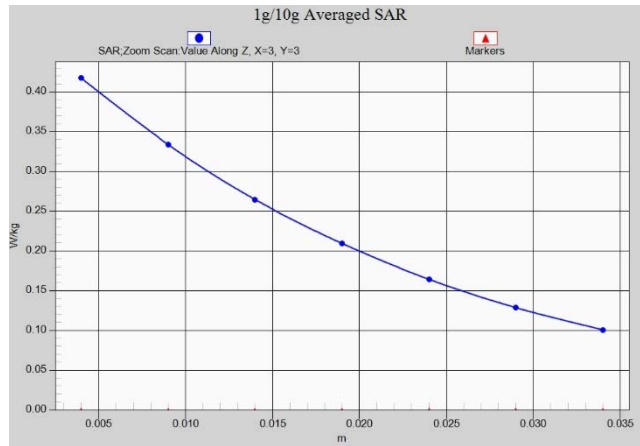
Fig.A.1- 16 Z-Scan at power reference point (LTE band12)
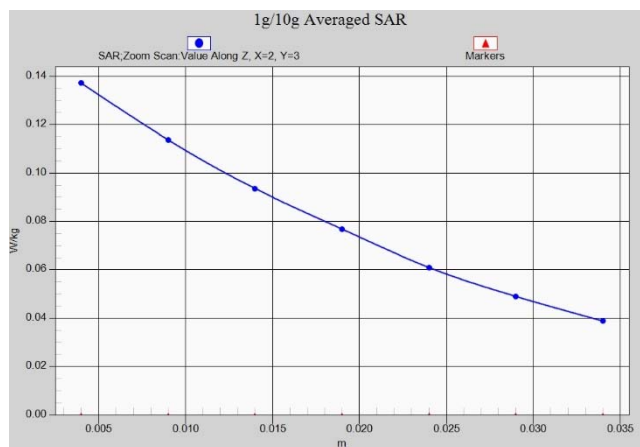
Fig.A.1- 17 Z-Scan at power reference point (LTE band13)
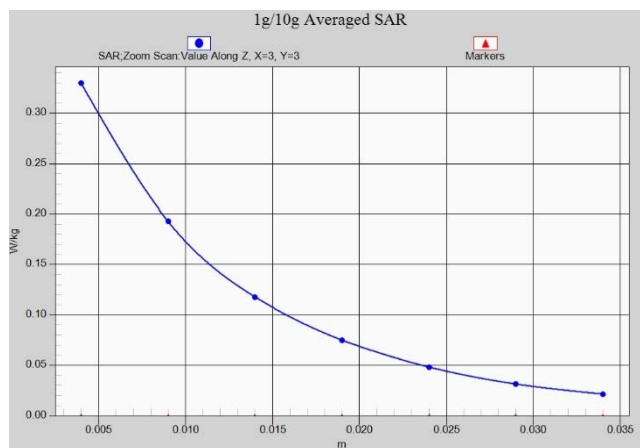
Fig.A.1- 18 Z-Scan at power reference point (LTE band13)
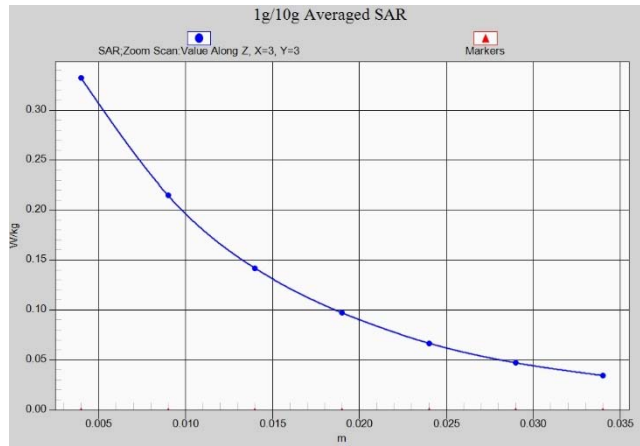
Fig.A.1- 19 Z-Scan at power reference point (LTE band66)
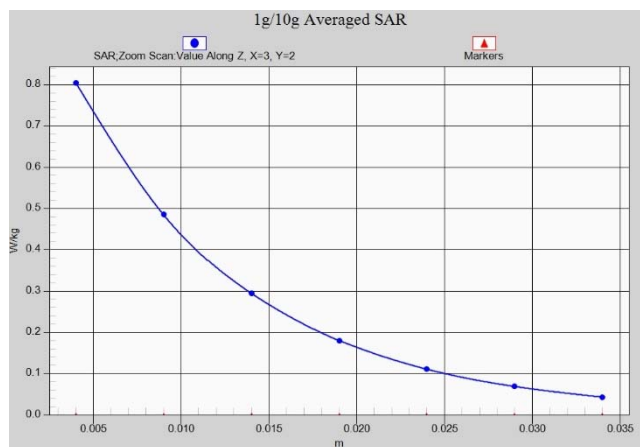
Fig.A.1- 20 Z-Scan at power reference point (LTE band66)
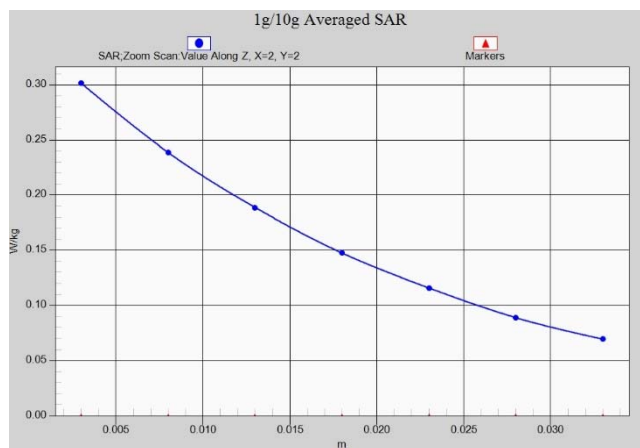
Fig.A.1- 21 Z-Scan at power reference point (LTE band71)
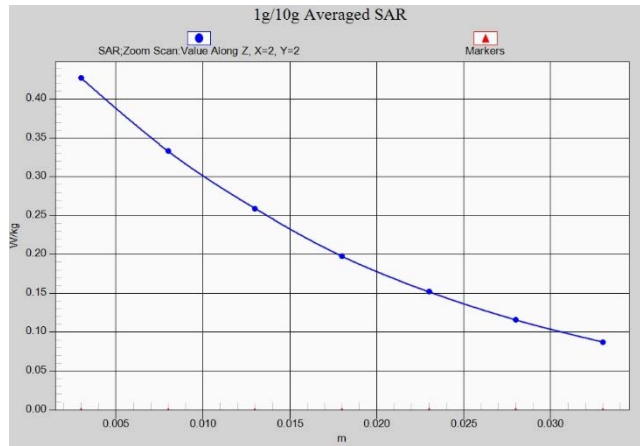
Fig.A.1- 22 Z-Scan at power reference point (LTE band71)
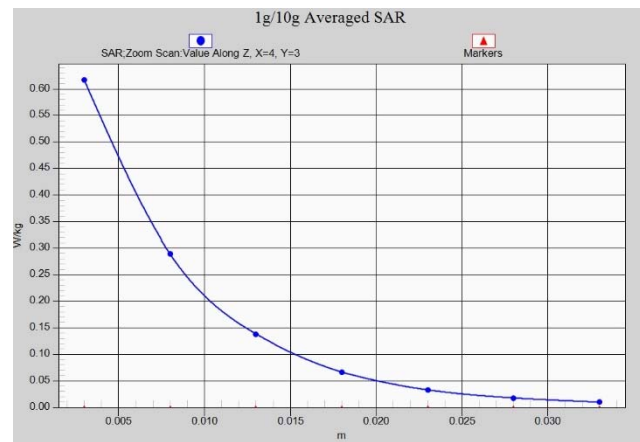
Fig.A.1- 23 Z-Scan at power reference point (Wifi2450)

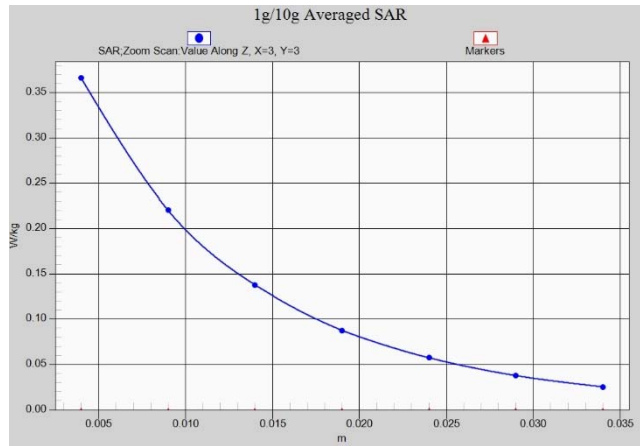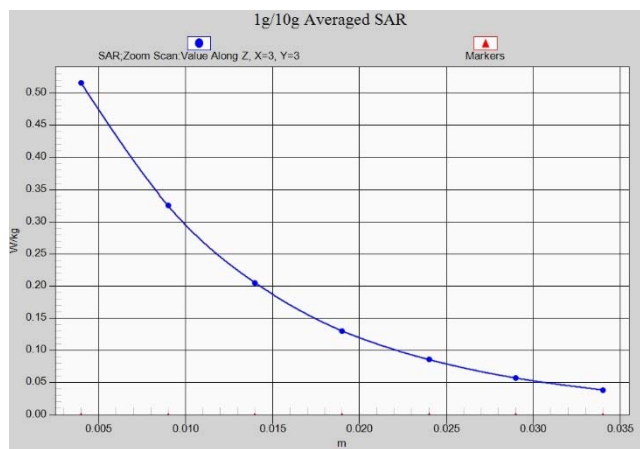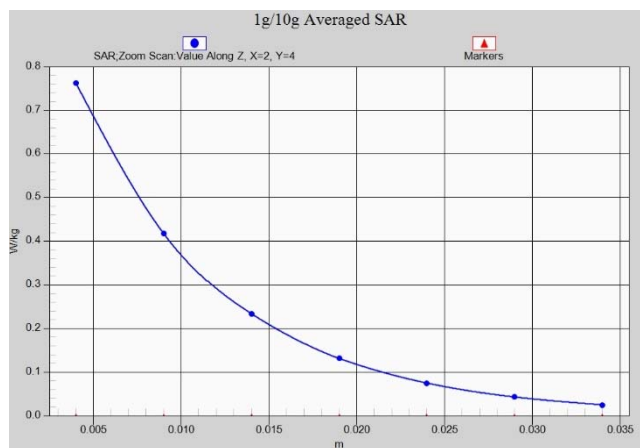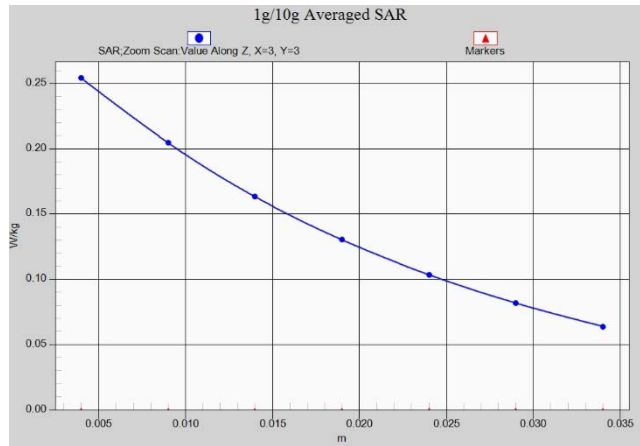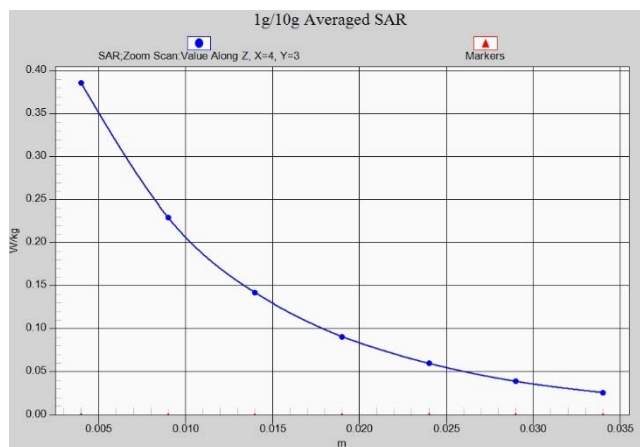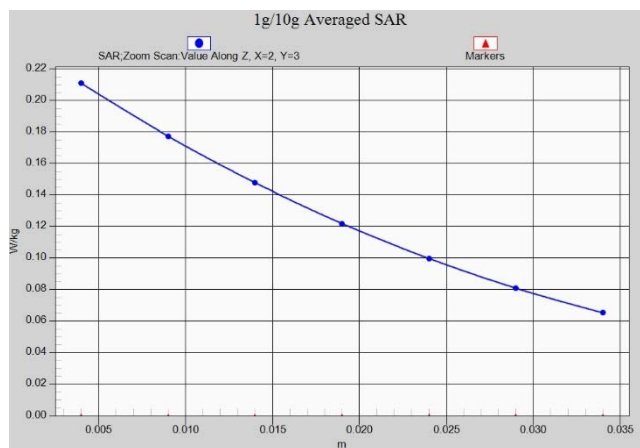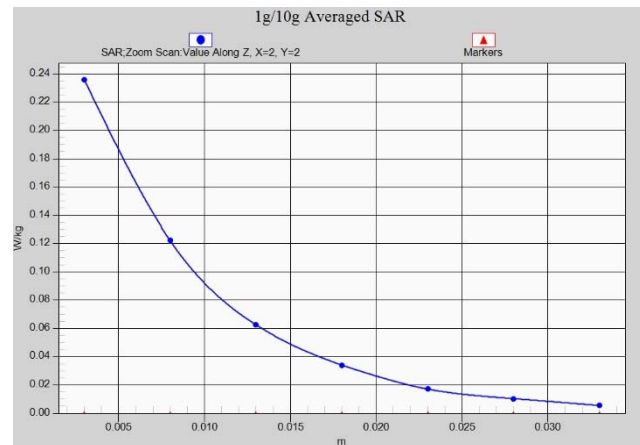**Fig.A.1- 24 Z-Scan at power reference point (Wifi2450)**

ANNEX B   System Verification Results

750 MHz

Date: 4/22/2018
Electronics: DAE4 Sn1525
Medium: Head 750 MHz
Medium parameters used: f = 750 MHz; σ =0.888 mho/m; ε_r = 41.35; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.3°C
Communication System: CW Frequency: 750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(10.57,10.57,10.57)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
   Reference Value = 59.86 V/m; Power Drift = -0.08
   Fast SAR: SAR(1 g) = 2.08 W/kg; SAR(10 g) = 1.35 W/kg
Maximum value of SAR (interpolated) = 2.79 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =59.86 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 3.21 W/kg
SAR(1 g) = 2.09 W/kg; SAR(10 g) = 1.38 W/kg
Maximum value of SAR (measured) = 2.82 W/kg
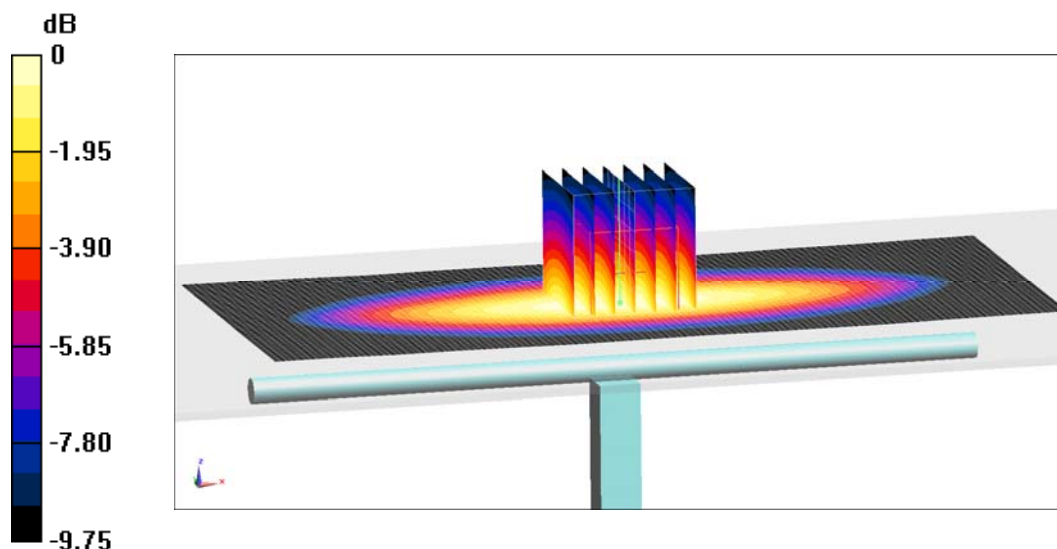
0 dB = 2.82 W/kg = 4.5 dB W/kg
Fig.B.1 validation 750 MHz 250mW

750 MHz

Date: 4/22/2018
Electronics: DAE4 Sn1525
Medium: Body 750 MHz
Medium parameters used: f = 750 MHz; σ =0.955 mho/m; ε_r = 55.95; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC
Communication System: CW Frequency: 750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(10.63,10.63,10.63)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 57.74 V/m; Power Drift = 0.05
Fast SAR: SAR(1 g) = 2.14 W/kg; SAR(10 g) = 1.4 W/kg
Maximum value of SAR (interpolated) = 3.31 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =57.74 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 3.33 W/kg
SAR(1 g) = 2.14 W/kg; SAR(10 g) = 1.4 W/kg
Maximum value of SAR (measured) = 2.9 W/kg
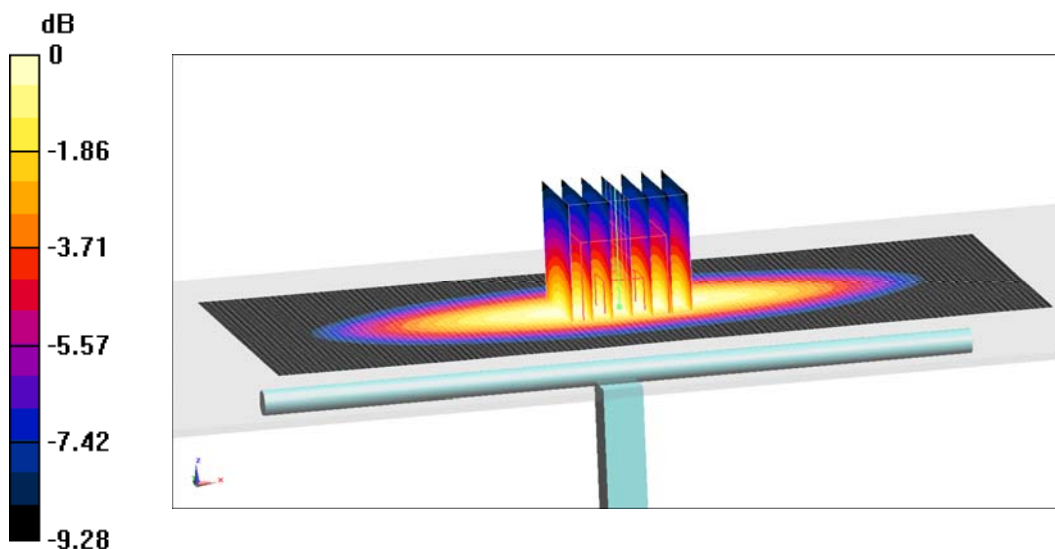
0 dB = 2.9 W/kg = 4.62 dB W/kg

Fig.B.2 validation 750 MHz 250mW

835 MHz

Date: 4/23/2018
Electronics: DAE4 Sn1525
Medium: Head 835 MHz
Medium parameters used: f = 835 MHz; σ =0.892 mho/m; ε_r = 41.1; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC
Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(10.28,10.28,10.28)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

    Reference Value = 63.19 V/m; Power Drift = 0.06

    Fast SAR: SAR(1 g) = 2.32 W/kg; SAR(10 g) = 1.49 W/kg

Maximum value of SAR (interpolated) = 3.74 W/kg

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

    Reference Value =63.19 V/m; Power Drift = 0.06 dB

    Peak SAR (extrapolated) = 4.04 W/kg

    SAR(1 g) = 2.31 W/kg; SAR(10 g) = 1.52 W/kg

Maximum value of SAR (measured) = 3.65 W/kg
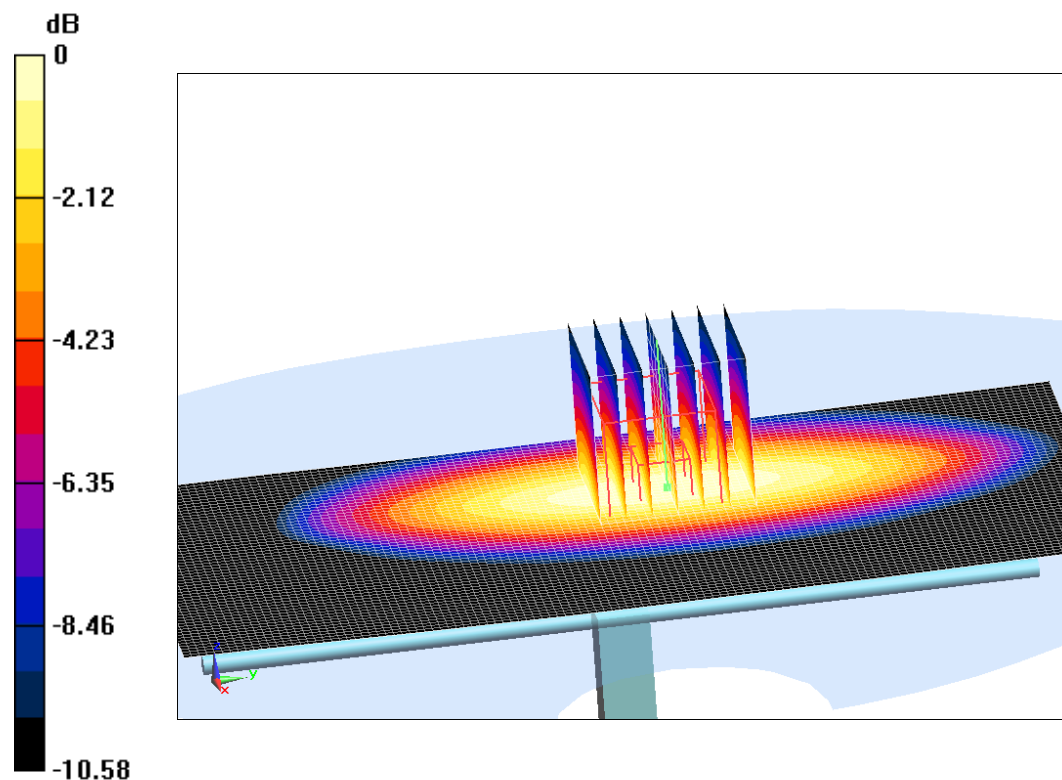
0 dB = 3.65 W/kg = 5.62 dB W/kg

Fig.B.3 validation 835 MHz 250mW

835 MHz

Date: 4/23/2018
Electronics: DAE4 Sn1525
Medium: Body 835 MHz
Medium parameters used: f = 835 MHz; σ =0.977 mho/m; ε_r = 54.29; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC
Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(10.21,10.21,10.21)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 58.93 V/m; Power Drift = -0.04
Fast SAR: SAR(1 g) = 2.34 W/kg; SAR(10 g) = 1.53 W/kg
Maximum value of SAR (interpolated) = 3.48 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =58.93 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 3.67 W/kg
SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.55 W/kg
Maximum value of SAR (measured) = 3.2 W/kg
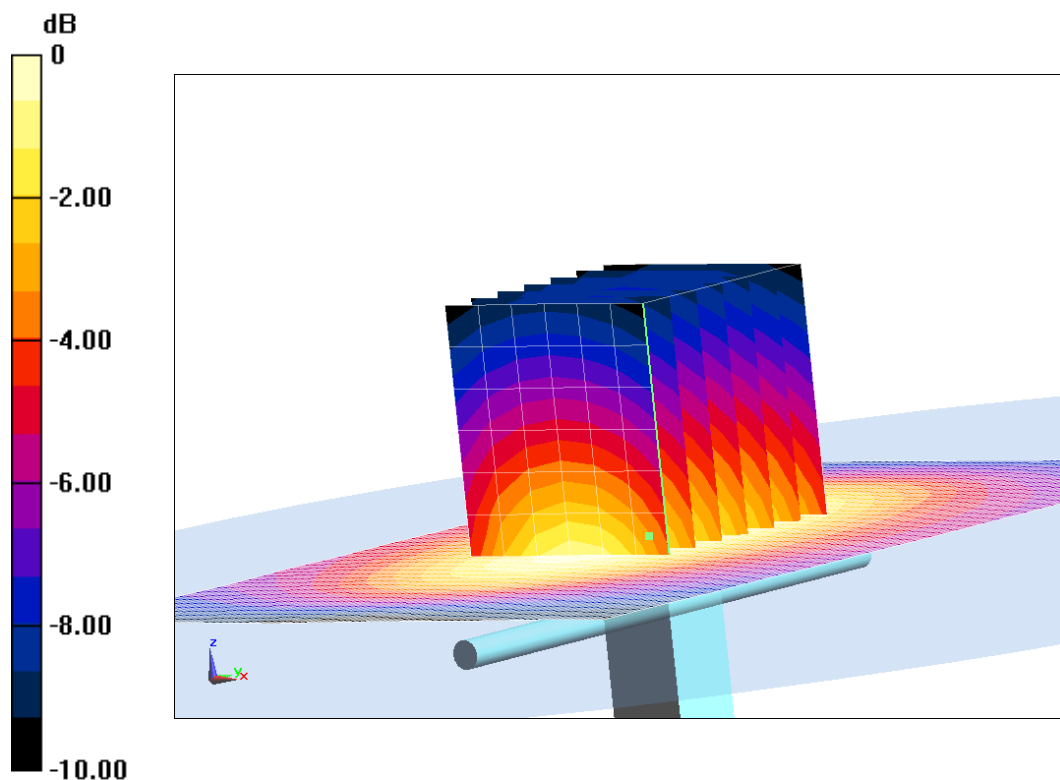
0 dB = 3.2 W/kg = 5.05 dB W/kg

Fig.B.4 validation 835 MHz 250mW

1750 MHz

Date: 4/24/2018

Electronics: DAE4 Sn1525

Medium: Head 1750 MHz

Medium parameters used: f = 1750 MHz; σ =1.377 mho/m; ε_r = 40.82; ρ = 1000 kg/m³

Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC

Communication System: CW Frequency: 1750 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(8.70,8.70,8.70)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 107.9 V/m; Power Drift = -0.03

Fast SAR: SAR(1 g) = 9.36 W/kg; SAR(10 g) = 4.76 W/kg

Maximum value of SAR (interpolated) = 14.77 W/kg

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

Reference Value =107.9 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 17.99 W/kg

SAR(1 g) = 9.19 W/kg; SAR(10 g) = 4.86 W/kg

Maximum value of SAR (measured) = 14.7 W/kg
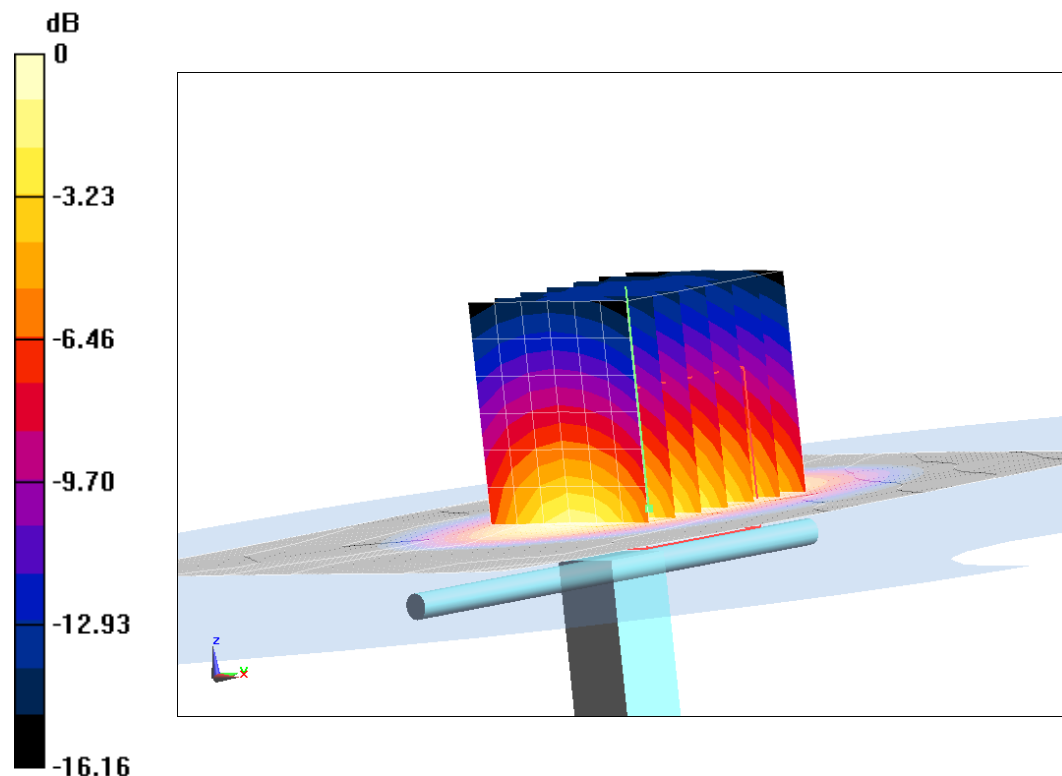
0 dB = 14.7 W/kg = 11.67 dB W/kg

Fig.B.5 validation 1750 MHz 250mW

1750 MHz

Date: 4/24/2018

Electronics: DAE4 Sn1525

Medium: Body 1750 MHz

Medium parameters used: f = 1750 MHz; σ =1.485 mho/m; ε_r = 52.58; ρ = 1000 kg/m^3

Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC

Communication System: CW Frequency: 1750 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(8.60,8.60,8.60)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 99.82 V/m; Power Drift = -0.07

Fast SAR: SAR(1 g) = 9.26 W/kg; SAR(10 g) = 4.92 W/kg

Maximum value of SAR (interpolated) = 16.45 W/kg

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

Reference Value =99.82 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 16.22 W/kg

SAR(1 g) = 9.43 W/kg; SAR(10 g) = 4.93 W/kg

Maximum value of SAR (measured) = 13.57 W/kg
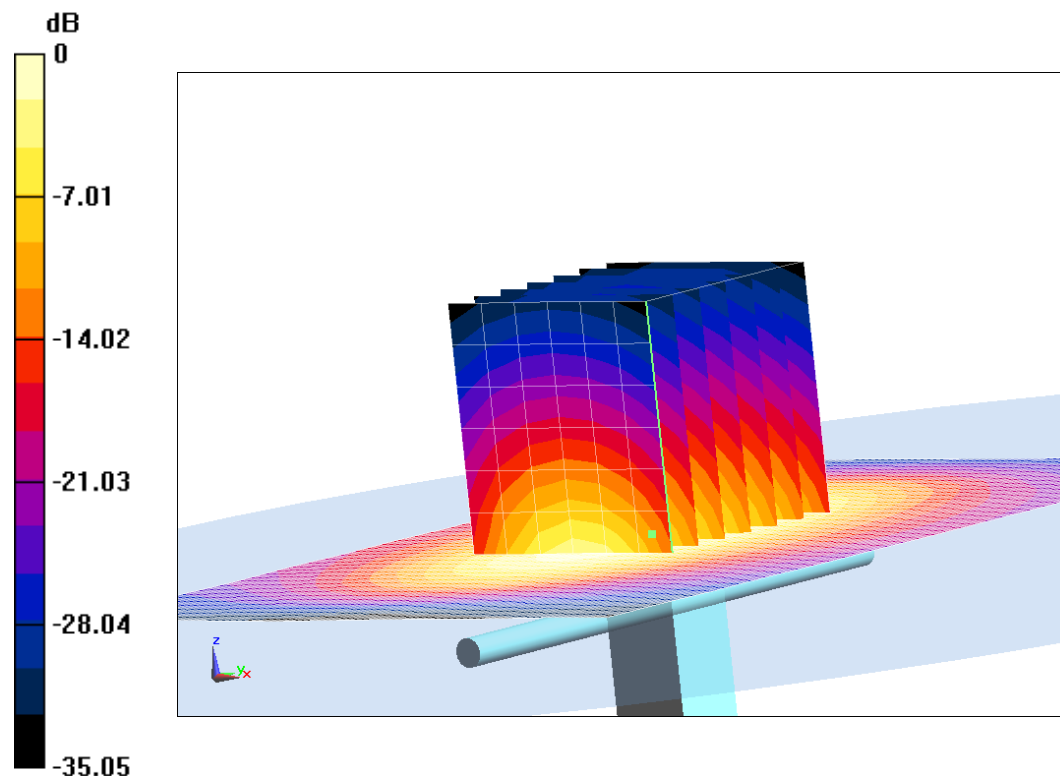
0 dB = 13.57 W/kg = 11.33 dB W/kg

Fig.B.6 validation 1750 MHz 250mW

1900 MHz

Date: 4/25/2018

Electronics: DAE4 Sn1525

Medium: Head 1900 MHz

Medium parameters used: f = 1900 MHz; σ =1.428 mho/m; ε_r = 39.99; ρ = 1000 kg/m^3

Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC

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

Probe: EX3DV4 – SN7464 ConvF(8.39,8.39,8.39)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

    Reference Value = 107.13 V/m; Power Drift = -0.02

    Fast SAR: SAR(1 g) = 9.97 W/kg; SAR(10 g) = 5.19 W/kg

Maximum value of SAR (interpolated) = 14.6 W/kg

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

    Reference Value =107.13 V/m; Power Drift = -0.02 dB

    Peak SAR (extrapolated) = 18.63 W/kg

    SAR(1 g) = 10 W/kg; SAR(10 g) = 5.33 W/kg

Maximum value of SAR (measured) = 14.78 W/kg
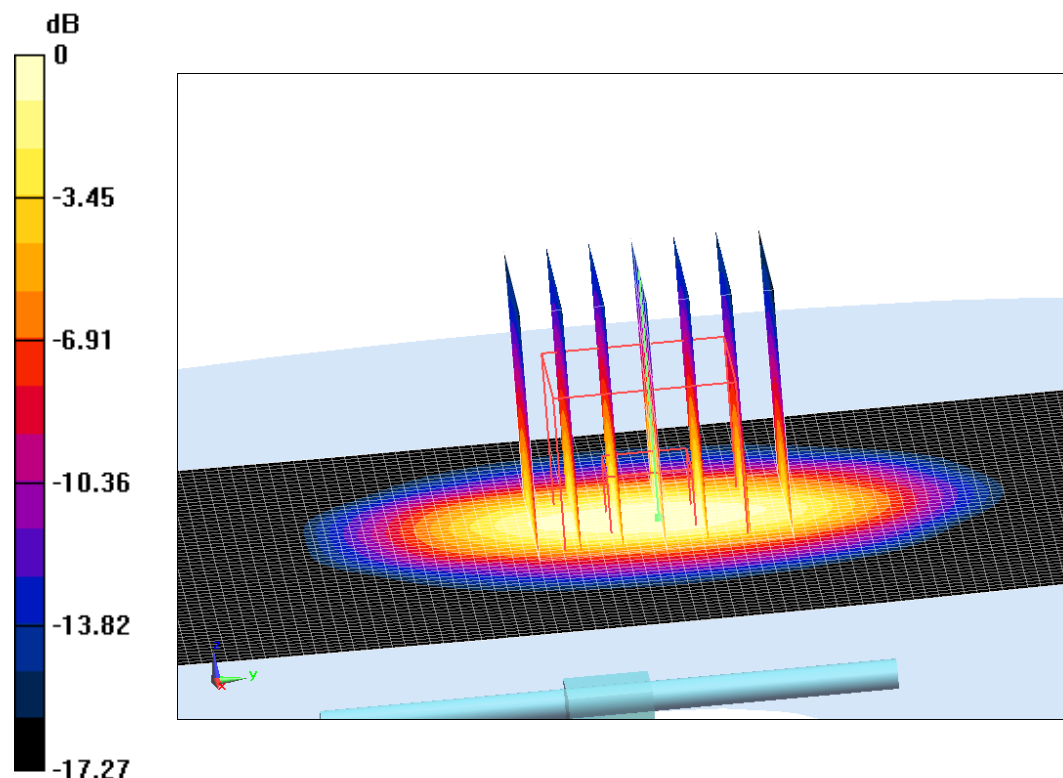
0 dB = 14.78 W/kg = 11.7 dB W/kg

Fig.B.7 validation 1900 MHz 250mW

1900 MHz

Date: 4/25/2018
Electronics: DAE4 Sn1525
Medium: Body 1900 MHz
Medium parameters used: f = 1900 MHz; σ =1.51 mho/m; ε_r = 53.11; ρ = 1000 kg/m³
Ambient Temperature: 22.5°C Liquid Temperature: 22.3°C
Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(8.32,8.32,8.32)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
   Reference Value = 100.49 V/m; Power Drift = 0.01
   Fast SAR: SAR(1 g) = 10.13 W/kg; SAR(10 g) = 5.4 W/kg
Maximum value of SAR (interpolated) = 17.56 W/kg

   System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
   Reference Value =100.49 V/m; Power Drift = 0.01 dB
   Peak SAR (extrapolated) = 17.63 W/kg
   SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.35 W/kg
Maximum value of SAR (measured) = 14.28 W/kg
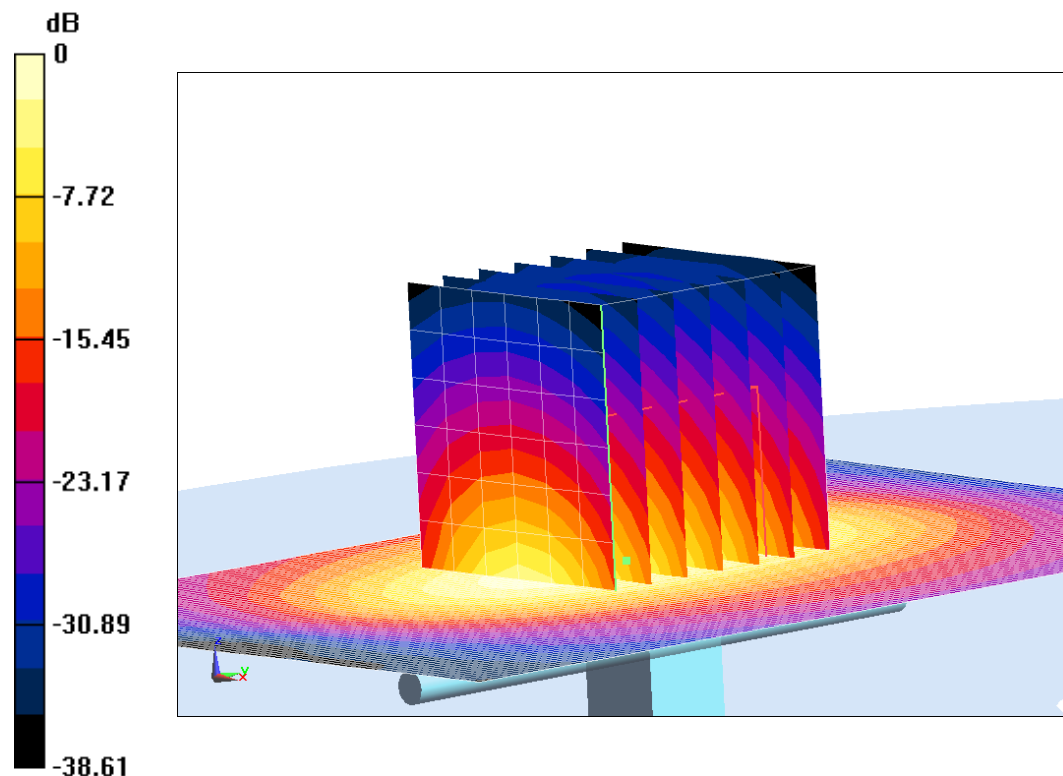
0 dB = 14.28 W/kg = 11.55 dB W/kg

Fig.B.8 validation 1900 MHz 250mW

2450 MHz

Date: 4/26/2018
Electronics: DAE4 Sn1525
Medium: Head 2450 MHz
Medium parameters used: f = 2450 MHz; σ =1.78 mho/m; ε_r = 38.99; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(7.89,7.89,7.89)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000
   mm
   Reference Value = 112.6 V/m; Power Drift = 0.04
   Fast SAR: SAR(1 g) = 12.87 W/kg; SAR(10 g) = 6.1 W/kg
Maximum value of SAR (interpolated) = 20.99 W/kg

   System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm,
   dy=5mm, dz=5mm
   Reference Value =112.6 V/m; Power Drift = 0.04 dB
   Peak SAR (extrapolated) = 27.12 W/kg
   SAR(1 g) = 12.82 W/kg; SAR(10 g) = 6.25 W/kg
Maximum value of SAR (measured) = 21.47 W/kg

0 dB = 21.47 W/kg = 13.32 dB W/kg

Fig.B.9 validation 2450 MHz 250mW

2450 MHz

Date: 4/26/2018
Electronics: DAE4 Sn1525
Medium: Body 2450 MHz
Medium parameters used: f = 2450 MHz; σ =1.957 mho/m; ε_r = 53.49; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(8.09,8.09,8.09)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
   Reference Value = 102.81 V/m; Power Drift = 0.05
   Fast SAR: SAR(1 g) = 12.56 W/kg; SAR(10 g) = 6.06 W/kg
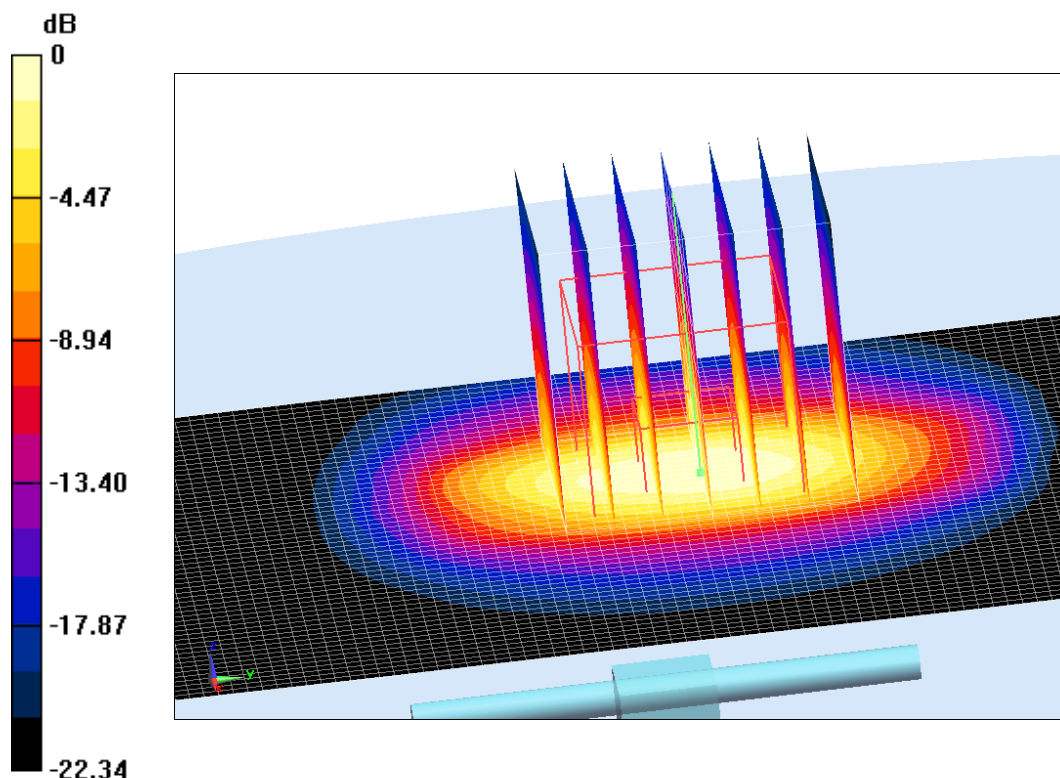Maximum value of SAR (interpolated) = 25.14 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
   Reference Value =102.81 V/m; Power Drift = 0.05 dB
   Peak SAR (extrapolated) = 25.79 W/kg
   SAR(1 g) = 12.38 W/kg; SAR(10 g) = 5.92 W/kg
Maximum value of SAR (measured) = 19.7 W/kg
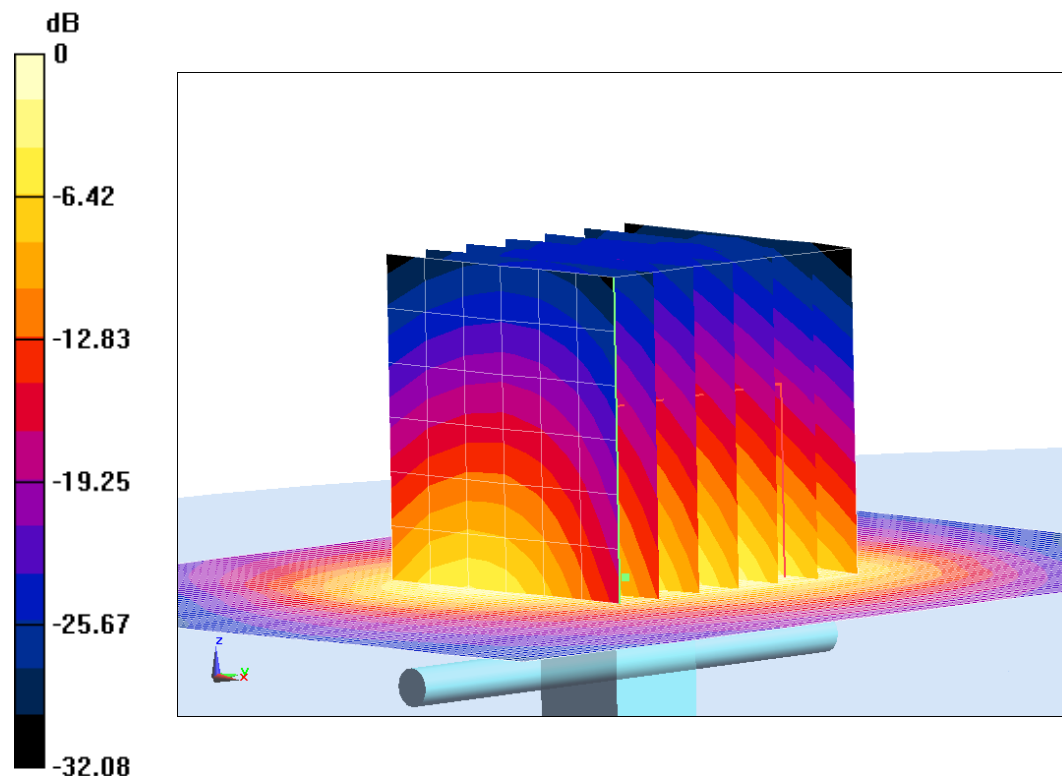
0 dB = 19.7 W/kg = 12.94 dB W/kg

Fig.B.10 validation 2450 MHz 250mW

The SAR system verification must be required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR.

Table B.1 Comparison between area scan and zoom scan for system verification

Date	Band	Position	Area scan (1g)	Zoom scan (1g)	Drift (%)
2018-4-22	750	Head	2.08	2.09	-0.48
	750	Body	2.14	2.14	0.00
2018-4-23	835	Head	2.32	2.31	0.43
	835	Body	2.34	2.39	-2.09
2018-4-24	1750	Head	9.36	9.19	1.85
	1750	Body	9.26	9.43	-1.80
2018-4-25	1900	Head	9.97	10	-0.30
	1900	Body	10.13	10.2	-0.69
2018-4-26	2450	Head	12.87	12.82	0.39
	2450	Body	12.56	12.38	1.45

ANNEX C   SAR Measurement Setup

C.1 Measurement Set-up

The Dasy4 or DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:
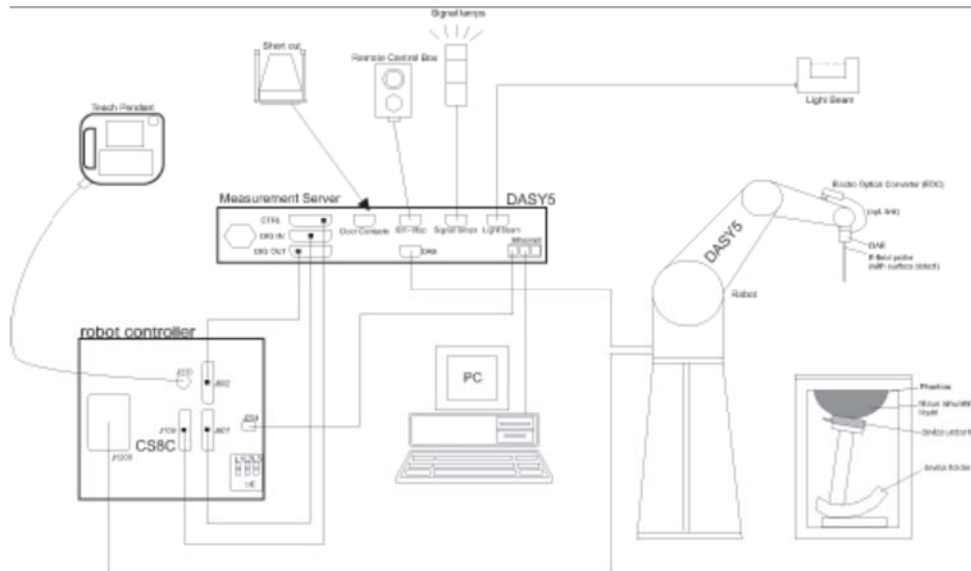
Picture C.1 SAR Lab Test Measurement Set-up

- 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 DASY4 or 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 Dasy4 or 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 DASY4 or DASY5 software reads the reflection durning a software approach and looks for the maximum using 2nd ord curve fitting. The approach is stopped at reaching the maximum.

Probe Specifications:

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

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 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 inn 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^2.

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:

Δt = Exposure time (30 seconds),

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

ΔT = Temperature increase due to RF exposure.

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

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

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 (DASY4: RX90XL; 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 4

Picture C.6 DASY 5

C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (dasy4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 128MB), RAM (DASY4: 64 MB, 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 broad, which is directly connected to the PC/104 bus of the CPU broad.

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.7 Server for DASY 4

Picture C.8 Server for DASY 5