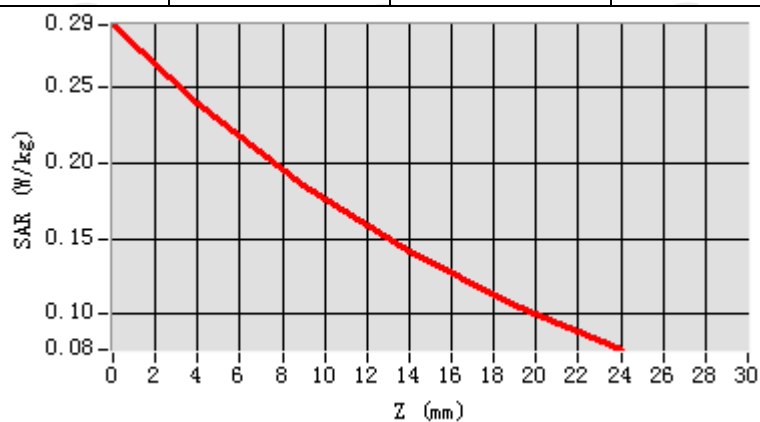
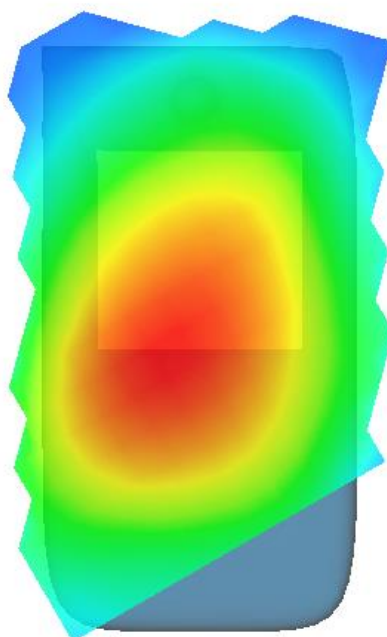


Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2913	0.2393	0.1850	0.1411	0.1058



Hot spot position



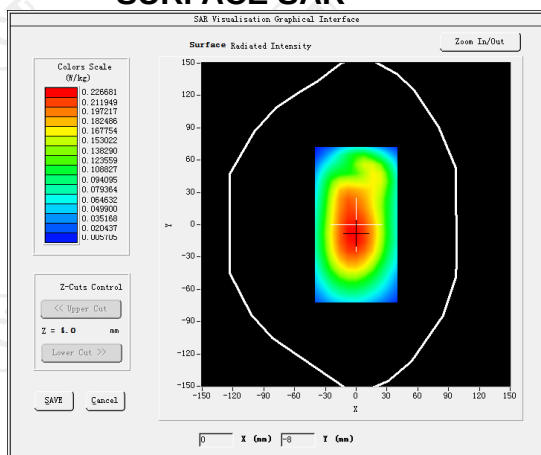
MEASUREMENT 2

Low Band SAR (Channel 20450):

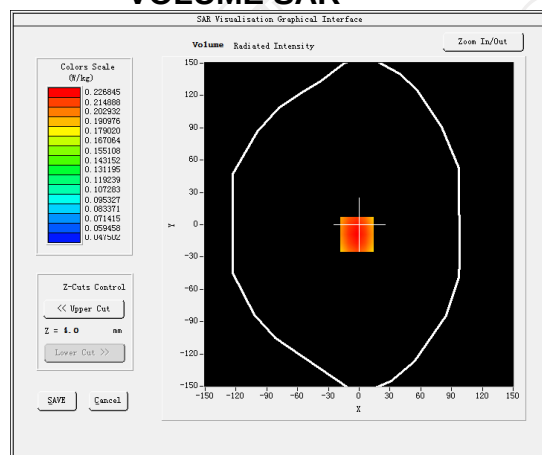
Date: 08/16/2024

Frequency (MHz)	829.000000
Relative permittivity (real part)	41.417760
Relative permittivity (imaginary part)	18.129852
Conductivity (S/m)	0.874923
Variation (%)	3.710000
Crest Factor	1.0
Probe Conversion factor	1.80
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back-open(10mm)
Band	LTE band 5(1 RB#0)

SURFACE SAR

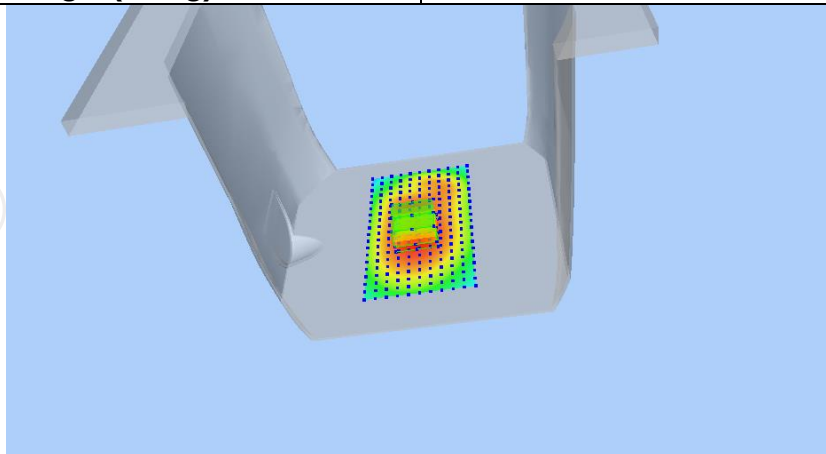


VOLUME SAR

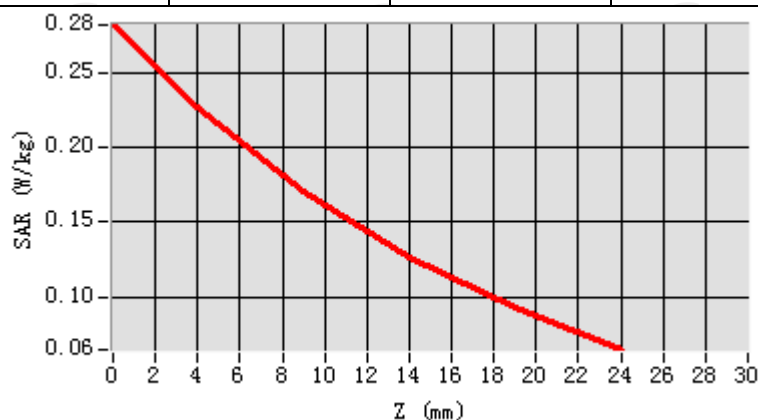


Maximum location: X=-2.00, Y=-9.00 SAR Peak: 0.28 W/kg

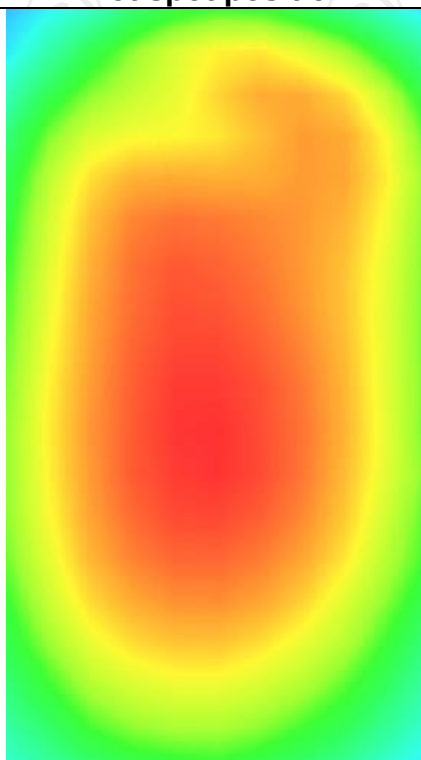
SAR 10g (W/Kg)	0.171264
SAR 1g (W/Kg)	0.230514



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2817	0.2268	0.1708	0.1268	0.0924



Hot spot position



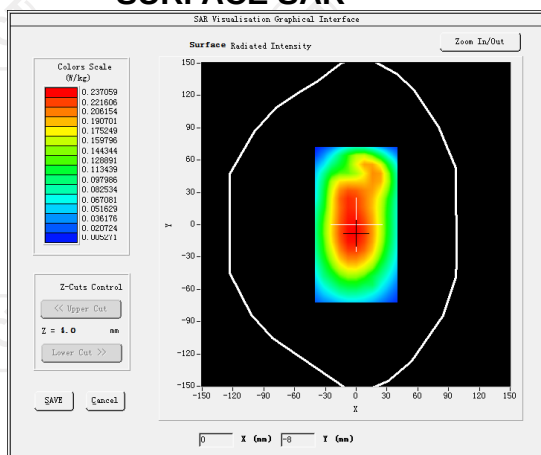
MEASUREMENT 3

Low Band SAR (Channel 20450):

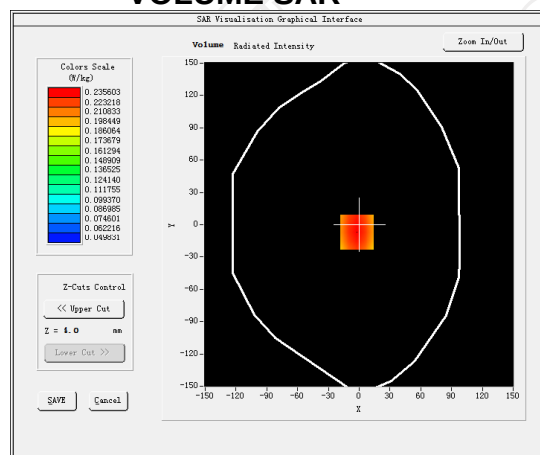
Date: 08/16/2024

Frequency (MHz)	829.000000
Relative permittivity (real part)	41.417760
Relative permittivity (imaginary part)	18.129852
Conductivity (S/m)	0.874923
Variation (%)	0.910000
Crest Factor	1.0
Probe Conversion factor	1.80
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back-open((hotspot 10mm)
Band	LTE band 5(1 RB#0)

SURFACE SAR

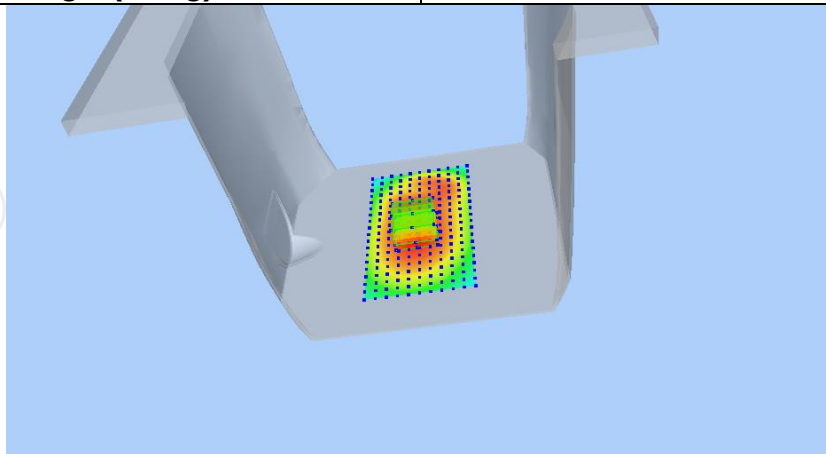


VOLUME SAR

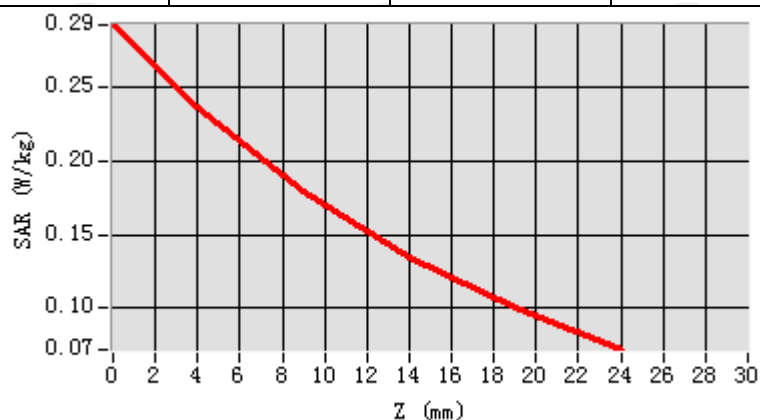


Maximum location: X=-2.00, Y=-7.00 SAR Peak: 0.29 W/kg

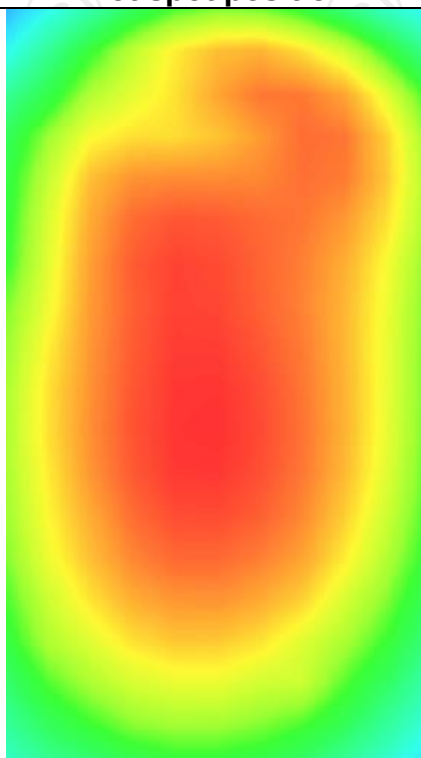
SAR 10g (W/Kg)	0.175612
SAR 1g (W/Kg)	0.242157



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2917	0.2356	0.1788	0.1345	0.1000



Hot spot position



LTE Band 7

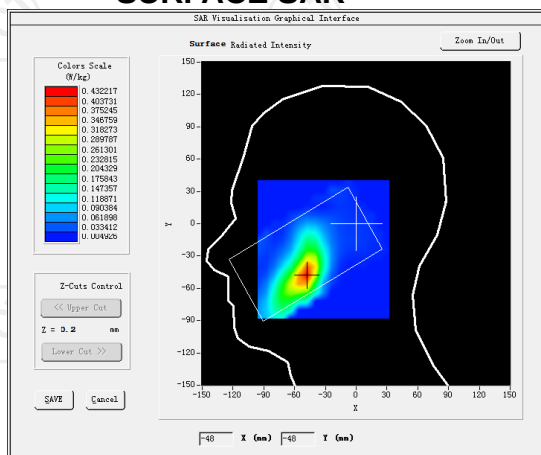
MEASUREMENT 1

High Band SAR (Channel 21350):

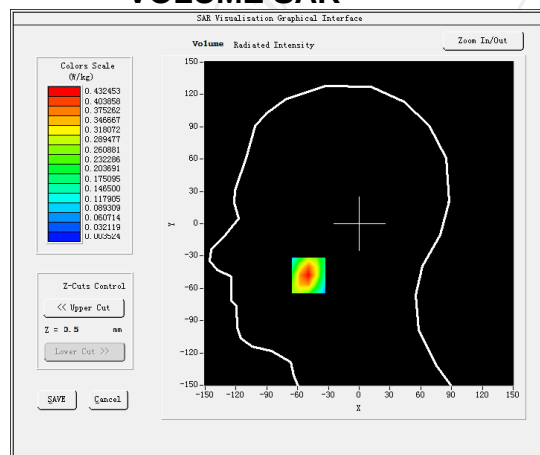
Date: 08/27/2024

Frequency (MHz)	2560.000000
Relative permittivity (real part)	38.853477
Relative permittivity (imaginary part)	13.545489
Conductivity (S/m)	1.922567
Variation (%)	3.180000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	<u>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 7(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



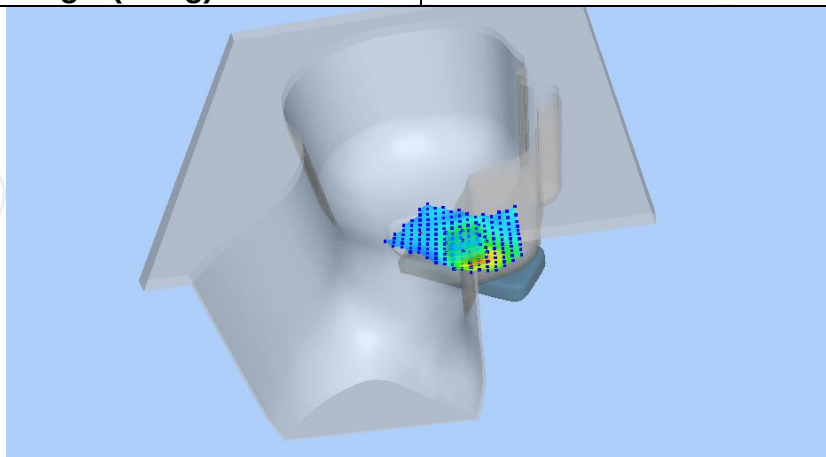
Maximum location: X=-49.00, Y=-48.00 SAR Peak: 0.88 W/kg

SAR 10g (W/Kg)

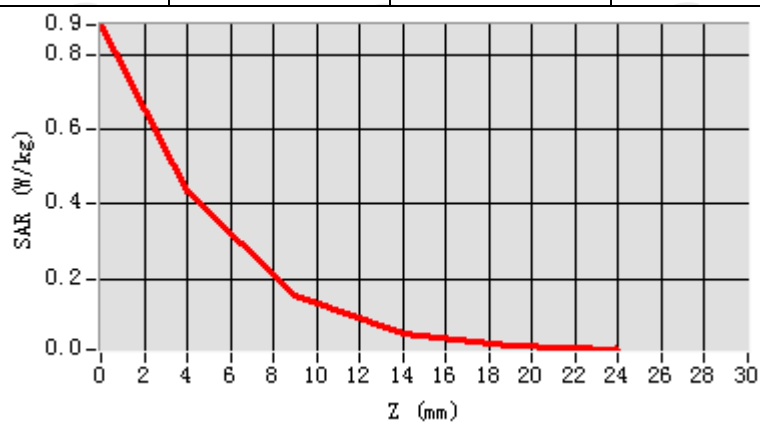
0.161547

SAR 1g (W/Kg)

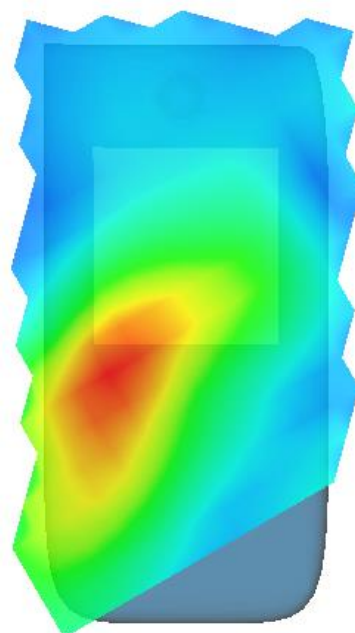
0.427914



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.8804	0.4325	0.1545	0.0508	0.0199



Hot spot position



MEASUREMENT 2

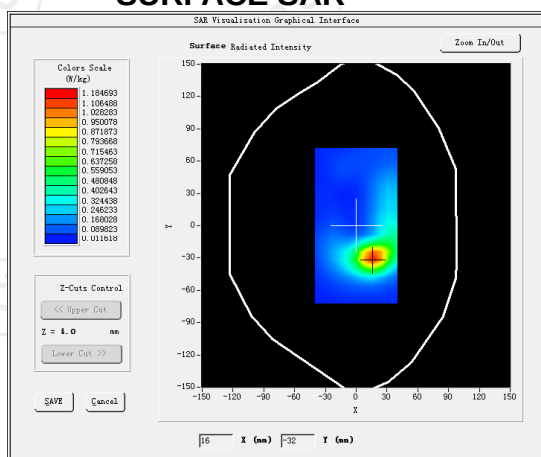
High Band SAR (Channel 21350):

Date: 08/27/2024

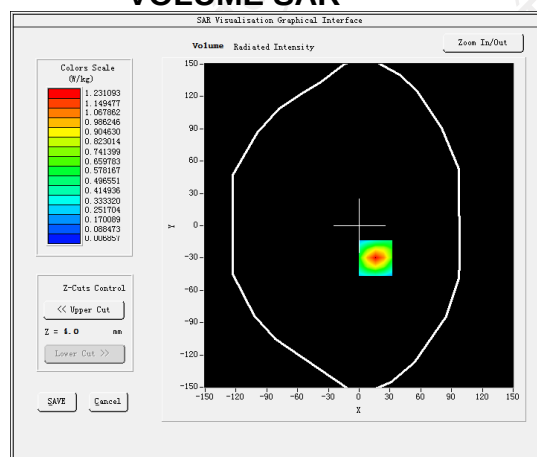
Frequency (MHz)	2560.000000
Relative permittivity (real part)	38.853477
Relative permittivity (imaginary part)	13.545489
Conductivity (S/m)	1.922567
Variation (%)	-0.230000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back-open(10mm)
Band	LTE band 7(1 RB#0)

SURFACE SAR

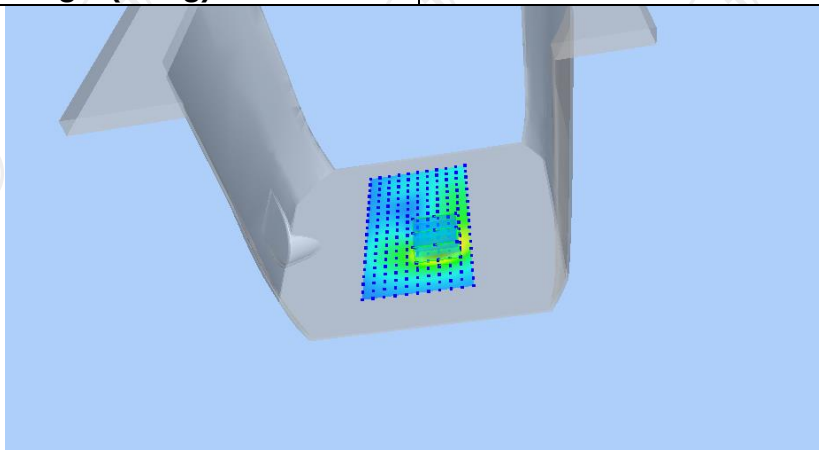


VOLUME SAR

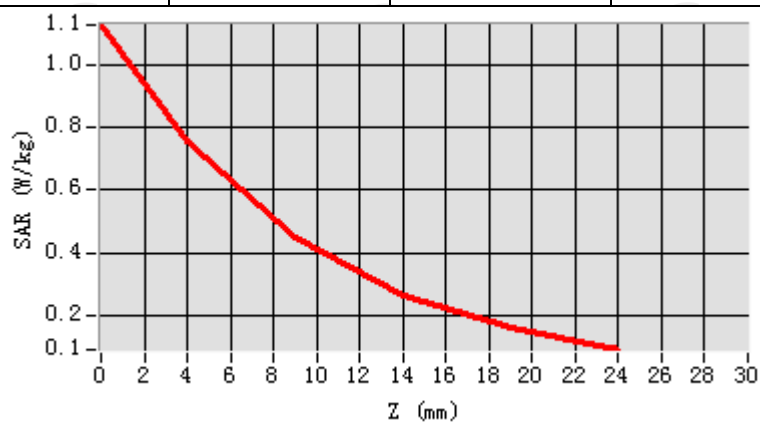


Maximum location: X=16.00, Y=-30.00 SAR Peak: 1.14 W/kg

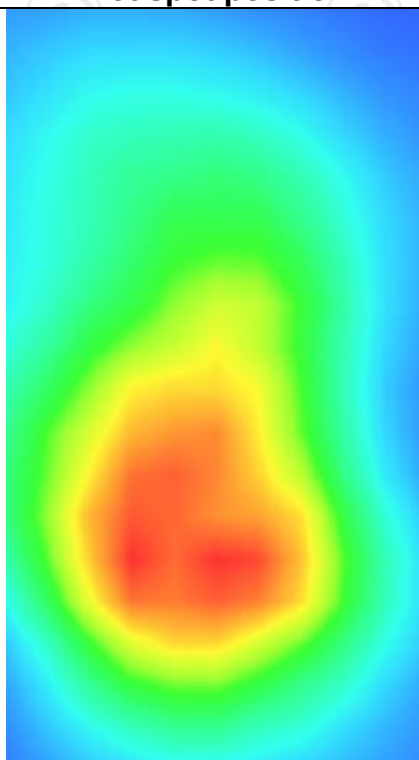
SAR 10g (W/Kg)	0.402445
SAR 1g (W/Kg)	0.765120



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.1277	0.7571	0.4501	0.2664	0.1596



Hot spot position



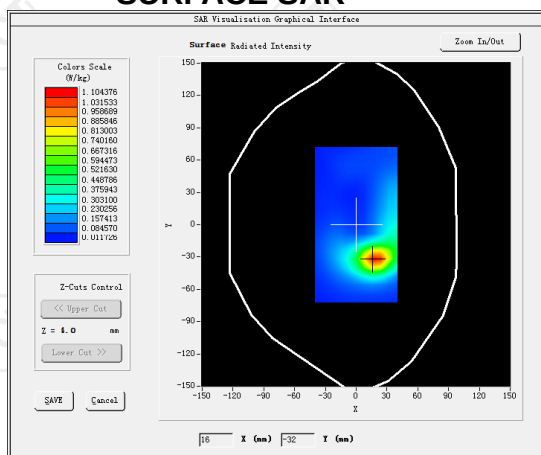
MEASUREMENT 3

High Band SAR (Channel 21350):

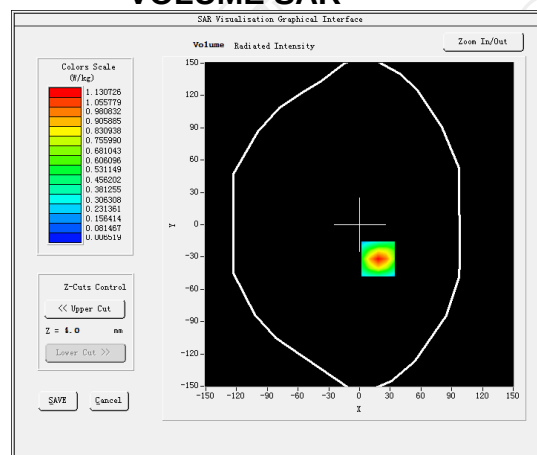
Date: 08/27/2024

Frequency (MHz)	2560.000000
Relative permittivity (real part)	38.853477
Relative permittivity (imaginary part)	13.545489
Conductivity (S/m)	1.922567
Variation (%)	-0.620000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	dx=12mm dy=12mm, h= 5.00 mm
ZoomScan	5x5x7,dx=5mm dy=5mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back-open(hotspot 10mm)
Band	LTE band 7(1 RB#0)

SURFACE SAR

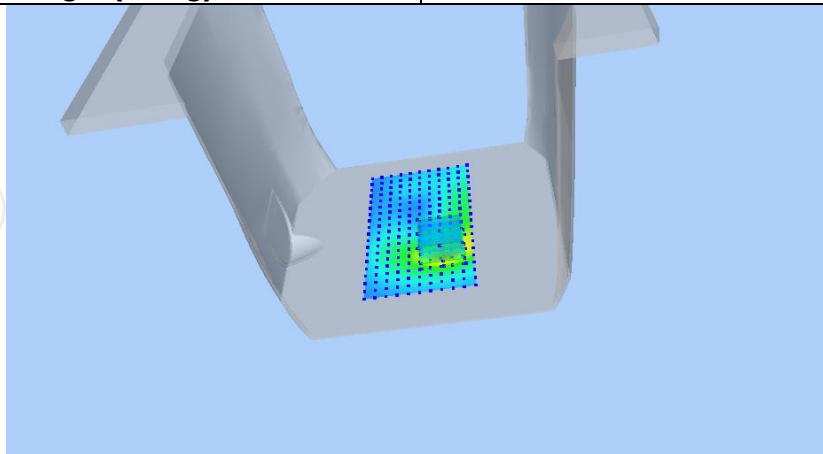


VOLUME SAR

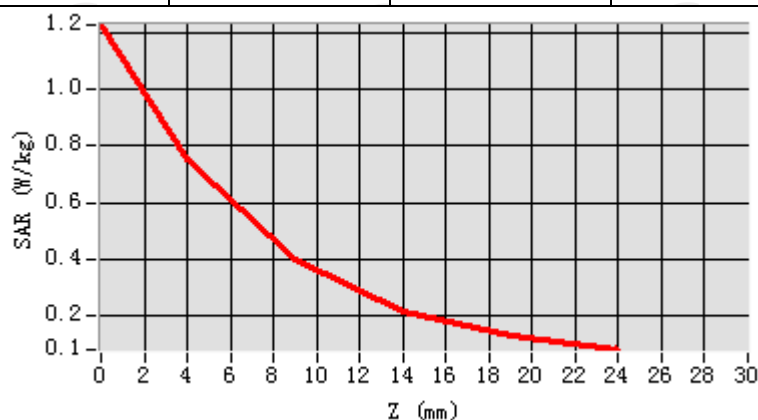


Maximum location: X=18.00, Y=-32.00 SAR Peak: 1.23 W/kg

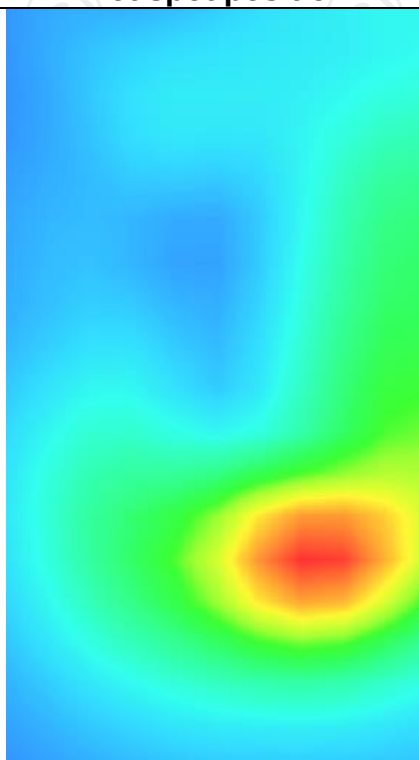
SAR 10g (W/Kg)	0.400208
SAR 1g (W/Kg)	0.759411



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.2264	0.7556	0.4017	0.2188	0.1306



Hot spot position



LTE Band 12

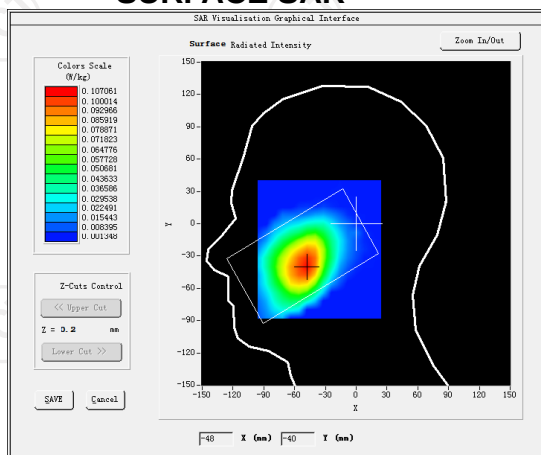
MEASUREMENT 1

High Band SAR (Channel 23130):

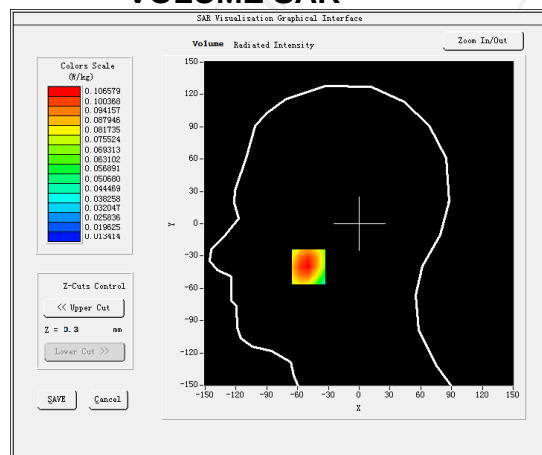
Date: 08/14/2024

Frequency (MHz)	711.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	0.720000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	<u>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 12(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



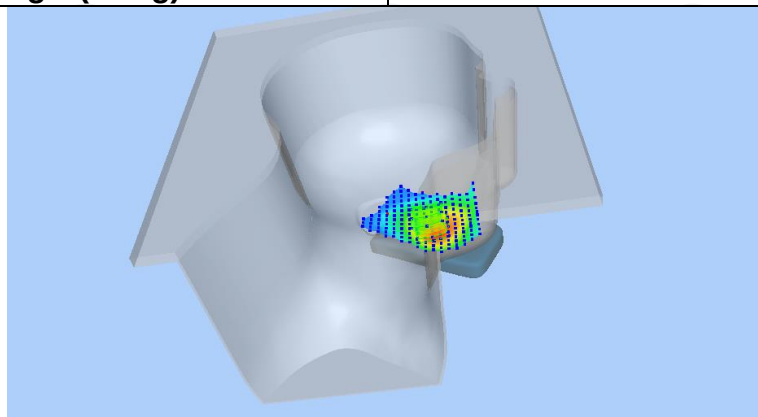
Maximum location: X=-39.00, Y=-41.00 SAR Peak: 0.11 W/kg

SAR 10g (W/Kg)

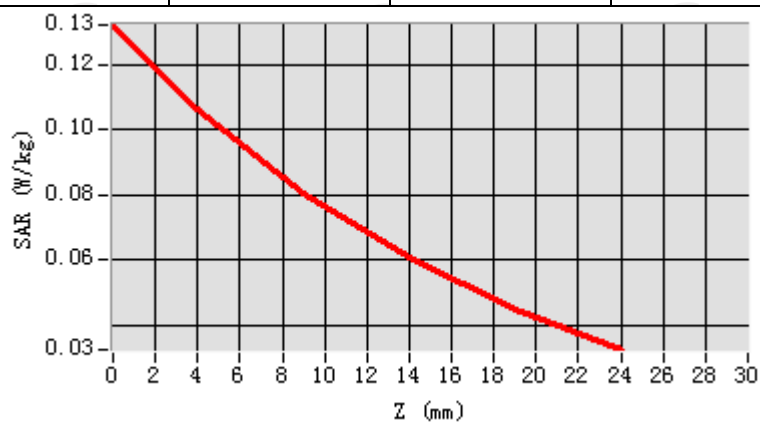
0.070891

SAR 1g (W/Kg)

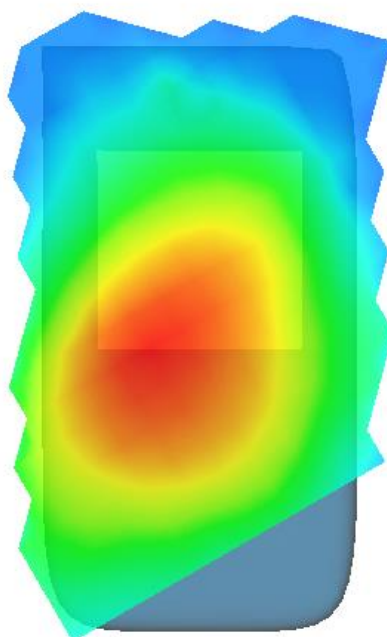
0.108412



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1331	0.1051	0.0707	0.0606	0.0451



Hot spot position



MEASUREMENT 2

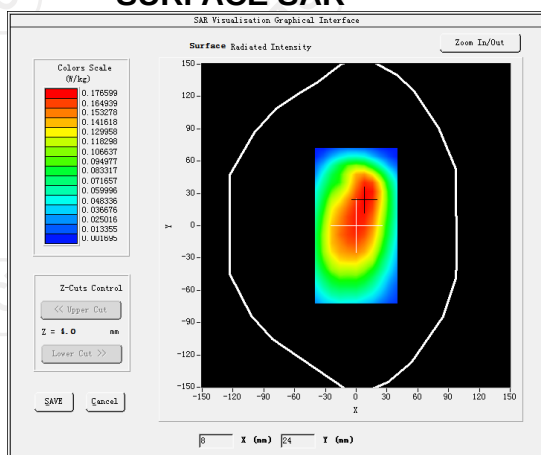
High Band SAR (Channel 23130):

Date: 08/14/2024

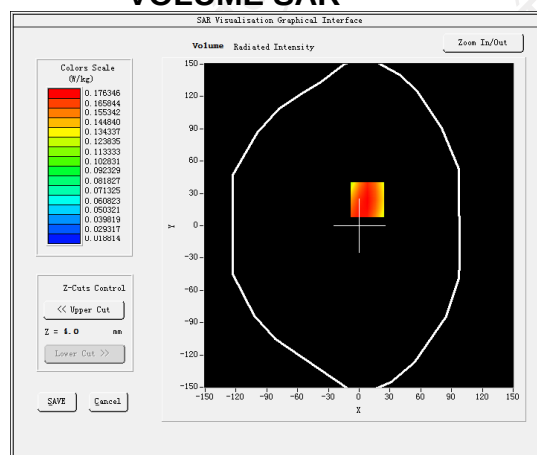
Frequency (MHz)	711.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	-2.820000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back-open(10mm)
Band	<u>LTE band 12(1 RB#0)</u>

SURFACE SAR

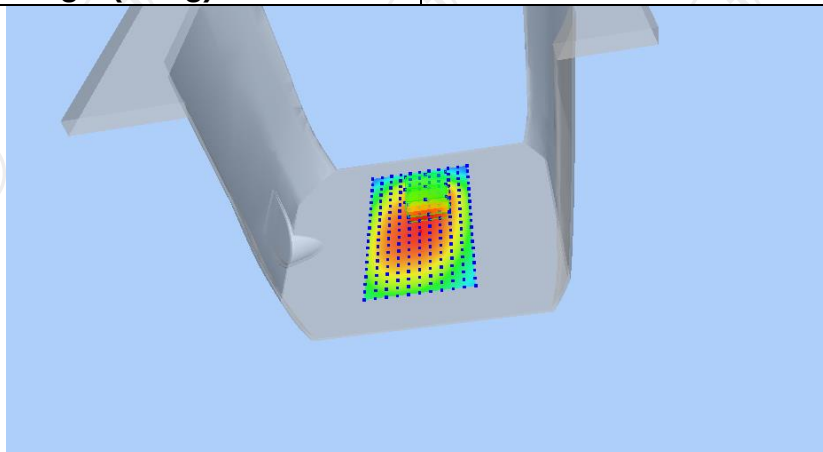


VOLUME SAR

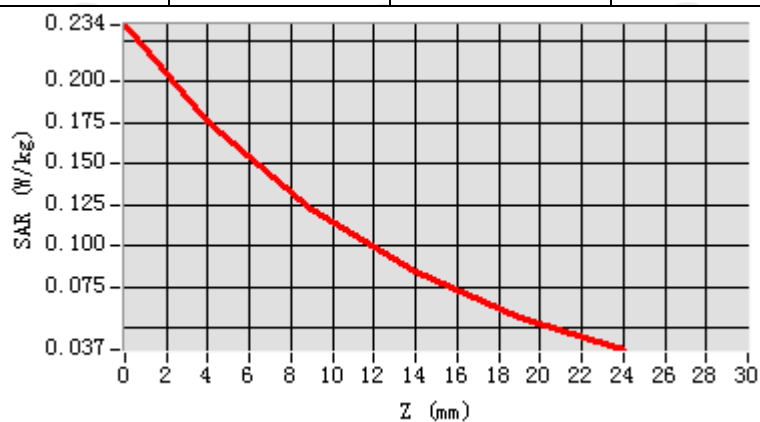


Maximum location: X=6.00, Y=14.00 SAR Peak: 0.15 W/kg

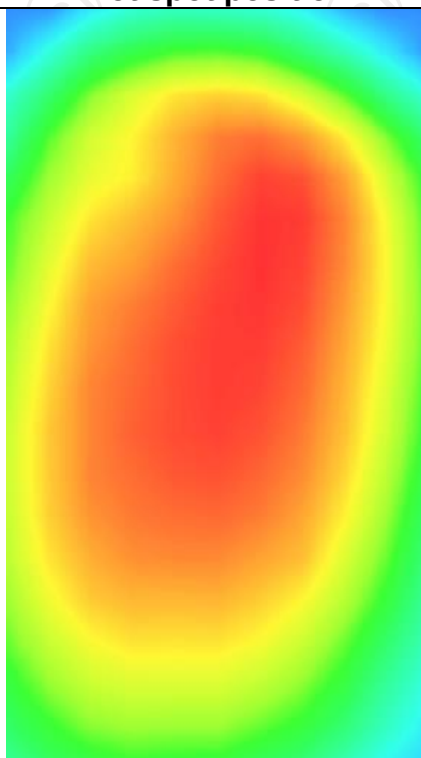
SAR 10g (W/Kg)	0.123051
SAR 1g (W/Kg)	0.173242



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2343	0.1763	0.1220	0.0836	0.0566



Hot spot position



MEASUREMENT 3

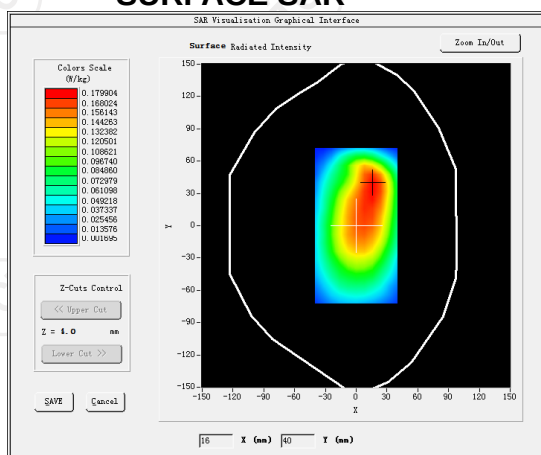
High Band SAR (Channel 23130):

Date: 08/14/2024

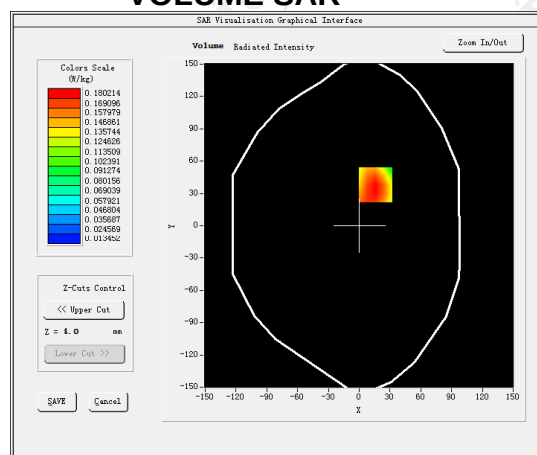
Frequency (MHz)	711.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	0.060000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back-open(hotspot 10mm)
Band	<u>LTE band 12(1 RB#0)</u>

SURFACE SAR

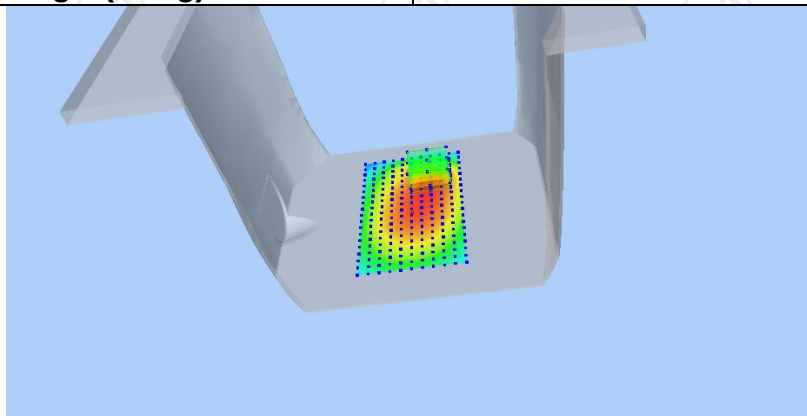


VOLUME SAR

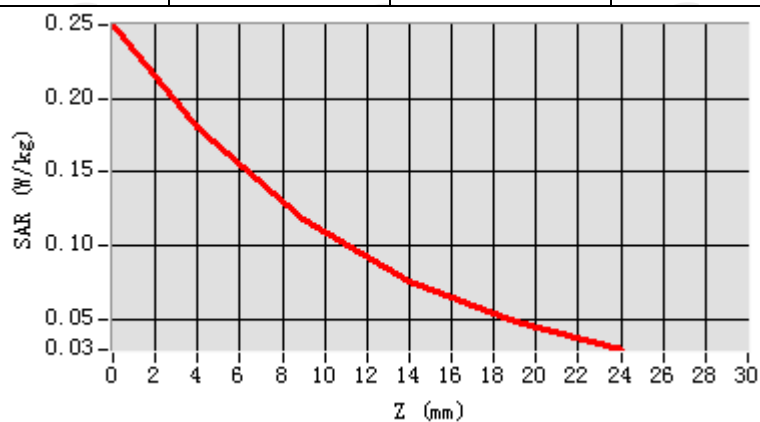


Maximum location: X=6.00, Y=28.00 SAR Peak: 0.24 W/kg

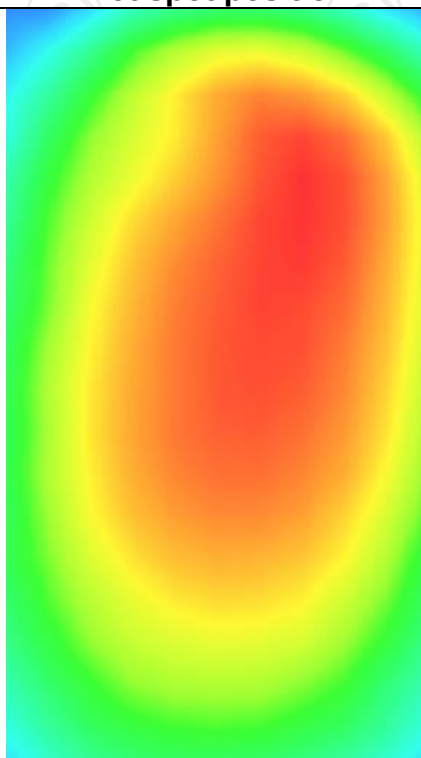
SAR 10g (W/Kg)	0.120341
SAR 1g (W/Kg)	0.182340



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2499	0.1801	0.1173	0.0758	0.0481



Hot spot position



LTE Band 13

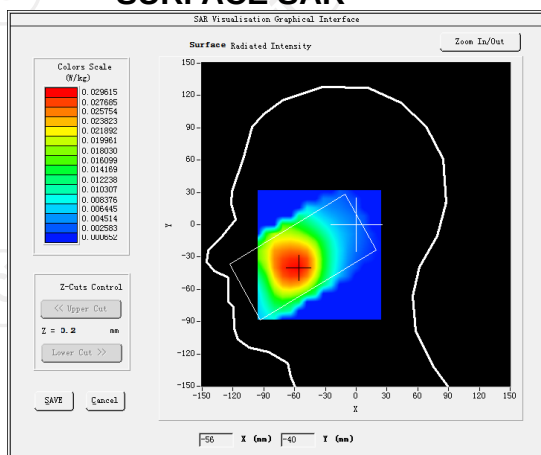
MEASUREMENT 1

Middle Band SAR (Channel 23230):

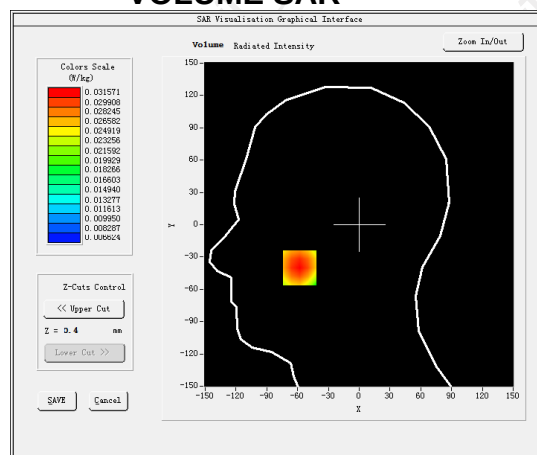
Date: 08/14/2024

Frequency (MHz)	782.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	1.080000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	<u>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 13(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



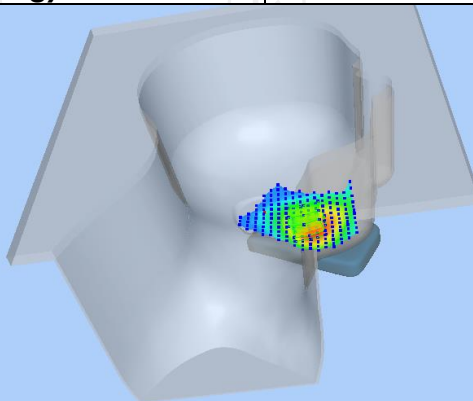
Maximum location: X=-48.00, Y=-42.00 SAR Peak: 0.13 W/kg

SAR 10g (W/Kg)

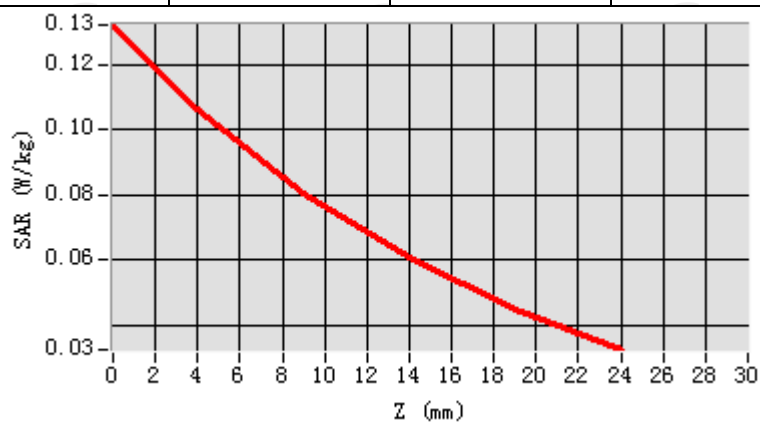
0.081254

SAR 1g (W/Kg)

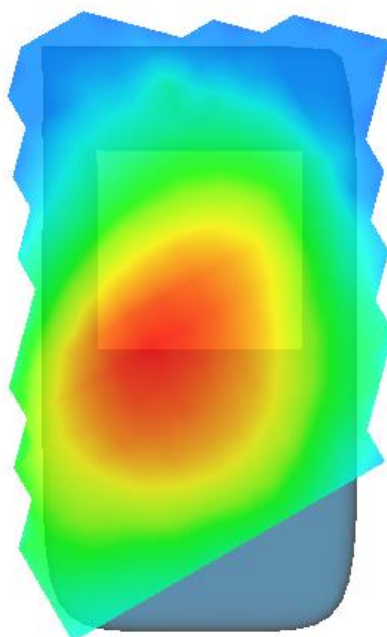
0.103147



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1343	0.1070	0.0812	0.0610	0.0450



Hot spot position

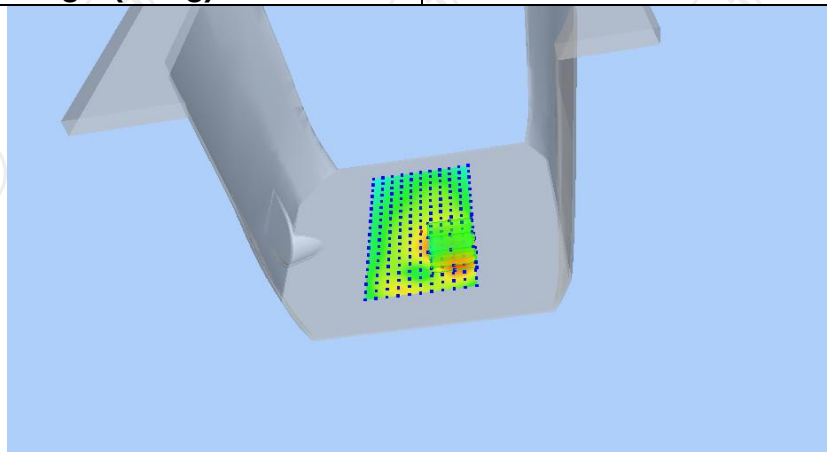
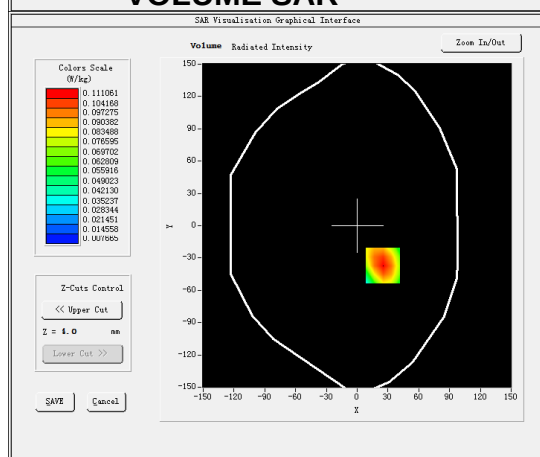
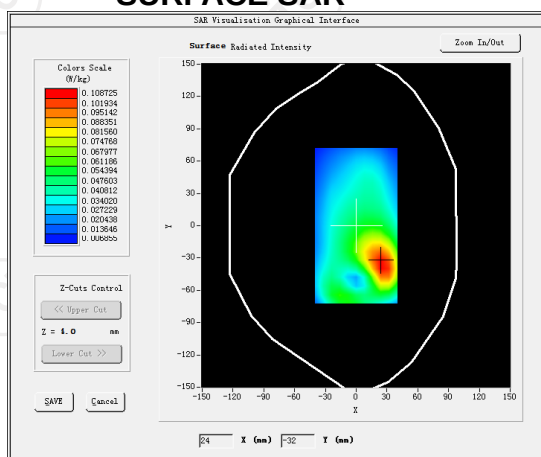
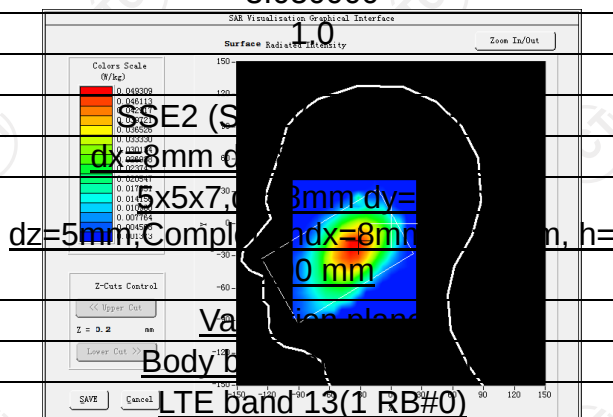


MEASUREMENT 2

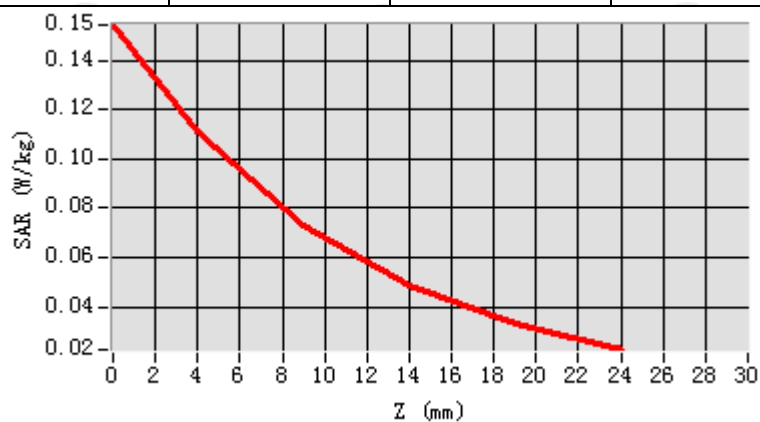
Middle Band SAR (Channel 23230):

Date: 08/14/2024

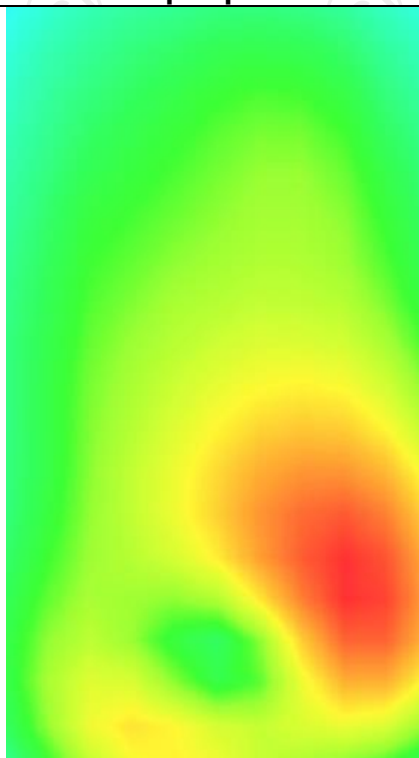
Frequency (MHz)	782.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	3.050000
Crest Factor	
Probe Conversion factor	
E-Field Probe:	
Area Scan	
ZoomScan	
Phantom	
Device Position	
Band	
SURFACE SAR	VOLUME SAR
Maximum location: X=25.00, Y=-37.00 SAR Peak: 0.15 W/kg	
SAR 10g (W/Kg)	0.071367
SAR 1g (W/Kg)	0.113057



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1211	0.1120	0.0731	0.0490	0.0340



Hot spot position



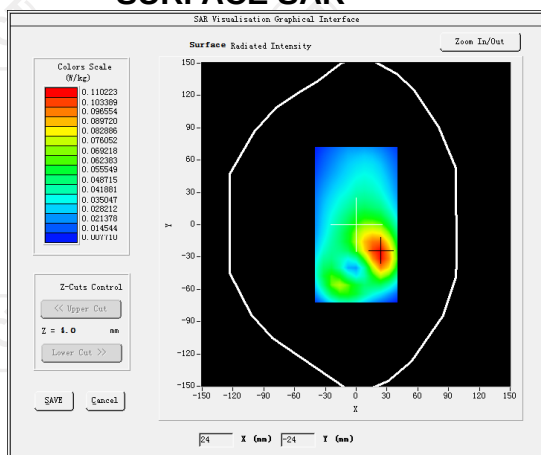
MEASUREMENT 3

Middle Band SAR (Channel 23230):

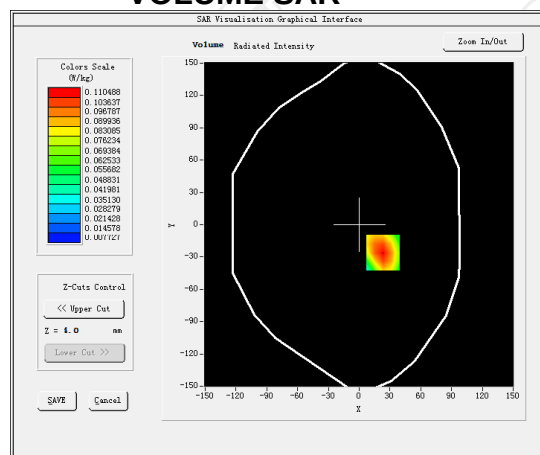
Date: 08/14/2024

Frequency (MHz)	782.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	0.660000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN25/22 EPG0375)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back-open(hotspot 10mm)
Band	LTE band 13(1 RB#0)

SURFACE SAR

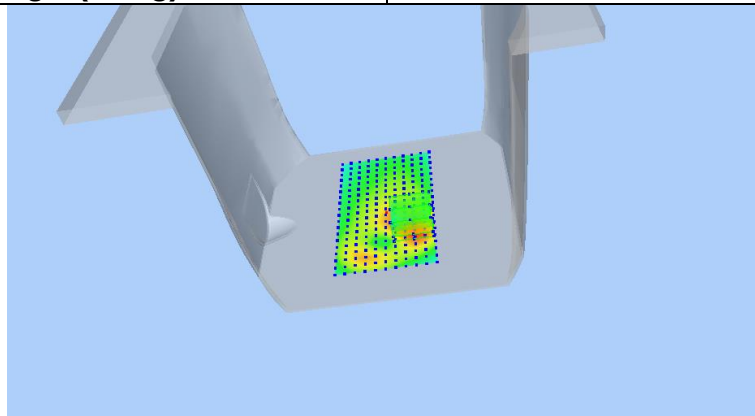


VOLUME SAR

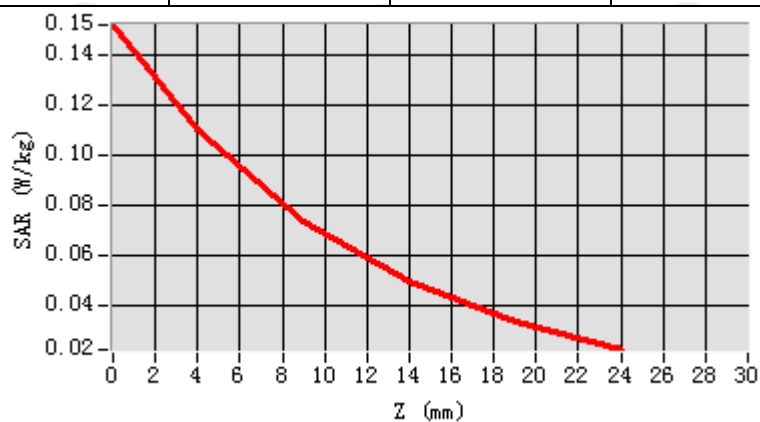


Maximum location: X=22.00, Y=-24.00 SAR Peak: 0.15 W/kg

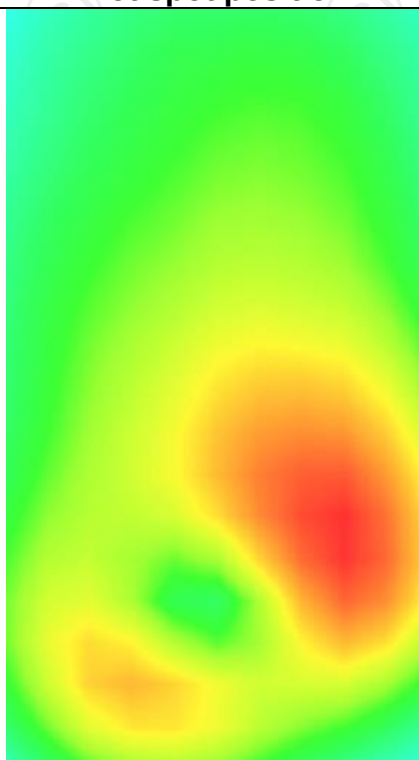
SAR 10g (W/Kg)	0.076321
SAR 1g (W/Kg)	0.115261



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1520	0.1110	0.0734	0.0492	0.0340



Hot spot position



LTE Band 17

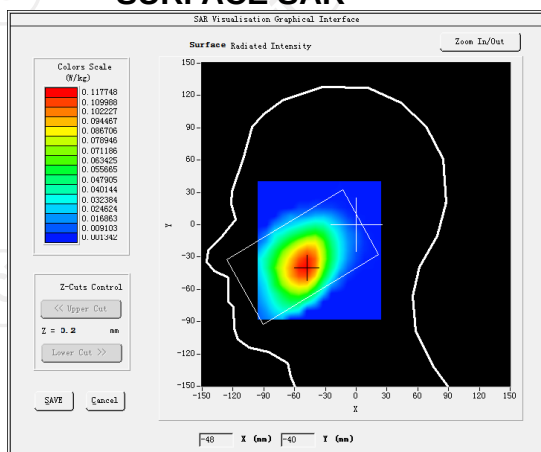
MEASUREMENT 1

High Band SAR (Channel 23800):

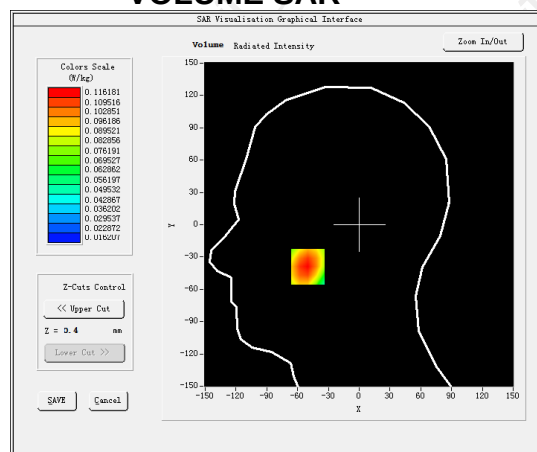
Date: 08/14/2024

Frequency (MHz)	711.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	-1.930000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	<u>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 17(1 RB#24)</u>

SURFACE SAR



VOLUME SAR



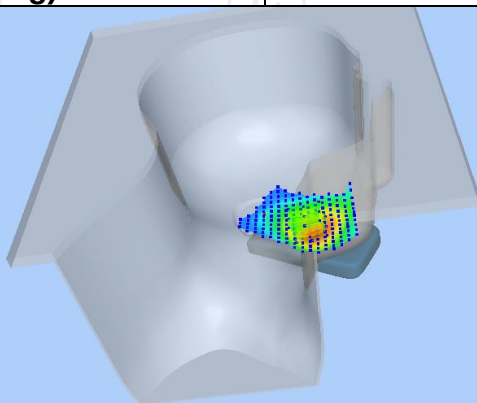
Maximum location: X=-50.00, Y=-39.00 SAR Peak: 0.14 W/kg

SAR 10g (W/Kg)

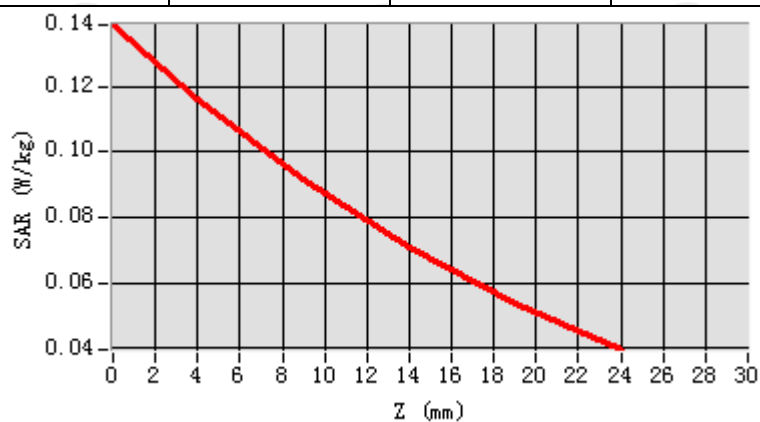
0.089541

SAR 1g (W/Kg)

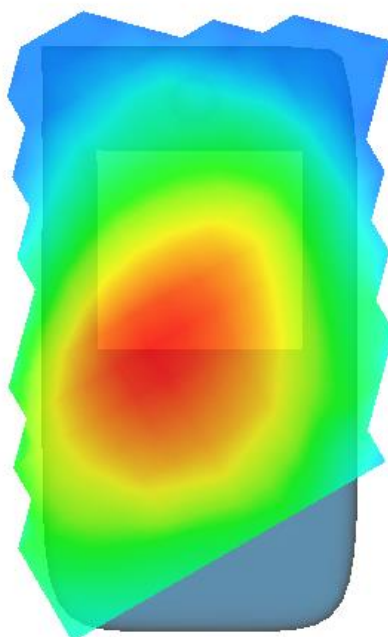
0.124153



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1390	0.1162	0.0916	0.0710	0.0539



Hot spot position



MEASUREMENT 2

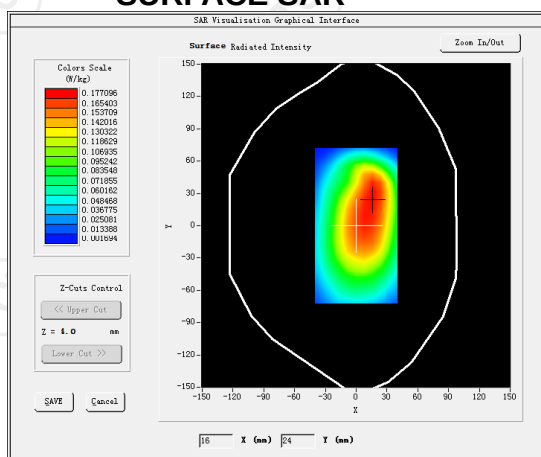
High Band SAR (Channel 23800):

Date: 08/14/2024

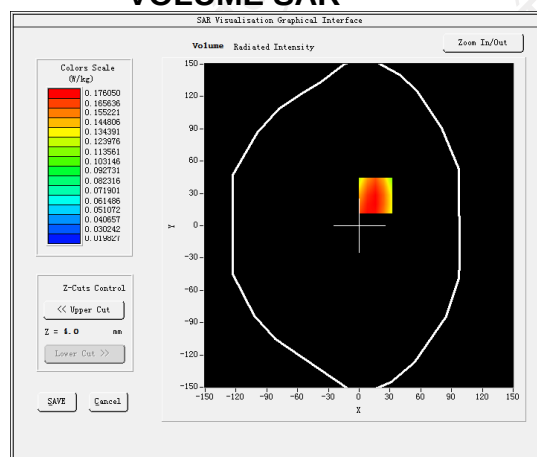
Frequency (MHz)	711.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	-4.120000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back-open(10mm)
Band	LTE band 17(1 RB#24)

SURFACE SAR

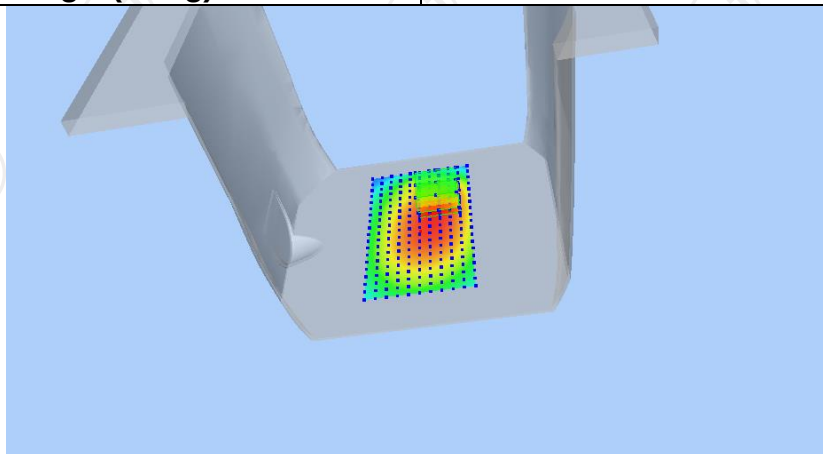


VOLUME SAR

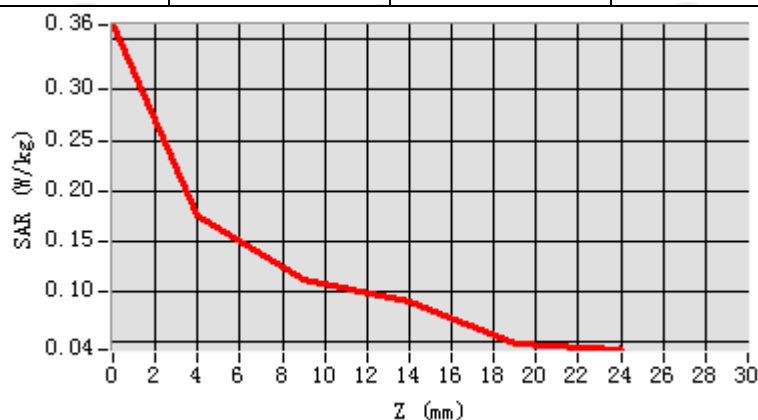


Maximum location: X=16.00, Y=28.00 SAR Peak: 0.23 W/kg

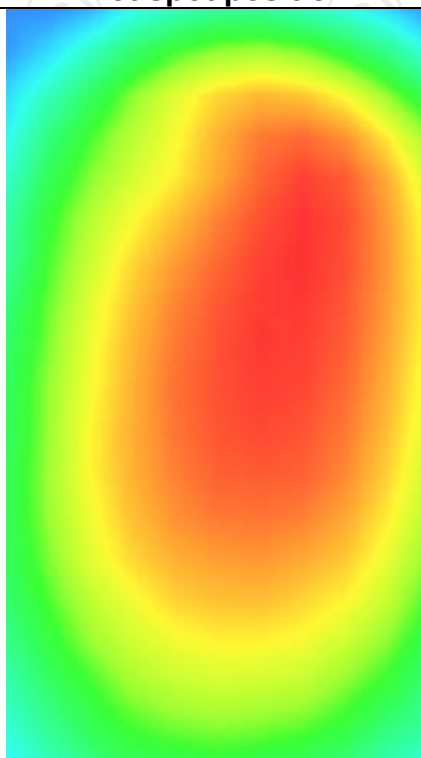
SAR 10g (W/Kg)	0.108942
SAR 1g (W/Kg)	0.169541



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3647	0.1761	0.1123	0.0891	0.0484



Hot spot position



MEASUREMENT 3

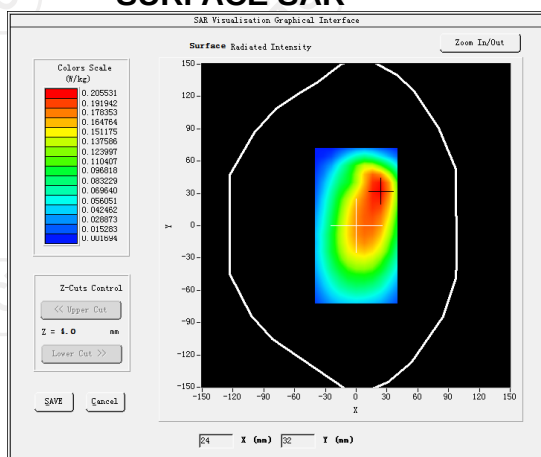
High Band SAR (Channel 23800):

Date: 08/14/2024

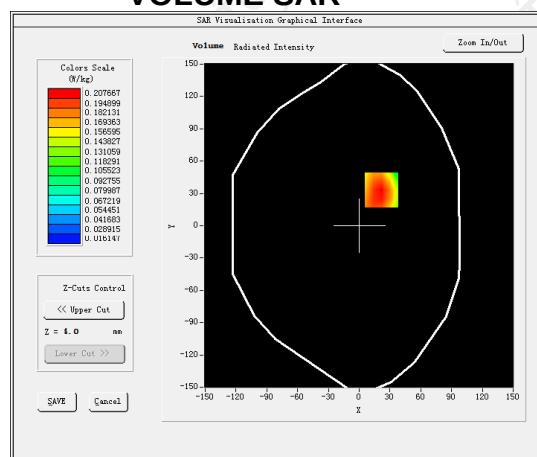
Frequency (MHz)	711.000000
Relative permittivity (real part)	40.761260
Relative permittivity (imaginary part)	17.130904
Conductivity (S/m)	0.931220
Variation (%)	0.170000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back(hotspot 10mm)
Band	<u>LTE band 17(1 RB#24)</u>

SURFACE SAR

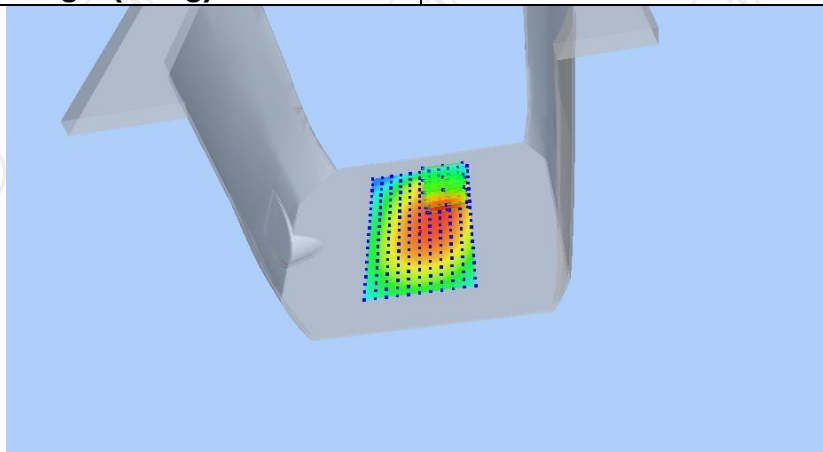


VOLUME SAR

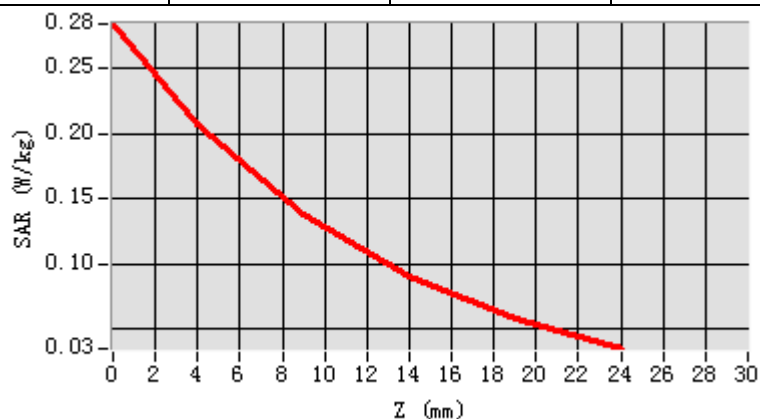


Maximum location: X=22.00, Y=33.00 SAR Peak: 0.29 W/kg

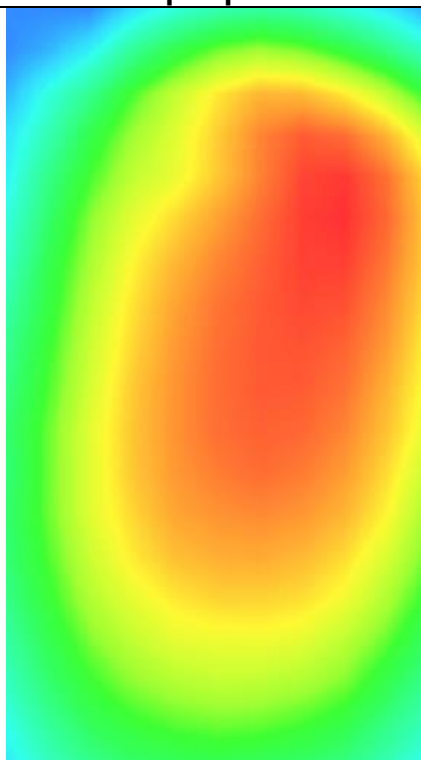
SAR 10g (W/Kg)	0.136217
SAR 1g (W/Kg)	0.214157



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2842	0.2077	0.1378	0.0901	0.0578



Hot spot position



LTE Band 66

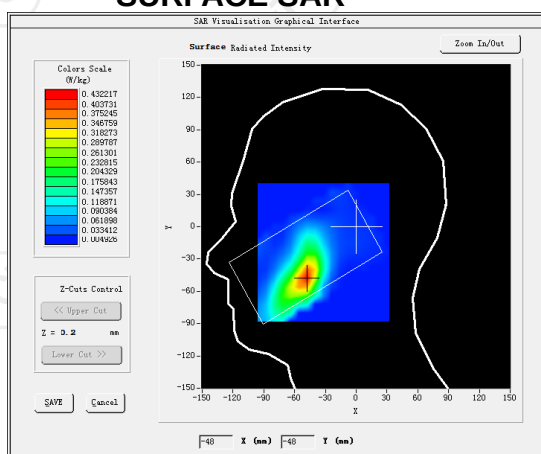
MEASUREMENT 1

High Band SAR (Channel 132572):

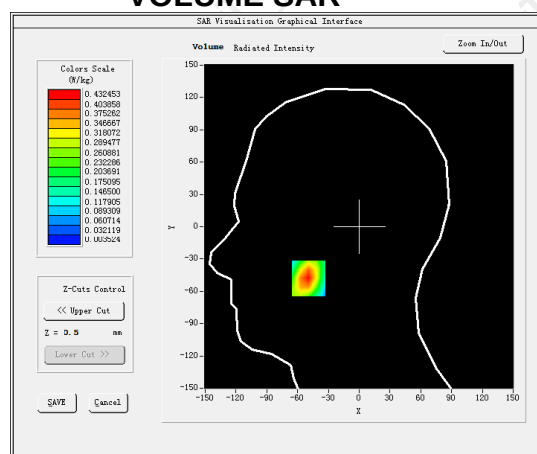
Date: 08/19/2024

Frequency (MHz)	1770.000000
Relative permittivity (real part)	40.115910
Relative permittivity (imaginary part)	14.136136
Conductivity (S/m)	1.360603
Variation (%)	-1.960000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	<u>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 66(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



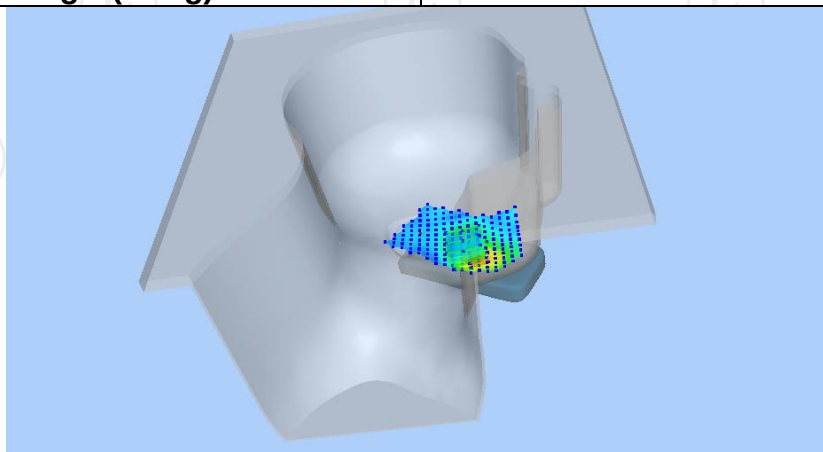
Maximum location: X=-49.00, Y=-48.00 SAR Peak: 0.22 W/kg

SAR 10g (W/Kg)

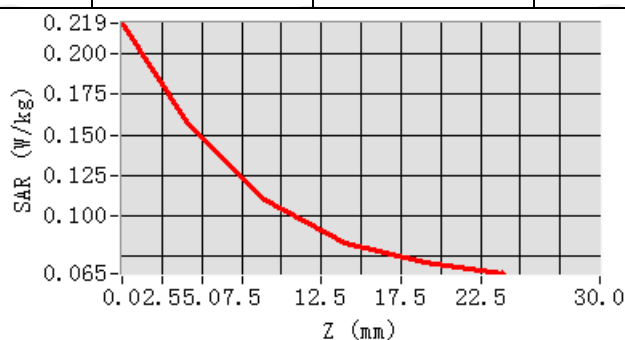
0.112509

SAR 1g (W/Kg)

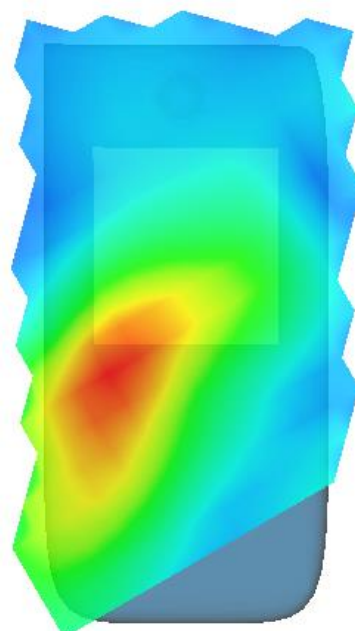
0.161247



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2187	0.1588	0.1102	0.0836	0.0711



Hot spot position



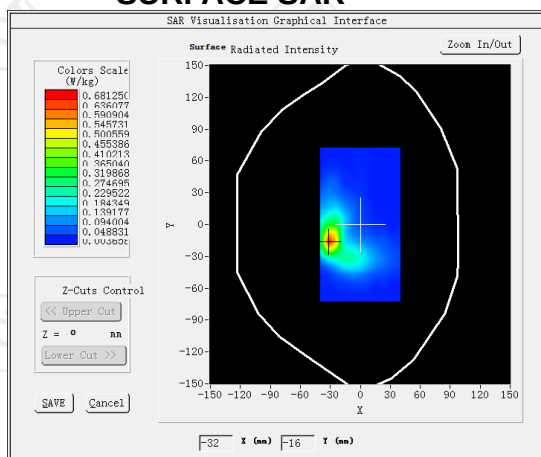
MEASUREMENT 2

High Band SAR (Channel 132572):

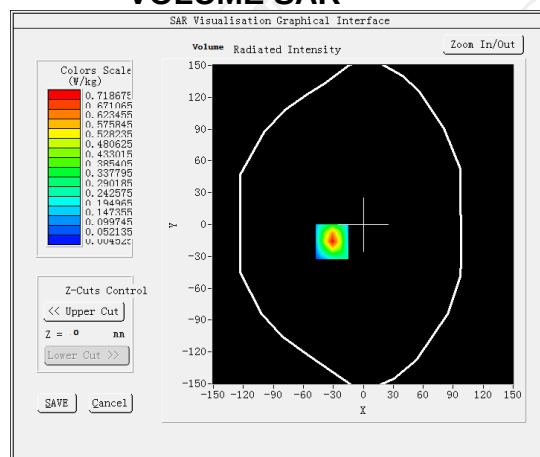
Date: 08/19/2024

Frequency (MHz)	1770.000000
Relative permittivity (real part)	40.115910
Relative permittivity (imaginary part)	14.136136
Conductivity (S/m)	1.360603
Variation (%)	-3.050000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	LTE band 66(1 RB#0)

SURFACE SAR

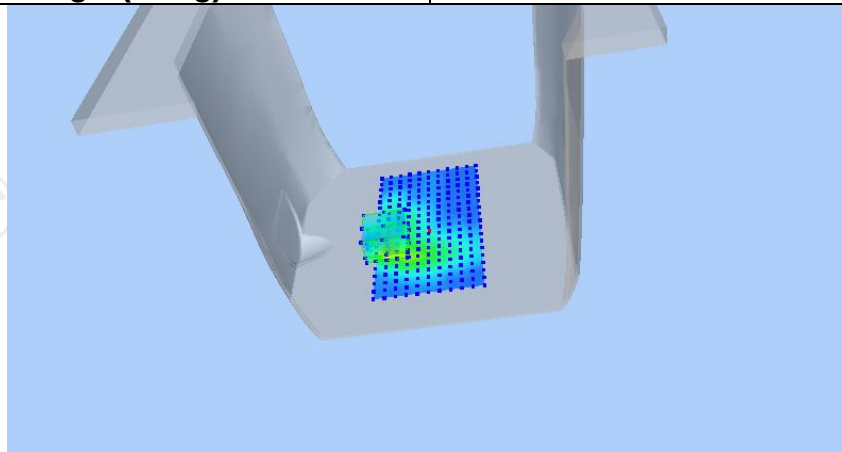


VOLUME SAR

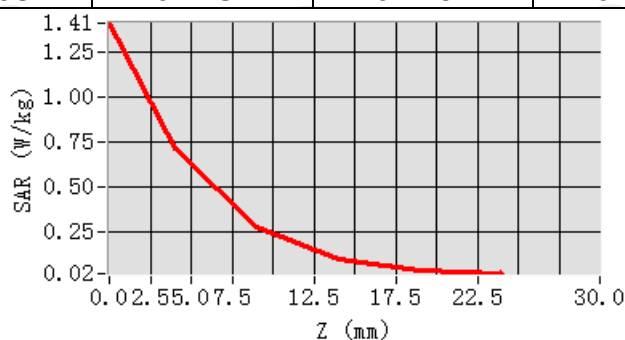


Maximum location: X=-31.00, Y=-16.00 SAR Peak: 1.41 W/kg

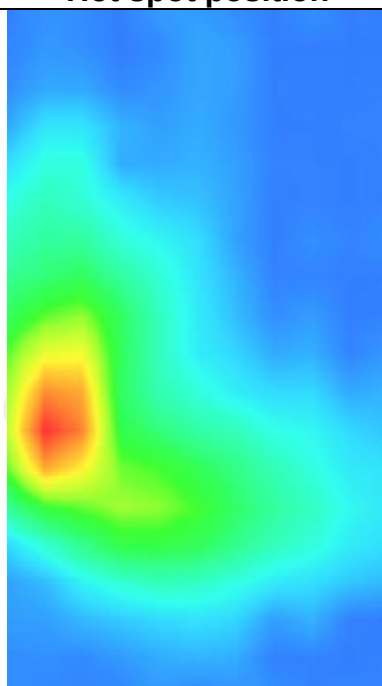
SAR 10g (W/Kg)	0.276214
SAR 1g (W/Kg)	0.702164



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.4098	0.7187	0.2764	0.1016	0.0443



Hot spot position



MEASUREMENT 3

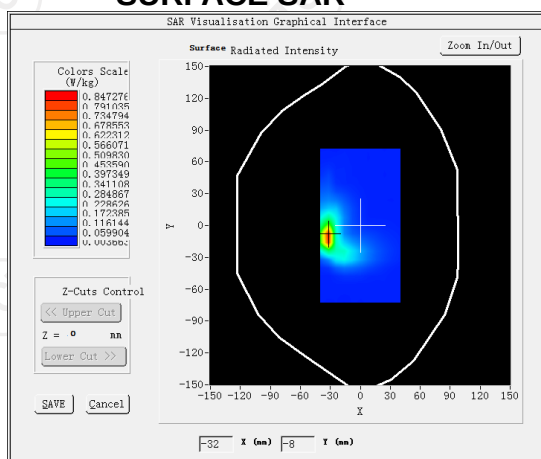
High Band SAR (Channel 132572):

Date: 08/19/2024

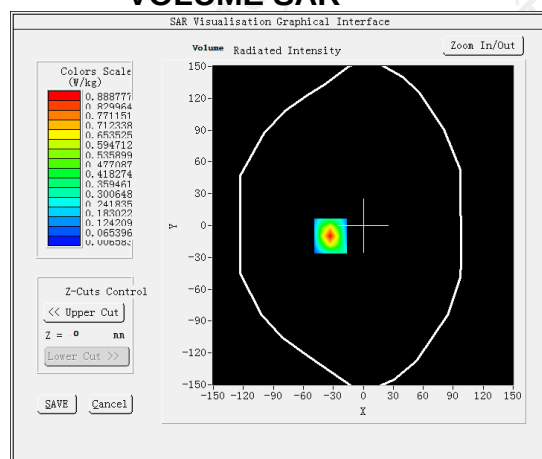
Frequency (MHz)	1770.000000
Relative permittivity (real part)	40.115910
Relative permittivity (imaginary part)	14.136136
Conductivity (S/m)	1.360603
Variation (%)	0.280000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back(hotspot 10mm)
Band	<u>LTE band 66(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



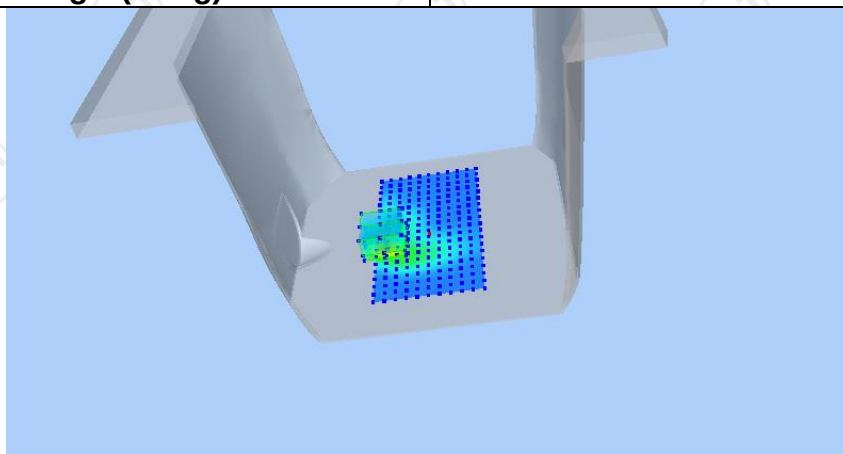
Maximum location: X=-33.00, Y=-10.00 SAR Peak: 1.03W/kg

SAR 10g (W/Kg)

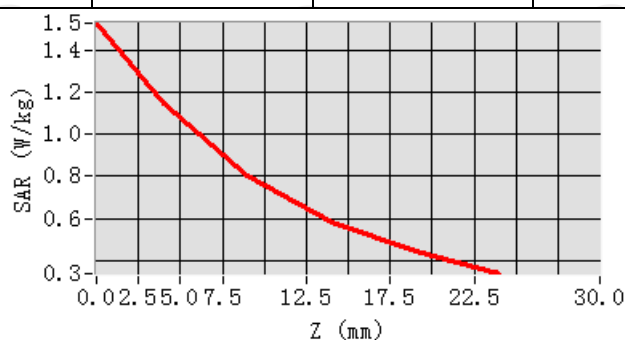
0.545378

SAR 1g (W/Kg)

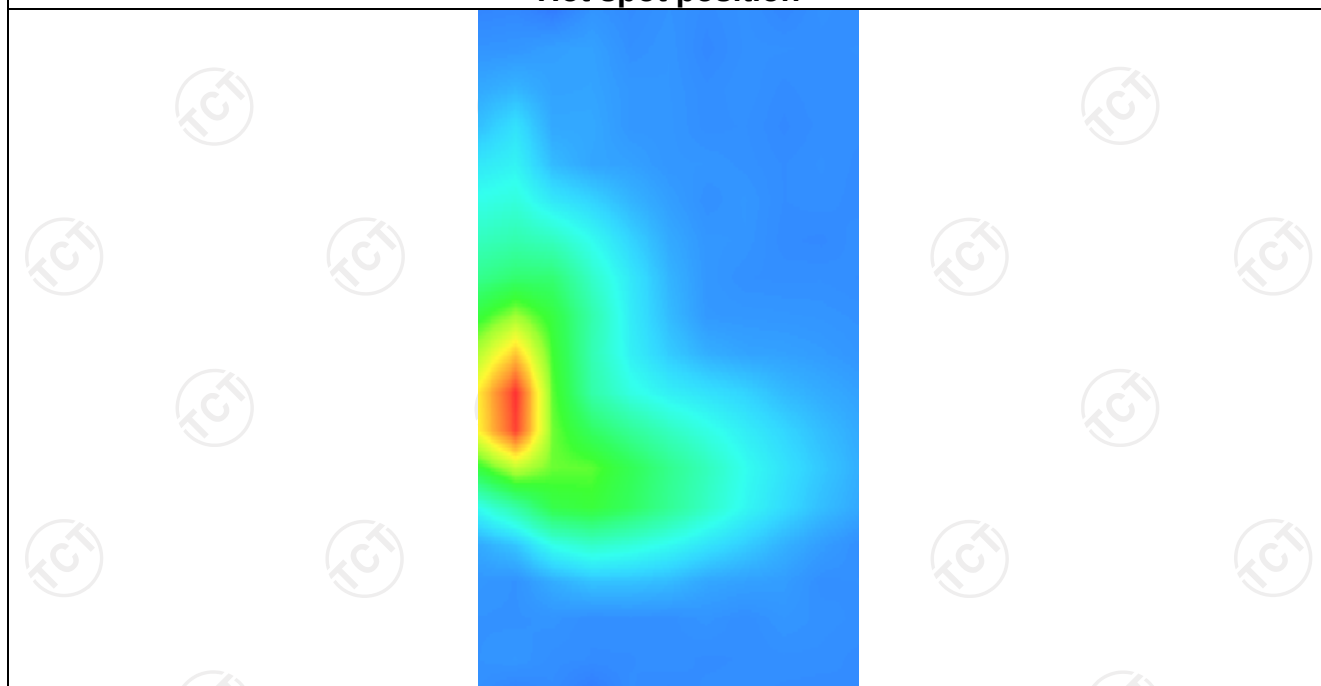
0.742201



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.4165	0.7667	0.5659	0.4569	0.3139



Hot spot position



LTE Band 71

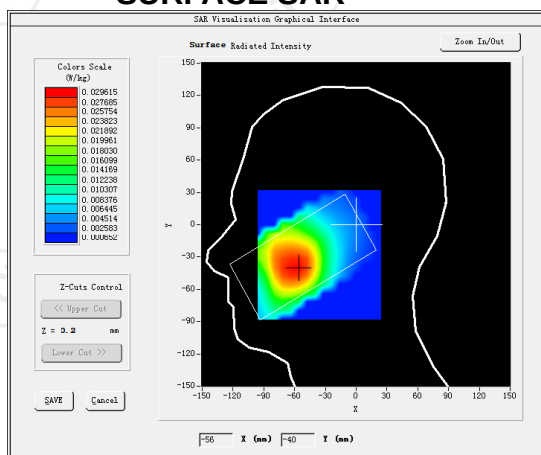
MEASUREMENT 1

Low Band SAR (Channel 133322):

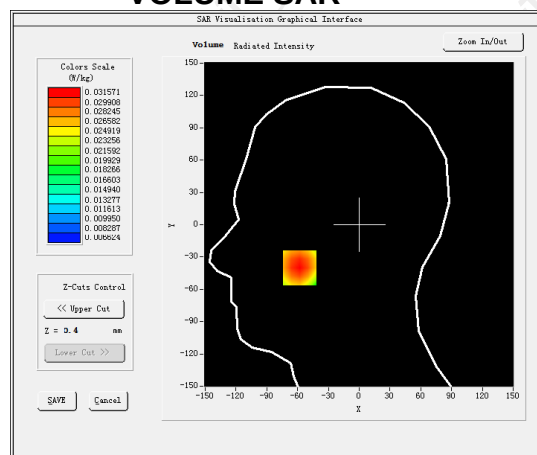
Date: 08/14/2024

Frequency (MHz)	673.000000
Relative permittivity (real part)	41.432976
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.862835
Variation (%)	0.760000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	<u>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 71(1 RB#49)</u>

SURFACE SAR



VOLUME SAR



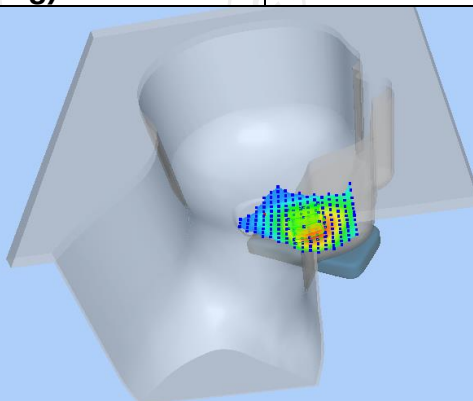
Maximum location: X=-49.00, Y=-40.00 SAR Peak: 0.16 W/kg

SAR 10g (W/Kg)

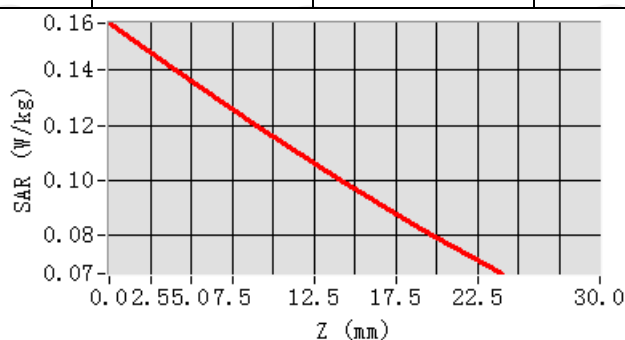
0.123061

SAR 1g (W/Kg)

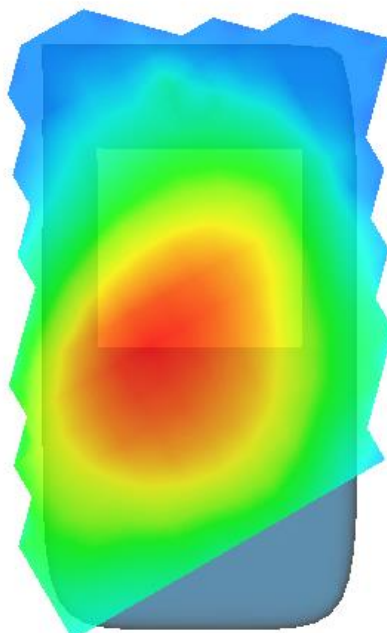
0.144120



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1572	0.1401	0.1196	0.1003	0.0824



Hot spot position



MEASUREMENT 2

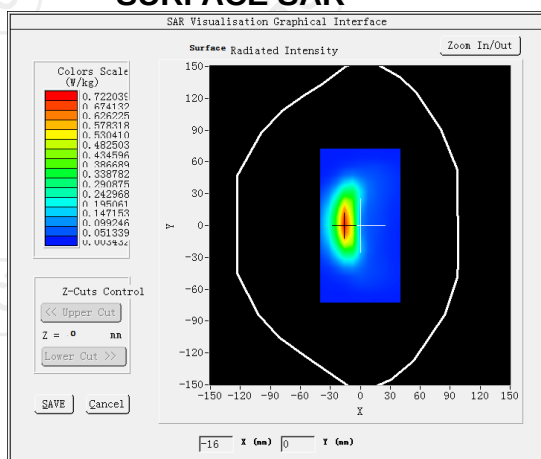
Low Band SAR (Channel 133322):

Date: 08/14/2024

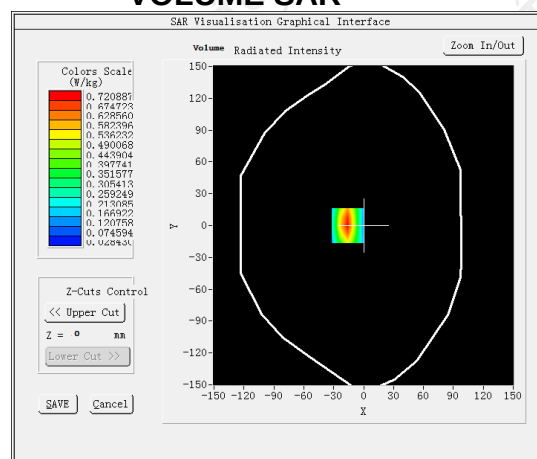
Frequency (MHz)	673.000000
Relative permittivity (real part)	41.500000
Relative permittivity (imaginary part)	19.400000
Conductivity (S/m)	0.901561
Variation (%)	1.660000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back(0mm)
Band	<u>LTE band 71(1 RB#49)</u>

SURFACE SAR

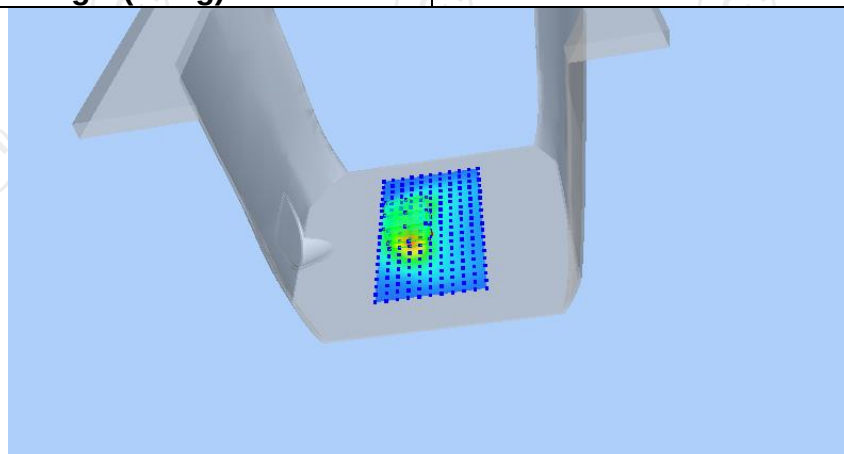


VOLUME SAR

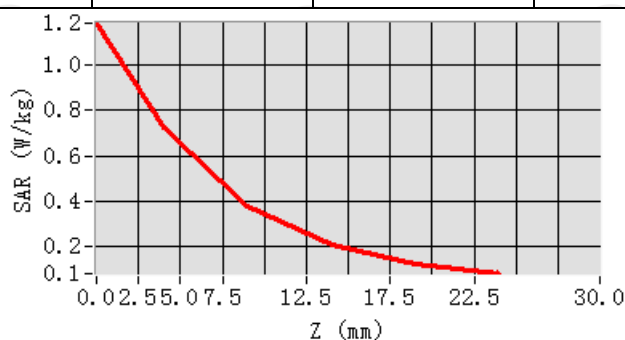


Maximum location: X=-16.00, Y=0.00 SAR Peak: 1.19 W/kg

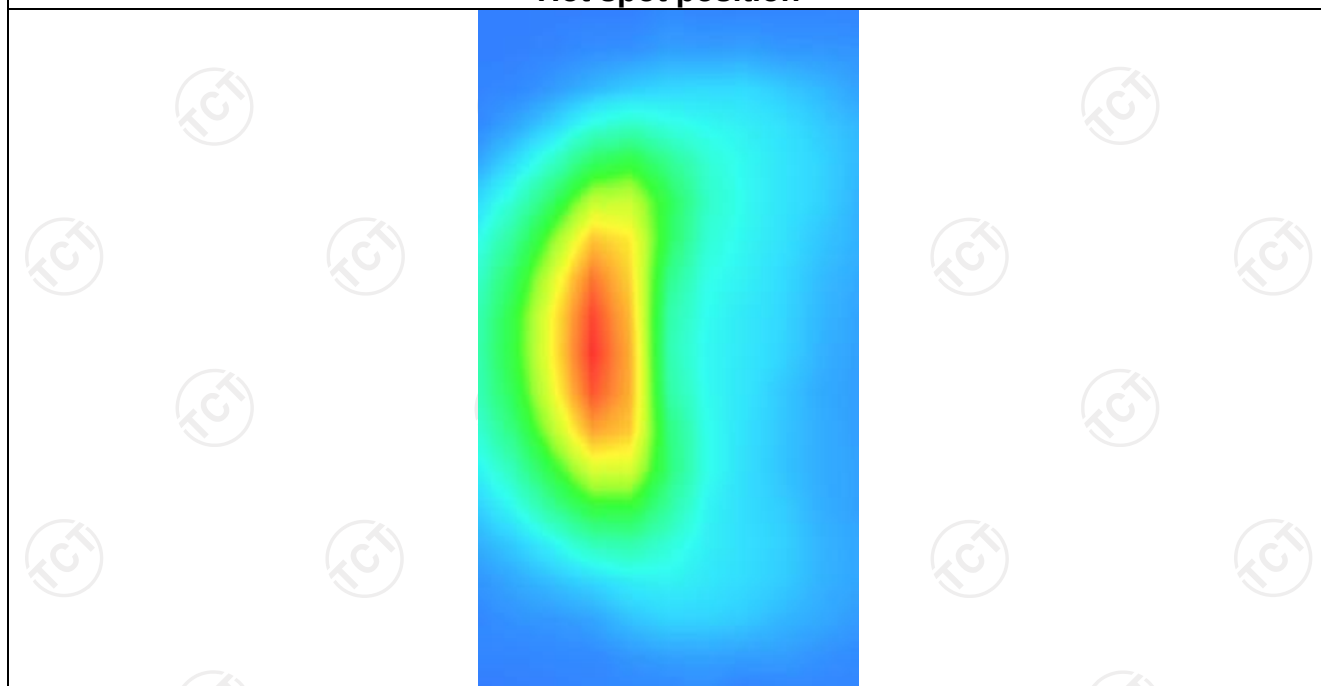
SAR 10g (W/Kg)	0.382035
SAR 1g (W/Kg)	0.674704



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.1828	0.7209	0.3786	0.2060	0.1256



Hot spot position



MEASUREMENT 3

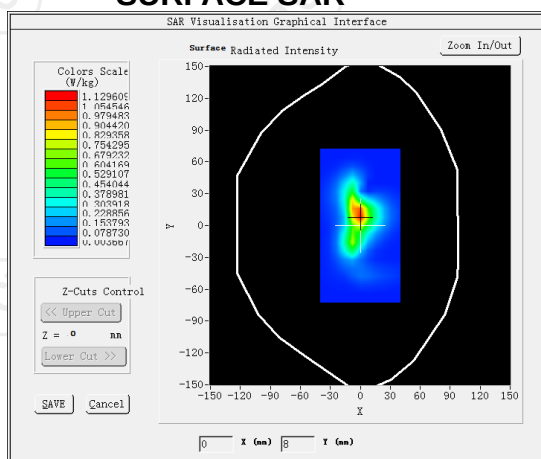
Low Band SAR (Channel 133322):

Date: 08/14/2024

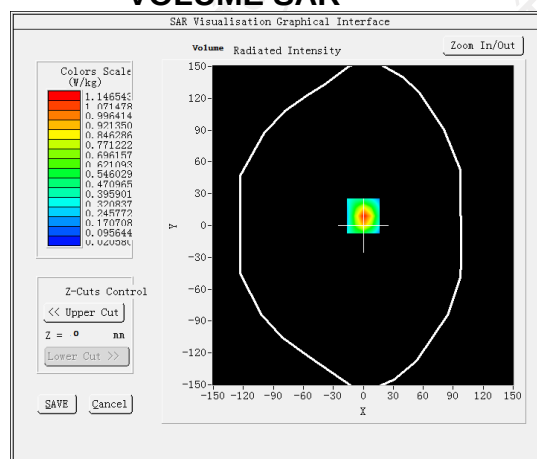
Frequency (MHz)	673.000000
Relative permittivity (real part)	41.500000
Relative permittivity (imaginary part)	19.400000
Conductivity (S/m)	0.901561
Variation (%)	-3.050000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back(hotspot 0mm)
Band	<u>LTE band 71(1RB#49)</u>

SURFACE SAR

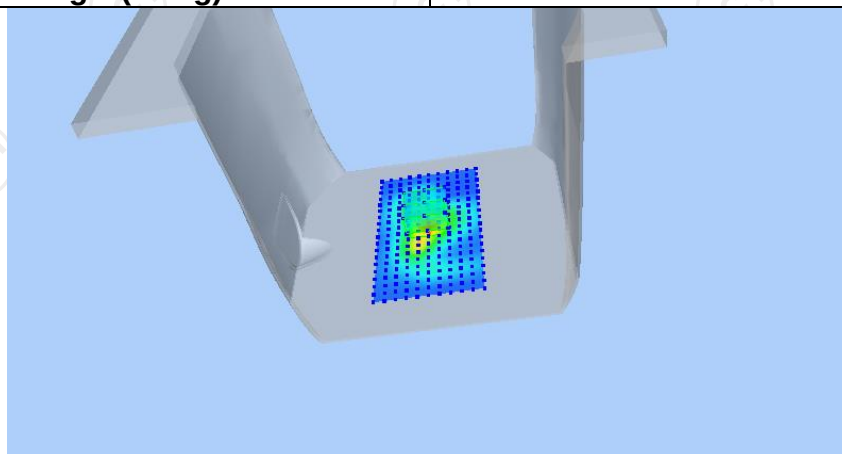


VOLUME SAR

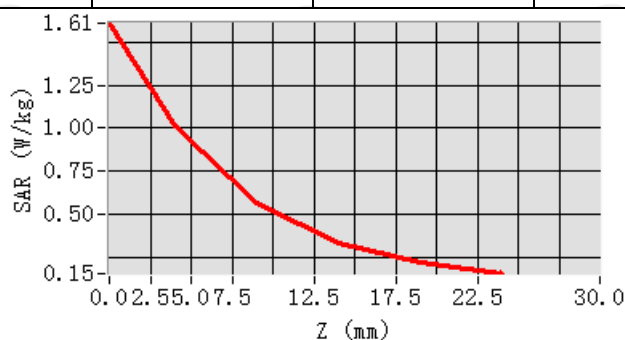


Maximum location: X=-16.00, Y=0.00 SAR Peak: 1.63 W/kg

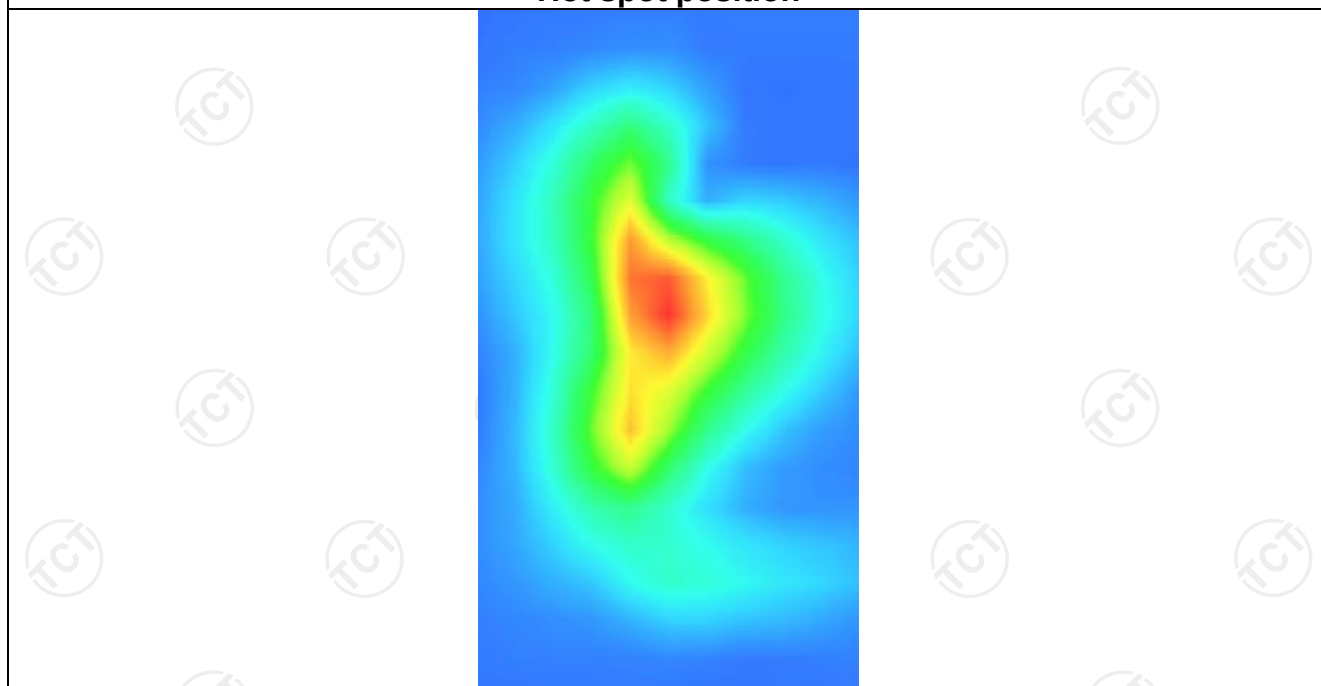
SAR 10g (W/Kg)	0.428009
SAR 1g (W/Kg)	0.721487



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.6115	1.0167	0.5657	0.3309	0.2175



Hot spot position



WLAN 2.4G

MEASUREMENT 1

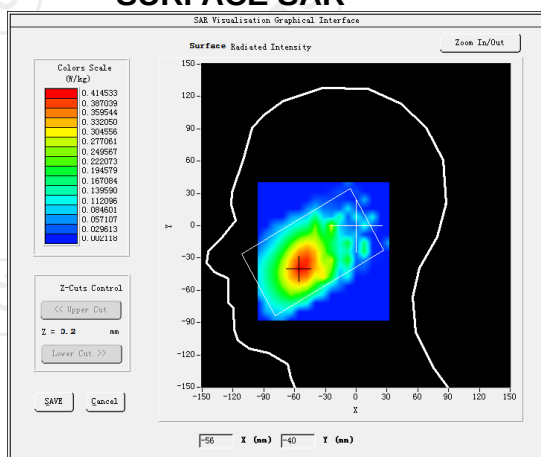
Low Band SAR (Channel 1):

Date: 08/22/2024

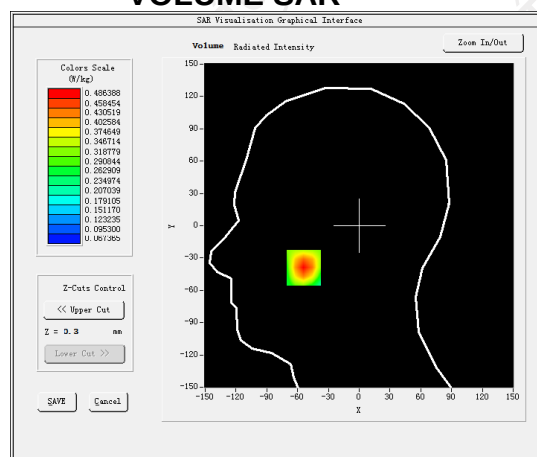
Frequency (MHz)	2412.000000
Relative permittivity (real part)	37.821613
Relative permittivity (imaginary part)	13.546980
Conductivity (S/m)	1.834111
Variation (%)	1.590000
Crest Factor	1.0
Probe Conversion factor	2.31
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	<u>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>IEEE 802.11b ISM</u>

SURFACE SAR

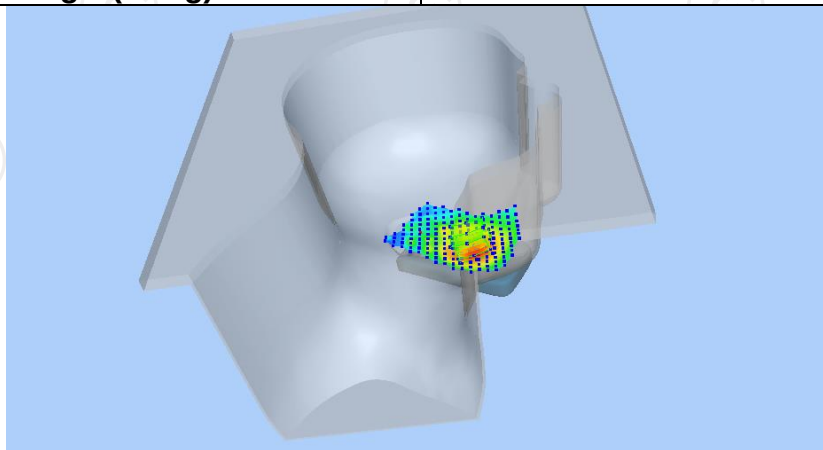


VOLUME SAR

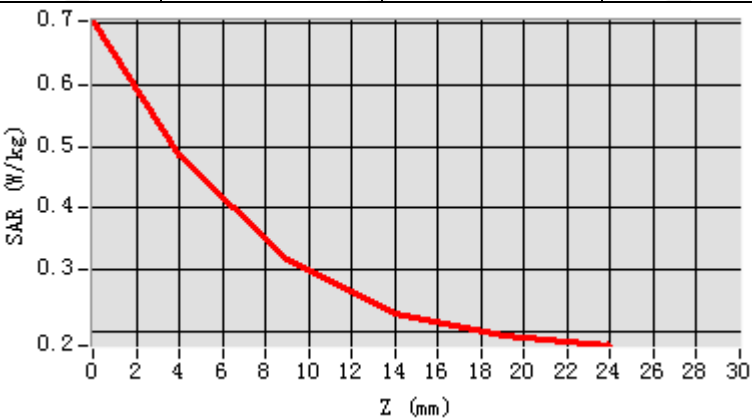


Maximum location: X=-54.00, Y=-39.00 SAR Peak: 0.71 W/kg

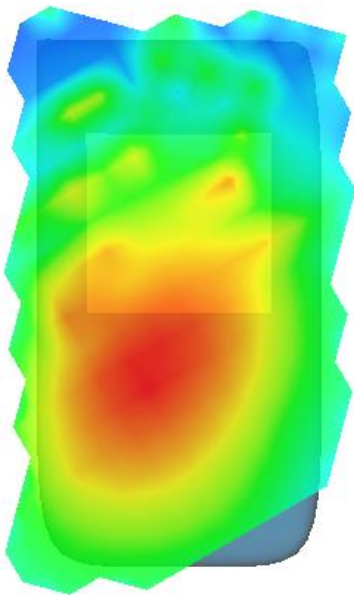
SAR 10g (W/Kg)	0.310883
SAR 1g (W/Kg)	0.475215



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.7029	0.4864	0.3177	0.2307	0.1937



Hot spot position



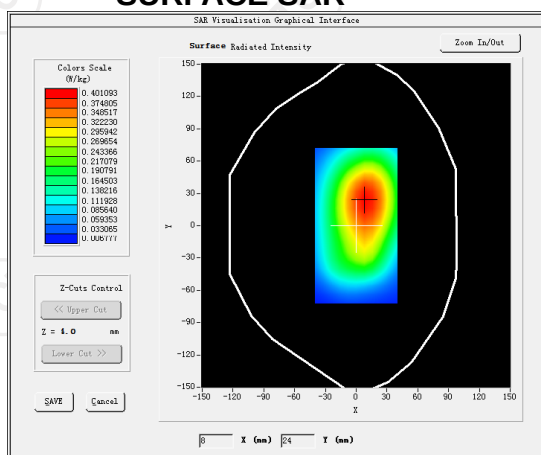
MEASUREMENT 2

Low Band SAR (Channel 1):

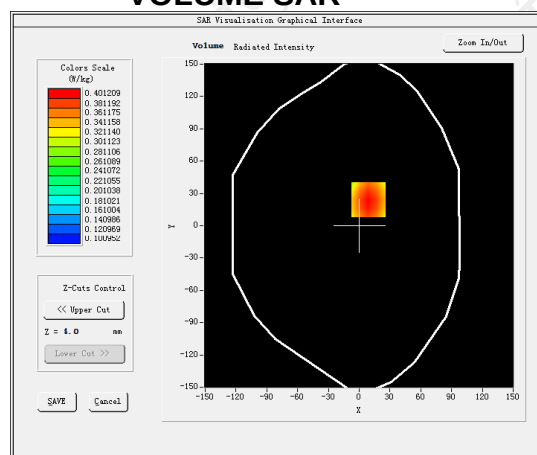
Date: 08/22/2024

Frequency (MHz)	2412.000000
Relative permittivity (real part)	37.821613
Relative permittivity (imaginary part)	13.546980
Conductivity (S/m)	1.834111
Variation (%)	2.120000
Crest Factor	1.0
Probe Conversion factor	2.31
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back-open(10mm)
Band	<u>IEEE 802.11b ISM</u>

SURFACE SAR

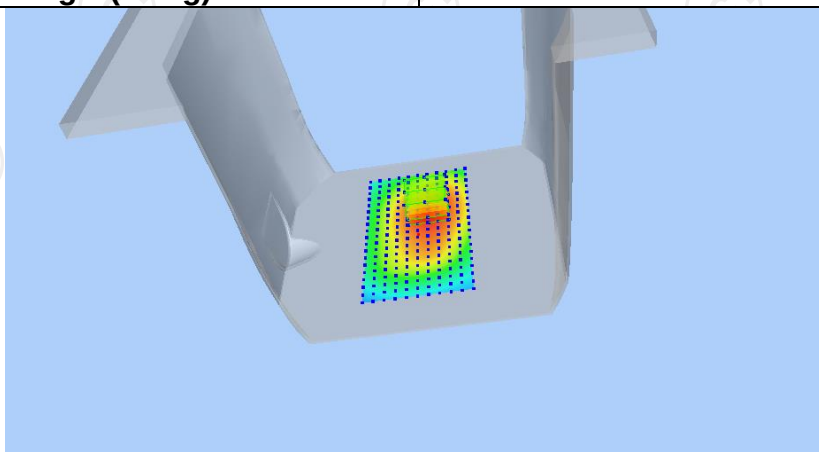


VOLUME SAR

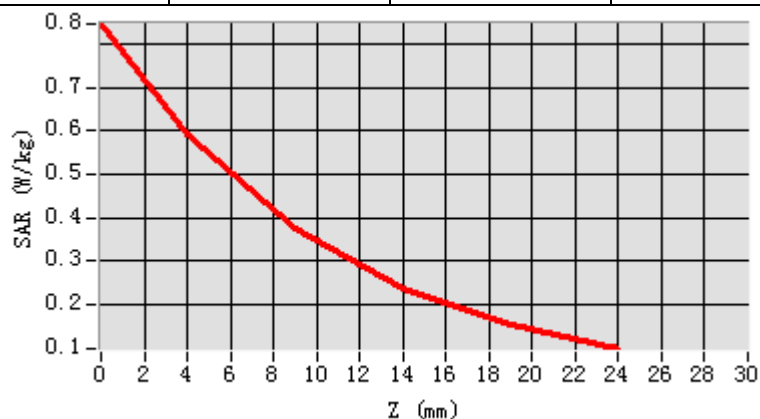


Maximum location: X=9.00, Y=24.00 SAR Peak: 0.80 W/kg

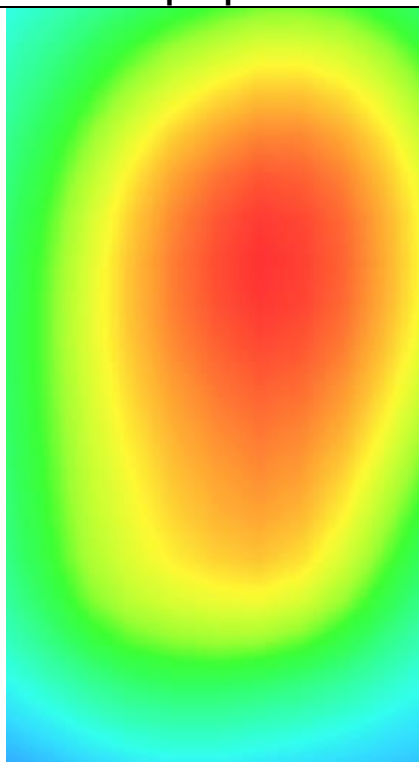
SAR 10g (W/Kg)	0.293649
SAR 1g (W/Kg)	0.594936



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.8471	0.5922	0.3744	0.2385	0.1553



Hot spot position



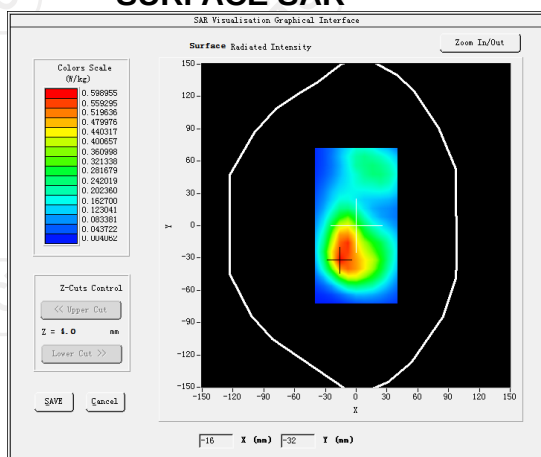
MEASUREMENT 3

Low Band SAR (Channel 1):

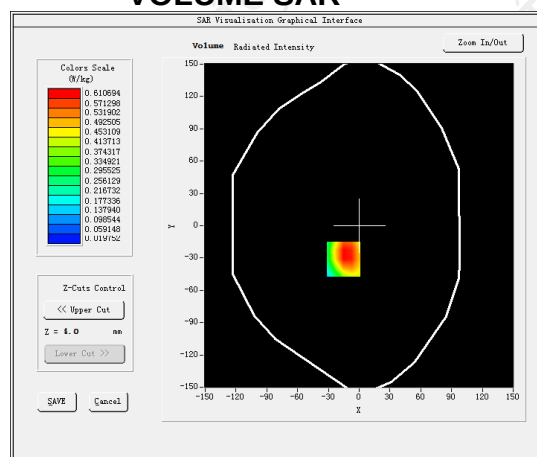
Date: 08/22/2024

Frequency (MHz)	2412.000000
Relative permittivity (real part)	37.821613
Relative permittivity (imaginary part)	13.546980
Conductivity (S/m)	1.834111
Variation (%)	-2.110000
Crest Factor	1.0
Probe Conversion factor	2.31
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back-open(10mm)
Band	<u>IEEE 802.11b ISM(hotspot)</u>

SURFACE SAR

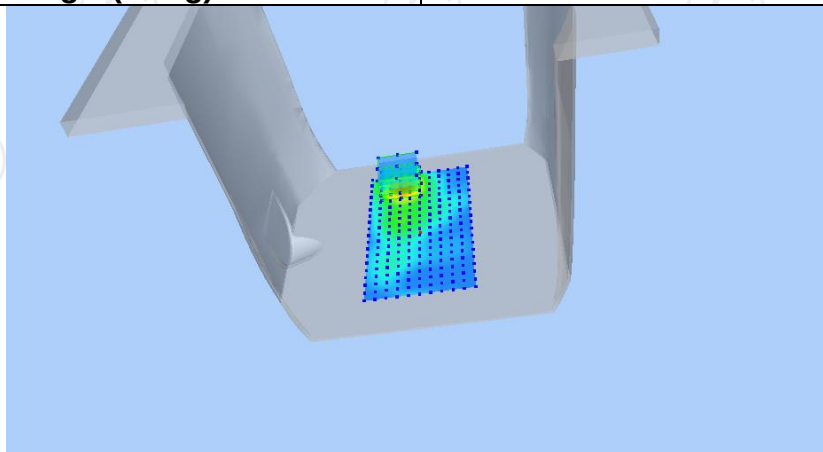


VOLUME SAR

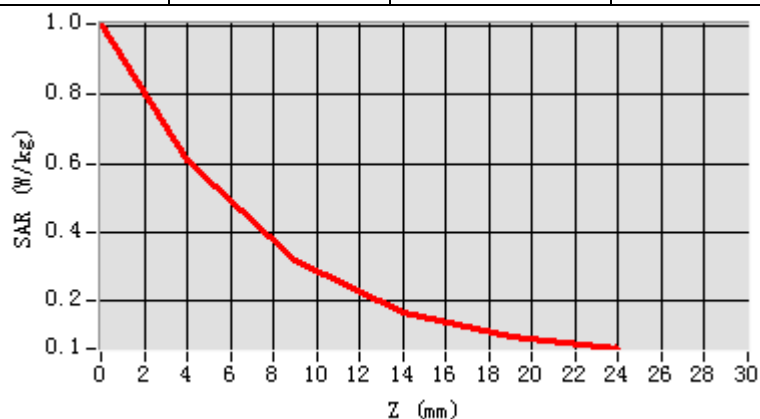


Maximum location: X=-11.00, Y=-21.00 SAR Peak: 1.00 W/kg

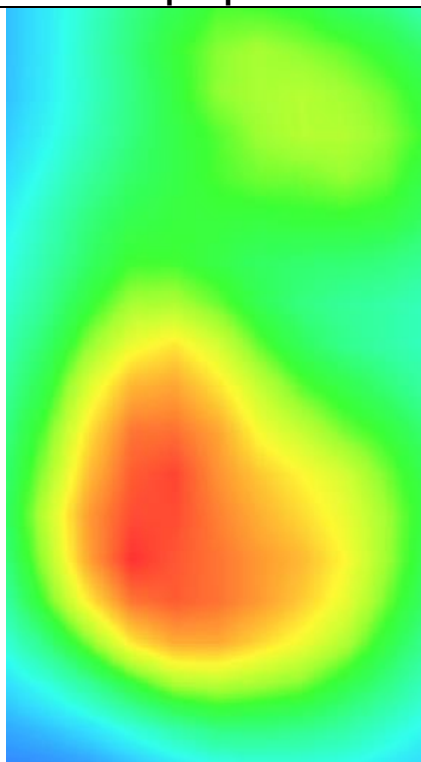
SAR 10g (W/Kg)	0.314186
SAR 1g (W/Kg)	0.508980



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.0090	0.6082	0.3139	0.1660	0.0970

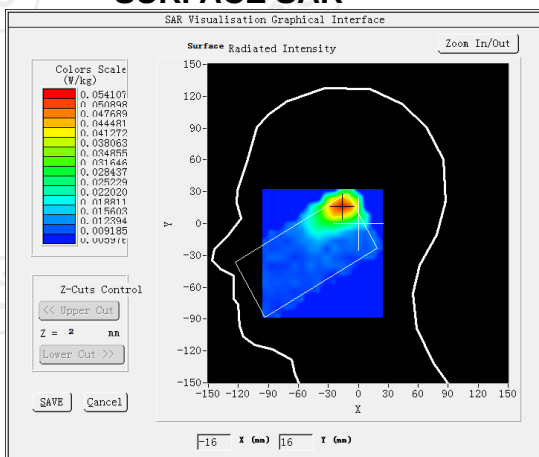
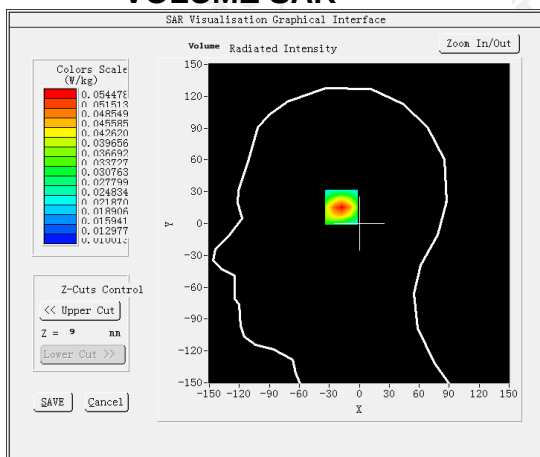
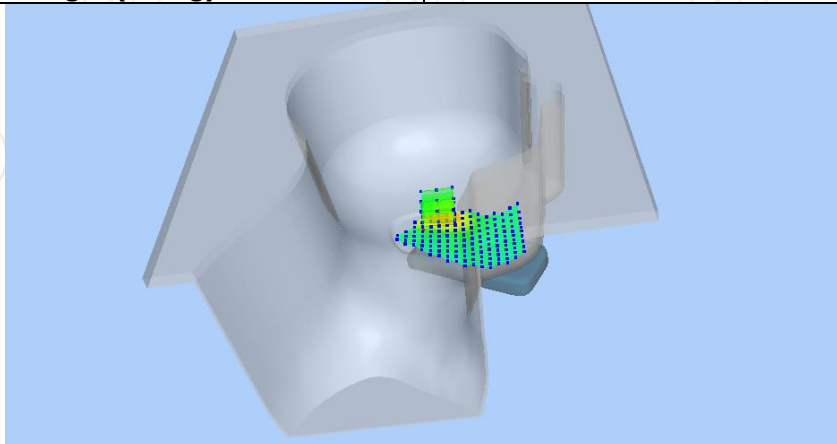


Hot spot position

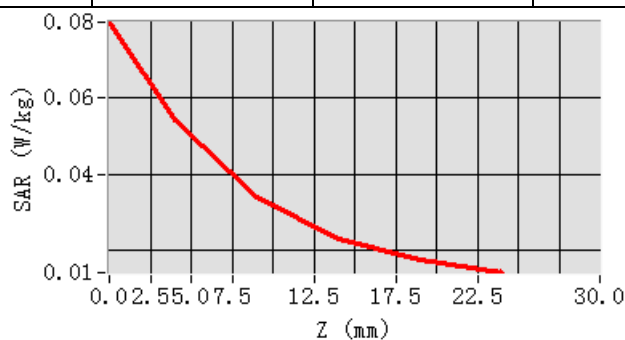


BT

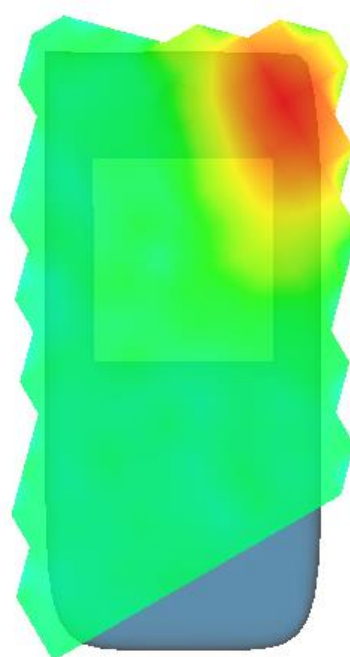
MEASUREMENT 1

Low Band SAR (Channel 0):		Date: 08/22/2024
Frequency (MHz)	2402.000000	
Relative permittivity (real part)	37.821613	
Relative permittivity (imaginary part)	13.546980	
Conductivity (S/m)	1.834111	
Variation (%)	1.620000	
Crest Factor	1.0	
Probe Conversion factor	2.31	
E-Field Probe:	SSE2 (SN 25/22 EPG0375)	
Area Scan	dx=12mm dy=12mm, h= 5.00 mm	
ZoomScan	5x5x7,dx=5mm dy=5mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm	
Phantom	Left head	
Device Position	Cheek	
Band	GFSK	
SURFACE SAR		VOLUME SAR
		
Maximum location: X=-16.00, Y=17.00 SAR Peak: 0.08 W/kg		
SAR 10g (W/Kg)		0.033054
SAR 1g (W/Kg)		0.053621
		

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0800	0.0545	0.0342	0.0231	0.0175



Hot spot position



MEASUREMENT 2

Low Band SAR (Channel 0):

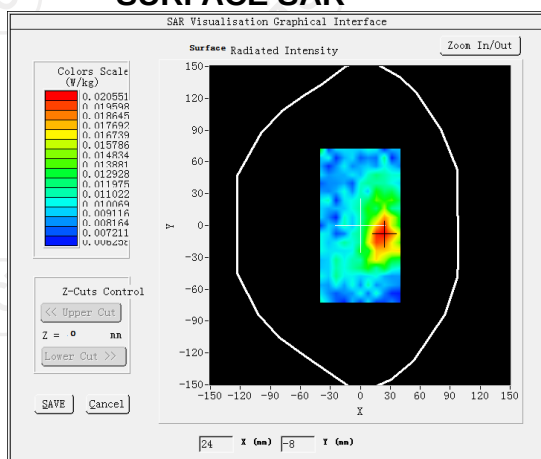
Date: 08/22/2024

Frequency (MHz)	2402.000000
Relative permittivity (real part)	37.821613
Relative permittivity (imaginary part)	13.546980
Conductivity (S/m)	1.834111
Variation (%)	0.890000
Crest Factor	1.0
Probe Conversion factor	2.31
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

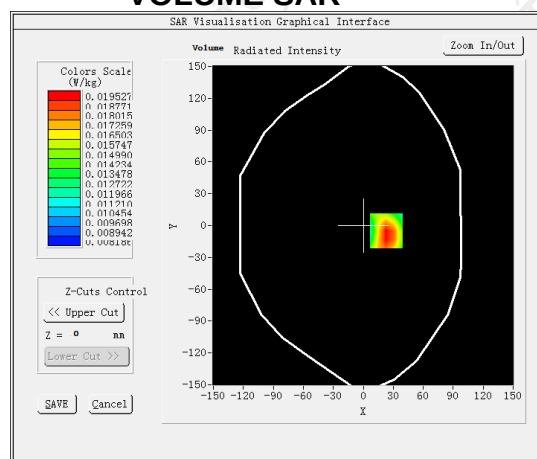
Phantom	Validation plane
Device Position	Body back-open(10mm)

Band	GFSK
------	------

SURFACE SAR



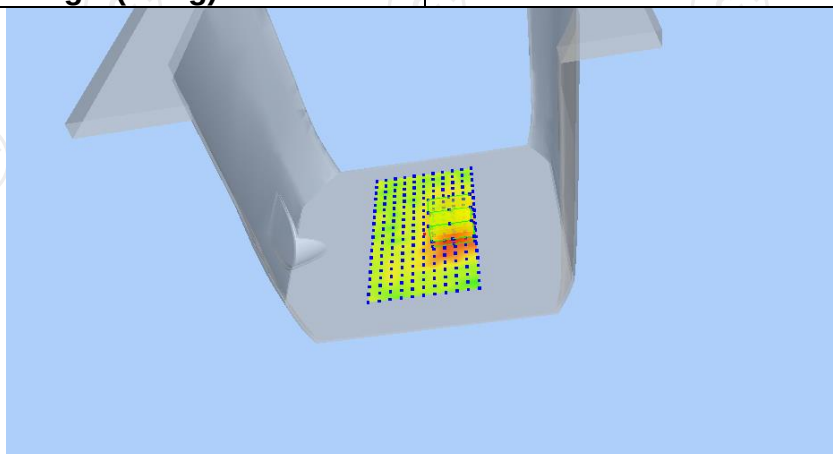
VOLUME SAR



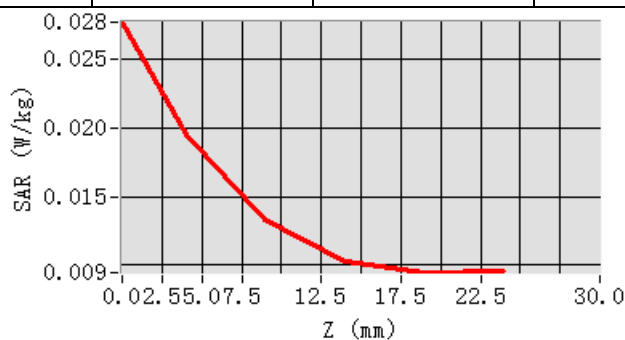
Maximum location: X=23.00, Y=-5.00 SAR Peak: 0.03 W/kg

SAR 10g (W/Kg)	0.014125
----------------	----------

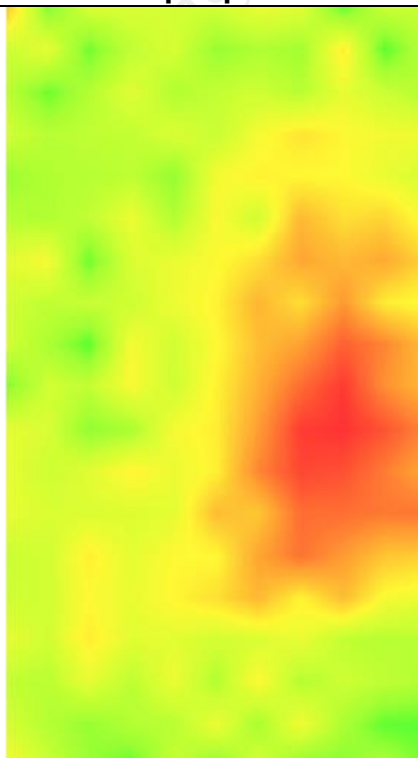
SAR 1g (W/Kg)	0.020616
---------------	----------



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0277	0.0195	0.0133	0.0103	0.0095



Hot spot position



Appendix A: EUT Photos



Liquid depth



The Body Liquid of 835MHz (15.4cm)



The Body Liquid of 1800MHz (15.2 cm)



The Body Liquid of 1900MHz (16.4 cm)



The Body Liquid of 2450MHz (15.3cm)

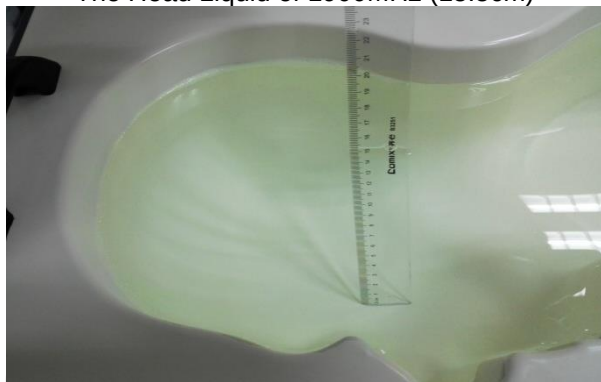
The Body Liquid of 2600MHz (16.5cm)



The Head Liquid of 1900MHz (15.5cm)



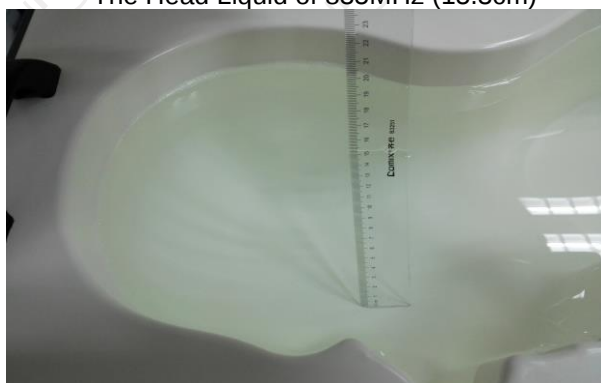
The Head Liquid of 2450MHz (15.6cm)



The Head Liquid of 835MHz (15.3cm)

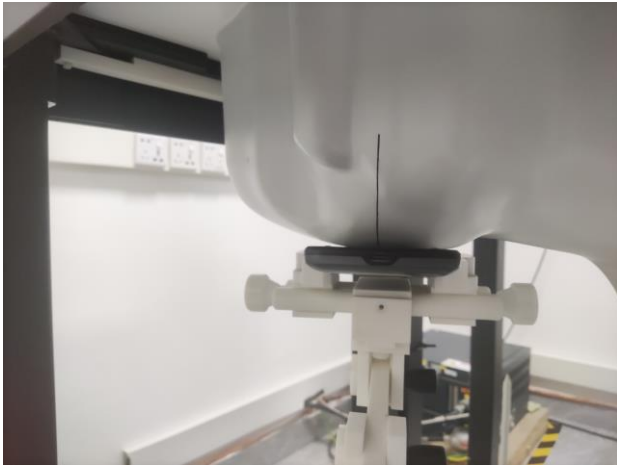


The Head Liquid of 1800MHz (15.2cm)



The Head Liquid of 2600MHz (15.1cm)

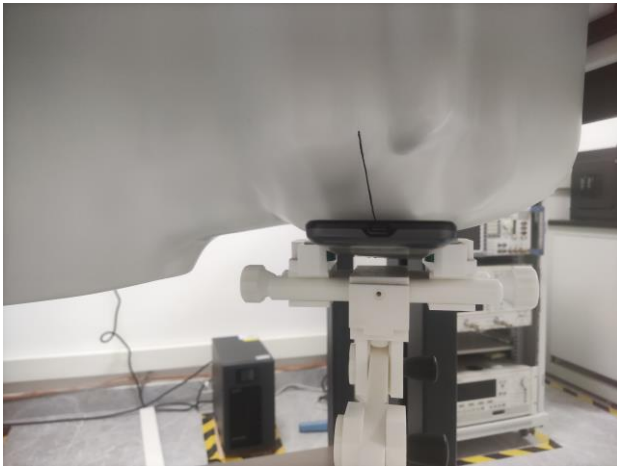
Appendix B: Test Setup Photos



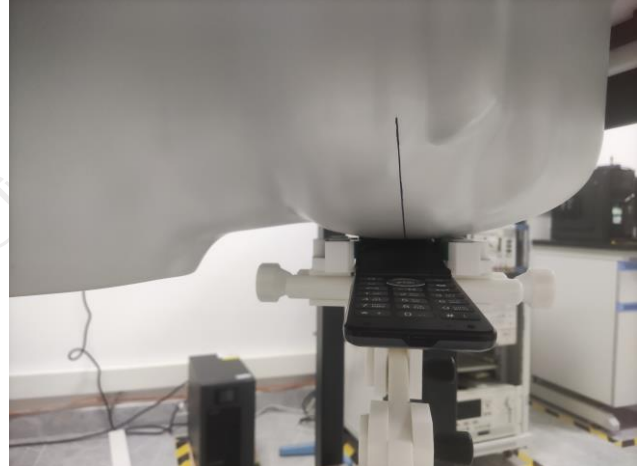
Right Cheek



Right Tilted



Left Cheek



Left Tilted



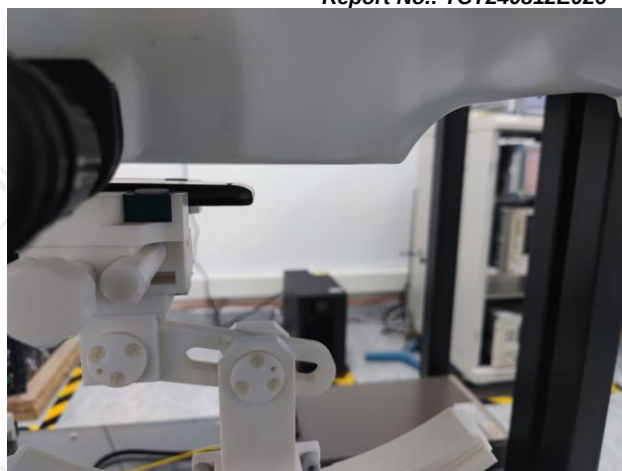
Body worn – Front close (10mm)



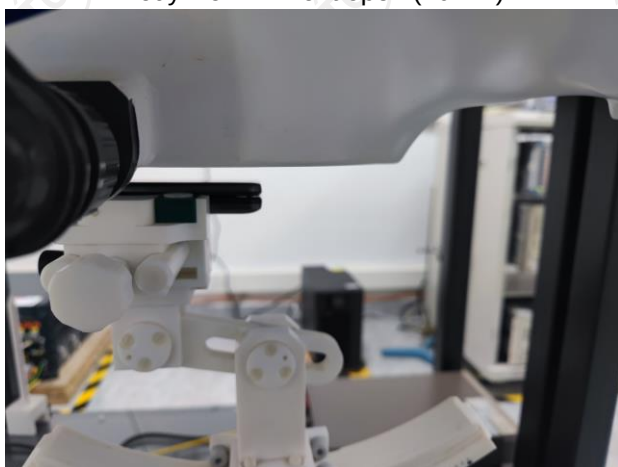
Body worn – Back close (10mm)



Body worn – Front open (10mm)



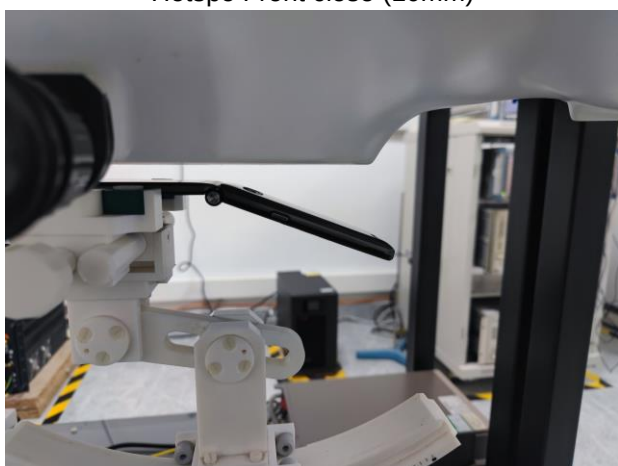
Body worn – Back open (10mm)



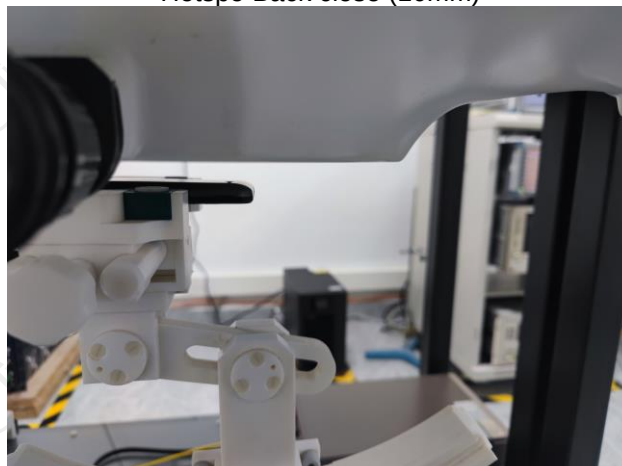
Hotspo Front close (10mm)



Hotspo Back close (10mm)



Hotspo Front open (10mm)



Hotspo Back open (10mm)



Hotspot Top close (10mm)



Hotspot Right close (10mm)



Hotspot Bottom close (10mm)



Hotspot Left close (10mm)



Hotspot Right open (10mm)



Hotspot Left open (10mm)



Hotspot Bottom open (10mm)

Appendix C: Probe Calibration Certificate

COMOSAR E-FIELD Probe



COMOSAR E-Field Probe Calibration Report

Ref : ACR.180.7.22.BES.B

SHENZHEN TONGCE TESTING LAB

2101 & 2201, ZHENCHANG FACTORY RENSHAN INDUSTRIAL
ZONE, FUHAI SUBDISTRICT, BAO'AN DISTRICT SHENZHEN,
GUANGDONG, 518103, PEOPLE'S REPUBLIC OF CHINA

MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 25/22 EPG0375

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 06/29/2024



Accreditations #2-6789
Scope available on www.cofrac.fr

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Summary:

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed at MVG, using the CALIPROBE test bench, for use with a MVG COMOSAR system only. The test results covered by accreditation are traceable to the International System of Units (SI).

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

	Name	Function	Date	Signature
Prepared by :	Jérôme Le Gall	Measurement Responsible	6/30/2024	
Checked & approved by:	Jérôme Luc	Technical Manager	6/30/2024	
Authorized by:	Yann Toutain	Laboratory Director	7/05/2024	

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Name	Date	Modifications
A	Jérôme Le Gall	6/30/2024	Initial release

Page: 2/11

Template_ACR.DDD.N.YY.MVGB.ISSUE_COMOSAR Probe vK

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 25/22 EPGO375
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.197 MΩ Dipole 2: R2=0.230 MΩ Dipole 3: R3=0.208 MΩ

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards.



Figure 1 – MVG COMOSAR Dosimetric E field Probe

Probe Length	330 mm
Length of Individual Dipoles	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 mm

3 MEASUREMENT METHOD

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

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3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 to 360 degrees in 15-degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

3.1 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

The boundary effect uncertainty can be estimated according to the following uncertainty approximation formula based on linear and exponential extrapolations between the surface and $d_{be} + d_{step}$ along lines that are approximately normal to the surface:

$$SAR_{uncertainty} [\%] = \Delta SAR_{be} \frac{(d_{be} + d_{step})^2}{2d_{step}} \frac{(e^{-d_{be}/(\delta/2)})}{\delta/2} \quad \text{for } (d_{be} + d_{step}) < 10 \text{ mm}$$

where

$SAR_{uncertainty}$ is the uncertainty in percent of the probe boundary effect

d_{be} is the distance between the surface and the closest *zoom-scan* measurement point, in millimetre

Δ_{step} is the separation distance between the first and second measurement points that are closest to the phantom surface, in millimetre, assuming the boundary effect at the second location is negligible

δ is the minimum penetration depth in millimetres of the head tissue-equivalent liquids defined in this standard, i.e., $\delta \approx 14$ mm at 3 GHz;

ΔSAR_{be} in percent of SAR is the deviation between the measured SAR value, at the distance d_{be} from the boundary, and the analytical SAR value.

The measured worst case boundary effect SAR uncertainty[%] for scanning distances larger than 4mm is 1.0% Limit ,2%).



4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide

ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Expanded uncertainty 95 % confidence level $k = 2$					14 %

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters

Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
0.64	0.53	0.44

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
106	108	109

Calibration curves $e_i=f(V)$ ($i=1,2,3$) allow to obtain E-field value using the formula:

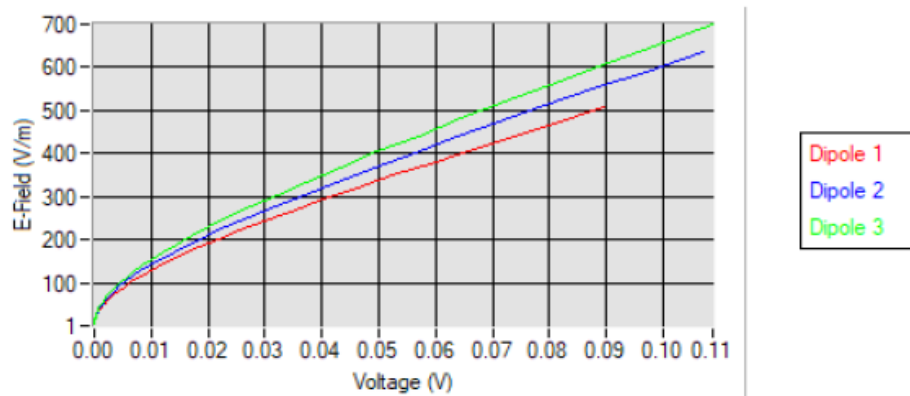
$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$



COMOSAR E-FIELD PROBE CALIBRATION REPORT

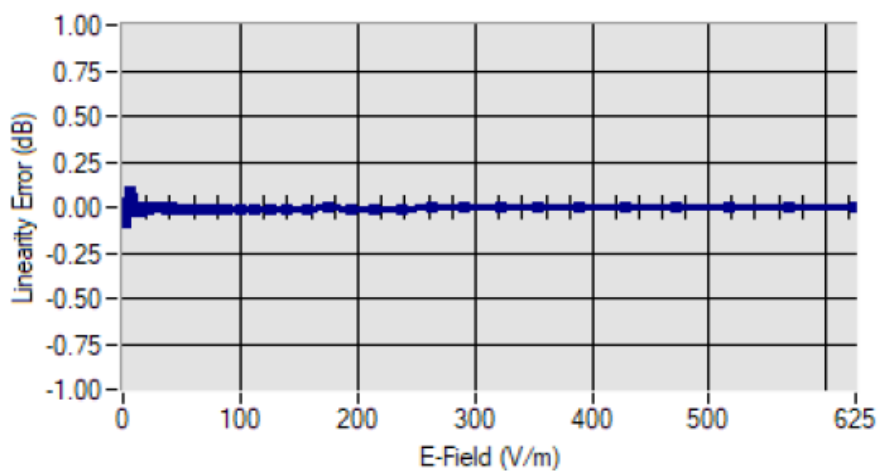
Ref: ACR.180.7.22.BES.B

Calibration curves



5.2 LINEARITY

Linearity



Linearity: +/-1.94% (+/-0.09dB)



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	ConvF
HL750	750	1.71
BL750	750	1.78
HL900	900	1.91
BL900	900	1.96
HL1800	1800	2.08
BL1800	1800	2.16
HL2000	2000	2.03
BL2000	2000	2.10
HL2450	2450	2.31
BL2450	2450	2.37
HL2600	2600	2.16
BL2600	2600	2.23
HL3500	3500	2.21
BL3500	3500	2.28
HL3700	3700	3.45
BL3700	3700	3.15
HL4600	4600	3.30
BL4600	4600	3.70
HL5200	5200	2.01
BL5200	5200	2.08
HL5600	5600	2.07
BL5600	5600	2.12
HL5800	5800	2.06
BL5800	5800	2.13

LOWER DETECTION LIMIT: 7mW/kg

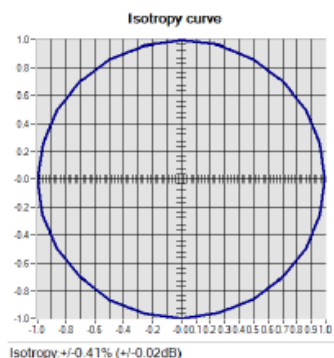


COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

5.4 ISOTROPY

HL1800 MHz





6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
CALIPROBE Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2024
Network Analyzer	Agilent 8753ES	MY40003210	10/2023	10/2026
Network Analyzer – Calibration kit	HP 85033D	3423A08186	06/2021	06/2027
Multimeter	Keithley 2000	1160271	02/2023	02/2026
Signal Generator	Rohde & Schwarz SMB	106589	03/2022	03/2025
Amplifier	MVG	MODU-023-C-0002	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	06/2024	06/2027
Power Meter	Rohde & Schwarz NRVD	832839-056	11/2023	11/2026
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	MVG	SN 32/16 WG4_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_0G900_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG6_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_1G500_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG8_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_1G800B_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_1G800H_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG10_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_3G500_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG12_1	Validated. No cal required.	Validated. No cal required.

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

Liquid transition	MVG	SN 32/16 WGLIQ_5G000_1	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2024	06/2027

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Dielectric Probe Calibration Report

Ref: ACR.138.4.33.SATU.A

SHENZHEN TONGCE TESTING LAB
2101&2201, ZHENCHANG FACTORY, RENSHAN
INDUSTRIAL ZONE, FUHAI SUBDISTRICT, BAOAN
DISTRICT, SHENZHEN, GUANGDONG, 518103,
PEOPLES REPUBLIC OF CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE

FREQUENCY: 0.3-6 GHZ
SERIAL NO.: SN 19/15 OCPG 71

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/05/2024

Summary:

This document presents the method and results from an accredited Dielectric Probe calibration performed in MVG USA using the LIMESAR test bench. All calibration results are traceable to national metrology institutions.



SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	06/05/2024	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	06/05/2024	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	06/05/2024	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	SHENZHEN TONGCE TESTING LAB

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	06/05/2024	Initial release

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SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

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SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

1 INTRODUCTION

This document contains a summary of the suggested methods and requirements set forth by the IEEE 1528 and CEI/IEC 62209 standards for liquid permittivity measurements and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	LIMESAR DIELECTRIC PROBE
Manufacturer	MVG
Model	SCLMP
Serial Number	SN 19/15 OCPG 71
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's Dielectric Probes are built in accordance to the IEEE 1528 and CEI/IEC 62209 standards. The product is designed for use with the LIMESAR test bench only.



Figure 1 – MVG LIMESAR Dielectric Probe

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4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209-1 & 2 standards outline techniques for dielectric property measurements. The LIMESAR test bench employs one of the methods outlined in the standards, using a contact probe or open-ended coaxial transmission-line probe and vector network analyzer. The standards recommend the measurement of two reference materials that have well established and stable dielectric properties to validate the system, one for the calibration and one for checking the calibration. The LIMESAR test bench uses De-ionized water as the reference for the calibration and either DMS or Methanol as the reference for checking the calibration. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 LIQUID PERMITTIVITY MEASUREMENTS

The permittivity of a liquid with well established dielectric properties was measured and the measurement results compared to the values provided in the fore mentioned standards.

5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

5.1 DIELECTRIC PERMITTIVITY MEASUREMENT

The following uncertainties apply to the Dielectric Permittivity measurement:

Uncertainty analysis of Permittivity Measurement					
ERROR SOURCES	Uncertainty value (+/- %)	Probability Distribution	Divisor	ci	Standard Uncertainty (+/- %)
Repeatability (n repeats, mid-band)	4.00%	N	1	1	4.000%
Deviation from reference liquid	5.00%	R	$\sqrt{3}$	1	2.887%
Network analyser-drift, linearity	2.00%	R	$\sqrt{3}$	1	1.155%
Test-port cable variations	0.00%	U	$\sqrt{2}$	1	0.000%
Combined standard uncertainty					5.066%
Expanded uncertainty (confidence level of 95%, $k = 2$)					10.0%

Uncertainty analysis of Conductivity Measurement					
ERROR SOURCES	Uncertainty value (+/- %)	Probability Distribution	Divisor	ci	Standard Uncertainty (+/- %)
Repeatability (n repeats, mid-band)	3.50%	N	1	1	3.500%
Deviation from reference liquid	3.00%	R	$\sqrt{3}$	1	1.732%
Network analyser-drift, linearity	2.00%	R	$\sqrt{3}$	1	1.155%
Test-port cable variations	0.00%	U	$\sqrt{2}$	1	0.000%
Combined standard uncertainty					4.072%
Expanded uncertainty (confidence level of 95%, $k = 2$)					8.1%

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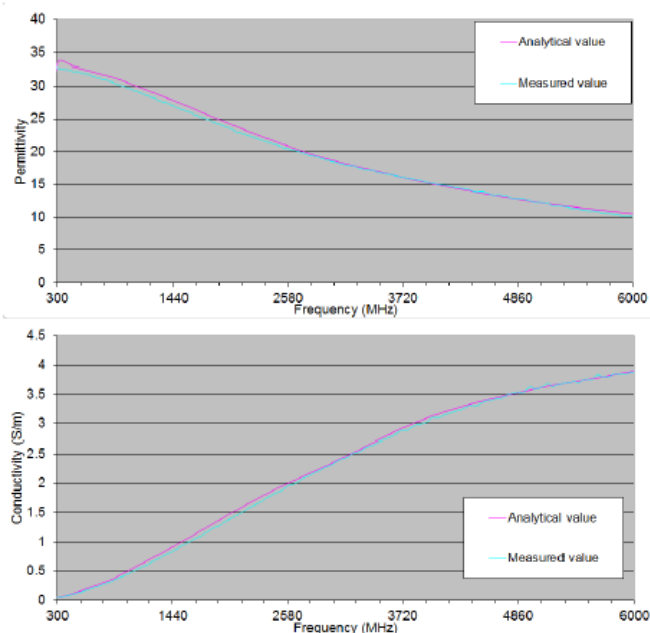
6 CALIBRATION MEASUREMENT RESULTS

Measurement Condition

Software	LIMESAR
Liquid Temperature	21°C
Lab Temperature	21°C
Lab Humidity	44%

6.1 LIQUID PERMITTIVITY MEASUREMENT

A liquid of known characteristics (methanol at 20°C) is measured with the probe and the results (complex permittivity $\epsilon' + j\epsilon''$) are compared with the well-known theoretical values for this liquid.



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