UltraTech
Group of Labs

November 29, 2000

ICOM Incorporated
1-6-19 Kamikurazukuri Hirano-Ku
Osaka, Japan, 547

Attn.: **Mr. Tadashi Maebayshi**

Subject: **Verification Testing in accordance with SAR (Specific Absorption Rate) requirements using guidelines established in:**

IEEE C95.1-1991,
FCC OET Bulletin 65 (Supplement C)
Industry Canada RSS-102 (Issue 1)
ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)

Product: **UHF Transceiver**
Model: **IC-F4GS-3**

Dear Mr. Maebayshi

The product sample has been tested in accordance with **SAR (Specific Absorption Rate) requirements using guidelines established in IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C), Industry Canada RSS-102(Issue 1) and ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1),** and the results and observation were recorded in the engineering report, Our File No.: ICOM-021-SAR

Enclosed you will find a copy of the engineering report. If you have any queries, please do not hesitate to contact us.

Yours truly,

Tri Minh Luu, P.Eng
Vice President - Engineering

Encl.

3000 Bristol Circle,
Oakville, Ontario, Canada
L6H 6G4

Telephone (905) 829-1570
Facsimile (905) 829-8050

CERTIFICATE OF COMPLIANCE

November 29, 2000 File No.: ICOM-021-SAR

ICOM Incorporated
1-6-19 Kamikurazukuri Hirano-Ku
Osaka, Japan, 547

NOT TRANSFERABLE

This Verification Certificate is hereby issued to the named GRANTEE and is VALID ONLY for the equipment identified hereon for use under the rules and regulations listed below:

GRANTEE'S NAME:	**ICOM Incorporate**
PRODUCT UNDER TEST:	**UHF Transceiver**
MODEL NO.:	**IC-F4GS-3**
FCC ID:	**AFJ IC-F4G-3**
OPERATING FREQUENCY RANGE:	**470.100-499.900 MHz**
NOMINAL RF OUTPUT POWER:	**4.0 W Peak/Average**
MAXIMUM S.A.R.:	**4.671 W/Kg**

APPLICABLE STANDARDS: **SAR (Specific Absorption Rate) requirements using guidelines established in IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C), Industry Canada RSS-102 (Issue 1) and ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)**

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST Technology (NIST)*

Approved by: Tri M. Luu, P.Eng.
V.P. – Engineering

UltraTech

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ENGINEERING TEST REPORT

UHF Transceiver
Model No.: IC-F4GS-3

Tested For

ICOM Incorporated
1-6-19 Kamikurazukuri Hirano-Ku
Osaka, Japan, 547

In Accordance With

SAR (Specific Absorption Rate) Requirements
using guidelines established in IEEE C95.1-1991,
FCC OET Bulletin 65 (Supplement C),
Industry Canada RSS-102 (Issue 1) and
ACA Radiocommunications (Electromagnetic Radiation – Human Exposure)
Amendment Standard 2000 (No. 1)

UltraTech's File No.: ICOM-021-SAR

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: November 29, 2000	
Report Prepared by: Carolyn Luu Issued Date: November 29, 2000	Tested by: JaeWook Choi Test Dates: November 11, 2000

The results in this Test Report apply only to the sample(s) tested, which has been randomly selected.

UltraTech

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ANNEX D: Tissue Calibration

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	SAR (Specific Absorption Rate) Requirements IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C) Industry Canada RSS-102 (Issue 1). ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)
Title	Safety Levels with respect to human exposure to Radio Frequency Electromagnetic Fields Guideline for Evaluating the Environmental Effects of Radio Frequency Radiation
Purpose of Test:	To show compliance with Federal regulated SAR requirements in Canada and the US.
Method of Measurements:	IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C) and Industry Canada RSS-102(Issue 1)
Exposure Category	[ ] General population, uncontrolled exposure **[X] occupational, controlled exposure**

1.2. REFERENCES

The methods and procedures used for the measurements contained in this report are details in the following reference standards:

Publications	**Year**	**Title**
Industry Canada RSS102	1999	"Evaluation Procedure for Mobile and Portable Radio Transmitters with respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields"
ACA	2000	ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)
NCRP Report No.86	1986	"Biological Effects and Exposure Criteria for radio Frequency Electromagnetic Fields"
FCC OET Bulletin 65	1997	"Evaluating Compliance with FCC Guidelines for Human Exposure to radio Frequency Fields"
ANSI/IEEE C95.3	1992	"Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave"
ANSI/IEEE C95.1	1992	"Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz"
AS/NZS 2722.1	1998	Interim Australian/New Zealand Standard. "Radiofrequency fields, Part 1:Maximum exposure levels – 3kHz to 300GHz "

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT AND MANUFACTURER INFORMATION

APPLICANT:	
Name:	ICOM Incorporated
Address:	1-6-19 Kamikurazukuri Hirano-Ku Osaka, Japan , 547
Contact Person:	Mr. Tadashi Maebayshi Phone #: 011-816793-5302 Fax #: 011-816793-0013 Email Address: export@icom.co.jp

MANUFACTURER:	
Name:	ICOM Incorporated
Address:	1-6-19 Kamikurazukuri Hirano-Ku Osaka, Japan, 547
Contact Person:	ICOM Incorporated Phone #: 011-816793-5302 Fax #: 011-816793-0013 Email Address: export@icom.co.jp

2.2. DEVICE UNDER TEST (DUT) DESCRIPTION

The following information are supplied by the applicant.

Trade Name	ICOM Inc.
Type/Model Number	IC-F4GS-3
Serial Number	00108
Type of Equipment	UHF Transceiver
Frequency of Operation	470.100-499.900 MHz
Rated RF Power	4.0 W
Duty Cycle	50 %
Modulation Employed	Frequency Modulation
Antenna Type	Monopole
External Power Supply	Ni-MH Battery (7.2V/1650mAh) Ni-Cd Battery (7.2V/1100mAh)
Primary User Functions of DUT:	Voice Radio Communication Through Air

2.3. LIST OF DUT'S ACCESSORIES:

<Battery Charger, BC-137 >

<AC adapter, BC-122>

<Battery Charger, BC-119 + AD-94>

<AC adapter BC-124 >

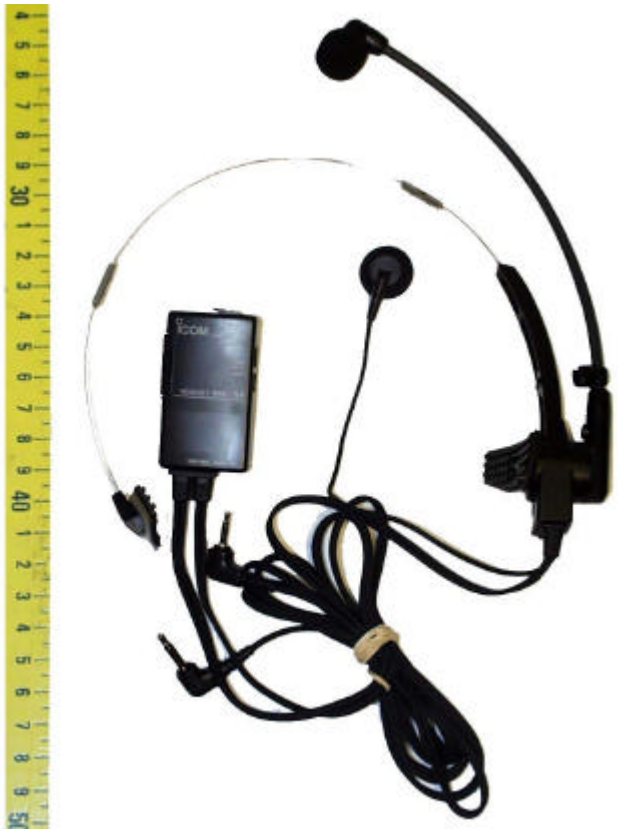
< Battery pack : Ni-MH 7.2V/1650mAh, BP-210 >

< Battery pack : Ni-Cd 7.2V/1100mAh, BP-209 >

< Speaker Microphone, HM-46L>

< Belt clip, MB-68 >

< Belt clip(alligator type), MB-74 >



<Headset, HS-51>

2.4. SPECIAL CHANGES ON THE DUT'S HARDWARE/SOFTWARE FOR TESTING PURPOSES

None

2.5. ANCILLARY EQUIPMENT

Battery Charger, Belt Clip, AC Adapter, Battery NI-Cd-7.2V/1100mAh, Battery Ni-MH-7.2V/1650mAh, Headset, Speaker microphone

2.6. GENERAL TEST CONFIGURATIONS

2.6.1. Equipment Configuration

Power and signal distribution, grounding, interconnecting cabling and physical placement of equipment of a test system shall simulate the typical application and usage in so far as is practicable, and shall be in accordance with the relevant product specifications of the manufacturer.

The configuration that tends to maximize the DUT's emission or minimize its immunity is not usually intuitively obvious and in most instances selection will involve some trial and error testing. For example, interface cables may be moved or equipment re-orientated during initial stages of testing and the effects on the results observed.

Only configurations within the range of positions likely to occur in normal use need to be considered.

The configuration selected shall be fully detailed and documented in the test report, together with the justification for selecting that particular configuration.

2.6.2. Exercising Equipment

The exercising equipment and other auxiliary equipment shall be sufficiently decoupled from the EUT so that the performance of such equipment does not significantly influence the test results.

2.7. SPECIFIC OPERATING CONDITIONS

Not specified.

2.8. BLOCK DIAGRAM OF TEST SETUP

The EUT was configured as normal intended use. The following block diagram shows the equipment arrangement during tests:

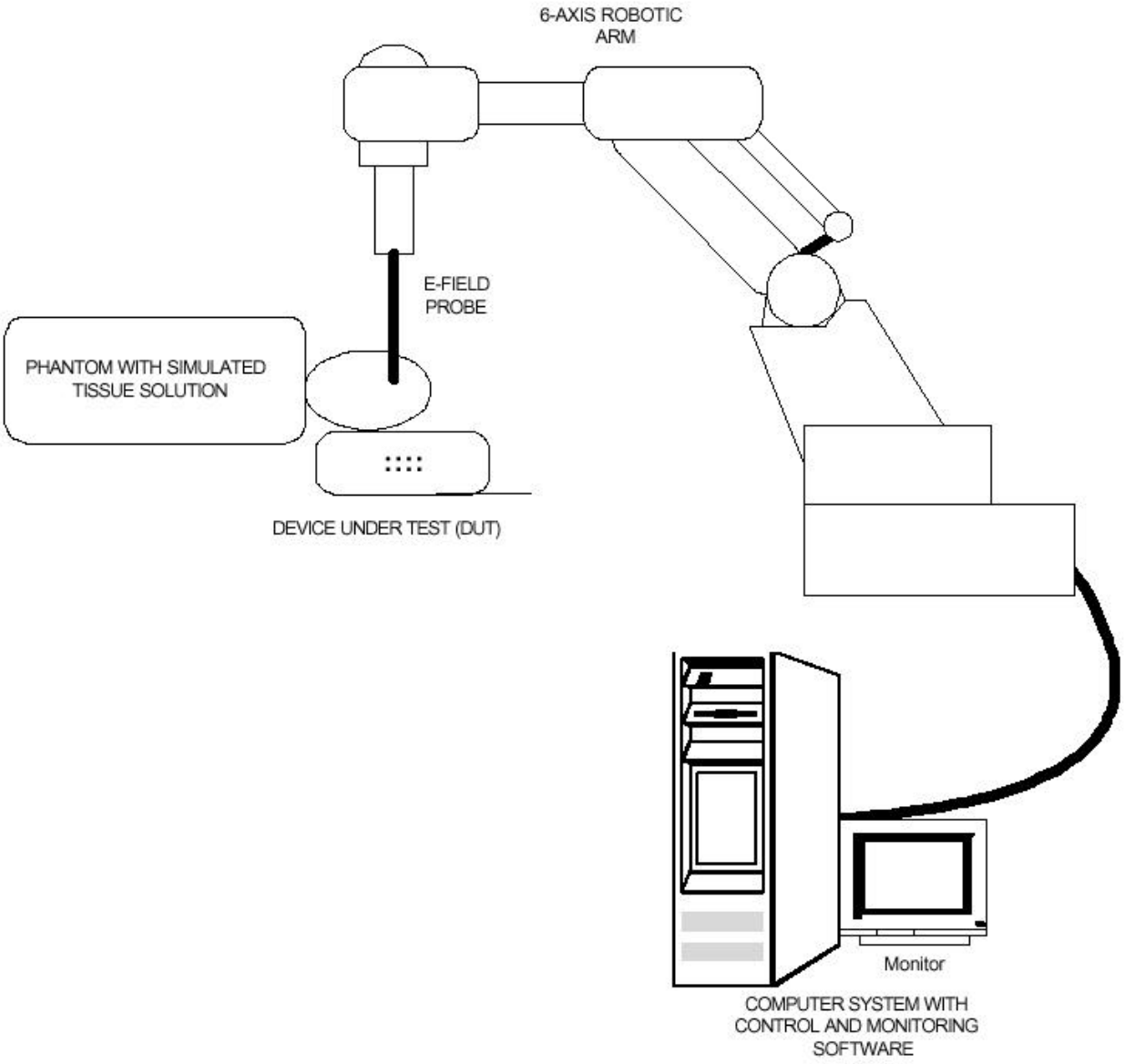


EXHIBIT 3. SUMMARY OF TEST RESULTS

3.1. LOCATION OF TESTS

All of the measurements described in this report were performed at UltraTech Group of Labs located in:

3000 Bristol Circle, Oakville, Ontario, Canada.

3.2. APPLICABILITY & SUMMARY OF SAR RESULTS

The peak spatial - average SAR measured was found to be 4.671W/Kg

SAR Limits	Test Requirements	Compliance (Yes/No)
General population/Uncontrolled exposure 0.08W/kg whole body average and spatial peak SAR of 1.6W/kg, averaged over 1gram of tissue Hands, wrist, feet and ankles have a peak SAR not to exceed 4 W/kg, averaged over 10 grams of tissue.	Requirements using guidelines established in IEEE C95.1-1991 FCC OET Bulletin 65 (Supplement C) Industry Canada RSS-102 (Issue 1). ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)	N/A
Occupational/Controlled Exposure 0.4W/kg whole body average and spatial peak SAR of 8W/kg, averaged over 1gram of tissue Hands, wrist, feet and ankles have a peak SAR not to exceed 20 W/kg, averaged over 10 grams of tissue.	Requirements using guidelines established in IEEE C95.1-1991 FCC OET Bulletin 65 (Supplement C), Industry Canada RSS-102 (Issue 1) ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)	Yes

EXHIBIT 4. MEASUREMENTS, EXAMINATIONS & TEST DATA

4.1. TEST SETUP

EUT Information		Condition	
Radio Type	UHF Transceiver	Robot Type	6 Axis
Model Number	IC-F4GS-3	Scan Type	SAR
Serial Number	00108	Measured Field	E
Frequency Band (MHz)	470.100-499.900	Phantom Type	Open back full body
Frequency Tested (MHz)	470.100, 485.100, 499.900	Phantom Position	Waist, Head-front
Nominal Output Power (W)	4.0	Room Temperature	25 ± 1 °C
Antenna Type	Attachable Monopole		
Signal Type	CW		
Duty Cycle	50% (Half-duplex type PTT*)		

Type of Tissue	Brain	Muscle		
Target Frequency (MHz)	480	480		
Target Dielectric Constant	48.6	57.4		
Target Conductivity (S/m)	0.62	0.84		
Composition (by weight)	Tap Water (43.40%) Sugar (55.06%) Salt (1.40%) HEC (0.10%) Bactericide (0.05%)	Tap Water (51.16 %) Sugar (46.78 %) Salt (1.49%) HEC (0.52 %) Bactericide (0.05%)		
Measured Dielectric Constant	50.2	58.0		
Measured Conductivity (S/m)	0.65	0.83		
Probe Name	E	E		
Probe Orientation	Isotropic	Isotropic		
Probe Offset (mm)	2.25	2.25		
Sensor Factor	10.8	10.8		
Conversion Factor	0.316	0.452		
Calibration Date (MM/DD/YY)	10/7/99	10/8/99		

* EUT is transmitting with 100% duty cycle but **50% duty factor** can only be applied for truly PTT device, that is using a mechanical switch and the device is designed for PTT that does not have feasibility to be connected to wired lines through an operator.

4.2. PHOTOGRAPH OF EUT

< Front View >

< Rear View >

4.3. PHOTOGRAPHS OF EUT POSITION

*** The worst case test configuration was determined with different orientation of the EUT (Antenna parallel to the phantom and the tip of the antenna in contact with the phantom), belt clips (normal (MN: MB-68) and alligator belt clip (MN: MB-74) and the speaker microphone (MN: HM-46L) or headset (MN: HS-51**). The EUT positioned parallel to the phantom with normal belt clip and headset yield higher SAR reading**.***

< Overview – Waist with the antenna positioned parallel to the phantom and headset >

< Close-up view – Waist with the antenna positioned parallel to the phantom and headset>

< Overview - Head front >

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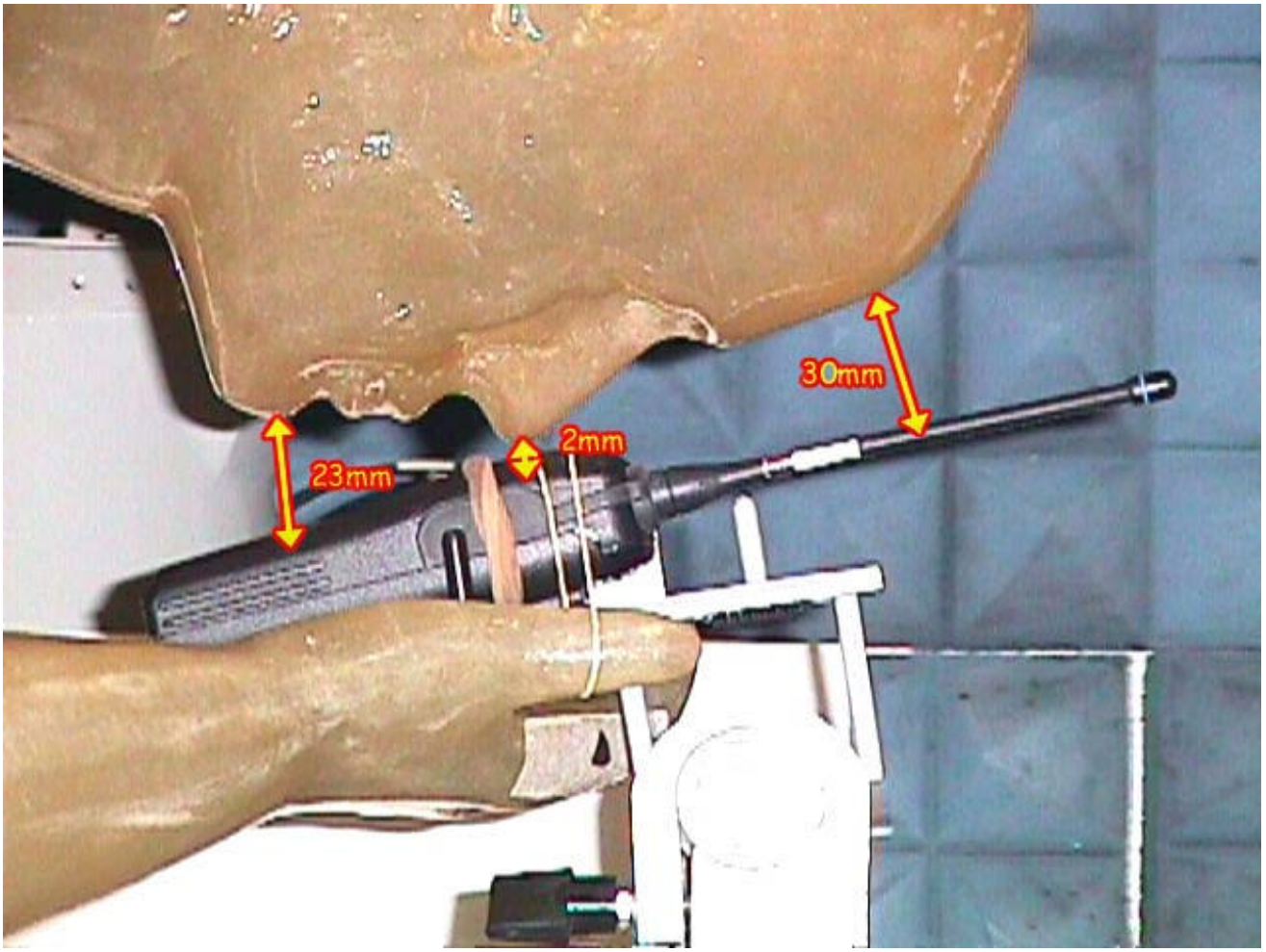
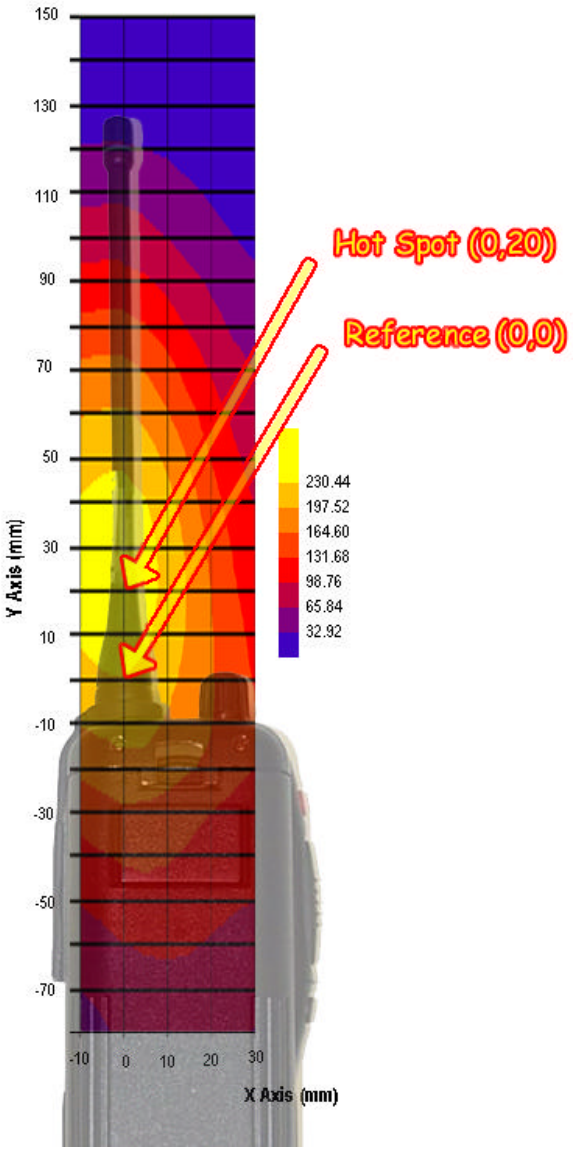


< Close-up view-Head front >

4.4. MAXIMUM FIELD LOCATION (REF. TO. P. 21)



4.5. PEAK SPATIAL-AVERAGE SAR MEASURED

Maximum Field at (0, 20)				
DUT Positioning	Frequency (MHz)	Measured Power (W)	SAR (W/Kg)	DUT Configuration
Waist	470.100	3.99	4.671 (9.342)	Waist with large capacity battery pack

4.6. SAR MEASUREMENT DATA

DUT Positioning	Frequency (MHz)	Measured Power (W)	SAR (W/Kg)	DUT Configuration
Waist	470.100	3.99	4.671 (9.342)	Waist with large capacity battery pack
	485.100	4.03	4.340 (8.681)	
	499.900	4.12	4.015 (8.030)	
Head – Front	470.100	3.93	3.141 (6.283)	Head front with large capacity battery pack
	482.100	3.97	3.240 (6.481)	
	499.900	4.03	3.145 (6.291)	

*** The SAR Measurement inside the parenthesis indicates the reading before 50 % duty factor is applied for the half-duplex type PTT.**
** The worst case test configuration was determined with different orientation of the EUT (Antenna parallel to the phantom and the tip of the antenna in contact with the phantom), belt clips (normal (MN: MB-68) and alligator belt clip (MN: MB-74) and the speaker microphone(MN: HM-46L) or headset(MN: HS-51**). The EUT positioned parallel to the phantom with normal belt clip and headset yield higher SAR reading**.

EXHIBIT 5. SAR SYSTEM CONFIGURATION & TEST METHODOLOGY

5.1. MEASUREMENT SYSTEM SPECIFICATIONS

Positioning Equipment	Probe
Type : 3D Near Field Scanner Location Repeatability : 0.1mm Speed 180 °/sec AC motors	Sensor : E-Field Spatial Resolution : 0.1 cm^3 Isotropic Response : ± 0.25 dB Dynamic Range : 2 μW/g to 100 mW/g
Computer	**Phantom**
Type : 166 MHz Pentium Memory : 32 Meg. RAM Operating System : Windows NT Monitor : 17" SVGA	Tissue : Simulated Tissue with electrical characteristics similar to those of the human at normal body temperature. Shell : Fiberglass human shell shaped (1.5 mm thick)

5.2. TEST PROCEDURES

In the SAR measurement, the positioning of the probes must be performed with sufficient accuracy to obtain repeatable measurements in the presence of rapid spatial attenuation phenomena. The accurate positioning of the E-field probe is accomplished by using a high precision robot. The robot can be taught to position the probe sensor following a specific pattern of points. In a first sweep, the sensor is positioned as close as possible to the interface, with the sensor enclosure touching the inside of the fiberglass shell. The SAR is measured on a grid of points, which covers the curved surface of the phantom in an area larger than the size of the DUT. After the initial scan, a high- resolution grid is used to locate the absolute maximum measured energy point. At this location, attenuation versus depth scan will be accomplished by the measurement system to calculate the SAR value.

5.3. PHANTOM

The phantom used in the evaluation of the RF exposure of the user of the wireless device is a clear fiberglass enclosure 1.5 mm thick, shaped like a human head or body and filled with a mixture simulating the dielectric characteristics of the brain, muscle or other types of human tissue. The maximum width of the cranial model is 17 cm, the cephalic index is 0.7 and the crown circumference of the cranial model is 61 cm. The ear is 6 mm above the outer surface of the shell.

5.4. SIMULATED TISSUE

Simulated Tissue: Suggested in a paper by George Hartsgrove and colleagues in University of Ottawa Ref.: Bioelectromagnetics 8:29-36 (1987)

Ingredient	Quantity
Water	40.4 %
Sugar	56.0 %
Salt	2.5 %
HEC	1.0 %
Bactericide	0.1 %

Table. Example of composition of simulated tissue.

This simulated tissue is mainly composed of water, sugar and salt. At higher frequencies, in order to achieve the proper conductivity, the solution does not contain salt. Also, at these frequencies, D.I. water and alcohol is preferred.

Tissue Density : Approximately 1.25 g/cm^3

5.4.1. Preparation

We determine the volume needs and carefully measure all components. A clean container is used were the ingredients will be mixed. A stirring paddle and a hand drill is used to stir the mixture. First we heat the DI water to about 40 ^{o}C to help the ingredients to dissolve and then we pour the salt and the bactericide. We stir until all the ingredients are completely dissolved. We continue stirring slowly while adding the sugar. We avoid high RPM from the mixing device to prevent air bubbles in the mixture. Later on, we add the HEC to maintain the solution homogeneous. Mixing time is approximately 30 to 40 min.

5.5. MEASUREMENT OF ELECTRICAL CHARACTERISTICS OF SIMULATED TISSUE

1) Network Analyzer HP8753C or others

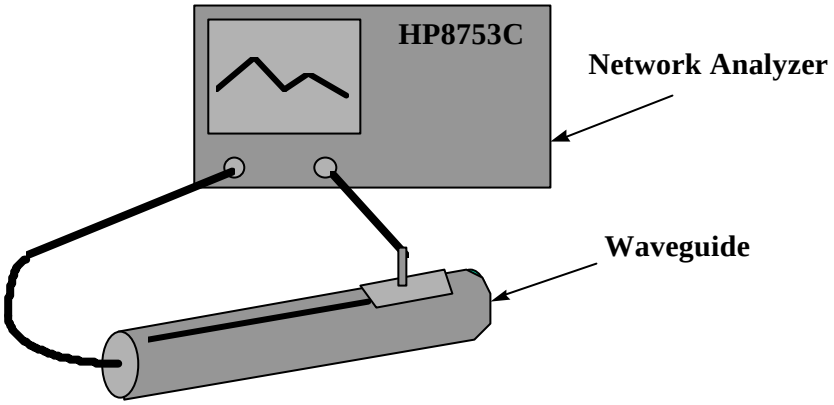
2) Slotted Coaxial Waveguide

5.5.1. Description of the slotted coaxial waveguide

The cylindrical waveguide is constructed with copper tube of about 30 to 40 cm of length, generally 12.5 mm diameter, with connectors at both ends. Inside of this tube, a conductive rod about 6.3 mm is coaxial supported by the two ends connectors (radiator). A slot 3 mm wide start at the beginning of the tube to almost the two third of the tube length. The outer edge of the slotted tube is marked in centimeters (10 to 12) every 1 centimeter, 0.5 if higher frequencies. A saddle piece containing the sampling probe is inserted in the slot so the tip of the probe is close but not in contact with the inner conductor (radiator).

To measure the electrical characteristics of the liquid simulated tissue, we fill the coaxial waveguide, select CW frequency and measure amplitude and phase with the Network Analyzer for every point in the slot (typically 11). An effort is made to keep the results dielectric constant and conductivity within 5 % of published data.

Electrical Characteristics Measurement Setup



$$c = 3 \cdot 10^{8} \text{ m/s}$$

$$A = \frac{\Delta A}{20} \ln_{10} \frac{1}{m}$$

$$\theta = \frac{\Delta\theta \cdot 2\pi}{360}$$

$$\lambda = \frac{c}{f} \cdot \frac{100}{2.54} \text{inches}$$

$$\varepsilon_{re} = \frac{(A^2 + \theta^2) \cdot \lambda^2}{4\pi^2}$$

$$\theta' = \left| \frac{|A| \cdot \lambda}{4\pi \sqrt{\varepsilon_{re}}} \right|$$

$$S = \tan(2\theta')$$

$$\varepsilon_r = \frac{\varepsilon_{re}}{\sqrt{(1 + S^2)}}$$

$$\sigma = S \cdot 2\pi \cdot f \cdot 8.854 \cdot 10^{12} \cdot \varepsilon_r \text{ (S/m)}$$

where;

ΔA is the amplitude attenuation in dB

$\Delta\theta$ is the phase change in degrees for 5 cm of wave propagation in the slotted line

f is the frequency of interest in Hz

5.6. SYSTEM DESCRIPTION

The measurement system consists of an E-field probe, instrumentation amplifiers, RF transparent cable connecting the amplifiers to the computer, the robotics arm with its extension and proximity sensors, a phantom with simulated tissue and a radio holder to support the device under test. The E-field probe is a three channel device used to measure RF electric fields in the near vicinity of the source. The three sensors are mutually orthogonal positioned dipoles, and are constructed over a quartz substrate. Located in the center of the dipole is a Schottky diode. High impedance lines are connecting the sensor to the amplifier and then optically linked to the computer. The probe has an isotropic response and is transparent to the RF fields.

Calibration is performed by two steps:

1) Determination of free space E-field from amplified probe outputs in a test RF field. This calibration is performed in a TEM cell when the frequency is below 1 GHz and in a waveguide or some other methodologies above 1 GHz. For the free space calibration, we place the probe 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. This reading equate to $1mW/cm^2$ if that power density is available in the correspondent cavity.

2) Correlation of the measured free space E-field, to temperature rise in a dielectric medium. E-field temperature correlation calibration is performed in a planar phantom filled with the appropriate simulated tissue.

For temperature correlation calibration, a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe. First, the location of the maximum E-field close to the phantom's inner surface is determined as a function of power into the RF source; in this case, a dipole. Then, the E-field probe is moved sideways so that the temperature probe, while affixed to the E-field probe is placed at the previous location of the E-field probe. Finally, temperature changes for 30 seconds exposure at the same RF power levels used for the E-field measurement are recorded. The following equation relates SAR to initial temperature slope:

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

where:
Δt = exposure time (30 seconds),
C = heat capacity of tissue (brain or muscle),
ΔT = temperature increase due to RF exposure.

The heat capacity used for brain simulated tissue is 2.7 joules/^{0}C/g and 3.0 joules/^{0}C/g for muscle.

SAR is proportional to T / t, the initial rate of tissue heating, before thermal diffusion takes place. Now, it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E-field;

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

where:
σ = Simulated tissue conductivity,
ρ = Tissue density (1.25 g/cm^3 for simulated tissue)

5.7. DATA EXTRAPOLATION (CURVE FITTING)

There is a distance from the center of the sensor (diode) to the end of the protective tube called 'probe offset'. To compensate we use an exponential curve fitting method to obtain the peak surface value from the voltages measured at the distance from the inner surface of the phantom. At the point where the highest voltage was recorded, the field is measured as close as possible to the phantom's surface and every 1mm along the ` Z ` axis for a distance of 50 mm. The appropriate exponential curve is obtained from all the points measured and used to define an exponential decay of the energy density versus depth.

$$E(z) = E_0 \cdot e^{-z/\delta} \text{ (mV)}$$

5.8. INTERPOLATION AND GRAM AVERAGING

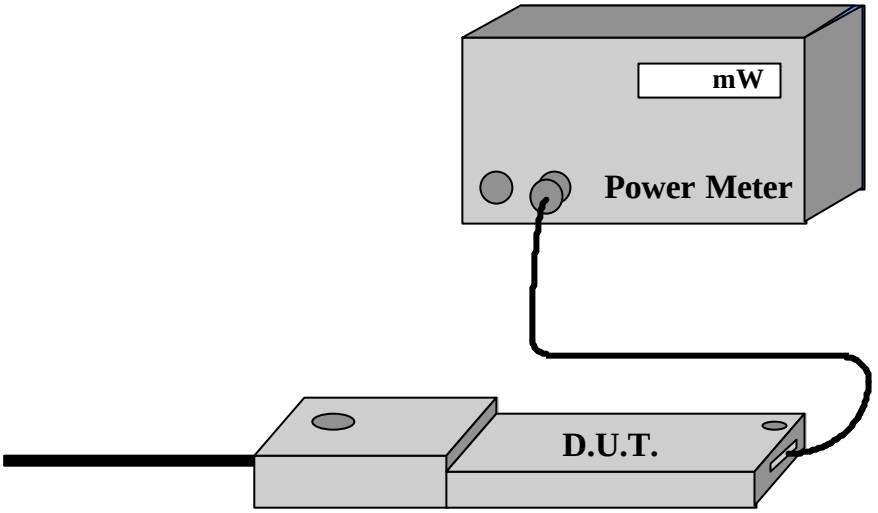
The voltage, (1 cm) above the phantoms surface (E_{tot} 1 cm), is needed to calculate the exposure over one gram of tissue. This SAR value that estimates the average over 1 gram of tissue, is obtained by taking the integral over 1 cm^2 surface of the measured field along the exponential decay curve of the energy density with depth.

$$SAR(mW/g) = \int_{v=1g} SAR(\bullet)dv = \int_{s=1cm^2} \int_0^{1cm} E(z) \cdot \frac{CF}{SensorFactor} dzds$$

5.9. POWER MEASUREMENT

When ever possible, a conducted power measurement is performed. To accomplish this, we utilize a fully charged battery, a calibrated power meter and a cable adapter provided by the manufacturer. The data of the cable and related circuit losses are also provided by the manufacturer. The power measurement is then performed across the operational band and the channel with the highest output power is recorded.

Power measurement is performed before and after the SAR to verify if the battery was delivering full power for the time of test. A difference in output power would determinate a need for battery replacement and repetition the SAR test.



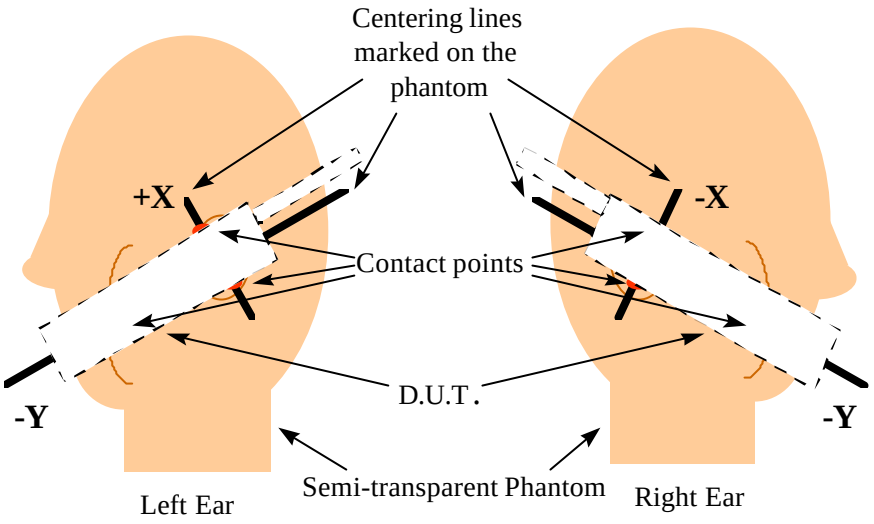
Measured Power Measured Power + Cable and Switching Mechanism Loss

5.10. POSITIONING OF D.U.T.

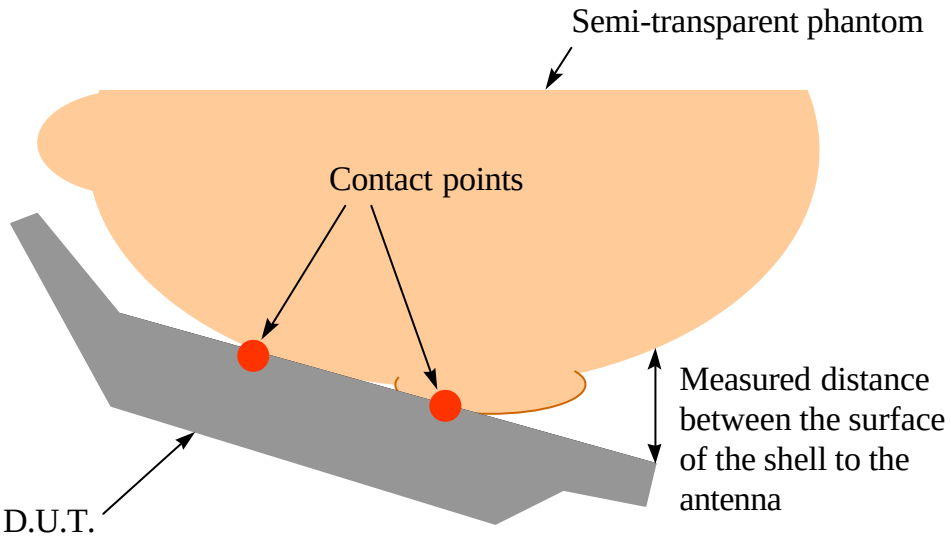
The clear fiberglass phantom shell have been previously marked with a highly visible line, so can easily be seen through the liquid simulated tissue. In the case of testing a cellular phone, this line is connecting the ear channel with the corner of the lips. The D.U.T. is then placed by centering the speaker with the ear channel and the center of the radio width with the corner of the mouth. At the same time the surface of the D.U.T. is always in contact with the phantoms shell. Three points contact; two in the ear region and one on the chin in addition to the previously describe alignment will assure repeatability of the test.

For HAND HELD devices (push-to-talk), or any other type of wireless transmitters, the D.U.T. will be positioned as suggested by manufacturer operational manuals .

Positioning of the D.U.T.



Side View



5.11. SAR MEASUREMENT UNCERTAINTY

This uncertainty analysis covers the 3D-EMC Laboratory test procedure for Specific Absorption Rate (SAR) associated with wireless telephones and similar devices.

Standards Covered Are:

WGMTE 96/4 - Secretary SC211/B

FCC 96-326, ET Docket No. 93-62

Industry Canada RSS 102

ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)

The laboratory test procedure, and this uncertainty analysis, may be used to cover all standards above. It is based on test equipment and procedures specified by 3D-EMC Laboratories, Inc. located in Ft. Lauderdale, Florida.

Measurement Uncertainty:

Table I. Estimated SAR Measurement Uncertainty

Contribution	Error (±dB)	Probability Distribution	Type Evaluation	Standard Uncertainty (±dB)
A. Field Measurement Errors:		Rectangular	Type B	
Isotropy in Phantom BTS Liquid	0.8			0.46
Frequency Response	0.2			0.12
Linearity	0.2			0.12
Probe Calibration Error (rss)	0.7			0.40
Duty Factor Variability	0.2			0.12
B. Spatial Peak SAR Errors:		Normal	Type A	
Extrapolation & Interpolation, and Position	0.2			0.20
Integration & Search Routine	0.1			0.10
Cube Shape	0.2			0.20
C. Additional Errors:		Rectangular	Type B	
Solution Variability (Worst-Case SAR)	0.21			0.12
D. Combined Standard Uncertainty, u_c:		Normal	-	0.52
E. Expanded Uncertainty, U:		Normal (k=2)	-	1.04
		95% Confidence	-	27.14%

ANNEX A: Waist SAR Measurement

470.100 MHz W	- 4.671 (9.342) W/Kg
485.100 MHz W	- 4.340 (8.681) W/Kg
499.900 MHz W	- 4.015 (8.030) W/Kg

* The SAR Measurement inside the parenthesis indicates the reading before 50 % duty factor is applied for the half-duplex type PTT.

Test Information

Date : 11/24/00
Time : 2:02:45 PM

Product	: UHF Transceiver	**Test**	: SAR
Manufacturer	: ICOM Incorporated	**Frequency (MHz)**	: 470.100
Model Number	: IC-F4GS-3	**Nominal Output Power (W)**	: 4.0
Serial Number	: 00108	**Antenna Type**	: Monopole
FCC ID Number	: AFJ IC-F4G-3	**Signal**	: CW

Phantom	: Waist	**Dielectric Constant**	: 58.0
Simulated Tissue	: Muscle	**Conductivity**	: 0.83

Probe	: ETR_225_1_999	**Antenna Position**	: FIX
Probe Offset (mm)	: 2.250	**Measured Power (W) (conducted)**	: 3.99
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 0.452	**Cable Insertion Loss (dB)**	: 0.1
Calibrated Date	: 10/8/99	**Compensated Power (W)**	: 4.083

Amplifier Setting :

Channel 1 : 0.0070 Channel 2 : 0.0067 Channel 3 : 0.0081

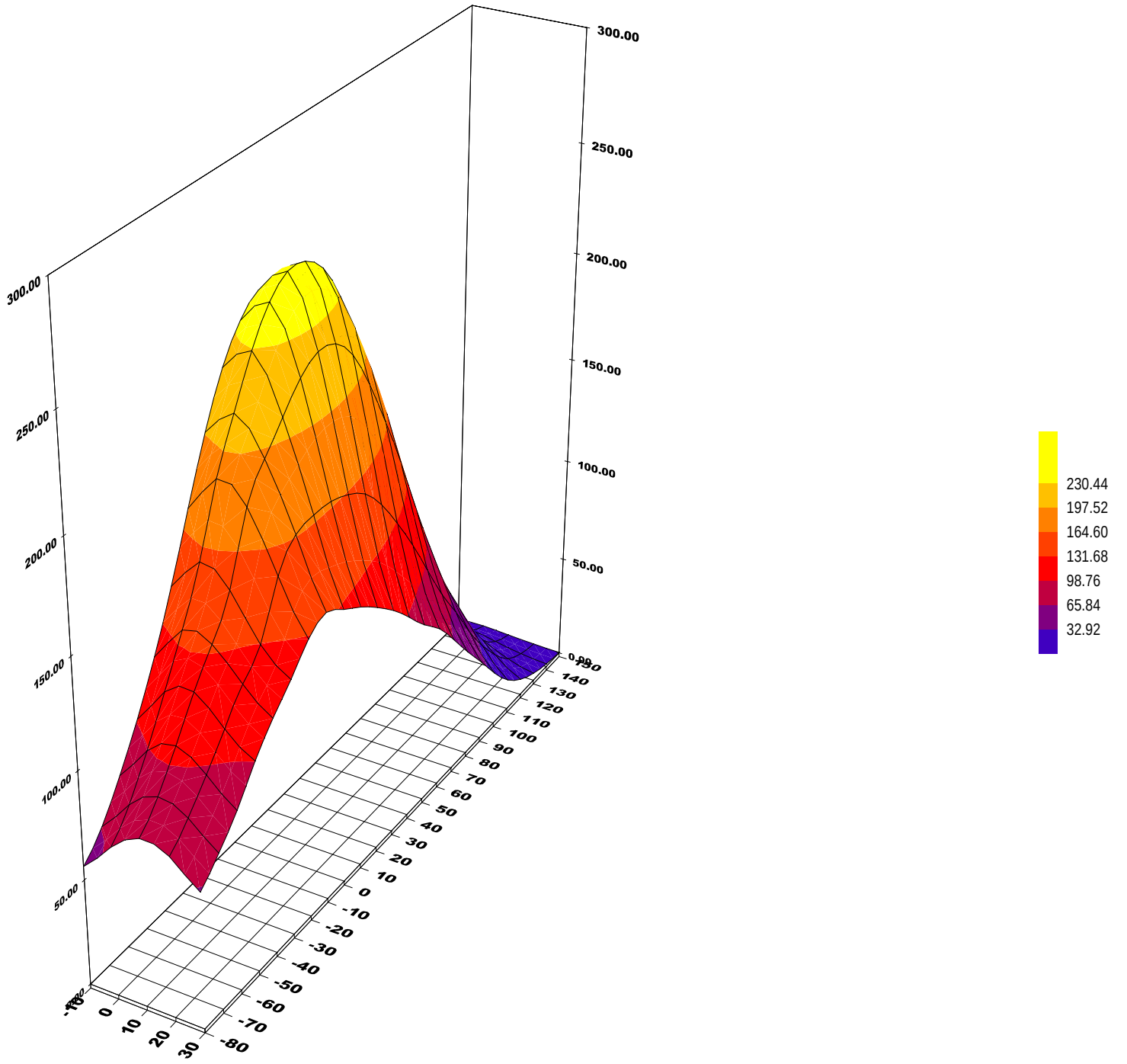
Location of Maximum Field :

X = 0 Y = 20

Measured Values (mV) :

258.560	238.703	216.264	202.221	186.686	180.448
171.872	163.517	156.189	148.366	141.683	

Peak Voltage (mV) : 271.300 **1 Cm Voltage (mV)** : 161.991 **SAR (W/Kg)** : 9.342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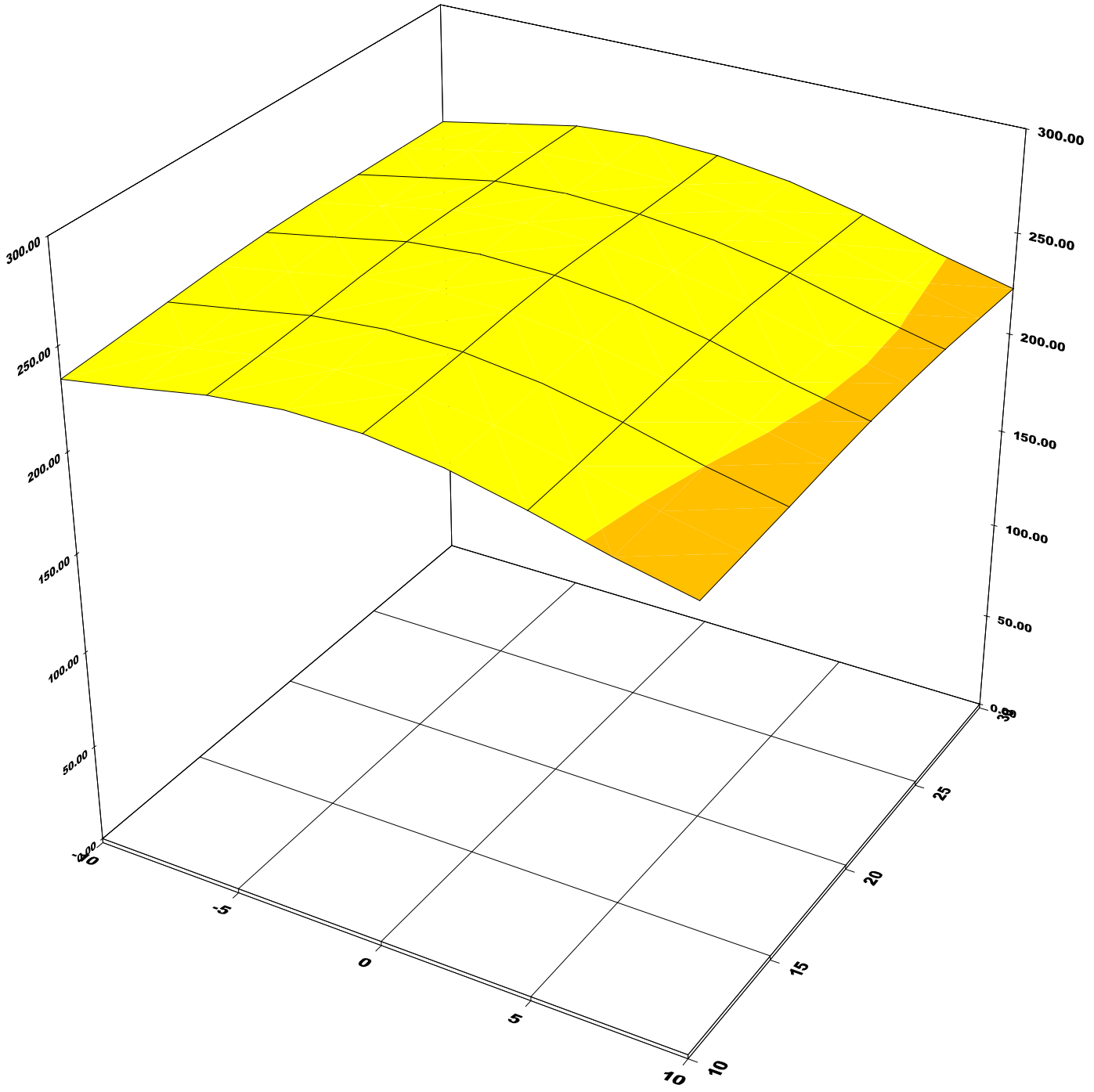
250.00
200.00
150.00
100.00
50.00
300.00
250.00
200.00
150.00
100.00
50.00
-10
0
10
20
30
0.00
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
230.44
197.52
164.60
131.68
98.76
65.84
32.92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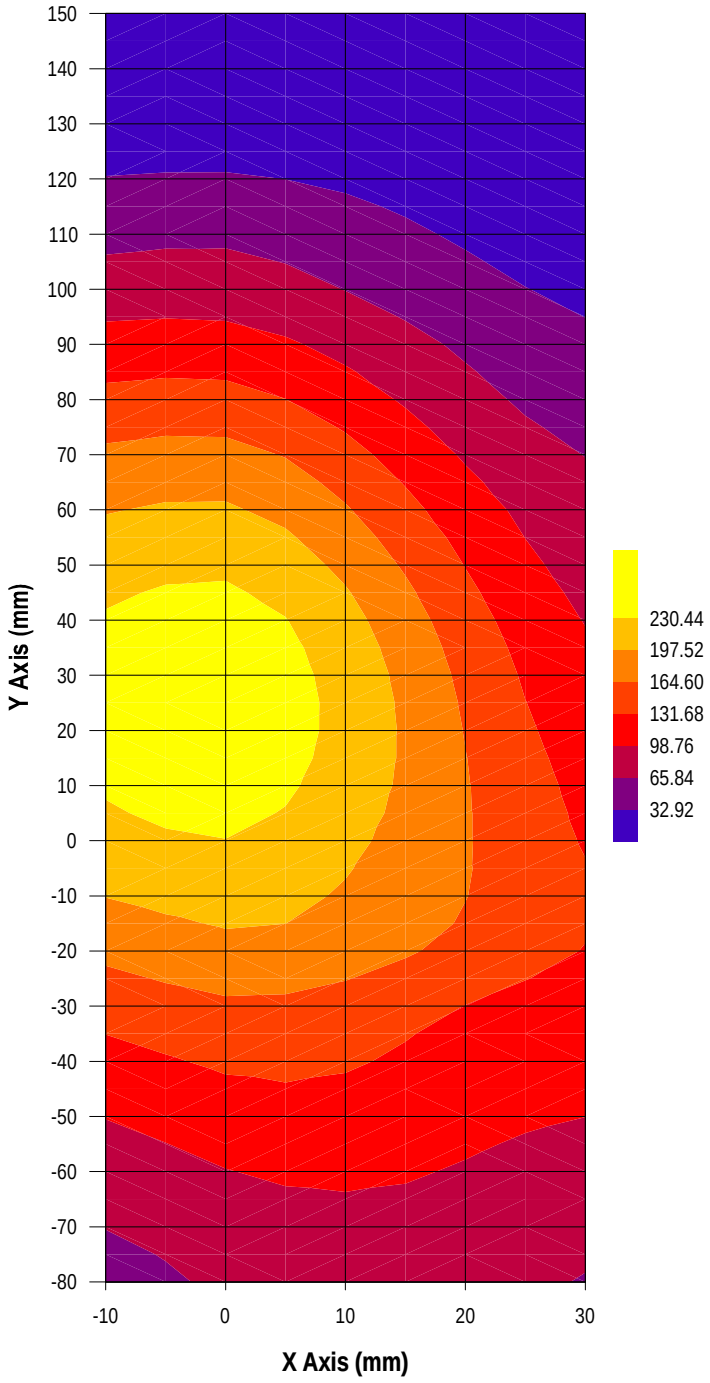
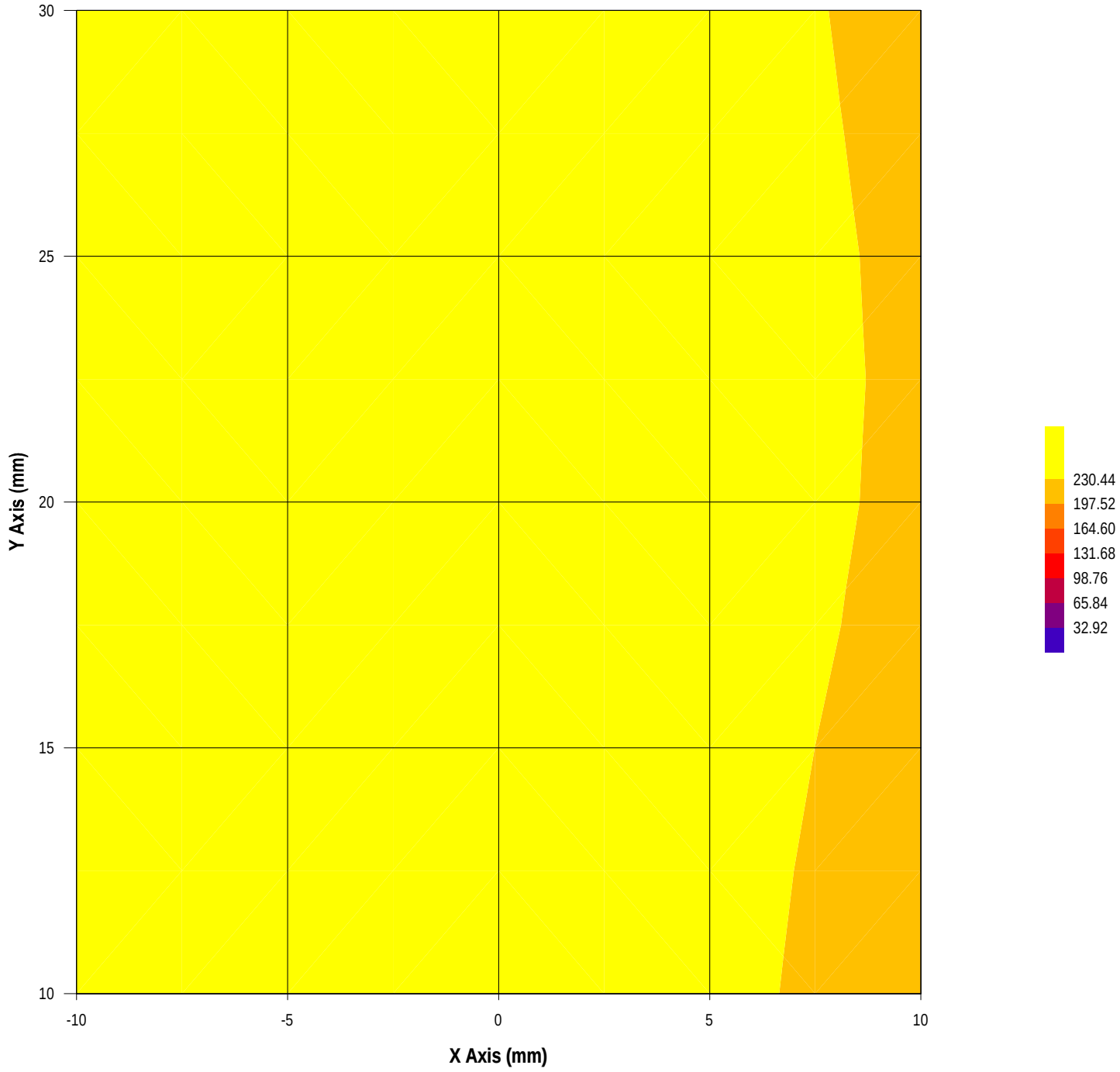
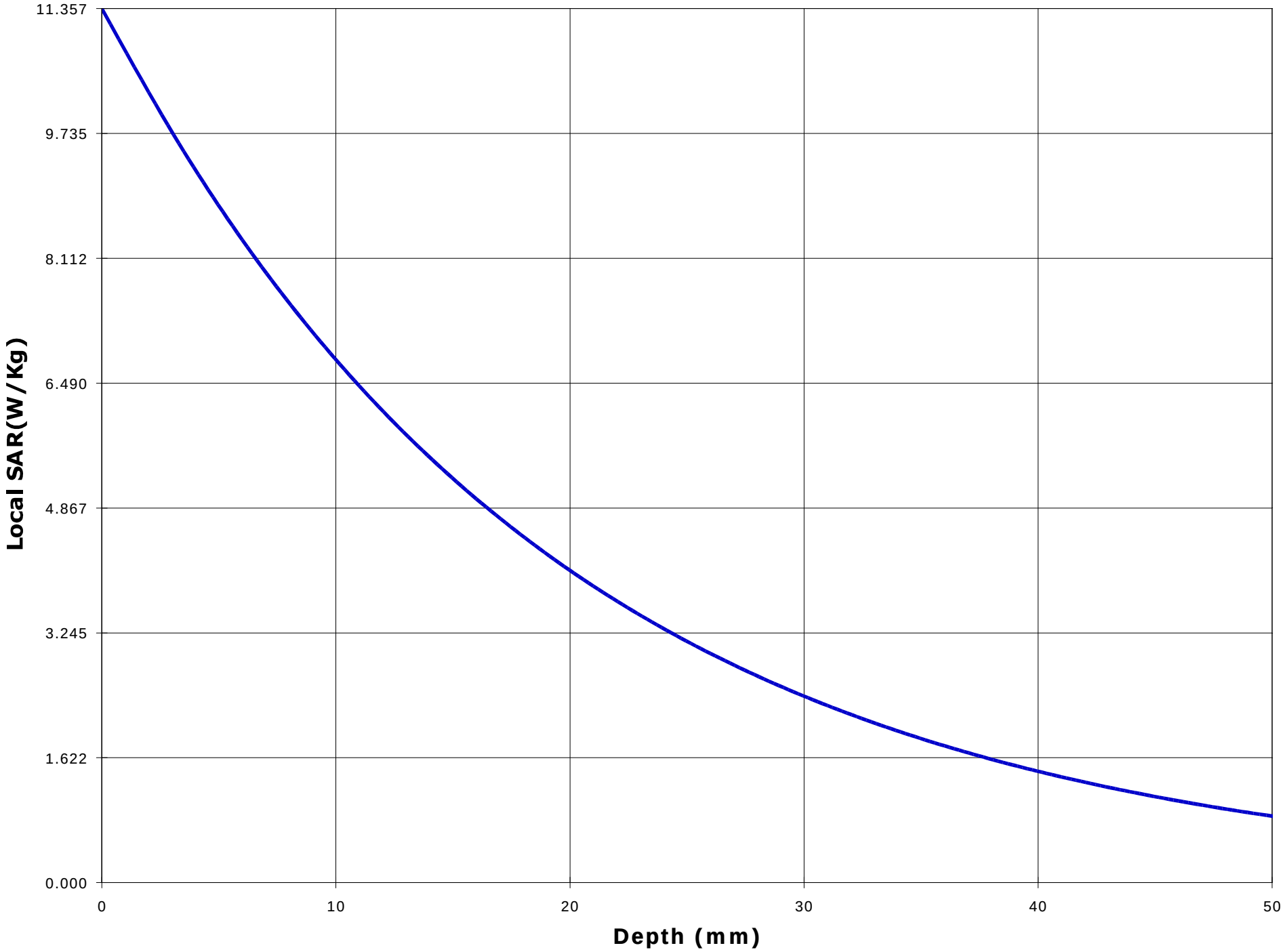
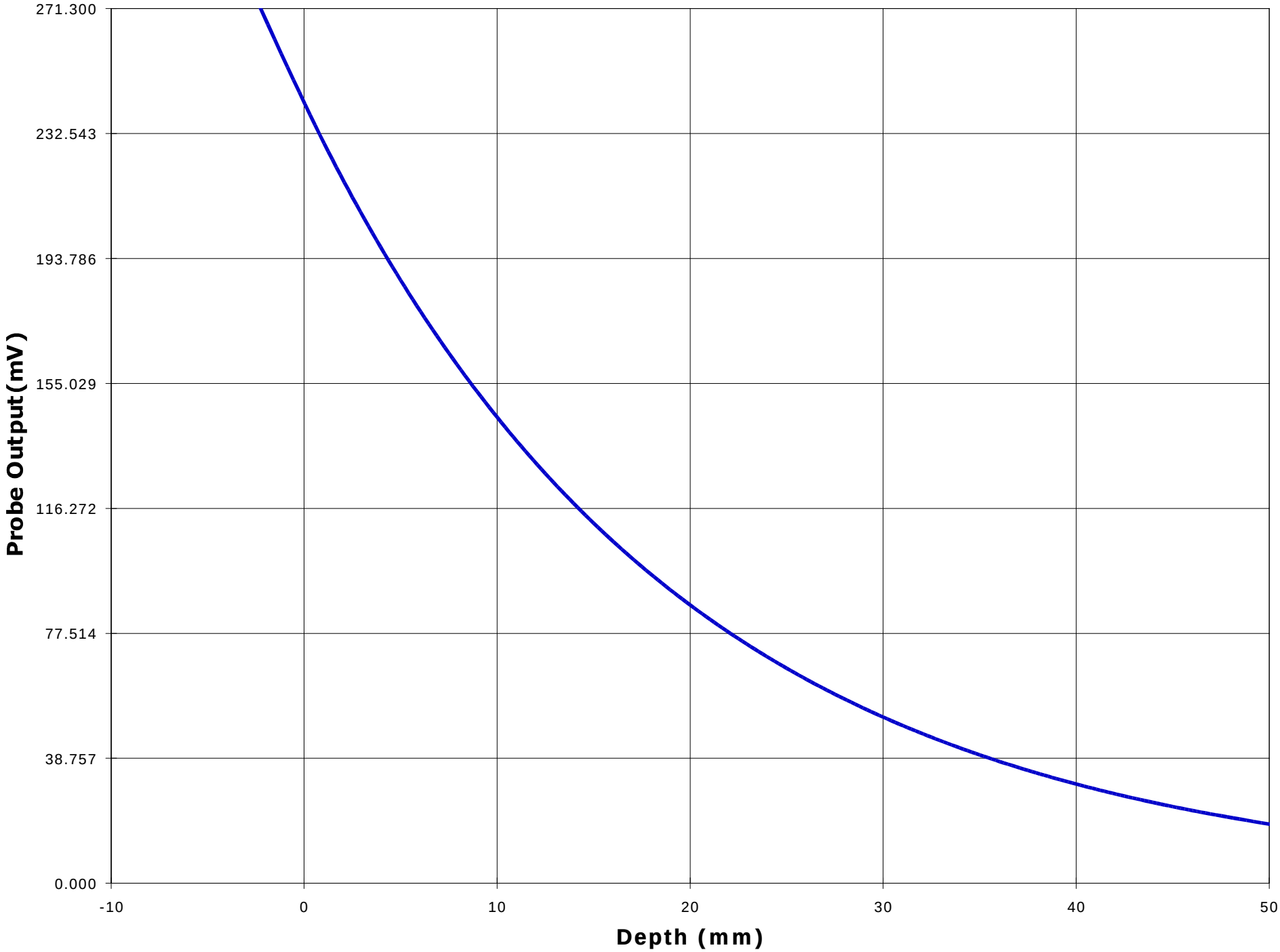
250.00
200.00
150.00
100.00
50.00
0.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
-5
0
5
10
15
20
25
30
230.44
197.52
164.60
131.68
98.76
65.84
32.92


150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Y Axis (mm)
-10
0
10
20
30
X Axis (mm)
230.44
197.52
164.60
131.68
98.76
65.84
32.92


30
25
20
15
10
Y Axis (mm)
-10
-5
0
5
10
X Axis (mm)
230.44
197.52
164.60
131.68
98.76
65.84
32.92


11.357
9.735
8.112
6.490
4.867
3.245
1.622
0.000
Local SAR(W/Kg)
0
10
20
30
40
50
Depth (mm)


271.300
232.543
193.786
155.029
116.272
77.514
38.757
0.000
Probe Output(mV)
-10
0
10
20
30
40
50
Depth (mm)

Test Information

Date : 11/24/00
Time : 1:46:07 PM

Product	: UHF Transceiver	**Test**	: SAR
Manufacturer	: ICOM Incorporated	**Frequency (MHz)**	: 485.100
Model Number	: IC-F4GS-3	**Nominal Output Power (W)**	: 4.0
Serial Number	: 00108	**Antenna Type**	: Monopole
FCC ID Number	: AFJ IC-F4G-3	**Signal**	: CW

Phantom	: Waist	**Dielectric Constant**	: 58.0
Simulated Tissue	: Muscle	**Conductivity**	: 0.83

Probe	: ETR_225_1_999	**Antenna Position**	: FIX
Probe Offset (mm)	: 2.250	**Measured Power (W) (conducted)**	: 4.03
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 0.452	**Cable Insertion Loss (dB)**	: 0.1
Calibrated Date	: 10/8/99	**Compensated Power (W)**	: 4.124

Amplifier Setting :

Channel 1 : 0.0070 Channel 2 : 0.0067 Channel 3 : 0.0081

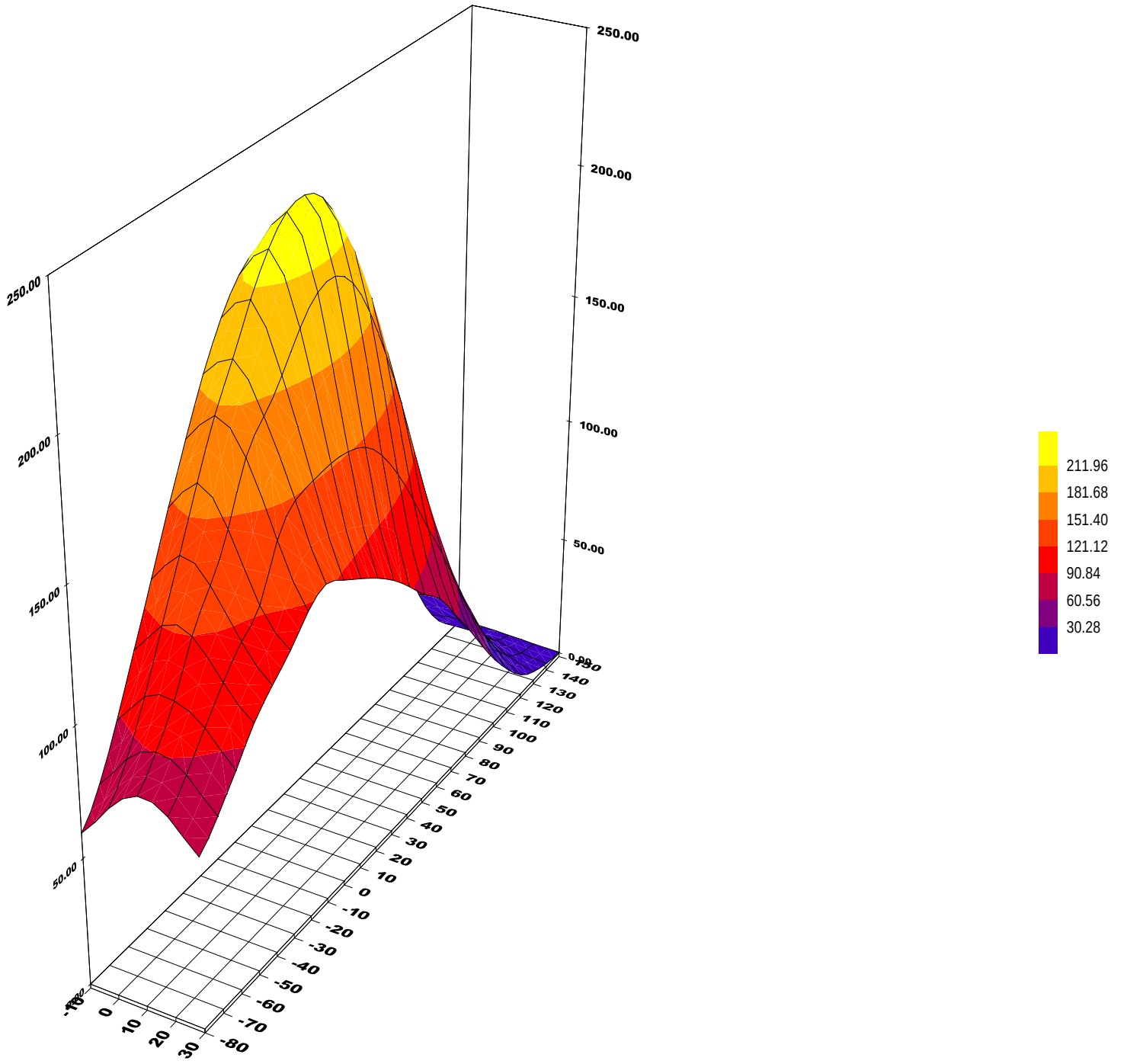
Location of Maximum Field :

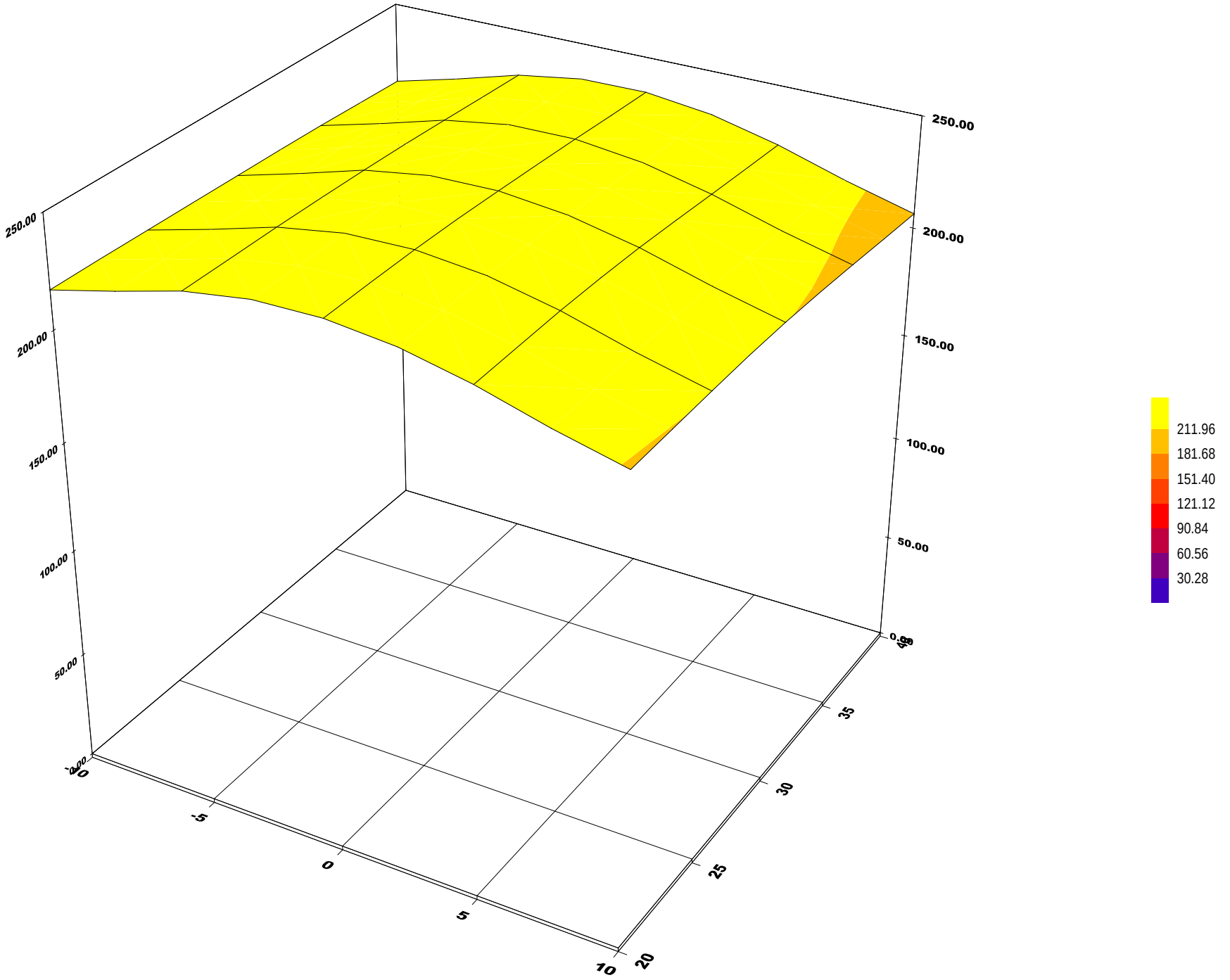
X = 0 Y = 25

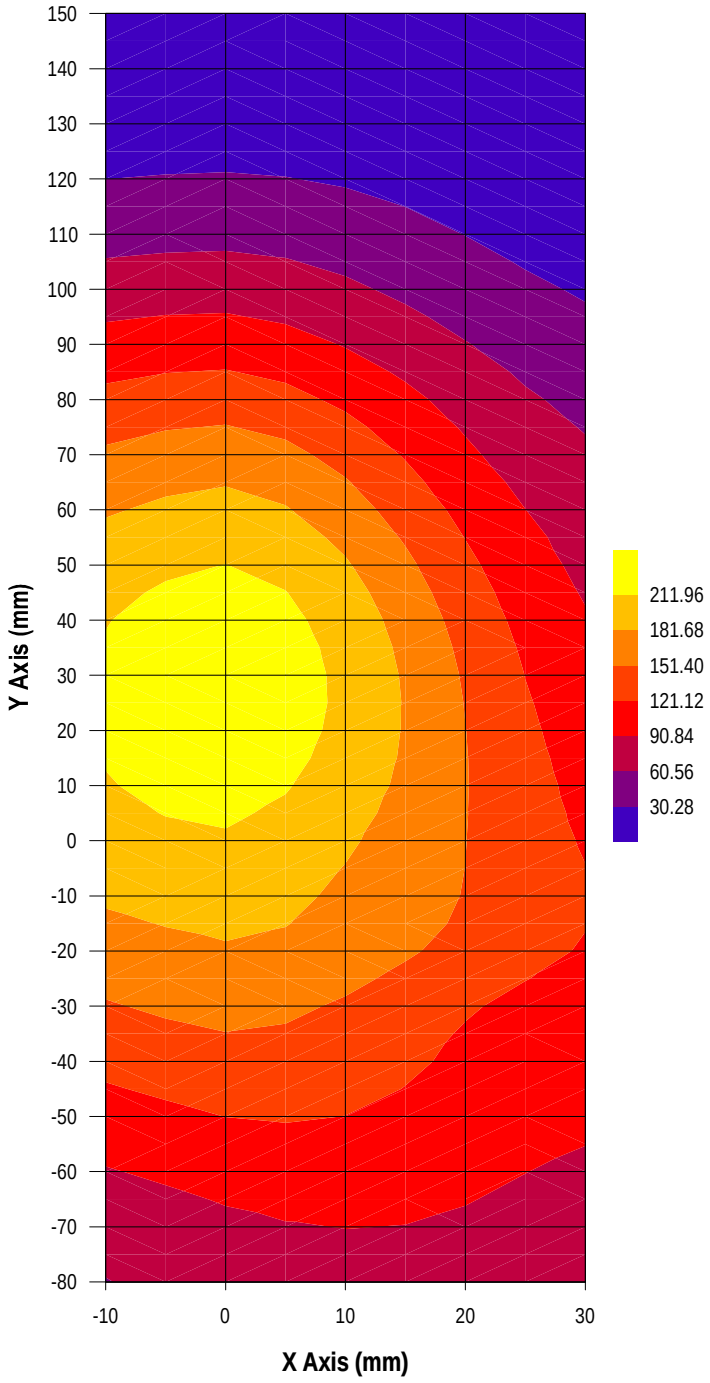
Measured Values (mV) :

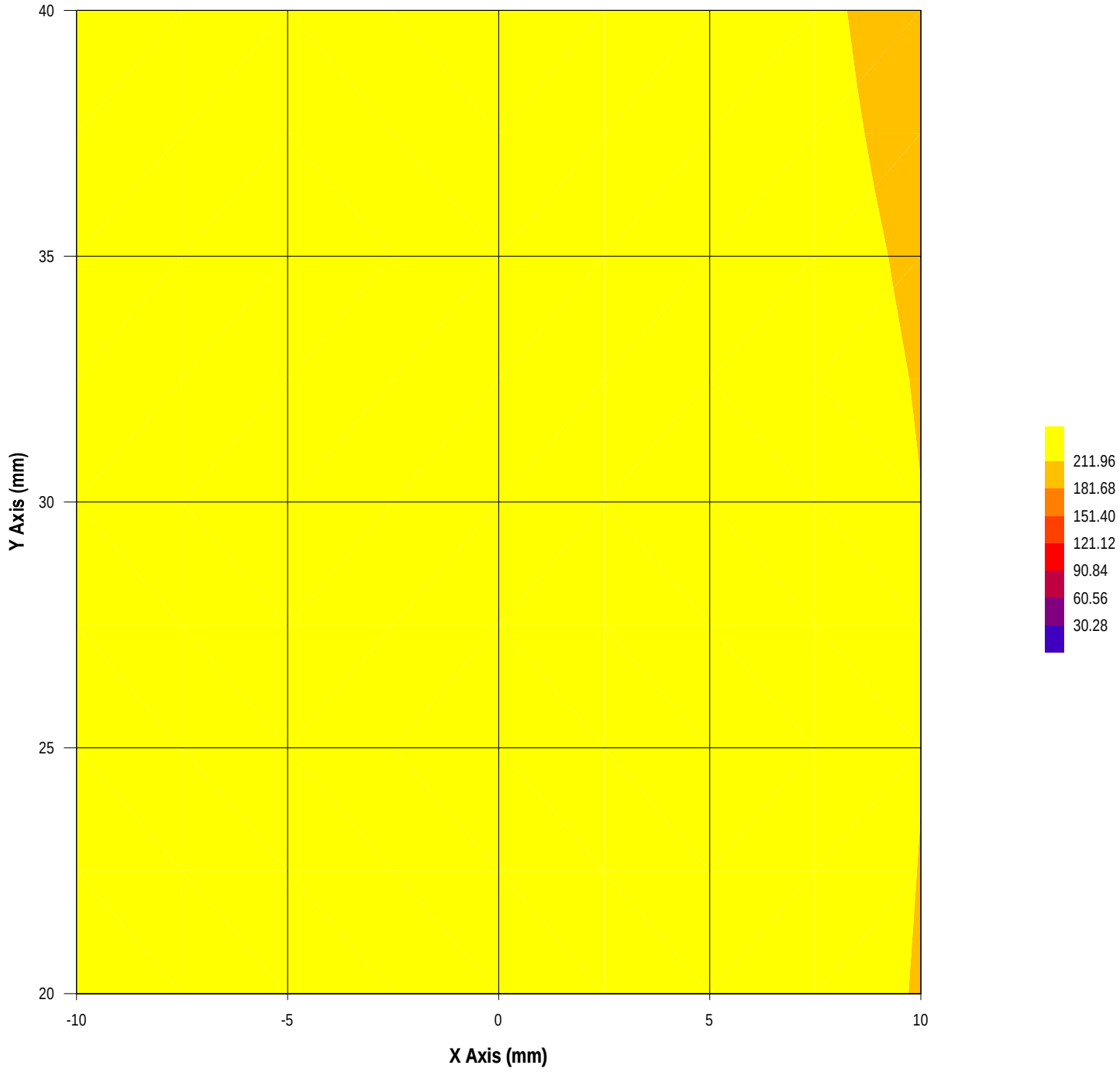
241.794 222.597 201.433 187.456 176.570 167.078
158.275 150.433 143.285 136.439 129.749

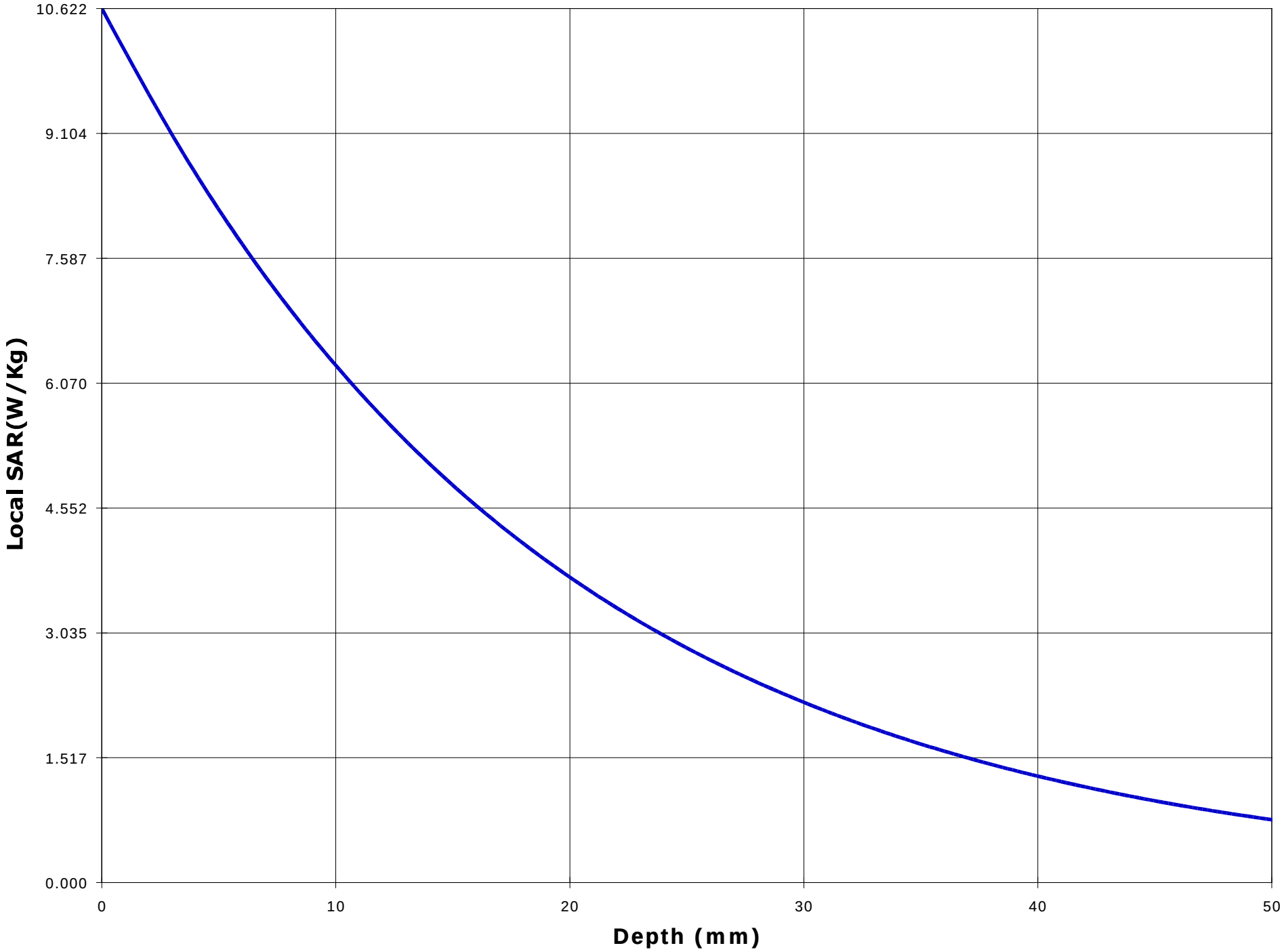
Peak Voltage (mV) : 253.736 **1 Cm Voltage (mV)** : 149.827 **SAR (W/Kg)** : 8.681

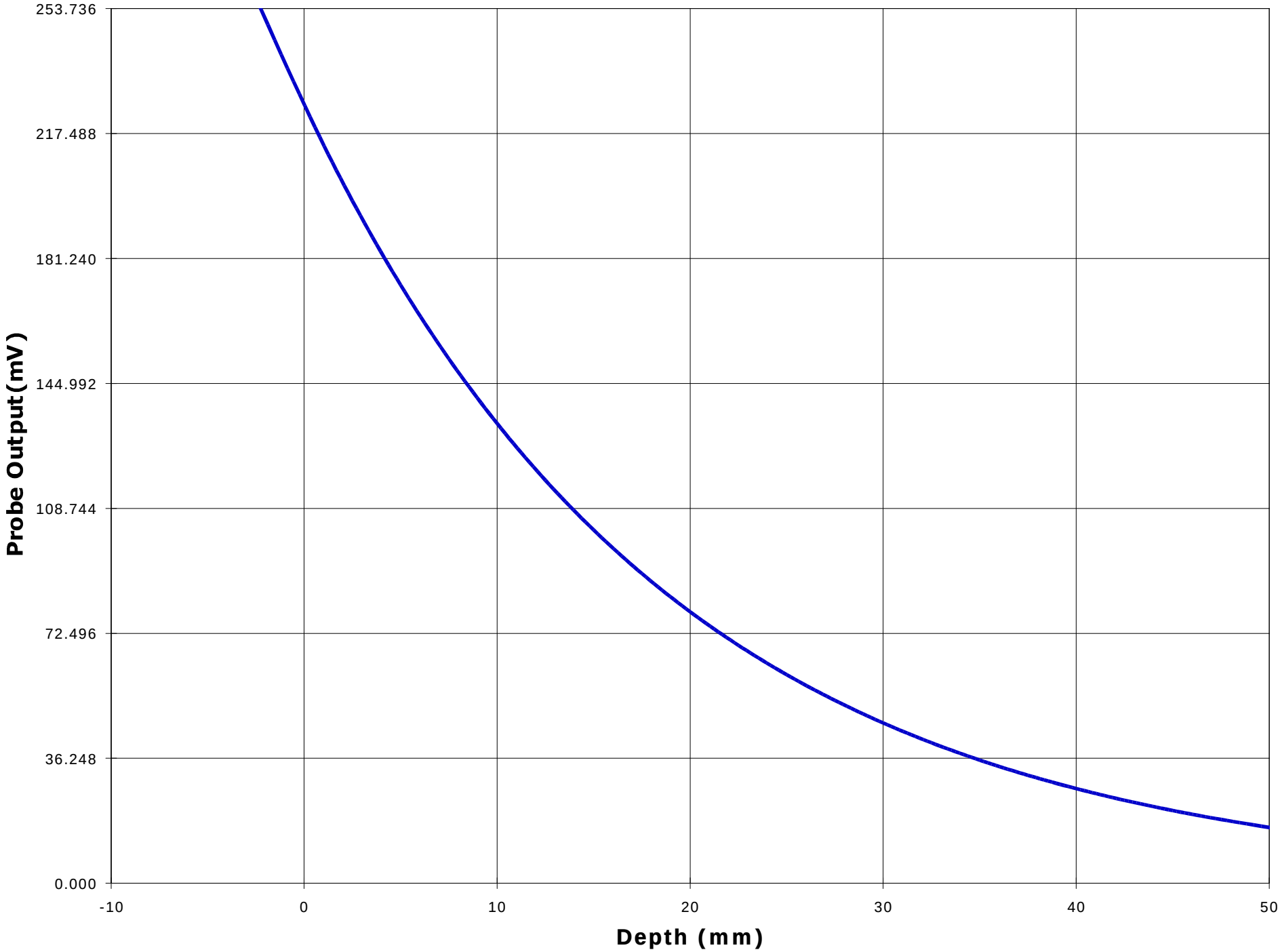

250.00
200.00
150.00
100.00
50.00
211.96
181.68
151.40
121.12
90.84
60.56
30.28


250.00
200.00
150.00
100.00
50.00
0.00
250.00
200.00
150.00
100.00
50.00
0.00
-10
-5
0
5
10
20
25
30
35
40
211.96
181.68
151.40
121.12
90.84
60.56
30.28


150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Y Axis (mm)
-10
0
10
20
30
X Axis (mm)
211.96
181.68
151.40
121.12
90.84
60.56
30.28


40
35
30
25
20
Y Axis (mm)
-10
-5
0
5
10
X Axis (mm)
211.96
181.68
151.40
121.12
90.84
60.56
30.28


10.622
9.104
7.587
6.070
4.552
3.035
1.517
0.000
Local SAR(W/Kg)
0
10
20
30
40
50
Depth (mm)


253.736
217.488
181.240
144.992
108.744
72.496
36.248
0.000
Probe Output(mV)
-10
0
10
20
30
40
50
Depth (mm)

Test Information

Date : 11/24/00
Time : 1:28:39 PM

Product	: UHF Transceiver	**Test**	: SAR
Manufacturer	: ICOM Incorporated	**Frequency (MHz)**	: 499.900
Model Number	: IC-F4GS-3	**Nominal Output Power (W)**	: 4.0
Serial Number	: 00108	**Antenna Type**	: Monopole
FCC ID Number	: AFJ IC-F4G-3	**Signal**	: CW

Phantom	: Waist	**Dielectric Constant**	: 58.0
Simulated Tissue	: Muscle	**Conductivity**	: 0.83

Probe	: ETR_225_1_999	**Antenna Position**	: FIX
Probe Offset (mm)	: 2.250	**Measured Power (W) (conducted)**	: 4.12
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 0.452	**Cable Insertion Loss (dB)**	: 0.1
Calibrated Date	: 10/8/99	**Compensated Power (W)**	: 4.216

Amplifier Setting :

Channel 1 : 0.0070 Channel 2 : 0.0067 Channel 3 : 0.0081

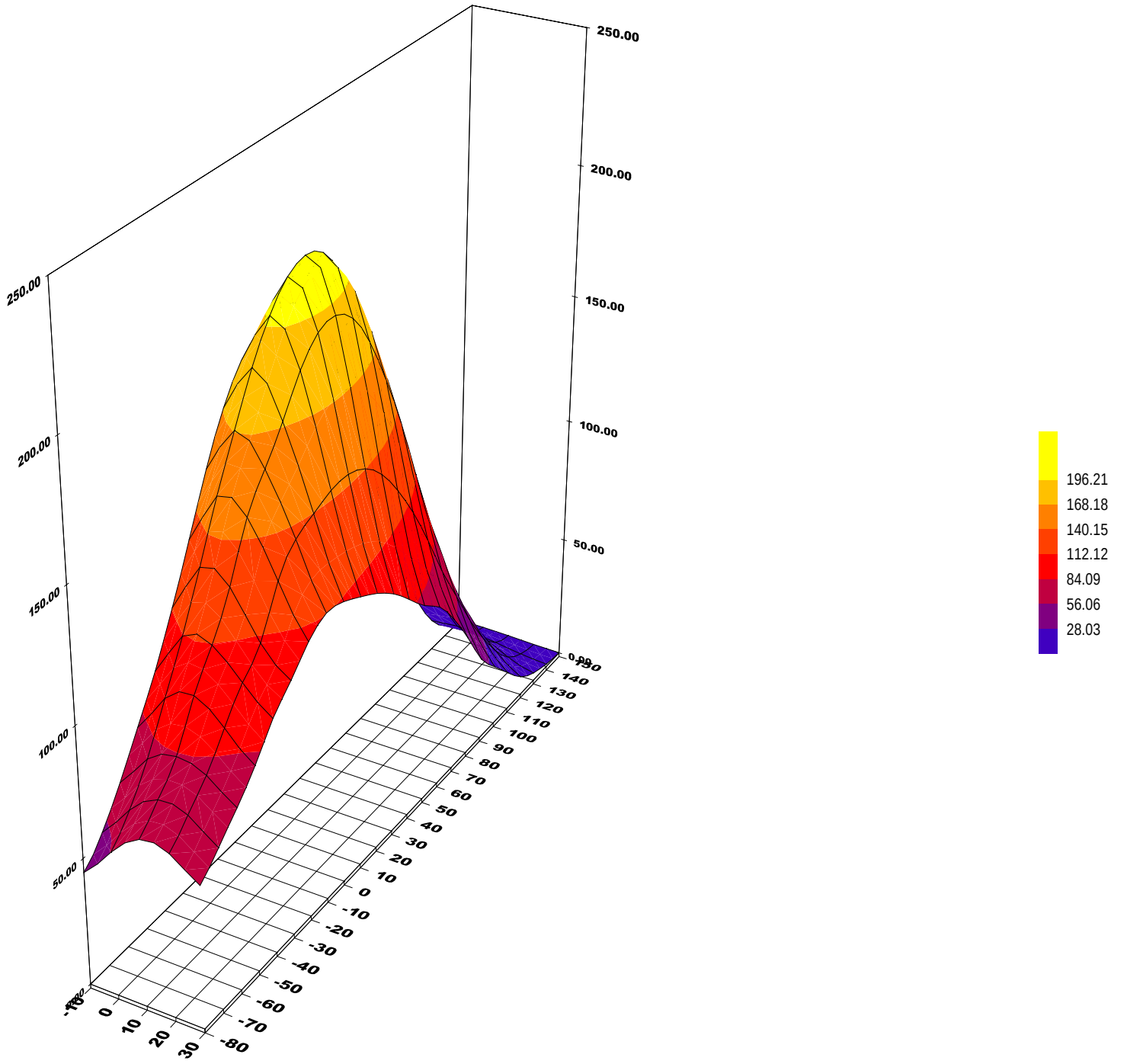
Location of Maximum Field :

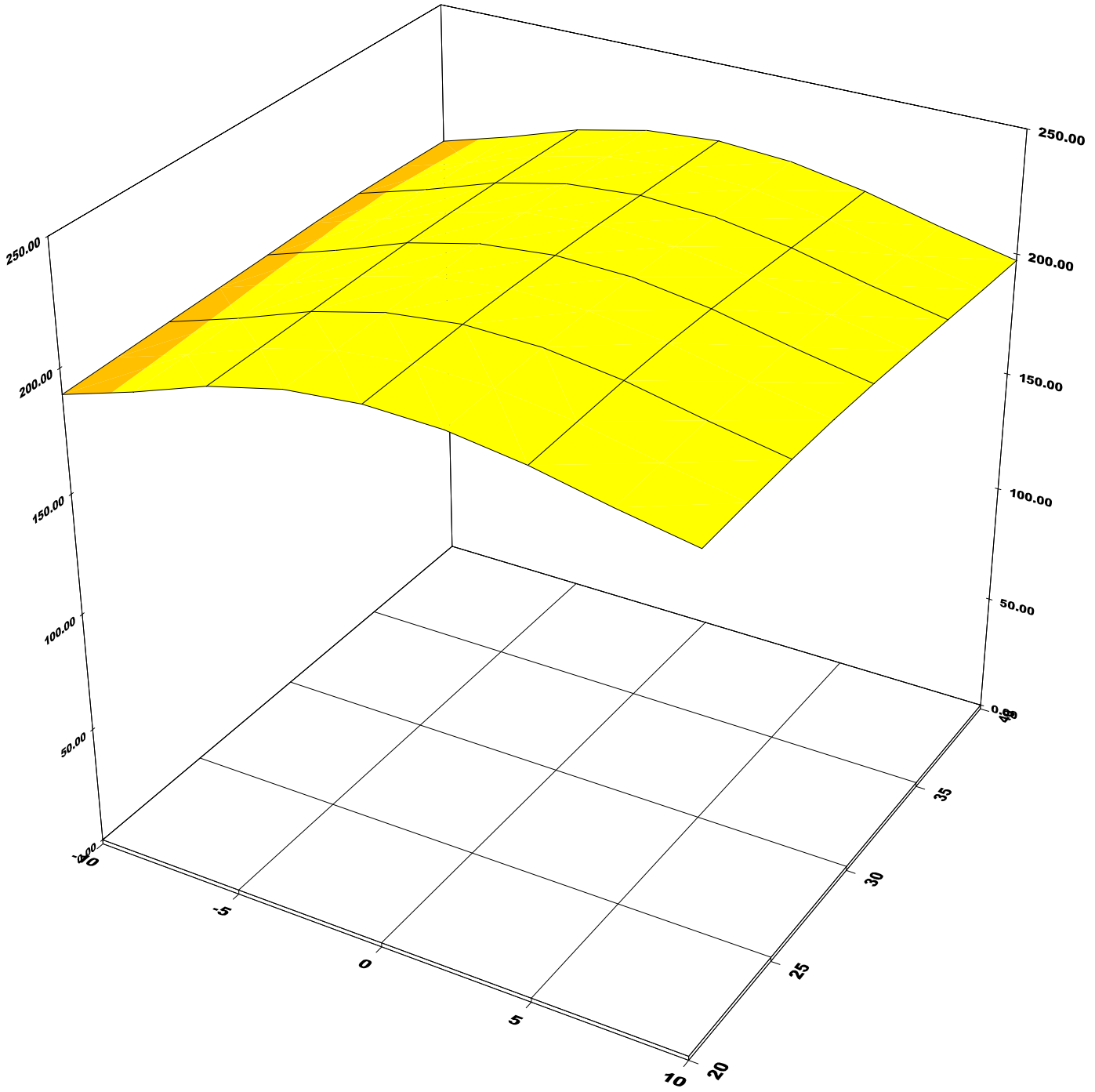
X = 0 Y = 25

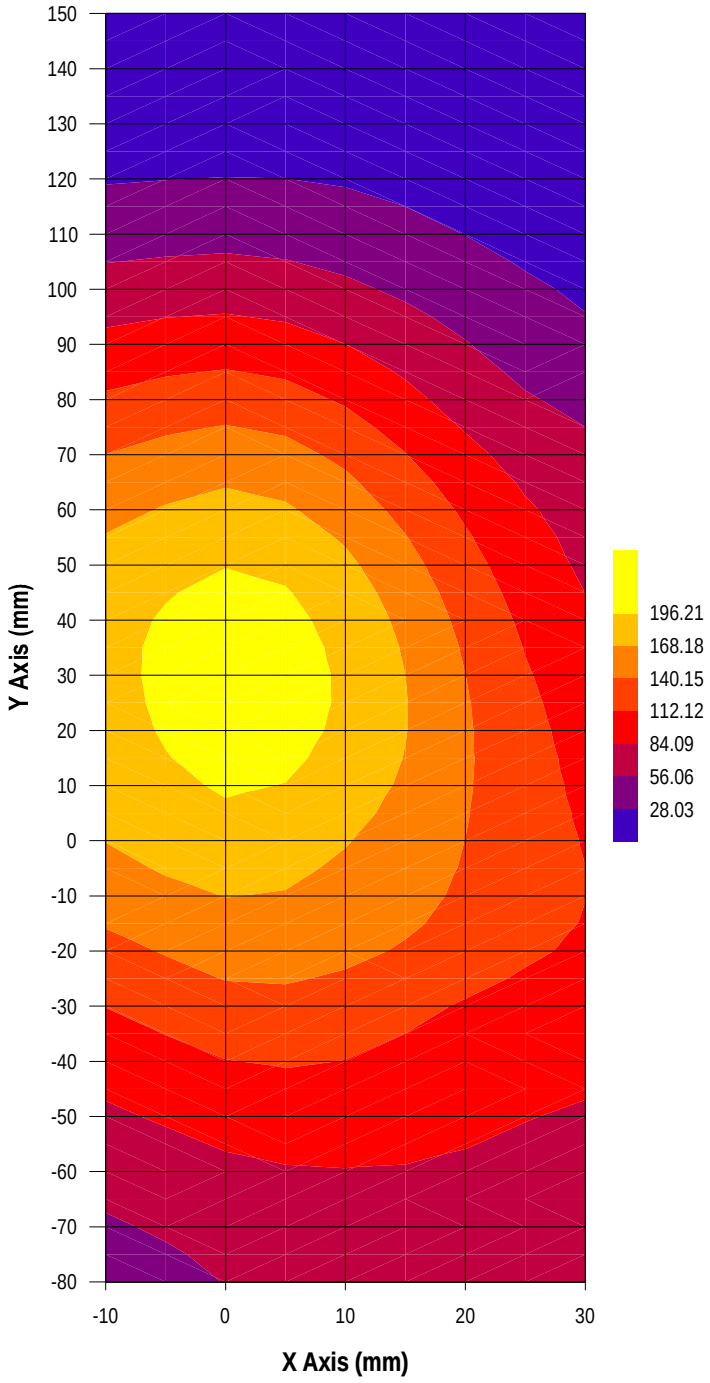
Measured Values (mV) :

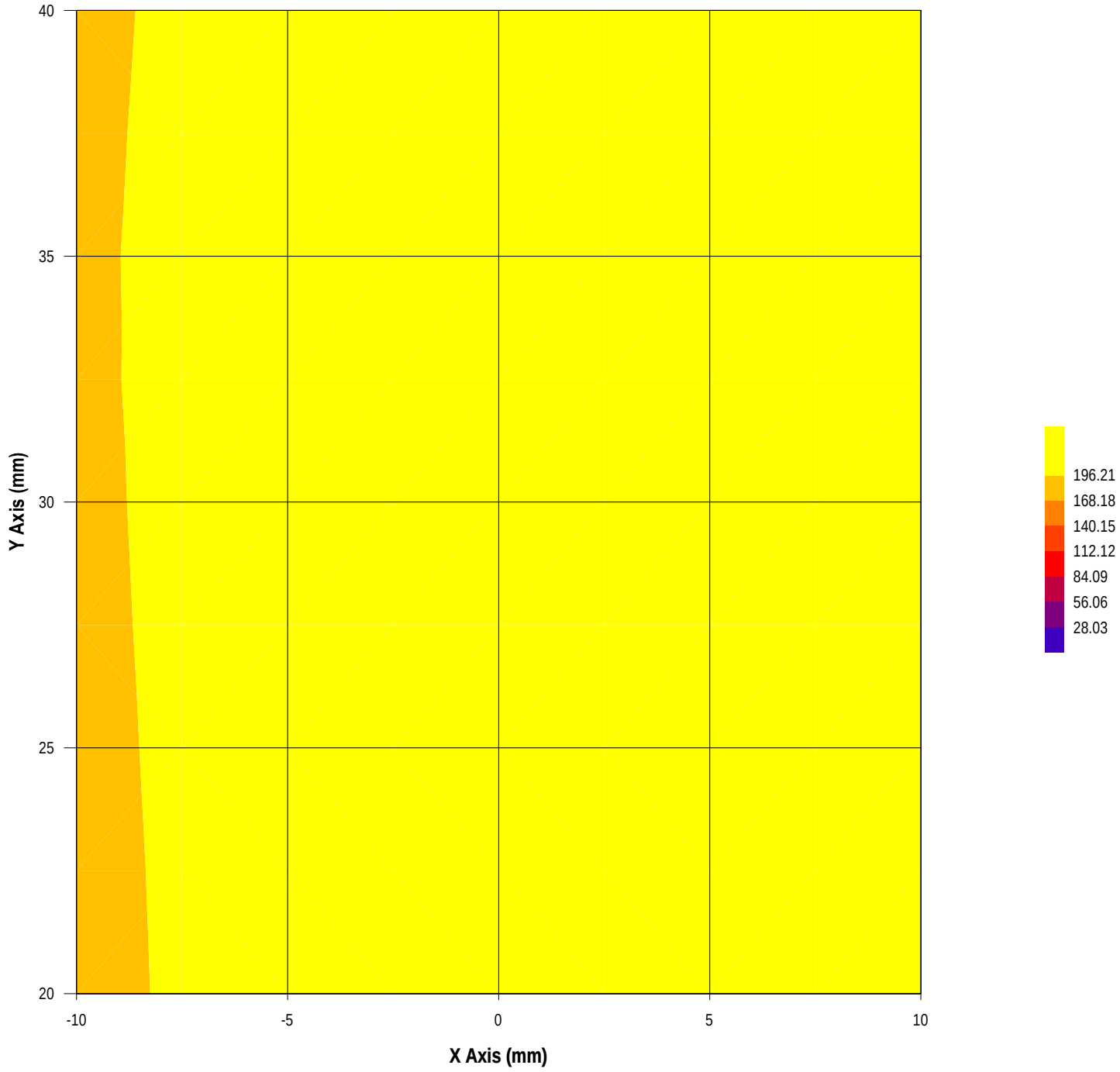
224.775	206.318	187.197	173.796	163.389	154.346
146.177	138.680	131.730	125.090	119.097	

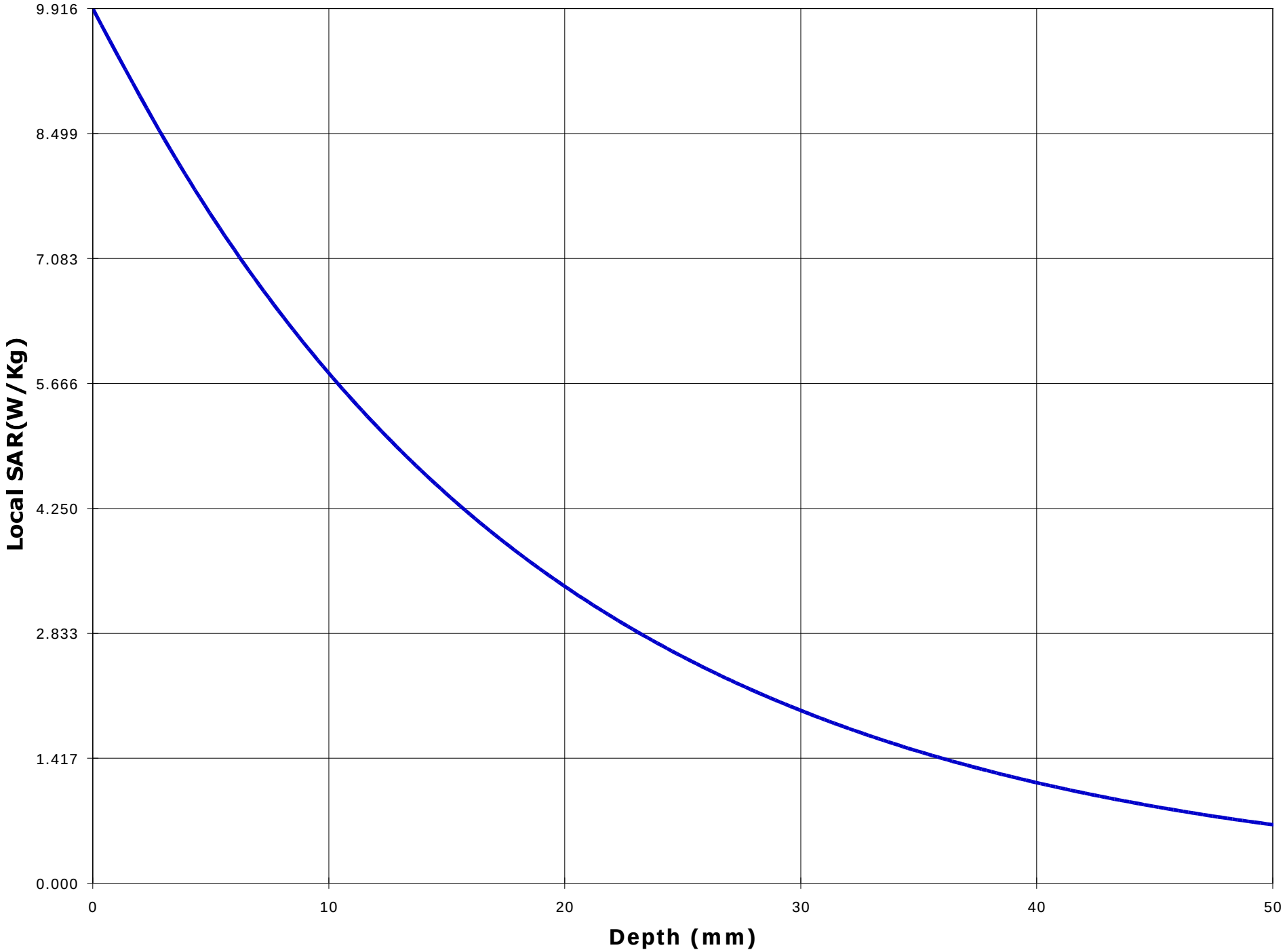
Peak Voltage (mV) : 236.873 **1 Cm Voltage (mV)** : 137.852 **SAR (W/Kg)** : 8.030

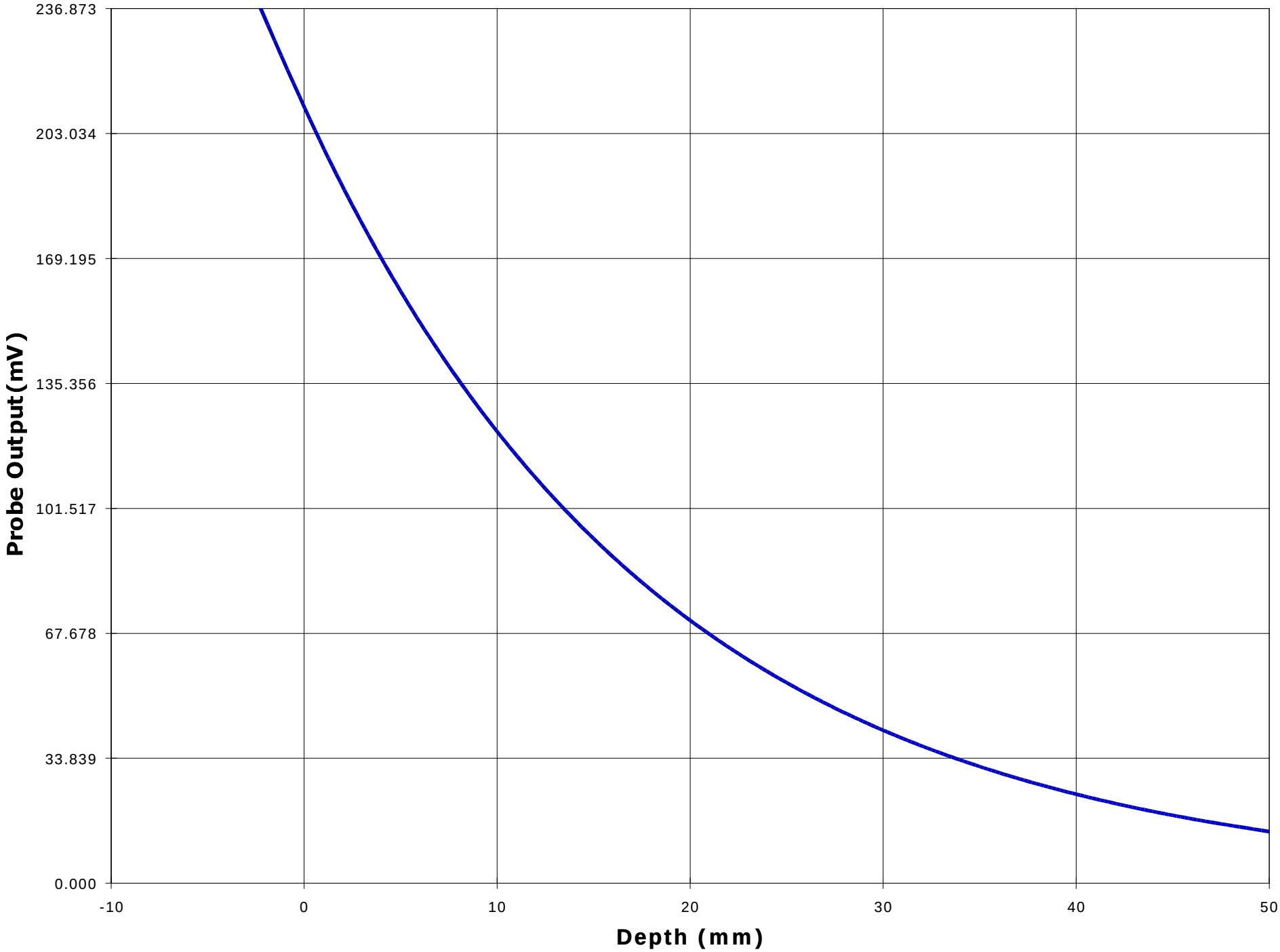

250.00
200.00
150.00
100.00
50.00
250.00
200.00
150.00
100.00
50.00
0.00
190
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-10
0
10
20
30
196.21
168.18
140.15
112.12
84.09
56.06
28.03


250.00
200.00
150.00
100.00
50.00
0.00
250.00
200.00
150.00
100.00
50.00
0.00
-10
-5
0
5
10
20
25
30
35
40
196.21
168.18
140.15
112.12
84.09
56.06
28.03


150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Y Axis (mm)
-10
0
10
20
30
X Axis (mm)
196.21
168.18
140.15
112.12
84.09
56.06
28.03


40
35
30
25
20
Y Axis (mm)
-10
-5
0
5
10
X Axis (mm)
196.21
168.18
140.15
112.12
84.09
56.06
28.03


9.916
8.499
7.083
5.666
4.250
2.833
1.417
0.000
Local SAR(W/Kg)
0
10
20
30
40
50
Depth (mm)


236.873
203.034
169.195
135.356
101.517
67.678
33.839
0.000
Probe Output(mV)
-10
0
10
20
30
40
50
Depth (mm)

ANNEX B: Head-front SAR Measurement

470.100 MHz W	- 3.141 (6.283) W/Kg
485.100 MHz W	- 3.240 (6.481) W/Kg
499.900 MHz W	- 3.145 (6.291) W/Kg

* The SAR Measurement inside the parenthesis indicates the reading before 50 % duty factor is applied for the half-duplex type PTT.

Test Information

Date : 11/22/00
Time : 1:57:52 PM

Product	: UHF Transceiver	**Test**	: SAR
Manufacturer	: ICOM Incorporated	**Frequency (MHz)**	: 470.100
Model Number	: IC-F4GS-3	**Nominal Output Power (W)**	: 4.0
Serial Number	: 00108	**Antenna Type**	: Monopole
FCC ID Number	: AFJ IC-F4G-3	**Signal**	: CW

Phantom	: Head - Front	**Dielectric Constant**	: 50.2
Simulated Tissue	: Brain	**Conductivity**	: 0.65

Probe	: ETR_225_1_999	**Antenna Position**	: FIX
Probe Offset (mm)	: 2.250	**Measured Power (W) (conducted)**	: 3.93
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 0.316	**Cable Insertion Loss (dB)**	: 0.1
Calibrated Date	: 10/7/99	**Compensated Power (W)**	: 4.022

Amplifier Setting :

Channel 1 : 0.0070 Channel 2 : 0.0067 Channel 3 : 0.0081

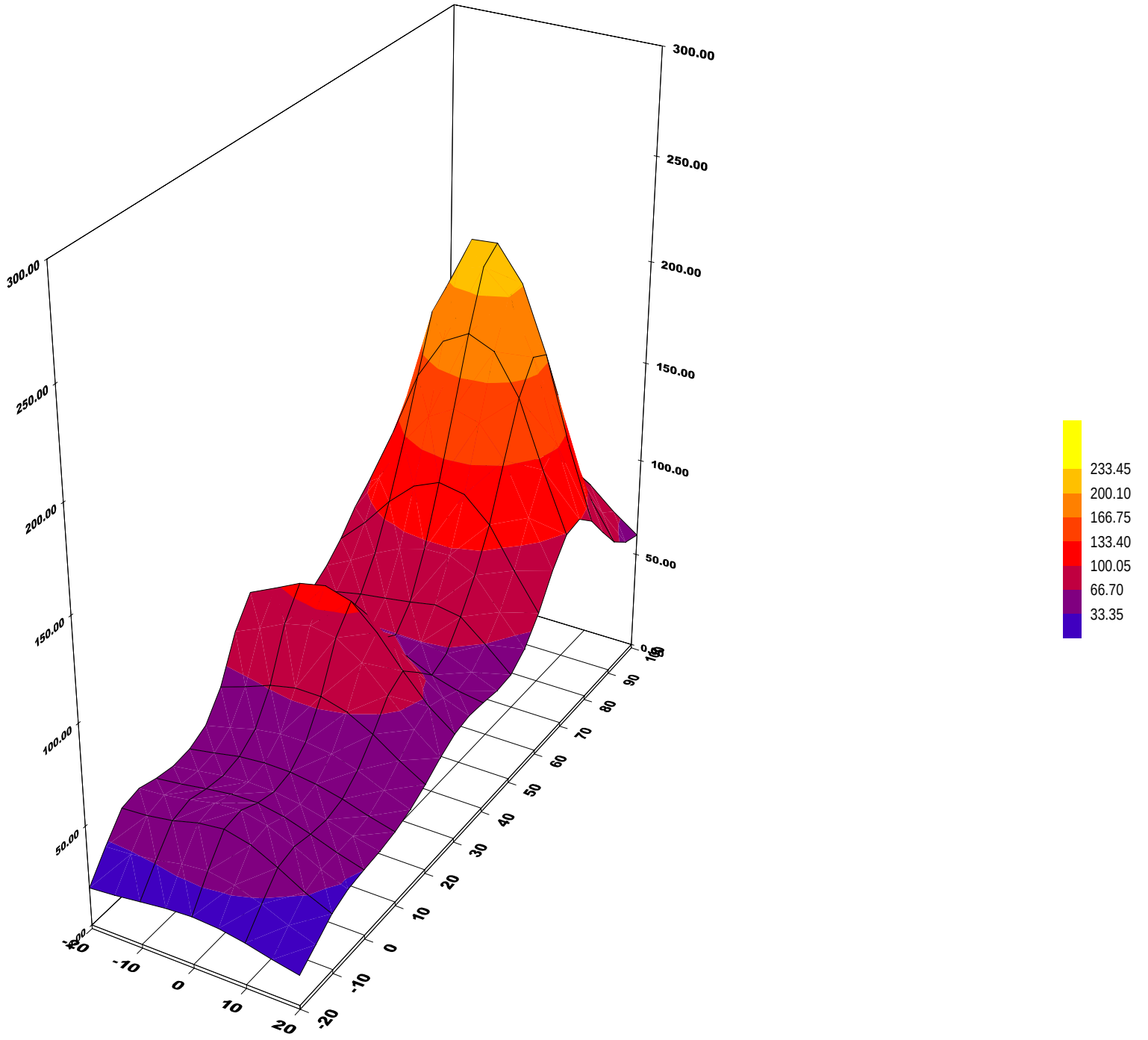
Location of Maximum Field :

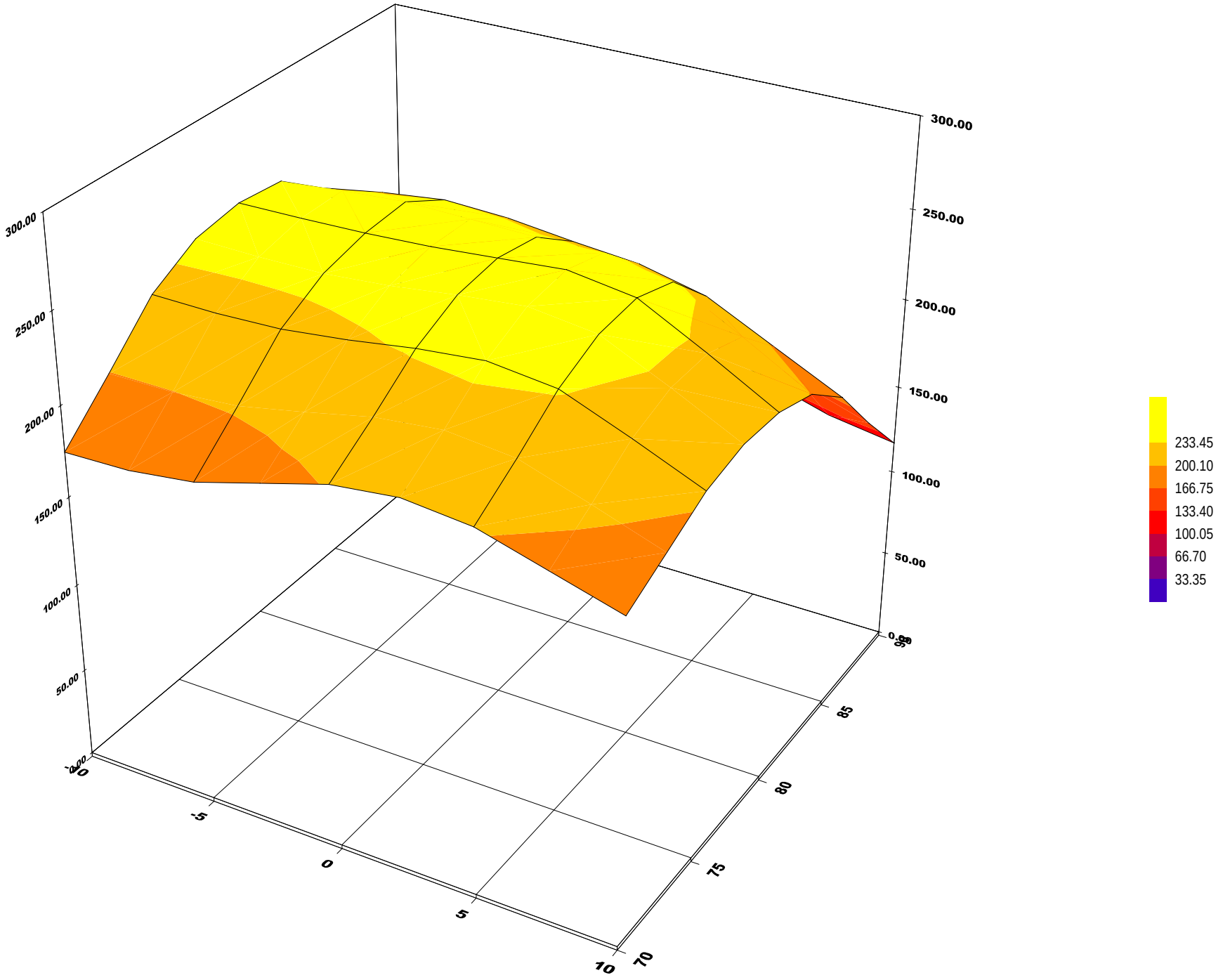
X = 5 Y = 80

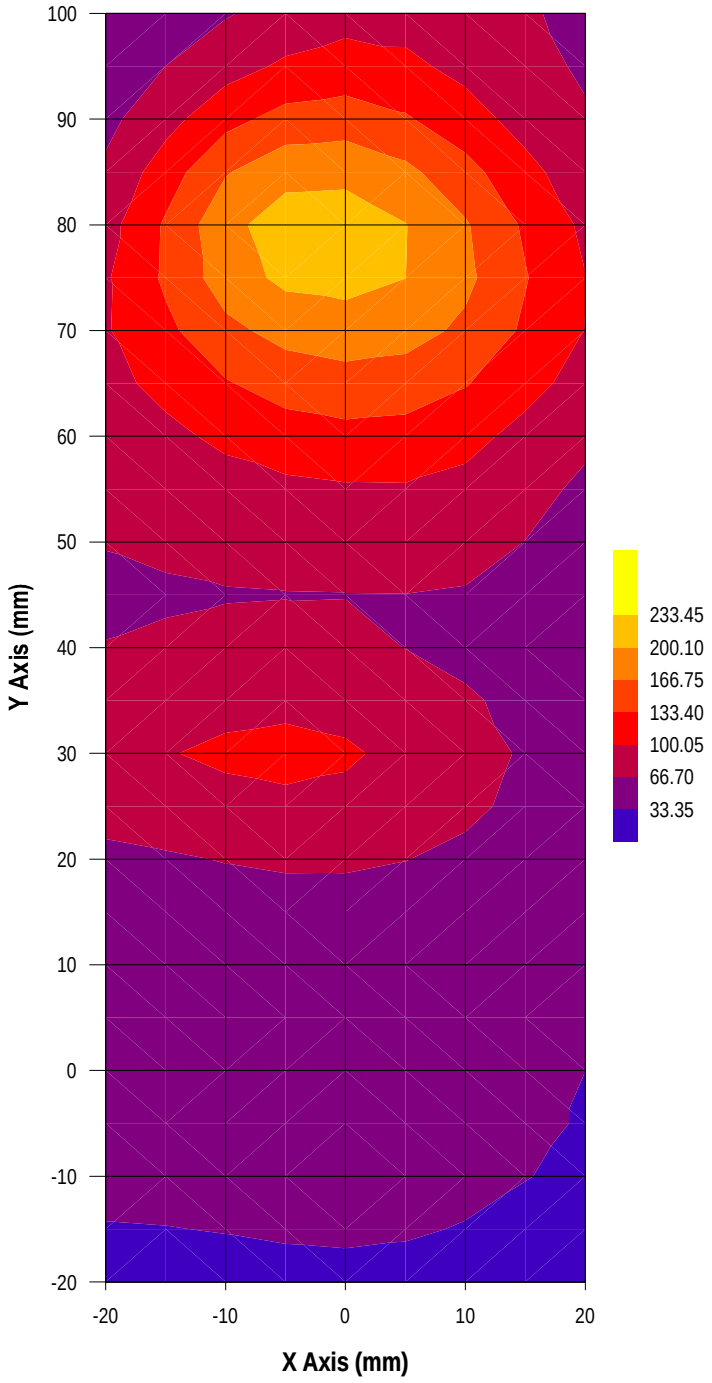
Measured Values (mV) :

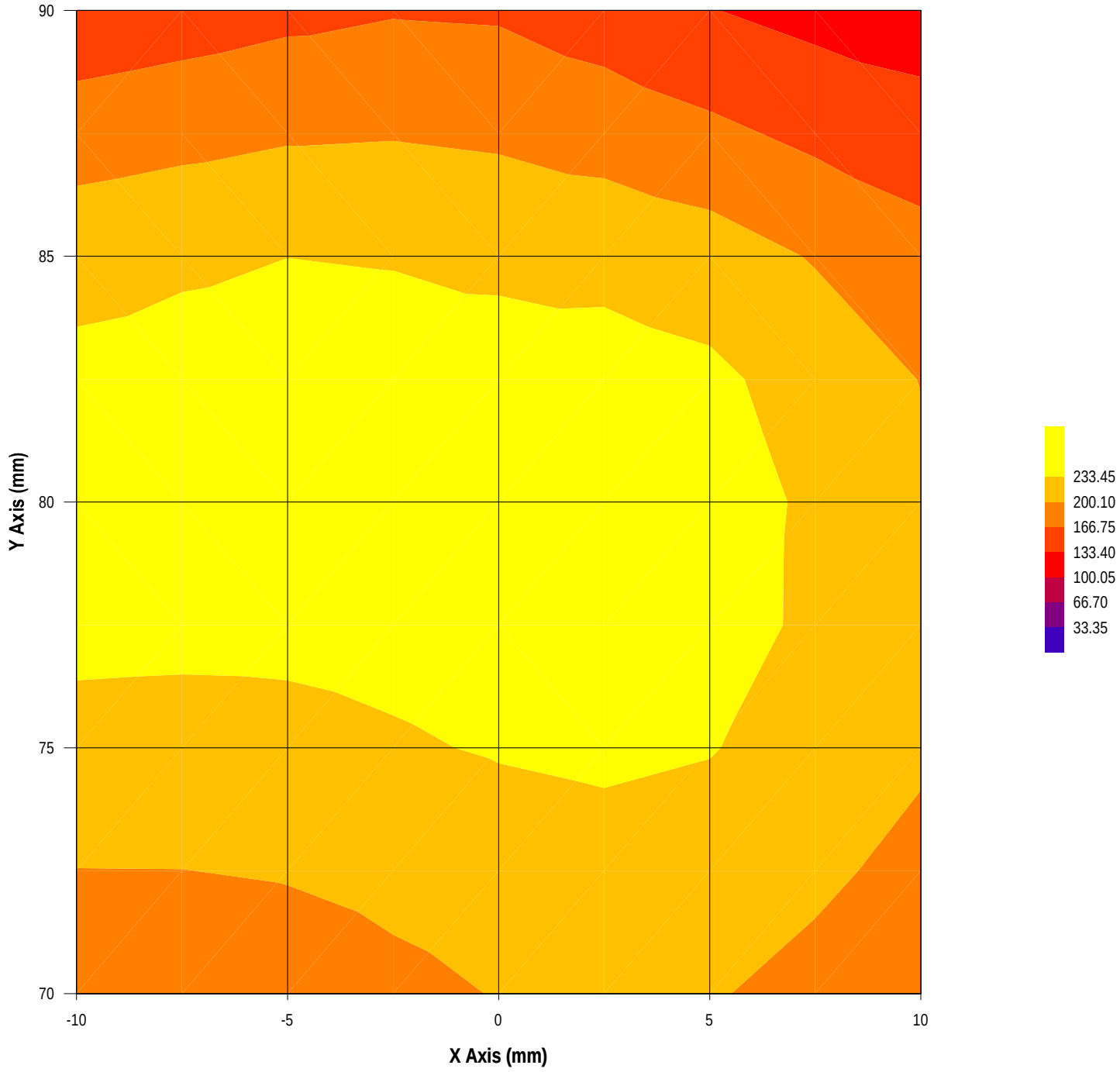
268.921	276.250	244.481	229.812	215.134	195.619
174.454	157.360	144.050	132.911	121.869	

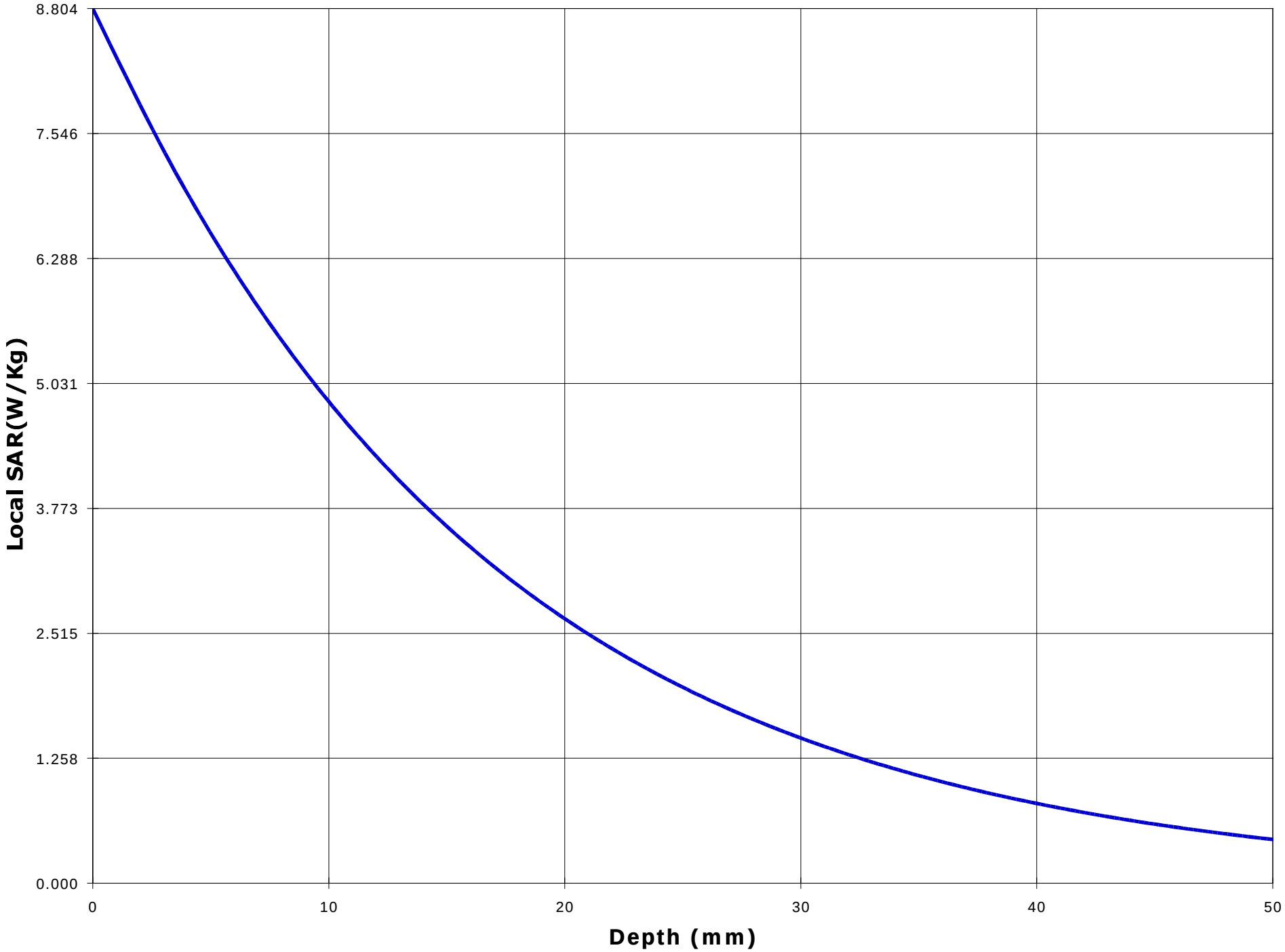
Peak Voltage (mV) : 300.978 **1 Cm Voltage (mV)** : 165.292 **SAR (W/Kg)** : 6.283

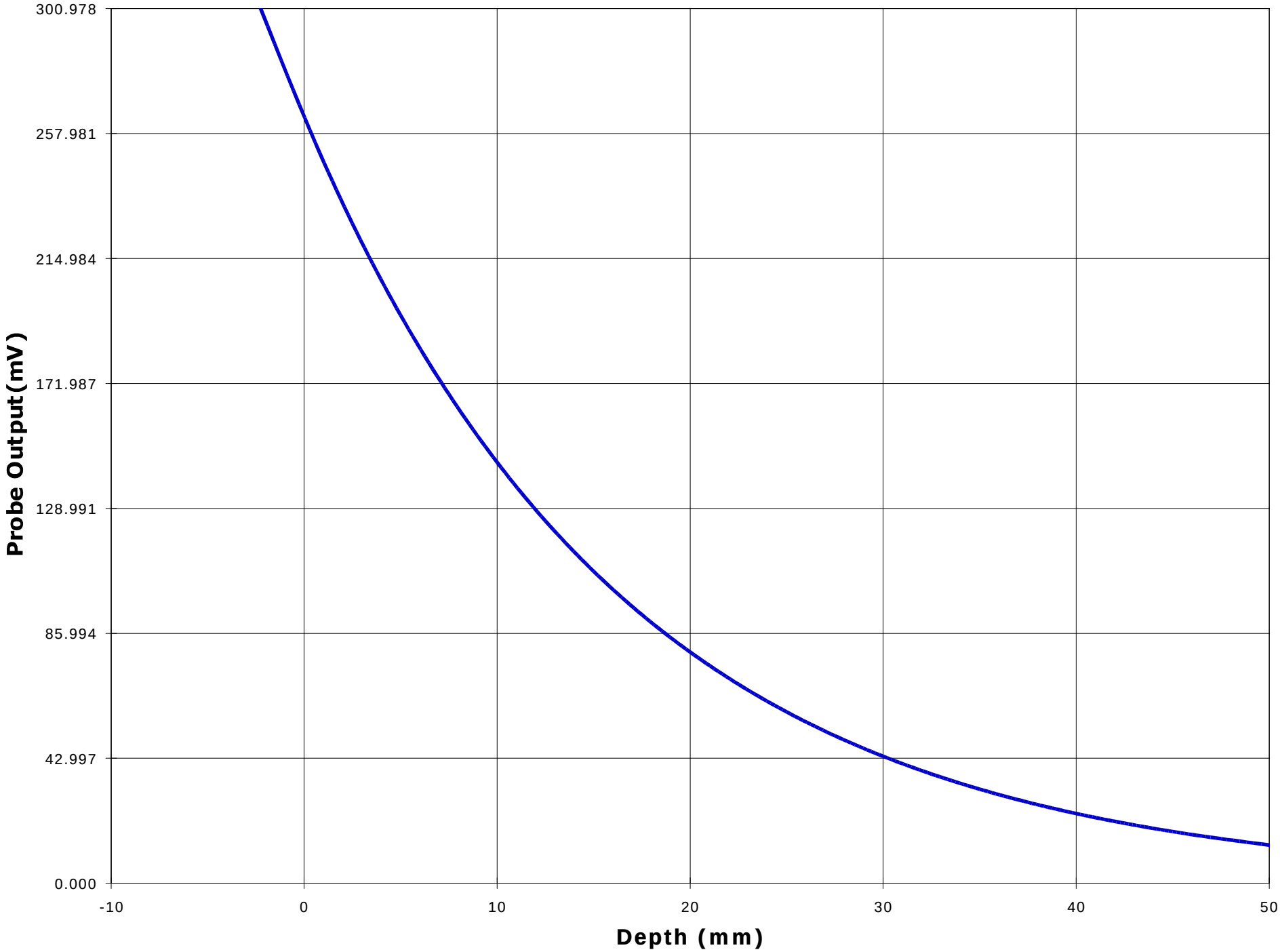

300.00
250.00
200.00
150.00
100.00
50.00
233.45
200.10
166.75
133.40
100.05
66.70
33.35


300.00
250.00
200.00
150.00
100.00
50.00
0.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
-10
-5
0
5
10
70
75
80
85
90
233.45
200.10
166.75
133.40
100.05
66.70
33.35


100
90
80
70
60
50
40
30
20
10
0
-10
-20
Y Axis (mm)
-20
-10
0
10
20
X Axis (mm)
233.45
200.10
166.75
133.40
100.05
66.70
33.35


90
85
80
75
70
Y Axis (mm)
-10
-5
0
5
10
X Axis (mm)
233.45
200.10
166.75
133.40
100.05
66.70
33.35


8.804
7.546
6.288
5.031
3.773
2.515
1.258
0.000
Local SAR(W/Kg)
0
10
20
30
40
50
Depth (mm)


300.978
257.981
214.984
171.987
128.991
85.994
42.997
0.000
Probe Output(mV)
-10
0
10
20
30
40
50
Depth (mm)

Test Information

Date : 11/22/00
Time : 2:14:48 PM

Product	: UHF Transceiver	**Test**	: SAR
Manufacturer	: ICOM Incorporated	**Frequency (MHz)**	: 485.100
Model Number	: IC-F4GS-3	**Nominal Output Power (W)**	: 4.0
Serial Number	: 00108	**Antenna Type**	: Monopole
FCC ID Number	: AFJ IC-F4G-3	**Signal**	: CW

Phantom	: Head - Front	**Dielectric Constant**	: 50.2
Simulated Tissue	: Brain	**Conductivity**	: 0.65

Probe	: ETR_225_1_999	**Antenna Position**	: FIX
Probe Offset (mm)	: 2.250	**Measured Power (W) (conducted)**	: 3.97
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 0.316	**Cable Insertion Loss (dB)**	: 0.1
Calibrated Date	: 10/7/99	**Compensated Power (W)**	: 4.062

Amplifier Setting :

Channel 1 : 0.0070 Channel 2 : 0.0067 Channel 3 : 0.0081

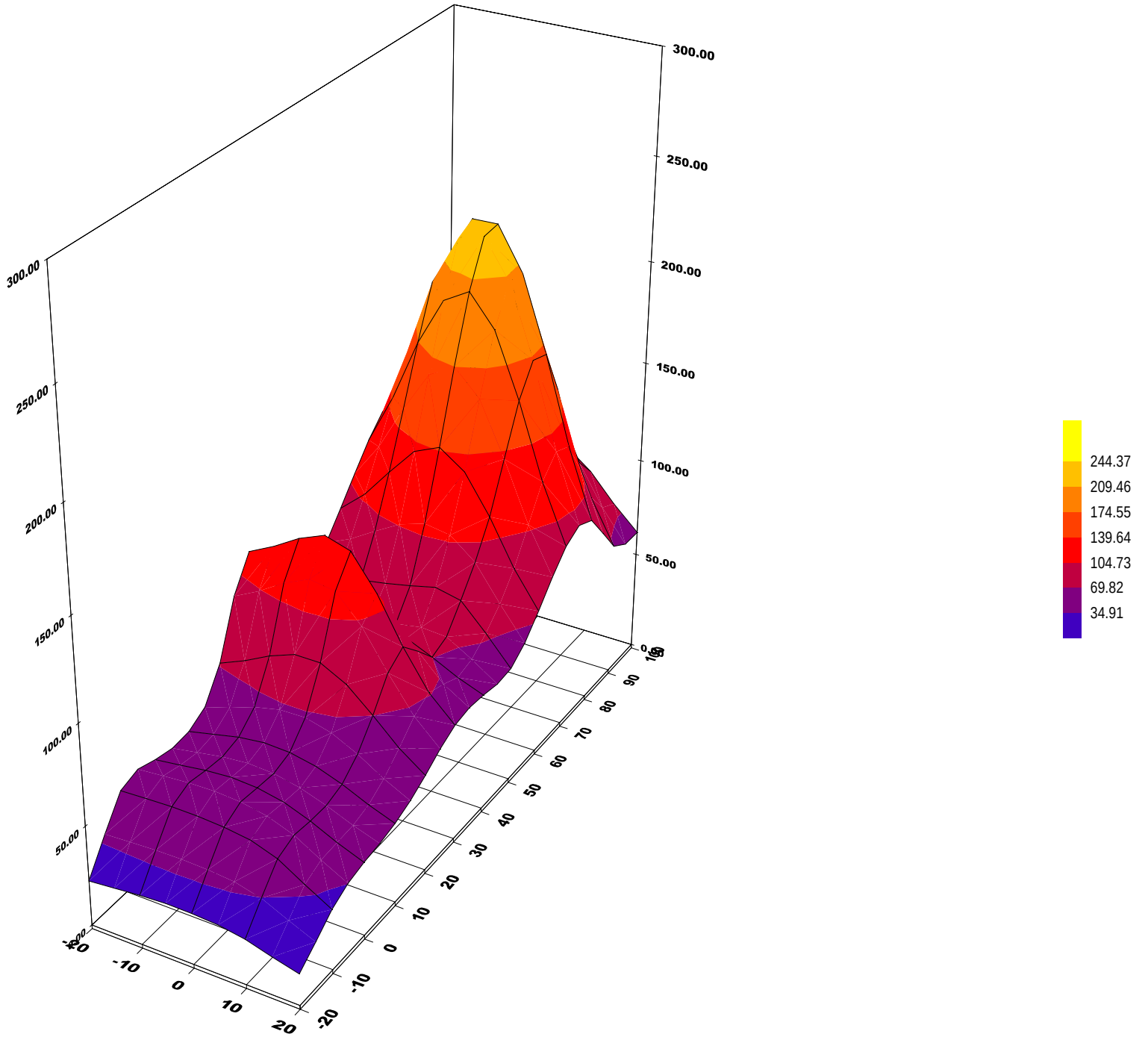
Location of Maximum Field :

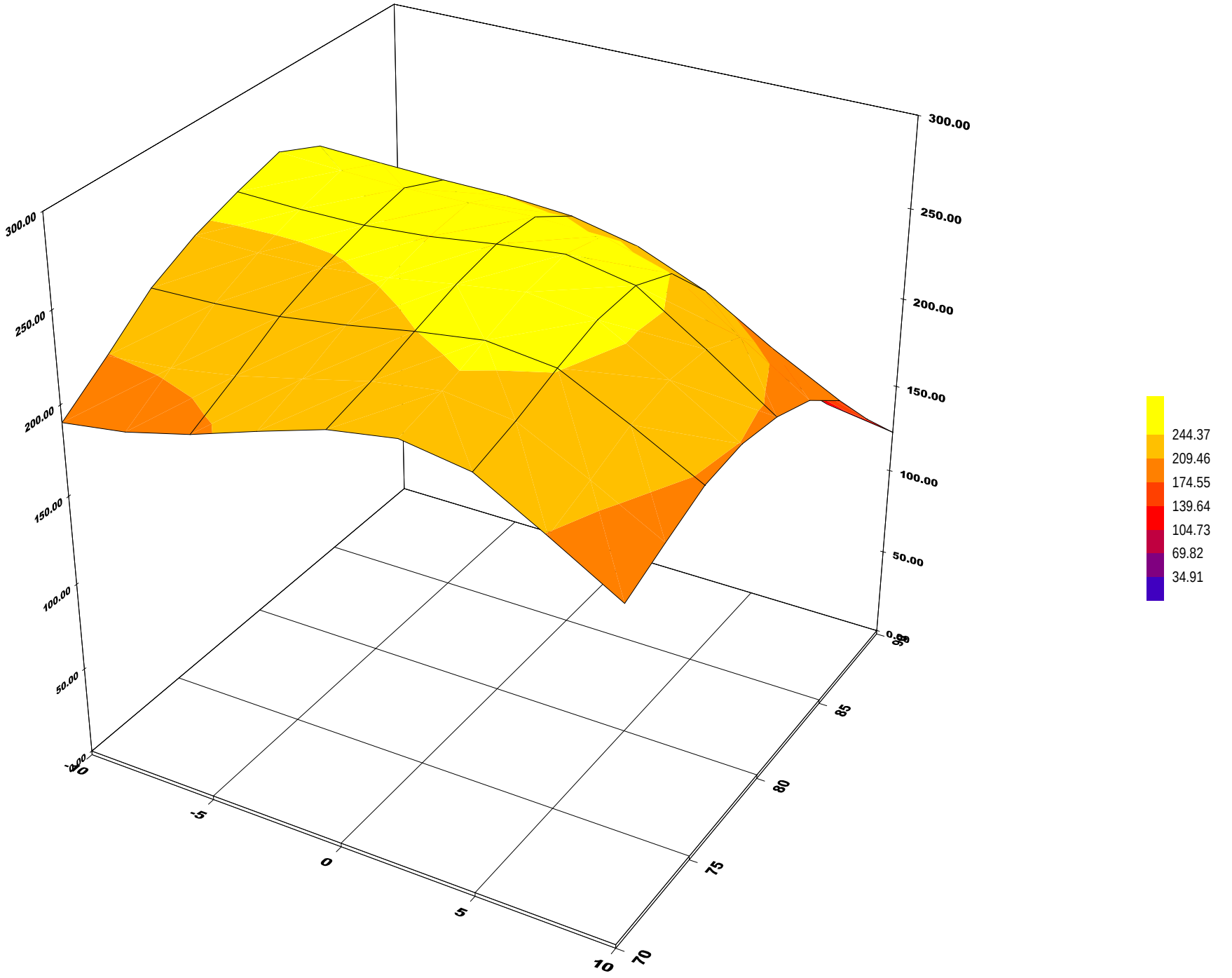
X = 5 Y = 80

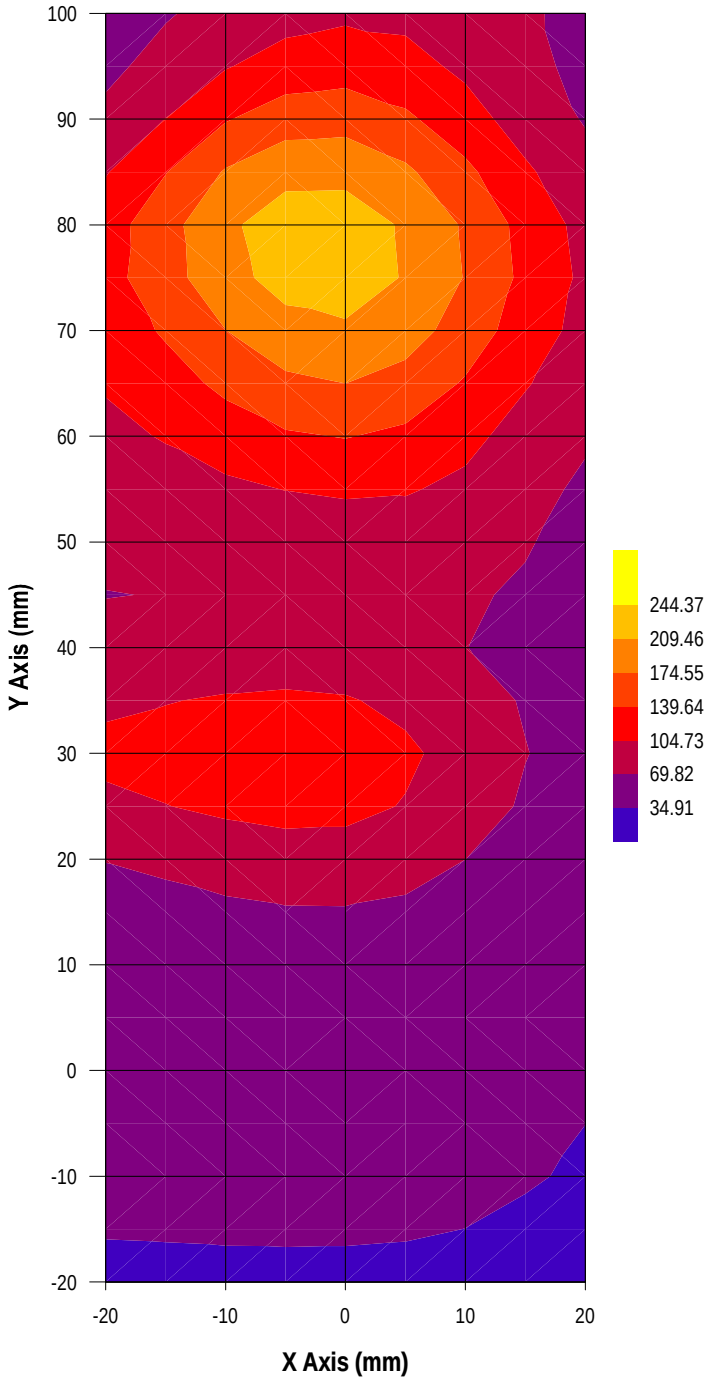
Measured Values (mV) :

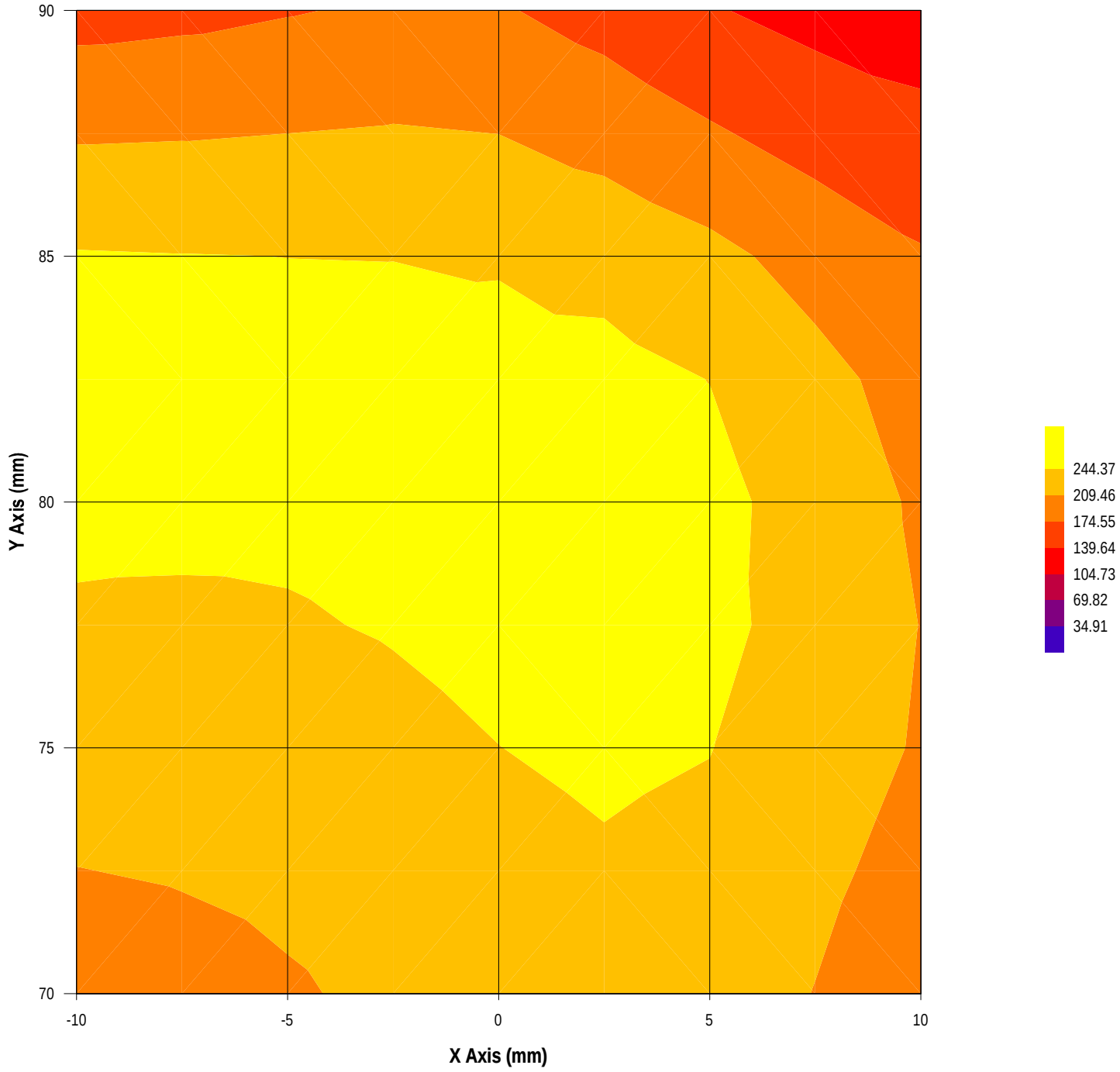
281.144	287.425	258.997	239.888	224.467	207.718
183.562	164.456	149.724	138.278	128.024	

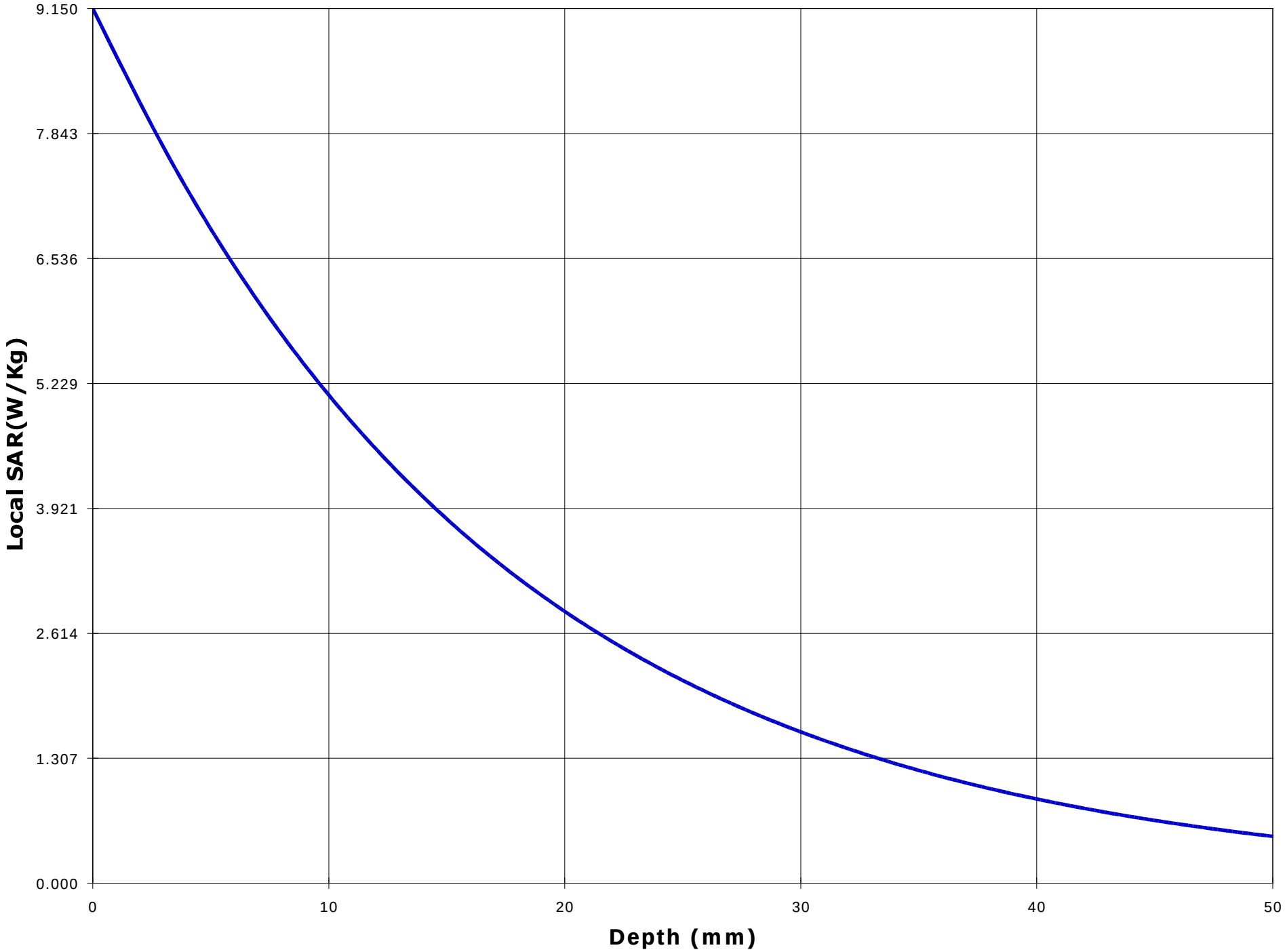
Peak Voltage (mV) : 312.820 **1 Cm Voltage (mV)** : 174.149 **SAR (W/Kg)** : 6.481

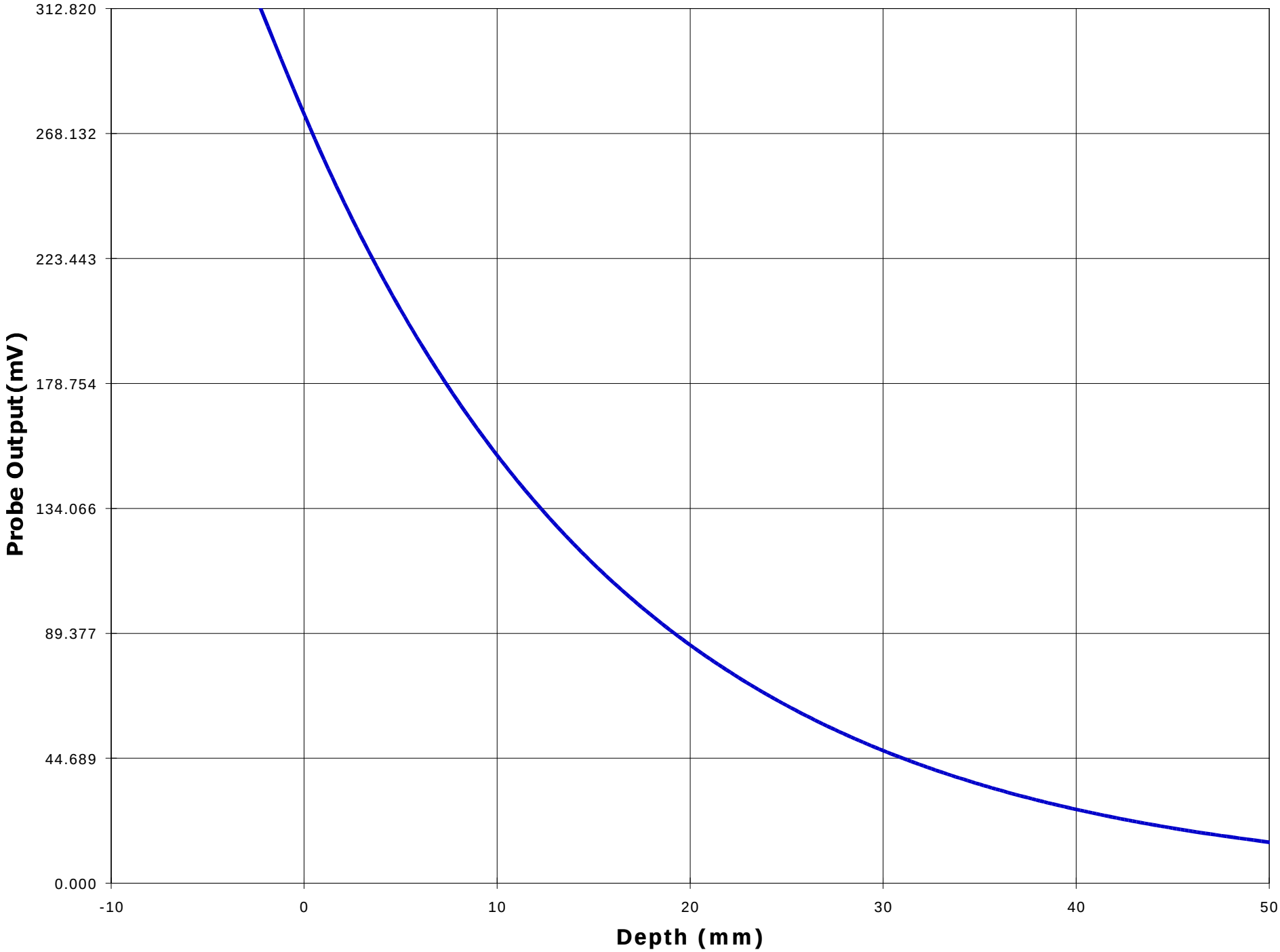

300.00
250.00
200.00
150.00
100.00
50.00
244.37
209.46
174.55
139.64
104.73
69.82
34.91


300.00
250.00
200.00
150.00
100.00
50.00
0.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
-10
-5
0
5
10
70
75
80
85
90
244.37
209.46
174.55
139.64
104.73
69.82
34.91


100
90
80
70
60
50
40
30
20
10
0
-10
-20
Y Axis (mm)
-20
-10
0
10
20
X Axis (mm)
244.37
209.46
174.55
139.64
104.73
69.82
34.91


90
85
80
75
70
Y Axis (mm)
-10
-5
0
5
10
X Axis (mm)
244.37
209.46
174.55
139.64
104.73
69.82
34.91


9.150
7.843
6.536
5.229
3.921
2.614
1.307
0.000
Local SAR(W/Kg)
0
10
20
30
40
50
Depth (mm)


312.820
268.132
223.443
178.754
134.066
89.377
44.689
0.000
Probe Output(mV)
-10
0
10
20
30
40
50
Depth (mm)

Test Information

Date : 11/22/00
Time : 2:34:19 PM

Product	: UHF Transceiver	**Test**	: SAR
Manufacturer	: ICOM Incorporated	**Frequency (MHz)**	: 499.900
Model Number	: IC-F4GS-3	**Nominal Output Power (W)**	: 4.0
Serial Number	: 00108	**Antenna Type**	: Monopole
FCC ID Number	: AFJ IC-F4G-3	**Signal**	: CW

Phantom	: Head - Front	**Dielectric Constant**	: 50.2
Simulated Tissue	: Brain	**Conductivity**	: 0.65

Probe	: ETR_225_1_999	**Antenna Position**	: FIX
Probe Offset (mm)	: 2.250	**Measured Power (W) (conducted)**	: 4.03
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 0.316	**Cable Insertion Loss (dB)**	: 0.1
Calibrated Date	: 10/7/99	**Compensated Power (W)**	: 4.124

Amplifier Setting :

Channel 1 : 0.0070 Channel 2 : 0.0067 Channel 3 : 0.0081

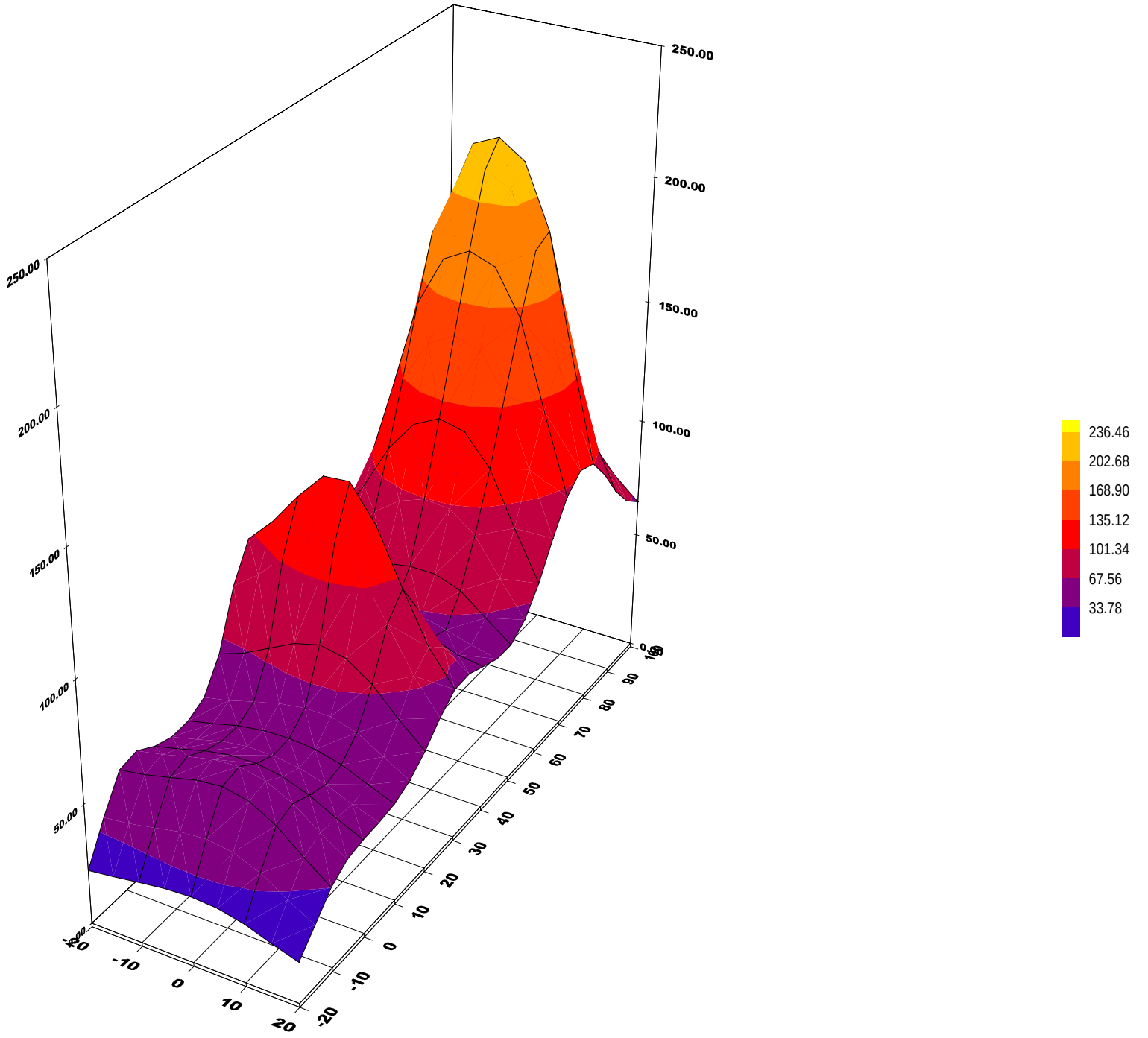
Location of Maximum Field :

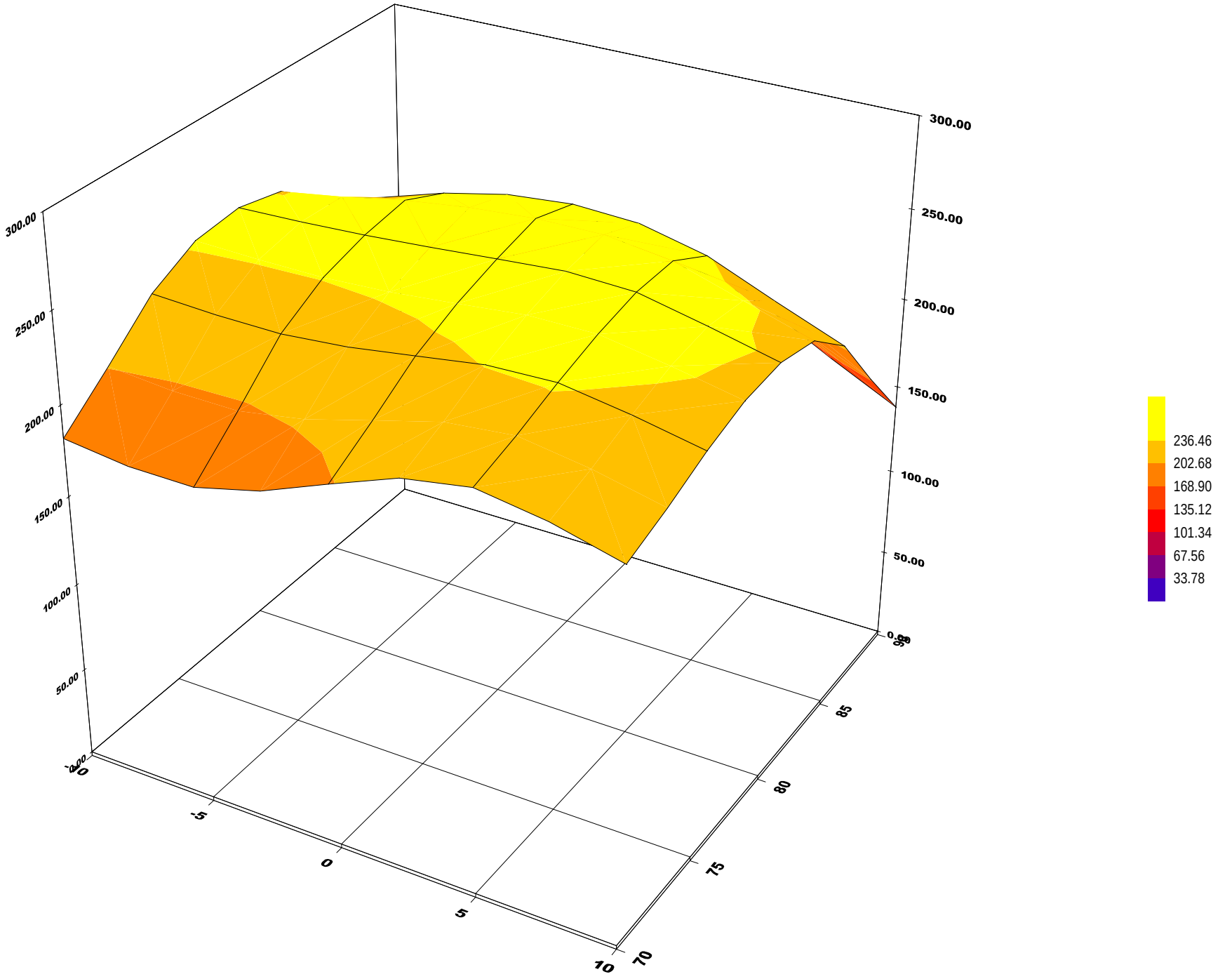
X = 0 Y = 85

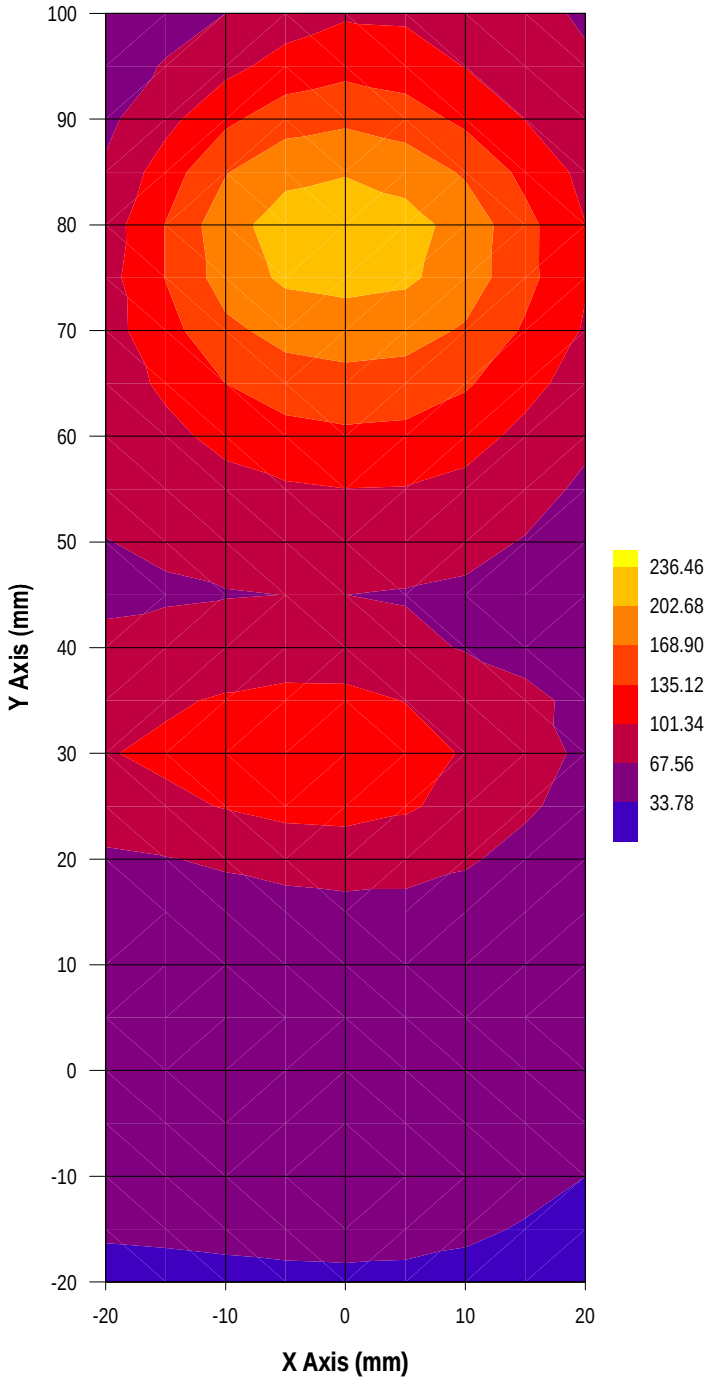
Measured Values (mV) :

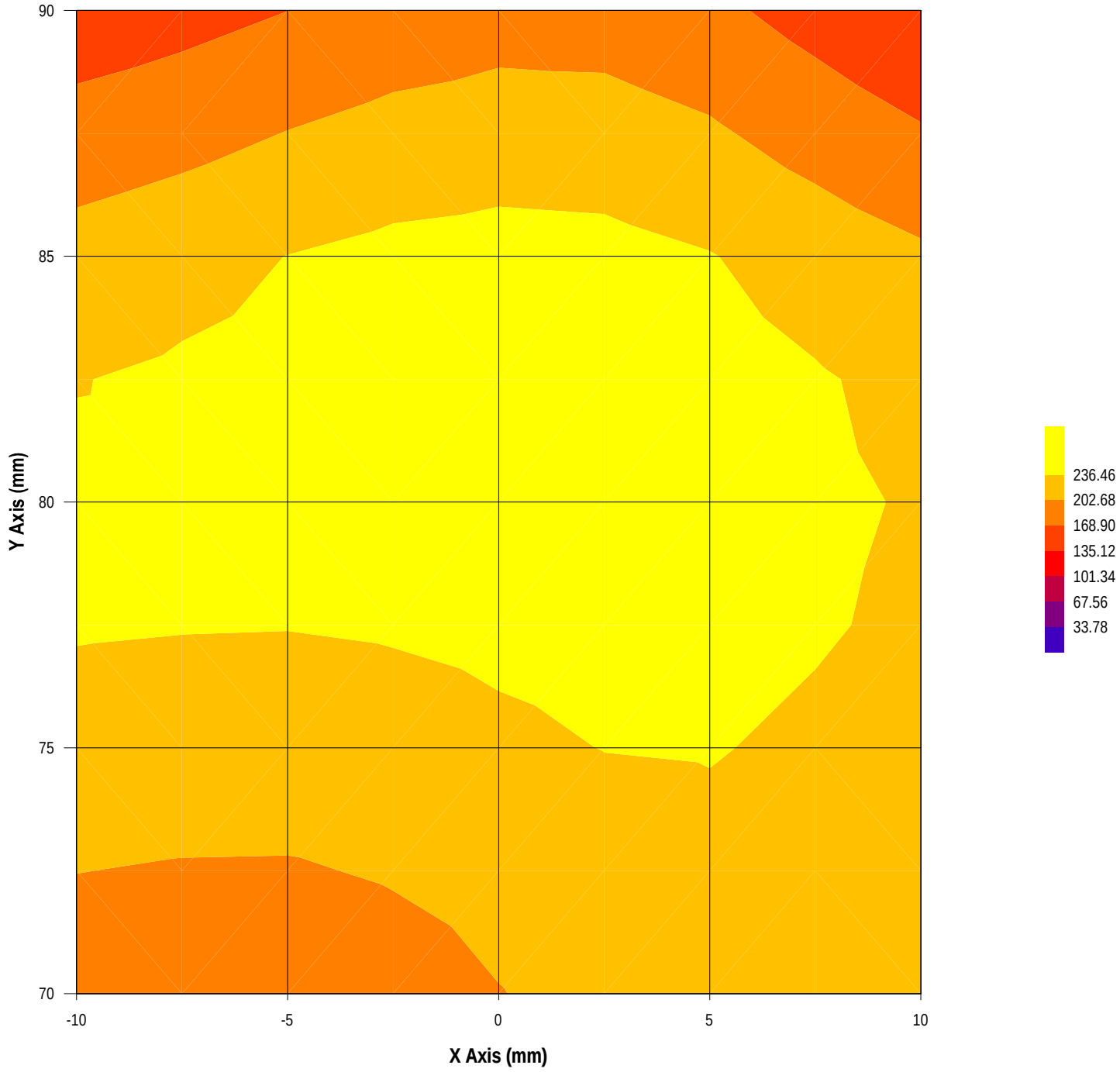
269.836	250.973	215.975	192.013	175.951	160.389
148.683	138.050	128.919	120.313	112.441	

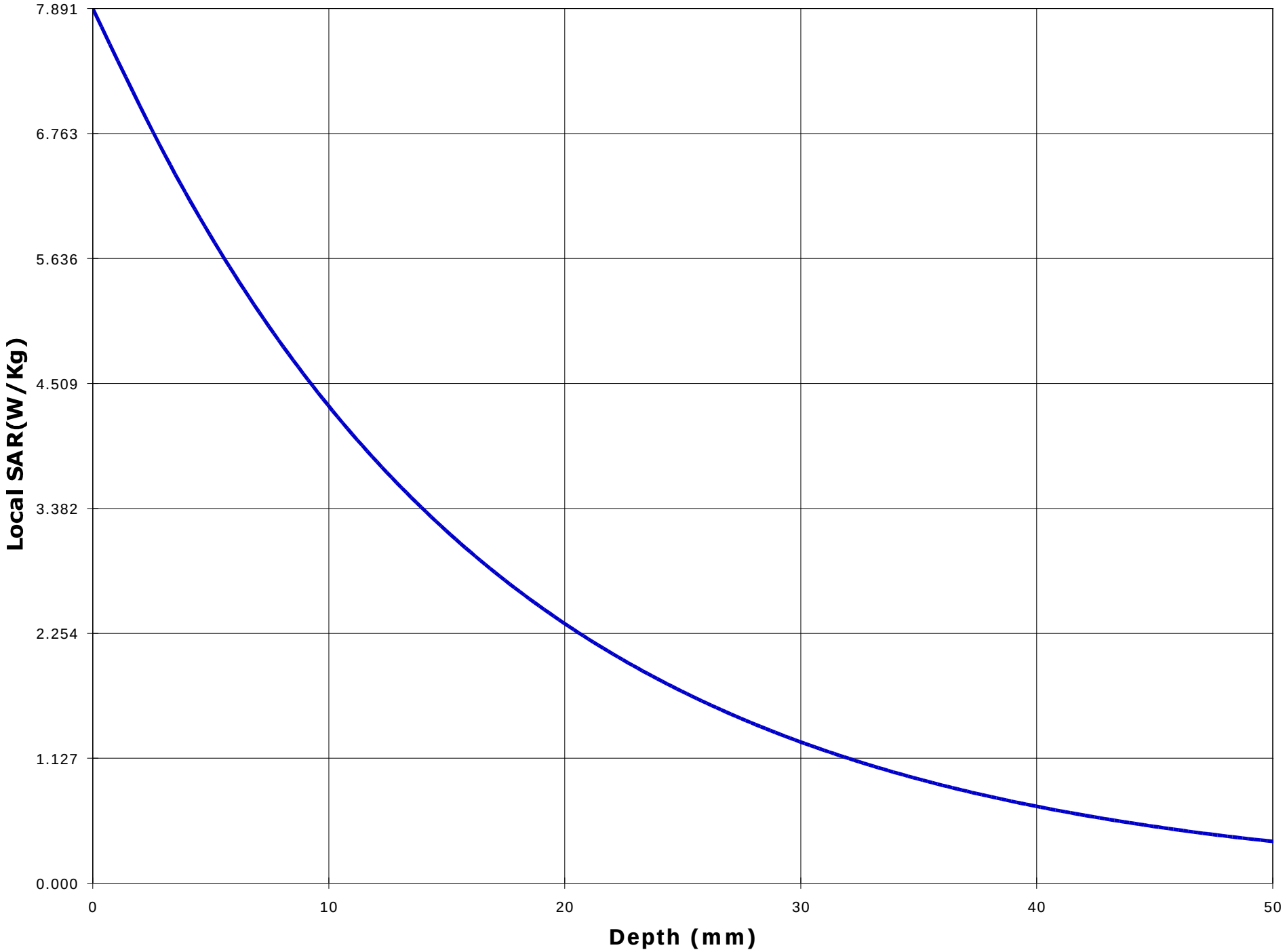
Peak Voltage (mV) : 269.761 **1 Cm Voltage (mV)** : 146.751 **SAR (W/Kg)** : 6.291

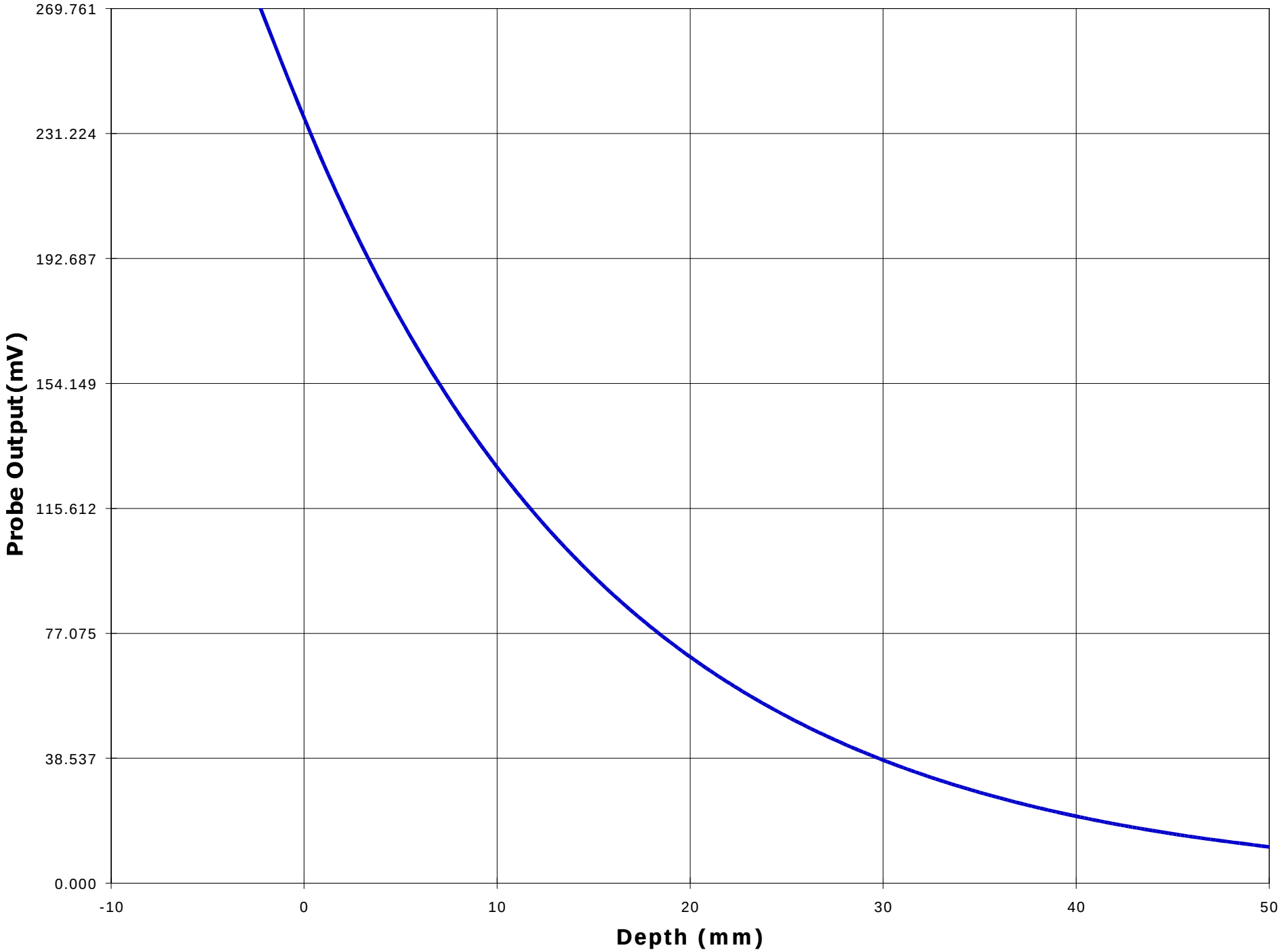

250.00
200.00
150.00
100.00
50.00
236.46
202.68
168.90
135.12
101.34
67.56
33.78


300.00
250.00
200.00
150.00
100.00
50.00
0.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
-10
-5
0
5
10
70
75
80
85
90
236.46
202.68
168.90
135.12
101.34
67.56
33.78


100
90
80
70
60
50
40
30
20
10
0
-10
-20
Y Axis (mm)
-20
-10
0
10
20
X Axis (mm)
236.46
202.68
168.90
135.12
101.34
67.56
33.78


90
85
80
75
70
Y Axis (mm)
-10
-5
0
5
10
X Axis (mm)
236.46
202.68
168.90
135.12
101.34
67.56
33.78


7.891
6.763
5.636
4.509
3.382
2.254
1.127
0.000
Local SAR(W/Kg)
0
10
20
30
40
50
Depth (mm)


269.761
231.224
192.687
154.149
115.612
77.075
38.537
0.000
Probe Output(mV)
-10
0
10
20
30
40
50
Depth (mm)

ANNEX C: Tissue Calibration

Ultratech Group of Labs.
3000 Bristol Circle Road
Oakville, Ontario
Canada L6H 6G4

Phone (905) 829-1570
FAX (905) 829-8050
Email vhk.ultratech@sympatico.ca

Name: Jay **Date:** 11/3/00

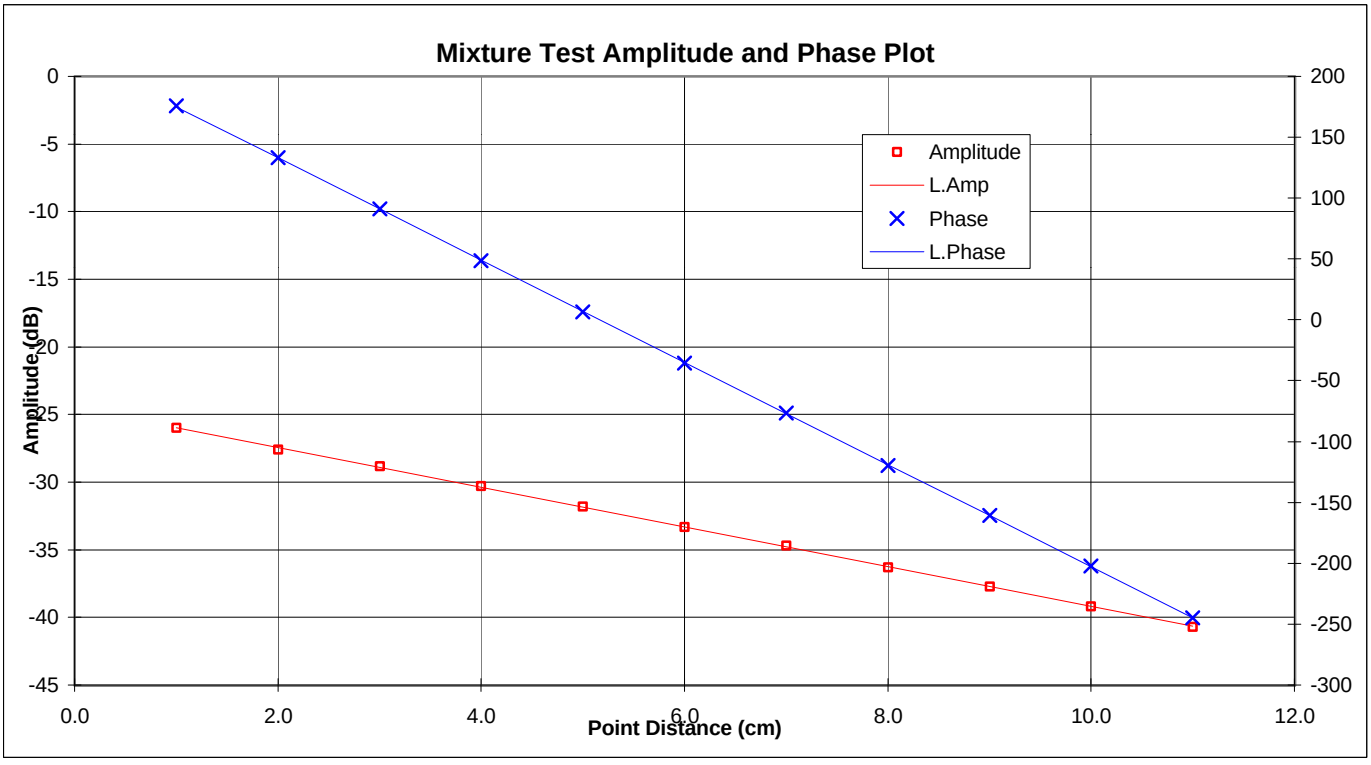
Frequency: 480 MHz **Mixture:** Brain **Room Temp.:** 25 °C

# of Points: 11 **Point Dist:** 1 cm

Point	Amplitude	Phase
1	-26.00	175.60
2	-27.60	133.00
3	-28.80	91.30
4	-30.30	48.80
5	-31.80	6.50
6	-33.30	-35.60
7	-34.70	-76.80
8	-36.30	-119.50
9	-37.70	-160.60
10	-39.20	157.70
11	-40.70	115.20

Composition	weight	% in weight
Tap Water	23,903.0 g	43.40 %
DI Water	0.0 g	0.00 %
Sugar	30,327.0 g	55.06 %
Alcohol	0.0 g	0.00 %
Salt	770.0 g	1.40 %
HEC	55.0 g	0.10 %
Bactericide	25.0 g	0.05 %
	0.0 g	0.00 %
	0.0 g	0.00 %
	0.0 g	0.00 %

Results:		Target	Low Limit	High Limit	% Off Target
D. Const:	50.2	48.6	46.211913	51.076325	3.29
Conductivity:	0.65	0.62	0.5885155	0.6504645	5.53



Ultratech Group of Labs.
3000 Bristol Circle Road
Oakville, Ontario
Canada L6H 6G4

Phone (905) 829-1570
FAX (905) 829-8050
Email vhk.ultratech@sympatico.ca

Name: Jay **Date:** 11/6/00

Frequency: 480 MHz **Mixture:** Muscle **Room Temp.:** 25 °C

# of Points: 11 **Point Dist:** 1 cm

Point	Amplitude	Phase
1	-22.60	139.50
2	-24.20	94.60
3	-25.90	48.20
4	-27.70	3.00
5	-29.60	-42.50
6	-31.10	-86.90
7	-32.90	-132.80
8	-34.60	-178.30
9	-36.40	135.90
10	-38.00	91.50
11	-39.70	46.70

Composition	weight	% in weight
Tap Water	34,452.0 g	51.16 %
DI Water	0.0 g	0.00 %
Sugar	31,500.0 g	46.78 %
Alcohol	0.0 g	0.00 %
Salt	1,000.0 g	1.49 %
HEC	350.0 g	0.52 %
Bactericide	35.0 g	0.05 %
	0.0 g	0.00 %
	0.0 g	0.00 %
	0.0 g	0.00 %

Results:		Target	Low Limit	High Limit	% Off Target
D. Const:	58.0	57.4	54.564201	60.307801	0.93
Conductivity:	0.83	0.84	0.7964724	0.8803116	-1.34