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Accreditation No.: **SCS 108**

Client **CCS (Auden)**

Certificate No: **EX3-3554\_Nov04**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3554**

Calibration procedure(s) **QA CAL-01.v5**  
**Calibration procedure for dosimetric E-field probes**

Calibration date: **November 19, 2004**

Condition of the calibrated item **In Tolerance**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID #            | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-------------------------------------------|-----------------------|
| Power meter E4419B         | GB41293874      | 5-May-04 (METAS, No. 251-00388)           | May-05                |
| Power sensor E4412A        | MY41495277      | 5-May-04 (METAS, No. 251-00388)           | May-05                |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 10-Aug-04 (METAS, No. 251-00403)          | Aug-05                |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 3-May-04 (METAS, No. 251-00389)           | May-05                |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 10-Aug-04 (METAS, No. 251-00404)          | Aug-05                |
| Reference Probe ES3DV2     | SN: 3013        | 8-Jan-04 (SPEAG, No. ES3-3013_Jan04)      | Jan-05                |
| DAE4                       | SN: 617         | 26-May-04 (SPEAG, No. DAE4-617_May04)     | May-05                |

| Secondary Standards       | ID #         | Check Date (in house)                    | Scheduled Check        |
|---------------------------|--------------|------------------------------------------|------------------------|
| Power sensor HP 8481A     | MY41092180   | 18-Sep-02 (SPEAG, in house check Oct-03) | In house check: Oct 05 |
| RF generator HP 8648C     | US3642U01700 | 4-Aug-99 (SPEAG, in house check Dec-03)  | In house check: Dec-05 |
| Network Analyzer HP 8753E | US37390585   | 18-Oct-01 (SPEAG, in house check Nov-03) | In house check: Nov 04 |

|                | Name          | Function              | Signature |
|----------------|---------------|-----------------------|-----------|
| Calibrated by: | Nico Vetterli | Laboratory Technician |           |
| Approved by:   | Katja Pokovic | Technical Manager     |           |

Issued: December 7, 2004

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



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### Glossary:

|                          |                                                                                                                                                      |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                             |
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                            |
| ConF                     | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                           |
| DCP                      | diode compression point                                                                                                                              |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                    |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis |

### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below *ConvF*).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY 4.3 B17 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

# Probe EX3DV4

## SN:3554

|               |                   |
|---------------|-------------------|
| Manufactured: | July 13, 2004     |
| Calibrated:   | November 19, 2004 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

## DASY - Parameters of Probe: EX3DV4 SN:3554

### Sensitivity in Free Space<sup>A</sup>

### Diode Compression<sup>B</sup>

|       |             |                                     |       |       |
|-------|-------------|-------------------------------------|-------|-------|
| NormX | 0.39 ± 9.9% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP X | 92 mV |
| NormY | 0.41 ± 9.9% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Y | 92 mV |
| NormZ | 0.42 ± 9.9% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Z | 92 mV |

### Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 8.

### Boundary Effect

**TSL**                      **900 MHz**      **Typical SAR gradient: 5 % per mm**

|                                           |                              |               |               |
|-------------------------------------------|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>2.0 mm</b> | <b>3.0 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 3.7           | 1.1           |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.2           | 0.4           |

**TSL**                      **1750 MHz**      **Typical SAR gradient: 10 % per mm**

|                                           |                              |               |               |
|-------------------------------------------|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>2.0 mm</b> | <b>3.0 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 4.8           | 2.4           |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.8           | 0.8           |

### Sensor Offset

Probe Tip to Sensor Center                      **1.0 mm**

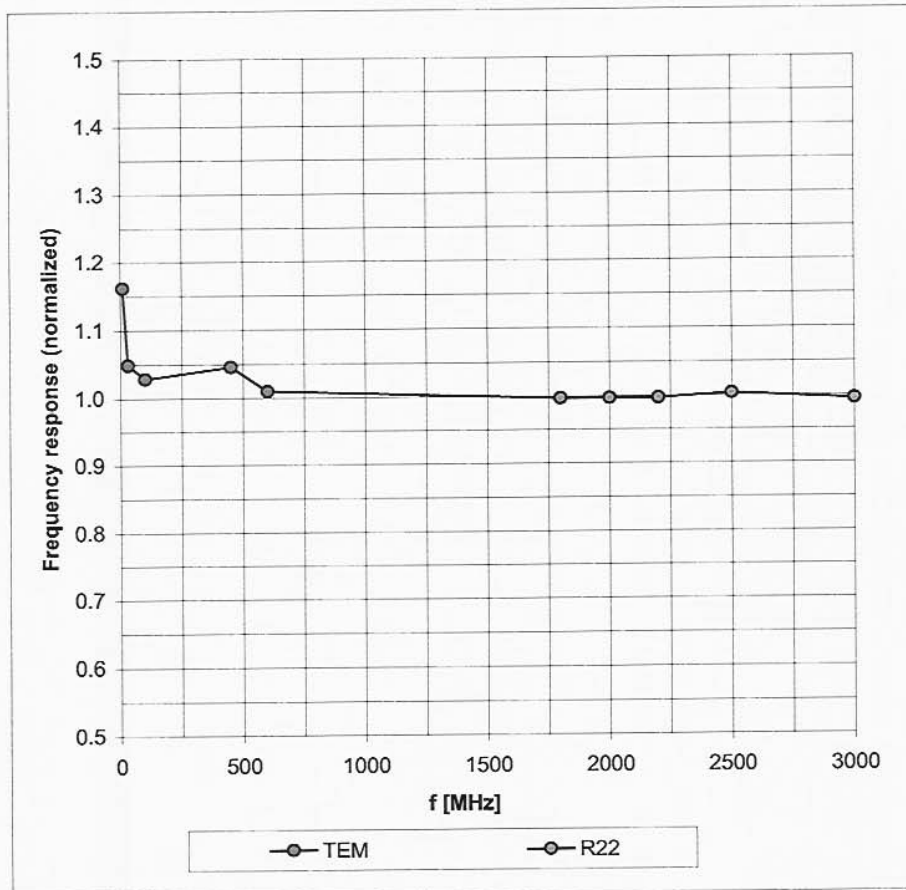
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Page 8).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

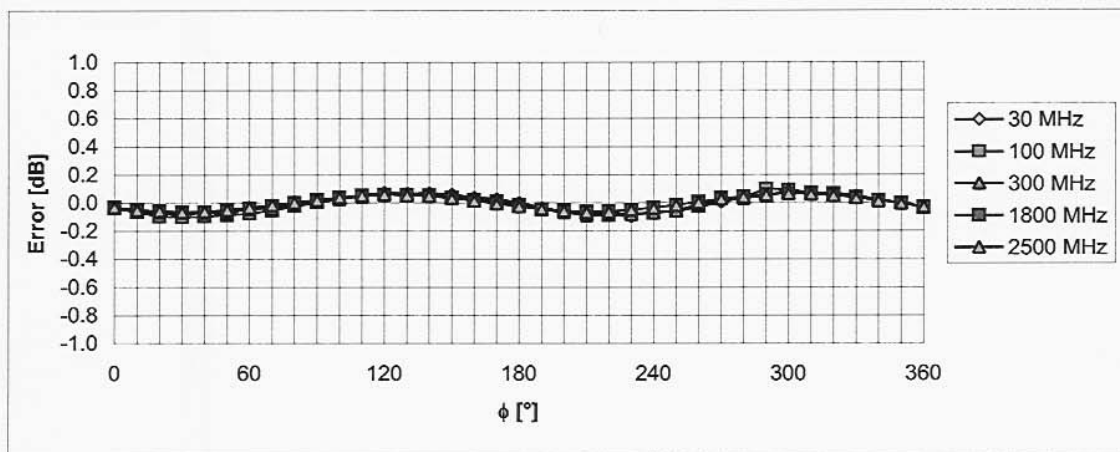
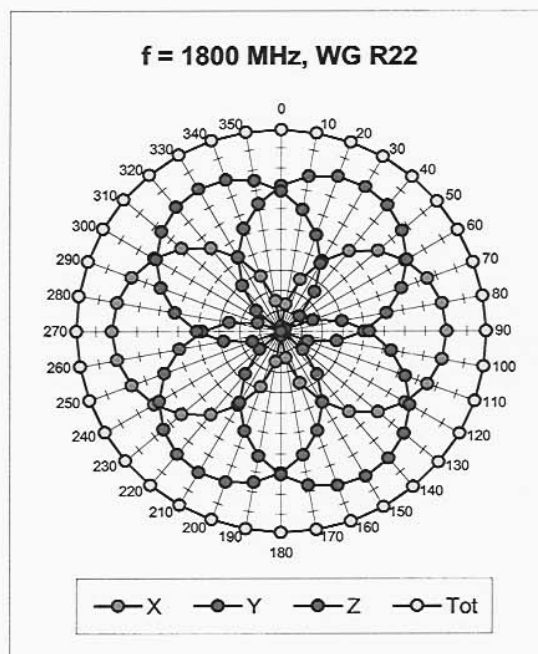
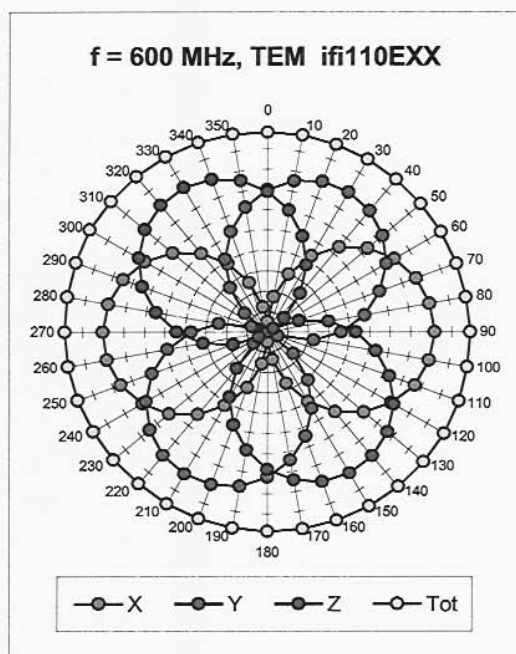
## Frequency Response of E-Field

(TEM-Cell: ifi110 EXX, Waveguide: R22)



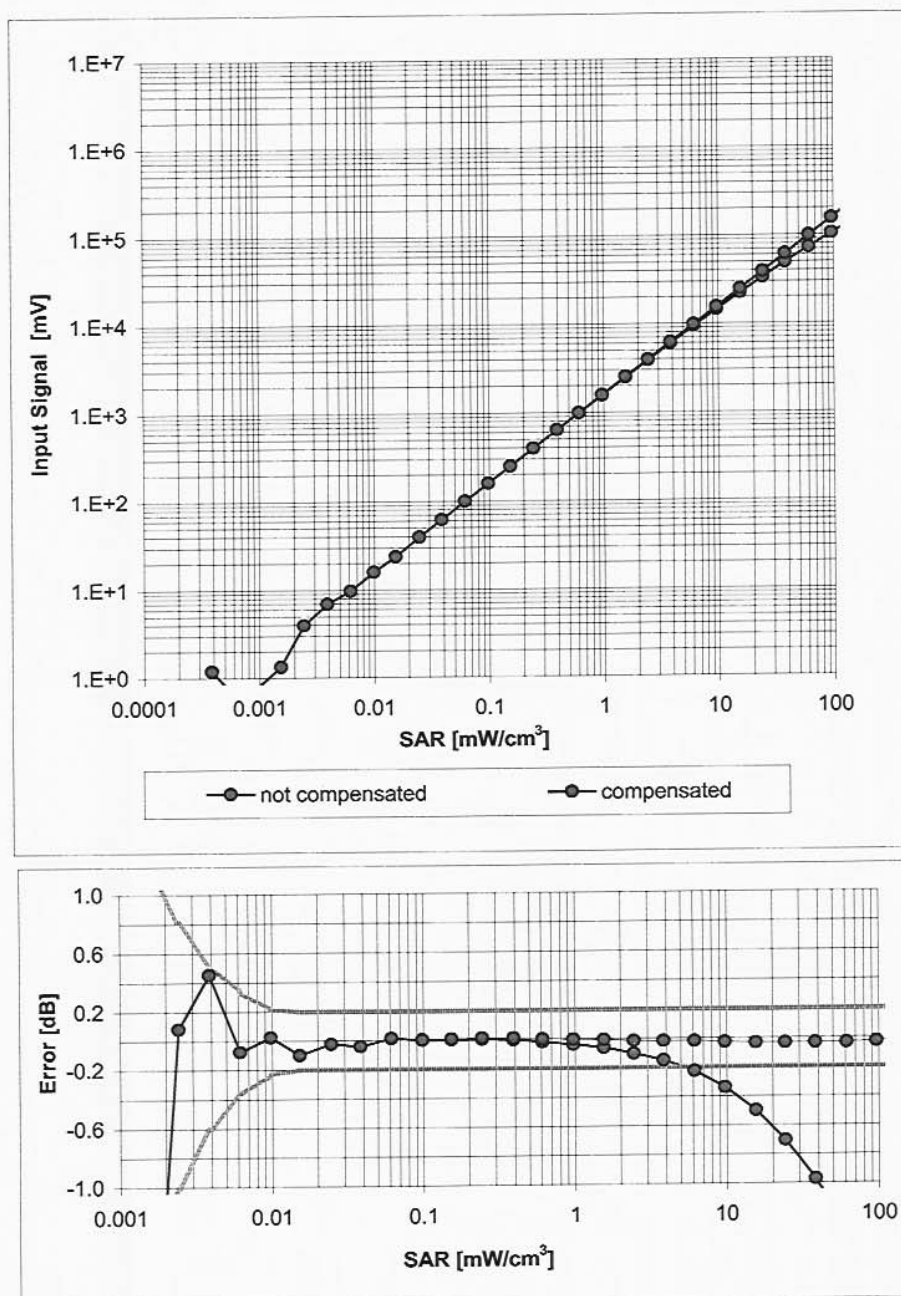
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

## Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



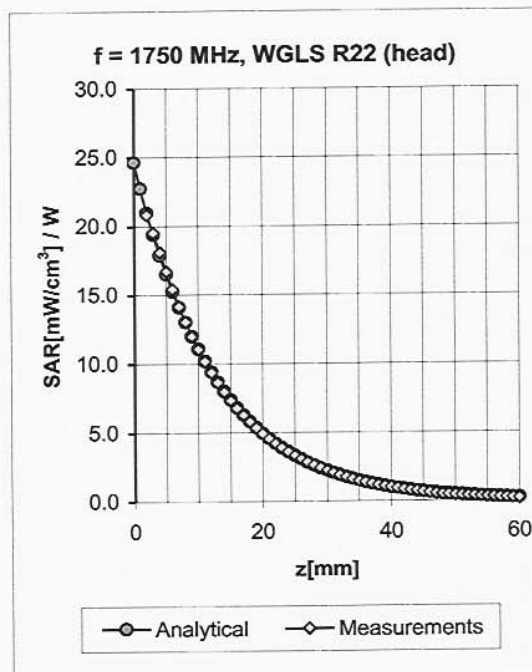
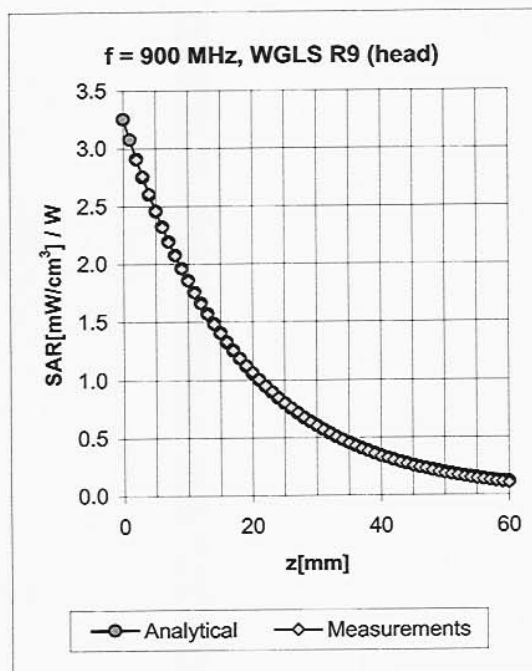
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

# Dynamic Range $f(\text{SAR}_{\text{head}})$ (Waveguide R22, $f = 1800 \text{ MHz}$ )



Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment

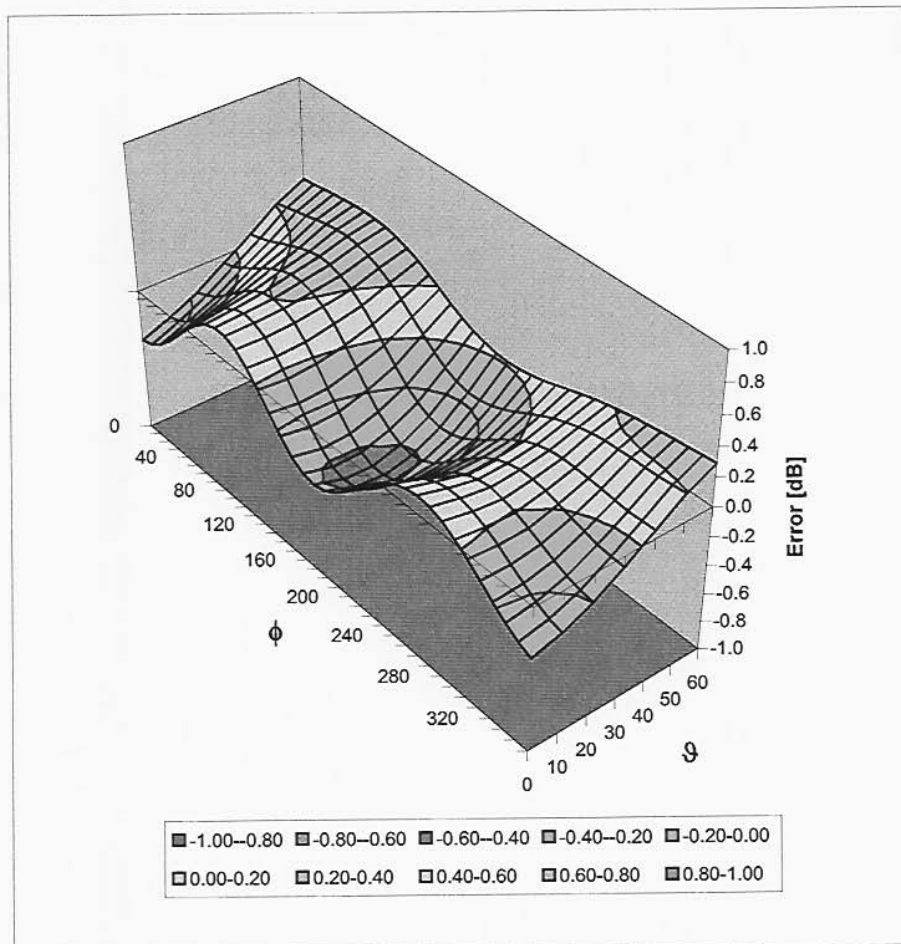


| f [MHz] | Validity [MHz] <sup>c</sup> | TSL  | Permittivity | Conductivity | Alpha | Depth | ConvF Uncertainty  |
|---------|-----------------------------|------|--------------|--------------|-------|-------|--------------------|
| 835     | ± 50 / ± 100                | Head | 41.5 ± 5%    | 0.90 ± 5%    | 0.91  | 0.66  | 7.94 ± 11.0% (k=2) |
| 900     | ± 50 / ± 100                | Head | 41.5 ± 5%    | 0.97 ± 5%    | 1.01  | 0.61  | 7.58 ± 11.0% (k=2) |
| 1750    | ± 50 / ± 100                | Head | 40.1 ± 5%    | 1.37 ± 5%    | 0.65  | 0.80  | 6.85 ± 11.0% (k=2) |
| 1900    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.59  | 0.89  | 6.61 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Head | 39.2 ± 5%    | 1.80 ± 5%    | 0.67  | 0.74  | 6.20 ± 11.8% (k=2) |
|         |                             |      |              |              |       |       |                    |
| 835     | ± 50 / ± 100                | Body | 55.2 ± 5%    | 0.97 ± 5%    | 0.96  | 0.66  | 7.81 ± 11.0% (k=2) |
| 900     | ± 50 / ± 100                | Body | 55.0 ± 5%    | 1.05 ± 5%    | 1.06  | 0.61  | 7.57 ± 11.0% (k=2) |
| 1750    | ± 50 / ± 100                | Body | 53.4 ± 5%    | 1.49 ± 5%    | 0.52  | 1.15  | 6.40 ± 11.0% (k=2) |
| 1900    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.46  | 1.35  | 6.24 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Body | 52.7 ± 5%    | 1.95 ± 5%    | 0.79  | 0.67  | 6.14 ± 11.8% (k=2) |

<sup>c</sup> The validity of ± 100 MHz only applies for DASY 4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

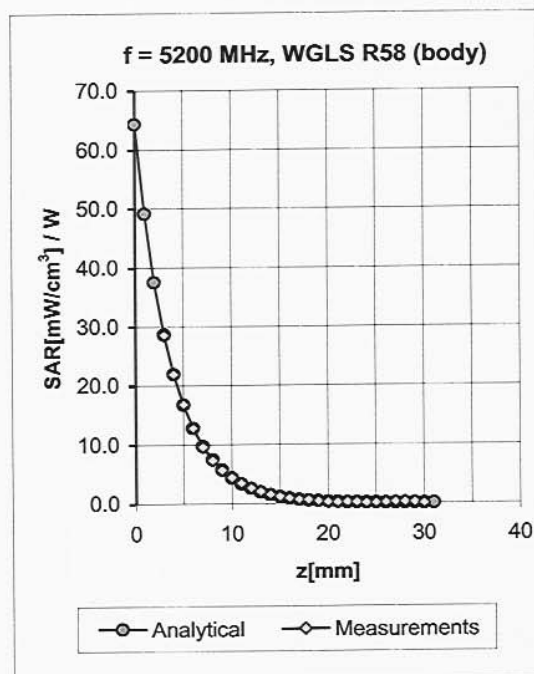
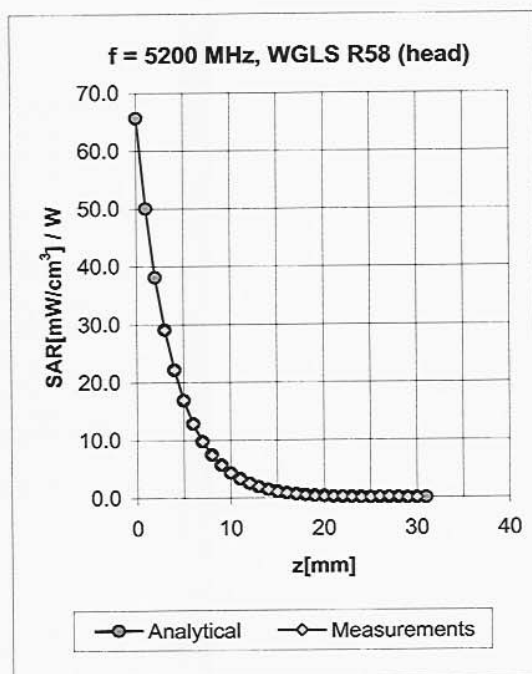
## Deviation from Isotropy in HSL

Error ( $\phi$ ,  $\vartheta$ ),  $f = 900$  MHz



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )

# Appendix<sup>D</sup>



| f [MHz] <sup>D</sup> | Validity [MHz] | TSL  | Permittivity | Conductivity | Alpha | Depth | ConvF | Uncertainty   |
|----------------------|----------------|------|--------------|--------------|-------|-------|-------|---------------|
| 5200                 | ± 50           | Head | 36.0 ± 5%    | 4.66 ± 5%    | 0.48  | 1.80  | 4.27  | ± 13.6% (k=2) |
| 5500                 | ± 50           | Head | 35.6 ± 5%    | 4.96 ± 5%    | 0.46  | 1.80  | 3.87  | ± 13.6% (k=2) |
| 5800                 | ± 50           | Head | 35.3 ± 5%    | 5.27 ± 5%    | 0.46  | 1.80  | 3.85  | ± 13.6% (k=2) |
| 5200                 | ± 50           | Body | 49.0 ± 5%    | 5.30 ± 5%    | 0.47  | 1.80  | 4.04  | ± 13.6% (k=2) |
| 5500                 | ± 50           | Body | 48.6 ± 5%    | 5.65 ± 5%    | 0.48  | 1.90  | 3.63  | ± 13.6% (k=2) |
| 5800                 | ± 50           | Body | 48.2 ± 5%    | 6.00 ± 5%    | 0.48  | 1.90  | 3.62  | ± 13.6% (k=2) |

<sup>D</sup> Accreditation for ConvF assessment above 3000 MHz is currently applied for. Accreditation is expected at the beginning of 2005.