TCC
Nokia

FINAS
Finnish Accreditation Service
T117 (EN ISO/IEC 17025)

SAR Compliance Test Report

Test report no.:	Cph_SAR_0821_11	**Date of report:**	2008-05-23
Template version:	9.0	**Number of pages:**	61
Testing laboratory:	TCC Nokia Copenhagen Laboratory Frederikskaj 1790 COPENHAGEN V DENMARK Tel. +45 33 292929 Fax. +45 33 292934	**Client:**	Nokia Corporation P.O. Box 300 Yrttipellontie 6 FIN-90230 OULU, FINLAND Tel. +358 (0) 7180 08000 Fax. +358 (0) 7180 58300
Responsible test engineer:	Jesper Nielsen	**Product contact person:**	Sonja Länkinen
Measurements made by:	Jesper Nielsen		
Tested device:	RM-356		
FCC ID:	LJPRM-356	**IC:**	661E-RM356
Supplement reports:	Cph_SAR_0821_12		

Testing has been carried out in accordance with:

47CFR §2.1093
Radiofrequency Radiation Exposure Evaluation: Portable Devices

FCC OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01)
Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

RSS-102
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

IEEE 1528 - 2003
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Technique

Documentation: The documentation of the testing performed on the tested devices is archived for 15 years at TCC Nokia.

Test results: **The tested device complies with the requirements in respect of all parameters subject to the test.** The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.

Date and signatures:

For the contents:

Leif Funch Klysner
Test System Manager

Digitally signed by Leif Funch Klysner
DN: cn=Leif Funch Klysner, o=Radio Spectrum, ou=CertT, email=leif.klysner@nokia.com, c=DK
Date: 2008.10.09 14:37:28 +02'00'

CONTENTS

1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Period of test	2008-04-26 to 2008-05-19
SN, HW and SW numbers of tested device	SN: 004401/10/048450/6, HW: 0502, SW: V01.10.1, DUT: 26113
Batteries used in testing	BL-5J, DUT: 26103, 26104, 26105 26106, 26107, 26110
Headsets used in testing	HS-45+AD-54, DUT: 26109, 26108
Other accessories used in testing	-
State of sample	Prototype unit
Notes	-

1.2 Maximum Results

The maximum measured SAR values for Head configuration and Body Worn configuration are given in section 1.2.1 and 1.2.2 respectively. The device conforms to the requirements of the standard(s) when the maximum measured SAR value is less than or equal to the limit.

1.2.1 Head Configuration

Mode	Ch / *f* (MHz)	Radiated power	Position	Measured SAR value (1g avg)	Scaled* SAR value (1g avg)	SAR limit (1g avg)	Result
3-slot GPRS 850	251 / 848.8	23.9 dBm ERP	Left, Cheek	0.466 W/kg	**0.52 W/kg**	1.6 W/kg	PASSED
GSM 1900	810 / 1909.8	29.5 dBm EIRP	Right, Cheek	0.937 W/kg	**1.05 W/kg**	1.6 W/kg	PASSED
WLAN 2450	11 / 2462.0	20.3 dBm EIRP	Right, Cheek	0.211 W/kg	**0.24 W/kg**	1.6 W/kg	PASSED
3-slot GPRS 850 + WLAN 2450	-	-	Left, Cheek	0.644 W/kg	**0.72 W/kg**	1.6 W/kg	PASSED
GSM 1900 + WLAN 2450	-	-	Right, Cheek	1.148 W/kg	**1.29 W/kg**	1.6 W/kg	PASSED

1.2.2 Body Worn Configuration

Mode	Ch / *f* (MHz)	Radiated power	Separation distance	Measured SAR value (1g avg)	Scaled* SAR value (1g avg)	SAR limit (1g avg)	Result
3-slot GPRS 850	251 / 848.8	23.9 dBm ERP	1.5 cm	0.647 W/kg	**0.72 W/kg**	1.6 W/kg	PASSED
GSM 1900	512 / 1850.2	30.9 dBm EIRP	1.5 cm	0.494 W/kg	**0.55 W/kg**	1.6 W/kg	PASSED
WLAN 2450	11 / 2462.0	20.3 dBm EIRP	1.5 cm	0.074 W/kg	**0.08 W/kg**	1.6 W/kg	PASSED
3-slot GPRS 850 + WLAN 2450	-	-	1.5 cm	0.721 W/kg	**0.81 W/kg**	1.6 W/kg	PASSED
GSM 1900 + WLAN 2450	-	-	1.5 cm	0.568 W/kg	**0.64 W/kg**	1.6 W/kg	PASSED

*SAR values are scaled up by 12% to cover measurement drift.

1.2.3 Maximum Drift

Maximum drift covered by 12% scaling up of the SAR values	Maximum drift during measurements
0.5dB	0.45 dB

1.2.4 Measurement Uncertainty

Expanded Uncertainty (k=2) 95%	± 25.8%

2. DESCRIPTION OF THE DEVICE UNDER TEST

Device category	Portable
Exposure environment	General population / uncontrolled

Modes of Operation	Bands	Modulation Mode	Duty Cycle	Transmitter Frequency Range (MHz)
GSM	850 1900	GMSK	1/8	824 – 849 1850 – 1910
GPRS	850 1900	GMSK	1/8 to 3/8	824 – 849 1850 – 1910
EGPRS	850 1900	GMSK / 8PSK	1/8 to 3/8	824 – 849 1850 – 1910
BT	2450	GFSK	1	2402 – 2480
WLAN	2450	11Mbps QPSK	1	2412 – 2462

Outside of USA and Canada, the transmitter of the device is capable of operating also in GSM/GPRS/EGPRS900, GSM/GPRS/EGPRS1800, WCDMA900 and WCDMA2100 bands which are not part of this filing.

This device has Dual Transfer Mode capability for use at the ear. Therefore, SAR for multi slot GPRS mode was evaluated against the head profile of the phantom.

2.1 Description of the Antenna

The device has an internal antenna.

3. TEST CONDITIONS

3.1 Temperature and Humidity

Ambient temperature (°C):	35 to 55
Ambient humidity (RH %):	20.5 to 22.5

3.2 Test Signal, Frequencies and Output Power

The device was put into operation by using a call tester except for testing WLAN2450 where control software was used. Communication between the device and the call tester was established by air link.

The device output power was set to maximum power level for all tests; a fully charged battery was used for every test sequence.

In all operating bands the measurements were performed on lowest, middle and highest channels.

The radiated output power of the device was measured by a separate test laboratory on the same unit(s) as used for SAR testing.

4. DESCRIPTION OF THE TEST EQUIPMENT

4.1 Measurement System and Components

The measurements were performed using an automated near-field scanning system, DASY4, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland. The SAR extrapolation algorithm used in all measurements was the 'advanced extrapolation' algorithm.

The following table lists calibration dates of SPEAG components:

Test Equipment	Serial Number	Calibration interval	Calibration expiry
DAE3	339	12 months	2008-06
DAE3	501	12 months	2009-03
DAE4	682	12 months	2008-08
E-field Probe ES3DV3	3117	12 months	2008-08
E-field Probe ES3DV3	3118	12 months	2008-10
Dipole Validation Kit, D835V2	4d042	24 months	2008-09
Dipole Validation Kit, D1900V2	5d026	24 months	2010-03
Dipole Validation Kit, D2450V2	790	24 months	2008-08
DASY4 software	Version 4.7	-	-

Additional test equipment used in testing:

Test Equipment	Model	Serial Number	Calibration interval	Calibration expiry
Signal Generator	SME06	848650/011	36 months	2008-07
Amplifier	2100-BBS3Q8CCJ	1003	-	-
Power Meter	NRP	100293	24 months	2009-07
Power Sensor	NRP-Z51	100830	24 months	2009-07
Call Tester	CMU200	105900	-	-
Call Tester	CMU200	110735	-	-
BT Tester	CBT	100263	-	-
Vector Network Analyzer	AT8753ES	MY40001091	12 months	2008-08
Dielectric Probe Kit	HP85070B	US33020403	-	-

4.1.1 Isotropic E-field Probe Type ES3DV3

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., butyl diglycol)
Calibration	Calibration certificate in Appendix C
Frequency	10 MHz to 4 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 4 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in HSL (rotation normal to probe axis)
Dynamic Range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 20 mm Body diameter: 12 mm Tip diameter: 3.9 mm Distance from probe tip to dipole centers: 2.0 mm
Application	General dosimetry up to 4 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.2 Phantoms

The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SPEAG. The phantom conforms to the requirements of IEEE 1528 - 2003.

System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

The SPEAG device holder (see Section 5.1) was used to position the device in all tests whilst a tripod was used to position the validation dipoles against the flat section of phantom.

4.3 Tissue Simulants

Recommended values for the dielectric parameters of the tissue simulants are given in IEEE 1528 - 2003 and FCC Supplement C to OET Bulletin 65. All tests were carried out using simulants whose dielectric parameters were within ± 5% of the recommended values. All tests were carried out within 24 hours of measuring the dielectric parameters.

The depth of the tissue simulant was 15.0 ± 0.5 cm measured from the ear reference point during system checking and device measurements.

4.3.1 Tissue Simulant Recipes

The following recipe(s) were used for Head and Body tissue simulant(s):

800MHz band

Ingredient	Head (% by weight)	Body (% by weight)
Deionised Water	39.74	55.97
HEC	0.25	1.21
Sugar	58.31	41.76
Preservative	0.15	0.27
Salt	1.55	0.79

1900MHz band

Ingredient	Head (% by weight)	Body (% by weight)
Deionised Water	54.88	69.02
Butyl Diglycol	44.91	30.76
Salt	0.21	0.22

2450MHz band

Ingredient	Head (% by weight)	Body (% by weight)
Deionised Water	56.0	70.20
Tween 20	44.0	29.62
Salt	-	0.18

4.3.2 System Checking

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulants were measured every day using the dielectric probe kit and the network analyser. A system check measurement was made following the determination of the dielectric parameters of the simulant, using the dipole validation kit. A power level of 250 mW was supplied to the dipole antenna, which was placed under the flat section of the twin SAM phantom. The system checking results (dielectric parameters and SAR values) are given in the table below.

System checking, head tissue simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters		Temp [°C]
			ε_r	σ [S/m]	
	Reference result	2.33	42.2	0.90	
	± 10% window	2.10 - 2.56			
835	2008-05-14	2.24	40.3	0.89	22.5
	Reference result	10.3	40.2	1.47	
	± 10% window	9.3 - 11.3			
1900	2008-05-19	10.7	39.2	1.49	22.4
	Reference result	14.1	39.8	1.84	
	± 10% window	12.7 - 15.5			
2450	2008-04-26	14.2	38.9	1.84	22.5

System checking, body tissue simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters		Temp [°C]
			ε_r	σ [S/m]	
	Reference result	2.45	53.8	0.98	
	± 10% window	2.20 - 2.70			
835	2008-05-19	2.47	53.0	0.97	22.5
	Reference result	13.5	51.9	1.96	
	± 10% window	12.2 - 14.9			
2450	2008-04-29	13.9	51.8	1.98	22.3

Plots of the system checking scans are given in Appendix A.

4.3.3 Tissue Simulants used in the Measurements

Head tissue simulant measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		ε_r	σ [S/m]	
	Recommended value	41.5	0.90	
	± 5% window	39.4 – 43.6	0.86 – 0.95	
836	2008-05-14	40.3	0.89	22.5
	Recommended value	40.0	1.40	
	± 5% window	38.0 – 42.0	1.33 – 1.47	
1880	2008-05-19	39.2	1.47	22.4
	Recommended value	39.2	1.79	
	± 5% window	37.3 – 41.2	1.70 – 1.88	
2442	2008-04-26	38.9	1.83	22.5

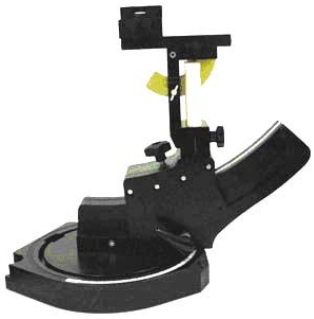
Body tissue simulant measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		ε_r	σ [S/m]	
	Recommended value	55.2	0.97	
	± 5% window	52.4 – 58.0	0.92 – 1.02	
836	2008-05-19	53.0	0.96	22.5
	Recommended value	53.3	1.52	
	± 5% window	50.6 – 56.0	1.44 – 1.60	
1880	2008-05-19	52.8	1.60	22.5
	Recommended value	52.7	1.94	
	± 5% window	50.1 – 55.3	1.85 – 2.04	
2442	2008-04-29	51.8	1.98	22.3

5. DESCRIPTION OF THE TEST PROCEDURE

5.1 Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the Dasy system.



Device holder supplied by SPEAG

A Nokia designed spacer (illustrated below) was used to position the device within the SPEAG holder. The spacer positions the device so that the holder has minimal effect on the test results but still holds the device securely. The spacer was removed before the tests.

Nokia spacer

5.2 Test Positions

5.2.1 Against Phantom Head

Measurements were made in “cheek” and “tilt” positions on both the left hand and right hand sides of the phantom.

The positions used in the measurements were according to IEEE 1528 - 2003 "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques".

5.2.2 Body Worn Configuration

The device was placed in the SPEAG holder using the Nokia spacer and placed below the flat section of the phantom. The distance between the device and the phantom was kept at the separation distance indicated in Section 1.2.2 using a separate flat spacer that was removed before the start of the measurements. The device was oriented with both sides facing the phantom to find the highest results.

5.3 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan, a minimum of 5x5x7 points covering a volume of at least 30x30x30mm, was performed around the highest E-field value to determine the averaged SAR value. Drift was determined by measuring the same point at the start of the area scan and again at the end of the zoom scan.

5.4 SAR Averaging Methods

The maximum SAR value was averaged over a cube of tissue using interpolation and extrapolation.

The interpolation, extrapolation and maximum search routines within Dasy4 are all based on the modified Quadratic Shepard's method (Robert J. Renka, "Multivariate Interpolation Of Large Sets Of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148).

The interpolation scheme combines a least-square fitted function method with a weighted average method. A trivariate 3-D / bivariate 2-D quadratic function is computed for each measurement point and fitted to neighbouring points by a least-square method. For the zoom scan, inverse distance weighting is incorporated to fit distant points more accurately. The interpolating function is finally calculated as a weighted average of the quadratics.

In the zoom scan, the interpolation function is used to extrapolate the Peak SAR from the deepest measurement points to the inner surface of the phantom.

6. MEASUREMENT UNCERTAINTY

Table 6.1 – Measurement uncertainty evaluation

Uncertainty Component	Section in IEEE 1528	Tol. (%)	Prob Dist	Div	c_i	$c_i . u_i$ (%)	v_i
Measurement System							
Probe Calibration	E2.1	±5.9	N	1	1	±5.9	∞
Axial Isotropy	E2.2	±4.7	R	√3	$(1-c_p)^{1/2}$	±1.9	∞
Hemispherical Isotropy	E2.2	±9.6	R	√3	$(c_p)^{1/2}$	±3.9	∞
Boundary Effect	E2.3	±1.0	R	√3	1	±0.6	∞
Linearity	E2.4	±4.7	R	√3	1	±2.7	∞
System Detection Limits	E2.5	±1.0	R	√3	1	±0.6	∞
Readout Electronics	E2.6	±1.0	N	1	1	±1.0	∞
Response Time	E2.7	±0.8	R	√3	1	±0.5	∞
Integration Time	E2.8	±2.6	R	√3	1	±1.5	∞
RF Ambient Conditions - Noise	E6.1	±3.0	R	√3	1	±1.7	∞
RF Ambient Conditions - Reflections	E6.1	±3.0	R	√3	1	±1.7	∞
Probe Positioner Mechanical Tolerance	E6.2	±0.4	R	√3	1	±0.2	∞
Probe Positioning with respect to Phantom Shell	E6.3	±2.9	R	√3	1	±1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E5	±3.9	R	√3	1	±2.3	∞
Test sample Related							
Test Sample Positioning	E4.2	±6.0	N	1	1	±6.0	11
Device Holder Uncertainty	E4.1	±5.0	N	1	1	±5.0	7
Output Power Variation - SAR drift measurement	6.6.3	±0.0	R	√3	1	±0.0	∞
Phantom and Tissue Parameters							
Phantom Uncertainty (shape and thickness tolerances)	E3.1	±4.0	R	√3	1	±2.3	∞
Conductivity Target - tolerance	E3.2	±5.0	R	√3	0.64	±1.8	∞
Conductivity - measurement uncertainty	E3.3	±5.5	N	1	0.64	±3.5	5
Permittivity Target - tolerance	E3.2	±5.0	R	√3	0.6	±1.7	∞
Permittivity - measurement uncertainty	E3.3	±2.9	N	1	0.6	±1.7	5
Combined Standard Uncertainty			RSS			**±12.9**	116
Coverage Factor for 95%			**k=2**				
Expanded Uncertainty						**±25.8**	

7. RESULTS

The measured Head SAR values for the test device are tabulated below:

850MHz Head SAR results

Option used	Test configuration		SAR, averaged over 1g (W/kg)		
			Ch 128 824.2 MHz	Ch190 836.6 MHz	Ch 251 848.8 MHz
GSM	Power		26.1 dBm	27.5 dBm	27.4 dBm
	Left	Cheek	-	0.345	-
		Tilt	-	-	-
	Right	Cheek	-	-	-
		Tilt	-	-	-
2-slot GPRS	Power		24.5 dBm	25.7 dBm	25.5 dBm
	Left	Cheek	-	0.431	-
		Tilt	-	-	-
	Right	Cheek	-	-	-
		Tilt	-	-	-
3-slot GPRS	Power		23.1 dBm	24.1 dBm	23.9 dBm
	Left	Cheek	0.396	0.437	**0.466**
		Tilt	-	0.301	-
	Right	Cheek	-	0.409	-
		Tilt	-	0.287	-
3-slot 8PSK EGPRS	Power		18.7 dBm	19.8 dBm	19.2 dBm
	Left	Cheek	-	-	0.082
		Tilt	-	-	-
	Right	Cheek	-	-	-
		Tilt	-	-	-
3-slot GPRS	Left cheek, BT active		-	-	0.463

1900MHz Head SAR results

Option used	Test configuration		SAR, averaged over 1g (W/kg)		
			Ch 512 1850.2 MHz	Ch 661 1880.0 MHz	Ch 810 1909.8 MHz
GSM	Power		30.9 dBm	30.6 dBm	29.5 dBm
	Left	Cheek	-	0.700	-
		Tilt	-	0.303	-
	Right	Cheek	0.881	0.744	**0.937**
		Tilt	-	0.380	-
2-slot GPRS	Power		28.0 dBm	28.2 dBm	27.2 dBm
	Left	Cheek	-	0.682	-
		Tilt	-	-	-
	Right	Cheek	-	-	-
		Tilt	-	-	-
3-slot GPRS	Power		26.3 dBm	26.3 dBm	25.4 dBm
	Left	Cheek	-	0.664	-
		Tilt	-	-	-
	Right	Cheek	-	-	-
		Tilt	-	-	-
1-slot 8PSK EGPRS	Power		26.9 dBm	27.2 dBm	26.2 dBm
	Left	Cheek	-	-	-
		Tilt	-	-	-
	Right	Cheek	-	-	0.323
		Tilt	-	-	-
GSM	Right cheek, BT active		-	-	0.925

2450MHz Head SAR results

Option used	Test configuration		SAR, averaged over 1g (W/kg)		
			Ch 1 2412.0 MHz	Ch 7 2442.0 MHz	Ch 11 2462.0 MHz
WLAN	Power		20.7 dBm	21.1 dBm	20.3 dBm
	Left	Cheek	-	0.178	-
		Tilt	-	0.066	-
	Right	Cheek	0.202	0.203	**0.211**
		Tilt	-	0.061	-

The measured Body SAR values for the test device are tabulated below:

850MHz Body SAR results

Option used	Test configuration	SAR, averaged over 1g (W/kg)		
		Ch 128 824.2 MHz	Ch190 836.6 MHz	Ch 251 848.8 MHz
3-slot GPRS	**Power**	**23.1 dBm**	**24.1 dBm**	**23.9 dBm**
Display facing Phantom	Without headset	-	0.387	-
	Headset HS-45+AD-54	-	0.214	-
Back facing Phantom	Without headset	0.464	0.567	**0.647**
	Headset HS-45+AD-54	0.292	0.346	0.381
3-slot GPRS Back facing phantom	Without headset BT active	-	-	0.642

1900MHz Body SAR results

Option used	Test configuration	SAR, averaged over 1g (W/kg)		
		Ch 512 1850.2 MHz	Ch 661 1880.0 MHz	Ch 810 1909.8 MHz
GSM	**Power**	**30.9 dBm**	**30.6 dBm**	**29.5 dBm**
Display facing phantom	Without headset	-	0.354	-
	Headset HS-45+AD-54	-	0.307	-
Back facing phantom	Without headset	**0.494**	0.471	0.426
	Headset HS-45+AD-54	0.446	0.423	0.392
GSM Back facing phantom	Without headset BT active	0.493	-	-

2450MHz Body SAR results

Option used	Test configuration	SAR, averaged over 1g (W/kg)		
		Ch 1 2412.0 MHz	Ch 7 2442.0 MHz	Ch 11 2462.0 MHz
WLAN	Power	20.7 dBm	21.1 dBm	20.3 dBm
Display facing phantom	Without headset	-	0.030	-
	Headset HS-45+AD-54	-	0.029	-
Back facing phantom	Without headset	0.064	0.059	**0.074**
	Headset HS-45+AD-54	0.055	0.052	0.065

Simultaneous transmissions: Combined SAR results

Test configuration	Max. 1g SAR results		
	WLAN	GSM 850	GSM 1900
Head: Left, Cheek	0.178	0.466	0.700
Head: Left, Tilt	0.066	0.301	0.303
Head: Right, Cheek	0.211	0.409	0.937
Head: Right, Tilt	0.061	0.287	0.380
Body: Without Headset	0.074	0.647	0.494
Body: Headset HS-45+AD-54	0.065	0.381	0.446

Test configuration	Combined 1g SAR values	
	WLAN + 850MHz band	WLAN + 1900MHz band
Head: Left, Cheek	**0.644**	0.878
Head: Left, Tilt	0.367	0.369
Head: Right, Cheek	0.620	**1.148**
Head: Right, Tilt	0.348	0.441
Body: Without Headset	**0.721**	**0.568**
Body: Headset HS-45+AD-54	0.446	0.511

Combining the maximum SAR values of WLAN2450 and the cellular bands tends to overestimate the SAR value since their maxima do not necessarily occur in the same location.

Plots of the Measurement scans are given in Appendix B.