ISO/TC22/SC3/WG3 N 2611

French document on ISO-11452-2 Field - Uniformity

This document presents data on field uniformity measurements performed in 4 laboratories with the calibration setup described in ISO 11452-2.

1 – Test laboratories

The main characteristics of the 3 laboratories are described in the following table.

Laboratory	Dimensions L x l x h (m)	Absorber type	Antenna used	Field probe	Table / ground plane size L x l (m)	Connection between ground plane and shielded enclosure
Lab A	6,4 x 4 x 3,1 (with absorbers)	Hybrid (ferrite + 25 cm pyramidal foam)	Log-periodic STLP 9128C Horn antenna AT 4002a	HI 6105	2,5 x 1,2	Horizontal
Lab B	7 x 4,75 x 4,8 (with absorbers)	Hybrid (ferrite + 60 cm pyramidal foam)	Biconilog SAS 521-7	HI 6105	2,5 x 1,2	Vertical
Lab C	7,44 x 4,71 x 4,1 (without absorbers)	70 cm pyramidal foam	Horn antenna ARA DRG2020 Horn antenna AT 4002a	DARE Radisense	2,8 x 1	Horizontal
Lab D	5 x 4,4 x 3,3 (without absorbers)	45 cm pyramidal foam	Log-periodic STLP 9128C Horn antenna AT 4002a	DARE Radisense CTR 1001S	2,5 x 1,1	Vertical

2 – Measurements

The main field uniformity measurements which have been performed are described in the following table.

Laboratory	Frequency range MHz	Polarisation	Field probe positions for homogeneity	Comment
Lab A	200 – 4000	Vertical	25 cm right from calibration point 25 cm left from calibration point	
			50 cm right from calibration point 50 cm left from calibration point	
			75 cm right from calibration point 75 cm left from calibration point	
	400 - 4000	Horizontal	Same as vertical (25, 50 and 75 cm)	
Lab B	200 – 2000	Vertical	Same as Lab A	
	400 - 2000	Horizontal	Same as Lab A	
Lab C	200 – 4000	Vertical	25 cm right from calibration point 25 cm left from calibration point	Above 1000 MHz the calibration point has been kept at the middle of the harness (and not in front of the DUT)
			50 cm right from calibration point 50 cm left from calibration point	
	400 - 4000	Horizontal	Same as vertical (25 and 50)	
Lab D	200 – 3200	Vertical	25 cm right from calibration point 25 cm left from calibration point	
			50 cm right from calibration point 50 cm left from calibration point	
			75 cm right from calibration point 75 cm left from calibration point	Performed only from 200 to 1000 MHz
	400 - 3200	Horizontal	Same as vertical (25, 50 and 75 cm)	75 cm performed only from 200 to 1000 MHz
Note : All measurements have been done with ISO 11452-1 linear frequency steps.				

3 – Test results

The synthesis of field uniformity measurement results are shown in the following tables

3.1 Laboratory A

Criteria	Vertical polarization : % of points within the criteria					
	Probe 25 cm left	Probe 50 cm left	Probe 75 cm left	Probe 25 cm right	Probe 50 cm right	Probe 75 cm right
Field ≥ 50% of reference field (200 MHz – 4 GHz)	74,8 %	46,5 %	30,7 %	91,3 %	50,4 %	28,4 %
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	100 %	76,4 %	100 %	100 %	70,6 %
Field ≥ 50% of reference field (1 GHz – 4 GHz)	57,9 %	10,5 %	0 %	85,5 %	17,1 %	0 %
1: Values greater than 80 % are highlighted in green						

Criteria	Horizontal polarization : % of points within the criteria					
	Probe 25 cm left	Probe 50 cm left	Probe 75 cm left	Probe 25 cm right	Probe 50 cm right	Probe 75 cm right
Field ≥ 50% of reference field (200 MHz – 4 GHz)	75,7 %	33,6 %	23,4 %	100 %	47,7 %	13,1 %
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	100 %	80,7 %	100 %	100 %	45,2 %
Field ≥ 50% of reference field (1 GHz – 4 GHz)	65,8 %	6,6 %	0 %	100 %	26,3 %	0 %
1: Values greater than 80 % are highlighted in green						

3.2 Laboratory B

Criteria	Vertical polarization : % of points within the criteria					
	Probe 25 cm left	Probe 50 cm left	Probe 75 cm left	Probe 25 cm right	Probe 50 cm right	Probe 75 cm right
Field ≥ 50% of reference field (200 MHz – 2 GHz)	100 %	100 %	89,6 %	100 %	100 %	98,7 %
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	100 %	98 %	100 %	100 %	100 %
Field ≥ 50% of reference field (1 GHz – 2 GHz)	100 %	100 %	73,1 %	100 %	100 %	96,2 %
1: Values greater than 80 % are highlighted in green 2: Measurements have been performed only up to 2 GHz						

Criteria	Horizontal polarization : % of points within the criteria					
	Probe 25 cm left	Probe 50 cm left	Probe 75 cm left	Probe 25 cm right	Probe 50 cm right	Probe 75 cm right
Field ≥ 50% of reference field (200 MHz – 2 GHz)	100 %	80,7 %	1,8 %	100 %	98,3 %	3,5 %
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	96,8 %	3,2 %	100 %	96,8 %	6,5 %
Field ≥ 50% of reference field (1 GHz – 2 GHz)	100 %	61,5 %	0 %	100 %	100 %	0 %
1: Values greater than 80 % are highlighted in green 2: Measurements have been performed only up to 2 GHz						

3.3 Laboratory C

Criteria	Vertical polarization : % of points within the criteria					
	Probe 25 cm left	**Probe 50 cm left**	**Probe 75 cm left**	**Probe 25 cm right**	**Probe 50 cm right**	**Probe 75 cm right**
Field ≥ 50% of reference field (200 MHz – 4 GHz)	84,3 %	45,7 %	NA	100 %	51,2 %	NA
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	100 %	NA	100 %	100 %	NA
Field ≥ 50% of reference field (1 GHz – 4 GHz)	73,7 %	9,2 %	NA	100 %	18,4 %	NA
1: Values greater than 80 % are highlighted in green 2: Measurement not done for the 75 cm positions.						

Criteria	Horizontal polarization : % of points within the criteria					
	Probe 25 cm left	**Probe 50 cm left**	**Probe 75 cm left**	**Probe 25 cm right**	**Probe 50 cm right**	**Probe 75 cm right**
Field ≥ 50% of reference field (200 MHz – 4 GHz)	94,4 %	53,3 %	NA	100 %	51,4 %	NA
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	100 %	NA	100 %	100 %	NA
Field ≥ 50% of reference field (1 GHz – 4 GHz)	92,1 %	34,2 %	NA	100 %	31,6 %	NA
1: Values greater than 80 % are highlighted in green 2: Measurement not done for the 75 cm positions.						

3.4 Laboratory D

Criteria	Vertical polarization : % of points within the criteria					
	Probe 25 cm left	**Probe 50 cm left**	**Probe 75 cm left**	**Probe 25 cm right**	**Probe 50 cm right**	**Probe 75 cm right**
Field ≥ 50% of reference field (200 MHz – 3,2 GHz)	97,2 %	54,2 %	NA	92,5 %	50,5 %	NA
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	100 %	NA	100 %	100 %	NA
Field ≥ 50% of reference field (1 GHz – 3,2 GHz)	94,6 %	12,5 %	NA	85,7 %	5,4 %	NA
1: Values greater than 80 % are highlighted in green 2: Measurements have been performed only up to 3,2 GHz 3: Measurement not done for the 75 cm positions.						

Criteria	Horizontal polarization : % of points within the criteria					
	Probe 25 cm left	**Probe 50 cm left**	**Probe 75 cm left**	**Probe 25 cm right**	**Probe 50 cm right**	**Probe 75 cm right**
Field ≥ 50% of reference field (200 MHz – 3,2 GHz)	100 %	44,8 %	NA	100 %	39,1 %	NA
Field ≥ 50% of reference field (200 MHz – 1 GHz)	100 %	100 %	NA	100 %	100 %	NA
Field ≥ 50% of reference field (1 GHz – 3,2 GHz)	100 %	14,3 %	NA	100 %	5,4 %	NA
1: Values greater than 80 % are highlighted in green 2: Measurements have been performed only up to 3,2 GHz 3: Measurement not done for the 75 cm positions.						

4 **– Synthesis of measurements**

The field uniformity measurement performed in the 4 laboratory have shown that :

For the frequency range 200 MHz to 1000 MHz

- A field uniformity criteria of : " From 200 MHz to 1000 MHz, the field uniformity at two points, at 0,50 m on each side of the calibration point (centre of harness) shall not be less than 50 % of the nominal field strength (relative to the calibration point) for at least 80 % of the test frequency points. The field uniformity requirement shall be fulfilled separately for each polarization. For existing facilities where the field uniformity requirement cannot be met, this shall be stated in the test report. The user shall also ensure good reproducibility of the measurement." could be a good proposal.
- An equivalent criteria with 0,25 m distance is not sufficiently selective.

For frequencies above 1000 MHz

- It seems difficult to find a representative and selective criteria to be used for frequencies from 1000 MHz to 18 GHz
- A field uniformity criteria of : " From 1000 MHz to 2000 MHz, the field uniformity at two points, at 0,25 m on each side of the calibration point (centre of DUT) shall not be less than 50 % of the nominal field strength (relative to the calibration point) for at least 80 % of the test frequency points. The field uniformity requirement shall be fulfilled separately for each polarization. For existing facilities where the field uniformity requirement cannot be met, this shall be stated in the test report. The user shall also ensure good reproducibility of the measurement." could be a good proposal.

Note : Detailed measurement results and pictures are provided in Annex A and B.

5 **– French proposal**

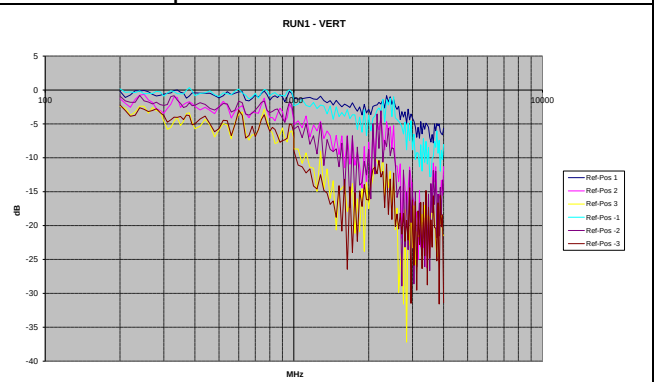
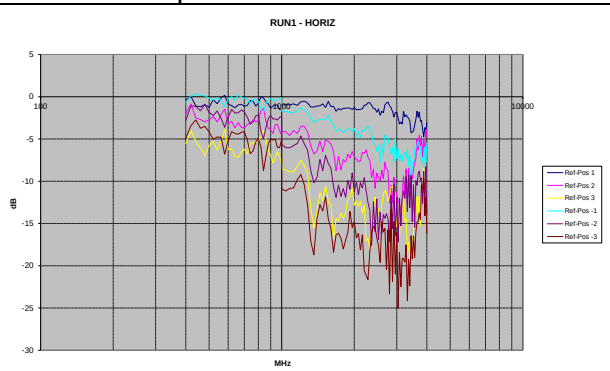
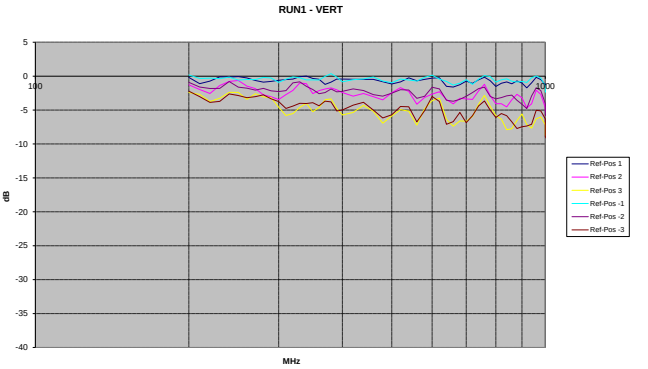
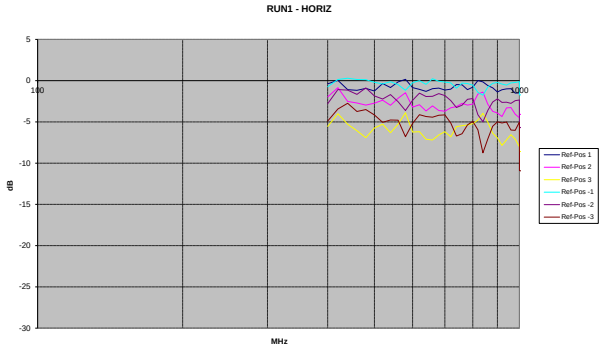
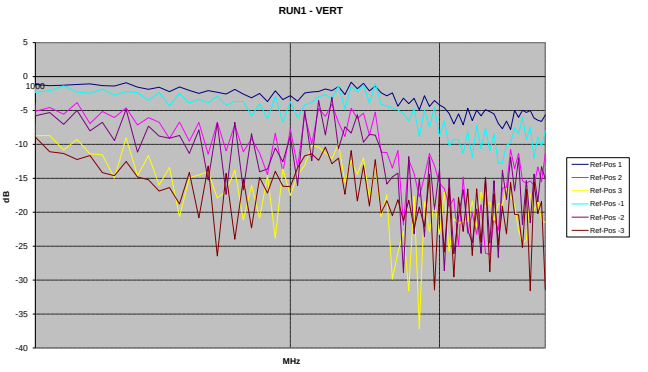
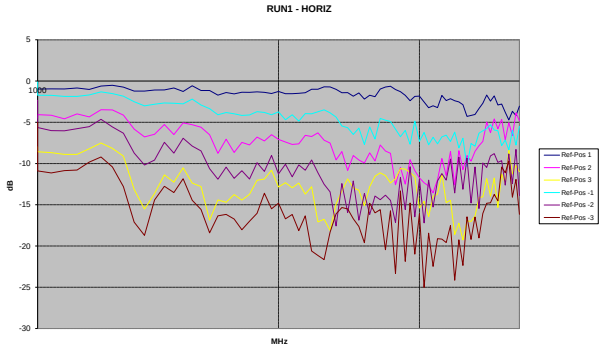
As requested during last WG3 meeting, French experts have provided technical data to support the proposal to include in ISO 11452-2 the following field uniformity criteria :

- "From 200 MHz to 1000 MHz, the field uniformity at two points, at 0,50 m on each side of the calibration point (centre of harness) shall not be less than 50 % of the nominal field strength (relative to the calibration point) for at least 80 % of the test frequency points. The field uniformity requirement shall be fulfilled separately for each polarization. For existing facilities where the field uniformity requirement cannot be met, this shall be stated in the test report. The user shall also ensure good reproducibility of the measurement.".
- "From 1000 MHz to 2000 MHz, the field uniformity at two points, at 0,25 m on each side of the calibration point (centre of DUT) shall not be less than 50 % of the nominal field strength (relative to the calibration point) for at least 80 % of the test frequency points. The field uniformity requirement shall be fulfilled separately for each polarization. For existing facilities where the field uniformity requirement cannot be met, this shall be stated in the test report. The user shall also ensure good reproducibility of the measurement.".

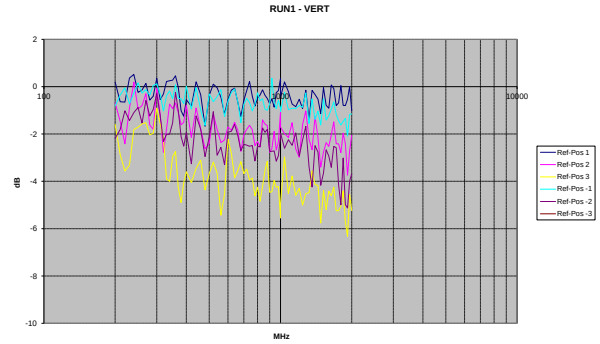
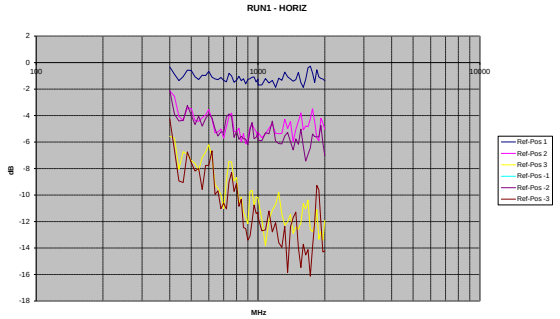
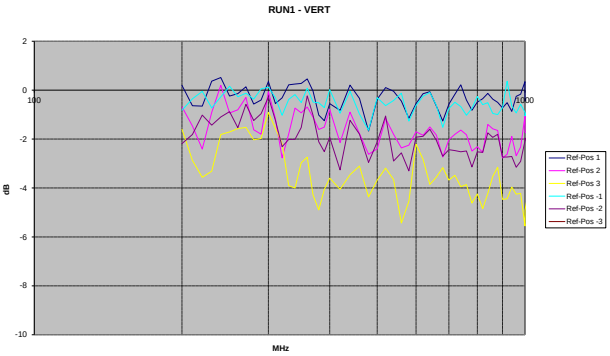
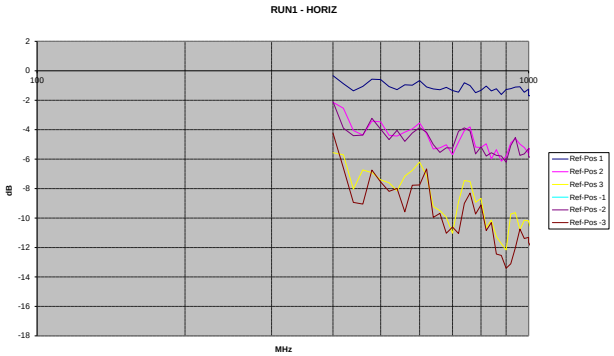
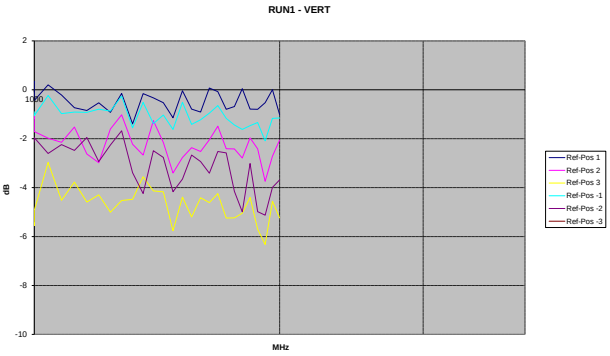
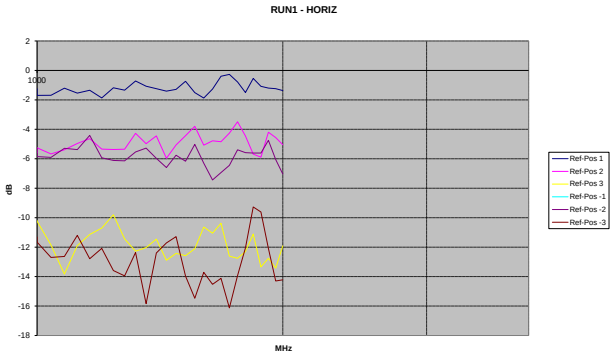
Note : When reading the field uniformity criteria stated in ISO 11451-2, it may be not clearly stated that the field uniformity criteria shall be met separately for each side.
The sentence " The field uniformity requirement shall be fulfilled separately for each polarization." might be changed by "The field uniformity requirement shall be fulfilled separately for each polarization and for each side." Both in ISO 11451-2 and in the previous French proposal for ISO 11452-2."

Annex A : Detailed measurement results

Laboratory A

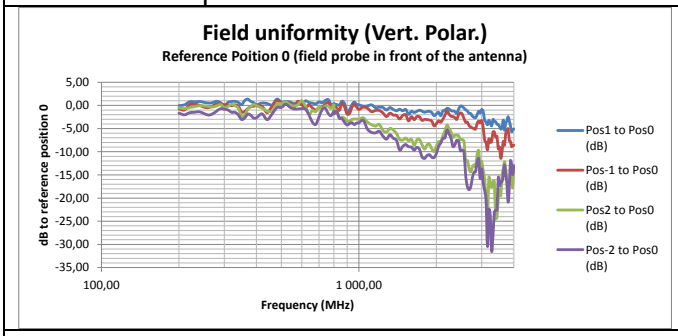
Vertical polarisation 200 MHz – 4 GHz	Horizontal polarisation 200 MHz – 4 GHz
	
Vertical polarisation 200 MHz – 1 GHz	**Horizontal polarisation 200 MHz – 1 GHz**
	
Vertical polarisation 1 GHz – 4 GHz	**Horizontal polarisation 1 GHz – 4 GHz**
	

Laboratory B

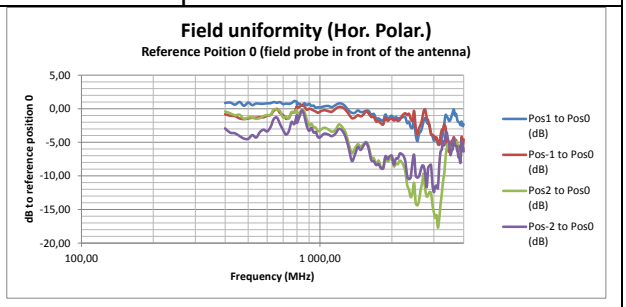
Vertical polarisation 200 MHz – 2 GHz	Horizontal polarisation 200 MHz – 2 GHz
	
Vertical polarisation 200 MHz – 1 GHz	**Horizontal polarisation 200 MHz – 1 GHz**
	
Vertical polarisation 1 GHz – 2 GHz	**Horizontal polarisation 1 GHz – 2 GHz**
	

Laboratory C

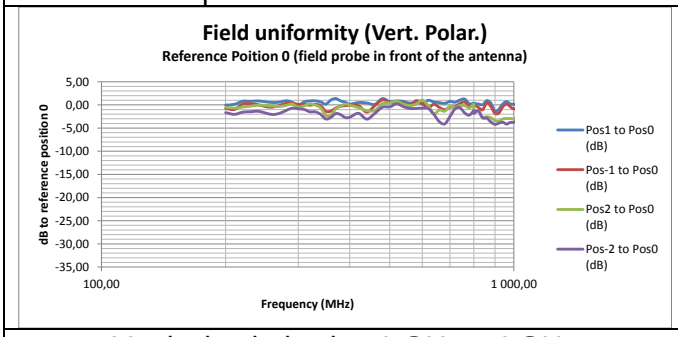
Vertical polarisation 200 MHz – 4 GHz



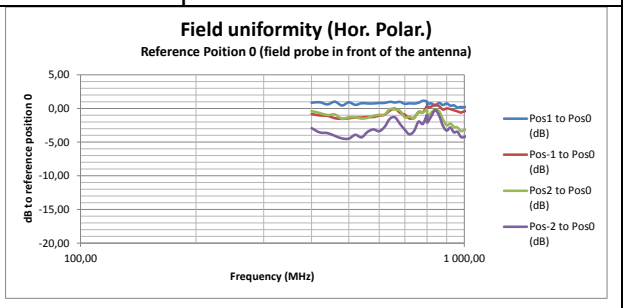
Horizontal polarisation 200 MHz – 4 GHz



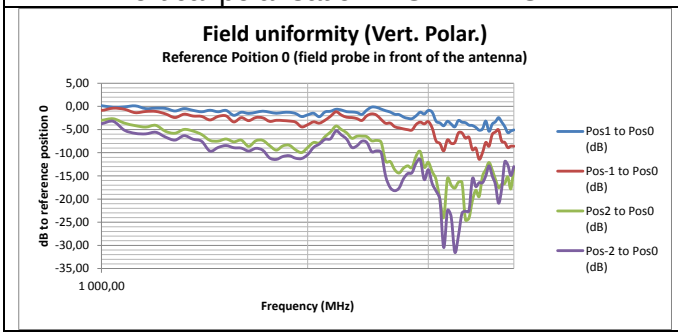
Vertical polarisation 200 MHz – 1 GHz



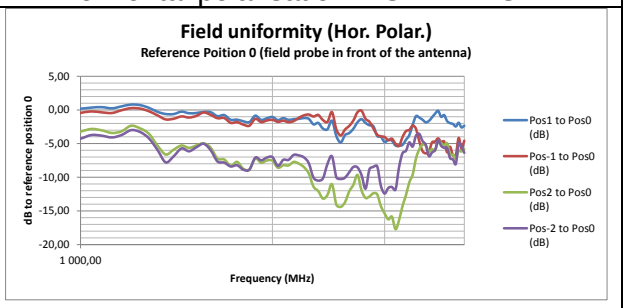
Horizontal polarisation 200 MHz – 1 GHz



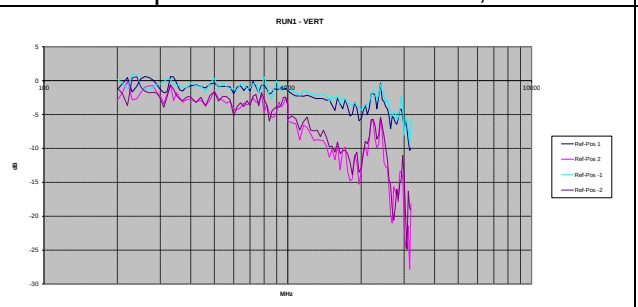
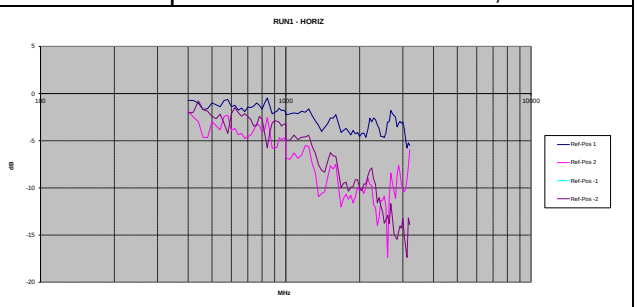
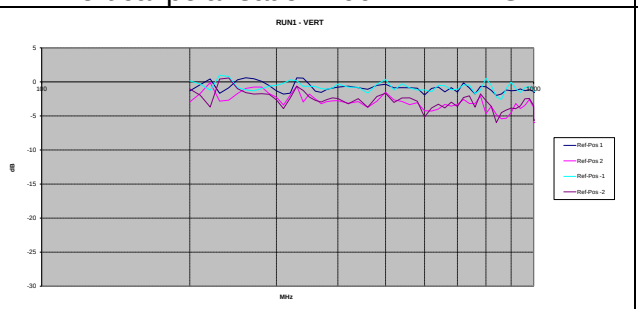
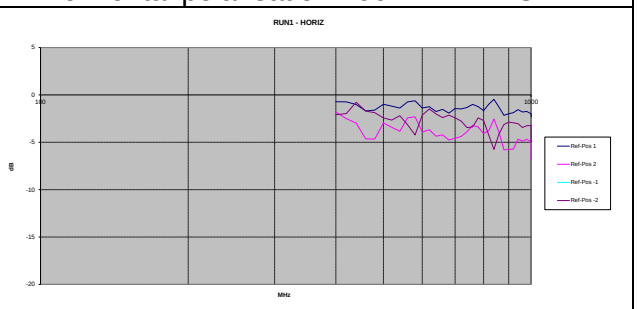
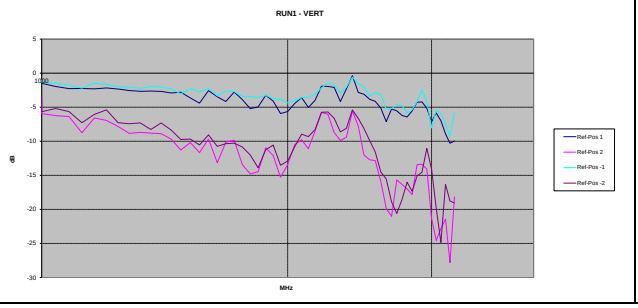
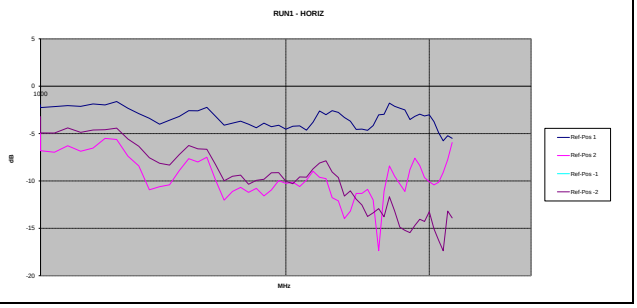
Vertical polarisation 1 GHz – 4 GHz



Horizontal polarisation 1 GHz – 4 GHz



Laboratory D

Vertical polarisation 200 MHz – 3,2 GHz	Horizontal polarisation 200 MHz – 3,2 GHz
	
Vertical polarisation 200 MHz – 1 GHz	**Horizontal polarisation 200 MHz – 1 GHz**
	
Vertical polarisation 1 GHz – 3,2 GHz	**Horizontal polarisation 1 GHz – 3,2 GHz**
	

Annex B : Pictures

Laboratory A

Laboratory B

Laboratory C

Not available

Laboratory D