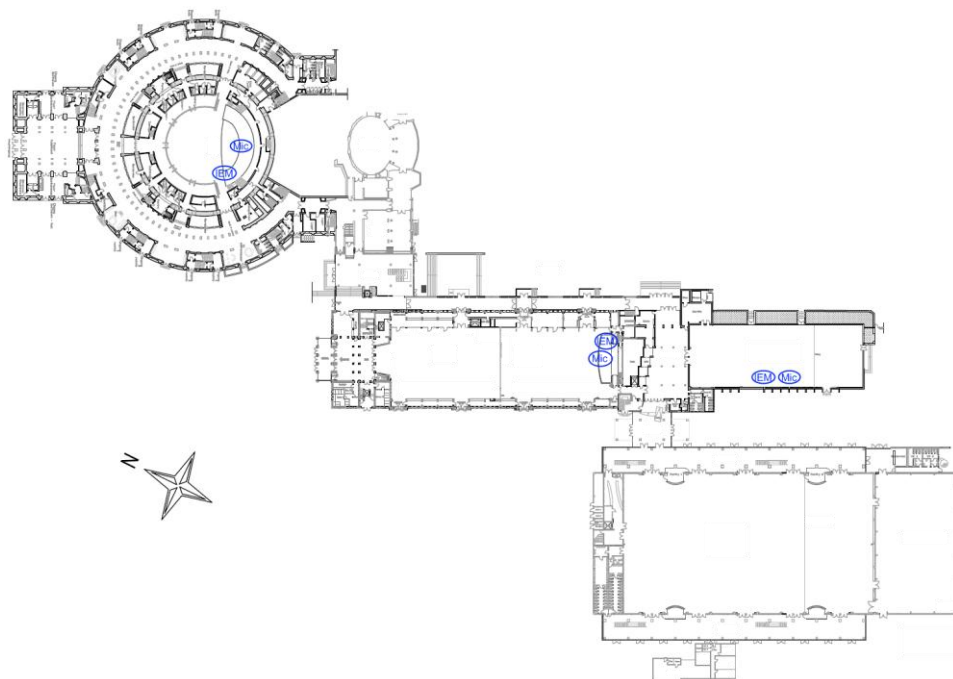


Measurement report on PWMS propagation model using the example of a typical conference installation for L-Band frequencies proposed for secondary usage

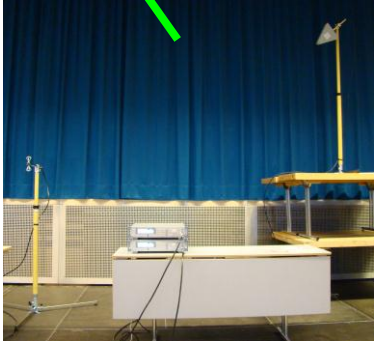
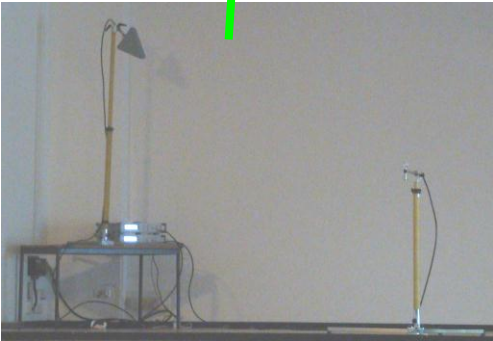
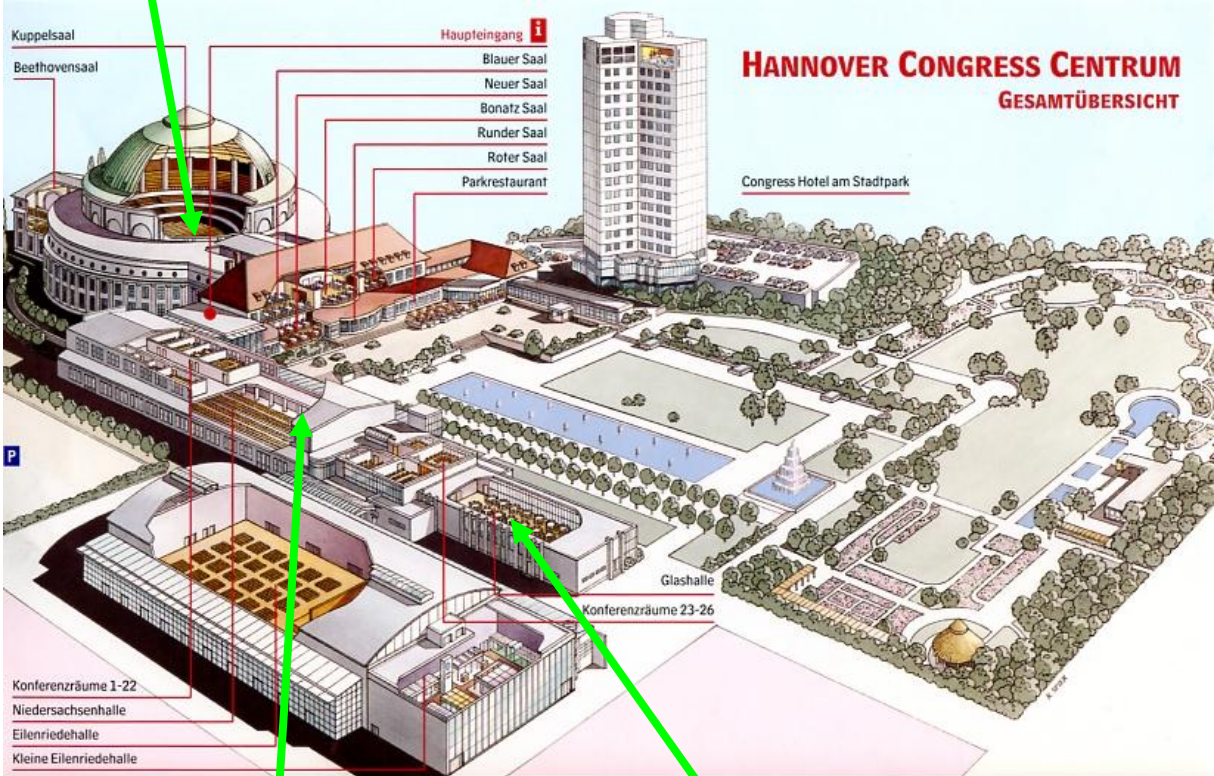


Hanover, 4th February 2008

Position of Microphone and IEM test installation

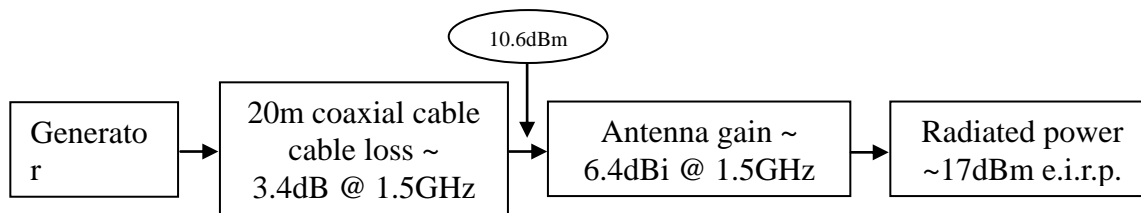
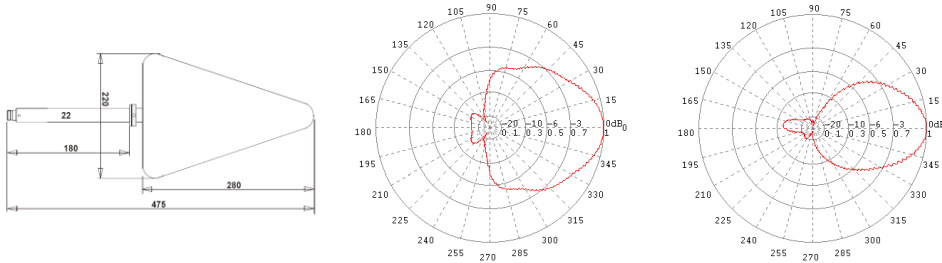


Wireless microphone and IEM set up at Kuppelsaal, Niedersachsenhalle and Glashalle



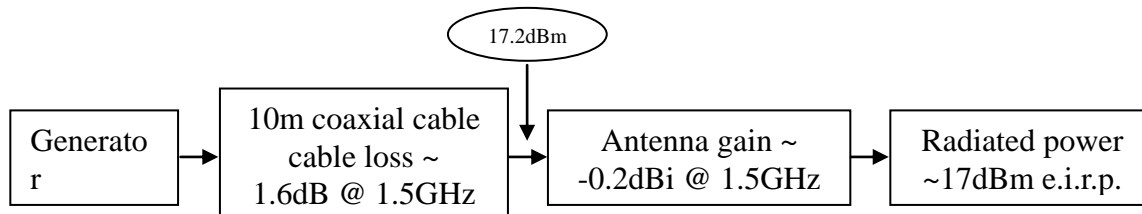
IEM transmitter configuration

- RF generator SML02
- 20m RF cable ECOFLEX 10
- Directional Antenna ESLP 9145 mounted on Glasfibre-stand, vertical pol. approx. 45° angle



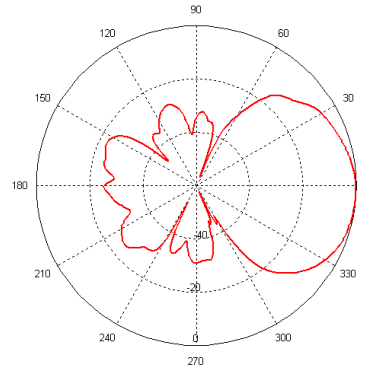
Hand held wireless microphone configuration

- RF generator SML02
- 10m antenna cable ECOFLEX 10
- Dipole-antenna SBA 9113 mounted on Glasfibre -stand, vertical polarized

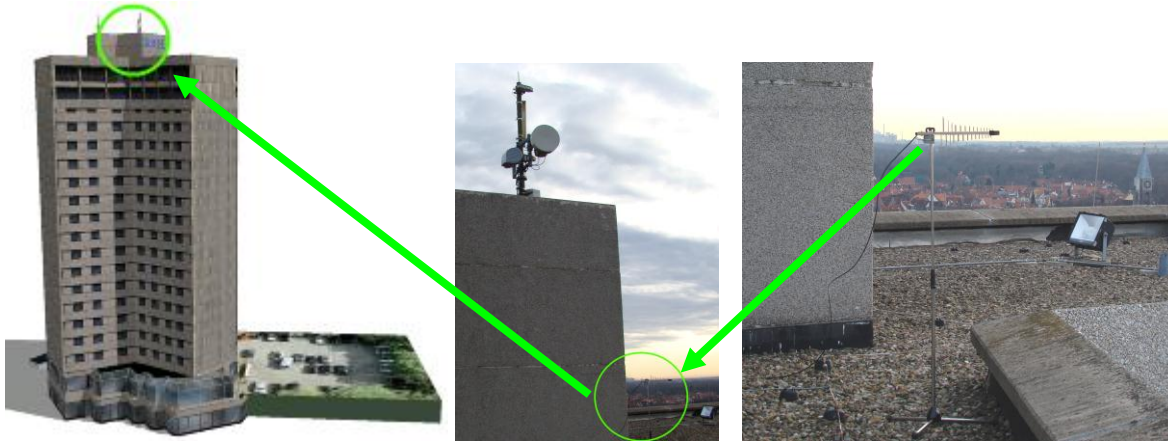


Measurement set up on top floor of hotel

- RF spectrum analyser FSQ03
- Laptop, software 'UHF Recorder' including L-Band option (DKE-AK731.0.8)
- L-band-antenna LAT54 mounted on microphone stand, directed to Glashalle



LAT54 at 1500 MHz



Measurement antenna set up on mid-height floor of hotel

Mobile measurement set up

- RF network and spectrum analyzer ZVL06
- Laptop, software 'UHF Recorder' including L-Band option (DKE-AK731.0.8)
- Omni directional ground plane antenna
- External battery including DC/DC converter



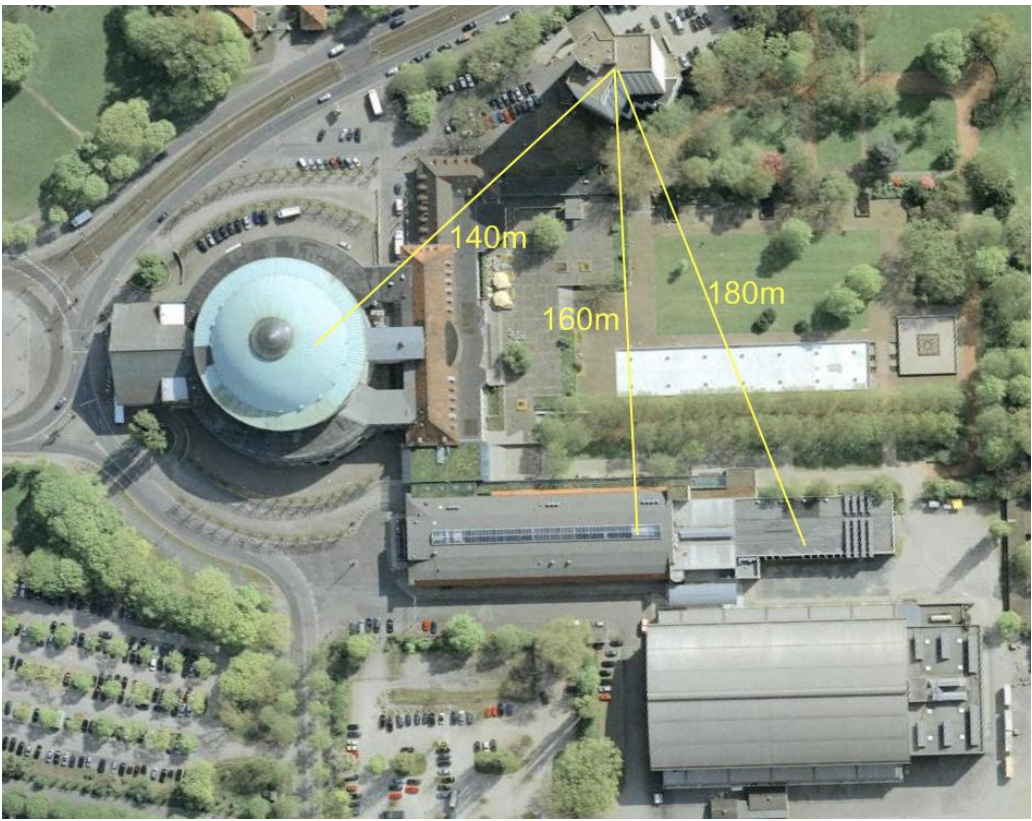
Mobile measurement set up in front of Glashalle



Measurement location at ground level



Distance to measurement stations located in the hotel



Description of measurement setup at RF receiving locations

1. Hotel Location

The directional antenna is pointed at Glashalle. The measured RF levels show the maximum interference level for a RF link in the main link direction Glashalle. Building walls made out of standard glass, no metallic coating, distance to RF measurement receiver is 180m, identical antenna polarization. The table shows the maximum levels measured over a continuous time period.

2. Location of mobile measurement setups (indoor and outdoor)

The antenna is adjusted for maximum field strength and the measurements were recorded in the table below.

Measurement results: Wireless microphone transmitter and IEM transmitter

Receiver location Transmitter location	Maximum receiving level [dBm]													
	1		2		3		4		5		6		7	
	f1	f2	f1	f2	f1	f2	f1	f2	f1	f2	f1	f2	f1	f2
Kuppelsaal	n/a.	n/a.	-80	-100	-87	-92	n/a	-101	n/a	n/a	n/a.	-105	n/a	-105
Glashalle	-86	-78	n/a	n/a.	-95	-105	-76	-88	-63	-63	-70	-67	-105	-105
Niedersachsenhalle	-90	-98	n/a	-103	-88	-90	-91	-106	-106	-107	-94	-104	-111	-106

Table results rounded to integer values

n/a = Not applicable, i.e. receiving level below minimum receiving level of receiving measurement equipment (-112dBm)

f1, f2 = frequencies 1485 / 1515 MHz

Antenna amplification = 10dBi antenna used at hotel / 0dBi mobile antenna

Estimation of building attenuation

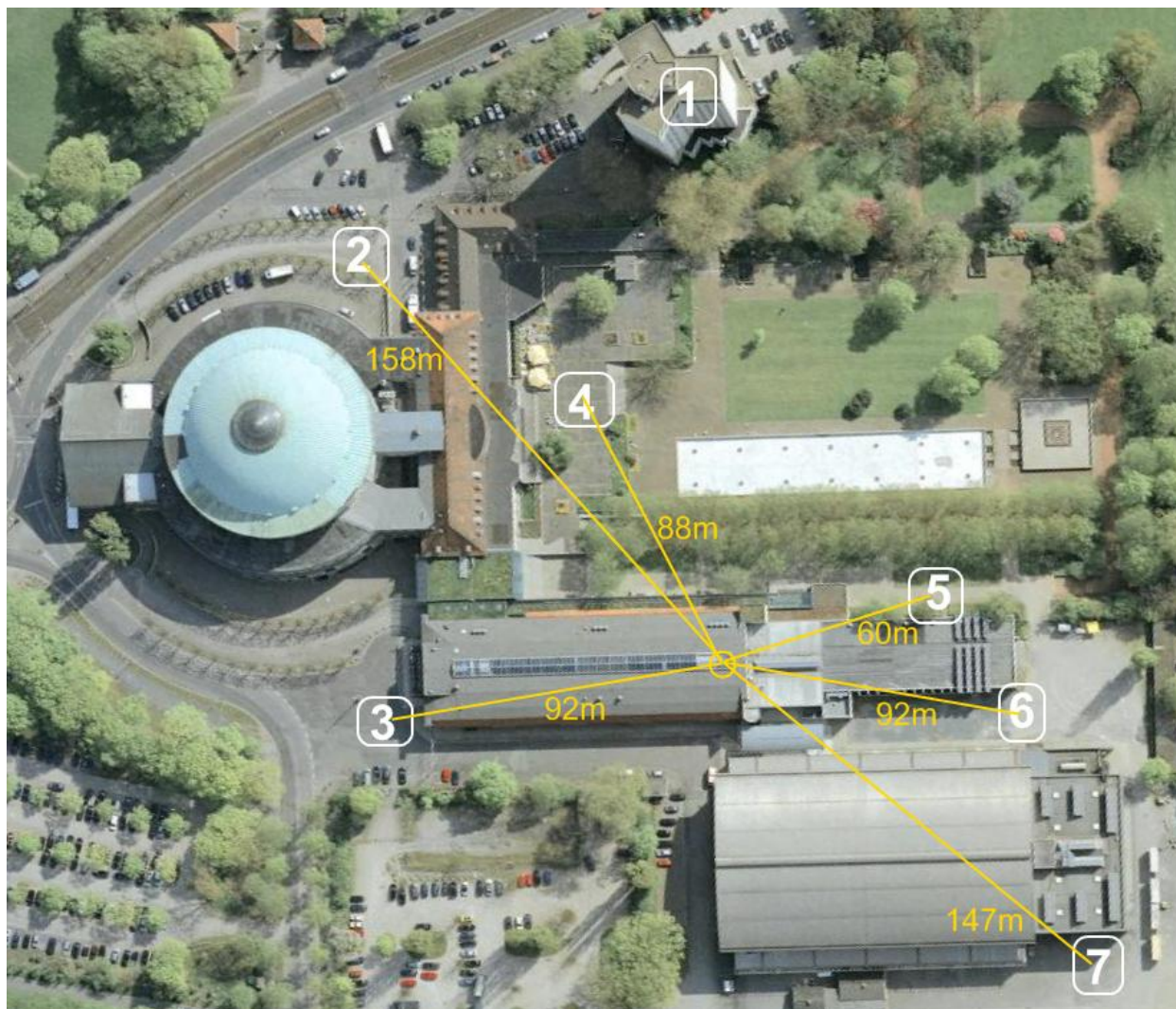
Measurement path	Path length	Receiving level based on free space path loss formula	Measured receiving level	Calculated attenuation by building
Hotel to Glashalle	180 m ^{*1}	-75 dBm	-86 dBm	11 dB
Hotel to Niedersachsenhalle	160 m ^{*1}	-74 dBm	-90 dBm	16 dB
Kuppelsaal to test point 3	89 m	-61 dBm	-88 dBm	27 dB

Table results rounded to integer values

*1 antenna gain measurement antenna used at Hotel included

Comparison of free space path loss calculation with measured values

1. Niedersachsenhalle



Estimation of additional path loss due to surrounding buildings (f1)

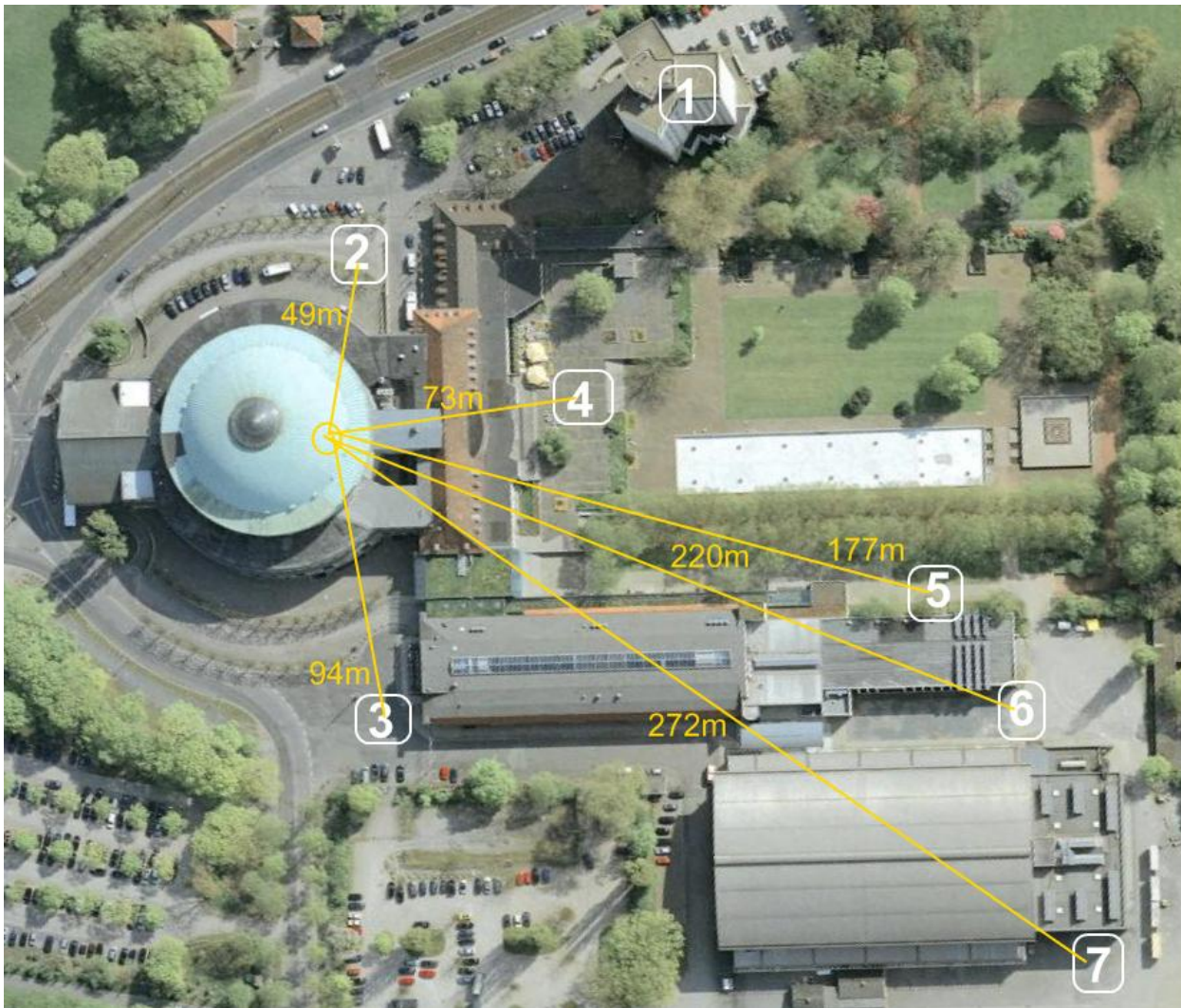
Measurement path	Path length	Receiving level based on free space path loss formula	Measured receiving level	Calculated attenuation in addition to free field path loss
Niedersachsenhalle to test point 2	158 m	-66 dBm ^{*f1}	n/a	n/a
Niedersachsenhalle to test point 3	92 m	-62 dBm ^{*f1}	-88 dBm ^{*f1}	26 dB
Niedersachsenhalle to test point 4	88 m	-61 dBm ^{*f1}	-91 dBm ^{*f1}	30 dB
Niedersachsenhalle to test point 5	60 m	-58 dBm ^{*f1}	-106 dBm ^{*f1}	48 dB
Niedersachsenhalle to test point 6	92 m	-62 dBm ^{*f1}	-94 dBm ^{*f1}	32 dB
Niedersachsenhalle to test point 7	147 m	-66 dBm ^{*f1}	-111 dBm ^{*f1}	45 dB

Table results rounded to integer values

n/a = Not applicable, i.e. receiving level below minimum receiving level of receiving measurement equipment (-115dBm)

f1 = 1485 MHz

2. Kuppelsaal



Estimation of additional path loss due to surrounding buildings (f1)

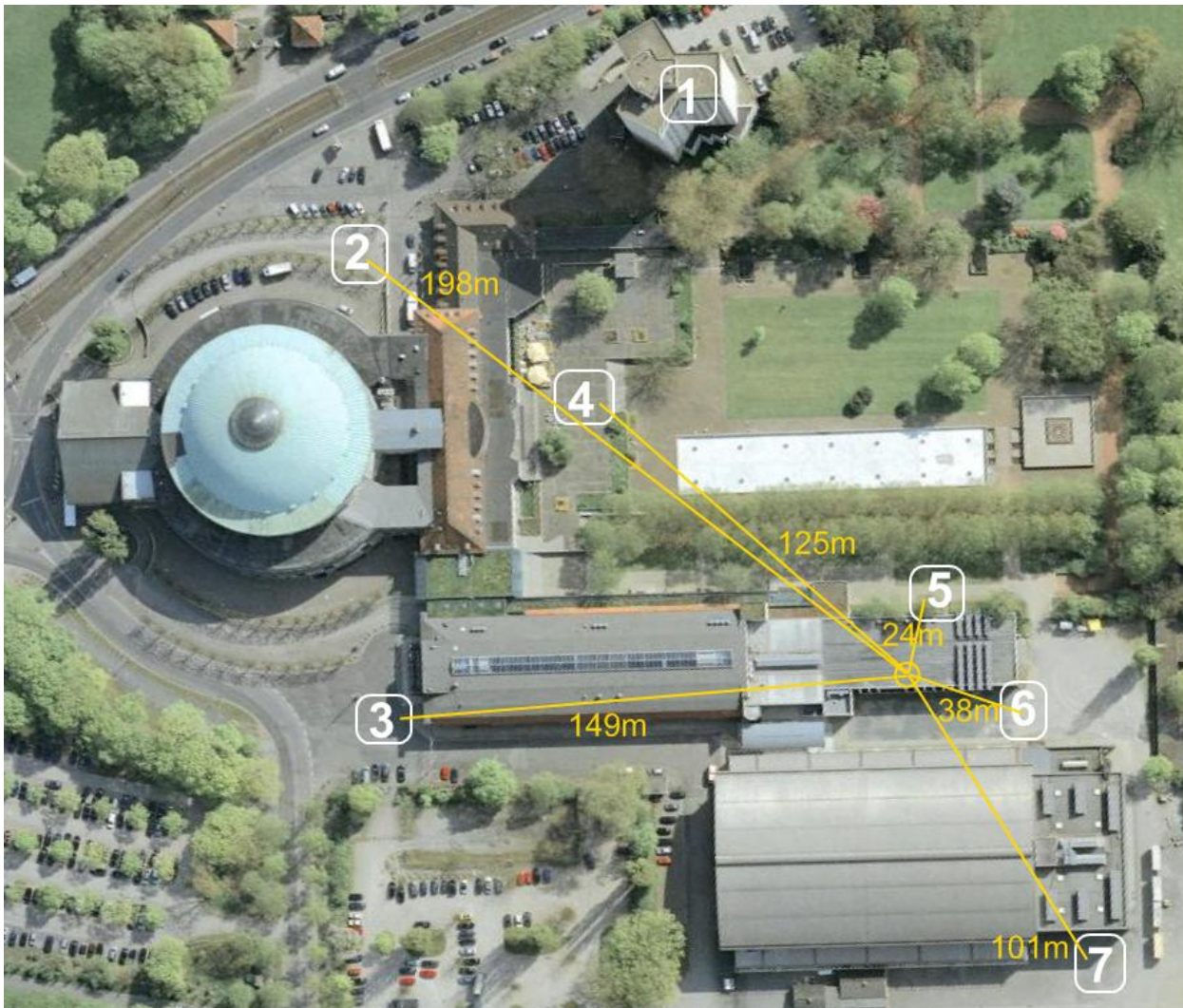
Measurement path	Path length	Receiving level based on free space path loss formula	Measured receiving level	Calculated attenuation in addition to free field path loss
Kuppelsaal to test point 2	49 m	-56 dBm ^{*f1}	-80 dBm ^{*f1}	24 dB
Kuppelsaal to test point 3	94 m	-62 dBm ^{*f1}	-87 dBm ^{*f1}	25 dB
Kuppelsaal to test point 4	73 m	-60 dBm ^{*f1}	n/a	n/a
Kuppelsaal to test point 5	177 m	-67 dBm ^{*f1}	n/a	n/a
Kuppelsaal to test point 6	220 m	-69 dBm ^{*f1}	n/a	n/a
Kuppelsaal to test point 7	272 m	-71 dBm ^{*f1}	n/a	n/a

Table results rounded to integer values

n/a = Not applicable, i.e. receiving level below minimum receiving level of receiving measurement equipment (-112dBm)

f1 = 1485 MHz

Glashalle



Estimation of additional path loss due to surrounding buildings

Measurement path	Path length	Receiving level based on free space path loss formula	Measured receiving level	Calculated attenuation in addition to free field path loss
Glashalle to test point 2	198 m	-68 dBm ^{*f1}	n/a	n/a
Glashalle to test point 3	149 m	-66 dBm ^{*f1}	-95 dBm ^{*f1}	29 dB
Glashalle to test point 4	125 m	-64 dBm ^{*f1}	-76 dBm ^{*f1}	12 dB
Glashalle to test point 5	24 m	-50 dBm ^{*f1}	-63 dBm ^{*f1}	13 dB
Glashalle to test point 6	38 m	-54 dBm ^{*f1}	-70 dBm ^{*f1}	24 dB
Glashalle to test point 7	101 m	-62 dBm ^{*f1}	-105 dBm ^{*f1}	43 dB

Table results are rounded to integer values

n/a = Not applicable, i.e. receiving level below minimum receiving level of receiving measurement equipment (-112dBm)

f1 = 1485 MHz

Summary of results:

This report describes the propagation model of PWMS, in this case wireless microphone and IEM, in typical conference installations using L-Band frequencies. This measurement exercise was the first in a conference environment and will be followed by additional measurements, e.g. Theatre and Broadcast productions, to verify the findings.

Following the test results for this exercise it can be assumed that in a typical urban environment and with a defined protection distance, co-channel secondary use of PWMS devices is possible and is unlikely to cause harmful interference to primary services.

An adjacent channel allocation to PWMS using the existing UHF license scheme is also unlikely to cause harmful interference to primary services.

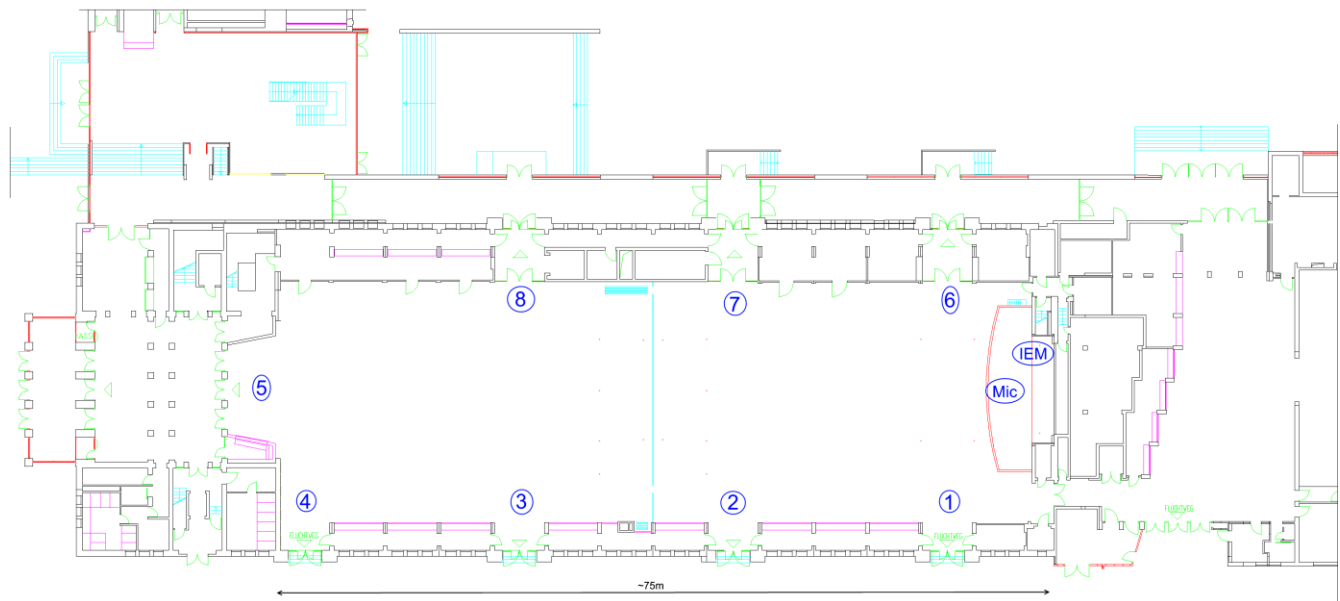
Matthias Fehr
Chairman of DKE WG 731.0.8
'Professional Wireless Microphone Systems'
at DIN and VDE - Germany

Annex

Information on estimated Indoor fieldstrength

Additional measurements were performed to monitor the indoor fieldstrength of the empty Niedersachsenhalle. These measurements results does not take account of the behaviour of RF fading notches made by reflections and are therefore only informative.

Location of measurement receiver in Niedersachsenhalle



Measurement results of maximum field strength in empty Niedersachsenhalle

No	Location (looking from stage)	Max. level in dBm	
		Wireless microphone substitute, f1	IEM-substitute, f2
1	1 st left hand door	-43	-54
2	2 nd left hand door	-50	-49
3	3 rd left hand door	-63	-66
4	4 th left hand door	-70	-70
5	Main entrance	-60	-73
6	1 st right hand door	-48	-55
7	2 nd right hand door	-49	-56
8	3 rd right hand door	-63	-70

f1, f2 = frequencies 1485 / 1515 MHz
receiving antenna gain = 0 dBi