Continuous Monitoring of public exposure to EMF

Eduardo Figueroa Karlström, PhD

AB Vascaia

On Assignment at Arbetslivsintitutet

Why Monitoring EMF?

The Government Environmental Program of 1999 promulgated a number of goals, among them those about the protection of the people from the Electromagnetic Radiation.

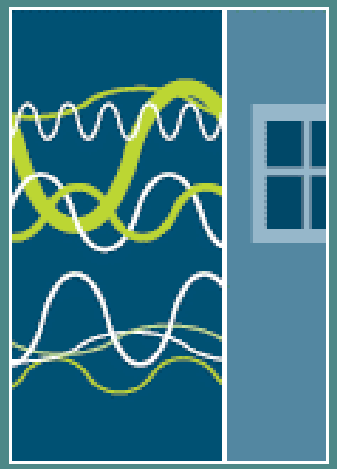
This generated a need of measurements that demanded for exploratory actions to assess best monitoring programs.

This task were conceived in the telecommunication industry and implemented at the SSI.

6 Säker strålmiljö

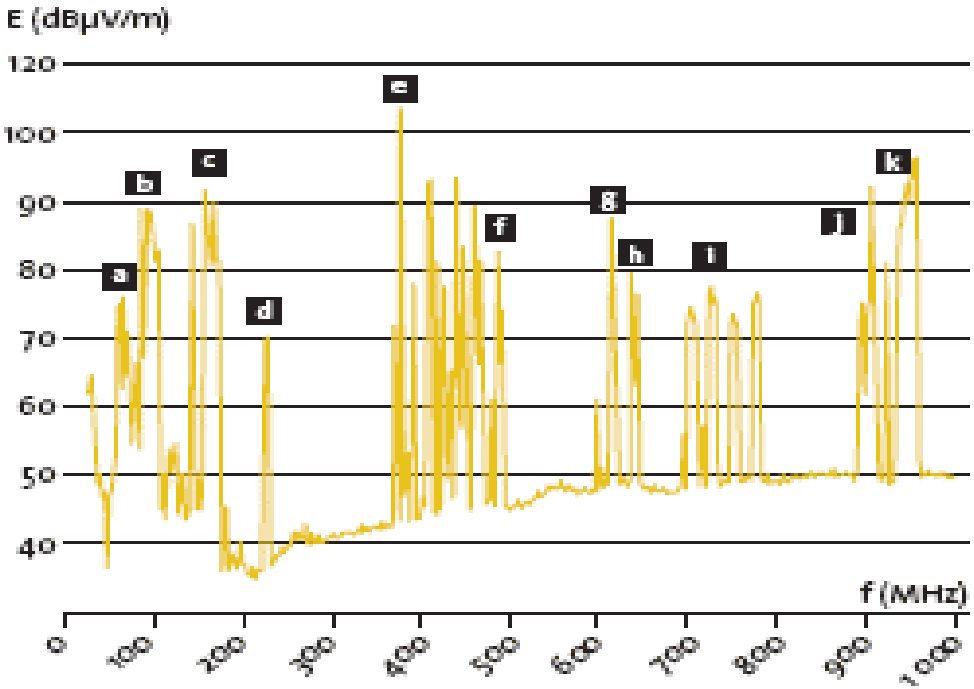
MILJÖKVALITETSMÅL

Människors hälsa och den biologiska mångfalden ska skyddas mot skadliga effekter av strålning i den yttre miljön.



DELMÅL 3

Riskerna med elektromagnetiska fält ska kontinuerligt kartläggas och nödvändiga åtgärder ska vidtas i takt med att sådana eventuella risker identifieras.



a TV 1	e komm.radio	i digital-TV
b FM-radio	f TV 2	j mobiltelefoner
c komm.radio	g finsk TV	k basstationer
d DAB-radio	h TV 4	

Not. Elektrisk fältstyrka, E, anges som ett logaritmiskt mått i en decibelskala.

KÄLLA: SSI

Både inomhus och utomhus exponeras vi för elektromagnetiska fält. Allmänhetens exponering från elektromagnetiska fält är i regel mer än hundra till tusen gånger under de gränsvärden som gäller både i Sverige och i övriga Europa.

Motivation of the Choice monitoring technique

1. What to measure:

   The impinging P_{in} [W/m^2] at the observation point

   The observation/measurement time and date

   The analysis of accumulated effects

   Diferentiate the sources of emission (frequency discrimination)

The selection of the observation point:

   Must be possible to be allocated closer to the places where the density of population is high

For what purposes?

   To gather results to allow for for long term assessment of epidemiological/biological effects on the public health. Data base for statistical correlation analysis

Total signal at observation point after path loss

$$\frac{P_R}{P_T} = \frac{1}{L} = k\frac{h_m h_b^2}{r^2 f_c^2}$$

and shadowing in the urban environment

Several models available, among them Furutsu model for multiple difraction

Total signal

$$P_T = \sum_i \sum_j S(f_{ij}, r_i)$$

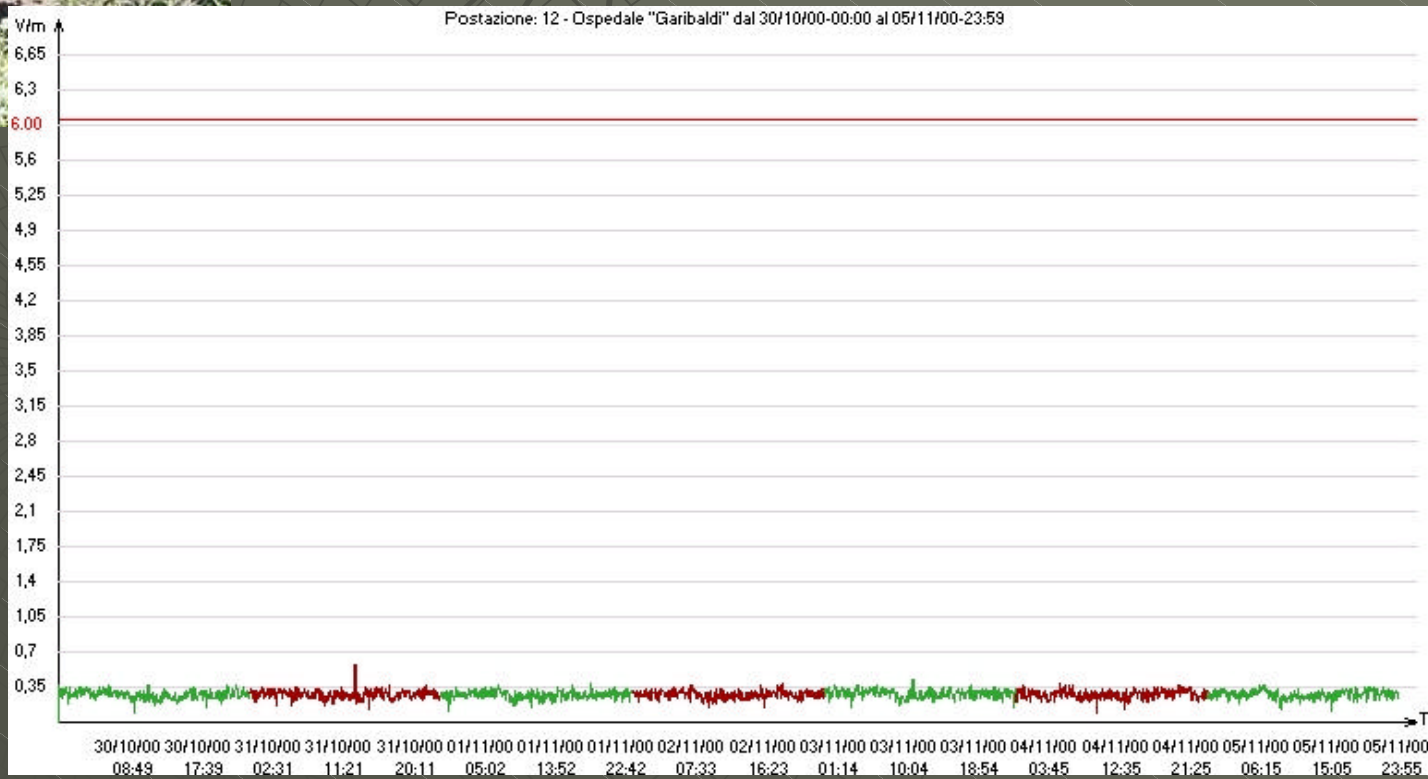
$$< S >= \frac{1}{2} EH$$

Where the modulus of the Poynting vector is added for each operator or RBS over the up-link and down-link frequencies.

The total signal for UMTS GSM-1800 and GSM-900 were thus obtained

Typical Monitoring station in Europé

Italy, Malta, Grece, Spain, Portugal

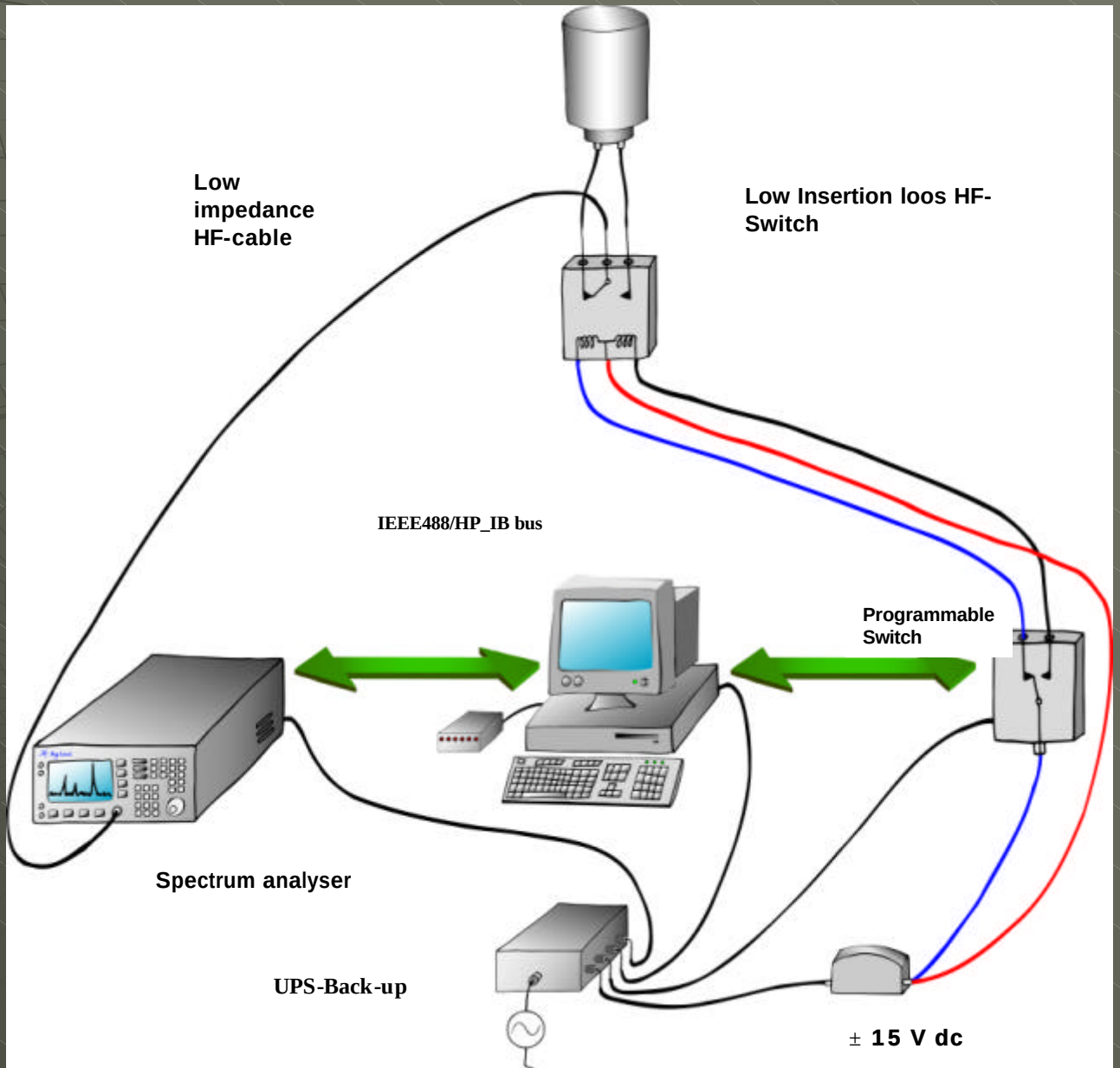


Measurements were done in the following intervals:

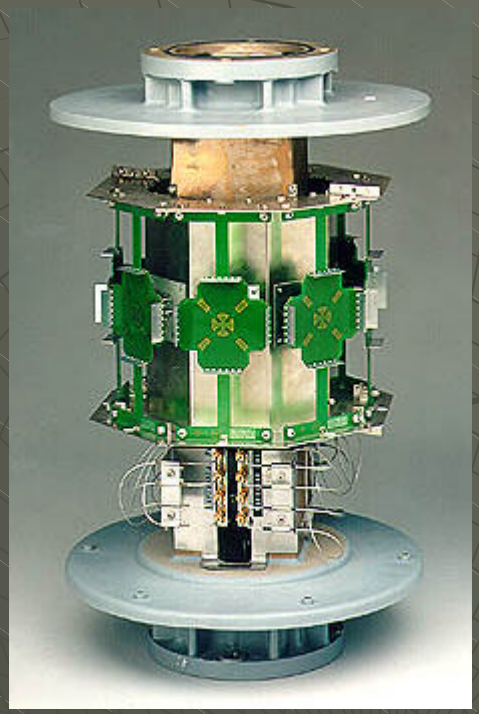
800-1000 MHz	GSM900	SweFour	929,9-936,7	884,9-891,7
		Telia	936,9-944,1	891,9-899,1
		Comviq	944,3-951,5	899,3-906,5
		Vodafone	951,7-958,9	906,7-913,9
1000-1600	Radar		1250-1400	
1600-1915	GSM1800	SweFour	1806,9-1809,9	1711,9-1714,9
		Comviq*	1810,1-1813,1	1715,1-1718,1
		Vodafone*	1813,3-1816,3	1718,3-1721,3
		Telia*	1816,5-1819,5	1721,5-1724,5
		Telia	1819,5-1834,9	1724,5-1739,9
		Comviq	1835,1-1853,1	1740,1-1758,1
		Vidafone	1862,5-1877,9	1767,5-1782,9
		DECT	1880 – 1900	1880 - 1900

1915-2175 MHz	UMTS	Vodafone	2110-2125	1920-1935
		Hi3G	2125-2140	1935-1950
		Orange	2140-2155	1950-1965
		SvUMTS	2155-2170	1965-1980
2175-2500 MHz	WLAN		2400-2483,5	
2500-3000 MHz				

Note: * Bands for use inside buildings

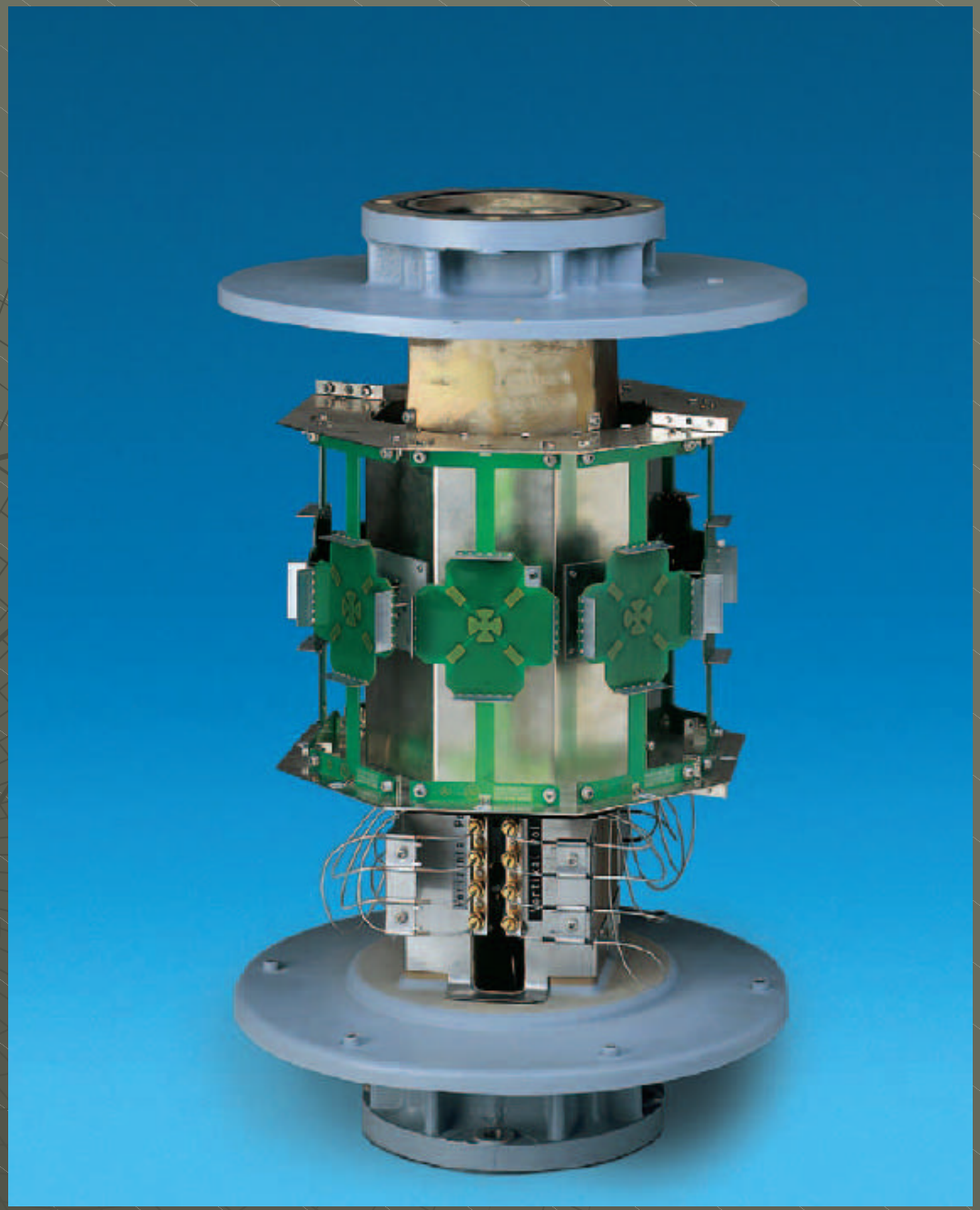

Low impedance HF-cable
Low Insertion loos HF-Switch
IEEE488/HP_IB bus
Programmable Switch
Spectrum analyser
UPS-Back-up
± 15 V dc

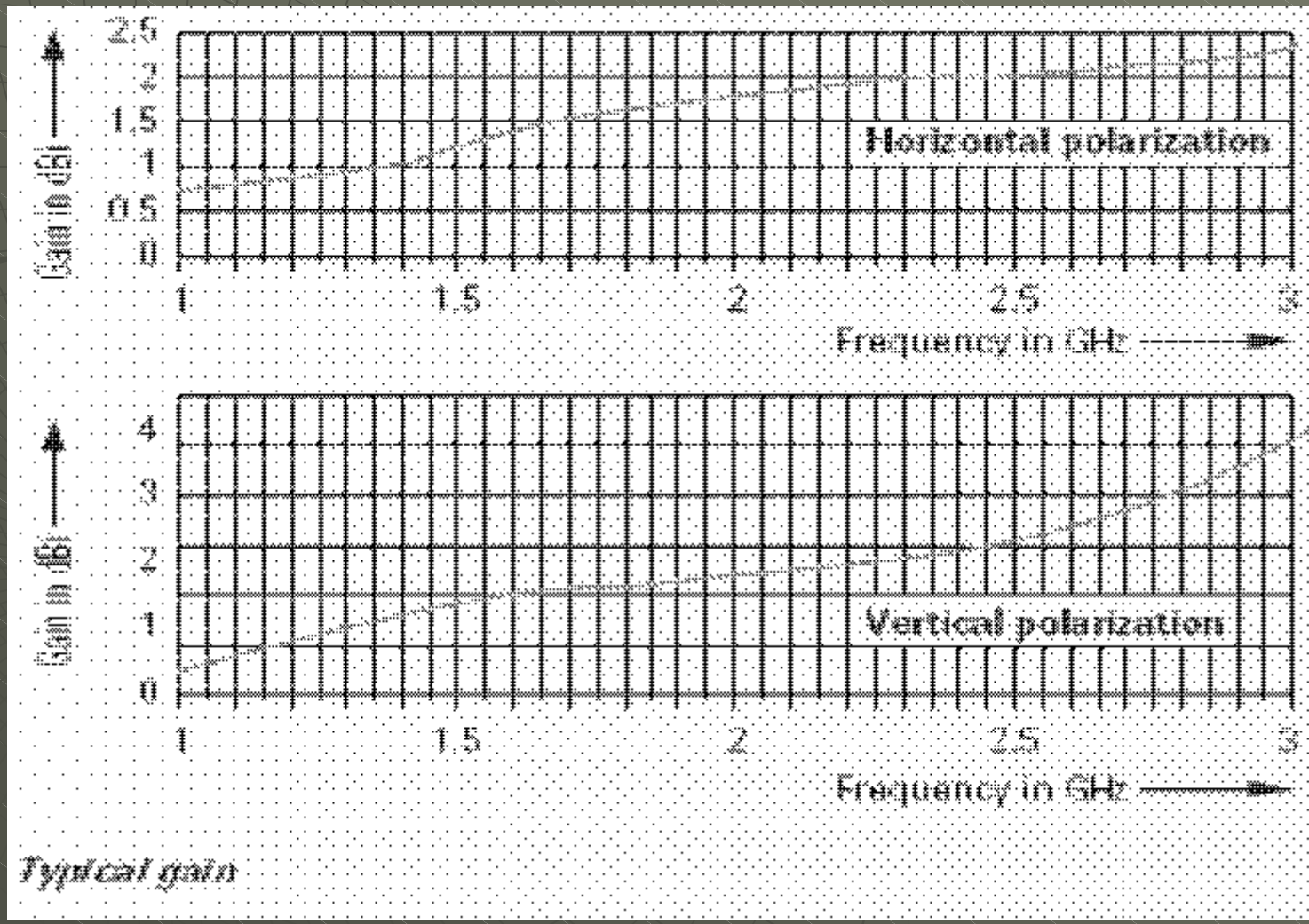
OMNIDIRECTIONAL ANTENNA HF-902 ROHDE & SCHWARTZ



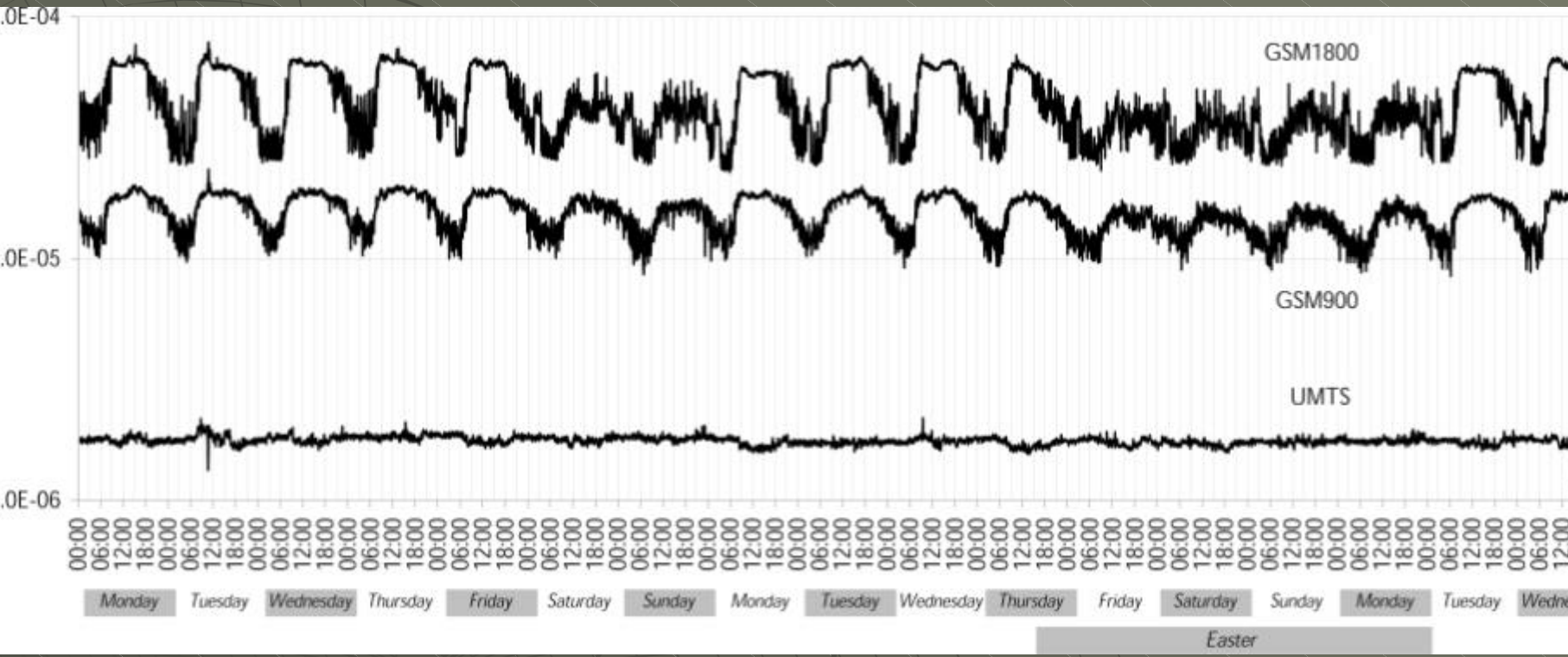
Omnidirectioal horizontally and vertical polarization

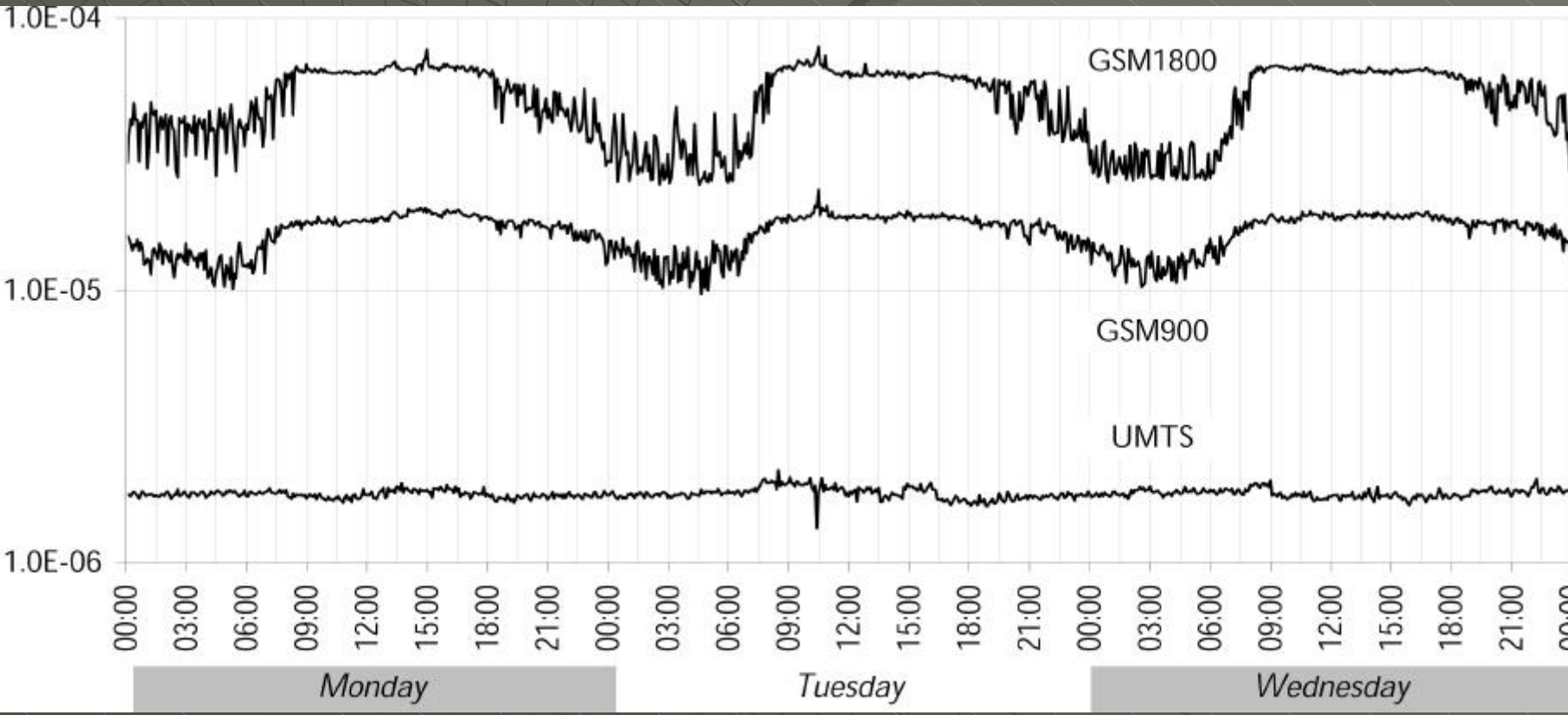
Freq. Range Cal	1 to 3 GHz
Uncal.	~700 MHz to 3.4 GHz
Gain	0 dB typical
Op. Temp	-40 to 65 °C
Dimemsions	31 cm diameter
	50 cm hight
	~8 kg weight
Max. Wind speed	~190 km/h
Input impedance	50 Ω
Connectors	2xN female



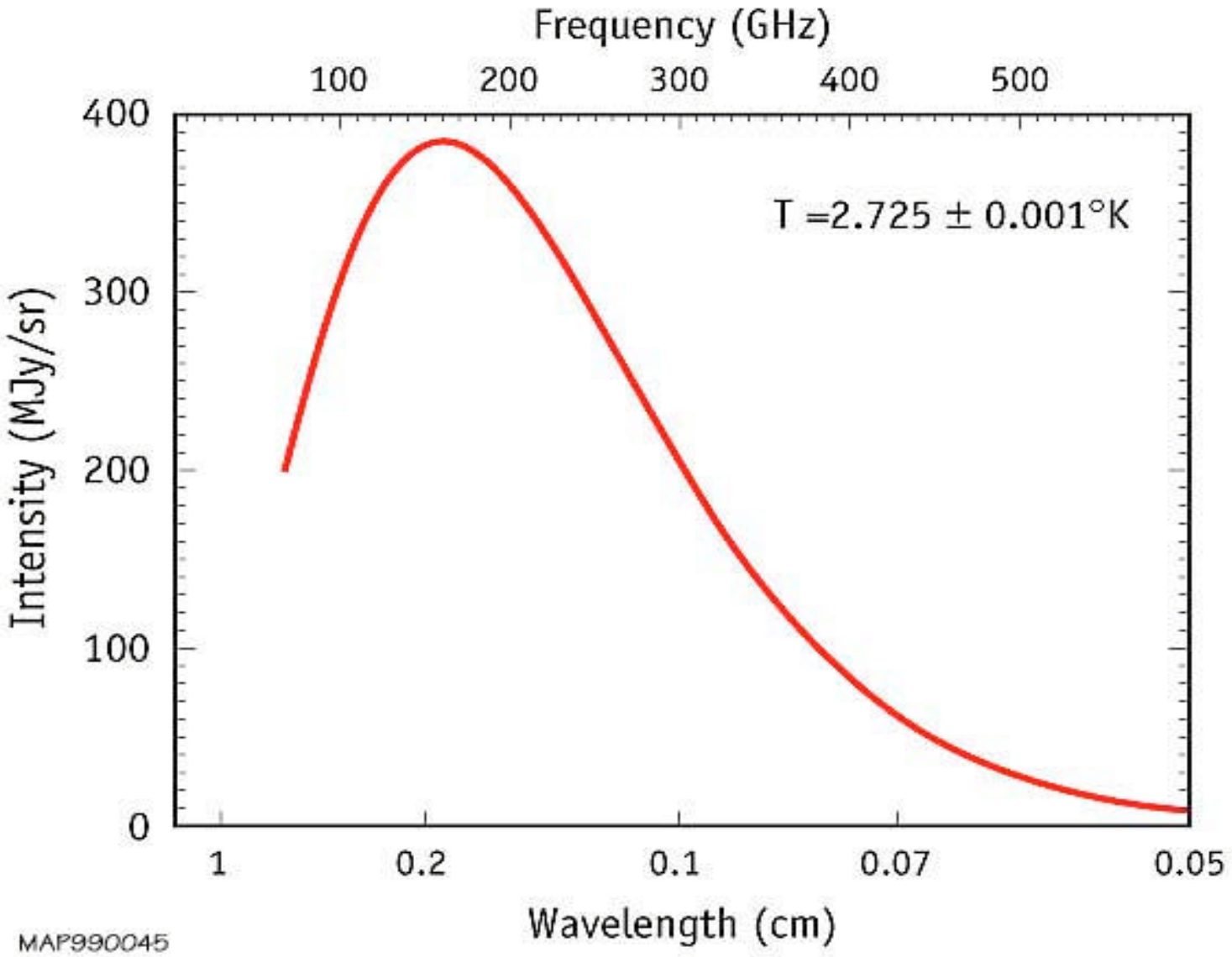


Typical gain


.0E-04
.0E-05
.0E-06
GSM1800
GSM900
UMTS
00:00
06:00
12:00
18:00
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
Easter


1.0E-04
1.0E-05
1.0E-06
GSM1800
GSM900
UMTS
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
Monday
Tuesday
Wednesday

Spectrum of the Cosmic Microwave Background



Solar radiation on Earths surface, maximum	**1400 W / m²**
Solar radiation at Scandinavian latitudes	**500 - 700 W / m²**
Solar radiation at worst conditions	**150 - 300 W / m²**

Frequency range for solar radiation ***10^4 Hz – 10^{19} Hz***

Highest emission from RBS	**2 W / m² FM ~100 MHz**
	3,7 W / m² TV ~500 MHz
	4,5 W / m² GSM-900
	9 W / m² GSM-1800
	10 W / m² UMTS / W-LAN

W-LAN 100 mW at frequency 5,875 10^9 Hz

The total power output from radio base stations have been going down since the introduction of mobile telephony

RadioLAN and Bluetooth (IEEE 802.11) have a maximum output of 100 milli-Watt (2.5 mW, 1 mW) at the various frequencies of the standard (902-928; 2 400-2 483; 5 725-5 875 MHz)

UMTS RBS have a maximum output of 20 Watt/antenn, ~2140 MHz (pilot signat att +33 dBm, max. +43dBm).

DECT telephoni, 100 mW; 1900 MHz
GSM had initially a maximum output of about 60 Watt/antenn, now 20 – 40 Watt; 1800 MHz, 900 MHz

NMT had even higher output power, about 100 Watt/antenn

NRJ Radio broadcasting emission is at 1000 Watt/antenn !
TV emissions have even higher output power, several kWatt/antenn !!

Monitoring model – a possible configuration of an urban station