

Studies of the effects of exposure to electromagnetic fields emitted from mobile phones on volunteers

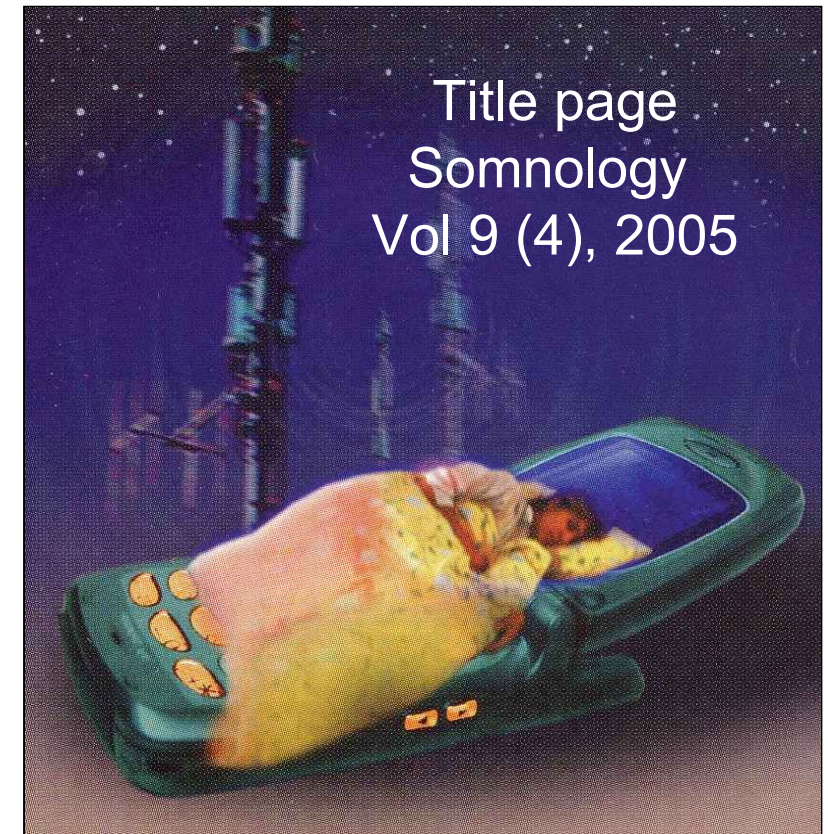
Investigation of sleep quality in subjects living near a mobile base station – Experimental study on the evaluation of possible psychological and physiological effects under residential conditions

Heidi Danker-Hopfe and **Hans Dorn**

German Mobile Telecommunication Research Programme
Munich, 12./13. December 2006

Overview

- Sleep – basics
- Motivation to study sleep in the context of electro-magnetic fields
- *Laboratory study:* mobile phones and sleep
- ***Field study:* base stations and sleep**



Field study: base stations and sleep

- **History**
- **Background**
- **Design**
- **Status of the project**



Charité – CBF project funded within the **DMF**

Title: *Investigation of sleep quality in subjects living near a mobile base station – Experimental study on the evaluation of possible psychological and physiological effects under residential conditions*

Duration: **March 1st, 2006 – September 30th, 2007**

Ein ostfriesisches Dorf schläft für die Wissenschaft

Pilotstudie untersucht Auswirkungen von Mobilfunkmasten

Feasibility study

Investigations of sleep quality in subjects living in the vicinity of base stations

*(funded by the Ministry of Social Affairs, Women, Family and Health of
Lower Saxony)*

Flachsmeer, November 10th to Dezember 7th, 2002

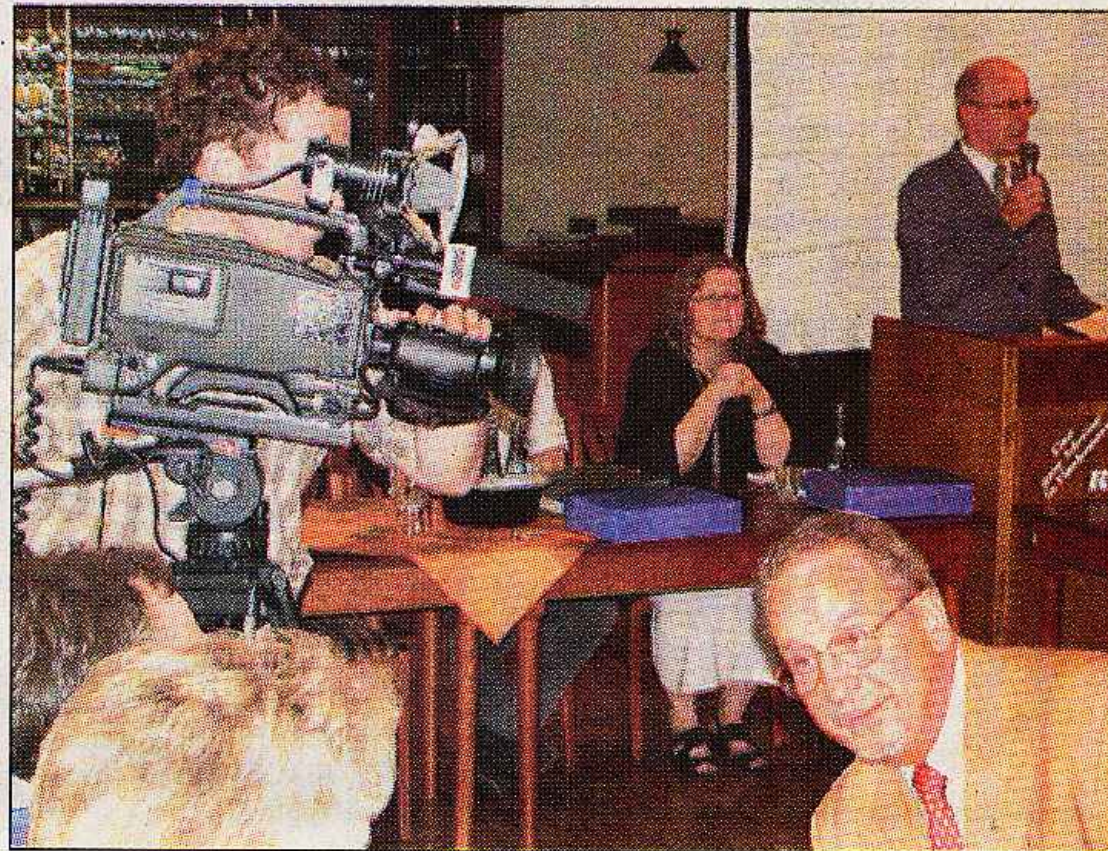
**Participants: 47 men and 58 women
(15 to 88 years)**

Presentation of results: June 19, 2003

Ein Dorf schläft für die Nation

■ **Flachsmeer (nbg)** Die Bürger der Westoverledinger Ortschaft Flachsmeer ebnen den Weg für eine bundesweite Studie zu möglichen Gesundheitsgefahren durch Handystrahlen.

105 Einwohner Flachsmeers hatten in einer weltweit einzigartigen Studie zwölf Nächte lang im Auftrag der Wissenschaft geschlafen. In dieser Machbarkeitsstudie wurde untersucht, ob Auswirkungen



Auch das NDR-Fernsehen interessierte sich für die Ergebnisse der Flachsmeerer Schlafstudie, die von Heidi Danker-Hopfe (Bildmitte) vorgestellt wurden. Foto: Pressebüro Nordwest

Sonntags-
report

June 22,
2003



Charité – CBF project funded within the **DMF**

Title: *Investigation of sleep quality in subjects living near a mobile base station – Experimental study on the evaluation of possible psychological and physiological effects under residential conditions*

Duration: **June 15, 2005 – September 15, 2005 – pilot study**

Aims of the pilot study

- write a review of the literature
- get an ethics vote (September 6, 2005)
- achieve an agreement with the network providers T-mobile, Vodafone, E-plus and O2 concerning technical support

All aims were achieved —→ funding of the main study

Field study: base stations and sleep

- History
- **Background**
- Design
- Status of the project

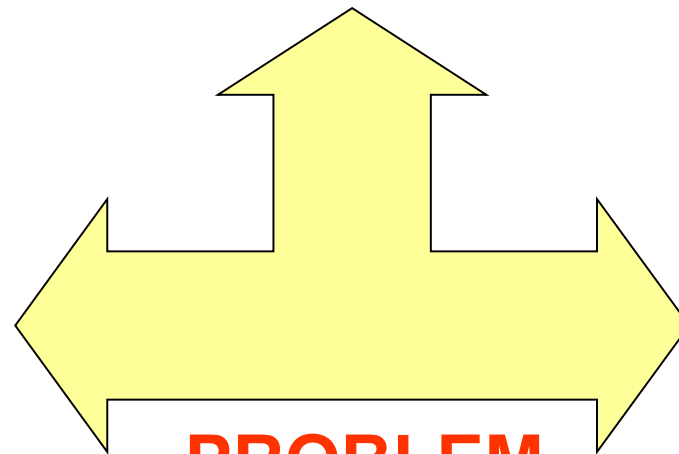
No further information

**we refer to the presentation by
Gabriele Berg**

Field study: base stations and sleep

- History
- Background
- **Design**
- Status of the project

Field studies on sleep of people living in the vicinity of mobile phone base stations



psychological
effects

PROBLEM
“disentangle”

physiological
effects

Solution: experimental field study

Field study - design

Field study - design

Selection of sites

- **no mobile service available**
- **only weak fields from other RF-sources (TV etc.)**
- **no emotional EMF-discussion in the run-up to the study**

Selection of subjects

- **age > 17 years**
- **ability to give an informed consent**
- **living close (≤ 500 m) to a site suitable for placing the experimental base station**

Selection of study sites: procedure

Search for sites: www.keinnetz.de, personal communication etc.

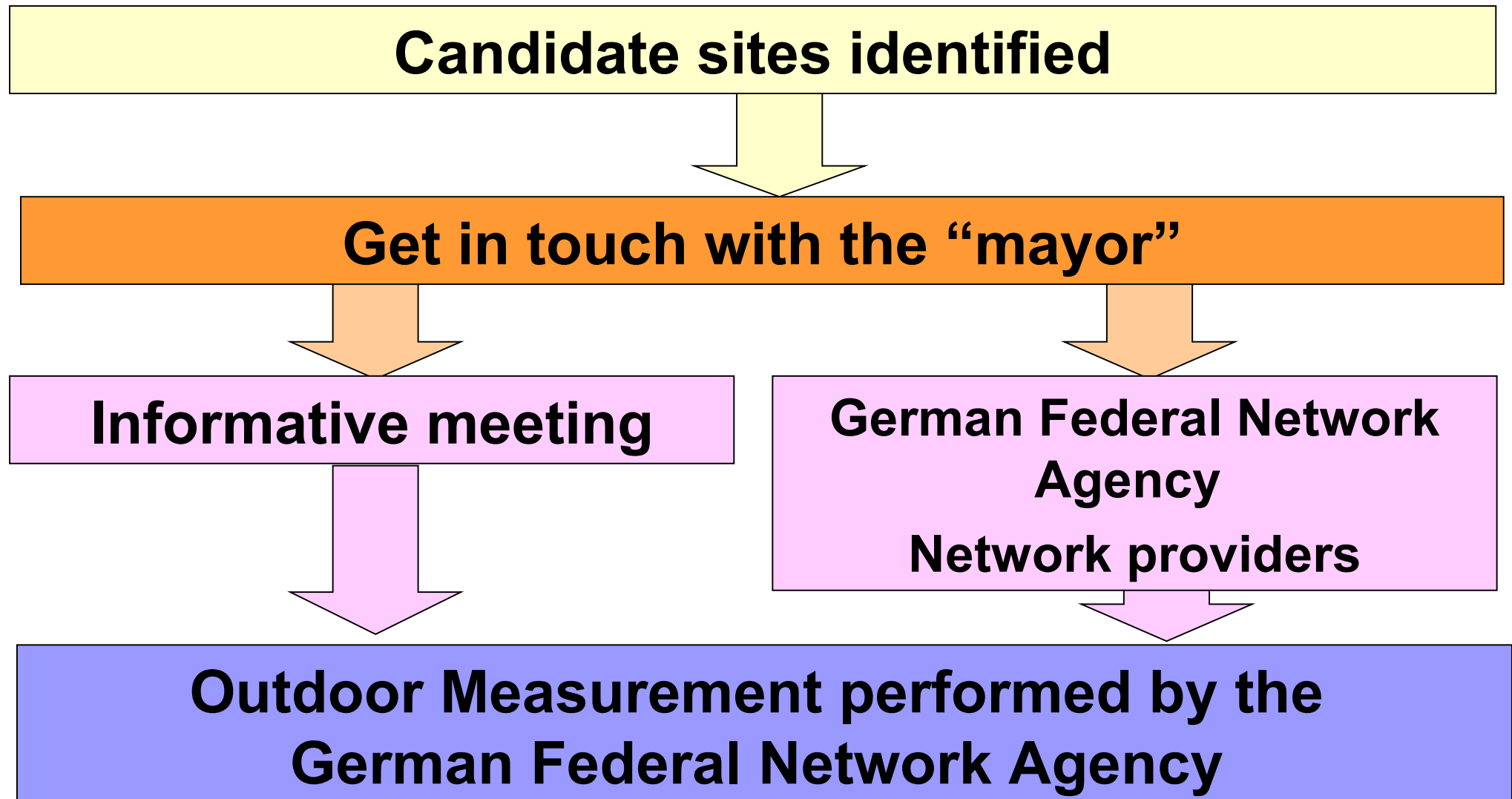


Second study site: Lower Saxony

Third study site: **Thuringia**

Preliminary fourth study site: **Schleswig Holstein**

Selection of study sites: procedure



Outdoor measurement according to the standard: "*Reg TP MV EMF 03, Ausgabe Februar 2003*"

- peak hold measurement while rotating antennas to include all directions for both vertical and horizontal polarizations
- all signals above a threshold of 40dB below legal limits are registered or, if none present, the 2 strongest per measuring frequency range (can be at noise floor level)

						E_{eff}	$E_{\text{g eff}}$	Bedingungen E-Feld	Berechnung Bedingung 3 nach 1999/519/EG	H_{eff}	$H_{\text{g eff}}$	Bedingungen H-Feld	Berechnung Bedingung 4 nach 1999/519/EG
Zellen-Nr.	Messsystem	Frequenz	Meßwert F_{PKmax}	Kombinierte Standard- unsicherheit	erweiterte Messun- sicherheit bei 95%	Effektiv- wert	Grenzwert für Effektiv- wert	Bed. 1 *	Bed. 3 *	Effektiv- wert	Grenzwert für Effektiv- wert	Bed. 2 *	Bed. 4 *
Nr		MHz	dB($\mu\text{V/m}$)	Faktor	dB	V/m	V/m	Faktor	Faktor	mA/m	mA/m	Faktor	Faktor
1	6	0,13	84,6	0,186	2,7	0,0232	87,0	0,0002684	0,0000000	0,061	5000,0	0,0000123	0,0000000
2	6	0,15	90,6	0,186	2,7	0,0462	87,0	0,0005315	0,0000000	0,123	4812,1	0,0000245	0,0000000
3	6	5,93	75,8	0,186	2,7	0,0084	35,7	0,0000967	0,0000001	0,022	123,1	0,0000045	0,0000000
4	6	6,1	73,3	0,186	2,7	0,0063	35,2	0,0000725	0,0000000	0,017	119,6	0,0000033	0,0000000
5	7	87,5	67,1	0,157	2,3	0,0030	27,5	0,0000000	0,0000000	0,008	73,0	0,0000000	0,0000000
6	7	91,03	68,1	0,157	2,3	0,0033	27,5	0,0000000	0,0000000	0,009	73,0	0,0000000	0,0000000
7	7	128,86	58,6	0,157	2,3	0,0011	27,5	0,0000000	0,0000000	0,003	73,0	0,0000000	0,0000000
8	7	132,72	45,4	0,157	2,3	0,0002	27,5	0,0000000	0,0000000	0,001	73,0	0,0000000	0,0000000
9	7	133,4	46,4	0,157	2,3	0,0003	27,5	0,0000000	0,0000000	0,001	73,0	0,0000000	0,0000000
10	9	1028	70,7	0,163	2,4	0,0045	44,1	0,0000000	0,0000000	0,012	118,6	0,0000000	0,0000000
11	9	1463	73,5	0,163	2,4	0,0062	52,6	0,0000000	0,0000000	0,017	141,5	0,0000000	0,0000000
12	9	1886	79,8	0,163	2,4	0,0129	59,7	0,0000000	0,0000000	0,034	160,7	0,0000000	0,0000000
13	9	1890	80,2	0,163	2,4	0,0135	59,8	0,0000000	0,0000001	0,036	160,9	0,0000000	0,0000000

Quelle: RegTP-Messung in Frebershausen

Selektive Messtechnik

Mess- system	Messgerätekombination	Bemerkungen
Nr	Typ	
1	FSU-8 mit Rahmen HFH2-Z2	Frequenz 9 kHz - 30 MHz
2	FSU-8 mit Bikonischer Breitbandantenne BBA 9106	Frequenz 30 kHz - 300 MHz
3	FSU-8 mit Bikonischer Breitbandantenne UBA9116	Frequenz 300 MHz - 1000 MHz
4	FSU-8 mit Logper VUSLP 9111	Frequenz 1000 MHz - 3000 MHz
5	FSU-8 mit Log.-Per. Breitbandantenne USLP 9142	Frequenz 1000 MHz -3000 MHz
6	ESPI mit Rahmen HFH2-Z2	Frequenz 9 kHz - 30 MHz
7	ESPI mit Bikonischer Breitbandantenne BBA 9106	Frequenz 30 kHz - 300 MHz
8	ESPI mit Bikonischer Breitbandantenne UBA9116	Frequenz 300 MHz - 1000 MHz
9	ESPI mit Logper VUSLP 9111	Frequenz 1000 MHz - 3000 MHz
10	ESPI mit Log.-Per. Breitbandantenne USLP 9142	Frequenz 1000 MHz -3000 MHz

**Quelle:
RegTP-Messung in
Frebershausen**

Summationsbedingungen:

$$\text{Bed. 1: } \sum_{i=1\text{Hz}}^{1\text{MHz}} \frac{E_i}{E_{L,i}} + \sum_{i>1\text{MHz}} \frac{E_i}{87} \leq 1$$

$$\text{Bed. 2: } \sum_{j=1\text{Hz}}^{150\text{kHz}} \frac{H_j}{H_{L,j}} + \sum_{j>150\text{kHz}} \frac{H_j}{5000} \leq 1$$

$$\text{Bed. 3: } \sum_{i=100\text{kHz}}^{1\text{MHz}} \left(\frac{E_i}{87 \sqrt{f}} \right)^2 + \sum_{i>1\text{MHz}} \left(\frac{E_i}{E_{L,i}} \right)^2 \leq 1$$

$$\text{Bed. 4: } \sum_{j=100\text{kHz}}^{150\text{kHz}} \left(\frac{H_j}{730 \sqrt{f}} \right)^2 + \sum_{j>150\text{kHz}} \left(\frac{H_j}{H_{L,j}} \right)^2 \leq 1$$

Spitzenwertfaktor:

$$\text{Spitzenwertfaktor: } \frac{E_s}{E_{gs}} \leq 1 \quad \text{bzw.} \quad \frac{H_s}{H_{gs}} \leq 1$$

Bedeutung der Formelzeichen

E_i : Elektrische Feldstärke bei der Frequenz i in V/m

$E_{L,i}$: Referenzwert (Grenzwert) für das elektrische Feld bei der Frequenz i in V/m

H_j : Magnetische Feldstärke bei der Frequenz j in mA/m

$H_{L,j}$: Referenzwert (Grenzwert) für das magnetische Feld bei der Frequenz j in mA/m

f : Frequenz in MHz

E_s : Spitzeneffektivwert der elektrischen Feldstärke in V/m

E_{gs} : Spitzenwert-Grenzwert E-Feld für gepulste Signale in V/m

H_s : Spitzeneffektivwert der magnetischen Feldstärke in mA/m

H_{gs} : Spitzenwert-Grenzwert H-Feld für gepulste Signale in mA/m

Quelle: RegTP-Messung in Frebershausen

Transport of the experimental base station to the study site

Characteristics:

Container, originally used for disaster recovery, containing GSM 900 and GSM 1800 base transceiver stations (BTS), a mast, cables, antennas and a power supply system

BTS deliver generic GSM signals using a test mode without net service -> not displayed on mobiles



Transport of the experimental base station to the study site



Characteristics *contd:*

auxiliary signal generators and power amplifiers add 6/8 pulsed GSM signals

Sum signal simulates a base station transmitting near full capacity

Computer based double blind exposition control via RF relays for switching



Prior to any other action in the project:

P

**participants sign an
informed consent;**

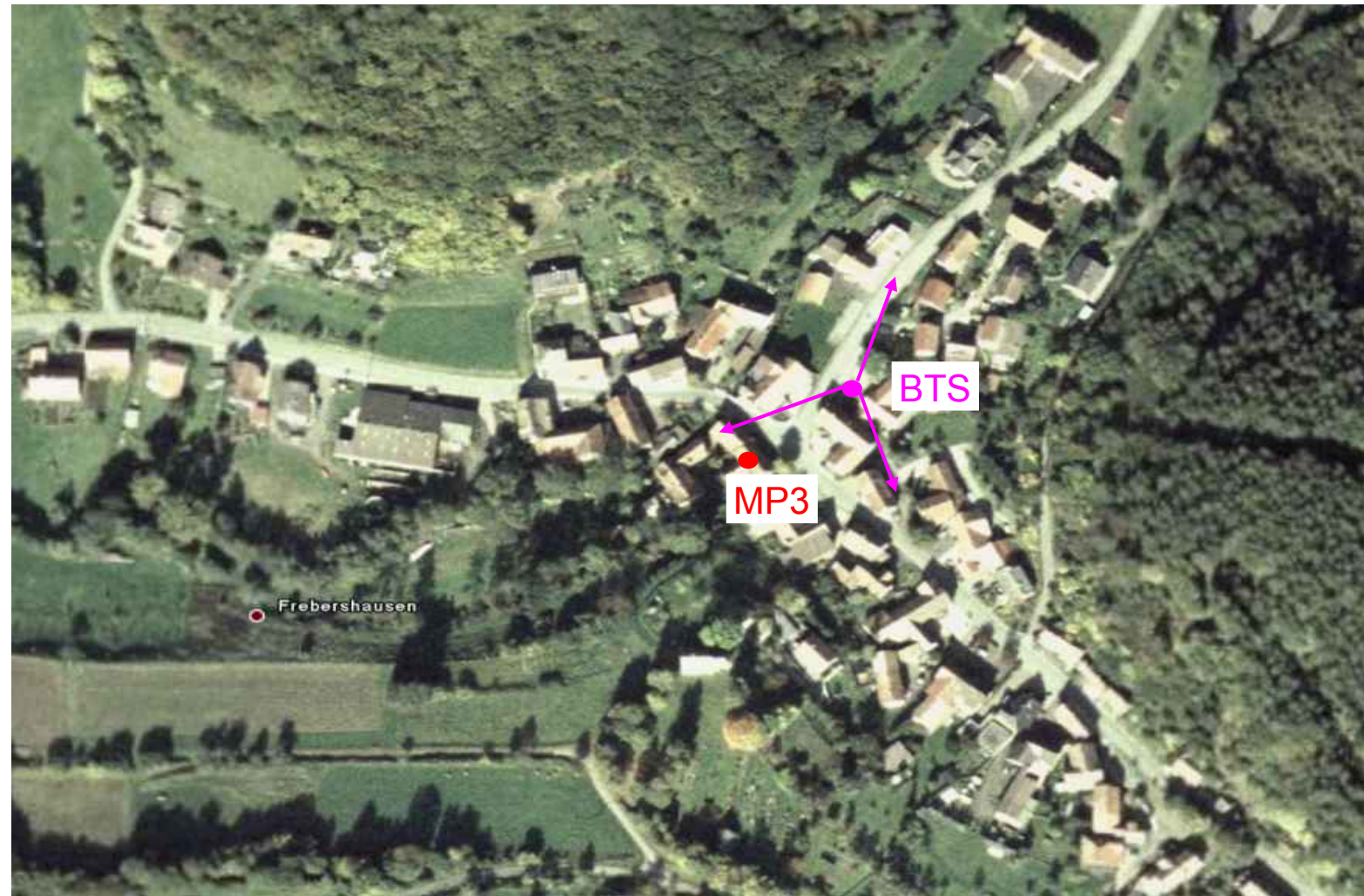
**Completion of questionnaires
concerning sleep and wellbeing**

- **LISST (Landecker Inventar zur Erfassung von Schlafstörungen)**
- **Pittsburgh Schlafqualitäts-Index (PSQI)**
- **Epworth Sleepiness Scale (ESS)**
- **Morning-Evening-Type assessment (MAB)**
- **Zung's Anxiety Scale and Depression Scale (SAS and SDS)**
- **Attitude towards mobile communication (based on the infas interview)**
- **Personality traits (NEO-FFI)**

Outdoor measurement by the IMST GmbH



photo by
courtesy of IMST
GmbH



Location of measuring point 3
and antenna directions of the experimental base station

singular measurement of the signal at the pillow of each participant's bed

DECT phones will be replaced for the time of the study

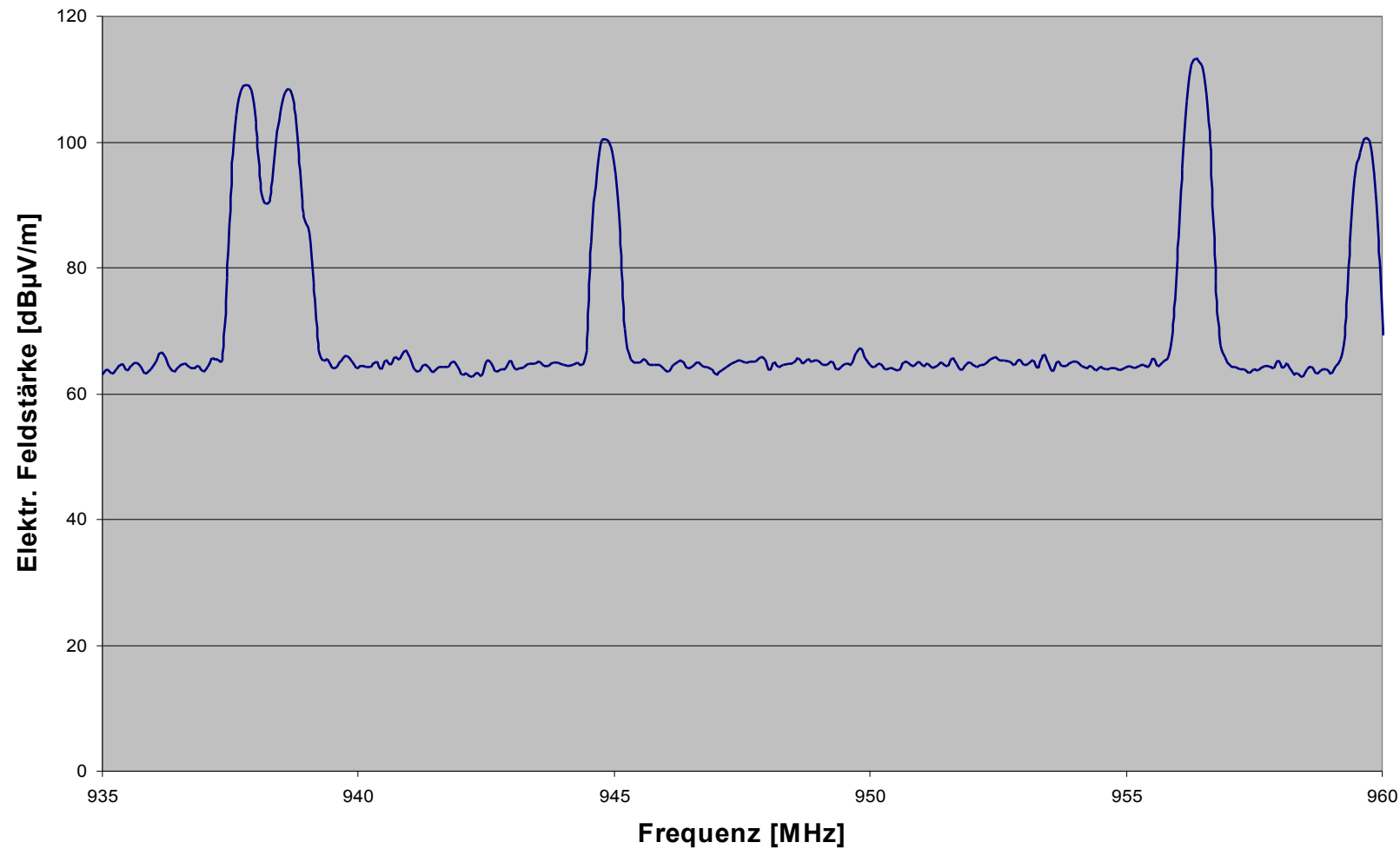
1 week

- both experimental ("test") and external background exposition are assessed
- frequency selective and isotropic methods are used (additionally code selective for UMTS)
- signals of the various transmitting services are measured individually
- to be able to detect background signals of field strengths 40dB below experimental exposition a multistep approach is taken – applying different methods depending from the test signal strength encountered



GSM 900

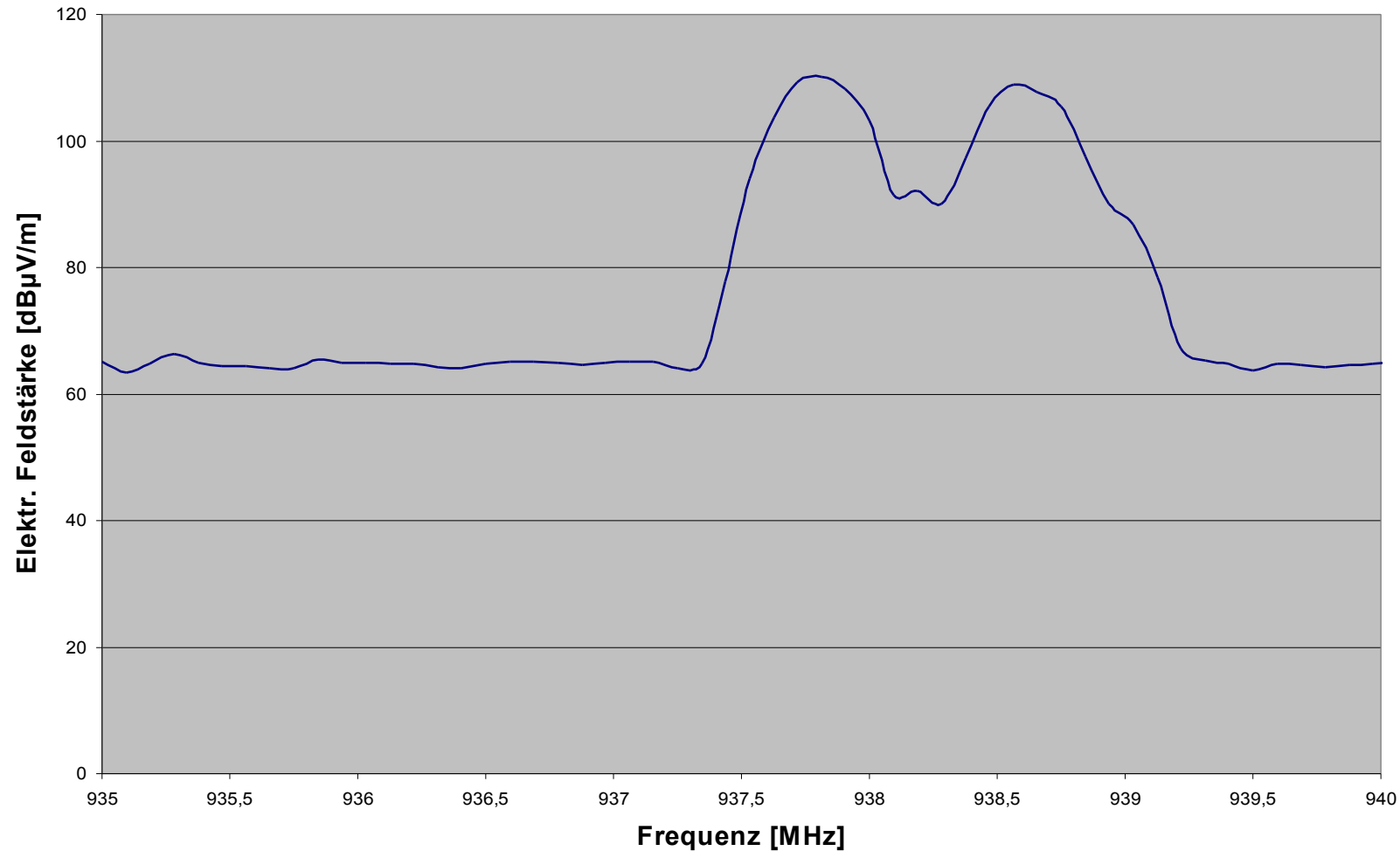
figure by courtesy of IMST GmbH



GSM 900 downlink: signals of the experimental base station

GSM 900 (cutout)

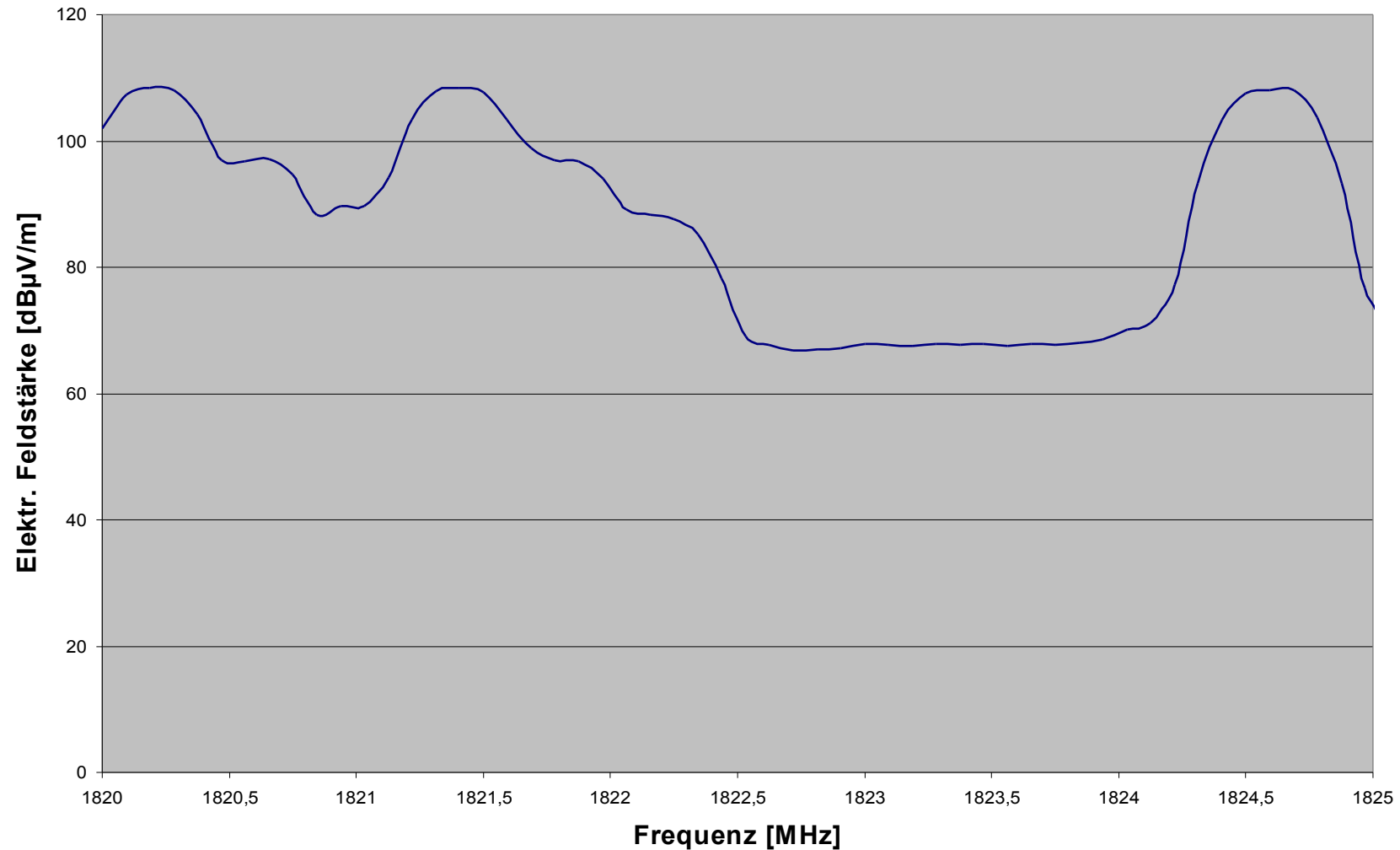
figure by courtesy of IMST GmbH



Signals of four channels below 940 MHz (seven GSM 900 downlink channels total)

GSM 1800

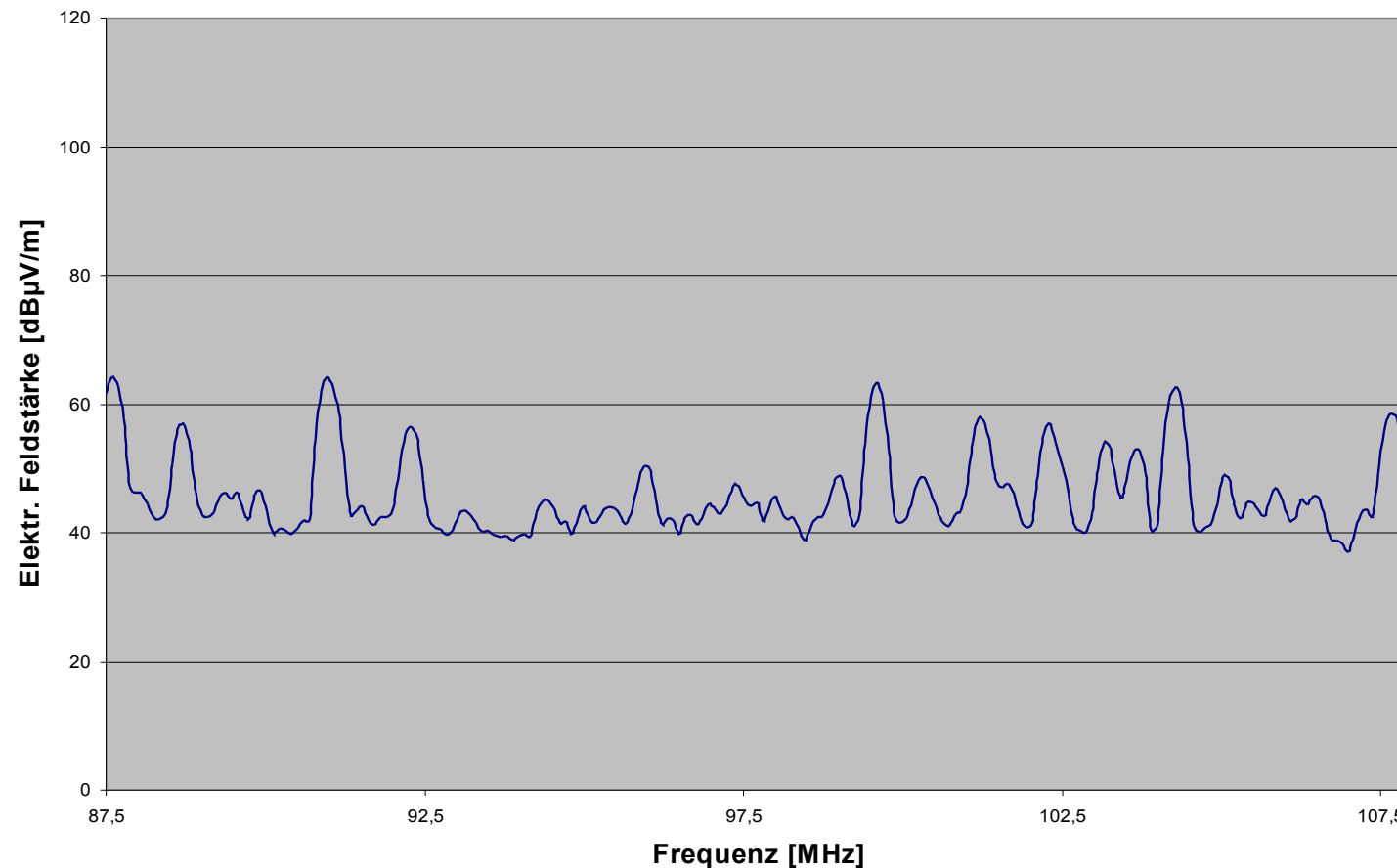
figure by courtesy of IMST GmbH



GSM 1800 downlink: signals of the experimental base station

UKW

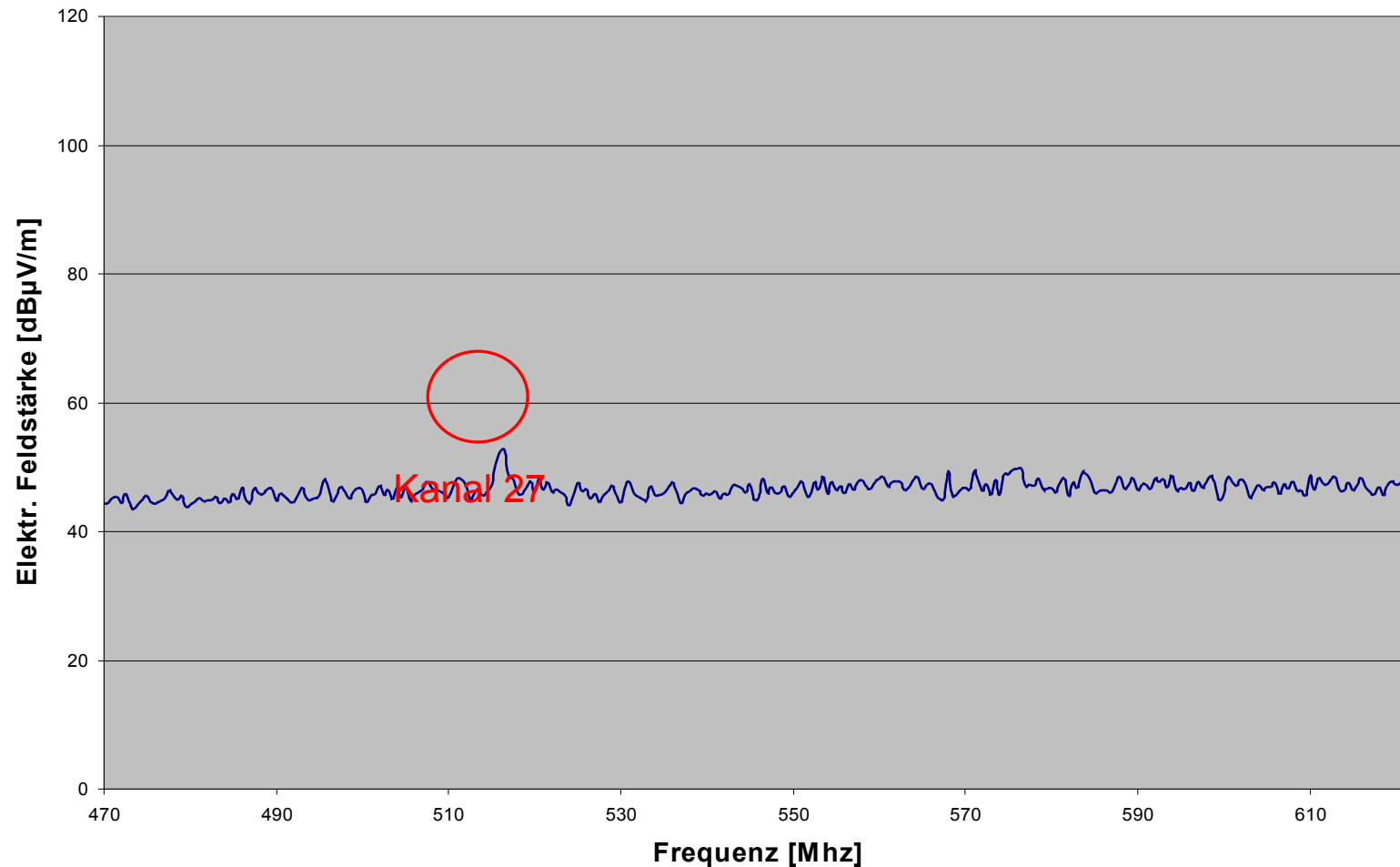
figure by courtesy of IMST GmbH



Signals of FM broadcast

Analog-TV (TV-Band IV)

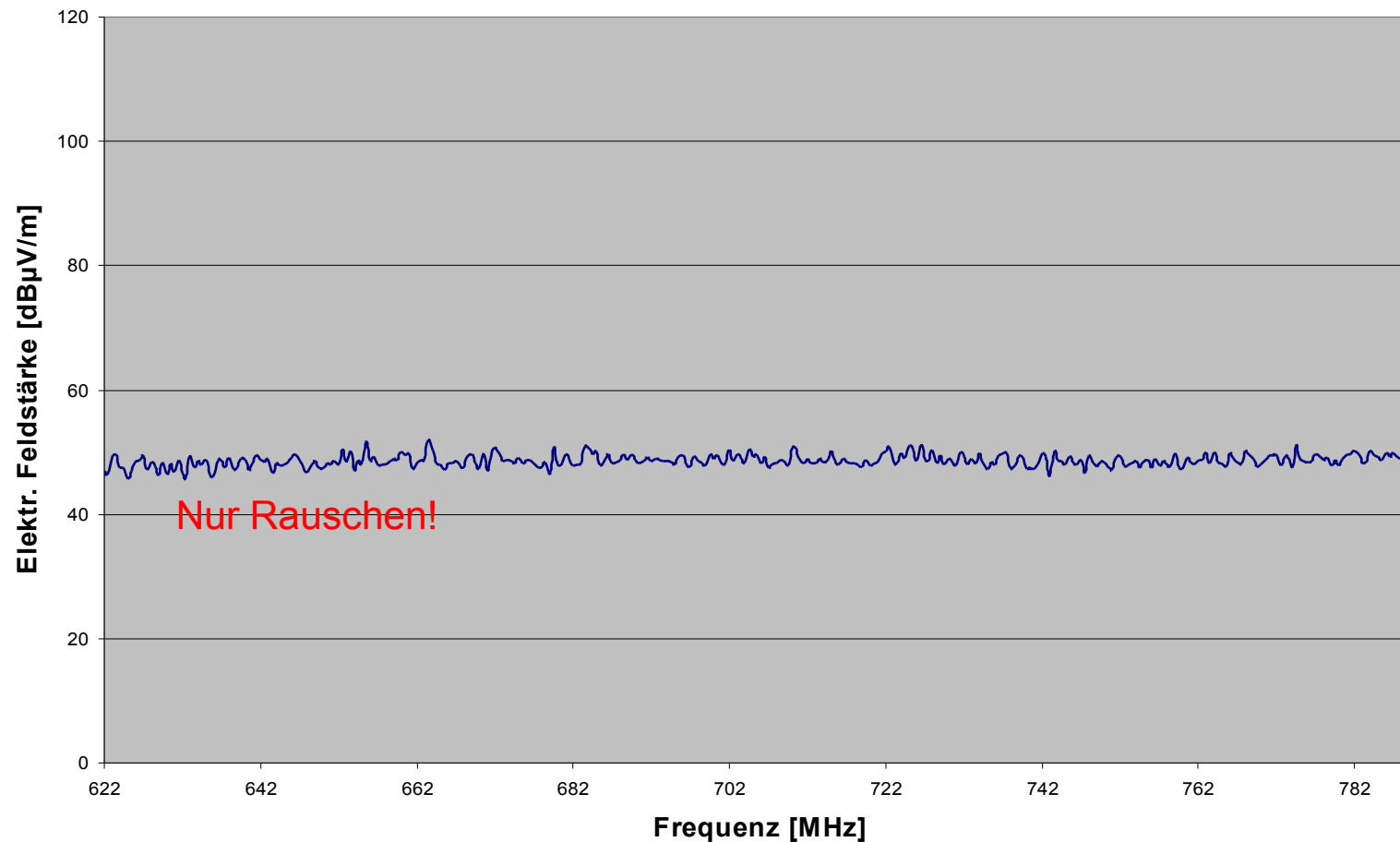
figure by courtesy of IMST GmbH



A single detectable UHF TV signal

Analog-TV (TV-Band V)

figure by courtesy of IMST GmbH



No detectable signals in the second UHF TV frequency band

Collection of sleep related data: duration 2 weeks (12 nights)

no exposition during the day, randomized exposition (sham and verum) during the nights

**subjective
sleep quality**

**objective
sleep quality**

Morning- /evening protocols

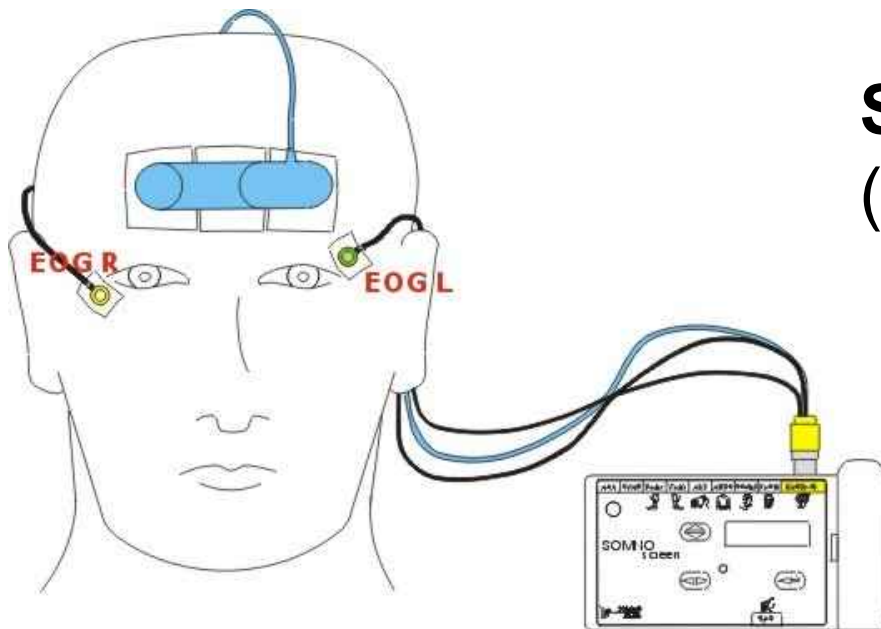
Recommended by the *German Society for Sleep Research and Sleep Medicine* (DGSM), supplemented by questions concerning problems with handling the device used to collect objective data

Registration and automatic analysis of sleep EEG

Storage of the original frontally recorded bipolar EEG signal

objective sleep quality

***Registration and automatic analysis of sleep EEG -
Storage of the original frontally recorded bipolar EEG
signal***



SOMNOscreen Neuro Kombi
(SOMNOmedics)

Field study: base stations and sleep

- History
- Background
- Design
- **Status of the project**



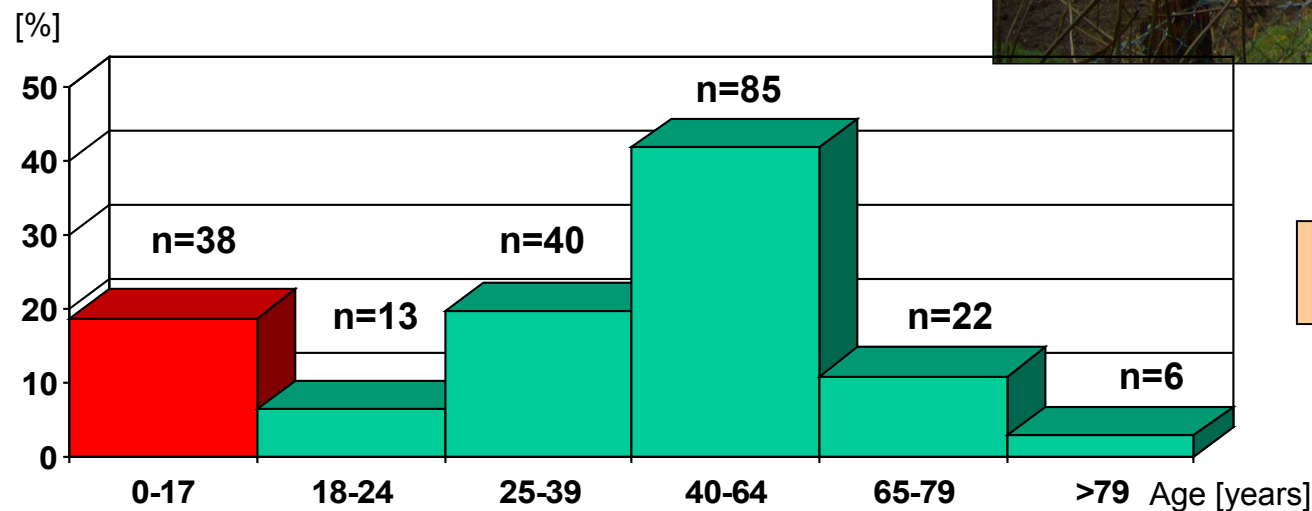
Status of the project

First study site:

Frebershausen (Hessen)

Number of inhabitants: 204

92 males and **102 females**



Eligible: 166

Status of the project

First study site:

Frebershausen (Hessen)

Data collection (12.11. - 2.12.2006)

n = 34

(20.5% of the eligible population)
enrolled



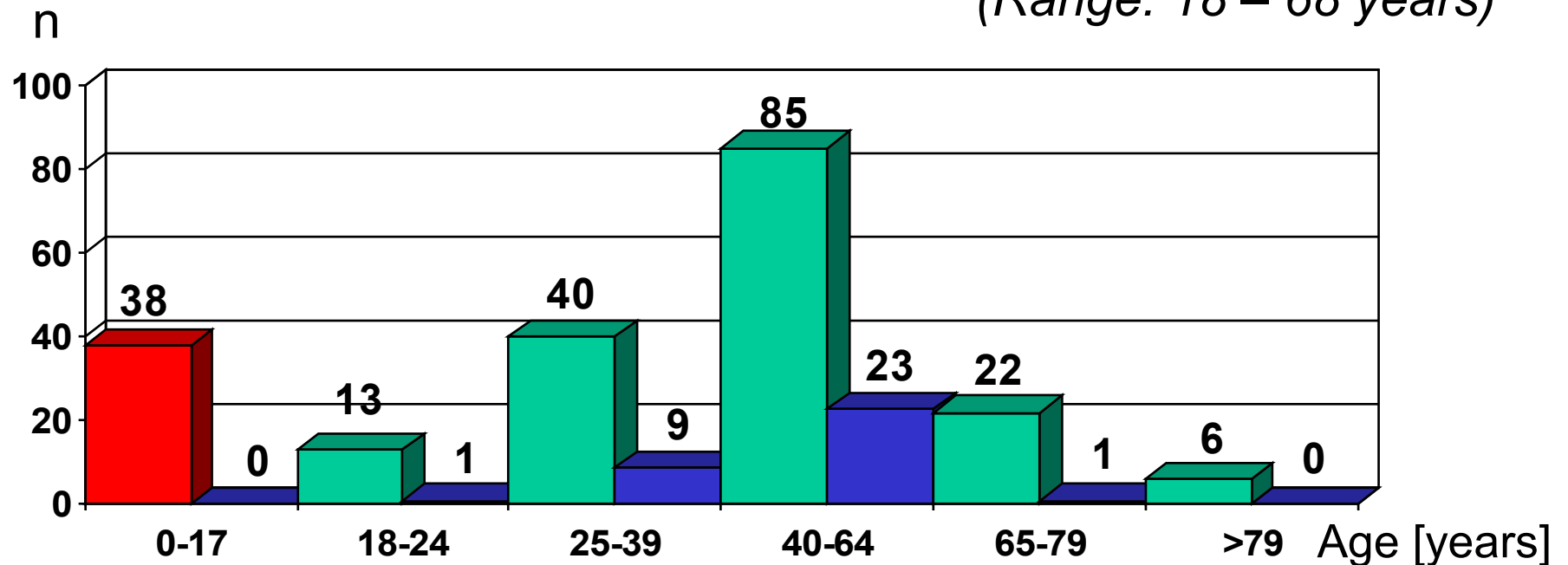
Frebershausen

Sample characteristics

Mean age of participants:

44.2 ± 11.8 years

(Range: 18 – 68 years)



17 males: 50%

17 females: 50%

Study completed

12 nights	20 subjects (58.8%)
------------------	----------------------------

11 nights	7 subjects (20.6%)
------------------	---------------------------

10 nights	3 subjects (8.8%)
------------------	---------------------------

6 nights	1 subject (2.9%)
-----------------	--------------------------

4 nights	2 subjects (5.9%)
-----------------	---------------------------

0 nights	1 subject (2.9%)
-----------------	--------------------------

Drop out rate:
11.8 %

Network providers

T-Mobile
Vodafone
E-Plus
O2



FGF

Gerd Friedrich, PhD

IMST GmbH, Kamp Lintfort

Achim Bahr, PhD

Thomas Bolz, Dipl.-Ing

Christian Bornkessel, Dr.-Ing. and his team

Fachhochschule Deggendorf

Matthias Wuschek, Prof. Dr.-Ing. and his team

Federal Agency of Radiation Protection

Blanka Pophof, PhD

Thank you for your attention

Charité - CBF

Ansgar Bach, Dipl. Chem. PhD

Malek Bajbouj, MD PhD

Oliver Berndt, Dipl. Phys.

Johannes Boeckh, Dipl. Psych.

Timur Cetin, Dipl. Biol.

Martina Grosch, MTA-F

Marie-Luise Hansen, MD

Almut Heinken, Biol. Stud.

Anita Peter, MD

Michaela Noack, MTA-F

Grit Renner, MTA-F

Peter Schlattmann, MD statistician

Andrea Schmidt, MTA

Katrin Schulze, MTA-F

Stefanie Voigtländer, MTA-F