

ITU Workshop
Spectrum Monitoring Today and Tomorrow.
Tasks, Problems and Solutions
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INSPECTION OF RADIO STATIONS
From a Monitoring Perspective

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Inspection of Radio Stations

Content:

- Types of Inspection
- Conformity Check
- License Exempt
- Technical Parameters
- Remote/on Site
- Position in the Organisation
- Remote Inspections using ITU-R SM.1809/1793
- Inspection during Events

Different Types of Inspection

- on site inspections
- remote inspections or from a distance
(performed by monitoring stations)
- using a helicopter
- measuring along a route (coverage)
- administrative inspection

Different types of Inspection

Inspection
of
Radio Stations

ON SITE
INSPECTIONS

TECHNICAL
PARAMETERS

REMOTE
INSPECTION
(FROM A DISTANCE)

TECHNICAL
PARAMETERS
(PERIODICAL TECHNICAL
MONITORING)

ADMINISTRATIVE
INSPECTION

Licences
available?

INSPECTIONS
USING A
HELICOPTER

TECHNICAL
PARAMETERS

MOBILE
MONITORING

COVERAGE

Different types of Inspection

The name SITE INSPECTION causes confusion. We do not inspect the site, we want to inspect the radio station (on a site)

SITE INSPECTION = SITE SURVEY

Better:

(On Site) Inspection of Radio Stations

Conformity

Inspection of radio stations to check conformity with:

- License Conditions
- National Regulations
- International Regulations
- Type Approval

Also SRD's (license exempt) should comply with rules

Conformity

License exempt radio stations should also not exceed the allowed system parameters such as :

Power

Bandwidth

Indoor antenna

2.4 GHz License Exempt

The frequency band 2400-2500 MHz is allocated to the Fixed, Mobile, Radio-location and Amateur services and may be used by

ISM applications:

Industrial, Scientific and Medical

2.4 GHz License Exempt

A lot of other services/applications/use:

- WLAN / WiFi / IEEE802.11(a,b,g)
- Microwave oven (leakage)
- Broadcasting services
- RF identification devices (RFID)
- FWA systems (licensed?)
- BlueTooth
- Cordless telephones
- Video links

2.4 GHz License Exempt

- RLAN/WIFI is often not allowed to exceed **100 mWatt**.

- Monitoring campaign in France:

EIRP measured : **52 mWatt – 30.2 Watt**

- Monitoring campaign in Germany:

EIRP measured: **417 mWatt**

2.4 GHz License Exempt

- Though most of these 2.4 MHz radio systems do not need a license they are not allowed to exceed the permitted parameters as bandwidth, power, etc.

Technical Parameters to be measured (1)

➤ Power or field strength	0	M
➤ Bandwidth	0	M
➤ Frequency + stability	0	M
➤ Antenna pattern	-	-
➤ Antenna height/azimuth	0	M *
➤ Geographical coordinates	0	-

Technical Parameters to be measured (2)

➤ Harmonics, Intermod, Spurious	O	M
➤ Type of Modulation	O	M
➤ Deviation (FM)	O	M
➤ Geographical coverage	-	-

On Site Inspection

Advantage:

A lot of parameters can be measured

Disadvantage:

- Power can be measured but not what is coming out of the antenna.
- Only one at a time → **Very expensive**
- Time consuming
- Short period of time

Remote Inspections

(from a distance)

Monitoring= (in short)

- Measuring spectrum occupancy
- Measuring technical parameters of radio stations:
 - identification
 - interference
 - un authorized transmissions
 - verify license conditions : power
bandwidth
pattern (partly)

(Also on request of all other Spectrum Affairs departments)

Remote Inspections

(from a distance)

Advantage:

- A lot of radio stations within the coverage of monitoring stations (including remote stations)
- Very limited human labour needed (cheap)
- Easy to automate, lot of stations (500 or 1000 frequencies/channels) same time
- Easy to compare (automatically) with theoretical values (from planning tools)
- Easy access to results because automatic processing and presenting of data
- Very limited human labour needed (cheap)
- Can serve very easy as input/trigger for on site inspections

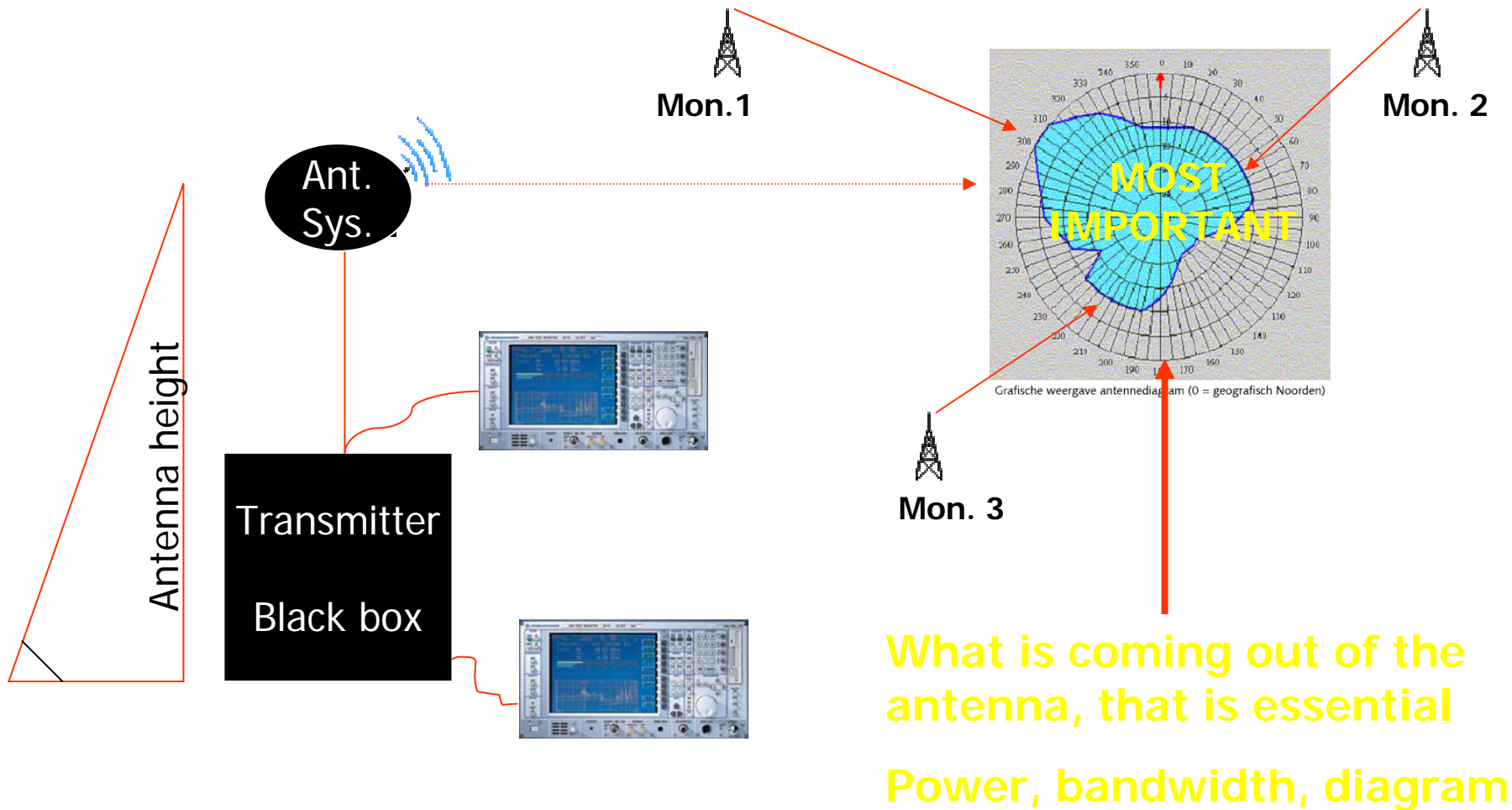
Remote Inspections

(from a distance)

Disadvantage

- Only applicable for stations not too far from monitoring station (manned or unmanned)
- Only field strength (antenna height) and bandwidth

Remote/On Site Inspection

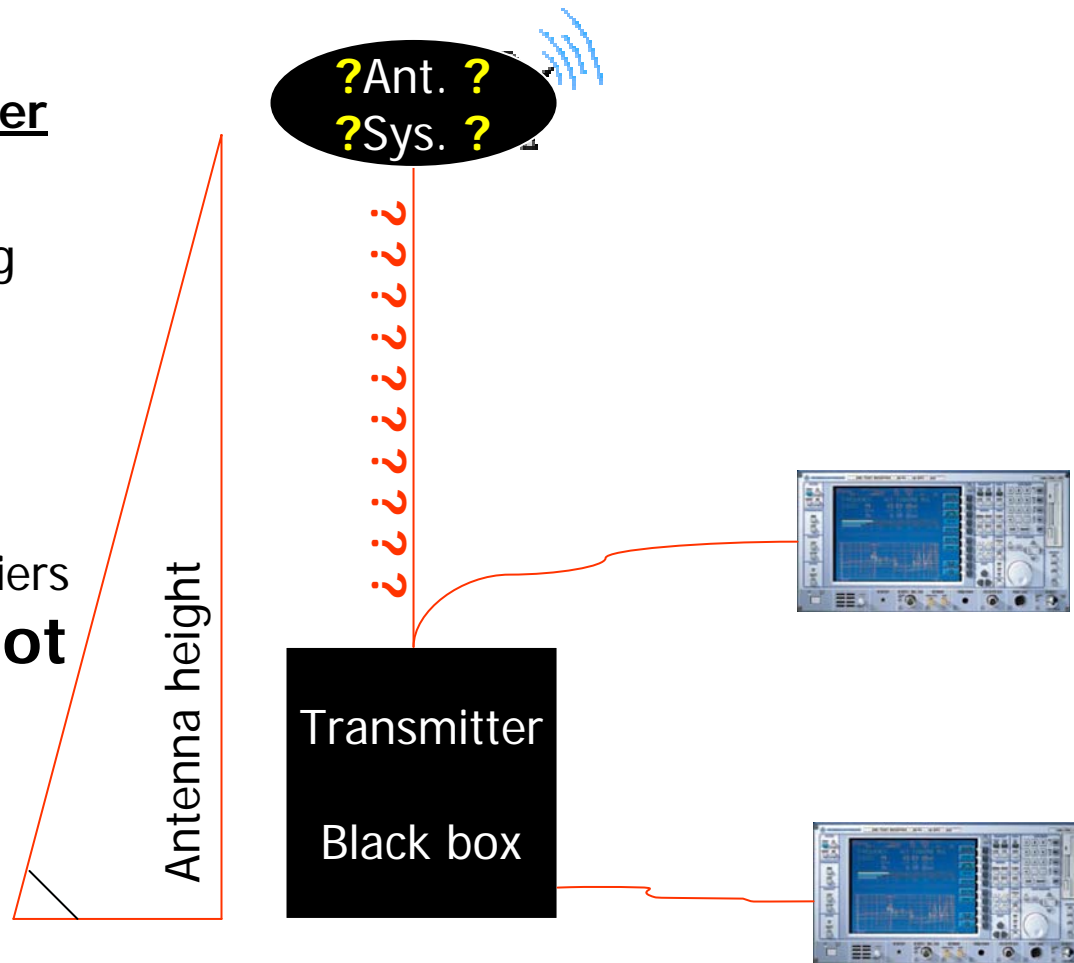


Remote/On Site Inspection

On Site the **transmitter** output is measured.

No idea what is coming out of the **antenna!**

Information on cables, connectors antenna properties etc. from manufactures or suppliers in practice often are **not correct**



Remote/On Site Inspection

- Approx. 90% of all TX problems are caused by exceeding of Power or Bandwidth limits

Conclusion:

Monitoring can do a lot of work related to inspections (understatement)

In general:

Don't do it on location (on site) if you can do it remotely !!!!

(Unless you have unlimited resources, time, staff and budget)

Inspection of Radio Stations

Reasons or triggers for inspection:

- Statistics
- Random Check
- Selective Check
- Risk Analyses
- Based on information out of the "field"
- Based on Monitoring information (remote inspection)
- Routine inspections
- Pre start inspections
- On request of other departments in organisation
- History of compliance (of stations or services)

Inspection of Radio Stations Pre Start

Useful but after staff left site nobody knows what is happening. (no theory!)

Monitoring can very easy/fast/cheap control stations. In case of changes go back for a on site inspection.

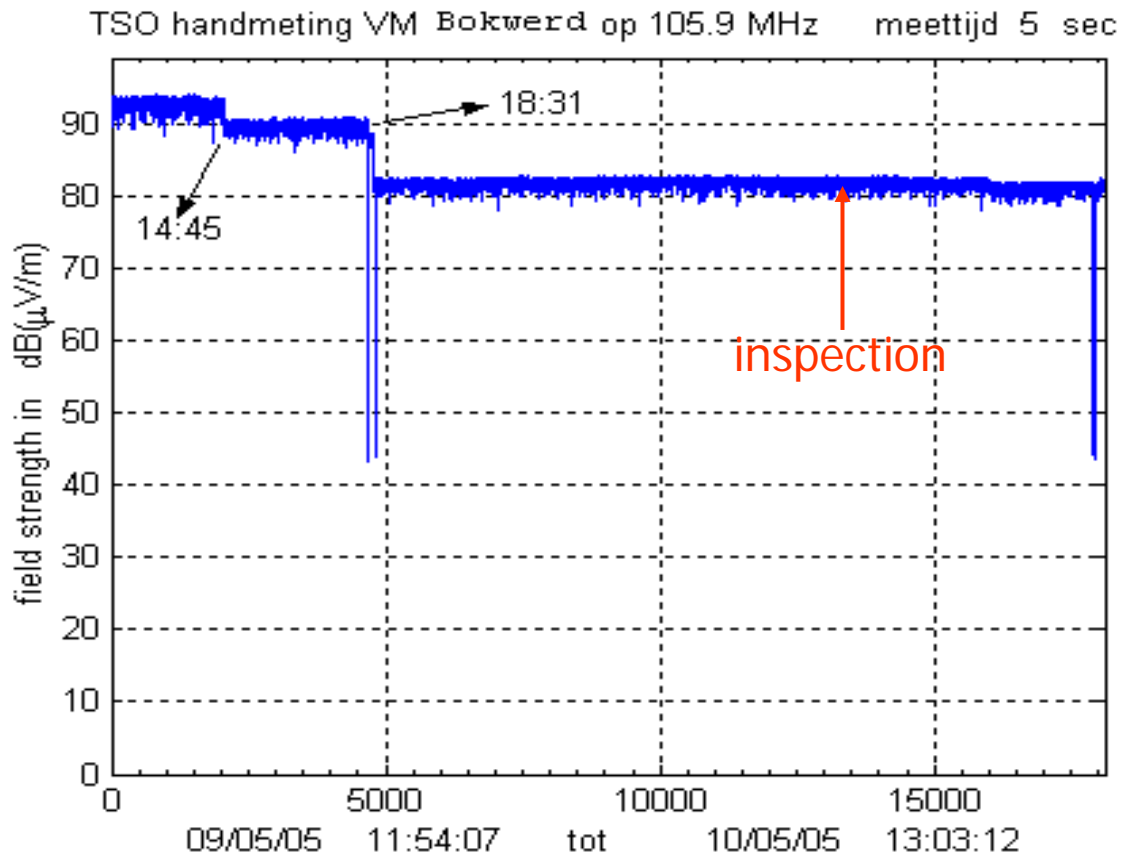
Inspection of Radio Stations Pre Start

- During pre start inspection the site is visited by the RCA. Check all.
- Monitoring is also observing same channel and logging field strength and band with values from a distance at start of transmission in narrow contact with the engineer at the site.
- Future exceedings are recognized very easy

Inspection of Radio Stations announced

Measured:
94 dBuV/M

Calculated:
82 dBuV/M



09/05/2005 abt. 1400 hrs inspection announced for 10/5

Inspection of Radio Stations

Position in the organisation 1. (review)

- ITU SG1 WP1C is preparing an Inspection Report
- ITU Handbook Spectrum Monitoring
- ITU Handbook Spectrum Management
- CEPT/ECC report 15 (inspection closely related to monitoring)
- CEPT/ECC report 66 (monitoring as an overall inspection activity)

Inspection of Radio Stations

Position in the organisation 2 (Practically)

- Most of equipment already available
- Monitoring performs already routine inspections, periodical technical monitoring, which can be extended to a large scale
- Monitoring Engineer is also Inspection Engineer (multi-functional)
- From 12 monitoring stations a lot of radio stations can be controlled (field strength) automatically see example
- Operational point of view.
- Separation of tasks:
 - to authorize use of spectrum
 - inspection process

Inspection of Radio Stations

Position in the organisation 3

ITU SG1 WP1C is working on an Inspection Report:
(WP1C= Spectrum **MONITORING**)

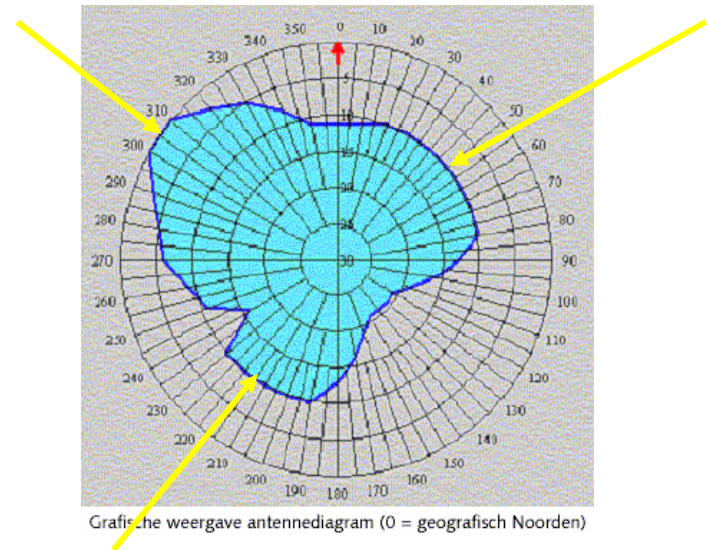
Many countries contributed: USA, France Germany,
Netherlands, Brasil, Russia, . . .

It depends from country to country but at
least there is a “**strong relation**” between
Inspection and Monitoring

Remote Inspection of radio stations Manually

- **Fieldstrength** and **bandwidth** can be measured manually from remote monitoring stations, depending on the number and location of fixed, mobile or portable stations.

Directional antennas
can be used



Remote Inspection of radio stations Manually

- Results of these manual field strength and bandwidth measurements can be compared with previous (e.g. pre-start) measurements and/or calculated values from planning tools

Remote Inspections using Frequency Band Occupancy Measurements, ITU-R SM.1809

FBO Measurements according ITU-R SM.1809 or ECC(05)01, combined with processing described in ITU-R SM.1793, can easily be used for remote inspections.

Measured field strength values can be compared **automatically** with theoretical values.

Remote Inspection using ITU-R SM.1809 processing in accordance with ITU-R SM.1709

Step:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
MHz:	87.5					87.6					87.7					87.8
00:00:00	63.8	61.7	51.8	32.3	35.0	37.7	34.3	39.6	52.8	64.9	72.2	65.0	51.7	41.2	37.6	50.1
00:00:10	63.9	61.3	51.5	32.0	35.6	36.8	33.6	39.1	52.9	64.8	72.3	65.5	51.9	41.8	37.7	50.8
00:00:20	61.7	61.7	50.8	32.9	35.3	37.9	33.9	39.8	52.1	65.4	72.7	65.4	51.9	42.2	37.6	50.9
00:00:30	63.3	61.9	52.7	31.5	34.6	38.7	34.0	40.6	52.8	65.2	72.1	66.0	51.1	41.7	37.0	49.5
00:00:40	63.8	62.0	51.3	32.3	35.0	37.7	33.6	39.9	52.5	64.9	72.8	65.5	52.7	41.2	38.3	50.7
00:00:50	63.1	62.3	51.8	32.8	35.7	38.4	36.3	39.6	53.1	64.3	72.2	64.9	53.7	41.3	37.6	50.1
00:01:00	64.8	60.7	50.0	32.1	36.1	37.1	36.8	39.3	52.8	64.2	72.6	65.0	51.6	40.9	37.8	50.4
00:01:10	62.8	61.9	51.9	33.0	35.0	36.2	31.9	39.1	52.3	64.1	72.3	65.2	51.5	41.8	36.6	50.7
00.01.20																
00.01.30 ... etc.																

Remote Inspection using ITU-R SM.1809 processing in accordance with ITU-R SM.1709

Step:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
MHz:	87.5					87.6					87.7					87.8
00:00:00	63.8					37.7					72.2					50.1
00:00:10	63.9					36.8					72.3					50.8
00:00:20	61.7					37.9					72.7					50.9
00:00:30	63.3					38.7					72.1					49.5
00:00:40	63.8					37.7					72.8					50.7
00:00:50	63.1					38.4					72.2					50.1
00:01:00	64.8					37.1					72.6					50.4
00:01:10	62.8					36.2					72.3					50.7
00:01:20																
00:01:30																

Scan time 10 s.: 8600 values/24h

Remote Inspection using ITU-R SM.1809

- Collect the available theoretical/calculated values from the planning tools used.

What field strength values can be expected at what location. (remote monitoring station)

- Combine (automatically) the measured and calculated presentations, plots and tables

Remote Inspection using ITU-R SM.1809 example of planning tool info (Chir+)

```

Wanted Transmit. : Bokwerd (MEETNET)
Frequency/MHz    : 87.600   Chan. :
MaxERP kW       : 0.000   Dir  : ND
Longit. / Latit. : 005E51 28 / 51N00 16
Heff Max        : 62      Country: HOL
Polarisation    : V       OS      : MP
Receiving Pol.  : V       Service: FM Broadcast
Offset          : 0       System : FM
Antenna Discrimination in Use
  
```

Location (remote) monitoring station (RM12)

ENU	OS	TRANSMITTER	DIS	AZM	Z%	DIR	LONGITUDE	LATITUDE	E1KW	ERP	PR	IVH	ATD	f/MHz	DF	CHA	HEFF	LM
96.8	SV	MIERLO	50.9	159.3	0	D	005E36 00	51N26 00	51.8	0.0	45	0	0.0	87.60	0		139	HC
93.5									56.5	0.0	37		0.0					
92.5	P	BIEDENKOPF	187.4	272.9	0	ND	008E32 00	50N57 00	35.5	20.0	37	0	0.0	87.60	0		286	
83.4									18.4	20.0	45		0.0					
86.8	P	LEGLISE	134.7	6.2	0	ND	005E39 00	49N48 00	39.8	10.0	37	0	0.0	87.60	0		150	BE
79.8									24.8	10.0	45		0.0					
82.5	SV	MAASTRICHT	23.3	35.1	0	ND	005E40 00	50N50 00	62.5	-13.0	33	0	0.0	87.70	100		72	HC
76.6									64.6	-13.0	25		0.0					
79.7	C	KOELNTURM	76.2	275.1	0	D	006E56 36	50N56 57	49.7	-7.0	37	0	0.0	87.60	0		137	
78.6									40.6	-7.0	45		0.0					
72.0	SV	ENSCHDE	154.9	208.6	0	D	006E55 00	52N14 00	36.0	-1.0	37	0	0.0	87.60	0		85	HC
62.9									18.9	-1.0	45		0.0					
71.1	P	HAMBURG	401.5	227.6	0	ND	010E06 00	53N31 00	14.1	20.0	37	0	0.0	87.60	0		256	
60.4									-4.6	20.0	45		0.0					
70.9	C	OOSTENDE	207.0	95.9	0	D	002E54 49	51N13 56	30.7	3.2	37	0	0.0	87.60	0		97	BE
60.1									12.0	3.2	45		0.0					
69.5	C	ATH	152.0	73.3	0	D	003E46 37	50N37 47	32.5	0.0	37	0	0.0	87.60	0		7	BE
59.9									14.9	0.0	45		0.0					
67.3	SV	**NAALDWIJK_C	158.6	133.6	0	D	004E13 00	52N00 00	36.3	-6.0	37	0	0.0	87.60	0		122	HC
58.5									19.5	-6.0	45		0.0					

[Link Chir+](#)

Remote Inspection using ITU-R SM.1809

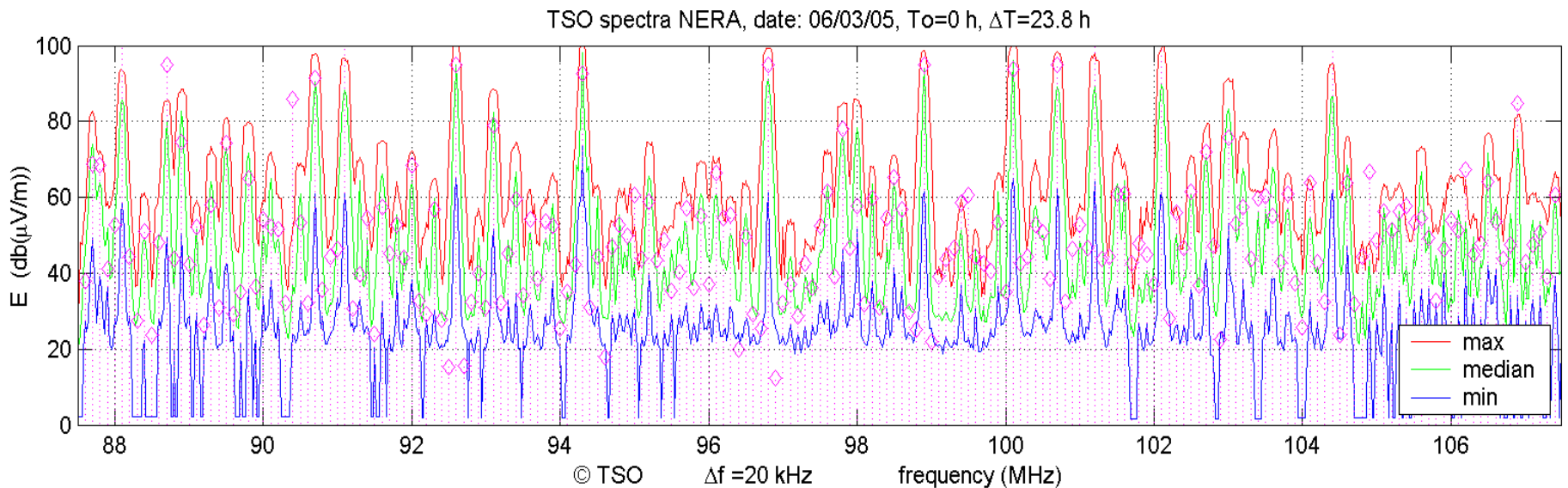
example of planning tool info (Chir+)

freq	RM1 HEER	RM2 NERA	RM3 HOEK	RM4 BRED	RM5 AXEL	RM6 HARD	RM7 EIND	RM8 GRON	RM9 HOOG	RM10 HENG	RM11 NIJM	RM12 BOKW
87.6	31.30	37.80	82.20	55.90	47.10	35.30	99.10	75.70	62.10	82.20	57.60	51.80
87.7	76.70	68.80	41.80	38.10	38.00	64.60	34.40	39.90	49.00	43.60	46.90	49.50
87.8	36.10	68.40	29.00	54.60	30.10	36.10	40.40	24.20	38.60	38.80	68.10	36.70
87.9	32.60	41.20	57.80	55.60	73.00	24.90	44.10	18.60	22.40	24.60	52.60	32.50
88.0	54.50	52.80	35.60	37.20	30.10	60.50	42.80	85.80	92.30	62.60	45.00	55.10
88.1	59.00	102.80	45.30	42.80	42.30	38.70	37.60	22.80	26.90	35.10	44.20	23.40
88.2	34.20	44.30	37.10	54.40	39.70	54.40	73.10	36.00	37.00	41.30	61.00	79.40
88.3	41.60	27.50	17.80	30.10	47.90	29.00	24.70	42.80	41.30	40.60	29.60	23.40
88.4	39.10	51.10	61.00	67.80	61.50	33.30	41.20	28.10	44.20	75.20	33.10	45.50
88.5	16.20	23.80	21.30	36.30	43.00	19.70	43.70	22.70	26.10	35.90	52.40	66.90
88.6	50.60	48.10	60.90	62.60	50.70	57.00	111.20	80.90	86.70	56.60	52.30	38.10
88.7	47.60	94.80	33.90	36.50	49.10	-13.70	37.10	18.60	27.30	33.80	41.50	34.70
88.8	35.60	43.70	35.70	45.10	47.20	45.70	57.10	37.60	47.10	61.00	60.50	61.80
88.9	67.10	74.60	51.40	41.10	31.40	29.90	54.40	25.20	48.00	54.00	66.70	50.40
89.0	32.00	42.40	48.50	71.20	67.60	47.70	56.10	24.30	35.70	48.20	43.80	49.20
89.1	42.00	52.30	34.60	50.20	35.90	44.00	50.60	108.00	44.50	39.20	84.40	37.20
89.2	37.00	26.40	23.60	66.00	29.90	42.40	39.30	36.80	49.10	52.40	33.70	82.30

[Link chir + table](#)

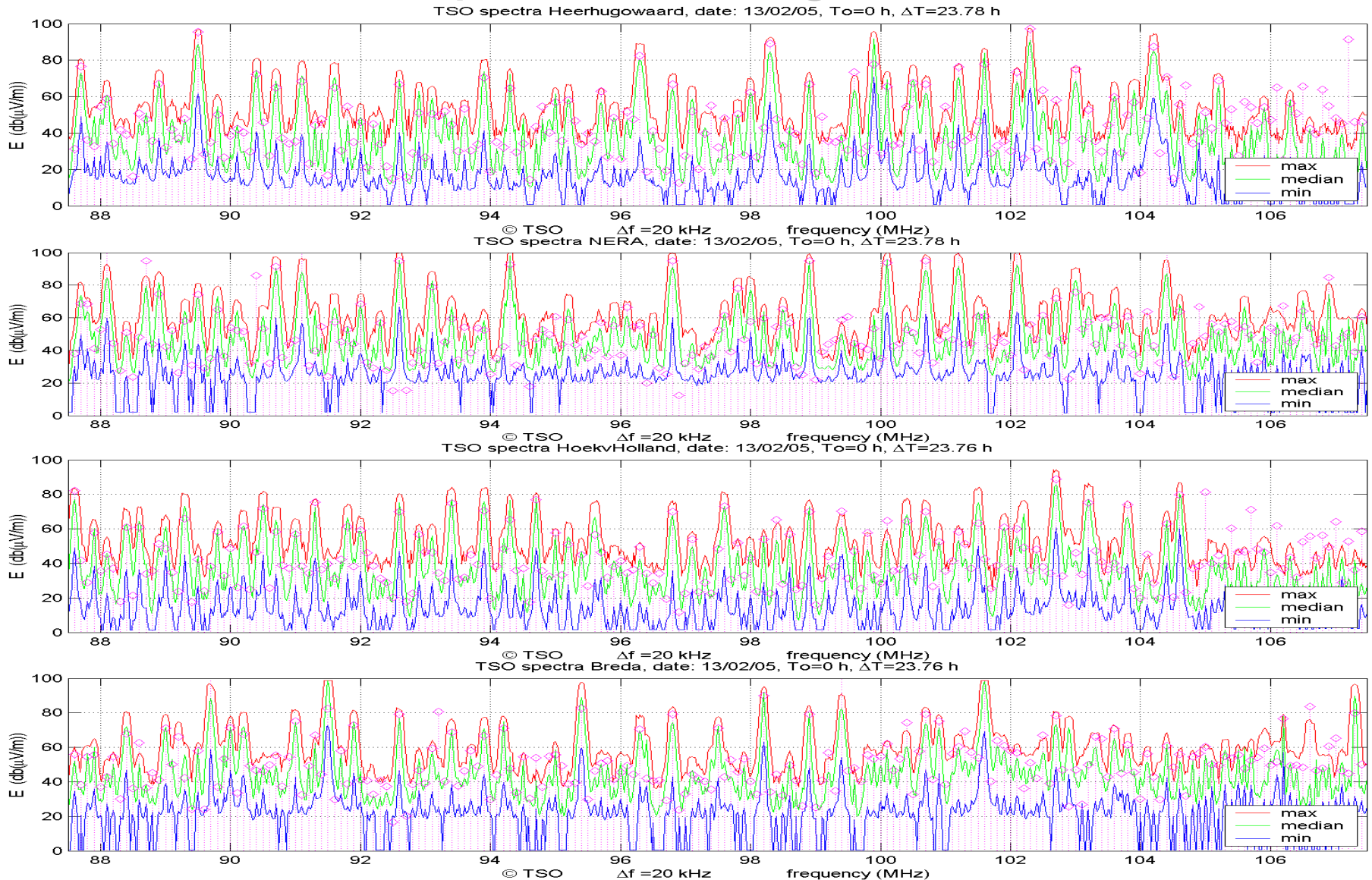
Remote Inspection using ITU-R SM.1809

Comparison of measured and calculated field strength in min/med/max plot

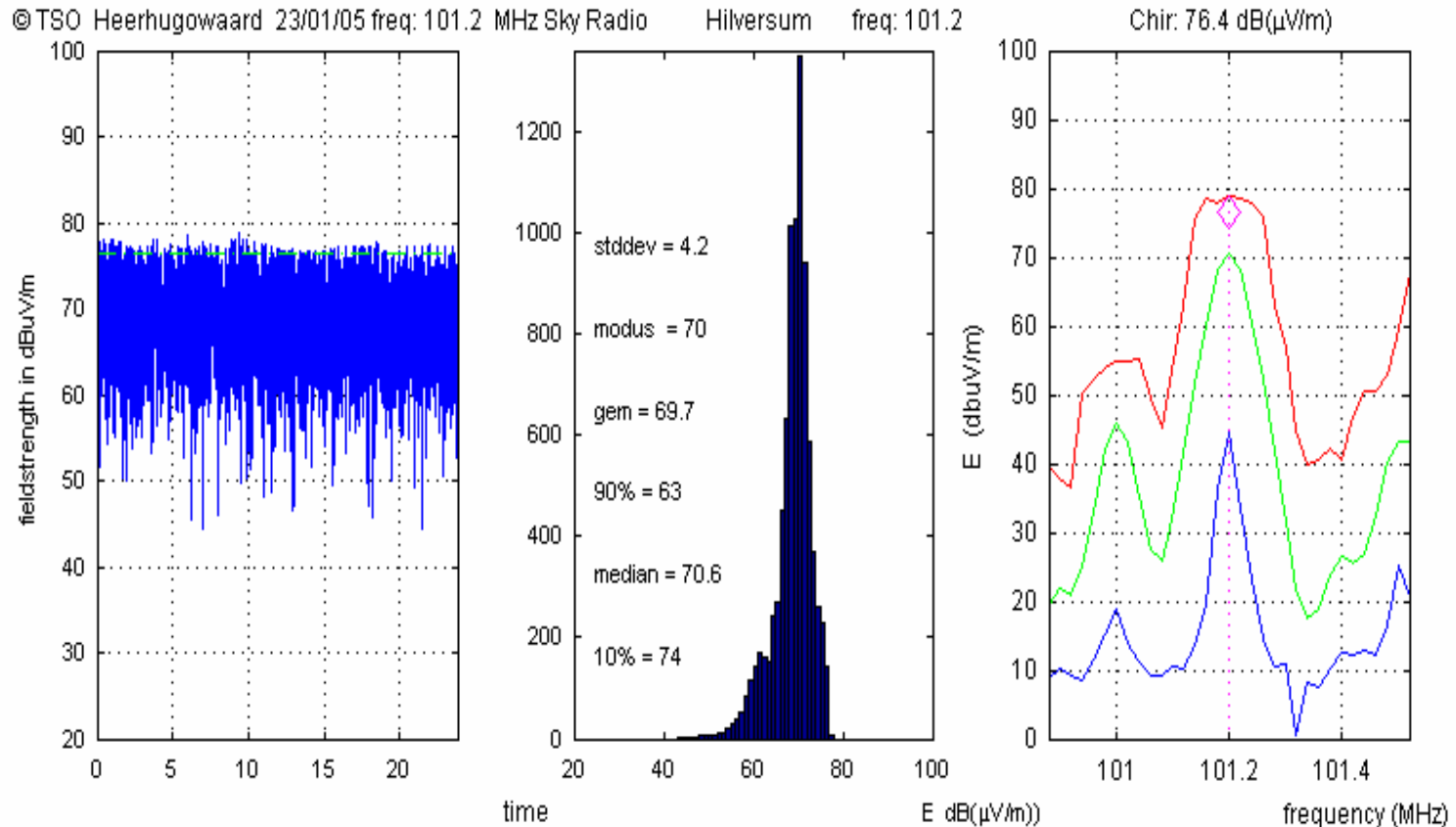


[Link to HTML plot](#)

Remote Inspection using ITU-R SM.1809



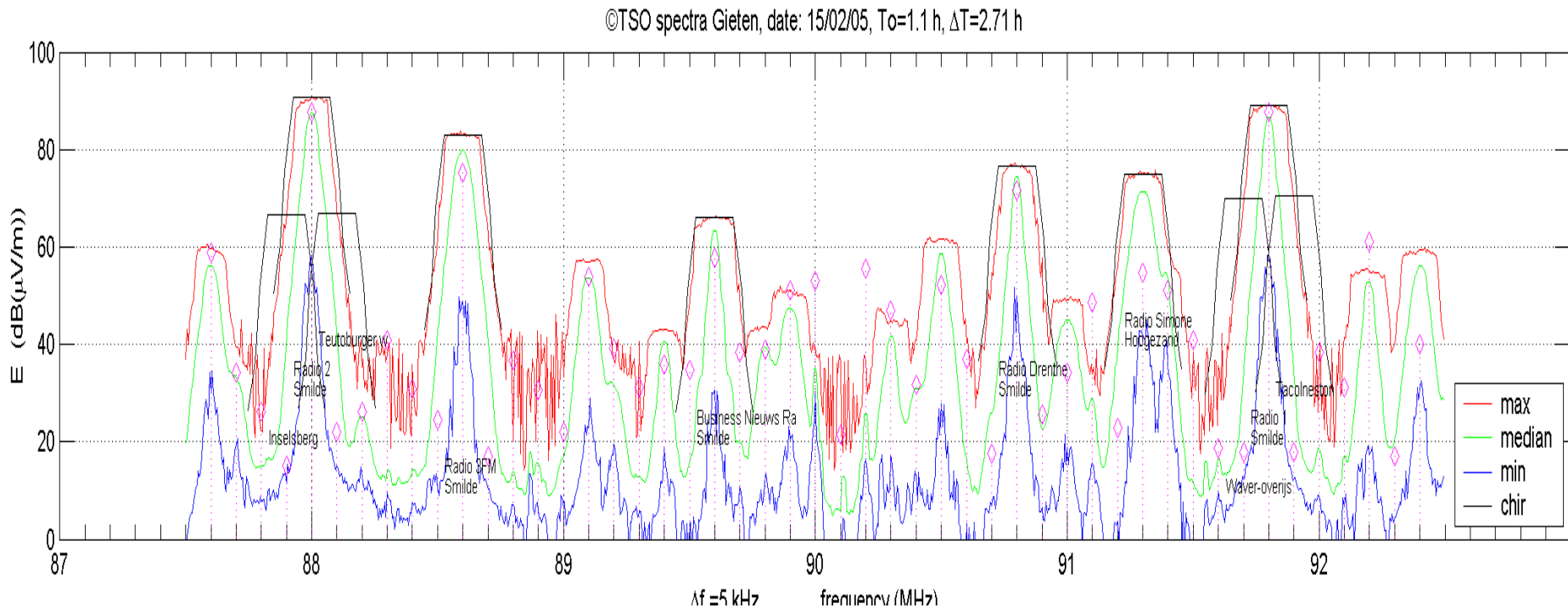
Remote Inspection using ITU-R SM.1809



[Link to TSO server](#)

Remote Inspection using ITU-R SM.1809

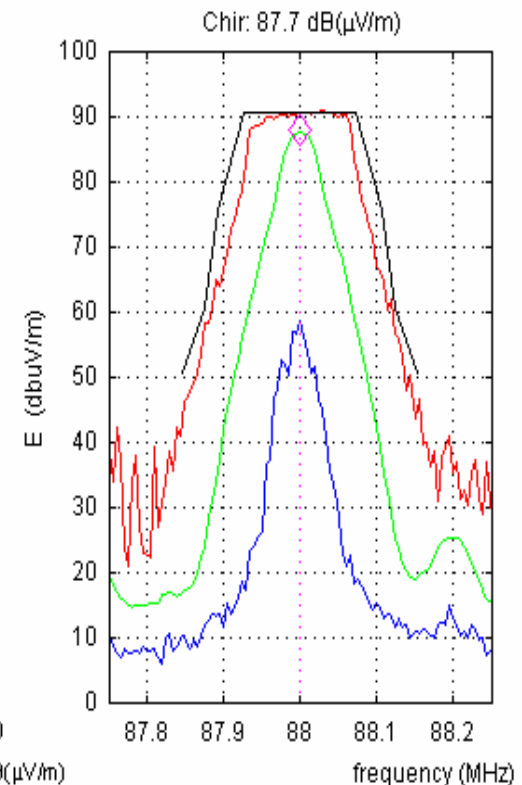
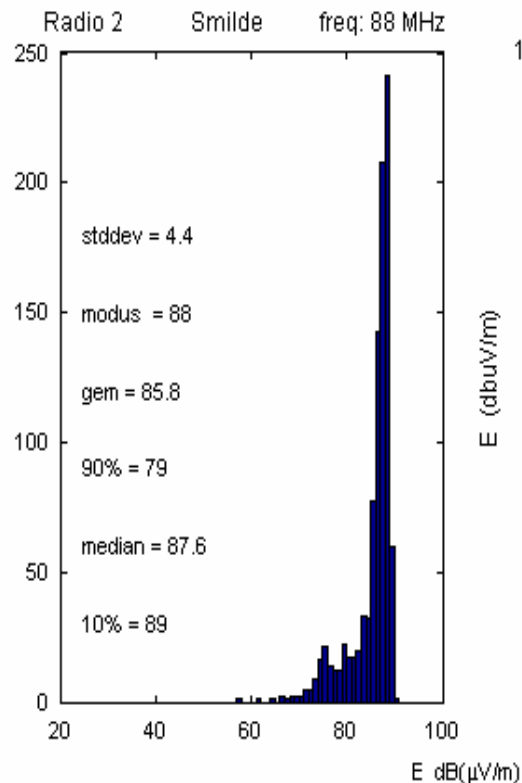
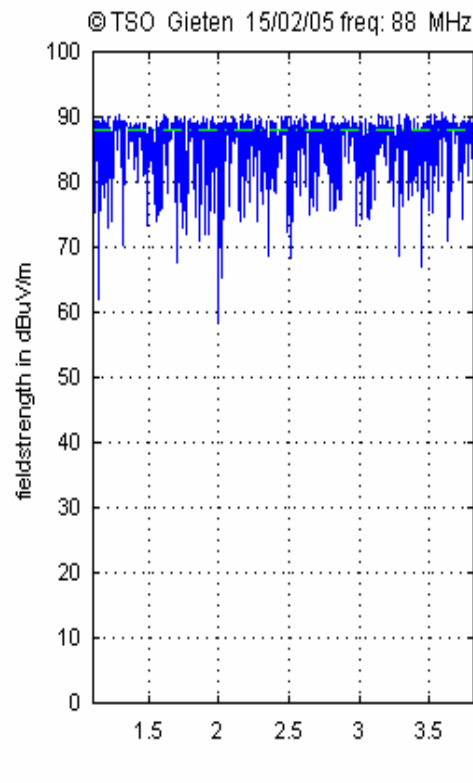
Simulation of spectrum mask measurements out of results from frequency band registrations



[Link to HTML plot](#)

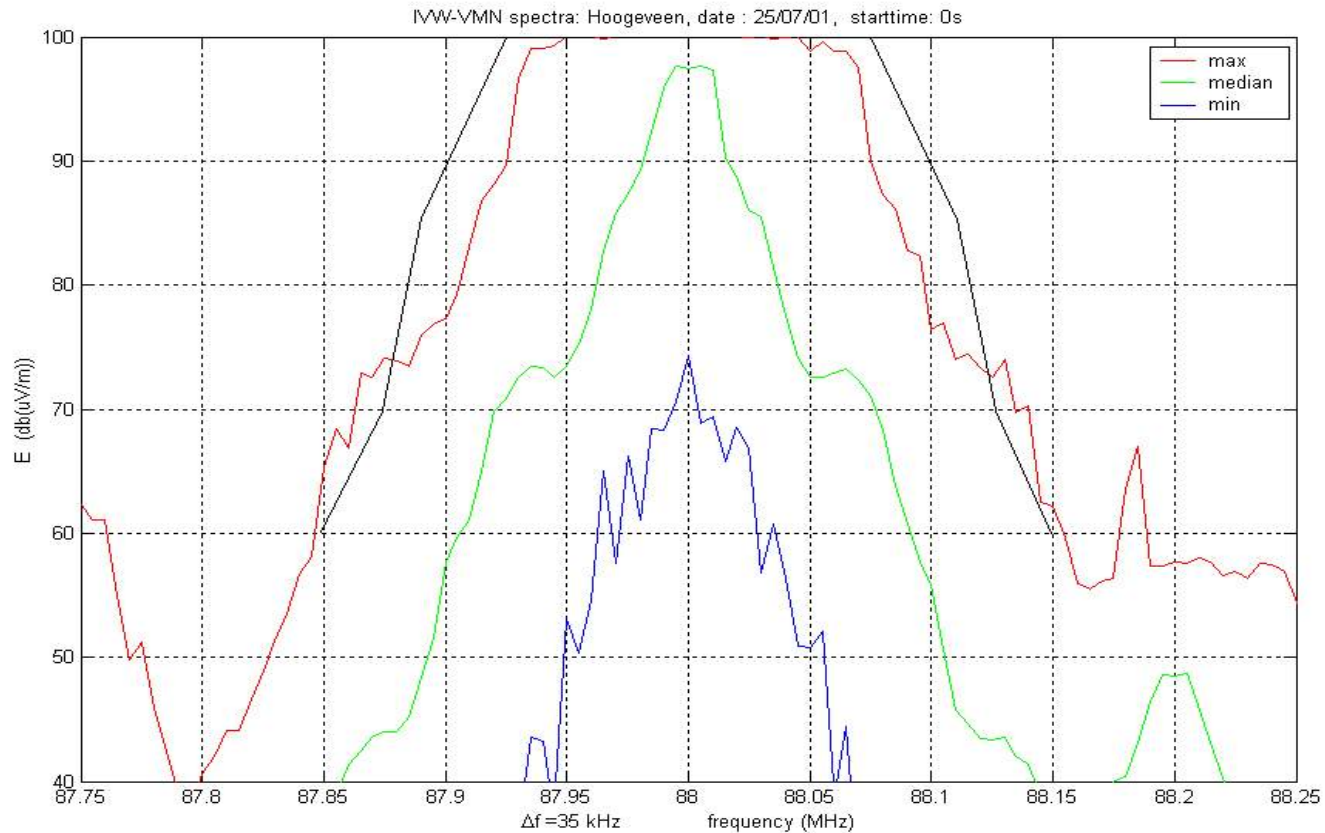
Remote Inspection using ITU-R SM.1809

Simulation of spectrum mask measurements out of results from frequency band registrations



Remote Inspection using ITU-R SM.1809

Simulation of Spectrum mask out of FBO, span 350 kHz



Remote Inspection using ITU-R SM.1809

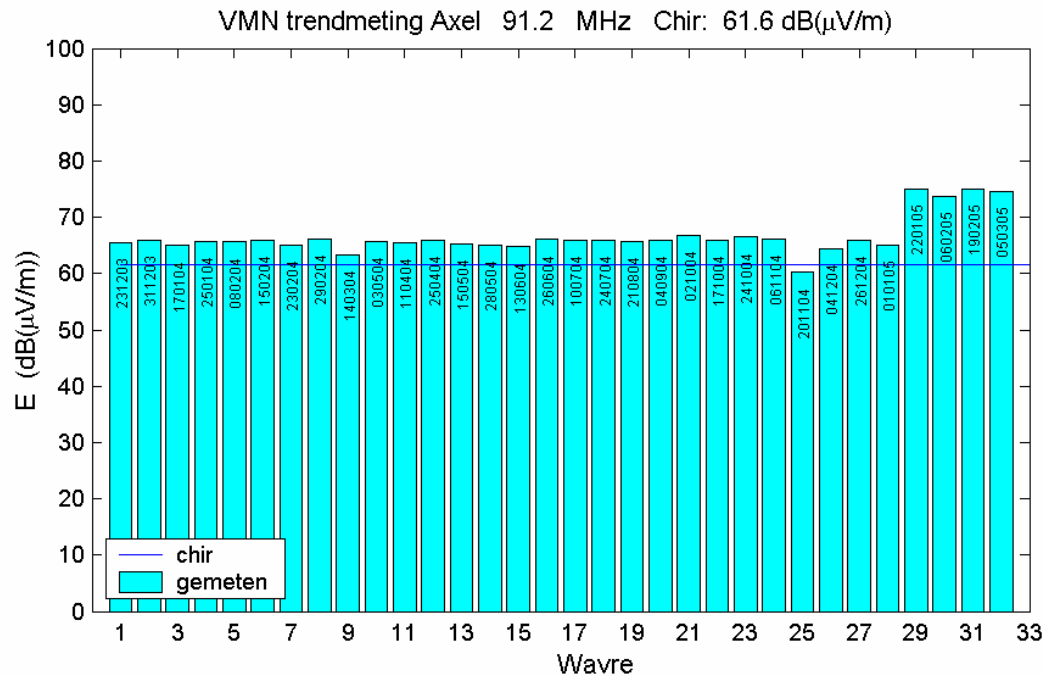
Mobiele Meetpost Lelystad 24-04-2004

freq.	station	location	chir	measured	Stdev	difference
87,6	Yorin FM	Smilde	32,3	47,4	8,2	-15,1
87,7	Yorin FM	Lelystad	96,4	83,3	3,5	13,1
87,8	Yorin FM	Utrecht	38,6	47,6	7,3	-9,0
87,9	Yorin FM	Den Bosch	28,6	29,2	5,6	-0,6
88,0	Radio 2	Smilde	61,0	53,2	5,2	7,8
88,1	Yorin FM	Hilversum	48,6	49,0	4,1	-0,4
88,2	Radio 2	Roermond	36,5	40,4	4,3	-3,9
88,3		Bremen	26,5	18,5	3,5	8,0
88,4	ID&T Radio	Roosendaal	36,1	30,1	7,1	6,0
88,5		Liege	15,7	20,1	4,6	-4,4
88,6	Radio 3FM	Smilde	56,7	48,5	5,2	8,2
88,7	Radio Noord-Hollan	Hilversum	49,8	43,6	4,2	6,2
88,8		Langenberg	39,9	16,0	4,6	23,9
88,9	Radio Noord-Hollan	Amsterdam	42,8	37,1	4,7	5,7
89,0	RTL FM	Lochem	35,2	24,9	6,6	10,3
89,1		Megen 1	42,0	38,1	5,5	3,9
89,2	Rebecca	Zwolle	42,6	45,8	3,8	-3,2
89,3	Rebecca	Lelystad	67,2	73,1	3,8	-5,9
89,4	Radio Oost	Losser	31,0	37,9	7,9	-6,9
89,5	RTL FM	Utrecht	40,9	43,2	4,6	-2,3
89,6	Business Nieuws Ra	Smilde	30,3	29,4	3,6	0,9
89,7		Muenster	34,0	40,4	12,7	-6,4
89,8	Radio Flevoland	Lelystad	96,8	89,2	4,2	7,6
89,9		Genk	27,3	42,9	10,8	-15,6
90,0	RTL FM	Loon op zand	33,7	28,3	5,4	5,4



Remote Inspection using ITU-R SM.1809

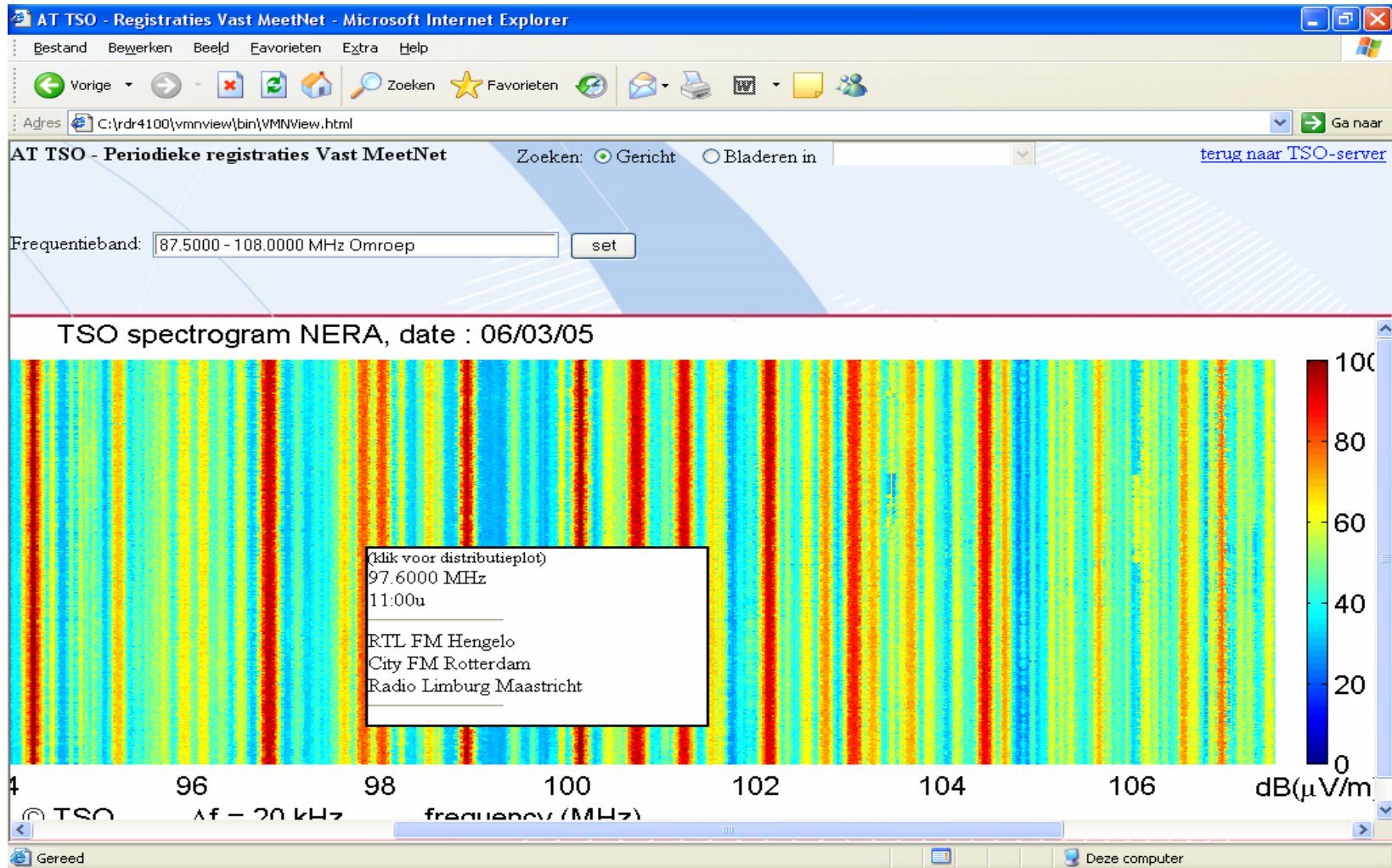
Historical Trends



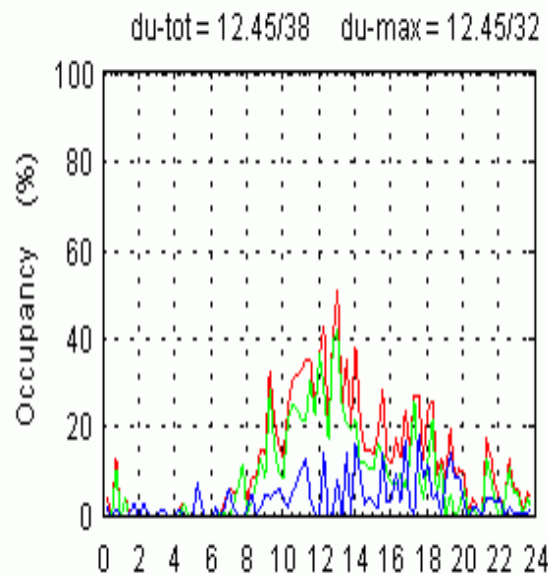
[Link to trend table](#)

Remote Inspection using ITU-R SM.1809

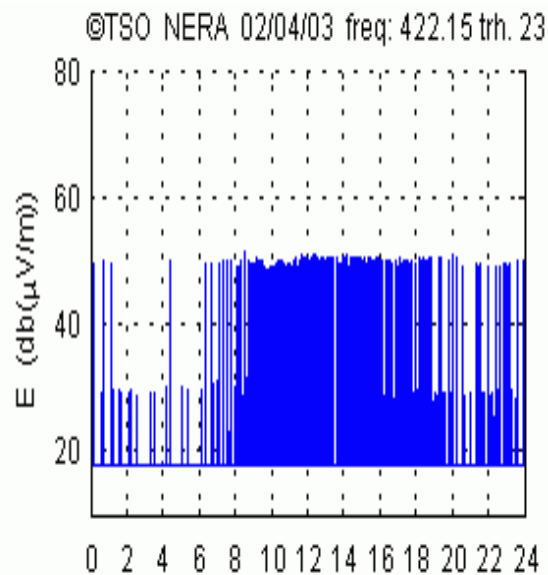
Identification



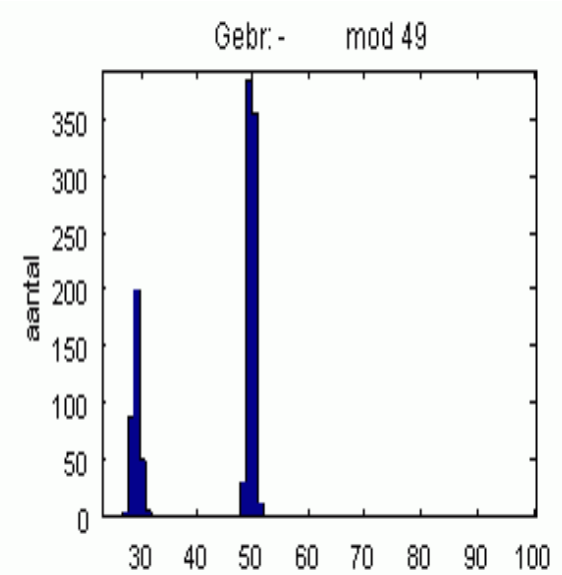
Remote Inspection using ITU-R SM.1809 processed as in ITU-R SM.1793



Occupancy over 24h



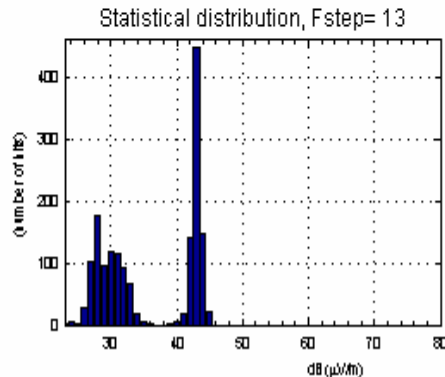
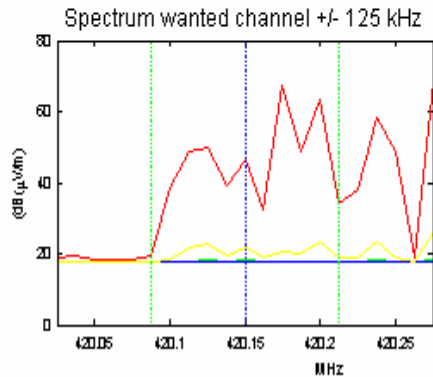
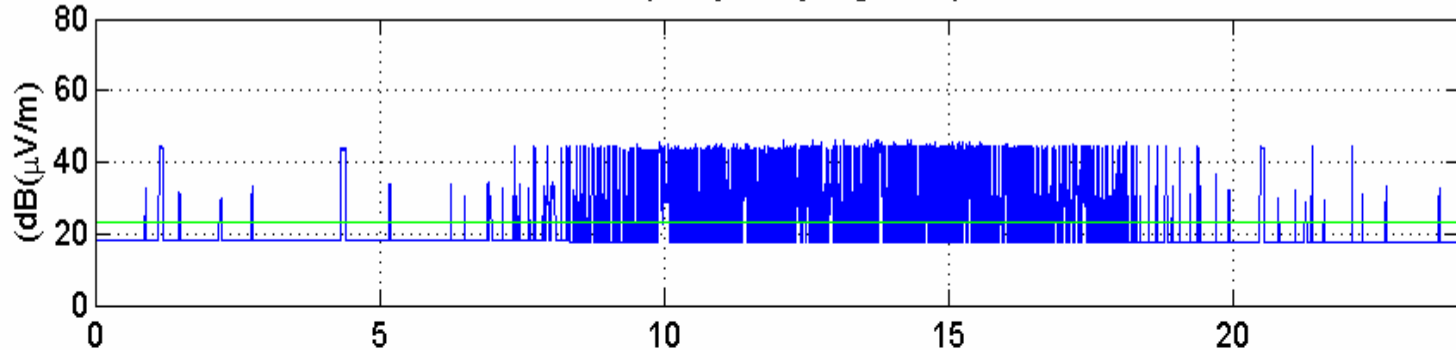
Field strength over time



Statistical distribution

Remote Inspection using ITU-R SM.1809 processed as in ITU-R SM.1793

© SMTA Bokwerd Channel Occupancy Analysing freq.: 420.15 MHz date: 02/04/03



Threshold : 23 dB(µV/m)
Step/Filter : 12.5/15 kHz
Occupancy : 18.8 %
Av. exc. tresh : 14 dB
Modus : 43 dB(µV/m)
Cumulative Occ. : 67.3 %
Av.Cum. Occ. : 5.2 %
Av.Occ.used ch. : 11.2 %
Total/used chan. : 13 / 6

Monitoring checks number of users on channel, compares theoretical and measured fieldstrength, etc. (1000 channels/day possible)

Inspection of Radio Stations SUMMARY

- Bandwidth and field strength (power) most important parameters for inspection
- Perform remote inspections if possible.
 - Minimum human labor
 - Hundreds of inspection per day
 - Very cheap(compared with on site inspections)
- In general: Don't do it on location when you can do it from remote

Inspection of Radio Stations

Thank You

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