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Exposure of the general public due to digital broadcast transmitters compared to analogue ones

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Motivation

- Coverage aims of DVB-T
  - portable indoor (small room antenna)
  - portable outdoor (small rod antenna outside the building)
  - fixed antenna (antenna on the roof of a building)

- FAQ on the official German website for the switchover to DVB-T

  “No. The digital broadcast requires lower transmitter power, so that the total exposure does not increase.” (source: http://nrw.ueberallfernsehen.de)

- Study: MiniWatt

  The digital signal experiences an attenuation through the wall which compensates the gain of digitizing.

=> Effect on the exposure situation is unclear!

General Aspects

- Time period for the project: October 2004 – March 2006
- General project steps
  - 1. Survey
    - Signal structures of DVB-T, DAB, Analogue-TV and FM-Radio
    - Comparison of the transmitter density and installed ERP
    - Calculation methods, international projects etc.
  - 2. Development of methods for the exposure estimation
    - Measurement equipment and parameters
    - Development of a simple calculation tool, comparing with other methods
  - 3. Exposure determination
    - Extensive measurements
    - Comparison of measurements and calculations

Initiation of DVB-T in Germany

Bremen
Hannover / Braunschweig
DVB-T since November 2004

Hamburg / Lübeck - Kiel
DVB-T since April 2005

Rostock / Schwerin
DVB-T since May 2005

Berlin
DVB-T since Oktober 2003

Ruhrgebiet / Düsseldorf
DVB-T since April 2005

Kassel
DVB-T since June 2006

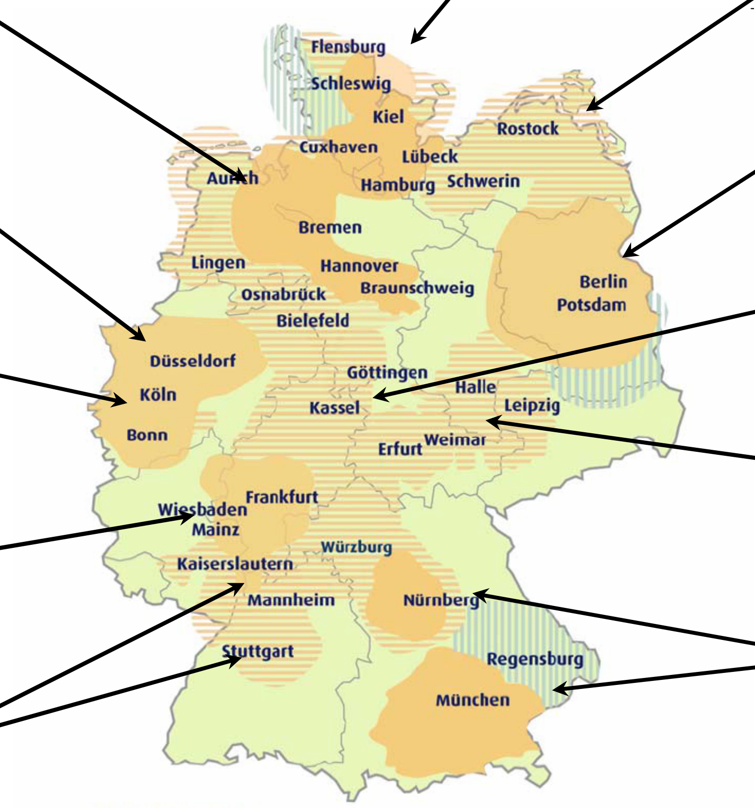
Köln / Bonn
DVB-T since November 2004

Halle / Leipzig
Erfurt / Weimar
DVB-T since May 2005

Frankfurt / Wiesbaden / Mainz
DVB-T since December 2004

Nürnberg
München
DVB-T since August 2005

Ludwigshafen / Mannheim
Stuttgart
DVB-T since June 2006



DVB-T on air | DVB-T on air (only public broadcast service) | DVB-T start planned in 2006

Source: http://www.ueberallfernsehen.de (May 2006)

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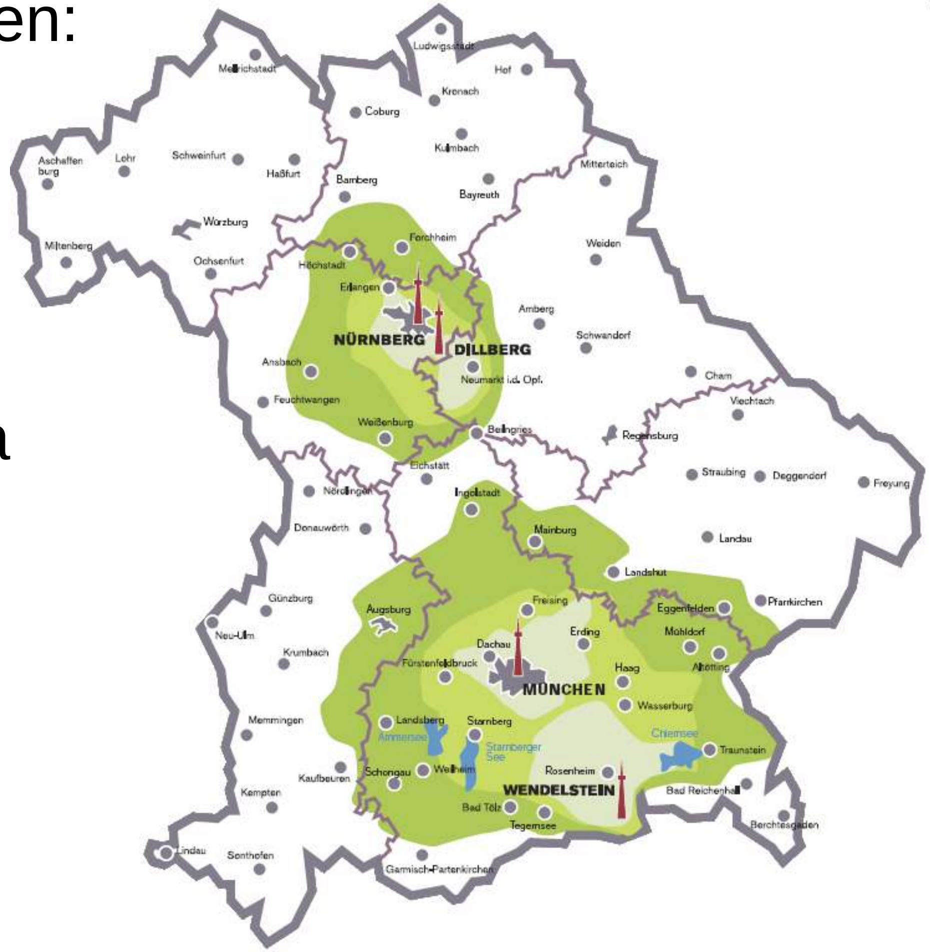
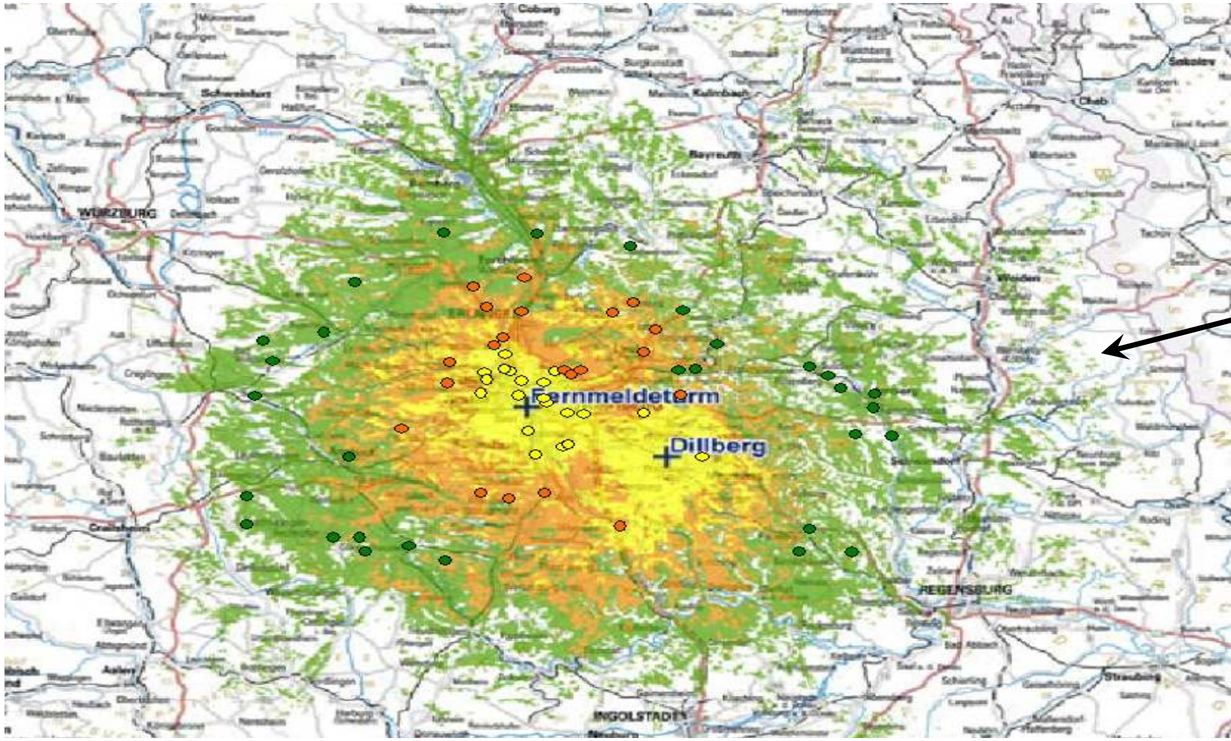
Exposure Measurement

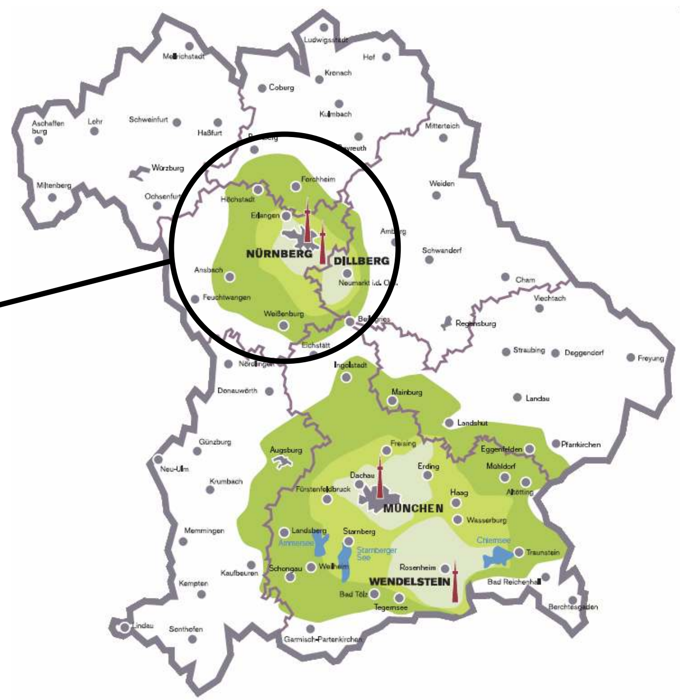
- Comparison of exposure between:
  - Analogue TV (before) with
  - DVB-T (after)
- Additionally FM-radio, DAB
  (simulcast situation)
- Before/after in the identical area
  - Direct comparison possible
  - Results not influenced by topographic or morphographic differences

**=> DVB-T start regions
North and South of Bavaria**



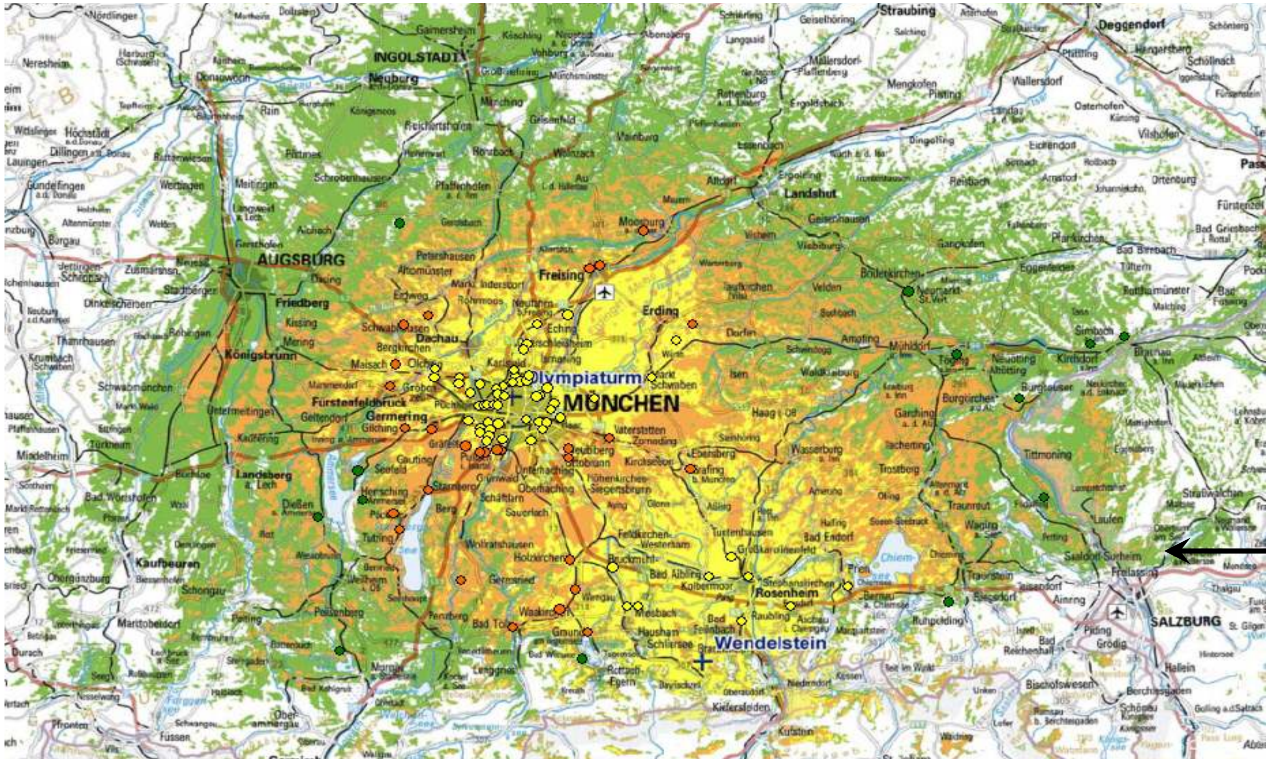
Measurement points: Start region Nuremberg

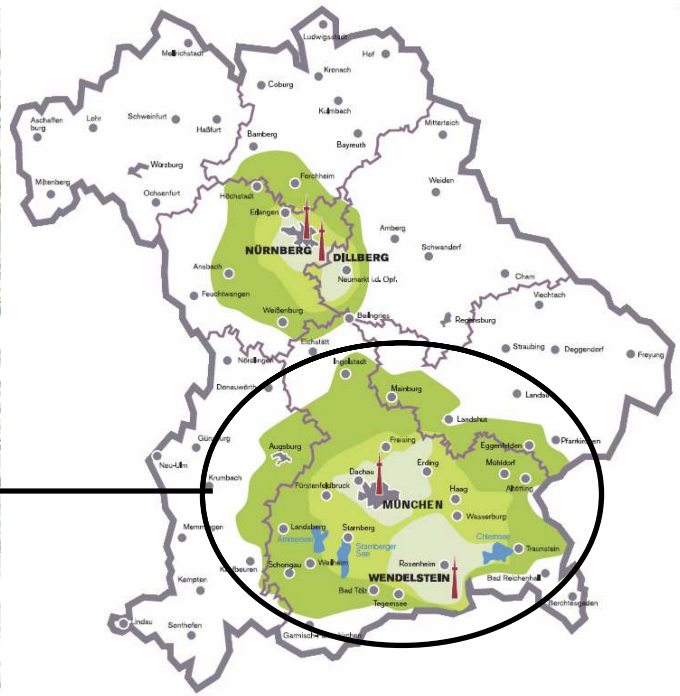




- 200 statistically distributed points in both areas
- Measurement point density proportional to population
- “Before” – “After” measurements at identical points

Measurement points: Start region Munich





- Statistically distributed points
- furthermore systematic measurements
  - "Line measurements"
  - "Height dependence"

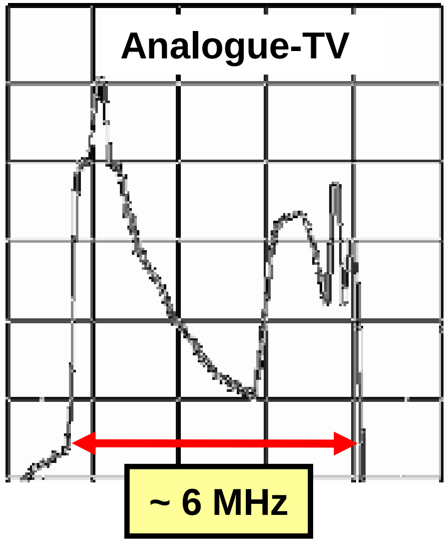
=> Altogether more than <u>300</u> points

Measurement settings: analogue

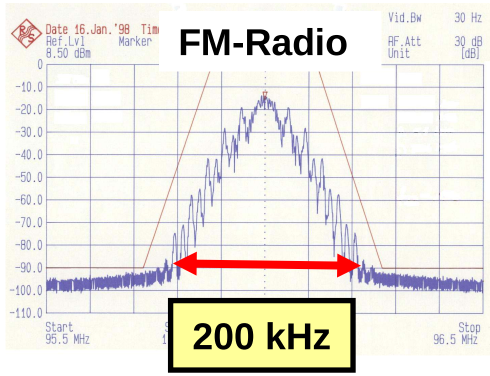
Measurement: Spectrum analyzer with peak detector

Analogue-TV:

- mixture of different signals
- mean exposure is dependent on transmitted information
- measurement of immission due to peak sync power
    - reduction of 2.3 dB (Worst Case)
    - reduction of 4 dB (typical screen content)



	Detector	RBW	Sweep time
Analogue – TV	Peak	0.3 – 3 MHz	Not critical
FM-Radio	Peak	200 kHz	Not critical



Measurements were accomplished with SRM-3000 from Narda

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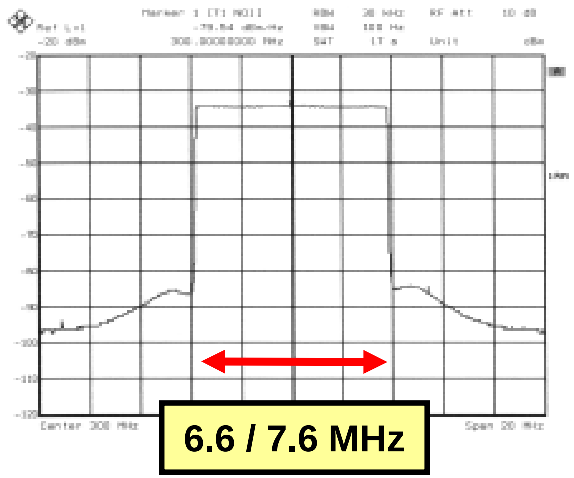
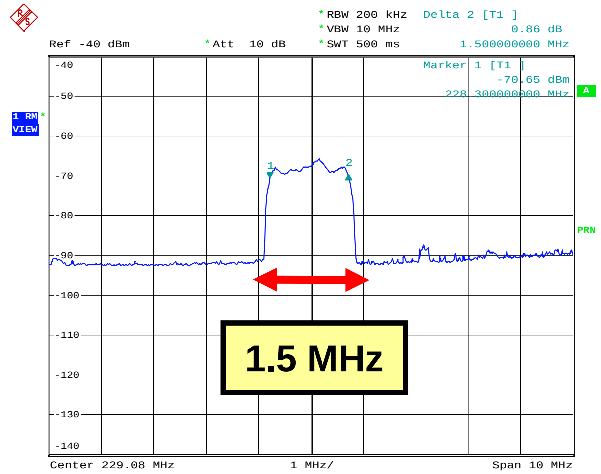
Measurement settings: digital

Measurement: Spectrum analyzer with RMS detector

DVB-T and DAB:

- peak detector overestimates in dimension of the crest factor (10 – 12 dB)
- too small sweep times lead to overestimations
- too small RBW lead to underestimations (option: measurement value increased with a correction factor)

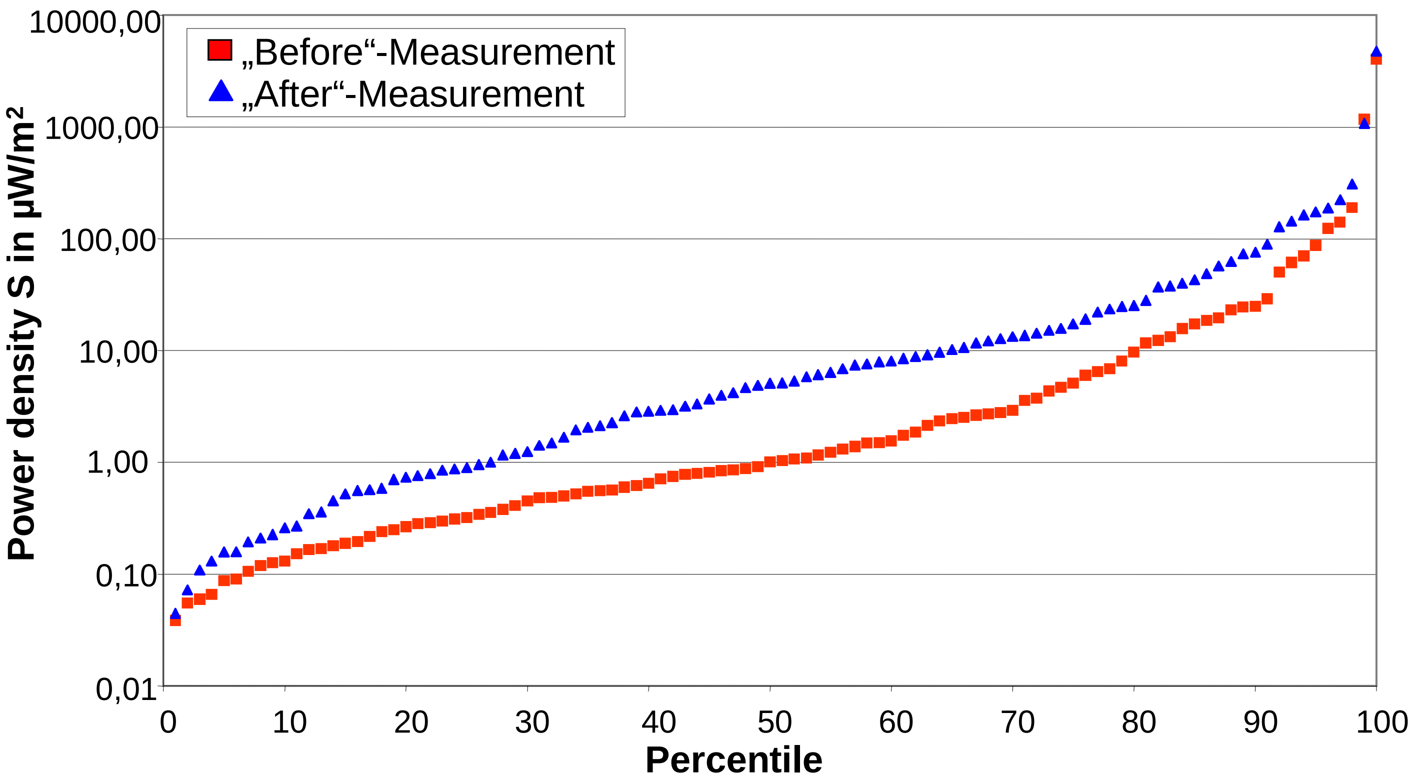




	Detector	RBW	Sweep time
DVB-T	RMS	6.6 / 7.6 MHz or correction	100 – 200 ms
DAB	RMS	1.5 MHz or correction	100 – 200 ms

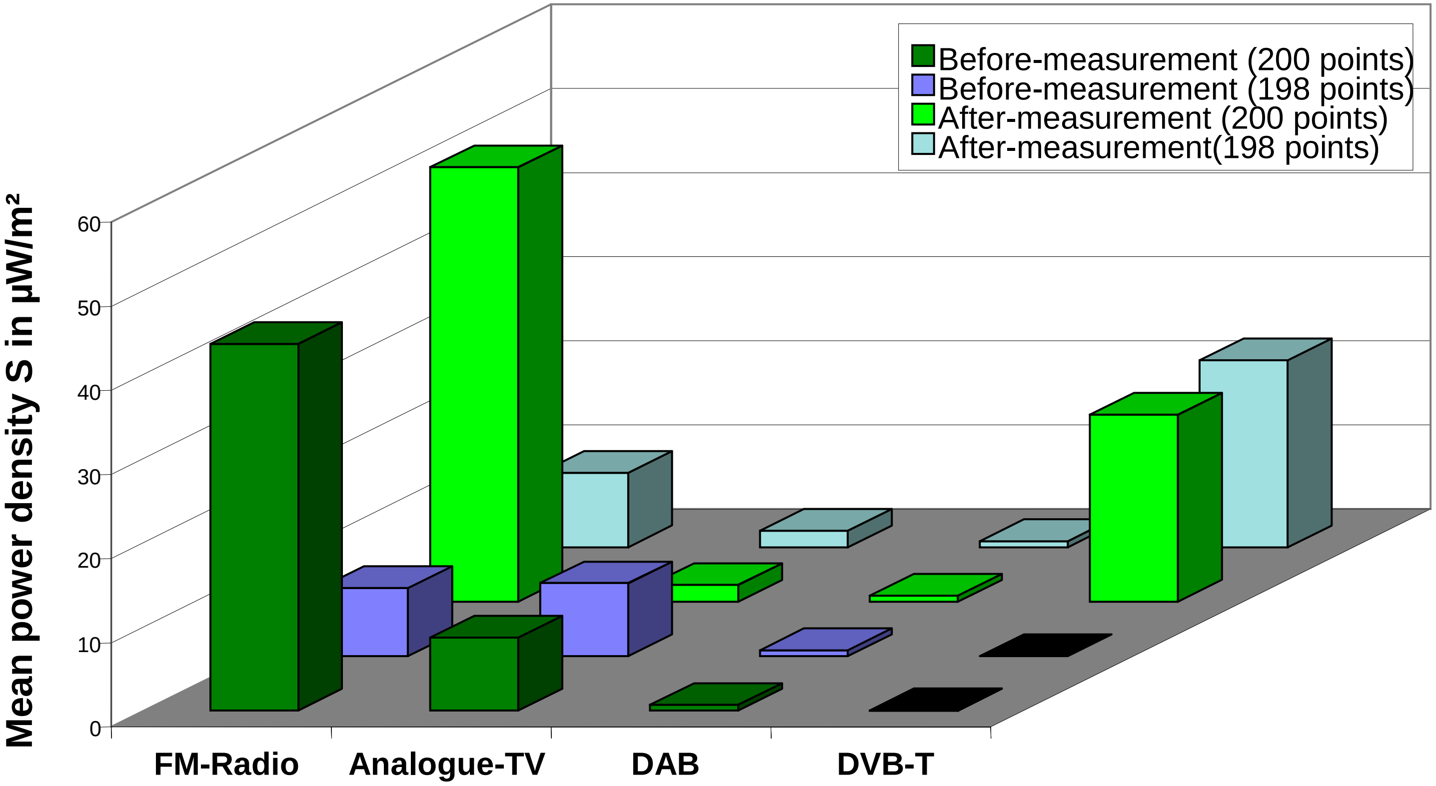
Measurements were accomplished with SRM-3000 from Narda

Total Immission



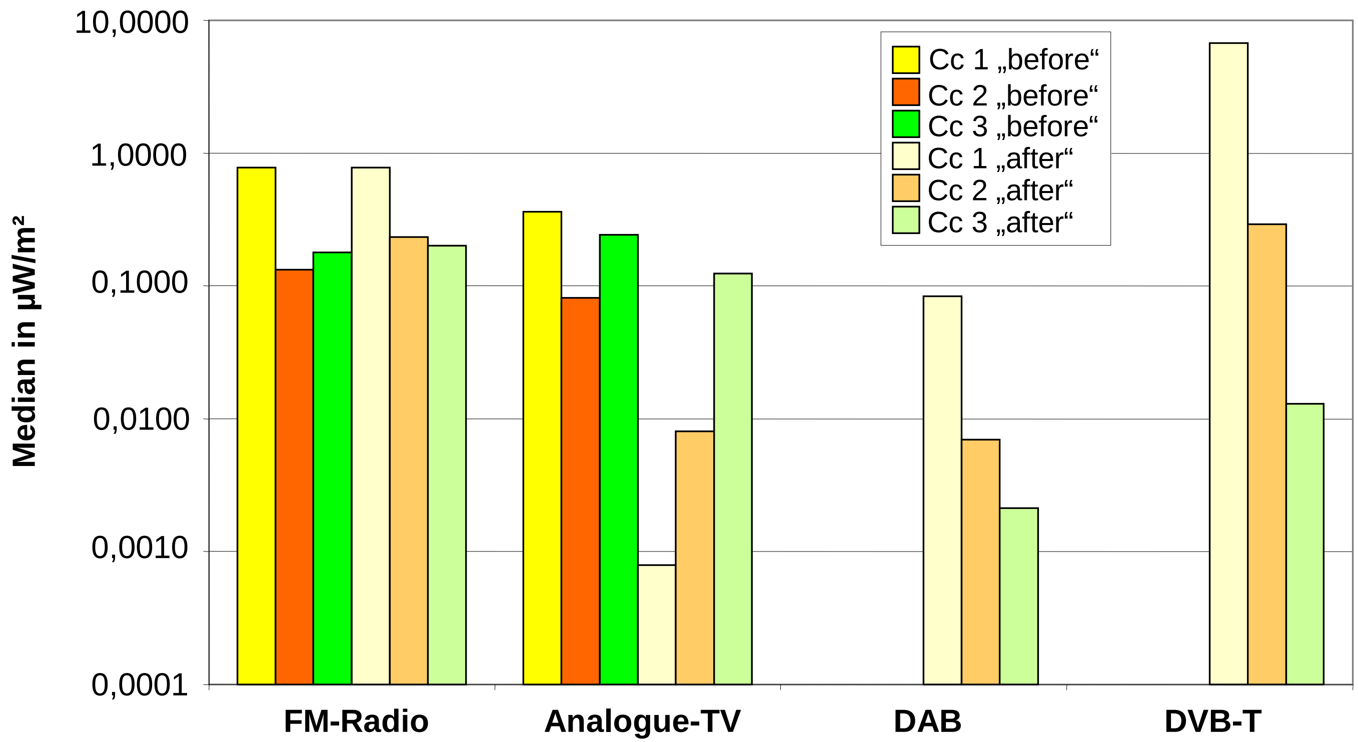
- Exposure values have a big dynamic range of more than 50 dB
- Point with highest sum exposure shows only 0.3 % of allowed limits (power density)
- Increase of total exposure after the switchover to DVB-T

Immission: single services



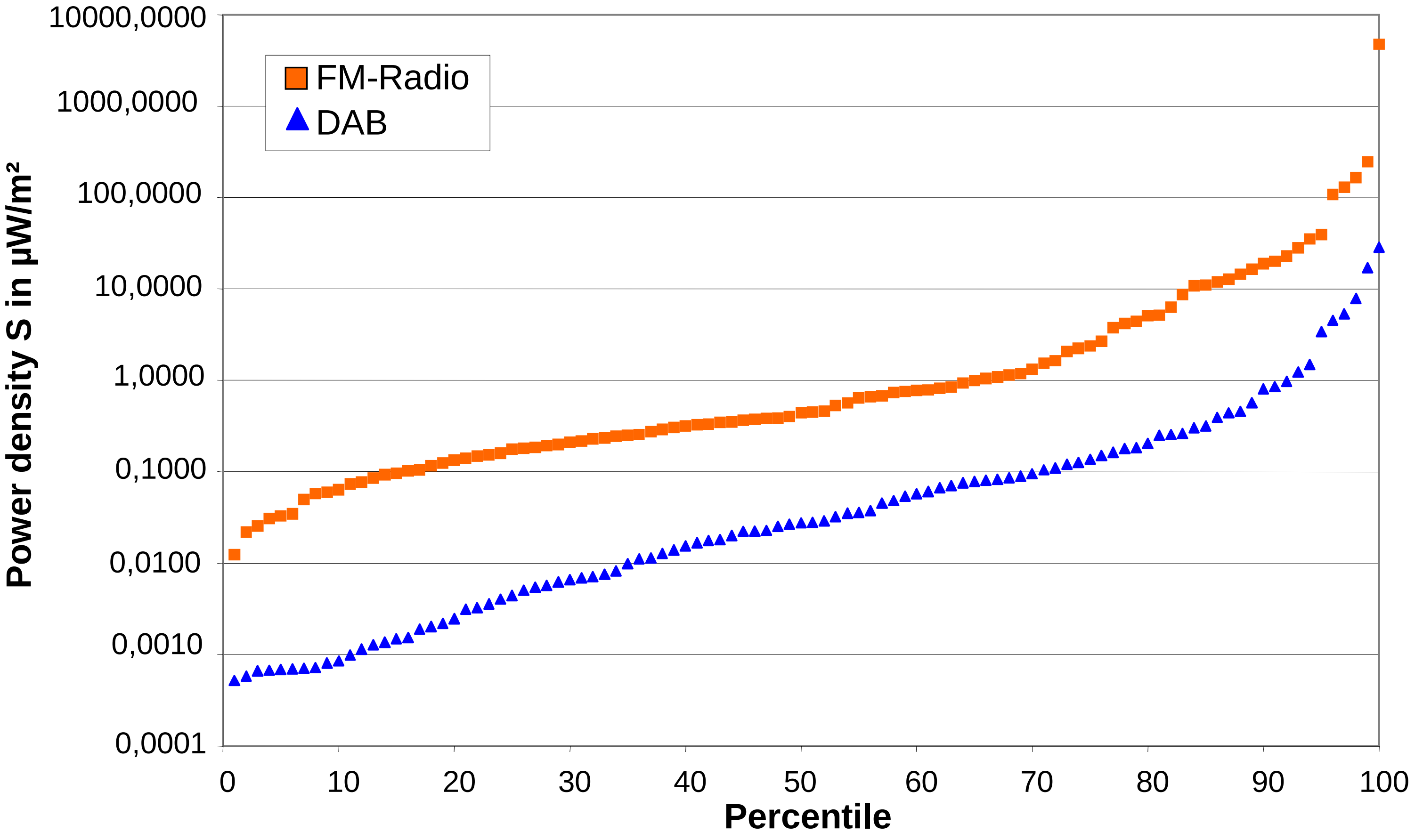
- Mean Power density is not a good indicator to determine mean exposure
- Median value is much more better

Median - Exposure



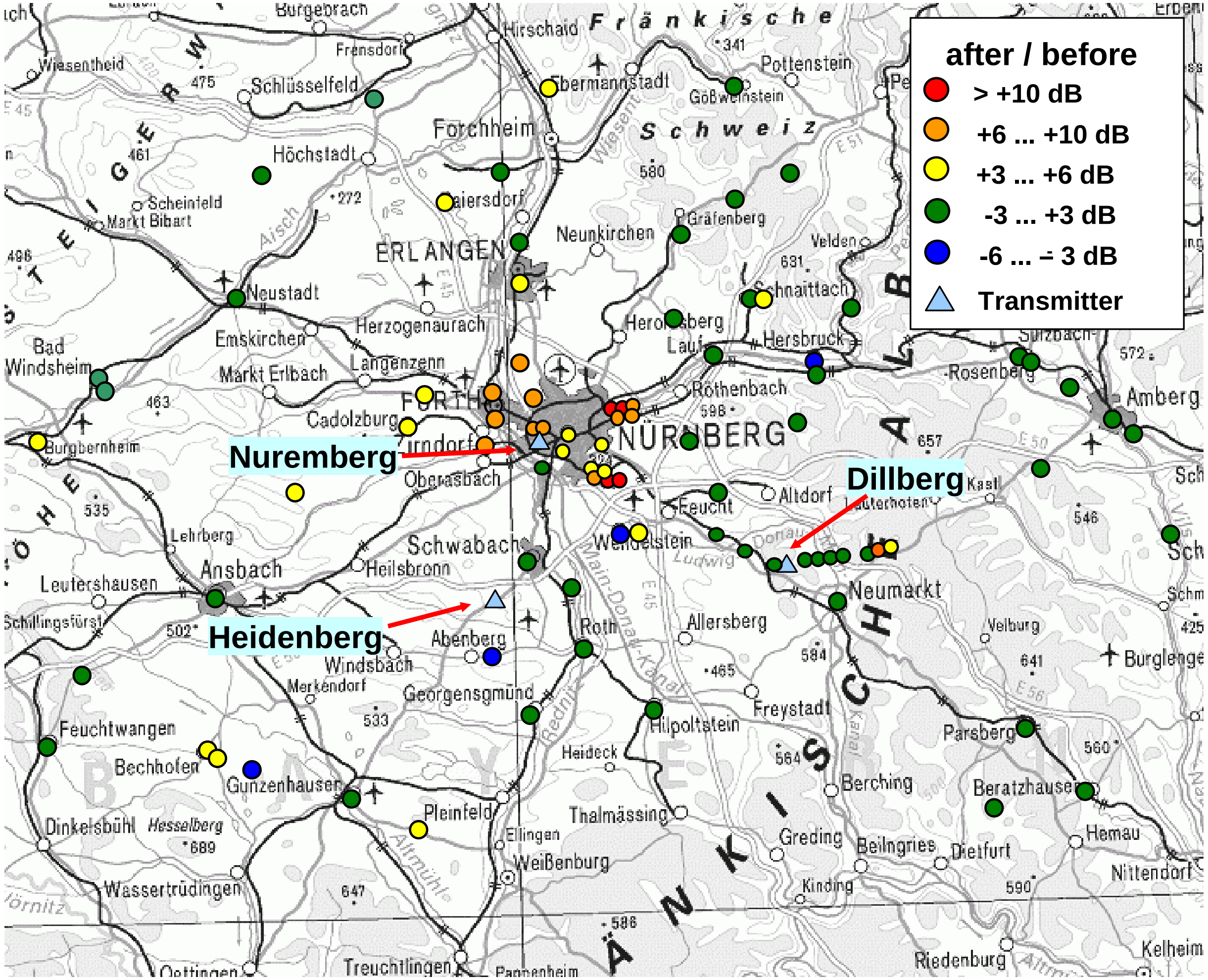
- Decrease of the median values from DVB-T from 1st coverage class to 3rd
- FM-Radio and analogue-TV show a more uniform distribution
- Exposure comparison only representative in “portable indoor” region

DAB vs. FM-Radio



- Difference from FM-Radio to DAB is 11.3 dB
- Increase of transmitter power for DAB will reduce the dominance of FM-Radio

DVB-T start region Nuremberg



„portable indoor“ region:

1. Region (Nuremberg, Erlangen, Fürth)

   Mean increase factor: 6.8 dB

   => Displacement of TV-Transmitter

2. Region around Dillberg

   Moderate increase of 1.5 dB

Outside „portable indoor“ region

NO significant change of mean exposure

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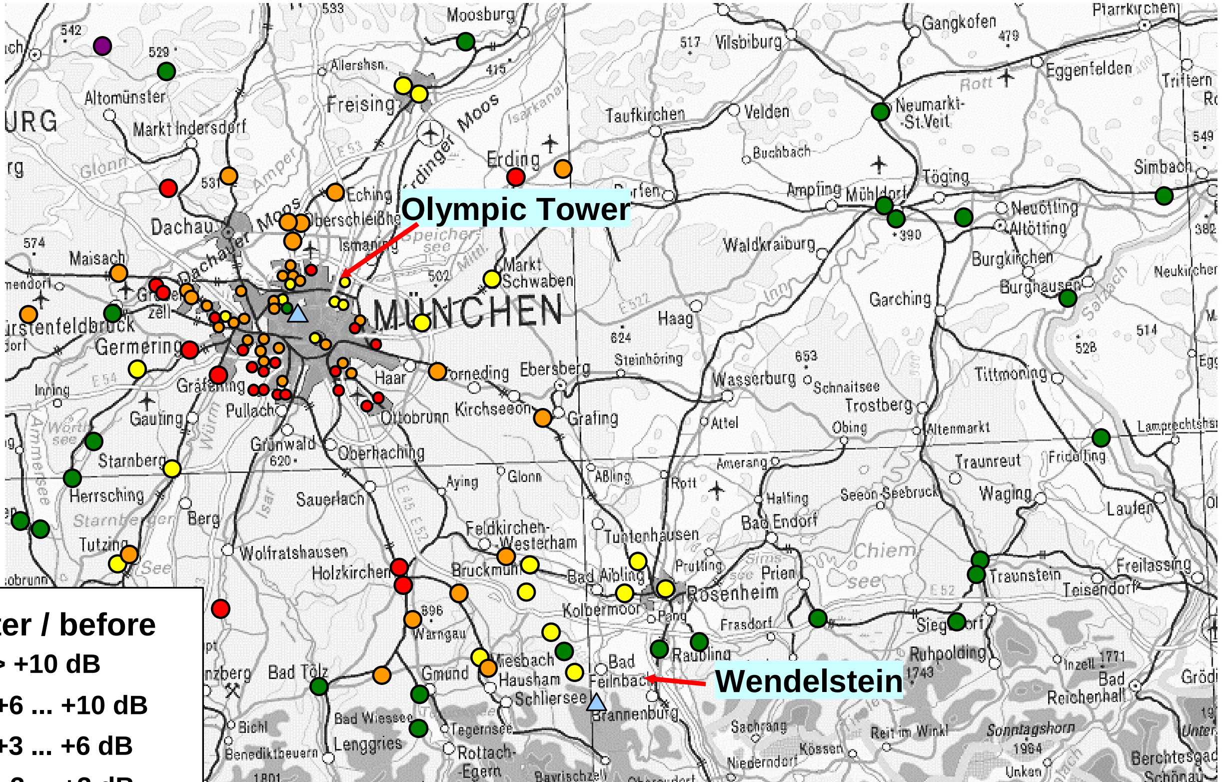
DVB-T start region Munich



after / before

- > +10 dB
- +6 ... +10 dB
- +3 ... +6 dB
- -3 ... +3 dB
- -6 ... -3 dB
- < -6 dB
- Transmitter

„portable indoor“ region:

1. Munich, neighbourhood counties up to the Wendelstein mountain:

   Mean increase factor: 6.5 dB

   => increase of ERP

   increase of antenna height at the Olympic tower

Outside „portable indoor“ region

NO significant change of mean exposure

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Summary of Exposure measurements

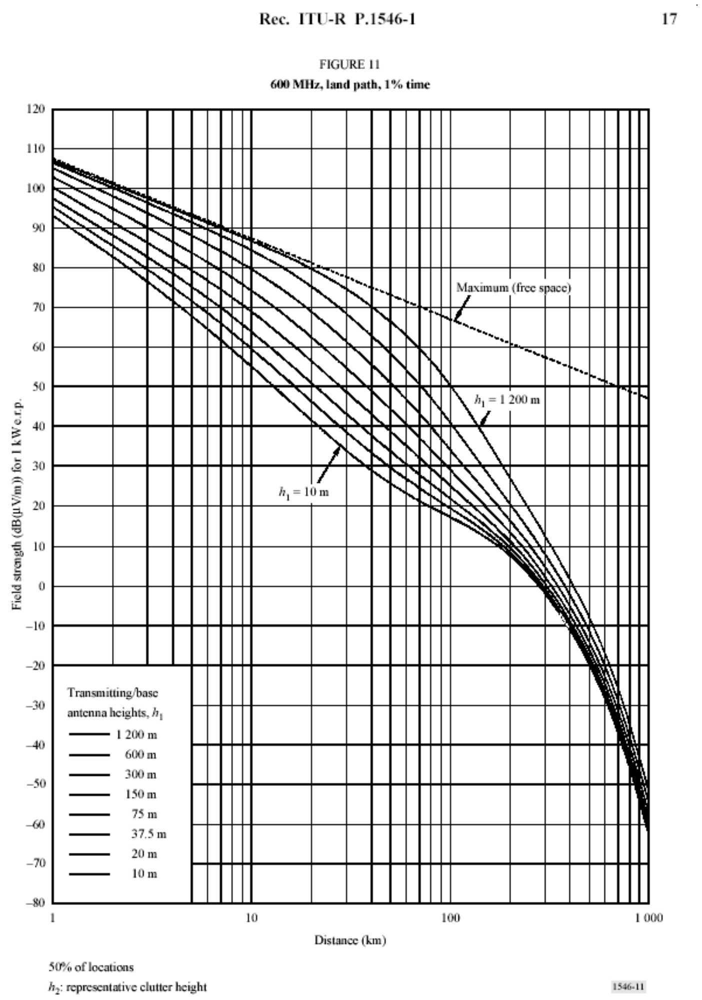
- Exposure values have a large dynamic range of more than 50 dB
- Only 0.3 % of the maximum allowed level (power density) was reached at point with largest sum-exposure
- Mean increase of the exposure values in “portable indoor” region (BUT: different factors: increase of ERP; displacement of transmitters; change of antenna height)
- Change of ERP at the transmitter of the considered region can be taken as a coarse indicator for the mean change of exposure (e.g. Dillberg: ERP increase = Exposure increase)
- DVB-T does not increase the exposure in general (ERP reductions were shown in Berlin and Bremen)
- The kind of exposure changing in the border areas can not be predicted yet (exposure is caused by further main analogue transmitters outside)

Comparison Measurement - Calculation

Developed calculation method:

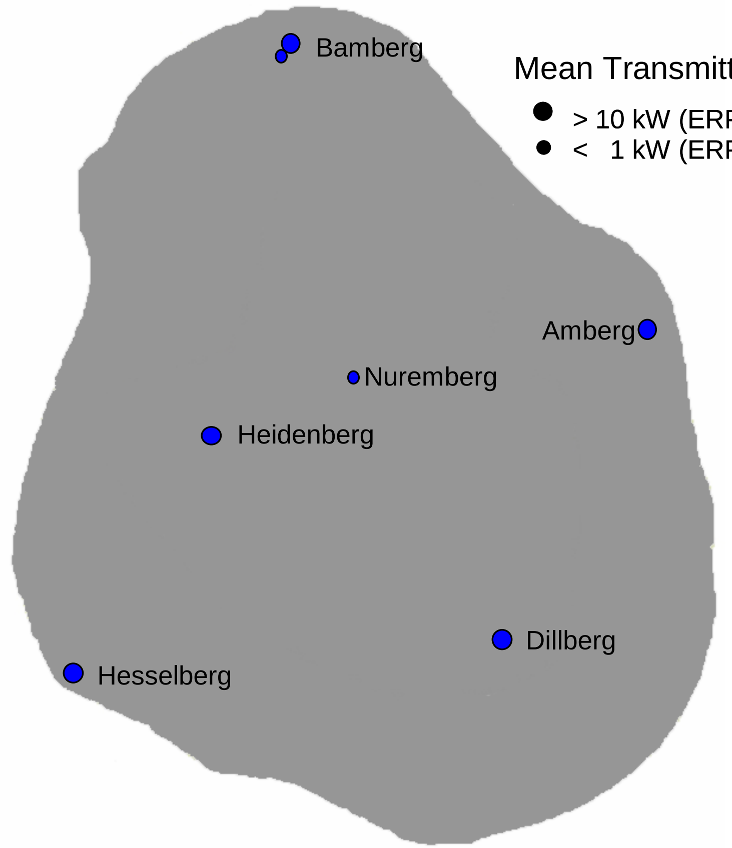
FPT (Field Prediction Tool)

- based on ITU-R P.1546 (propagation curves)
- only a few input parameters
  - Transmitter power (kW ERP)
  - Antenna pattern (only horizontal)
  - Transmitter height over ground
  - Effective antenna height (-> here: mean height in all directions)
  - Correction factors for receiving antenna height depending on the configuration
    - dense urban area
    - urban area
    - suburban area
    - land

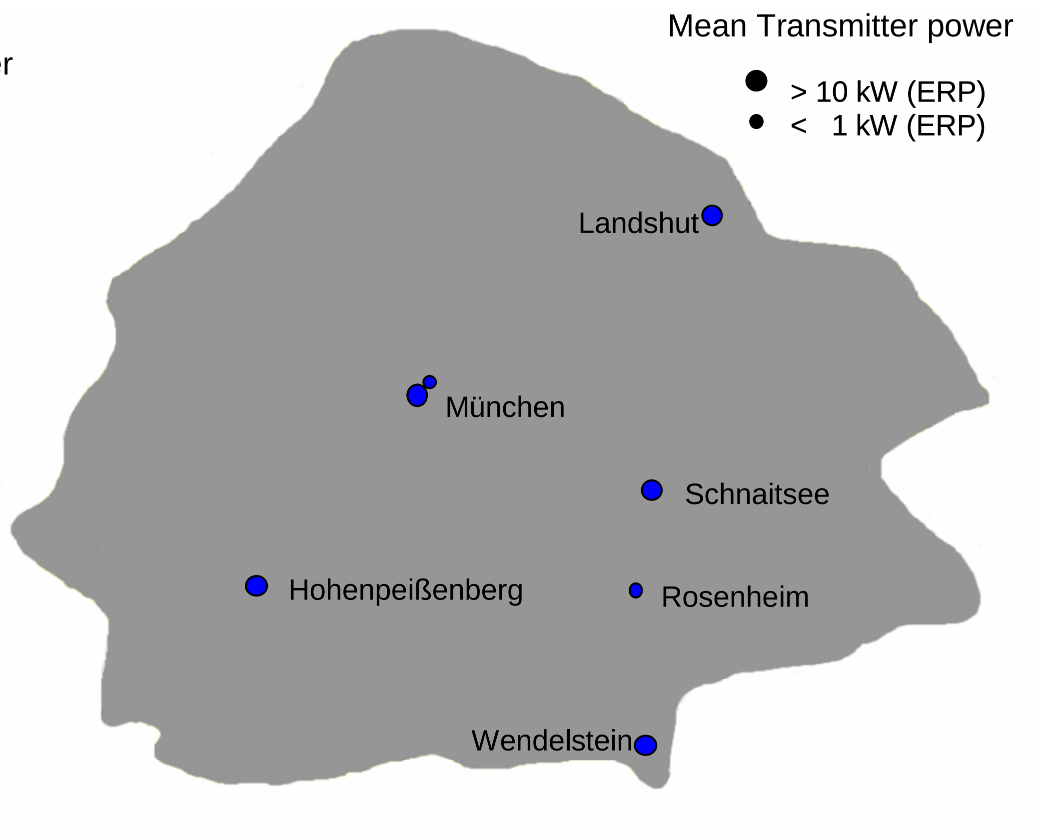


Measurement-Calculation: Analogue - TV

DVB-T start region Nuremberg



DVB-T start region Munich



=> 1135 points for the comparison between measurement and calculations for analogue-TV

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Calculation results for analogue TV

Configuration	Correction for rec. antenna height	Number of points	Mean deviation in [dB]	Percentage of points with overestimations
all	yes	1135	12.9	27.8
all	no	1135	24.8	96.2

1. Optimization for a small mean deviation
   - Mean deviation for all configurations is 9 dB
   - In 78% of all cases show only a difference of ± 3 dB
2. Optimization for a high percentage of points with an overestimation
   - 100 % overestimations for the background of measurement uncertainty
   - suitable as Worst Case method
   - But: high mean deviation of 30 dB

Same procedure for DVB-T, FM-Radio, DAB (country-wide and local)

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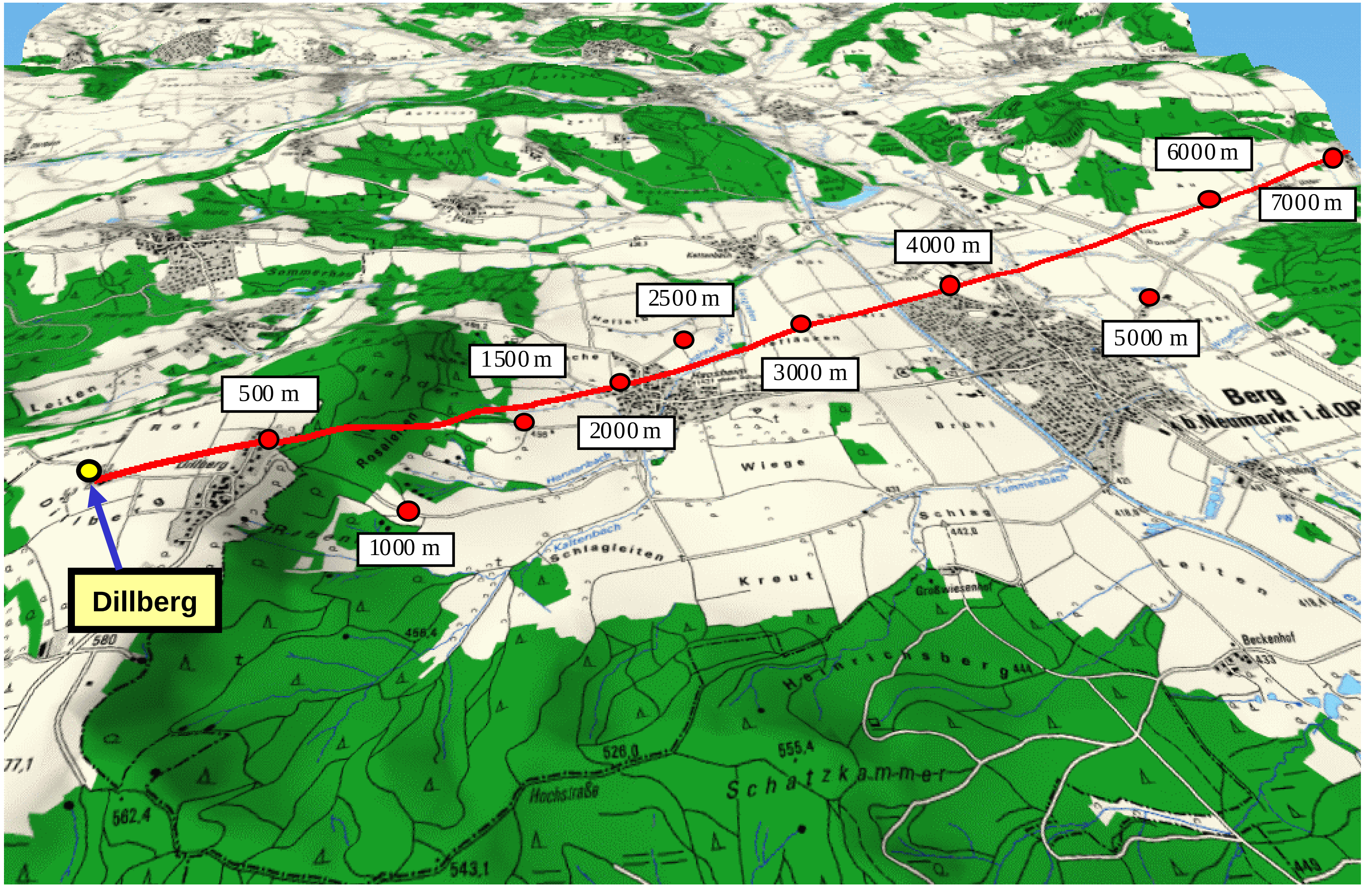
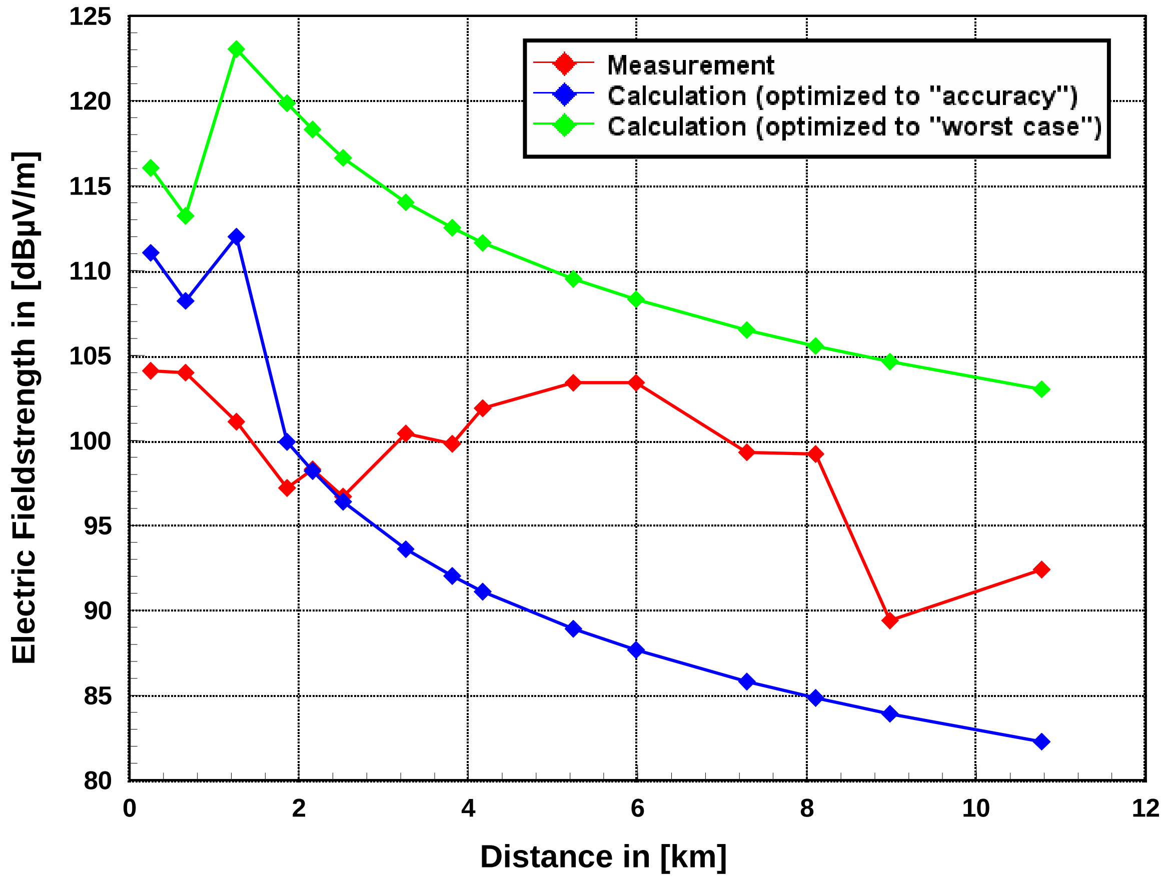
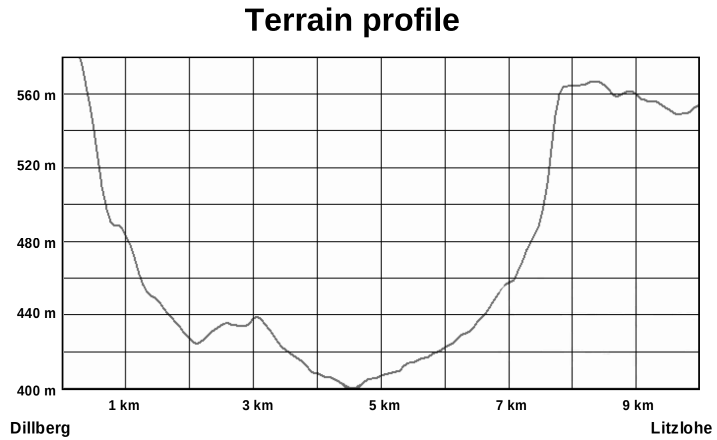
Line Measurements



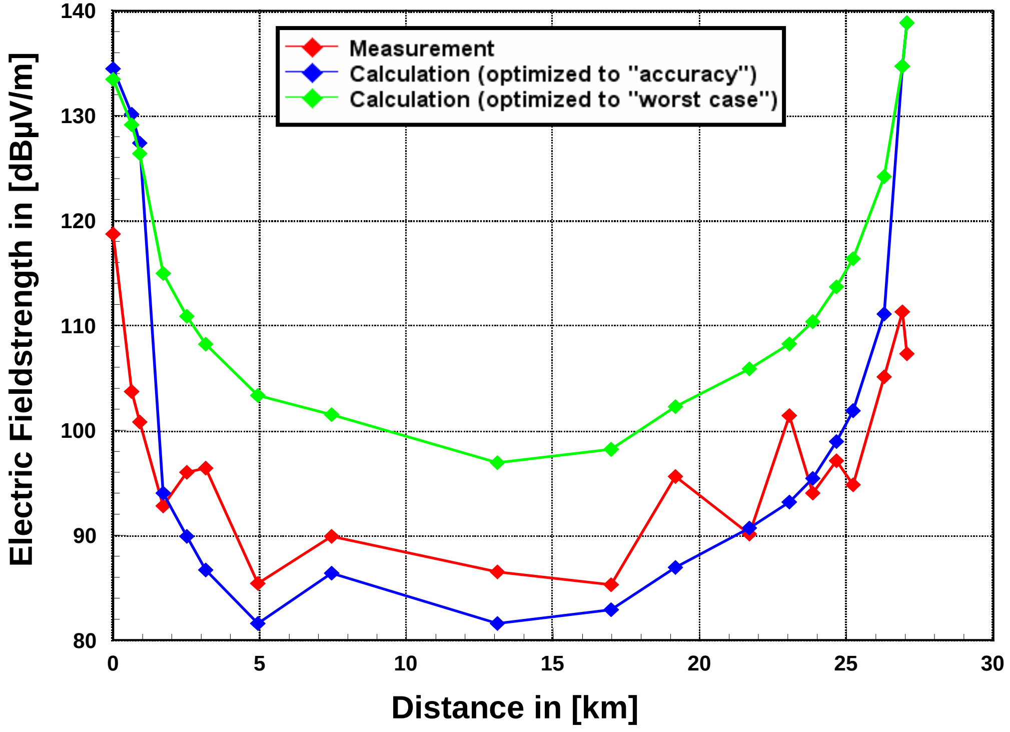
Line-Measurement: FM-Radio

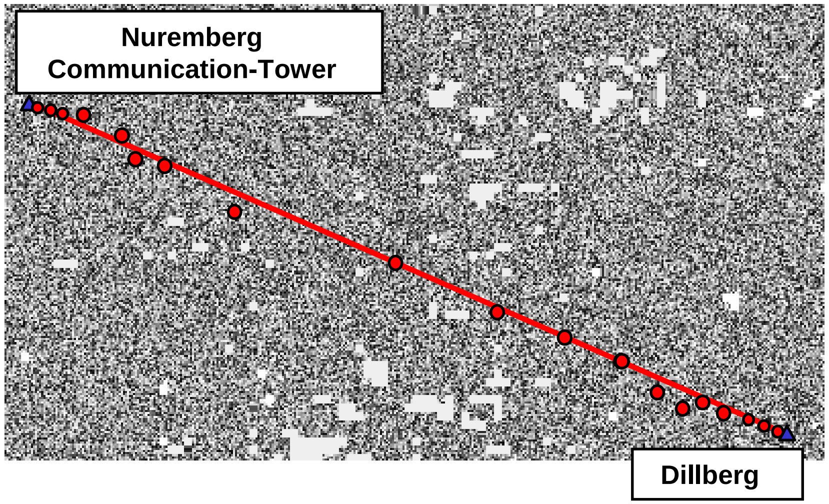




⇒ Representation of the terrain height with only ONE value for a transmitter results in great differences

Line-Measurement: DVB-T, Channel 34





- DVB-T is a single frequency network => superposition of signals from all broadcast transmitters at a measurement point
- Calculation optimized to get a small mean deviation show a better accuracy
- Calculation optimized on points with overestimations: Worst Case, but high mean deviations

Summary: Calculation methods

- Development of a tool with only a few input parameters based on a ITU recommendation
- Optimization to get a small mean deviation

  ⇒ Mean deviations from 7.3 to 11.5 dB

  ⇒ But in 78 – 80 % of all cases difference of ± 3 dB (good accuracy)

- Optimization for points with an overestimation

  ⇒ Suitable as Worst Case; but high mean deviations of 20 – 30 dB

The End

Thank you very much for your interest!

Questions?