Man Made Noise measurement system ENAMS – overview, first results

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DCC; ENAMS 2020-09-12/Dr. Ha.

ENAMS – An idea of DARC EMI-Unit

- Head of EMI-Unit: Klaus Eichel, DL6SES

- An independant stand alone system (Range: 50 kHz to 31 MHz)

- Measurement results must be comparable to results of standard measurement procedures (EN 550xx, CISPR, ITU R)

- Centralized Server for administration and data collecting (control and backup) but decentralized independant measurement systems

- 50 locations spreaded in DL – according to ITU-R P372 categories

- stable parameters over the next 5 years

- Further information http://enams.darc.de

ENAMS – Why is it needed?

International treaties bind nations to use spectrum according to the ITU-regulations

- EMI-Certification Measurements – emissions of devices are certified
  - 0-30 MHz: conducted line emission measurements but no radiated noise (laboratory size < wavelength)
  - Technology of power devices changed over past 50 years
  - Increasing number of power electronic devices without certification
  - Fast switching power electronics in solar converters and optimizers

  Solution:
- Collect arguments against **radiated** radio noise below 30 MHz

Noise-Monitor systems – ham radio acitivties (known to me)

- ARRL noise measurement campain

- TAPR Working group: developement of TangerineSDR (noise measurement?)

- IARU Region 1: EMI-manager-discussion

- several national inititatives in Europe (GB, NL, CH, …)
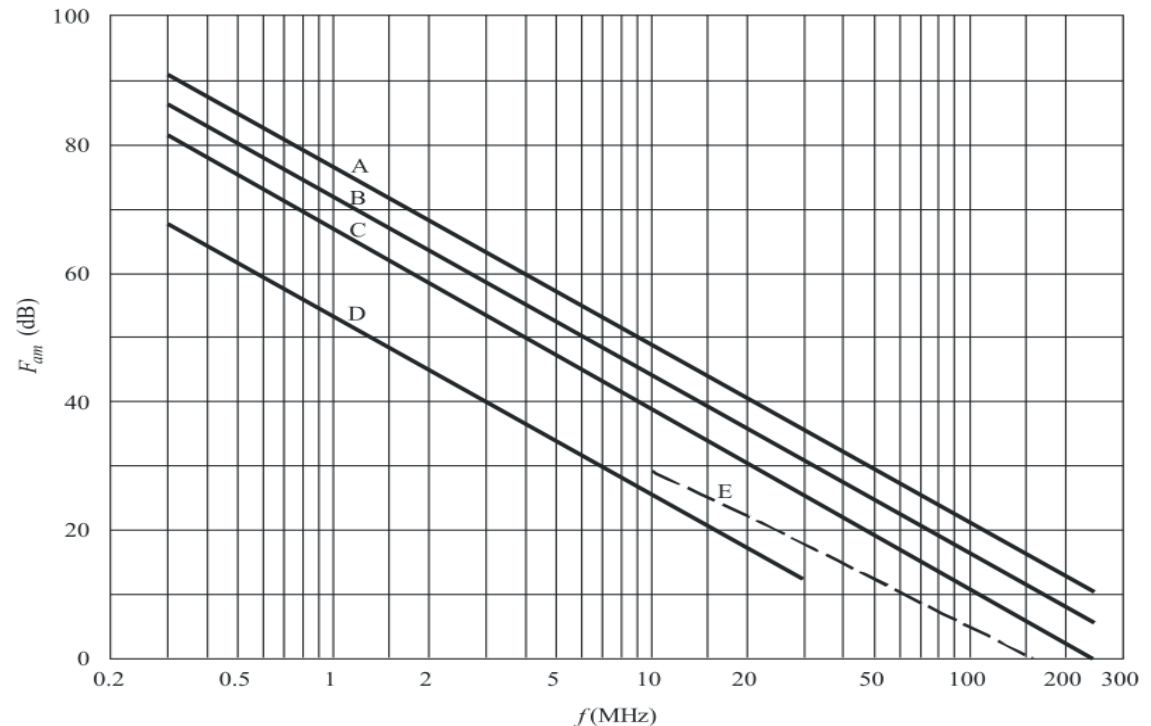

   Open, not completed list ...

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R P.372-14
(08/2019)

Radio noise

P Series

# Recommendtion ITU-R P 372-14 (2019/08) Radio Noise

- measured as „Noise figure" with 9 kHz bandwidth (ref to $R_0 = -174$ dBm/Hz)

- with **defined antenna** (field sensor)

- A: Industrial

- B: Residential

- C: Rural

- (D: quiet rural

- E: Galactic)

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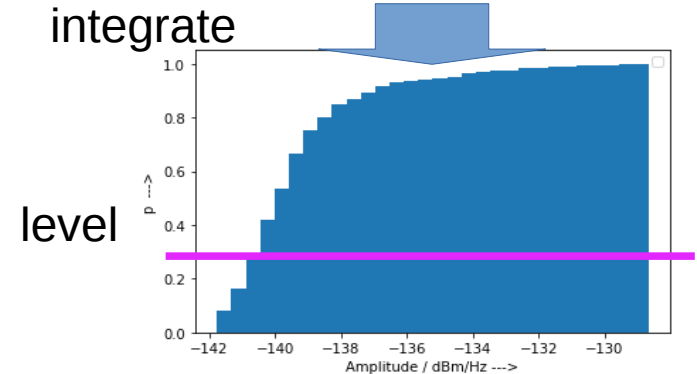- C: Rural

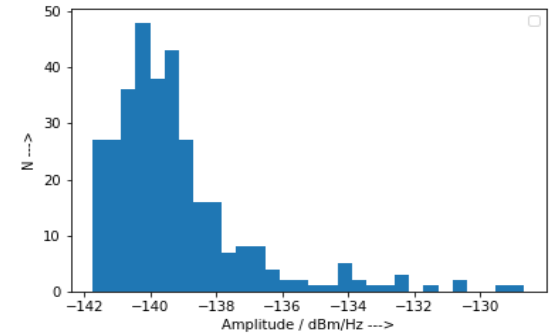- (D: quiet rural

- E: Galactic)
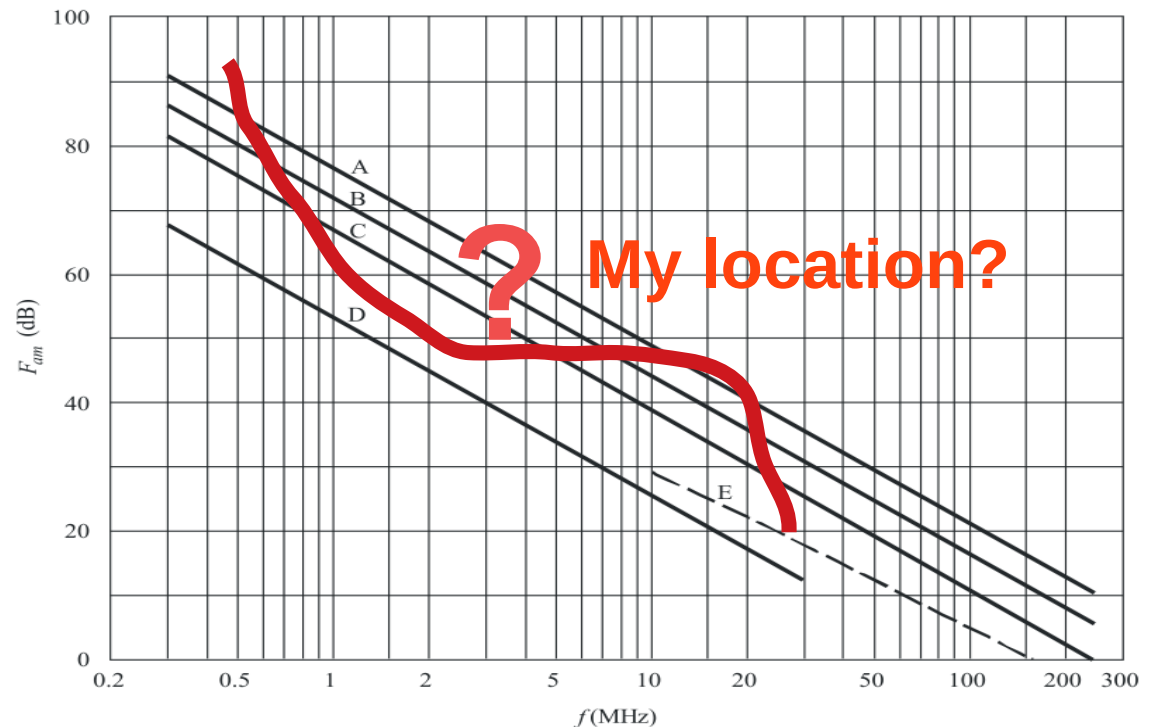
What ist the Radio Noise level?

- Measured with actual 305 Hz bin width (0,055 – 31,1 MHz)

- 1 s, RMS

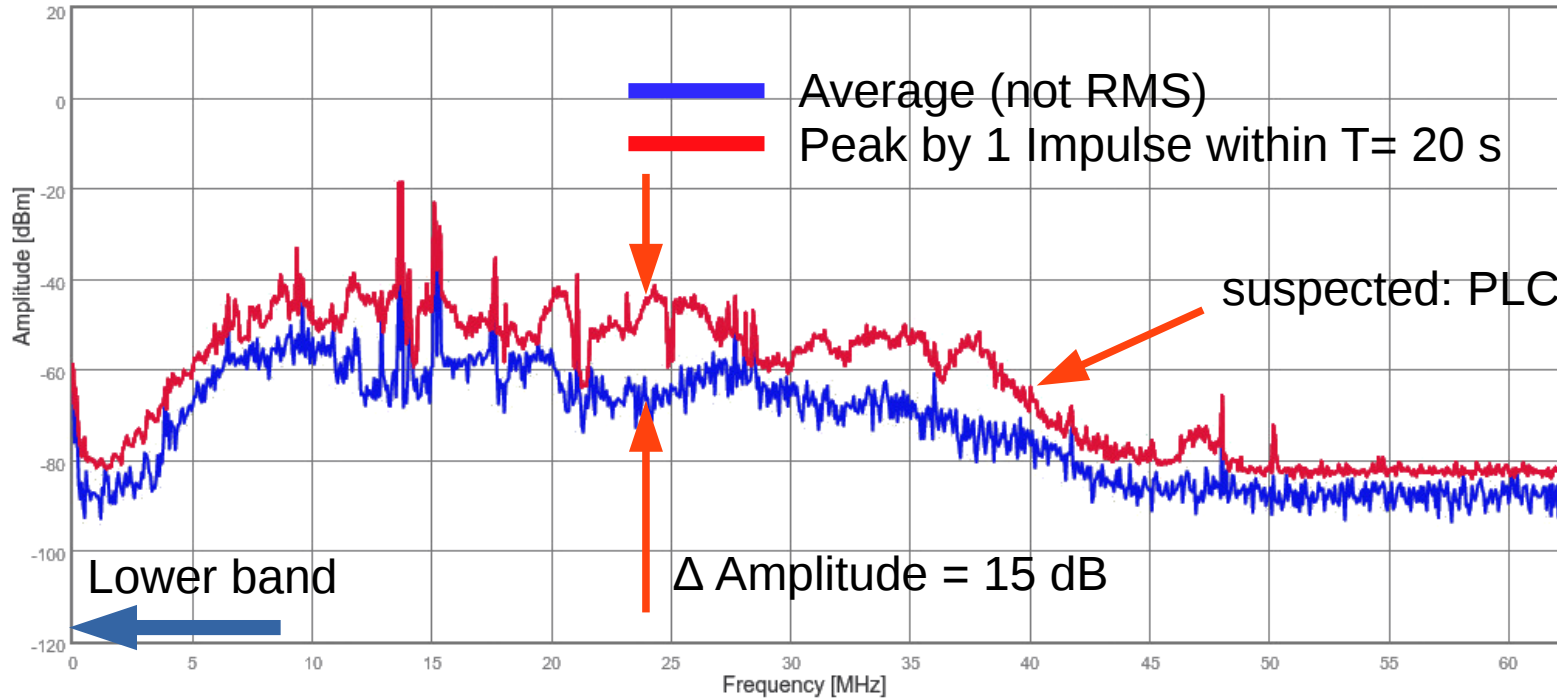- Noise floor on a crowded ham band?

- Impulse noise?

2019-09-01_04:30 Z

40 m

Noise level?

305 Hz

Amplitude / dBμV --->

f / MHz --->

HSB
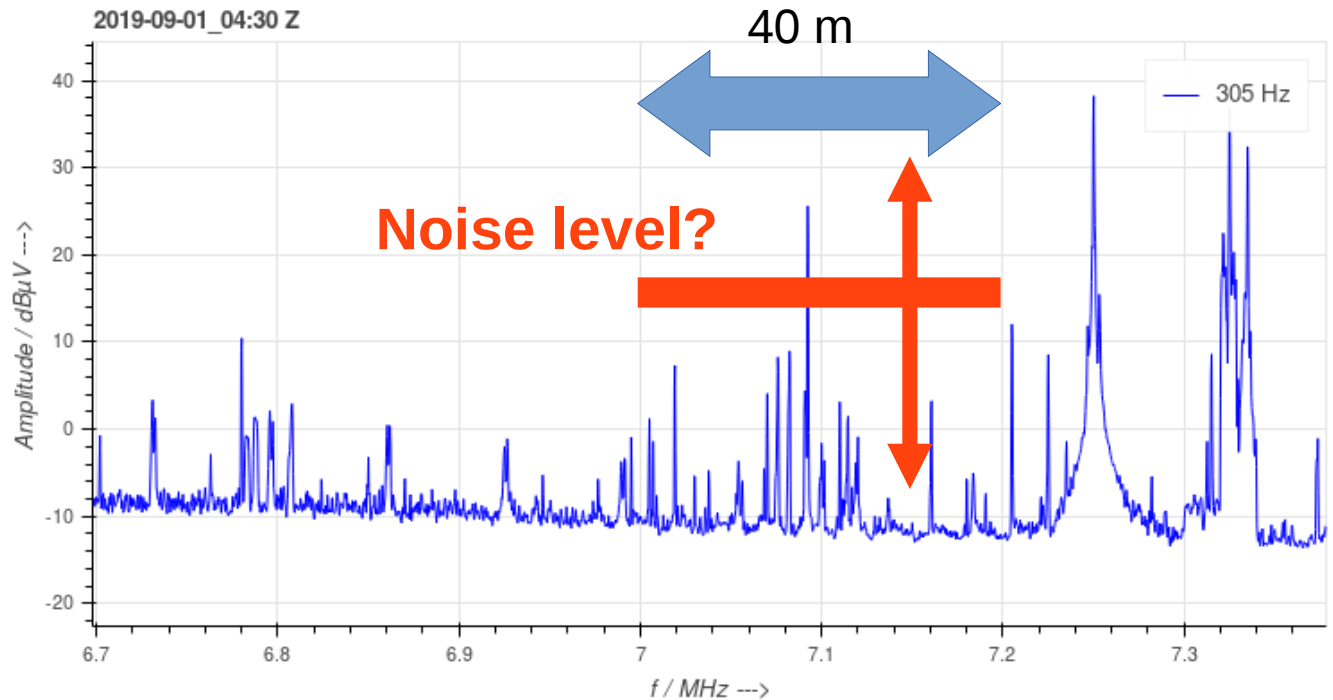
Noise level estimation

- According to ITU SM 2055 and SM 2155

- Amplitude minimum?

- **Better solution**: Statistics

  - ~ 100 kHz

  - 327 bins

  - Select al level for the
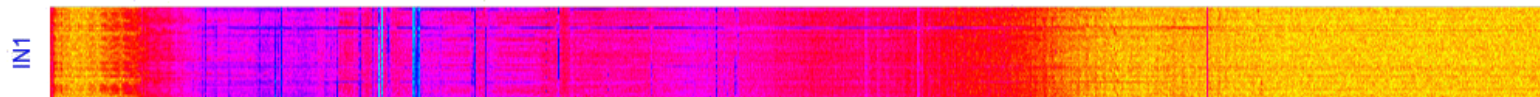   cumulative total frequency

integrate

level

HSB

PLC burst noise:
Measured Spectrum 0 – 62,5 MHz

Average (not RMS)

Peak by 1 Impulse within T= 20 s

suspected: PLC

Lower band

Δ Amplitude = 15 dB

Measured on Sunday 21.6.20, 11:07 GMT Bremen, NB

Upper band shown

burst

Expected results of the RF-EMI-Monitor

- What are the superimposed results of many electrical systems?

- What noise levels could be found in different ITU-R categories?

- What frequency range is concerned?

- what is the longer-term development of man-made-noise over month and years?

- With the 50 stations in Germany a geografical distributed „heatmap of noise" and the dependency over time

More Standards / Recommendations

- CISPR 16-1-1 3/2015 Measurement instruments

- CISPR 16-x

- SM.2055 Radio noise measurements

- SM.2125 Parameters of and measurement procedures on HF/VHF/UHF monitoring receivers and stations

- SM.2155 Man-made noise measurements in the HF range

conventional measurement up to 30 MHz

- Measurement proc. CISPR16-1-1: sequentially tuned (RMS): one frequency lasts for 1 s

841 850 859 868   F/kHz

86   87   88   89   time/s
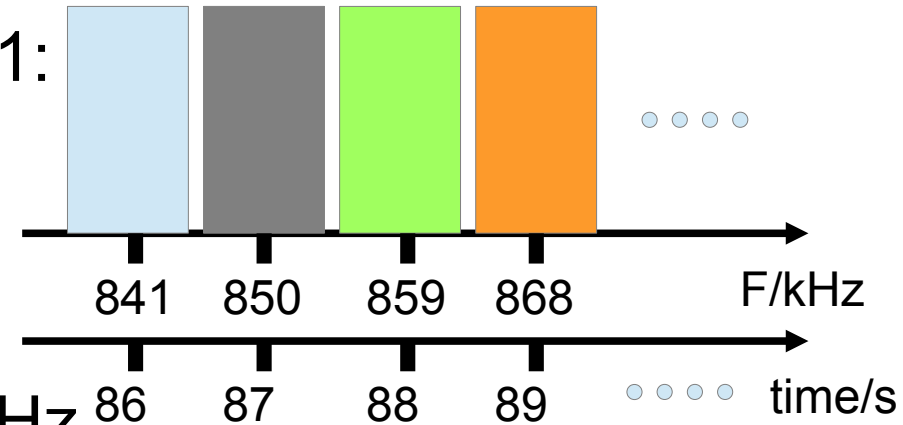
- example: measurement range 0,055-30 MHz **1 measurement** needs **3438 s = 57 min** (with 9 kHz filter)

→ With this procedure a new measurement repeated every 10 minutes is **not possible**

Remarks on the field sensor of ENAMS
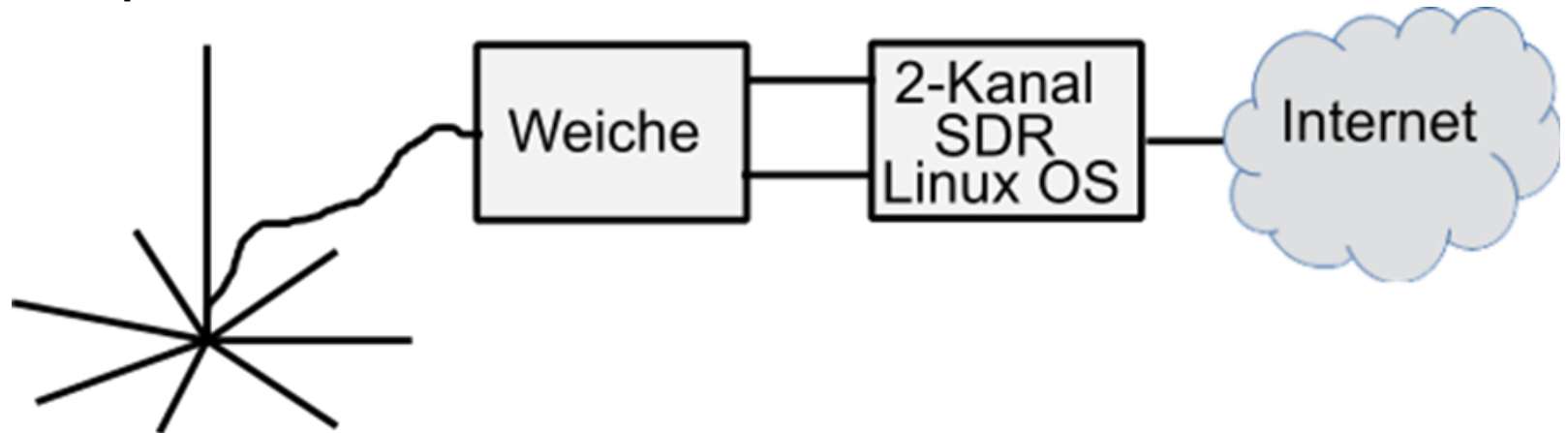
ITU-R P372 Noise figure

Refers to a λ/4 monopole antenna as sensor

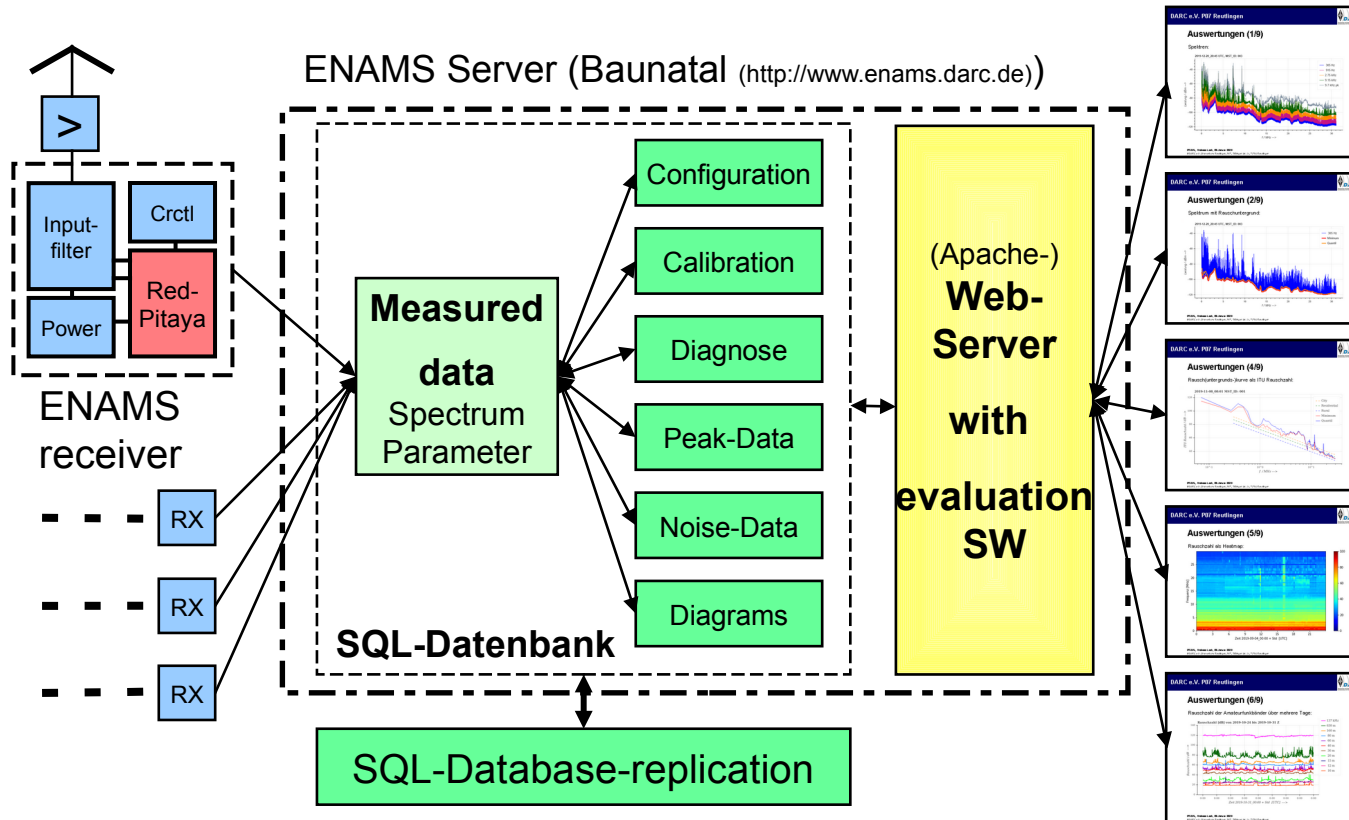ENAMS uses an active antenna 1 m length, 1 m high over radial network on ground

ENAMS Antenna: Antenna factor can be calculated

HSB

Measurement system (frontend)

- According to ITU SM 2155 recommendations

- specified antenna

- 2 band amplifier

- SDR

- INet

ENAMS System overview

Measurement procedure of ENAMS

- Redpitaya: 2-channel-14 bit ADC, 125 MHz sample rate, Linux-OS

- Take a 1 sec sample to ramdisk by using the HDSDR-FPGA-Modul (GnuRadio) from Pavel Demin with 1,2 MHz band segment

- Calculate the power spectrum density (PSD) with 300 Hz Bin width

- collect the PSD-300Hz

- 29 Steps from a few kHz up to 30 MHz

- Add peak measurement for pulsed amplitude with 9 kHz resolution

- Put the result to a collecting central data base(s) 110.000 bins / measurement

- Measurement takes about 5:30 min

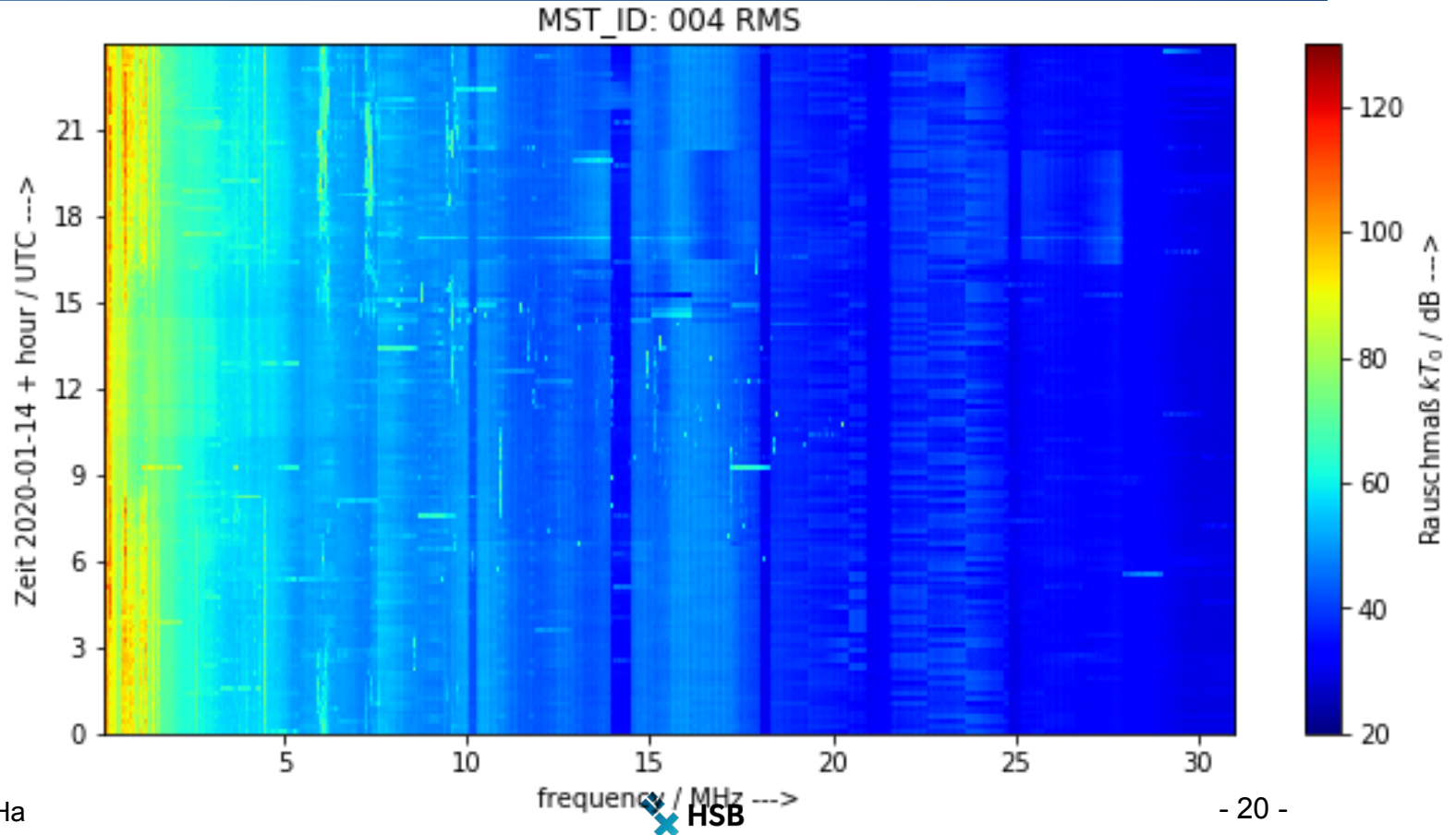- Repeat measurement by cron (systemd) every 10 -15 min

Calculate more Results

- Make some more calculations

  - Mean, RMS

  - Peak hold

- Calculate and show results for different bandwidth

  (300 Hz – CW, 2.7 kHz- SSB, 9 kHz – ITU recommendation)

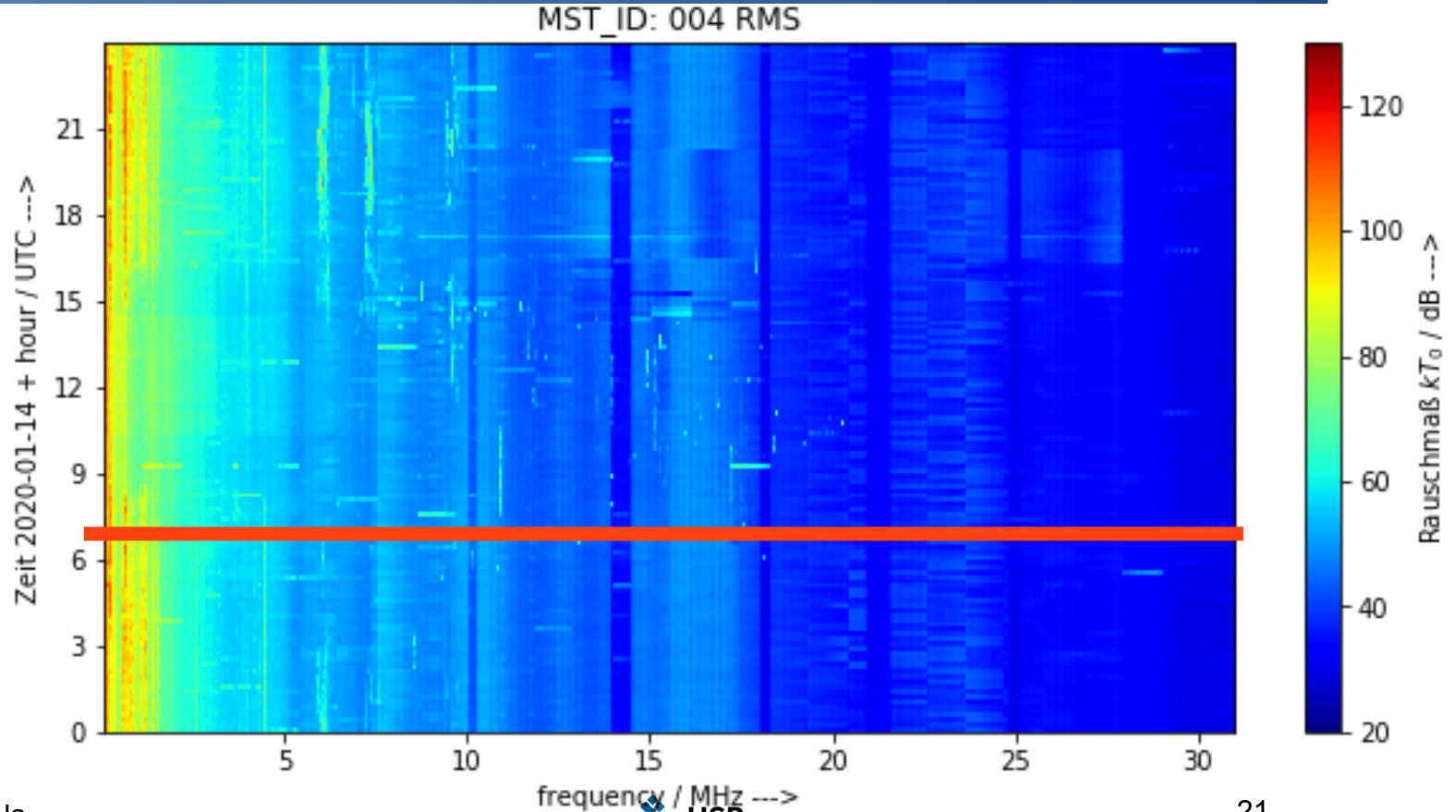- Server for further evaluation and comparison

Some results (RMS) based on ITU-R P372

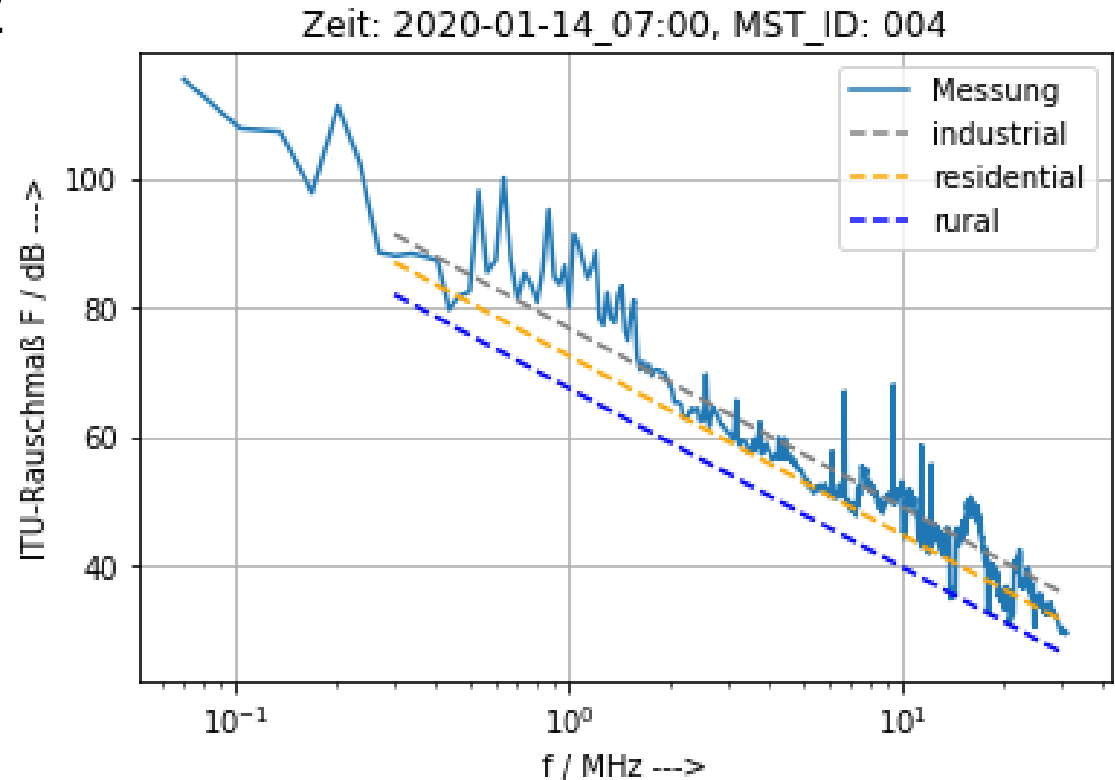HSB

RMS of ITU P372 noise figure

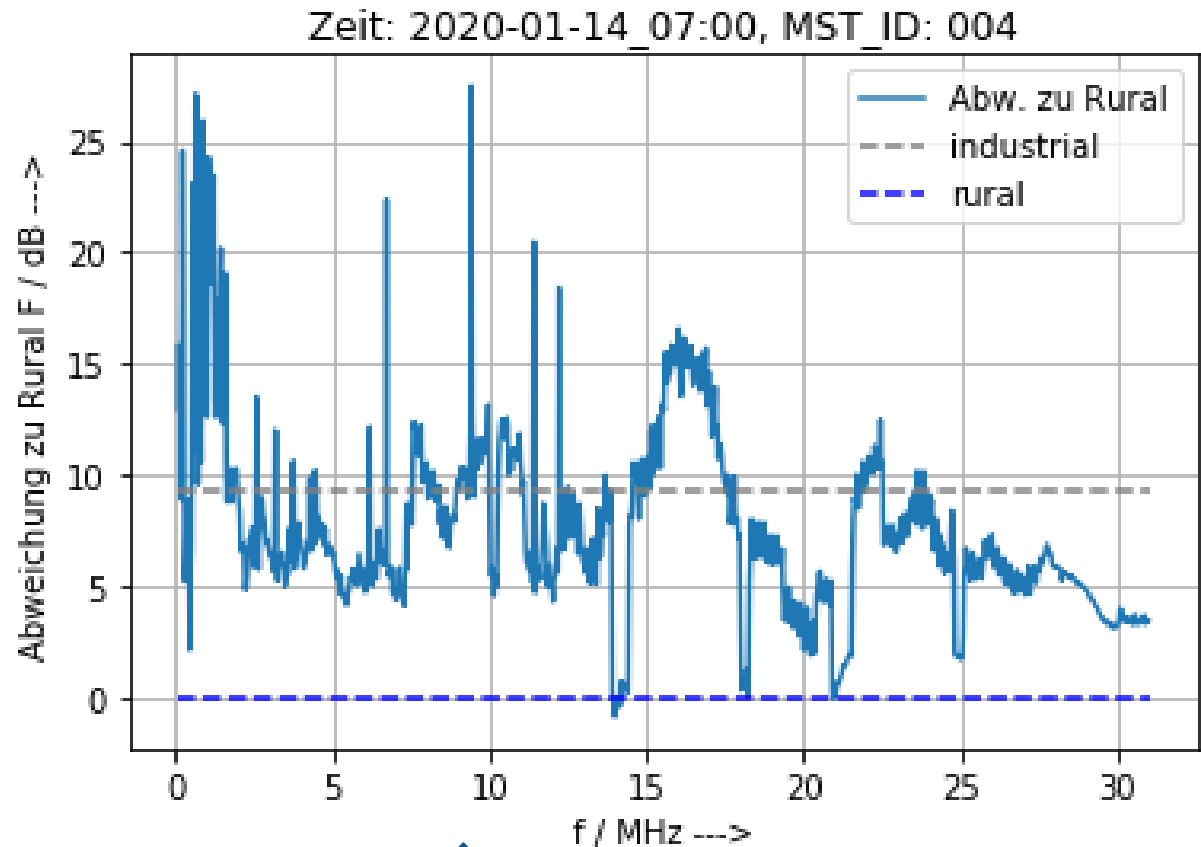- Residental location

RMS of ITU P372 noise figure

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MST_ID: 004 RMS

HSB

Measurement at 07:00 GMT, 14.Jan 2020

- Refers to ITU-R P372

Zeit: 2020-01-14_07:00, MST_ID: 004

HSB

Transformed and based on „rural"

Zeit: 2020-01-14_07:00, MST_ID: 004

Transformed and based on „rural"

- |

Zeit: 2020-01-14_07:00, MST_ID: 004

HAM bands

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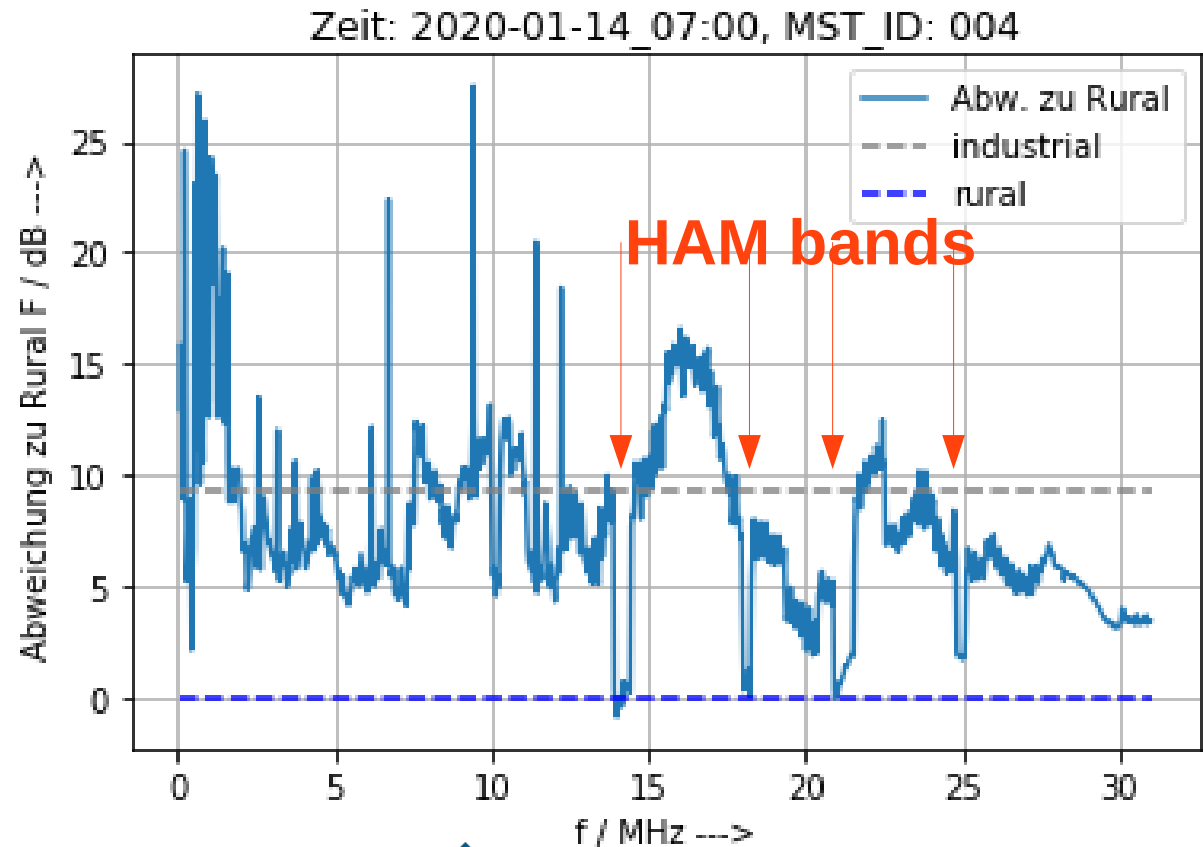
Display daily waterfall based on „rural"

- Deviation to rural

MST_ID: 004 RMS, Diff to Rural

HSB
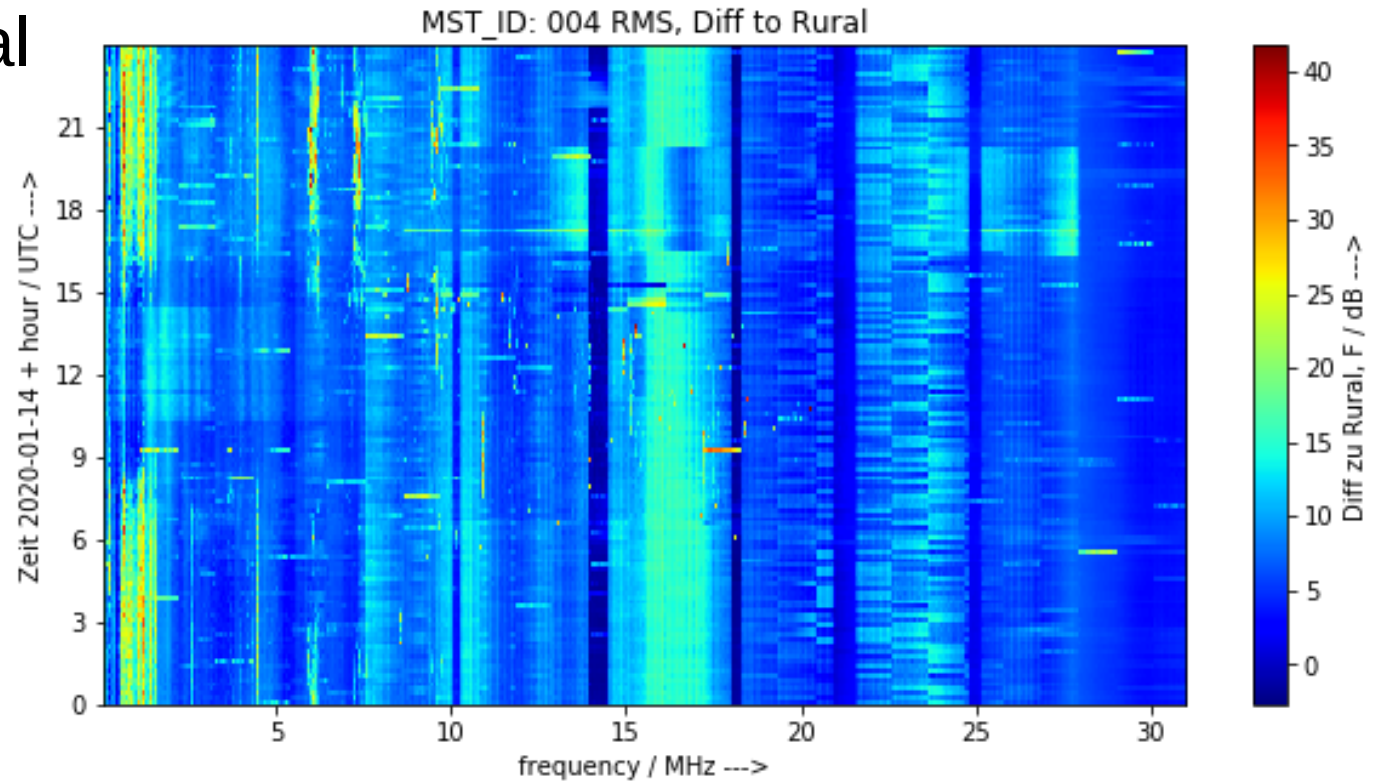
Noise power in ham bands and total

- deviation to rural

MST_ID: 004 2020-01-14

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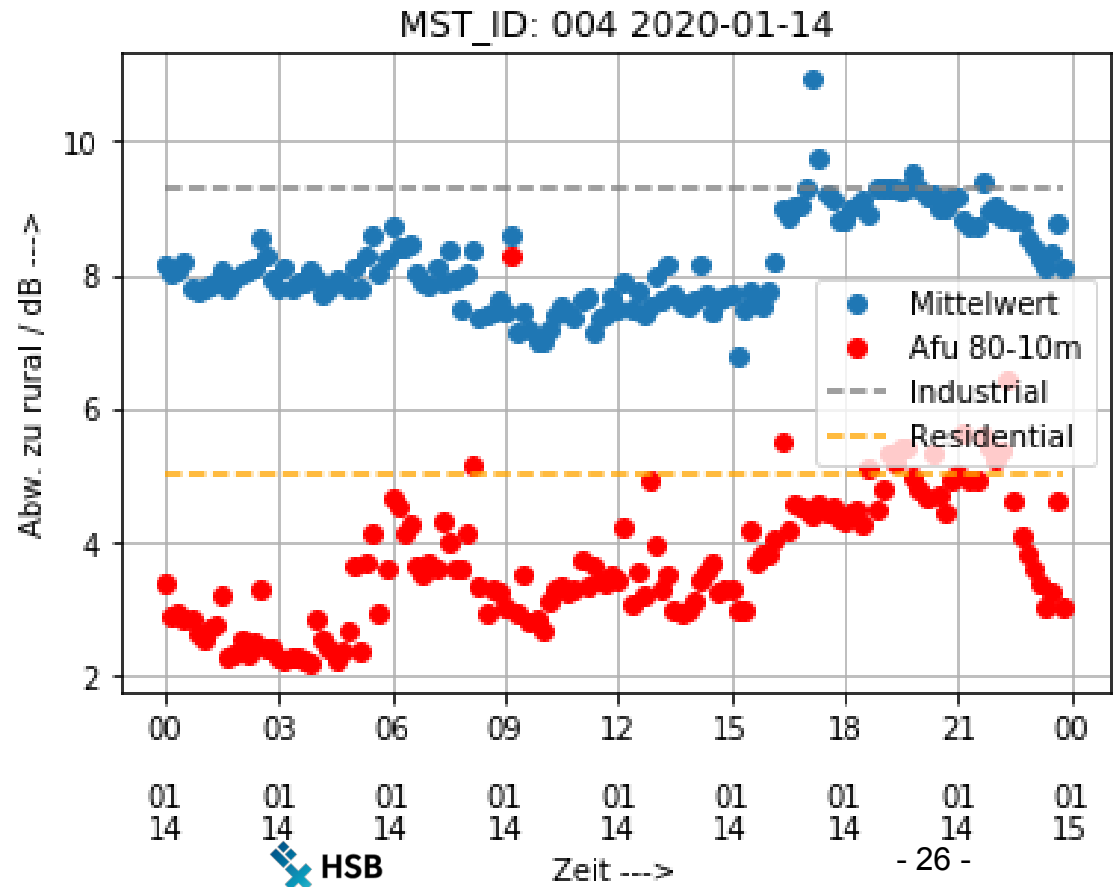
conclusion

- Environmental EMI could be measured with SDR

- ENAMS is in operation since end of 2019

- Comparison with the ITU-Radio Noise Regulation is a must for external argumentation

- Noise figure is dependent on time and frequency

Questions

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