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APWPT
ASSOCIATION OF PROFESSIONAL WIRELESS PRODUCTION TECHNOLOGY

**WS on Current and Future Use of Spectrum by PMSE - Update 2019**

**Topic: Radio Technology and Spectrum Access for Wireless Production Tools - PMSE**

# A methodology for the practical recording of PMSE frequency use and a quick summary of more than 10 years of spectrum observation in the event production

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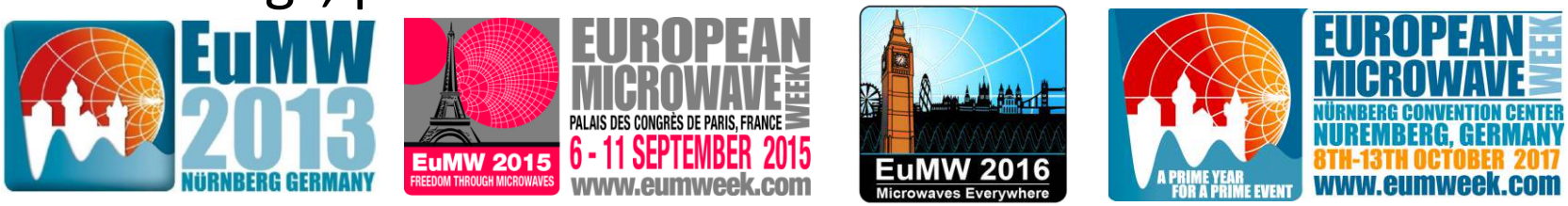
- Introduction to the Spectrum Recordings of APWPT, DKE and many supporting organisations during event productions from Broadcast, Culture and the Creative Industries.
- A quick overview of the long-term work for spectrum recordings, presented in




- The methodology for the practical recording of Audio PMSE frequency use in the UHF TV band.
- A quick summary of more than 10 years of spectrum observations in the content and event production sectors.

# Introduction

# Introduction

- The use of radio spectrum by wireless production tools is constantly changing and more and more wireless applications are seeking access to spectrum.
- The design and the optimisation of methodology for spectrum recording and analysis in the context of event production and the subsequent evaluation of the recorded data is a considerable challenge.
- Therefore, since 2013 we presented, discussed and optimised the
  - Method for spectrum recording and
  - the method for the analysis of these recordings.

# Motives for recording the radio spectrum

- Administrative authorities consider the radio spectrum in the context of “radio compatibility, frequency planning, frequency coordination and EMC" in an attempt to optimise its use.
- At the same time, we realise that the use of radio spectrum is increasing in art, broadcasting, culture, event production and the creative industries.
- Spectrum use during event production is a specialist topic and is, consequently, subject to frequent misinterpretation. This has implications for product standards and spectrum regulation. Therefore, APWPT, DKE and supporting organizations are collecting information on the spectrum use of wireless production tools, especially Audio PMSE.

# DKE, APWPT and production teams

- DKE (DIN/VDE) is the competence centre for electro-technical standardization in Germany. The DKE AK 731.0.8 is the relevant working group for “Professional Radio Microphone Systems and Event Technology”.
- APWPT - Association of Professional Wireless Production Technology - focuses on ensuring the continued availability of interference-free radio spectrum in order to enable the continuation and the ongoing improvement of high-quality content production.
- In addition, a number of production teams and frequency coordinators recorded for more than 10 years the spectrum use of wireless production tools (PMSE) and have provided additional information.

# Spectrum Recording Methodology

# Spectrum Recording Methodology



Comparable recordings and evaluation of spectrum usage during different productions by use of this methodology persue the following goals:

1. **Transparent Recording of Scanned Data**

   Each scan cycle is stored in a new ASCII file and contains important metadata for subsequent data evaluation.

2. **Signal Dynamic, Automatic Attenuation Correction**

   The recording of the scanner-input attenuation is automatically adjusted to the local signal dynamic.

3. **Use of different scanning bandwidth or detectors**

# Spectrum Recording Methodology

## Example of a recorded high-resolution data set

```
!Spectrum occupation recording
!============================

! Project time       : Date and Time of the Scan set
! Project title      : Title of the Event
! Company name       : Demo Org
! Mail address       : demo@demo.org
! GPS Latitude       : Not supported
! GPS Longitude      : Not supported
! Equipment          : Rohde&Schwarz,FSU-8,200278/008,4.71
! Inp. Attenuator    : 0dB
! Pre-Amplifier      : ON
! Add Input Gain     : 0dB
! Sweep points       : 1 #
! Wide scan RBW      : 10000kHz
! Narrow scan RBW: 30kHz
! WB detector        : RMS
! NB detector        : RMS
! Scan type          : fixed
! File name          : Scan0526191350298931.txt
!
! Scan unit          : 1 of 2…
```

```
!Freq. ! Level ! Level!
! kHz  ! [dBm]! [dBm]!
!       ! 30kHz! 10MHz!
!
470000;-118.98;-72.01
470010;-130.78;-72.36
470020;-115.65;-72.16
470030;-121.94;-72.07
470040;-116.37;-71.84
470050;-118.45;-72.19
470060;-116.55;-71.81
470070;-116.99;-71.99
470080;-115.44;-71.63
470090;-116.93;-72.01
470100;-111.53;-71.69
470110;-110.24;-71.84
470120;-113.84;-71.48
470130;-115.29;-71.77
470140;-117.36;-71.50
470150;-124.07;-71.67
470160;-127.42;-71.40
470170;-116.59;-71.68…
```

# Some Advantages of the Methodology



- Each data set can be imported into Excel or similar tools and evaluated separately.
- Each record contains information for comprehensive analysis, for example:
  - measurement bandwidth,
  - if the scan has been completed or the input attenuator was changed and
  - If available, location coordinates, .
- Each data set contains information on antenna cable attenuation, filter attenuation, or gain from external components inserted before the scanner input.
- Each record contains the number of scan stations and its own scanner number.

# Some Disadvantages of the Methodology

- The speed of data analysis is reduced compared to binary single file recording.
- The maximum number of scans is limited by the Windows operating system or the file system.
  In practice, however, scans with more than 400,000 individual data files were evaluated on computers with Windows 64 bit (7 or 10).

# Requirements before Scan or Statistic

Presented at EuMW2017

## Before Scans

- Setup of Scan
- Input of important project data
  Title, Organization und Contact info
- Selection of scan frequency ranges
  VHF, UHF, DME, L-Band or 2 GHz
- Enter the number and max number of the scanstation(s)
- Select the scan mode
  Fix location scan or mobile scan
- Select the scan method
  Normal or Fast scan. HRM scan mode.
- Consideration of external input gain or loss
- Logging of the scan mode
  - Usually not required -
- Start Scan

## Before Statistics

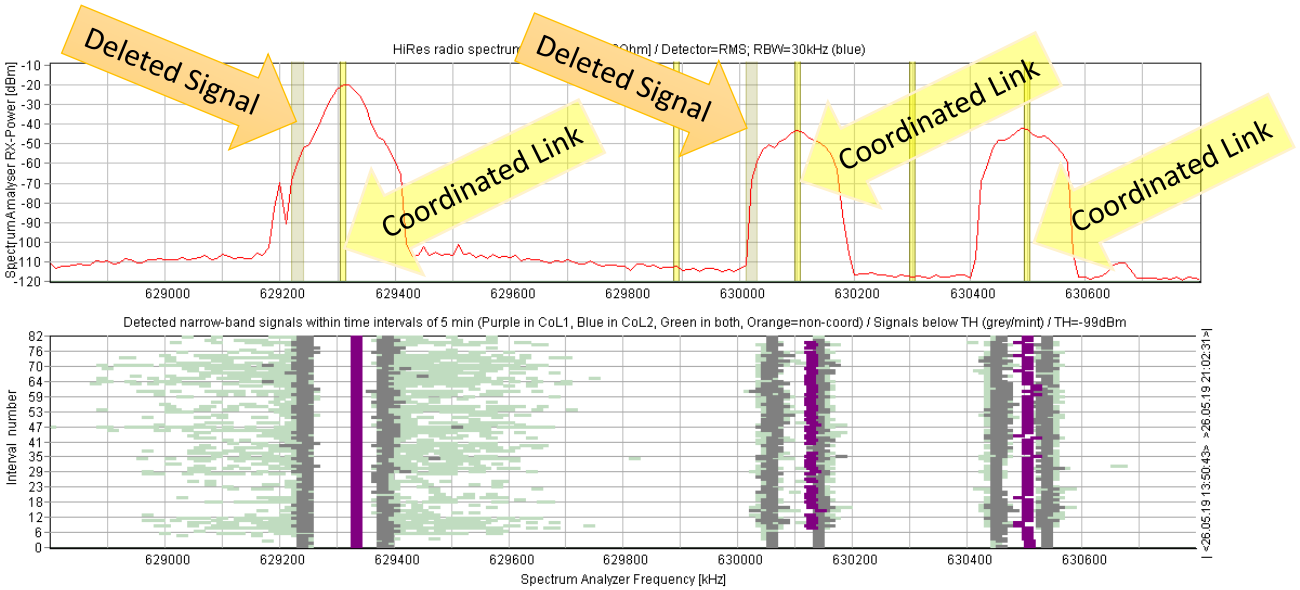
- Start
- Review of existing project data
  Scan data, project info and coordination
- Import of the scan data and import of the coordination table
- To add missing marks of DAB +, TV and IMT
- Select or deselect the level corrections
- Start of the automatic analysis
  1st run for error detection
- First view of the results
  If necessary, to remove distorted scans
- Revision of results
  Removing of wrongly detected signals and "Stop"
- Restart of the data evaluation
  Finalizing by pressing „Finalize stat“
- Take over the provided results (RTF, TXT and PNG)
- Stop

# Spectrum Analysis Methodology

# Spectrum Analysis Methodology (1)

## 1. Number of detected and coordinated Audio PMSE

The software, PMSE Occupation Recorder, detects links in each scanned file; TV and IMT channels must be marked beforehand. In most cases a high hit rate of link detection is achieved. Incorrectly recognized links are subsequently deleted and unrecognized links are subsequently marked. This figures show an example;




Comparison with any available frequency coordination information supports this process. The manually added correction information is considered during a final statistics run.

# Spectrum Analysis Methodology (2)



## 2. Summary of the Statistical Results of the Spectrum Scans

For each scan scenario, a Report is automatically generated that summarises comprehensive information (up to 30 pages of text and graphics).

Example

This is a table generated from scanning results and published in an IEEE paper at SET2019:

*"Radio Spectrum Scanning at the Brazilian 2018 - FIA Formula One World Championship"*

Link for download of the presentation

For PR work, a simplified two-page report with a few graphics is also generated.

| Description | Spectrum Information |
|---|---|
| Scanned frequency band | 470 to 862 MHz |
| Range of scanned frequency band | 392 MHz |
| TV channels in use by Broadcast | 31 |
| Radio spectrum in use by Broadcast | 186 MHz |
| LTE channels in use by IMT | 12 |
| Radio spectrum in use by IMT | 60 MHz |
| Radio spectrum in use by non-PMSE wide-band systems | 75 MHz |
| Radio spectrum in use by wide-band PMSE systems | 10 MHz |
| Radio spectrum remaining for NB and WB PMSE | 81 MHz |
| Radio spectrum below 470 MHz, e.g. used by TalkBack | 60 MHz |
| Narrow-band PMSE detected outside of TV channels | 51 |
| Narrow-band PMSE manually marked outside TV channels | 23 |
| Narrow-band PMSE manually marked in TV channels | 3 |
| Required spectrum for detected narrow-band PMSE [a] | 39.00 MHz / 77 Links |
| Required spectrum for narrow-band and wide-band PMSE [b] | 49.00 MHz |
| Spectrum density of detected narrow-band PMSE [b] | 0.951 Links/MHz |
| Coordinated PMSE in the scanned frequency band | 162 |
| Coordinated narrow-band PMSE in the scanned band | 159 |
| Coordinated audio PMSE in wide-band systems | 2 |
| Coordinated video PMSE in wide-band systems | 1 |
| Spectrum density of all coordinated PMSE | 2.000 Links/MHz |

(a) Calculation bases on a 500 kHz grid and two additional 250 kHz guard bands and manually marked links. T not consider required guard bands to TV or IMT channels

(b) Calculation considers manually marked links

(c) Stat software version: PMSE Occupation Recorder R6.3.15a

# Spectrum Analysis Methodology (3)



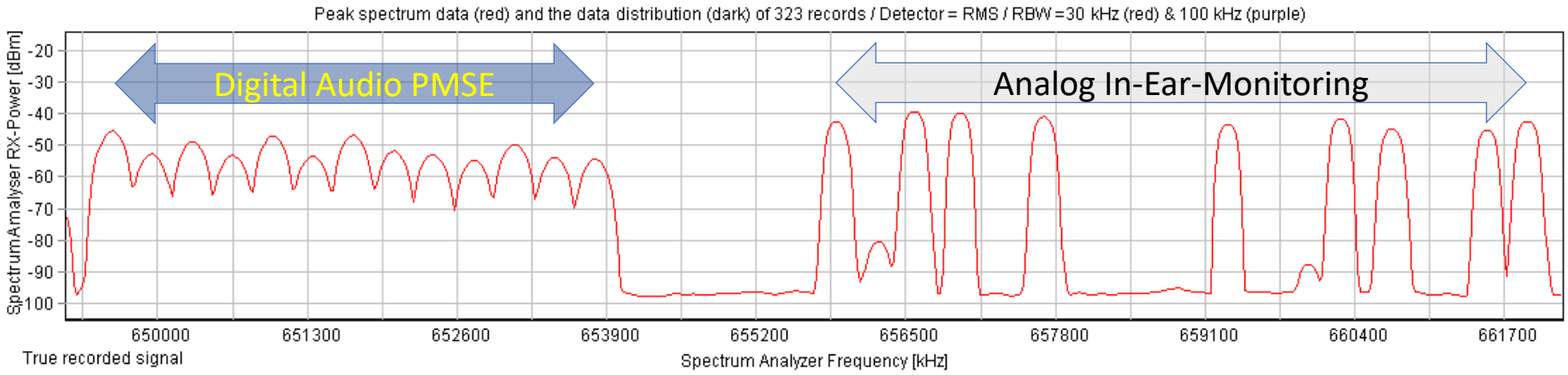
## 3. Calculation of the radio spectrum required for audio links

A required bandwidth of 500 kHz is assumed for each link.
In addition, two times a guard distance of 250 kHz.

**This is, of course, a compromise;**

- Intermodulation-free frequency use requires considerably more radio spectrum, for example analogue In-Ear-Monitoring links.
- By contrast, modern digital audio PMSE can use a slightly smaller link grid.

The figure below shows on the left a high-density digital audio PMSE link cluster and on the right an analogue In-Ear-Monitor link cluster;



# Spectrum Analysis Methodology (4)



## 3. Calculation of the radio spectrum available for audio PMSE

In order to be able to compare spectrum scans over many years and derive trends from them, 470 to 862 MHz is used for the UHF TV range. From this, locally used television channels and mobile radio frequency ranges are subtracted. The result is different at each location and changes over time. Data from many productions at different locations, over a long period of time, has resulted in the identification of trends.

## 4. Automatic provision of graphics and tables

In practice, further documents are created with the results of the spectrum recordings. It is helpful to be able to access a set of graphics and tables. Therefore, the analysis software, for example, creates up to 65 graphs that can be easily referenced and used. The advantage here is that comparable graphics can be shown in many different publications.

Note: the methodology presented here will continue to be improved, taking into account incoming comments and suggestions.

# Results of Spectrum Recordings

# Introductory note (1)

## Notes on the split of some recorded data into segments

- The recorded event productions take place in different time slots. Some are produced over a few hours, others are in production over several weeks, for example the annual Eurovision Song Contest can have a total production time of up to 6 weeks (Israel 2019, for example).
- In order to be able to compare these longer events with shorter events, the data sets of long productions are split into data segments, a maximum period of three days.
- In the case of long duration productions with only one common frequency coordination, this information will only be taken into account once.

# Introductory note (2)



## Notes on the used coordination information

- Most events have frequency coordination. Due to the close cooperation with the relevant contact, it is usually possible to receive the coordination information before the start of any given production.
- It is common practice to coordinate additional links during the production or to change existing frequency usage. These changes are not always made available to the scanning team.
- For a few productions with a long period of time, coordination information is available for individual days. These are then assigned to the respective time segment.
- It should be noted that
  - for older events, no coordination information was made available and
  - sometimes coordination information contains a few, additional links as a reserve for special interference situations.

# Introductory note (3)



## Notes on the detected links

- In metropolitan areas, several productions often take place simultaneously, in close proximity.
- Outside the venue, news reporting teams are frequently active. Their frequency usage may take place outside or inside of the recorded event. Their links are often visible to the scanning process.
- Therefore, our spectrum scans sometimes show links that are not coordinated for the observed production.

# Information on events taking place in several different countries

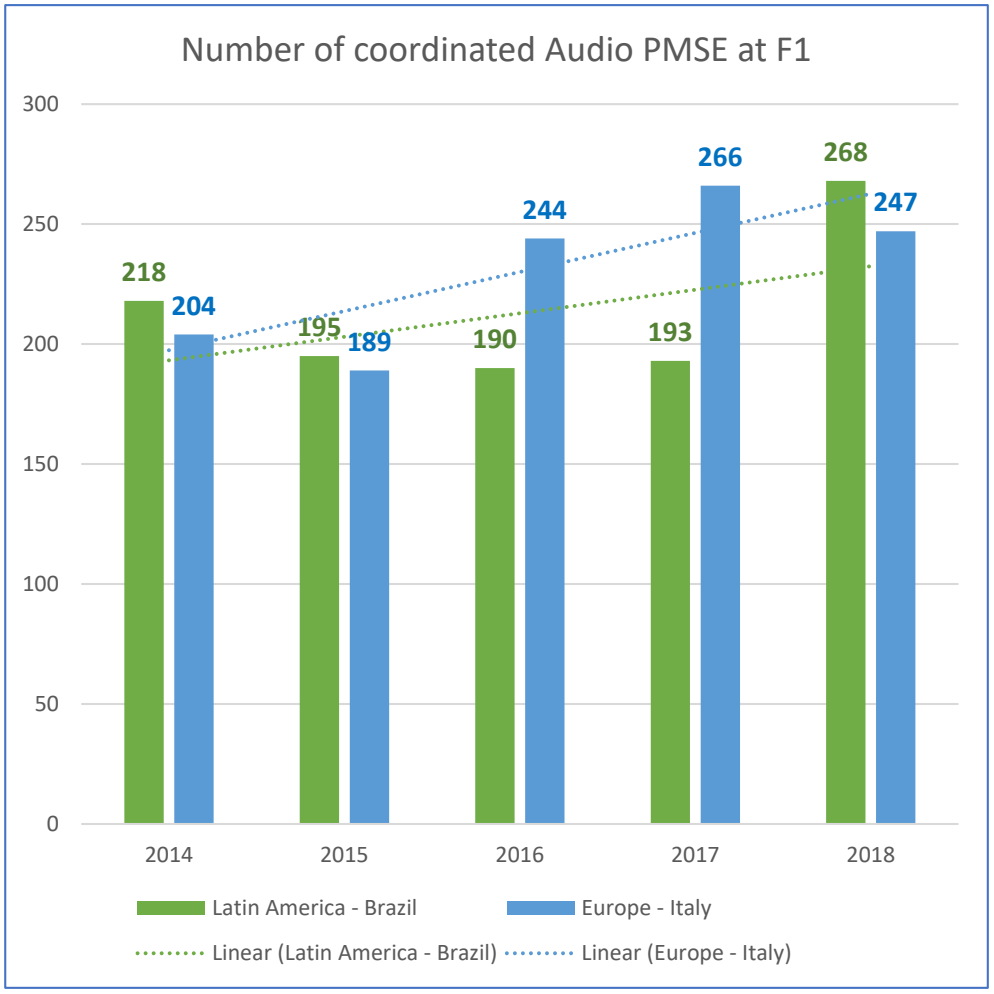
# Formula One in Brazil and Italy

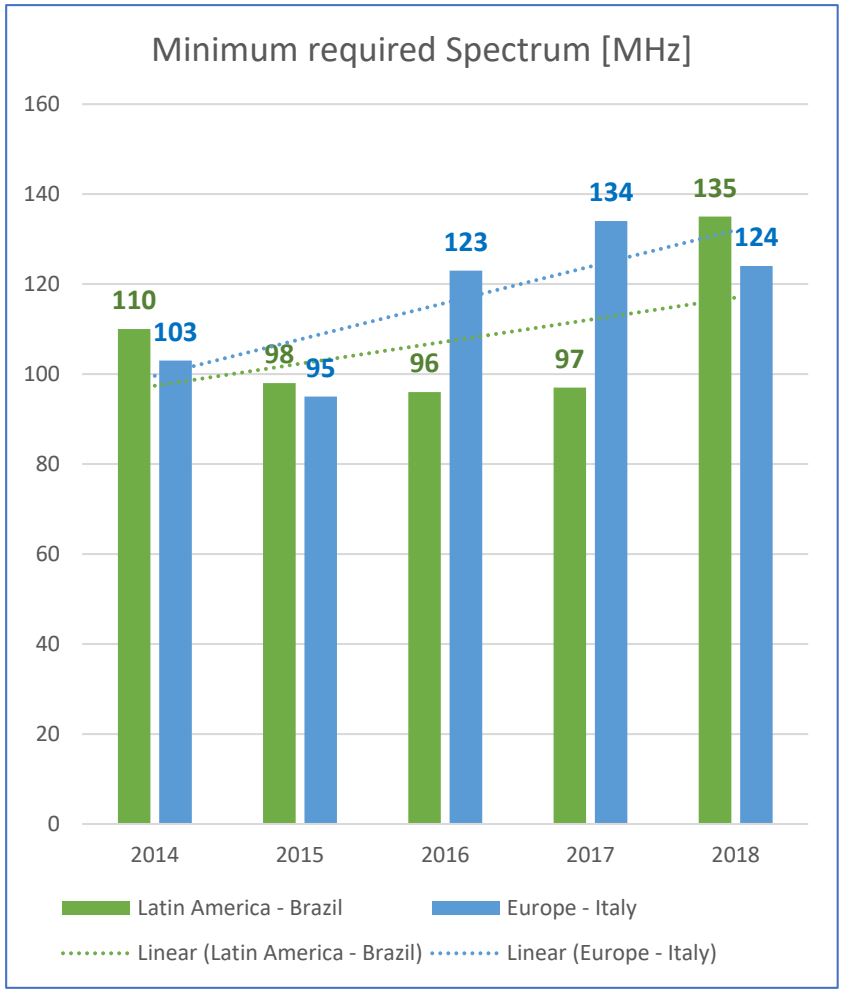
## - 8 events -

Note: this is an update of information presented at IBC2018

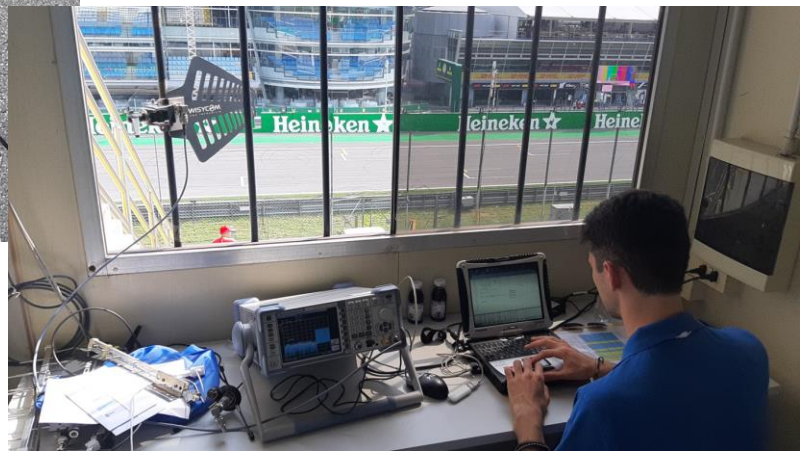
# Formula One in Brazil and Italy

## Final day of production



# Pictures of Formula One, Monza 2019




Source: RAI WAY

# Further information on Car Racing

- Information from Formula One, Monza 2019 - Spectrum Monitoring
  https://www.apwpt.org/downloads/f1--monza--2019.pdf

- Information from MOTO GP  MISANO 2019 - Frequency Coordination
  https://www.apwpt.org/downloads/moto-gp--misano-2019.pdf

- Presentation of IBC2018;
  https://www.apwpt.org/downloads/ibc2018_frequencies-f1-gp.pdf

  Note:
  CEPT PT FM51 is currently working on an update of ECC Report 204. APWPT has contributed the information contained in this presentation regarding Formula One frequency coordination. FM51 has subsequently invited all attending organisations to provide further information.

# Soccer Matches

## - 8 events -

Note: soccer matches, from a PMSE perspective, are relatively small productions!

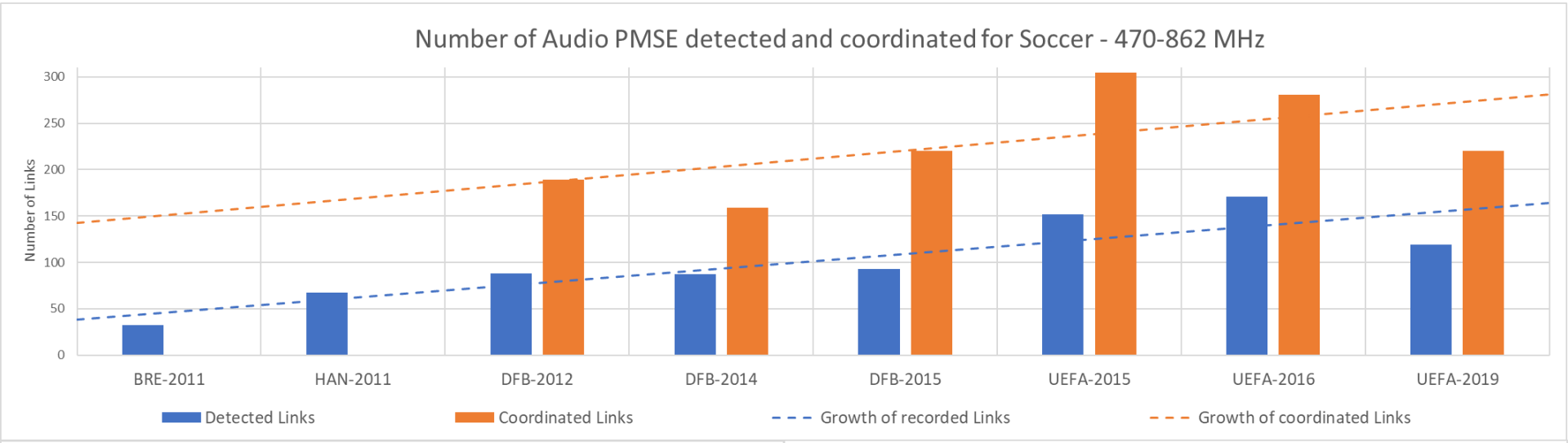
# List of events and countries of Soccer Matches

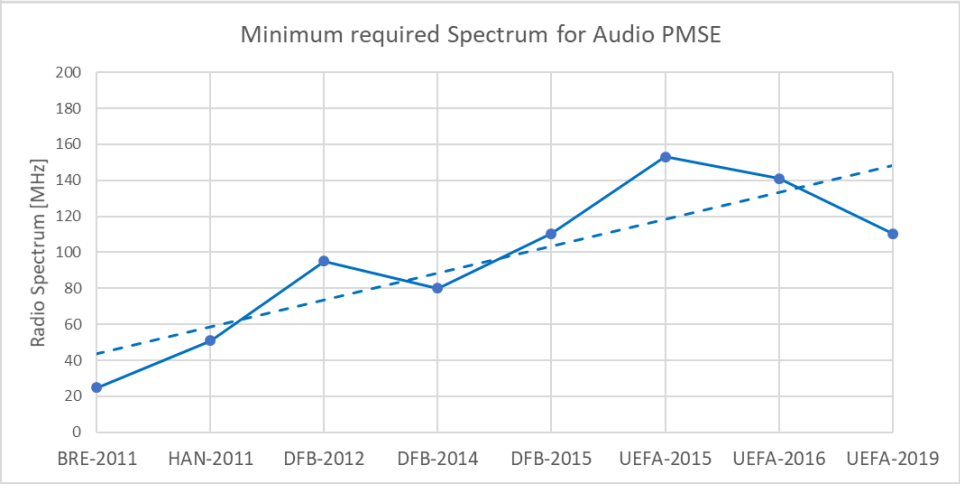
| No | Name | Short Name | Scan starts | Scan stoped | Start [MHz] | Stop [MHz] | Scan units | Avaiable [MHz] | Minimum required Spectrum [MHz] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Soccer Match at Bremen, Germany | BRE-2011 | 25.09.2011 | 25.09.2011 | 470 | 862 | 1 | 344 | **24,8** |
| 2 | Soccer Match at Hannover, Germany | HAN-2011 | 02.10.2011 | 02.10.2011 | 470 | 862 | 1 | 288 | **51,0** |
| 3 | DFB Cup Final, Berlin 2012, Germany | DFB-2012 | 12.05.2012 | 12.05.2012 | 470 | 862 | 3 | 300 | **95,0** |
| 4 | DFB Cup Final, Berlin 2014, Germany | DFB-2014 | 17.05.2014 | 17.05.2014 | 470 | 862 | 3 | 270 | **80,0** |
| 5 | DFB Cup Final, Berlin 2015, Germany | DFB-2015 | 30.05.2015 | 30.05.2015 | 470 | 862 | 3 | 272 | **110,5** |
| 6 | UEFA Champions League Final 2015, Germany | UEFA-2015 | 05.06.2015 | 07.06.2015 | 470 | 862 | 3 | 272 | **153,0** |
| 7 | UEFA Champions League Final 2016, Italy | UEFA-2016 | 01.06.2016 | 01.06.2016 | 470 | 862 | 2 | 344 | **141,0** |
| 8 | UEFA Champions League Final 2019, Spain | UEFA-2019 | 01.06.2019 | 02.06.2019 | 470 | 862 | 3 | 188 | **110,5** |

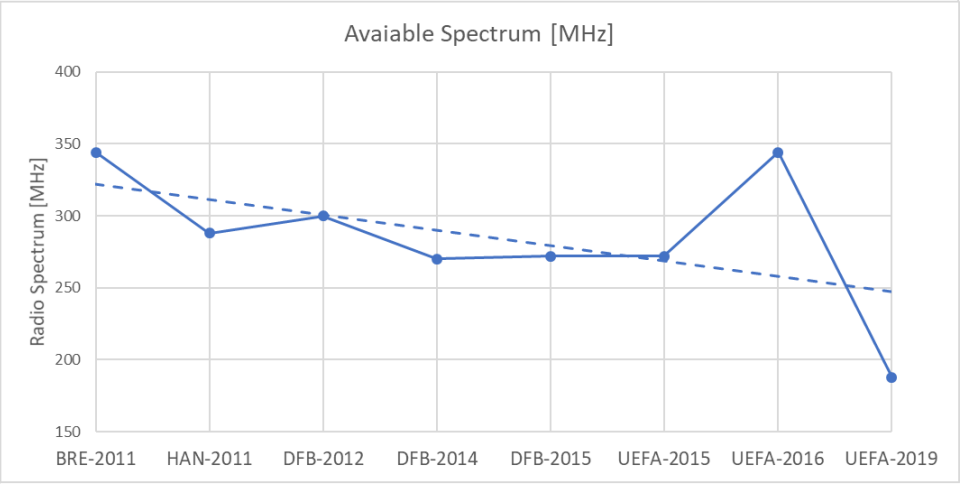
Input data | Output data | Estimation

# Soccer Matches

Note: too small number of event information, no safe trend evaluation possible.



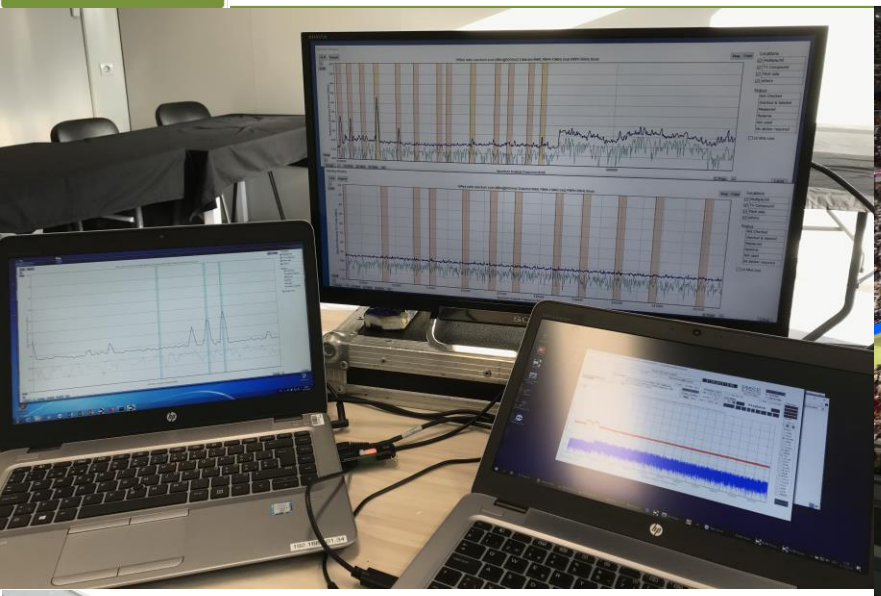



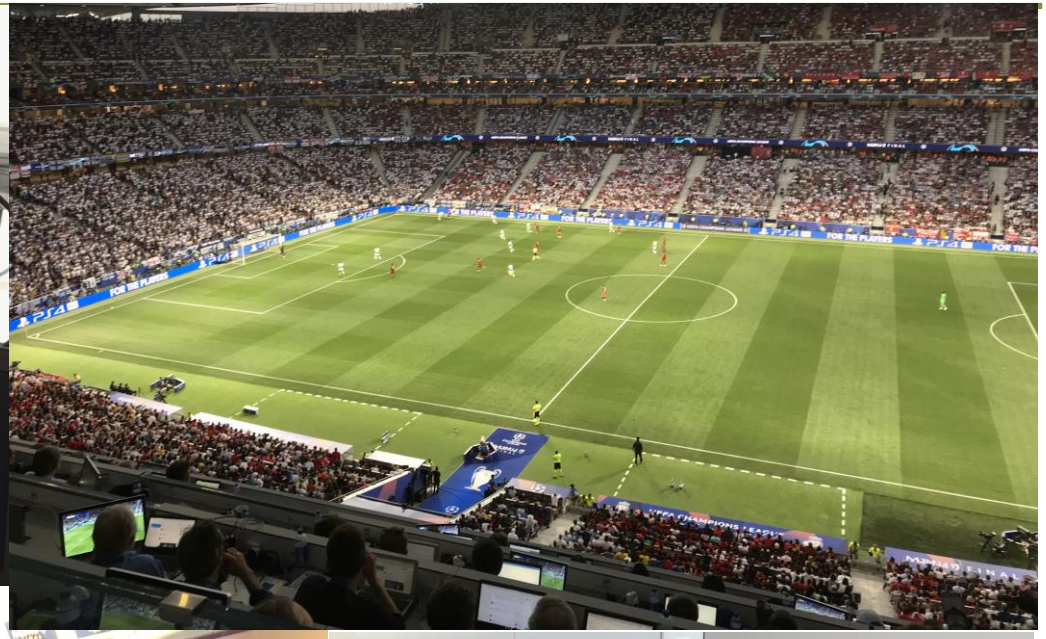



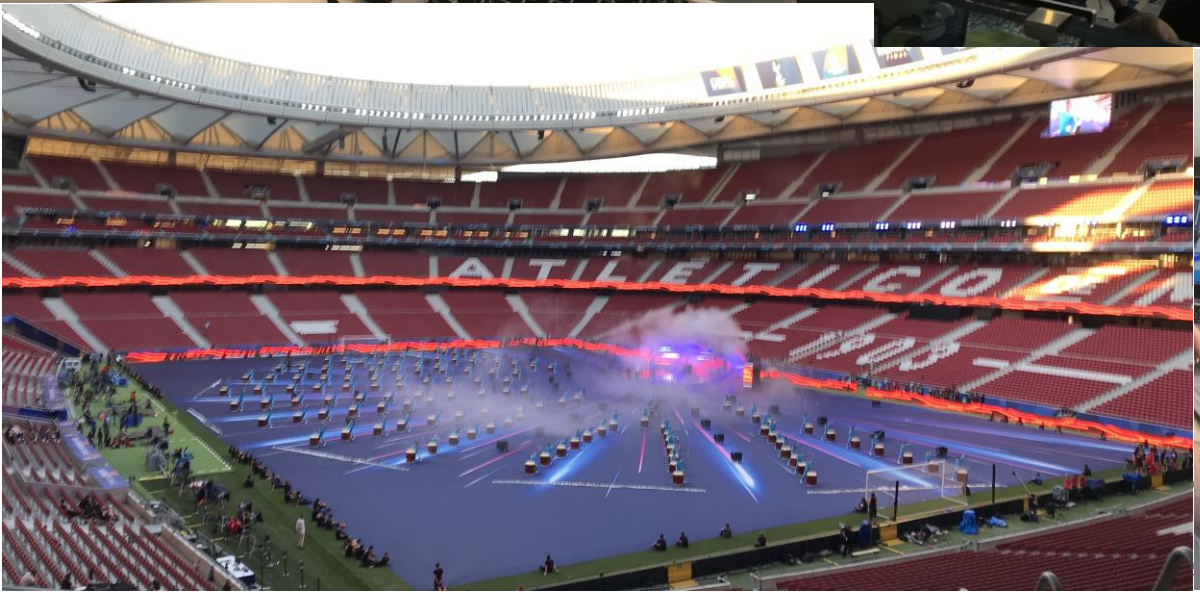

On right you see a small number of coordinated links during UEFA-2019. In background was a high density of DTT in the UHF TV band and a limited public interest because teams from a single country were in the final.

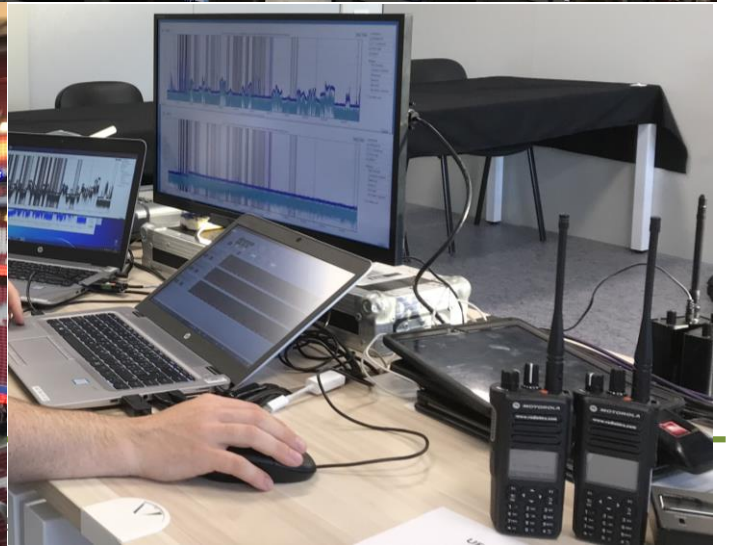
# Pictures of Events in Italy and Switzerland

Source: TPC









# Eurovision Song Contest (ESC)

## - 9 events -

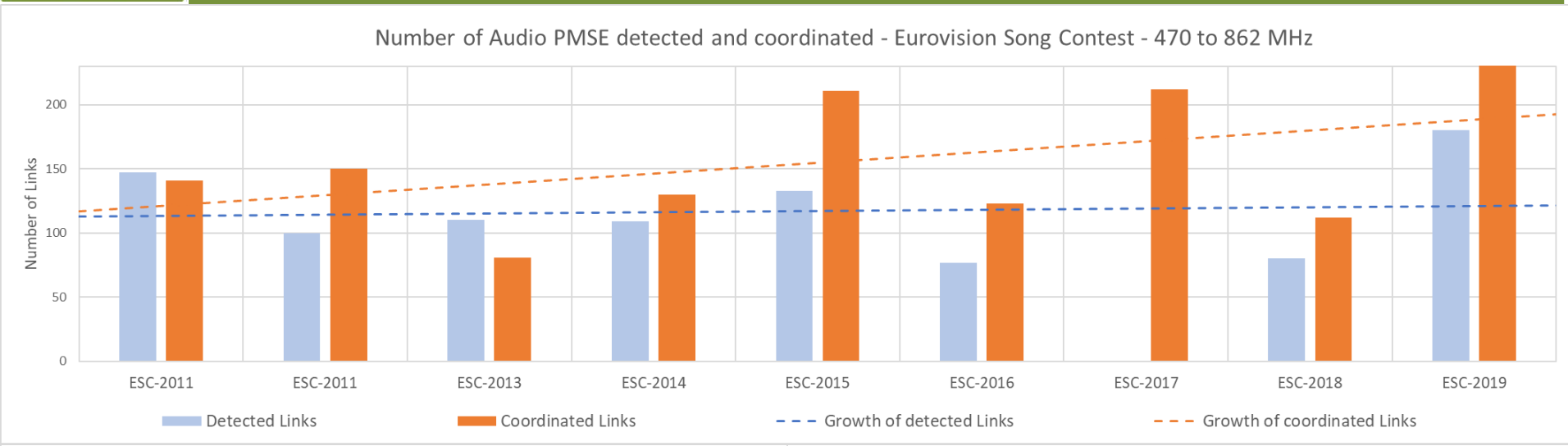
# List of events and countries of ESC

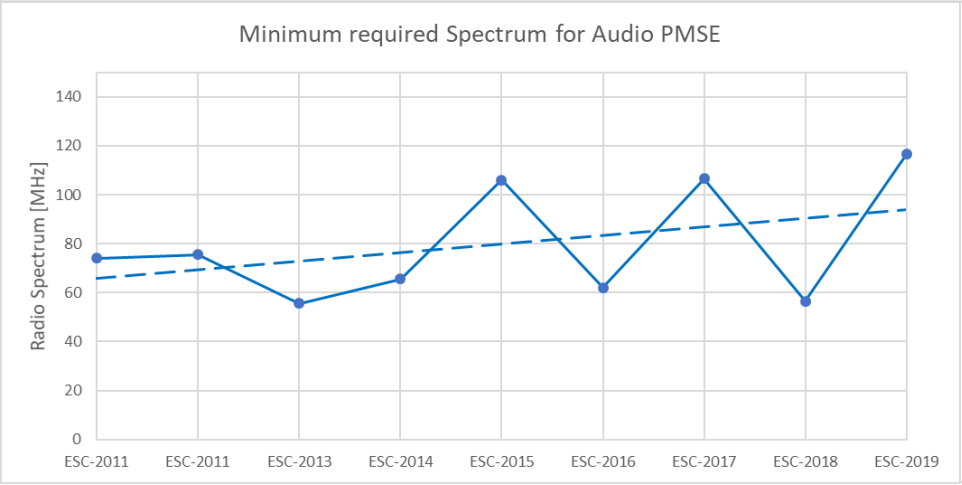
| No | Name | Short Name | Scan starts | Scan stoped | Start [MHz] | Stop [MHz] | Scan units | Avaiable [MHz] | Minimum required Spectrum [MHz] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Eurovision Song Contest 2011, Germany | ESC-2011 | 12.05.2011 | 15.05.2011 | 470 | 862 | 1 | 336 | **74,0** |
| 2 | Eurovision Song Contest 2012, Azerbaijan (short recording | ESC-2011 | 26.05.2012 | 26.05.2012 | 470 | 862 | 1 | 376 | **75,5** |
| 3 | Eurovision Song Contest 2013, Sweden (short recording) | ESC-2013 | 12.02.2013 | 14.02.2013 | 470 | 862 | 2 | 342 | **55,5** |
| 4 | Eurovision Song Contest 2014, Copenhagen | ESC-2014 | 24.04.2014 | 10.05.2014 | 470 | 862 | 1 | 201 | **65,5** |
| 5 | Eurovision Song Contest 2015, Austria | ESC-2015 | 06.05.2015 | 24.05.2015 | 470 | 862 | 2 | 304 | **106,0** |
| 6 | Eurovision Song Contest 2016, Sweden | ESC-2016 | 12.05.2016 | 15.05.2016 | 470 | 862 | 1 | 276 | **62,0** |
| 7 | Eurovision Song Contest 2017, Ukraine (EBU information) | ESC-2017 | 13.05.2019 | 13.05.2019 | 470 | 862 | 0 | 304 | **106,5** |
| 8 | Eurovision Song Contest 2018, Spain (short recording) | ESC-2018 | 12.05.2018 | 12.05.2018 | 470 | 862 | 1 | 316 | **56,5** |
| 9 | Eurovision Song Contest 2019, Israel (added EBU info) | ESC-2019 | 12.05.2018 | 12.05.2018 | 470 | 862 | 0 | 316 | **116,5** |

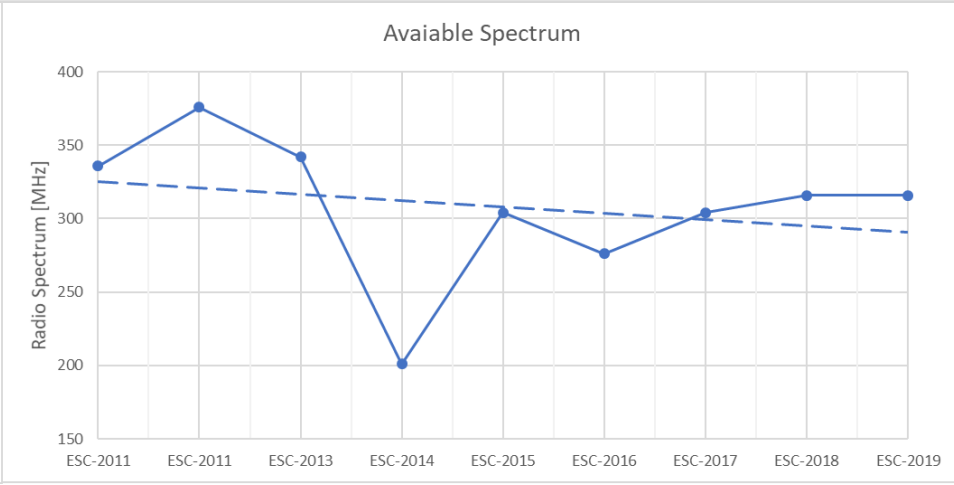
Input data | Output data | Estimation

# Eurovision Song Contest

## Event summary



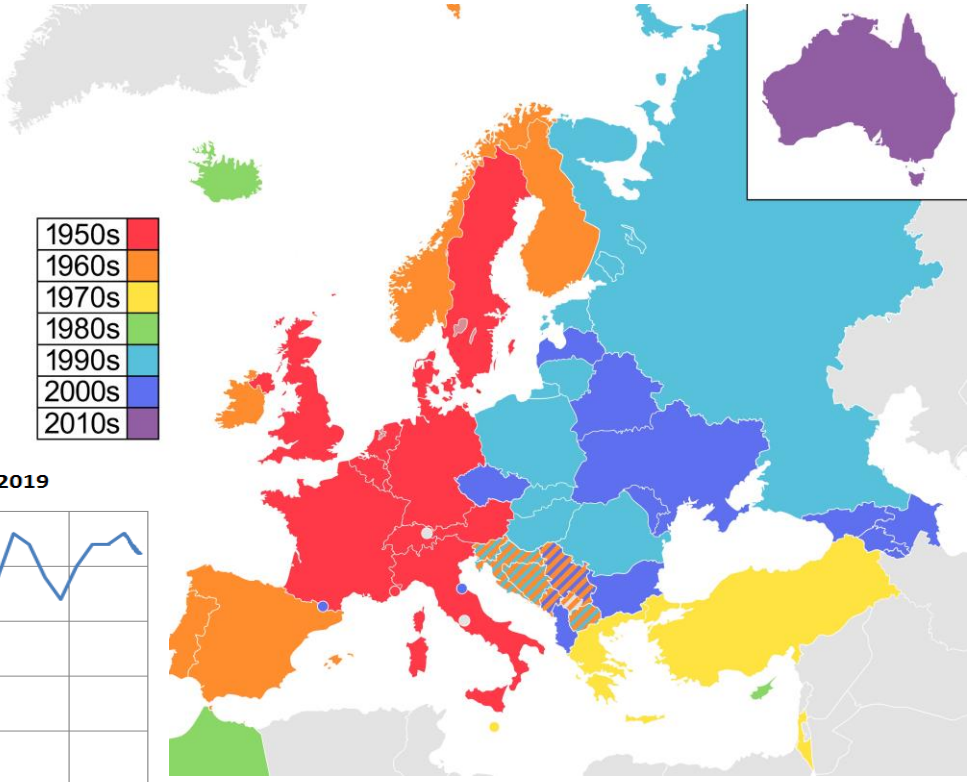



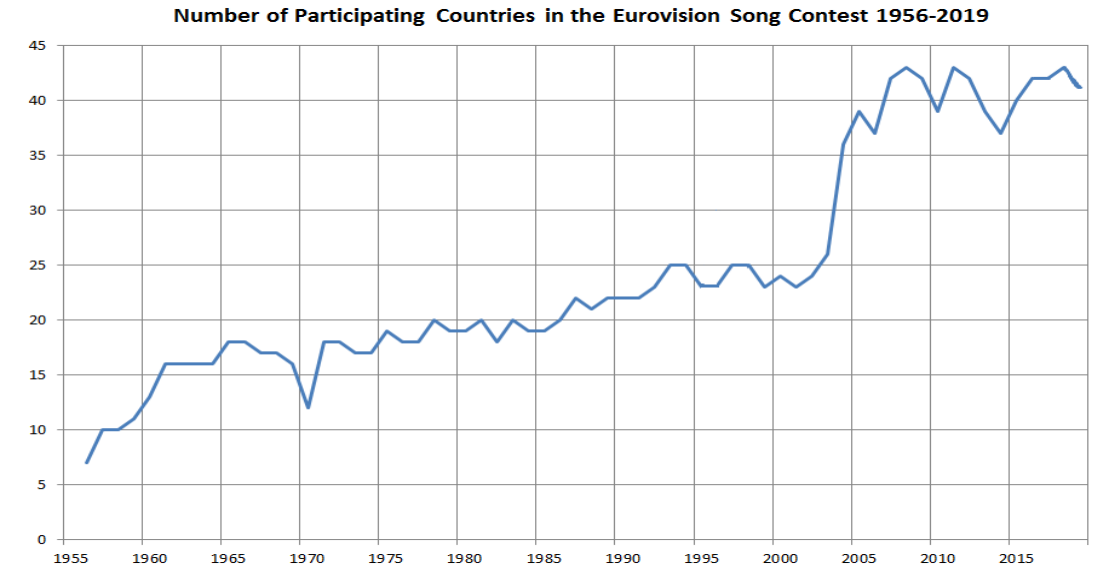

The Webpage of European Broadcast Union (EBU) shows for the Eurovision Song Contest these numbers of wireless Microphones and IEM; 2017: 212 / 2019: 232

# Some background information of ESC

Source: WIKIPEDIA

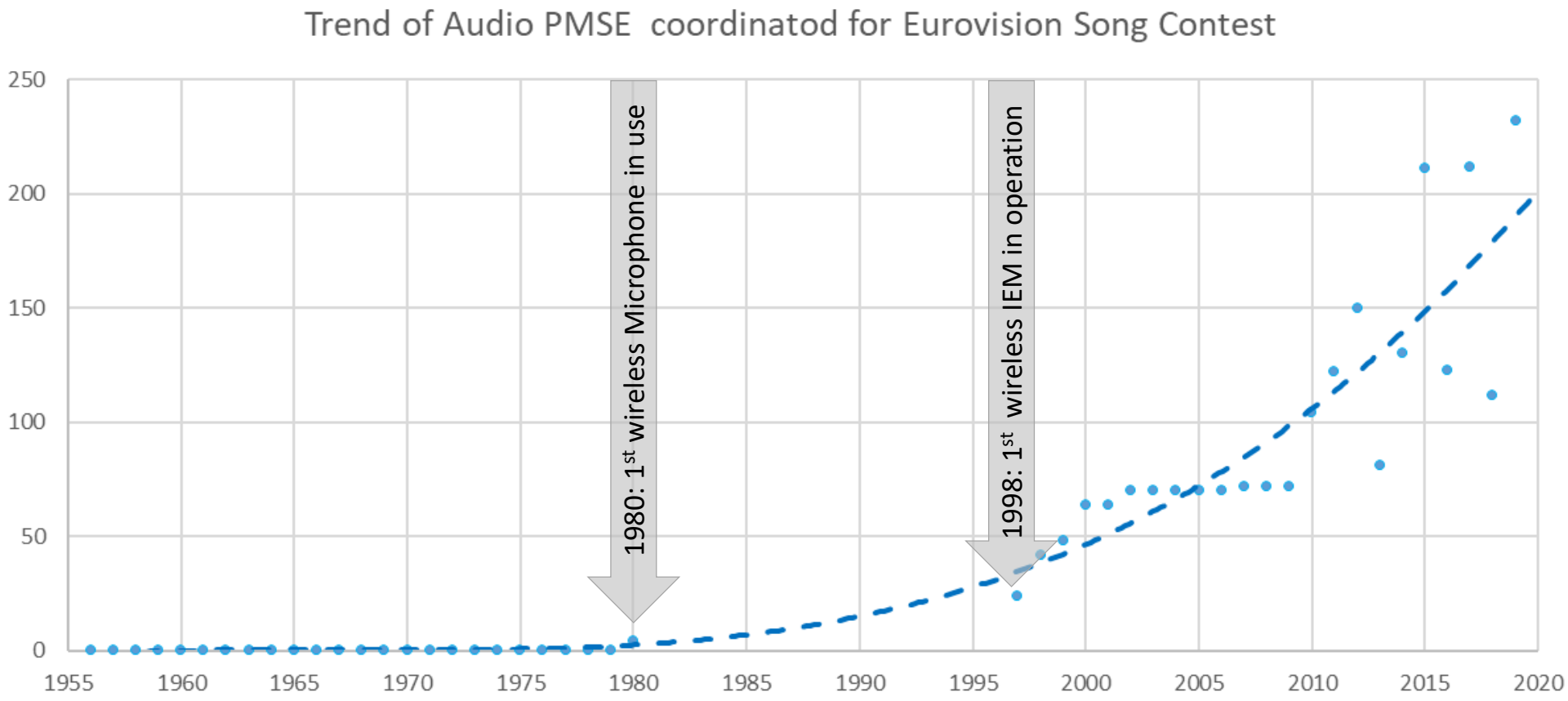
Eurovision has been broadcasting every year since its inauguration in 1956, making it the longest-running annual international television contest and one of the world's longest-running television programmes.
It is also one of the most watched non-sporting events, with audience figures of between 100 million and 600 million internationally



# Some background information of ESC

Information researched by APWPT



# Upcoming ESC in 2020

- The preparation of the next Eurovision Song Contest (ESC2020) has already begun. Many frequencies for wireless production tools have to be coordinated well in advance. In order to ensure the required production quality for all participating nations, several possible interference scenarios must be considered and discussed.
- Interestingly, with regards to the 700 MHz frequency band, The Netherlands (NL) has announced that it will only start mobile phone deployment in the 700 MHz band after completion of the ESC2020 production.
- What will happen if the Netherlands wins the 2020 ESC?

# Results of Spectrum Recordings

## - Switzerland -

## - 35 events or event segments -

# List of Recordings - Switzerland

## Event summary (1)

| No | Name | Short Name | Scan starts | Scan stoped | Start [MHz] | Stop [MHz] | Scan units | Avaiable for PMSE [MHz] | Minimum required Spectrum [MHz] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Einsiedler Welttheater | EWT-210613 | 21.06.2013 | 21.06.2013 | 470 | 862 | 1 | 368 | **41,5** |
| 2 | Art on Ice 2015 | AOI-070215 | 07.02.2015 | 07.02.2015 | 470 | 862 | 1 | 364 | **24,5** |
| 3 | Swiss Music Award 2015 | SMA-270215 | 27.02.2015 | 27.02.2015 | 470 | 862 | 1 | 364 | **49,5** |
| 4 | FIFA Congress Zürich 2015 | FKZ-290515 | 29.05.2015 | 29.05.2015 | 470 | 862 | 1 | 364 | **36,0** |
| 5 | 1st Scan Section of Open Air Frauenfeld 2015 | OAF-090715 | 09.07.2015 | 10.07.2015 | 470 | 862 | 1 | 336 | **111,0** |
| 6 | 2nd Scan Section of Open Air Frauenfeld 2015 | OAF-110715 | 11.07.2015 | 12.07.2015 | 470 | 862 | 1 | 336 | **78,0** |
| 7 | Weltklasse Zürich 2015 | WKZ-030915 | 03.09.2015 | 03.09.2015 | 470 | 862 | 1 | 316 | **46,5** |
| 8 | Energy Stars for Free 2015 | ESF-131115 | 13.11.2015 | 13.11.2015 | 470 | 862 | 1 | 324 | **69,0** |
| 9 | FIFA Ballon d'Or Zurich 2016 | FBO-100116 | 10.01.2016 | 11.01.2016 | 470 | 862 | 1 | 324 | **62,0** |
| 10 | Swiss Music Award 2016 | SMA-120216 | 12.02.2016 | 12.02.2016 | 470 | 862 | 1 | 324 | **59,5** |
| 11 | Opening of the Gotthard Base Tunnel | GBT-310516 | 31.05.2016 | 01.06.2016 | 470 | 862 | 2 | 324 | **156,5** |
| 12 | Euroleague Final Basel 2016 | EFB-010616 | 01.06.2016 | 01.06.2016 | 470 | 862 | 2 | 344 | **141,0** |
| 13 | Energy Air 2016 Bern | EAB-030916 | 03.09.2016 | 03.09.2016 | 470 | 862 | 1 | 392 | **83,5** |
| 14 | Energy Stars for Free 2016 | ESF-030916 | 03.09.2016 | 03.09.2016 | 470 | 862 | 2 | 316 | **83,5** |
| 15 | Energy Star Night 2016 | ESN-251116 | 25.11.2016 | 25.11.2016 | 470 | 862 | 1 | 324 | **50,0** |
| 16 | 1st Scan Section of Alpine World Ski Championships 2017 | AWS 010217 | 01.02.2017 | 03.02.2017 | 470 | 862 | 1 | 308 | **176,5** |
| 17 | 1st Scan Section of Art on Ice 2017 | AOI-040217 | 04.02.2017 | 04.02.2017 | 470 | 862 | 3 | 300 | **47,3** |
| 18 | 2nd Scan Section of Alpine World Ski Championships 2017 | AWS 040217 | 04.02.2017 | 06.02.2017 | 470 | 862 | 1 | 308 | **173,5** |
| 19 | 3rd Scan Section of Alpine World Ski Championships 2017 | AWS 070217 | 07.02.2017 | 09.02.2017 | 470 | 862 | 1 | 308 | **173,0** |

Input data  Output data

# List of Recordings - Switzerland

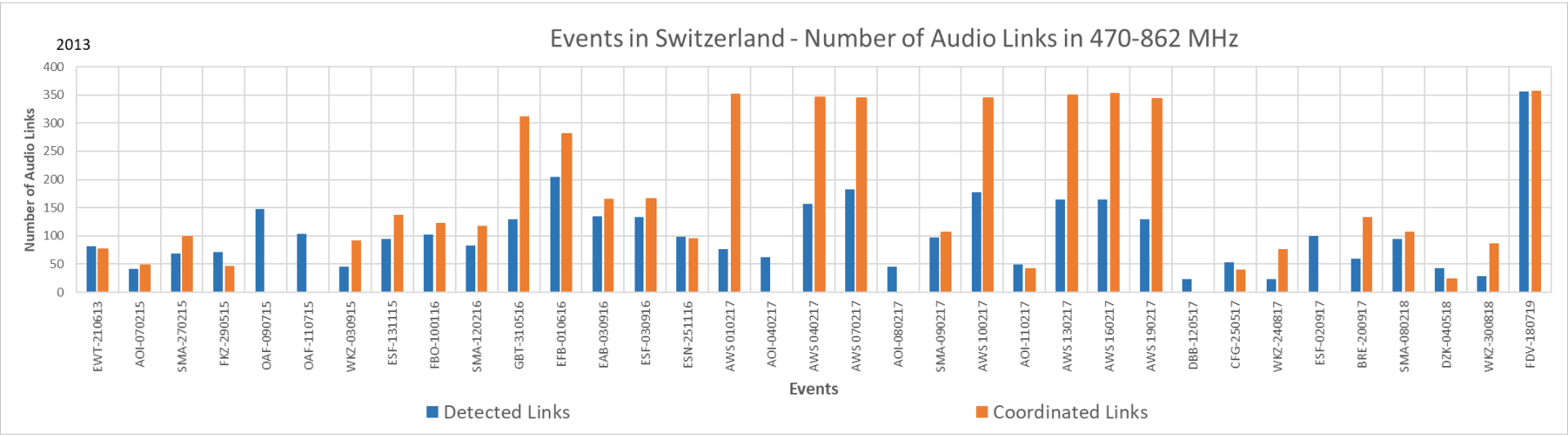
## Event summary (2)

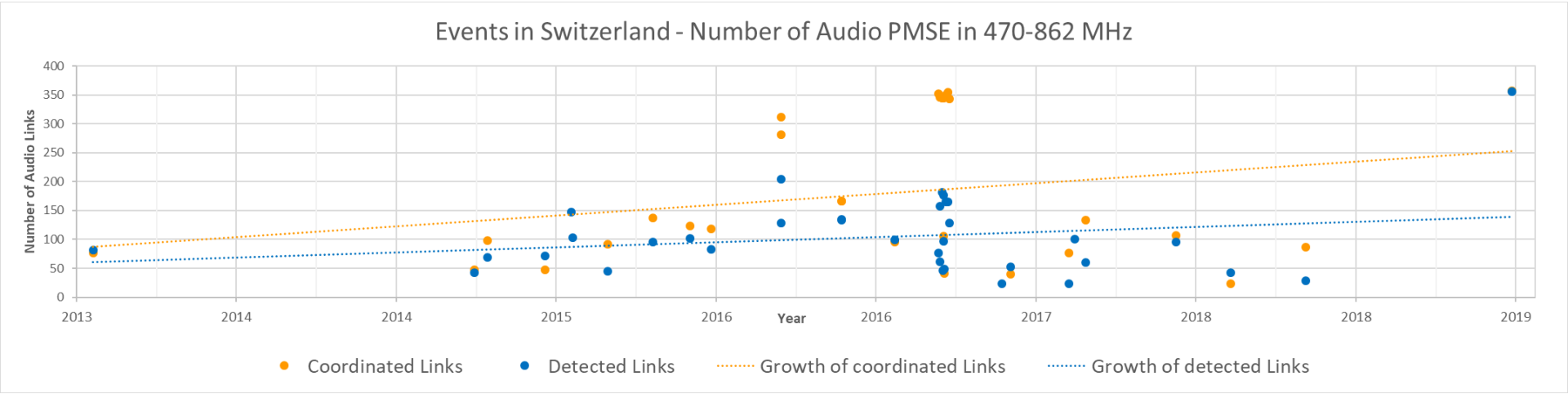
| No | Name | Short Name | Scan starts | Scan stoped | Start [MHz] | Stop [MHz] | Scan units | Avaiable for PMSE [MHz] | Minimum required Spectrum [MHz] |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 2nd Scan Section of Art on Ice 2017 | AOI-080217 | 08.02.2017 | 08.02.2017 | 470 | 862 | 3 | 300 | **35,3** |
| 21 | Swiss Music Award 2017 | SMA-090217 | 09.02.2017 | 10.02.2017 | 470 | 862 | 1 | 324 | **53,5** |
| 22 | 4st Scan Section of Alpine World Ski Championships 2017 | AWS 100217 | 10.02.2017 | 12.02.2017 | 470 | 862 | 1 | 308 | **173,0** |
| 23 | 3rd Scan Section of Art on Ice 2017 | AOI-110217 | 11.02.2017 | 11.02.2017 | 470 | 862 | 3 | 300 | **25,0** |
| 24 | 5th Scan Section of Alpine World Ski Championships 2017 | AWS 130217 | 13.02.2017 | 15.02.2017 | 470 | 862 | 1 | 308 | **175,0** |
| 25 | 6th Scan Section of Alpine World Ski Championships 2017 | AWS 160217 | 16.02.2017 | 18.02.2017 | 470 | 862 | 1 | 308 | **177,5** |
| 26 | 7th Scan Section of Alpine World Ski Championships 2017 | AWS 190217 | 19.02.2017 | 19.02.2017 | 470 | 862 | 1 | 308 | **172,0** |
| 27 | DEVIGUS BKW 2017 BERN | DBB-120517 | 12.05.2017 | 12.05.2017 | 470 | 862 | 1 | 316 | **18,0** |
| 28 | Cap Finale Geneva | CFG-250517 | 25.05.2017 | 25.05.2017 | 470 | 862 | 1 | 260 | **27,0** |
| 29 | Weltklasse Zürich 2017 | WKZ-240817 | 24.08.2017 | 24.08.2017 | 470 | 862 | 1 | 324 | **39,0** |
| 30 | Energy Stars for Free 2017 | ESF-020917 | 02.09.2017 | 02.09.2017 | 470 | 862 | 1 | 316 | **75,8** |
| 31 | Bundesrat Election 2017 | BRE-200917 | 20.09.2017 | 20.09.2017 | 470 | 862 | 1 | 332 | **67,0** |
| 32 | Swiss Music Award 2018 | SMA-080218 | 08.02.2018 | 09.02.2018 | 470 | 862 | 1 | 324 | **54,0** |
| 33 | DEVIGUS - ZUGER KB 2018 | DZK-040518 | 04.05.2018 | 05.05.2018 | 470 | 862 | 1 | 324 | **22,0** |
| 34 | Weltklasse Zürich 2018 | WKZ-300818 | 30.08.2018 | 30.08.2018 | 470 | 862 | 1 | 324 | **44,0** |
| 35 | Fête des Vignerons 2019 (SDB2-Import) | FDV-180719 | 18.07.2019 | 11.08.2019 | 470 | 862 | 1 | 274 | **179,0** |

Input data  Output data

# Output of Spectrum Recordings - Switzerland

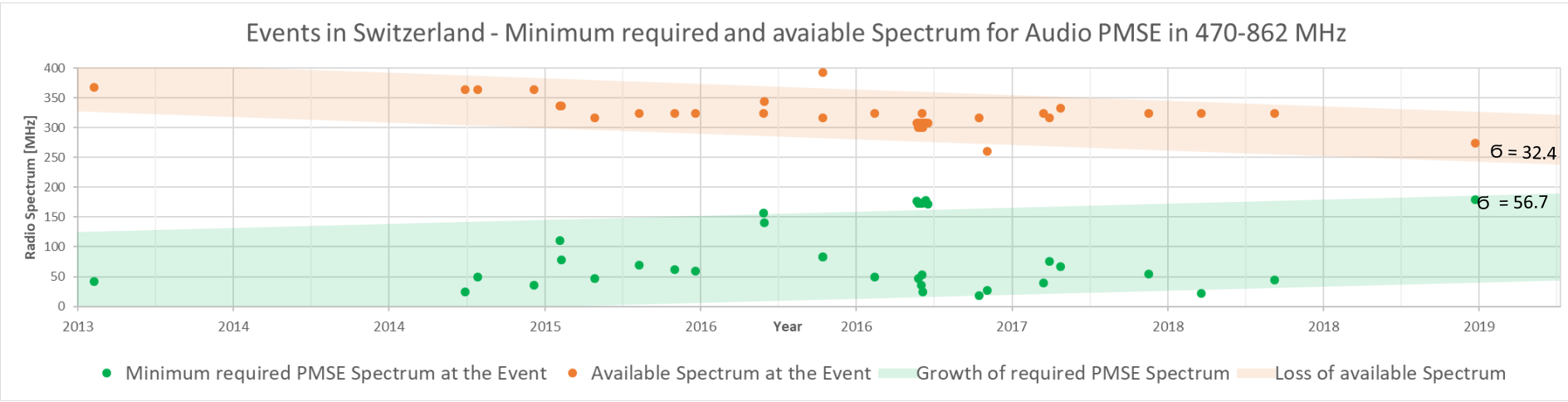
## Statistic of coordinated and detected Audio PMSE

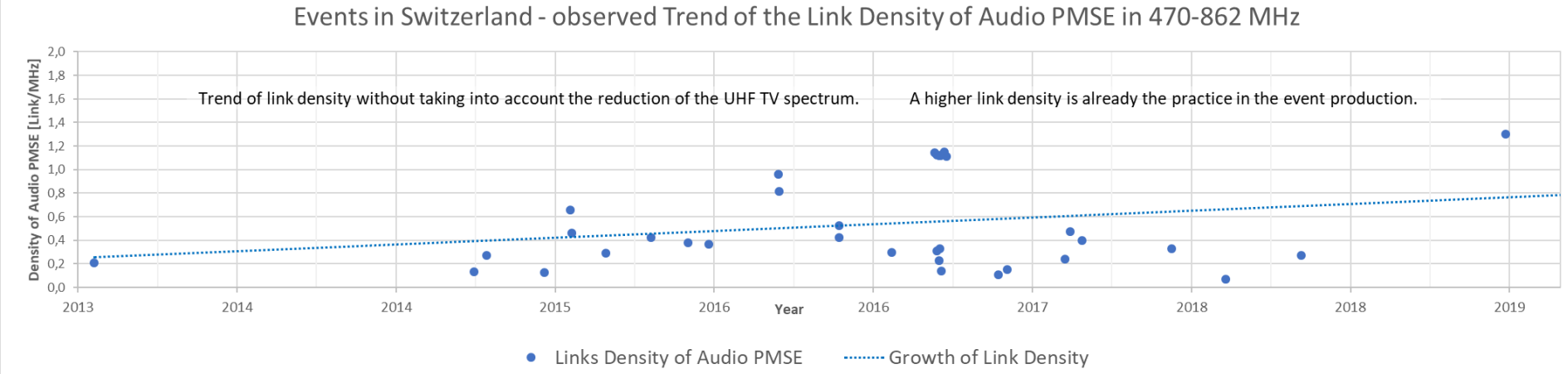


# Output of Spectrum Recordings - Switzerland

## Available and required Spectrum and Density of Audio PMSE



# Summary of spectrum recordings in CH

1. The recorded scenarios show that the number of detected and coordinated audio PMSE links is increasing.
   Note: because some coordination information was not available, a stronger growth must be assumed here.
2. The use of digital audio PMSE increases link density.
   However, this trend is only applicable to limited scenarios.
   In particular, events that require mixed equipment and high usage density, utilising PMSE equipment sourced from many different countries, will not fully benefit from audio PMSE digitisation.
3. It can be demonstrated that the availability of spectrum for PMSE equipment deployment has decreased over the years.
   Note: here we must take into account the recently changed situation of terrestrial television transmission in Switzerland.
   However, in the border regions, close to neighbouring countries, there is still a complex situation of frequency use for audio PMSE.

# Result of Spectrum Recordings

## - Germany -

## - 38 events or event segments -

# List of Spectrum Recordings - Germany

## Event summary (1)

| No | Name | Short Name | Scan starts | Scan stoped | Start [MHz] | Stop [MHz] | Scan units | Avaiable for PMSE [MHz] | Minimum required Spectrum [MHz] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Live Earth Hamburg 2007 | LEH-060707 | 06.07.2007 | 06.07.2007 | 470 | 862 | 1 | 392 | **56,8** |
| 2 | Prolight+Sound Frankfurt 2007 | PLS-270307 | 27.03.2007 | 31.03.2007 | 470 | 862 | 1 | 312 | **125,8** |
| 3 | Plenarsitzung im Bundesrat Berlin 2007 | PBB-230607 | 22.06.2007 | 23.06.2007 | 470 | 862 | 1 | 336 | **41,0** |
| 4 | Landtagswahl Niedersachsen 2008 | GE2008-01 | 27.01.2008 | 27.01.2008 | 470 | 862 | 1 | 352 | **162,5** |
| 5 | Bürgerschaftswahlen Hamburg 2008 | GE2008-02 | 24.02.2008 | 24.02.2008 | 470 | 862 | 2 | 344 | **128,5** |
| 6 | Landtagswahl Bayern 2008 | GE2008-09 | 28.09.2008 | 28.09.2008 | 470 | 862 | 2 | 328 | **111,5** |
| 7 | Bürgerschaftswahlen Hamburg 2011 | GE2011-02 | 20.02.2011 | 20.02.2011 | 470 | 862 | 2 | 328 | **103,5** |
| 8 | Landtagswahl Sachsen Anhalt 2011 | GE2011-031 | 20.03.2011 | 20.03.2011 | 470 | 862 | 2 | 368 | **54,5** |
| 9 | Landtagswahl Baden Württemberg 2011 | GE2011-032 | 27.03.2011 | 27.03.2011 | 470 | 862 | 1 | 368 | **83,0** |
| 10 | Landtagswahl Rheinlad-Pfalz 2011 | GE2011-033 | 27.03.2011 | 27.03.2011 | 470 | 862 | 1 | 336 | **74,0** |
| 11 | Eurovision Song Contest 2011, Düsseldorf | ESC-120511 | 12.05.2011 | 15.05.2011 | 470 | 862 | 1 | 336 | **74,0** |
| 12 | Bremer Bürgerschaftswahl 2011 | BBW-220511 | 22.05.2011 | 22.05.2011 | 470 | 862 | 2 | 339 | **80,0** |
| 13 | Landtagswahl Mecklenburg-Vorpommern 2011 | GE2011-091 | 04.09.2011 | 04.09.2011 | 470 | 862 | 2 | 324 | **82,3** |
| 14 | International Motor Show Germany - IAA 2011 | IAA-150911 | 15.09.2011 | 16.09.2011 | 470 | 862 | 1 | 352 | **98,8** |
| 15 | Wahl zum Berliner Abgeordnetenhaus 2011 | GE2011-092 | 18.09.2011 | 18.09.2011 | 470 | 862 | 1 | 336 | **98,0** |
| 16 | Wahl zum Schleswig-Holsteinischen Landtag 2012 | GE2012-051 | 06.05.2012 | 06.05.2012 | 470 | 862 | 3 | 344 | **114,5** |
| 17 | DFB Pokalfinale Berlin 2012 | DFB-120512 | 12.05.2012 | 12.05.2012 | 470 | 862 | 3 | 300 | **95,0** |
| 18 | Landtagswahl in Nordrhein-Westfalen 2012 | GE2012-052 | 13.05.2012 | 13.05.2012 | 470 | 862 | 2 | 324 | **68,0** |
| 19 | 179th Oktoberfest Munich 2012 | OFM-210912 | 21.09.2012 | 22.09.2012 | 470 | 862 | 1 | 300 | **68,8** |
| 20 | Landtagswahl in Niedersachsen 2013 | GE2013-01 | 20.01.2013 | 20.01.2013 | 470 | 862 | 3 | 326 | **154,0** |

Input data  Output data

# List of Spectrum Recordings - Germany

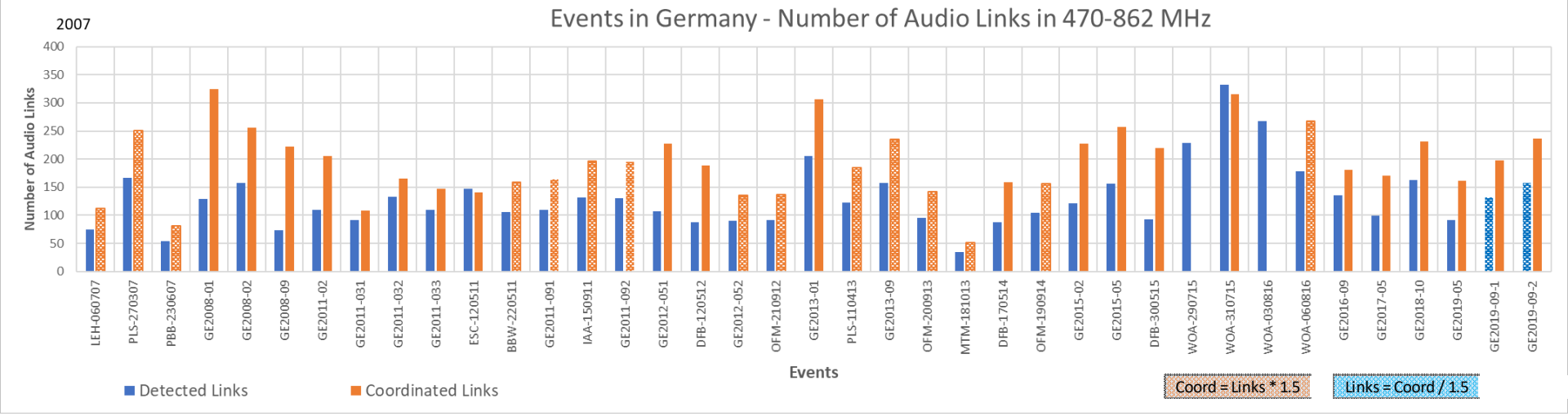
## Event summary (2)

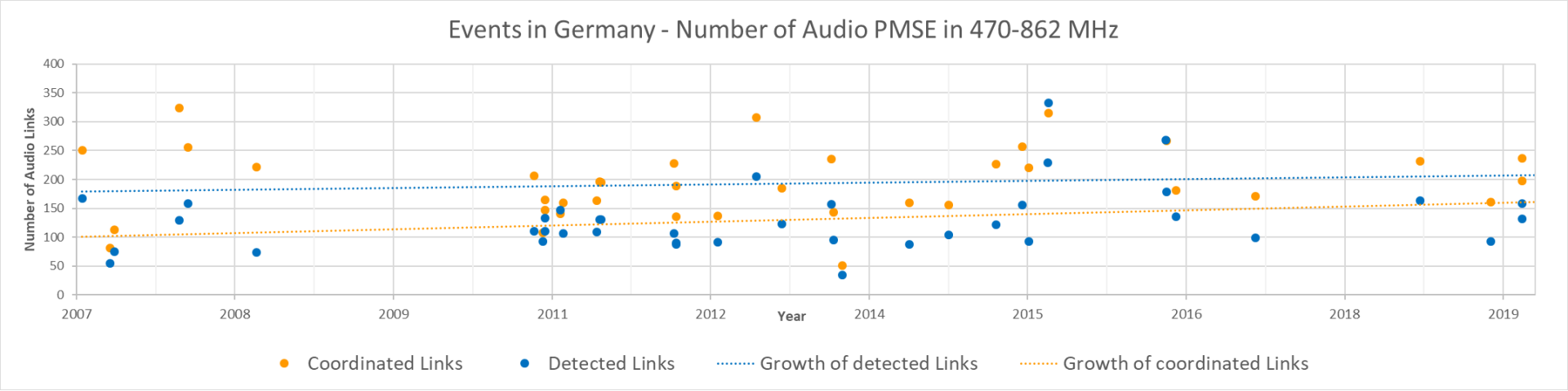
| No | Name | Short Name | Scan starts | Scan stoped | Start [MHz] | Stop [MHz] | Scan units | Avaiable for PMSE [MHz] | Minimum required Spectrum [MHz] |
|---|---|---|---|---|---|---|---|---|---|
| 21 | Prolight+Sound Frankfurt 2013 | PLS-110413 | 11.04.2013 | 12.04.2013 | 470 | 862 | 2 | 180 | **92,8** |
| 22 | Landtagswahl in Bayern 2013 | GE2013-09 | 15.09.2013 | 15.09.2013 | 470 | 862 | 3 | 280 | **118,3** |
| 23 | 180th Oktoberfest Munich 2013 | OFM-200913 | 20.09.2013 | 21.09.2013 | 470 | 862 | 2 | 256 | **71,8** |
| 24 | Medientage Munich 2013 | MTM-181013 | 18.10.2013 | 18.10.2013 | 470 | 862 | 1 | 296 | **26,0** |
| 25 | DFB Pokalfinale Berlin 2014 | DFB-170514 | 17.05.2014 | 17.05.2014 | 470 | 862 | 3 | 270 | **80,0** |
| 26 | 181th Oktoberfest Munich 2014 | OFM-190914 | 19.09.2014 | 20.09.2014 | 470 | 862 | 2 | 252 | **78,5** |
| 27 | Bürgerschaftswahlen Hamburg 2015 | GE2015-02 | 15.02.2015 | 15.02.2015 | 470 | 862 | 2 | 288 | **114,0** |
| 28 | Bürgerschaftswahl in Bremen 2015 | GE2015-05 | 10.05.2015 | 10.05.2015 | 470 | 862 | 2 | 296 | **129,0** |
| 29 | DFB Pokalfinale Berlin 2015 | DFB-300515 | 30.05.2015 | 30.05.2015 | 470 | 862 | 3 | 272 | **110,5** |
| 30 | Wacken Open Air 2015, 1st and 2nd day | WOA-290715 | 29.07.2015 | 30.07.2015 | 470 | 862 | 2 | 328 | **172,5** |
| 31 | Wacken Open Air 2015, 3rd to 5th day | WOA-310715 | 31.07.2015 | 02.08.2015 | 470 | 862 | 2 | 328 | **166,5** |
| 32 | Wacken Open Air 2016, 1st to 3rd day | WOA-030816 | 03.08.2016 | 05.08.2016 | 470 | 862 | 2 | 308 | **201,8** |
| 33 | Wacken Open Air 2016, 4th and 5th day | WOA-060816 | 06.08.2016 | 07.08.2016 | 470 | 862 | 2 | 308 | **134,0** |
| 34 | Landtagswahl Mecklenburg-Vorpommern 2016 | GE2016-09 | 04.09.2016 | 04.09.2016 | 470 | 862 | 1 | 328 | **91,0** |
| 35 | Landtagswahl in Nordrhein-Westfalen 2017 | GE2017-05 | 14.05.2017 | 14.05.2017 | 470 | 862 | 2 | 276 | **86,0** |
| 36 | Landtagswahl Bayern 2018 | GE2018-10 | 14.10.2018 | 14.10.2018 | 470 | 862 | 2 | 268 | **116,0** |
| 37 | Bremer Bürgerschaftswahl 2019 | GE2019-05 | 26.05.2019 | 26.05.2019 | 470 | 862 | 2 | 284 | **81,0** |
| 38 | Landtagswahl Brandenburg 2019 (Coordination only) | GE2019-09-1 | 01.09.2019 | 01.09.2019 | 470 | 862 | 0 | 284 | **99,5** |
| 39 | Landtagswahl Sachsen 2019 (Coordination only) | GE2019-09-2 | 01.09.2019 | 01.09.2019 | 470 | 862 | 0 | 276 | **119,0** |

Input data  Output data

# Output of Spectrum Recordings - Germany

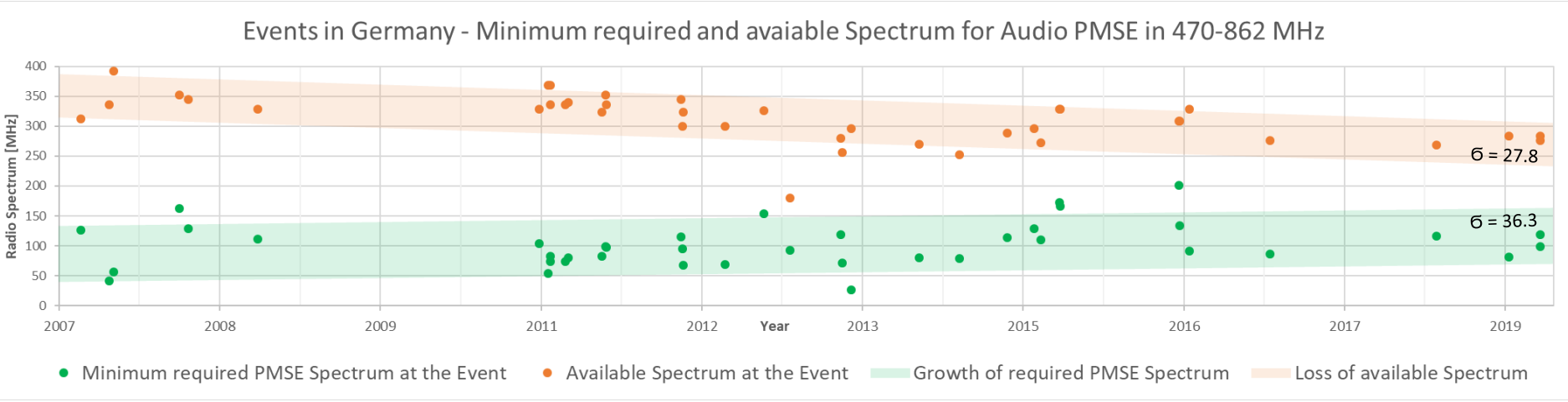
## Statistic of coordinated and detected Audio PMSE

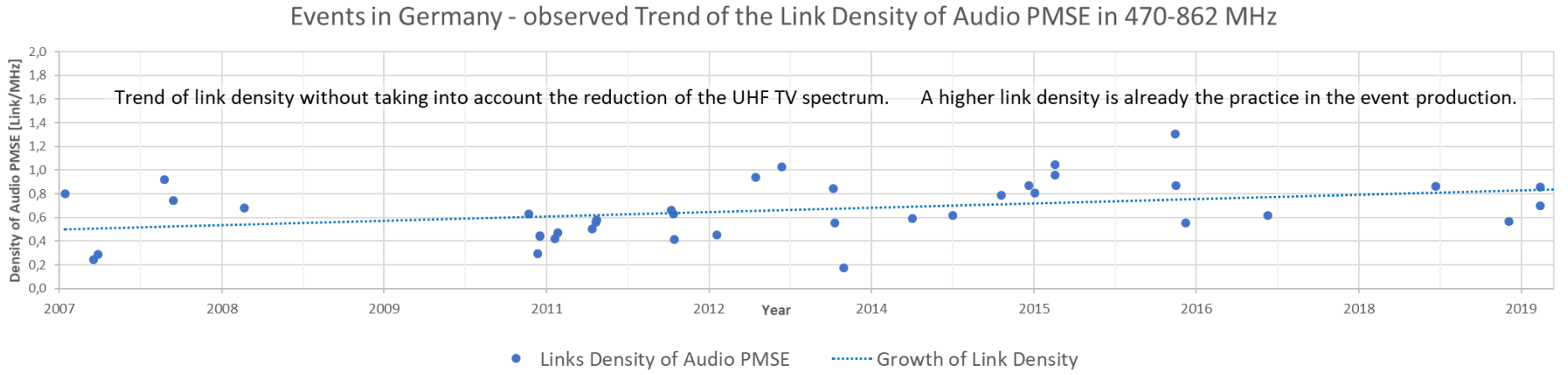


# Output of Spectrum Recordings - Germany

## Available and required Spectrum and Density of Audio PMSE

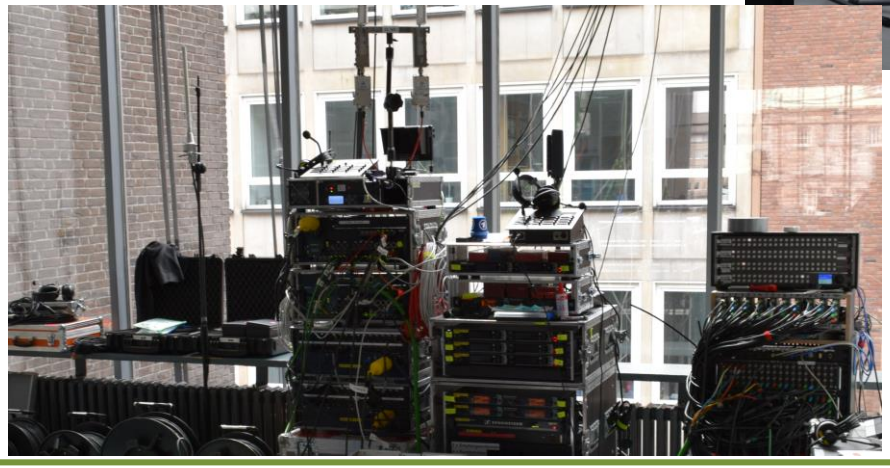


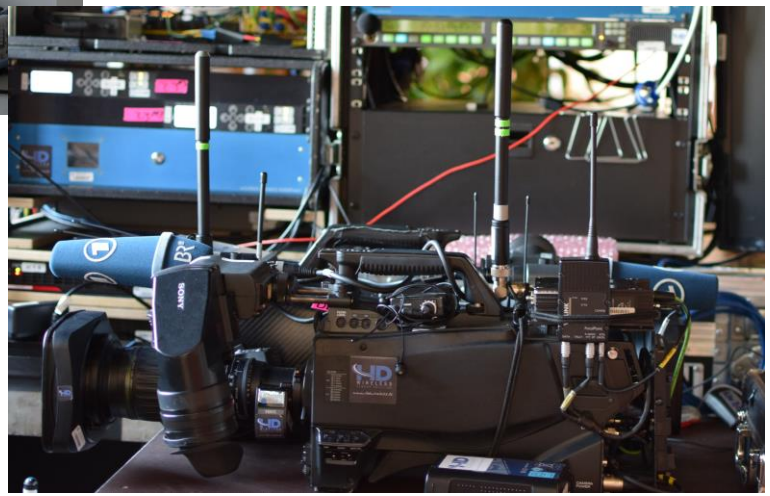



# Summary of spectrum recordings in D

1. The recorded scenarios show that the number of detected and coordinated audio PMSE links is increasing.
   Note: because some coordination information was not available, a stronger growth must be assumed here.
2. The use of digital audio PMSE increases link density. However, this trend is only applicable to limited scenarios. In particular, events that require mixed equipment and high usage density, utilising PMSE equipment sourced from many different countries, will not fully benefit from audio PMSE digitisation.
3. It can be demonstrated that the availability of spectrum for PMSE equipment deployment has decreased over the years.
   Note: in metropolitan areas and in the border regions, close to neighboring countries, there is still a highly complex situation for frequency use by audio PMSE.

# Pictures of Events in Germany





Source: APWPT

# Summary

# Summary (1)

- Over a period of many years now, the use of spectrum by wireless production tools had been observed during events and the collected data has been evaluated.

- The presented data indicates that;
  - the use of radio spectrum is **increasing** and
  - the available radio spectrum in the UHF TV band is **decreasing**

- So far, the observed audio PMSE technology improvements are limited in their ability to totally resolve these fundamental issues.

# Summary (2)

- The data presented here was recorded before IMT implementation in the 700 MHz range.

- Therefore, it is **urgently required** that this additional loss of up to 100 MHz is very carefully considered in…
  - International working groups
  - The national allocation of 1350-1400 and 1518-1525 MHz
  - By production teams in the preparation of events and content production for the future

# Information on PMSE Workshops

- 1st PMSE WS, Nuremberg 2013
  https://www.apwpt.org/history/germany/2013/index.html#710036a256110b501
- 2nd PMSE WS, Paris 2015
  https://www.apwpt.org/history/paris/2015/index.html#213440a50d0820403
- 3rd PMSE WS, London 2016
  https://www.apwpt.org/h2/united-kingdom/2016/index.html#213440a6600767c02
- 4th PMSE WS, Nuremberg 2017
  https://www.apwpt.org/history/germany/2017/index.html#730133a73e04e4c02
- 5th PMSE WS, Paris 2019
  https://www.apwpt.org/history/paris/2019/index.html#336668aa3b0e2c10b

- Introductory WEB page
  https://www.apwpt.org/h3/fau-and-apwpt---pmse-workshops-at-eumw/index.html#336668aa490d06606

# How to get further information?



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