

Monitoring radio spectrum use within the context of the Eurovision Song Contest 2011 An event in Düsseldorf, Germany

A report by the DKE WG 731.0.8
“Professional Wireless Microphones and Event Technology”

Baiersdorf (D), December 2011

Preface

The Eurovision Song Contest (ESC) has been a major annual TV spectacle that has been broadcast in Europe and parts of the Middle East since 1956. The organizer of the event is the European Broadcast Union (EBU). There are 74 radio and television stations from Europe, North Africa and the Middle East as well as 36 associate members in the EBU.

The EBU member countries from these regions compete against one another in the music contest. The winner of the contest becomes the host of the event in the following year. Accordingly, a great deal of attention is given to perfect technical implementation since the ESC is an “event of national interest” for the host country.

The reports leading up to the event and during the ESC event give spectators a glimpse into the host country.

This year, the event was hosted at the “ESPRIT Arena” in Düsseldorf. It provides the best conditions for television production and can accommodate 35,000 spectators.

DKE-AK 731.0.8 had the opportunity to watch the event and in the following, reports about the experience.

Matthias Fehr, Bruno Marx, Norbert Hilbich



Picture: Matthias Fehr

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Eurovision Song Contest 2011

The major event in public presentation

The European Broadcasting Union (EBU) summarizes the event

70 million saw Eurovision Song Contest Final

.. This brings the cumulative number of viewers for the three live shows to 114,5 million, nearly 9 million more than last year.

The 2011 Eurovision Song Contest was broadcast on television in all 43 participating countries, as well as in Kosovo, Kazakhstan, Australia and New Zealand, as well as worldwide on the internet. 15 national radio stations aired Europe's favourite TV show.

Records crushed

"The Eurovision Song Contest doesn't only stand for 7.5 hours of high-quality live entertainment, it is also a ratings success across Europe. Several broadcasters saw old records crushed, reporting to the EBU massive viewer interest," says Jon Ola Sand, the Executive Supervisor of the Eurovision Song Contest on behalf of the EBU. "There is something magical about having so many people across Europe and around the world doing the same thing at the same time," Sand added.

Increase in social media activity

The online live streams of the three shows generated 804,000 viewing sessions. In the lead up to the 2011 contest in Germany, the official website www.eurovision.tv generated some 87 million page views, which is 8% more than last year.

"We saw a significant increase in social media activity this year, with almost 400,000 registered fans on Facebook and several global trending topics on Twitter during the live shows. This means a lot to us, since we are eager to involve a new generation of dedicated viewers with the Eurovision Song Contest,"..

(Quelle: Jarmo Siim, http://www.eurovision.tv/page/news?id=36773&t=70_million_saw_eurovision_song_contest_final)

Use of modern technology and significant event expenses

“EventElevator” on the technology

85 km of cable, a 350,000 watt PA and 2,160 spotlights.

The Eurovision Song Contest 2011 is over and the technical prowess really stood out, especially behind the scenes: countless people quietly ensured that what may well be the most spectacular event of the year went off without a hitch.

Whether it was the unbelievable amount of material mounted aurally, or the fact that the roof of the arena served as a reflector for radio signals from the microphones: there was little about the ESC in Düsseldorf that was not extraordinary.



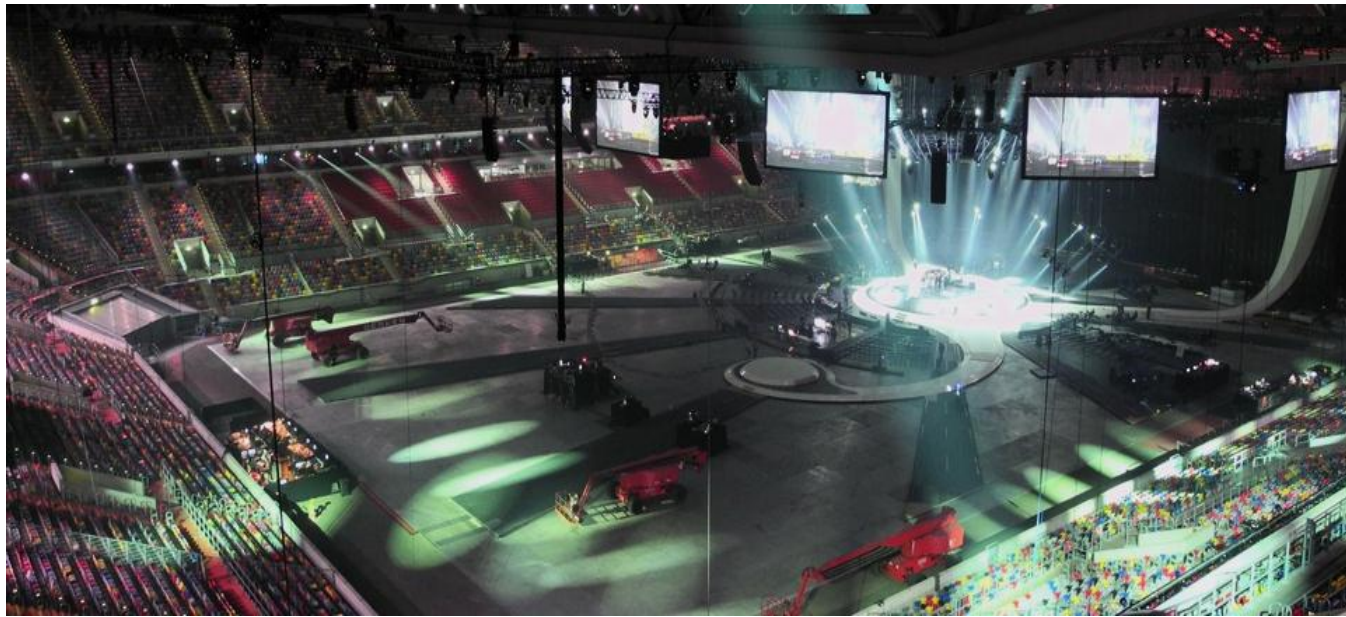
Picture: Matthias Fehr

Approximately 300 trucks transported around 220 tons of equipment to the venue. Most of this material was mounted aurally (i.e. suspended), which allowed a clear view of the stage from all directions.

As well as creating a visually compelling concept, communication among all of those involved in the production had to be ensured. With considerable effort, the artists have to be broadcast over wireless microphones without interference and optimally controlled using feedback links (the so-called in-ear monitors).

Due to the size of the hall and the equipment suspended from the supporting structures (e.g. spotlights or projectors, see image above), the view between the antennas of the event production and the stage was largely unobstructed. Nevertheless it was a considerable technical challenge to ensure the necessary transmission quality for approximately 90m.

The image on the next page gives a detailed impression of the structure as well as the location of the antennas needed for the event itself, and the measurement antennas that were used to document the event.



The technical setup for the event began on 20 March, and was completed in about 4 weeks. This was followed by four weeks of actual rehearsals with the artists and ended with the final on Saturday, 14 May 2011. During the construction period, parts of the wireless communication network were operational. The entire UHF spectrum was needed by the start of the artist rehearsals, e.g. starting approximately four weeks before the final.

2,500 journalists from 43 participating countries were accredited for this major event. To this end, the adjacent athletics hall was converted into a press centre, in which 20 wireless microphones were used for the information events, interviews, question time and much more.



Pictures : Matthias Fehr

ESC 2011 Düsseldorf, ESPRIT-Arena: Background behind the large construction site

About three weeks before the final of the 56th Eurovision Song Contest, journalists were able to get an idea of the construction work that the city had initiated in the ESPRIT Arena together with broadcaster NDR. The hall is primarily used as the home stadium of the second division football team, Fortuna Düsseldorf, but it was converted into a large television studio for the 2011 ESC. The person from NDR who was responsible for the prestigious singing contest viewed throughout Europe – Thomas Schreiber – provided insight into the large construction site and was satisfied with how smoothly the construction was going.

56. Eurovision Song Contest: The tour of the construction work

On Monday, 18 April 2011, Thomas Schreiber gave a group of journalists a tour of the large construction site and above all, explained the background of the technology such as lighting, sound and power generation: "Here in Düsseldorf we have found unique opportunities in the area." After last year's victory, says Schreiber, the search was on for a suitable hall, and the Düsseldorf Arena turned out to be the best option. In fact, the ESPRIT Arena was predestined for this kind of event, above all because of its location: the technicians, participants and organizers have a virtually inexhaustible amount of space for OB vehicles and trucks of every size.

The movers and shakers saw the fact that the adjacent athletic hall could be converted into a press centre as a special bonus: optimal operating conditions could be set up there for the 2,500 accredited journalists. There had never been such a large number of press representatives at any ESC until now, said Schreiber. The fact that 80,000 tickets had already been sold three weeks before the start of the contest may also set a new record. The only tickets remaining were for the jury final on 13 May and for the two semi-finals on 10 and 12 May. But regardless of which event: the main stage situated in the middle of the ESPRIT Arena should be the centre of all attention.

Involved in the construction, according to Schreiber, are approximately 100 companies, whose cooperation with one another was running smoothly, much to the satisfaction of the organizers. An outwardly visible sign of this: the logo for the Eurovision Song Contests on the façade of the arena. The glimpse inside was not limited to the stage with its 13m circumference, but also concentrated on the large LED wall, which is 60m wide and 18m high. Approximately 2,200 spotlights and sophisticated computer technology help to create more than 31,000 lighting effects. The people responsible for this: Jerry Appelt and Matthias Kublik, who are working on such a large hall for the first time with the ESC 2011.

For unlike the 55th Eurovision Song Contest in Oslo, where there were 18,000 spectators seated in the hall, the ESPRIT Arena was built for 35,000 spectators. The technical director for the Eurovision Song Contest 2011 is Dieter Thiessen, who doesn't even lose his cool at the possibility of a power failure: "The arena has its own, small power plant." The arena can accommodate up to 1,500 journalists at a time in the press room located right in the area. A total of 46 camera platforms leave no detail of the events unseen. 26 dressing rooms for the artists were set up on the top floor of the arena. With all of the enthusiasm for the effort made at the site, the movers and shakers didn't fail to address the topic of money.

The ESC in Düsseldorf and the cost

Thomas Schreiber: "The Song Contest in Oslo cost €16.25 million and ARD is only paying €12.1 million this year." ARD also collected approximately 3.8 million euros in participant fees as well as money from the sale of tickets and from the sponsors. Mayor Dirk Elbers, whose idea it was for the ESC 2011 to take place in Düsseldorf, cited very different facts. He pointed out the fact that according to expert opinion, a traditional advertising campaign – which would have the same effect for the city as can be achieved by the ESC with its transmission to 120 million people worldwide – would have cost €200 million.

Mayor Dirk Elbers: "Parties, chilling out, enjoying life"

In fact, the city raised approximately €7 million for the ESC and reduced this amount through revenue such as that brought in from the airline, Air Berlin, which, as the namesake of the Fortuna provisional stadium, bought into "airberlin world". Elbers noted that he had brought the ESC to Düsseldorf strictly within the context of economic development. Elbers stated in the publication, "Rathaus aktuell": "In Oslo, there was a 14% increase in visitors after the Song Contest last year." Elbers, who had already welcomed the ESC to the Rheine at the presentation of the key to the city in January 2011, is banking on the world remembering Düsseldorf after the ESC.

(Quelle: Jörg Tilmes, <http://www.suite101.de/content/esc-2011-duesseldorf-esprit-arena-hintergruende-zur-grossbaustelle-a109508>)

Eurovision Song Contest 2011

The event production

Frequency coordination and information about the devices

The entire frequency coordination was carried out centrally and was strictly organized in order to rule out as many uncertainties as possible. Journalists who used unregistered wireless equipment immediately lost their accreditation. The usual news crews with their wireless devices were not permitted at this event in order to avoid any potential interference with the event right from the outset.

A total of approximately 273 wireless radio transmission links was used.

These were split into:

Frequency range	Use	Number
below 470 MHz	Communication	52
470 – 790 MHz	Mics and in-ear	212
Above 1,800 MHz	Cameras	9

The 212 wireless microphones and in-ear monitor systems (including the average distances) were divided up as follows:

- 184 microphones and in-ear monitor radio links for production
- 20 microphones for the press centre
- 8 microphones and in-ear monitor links for reporting by Pro 7

Addendum:

- Unlike other radio technology, the audio production technology was designed with redundancy.
- Of the 184 radio links in the entire production, 168 were used for the artists.
Of these 168 links, 44 were in-ear monitor systems equipped with their own antenna splitters.
- The 138 handheld and pocket microphone transmitters were each picked up by a Diversity receiver system.



Picture: Matthias Fehr

ESC2011 – distinct from other events

The highest demands on live-performance quality in combination with a high number of wireless links pose a special challenge for the production of this event and at the same time, are a defining characteristic of this production as compared with other productions.

Audio production

The “EBU, Technical Handbook” for the ESC 2011 divides audio production into the following areas

1. IN-EAR MONITOR REHEARSALS

This was an in-ear monitor rehearsal (IEM rehearsal), that took place in a so-called “in-ear rehearsal room” for each country before the actual main rehearsal on the main stage.

2. MICROPHONE & IN-EAR MONITORING

There were wireless microphones and in-ear monitoring available to all participants.

3. PA & MONITORING

This included, for example, the mixers, amplifiers and speakers. In addition, a backup solution for the in-ear monitoring was also provided.

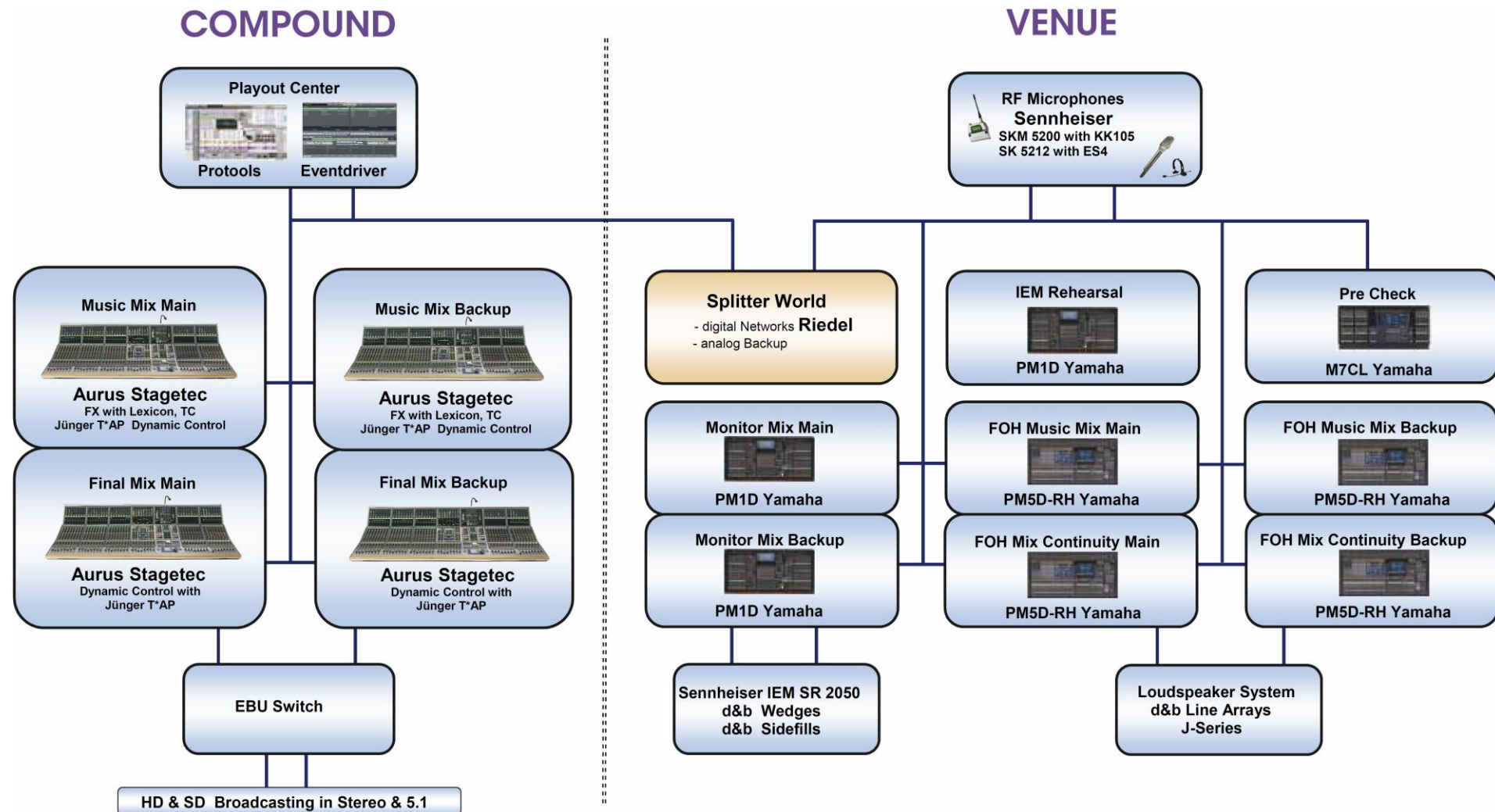
4. TV SOUND

This is the technology needed for the “final mix”. This includes, for example, mobile studios equipped with professional studio technology installed in outside broadcasting vehicles.

5. VIEWING ROOM

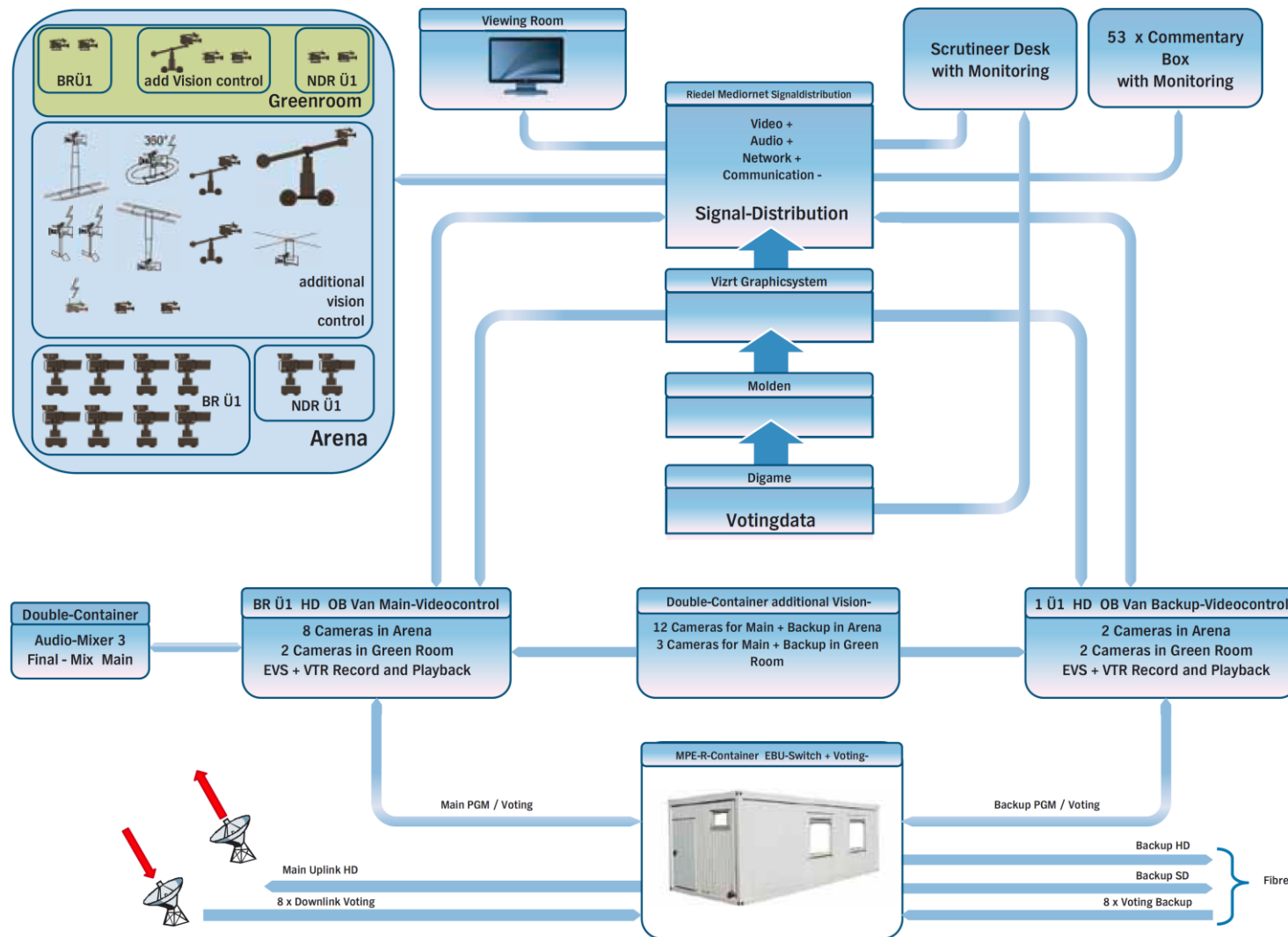
Assessments and test recordings could be made in this room

Schematic representation of audio production



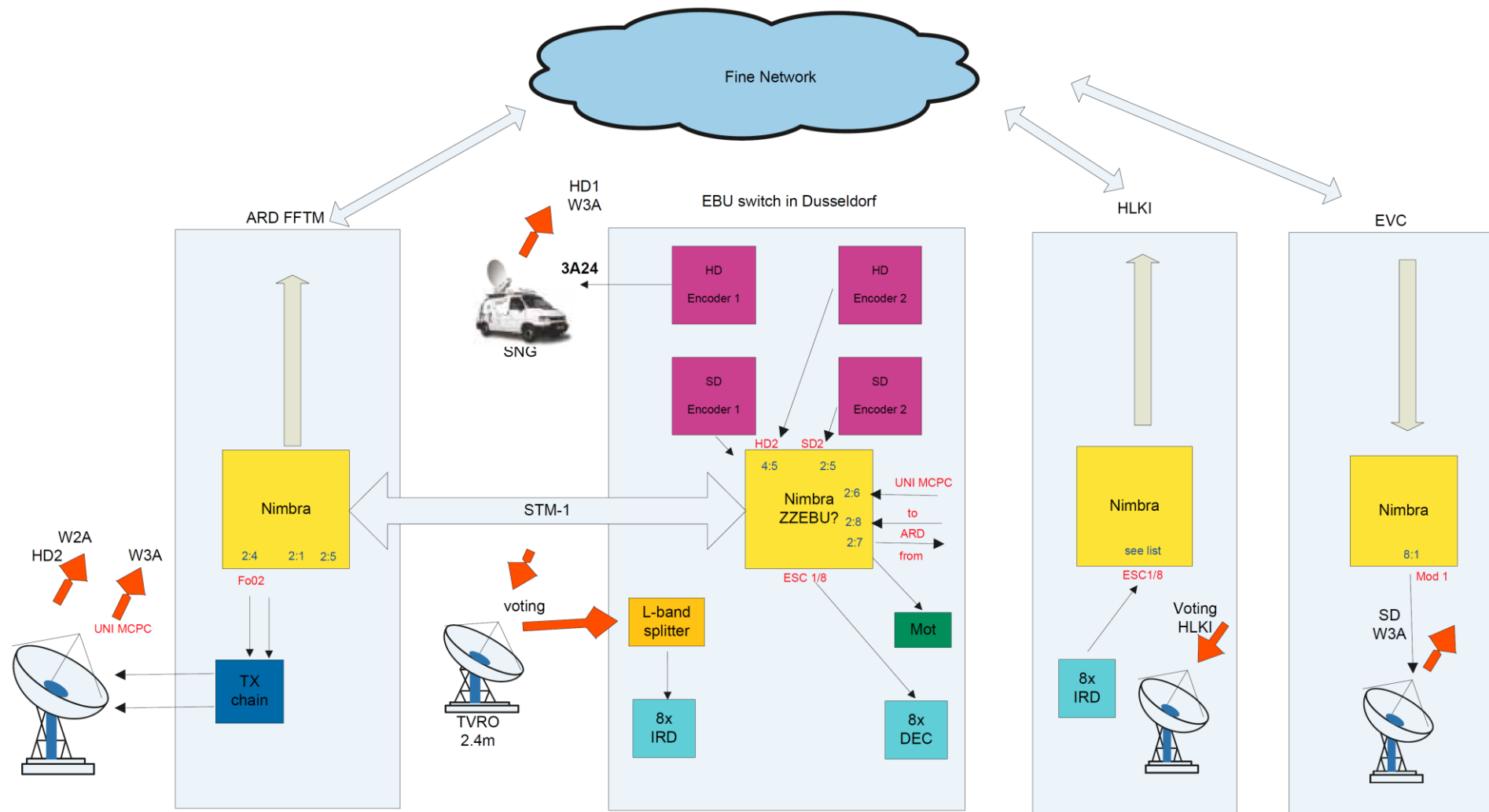
Spurce: NDR, ESC2011 - Technical Handbook

Video production



Source: NDR, ESC2011 - Technical Handbook

The international backbone (EBU SWITCH & TRANSMISSION)



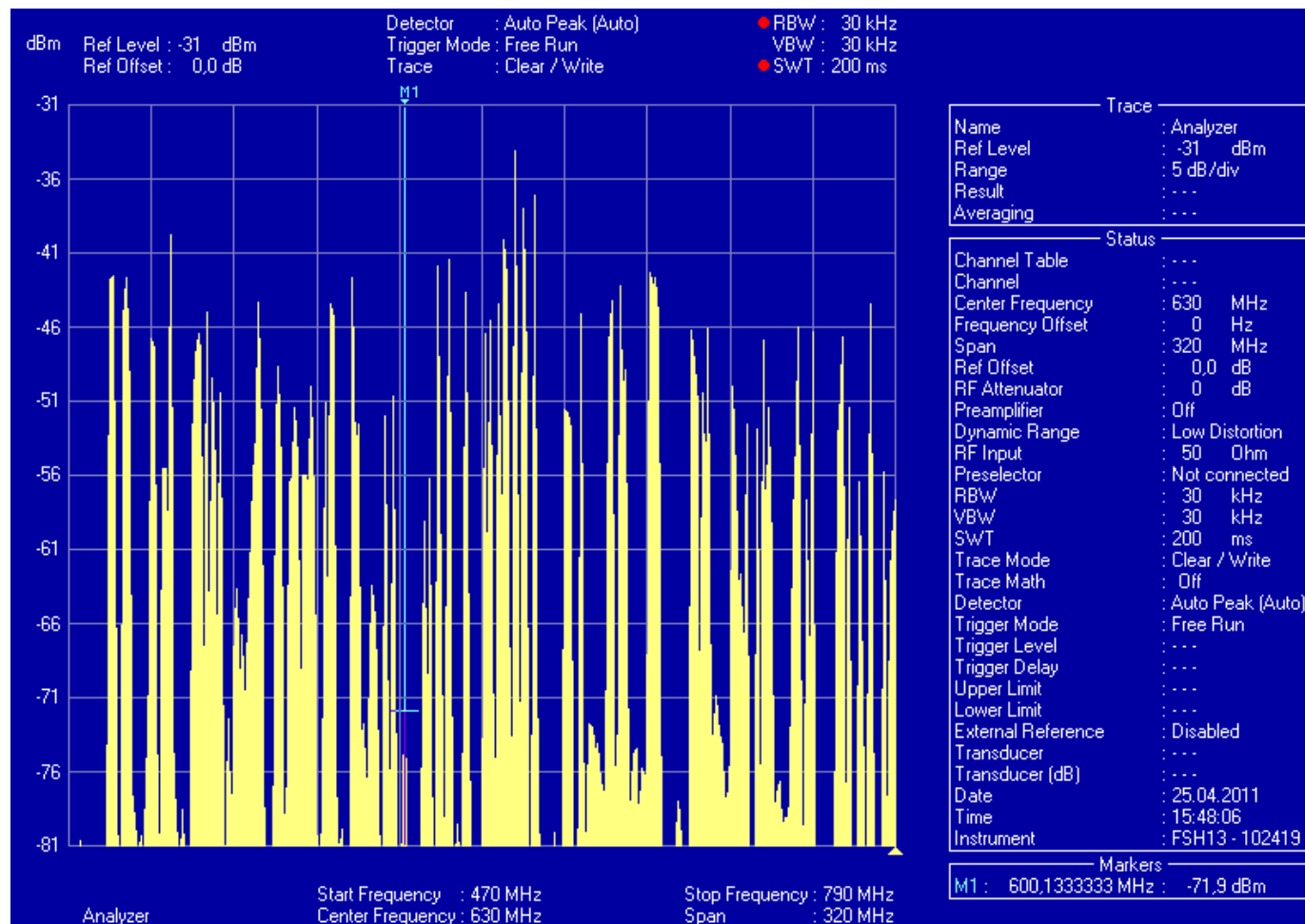
Source: NDR, ESC2011 - Technical Handbook

Eurovision Song Contest 2011

Monitoring the radio spectrum

UHF scans, documentation of the spectrum use

1) Spectrum monitoring with typical measurement resolution in the frequency axis (Source: IRT Munich)



It is possible to get a good impression of the density of the UHF frequency allocation using (manual) spectrum scans

2) Spectrum monitoring with specialized scanning and analysis software (DKE-AK 731.0.8)

The analysis function UHF-4500 scans from the main event on from 17:34 on 14.05.2011 to 03:00 on 15.05.2011 were selected from the 15 days of spectrum recording in order to demonstrate the analysis function.

Shown here is the program interface with labelled output windows:

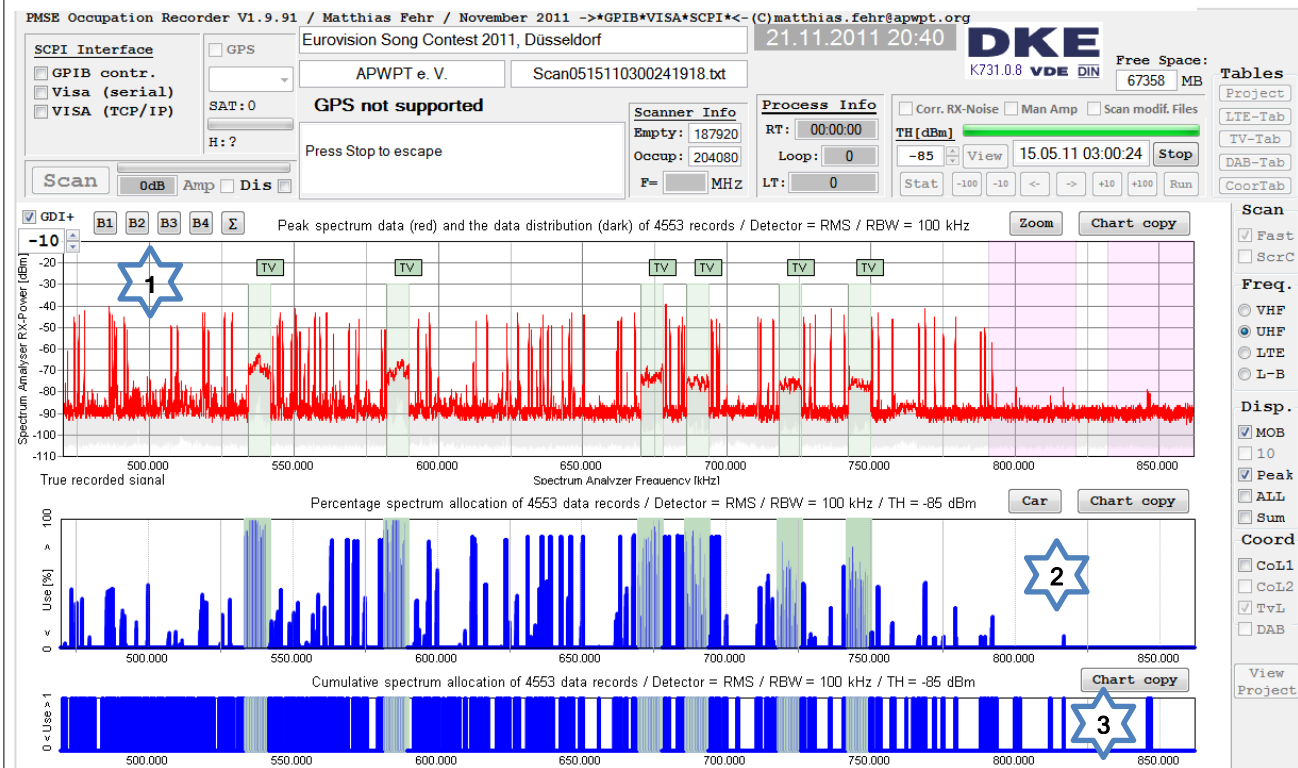
(1) The red line in the spectrum display window with its pronounced peaks shows the maximum reception level over the measurement period. The light-blue blocks are the DVB-T transmitters.

Two pink columns on the right side of the window mark the new mobile radio ranges.

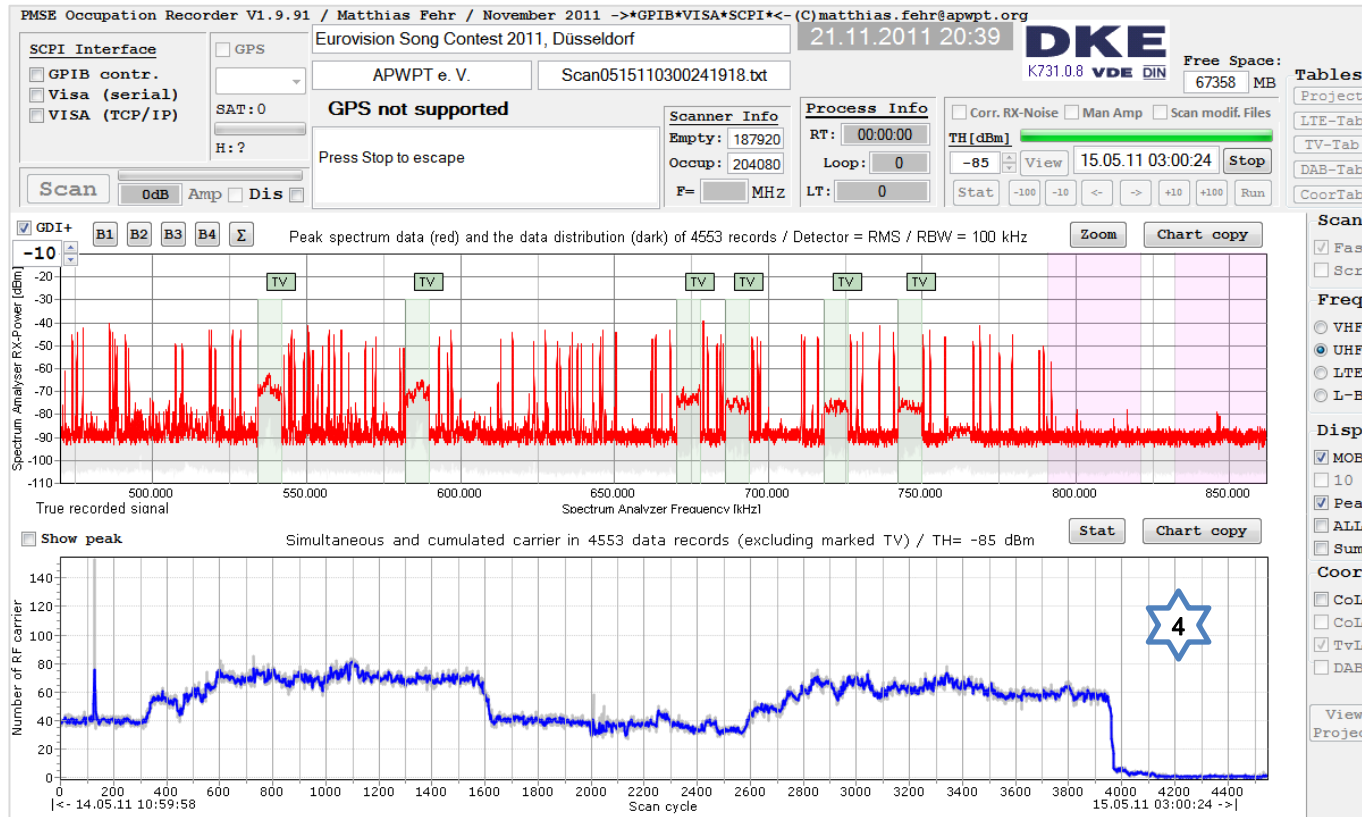
(2) This window shows the duration of the signal reception if it exceeds the evaluation threshold. 100% means constant reception on this frequency. Signals that only briefly exceed the threshold are not shown in this window.

(3) The third output window provides a workaround. Here, a blue bar shows where the frequency exceeded the threshold at least once.

Results output on the frequency axis:



Results output on the time axis:



(4) The second figure shows another evaluation mode.

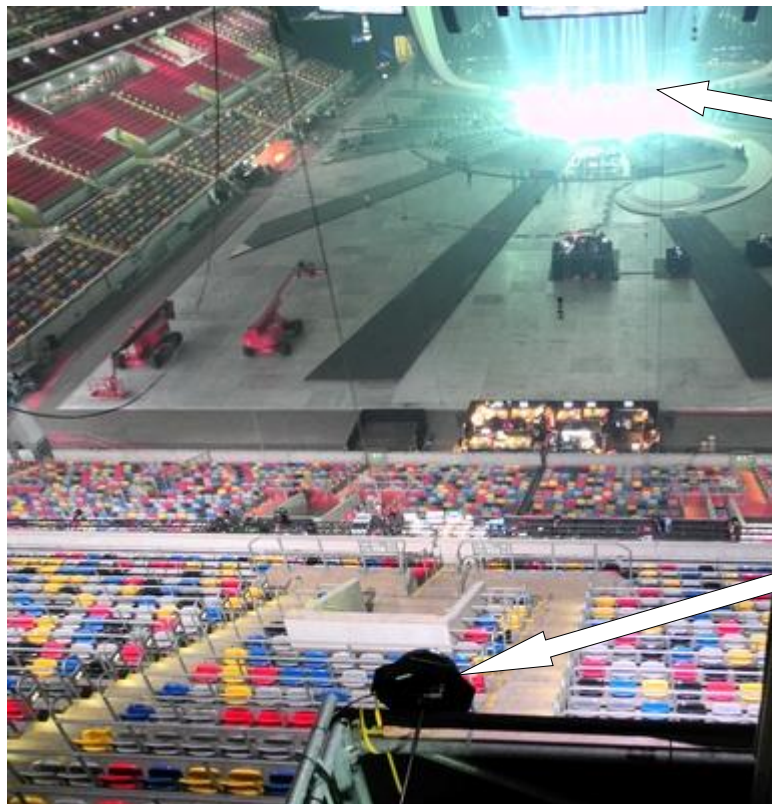
This figure shows the number of signals received simultaneously. Only narrow-band signals (<500 kHz bandwidth) are evaluated, which, based on their characteristics, could represent a wireless microphone or in-ear monitor signal.

With an update rate of typically 13s, even relatively short signals can be recorded and subsequently evaluated.

In addition to the graphical output windows, the software creates ASCII output data with more extensive project information, which can be further processed later using spread sheets.

The installed measuring equipment

Finding the most undisrupted reception conditions for each spectrum recording under the respective conditions of the event posed a special challenge. The measuring equipment had to perform its intended task throughout the event without being obtrusive and at the same time, make it possible to obtain the most realistic view of the radio spectrum possible – a task that could only be fulfilled by compromising.

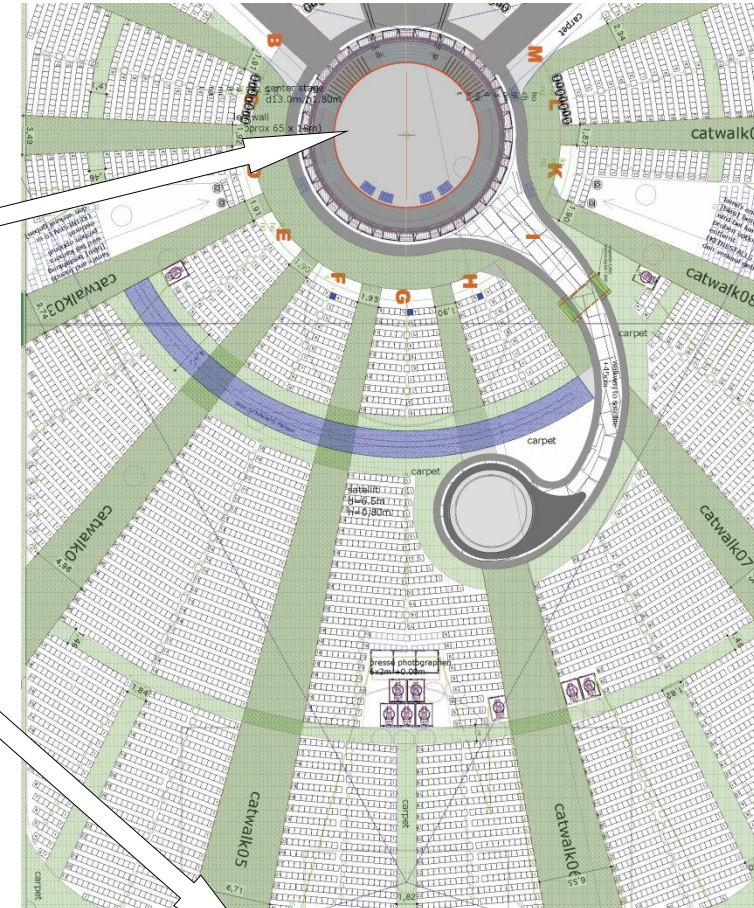
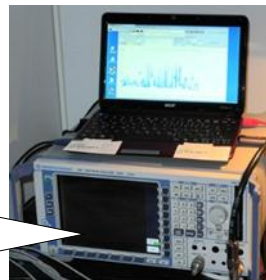


Picture: Matthias Fehr

Main stage

Circular UHF-
test antenna

Scan system
R&S FSP 3

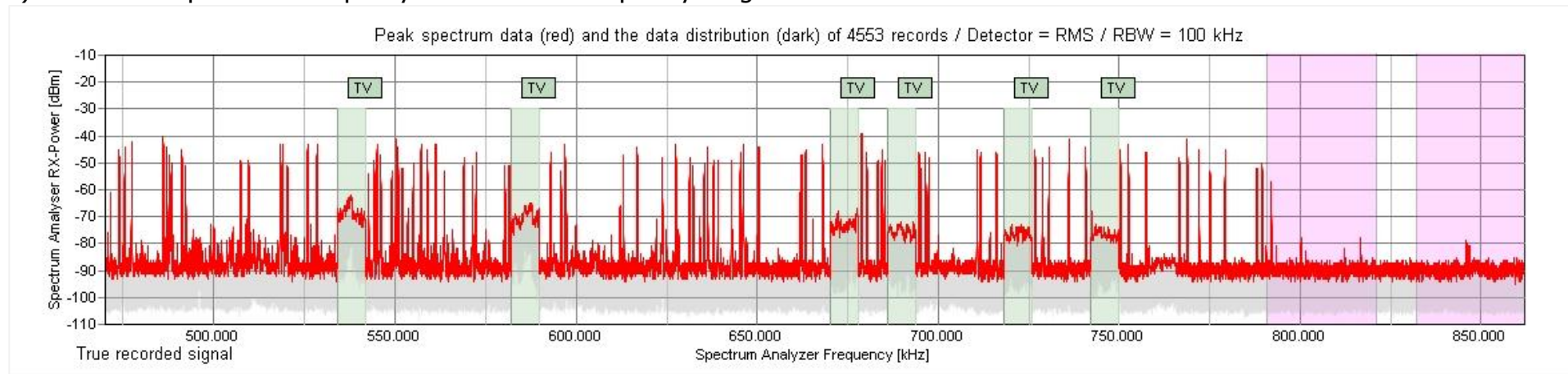


Eurovision Song Contest 2011

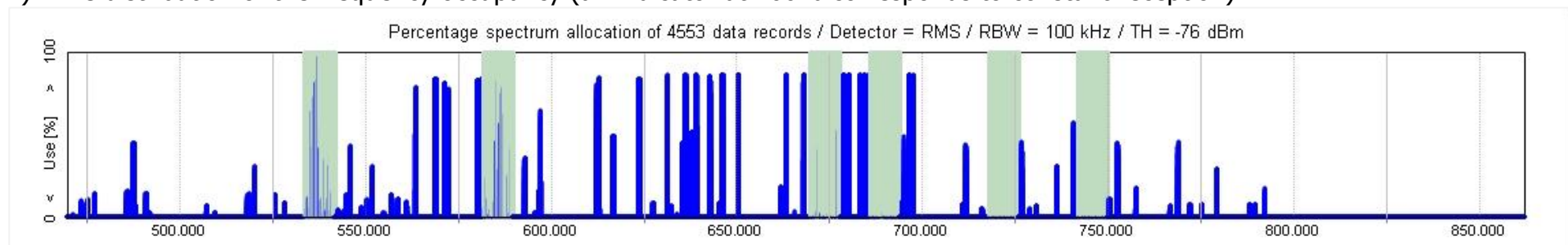
The UHF TV and radio spectrum occupancy from 14-15 May 2011

Evaluation of 16 hours of spectrum recording during the main event from 14 to 15.05.2011

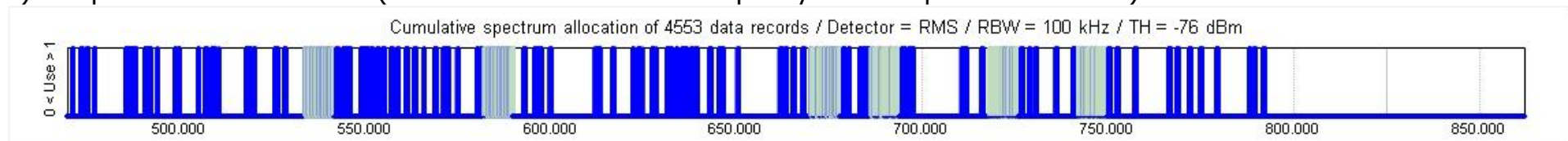
1) Cumulative spectrum occupancy in the overall frequency range



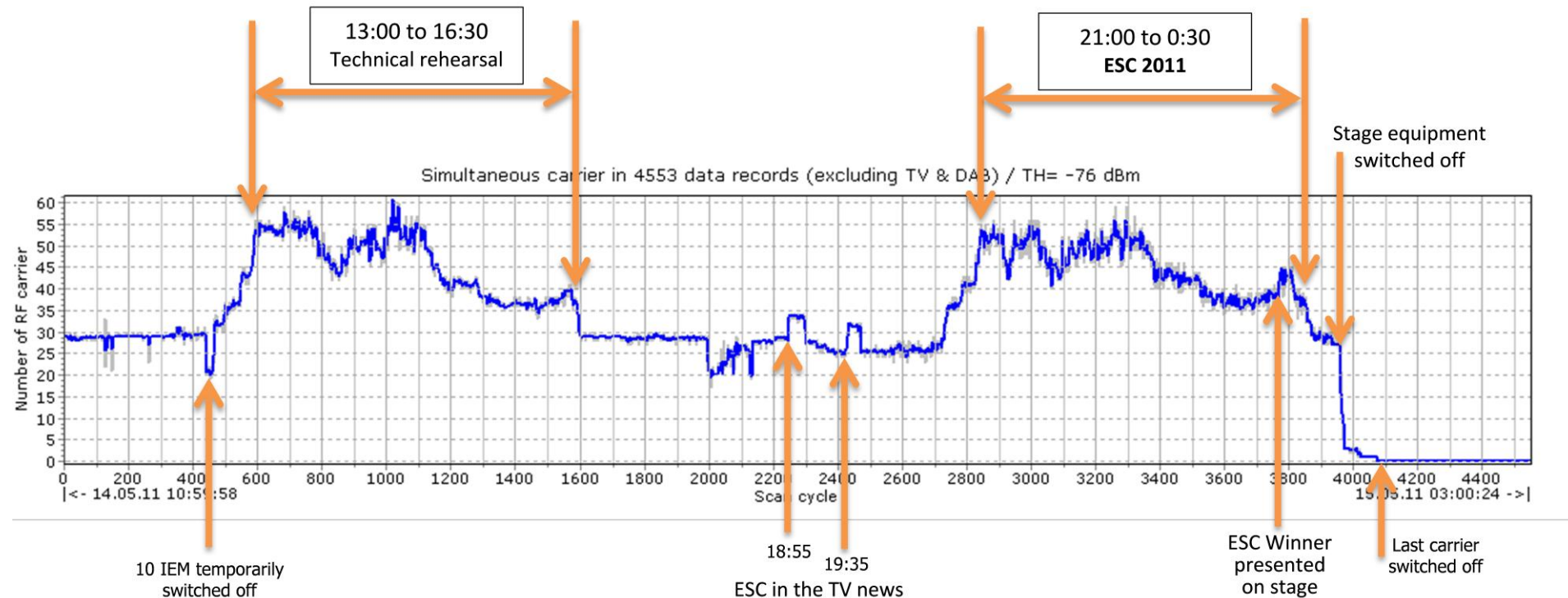
2) Time distribution of the frequency occupancy (an indicator at 100% corresponds to constant reception)



3) Compilation of all allocations (a blue bar means that the frequency was occupied at least once)



4) Figure showing simultaneously received signals and their correlation with the event schedule

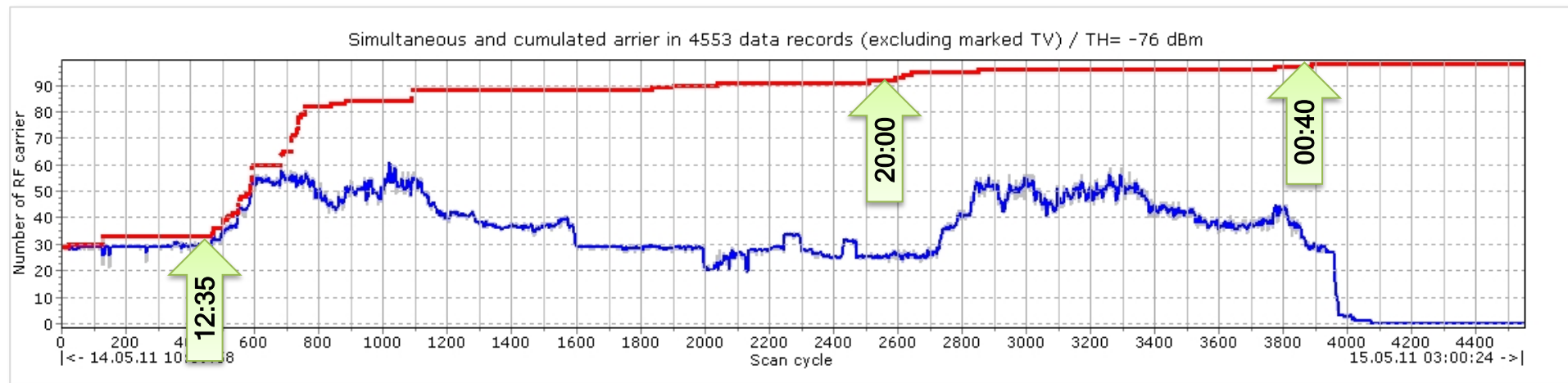


It is clear that the density with which the spectrum was occupied in the venue can never be assumed to be constant, but rather, it follows the progress of the event. Changes were observed in the minute range.

Explanation:

- In order to increase accuracy of measurement, all TV stations have been hidden from the spectrum analysis.
- From the perspective of signal analysis, it is irrelevant whether the microphone is switched on or off, or the performer leaves the venue (reception area) for example. In both cases, the number of signals observed changes.

5) Figure showing the overall occupancy rate



This figure also shows the number of occupied frequencies (red line).
 Until 12:35, only the IEM links are switched on. Until ca. 20:00, 90 frequencies were occupied.
 During the main event, this trend was expanded to 99 frequencies.

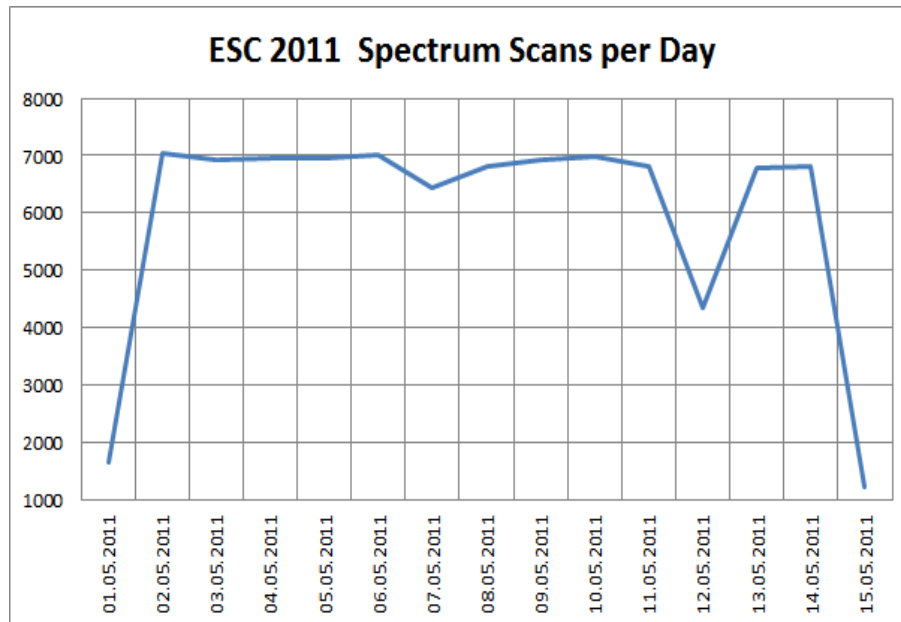
6) Tabular summary of the spectrum occupancy in the 470-862 MHz range

Recorded number of carrier	
Bandwidth < 200 kHz	99
Bandwidth 200 to 500 kHz	0
Bandwidth 500 to 1000 kHz	0
Bandwidth 1000 to 5000 kHz	0
Bandwidth 5000 to 10000 kHz (e.g. TV)	6

Eurovision Song Contest 2011

The occupancy of the UHF TV and-radio spectrum from 1-15 May 2011

Brief summary of the spectrum recording over 15 days of the Eurovision Song Contest 2011

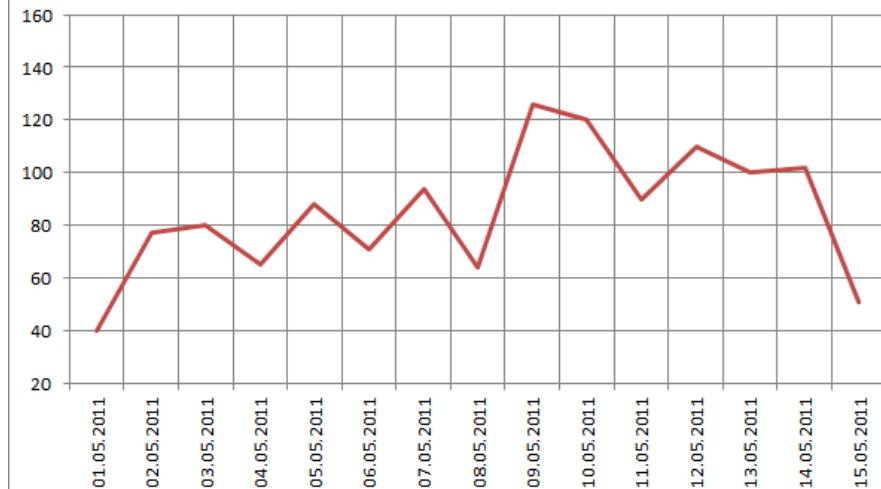


During the recording period, it was possible to obtain a nearly complete spectrum recording with a nearly optimum view of the stage. Only on 7 May and on 12 May were there interruptions in the spectrum recording for different reasons.

A total of 177 narrow-band signals (no TV) could be detected over the 15-day observation period.

A detailed look at the scan results for the individual observation days can be found in the appendix.

ESC 2011 Recorded Carrier @ BW<200kHz

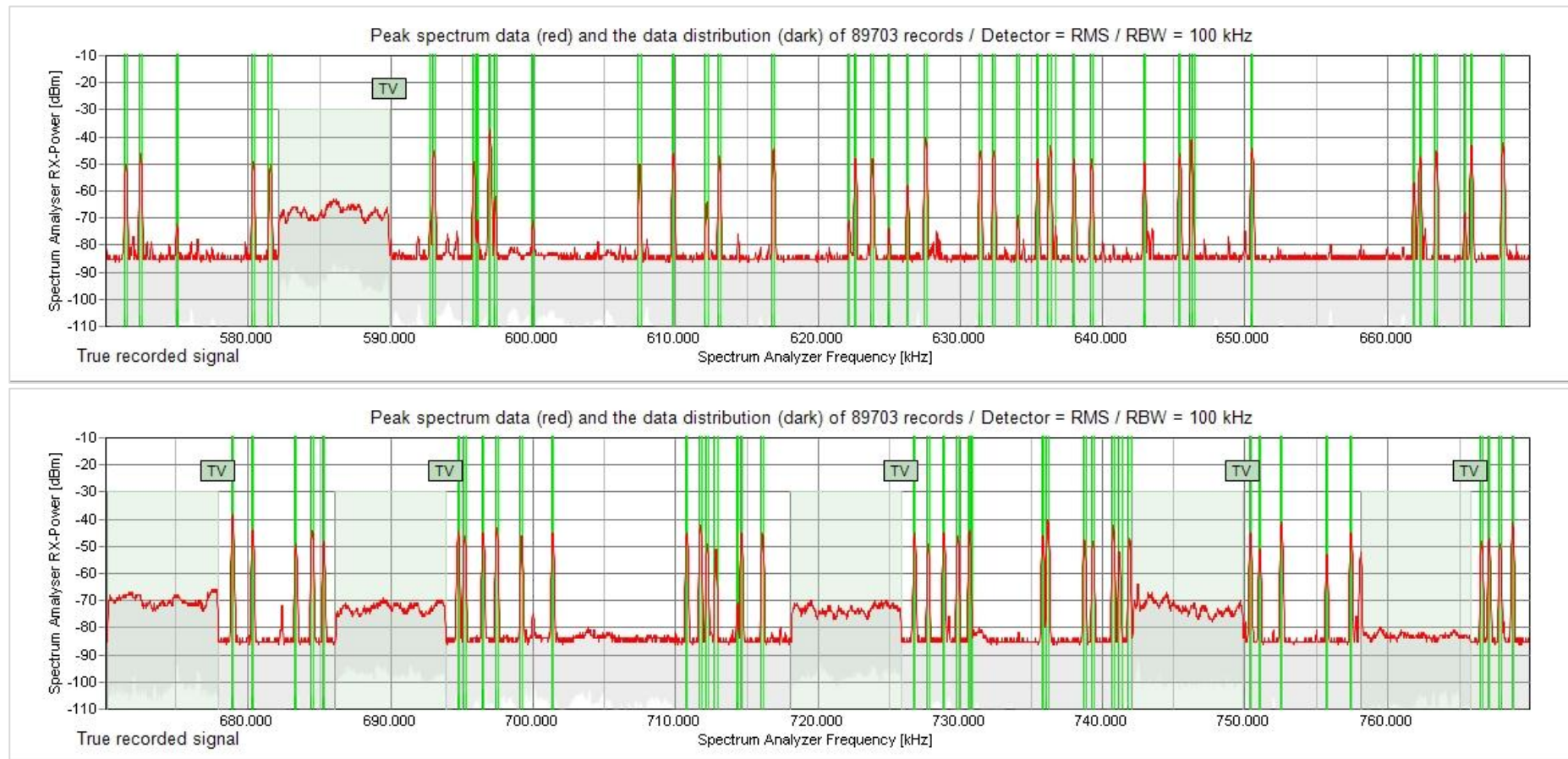


Date	Scanning period		Samples	Carrier<200kHz
	from	to		
01.05.2011	18:24	00:00	1660	40
02.05.2011	00:00	00:00	7030	77
03.05.2011	00:00	00:00	6934	80
04.05.2011	00:00	00:00	6969	65
05.05.2011	00:00	00:00	6965	88
06.05.2011	00:00	00:00	7002	71
07.05.2011	00:00	00:00	6434	94
08.05.2011	00:00	00:00	6817	64
09.05.2011	00:00	00:00	6926	126
10.05.2011	00:00	00:00	6978	120
11.05.2011	00:00	00:00	6822	90
12.05.2011	00:00	00:00	4343	110
13.05.2011	00:00	00:00	6780	100
14.05.2011	00:00	00:00	6820	102
15.05.2011	00:00	04:16	1216	51

Plausibility check of the automatic spectrum analysis

The software used for automatic spectrum analysis required a substantial development effort.

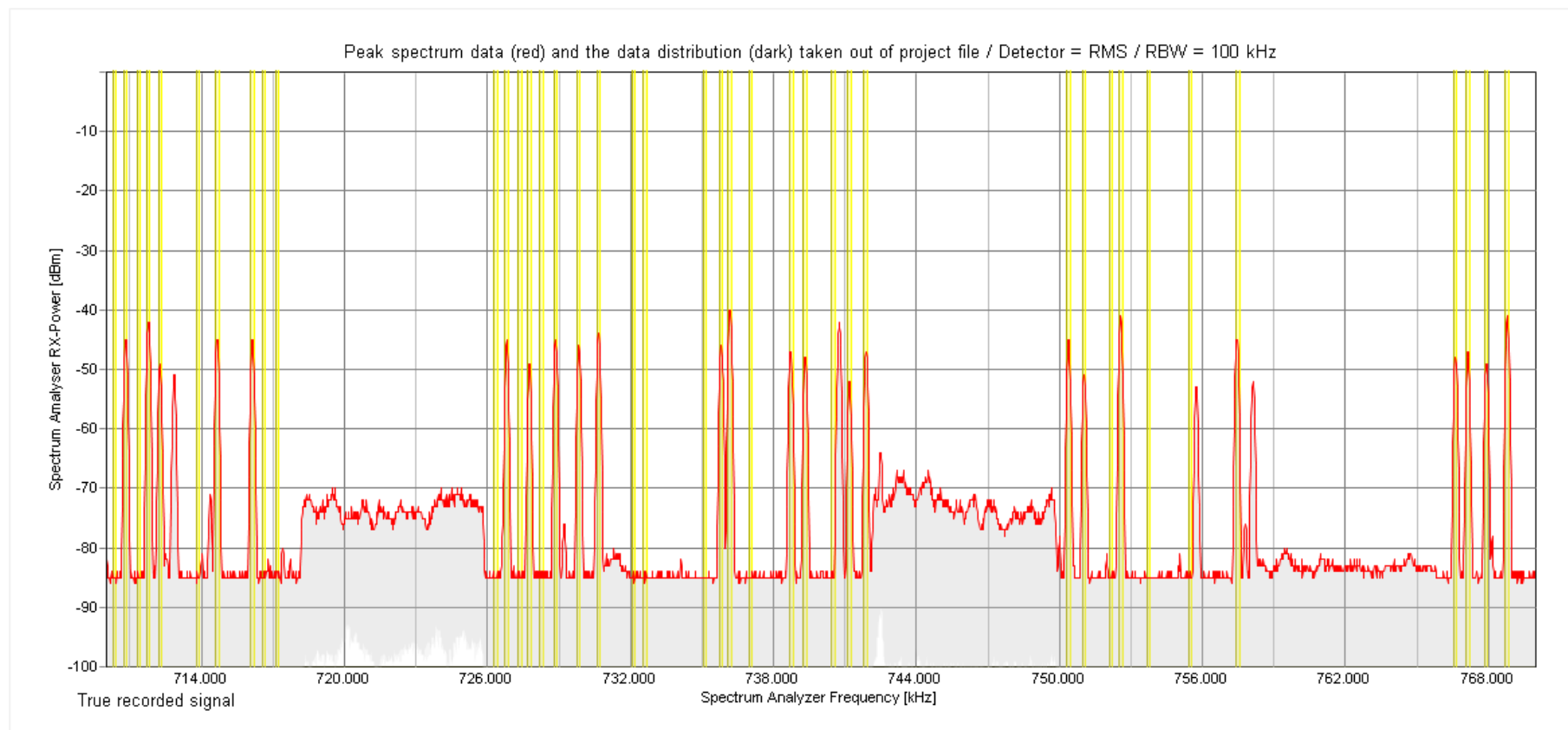
The fact that 89703 spectrum scans were performed within the 15 days made a manual evaluation impracticable. In order to be able to check the auto-detected signals, a programming function has been programmed to place these signals behind the recorded sum spectrum in colour. The following images show a high hit probability:



Automatic comparison of the frequency occupation with the frequency coordination of the organizer

The organizers had already handed over a frequency list to the DKE working group in advance. Accordingly, we were looking forward to seeing how well the results at the main event approximately 15 days later matched. To that end, the coordinated frequencies were placed behind the recorded spectrum as a yellow line using a special program. A table was then created using that data.

The following image shows the frequency range from 710 to 770 MHz as an excerpt of the 15 days of collected scan data:



Practical frequency planning

Initial frequency planning was done according to preliminary spectrum scans in the event hall. In so doing, care was given to ensure a high degree of intermodulation freedom, especially for the wireless systems of the artists. This eliminated the possibility of sound interference in advance. Other sources of sound interference were eliminated by implementing a rule regarding the operation of broadcasting equipment in the venue, as described above. This measure was monitored by security staff.

As is evident on the preceding page, the actual frequency occupancy deviated from the preliminary planning. Clearly the organizer was forced to adapt the frequencies over the two-week rehearsal period in the interest of live quality. This situation is typical for such events.

The spectrum quality and the changes made were monitored by two sound engineers, who evaluated the audio quality of the links used in a specially prepared, sound-insulated container. This radio frequency monitoring was largely set up to identify and eliminate interference. The limited time available was not used to locate the source of the interference, but instead, a different frequency was used for the signal being transmitted. This made it possible to respond manually at very short notice to interference, for example by switching to other frequencies.

This practical example makes it clear how sensitive the balance between the necessary high production quality and an actual interference situation demonstrates that there is a significant event risk, which must be held in check by the efforts of technology and personnel.

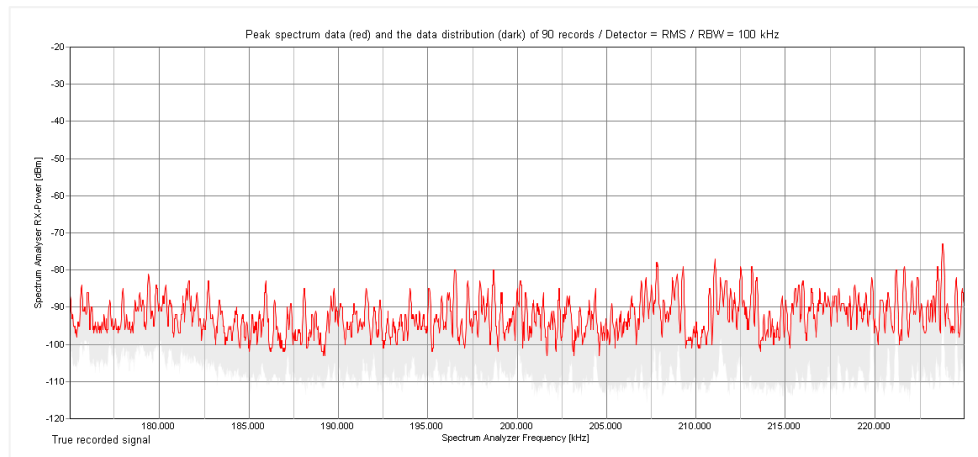
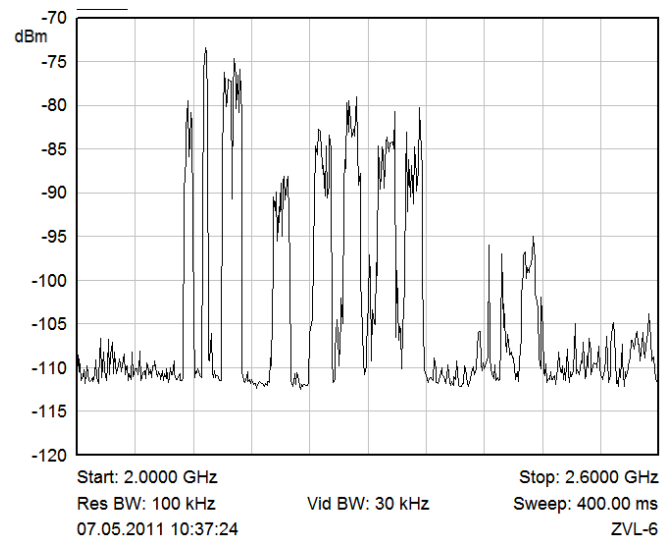
In practice, the professional spectrum users must have the option to avoid interference or to be able to react flexibly to changes in the framework conditions.

This largely unknown need to act must be reflected in the radio spectrum regulation policies and allocation.

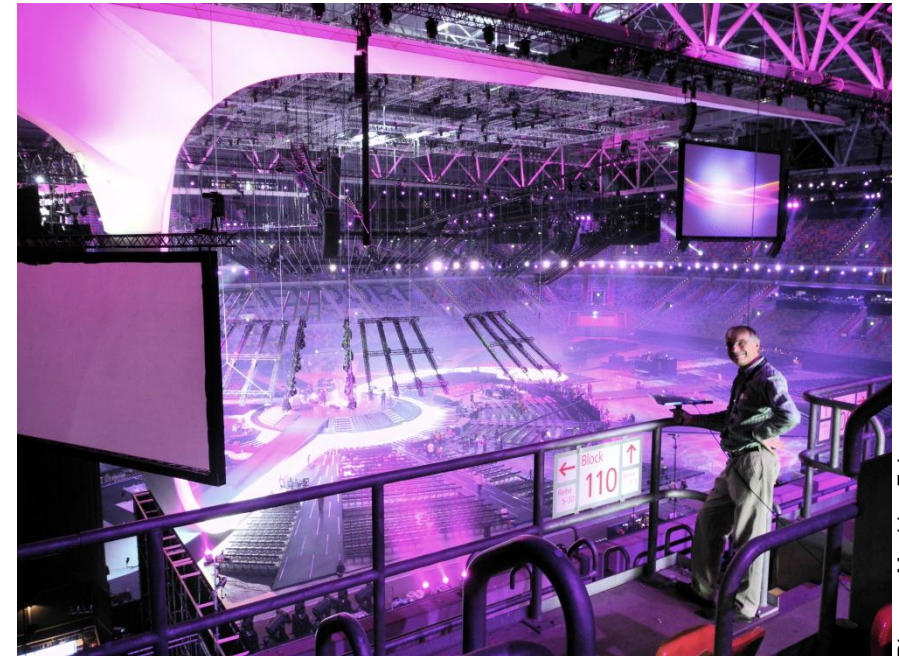
The regulations in many countries currently place unnecessary constraints on users. This does not serve the purpose of a trouble-free live production. It is to be hoped that this requirement for action will be reflected in the necessary regulatory practice.

The event could only be safeguarded through the active support of the metering services of the Federal Network Agency (BNetzA).

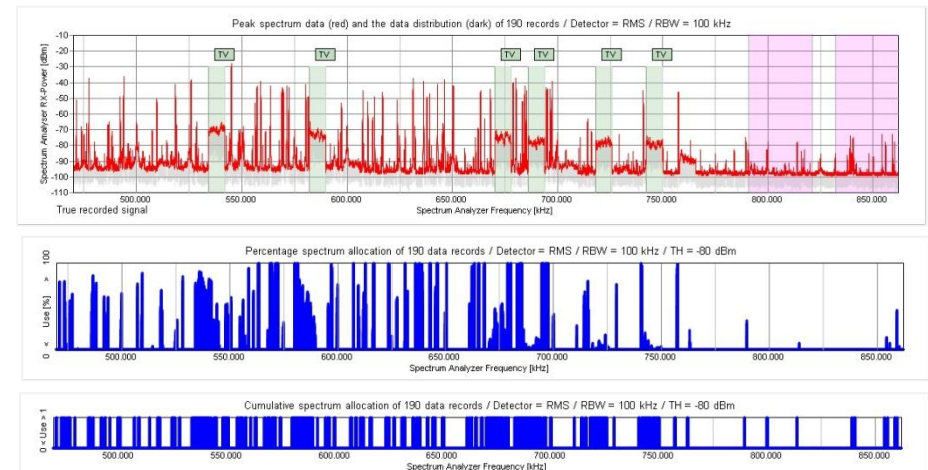
Accompanying internal measurements:



Typical VHF interference level observed at a large distance



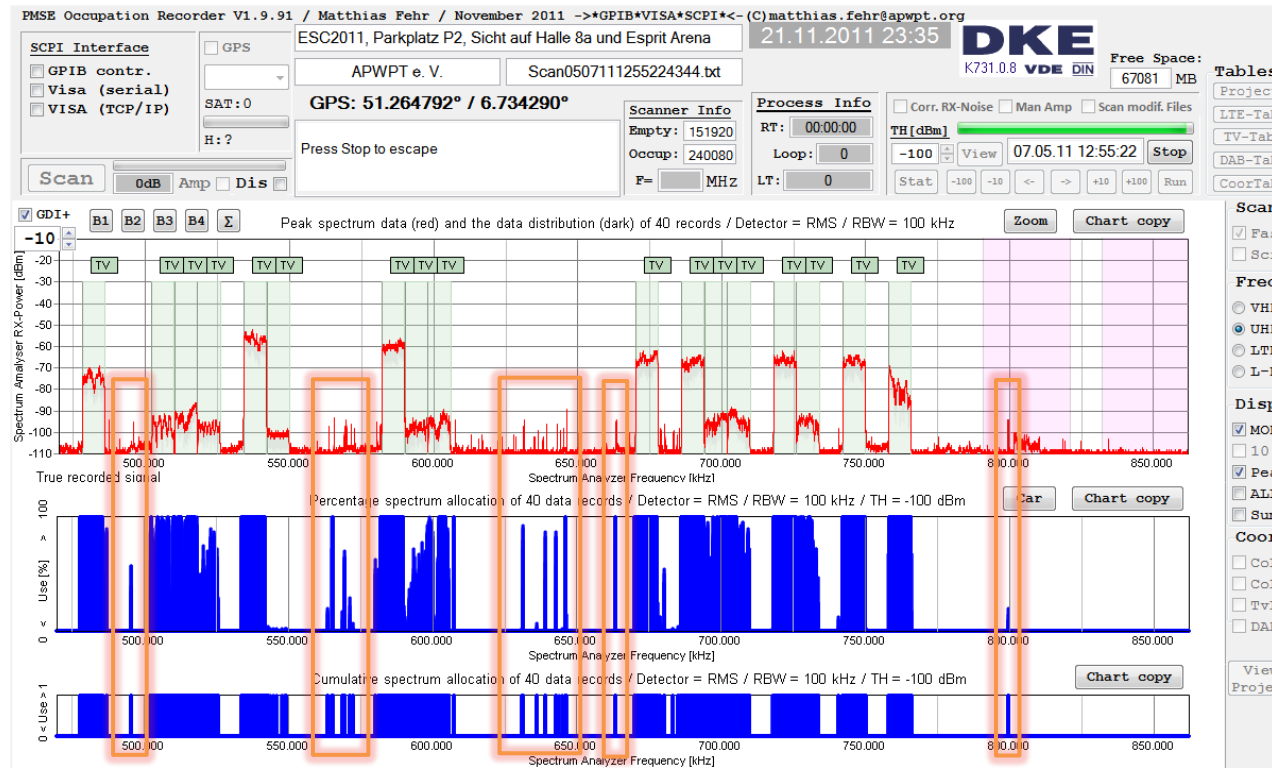
Picture: Mathias Fehr



Short-time scan in the UHF range

Accompanying external measurements:

At a distance of approx. 350 m, signals from the stage installation which passed through the event building could still be clearly detected:



Picture: Matthias Fehr



Picture: Google Earth

A building attenuation of approx. 10 dB in respect of the "ESPRIT arena" could be derived from the received volume levels and the free space path loss (see table on right).

A low level of building attenuation can lead to an on-going event being considerably disrupted by external signals. It is essential to take this into account.

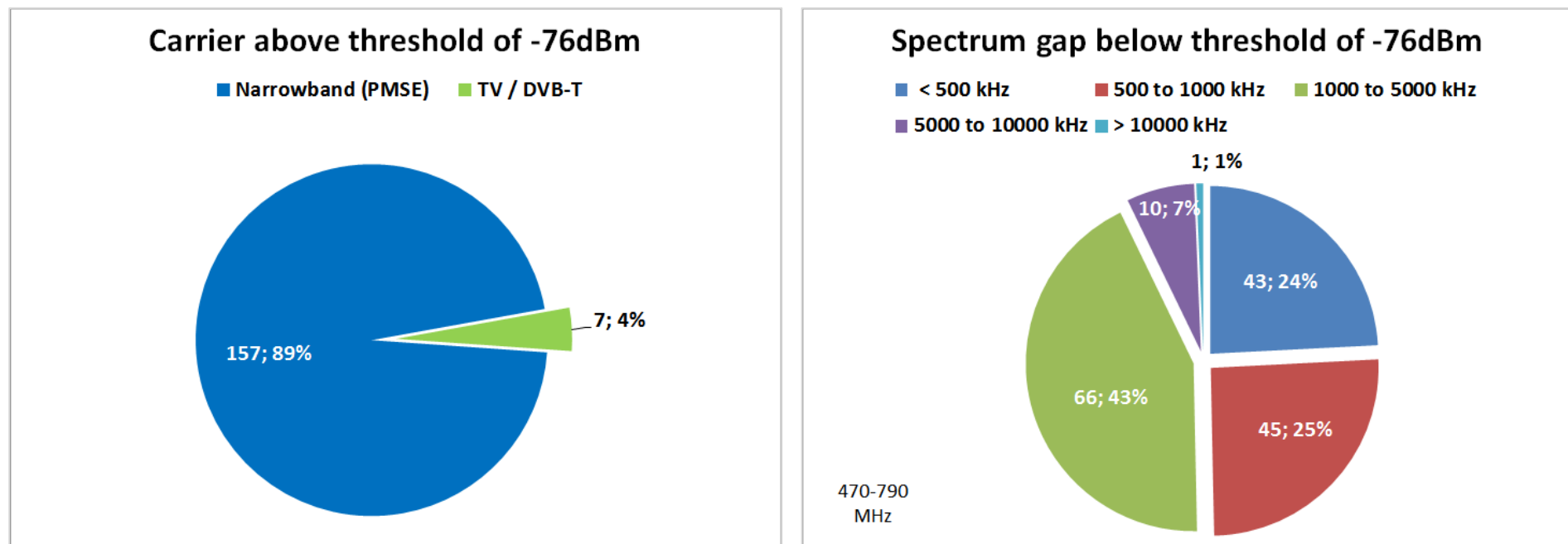
Free space path loss of signals		
470 MHz	670 MHz	870 MHz
77 dB	80 dB	82.5 dB

Spectrum occupancy summary

During the recording period of 15 days it was possible to obtain an almost complete spectrum recording with the main stage nearly in view. The results of the recordings are contained in a data set approx. 45 GB in size.

Presented below is a short summary of the total data:

1) Summary of the signals above a particular threshold criterion and the spectrum below this threshold:



Notes:

- A relatively high evaluation threshold was selected deliberately in order to avoid interfering influences, e.g. originating from the trade fair, "Interpack", which was taking place at the same time. Further information can be found under the heading "Is the Eurovision Song Contest an isolated event?"
- Detailed information about the scan results on the individual recording days is contained in the annex.

2) List of signals from the spectrum evaluation

CF	BW	CF	BW	CF	BW	CF	BW	CF	BW	CF	BW	CF	BW
470060	200	520350	220	572430	200	635440	200	697440	200	751030	200	800120	200
471440	200	525880	200	575020	200	636280	200	699160	200	752570	200	807510	200
473790	220	526560	200	580320	200	636700	200	701360	200	755760	200	807890	200
475440	200	526760	200	581530	220	638010	200	710810	200	757440	200	810440	200
476220	200	528510	200	585980	7800	639230	200	711760	200	761980	7800	811260	200
477340	200	534000	200	592760	200	642950	200	712240	200	766610	200	811840	200
486000	200	537980	7800	593040	200	645420	200	712860	280	767150	200	812950	200
486350	220	542680	200	595850	200	646210	220	714360	200	767930	200	813500	200
487000	200	544260	200	596100	200	646390	200	714660	200	768810	200	813900	200
487800	200	545080	200	596960	200	650500	200	716110	200	771090	200	814600	200
488310	200	546050	200	597360	200	661870	200	721980	7800	772030	200	815330	200
491150	200	549160	200	600030	200	662290	200	726800	200	775130	200	815580	200
492190	200	550020	200	607490	220	663420	200	727750	200	776050	200	816060	200
493890	200	550460	200	609860	200	665460	200	728850	200	778060	200	817320	200
494030	200	550850	200	612210	260	665900	200	729830	200	779300	200	830100	200
499200	200	552050	200	613060	200	668130	200	730650	200	782010	200	831910	200
500030	200	553600	200	616870	200	673980	7800	730800	200	783710	200	840420	200
507410	200	555090	200	622200	200	678900	200	735790	200	785200	200	854330	300
508860	200	556360	200	622640	200	680320	200	736160	200	786800	200	859100	200
509060	200	557230	200	623810	220	683340	200	738740	200	788120	200	860160	200
509320	200	558930	200	625020	200	684490	200	739340	200	788830	200		
509590	200	559080	200	626300	200	685290	200	740750	200	789480	200		
514000	200	561270	200	627560	200	689980	7800	741230	260	790610	200		
518320	320	563630	200	631400	200	694750	200	741920	280	792010	200		
519010	200	569030	200	632370	200	695180	200	745980	7800	798000	200		
520350	220	569710	200	634060	200	696510	200	750380	200	799500	200		

Explanation: CF = centre frequency/BW = signal band width/all figures are in kHz

Methods used to reduce errors resulting from measuring device overshooting effects

The scan software calculates the total output in the frequency range under observation with every scan run. If this output exceeds a preset level, the input attenuator of the measuring device is increased. Overshooting effects are thus reduced. If the opposite occurs, the input attenuator is automatically reduced. Every data set of a scan run with an attenuation shift is labelled and is not included in further evaluation.

Limitations of the measurement results

All recordings represent observations resulting from a restricted view of the measurement site. In particular, frequency occupancies in neighbouring areas or in the ESC Press Centre cannot usually be recorded from one measurement site.

An evaluation threshold set deliberately high (-76 dBm) limits the evaluation of weak or obstructed signal sources. This results in a lower actual content (less signals), a fact which should be taken into account in further deliberations.

Warning against misinterpretations

1) Unoccupied radio spectrum

Due to the limitation described above, no conclusion can be drawn regarding unoccupied UHF spectrum. UHF spectrum which was below the level of the evaluation threshold was not necessarily unoccupied radio spectrum.

2) Occupied frequencies

Practical experience has repeatedly confirmed the fact that the view from a single observation site can only result in an incomplete recording of the occupied frequencies. Thus the frequency occupancy recorded is only a part of the actual total occupancy.

Eurovision Song Contest 2011

Necessary production frequencies,
derivation and change over time

Production frequencies as a problem from the perspective of the event organiser

The event organiser bears the responsibility for the economic impact of the event or the efficient use of the available budget. In addition, the organiser is obliged to generate a wide range of secondary effects by ensuring the success of the event. These include, for example, effects on the labour market, on tourism (hotels) and numerous other activities accompanying the event (e.g. crafts or integrated trades, telecommunications and advertising). The example of ESC2011 clearly shows that significant investments are undertaken in staff and infrastructure and that these rely on the event's success - thus making its success obligatory. It should not be forgotten that the orientation of the Eurovision Song Contest represents a significant international obligation. The quality and impact of previous events mean that every person and company involved has a "moral obligation", at the very least, to ensure the quality of the event. The organiser must ensure that participants from all countries encounter production conditions of equal value and that the competitors are treated fairly. This includes, in particular, the quality of the live sound, live video and the accompanying interpretation. Even a partial failure of these three components is inevitably liable to be interpreted as unfair treatment and could disrupt further progress of the event.

Safeguarding production conditions with the domiciliary right

During the Eurovision Song Contest 2011, the domiciliary right was comprehensively implemented as a key instrument. This applied not only in relation to issues concerning the security of the event (e.g. access control on the basis of prior accreditation), but also to the safeguarding of the production frequencies. Thus, even during rehearsals, the presence of employees of the Germany Federal Network Agency (the national regulator) was observed. This also shows how sensitively the safeguarding of the production frequencies was handled.

A vision of the future - licence-free radio technology with "pre-formulated protection criteria"?

Currently, the approval of so-called "White Space Devices (WSD)" in the UHF TV band is being discussed. Based on the experience gained during the ESC 2011, in particular the type of flexible frequency occupation practised here, we find it difficult to envisage a parallel operation of WSD without it affecting the event (every additional device fundamentally affects the already sensitive production balance). To us it seems equally questionable to retain licence-free WSD in a safe usable condition for the total duration of the production and for the numerous integrated live events.

The ESC organiser will continue to demand accreditation for all transmitters (including the UHF TV band) via the domiciliary right and speak out about restrictions on use. That will also have to be accepted by WSD. It is therefore particularly important to us that this report be taken into consideration during the WSD approval discussions.

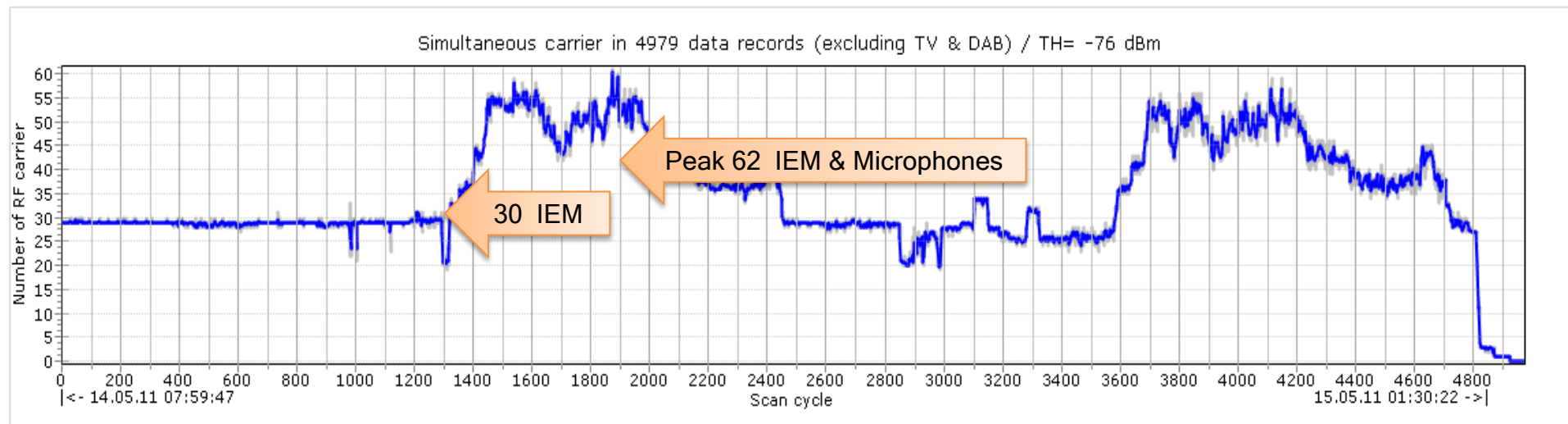
Consideration of the radio spectrum required, using the UHF PMSE as an example

Preliminary note:

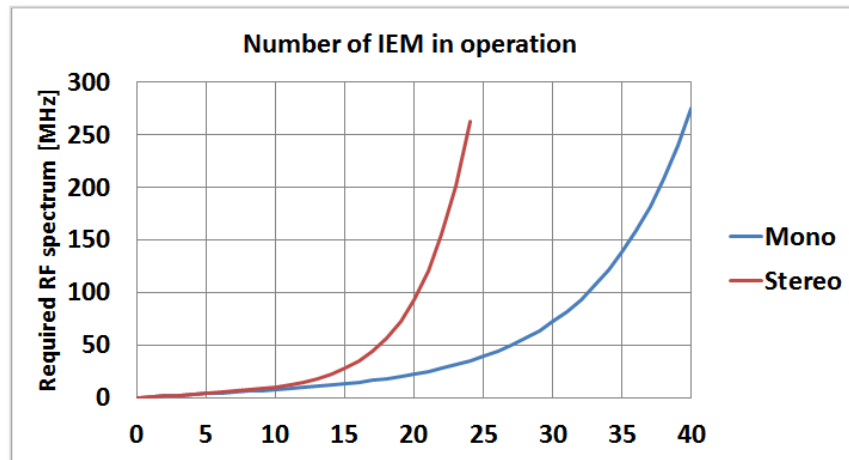
Analysing the spectrum usage of an event is a complex task. The accuracy stands or falls with the quality of the spectrum recording. In addition, the information available about the PMSE used and their application needs to be as accurate as possible. In view of this, the following details can only provide an initial view of the possible methodology, which needs to be further developed.

5 steps towards evaluation of the required radio spectrum

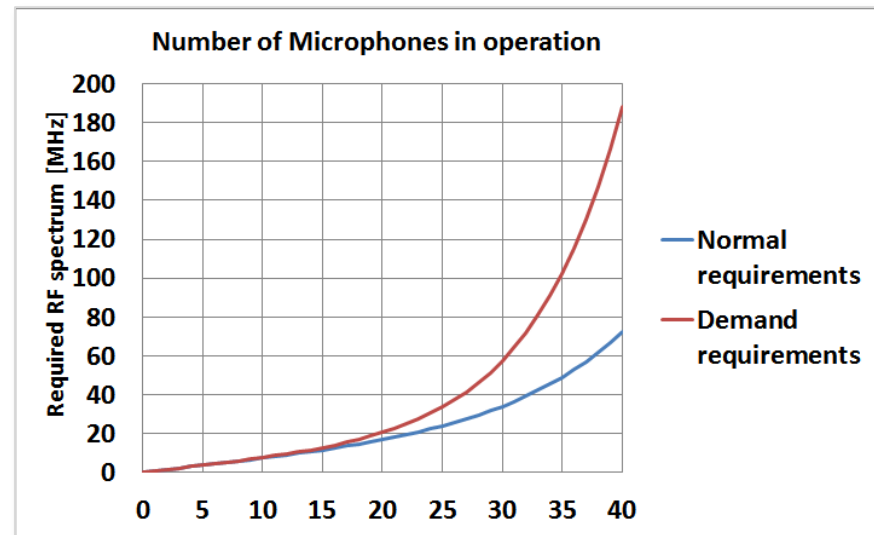
- 1) Specification of the PMSE operated simultaneously from the data obtained during the spectrum recording



2) Specification of the spectrum required for IEM and microphones

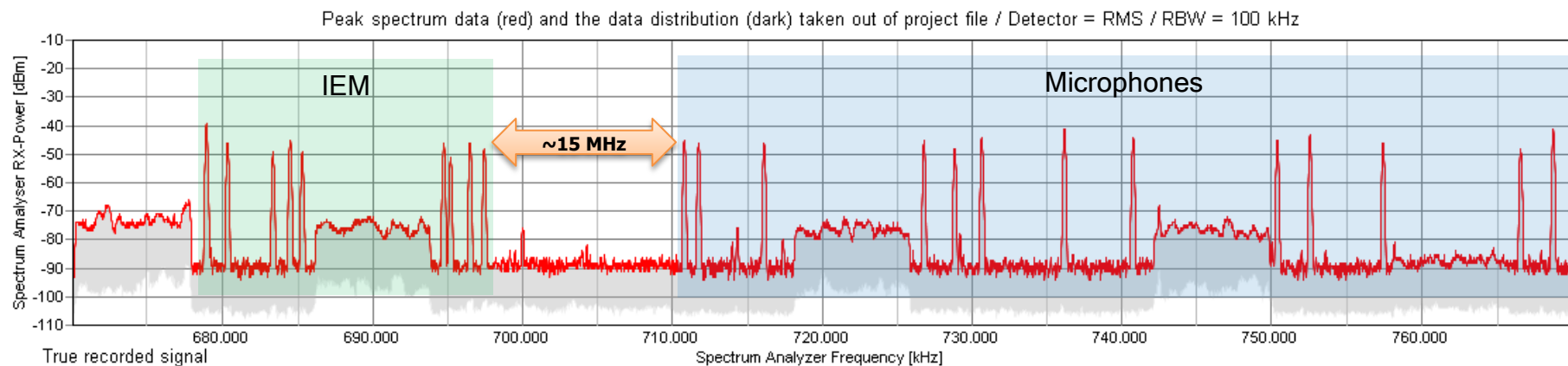


→ 30 IEM require at least 72 MHz spectrum



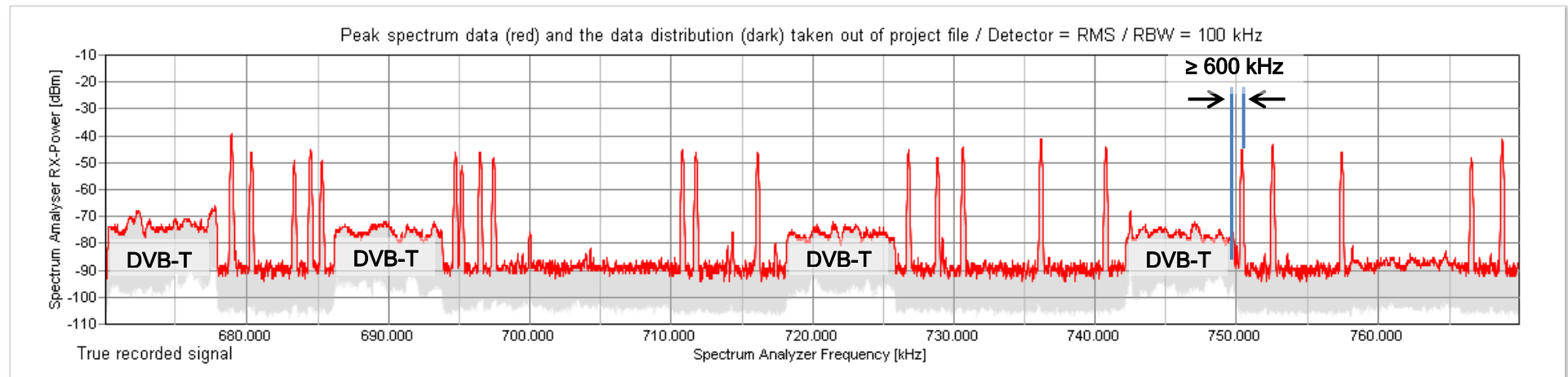
→ 32 wireless microphones require an additional 72 MHz

3) Required frequency channel spacing to operate transmitter/receiver combinations worn on the body



→ The scan data suggest the coordination of three of these protectively spaced frequency channels (guard bands).

4) Consideration of TV transmitters and necessary protection distances



- 6 regional TV transmitters occupy 48 MHz of the UHF spectrum.
- 12 narrow safety bands must also be included at the channel limits of the TV transmitters

→ The television transmitters occupy 50.4 MHz

5) Summary

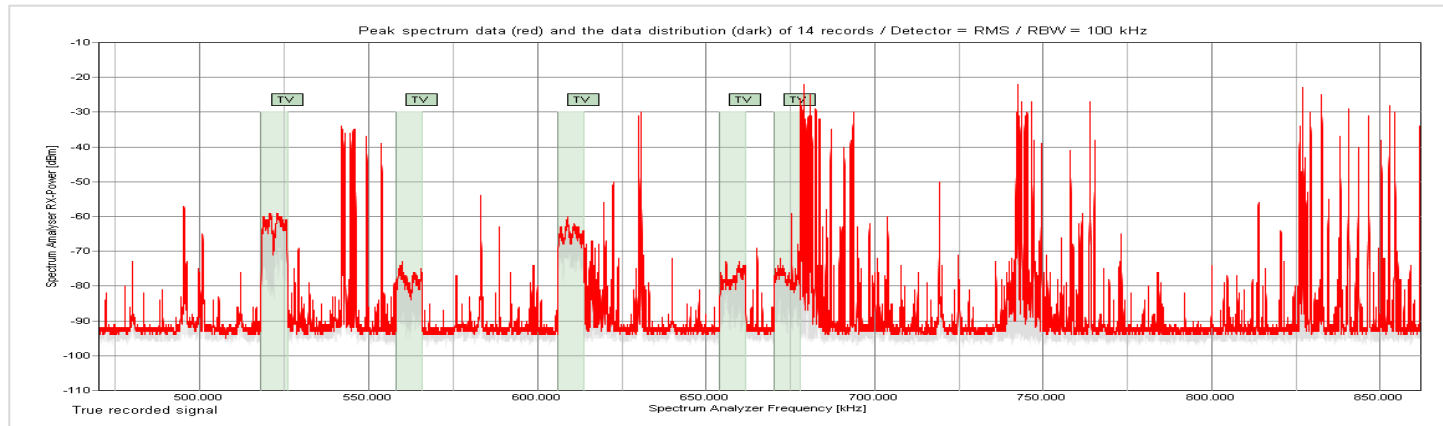
Spectral components	Bandwidth
30 IEM	> 72 MHz
32 microphones	72 MHz
IEM/microphone safety bands	45 MHz
DVB-T transmitters	50.4 MHz
DVB-T/ microphone safety bands	2.4 MHz
Total	241.8 MHz

Evaluation:

1. The PMSE accounted for require at least **242 MHz** UHF spectrum (including the television transmitters stored in the spectrum) for a production on intermodulation- free frequencies.
2. Due to the restricted visual range of the measurement antenna it can be assumed that the actual number of PMSE operated simultaneously is higher. Consequently the spectrum requirement is correspondingly higher.
3. **The event organiser was forced to switch the PMSE on and off during the course of the event. This is a complicated process from a logistic point of view because the switching operations have to be synchronised with the actual progress of the event.**

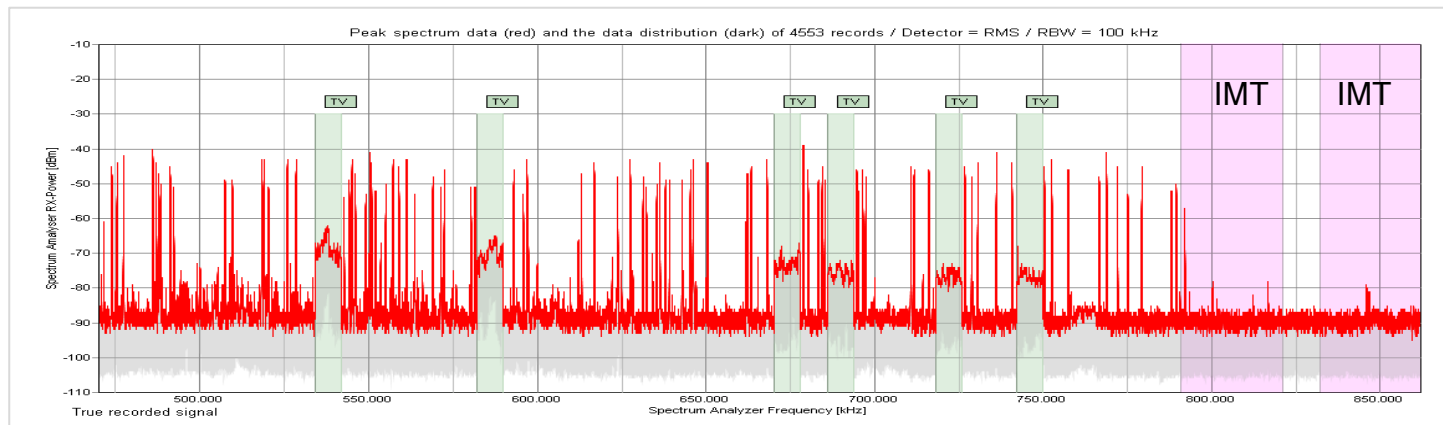
The changing UHF frequency usage of the Eurovision Song Contest

1) Eurovision Song Contest 2007 – Helsinki (a short look at a rehearsal day)



At the event	
Microphones	54
IEM	16

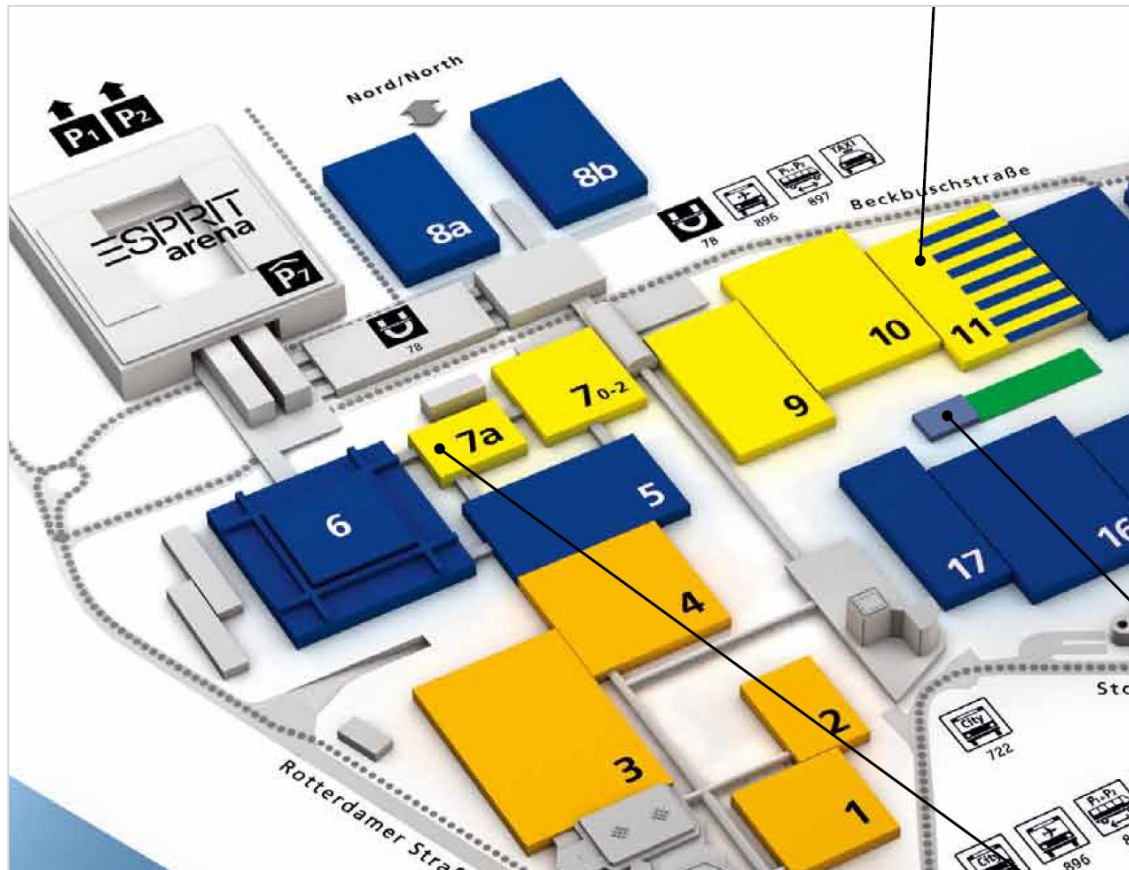
2) Eurovision Song Contest 2011 - Düsseldorf (a look at the main event)



At the event	
Microphones	124
IEM	44

Is the Eurovision Song Contest an isolated event?

In the period from 12th to 18th May 2011, i.e. at the same time as the ESC, the trade fair, "Interpack - Processes and Packaging", was held. With 2703 exhibitors from 59 countries and 166,000 visitors, it is one of the largest trade fairs to be held in Düsseldorf. The graphic below shows its direct proximity to the "ESPRIT arena", the venue for the ESC:



Source: Düsseldorf trade fair, "Hall plan for Interpack", <http://www.interpack.de/>

The Eurovision Song Contest 2011 was no isolated event taking place "somewhere on a green meadow, far from civilisation". On the contrary, it is an event that takes place in a metropolitan area where there are interactions with neighbouring events that are hard to predict.

Taking into account what we learnt from the free space measurement (see "Accompanying external measurements) and the low building attenuation of the "ESPRIT arena", the complexity of safeguarding the production frequencies required becomes clear once again.

The complex way in which location affects events in metropolitan areas must be appropriately taken into account.

Eurovision Song Contest 2011

Summary

Overall evaluation:

The work of the DKE-WG 731.0.8 during the Eurovision Song Contest 2011 differed in many respects from previous spectrum recordings:

- The duration of the total production, spanning several weeks.
- A clearly delineated event environment with a sustainably exercised domiciliary right, e.g. through the presence of the Federal Network Agency (BNetzA).
- A direct view of the site of the main event
- An adequate safe distance from technical equipment that might cause interference
- Comprehensive support for the DKE working group from the event organiser, radio producers and the audio production team
- A long scan period of approximately 15 days, without major interruptions
- The practical experience of the DKE-WG 731.0.8 and a software tool that has been developed over the course of several years

The statements that can be made about the event are equally noteworthy:

- This type of event is produced with the highest demands for quality of live coverage and must be carefully planned and rehearsed.
- The distribution channel for the produced content extends across Europe and beyond. This is a clear differentiating characteristic in comparison to events that the DKE working group has observed before.
- With international voting, in particular, considerable side-effects have to be reckoned with, e.g. with respect to telecommunications.
- The host city provided massive support for the preparation and implementation of the event, seeing it as an opportunity to advertise itself
- In comparison to previous events the use of wireless production tools has increased.
- A frequency usage configured in a completely different way, which will influence the perception of these types of events.
In contrast to generally accepted opinion, we registered a short term change in frequency occupation during the course of the event.
- The event's radio signals were still received several hundred metres away. Conversely, that means that the event can be disrupted by other radio applications on the same frequencies from considerably further away. In this special event environment, that leads to an increased requirement for protection vis-à-vis other frequency occupancies; e.g. a trade fair event taking place at the same time.

Related links:

- Wikipedia (D): http://de.wikipedia.org/wiki/Eurovision_Song_Contest
- Wikipedia (E): http://en.wikipedia.org/wiki/Eurovision_Song_Contest
- Official ESC website: <http://www.eurovision.tv>
- NDR page on the Eurovision Song Contest: <http://www.eurovision.de/>
- Eurovision history (E): <http://www.esc-history.com/>
- All the results and artists since 1956 at hitparade.ch: <http://www.hitparade.ch/esc.asp>
- Television encyclopaedia of the Eurovision Song Contest (D): <http://www.fernsehlexikon.de/530/eurovision-song-contest>
- DKE German Commission for Electrical, Electronic & Information Technologies of DIN and VDE: <http://www.dke.de>
- ESPRIT arena Düsseldorf: <http://www.espritarena.de/en>

Eurovision Song Contest 2011

An introduction to the DKE team

The DKE working group 731.0.8

The DKE working group was founded in 2006. With this report, it has set itself the task of creating a comprehensive description of the Eurovision Song Contest 2011 and its PMSE radio spectrum usage.

We trust that with this we can support the responsible activity of international frequency regulation.

The ESC2012 measuring and editorial team of DKE-AK 731.0.8

- M. Fehr, freelance specialist in high frequency technology matthias.fehr@apwpt.org
- B. Marx, freelance specialist in events technology bruno.marx@apwpt.org
- N. Hilbich, application engineer specialising in wireless microphone applications norbert.hilbich@apwpt.org



Matthias Fehr



Bruno Marx



Norbert Hilbich



Eurovision Song Contest 2011

Final remarks

All things come to an end

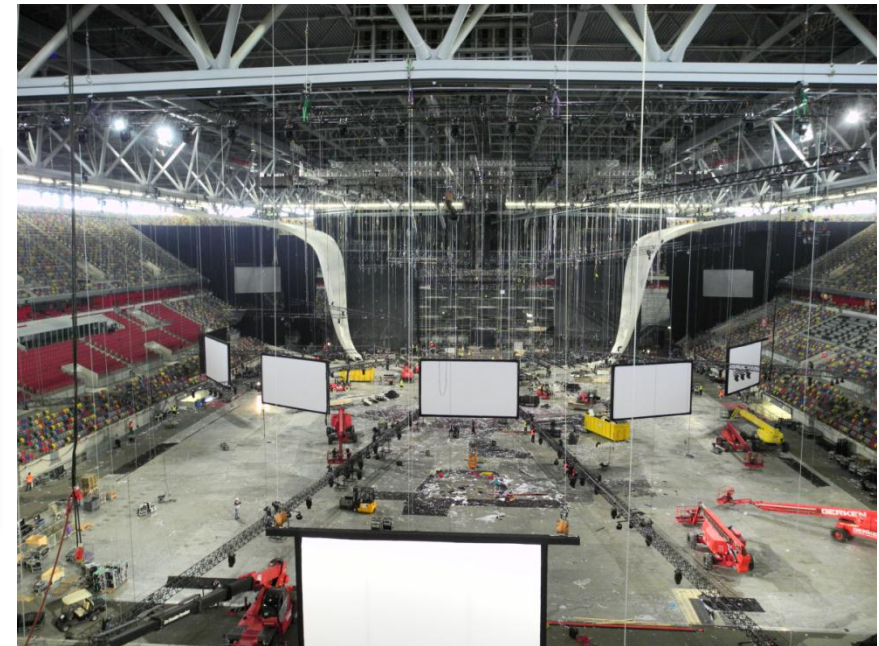
The event has finished and all the participants have left the stadium. The last television broadcast finished hours ago. All the microphones and cameras have been switched off and dismantled.

This picture shows the day after the event →

The work involved in setting everything up and taking it down is rarely depicted in event reports.

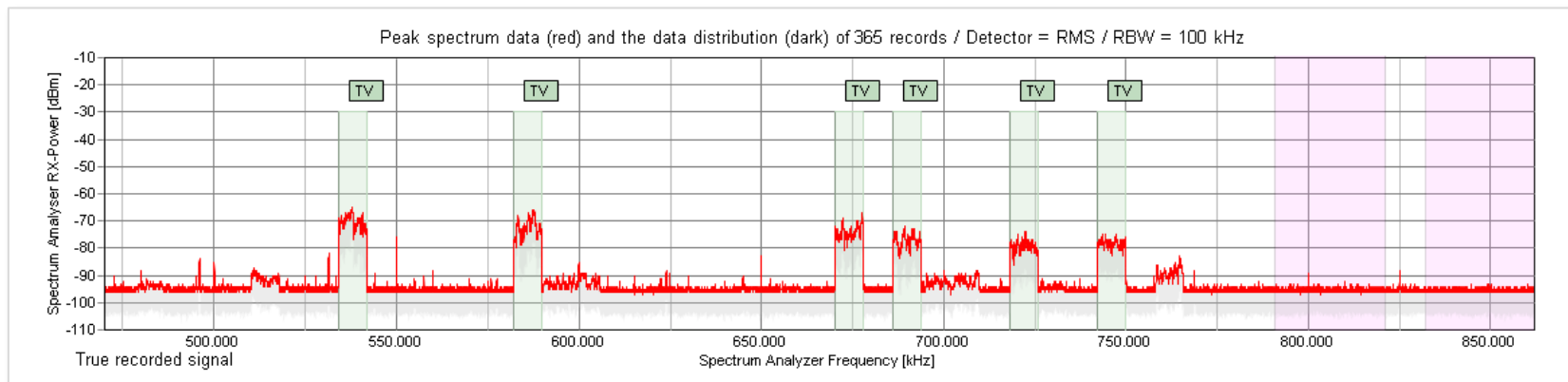
Nevertheless this work is a significant element of the event.

All the preparation and follow-up work for such events has an effect on the labour market and employment which should not be underestimated.



Picture: Matthias Fehr

After the event: virtually no narrow band signals in the UHF spectrum:



Our special thanks go to the following organisations and people

- 1) The team from Düsseldorf Congress as operators of the “ESPRIT arena” during the ESC2011
- 2) Norddeutscher Rundfunk [North German Broadcasting] (NDR), Messrs. D. Thiessen and U. Fricke
- 3) The MM Communications production team under the leadership of Messrs. M. Müller and J. Hering
- 4) The team from RIEDEL Communications GmbH & Co. KG, under the leadership of Mr. T. Riedel
- 5) The Institut für Rundfunktechnik GmbH [Institute for Broadcast Technology], under the leadership of Mr. J. Mezger
- 6) EBU TECHNICAL (CH), Mr. D. Ratkaj
- 7) Harman International (AKG), Mr. T. Lindenbauer
- 8) beyerdynamic GmbH & Co. KG, Mr. U. Roth
- 9) Radiotelevision Svizra Rumantscha (CH), Messrs. Rehm and Jeitziner
- 10) The working group K713 of the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE (DKE), Messrs. Butscheidt and Theis