



DAB+ measurement in complex scenarios

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Content



Measurements

- Introduction
 - Description of measurement vehicle
 - Stationary measurements
 - Mobile measurements and correlations
 - Checking the radiation diagram
 - Portable measurement devices and tests
- Conclusion

OIV general information

- 100% state owned limited liability company
- **Founded in 2002** as a spin-off from public broadcaster HRT
 - 98 years of radio broadcasting experience
 - 68 years TV broadcasting experience
- **Human resources**
 - ≈ 300 employees
 - > 50% university degrees
- **Certifications**
 - ISO 9001, ISO 14001, ISO 45001, ISO 27001, ISO 50001
 - Business security certificate

Broadcasting services

Network services

Multimedia services

Professional services

OIV Fire Detect AI service

OIV Pano 360 HD services

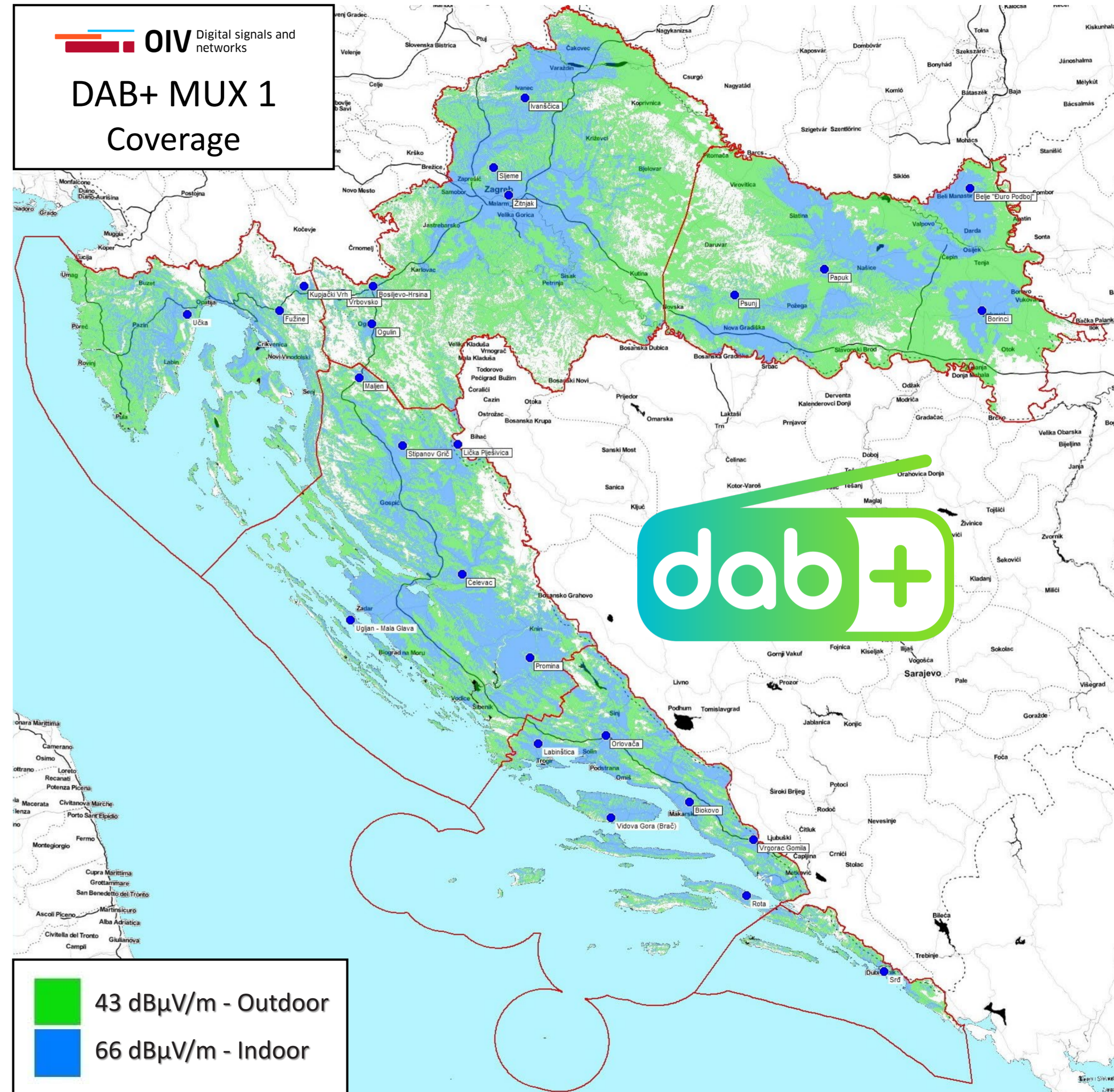
OIV Smartino IoT services

OVM Technology Alliance



Network and coverage

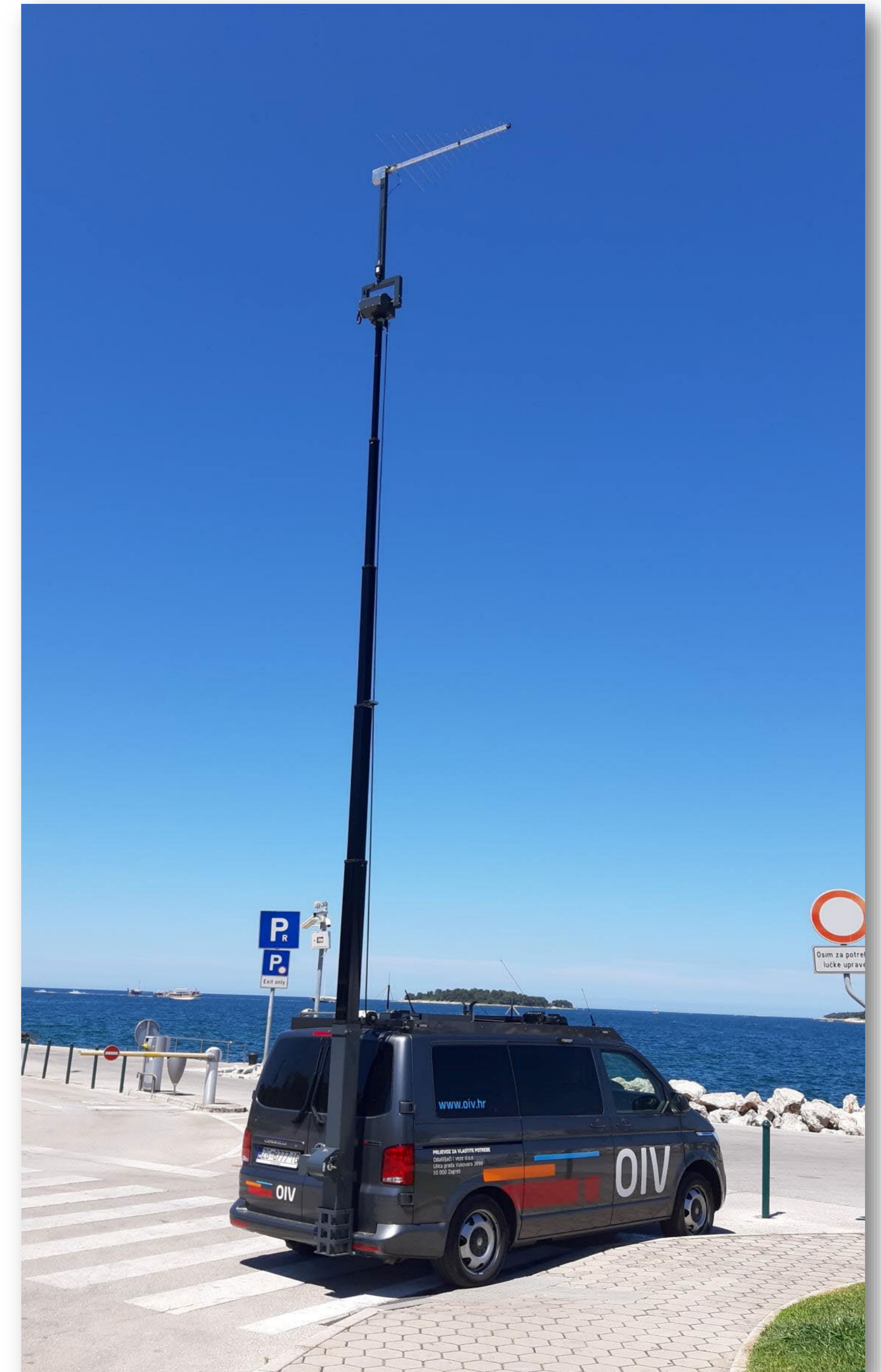
- Four years of the trial, test phase started in 2017, with 4 sites
- **Regular operation from November 2021**, phase 1 - from 16 November 2021, 10 sites
- National/regional mux (6 regions)
- **Network expansion 2022** - 27 sites now
- 2024 planned extension – further 9 sites
- Coverage - national:
 - Portable indoor = 66.5% of the population
 - Mobile outdoor = 97.1% of the population
 - Highways = 95.6%



Measurement vehicle

- Motorized telescopic mast 8m + antenna support with rotators = 10m
- Remote controlled rotators (polarisation, azimuth)
- Log-periodic antennas (FM, VHF and UHF)

- Rooftop:
 - UHF dipole antennas
 - DAB / FM whip antennas
 - GNSS receiver and compass antennas



Equipment

Deva DAB receiver

Deva mobile FM radio analyzer

R&S ETL analyzer

mast/rotator control

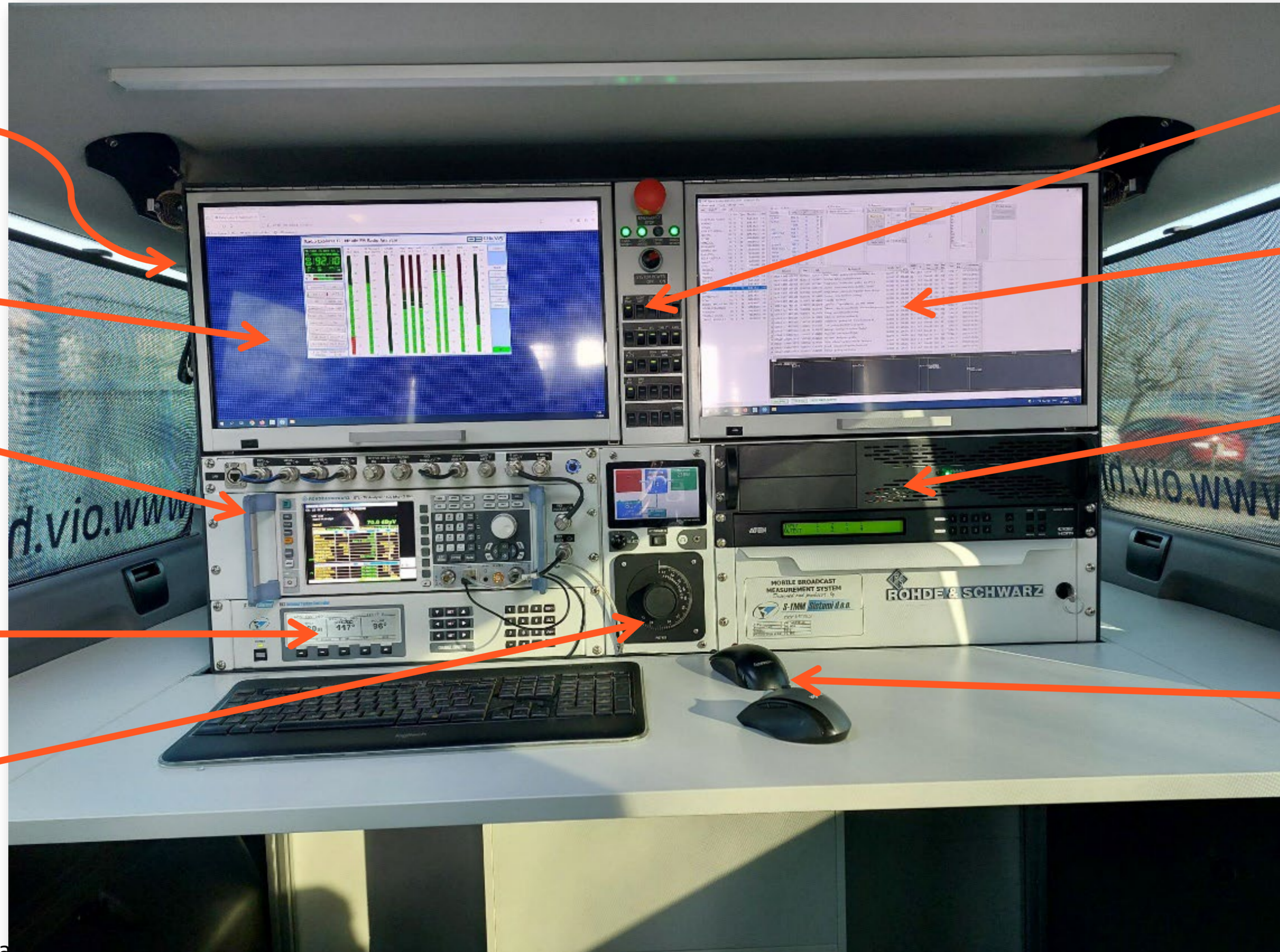
attenuator

power supply control

R&S BC Drive - software for mobile measurements

PC computer, video distributor

mice 😊



Stationary measurements

Reasons:

- Regulatory requirement – verifying the network deployment
- SFN control
- Verification of the network performance

Method:

- Log-periodic antenna, measurement height 3-10 m, R&S ETL analyzer
- CEPT/ERC Recommendation 74-02 E: Method of measuring the field strength at fixed points
- Measurement points position – no reflecting objects and as few overhead conductors within ten times the wavelength
- Fully automated and software-controlled mast
- Site database; automatic direction to sites



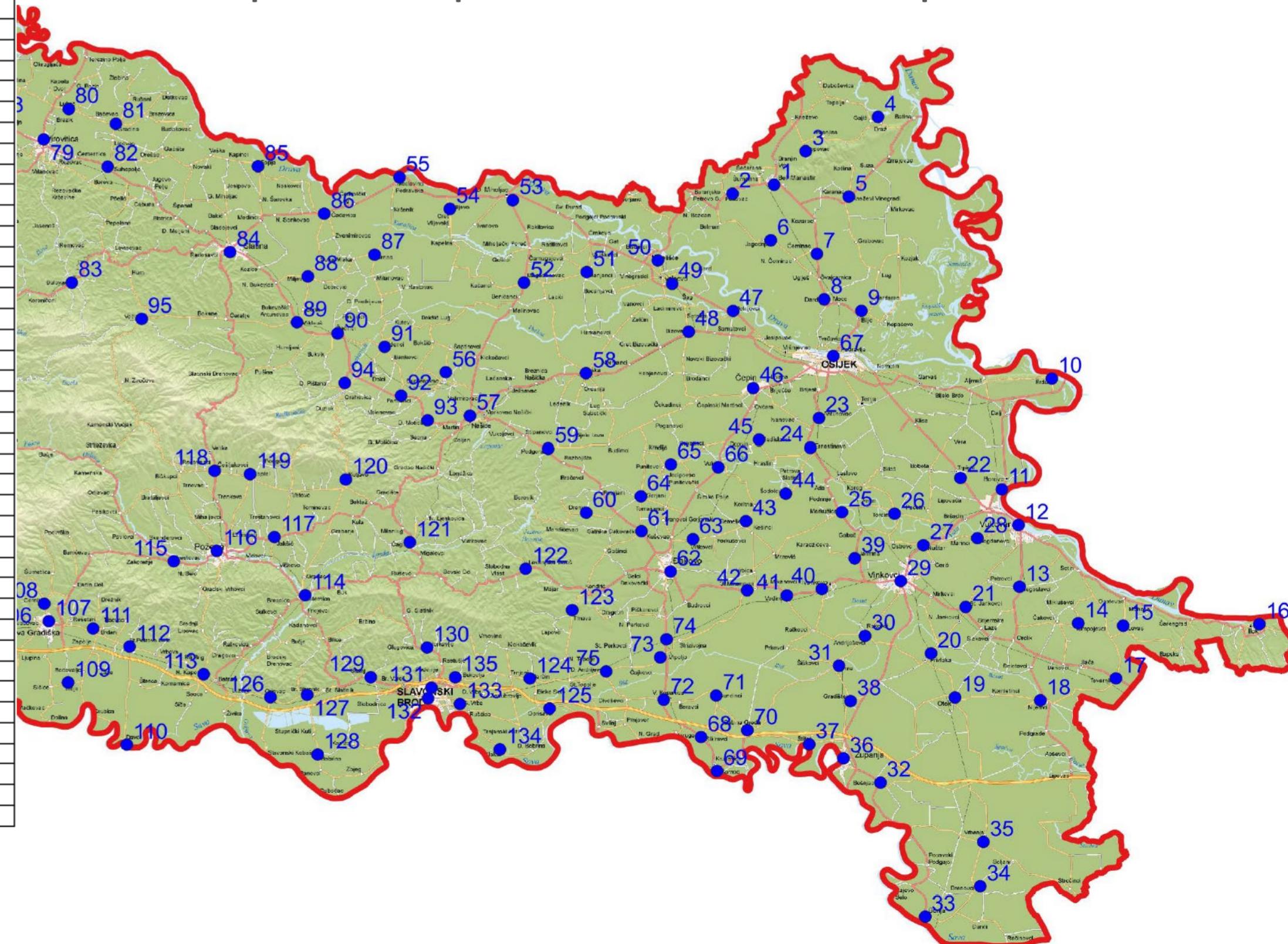
Stationary measurements

- License obligation; every settlement with over 1000 inhabitants,
- ~ 500 measurement points

- On each point:
 - Field strength
 - MER - Modulation Error Ratio
 - BER - Bit Error Rate before Viterbi
 - Impulse response – SFN check up

Tablični prikaz rezultata mjerenja - regija DA0

MT	Duljina	Širina	Mjesto	Opis mjerne točke	Objekt	Kanal	EI polje dBuV/m	MER dB	BER	Polarizacija	Općina	Napomena
1	18.608224	45.765902	Beli Manastir	ispred trgovine auto Baranja	BELJE "ĐURO PODBOJ"	8C	83.8	30.7	<1.0E-09	V	Da	
2	18.538393	45.756456	Petlovac	autobusna stanica na izlazu	BELJE "ĐURO PODBOJ"	8C	86.5	32.3	<1.0E-09	V	Da	
3	18.662627	45.805052	Popovac	centar, parkiralište kod dućana	BELJE "ĐURO PODBOJ"	8C	90.6	31.7	<1.0E-09	V	Da	
4	18.785324	45.843624	Draž	kod crkve	BELJE "ĐURO PODBOJ"	8C	71.5	31.6	<1.0E-09	V	Da	
5	18.732563	45.749265	Kneževi vinogradi	kod pošte	BELJE "ĐURO PODBOJ"	8C	87.0	31.5	<1.0E-09	V	Da	nema vidljivosti
6	18.600251	45.699620	Jagodnjak	autobusna stanica	BELJE "ĐURO PODBOJ"	8C	91.4	32.1	<1.0E-09	V	Da	
7	18.676646	45.681987	Čeminac	parkiralište tvrtke Dover	BELJE "ĐURO PODBOJ"	8C	84.3	32.2	<1.0E-09	V	Da	
8	18.686536	45.627313	Darda	parkiralište ispred pekarnice Zrinjevac	BELJE "ĐURO PODBOJ"	8C	82.0	32.2	<1.0E-09	V	Da	
9	18.748160	45.612425	Bilje	na kraju ulice kč br 51	BELJE "ĐURO PODBOJ"	8C	84.3	32.1	<1.0E-09	V	Da	
10	19.061848	45.524738	Erdut	kod crkve	BORINCI	8C	85.0	32.5	<1.0E-09	H	Da	
11	18.972937	45.395303	Borovo	autobusna stanica kod trgovine Velepromet	BORINCI	8C	78.8	32.1	<1.0E-09	H	Da	
12	18.998652	45.352229	Vukovar	autobusni kolodvor	BORINCI	8C	69.9	30.7	<1.0E-09	H	Da	
13	18.997047	45.278333	Negoslavci	parking ispred trgovine Boso	BORINCI	8C	73.5	30.4	<1.0E-09	H	Da	
14	19.092329	45.232525	Tompojevci	parking ispred trgovine Velepromet	BORINCI	8C	72.4	31.3	<1.0E-09	H	Da	
15	19.166644	45.227922	Lovas	križanje A Starčevića i F Račkoga	BORINCI	8C	68.2	31.1	<1.0E-09	H	Da	
16	19.392014	45.224261	Ilok	kod BP INA	BORINCI	8C	50.0	25.2	1.7E-04	H	Da	
17	19.151756	45.165282	Tovarnik	parking kod DVD doma	BORINCI	8C	65.6	31.9	<1.0E-09	H	Da	
18	19.025583	45.141908	Nijemci	kućni br 99	BORINCI	8C	67.5	31.0	<1.0E-09	H	Da	
19	18.884705	45.148270	Otok	Bana Jelačića 15	BORINCI	8C	74.5	31.9	<1.0E-09	H	Da	
20	18.847279	45.201828	Privlaka	Faličevci 132	BORINCI	8C	81.9	32.0	<1.0E-09	H	Da	
21	18.906920	45.256129	Stari Jankovci	Braće Radića 1	BORINCI	8C	86.8	32.1	<1.0E-09	H	Da	
22	18.904813	45.410539	Trpinja	parkiralište ispred dućana Poljocentar	BORINCI	8C	87.4	32.6	<1.0E-09	H	Da	
23	18.672546	45.485749	Antunovac	Školska 22	BORINCI	8C	82.8	32.4	<1.0E-09	H	Da	
24	18.656896	45.451037	Ernestinovo	kod vrtića	BORINCI	8C	84.4	32.3	<1.0E-09	H	Da	
25	18.706181	45.373535	Markušica	ispred crkve	BORINCI	8C	98.2	32.3	<1.0E-09	H	Da	
26	18.793580	45.369954	Tordinci	ispred pošte	BORINCI	8C	85.2	32.5	<1.0E-09	H	Da	
27	18.839896	45.331426	Nuštar	Seljačka sloga, Križni put 18	BORINCI	8C	92.2	31.8	<1.0E-09	H	Da	
28	18.929806	45.337888	Bogdanovci	kod crkve	BORINCI	8C	87.7	32.3	<1.0E-09	H	Da	
29	18.800591	45.289205	Vinkovci	parkiralište VSC (Vinkovci Shopping Capitol)	BORINCI	8C	96.4	32.1	<1.0E-09	H	Da	
30	18.738869	45.224966	Andrijaševci	kod pekare cibalijsa	BORINCI	8C	92.5	32.3	<1.0E-09	H	Da	
31	18.694342	45.190101	Cerna	kod groblja	BORINCI	8C	79.5	32.4	<1.0E-09	H	Da	
32	18.757538	45.049038	Bošnjaci	Vladimira Nazora 4	BORINCI	8C	71.4	32.0	<1.0E-09	H	Da	
33	18.824881	44.887177	Gunja	ispred Picerije Lamm	BORINCI	8C	57.7	29.0	<1.0E-09	H	Da	
34	18.916945	44.921782	Drenovci	ulica Franje Hanamana 33	BORINCI	8C	58.6	30.1	<1.0E-09	H	Da	
35	18.924290	44.974718	Vrbanja	autobusna stanica kod skretanja za Soljane	BORINCI	8C	62.2	31.7	<1.0E-09	H	Da	
36	18.697498	45.079260	Županja	kod Lidla	BORINCI	8C	71.9	32.1	<1.0E-09	H	Da	
37	18.641643	45.097090	Štitar	autobusna stanica ispred trgovina Patričar	BORINCI	8C	67.7	32.0	<1.0E-09	H	Da	
38	18.711810	45.147523	Gradište	Braće Radića 40a, veterinarska stanica	BORINCI	8C	77.3	32.0	<1.0E-09	H	Da	
39	18.725364	45.317968	Jarmina	kod crkve	BORINCI	8C	104.8	32.1	<1.0E-09	H	Da	
40	18.669529	45.282272	Ivankovo	početak Kolodvorske ulice	BORINCI	8C	96.1	32.1	<1.0E-09	H	Da	
41	18.611191	45.275746	Vodinci	autobusna stanica u sredini mjesta	BORINCI	8C	89.7	32.1	<1.0E-09	H	Da	
42	18.545627	45.283059	Stari Mikanovci	Matije Gupca 101	BORINCI	8C	75.4	31.9	<1.0E-09	H	Da	
43	18.546622	45.365817	Semeljci	autobusna stanica na izlaznoj cesti prema Osijeku	BORINCI	8C	90.1	31.7	<1.0E-09	H	Da	
44	18.613948	45.397496	Šodolovci	autobusna stanica ispred kč br 51	BORINCI	8C	86.2	32.1	<1.0E-09	H	Da	



Measurements – „all OK” example

General

R&S ETL Digital Overview S/N 105365, FW 3.54
Ch: 19 9C RF 206.352000 MHz T-DMB/DAB

* Att 5 dB
ExpLvl 64.50 dBμV

Level 64.9 dBμV

Ensemble: OIV Croatia DAB+ Date & Time(UTC): 11.12.2023, 08:40:53

Pass	Limit	Results	Limit	Unit
Level	47.0	64.9	117.0	dBμV
Sideband		Normal		
Transmission Mode		Mode I, 1536 carriers		
Carrier Freq Offset	-30000.0	70.5	30000.0	Hz
Bit Rate Offset	-20.0	0.3	20.0	ppm
MER/EVM (rms)	24.0	30.9	-----	dB
MER/EVM (peak)	10.0	18.6	-----	dB
BER before Viterbi		0.0e-8(743/1K00)	1.0e-2	
FIB Errors		0	1	/s

Subchannel parameters (SubChId ---, Type ---)

BER before RS		Not applicable	2.0e-4
Packet Error Ratio		Not applicable	1.0e-8
Packet Errors		Not applicable	1 /s
MPEG Ts Bitrate		Not applicable	kbit/s

Lvl 64.9dBμV | BER 0.0e-8 | MER 30.9dB DEMOD FIC

Date: 11.DEC.2023 09:54:38

MER over channel

R&S ETL MER vs Carrier S/N 105365, FW 3.54
Ch: 19 9C RF 206.352000 MHz T-DMB/DAB

* Att 5 dB
ExpLvl 64.50 dBμV

RMS 30.906 dB

Lvl 64.9dBμV | BER 0.0e-8 | MER 30.8dB DEMOD FIC

Date: 11.DEC.2023 09:54:44

Channel Impulse Response

R&S ETL Echo Pattern S/N 105365, FW 3.54
Ch: 19 9C RF 206.352000 MHz T-DMB/DAB

* Att 5 dB
ExpLvl 64.50 dBμV

EchoDetectionThreshold -31.467

Guard Start Guard Stop

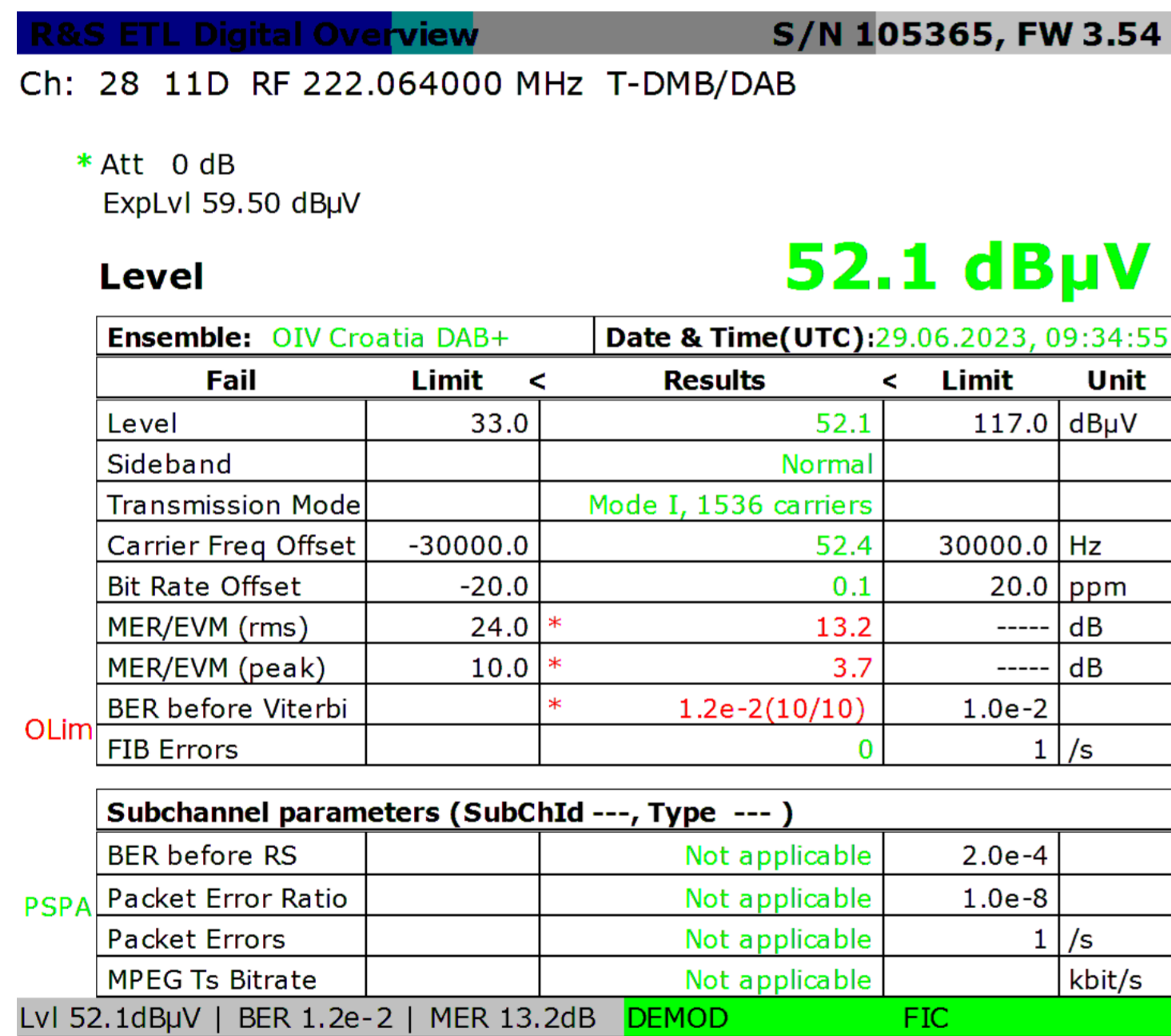
Rank	Level/dB	Time/μs	Level/dB	Time/μs
1	0.0	0.000	-44.5	-35.669
2	-43.1	875.005	-44.8	31.175
3	-43.9	745.174	-46.4	-96.018
4	-43.9	5.542	-47.1	810.846
5	-44.3	740.037	----	----

Lvl 65.0dBμV | BER 0.0e-8 | MER 30.8dB DEMOD FIC

Date: 11.DEC.2023 09:54:49

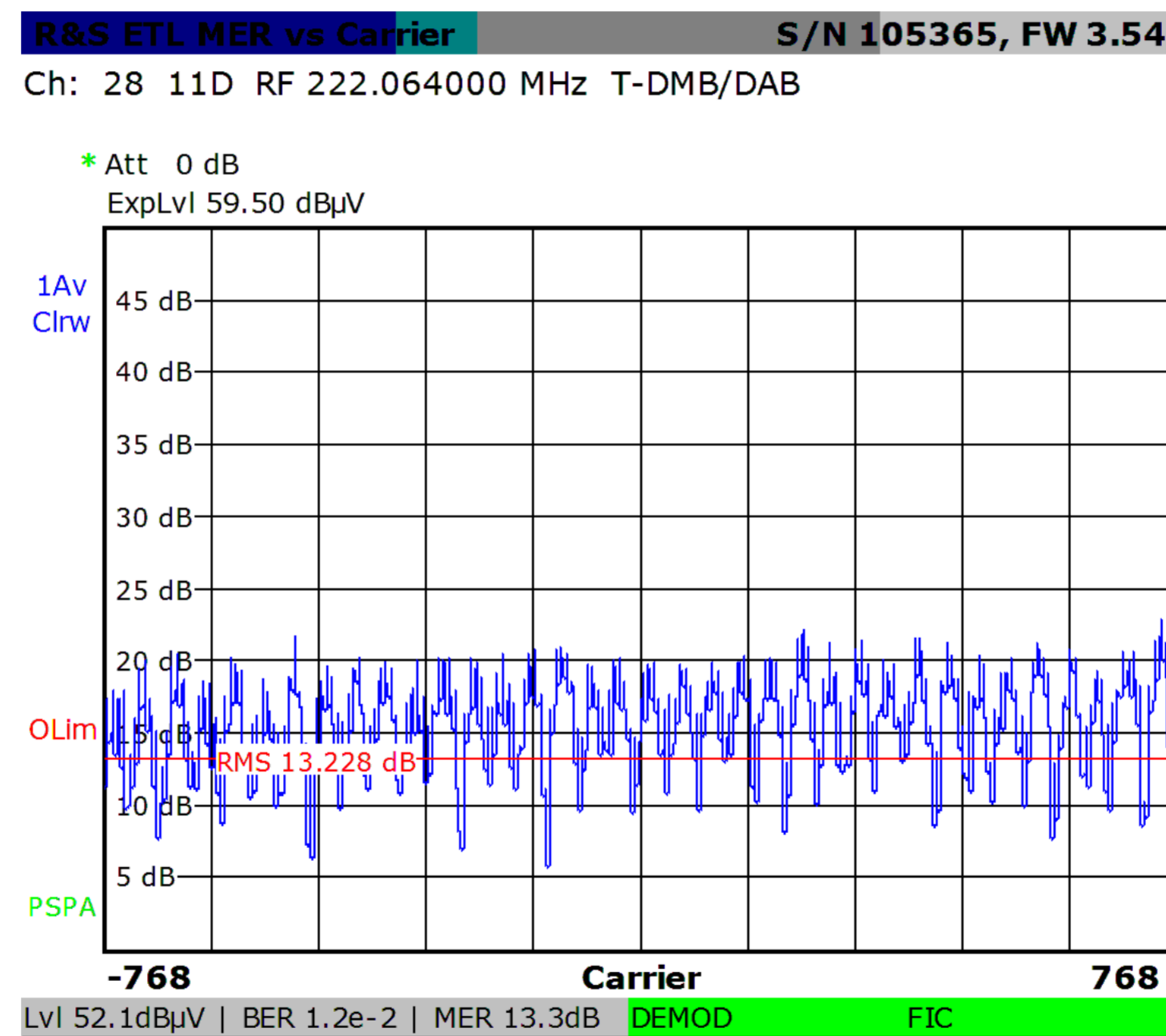
Measurements – out of guard interval example

General



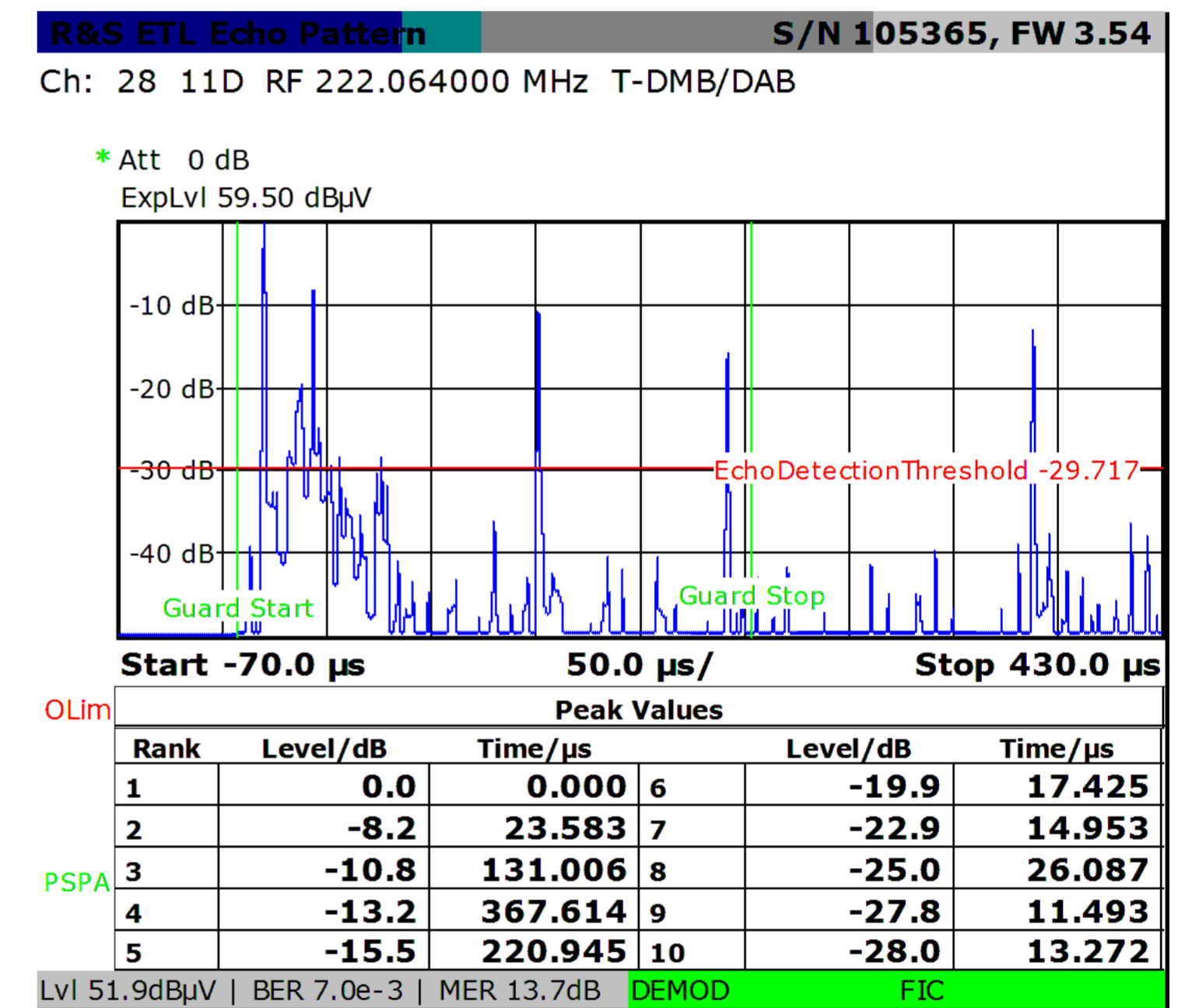
Date: 29.JUN.2023 11:38:52

MER over channel



Date: 29.JUN.2023 11:38:59

Channel Impulse Response



Date: 29.JUN.2023 11:39:41

Measurements – zero dB echo example

General

R&S ETL Digital Overview S/N 105365, FW 3.51
Ch: 19 9C RF 206.352000 MHz T-DMB/DAB

* Att 0 dB
ExpLvl 59.50 dBμV

Level 55.9 dBμV

Ensemble:	OIV Croatia DAB+	Date & Time(UTC):	20.02.2023, 09:07:17	
Fail	Limit	Results	Limit	Unit
Level	47.0	55.9	117.0	dBμV
Sideband		Normal		
Transmission Mode		Mode I, 1536 carriers		
Carrier Freq Offset	-30000.0	62.9	30000.0	Hz
Bit Rate Offset	-20.0	0.3	20.0	ppm
MER/EVM (rms)	24.0	29.1	-----	dB
MER/EVM (peak)	10.0	6.7	-----	dB
BER before Viterbi		7.8e-4(10/10)	1.0e-2	
FIB Errors		0	1	/s

Subchannel parameters (SubChId ---, Type ---)

BER before RS		Not applicable	2.0e-4
Packet Error Ratio		Not applicable	1.0e-8
Packet Errors		Not applicable	1 /s
MPEG Ts Bitrate		Not applicable	kbit/s

Lvl 55.9dBμV | BER 7.8e-4 | MER 29.1dB DEMOD FIC

Date: 20.FEB.2023 10:09:42

MER over channel

R&S ETL MER vs Carrier S/N 105365, FW 3.51
Ch: 19 9C RF 206.352000 MHz T-DMB/DAB

* Att 0 dB
ExpLvl 59.50 dBμV

RMS 29.287 dB

Lvl 55.9dBμV | BER 8.4e-4 | MER 29.2dB DEMOD FIC

Date: 20.FEB.2023 10:09:49

Channel Impulse Response

R&S ETL Echo Pattern S/N 105365, FW 3.51
Ch: 19 9C RF 206.352000 MHz T-DMB/DAB

* Att 0 dB
ExpLvl 59.50 dBμV

EchoDetectionThreshold -29.951

Guard Start Guard Stop

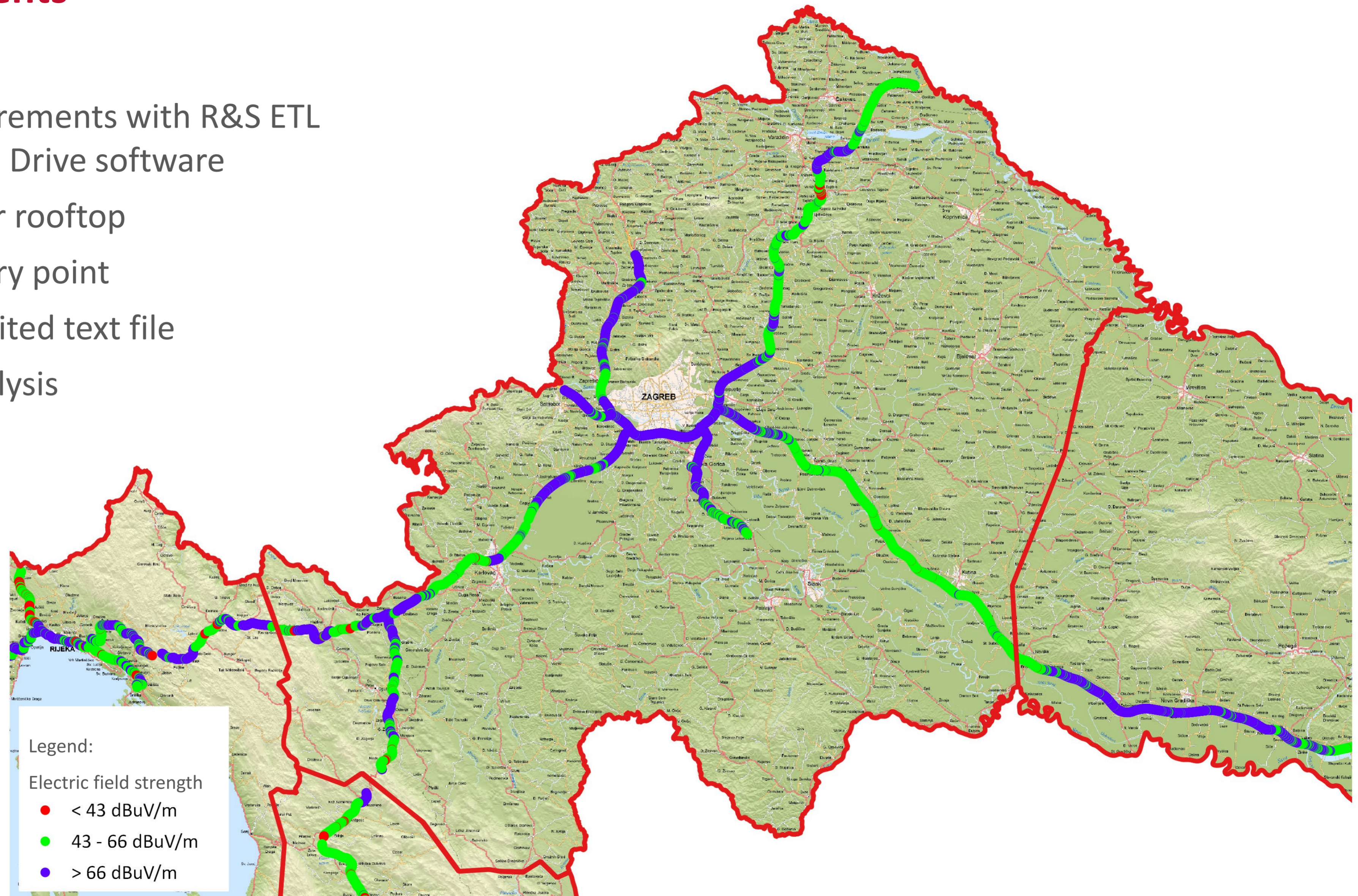
Rank	Level/dB	Time/μs	Level/dB	Time/μs
1	0.0	0.000	-31.8	10.829
2	-4.7	159.199	-32.0	162.018
3	-28.3	13.866	-34.4	5.741
4	-29.6	221.054	-36.4	2.894
5	-31.2	163.785	-36.5	8.683

Lvl 55.9dBμV | BER 7.2e-4 | MER 29.1dB DEMOD FIC

Date: 20.FEB.2023 10:10:24

Mobile measurements

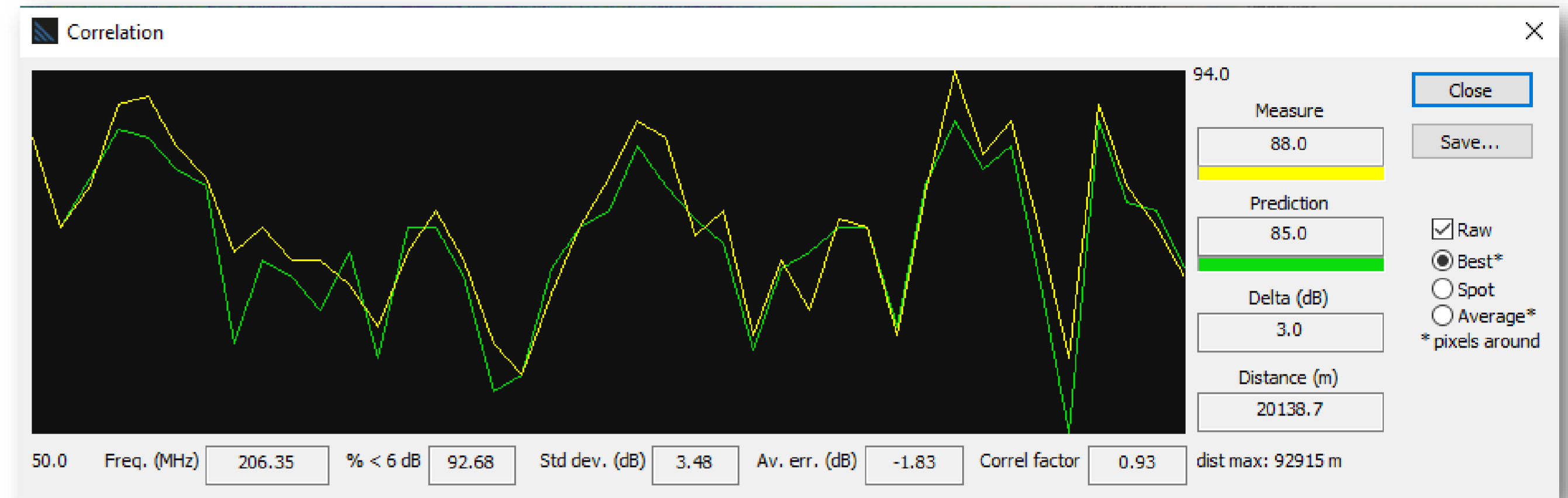
- DAB+ mobile measurements with R&S ETL analyzer and R&S BC Drive software
- Whip antenna on car rooftop
- GPS position for every point
- Export data to delimited text file
- GIS software for analysis



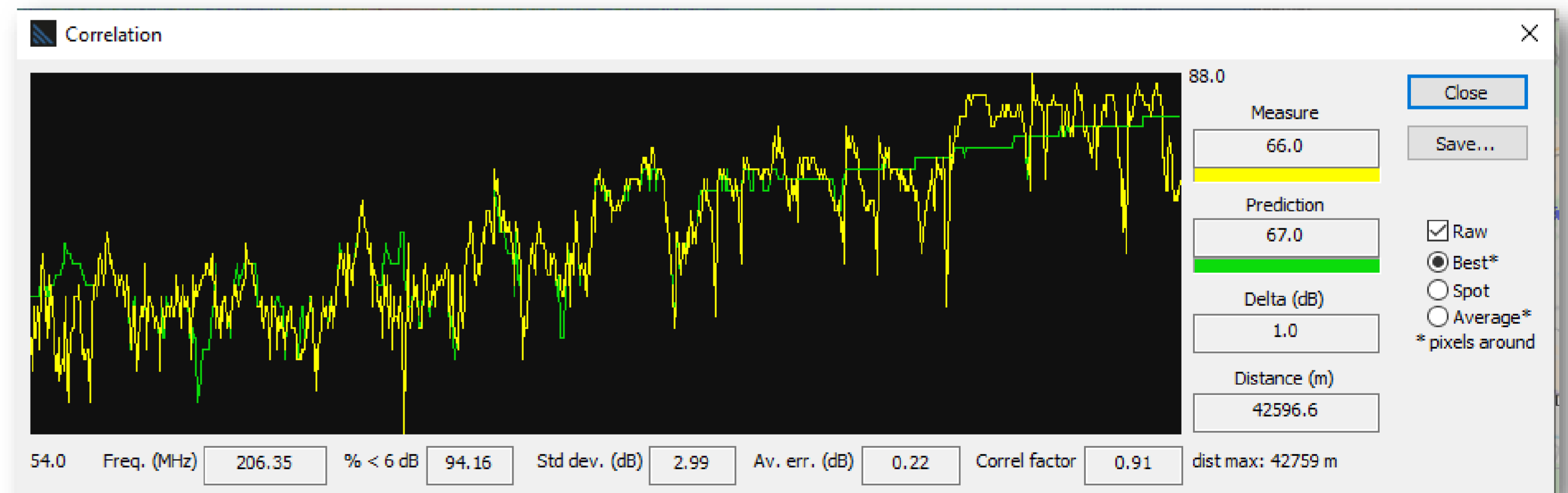
Correlation

- Software coverage prediction vs measurements
- Coverage calculation - ATDI HTZ Communication software
- Measurements import to ATDI

- Fixed points example:
 - 92.68% < 6 dB, average error -1.83 dB
- Highway mobile measurements example:
 - 94.16% < 6 dB, average error 0.22 dB



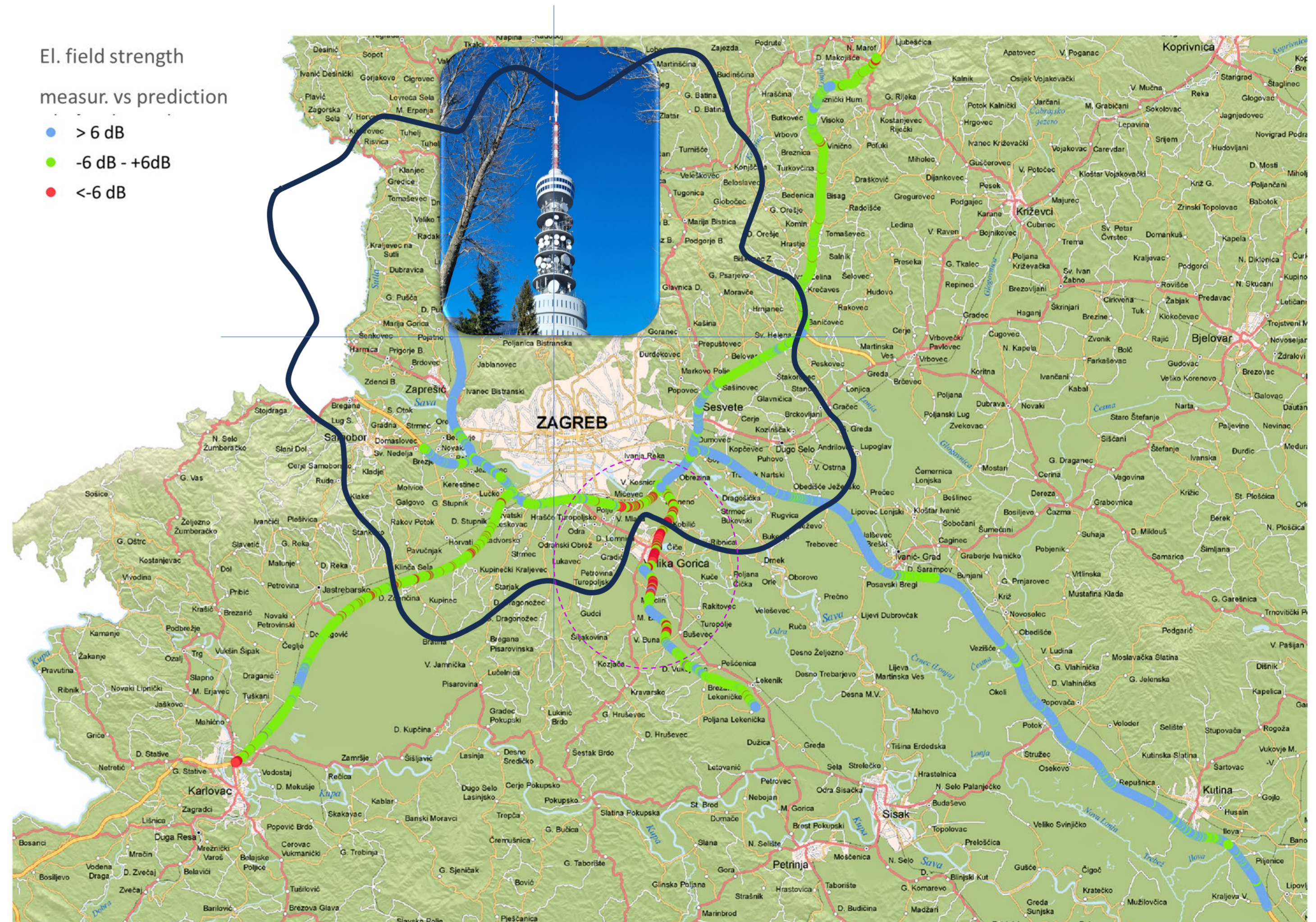
Coverage prediction vs fixed point measurements correlation



Coverage prediction vs mobile measurements correlation

Checking the radiation diagram of the antenna system

- Renewal of the antenna system
- Part of the SAT procedure
- Measurements before and after the antenna system replacement
- Mobile measurement vs prediction with new antenna pattern
- GIS software for space analysis – problem found
- Intervention in the antenna system – improvement of pattern in problematic segment



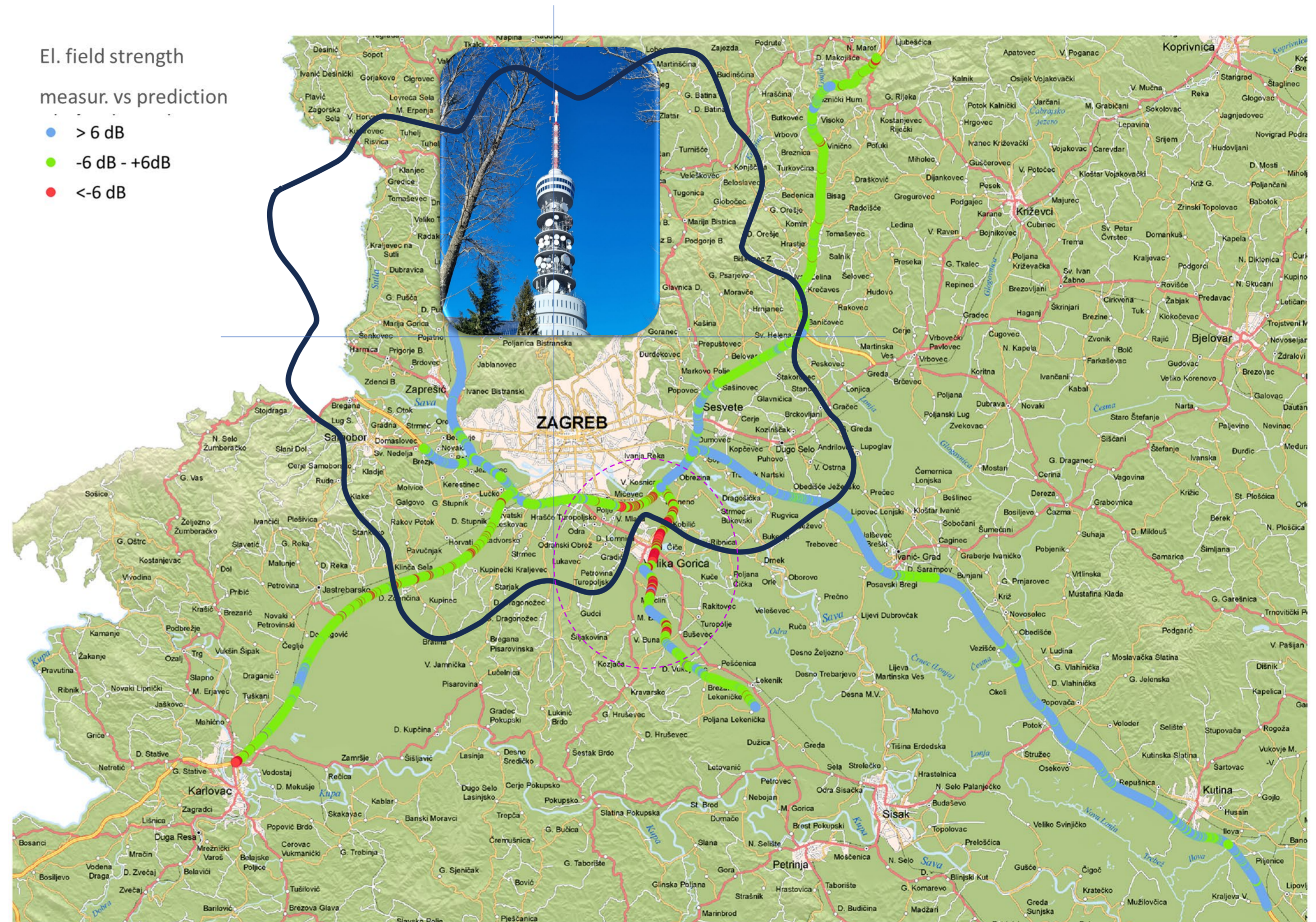
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Checking the radiation diagram of the antenna system

- Renewal of the antenna system
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Checking the frequency spectrum

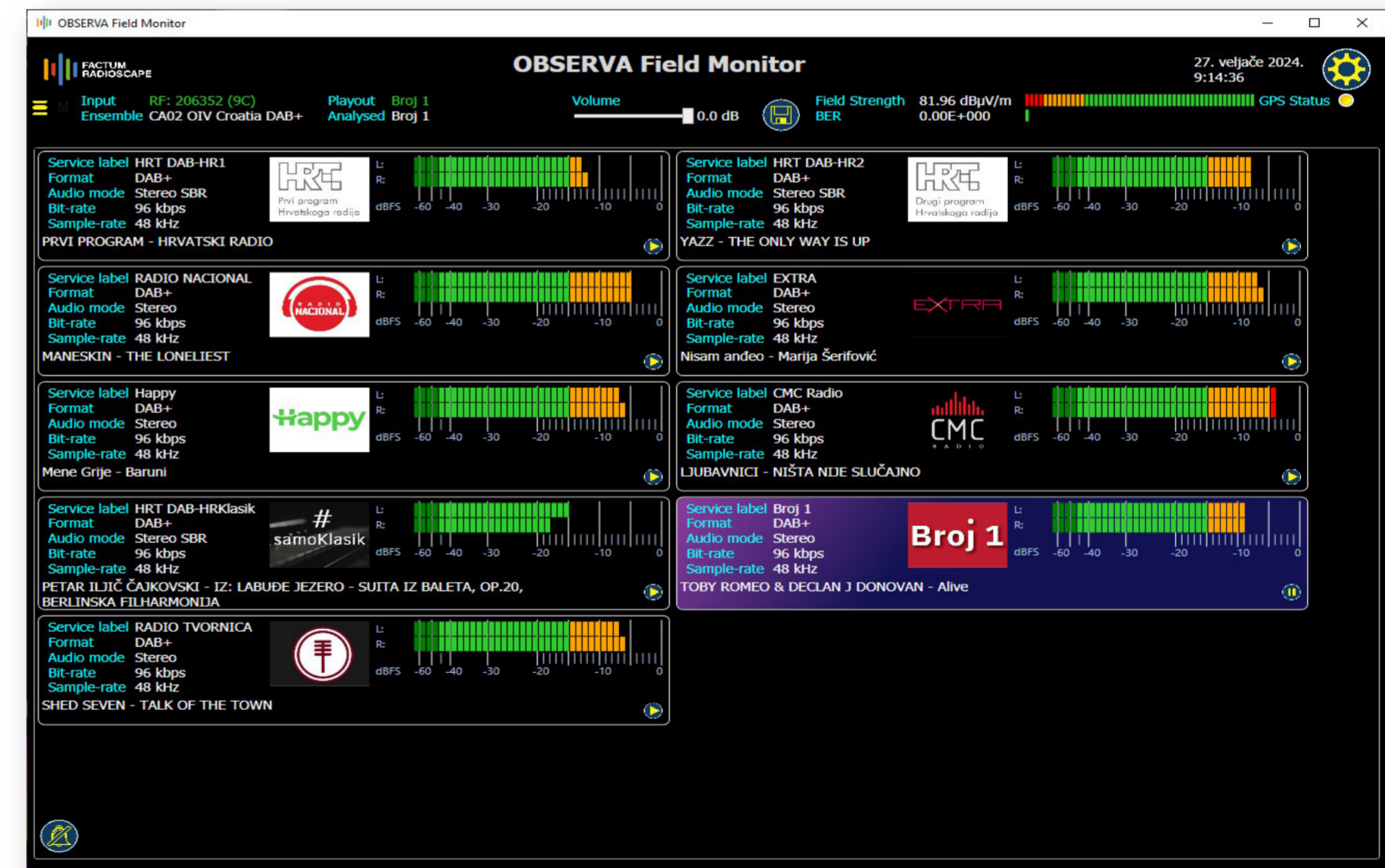
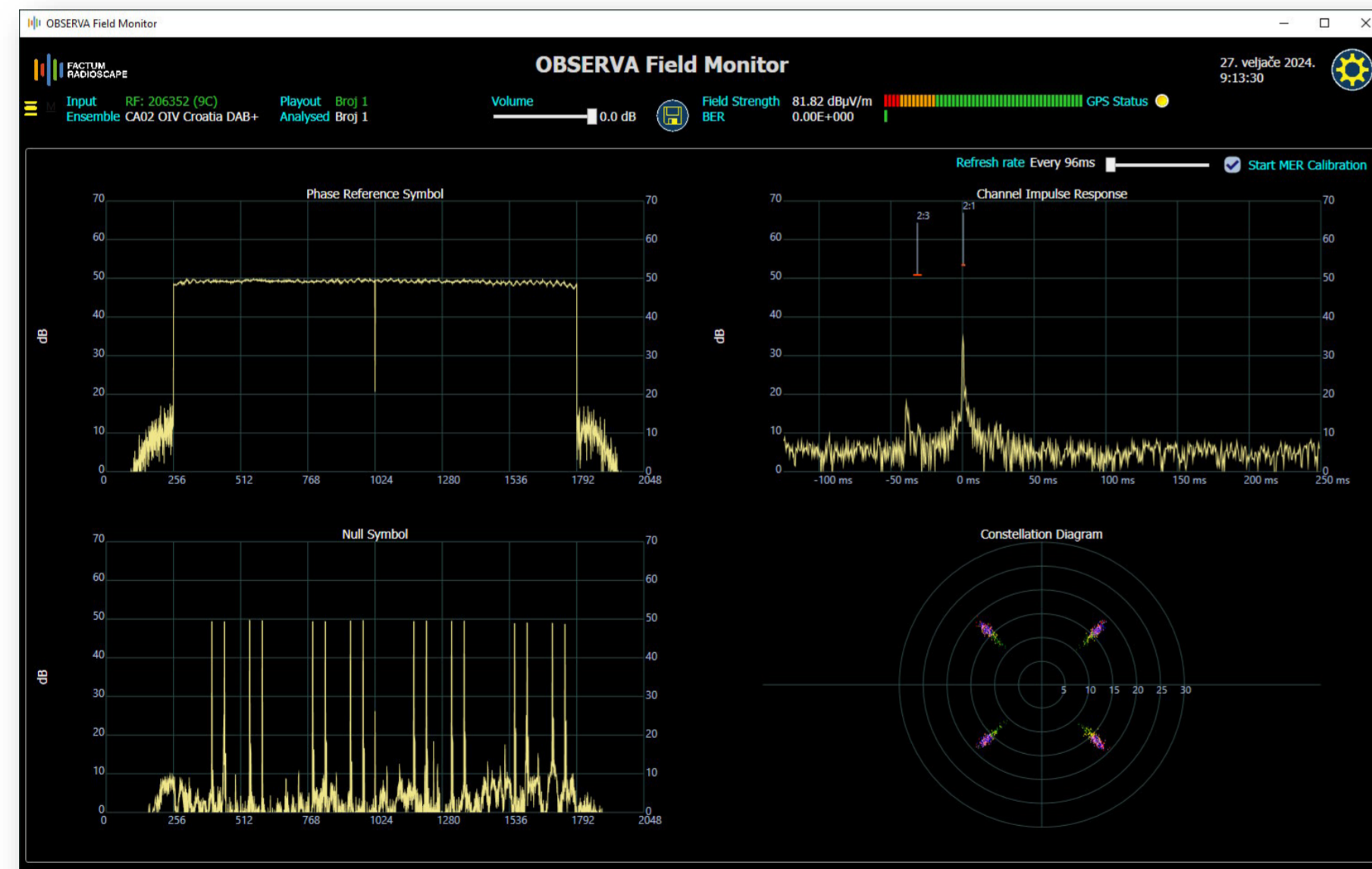


- Checking the network channels for interferences, both UHF (DVB-T2) and VHF (FM and DAB+)
- The campaign takes place once a year in summertime, on the Adriatic coast
- DVB-T2 and DAB+ spectrum is interference-free
- FM spectrum affected by interference
- OIV reports problems to our regulator



Portable measurement devices

- Not a reference measurement receivers, but handy for quick check ups
- RF measurements, additionally decoding of audio and data services



Other tests

Indoor coverage:

- around 50 measurements in front/inside the buildings



- average difference, the so-called "building penetration loss": 16.9 dB

Conclusion

- Network quality - prerequisite for the promotion and success of digital radio
- QoS is important to clients – broadcasters and listeners
- Reliable radio service - important in crisis
- OIV – always taking care about quality



Conclusion

- Network quality - prerequisite for the promotion and success of digital radio
- QoS is important to clients – broadcasters and listeners
- Reliable radio service - important in crisis
- Field tests and measurements are important because you never know who is listening 😊



OIV Digital signals and
networks

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