Ceyear

Radio Spectrum Monitoring and Signal Direction-Finding Solutions

Ceyear Technologies Co., Ltd

Contents

Ⅰ. Portable Spectrum Monitoring System

Ceyear 3943B monitoring receiver adopts a 10.1-inch full screen, a portable design without buttons and full touch. With a directional antenna, it can achieve high-performance radio signal reception in the frequency range of 9kHz to 8GHz; it has an analysis bandwidth of 20MHz and can capture Broad spectrum generated by short pulses or burst signals in electromagnetic space; using three-channel parallel working mechanism, which can provide spectrum measurement, level field strength measurement and signal demodulation at the same time; multi-touch interactive mode and portable external field design bring Good user experience.

Fig. 1 3943B Monitoring Receiver

Fig. 2 Different Modes of 3943B Monitoring Receiver

Fig. 3 Direction Finding using Amplitude Comparison Method

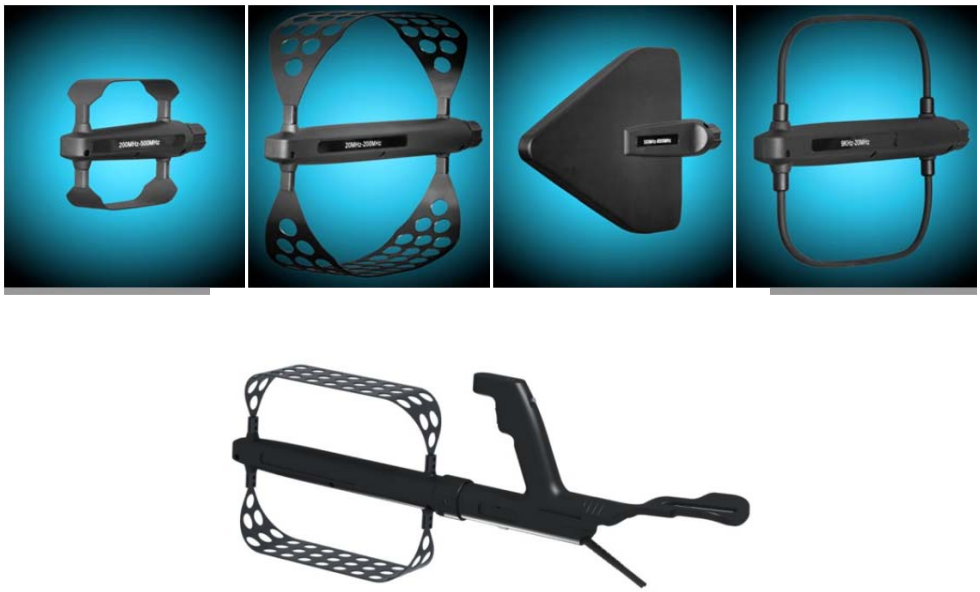


Fig. 4 Hand-held direction-finding antenna (one shared handle)

1. Main Functions

a) With analog demodulation ability, it can carry make demodulation and playback of analog modulation signal.

b) With the beeper sound function, the signal amplitude can be reflected to the loudness of the beeper sound.

c) With horizontal scanning function, signals can be easily oriented by using electronic compass and amplitude measurement.

d) Supports multiple signal scanning methods recommended by ITU. Fixed Frequency Reception (FFM), Panorama Scan (PSCAN), Frequency Scan (FSCAN), List Scan (MSCAN), which allows for fast frequency domain finding and monitoring

e) With IQ data recording, spectrum recording, demodulation audio recording and playback analysis functions

f) In conjunction with the directional antenna, the direction of the illegal signal is determined by using the amplitude comparison method to achieve direction measurement.

g) By using map function and horizontal scanning, three sets of this system can be deployed outdoors simultaneously, to carry out intersection positioning.

2. Specifications

Spectrum monitoring range	9 kHz to 8 GHz
Real-time bandwidth	20 MHz/ 40 MHz
Scanning speed	2 GHz/s @ 100 kHz
Analog demodulation type	AM, FM, PM, SSB, DSB, ISB, CW
Weight	≤3.5kg
Battery Working Time	≥3 hours (single battery)

3. Application Scenarios

Local or national radio regulatory committees, confidential security agencies, military security inspection services for routine frequency monitoring, interference sources, eavesdropping devices, illegal radio stations or the location of communications transmitters. Mainly used for close-range signal search and positioning, the equipment has the characteristics of small size, light weight and long continuous working time. By combining whistling sound with horizontal scanning, the signal of the specified frequency can be located and found, which is friendly to novice operators and easy to operate.

Scenario 1: Abnormal signal searching in closed space:

Through 3943B spectrum analyzer and handheld directional antenna, it can perform the rapid monitoring and demodulation of illegal signals. The system supports CAP and DAT format, abnormal signals can be recorded and saved, and non-destructive playback

analysis can be carried out after the event. It can control and the Monitoring Receiver and read back the data through a light weight PAD or Smart Phone.

Fig. 5 Conventional Seeking Interference Signals

Scenario 2: Abnormal Signal Searching

Through 3943B spectrum analyzer and handheld direction-finding antenna, horizontal scanning and map, it can perform the discovery, direction-finding, searching of abnormal signal source. Horizontal-scanning and map functions are used to locate the approximate location for a long distance and beeper sound function is used to accurately search the source for a close distance.

Fig. 6 Abnormal Source Searching

4. System Configuration List

Fig. 7 Suit case for Monitoring Receiver and Directional Antennas

Description	Main Specs	Quantity
3943B Monitoring Receiver	9kHz-8GHz	1
Hand-held directional antennas set	9kHz-8Ghz, Set of four handheld antennas, GPS, electronic compass	1
Portable suitcase	Can be loaded with 3943B monitoring reception and supporting directional antenna, easy to carry	1

Ⅱ. Movable Spectrum Monitoring and Direction-Finding System

Fig.8 Directional Antenna and Multi-array Antenna

1. Main Functions

a) By using directional antenna, spectrum monitoring function can be realized.

b) In conjunction with the directional antenna, the illegal signal generation device is accurately measured using the relevant interferometer algorithm.

c) With the ability of analog demodulation, it can carry on audio demodulation and playback of analog modulation signal.

d) With panoramic scan, list scan, frequency scan functions.

e) With map function, intersection positioning can be carried out.

f) Can be configured three sets of systems, to achieve multi-point measurement results of the triangular cross-positioning, to obtain accurate positioning results.

2. Performance Specifications

Spectrum monitoring range	9 kHz to 8 GHz
Direction-finding frequency range	20 MHZ to 8 GHz
Direction finding bandwidth	20 MHz/ 40 MHz
Direction finding speed	10 ms or less
Direction finding precision	2 ° RMS (20 MHZ to 700 MHZ) 1 ° RMS (700 MHZ - 6 GHZ)

The power supply mode	Battery powered or AC powered
Power consumption	less than 100W

3. Application Scenarios

The 3943B spectrum analyzer can be upgraded to a 3943B direction-finding receiver with directional options. With direction-finding antenna A and B, it can accurately measure the azimuth of illegal signal source, and then with map options, it can carry out AOA positioning.

The system can be deployed in different forms, such as fixed monitoring station, movable monitoring station and mobile monitoring station. It has the characteristics of high precision, small size and easy deployment.

Direction-finding receiver can also cooperate with the hand-held directional antenna to search abnormal signals at close distance. For now, drone can be searched by using the system.

Scenario 1:

By setting the directional time, the drone map signal and control signal of the known protocol can be measured, and the position and operator of the drone can be located.

Fig 9. Drone Detection and Location

Scenario 2:

Spectrum monitoring and signal geolocation to achieve electromagnetic protection for important areas, such as airports, exam places, military field and other large-scale activities.

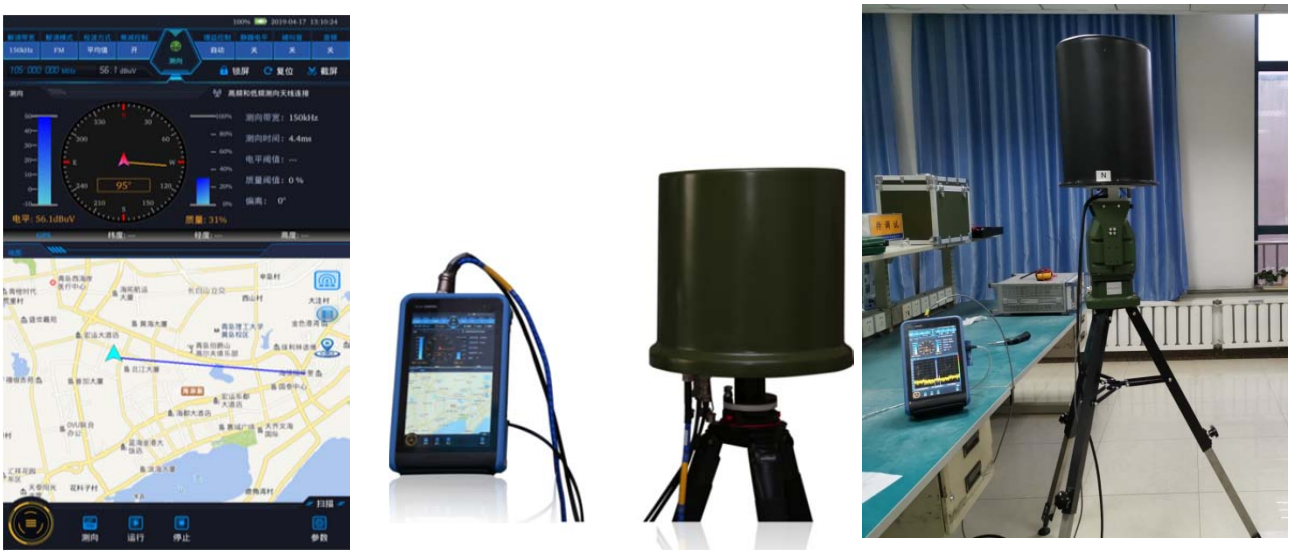


Fig.10 Direction Finding using Multi-array Antenna

Scenario 3:

A set of systems can be used to measure direction in multiple locations, and further realize triangular cross-positioning. To geolocate illegal signals or interference sources.

Three nodes can also be configured at the same time to quickly achieve triangular cross-positioning of multi-point measurement results, which can be used for real-time spectrum monitoring and illegal signal positioning in major areas such as airports, military zones, large-scale events.

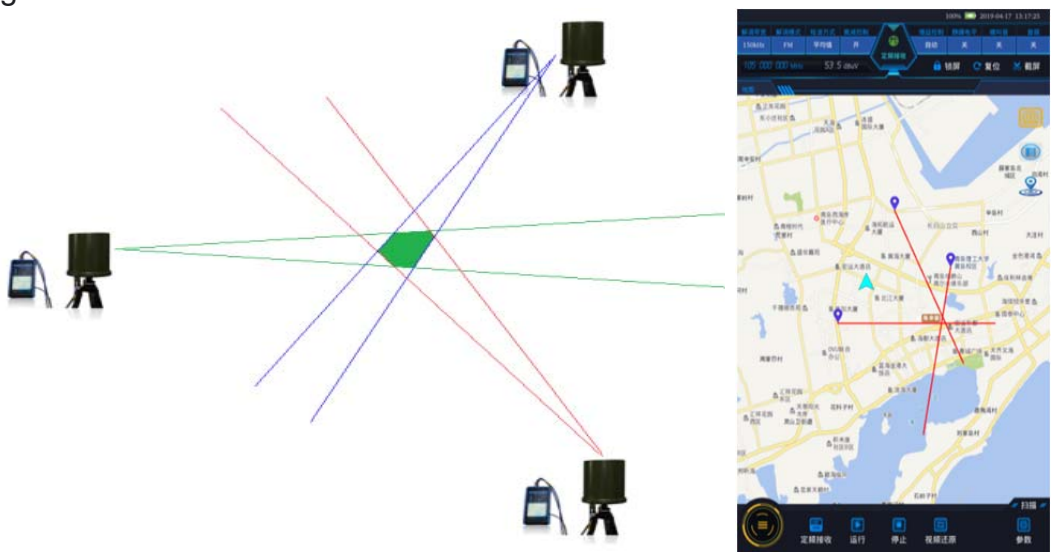


Fig. 11 Accurate Cross Location using 3 units at the same time

4. System Configuration List

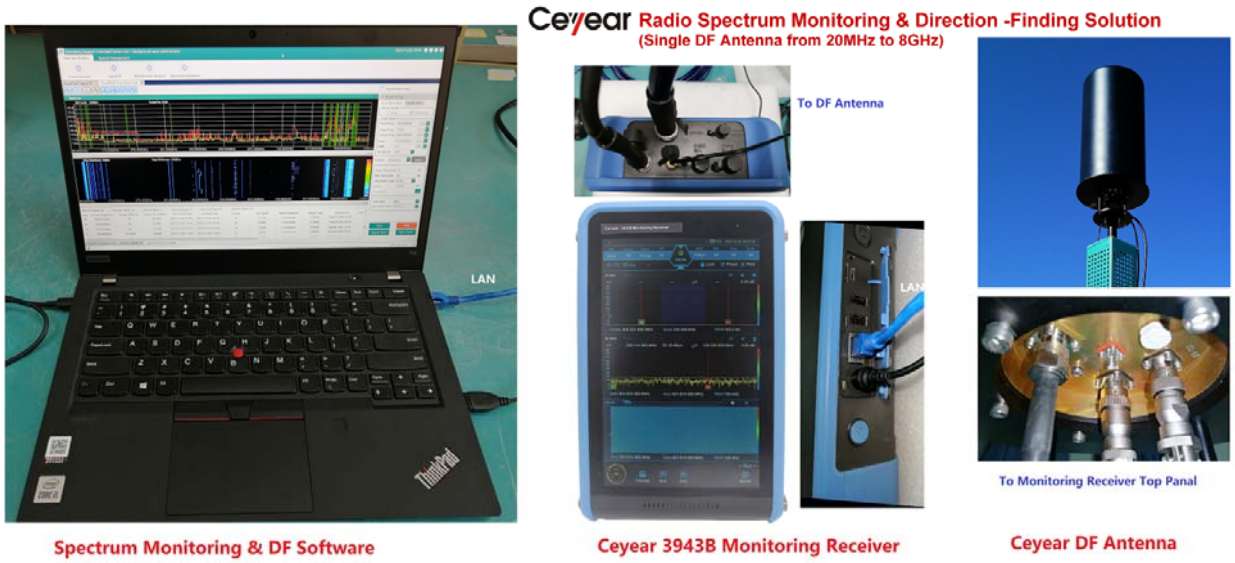
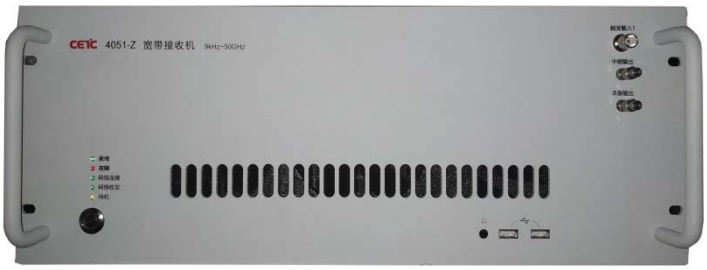


Fig. 12 Typical Configuration using a DF Antenna

Description	Main Specs	Quantity
3943B Monitoring Receiver or 3943B-Z Monitoring Receiver Module	The monitoring frequency is 9kHz- 8GHz, and the direction-finding frequency is 20MHz-8GHz	1
Directional antenna sets	9kHz-8GHz, a set of four hand-held antennas, GPS, electronic compass	1
Direction finding antenna	20MHz - 8GHz, an integrated DF antenna. Can also work as a monitoring antenna. Can be tripod-mounted or vehicle-mounted.	1
Mounting bracket for direction finding antenna	Rugged tripod	1
Laptop computer	To run Spectrum Monitoring and DF Software.	1

Ⅲ. High-end Spectrum Monitoring System

The removable spectrum monitoring system consists of high-performance notebook, spectrum monitoring and analysis software, high-performance monitoring receiver, long time data recorder, switch matrix and monitoring antenna in different frequency bands, which can carry out spectrum monitoring, automatic search and classification of radio signals, broadband IQ data storage, real-time mediation analysis and storage of digital signals, and is ideal for radio signal monitoring and recording in complex electromagnetic environment areas.



4051-Z Broadband Monitoring Receiver (No panel)

Fig. 13 4051-Z Series Monitoring Receiver（9kHz-50GHz）

Fig. 14 4711 series Data recorder and High Speed Optical Links

Fig. 15 3943B-Z Monitoring Receiver Module

Fig. 16 3637BD Switch Array

Fig. 17 Omni-directional Monitoring Antenna

1. Main Functions

a) With high-speed electromagnetic spectrum scanning detection function, abnormal signals can be detected by threshold, include level threshold etc.

b) With communication/non-communication signal measurement and analysis functions, including multi-domain correlation analysis, real-time spectrum analysis, pulse signal analysis, signal identification, signal demodulation.

c) With the function of seamless signal acquisition and mass storage, the signal can be recorded without interruption, and non-destructive playback and analysis after the event.

d) With electronic map function, positioning, timing.

e) Backtracking statistical analysis function, can be signal, image, mobile phone characteristics of the parameters of saving and secondary analysis

f) With electromagnetic situation display function, the electromagnetic situation of the region can be analyzed and evaluated by mobile continuous acquisition signal

g) Have a safety risk assessment based on GIS data to estimate signal distribution and range of influence through simulation of radiation sources

h) Can be installed on vehicle or fixed position.

2. Specifications

Monitoring frequency	9 kHz – 50 GHz
Analysis bandwidth	550 MHz
Record capacity	24 TB
Signal data recording rate	≥ 3.2 GB/s
Receiver sensitivity	≤-90 dBm (RBW=1kHz, full frequency band)
Signal identification type	AM, FM, SSB, DSB, 2ASK, 4ASK, MSK, 2FSK, 4FSK, 8FSK, 16FSK, 16QAM, 32QAM, 64QAM, 128QAM, BPSK, QPSK, 8PSK, 16PSK, etc
Signal measurement parameter	Center frequency, signal bandwidth, signal power, signal type, debugging mode, symbol rate, test position, discovery time, discovery times, etc

Analysis type of signal	Monopulse, Continuous Wave, Linear Frequency Modulation, Step Frequency Modulation, Triangle Frequency Modulation, Step Amplitude Modulation, Phase Coding, Barker Code, Frequency Diverging, Frequency Agility, Repeated Frequency Jitter/Irregularity/Sliding, etc
Pulse signal measurement parameters	Carrier frequency, pulse width, repetition frequency, duty cycle, pulse modulation parameters, peak power , average power, rise time, fall time, etc
Pulse width measurement range	0.02 us ~ 1000 us

3. Application scenarios

It is applied to the field o range test, electronic countermeasures training and exercises, and key area protection, etc., to solve the problems of electromagnetic environment monitoring and electromagnetic situation analysis of the broad band, and to realize the monitoring, recording and analysis of space spectrum signals.

One single system can realize signal monitoring and analysis.

Three of this system deployment simultaneously can be automatically networked through Mesh/4G to perform TDOA (Time Difference of Arrival) positioning of signals besides signal monitoring and analysis.

Each device in the system is compact enough to be used as a fixed station and integrated into a vehicle for movable monitoring.

Fig. 18 Aviation Cabinets and Complete Sets of Antennas

4. System Configuration List

Description	Main Specs	Quantity
4051H-B Spectrum analyzer	9 kHz-40 GHz/ 50 GHz	1
4711 Data recorder	12 TB record capacity	1
Monitoring antenna set	9 kHz-50 GHz, banded seamless coverage, requiring 5 to 6 antennas	1
Lifting bracket	Lifting height ≥ 5m	1
Laptop PC	CPU:I7-8700, graphics card :MX250	1
Rugged exchange	1000 Mbps	1
Portable oil machine	≥ 2 kw	1
Portable aviation cabinet	Size 8U, easy to move	1
Signal analysis software		1

Ⅳ. High-end Spectrum Monitoring and Direction-Finding System

1. Main Functions

a) It has the function of high-speed electromagnetic spectrum scanning detection, which can detect the threshold value of abnormal signals, including electronical level threshold etc.

b) With the function of signal measurement and analysis, including multi-domain correlation analysis, real-time spectrum analysis, pulse signal analysis, signal identification, signal demodulation.

c) With the function of seamless signal acquisition and mass storage, the signal can be recorded without interruption, and non-destructive playback and analysis after the event.

d) With the function of signal direction-finding and positioning. Direction-finding and AOA (Angle of Arrival) positioning of signals can be carried out using a single set of receiver system. The accurate positioning of signals can be carried out using TDOA (Time Difference of Arrival) technology by deployment of three sets of systems simultaneously.

e) It has the function of retrospective statistical analysis, which can save and analyze the characteristic parameters of signal, image, and mobile phone.

f) With the function of electromagnetic situation display, it can analyze and evaluate the electromagnetic situation of the region through the continuous acquisition of signals by vehicle- mounted system maneuverability.

g) Safety risk assessment, based on GIS data, it is capable to estimate signal distribution and impact area through analogue simulation of signal sources.

h) With mobile phone control function: 4G mobile phone signal can be shielded, warned, controlled, information extracted, and support white and black list mode.

i) With the function of image recognition and correlation, it can automatically recognize and save faces and license plates, and correlate with the extracted mobile phone information.

2. Specifications

Monitoring frequency	9 KHz to 50 GHz
Analysis bandwidth	550 MHz
Record capacity	12 TB (can be adjusted according to user requirements)
Signal data recording rate	Acuity 3.2 GB/s
Receiver sensitivity	≤-90 dBm (RBW=1kHz, full frequency band)
Signal identification type	AM, FM, SSB, DSB, 2ASK, 4ASK, MSK, 2FSK, 4FSK, 8FSK, 16FSK, 16QAM, 32QAM, 64QAM, 128QAM, BPSK, QPSK, 8PSK, 16PSK, etc
Signal measurement parameter	Center frequency, signal bandwidth, signal power, signal type, debugging mode, symbol rate, test position, discovery time, discovery times, etc
Analysis type of signal	Single Pulse, Continuous Wave, Linear Frequency Modulation, Step Frequency Modulation, Triangle Frequency Modulation, Step Amplitude Modulation, Phase Coding, Barker Code, Frequency Diverging, Frequency Agility, Repeated Frequency Jitter/Irregularity/Sliding, etc
Pulse signal measurement parameters	Carrier frequency, pulse width, repetition frequency, duty cycle, pulse modulation parameters, peak power, average power, rise time, fall time, etc
Pulse width measurement range	0.02 us ~ 1000 us
HD Camera	High resolution and high speed camera

3. Application scenarios

This configuration can carry out electromagnetic environmental inspection and comprehensive analysis and evaluation of major military activities, important areas and large equipment platforms, and provide technical support for security and confidentiality.

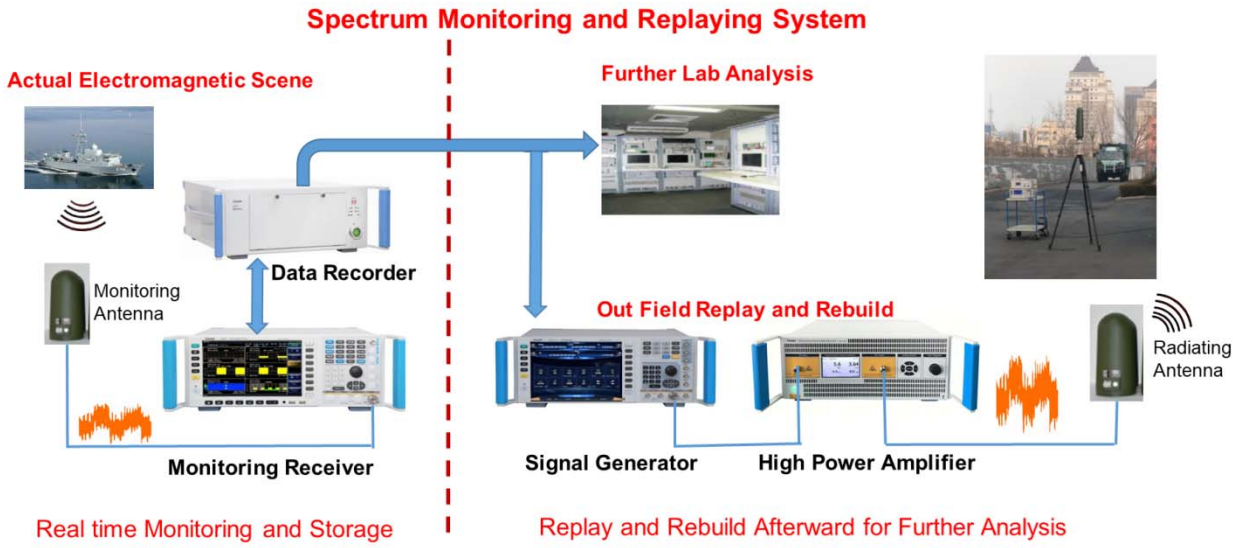


Fig 19. Signal Monitoring, DF and Playback Systems

Fig. 20 Some Vehicle and Fixed Station Solutions

4. System Configuration List

Name	Characteristics	Quantity
4051H-Z Monitoring Receiver	9 kHz-40 GHz/ 50 GHz	1
3943B-Z Monitoring Receiver	9 kHz-8 GHz，2 units	2
3637BD Switch Matrix	Switch the antenna input signal	1
4711 Data recorder	12 TB record capacity for long time data record. Capacity can be adjustable	1
Monitoring antenna set	9 kHz-50 GHz, covered by 4 antenna seamlessly	1
Lifting bracket	Lift height ≥ 5 m	1
Laptop	CPU:I7-8700, Graphic Card :MX250	1
On-board Server	High-speed data analysis and data storage	1
Rugged exchange	1000 Mbps	1
Power management and battery pack	≥ 2 kW	1
Portable aviation cabinet	Size 16U，2units	1
PC and Signal analysis software		1

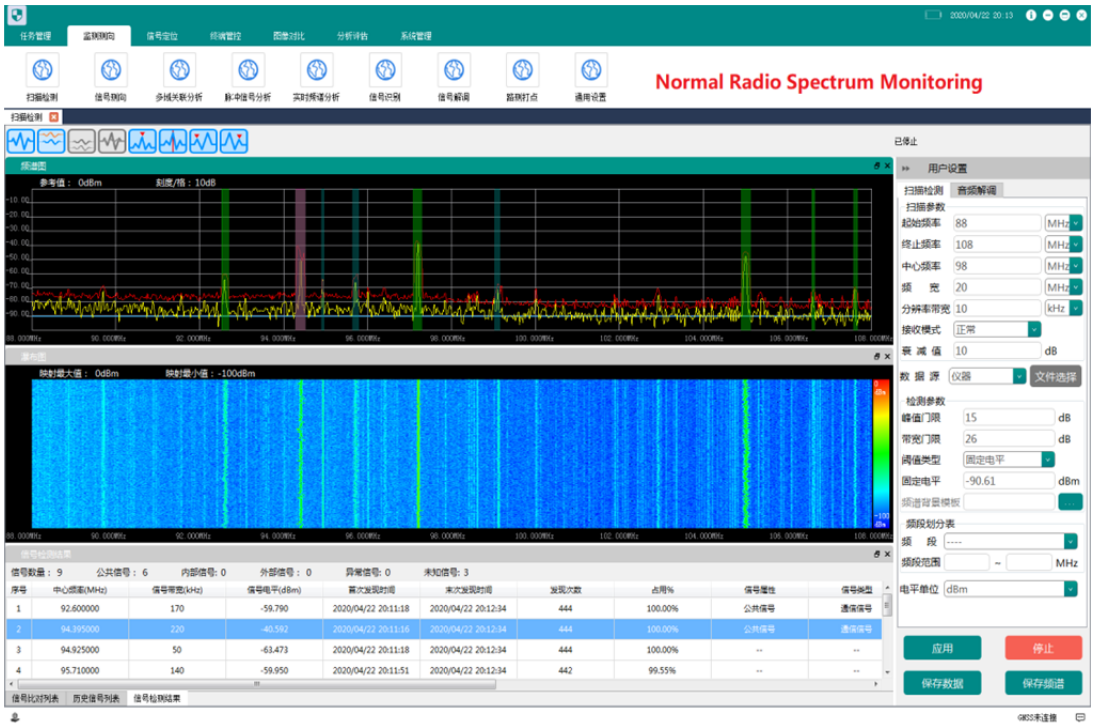
Ⅴ. Signal Analysis Software Introduction

The software can be equipped with electronic maps, GPS/Beidou and electronic compass. It can record the geographical location of the monitoring system and the illegal signals. The multi-purpose monitoring and analysis software can manage the data of signals, monitoring and analysis. With spectrum monitoring, monitoring presets, over-limit warning, data record, playback, signal orientation search and automatic reporting functions, the software uses Windows OS and MySql database, with an open, universal, scalable framework structure, to achieve software and hardware functional components, modularity and standardization.

According to the specific needs of users, it can be used for electromagnetic environment monitoring, interference detection, electronic information equipment scientific research and production and maintenance support testing, critical areas of suspicious electromagnetic signal detection, interference signal source positioning and key areas of electromagnetic spectrum management and other fields.

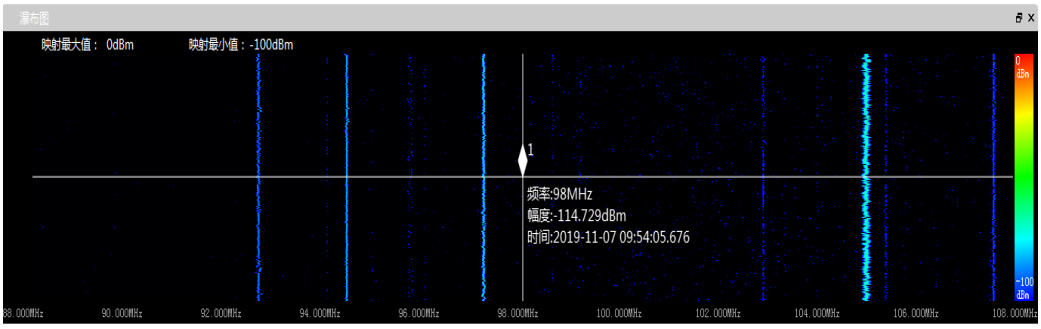
1. Electromagnetic Spectrum Monitoring

Monitoring data can be retrieved quickly. The data can be panoramic or partially enlarged. It's very convenient for users to watch, manage the spectrum data.



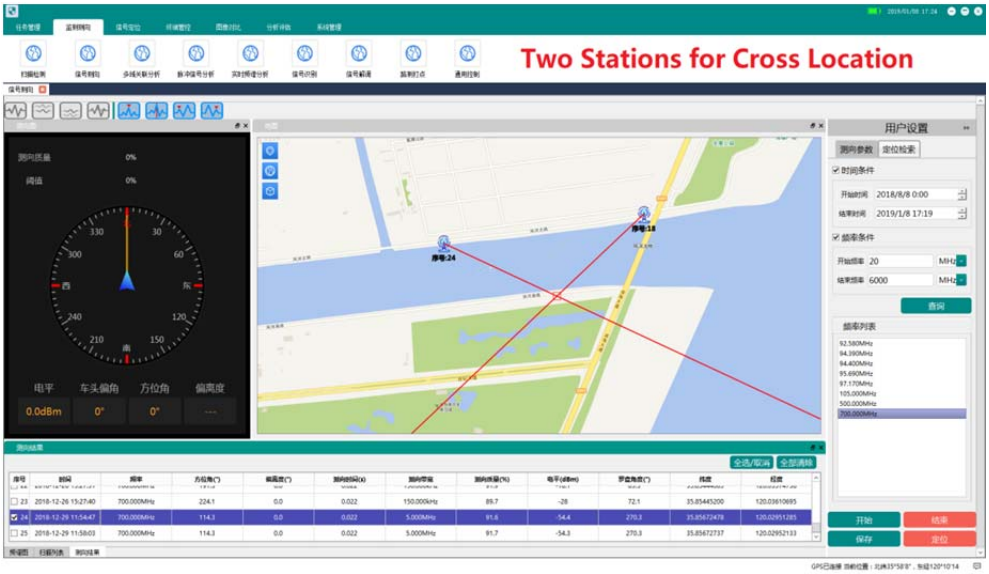
2. Monitoring Waterfall

Waterfall can help clearly see the spectrum along time changes. It is easy to analyze the electromagnetic situation.



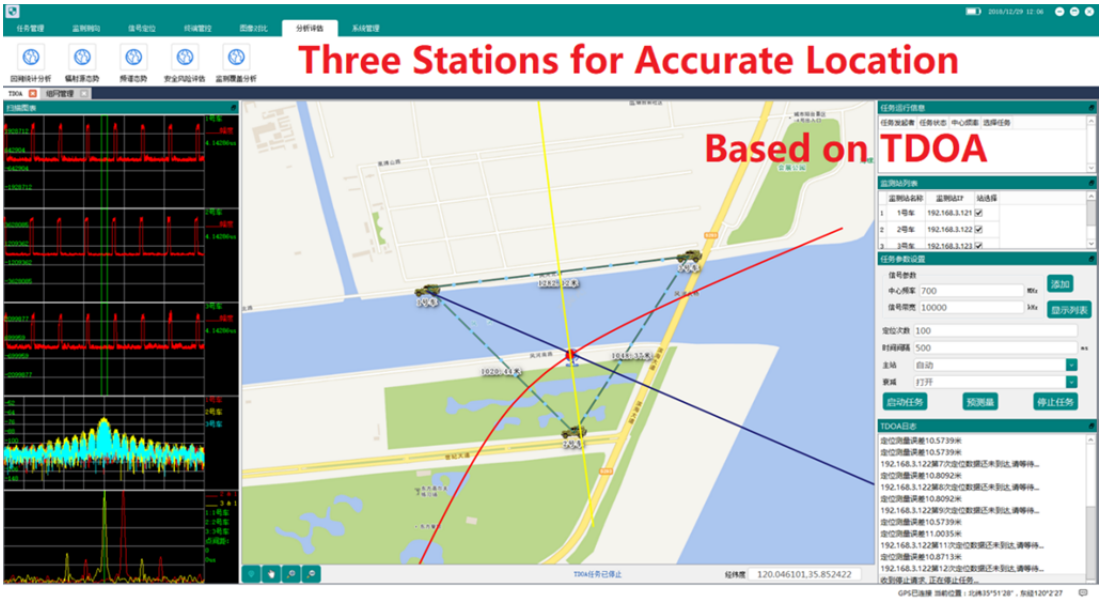
3. Signal Direction-Finding using DF Antennas

Together with DF (Direction-Finding) antennas, the function of signal direction finding is based on the correlation interference to find the direction. One single-station can find the direction and two or more stations together can crossly locate the signal.



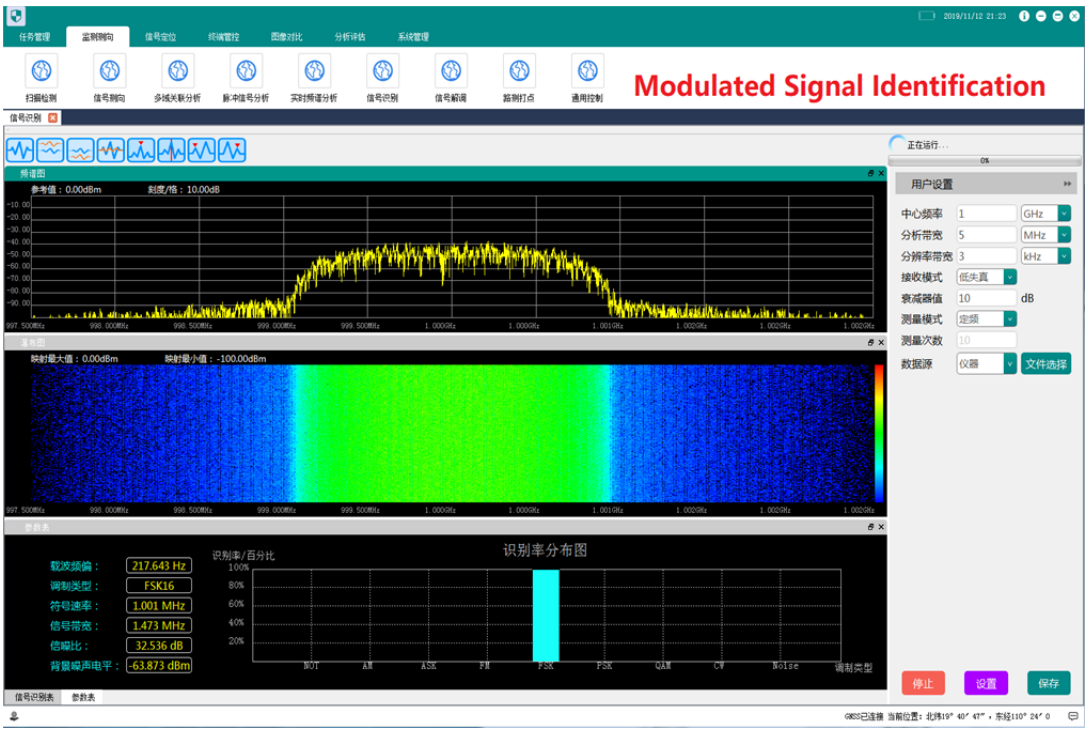
4. Signal Geolocation

Also together with normal monitoring antennas, the three stations can locate the illegal signal using TDOA (Time Difference of Arrival).



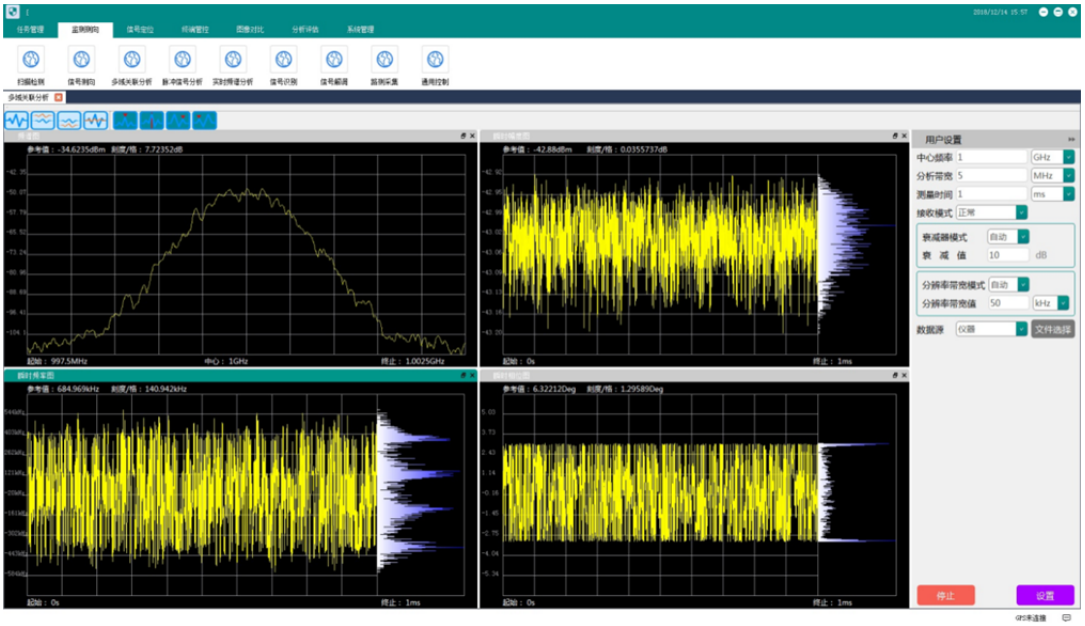
5. Signal Identification

Automatic identification of more than 20 conventional modulation signals can be achieved. The database can be extensive because the I, Q data is already read back.



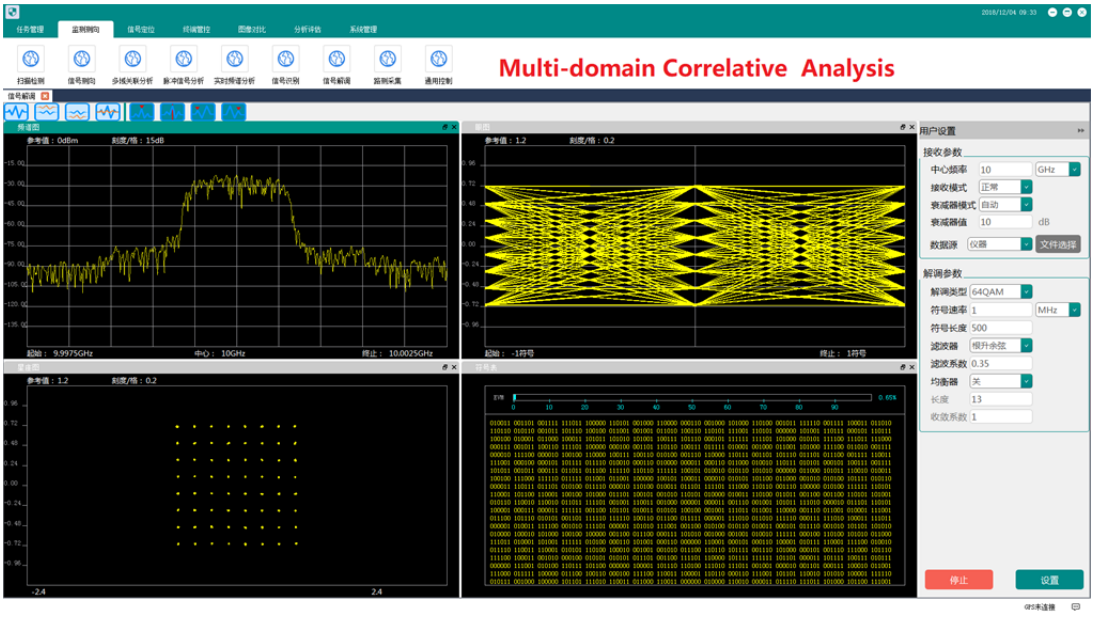
6. Signal Multi-Domain Association Analysis

Multi-domain association analysis of signals is carried out at many different domains, such as signal spectrum, time-amplitude, time-frequency, time-project, etc.



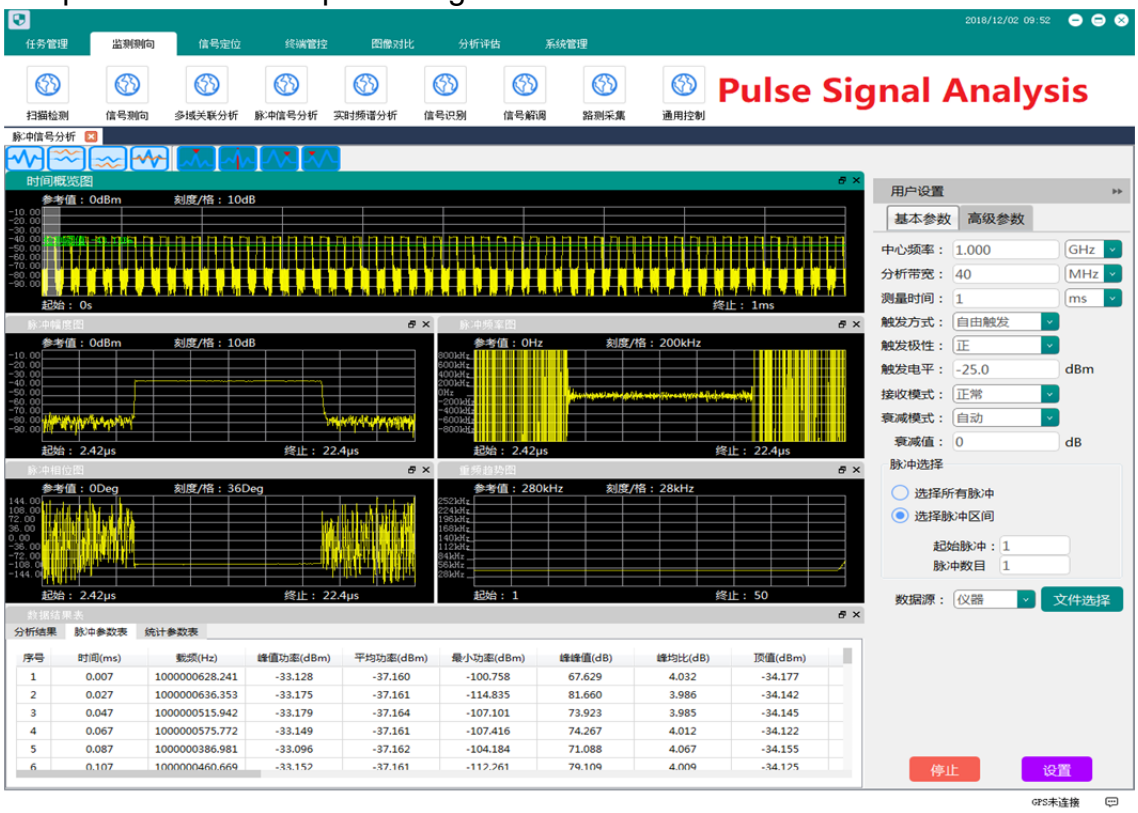
7. Signal Demodulation

Analyze and demodulate the digital signal.



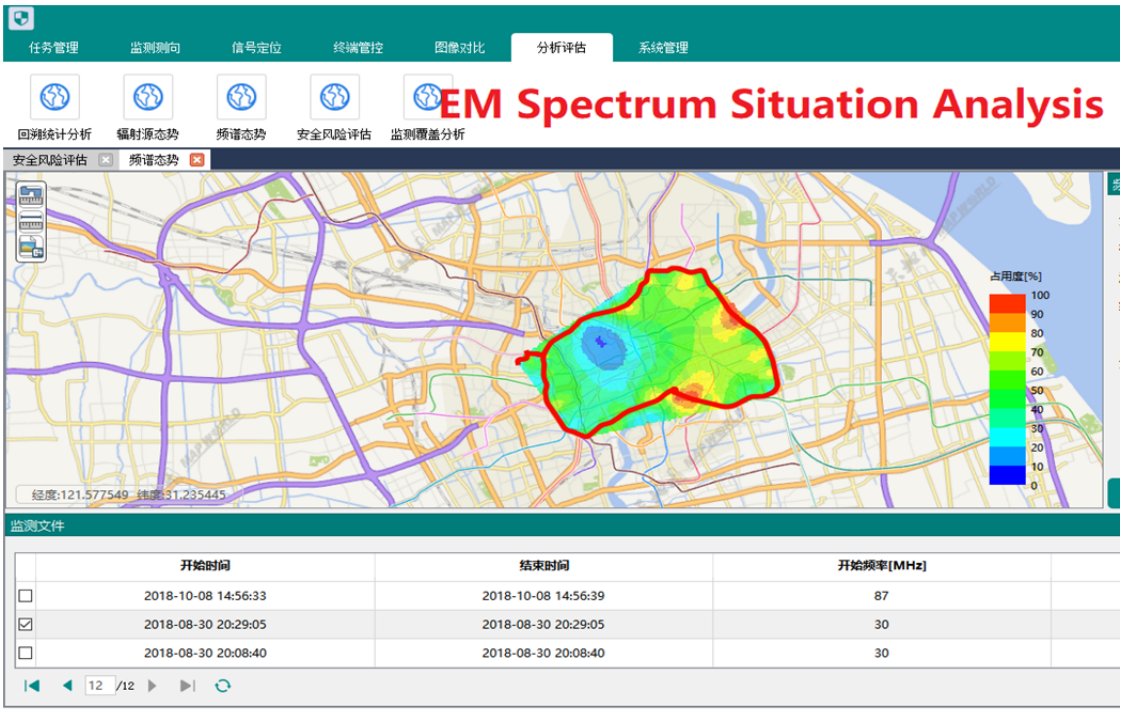
8. Pulse Signal Analysis

The software can make the measurement and statistical analysis of the in-pulse and inter-pulse parameters of the pulsed signal.



9. Spectrum Situation Analysis

Based on multi-location spectrum data, regional electromagnetic spectrum situation map can be formed.



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Focus on Measurement
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Ceyear Technologies Co., Ltd
Tel: +86 532 86896691
Add: No. 98, Xiangjiang Road, Qingdao (266555), China
http://www.ceyear.com
Email: sales@ceyear.com; zhaohao@ceyear.com (Hawldy)