

# The need for speed: Spectral shape detector accelerates signal search

The challenges of radiomonitoring are on the rise as radio networking sweeps the globe, but the spectral shape detector offers a way forward. It represents a new class of innovative signal monitoring and recognition solutions that instantaneously detect definable spectral shapes in densely populated frequency bands.

## Challenge accepted – and mastered

Intercept operators typically deal with one or more of the following tasks:

- Identifying and extracting signals of interest
- Identifying and excluding unwanted signals
- Expanding lists of identifiable signal types

The explosive growth in number and diversity of radio technologies in recent years has created challenges that call for high-performance technical solutions. The spectral shape detector software package from Rohde & Schwarz sustainably accelerates the signal recognition and analysis process. It analyses over 1000 signals per second to ensure effective monitoring of radio bands of interest and reliable detection of signals even under harsh radio conditions (see box on right). When combined with Rohde & Schwarz high-speed scalable signal search solutions (examples in Fig. 1), it drastically improves signal detection and signal processing workflows.

The spectral shape detector features a filter function (based on a spectral reference library) that accelerates automatic recognition, search and classification processes. It performs advanced spectral pattern matching based on user-defined signal categories to select signals for further processing.

## Unique features

The spectral shape detector combines high speed, predefined spectral shapes and a new search algorithm to offer the following:

### ■ High-speed spectral search function

The spectral shape detector analyzes more than 1000 signals per second – a task that would take over ten minutes with a baseband classifier.

### ■ Outstanding robustness and reliability

The software excels in dealing with varying signal scenarios, by considering the noise, fading or sampling rate variations. The shape descriptions used for signal recognition are based on numerous samples of actual signals and produce reliable analysis results even in complex scenarios.

### ■ High productivity from the start

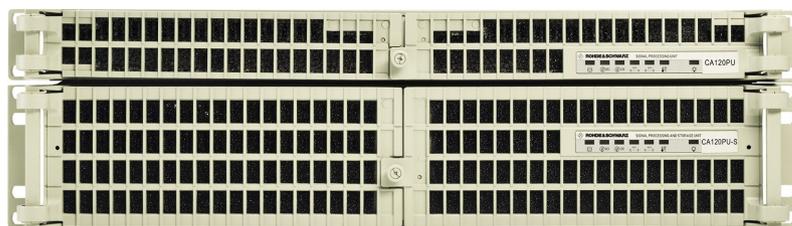
The spectral shape detector is delivered with predefined distinct spectral shapes (e.g. CW, AM DSB, multichannel and FSK signals) to ensure immediate productive operation upon installation. Users can also expand the spectral reference library quickly and easily.

### ■ Flexible configuration

The spectral shape detector offers users diverse options for defining and configuring spectral shapes according to their requirements.



Fig. 1: The spectral shape detector is a software extension for Rohde & Schwarz signal analysis solutions. Left: The R&S®CA100 PC-based signal processing and signal analysis software. Right: Example of R&S®CA120 configuration for multichannel signal analysis.

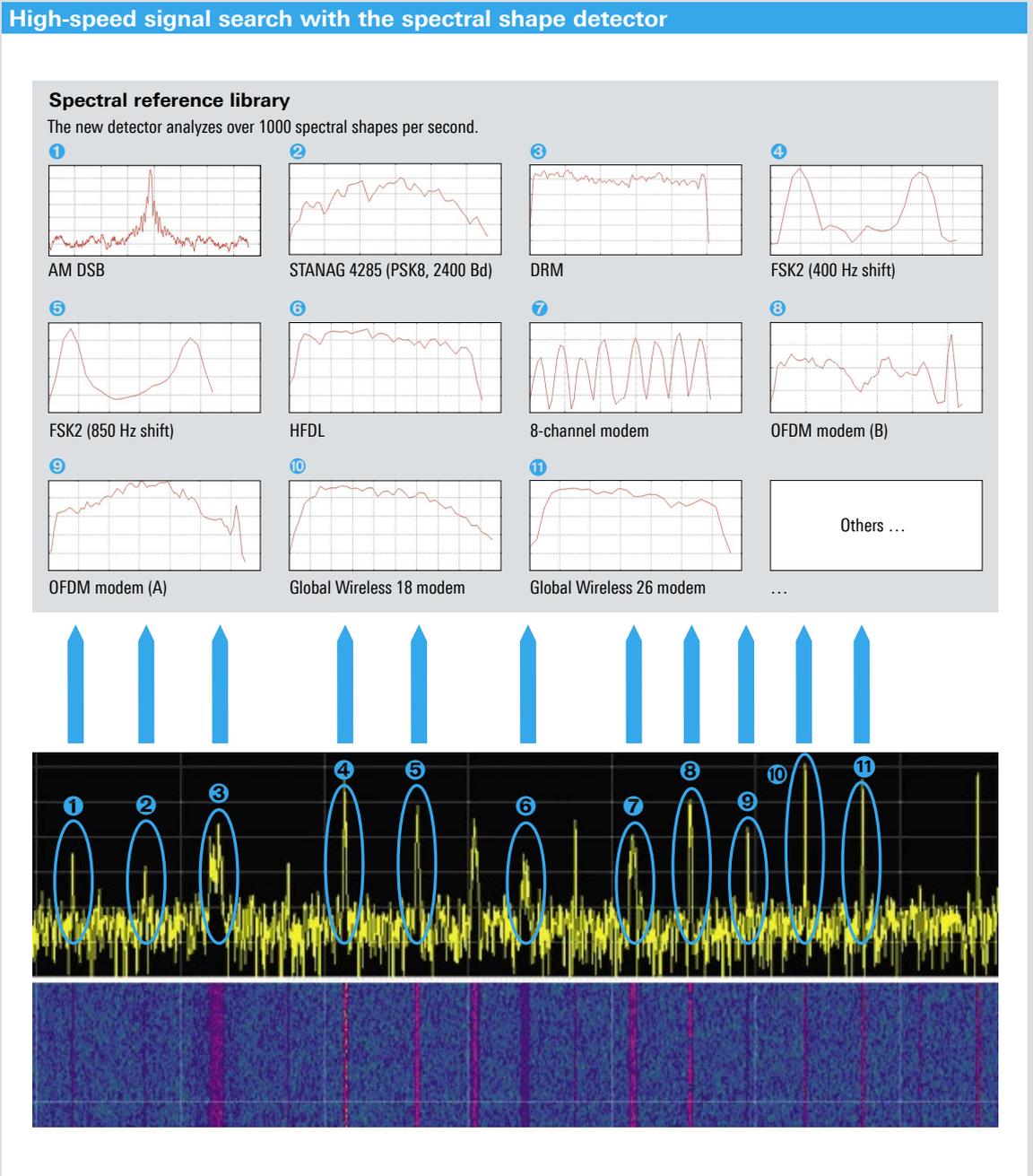


## The spectral shape detector at a glance

In radiocommunications today, frequency bands are occupied with thousands of signals. This creates an immense challenge for radiomonitoring system operators searching for signals of interest in large, densely populated frequency ranges. To simplify this task, Rohde&Schwarz has developed the spectral shape detector for high-speed detection of signals in the spectrum (Fig. 2). Its unique detection mechanism analyzes over 1000 spectral shapes per second to ensure effective

monitoring and interception of activities in today's signal scenarios. The detector can be configured as an intelligent search filter to let through signals of interest or filter out unwanted signals prior to further processing. The decisions of the spectral shape detector matching algorithm are based on criteria stored in a comprehensive decision matrix that reliably evaluates the similarities between input signals and the saved shape description set.

Fig. 2: High-speed search for spectral shapes by comparing the live spectrum with user-defined or pre-defined generic spectral shapes stored in the spectral reference library.



## Core concept of signal detection

The spectral shape detector is compatible with Rohde&Schwarz signal analysis solutions such as the R&S®CA100 and R&S®CA120. It matches incoming signals with shapes defined in a spectral reference library. These shapes contain user-defined signal categories and predefined categories (e. g. CW, AM DSB, multichannel and FSK signals). The detector recognizes certain generic signal types without requiring spectral shapes to be created for them.

The operational workflow is as follows: The spectral shape detector consists of a training application and a detection application (Fig. 4). The training application has two parts (the spectral collector and the spectral detector trainer) and is used for acquiring new shapes and expanding the spectral reference library. The spectral collector automatically gathers and processes various instances of the same signal type (Fig. 3). The spectral detector trainer recognizes these instances as a learning resource, from which it extracts the spectral characteristics of a given signal type and feeds them into the spectral reference library.

After the training phase has been completed, the spectral shape detector can detect signals with similar spectral characteristics and process live spectra (receiver can be in fixed frequency or scanning mode). The detector employs a decision algorithm to determine how closely the features of an acquired signal correlate with shapes stored in the spectral reference library. A decision is made based on many criteria and comprehensive evaluation functions.

## Benefits of collaboration with baseband classification

The advantages of the spectral shape detector become particularly clear when it is combined with a baseband classifier – a well-established and reliable solution for the technical analysis of a wide variety of signals. Unlike the spectral shape detector, baseband classifiers operate in the time domain. They determine the modulation type and transmission system or code of a given signal and measure all of its parameters, including time behavior and symbol rate. However, as already mentioned, this type of analysis is relatively time-consuming. The

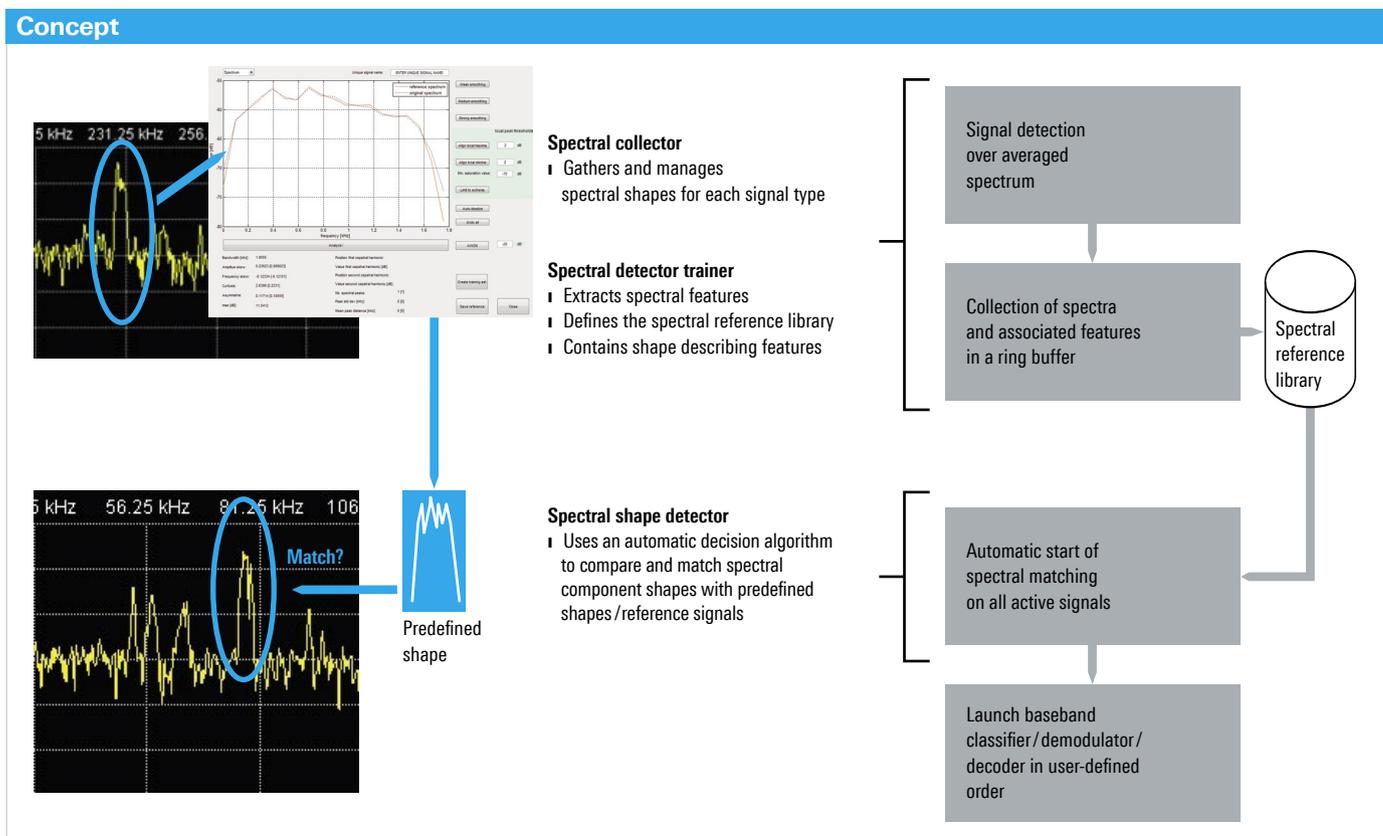
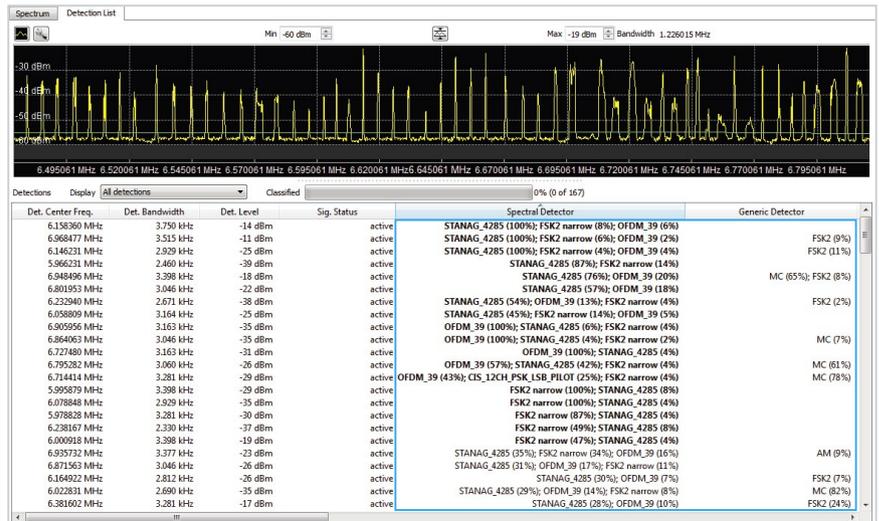
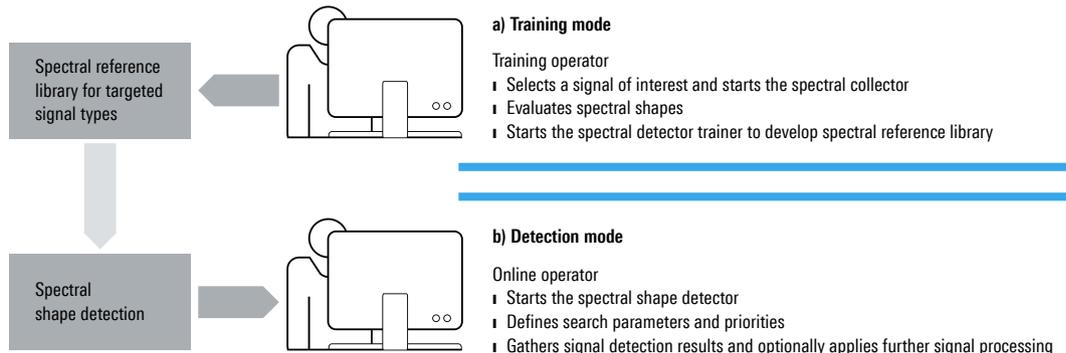
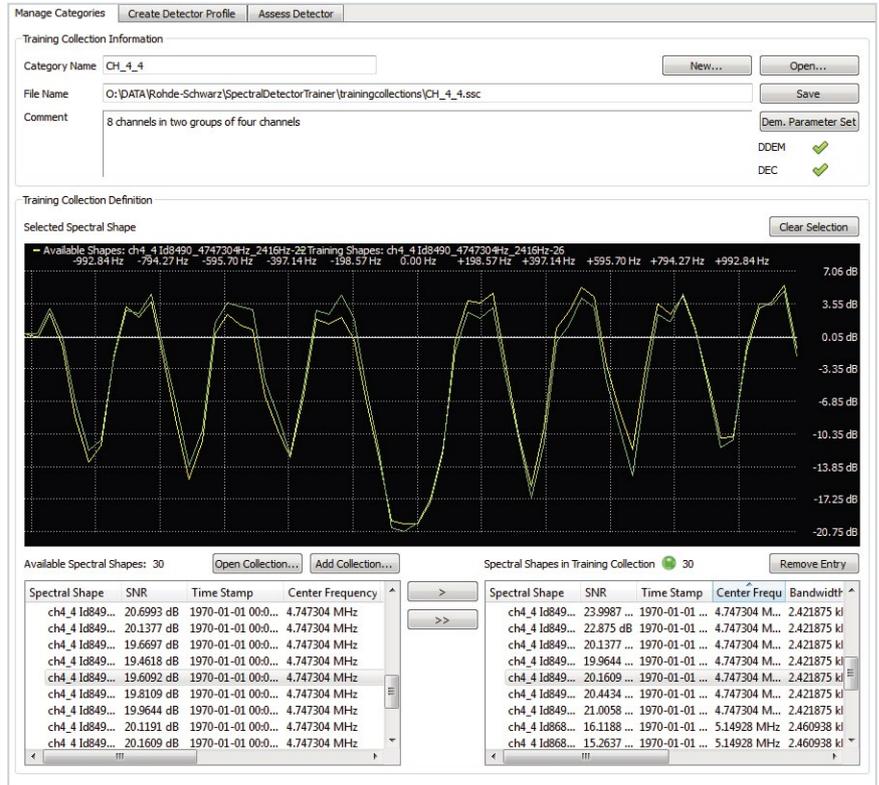


Fig. 3: Spectral shape detection process with the spectral collector, spectral detector trainer and spectral shape detector.

Fig. 4: Training (upper section) and detection modes of the spectral shape detector. The spectral shape collector gathers shapes that are similar to a specified signal and then the spectral detector trainer extracts the features of this signal type from all of these samples and stores them in the spectral reference library. The lower section of Fig. 4 shows productive operation with detection results.

## Spectral shape detector operating modes



baseband classifier should therefore only deal with wanted signals, which the spectral shape detector can reliably supply. As an upstream filter, the spectral shape detector only forwards signals of interest to the baseband classifier for optimum utilization of analysis resources. The high speed of the spectral shape detector combined with the in-depth analysis of the baseband classifier provides a very effective total solution.

### System solution with R&S®RAMON

An integrated system solution based on the R&S®RAMON system software is currently under development (Figs. 5 and 6) and will provide users with a number of additional functions. Depending on the setup of the radiomonitoring system on which the R&S®CA120 analysis system is installed, the signals delivered by the spectral shape detector will be linked with signals from other sensors such as direction finders and saved in the R&S®RAMON signal and reference database. This allows extensive automatic analysis of acquired transmissions as well as fully automatic recognition of selected radio networks.

#### Example: R&S®RAMON radiomonitoring system with three workstations

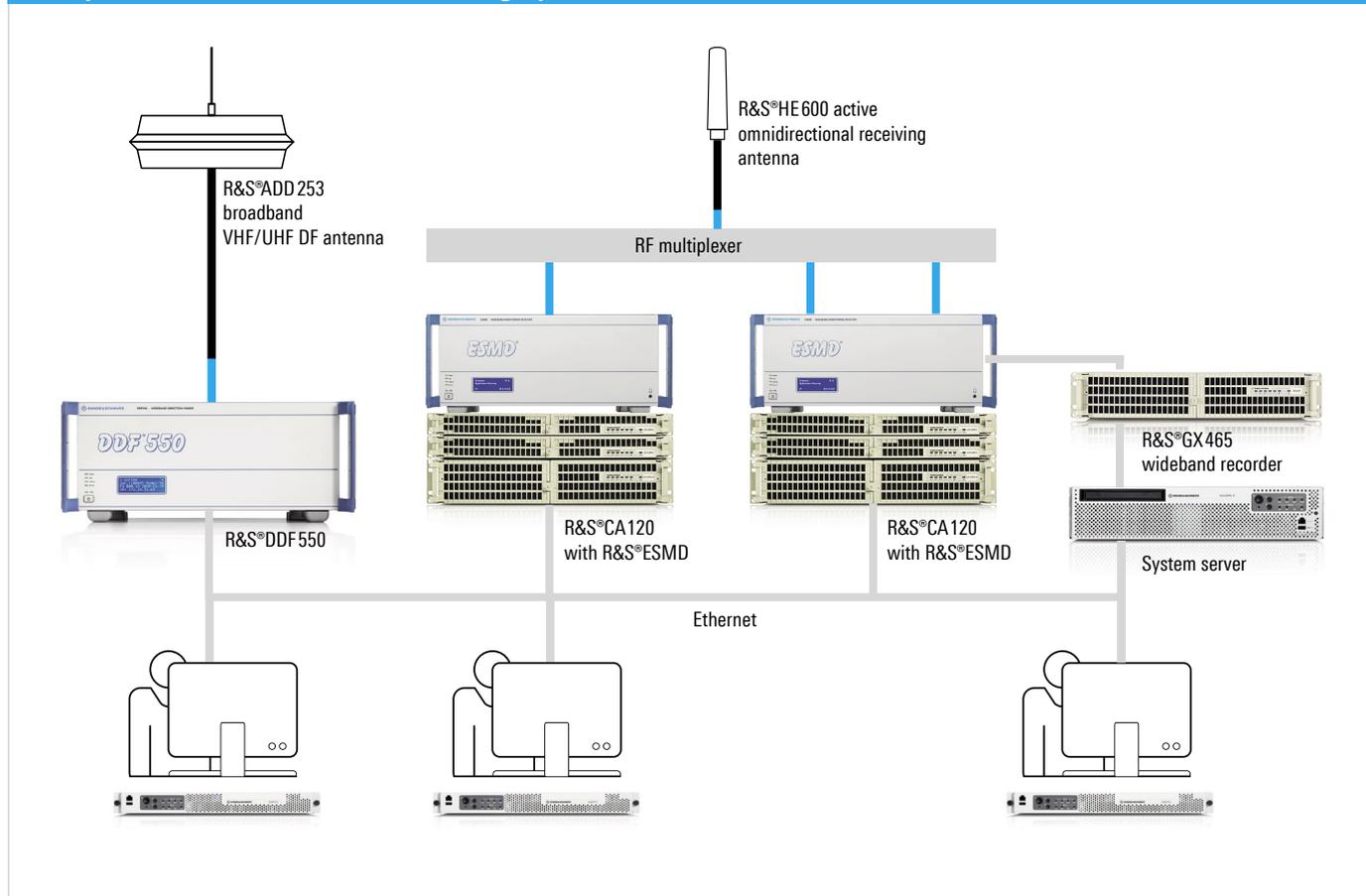


Fig. 5: The R&S®RAMON system with two R&S®ESMD wideband receivers, an R&S®DDF550 direction finder, an R&S®GX465 wideband recorder and three workstations. Each R&S®CA120 signal analysis solution automatically processes the wideband signal scenario from the R&S®ESMD on up to 32 channels simultaneously. The spectral shape detector can be combined with the R&S®RAMON software for very high-speed search applications.

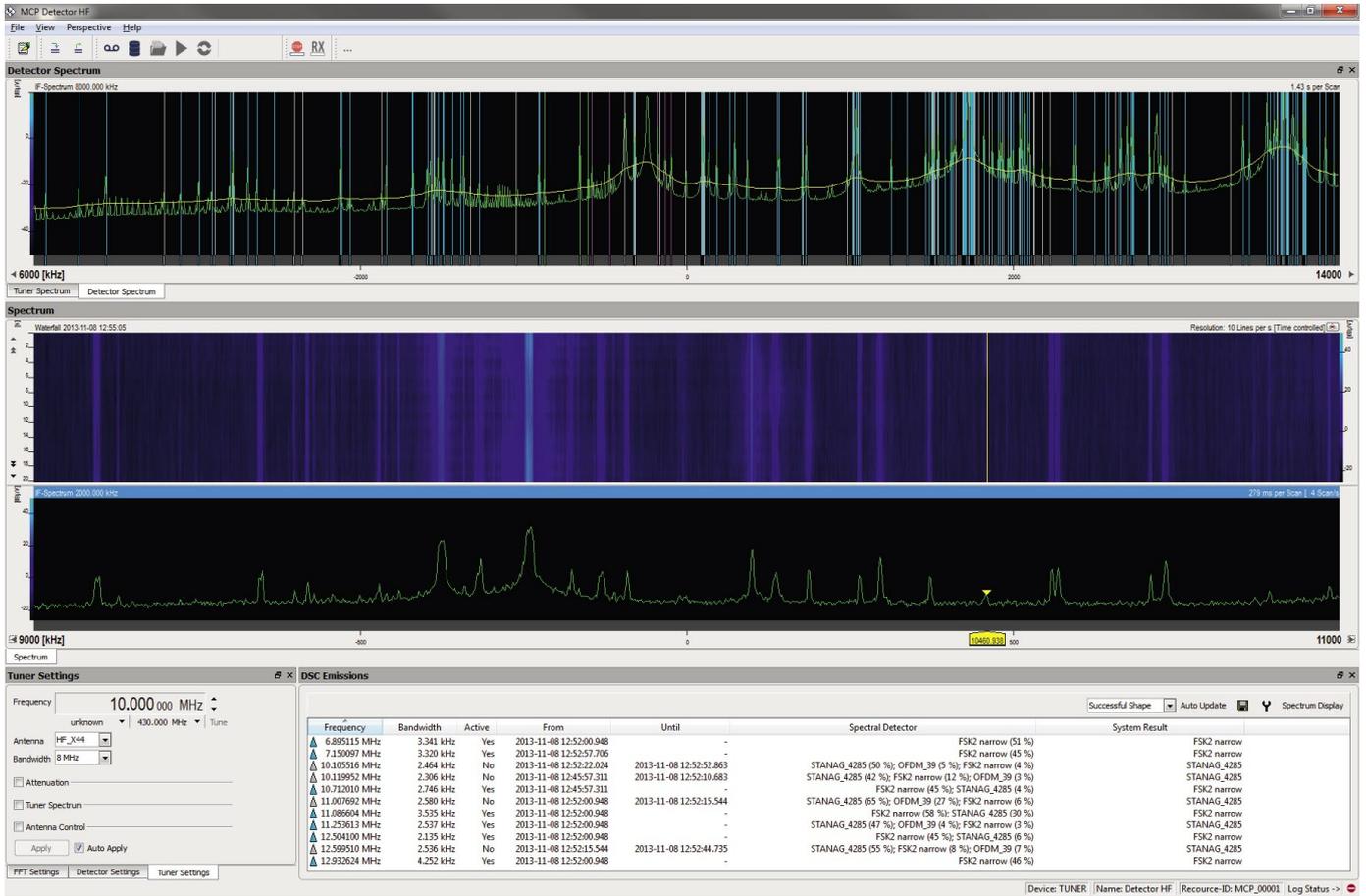


Fig. 6: Detection results of the R&S®RAMON system software with the spectral shape detector.

## Summary

With its quick, robust, reliable and configurable spectral shape recognition function, the spectral shape detector from Rohde&Schwarz makes it possible to conduct high-speed signal searches within a wide frequency band and in densely populated signal scenarios. The spectral shape detector enhances the R&S®CA100 and R&S®CA120 with high-speed signal search applications by improving their signal recognition and processing workflows.

In addition to the features and applications of the spectral shape detector described above, a scripting interface is made available to fully automate the processing application. The benefit for users is the combination of the spectral shape detector and fully automatic signal processing (demodulation, decoding and recording). JavaScript can be used to trigger actions to control recording and further processing. Scripts are used to define conditions and criteria based on all relevant parameters.

YingSin Phuan