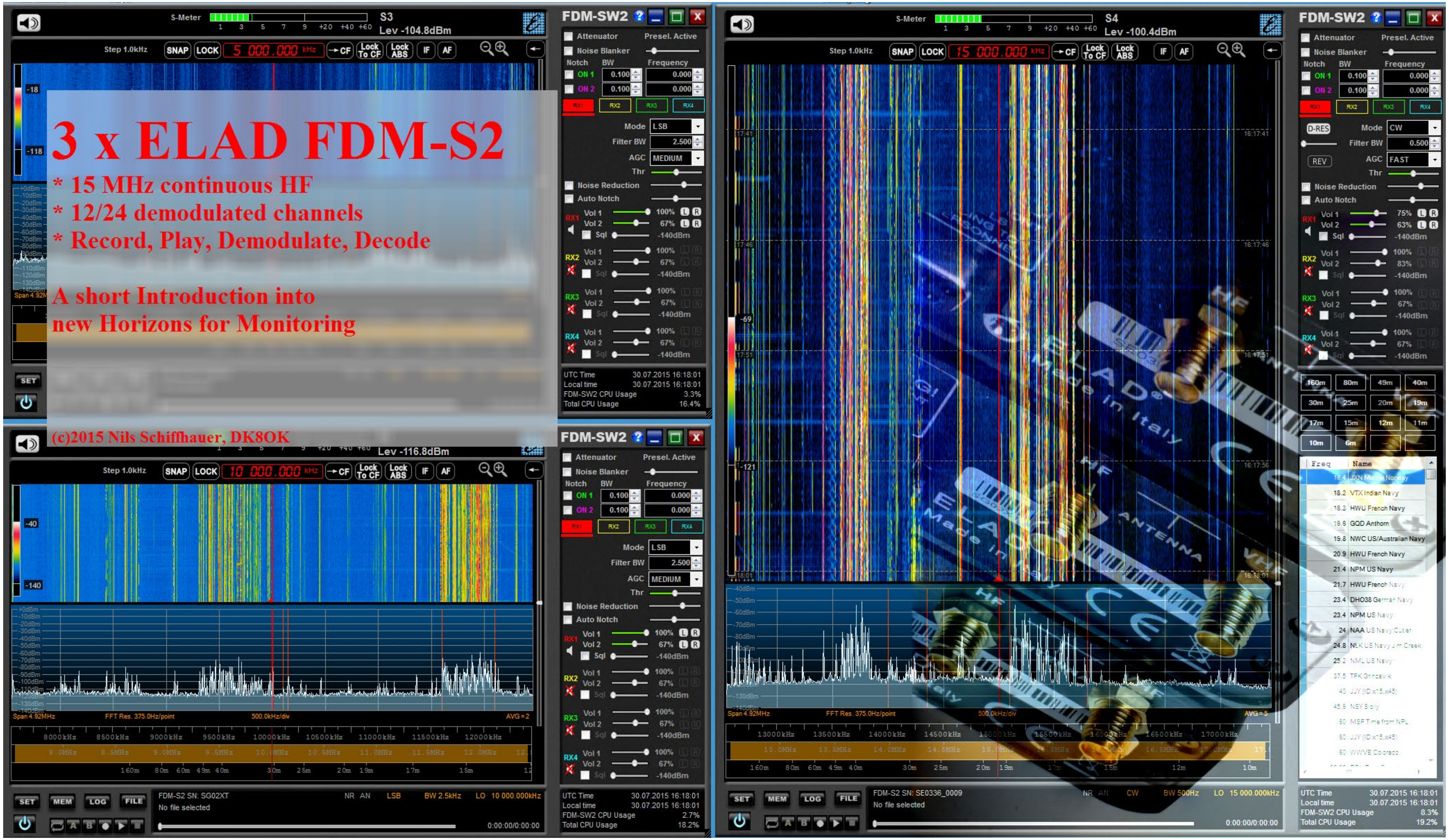
3 x ELAD FDM-S2

* 15 MHz continuous HF
* 12/24 demodulated channels
* Record, Play, Demodulate, Decode

A short Introduction into
new Horizons for Monitoring



3 x 5 MHz x 16 Bit: Recording and Playing

This paper describes the recording and analyzing of 3 x 5 MHz HF "in a row". As a result, you will have an overlook over 15 MHz of HF in three portions of 5 MHz (alias-free) each.

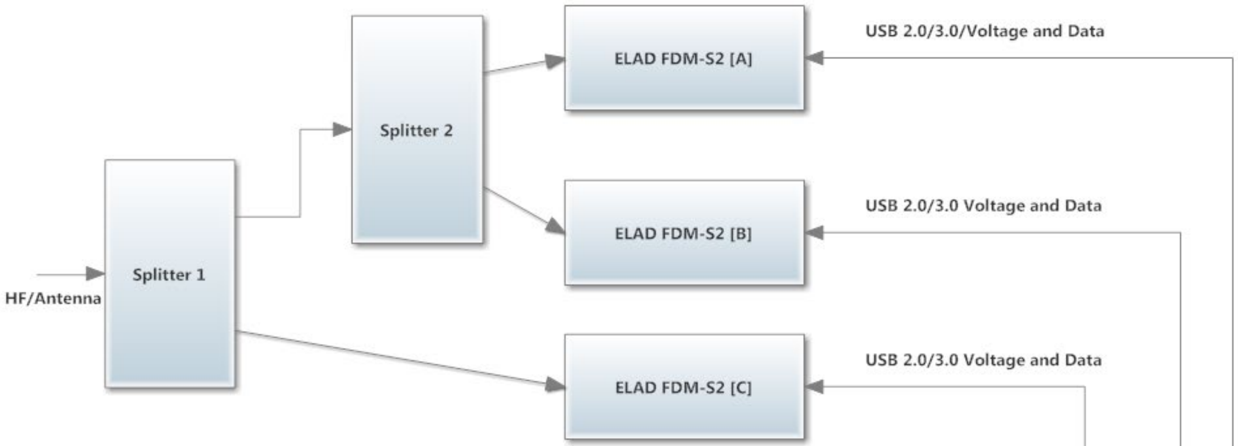
Receiver of choice is ELAD's ***FDM-S2***, providing excellent performance at a budget price. They are fed by a quadloop of 20 m circumference - via two ***Heros splitters, type VLF*** [4 kHz to 60 MHz].

Figure 1 shows the general schematics: Each receiver is connected to an USB-socket of the PC. As each socket has to provide power (5 V, .75 A) as well as data, your PC should provide at least three independent USB connectors.

During recording, all data has to be saved. One hour/5 MHz of recording needs about 90 GB. You will need at least 6.6 TB for 15 MHz/24 h. This will call for an external hard disk, I use a ***MyBook Duo*** by Western Digital (USB 3.0, 12 TB) which provides a good relation between price and performance.

Software used is ***SDR Console*** for recording and SDR File Analyser for playing, a module of thissoftware. For analyzing, I use the technique of the "Living Sonagram", laid out in ***this paper***.

I show here just one possible set-up which works smoothly with my configuration. This depends on many factors. So it may also work with your set-up - or not. If not, try other combinations of USB sockets and/or another arrangement between internal/external hard disk. You are working at the brink of our hobby, and surely you have to experiment a bit. Please share your experiences and results within the community!



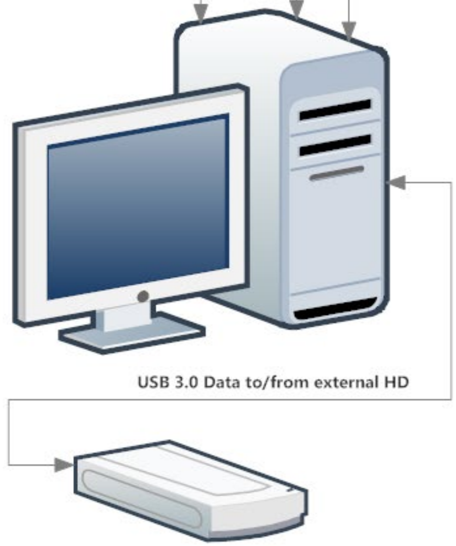


Figure 1: Two splitters, three receivers, one PC, one external HD - and their interconnections. Each splitter output will have about 3.5 dB loss compared to its input signal. My antenna delivers much steam that I have to switch in the 10 dB attenuator of an FDM-S2 at dusk with its big signals. Thus, this configuration may work without the attenuator. Nevertheless, it's a good idea to have tuned receiver „C" to the highest frequency (only 3.5 dB down against 7 dB of the others). You may need this better noise factor especially above 10 to 15 MHz.

A last word to the price of such a monitoring station: When I bought a ***Drake SPR-4*** with some accessories in the mid-1970's, this set me back by at least 2.500 DM. Gaining an average disposable income, you had to work more than two full months to buy this beauty. In 2014, with an average disposable income of 1.737 Euro/month, you will get the complete monitoring post described here for less than two months' work, including an able PC. It's still a lot of money, but for it you get a power which never before had been in the hand of shortwave listeners: Have fun!

Receiving

After all connections had been made (Figure 1), you first have to define the receivers so the software knows about them (Figure 2). Then you have to open one instance of the software after the other, clicking into the appropriate receiver's icon (Figure 3). Eventually, reception of all three SDRs in parallel starts (Figure 4).

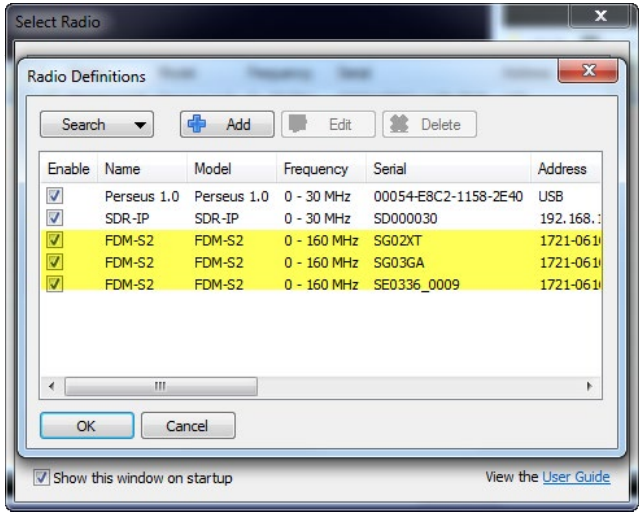


Figure 2: Radio Definition - the three FDM-S2s have been marked here.

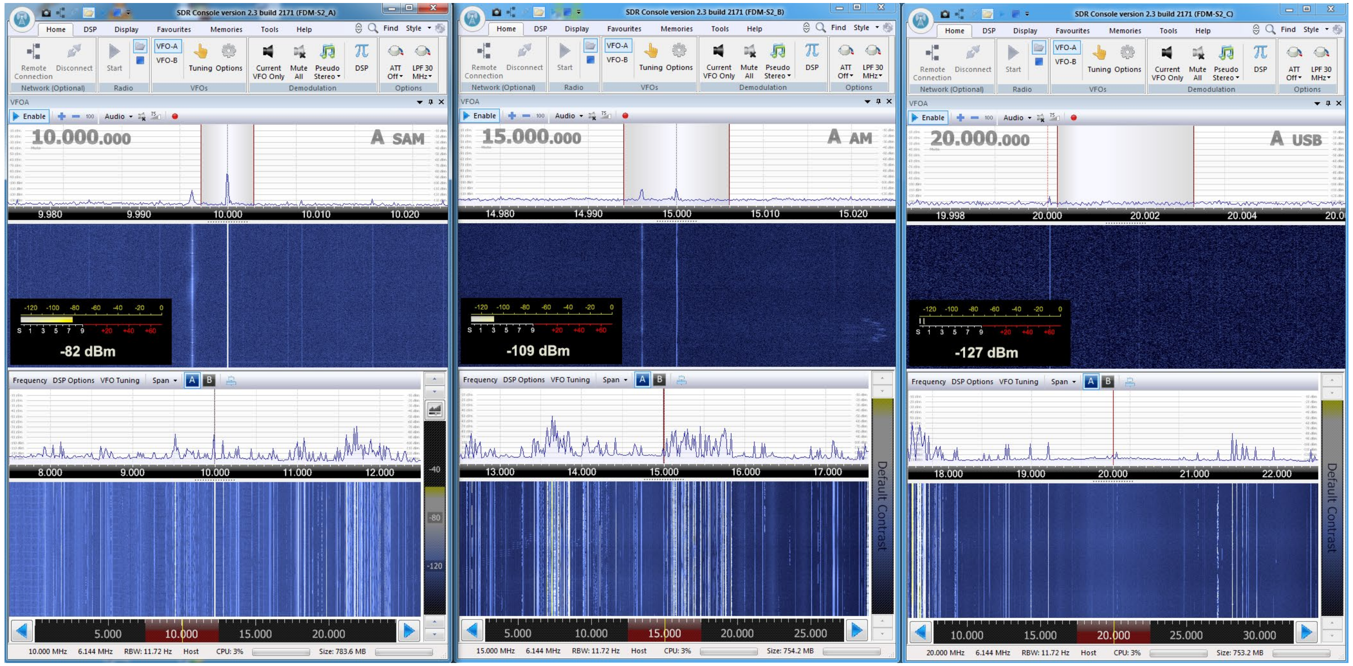


Figure 4: Here you see three receiver active in parallel. Together they cover the range from 7.5 to 22.5 MHz.
You can tune, listen and record - see next page for that.

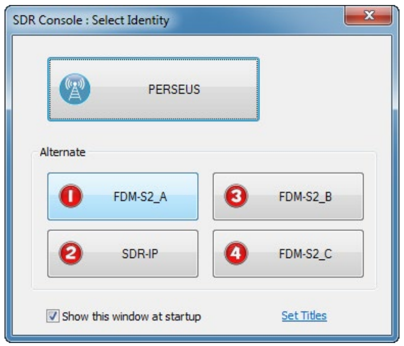


Figure 3: Just click the receiver you want to open in one of three instances of the software. Here „A“ is chosen.

Recording

For recording, you should prepare different folders for each receiver in advance. I named them A, B and C. These are the destination folders for the HF WAV recordings of the appropriate receiver.

Set the receiver to the centre frequency you want. Set the destination folder. Start the recording either manually or scheduled.

See Figures 5 & 6 as example for a scheduled recording, starting at 20:00 UTC at centre frequencies of 5.5, 10.5 and 15.5 MHz with a bandwidth of 6.144 MHz each. Results: see next page.

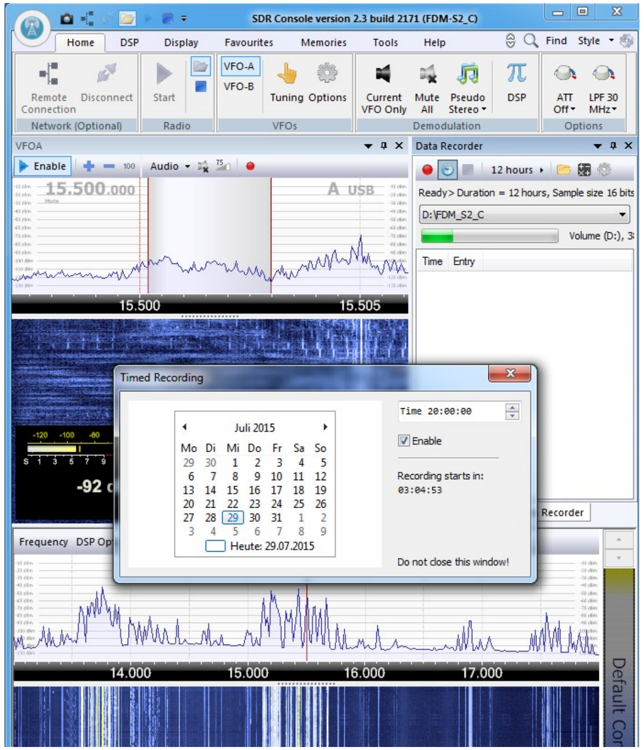


Figure 5: Scheduled recording will start on July, 29th at 20:00 UTC and will last for 12 hours.

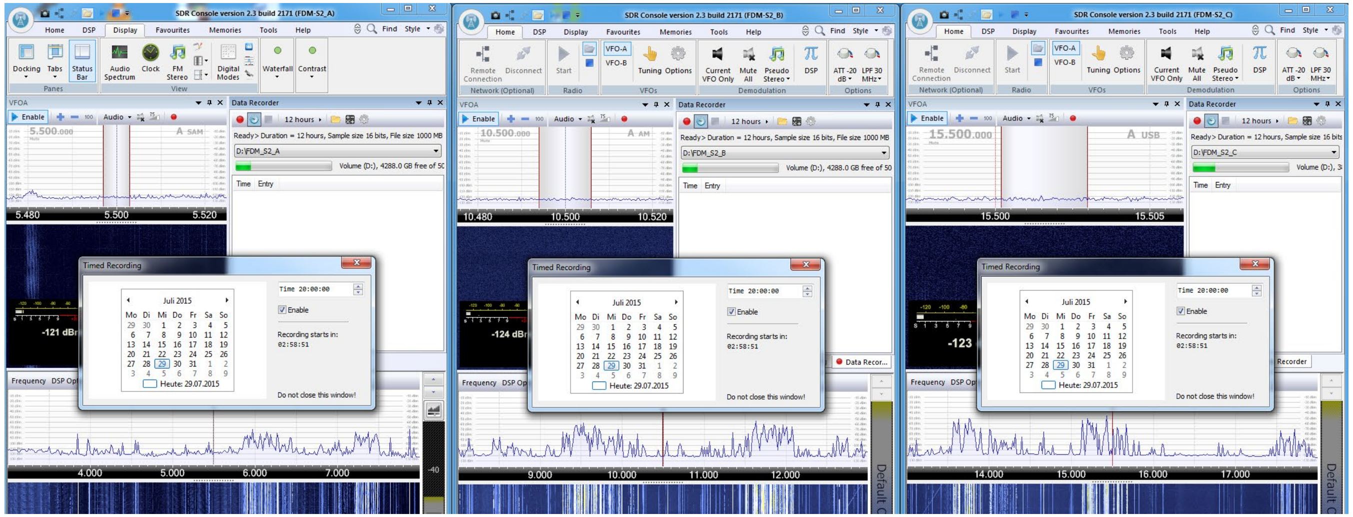


Figure 6: Each of the three FDM-S2s has been tuned to a different centre frequency, resulting in a band from 3 MHz to 18 MHz. Scheduled recording will start on July, 29th at 20:00 UTC and will last for 12 hours.

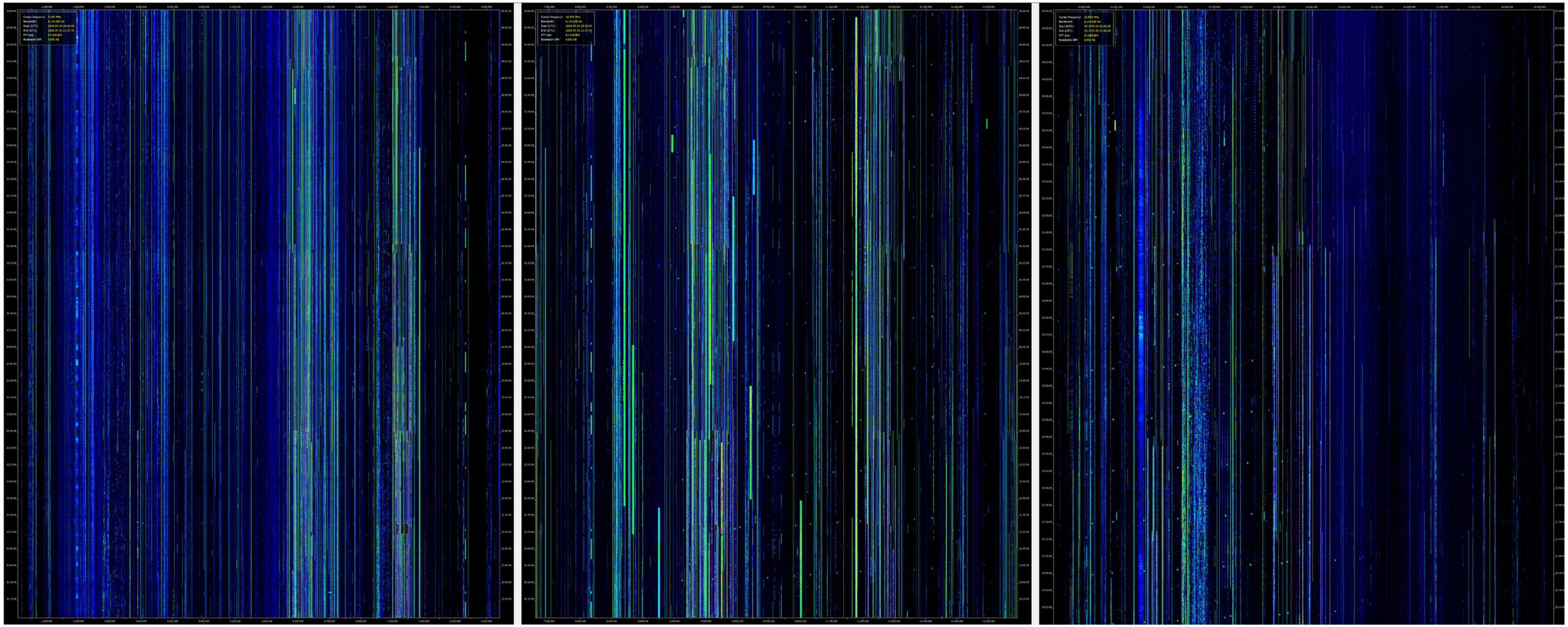
SDR Data File Analyser I

As I wanted only nine hours of recording, I manually stopped it (start: 20:00 UTC) shortly after 05:00 UTC. The software doesn't offer "nine hours".

Each of the A, B and C folder is now filled with 818 files which sum up to 745 GB. The whole session needs roughly 2,4 TB for 15 MHz/9 hours/16 bit.

After recording, each of the three sessions had been processed through "SDR Data File Analyser" to get an overlook over the whole recording, see Figures 7 a-c; see below.

Figure 7: These three screenshots show (from left to right) the complete sonagrams of the output of receivers A to C: 3 MHz to 18 MHz continously during 6 hours! Easily, you will see the broadcast bands and the ham bands. You may e.g. „play" each band by just placing the mouse on the signal (frequency/time) you want. Bug: The recent version of the software has some problems to correctly keep the time over/after midnight. Yet, cursor „Show values" shows the correct time.



SDR Data File Analyser II

You may use the sonagrams from Figures 7 a-c "as is", or zoomed. This depends on the stations you are interested in. If you monitor brodcasters with stick to a channel and are up to 10+ kHz wide, you probably won't need any zooming. But if you go for weak and short transmissions in narrow modes, zooming is a must.

Zooming factor again depends both on your prey and on your experience. I prefer a sonagram with 100 Hz width and of 1 s length per pixel (see Figure 8 for a monitoring layout). For me, this is the optimum offering a fast workflow where I often recognize the mode simply from its distinctive pattern, and don't miss even very short frequency hoppers.

Challenges

Using the above mentioned techniques, you are a pioneer within the community. The biggest challenge you might face is „stuttering" (Figure 9). It's reason is mostly a bottleneck in data transfer. To find this, you have to systematically change all combinations: USB sockets for receivers and external hard disk, number of receivers in parallel and/or their width, or file size. An able PC with lot of RAM helps, like a huge internal hard disk (RAID0). Furthermore, each installation seems to be individual. You will nowhere get a running system „off the shelf" or a fool-proof recipe.

On the next page, please see some examples with three FDM-S2 running under their ELAD software. Also they should stimulate your further work and fun with this nice equipment!

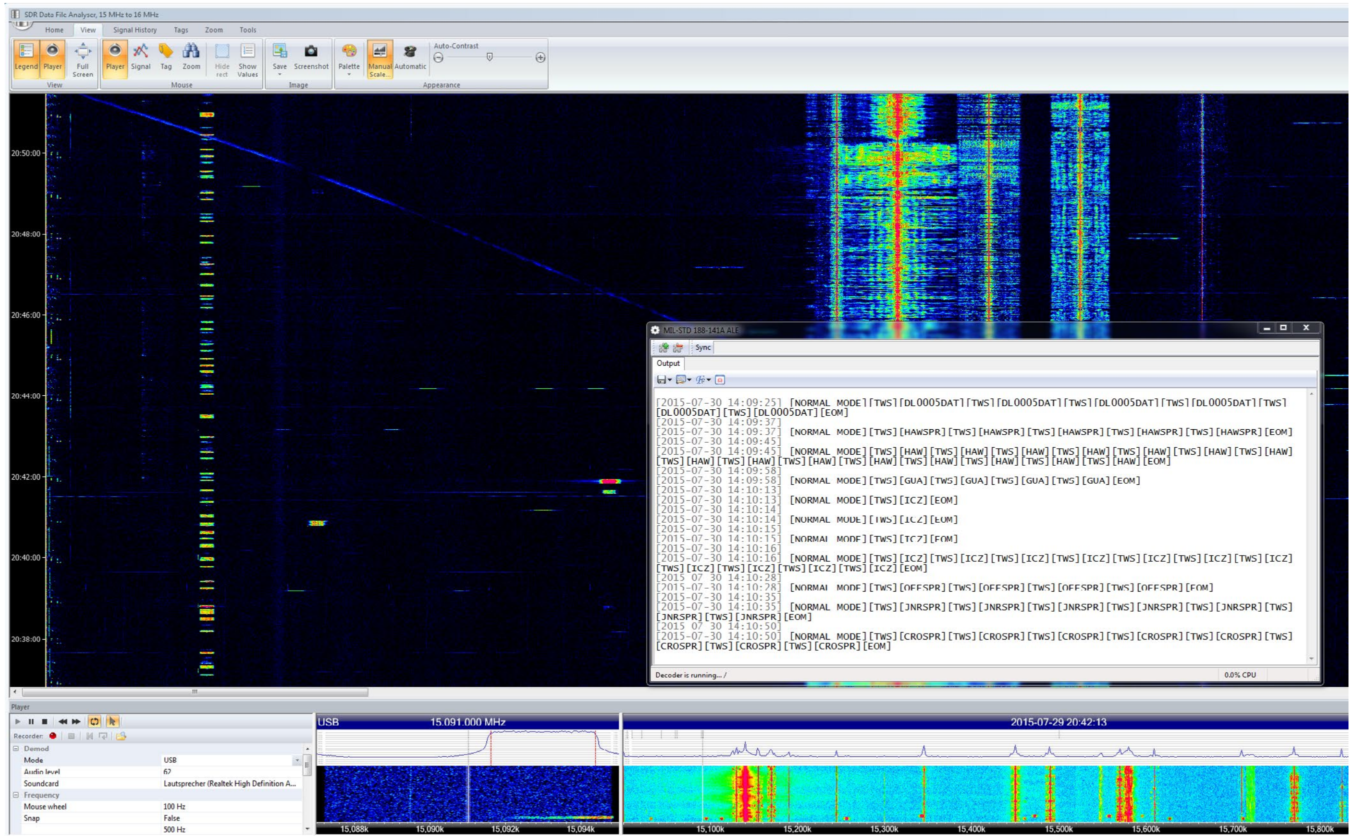


Figure 8: A typical layout to chase some of these short ALE transmissions. The sonagram is zoomed to 100 Hz width/1 s length per pixel. Demodulator and tuning you will find in the bottom windows. The audio is fed to a decoder, showing signals from e.g. Guam, Italy, Puerto Rico, Nebraska/USA and Ascension Island.

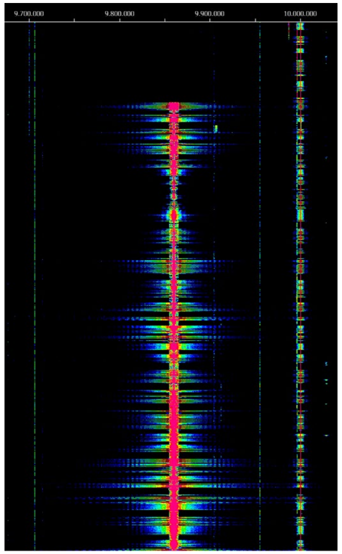


Figure 9: This recording/sonagram suffers from stuttering. You see the frequent dropping of a continous AM signal and a severe overshooting whenever it returns. Stuttering is annoying even if listening to broadcast and leaves the recording completely worthless if decoding data. Compare the pattern of this signal with the smuch smoother ones of the broadcasters in Figure 8.

12/24 Channels: FDM-SW2 Software

Above we have played with the feature of a 15 MHz wide recording. You use this method to e.g. dig out stations on unknown channels.

If you already know the channels, another method comes into play. ELAD‘s elegant FDM-SW2 software provides up to four/eight different demodulators each within the given up to 6.144 MHz spectrum. You may tune each receiver completely independently, e.g. with different modes and bandwidths.

The demodulated output of each of these sub-receivers can be routed to an respectively different virtual audio cable, or VAC. Each of this VAC may be used as input for separate decoders/ audio recorders.

The general concept plus a step-by-step introdction to this method has been laid out in detail with many examples in ***this paper***. Please refer to it if you are not quite familiar with ***VAC software*** and/or working with multiple instances of decoder software.

The setup of receivers, sub-receivers, VACs and decoders has to be planned carefully. Each time, when I thought to do this „just on the fly“, I get puzzled and surely go back to such a table.

First you have to open each FDM-S2 receiver with a separate instance of FDM-SW2 software. Tune each receiver to the centre frequency you want - see Figure 10 for an example.

Then you have to prepare each receiver according to your task - see Figure 11 (table).

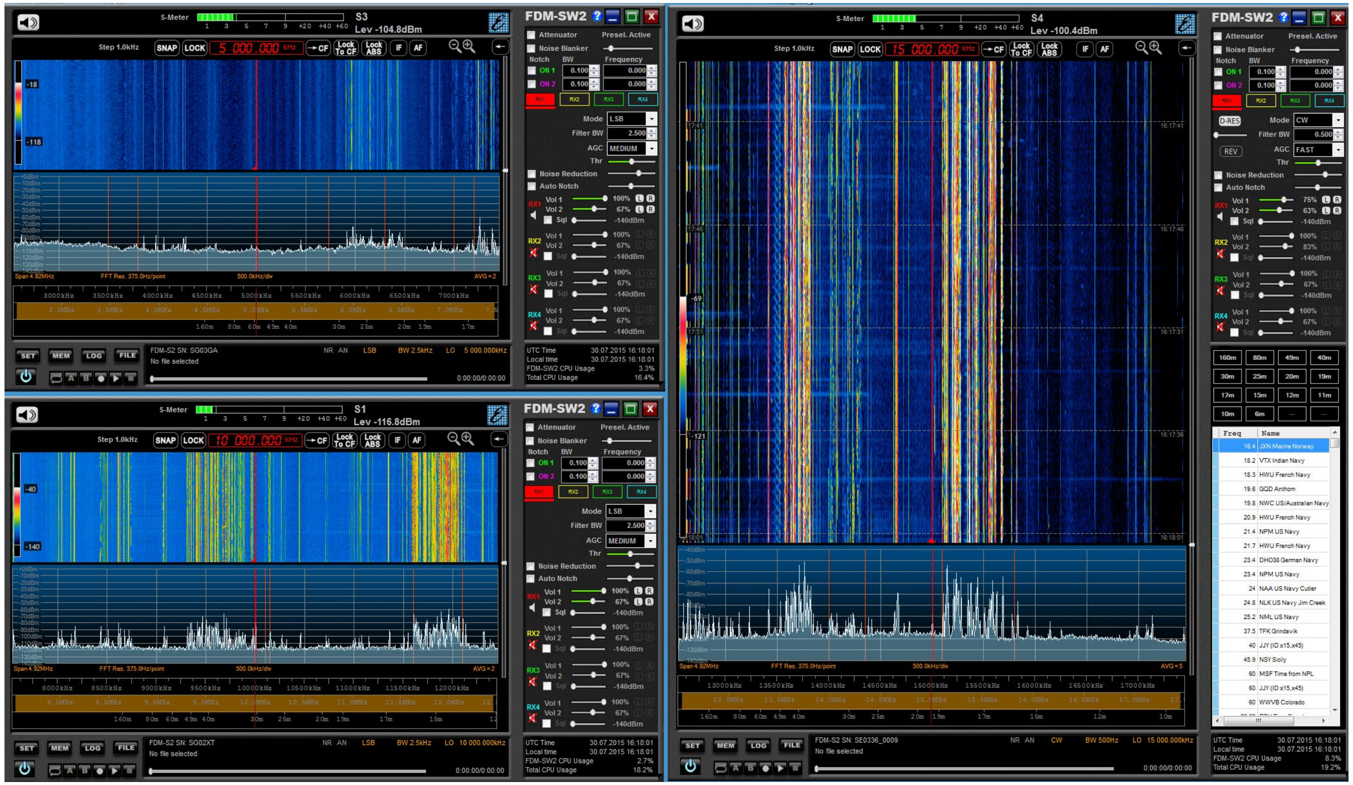


Figure 10: All three FDM-SW2 receivers had been opened with a different instance of FDM-SW2 software. Two receivers are tuned to centre frequencies of 5 MHz and 10 MHz respectively (left column, landscapce format), the third is centred on 15 MHz (right column, portait format).

Figure 11: An EXCEL sheet makes it easy to match your task with receivers, VACs and decoders. You may route audio also to a recorder. In this example, all entries are sorted by their frequency. This makes it easy to assign them to appropriate receivers.

Frequency	Receiver	Centre	VAC_##	Mode	Bandwidth	Decoder_instance	Service	Notes/Modes	Remarks
5 547.000	FDM-S2_A	7 MHz	VAC_7	USB	2500	PC-HFDL_1	ARINC Shannon	2-/4-PSK	Aero
8 414.500	FDM-S2_A	7 MHz	VAC_3	RTTY	500	YaDD_3	DCS	2-FSK	Ship/Coastal
8 992.000	FDM-S2_A	7 MHz	VAC_5	USB	2500	PC-ALE_2	U.S. Air Force, HF-GCS	MIL-STD-188-141A	24 h
10 081.000	FDM-S2_B	12 MHz	VAC_8	USB	2500	PC-HFDL_2	ARINC Shannon	2-/4-PSK	Aero
10 138.700	FDM-S2_B	12 MHz	VAC_6	USB	2500	WSPR	WSPR-Net	4-FSK	Ham Radio
11 175.000	FDM-S2_B	12 MHz	VAC_4	USB	2500	PC-ALE_1	U.S. Air Force, HF-GCS	MIL-STD-188-141A	24 h
11 384.000	FDM-S2_B	12 MHz	VAC_9	USB	2500	PC-HFDL_2	ARINC Shannon	2-/4-PSK	Aero
12 577.000	FDM-S2_B	12 MHz	VAC_2	RTTY	500	YaDD_2	DCS	2-FSK	Ship/Coastal
13 935.500	FDM-S2_B	12 MHz	VAC-12	USB	3000	W-PC	SAILMAIL Lunenburg	PACTOR-III	Coastal
14 851.700	FDM-S2_C	16 MHz	VAC-11	USB	3000	Sorcerer	Pakistan Navy	PACTOR-II/FEC	5-lgs
16 804.500	FDM-S2_C	16 MHz	VAC_1	RTTY	500	YaDD_1	DCS	2-FSK	Ship/Coastal
18 034.700	FDM-S2_C	16 MHz	VAC-10	USB	3000	CMAS 2000	Egyptian MFA	SITOR-A/CODAN	mixed modes