Radar Systems on Shortwave

observed and compiled by DK2OM – Wolf Hadel
Coordinator IARUMS Region 1

State: August 2013

Contents:

Introduction

The shortwaves are crowded by many kinds of Radars. Radars are often disturbing Amateurradio, Weatherfax, Military traffic and other services, too. This collection is only a small overview! We are expecting more systems with partly very complicate parameters and purposes. Observations with SDR-Receivers (like Perseus) and analysis by the sophisticated Wavecom products are often helpful. Other equipments, which are used by laboratories are much too expensive for Radioamateurs.

Measurements with W-Code, W61PC (Wavecom), Gram50 and Perseus: DK2OM
All other sources are exactly mentioned!

1. Ionosphere Diagnostic Radars

Such kinds of Radar have been developed to study the structures and the properties of the Ionosphere.

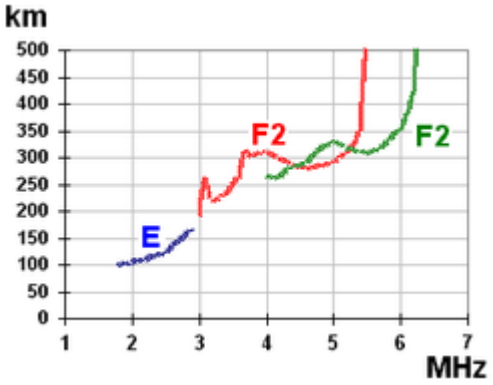
1.1 HAARP – USA (High Frequency Active Auroral Research Program)

source:

http://www.haarp.alaska.edu/haarp/

1.2 Ionosondes

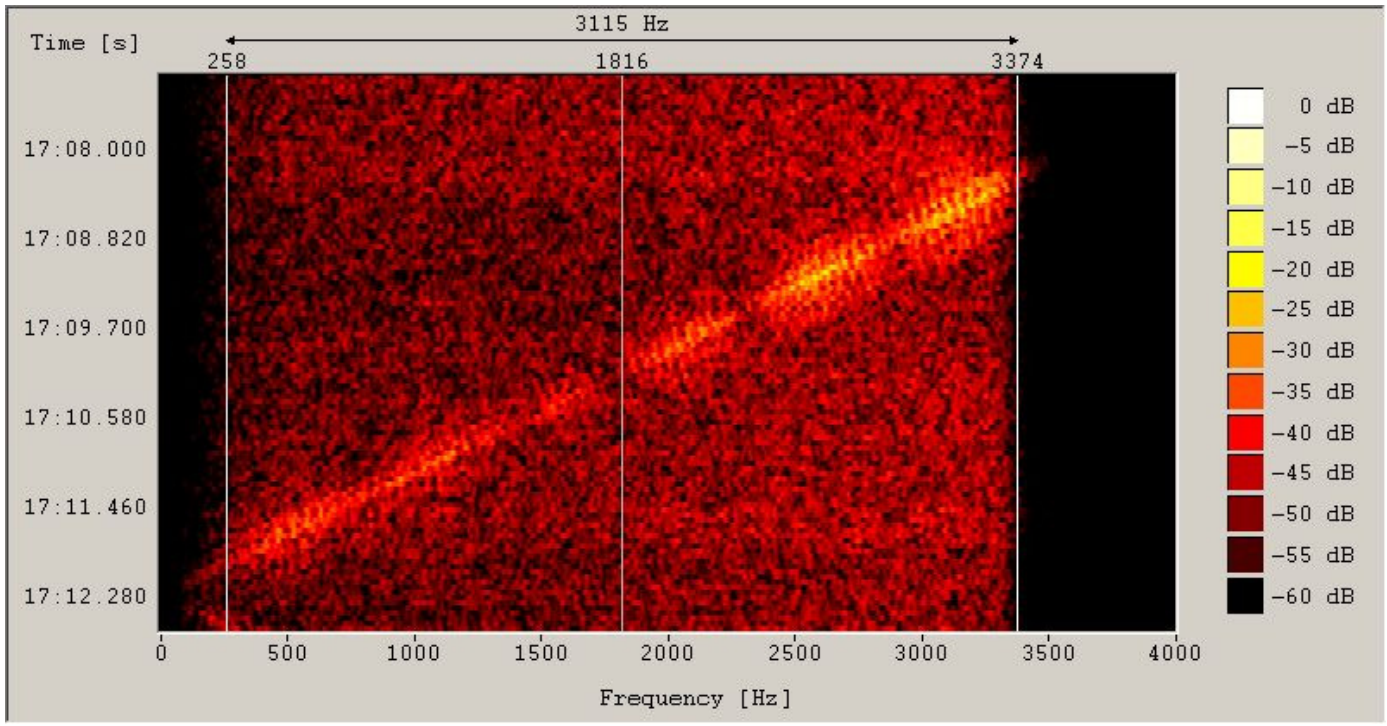
Ionosondes are examinating ionospheric physics, especially reflections for military and other purposes. Very fast sweeps are running over large frequency ranges during few seconds.



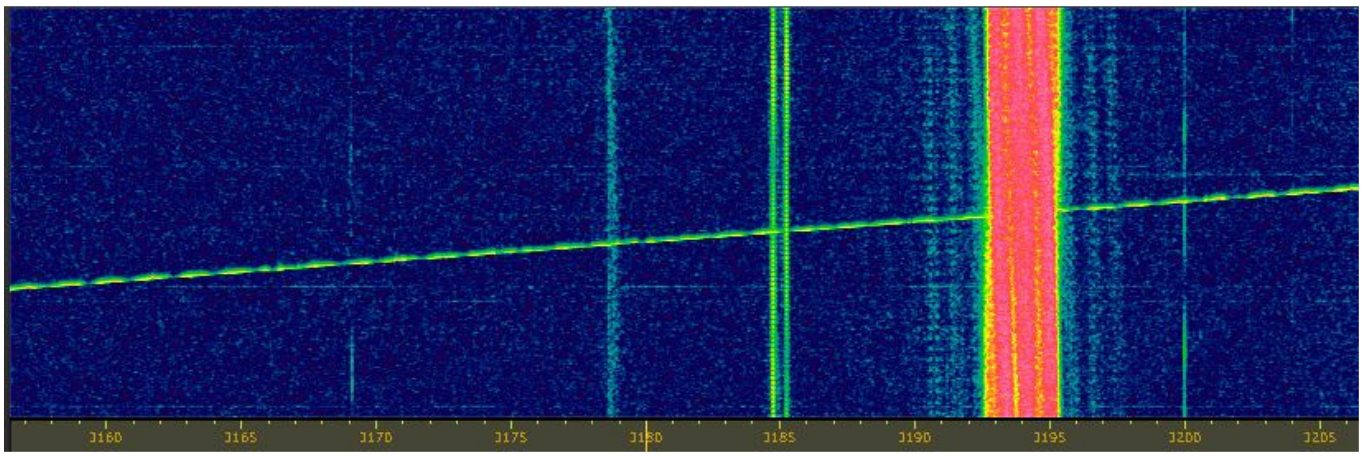
source:

http://wikien4.appspot.com/wiki/Ionosonde

Ionosondes observed by DK2OM:



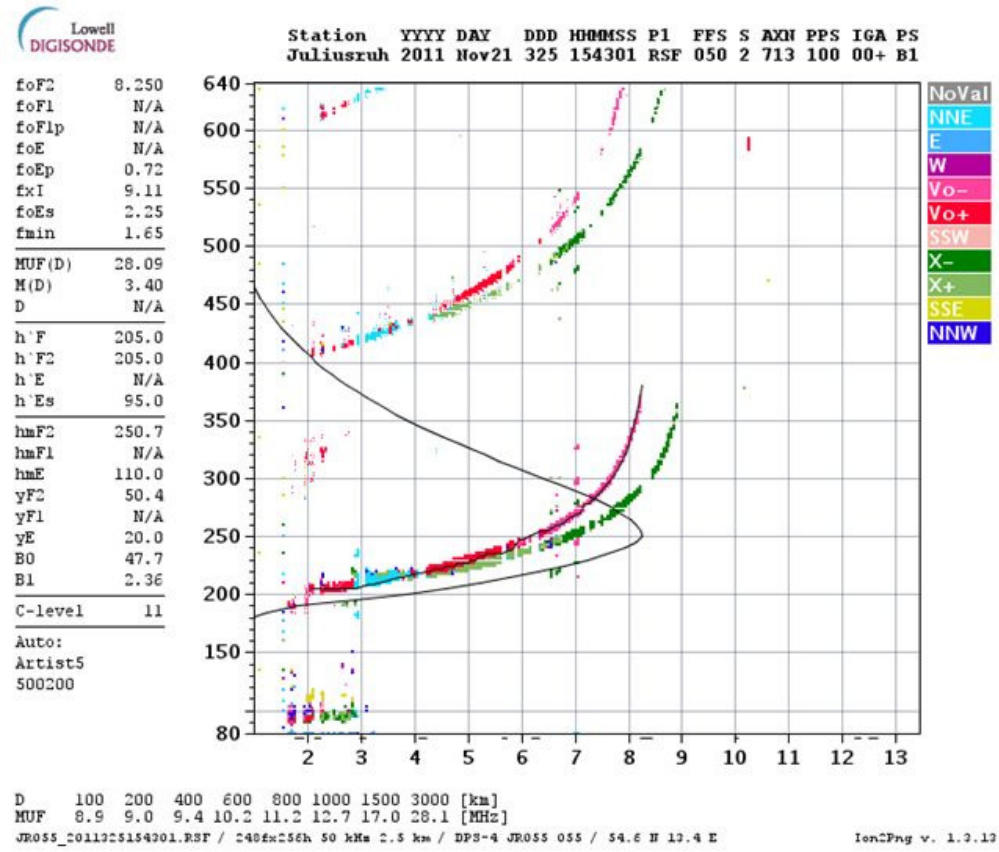
slow type of ionosonde



fast running system

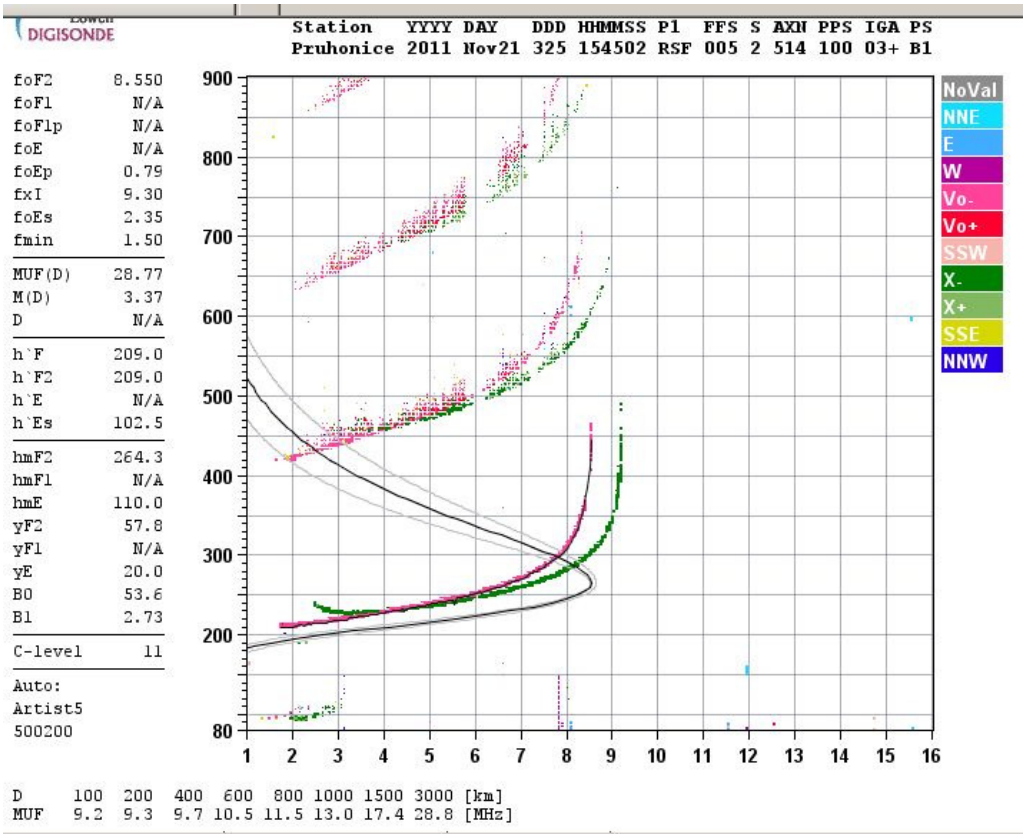
Ionogram from Juliusruh – Germany

http://www.iap-kborn.de/Ionosonde.172.0.html

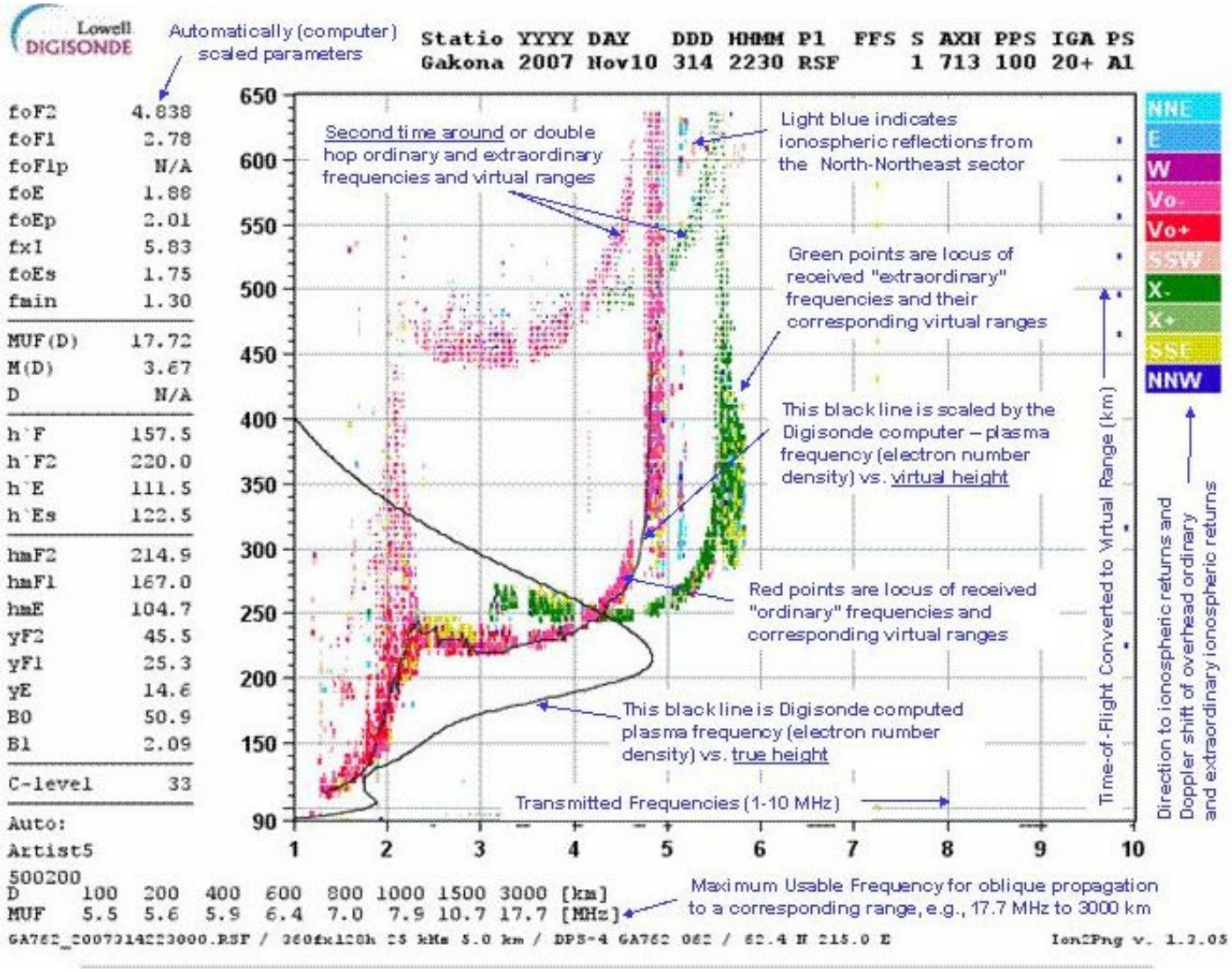


Ionogram from Pruhonice – Czech Republic

http://147.231.47.3/latestFrames.htm

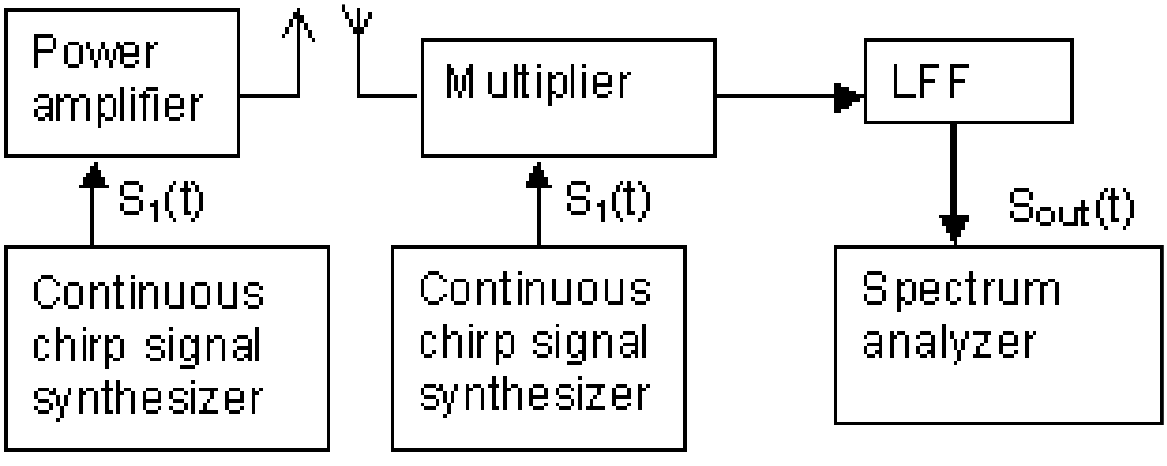


How to read a ionogram – source: http://en.wikipedia.org/wiki/Ionogram



The function of a continuous chirp signal sounder :

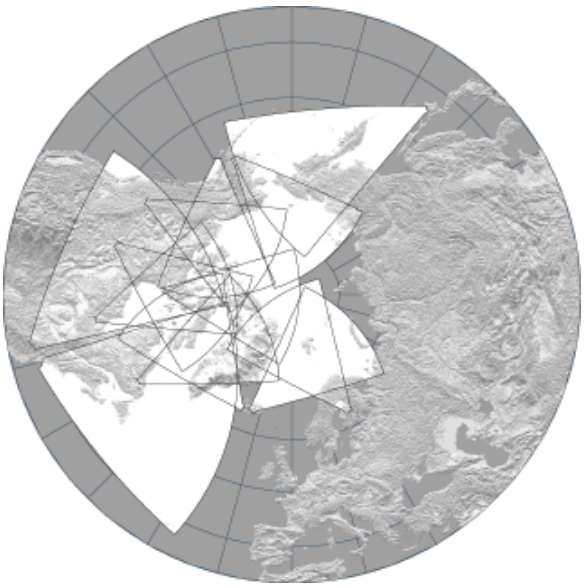
source: http://rp.iszf.irk.ru/esceir/lchmen/pictlchmen/scemeen.gif



Continuous chirp signal sounder block-scheme

1.3 Superdarn

SuperDARN stands for Super Dual Auroral Radar Network.



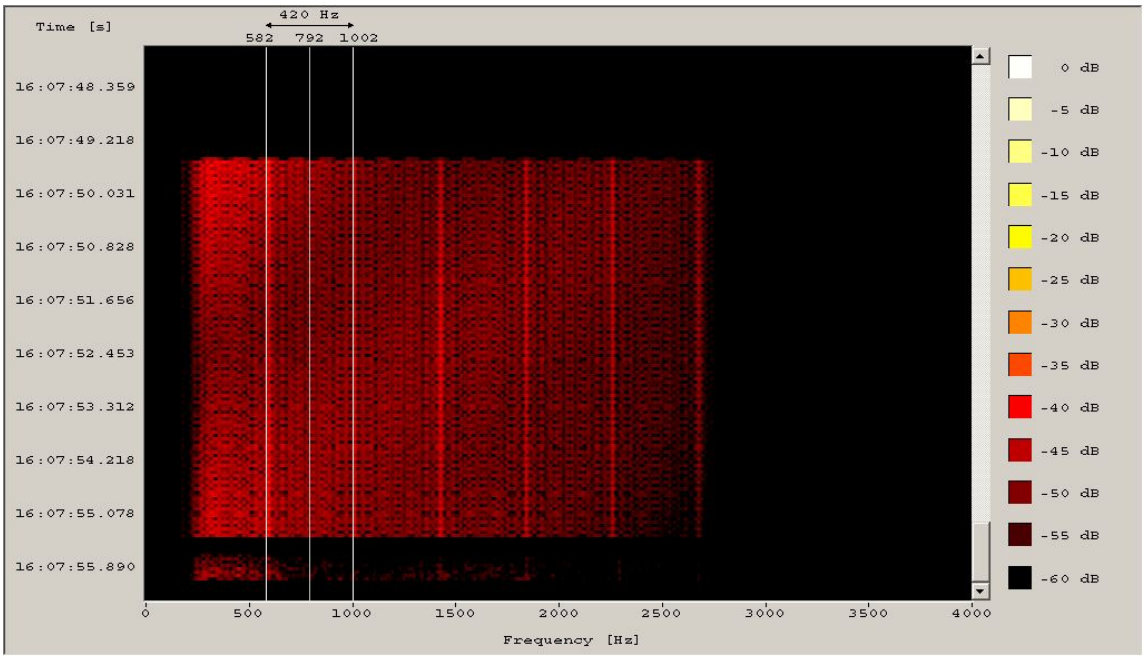
Northern hemisphere exploration.

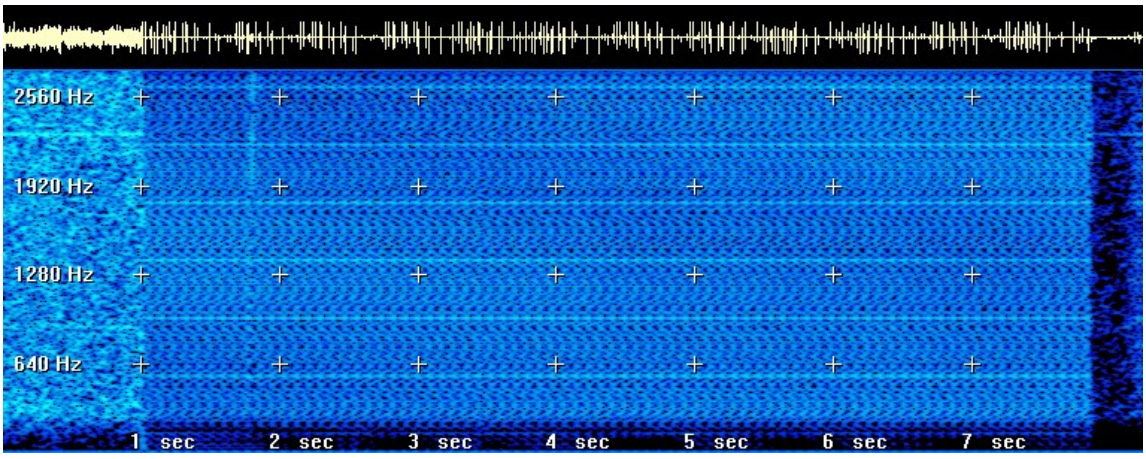
source:

http://superdarn.jhuapl.edu/

Superdarnsignals above 10150 kHz observed by DK2OM:

soundfile: http://www.iarums-r1.org/iarums/sound/superdarn.wav

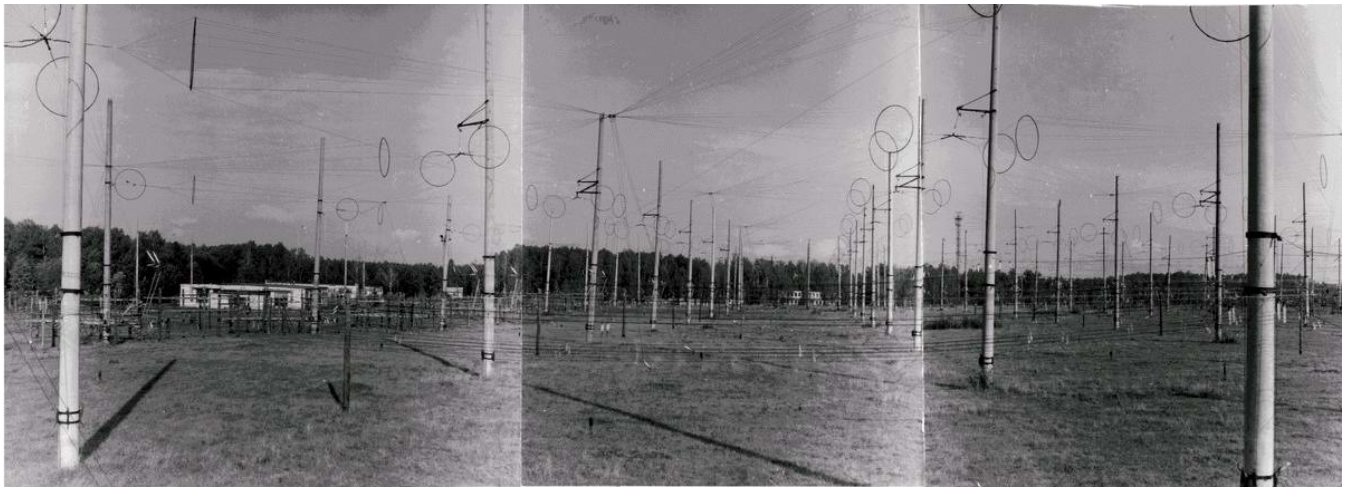




1.4 SURA (HAARP like Facility) – Russia - close to Nizhny Novgorod

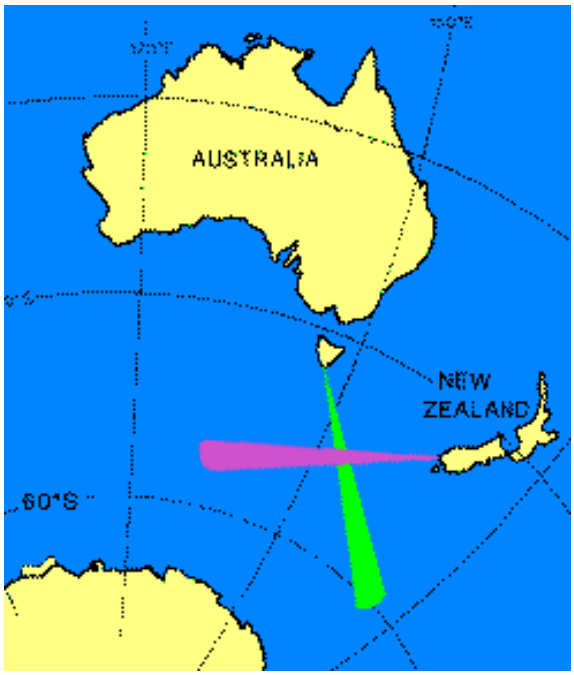
source:

http://www.thelivingmoon.com/45jack_files/03files/SURA_Radar_Facility.html



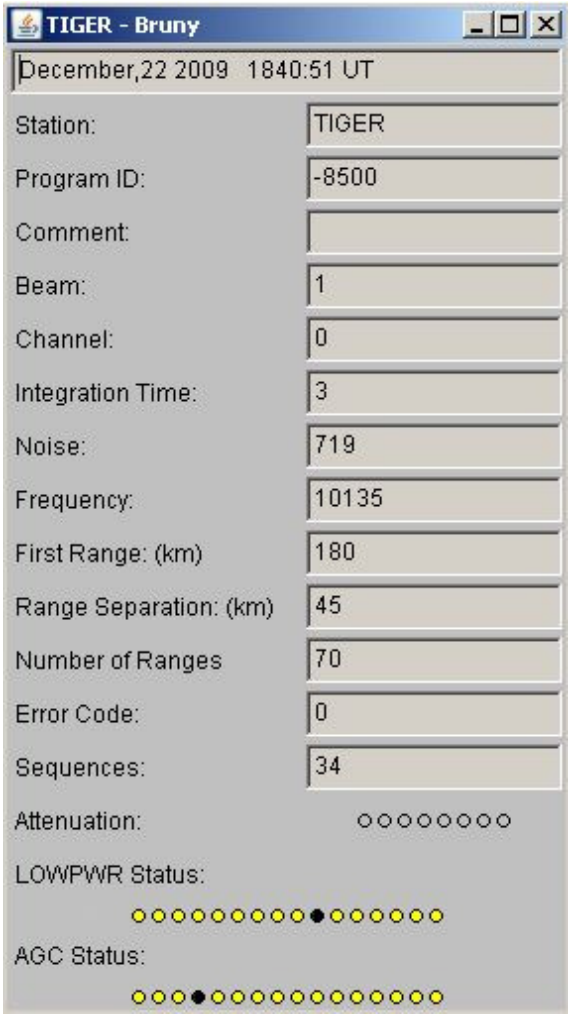
1.5 Tiger-Radar – Australia – New Zealand

source: http://www.tiger.latrobe.edu.au/



TIGER is part of an international network of similar HF radars called SuperDARN (Super Dual Auroral Radar Network) operated by ten nations to provide simultaneous coverage of both southern and northern polar regions.
TIGER explores the impact of solar disturbances on Earth by monitoring the location of aurora and related phenomena occurring in the ionosphere - 100 to 300km above the Earth.

Tiger Radar on 10135 kHz! - http://www.tiger.latrobe.edu.au/

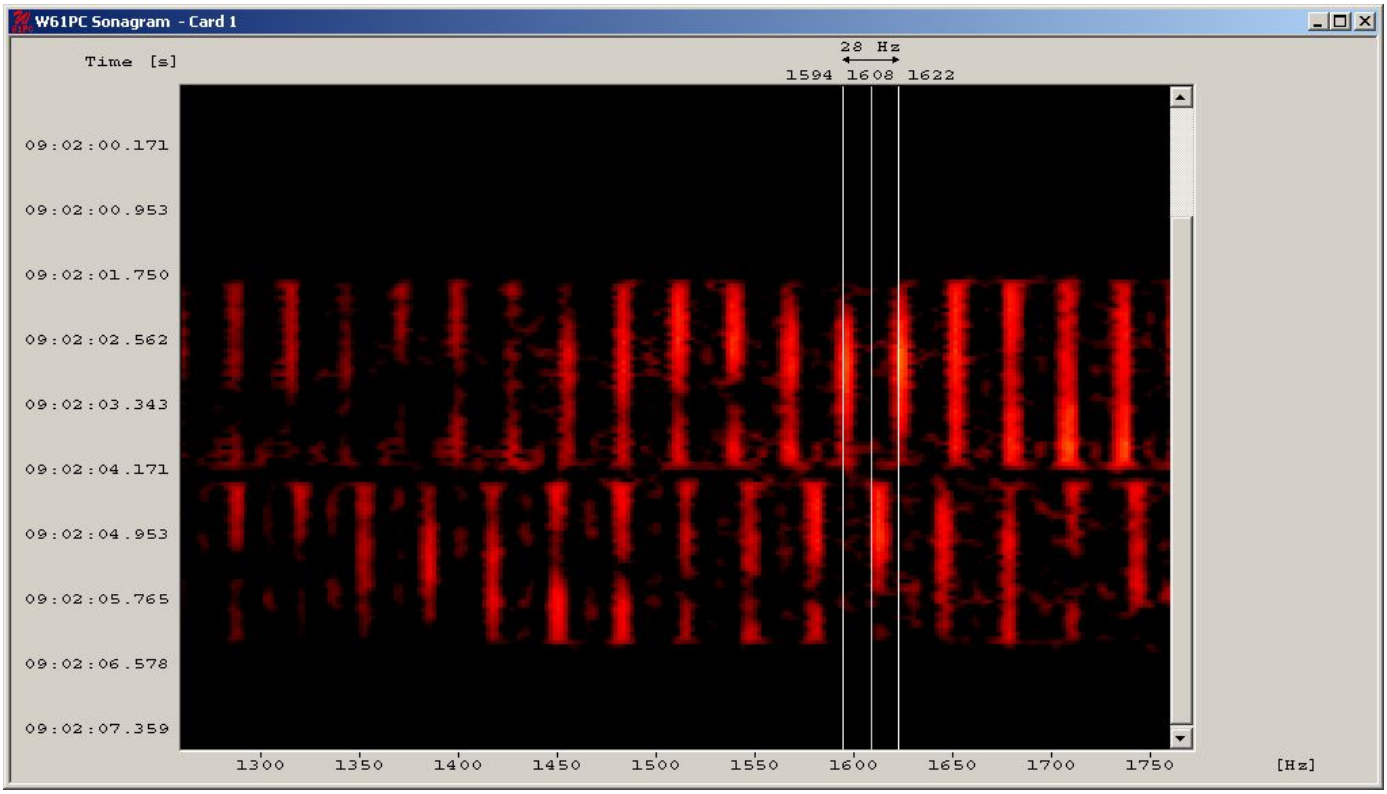


Tiger Radar operating on 10135 kHz.
After a complaint of DJ9KR and Australian Amateurs the transmission frequencies were changed.
The "Tiger" left the 30 m-band.

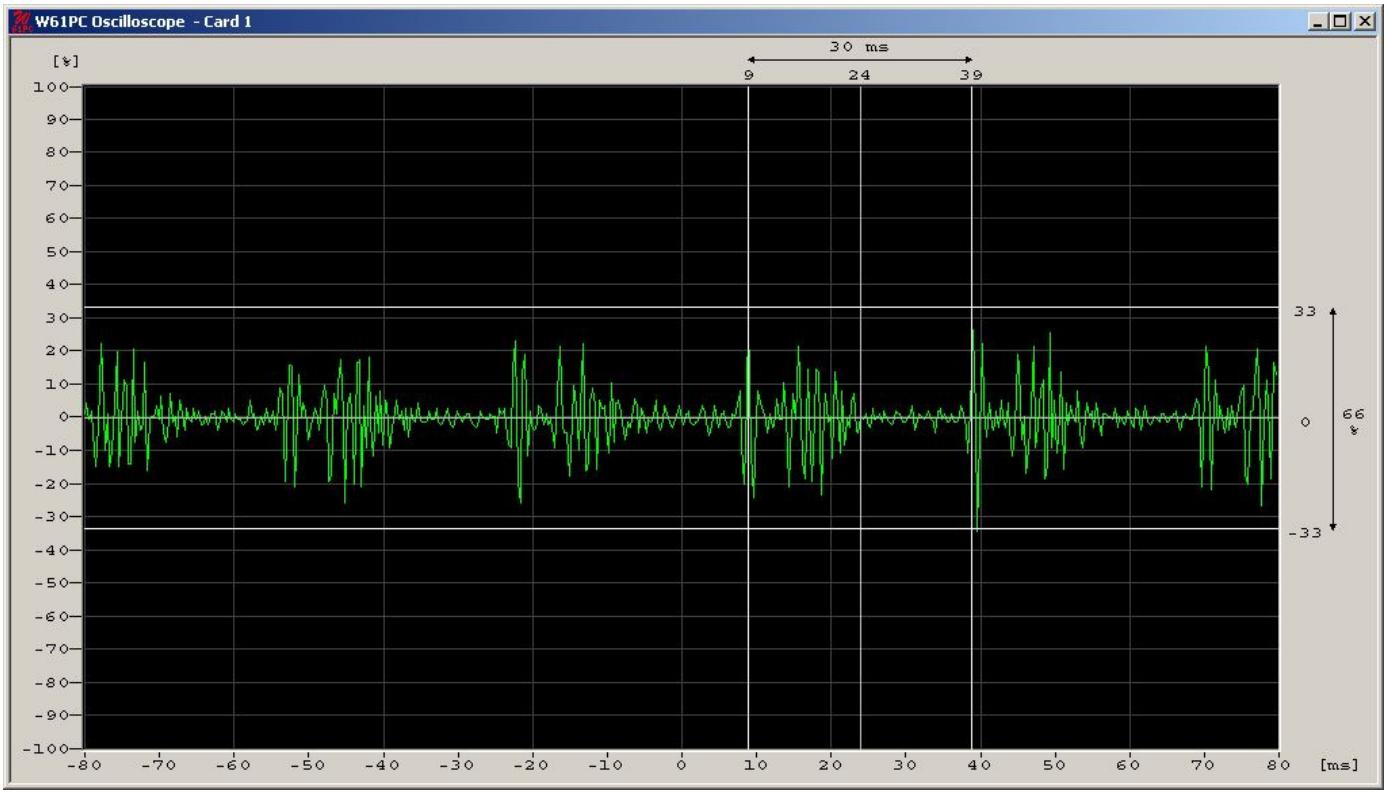
<<<<<< !!!

soundfile: http://www.iarums-r1.org/iarums/sound/tiger1.wav

Tiger Radar analyzed by DK2OM – WAV-file from Australian Amateurs



Pulse measurement (PRF = pulse repeat frequency)



soundfile: http://www.iarums-r1.org/iarums/sound/tiger1.wav

1.6 SOUSY Svalbard Radar – SSR – Norway

SOUSY = SOUnding SYstem for atmospheric structure and dynamics

source: http://www.mps.mpg.de/en/projekte/sousy/sousy_radar_mobile.html

source: http://www.mps.mpg.de/en/projekte/sousy/sousy_ssr.html

source: http://radars.uit.no/sousy/

The SSR Project
In the polar middle atmosphere phenomena from above, resulting from the effect of the solar wind on the Earth's atmosphere, and phenomena from below, such as gravity waves propagating upwards from the troposphere, are merging. The relative importance of these effects from above and below should be studied. The polar summer mesosphere is extremely cold such that ice particles form, resulting in Noctilucent Clouds and in particular electromagnetic wave scattering, manifest in Polar Mesosphere Summer Echoes. The polar stratosphere and troposphere are strongly affected by dynamic processes occurring in connection with the polar vortex.

Basic system parameters of the SOUSY-Svalbard-Radar (SSR)

Location near Longyearbyen (78 ° N, 16 ° E) on Spitzbergen/Svalbard

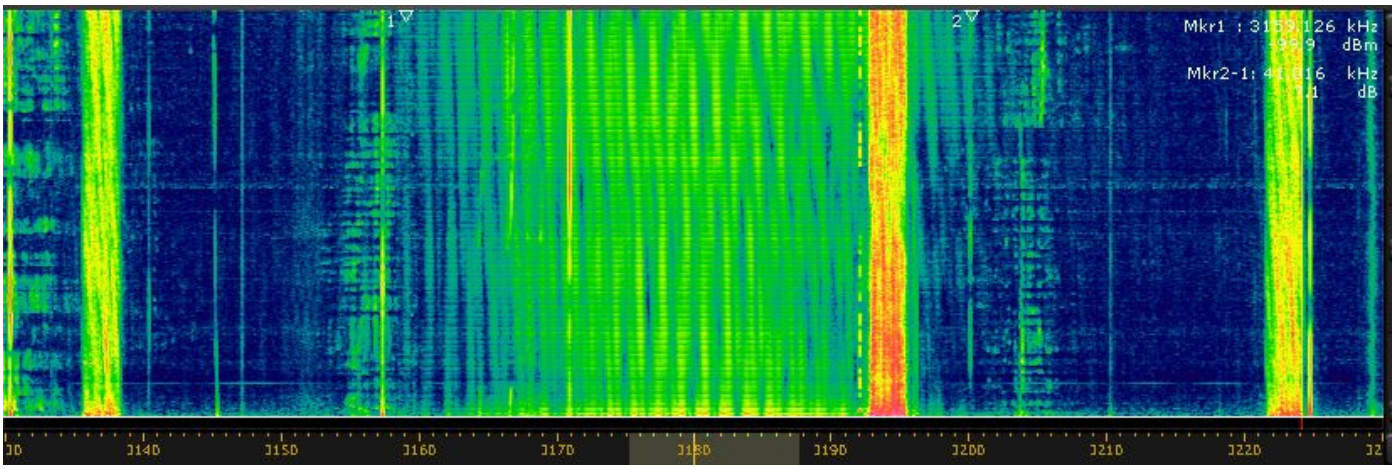
```
Transmitter:
-----------
Frequency ........................... 53.5 MHz
Pulse Peak Power .................... 60   kW
Duty Cycle .......................... 4%
min. Pulse Length ................... 1 microseconds

Antenna:
-------
Single Element ...................... 4-element Yagi
Number of Elements .................. 356
Beamwidth ........................... 4.5 degrees
Gain ................................ 33  dBi
Pointingdirections :
                    vertical, 5 ° to NE, SE, SW, NW
```

1.7 MF Ionospheric Radar Juliusruh - Germany

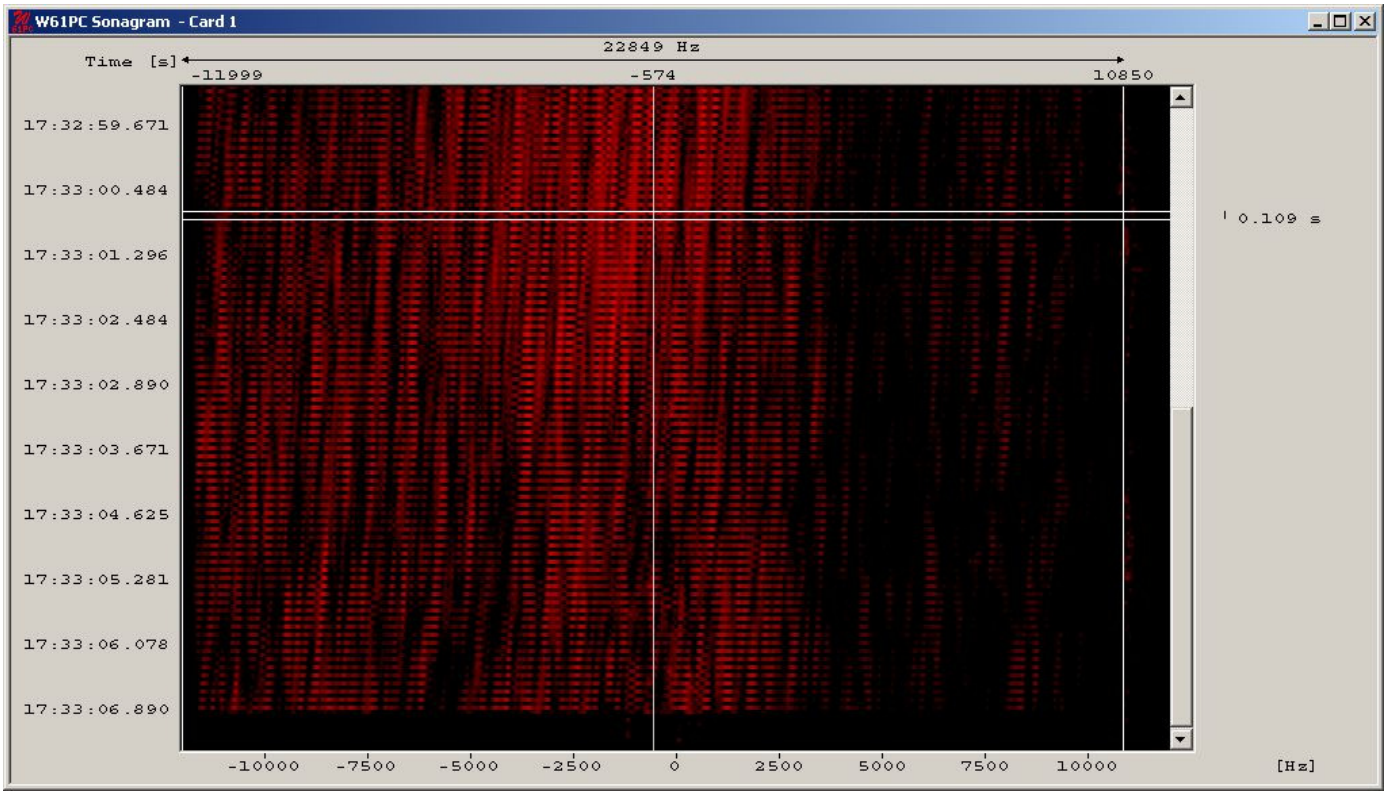
The MF Radar Juliusruh is analyzing the Ionosphere between 60 and 90 km altitude (D-layer), especially the Ionospheric winds.

source: http://www.iap-kborn.de/Juliusruh-MF-Radar.175.0.html

MF Radar Juliusruh - centered 3.18 MHz – mode: FMCW with different sweepsrates



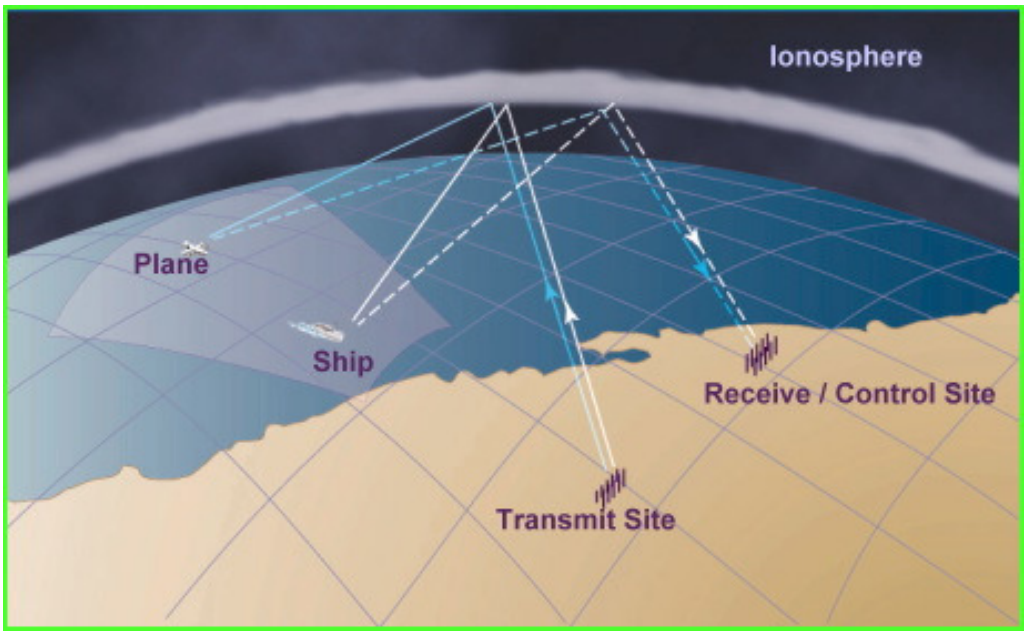
MF Radar Juliusruh with 10 sweeps/sec (analyzed by W61PC in IF-MODE)



2. Over The Horizon Radars (OTHR)

2.01 Basic Infos

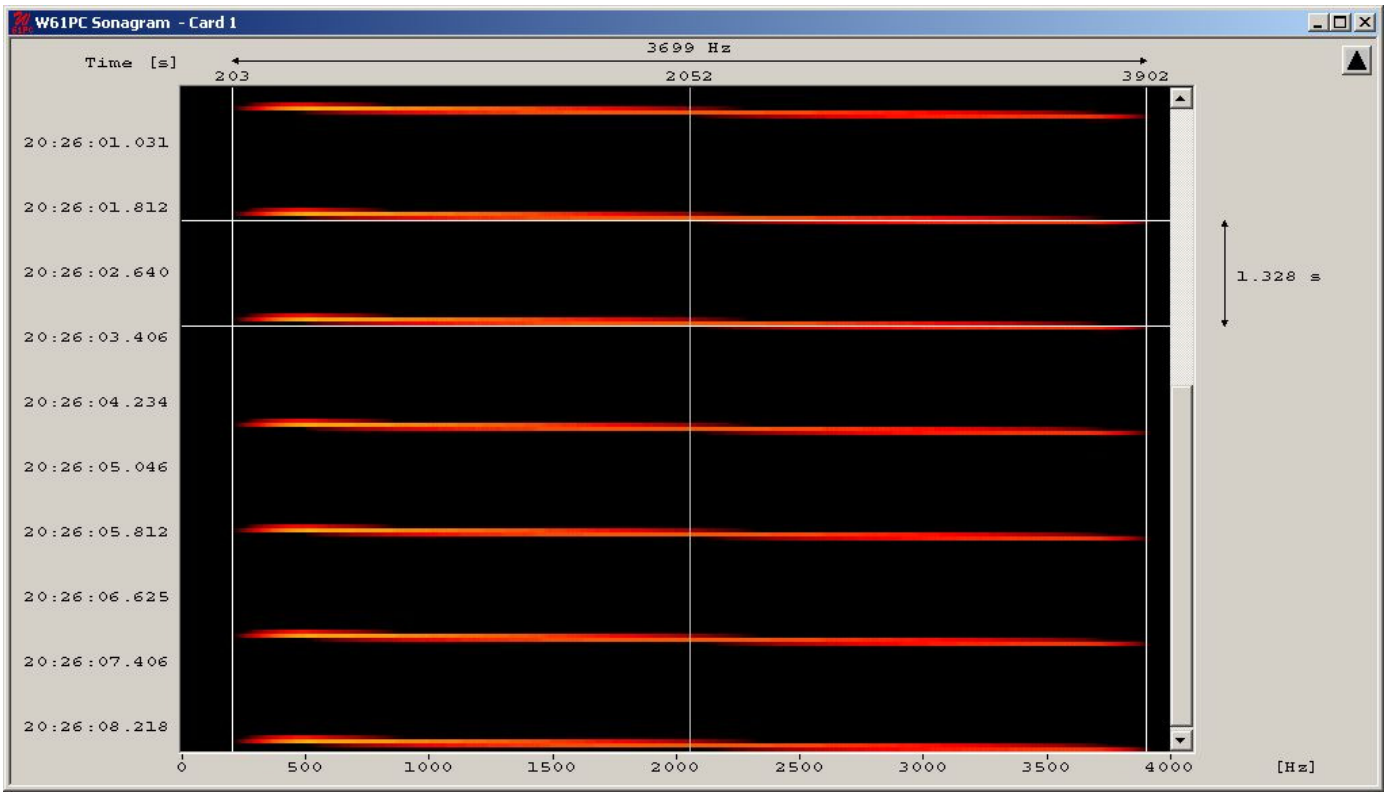
source: http://www.sri.com/esd/rsed/oth_files/oth_concept.html



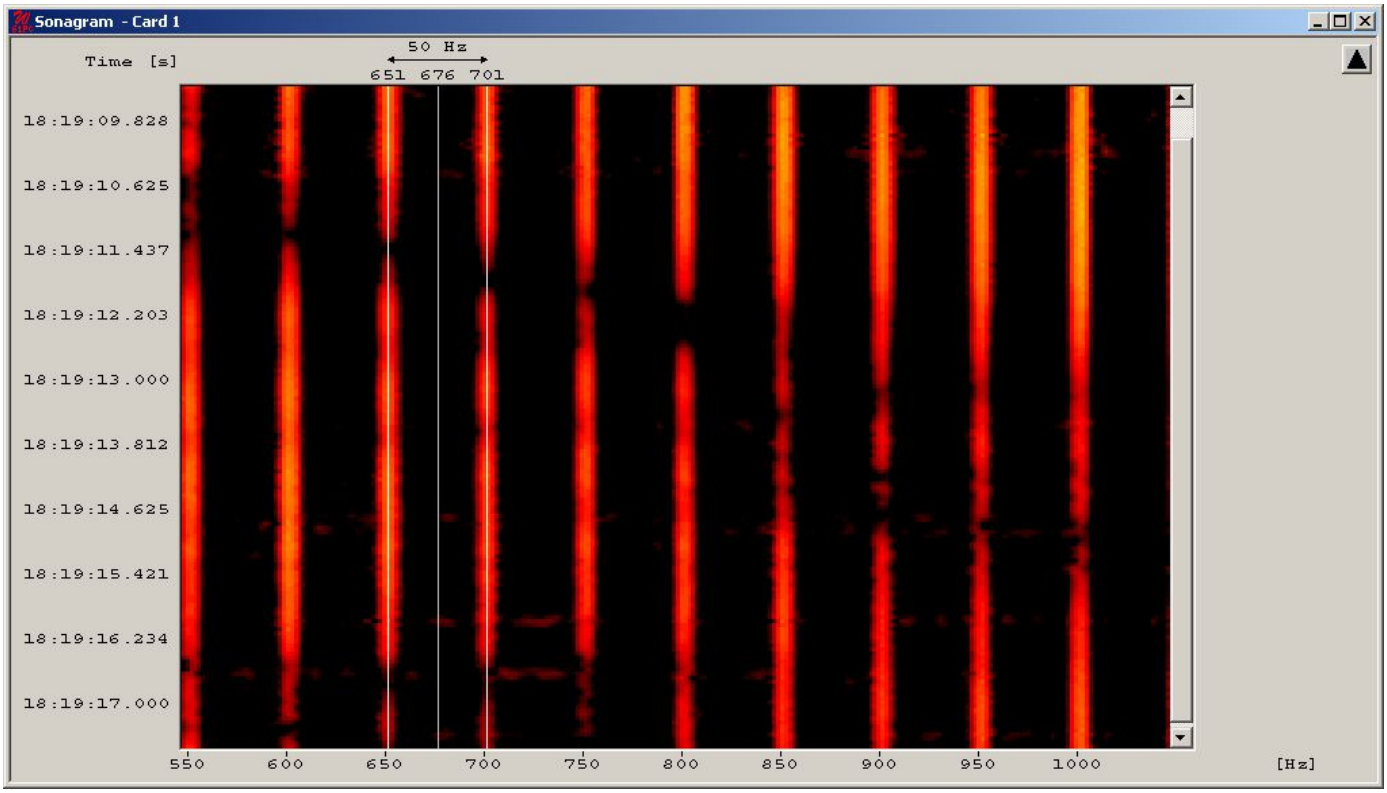
OTH-Radars can often be observed as sweepgenerator systems. One sweep is stretching over 10 or 20 kHz, sometimes more! Such OTHRs are classified as **"FMCW"**, which means **Frequency Modulated Continuous Waves**.

The homebrew radar (created by DK2OM) shows the function:
Sonagram from a soundcard sweepgenerator!
One sweep is covering 3.6 kHz, breaks of 1.32 seconds between the sweeps.
During the breaks, reflected signals can be received.

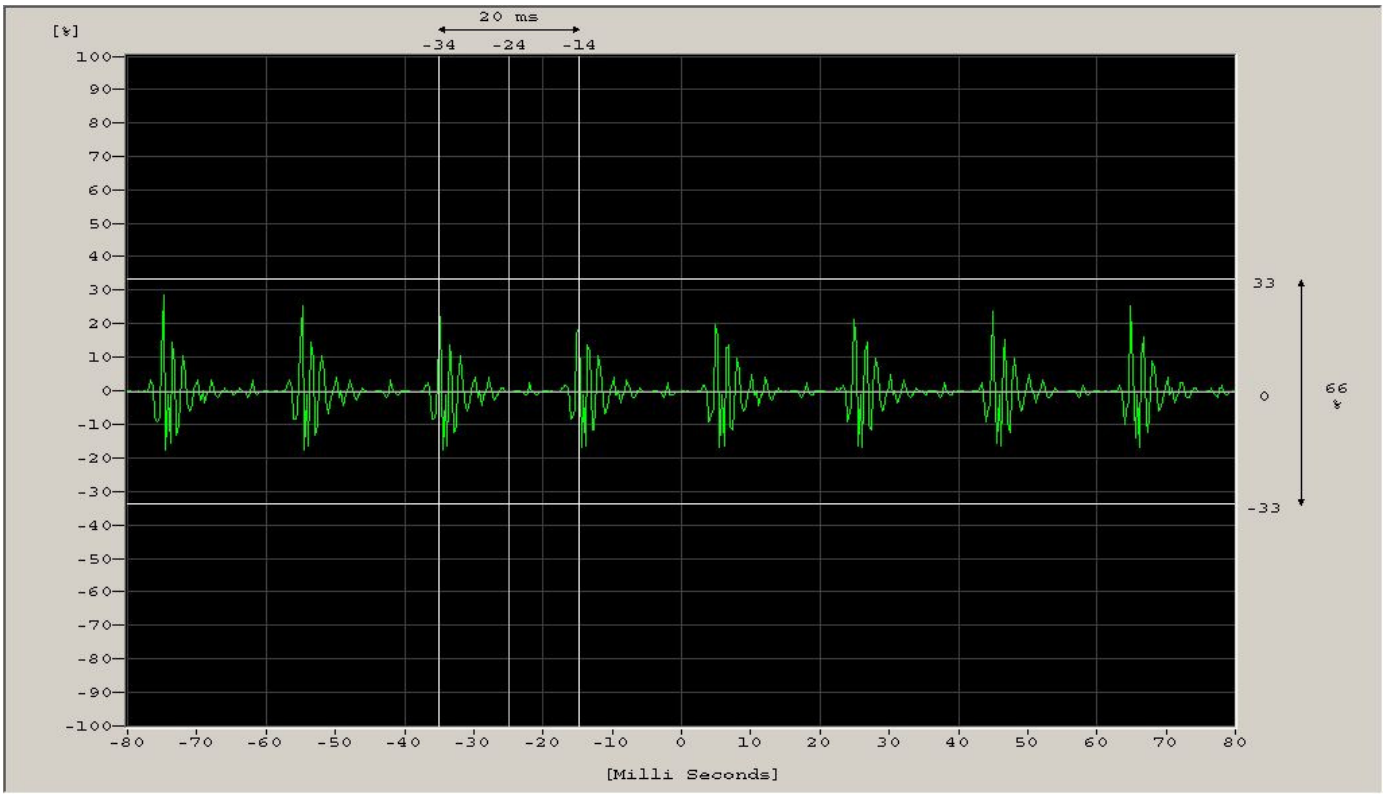
soundfile: http://www.iarums-r1.org/iarums/sound/sweep.wav



Measuring the sweeprate from the receiver AF:



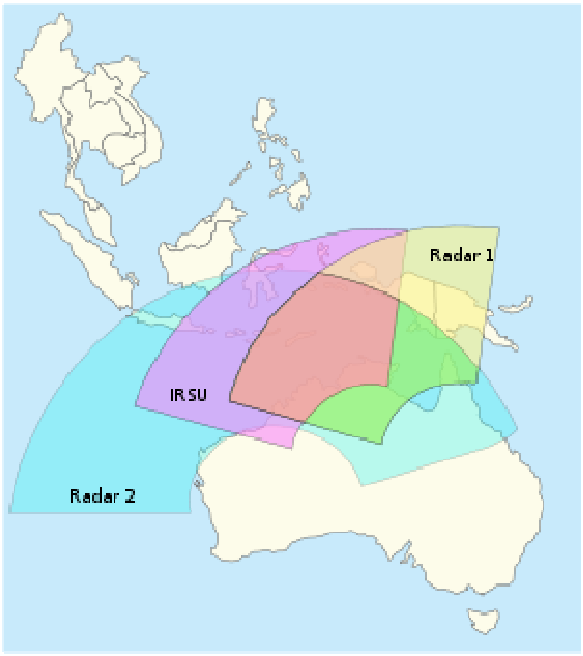
You can only see the spectral lines, if you are using the AF-input of your soundcard or decoder. The sonagram above shows an OTHR with 50 sweeps/sec. Measuring the distance between 2 spectral lines will give you the sweeprate. In this case 50 sweeps/sec.



An exact method is the use of an oscilloscope. The OTHR above has 20 msec between the sweeps. Calculation: 1000 msec : 20 msec = 50 sweeps/second

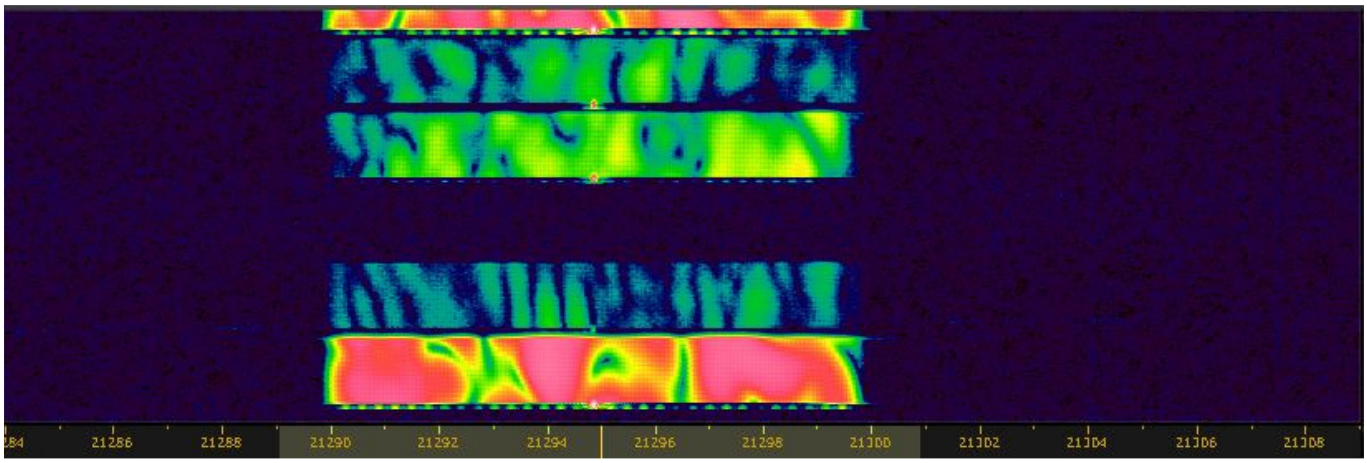
2.02 OTHR Australia – JORN - Jindalee Operational Radar Network

source:
http://en.wikipedia.org/wiki/Jindalee_Operational_Radar_Network

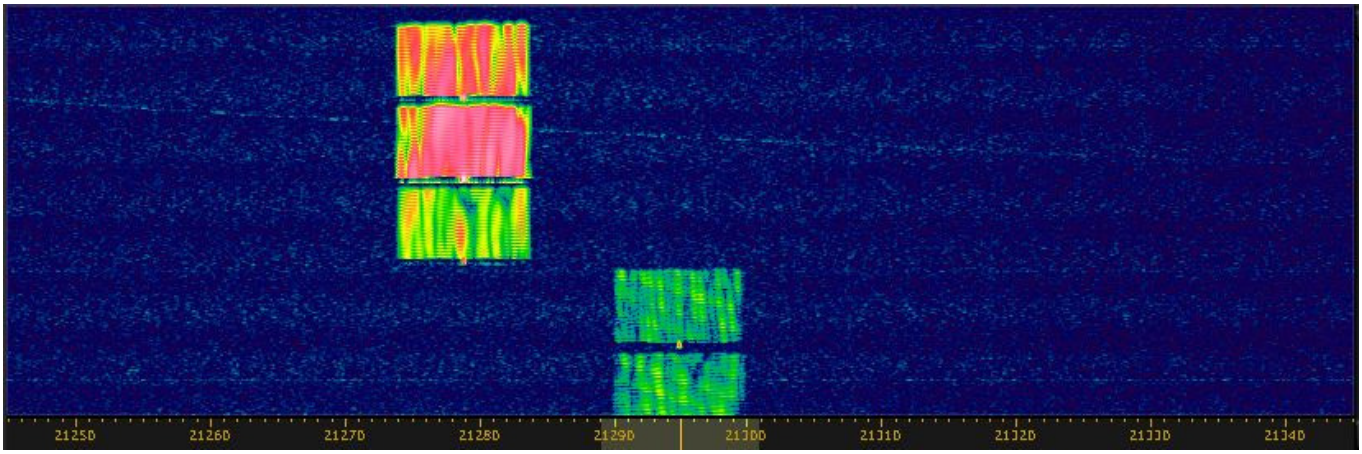


JORN on 21 MHz – found by DK2OM:

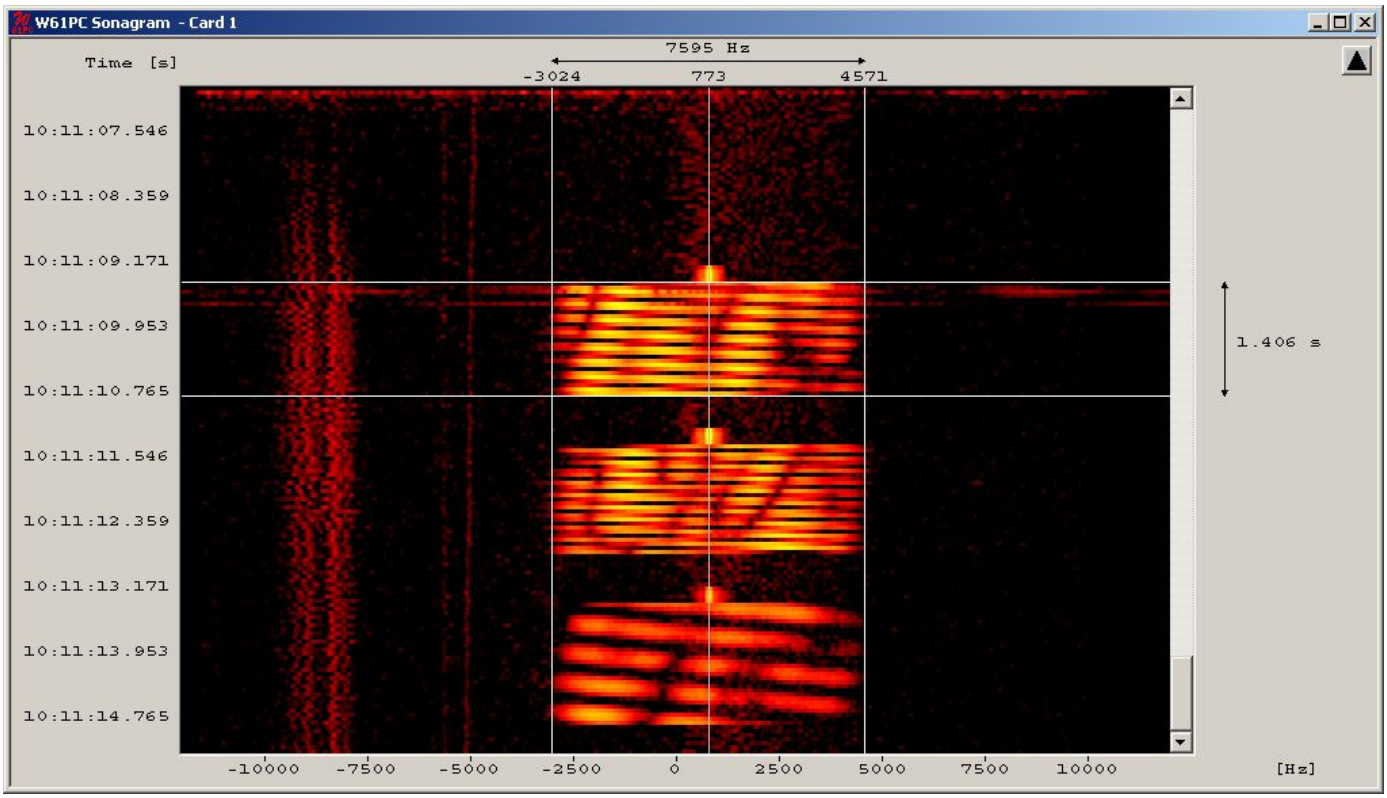
JORN burst system on 21295 kHz – covering 10 kHz bandwidth



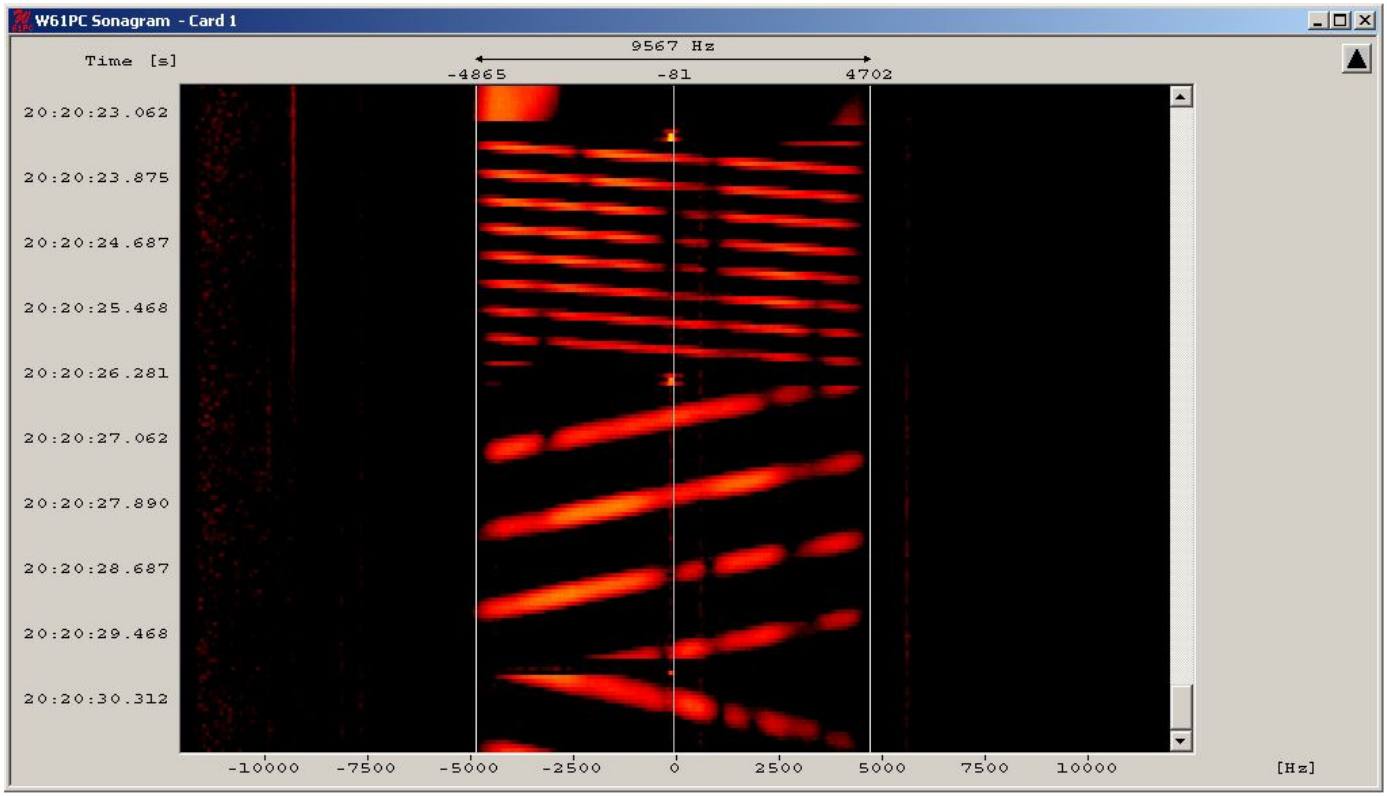
JORN burst system hopping down to 21274 and up to 21295 kHz



JORN on 10153 kHz – operating with different sweeprates - observe the typical intro tones!



JORN bursts on 22960 kHz at first with short range (high sweprates), then switching up to long range (lower sweeprates), like a searchlight.



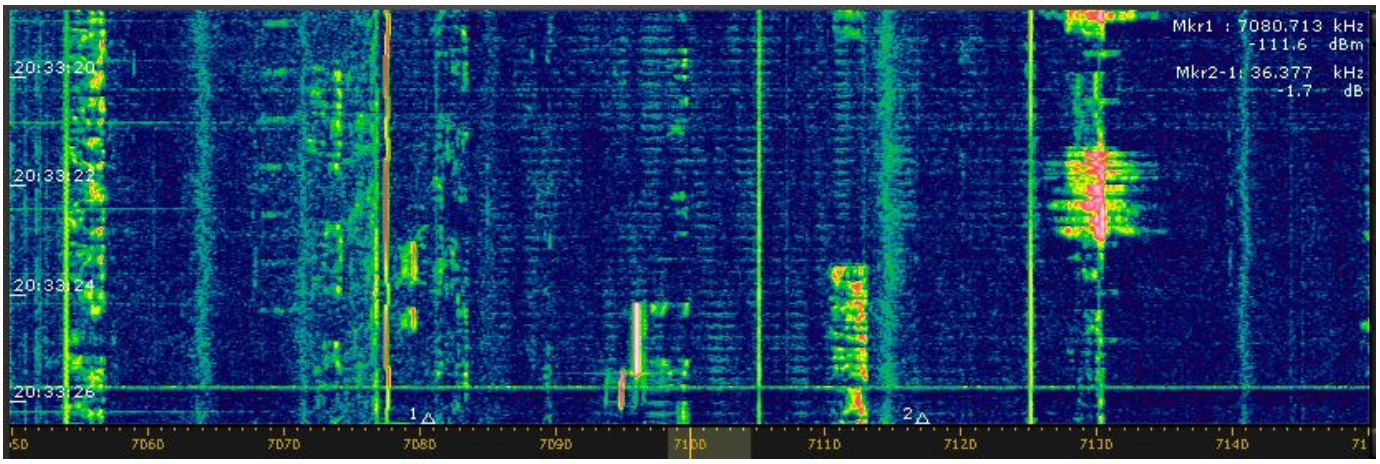
JORN on 22950 kHz in searchlight mode – operating with decreasing sweeprates – Observe the typical intro tones!

soundfile: http://www.iarums-r1.org/iarums/sound/ausoth.wav

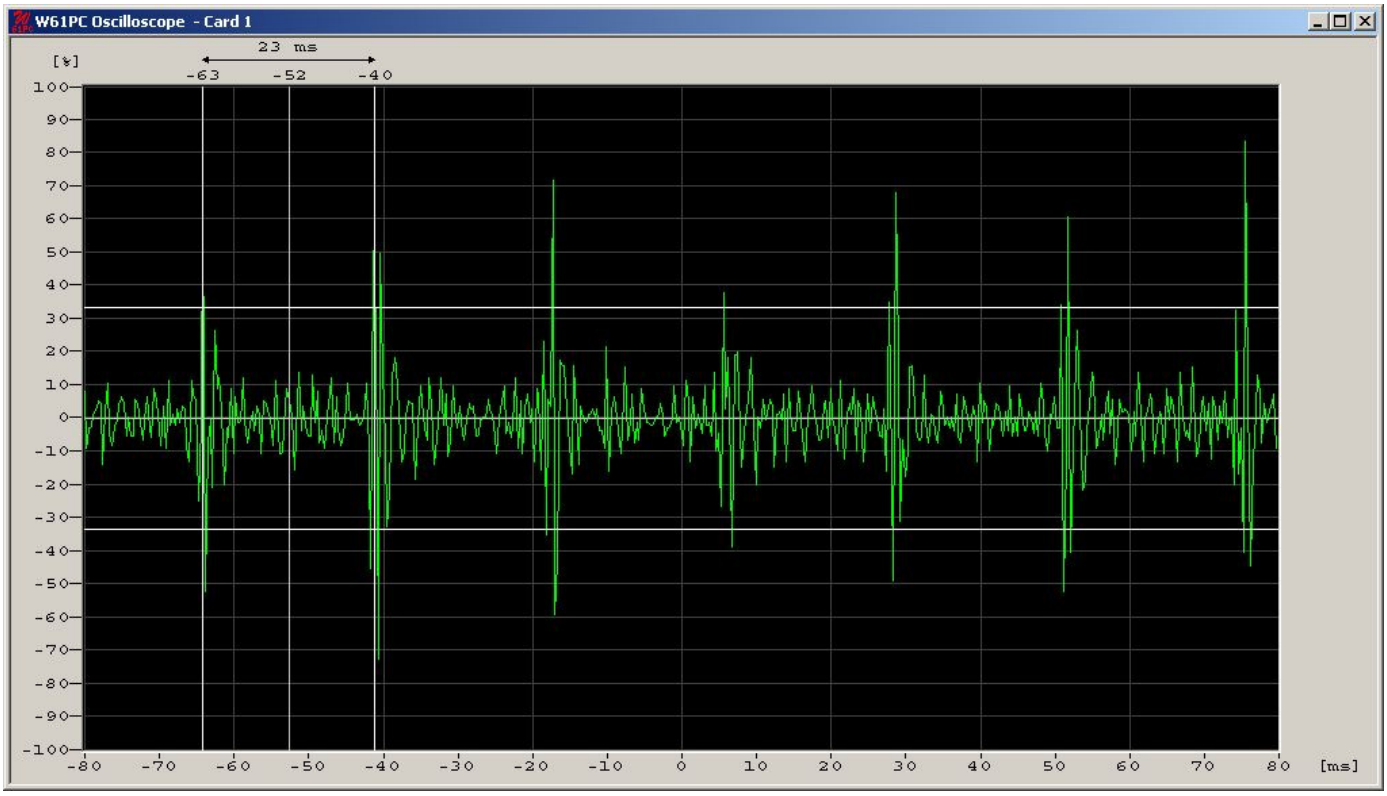
2.03 OTHR China – constant and burst systems

soundfile: http://www.iarums-r1.org/iarums/sound/oth-chn.wav

OTHR China (continuous) is often disturbing 7 MHz – sonagram from Perseus here: disturbing 7080 – 7130 kHz with 43.5 sps – in Europe often audible during the Winter evenings – concerned is the 7 MHz-band in Region 3 and USA westcoast!



OTHR China with 43.5 sweeps/sec - 23 msec between the sweeps – calculation: 1000 msec : 23 msec = 43.5 sweeps/sec

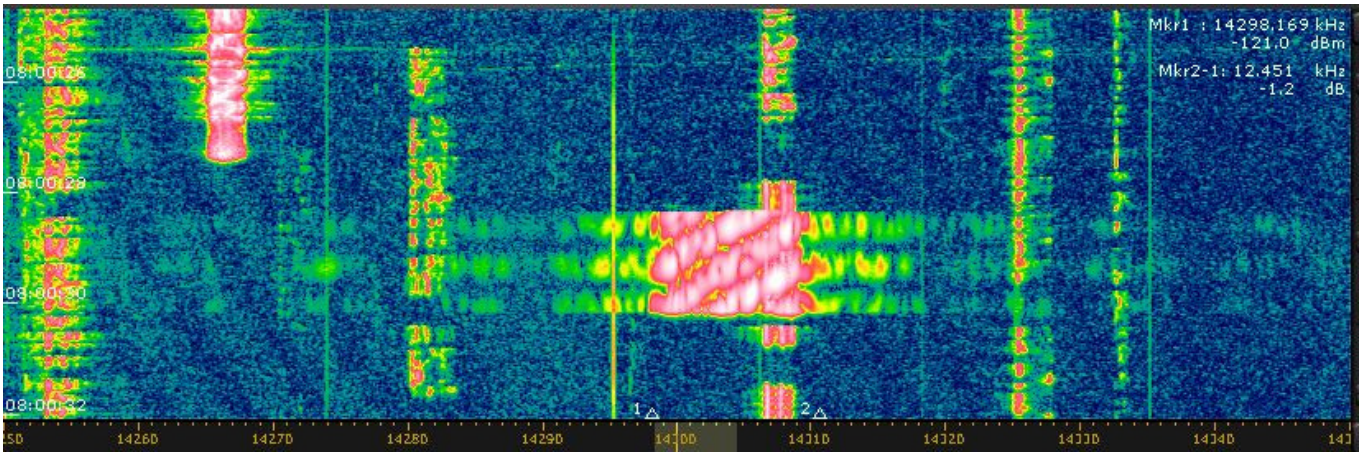


OTHR China – burst systems

soundfile: http://www.iarums-r1.org/iarums/sound/oth-chnb.wav

Chinese burst system on 14300 kHz (Perseus)

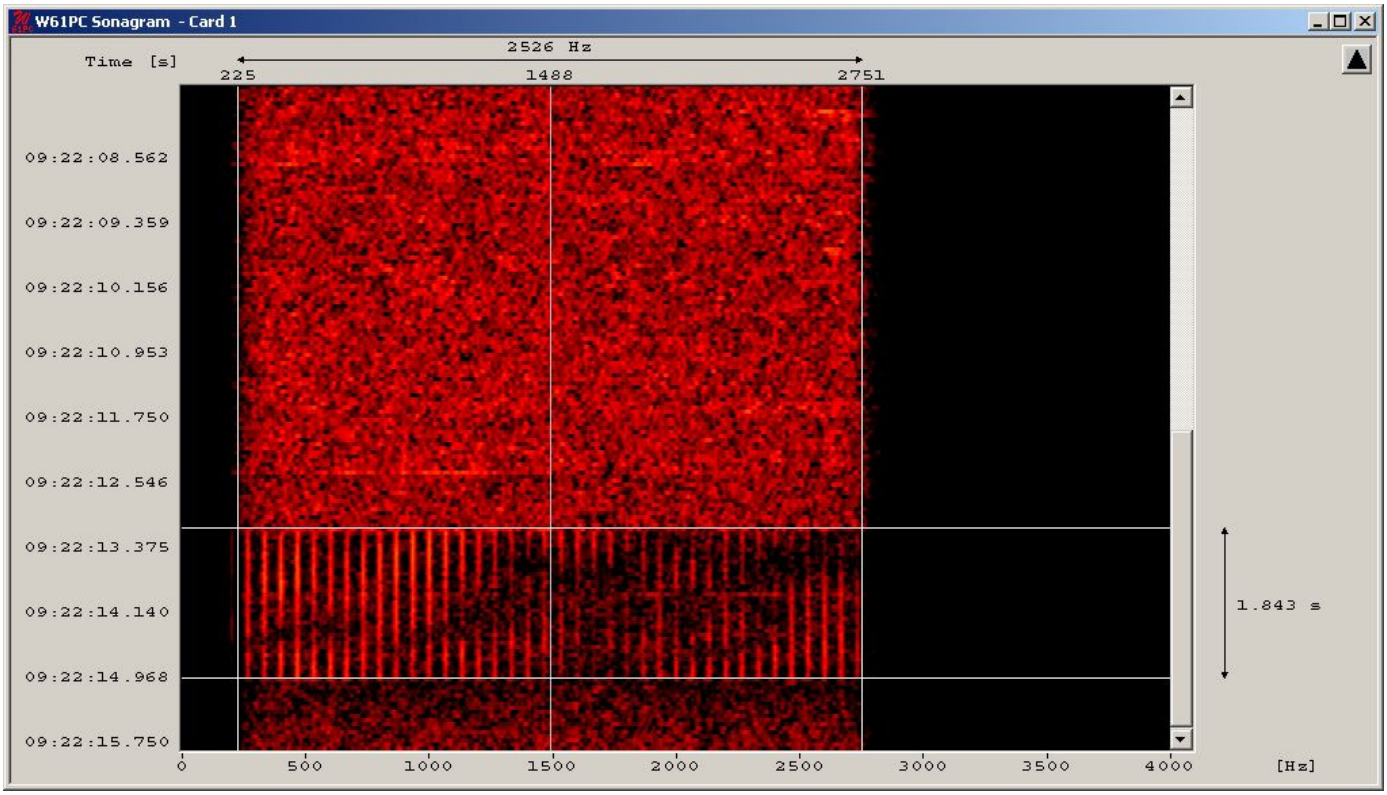
Observe the red marker below 14300 kHz!



^

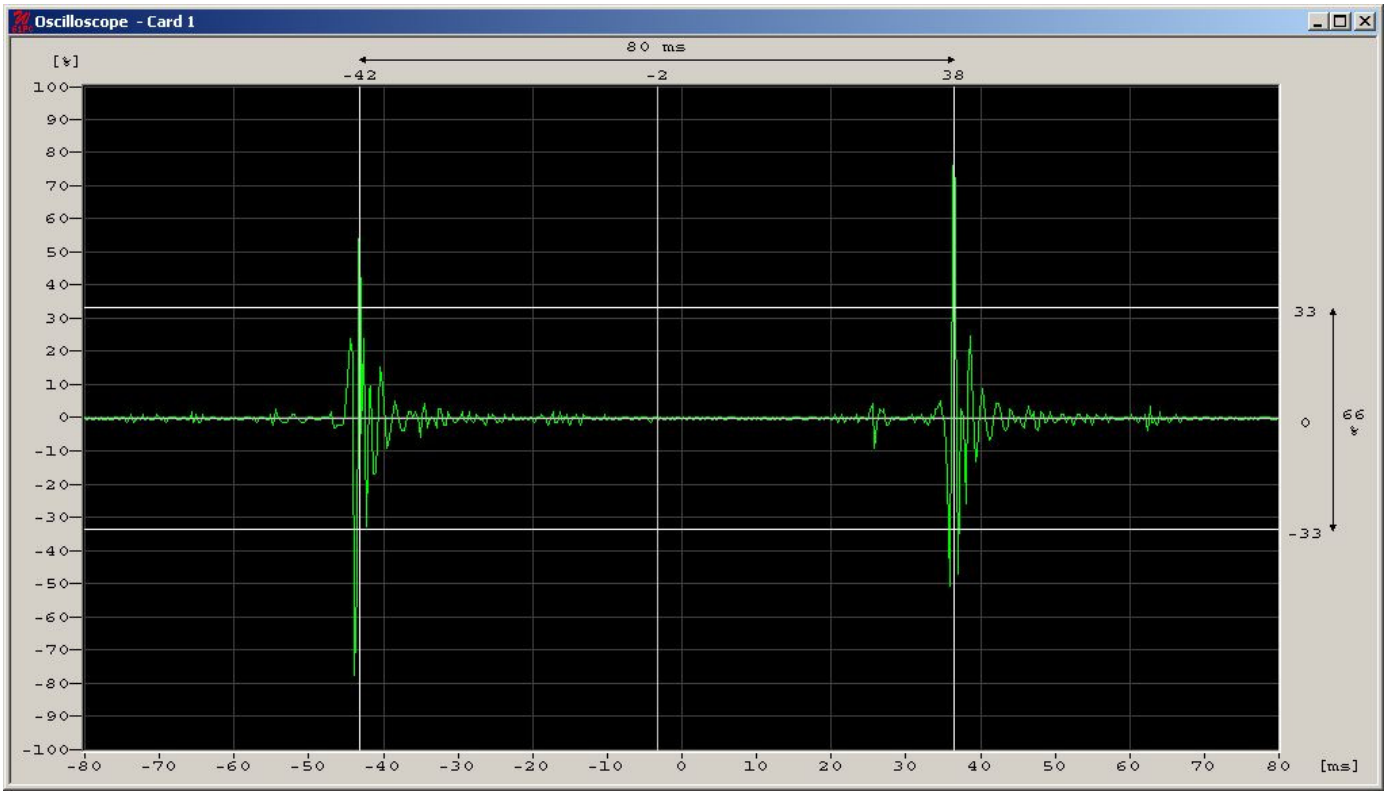
14300 kHz

Chinese OTHR with bursts of 1.843 sec duration and 66.66 sweeps/sec – each burst 10 kHz wide

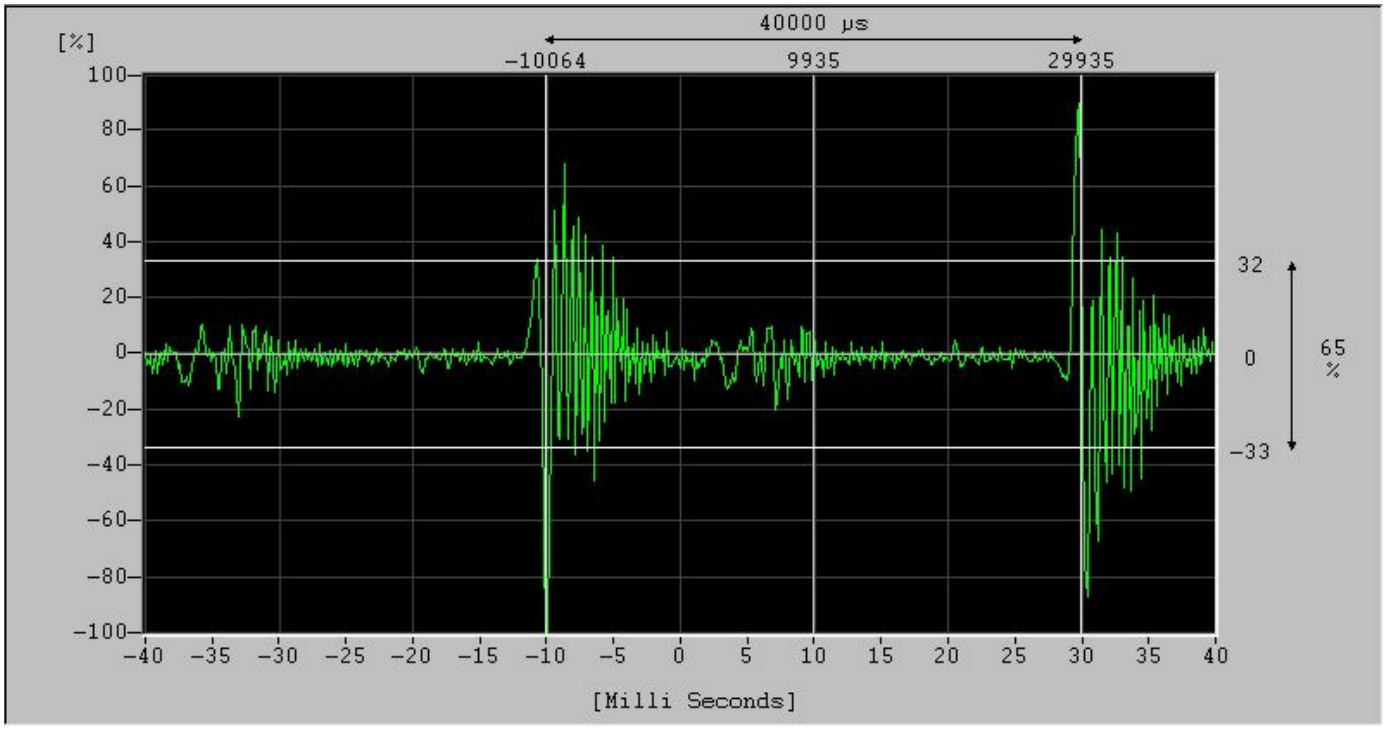


2.04 OTHR Cyprus

The British Royal Airforce is operating the OTH Radar Cyprus. It is often disturbing 10, 18, 21 and 28 MHz-Amateurbands with sweeprates of 25 and 50 sweeps/sec, sometimes 12.5 sweeps/sec. The signals are stretching over 20 kHz or more.

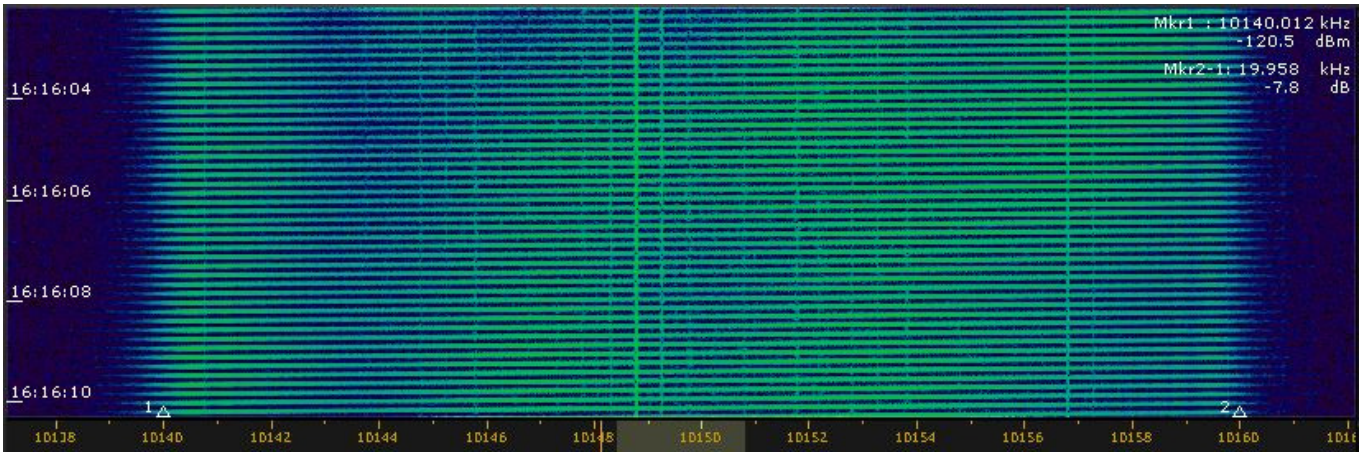


The version with 12.5 sweeps/sec.

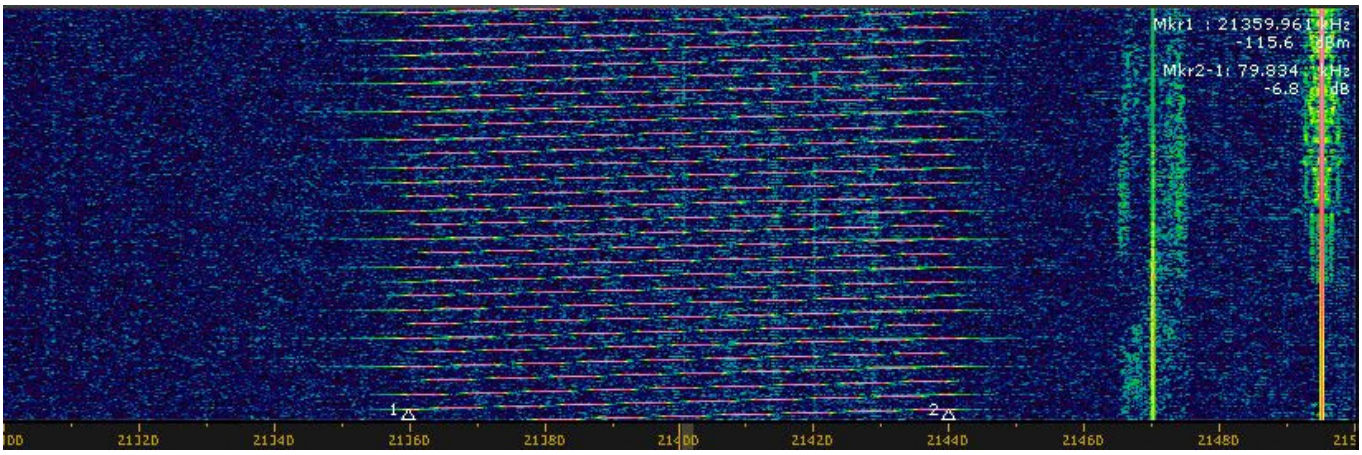


This version is operating with 25 sweeps/sec.

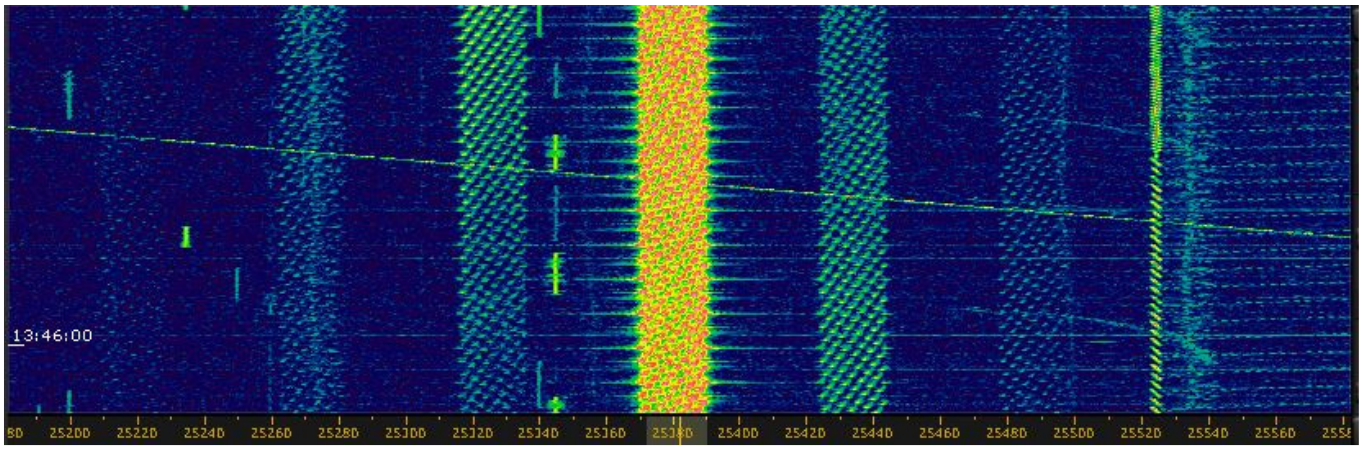
OTHR Cyprus on 10 MHz analyzed by Perseus (25 sweeps/sec):



The Perseus sonagram shows the bandwidth of 20 kHz.



This version is running with a bandwidth of 80 kHz (21360 – 21440 kHz).



OTHR Cyprus centered on 25380 kHz with spurious emissions.

2.05 OTHR France - Nostradamus

(area of Paris)

Antenna array:

source:

http://www.onera.fr/photos-en/instexp/nostradamus.php

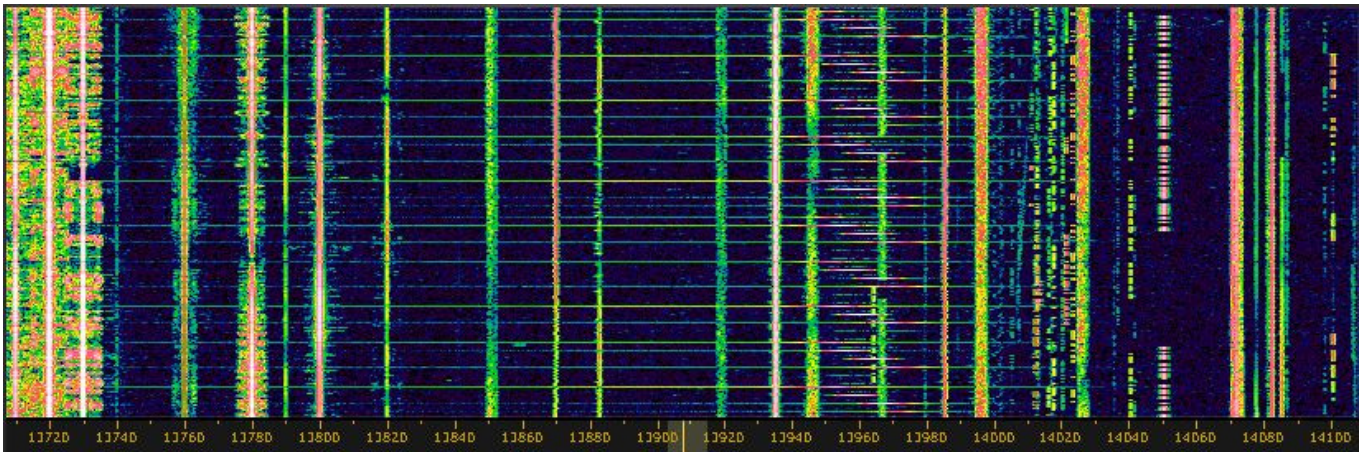
“The Nostradamus radar system is a set of 288 bi-cone antenna elements distributed over the arms of a three-branch star, with a buried infrastructure to shelter the transmission and reception electronics.

Nostradamus detects any aircraft flying 700 to 2000 kilometers away. Indeed, this new radar concept is based on very-low-frequency waves (6 to 30 MHz) that bounce off the ionosphere, which allows it to detect targets beyond the horizon.

Whereas transhorizon radars usely require huge linear antenna networks to beam the signals, the special surface distribution of Nostradamus makes it possible to control the electronic beams both in azimuth (360°) and elevation.”

source: http://www.onera.fr/photos-en/instexp/nostradamus.php

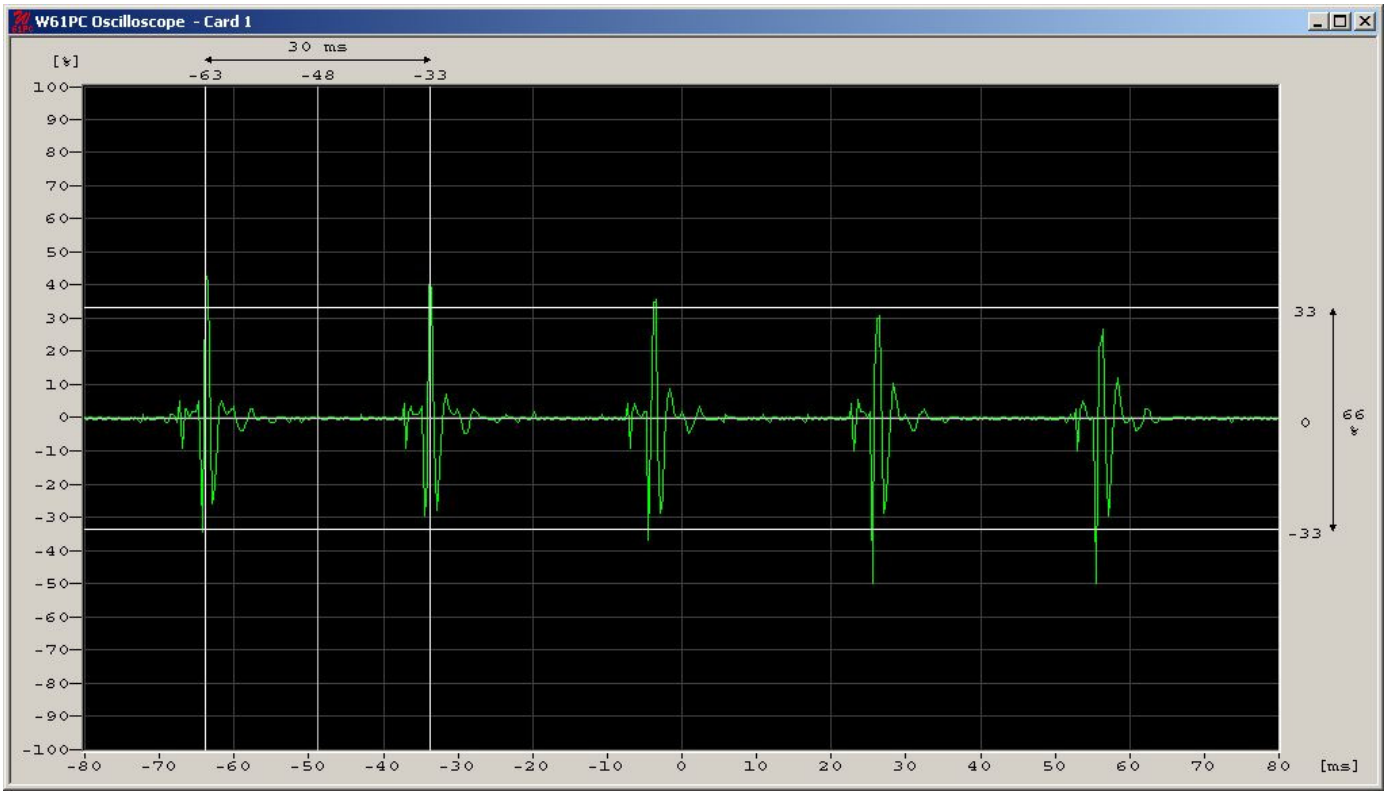
soundfile: http://www.iarums-r1.org/iarums/sound/french-oth.wav



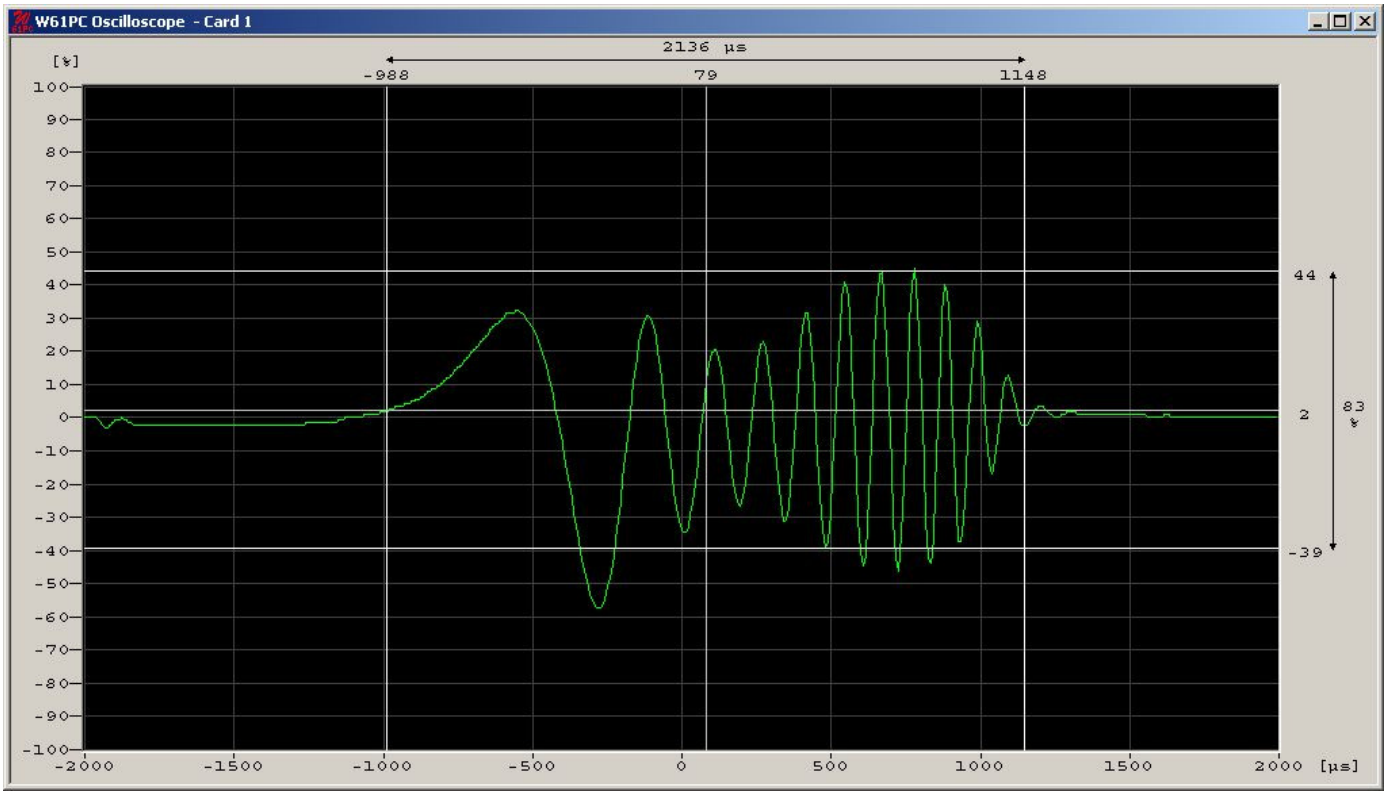
Nostradamus disturbing 14 MHz-amateurband – caused by technical problems. (Only few days …)

Nostradamus is often operating below 14000 kHz.

Nostradamus sweeprate measurement:



The oscillogram shows 30 ms gaps between the sweeps, which means 33.33 sweeps/sec.



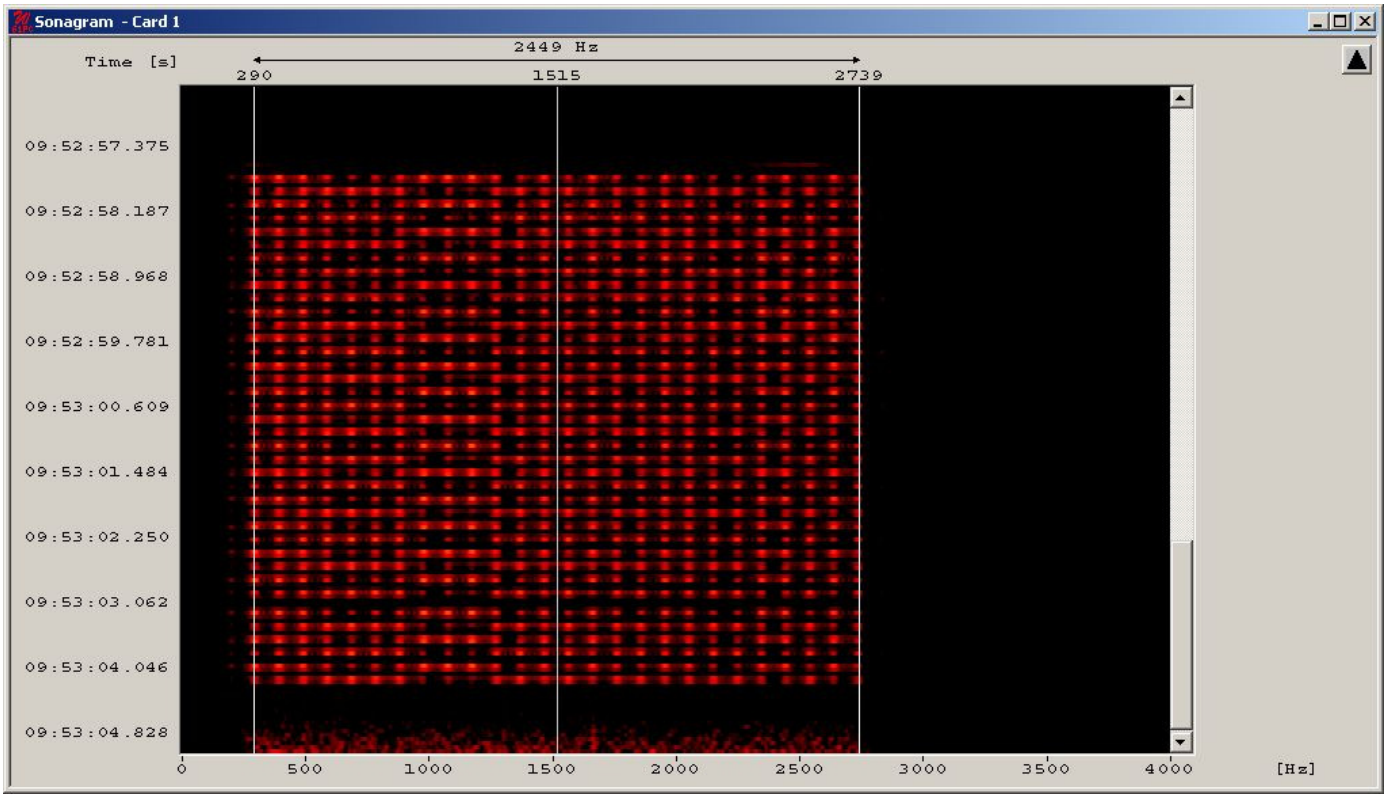
The length of 1 sweep is about 2 msec.

2.06 OTH Radar France – burst system

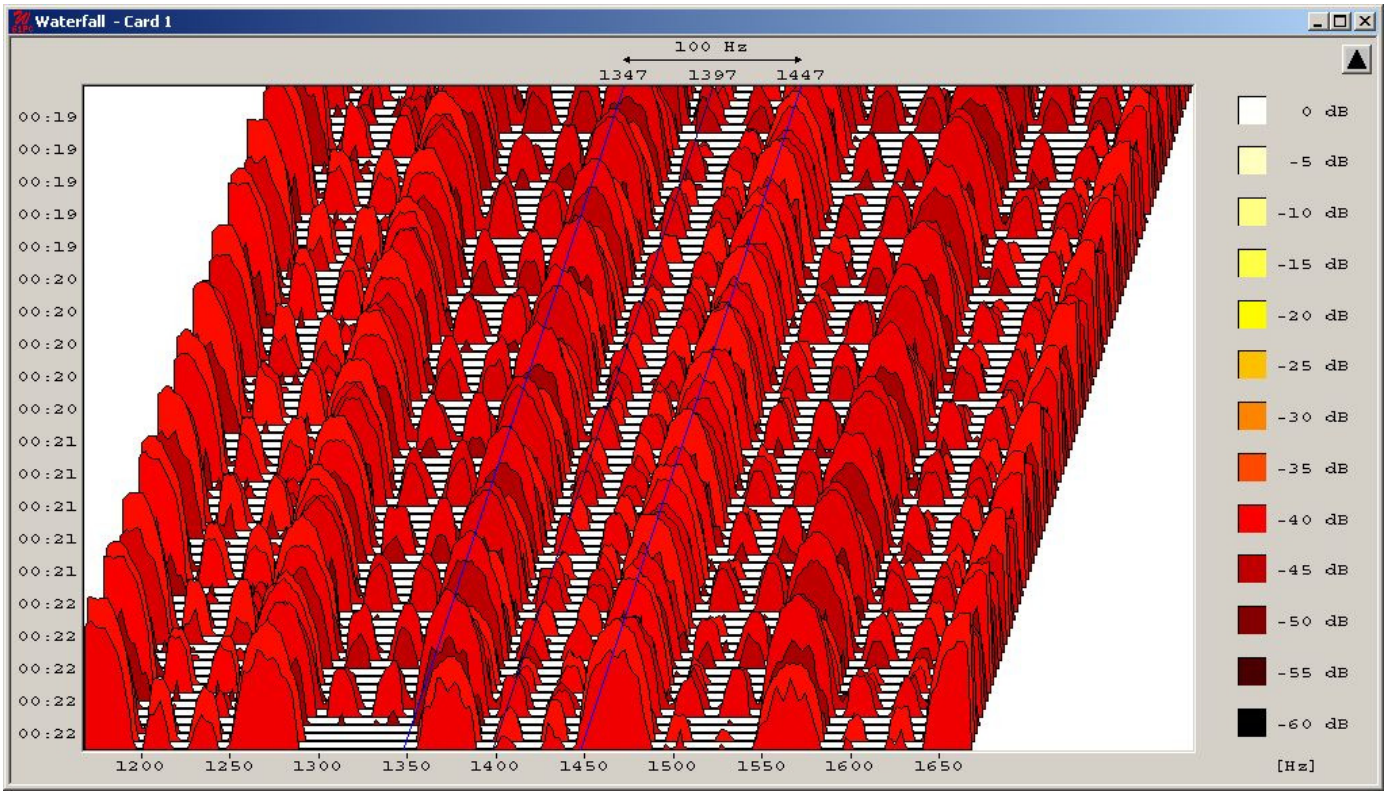
This kind of Radar was often observed on 7000, 14000 and 21000 kHz in 2012. Location: South-France. The bursts contained 6 sweeps/sec, bandwidth 20 kHz.

soundfile: http://www.iarums-r1.org/iarums/sound/14000-r.wav

The French burst system analyzed by W61PC. Each sweep is divided in blocks similar to CODAR.



The same system shown by the Wavecom "Waterfall".

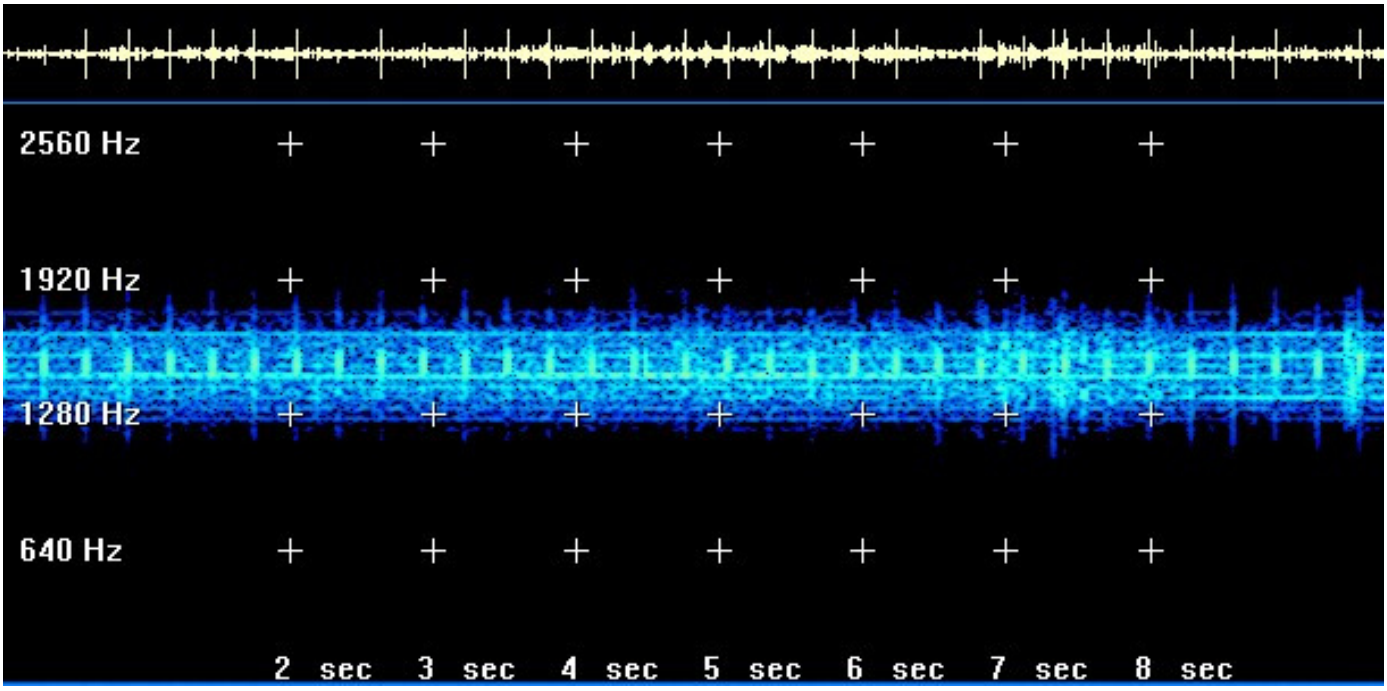


2.07 OTHR Iran (old and new)

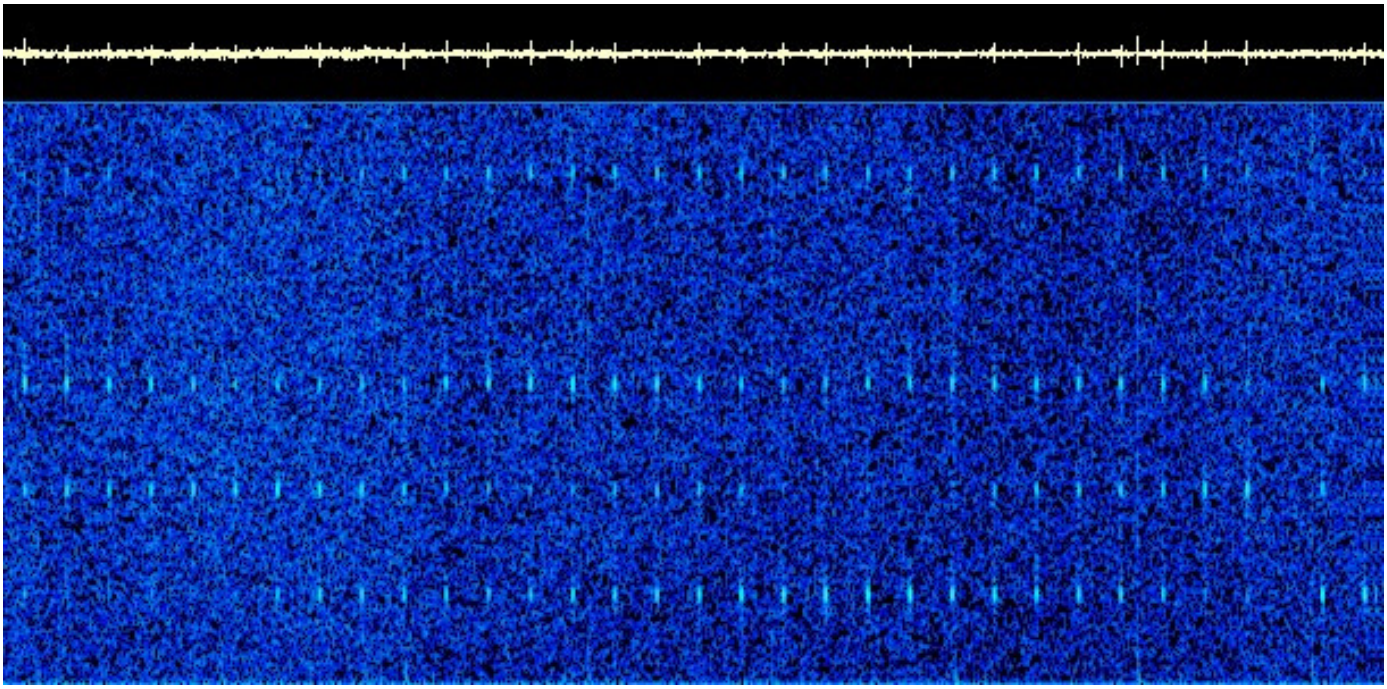
Ticking pulses (like an old tin clock) on 14000 and 21000 kHz (synchronous) in 2004. Perhaps the Iranian military took its first steps to create an own OTHR.

soundfile: http://www.iarums-r1.org/iarums/sound/Iran-Radar.wav

Sonagram by Gram50

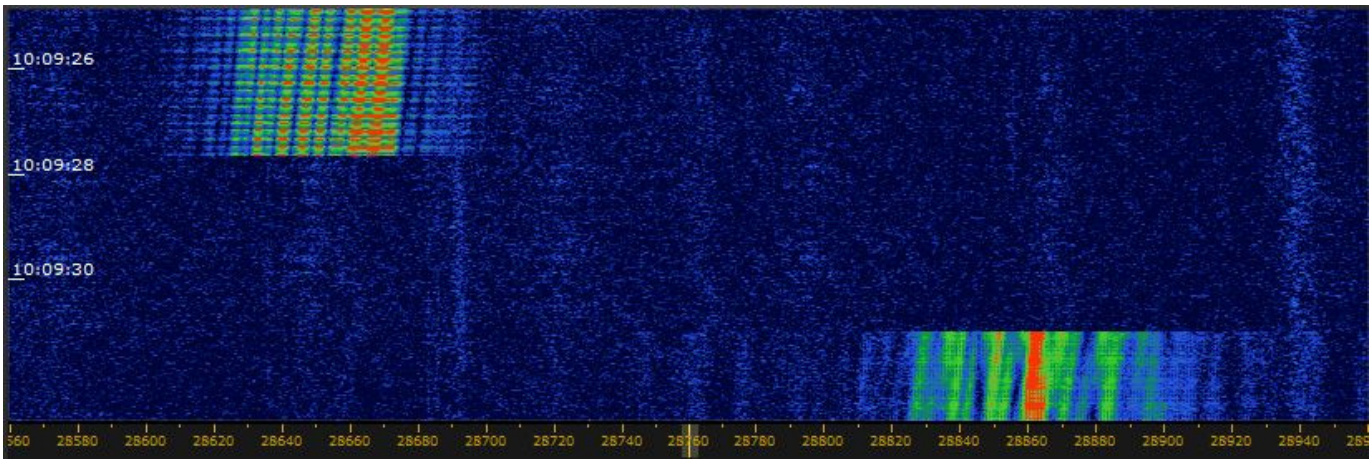


Another version from 2005. Sonagram by Gram50.

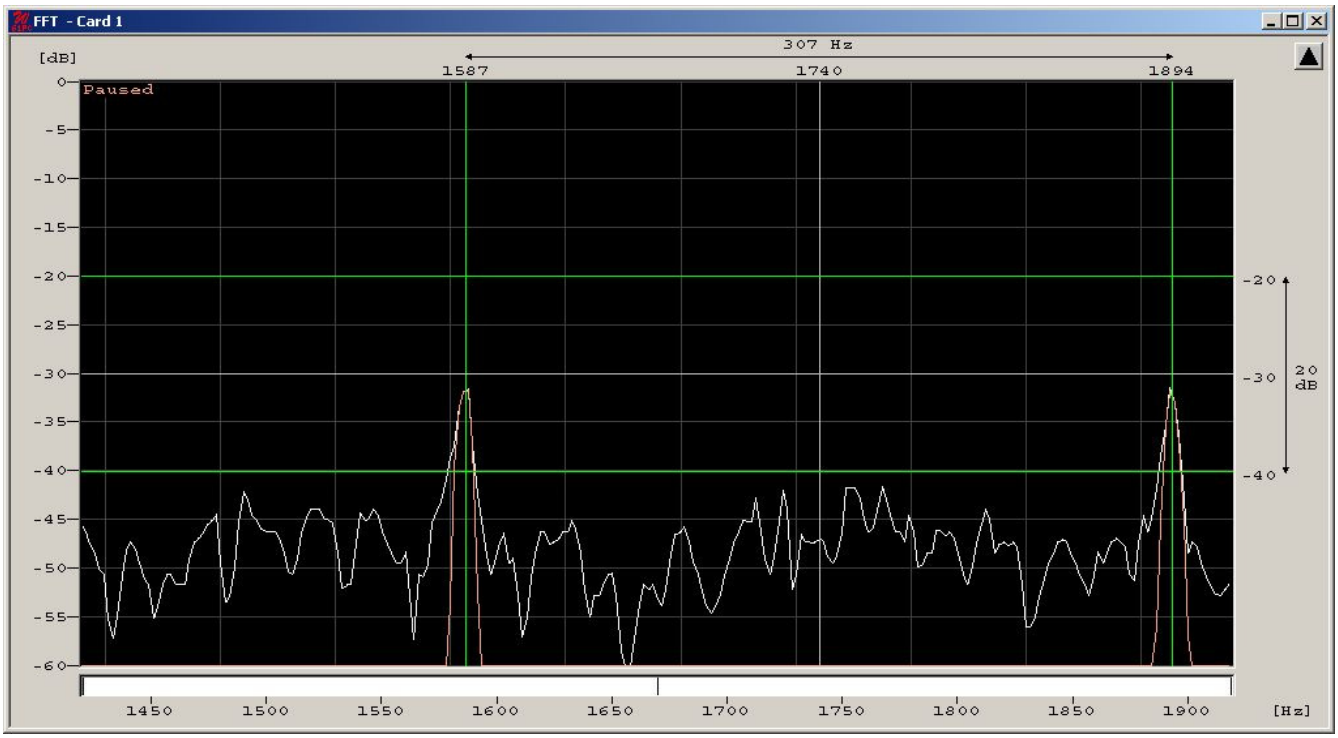


Burst OTH Radar from Iran observed on 28650 kHz in December 2012 – jumping mode - covering about 60 kHz – often splattering +/- 300 kHz

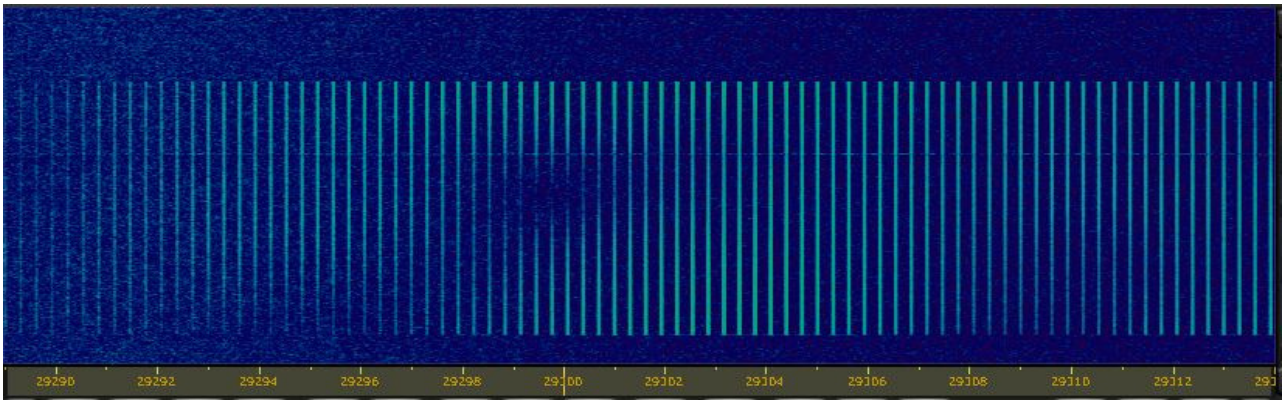
soundfile: http://www.iarums-r1.org/iarums/sound/29000-iran.wav



The FFT display shows 307 sweeps/sec.

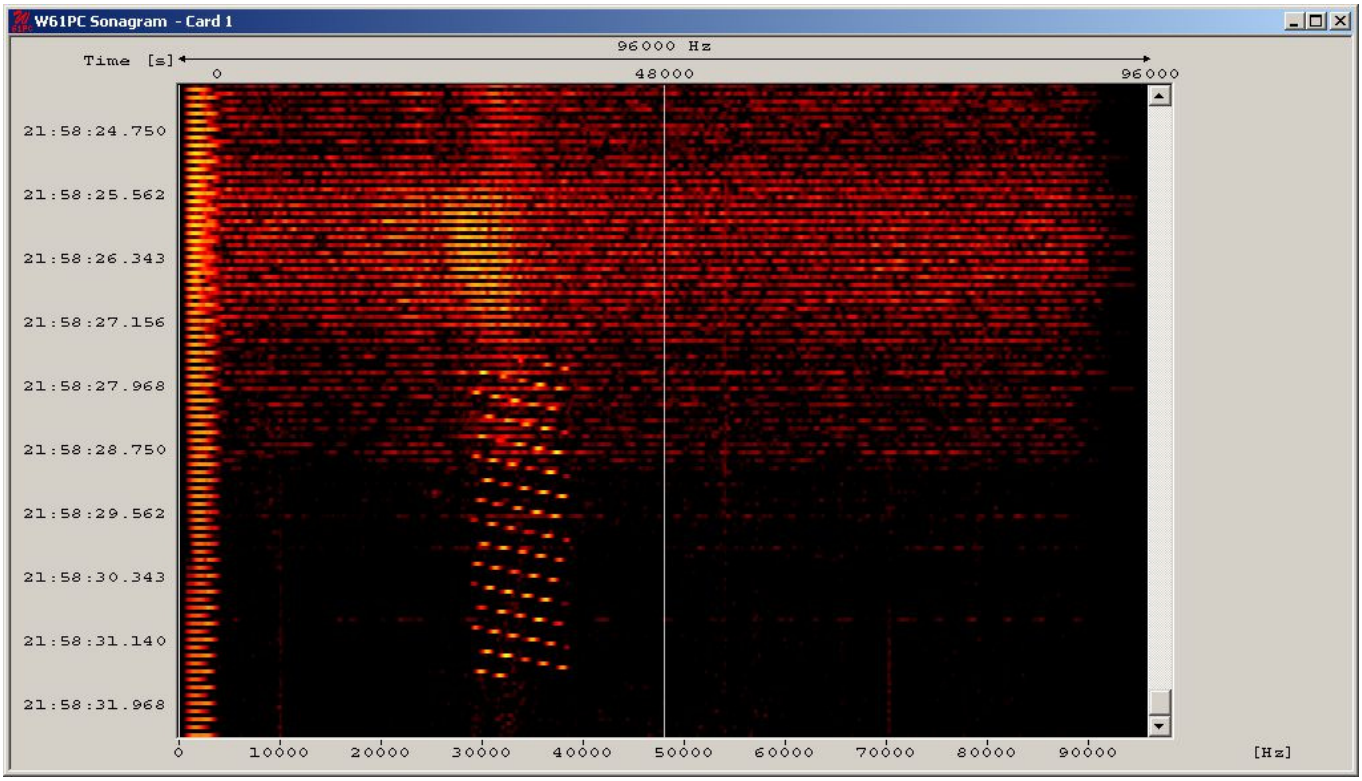


The AF analysis only shows spectral lines. The difference between 2 neighboured spectral lines will give you the sweeprate.

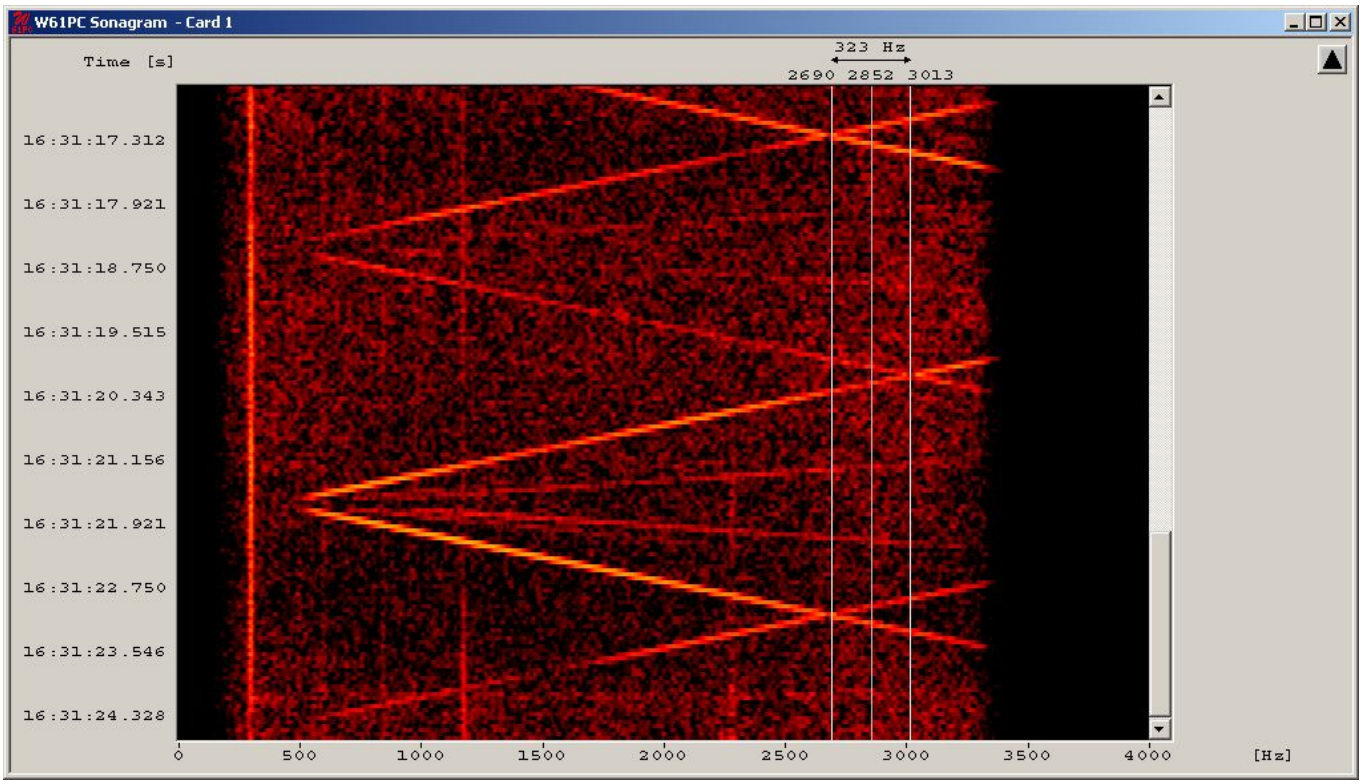


2.08 OTHR Israel

Long lasting carriers were often observed around 14000 kHz. The Israeli Navy seemed to test special reflections from carriers – phase diagnostics??? (unconfirmed!)



Israeli OTHR with 50 sweeps/sec – about 10 kHz spread.

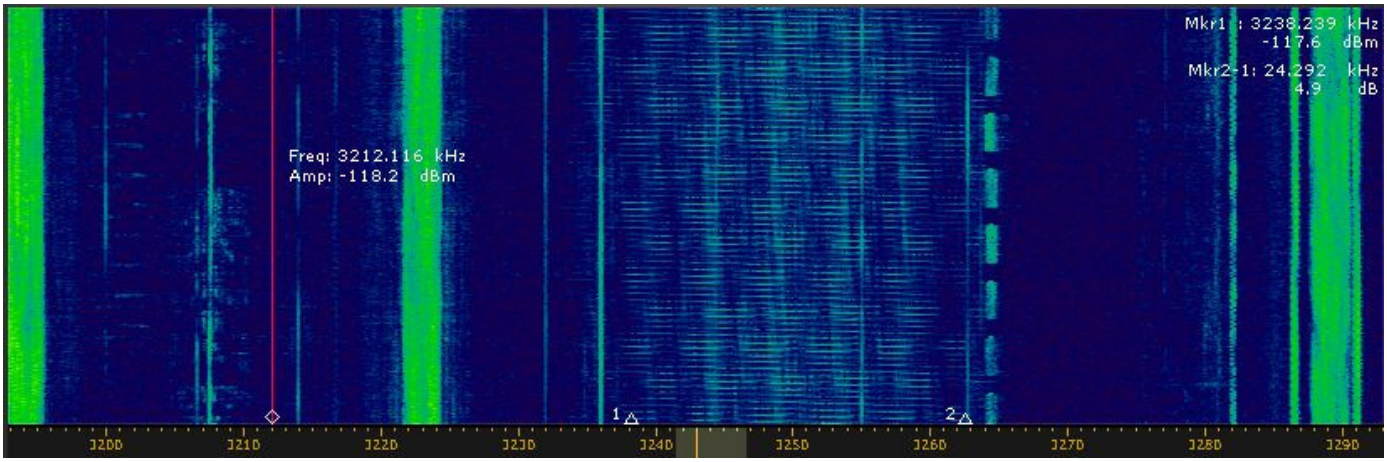


Mysterious sawtooth generator on 7001.5 kHz – long lasting signals transmitted from Israel. A new kind of OTHR???

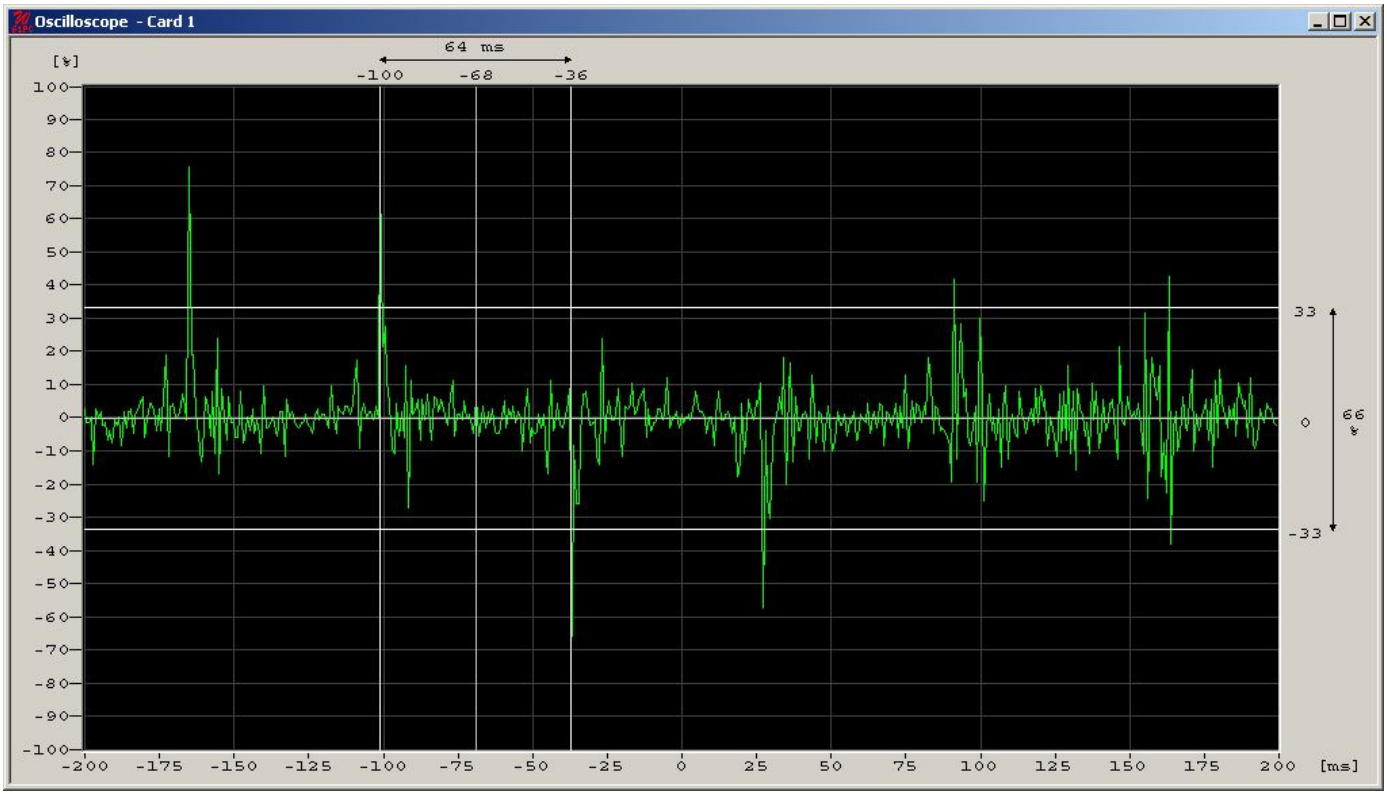
2.09 OTHR Romania on 3250 kHz

Coastal region of Romania (also active: Greek coastal region)

Covering about 25 kHz – permanent active.

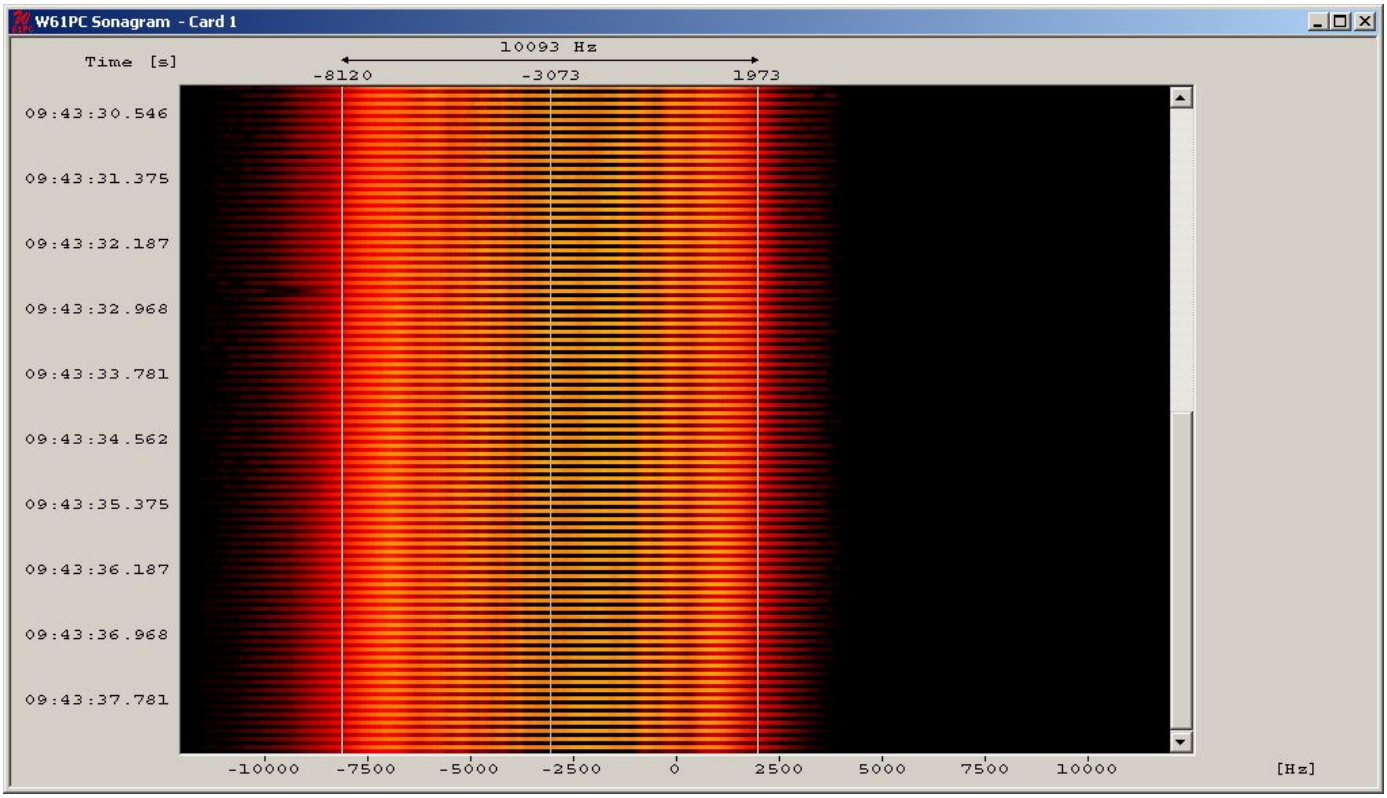


Sweeprate measurement by Wavecom oscillogram: 1000 : 64 = 15.625 sweeps/sec

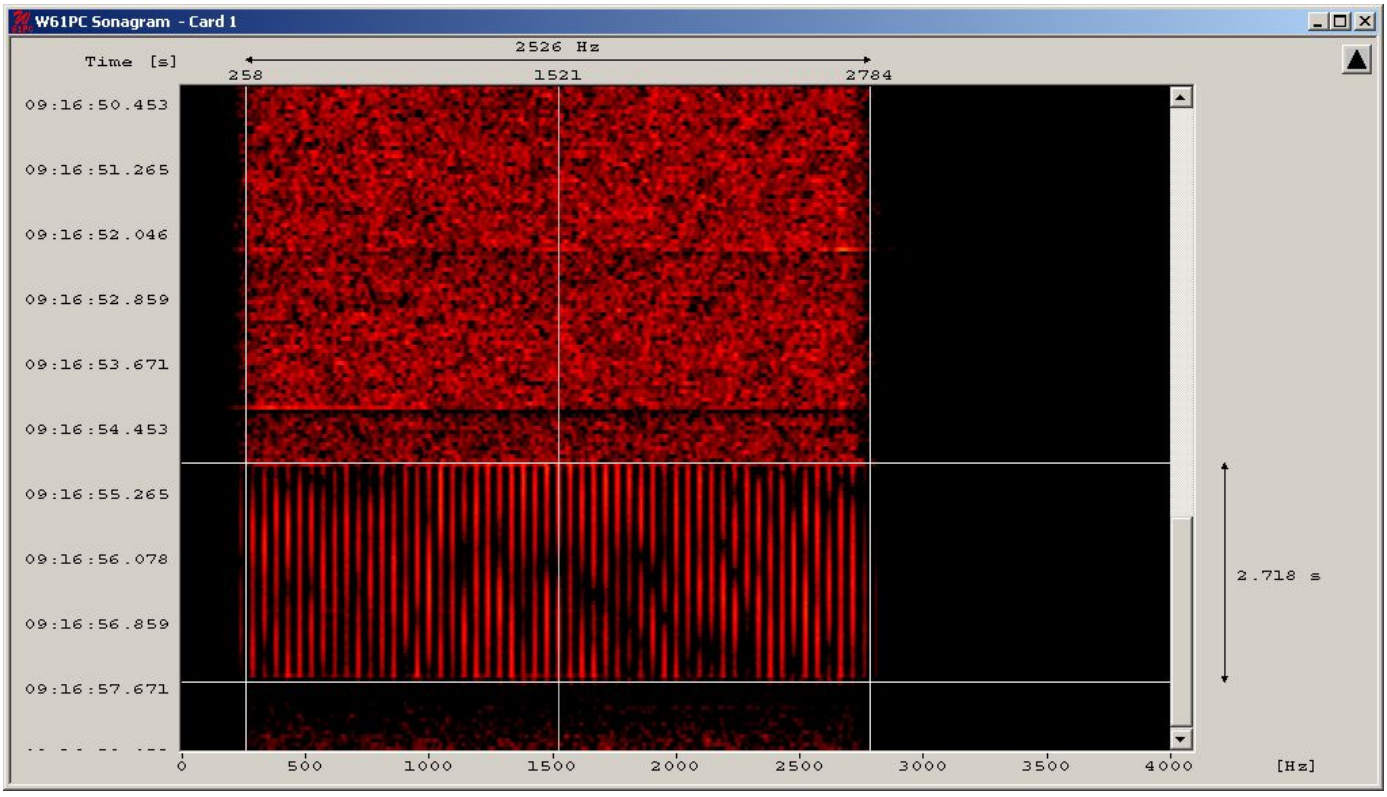


2.10 OTHR Russia

“ABM2-Radar” (Steelyard) on 14 MHz, 10 kHz wide, operated with 10, 50 and 100 sweeps/sec. Continuous transmission! Very common in earlier years.



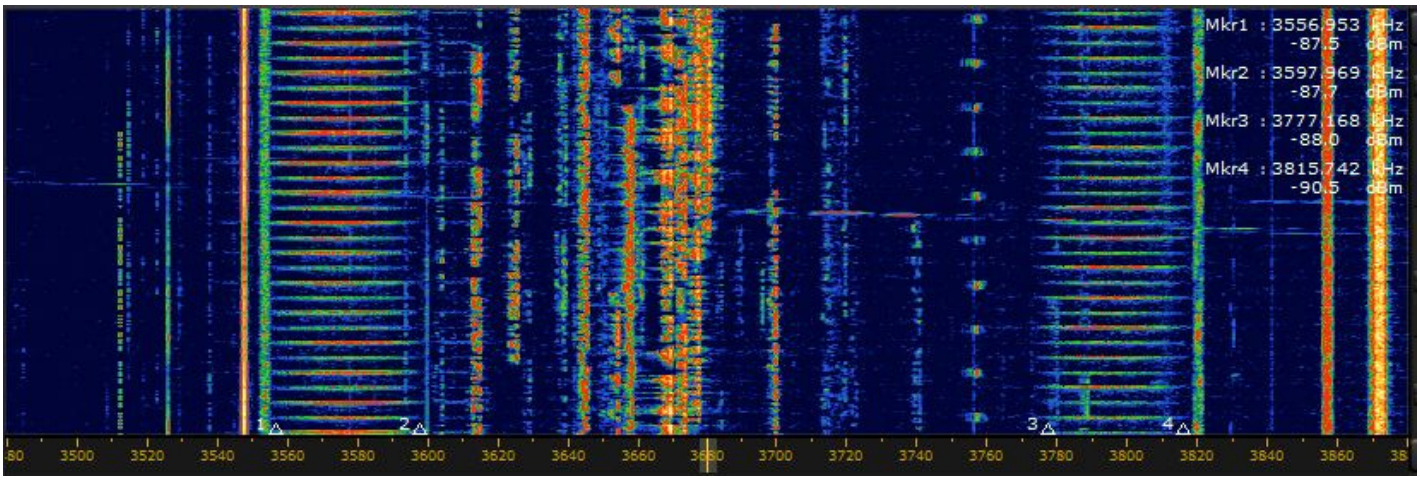
Later burst version operating with 50 sweeps/sec, 10 kHz wide in January 2011. Often on the 14 MHz Amateur band.



Russian continuous Radar on 3500 – 3800 kHz – 43.5 or 87 sps with 40 – 50 kHz bandwidth in 2013 – location: Makhachkala, Caspian Sea – audible every evening

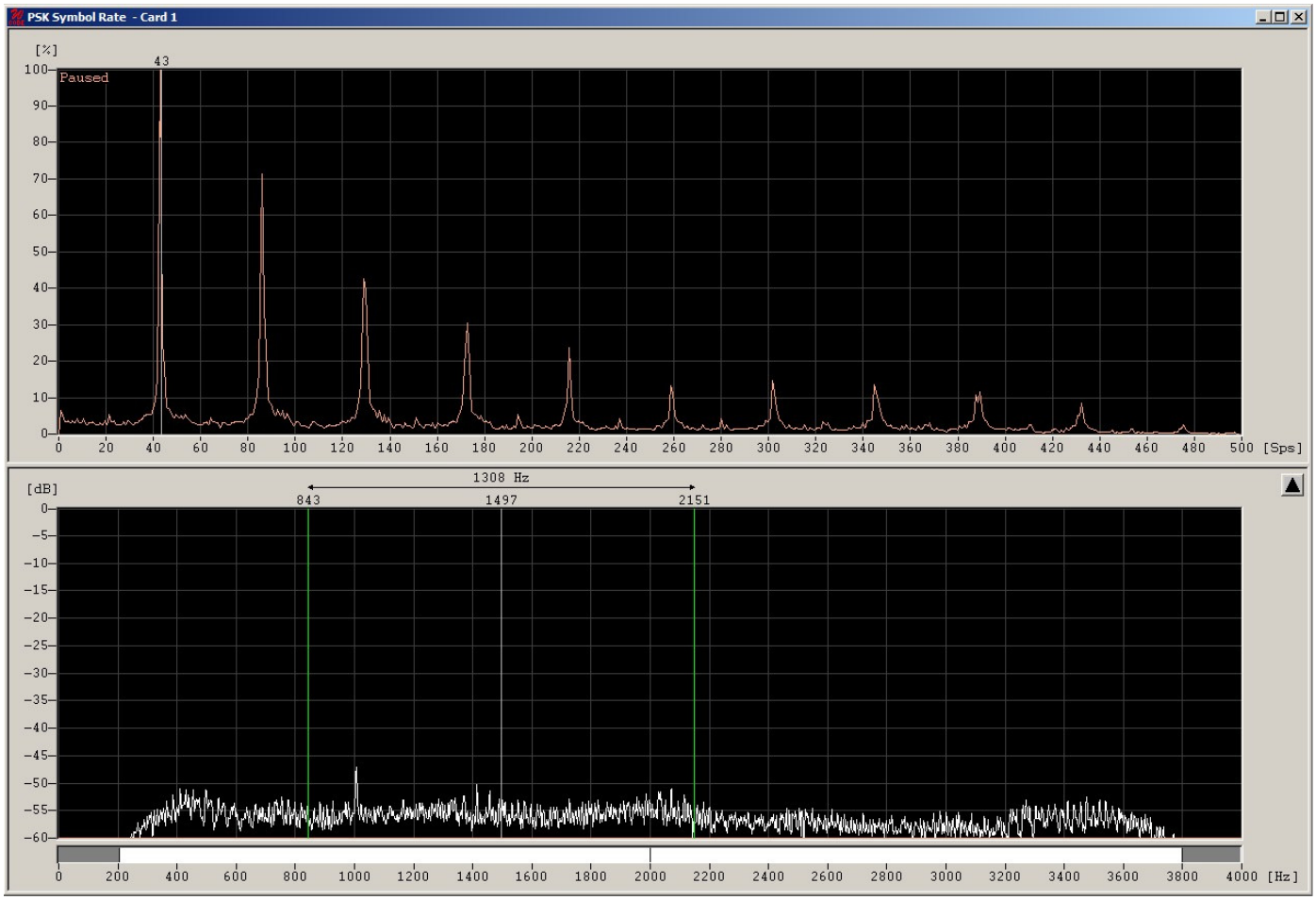
soundfile: http://www.iarums-r1.org/iarums/sound/3570-rus-othr.wav

Screenshot: March 2013 – 2 synchronous systems visible



kHz 3550 3600 3780 3820

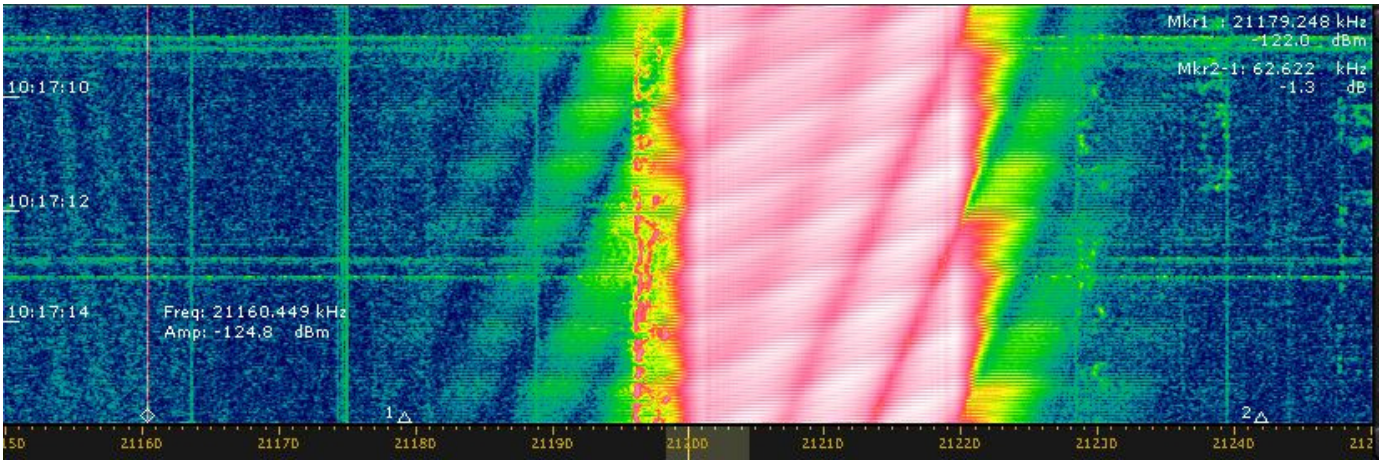
The symbolrate is showing 43 symbols (sweeps/sec).



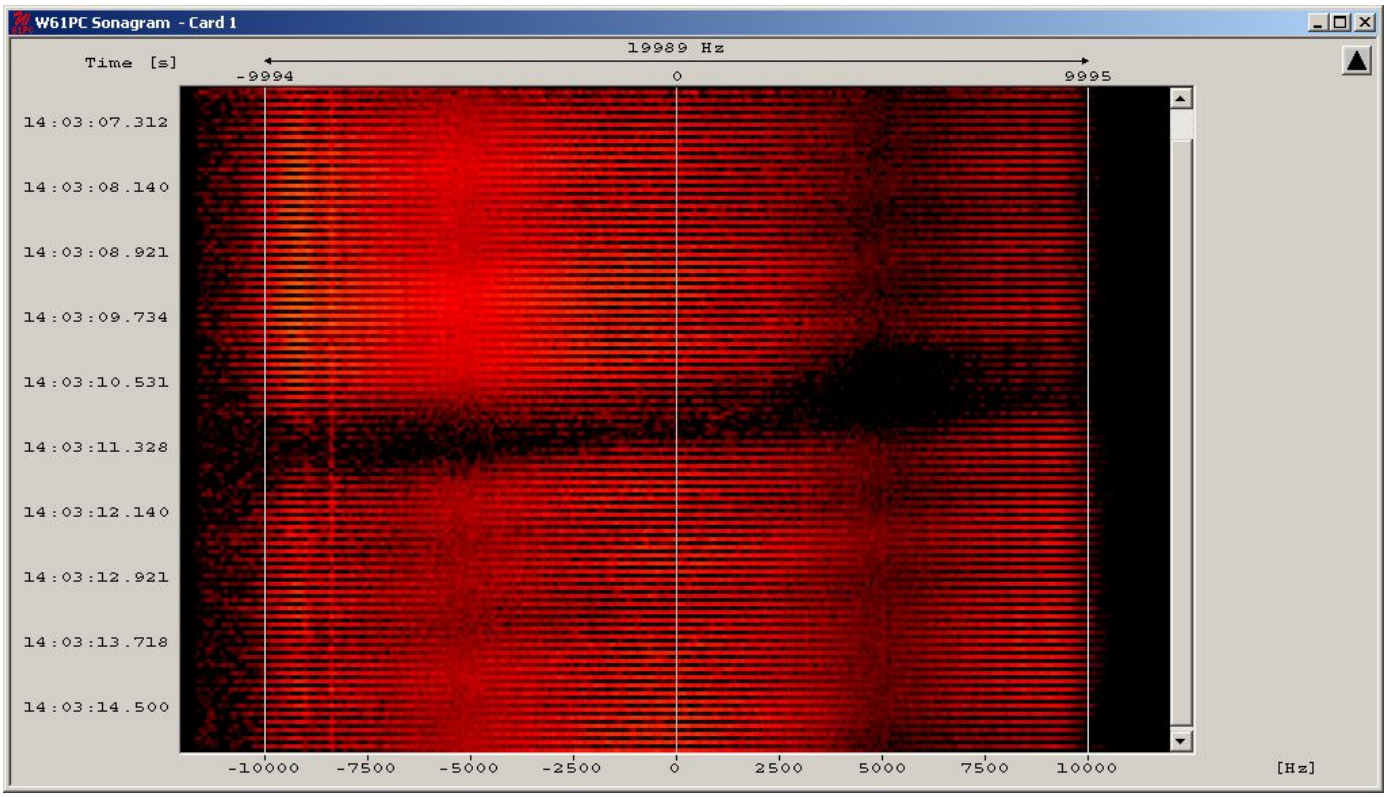
2.11 OTHR Turkey

The Turkish OTH Radars are using the same parameters as the Cyprus Radar, 50 and 25 sweeps/sec and 20 kHz spread. Their locations are Ankara and South-East and West-Turkey. The systems are often disturbing the 18, 21 and 28 MHz-bands.

soundfile: http://www.iarums-r1.org/iarums/sound/oth-tur.wav



Turkish OTH-Radar on 21210 kHz with 50 sweeps/sec and 20 kHz spread.

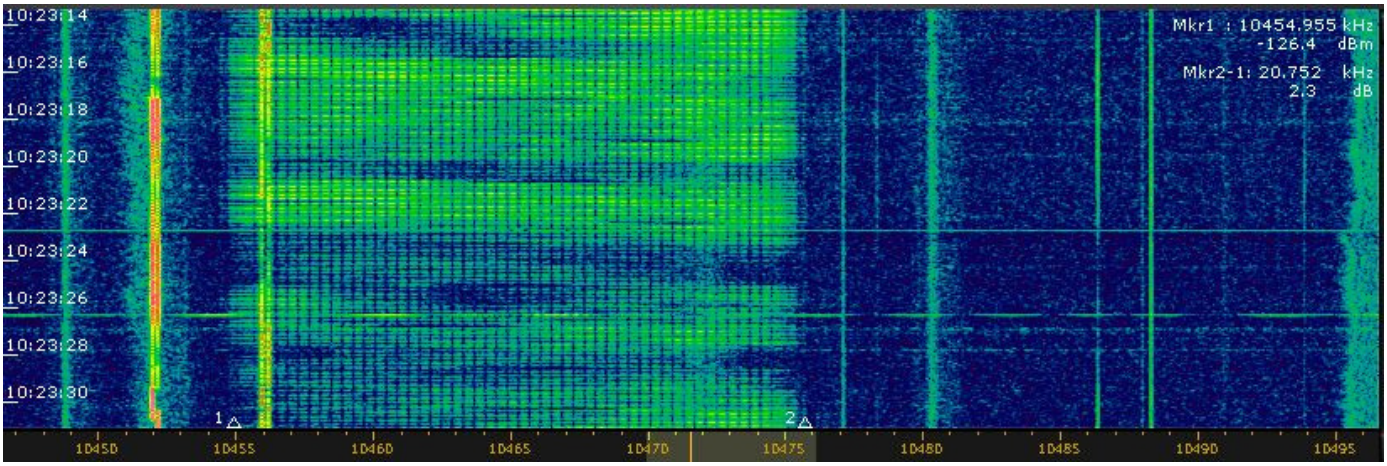


Turkish OTH Radar with 50 sweeps/sec, 20 kHz spread on 21 MHz.
Fading is visible as dark layers.

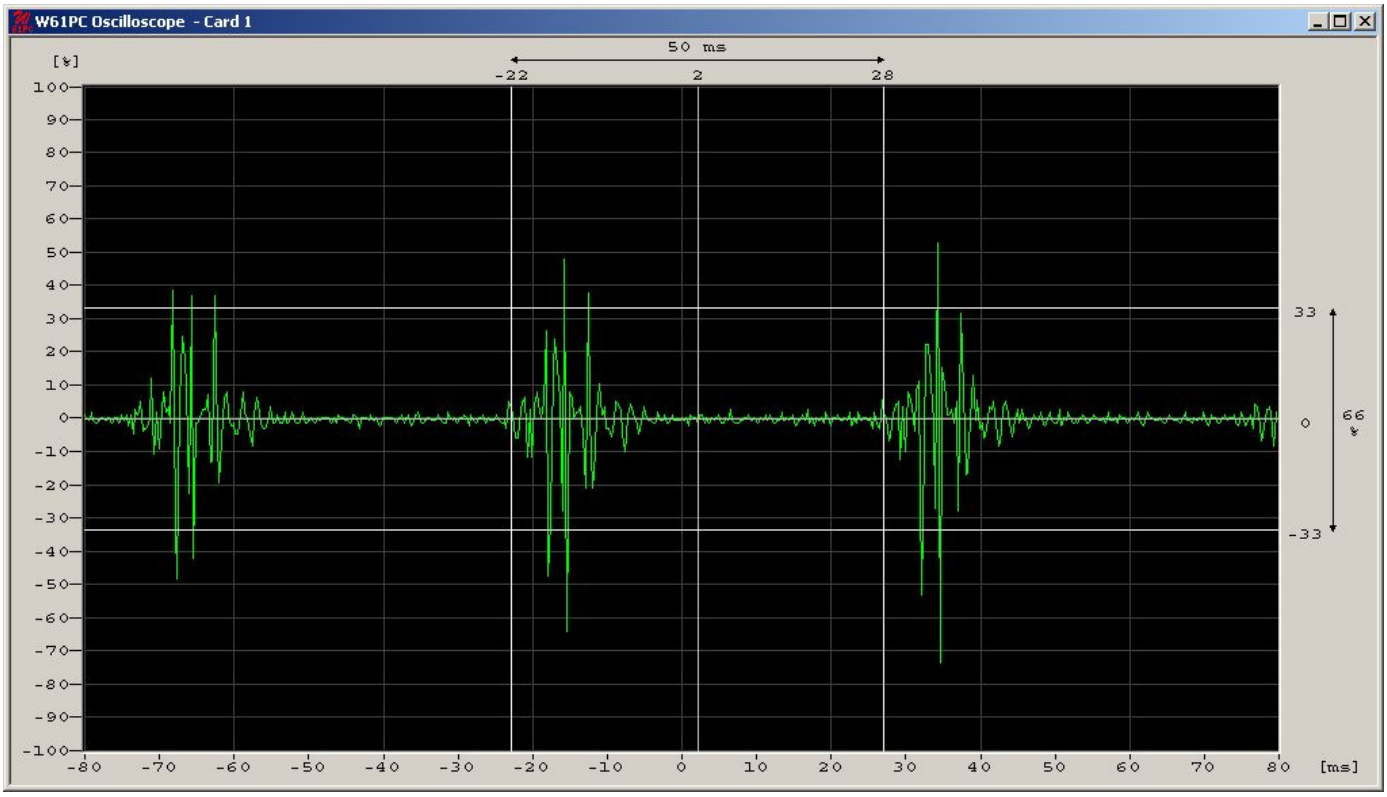
2.12 OTHR Great Britain

Rather new on shortwave, the British OTH Radar from the eastcoast of Britain.

British OTH Radar on 10445 kHz operating with 20 sweeps/sec, 20 kHz spread.

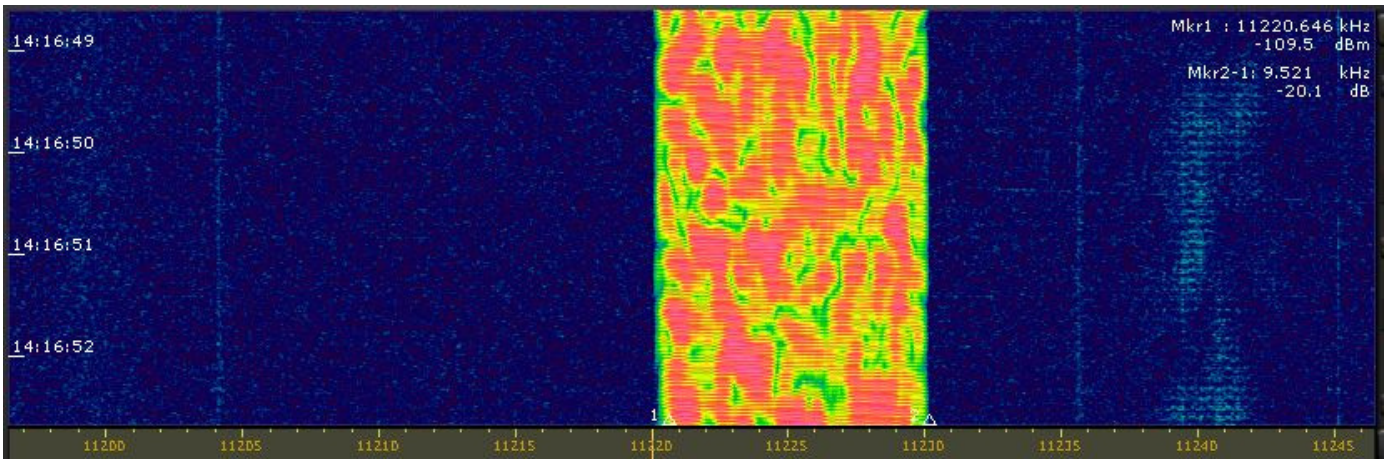


British OTH Radar with 20 sweeps/sec, 20 kHz wide.

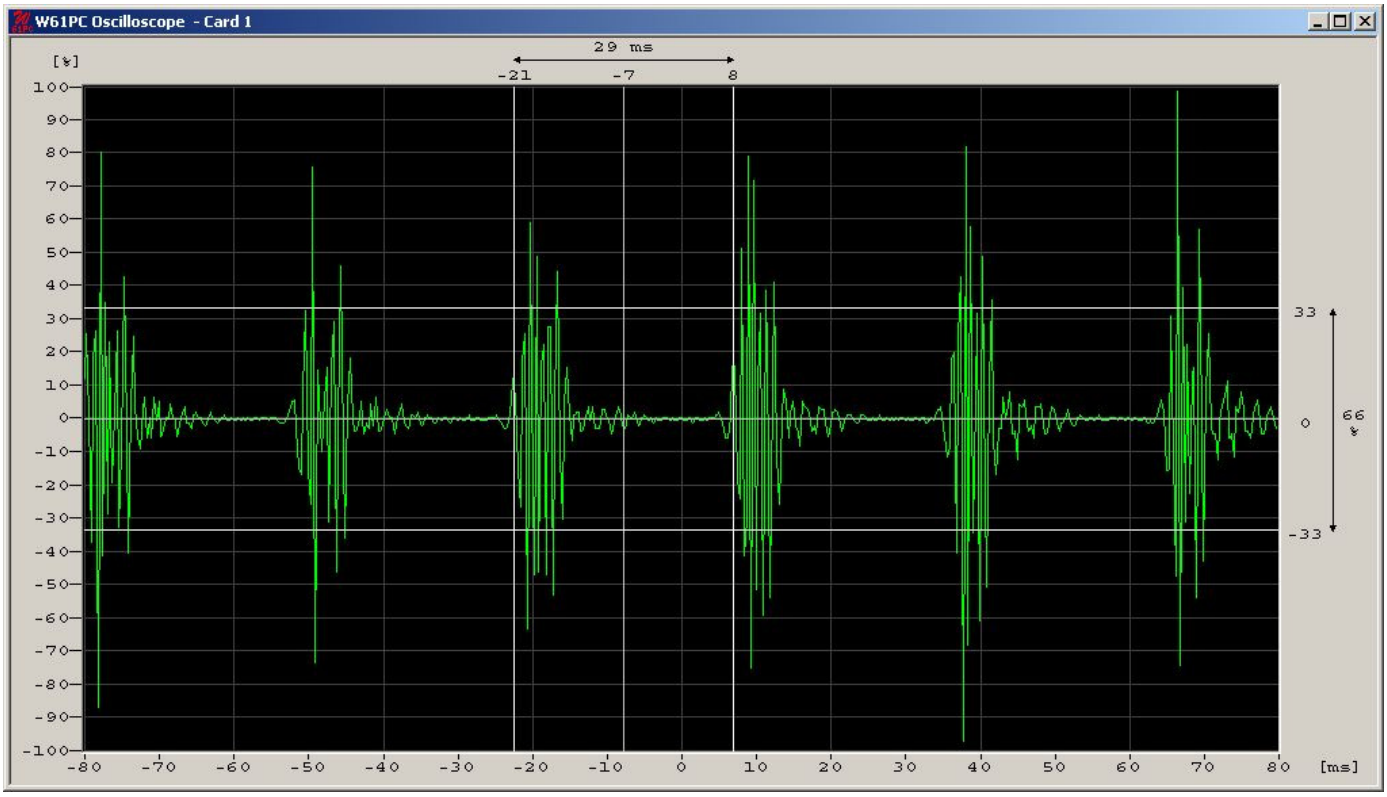


2.13 OTHR Ukraine

The OTH Radar from Ukraine has been found per accident in January 2011.



OTH Radar Ukraine on 11225 kHz with 34.5 sweeps/sec and 10 kHz spread.

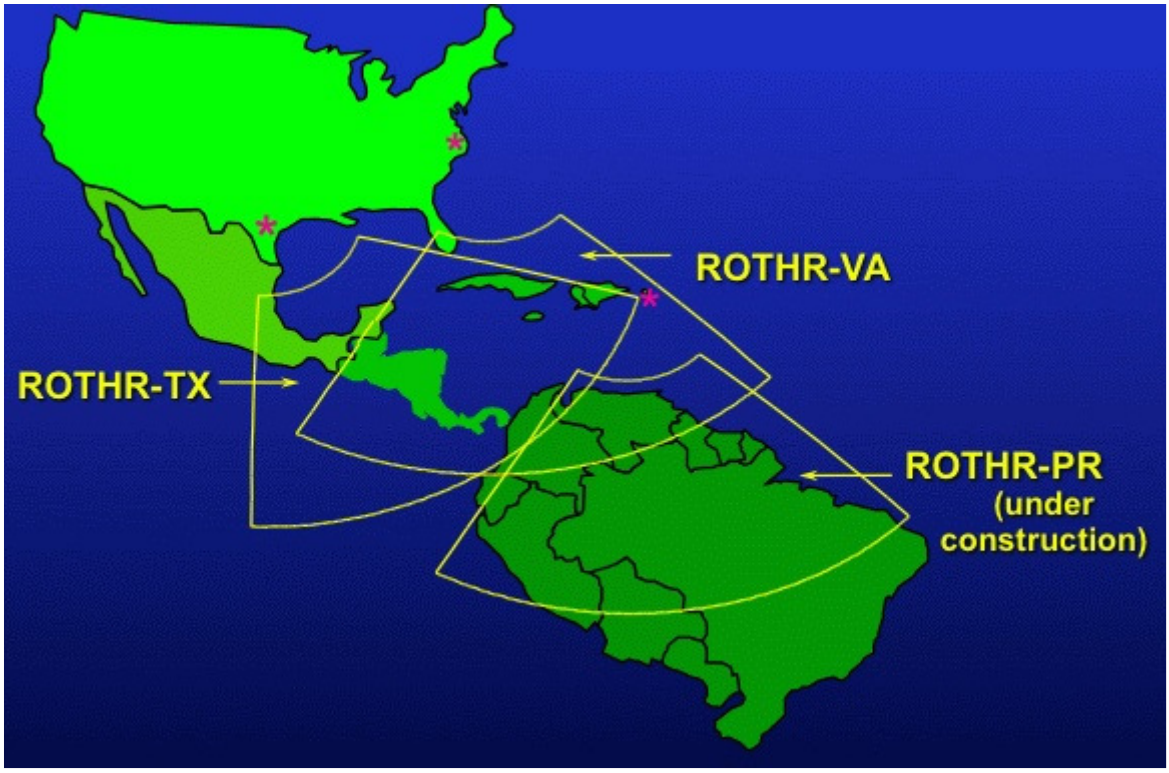


OTH Radar Ukraine on 11225 kHz with 34.5 sweeps/sec and 10 kHz spread.

2.14 OTHR USA

US Navy OTH Radar - source: http://en.wikipedia.org/wiki/Over-the-horizon_radar

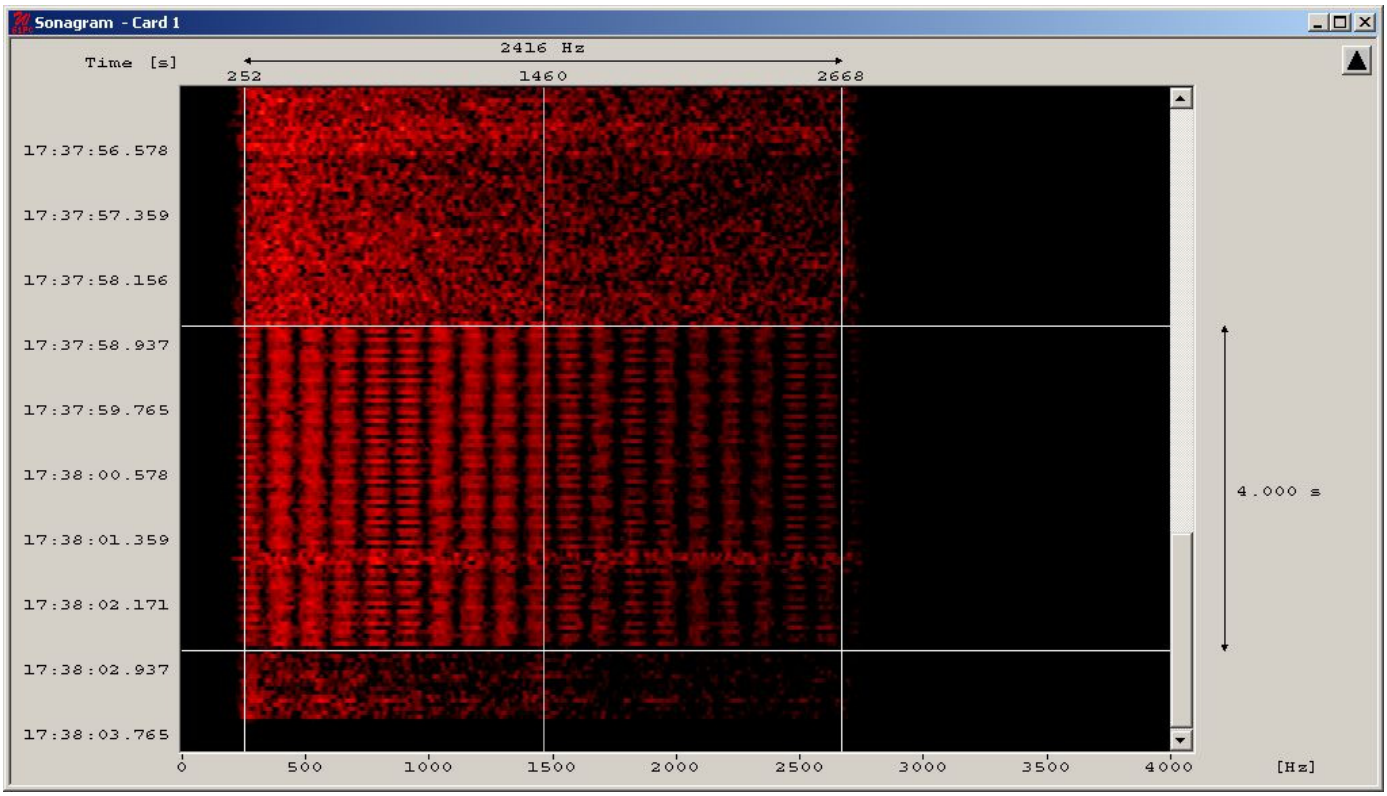
"**Over-the-horizon radar**, or **OTH** (sometimes also *beyond the horizon*, or **BTH**), is a design concept for radar systems to allow them to detect targets at very long ranges, typically up to thousands of kilometers. Several OTH radar systems were deployed starting in the 1950s and 60s as part of early warning radar systems, but these have generally been replaced by airborne early warning systems instead. OTH radars have recently been making something of a comeback, as the need for accurate long-range tracking becomes less important with the ending of the Cold War, and less-expensive ground based radars are once again being looked at for roles such as maritime reconnaissance and drug enforcement."



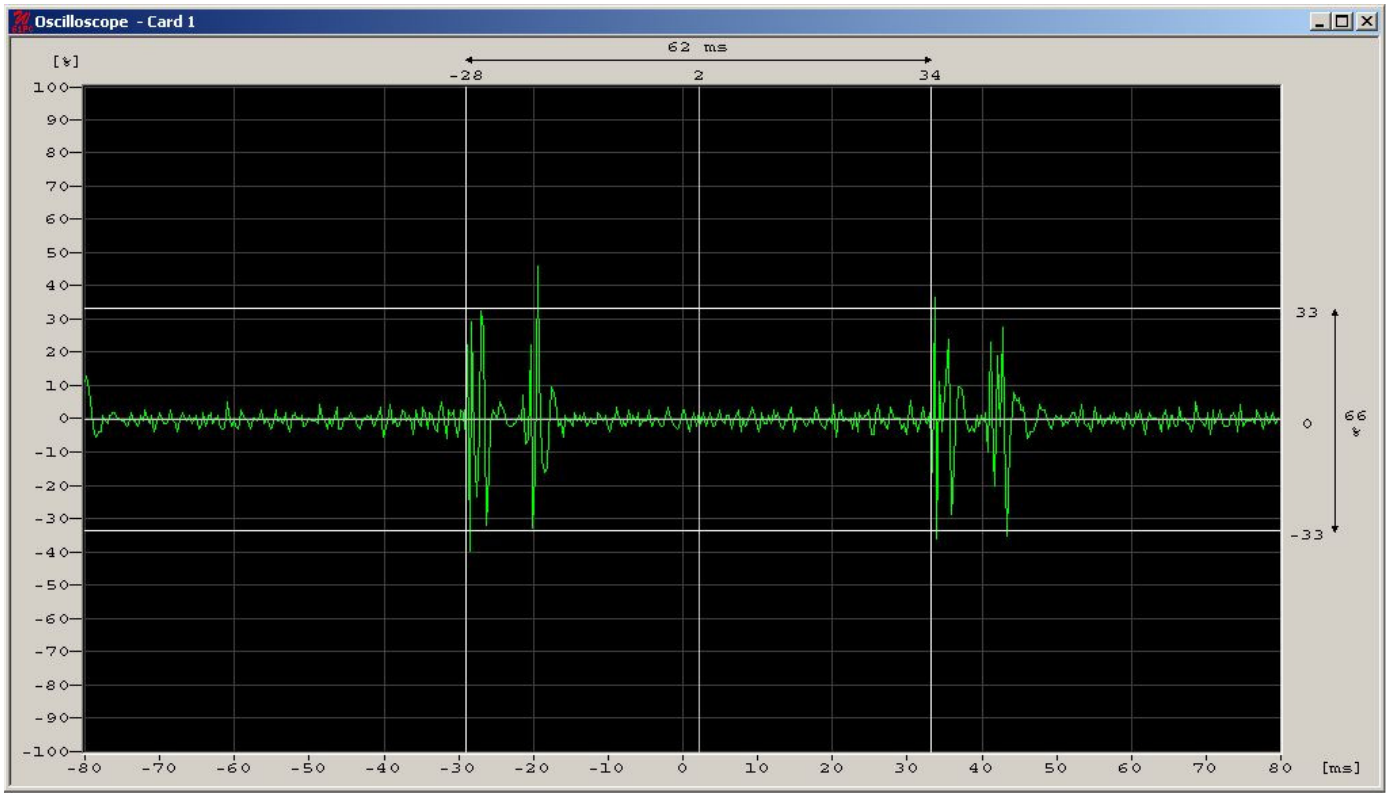
2.15 OTHR unknown

Unknown Radar on 21000 kHz in May 2011 – burstsystem

soundfile: http://www.iarums-r1.org/iarums/sound/unk21.wav



Sonagram on 21000 kHz - duration of 1 burst = 4 sec



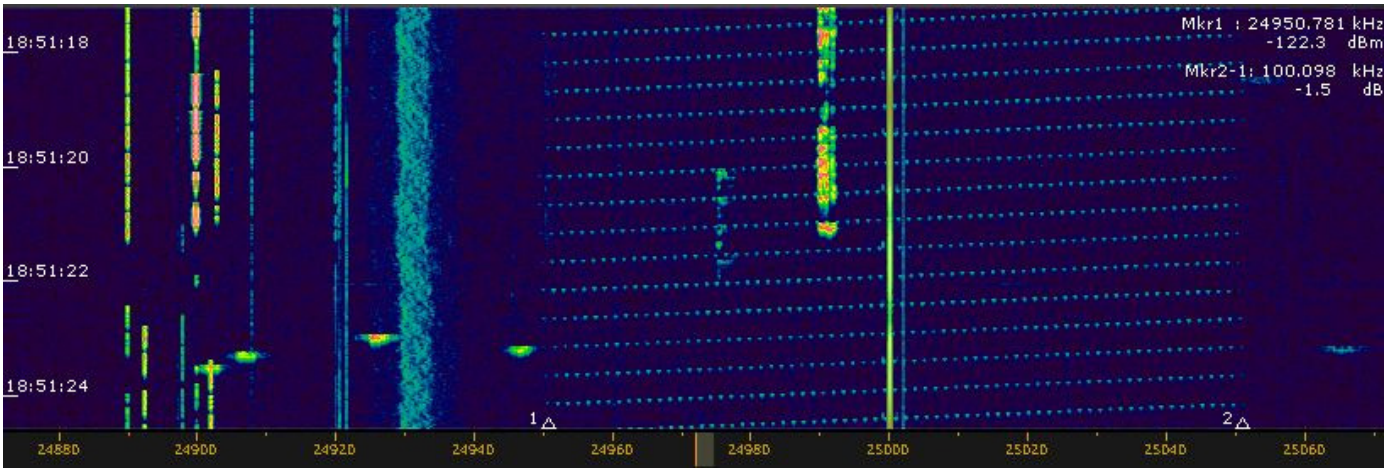
Sweeprate measurement on 21000 kHz, 16.1 sweeps/sec.

3. Ocean Wave Radars

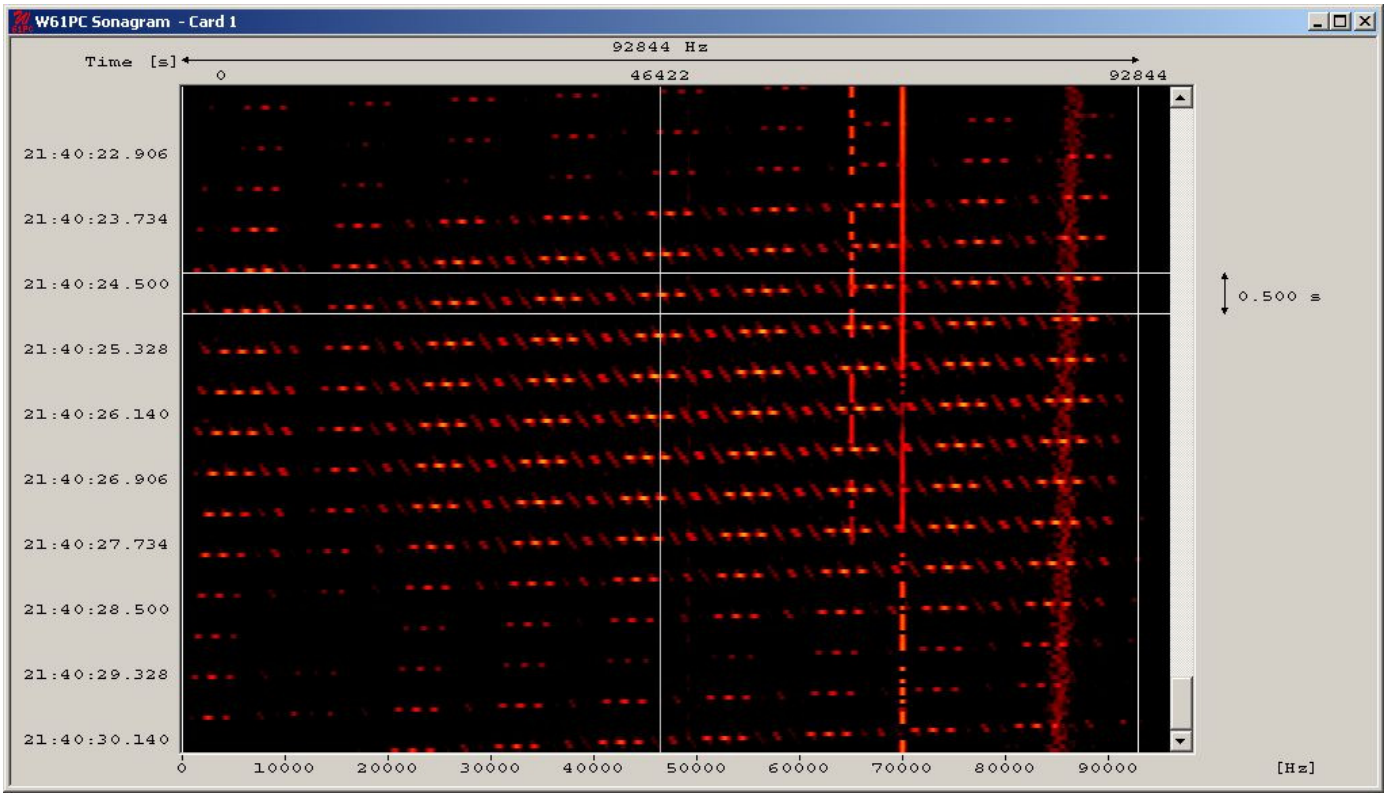
3.1 Codar (CODAR = COastal raDAR)

Codar Info Site: http://www.codar.com/

soundfile: http://www.iarums-r1.org/iarums/sound/codarhf.wav



Codar system from Italy disturbing the 24 MHz-Amateurband in May 2010. Observe the 100 kHz spread! 2 sweeps/sec



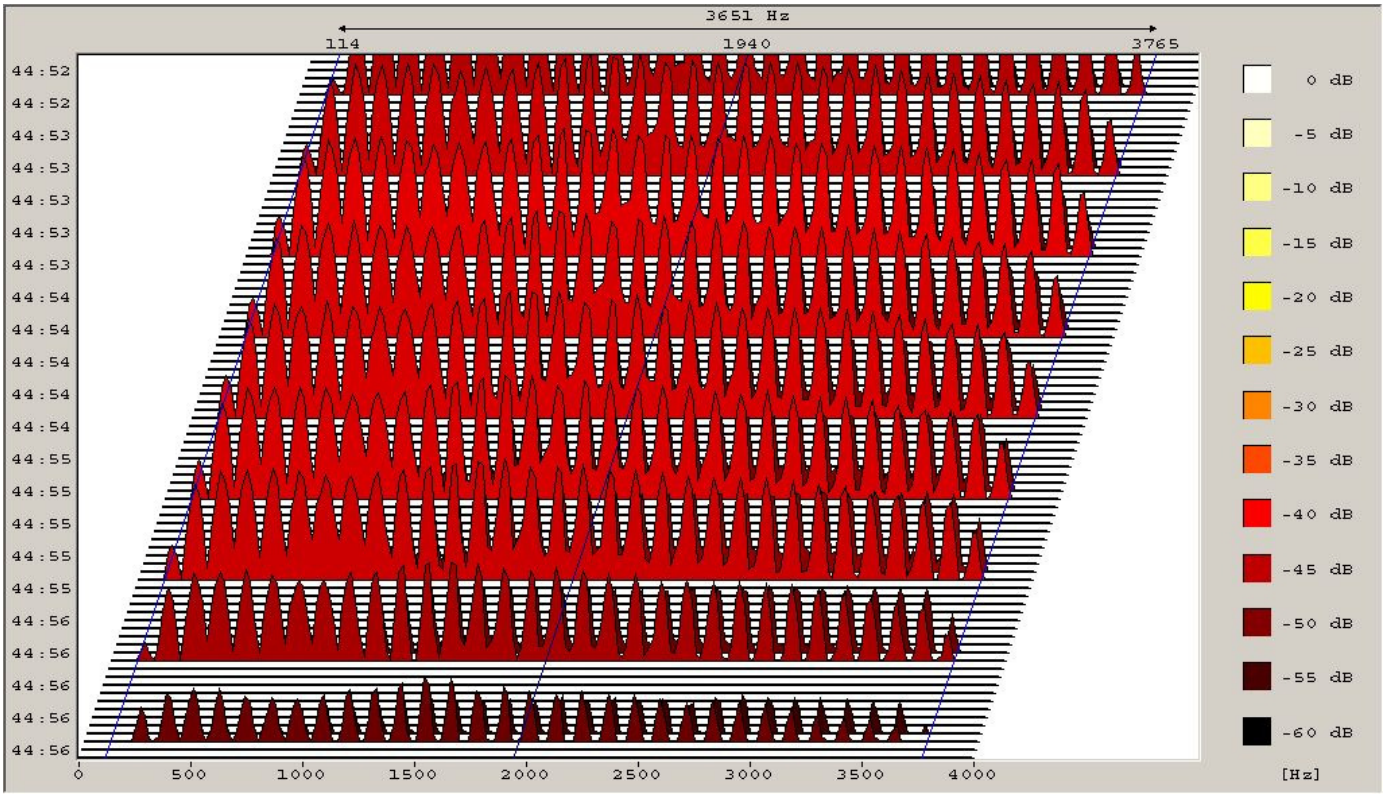
A typical Codar sonagram on 24 MHz, 2 sweeps/sec, short range version. Each sweep is divided in several blocks.

Codar in Croatia (RTZub) with Goundplane Antenna – not active in 2011

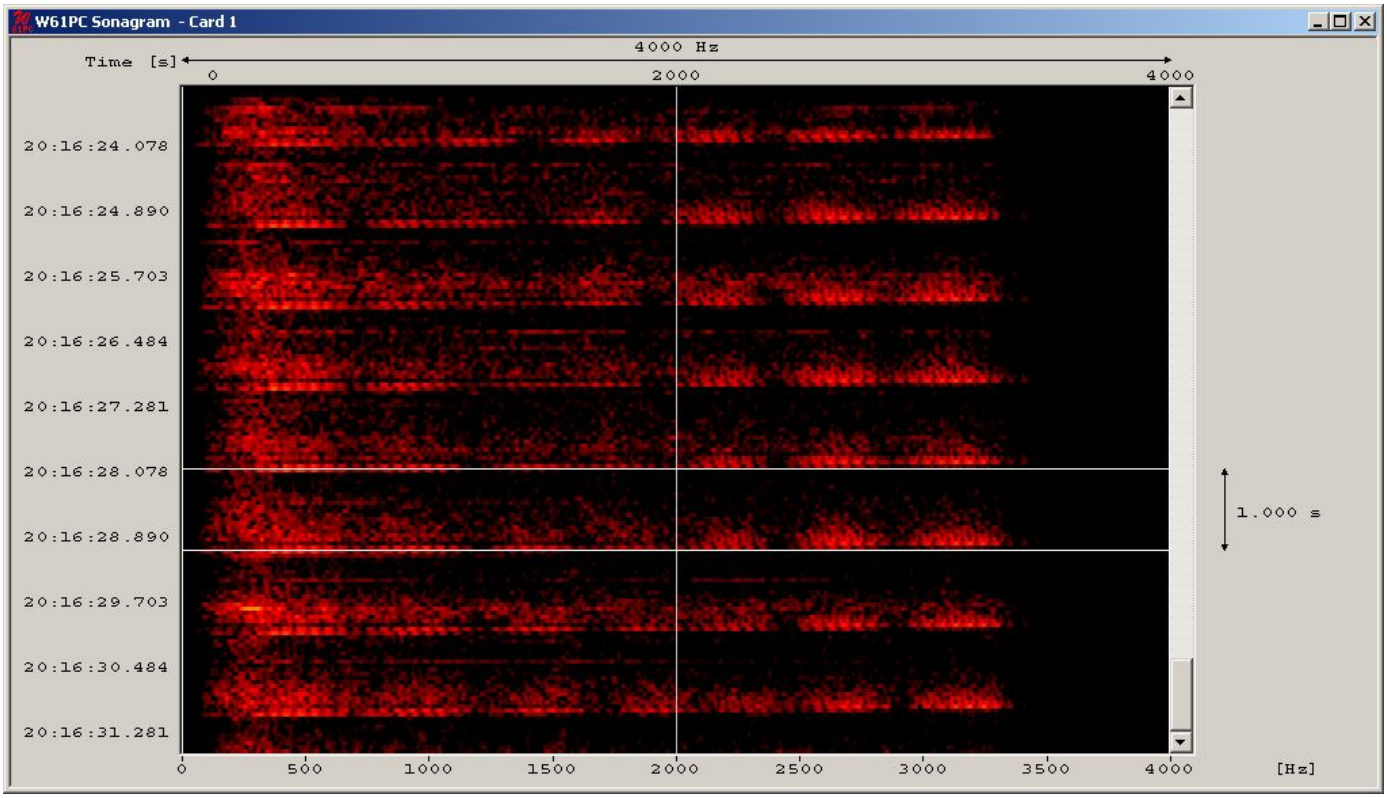
Codar in Croatia (Savudrije) – not active in 2011

source: http://www.izor.hr/nascum/index.htm

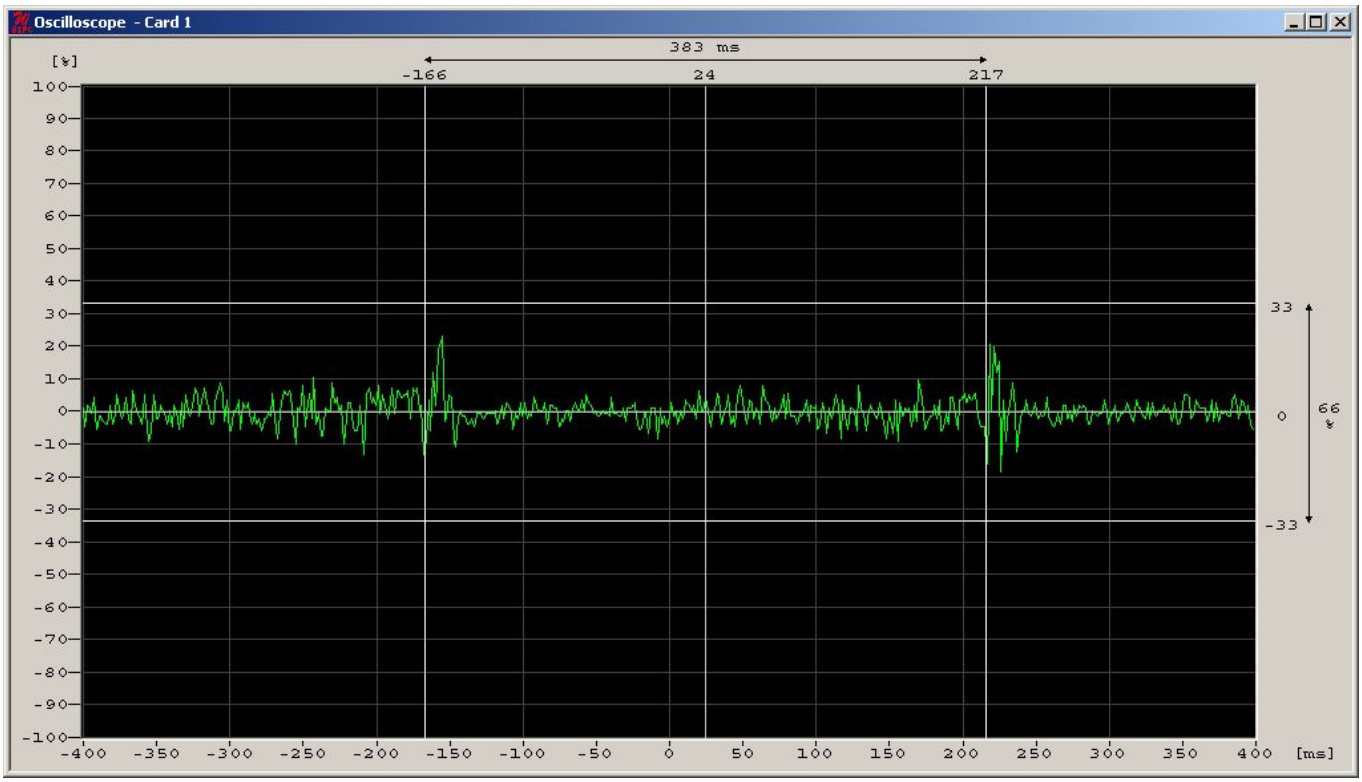
Codar HF Radar on 24 MHz from Italy on the waterfall.



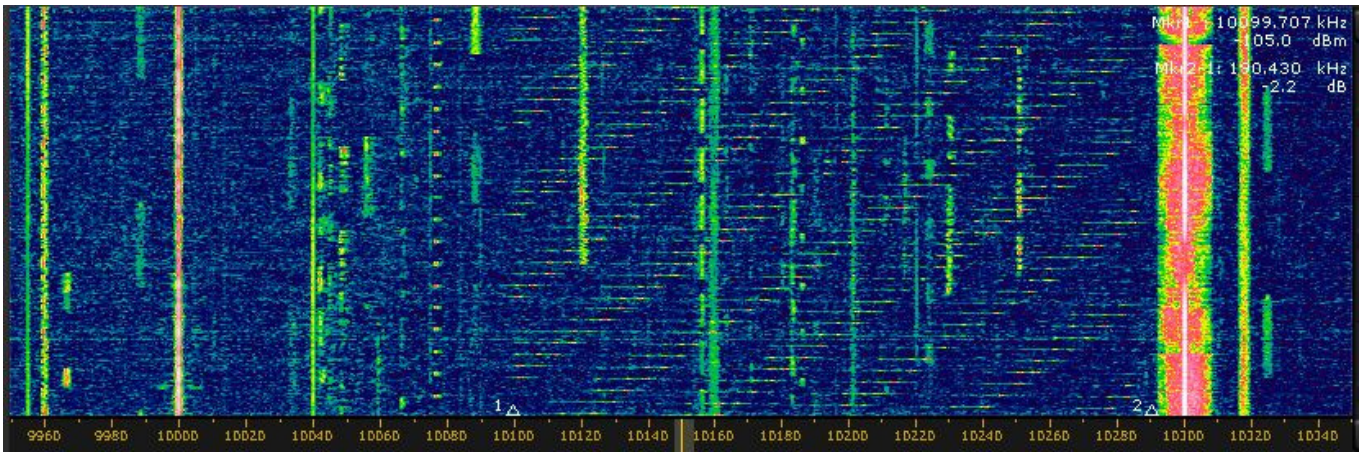
Codar long range version with 1 sweep/sec below 5 MHz.



Far East Coastal Radar:



Coastal Radar from China ??? disturbing 7 MHz with 2.6 sweeps/sec

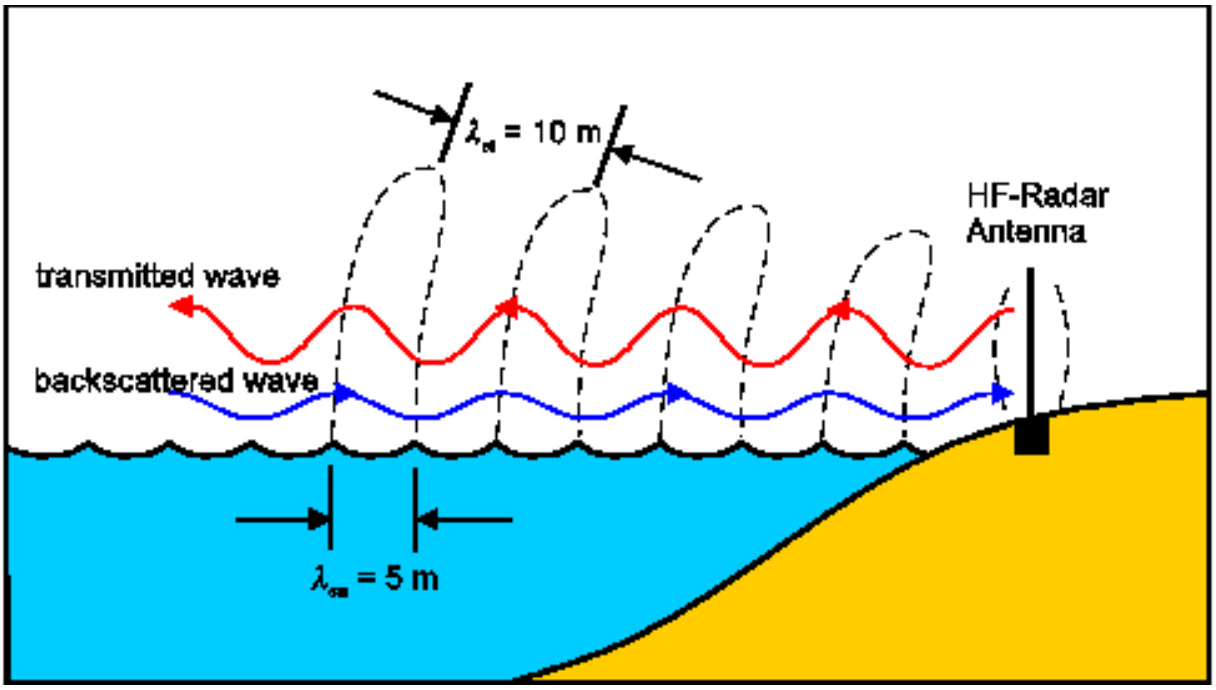


Coastal Radar from China ??? on 10100 – 10290 kHz – 2.6 sweeps/sec – disturbing 10100 – 10150 kHz (August - November 2011)

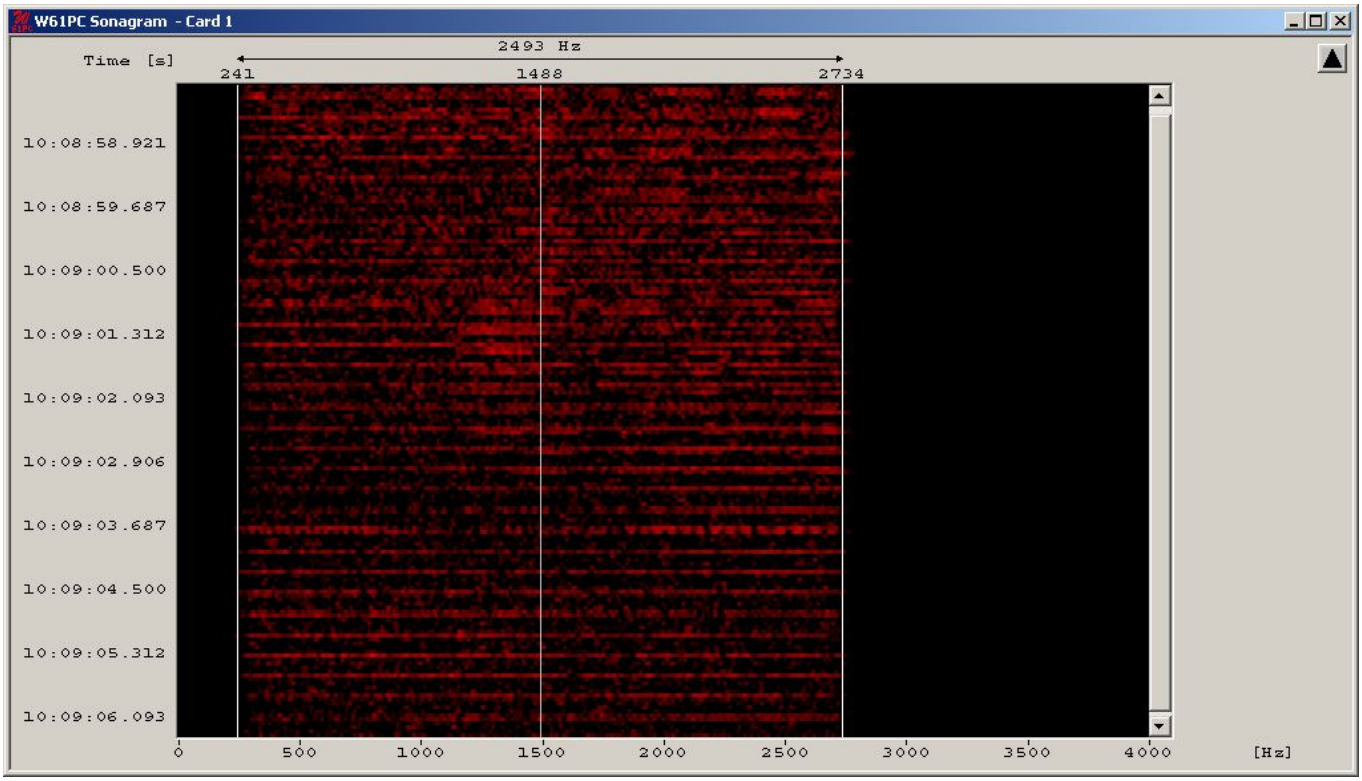
3.2 WERA – Germany (Ground Wave Radar – University of Hamburg)

WERA Info Site: http://ifmaxp1.ifm.uni-hamburg.de/WERA.shtml

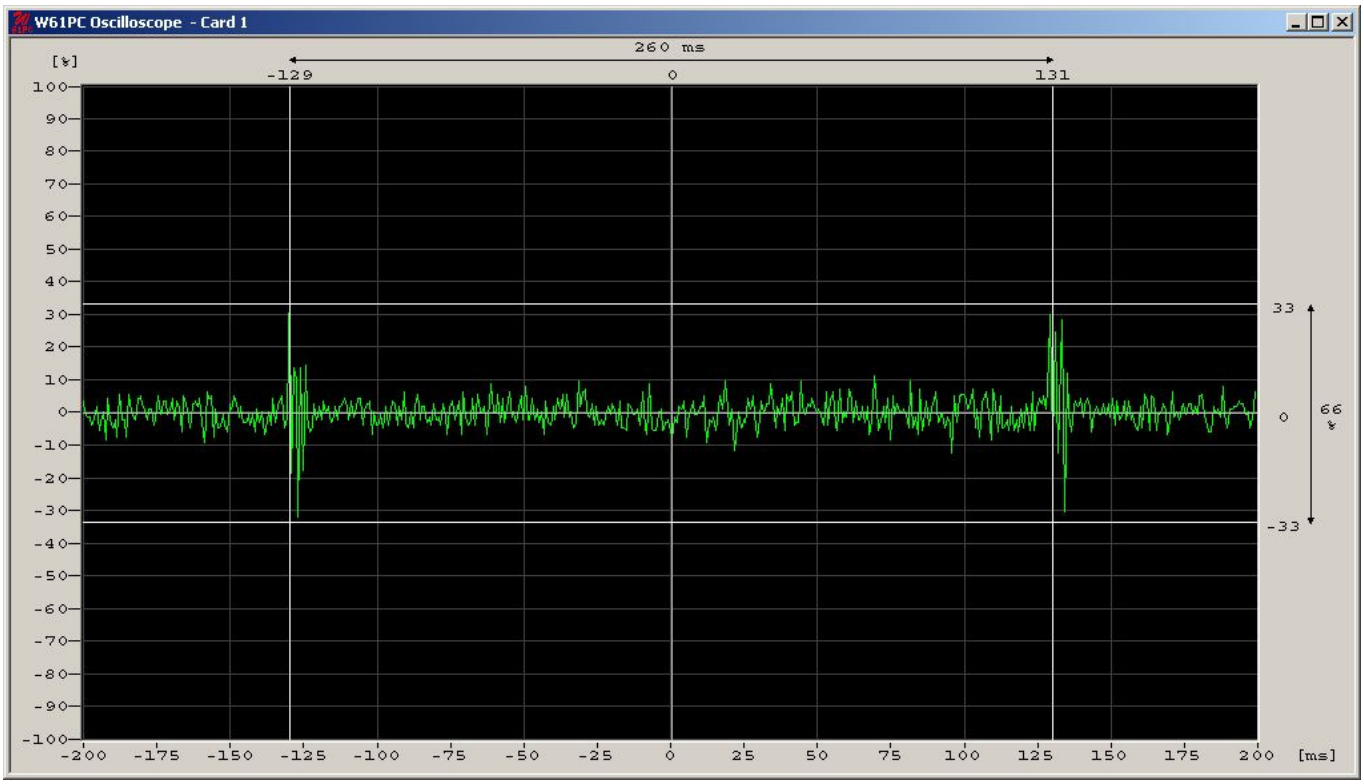
The function of WERA:



Shore based system:



WERA version used in north-west France on 12300 kHz and below.



French WERA version with 3.85 sweeps/sec.

- END -