The 143.050MHz Graves Radar a VHF Beacon

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This article is about the Graves radar located in Dijon, France (JN27si). Its operating at 143.050MHz and on-the air-since januari 2006.
The radar is interesting to the VHF radio amateur and a great source for experiments. The signal is a powerfull continuous wave signal without any modulation. Its on the air 24/7[i].
This make it suitable as a beacon for al kinds of propagation experiments such as moonbounce, meteorscatter etc... Everybody who listened to the radar signals is very enthousiastic about it and speaks about the impressing signal levels. Though the radar is transmitting southwards strong ms reflections are reported up to JP31 square.
A nice thing is that the radar operates close to the 144MHz band. So existing weak signal equipment can be used.

The Graves Radar system is a bi-static radar system with a separate tx and rx location. Its main purpose is to detect satellites and determine their orbital parameters.
I found on the internet the "Graves Sourcebook[ii]" which gives a lot of information.
(http://www.fas.org/spp/military/program/track/graves.pdf)
By observing the radar signals and with help of other radio amateurs I got some better understanding about how the radar is working. This article is an introduction on how to receive the radar.

How does the radar transmitter work?
The radar has 4 separate phased-array antenna systems that are tilted. Each antenna is covering a sector of 45 degrees azimuth. The radar illuminates the southern sky so the area from 90 degrees to 270 degrees azimuth is covered.

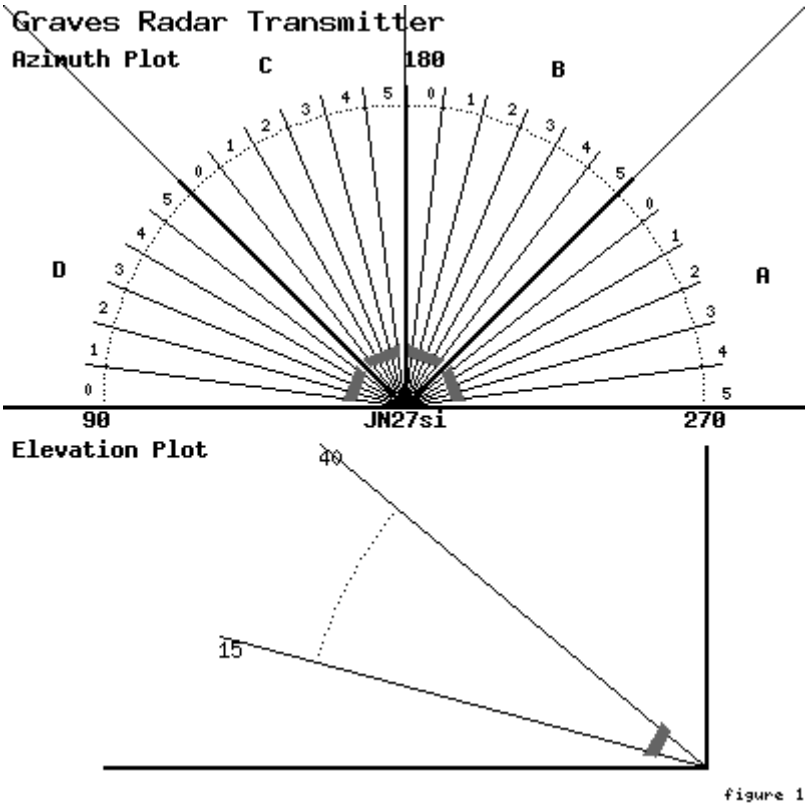

figure 1

Azimuth Beam Pattern
The horizontal beam has a beamwidth of 7,5 degrees. As seen in the figure 1 there are 4 sectors numbered A, B, C and D. If one sector is viewed closer, for example sector D (90 to 135 degrees azimuth), it can be seen that the beam is taking 6 steps of each 7.5 degrees to sweep this complete sector. It takes 19,2 seconds to step through one sector. So one step of a section is 3.2 seconds. This is explained in detail in tabel 1. One sector is scanned 4500 times in 24 hours.

Step	Azimuth (degrees)	Duration (seconds)	Start time
0	090,0 - 097,5	3,2	00:00,0
1	097,5 - 105,0	3,2	00:03,2
2	105,0 - 112,5	3,2	00:06,4
3	112,5 - 120,0	3,2	00:09,6
4	120,0 - 127,5	3,2	00:12,8
5	127,5 - 135,0	3,2	00:16,0
		Total 19,2	End at 00:19,2 and starting again on step 0

Tabel 1

This pattern is exactly the same for the beams in sector A (225-270), B(180-225) and C(135-180). So 4 beams are scanning simultaneous the southern sky like a lighthouse.

Elevation Beam Pattern
I found on the internet that the vertical beamwidth is 25 degrees. I observed moonrise on the graves radar and the reflection started at when the moon is 15 degrees elevation at JN27si. When the moon is 40 degrees elevation reflections are still very good.

Moonreflection

Great reflections can be received, when the moon is within the radar scanning range. It is possible to get reflection for 12 hours.

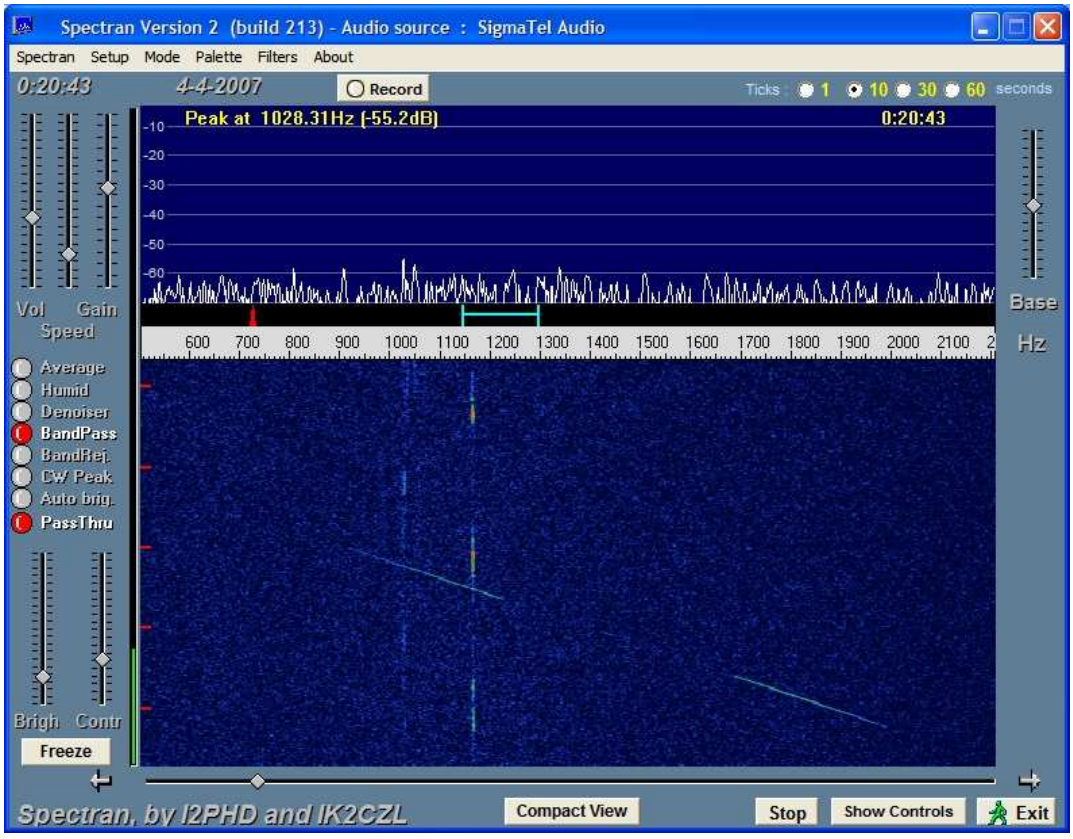

figure 2

A moonreflection can be received with a small one yagi station and a ssb receiver. I know amateurs who managed this with a ground plane or discone antenna.
The sceenshot above (figure 2) shows a moonreflection where the beampattern described earlier can clearly be observed. The moonbounce signal is at 1160Hz. You see the 19,2 second scan pattern and also the 3,2 second steps of switching the antenna azimuth.
The direct signal via tropo is at 1040Hz. I' am located 450Km north of the radar (JO21QK). Also seen is a reflection on a passing satellite.

Other applications

Besides the moonbouce beacon the Graves signal can be used for many more applications:

1. Living in europe strong meteor refelections can be observed the whole day. Andy, G7IZU, is using the radar for his online meteorscatter detection alert system. (http://www.tvcomm.co.uk/radio/live_b.html)
2. Satellite tracking.
3. High power beacon to study FAI, Es or maybe TEP propagation.
4. Fill in yourself…….

Please try to receive the radar yourself and be amazed. Also let me know if new applications with the radar are developed interesting to amateur radio..

73 Rob

[i] Sometimes the Graves radar is off the air during 24 or 48 period. I think maintenance.
[ii] http://www.fas.org/spp/military/program/track/graves.pdf