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WRITING ON THE MOON AT 10GHz WITH ALICE SOFTWARE
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My name is Andrea Mancini (IW4CJM), and the subject of this presentation is a study made with the cooperation of the Radioastronomy Association "Bagnara di Romagna",on how to "write on the moon".
Our group numbers 12 radio hams and is involved in EME work on several frequencies.
The equipment in use is made up of a 7 meter professionally made dish with a gain (on 10 Ghz)of 55 Dbi,with a rx NF around 1Db,and a power output of 50 watts.
This is an example of echoes in CW and in SSB.
The experiment originated as part of a study on 24 Ghz propagation,where the water vapor content of atmospheric air is very important. The idea was to assemble a beacon generating CW signals in various conditions of temperature and relative humidity; the mode selected was "hell writing".
This mode was developed by a German inventor, Rudolf Hell, in 1929, and has been in use until WW2.
The actual writing is obtained using audio tones within the transmitter's audio band, so that, if Spectran is used to decode, numbers and letters will appear on the screen.
When I first mentioned this first test to the other Association's members,they were enthusiastic,and Vico(I4ZAU) said:"Couldn't you use the Moon to write on,at 10 Ghz?".
At that time to appeared to be a long shot, as the technique used letters defined on a 100 Hz bandwidth and it was intended for tropo DX. To write on the Moon, a considerably wider passband was necessary to compensate for the Doppler effect.
So,after a few days the tropo experiment was shelved and writing on the Moon was undertaken in its place. It was initially necessary to define how signals changed when reflected by the Moon; for this, I relied on my experience with bistatic radar.
Our echo on CW was 26 dB above noise; at home,my 1.5 meter dish had 13 dB less , so 26-13= +13 dB, determined using Spectran software. A 10 Ghz signal was sent to the moon with the big dish, and I listened to it from home. This is a bistatic radar configuration. As you can see, the received signal was 10 to 13 dB above the noise, and my home NF was not all that great(about 1.8 dB).
This is how the signal sounds, as recorded at home.
The first thing we did was a radar map of the moon using bistatic radar at 10 Ghz. The signal from the 7-meter dish was sent while the dish itself was slowly moved at a steady speed across the surface of the moon,from the east to the west limb. Signal was CW and I recorded it at home.
As you can see from the picture, I had a map of the moon at 10 Ghz., the signal dynamic being 13 dB. By plotting the moon diameter on the graph, we observe that the signal is loudest from the central zone of the moon, in the vicinity of the half-diameter.
One conclusion we drew from all of this is that the most effective diameter of a dish for 10 Ghz. Eme, is about 7-8 meters.
Doppler plays an important role in decoding signals at 10 GHz.
As we can see,the first Doppler effect is the shift between rx-tx frequencies, due to the relative Moon-Earth speeds, and is in the order of +/- 25 KHz. This is a well known fact, and there is software available to predict it.
The signal transmitted from the big dish, has a one Hertz bandwidth, but the reflected signal has 120 Hz bandwidth. I'll call this "second Doppler" (Doppler smear).

Another change in the reflected signal is delay time: the moon is a near-sphere with a diameter of close to 3476 kms.,therefore the signal reflected from the peripheral area has an additional 1738 kms. to go plus another 1738 coming back. The delay for this additional distance is 12 milliseconds.
To “write on the moon”,a clear understanding of the “second Doppler”is necessary.
The Moon regions, as seen by an Earth observer,all move at different speeds, so the Doppler shows some variations, shifting on both sides of the central frequency. If we visualize three separate areas of the Moon, we can assume that these three points are each at a different distance from the Earth observer,and therefore move at different speeds.
We then have 3 different distances and 3 different frequency shifts.
The “second Doppler” components of the reflected signal, are caused by: 1)the moon-earth distance; 2)the TX antenna diameter; 3)the RX antenna diameter; 4)the observer’s latitude.
In this picture, the two reflected signals are: #1)our echoes with the 7 meter TX/RX dish; and #2) a signal from a DB6NT test, carried out with a 20 meter dish.This last antenna has a very narrow beamwidth, and the “second Doppler” is just 50 Hz.
So,during a moon pass above our horizon,the “first Doppler” is maximum at moonrise, is about zero at the meridian transit,and then again at a maximum at moonset.
The “second Doppler” behaves differently: it is minimum at moonrise,maximum at the meridian and again minimum at moonset.
On this video, we are able to determine that, with our 7 meter dish, on an average pass,the “second Doppler” varied from 40 to 120 Hz.
Based on this, I came to realize that I needed to increase the letters’ size from 100 to 800 Hz, using Spectran left-to-right scan.Subsequently, I have been able to obtain the same result with up/down Spectran scan, which is the normally used mode.
After this change,I was ready to write on the Moon,and the first tests,carried out on May 5,2004, were successful; you can see the result on the monitor,with several echoes to line up in frequency first,and then the “IQ4DF” message. This is the best result we obtained on this particular occasion.
In the following weeks,as I was not totally happy with the results, I have been able to improve the definition, again with up/down Spectran scan, with a text bandwidth of 1000 Hz and a letter height of 2.5 seconds.
While experimenting,I noticed that the text had a better definition if ,instead of a single tone, two were used,separated by about 18 Hz, as the dot density was double at the center ; theoretically,there should be no difference, but in fact there is one (I called this “the painter’s theory”).
In actual practice,with Paint you can try with a single tone and then with two distinct tones: where the two jets overlap the dot density is highest.
This is the letter “i” ,made up of two tones: initially the s/n ratio was 50 dB; after some improvements a s/n ratio of 90 dB was obtained, an excellent result.
This is the final result:

In order to allow some of the more modestly equipped stations to use the method, the letter transmission has been limited to one at a time.
After all these changes ,this is how we received F6KSX, using the 7 mt dish and 200 watts in TX and a 3.3 meter dish in RX. It is a communication mode halfway between cw and ssb; at the end,I sent a “ciao” greeting.
In the Conference CD, a program will be available that you can try out to write on the Moon; I called it “Alice”,from my newborn daughter’s name. It is also available from: www.crbr.it.
When installed,you’ll see three windows where the text can be typed. When you click “add”,the program will generate the tones corresponding to the letters; if you click”save”, you can store your text for future use.
The “O” slot is used to add some time delay between letters.
At present it is only possible to send one letter at a time; if you click on “@”,this will generate the word “ALICE”, so that on the other side they will know the kind of mode you are going to use.

This is Andy and Alice working on the program…..
I am now going to show a short video of the first “ALICE” QSO via the Moon, made in 2004 during our yearly microwave convention…… Operating conditions were 20 watts and 3 meter dish on TX and the 7 meter dish with 1dB NF RX.
I’ll now start the video. Thanks for the attention; if there are any questions, I’ll be glad to answer Them.

Andrea Mancini