EME: Beyond the impossible

A radio amateur is always looking for new challenges. After the success of the attempt did at the end of November 2010 with only 20 watts, I tried to raise the bar again. The occasion came on the afternoon of January 5, 2011. I saw on the EME chat that Franco, I2FAK was calling CQ EME on the frequency of 144,125 MHz. I tuned on my Kenwood and I set the power trimmer to a minimum. The minimum power of the TS711E is only 2 watts. I tried the impossible and that time the impossible happened. Come says an Arabic proverb: " Don't *give up. You'd risk doing it just an hour before the miracle.* I didn't give up. I remembered Fred Schnell and Leon Deloy, the first OMs to establish a transatlantic QSO, they tried all night. I kept calling repeatedly, I also had little time as the moon was setting down and would soon fall below the horizon. I trusted in Franco's ability and in his great antennas array. These factors can help the miracle. My surprise was enormous when I saw the three OOO appear on the screen of my computer, which meant that he had received my message. At 4:38 p.m., I can complete the QSO, when I see the RRR appear on the screen. After the QSO, Franco chatted to me the following string confirming that he had managed to decode my message to -28 dB below the noise level, very weak but still had received it. *So, I2FAK wrote on the EME Chat:*

IK3XTV Flavio, this is the decode: 163300 3 -28 2.5 105 0 * I2FAK IK3XTV 1 0

Franco sent me a decoding report at a level of -28 dB and a DT (delay time) of 2.5 seconds, which confirmed without any doubt that the signal was from the Moon. I had managed to complete a bilateral contact via EME with only 2 watts of power obtained by adjusting my Kenwood TS711E to the minimum power. I considered it a great success and a great stroke of luck. I am aware that each of us has a miracle at our disposal, but only one! In fact, I tried, at other times, to repeat the experiment with I2FAK but without success.

I do some calculations: 10 dB is missing

Before this event, I did several contacts with I2FAK , using a power of 250 W, the best reception ratio I received from him was -21 dB, but in this case, I called him with only 2 W, so 21 dB less of power. However, in that direction of the moon and at that elevation, I calculated a ground gain of about 4 dB, So my signal was supposed to arrive at -21-21+4= -38 dB. Given the S/N of -28 dB I received from I2FAK, I can establish that "something" earned to my signal about 10 dB.

Grey line focus hypothesis

but where did those 10 dB come from?

At that time, at 16:33 UTC, the moon was setting, it was low on the horizon at about 4 degrees of elevation. I took advantage of the favorable effect of ground gain. But the ground gain alone we saw that it is not enough. Only two antennas of 8 elements, and 2 watts are really few. I try to explain the reasons for that incredible event. Let's see what happens on the Grey line. Due to the pressure of solar radiation, the ionosphere and the earth are not two concentric spheres, this fact leads to a continuous deformation of the ionosphere that is noticeably highlighted when the sun sets on a meridian (terminator). At this stage the ionosphere is highly dynamic and undergoes a drastic change of ionization in the transition from day to night. The electron density in layer E decreases by a factor of 200 to 1 and by a factor of about 100 to 1 in F layer. After sunset, D layer quickly disappears. The signal passing through this portion of the ionosphere for a few hundred kilometers and may encounter oblique surfaces relative to the ground as well as real curved surfaces that can give focusing effects. These additional decibels may be arrived from a focusing effect on the grey line, that the wave beam crossed to reach the surface of the

Moon. The strange thing is that the I2FAK signal came me less strong than usual, so much so that I also had difficulty decoding it, as if in his case, the Grey line degraded his signal.

These are the QSO data: Frequency :144.125 MHz - Date:05.01.2011 Time: 16.35 UTC
Kp index=0 (Quiet) - IK3XTV Antenna 2x8 elements I0jxx. Length 4 meters - RTX Kenwood TS711E – LNA Gasfet

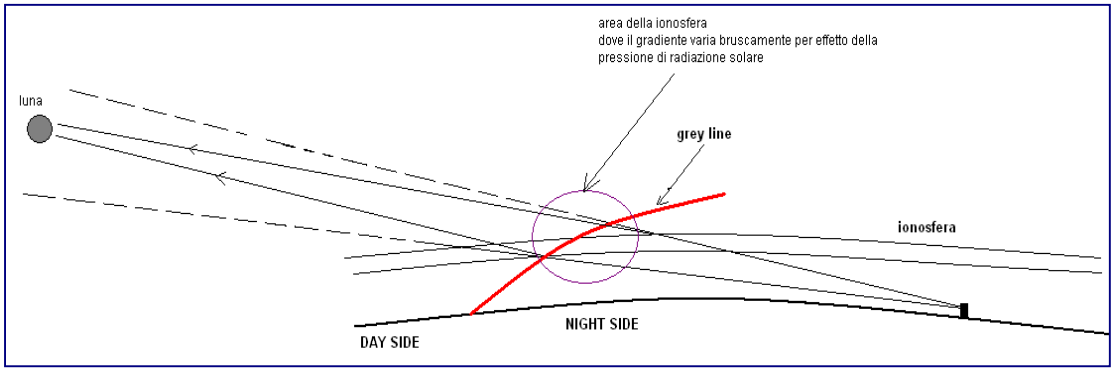

Fig. Diagram of the signal crossing the ionosphere and meets the Grey line

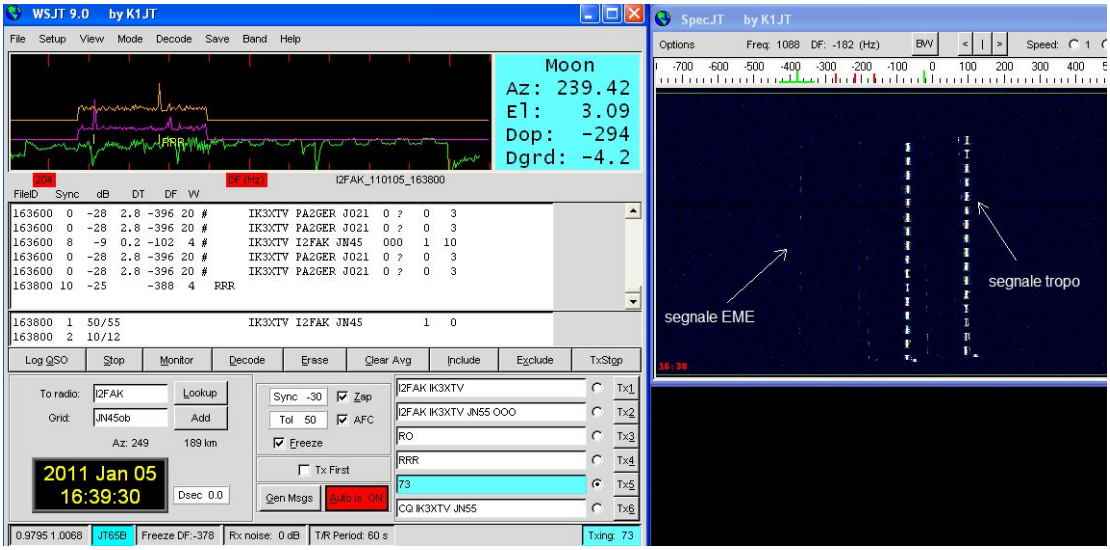

Fig. Screenshot of WSJT with RRR received at 16:38 UTC by I2FAK. In the spectrum on the right side, you can see both tracks, EME and tropo.

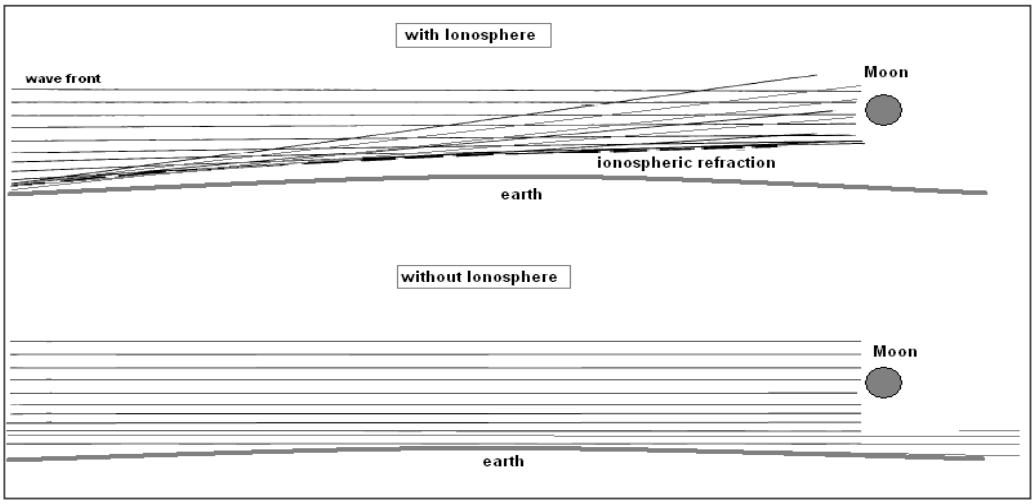

Fig. With a little imagination, I draft what could have happened to focus the signal towards the moon.

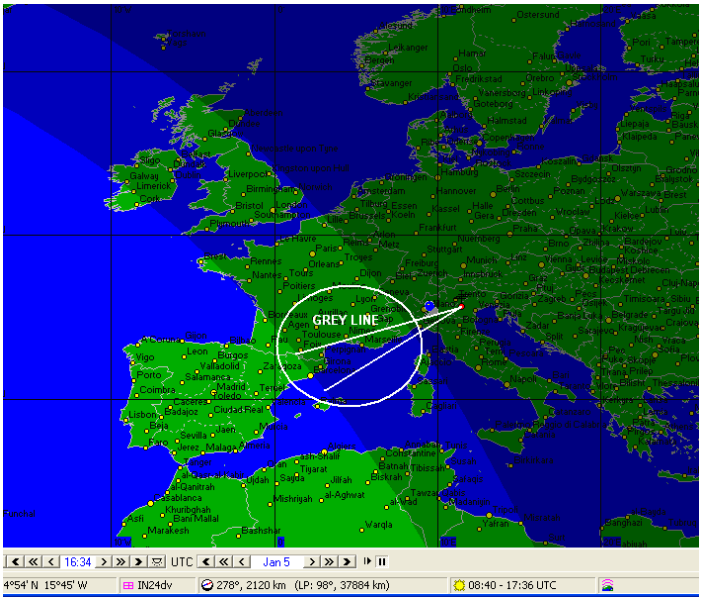

Fig. The map shows the position of the terminator and the direction of my irradiation beam to the moon that was setting. At that moment the wave train crossed an ionosphere on the Grey line, undergoing possible focus phenomena.

"You have to believe in the impossible, because the impossible can happen"
Heraclitus

Fig. These are the EME antennas of Franco Giorgi, I2FAK. It is an Array of 16 Log-Loop Yagi of 19 elements.