The year 1997 - 10 GHz Moonbounce in ZL

EME Record
Recently NZART Awarded a Certificat of Merit to Greg, ZL1GSG, and Joe DJ7FJ, for their World Record making 10GHz EME contact of 18,340Km on March 12th 1997

Greg ZL1GSG

Moonbounce (Earth-Moon-Earth, EME) is the term for a radio contact between two stations on earth that uses the moon as a reflector for radio waves. EME activity tends to require a rather more complicated technical setup than your average "home station". But then again, this is amateur radio, it's supposed to be experimental, and even if the only way to communicate via EME is with a few faint signals in CW (morse code), it still gives you an enormous sense of achievement.

On all microwave bands, parabolic dish antennas are a virtual must for EME activity: the signal loss on the long path between earth, moon, and back means that only a small fraction of the transmitted signal arrives at the receiver - a big aerial is needed to hear it at all.

My 10 GHz moonbounce activity begun in '93 when our group, Joe (DJ7FJ) and I (DL2GSG), had our first QSOs with G3WDG, SM4DHN and WA7CJO. During the following years we had all sorts of weird moonbounce activities on nearly all bands possible. During that time, I constructed a portable 10 GHz EME station. That station consisted of a 1.8 m parabolic dish antenna on a tripod and a 50 W travelling wave tube amplifier - all capable of running at 12 V from car batteries.

Move to ZL

After I moved to ZL in '95, a QSO with Joe DJ7FJ was an obvious idea. We didn't think that this would be a problem, because we'd had QSOs before, with reasonable signals on both sides. Well, that's at least what we thought. After a couple of unsuccessful tests I got the feeling that something else was going wrong. In May '96 I gave Jim WA7CJO a ring and we arranged a sked on the 14/03/96 (UTC). This QSO proved to be no problem at all. Signals were as they should be and, as a spin-off, we had the first 10 GHz EME QSO from ZL.

In June 96, the NZART Conference in Wellington gave me new hope. During a paper session on satellite TV, I met ZL2MF who told me that he had a 3 m dish for sale. I had a look at the dish the same evening and bought it on the spot.

Some time later, I shifted the 8 segments of the dish and all the bits and pieces to Auckland. The moulded plastic segments needed some repair. EME requires the dish to point at the moon at all times. This meant building a completely new mount for the dish, movable in both azimuth and elevation.

One of the major requirements for the new system was that it had to be "portable", i.e., that it could easily be moved to a different location. Why portable? First of all, I had not enough space around my flat. However, the main reason was that you have to see as much of the moon path as possible to get long time windows for the QSO. It is also in the nature of the thing (eme) that the sun and the moon don't shine for everybody at the same time. Under optimal conditions, the moon will have only 10 degrees of elevation (above the

horizon) left here in NZ when it rises at Joe's QTH (location). As Joe needs a minimuml elevation of 5 degrees to get over some hills around his Black Forest QTH, there are only 5 degrees left for us - provided that I am able to work down to the horizon. For that reason I did my tests at Muriwai and Awhitu, on NZ's West Coast west and southwest of Auckland. Both QTHs are at 200 m above sea level and on a slope towards the Tasman Sea.

The New Station

The station now had the 3 m dish with a 3 by 3 m timber frame foundation. The dish was fed from a primary horn in VE4MA style with a scalar ring. The waveguide TX/RX (transmit/receive) switch was flanged directly to the horn. As transmitter I still used my TWT amplifier with an output of 50 W and a gain of 65 dB. The TX power was fed to the TX/RX switch via a waveguide. For RX, a low noise HEMT preamp was flanged to the RX port of the RX/TX switch. The gain of the preamp was 20 dB with a NF < 1.0 dB. The RX and TX path were combined again in the 10 GHz/144 MHz transverter which was followed by a 144 MHz/28 MHz transverter and a Kenwood TS-430 as exciter. The 10 GHz transverter and the preamp were home brewed (own designs).

You might ask "how can you find and follow the moon with an antenna of 47 dB gain and a beamwidth of 0.7 degrees?" Easy! The moon temperature at 10 GHz is about 200 K warmer than its background in the sky. That "heat" is radiated as noise, which you can pick up with a suitable receiver. Most of the 10 GHz EME HAMs use astronomical receivers with a RX bandwidth > 1 MHz. With these instruments, you can pick up noise differences of less than 0.1 dB. My receive system gives me 1.7 dB moon noise and 14.5 dB sun noise.

The sked of 12/3/97 and the preparations for it turned out to be a real nightmare. A couple of days before the sked, I assembled and tested the rig at Awhitu. As we assembled the dish, the rim of one of the segments cracked to a length of 10 cm. Nevertheless, one positive result of the test was that the system was good enough to track the moon. Radio signals take about 2 seconds to get to the moon and back. This turns out to be useful for testing purposes, as I can use my own station to check whether the echoes are coming back. Luckily, I was able to hear my own echoes down to as little as 0.7 deg elevation. Ready - as long as nothing falls apart!

In the days between the test and the sked cyclone Gavin paid a brief visit to NZ. I already considered cancelling the sked, but a couple of hours before the time it cleared up and the wind eased off. Everything was fine on the night and our moon echoes were again just as they were supposed to be.

The Successful Record Contact

10 minutes before the window to Joe opened up, we started to transmit in the sked sequence. This involves one minute of transmission, then a minute of listening, followed by a minute of transmission, and so on. Then, a few minutes before the sked, I started to transmit, but nothing happened! Panic! It looked as if the waveguide switch or its controller had developed a fault. The spare switch controller didn't work either, and the spare switch also showed no sign of life. It turned out to be the cable between switch and controller. By now, the fuses in both controllers had already been blown... Ok - insert new fuses and handle the switching with the spare controller operated by the crew behind the dish controlled by "voice" command. By now, 5 minutes of the 20 min maximum sked time had gone - what a drama! I went back on transmit and then back to receive. This time, I could hear DJ7FJ's signal coming back with a reception report!

The reception reports were exchanged as "O/O" and we even had enough time left to watch a perfect full moon set, not to forget the bottle of bubbly! A new world record for EME on 10GHz had been set with a distance of 18340 km, and the second EME contact on 10GHz from ZL had been completed.

After the QSO with DJ7FJ and the comments from VK2ALU and G3WDG about their earlier QSO (then the world record), it seems to me that additional attenuation in the atmosphere for low elevations may have caused the problems I had in the beginning with the smaller dish.

All of this was only possible because of the help of quite a number of fellow HAMs. Some helped me to organise equipment, some during the testing and of course during the half a dozen unsuccessful skeds that took place mostly during rainy and stormy nights. Thanks go to the Awhitu farmer for making the QTH available, and to ZL1AVZ, ZL1PL, ZL1QF, ZL1DDL, ZL1TTH, and ZL3VTV who helped to manage the QSO to DJ7FJ.