Various first ever QSO's on the Millimetre frequencies between the Netherlands and Germany.

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On July 28, 2022, DB6NT and PA0EHG made several first ever QSO's on the Extremely High Frequency bands that are available to us as radio amateurs.
This successful experiment was preceded by a period of preparation and planning.

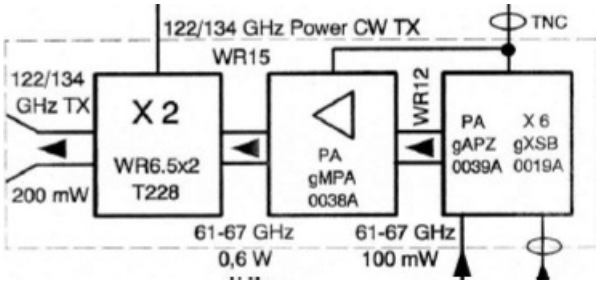
Building the equipment,
In recent years Michael DB6NT has worked on the construction of three stations for millimetre frequencies. Based on his many years of experience with microwaves, Michael has not taken the simple path but has built the stations with high power and the very best quality, which will certainly be able to compete to professional equipment at this moment.

A brief summary of the parameters of the stations.
A dish with a diameter of 40 cm is used as antenna, one of the dishes is made on a lathe from solid aluminium, the second one is from an optical application which was polished to such an extent that it is also suitable as an optical mirror.
To be able to make maximum output, Michael has chosen to work with frequency multipliers and therefore only to generate a CW signal. If SSB were desired, a signal with a Local oscillator would have to be mixed with a loss in available power. Due to the choice of frequency multiplication, it is only possible to transmit in CW, resulting in more than impressive output powers for these frequencies.
At 122 GHz, the station makes an output power of no less than 200 milliWatts. This is generated by generating half a Watt at about 60 GHz and then multiplying it to 122 GHz with a doubler.
If you put your finger on the waveguide while the transmitter is on, you will feel the finger getting hot and that indicates that some serious power is coming out !!!
Also on the receiver side, the most optimal performance has been chosen, where high sensitivity is achieved by mounting the converter head directly in the focus of the antenna and not using a transmit/receive switch. During transmission, the receiver head must then be removed from the dish in order to mount the transmitter head in focus and to be able to transmit. That seems difficult, but the benefits it provides in signal strength is more than worth the somehow complicated conversion from receiver to transmitting.

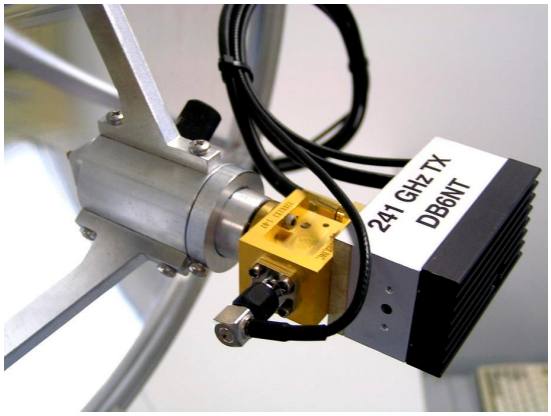
The conversion is relatively simple, all necessary heads are mounted on a holder at the rear of the dish, the relevant holder must be lifted out of the holder and can then be mounted in the focal point at the front of the dish.

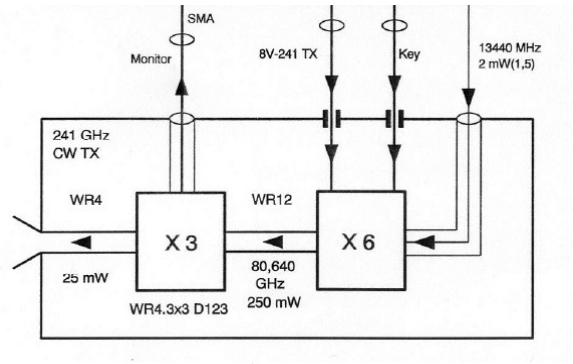
The photo shows the two heads for 122 and 134 GHz, the transmitter head in front and the receiver head to the right.

The transmitter head contains a times six frequency multiplier from 10 to 60 GHz then an amplifier to 100 mW and then the power amplifier at about 60 GHz with 0.6 Watt power, followed by the doubler



The transmitter head for 241 GHz mounted in the dish and the block diagram of the transmitter head





The station is stored in a few large suitcases and is therefore safely stored for transport. Power is supplied by means of a battery which has sufficient power to operate the system for a few hours.
Mechanically, the system is made up of an equipment cabinet containing the local oscillators and the control panel with underneath an adjustment plate with fine adjustment options to align the antenna direction which fits on a tripod stand.
144 MHz is used as the intermediate frequency for reception, for which a Yeasu FT-290R transceiver is used.

The photo shows the equipment as set up during the experiments at the Eemshaven

The second station is similar in design but has some extra switching options to be able to change bands.

Start of the first QSO between PA and DL.

A few months ago I received an email from Michael DB6NT asking if I would be interested in doing some experiments on the high millimetre bands and possibly making the first ever QSO's on these bands between PA and DL.
He also had a proposal for a trajectory for the experiment, from the contest location of DF0MU In DL to a location just south of Enschede in PA. The trajectory would have to be examined first whether such an experiment had any chance of success.
Because I lived in Enschede in the past for a few years, I had my doubts about the location just south of Enschede, which I immediately told to him. I agreed that I would try to do some site survey and visit the site to find if this would be possible.

In the weeks that followed, I first searched internet using Google maps, among other things such as the topographical map of the Netherlands and Germany, containing the elevation of the different locations, to find how suitable the various sites could be.
DF0MU's contest QTH quickly became apparent as a very suitable site. The other site, south of Enschede, was as far as I could see with streetview, at least very doubtful.
The SRTMPathProfile software was also used to investigate whether the route is free of obstacles such as other hills.
The route from DF0MU to Enschede came out as excellent from the SRTMPathProfile software, unfortunately that program does not take existing trees into account. A site visit and site survey was therefore really necessary.
Because the expectation for the location south of Enschede was not looking good, I decided to search for further possibilities based on the topographical elevation map.
Using the topographical map I found a high observation tower Lönsberg between the village of Halle and Getelo in Germany just north of Ootmarsum. That seemed like a good possible site, and I searched for a second location that would allow a line of sight contact. Further searching on the topographical elevation map gave me a number of locations where I expected a possible line of sight to the observation tower.
I decided to visit the several locations I found to determine whether, what looked good on the topographic map and with the help of Google street view, would indeed be suitable.
The view tower Lönsberg was a beautiful point, once on top of the tower you see a lot of horizon but also a lot of trees. Afterwards it became clear to me that the horizon I saw was very deceptive and was much further than the intended distances. We wanted to look for a distance of at least over 10 km away and preferably somewhere between 20 and 30 km. Then I proceeded to look at the other possible locations and it became clear that all the possibilities I had previously selected were hampered by large amounts of trees that made any line of sight to the observation tower impossible.

After that disappointing turn-off, it became clear to me that I would have to look much further North because there are far fewer trees in that area. A new search using the topographic map gave me the idea that there would be possibilities on the coast near Emden in Germany and near the vicinity of Eemshaven in the Netherlands.
Again using Google street view I found a site near the Pilsumer tower in Germany and on the other side near the Eemshaven, a spot somewhere on the dike. I didn't find an exact site at the time, but I decided to be confident that we would be able to find it on the day of the actual test.

After that we had to wait for suitable weather, we postponed our first planned date because the weather forecast indicated that it could be 40 degrees. Not ideal for the MMwave frequencies and also not the most favourable situation for us as an operator and for the equipment.

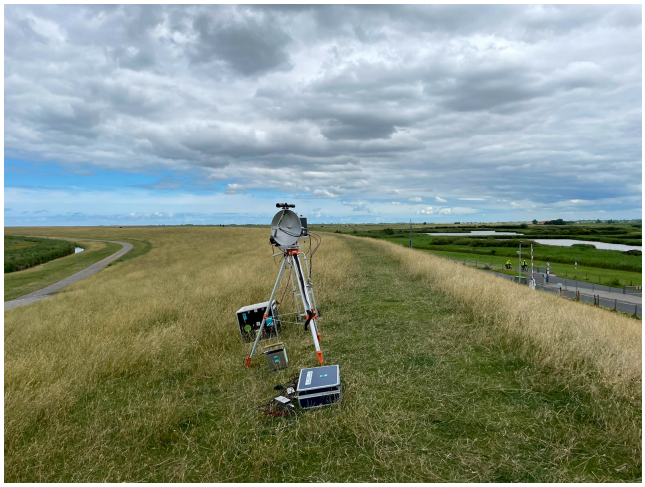
On July 27, Michael started his journey to me and in the evening we started examined the equipment extensively and tested the construction so that I knew well how everything worked and how it can be built up.

Michael next to the equipment in my backyard, explaining and testing the operation of the transmitter and receivers.

The next morning we left together on the way for the experiment on EHF bands.

Once I arrived in Eemshaven, the most important thing I had to do was to find a suitable site with good unobstructed take off. Close to the harbour I saw a pedestrian crossover the railway track, which immediately prompted me to look further into the possibilities. The crossover was a bridge with stairs on both sides and once at the top I realised that this could be a very good option. The only limitation was a high fence looking too high for the dish to look over and it for sure would block any MMwave signal. I decided to look at the corner of the bridge and see if I could stand there and keep clear of the fence. A compass was used to check whether the direction for the antenna would be clear which gave me good confidence. I decided to start using this location. The equipment was carried up the stairs and slowly I could start setting up the station. During the build-up I was called by Michael who told me that he had also found his set-up point which he wanted to use. He would start getting the equipment up to the dike and then start building up the station.

Site PA0EHG at Eemshaven



site DB6NT

We agreed that we would start the experiment at 76 GHz, Michael would be the first to transmit. A short period later I had the receiver running and I heard Michael switch on his transmitter, immediately a very strong signal. I started to fine-tune the antenna direction with the help of the received signal. The signal was way too strong and I had to uncouple the BNC IF cable to the receiver, to be able to further optimise the antenna heading. After turning the azimuth and the elevation back and forth a few times, I had my antenna optimal and the signal was again a lot stronger. Then I started transmitting and Michael took the time to align his antenna for maximum signal, again this gave a significant improvement. Then we made the QSO by exchanging reports and locator back and forth and agreed that I should listen on 122 GHz and Michael would transmit first.

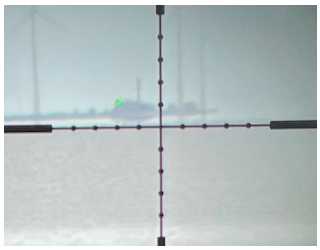
I removed the 76 GHz transverter from focus and mounted the 122 GHz receiver head. A moment later I heard the transmitter switching on from Michael who put out a carrier wave. It resulted in a strong signal which is not very much changed by further aligning the antenna. Then I went to convert my station to transmit, take the receive head out of focus and put the transmit head in.
Then turn on the transmitter and wait briefly for confirmation that my signal also came in well. At 12.54 LT we

made the first QSO, we both gave a report of 599 and my locator was JO33JL70TX and Michael's JO33MM60CH which is a distance of 16.2 km.
The QSO on 122 GHz went smoothly, after which we were able to convert to the next band, I was going to listen on 134 GHz. Remove the 122 GHz transmitter head from the antenna, insert the 134 GHz receiver head and set another switch on the front of the cabinet to 134 GHz. A short time later I heard Michael's transmitter switch on here too. The signal here was also very strong. I was going to transmit and then pass my report to Michael.
At 13.02 LT we made the QSO by exchanging the callsigns the report and the locator on both sides and confirming with RR. When I switched back to reception I was still dismantling the transmitter head from the antenna and I could already hear Michael's signal while the receiver head was hanging down at that moment. I took the receiver head and held the waveguide in the direction of Michael and the signal was easily copied with open waveguide so without using the antenna. After that the head was mounted in the focus of the antenna to have the hands free to receive and write down Michael's report.

That first QSO was also successful and it was time to try the last and highest frequency of 241 GHz. Here too I would be the first to listen, after Michael switched on the transmitter I immediately found the signal, which was not as strong as on 134 GHz but good to be able to make a QSO. I then further aligned the antenna, which gave a significant signal improvement.

In the end the signal on this band was also 599 but there was fading on it but that was no problem. After I had mounted my transmitter in the focus I was able to give the report to go back a little later and receive the report.
At 13.13 LT we made the first QSO on 241 GHz between DL and PA with back and forth 599 reports and exchanging locator and RR. Then I asked Michael to set up a carrier again to try and see if I could hear the signal with an open waveguide. If it was audible, it was in any case too weak to determine with certainty. After that we tried to make an SSB QSO which is possible on this band. We could hear the signal back and forth but it was just too weak to understand it. If it had been 2 to 3 dB stronger it should have worked.

Using our 70 cm talkback frequency, we talked for a while and then I suggested that a strong green LED be mounted in the antenna to try and see if Michael could see this from 16 km away. At first I had mounted the LED but it was not in focus properly, when I did put it in focus the green light was immediately seen on the other side, which was something I personally did not expect because we were in daylight during our testing.



The green light from the dish is visible on the other side about 16 km away.

After that we agreed what we wanted to do further and decided that Michael would come over to the Netherlands and then also make the first connection within the Netherlands on 134 and 241 GHz over a short distance.
The ride Michael had to make took a lot longer than expected for a distance of 16 km straight line. I had to wait almost 2 hours for him to arrive at my place. We therefore decided to make the first ever QSO within the Netherlands over a short distance, which we could see from the bridge.
After Michael had driven there and had set up the equipment, we were able to make the QSO's within PA0 on 134 and 241 GHz.
At 16.10 LT we made the first QSO within the Netherlands on 134 GHz in CW and immediately afterwards at 16.16 LT we made the first QSO within the Netherlands on 241 GHz in SSB.

Then dismount all the equipment and bring it back to the car and pack it up and start the journey home. Once we got home, we had a good meal and a pleasant evening where we looked back with enthusiasm on the

experiments of this day. We have already discussed plans for a possible follow up and after the evening had already passed into the small hours we went to bed. The next morning Michael started his journey home.

Looking back on this experiment and the things that are remarkable, I have to say that there are a number of things that are very striking.
First of all, it is more than obvious that we received very strong signals back and forth, that is primarily due to the fabulous station that DB6NT built. Output powers that burn your finger when you hold it in front of the waveguide are really unprecedented for these bands. At 122 GHz, the transmitter has an output of no less than 200 milliWatts. At 134 GHz, the power is about 150 milliWatts. The receivers are also of high quality with a noise figure of 5.5 dB DSB at 122 GHz and 5.5 dB DSB at 134 GHz. At 241 GHz, the output power is 25 milliWatts and the noise figure is 9 dB DSB.
The parabolic reflector has a diameter of 40 cm, which provides an enormous antenna gain, which has the downside that the alignment must be done very accurately. In practice that was not so bad for me, the enormous field strength we received made it very easy. Looking for the needle in the haystack was not necessary and from the first moment the transmitter was switched on, it was also received on the other side.
Also striking for me was the enormous frequency stability of the local oscillators, GPS-locked systems are not used because experience shows that they are sometimes disturbed when testing is done at special locations near GSM masts. Also now I was very close to a radar installation which could possibly be a source of interference on a GPS locked oscillator.
10 MHz oscillators are used in the equipment, which work very stable and already give good stability after 5 minutes of warming up. It was not even necessary to tune more than a few hundred hertz during the experiments. An enormous advantage which, when finding very weak signals, makes it possible to search for direction only with the antenna and not have to search over a large part of the frequency.

The experiment with the green LED light was also quite successful, first of all it shows that there was a real optical view between the two locations. I did not expect that this would also succeed so well during daylight, which makes it a meaningful and successful experiment.

A Link to my Webseite
http://www.pa0ehg.com/

A Link to Michaels Webseite
www.db6nt.de

The link to the Technical documention from Michael.
http://www.db6nt.de/download-archiv.html

Link to the Video we made from this experiment and first ever QSO's.
https://www.youtube.com/watch?v=Gs9txoXLufE