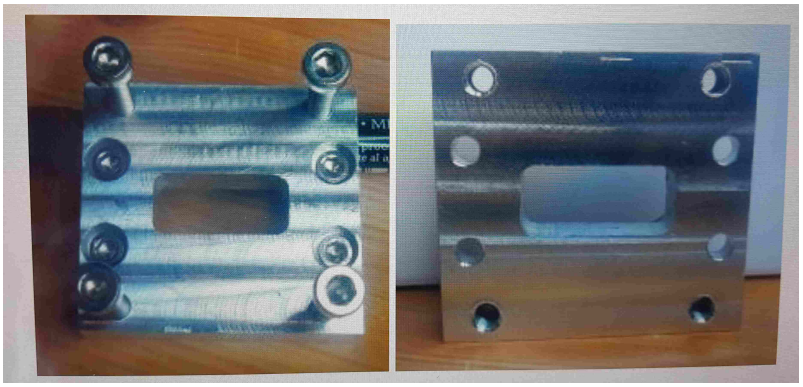
Testing various feed-choke combinations for 10Ghz – PA0PLY Aug. – 2023

Introduction.
Although I am happy with the performance of my 3cm EME set-up, there was some concern in respect to the Moonnoise measured with my system. I always measure a lower value compared to the value indicated by the simulation software of the late Dough, VK3UM.
In the summer of 2022, further investigation was done with the joint help of Hans, DC1EHG and John PA7JB, in order to see if some improvement of the system is possible.

Following points were adressed during the investigation:

- Pre-amp performance.
- WG-16 to Round 22mm transition.
- Dish performance.
- Illumination of the dish.
- Various feed-choke combinations.
- Testing in an antenna testroom.
- Actual measurements with the dish.

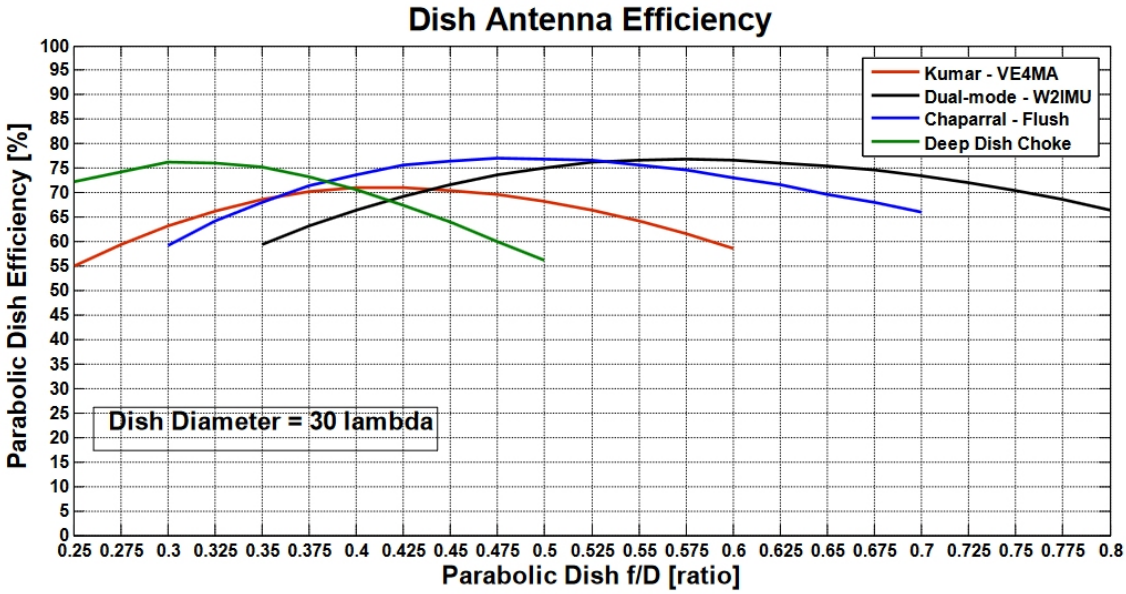
Pre-amplifier performance.
The pre-amplifier used in my system is a model: DU3T. The pre-amplifier was tested as a stand alone item using an EATON 2075B Noise Gain Analyser. The measurement confirmed the given specifications for a Noisefigure of 0.52dB. The pre-amplifier input connection is WG-16, while the used WG-switch is a WG-17 type waveguide connection. Therefor a small 10.1mm adapter is used for proper matching. Waveguide dimensions: 9.8 x 21.1mm



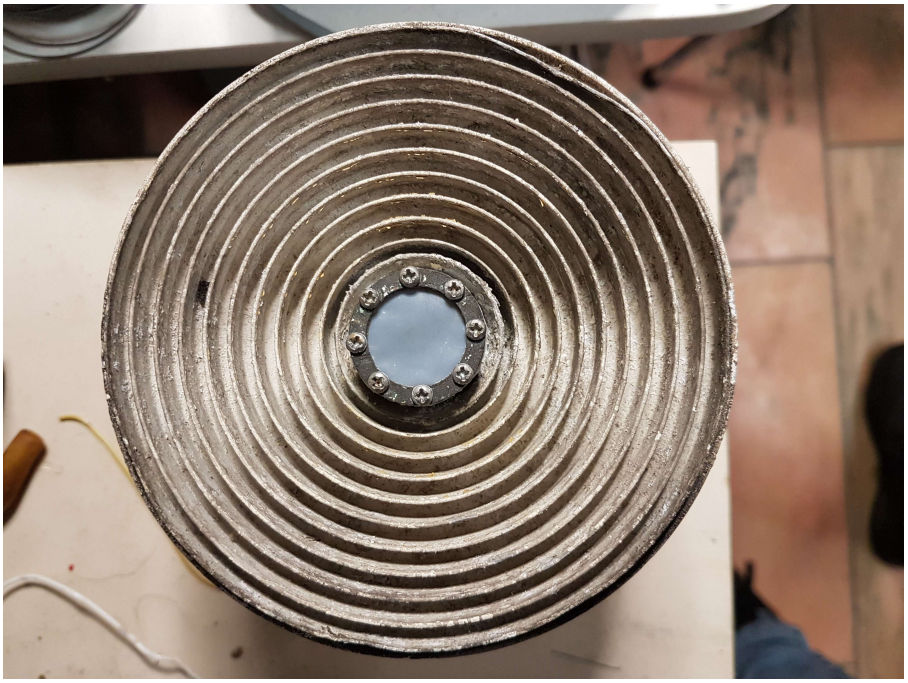
WG-16 to Round 22mm transition.
The feed is connected to the WG-switch using another adapter to WG-16.
The connection for the feed is a transition from WG to round Copperpipe with an outside diameter of 22mm. The inner diameter is 20mm.
Several transitions were measured for optimal Returnloss performance. Rather then using tuning screws, it was found that the Returnloss can also be tuned by tweaking the length of the Copperpipe. Figures of Returnloss were found in the range of –17dB to –23dB.

Transition WG16 to Round 22/20mm Cu (PA7JB).

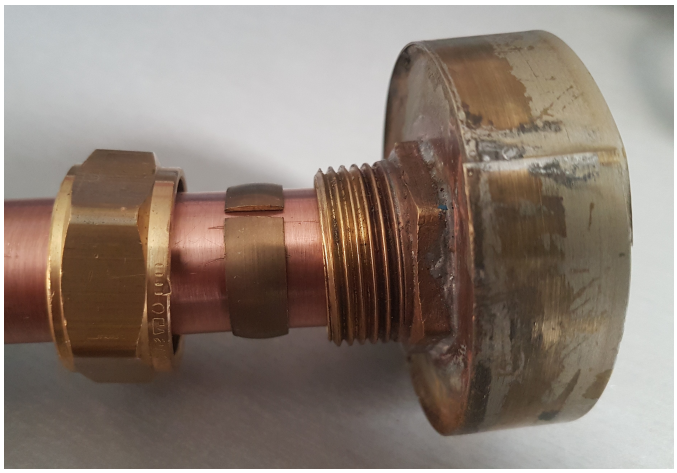
Dish performance.
After some investigation it was concluded that this dish is a so-called deep dish with its f/D of 0.3. Based on this conclusion, there were some doubts if it was possible to increase it's overall performance. Most of the feeds published are tuned for dishes with a larger f/D (more then 0.35). There are several publications reflecting the use of a particular feed system for a typical f/D dish.



Besides this, there was some serious concern about the effect of the painting on the dish surface. We knew that a corrugated feed used in the dish of Hans, DC1EHG, also f/D=0.3, gives a good performance. Using his feed in my dish, at least confirmed that the paint is not the source of less optimal performance.

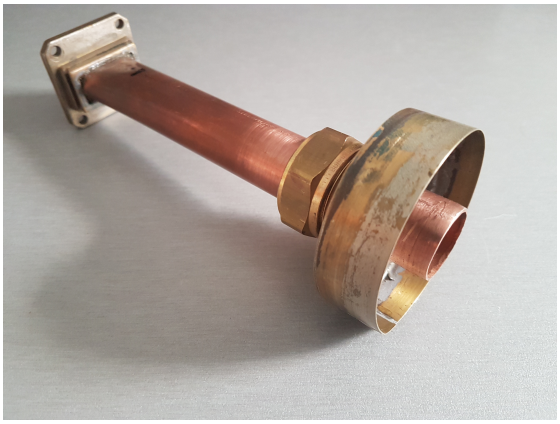

Corrugated feed example

Various feed-choke combinations.
Based on above investigations, it was concluded that the possible improvement could only be realised using a proper feed-choke combination.
So far a KUMAR choke design published by Ingolf, SM6FHZ was used. Possible other candidates are a Chaparral type of choke, like used by LX1DB and DL1YMK as well as another feed designed by Rasto, OM6AA. The latter was published in DUBUS-2014 and designed for a dish with f/D=0.3.
Both the KUMAR and CHAPARRAL chokes were constructed using a Copper screw fitting for 22mm Cu-pipe. This ensures a good RF contact all around the body of the pipe.

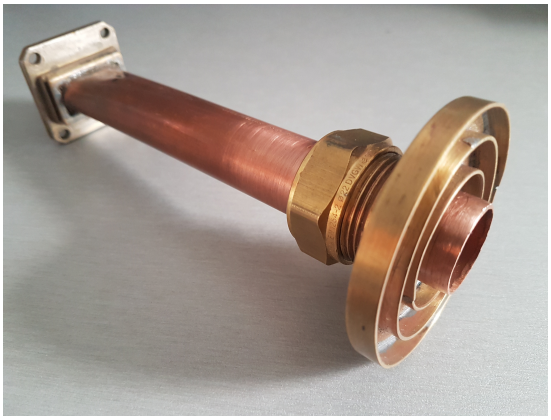


Fitting a choke to the 22mm CU-pipe.

Using this construction it is possible to adjust the position of the choke in order to match the best performance for each set-up.

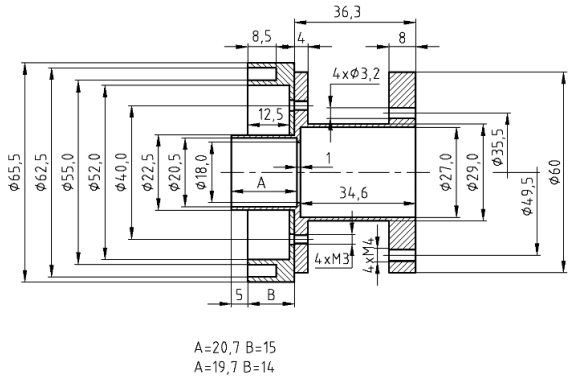


KUMAR Choke

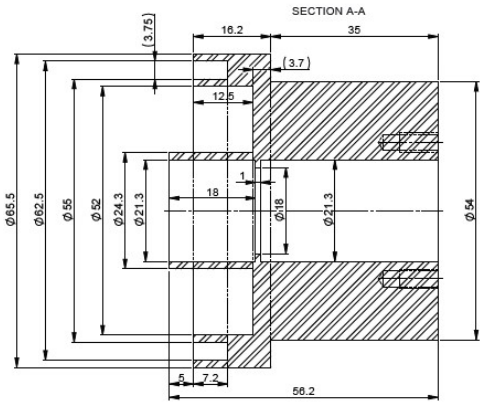


CHAPARRAL Choke

The feed designed by OM6AA.
Described in his very nice article published on his website and in DUBUS as well, I considered to use the design of Rasto, OM6AA, with some change in order to be able to fit it onto a 22mm Cu-pipe.
The choke design published in the article on his website turned out to be slightly different from the one which was published in the DUBUS magazine.
After consulting Rasto, he informed that the Website version has a little wider beamwidth, compared to the DUBUS version. The Website version is optimised for TX, while the DUBUS version is optimised for RX performance.

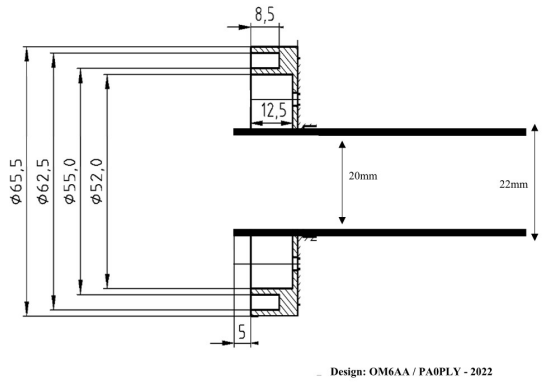


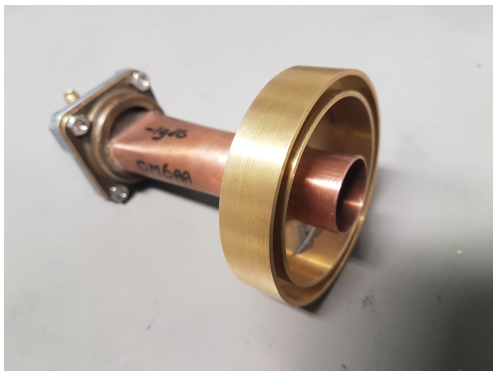
OM6AA feed for f/D=0.3 (Website)



OM6AA feed for f/D=0.3 (DUBUS)

Looking at both designs, it was not clear what the function of the implemented iris was. After some discussions, it was concluded that the iris is used for impedance matching between the different sizes of waveguides used in this design.
The design was modified in order to have it fit onto a 22/20mm Cu-pipe. Now there are no different waveguide sizes in the design and possible matching might be done by using 3 tuning screws in the Waveguide section.



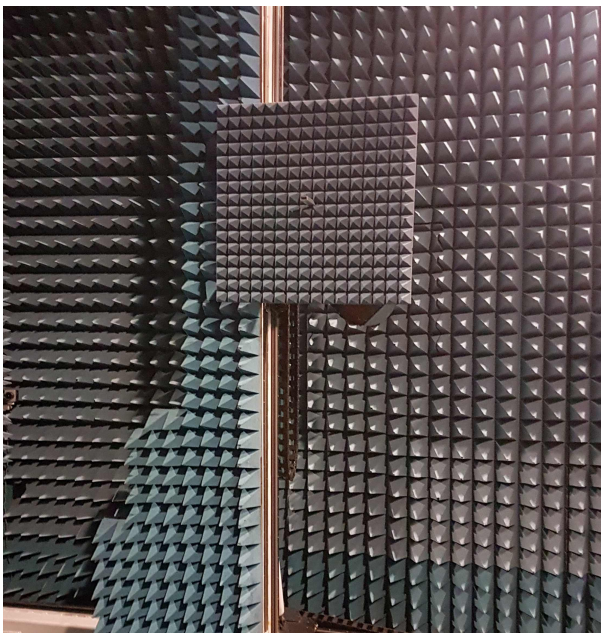


OM6AA feed for f/D=0.3 modified Pa0PLY version

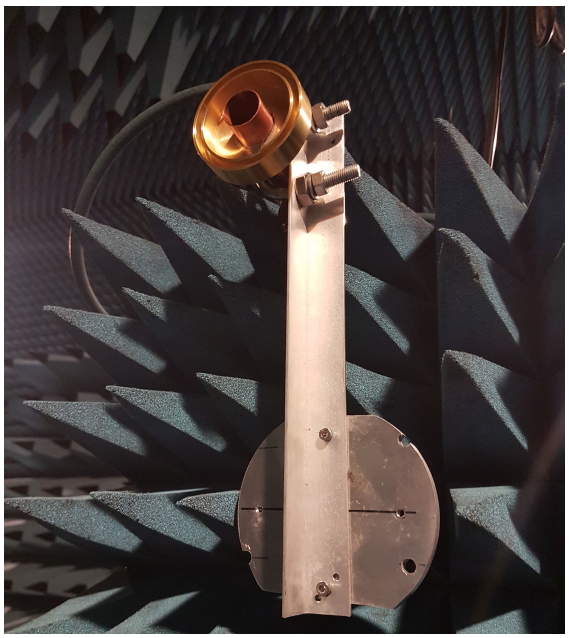
The choke was produced by Bert, PE1RKI. Initially I used some screws to fit the choke onto the Copperpipe. After some testing we decided to fully solder the choke onto the Copperpipe for maximum RF contact. The distance between the choke and the feed mouth was kept at 5mm, same as in the original OM6AA design.

Testing in an antenna testroom.
To get a good idea of the performance for various combinations testing in an Antenna Test room would of help.
Together with Nico, PA3ADU, we spend several hours in a professional full anechoic antenna testroom for antenna pattern measurements. Such a room makes it possible to generate patterns of a test antenna with minimum reflections and surrounding effects of walls, ceiling and floor, avoiding triple transit phase errors.

For the source antenna an open waveguide was used, surrounded by absorbing materials.
The testposition is also surrounded by RF absorbing materials, in order to ensure minimum influences from the positioner. In order to compare various test objects, an open waveguide was used as the reference antenna.
Another test we wanted to perform is the possible influence of a plastic dustcap such as used on the Bulls-Eye LNB.



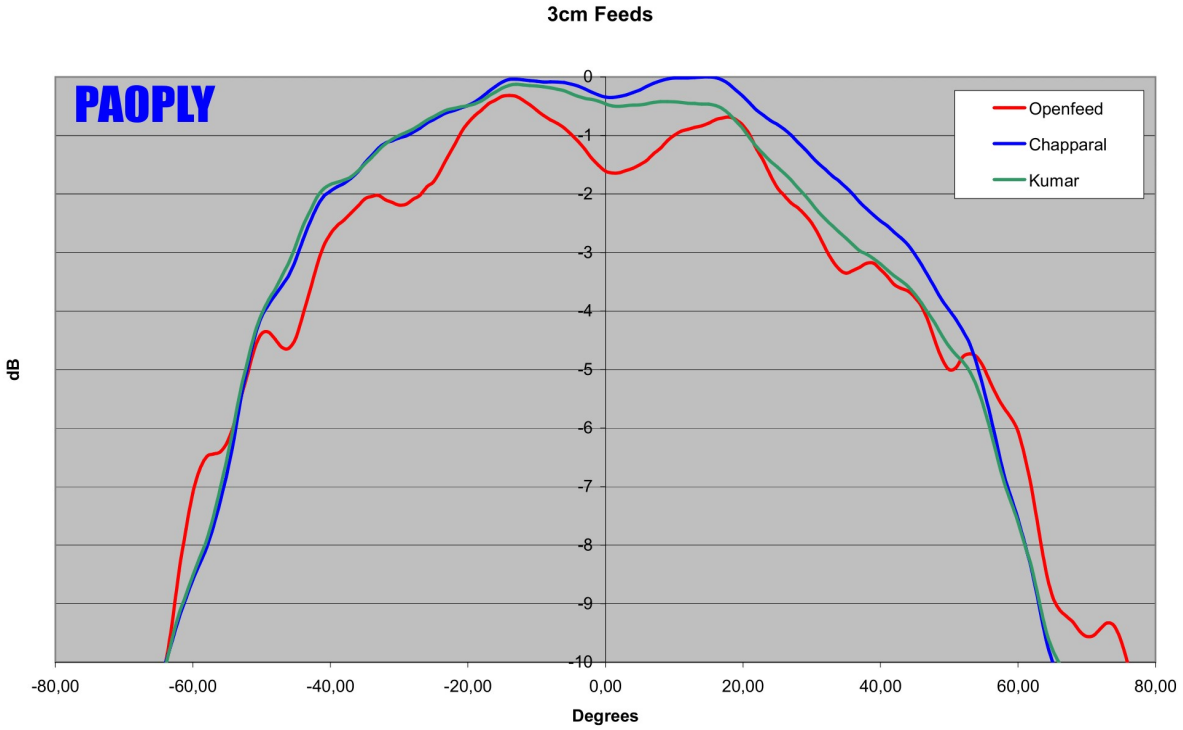
Source Antenna.



Test position.

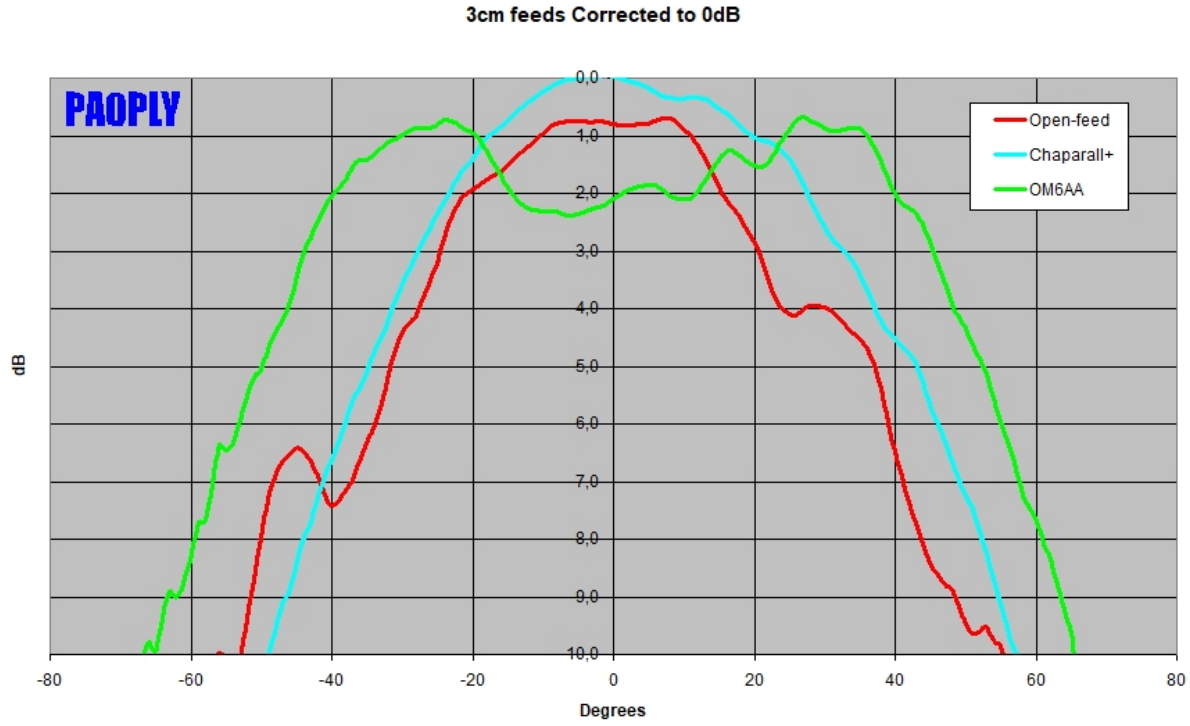
Tests were performed over an range of +85 Degrees to –85 Degrees Azimuth from boresight in steps of 1 Degree, while keeping the Elevation constant.

Performance comparison between KUMAR - CHAPARRAL- Open feed.
The picture below shows the comparision between the open feed and the use of two different chokes. Please note that the measurement results are normalized to the feed with the highest forward gain.

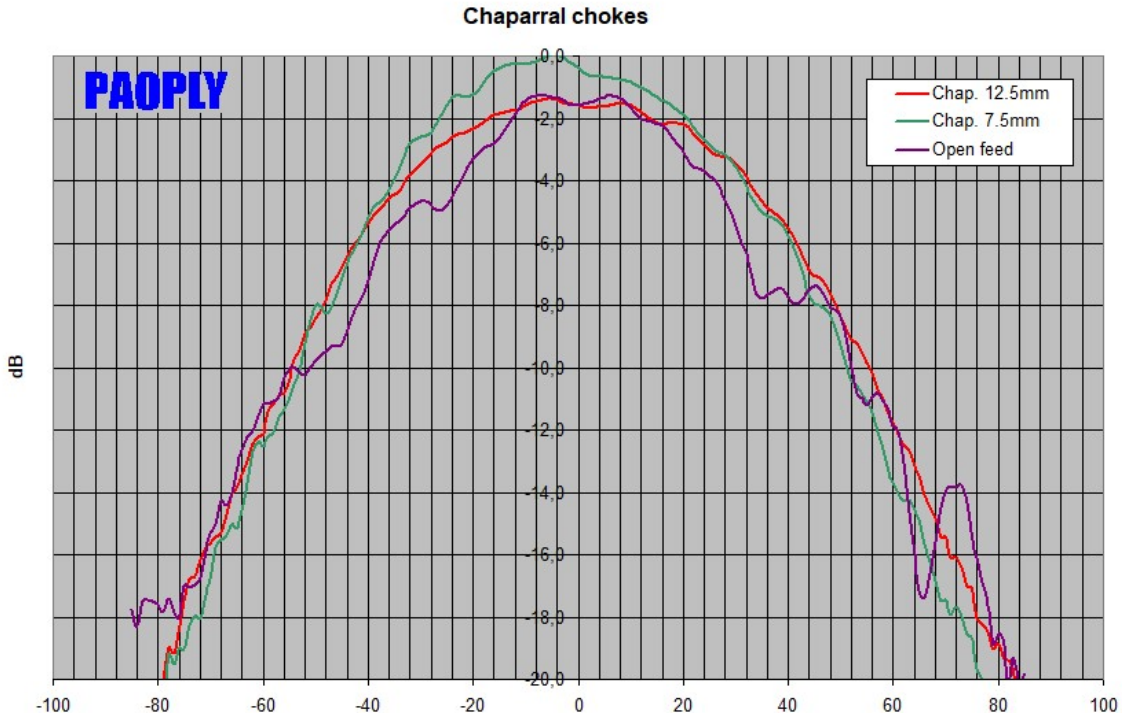


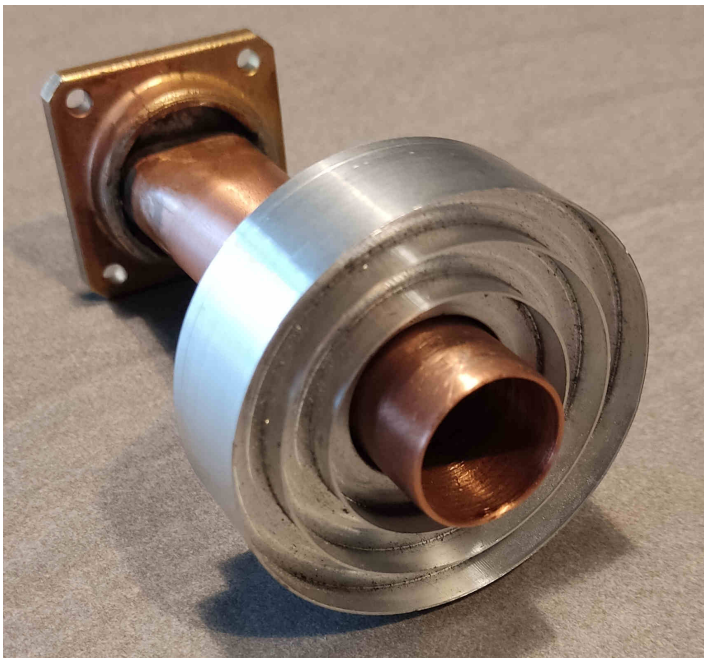
Below –10dB no noticable differences were found. The Chaparral choke shows a little better performance compared to the Kumar choke. These tests were performed on the same waveguide feed, using the screw fitting to mount the chokes.

Performance comparison between OM6AA - CHAPARRAL- Open feed.
A second set of testing was performed a couple of days later. Here the comparison was made between the Chaparral choke fitted on the open waveguide and another feed with an OM6AA choke soldered onto the copper pipe.



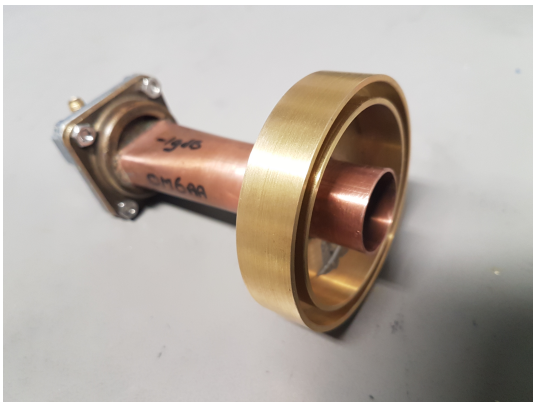
Performance comparison between CHAPARRAL chokes at different distances.
Sine the position of the choke relative to the mouth of the waveguide is adjustable, two different positions of the Chaparral choke were tested, to see the effect on the beamwidth.

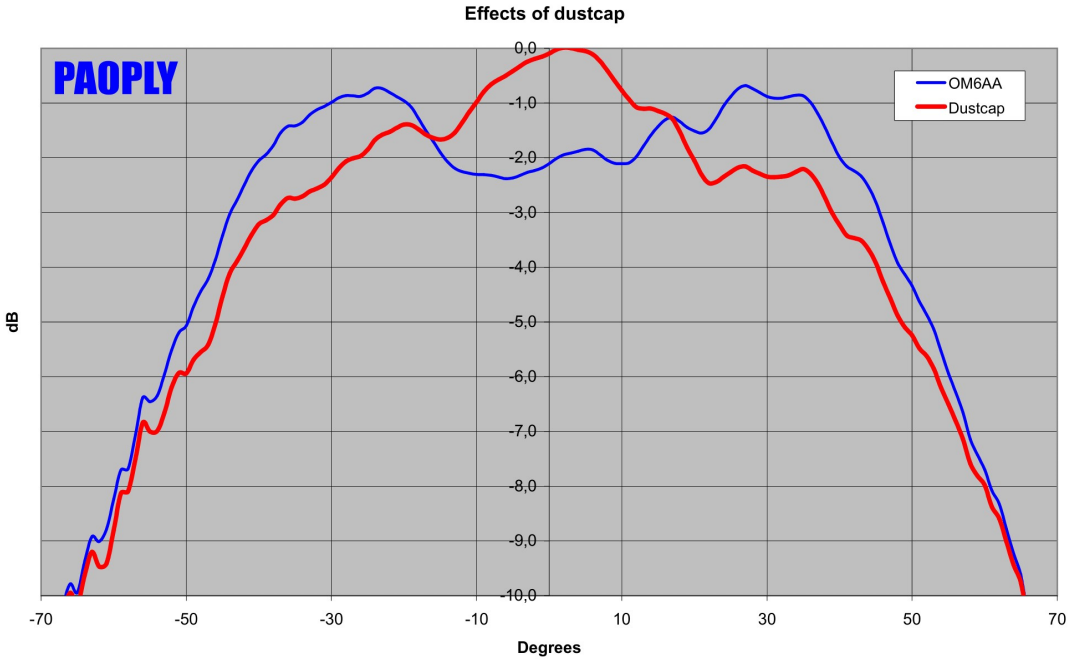




Typical Chaparral choke feed (PA3CSG)

Performance comparison between OM6AA – with and without dustcap.
Since we wanted an optimal situation, possible influences on the performance caused by a dustcap were tested. Dustcaps are more or less standard on every standard LNB. The dustcap available, orginates from a Bulls-Eye LNB.

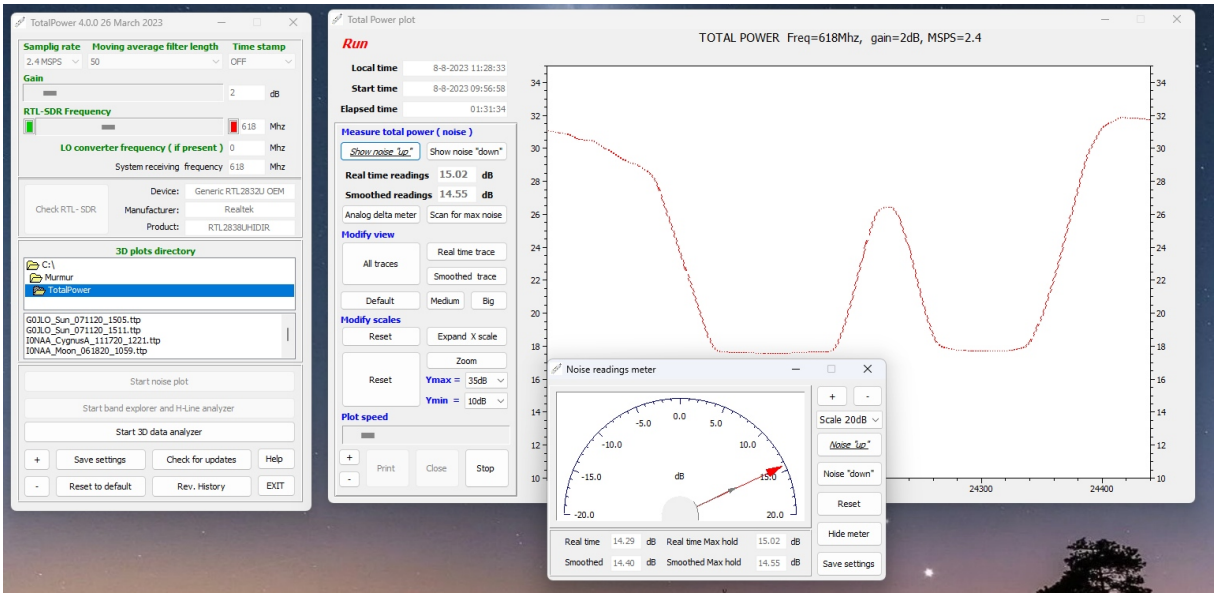




Performance testing using the 3m dish.
Final performance testing was performed using the 3m prime focus dish with f/D-0.3.
For optimal adjustment a small actuator was installed to be able to adjust the feeds to the focusposition more accurately.

Remote controlled actuator for optimal focus positioning.

The feeds are connected to the waveguide switch and pre-amplifier. Then a Bulls-Eye LNB converts the 10368Mhz frequency down to 618MHz, which is fed to a RTL-dongle.
The RTL dongle is connected to the Total Power software of Mario IoNAA.
The measurements were performed for Sunnoise readings. The Sun position was more then 45Degr ELE to avoid possible ground and environmental effects.



Example of Sunnoise measurement using Total Power software (I0NAA)

Results.

Feed type	Sunnoise	Remarks
Open waveguide-22mm	13.5dB	Reference measurement
Kumar choke SM6FHZ	14.6dB	Screwed fitting
Kumar choke SM6FHZ *	15.2dB	Soldered version / Rl –20dB
Chaparral choke	14.4dB	Screwed fitting at 7.5mm
OM6AA choke	14.7dB	Soldered version with dustcap
OM6AA choke *	15.2dB	Soldered version no dustcap / Rl –19dB
OM6AA choke & Dustcap	2.0dB	Moonnoise

Note: * These tests were performed in sequence within 1 hour, to avoid possible changes in the sunflux.

Final conclusion.

- Both the SM6FHZ Kumar type of choke as well as the OM6AA type of choke are giving a good result for a deep dish with f/D = 0.3.
- Carefully construction for the Kumar choke is required to get the best results.
- Using the screw type of connection compared to soldering of the choke onto the copperpipe results is an degradation of 0.6dB
- Using a dustcap, like the one delivered with the Bulls-Eye LNB, will result in a degradation of 0.5dB
- The transition from a waveguide to round 22mm copperpipe can be done using a WG-16 type flange. The copperpipe will more easily fit into a WG-16 flange rather then the smaller WG-17 version. Depending on availability it is wise to opt for a system set-up using one type of WG, in order to avoid the use of adapters from one to another size waveguide.
- Sunnoise measurements using a RTL-dongle and the I0NAA software is an good tool to evaluate the overall performance of a system.

Support & References.

A great thanks for the support during the entire investigations to:

- Hans van Alphen, DC1EHG
- John Lambo, PA7JB
- Nico Ebbendorf, PA3ADU
- DL1YMK, ON4BCB, SM6FHZ, DL3WDG.

References:

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