76 GHz EME – The Next Frontier

First Ever two-way 76 GHz EME QSO by Amateur Radio

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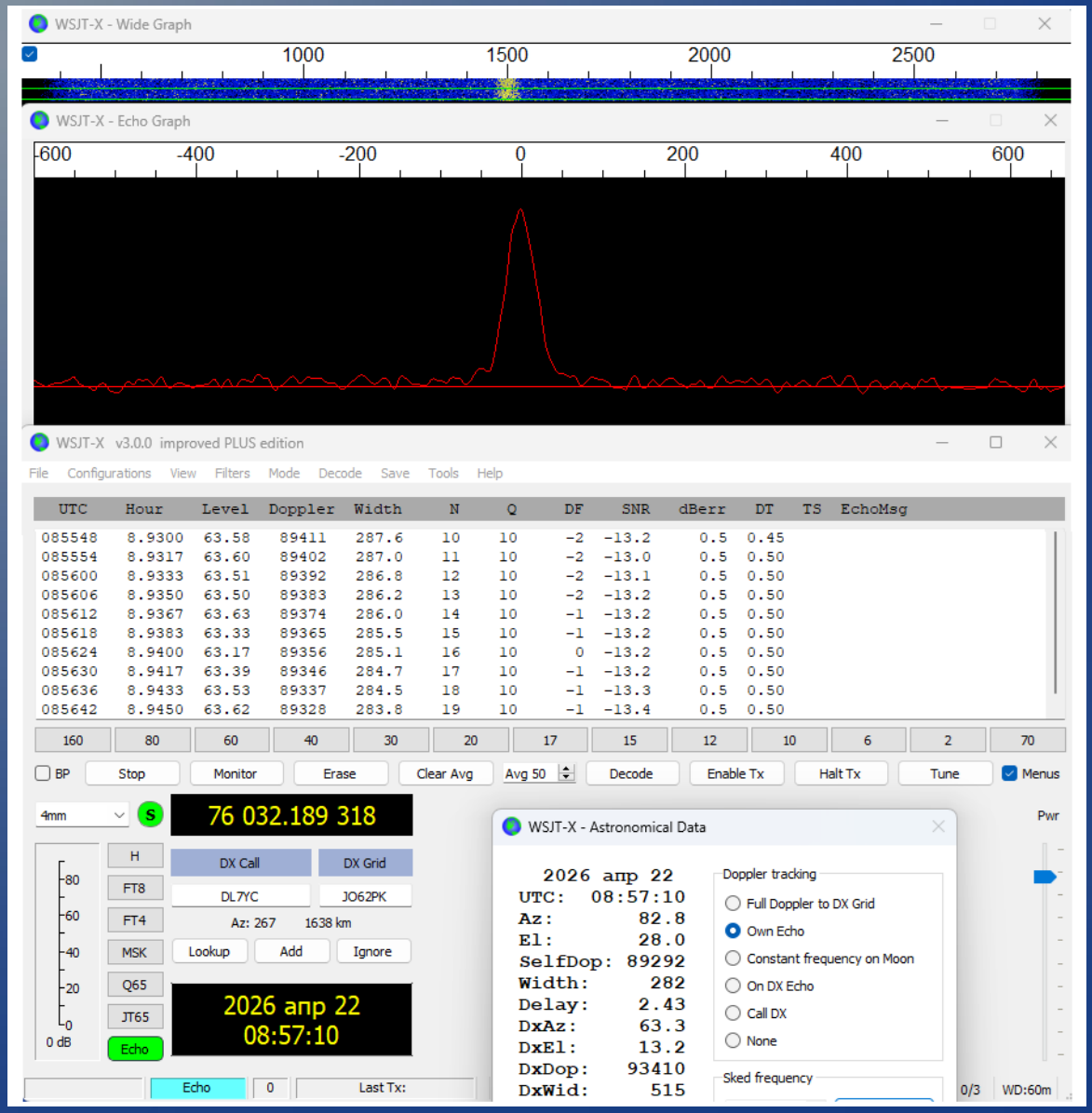
Introduction

- EME radio amateur communication becomes increasingly complicated the higher the QRG
- Above 40 GHz there is still much unknown territory to explore
- Tracking precision, Atmospheric losses, Spectral broadening due to Libration become more and more important

Medium Term Goals

- Improvement of the Noise-Figure (now 2.2-2.5dB)
- Better understanding of the weather influence
- Comparison and study of the predicted Libration versus the actual Libration using a 2.4m reflector which narrows the beam more

Echo Tests with 8.1W at RW3BP



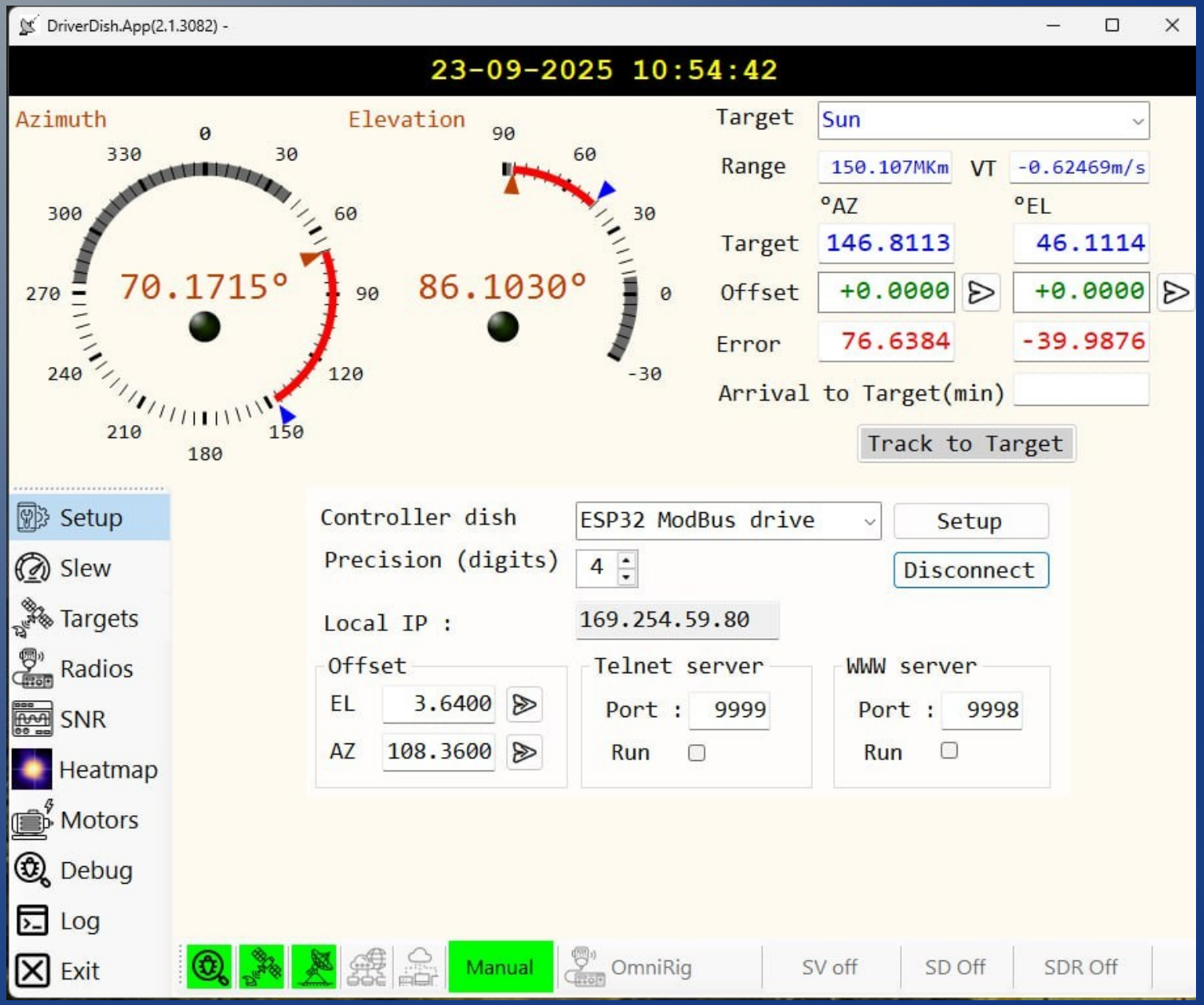
How About the Current Situation?

- The influence of the system noise figure is assumed to be known

- Likewise, the adherence to frequency accuracy through GPS locking is assumed to be understood

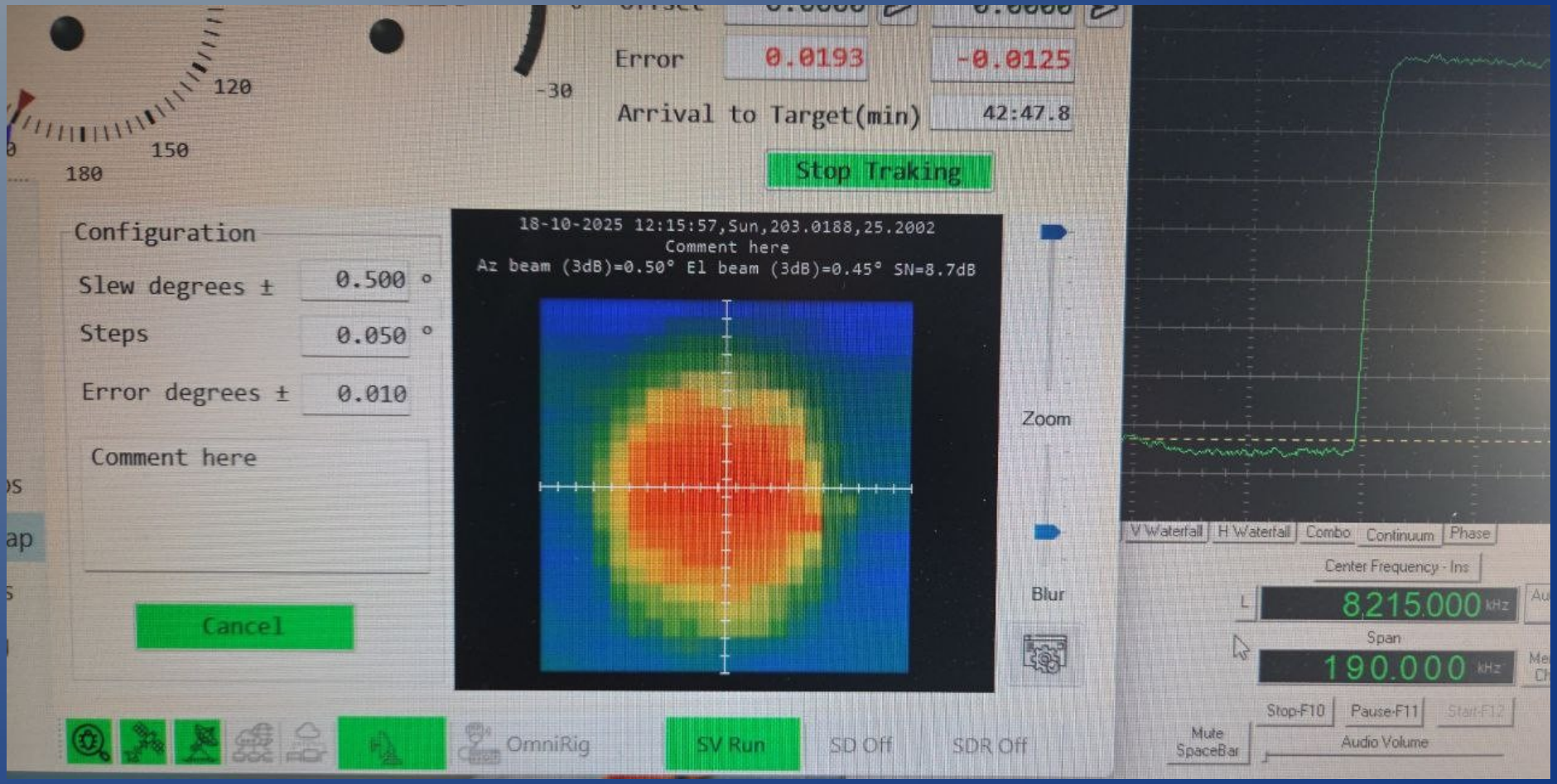
- The TRACKING ACCURACY is largely under control (+/-0.005 deg) thanks to use of dual-drive precision gearboxes, 18-bit angle encoders, and EA3HMJ hardware & software

DriverDish App developed by EA3HMJ



Heatmap Feature Verifying Tracking

The noise in SpectraVue is measured from IF

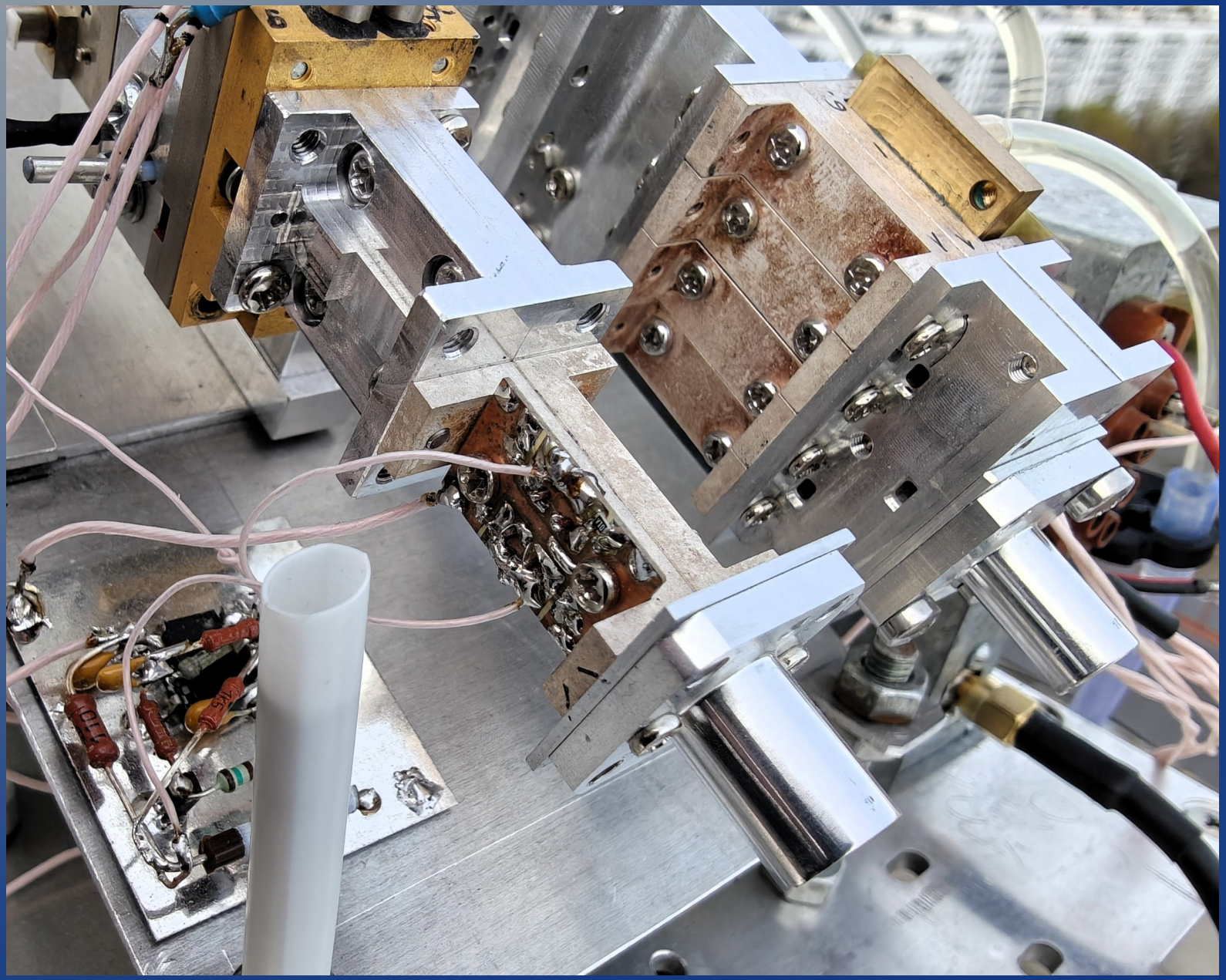


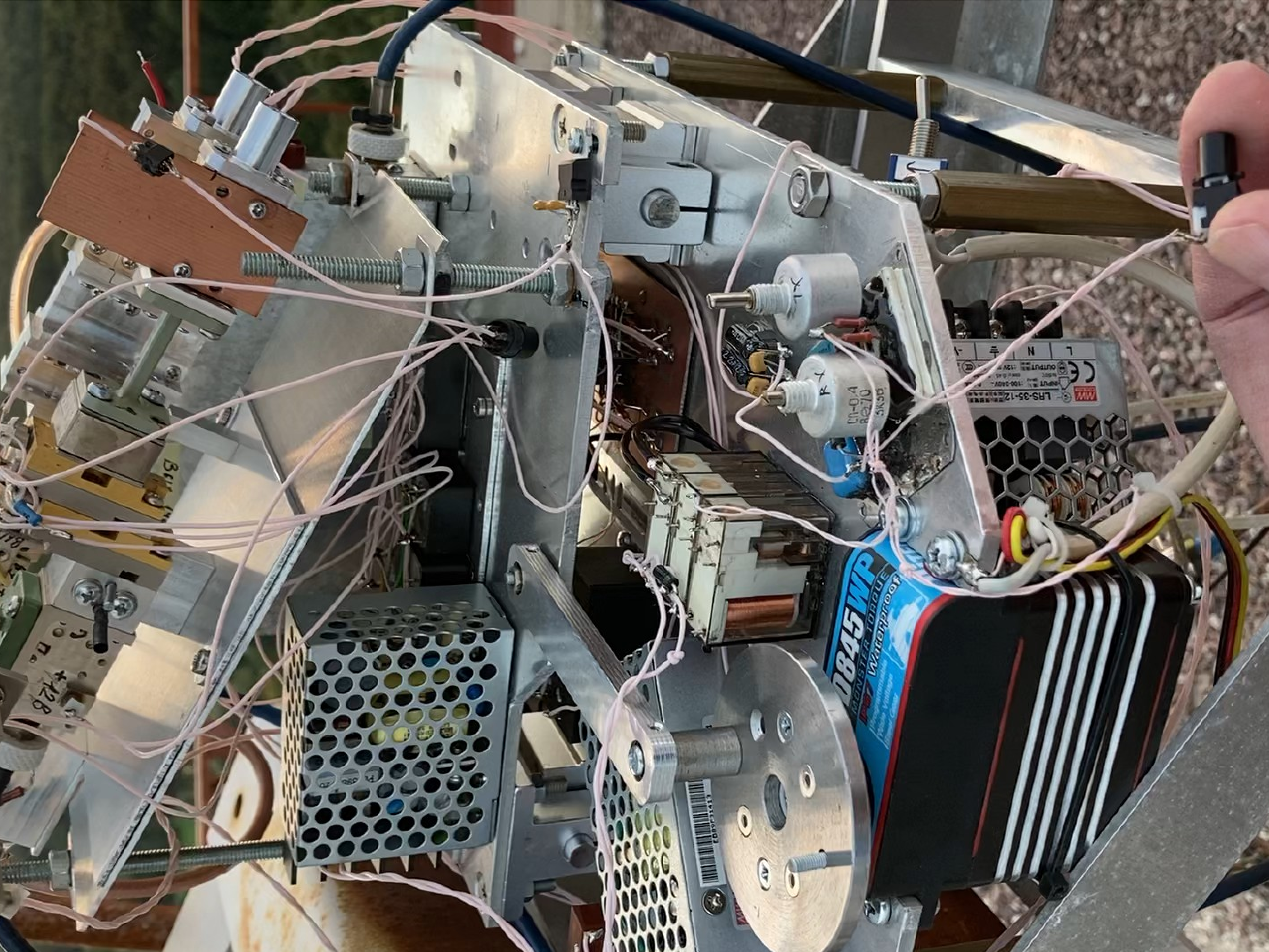
Situation at RW3BP - KO85vs

Gregorian 2.4m Offset Dish System

CNC milled sub-reflector. It’s profile corrects antenna RMS parameter. Gain improvement of about 2 dB.

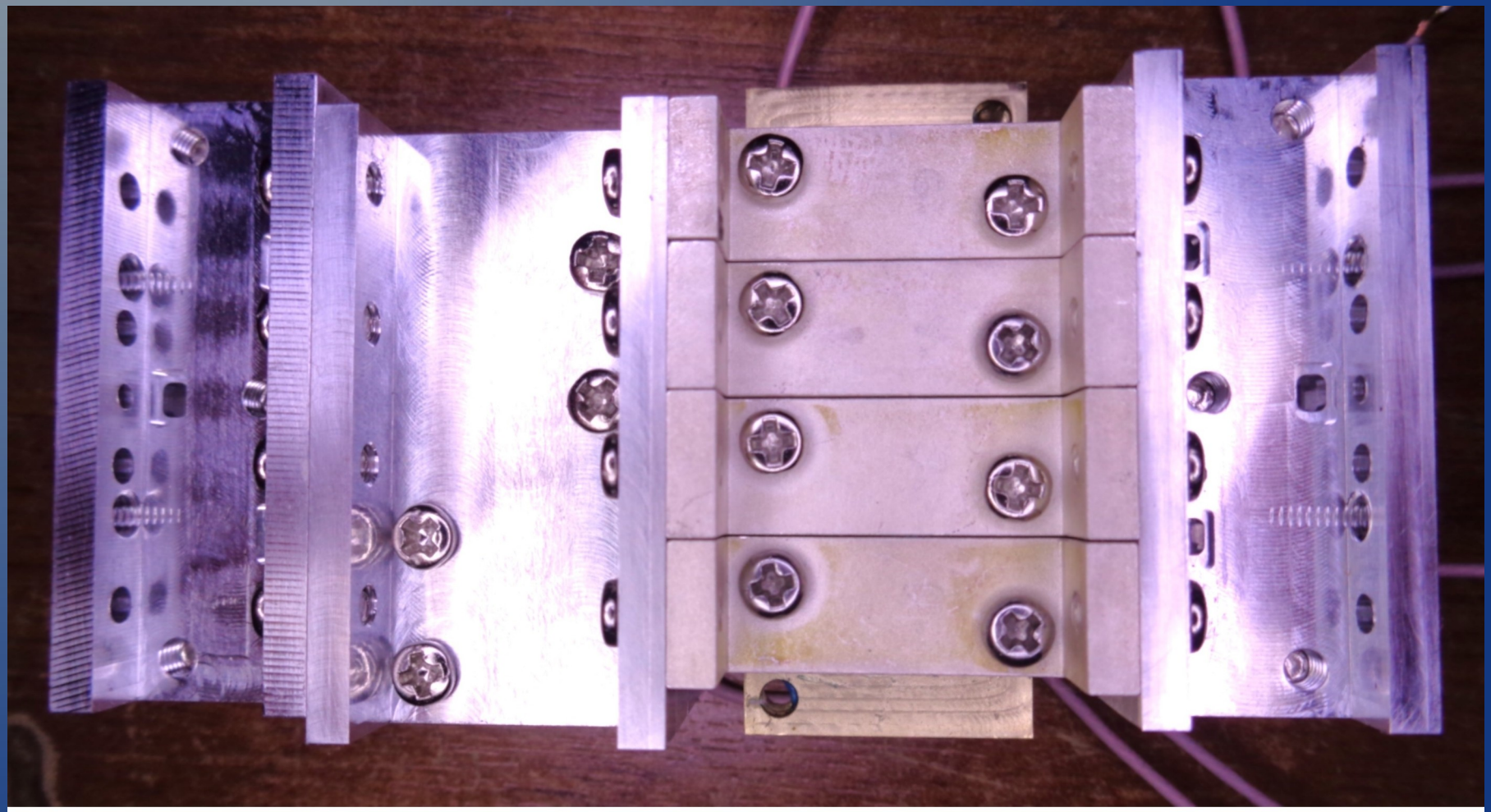
Closeup of the RW3BP Outdoor Unit




D845WP
MONSTER TORQUE
Waterproof
LRS-35-12

RW3BP 8.1W homebuild 76 GHz SSPA

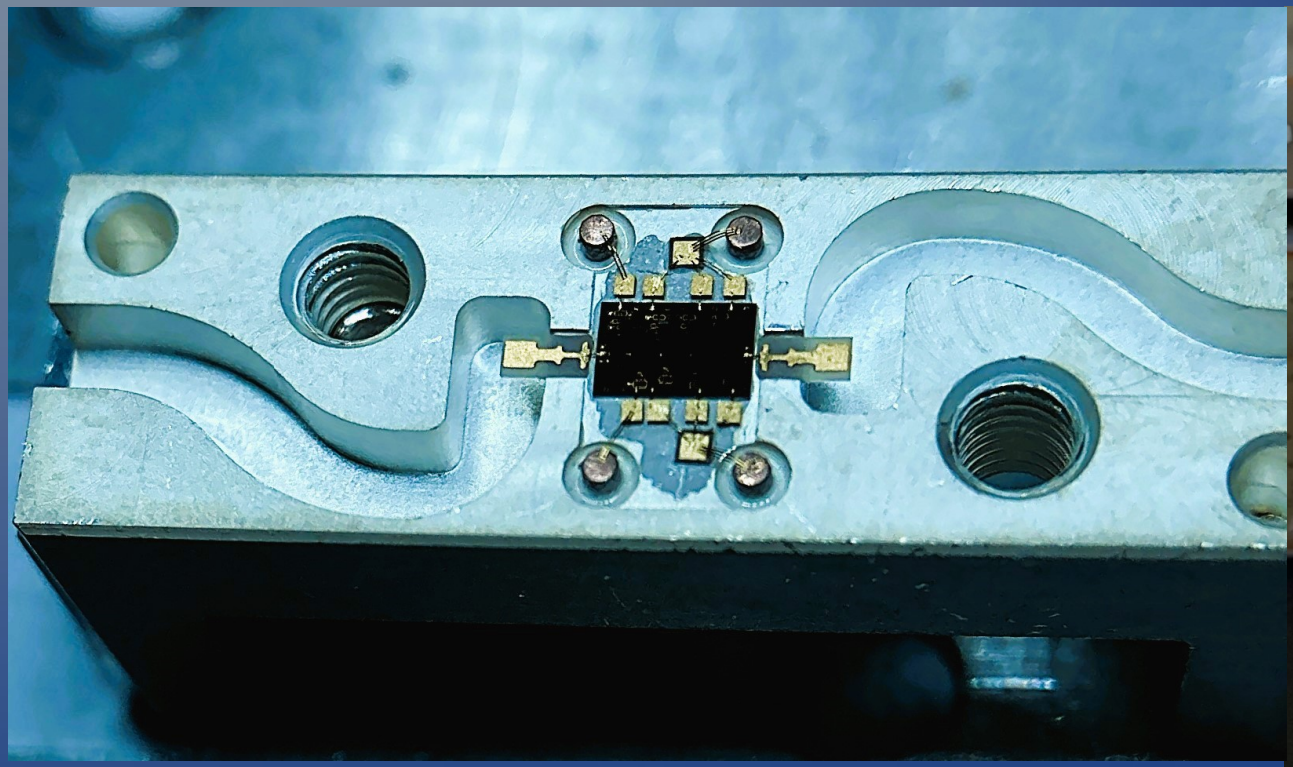
- 4 x 2.2 W Amplifiers

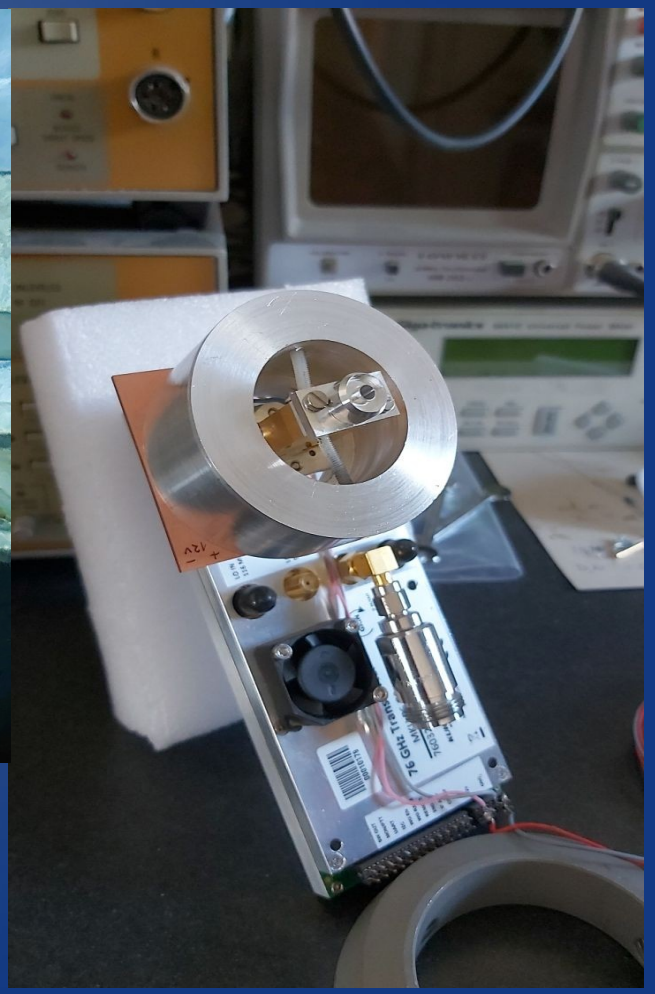


DIVIDER PHASE SHIFTER 4 x 2.2W AMPS COMBINER

Uncooled LNA`s - NF < 2.5 dB

- RW3BP 2.2 dB low noise 76GHz preamps with CGY 2190UH/C2

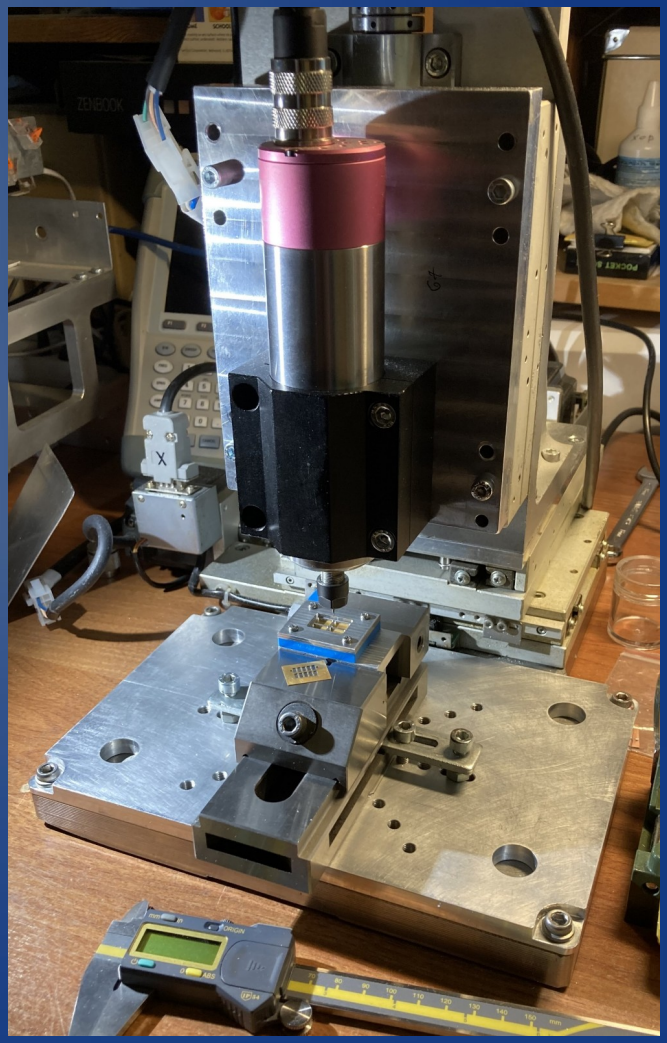




RW3BP In the Home Workshop

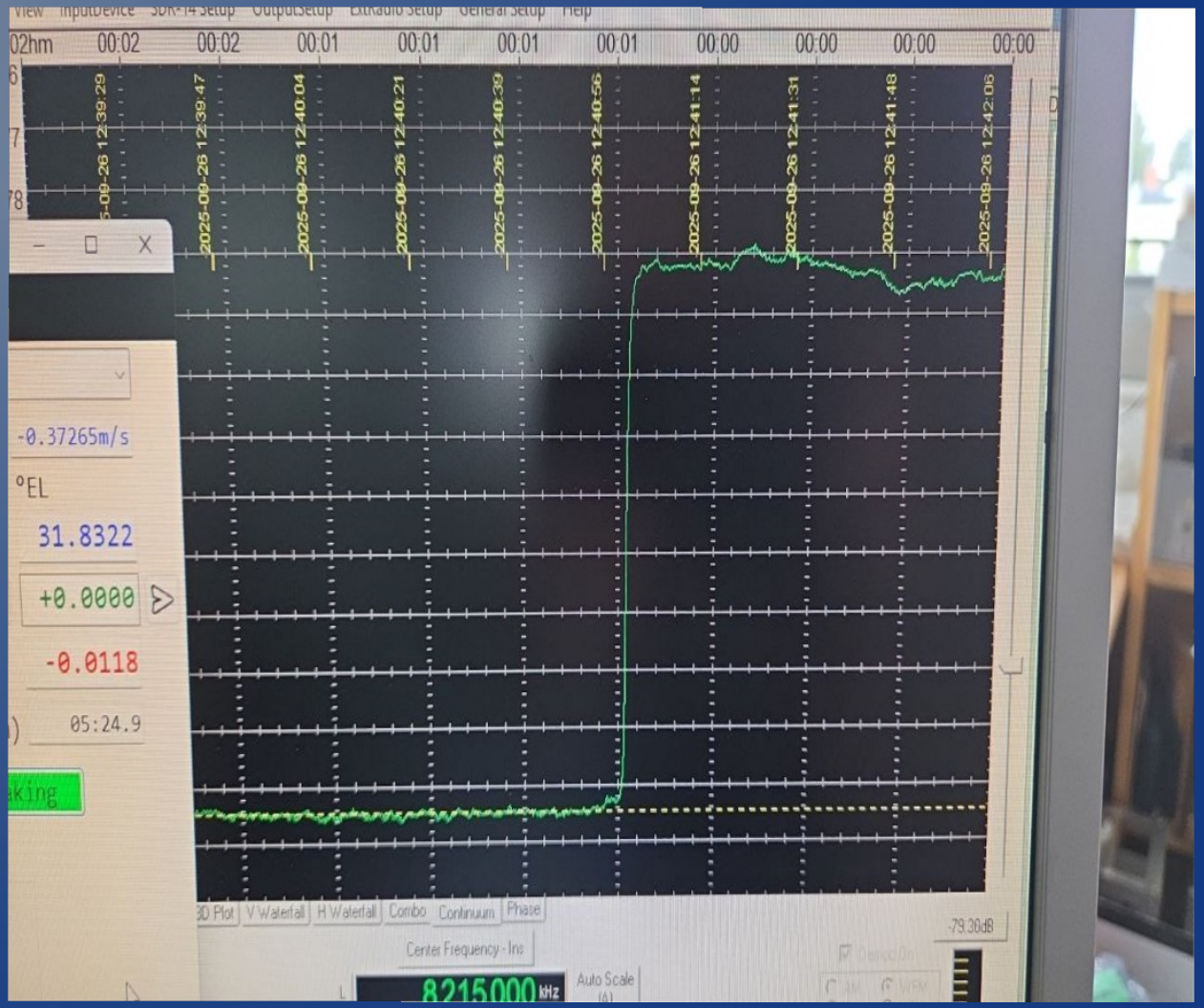
Wire bonding

Microstrip milling

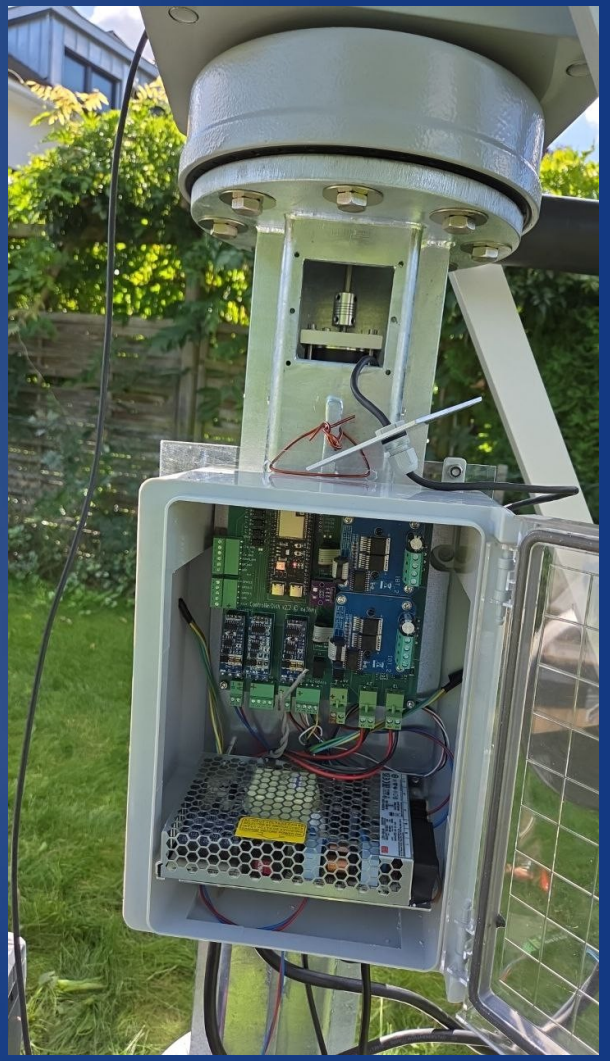


DL7YC TRV – LNA – SpectraVue

IF: 8.1MHz - Linearity controlled with R&S Video Noise Meter



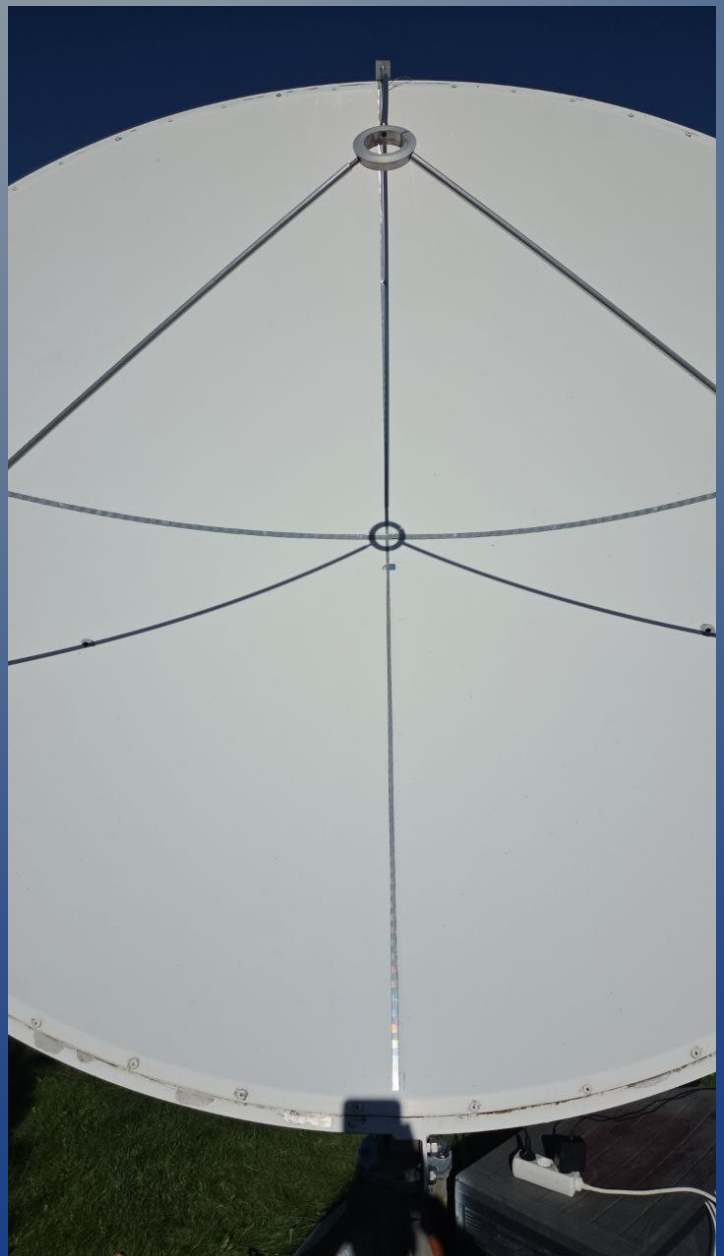
DL7YC Dual Slewing Drive with 18-Bit Encoders



Development So Far

- With this prior knowledge, extensive reception tests were undertaken in October 2025 between RW3BP (TX 8.1 Watts) and DL7YC
- The choice of test days and times was important (10.10.2025)
- The influence of the weather is far less critical than assumed (as was already the case with 47 GHz too)
- The required TX power was unknown and could now be verified for the first time !!

Reflector Adjustment Using the Sun



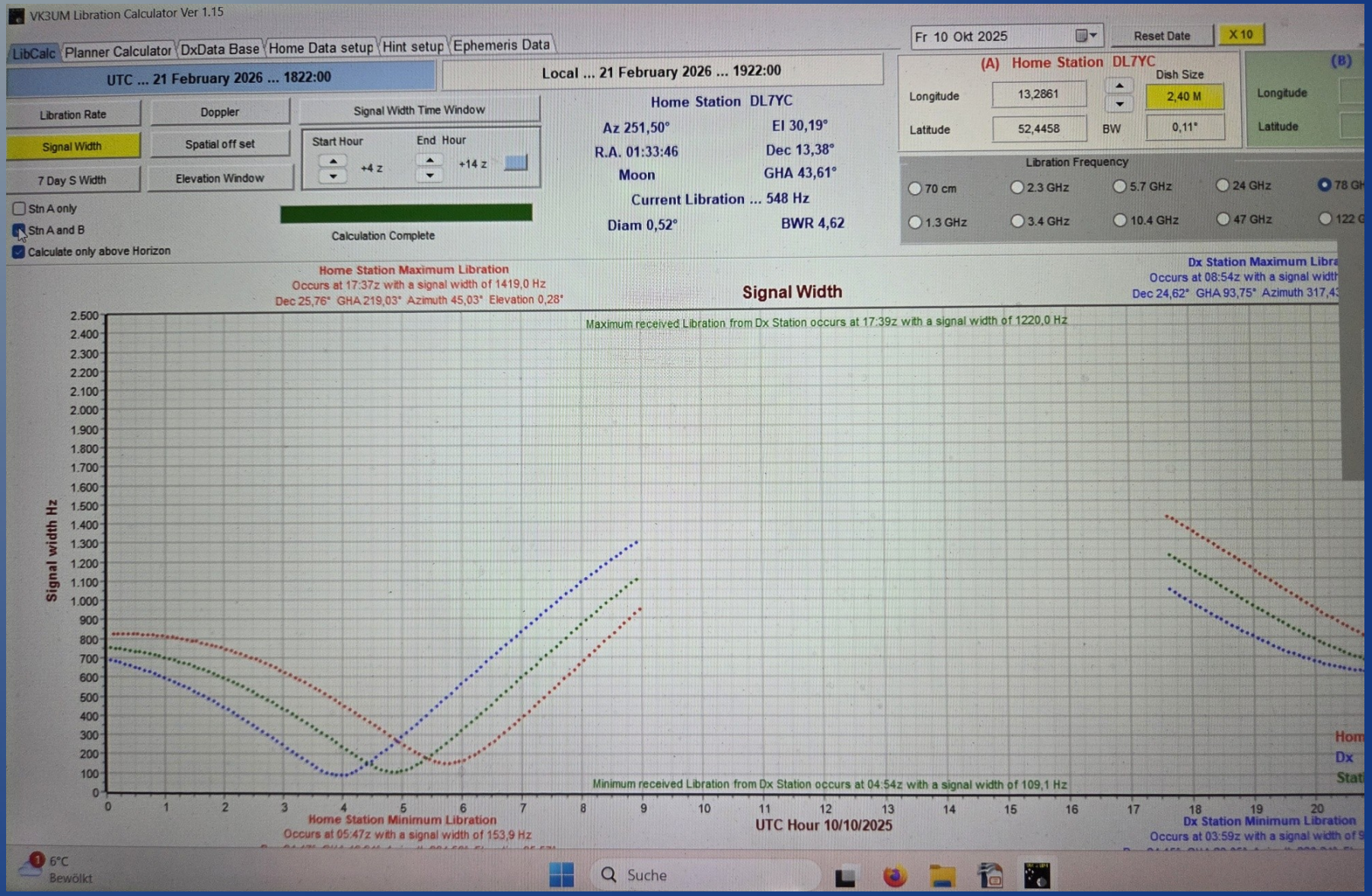
First EME QSO at 76 GHz

On October 10th and 11th, 2025 using WSJT-X (Q65-60E) a 2 Way QSO was achieved for the first time worldwide !

- Q65-120E and CW continuous wave transmissions were also successfully received

- Regardless of the S/N values displayed at the WSJT screen, subsequent offline decodings yielded S/N values of 1 – 4 dB

LibCalc at 10.10.2025

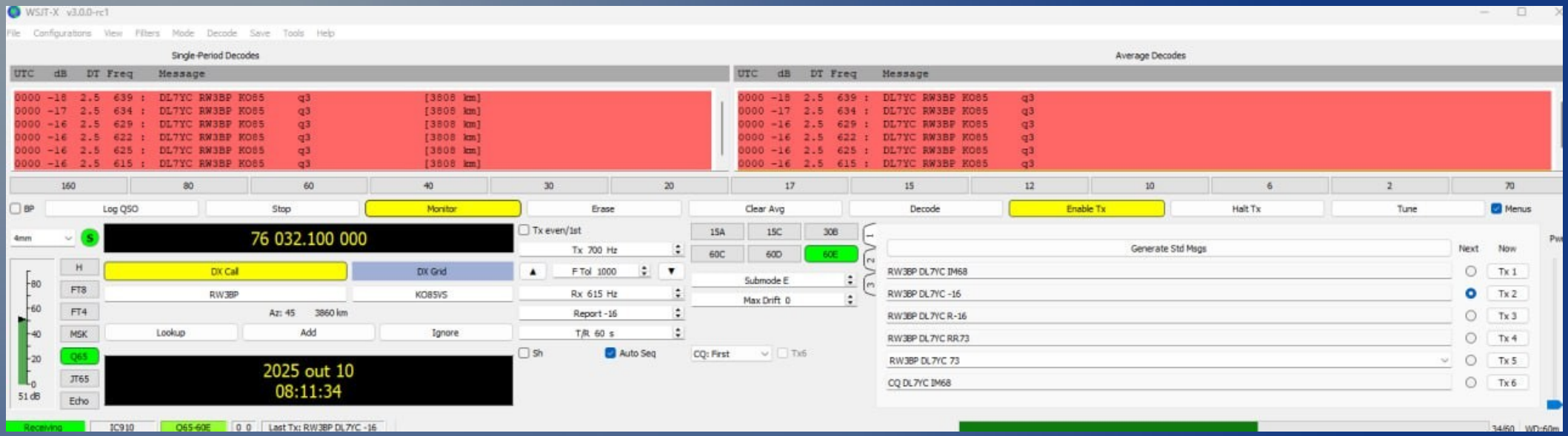


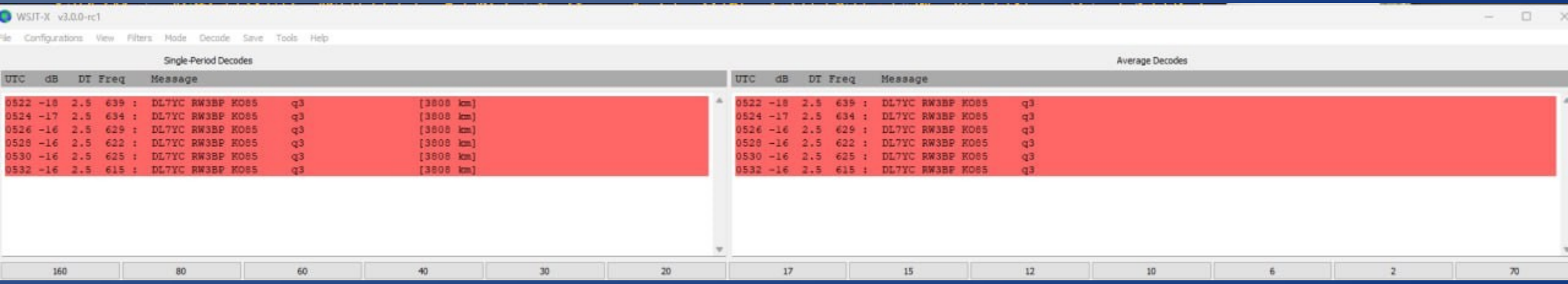
Important Insights Gained

- The files recorded by DL7YC were susequently decoded and verified by several other amateurs, like DL3WDG and CT1BYM

- CT1BYM and others used a special function of WSJT-X (noise addition) to analyze all prior recorded data files

Past Decodes by CT1BYM





More Important Insights Gained

- CT1BYM was able to add up to 6dB of noise to approximately 15% of the recorded files during decoding the 2025 files!

- We remind you: The transmit power used was 8.1- 8.2 Watts !

- This means: Even with 2.1 Watt (- 6dB) TX power, successful decoding would have been possible under THESE conditions !

More Important Insights Gained

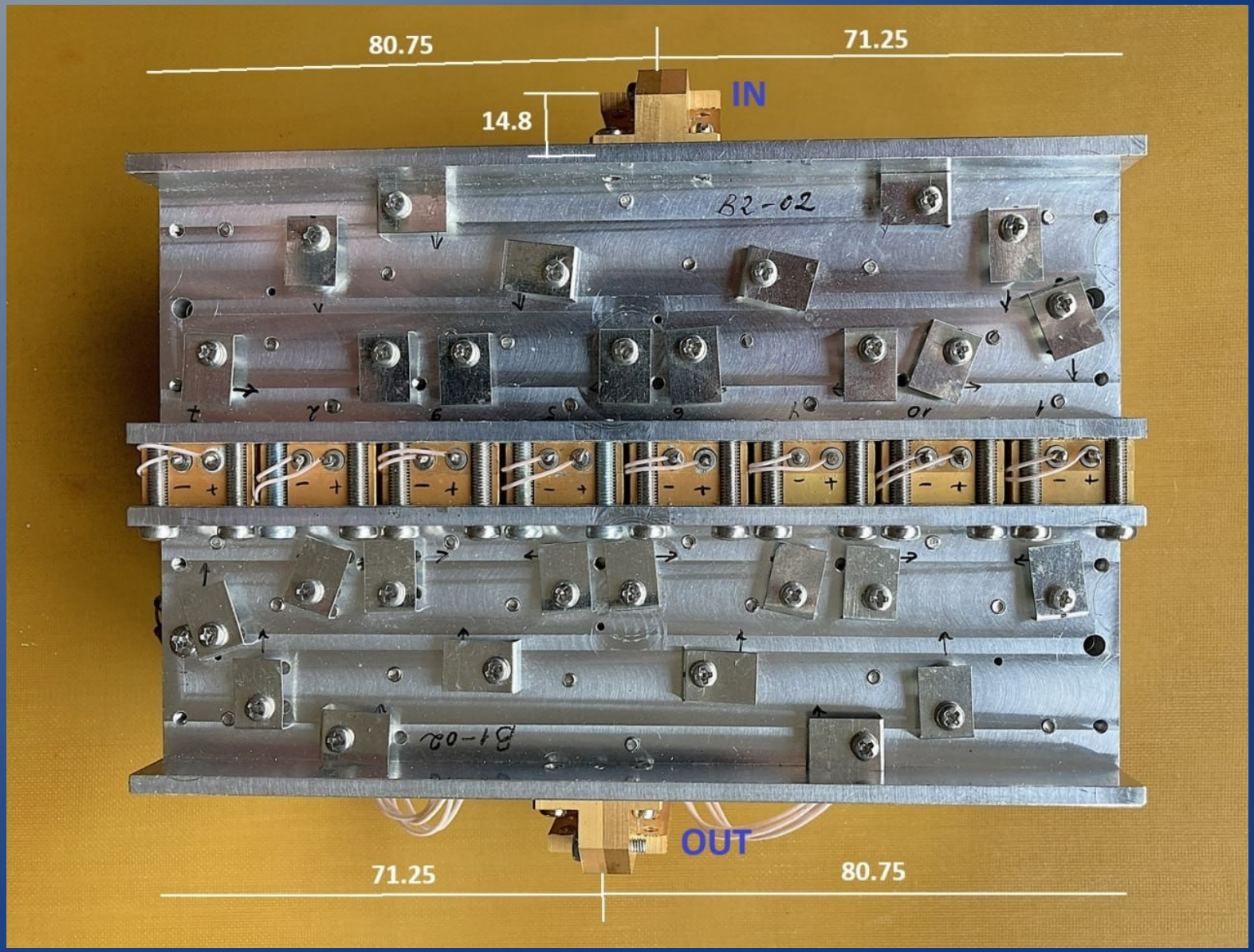
- This realization made continuing the experiments worthwhile

- Previously it was unknown what TX power was even necessary with 2.4m dishes and < 2.5 dB noise figure

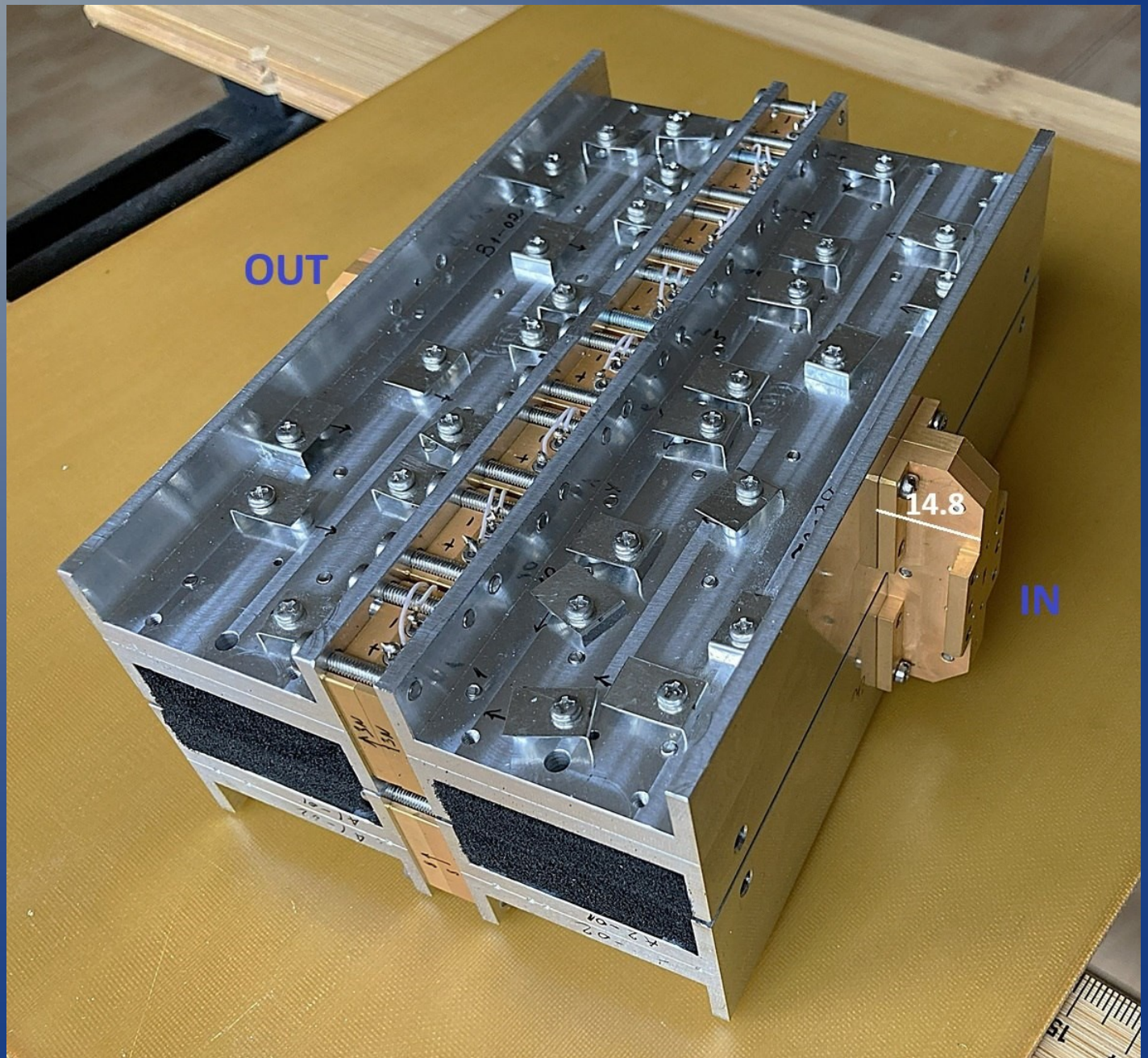
- A second TX with 5.0 Watts (construction by RW3BP) was available, which DL7YC could integrate into his system

76 GHz / 5.0 Watt TX – Upper Side

Phase Tuning Elements at Coupler



76 GHz / 5.0 Watt TX Complete



System Integration

- The transmit power of 5.0 Watts is apparently sufficient to be decodable as well
- However there is Little or No room for additonal losses on either TX or RX
- This means:
- No waveguides AFTER the TX output
- No antenna relay possible

System Integration at DL7YC

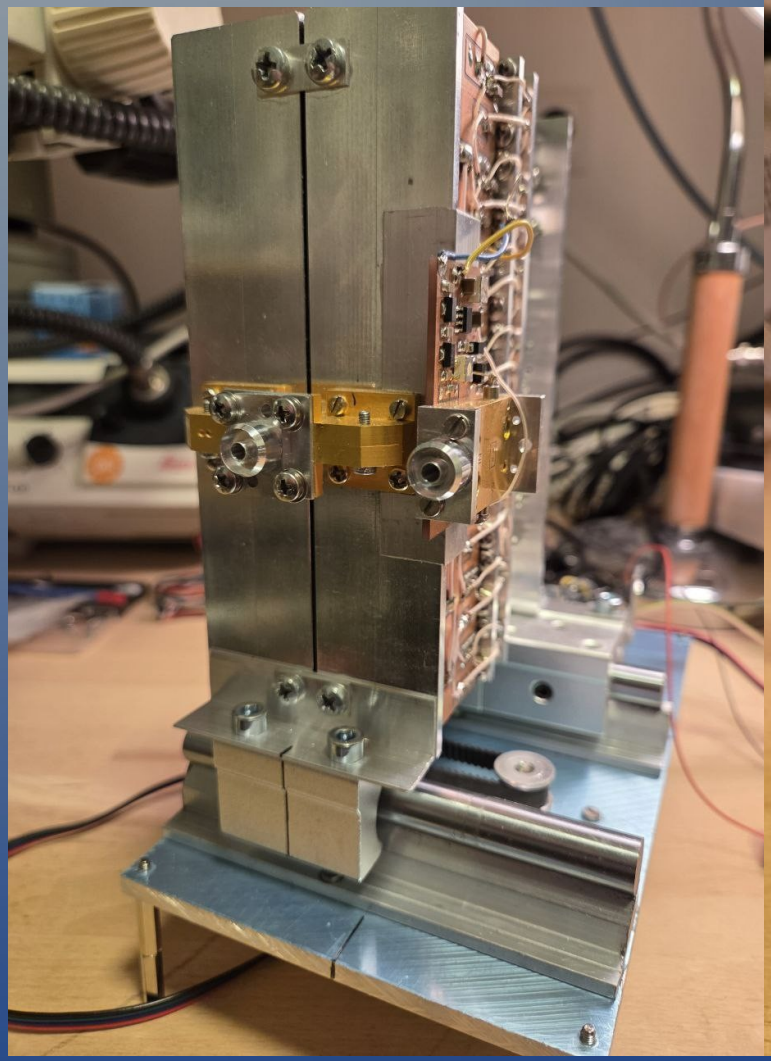
- How can this be achieved in a PF dish ???

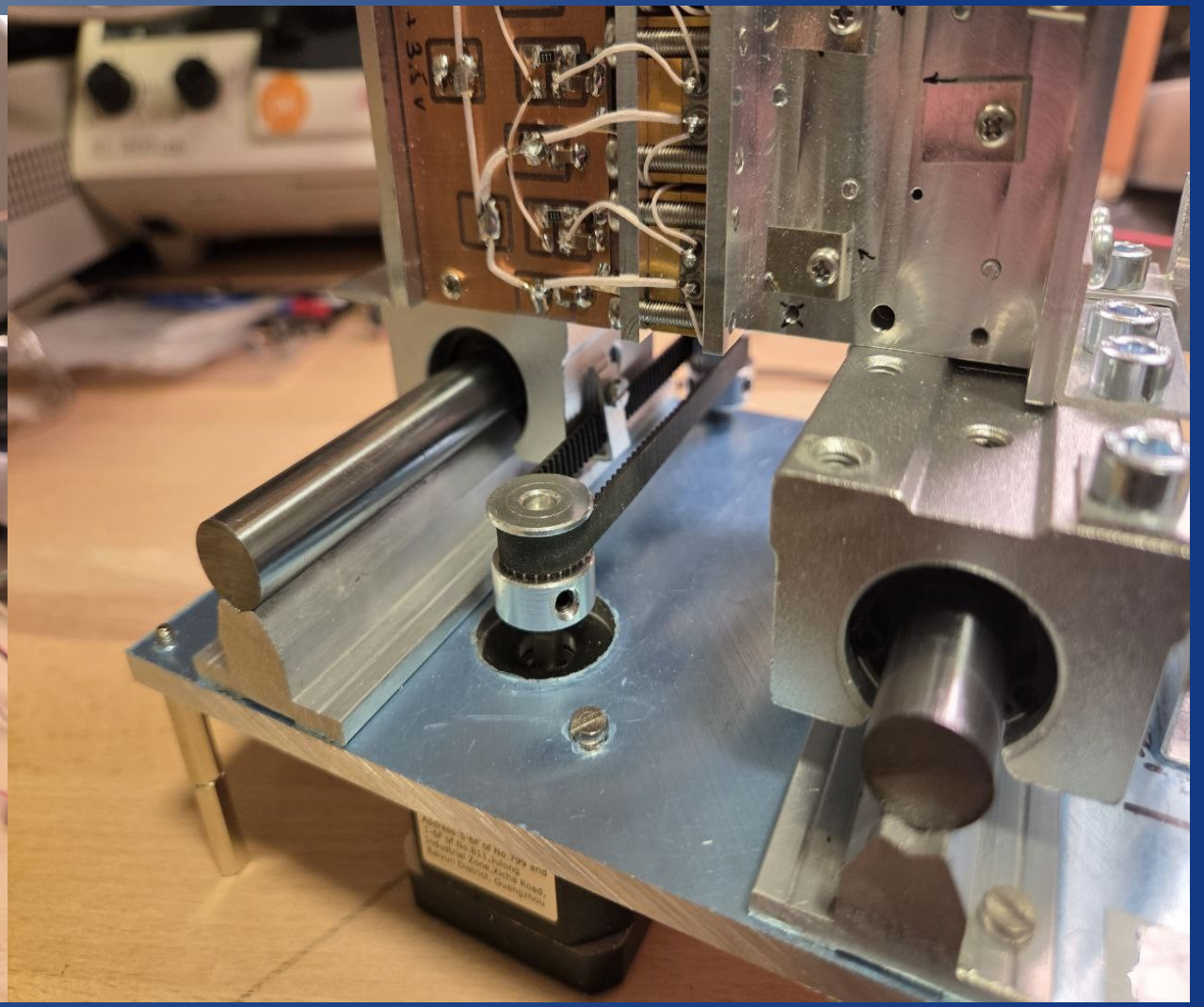
- The RX preamplifier is located directly behind the RX feedhorn

- A second feedhorn (TX only) is located on the Output of the last WG coupler from the 16 individual medium power amplifiers

- The RX to TX switch is achieved by horizontal moving both units using a stepper motor to overcome the distance of 38mm.

Tx and RX Ball Bearing Mounted





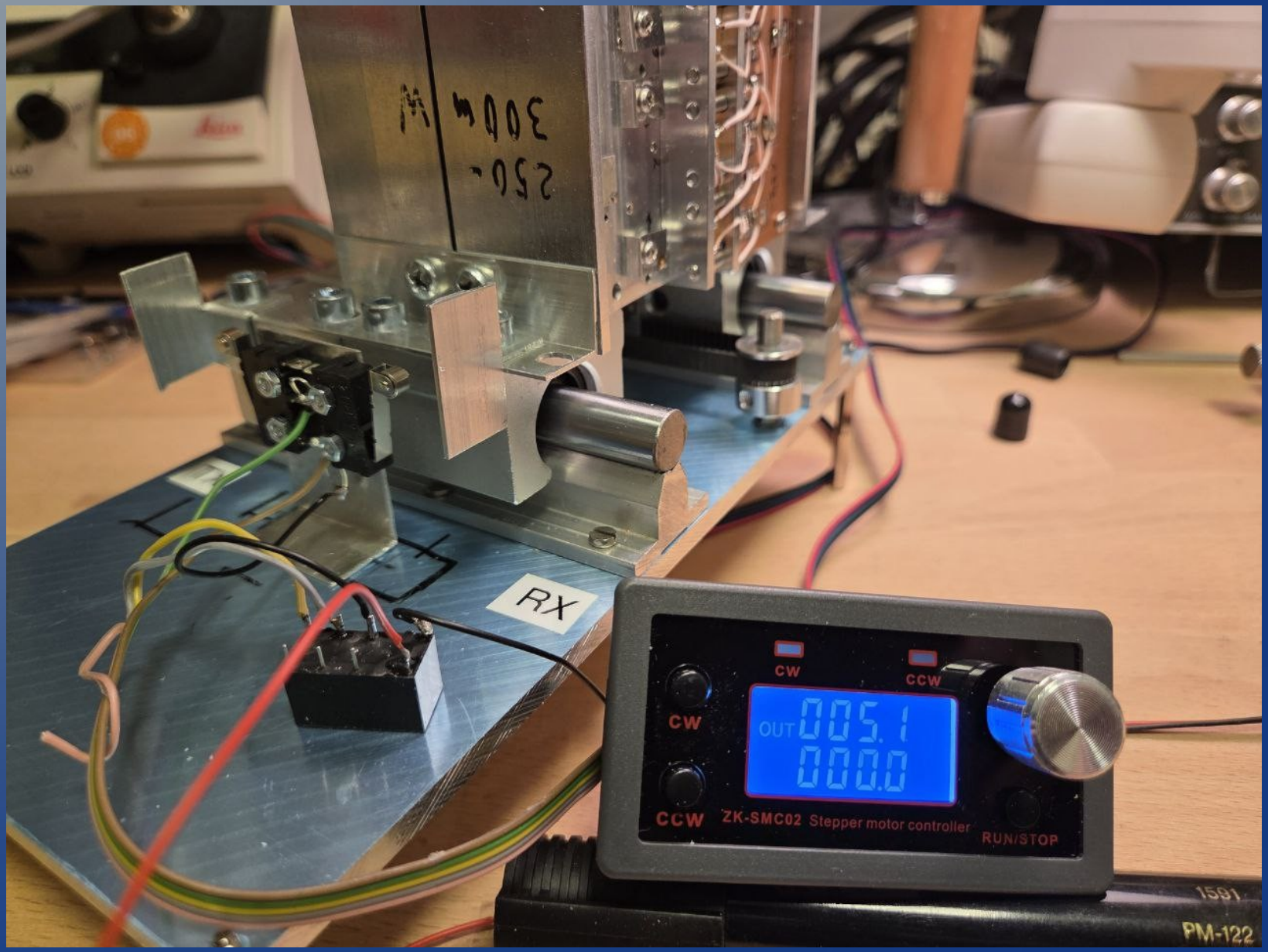
System Integration at DL7YC

- How is this mechanically achieved ???

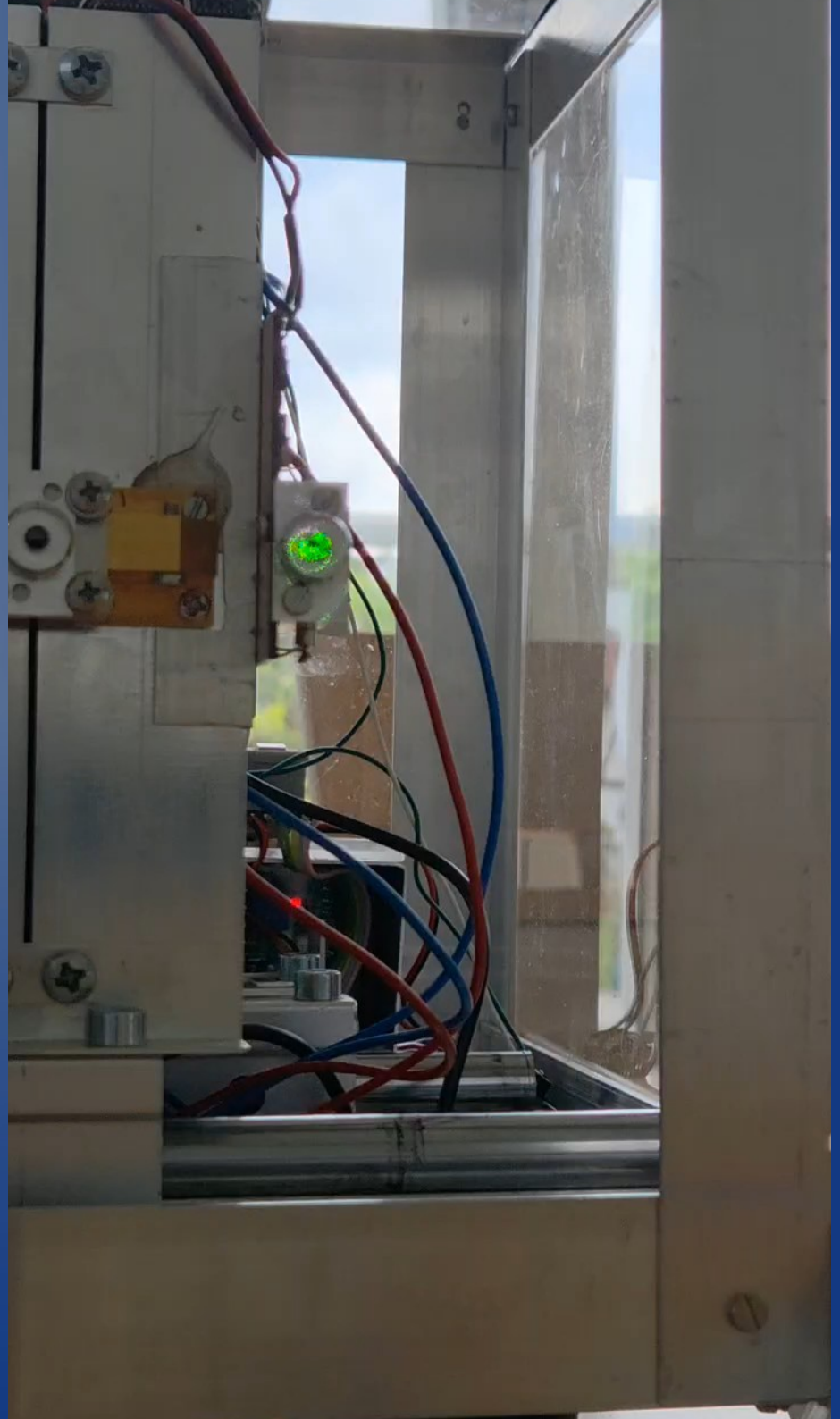
- The entire TX/RX is moved horizontally with an accuracy of 0.1mm within 600 – 800 mS on linear bearings using a toothbelt and a stepper motor unit

- Built into a lightweight cage, the complete 76 GHz station (including the TRV and the oscillator chain) is thus located in the focus of the PF parabolic dish

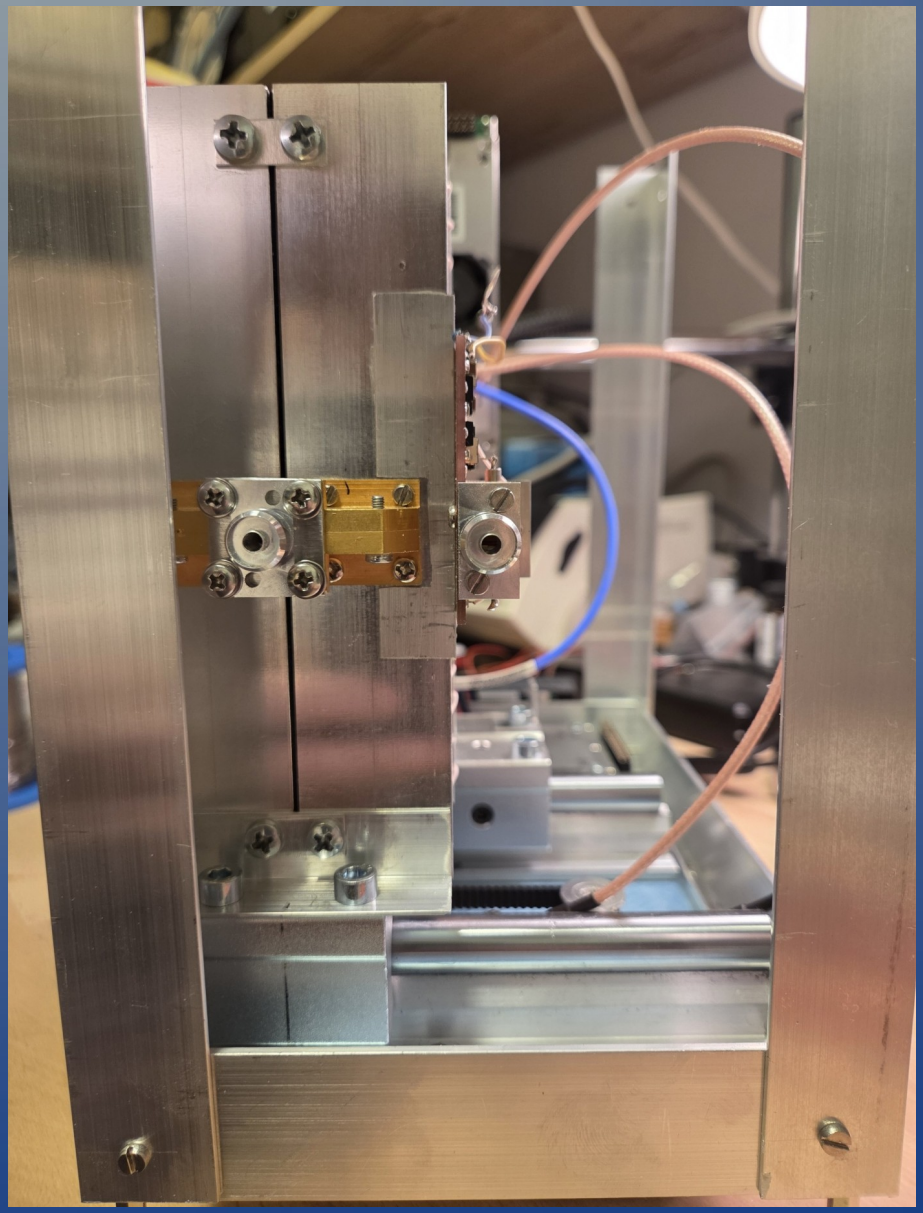
Motordriver Unit using End Switches

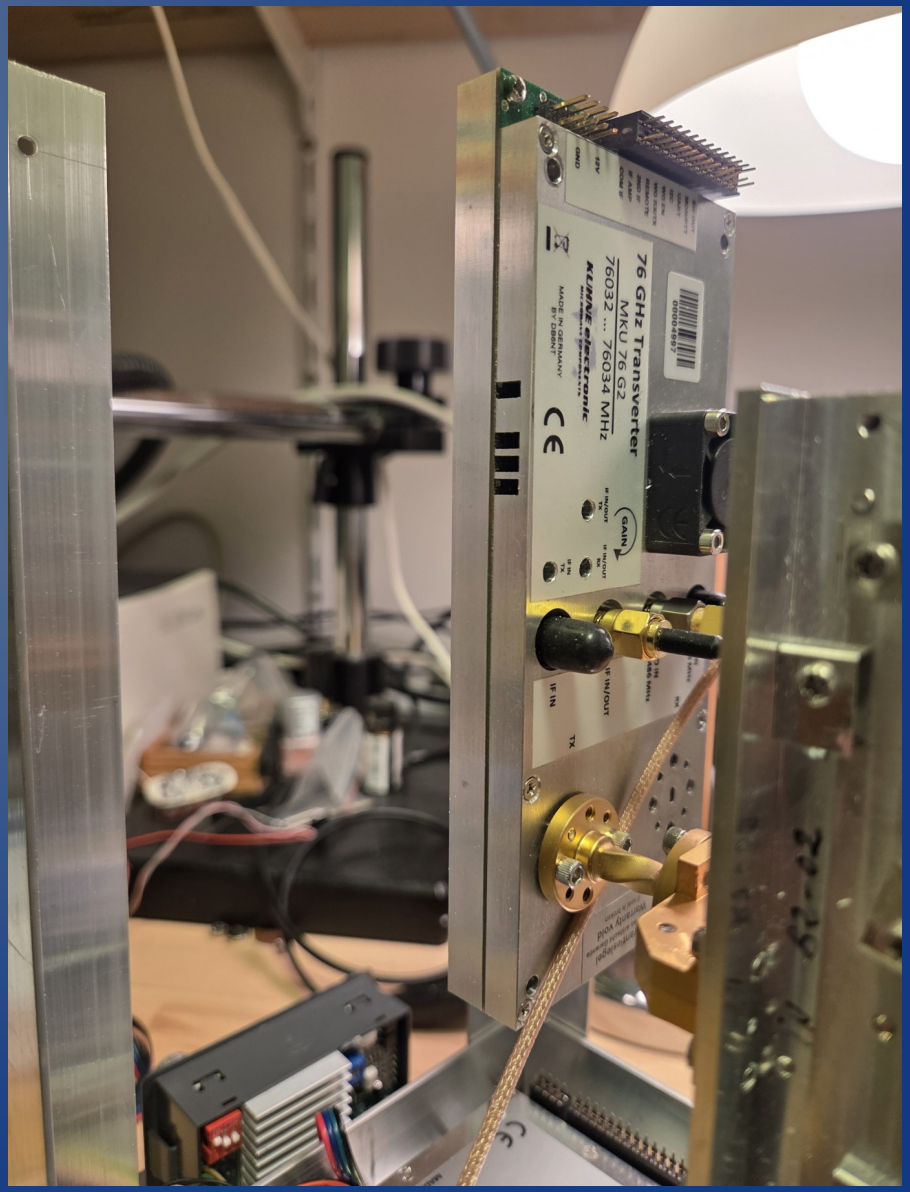


Precision TX/ RX Move in <800mS at DL7YC



Details of the 76 GHz Feedbox





System Integration at DL7YC

- The system integration into the final feedbox took place in March 2026

- Unlike the integration at RW3BP, at DL7YC the feedbox had to be mounted centrally (at boresight) of the 2.4m PF dish

System Integration at DL7YC

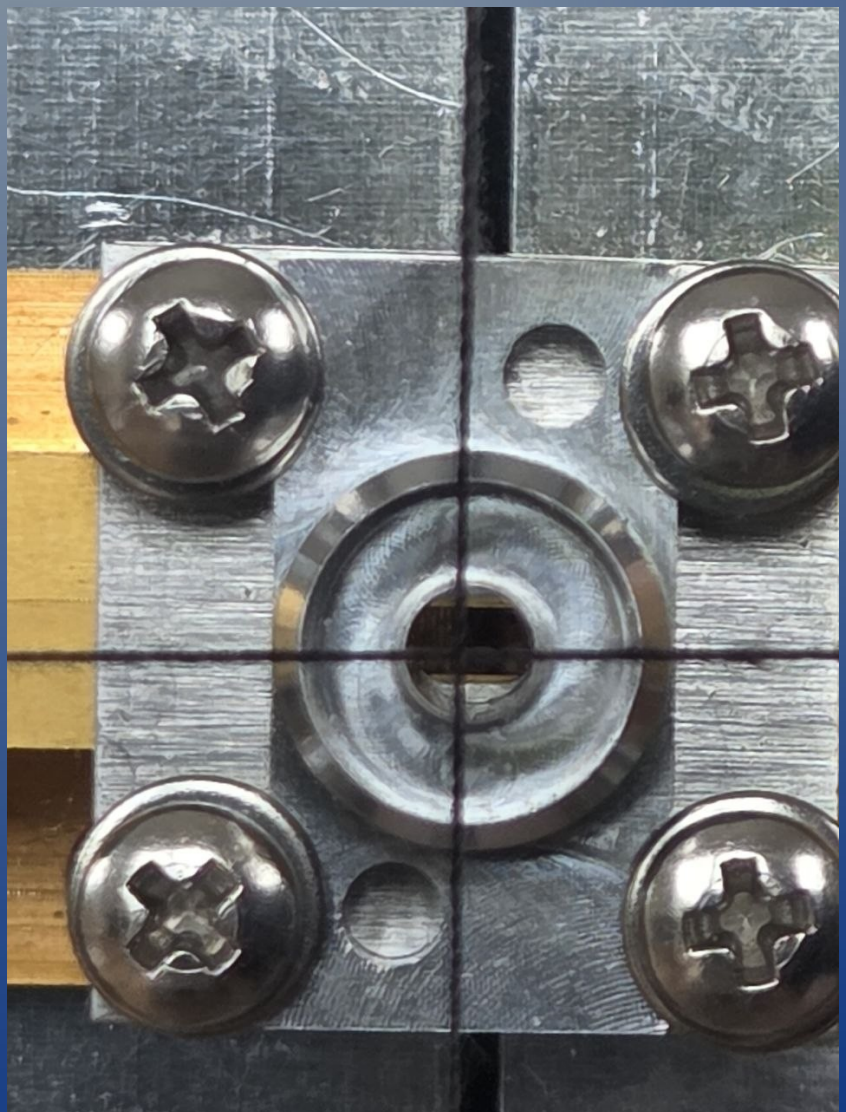
During the integration and setup of the box, the following problems came to light:

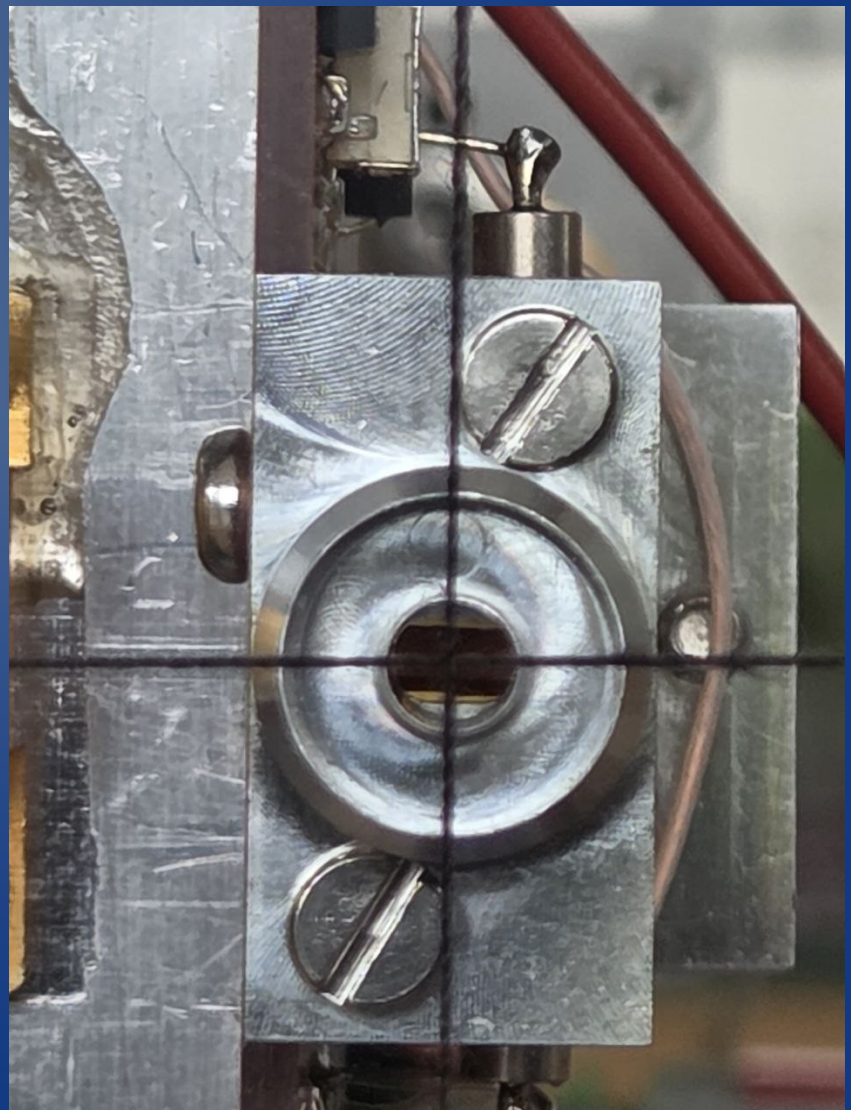
1. Both feed horns must move on exactly the same horizontal plane (vertical deviation of feedholder from left to right <0.2mm)

2. The travel distance has to be exactly the same (<0.1mm) as the boresight distance of the individual feeds.

System Integration at DL7YC

- Example of a slight misalignment of feeds





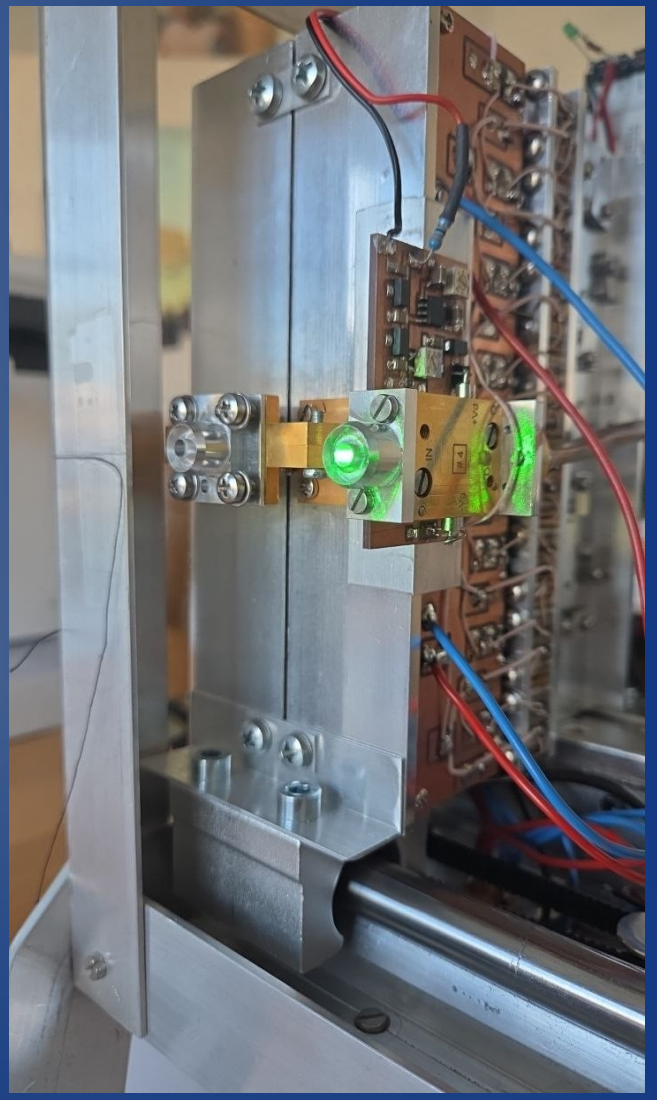
System Integration at DL7YC

- Additionally the feeds have to be oriented exactly in boresight direction (z-axis).

- And last but not least: Both feeds have to be in the focal plane, when they reached their end-travel-position!

- Any change to a single parameter usually and often unintentionally alters other values as well.

Laser Adjustment for Better Alignment



DL7YC trial to find the exact feed positions

EXTREME Low Tolerances Needed

- Calculation of tolerances – made by RW3BP

If we use the UA3AVR graph, we get the following figures:

Loss = 0.5 dB Angle θ = 0.010 degrees
Loss = 1.0 dB Angle θ = 0.017 degrees
Loss = 2.0 dB Angle θ = 0.029 degrees
Loss = 3.0 dB Angle θ = 0.038 degrees

The corresponding inaccuracy of the feed horn movement
Δ = θ * F. Here, θ is in radians.
For the DL7YC antenna, F = 0.91 m. Then we get:

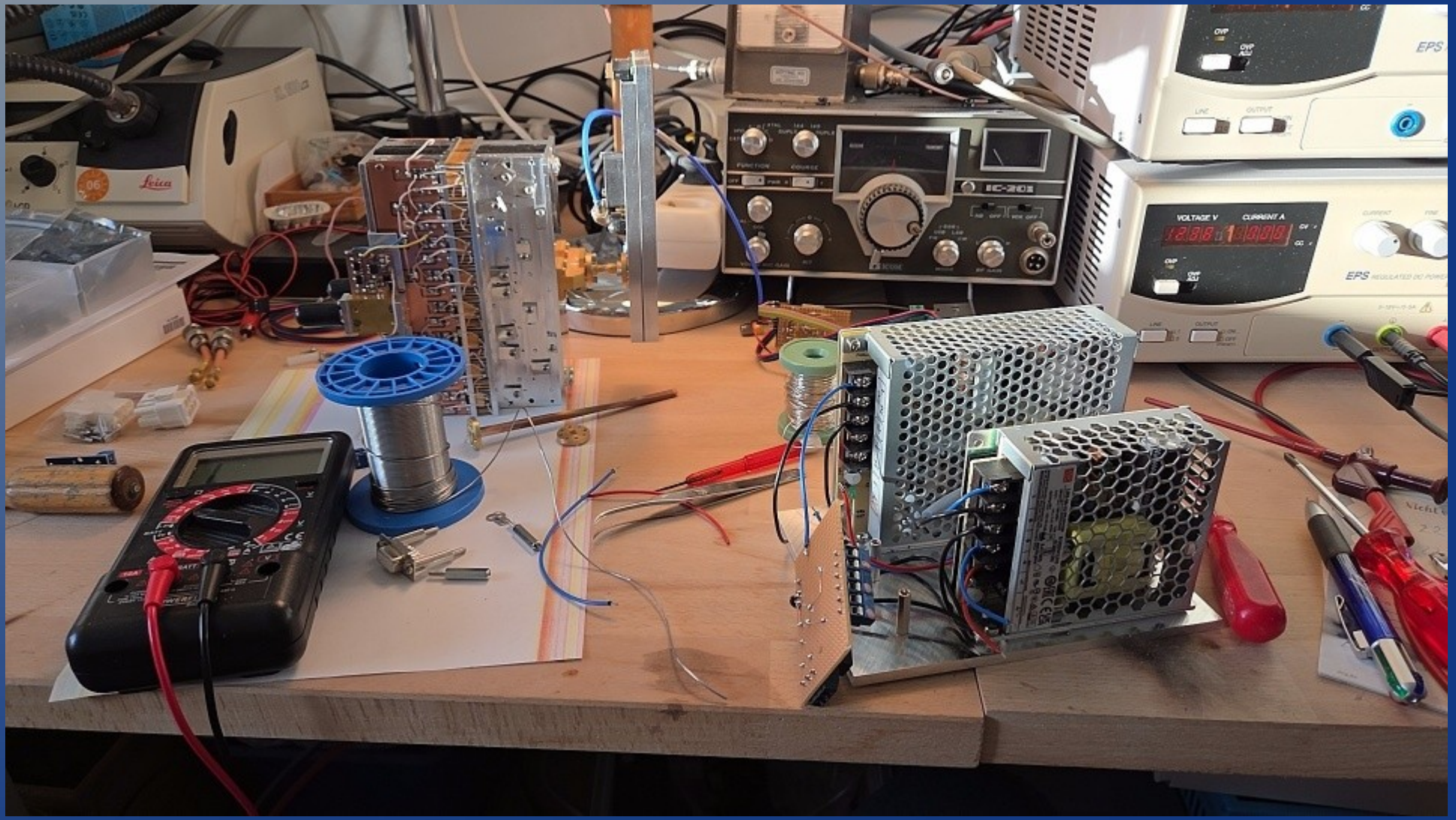
Loss = 0.5 dB Δ = 0.16 mm
Loss = 1.0 dB Δ = 0.27 mm
Loss = 2.0 dB Δ = 0.45 mm
Loss = 3.0 dB Δ = 0.60 mm

Special Power Supply at DL7YC

- The feedbox at DL7YC needed various voltages:
- +13.6V for the LOCAL oscillator, TRV, LNA and stepper motor supply
- - 5.0V as fixed bias supply for the SSPA
- +3.5V / 13A as Vdd supply for the SSPA. For security reasons, this power supply is switched on at the primary side to prevent transients.

Special 76GHz 3.5V Power Supply

In the background is a 50 year old 144MHz tester!



Special Power Supply at DL7YC

The +3.5V / 13A Vdd supply for the SSPA had to be VERY stiff.....but it is connected remotely by two 5m long 20 mm copper wires.

- A 1/10 volt reduction (from 3.5v) significantly reduces the output power of 5W …... but a Vdd of 4.0 volt is dangerous for the expensive MMIC`s.

- All return wires must be routed separately to the SSPA to avoid current coupling !!!!

Waterproof Feedbox at DL7YC

Waterproof Feedbox at DL7YC

2.4 m Prime Focus dish with 76 GHz feedbox & Acrylic co

The Day of the QSO

April 22, 2026 * 10:05.....10:43 UTC

Libration minimum at 10:30 …. <180Hz nominal. The true Lib was lower due to the large dish size

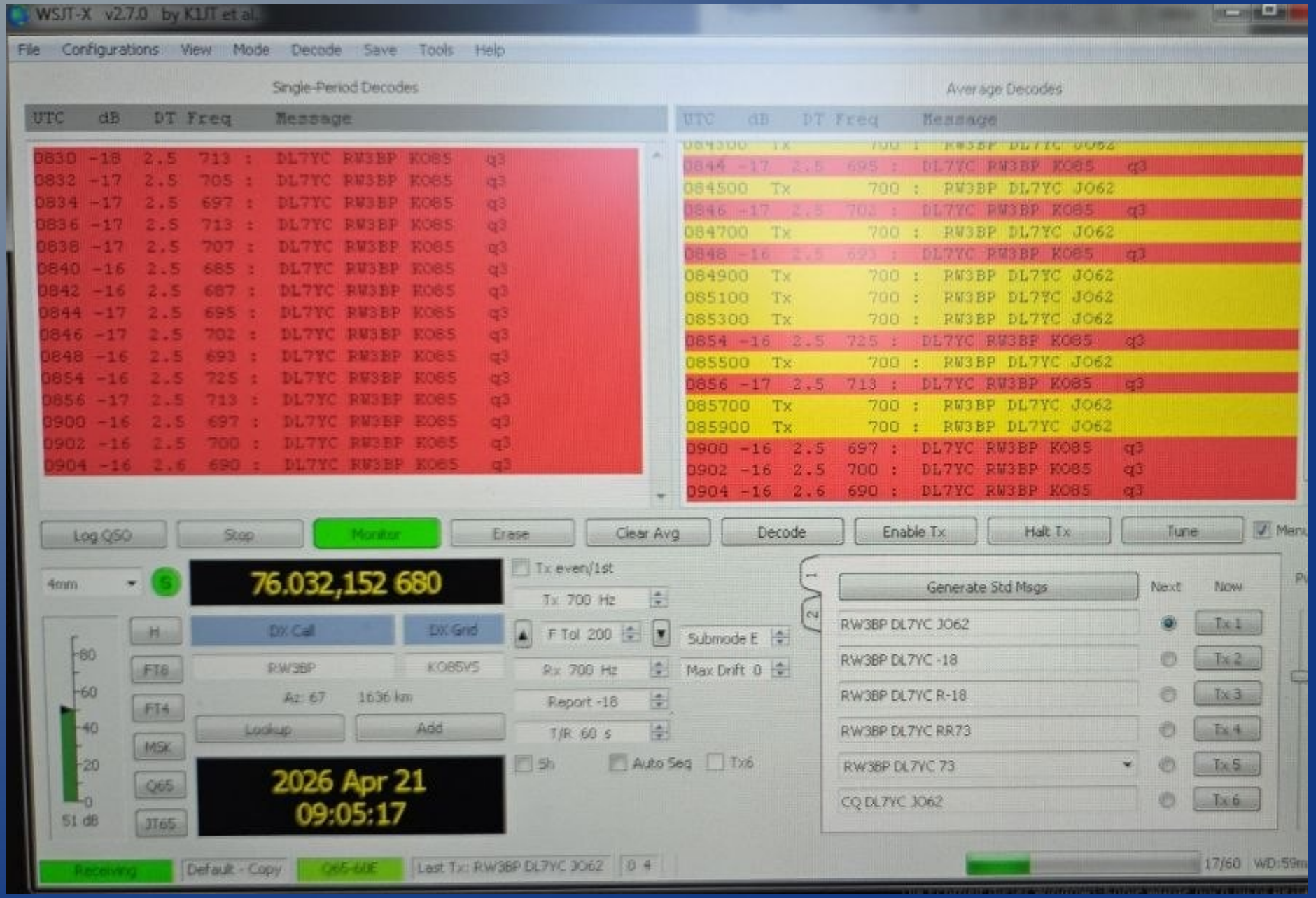
At RW3BP: clear sky, 986 hPa, 26% rel. Hum, +12 deg C

At DL7YC: clear sky, 1022 hPa, 39% rel. Hum, +12 deg C

The Day of the QSO

- After automated echo testing some time before RW3BP started to transmit @ 10:04UTC
- DL7YC decoded his transmission 10:06 first time, and than ALL WSJT-X every 2 minutes until 10:42 UTC
- Sergei had No decodes of my signal, but after 14 min he started to move his antenna on RX (odd times) by 0.1 deg east. Nothing heard.....
- A second 0.1 deg move to the east (totally 0.2 deg) at RX had the same result.....

DL7YC Decoded RW3BP Every Time



The Day of the QSO

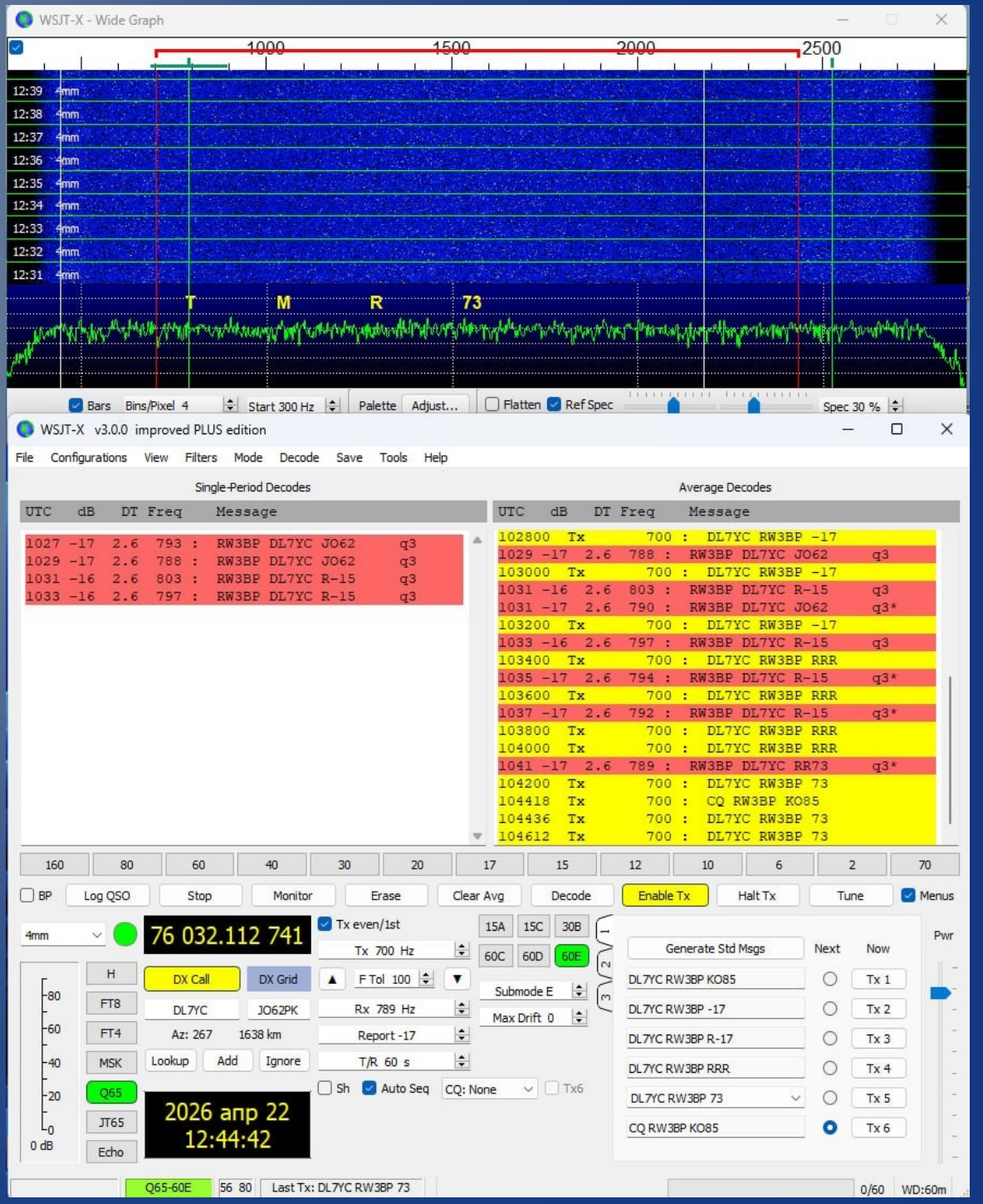
Third attempt was a 0.1 deg move to the West side at RW3BP`s RX period with **Sucessful decoding DL7YC`s report -17 !!!!**

What happened ?

DL7YC`s antenna spot at TX was 0.1deg apart from his RX spot. This feed misalignment was further investigated and identified as a feed travel distance error.

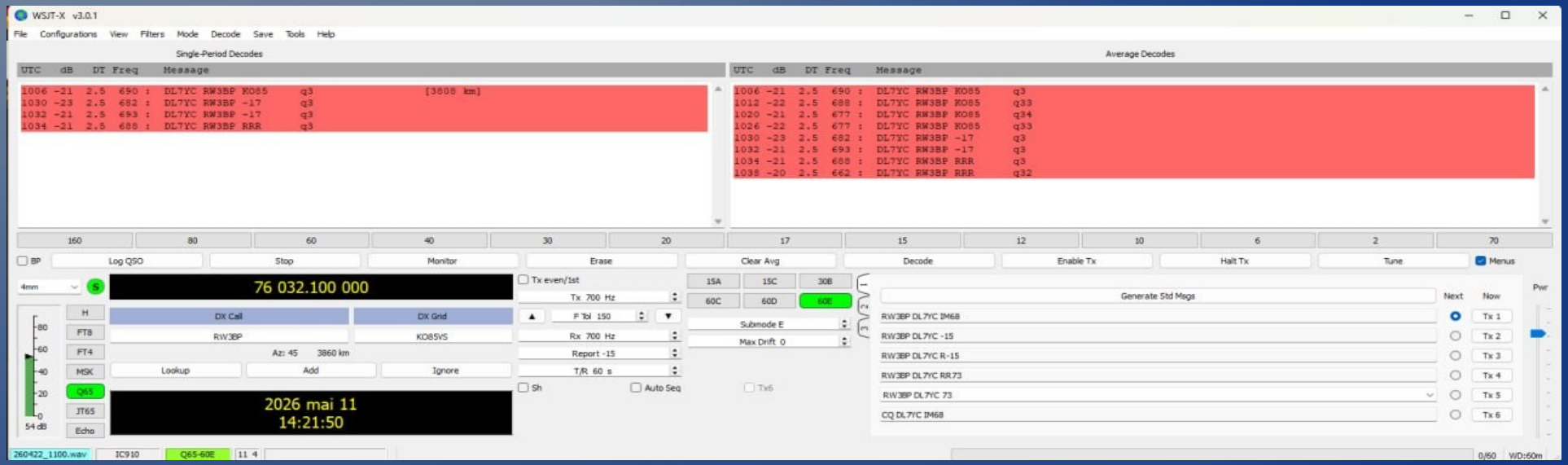
First 76 GHz EME QSO completed !

- This is a screenshot of DL7YC`s 5.0W signals
- The RW3BP signals were between -14/-16 dB



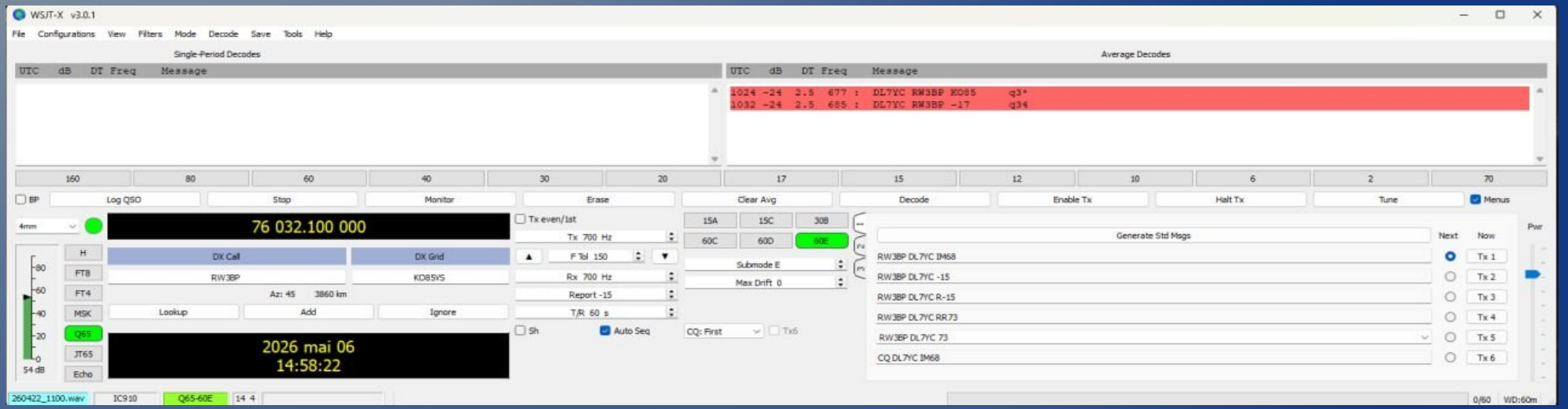
Post Processing of Decodings

- This is an example of 7.5dB added noise to WSJT decoded file – processed by CT1BYM



Final Results

9.2 dB Added Noise gave the following result!



This decode shows that 9.2dB less TX power (1.2 Watts) is probably sufficient to overcome all losses to and from the moon

This was the Short Story of the Worldwide FIRST 76 GHz EME QSO

Thank You for your Attention!

Are There Any Questions?