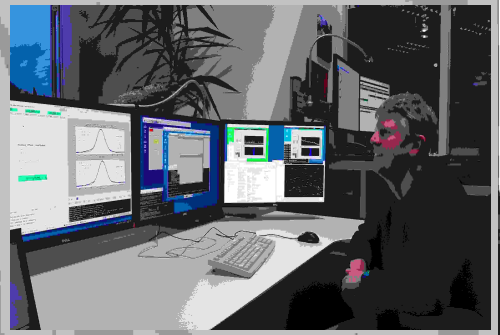
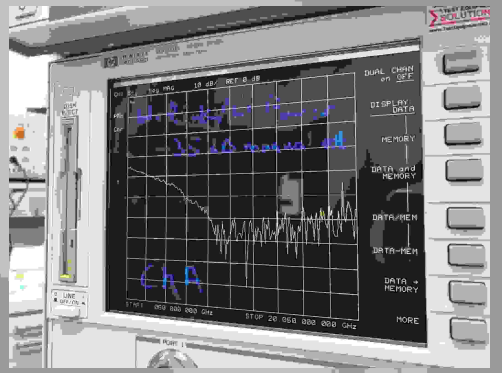
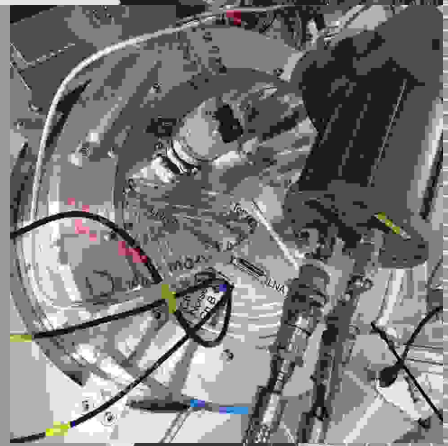
Integration of the BRAND receiver in Effelsberg

Parisa Rahimi, Uwe Bach
25.06.2024

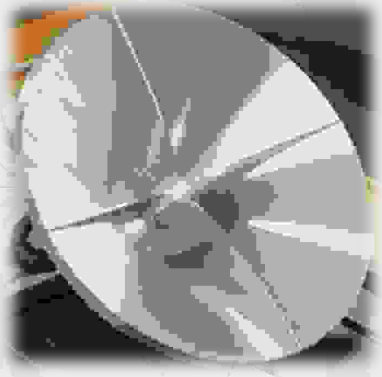
First sky test of BRAND analog front-end ever in Effelsberg over the course of 6 months Integration and preparation time.

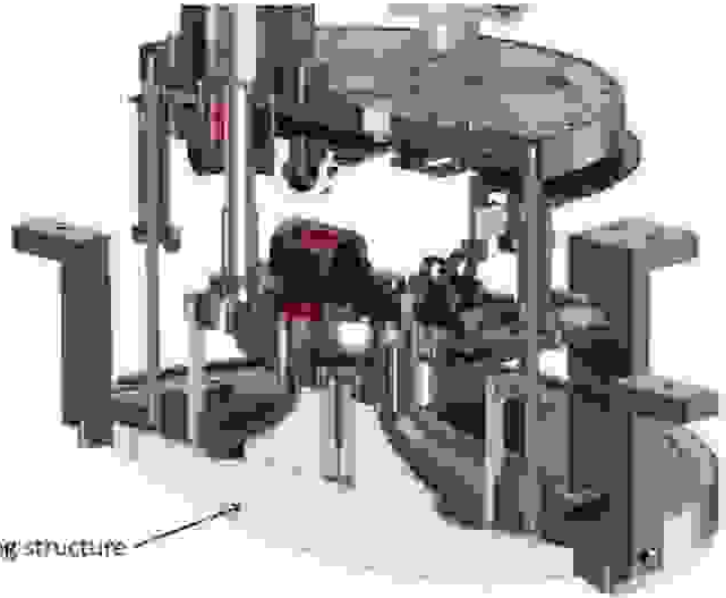


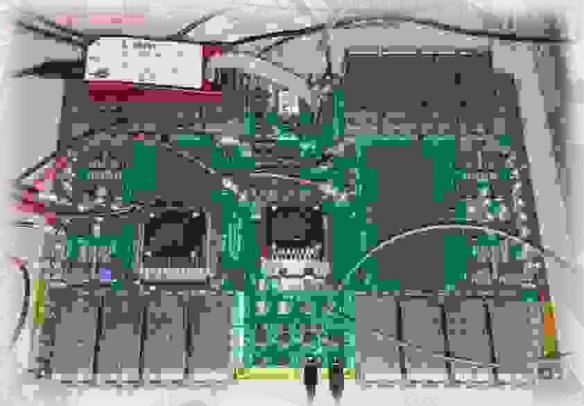




BRAND Development in previous years







- Frequency range 1.5 -15.5 GHz
- Advantage application in VLBI and Geodetic, spectroscopy etc.
- Highest BW possibility of 14 GHz:

→ reduced needed observation and receiver change time

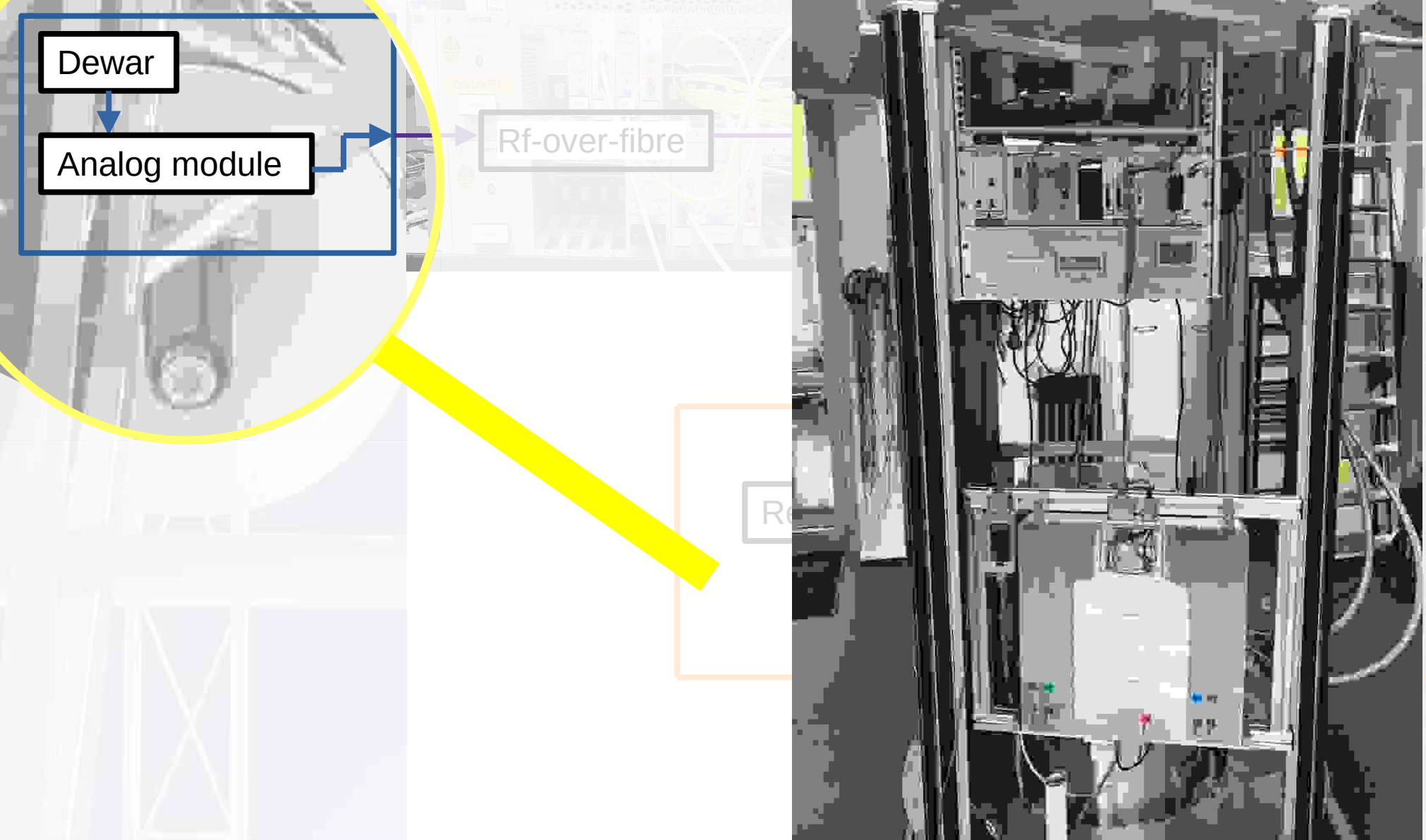
→ data availability of a wide BW at once

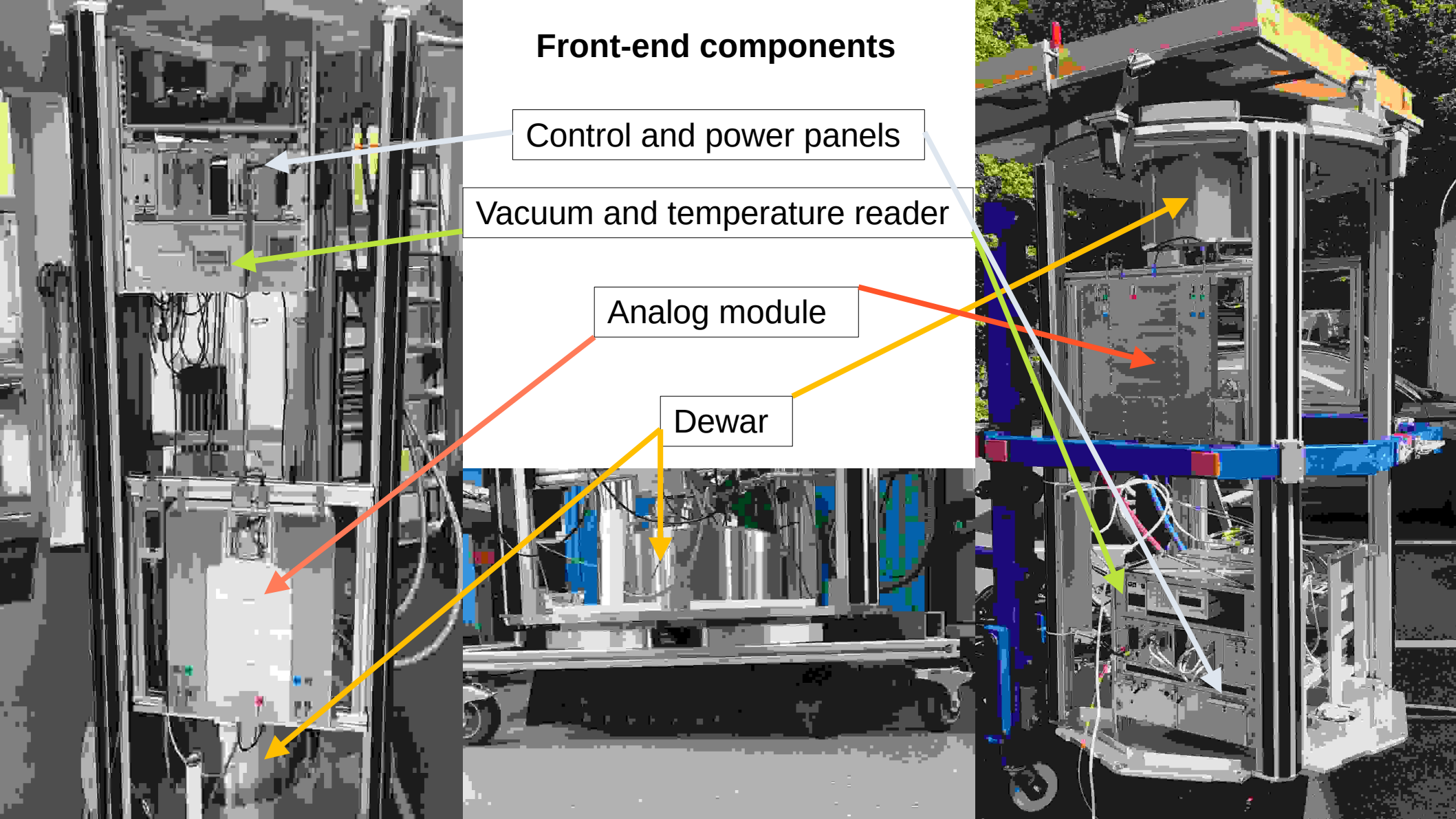
Dewar

Analog module

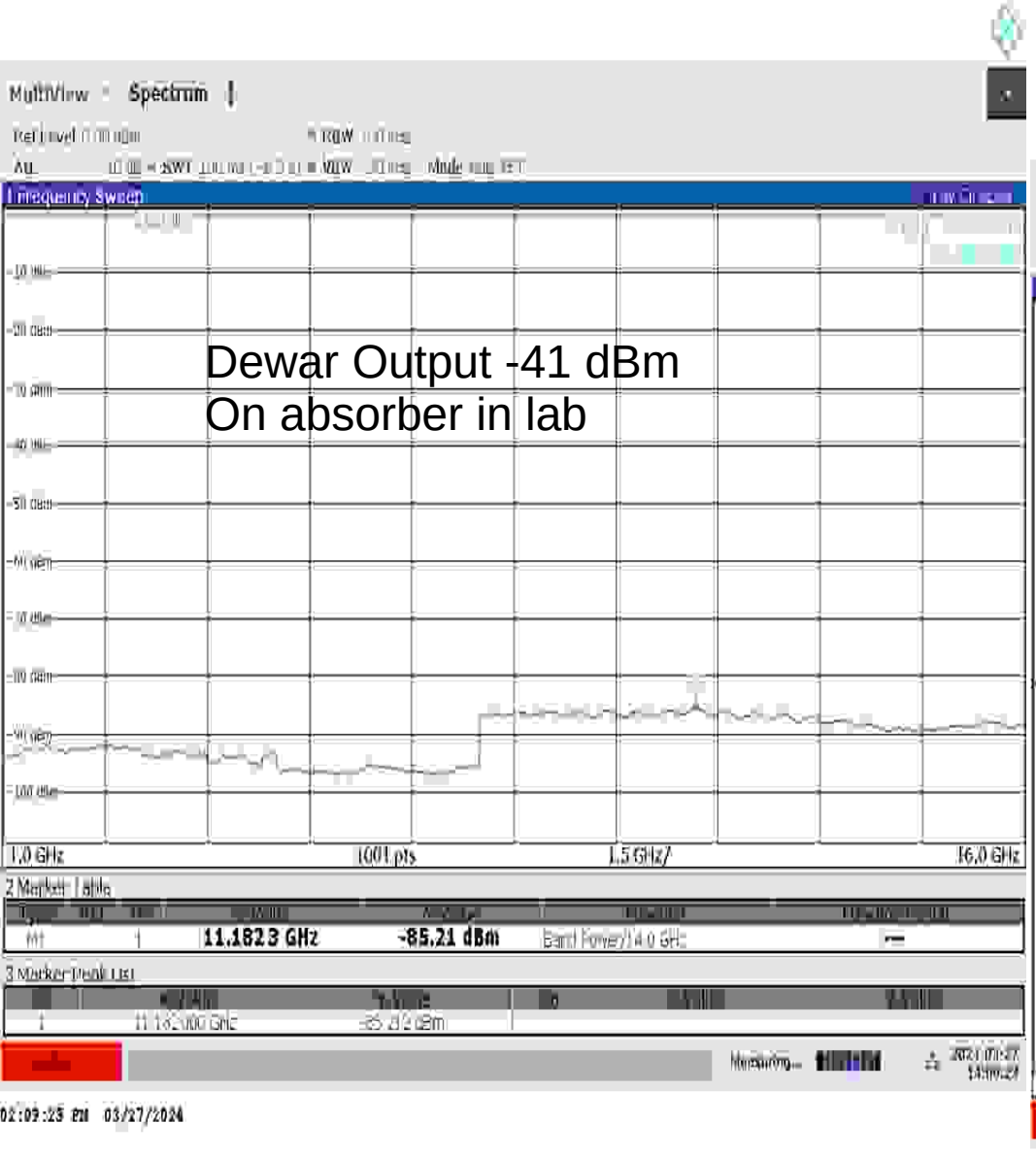
Rf-over-fibre

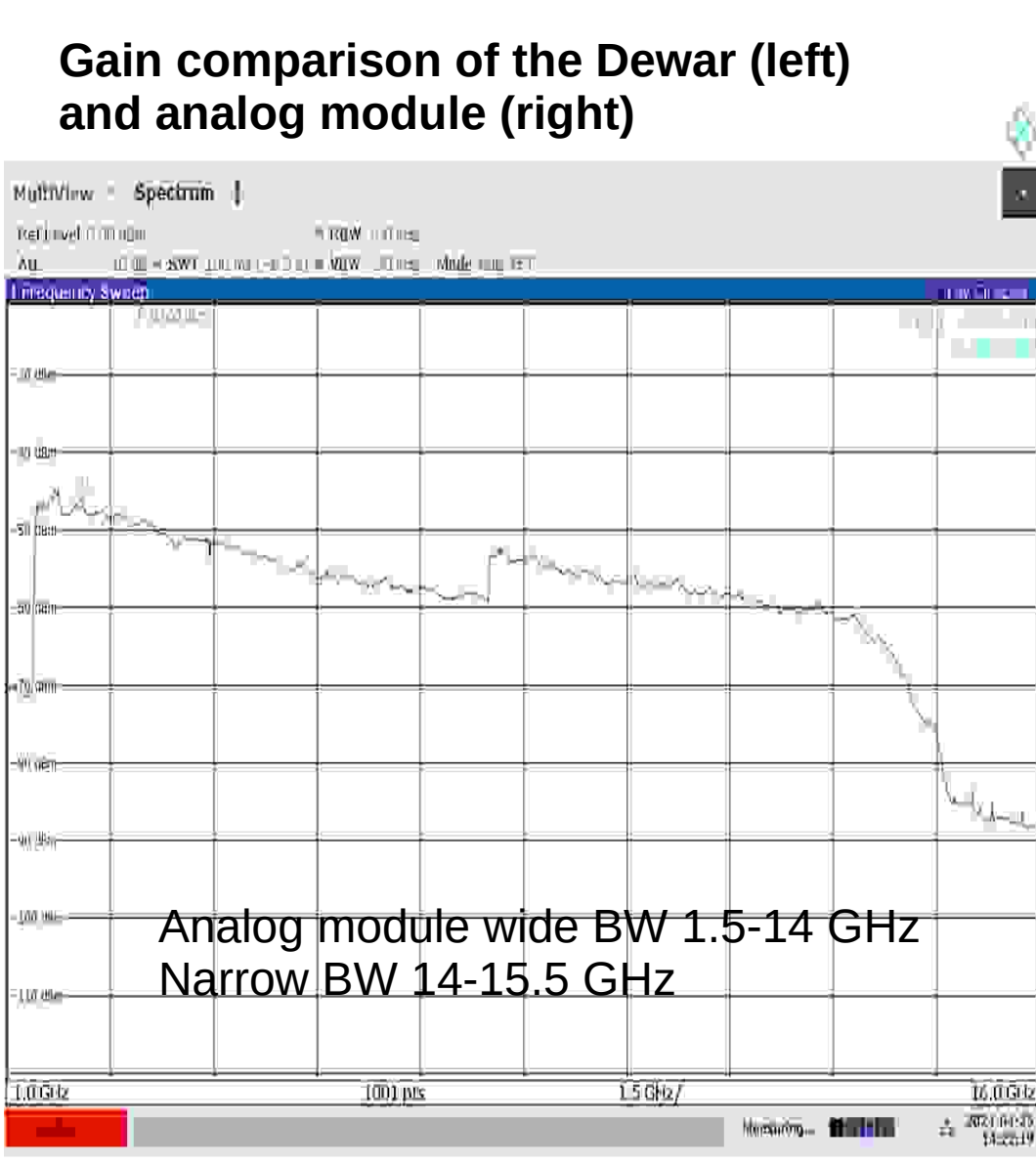
The BRAND digital front-end will be kept in Faraday room as back-end for the first rounds of integration


Dewar
Analog module
Rf-over-fibre


Front-end components
Control and power panels
Vacuum and temperature reader
Analog module
Dewar

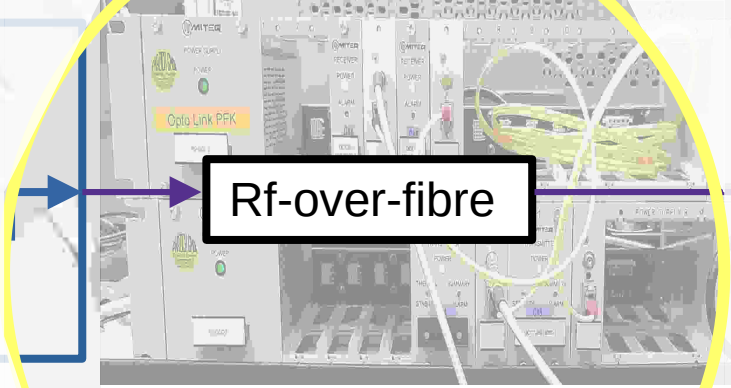
Gain comparison of the Dewar (left) and analog module (right)





Dewar

Analog module



Rf-over-fibre

4 GHz BW pre filter

DBBC3 down-converter

0-4 GHz post filter

Analog gain module

Recorder

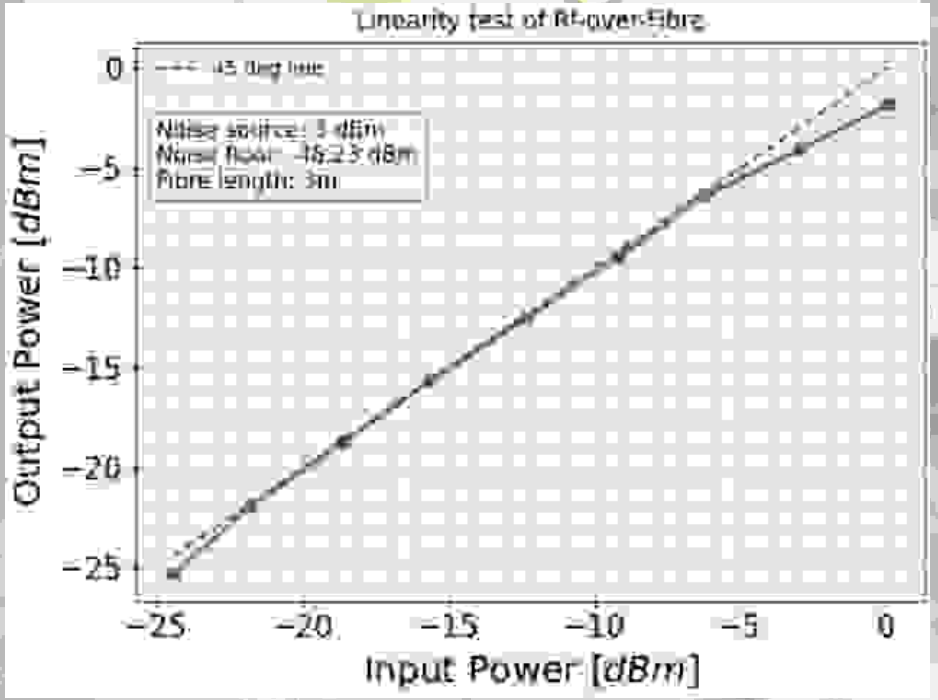
DBBC3

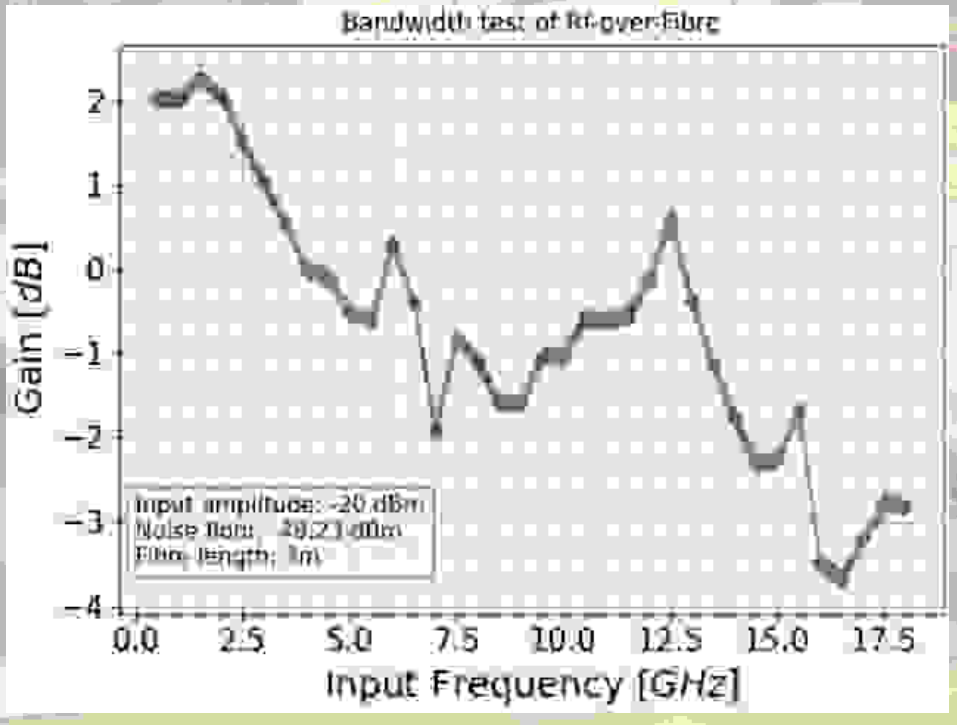
Spectrometer/ XFFTS

Why Rf-over-fibre?

→ a shield for BRAND digital front-end is yet to be designed and built to cover RFI and power dissipation issues

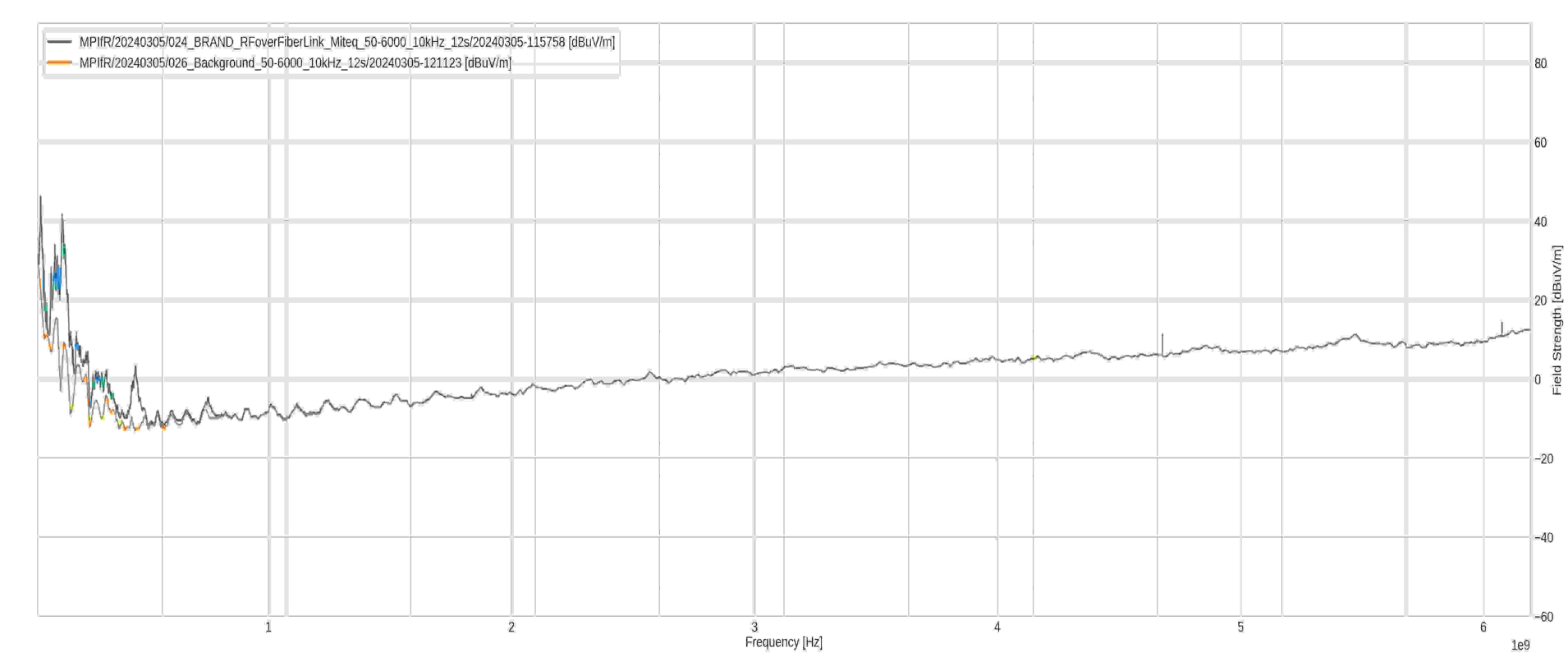
→ BRAND digital front-end will remain in Faraday room and work as back-end, using Rf-over-fibre to transfer the signal



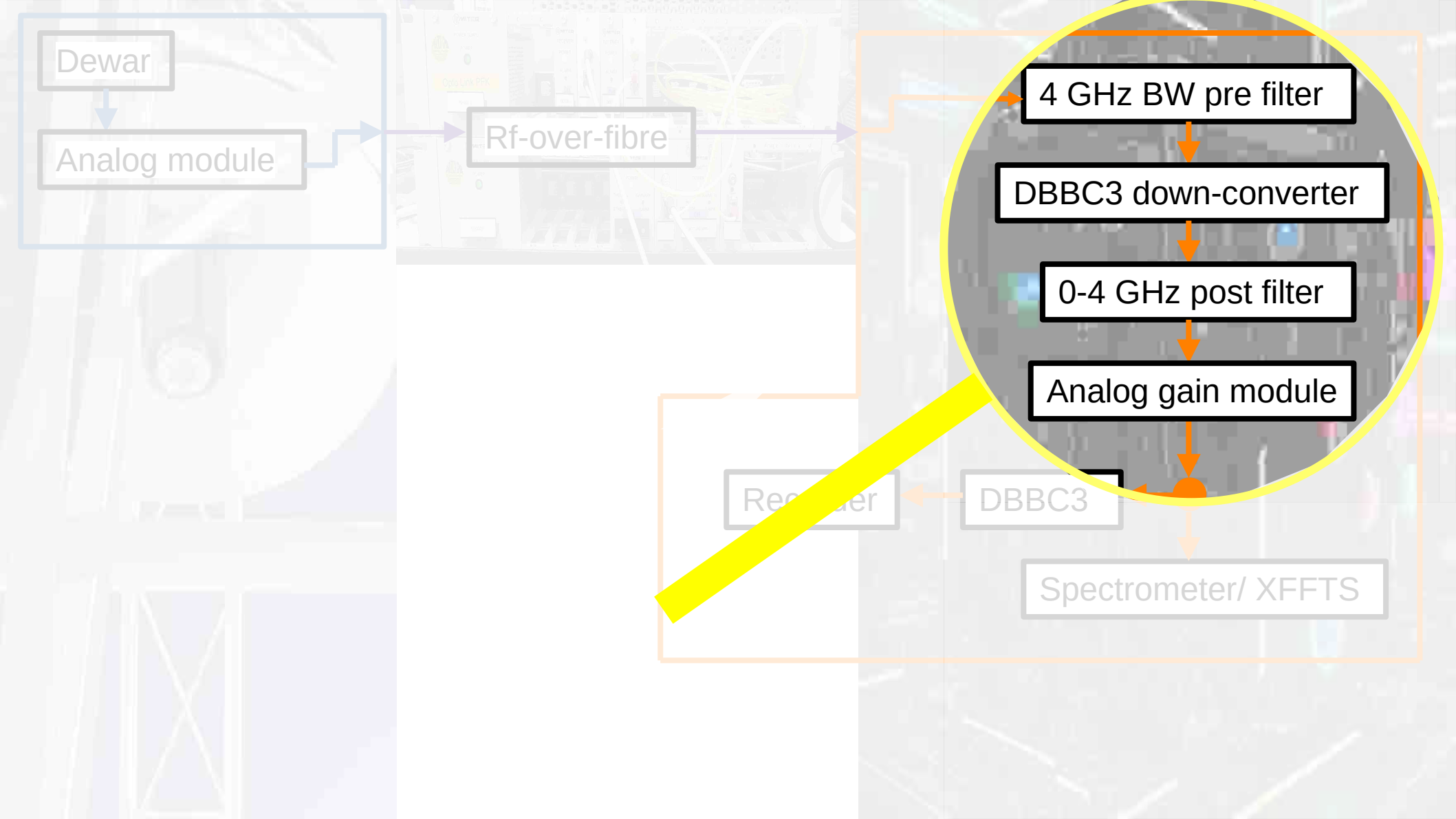


Rf-over-fibre linearity and BW with manual frequency sweeping and network analyzer

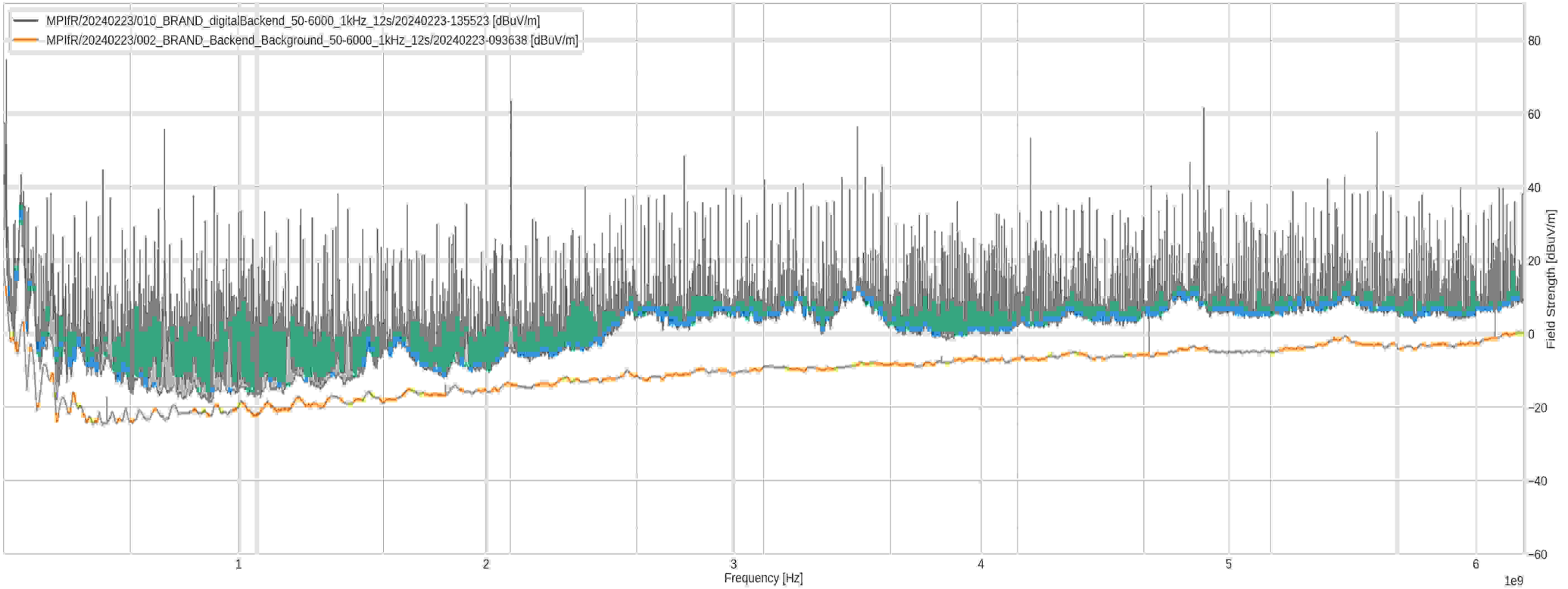
Down side of Rf-over-fibre:
→ goes to compression and non linearity by -3 dBm → causes intermodulation → requires fine tuning of the gain values



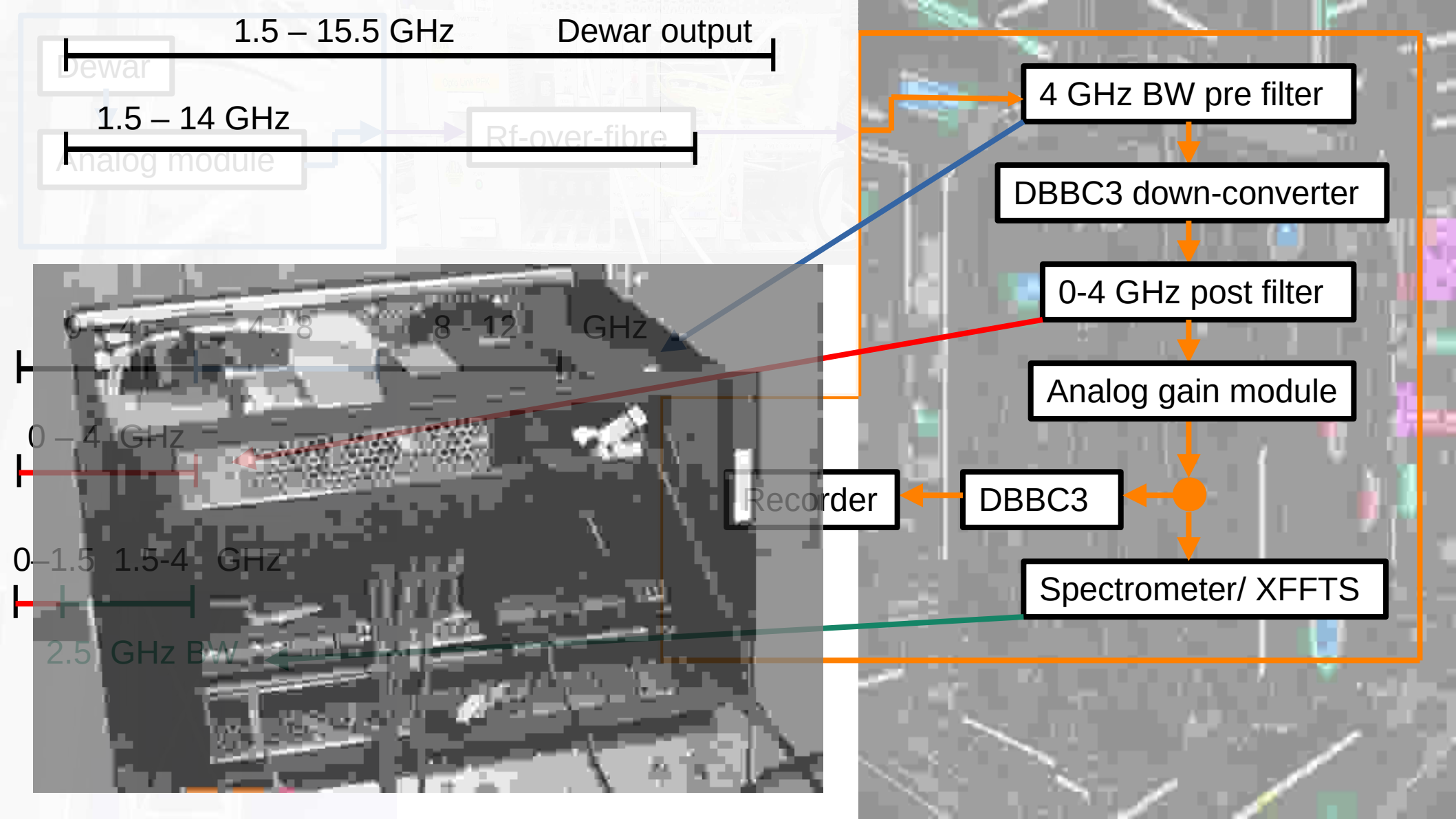
Testing Rf-over-fibre module in the anechoic chamber in Bonn


Dewar
Analog module
Rf-over-fibre
4 GHz BW pre filter
DBBC3 down-converter
0-4 GHz post filter
Analog gain module
DBBC3
Spectrometer/ XFFTS

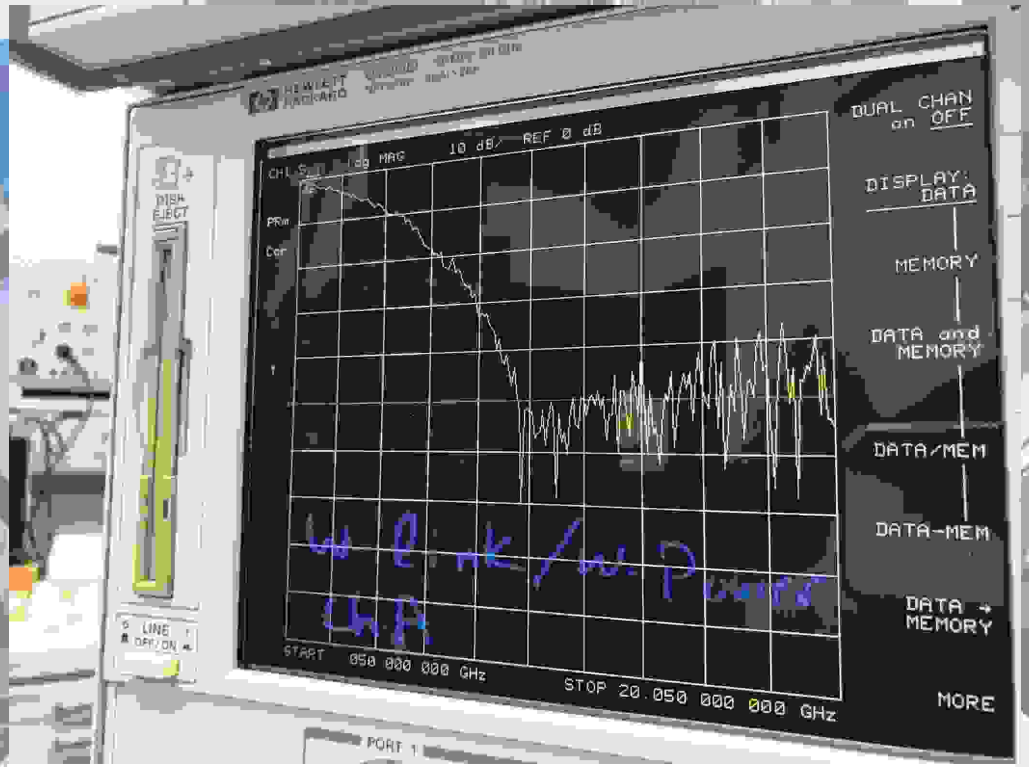
Why Rf-over-fibre?
THAT! Is why!



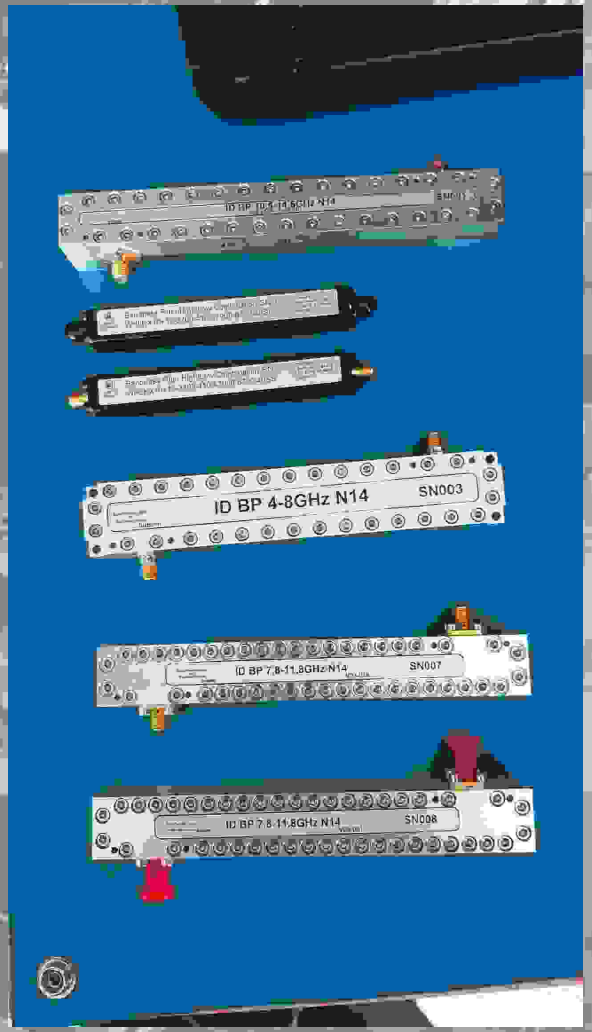
Testing the BRAND digital front-end in the anechoic chamber in Bonn


1.5 – 15.5 GHz
Dewar output
1.5 – 14 GHz
4 GHz BW pre filter
DBBC3 down-converter
0-4 GHz post filter
Analog gain module
DBBC3
Spectrometer/ XFFTS
0 – 4 GHz
0 – 1.5
1.5-4 GHz
2.5 GHz BW

Testing analog gain module:
to regain after down-conversion
→ <u>Down side</u>: the gain is sloped



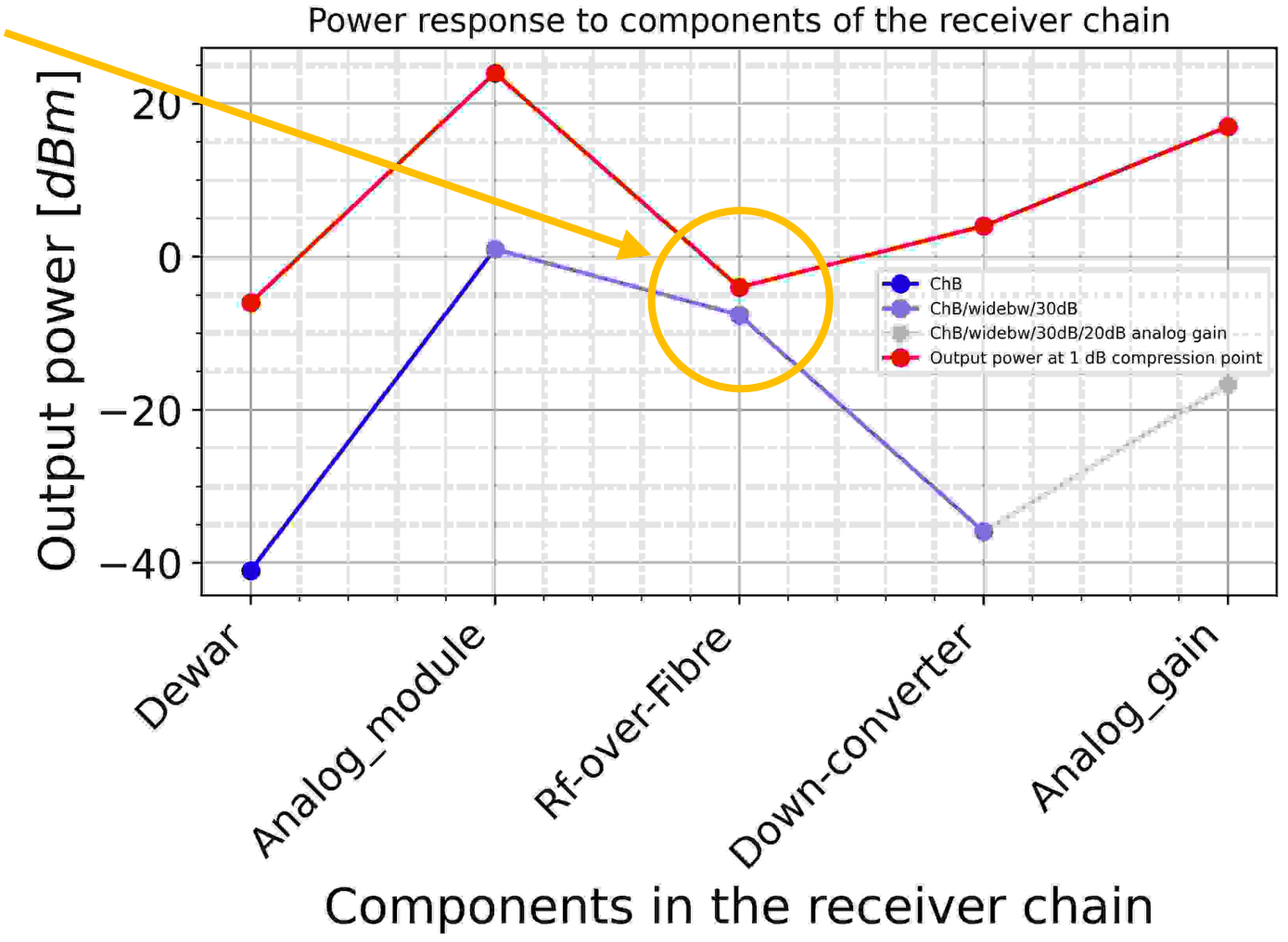
50 dB max gain possibility with steps of 1 dB

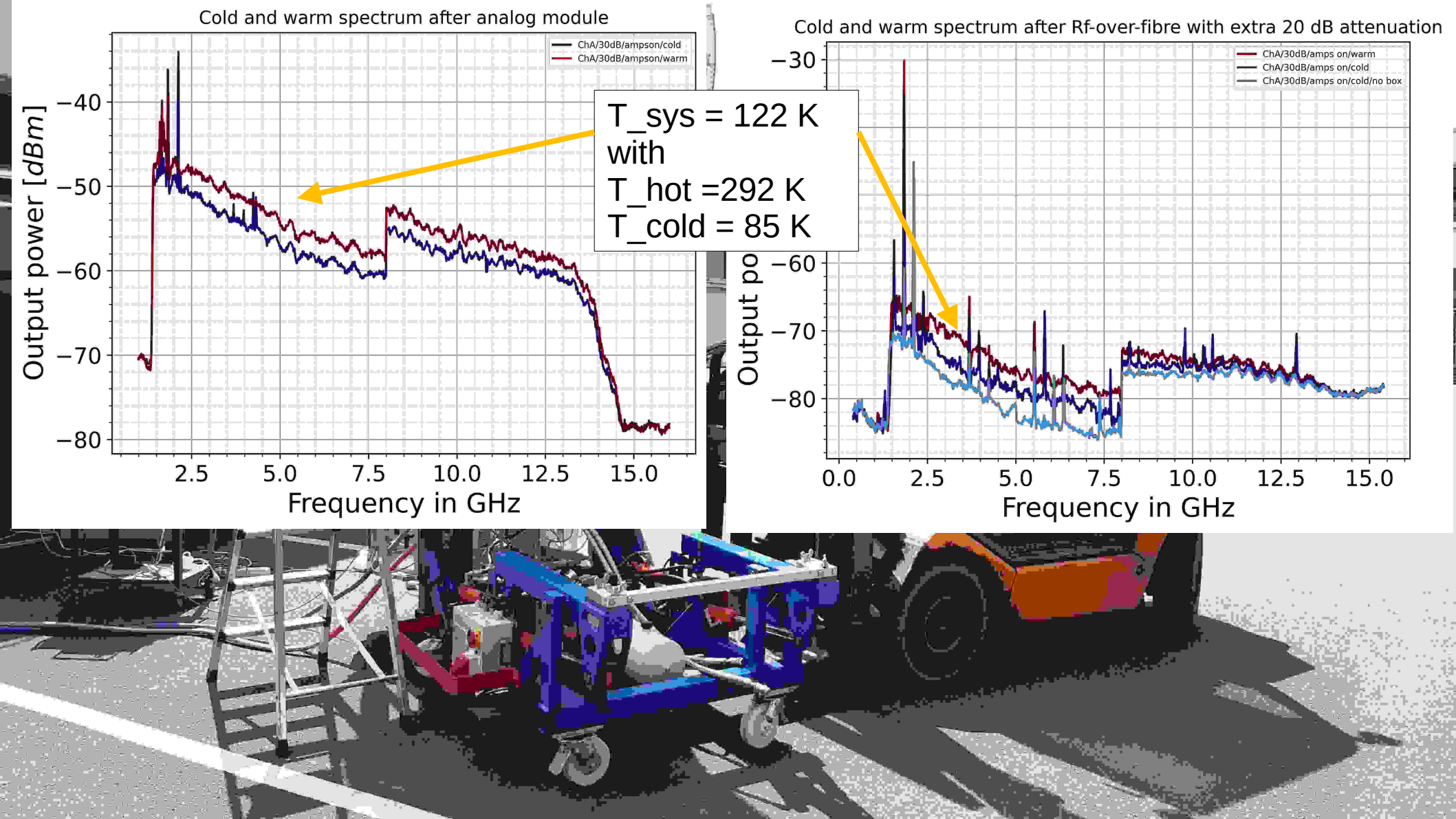


Post and pre filters for down-conversion

Rf-over-fibre is more prone to compression

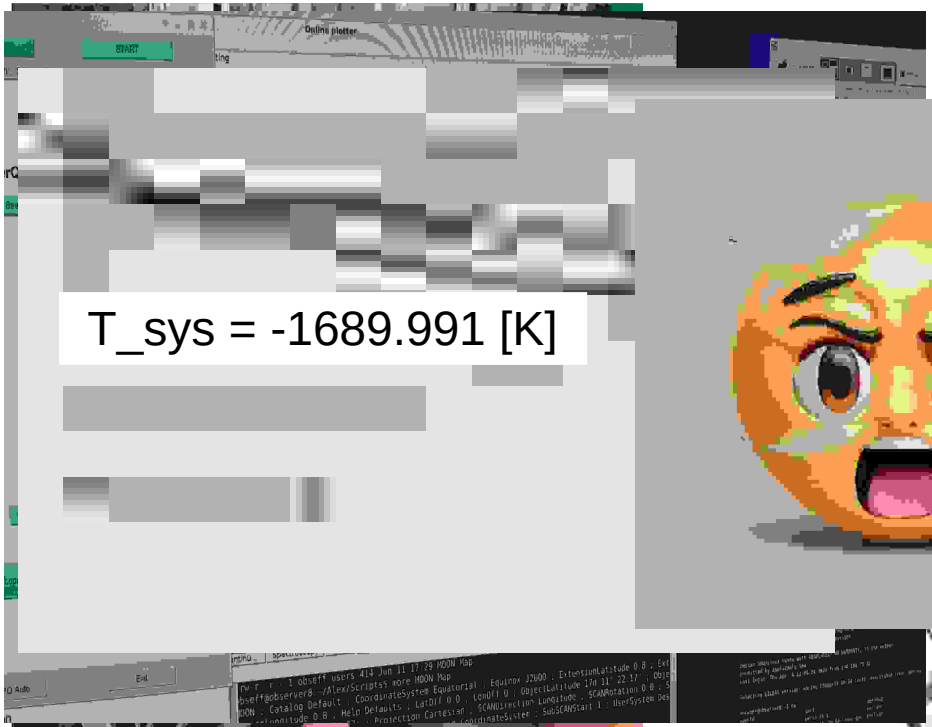
→ BRAND digital front-end in the receiver box with proper shielding




Cold and warm spectrum after analog module
ChA/30dB/ampson/cold
ChA/30dB/ampson/warm
Output power [dBm]
−40
−50
−60
−70
−80
2.5
5.0
7.5
10.0
12.5
15.0
Frequency in GHz
T_sys = 122 K
with
T_hot =292 K
T_cold = 85 K
Cold and warm spectrum after Rf-over-fibre with extra 20 dB attenuation
ChA/30dB/amps on/warm
ChA/30dB/amps on/cold
ChA/30dB/amps on/cold/no box
Output po
−30
−60
−70
−80
0.0
2.5
5.0
7.5
10.0
12.5
15.0
Frequency in GHz


STILL

In the perfect world...



BRAND test observations

Single dish tests: 1.5 GHz to 12 GHz

- Pointings on known calibrators to estimate Tcal, Tsys
- ONOFFs with Moon (~250K) as hot-cold, moon-sky comparison
- Spectroscopic measurements of W3 cloud

VLBI test at C-band

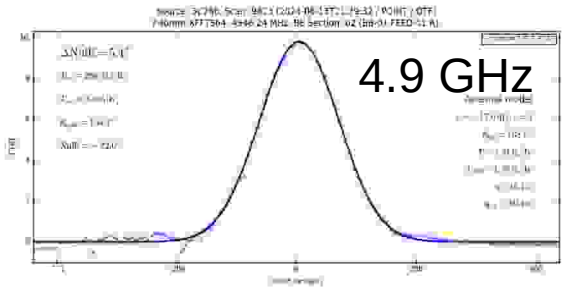
- Repeated 4 Gbps EVN NME N24C2 with Ef, Mc, On, and Ys

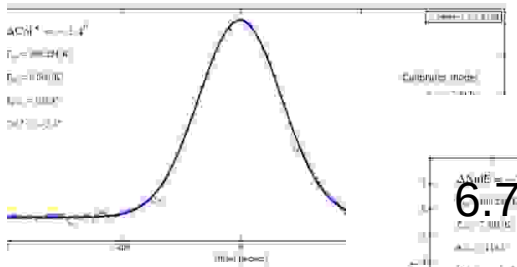
Settings: Receiver RF connected with analog optical fibre to downconverter in Faradayroom (~400m). Downconverter: Filters of 0-4 GHz, 4-8 GHz, 8-12 GHz, with mixer and synthesizer at 4, 8, and 12 GHz, upper or lower side band on 2.5 GHz FFT spectrometer (64k channels).

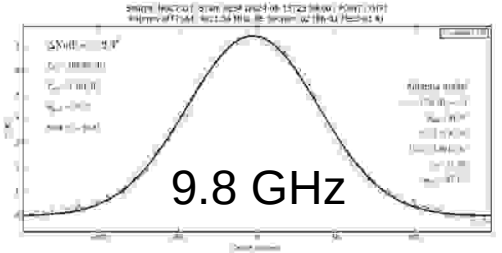
BRAND test observations

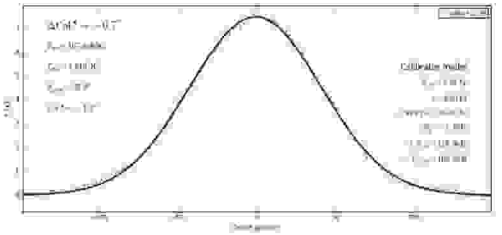
First pointings

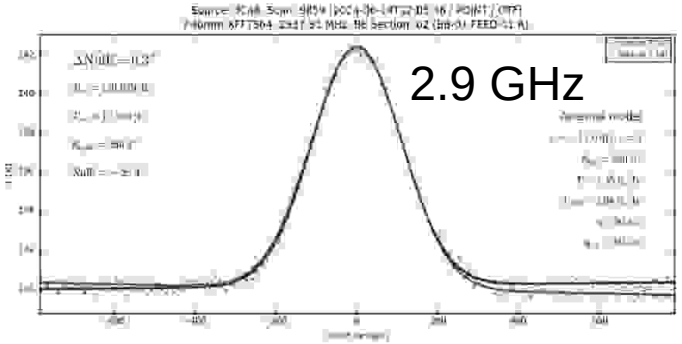
- Tsys ~ 100 K
- Tcal ~ 240 – 100 K

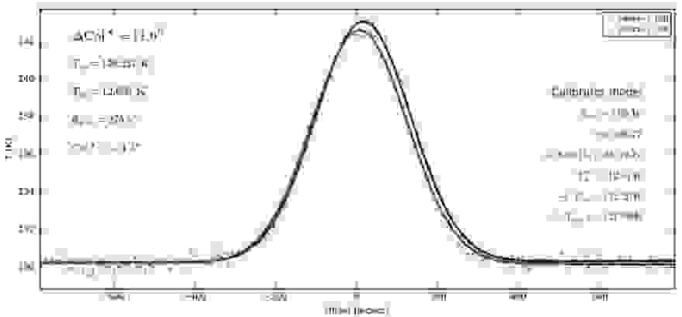


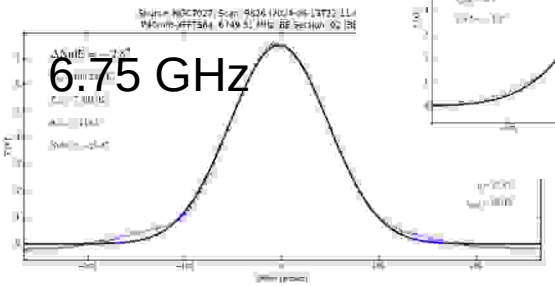


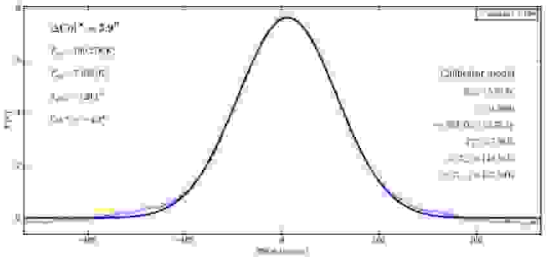








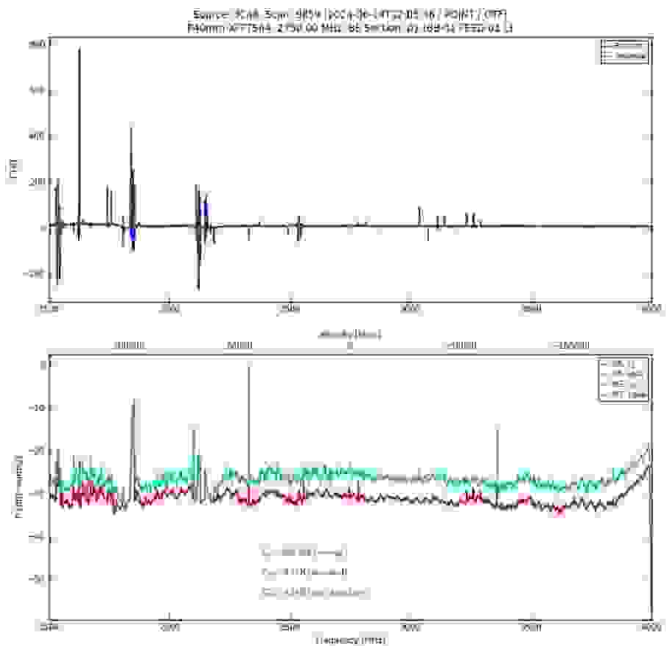




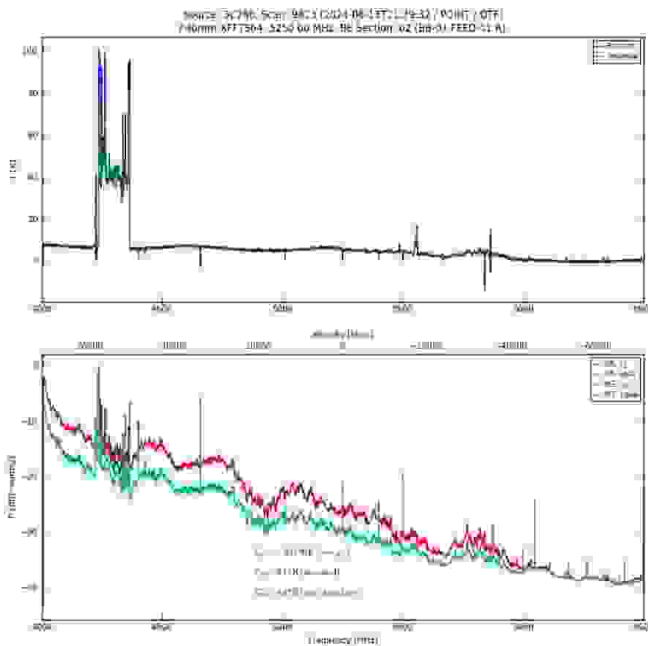
BRAND test observations

Spectrum from 1.5 to 8 GHz

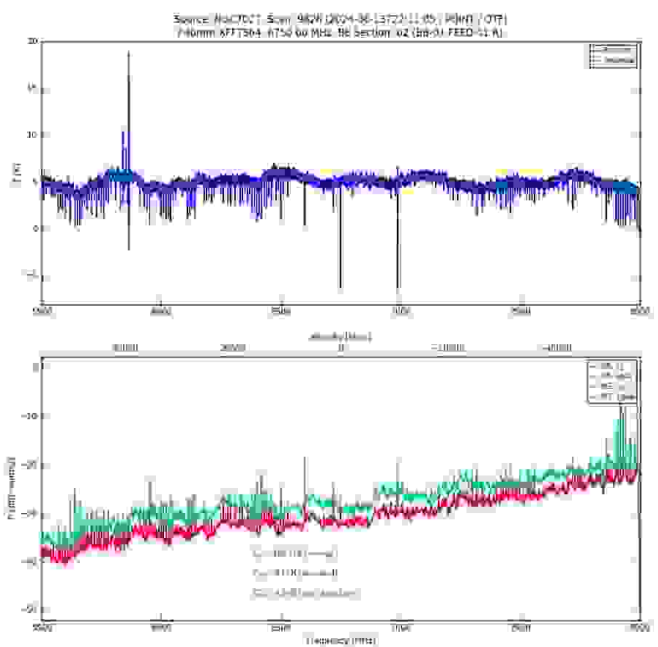
1.5 – 4 GHz



4 – 6.5 GHz



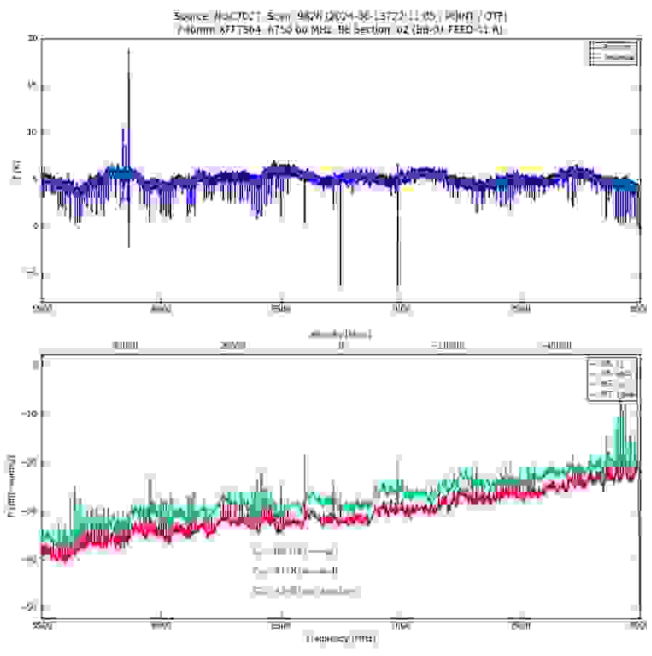
6.5 – 8 GHz



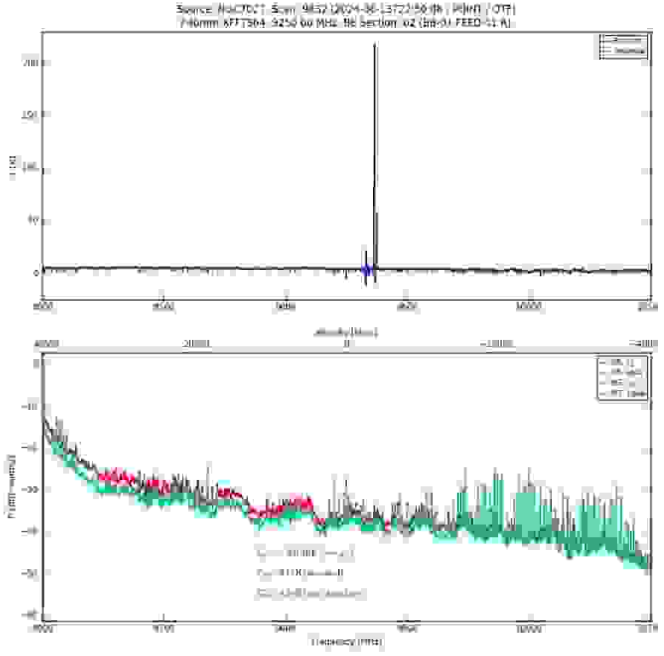
BRAND test observations

Spectrum from 6.5 to 12 GHz

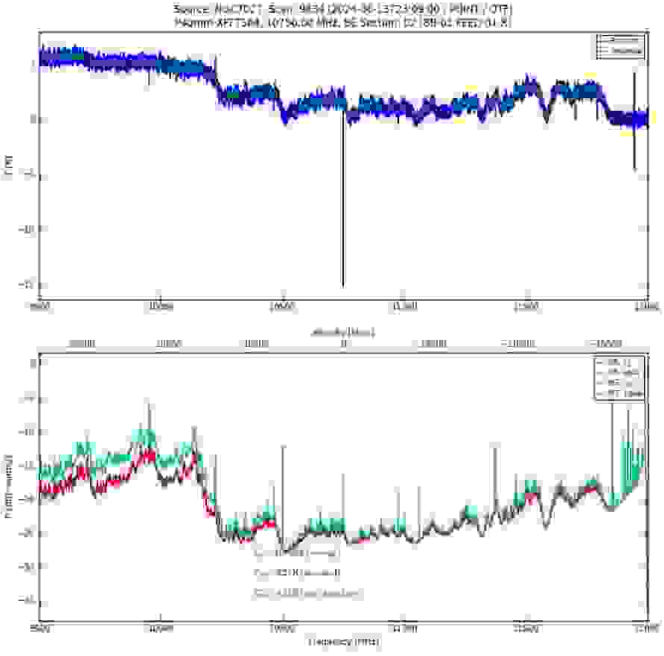
6.5 – 8 GHz



8 – 10.5 GHz



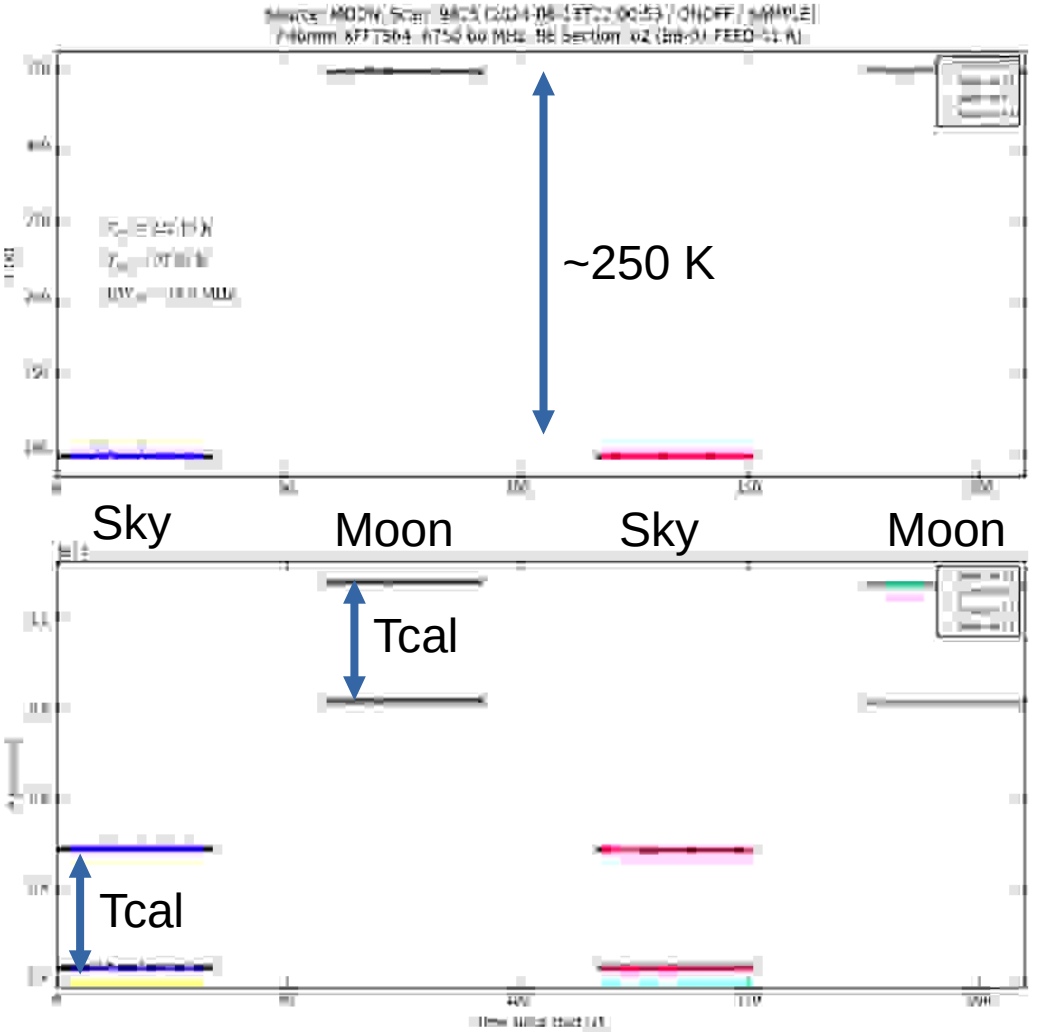
9.5 – 12 GHz



BRAND test observations

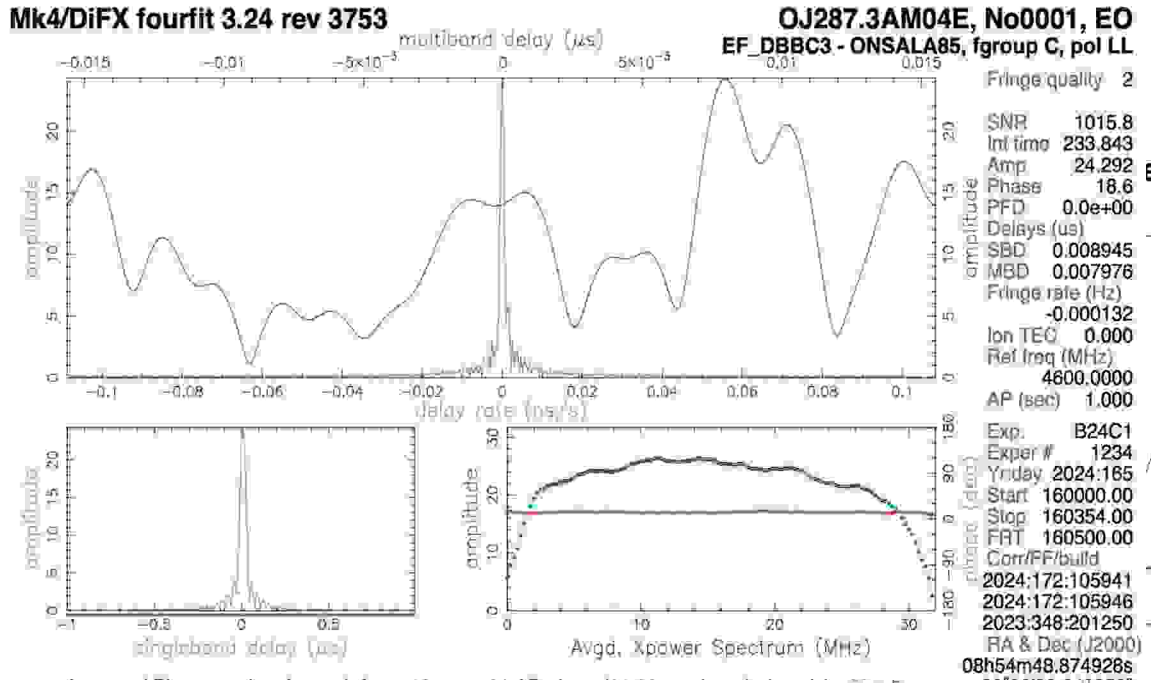
Hot-cold measurements on the Moon

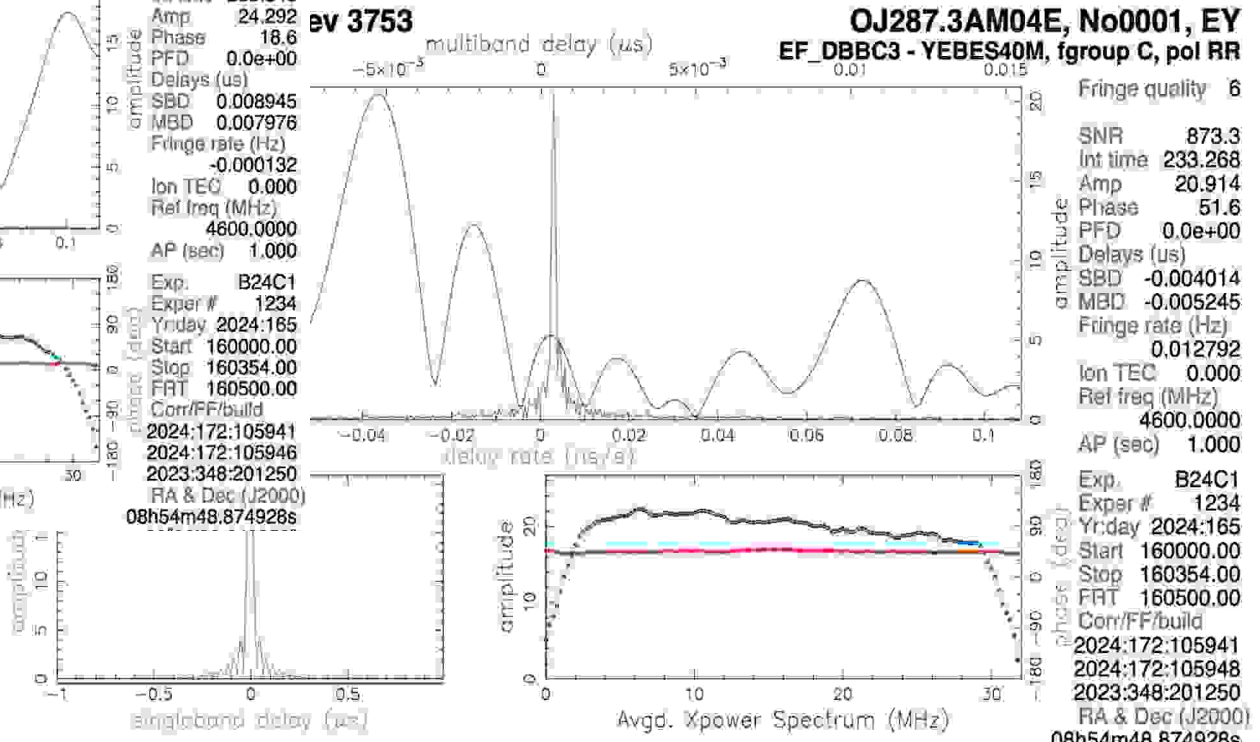
- Tsys ~ 80-90 K



BRAND test observations

First VLBI Fringes at 4.85 GHz.





First ever lift, installation and integration of BRAND front-end has been carried over successfully over the course of 6 months.

First ever sky test and VLBI observation of BRAND front-end

First ever integration of BRAND digital front-end (used as back-end atm) will proceed soon...

With help of:

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