EUROPEAN VLBI NETWORK

INAF

Max-Planck-Institut für Radioastronomie

RadioNet

BRAND EVN —

Status

W. Alef on behalf of the BRAND team

ONSALA RYMDOBSERVATORIUM
CHALMERS TEKNISKA HÖGSKOLA

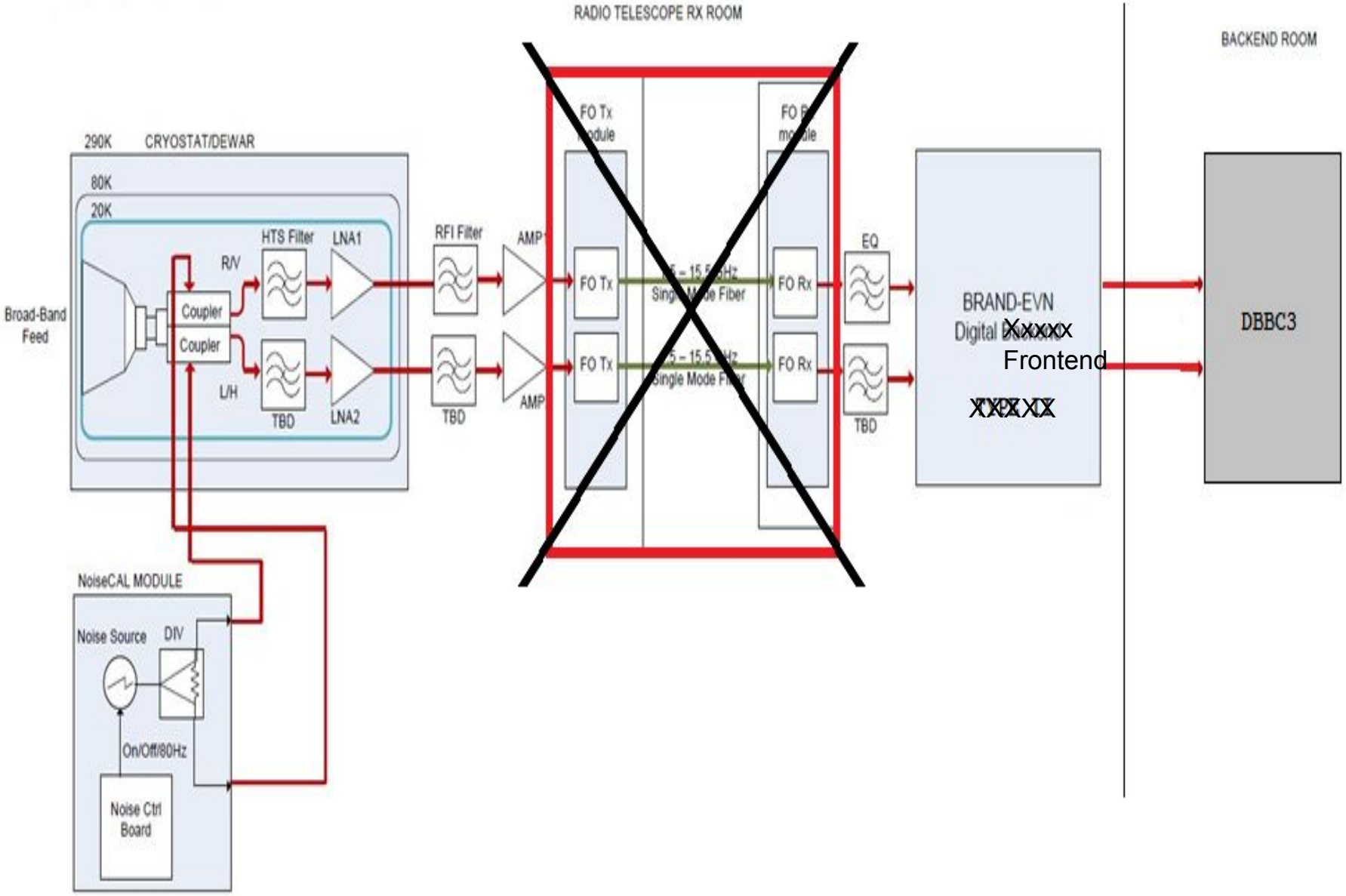
GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO
INSTITUTO GEOGRÁFICO NACIONAL
cnig

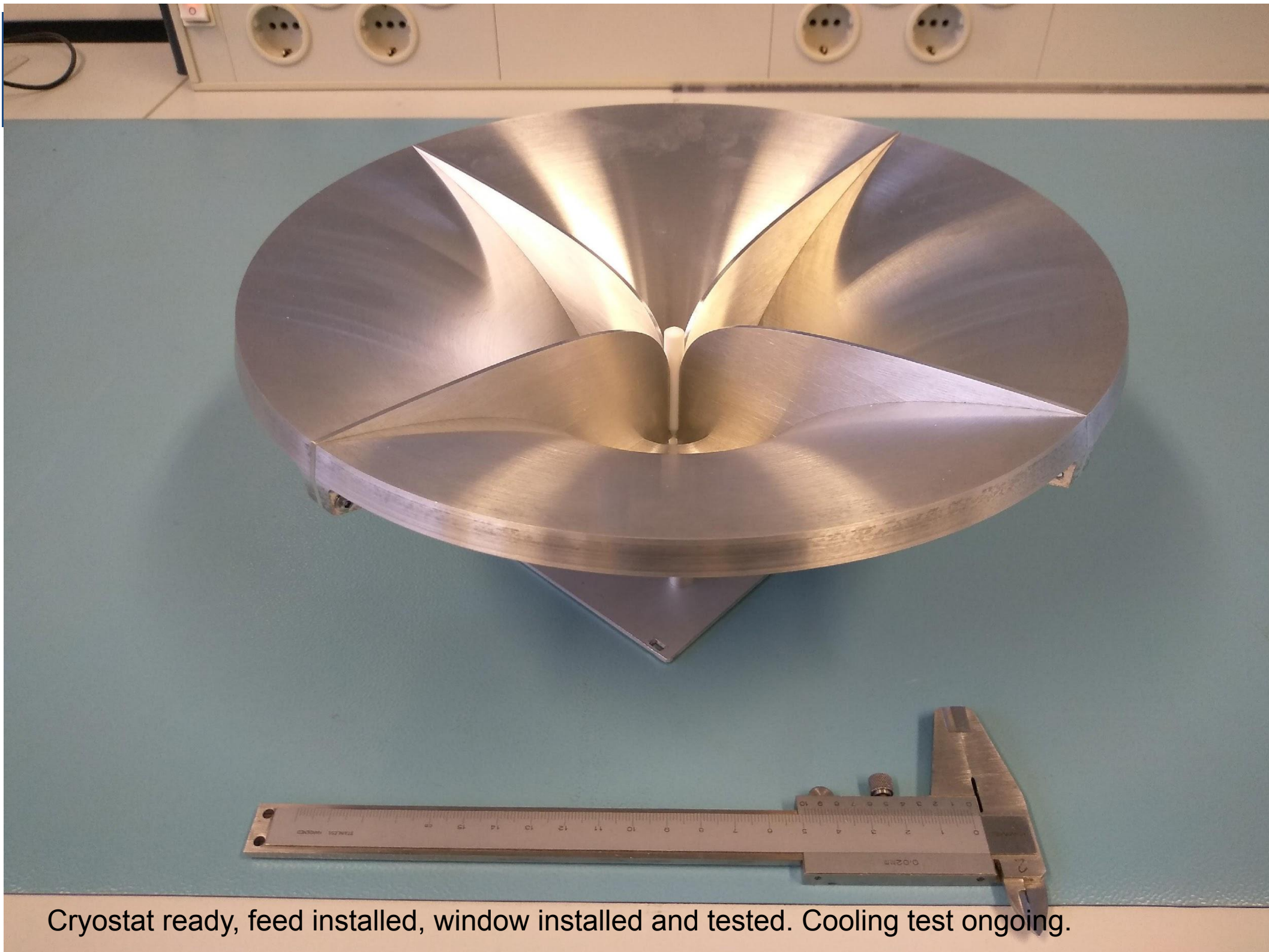
Yebes Observatory

ASTRON
Netherlands Institute for Radio Astronomy

VENTSPILS AUGSTSKOLA

BRAND block diagram





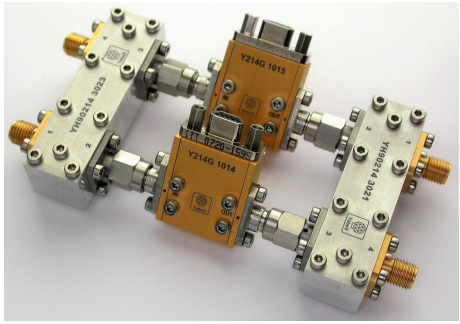
Cryostat ready, feed installed, window installed and tested. Cooling test ongoing.

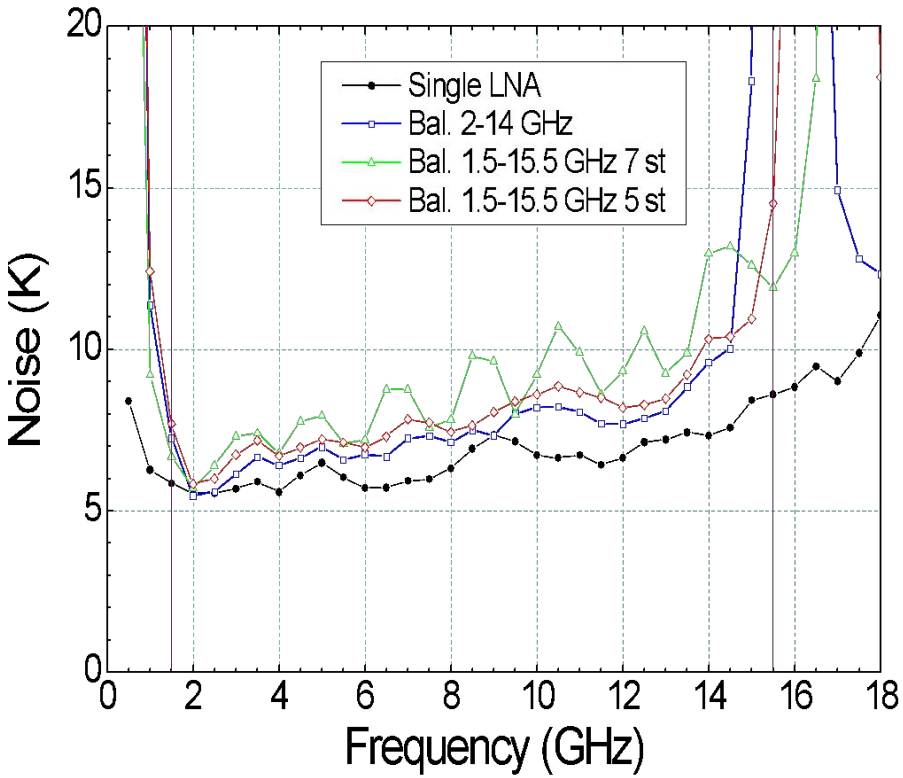
Status: HTSC filters

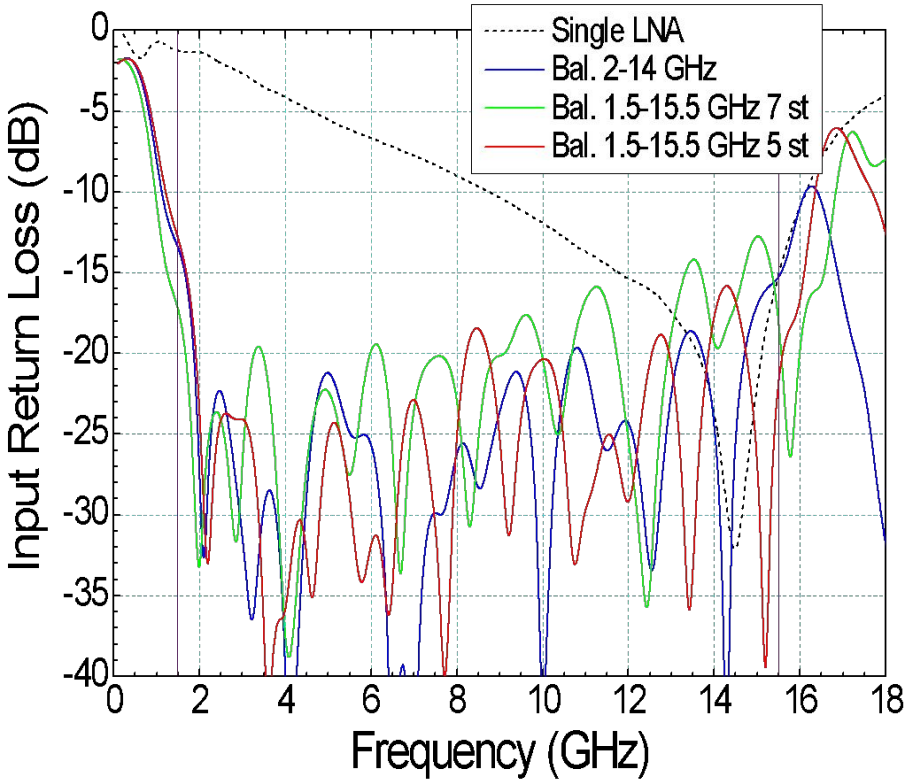
- High Temperature Superconductor Filters, desired:
  - a high pass to cut below 1.5 GHz
  - 2 notches for strongest RFI → (1.8 GHz, 2.2 GHz)
  - A direction coupler for phase-cal & calibration
- Realised in 3 separate devices
  - LNA + HTS filters + coupler measured at Onsala and Yebes
- Couplers are still a problem: ordered VGOS couplers

Status: LNA

- Best solution for extreme bandwidth found:
  - Balanced amplifier with 2 hybrids and 2 LNAs

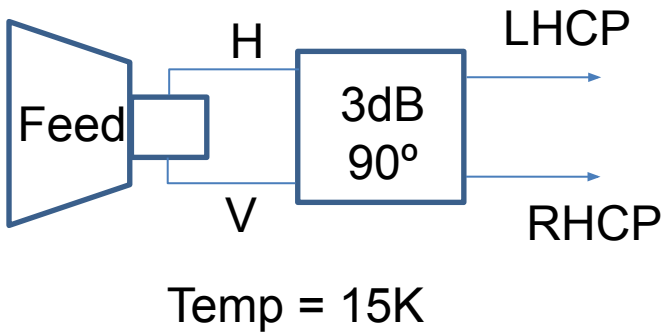






Status: Polarization

- Linear to circular polarization conversion can be achieved using 3dB/90º hybrid (same hybrid as for balanced LNA)
- Average noise penalty across the band < 2.5 Kelvin
- Yebes development for BRAND and VGOS



Measurements of filters + LNA

3. HPF + Notch + U-cable + LNA

- Complete chain measurement without Coupler
- Filter resonances around 10 GHz and 14.5 GHz
- **Avg dTn = 2.13 K => Avg loss of HPF+Notch = 0.37 dB**

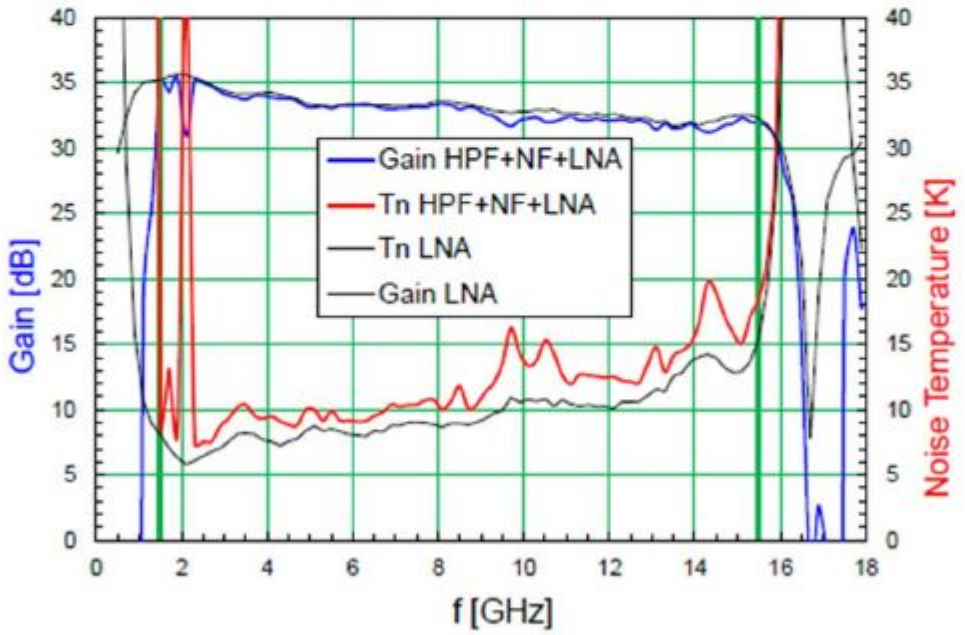
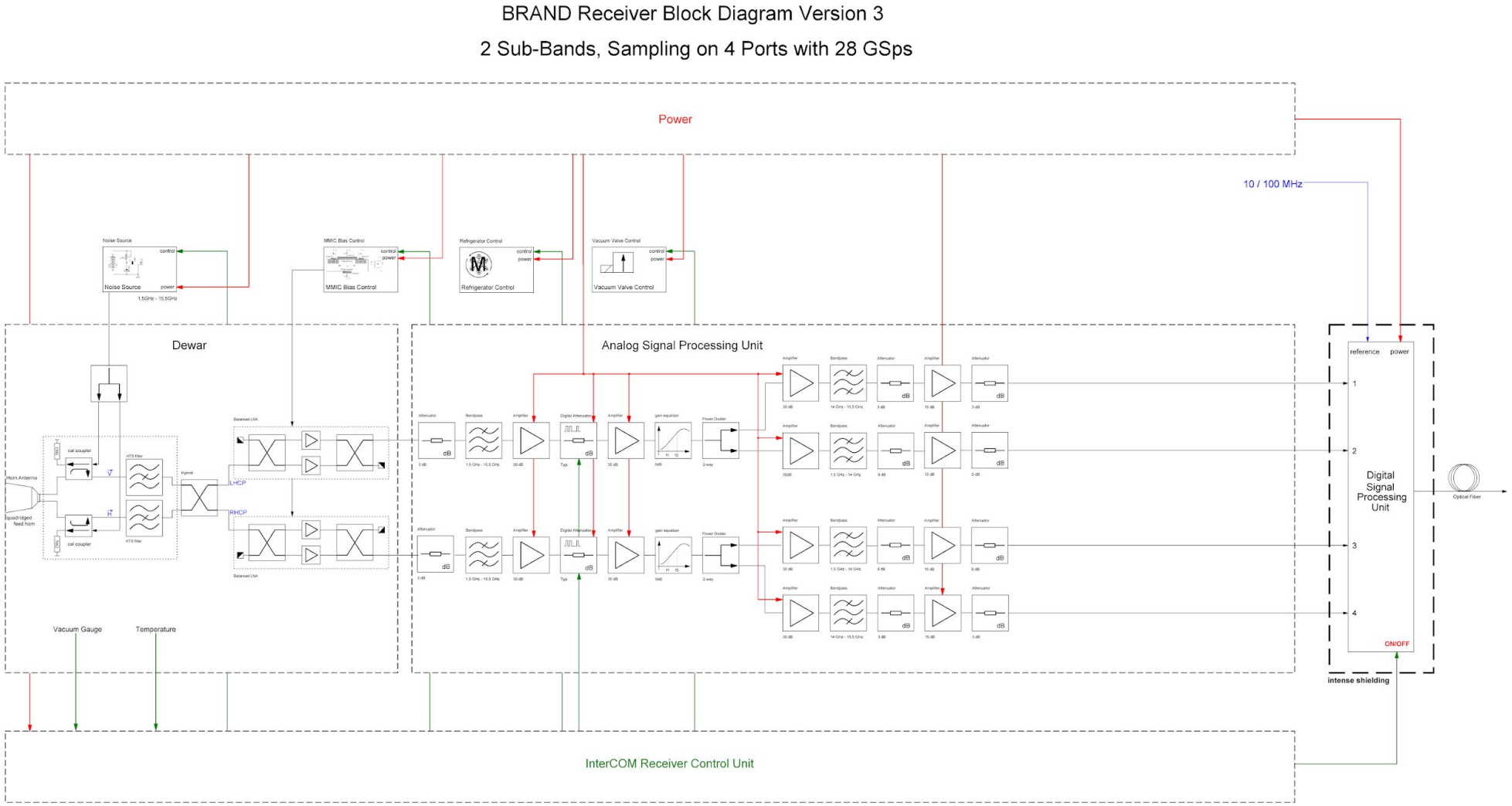
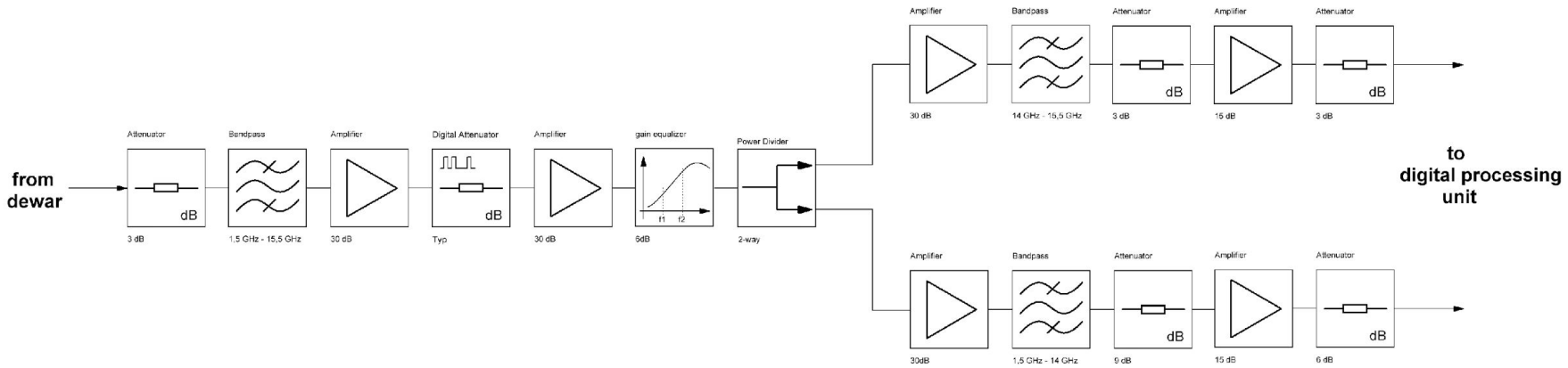


Figure 13: *Highpass filter + Notch filter + "U" cable + Balanced amplifier noise and gain compared to balanced amplifier alone. Note the various features introduced by the filters, best viewed in the figures corresponding to each filter.*

Analogue signal processing II

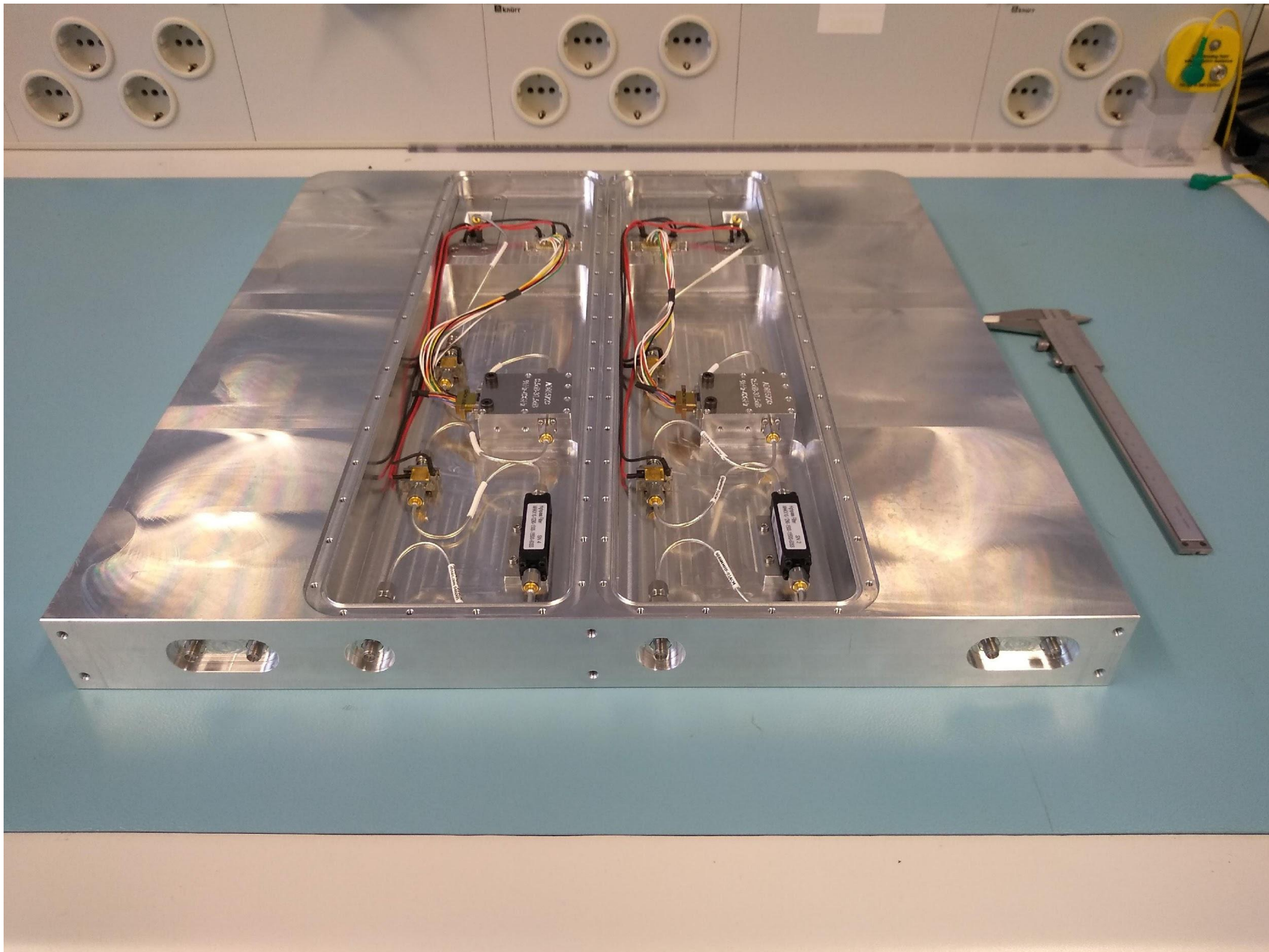


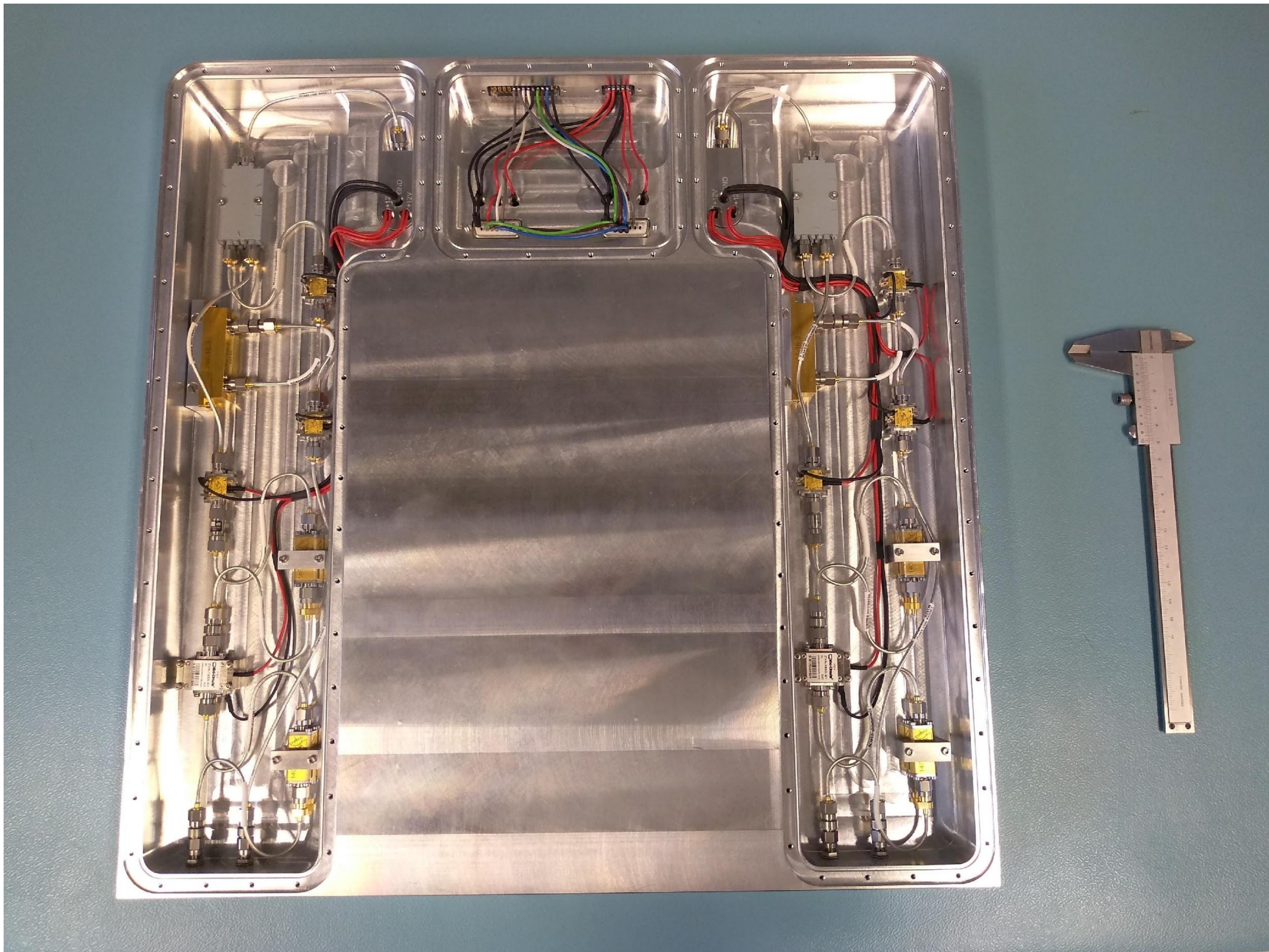
Analogue signal processing III



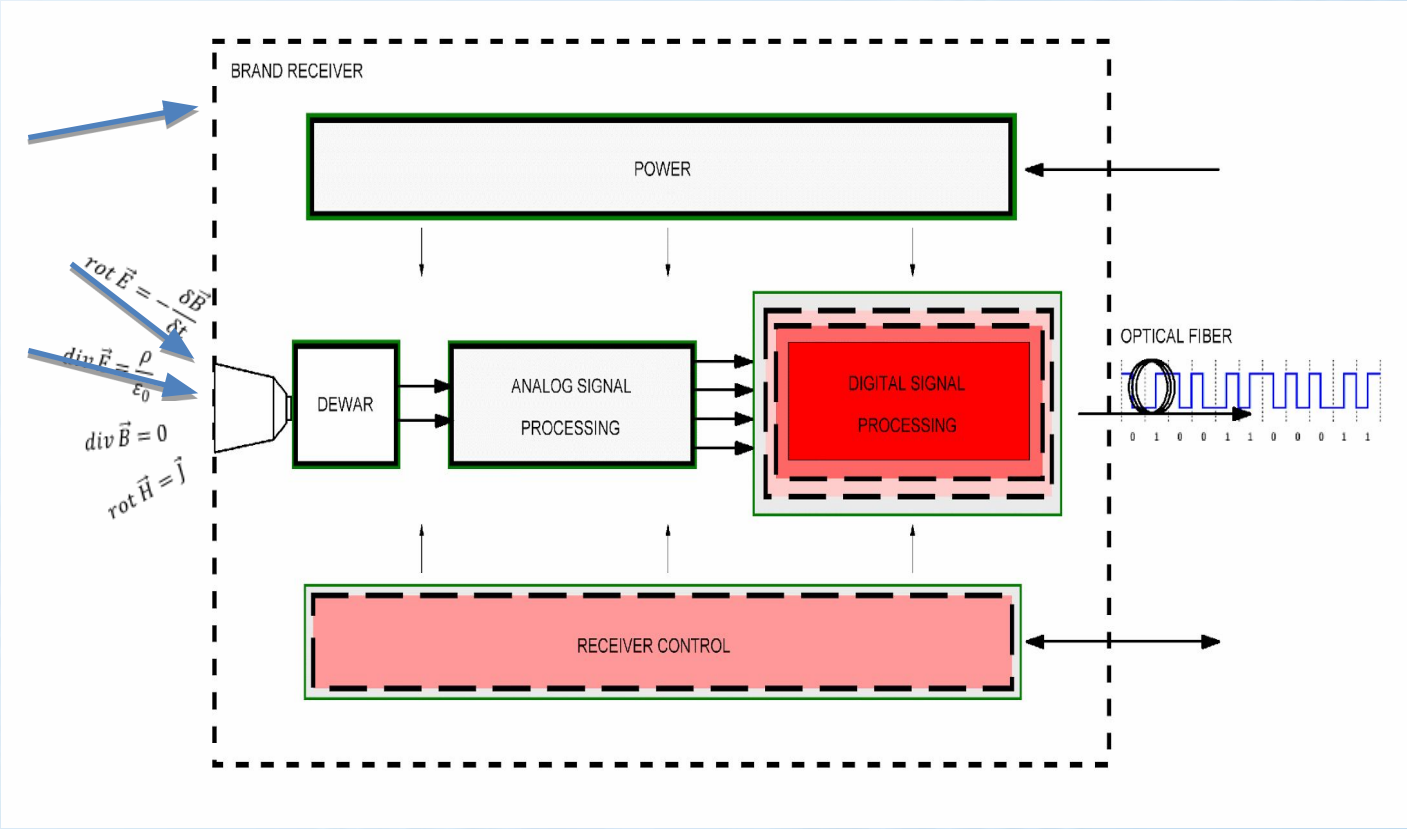
- Sampling in 2 sub-bands avoids the use of the high sampling clock (but needs 4 instead of 2 ports)
- Very good filters are required to minimize aliasing effects at 14 GHz
- Hardware can be changed to Version 1 with moderate effort (for testing data capturing with 56 GSps data rate)

- Sampling on 4 ports with 28 GSps





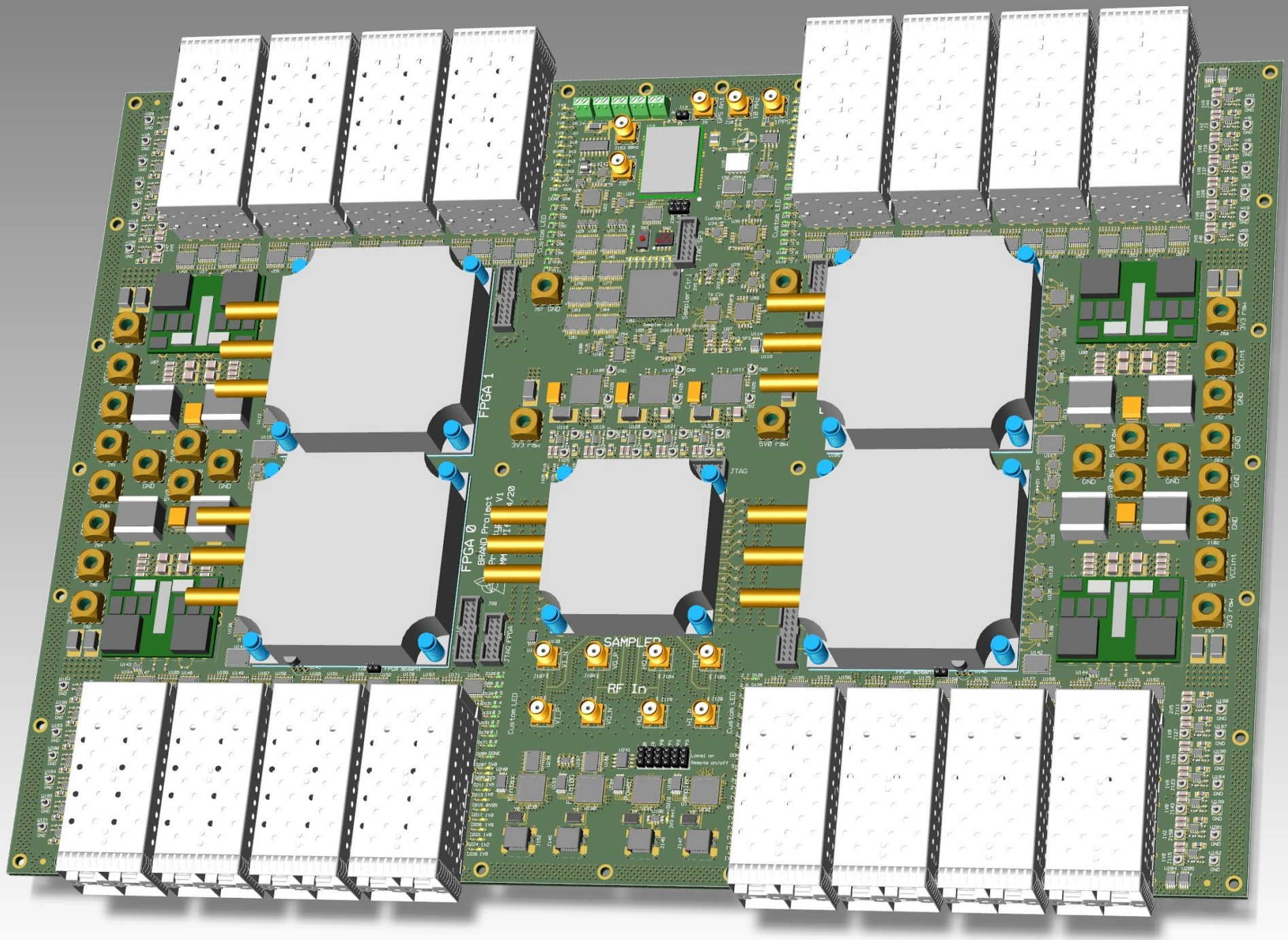
Signal processing in receiver



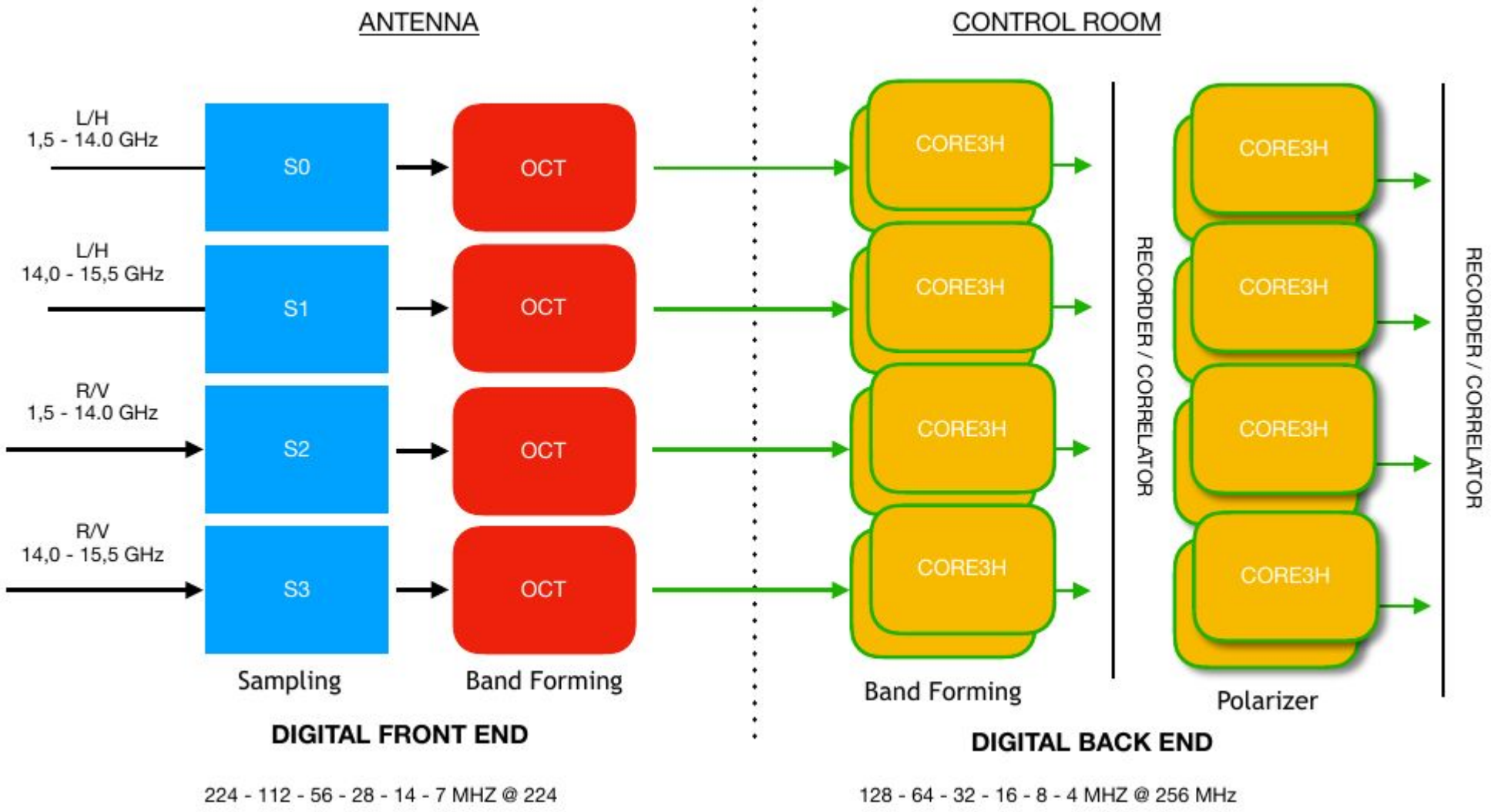
- Receiver output: digital signal via optical fiber
- Strong shielding is required to avoid ‚self-inflicted' RFI (> 120 dB)
- Good temperature management is needed to get rid of the resulting heat

Status digital frontend

- We were able to procure 16 GHz samplers and an evaluation board
- We designed a sampling/processing board (digital frontend)
- We are waiting for a quote for this board
  - Will handle 2 polarisations and full bandwidth.
  - 1 sampler w. 4 inputs @14GHz, 4 Xilinx Kintec Ultrascale FPGAs
    - 2x 0GHz – 14GHz, 2x 14GHz – 15.5GHz in 2nd Nyquist zone
  - PCB will work in the microwave regime: Input is ~900 Tb/s
  - 22 layers, ~4000 differential lines. 2 boards will be made.

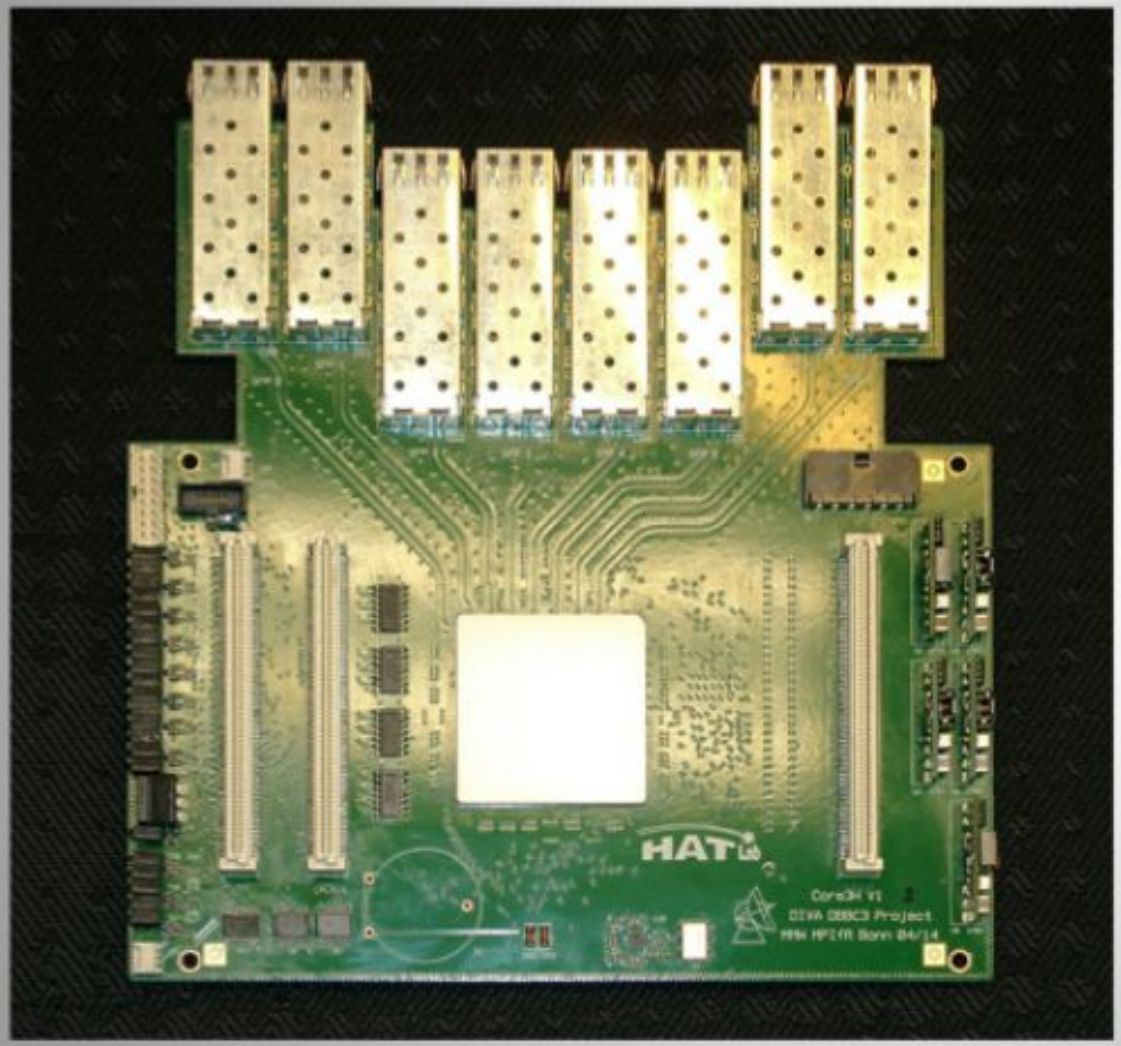

FPGA 1
FPGA 0
SAMPLER
RF In
JTAG
3V3 raw
5V0 raw
VCCint

Block diagram signal flow



Digital Backend DBBC3 board

CORE3H



- Input bus: **HSI / HSI2** (128 bit differential)
- Input sampling representation: **10 bit**
- Max Input bandwidth : **4 GHz**
- Processing capability: **DSC, OCT, DDC**
- Max Output: **8 x 10GE SFP+**
- Network Input: **8 x 10GE SFP+**

Status firmware/software

1) Mostly ready
   - Collaborating on setup of 96 sampler transceivers w. manufacturer
2) Polarization conversion (digital; ASTRON) – first version in May
3) Small changes in DBBC3 firmware
4) Control software for receiver & digital frontend
5) Recorder no problem as we will use DBBC3 output
6) Implemented autoband mode in DiFX correlator (also for PdB)

Delays due to COVID19

Everything which was not ready before the pandemic started will be delayed! Total estimated delay ca. 6 months.

- Labs partly or completely closed
- No travel
- No collaborating possible
- Delays of quotes and ordered items

Summary

Everything which was not ready before the pandemic started will be delayed! Total estimated delay ca. 6 months.

- Dewar under test w. feed and window
- Coupler still not OK, filters acceptable. New couplers ordered
- LNA ready: balanced amplifier with polarisation conversion
- Digital frontend: need quote for PCB and populating the board
  - Box has to be built
- Digital backend: 8 CORE3H w. 8 tranceivers ordered
- Firmware mostly ready; software mostly ready
- Receiver box mostly ready

Sampler crisis

- Sampler chip is not freely available on the market
  - we have a commitment from the manufacturer that they will supply us with more chips to cover at least the demand of the EVN.
- 1 chip is needed per receiver
- The manufacturer of the sampler chips has announced that they will discontinue this chip
- Last orders can be placed till the end of August w. delivery end of February 2021
- New chip **might** become available for us 2022