Design Challenges of Highly Integrated RF Electronics for Astronomical Receivers

PAF & Advanced Receiver workshop
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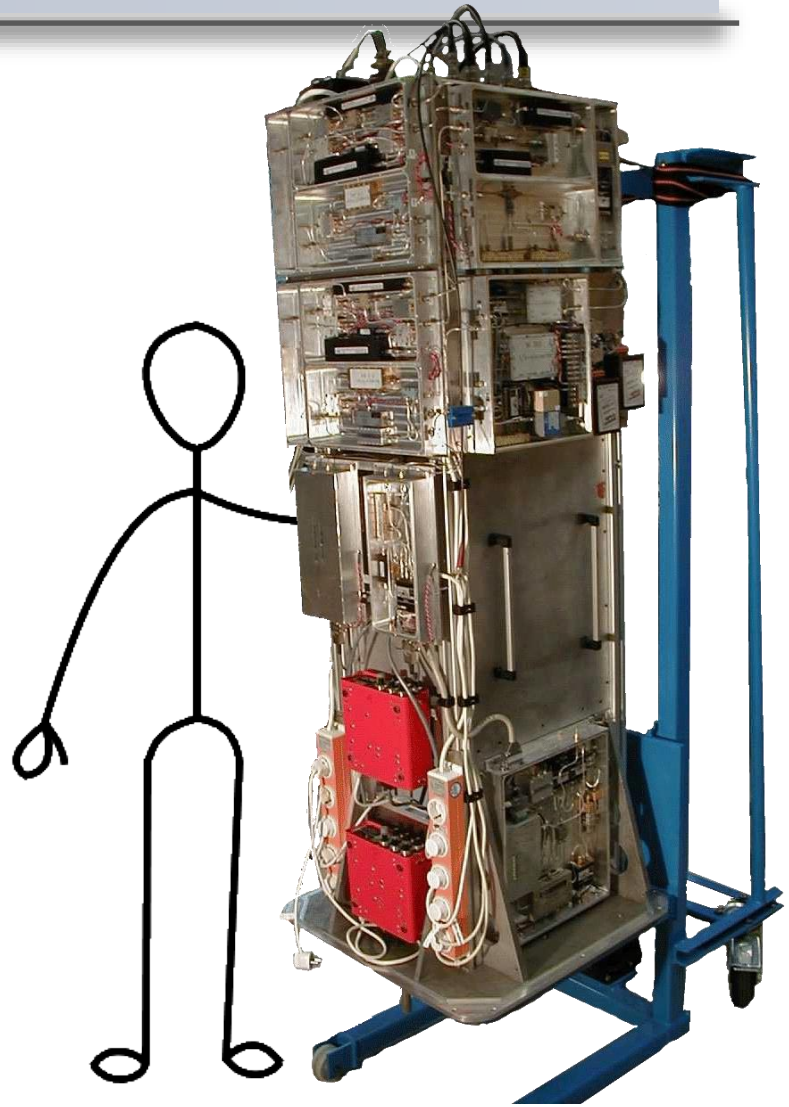
Challenges:

- Increased analogue bandwith
- Restriction on space
- Restriction on weight
- Remote access to ‚housekeeping – data‘
- Digitisation in the receiver box
- Reduction of costs
- …

More compact design on PCB. If possible modular design to be able to reuse it in other receivers.



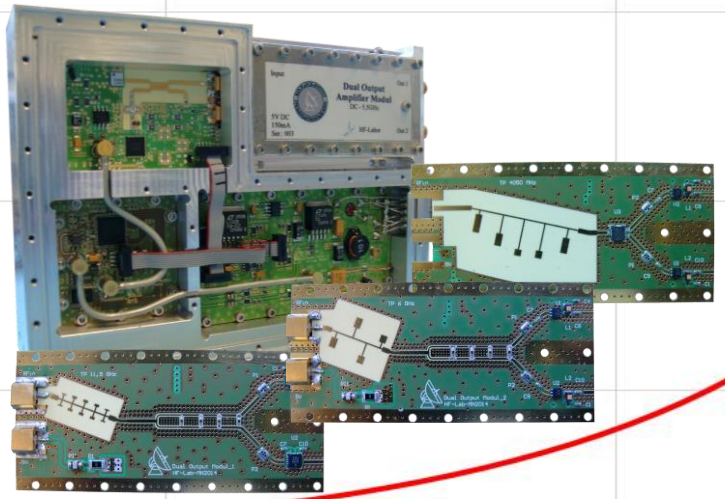
MPIfR -

- High Frequency Receiver Laboratory

IF on PCB

- IF on PCB
- Synthesizer for LO generation on PCB

➢ ‚Functions per Volume‘ increases



MeerKAT

EDD

integration density

2000 2005 2010 2015 2020

year

MeerKAT receiver electronic box

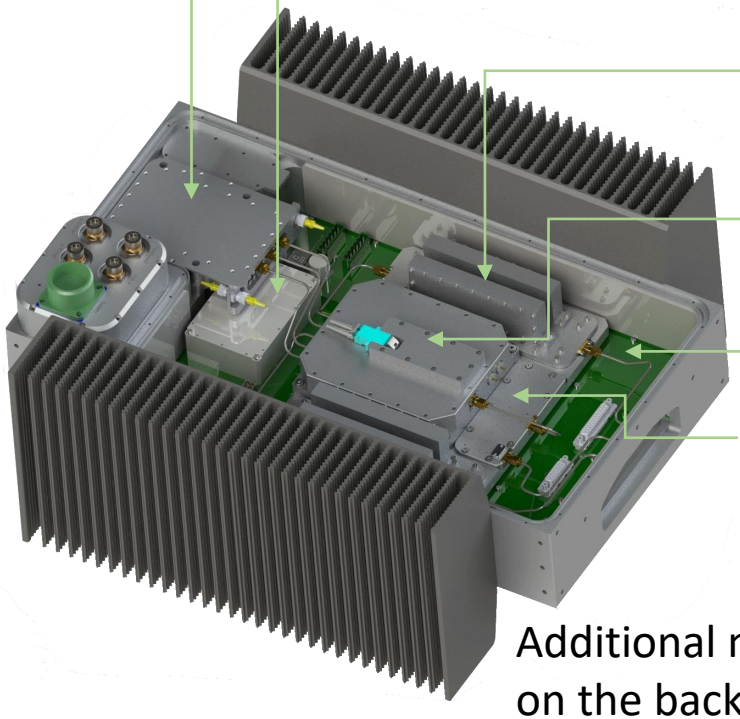
Time and reference module

Receiver controller

digitizer

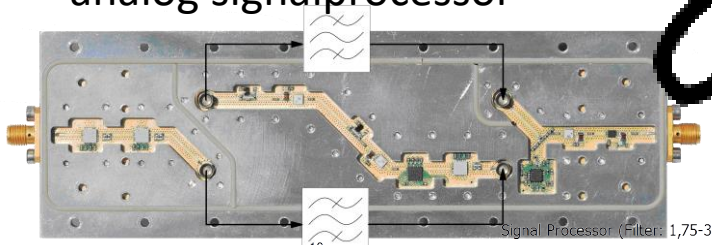
Mainboard

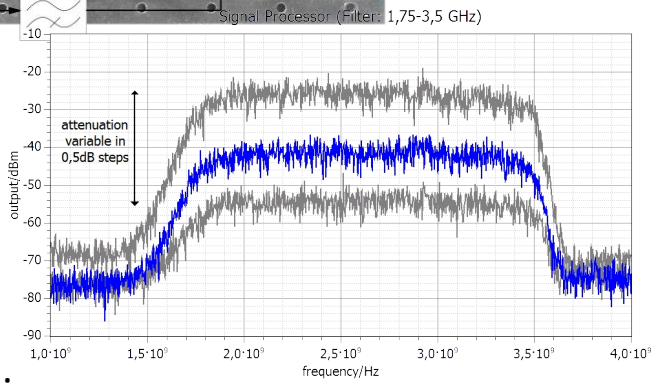
Noise generator



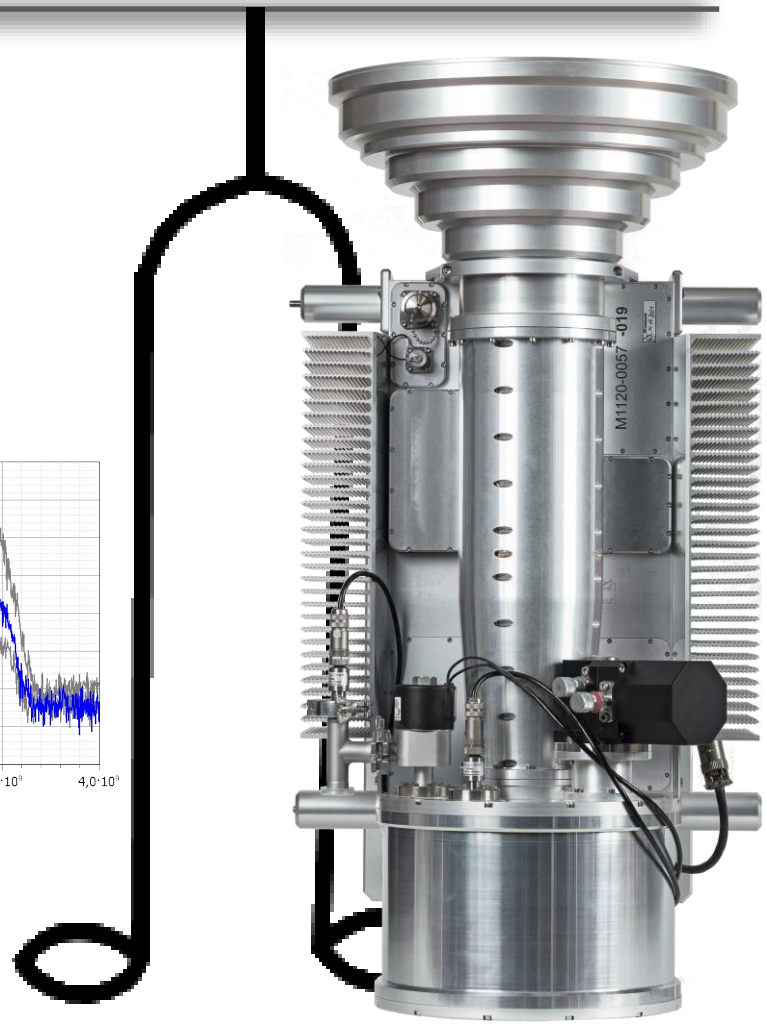
Additional modules
on the back side

analog signalprocessor

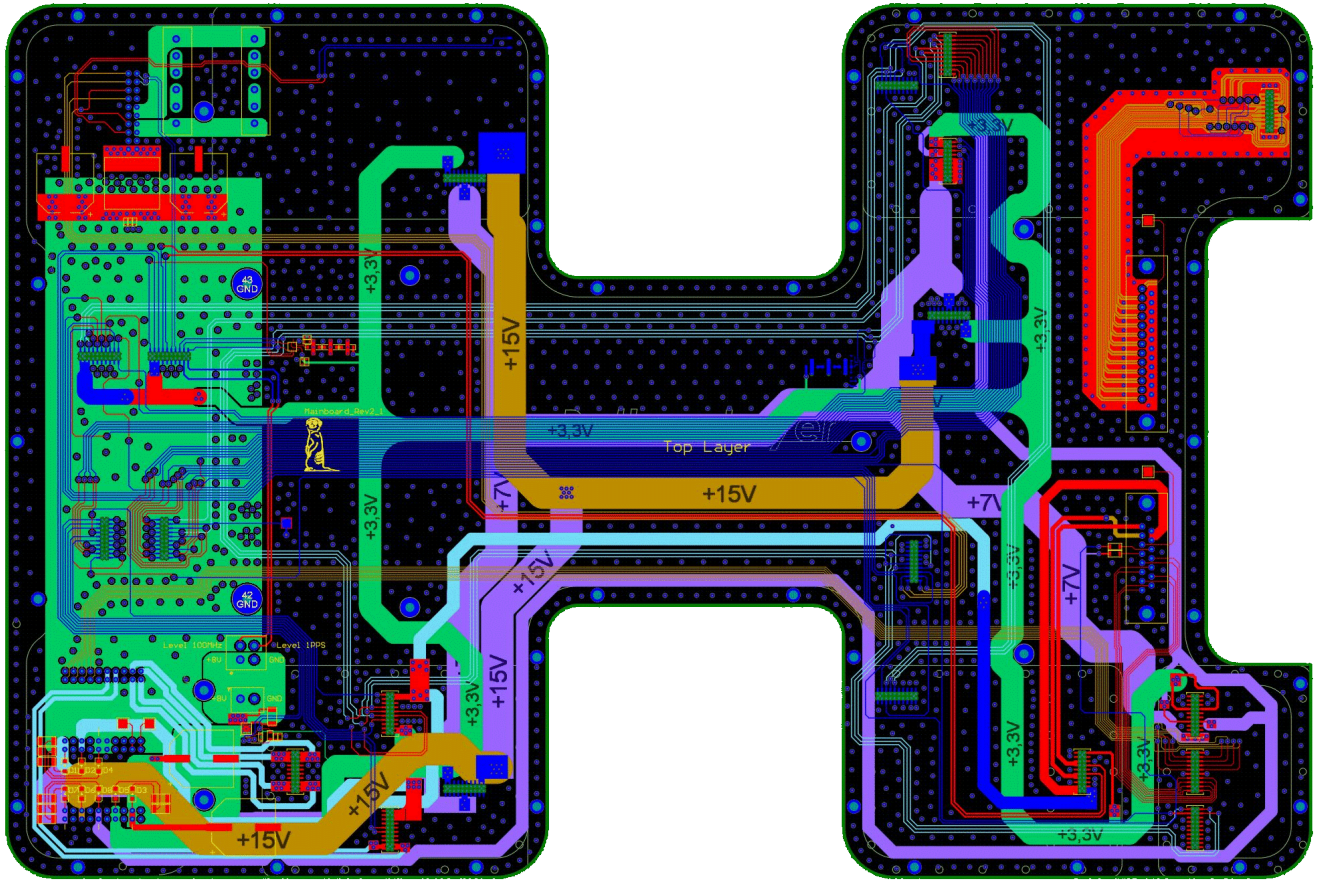




Filters:
1,75GHz – 3,5GHz
2GHz – 4GHz
3GHz – 6GHz
4GHz – 8GHz



Mainboard MeerKAT S-Band Receiver

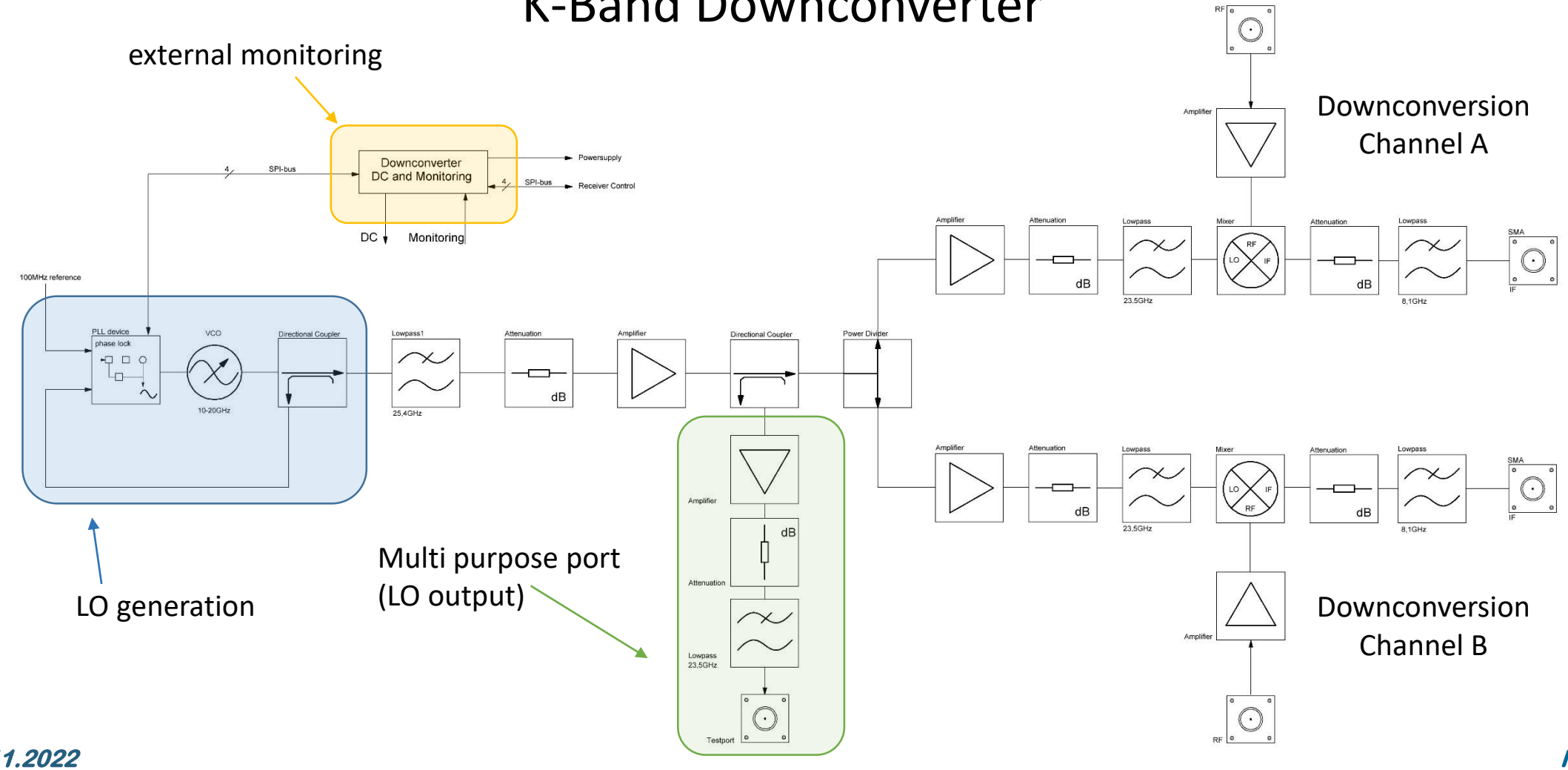


- 10 layer board
- Bus signals (SPI, RS485)
- Sensor signals (analogue voltages)
- High current planes (peltier elements)
- LNA bias
- DC bias, GND planes

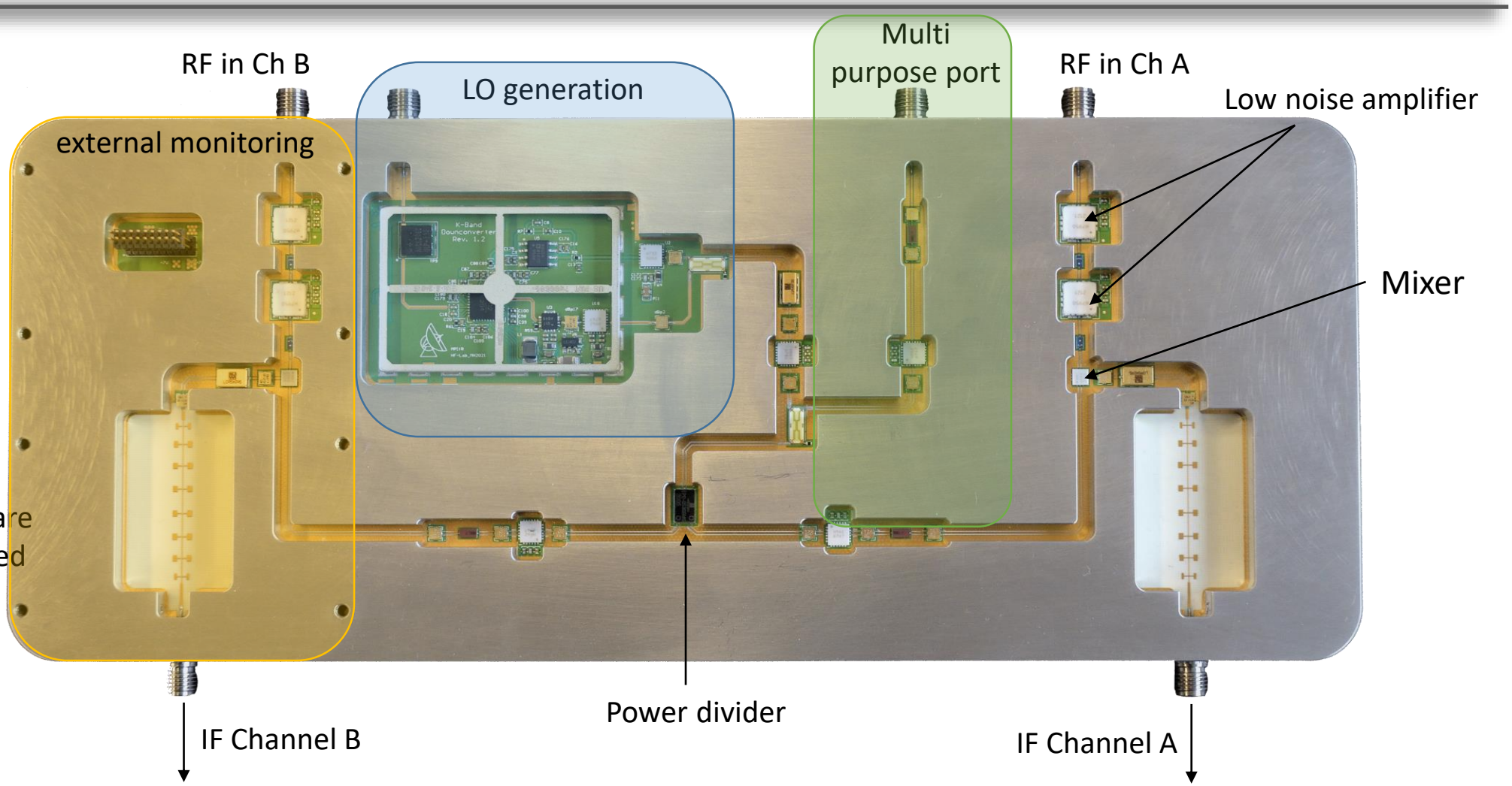
➢ *577 connections routed*
➢ *132 signal nets*
➢ *>2200 GND vias*

The great advantage of this type of wiring: once the connections are correct, they are also correct in the next box.

K-Band Downconverter



Monitoring unit:
voltages and currents are measured, AD converted and monitored by the receiver controller.



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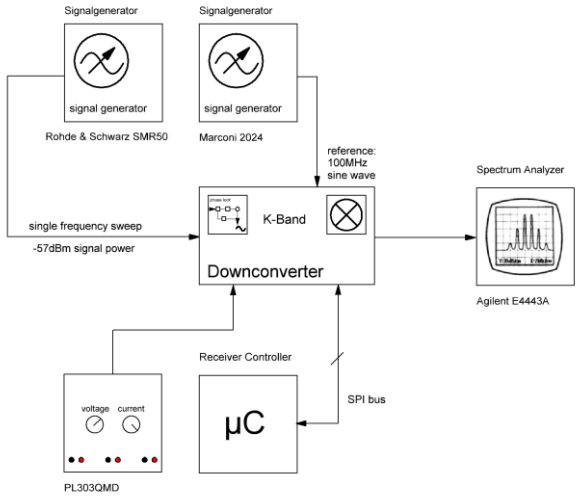
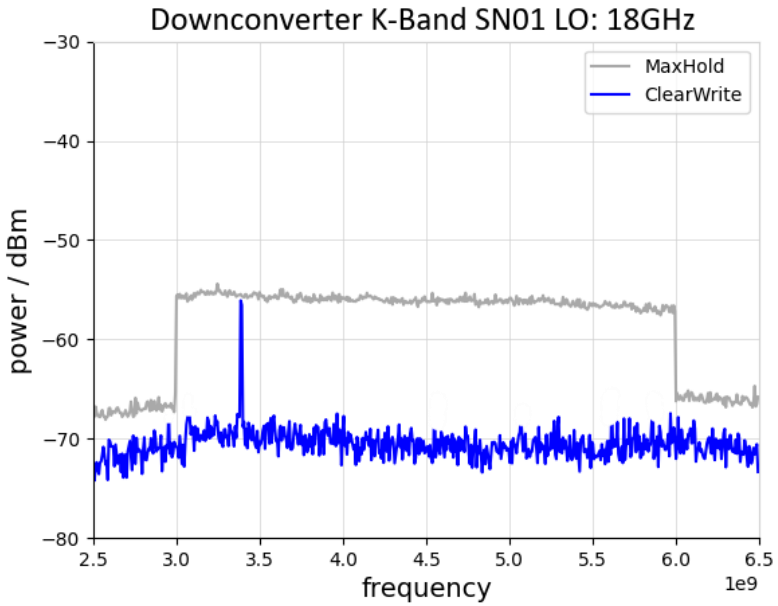
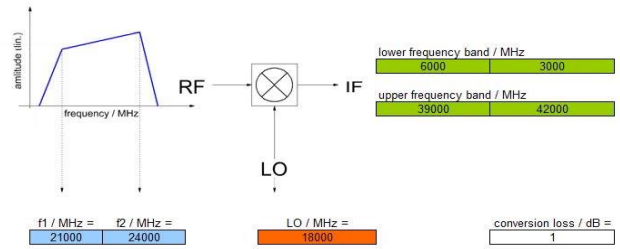
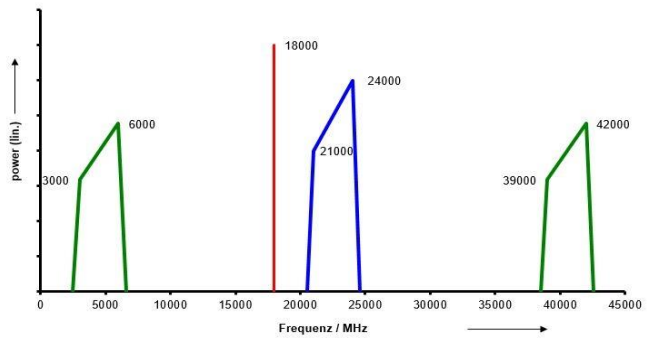


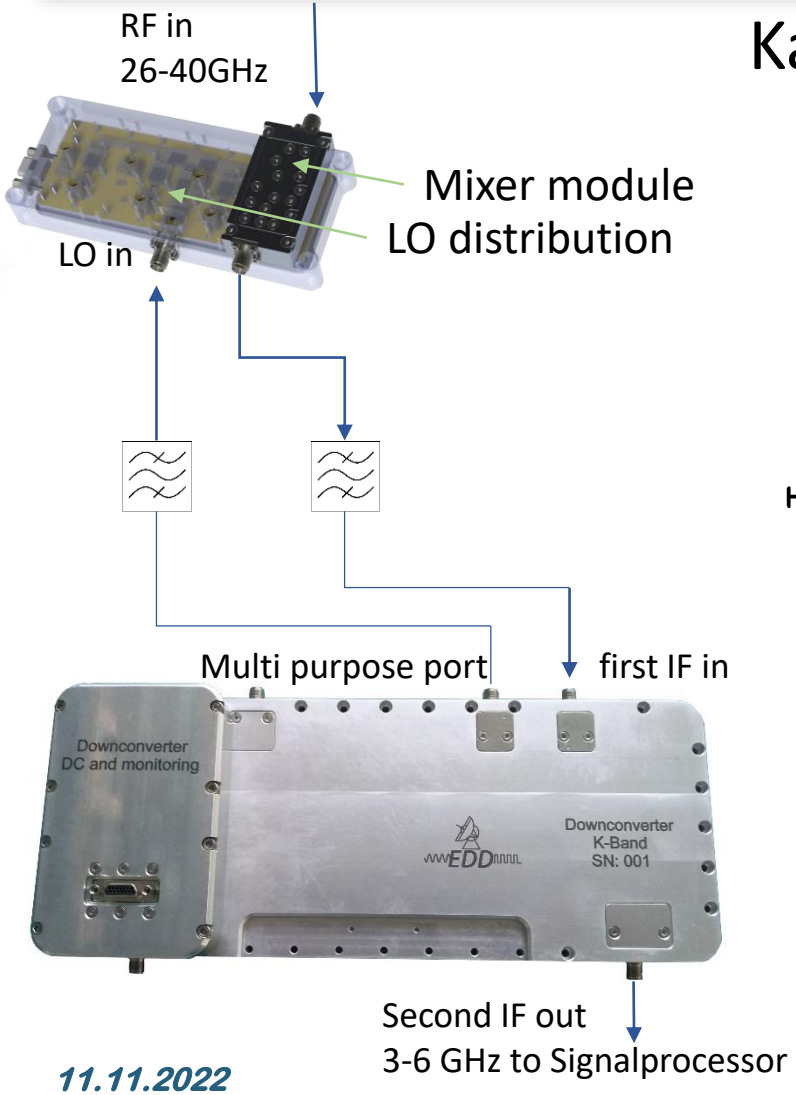


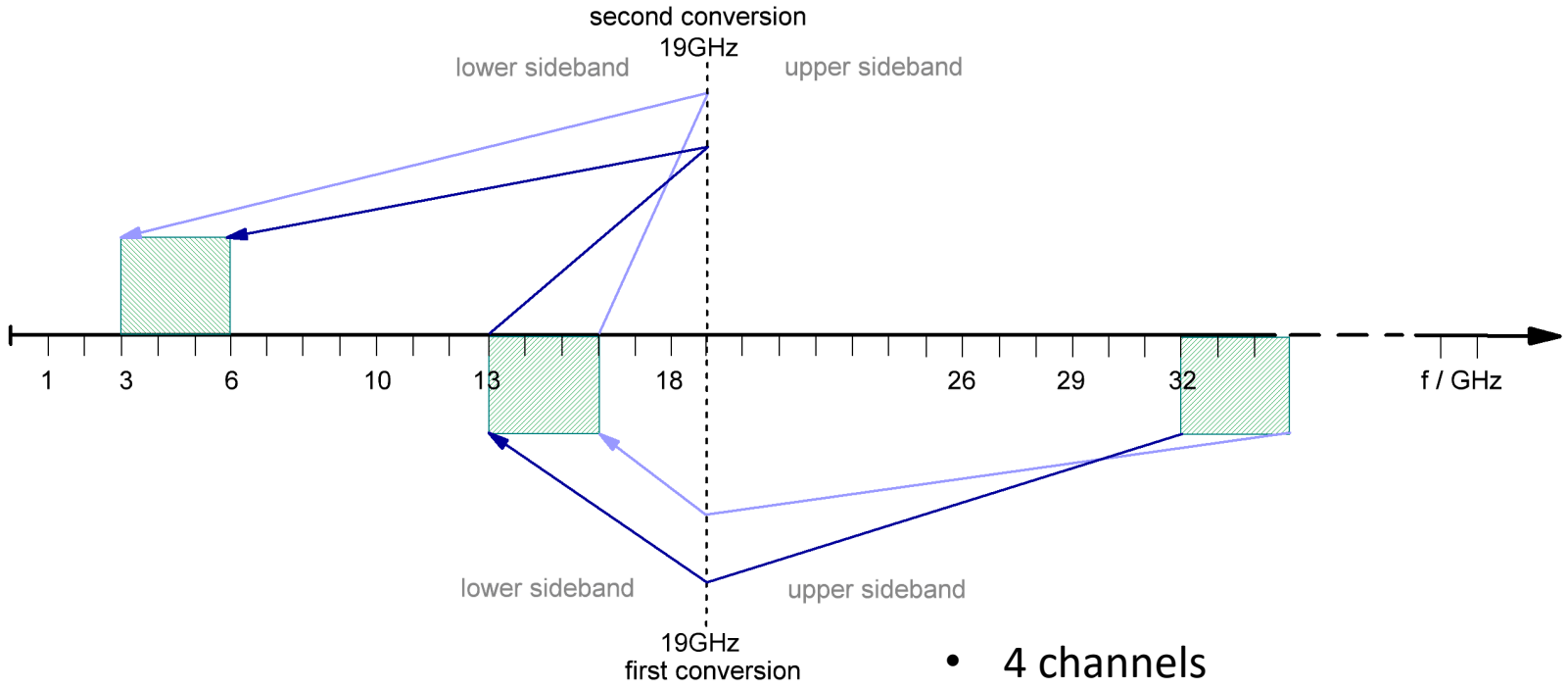




- Compact design with LO generation, LO distribution and downconvertion of RF signal (2 channels) on a single PCB.
- Matches the footprint of the MeerKAT receiver box (can be connected directly to the Signal Processors)
- Multi purpose port opens up new possibilities…

Ka-Band Downconverter





- 4 channels
- Same LO signal for first and second conversion
- High quality filters are needed

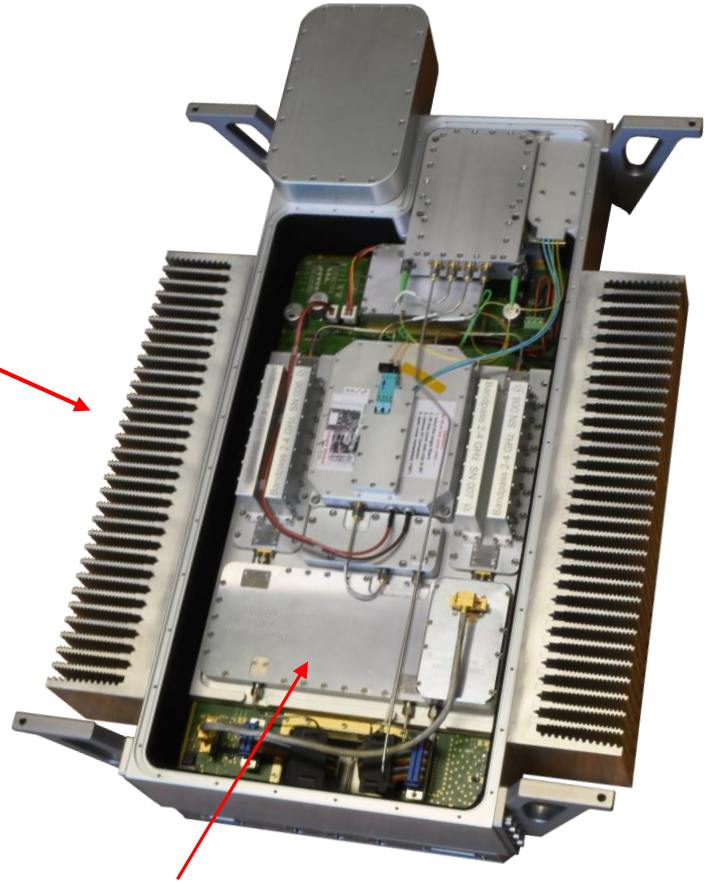
Receivers with downconverters in operation

K-Band receiver for Narit (Thailand)

Ku-Band receiver for the SKAMPI Telescope in South Afrika

Ku-Band receiver for BRASS (Hamburg)

Cx-Band receiver in Effelsberg



K-Band Downconverter

Thanks for listening.