



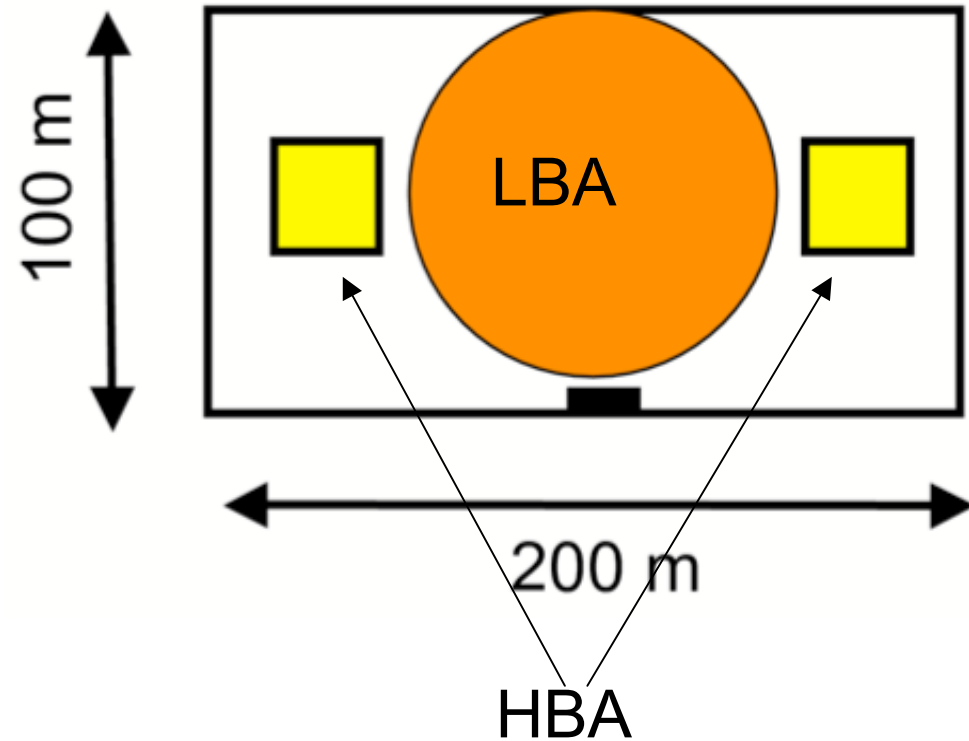
# *The Impact of LOFAR Super Station on Station Hardware and Software*

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**LOFAR Super Station (LSS) workshop  
Thursday 17 & Friday 18 January, 2008, APC, Paris**

➤ Reduce Station Size

- 48 receivers per station
- 2x24 HBA and 2x48 LBA
- LBA connected to LBL+LBH inputs



- Which points have to be addressed when...
  - ☞ The LBA is an antenna array of  $N$  elements
  - ☞ The coax cable length is more than 100m
  - ☞ Antennas operate at lower frequency

➤ Station calibration

☞ Array calibration

☞ Antennas further apart, different calibration strategy?

☞ Increase in LCU processing

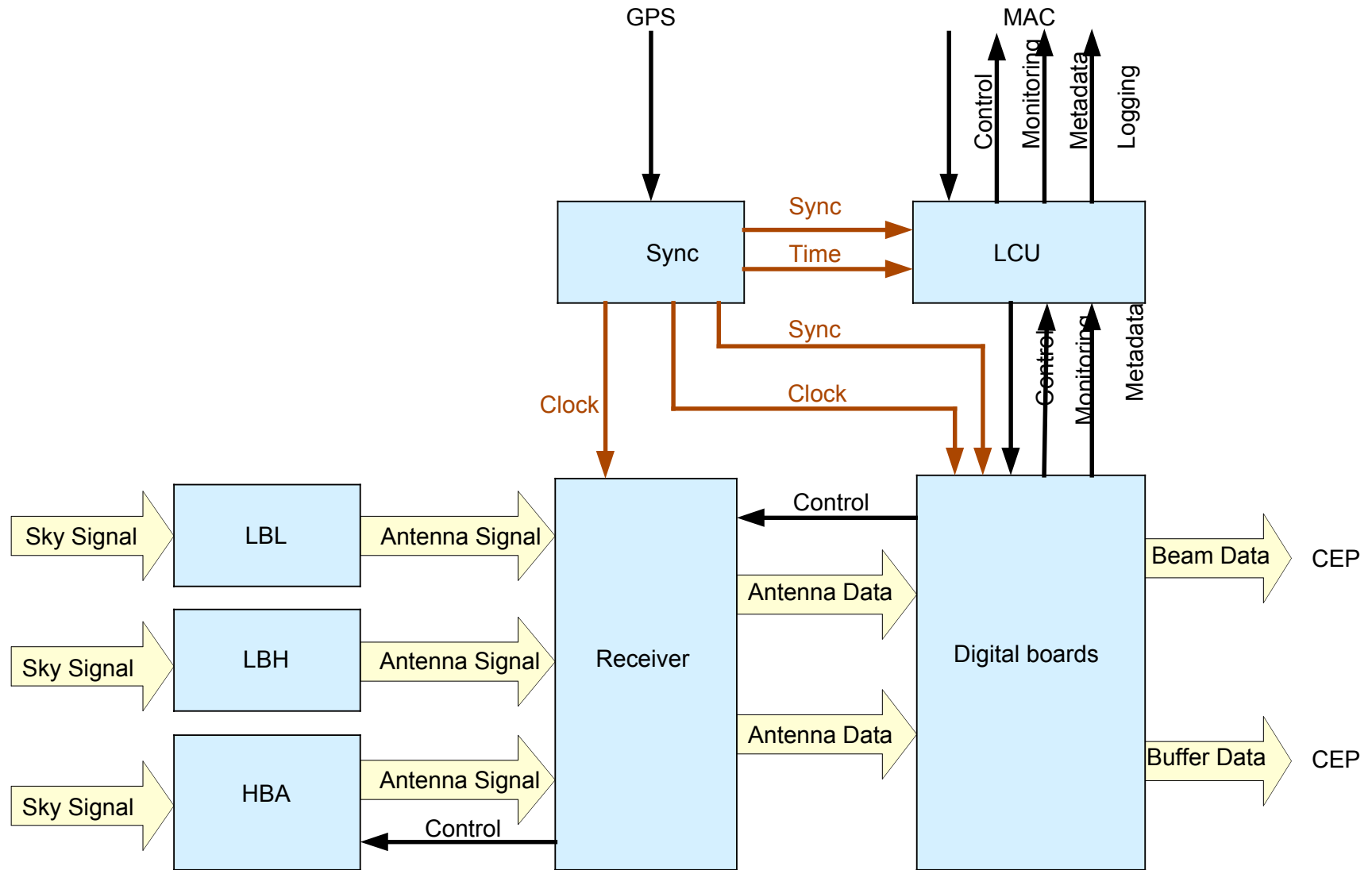
➤ Beamforming

☞ Beam control has to drive the analog LBA beamformer  
(increase in LCU processing)

☞ Current maximal update rate of weights is 1 s

☞ Control of low band antenna array

# Control Within LOFAR Station

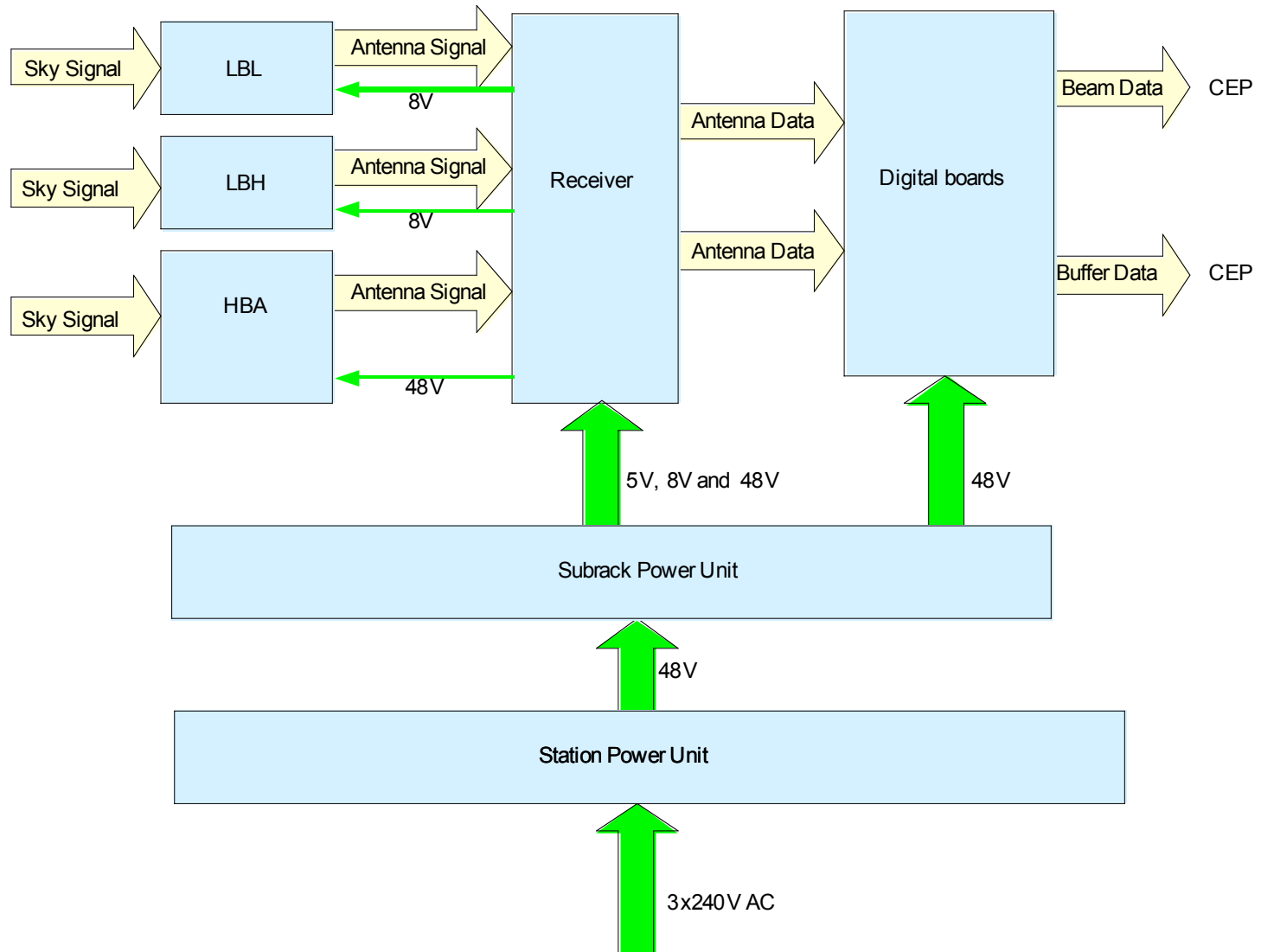




- Low Band Array control can be done via modem on RCU, like HBA control.

- Station calibration
  - ☞ Array calibration
  - ☞ Antennas further apart, different calibration strategy?
  - ☞ Increase in LCU processing
- Beamforming
  - ☞ Beam control has to drive the analog LBA beamformer (increase in LCU processing)
  - ☞ Current maximal update rate of weights is 1 s
  - ☞ Control of low band antenna array
- **Increase in power consumption per RCU input**

# Power Distribution within Station





- 48V power supply 6 x 1.6kW
  - ☞ Digital Boards 550W/subrack -> 3.3kW full station
  - ☞ RCU 160W/subrack -> 1kW full station
  - ☞ for antenna(-array) 50W / antenna (dual pol.)
  
- Subrack Power Unit (SPU)
  - ☞ 8V max. power 220W
    - RCU (8V) 44W
    - for antenna(-array) 11W/antenna (dual pol.)  
current antenna ~3W

COAX9

R inner            19  $\Omega$ /km

R outer            12  $\Omega$ /km

I ant                200 mA            V ant        8        V

DC cable loss (V)

	Cable Length
# ant pol.	115m
1	0.713
2	1.426
4	2.852
8	5.704
16	11.408
20	14.26

LBA min 5.3V

- 48 V supply instead of 8 V
- External power supply for the antenna array
- More expensive coax cable with less DC loss
- Beamformer near the receiver

- Central, near the receiver
  - ☞ No DC cable loss
  - ☞ Sensitive to cable tolerances
  
- Local, near the antennas
  - ☞ Cabling easier, only 2 cables needed (or 3 for separate power cable)
  - ☞ Sensitive to environment (rain, temperature)

- Station calibration
  - ☞ Array calibration
  - ☞ Antennas further apart, different calibration strategy?
  - ☞ Increase in LCU processing
- Beamforming
  - ☞ Beam control has to drive the analog LBA beamformer (increase in LCU processing)
  - ☞ Current maximal update rate of weights is 1 s
  - ☞ Control of low band antenna array
- Increase in power consumption per RCU input
- Longer cable to antennas

- Sensitivity reduced (RCU noise is dominant due to cable loss)
- RF cable loss (9dB/100m @250MHz, 4dB/100m @ 50MHz)
- Attenuator on RCU possible up to 15dB
- Length compensation in RSP max. ~125m (max. ~100 samples = 500ns, cable ~3.9ns/m)
- DC loss increase

COAX9

R inner            19  $\Omega$ /km

R outer            12  $\Omega$ /km

I ant                200 mA            V ant        8        V

DC cable loss (V)

# ant pol	Cable length					
	50m	80m	115m	200m	300m	400m
1	0.31	0.496	0.713	1.24	1.86	2.48
2	0.62	0.992	1.426	2.48	3.72	4.96
4	1.24	1.984	2.852	4.96	7.44	9.92
8	2.48	3.968	5.704	9.92	14.88	19.84
16	4.96	7.936	11.408	19.84	29.76	39.68
20	6.2	9.92	14.26	24.8	37.2	49.6

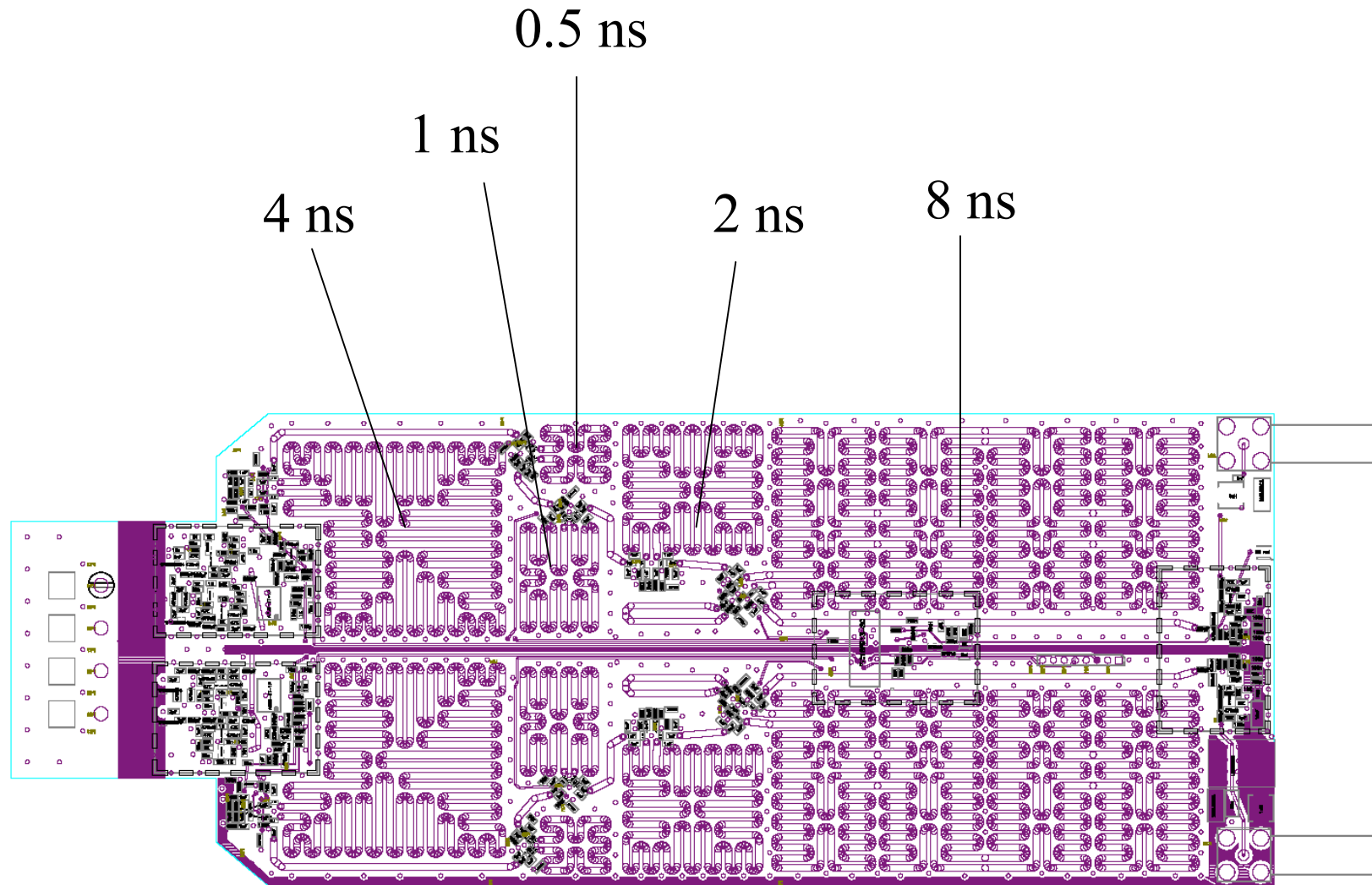
LBA min 5.3V

- Station calibration
  - ☞ Array calibration
  - ☞ Antennas further apart, different calibration strategy?
  - ☞ Increase in LCU processing
- Beamforming
  - ☞ Beam control has to drive the analog LBA beamformer (increase in LCU processing)
- Current maximal update rate of weights is 1 s
- Control of low band antenna array
- Increase in power consumption per RCU input
- Longer cable to antennas
- **Optimized for low frequencies ( $\sim 20\text{MHz}$ )**

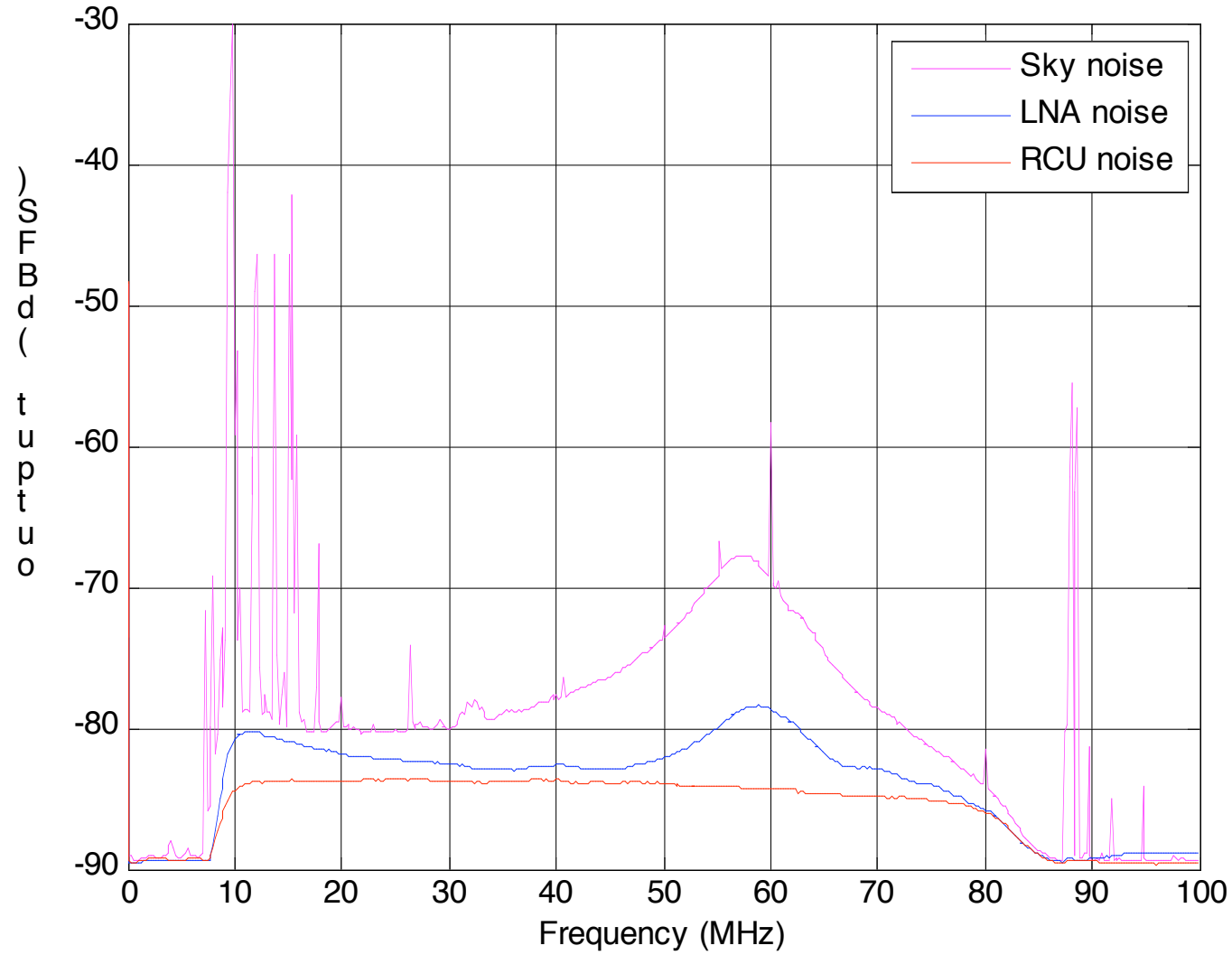


- Both low band inputs can use both the 30 MHz HPF and 10 MHz HPF
  
- Increase in RFI level
  - More linearity issues in Amplifiers, ADC
  
- Current design optimized for 30-80 MHz
  
- Antenna structure increased → longer true time delays and longer cabling

# High Band Antenna Front End Unit



# Output Spectrum



- Mickey Mouse  
Station splitter (output bandwidth 2x)
  
- Plans for additional digital processing hardware
  - ☞ NWO proposal for a expandable X-correlation box
  - ☞ Radionet proposal for a multi-purpose scaleable computing platform

# RCU Block diagram

