WP13 - Blue Sky project: Wireless Data Transfer for High-Energy Physics Applications

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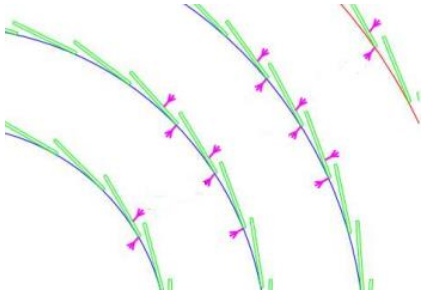
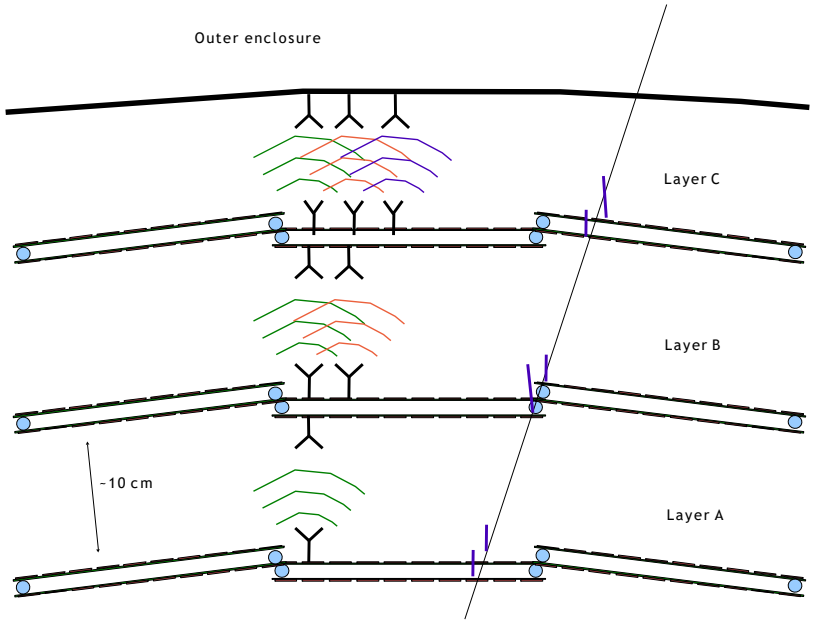
Motivation

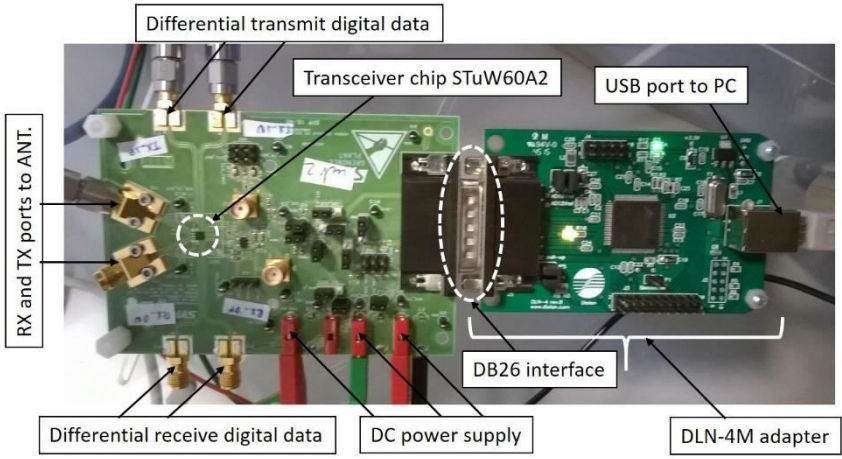
- Cables contribute significantly in active detector volume and cause multiple scattering
- We propose to totally/partially replace the cables with 60 GHz wireless links
- Wireless links have the advantages of:
  - Cost reduction
  - Simplified installation and repair
  - Reduction in dead material
  - Reduced latency: Radial readout instead of axial
  - Simplified broadcast: If one signal is to be sent to many receivers



Blue Sky project: Wireless Data Transfer for High-Energy Physics Applications

- Study of components and antennas integration
- Full link demonstrator(s) from 1 tile to 2 and 3 tiles – several mock-ups to be tested
- Use and integrate commercially available components
- Study the performance of the system (data rate, bit error rate, modulation schemes, usage of bandwidth, crosstalk in repeater, etc.)





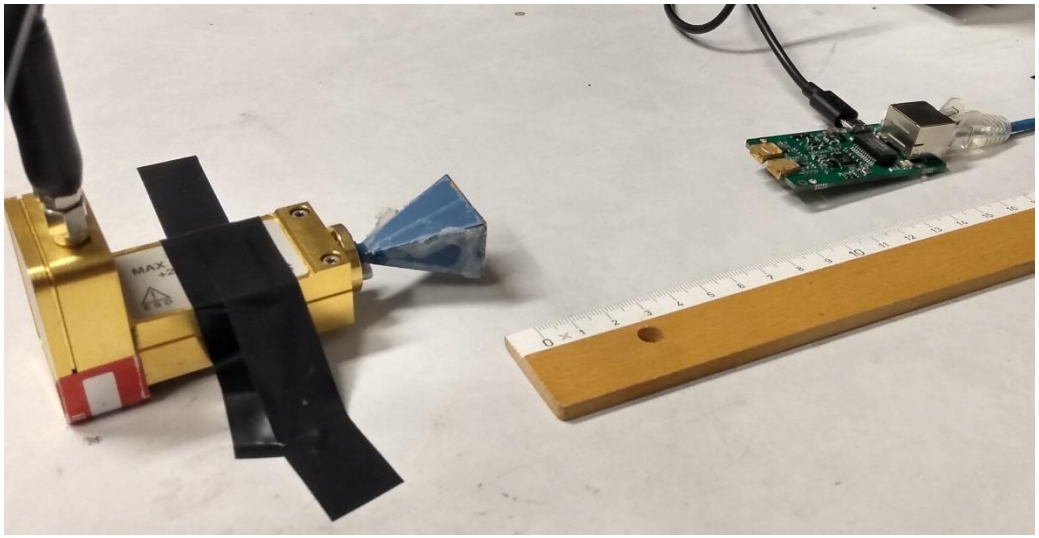
Debit 1 Gbps per layer and is cumulative, thus it will be reaching 3 Gbps at the outer enclosure.

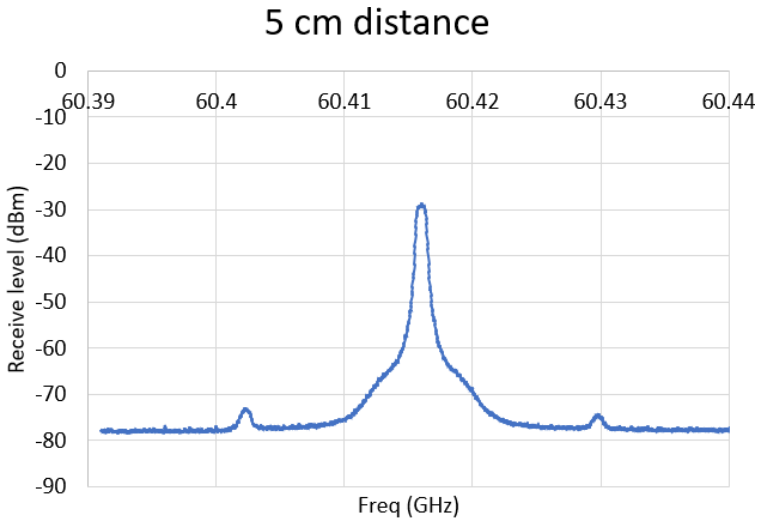
Courtesy of CEA-Letti and STMicroelectronics

SK202 boards (employing ST-60 GHz transceiver chip)

Board outlook:

SK202: radiation power measurements





Peak value: -28.7 dBm

- Power measurements of the SK202 board to horn antenna harmonic mixer with a 20 GHz spectrum analyser.
- Measurements are done at different distances, i.e., 5 cm, 10 cm, 15 cm and 20 cm

distance	5	10	15	20	cm
received power	-28.7	-31.9	-34	-37.8	dBm

~1 Gbps connectivity tests at different distances

distance of 5 cm

```
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  4]   0.00-30.00  sec  3.28 GBytes   940 Mbits/sec  0.000 ms  0/0 (0%)
[  4] Sent 0 datagrams

iperf Done.
```

distance of 4 cm

```
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  4]   0.00-30.00  sec  3.27 GBytes   935 Mbits/sec  0.000 ms  0/0 (0%)
[  4] Sent 0 datagrams

iperf Done.
```

distance of 3 cm

```
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  4]   0.00-100.00 sec  3.27 GBytes   941 Mbits/sec  0.000 ms  0/0 (0%)
[  4] Sent 0 datagrams

iperf Done.
```

distance of 2 cm

```
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  4]   0.00-30.00  sec  3.27 GBytes   955 Mbits/sec  0.000 ms  0/0 (0%)
[  4] Sent 0 datagrams

iperf Done.
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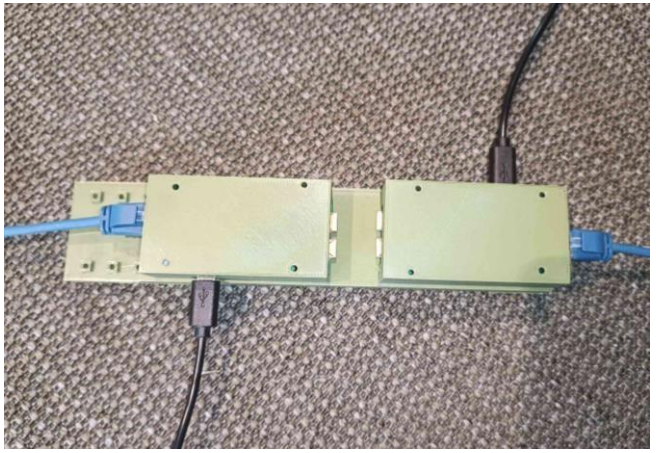
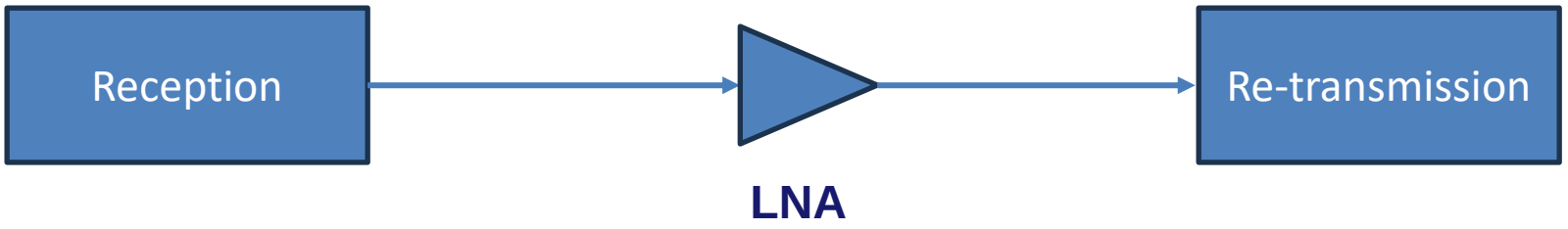


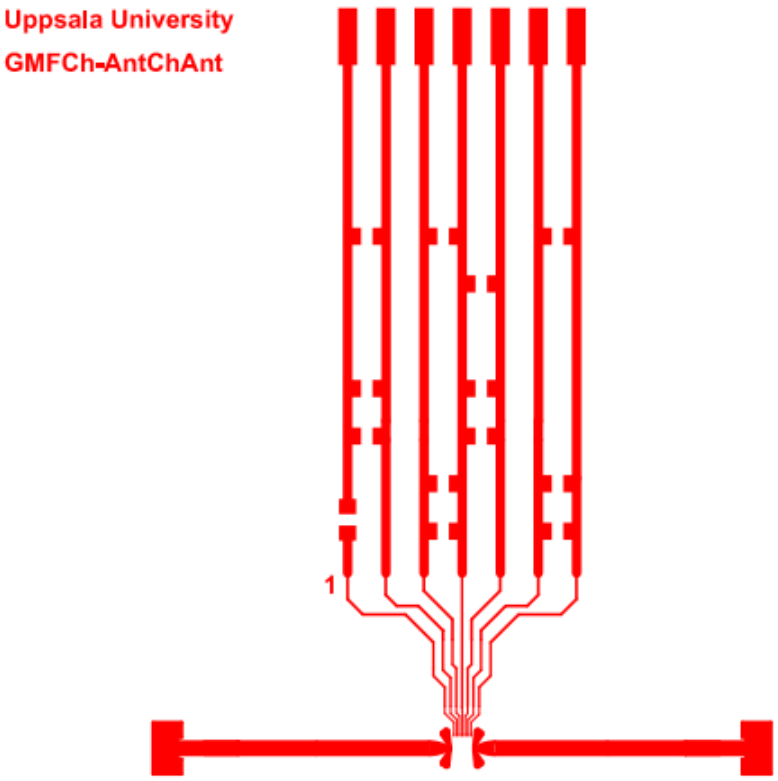
in average 940 Mb/sec are obtained in this configuration

- The SK202 boards don’t communicate at distances higher than 5 cm, as the receive power is not enough which is needed for the down-conversion.

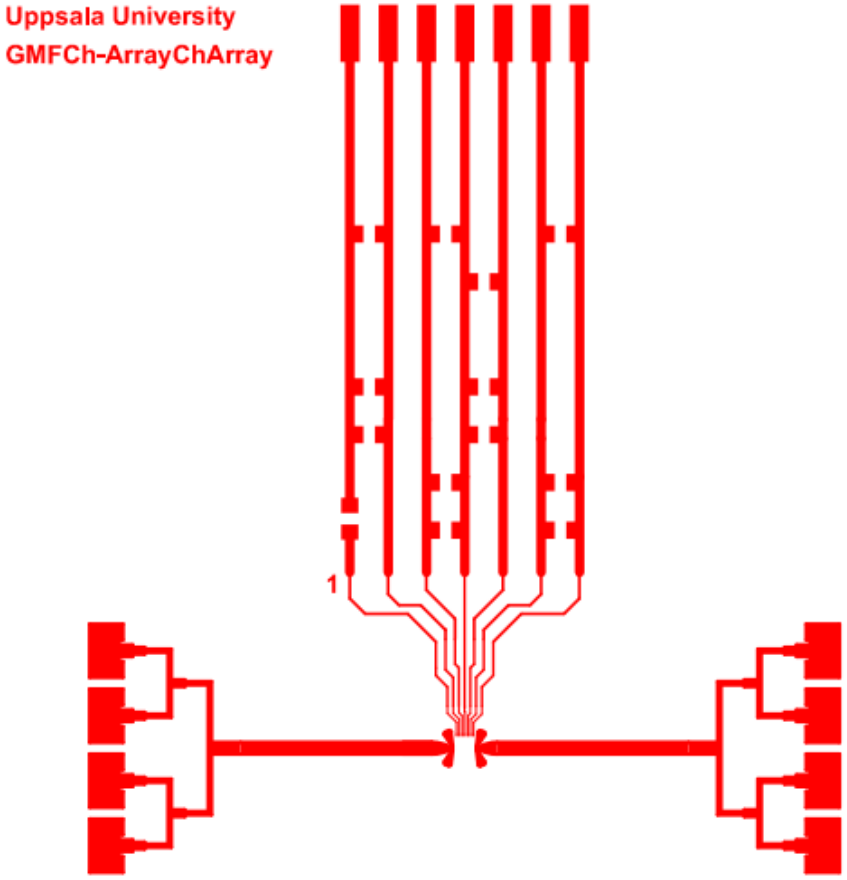
Plan now is to integrate an LNA after the Tx on a new repeater mm-wave board to extend this range to 20 cm.



Repeater designs

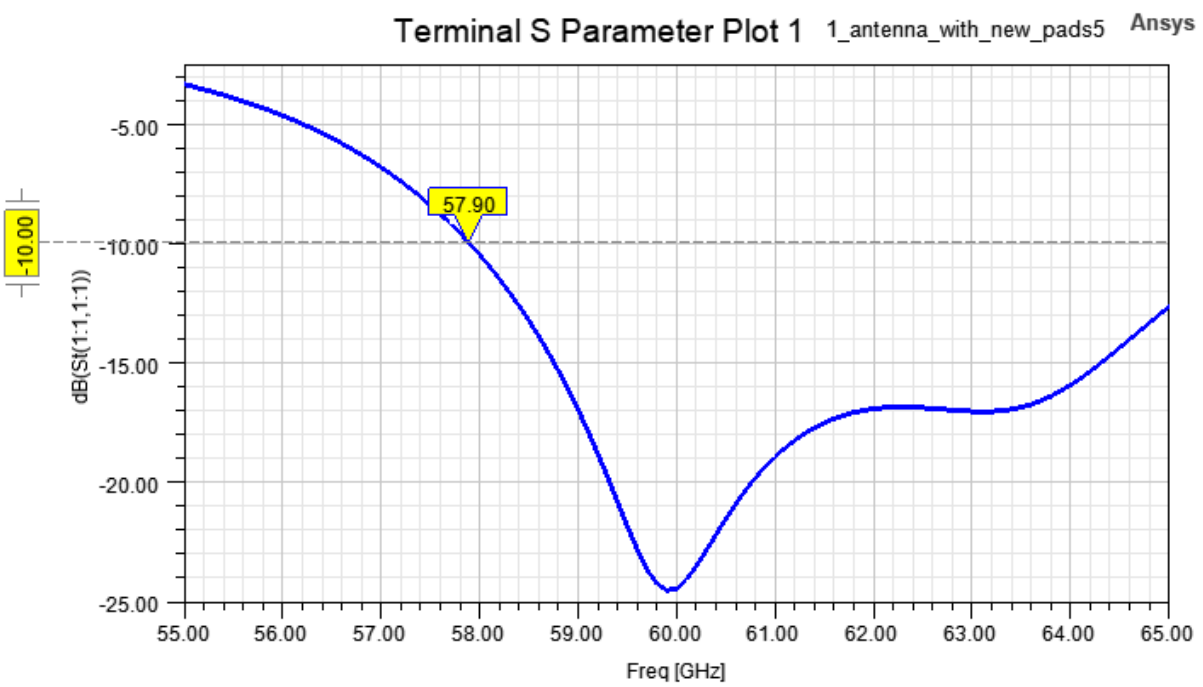


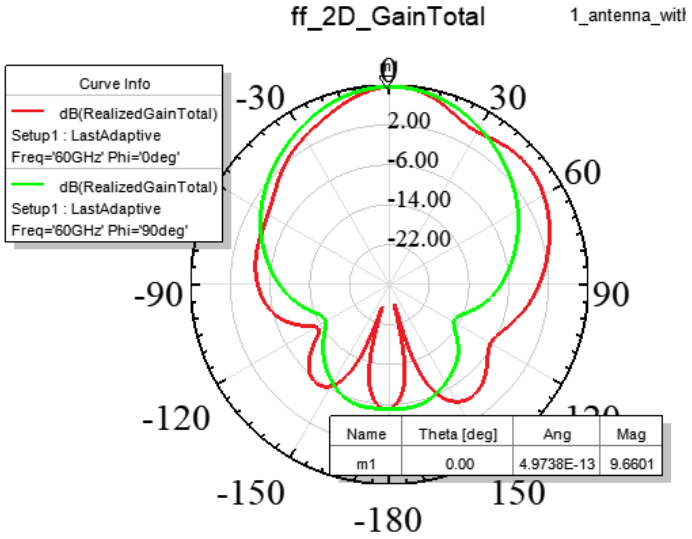
antenna-LNA-antenna

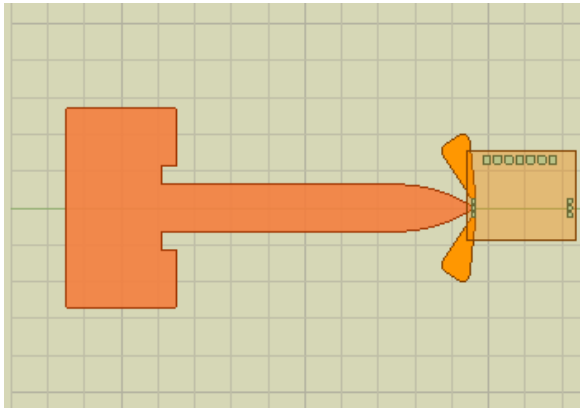


array-LNA-array

Chip feeding a single patch antenna

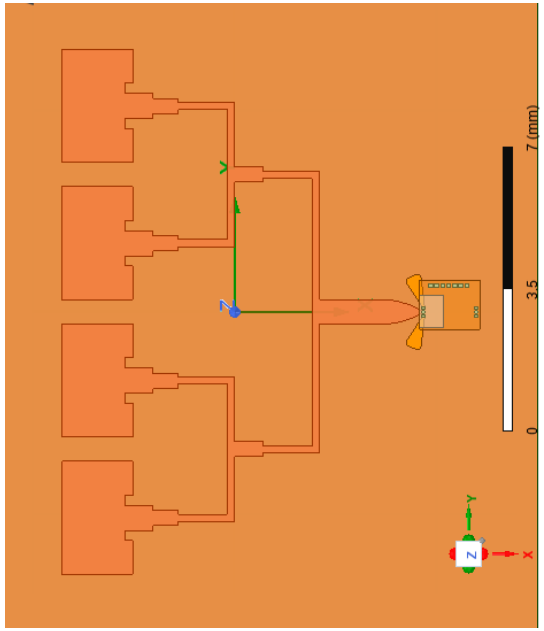


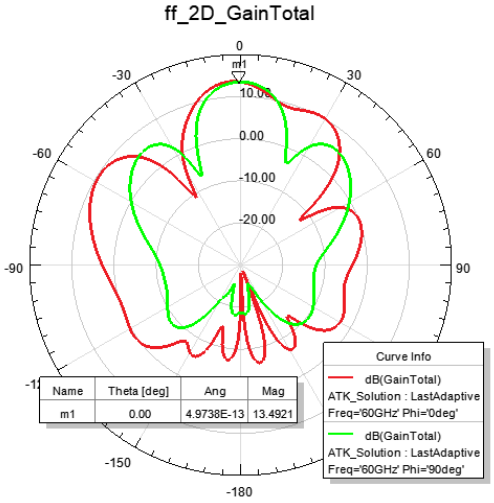


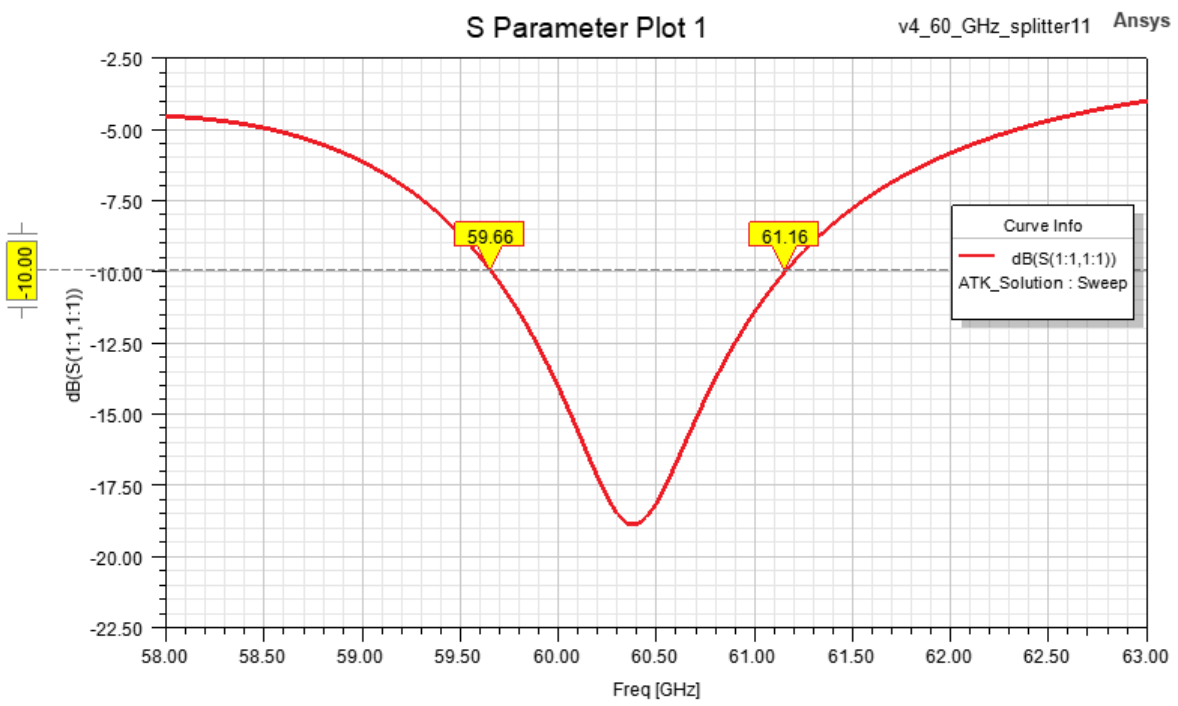


9.6 dBi peak gain

Chip feeding an array – for higher gain







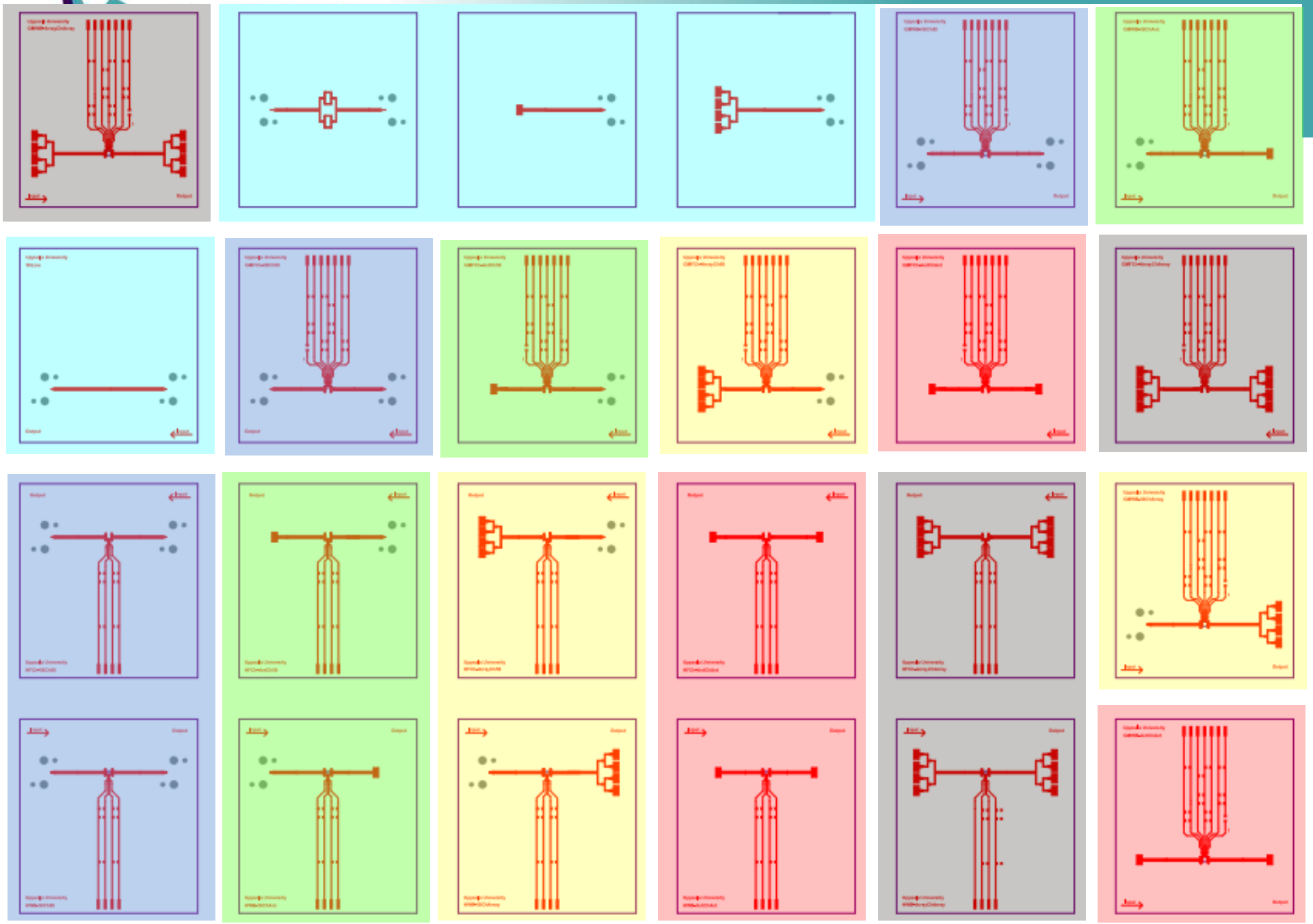
13.5 dBi peak gain

LNAs to be used

1. Gotmic gANZ0031 C V-band LNA MMIC 57-66 (52 - 72) GHz

2. Hittite HMC-ALH382 LNA 57-65 GHz

- Both to be implemented with stud bumps as well as with wirebond configurations
- ACB Group CIBEL, France, is doing the PCB fabrication
- TAI-PRO Engineering, Belgium will do the amplifier assembly using stud bump
- Note, Norrtälje (about 80 km from Uppsala) will do the wirebonding part



Below designs have been ordered for fabrication

Designs without chip: (4 designs for antenna characterization and de-embedding)

i. *RC-antenna
ii. RC-array
iii. RC-powerSplitter-RC
iv. RC-50ohmLine-RC

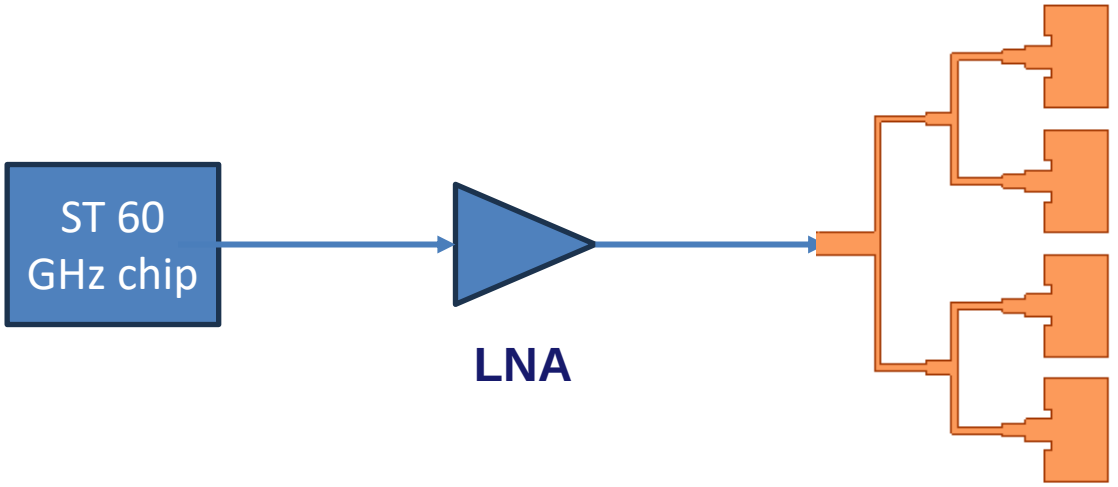
Designs with Gotmic and Hittite chips, one set with stud bumps and other with wirebonding: (5x4 = 20 designs)

i. RC-LNA-RC (LNA performance)
ii. RC-LNA-antenna (EIRP)
iii. RC-LNA-array (EIRP)
iv. antenna-LNA-antenna (Repeater)
v. array-LNA-array (Repeater)

(*RC stands for Rosenberger connector)

Work in progress / future plan

- Measurements for newly fabricated boards are to start from the end of this week
- Make a prototype where the LNA is integrated between the 60 GHz transceiver chip and the antenna/antenna array.



- Using the existing gigabit transfer (GBT) boards (which are mainly designed for optical communication) with the help of optical to RF conversion

Thanks