



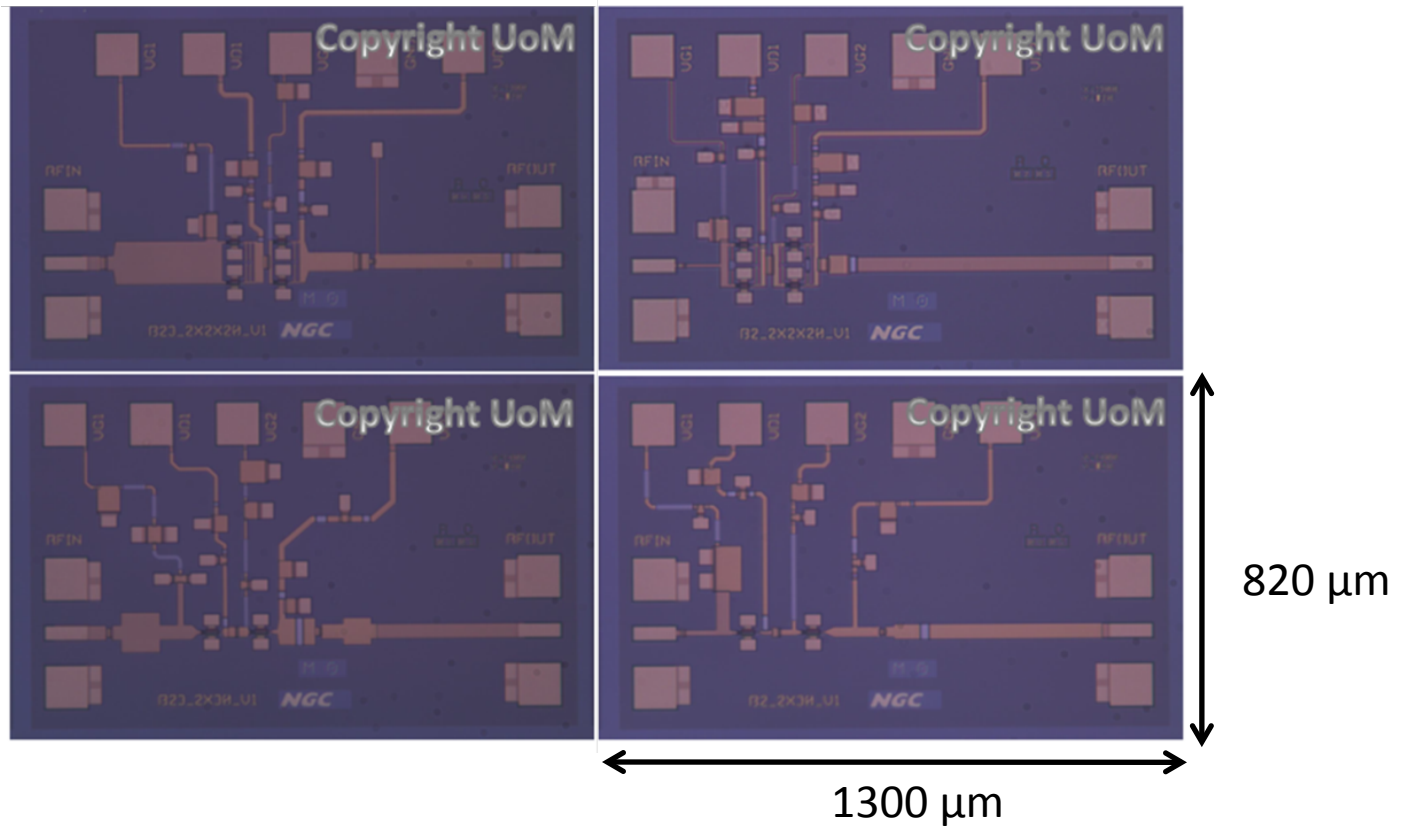
Low Noise Amplifiers for ALMA Bands 2+3 and 2

ALMA Band 2+3 Workshop
Chalmers, May 2016

Presented by: D. George
With: D. Cuadrado-Calle and G. Fuller
University of Manchester (UK)
Collaborators: Caltech, JPL and RAL.

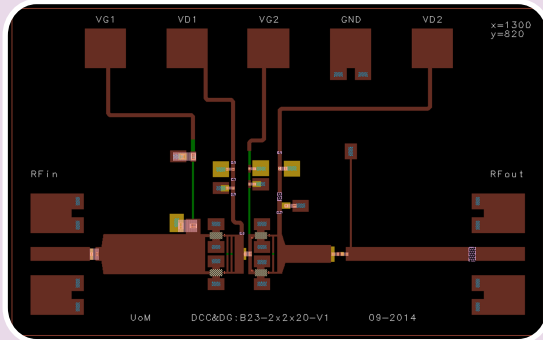
MMICs: designs and first results.

- Four MMIC designs. Each one with different stability versions.
- Fabrication completed on December 2016.
- Microscopic photographs of the fabricated MMICs:

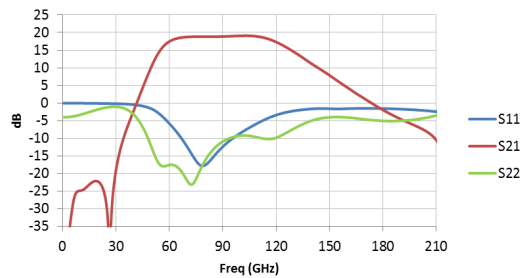


MMIC DESIGN 1 LNA for ALMA band 2/3 with a 2x2x20 topology

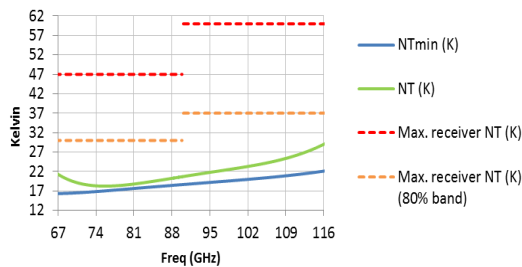
B23-2x2x20-v1



S-Parameters

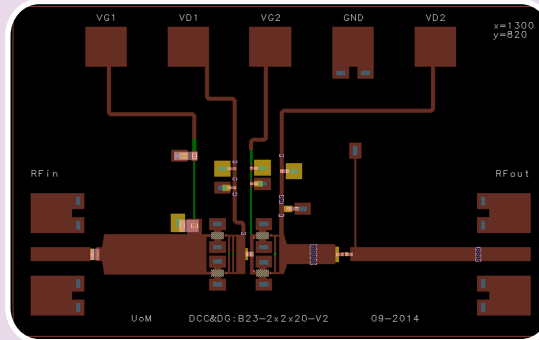


Noise temperature

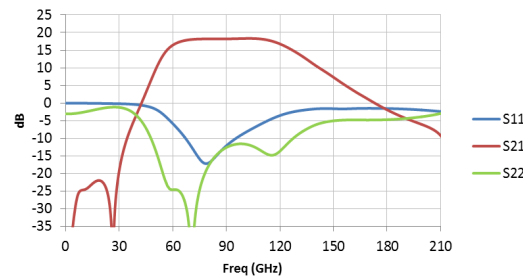


$K > 1.4$

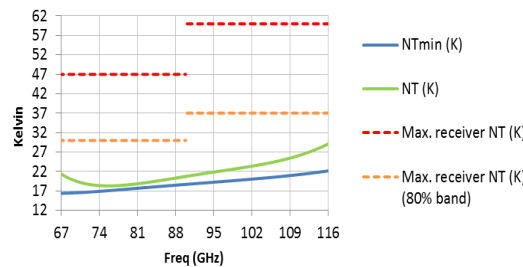
B23-2x2x20-v2



S-Parameters

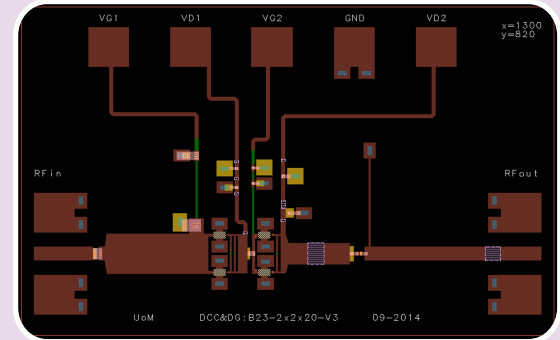


Noise temperature

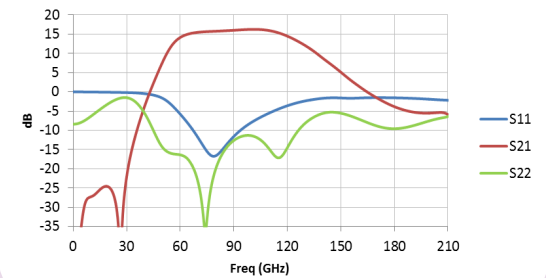


$K > 1.8$

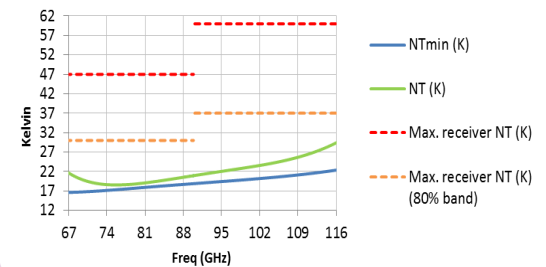
B23-2x2x20-v3



S-Parameters



Noise temperature

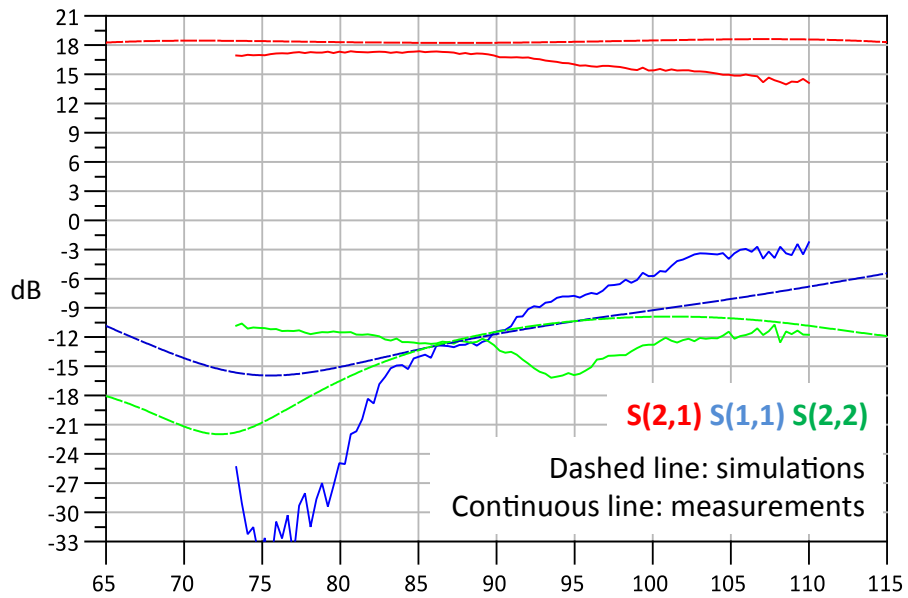


$K > 3$

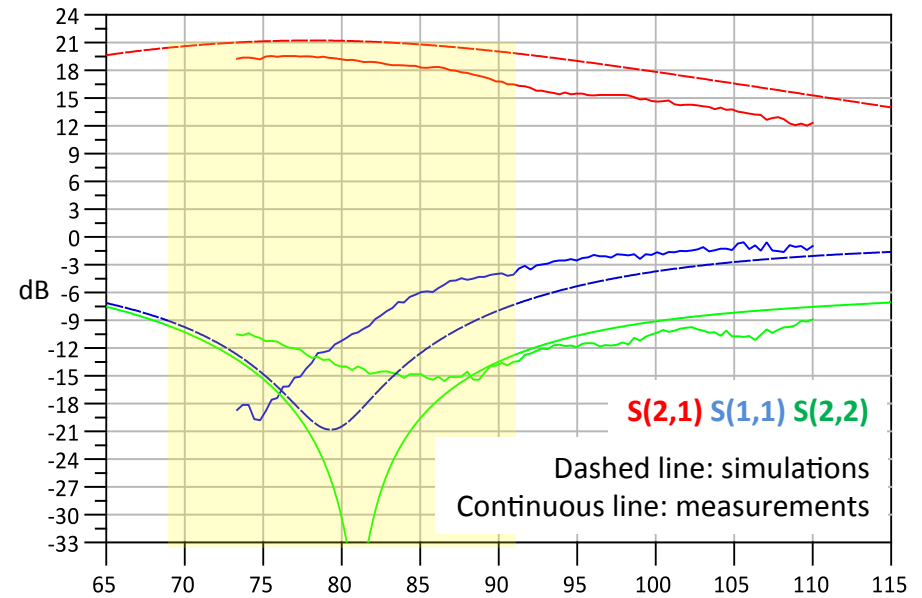
First S-parameters measurements of the MMICs

- First S-parameters tests at room temperature.
- Performed at JPL and NGC laboratories.
- We show a comparison between the S-parameters of one MMIC of each design at room temperature and the simulations at 20K.
- These first tests were performed using a bias of 167 mA/mm, for safety reasons. Future tests will be done at 200-250 mA/mm.

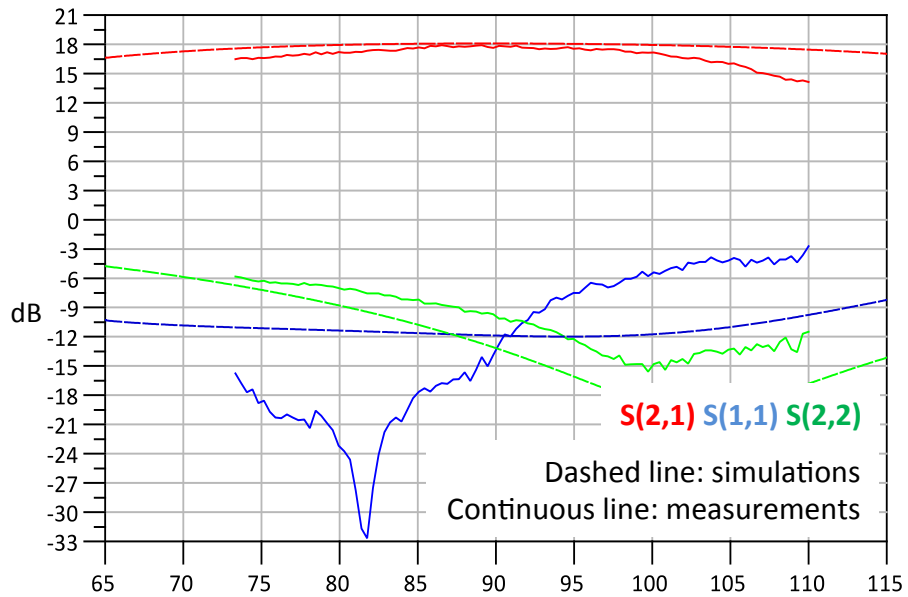
B23_2x2x20_v1 (Simulation vs Measurement)



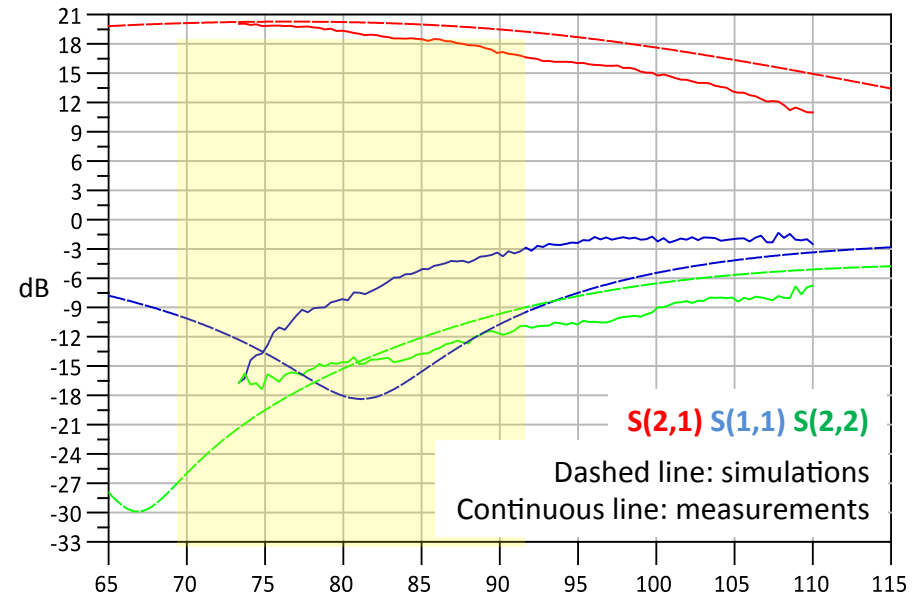
B2_2x2x20_v1 (Simulation vs Measurement)



B23_2x30_v1 (Simulation vs Measurement)



B2_2x30_v1 (Simulation vs Measurement)



Very Preliminary noise measurements of the MMICs

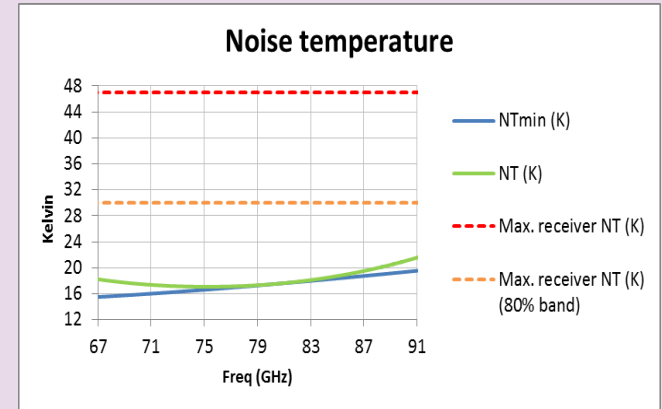
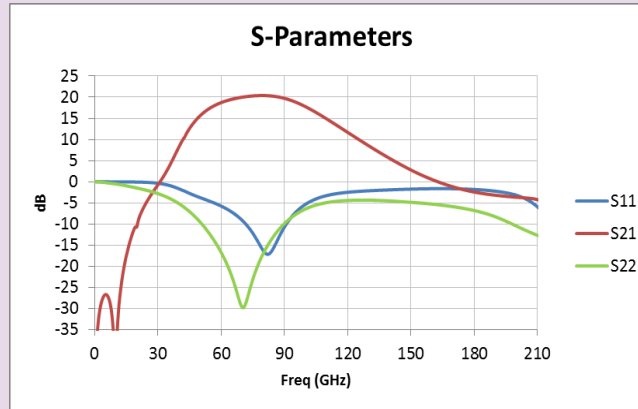
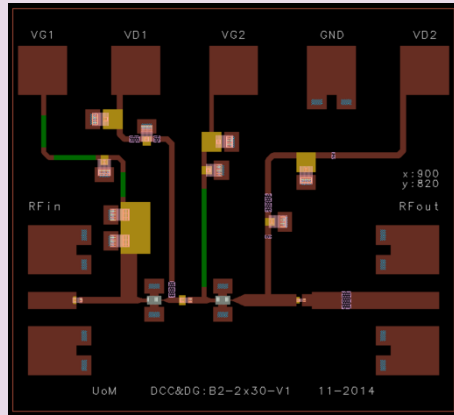
- **First** noise tests at cryogenic temperature.
- Cryogenic probe station at Caltech's radio astronomy lab.
- Initial tests were done only for ONE sample of each design.
- The performance may improve significantly when testing more samples.
- **A bias optimization wasn't performed for this tests.**

About the Cryogenic Probe Station:

- It is used for relative measurements.
- The input probe is not calibrated. It has been observed that the noise measured with the cryogenic probe station is typically ~5K higher than for packaged devices.
- The setup used for these tests works in the 75-116 GHz frequency range.

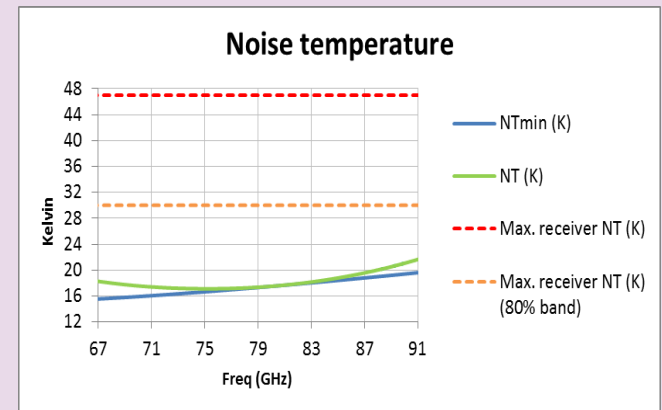
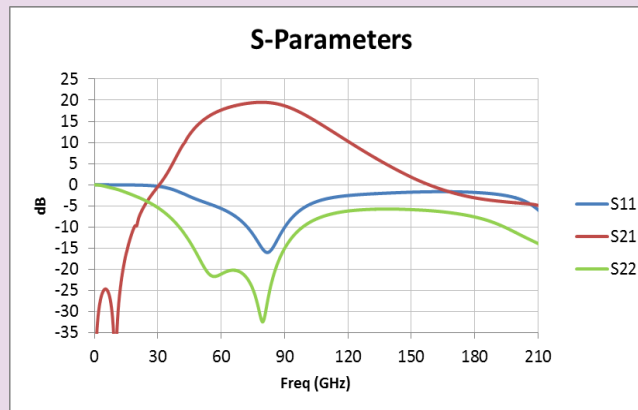
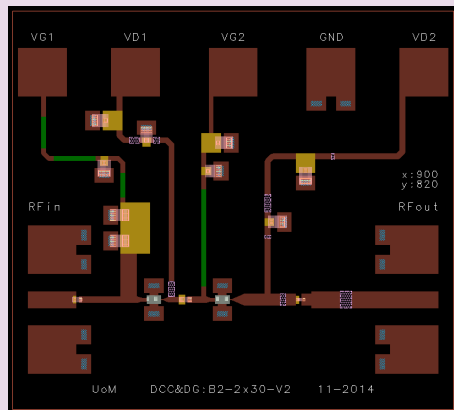
MMIC DESIGN 4 LNA for ALMA band 2 with a 2x30 topology

B2-2x30-v1



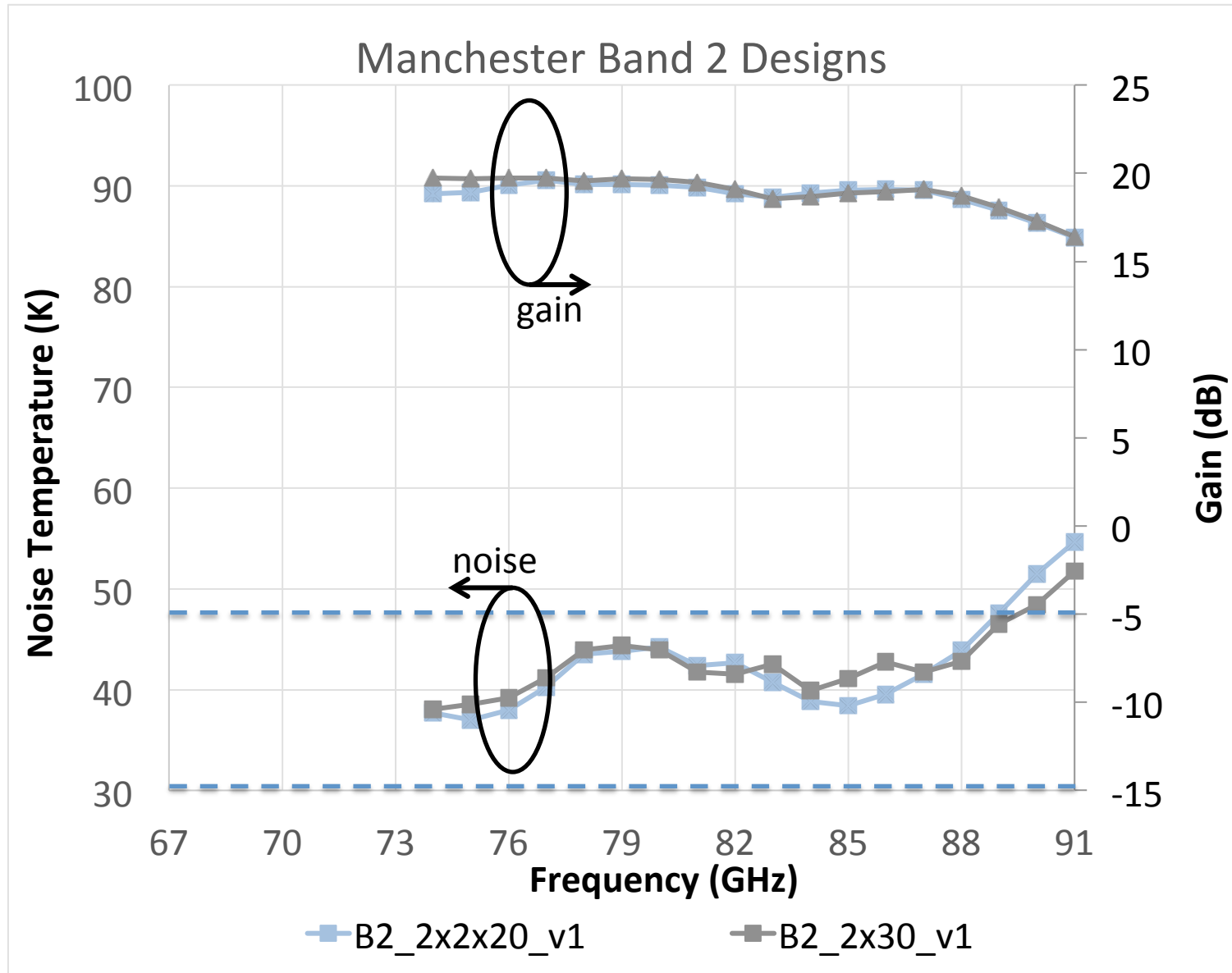
$K > 1.7$

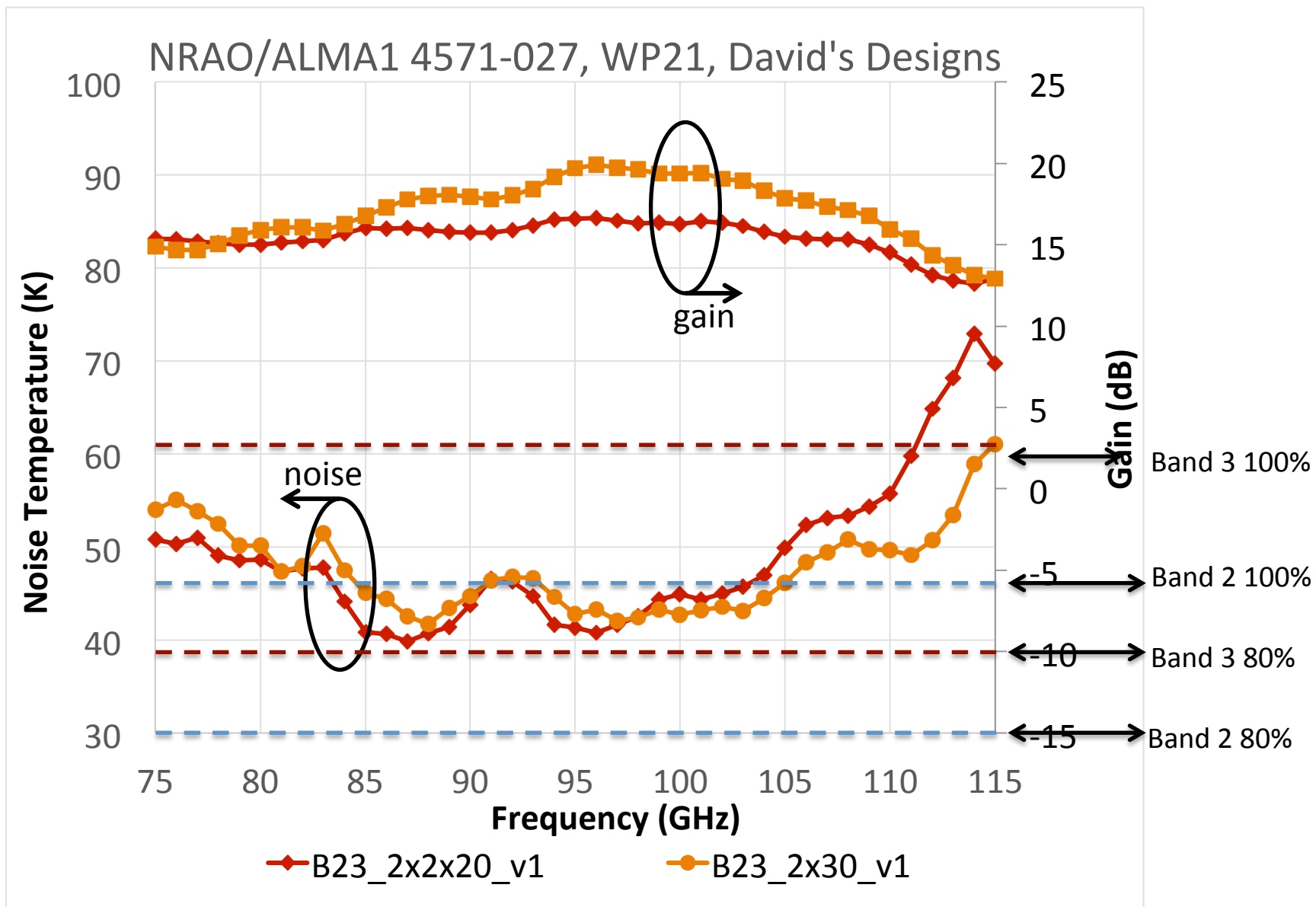
B2-2x30-v2



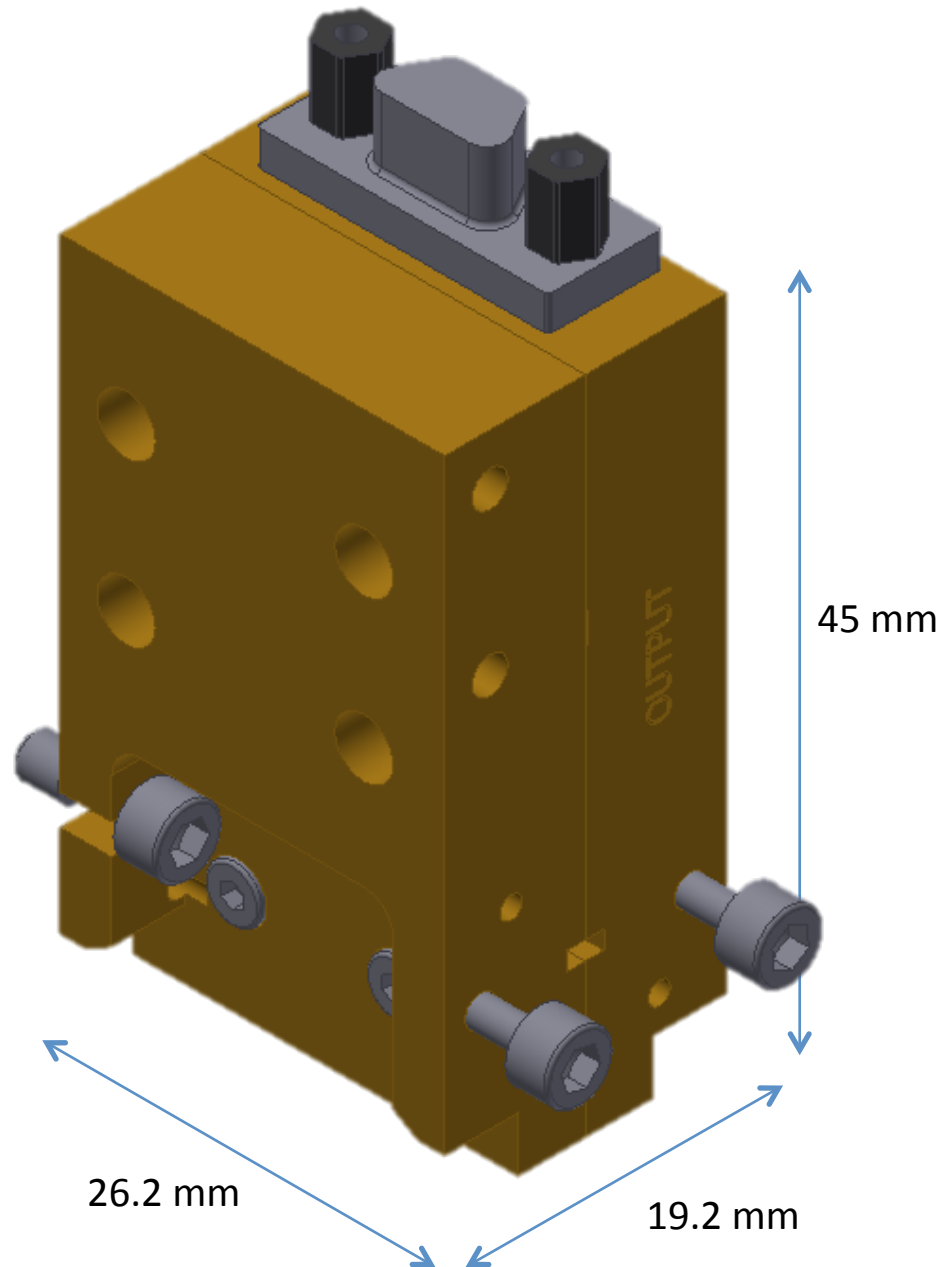
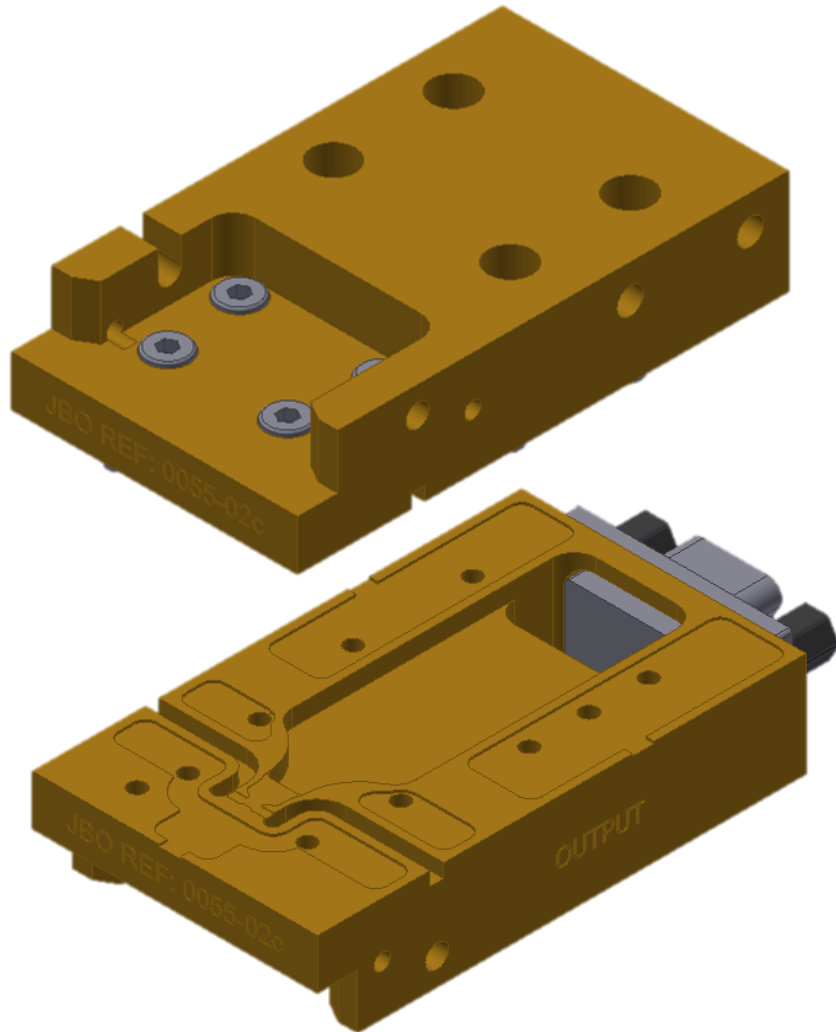
$K > 2.7$

- Two ALMA band 2 MMICs:

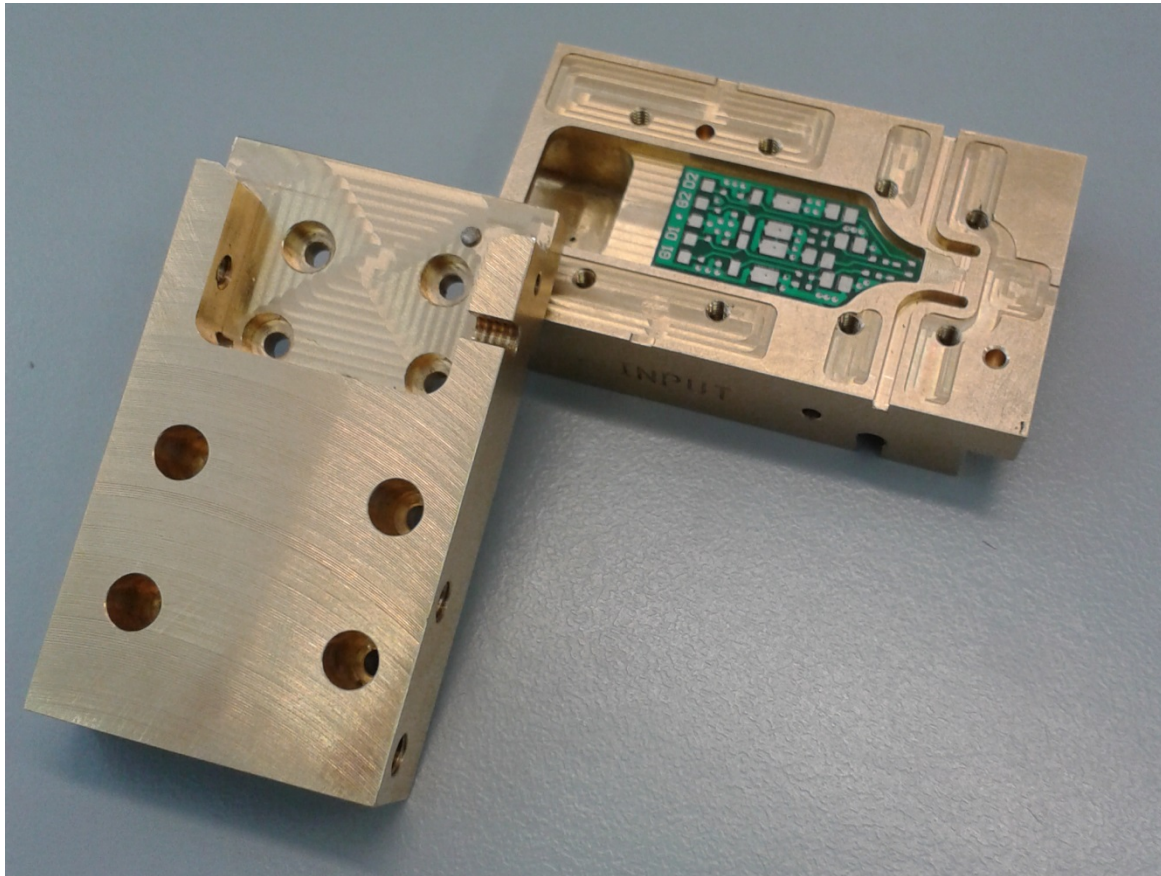




Package design V2



The fabrication of two blocks was completed at the mechanical workshop of the UoM in April 2016:



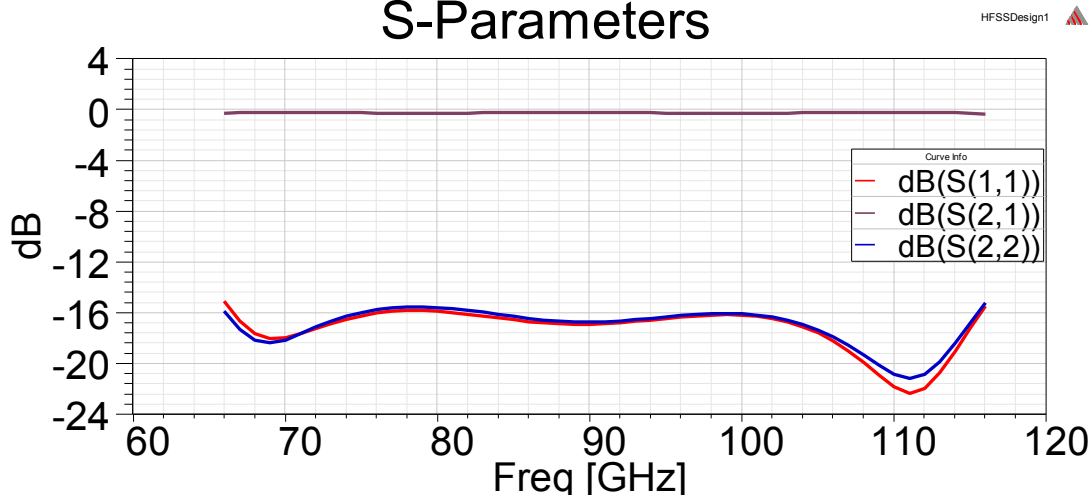
Waveguide-to-Microstrip Probes

Material: 3 mil quartz, gold: 3 μm .

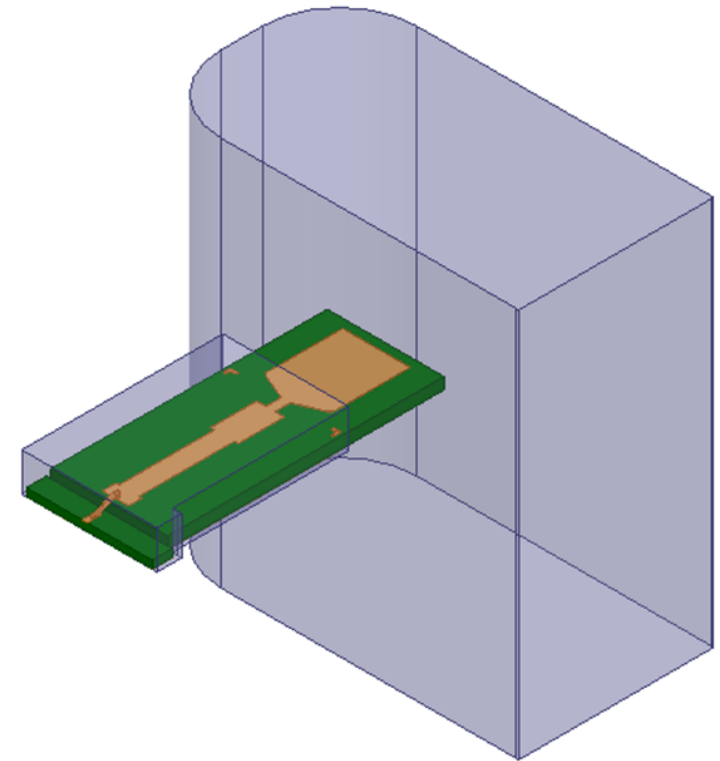
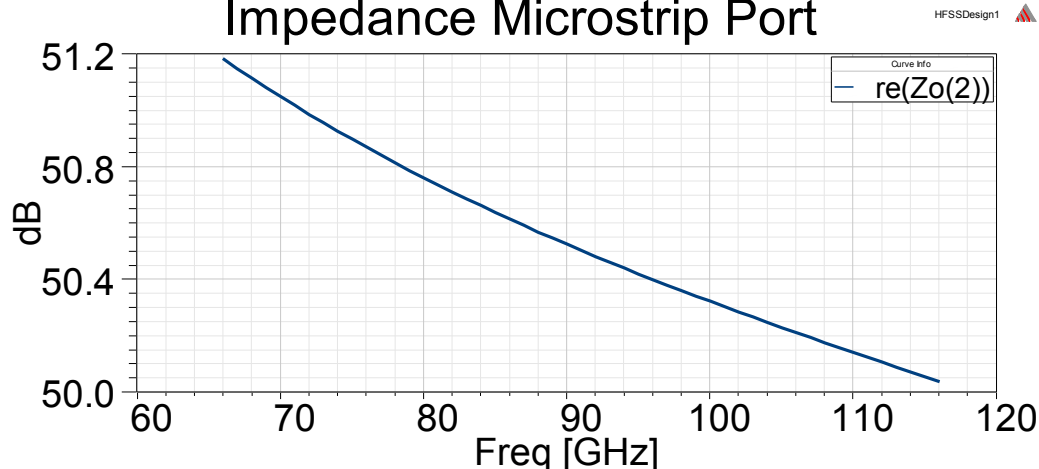
Fabrication completed in April 2016.

Simulated performance:

S-Parameters

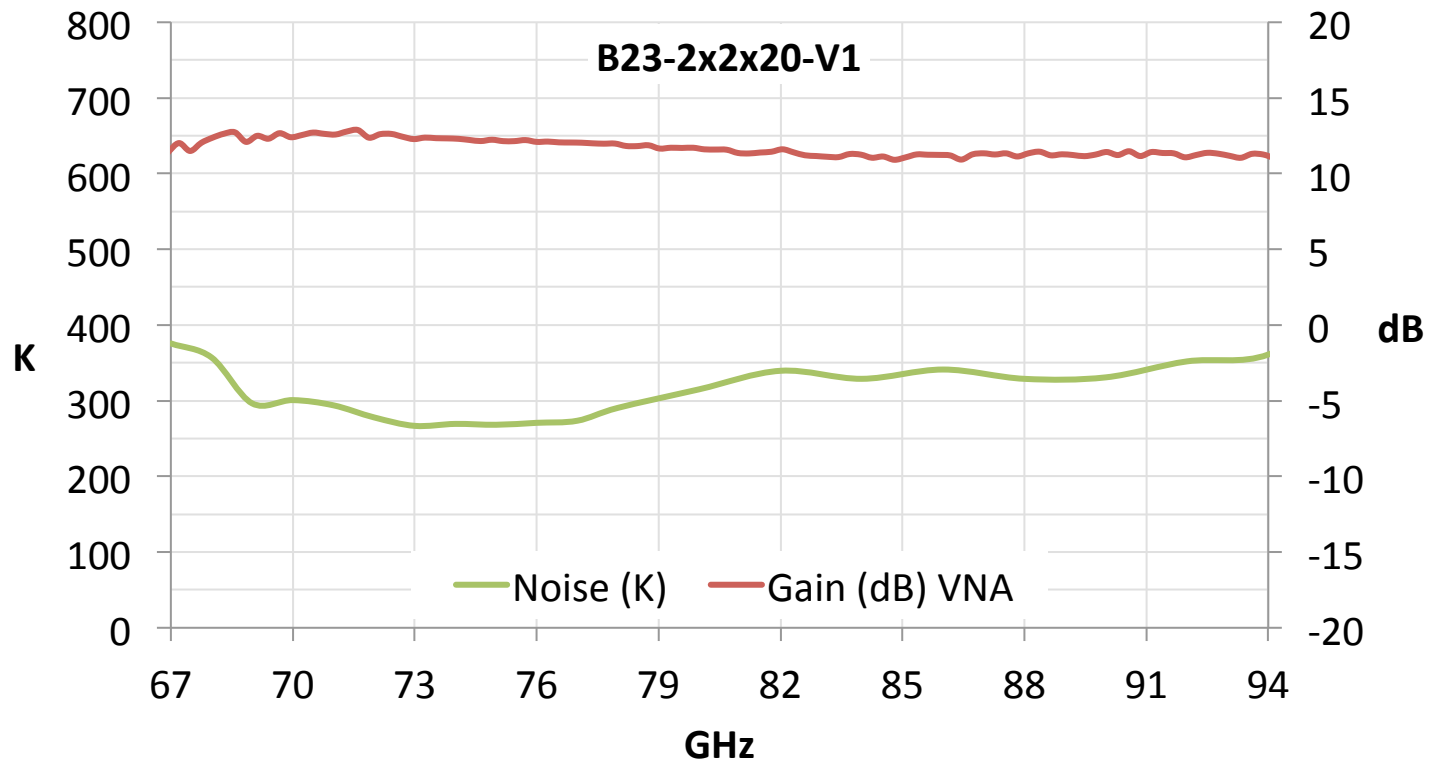


Impedance Microstrip Port

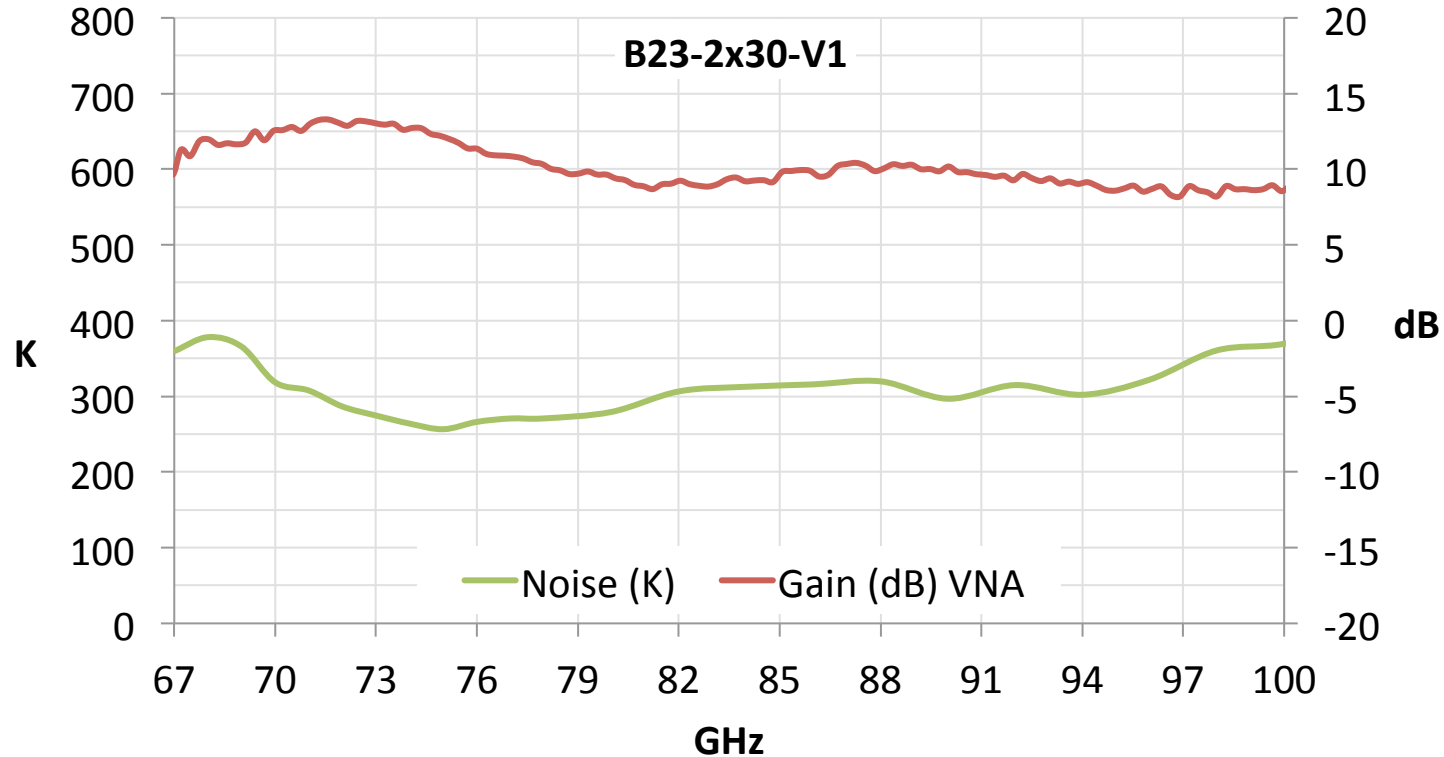


Room Temp. Characterisation of two WR-10 LNAs

- First two LNAs packaged in a JPL's WR-10 body (fabricated in Manchester).
- Characterisation of design B23-2x2x20-v1:
 - Noise measured using the Y-factor method with cold/hot loads:
 - Gain measured in the VNA with a WR-10 setup.



- Characterisation of design B23-2x30-v1:
 - Noise measured using the Y-factor method with cold/hot loads:
 - Gain measured in the VNA with a WR-10 setup.



- These blocks can be biased for a higher gain of ~ 15 dB.

Conclusions and future work

- Development of LNAs for ALMA bands 2 (67–90 GHz) and 2+3 (67–116 GHz).
- MMICs have proved to fully functional at both room and cryogenic temperatures.
- First 2 blocks packaged and tested at room temperature.
 - LNA #1: Noise between 250-350 K in the 67-100 GHz frequency range.
 - LNA #2: Noise between 250-350 K in the 67-95 GHz frequency range.
- Further testing will be done in May and June at Caltech/JPL laboratories, both for MMICs (cryogenic) and packaged LNAs (room temperature and cryogenic).