ALMA Band 2+3 LO and down-convert Mixer development at STFC

***Hui Wang*, Emma-May Butroid and Brian Ellison**

RAL Space

STFC-Rutherford Appleton Laboratory, UK

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Science & Technology Facilities Council

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Objectives

- Design and construction of the necessary LO chain
- Development of suitable down conversion mixers
- Development of appropriate electronic interfaces and software control
- Integration of the system into a pre-prototype form
- Use of the system to support cryogenic LNAs performance testing

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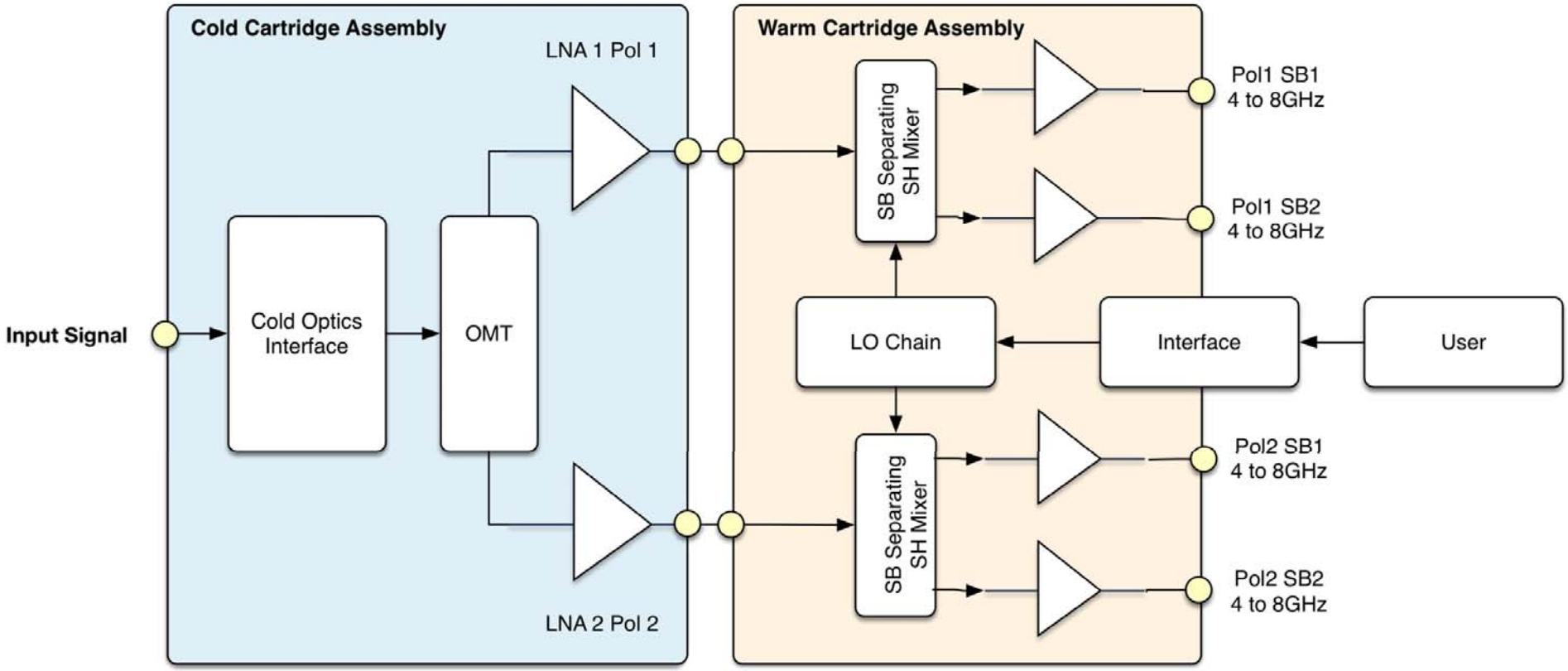
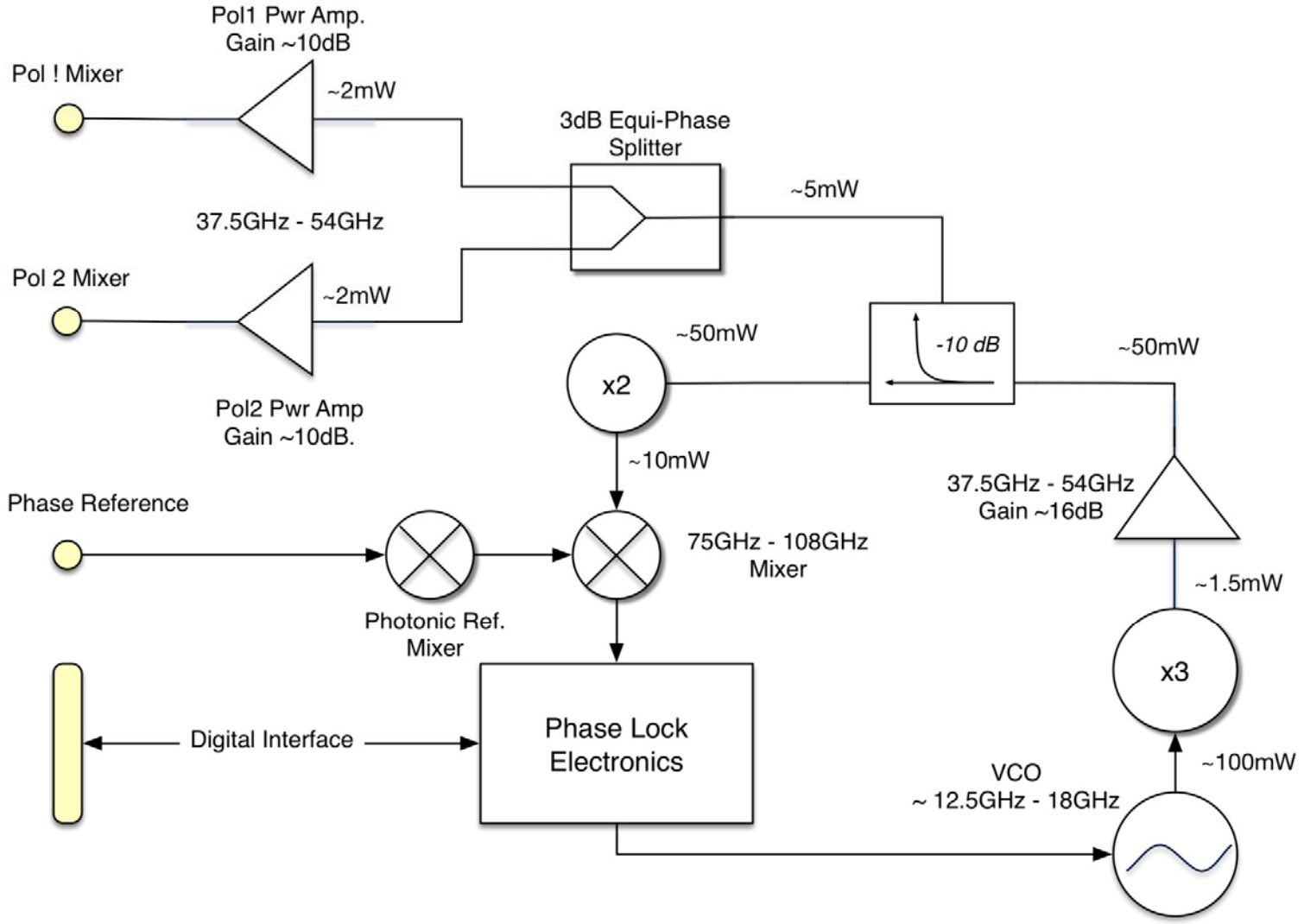
Band 2+3 Receiver Concept



Local Oscillator Chain



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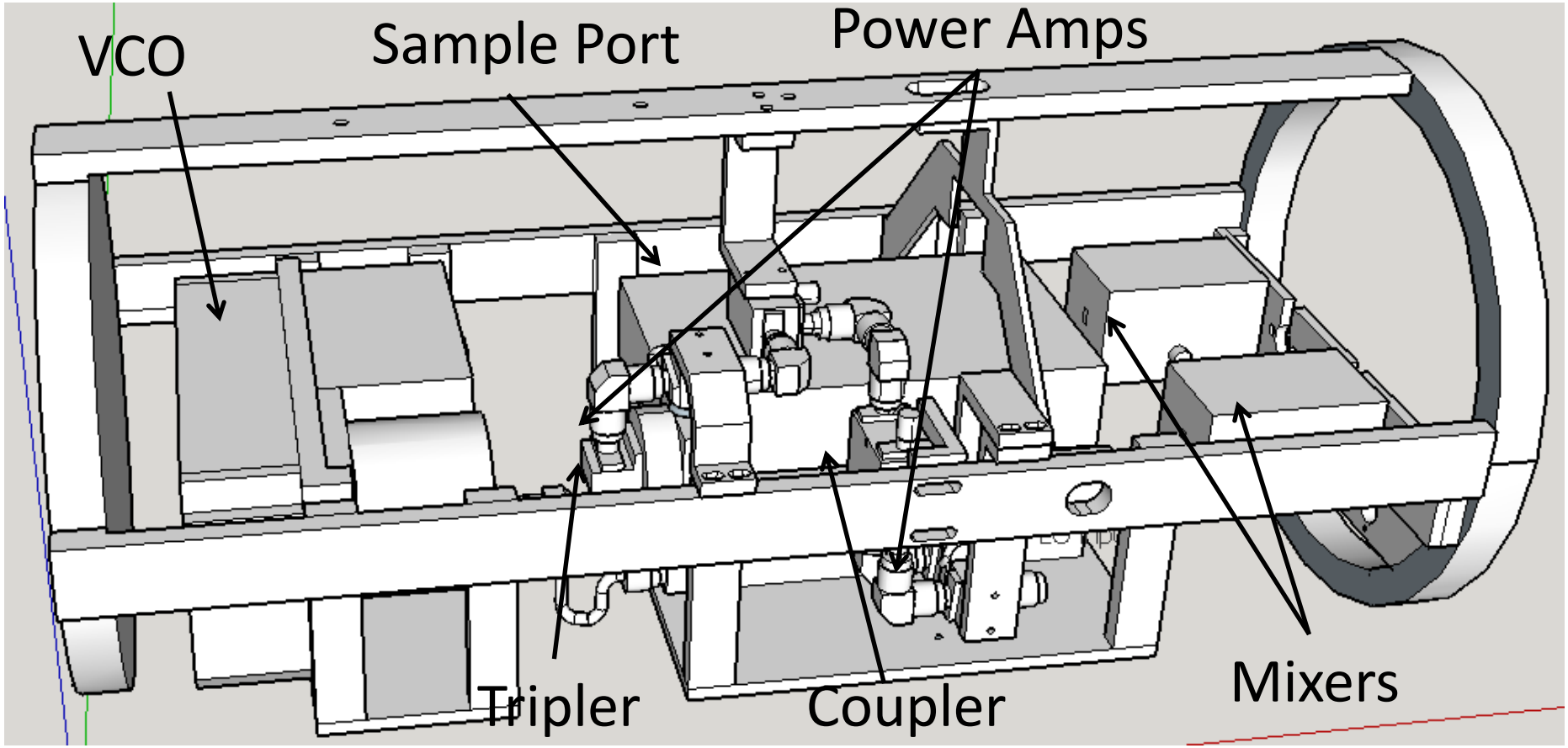
Local Oscillator Chain



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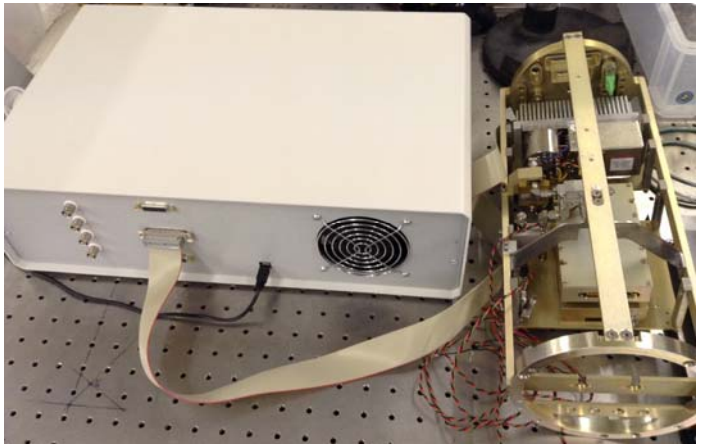
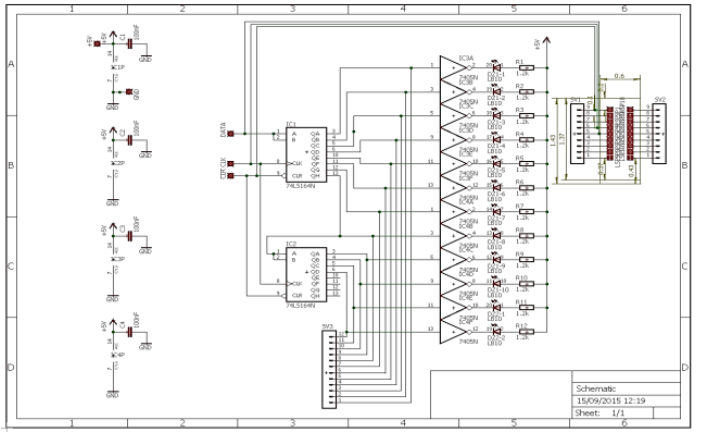
LO Control Interface

- An objective encoded software application has been developed to provide a user interface to the down-convertor
- VCO frequency is set by the user and transferred to the VCO via a USB and digital interface circuit
- Maximum range of VCO: 13-17.5GHz
- A x3 multiplier produces a LO tuning range of 39-52.5GHz





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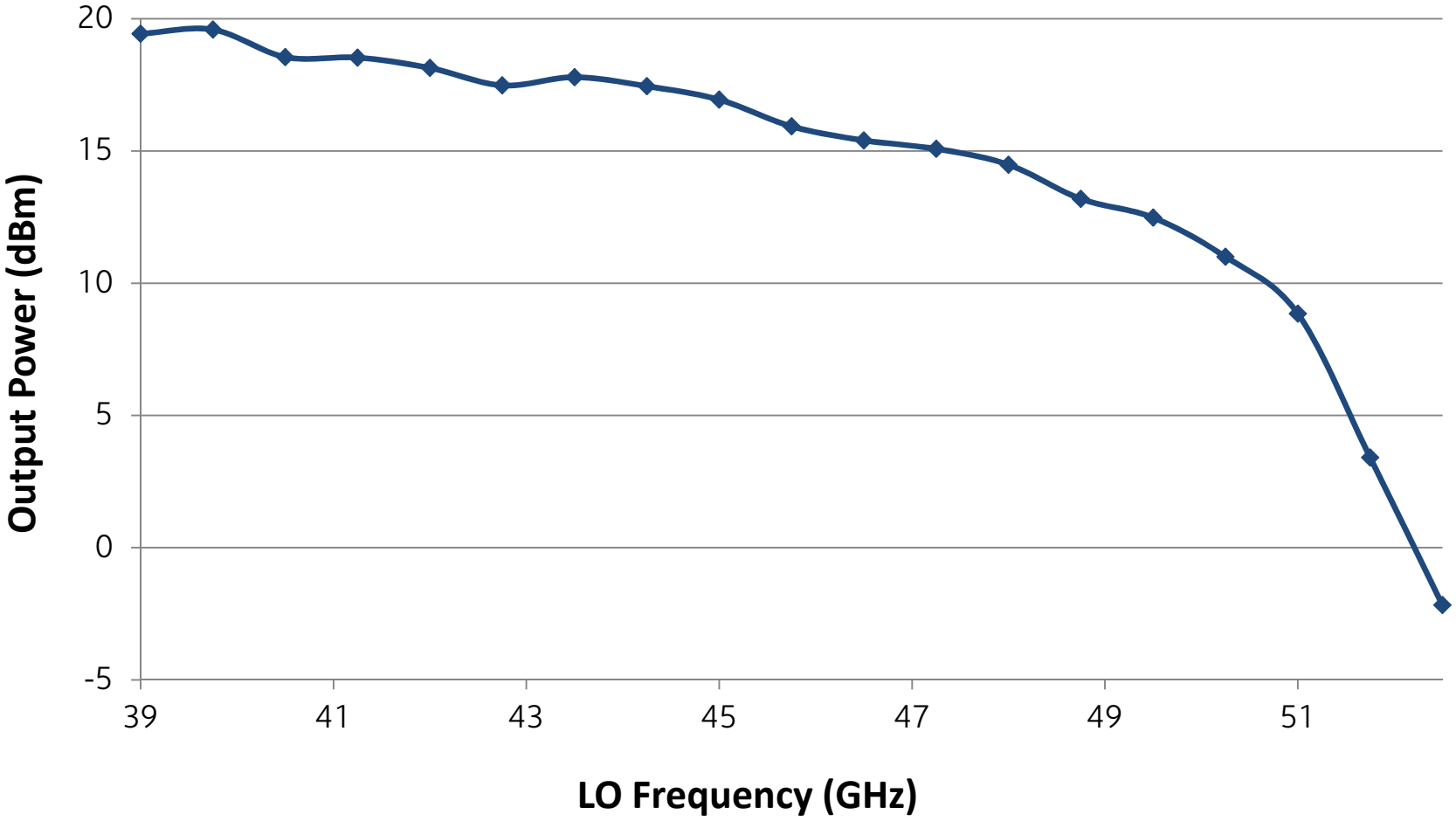
Local Oscillator Power Level



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Sub-Harmonic Image-Rejection Mixer (SHIRM) Development

- Frequency range
  - RF: 67-116 GHz
  - IF: 4-12 GHz (Goal); 4-8 GHz (current ALMA)
  - LO: 39.5-52 GHz
- Package
  - RF: WR10 waveguide
  - LO: WR19 waveguide
  - Integrated RF, LO and IF hybrids with two DSB mixers into a single housing

Sub-Harmonic Image-Rejection Mixer (SHIRM) Development

- Two possible phasing topologies when employing sub-harmonic mixers
  - ΦRF=0°, ΦLO=45°
  - ΦRF=90°, ΦLO=90°
- Devices employ planar Schottky diode technology from RAL Space

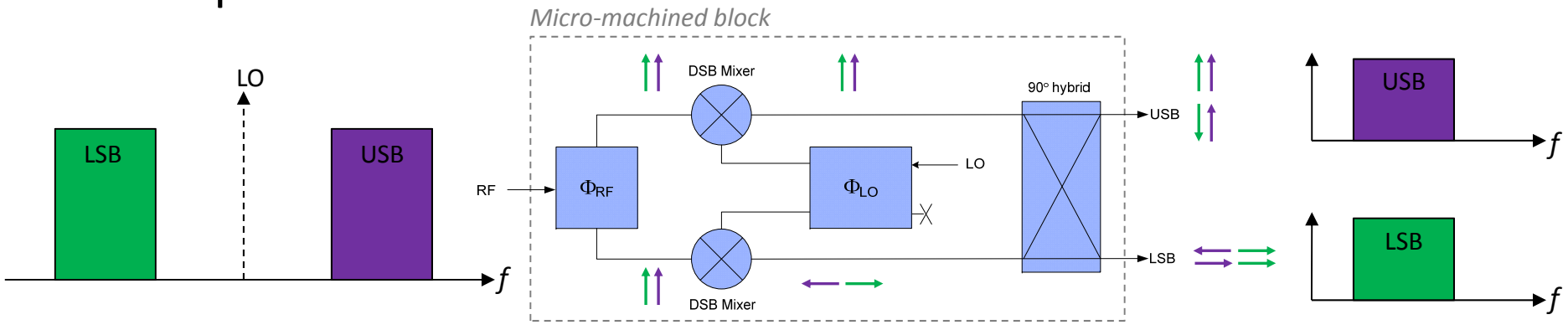
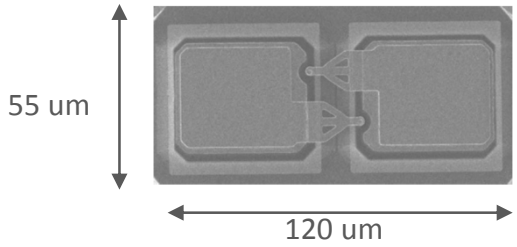
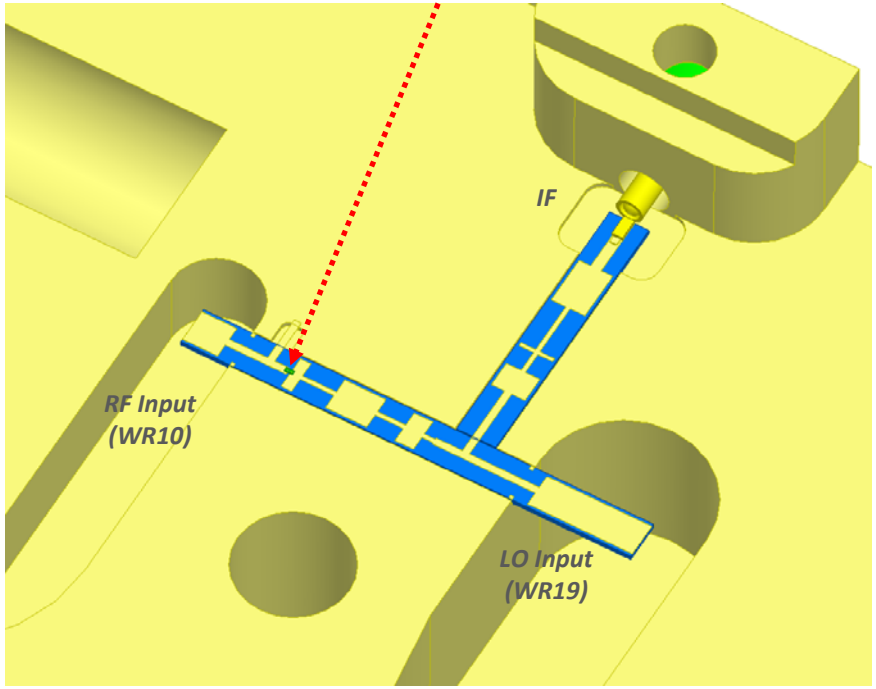


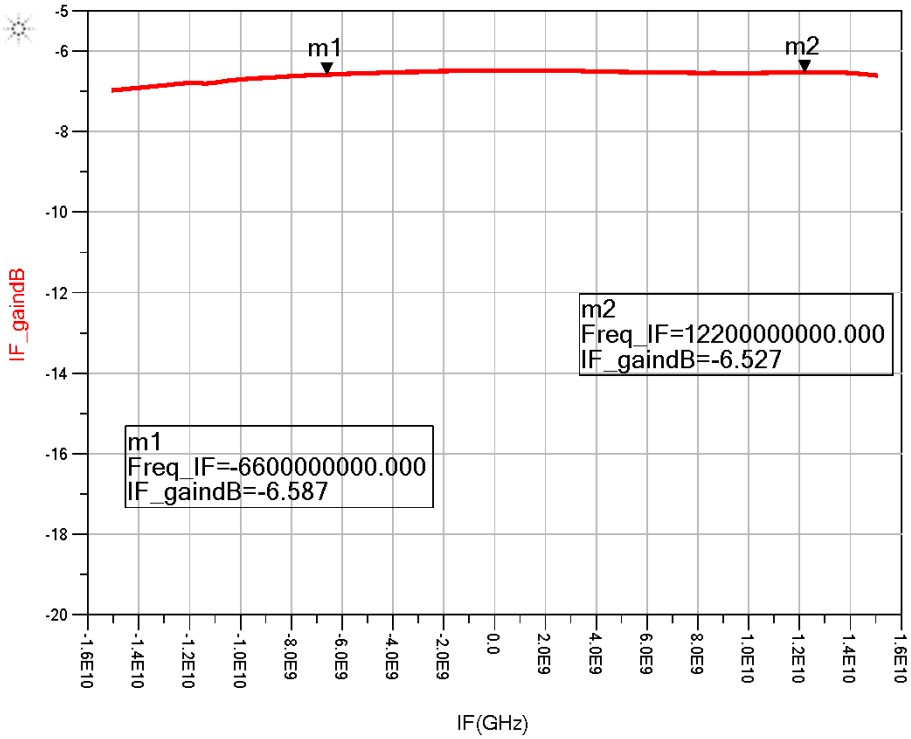
Image Rejection Mixer Architecture

DSB subharmonic mixer with predicted performance





LO@46GHz, P_LO=3mW, IF: -15 to 15GHz



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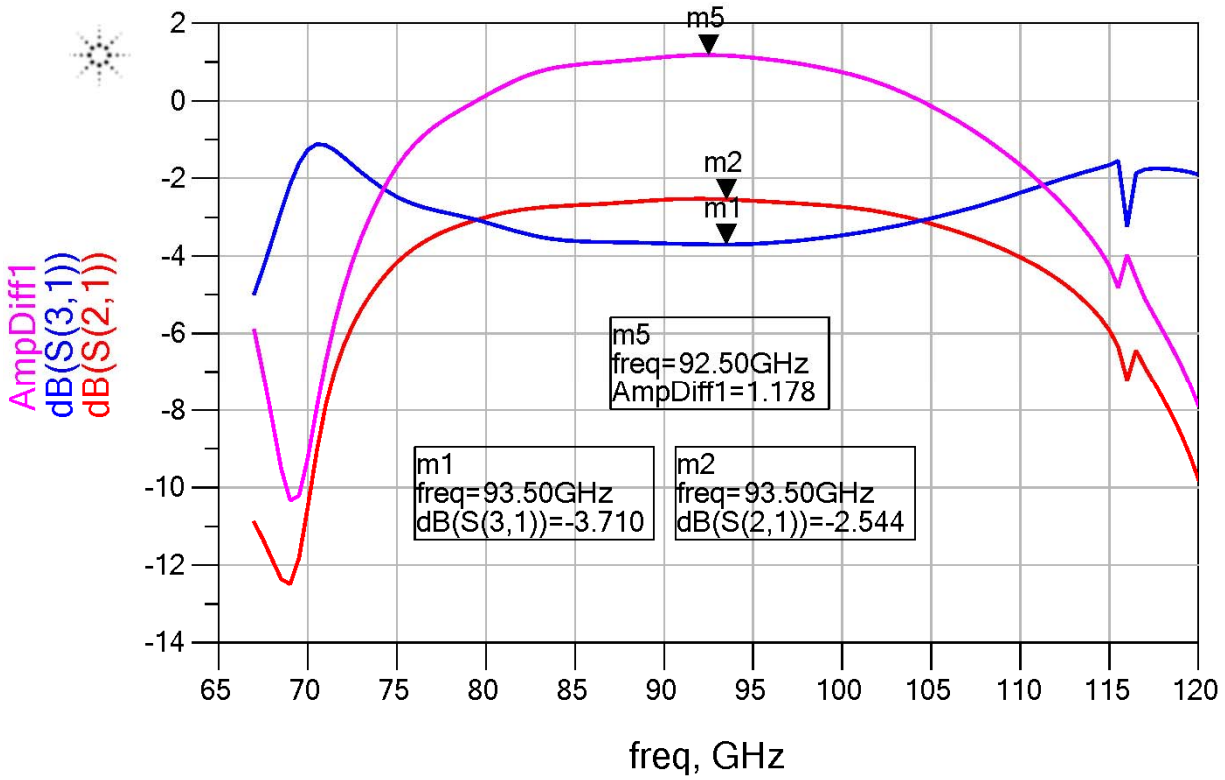
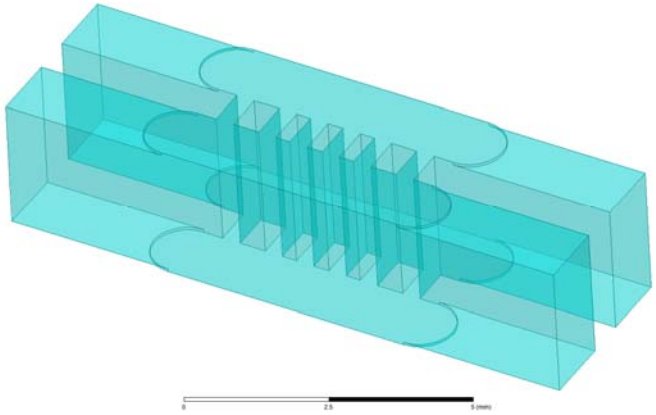
RF Hybrid





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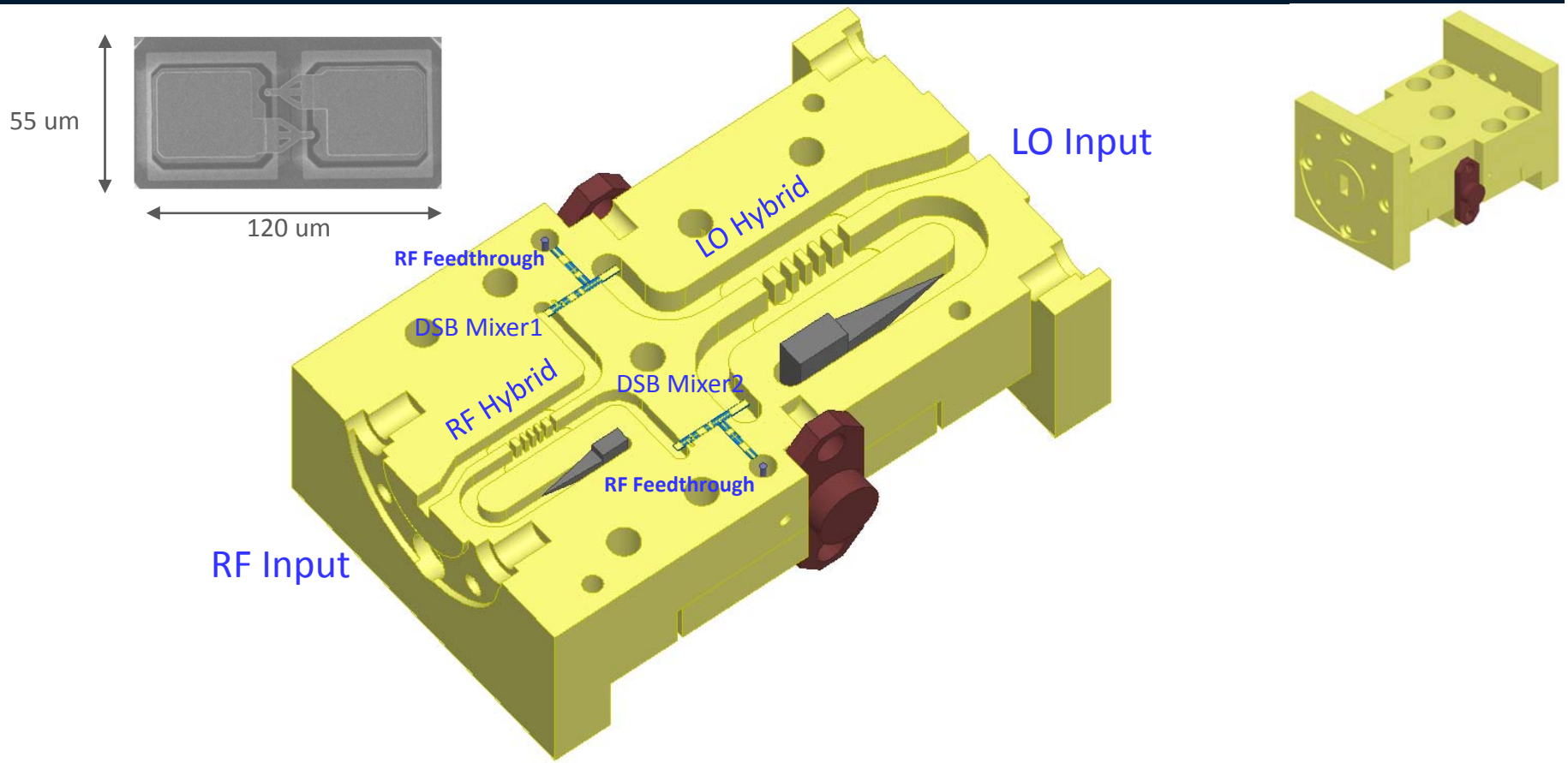
SHIRM 3D Drawing



- Block dimension: 50mm*30mm*30mm
- Three layers – single house including RF, LO and IF hybrids

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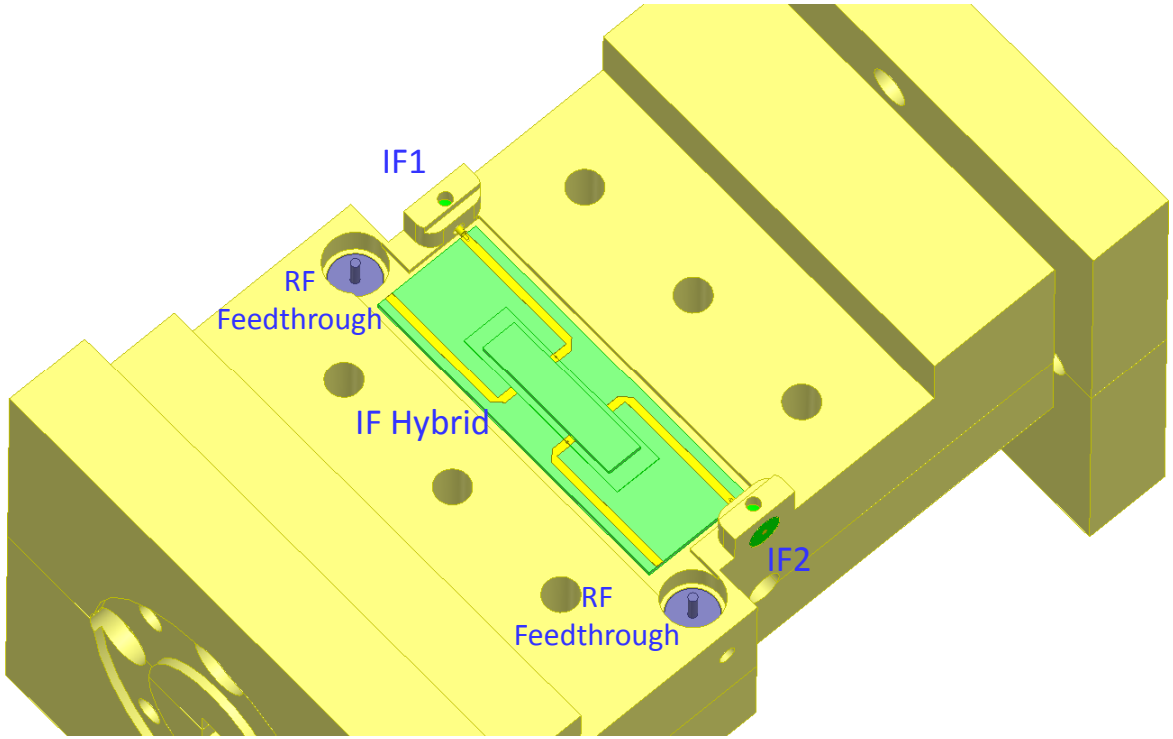
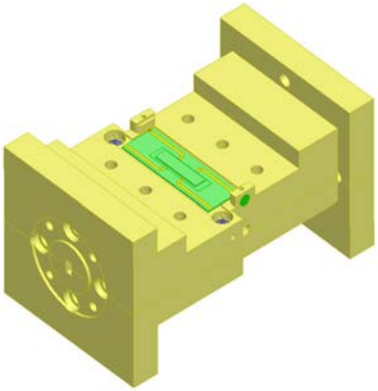
SHIRM 3D Drawing





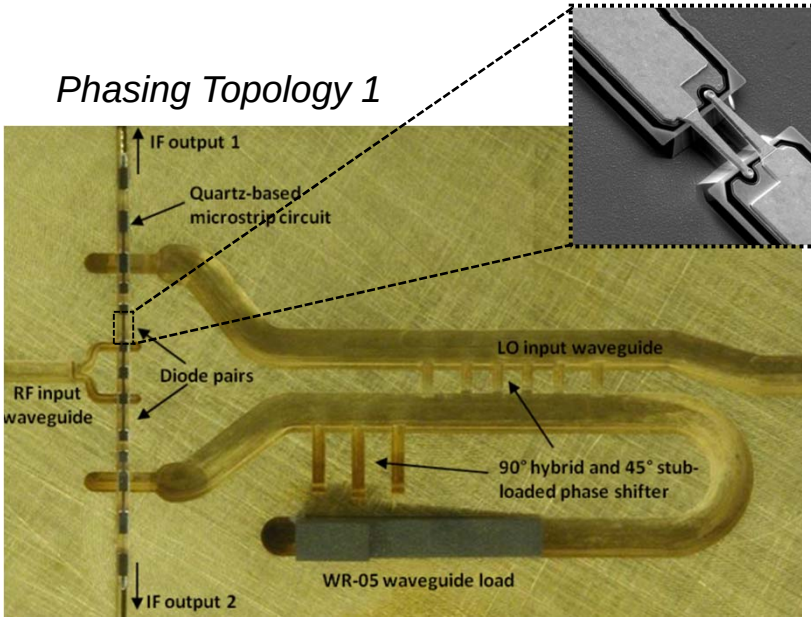
- Top layer contains IF hybrid
- Predicted Mixer NT of 1000K and CL of 8dB

Previous SHIRM at 340GHz

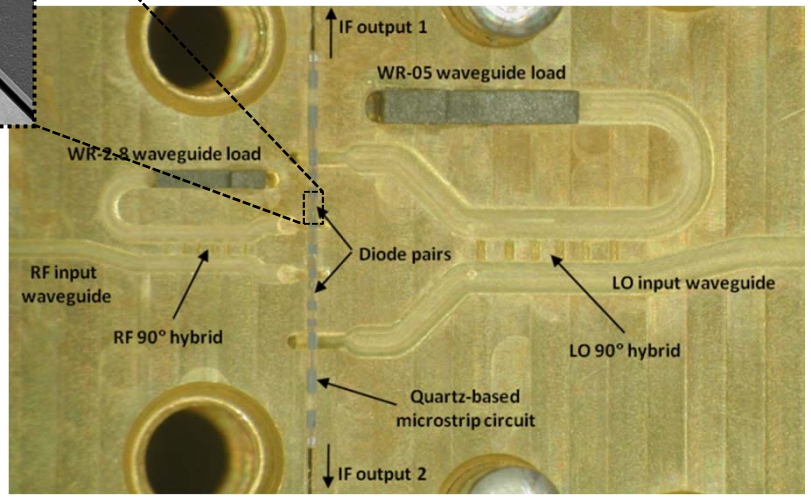
- SHIRM Optimised performance
  - Sideband rejection: 15 dB min. (>20 dB nom.)
  - SSB receiver noise temperature: ~3000 K

- Devices employ planar Schottky diode technology from RAL Space

Phasing Topology 1



Phasing Topology 2



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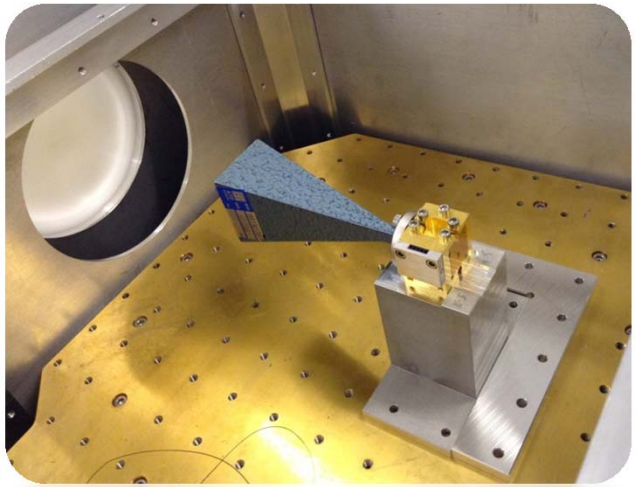
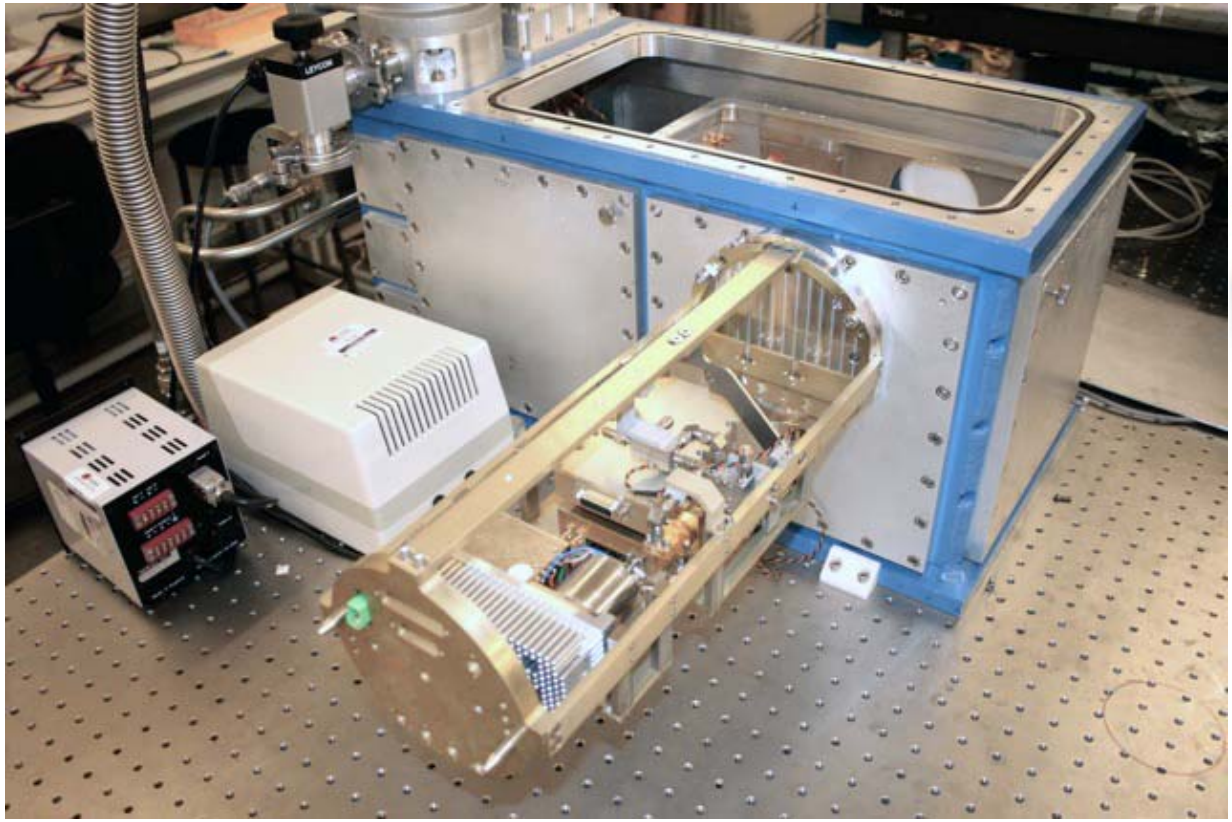
LNA test setup for Band 2+3





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Summary

- LO chain has been implemented into a pre-prototype form
- Appropriate electronic interfaces and software control developed
- SHIRM to be tested and integrated into the system to support LNAs measurement

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Acknowledgements

The research described has received funding from the STFC Project Research and Development scheme, and the European Southern Observatory 2010 upgrade fund.