

## Band 5 Development Project

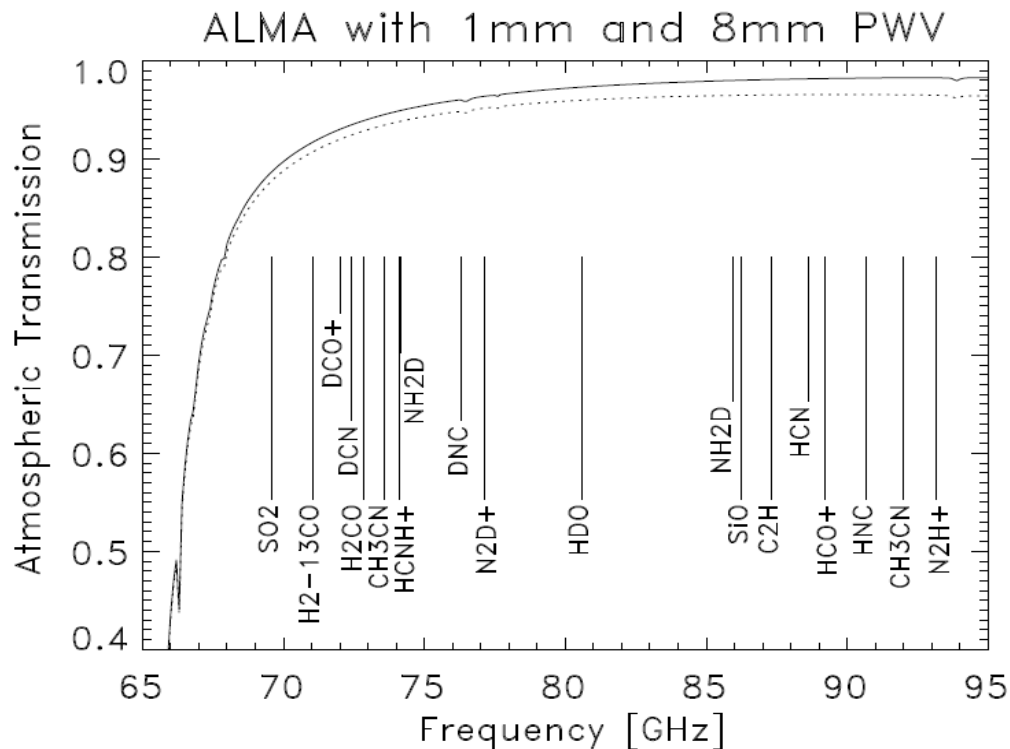
- Full suite (66 + spares) of band 5 (163-211 GHz) receivers
- European Led Project
- Key Science Topics:
  - The Earliest Galaxies (e.g. [CII] at  $8.0 < z < 10.65$ )
  - Water in Planetary and Protoplanetary Systems
- North America responsible for Local Oscillator (LO)
  - LO cost is \$3.3M (European cost is ~12M Euros)
- Implementing extension of LO tuning range to always keep 183 GHz line out of unwanted sideband
- Pre-Production LO will be delivered later this month
- LO production will begin early 2013 and finish 2014 (cold cartridge production continues through 2017)



## Band I Design Study

- Band I is East Asian led effort
- Kickoff meeting held in Taipei in June 2012
- CDL working on development of optics, OMT, LNA, LO, and downconversion options
- Proposed spec change to extend upper band edge from 45 to 50 GHz
- Full development proposal to be prepared by ASIAA in 2013, will include components from various sources (based on performance)
- Specifications and ICDs in draft form

## Band 2 Design Study



- Context of Star Formation (deuterated molecules in cold clouds)
- Origin of Life (complex organic molecules)
- Galaxies across Cosmic Time (CO at intermediate  $z$ , 0.37-0.7)

- Joint study with the Arizona Radio Observatory



## Band 2 Gain/Noise Budget

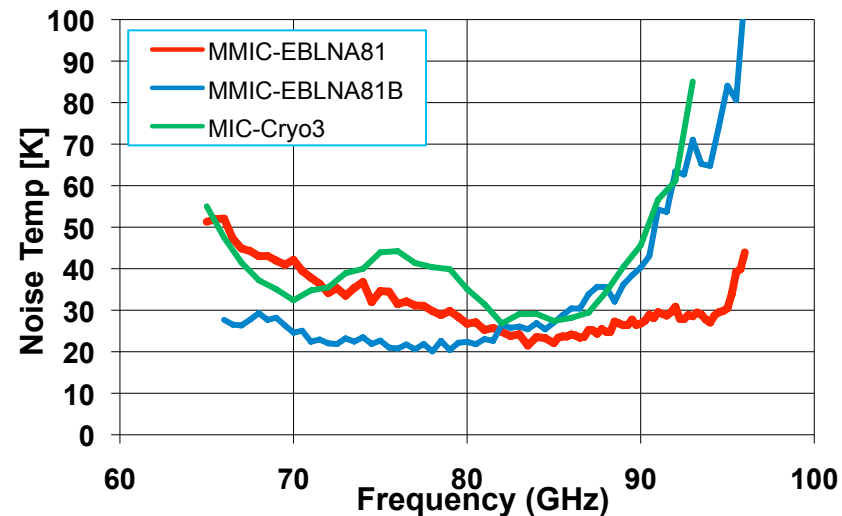
**Table 2:** Preliminary gain and noise budget for the ALMA band 2 receiver.

Component/Stage	Gain (dB)	Noise Temperature (K)	T <sub>EQ</sub> (K) referenced to the input
Lens/Window (297K)	-0.16	11.1	11.1
IR Filters (15K, 110K)	-0.1	2.5	2.6
Feedhorn (15K)	-0.1	0.35	0.4
OMT (15K)	-0.1	0.35	0.4
Cryogenic LNA (15K)	30	30	33.4
Cryogenic Isolator (15K)	-1	3.9	insignificant
Cryogenic Postamp (15K)	25	80	0.1
Waveguide Feedthru (297K)	-1	77	insignificant
Downconverter (297K)	-15	5000	insignificant
Warm IF Amplifier (297K)	20	175	insignificant
<b>Total</b>	<b>57.5</b>		<b>48.0</b>

- Current ALMA Band 2 Noise Specification: 30 K SSB over 80% of the RF band and 47 K SSB at any RF frequency in the band, where the RF band is defined as 67-90 GHz.
- To meet this spec would require a cold lens **and** a LNA with 20K noise temperature
- Also investigate tradeoff of extending upper band edge to 93.2 GHz (simultaneous observations of [N2D+]/[N2H+] line pair)

# Overview of Deliverables

Milestone	Status
Band 2 Science Workshop	Will be held in Charlottesville April 2013
Band 2 OMT and horn demonstrated	11-18 GHz scaled OMT works well
Optics report complete	
MMIC LNA delivered to ARO	Delivered June 2012
MIC LNA delivered to ARO	Successfully tested last week (see plot)
Prototype Band 2 downconverter complete	In fabrication
Modifications to 12m downconverter complete	Parts on order
ARO 12m observations using prototype LNAs complete	



## Band 6 v2 Design Study

- Joint study with the University of Virginia
- Balanced sideband-separating receivers with 4-12 GHz IF
  - Current band 6 receivers have relatively poor noise at low RF-low IF combination, hinders simultaneous observations of  $^{12}\text{CO}$  and  $^{13}\text{CO}$  (230.5 and 220.4 GHz)
- Nb/Al-AlN/Nb SIS junctions
  - Improved noise at edges of band
- Balanced 4-12 GHz IF LNA development
- Improved OMT and Feed Horn design
  - Solve cross-pol issues
  - Remove 227 GHz “trapped-mode resonance” noise spike

## Band 6 v2 Design Study

- Balanced band 6 mixer using current Nb/AlO<sub>x</sub>/Nb SIS mixers in fabrication
- Nb/Al-AlN/Nb SIS wafer in fabrication using existing maskset
- Investigating multiple LNA options, including MMICs from Chalmers