The ALMA Front End

John C. Webber
National Radio Astronomy Observatory, Charlottesville, 22903 VA, USA

The ALMA project, a collaboration of North American, European, Japanese, and Taiwanese scientific agencies, is building the ALMA radio astronomy array, consisting of (1) a main array of fifty 12-meter diameter antennas and (2) a compact array (ACA) of four 12-meter and twelve 7-meter antennas. The instrument is to be used for observing astronomical sources in ten bands from 31 to 950 GHz at a 5000 meter elevation site in the Atacama Desert of Chile.

The ALMA Front End is an assembly of multiple mm and sub-mm wavelength receivers with an amplitude calibration device and water vapor radiometer. The spectrum from 31 to 950 GHz which is observable through the Earth's atmosphere is divided into ten receiver bands. In the initial construction phase, seven bands are currently funded and all use SIS mixers:

ALMA Band	Frequency Range (GHz)	Responsible Organization	Delivered Receiver Temperature (K)
3	84-116	Herzberg Institute for Astrophysics (HIA, Canada)	37 SSB
4	125-163	National Astronomical Observatory of Japan (NAOJ)	Testing
6	211-275	National Radio Astronomy Observatory (NRAO, USA)	40 SSB
7	275-373	Institut de Radioastronomie Millimétrique (IRAM, France)	50 SSB
8	385-500	National Astronomical Observatory of Japan (NAOJ)	Testing
9	602-720	Netherlands Research School For Astronomy (NOVA)	100 DSB
10	787-950	National Astronomical Observatory of Japan (NAOJ)	Under development

The 1-meter-diameter cryostats from Rutherford Appleton Laboratory (RAL, UK), will house these receivers and accommodate the remaining four bands when they are eventually funded.

Unlike previous generations of mm and sub-mm receivers, the ALMA Front End is electronically tunable in all respects. The SIS mixers use Nb/Al-AlO_x/Nb tunnel junctions and are of advanced fixed-tuned design with wide IF bandwidth. For bands 4 and higher, wideband varistor frequency multipliers are mounted on the 110K stage of the cryostat. LO power to drive the multipliers is provided by a chain of band-specific active multipliers, filters, and amplifiers, with a YIG-tuned oscillator as the fundamental signal source. A final variable-gain MMIC power amplifier provides adjustable LO drive power for the multipliers. The LO drive signal to the multipliers is phase-locked to the output of a reference photomixer which is driven by two centrally-located phase-locked infrared lasers over a phase-stabilized optical fiber. The ALMA Front End meets the extremely stringent phase noise and phase stability specifications needed for operation up to 950 GHz on baselines up to 15 km.

The status of assembling and testing the first ALMA Front Ends in the laboratory and with the ALMA antennas will be presented. This work has been performed over a period of several years as a widely distributed effort coordinated by the NRAO, the European Southern Observatory (ESO), and the NAOJ. Other institutions with significant participation include the HIA, IRAM, NOVA, Onsala Space Observatory (OSO, Sweden), RAL, the Centro Astronomico de Yebes (CAY, Spain), the University of Cambridge / Astrophysics (CA, UK), and the Academia Sinica (Taiwan).