ATACAMA LARGE MILLIMETER ARRAY

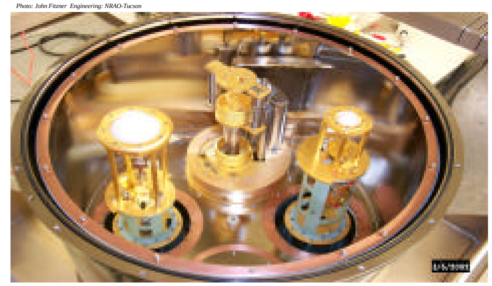
BUILDING THE INSTRUMENT TO IMAGE COSMIC DAWNS

A prototype ALMA antenna can be seen under construction at the Very Large Array site of the ALMA Test Facility in this drawing. Most of the parts for the Vertex antenna, the ALMA/NA prototype have arrived at the site; acceptance is scheduled for late July. Other prototype antennas are expected to arrive during 2003; testing of prototypes is scheduled for completion early in 2004.

Photo: John Fitzner Engineering: NRAO-Tucson

A receiver built especially to evaluate the ALMA prototype antennas, the evaulation receiver, has been constructed at NRAO-Tucson. The receiver contains dual polarization cartridges at 3mm, and single polarization cartridges at 1.3mm. This receiver package will be installed on the Vertex antenna at the ALMA Test Facility site during Autumn 2002.

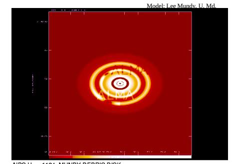
Photo: John Fitzner Engineering: NRAO-Tucson



The heart of the receiver shown at left lies within its dewar. At left is shown the 'works' of the receiver, termed a cartridge, for the 3mm band. At right is the 1.3mm band cartridge.

ALMA Simulation of a Planet-Bearing Debris Disk

Model: Lee Mundy, U. Md.



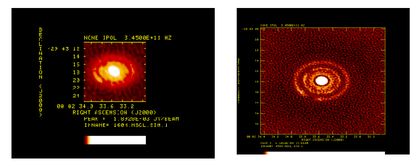
AIPS User 1134 MUNDY DEBRIS DISK

Model

- Tdust at 1 AU = 350 K
- Tdust power law index q = 0.45
- Surface density power law index = 1.3
- Inclination = 45 degrees

Feature	Amplitude	Radius (AU)	Width (AU)	PA (deg)
Dark Ring	1.0	7	2	
Dark Ring	2.0	16	4	
Planet Debris	1.5	40	5	45
Planet Debris	3.0	60	9	155

The model is a simulated modestly-bright debris disk at a distance of 12 pc located around a Sun-like star. The observing frequency is 345 GHz, at which the total emission is 10 mJy. The disk has an inner radius at 3 AU and an outer radius at 125 AU, with a mass of roughly 0.4 lunar masses of dust. This is a fairly dusty system, of which perhaps a dozen might be available.



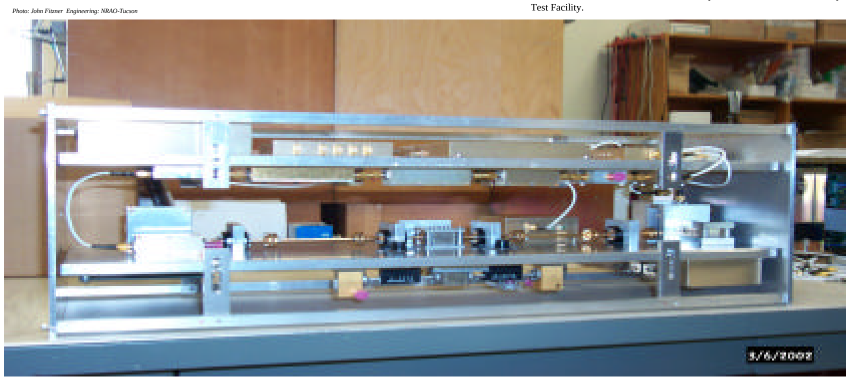
Simulations: M. Holdaway, NRAO-Tucson

The debris disk model is spread over several primary beamwidths of the ALMA antenna. Imaging the disk would pose a problem for current interferometers, which do not recover short spacing data from the antennas operating as single units. ALMA will incorporate this data to provide high fidelity images. Simulations of an ALMA observation of the debris disk using multi-scale CLEAN in the aips++ package. On the left, an observation with the compact (150 m) array, stretched to show the structures in the disk in a four hour integration. On the right, a 4 hour observation with the 450m array, which achieves higher resolution. Thermal noise limits sensitivity. A combination of these two observations would afford the best representation of the original image. Clearly, in one transit ALMA would be able to constrain 1) the photospheric flux of the central star (not resolved from inner dust in these compact configurations), 2) the general structure of the disk—suggesting the presence of planets and 3) the total dust mass of the disk, as all of the flux is recovered in the image. With further integration and higher resolution, the details of the model emerge.

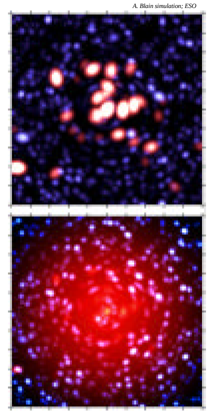
Image fidelity is the ratio of the model to the difference (model – simulated) image, so higher numbers reflect more accurate quality. For a wide range of medians, the fidelity measure lies near 100, showing that ALMA images will be of quite high quality indeed.

The holography receiver has been designed and constructed at NRAO-Tucson. It was built especially to evaluate the ALMA prototype antennas. The Holography Receiver and the Optical Pointing Telescopes will be the first instruments deployed on the Vertex prototype antenna. Using software developed at IRAM, it will be used to measure the accuracy of the antenna surface, specified to be better than 20 microns rms. The source used for observations with this receiver is a photonic transmitter located atop a tower adjacent to the ALMA Test Facility.

Photo: John Fitzner Engineering: NRAO-Tucson



A. Blain simulation; ESO



The simulated appearance of a cluster of galaxies at a redshift $z = 0.2$ observed using ALMA at a frequency of 350 GHz at a relatively low resolution of 3 arcsec (left). Red is used to denote galaxies that are members of the cluster and the diffuse emission from the Sunyaev-Zel'dovich effect. Blue is used to represent background galaxies magnified by the cluster. A simulation of the same field in the optical R-band is also shown (right). The submillimeter image is much more sensitive to the high-redshift background galaxies. The images are 100 arcsec on a side. A survey of the whole field with ALMA (about 30 ALMA pointings) would reveal the brightest sources, while the faintest sources (with fluxes of 0.01 mJy) in the 350-GHz image could be detected in about 70 hours of integration per field.