THE RECEIVER SYSTEM-MM REGIME

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OUTLINE

1. The Atmosphere – Why Go To High, Dry Sites?
2. Technical Difficulties
3. Practical Receivers
4. The ALMA Project
Atmospheric transmission at Chajnantor, pwv = 0.5 mm

Fig. 1
BLOCK DIAGRAM OF MM/SUB-MM RECEIVER

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Principle of a mm/submm radioastronomy receiver

Heterodyne principle = mixing of two frequencies to produce difference signal
Radio frequency (RF) ⊗ local oscillator frequency (LO) → intermediate frequency (IF)

Optics

- SIS = Superconductor-Insulator-Superconductor (mixing element)
- sensitivity approaching quantum limit
- amplitude and phase measured

astronomy RF signal (e.g. 650 GHz)

LO ref in

LO signal (e.g. 642 GHz)

IF signal out (e.g. 8 GHz)

SIS mixer IF amp(s)

to correlator or spectrometer

0 8 // 642 650 GHz
ARRANGEMENT OF OPTICAL ELEMENTS ON AN ANTENNA EQUIPED FOR MM/SUB-MM RADIOASTRONOMY

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VARIABLE ARRANGEMENTS FOR POLARIZATION DIPLEXING
Fig. 7

COMPACT REMOVEABLE RECEIVER “INSERT”
4K CLOSED CYCLE REFRIGERATOR

Fig. 8
HIGH FREQUENCY RECEIVER USING INSERTS

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OPTICS USED FOR SIDEBAND TERMINATION
POLARIZATION DIPLEXERS (OMTs)

“A passive microwave component that separates orthogonal polarizations within the same frequency band.”

Due to difficulty in machining and the absence of suitable analysis tools such diplexers in the past have used free standing wire grids.

However, today we may fabricate ortho mode transducers (OMTs) in waveguide and have good performance over a waveguide band.

A design team here at NRAO has realized such OMTs up to 300GHz. The prospect is that we will extend these techniques up to 1000 GHz (1THz).
Polarization Diplexer Based on Bøifot
OMT Development
Band 3 OMT Views
## Receiver Frequencies

<table>
<thead>
<tr>
<th>Band</th>
<th>Lower (GHz)</th>
<th>Upper (GHz)</th>
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<tbody>
<tr>
<td>1</td>
<td>31.3</td>
<td>45</td>
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<tr>
<td>2</td>
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<td>720</td>
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<tr>
<td>10</td>
<td>787</td>
<td>950</td>
</tr>
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ALMA LO
Approach
ALMA Photonic LO Approach
Round-Trip Phase Correction

The path length to each antenna is actively corrected by a round-trip phase correction scheme.

The active control is based on the output of an optical interferometer with a stable master laser source.
**Line Length Corrector: Description**

The line length corrector, together with the photonic reference receiver, forms an optical interferometer with a maximum of 50 km round-trip length.

The “short arm” of the interferometer is a sample of the master laser which is distributed to each of the 64 Line length corrector modules.

The Corrector compensates for changes in the fiber distribution length due to environmental effects.

The compensation is accomplished by insertion of fiber in an amount opposite to the environmental changes. This is done by stretching or heating the fiber.
Round Trip Correction by Optical Interferometer and Measurement of Phase Drift of Beatnote Transmitted over 25 km of fiber

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Line Length Corrector: Prototype Results

Phase Difference (at 25 GHz) and Stretcher Position plotted vs time

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Photonic Reference Approach: ALMA Baseline Plan

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Instrument Development

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LaserSynthesizer: Photo
Laser Synthesizer: Photo