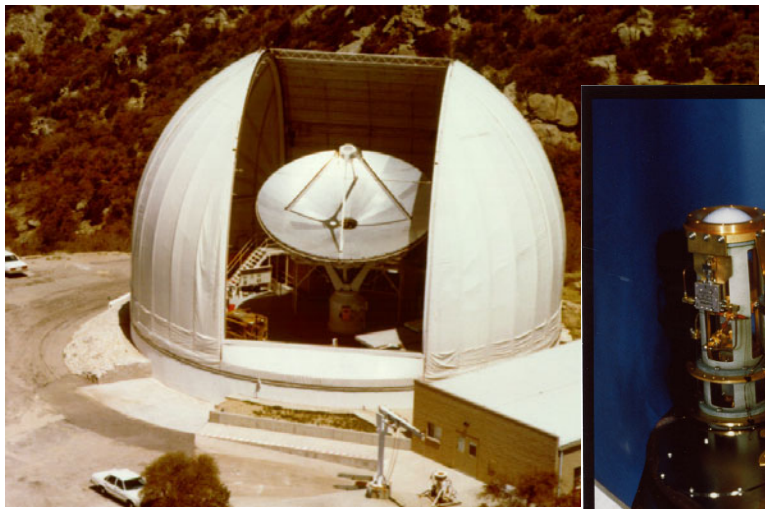
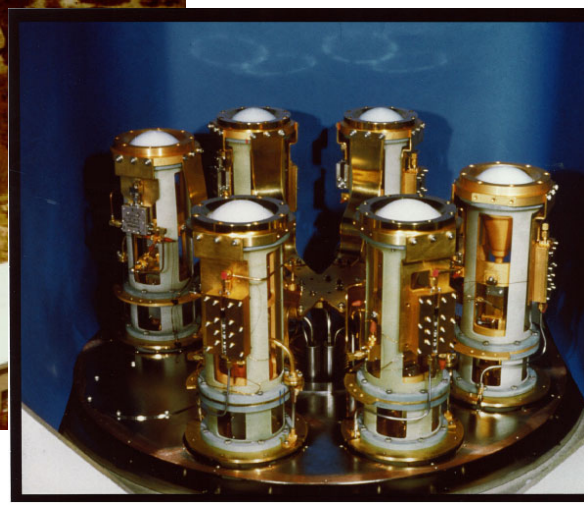
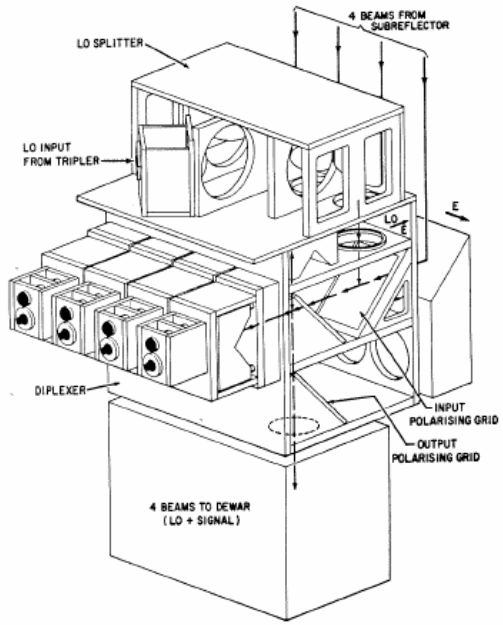
12 m Telescope mm-wave Receivers



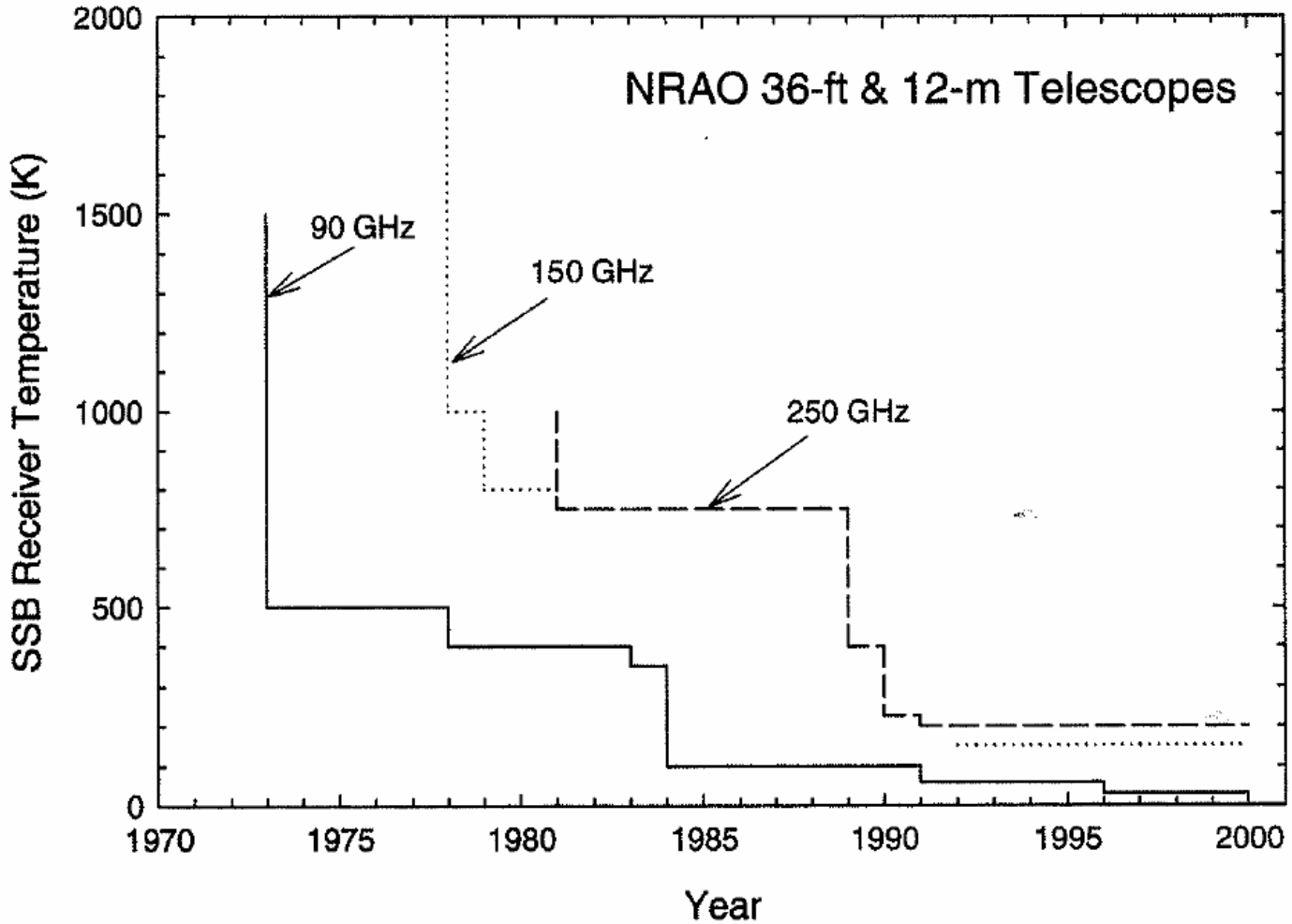




The 80's and 90's

- Exciting times at NRAO Tucson!
  - New telescope
  - New 'downtown' facilities
  - New receivers, electronics and control system
  - Great Technical and Operations Staff

Receivers Noise Temperatures



Graph from
M.A.Gordon

mm-wave Local Oscillators

- *Implementation of the Klystron oscillator alternative:*

  – Klystrons were ‘temperamental’, short-lived and clumsy to use.

  Five tubes were needed to cover the 3mm window. Required high-voltage electronics and liquid cooling. Expensive: $50k/year for replacements.

  – Broad frequency tuning range Gunn diode oscillators became available in 1985.

  Designed and manufactured by J. E. Carlstrom. Commercial PLL boxes. This new LO was implemented on all mm-wave receivers.

  Still operational today!

  – Significant gain in observing time

New Generation of SIS Receivers

- Needed new receivers with full band coverage, higher sensitivity and easy of operation/maintenance.
- J. Payne moves to Charlottesville in 1988 to work on the development of the 1mm and 3mm SIS receivers at the CDL.
- Designed and implemented the receiver inserts concept (‘the rockets’)
- Dual polarization, single beam, SSB receivers using new SIS mixers by A. Kerr and SK Pan.
- Best 2-3mm Inserts: 30 Kelvin DSB noise temperatures.
- Stainless steel cryostats ready to accept up to 8 inserts.
- Closed cycle 4 K Joule-Thompson systems.
- New M&C system

New Generation of SIS Receivers

Perfetto

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

April 21, 1989

MEMORANDUM:

TO: Addressee

FROM: J. Payne J.P.

SUBJECT: 70-115 GHz Receiver and 4 K Systems

Here is a review of where we are with the new 70-115 GHz SIS receiver and a plan for the next few months. There are bound to be mistakes and omissions, but, hopefully, it will be helpful. Please call me or send me an E-mail message with any comments.

1.0 Broad Overview of Where We Are

A test dewar has been fabricated and equipped with a 4 K closed-cycle refrigerator. An insert, consisting of a lens, feed, LO coupler, mixer, IF amplifier, isolator and backshort drive, has been fabricated and tested for the 90-115 GHz band. When installed in the test dewar with a window and IR filter appropriate for use in a practical receiver, we measure a total receiver noise temperature of 19.1 K DSB at 100 GHz - a comfortable world record.

Low loss optics suitable for use in a practical receiver have been fabricated and measured. A crossed-grid polarization diplexer, together with an offset parabola, is used to focus two orthogonal signal polarizations into two inserts within the receiver dewar at 4 K. The room temperature loss of the parabola and diplexer has been measured at 0.15 dB. The pattern of the feed and parabola has been measured and is useable, but is slightly too broad. James is now designing the final version.

A dewar suitable for up to eight inserts has been designed and will be fabricated in Green Bank in the next few weeks.

We are now faced with building a complete receiver suitable for use on the telescope. Obviously, this is going to involve more people; in particular, Tucson is going to be very involved.

New Generation of SIS Receivers

2 – 3 mm Band

Receiver Inserts

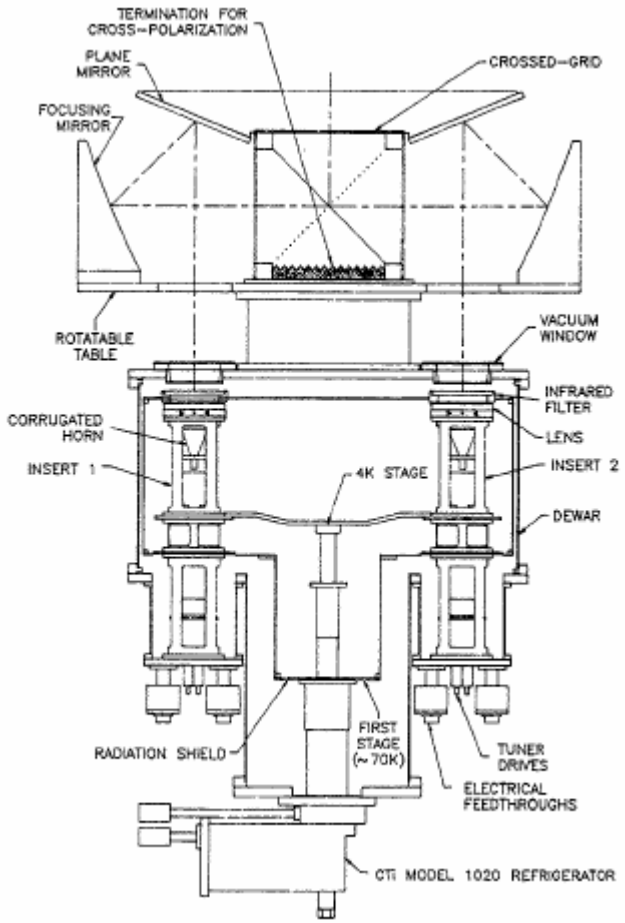
3mmLO: 68 – 90 GHz

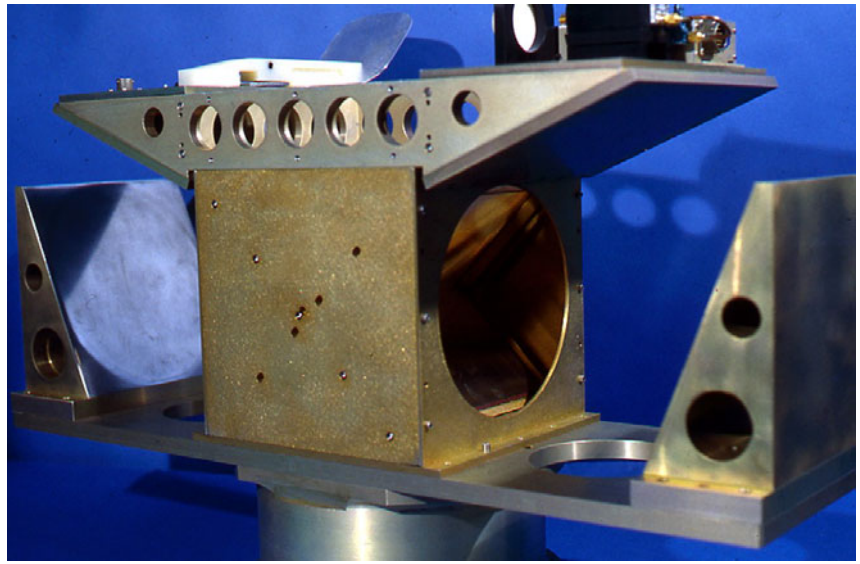
3mmHI: 90 – 116 GHz

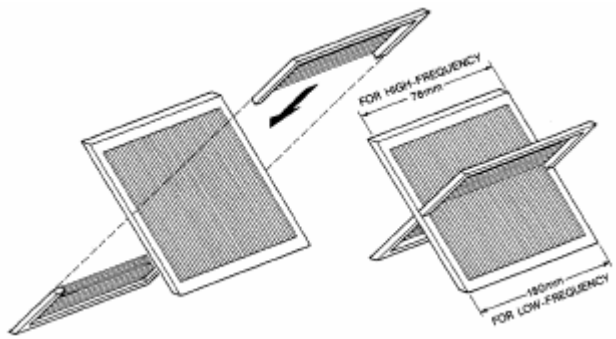
2mm: 130 – 170 GHz

New Generation of SIS Receivers

2 – 3 mm Receiver

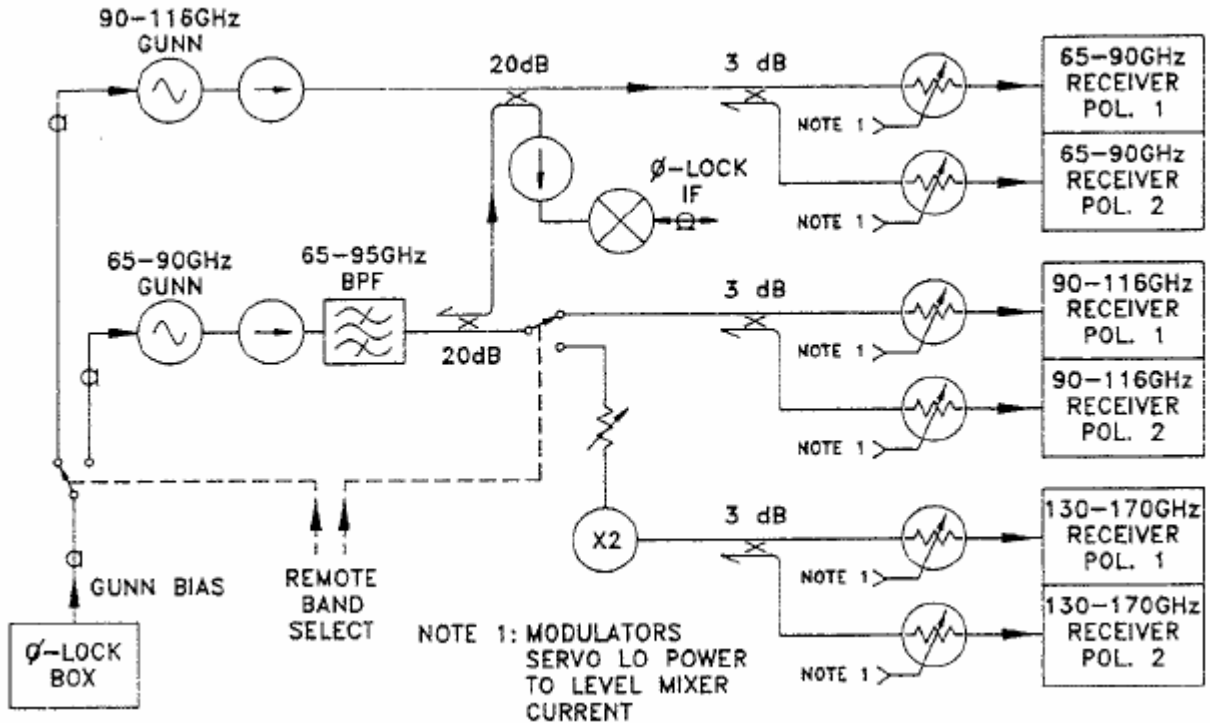






New Generation of SIS Receivers

2 – 3 mm Rx Local Oscillator Block Diagram

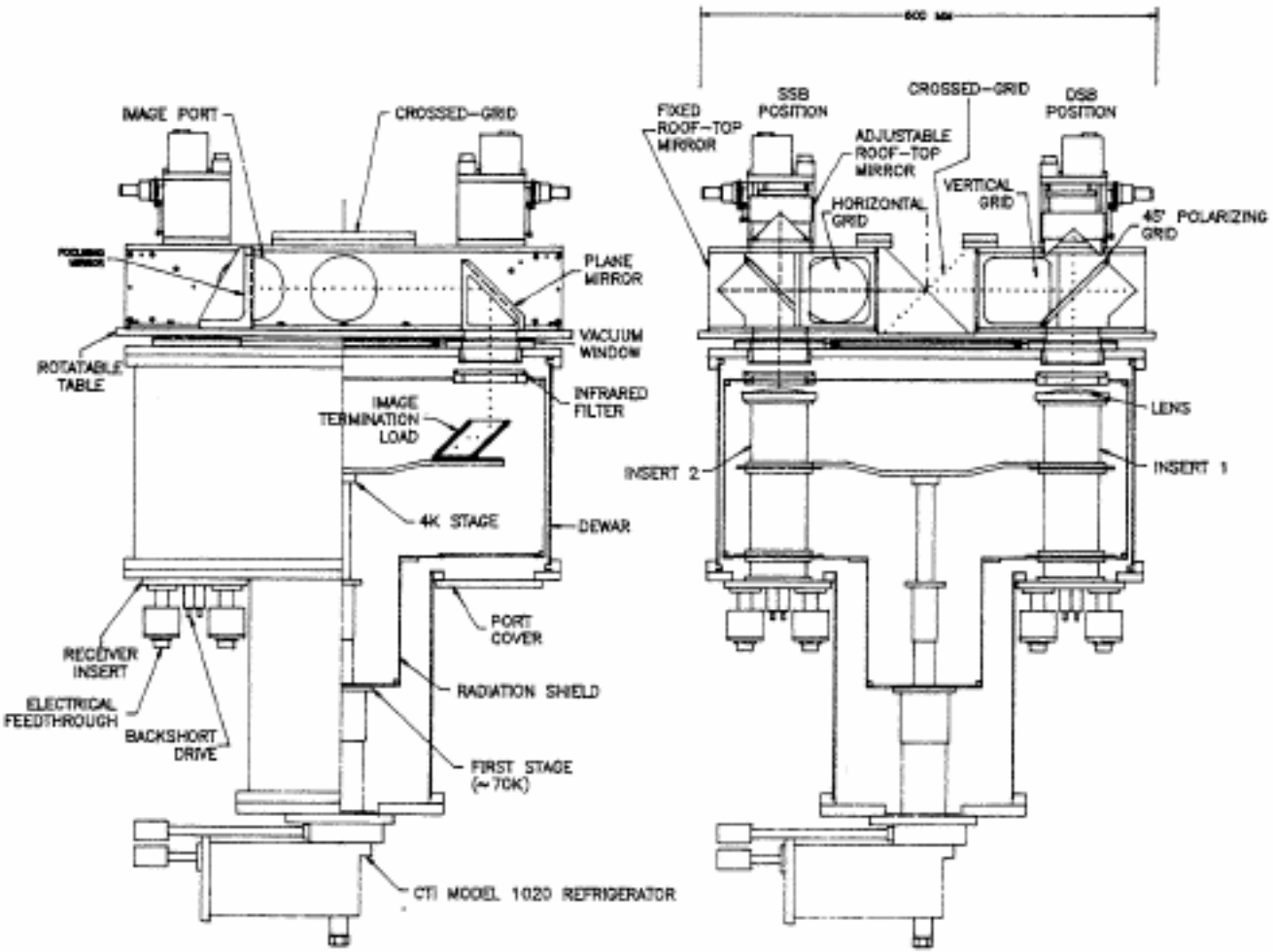


New Generation of SIS Receivers

2 – 3 mm Receiver

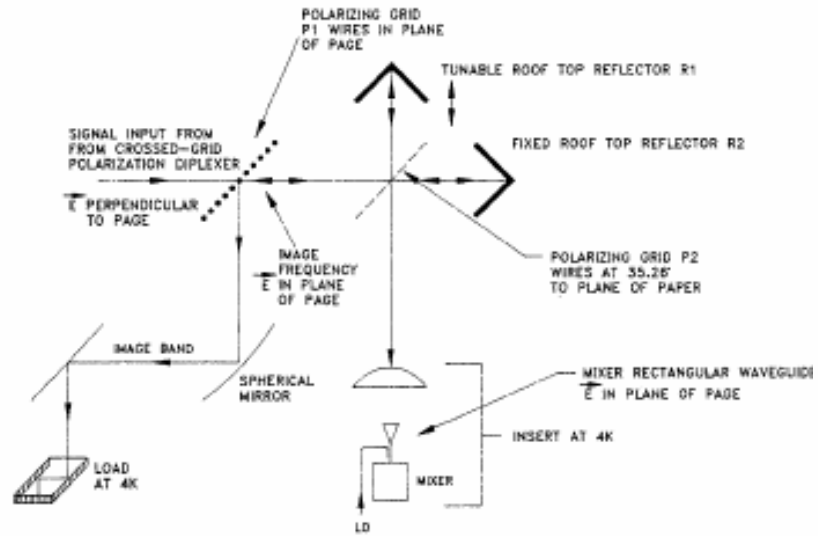
New Generation of SIS Receivers

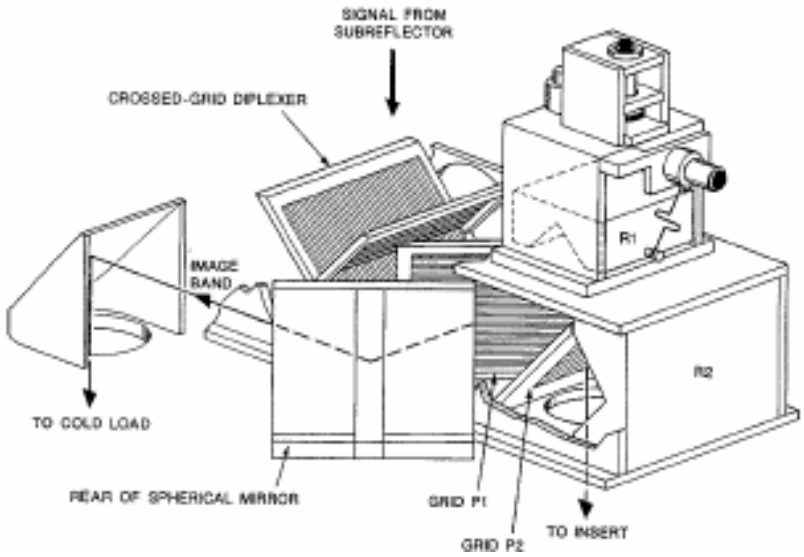
Layout of the 1mm Receiver



New Generation of SIS Receivers

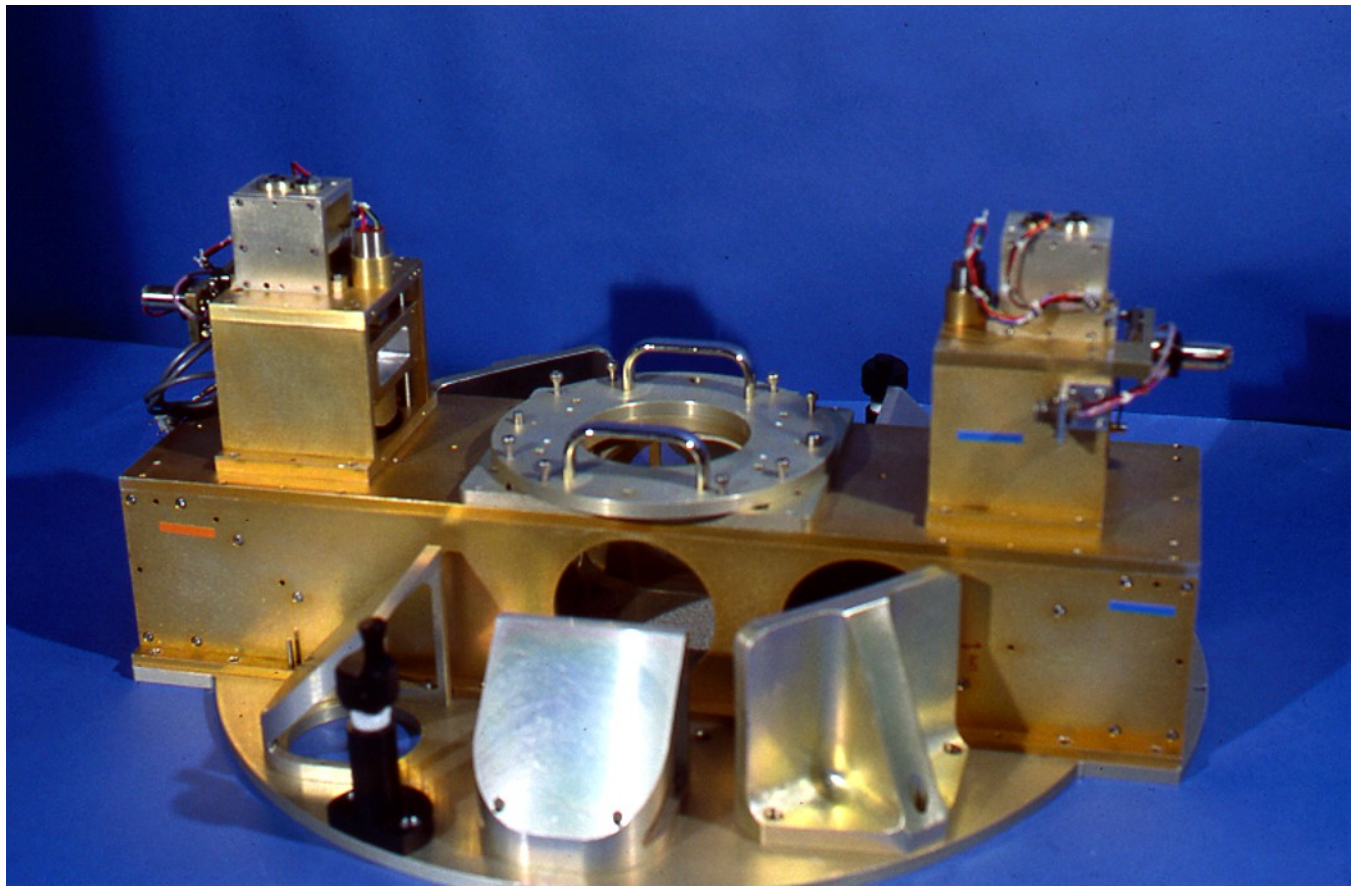
1mm Receiver Optics



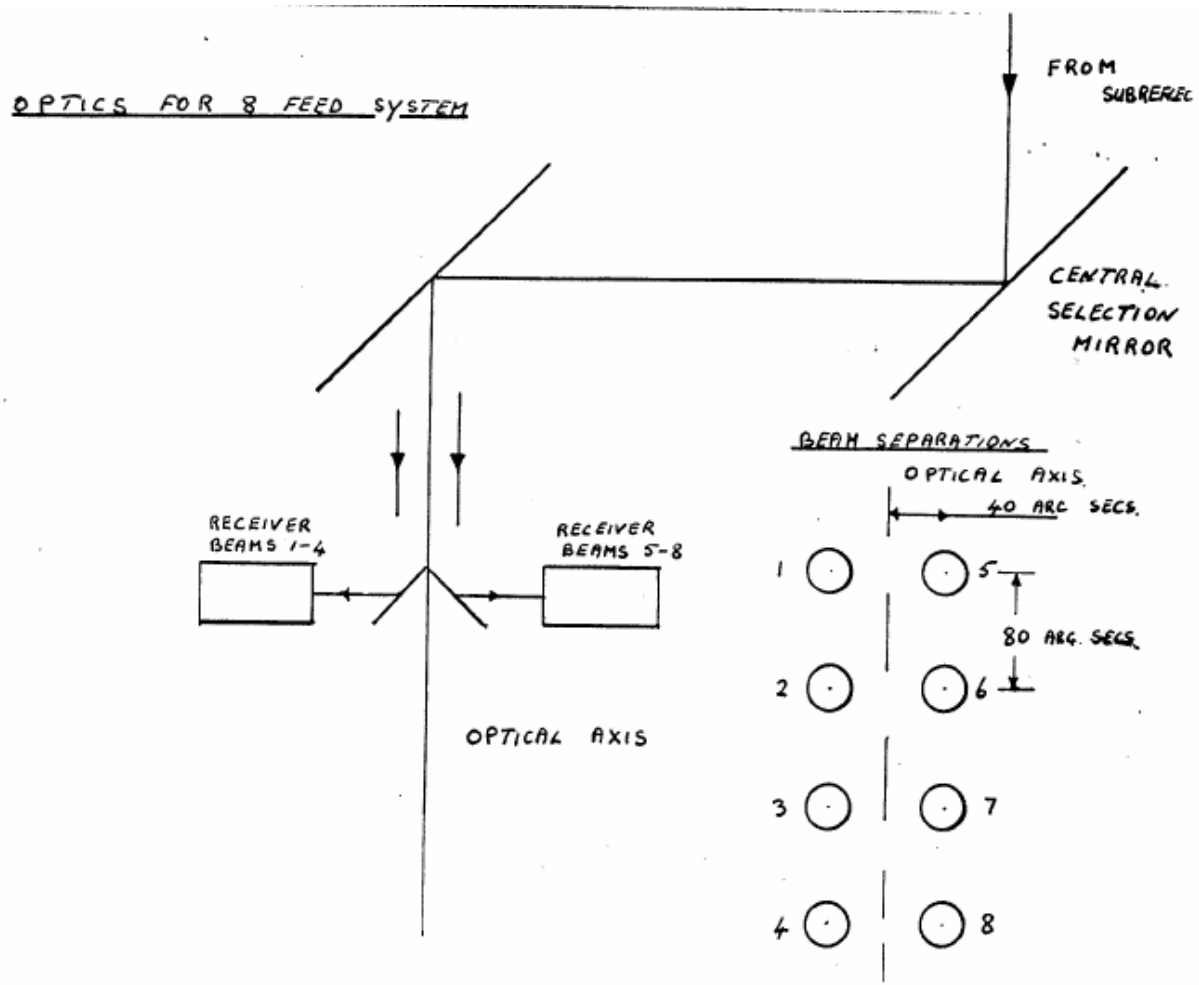


New Generation of SIS Receivers

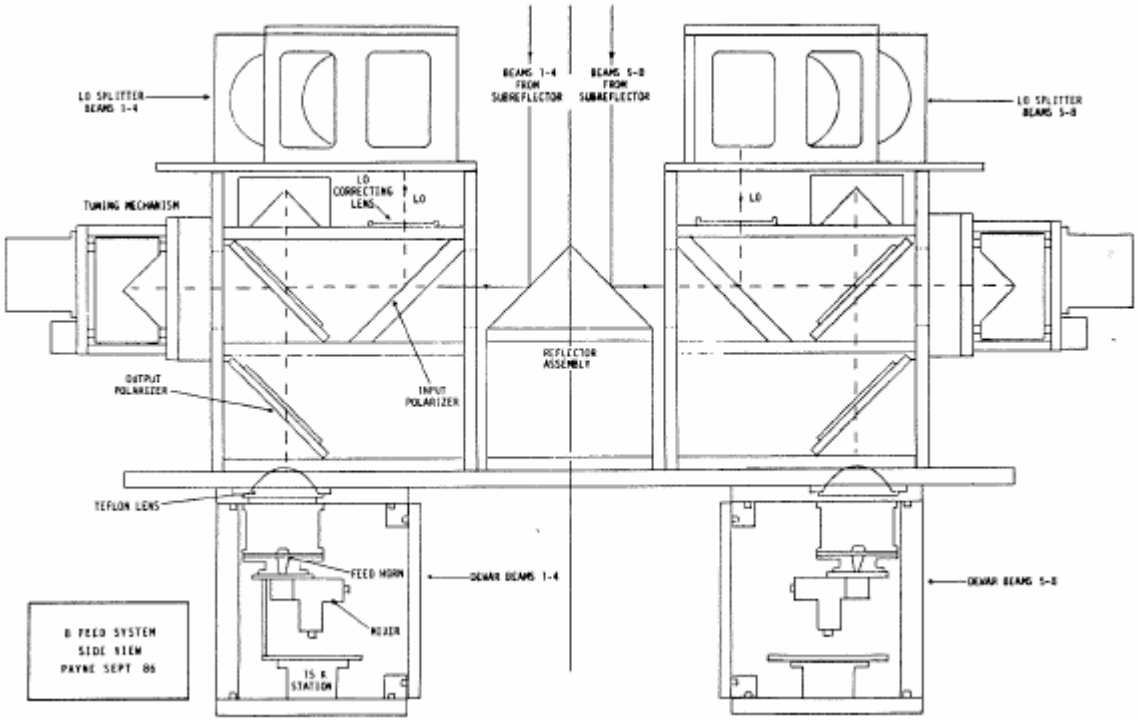
1mm Receiver Optics



The 230 GHz 8-Beam Receiver
John Payne's Optics Sketch



The 230 GHz 8-Beam Receiver



Schottky mixer optics

Completed in 1988

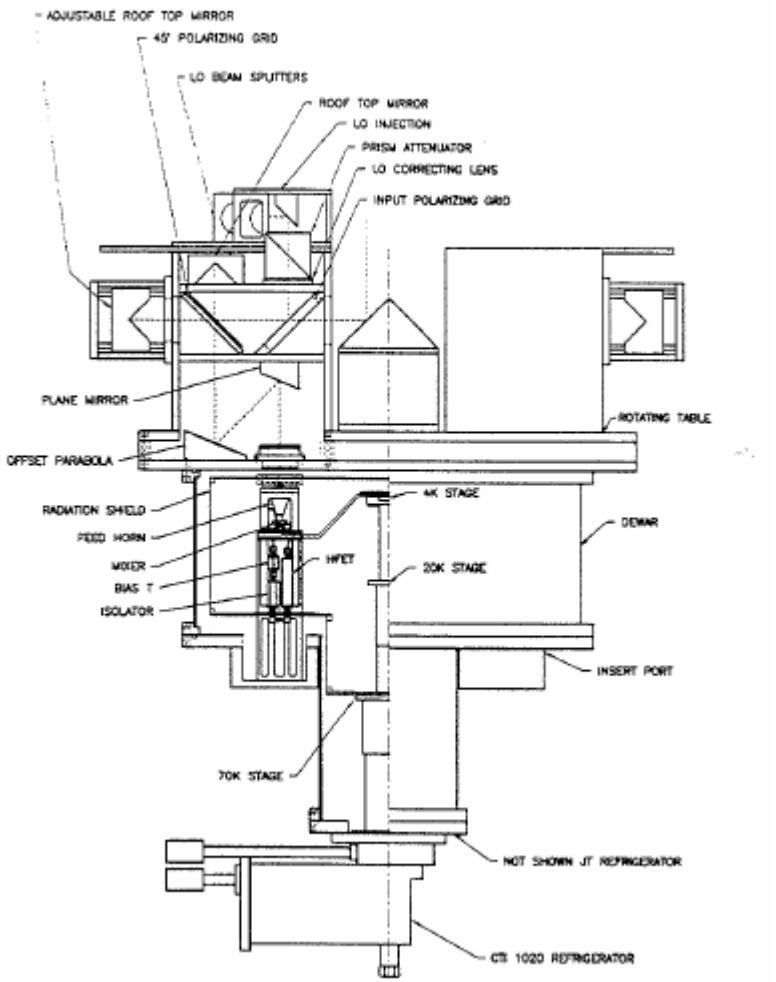
Mapping of extended sources.

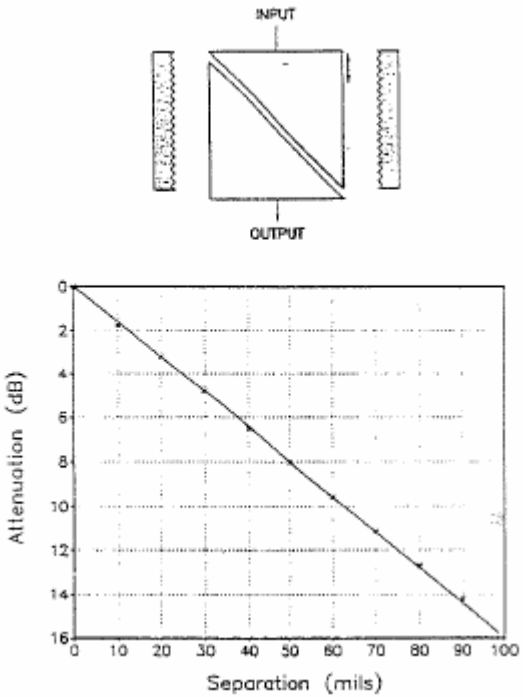
Beam array can be rotated about its center to track parallactic angle.

Fitted with SIS mixers in 1994.

Adjustable LOs by using double prism attenuators for each channel.

The 230 GHz 8-Beam Receiver Upgrade





Kitt Peak

John,

Thank you for showing us the way…