MMA Project Book, Chapter 5 Section 1

Evaluation Receivers

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1998-11-18: Major revision

Summary

The receiver development plan consists of two distinct efforts. One will result in a receiver suitable for the evaluation of the first antenna. A copy of this receiver will be constructed at the end of the D&D phase permitting the first interferometry tests to proceed on delivery of the second antenna. These receivers are designed to be "throw-away" items, although many of the components and techniques developed will be used in the final receivers for the MMA. These initial receivers are referred to as "evaluation receivers" in this Chapter. The specifications for these receivers are given in Table 5.1 and the principal milestones in Table 5.2.

The second effort will be to develop plans and some prototype components for the final receivers that will enable the construction of the receivers to proceed in a timely manner at the end of the D&D phase. Here these receivers are referred to as the "production receivers."

Table 5.1 Specifications for The Evaluation Receivers.

Frequency Band	Detector Element
30-40 GHz	HFET amplifier
86-115 GHz	SIS mixer
86-115 GHz	HFET amplifier
210-270 GHz	SIS mixer
All bands are dual linear polarization.	

Table 5.2 Principal Milestones for Evaluation Receivers during D&D Phase.

Task	Date
Optics decision	January 1999
4k refrigerator selection	January 1999
Dewar design complete	March 1999
All components delivered	November 1999
Receiver assembly complete	May 2000
Receiver tests complete	July 2000
Deliver receiver to VLA site	June 2001

5.1 Evaluation Receivers

5.1.1 Introduction

The receivers designed for the evaluation of the first antenna and the initial interferometer tests will be independent of the receivers that will finally be mass-produced for the MMA. Some components will be similar or identical and efforts will be made to design the receivers in such a way that some parts of the design will be transferable to the production receivers. However the focus of the effort will be to produce in a timely manner a receiver system that is suitable for the initial tests. This will involve the use of many components identical to those used on the present 12m receivers.

5.1.2 Specifications

The evaluation receivers will be equipped with three frequency bands. These are 30-40 GHz, 86-115 GHz and 210-270 GHz. The I.F. will be 4-6 GHz. All receivers will be dual channel receiving orthogonal linear polarizations. The noise performance of the receivers will be the best that can be obtained with today's components and will be more than adequate for the initial measurements. An important point is that continuum measurements will be needed to measure aperture efficiency at the various frequencies. Beam switching with the nutating sub-reflector will be used and, due to the mechanical nature of the switching mechanism, it is necessary for the detected output of the receivers to have a power spectrum that is flat down to a few Hz. There seems to be some doubt that the high frequency HFET amplifiers will satisfy this requirement and this is discussed in more detail below.

5.1.3 The Receiver Dewar

The layout of the dewar will follow that shown in Figure 1, which may be regarded as a baseline design. This layout follows the ideas that are used in the present Tucson receivers with the exception that the change in frequency bands is achieved by simply changing the pointing of the antenna rather than rotating external optics. This system results in errors due to off-axis operation (see MMA Memo 175), but these errors, coma, etc., are shown to be negligible.

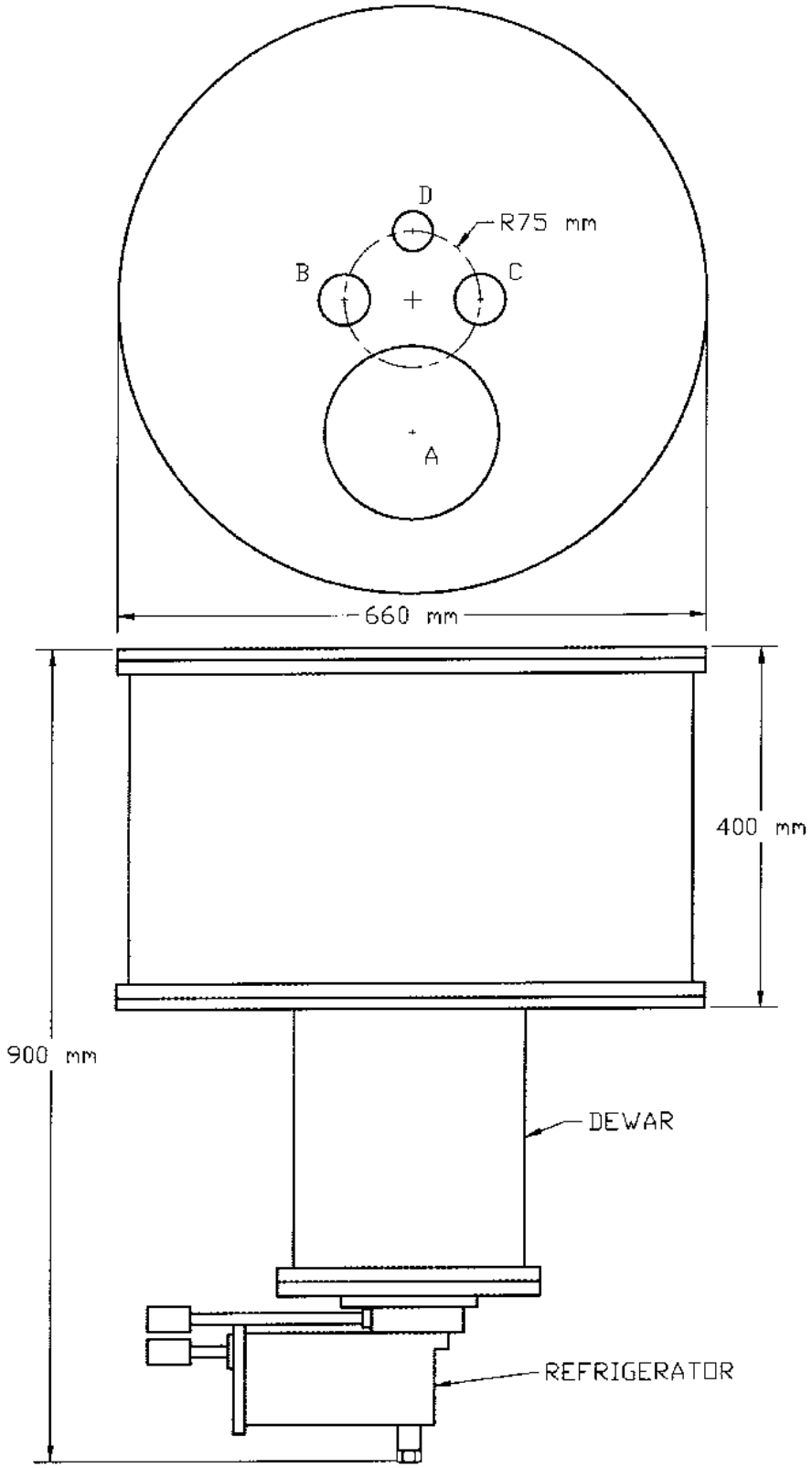
D
R75 mm
B
C
A
660 mm
400 mm
900 mm
DEWAR
REFRIGERATOR

Figure 1. The Evaluatiion Receiver Dewar

A decision is pending on the 4K cryogenic system that will be used on the evaluation receivers.

5.1.4 The Receiver Optics

For the evaluation receiver, we plan a simple optical arrangement with "clean" optics that follow the suggestions in MMA Memo #215 .

5.1.5 Polarization Diplexing

In the past, the NRAO receivers have used room temperature wire grid polarization diplexers. Recently, a full waveguide band diplexer (ortho mode transducer, OMT) has been developed for the 3 mm band and it is hoped to extend this technique to the 1 mm band. This will result in lower receiver noise as the OMT will operate at cryogenic temperatures.

5.1.6 Evaluation Receiver Block Diagrams

5.1.6.1 Introduction

The block diagrams for the different receiver bands described here are tentative and may be modified extensively in the next few months.

5.1.6.2 The 30-40 GHz Receiver

The block diagram for this receiver is shown in Figure 2.

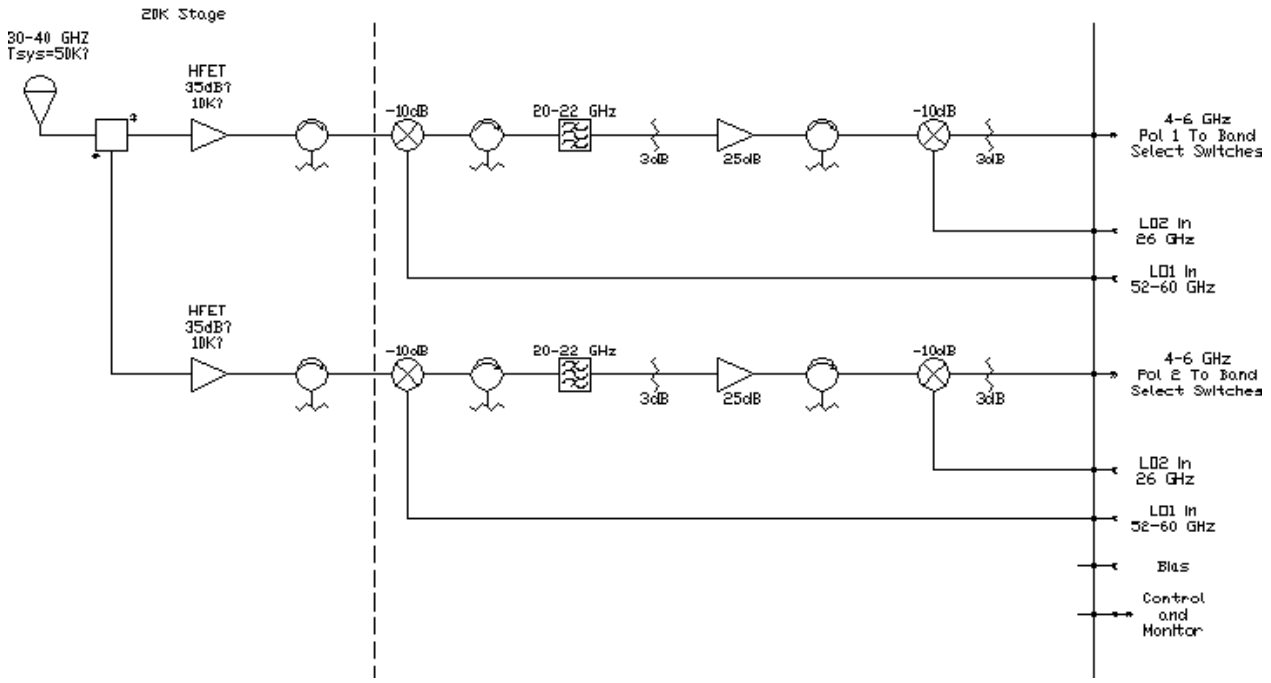

Figure 2. The 30-40 GHz Receiver.

5.1.6.3 The 86-115 GHz Receiver

There is uncertainty at present about the performance of the HFET amplifiers for use at this frequency. What is proposed here is that the evaluation receivers contain two receivers in this band : one , a dual polarization receiver using HFET amplifiers, the other a similar receiver using SIS mixers. In this way we hope to make an evaluation of the low frequency post detection noise that will be critical for continuum observations using the nutating sub-reflector. Although it should be possible to evaluate the receiver performance in the laboratory prior to telescope observations it is felt that telescope observations will give the most unambiguous results. Block diagrams of both these receivers is shown in Figures 3 and 4. The SIS receiver will use the tuneable mixers that are in use at the 12m telescope today.

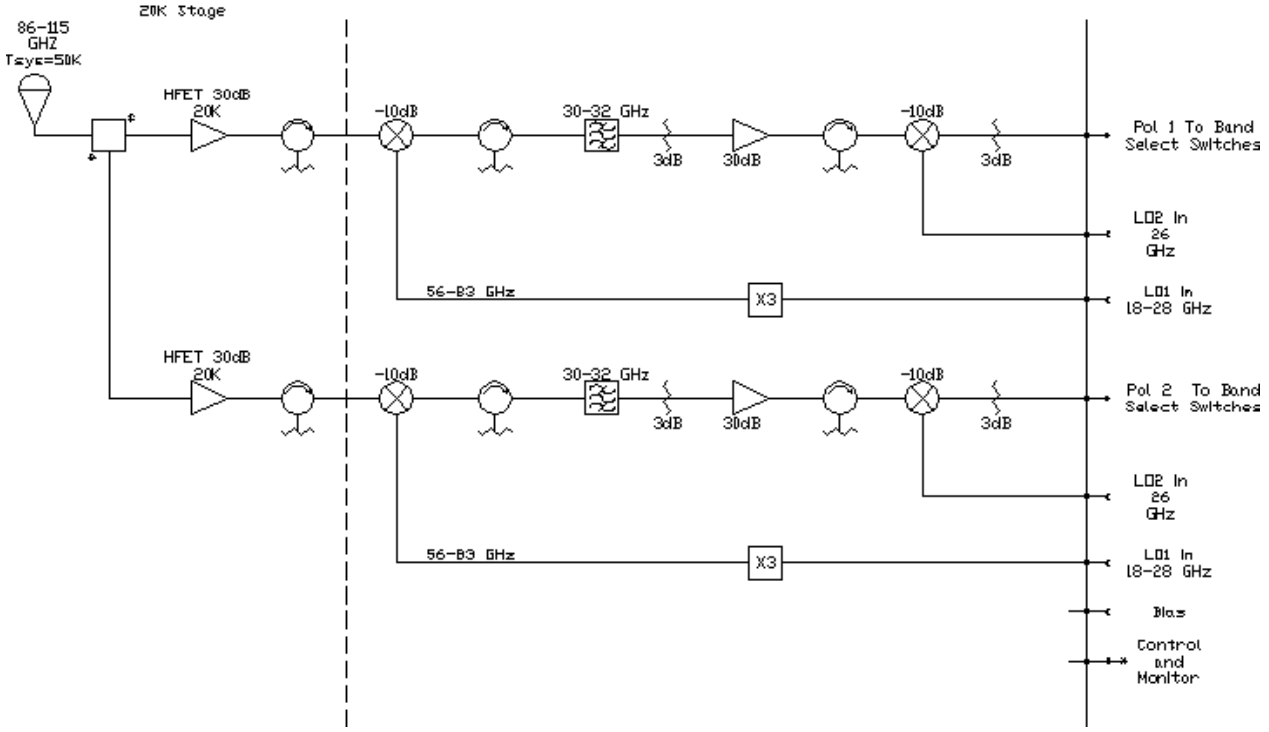

Figure 3. The 86-115 GHz HFET Receiver.

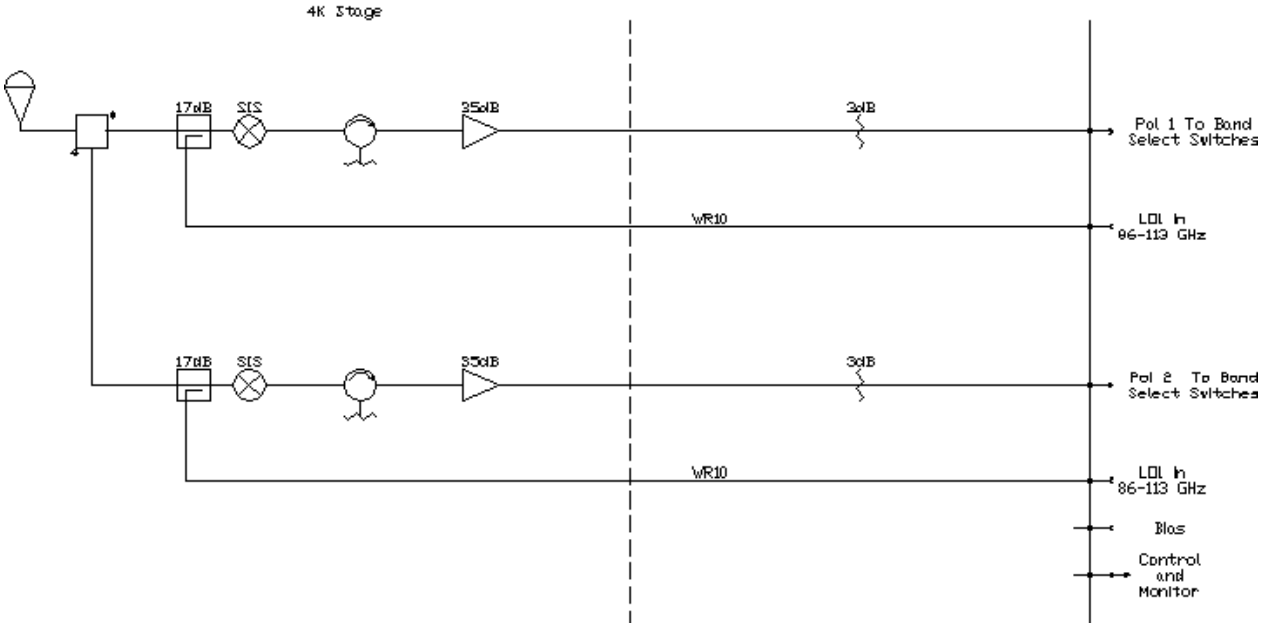

Figure 4. The 86-115 GHz SIS Receiver.

5.1.6.4 The 210-270 GHz Receiver

A block diagram of this receiver is shown in Figure 5. The components are all today's technology, although it is anticipated that a major effort will go into achieving phase stability. Again, the mixers used will be identical to the fixed backshort design used on the 12m telescope today.

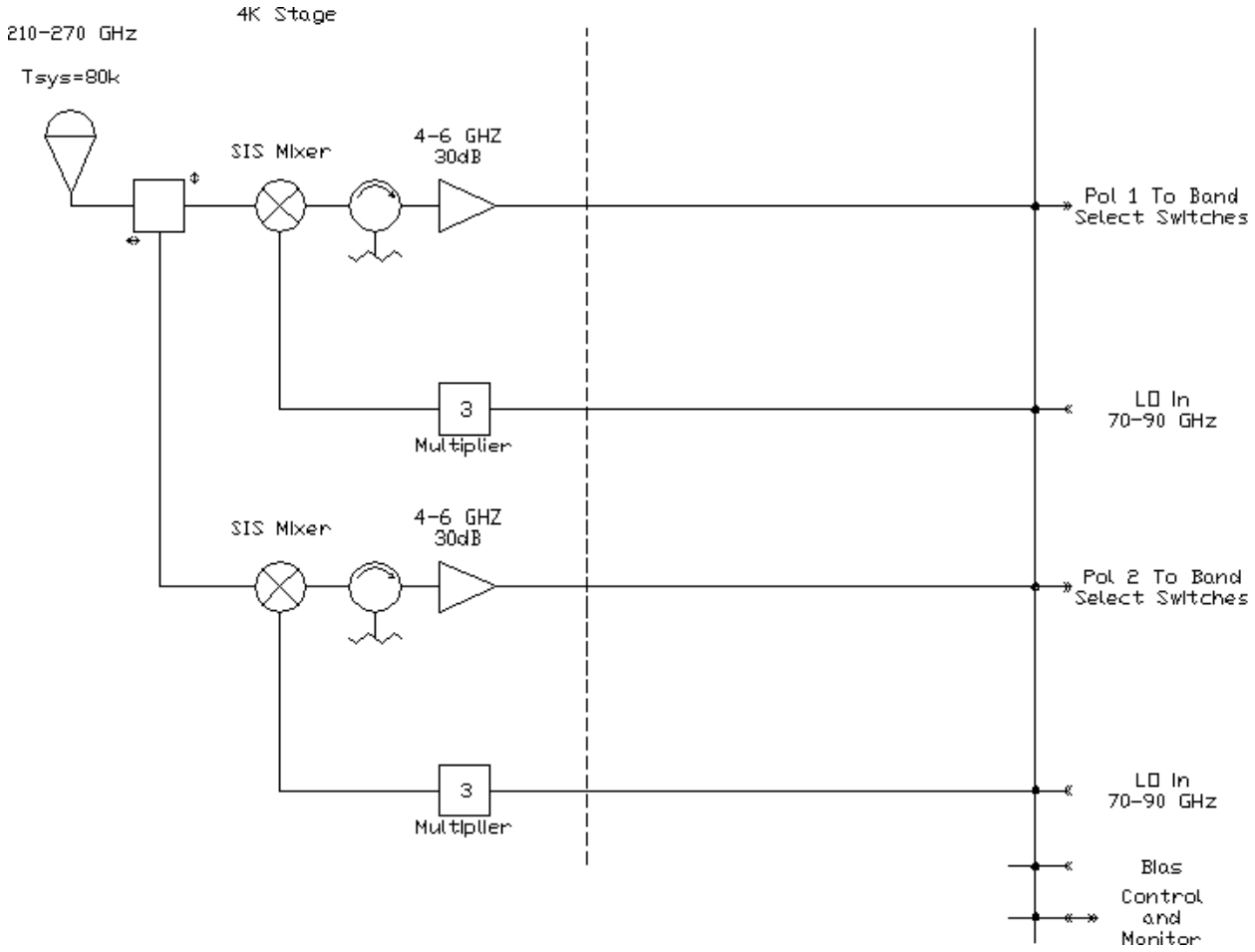

Figure 5. The 210-270 GHz Receiver.