

Jewell

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.

2.0 Details

2.1 Cryogenics

We have two complete and tested 4 K refrigerators. One is in the test dewar in Charlottesville; the other is in Green Bank. To power one refrigerator we need either one of the large, self-contained, 4 K compressors

(call this the JPL compressor) or two separate compressors: one for the 1020, the other for the J-T valve (call this the J-T compressor). For the tests in Green Bank on the test dewar, we used a conventional NRAO compressor for the 1020 and a J-T compressor. In Charlottesville, we have been using a JPL compressor. In Tucson we have two JPL compressors scrounged from the VLA.

We have parts in Green Bank for three J-T compressors, and parts are being fabricated for three more refrigerators. Jack is sending a 1020 refrigerator to Green Bank for the next refrigerator. On the telescope we plan to use a conventional compressor for the 1020 and a J-T compressor.

Fabrication of refrigerators and compressors will continue in Green Bank under the general supervision of Fred Crews.

## 2.2 Dewars

We have had one square test dewar in operation since November 1988. This dewar is suitable for testing the inserts for the 70-115 GHz receiver (and future inserts for 130-170 GHz) and also the rectangular dewar intended for the 230 GHz receiver. For the uninitiated, the insert is known as the "rocket" and the rectangular dewar as the "Lamb sandwich."

Two more square dewars have been fabricated; one is being outfitted in Green Bank and will be shipped to Tucson in the near future.

The large, circular, stainless steel dewar for use on the telescope with the 70-115 GHz inserts has been designed, and fabrication will begin shortly in Green Bank.

## 2.3 Inserts

One prototype insert for 70-115 GHz has been built. It is about 5" in diameter and about 14" long. It is a self-contained receiver consisting of a lens, horn, LO coupler, mixer, backshort drive and IF amplifier. The prototype works satisfactorily and four more, slightly modified versions, will be fabricated shortly. Over the next few months, we will be producing two 70-90 GHz inserts, two 90-115 GHz inserts and, when mixers are available, two for 130-170 GHz. Two backshort drives are needed for each insert and, at present, these are manually driven. For telescope use, these need to be servo controlled.

## 2.4 Optics

Sketches of the optics have been shown many times. The most difficult part to fabricate was the crossed-grid diplexer. This has been successfully fabricated by Garnett, and tests indicate that the performance is excellent. The offset parabola produced by James and Jeff works well, although a few final adjustments are needed.

The receiver optics assembly, a rotating table on top of the dewar, has been roughly designed but needs refining.

The antenna range in Green Bank is unsatisfactory for making measurements on millimeter feeds, and we must build a suitable facility in Tucson to support James' feed work.

### 3.0 Future Work

Attached is a table of parts to be made, together with the location of manufacture.

A schedule for the completion of the cryogenic/RF part of the receiver is pretty much dictated by machine shop time. I would hope that the schedule would look something like this:

JOB	PERSON	COMPLETION DATE
Radiation shield design	John	May 15
Optical assembly design	John	May 22
Modifications to insert design	John	May 15
Fabrication of refrigerator #3	Dave/Jack	July 1
Fabrication of compressor #2	Dave/Jack	July 1
Completion of main dewar	GB Shop	June 15
Completion of radiation shields	GB Shop	June 15
Refrigerator/dewar test	John	July 15
90-115 GHz inserts complete	CV Shop/Dan	July 15
70-90 GHz inserts complete	CV Shop/Dan	July 30
Mate inserts to dewar/RF tests	John/Pan/Tony	August 15
Mate optics to dewar and test	John/Pan/Tony	August 30

This schedule assumes lots of things that may not be true and it's intended to form a basis for discussion.

Inevitably, there will be travel involved - mainly from Tucson to Green Bank and Charlottesville. Details can be discussed on my return to Tucson at the beginning of May. Trips that I consider necessary are as follows:

- 1) Jack should spend two weeks in Green Bank building and testing the next 4 K refrigerator and one J-T compressor.

- 2) Jeff should spend one or two weeks in Green Bank installing the parabola and lens software on the N/C mill. Overlap with Jack's visit to assist Jack in the refrigerator and compressor fabrication is desirable.
- 3) Antonio should visit both Charlottesville and Green Bank.

Attachment

Addressee: N. Bailey  
M. Balister  
M. Barkley  
D. Boyd  
J. Cochran  
F. Crews  
D. Emerson  
R. Freund  
N. Horner  
P. Jewell  
F. Johnson  
A. R. Kerr  
J. Kingsley  
J. Lamb  
S-K. Pan  
A. Perfetto  
S. Srikanth  
G. Taylor  
P. Vanden Bout  
D. Webb

PARTS LIST FOR 70-115 GHz RECEIVER

PART	# REQ.	DESIGN	FABRICATION	NOTES
70-90 GHz lens	2	Sri/James	Tucson	Need by June 15
70-90 GHz horn	2	Done	Being made	
70-90 GHz coupler	2	Done	CV	
90-115 GHz coupler	2	Done	CV	New coupler to replace existing ones
70-115 GHz lens	2	Done	Tucson	
90-115 GHz horn	2	Done	Done	
70-90 GHz mixer	2	Done	Done	
90-115 GHz mixer	2	Done	Done	Debate about type
70-90 insert	2	John	CV Shop	Need by June 15
90-115 insert	2	John	CV Shop	Need by June 15
Backshort drives	6	Done	CV Shop	Need by June 15
Backshort servos	6	John	CV Shop	
1.5 GHz amplifiers	4	Done	Kirk	Need by June 15
Isolator	4	-	-	Do we have them?
LO waveguide windows	4	Done	CV Shop	Need by June 15
70-90 IR filter	2	Nancy	CV Shop (TUC ?)	Need by June 15
90-115 IR filter	2	Nancy	CV Shop (TUC ?)	Need by June 15
Filter holder	8	Done	CV Shop	Need by June 15
Optical select assy.	1	John	GB Shop	Need by July 15
Parabolas	2	James/Jeff	Tucson (GB ?)	
Crossed-grid polarizer	1	Done	Done	
Main dewar	1	Done	GB Shop	Need by June 1
Radiation shields	1	John	GB Shop	
Input windows	8	Done	GB Shop/Dan	Use Highload 60
Receiver frame	1	Jeff	Tucson	
Circuitry, telescope integration, systems work	-	Antonio/ James/Jack	Tucson	
Cryogenic instrumentation	-	James	Tucson	
Bias-T	6	Done	CV	
Input polarizer	4	John	CV	
Cold load	4	Tony	CV	