OVLBI EARTH STATION PROJECT

REQUIREMENTS FOR FEEDS AND OPTICS ON THE 45FT ANTENNA IN GREEN BANK

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1.0 Frequency Coverage

It is necessary to feed the antenna so as to put coincident beams on the sky at any combination of frequencies in the Space Research allocations between 7 GHz and 18 GHz. These allocations are:

Frequencies	Direction	Space Research Allocation
7.190 - 7.235 GHz	uplink only	primary
8.450 - 8.500	downlink only	primary
13.400 -15.350	both directions	secondary

The situation in the 12 to 15.5 GHz region is a bit complicated, as is illustrated in Figure 1. Excerpts from the Radio Regulations are shown in Figure 2.

It will be necessary to use circular polarization in each band. For convenience, we would like to have both senses of polarization available at all frequencies, but in fact we will only use one in each subband; preliminary selection of the polarization sense is LCP for all downlinks and RCP for all uplinks.

Although we want coverage of all the allocated frequencies to allow for future work, the specific missions for which support is funded will use the following, which therefore have the highest priority for good performance:

7.200 GHz:	Radioastron CW uplink, LCP.
8.472 GHz:	Radioastron CW downlink, RCP.
13.400 GHz:	VSOP CW uplink (preliminary), polarization TBD.
15.050 GHz:	VSOP data downlink, pol TBD, 150 MHz bandwidth.
15.063 GHz:	Radioastron data downlink, RCP, 150 MHz.

2.0 Optical Constraints

The antenna can support either prime focus or cassegrain optics. The basic optical dimensions are:

Primary diameter	D	540 in (13.7 m)	
Focal length	f	200 in (5.08 m)	[f/D=0.37]
Clear access at vertex		16 in (0.81 m) radius	
Inner panels stop at		24 in (1.22 m) radius	
Blockage from focal package		54 in (1.37 m) radius	

In principle, a subreflector up to 1.37 m radius (108 inch diameter) could be installed, but it would be heavy and expensive. A diameter of 1.0 m is 25 wavelengths at the lowest supported frequency, so we will assume this subreflector size for any cassegrain design.

A prime focus design is slightly preferred because the antenna already has good access to the prime focus, along with most of the required cabling. But a cassegrain design will be selected if there is a significant performance advantage. Both types should be studied.

3.0 Performance Required

The highest priority of the design is to maximize the receiving sensitivity (gain-to-system temperature ratio) at 15 GHz. Cryogenically cooled receivers will be used, and as much as possible of the input circuit will be cooled (including at least the polarizer). A receiver temperature of about 20 K is expected at this frequency. Operation at elevations from 5 deg to 90 deg is planned, and it can be assumed that the sky temperature is 5 K at 90 deg and 50 K at 5 deg, for a system temperature less spillover of 25 to 70 K.

For receiving at 8.5 GHz, a separate cryogenically cooled receiver will be used, but the spacecraft signals are expected to be strong (see OVLBI-ES No. 2), so some compromise of efficiency is allowable.

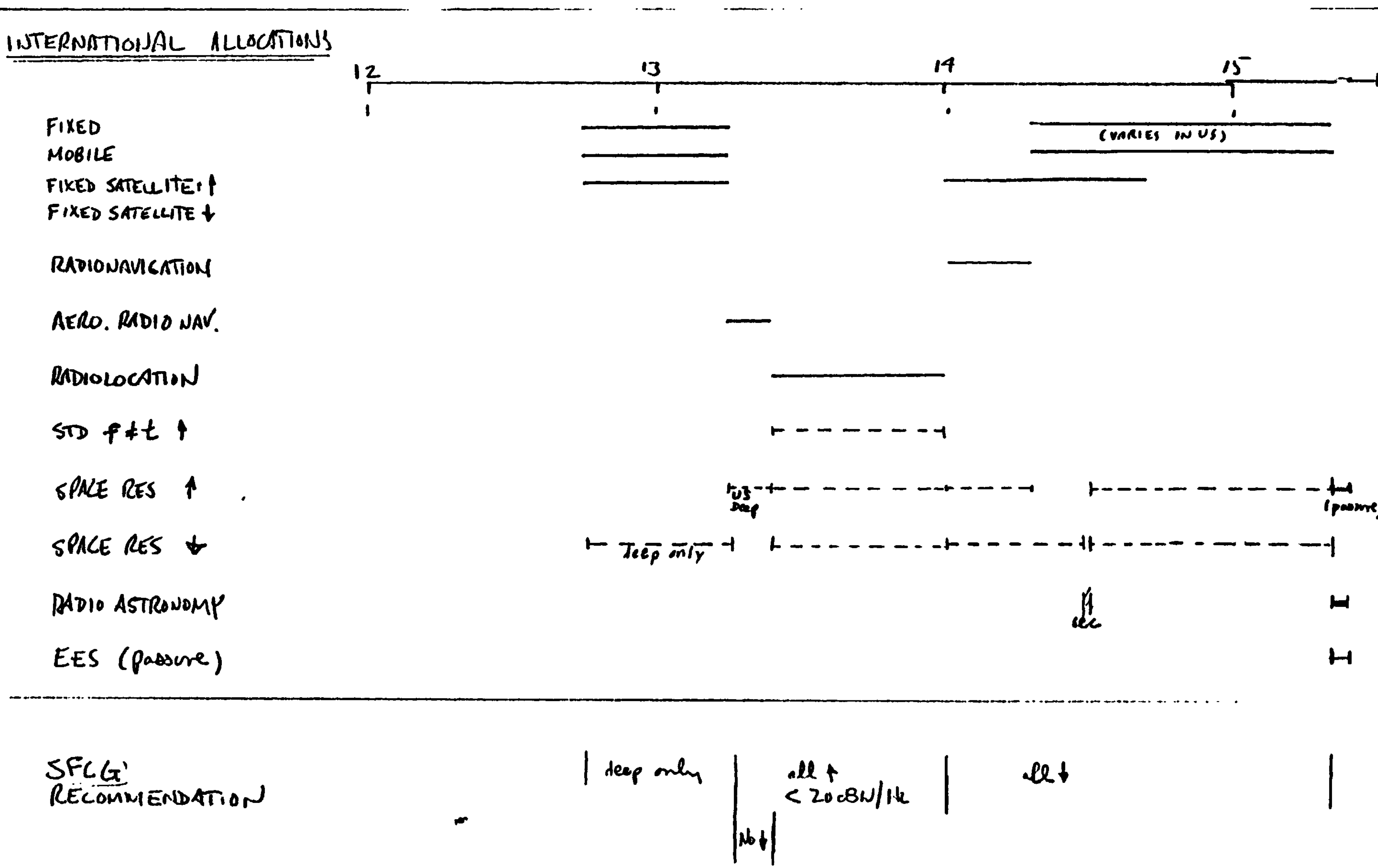
For transmitting at 7.2 GHz and 13.4 GHz, gain should be maximized and spillover is unimportant. But performance can be compromised in favor of 15 GHz sensitivity.

At each frequency, polarization loss must be held to 0.5 dB mzximum, with a goal of 0.2 dB.

The feed system must provide a minimum of four I/O ports:

Port	Polarization	Optimized at
7-8 GHz uplink input	LCP	7.20 GHz
7-8 GHz downlink output	RCP	8.47
13-15 GHz uplink input	LCP	13.4
13-15 GHz downlink output	RCP	15.05

Isolation between any two ports must be 15 dB minimum, perferably more than 20 dB, at least at the optimized frequencies, and preferably across the bands.



INTERNATIONAL ALLOCATIONS
12
13
14
15
FIXED
MOBILE
FIXED SATELLITE ↑
FIXED SATELLITE ↓
(VARIES IN US)
RADIONAVIGATION
AERO. RADIO NAV.
RADIOLOCATION
STD f & t ↑
SPACE RES ↑
US Deep
(passive)
SPACE RES ↓
Deep only
RADIO ASTRONOMY
EES (passive)
SFCG RECOMMENDATION
deep only
No ↓
all ↑
< 20 dBW/Hz
all ↓

FIGURE 1

INTERNATIONAL			UNITED STATES				
Region 1 MHz	Region 2 MHz	Region 3 MHz	Band MHz 1	National Provisions 2	Government Allocation 3	Non-Government Allocation 4	Remarks 5
7075–7250	FIXED MOBILE		7075–7125	809		FIXED MOBILE NG118	
			7125–7190	US252 809	FIXED G116		
			7190–7235	809	FIXED SPACE RESEARCH (Earth-to-space)		
	809 810 811		7235–7250	809	FIXED		
8400–8500	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (Space-to-Earth) 816 817		8400–8450		FIXED SPACE RESEARCH (Space-to-Earth) (Deep Space Only)		
	818		8450–8500		FIXED SPACE RESEARCH (Space-to-Earth)	SPACE RESEARCH (Space-to-Earth)	
8500–8750	RADIOLOCATION 713 819 820		8500–9000	US53 US110 713	RADIOLOCATION	Radiolocation	See Part 7.18 of the NTIA Manual.
12.75–13.25	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Space Research (Deep Space) (Space-to-Earth)		12.75–13.25	US251		FIXED MOBILE FIXED-SATELLITE (Earth-to-space) NG53 NG104 NG118	
13.25–13.4	AERONAUTICAL RADIONAVIGATION 851 852 853		13.25–13.4	851	AERONAUTICAL RADIONAVIGATION Space Research (Earth-to-space)	AERONAUTICAL RADIONAVIGATION Space Research (Earth-to-space)	
13.4–14	RADIOLOCATION Standard Frequency and Time Signal-Satellite (Earth-to-space) Space Research 713 853 854 855		13.4–14.0	US110 713	RADIOLOCATION Space Research Standard Frequency and Time Signal-Satellite (Earth-to-space) G59	Radiolocation Space Research Standard Frequency and Time Signal-Satellite (Earth-to-space)	See Part 7.18 of the NTIA Manual.
12.75–13.25	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Space Research (Deep Space) (Space-to-Earth)		12.75–13.25	US251		FIXED MOBILE FIXED-SATELLITE (Earth-to-space) NG53 NG104 NG118	
13.25–13.4	AERONAUTICAL RADIONAVIGATION 851 852 853		13.25–13.4	851	AERONAUTICAL RADIONAVIGATION Space Research (Earth-to-space)	AERONAUTICAL RADIONAVIGATION Space Research (Earth-to-space)	
13.4–14	RADIOLOCATION Standard Frequency and Time Signal-Satellite (Earth-to-space) Space Research 713 853 854 855		13.4–14.0	US110 713	RADIOLOCATION Space Research Standard Frequency and Time Signal-Satellite (Earth-to-space) G59	Radiolocation Space Research Standard Frequency and Time Signal-Satellite (Earth-to-space)	See Part 7.18 of the NTIA Manual.
14.5–14.8	FIXED FIXED-SATELLITE (Earth-to-space) 863 MOBILE Space Research		14.5–14.7145		FIXED Mobile Space Research		
			14.7145–15.1365		Fixed MOBILE Space Research G119		
14.8–15.35	FIXED MOBILE Space Research 720		15.1365–15.35	US211 720	FIXED Mobile Space Research		
15.35–15.4	EARTH EXPLORATION-SATELLITE (Passive) RADIO ASTRONOMY SPACE RESEARCH (Passive) 864 865		15.35–15.4	US74 US246	RADIO ASTRONOMY EARTH EXPLORATION-SATELLITE (Passive) SPACE RESEARCH (Passive)	RADIO ASTRONOMY EARTH EXPLORATION-SATELLITE (Passive) SPACE RESEARCH (Passive)	

FIGURE 2