Interoffice

VLB ARRAY MEMO No. 556

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National Radio Astronomy Observatory
Socorro, New Mexico

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Subject: Choice of frequency range for VLBA Sband receiver

Because of the decision at the most recent VLBA Design Review to install Sband and Xband receivers on the Pie Town antenna, we are reviving the question of the frequency band to use for the Sband receiver.

Our preference is that the Sband frequency range should include 2655-2700 MHz which is allocated to radio astronomy (2690-2700 is a primary allocation). Our primary reasons are political and are related to our experiences in frequency coordination:

Radio astronomy is a small but highly visible telecommunications service. It has little direct political power when compared to other services such as the broadcast industry, the military, etc. Yet over the last thirty years radio astronomy has been able to obtain, even expand, very generous allocations in the radio spectrum for our use. Yet the understanding that has been so fruitful to radio astronomy is a fragile one. Radio astronomy faces serious threats to our existing allocations, especially from satellite-, aircraft-, even balloon-borne transmitters (including proposals for satellite-borne Lband RADARS!). Our supporters at the Committee on Radio Frequencies (CORF), the International Consultative Radio Committee (CCIR) of the International Telecommunications Union, and elsewhere need our support; one of their highest priorities is to protect radio astronomy from such transmitters in bands adjacent to allocations for radio astronomy as well as in shared allocations.

How do these considerations relate to the choice of Sband frequencies for the VLBA? Our competitors for the radio spectrum will see in the existing plans to use only 2150-2350 MHz on the VLBA that radio astronomers are deliberately ignoring the existing primary allocation for radio astronomy at 2690-2700 MHz and secondary allocation at 2655-2690 MHz to use frequencies not allocated for radio astronomy. 2655-2690 MHz is also allocated to broadcast satellites but qualitatively this does not differ from the space-to-earth and space-to-space allocations at 2200-2290 MHz; or so radio astronomers argue in trying to obtain protection from any satellite-borne transmitters. Such an action will seriously undermine our credibility as we ask for greater protection for radio astronomy.

Furthermore, we think the study of the spectral and polarization properties of radio sources are better served by using the bands allocated to radio astronomy. After all, the existing allocations at L-, S-, and Cband were chosen to provide the octave spacing deemed optimal for such studies.

We propose that the frequency range of the Sband receiver on the VLBA be expanded to cover 2200-2700 MHz to include both the deep-space and radio-astronomy allocations. This would require using an Lband-type polarizer costing $2-3000 and adding about 2K to the system temperature. Initially, we would be satisfied with a receiver optimized for 2300 MHz as long as the performance at 2700 MHz was reasonable (specifications now are for 16K receiver temperature and 33K system temperature at 2300 MHz; we would be satisfied with 48K receiver temperature and 65K system temperature at 2700 MHz); the long-term goal should be to improve this.

We are also not convinced that switching from the deep-space to the radio-astonomy allocation would be that much of a hardship on the geodecists. We should ask them for a census of their stations, including characteristics of the Sband receiver (cooled or uncooled, frequency range, frequency of use, etc.), and for an evaluation of the costs of this modification.

Appendices A and B include relevant documentation from the Recommendations and Reports of the CCIR, 1982, and Appendix C, the frequency allocations in Sband.

APPENDIX A

The following excerpts from Report 852, Characteristics of the Radioastronomy Service and Preferred Frequency Bands, of the International Radio Consultative Committee (CCIR) of the International Telecommunication Union, summarize the status of allocations for radio astronomy:

Section 2.2 The bands made available to the radioastronomy service, in accordance with the Final Acts of the World Administrative Radio Conference, Geneva, 1979, represent a significant improvement over previous international allocations made to the service, and are a partial fulfilment of the requirements of the service. However, many of the allocated bands have insufficient bandwidths; they are in most cases shared with other services; many apply to limited areas of the world; and there are large intervals between some of the allocated bands. [Among the allocated bands considered important for continuum measurements are 2690-2700 MHz and 2655-2690 MHz.]

Section 4.2 Therefore, in the absence of interference, radioastronomers can profit from the widest bandwidth that can be used without degradation of receiver noise temperature... The nature of the protection accorded radioastronomy is not the same in each of these bands [for continuum observations] and in some cases would be considered inadequate to permit full use of the band by radioastronomers... In addition the bandwidths of the primary allocations at 2695 MHz and 4995 MHz are much too narrow.

APPENDIX B

To maintain and expand the protection for frequencies allocated to radio astronomy, the CCIR makes RECOMMENDATION 314-5, Protection for Frequencies Used for Radioastronomical Measurements:

THE CCIR, CONSIDERING

(b) that protection from interference on certain frequencies is essential to radioastronomy and the associated measurements;

(e) that, for other types [continuum] of radioastronomical observation, a certain number frequency bands are in use, the exact positions of which in the spectrum are not of critical importance, but of which the centre frequencies should be approximately in the ratio of two to one;

(k) that harmful interference to radioastronomy can be caused by terrestrial transmissions reflected by the Moon, by aircraft, and possibly by artificial satellites;

(l) that some transmissions from spacecraft introduce problems of interference to radioastronomy and that these cannot be avoided by choice of site for an observatory or by local protection;

(p) that the World Administrative Radio Conference, Geneva, 1979, made improved allocations for radiosastronomy, but that protection in many bands, particularly below 20 GHz, will need careful planning of other radio services,

UNANIMOUSLY RECOMMENDS

1. that radioastronomers should be encouraged to choose sites as free as possible from interference;

2. that administrations should afford all practicable protection to the frequencies used by radioastronomers in their own and neighboring countries;

3. that particular attention should be given to securing adequate protection for the frequency bands listed in Table I, which contain observed Doppler shifted frequencies of the most important spectral lines selected at the General Assembly of the International Astronomical Union (IAU), 1979;

5. that consideration be given to securing improvement in the international protection of the series of frequency bands above 10 MHz, now available to the radioastronomy service, in accordance with the Radio Regulations as amended by the World Administrative Radio Conference, Geneva, 1979;

6. that administrations, in seeking to afford protection to particular radioastronomical observations, should take all practical steps to reduce to the absolute minimum amplitude, harmonic radiations and other spurious emissions falling within the band of the frequencies to be protected for radioastronomy, particularly those emissions from aircraft, spacecraft and balloons;

7. that it is very difficult for the radioastronomy service to share frequencies with any other service in which direct line-of-sight paths from the transmitters to the observatories are involved. Above about 40 MHz sharing may be practicable with services in which the transmitters are not in direct line-of-sight from the observatories, but coordination may be necessary, particularly if the transmitters are of high power.

APPENDIX C

The frequency allocations in the vicinity of Sband are

1990-2110 MHz	Fixed, Mobile
2110-2200 MHz	Fixed
2200-2290 MHz	Fixed (Line-of-sight)
	Mobile (Line-of-sight)
	Space research (Space-to-earth, space-to-space)
2290-2300 MHz	Space research (Space-to-earth, deep space only)
	Fixed
	Mobile (Except aeronautical mobile)
2300-2310 MHz	Radiolocation
2310-2390 MHz	Radiolocation
	Mobile
2390-2450 MHz	Radiolocation
2450-2500 MHz	Fixed
	Mobile
2500-2655 MHz	Broadcasting-satellite
	Fixed
2655-2690 MHz	Broadcasting-satellite
	Fixed
	Radio astronomy
2690-2700 MHz	RADIO ASTRONOMY
	Earth exploration-satellite (Passive)
	Space research (Passive)
2700-2900 MHz	Aeronautical radionavigation
	Meteorological aids
	Radiolocation

The frequency band of 2150-2350 MHz has been chosen for the VLBA for compatibility with existing geodetic stations, particularly the Deep Space Network. The broadcasting-satellite service does not expect to need the band 2655-2690 MHz for twenty years or so, and will add users at the low-frequency end first.

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