Operation of a Millimeter-wave Telescope

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I. Operational Constraints

The essence of a visitor-oriented telescope is reliable operation. The NRAO must be able to schedule a visitor's program months in advance with confidence that the instrumentation will operate well at that time. The fact that the instrumentation is not only close to the state-of-the-art but is continually changing brings additional challenge to the support staff.

Experience with the telescopes in Green Bank and with the 36-ft telescope in Tucson leads us to a number of guidelines. First, equipment should be redundant wherever possible. For an isolated site, this means simply 2 of everything; for a clustered site such as Green Bank, one device may serve as the spare for several telescopes. An important effect of maintaining spares in module form is that telescope operators can substitute the spare device, thereby deferring repairs to normal working hours and achieving efficient use of technical manpower.

Second, a new millimeter-wave telescope should be accompanied by a laboratory facility where most, if not all, of the instrumentation is built. The most effective repairs to observing equipment are done by the builders. The reason lies in the importance of quick and accurate diagnosis -- best done by the designer. The proximity of the designers to the actual telescope operation not only brings better service but also more trouble-free designs, because the engineers become aware of the operational environment in a first-hand way.

Third, there must also be good access to the telescope from the development laboratory. Redundancy cannot apply to front ends, nor can it apply to the interfaces between equipment and computer. Frequently, problems arise because the visiting astronomer must use equipment about which he has only a superficial understanding. Typically, an astronomical program may have been allotted 4 days; the loss of a night shortens the program by 12%, of a full day, 25%. The complexity of the equipment makes the stationing of a general purpose technician on the mountain a questionable asset. Therefore, support personnel must be able to get to the telescope any time of the day or night. Moreover, experience shows that maintenance on domes, telescope, and other facilities closely associated with the astronomical activity is a continual thing, such that mechanics must be at the site on a daily basis. Experience at Tucson shows that personnel are willing to tolerate a 1.5 hour drive but not much longer.

Fourth, scheduling should be done at each site, thereby requiring that a management individual with an astronomical background be located at each site. To anticipate visitor programs, the engineers usually need some interpretation of the astronomical objectives, and the astronomers need some guidance concerning the limitations of the instrumentation. This coordination between engineers and astronomers is best done by an NRAO astronomer-manager, who is not only knowledgeable in both areas, but has the authority to commit telescope time and technical support to the visiting astronomers.

Fifth, purchasing should be conducted at each site. Close contact between the builders and the purchasing agent is essential to acquire the highly specialized components of telescope and receiver systems.

II. Physical Plant

The requirements for the physical plant depend upon the location of the telescope. We consider two possible situations: an isolated mountain installation like that at Tucson and a cluster situation like that at Green Bank.

The mountain installation requires a complex of buildings at the telescope and another, larger complex of buildings in a nearby town. The mountain installation, for sites considered in this proposal, involves travel time to and from the site of 3 hours/day or greater. It is not cost-effective to require all employees to work at the mountain location, simply because 38% or more of the work force would be spent in travel. Furthermore, the high altitude sites would require pressuration of a large building, including offices, libraries, and the substantial laboratory areas. The work force divides naturally into those required for mountain operation such as telescope operators, mechanics, and maintenance personnel, and a "downtown" group consisting of the astronomer-manager, the resident engineers and technicians, business, accounting and clerical personnel. But, because of the equipment complexity, substantial laboratory space is also required on the mountain, which the technical people use when they're required at the telescope.

The mountain buildings should include the telescope, moderate-sized laboratory space, a mechanical shop, storage space, dining facilities, and dormitories. Except for storage, all space should be pressurized if the site lies above 10,000 ft or so. Downtown buildings should include offices, laboratory space adequate for major development, machine shop, library, a meeting room, and a lunch room.

The cluster installation requires less space because it is possible to share facilities with other telescopes. If the main laboratory lies within 5

minutes of the telescope, nearly all repairs and receiver preparation can be done in a central location. Dining facilities and dormitories can be shared. Only one astronomer-manager is required for the entire cluster.

III. Personnel

Although it is difficult to anticipate the personnel levels necessary to support telescope operation, we can roughly extrapolate from the existing situation at the 36-ft telescope. Table 1 lists the manpower now at the 36-ft, and what will be needed for the mountain or cluster locations of the 25m. The fractional values indicate sharing with other telescopes.

IV. Operating Costs

These figures are scaled from operation cost at the 36-ft in 1974. Projections are only approximate.

Table 1

Estimated Support of mm-wave Telescopes

Position	36-ft	25-m Mountain	25-m Cluster
Astronomer-manager	1	1	1/2
Head, telescope operations	1	1	1/2
Telescope engineer	1	1	1
Telescope mechanic	1	2	2
Telescope operators	5	5	5
Programmer	1	1	1
Business manager	1	1	1/2
Bookkeeper/buyer	0	2	1
Administrative aide	1	1	1/2
Secretary	1	2	1
Head, Electronics	1	1	1
Electronic engineer	2	4	4
Technician	5	7	7
Cook	0	1	1/2
Housekeeper	0	1	1/2
General Maintenance men	0	2	1/2
Janitor	0	1	1/2
Machinist	0	1	1/2
Total	21	35	26
Estimated salary	$280K	$460K	$350K
Operation: services, supplies	$480K	$790K	$600K
Receiver development	$100K	$200K	$200K
Total (1974 dollars)	$860K	$1450K	$1150K

(These figures do not include the maintenance of access roads, etc.)