NATIONAL RADIO ASTRONOMY OBSERVATORY: LONG RANGE PLAN

The operation of the National Radio Astronomy Observatory (NRAO) as it exists today is assumed to go slightly above level funding with an annual inflation rate of 5%; see Table 1. This schedule does not allow for major improvement of the existing equipment. However, the ongoing projects, such as the development of additional computing capacity for the Very Large Array (VLA) (on an interim basis) and for the 12 meter telescope, the addition and improvement of receivers and other electronic components at the VLA, and the development of the spectrum processor at the 300 foot telescope, can be carried out, possibly on somewhat delayed schedules.

On a long-term basis, the computing needs of the VLA and, toward the end of the decade, of the then operating Very Long Baseline Array (VLBA) cannot be met by level funding. NRAO has developed first steps in projecting the anticipated data flow, weighted by frequency, type, and importance of specific scientific projects. It was concluded that a need for a 60 to 80 Mflop capability is realistic. An internal study of possible ways to accommodate this large amount of data handling is currently under way and will be submitted to an outside panel of computer experts. The problem has already attracted national attention. It is realized that technology moves very fast and that, as a consequence, a certain dilemma exists in that freezing a computer design into an inflexible architecture is as much to be avoided as waiting too long for cheaper and faster computer elements while data are acquired but not properly processed. With the growing awareness that this type of problem is comparable to the more "classical" one in theoretical work, where having all the elegant equations plus solving schemes ready, but not enough computer capability to do the actual calculations is the complaint. Thus, the planning summarized in Table 1 should be seen as part of the national computer discussions and initiatives across the various scientific fields.

Most of NRAO's effort in terms of new initiatives will go to the VLBA through the remainder of the decade. Funding is currently assumed to occur in four more or less equal installments in FYs 1985-1988. This leads to an antenna acquisition schedule of 1, 3, 3, 3, partial operation in 1987, and completion in 1990. A tentative budget is shown in Table 2; it should be recalled that the detailed costing is part of the design effort currently under way.

The outlined construction schedule requires the start of operations in CY 1986 and full operation in 1989. The figures quoted in Table 1 refer to this schedule.

Finally, NRAO will be engaged in the design and ultimately construction of a mm wave array. Studies of the directions of astronomy and astrophysics in the next decade have stressed the importance of high angular resolution, high sensitivity observations at millimeter wavelengths to a wide variety of problems. The outstanding requirement for future research in star formation and the evolution of galaxies is for images of the non-luminous

interstellar matter at millimeter wavelengths, in other galaxies as well as our own, with an angular resolution comparable to that now available in optical wavelength astronomy. This requirement broadly defines a telescope with an angular resolution of better than 1 arc-second, a collecting area of approximately 2,000 square meters, and an operating wavelength of 1 millimeter and longer. A millimeter-wavelength array has emerged as the consensus instrument to meet those specifications. Technical studies now underway at the NRAO will lead to the detailed design of the array. Current efforts are concentrated on defining the number, the size, and the configuration of the elements of the array, selecting a good site, and developing the electronics. The NRAO has convened a technical advisory committee, under the chairmanship of Robert W. Wilson of Bell Laboratories, to provide advice and guidance on the project from millimeter-wave scientists from outside of the NRAO.

Table 1

National Radio Astronomy Observatory
Long-Range Budget Projections - 1984-1989

Budget Estimate (millions)	1984	1985	1986	1987	1988	1989
I. OPERATIONS						
Existing Operations	$16.2	$17.0	$18.2	$19.4	$20.3	$21.3
New Operations (VLBA)	-	-	0.5	2.1	3.9	6.0
Total Operations	$16.2	$17.0	$18.7	$20.5	$24.2	$27.3
II. EQUIPMENT						
Research Equipment	$ 1.3	$ 1.1	$ 3.0	$ 3.6	$ 4.2	$ 4.7
Operating Equipment	0.2	0.2	0.2	0.2	0.2	0.2
Total Equipment	$ 1.5	$ 1.3	$ 3.2	$ 3.8	$ 4.4	$ 4.9
Subtotal - Operations and Equipment	$17.7	$18.3	$31.9	$24.3	$28.6	$32.2
		3.4%				
III. CONSTRUCTION & DESIGN						
Very Long Baseline Array	$ 2.5	$15.0	$16.3	$17.1	$17.9	-
VLA Building, Socorro	-	-	2.0	-	-	-
Building/Building Addition	-	-	2.0	-	-	-
Major Computer System	-	-	-	10.0	1.0	1.0
Millimeter-Wave Array	-	-	-	-	-	25.0
Space Radio Astronomy	-	-	-	-	-	5.0
Total Construction & Design	$ 2.5	$15.0	$20.3	$27.1	$23.9	$31.0
TOTAL PLAN	$20.2	$33.3	$42.2	$51.4	$52.5	$63.2

Table 2

VLBA BUDGET AND COST ESTIMATE

(1985$ Thousands)

	1984*	1985	1986	1987	1988	TOTAL
ANTENNA STARTS		1	3	3	3	10
ANTENNAS, BLDGS., PROJECT MANAGEMENT	1,260	7,450	11,150	8,200	9,500	37,560
ELECTRONICS	490	4,500	1,800	2,200	2,200	11,190
CONTROL, CORRELATOR, DATA PROCESSING	750	2,900	2,400	3,900	2,600	12,550
SYSTEMS ENGINEERING, SPARES, MISC.	0	150	150	1,200	1,200	2,700
TOTALS (85$)	2,500	15,000	15,500	15,500	15,500	64,000

The breakdown of the annual budgets is tentative. Detailed costing is a major objective of the design study* in FY 1984.