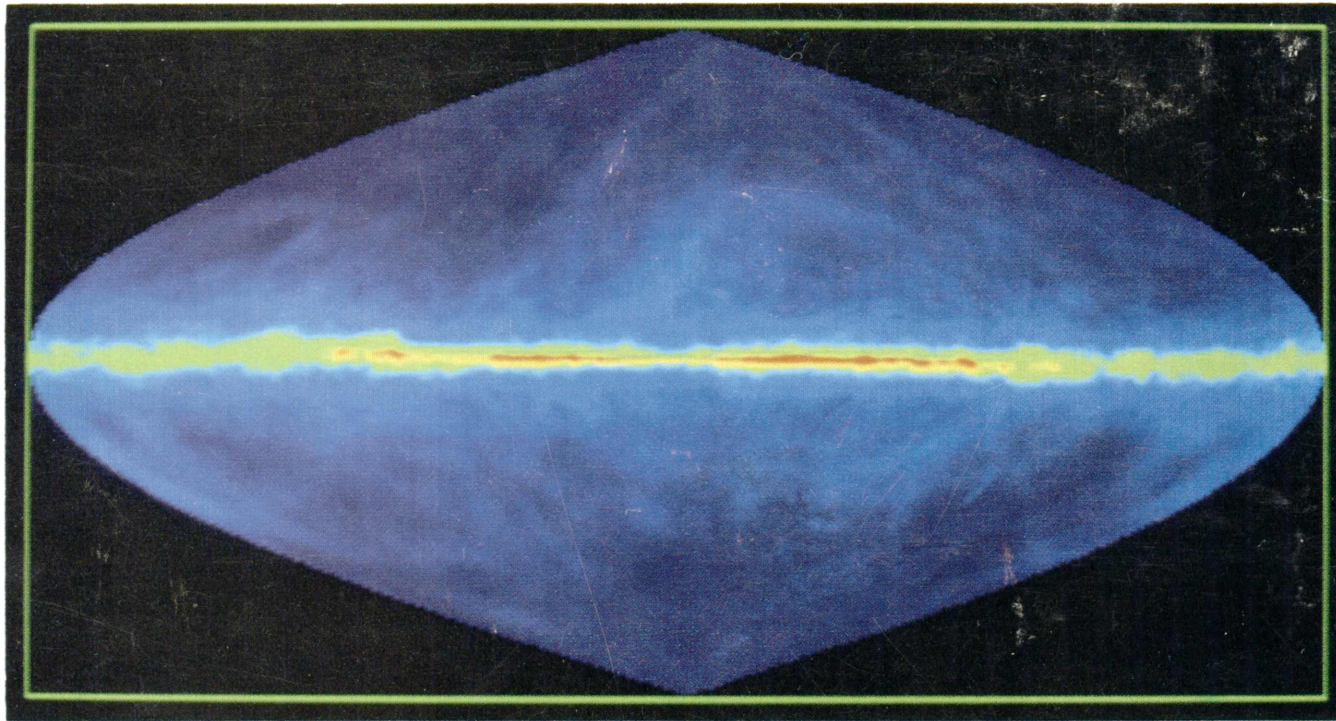


NATIONAL RADIO



ASTRONOMY OBSERVATORY

OBSERVING SUMMARY-1990 STATISTICS



February 1991

THE HYDROGEN SKY

This figure shows the amount of atomic hydrogen at all locations in the sky. All of this hydrogen is in our galaxy. Red indicates directions of high hydrogen density, blue and black show areas with little hydrogen. The figure is centered on the galactic center and galactic longitude increases to the left. The data came from measurements of the 21cm line of hydrogen by radio telescopes. Some of the hydrogen loops outline old supernova remnants.

This image is a composite from many 21cm surveys. It includes data from the NRAO Green bank, West Virginia 140-foot and 300-foot telescopes, the 85-foot Hat Creek Telescope of the University of California at Berkeley, The AT&T Bell-Labs Horn-Reflector Telescope at Holmdel, New Jersey and the 60-foot Telescope at the Parkes Radio Observatory in Australia.

NATIONAL RADIO ASTRONOMY OBSERVATORY

Observing Summary – 1990 Statistics



February 1991

SOME HIGHLIGHTS OF THE 1990 RESEARCH PROGRAM

- **The VLA has been used to make the first detailed measurements of velocities within a kiloparsec-scale radio jet. Velocities of features in the M87 jet were obtained by comparing 2 cm images made at five epochs between 1982 and 1989. The resolution of individual images is 0".1; the observed position changes are typically less than 0".01. The brightest feature in the jet is a sharp linear ridge running across the jet about 12" from the nucleus of the galaxy. This feature appears to move away from the nucleus at 48 ± 2 percent of the speed of light (c), and also moves transverse to the jet axis at 16 ± 3 percent of c . The net velocity is nearly perpendicular to the linear ridge, suggesting a wave-like behavior for this feature. Other features in the jet between 3" and 16" from the nucleus show similar speeds, while a feature near the end of the jet (20" from nucleus) appears nearly stationary.**
- **The 12-meter telescope participated in an international millimeter-wave VLBI experiment at wavelengths of 3 and 1 mm, and 6 cm, and included Hat Creek, Owens Valley, Onsala, Nobeyama, and SEST millimeter-wave observatories. The project included observations of a number of quasars with the goal of studying jet components in their early stages of development. The new 1.2 mm SIS receiver was used at the 12-meter. Observations were successful.**
- **The first clear VLA detection of gyroresonance emission in the solar corona has been made at 15 GHz, implying that field strengths in the corona can exceed 1800 gauss as deduced from the spectrum of active region emission over the penumbra of a large symmetric sunspot. The flux from the gyroresonance source is a significant fraction of the total flux from the active region. The imaging capabilities of the VLA demonstrate the inhomogeneity of the corona above sunspots and show that the strongest coronal fields apparently do not lie over the strongest photospheric fields. The presence of localized compact flux tubes in the coronal regions above active regions is suspected.**
- **The highest pulsar timing accuracy ever achieved at any telescope was accomplished at the 140-foot telescope on PSR 1937+21, the rms accuracy over a five-day interval being ± 130 nanoseconds. After a set of pulsars has been monitored at several epochs to this accuracy, both solar system ephemerides will be improved and limits to the gravitational radiation remaining from the early universe will be lowered. The eclipsing millisecond binary pulsar 1744-24A has been detected at 800, 1330, and 1660 MHz, showing that the pulsar is eclipsed behind an 0.1 solar mass companion for about half the 109-minute orbit, and that the companion's eclipsing region is much larger than its Roche lobe. Anomalous disappearances of the pulsed signal occur up to several hours, suggesting that there is excess material in the vicinity of the binary system.**

- **The 12-meter telescope has been used to probe planetary atmospheres. CO absorption profiles at high spectral resolution have revealed 20-30 m/s wind velocities in the high (~100 km) Venus atmosphere. Different depths in the atmosphere can be sampled. Atmospheric temperatures and mixing profiles are also being studied. The temperature state of Mars has been studied to a height of ~70 km. In addition to the warm, dusty state observed by planetary spacecraft probes, a clear, cold state has also been found. The atmospheric states may vary seasonally, or chaotically with the occurrence of storms.**
- **A qualitatively new view of the radio source population of the Milky Way has been provided by an extensive VLA survey of the galactic plane at 1400 MHz, in the longitude range 20 to 120 degrees. At the 85 percent completion level, 1991 sources have been detected to a limiting peak flux density of 20 mJy for sources smaller than 20". The dominant source populations are compact HII regions, young supernova remnants, planetary nebulae, and radio stars. The survey sensitivity is well matched to that of the IRAS all-sky survey in the far infrared.**
- **New observations of HI rotation curves at the VLA have uncovered two galaxies with significantly declining rotation curves between 1 and 3 optical radii. Snapshot D configuration VLA observations of NGC 3521 and NGC 2683 were obtained as part of a program to search for galaxies with extended HI envelopes in order to study their dark matter. The derived velocity decrease for both galaxies is large, about 25 percent of the maximum rotation velocity, and is present on both sides of each galaxy. In spite of the large velocity declines, however, most dark matter is still needed to explain the observed rotation velocities. Most other galaxies with flat or slightly rising rotation curves require even more dark matter. Preliminary indications are that declining rotation curves are a general feature of the brighter galaxies that have more compact light distributions, indicating that the potential wells in these systems are steeper than normal. Further rotation curve studies of compact bright galaxies are required, however, in order to confirm such systematic properties.**

OBSERVING HOURS

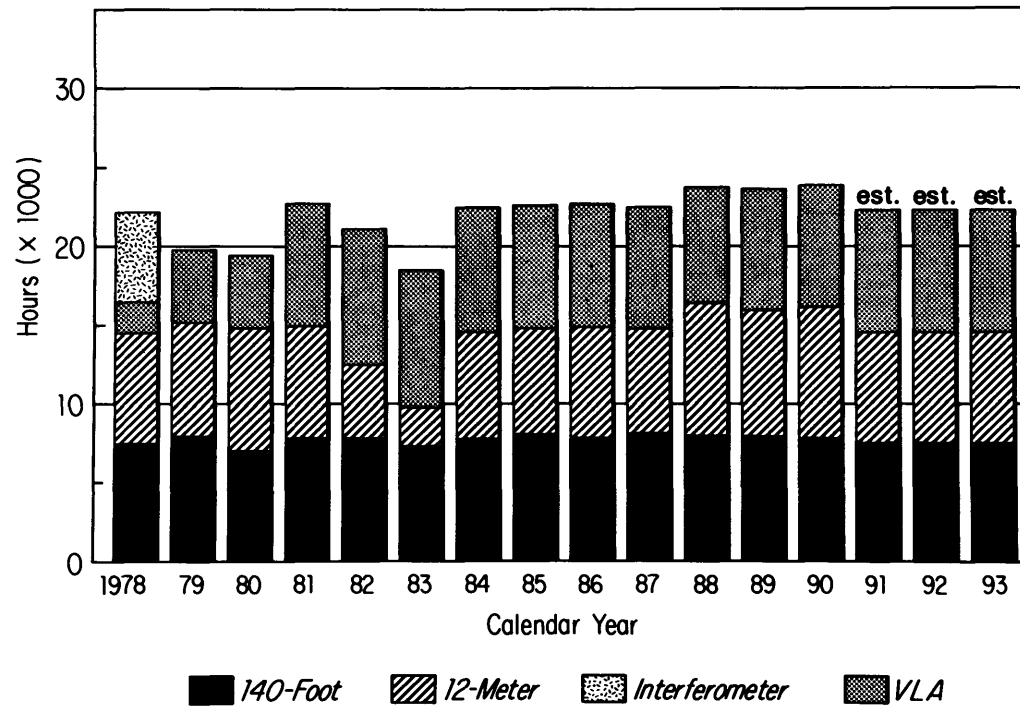


Fig. 1. This figure shows the hours scheduled for observing on each telescope during the last decade.

DISTRIBUTION OF SCHEDULED OBSERVING TIME

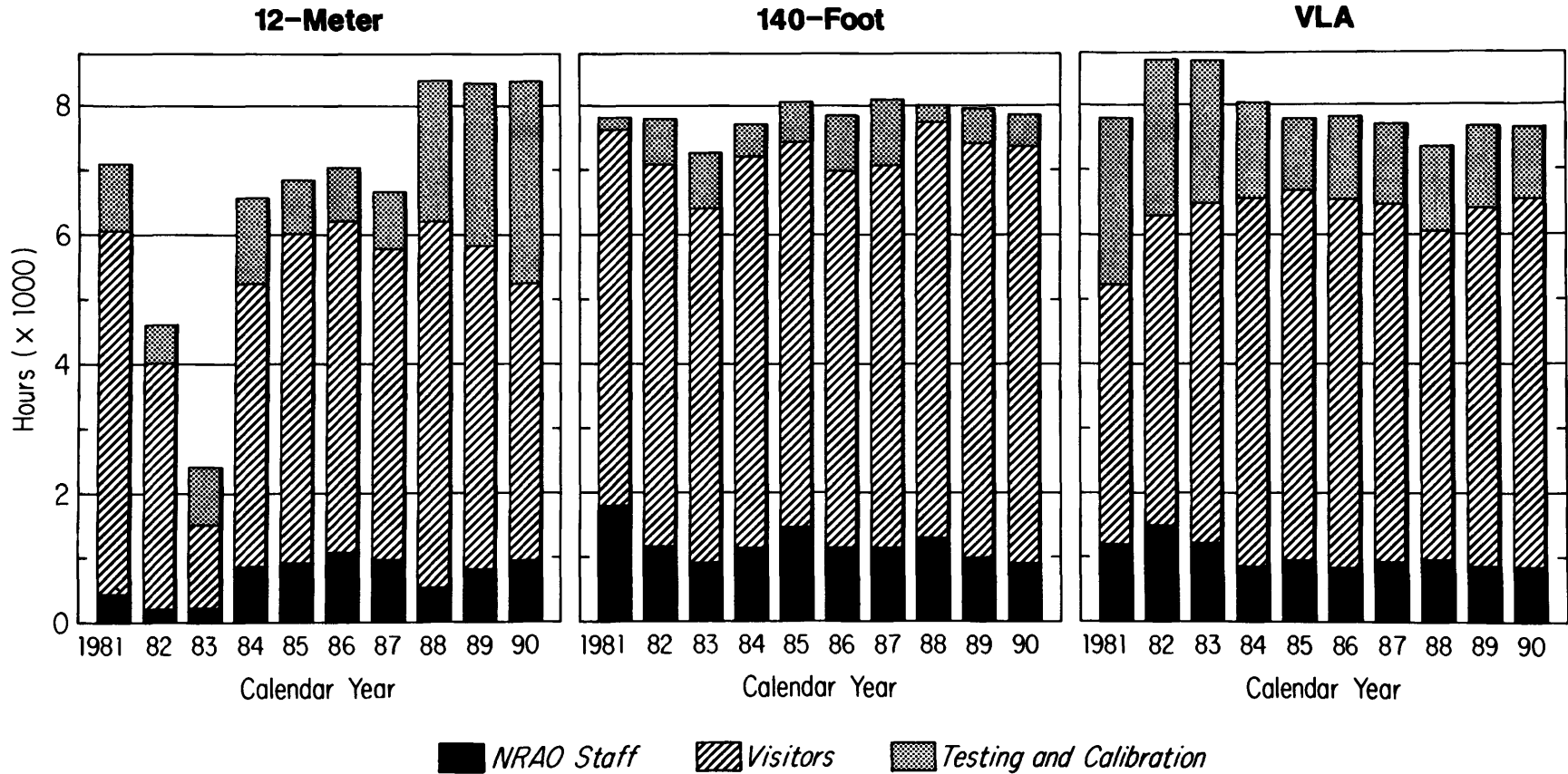


Fig. 2. These graphs show the number of hours scheduled for calibration and for observing by the NRAO staff and by visitors on each telescope system during the last decade.

12-METER RADIO TELESCOPE SUMMARY

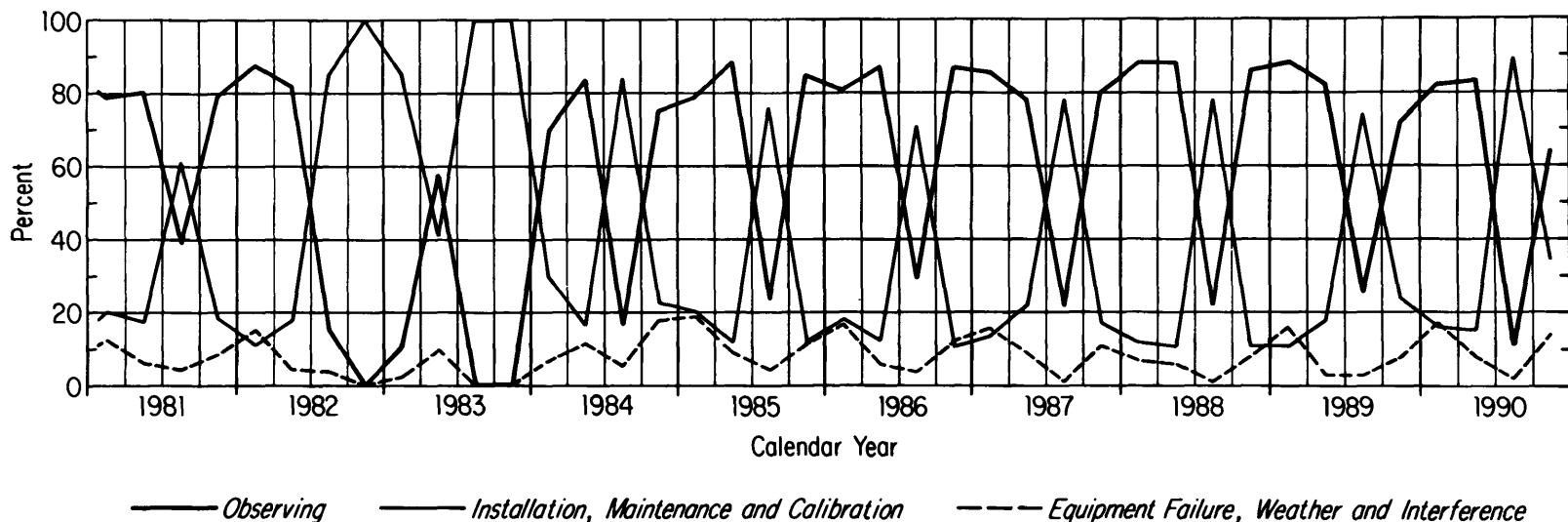


Fig. 3. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing; for routine calibration, maintenance, and installation of new experiments; and the percentage of time lost due to equipment failure, bad weather, and radio interference. The telescope is removed from service for a period of 4-6 weeks each summer during the wet season. This period is used for maintenance and upgrading of the instrument. During the last half of 1982 and most of 1983 the telescope was out of service for the replacement of the reflecting surface and its backup structure.

140-FOOT RADIO TELESCOPE SUMMARY

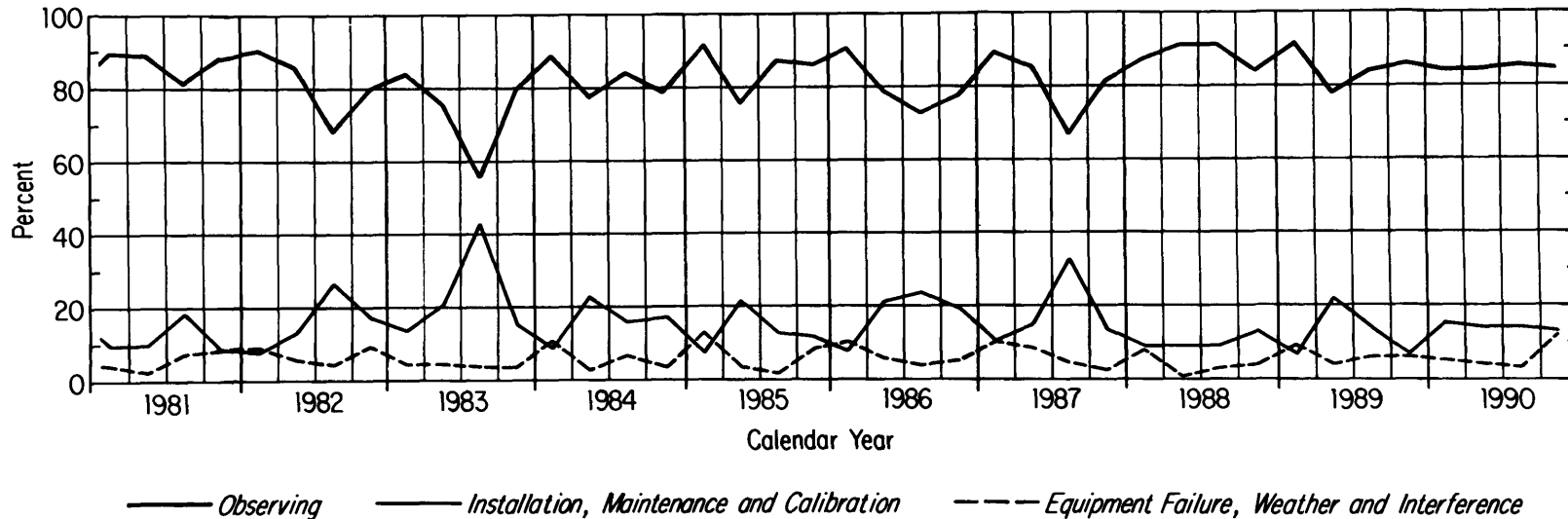


Fig. 4. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing; for routine calibration, maintenance, and installation of new experiments; and the percentage of time lost due to equipment failure, bad weather, and radio interference. Major improvements to the telescope system include: 1980 - installation of the Model IV autocorrelator receiver; 1982 - brake overhaul and installation of the second channel of the upconverter/maser receiver; 1987 - holographic surface tests and panel readjustments.

VERY LARGE ARRAY TELESCOPE SUMMARY

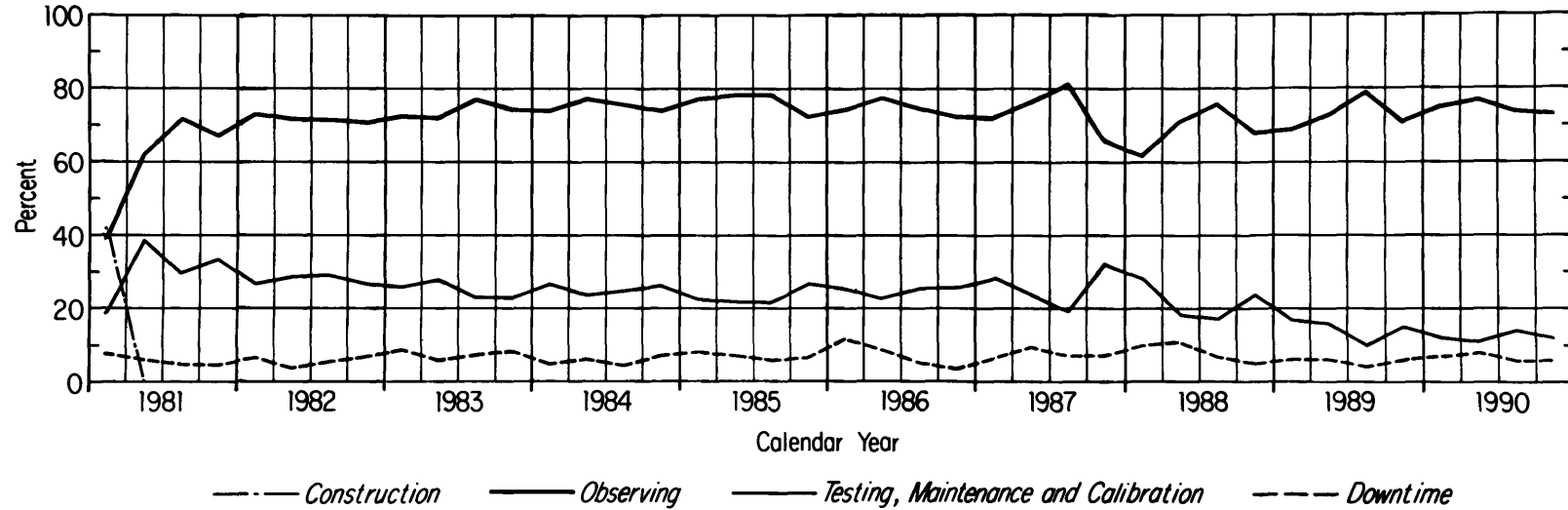


Fig. 5. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing; for routine system testing, maintenance, and calibration; and the percentage of time lost due to hardware or software failure, power failure, or bad weather. Time scheduled for completion of the construction was reduced to zero after the first quarter of 1981.

FULL-TIME PERMANENT EMPLOYEES

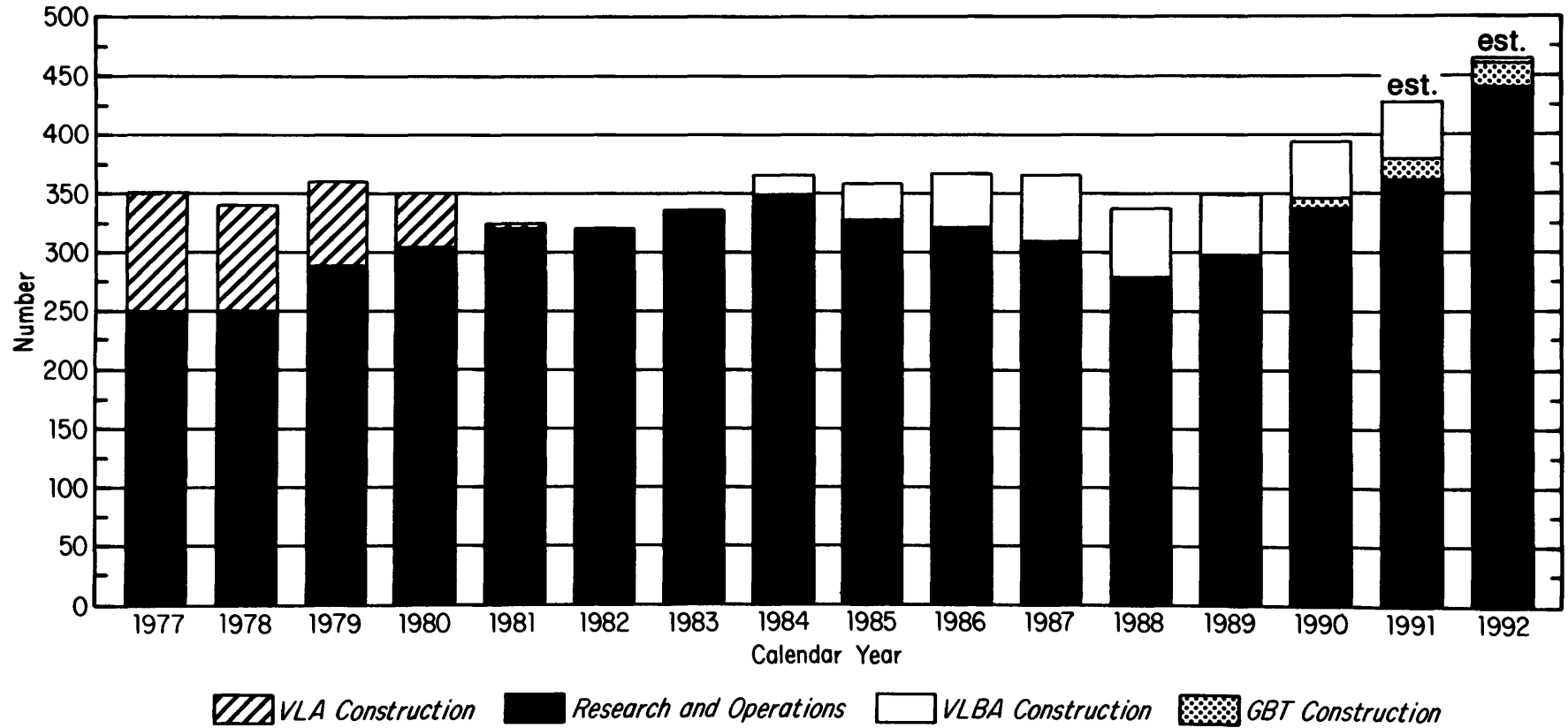


Fig. 6. This figure shows the total number of NRAO full-time, permanent employees at the end of each year, projected into the future.

NUMBER OF PEOPLE OBSERVING WITH NRAO TELESCOPES

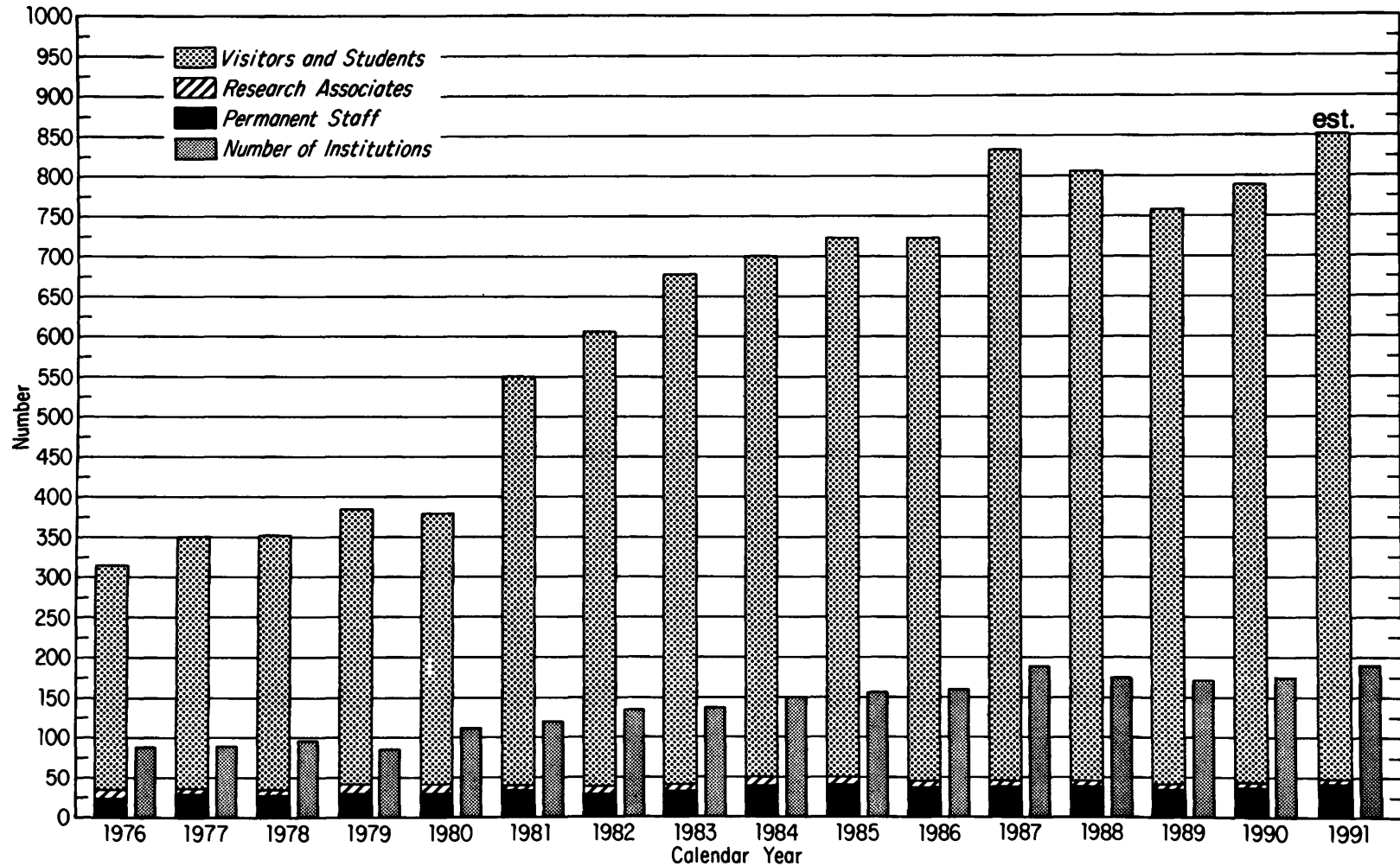


Fig. 7.

This bar chart shows for each calendar year the number of NRAO permanent research staff and the number of research associates who used the telescopes. In addition it shows the total number of visitor-users of NRAO telescopes and the number of institutions from which the NRAO visitors came. The significant jump in these last two categories starting in 1981 reflects the increased use of the VLA.

DISTRIBUTION OF TELESCOPE TIME BY PERCENT

	12-M	140-FT	VLA	1990 Summary
Visitors	41%	65%	57%	54%
Students	8%	9%	8%	8%
Permanent Staff	10%	10%	8%	9%
Research Associates	1%	<1.0%	2%	1%
Test and Calibration	36%	6%	13%	18%
Maintenance and Installation	3%	8%	11%	8%
Holidays and Unscheduled	1%	2%	1%	2%

**DISTRIBUTION OF SCHEDULED OBSERVING PROGRAMS
IN VARIOUS RESEARCH AREAS, BY PERCENT**

	12-M	140-FT	VLA	OVERALL
I. SOLAR SYSTEM --				
Sun, Planet, Satellites, and Comets	5%	3%	6%	5%
II. STELLAR --				
Pulsars, X-ray Sources, Planetary Nebulae, Circumstellar Shells, Supernova Remnants, Masers, Novae, Supernovae, and Stars	5%	18%	27%	22%
III. GALACTIC --				
Galactic Structure, Center, Molecular Clouds, HII Regions, Star Formation, Molecules, and Interstellar Medium	50%	21%	17%	22%
IV. EXTRAGALACTIC --				
Normal and Active Galaxies, Radio Galaxies, Clusters, Quasars, VLBA Studies, Extragalactic Molecules, and Cosmology	40%	58%	50%	51%

INSTITUTIONS FROM WHICH VISITORS CAME TO USE NRAO TELESCOPES DURING 1990

INSTITUTION	140-FT	TELESCOPES 12-M	VLA
1. Air & Space Museum		x	
2. Alabama, U. of	x		
3. Alaska, U. of		x	
4. Alberta, U. of (Canada)	x		
5. Amsterdam, U. of - Astronomy Institute			x
6. Anglo Australian Observatory - UKSTU (Schmidt)			x
7. Applied Research Corporation	x		x
8. Arcetri Astrophysical Observatory (Italy)	x		x
9. Arizona, U. of - Steward Observatory, L & P Lab.		x	x
10. Arizona State University		x	x
11. AURA, Inc.	x		x
12. Barcelona, U. of (Spain)			x
13. Beijing Astronomical Observatory (P.R. of China)	x	x	x
14. Bell Laboratories (New Jersey)			x
15. Bologna, U. of (Italy)	x		x

INSTITUTION		140-FT	TELESCOPES 12-M	VLA
16.	Bonn U. (FRG)			X
17.	Bordeaux Observatory (France)		X	X
18.	Boston U.	X		X
19.	Brandeis University	X		X
20.	Brazilian Space Agency - INPE			X
21.	British Columbia, U. of (Canada)			X
22.	Budapest U. of (Hungary)	X		X
23.	Calgary, U. of (Canada)			X
24.	California, U. of, Davis			X
25.	California, U. of, Berkeley - Hat Creek Observatory	X	X	X
26.	California, U. of, L.A.	X	X	X
27.	California, U. of, San Diego	X		X
28.	California, U. of, Santa Barbara	X	X	X
29.	Caltech - OVRA, Mt. Palomar	X	X	X
30.	Cambridge University - Cavendish, Mullard, IOA			X
31.	Carleton College			X
32.	Catania U. (Italy)			X
33.	Catolica U. (Chile)			X
34.	CFA (Harvard + SAO)	X	X	X
35.	CNRS, France (CEN, Saclay)		X	X

		TELESCOPES		
INSTITUTION		140-FT	12-M	VLA
36.	Chalmers-Onsala Space Observatory (Sweden)	x	x	x
37.	Chicago, U. of - Yerkes Observatory	x		
38.	CSIR (Johannesburg, South Africa)	x		x
39.	Colgate University		x	
40.	Colorado, U. of - JILA (Boulder)		x	x
41.	Columbia University	x		x
42.	Copernicus U. - Torun Observatory (Poland)			x
43.	Cornell University	x		x
44.	CSIRO (Australia)	x		x
45.	CTIO (Cerro Tololo Inter. Observatory)			x
46.	DRAO (Dominion Radio Astrophysical Observatory)	x	x	x
47.	Delaware, U. of			x
48.	DTM - Carnegie Institute	x		x
49.	Durham, U. of (U.K.)			x
50.	Edinburgh, U. of (Scotland)	x		
51.	ESO (European Southern Observatory - FRG, Chile)			x
52.	Florida, U. of			x
53.	Georgia, U. of			x
54.	Groningen, U. of - Kapteyn Lab.	x		x
55.	Hamburger Sternwarte (FRG)			x

		TELESCOPES		
INSTITUTION		140-FT	12-M	VLA
56.	Hanscom Air Force Base - AFGL	X		
57.	Haverford College			X
58.	Hawaii, U. of - Institute of Astronomy			X
59.	Haystack Observatory - NEROC	X	X	X
60.	Heidelberg Observatory			X
61.	Hofstra University	X	X	
62.	IBM (Watson Research Center)			X
63.	IAR, Buenos Aires (Argentina)			X
64.	Illinois, U. of - Vermillion River Observatory		X	X
65.	Indian Institute of Astrophysics (India)			X
66.	Institute of Astrophysics (Granada)	X		X
67.	Institute of Astrophysics (Paris)		X	X
68.	Institute for A & A, Andalucia	X		X
69.	Institute for Space Research (USSR)	X		X
70.	INTA - NASA (Madrid)	X		
71.	Interferometrics, Inc.	X		X
72.	Iowa, U. of	X		X
73.	IRAM (France, Spain)		X	X
74.	Itapetinga Observatory (Brazil)	X		
75.	Johns Hopkins University	X		X

		TELESCOPES		
INSTITUTION		140-FT	12-M	VLA
76.	JPL - Goldstone	x	x	x
77.	Kentucky, U. of	x		x
78.	Kyung Hee University (Korea)	x		
79.	KPNO - NOAO (National Solar Observatory)		x	x
80.	Lafayette College			x
81.	Laguna, U. of (Spain)			x
82.	Lebedev Physics Institute (USSR)	x		x
83.	Leiden, U. of - Huygens Labs.	x		x
84.	Los Alamos Scientific Laboratory (LANL)			x
85.	Lowell Observatory	x		
86.	Manchester, U. of - Jodrell, Nuffield	x		x
87.	Maryland, U. of - Clark Lake Observatory		x	x
88.	Massachusetts, U. of - Five College Observatory	x	x	x
89.	Meudon Observatory			x
90.	Mexico, U. of - Institute of Astronomy (UNAM)			x
91.	Michigan, U. of		x	x
92.	Middlebury College			x
93.	Minnesota, U. of			x
94.	MIT - Lincoln Laboratories	x	x	x
95.	MMTO - Multimirror Telescope Observatory			x

INSTITUTION		140-FT	TELESCOPES	
			12-M	VLA
96.	Molecular Research Institute (Calif.)	x		
97.	Monash University (Australia)	x		
98.	MPI (Heidelberg, FRG)			x
99.	MPIR (Bonn, FRG)	x	x	x
100.	MPIfEP, Garching (FRG)			x
101.	Mt. Stromlo Observatory (Australia)			x
102.	Mt. Wilson & Las Campanas - Carnegie			x
103.	NAIC - Arecibo Observatory	x		x
104.	Nanjing Observatory	x		
105.	Nanjing, U. of (China)	x		x
106.	NASA, Ames			x
107.	NASA/GSFC - Goddard		x	x
108.	NFRA (Netherlands Found. for Radio Astronomy)	x		x
109.	NMIMT (New Mexico Inst. of Mining Technology)		x	x
110.	New Mexico, U. of		x	x
111.	New Mexico State University			x
112.	Nobeyama Observatory (Japan)	x		x
113.	Nigeria, U. of			x
114.	North Carolina State University			x
115.	Northwestern University		x	x

INSTITUTION		140-FT	TELESCOPES 12-M	VLA
116.	NRC - Algonquin, Herzberg	x		x
117.	NRL (Naval Research Laboratories)	x	x	x
118.	Oberlin College			x
119.	Ohio State University			x
120.	Oklahoma, U. of			x
121.	Oxford University (U.K.)			x
122.	Padova Observatory (Italy)			x
123.	Padua, U. of (Italy)			x
124.	Paris Observatory		x	x
125.	Peking Observatory			x
126.	Penn State University	x	x	x
127.	Pennsylvania, U. of	x		x
128.	Pittsburgh, U. of - Allegheny Observatory	x		x
129.	Preston/Lancashire Polytechnic (U.K.)			x
130.	Princeton University - Inst. Advanced Studies	x	x	x
131.	Puerto Rico University			x
132.	Pulkovo Observatory (USSR)			x
133.	Purple Mountain Observatory (China)	x		
134.	Queen Mary College (U.K.)		x	
135.	Queens University (Canada)			x

INSTITUTION		140-FT	TELESCOPES 12-M	VLA
136.	Raman Institute (India)			X
137.	Rensselaer Polytechnic Institute		X	
138.	Rikkyo University (Japan)			X
139.	Royal Greenwich Observatory (U.K.)			X
140.	Royal Observatory - UKIRT (Scotland)			X
141.	SERC, Rutherford Appleton Lab. (U.K.)			X
142.	Solar Physics Research Corporation			X
143.	Space Telescope Science Institute	X	X	X
144.	SUNY (all campi)		X	X
145.	Sussex, U. of (U.K.)	X		
146.	SFIT, ETH - Swiss Federal Institute of Technology	X		X
147.	Sydney, U. of (Australia)	X		X
148.	Systems & Applied Science Corporation			X
149.	Tasmania, U. of (Australia)			X
150.	Tata Institute - TIFR, RAC (India)	X		X
151.	Texas, U. of - McDonald Observatory		X	X
152.	Tokyo University - Tokyo Astronomical Observatory			X
153.	Torino University (Italy)			X
154.	Toronto, U. of - David Dunlap Observatory	X	X	X
155.	Toulouse Observatory (France)			X

INSTITUTION		140-FT	TELESCOPES 12-M	VLA
156.	Trinity College (Texas)	x		x
157.	Tufts University			x
158.	Union College (New York)		x	
159.	University College London			x
160.	(unaffiliated)		x	
161.	USNO - United States Naval Observatory			x
162.	Utrecht, U. of - Astronomical Inst. (Netherlands)	x		
163.	Utsunomiya University (Japan)			x
164.	Vanderbilt University			x
165.	Vassar College			x
166.	Vermont, U. of			x
167.	Virginia, U. of	x	x	x
168.	VPI & SU	x		x
169.	Washington, U. of	x		
170.	West Virginia University	x		
171.	Western Ontario, U. of			x
172.	Wisconsin, U. of - Washburn Observatory	x		x
173.	Yebes Observatory - CAY (Spain)	x	x	
174.	York University (Canada)			x
175.	Yunnan Observatory (China)			x

SUMMARY	140-FT	TELESCOPES 12-M	VLA
Number of Institutions	75	46	149
Number of Visitors	188	80	509
Number of Students	29	23	91
Number of Research Associates	3	1	7
Number of Permanent Staff	16	7	27
Total Observers	236	111	634

All told, 744 visitors, including 121 students, from 175 institutions.

NRAO STUDENT PROGRAM

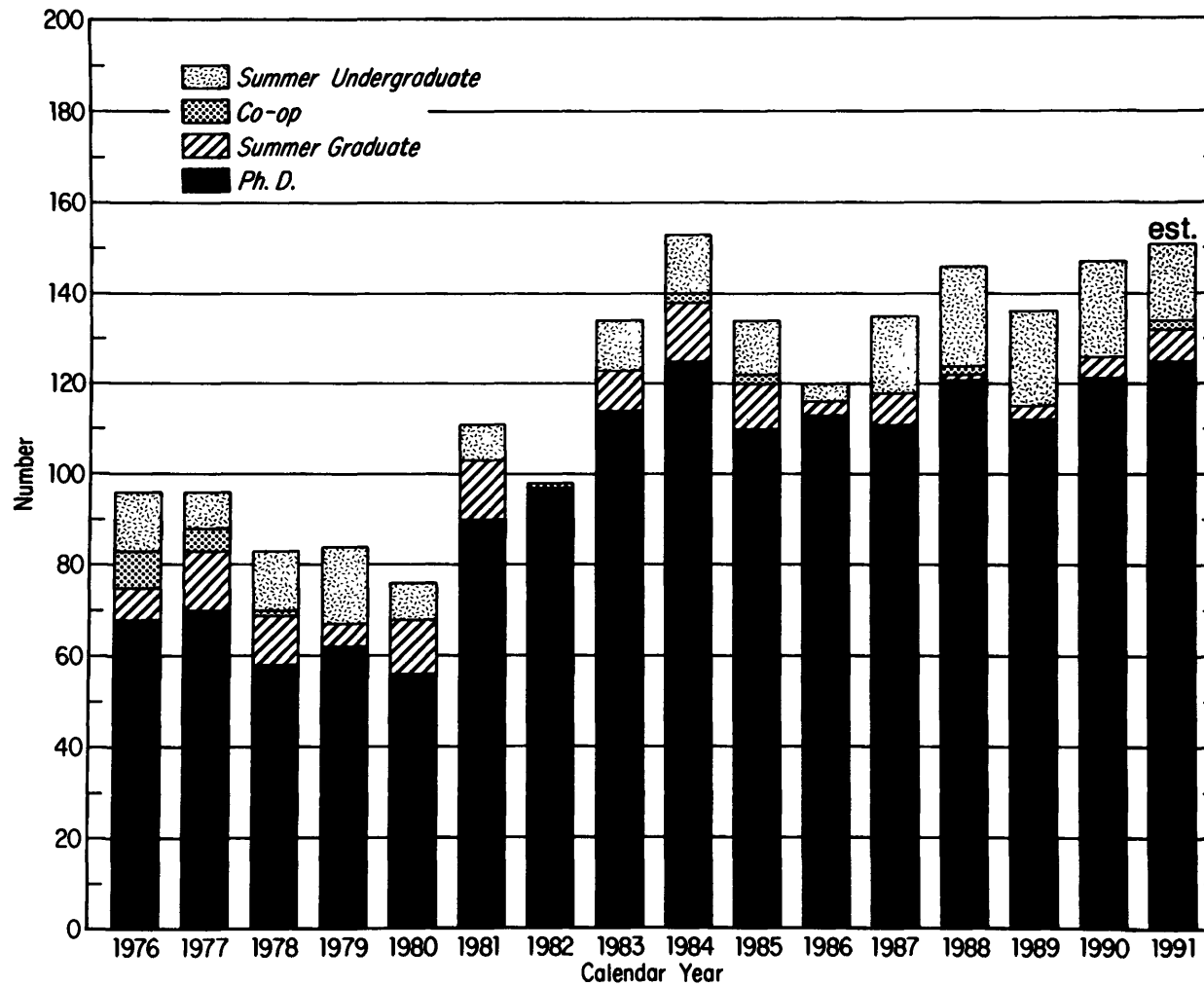


Fig. 8. This figure shows for each calendar year the number of PhD students (salaried and non-salaried), co-op students, and summer undergraduate and graduate students who observed or worked at the NRAO during that year. Beginning in 1987 the majority of the undergraduate summer students were funded by a separate NSF Grant for Research Experience for Undergraduates.

RECEIVER NAME	APPLICABLE TELESCOPE	FREQUENCY (GHz)	AMPLIFIER TYPE	SYSTEM TEMPERATURE (KELVIN)	3 dB BANDWIDTH (MHz)	FEED TYPE	POLARIZATION	CALIBRATION VALUE	SWITCHING SYSTEM	REMARKS	PERSON(S) IN CHARGE
50-500 MHz Rx	140 FT	50-88 MHz	HIGH DYNAMIC RANGE TRANSISTOR DUAL CHANNEL	300 + Teky	38	OPEN SLEEVE CROSSED DIPOLE	ORTHOGONAL LINEAR OR REMOVABLE QUAD HYBRID AT FEED FOR RCP AND LCP	ADJUSTABLE 2 TO 2500K	DICKE SWITCH: REFERENCE TEMPERATURE ADJUSTABLE FROM 100 TO 100,000K	FEED CHANGES FROM 50-88 MHz TO 110-240 MHz OR TO 450-500 MHz REQUIRE TWO HOURS.	NORROD (OLIVER)
		110-240 MHz			130	BROADBAND CROSSED DIPOLE			FREQUENCY SWITCH		
		450-500 MHz	FET AMP	50-80	50	CAVITY BACKED CROSSED DIPOLE	RCP AND LCP		FREQUENCY SWITCH	450-500 MHz AMP IN 50-250 MHz Rx	
300-1000 MHz Rx	140 FT	280-350 MHz	COOLED GASFET AMP DUAL CHANNEL	60-100	70	280-350 350-410 450-500 CAVITY BACKED CROSSED DIPOLES	DUAL ORTHOGONAL LINEAR IF POLARIMETER OR RF HYBRID FOR RCP AND LCP	5K	FREQUENCY SWITCHING	NEW 750-850 FET'S INSTALLED MID-YEAR ONE OF THE SIX FEEDS 280-350 MHz 350-420 MHz 450-500 MHz 500-750 MHz 750-850 MHz OR 750-1000 MHz CAN BE USED. TO CHANGE FEEDS REQUIRES TWO HOURS.	NORROD (SHANK)
		350-420 MHz			60						
		500-750 MHz	COOLED GASFET AMP DUAL CHANNEL	50-70	250	500-750 SCALAR WITH CROSSED DIPOLES					
		750-850 MHz	COOLED GASFET AMP DUAL CHANNEL	45-50	100	750-1000 SCALAR WITH CROSSED DIPOLES					
		750-1000 MHz	COOLED GASFET AMP DUAL CHANNEL	50-70	250	750-1000 SCALAR WITH CROSSED DIPOLES					
6/25 CM Rx	140 FT	1.00-1.45 (25 CM)	COOLED GASFET AMP DUAL CHANNEL	35-40	450	SINGLE BEAM SCALAR	ORTHOGONAL LINEAR	4K TO 6K	FREQUENCY SWITCHING NOISE ADDING	FEED CHANGE REQUIRED TO SWITCH BANDS TAKES TWO HOURS.	NORROD (SHANK)
		4.47-5.05 (6 CM)	COOLED GASFET AMP DUAL CHANNEL	50-60	580	SINGLE BEAM DUAL BEAM OFFSET 3 HPBW	ORTH CIRCULAR OR ORTH LINEAR IDENTICAL OR ORTH CIRCULAR OR IDENTICAL LINEAR	1.4K OR 12.8K	OTHER POLARIZATION BEAM SWITCHING		
21 CM, 4-FEED Rx	140 FT	1.30-1.50	UNCOOLED GASFET 4 CHANNEL	90-100	200 MAX. 77 MIN.	FOUR HORNS	LINEAR	7K (CAL) 440K NOISE ADD	NOISE ADDING OR FREQUENCY SWITCHING	LINE OR CONTINUUM FROM CONTROL ROOM. RF BANDWIDTH VARIABLE FROM CONTROL ROOM.	BEHRENS (VRABLE)

RECEIVER NAME	APPLICABLE TELESCOPE	FREQUENCY (GHz)	AMPLIFIER TYPE	SYSTEM TEMPERATURE (KELVIN)	3 dB BANDWIDTH (MHz)	FEED TYPE	POLARIZATION	CALIBRATION VALUE	SWITCHING SYSTEM	REMARKS	PERSON(S) IN CHARGE								
1.3-1.8 GHz Rx	140 FT	1.30-1.80	DUAL CHANNEL COOLED HEMT	19-25	UP TO 120 FEED LIMITED	THREE 2HE SINGLE BEAM 1.30-1.36 1.36-1.43 1.80-1.72 ZEEMAN 1.36-1.43	ORTHOGONAL LINEAR OR CIRCULAR	2K AND 200K	FREQUENCY OR POLARIZATION SWITCHING OR NOISE ADDING	EITHER CIRCULAR OR LINEAR POLARIZATIONS ARE SELECTABLE. CIRCULAR POLARIZATION REQUIRES ADJUSTMENTS FROM THE CONTROL ROOM. BAND CHANGE REQUIRES 2 TO 3 HOURS. OBSERVATIONS OUTSIDE STATED FEED BANDS POSSIBLE AT REDUCED EFFICIENCIES.	NORROD (CHESTNUT)								
11 CM, 3-FEED Rx	140 FT	2.64-2.75	UNCOOLED GASFET 4 CHANNEL	130	110 DSB (IF 5-55)	3 HORNS	CIRCULAR OR LINEAR	4K	300 K LOAD OR POLARIZATION OR BEAM	CONTINUUM RECEIVER. ON-AXIS HORN HAS RECEIVERS ON BOTH POLARIZATIONS. FOUR HOURS TO CHANGE POLARIZATION. FIXED LO AT 2.695 GHz.	NORROD (CHESTNUT)								
2-5 GHz Rx	140 FT	2.9-3.4	DUAL CHANNEL COOLED FET	38±4	UP TO 250 FEED LIMITED	TWO 2HE SINGLE BEAM 2.90-3.1 3.20-3.4	ORTHOGONAL LINEAR	2K AND 150K	FREQUENCY SWITCHING NOISE ADDING	BAND CHANGE REQUIRES FEED CHANGE. THIS TAKES 2-3 HOURS. FREQUENCY SWITCHING REQUIRES 50 MS BLANKING TIME.	BEHRENS (CHESTNUT)								
		4.6-5.0	DUAL CHANNEL COOLED HEMT	28±5	UP TO 200 FEED LIMITED	ONE 2HE SINGLE BEAM 4.6-4.8	CIRCULAR	3K AND 150K		RECEIVER BAND LIMITED BY 4.6-4.8 GHz FEED. FREQUENCY SWITCHING REQUIRES 50 MS BLANKING TIME.									
6 CM, 7-FEED Rx	140 FT	4.6-5.1	COOLED HEMT FOURTEEN CHANNEL	35-45	500	7 CORRUGATED HORNS 3 HPBW APART	DUAL CIRCULAR	4K	NONE	CONTINUUM USE ONLY. TOTAL POWER RF DETECTION.	BEHRENS (CHESTNUT)								
CASSEGRAIN A AND B RECEIVERS	140 FT	4.7-7.2	UPCONVERTER MASER	30-50	60-300	CASSEGRAIN	FIXED LINEAR CIRCULAR VLB	3-7K	FREQUENCY OR NUTATOR BEAM	<table border="1"> <thead> <tr> <th>FREQUENCY</th> <th>T_{sys} z</th> </tr> </thead> <tbody> <tr> <td>4.7-4.9</td> <td>40-50</td> </tr> <tr> <td>4.9-6.5</td> <td>30-40</td> </tr> <tr> <td>6.5-7.2</td> <td>40-50</td> </tr> </tbody> </table>	FREQUENCY	T _{sys} z	4.7-4.9	40-50	4.9-6.5	30-40	6.5-7.2	40-50	BROCKWAY (DUNBRACK)
		FREQUENCY	T _{sys} z																
		4.7-4.9	40-50																
		4.9-6.5	30-40																
		6.5-7.2	40-50																
7.6-11.2	UPCONVERTER MASER	35-80	80-300	CASSEGRAIN	FIXED LINEAR CIRCULAR VLB	3-7K	FREQUENCY OR NUTATOR BEAM	<table border="1"> <tbody> <tr> <td>7.6-8.5</td> <td>50-80</td> </tr> <tr> <td>8.5-11.2</td> <td>35-45</td> </tr> </tbody> </table>	7.6-8.5	50-80	8.5-11.2	35-45							
7.6-8.5	50-80																		
8.5-11.2	35-45																		
12-16.2	UPCONVERTER MASER	50-80	80-300	CASSEGRAIN	FIXED LINEAR	3-7K	FREQUENCY OR NUTATOR BEAM	12.0-16.2 50-80											
18.2-25.2	MASER	40-70	80-300	CASSEGRAIN	FIXED LINEAR CIRCULAR VLB	2-6K	FREQUENCY OR NUTATOR BEAM	18.2-25.2 40-70											
25-35	COOLED HEMT	50-80	500	CASSEGRAIN	FIXED LINEAR	3-7K	FREQUENCY OR NUTATOR BEAM	ONE RECEIVER											
NUTATOR		SUBREFLECTOR CORRECTS FOR TELESCOPE ASTIGMATISM AND LATERAL OFFSET. BEAM SPLITTER AVAILABLE 8 TO 25 GHz. NUTATING TRANSITION TIME 50 MILLISECONDS. 5 Hz MAXIMUM FREQUENCY. BEAM SHIFT DIRECTION FIXED. A. RECEIVER: 22.5° SOUTH OF EAST. B. RECEIVER: 22.5° NORTH OF WEST.							BEAM SHIFT = 0-18 ARC MIN.	FOUR HOURS FOR BAND CHANGE. NOISE ADDING AVAILABLE.									

APPLICABLE TELESCOPE	FREQUENCY (GHz)	AMPLIFIER TYPE	RECEIVER TEMPERATURE (KELVIN)	CONTINUUM SENSITIVITY (JANSKY /SEC)	3 dB BANDWIDTH (MHz)	FEED TYPE	POLARIZATION	CALIBRATION VALUE	SWITCHING SYSTEM	REMARKS	PERSON(S) IN CHARGE
12 M	70-115	SSS	APPROX 100 SSB	TO BE MEASURED	600 MHz	HORN-LENS	DUAL LINEAR	10 K	NUTATING SUBREFLECTOR		LAMB
12 M	200-250	SSS	200-300 SSB	NOT MEASURED	600 MHz	HORN-LENS	DUAL LINEAR	-	NUTATING SUBREFLECTOR		LAMB
12 M	250-305	COOLED MIXER	1000-2000 SSB	NOT MEASURED	600 MHz	HORN-LENS	DUAL LINEAR	-	NUTATING SUBREFLECTOR		LAMB
12 M	330-380	COOLED MIXER	1400-2000 SSB	12	600 MHz	HORN-LENS	DUAL LINEAR	-	NUTATING SUBREFLECTOR		LAMB

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APPLICABLE TELESCOPE	FREQUENCY (MHz)	AMPLIFIER TYPE	SYSTEM TEMPERATURE (KELVIN)	3 dB BANDWIDTH (MHz)	FEED TYPE	POLARIZATION	CALIBRATION VALUE	SWITCHING SYSTEM	REMARKS	PERSON(S) IN CHARGE
VLA	308-343	UNCOOLED TRANSISTOR	180	3 MHz (LIMITED BY INTERFERENCE)	PRIME FOCUS	DUAL ORTHOGONAL CIRCULAR	10	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.		LILIE
VLA	1340-1730	COOLED FET	60	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	4	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.	22 ANTENNAS	LILIE
VLA	1340-1730	COOLED HEMT	35	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	4	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.	ANTENNAS 3, 4, 11, 23 & 25 UPGRADED AS OF DECEMBER 5, 1990	LILIE
VLA	4500-5000	COOLED PARAMP OR COOLED PARAMP AND FET	60	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	4	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.		LILIE
VLA	8000-8800	COOLED HEMT	35	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	4	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.		LILIE
VLA	14400-15400	COOLED FET	110	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	7	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.		LILIE
VLA	22000-24000	COOLED HEMT	130	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	10	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.		LILIE
VLA	75	UNCOOLED TRANSISTOR	~ 1200	0.8	PRIME	DUAL ORTHOGONAL CIRCULAR	120	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.	ANTENNAS 3, 6, 7, 10, 11, 20, 21 & 28	LILIE

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