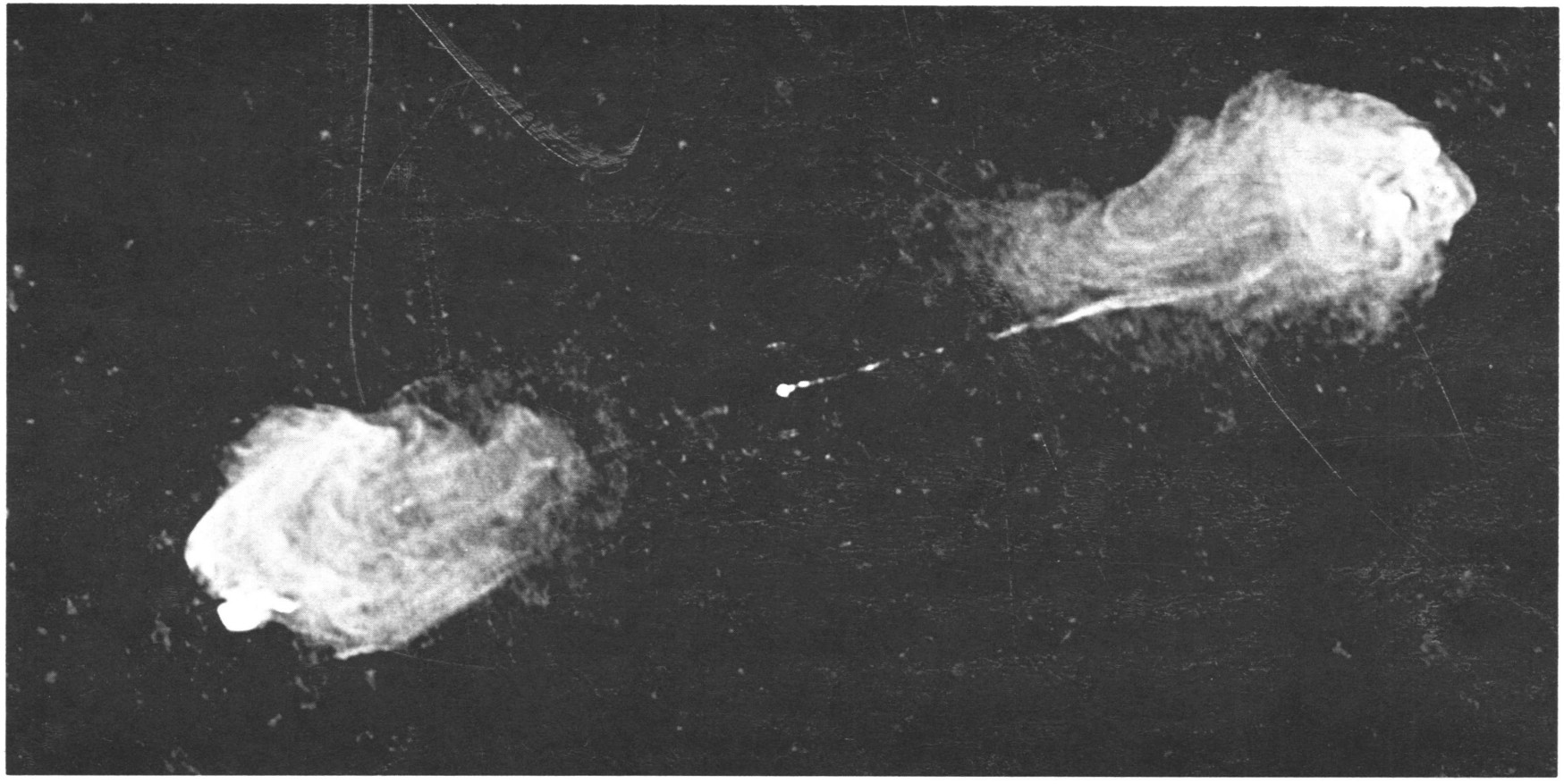
NATIONAL RADIO ASTRONOMY OBSERVATORY



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Observing Summary - 1986 Statistics

February 1987

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Some Highlights of the 1986 Research Program

- High angular resolution studies of the dynamics of various compact molecular cloud cores were carried out in the spectral lines of ammonia using the VLA. The observations in the direction of the compact HII region G10.6-0.4 provide evidence for the existence of an accreting envelope surrounding a newly formed star. Both rotation and collapse motions have been detected, clearly reflecting the dynamics of the star formation process.

- Carbon monoxide emission in the J = 2-1 line was detected in several planetary nebulae with the 12-meter telescope. Detailed studies of the Ring and Helix nebulae uncovered kinematic and morphological evidence that the molecular gas plays a dominant role in the origin, morphology, and evolution of at least some planetaries. Tantalizing evidence has been found that the presence of molecular gas in planetaries may be a very common phenomenon.

- Another binary pulsar, the seventh known, was discovered with the 300-foot telescope. Refined pulse-arrival-time observations of over seventy candidate pulsars originally found in the Princeton/NRAO survey during 1983 and 1984 have revealed the existence of two binary pulsars. The latest, PSR 1831-00, has an unusually small mass function and very small orbital diameter, both implying a very small companion mass, of order one-tenth the solar mass.

- The first measurements of the magnetic field strength in dark molecular clouds were made with the improved L-band receiver system on the 140-foot telescope. The extra sensitivity made possible the detection of Zeeman splitting toward weak OH emission lines in the ρ Oph dark cloud, where the role of magnetic fields in molecular cloud dynamics and in the star formation process can now be further tested.

- VLA observations were first used to identify a previously unrecognized supernova in the edge-on spiral galaxy NGC 891. The object was five times more powerful than any known radio supernova, outshining the galaxy nucleus by more than an order of magnitude. Optically determined line widths as narrow as 750 km/sec may possibly classify the object as a rare Class V supernova.

- During 1986, VLA multi-configuration, multi-frequency observations of the Saturn system were obtained while the rings were at maximum opening angle. Previously unobserved properties of the rings were the linearly polarized flux from the sides of the rings caused by light scattered perpendicularly into the line of sight, and a front-rear brightness difference that demonstrates the dominance of forward scattering. On Saturn's disk, a radio feature seen for the first time traces a broad warm band between 30 and 50 degrees North latitude.

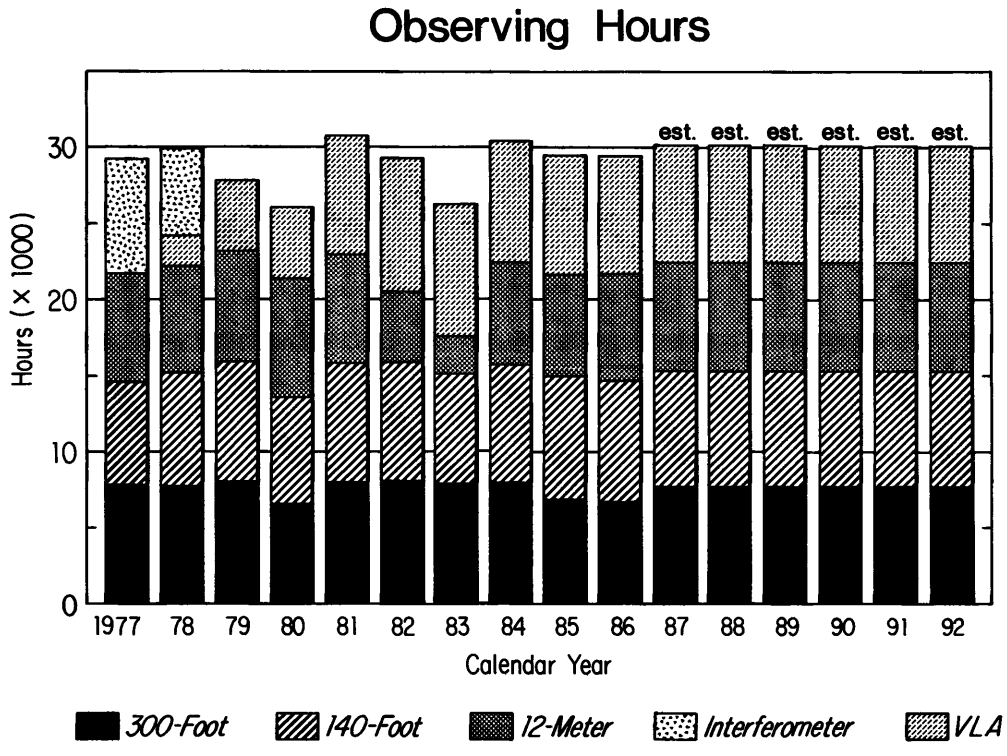

Fig. 1. This figure shows the hours scheduled for observing on each telescope during the last decade.

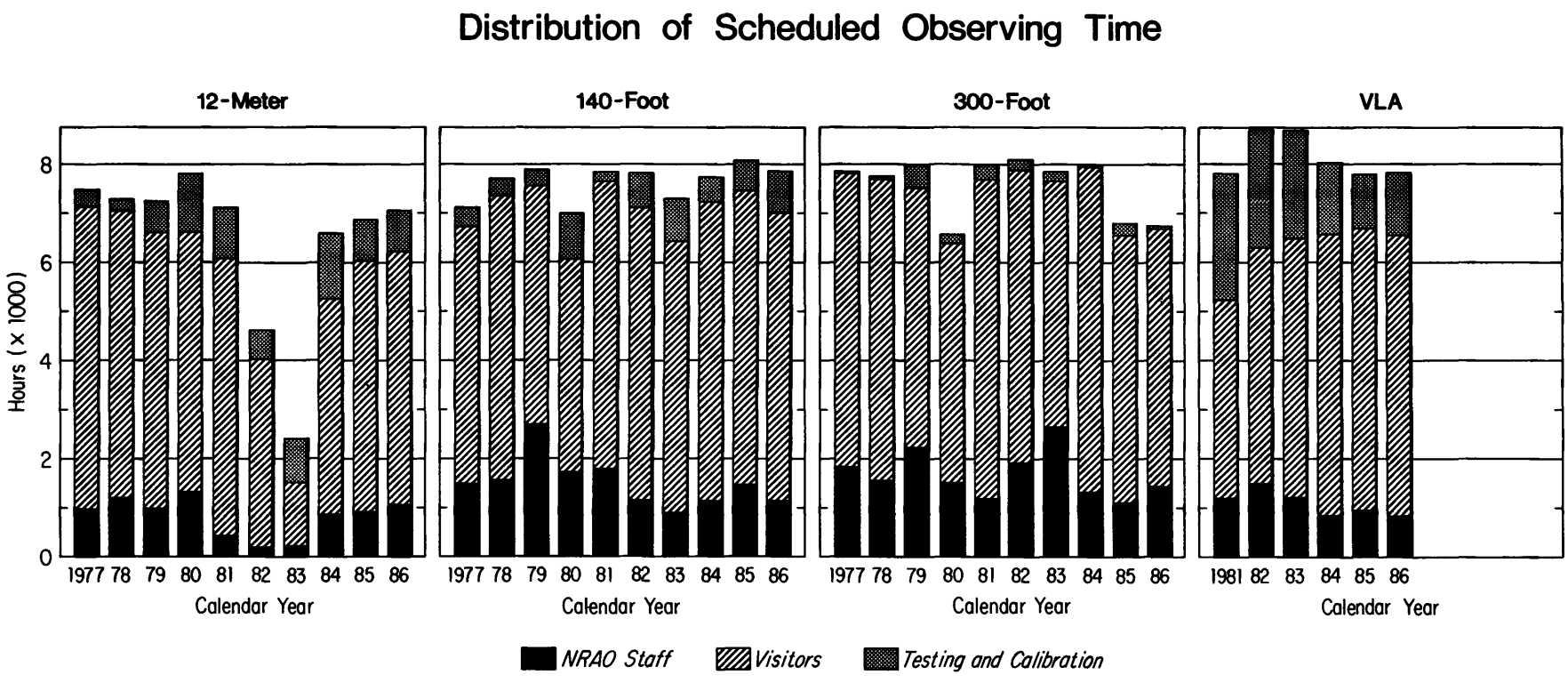

Fig. 2. These graphs show the number of hours scheduled for calibration and for observing by the NRAO staff and by visitors on each telescope system during the last decade.

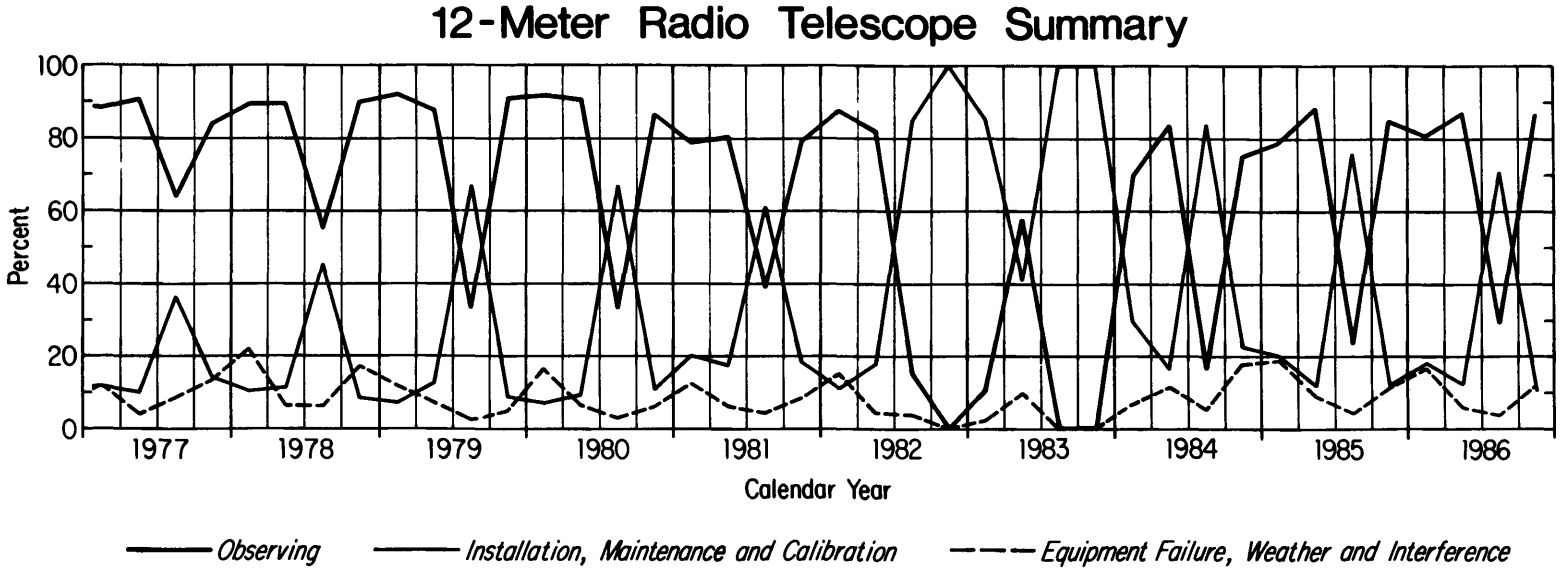

Fig. 3. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine calibration, maintenance, and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference. 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.

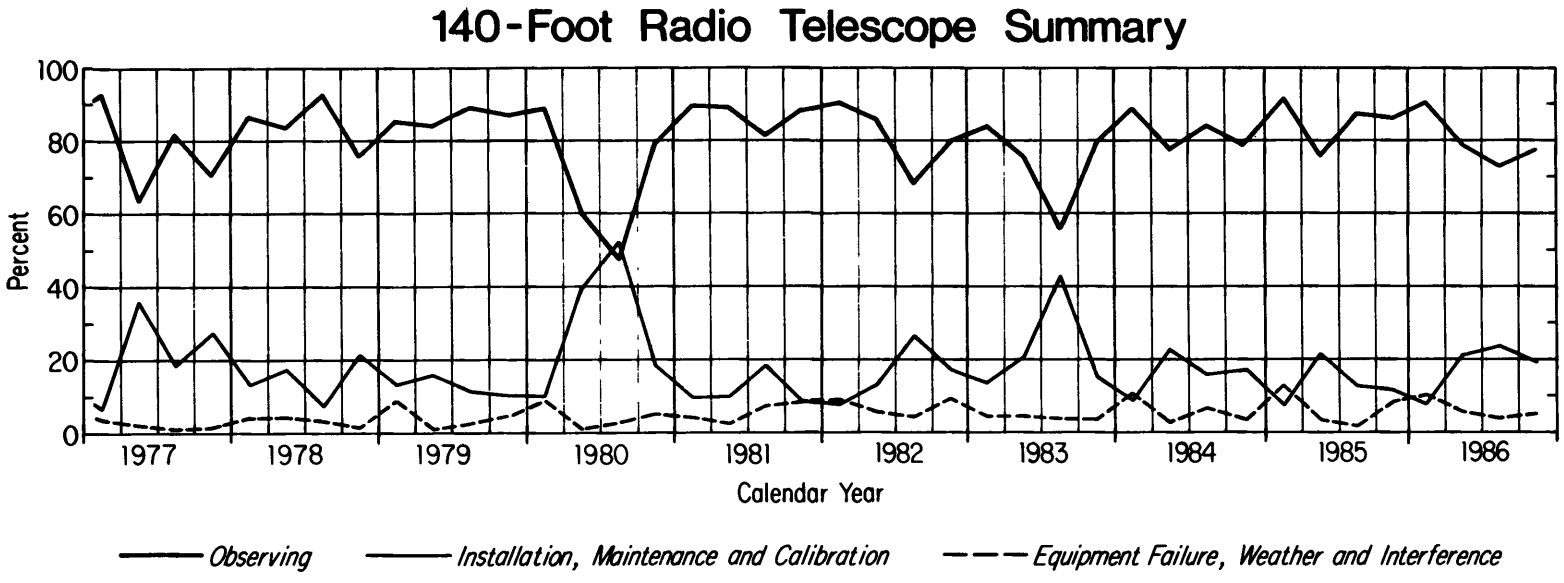

Fig. 4. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine calibration, maintenance, and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference. Major improvements to the telescope system include: 1977 - data processing computer and installation of the maser Cassegrain system; 1978 - tests of the deformable subreflector; 1980 - installation of the Model IV auto-correlation receiver; 1982 - beam efficiency and pointing tests at 1.3 cm; 1983 - brake overhaul and installation of the second channel of the upconverter/maser receiver.

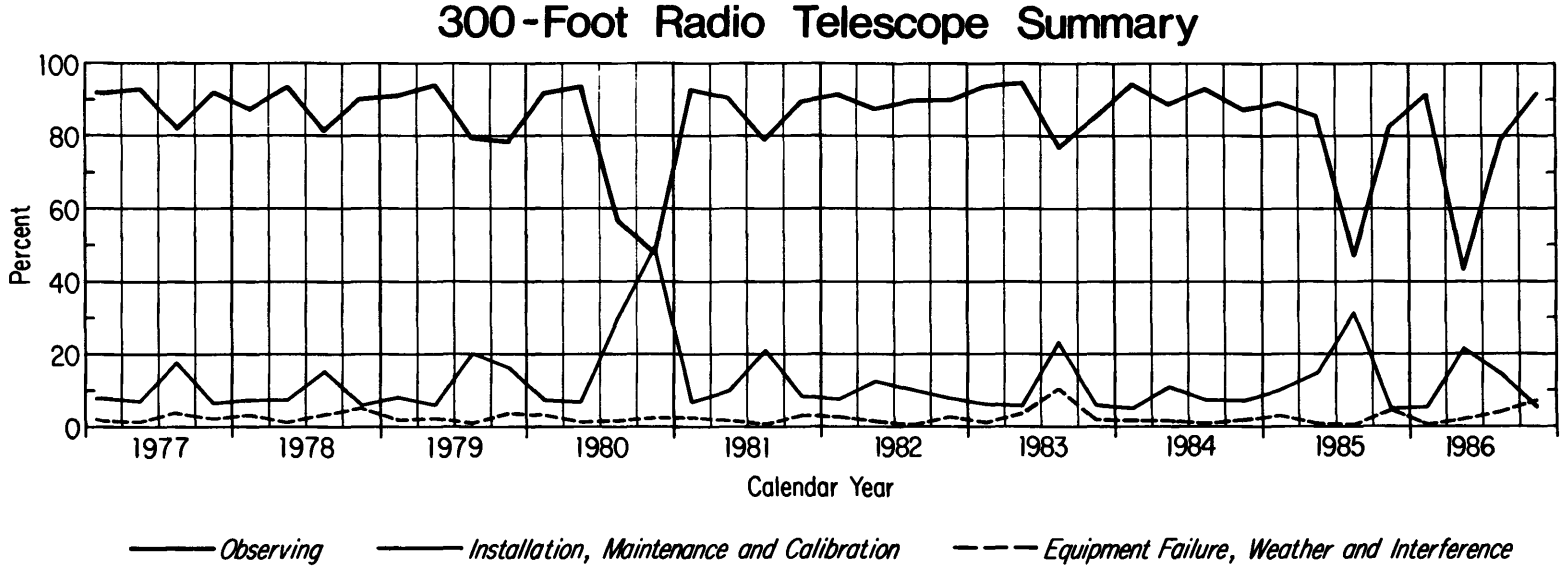

Fig. 5. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine calibration, maintenance, and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference. During 1980 a new traveling feed was installed, in 1983 cables were replaced and the telescope was painted, and during 1985 N-S motion was added to the traveling feed.

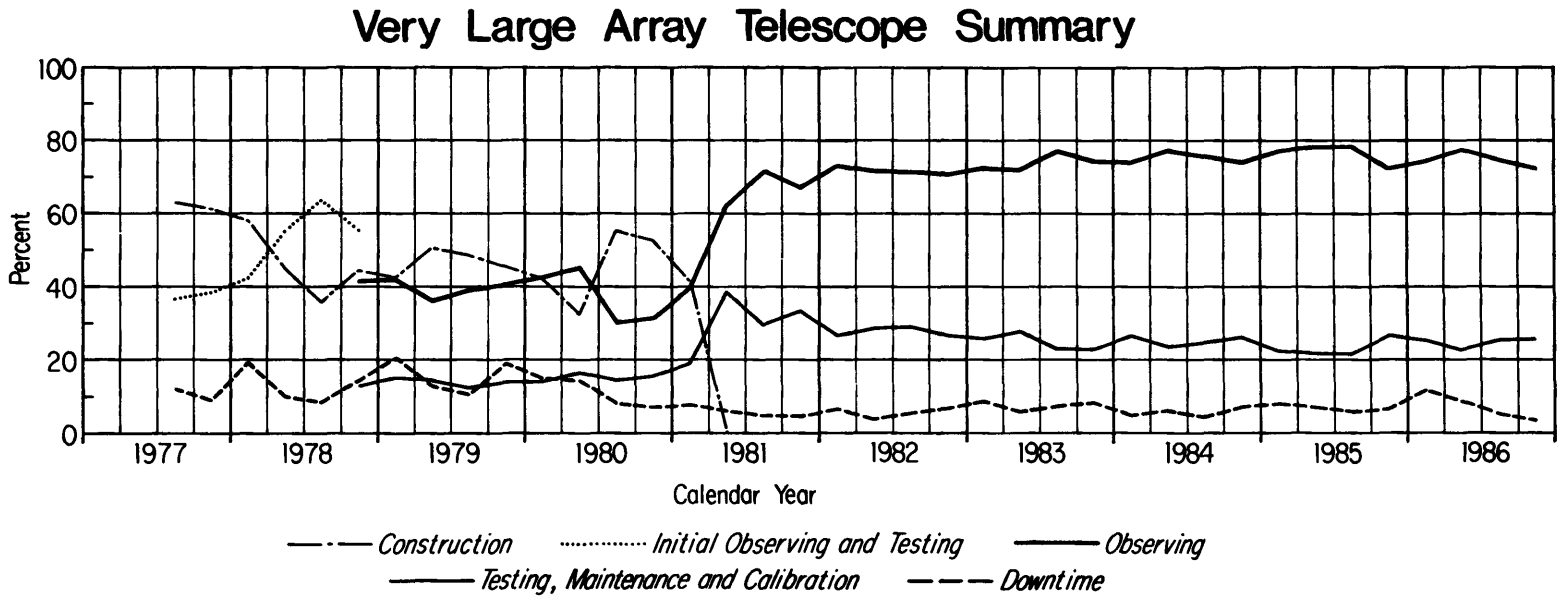

Fig. 6. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine system testing, maintenance, and calibration and the percentage of time lost due to hardware or software failure, power failure, or bad weather. During 1977 and 1978 no distinction was made between astronomical and test observing. Time scheduled for completion of the construction was reduced to zero after the first quarter of 1981.

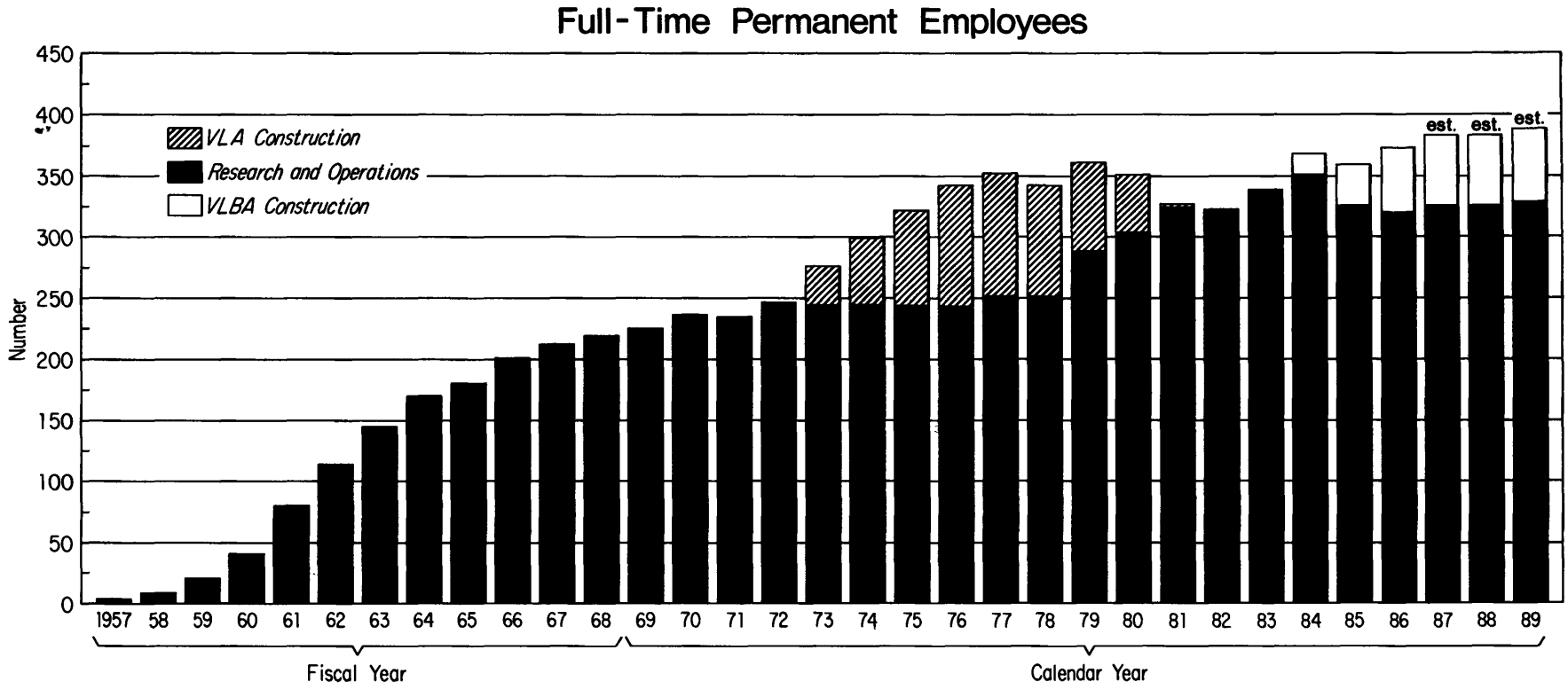

Fig. 7. This figure shows the total number of NRAO full-time, permanent employees at the end of each year, projected into the future.

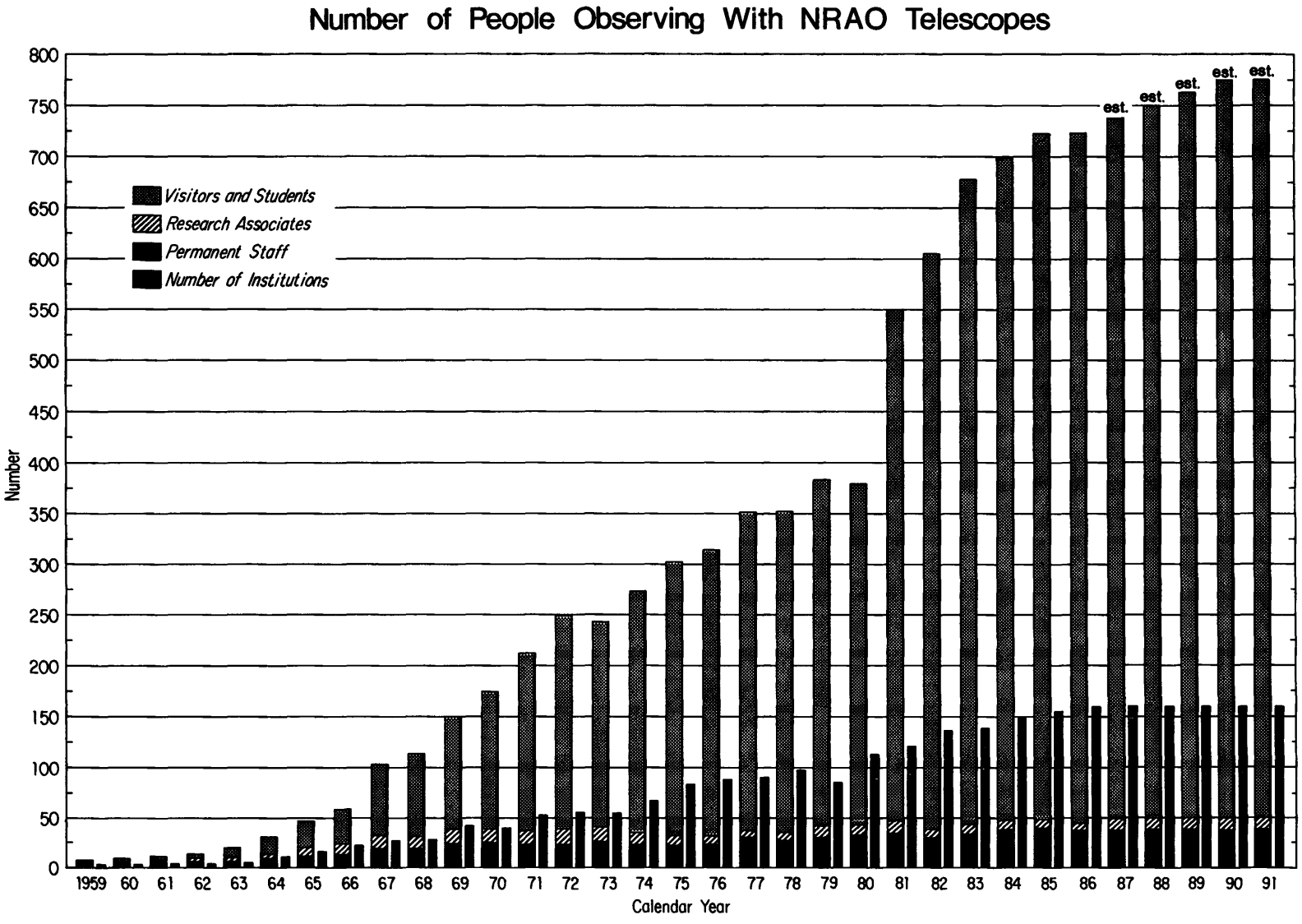

Fig. 8. This bar chart shows for each calendar year the number of NRAO permanent research staff and the number of research associates who use the telescopes. In addition, it shows the total number of visitor-users of NRAO telescopes and the number of institutions from which the NRAO visitors come. The significant jump in these last two categories for 1981 reflects the increased use of the VLA.

Distribution of Telescope Time by Per Cent

	12-meter	140-foot	300-foot	VLA	1985 Summary
Visitors	50%	61%	43%	58%	53%
Students	9%	6%	17%	7%	10%
Permanent Staff	11%	11%	15%	8%	11%
Research Associates	1%	2%	1%	2%	2%
Tests and Calibrations	10%	10%	1%	15%	9%
Maintenance and Installation	18%	8%	11%	9%	11%
Holidays and Unscheduled	1%	2%	12%	1%	4%

Distribution of Scheduled Observing Programs in Various Research Areas, by Percent

	12-meter	140-foot	300-foot	VLA	Overall
I. SOLAR SYSTEM --					
Sun, Planets, Satellites, and Comets	1%	2%	0%	4%	2%
II. STELLAR --					
Pulsars, X-ray Sources, Planetary Nebulae, Circumstellar Shells, Supernova Remnants, Masers, Novae, Supernovae, and Stars	16%	10%	15%	30%	18%
III. GALACTIC --					
Galactic Structure, Center, Molecular Clouds, HII Regions, Star Formation, Molecules, and Interstellar Medium	48%	29%	5%	18%	25%
IV. EXTRAGALACTIC --					
Normal and Active Galaxies, Radio Galaxies, Clusters, Quasars, VLB Studies, Extragalactic Molecules, and Cosmology	35%	59%	80%	48%	55%

Institutions from which Visitors Came to Use NRAO Telescopes during 1986

	Institution	Telescope 12-m	140-ft	300-ft	VLA
1.	Anglo Australian Observatory				x
2.	Alabama, U. of				x
3.	Applied Research Corporation				x
4.	Arcetri Astrophysical Observatory (Italy)		x		x
5.	Arizona, U. of - Steward Obs., L & P Lab.	x		x	x
6.	Arizona State University	x			
7.	Bell Laboratories (New Jersey)				x
8.	Birmingham, U. of (U.K.)				x
9.	Bologna, U. of (Italy)		x	x	x
10.	Bonn U. (FRG)				x
11.	Boston U.	x	x		x
12.	Brandeis University		x		x
13.	British Columbia, U. of (Canada)	x		x	x
14.	Brookhaven National Laboratories		x		
15.	Bureau de Longitudes (Paris)		x		x
16.	Calgary, U. of (Canada)	x			x
17.	California, U. of, Davis				x
18.	California, U. of, Berkeley - Hat Creek Obs.	x	x	x	x
19.	California, U. of, L. A.	x	x		x
20.	California, U. of, San Diego		x		x
21.	Caltech - OVRA, Mt. Palomar	x	x	x	x
22.	Cambridge University - Cavendish, Mullard, IOA	x			x
23.	Carleton College			x	
24.	Catania U. (Italy)				x
25.	CFA - (Harvard & SAO)	x	x		x

	Institution	Telescope 12-m	140-ft	300-ft	VLA
26.	Chalmers-Onsala Space Observatory (Sweden)	x	x		x
27.	Chicago, U. of - Yerkes Observatory	x	x		x
28.	CSIR (Johannesburg, South Africa)		x		x
29.	Colgate University	x		x	
30.	Colorado, U. of - JILA (Boulder)	x			x
31.	Columbia University		x		x
32.	Computer Science Corporation				x
33.	Copernicus U. - Torun Observatory (Poland)		x		x
34.	Cornell University		x	x	x
35.	CSIRO (Australia)				x
36.	Dartmouth College				x
37.	DAO - (Dominion Astrophysical Observatory)	x			x
38.	DRAO - (Dominion Radio Astrophysical Observatory)	x			x
39.	Delaware, U. of				x
40.	Duke University	x			
41.	Ecole Normale Superieure (Paris)				x
42.	Edinburgh, U. of (Scotland)				x
43.	ESO - (European Southern Observatory - FRG, Chile)				x
44.	ESOC (Damstadt, FRG)				x
45.	ESTEC (Netherlands)				x
46.	Florida, U. of	x			x
47.	Georgia State University				x
48.	George Mason University				x
49.	Glasgow, U. of (U.K.)				x
50.	Gottingen Academy Science (FRG)				x

	Institution	Telescope			
		12-m	140-ft	300-ft	VLA
51.	Groningen, U. of - Kapteyn Lab.				x
52.	Hamburger Sternwarte (FRG)				x
53.	Haute-Provence Observatory				x
54.	Haverford College				x
55.	Hawaii, U. of - Institute of Astronomy	x			x
56.	Haystack Observatory - NEROC		x		x
57.	Helsinki, U. of		x		
58.	High Altitude Observatory	x			
59.	Hofstra University	x			
60.	Howard University	x			
61.	IAR, Buenos Aires (Argentina)				x
62.	IAS-Frascati (Italy)				x
63.	Illinois, U. of - Vermillion River Observatory	x	x	x	x
64.	Imperial College (London)				x
65.	Institute of Astrophysics (Granada)		x		x
66.	Institute of Astrophysics (Paris)				x
67.	Institute for Space Research (USSR)		x		x
68.	Iowa, U. of		x		x
69.	Iowa State University				x
70.	IRAM (France, Spain)	x			x
71.	Jagiellonian University (Poland)				x
72.	Johns Hopkins University - Space Tel. Sci. Inst.	x	x	x	x
73.	JPL - Goldstone		x		x
74.	Keele, U. of (U.K.)				x
75.	Kent, U. of (U.K.)				x

	Institution	Telescope 12-m	140-ft	300-ft	VLA
76.	Kentucky, U. of		x		x
77.	KPNO - NOAO			x	x
78.	Lafayette College				x
79.	Laguna, U. of (Spain)				x
80.	Laval, U. of (Canada)				x
81.	Leicester, U. of (U.K.)		x		x
82.	Leiden, U. of - Huygens Labs.	x	x		x
83.	Lille, U. de (France)	x	x		
84.	Lockheed Research Laboratory	x			
85.	Los Alamos Scientific Laboratory (LANL)				x
86.	MacQuarie, U. of (Australia)				x
87.	Manchester, U. of - Jodrell, Nuffield		x		x
88.	Marseille Observatory				x
89.	Maryland, U. of - Clark Lake Observatory	x	x	x	x
90.	Massachusetts, U. of - Five College Observatory	x	x	x	x
91.	Meudon Observatory	x	x		x
92.	Mexico, U. of - Institute of Astronomy	x	x		x
93.	Michigan, U. of		x	x	x
94.	Milano (Italy)				x
95.	Minnesota, U. of				x
96.	Missouri, U. of (St. Louis)	x			
97.	MIT - Lincoln Laboratories		x	x	x
98.	Monash University (Australia)				x
99.	Montreal, U. of				x
100.	MPI (Heidelberg, FRG)				x

	Institution	Telescope 12-m	140-ft	300-ft	VLA
101.	MPIR (Bonn, FRG)		x		x
102.	Mt. Stromlo Observatory (Australia)				x
103.	Mt. Wilson & Las Campanas - Carnegie				x
104.	NAIC - Arecibo Observatory		x		x
105.	Nagoya University (Japan)	x			
106.	NASA/GSFC - Goddard	x	x		x
107.	NASA, Institute for Space Studies		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
111.	New Mexico State University				x
112.	New York University	x			
113.	Nobeyama Observatory (Japan)				x
114.	North Carolina, U. of				x
115.	North Carolina State University				x
116.	Northeastern University				x
117.	NRC - Algonquin, Herzberg	x	x		x
118.	NRL (Naval Research Laboratories)	x	x	x	x
119.	Ohio State University				x
120.	Oklahoma, U. of				x
121.	Oregon, U. of				x
122.	Paris Observatory				x
123.	Penn State University	x	x		x
124.	Pennsylvania, U. of		x		
125.	Pittsburgh, U. of - Allegheny Observatory	x	x	x	x

	Institution	Telescope			
		12-m	140-ft	300-ft	VLA
126.	Preston/Lancashire Polytechnic (U.K.)	x			x
127.	Princeton University - Inst. Advanced Studies	x		x	x
128.	Puerto Rico University	x	x		x
129.	Queen Mary College (U.K.)	x			x
130.	Queens University (Canada)				x
131.	Raman Institute (India)		x		x
132.	Rensselaer Polytechnic Institute	x			x
133.	Royal Greenwich Observatory (U.K.)				x
134.	Royal Observatory - UKIRT (Scotland)				x
135.	Rutgers State University				x
136.	South African Astronmical Obs. (SAAO, Cape Town)				x
137.	Stockholm Observatory	x			x
138.	SUNY (all campuses)	x			x
139.	Sydney, U. of (Australia)				x
140.	Systems & Applied Science Corporation				x
141.	Tata Institute - TIFR, RAC (India)		x		x
142.	Tel-Aviv University - Wise Observatory				x
143.	Texas, U. of - McDonald Observatory	x	x		x
144.	Thessalonike University (Greece)				x
145.	Tokyo University - Tokyo Astronomical Observatory				x
146.	Toledo, U. of				x
147.	Toronto, U. of - David Dunlap Observatory	x	x		x
148.	Tufts University				x
149.	Turku, U. of (Finland)		x		x
150.	University College London				x

Institution	Telescope			
	12-m	140-ft	300-ft	VLA
151. (unaffiliated)	x			
152. USNO - United States Naval Observatory				x
153. Utrecht, U. of - Astronomical Inst. (Netherlands)				x
154. Virginia, U. of	x	x	x	x
155. VPI & SU			x	x
156. Washington, U. of	x			x
157. Williams College			x	
158. Wisconsin, U. of - Washburn Observatory	x	x		x
159. Wyoming, U. of	x			
No. of Institutions	54	55	21	140
No. of Visitors	101	156	32	472
No. of Students	24	20	12	77
No. of Research Associates	2	2	1	6
No. of Permanent Staff	10	16	5	32
Total Observers	137	194	50	587

All told, 679 visitors, including 113 students, from 159 institutions.

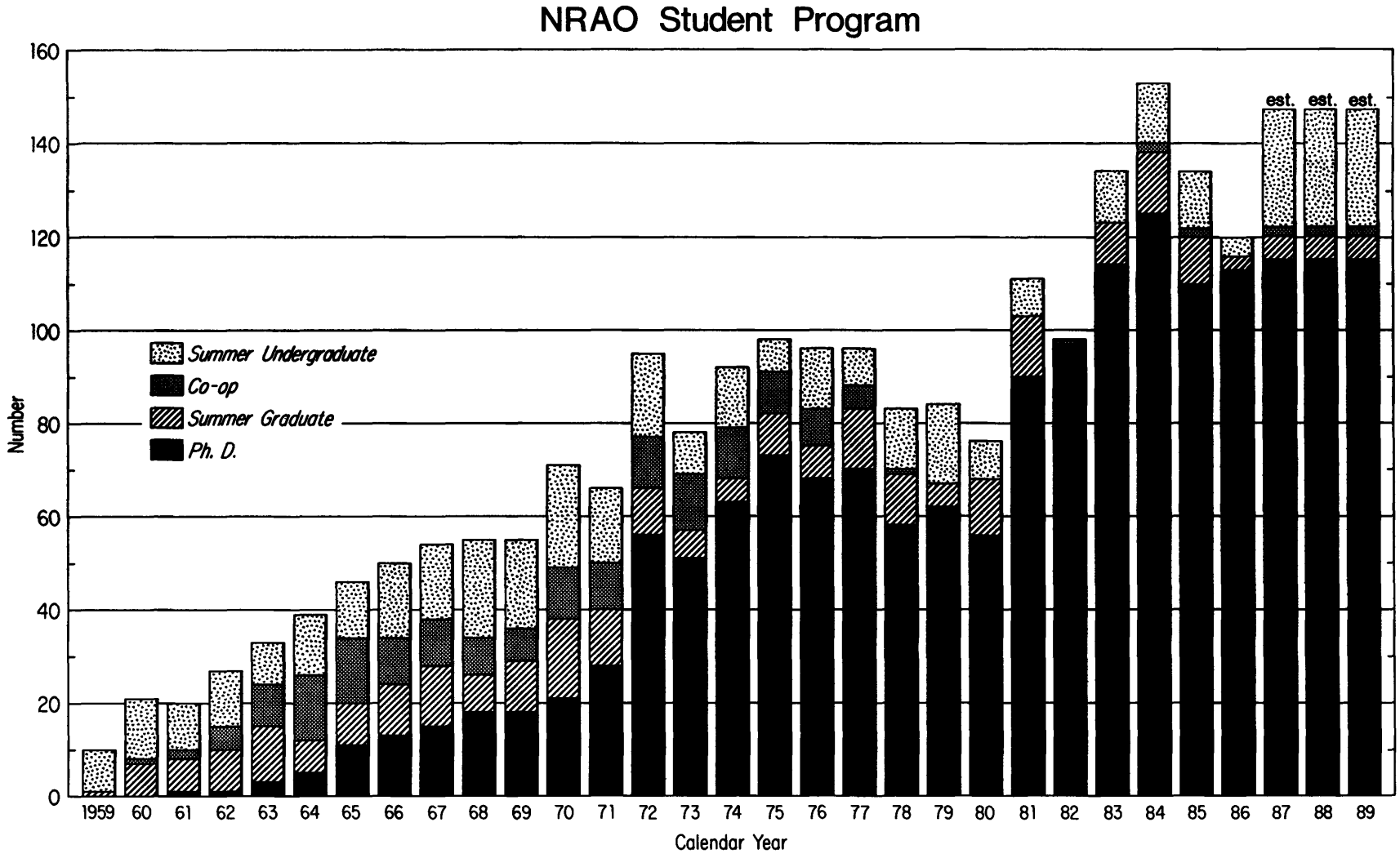

Fig. 9. This figure shows for each calendar year the number of Ph.D. students (salaried and non-salaried), co-op students, and summer undergraduate and graduate students who observed or worked at the NRAO during that year.

NRAO Front-End Box Status

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
25–250 MHz Rx	300 FT TRAVELING FEED	25–50 MHz	HIGH DYNAMIC RANGE TRANSISTOR DUAL CHANNEL	300 + Tsky	25	FAT DIPOLE	SINGLE LINEAR E–W	ADJUSTABLE 2 TO 2500K	DICKE SWITCH: REFERENCE TEMPERATURE ADJUSTABLE FROM 100 TO 100,000K OR FREQUENCY SWITCH	CAN ONLY BE INSTALLED ON 300' TRAVELING FEED.	COE (OLIVER)
	300 FT TRAVELING FEED OR 140 FT	50–88 MHz			38	OPEN SLEEVE CROSSED DIPOLE	ORTHOGONAL LINEAR OR REMOVABLE QUAD HYBRID AT FEED FOR RCP AND LCP			FEED CHANGES FROM 50–88 MHz TO 110–240 MHz OR TO 450–500 MHz REQUIRE TWO HOURS ON THE 140' AND THREE HOURS ON THE 300'.	
		110–240 MHz			130	BROADBAND CROSSED DIPOLE					
		450–500 MHz	FET AMP	50–80	50	CAVITY BACKED CROSSED DIPOLE	RCP AND LCP		FREQUENCY SWITCH	450–500 MHz AMP IN 25–250 MHz Rx	
300–1000 MHz Rx	300 FT TRAVELING FEED OR 300/140 FT STERLING MOUNT	280–350 MHz	COOLED UP–CONVERTER/ GASFET AMP DUAL CHANNEL	45–85	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	WHEN INSTALLED ON THE 300' TRAVELING FEED, TWO FEEDS CAN BE USED: THE 750–1000 MHz ON THE WEST END OF THE BOX AND ONE OF THE OTHERS ON THE EAST END. SELECTION OF ONE OF THE TWO FEEDS SHOULD TAKE LESS THAN FIVE MINUTES. TO CHANGE A FEED REQUIRES THREE HOURS.	COE (SHANK)
		350–410 MHz			60						
		450–500 MHz	COOLED UP–CONVERTER/ GASFET AMP DUAL CHANNEL	50–70	50	500–750 SCALAR WITH CROSSED DIPOLES				WHEN INSTALLED IN THE STERLING MOUNT ON THE 140' OR 300' ANTENNAS, ONLY ONE OF THE FIVE FEEDS 280–350 MHz 350–410 MHz 450–500 MHz 500–750 MHz OR 750–1000 MHz CAN BE USED. TO CHANGE FEEDS REQUIRES TWO HOURS ON THE 140' AND THREE HOURS ON THE 300'.	
		500–750 MHz			250						
		750–1000 MHz	COOLED UP–CONVERTER/ GASFET AMP DUAL CHANNEL	50–90	250	750–1000 SCALAR WITH CROSSED DIPOLES					
6/25 CM Rx	300/140 FT	1.00–1.46 (25 CM)	COOLED FET DUAL CHANNEL	35–40	450	SINGLE BEAM SCALAR	ORTHOGONAL LINEAR	8K TO 14K	FREQUENCY SWITCHING NOISE ADDING	FEED CHANGE REQUIRED TO SWITCH BANDS. THIS TAKES TWO HOURS ON THE 140' AND THREE HOURS ON THE 300'.	COE (SHANK)
		4.47–5.05 (6 CM)	COOLED GASFET DUAL CHANNEL	50–60	580	SINGLE BEAM	ORTH CIRCULAR OR ORTH LINEAR	1.4K OR 12.8K	OTHER POLARIZATION		
						DUAL BEAM OFFSET 3 HPBW	IDENTICAL OR ORTH CIRCULAR OR IDENTICAL LINEAR		BEAM SWITCHING		
21 CM, 4–FEED Rx	300/140 FT	1.30–1.80	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	300/140 FT	1.30–1.80	DUAL CHANNEL COOLED FET	23–30	UP TO 120 FEED LIMITED	THREE 2HE SINGLE BEAM 1.30–1.36 1.36–1.43 1.60–1.72	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	300/140 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.	BRADLEY (CHESTNUT)
2–5 GHz Rx	300/140 FT	2.9–3.4	DUAL CHANNEL COOLED FET	25–35	UP TO 250 FEED LIMITED	TWO 2HE SINGLE BEAM 2.90–3.15 3.15–3.40	ORTHOGONAL LINEAR OR CIRCULAR	LOW 1.8 HIGH 150	FREQUENCY SWITCHING NOISE ADDING	BAND CHANGE REQUIRES FEED CHANGE. THIS TAKES 2–3 HOURS. CIRCULAR POLARIZATION REQUIRES PHASE EQUALIZATION ADJUSTMENTS FROM THE CONTROL ROOM. FREQUENCY SWITCHING REQUIRES 50 MS BLANKING TIME.	BRADLEY (CHESTNUT)
		4.6–5.0	DUAL CHANNEL COOLED FET	25–35	UP TO 200 FEED LIMITED	ONE 2HE SINGLE BEAM 4.6–4.8				BAND CHANGE REQUIRES FEED CHANGE. THIS TAKES 2–3 HOURS. LINEAR POLARIZATION REQUIRES PHASE EQUALIZATION ADJUSTMENTS FROM THE CONTROL ROOM. FREQUENCY SWITCHING REQUIRES 50 MS BLANKING TIME.	
9 CM Rx	300/140 FT	3.12–3.37	COOLED PARAMPS DUAL CHANNEL	65 K LOAD SWITCHED 75 K BEAM SWITCHED	250 FIXED TUNED	DUAL BEAMS OFFSET BY 3 HPBW SINGLY POLARIZED	IDENTICAL LINEAR OR IDENTICAL CIRCULAR OR ORTH CIRCULAR	4K AND 14K	COOLED DICKE SWITCHES (LATCHING FERRITE) FOR LOAD (20K) SWITCHING OR BEAM SWITCHING WITH NOISE INJECTION FOR BALANCING; 10 Hz MAXIMUM RATE.	CONTINUUM USE.	BEHRENS (JEFFRIES)
6 CM, 7–FEED Rx	300/140 FT	4.6–5.1	COOLED FET FOURTEEN CHANNEL	60–70	500	7 CORRUGATED HORNS 3 HPBW APART	DUAL CIRCULAR	5K	NONE	CONTINUUM USE ONLY. TOTAL POWER RF DETECTION.	BEHRENS (JEFFRIES)
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	FREQUENCY / T_{sys}: 4.7–4.9 / 40–50; 4.9–6.5 / 30–40; 6.5–7.2 / 40–50	BROCKWAY (DUNBRACK)
		7.6–11.2	UPCONVERTER MASER	35–80	60–300	CASSEGRAIN	FIXED LINEAR CIRCULAR VLB	3–7K	FREQUENCY OR NUTATOR BEAM	7.6–8.5 / 50–80; 8.5–11.2 / 35–45	
		12–18.2	UPCONVERTER MASER	50–80	60–300	CASSEGRAIN	FIXED LINEAR	3–7K	FREQUENCY OR NUTATOR BEAM	12.0–18.2 / 50–80	
		18.2–25.2	MASER	40–70	60–300	CASSEGRAIN	FIXED LINEAR CIRCULAR VLB	2–6K	FREQUENCY OR NUTATOR BEAM	18.2–25.2 / 40–70	
	NUTATOR	SUBREFLECTOR CORRECTS FOR TELESCOPE ASTIGMATISM AND LATERAL OFFSET. BEAM SPLITTER AVAILABLE ABOVE 8 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	COOLED MIXER	260–400 SSB	1.0	600 MHz	HORN–LENS	DUAL LINEAR	10 K	NUTATING SUBREFLECTOR		COCHRAN
12 M	90–115	SIS	APPROX. 100	TO BE MEASURED	600 MHz	HORN–LENS	DUAL LINEAR	10 K	NUTATING SUBREFLECTOR		LAMB
12 M	330–360	COOLED MIXER	1400–2000 SSB	12	600 MHz	HORN–LENS	SINGLE LINEAR	–	NUTATING SUBREFLECTOR		PAYNE
12 M	200–270	COOLED MIXER	500–1000 SSB	6 AT 230 GHz	600 MHz	HORN–LENS	DUAL LINEAR	–	NUTATING SUBREFLECTOR	RANGE WILL BE EXTENDED TO 270–300 LATER IN 1987.	PAYNE
12 M	0.8 MM, 1.0 MM, 2.0 MM	0.3 K BOLOMETER	SYSTEM NEP APPROXIMATELY 2×10^{-14} W $Hz^{-1/2}$	APPROX. 3 AT 1 MM	MATCHED TO ATMOSPHERIC WINDOW	LENS–WINSTON CONE	UNPOLARIZED	–	NUTATING SUBREFLECTOR	WAVELENGTH MAY BE SELECTED WITH FILTER WHEEL.	PAYNE

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
VLA	308–343	UNCOOLED TRANSISTER	250* 150**	3 MHz (LIMITED BY INTERFERENCE)	PRIME FOCUS***	DUAL ORTHOGONAL CIRCULAR	25* 10**	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.	* ANTENNAS 8, 12 AND 15. ** ELEVEN OTHER ANTENNAS. *** FEED IS OFF-AXIS ON ANTENNAS 8 AND 12.	LILIE
VLA	1340–1730	COOLED FET	60	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	4	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.		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	45	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	4	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.	ON SIX ANTENNAS AS OF OCTOBER 1986.	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 MIXER	350	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	20	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.		LILIE
VLA	22000–24000	COOLED HEMT	110	55	CASSEGRAIN	DUAL ORTHOGONAL CIRCULAR	10	NOISE INJECTION, 9.6 Hz, 50 PERCENT CYCLE.	ON ANTENNA NO. 23 ONLY. LCP ONLY.	LILIE

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