# NATIONAL RADIO ASTRONOMY OBSERVATORY

# 1977

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# OBSERVING SUMMARY

## Some Highlights of the 1976 Research Program

- The first two VLA antennas were used successfully as an interferometer in February, 1976. By the end of 1976, six antennas had been operated as an interferometer in test observing runs.

- Amongst the improvements to existing facilities are the new radiometers at 9 cm and at 25/6 cm for Green Bank. The pointing accuracy of the 140-foot antenna was improved by insulating critical parts of the structure.

- The 300-foot telescope was used to detect the redshifted hydrogen absorption feature in the spectrum of the radio source AO 0235+164. This is the first instance in which optical and radio spectral lines have been measured in a source having large redshift.

- The 140-foot telescope was used as an element of a Very Long Baseline Interferometer in the detection of an extremely small radio source in the Galactic Center. This source, with dimensions less than the solar system, is similar to, but less luminous than, compact sources observed in other galaxies.

- The interferometer was used to detect emission from the binary HR1099. Subsequently, a large radio flare was observed simultaneously with a Ly-α and H-α outburst from the star.

- New molecules detected with the 36-foot telescope include a number of deuterated species such as $DCO^+$, and ketene, the least saturated version of the CCO molecule frame.

# OBSERVING HOURS

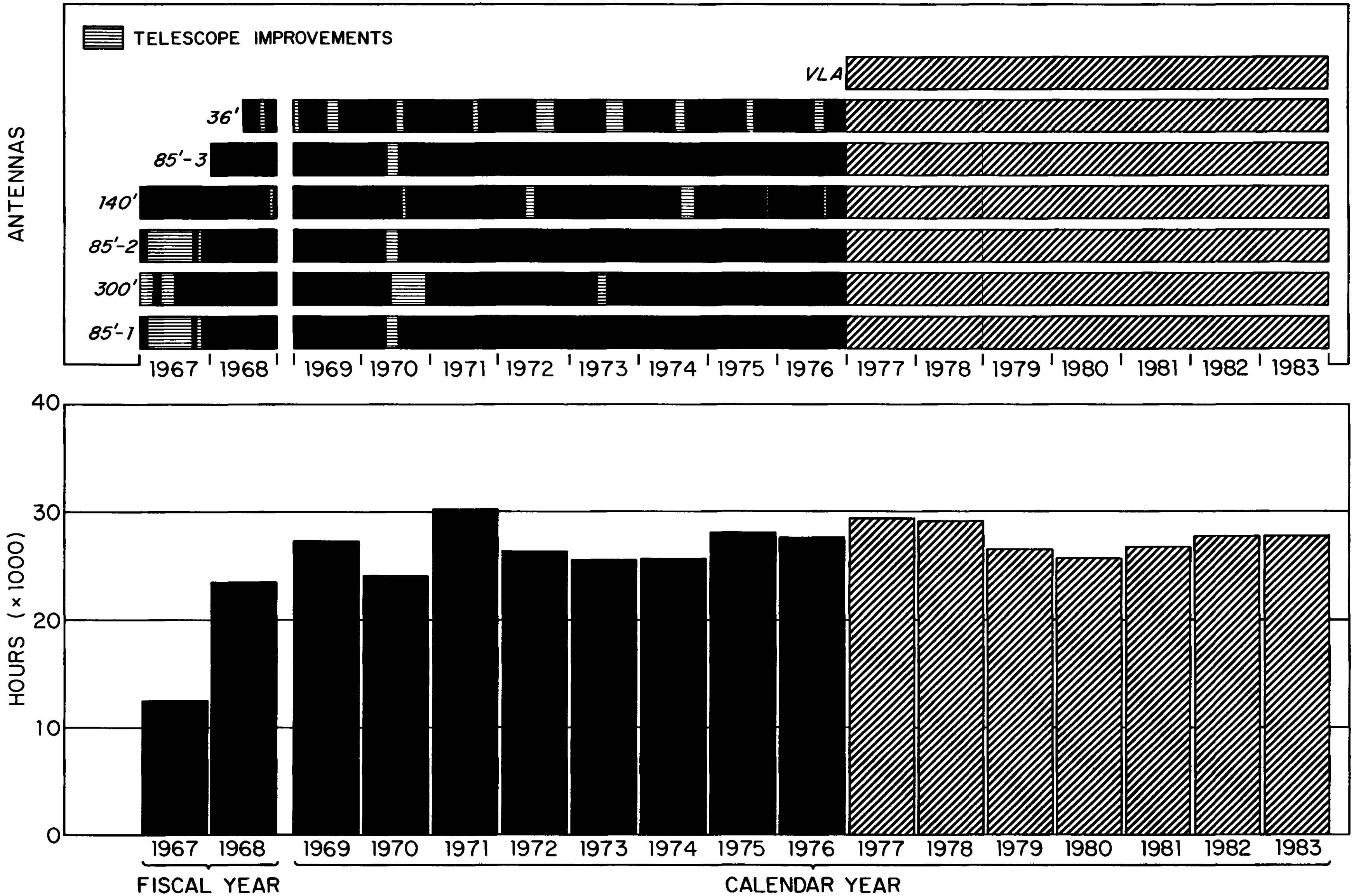


**Fig. 1.** The upper figure shows the year in which existing (black) or planned (shaded) telescope systems are incorporated into the NRAO observing program. The lower figures show the total number of hours of observing time during each year.

## OBSERVING TIME DISTRIBUTION

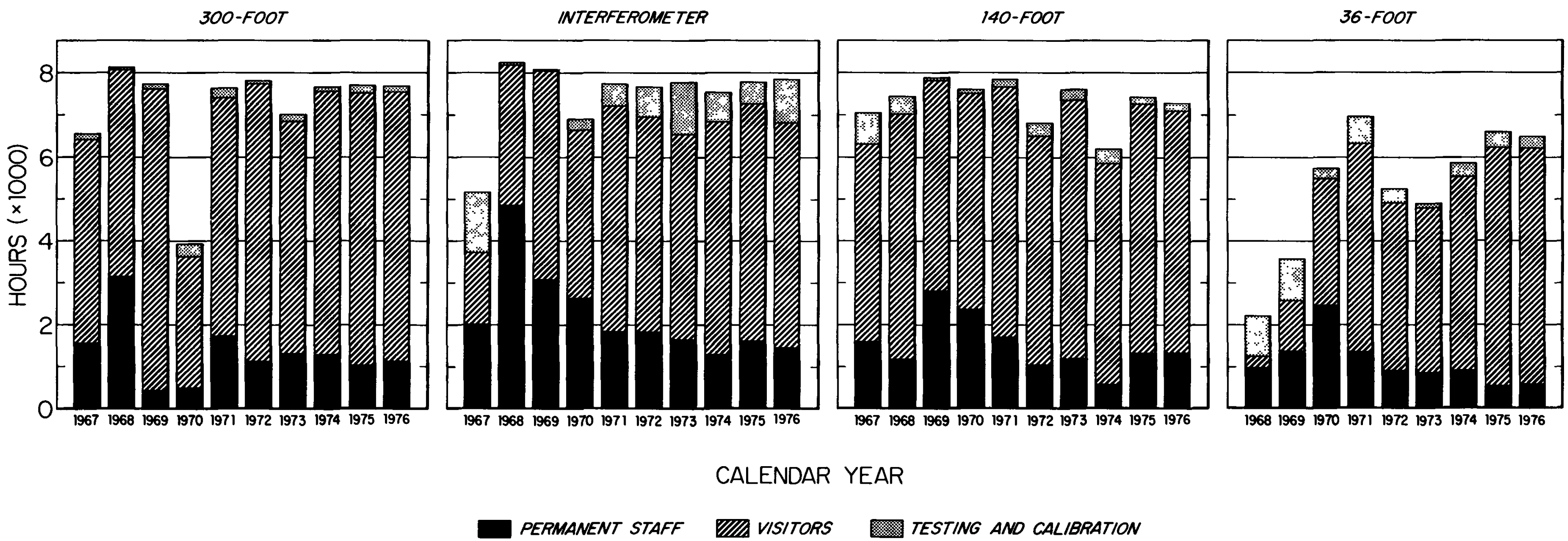


Fig. 2. These graphs show the number of hours devoted to calibration and testing and to observing by NRAO permanent staff members and by visitors on each telescope system during the last decade. The 36-foot telescope began operation in 1968.

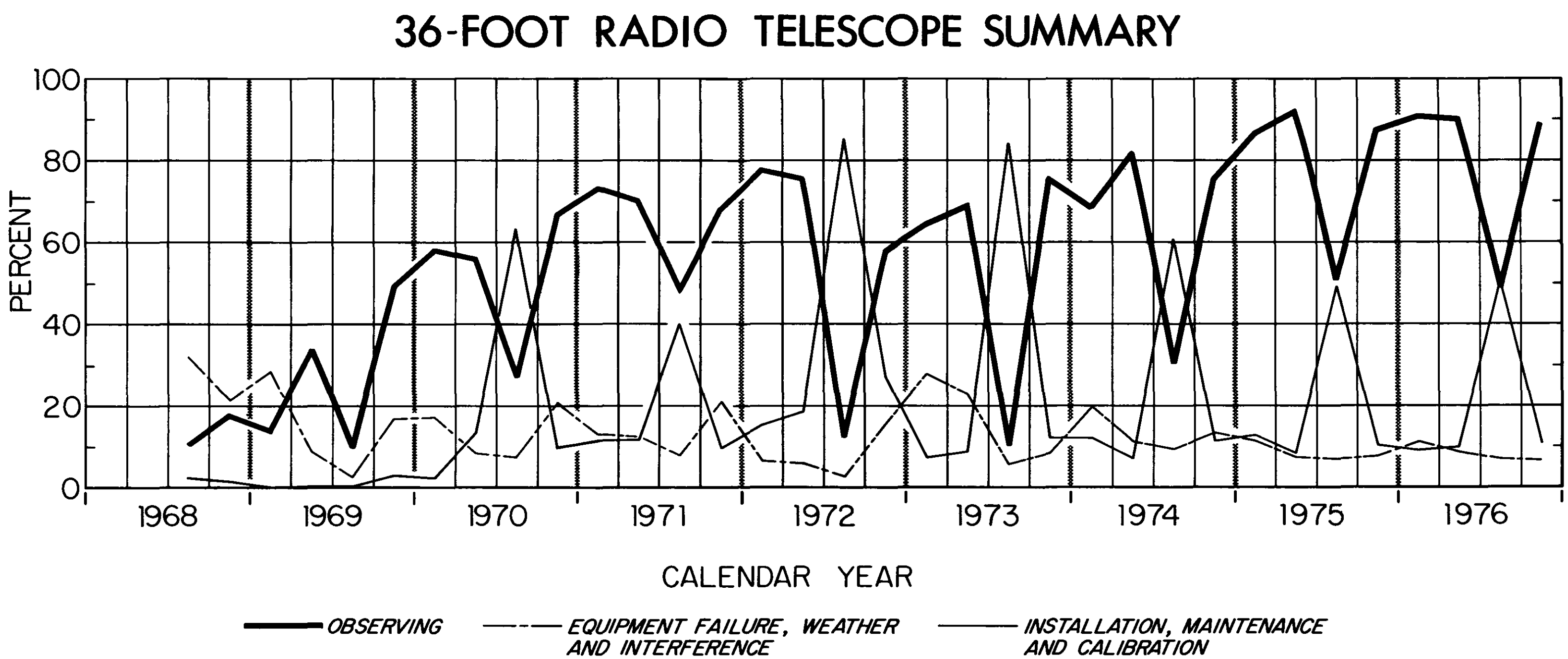


Fig. 3. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine calibration, maintenance, and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference.

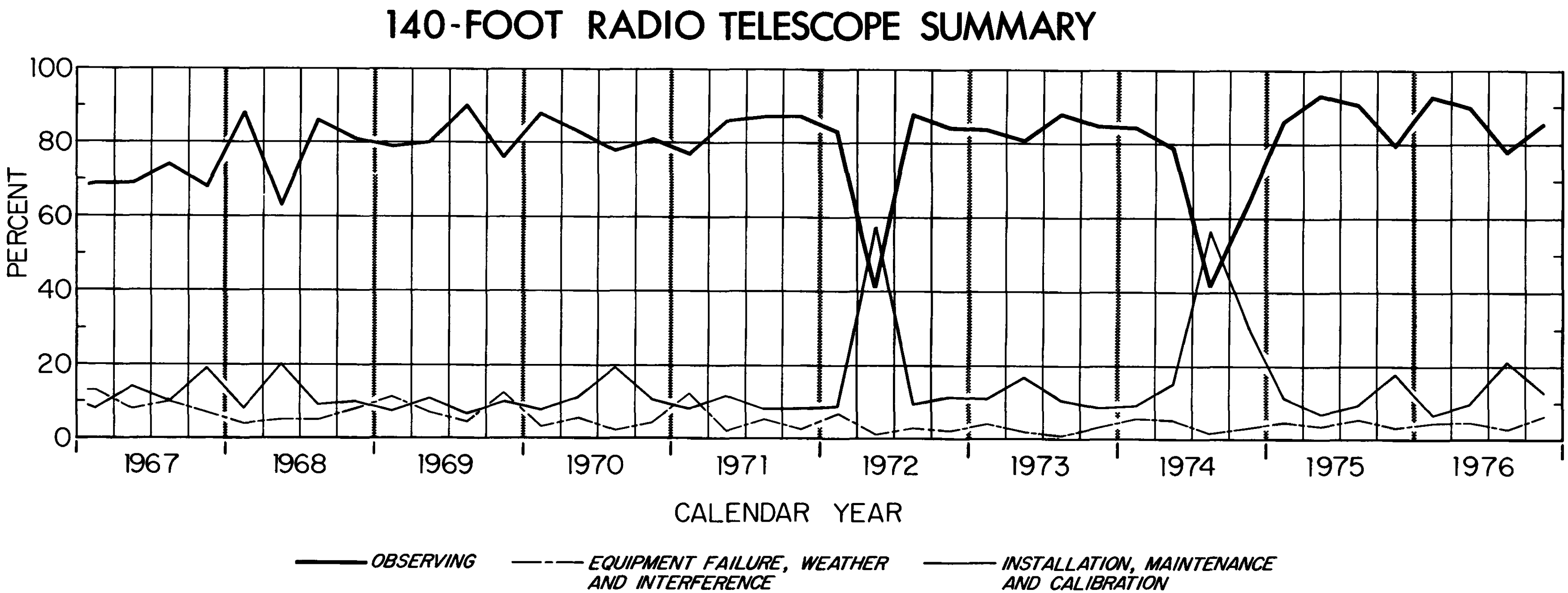


Fig. 4. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine calibration, maintenance, and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference.

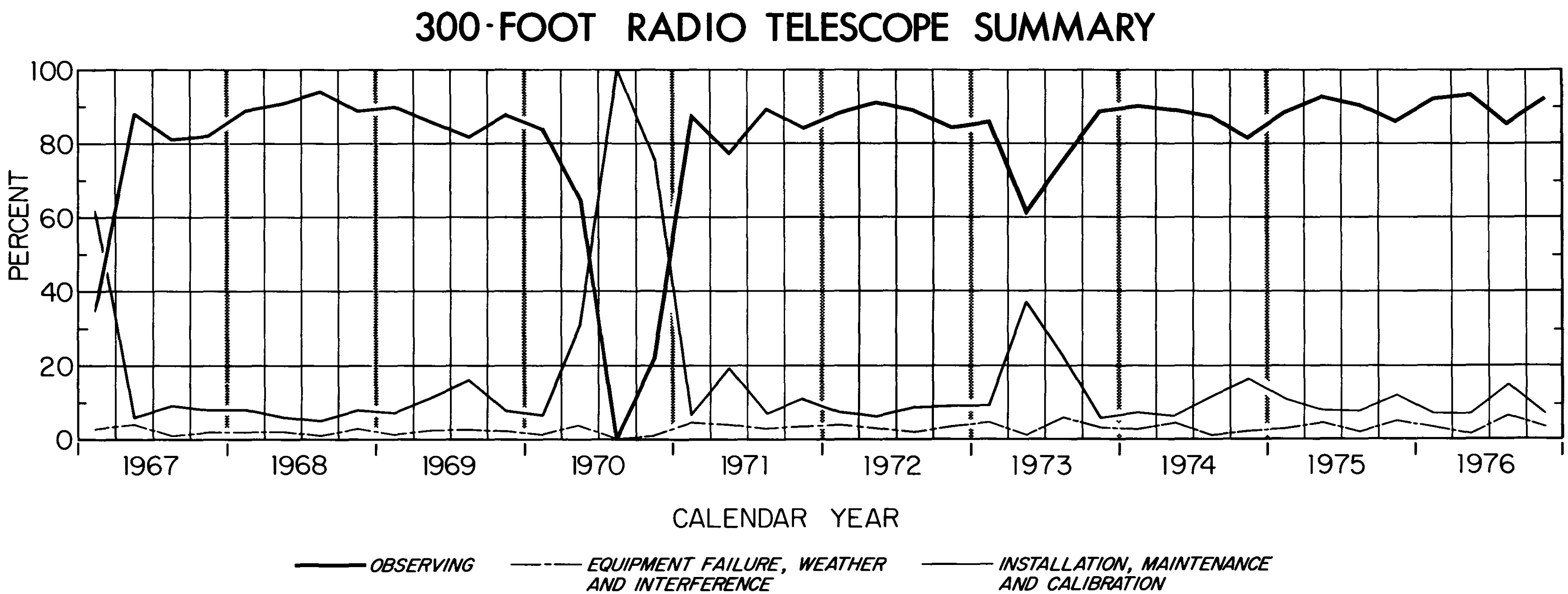


Fig. 5. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine calibration, maintenance, and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference.

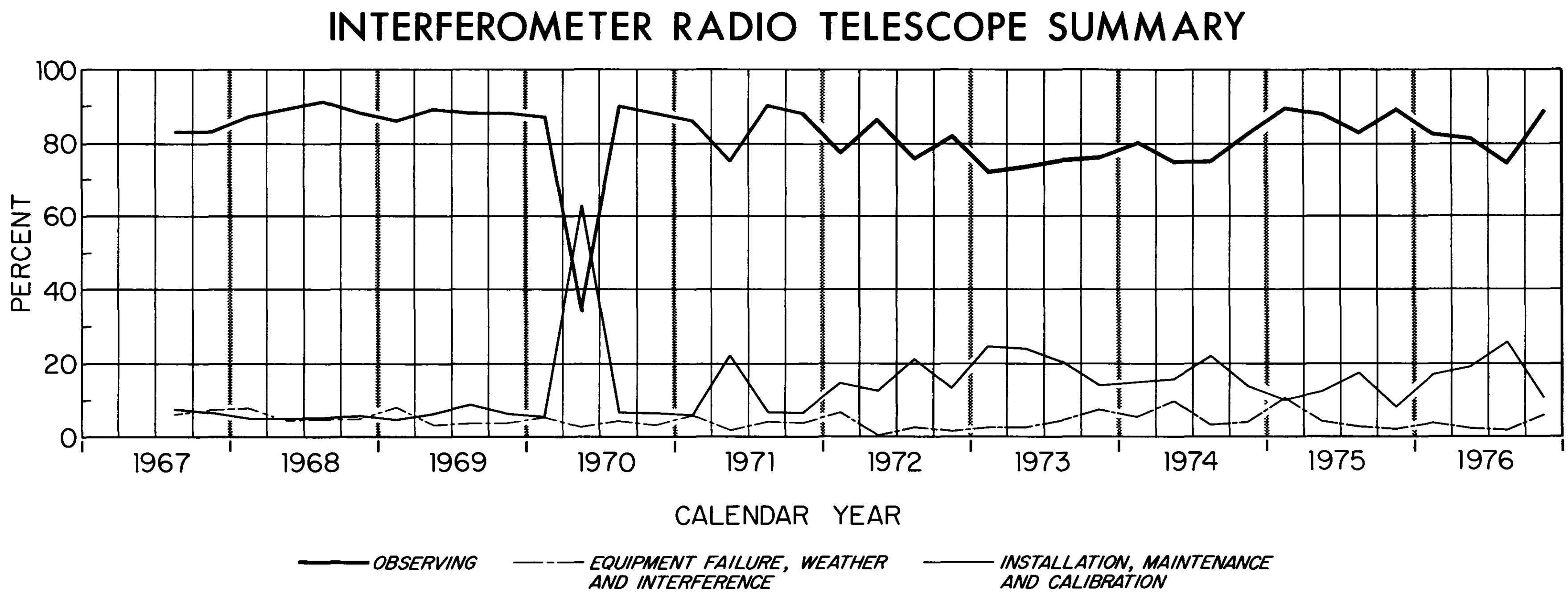


Fig. 6. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine calibration, maintenance, and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference.

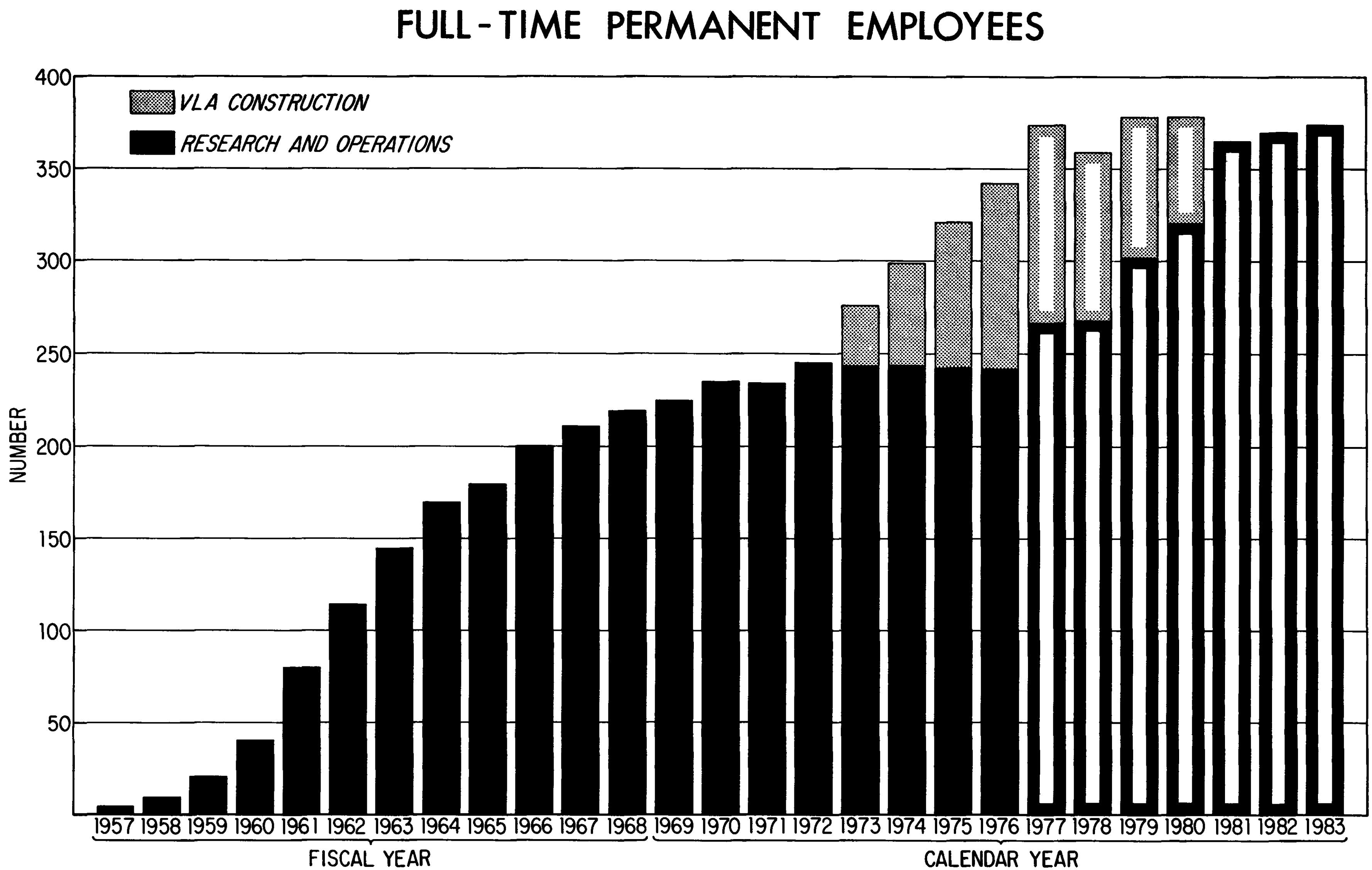


**Fig. 7.** **This figure shows the total number of NRAO full-time, permanent employees at the end of each year, projected into the future.**

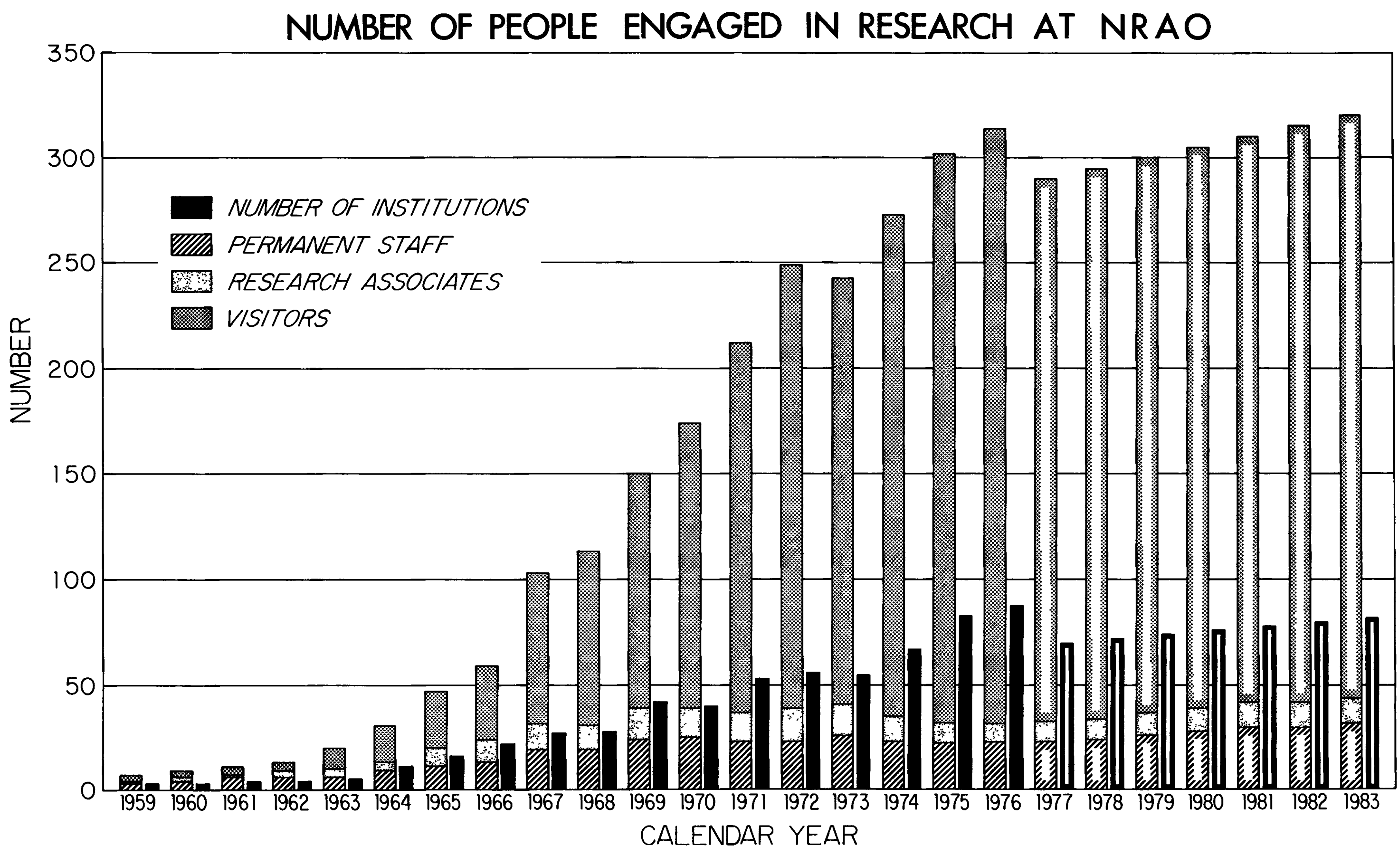


Fig. 8. This bar chart shows for each calendar year the size of the NRAO permanent research staff and the number of research associates on one or two year appointments. In addition it shows the total number of visitor-users of NRAO telescopes and the number of institutions from which the NRAO visitors come.

Distribution of Telescope Time by Per Cent

| | 36-ft | Interferometer | 140-ft | 300-ft | 1976 Summary |
|---|---|---|---|---|---|
| Visitors | 61% | 40% | 50% | 28% | 45% |
| Students | 9 | 15 | 15 | 23 | 16 |
| Permanent Staff | 7 | 17 | 16 | 14 | 13 |
| Research Associates | 1 | 9 | 5 | 24 | 10 |
| Test and Calibrate | 4 | 12 | 2 | 2 | 5 |
| Maintenance and Installation | 17 | 6 | 11 | 8 | 10 |
| Holidays and Unscheduled | 1 | 1 | 1 | 1 | 1 |

Distribution of Scheduled Observing Time in Various Research Areas, by Per Cent

| | | 36-ft | Interferometer | 140-ft | 300-ft | 1976 Summary |
|---|---|---|---|---|---|---|
| I. | Solar System--Sun, Planets, Satellites, Interplanetary Medium | 2% | 2% | 1% | 4% | 2% |
| II. | Galactic Sources--Continuum Stars, X-ray Sources, HII Regions, Supernova Remnants, etc. | 6 | 24 | 2 | 28 | 15 |
| III. | Galactic Sources--Line Dust Clouds, HII Regions, IR Sources, Molecular Searches, etc. | 67 | 4 | 54 | 1 | 31 |
| IV. | Galactic Structure--Line and Continuum Spiral Arms, Halo, Galactic Center, High Velocity Clouds | 7 | 3 | 6 | 12 | 7 |
| V. | Extragalactic Sources--Continuum Normal Galaxies, Radio Galaxies, Quasars, VLB Studies | 11 | 57 | 24 | 21 | 28 |
| VI. | Extragalactic Sources--Line Hydrogen, Molecules in Galaxies, Quasar Absorption Studies, etc. | 7 | 10 | 13 | 34 | 17 |

INSTITUTIONS FROM WHICH VISITORS CAME TO USE NRAO TELESCOPES DURING 1976

| | | Telescope | | | |
|---|---|---|---|---|---|
| | Institution | 36-ft | Interferometer | 140-ft | 300-ft |
| 1. | Aerospace Corp. | x | | x | |
| 2. | Alabama, U. of | | | x | x |
| 3. | Arizona, U. of | x | x | x | |
| 4. | Ball Brothers Research Corp. | x | | | |
| 5. | Battelle-Northwest Laboratories | | | x | |
| 6. | Bell Telephone Laboratories | x | | | |
| 7. | Berkeley, U. of California | x | x | x | x |
| 8. | Bologna, U. of Italy | x | | x | x |
| 9. | Brandeis U. | | x | | |
| 10. | British Columbia, U. of | | x | | x |
| 11. | Cambridge, U., England | | | x | |
| 12. | California Institute of Technology | x | x | x | x |
| 13. | Chalmers Institute of Technology, Sweden | | | x | |
| 14. | Chicago, U. of | x | | x | |
| 15. | Columbia U. | x | | | |
| 16. | CSIRO, Australia | | x | x | |
| 17. | Cornell U. | | x | | x |
| 18. | DTM, Carnegie | | | x | x |
| 19. | Florida, U. of | | x | | |
| 20. | Fordham U. | x | | x | |
| 21. | Forth, Inc. | x | | | |
| 22. | Gorky Radio Physical Inst., USSR | x | | | |
| 23. | Harvard, Center for Astrophysics | x | x | x | x |
| 24. | Harvard, Fort Davis | | | x | |
| 25. | Haverford College | x | | | |

| | Institution | 36-ft | Interferometer | 140-ft | 300-ft |
|---|---|---|---|---|---|
| 26. | Hawaii, U. of | | | x | |
| 27. | Haystack Research Facility | | | x | |
| 28. | Illinois, U. of | x | x | x | |
| 29. | Indiana U. | x | x | x | x |
| 30. | Inst. de Astrophys., Liège, Belgium | x | | | |
| 31. | Inst. of Advanced Studies, Princeton | | x | | |
| 32. | IOTA, Cambridge, England | | x | | |
| 33. | International Res. and Tech. Corp. | | | x | |
| 34. | Iowa, U. of | | | x | x |
| 35. | Jagellonian U., Poland | | x | | |
| 36. | Jet Propulsion Lab | x | | x | |
| 37. | Jodrell Bank, England | | x | x | x |
| 38. | Kapteyn Lab, Groningen, Netherlands | | | x | x |
| 39. | Kentucky, U. of | x | | x | |
| 40. | Kitt Peak National Observatory | x | x | | |
| 41. | Leiden Observatory, Netherlands | | x | | |
| 42. | Lockheed Research Lab | x | x | | |
| 43. | Los Angeles, U. of California | x | | x | |
| 44. | Maryland, U. of | x | x | x | x |
| 45. | Massachusetts, U. of | x | x | x | x |
| 46. | Massachusetts Inst. of Technology | x | x | x | x |
| 47. | Max-Planck I.R., Bonn, W. Germany | x | x | x | |
| 48. | McKenzie U., Sao Paulo, Brazil | x | | | |
| 49. | Meudon, France | x | | x | |
| 50. | Michigan State U. | | x | | |
| 51. | Minnesota, U. of | x | x | x | x |
| 52. | Monash U., Australia | x | | | |
| 53. | NASA - Ames Research Center | | | x | |
| 54. | NASA - Goddard (Greenbelt) | x | x | x | x |
| 55. | NASA Institute for Space Studies (NYC) | x | | x | |

| | Institution | 36-ft | Interferometer | 140-ft | 300-ft |
|---|---|---|---|---|---|
| 56. | NASA Marshall Space Flight Center | x | | | |
| 57. | National Astronomy & Ionospheric Center | x | x | | |
| 58. | National Bureau of Standards | x | | x | |
| 59. | National Research Council, Canada | | x | x | |
| 60. | Naval Research Labs | x | x | x | x |
| 61. | National Science Foundation, D. C. | | x | | |
| 62. | Nevada, U. of, Las Vegas | | | x | |
| 63. | Ohio State U. | | x | | |
| 64. | Pan American U. | | | | x |
| 65. | Penn State U. | | | | x |
| 66. | Pittsburgh, U. of | x | | x | x |
| 67. | Princeton U. | x | | x | |
| 68. | Queen Mary College, London, England | x | | | |
| 69. | Rensselaer Polytechnic Inst. | x | | x | |
| 70. | Rice U. | | | x | |
| 71. | Sagam Chemical Research Center, Japan | | | x | |
| 72. | San Diego, U. of California | | | | x |
| 73. | Santa Cruz, U. of California | | x | x | x |
| 74. | South Florida, U. of | | x | | |
| 75. | SUNY, Stony Brook | x | | | |
| 76. | Tennessee, U. of | x | | | |
| 77. | Texas, U. of | x | x | x | |
| 78. | Tokyo Astronomical Observatory, Japan | x | | | |
| 79. | Toronto, U. of, Canada | | x | x | x |
| 80. | Torun Observatory, Poland | | x | | |
| 81. | Toyama U., Japan | x | | x | |
| 82. | Tufts U. | | x | | |
| 83. | Virginia, U. of | x | x | x | x |
| 84. | Virginia Polytechnic Inst. & State U. | x | x | x | x |
| 85. | Washington, U. of | x | x | x | x |

| Institution | | 36-ft | Interferometer | 140-ft | 300-ft |
|---|---|---|---|---|---|
| 86. | Wisconsin, U. of | | | x | |
| 87. | Yale U. | | | x | x |
| 89. | York U., Canada | | x | | |

| | | | | |
|---|---|---|---|---|
| No. Institutions : | 48 | 40 | 53 | 28 |
| No. Visitors : | 83 | 61 | 109 | 41 |
| No. Students : | 20 | 17 | 33 | 19 |
| No. Research Associates : | 2 | 4 | 6 | 6 |
| No. Permanent Staff : | 8 | 10 | 10 | 11 |
| Total Observers : | 113 | 92 | 158 | 77 |

All told, 282 visitors, including 68 students, from 88 institutions.

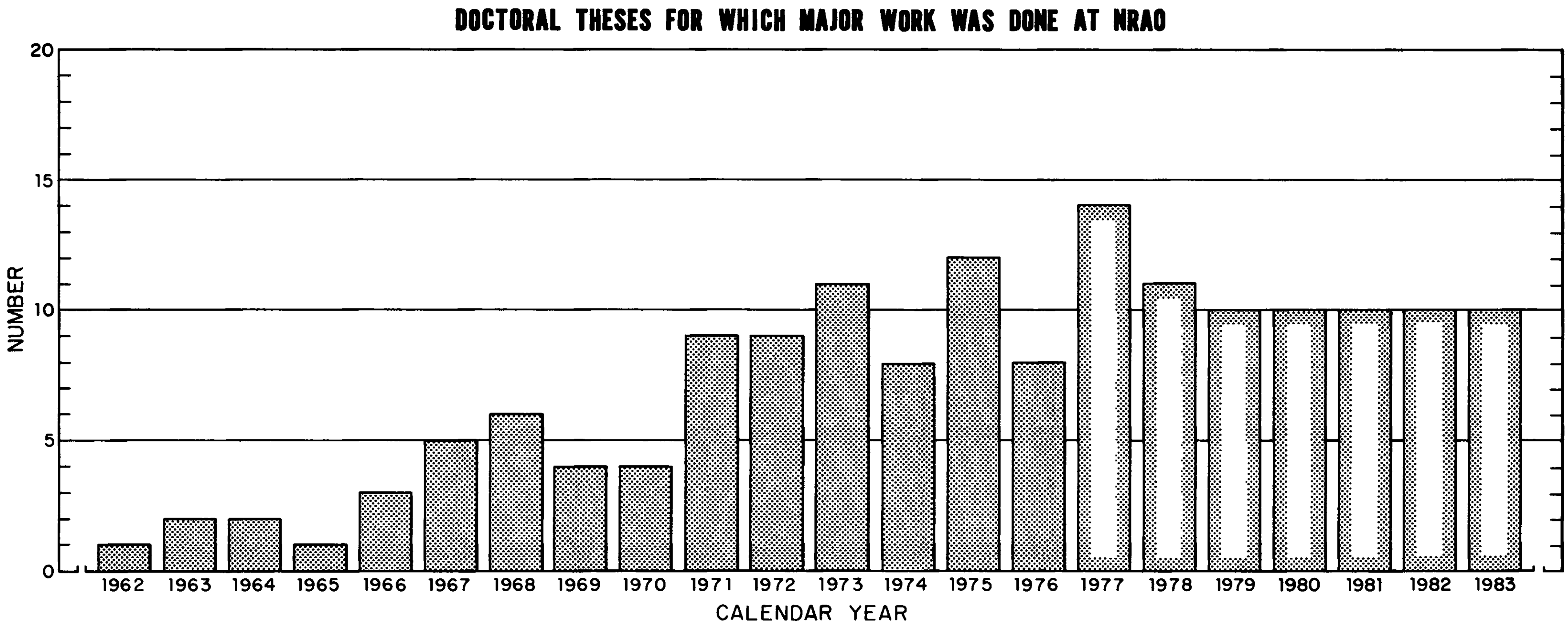


**Fig. 9.** This bar chart shows the number of doctoral dissertations produced each calendar year by Ph.D. students where the major work on the theses was done at the NRAO.

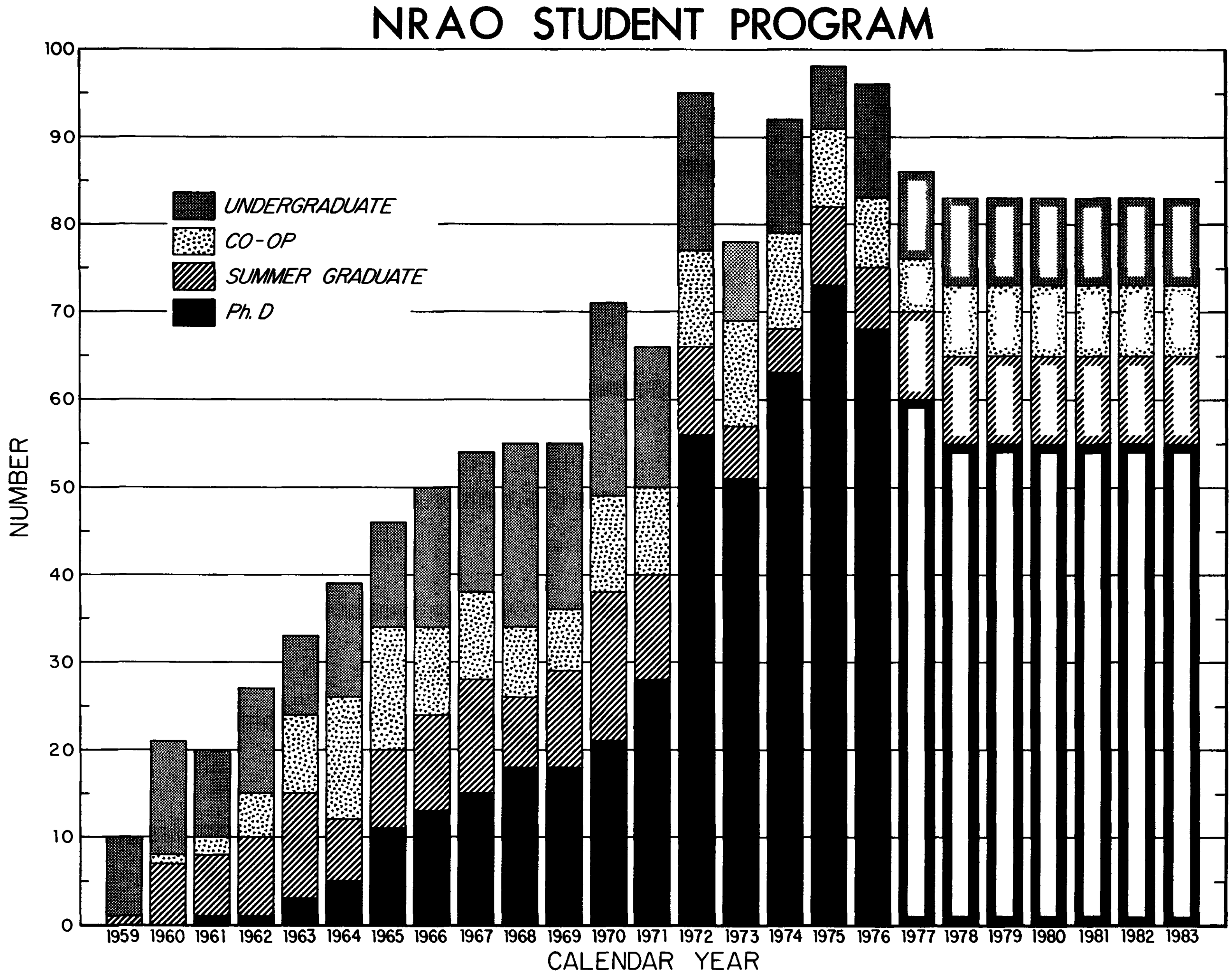


Fig. 10. This figure shows for each calendar year the number of Ph.D. students (salaried and non-salaried), co-op students, and summer undergraduate and graduate students who observed or worked at the NRAO during that year.

## NRAO FRONT-END BOX STATUS

TECHNICAL DATA SHEET
NOVEMBER 1976



| Applicable Telescope | Frequency (MHz) | Amplifier Type | System Temperature (Kelvin) | 3 dB Bandwidth (MHz) | Feed Type | Polarization | Calibration Value | Switching System | Remarks | Person in Charge |
|---|---|---|---|---|---|---|---|---|---|---|
| 300-ft Fixed on Traveling Feed | 50-80 | Transistor | ≥ 450 K - ≥ 500 K with Dicke switch. | 5 | ≃ 10% Bandwidth. Tunable Crossed-Dipole. | Simultaneous 0°, 45°, 90°, 135° Linear, RCP and LCP. Removable quad hybrid at feed for circular. | Adjustable 30 K to 30 000 K. | Removable diode Dicke switch. | Designed for pulsar, continuum, and line work. 110-500 MHz feeds can be manually rotated 45° and 90° for polarization work. Usable with 4-channel multi-bandwidth receiver and all NRAO line receivers. About 2 hours to change Dicke switch and feed hybrid. Frequency switching not available. | Behrens |
| 140-ft Clip-On | 110-250 | | ≥ 200 K - ≥ 260 K with Dicke switch. | 140 | Broadband Crossed-Dipole. | | Adjustable 8 K to 8000 K. | | | |
| | 250-500 | | ≥ 320 K. ≥ 200 K with removable 330-450 MHz amplifiers. Additional 50 K with Dicke switch. | 250 | Broadband Crossed-Dipole. | | Adjustable 1.5 K to 1500 K. | | | |
| 300-ft Fixed on Traveling Feed 140-ft | 515-610 | Paramp ChX | ≥ 150 | 20 to 40 | Broadband Crossed-Dipole | Single linear; circular with removable quad hybrid. Dual polarization at 610 MHz. | 5 K or 50 K | Frequency switching. Removable Dicke switch. | Traveling feed box for 300-ft. Can be used on 140-ft. No box rotation. Multiple polarization with IF polarizer on 300-ft at 610 MHz. About 2 hours to change hybrid and Dicke switch. Feed can be manually rotated 45° and 90° on box. | Brundage |
| | 610-740 | Paramp ChY | | | | | | | | |
| 300-ft Fixed on Traveling Feed 140-ft | 740-880 | Paramp ChX | ≥ 150 | 20 to 40 | Broadband Crossed-Dipole. | Single linear; circular with removable quad hybrid. Dual polarization at 835 MHz. | 5 K or 50 K | Frequency switching. Removable Dicke switch. | Traveling feed box for 300-ft. Can be used on 140-ft. No box rotation. Multiple polarization with IF polarizer on 300-ft at 835 MHz. About 2 hours to change hybrid and Dicke switch. Feed can be manually rotated 45° and 90° on box. | Brundage |
| | 830-1000 | Paramp ChY | | | | | | | | |
| 300/140-ft | 1000—1450 Dual Channel | Cooled Upconverter | 45 to 70 | 200 | Single Beam Scalar | Orth. Linear | 3.4 K | Frequency switching. | Part of 4.5—5.1 GHz receiver listed below. Feed change required to go to 6 cm. | Coe |
| 140-ft | 1350—1750 Dual Channel | Cooled Upconverter | | | | | | | See Cassegrain description on page 3. | |
| 300/140-ft | 1400 x 4 | Paramp | 150 | 60 | 4 Horns | Linear | 4 K and 15 K | 300 K load, Dicke switching, or frequency switching. | Line or continuum from control room. | |

| Applicable Telescope | Frequency (MHz) | Amplifier Type | System Temperature (Kelvin) | 3 dB Bandwidth (MHz) | Feed Type | Polarization | Calibration Value | Switching System | Remarks | Person in Charge |
|---|---|---|---|---|---|---|---|---|---|---|
| 140/300-ft | 1410<br>Dual<br>Channel | Cooled<br>Paramp | 50 | 25 | Scalar | Orth. Linear | 4 K | Frequency switching. | Can be remotely tuned anywhere in frequency range 1375-1435 MHz. Two channels can be used simultaneously at different frequencies. Six polarizations are available simultaneously with IF polarimeter. Will tune 1370-1440 MHz with higher noise temperature outside range 1375-1435 MHz. | |
| | | | 80 | | Zeeman | Orth. Linear<br>or<br>Circular | | | | |
| 140/300-ft | 1610—<br>1720<br>Dual<br>Channel | Cooled<br>Paramp | 60 | 30 | Scalar | Orth. Linear | 4 K | Frequency switching. | Can be remotely tuned anywhere in frequency range 1610-1720 MHz. Two channels can be used simultaneously at different frequencies. Six polarizations are available simultaneously with IF polarimeter. Will tune 1540-1780 MHz with higher noise temperature outside range 1610-1720 MHz. | |
| 140/300-ft | 1000 to<br>2000 | Paramp | 175 to 300 | 20 to 60 | 1-2 GHz<br>Scalar | Linear | 10 K | 300 K load or frequency switching. | Set of seven tunable paramps in two receiver boxes. Paramp change 2 hours. Receiver change 4 hours.<br>Rx 1: 1.0-1.15 \| 1.16-1.3 \| 1.3-1.7 \| 1.62-2.0<br>Rx 2: 2.0-2.54 \| 2.5 -3.15 \| 3.4-3.7 \| Paramps.<br>2.1-2.4 \| 2.6 -3.1 \| 3.3-3.9 \| LO Multi-pliers.<br>Installed Micromega 13 cm paramp (2295 MHz) and Radiation Systems feed. | Dunbrack |
| 140/300-ft | 2000 to<br>4000 | Paramp | 220 to 450<br>130 between<br>2295 to<br>2380 MHz. | 30 to 100 | 2-4 GHz<br>Scalar | Linear | 10 K | 300 K load or frequency switching. | | |
| 300/140-ft | 2695 x 4 | Degenerate<br>Paramp | 120 | 100<br>DSB | 3 Horns | Circular or<br>Linear | 4 K | 300 K load or polarization. | Continuum receiver. On-axis horn has paramps on both polarizations. Four hours to change polarization. | |
| 300/140-ft | 3120—<br>3370<br>Dual<br>Channel | Cooled<br>Paramps | 55 K line and load switched.<br>70 K polariza-tion switched. | 250<br>Fixed<br>Tuned | Single<br>Beam,<br>Dual<br>Polarized | Orth. Linear<br>or<br>Orth.<br>Circular | 4 K<br>and<br>14 K | Cooled Dicke switches (latching ferrite) for load (20 K) switching or beam/polarization switching with noise injection for balancing 10 Hz maximum rate. Frequency switching requires 30 ms blanking. | Continuum and line use. Feed change approxi-mately 6 hours on 300-ft and 2 hours on 140-ft. | Brundage |
| | | | 63 K load switched.<br>75 K beam switched. | 250<br>Fixed<br>Tuned | Dual Beams offset by 15 arc min (3 HPBW), singly polarized. | Identical Linear<br>or<br>Identical<br>Circular<br>or<br>Orth. Circular | | | | |
| 300/140-ft | 4500—<br>5100<br>Dual<br>Channel | Cooled<br>Paramp | 70 | 580 | Single Beam | Orth. Linear | 1.4 K | Other polarization, cold load. | Includes cooled upconverter for 1.0—1.45 GHz. Feed change required to go to 25 cm. | Coe |
| | | | | | Dual Beam<br>Offset<br>3 HPBW | Identical or<br>Orth. Circular<br>or Ident. Linear | | | | |
| 140-ft | 4500—<br>5000<br>Dual<br>Channel | Cooled<br>Paramp | | | | | | | See Cassegrain description on page 3. | |
| 140/300-ft | 4750—<br>5100 | AIL<br>Cooled<br>Paramp | 90 line<br>135 continuum | 225 | Scalar or<br>2 Horns | Dual Linear<br>Orth. Linear | 4 K | Other polarization, other beam, or 50 K load. | Feed change requires 3 hours. Dual horns are used for beam switching. A horn can be mounted off-axis to scalar feed, but beam spacing is high, approximately 30'. Two hours for switch change. | Behrens |
| 140/300-ft | 4500—<br>5300 | TRG<br>Cooled<br>Paramp | 50-70 line | 250 | Scalar | Linear | ≈ 5 K | Frequency switching. | Bandwidth and noise varies with center fre-quency. | Behrens |

TECHNICAL DATA SHEET
NOVEMBER 1976

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| Applicable Telescope | Frequency (MHz) | Amplifier Type | System Temperature (Kelvin) | 3 dB Bandwdith (MHz) | Feed Type | Polarization | Calibration Value | Switching System | Remarks | Person in Charge |
|---|---|---|---|---|---|---|---|---|---|---|
| Any | 4800—5100 | Paramp | 150 | 20 | | | ≈ 10 K | Dicke switch available. | Packaged in small temperature-controlled box. Can be installed on other telescopes with little effort. | |
| 140-ft | 8.2—8.5 GHz | Cooled Paramp | 65 line<br>85 continuum | 125 | Conical Horn | Linear or Circular | ≈ 9 K | Frequency or off-axis beam. | Two hours to change switch; 1/2 hour to change polarization. | Brockway |
| 140-ft | 5.2—10.4 GHz | Paramps | 300 to 400 | 40 | Horn | Linear | ≈ 20 K | Frequency switching. | Set of 7 tunable paramps in 2 bands about 7 GHz. Paramp change 1-1/2 hours. Band change 3 hours.<br>Band 1: 5.2—5.8 \| 5.8—6.4 \| 6.4—7.0 \|<br>Band 2: 7.0—7.8 \| 7.8—8.6 \| 8.6—9.5 \| 9.5—10.4<br>Circular polarization available at select frequencies. | Brockway |
| 140-ft | 6035 | Paramp | ≈ 90 | 150 | Scalar | Linear or Circular | ≈ 10 K | Frequency | Available late 1976. | Brockway |
| Any | 10 695 | Paramp | 250 | 20 | | | ≈ 10 K | Dicke switch available. | Packaged in small temperature-controlled box. Can be installed on other telescopes with little effort. | |
| 140-ft | 10 300—11 000 | TRG Cooled Paramp | 120 continuum<br>70—90 line | 300 | 2 Horns or Scalar | Dual Linear or Orth. Linear/Circular | ≈ 7 K | Other polarization, other beam, or 25 K load. | Two feed arrangements available: (1) Scalar and (2) dual horns for beam switching. Bandwidth and noise varies with center frequency. Two hours to change switch. | Behrens |
| 140-ft | 14.4—14.9 GHz Dual Channel | Cooled Paramp | 100-150 | 500 | 2 Horns or Scalar | Orth. Linear/Circular or Dual Circular/Linear | ≈ 20 K | Frequency, beam, or polarization switching. | Two feeds available: Two off-axis horns or dual polarization scalar. | |
| 140-ft | 14.4—15.4 GHz | Cooled Mixer | | | | | | | See Cassegrain description on page 3. | |
| 140-ft | 12.4—18 GHz | TDA's | 1000 to 1300 | 50 | Horn | Linear | ≈ 10 K | Off-axis beam. | Contains LO system tunable 12.4—18 GHz. Three TDA's to cover the band: 12.4—14.5, 14.5—16.0, and 16.0—18.0. | Brockway |
| 140-ft Cassegrain | 1350—1750 Dual Ch. | Cooled Upconverter | 50 to 75 | 400 | Lens Corrected Horn | Orth. Linear | 10 K | Frequency. | Cassegrain receiver. Frequency bands selected by changing position of subreflector. Beam switched by nutating subreflector. Dual frequency operation available at 2 and 6 cm with feed dichroic system. | Brockway |
| | 4500—5000 Dual Ch. | Cooled Paramp | 45 to 70 | 500 | Horn | Orth. Circular | 10 K | Frequency or beam. | | |
| | 14.4—15.4 GHz | Cooled Mixer | 350 to 600 | 500 | Horn | Orth. Circular | 50 K and 5 K | Frequency or beam. | | |
| | 22.2—24.0 GHz | Cooled Mixer | 500 to 600 | 500 | Horn | Orth. Linear | 50 K and 5 K | Frequency or beam. | | |

# NRAO FRONT-END BOX STATUS



| Applicable Telescope | Frequency (MHz) | Amplifier Type | System Temperature (Kelvin) | 3 dB Bandwidth (MHz) | Feed Type | Polarization | Calibration Value | Switching System | Remarks | Person in Charge |
|---|---|---|---|---|---|---|---|---|---|---|
| 36-ft | 22—24 GHz | Degenerate Paramp | 300 DSB | 100 DSB | Horn | Linear | ≈ 60 K | Load, beam, or frequency. | Stabilized LO system. | Cochran |
| 36-ft | 31—50 GHz | Mixer | 1500 SSB | 100 | Horn | Linear | 150 K | Chopper wheel or frequency. | Line receiver. | Ross |
| 36-ft | 31.4 GHz | Mixer | 700 DSB | 400 | 2 Horns | Variable | 13.8 K | Other beam or load. | Continuum receiver. | Freund |
| 36-ft | 31.4 GHz | Mixer | 530 DSB (Each Channel) | 1 GHz | Cassegrain and Horn | Dual Linear | ≤ 10 K | Nutating subreflector. | Continuum receiver. Four channels with two feeds each receiving orthogonal linear polarizations. This configuration gives an improvement in signal to noise of three over a single channel. This represents an improvement of 5.5 over the existing prime focus receiver (a reduction in integration time of a factor of 29). Available 12/76. | Freund |
| 36-ft | 47.5 GHz | Degenerate Paramp | 150 DSB | 200 DSB | Horn | Linear | 10 K | Nutating subreflector. | Line or continuum. Two channels receive orthogonal linear polarizations. One channel tunes from 46.4 to 47.38 GHz with an IF bandwidth of 150 MHz. The other channel tunes from 45.3 to 47.2 GHz with an IF bandwidth of 75 MHz. | Ross |
| 36-ft | 67—85 GHz | Mixers | 1500 SSB | 100 | Horn | Linear | 30 K | Frequency or chopper wheel. | Stabilized LO for line work. Component changes required to tune over the 67-85 GHz range. | Ross |
| 36-ft | 80—120 GHz | Cooled Mixer | 500—1000 SSB per channel | 500 MHz | Cassegrain Horn and Lens | Dual Linear | ≤ 10 K | Nutating subreflector or frequency. | Line or continuum. Two channels receive orthogonal linear polarizations. The second LO in one channel is variable, allowing channels to be separated by up to 500 MHz. A B.T.L. image rejection filter is available for calibrated spectral line work. | Davis |
| 36-ft | 80—120 GHz<br>33—50 GHz | Cooled Mixer | 500—1000 SSB per channel | 500 MHz | Cassegrain Horn and Lens | Dual Linear | ≤ 10 K | Nutating subreflector or frequency. | Two dual channel mixer receivers in same box. Line or continuum. The two channels of each receiver are orthogonally polarized. The second LO in one channel is variable, allowing channels to be separated by up to 500 MHz. Three hours should be allowed for changes from 80-120 to 33-50 or vice versa. The 33-50 GHz receiver will use an image rejection mixer; the 80-120 GHz receiver will use an image rejection filter for line work. Available December 1976. | Davis |
| 36-ft | 250 GHz | Cooled "3-Part" Bolometer | 30 000 | 100 GHz Limited by filters and atmosphere. | Optical Single or Dual Beam | Unpolarized | Special procedure. | Other beam or load. | Scandium-Germanium bolometer. Reaches approximately 4 Jansky RMS in 1 hour under dry weather conditions. NEP 2 x $10^{-13}$. | Albaugh |

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