the
Observer

fall '81

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A special thanks to all the people who contributed articles and who helped with the OBSERVER.

WATCHING THE EVOLUTION OF A RADIO SOURCE

R. M. Hjellming

In the early 1970's, the Green Bank interferometer played an important role in the first extensive observations of a variety of stars that were radio sources. The initial motivation for much of this observing was a hypothetical question about the potential of the VLA for observing stars. Since the first observations of novae, an X-ray star, and the star Antares with the Green Bank interferometer in 1970, roughly a hundred stars of different types have been observed as radio sources. Most radio sources associated with stars are so small that they cannot be resolved. They mainly exhibit interesting changes in radio flux and spectrum on time scales that range from minutes to years.

One star system, known as SS433 from its' initial discovery as the 433rd entry in a catalog of optical emission line stars published by Stephenson and Sanduleak, is now nearly the ultimate in radio stars: a star with radio "jet" structures that can be observed by the VLA as changing drastically from one month to the next.

SS433 gained notoriety as the object that is "both coming and going at the same time". This is an apt description of the behavior of the material that produces its' optical emission lines. Most of these lines have twin components which change wavelength, in opposite directions, continuously from night to night in a manner

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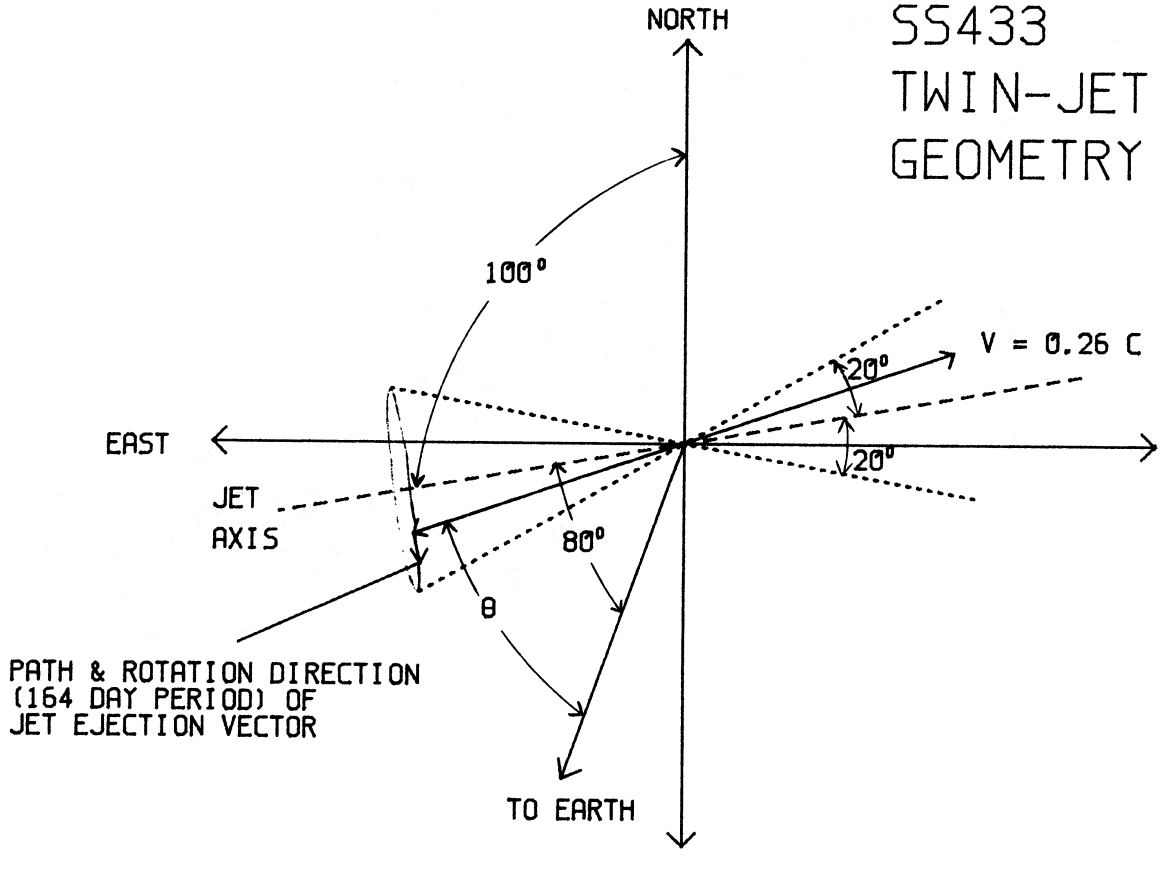

Figure 1.

best interpreted in terms of emitting gas moving in opposite directions with speeds 0.26 times the speed of light (78,000 km/sec). However, the direction of motion of these gas streams rotates every 164 days around an axis at a 20 degree angle, and this axis is fixed at an angle of 80 degrees from the line of sight, only 10 degrees from the plane of sky.

Since the VLA was first available with most of its' antennas spread out at least 10's of kilometers along all three arms of the Wye, SS433 has been observed as a source with variable radio structure. In the June 15 issue of the Astrophysical Journal Letters a series of maps made by myself and Ken Johnston of NRL were shown to be evolving exactly as one would expect from radio-emitting material associated with twin-jet ejection vectors with the geometry shown in Figure 1. This geometry is consistent with the behavior of the optical emission lines, but the radio data have permitted the determination of many of the other parameters that were previously unknown or uncertain. In Figure 1, 0 is the angle to the line of sight at a particular instant, and it ranges between 60 and 100 degrees as the ejection vector rotates around the jet axis every 164 days. All ejected material remains, except for any expansion effects, on the surface of the twin-cones with surfaces 20 degrees from the jet axis. Furthermore, the only possible locations for ejected material on the twin-cones are the corkscrew-like curves such as those shown in Figure 2 super-imposed upon a series of VLA maps made between December 14, 1980, and April 21, 1981. The first two contour maps are at 2 cm with 0.13" resolution and the last three are 6 cm maps with 0.4" resolution. The dashed lines in Figure 2 indicate the extremes of the conical surfaces corresponding to the geometry of Figure 1. Maps similar but inferior to these were first used to

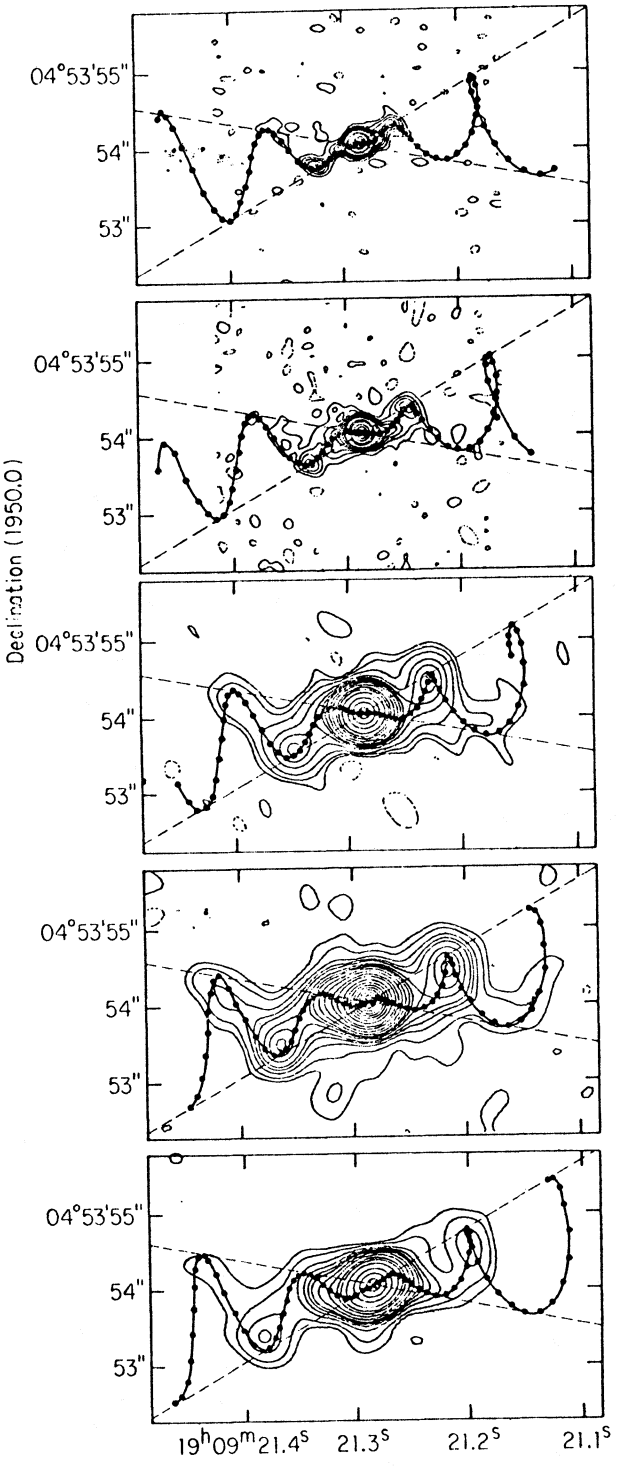

Figure 2.

determine all of the parameters of the twin-jet model as shown in Figure 1.

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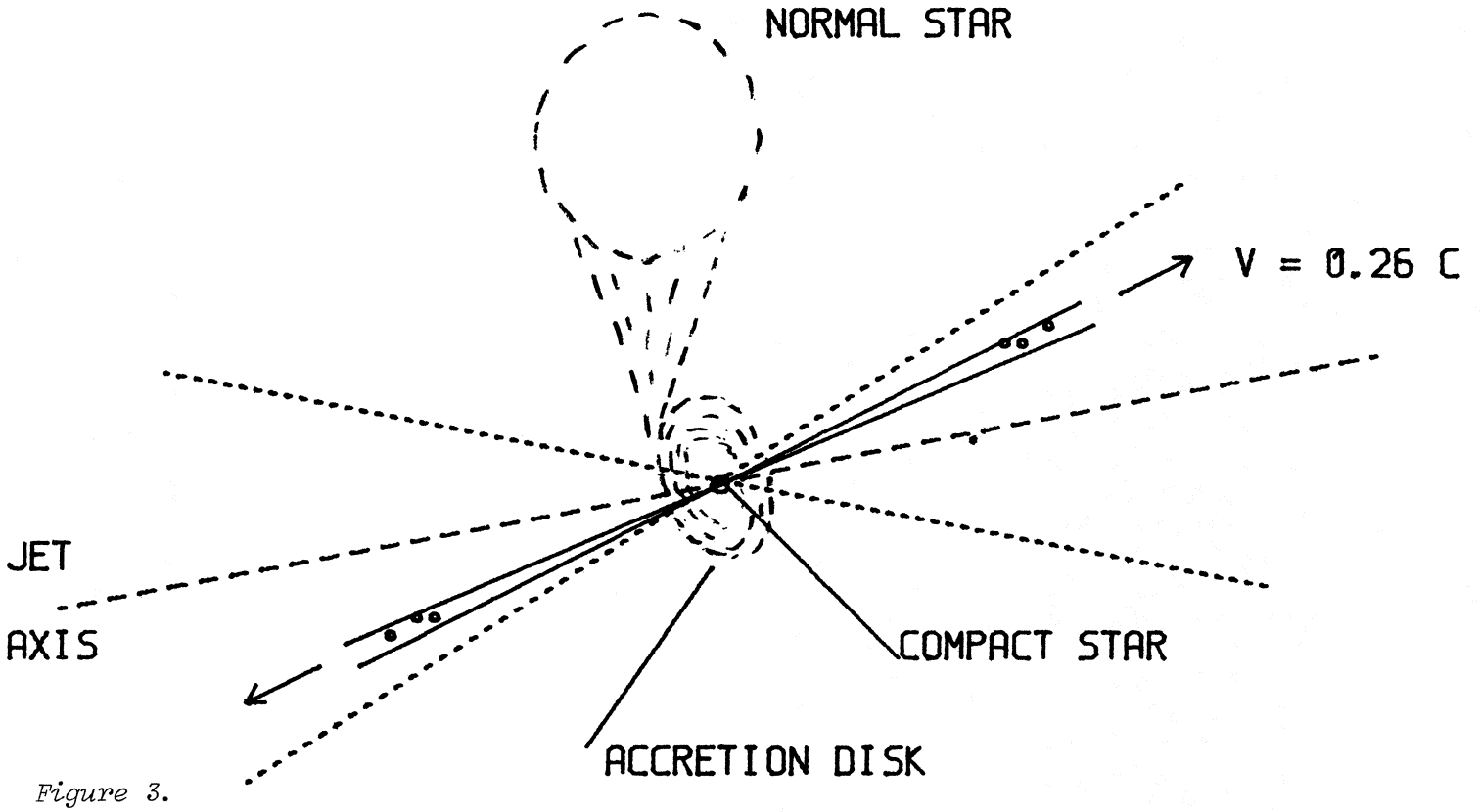

Figure 3.

Relativistic time travel effects allow the absolute determination of the speed of the moving radio-emitting material. This is the same 78,000 km/sec indicated by the optical emission lines, but in this case you can actually see the radio emission move across the sky away from the SS433 star system from one month to next. The combination of this velocity and the observed angular motion determine the distance to SS433 to be 18,000 light years.

The filled circles on the corkscrew patterns of Figure 2 correspond to ten day time intervals for the time of ejection from the center. As can be seen from Figure 2, all the radio emission, which is due to highly (20%) linearly polarized synchrotron radiation from relativistic electrons in magnetic fields, is located on the corkscrew patterns. In addition, the strength of the ejected radio emission weakens with time until it becomes undetectable several arcseconds from the star. Thus, in addition to the evolution of a radio source due primarily to motions and geometric effects, one can study the evolution in strength and spectrum with time. Thus one can obtain information which is not available, for example, for extra-galactic radio jets. Analysis of the SS433 evolution data is still under way, but exponential decays with time scales from 30 to 90 days are clearly seen in particular evolutionary sequences.

What is the root cause of it all? The wealth of optical and radio information about SS433 makes it very likely that the inner regions of SS433 look very much like the double star environment sketched in Figure 3. One star is dumping massive amounts of gas upon another "star" which is either a neutron star or a black hole. This process produces a rotating accretion disk that induces oppositely directed flows of gas moving along the axes of rotation with speeds of 78,000 km/sec. The dumping star induces precession in the

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accreting disk with a period of 164 days, and this produces the rotation of the flows about the jet axis of Figure 1, which is basically the axis of precession for the accretion disk. The little "blobs" in the flows of Figure 3 are the optically emitting regions which occur only within a few light days of the center. Somewhere in the inner tens of light days of these flows relativistic electrons, and probably magnetic fields, are generated by magnetohydrodynamic phenomena. The effects of this production of particles and fields are then seen in the moving radio-emitting material in regions from 10's to a few hundreds of light days from the star system. At any particular time one is observing the accumulation of a few hundred days of ejection in the proper motion corkscrews such as those seen in Figure 2.

Many of the SS433 radio jet phenomena may be the same, though on very different size and energy scales, as those occuring for some extra-galactic radio jets. Thus a radio star in our galaxy may prove to be a major "Rosetta Stone" for understanding the cores and jets of extra-galactic radio sources. One would like to have more SS433's to study, but despite many searches, astronomers have not yet found another star system with highly supersonic, twin-jet phenomena.

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NEW SITE DIRECTOR FOR GREEN BANK

Bob Havlen

Friendly competition between the two U. S. National Centers for Radio Astronomy has resulted in the appointment of Martha Haynes as the new Green Bank Site Director. Martha replaces Rick Fisher, who will resume his former electronics development duties in the electronics lab.

Although new to her duties as Site Director, Martha is certainly not new to

Martha Haynes

the Green Bank environment. Her friendly smile and Boston accent will be quite familiar to all the Green Bank staffers who recall her student days with the NRAO. She first got her introduction to the subtleties of radio astronomy as a summer student with Dick Sramek and later returned to carry out most of her thesis observations on the 300-foot as a student with Mort Roberts while jointly sponsored by the NRAO and Indiana University.

Martha's involvement in the operation of a visitor oriented national facility increased by several orders of magnitude when, after completing her degree, she accepted a research associate position at Arecibo. During the past three years at Arecibo, while aggressively pursuing her pet research project of environmental effects on the HI content of galaxies, she moved up into a staff scientist position and became heavily involved in numerous visitor programs where her dedication and experience with the equipment

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were important ingredients to the success of the mission. Even then, Martha found the time and motivation to become fluent in Spanish, help her husband, Ricardo Giovanelli, build their own house from the ground up, and visit the NRAO frequently, both in her capacity as a member of the NRAO User's Committee and as a visiting observer.

Now that she is assigned the task of overseeing the pulse of Green Bank activity, many areas will simultaneously demand her attention. Everyone who knows Martha will agree that what is one observatory's loss is another observatory's gain. We all wish her well in the new challenges that she now faces.

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"HOW HOT IS IT?"

Pat Crane

Summer in Green Bank -- I enjoyed the cool summer weather so common here. I just returned from New Mexico, where I also enjoy the dry heat. I carefully avoided the wet heat in Washington, D. C. (where U.R.S.I. General Assembly met) and Charlottesville.

Can my preferences be quantified? Certainly, and the National Weater Service has produced this table (similar to the wind-chill chart Richard Fleming reproduced in his article for the December 1976 Observer on homeostasis) which shows the apparent temperature for various combinations of temperatures and humidity. As you can see, 85° and 90% humidity in Green Bank (102°) is more comfortable than 105° and 20% in Albuquerque or Tucson (105°), and both are much more comfortable that the 90° and 90% humidity in Charlottesville (122°).

If the apparent temperature is above 130°, heatstroke or sunstroke may be imminent; it is extremely dangerous.

	Air Temperature										
	70	75	80	85	90	95	100	105	110	115	120
Relative Humidity	Apparent Temperature*										
0%	64	69	73	78	83	87	91	95	99	103	107
10%	65	70	75	80	85	90	95	100	105	111	116
20%	66	72	77	82	87	93	99	105	112	120	130
30%	67	73	78	84	90	96	104	113	123	135	148
40%	68	74	79	86	93	101	110	123	137	151	
50%	69	75	81	88	96	107	120	135	150		
60%	70	76	82	90	100	114	132	149			
70%	70	77	85	93	106	124	144				
80%	71	78	86	97	113	136					
90%	71	79	88	102	122						
100%	72	80	91	108							

*Degrees Fahrenheit.

Between 105° and 103°, sunstroke, heat cramps, and heat exhaustion are possible. With prolonged exposure and physical activity, heatstroke can occur. Between 90° and 105° all are possible with lengthy exposure and activity.

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BROTHERS HAVE ROYAL CELEBRATION

Aileen Cornwell & Sandy Braun

July 29 was the scene of a glittering social occasion at the Socorro home of the Hunt brothers, Gareth and Adrian formerly of Portsmouth, England. Unable to be in England for "The Wedding of the Century", they decided to mark the occasion with a Royal Celebration Socorro style. Resplendent in formal attire the international array of guests began arriving early in the evening and the festivities continued until late the next morning. Featured were international cuisine, the Royal roasting and a magnificent display of fireworks which thrilled assembled guests and neighbors. The decoration of the house featured portraits of the British

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Left to right: Gareth Hunt, Ina Cole, Arnold Rots.

Royal Family and the colour scheme was predominantly red, white and blue.

Out of town guests included: Jean and John Higgs of England, Vim and Joan Brouw of Holland, Tim and Aileen Comwell of England, Rick and Peggy Perley of Canada, Carl and June Bignell of Canada, Arnold and Betty Rots of Holland, Larenso Zaninetti of Italy, Alan and Mary Bridle of England and Ireland, Gloria Seaquest of Canada; and Errol Watson of Jamaica.

From Socorro were: Al and Sandy Braun, Kathleen Garrett, Claire Teuton, Bob DuQuet, Don Slosar, Eva Jean Rigby, Ed Fomalont, Alan Stavely, Dick Sramek, Chris O'Dea and, deserving special mention, James and Ina Cole, a particularly regal couple. Unable to attend was Dr. C. J. Salter of India, but there can be no doubt that he was present in spirit.

Although familiar faces from home were greatly missed it is true to say that friends from Socorro were able to make this occasion a joyous and memorable one and to shorten the distance between the old and new world.

(The above article was reprinted from the Socorro "Chieftan".)

A LETTER FROM BARRY CLARK TO WIM BROUW

Dear Wim,

In your article "Astronomy in the Netherlands" in the July 1981 issue of The Observer, we find the sentence "The Netherlands (Holland is only part of the country, and people from other parts of the country hate to be called "Hollanders' as much as Americans dislike being called 'Texans') is a small country ..."

I do find it rather unbelievable that anybody would dislike being called a Texan. Embarassed at having to disown the honorific, perhaps, but dislike ... surely not. Inappropriate though your metaphor is, I can understand its meaning merely by contemplating the carnage which must have been wreaked upon innocent Europeans who had the misfortune to call a Texan "Yankee".

Sincerely,

Barry Clark
Texan AND American

INSTRUMENTATION WORKSHOP

Rick Fisher

Green Bank turned on three spectacular fall days for 47 visiting electronics engineers who took part in a workshop on radio astronomy instrumentation sponsored by NRAO on September 21-23. It was an opportunity for people who spend most of their time in the laboratory to get out and swap notes on problems of common interest as well as to hear talks on a wide range of topics in instrumentation. Thanks go to many of the NRAO staff from all four sites for presenting an extremely interesting set of survey lectures and to many other participants for talks on specific subjects from their home institutions.

Plenty of time was available for tours through the Green Bank labs and telescopes, and for people to buttonhole co-experts in their fields of interest.

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THE 12-METER TELESCOPE

John Findlay

As Mark Gordon noted in the first NRAO Newsletter, the 36-foot will become a 12-meter telescope when its new back-up structure (BUS) and surface are in place and working. So we shall describe progress for the *Observer* under this title.

The plan we are following is briefly as follows:

(a) Rebuild a new BUS to replace all of the present structure above the elevation bearings. Retain these bearings, the elevation wheel, brakes and drives and, of course, retain the azimuth tower, bearings, drives and brakes as at present.

Bill Horne is the leader of the group doing the new BUS. Design work is going ahead (Lee King) and more details will be given later.

(b) Buy a new surface from ESSCO and set it on the BUS.

Here we were fortunate that ESSCO has recently just completed a 13.7 meter (45-foot) precise radar. This dish has a focal length of 5.08 meters, so, if the same molds were used to make us a 12-meter surface, the resultant f/D would be 0.423.

We asked several possible suppliers, but had no difficulty in choosing a good offer from ESSCO.

We shall pre-assemble the BUS in Green Bank and there put the surface in place, and measure and adjust it. We shall then repeat the task on the telescope on Kitt Peak. It is our intent to get an RMS value for the completed surface, in place, of 70 micrometers.

I am leading this part of the project -- with help from several others.

(c) John Payne is the electronics chief, and he has a very nice plan to carry front-ends in the new BUS. He will describe this sometime later.

(d) It is early yet for Tucson to do much, but work there will be considerable. Our 12-meter size means some small changes to the roof of the control building. We believe we must be very careful with the new surface (we plan not to walk on it), and we shall obviously have to erect it with care. As an insurance, which we hope not to be needed, we are buying four spare panels from ESSCO. Our present plan shows 36-foot observing to end about June 1982, and the 12-meter to be in full use by the end of that year.

Work at Tucson will fall mainly onto Paul Rhodes. Dale Webb has already worked on the ESSCO contract and administration will be done by him, J. Marymor and Ted Riffe. The whole task belongs to Hein Hvatum -- we hope he doesn't get too many gray hairs!

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NSF FUNDING

Rick Fisher

A front page newspaper article this summer caused quite a stir around NRAO, because it reported that the National Science Foundation, along with a few other agencies, had been deleted from the President's budget just before it was voted on by Congress. The Congress took corrective action fairly quickly: the House of Representatives bill calls for $1103.5 million, $70 million more than Reagan's request. The Senate bill calls for $1047.5 million, 14 million increase over Reagan's request. As I'm writing this there will be a House-Senate conference to resolve differences between the two bills. And before this got on the press Reagan announced as 12% across-the-board budget cut. No wonder Physics Today in reporting about NSF budget remarked,"At the moment it would be difficult, if not impossible to predict what will happen to the NSF budget."

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GEOLOGY OF POCAHONTAS COUNTY, WEST VIRGINIA

The rocks which crop out in Pocahontas County range in age from Pennsylvania to Upper Ordovician, and include sandstones, shales, limestones, siltstones, and coals. The major geologic structure in the county is Browns Mountain anticline, a northeast-southwest trending ridge. The rocks at the surface of Browns Mountain are Upper Ordivician, Silurian, and Devonian (see geologic map). An anticline is a structural high where beds are arched up, with the oldest rocks exposed at the center or crest, and younger rocks exposed along each flank. State Highway 39 cuts across the middle of Browns Mountain anticline and exposes beds dipping toward the crest on both flanks. On the east side of the anticline, near Minnehaha Springs, the beds dip toward the east; at the core, the beds are essentially flat lying; on the west flank, near Huntersville, the beds dip toward the west.

West of Browns Mountain, the rocks are of Pennsylvanian and Mississippian age and are essentially flat-lying. The Mississippian Greenbrier Limestone outcrop belt runs northeast-southwest through the approximate center of the county and is where many caves occur. Some coals are found in the western third of the county where Pennsylvanian rocks crop out.

The two most likely gas reservoirs in eastern West Virginia are the Lower Devonian Oriskany Sandstone and the Upper Silurian Tuscarora Sandstone. The most likely structure for drilling is Browns Mountain anticline. However, the two likely targets both crop out along the structure: the Oriskany along both flanks, and the Tuscarora near the core (Devil's Backbone along Rt. 39 is Tuscarora Sandstone). Since these rocks are at the surface, they are not at depth to be drilled into. The two areas where gas has been found in the county are both in the northern part of Pocahontas County. Here the Oriskany is at a sufficient depth to hold gas, and the younger Mississippian and Upper Devonian rocks are at the surface. The Glady gas storage field extends into

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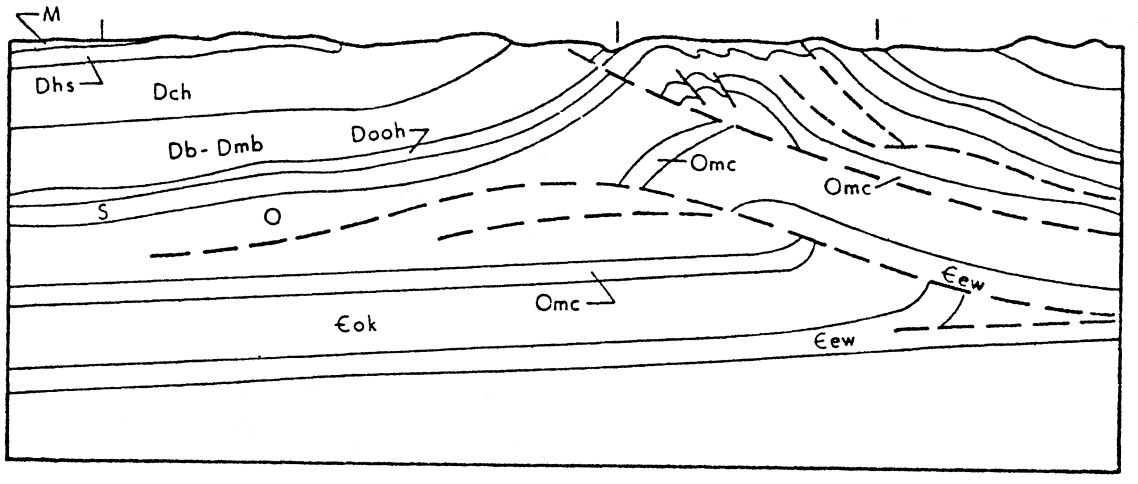
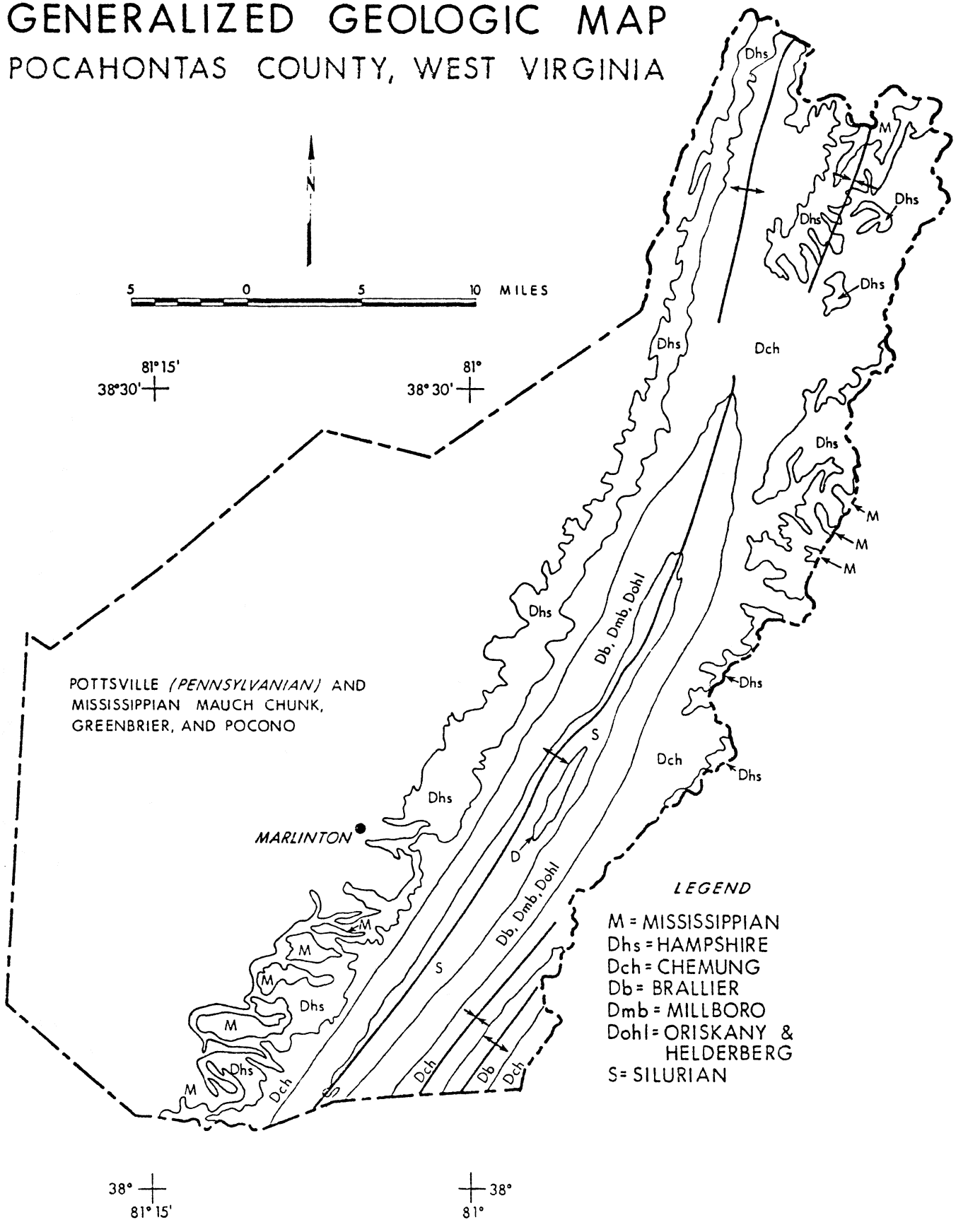


M = MISSISSIPPIAN
Dhs = HAMPSHIRE
Dch = CHEMUNG
Db-Dmb = BRALLIER & MILLBORO
Dooh = NEEDMORE THROUGH HELDERBERG
S = SILURIAN
O = UPPER ORDOVICIAN
Omc = MIDDLE ORDOVICIAN
Eok = KNOX
Eew = ELBROOK & WAYNESBORO

GENERALIZED GEOLOGIC MAP

POCAHONTAS COUNTY, WEST VIRGINIA



WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY, JUNE, 1981

Pocahontas County from Randolph County and is operated by Columbia Gas Transmission Corporation. The Thornwood field, on the West Virginia-Virginia State line, is a small field which is shut-in because there is no pipeline serving that area. Thornwood field was drilled by Cities Service Company (formerly Columbian Carbon Company).

Several wells have been drilled along Browns Mountain anticline, but none have proved successful. The wells have encountered a series of thrust faults, as can be seen on the cross-section. Thirty-nine wells have been drilled in Pocahontas County to date. About ten of these were drilled as storage wells in the Glady field. The two deepest wells are Pocahontas 18 and 21. Pocahontas 18, completed in June 1961, had a total depth of 10,805 feet with a non-commercial amount of gas in the Tuscarora Sandstone. Pocahontas 21, completed in August 1963, had a total depth of 11,932 feet. Several shows of gas were reported in this well, which also encountered several faults.

No wells have been drilled in Pocahontas County since 1966. In the last few years, activity in the Appalachian Basin as a whole and in West Virginia has increased.

West Virginia Geological and Economic Survey
Morgantown, West Virginia 26505
Robert B. Erwin
Director and State Geologist

THE WEST VIRGINIA GEOLOGICAL SURVEY OIL AND GAS SECTION

West Virginia Geological and Economic Survey

The West Virginia Geological Survey is housed in Mont Chateau Lodge 10 miles east of Morgantown. Although the survey has always maintained close professional ties with the geology department at West Virginia University, the Survey is not part of the university, but is a separate State agency. Furthermore, the Survey is not a regulatory agency, but instead is a service-research organization.

The Oil and Gas Section is one of 9 sections in the Survey. Geologists in the section divide their time between answering service requests (phone calls, letters, visits) from individuals, companies, and government agencies, and in conducting oil- and gas-oriented research. These research projects often result in published maps or booklets that explain the oil and gas geology and potential of a certain geologic formation or area of the State. These maps and booklets are available for purchase through the Survey's publication office.

The Oil and Gas Section maintains a series of files containing basic data useful to anyone interested in oil and gas in West Virginia. Copies of well locations plats and drillers' logs are on file for all wells drilled in the State since 1929. Wire-line longs for selected wells also are available. Copies of all plats and logs can be purchased. In addition, the section supervises a well sample library near Morgantown in which well cuttings and cores from several thousand wells are available for inspection.

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A NEW BASELINE FOR THE GREEN BANK INTERFEROMETER

Rick Fisher

The Green Bank interferometer has been so successful in its new job with the Naval Observatory that it is in the process of being expanded. Combined with the photographic zenith tube (PZT) observations, the 35-km interferometer provides a very accurate measure of the rate of the Earth's rotation and the motion of its pole. The Bureau International de l'Heure in Paris, which provides the international time standard, gives a weight of 16% to the USNO interferometric

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observations when averaging them with those of 93 other observatories. This high weight reflects the precision and worldwide confidence which the interferometer has established in its relatively short lifetime.

The next logical step is to add another long baseline at approximately right angles to the present one so that the PZT measurements will not be required to disentangle time and polar motion. After quite a bit of work to establish the most economical approach, the new baseline project officially got underway in March 1981. The site selected for the new telescope is 32 km from Green Bank near Monterville, West Virginia, and two sites have been found for reflectors to relay the radio link to and from the Green Bank site. The antenna will be a new one approximately 15 meters (49 feet) in diameter. One of the 85-foot antennas will be taken out of service so that its receiver and associated electronics can be used with the new antenna. Included in the project will be an upgrade of the radio link to the 45-foot near Huntersville to eliminate some interference to the 300-foot and 140-foot telescopes.

If we can keep to our admittedly ambitious schedule, we would like to start testing the new baseline in the Fall of 1983. The project will cost the Navy about 1 ½ million dollars and is forecast to require about 8 ½ man-years of effort from the NRAO staff. Since most of the people involved can work only part time on the project, this will mean that quite a few people will be involved to complete the task in 2 ½ years.

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SOCCER IN GREEN BANK

Richard Fleming

Pocahontas County Soccer League has recently completed its third season. We had 400 registered players, 61 adult coaches and 5 referees involved this year. The players ranged between the ages of 5 and 18. Teams were divided up in the following age groups. The youngest players, ages 5 and 6, participated in a low key, learn about soccer, have fun team. Ages 7-8, 9-10, 11-12 were organized into co-ed teams and played games throughout the county. Players above age 12 were divided into 13-15 year old boys, 16-18 year old boys and 13-18 year old girls.

Employees and spouses who coached teams were Carol and Richard Ziegler, Bill Brundage, Marty McGreal, Bruce and Freda McKean, Richard Lacasse, Roger Norrod, Steve and Celia Gottesman, who were visiting Green Bank for the summer and who coached the 5-6 year old team, Jim Lyons (co-op student from RPI) and Wendell Monk.

Referees were Pat Crane, Dave Williams, Willie Shank and Richard Fleming.

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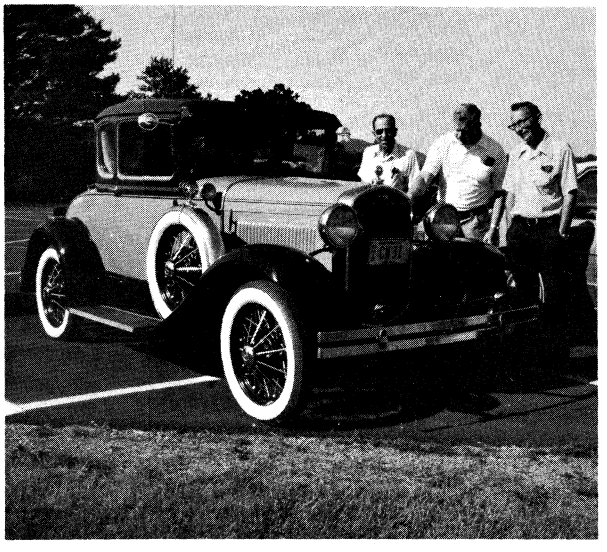
MODEL T'S

Wally Oref

No doubt about it. Tourists come to Green Bank in a wide variety of vehicles. Over a summer tour season you see probably every type of car, truck, recreational vehicle, and motorcycle made. The newer ones only catch your eye for a few seconds, it's the old ones that hold your attention and often prompt a "look-see". The beautifully restored Model T's shown in the two photos below did that to a group of us on a day in June this summer.

On June 23, a group of Model T owners stopped here for a tour on their way to an antique car rally in Pennsylvania. I asked the owner of the 1929 Model T what it was worth. He replied, "I recently turned down $20,000."

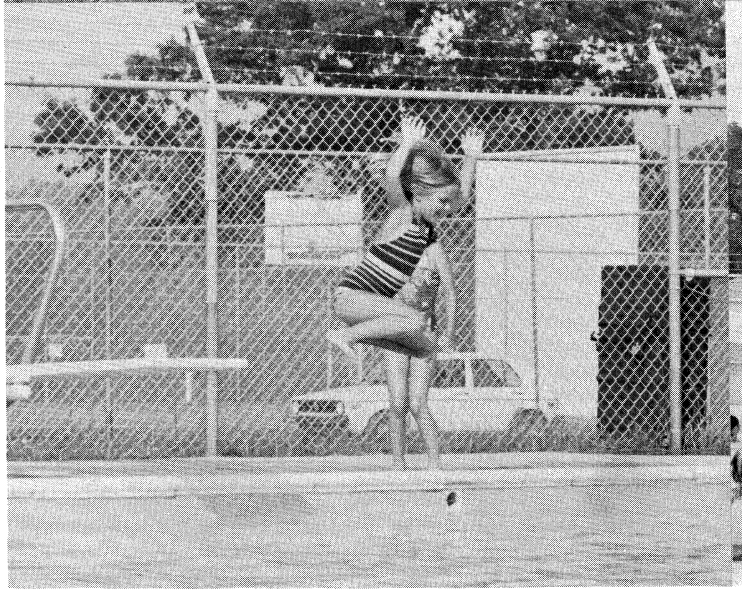


Tony Hamed, Bob Vance and Don Stone admire a 1929 Model T.

Left: 1928 Model T. Middle: 1930 Model T.

THE GREEN BANK 1981 SUMMER PICNIC SPEAKS FOR ITSELF

Photos by Ken Kellermann



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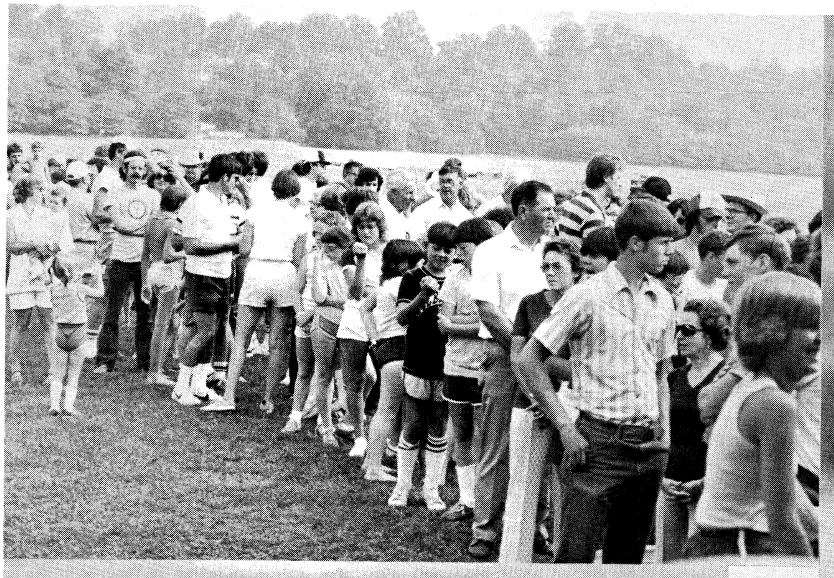

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GREEN BANK: A FASCINATING AND FRUITFUL EXPERIENCE

Jim Lyons

At the end of this August, I finished up my first co-op work assignment. This fall I'll be entering my junior year of electrical engineering. What are the impressions created in a pure city-boy after spending eight months in wild West Virginia? Listing them would be tough, but they'll surely form the basis of many fond memories for years to come.

The work, tinkering with 140-foot cassegrain feed patterns and applying a scattering program to the same system's subreflector, was usually interesting and always challenging. Knowing nothing of the technical aspects of Radio Astronomy and having had only three semesters of school, I felt pretty stupid for quite a while. Fortunately I was working for the very competent, and incredibly patient, Rick Fisher. I really enjoyed working with Rick and learned a lot from his techniques of approaching and solving problems. We had many fascinating discussions, not only concerning the details of some work-related problem, but also about a few of Green Bank's difficulties. For example, after a few months I approached Rick with the complaint (which may seem a strange one) that no pressure was being directed at me; the apathy towards my progress left me in a kind of limbo. Rick immediately recognized the problem and said it was fairly omnipresent at the Green Bank site. I mentioned to him that I found the lack of enthusiasm many people had for the work difficult to accept, even though I caught the bug for a couple of months myself.

To solve this problem I had to generate my own interest in my work and recognize what I wanted to get accomplished before leaving. At times, doing this proved to be downright difficult, but I suppose it's representative of the way working conditions actually are. I still can't help but feel that there exists among workers a sparseness of interest in what other people at the observatory are engaged in.

By no means does the presence of this apathy mean that people were unwilling to help. On the contrary, whenever I approached someone with an equipment, programming or whatever question, I found them to be genuinely interested in helping. Such support is vital to the confused student.

Now for the interesting stuff! People often asked me what I did in off-hours. Those who lived and worked in the area and those just visiting (that is, everybody) were pretty sure I lost or would lose, my mind to boredom. About two weeks after my arrival, when the novelty had worn-off, I did wonder why I chose the slow-paced life and arctic weather conditions of Green Bank.

Without realizing it, the people at the lab spared my mind! A group of guys played basketball on Wednesday evenings. Then came the Tuesday bowling league (the company of which I really enjoyed) and the crazy rides to Elkins. I spent many a talkative hour at the homes of Reg Atkins and Rick Fisher and was taught how to shoot high-powered rifles by Reg. In an act of unparalleled kindness, Marc Damashek loaned me his Opel, which really made the summer enjoyable. George Grove and I went to a woodchopping contest, complete with Little Miss Woodchip. The Norrods, myself and others hiked on some of the local trails, complete with blisters and aching muscles. (I'll never forget my visions of that ice-cold Dr. Pepper!)

And then there was soccer. Due to the efforts of people like Richard Fleming, the game has really caught-on in these mountains. (VLA beware! Pat Crane's only reason for joining your staff is to spread the soccer fire.) Crowds of observatory people spent many, many hours coaching and playing.

Obviously the impressions I have of the people I worked with are quite good. Everywhere, the hospitality was nearly overwhelming. I believe I have made many life-long friends in Green Bank and I am very much looking forward to returning next May.

* * * * * *

FROM THE VLA SUMMER STUDENTS

On the next few pages are the comments and observations made by the VLA summer students.

Michael Fitzsimmons

I found my stay at the VLA this summer to more than satisfy the expectations I had made in May. The projects that I worked with Dick Sramek on were interesting and very educational. One of the projects involved studying the rotation of the Plains of San Augustin. We found significant rotations around the y-axis (pointing to the east) and the z-axis (zenith). These rotations may be caused by changes in the earth's crust and by errors in time. The second project was a study of the stability of phase data. Because of the large baselines, instabilities in the atmosphere can have a significant impact on the phase data received by the array. Our initial analysis seems to indicate that these instabilities are caused by large slow moving clouds of water vapor gas. These clouds of water vapor slow down signals at one antenna while another antenna receives the same signals at an earlier time. This difference is called a phase instability.

I was also very fortunate to be able to go to the IAU Symposium held during the week of August 3. I would like to thank Eva Rigby, and Dick Thompson for the opportunity to meet many astronomers from around the world and learn something about astronomy in the process. I found escorting the three Soviet astronomers, I. S. Shklovskii, N. S. Kardashev, and Y. N. Parisjskij, around New Mexico particularly enjoyable.

As a final project, the summer students were given one and a half hours of observation time with the array. On behalf of the summer students I would like to thank C. Bignell, R. Ekers, R. Sramek for obtaining this time and assisting us with the data analysis. We chose to observe three previously unobserved sources at both 6cm and 20cm wavelengths.

The sources were:

	RA(1950)	DEC
3C180	07:24:33.50	-01 58' 44"
3C228	09:47:27.65	14 34' 00"
MARK645	12:01:11.10	59 01' 00"

These sources were observed in snapshot mode. The maps were made, cleaned, and displayed using the recently installed AIPS program. Both 3C sources produced good maps. Unfortunately, we did not find the Markarian. This may have been a result of overresolving the source or observing it for too short a time. 3C228 is a classic example of a radio galaxy because of its double lobed structure and the leading brightness at the ends. It is about 8% polarized in the 20cm band. No core was observed at 6cm. The bridge of 3C180 was found to be highly polarized at about the 45% level near 3C180A. It is the considered opinion of the summer students that the observation time was an excellent idea, and we hope that it will be continued in the future.

Some of the results of our observations:

Source	RA(1950)	DEC	Flux(Jy) @20 cm
3C180:a	7:24:32.711	-01 59 24.75	0.174
3C180:b	7:24:33.637	-01 57 41.75	0.055
3C228:a	9:47:27.523	14 33 42.42	1.117
3C228:b	9:47:27.988	14 34 27.99	0.680

(See Figure 1. next page)

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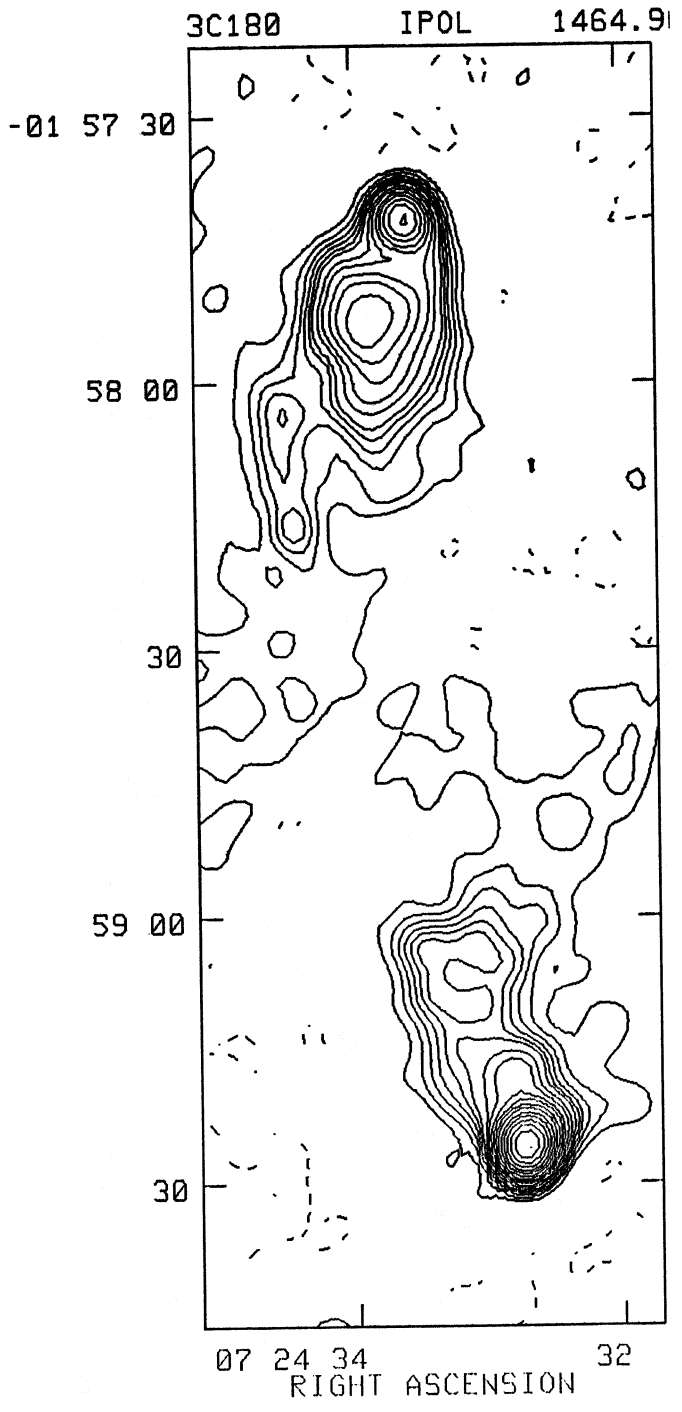
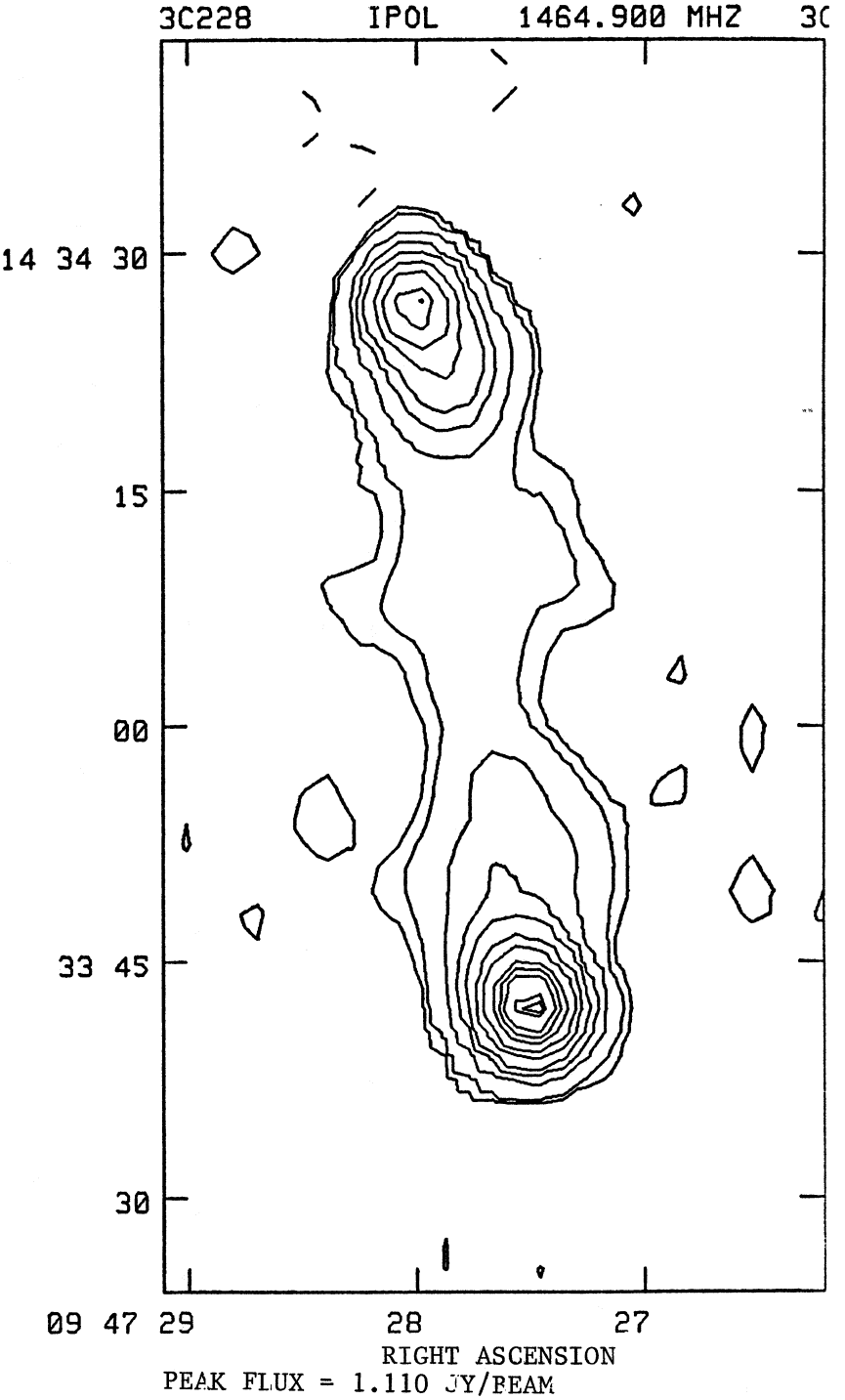


PEAK FLUX = 0.174 JY/BEAM
LEVS = 0.174E-2 * (-1.0,1.0,2.0,3.0, 4.0,5.0,6.0,8.0,10.0,13.0,16.0,20.0, 25.0,32.0,40.0,50.0,63.0,79.0,100.0)



PEAK FLUX = 1.110 JY/BEAM
LEVS = 1.110 * (-5.0,-0.8,0.8,1.5,5.0, 10.0,15.0,25.0,35.0,50.0,60.0,70.0,90.0, 95.0)

Kenneth Mighell

During this summer I worked for Frazer Owen on astrometric projects. I worked primarily on two FORTRAN computer programs. The first of which was an interactive version of a previous program called OPTFIT which calculates the right ascension and declination of optical objects that are considered as candidates for radio sources. A measuring machine is used to determine the micrometer coordinates of the reference stars and optical objects on a Mount Palomar Sky Survey print. From the known positions of the reference stars, OPTFIT calculates the positions of the optical objects. The second program, called NEARBY, finds all the stars in the Smithsonian Astrophysical Observatory Star Catalog within a radius of less than or equal to two degrees of arc from any point on the celestial sphere. NEARBY calculates the X and Y field coordinates (in millimeters) with the field center having the coordinates of (0,0). These field coordinates enable one to make an overlay to help find an optical object at a radio source position on a Mount Palomar Sky Survey print.

I really enjoyed going to the IAU Symposium in Albuquerque in early August. I began to understand the truly international nature of the field of radio astronomy. As a student, it was quite exciting to hear and talk to people who I have only known previously as names in textbooks or journal articles.

The observation that the VLA summer students made of 3C228, 3C180 and MRK645 was probably the most educational aspect of the whole summer. Although many problems were encountered in the analysis of the MRK645 data -- which we never could find -- the analyses of 3C228 and 3C180 went smoothly. By the end of the twelve weeks, I had become quite comfortable with the Astronomical Image Processing System (AIPS). Through the use of the self calibration program ASCAL, I had been able to triple the dynamic range of my map of 3C180 at 20 cm. I really recommend that observations by the VLA summer students should become a tradition.

This past summer has been quite delightful. I have been inspired to continue on in radio astronomy and hope to return to the VLA in the future as an observer.

Tom Cwik

My impressions of the VLA after completing the summer are easily divided into two parts -- time spent at the VLA site (or riding to and from it on the bus), and time spent living in Socorro.

My time on site was mainly spent working on a low-frequency feed for the 25-meter dishes. In the future though, I'll probably remember less of the feed design than the relaxed atmosphere that made for a productive time, and the interesting and friendly people on site. And sleeping on the bus while the bridge players dealt cards. And watching the afternoon lightning and rain storms.

A fringe benefit was spending a day at the IAU, and then escorting three Russian astronomers through Albuquerque on a shopping binge. A shopping binge that included buying 40 dollars worth of colored markers and the entire stock of liquid paper.

Being orignally from a large midwestern city, the summer in Socorro brought home the stark realities of living in a small southwestern town. Yet by summer's end the peaceful living became quite enjoyable.

Mike Andrews

I have found my experience at the VLA to be most rewarding. The entire staff was very friendly and helpful.

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I learned a great deal about data analysis and radio astronomy in general. Far more rewarding though is the experience I have gained in how to do research. This is the first work that was truly original. There was no place to check the answer. Thank you for the opportunity.

Michael Lesser

Besides mastering the fine art of sleeping on a bouncing bus, I realize that my summer at the VLA gave me a great deal of insight into how astronomical research should be done. I know now that it takes a great deal of patience, coffee, colleague confrontations, and more coffee.

Perhaps, most importantly, I learned to look to the basic foundation of a theory, whether one is proposing a new theory, writing a computer program, or just sketching a line of attack on a problem. One must never forget the basic intention of research, or lose sight of the premises. Often I would get so involved in a program that I lost track of my basic goal, usually because I first lost track of my foundation. At the VLA, I often heard scientists asking (or questioning) the most basic facts, whether it was a physical problem or one dealing with the instrument's performance. I am sure that this adherence to the "scientific method" so drilled into us in elementary science courses has proven the most valuable piece of information I learned.

On the non-scientific side, I found that there are much greater differences between Socorro and Los Angeles than smog, roller skates, and waves. Socorro was very peaceful (boring at times), friendly and a great place to relax. It is really a shame that I didn't take proper opportunity of the intensive study atmosphere available on the weekends. I did find the small town atmosphere a welcome change from the big city. Even the weather was agreeable.

I greatly enjoyed the town's social life, Tech movies, potlucks, and pool tables. I perhaps enjoyed most of all the scenic beauty of the area.

All in all, I had a wonderful time and found the experience very stimulating. I learned much during my first introduction to image processing and I hope that I will always find the scientists and staff I work with as friendly and helpful as those at the VLA.

* * * * * *

FRUIT LEATHER

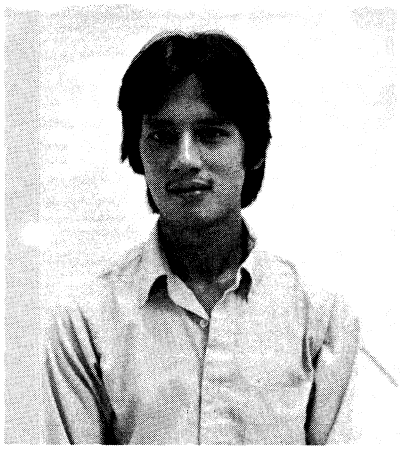
Pat Crane

4 cups dry, fully ripe fruit,
I left the skins on
6 Tbsp. (level) sugar - I like
and used white corn syrup.

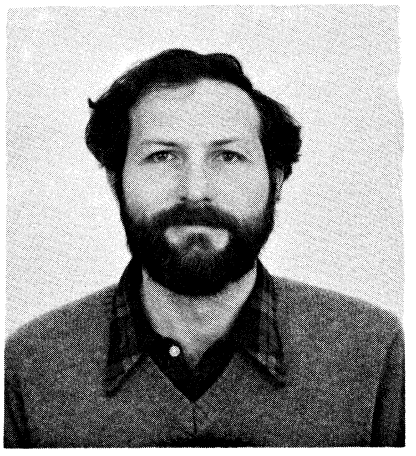
Mix, heat and with wooden spoon stir until warm, not over 180°.
Add 1 tsp. lemon juice or more, put in blender and blend well until the skins do not show.
Heat to 180° and no more, stirring with wooden spoon. Cool before spreading on cookie sheets which have been covered with plastic wrap. Let dry in the sun until it will peel off the plastic wrap. When dry roll up.
If there is not enough sun, put into oven with the door open at 150° until dry and will peel off plastic wrap.
When serving, unwrap, take off plastic wrap and roll up and slice like cinnamon rolls.
It will keep at room temperature for a month -- 4 months in the refrigerator and one year in the freezer.

PERSONNEL UPDATE

New Employees



Man Q. Tran
Technical Trainee I
Computer Division - CV



Ricardo Giovanelli
Systems Scientist
Scientific Services - GB

Other New Employees
(Photos Not Available)

Jay P. Morreale
Advanced Technician
Electronics - Tucson

Nancy K. Ortiz
Accountant
Fiscal - NM

Carl F. Puleo, Jr.
Technical Specialist II
Array Operations - NM

Ernest R. Seaquist
Visiting Scientist
Basic Research - NM

Rehires

Ricardo Giovanelli
Systems Scientist
Scientific Services - GB

Martha P. Haynes
Asst. Dir. GB Operations
Scientific Services - GB

Patrick E. Palmer
Visiting Scientist
Basic Research - NM

Transfer

Patrick C. Crane

from Scientific Services - GB to Site Management - NM

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PERSONNEL UPDATE
(Continued)

Leave of Absence

Magne B. Hagstrom
Walter Jaffe
Albert K. Wu

Return from Leave of Absence

Craig R. Moore

Terminations

G. Dick van Albada
Reginald Atkins
John Basart
Daniel L. Bass
Thomas H. Brasso
Willem N. Brouw
Susan E. Delap
John Dreher
Shawn P. Ewald
Leonard M. Fulcher
Richard Hagen
Stanley S. Hansen
Dorothy Larkin
Shirley A. Melton
Charles R. McCrickard
Kenneth Nottingham
Patrick Palmer
Jeffery J. Puschell
Michael T. Routt
Craig L. Sarazin

Retirement

Harlan G. Tallman

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1982 HOLIDAY CALENDAR

Friday, January 1	New Year's Day
Monday, February 15	Washington's Birthday Observed
Friday, April 9	Holiday
Friday, May 28	Holiday
Monday, May 31	Memorial Day Observed
Monday, July 5	Holiday
Monday, September 6	Labor Day
Thursday, November 11	Veterans Day
Thursday, November 25	Thanksgiving Day
Friday, November 26	Holiday
Thursday, December 23	1/2 Holiday
Friday, December 24	Holiday
Friday, December 31	Holiday*

* For New Year's Day, 1983

NRAO ROUNDUP

Reprinted from the NRAO Quarterly Report for April 1, 1981 - June 30, 1981

ELECTRONICS DIVISION

Charlottesville

Development of solid-state millimeter-wave local oscillators continues. Gunn diode oscillators giving 60 mW at 72 GHz and a doubler which gives 9.2 ± 1.2 dB conversion loss without tuning over the entire 80-120 GHz band have been fabricated.

SIS junctions tested for mixer use at 115 GHz have given poor results (∿ 10 dB conversion loss) and poor reliability. Modifications in the junction fabrication technique are planned.

Six FET amplifiers operating in the 1.0 to 1.7 GHz range have been completed for use as replacements for paramps in Green Bank. A two-stage 15 GHz amplifier giving 60 K noise temperature and 20 dB gain has been constructed. This type of amplifier will be used to increase VLA sensitivity by a factor of 3 at a wavelength of 2 cm.

Green Bank

An investigation of a future VLBI correlator using recirculating techniques has been started.

The C-band subsystem of the 140-foot maser receiver was tested during this quarter. System temperature at zenith is 50 K or less from 4.7 GHz to 7.0 GHz, 40 K or less from 5.0 GHz to 6.1 GHz, and 34 K or less from 5.7 to 6.1 GHz.

Four receivers, the 24 cm, 4-feet 21 cm, 21 cm, and 18 cm, are being retrofitted to use GASFET's as front-ends. The 25-cm is still in the system design stage, while the latter three are under construction and will be available in the fall.

One of the TPI 1054 tape drives is ready for testing at the telescope. A spare unit is under construction.

Design of the final board, the filter/detector board, for the 256-channel, 2 MHz per channel, filter receivers is complete. The fabrication of the boards is now out for bids. All parts for these units are now in hand or on order.

Focus and polarization readouts for the 140-foot telescope have been procured and interfaced to the present system.

In an attempt to get a maser amplifier to span 18 GHz to 26 GHz, a new ruby structure was machined, with tolerances closely maintained. The new structure phased very nicely, and preliminary tests indicate that the desired frequency coverage is achievable.

Field patterns and return losses of the C and X band feeds for the 140-foot Cassegrain system have been measured to verify the design. The radiation pattern of a 3-cm dual hybrid mode feed was optimized and its efficiency measured.

A JPL program to analyze scatter from a generalized surface, given the incident field and surface, has been modified to some extent and used to analyze the performance of the subreflector on the 140-foot telescope.

All modules, except the Analog Reproduce Modules, and heads for the second NRAO Mark III VLB system were delivered to the VLA and tested. Except for some minor bugs, the system is operational. A second version of the Analog Reproduce Modules is now under construction, since the design of the first set resulted in poor signal-to-noise ratio. The heads have been partially tested, and no problems are anticipated with them.

A reflector for the upgraded interferometer link has been purchased. Design on both the upgraded and new links is in progress.

Spare upconverters for the 300 to 1000 MHz receiver have been fabricated and tested. A report documenting the upconverters is in press.

Tucson

During this quarter, the 200-235 GHz receiver has been tested on the telescope. The noise temperature was slightly over

--*continued, next page*--

800 K SSB, the aperture efficiency of the telescope was five percent and the beam efficiency approximately 40 percent.

A new, fast beam-switching device for continuum use has been tested at a wavelength of 3 mm, and we now have a sensitivity of 1.5 JY in one second. This is an improvement of 1.4 over our present sensitivity.

A new calibration system has been tested during this quarter. This calibration scheme used a cooled chopper and will permit more accurate calibration of spectral line data.

COMPUTER DIVISION

VLA Post-Processing

Two mega-bytes of solid-state memory have been added to the VAX 11/780, bringing the total capacity to three mega-bytes.

Six Visual 400 terminals have been purchased for the VAX. Four are located in the CRT room and the others will be placed in strategic locations elsewhere.

The following improvements to the astronomical imaging processing system have recently been made: Syntax modification for minimum matching, additional u-v one-dimensional/profile software, TV wedge and Roam software.

The AIPS on the VAX at the VLA is being used to capacity. AIPS software is being exported to several institutions' VAX computers.

VERY LARGE ARRAY

The array was scheduled for observations 62 percent of the time during the second quarter.

During the quarter, the DEC 10 upgrade components (a DEC 10 KL and a VAX) were received. The conversion to the DEC 10 KL and the installation of the DEC NET software in the DEC computers at the site was also begun.

The array was reconfigured to the B array on 27 April. A major structural failure on transporter No. 2 was successfully repaired. A MK III VLBI terminal was delivered to the site from Green Bank in June. Installation and testing of the unit were completed, giving the VLA full VLBI observing capability with both MK II and MK III recording systems. A new observing mode -- the "autocorrelation mode" -- was introduced during the quarter. In this mode, the digitized IF signals from many antennas are added together to create a pseudo-IF signal. This pseudo-IF is then fed back into the correlator in place of two antennas so that its spectrum can be measured. The technique is essentially the same as using the VLA as a large single-dish spectrometer.

ENGINEERING DIVISION

Preliminary planning was started for the assembly and measurement of a new 12-meter surface and back-up structure for the 36-foot. Conceptual designs for a 12-meter back-up structure were developed. The conceptual designs and procedures for measuring and setting the 12-meter surface were started.

Sites for the passive relectors and the antenna for the addition to the interferometer were reviewed and definite locations decided upon. Specifications were completed and an RFP issued for a new antenna for the interferometer addition.

A procedure was developed and parts fabricated to relocate the adjustable feed mount in the focal point structure of the 140-foot. Design of the interface for a new read-out system on the 140-foot adjustable feed mount was completed and parts fabricated.

Routine engineering assistance was provided operations and maintenance at Charlottesville, Green Bank, Tucson, and Socorro.