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~ Green Bank Telescope ~

Figure 1: GBT photograph at SARA 2007 Conference
(Credit: Heather Fries, Kodak Z60 Zoom Digital, July 2, 10:07 am)

Get Ready! Call for Papers, page 7

~ The President's Page ~

For several years, the SARA Board has wrestled on and off with a growing cost issue associated with our Journal. What wasn't apparent to the membership at large was how the members taking the electronic version were subsidizing the rising postage and printing costs of the less than 100 hardcopy members this past five years. Tom Crowley tallied the costs for us.

The following are the current costs of producing and mailing the SARA Journal projected over a 12 month period based on 100 hard copies:

Cost of mailing	$590.71
Ave. cost of 1 issue	$5.91
Cost per hard copy member per year	$35.44
Loss per hard copy member	$11.44
Total Cost per year	$3,544.26
Member income	$2,400.00
Loss per Year	$1,144.26

Meanwhile we wrestled with the disparity between what we could present in the electronic version of the Journal versus the black and white 24-page printed copy. This has drawn the majority of our membership to be comfortable downloading the color, often larger and page numbered, pdf version.

But as the number of hardcopy members fall, the cost per copy quickly rises. And we are almost preparing two Journals, in that the hardcopy one has to be carefully pared down from the electronic version. Unfortunately, as the quality of our articles has increased, with more space for graphs, pictures, and diagrams, it makes the editing down to 24 pages even harder.

There was talk of raising the print membership cost to $40, but we knew that would cause many simply to drop out of SARA. A number of organizations I belong to have faced similar decisions, ultimately dropping their printed Journals in favor of all electronic ones. The SETI-League switched to an all electronic Journal and lost only two or three members out of over a thousand.

Today after much deliberation, SARA is also immediately going all electronic. As of last summer's conference, everyone's expiration date had been consolidated to be the conference date. So if you have not renewed, please do so, safe in the fact that with the dropping of the printed version of the Journal, we are able to bring you so much more via the expanded electronic Journal. In many respects, we are limited only in trying to keep download times reasonable for the members who are still on dial-up Internet access. 1MB / 24 pages was the old maximum; 2MB and around 36 pages may be a reasonable new target. Let us know.

Of course, the Journal is only as good as its contributed articles. So please talk to John Mannone. If you are working on a new project of any sort, and can share your experiences in print and photo, both good and bad learning experience, please do.

Charles Osborne K4CSO

~ Treasurer's Note ~

SARA Dues of $20.00 for the Electronic Journal are payable on an annual basis, with the SARA membership year ending on 15 June. Membership requires a check to "Society of Amateur Radio Astronomers" or payment via PayPal.

SARA Life Memberships are now offered for a one-time payment of twenty times the basic annual membership fee (or, currently, $400 US). Life Memberships entitle SARA members to receive the Journal via electronic delivery only.

Other SARA items:
Proceedings of the 2006 and 2007 SARA annual meeting are available at $20.00 for non- USA members the cost is $25.00

A CD with all of the SARA Journals through 2006 and Grote Reber's Antenna is available for $10.00 with your SARA renewal and $15.00 if not renewing. ($15.00 for renewing non- USA members.)

SARA decals are available for $1.50 each, $2.00 for non-USA members

If you live outside of the USA, please do not send checks. Please send postal money orders. It is also important to include a street address. Post office boxes are not acceptable for all deliveries.

NOTE: You may now remit your SARA Membership Dues via PayPal, through the following link. www.radio-astronomy.org. It is still necessary to send the information below to our Treasurer, via post or email

Tom Crowley, SARA Treasurer, 42 Ivy Chase, Atlanta, GA 30342

Please welcome the new SARA members:

Edward White	Alvin Ureles	Boyd Applegate	Peter Vickers
Vince Adams	Jack Carpenter	Gary Schmalenburg	Karen Holland
Lee Kitchens	John DuBois	George Garza	James Dunn
Henry Catherino	Bruce Bodner	Martyn Kinder	Bob Culbertson

~Western Regional Conference Possibility~

This is a heads-up announcement for the possibility of a Western Regional Conference. One of our Directors, Rodney Howe, has been working feverishly with logistics for a March conference. We direct you to visit the SARA website for a follow-up announcement around mid January.

~ From the Editor's Desk ~

Your feedback is important to me and again, I will encourage you to submit (email blurbs to academic papers; hands-on project tips to analytical tools; etc.). Submission Guidelines are posted on the SARA website: [http://radio-astronomy.org/publicat/authjrnl.htm].

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Due to excessive cost of producing a print journal, the leadership has decided to go to an electronic-only version of the journal, effective after the conference. Though this may upset some, it is essential that the organization is careful with cost ineffective practices. We hope you will understand and enjoy the benefits of an electronic journal. Of course, if anyone wants a hard copy, I will be happy to reproduce it and mail it to you at my cost.

***

In this issue, you will find a number of excellent articles contributed by fellow members. You will find out about an improved square law detector (Bruce Randall), Yagi antennas to "hear" Jupiter (Hal Braschwitz), a remotely accessible amateur radio astronomy observatory (Chuck Forster). Perhaps a review on how to make printed circuit boards might be exciting. Often, I like to fuse art and science, the third NRAO Image Contest winners will not disappoint you. This issue will pay a small tribute to Arthur C. Clarke and Paul Shuch.

Jon Wallace and Kerry Smith have developed a CD and DVD to help us promote the IBT. If you are interested in advance copies, please contact Jon at fjwallace@snet.net. I plan to feature their work in more detail in the next issue.

I am pleased to announce that I have been selected as a JPL Solar System Ambassador for the Great State of Tennessee. My commission starts in January 2008. No doubt, I will have opportunity to promote the value of radio astronomy in this new outreach position. Please visit my website for an interesting blend of astronomy —the art and science— for innovated outreach ideas [http://home.earthlink.net/~jcmannone/].

John C. Mannone, Editor

~Call for Papers~
SARA 2008 Annual Conference

Conference contributors, please be advised SARA is soliciting a call for papers for the SARA Conference (June 29-July 2, 2008) at NRAO, Green Bank, WV.

Papers on radio astronomy hardware, software, education, research strategies, and philosophy are welcome. SARA members or supporters wishing to present a paper should comply with the following:

Email a letter of intent, including a proposed title and informal abstract or outline (not to exceed 100 words) to the SARA vice president no later than March 1, 2008.

First-draft manuscripts must be received no later than April 1, 2008.

Accepted papers must be camera-ready by no later than May 1, 2008.

See Guidelines for Submitting Papers, as well as other helpful details, can be found on the official SARA website, Please visit and make your New Year's resolution now. [http://radio-astronomy.org/meetings/cfp2008.htm].

It is important that we all comply with the timetable so that we can have a successful conference and proceedings!

~ 2007 Karl G. Jansky Lectureship Awarded to Professor Karl M. Menten ~

Associated Universities, Inc., (AUI) and the National Radio Astronomy Observatory (NRAO) have awarded the 2007 Karl G. Jansky Lectureship to Professor Karl M. Menten of the Max-Planck-Institute for Radioastronomy in Bonn, Germany.

Figure 2: Karl Menten (Credit: NRAO)

Professor Menten is an extraordinarily productive scientist whose research has improved our fundamental understanding in a number of areas of astronomy. He has studied the chemistry of molecular clouds from which new stars are formed, the process of star formation in our own Milky Way Galaxy and in the early Universe, and the outer atmospheres of stars nearing the end of their "normal" lives.

In 1991, Menten used NRAO's 140-foot Telescope at Green Bank, West Virginia, to discover strong radio emission from methanol masers in star-forming regions. These masers amplify, or strengthen, radio emission the same way a laser amplifies visible-light emission. Menten developed the observation of these methanol masers into a powerful tool for studying the formation of stars much more massive than our Sun, because the strong maser emission points astronomers to the stellar birthplaces. In addition, Menten pioneered the use of ultra-high-resolution observations with NRAO's Very Long Baseline Array to observe masers to make precision determinations of the structure, size and dynamics of the Milky Way.

Menten received his doctoral degree in 1987 from the University of Bonn, Germany. He then joined the Harvard-Smithsonian Center for Astrophysics, working there until 1996, when he became the Director for Millimeter and Submillimeter Astronomy at the Max-Planck-Institute for Radioastronomy. In addition to that position, he also has been a Professor for Experimental Astrophysics at the University of Bonn since 2001. He initiated the Atacama Pathfinder Experiment (APEX), a 12-meter diameter telescope high in Chile's Atacama Desert, where the Atacama Large Millimeter/submillimeter Array (ALMA) is being built. APEX pioneered submillimeter-wavelength observations at Atacama, proving the quality of the site for such research.

As Jansky Lecturer, Menten will give a presentation entitled, "Tuning in to the Molecular Universe," at NRAO facilities in Charlottesville, Virginia, Green Bank, West Virginia, and Socorro, New Mexico. The Jansky Lectureship is an honor established by the trustees of AUI to recognize outstanding contributions to the advancement of astronomy.

(Editor's note: Article reproduced from the NRAO website. More information is cited below)

~Methanol Masers~

I recommend Elitzur, Moshe, *Masers in the Sky*, Science, July 1, 2005,Vol. 309, No. 5731, pp. 71 – 72. This pdf is downloadable: [http://www.sciencemag.org/cgi/reprint/309/5731/71.pdf].

Menten's discovery is implied in the Lowell Telescope reference below. He published these results in: Lecture Notes in Physics, Volume 412, Springer Berlin, Heidelberg, 1993, Astrophysical Masers, Chapter 8: *Methanol Masers in Star Forming Regions*, Karl. M. Menten, pp.199-202.

Masers are important in astrophysics. Cited from a proposal for the Lowell Telescope, even before the GBT was built, argues the importance of the 6.7 GHz methanol masing line [http://www.jb.man.ac.uk/news/jif/part5.html]:

The methanol maser transition at 6.7 GHz is particularly important. It is one of the very strongest cosmic maser emission lines and masing appears to take place over a broader range of physical conditions than for other molecular species. Methanol masers are usually associated with compact HII (ionized hydrogen) regions and infrared sources, which are pointers to sites where massive stars are being formed. In broad terms these masers signpost warm (100-400K) dense gas in star-formation sites. Methanol therefore provides the link between the cold (~10 K) molecular phase of the interstellar medium and the ionized photosphere of the protostar (1000s K). These masers are also found where there are no other signposts of star-formation, suggesting that methanol masers may be the first general indicators that star-formation is occurring.

A survey for methanol masers is, therefore, the best and possibly the only feasible way to take a complete census of star-formation in the Galaxy. As the 6.7 GHz maser is a relatively recent discovery (1991) there has not yet been a systematic survey of the whole Galaxy.

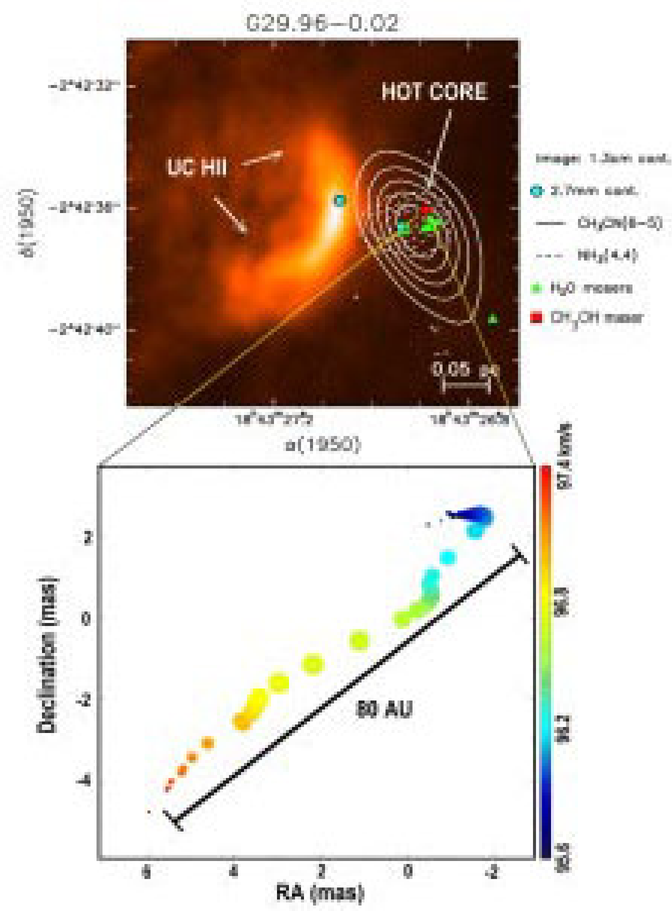

Figure 3: Galactic Star Formation and Methanol Masers
[http://www.merlin.ac.uk/e-merlin/emerlin4.pdf]

~An Improved Square Law Detector Based on the NE602 IC~

By Bruce Randall, WD4JQV

Diodes have been used as square law detectors almost exclusively in amateur radio telescope receivers. The diode is simple but has some significant disadvantages. Its output level is in the range of 20mV at most before square law conformity deviates significantly from ideal. It also has poor and unpredictable temperature drift. The part-to-part variation is also very significant. The low output level is very demanding of the accuracy requirements for the DC amplifier.

The square law detector described here works well with 5MHz to 125MHz input frequencies. 30mV RMS of RF input gives about 1.0VDC of output. Output levels of 2.0VDC, on single frequency signals and above 1.0VDC on noise, are available with negligible loss in square law accuracy. It requires plus and minus 5.0VDC power supplies.

At the 1993 SARA conference, I described a square law detector based on the MC1496 balanced modulator IC used as an analog multiplier. It had good square law conformity, required too many external parts, needed odd power supply levels, and had some DC offset error problems. Charles Osborne and Jeff Kruth both built detectors based on this and used them in radio astronomy applications. They both had reasonable success.

The square law detector described here (based on the NE602 or SA602 mixer IC and some other assorted ICs) alleviates both the diode problems and MC1496 circuit problems to a great degree. The NE602 is used as an analog multiplier, just as the MC1496 was in the earlier design. The total circuit seems to have too many parts (See Fig 4, 5 and 6) but nothing is critical or uses black magic to make it work. Because this detector works with very low input levels, much less IF amplifier gain is required. Because of the large output level, one less stage of DC amplification is used.

A chopping scheme, which is the significant addition over the original MC1496 circuit, virtually eliminates DC offset errors and the associated baseline drift. Note that in the days of vacuum tubes, chopping was used in DC amplifiers with DC errors of a few microvolts while the tubes themselves had DC errors of volts. The tubes amplified AC signals, where the DC errors were of no consequence. The chopping idea is definitely not new. It is also still a good idea. The chopping frequency used is about 512Hz. Chopping frequency is not critical, but must avoid harmonics of the local power line frequency.

Please refer to Figure 4. U1, a Mini Circuits Labs SBL1 or similar double balanced mixer is used as an input chopper. The phase shift through this device is either 0° or 180° according to the polarity of the signal at pins 3 and 4. Note that the mixer used must have a DC coupled IF port. (Virtually all mixers for use under 500MHz do have DC coupled IF ports.) The IF port is used as the control port. The polarity (or phase) is alternated back and forth at the 512Hz rate. The signal amplitude is reduced by a consistent loss and is not affected by the phase selection.
U2, the NE602 multiplies the signal on pin 1 by the signal on pin 6. Note that the signal on pin 1 will be either inverted or non-inverted, according to the state of the input chopper. If pin 1 is not

inverted then we have a plus times a plus, or a minus times a minus, so the product is plus. If the pin 1 signal is inverted, we have a plus times a minus, or a minus times a plus, so the product is a minus. Notice that the U2 output at pins 4 and 5 is an AC signal at the same frequency as the chopping. This signal will be processed later by a synchronous detector to produce a DC output.

Toggle switch S1 allows disabling of the AC switch drive for verification of DC offset errors. S1 is also useful for using this detector in a phase switched interferometer. In the case of the phase switched interferometer, the chopping is done at the antenna or RF amplifier circuit instead of the detector input.

Please refer to Figure 5. Amplifier U3A is an AC coupled amplifier. It is a differential input amplifier with a gain of 15.0.

CMOS switch U4 along with amplifier U3B makes up an amplifier with a gain that is selectable as plus or minus 1.0, according to the switch drive to U4. Because this is the essentially the same signal as drives U1, this becomes a synchronous demodulator. During the plus half of the signal from U3A, the gain of U3B is plus 1.0 resulting in a plus output. During the minus half of the signal from U3A, the gain of U3B is minus 1.0, again resulting in a plus output.

Matching of resistors around U3B is critical for minimizing output noise at the chopping frequency. R14 should match R15 and R13 should match R16. Out of the four 100K 1% resistors, you could measure them, and order them as follows from low to high value: R14, R15, R13, R16. The 1% values are good enough without hand matching for most applications.

C17 and C18 also affect balance. If they were made large, such as 1uF, then the low bandwidth will kill any residual chopping noise. If the detector is used in a Dicke switching receiver, the detector bandwidth must be wide so C17 and C18 should be 100pF or so. Tuning for the application may be required, as is true of any radio telescope.

There are 4 sources of phase ambiguity in this detector circuit:

- U1 is not defined for phasing. I suspect all SBL1s would be the same. Another brand mixer may very well be different. My unit was built from a surplus part "equivalent" to an SBL1.
- U2 does not specify phasing in the data sheet. I am sure they would all be the same. I did not bother to figure it out.
- U4 amplifier switching has a defined phase. A logical one on the CLK1 signal sets the gain to plus 1.0.
- Switch S2 in figure 3 always allows me to get the correct phase by choosing the switch position that happens to work!

Refer to figure 6. This is the chopping clock generator. U5A, U5B, and U5C make an RC oscillator that is reasonably stable. R10 is adjusted to a frequency that is in the area of 1.0kHz and is NOT a harmonic of the 60Hz line frequency (or 50Hz, as needed).

Flip-flop U6 divides the RC oscillator frequency by two and, more important, assures 50/50 duty cycle. Most chopping schemes, this one included, depend on having good symmetry of the switching waveform.

My present system steals some signal off an existing crystal oscillator and divides it down with a binary divider to the 500Hz area. A 32.768 kHz crystal frequency divided by 64 would give a 512Hz clock, which is suitable. If a crystal oscillator is used then this becomes an adjustment-free square law detector. One might note that the more adjustments something has, the more possible wrong settings it has where it won't work!

My unit was constructed using an NE602 breadboard from FAR Circuits to mount all the parts in the Figure 1 and 2 schematics. Extra holes were drilled in the RF input section of the board for U1. All RF connections were wired with very short wires where FAR had not given me the needed traces. Extra holes were drilled in the audio side of the FAR board and a couple of wire-wrap sockets installed. U3, U4 and the associated small parts were put in wire wrap sockets and wired together with wire wrap wires. The CLK1 and CLK2 signals should be kept as far as possible from U2 and U3. The finished board went in a shielded aluminum box. It is NOT pretty.... It does work.

In the testing of this detector I started by verifying that the clock signals were OK. With switch S1 set to the disable position, the detector DC output voltage should be within a few mV of 0.0V. Apply 30mV RMS of 30MHz or the appropriate IF frequency signal to the input. Enable S1. If the output goes negative, then switch S2 needs to be reversed, unless your application needs negative output voltage. Move the input level up and down and observe that the output tracks. A 3dB increase should double the output voltage. A 3dB decrease should half the output voltage.

An added note for the pulsar researchers: The chopping frequency should be well above the repetition frequency of the pulsar, and not a harmonic of it. Pulsar frequency components in the residual chopping noise could produce false detections. Most pulsars are slow compared to the 500Hz chopping rate that this is not a problem.

I hope many people will find this design useful, and I would really like to see some significant improvements on this work being published in the future.

Bruce Randall can be contacted at brandall@cetlink.net.

Reference:

Handout at 1993 SARA conference on Detectors by Bruce Randall

NXP data sheet on the SA602
[http://www.nxp.com/acrobat_download/datasheets/SA602A.pdf]

FAR Circuits UNIVERSAL NE602 BOARD BY J. CARR
18N640 FIELD CT.
Dundee, IL 60118
Web: [http://www.farcircuits.net/misc1.htm]
Email: farcir@ais.net

Parts List:

Item	Quantity	Reference	Part
1	6	C1,C3,C4,C5,C9,C10	0.001uF 10% 50V general purpose ceramic
2	1	C2	33uF 15V Electrolytic, general purpose
3	2	C7,C6	0.01uF 20% 50V general purpose ceramic
4	1	C8	100uF 10V Electrolytic, general purpose
5	3	C11,C12,C20	10uF 16V Electrolytic, general purpose
6	3	C13,C14,C21	0.1uF 20% 50V general purpose ceramic
7	1	C15	22PF 5% 50V COG type ceramic
8	2	C18,C17	0.1uF 50V 5% Mylar Film
9	1	C19	0.022uF 50V 5% Mylar Film
10	2	J1,J2	BNC or connector of your choice
11	1	L1	8uH molded choke, not critical.
12	1	R1	180 ohm 5%
13	1	R2	560 ohm 5%
14	2	R3,R6	75 ohm 5%
15	2	R4,R5	680 ohm 5%
16	1	R7	10 ohms
17	2	R11,R8	150K 1%
18	2	R10,R9	10k 1%
19	2	R17,R12	100 ohm 5%
20	4	R13,R14,R15,R16	100K 1%
21	1	R18	100K 5%
22	1	R19	5K 5%
23	1	R20	17.4K 1%
24	1	R21	10 ohm 5%
25	2	S1,S2	Switch SPDT
26	1	U1	SBL1 mixer from Mini Circuit Labs or equiv.
27	1	U2	NE602
28	1	U3	LMC662 dual op amp from NSC
29	1	U4	MC14053
30	1	U5	74HC04
31	1	U6	74HC74

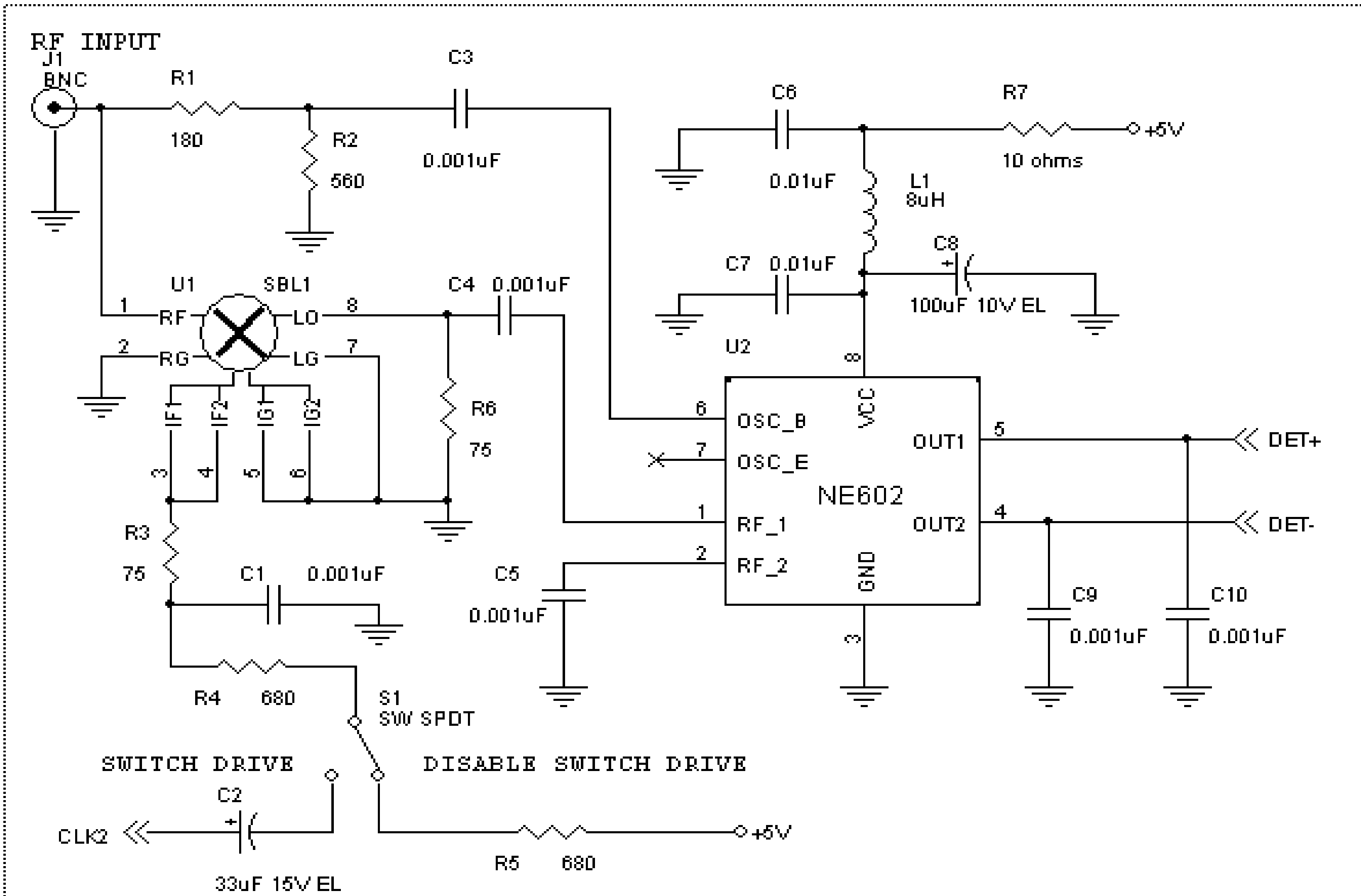

Figure 4: Chopping Switch and Squaring Circuit

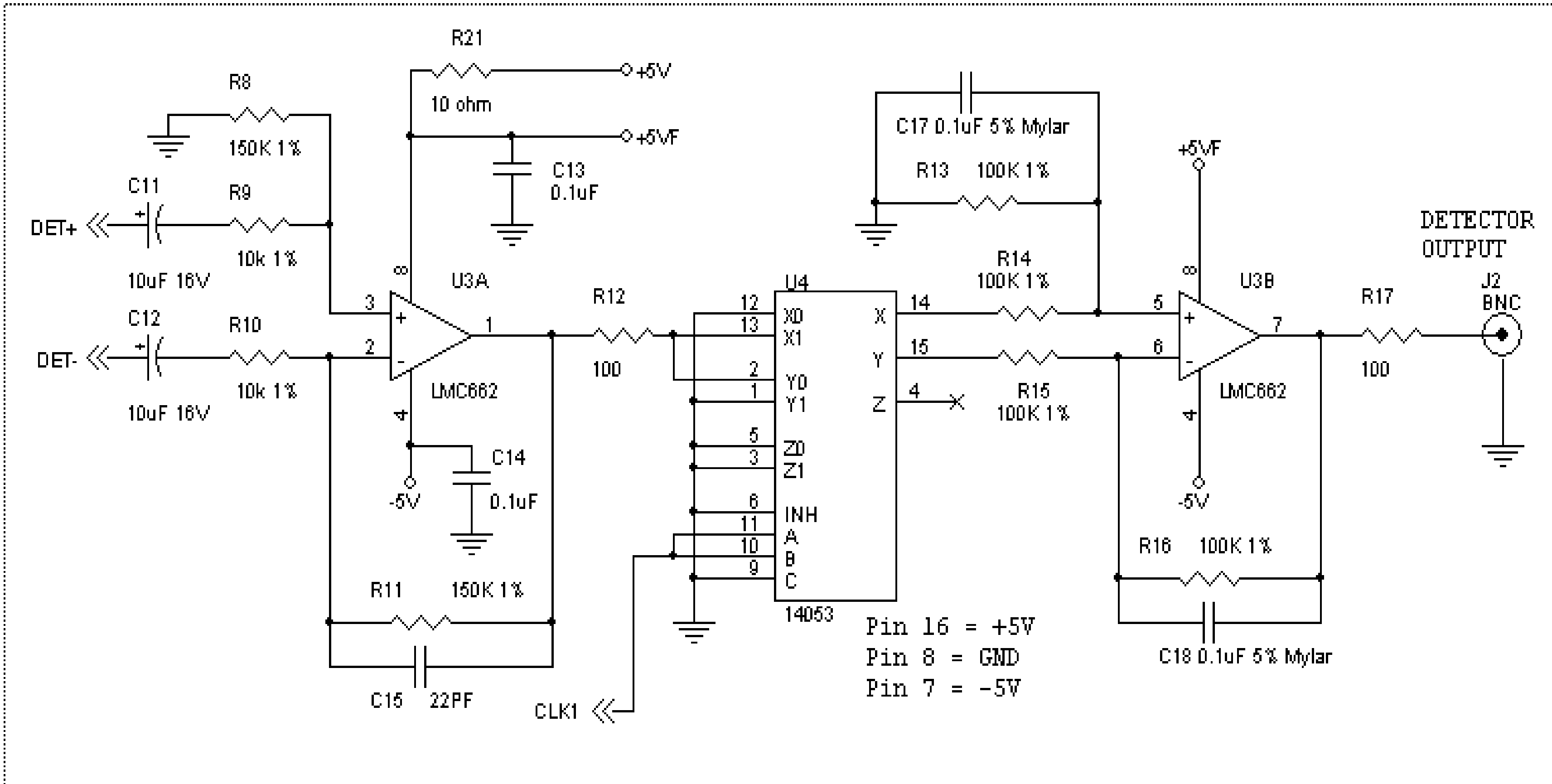

Figure 5: Amplifier and Synchronous Demodulator

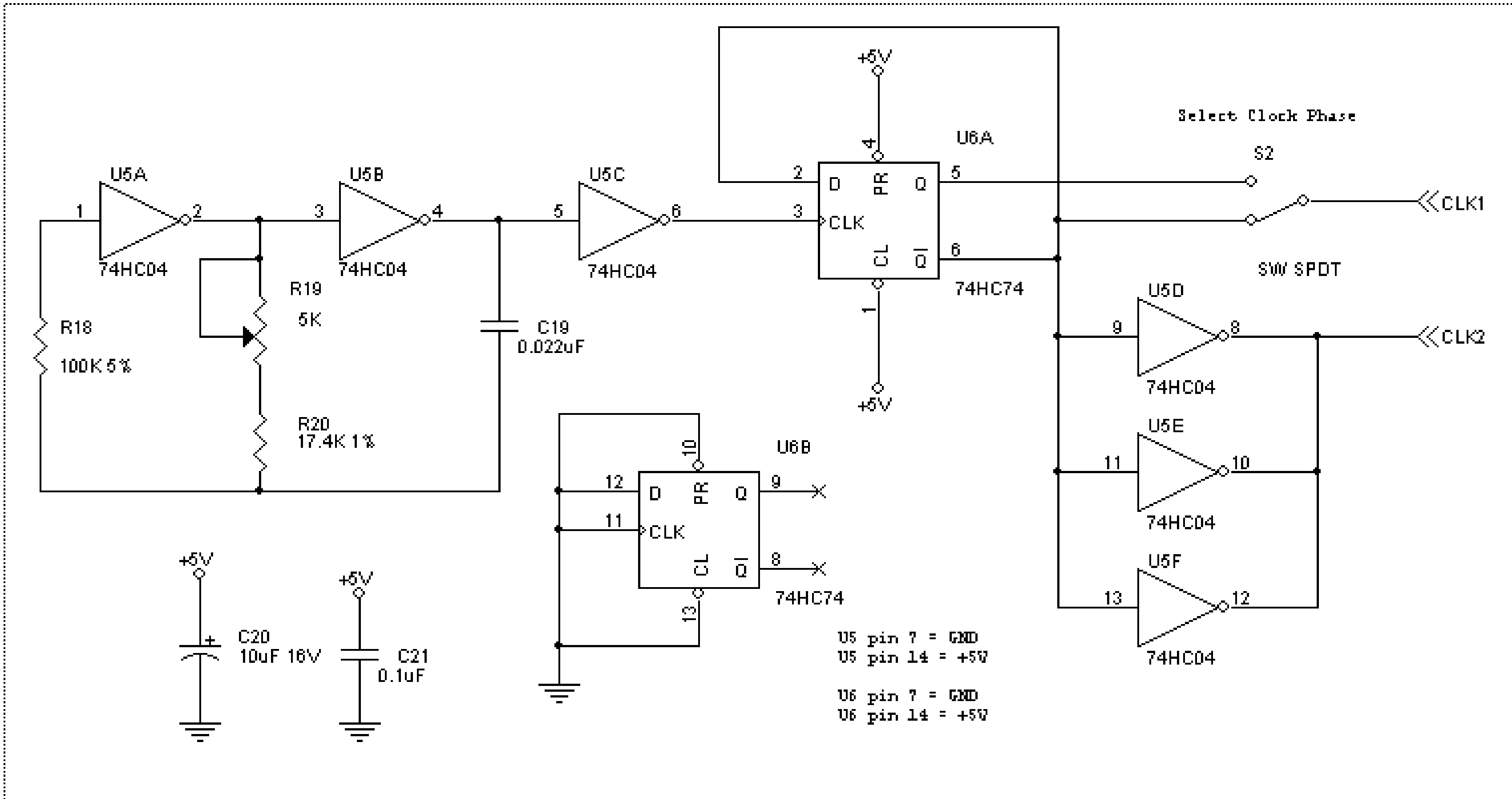

Figure 6: Logic and Clocks

~YAGI Antennas for Jupiter Noise Reception~

By Hal Braschwitz

A couple of queries were submitted recently on the SARA List Server concerning the use of Yagi arrays for Jupiter Noise reception. One dealt with tilting of the array boom to adjust the vertical pattern performance. In free space, remote from any other materials, this would work nicely. It would be equivalent to adjusting the beam of a search light and the beam would follow the direction of the antenna boom, in other words, a line in the plane of the antenna elements and perpendicular to the center of the antenna elements.

Our antennas are not in free space but sited above and close to real earth. This has a profound effect on the performance of any antenna. The earth at the decametric frequency range acts as a lossy dielectric material. The pattern of an antenna so situated is composed of rays from the antenna along with other rays reflected from the ground. These rays combine in various ways to form a composite antenna pattern.

All of the antenna patterns shown below were created with EZNEC 4+ using NEC2 as the computing engine. Figure 8 shows an elevation pattern of a generic three-element Yagi antenna in free space operating at a frequency of 21 MHz. Figure 8a shows the elevation pattern with the boom in a horizontal position and Figure 8b shows the antenna pattern with the boom elevated at 45 degrees. Notice that this follows the search light phenomenon.

Figure 9 shows the elevation pattern of the same antenna located at a height of 25 feet (0.589 wavelength) over average ground (conductivity of 5 millisiemens and dielectric constant of 13). Figure 9a shows the elevation pattern of this antenna with elements in a horizontal plane, the normal method of operation. Figure 9b shows the azimuth pattern of this same antenna. Figure 9c shows the elevation pattern of this antenna with the plane of the elements situated at an angle of 30 degrees with the horizontal. Notice that the elevation pattern is virtually unchanged in these circumstances except that the back lobe pattern has deteriorated.

An effective way to have some control over the elevation pattern with this antenna is to vary the height over the ground plane. Figure 10 shows this situation. Figure 10c is the same as figure 9a which is our test antenna at the height of 25 feet. Actually, this appears to be a useable height for Jupiter reception for the next couple of years from most areas in the United States and for other locations with similar northern latitudes. Figure 10a shows the elevation pattern of the antenna at a height of 15 feet, figure 10b, height of 20 feet, figure 10c, height of 25 feet and figure10d, a height of 30 feet. Notice at 30 feet, a secondary lobe pointed at the zenith is growing and may result in reception of spurious noise from that direction to confuse the signal being received from Jupiter.

However, to show the effectiveness of a three-element monoband 15-meter Yagi at an appropriate height for Jupiter reception, I modeled the Jansky Bruce Array from the dimensions of the replica of that antenna on the front lawn of the Green Bank Observatory for comparison. The Jansky Bruce Array at Green Bank has been proven an effective antenna for receiving Jupiter emissions. Figure 11a shows the modeled elevation pattern of the Jansky Bruce array and Figure 11b shows the azimuthal pattern of that antenna.

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All of the caveats of antenna modeling apply, such as they are only models of the real thing over a homogeneous flat ground. However, it does give a reasonable representation of the actual antenna performance in most instances. The Yagi antennas described above are horizontally polarized, while the Jansky Bruce Array is a vertically polarized array.

In conclusion, the three-element 15-meter monoband Yagi array would be an adequate antenna for HF Jupiter reception. The height of the antenna could be tailored to produce an elevation pattern to optimize performance at a particular location. Tilting the boom of such an antenna does not alter its elevation pattern in the usual application. The Yagi is somewhat limited in operating bandwidth to about 4 percent. To cover a broader range of frequencies, a log periodic dipole array (LPDA) might be the answer. However, such an antenna would be somewhat larger and feed arrangements more complex.

(Editor's supplement below)

~Decametric Jovian Emission~

Jovian-Io magnetic substorms are the source of the HF decametric emissions. The electrically conductive atmosphere of Io, resulting from ionization of sulfur gases ejected from volcanic activity spurred by Jovian tidal forces, interacts with Jupiter's magnetic field as the moon sweeps by its poles. Nonrelativistic electrons spiral around magnetic field lines towards the poles emitting radio waves (cyclotron resonance). The enhanced emission from the Jupiter-Io interaction goes up to 40 MHz. The Radio JOVE Project, [http://radiojove.gsfc.nasa.gov/], supplies an inexpensive kit (electronics and a dual dipole antenna array) to monitor emissions around 20 MHz (only frequencies above the electron plasma frequency of Earth's ionosphere penetrate from extraterrestrial sources).

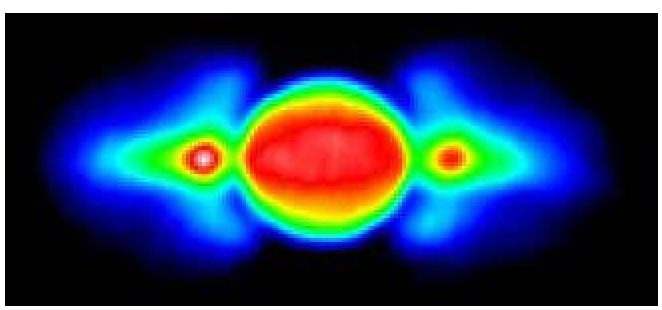


Figure 7: A 13-cm radio image of Jupiter (Amateur reception is around 1500 cm)
Credit: Australia Telescope National Facility (ATNF), New South Wales
[http://www.spacetoday.org/SolSys/Jupiter/JupiterRadio.html]

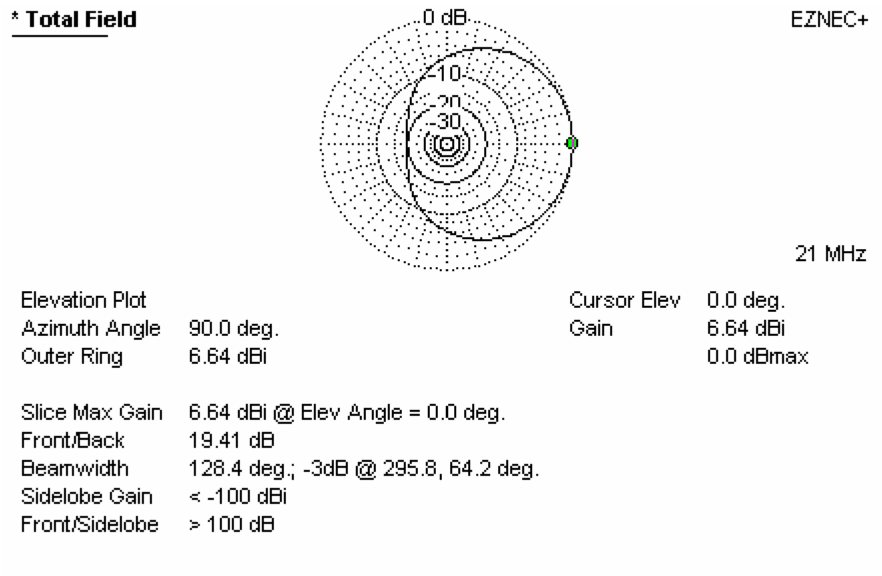


Figure 8a: Generic 3-element 21 MHz Yagi,
Elevation Pattern in free space, elements in horizontal plane

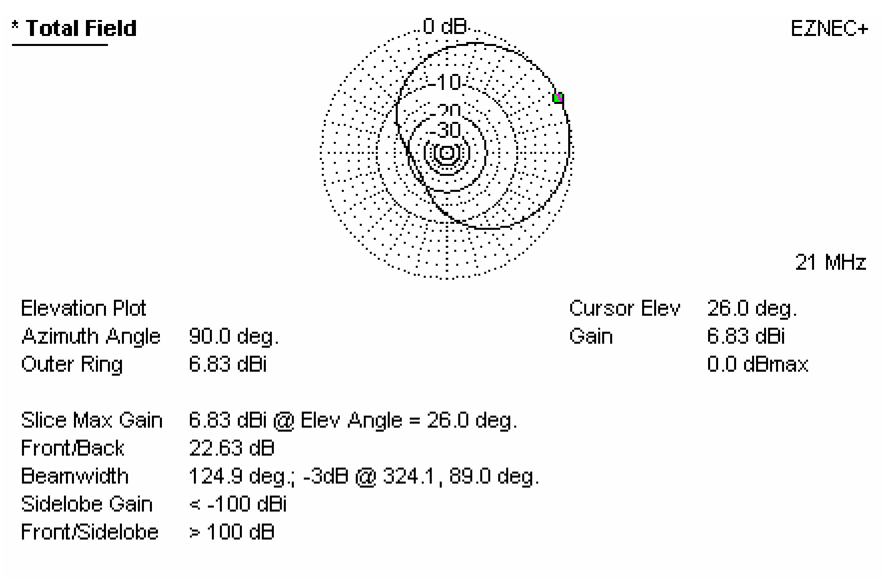


Figure 8b: Generic 3-element 21 MHz Yagi,
Elevation Pattern in free space, elements tilted upward at 30 degrees

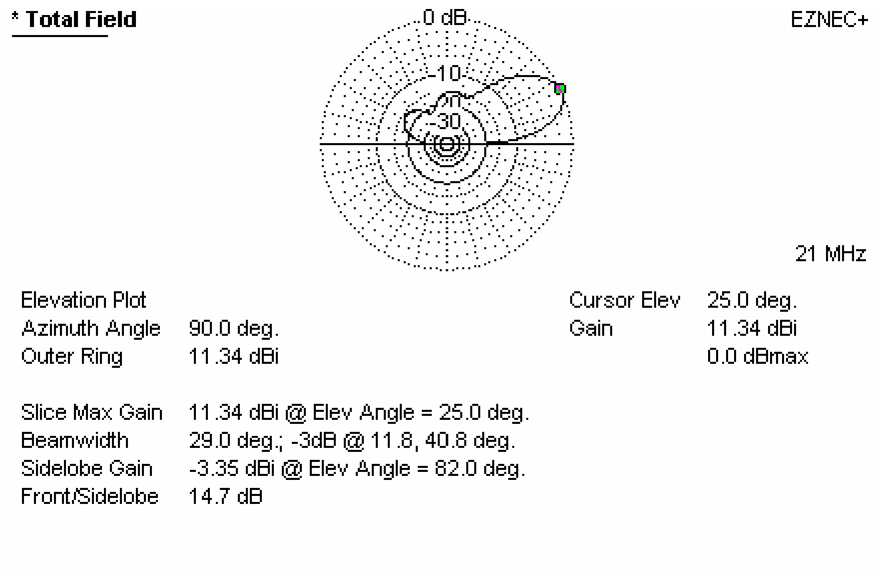


Figure 9a: Generic 3-element 21 MHz Yagi,
Elevation Pattern over real ground at 25 feet, boom horizontal

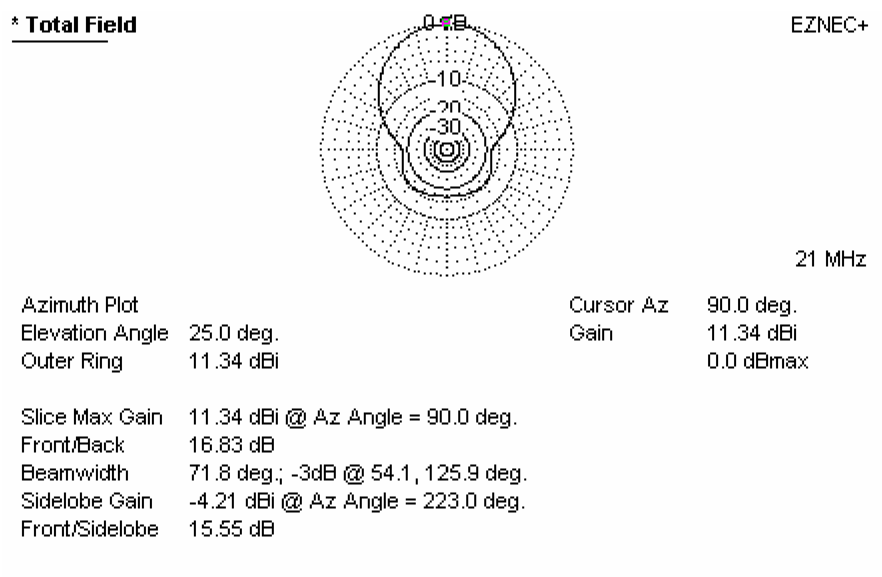


Figure 9b: Generic 3-element 21 MHz Yagi,
Azimuth pattern at 25 degrees over real ground, boom horizontal

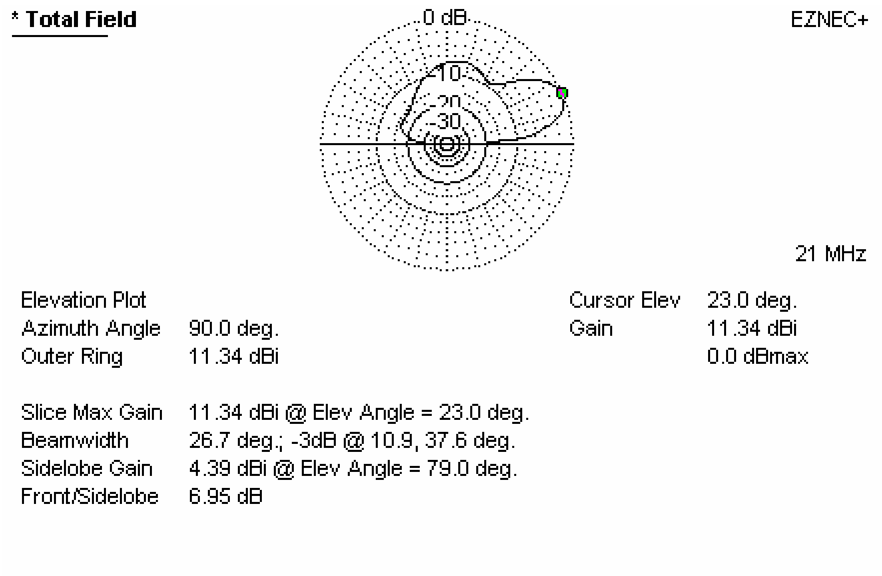


Figure 9c: Generic 3-element 21 MHz Yagi,
Elevation Pattern over real ground at 25 feet, boom tilted upward at 30 degrees

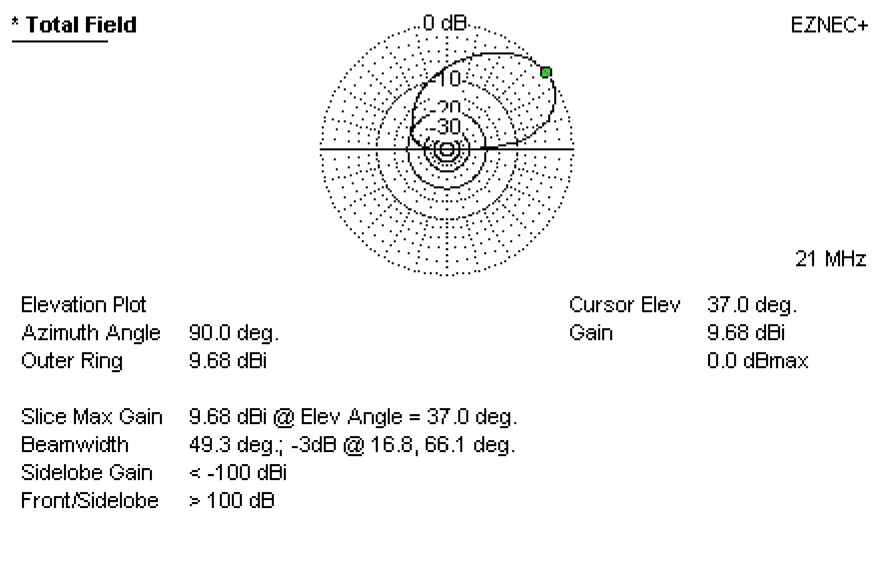


Figure 10a: Generic 3-element 21 MHz Yagi,
Elevation Pattern over real ground at 15 feet, boom horizontal

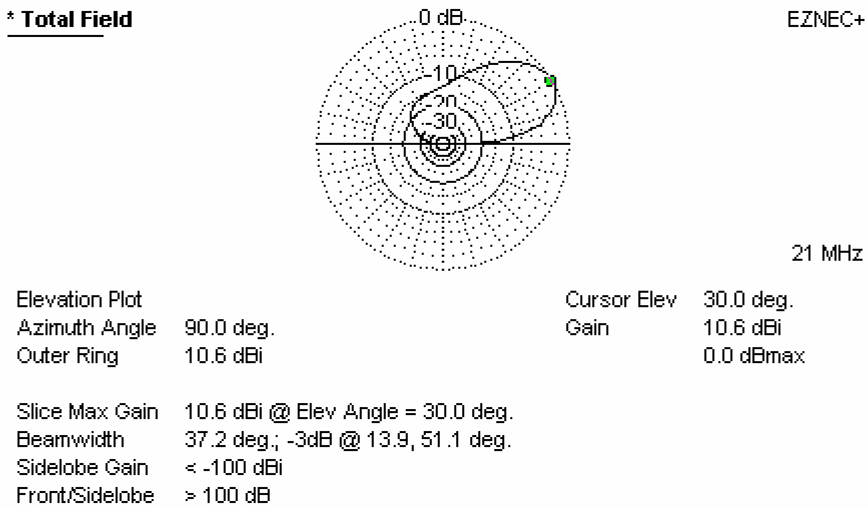


Figure 10b: Generic 3-element 21 MHz Yagi,
Elevation Pattern over real ground at 20 feet, boom horizontal

(Figure 10c same as Figure 9a)

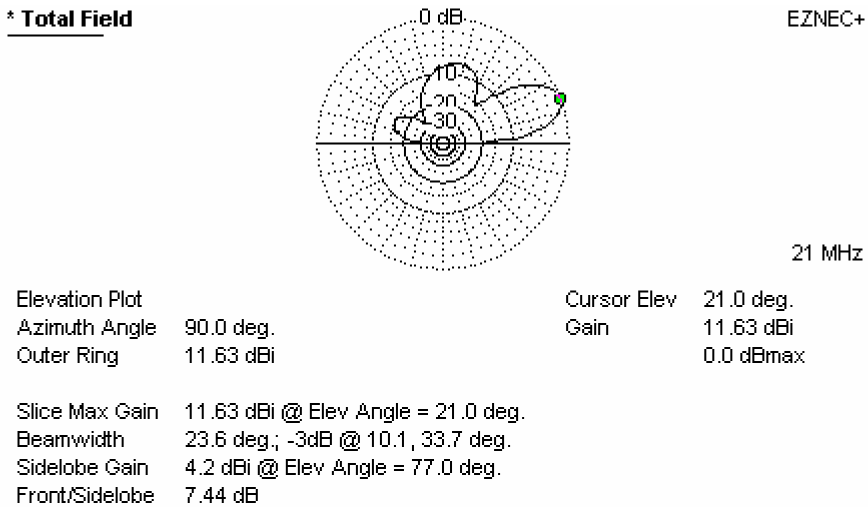


Figure 10d: Generic 3-element 21 MHz Yagi,
Elevation Pattern over real ground at 30 feet, boom horizontal

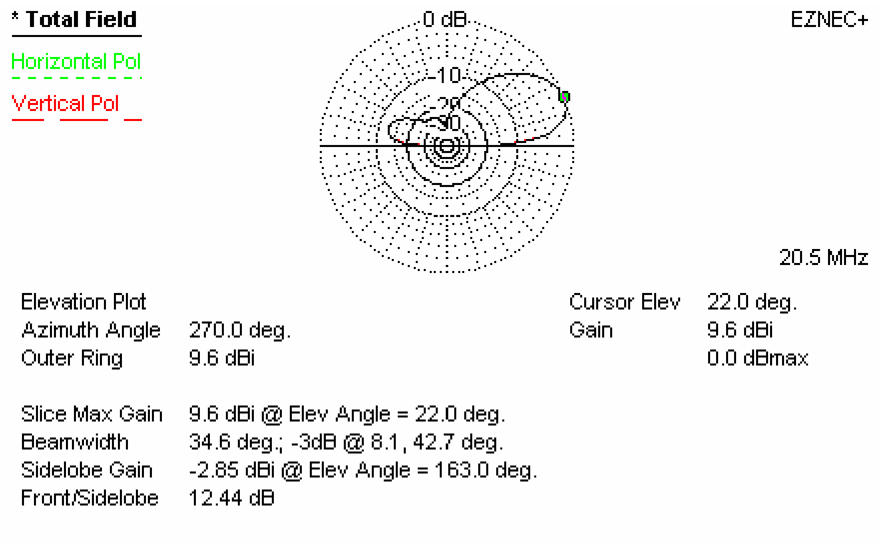


Figure 11a: Jansky Bruce Array Elevation Pattern

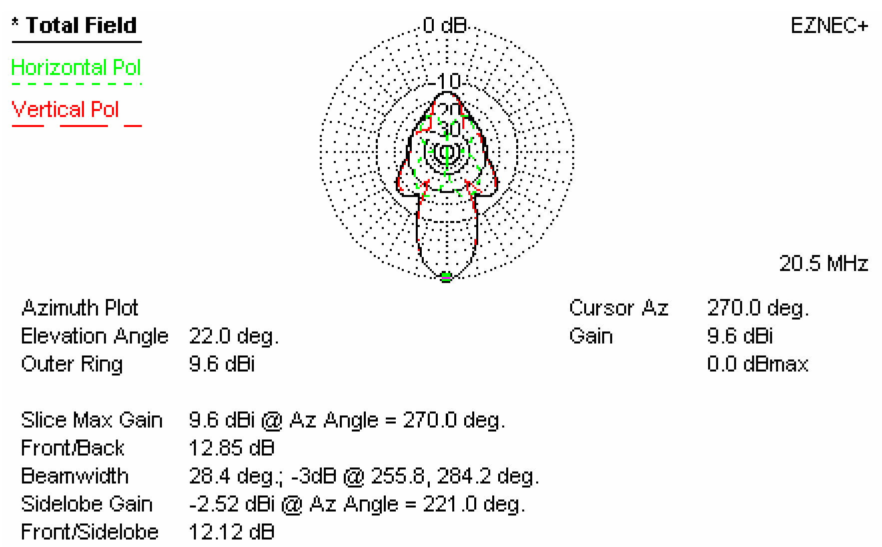


Figure 11b: Jansky Bruce Array,
Azimuth Pattern at an elevation angle of 22 degrees

~ Radio Astronomy Toolbox:
Printed Circuit Boards for the Masses ~

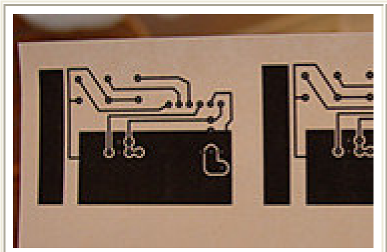
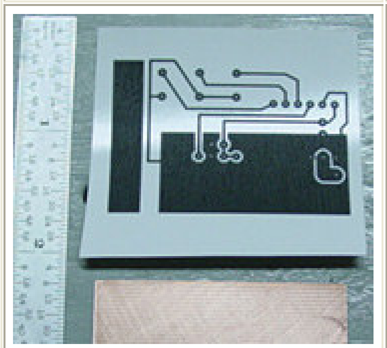
*(Editor's Note: Adapted from **5 Bears Research**, [http://www.5bears.com/pcb.htm])*

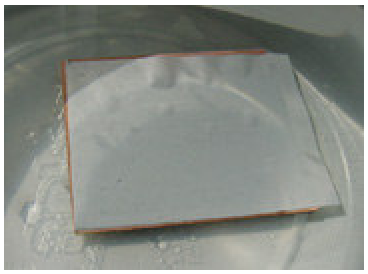
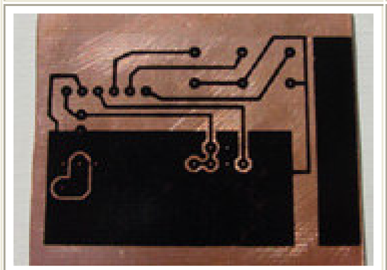
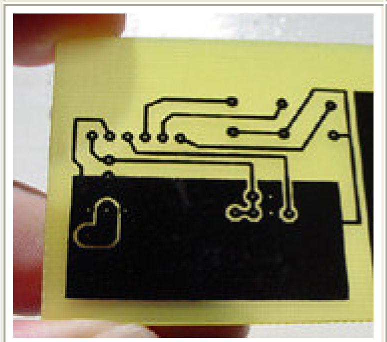
(*In the voice of the article)*: Creating PCB's at home has always been a hassle. The basic methods available include manually laying out the traces with trace transfers (not recommended), photo-reproduction (specialized and expensive), or the using a laser printer in the *toner transfer* method. This latter has been somewhat hit or miss for me, with variable results. A bit of internet research led to the discovery of [http://www.fullnet.com/~tomg/gooteepc.htm], an absolutely *dynamite* article. All the credit goes to Tom Gootee for finding a paper that really works.

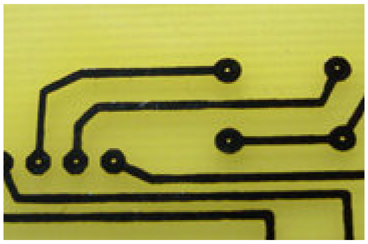
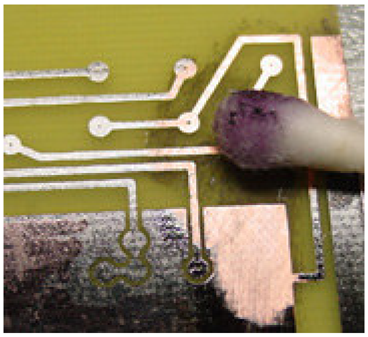
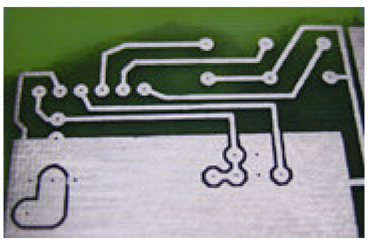
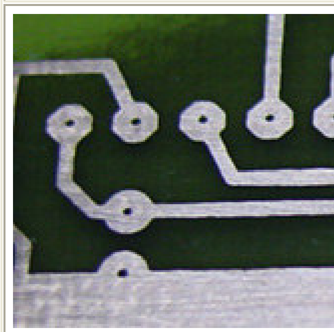
The procedure is simple. You need some Jet Print brand Photo paper (glossy). The stuff I bought was *Jet Print Multi-Project Photo Paper, 07033-0.* Jet Print color-codes their inkjet photo papers. Look for the stuff with the green band; it's about $0.75 per sheet here in Texas.

The next step is to produce *positive* images of the traces you want using almost any editor, CAD program, etc. The image must print to the exact scale needed.

Figure 12: Printed Circuit Board Layout Sequence

	Once the image is created, test-print the traces on a sheet of regular paper. You *must* use a laser printer; inkjet printers will not work. If it all looks good, load a sheet of the Jet Print into your printer tray, set your printer for darkest image, and print. Here is the image of my traces printed to the Jet Print paper.
	Cut out the traces, leaving a bit of paper surrounding the traces as a border. Prepare your copper board by first sanding it lightly in a crosshatched pattern with 400-grit paper. Next, degrease and clean the copper with alcohol or similar. My Jet printed circuit is shown here next to a small, prepared board.

	Borrow an iron from the house boss. Set it on its highest temperature and allow it to warm up. Tack the paper down on one corner of the board. It will immediately begin to fuse and stick. Continue to iron the paper onto the board. Go ahead and use a bit of pressure. This 2 square-inch board was ironed for about 3 minutes. Use the edge of the iron as well to apply higher pressure in a pattern. You can tell when you're done because you will actually be able to *see* the traces through the paper (something in the heating process causes this phenomenon). Give it another minute for luck, then drop the fused paper and board...
	...into a bowl of hot water. It will immediately bubble and begin to separate from the copper. Don't rush things, let it soak for a good 10 to 30 minutes. You may need to help the paper separate a bit.—it won't float free on its own. But if you used a good hot iron, you won't have any trouble with trace mask peeling off the copper. It *really* fuses well.
	The PCB is ready to etch! Note the very clean image: no melting or blurring at all!
	Place it into the ferric chloride etch. Keep an eye on it and agitate it occasionally. A plastic fork is handy to lift and inspect the board.
	The fused toner does a superb job. No creep of etchant under the mask is evident.

	Here is a nice, close view of the etched board before the toner is stripped to reveal the copper. The pads in the lower left were originally octagonal and they retain their shape perfectly.
	The only reliable solvent to remove the toner is acetone. Other solvents such as xylol (xylene) or alcohol work, but they are very slow!
	This is the completed board. The copper looks tin-plated, but it is a “trick of lighting,” it is still copper. All that remains now is drilling.
	A super close-up: note the clean traces, lack of pinholes or etchant bleed. These are 20-mil traces. Overall, this a great way to make simple PCB's at home with confidence!

~A Remotely Accessible Amateur Radio Astronomy Observatory~

By Chuck Forster

The E. B. Seti group in conjunction with the Society of Amateur Radio astronomers "Old Timers" (SARA-OT) special interest group presents a remote controlled observatory for use by beginning amateur radio astronomers.

High school students or science groups will be given priority for using the observatory. The goal of the proposed experiments will be considered in an effort to help provide a reasonable opportunity for success.

Cost to the user will be approximately $20/month or less. This expense provides you with an account on "GoToMyPC.com". Equipment required by the user will be an Apple Mac running the Safari web browser or any Windows computer running Internet Explorer or a similar web browser. A high-speed internet connection (DSL or Cable) will be required.

The observatory includes:

(1) A 16-foot dish connected to a SpectraCyber receiving system running SpectraCyber 1 software in continuum or spectral mode.

(2) A phased dipole constructed per Radio Jove guidelines connected to an Icom R-71 receiver tuned to 20.1 MHz in "AGC off" mode.

(3) A long wire antenna connected to an HP 310A VLF wave analyzer monitoring the signal strength of the WWVB transmission at 60 kHz.

(4) An Icom R-7000 tuned to a distant FM station to detect signal bursts due to meteors entering the earth's atmosphere.

(5) A photocell to show daylight/nighttime periods.

The SpectraCyber output is not shown on the Radio SkyPipe chart, but all data is remotely down loadable.

Radio SkyPipe data is presently published on the web and will continue to be published during any project.

A near real time video of the observatory control room can be found at www.phasorlabs.com/phcam.htm.

The only requirement made by the E. B. Seti group is that any reports summarizing a research project be made available for publishing on www.rainfo.net and the SARA Journal.

Planned operation of the observatory will be 24/7 and I do not expect to stop operation during lightning storms. Power to the site is reasonably reliable and UPS systems are installed to ride through 15-minute power interruptions.

Reasonable modifications to the observatory will be made to accommodate experiments.

From November to April, site changes or repairs may be delayed, but I am working on improving this.

This site does not receive any compensation from any source other than the Phasor Labs company.

If you would like to consider using this site, contact Chuck at cforster@phasorlabs.com

Where is the site?
Located near Oregon, WI it is at a small airport (Syvrud 7WI5). Nearby interference seems reasonably low, but this can be a project for an observer to determine.

Figure 13: Remote Amateur Radio Astronomy Observatory (Oregon, WI)

Figure 14: The 16-foot dish (the 12 GHZ feed horn shown
has been replaced with a 1420 MHz feed horn/LNA assembly)

Figure 15: The Control Room

How is the site accessed?

By going to *GoToMyPC.com*. When you log onto the control room computer, it is the same as if you were at the site. You have full control of the programs, file transfer (including to your computer) and even rebooting if required.

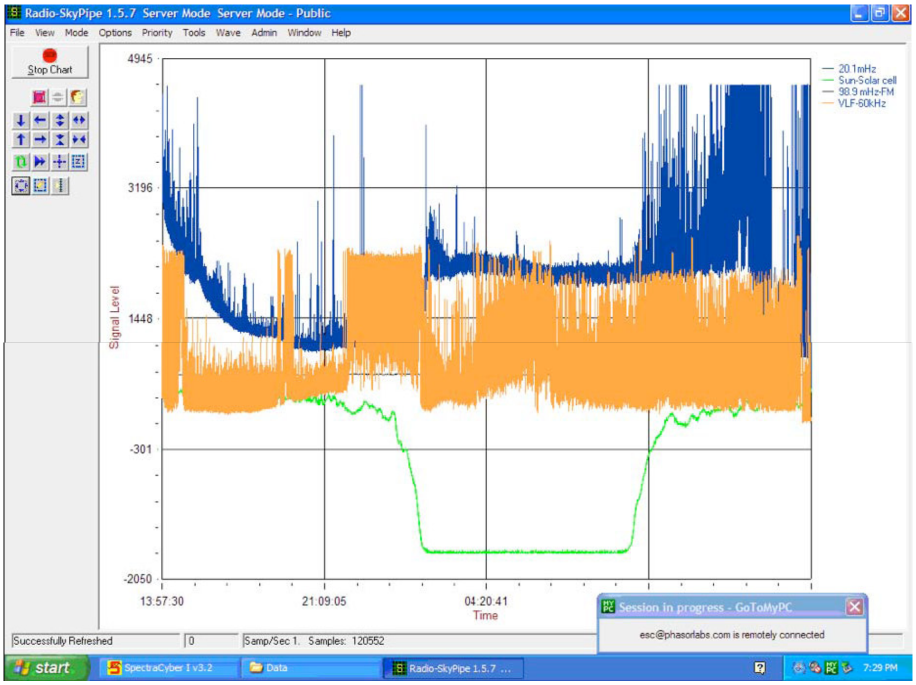


Figure 16: The screen shows control of the Radio SkyPipe program

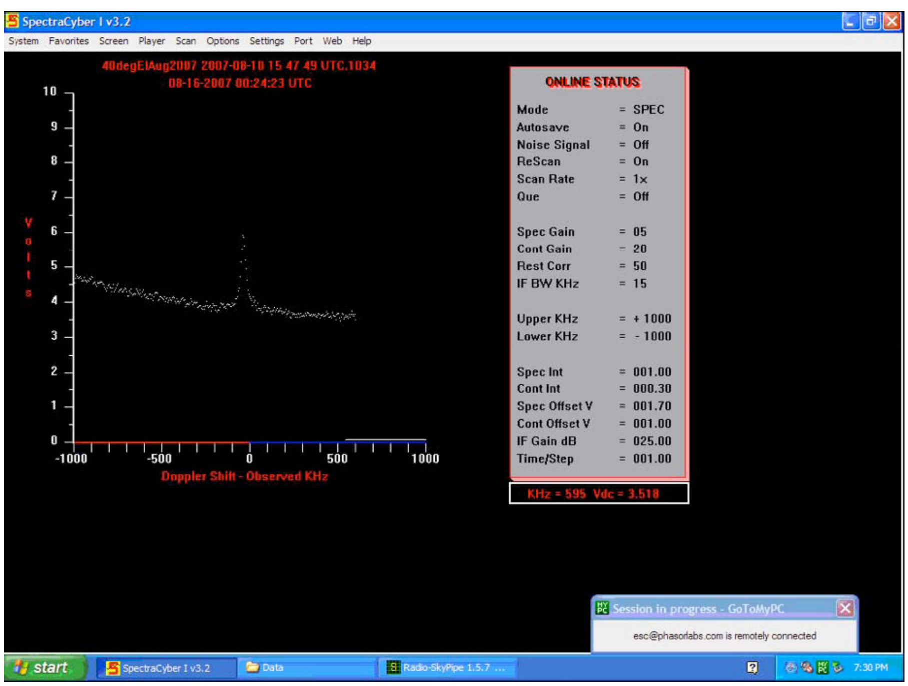


Figure 17: The screen shows control of the SpectraCyber 1 program

~ 2007 AUI/NRAO Image Contest: Prizes Awarded~

This is the third annual image contest. Let the pictures bedazzle you and the astronomy inspire. The winners were announced in October. The 1st, 2nd, and 3rd prizes were $1000, $500, and $250, respectively. Pictures and text are adapted from the NRAO website [http://www.nrao.edu/imagegallery/image_contest/image_contest_2007_prizes.shtml]

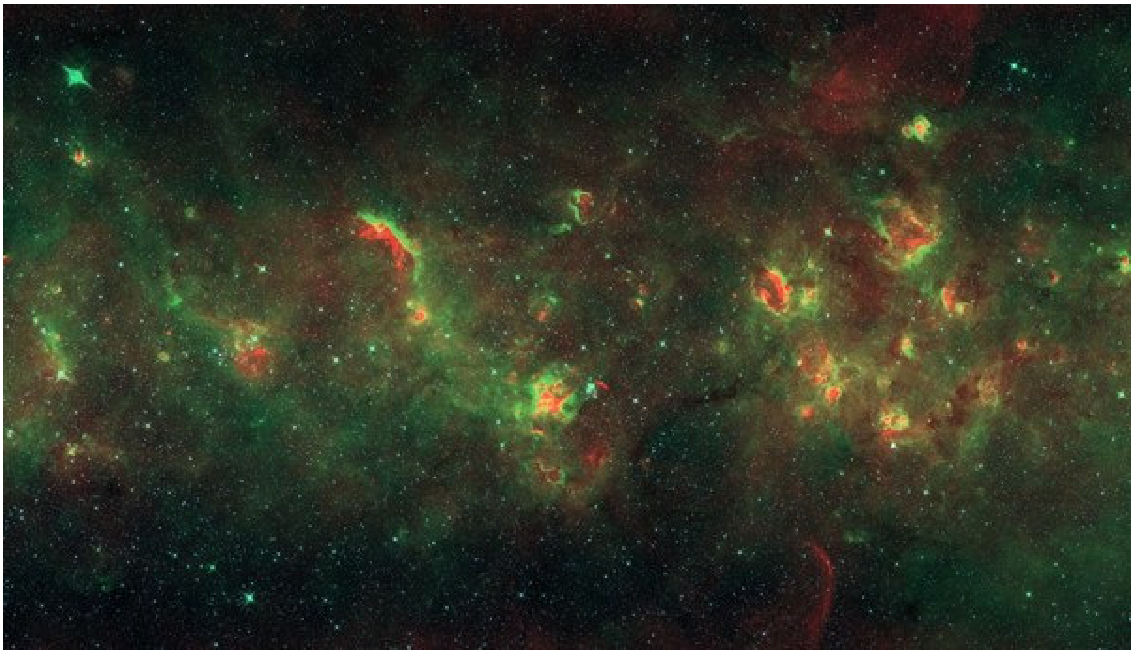


Figure 18: First Prize: *Birth and Death in the Milky Way.*

Image courtesy of NRAO/AUI and (Rick White, STScI) (Bob Becker, IGPP/LLNL & UC-Davis) (David Helfand, Columbia)

This panorama of a section of the Milky Way in the constellations of Scutum and Aquila illustrates the dynamic interplay between the birth and death of massive stars in our Galaxy. The image is a composite of a radio image constructed from observations taken in several configurations of the Very Large Array at a wavelength of 20 cm for the MAGPIS survey with mid-infrared data taken as part of the GLIMPSE survey conducted by the Spitzer Space Telescope. The radio data are coded red, the long-wavelength infrared data (at 8 micrometers) green, and the shorter wavelength infrared data blue-white; yellow regions in the image show places where both radio and infrared emission is prominent. Normal stars are brightest at the shortest wavelengths, showing up as the myriad of blue-white points. Birth sites of the youngest massive stars show up as yellow clumps – radiation from the newborn stars heats surrounding dust producing infrared emission, while the ultraviolet light from these stars separates electrons from hydrogen atoms giving rise to radio emission. More mature stars have managed to destroy the dust nearby leaving red cores surrounded by yellow, then green, shells as the temperature drops far from the stars. The prominent red arcs mark the sites where massive stars have died in titanic explosions and blasted their gas light years into space at thousands of miles per second; their radio emission is produced as electrons, accelerated to nearly the speed of light by the outward moving blast waves, spiral in the Galactic magnetic field. The diffuse green glow reveals the tiny dust particles that suffuse interstellar space along the band of the Milky Way; dark filaments superposed on this emission show regions where the gas and dust are so thick that no light can get through – regions in which future generations of stars will form (Investigators: Helfand, Becker, White).

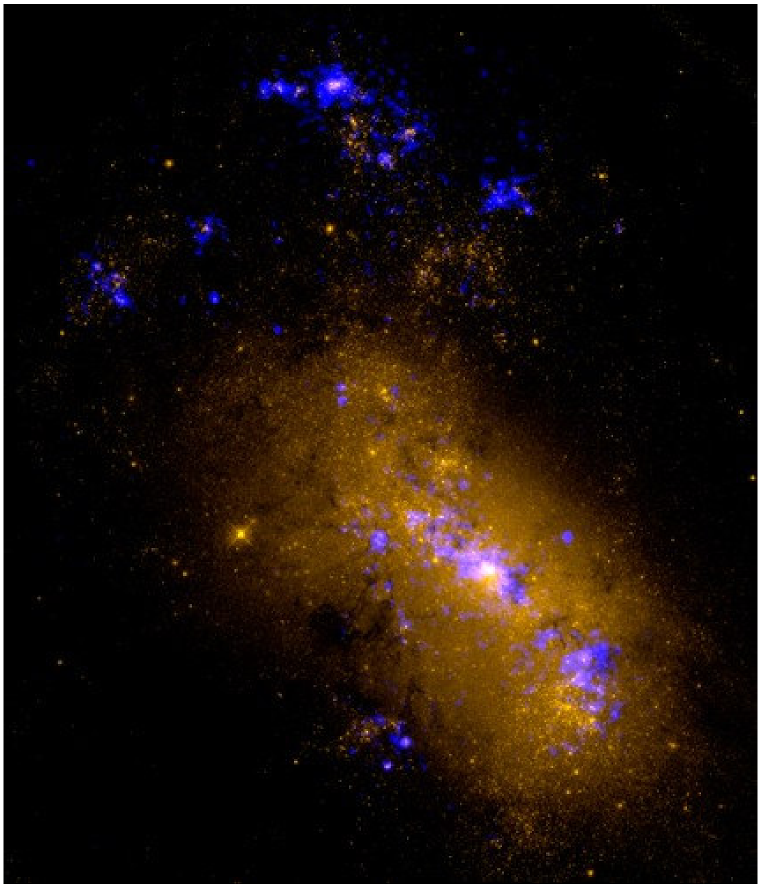


Figure 19: Second Prize: *Emerging Super Star Clusters in NGC 4449*

Image courtesy of NRAO/AUI and Image courtesy of Amy Reines, University of Virginia, NRAO/AUI

Radio imaging with the Very Large Array captures newborn massive star clusters as they emerge from their birth material in the galaxy NGC 4449. These "super star clusters" contain tens to hundreds of thousands of stars. The young stars produce hot ionized gas, which is detectable at radio wavelengths, shown in blue here. An image from the Hubble Space Telescope shows the visible starlight in yellow (Investigators: Amy Reines, Kelsey Johnson, and Miller Goss).

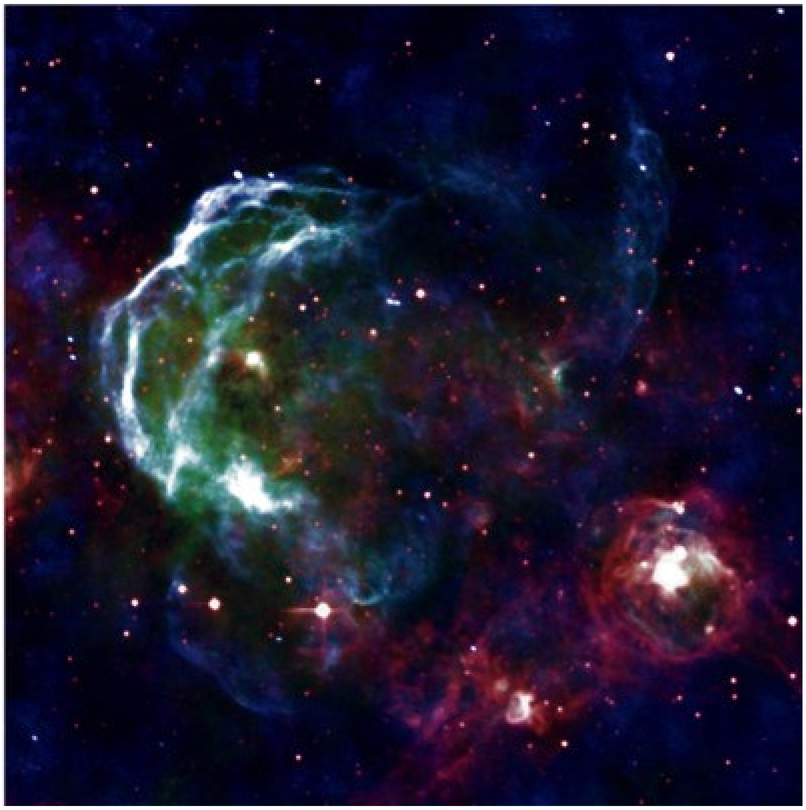


Figure 20: Third Prize: *The Corpse of a Star*

Image courtesy of NRAO/AUI

This shell of hot gas is the remains of a star, which exploded around 30,000 years ago. It is thought to be the remnant of a core-collapse supernova, which occurs when a star runs out of fuel for nuclear fusion, collapses under its own weight, and then rebounds, producing a shock wave, which rips outward through the surrounding material. Even though it is located over 6000 light years away, at peak brightness, the supernova would have been visible during the daytime to our ancestors on Earth. The shock front can clearly be seen in this image as the blue-green structure, visible in radio waves from the Galactic Plane Survey (a survey of our Milky Way Galaxy undertaken by the Very Large Array radio telescope; the image also contains infrared data from the MSX satellite, shown in red). In the 30,000 years since the explosion, this shock has reached over 60 light years away from its parent star (and slowed down to "only" 70,000 miles per hour), sweeping up surrounding gas, and enriching our Galaxy with heavy elements. The deaths of similar stars eons ago in our Sun's neighborhood seeded our solar system with the material necessary for life to begin (Investigators: D. Helfand, R. Becker, and R. White).

~Dr. Paul Shuch Honored by International Astronautics Academy~

Paul Shuch, currently serving as the SARA Vice President, was recently honored for his contributions. The excerpt below has been adapted from a press release:

Little Ferry, NJ.., August 2007 – H. Paul Shuch, the author, educator and engineer who heads up a grass-roots Search for Extra-Terrestrial Intelligence, has been elected to Full Membership in the prestigious International Academy of Astronautics (IAA). A Corresponding Member of the academy since 2003, Prof. Shuch left a successful academic career in 1995 to become Executive Director of the newly founded SETI League, an international nonprofit organization. Currently, as Executive Director Emeritus, he remains responsible for planning and implementing The SETI League's educational, scientific, technology and outreach programs. His elevation to Full Membership in the academy will be formalized at this year's International Astronautical Congress, to be held next month in Hyderabad, India.

The IAA is a scientific institution devoted to fostering the development of astronautics for peaceful purposes, recognizing individuals who have distinguished themselves in a branch of science or technology related to astronautics, and providing programs through which the membership can contribute to international endeavors in the advancement of aerospace science. It was founded in Stockholm in 1960 by the noted aerodynamicist Dr. Theodore Von Karman. The International Academy of Astronautics (IAA) website is found at [http://iaaweb.org/content/view/277/416/].

With his elevation to Full Member, Dr. Shuch joins several hundred distinguished space scientists and engineers from 60 countries, including two other SETI League members, in lifetime IAA membership. The academy cooperates, exchanges and conducts joint meetings with national academies, and prepares cosmic planning studies through its six commissions. The academy also organizes many independent international scientific meetings, such as the Humans in Space, Small Satellite, Low Cost Planetary Mission, Realistic Near-term Advanced Scientific Space Mission, and Impact of Space Technology Innovation on Economic Development conferences.

Dr. Shuch was appointed to the IAA's SETI Permanent Study Group in 2000, and currently serves as its co-chairman and webmaster. He has presented papers at nine different IAA meetings in Europe, North America, South America, and Asia, and published articles in its peer reviewed scholarly journal, *Acta Astronautica*. "This bodes well for SETI," says Shuch of his election to Full Membership, "because it is yet another indicator that our research is being accepted, and respected, by the mainstream scientific community."

~ Radio Astronomy Miscellany: Arthur C. Clarke ~

By John C. Mannone

December 16, 2007: Arthur C. Clarke celebrates his 90th birthday. In a recent news announcement (referenced at end of this note), CNN cites Clarke's three wishes:

COLOMBO, Sri Lanka (AP) -- Science fiction writer Arthur C. Clarke listed three wishes on his 90th birthday: for the world to embrace cleaner energy resources, for a lasting peace in his adopted home, Sri Lanka, and for evidence of extraterrestrial beings.

For your enlightenment, I have placed several links to Sir Clarke's biographical information and prolific career at the end of this note.

You all may already be aware of Clarke's seminal paper on satellite communication with satellites in geosynchronous orbit, "Extra-Terrestrial Relays," *Wireless World*, October 1945, pp. 305-30. See [http://www.lsi.usp.br/~rbianchi/clarke/ACC.ETRelaysFull.html]. This is an excellent example of science fiction being the progenitor of science. This is rare (of course, the other way around is typical). The relevance to us is that there is a Clarke belt of satellites just as he had proposed for communications. Many of us are enjoying TV right now because of his insight into simple, but profound Newtonian mechanics. The SARA/NRAO program promoting radio astronomy has its Navigators often train their 12 GHz radio telescopes (IBT) on microwave transmitters parked in those orbits. Clarke's insight should be no surprise — he is physicist (B.Sc. 1948) and a creative thinker as evidenced by his ubiquitous science fiction writings and screenplays.

Concerning science and art, most of you are aware my poetry has been published in several literary journals, astronomical publications and quality e-zines (e.g., see Spring 06 and Spring/Summer 07, [http://astropoetica.com]). So, it is needless to say that I am delighted to hear that Clarke wants to be remembered as a writer more than anything else, [http://www.cnn.com/2007/SHOWBIZ/books/12/17/people.arthurcclarke.ap/index.html].

The Clarke Foundation provides a good, yet brief, biography and vita:
Biography: [http://www.clarkefoundation.org/acc/biography.php]
Vita: [http://www.clarkefoundation.org/acc/vita.php]

.A biography adapted from the book, McAleer, Neil, *Arthur C. Clarke - The Authorized Biography*. Chicago: Contemporary Books, 1992, is annotated by Bianchi in the reference, [http://www.lsi.usp.br/~rbianchi/clarke/ACC.Biography.html].

Wikipedia, though not an absolute source, not only provides biographical information, but also interesting links, [http://en.wikipedia.org/wiki/Arthur_C._Clarke].

~ Radio Astronomy Resources ~

SARA
http://radio-astronomy.org

Radio Astronomy Supplies
(Jeffrey M. Lichtman)
P.O. Box 450546
Sunrise, FL 33345-0546
(954) 965-4471 / jmlras@mindspring.com
http://www.radioastronomysupplies.com

Radio Sky Publishing
(Jim Sky)
PMB 242, Box 7063
Ocean View, HI 96737
(808) 328-1114
http://radiosky.com

National Radio Astronomy Observatory
http://www.nrao.edu

Tamke-Allan Observatory
(David Fields)
http://roanestate.edu/obs

Jamesburg Earth Station volunteer group
http://www.jamesburgdish.org
http://www.bambi.net/jamesburg.html

RF Associates
(Richard Flagg)
1721-I Young Street
Honolulu, HI 96826
(808) 947-2546

SETI League
http://www.setileague.org

European Radio Astronomy Club
http://www.eracnet.org/

Pisgah Astronomical Research Institute
http://www.pari.edu

Society of Amateur Radio Astronomers
c/o Tom Crowley
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crowleytj@hotmail.com

Address Service Requested
October/November/December 2007