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~ 50 Year Commemorative ~



Figure 1: Sputnik History- wav file on telemetry of Sputnik I passing overhead [http://www.hq.nasa.gov/office/pao/History/sputnik/]

~ The President's Page ~



Figure 2: Russian matchbox cover of Sputnik [http://www.cosmodog.com/LAIbrary/sputnik.html]

Half Century in Space

Hard to imagine, but October 4 marks 50 years since Sputnik's orbiting of Earth spurred America into the space race.

I was born that same year and grew up watching multiple networks pre-empt normal TV programming for hours on end with every manned launch. I knew it was important. After all a launch could even pre-empt Saturday morning cartoons!

Back then you'd get maybe three off air TV channels. And often they were all covering the launch.

With fifty circuits of the Sun behind me, my perspective has gained some wisdom. I now look back and don't see a national desire for technical growth. But rather I see it all as something much closer to a national football rivalry. Without some clear win-lose goal after the Moon landing, the whole space program sort of fizzled. It is a tough act to follow, but Mars and other targets have been waiting patiently all that time.

It is a shame that when rockets blow up on the launch pad, the support "peters out" and every newspaper article leads with the "cost" of the failure. America only supports winners, unfortunately. If you can't forecast innovation and discovery, people just move on to someone who will claim to be able to do just that.

Fifty years later we're even more "jaded". Instead of three TV channels we have hundreds. SciFi shows make intergalactic travel seem push button simple. It really is hard to impress today's youth. So the next time you wonder why NASA can't seem to get its act together, blame our competitive nature and modern saturation marketing. NASA needs a Superhero. Or at the very least, NASA needs a Star Wars style marketing mastermind to act as cheerleader. A goodly portion of the audience relate to WWF wrestling much better than science.

Do your part. Be a cheerleader for NASA and space science in general. As SARA members, we're much more likely to understand the technology and be able to explain it to our friends and the general public. At the very least, our enthusiasm can be contagious.

Charles Osborne K4CSO

~ Editor's Addendum ~

In 1952, the International Council of Scientific Unions (ICSU) established July 1, 1957 to December 31, 1958 as the International Geophysical Year (IGY), coincident with maximum solar sunspot activity.

In March 1953, the NAS created a US National Committee to oversee US IGY projects, which included investigations of auroras aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, the ionosphere, determinations of longitude and latitude, meteorology, oceanography, seismology, solar activity, and the upper atmosphere. The latter promoted a plan to orbit satellites—and a program to launch the first artificial satellite. In October1954, the ICSU adopted a resolution for an artificial satellite to map the Earth's surface during the IGY. In July 1955, the White House announced plans and solicited proposals for this project. In September 1955, the Naval Research Laboratory's Vanguard proposal was chosen. But on October 4, 1957, the USSR launched the world's first artificial satellite, Sputnik I, and shocked the world. The 184-pound satellite was launched by an R7 rocket (developed for the intercontinental ballistic missile program).

Sputnik is a Russian word meaning, "traveling companion of the world." This satellite carried a thermometer and two radio transmitters, which transmitted atmospheric data during its low orbits (period 96.2 minutes). Telemetry malfunctioned after 21 days and orbital stability was not maintained. After 57 days in orbit, it was destroyed during reentry on January 4, 1958

That launch ushered in new political, military, technological, and scientific developments. While the Sputnik launch was a single event, it marked the start of the space age and the U.S.-U.S.S.R space race.

Responding to the political backlash created over the launching of Sputnik 1, the first artificial satellite in Earth orbit, the U.S. Defense Department immediately began providing funding for another U.S. satellite project. As a parallel project to Vanguard, Wernher von Braun and his Army Redstone Arsenal team began work on the Explorer project.

On January 31, 1958, the tide changed, when the United States successfully launched Explorer I [note: Sputnik 1 burned-up in the same month]. This satellite carried a small scientific payload that eventually discovered the magnetic radiation belts around the Earth, named after principal investigator James Van Allen.

The Sputnik launch also led directly to the creation of National Aeronautics and Space Administration (NASA). In July 1958, Congress passed the National Aeronautics and Space Act, which created NASA as of October 1, 1958 from the National Advisory Committee for Aeronautics (NACA) and other government agencies.

Adapted from *First Artificial Satellite In Space*, by Nick Greene, [http://space.about.com/cs/history/a/sputnik1.htm] and The History of Satellites: Sputnik and The Dawn of the Space Age, Roger D. Launius, NASA Chief Historian, [http://www.hq.nasa.gov/office/pao/History/sputnik/]

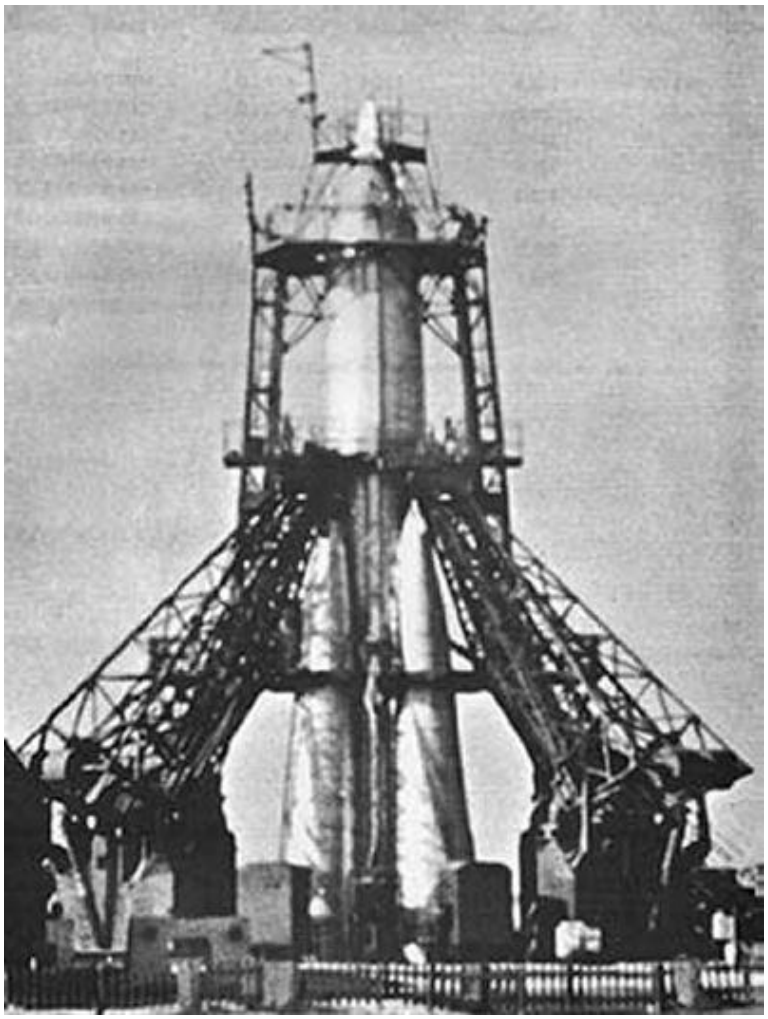


Figure 3: Sputnik on the launch pad being prepared for lift-off on the R7 Rocket [http://www.aerospaceweb.org/question/spacecraft/q0179.shtml]

~ From the Editor's Desk ~

The post-conference issue of Radio Astronomy (June/July 2007) drew good comments It was designed to maintain a certain level of excitement about radio astronomy and counter the emotional crash after a successful conference. In addition, I wanted to share some of the excitement with those who wanted to attend, but just could not. I hope I was successful in doing that. As always, 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].

***

Due to excessive cost of producing a print journal, the leadership is seriously considering expediting an electronic-only version of the journal. 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.

***

In this issue, you will find an informal description of Don Latham's exploits with an affordable alternative to digital filter design; David Fields and Mike Castelaz take us into the classroom; Charles Osborne and John Mannone take you on a reminiscence of some special anniversaries- the Sputnik launch and the discovery of 21-centimeter line. The Solar Radio Astronomy Miscellany section covers an exciting new possibility for radio astronomy outreach—a solar weather observing program by the Stanford Solar Center.

***

New and old members should be interested in filling out the ***Interactive Questionnaire*** concerning your areas of interest [http://radio-astronomy.org/admin/survey.htm].

The 2008 SARA Conference dates, June 29-July 2, have been confirmed to precede the Green Bank Star Quest star party. Our Treasurer has set new rates for the 2008 Conference. Please visit our web page at [http://www.radio-astronomy.org/] to study the changes.

Now, for my usual shameless plug, please visit my website for an interesting blend of astronomy —the art and science— for innovative outreach ideas. *Adventures in Astronomy* is found at [http://home.earthlink.net/~jcmannone/].

John C. Mannone, Editor

~A Cooperative Tale: Connecting a *Quickfilter* Demo Board to *Radio SkyPipe* Data Acquisition Software ~

By Don Latham

In one of the numerous free magazines I get, a news bit appeared about a chip with programmable amplifiers, A/D conversion, and programmable FIR filter banks from a manufacturer called *Quickfilter Technologies*, [www.quickfiltertech.com]. So I got further information. A demo board is available. I'm a "sucker" for demo boards, they often enable me to try things without having to design a board or stick something together. (Dip packages aren't available for too many new devices, either.)

The *Quickfilter* (QF) demo board looks good. It is available for $200 from Mouser or Digikey. The board contains a QF data processing chip, USB port hardware, and a development software suite.

Their processing chip is the QFA512; its block diagram is shown below (Figure 4).

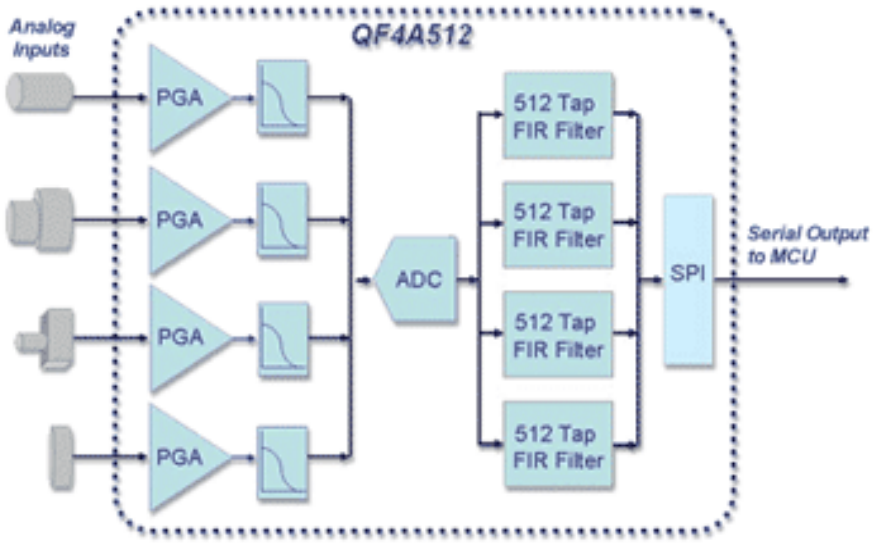


Figure 4: Data Processing Chip, QFA512 (reproduced with permission from *Quickfilter Technologies*)

With the development kit, we have four programmable amplifiers, low pass filtered for anti-aliasing, a fast 16-bit A/D converter (ADC), and four software programmable FIR filters, all connected to a USB port.

The input amplifiers allow for either differential or single-ended, AC or DC coupled inputs. Some input resistors and capacitors must be added, but there is space on the demo board to mount what is needed. The input amplifiers can also be operated in chopper-stabilized mode or not, depending on the desired bandwidth. (Editor's note: An example

of chopper-stabilized circuits is available here: [http://metrology.hut.fi/courses/s108-180/Luento4/chopamp.pdf]).

Next is a multiplexed ADC that can operate on the outputs of any of the input amplifiers. In single-channel operation, the ADC-multiplexer combination on the demo board can sample at a maximum rate of 2.5 MHz, and more than 700 kHz (each) using all four channels. The nominal resolution is16 bits.

The filter channels can implement Finite Impulse Response (FIR) filters; including low pass, high pass, notch and band pass filters. Two filters can be run per channel, for example, a low pass filter with a notch, say at 60 Hz.

The development kit comes with software to design the desired filters. In addition, a test system performs Fast Fourier Transforms (FFT) on the filter outputs and stores the results.

This might be a useful device for both SARA and Seti League members looking for a simple digital signal processing system. All that was missing was a good way to capture and store the data output from the development board. Then I had an *aha moment*—Jim Sky's *Radio SkyPipe* (RSP) software! Here is data acquisition software that can display, tag, and save data from many channels, and has a general interface to data acquisition (UDS) built in. The *Quickfilter* development kit software could be combined with *Radio SkyPipe* using the QF development kit software to specify the channel characteristics, and RSP to acquire, view, and store the data from the development kit. A marriage of these two very powerful systems would cost about $250. The result would be both powerful and extremely flexible.

The rest is history. First, I studied my copy of *Radio SkyPipe Pro*, especially the UDS aspect of the program to acquire data from another A/D converter. Next, I emailed Charles Osborne (SARA) and Dr. Paul Shuch (Seti League) to get permission to use the organizations' names in talks with the *Quickfilter* folks. My hope was to get a copy of the source code for the QF development kit software so I could adapt it to the UDS interface specs provided with RSP. In addition, I thought that QF could benefit from using the organization names in their advertising or other places. Charles and Paul came through (thanks!).

Subsequently, I started working with the QF folks. Understandably, they were reluctant to part with the code for the development kit software at first. However, Mr. Ed Rocha, President of the company, very kindly volunteered to get his programmers to hook the programs together! When I got in touch with Jim Sky, he sent a complimentary copy of RSP to the QF programmers. After some correspondence between them, *voìla*! I suspect this kind of cooperation might not work with larger companies, such as *Analog Devices*. However, with small, but growing companies, such as *Quickfilter Technologies*, a more personal contact and cooperation is still possible. For example, I was able to talk directly to the QF software engineer (wizard), Ms. Anne Ngo.

How does this combination work? Quite well. Suppose you want to look at a signal using a one-kilohertz low pass filter, but there is a lot of nasty 60 Hz riding on top. Let's go through the filter program and interface with RSP.

First, bring up the filter design application- *Create Filter* (Figure 5).

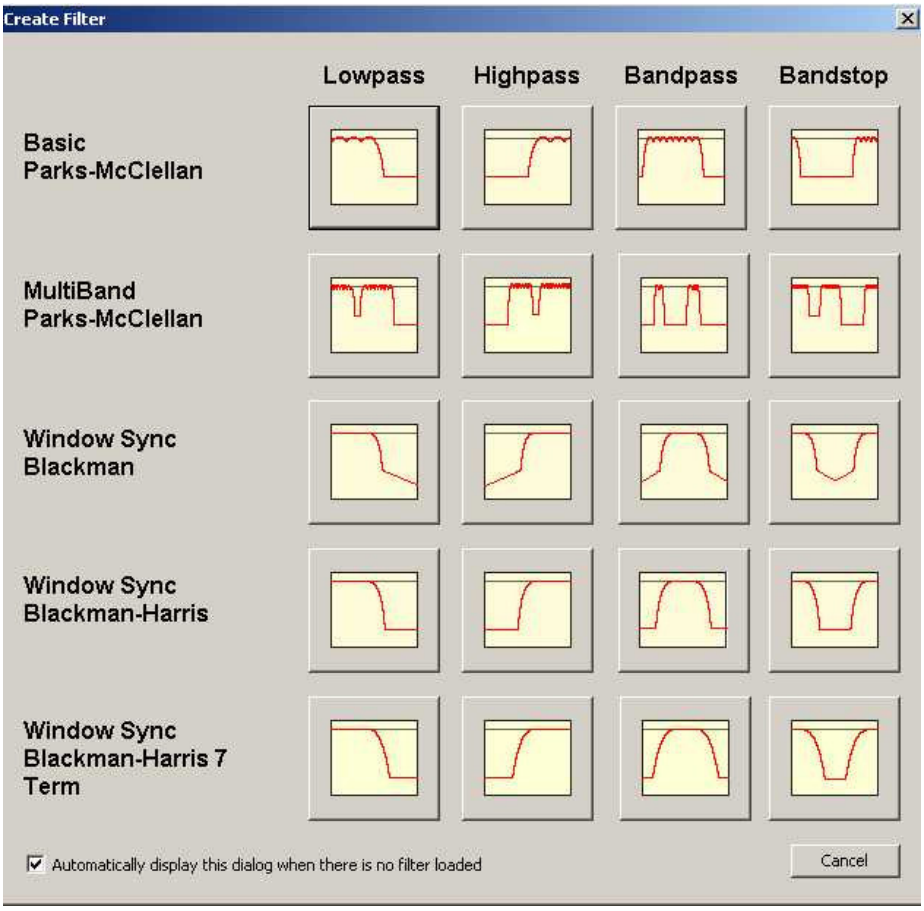


Figure 5: An array of filters to select from

Here, we want the multi-band Parks-McClellan filter. Click on that to produce the *QF Filter* screen with the FIR Specification Editor (Figure 6).

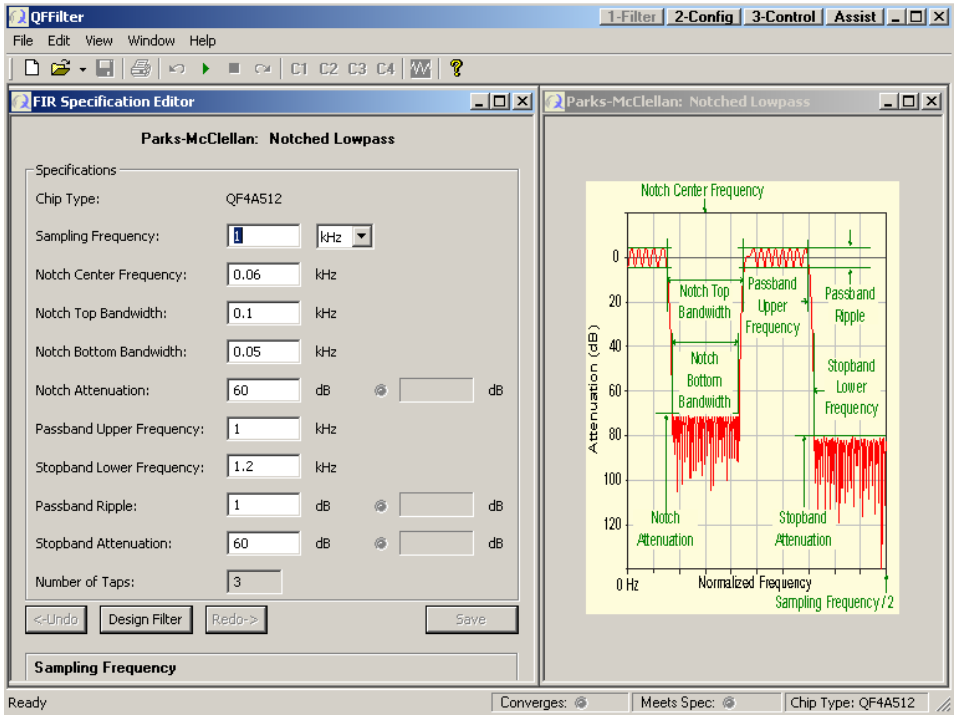


Figure 6: Type in filter design characteristics before executing the *Design Filter* command

Then simply click on *Design Filter*. The program goes quickly into operation, designing the filter for you. The result is displayed automatically (see Figure 7):

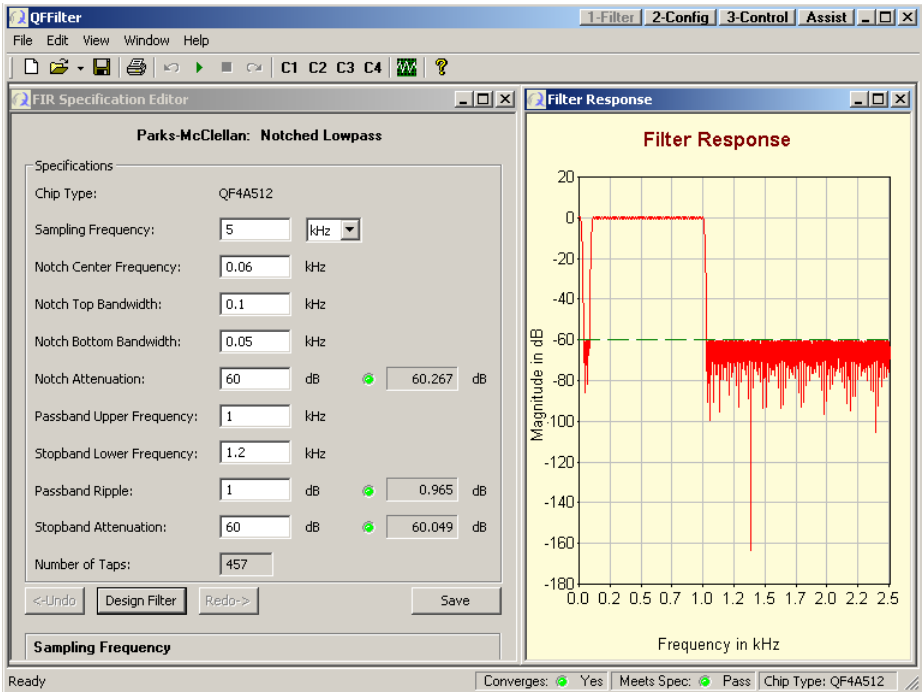


Figure 7: Filter Response output of *Design Filter* command

If you like it, hit *Save*, and you'll get the usual prompt box from windows. Then proceed to implement the design in the filter hardware (Figure 8):

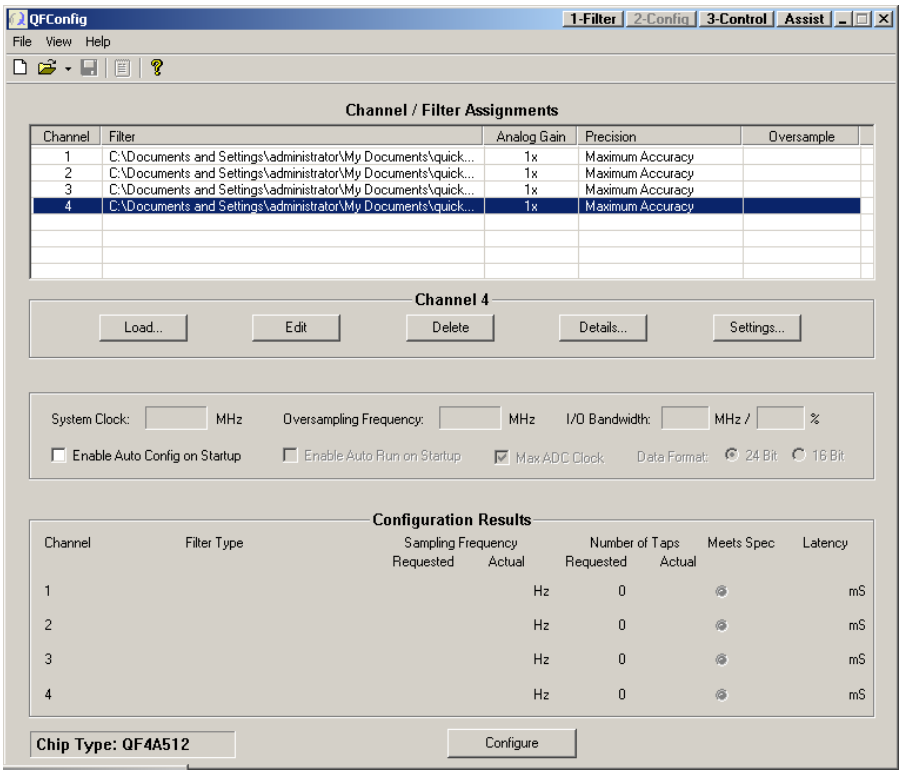


Figure 8: Configuration Control

In the example here, I loaded the main design into channel 1 and some others into channels 2 through 4. Hit configure (*config*), and the program will generate a file that will load to the evaluation hardware in the next step.

The next step after configure is the utilization of the control program. This uses the configure file from the last step (Figure 9):

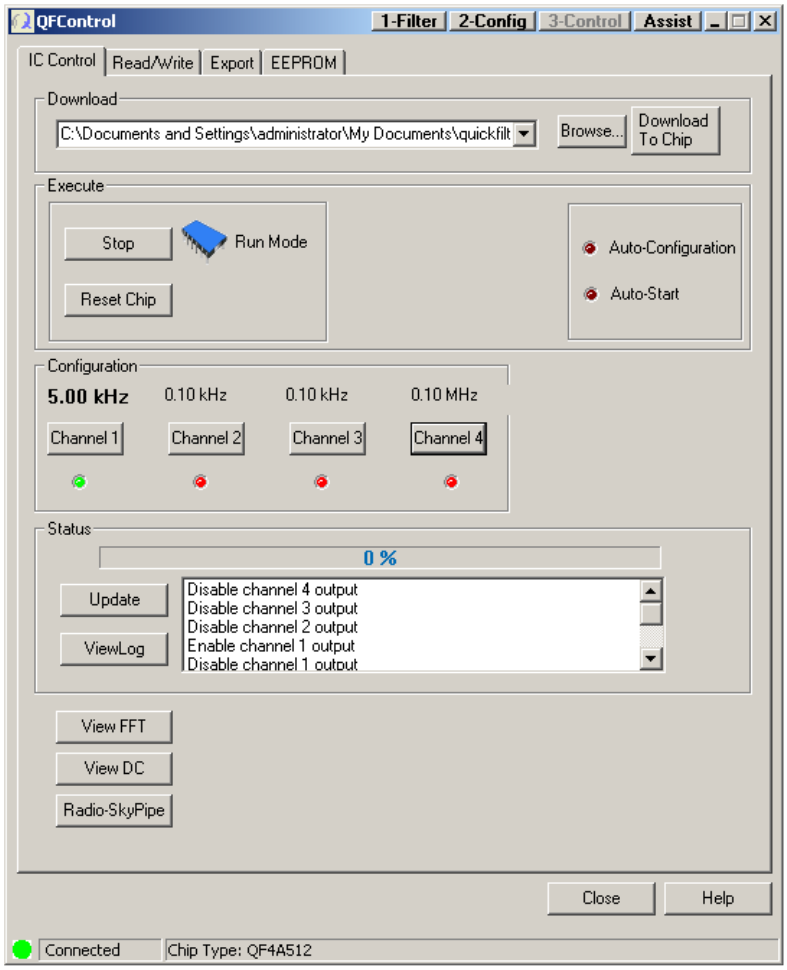


Figure 9: Control

I've used the browse button to pick the configuration I want, and then the Download-to-Chip button to do the download. The process is shown in the status window of the control window. And, as shown, I'm ready to go!

To recap: I picked a filter type to try out using the Filter application and saved the filter to a passing file. Then I used the *config* application to generate another passing file that includes that design as well as others I might want to put on the other three channels. Those were picked from the list of design passing files I've previously designed. Alternatively, for some applications, I might wish to return to the Filter application and design another filter for another channel for the present configuration.

At any rate, the total configuration for the evaluation (*eval*) board is now specified, and the file is available. Now I can load the *config* file to the board. I can also close all windows except the control window.

At the bottom left of the control window are the test/operate buttons. We want to look at the result of our design to see how it *really works*. Note that we disabled all but channel

1 for our testing, and the actions were shown in the status window. Click on the FFT button,

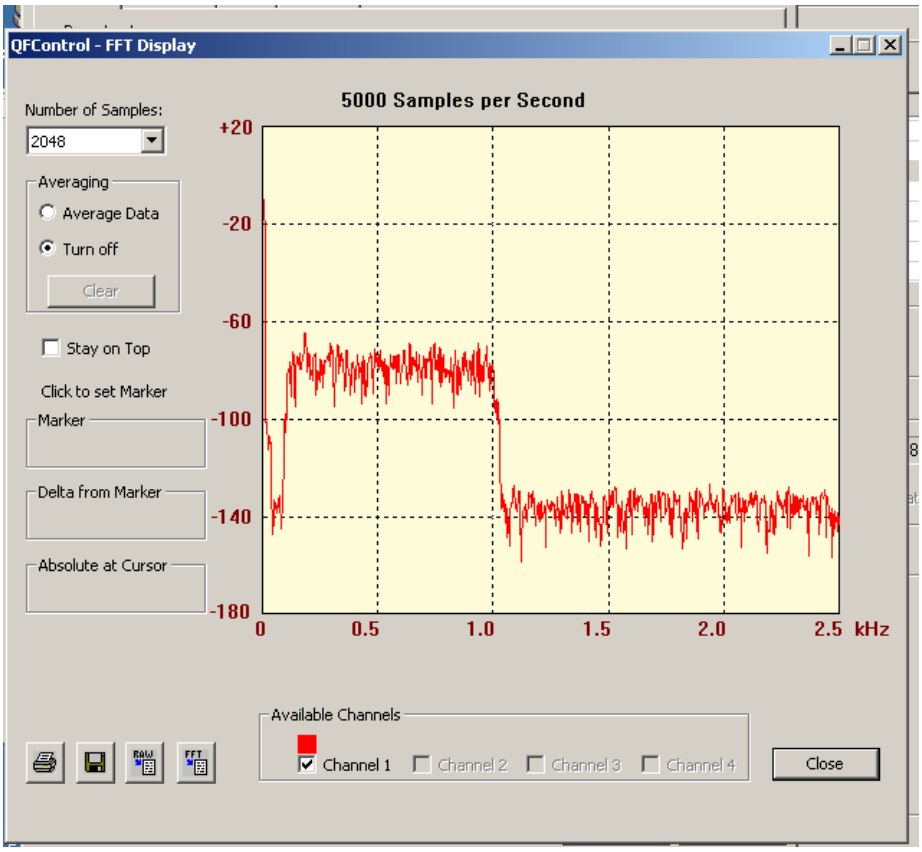


Figure 10: Digital Signal Processing- FFT

and there it is. In less time than it took to type this description and insert the "screen grabs," We've designed, implemented, tested, and displayed the test output for the desired filter! Note the cut-off is right where we wanted it, so is the 60 Hz notch. This design software is the best we've ever used, bar none!

But the fun has only begun. There are a couple of things to note at this point. One is, you may minimize the QF control window, but don't close it, or the application will stop running (duh!). You can, of course, turn off the FFT window, or bring up the view DC window at any time. We won't cover the DC window here, but note it is a DC voltmeter (if you have configured the *eval* board to DC, it is covered in the app notes). It can be an RMS AC voltmeter, too. Now we're ready to connect the *eval* board output to RSP. Remember from now on, do not close the *Quickfilter* control window (the running program is talking to Radio-SkyPipe). The FFT and/or DC windows may be closed, however.

There may be other possible sequences at this point, but I have found this one works best for me. On the QF Control window, hit the RSP button.

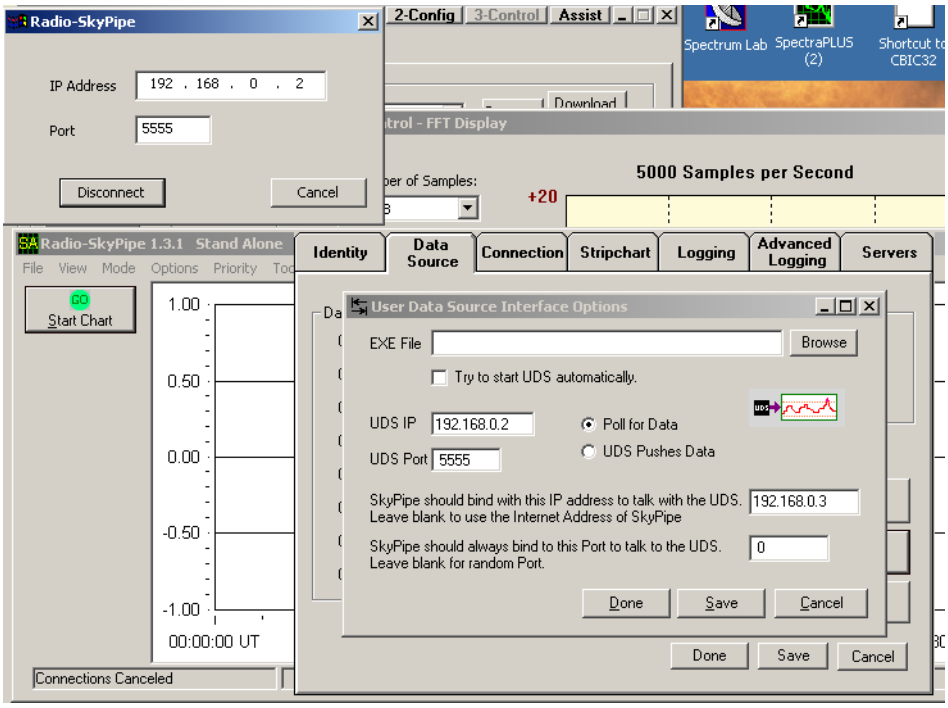


Figure 11: Radio SkyPipe and FFT

The small window showing the IP address and the Port will show up. Hit connect. Now invoke Radio-SkyPipe, and select the Options, Data source, and UDS buttons. You should see a lot of windows, but everything's under control. To get these programs talking, look at the IP Address and Port on the little Radio-SkyPipe window. Put those values in to the UDS IP and UDS Port on the UDS Interface Options windows of RSP. Also, "SkyPipe should bind with…" must have the same address, as the UDS IP (not different, as shown here) and ***the port number must be zero*** as shown. Don't forget to Poll for Data! Hit "SAVE" on the RSP interface options window, and then close it.

Now, you should still have the data window open on RSP. Make sure the data source on channel 1 is set on UDS, and all the rest are set to none. These sources must agree with the number of channels that are open on the QF board!

Save the data source window, and then close it. Hit "Start chart" on RSP and you should see the signal coming through. If not, check the agreement of the IP addresses, port number, and the zero port number. Make sure the little QF window shows "disconnect".

If "all is well," there is another thing you can do. Bring the QF control window to the front and hit the FFT button. Stop the chart and arrange the windows.

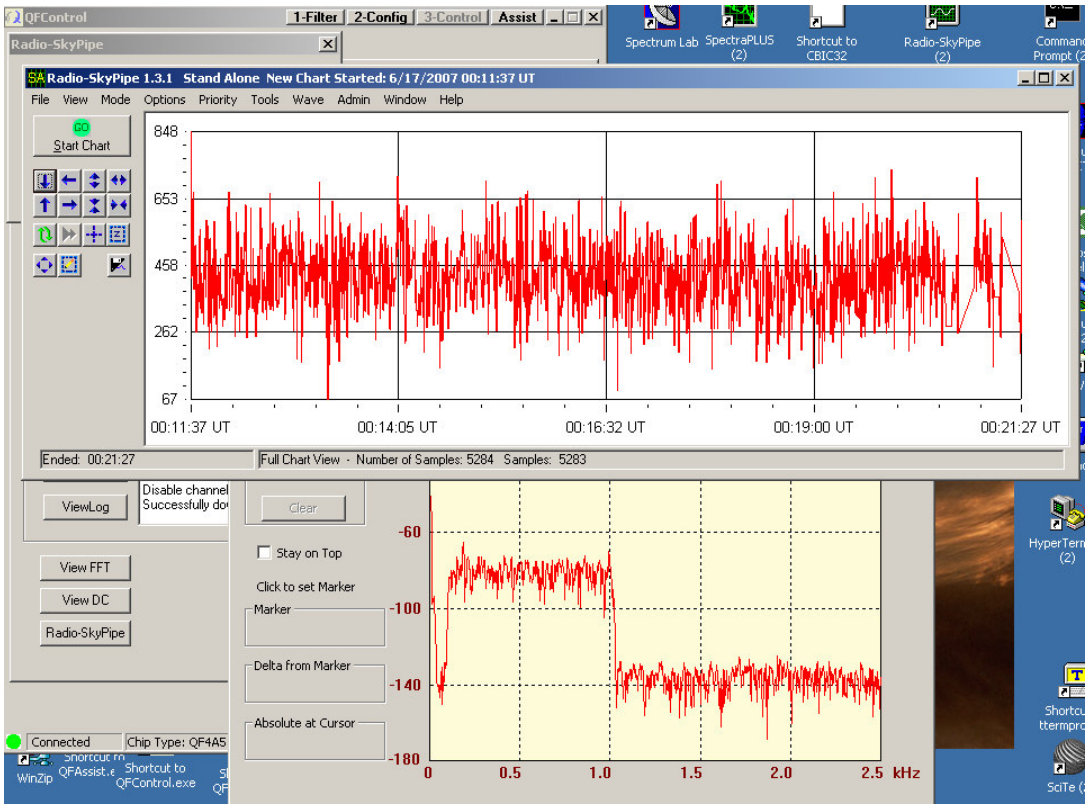


Figure 12: Temporal and Spectral Signal

The signal and its FFT are displayed simultaneously (Figure 12)!

I've just scratched the surface of possibility for this combination, and there is a lot to learn as well. The poll for data is asynchronous and RSP grabs a subset of the signal from the QF board. Quickfilter Pro can store an FFT snapshot while Radio-SkyPipe continues to get data by using the Save button on the QFT Chart window. Note: other programs that can poll for data on the 5555 port might be able to access the QF data, too.

Thanks to the voluntary cooperation between the Quickfilter company and Jim Sky, I can now develop filters I need, implement them, check them with (storable) FFT's and collect the data with an Internet-connected data acquisition program. That's truly remarkable, and I cannot possibly thank everyone concerned enough for his or her efforts.

Now, as soon as I can get my dish to point where I want it (another story) and attach a reliable front end to it, I can hook the outputs (I and Q) of my downconverter to the Quickfilter development board. Then I can "wail on the data" to my heart's content. Don't forget that Radio SkyPipe can manipulate data "on the fly" (such as squaring it). While not as elegant as the more expensive software defined radio, this setup for about $250 is quite good!

If anyone wants to try this, I'd be happy to pass on what I know. Be assured I am going to continue to work with this setup to see what can be done with it. I'll try to get results posted on a website soon. Again, many thanks to all concerned for the cooperation that made this project possible!

~ History & Physics of the 21 cm Line ~

September 1 marks the fifty-sixth anniversary of the paper by Ewen and Purcell in Nature announcing the discovery of the hydrogen 21-cm line. In fact, they had seen the signal months before, but waited for validation by Dutch and Australian astronomers before publishing the results. In the pages following the Ewen and Purcell report, Muller and Oort includes the text of a cable sent by Pawsey from Australia. Oort had already realized the significance of the discovery — that detection of this spectral line, produced by transitions between hyperfine levels of the ground-state hydrogen atom, would permit measurements of velocities by the Doppler effect. The 21-cm line put radio astronomy on the map, and brought about a revolution in the study of galactic structure. These original papers are appended:

Ewen, H. I. & Purcell, E. M. *Nature* **168,** 356-358 (1951)
Muller, C. A. & Oort, J. H. *Nature* **168,** 357–358 (1951).

The hydrogen in our galaxy has been mapped by the observation of the 21-cm wavelength line of hydrogen gas. At 1420 MHz, this radiation from hydrogen penetrates the dust clouds and gives us a more complete map of the hydrogen than that of the stars themselves since their visible light won't penetrate the dust clouds.

The 1420 MHz radiation comes from the transition between the two levels of the hydrogen 1s ground state, slightly split by the interaction between the electron spin and the nuclear spin. The splitting is known as hyperfine structure. Because of the quantum properties of radiation, hydrogen in its lower state will absorb 1420 MHz and the observation of 1420 MHz in emission implies a prior excitation to the upper state.

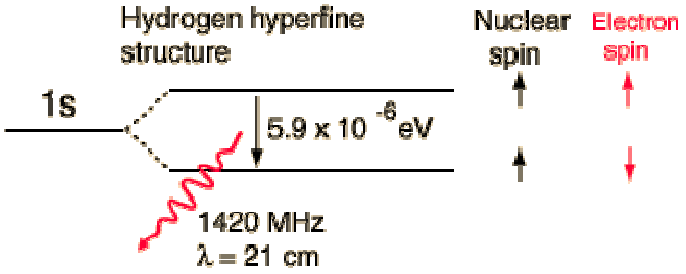


Figure 13: Spin-spin splitting

This splitting of the hydrogen ground state is extremely small compared to the ground state energy of -13.6 eV, only about two parts in a million. The two states come from the fact that both the electron and nuclear spins are 1/2 for the proton, so there are two possible states, spin parallel and spin anti-parallel. The state with the spins parallel is slightly higher in energy (less tightly bound).

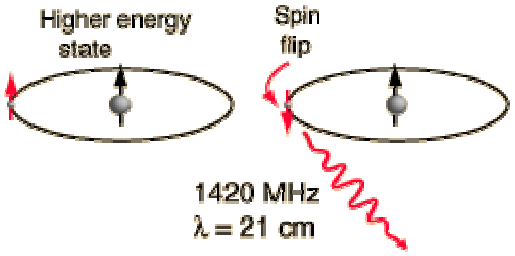


Figure 14: In visualizing the transition as a spin-flip, it should be noted that the quantum mechanical property called "spin" is not literally a classical spinning charge sphere. It is a description of the behavior of quantum mechanical angular momentum and does not have a definitive classical analogy.

The observation of the 21cm line of hydrogen marked the birth of spectral-line radio astronomy. As noted above, it was first observed in 1951 by Harold Ewen and Edward M. Purcell at Harvard, followed soon afterward by observers in Holland and Australia. The prediction that the 21 cm line should be observable in emission was made in 1944 by Dutch astronomer H. C. van de Hulst.

References:

Hyper-physics [http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/h21.html]

Nature: Physics Portal [http://www.nature.com/physics/looking-back/ewen/index.html]

Bruce Medalists [http://www.phys-astro.sonoma.edu/BruceMedalists/vandeHulst/index.html]



Figure 15: Hendrik Christoffel van de Hulst (19 November 1918 - 31 July 2000) was the 1978 Bruce Medalist winner (Courtesy of *Physics Today*).

OBSERVATION OF A LINE IN THE GALACTIC RADIO SPECTRUM

Radiation from Galactic Hydrogen at 1,420 Mc./sec.

THE ground-state of the hydrogen atom is a hyperfine doublet the splitting of which, determined by the method of atomic beams, is 1,420·405 Mc./sec.[1]. Transitions occur between the upper ($F = 1$) and lower ($F = 0$) components by magnetic dipole radiation or absorption. The possibility of detecting this transition in the spectrum of galactic radiation, first suggested by H. C. van de Hulst[2], has remained one of the challenging problems of radio-astronomy. In interstellar regions not too near hot stars, hydrogen atoms are relatively abundant, there being, according to the usual estimate, about one atom per cm.^{3}. Most of these atoms should be in the ground-state. The detectability of the hyperfine transition hinges on the question whether the temperature which characterizes the distribution of population over the hyperfine doublet—which for want of a better name we shall call the hydrogen 'spin temperature'—is lower than, equal to, or greater than the temperature which characterizes the background radiation field in this part of the galactic radio spectrum. If the spin temperature is lower than the temperature of the radiation field, the hyperfine line ought to appear in absorption; if it is higher, one would expect a 'bright' line; while if the temperatures are the same no line could be detected. The total intensity within the line, per unit band-width, should depend only on the difference between these temperatures, providing the source is thick enough to be opaque.

We can now report success in observing this line. A micro-wave radiometer, built especially for the purpose, consists mainly of a double superheterodyne receiver with pass band of 17 kc., the band being shifted back and forth through 75 kc. thirty times per second. The conventional phase-sensitive detector and narrow (0·016 c./s.) filter then enable the radiometer to record the apparent radio temperature *difference* between two spectral bands 75 kc. apart. These bands are slowly swept in frequency through the region of interest. The overall noise figure of the receiver, measured by the glow-discharge method[3], is 11 db., and the mean output fluctuation at the recorder corresponds to a temperature change of 3·5°. The antenna is a pyramidal horn of about 12° half-power beam-width. It is rigidly mounted at declination −5°; scanning is effected by the earth's rotation.

The line was first detected on March 25, 1951. It appeared in emission with a width of about 80 kc., and was most intense in the direction 18 hr. right ascension. Many subsequent observations have established the following facts. At declination −5° the line is detectable, by our equipment, over a period of about six hours, during which the apparent temperature at the centre of the line rises to a maximum of 25° above background and then subsides into the background. The source appears to be an extended one approximately centred about the galactic plane. The frequency of the centre of the line, which was measured with an accuracy of ±5 kc., was displaced some 150 kc. above the laboratory value, and this shift varied during an observing period. Both the shift and its variation are reasonably well accounted for by the earth's orbital motion and the motion of the solar system toward Hercules. The period of reception shifts two hours per month, in solar time, as it ought to.

Some conclusions can already be drawn from these results. Extrapolation of radio temperature data for somewhat lower frequencies[4] suggests that the background radiation temperature near the 21-cm. line is not more than 10° K. Then the hydrogen spin temperature is not more than 35° K., if the source is 'thick'. But we can calculate the opacity of the source on the assumption of a spin temperature of 35° K. and 1 atom/cm.^{3}, using only the observed line-width and the matrix element of the transition in question, and we obtained 900 light-years for the absorption-length. As this is much smaller than galactic dimensions, we conclude that the temperature observed corresponds indeed to the spin temperature at the source. To the extent that 'self-absorption' contributes to the observed line-width, the true absorption length at the frequency of the centre may be *less* than that computed. Further evidence for relatively high opacity is the absence of large frequency-shifts, which would be expected to arise from galactic rotation were the opacity-thickness comparable to the size of the galaxy. This conclusion is contrary to the prediction of Shklovsky[5], who has recently discussed the possibility of detecting galactic line radiation.

We have made rough theoretical estimates of the efficacy of various processes through which energy is exchanged between the hydrogen hyperfine levels and the other thermal reservoirs in the interstellar matter plus radiation complex. Of these we find exchange with the radiation field (involving spontaneous emission) and exchange with gas-kinetic energy of the hydrogen atoms (via H–H collisions) much the most important, with the latter process probably dominant. This is consistent with the observation, and if correct implies that the gas-kinetic temperature of the hydrogen exceeds, but not greatly, the spin temperature. The estimated spin relaxation time for these processes is of the order of 10^5 years.

This work was assisted by a grant from the Rumford Fund of the American Academy of Arts and Sciences.

H. I. Ewen
E. M. Purcell

Lyman Laboratory,
Harvard University,
Cambridge,
Mass.
June 14.

[1] Kusch, P., and Prodell, A. G., *Phys. Rev.*, **79**, 1009 (1950).
[2] van de Hulst, H. C., *Nederl. Tij. Natuurkunde*, 's-Gravenhage-Martinus Nyhoff, **11**, 201 (1945).
[3] Mumford, W. W., *Bell Syst. Tech. J.*, **28**, 608 (1949).
[4] Herbstreit, J. W., and Johler, J. R., *Nature*, **161**, 515 (1948).
[5] Shklovsky, I. S., *Astronomicheskii Zhurnal*, **26**, 10 (1949) (in Russian).

The Interstellar Hydrogen Line at 1,420 Mc./sec., and an Estimate of Galactic Rotation

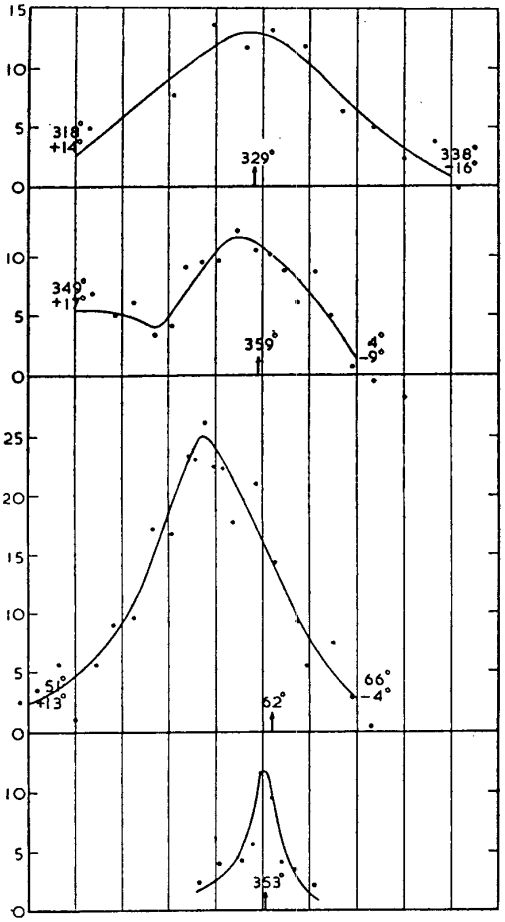
Following a suggestion made by Dr. H. C. van de Hulst in 1944[1], attempts have been made to measure the radiation at 1,420 Mc./sec. (λ21 cm.) emitted by atomic interstellar hydrogen. The first experimental evidence for the presence of this interstellar emission line was obtained by Ewen and Purcell on March 25, 1951 (see the preceding communication). In the Netherlands, the first successful measurements were made on May 11.

The receiver consists of a double superheterodyne instrument, with a crystal-controlled first local oscillator, which is switched between two frequencies 110 kc. apart thirty times per second by a reactance modulator. By varying the frequency of the second local oscillator, the two frequencies can be moved together through a 4-Mc. wide pass band at 1,420 Mc. The pass band of the second i.f. channel is 25 kc. wide. Behind the usual phase-sensitive detector a narrow-band filter with a time constant of 12 sec. is used. So the difference between two frequency bands 110 kc. apart is measured. The noise factor of the receiver has not yet been measured. The losses in the coaxial antenna cable are rather high, and an effective noise factor of the whole receiving system of 25 has been deduced from other measurements with the sun as a source of noise. Important parts of the receiver have been constructed at the Philips Laboratory in Eindhoven under the supervision of Dr. F. L. Stumpers.

The receiver has been mounted behind a movable paraboloid of 7·5 m. aperture and 1·7 m. focal-length at the radio station at Kootwijk, which was kindly put at our disposal for these measurements by the Radio Department of the Post and Telegraph Service. The beam-width at half-power is 2·8°.

The results of the measurements made on a few of the first tracings are shown in the accompanying graphs. While these tracings were being made, the instrument was left in a fixed position relative to the earth, the motion across the sky being provided by the earth's rotation. The frequency of the second local oscillator is switched every 3 min. between positions in which either of the two pass bands coincides with the spectral line. The first position gives a positive, the other a negative, deflexion on the recording meter. The curves show the intensity as function of the right-ascension; the interval between successive vertical lines is 20 min. of time. The point at which each sweep crossed the galactic equator has been marked with an arrow, accompanied by a number giving the corresponding longitude. The galactic co-ordinates at the beginning and end of each tracing have also been indicated. The curves shown may be slightly distorted because the radial components of the orbital motion of the earth, of the sun's motion relative to the nearby interstellar clouds and of differential galactic rotation are different for the various directions. However, we do not believe that these effects will have seriously affected the general shapes of the records, except for latitudes less than 1½°, where in some directions the line is greatly widened by galactic rotation, and the measured intensities will be too small.

It is evident from the wide spread in galactic latitude that the clouds observed must be relatively close to the earth. From the width of the emission line observed in the region of the centre of the



Galaxy, where the rotation of the galactic system does not affect the line, it is found that the random velocities average about 5 km./sec. in one co-ordinate, which agrees approximately with what had been found from absorption lines in the visual region. With such small velocities it is unlikely that the gas extends to more than an average distance of about 50 parsecs from the galactic plane. With an average latitude of the order of 8°, the gas seen in the general direction of the centre cannot then be farther away than 300 or 400 parsecs. In Cygnus the distance may be twice this amount.

These small distances might be taken as an indication either that the more central parts of the Galaxy are devoid of atomic hydrogen, or else that within a distance of between 500 and 1,000 parsecs in the galactic plane the gas becomes optically thick in the wave-length of this line. Although we should like to reserve a definite judgment until more complete measures have been obtained, we believe the latter alternative is the more probable on the basis of the results so far available.

In order to test the presence of radiating hydrogen in the inner regions of the Galaxy, measures have been made across the Milky Way at $l = 355°$, 30° from the centre, where the change of frequency due to differential galactic rotation should make it

possible to observe the gas up to large distances. Provisional measures indicate that the emission line in this direction has an effective width of about 330 kc./sec., or 70 km./sec., and that the rotational velocity of the galactic system at a distance from the centre equal to half the sun's distance from the centre is approximately 190 km./sec. This agrees well enough with the rotational velocity of 205 km./sec. computed from a schematic model of the galactic system[2]. (In both cases a value of 270 km./sec. has been assumed for the rotation near the sun.)

The graph at the bottom shows the results of a registration across the Milky Way at 355° longitude and at a frequency 250 kc./sec. lower than the normal frequency of the line, corresponding to a differential radial velocity of +55 km./sec. The gas clouds observed at this frequency are presumably situated at an average distance of about 8 kiloparsecs. It may be noted that the spread in latitude is quite small, and may roughly correspond to the beam-width of the instrument, as would be expected for these large distances.

The tracings reveal many irregularities in distribution. The extension to high positive latitudes in the second graph may possibly be connected with the well-known dense clouds in Ophiuchus. The maxima in the Cygnus region lie systematically about 2½° south of the galactic circle at longitudes between 40° and 45°, while between 56° and 62° they occur roughly 3° north of the plane. Though no weight should be attached to the exact differences in height of the various sweeps, the intensities in Cygnus appear to be definitely higher than in other regions (except in that opposite the centre). This may be ascribed to the effects of galactic rotation. The fact that the intensity is also lower in the direction towards the centre, where these effects are presumably negligible, is possibly due to the superposition of continuous background radiation, which has probably a considerable intensity in this direction.

The measurements reported in this communication are of a provisional nature. Improvements in the receiver are possible, and are now being made in preparation for more systematic measurements.

The investigation has been made possible by grants from the Netherlands Organization for Pure Research (Z.W.O.).

C. A. Muller
J. H. Oort

Netherlands Foundation for Radio Astronomy,
Kootwijk Radio Station.
Observatory,
Leyden.
June 26.

[1] Van de Hulst, H. C., *Nederl. Tij. Natuurkunde*, 11, 201 (1945).
[2] Oort, J. H., *Bull. Astro. Inst. Netherlands*, 9, 193 (1941).

The following cable dated July 12 has been received from Sydney, N.S.W.:

Referring Prof. Purcell's letter of June 14 announcing the discovery of hyperfine structure of the hydrogen line in galactic radio spectrum, confirmation of this has been obtained by Christiansen and Hindman, of the Radio Physics Laboratory, Commonwealth Scientific and Industrial Research Organization, using narrow-beam aerial. Intensity and line-width are of same order as reported, and observations near declination 20° S. show similar extent about galactic equator. J. L. Pawsey

VARIATIONS IN THE CHEMICAL COMPOSITION OF STRATOSPHERE AIR

By Dr. K. F. Chackett, Prof. F. A. Paneth, F.R.S., P. Reasbeck and B. S. Wiborg

Londonderry Laboratory for Radiochemistry, University of Durham

In a previous article[1] analyses of upper air samples obtained from 52–66·5 km. height by means of *V*2 and Aerobee rockets were described, and it was shown that in all cases the composition of the samples was nearly the same as at ground-level, with respect to the ratio of helium, neon and argon to nitrogen. At the same time it was pointed out that some uncertainty must be attached to the helium values because the air was sent to us in glass vessels. Recently, we received, from the University of Michigan, stratosphere air in the original steel bottles in which the samples had been collected; a new and improved sampling technique had been employed, and in the meantime our method of analysis had also been further developed. We now wish to communicate our latest results, which provide evidence for gravitational separation between 64·3 and 71·8 km. height (M.S.L.). Details of the experimental procedure will be published later.

We owe the following information about the new sampling arrangements to the scientific workers of the Department of Aeronautical Engineering, University of Michigan[2]. Three evacuated steel bottles were located immediately behind the hollow nose cone of an 'Aerobee' rocket. The bottles were soldered to thin copper tubes, one inch in diameter, the sealed-off ends of which projected into the cone. The latter was ejected automatically just before sampling. At a predetermined instant a steel knife was arranged to cut through one tube, and five seconds later this was squeezed shut at a lower point by a pyrotechnically operated vice. The second and third bottles were opened and shut at successively later times. Control experiments had shown that the sealing mechanism gave satisfactory vacuum-tight seals without the use of solder.

A successful flight took place from the White Sands Proving Ground in New Mexico on December 19, 1950. After recovery, the three steel bottles were dispatched to us and their contents analysed by our micro-method for oxygen, nitrogen and the inert gases helium, neon and argon. Since our previous work, an entirely new apparatus had been built with several improvements over the old model. Thus, the air pipette was of smaller volume, enabling us to take smaller amounts of gas (between 0·07 and 0·10 c.c. s.t.p. for each analysis); the same pipette was used for the helium–neon analysis and for the nitrogen–argon analysis; and the fractionating column consisted now of fifteen units instead of twelve, each smaller than formerly, and operated by means of a mechanical device which could be set to perform any number of fractionations and then stop.

In general, runs on the stratosphere air were sandwiched between runs on ground-level air, so that a good check could be kept on the satisfactory working of the apparatus. As we found in the earlier work, the oxygen content of the samples was much below normal in spite of the fact that the sampling vessels were always cold. It is impossible to assume that there really is this deficit of oxygen in the

~ Radio and Optical Astronomy in the Classroom ~

By David E. Fields and Michael P. Mueller

Abstract:

On April 1, 2006, Roane State Community College presented the first of what is expected to be a series of symposia focusing on new modes of teaching – the *2006 Symposium on Powerful Teaching.* This is the second astronomy-related symposium presented at our college. The first, a regional SARA conference presented on Nov. 16, 2002, featured 16 speakers and specifically focused on radio astronomy. The title was *Radio Astronomy in Education.*

These symposia document some aspects of radio and optical astronomy being pursued at our little observatory and for this reason, SARA readers may find it interesting to consider the diversity of presentations and contributions of radio astronomy. Here we focus just on the April 1, 2006 symposium.

Symposium on Powerful Teaching:

The April 1, 2006 symposium was well attended by over 200 primary, secondary and college faculty plus representatives of local industry. The local astronomy community responded well, and radio astronomy was discussed in five of the sessions, for a total of 14 presentations. The sessions were organized mostly around activities springing from our astronomy courses, which include both optical and radio astronomy. We produced a CD for the attendees, something that we had previously done for each of two teacher's workshops in Astronomy that we did in 2001.

Symposium Organization:

Five Astronomy sessions were scheduled. The first session considered the importance of including astronomy in the K-12 curriculum. A renaissance science, astronomy integrates our culture and our history with the more recently developed scientific disciplines of physics, chemistry, and biology. Astronomy requires us to develop linguistic abilities, as we must include foreign languages, poetry, and mathematics. Tamke-Allan Observatory (TAO) is the focus of astronomy activities at Roane State Community College. It has become a local and much-appreciated college resource, which is supported by the local educational and amateur astronomy community.

Presentations Given:

Session I: Powerful Astronomy in the Classroom, Grades K-5

Powerful teaching begins in the classroom, but effective teaching must reach beyond. Outside educational materials, visits by local astronomers, school star parties hosted by TAO astronomers and Internet access are all important.

- Experiences in K-5 Astronomy (Kris Light, Willow Book School, Oak Ridge)

  Teaching techniques that have been especially productive will be discussed and handouts will be available to all participants in this session. The format will be a workshop on the phases of the moon, the planets, day/night cycles, and the year. A well-equipped and inspiring classroom is a necessary component for inspiring the K-5 crowd. Another requirement is involving parents and community in related activities. Assistance from astronomers at TAO and from local astronomy groups has been very valuable in reaching beyond the classroom.

Session II: Powerful Astronomy in the Classroom, Grades 6-12

Astronomy is a gateway to the sciences. Through astronomy, we recognize the relevance of biology and the necessity of physics and chemistry for understanding our place in the universe. Unfortunately, because of illumination from street lamps, car headlights and lighted signs, the night skies are becoming less accessible. Only when we find an isolated mountain, such as the one on which the Tamke-Allan Observatory is located, can we rediscover our galaxy—the Milky Way— and obtain magnified glimpses of distant planets, the star-like moons of other planets and the diffuse glow of distant nebulae and comets. This session will explore classroom resources in astronomy used in courses at Roane State Community College and at TAO.

- Teaching through the Astronomy Window (Dr. Adolf King, V.P. Academic Affairs, Roane State Community College)

  We have arrived at a time of opportunity and discovery in Astronomy. Just as discovery of the "New World" has been recognized as a watershed for planetary exploration, we will come to appreciate the investigation of space beyond our planetary atmosphere as a watershed for human knowledge of a broader frontier. Whether this exploration is to be done by humans or machines is yet to be determined.

- Engaging all the Senses: the Key to Effective Learning (Robert Kennedy, Ultimax, Inc. and Tamke-Allan Observatory)

  Many teachers are not yet aware of innovative resources that are useful in classrooms, especially those where science is still considered important.

Examples of computer simulations will demonstrate the usefulness of newly developed tools. They will be made available to attendees.

- Mapping Mars from the Classroom (Mike Mueller, Roane State Community College)

Students learn planetary (astro) geology structures and systems, solar system science and remote sensing by investigating images captured by the Mars Odyssey Spacecraft. This classroom technique has been used with excellent results in Arizona and in Tennessee and across the nation with both elementary and college-level classes.

- Discovering Astronomy Through Poetry (John C. Mannone, Hiwassee College, and Tamke-Allan Observatory)

  Poetry can be effectively used in any educational setting, but the sciences, and in particular Astronomy, will be emphasized here. Examples are taken from ancient, classical, modern periods as well as from the author's published "contemporary" astronomy-related poetry.

- Brainstorming Inside and Outside the Classroom (Ken Roy, DOE Oak Ridge Operations and Tamke-Allan Observatory)

  Brainstorming by TAO astronomers have lead to ideas on Solar Sails and underground living systems for planetary and asteroid colonization. These ideas have been developed and applied at conferences and in classrooms. Techniques of idea development and presentation will be discussed**.**

Session III: Powerful Astronomy—Connecting the Classroom to the World

Roane State Community College's Tamke-Allan Observatory is an educational and research facility that supports the educational community in several important ways: Astronomy classes are offered at the Harriman and Oak Ridge campuses, with laboratory sessions held at the Observatory. Research scholarships are available for high school students – see our web site for details. Non-credit courses and workshops complement our astronomy program. Examples are Astronomy Camp offered in the summer, workshops in Astronomy for Scouts, and occasional courses in Astrophotography, Telescope Operation and Sky Navigation, and Astro-Instrumentation. Stargazes are offered twice per month, on the First and Third Saturday. Students and teachers are always welcome. The Observatory is available for astronomy programs by advance arrangement. Stargazes are offered in support of community activities.

- Tamke Allan Observatory: A Door to Powerful Teaching (Dr. David Fields, Tamke-Allan Observatory, Roane State Community College)

How might teachers avail their students of TAO facilities? This presentation is an introduction to our projects and resources. TAO is a valuable resource that can be enjoyed on-site, through a visit to your schools, or via the Internet.

- Telescopes in the Classroom and on the Sidewalk (Dr. Owen Hoffman, SENES, Inc.)

Sidewalk Astronomy was developed in California largely through the efforts of John Dobson, who visited TAO last year. Our local work in Oak Ridge and Harriman, and at local schools has demonstrated that this is a valuable outreach technique. We'll setup and demonstrate telescopes and discuss techniques. Solar viewing techniques will be demonstrated at a noon outdoor session. Please note astronomy session V.

- Connecting the Classroom to the Observatories (Tyler Moore, Roane State Community College and Tamke-Allan Observatory)

  Tamke-Allan Observatory connects to the outside world through the Internet and makes available Solar and Jovian radio-astronomy data collected locally. We also access data collected by other investigators. Student projects using the Haystack Radio Telescope at MIT will also be discussed.

- Evidence of Mound Builder Astronomy At Ocmulgee National Park (Edna P. Dixon, Projects Coordinator, Perdido Bay Tribe of Southeastern Lower Muscogee Creeks, Inc.)

  Ocmulgee National Monument in Macon, GA is one of our country's most significant archaeological sites. It is one of the very few remnants of a once great southeastern culture and a contemporary of the well studied and preserved Cahokia on the Mississippi River. The first professional archaeological studies, begun in the 1930s, came to a grinding halt with the advent of WWII and very little has been done until recently. It has been found that there were several significant directional relationships – perhaps pointing to where the sun rose or set on the Solstices and Equinoxes; or perhaps constellations on certain days of the year. The Ocmulgee site was entirely astronomically based!

- Student Perspective on Developing a Winning Science Fair Project (Katie Sloop, Oak Ridge High School and Tamke-Allan Observatory)

  The author utilized the TAO Jove radio and a home-built system to perform radio observations of the sun and compare results with data acquired by other (satellite and earth) systems. This project won Grand Champion Junior Award, Southern Appalachian Regional Science Fair, plus 6 specialty awards from American Meteorological Society; nom. Discovery Channel Young Scientist Challenge; NOAA; Institute of Electrical and Electronic Engineers; and Instrumentation, Systems, and Automation (society)

Session IV: Opening the World of Astronomy to Remote Students

- Robots for the Classroom: Computer Controlled Telescopes and Other Devices (Dr. David Fields and Bill Howe, Tamke Allan Observatory)

  Tamke-Allan Observatory has two computer-controlled optical telescopes. Two electrically controlled radio telescopes are operational and another, to be operated under full computer control, is being built. Robot astronomy has a place in the classroom. A second application of robot control that we are working on is automated building of physical models of gravitationally and magnetically defined astronomical bodies and structures for the classroom. This has application for teaching both blind and sighted students.

Session V: Powerful Astronomy on the Sidewalk

The classroom of astronomy includes the universe. The sidewalk is a convenient first step outside, and local astronomers are usually ready to help. Support is readily given to local schools.

- Sidewalk Astronomy (Dr. Owen Hoffman, SENES, Inc. Michael Mcculloch, GamesforOne and Dr. David Fields, Tamke-Allan Observatory)**.**
  Filter-equipped telescopes were used to show solar structures. This session was a full-conference hands-on event offered outside the theater during lunch. This session is supported in part by a presentation given in astronomy session III.

Conclusions:

Tamke-Allan Observatory is a focus for astronomy at Roane State Community College. Our observatory advances because we receive support for our classroom, our teaching, our public stargazes and programs and our research both from the college and from our local community of scholars and hobbyists -- amateur radio and optical astronomers – who contribute their ideas and enthusiasm. Sponsoring local symposia is one avenue for advancing and sharing ideas, and this should be more widely explored.

We plan on supporting the college by hosting a symposium on Earth and Space Science for local teachers and scholars in Fall 2007.

Additional sources:

Fields, D. E., R.W. Willams and J. Strickland. 2001. BellSouth/Roane State Community College Astronomy Workshop for Teachers -- 2001. Mathematics-Sciences Division, Roane State Community College. Harriman Tennessee. August 2001. CD produced for each of two astronomy workshops.

Fields, D.E. 2001. “Reach for the Stars at Roane State” in The Oak Ridger. Oak Ridge, Tennessee. May 24, 2001.

Fields, D.E. 2001. “Final Report – July 2001”. Tamke-Allan Observatory/Environmental Learning Center, Community Science Learning Center Project. Roane State Community College. Harriman Tennessee. 2001.

Fields, D.E. 2002. SARA Regional Meeting Announcement. 2002. Journal of the Society of Amateur Radio Astronomers. Nov-Dec. p. 3.

Fields, D.E. Sessions I-IV in Mueller, M.P. (Ed.). 2006. Symposium on Powerful Teaching: Vol. 1. Harriman: Roane State Community College Press. (CD distributed at Symposium).

Lichtman, Jeffrey M. 2005 *Exploring the Radio Sky*. Sky and Telescope, volume 109, number 1, page 127.

Mueller, M.P. (Ed.). 2006. Symposium on Powerful Teaching: Vol. 1. Harriman: Roane State Community College Press. (CD distributed at Symposium).

(*Editor’s Note*: Please contact the author, David Fields at fieldsde@aol.com for contact information of the contributing symposia speakers)



Figure 16: Tamke-Allan Observatory Public Event
[http://www.roanestate.edu/obs/]

~ The School of Galactic Radio Astronomy:

An Internet Classroom ~

By M. W. Castelaz, J. D. Cline, C. S. Osborne, D. A. Moffett, J. Case

The School of Galactic Radio Astronomy (SGRA) takes its name from the source SGR-A, the center of the Milky Way Galaxy. SGRA is based at the Pisgah Astronomical Research Institute (PARI) as an experience-based schoolroom for use by middle and high school teachers and their students. Their scientific educational experience at SGRA relies on Internet access to PARI's remote-controlled 4.6-m radio telescope, which is equipped with a 1420 MHz receiver. The 1420 MHz signal may either be recorded as a spectrum over a 4 MHz bandpass or mapped over extended regions.

Teachers, classes, and Independent Study students access the 4.6-m radio telescope via the SGRA webpage. The SGRA webpage has four components: Radio Astronomy Basics, Observing, Guides, and Logbook. The Radio Astronomy Basics section summarizes the concepts of electromagnetic waves, detection of electromagnetic waves, sources of astronomical radio waves, and how astronomers use radio telescopes. The Observing section is the link to controlling the radio telescope and receiver. The Observing page is designed in the same way a control room at an observatory is designed. Controls include options of source selection, coordinate entry, slew, set, and guide selection, and tracking. Also within the Observing section is the curriculum, which presents eight modules based on relevant radio astronomy topics and objects. The Guides webpage contains atlases of the astronomical sky, catalogs, examples of observing sessions, and data reduction software that can be downloaded for analysis offline. The LOGBOOK page is primarily a guestbook, and evaluation form.

We acknowledge support from the Space Telescope Science Institute IDEAS Program, and the South Carolina State University PAIR Program.

If you would like more information about this abstract, please follow the link to [http://www.pari.edu].

~ Solar Radio Astronomy Miscellany: Space Weather Monitor Program ~

By John C. Mannone



Figure 17: Space Weather Monitor Program [http://solar-center.stanford.edu/SID/]

The receivers were developed at Stanford University in Palo Alto, California. They are partly supported by National Science Foundation (NSF) funds through the Center for Integrated Space Weather Modeling (CISM) in the Astronomy Department at Boston University. Nicholas Gross, the co-Director for Education in CISM, has written a news release (April 17, 2006) for his Middle School (Peabody School, Cambridge, MA). It has been modified with permission and integrated with another more current press release (Stanford Report, May 30, 2007, "Solar monitors distributed to encourage interest in science," by Chelsea Anne Young, Stanford News Service Intern), as well as expanded by the editor.

The radio receiver is provided by the project and the antenna is built by the participating group.

The receiver is pre-tuned to the frequency of a VLF radio station run by the government in various locations around the country, such as the one in North Dakota. Radio waves at these frequencies reflect off the ionosphere back to Earth. In this way, they can travel very long distances, even around the world. The strength of the reflected signal depends on the degree of ionization. Diurnal activity affects the electron number density, increasing by day with the greater UV and X-ray flux, as also with solar flares. These solar flares (as well as Gamma Ray Bursts (GRB)) suddenly enhance the signal. This is called a Sudden Ionospheric Disturbance (SID). The strength of the radio signals received by the antenna (typically an inductive loop), which is installed outside, such as on a roof, or inside away from power circuits. The signal strength measured by the receiver is sampled every five seconds by a sound card equipped computer. The data can be regularly transferred and uploaded to the Standard Solar Center database. The user can access this database to compare data from other receivers (local, regional and even worldwide) for differences for validation and/or corroboration.

Students and teachers can use the monitor and the Solar Center database to enhance their regular curriculum on the Sun and its effects on the Earth. It can also be used as the basis for impressive Science Fair Projects. Students will feel more connected to the star in our backyard. The project facilitates a tangible connection that students may have never experienced. Lower grades can learn to appreciate the technology used in exploring the world around us, while college students have the opportunity for research projects.

Though the Sun is currently quiet, it is expected to become more active in the next few years as it approaches the next solar maximum every eleven years It is predicted that this next maximum will be very active, providing many opportunities to ask interesting questions and measure solar activity. The increased activity will create problems such as diminished radio communications, satellite malfunctions, power fluctuations, and increased danger of radiation exposure to astronauts.

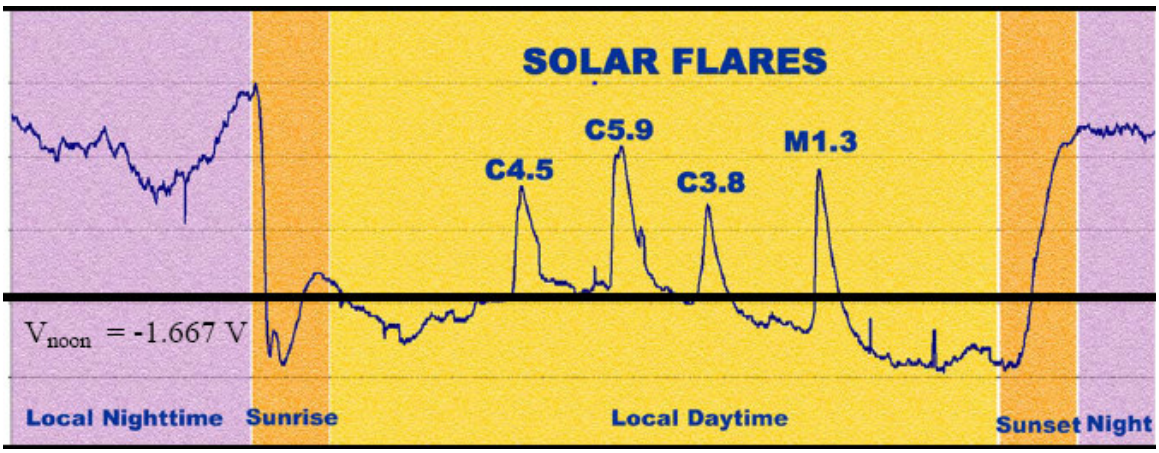


Figure 18: Typical output showing an active sun

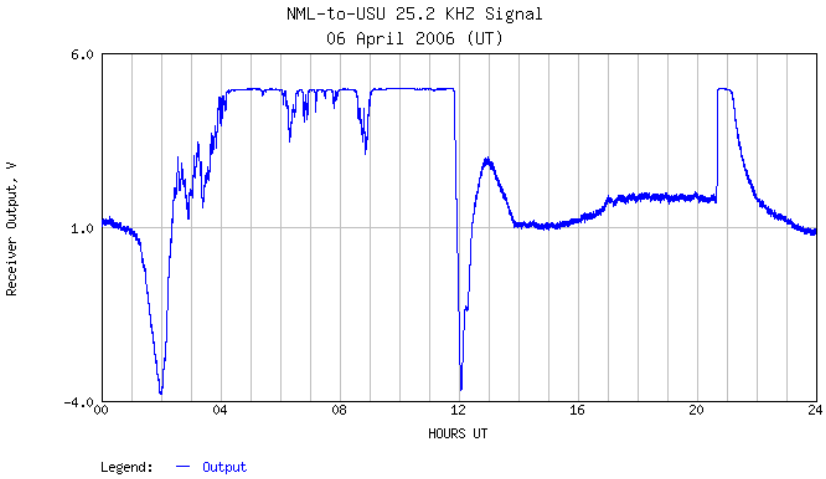


Figure 19: This plot was generated from data collected by the Stanford SID VLF receivers operated by Utah State University, Providence, UT, which monitors the U.S. Navy transmitter NML (25.2 kHz) located in LaMoure, ND [http://www.spacenv.com/~rice/vlf/]. A non-solar SID is captured at approximately 21 UT on April 6, 2006.

The program started in January 2006. As of May 2007, approximately 100 monitors have been shipped to various schools around the country and 12 other countries, including Ethiopia, Tunisia, Sri Lanka and Bulgaria. Additional NASA funding will allow another 100 SID monitors to be distributed. The United Nations has designated 2008 as the International Heliophysical Year (IHY). It is desired to place a monitor in every country in the United Nations, all 192. In this way, students all around the world will not only be connected to the Sun, but also to each other.

The education director at the Stanford Solar Center, Deborah Scherrer, heads the Stanford university project to produce and distribute these instruments that monitor the sun's impact on the ionosphere. It is hoped that that these small and easy-to-use monitors will encourage students everywhere to get excited and to get involved in science, but especially underprivileged students in the USA and in developing countries.

"We have the opportunity to reach students in every country of the world," she said. Her husband, research physicist Dr. Phil Scherrer adds, "You can be part of a worldwide experiment."

The SID monitors cost around $200 to build, the more sensitive AWESOME monitors are more costly ($3000) and are reserved for university research. About 30 of these have been distributed. See the world map below with sites depicted.

Application forms to use these receivers can be downloaded from the website. The user is required to build a loop antenna, which is inexpensive, requiring several hundred feet of #26 enameled wire. A PC is also needed. The database and blog is available to all participants. These will facilitate projects and communication.



Figure 20: Ray Mitchell, Chief SID engineer, checks the antenna at the Wilcox Solar Observatory in the Stanford foothills.



Figure 21: An inside view of the Stanford VLF Receiver

A circuit overview by Ray Mitchell, Chief Engineer and Bill Clark, Senior Circuit Design Lead at Stanford University Solar Center is extracted from the Technical Manual (version 1.0), as have been the schematic diagram, IC chip parts list, and the typical performance output monitoring active solar activity.

"The *Power Supply Section* takes input from the 9-10 VAC from the transformer and produces both regulated positive and negative 5 volt supplies. The TNC input feeds the broadband signal in from the antenna into the *Preamp Stage* with the RF gain control. The signal is then routed into the *Frequency Board Filter* Stage (FREQBOARD). This section extracts the desired VLF transmitter station frequency as Amplitude Modulation (AM) from the broadband signal. The AM signal leaves the FREQBOARD and routed to the *Post-Amp Stage* for a user-selectable signal boost the post-amp switch labeled x1, x5 and x10. The signal is routed to the *Signal Detect Stage* that performs a full-wave rectification of the signal making the waveform all positive, i.e. the absolute value of all signal components. The detected signal is then routed to the *Audio Output Stage* where the line-level audio signal is sent out the 1/8" audio output jack and monitored through power speakers. Also the detected signal from is routed into the *Signal Strength Stage*. An integrator (Resistor/Capacitor circuit) converts the detected AM signal into an average DC level, indicating overall signal strength. The DC level (analog output) exits the SID Monitor via the 2-position Phoenix connector that is connected to the DATAQ module (ADC) that converts the analog level to digital values that are then transmitted via RS-232 to the computer and recorded by the software."

Some of the key components (integrated circuits) copied from the parts list are:

AN78L05-ND	78L05	IC1	DIGI-KEY
AN79L05-ND	79L05	IC2	DIGI-KEY
296-1874-5-ND	TLE2082CP	IC3, IC4, IC5	DIGI-KEY
LT1490CN8-ND	LT1490	IC6	DIGI-KEY
MAX275BCPP-ND	MAX275BCCP	IC100	DIGI-KEY

The main portion of the circuit is shown below

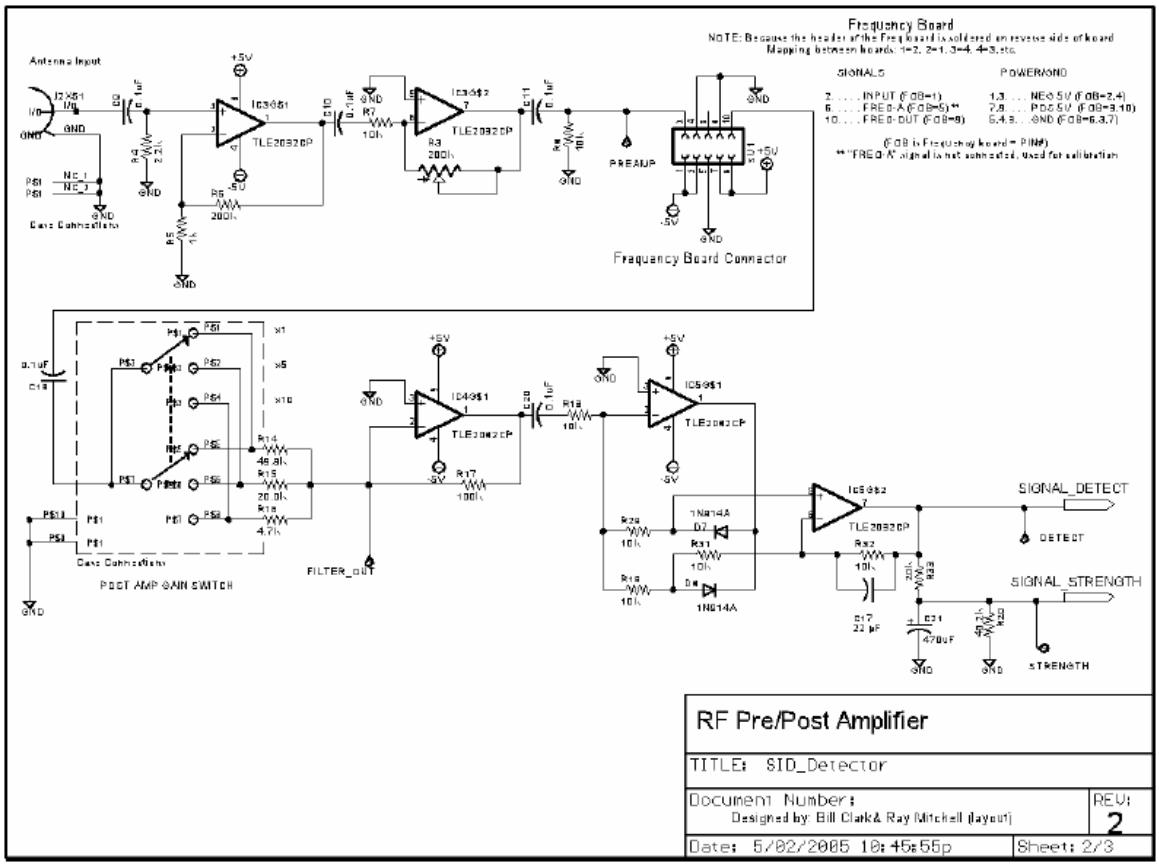


Figure 22: Pre/Post Amplifier Schematic



Figure 23: Red markers indicate SID monitor sites and blue markers indicate AWESOME monitor sites. VLF transmission sites are shown in green.

I have recently received a SID monitor and plan to implement it in the two Knox County High Schools where I have been teaching physics as a Distinguished Professional, as well as Hiwassee College where I also teach as a Professor of Physics. I think this is an excellent opportunity to do radio astronomy outreach and stimulate young minds. When this program, with its SID monitoring (solar flare impact on terrestrial VLF), is taken in concert with Radio Jove (HF solar flare emission), the IBT (microwave solar probe), and Natural Radio (whistlers, tweeks, choruses, etc.), not to mention H-alpha/Calcium-K optical/UV observations and the internet resources to give X-ray (GOES), kilometric (WIND), Visible/UV (SOHO), etc., amateur astronomers have multi-wavelength capability to study the sun.

~ *En Memoriam*: Two Heroes of Radio Astronomy ~

Dr. Kenneth L. Franklin, longtime Hayden Planetarium's top astronomer, whose accomplishments included helping pinpoint the first noise known to have come from another planet and inventing a watch for use on the moon, died in Boulder Colorado as the sun rose at 5:07 AM in New York, at the age of 84 [June 18, 2007]. His death was attributable to complications arising from heart surgery. He was a popular lecturer, the producer of his own radio program and an educator who encouraged students to analyze the radio emissions emanating from Jupiter that he had first discovered.

Credit: adapted from Tom Madigan, Editor, Custer Astronomy Institute



Figure 24: Astronomer Kenneth L. Franklin in 1972, during his heyday at the Hayden Planetarium in New York City. Courtesy of Sky & Telescope, [http://www.skyandtelescope.com/news/8093472.html]

Electrical Engineering Professor Emeritus Ronald Bracewell died of heart failure at his campus home on Aug. 12, 2007. He was 86. Prior to his death, Bracewell and his family lived on Stanford campus for 51 years.

Bracewell's scientific prowess influenced broad realms of science and technology. He was internationally renowned for his contributions to magnetic resonance imaging — work that pioneered common medical diagnostic tools such as MRIs and CAT scans.

Additionally, Bracewell was well known for his work in radio astronomy. In 1961, he constructed a complex telescope consisting of 32 dish antennas from which NASA produced daily solar maps for the Apollo moon landings. The telescope, which has since been dismantled, was considered the first of its kind to give automatic printed outputs that could be distributed worldwide.

Credit: adapted from Salone Kapur, The Stanford Daily, August 30, 2007
[http://daily.stanford.edu/article/2007/8/30/bracewellDiesAfter50YearsAtStanford]

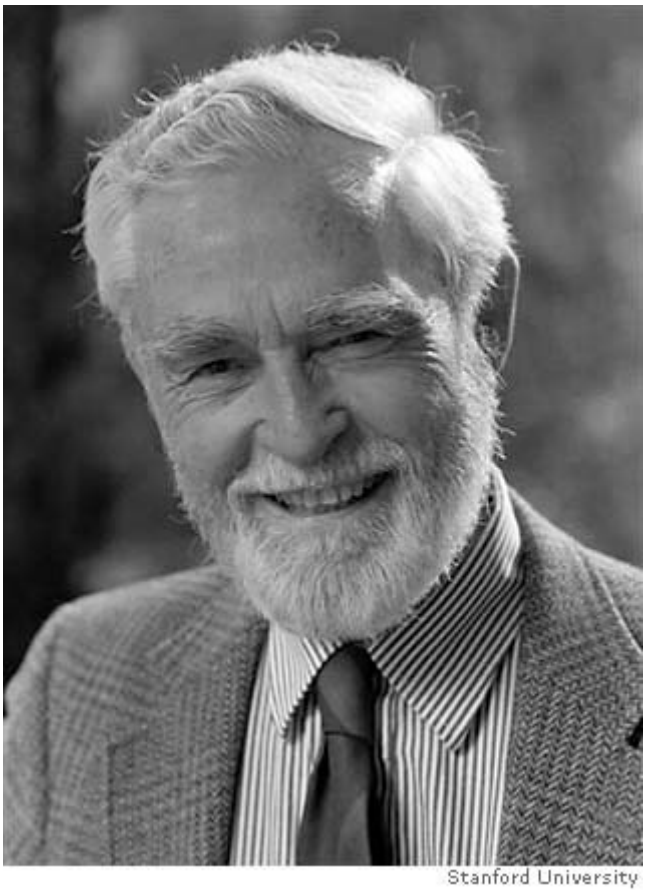


Figure 25: Scientific innovator, Stanford engineer Ronald Bracewell originated the imaging of objects by scanning them through radio and electromagnetic methods (Photo courtesy of Stanford).

~ Radio Astronomy Resources ~

SARA
http://radio-astronomy.org

Radio Astronomy Supplies
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P.O. Box 450546
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(954) 965-4471 / jmlras@mindspring.com
http://www.radioastronomysupplies.com

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

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

SETI League
http://www.setileague.org

European Radio Astronomy Club (ERAC)
http://www.eracnet.org/

Pisgah Astronomical Research Institute (PARI)
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