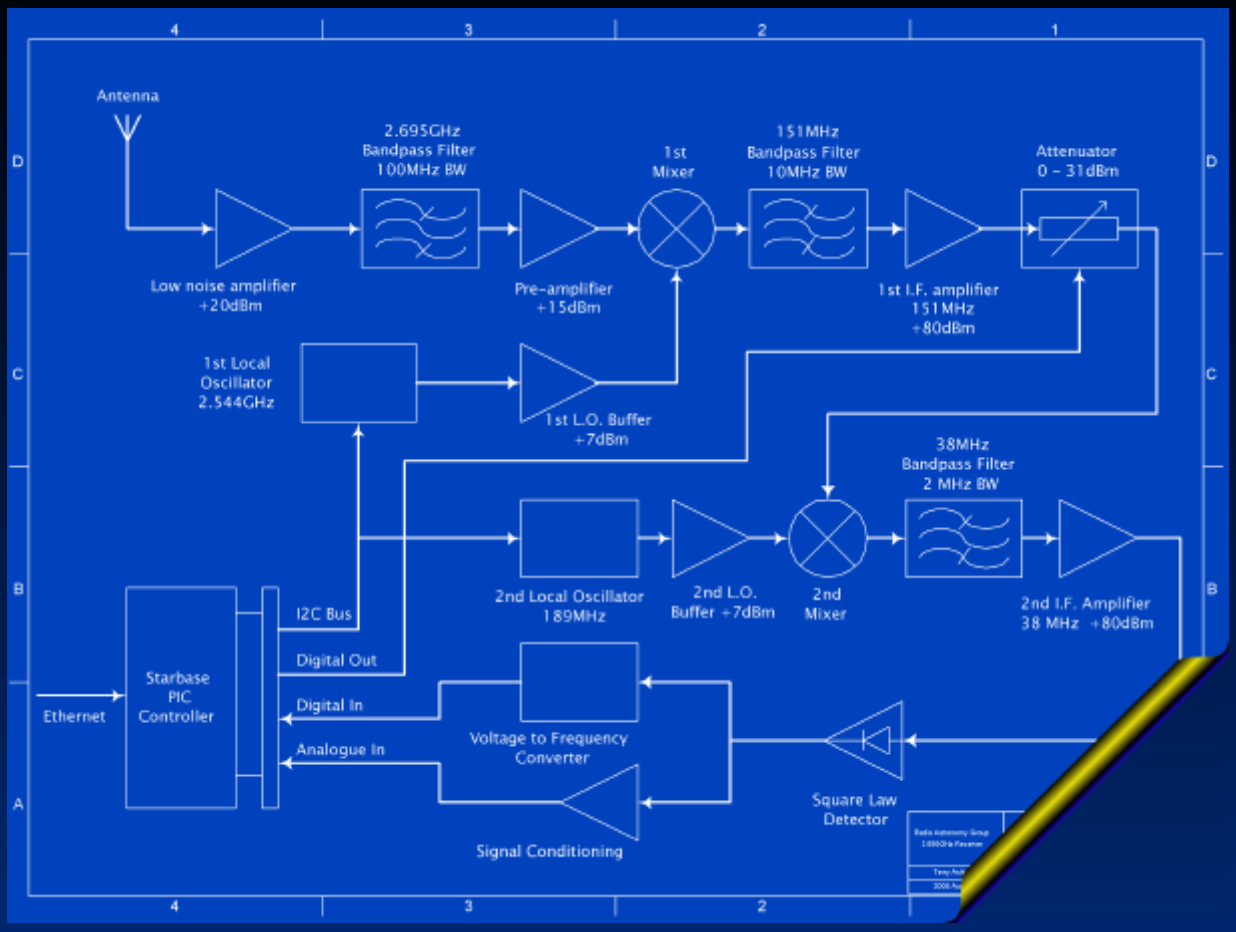
British Astronomical Association
Radio Astronomy Group

Baseline 2005 August
Volume 1 Number 1



Plug and Play Observatory

Observation Programmes launched

Cambridge Exhibition Meeting

Responding to Ofcom

Observatory News

Observatory Gallery

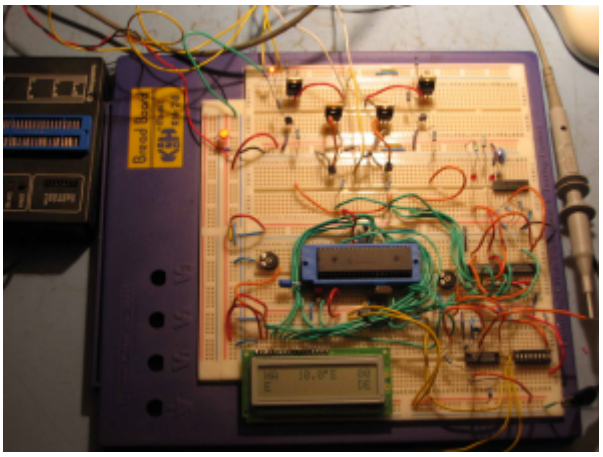
Laurence Newell's 3m on trailer

Putting it all together!

Colin Clements' Control Rooms
(above & below)

Laurence Newell's lab

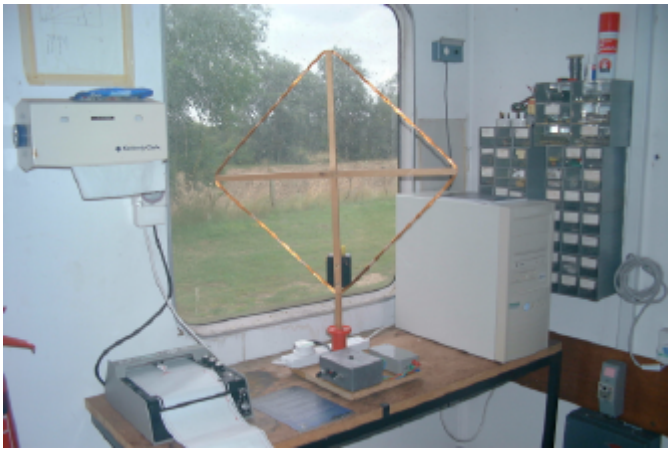
Colin Clements' Cylindrical Parabola



Alan Morgan's Dish Controller

Send in your photographs!

Guiseppe Miceli's lab



Peter King's VLF Receiver

Peter King's lab at the 151Mhz Array

Baseline

2005 August Vol. 1 No. 1

The Circular of the Radio Astronomy Group

Editor Dr Laurence Newell

Secretary Mrs Karen Holland

The *Circular* is published four times per year, in January, April, July and October. There is currently no subscription charge for the PDF form of the *Circular*.

Contributions

Please send all contributions to Karen Holland, either in paper form, or electronically.

karen.holland@xcam.co.uk

It is our policy to use Système Internationale (SI) units wherever possible.

www.simetric.co.uk

Advertisements

Advertisements are invited from both commercial vendors and from individual members. Please make sure that any images are supplied with at least 100dpi resolution, preferably not compressed (by JPEG etc.). There is no charge for this service.

Deadline

All material submitted for publication in the *Circular* must be received by the Editor no later than one month before the next publication date.

Membership of the RAG

There is currently no subscription for membership of the Radio Astronomy Group. If you wish to make use of the *Starbase* Plug and Play Observatory, please contact Karen Holland for a client configuration form.

radiogroup@britastro.com

www.britastro.org/radio

Contents

From the Coordinator

Introduction

Welcome to the very first issue of the Radio Astronomy Group *Circular*. Bearing in mind that we have recently acquired many new members at the Exhibition Meeting, and by email, I have used this issue to re-publish a few items to ensure that everyone is up to date. The Minutes of the three meetings of the Group officers are included, also an updated version of the *Starbase* project description. Several changes have taken place since the early 'Coordinator's Logs', and I want to invite your reactions.

The Circular will now become the principal means of communication with the membership. As with any voluntary non-commercial publication, we are always in need of material to publish. If you would like to write an article about your work, hardware or software project, or perhaps just write a letter, then don't hesitate, please send your contribution to Karen Holland. Please try to submit your work at least one month before the next publication date (shown near the Contents list).

There will be regular features which we will write ourselves, for instance the *Starbase* project development and Back to Basics. I expect that we will have one Officer's meeting per publication period, and these Minutes will continue to be published in the *Circular*. One of the most enjoyable aspects of writing the *Circular* is to receive feedback - *please* let me have your reactions!

Aims and Objectives

I have briefly restated our Aims and Objectives here, since I am sure that this particular *Circular* will become a point of introduction for many new members over the coming months. You are encouraged to distribute the PDF to anyone you feel may be interested.

Aims and Objectives

To give assistance to new amateur radio astronomers
Set up a panel of Technical Advisors
Co-ordinate Group Observing Programmes
Encourage information exchange
Provide design information, hardware and software

Development Project

To produce a modular *Plug and Play Observatory*
No radio or electronics expertise required by users
Multiple receivers with programmable controllers
Integrated software and database of observations

Group Officers

The Group officers are currently:

Laurence Newell	Group Coordinator
Terry Ashton	Assistant Coordinator
John Cook	VLF:SID Programme Leader
Peter King	MRAO 151Mhz Liaison
Karen Holland	Group Secretary

More biographical information is included in a later section.

Group Status

It is worth reminding all members that we are not officially a BAA Section, but rather a *Group*. Being a Section would carry with it certain responsibilities, such as the Section leader would be a trustee of the BAA, which has legal implications. There would also be the necessity to sit in Council meetings. We are reluctant to take the step of converting to a Section (which has been mentioned by several people) without a more tangible demonstration that the membership fully support this approach. If you feel that you'd like to see the Group become a Section, please come along to the October meeting and make your views known to the BAA! It is essential that we are convinced that we have an active, thriving community before undertaking this step.

Budget

The Ridley Grant

We applied for a Harold Ridley Grant to cover the initial costs of the development project. The grant application is included later in the Circular (minus the diagrams, which are now out of date). The grant was worth £250, and as yet we have not spent any of this money.

The Harold Ridley scheme is described at:

www.britastro.org/ridleygrant

BAA

The BAA Council have kindly allocated us a small 'get-you-started' budget of £400, mainly to cover publication costs and the October meeting.

PPARC PUS Grant

In view of the complexity of the proposed development project (described later in the Circular), we intend to apply for a PPARC Public Understanding of Science grant. These small awards (less than £10,000) would be ideally suited to our project, and would enable us to pay for contract

development, so reducing the time to market, and letting us concentrate more on the science rather than the mechanics of production.

The award scheme is described at:
www.pparc.ac.uk/rs/fs/pu/SmallAwards.asp

Treasurer's Report

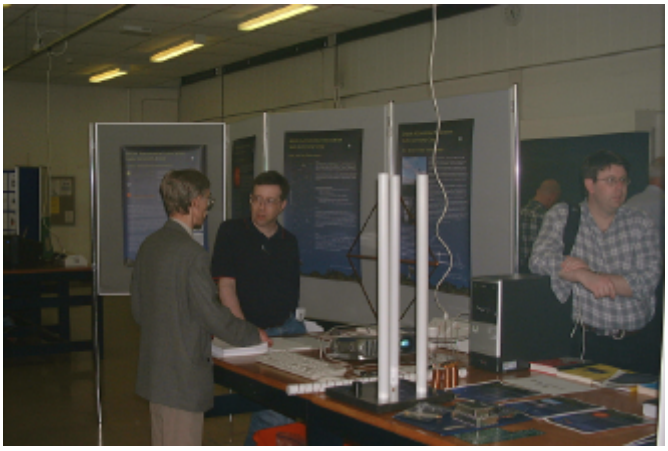
The Treasurer's Report this time is very simple: the Group is worth £650, with pending expenses for the Exhibition posters and the meeting. Also, there is no formal Treasurer – if you would like to take on this relatively undemanding role, please contact Karen. Experience of dealing with PPARC would be very useful.

Cambridge Exhibition Meeting

The Exhibition Meeting at the Cavendish Laboratories was a good opportunity to present the rejuvenated Group to the rest of the BAA, so we pulled out all the stops! The basic items on display were:

- 2.695Ghz Receiver prototype hardware
- VLF Receiver hardware from John's Observatory
- Prototype *Starbase* Repository software
- Peter Moreton's PIC board, connected to *Starbase*
- Posters of RAG activities

I designed and produced the four A2 sized posters, with input from the other team members. Each poster described one major activity of the Group – The Plug and Play Observatory architecture, 2.695Ghz Receiver, VLF SID Observations, and the liaison with the MRAO 151Mhz Array. PDFs of these posters are available on request, for members to print and use at their places of work, for instance. I was was able to borrow some display stands large enough to take the posters, and the overall effect was very impressive, as you can see.



John Cook talking to Murray Niman about his VLF work. The white poles are part of the prototype helical antennae for the 2.695Ghz Receiver. The display posters can be seen in the background.

John and Murray are still deep in conversation. The projection screen shows the *Starbase* Repository Explorer prototype, displaying John's VLF data. Terry is in the background, calculating how long it is until opening time.

The triumphant Team with their blue RAG badges
John Cook, Laurence Newell, Terry Ashton, Karen Holland
Photograph courtesy of Hazel Collett

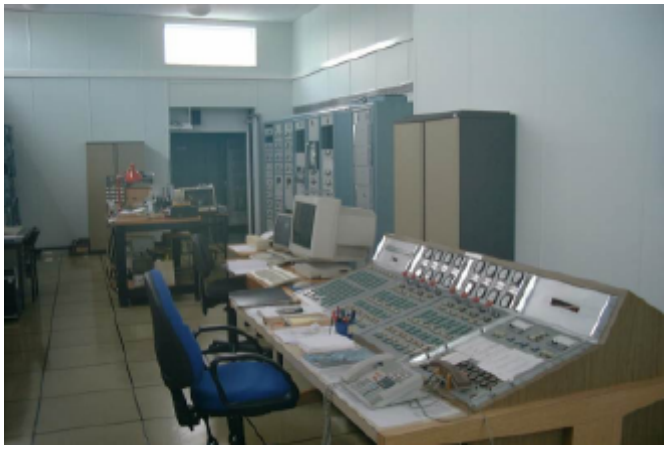
Unfortunately Peter King was unable to attend on the day, owing to a prior engagement, which is why he does not appear in the photographs. He was presented with his badge at a special ceremony some time later, from which there was no escape.

Printed copies of the posters were available for visitors to take away (at A4 size), as were the A5 fliers giving details of the Group Meeting. We received a lot of very positive feedback about our stand, particularly about the quality and consistency of the presentation. We managed to collect the names of another 14 people who wanted to be kept informed of RAG activities, bringing the total to over 60, in under a year. So all in all, a very successful day.

MRAO meeting

The third meeting of the Group's Officers was held recently at the Mullard Radio Astronomy Observatory (MRAO) at Lord's Bridge, Cambridge, by kind invitation of Peter King. The full meeting Minutes are included in a later section.

Following the meeting, we toured the Observatory, and some photographs are shown below. We hope to arrange a tour for the Group membership some time next year.



The main control room of the Ryle Telescope (the 5km array), in the Ryle Building. The telephone rings with a different Morse code signature for each member of staff. The computer system is installed in a small side room completely lined with copper sheet – a Faraday cage. The 5km array is currently being re-engineered for a different antenna configuration.

The main control room of the One-Mile Telescope. Everything has been left much as it was thirty years ago – even down to rolls of punched paper tape tied with perished rubber bands, and open logbooks. Terry wishes he hadn't left his sonic screwdriver at home – that neutron flux is bugging him.

The telescope was completed in 1964. It is an array of two fixed and one moveable, fully steerable, 20m diameter paraboloids operating simultaneously at 1420 and 408 MHz designed to perform aperture synthesis interferometry. The construction of this telescope and development of the Earth-rotation aperture synthesis used when operating it contributed to Sir Martin Ryle and Antony Hewish receiving the Nobel Prize for Physics in 1974.

One of the dishes of the Half Mile Telescope

The Half-Mile Telescope was built in 1968 with two aerials. Two more aerials were added in 1972, using donated dishes. Two of the dishes are fixed, two are moveable and share the One-Mile's track. The observing frequency was 1.42GHz, bandwidth 4MHz. The telescope was used for Hydrogen Line studies of nearby galaxies and produced the first good radio maps of hydrogen velocity distributions.

The main control room of the 4C Array.

The 4C Array is a cylindrical paraboloid radio telescope. It is 450m long, 20m wide, with a second, moveable element. The array was the first large aperture synthesis telescope, built in 1958. The 4C operated at 178 Mhz (1.7m), and located nearly 5000 sources of the 4C catalogue.

For more information, please visit:

www.mrao.cam.ac.uk/telescopes

www.answers.com

Ofcom Consultation Document

The Office of Communications (Ofcom) recently released a consultation document concerning changes in the way radio astronomy bands are allocated. The document invited responses to several questions posed by Ofcom. John Mason brought this to our attention, and Terry Ashton prepared a formal response to Ofcom on the Group's behalf. The full text is included in a later section.

BT Donations of Equipment

Laurence Newell works at BT's research and development facility at Adastral Park, Martlesham, and is always on the look out for redundant equipment for use by the Group. BT have made a charitable donation of several items to the BAA, the most valuable of which is a Hewlett Packard HP8568B Spectrum Analyser. This instrument can cover from 100Hz to 1.5Ghz, with a 10Hz resolution, and is just what we need to aid in the development of the high frequency receivers. Terry Ashton is the first lucky member to play host to this superlative piece of engineering. Terry likes to receive small gifts from time to time, such as drinking vouchers, crates of beer, or cash.

HP8568B Spectrum Analyser

BT also donated four ICS Advent industrial PCs. These were originally used on the yachts in the BT Global Challenge Yacht Race, so they are well travelled! Each machine is fitted with a dual motherboard, with twin 500Mhz Pentium processor cards and SCSI RAID drivers. Each processor has one fixed and one hot-swappable SCSI drive. Some are configured for 24V DC, some for 240V AC. One is now installed at the MRAO on the 151Mhz array. The other three are available for loan by *bona-fide* BAA members. They are very heavy!

ICS Advent Endeavour 7520 PC

Membership

The number of people asking to be added to the email distribution list continues to grow. We now have over sixty validated email addresses! We contacted all members on this list to ask if they wanted to withhold their email address from publication, and there were no replies received, so the list included later shows all current members who have elected to receive the *Circular* PDF by email. There are some others who use the postal system, but their names are not shown.

This number of members is very encouraging after such a short time 'back in action'. We are hoping for a high proportion of these people to be able to attend the meeting in Northampton in October. A good turnout would show the BAA that we are very active, and Council might look favourably on converting the Group back into a Section. Be there!

The membership database is now hosted by James Wilhelm, as part of an experiment to test the technologies behind the distributed observatory network which we call *Starbase*. The database currently used is MySQL: see www.mysql.com. James' server is running on Linux, and is heavily protected against intruders. The Group Officers each have access to this database using Navicat: see www.navicat.com.

As part of the conversion to a properly data-driven organisation, we have created a *Starbase* Client Application Form, available from Karen Holland. This form contains all of the fields currently used in the Repository database held on James Wilhelm's server. If you think that you would like to try the *Starbase* system when it becomes available, we would be very grateful if you could take the time to fill in this form carefully, so that we have an accurate record of your observatory details. When the *Starbase* network is launched this information will enable you to connect to the network using the client software which will be provided. Members who do not expect to use *Starbase* need only let us know their names and email addresses.

Group Meeting

On the next page you will find details of our first formal Meeting, to be held in Northampton in October. The Group Officers are looking forward to meeting you there!

Laurence Newell

Group Coordinator

2005 August

The RAG Meeting 2005 October 8th 10:30

Meeting Programme

The Humfrey Rooms, Castilian Terrace, Northampton, NN1 1LD

Dr Tim O'Brien, of Jodrell Bank	*Jodrell Bank's 6.4m Robotic Radio Telescope*
Dr Laurence Newell	*The Activities and Work of the BAA Radio Astronomy Group*
John Cook	*A Simple VLF Receiver for Solar Flare Monitoring*
Richard Lines	*The Schumaker-Levy – Jupiter Impact at 21MHz,* and Solar Observations at 600MHz
Bob Marriott	*The History of Radio Astronomy in the BAA*
James Wilhelm	*The John Smith 408MHz All Sky Survey*
Murray Niman	*Challenges to the Radio Astronomy Spectrum*
Peter King	*The Mullard Radio Astronomy Observatory 151Mhz Array*

Some of these speakers will be bringing demonstration equipment with them, and a prototype of the Group's own project should be available to view on the day. There will be a number of short slots available (15 mins) for members to talk about their projects. There will also be poster and demonstration space available. If anyone would like to share their work please contact Karen Holland. It is hoped to make all of the presentations available on CD-ROM after the meeting (as Powerpoint presentations if possible).

Meeting Location

Castilian Terrace is in the centre of this map,
just below St. Giles Street
You will find a shopping trolley to the West, amid a maze of twisty passages, all alike

OFCOM – RECOGNISED SPECTRUM ACCESS

Terry Ashton

If you would like to see the full consultation document, go to www.ofcom.org.uk/consult/condocs/astronomy. You will see that the RAG document stands very well against the other responses.

This document has been prepared by the Radio Astronomy Group of the British Astronomical Association (BAA RAG). The BAA is the leading organisation for amateur astronomy in the UK (see www.britastro.org). Amateur radio astronomy is probably unknown to Ofcom and consequently not on its agenda for RSA, but amateur radio telescopes do exist, and are subject to more interference than remotely located professional facilities. Our current observing programmes include work at 2.695GHz, 151MHz and 30kHz. How will Ofcom manage the amateur? The BAA Radio Astronomy Group would remind Ofcom that although we are amateurs, we do aspire to do work of a professional nature. Irrespective of the decisions made for professional radio astronomy, we think it essential that the amateur community is not charged licensing fees for their activities.

We would kindly ask Ofcom to keep us informed of all developments in the RSA debate.

Question 1. Do you agree that the RSA is an appropriate spectrum management tool for Radio Astronomy?

A mechanism for management already exists: the radio astronomy community has directed itself very well on its own up until now. It should be a fundamental right to use astronomical radio reception for science and education. If an external management structure is warranted then its only duty should be to guarantee access and maintain freedom from interference at no cost to the research community. There is no need to manage users who receive only.

Question 2. Do you agree with the list of proposed RSA parameters for Radio Astronomy?

It is agreed that the parameters should be taken into account but a policy already exists. Radio astronomers do not build their telescopes in the middle of cities and radio masts and transmitters are not erected near radio observatories as a prime consideration of geographical parameters. It is Ofcom's responsibility to regulate and enforce these policies.

It appears that it is in Ofcom's interest to provide more access to commercial users, who stand to benefit more than the radio astronomy community. The radio astronomy community cannot compete on an equal commercial footing with profit making entities that can bid more effectively for space in the radio band.

Whilst the interest in balancing radio astronomy with commercial usage is a well understood issue, the number of radio observatories in the United Kingdom is very much smaller than the number of transmitters required by the consumer market. This implies that there will be no balance. Ofcom should not be leaning towards the interests of those people generating the most funds. Spectrum use below 10GHz is already well congested but less than 1% of this is allocated to receive-only installations. Excuses should not be found as to why protection of allocated radio astronomy frequency bands cannot be endorsed.

Question 3. Is a rolling five-year term without fixed termination date appropriate for RSA for Radio Astronomy?

Five years is inappropriate as it is not long-term. When establishments such as the European Space Agency talk about long-term scientific research, they refer to 25 years. We can see that once RSA is established, and radio astronomers have subscribed to it, we will have this scenario in five years' time: "Owing to the spiralling increase in administrative costs…"

Question 4. Do you agree with the proposed basis for fees for Radio Astronomy RSA?

Ofcom recognises that there can be no alternative use for the allocated radio astronomy bands under international agreement. This by itself is sufficient reason not to introduce a fee for radio astronomy.

Question 5. Do you think that spectrum trading and liberalisation should be applied to Radio Astronomy RSA?

The currently allocated radio astronomy bands occupy the spectrum space that they do as a consequence of the natural radio frequency emissions from cosmic sources: observations are bound by constraints imposed by nature. There is no method by which these emissions can be changed and hence spectrum trading is unwarranted.

Question 6. Are there any regulatory impacts or policy considerations not otherwise mentioned in this consultation that are pertinent to RSA for Radio Astronomy?

The issue of RSA is one of costs being charged to users of the radio spectrum. The exploitation of the market associated with access to RF space generates competition

and business but revenue should come only from those who make a financial gain from said access. The whole point about competition is that it is driven by market demand, which will reduce access to radio astronomy groups who have no interest in making money. How can Ofcom ensure unrestricted access for the future of radio astronomy and still want to promote competition? How can radio astronomers be competitive if the primary drive for them is not a competitive one? Research only competes with research for access and this already exists through bidding for time on a facility. There is no need to add other complexities, which will interfere with the status quo of the research community users. Commercial entities should not have the ability to interfere with this.

Spectrum access to users associated with research and education should remain unchanged: administration costs are already subsidised by PPARC who pay Ofcom for access. Ofcom should acknowledge that research in the radio astronomy community has its policy dictated at an international level and abide by the subsequent international standards.

Observing Programmes

Radio Astronomy Frequency Allocations

Before we begin to describe our *Observing Programmes*, it is worth reviewing the frequencies which are currently allocated to Radio Astronomy. Probably the most useful frequencies are:

37.5 – 38.25 MHz	Continuum
73 – 74.6 MHz	
150.05 – 153 MHz	**Solar/Continuum/Pulsar (VHF)**
322 – 328.6 MHz	
406.1 – 410 MHz	
608 – 614 MHz	
1400 – 1427 MHz	**21cm Hydrogen Line (L band)**
1660 – 1660.5 MHz	
1660.5 – 1668.4 MHz	
1668.4 – 1670 MHz	
1718.8 – 1722.2 MHz	
2655 – 2690 MHz	
2690 – 2700 Mhz	**Solar/Continuum (S band)**
3260 – 3267 MHz	
3332 – 3339 MHz	
3345.8 – 3352.5 MHz	
4800 – 4990 MHz	
4990 – 5000 MHz	
5000 – 5030 MHz	
6650 – 6675.2 MHz	
10.6 – 10.68 GHz	
10.68 – 10.7 GHz	

We are launching three Observing Programmes, for Solar Observations at 2.695Ghz, Sudden Ionospheric Disturbances detected via VLF, and Solar Observations at 151Mhz using the Cambridge MRAO facility.

2.695Ghz Solar Observations

Terry Ashton

Solar Radio Activity

After the first studies of solar radio emission began in the 1940s, it soon became apparent that there were two components associated with the undisturbed sun. The first of these is an emission which remains invariant over very long periods of time (years), and forms what is known as the background level. Then there is the component which varies very slowly each day and has a period of about 27 days or one solar rotation. This, quite naturally, is known as the slowly varying or *S*-component and its source is associated with regions of high electron densities that form in the localities of sunspots and plages. Plages are areas of intensified brightness in the solar chromosphere that are usually observed in an emission line of calcium.

Selection of Frequency

The *S*-component is most obvious at frequencies ranging from 500MHz to 10GHz. There are several allocated Radio Astronomy bands in this range, and we chose the frequency of 2.695GHz, mainly because there is a strong correlation between the number of active areas on the sun and received radio emission at frequencies in the region of 3GHz.The integrated emission from the solar surface at this frequency is mostly thermal in origin and so signal strength should be high, even at times of low solar activity, and so making measurements should be easy and encouraging for the amateur. Studies of solar flares have rarely had spectroscopic treatment at these frequencies and there may well be a classification as yet distinct from the existing three types of burst currently associated with microwave flares at ~11cm wavelengths. Members of BAA RAG will make this discovery. Also, the emission associated with these flares is very weakly, usually circularly, polarised and we want to know all about this, too.

Telescope Considerations

Another reason for choosing this frequency is that a 2.695GHz telescope doesn't have to be very big and the smallest of back gardens will no longer be an excuse for not having an installation. In fact, even operating an interferometer with a baseline of 50 wavelengths only requires an east-west extent of some six metres. However, the instrument is really designed to be a single aerial (*total power*) solar radiometer. A discussion about the choice of aerial is to be found later in the description of the development project.

The telescope will be composed of an array of helices: a helix has a bandwidth range of the order of a factor of ~2 which ideally lends itself to spectroscopic observations.

Programme Objectives

We will endeavour to empirically find the formula relating the flux at 2.695GHz to active areas and later, determine how this changes with frequency using a radio spectrometer (a later phase of the development project).

The observation programme structure will take some time to evolve, but if you already work at this frequency (or perhaps 1420Mhz, 151Mhz or 38Mhz), then please send in your observations for the next *Circular*.

Sudden Ionospheric Disturbances

John Cook

The last 5 years has seen the 11-year solar cycle peak and decay, with some dramatic effects on the Earth's environment. In particular, we have seen some excellent Auroral displays from the UK, while satellites in earth orbit have experienced problems from increased radiation damage and atmospheric drag. Sun spot and H-alpha flare activity is under continuous scrutiny by members of the Solar Section, whilst X-ray activity remains largely in the professional domain. The BAA Radio Astronomy Group has observers monitoring in various parts of the Radio spectrum, including indirectly X-ray wavelengths.

Solar Flares originate in the lowest regions of the Sun's corona when complex magnetic fields begin to 'untangle' themselves and re-connect in a simpler way. Large amounts of energy are stored in these magnetic fields, and this energy is released during reconnection events. The electromagnetic radiation produced has strong components at many wavelengths, including X-rays. They all propagate at the speed of light, and reach the Earth just 8 minutes later. Satellites such as the GEOSS series monitor the X-ray intensities, and classify flares into C, M, or X classes as reported in the 'Space Weather' found on the Internet.

The sudden arrival of large X-ray intensities in the Earth's upper atmosphere increases the ionisation levels of the ionosphere layers responsible for reflecting terrestrial radio signals. In particular, the D layer reacts very quickly leading to a very simple way of detecting X-ray flares from the Earth's surface. Radio signals at Very Low Frequencies (below about 30kHz) propagate as a guided wave between the conductive Earth's surface and the D layer, travelling great distances around the globe. They also have the property of penetrating a short distance into sea water, and are therefore of great value in communicating with submarines. Increases in D layer ionisation lead to increased conductivity and absorption, altering its reflectivity to radio signals. A receiver monitoring a remote VLF transmitter will see the received signal strength change rapidly in direct response to the arrival of the X-ray energy. These Sudden Ionospheric Disturbances (SIDs) can last from a few minutes to several hours. Most references [1] show SIDs as a sudden increase in signal strength followed by a slow return to normal levels. They can however appear as sudden drops in signal strength before the slow return. These are often referred to as inverted SIDs. In practice, a signal will have components taking different paths from transmitter to receiver and thus creates an interference pattern. As the D layer ionisation changes, the interference pattern will move relative to the receiver, giving rise to the signal level changes that we record.

Signals in the VLF spectrum are mostly very high power (100kW or more), and associated either with research projects or military communications. Once a suitable signal has been located it can be monitored nearly continuously. Having two receivers monitoring different signals gives better coverage through breaks in transmission, and also allows genuine events to be distinguished from noise and other signal level changes. As noted above, SIDs can result in increasing or decreasing signal levels, and a pair of signals showing both effects will highlight even small C-class flares in quite a dramatic way.

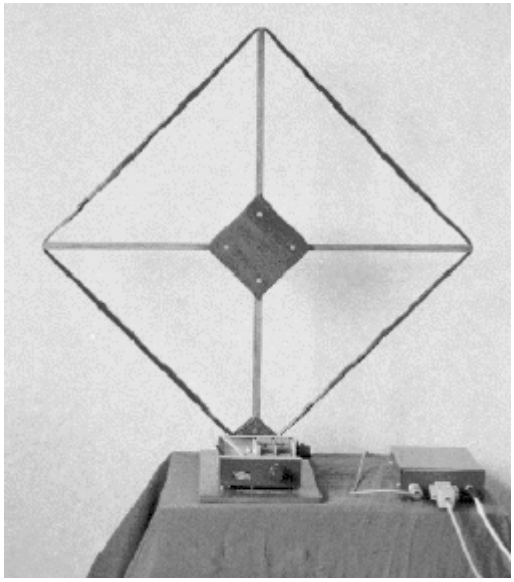
Receiver

I have been monitoring a signal from north Germany at 23.4kHz since March 2000, using a simple receiver fed by a small loop aerial, which is shown below.

The aerial is reminiscent of an earlier epoch of radio reception, but has several advantages:

- it is very compact compared to the wavelength concerned,
- it responds to the magnetic component of the signal
- it rejects electrical interference
- it can be screened against electrical interference if necessary,
- it is very directional,
- it is well suited to use indoors.

The aerial consists of 125 turns of 0.45mm copper wire wound on to a 580mm diagonal wooden frame, and is tuned with a combination of fixed and variable capacitors.



The receiver is more modern in appearance (the box at the lower right), but is based on the old Tuned Radio Frequency design once very popular in valve receivers. There is nothing novel in its design, but it has proved to be reliable and reproducible. An input stage buffers the aerial into a high-Q high-gain filter. Tuned to the desired frequency, its output is rectified and amplified to drive the recording equipment. A long time constant is used to remove all traces of the original modulation, and also reduce noise levels. The output is a 0.5 Volt signal, which is fed to a data logger. Samples are stored at 5 second intervals in memory, which can be read each day. The data are then used to draw a graph of signal strength through the day, the time and magnitude of any events being recorded and added to the monthly report of solar activity. The raw data are archived on disc. A variant of this receiver will be available as the *Starbase* VLF Module, the circuit board for which is shown in the next section.

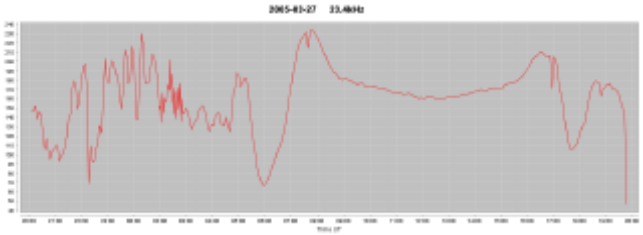
Tuning and Choice of Signal

Distant transmitters are more useful than local ones for this work. A list of signals can be found in [1] and also in a number of sources on the web [2]. Tuning the receiver to the required frequency can be tricky, and requires a little time & patience. I have found that the easiest way is to use an audio signal generator to first tune the aerial to the transmitter frequency, and then adjust the receiver. Connecting the aerial to the receiver and monitoring the filter output with an oscilloscope should then reveal the signal, allowing fine tuning for maximum output. The loop aerial is most sensitive in the plane of the loop, not face-on, and should be rotated for the best signal. Aerials for separate receivers can be put close together, without any ill effect on performance. The D.C. output has a long time constant to remove any residual modulation, making it unsuitable for initial tuning. Once the signal has been found, the DC gain can be set and the output connected to a recording device.

Results

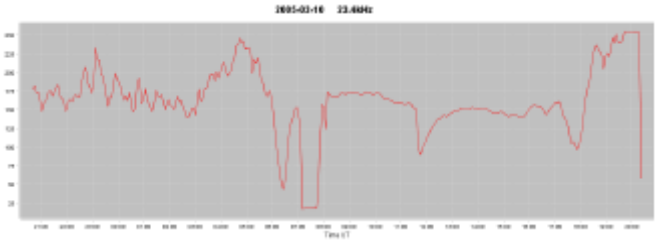
Examples of the recorded results are shown, from which some salient features can be seen.

2005 March 27



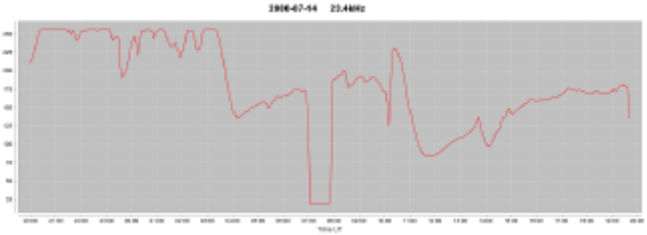
During local night, the Sun is not available to ionise the D layer, absorption is lower and the signal strength will be very high, and often off-scale. It is dominated by random changes in ionisation, and therefore random changes in signal level. As the Sun rises, signal strength will drop dramatically before rising back to its morning level. The changing angle of the Sun in the sky causes the signal strength to fall gently through the morning reaching a minimum at solar noon, and then rise gently towards sunset when the signal will again dip to a low level before returning to its nighttime level. There may be periods of the day when the signal goes off-air, showing as a sudden drop to zero. When it returns, the signal will be back on the Diurnal curve as if nothing had happened. This was a very quiet day on the Sun!

2005 March 10



The same basic features can be seen, with the addition of a large SID at 11:39UT. A C class solar flare was responsible, with quite dramatic results for signal propagation at the time. Normal diurnal activity resumed at about 12:30 - 13:00. A break in transmission is also recorded at 07:00UT, a frequent event for this signal.

2000 July 14



Close to solar maximum, this X-5 flare (10:04UT) did considerable damage to satellites, as well as causing disruption to short-wave radio traffic. A second, lesser event can be seen at 13:40.

All of these recordings are at 23.4kHz. Since starting this project, I have added a second VLF receiver channel as well as a magnetometer to spare inputs on my data logger. The second VLF receiver has been tuned to several frequencies, none of which have been as reliable as the first. A 16kHz signal turned out to be GBR in Rugby, and far too close to be of any use for solar monitoring. The SIDs recorded were very weak even for quite large solar events, as can be clearly seen on the 2004 July 14th event, which has hardly disturbed the signal despite its X-ray magnitude. A signal at about 21kHz is currently being used, from LeBlanc in central France.

The varying seasonal day length means that solar activity is poorly sampled during the winter compared to the summer months, leading to some missed events and an annual bias superimposed on activity charts produced from the recordings. As with other areas of solar observation, pooling results from observers around the globe can reduce these effects.

Conclusion

I have found that monitoring ionospheric disturbances can be a reliable way of detecting solar flares. The receiving equipment is fairly simple and very compact, and once a suitable signal has been found it can be recorded 24 hours per day for unattended operation.

Glossary

D layer
The lowest ionised region, at about 70 to 80km altitude. It forms the boundary between the stratosphere & ionosphere, and is present during the day.

E layer
A permanent ionised layer above the D layer, responsible for nighttime radio reflections.

VLF
Very low frequency. Usually 3kHz to 30kHz, although definitions vary.

SID
Sudden Ionospheric Disturbance. This is the all-inclusive term for flare-induced activity in the D layer, including signal enhancements and atmospheric enhancements. References give varying definitions.

References

[1] Observing the sun. Peter O. Taylor (Cambridge).
[2] www.vlf.it/trond2/list.html

VLF Programme Observers

The VLF Observation Programme is now running, using various receiver designs. The observers are currently:

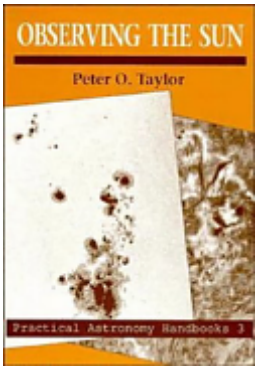
John Cook
Roberto Battaiola
Colin Clements
Peter King
Bob Middlefell
John Trott

If you are an active VLF observer, you are encouraged to send your observations to John Cook, who will collate all results received and publish them in a monthly report. The report will be distributed to any interested members, as a PDF file by email, or in the post, on request. The observation report for 2005 May and June is shown on the next page. These reports will become a regular feature in the *Circular*.

Prototypes of the *Starbase* VLF receiver will soon be available for evaluation (without the controller module). Please let John know if you would like to be a 'beta tester'!

Observation Archive

As the *Starbase* project evolves, in particular the Repository of observations, we would welcome the submission of the original observational data in electronic form, i.e. the the complete set of measurements of receiver output against time. The eventual aim is to import all received data into the Repository database, appropriately tagged with 'metadata' to fully describe the observation and observer. We hope to have data importers for common formats such as SkyPipe, AAVSO etc. Other importers will be produced as required. Eventually members would be able to browse all of the original data records, and perform their own analyses. The prototype Repository already contains John Cook's complete set of observations from 2000 to 2005, some 130Mb of data! (These also include his magnetometer results.)



Observing the Sun by Peter Taylor

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Published November 1991
173 pages 279 x 215 mm

VLF Observations 2005 May and June

The observers who have contributed to this listing are:

A	John Cook	23.4kHz	Tuned radio frequency receiver, 0.58m frame aerial
B	John Trott	23.4kHz	Twin op-amp receiver, 1.2m frame aerial (high Q)
C	John Trott	20.3kHz	Gyrator receiver with small frame aerial
D	Bob Middlefell	23.4kHz	Tuned radio frequency receiver, 0.5m frame aerial
E	Roberto Battaiola	21.75kHz	Modified AAVSO receiver
F	Colin Clements		AAVSO receiver, 0.76m screened loop aerial

X X ray class

O Observers

	X	O	A START PEAK END		B START PEAK END (UT)		C START PEAK END (UT)		D START PEAK END (UT)		E START PEAK END (UT)		F START PEAK END (UT)	
JUNE														
1	C2.3	1									10:42 10:52 10:58	1-		
1		1			14:38 14:45 15:10	2								
3	M1.0	4	12:05 12:22 12:50	2+	11:56 12:15 12:58	2+	11:57 12:02 12:25	1+			12:00 12:20 12:59	2+		
4	C2.2	1			06:40 06:47 07:07	1+								
4	C1.3	1			11:36 11:41 11:53	1-								
5	C3.5	3	13:32 13:50 14:35	2+	13:31 13:43 14:38	2+					13:31 13:48 14:22	2+		
7	C3.0	3	13:37 13:43 14:13	2	13:37 13:43 14:20	2	13:37 13:44 14:03	1+						
10		1									11:09 11:28 11:46	2		
14	C7.4	3	15:28 15:50 16:35	2+					15:28 15:36 ?	-	15:34 15:45 16:05	1+		
27	C2.8	3	08:46 08:49 09:00	1-	08:48 08:53 09:31	2							08:47 08:51 09:15	1+
MAY														
1		2			16:31 16:34 17:59	3								
3		5	10:32 10:37 11:00	1+	10:33 10:40 10:56	1	10:33 10:41 ?	-	10:31 11:05	2				
5		5	14:38 14:47 15:15	2	14:35 14:46 15:11	2	14:40 14:46 15:11	1+	14:35 15:10	2				
6		6	11:21 11:26 12:30	2+	11:23 11:31 12:54	3	11:16 11:31 13:04	3	11:34 11:56	1	11:19 11:31 11:54	2		
7		6	08:03 08:21 09:10	2+	08:03 08:09 ?	-	08:04 08:16 09:23	2+	08:05 08:19	1-	08:01 08:16 08:43	2		
7		3			11:52 11:57 12:10	1-			11:52 12:52	2+				
8		2			09:22 09:33 ?	-								
9		5	10:42 11:10 ?	-	10:34 10:46 ?	-	10:25 10:35 11:07	2			10:39 11:06 11:37	2+		
9		3	11:42 11:47 12:25	2							11:42 11:48 12:11	1+		
9		2									12:27 12:34 12:43	1-		
10		4	09:01 09:07 09:25	1	08:57 09:05 ?	-	09:01 09:07 09:41	2						
10		3			12:23 12:27 12:48	1+	12:22 12:28 12:42	1						
10		3			14:09 14:12 ?	-	14:10 14:13 14:23	1-						
11		3	06:34 06:49 07:35	2+							06:38 06:46 07:12	2		
11		5	16:59 17:02 ?	-	16:57 17:05 18:14	2+	16:58 17:03 17:39	2			16:58 17:02 17:20	1		
12		3			06:54 07:05 ?	-	06:55 07:00 ?	-						
12		5	07:29 07:38 08:40	2+	07:29 07:30 09:13	3	07:29 07:35 08:38	2+			07:29 07:37 08:08	2		
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13		2			12:56 13:02 13:40	2								
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13		3	16:32 17:14 18:15	3							17:06 17:13 17:27	1		
14		2			06:58 07:02 07:29	1+								
14		5	15:02 15:07 15:25	1	15:00 15:09 15:56	2+	15:01 15:06 15:47	2+			14:56 15:05 15:22	1+		
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16		3	09:02 09:23 10:15	2+							09:03 09:12 09:42	2		
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18		3					14:43 14:52 15:23	2			14:35 14:52 15:02	1+		
26		2									07:48 07:50 07:57	1-		
27		2									05:03 05:08 05:19	1-		
27		5	06:32 06:37 ?	-	06:27 06:37 ?	-	06:25 06:37 ?	-			06:25 06:35 06:39	1-		
27		5	12:26 12:43 13:50	2+	12:25 12:37 ?	-	12:23 12:33 ?	-			12:13 12:32 13:06	2+		
30		2									05:39 06:02 06:16	2		
30		2									06:38 06:52 07:06	1+		
31		2			14:38 14:44 15:10	2								

MRAO 151MHz Liaison

Peter King

The Mullard Radio Astronomy Observatory (MRAO) 151 MHz Interferometer, which has been used historically to compile several important surveys, is now available for use by Group members.

This telescope, known as the Cambridge Low-Frequency Synthesis Telescope (CLFST) is an east-west aperture synthesis system which operates at 151 MHz. It originally consisted of 60 steerable Yagis on a 4.6Km baseline, giving 776 simultaneous baselines. These provided a sensitivity of about 30 to 50 mJy/beam, and a total field of view of about 9 x 9 degrees. See the following for more information:

www.mrao.cam.ac.uk/telescopes/clfst

The CLFST has been used in the past to compile radio surveys of the northern skies. In particular, the 7C survey covered most of the northern hemisphere above a declination of 20 degrees, but generally away from the Galactic plane, at 151 MHz. It also produced the lower resolution 6C survey at 151 MHz, and the 8C survey at 38 MHz.

The antennae were constructed in 1980, in two groups of seven clusters of four Yagis. One group is now being renovated by MRAO in a conservation project. In an effort to reduce the amount of future maintenance that will be required, all of the antenna have been replaced, and four of the motors which drive the aerials in declination have also been replaced. This means that we are in a position to commence observing.

I have spent a considerable amount of effort and time renovating the electronics that is associated with the telescope. All of the old equipment that was not in use, or would not be required, has been removed from the rack and disposed of. This leaves the power supplies, an IF amplifier, and a stepper motor driver.

Originally, it would have been possible to access all the equipment from the main building, but I have a control box which allows me to set each of the antenna very accurately to the right declination from the observing hut.

My initial tests show that the system is operating well, using all 28 antenna, and this means that I will start some observing runs in the very near future. I have been informed, by a reliable source, that I should be able to pick up radio flare stars, and I am very enthusiastic about collecting observations for a joint project with the Variable Star Section. The plan is that the Variable Star Section will observe at visual wavelengths, whilst I monitor flares at radio wavelengths, and we will subsequently reduce and analyse the joint observations.

I also hope to map the sky out at radio wavelengths, which is a significant project that will take some time.

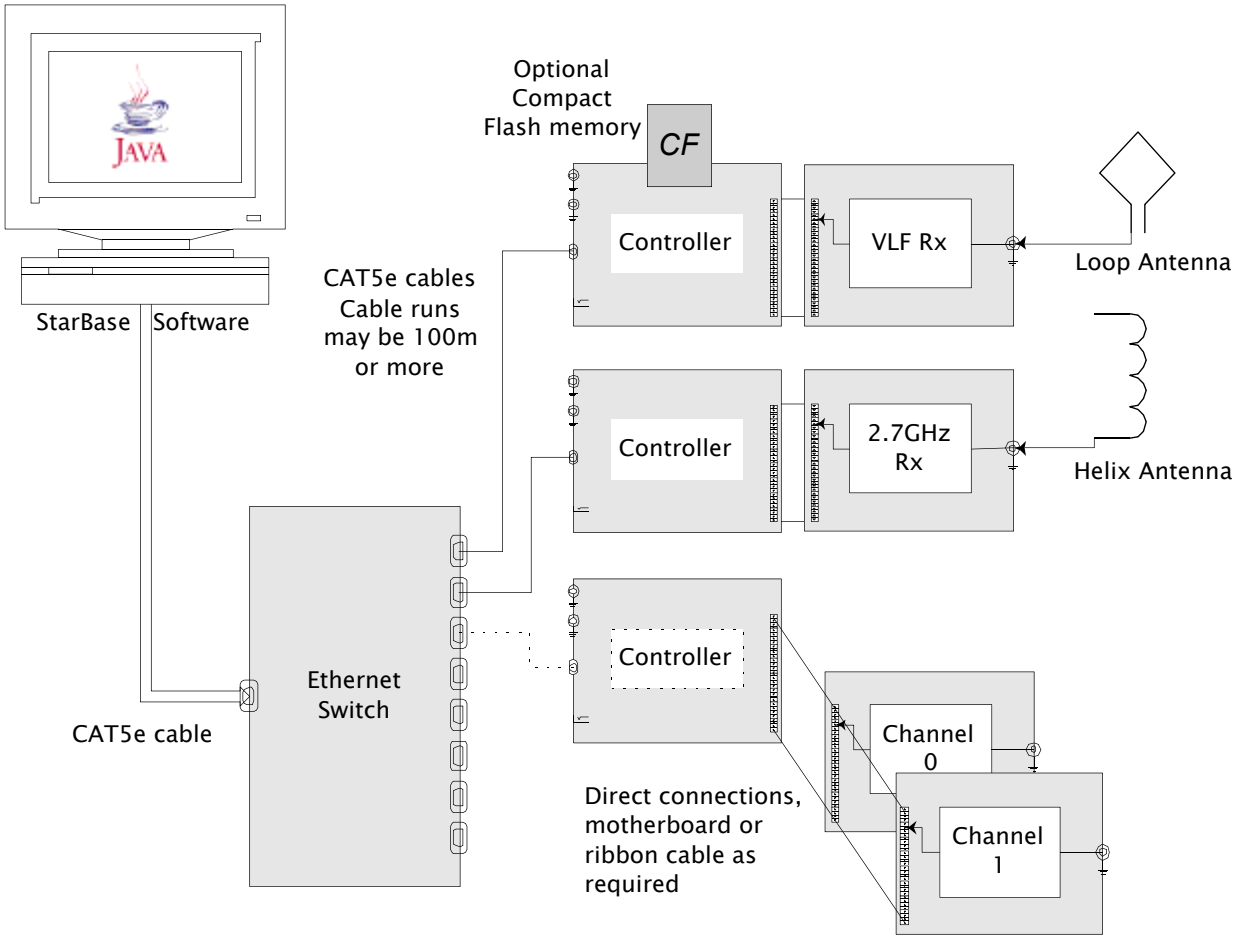
The 151Mhz Interferometer laboratory

It is hoped to be able to load the telescope output on to a publicly accessible FTP server, so that the data may be transferred to the Group database. Discussions are underway to determine the method of access to the telescope, as the University has obvious concerns regarding security. It may be that RAG will have a website that users will be able to access requested observations from, after they have been collected. It is likely that, in the initial stage, users will not be able to remotely operate the telescope.

I have been given permission to use two of the aerials exclusively for BAA projects, and applications for the use of this equipment are therefore invited. Full-power and interferometer use will be possible.

I will endeavour to keep members informed of progress of this project in future *Circulars*.

1 Jansky = 10^{-26} watts / square metre/ Hertz



The Objective

As you will have read, the main focus of the Radio Astronomy Group's activities is the *Plug and Play Observatory*. We have come across many potential amateur Radio Astronomers who have been put off by the complexity of learning the many different disciplines needed in order to design and build a radio telescope. The goal of this project is to make available a set of tried and tested modules which may be combined in several ways to form a radio telescope which is guaranteed to work 'out of the box'. Such a product would not only serve the amateur astronomy community, but would also find uses as a teaching aid in schools, since radio astronomy combines (at least) astronomy, radio, electronics, computing, mathematics, engineering and so on.

The *Plug and Play Observatory* has been designed from scratch, using the latest technologies and components where possible, which should ensure a long life as further modules are developed. We have had several iterations of the basic design ideas, and have settled on the one shown above. You may have seen earlier designs based on a USB module, but this was discarded because of the complexities of implementing USB protocols, and control from Java (the language of choice for the PC software), for the reasons outlined later.

The basic design goals were:

- A modular, extensible design
- Single or multiple module operation
- Stand alone use should be possible
- Design compliant with RoHS, WEEE, CE regulations
- Minimum configuration required by the user
- Good quality tested modules (not kits)
- Platform independent, object-oriented software
- All software is data-driven, i.e. from a database
- Integrated control, logging, analysis, comms
- Observatories should be combined into a network

The description which follows is only a brief introduction: later *Circulars* will go into more detail, and there will be a presentation at the October meeting. Be there!

Modular Design

The basic design goals of a cheap, easily produced yet flexible system dictates a very modular approach. Each module (e.g. receiver or controller) can be developed by a different team member and tested independently. We plan to make receivers for 2.695GHz and fixed frequency VLF to begin with, with discussions under way with Alan Morgan who has offered to make a Hydrogen line spectrometer. We also have a prototype scanning VLF receiver design from Peter King. Later modules will also include motor controller and shaft encoder interfaces, for steerable telescopes, and so on. Ultimately complete systems could be packaged as rack mounted units.

Each receiver and controller module will be housed in a separate screened can, allowing many combinations of telescope to be built. We intend eventually to produce a simple motherboard to provide a multi-channel receiver with only one controller, for a more cost-effective solution.

Data Logging

Many users will require only a single unit, whose primary purpose is to log the telescope output for most of the time. To satisfy this need, we intend to add a *Compact Flash* card socket to the PIC controller module. This will allow the module to run stand-alone acting just as a data logger. Compact Flash cards are now available offering up to 1Gbyte of storage, which should be enough to run the average installation unattended for a very long time! It is expected that the *CF* socket will have a dedicated PIC controller, because of the number of connections on the IDE-like interface.

Networking

One fundamental aspect of the modular approach is to ensure that the method of connecting the modules to the host is easy to use and readily available. Whilst USB would have met these criteria, and provided a true Plug and Play capability, the implementation is not so straightforward, particularly in software. After much deliberation, we decided to use the long-established Ethernet protocol. The hardware and software for this method is very easily and cheaply obtained, and although the data transfer rates are in general lower than USB2, the simpler implementation is of great benefit. Also, because we intend to develop the host software in Java (see later), this is much easier because Internet protocols are built into Java's libraries, whereas USB is not. The platform independence of Java means that any host operating system can run a *Starbase* Observatory. The only requirement on the user's PC is for a single network port; this is likely to be as readily available as USB.

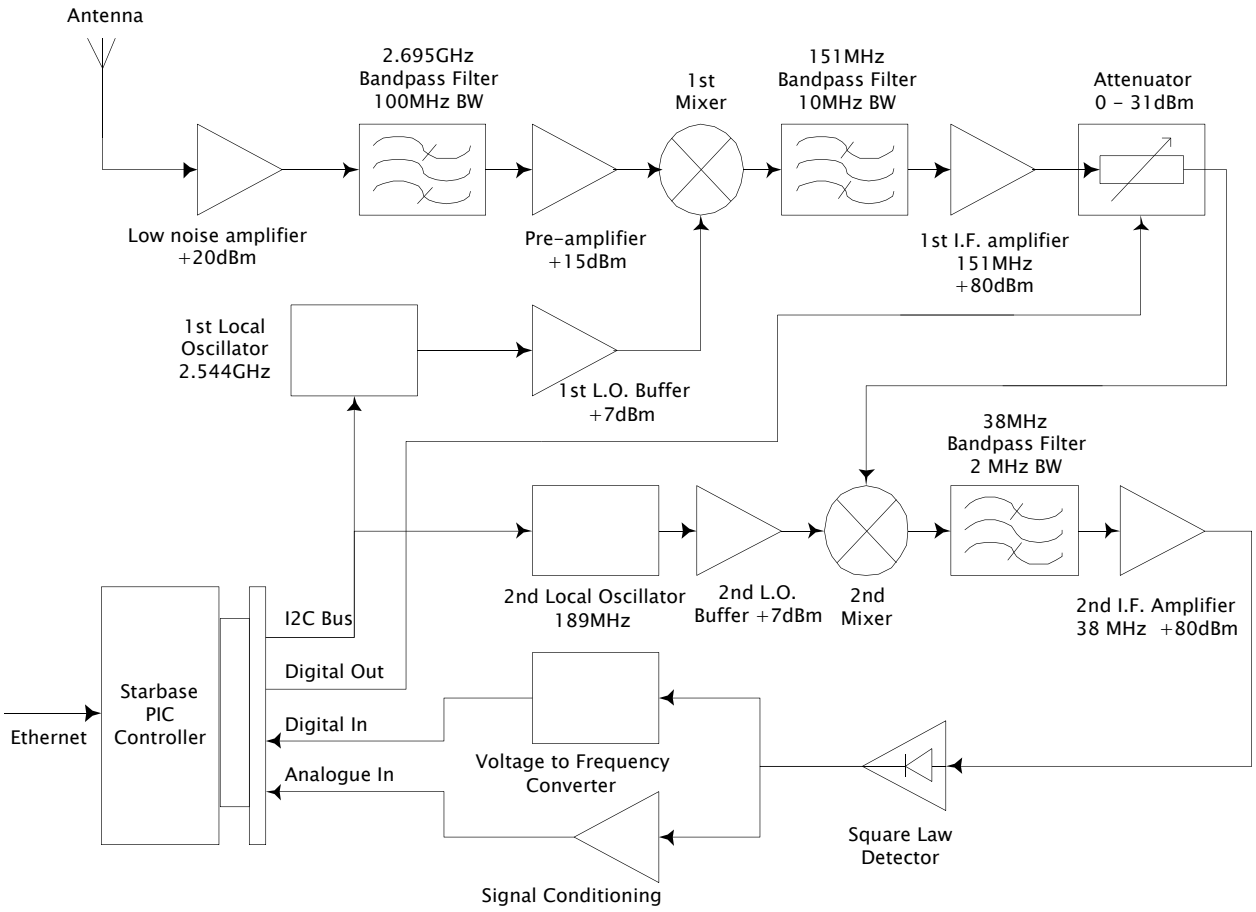
There are many advantages to using Ethernet:

- Cheap hardware (e.g. Switches and hubs, cables)
- A variety of software protocols for different tasks
- Java understands Ethernet
- Simple to connect multiple controllers
- Links may be extended with radio (!) or fibre

In the case of a single-receiver *Starbase* Observatory, clearly no switch or hub is necessary, just a simple twisted-pair CAT5 cable connection direct to the PC. This cable may be up to 100m in length, so the telescope may be situated at the end of a very long garden! (This is not possible with USB.) The software needs only to be told the IP address of the *Starbase* module, and everything else should be automatic.

Ethernet Protocols

The subject of Internet protocols is a complex one, and we are still learning the best way to tackle the problems posed by the design we have described. For those familiar with these things, we have considered using *Telnet*, to 'talk' directly to the PIC, but this is not an easy protocol to manage in the long term, since it is text-based, rather like a terminal emulator; if the software needs to change, then the text streams need to be parsed differently. This can become difficult to manage efficiently. We could run *HTTP*, effectively turning the PIC into a web server, but this is also a fairly clumsy way to do complex things. At the moment the favoured approach is to use the Simple Network Management Protocol (*SNMP*), which is used by many switches and routers. This is a *programmatic API*, i.e. there is a formal specification for the functions available, and so the software is more stable. In essence, SNMP provides means to set the values of variables in the remote device, and to interrogate their current state. These variables may be set up to control the device, or to return data to the host. A full discussion of SNMP is outside the scope of this introduction, and I expect a lively debate about the issues raised here at the October Meeting. Be there! If you have followed this so far, you might have spotted one other advantage: using Ethernet with a defined protocol like SNMP means that *any* SNMP-aware Ethernet device could be connected to *Starbase*! For example, a PC could *simulate* the PIC controller, which would not only be useful for testing, but also would allow an interface to third-party products like data loggers. Their outputs could be transformed into a form readable by *Starbase*, and therefore usable by the Repository. This could be a very powerful tool: other ideas may occur to you. Here's one to end on - if users have broadband 'always on' connections, their modules may be mapped on to the same network, making one huge telescope...

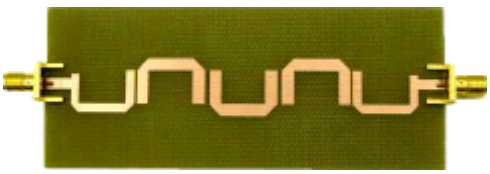


2.695GHz Receiver

Terry Ashton

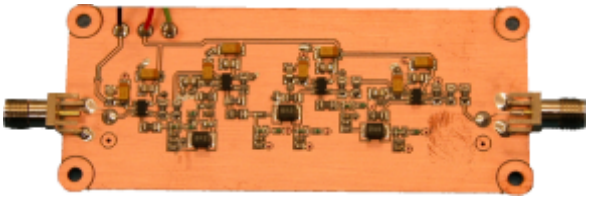
Our microwave receiver project, centred on 2.695GHz to place it in the middle of the 11cm allocated radio astronomy band, is still in its infancy and has a long way to go before completion.

As designer of this project I have been looking at the more complicated components first: for example, the bandpass filter prior to the first mixer is trying to be realised using microstrip techniques on common FR4 printed circuit material (shown below). Normally you wouldn't consider using this at such a high frequency because of the associated losses but, as amateurs, we are concerned with costs and as FR4 is very cheap we're interested in pursuing this route. It's going to take a few iterations to get the spot frequency and bandwidth correct but, of course, if the insertion loss turns out to be much greater than about 6dB we will be revising our ideas.



The 2.695Ghz bandpass filter, bandwidth approximately 100MHz

The working prototype of the 38Mhz IF strip is also shown below. The 151Mhz IF strip is a straightforward derivative of this circuit. We could therefore also provide radio telescopes working at 38Mhz and 151Mhz.



The 38Mhz IF strip (+80dBm)

I have carefully considered the choice of aerial for this receiver. Horns score points in their better immunity to interference but they can be rather unwieldy when large gains are required. Helixes have large sidelobes and so are more susceptible to interference but they are better suited to studying solar flares which, as frequency increases, become more and more circularly polarised. Hence it was decided to adopt the helix route although flares are not the only phenomena of interest.

The first question in designing a radio telescope which will be adequate for the task is, “how big does the aerial have to be?” What we’re really interested in is how *small* the aerial can be made before the received signal becomes unusable. Observations made at 2.8GHz by professional radio astronomers over the last 60 years have shown that at times of solar minimum, which occur at approximately 11 year intervals, the minimum emission is of the order of

60 solar flux units. This is the total integrated flux and so for any aerial that is polarised, such as the helix array we are intending to use, the signal will be halved. Hence 30 solar flux units is the minimum signal that should always be available and this is out target level. What does this mean? One solar flux unit or *sfu* is equal to 10,000 Janskys where one Jansky (abbreviated Jy and is the unit of celestial radio emission) is equal to $1x10^{-26}$W m^{-1} Hz^{-1}. Hence 30 sfu corresponds to

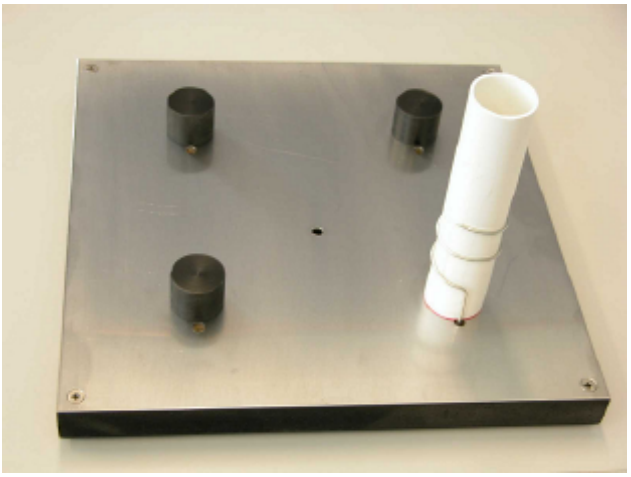
$$30 \times 10^{-22} \times 2.695 \times 10^{9} \text{ W m}^{-2} = 8.085 \times 10 \text{ W}^{-12} \text{ m}^{-1}$$

Therefore if we had an aerial with an effective aperture of one square metre, the received signal at 2.695GHz would be 8.085 picowatts. This is a very small signal at 20.1 micro-volts or -80.92dBm. It gets worse because our helix array, in its minimal configuration, has an effective aperture very much smaller than one square metre.

Each helix array module comprises four helixes working in axial-mode which occurs when the helix has more than about 5 turns. The individual helixes are made from 14 swg copper wire wound around a 36mm diameter former (36mm ABS waste pipe from your local plumbers' merchant) in such a manner that the pitch angle is approximately 12.75 degrees creating a spacing between turns of some 26.7mm. A single helix of 25 such turns will produce a gain of ~15dB and have a maximum effective aperture of 0.0312 square metres. Thus four helixes (gain of ~21dB) have a maximum effective aperture of ~0.125 square metres and our 30 sfu signal now drops to about 1 pico-watt or -90dBm, a signal of ~ 7micro-volts at the input of our receiver! Whilst this sounds rather small (and it is), it does illustrate how sensitive our receiver has to be. At times of solar maximum, the slowly varying component will be in the region of 200 - 300 sfu whilst flares, at any time, can exceed many thousands of sfu.

The reason for using four helixes is related to matching the impedance of the array to the 50-ohm input impedance of the receiver. A helix operating in axial-mode has a characteristic impedance of ~140 ohms. This can be transformed to 200 ohms by passing the helix wire through an insulator in its ground plane and folding the wire in such a way as not to be parallel to but gradually taper away from the ground plane. Four such transitions meeting at the centre and passed back through the ground plane will form a perfect 50-ohm match. Ideally, the tapered lengths want to be about one wavelength long which means that the spacing between helixes needs to be √2 wavelengths or 157.5mm.

Our helix array module thus comprises four 25-turn helixes spaced at the corners of an imaginary square of side-length 157.5mm and placed in the centre of a square metallic ground plane of side length 315mm. The radiometer will be expandable in either or both of the X and Y planes by bolting together a suitable number of array modules and connecting their outputs to the receiver via suitable power combiners to preserve signal phase and impedance matching.



The prototype helical antenna support plate. Four helices are constructed around plastic pipes as shown, and connected together behind the plate (315mm square). Each helix will be about 700mm in length.

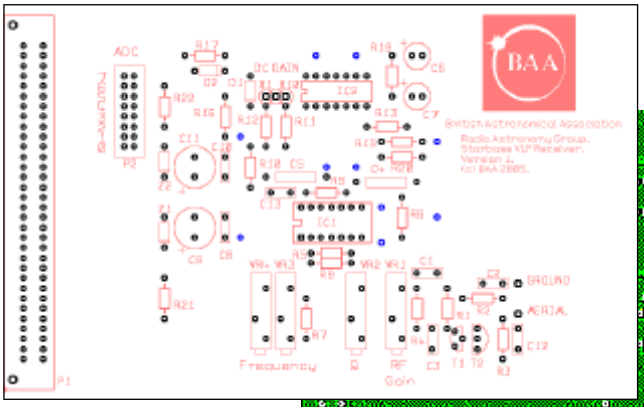
Please contact me if you would like to know more about this receiver design, or would like to be involved in the development.

Latest News!

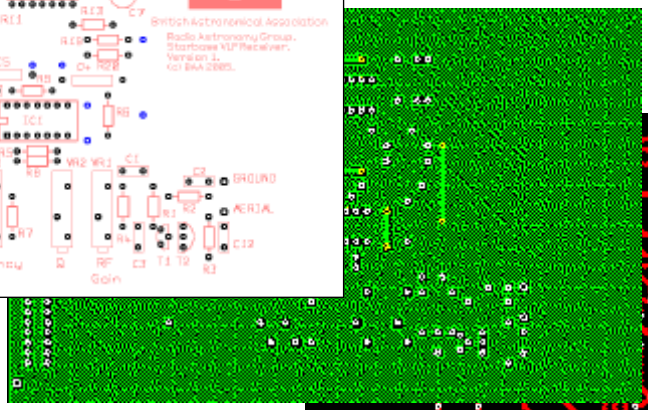
1.420Ghz Hydrogen Line Spectrometer

Alan Morgan, a recent new member of the RAG, has volunteered to design a 1.420Ghz receiver, with guidance from Terry Ashton. This receiver will be tunable over a small range, allowing us to observe the Doppler velocity distribution of the Hydrogen line emissions in the Galaxy - a radio spectrometer. See the Back to Basics section for information about the Hydrogen Line.

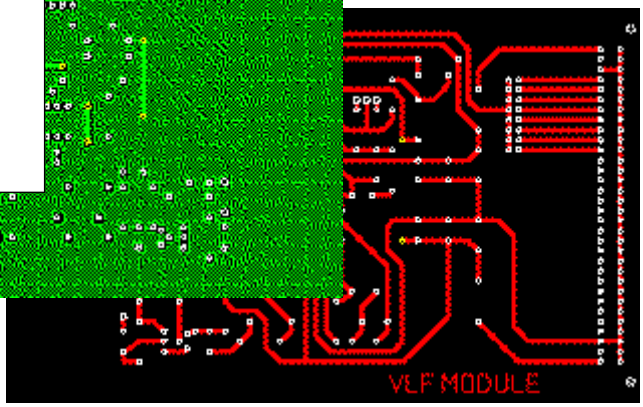
This project is very much in its early stages, but should progress well since it will use several of the building blocks from the 2.695Ghz project. The output of the spectrometer will be centred on 151.5Mhz (which is itself an allocated radio astronomy band), and so feed directly into the backend of the 2.695Ghz system. More news of this project in the next *Circular*.



The silkscreen



The groundplane



The component wiring

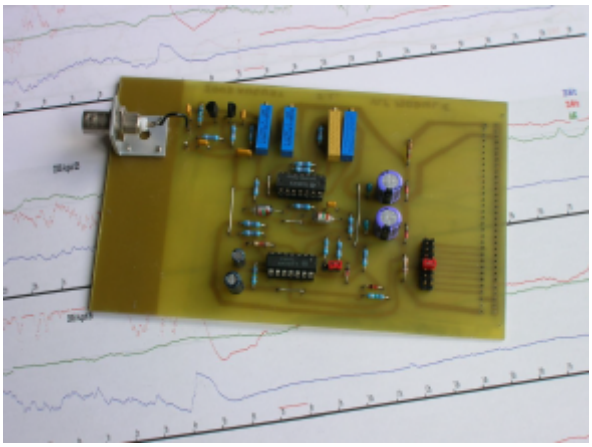
VLF Receiver

John Cook

The first receiver module for the Very Low Frequency (VLF) project is a slight modification to my existing design, mentioned previously. The changes to the original receiver include a link field to select the analogue to digital channel currently in use, and the addition of a I²C serial EEPROM. The circuit has also been changed to use the 15V supply rails of the *Starbase* specification.

The EEPROM requires a little explanation: it is programmed with the receiver's identification and calibration information, so that when the VLF Module is connected to a Controller Module, the PIC software can be automatically set up to drive the receiver correctly. Similarly, when the Controller is connected to *Starbase*, the host will know that a VLF Receiver is present in the Observatory's list of Instruments. This 'dynamic configuration' approach will be followed by all *Starbase* plugins.

I have produced a prototype PCB layout for this circuit, which is shown above. As you can see, we have standardised on a single Eurocard format (160mm by 100mm), and a DIN41612 64-way edge connector, which is specified in detail later in this section. This format gives a lot of flexibility for the use of screening cans or for rack-mounting in motherboard systems with multiple receivers. Prototyping boards are also easily obtainable. We intend to maintain a stock of screening cans pre-cut for the 64 way connector, which can be simply modified for custom designs (e.g. see www.perancea.com).



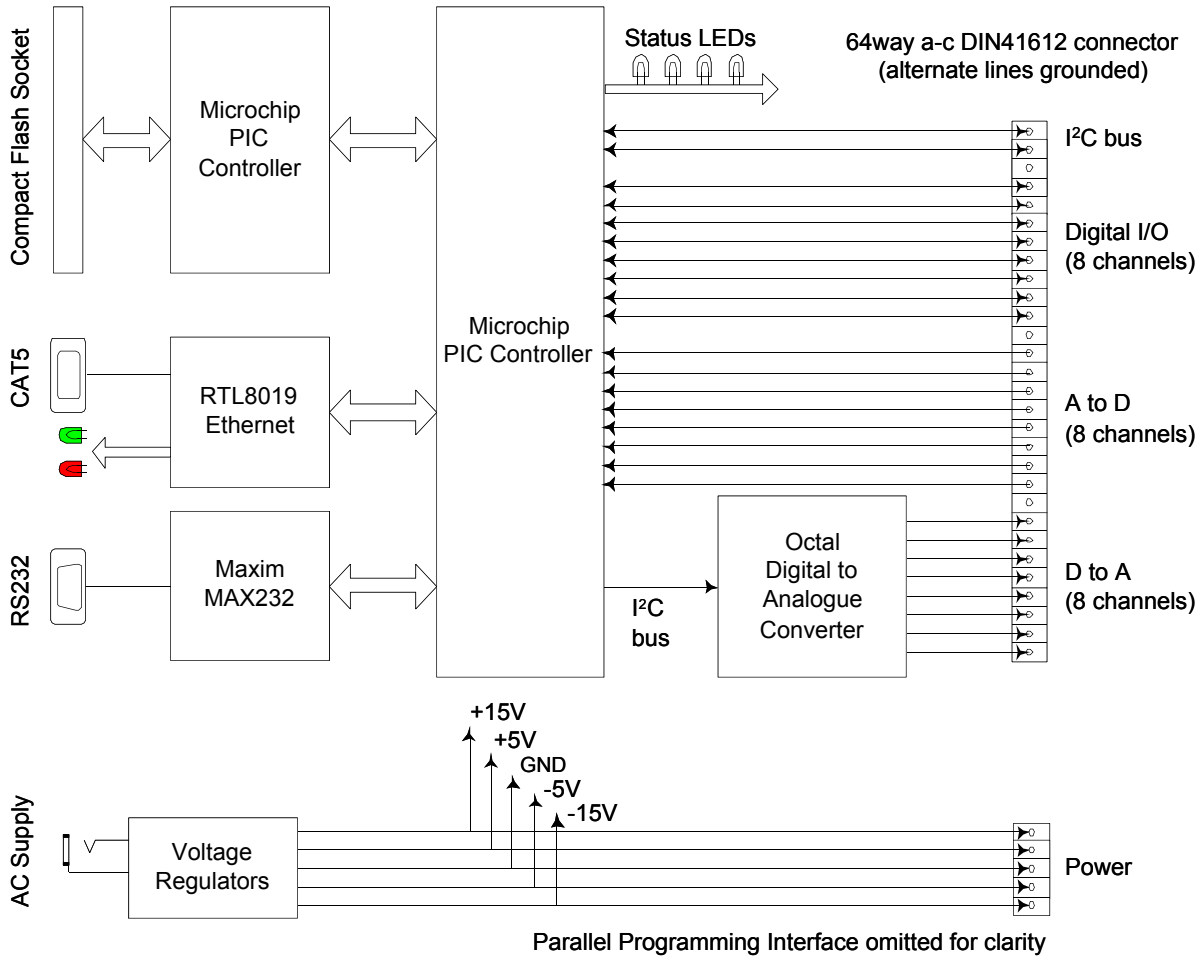
The prototype *Starbase* VLF Receiver
(ground plane omitted)

This version of the receiver operates at a fixed frequency, which can be varied by means of multi-turn potentiometers. There are also manual controls for the circuit 'Q' and for RF gain. The receiver module will however be supplied as a ready built and tested unit, with full documentation.

We are evaluating a design by Peter King which uses varicaps for tuning, and so could form the basis for a PC-controlled scanning receiver. This will be pursued further once we have some experience using the fixed-frequency unit in a full *Starbase* system.

I have also designed a dual-axis Magnetometer circuit, which has been used successfully for many years. I am currently modifying this design for use as a *Starbase* module; it will eventually be available in the same format as the VLF Module.

Controller Module

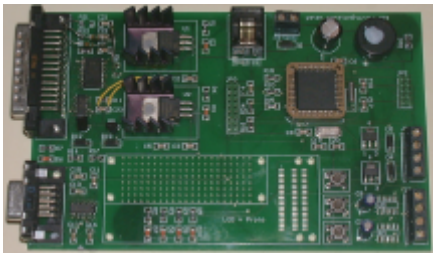


The Controller Module is the heart of the Plug and Play functionality of *Starbase*. The concept is straightforward – a controller module to interface a range of receivers to the PC, in such a way that the end user need not delve into configuration or programming of the host system. The implementation to achieve this is unfortunately rather more complex! As mentioned earlier, the intention is to use Ethernet as the main connection protocol. The controller will also have an RS232 port, to allow a simple command-line monitor program to control the device. This will be useful for stand-alone systems, and for production testing, and adds very little to the costs.

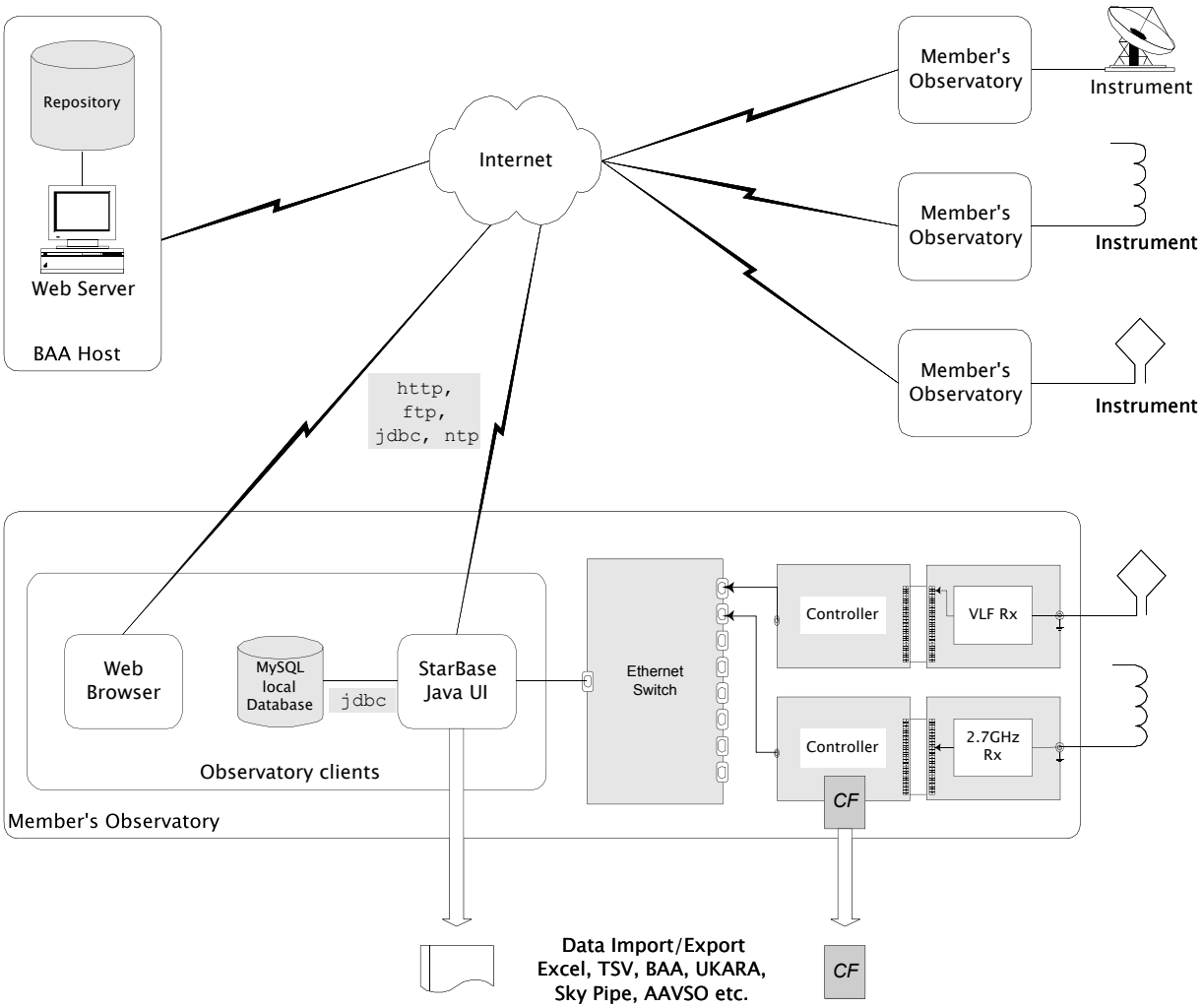
The Ethernet interface is achieved largely with one chip, the RTL8019. The RJ45 socket has built-in magnetic components to reduce RFI effects over the link, and has LEDs to indicate that a connection exists, and has traffic. One PIC microcontroller provides 8 channels of analogue to digital conversion, 8 channels of digital to analogue, and 8 channels of TTL level digital I/O. In addition, there is an I²C bus connection to the slave devices for extra control and automatic identification of which module is currently plugged in. The *Starbase* software will interrogate each Controller Module, and determine how to configure itself to control the current plugin. The user simply has to plug the unit into an Ethernet port.

We also hope to be able to offer a *Compact Flash* memory card socket, probably driven by another PIC microcontroller (because of pin count limitations). This will allow the Controller Module to run unattended for long periods as a data logger. The data may then be uploaded via the Ethernet link, or by removing the card and reading it directly on the PC.

Peter Moreton has kindly supplied us with a PIC prototype card (shown below), which has been a very useful in learning about the PIC and interfacing. Prototype software (written in C) running on this card was connected to the demonstration of *Starbase* presented at the Exhibition Meeting, using an RS232 port accessed by a simple terminal emulator written in Java. The emulator allows the capture of a terminal session as a text file or Excel spreadsheet, thus providing a crude data logging function.



The Grand Design



The diagram above shows the ultimate goal of the *Starbase* project: each member's Observatory is connected to the Internet (broadband or dialup), and can access a central BAA RAG Repository of observational data via a secure link. As described previously, each Observatory comprises at least one *Starbase* data collection module (usually a receiver) with an associated controller. The controller is connected to the local network on the user's PC via Ethernet, either directly or via a switch if multiple controllers are used.

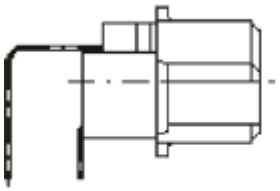
The detailed configuration of each observatory is registered in the Repository, and includes information about the Observatory itself (such as the location, height above sea level), the Observer making the observations (e.g. Name and email), the instruments used to make the observations (e.g. the types of receiver), and of course the data recorded. See the Client Application Form for an example. The database design (the schema) is almost complete, and will be described in a later *Circular*. The design has deliberately been made very general, with no assumptions about the type of data, the format or units of measurement.

We expect that the networked system would be used in the following way:

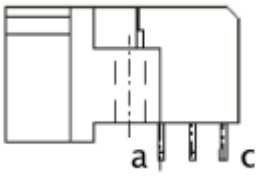
- An Observer makes a series of Observations
- These data are stored in the *Observatory's* database
- The Observer submits chosen data to the *Repository*
- An administrator approves the data for archiving
- The Observations become available to all users

Although the introduction of a rather formal Repository database does make the design more complex, it does offer many advantages for data management and analysis. The database holds these data in a published, open format, making it easy to retrieve observations made by any member. In principle we could have a website which allows data retrieval in the same manner as used by the Variable Star Section, or we can make use of the *Starbase* Java software to explore the data interactively. In this case, the user can download selected records to the Observatory's *local* database, to avoid having to go online every time the data are required for analysis. The user then builds up a local library of relevant observations.

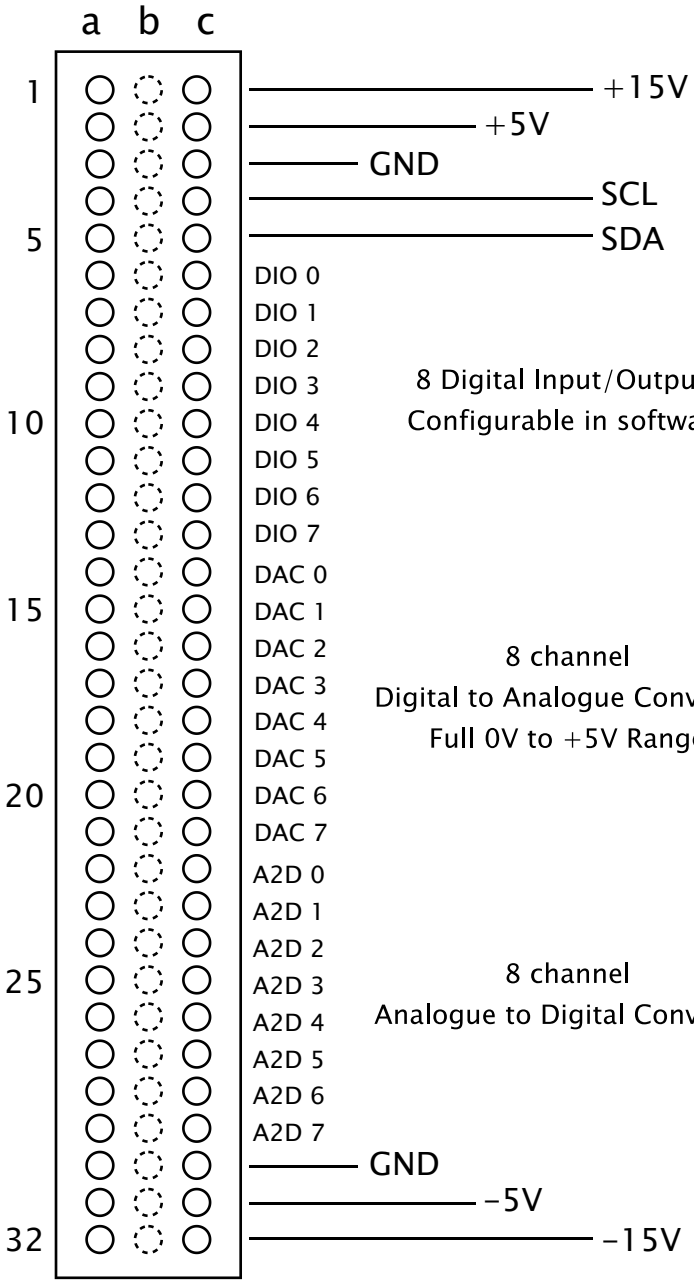
Connection side of Male DIN 41612
64 pin (a-c) connector for plugin module
(e.g. Receiver).
Row b not populated.



PIC Controller
Female



Plug in module
Male



8 Digital Input/Outputs
Configurable in software

8 channel
Digital to Analogue Converter
Full 0V to +5V Range

8 channel
Analogue to Digital Converter

DIN41612 Connector

Plugin Module Connector Specification

The diagram above shows the standardised pin connections for a *Starbase* plugin module, whether it be a receiver, control device, or custom circuitry. The current capacities of the power rails have not yet been decided.

The 'a' row is all connected to Ground. This provides an 'interdigital' ground when (e.g.) using a ribbon cable or motherboard to connect the plugin module; this helps reduce crosstalk and noise on low level analogue signals. The 'a' row is closest to the board edge, and therefore easily grounded. The I²C bus is next to the digital I/O section, again to reduce high frequency noise on the analogue sections. The analogue outputs are produced by an Octal DAC (driven from the I²C bus). The analogue inputs pass directly to the PIC A2D inputs. The power connections are at the extremities of the connector, simplifying power distribution and providing a level of safety. Pins 3 (a+c) and 30 (a+c) are guard grounds, to fully isolate the power from the signals.

Starbase Software

Laurence Newell

The *Starbase* software originated from a private development, which I initially intended as a simple telescope controller, but then it became a commercial application for managing endurance horse races! The basic design has therefore been fairly thoroughly field-tested. Its 'unique selling point' is that the design is *totally* data-driven, that is, *all* configuration data are held in a local MySQL database. This means that it is relatively straightforward to reconfigure the application's purpose by changing parameters in the database. This is a very powerful approach – imagine being able to change every function in an application such as Word, even down to the text displayed on the menus, and the function of those menus, the SQL queries used to retrieve the data for each operation, the error messages, the colours of everything, and so on. This reconfiguration may be performed by technically aware end users, or limited to the deployment process, so that the end product can be as flexible or as simple as required. Other developers have used XML as the storage medium for configuration parameters, but I personally find this rather clumsy when used on a large scale, so a database it is...

The software is written in Java, which is probably the most widely used object-oriented language available today. The choice of Java has many advantages for a large-scale distributed (networked) application such as *Starbase*, not least of which is that support for Internet protocols and database access is built in. It also has the advantage of being 'platform independent', which means in principle that the same software will run on Windows™, Linux™ or Apple Mac™ (each with an appropriate database). This should ease support issues, and allow use by a wider range of users. There is also a good web-based delivery mechanism called WebStart, which we may be able to use.

The bulk of the development so far has been in the underlying framework, but the *Starbase* structure itself is now beginning to evolve. For the time being, I have settled on four main sub-applications:

Observatory – configuration and use of *Instruments*
Repository – local database of *Observations*
Analysis Studio – data processing and presentation
Workshop – useful tools, experiments

The Observatory is the principal user interface, for the configuration and control of one or more Controller Modules and associated Receivers (in combination, called an *Instrument*). The Observatory automatically enumerates all Instruments connected to the Ethernet port.

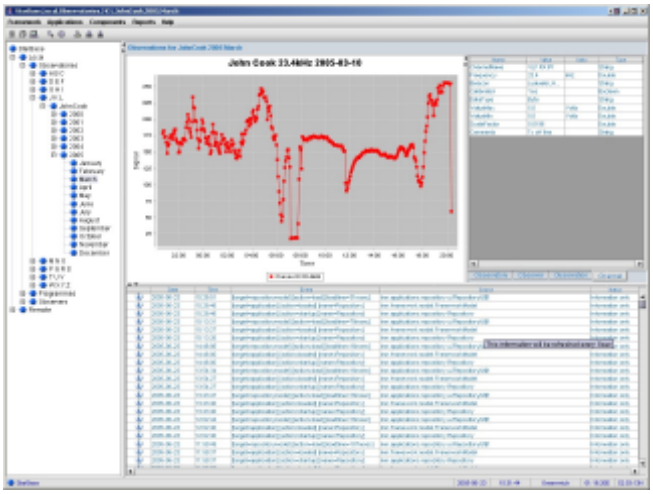
The local version of the Repository exists in a skeletal form, and the local database now holds some of John Cook's VLF observations as test data. The retrieval and display of these observations was demonstrated at the Exhibition Meeting (see the screenshot below). This version just allows access to the *local* database, not the remote host. The user interacts with the Repository Explorer as below:
In the left pane:

- Select the Observing Programme (2.695GHZ, VLF etc.)
- Select the Date range required
- Select the Observatory
- Select the Observer

The bottom pane now shows a list of Observations. In the bottom pane:

- Select the Observation from the date-ordered list

The left hand part of the top pane now shows a graph of the selected Observation. The top right area is a selection of tabbed 'Properties' lists. Here the Observatory, Observer, Observation and Channel 'metadata' may be examined in detail. All graphs may be printed, and properties may be exported as tab-separated text or as an Excel spreadsheet, or printed. This functionality is almost complete.



The prototype *Starbase* Local Repository

The Analysis Studio will contain data processing and presentation tools, to allow each user to analyse any observer's data. The Workshop is a collection of tools, and software experiments, documentation etc.

We have carried out some (successful) experiments with James Wilhelm's server to gain experience of using a remote MySQL database over a secure connection (SSH Tunnel). The *Starbase* software development is a *large* project – there is much more than the Repository! More details will follow, and at the October Meeting.

The RAG Website

The redevelopment of the RAG website has been taking much longer than anticipated. We would very much like a volunteer to become the RAG webmaster. Experience of HTML and graphic design is essential, with preferably MySQL and PHP.

We have already received contributions from Peter King, Colin Clements and John Cook. If you have any projects details or photographs you would like to share, please send them to Laurence Newell. We will endeavour to include everything in good time.

The website currently shows only the details of the forthcoming October meeting.

www.britastro.org/radio

Observatory News

NRAO Greenbank

Tom Crowley

Tom Crowley (SARA) has kindly sent us this report of his visit to the National Radio Astronomy Observatory in West Virginia, USA, during radio observations of comet Tempel 1.

wwwlocal.gb.nrao.edu/GBT

Image courtesy of NRAO/AUI

I've been at the Green Bank Telescope (GBT) looking over the shoulder of Dr Amy Lovell who is observing the comet Tempel 1 via L band spectroscopy at 1665 and 1667 MHz. Dr Lovell had invited me to come join her in the observations of this event 2 months ago while I was participating in a Super Nova search presentation at Agnes Scott College where Dr Lovell is a professor of physics and astronomy. Amy had forty+ hours of observing time on the GBT for the comet impact one-night prior and 6 nights immediately following the impact. The total time was 20:15 to 04:15 UT for 7 nights. There is an additional observing night on 24 July to see if the OH production has changed.

Monday night was a benchmark of pre-impact Hydroxyl (OH) production with OH production being in the noise and perhaps difficult to detect if at all. With 8 hours of integration on Tuesday night we were just able to detect OH. This was just slightly above the amount of OH production seen during the pre-impact Monday night run. The signal strength was approximately 1.5 mJy. We are working at the limits of the GBT. Wednesday night showed a slight improvement with the OH signal rising to 2 mJy after just 3 hours of integration. This rise fell away as observing continuing during the remainder of the evening. We speculated that the dust began to clear away from the blast site; sunlight may have been able to aid in the increased release of water vapour from the blast site. Thursday night was filled with GBT troubles and for all practical purposes the gathering of data was lost. Pointing accuracy was lost due to the loss of output from a weather station used to aid in pointing. We also lost an optical receiver in the control room. We were able to develop a work-around by substituting another. RFI also increased to a level to mask any signal that might have been detected. By Thursday night the GBT issues had been resolved and we began collecting data again. Early in the evening RFI was again an issue. Fortunately it cleared by 21:00 UT. There was a slight outburst from the comet raising the OH signal to 6 mJy for a few hours. The rise in OH needs to be correlated against other observations in order to determine if there is any significance to the increase seen in the observation.

Friday through Monday night's data again was just above the noise floor with no real rise shown. Integration times of less than 3 hours failed to detect the OH radical. Integration times of 8 hours were required. This is an early report and the data will continue to be massaged, hence it may be expected the initial report above will be modified.

It looked like the initial blast did not produce the volume of water expected. It was calculated that the Deep Impact would produce a 2-magnitude increase in the production of water from the comet. Pre-impact production is at the rate 5-6 $x10^{27}$ molecules per sec. It was expected that the water production would rise to N x 10^{30} molecules per sec. The increase was calculated to show Hydroxyl production of 30 to 100 mJy well within the reach of the GBT. To put this in perspective a cubic meter of water is 10^{28} of molecules. The production of water after impact was approximately a bathtub per second. It is truly amazing that any Earth based radio telescope can detect the OH output from such a minute source.

The lack of detection of large quantities of water being blown off the comet is indeed interesting. The Deep Impact appears to have been a glancing blow not creating the depth of impact expected. With that and the comet being at perihelion with lowest production of OH observable from Earth difficulty in detection was almost expected. During the week of observation as the comet

moved beyond perihelion a slight rise in OH output could be expected. The early results did not show the expected results.

The images of the comet just before impact show it to look more like an asteroid than what you would expect a dirty snowball comet to look like. The fact that this particular comet is a short period comet and has had many trips around the Sun may mean that it has blown most of its water off in the past. Perhaps some of the NEO asteroids may have been short period comets in the past, but I'm speculating. All in all looks like comet knowledge will be rewritten with the results of this experiment.

Comet 9P/Tempel 1 was discovered on April 3, 1867 by Ernst Wilhelm Leberecht Tempel of Marseille, France while visually searching for comets.

Colin Clements

My own expertise lies in L Band and C Band work where I conduct observations at the 21cm Hydrogen line, and continuum observations at 7.5cm (4 GHz). I have been an amateur Radio Astronomer for 33 years, starting initially at 11 metres in the early 1970s' and working up through 435 MHz, then 610 MHz, then finally 1.42 GHz and 4 Ghz. I 'dipped my toes' into Hydroxyl line (OH) observations at 1667 MHz a few years back, but can claim no verifiable success so I abandoned further work there. The electronics are still in-situ so I could restart again if or when I obtain increased aperture (I believe 5 metres is the minimum for reliable detection, as Hydroxyl emission is diffuse compared to Hydrogen. I have recently started indirect solar flare monitoring at VLF, but am a complete novice here .

Since the Autumn of 2004 the type of observations I have been carrying out at 1.42 Ghz have expanded, to the point where my L Band installation was hard pressed to meet all the demands I was placing on it. Consequently I took the decision to install another L Band antenna to take some of the workload off my existing 3 metre dish, but due to 'real estate' constraints another dish was out of the question. I therefore decided to construct a pyramidal horn and eventually found a proven design that had been built by students at the University of Berkeley in the USA. Full details can be found on their website:

www.ugastro.berkeley.edu/radiolab

The entire unit (including the mounting) was built for under £100, making it a very cost-effective solution; the accompanying photograph shows the horn on its alt-azimuth mount. It only lacks a declination scale for directional purposes. This will be fitted in September when initial tests are expected to begin, and it is hoped that preliminary performance data will be available for the October meeting. The horn has a gain of around 21dB and a beamwidth of approximately 15 degrees. A new German converter I have recently purchased will allow me access to the full 1.4 GHz allocation, permitting continuum as well as monochromatic observations to be carried out.

Colin Clements' Pyramidal Horn

John McKay

John is constructing a radio telescope with a 4m dish, for Hydrogen Line observations using a Spectra Cyber spectrometer receiver (from Radio Astronomy Supplies). His website shows some very clear initial 21cm scans:

www.3peaks.org.uk/index.htm

Jovian Anniversary

This year marks the 50th anniversary of the first detection, by Bernard Burke and Kenneth Franklin, of radio emission from the planet Jupiter. Detection occurred in 1955 January at a frequency of 22.2 Mhz. For an interesting history of the discovery, see:

radiojove.gsfc.nasa.gov/library/sci_briefs/discovery.html

Thanks to Colin Clements for bringing this to our attention.

Burke, B. F. and K. L. Franklin, Observations of a variable radio source associated with the planet Jupiter, Journal of Geophysical Research, vol. 60, pp 213-217, 1955.

Laurence Newell

The lower shelf contains the drive electronics, the middle shelf is the azimuth ring gear and motor, and the upper plate holds the elevation assembly.

I am constructing an altaz mounted, fully-steerable 3m radio telescope, intended originally for 4Ghz operation, using a C Band LNB. It is likely that the telescope will also use the *Starbase* 2.695Ghz receiver when it becomes available. This project has been in progress on and off for about fifteen years. The goal is to install a CCD camera and telescope coaxially in the focus box, to view the Sun in H-alpha simultaneously with receiving the radio signals. This requirement places a high demand on the accuracy of the drive mechanism (and may not be reliably achievable).

The drive system uses two high torque (approx 10kg cm) stepping motors and toothed belt gearing. Each axis can be monitored with a 12-bit absolute shaft encoder, giving approximately 5 minutes of arc resolution (mechanical errors are expected to be higher). Each axis has disc brake to fully lock the dish in position between moves. The yellow tubes contain 2mm sheets of lead, giving finely controllable counterweights, to cater for different receiver assemblies. The mounting has been designed to take a larger dish, up to 5m, just in case... The computer control system is effectively the prototype for *Starbase,* so there will be an Ethernet node up there in the drive housing!

The basic framework uses 50mm aluminium scaffold tubing and Kee Klamps www.keeklamp.com. The centre of the dish is currently about 4m above ground level. The telescope deck is mounted on a 'sledge' which plugs into a trailer, to allow mobile operation.

The John Smith 408Mhz All Sky Survey

James Wilhelm

The John Smith 10m Radio Telescope

The goal of the 408MHz All Sky Survey is to produce a map of the Milky Way Galaxy as seen at 408MHz from Southern England. The Survey makes use of the 10m telescope originally constructed by the late John Smith, a former Director of the BAA Radio Section. The observatory is situated in the countryside south of Cranleigh, in Surrey.

While the telescope itself has been in use since the sixties, the current survey has been running since 2001. It is a long term program, requiring all declinations to be scanned several times to improve the data and to get rid of interference.

Due to the size of the dish, the sun is a large source of interference, even when in the sidelobes! For this reason, some declinations only produce useful information at night. This all takes time and patience.

The data is sampled and stored on a PC. Once every week or two, the data are copied to floppies and made available to members of the survey. Members in Canada and America then process the data.

Currently, a map exists and a paper has been written. There is still more work to be done on the data and map. Some elevations also need to be scanned again. The paper is currently being reviewed by team members.

For more information, please visit:

www.408mhzsurvey.org.uk

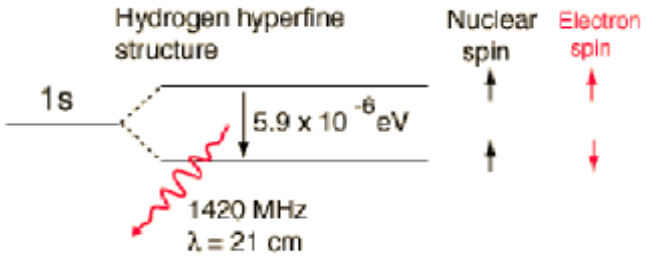
Do you run a radio telescope observatory? If so, please let other members know about your work. Send in information and photos to Karen Holland.

The Hydrogen 21-cm Line

Laurence Newell

Space between the stars contains many clouds of cold gas (approximately 10K to 100K), where hydrogen can exist as both atoms and molecules. This hydrogen cannot be observed visually, but in 1945 Van de Hulst predicted that it should be possible to detect radio emissions from *atomic* hydrogen at 21cm (1420MHz). Understanding his prediction requires a little quantum physics!

The cold hydrogen in these gas clouds will have very little energy – there is nothing around to provide heat – so the atoms will be in their lowest *energy state* (known as 1s). The ground state of atomic hydrogen (measured as 13.6 electron Volts eV, simply a measurement of energy) has, in a quantum mechanical description, two very closely spaced sub-levels, known as *hyperfine structure*. This splitting of the energy level comes about because of the quantum-mechanical parameter known as *spin*. The two components of the hydrogen atom, an electron and a proton, each have spin. Spin can have two states, which for convenience we can call *up* and *down* (spin is to do with quantum mechanical angular momentum, and does not have a classical analogy). So for the overall system, we can have the electron and the proton spins parallel or anti-parallel. It turns out that the anti-parallel state has the lowest energy, by the tiny amount of 5.9 x 10^{-6} eV, compared with the ground state energy of 13.6eV. This difference is, however, enough to be observed over galactic distances.



Natural physical systems are always trying to return to a lower energy state, if possible. A hydrogen atom in the parallel state will spontaneously *flip* back to the anti-parallel state, releasing a photon of wavelength 21cm. Detection of this photon (as an emission line) therefore implies that the atom was excited to the higher level by the absorption of a 21cm photon some time previously. Precise measurement of the frequency of the photon will reveal Doppler shift, so mapping the velocity distribution of the hydrogen in the clouds. 21cm radiation will penetrate dust clouds, and so provides a view of the Galaxy unobtainable in other ways.

The *spin-flip transition* is not observed in hydrogen on Earth, because the transition is 'highly forbidden' according to quantum mechanics, the rules of which describe both *allowed* and *forbidden* transitions. The allowed transitions are simply much more probable than the forbidden. The expectation is that the allowed transitions will occur more frequently than the mathematically unlikely forbidden transitions, because the atoms will be de-excited by collisions with other atoms long before the low probability events have a chance of happening. In interstellar space, however, there are few collisions, and so the probabilities of the forbidden transitions will be higher. The emission of the 21cm photons from billions of these very rare events accumulates over many hundreds of light years, resulting in a detectable signal here on Earth.

Ewen and Purcell, and very soon after, Muller and Oort verified Van de Hulst's prediction in 1951. Many subsequent surveys have provided detailed maps of the hydrogen distribution in interstellar space. We hope to provide a hydrogen line receiver as part of the *Starbase* range of receiver modules.

This horn antenna was used by Harold Ewen and Edward Purcell, at the Lyman Laboratory of Harvard University, in the first detection of the 21cm emission from neutral hydrogen in the Milky Way. The emission was first detected on March 25, 1951.

Solar Radio Emission Facts

Terry Ashton

I have been sending *Solar Radio Emission Facts* (SREFs) to the Group team on each working day, to prepare us for the availability of the 2.695Ghz receiver. The SREFs to date are given below. If you would like to receive these emails, please let me know on tjr@star.le.ac.uk.

#1 The first observation of the slowly-varying or S-Component of solar radio emission was made on 23rd November 1946. Arthur Covington observing the Sun at a frequency of 2,800MHz, i.e. a wavelength of ~10.7cm, from Ottawa, Canada, during a partial solar eclipse noted a major reduction in signal strength as the moon occulted a large sunspot.

#2 The flux spectrum of the S-Component shows a peak in the region of 3 - 6GHz (i.e. a corresponding wavelength range of 10 - 5 cm). The peak moves down in frequency towards 3GHz as the 11-year solar cycle approaches maximum.

#3 The S-Component associated with sunspots in the north-east and south-west quadrants of the photosphere is, most usually, left-hand circularly polarised.

#4 Although the cyclic variation of solar radio emission at microwave frequencies is mainly a consequence of the S-Component, an additional contribution is associated with those parts of the solar atmosphere that are not influenced by active regions. This additional emission is known as the basic or B-Component.

#5 Although the observed signal strength at frequencies around 3GHz is higher than that of 10GHz, the degree of polarisation for the S-Component is lower at 3GHz (<10%) than at 10GHz (~30%).

#6 The study of brightness distributions of the polarised and non-polarised components of the S-Component reveal that the polarised emission emanates in regions less than 1.5 arc-minutes in extent whereas larger diffuse regions contribute virtually nothing to the polarised emission.

#7 All types of solar radio bursts are directly linked with the phenomenon of solar flares as seen at optical wavelengths. Solar microwave bursts present themselves as short-period enhancements of the signal level when the whole of the Sun is monitored by a single frequency radiometer.

#8 Time profiles of the received signal strength from microwave bursts, i.e. the burst morphology, exhibit a rather smooth variation as compared to lower frequencies where the burst structure is more detailed. The same is true for microwave burst spectra.

#9 Examination of the morphology relating to microwave bursts over at least one solar cycle has led to many classification schemes but the most general one identifies three fundamental burst types:

- Gradual bursts
- Impulsive bursts
- Complex (and type IV) bursts

#10 Gradual bursts are characterised, as the name suggests, by a gradual increase to maximum intensity followed by a longer decrease in signal strength to the pre-burst level. Their duration is typically of the order of 10 minutes but, occasionally, may last several hours. In most cases the bursts are partially polarised but always circularly so (as opposed to elliptically, linearly or randomly polarised). Gradual bursts are illustrative of quasi-thermal processes of energy dissipation occurring in their source regions.

#11 Impulsive bursts usually develop as being superimposed on an existing gradual burst and thus indicate the beginning of a fast, non-thermal energy conversion process. The so-called "microwave spike burst" is a very high peak signal of short duration (< 1 minute) and is an extreme example of impulsive bursts.

#12 An impulsive burst most usually coincides with the "flash" phase of a H-alpha flare, a hard x-ray burst and a type III burst at metre wavelengths (more on this later).

#13 High-resolution (i.e. < 1 sec) observations of impulsive bursts reveal a highly structured form of the time versus intensity profile.

#14 Complex bursts may sometimes be "complex" in their nature but are generally nothing more than a rapid series of impulsive bursts.

#15 The type IV burst has been defined as "a long-period, continuous burst of radio emission accompanied by a major flare" but without any regard to the frequency range of its occurrence. At microwave frequencies, the type IV bursts (designated type IVμ) are generally complex in morphology and so a distinction between type IVμ and complex bursts is difficult to realise.

#16 The type IV burst corresponds with a stage in flare development that is only attained for the largest events and is associated with the ejection of particles during the "explosive" phase of the so-called proton flare.

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This section is for advertisements from commercial vendors or from RAG members. Currently there is no charge for this service. Please send your advertisement to Laurence Newell or Karen Holland. Please make sure that any images are supplied with at least 100dpi resolution, preferably not compressed (by JPEG etc.).

The UK Microwave Group

The Group was formed in the Autumn of 1999 to promote amateur microwave radio in the UK and establish strong links with microwavers and amateur microwave groups around the world. In early 2004 it became the representative voice of the UK amateur radio microwave enthusiast after the Radio Society of Great Britain Microwave Committee was disbanded. As a result, the UKuW Group took over the former RSGB Microwave Newsletter and now publishes it as Scatterpoint, which originally was the Group's own quarterly newsletter up to 2003.

The Group is affiliated to the RSGB and, through the Group Committee, works with the RSGB Spectrum Forum in matters of interest to the amateur microwaver. The Group is represented on the Forum by the RSGB Microwave Manager, Mike Dixon, G3PFR.

Membership of the UK Microwave Group is open to all interested in amateur microwaves whether they are resident in the UK or not. Membership benefits include the Group's 16 page newsletter, Scatterpoint, which is published ten times a year, discount on Group products, representation via the Group committee on the RSGB Spectrum Forum, full voting rights at Group meetings, UKμWG-organised microwave events in the UK such as contests and microwave "roundtable meetings", operating awards and trophies. Over the coming months, the Group plans to introduce a CD for newcomers to microwaves as part of an ongoing programme of providing practical information for amateur microwavers.

The annual subscription is only £6 a year which includes an emailed, PDF version of Scatterpoint. Those who prefer a paper edition can do so on payment of a surcharge. This varies according to which part of the world you live in. Full details can be found on the Group's webpages (see below), Scatterpoint, which is sent to some 20 countries around the world, contains technical articles and up-to-date news from the amateur microwave radio world.

The Group's Annual General Meeting is held at BT Adastral Park, Martlesham, Suffolk, each November as part of the Martlesham Microwave Round Table weekend.

Membership enquiries and applications should be sent to the Group Secretary, whose address can be found below. A membership form is available at the Group's website:
www.microwavers.org/ukugmemb.htm

RAG Greetings Card

Still available!

Copies of the RAG Greetings Card (with envelope) may be purchased for 50p each, from Laurence Newell.

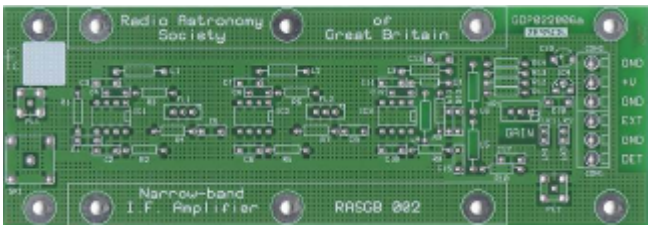
Please note that these cards are blank inside, and are not specifically for Christmas!

radiogroup@btinternet.com

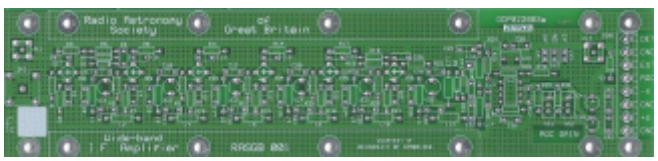
IF Amplifier Circuit Boards

As you may already know, we hold a stock of circuit boards which were produced by the well-intentioned but short-lived Radio Astronomy Society of Great Britain (RASGB). These boards are available on request to any RAG member. There is one wideband 45Mhz IF amplifier, and one narrower band 10.7Mhz IF amplifier. There is minimal documentation, but enough to get you going. Also, note that some components may be hard to obtain – minor design changes may be necessary. These are high quality boards which would give a good start to a receiver back-end. The 45Mhz design originated at MRAO, and is supplied courtesy of the University of Cambridge. Further details on request.

These photographs are not to the same scale.



10.7Mhz IF Amplifier



MRAO 45Mhz IF Amplifier

Dish Distributor

Maplin Electronics will be marketing a 1.8 metre prime focus satellite dish from September; according to their new catalogue it has a gain of 35.89 dB at 4 GHz, and 45.54 dB at 12.5 Ghz and will retail at £69.99. The dish is supplied in the form of six panels for self-assembly and comes with a 'ground mount' capable of providing 0 to 90 degrees elevation (see photograph). The Order Code is A12FB and full details can be found on page 304 of the new Maplin catalogue, or on their website.

RAG Loan Items

Don't forget that the RAG has three industrial-quality PCs available for loan to BAA members!

Each machine is fitted with a dual motherboard, with twin 500Mhz Pentium processor cards and SCSI RAID drivers. Each processor has one fixed and one hot-swappable 18Gb SCSI drive. The power supplies may be 24V DC or 240V AC. We can easily fit a mains supply if required.

If you are interested, please contact Laurence Newell. Note that these machines are very heavy, and would be expensive to send by courier. They are currently causing a gravitational anomaly near Ipswich, Suffolk.

Group Officers

Laurence Newell is the Group Coordinator, and is a software and database specialist working for BT, with experience in industrial control systems and the design of large websites. Apart from coordinating the various activities of the Group, he is responsible for writing the various software modules required for the *Plug and Play Observatory.* These include the various PIC controllers, and the PC-based Java software *Starbase*. Laurence has arranged for charitable donations by BT to the BAA, of various items of redundant equipment which will be of use in our development projects. He is developing a fully-steerable total power radiometer at 4Ghz/2.695Ghz.

Terry Ashton is our Assistant Coordinator, and is a specialist in RF engineering, also with experience of Digital Signal Processing. Terry is our Solar observation Team Leader. He is currently designing and building the modules which will comprise a 2.695Ghz radiotelescope. The sub-modules will allow operation at 151Mhz and 38Mhz, and it should also be possible to provide interferometry options at all frequencies. The 2.695Ghz project was described on a poster at the Exhibition Meeting. Terry prepared our response to OfCom concerning the recent proposals to change the way frequency bands are allocated to radio astronomy.

John Cook is our VLF Team Leader. John has experience in Electronics and Software, and has built a VLF receiver and a Magnetometer. He is now responsible for the collation of results from our SID observers, and for the presentation of those data for publication on our website or in the BAA Journal. A John prepared a poster outlining our VLF and SID work for the Exhibition Meeting. John has kindly agreed to his designs for a VLF receiver and Magnetometer to be modified and used as Group *Starbase* modules. John has an extensive set of VLF observations of his own, which will be used as the basis for the Group VLF data repository. Please send your VLF observations to John, preferably in an electronic form ready for publication.

Peter King works at Cambridge University, and has managed to negotiate the enviable but daunting task of renovating the MRAO Cambridge 151Mhz array. Peter has arranged use of the array by the Group, and so in view of this important work, it was felt that he should relinquish the role of VLF coordinator in order to allow him to concentrate on the 151Mhz array. Peter has described this project on a poster at the Exhibition Meeting. Use of this prestigious telescope system would allow the Group to undertake more ambitious work, and provide a geographical focal point for our meetings. Please contact Peter if you would like to know more.

Karen Holland is our Group Secretary, and is also the Circulars secretary of the BAA Variable Star Section, so she has much experience in the ways of the BAA. She has been tirelessly organising our first Meeting, collecting names of potential members, and distributing information at various BAA meetings. Karen is acting as our 'guinea-pig' for testing the *Plug and Play Observatory*, which should be usable by observers with no specialist radio or electronics knowledge. Please contact Karen with membership enquiries, articles for the Circular, to book a presentation slot at the Meeting, and so on.

Situations Vacant

We would very much appreciate an enthusiastic web developer to become the RAG Webmaster. Experience of HTML and graphic design is essential, and familiarity with PHP and MySQL would be very useful. It could be you!

We anticipate that if we are successful in our application for a PPARC grant that we would require a Treasurer, for which applications are invited.

Membership List

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Mr	John	Trott		jtrott90@hotmail.com
Mr	David	Waugh		davidmwaugh@aol.com
Mr	Chip	Weist		wwiest@sympatico.ca
Mr	James	Wilhelm		james.wilhelm@btinternet.com
Mr	Pete G	Willis		pete.willis@dial.pipex.com

It would be quite nice to know who 'mc1760' and 'rick' are!

Report to Council

Laurence Newell

This short report about the last year's activities of the RAG was recently submitted to Council for publication in the Journal.

The BAA Radio Astronomy Group (RAG), which had been dormant for some time, was officially re-established at a meeting in Northampton of the team of Officers on 2004 September 26th. Following many activities to publicise the new Group, the production of publicity materials, and the use of old mailing lists, there are now over 60 members, most of who keep in touch via email. There are some overseas members, mostly from the United States, Italy and Ireland. The membership is growing all the time, currently at the rate of about one unsolicited contact per week. Membership is free, and will remain so until we are able to offer a consistent and reliable service.

The principal aim of the RAG is to lead observation programmes in radio astronomy, which are achievable by amateurs using inexpensive systems. Initially these programmes will include solar observations at 2.695GHz, and detection of Sudden Ionospheric Disturbances (SIDs) using Very Low Frequency (VLF) receivers. These programmes will be fully introduced and described at the public RAG Meeting in 2005 October in Northampton, the speaker list for which is available on the Group website at www.britastro.org/radio. The irregular emails that have been distributed to members are being rationalised into a more formal Circular, the first issue of which is to be published in August.

In support of the above work, the RAG is designing and developing a *'Plug and Play' Radio Observatory*. The intention is to manufacture a system that can make useful observations without a detailed knowledge of electronics and software, since we feel that many more people would become involved in this subject if the initial learning curve were much shorter. The basic architecture of the PnP observatory includes an Ethernet enabled microcontroller, connected to a range of receiver modules, operating at the protected radio astronomy frequencies of 2.695GHz, 1.420MHz, 151MHz and 38MHz, and the VLF band of 10kHz to 30kHz. In addition, it is hoped to produce a dual-axis magnetometer and telescope drive control systems.

These modules will be controlled by software (written in Java, to give platform independence), which not only has a local database, but also the ability to connect to a remote observation 'Repository'. The principal design of this 'integrated observatory' is complete, and some modules are in place, as is the prototype remote database. About 10 members are actively involved in the development of this system, which we have called *Starbase*.

The RAG is in receipt of a Ridley Grant of £250 to support the development of the Plug and Play Observatory. In addition, Council made a budget allocation of £400 for the forthcoming year, principally for the production of publicity materials and preparations for the October public meeting. We are most grateful for these demonstrations of support.

The RAG has been fortunate to receive several donations of electronic equipment from British Telecom at Adastral Park, Martlesham. In particular, a spectrum analyser (1.5GHz) and four heavy-duty industrial PCs have been put to immediate use. One PC is now installed at the Mullard Radio Astronomy Laboratory (MRAO) at Cambridge University, where it will provide remote access to the recently renovated 151MHz steerable telescope, as part of the *Starbase* network. Tom Boles has acknowledged receipt of these items on behalf of the BAA. The RAG presented a stand at the Exhibition Meeting at the Cavendish in June, generating a lot of interest and collecting 15 new members. Four publication-quality A1 posters were produced explaining the main activities of the RAG, supported by an A5 flyer and A4 versions of the posters as handouts. Demonstrations of equipment for the VLF and microwave receivers were available, together with a working prototype of the *Starbase* integrated observatory software.

Work is continuing to completely redesign the RAG website at www.britastro.org/radio. Contributions have already been received from several members. The intention is that the website should be an integral part of the *Starbase* integrated observation network, as well as being a source of information useful to members and to the general public. This work is expected to take some time.

The Group has also made an official response to an Ofcom (Office of Communications) proposal to introduce 'Recognised Spectrum Access as applied to Radio Astronomy'. The RAG document, and responses from many other organisations, may be viewed at

www.ofcom.org.uk/consult/condocs/astronomy/responses/?a=87101.

Meetings of the Group Officers

Meeting 1 2004 September 26th

Karen Holland

Minutes of the first meeting of the Radio Astronomy Group, 136 Northampton Lane North, Moulton, NN3 7QW .
Present:
Laurence Newell, Terry Ashton, Karen Holland

Maurice Ballard sent apologies for absence due to sickness, and Peter King and James Wilhelm sent apologies as they would be at Jodrell Bank.

Goals and Expectations

It was agreed that the three *primary* aims of the new BAA Radio Astronomy Group (BAA RAG) would be to:

- give interested parties the opportunity to communicate and share their work, and encourage them to do so
- give assistance, guidance and encouragement to newcomers to radio astronomy through the formation of a panel of Technical Advisors
- suggest and co-ordinate some more advanced projects (pro-am projects where possible) for more experienced observers.

Details of the actions identified to accomplish the above are listed below; a few are listed as *future* actions, indicating that they will be completed in the longer-term.

The first aim would be met in several key ways:
- production of a regular news publication
- occasional RAG meetings
- through the development of the BAA RAG website at http://www.britastro.com/radio
- communication through an increased number of BAA journal articles
- participation at the BAA annual exhibition meeting
- development of an observations database (a *future* aim)
- production of a RAG speakers list, to include names and talk titles; talks should be of a wide range, from introduction to radio astronomy level, to descriptions of advanced projects and results.

The second aim would be met by:
- setting up, and making available a team of *specialist advisors* to the group, who can advise beginners in a particular area
- creating *RAG beginners projects*, for which simple equipment would be made available, if possible, to allow more people to become involved in radio astronomy who did not have the background in electronics necessary to build their own equipment
- publication of a RAG *beginners guide to radio astronomy* (future aim).

The third aim would be met by:
- creating *RAG advanced projects*, hopefully in collaboration with professional astronomers.

The RAG core group of officers – Roles and Responsibilities

The meeting proposed the following roles for the members of the core group:

Director and webmaster:	Laurence Newell
Assistant Director:	Terry Ashton
Secretary:	Karen Holland
Publicity:	Maurice Ballard
VLF technical advisor:	Peter King

It was hoped that Maurice might consider acting as publicity officer, and it was agreed that Laurence would contact Maurice to discuss this.

It had been agreed that the minutes would be circulated to other interested parties, to include James Wilhelm and Philip Beastall. James Wilhelm runs the UKARAnet website (http://www.ukaranet.org.uk), and might be willing to give talks on behalf of the BAA group.

Publicity

Laurence had identified several routes for publicising the work of the new RAG group, and it was agreed that, he (or Maurice, if willing) should start to advertise the goals and aims of the new group, as soon BAA council were happy with these. Any publicity material should clearly identify what RAG can offer to its members e.g. Publications, regularly updated website, meetings etc. No publicity material should be released to any groups until we are sure that the BAA is happy with the plans.

Terry agreed to contact the course tutor (Tim O'Brien) of the Jodrell Bank radio astronomy course that he had recently completed, to ask if the publicity material could be forwarded on to course students (numbering 29).

James Wilhelm had been particularly supportive of our work, and should be forwarded publicity material for inclusion on UKARAnet.

The BAA website is a particularly important publicity vehicle, and it was agreed that we should start to construct a good site, which should be regularly updated. Some thought would need to be given regarding the content of the site, to ensure that it was sufficiently different from the UKARAnet site, to be of interest to visitors.

It was agreed that we should make a request for a BAA electronic circular to be sent out announcing the aims and goals of the new group, and an expanded version of this announcement should be written as a news article for the journal.

Laurence still had the RASGB mailing list, Terry had a private email list (actually those belonging to the interested parties as discovered by Tom Boles in the RAG archive), and SARA conference attendees were also possibilities for publicity mailings.

In addition to this we could post notices on work and University noticeboards (Cambridge, Leicester, Brunel, Jodrell Bank etc.).

Membership and budget

It was agreed that it made sense to compile a membership list for the group to include interested parties. Membership of the group should involve a small cost, perhaps through subscription to a newsletter, as is the case for the Variable Star Section. Once an observations database was created, it might also be wise to offer complimentary membership of the group to members who contributed data to the database.

What was not clear was how financial matters should be dealt with, and it was agreed that Karen would ask Tom for more details. If a low-cost newsletter was to be produced then members' subscriptions would cover the cost, but exactly how the cash should be handled would need to be done in compliance with BAA requirements.

Karen thought that if we were considering holding a RAG meeting, we could cover much of the cost of room hire (probably the Humfrey rooms in Northampton) through an entry charge to the meeting. We could consider approaching the BAA for additional funding to cover speakers' expenses if necessary.

Publication

Whilst a good target would be to produce a short newsletter 4 times per year, it might be difficult to obtain sufficient material to produce this frequently. If we can produce enough material ourselves to produce issues for the first couple of years, then we would be more likely to be able to persuade potential contributors to provide material once the publication was seen to be successful.

It was agreed that we would start to try to accumulate articles towards the first 8 issues immediately, with a view to producing the first issue for sale at the first RAG meeting.

Laurence would also see if there was still the facility at his workplace to produce private publications, as this would enable us to produce a newsletter at very low cost.

Karen noted that it would be worth trying to make contact with radio astronomers in other countries that did not have strong national organisations, as some of the authors that contributed to the BAA Variable Star Section circular were occasionally from other countries which did not have a strong variable star group, and these people might be a good source of interesting articles. It was agreed that Laurence, as director, would introduce himself to the European radio astronomy club, and any other international radio astronomy organisations, partially in an effort to publicise RAG's existence, and also in an effort to find new members and newsletter contributions.

First RAG meeting

Karen said that she would ask the BAA meetings secretary for suggestions for meeting dates for the first Radio Astronomy meeting. Although meetings were usually planned at least a year in advance, it was agreed that, ideally, it would be preferred to have a meeting by next Spring, if possible. It might be possible to combine a half-day RAG meeting with a normal BAA meeting.

Exhibition meeting presence

It was agreed that we should start accumulating or producing suitable posters and exhibition material well in advance of the next exhibition meeting (next June). We also need to remember to book space at the meeting, and have a number of the *core group* available to answer questions etc.

Specific projects

There were a number of good candidates for projects, but it was agreed that it was important to focus on just one or two such projects initially, to ensure success.

Terry had a idea for producing a 2.8GHz receiver that would allow observers to monitor the sun's activity at this frequency. He felt that he could design and compile a kit that would provide all the equipment necessary for operation, when used together with a PC. This would be a very good way of introducing non radio astronomers to radio astronomy, as one of the current main hurdles to getting started in this field is a lack of electronics knowledge. We wondered if we might be able to apply to the BAA for funding to develop such a kit, and it was agreed that Karen would investigate this possibility. Once developed, the kit could be sold, but we were uncertain whether it would be acceptable for the BAA to sell electronic equipment that we had designed and constructed ourselves, even though it would not be mains-operated. We would need to investigate the feasibility of this possibility. Such a kit would be excellent, too, for introducing schools to the BAA. The antenna to detect the radio signals could be stuck out of a bathroom window!

It was agreed that Terry would investigate the costs involved both to develop the equipment, and the likely cost of producing the equipment for selling to interested parties. Laurence would investigate the suitability of the *Sky Pipe* software, as a possible component for the system.

It was thought that if this project were successful, then it would be possible to design other radio telescope components that would operate with the basic module and a PC in the same way, so that beginners could progress from the 2.8GHz project, to projects operating at other frequencies, in a relatively simple way. Peter King's VLF receiver could also be utilised in this way.

Another possible project would involve the construction of very large coils to monitor Schumann resonances (see for example wavelab.homestead.com/Schumanns.html). The earth and ionosphere form a resonant cavity that oscillates at a frequency of around 5-30Hz. It is possible to monitor these oscillations, which vary with geomagnetic conditions and weather. Karen and Terry were unsure where the borderline should be drawn between geophysics and astronomy, but this does seem like a possible future project.

There was also a number of surplus IF circuit boards produced by the RASGB that (with permission) might be made available for sale to members for a nominal sum. One 10.7MHz board may need attention since the RF ICs have been discontinued. Terry agreed to see if anything could be done that didn't require a major re-design effort. It was agreed that we should ask Peter King if he could check with Dr Paul Scott at Cambridge that it would be acceptable for us to sell these boards if there was demand.

It was agreed that we would ask Peter King to investigate the possibility of amateurs collaborating on Pro-am projects; Terry could also ask his Jodrell Bank course tutor if there were any projects of interest. In particular, mention had been made of the idea of monitoring Gamma ray burst afterglows in the VLF, and some effort should be made to see if this is a viable possibility with amateur equipment.

Actions lists

Laurence
Contact Maurice to see if he is happy to act as publicity officer
Start to compile a RAG speakers list (or I can keep the list if you send me the details as you collect people and talk titles - this list needs to be sent to BAA meetings secretary, local societies, FAS, AAE etc).
Start to develop and upgrade the website, whilst looking for a webmaster (we should advertise that we are looking for one in any publicity material)
Start to collect and send newsletter material to Karen
Investigate Sky Pipe
Investigate the feasibility of monitoring gamma ray burst afterglows in the VLF with amateur equipment
Think about any articles you could write (or encourage others to write) for the BAA journal on behalf of RAG
Start to compile or collect material suitable for long-term exhibition displays
Post publicity flyers at work and elsewhere
Think about how we will develop observations database (longer-term goal)
See if it is still possible to prepare private publications at work - this may influence software used for newsletter.
Make contact with international radio astronomy organisations, with a view to encouraging new members, newsletter contributions, collaboration etc.
Collaborate with Terry on investigating the requirements for the technical project, in particular the post-detector module with USB interface

Terry
Ask Jodrell Bank tutor if we can forward publicity material to course attendees
Ask course tutor if there are any potential Pro-am projects
Start to collect and send newsletter articles and material to Karen
Think about any articles you could write (or encourage others to write) for the BAA journal on behalf of RAG
Investigate 2.8Ghz project idea further (for a RAG beginners project); suggest that you assess both cost of

development and cost of production, and report back to core group
Start to compile or collect material suitable for long-term exhibition displays
Start to think about/write a beginners guide to radio astronomy (a longer term action unless you're really keen!)
Post publicity flyers at Leicester and elsewhere
Investigate to determine if the surplus IF boards might be suitable for sale without any further major re-design effort.

Peter
Ask professional radio astronomers at Cambridge about pro-am possibilities
Post a publicity flyer at Cambridge on suitable noticeboards
Ask Dr Paul Scott if we may sell the IF boards (if BAA permits). We can supply a sample to Peter if required.

Maurice – if willing to act in this capacity
Publicity work (after BAA council are happy with what we are doing)
Prepare website content, journal announcement, summary for council, BAA electronic announcement, flyers etc
Contact all those who might be interested – Laurence has multiple email lists
UKARAnet announcement and link to our website
Develop a publicity flyer for us to post
Request newsletter contributions in publicity material wherever possible

Karen
Circulate minutes to James Wilhelm, Philip Beastall, Tom Boles
Ask Hazel to put Laurence's name on the back of the Journal
Find out when annual reports are compiled from Hazel, and ask her to add Laurence's name to the list requesting an annual report.
Pat – BAA headed notepaper and compliments slips for Laurence
Investigate dates and venue for RAG meeting, need to start booking speakers soon.
Enquire as to the possibility of applying for BAA funding to develop the beginner's project kit.
Investigate whether we could sell this kit, or alternative route.
Post publicity flyer at Brunel and elsewhere
Ask about how we deal with money within the group – do we send all cash received for membership subscriptions to BAA, and claim expenses off them, aiming for the two to balance?
Start to form collection of articles for newsletter


The happy Team after the first meeting

Meeting 2 2005 April 24th

Karen Holland

Minutes of the Radio Astronomy Officer's meeting held on Sunday 24th April 2005 at 11am, at Xcam Ltd., Grove Farm, Moulton, Northampton, NN3 7TG

Officers present: Terry Ashton , John Cook, Karen Holland, Peter King , Laurence Newell.

Membership status

We now had around 30 members who have confirmed to us that they wish to remain members. Karen's recent York Astronomical Society talk had picked up four more, and publicity during local talks seemed like a good way to advertise our presence. John Cook had spoken at Winchester, where he had had the opportunity to cover a little of his radio work, and he reported that there had been a great deal of interest there.

Web site

Laurence showed a collection of images that were available for use on the website, some of which might be used in circular articles. Laurence had a contact who would produce the web site for him, and it was thought that it would take about a month before it would be ready.

Publicity material

It was agreed that Karen would draft some publicity material for the Journal, to be sent to Laurence. Karen commented that it was not always possible to get material accepted for the Journal if it was not considered acceptable. If an article was rejected, then perhaps we should write to Council asking for a newsletter-style publication that might be more suitable for news-type items. John Cook commented that his radio astronomy article had not been considered suitable material, and Karen had had a VS section CCD target list returned also.

An email circular was also considered a good idea, and this could be produced using the Journal material. A greetings card had been produced, which had been well received. A few of these remained for use.

In order to attract more people at general BAA meetings, and local society meetings, it was agreed that we should produce a glossy A5 flyer for handing out at meetings. This should be a simple publication, outlining the Radio Astronomy Groups aims, planned meetings, the plug-and-play system development etc. It was agreed that we would try to produce this as soon as possible. There was to be a BAA CCD Comet-Imaging meeting on 14th May, and the BAA Instruments and Imaging Section meeting on 21st May, which would provide good potential pools of new members, if the flyer could be produced in time for these meetings.

Circular 'Baseline'

Karen reported that she was happy to produce this, if it was in the same format as the VS section circular, which she had been producing for 9 years. It was agreed that Laurence would contact the BAA to ask if they would cover the cost of producing 200 off of the first circular for free issue at the exhibition meeting and other meetings. After this, circulation would be by subscription and sale at meetings, and Karen would ask her printer the cost for producing 50 off in subsequent runs; Laurence would enquire similarly at BT to find out how much this would cost.

Peter King agreed that he could produce a SID article for the circular. The meeting minutes for the first two officers' meetings would be included, so that members could see and comment on progress. John Cook had already sent an article to Karen covering his work.

Exhibition meeting

Peter King reported that he was unfortunately unable to be at the Exhibition meeting in 2005. It was thought that all other officers would be present.

It was confirmed that the space required would probably consist of a table or two; space for at least 4 A1 posters, and a site near to a window might be useful. Laurence commented that an Internet connection would be useful, although it was thought unlikely that this could be provided.

The posters to be produced were as follows:
Technical information about the plug-and-play system (Laurence)
Beginners poster about radio astronomy, and simplified information regarding the plug-and-play kit (Karen)
SIDs (John/Peter)
151 steerable array (Peter)
High frequency radio spectrogram work (Terry)

It was agreed that we should try to have a common format for the posters, so that they looked as though they belonged to the Radio Astronomy Group. Laurence was uncertain that we could produce posters of sufficient quality using Powerpoint slides, but agreed that if officers sent the information (text and images) to him, together with an image or slide to indicate the preferred format, then he would use Corel Painter to produce high quality artwork, suitable for printing in poster format at A1 size.

It was thought that if we were going to organise a visit to the Cambridge Radio telescopes during July, at the same time as the next officers meeting (see October meeting section below), then we should produce some flyers advertising this visit to give out at the Exhibition meeting. Peter commented that there were usually tours of the radio telescopes available during the Exhibition meetings and other meetings at Cambridge.

Regarding demonstration equipment, John suggested that he could bring along a non-working receiver, Terry could bring along the 2.695GHz aerial to show, and Laurence would bring along Peter Moreton's PIC board.

If the first circular could be made available for this meeting to give away, then this would also be brought along.

October Meeting

It was agreed that it would be necessary to have another officers' meeting, probably after the exhibition meeting in June, in order to discuss the arrangements for the October meeting, and so discussion was postponed until that time; Peter agreed that he would investigate which dates might be available to hold this meeting at Cambridge.

7 speakers had currently been booked for the October meeting.

After the meeting had finished, there was a short tour to the Humfrey rooms to look at the facilities available.

Officers of the Radio Astronomy Group

It was agreed that John Cook should join the officers of the section, working with Peter on VLF.

RAG archives

The RAG archives had been brought along. It was thought that these consisted mostly of correspondence, but could

be used for the extraction of possible members' details. Part of the archive was passed to Karen for this purpose; Terry has retained the remainder.

Speaker list

It was considered sensible to compile a speakers list at some point, that could be made available on the web pages. John Cook agreed that he would be willing to be on this, although preferred to speak at a local level, and not too frequently; longer-distance talks required time off work. Peter King and Laurence were also willing to give talks. Karen said that she would be willing to give beginners' talks once she had learnt sufficient, and had some experience with the plug-and-play kit to talk about. It was agreed that this activity would be delayed until the next meeting.

Project tasks

Terry showed two of the circuits that he had been designing: he showed the circuit that filtered the received signal at 2.695GHz prior to mixing down to 151 MHz, and the 38 MHz second I.F. strip. Laurence and Terry compiled a block diagram of the high-frequency module for future reference. The blocks (should have) consisted of

a low-noise antenna pre-amplifier (10 dB gain)
2.695GHz amplifier (40dB gain)
2.695GHz microstrip bandpass filter
2.695GHz to 151 MHz mixer
switchable attenuator, controlled by the PIC interface
151MHz bandpass filter
151MHz first I.F. strip (40dB gain)
151 MHz to 38MHz mixer
38 MHz second I.F. amplifier (80dbgain)
Detector

It was noted that individual segments of this circuit could be used directly at 151 MHz or at 38MHz (Terry noted that CygnusA had an anomaly at 38MHz which was not understood). This type of construction offered three different telescopes using these configurations. Additionally, the system could be used as an interferometer by duplicating the first four blocks and coupling with the first local oscillator. It was also possible to wind an extra set of helixes in the opposite sense thus enabling polarisation studies of the solar emission to be made.

John Cook gave a simple explanation of SID signal detection. He explained that you only saw SIDs when both you and the VLF beacon are in daylight. It was only possible to use beacon-observer combinations in which both systems were in daylight at the time of the detection. A SID could manifest itself as either a dip or a rise in the general level. It was thought that John's VLF receiver, with a simple channel 2 input, would be a good first unit for the Group to produce, whilst other options were considered further. John was happy for his circuits to be used in this non-profit-making activity, and it was agreed that John would lay out his circuit on a standard size Eurocard with a male 50-way IDC connector, as a daughter board. Laurence give John details of the mechanical and electronic interface for the daughter board, so that John could complete this work.

John also had a design for a Magnetometer. This was designed to detect changes in the earth's magnetosphere that could be due to coronal mass ejections, and therefore were sometimes indicative of auroral storms. John had such a magnetometer already made. It was agreed that we would also produce the magnetometer, which it was thought would be popular.

Laurence gave an overview of the hardware of the system, evolving towards a RS485 hub with multiple remote receivers, all of which would be connectable to the group's database. Multiple plug-in modules would be available in the future. Laurence also gave a demonstration of the software that he had been developing which was based on a system that he had developed for monitoring timing information during long-distance horse-races. This would be the basis upon which the Starbase software would run.

SID Observing Programme

John Cook explained that a great deal of data was currently being collected, although it was not really being analysed at the current time. Peter and John agreed that only the minimum of the reduced data was being stored at the moment (start and end times of events), but Laurence and Karen felt that it would be worth setting the database up to accept full data, in case it could be usefully analysed at a later date. It was agreed that the minimum reduced data would be displayed in articles and on the web pages, an that those observers who wanted to continue supplying a reduced level of data would not be discouraged from doing so. John's full data files were only of 68kb for each day of observing.

Gamma Ray Burst (GRB) Detection

Peter King told us of his exciting work to attempt GRB detection at VLF. There were very few people attempting this in the world and, although this was a personal project, it was considered good material for future circular articles and posters.

The 151 Steerable Array

The *151 steerable array* at Cambridge would be used by Peter, and might also be available to members for use under Peter's supervision. Laurence thought that a broadband Internet connection would make this facility much more useful, and easier to access. This telescope would be used for the Joint Variable Star project to monitor flare stars simultaneously in the optical and 151MHz windows.

AOB

The *1 mile array* had been a Cambridge Astronomical Society Radio Section project, but it appeared that they had ceased to work on this. Peter agreed that he would make some enquiries to see if we might work on this telescope in the future, although, as Laurence noted, it was important that we should not take on too many projects at the same time, as we were effort-limited. It was agreed that this should be progressed, but with a view to spending more time on this once the 151 array was working when more effort would be available.

The bewildered Team after the frog-catching competition

Meeting 3 2005 July 31st

Terry Ashton

Minutes of the 3rd BAARAG Officer's Meeting held at the MRAO, Cambridge, on 31st July 2005

Attendees: Laurence Newell, Terry Ashton, Peter King and John Cook.

Points of note prior to the meeting:
1. Laurence Newell was late so that the agreed 11.00am start was delayed.
2. Karen Holland, secretary to the Group, was fined £10 for being absent.
3. Those present thanked Peter King for providing a most-excellent and appropriate venue.

Management Issues

1. LN reported that the Group's current funds stood at £650 although an amount of up to £120 would probably be needed to pay for the as yet unpaid printing of fliers and posters. Concern was expressed regarding the possibility of £250 being required for the hiring of the venue for the meeting on 8th October. This money would be paid back to the BAA by Bob Marriott, the venue's curator, and an approach by the Group to Bob to determine if this fee could be waived was deemed essential.

2. The membership status comprises 60 good quality contacts, with a further 15 to 20 names being classified as "unsure". Additionally, KH has a few names remaining from the RASGB membership list who have not yet been contacted regarding membership of BAA RAG. Enquiries have been received from people in the USA and the Group has been delighted to welcome both Jeff Lichtman, of Radio Astronomy Supplies and founder of the Society of Amateur Radio Astronomers (SARA), and Tom Crowley. John Vincent remains unique in being the only member to request a withdrawal from the membership database. It was decided that a membership subscription should be deferred until we have attained "section status" and have a full range of receiver equipment available for purchase.

3. TA expressed a desire to have all letters of correspondence that are contained within the RAG archives, and currently in TA's possession, scanned and deposited in the Group's web pages to allow for easier access by interested parties. LN is to enquire with BT about the costs involved in producing PDF scans of the archived documents.

4. Progress with the Group's web-site is presently static owing to a bereavement in the web designer's family. LN therefore decided he would try to find time during his August vacation whereby the web-site could be finished using "WebPlus" from Serif. With the aim of breaking the memory limit of the BAA's web-site, LN will progress in the knowledge that James Wilhelm may provide our server facility should the BAA's memory capacity be exceeded.
LN alerted the officers to www.skype.com where a free voice over IP (VoIP) service is provided.

5. LN reminded us that the posters and fliers that we have already had printed have yet to be paid for. Reprints, or another print run, is warranted for the flier which needs e-mail corrections. This will probably occur after the October meeting when the flier will be up-dated. Up-dates, too, are required for some posters, e.g. the plug and play observatory, to reflect current project status in line with associated developments. PK is to investigate potential problems involved with displaying suitable

publicity material in the lecture room and souvenir shop of the MRAO. Our universal greeting card, which has encouraged BAA Council to produce something similar for Christmas, is still available at a cost of £0.50 per each including envelope.

6. The Group's circular or newsletter will be produced in portable data format (PDF) and distributed electronically. One member is currently without an e-mail facility but has sent KH a quantity of SAEs in order to receive hard copy via the postal system.

7. The BAA exhibition, held at the Cavendish Laboratory in Cambridge on 25th June, was considered a success for the Group, attracting praiseworthy comments from BAA Council and visitors alike. The addition of 14 new members to the Group was but one of several rewards for our efforts. It was agreed that we should have a working model to demonstrate at next year's event in order to build on the precedent we have already set. LN remarked that it should be possible to retain the display stands that he had borrowed for the exhibition. The repair or replacement of damaged connecting clips for the display panels needs to be investigated.

8. There was a degree of uncertainty about the path to follow regarding the formation of a company to cover all aspects of kit supply. Everyone was in agreement, however, that we should do something to protect our intellectual property interests and LN is to discuss the matter with the BAA president.

9. The development of a database for observations has commenced with the inclusion of the membership details. Each of the Group's officers needs to install a client on their PC so that they can work with the database (Navicat www.navicat.com). Armed with a blackboard and chalk, LN drew a graphic illustration of how the whole process has been conceived and how it works. The beginning of a repository is already under way and will initially comprise the voluminous SID data that has been collected by JC in recent years. LN was happy to receive a CD-ROM from JC containing the latter's archived observations.

10. It was agreed that the Group should endeavour to get articles of worth published in the BAA Journal as a direct means of advertising our existence. TA pointed out an article on the development of radio astronomy in England in the current issue of 'Radio Bygones' and is to contact the author about providing similar copy. TA also suggested that Gordon Brown's article describing relations between radio astronomy enthusiasts and the BAA, which appeared in the Journal some five years ago, should be sought and used as guide for an up-dated report on recent developments. The possibility of re-publishing articles was discussed and will be addressed further after the October meeting.

11. The production of a "speaker's list" is being carried out by KH and is another item for discussion which has been deferred until after the October meeting.

12. An annual report to Council needs to be in place by 8th August and LN agreed to write the required 500-word summary of the Group's activities and achievements. All agreed, though, that 500 words just wouldn't be enough to do our Group justice.

13. Amidst thunderous applause and cheering from the other officers, LN formally thanked TA for formulating our negative response to the Ofcom statement of policy regarding the proposal to charge radio astronomers for spectrum access. A private communication from KH had also thanked TA for an excellent job well done. In a wonderfully witty, acceptance-of-praise speech, TA stated that he had enjoyed generating our response and that from all of those available for inspection on the Ofcom web-site, our Group's contained the most venom. ☺
http://www.ofcom.org.uk/consult/condocs/astronomy/responses/

14. LN announced that, on behalf of the Group, he had become a member of the UK Microwave Group to which TA also subscribes. No embarrassment was shown by LN when he learned that he was the only non radio amateur amongst the officers present. (PK operates the call-sign G8KJP; JC operates the call-sign G8EDG and TA operates the call-sign G8MII) However, it is most useful for LN to act on the Group's behalf as all UK Microwave Group's AGMs are held in Martlesham Heath where LN resides. The question of affiliating to other established amateur radio societies, such as ERAC and SARA, was briefly addressed resulting in the unanimous decision that it should be in the correct order of things for other societies to affiliate with us, and not vice versa.

15. The issuing of a calibration certificate for amateur radio observatories was deferred to a time when the subject will be of more relevance, i.e. when there are many working observatories within the Group.

16. It was agreed by all that the BAA RAG's database is second to none thanks to the tremendous effort put into it by LN. Presently the largest database within the BAA is that hosted by the Variable Star Section and set up by Roger Dimmock. It is unlikely that the databases are compatible, but we continue to keep RD informed of our design work.

17. Valid claims for reimbursement of expenditure from any of the Group's officers will be considered by LN upon

forwarding an e-mail message to him containing all relevant details. Currently the Group's budget is held within a personal bank account in the name of LN. The probable expansion of the Group will mean that it should have its own bank account and LN will create this facility with HSBC, with all those present agreeing to be signatories on the account.

18. Next year marks the 75th anniversary of the discovery of cosmic radio waves by Karl Jansky and it is hoped that the Group will be marking this event in some way with the full endorsement of BAA Council. Some research needs to be done in order to find the exact date of the discovery and although TA will lead on this, assistance from any Group member will be most welcome. TA will discuss the matter of "celebration" with the new president of the BAA when he has taken up office in November. All officers agreed that a "party" would be a good idea with a suitable candidate invited as guest of honour: Jocelyn Bell is currently favourite as said guest and TA will investigate as to her willingness to attend.

Meeting arrangements for 8th October

1. The list of speakers is complete and described elsewhere e.g. the BAA RAG flier. An important addition to the list is for a timed schedule so that attendees will have details of refreshment breaks and lunchtime. It is hoped that the event will attract at least 20 to 30 spectators: anything much less than 20 will be disappointing and may result in much gloom amongst the officers so that many of them will resign and enter a monastery... (or Faraday cage Ed.)

2. Current publicity for the event includes its description on our web-site, on the fliers and in previous and forthcoming issues of the Journal. PK is to check on the possibility of advertising the meeting in the lecture room of the MRAO. TA will look into the possibility of advertising in relevant magazines, such as 'RadCom' and 'Practical Wireless', although the feeling is that it has been left too late for such an exercise.

3. It is hoped that the newly-acquired display boards will be suitably saturated with material relevant to the Group's activities on the day of the meeting. What is uncertain is whether any suitable demonstrations can be arranged which will "wow" the audience. All officers should have their thinking caps on for this one.

4. It was suggested, and endorsed by the officers, that a £5 entrance fee should be in force on the door to help pay for refreshments and lunch for the speakers plus their expenses. Another idea to generate funds is to hold a raffle and donations or suggestions for prizes will be most gratefully received.

5. It is very important that our corporate style of presentation is maintained and, consequently, all speakers will be requested to use Microsoft PowerPoint. LN will provide JC with a copy of this program together with templates and tutorials as and where necessary. It is hoped that a CD-ROM will be produced containing all talks presented at the meeting.

6. A questionnaire will be made available for attendees to complete at the meeting which we hope will generate valuable feedback on the Group's performance. LN will formulate the questions but any of the officers can make suggestions as per the questionnaire's content.

Projects

1. TA acknowledged receipt of a spectrum analyser that had been most generously donated by BT. It is arguably the most desirable piece of test equipment for a radio frequency design engineer to possess and should make for light work in calibrating all of our receivers up to 1.8GHz. Its first use will be for performance verification of the 38MHz intermediate frequency amplifier. TA went on to describe how work on the 2.695GHz radiometer was progressing and a summary will be made available for inclusion in the next Circular. Murray Niman had sent an e-mail communication to the Group regarding the planned 3GHz telephone network that will be immediately adjacent to the 2.69 – 2.70 GHz radio astronomy band. This will probably involve base stations transmitting up to 50W and so it is essential that we remind the authorities that their spectrum mask needs to be good enough to avoid interfering with the radio astronomy community. One new member, Alan Morgan, is keen to get involved with our hardware developments and TA will liaise with him on the production of a hydrogen line (H1) receiver operating at 1.421GHz.

2. JC reported that he had been studying several aerial designs and work has started on a new antenna and receiver with the specific aim of being able to monitor the 37.5kHz beacon transmissions from Keflavik in Iceland. JC is continuing his work coordinating the results from other SID observers (seven listed at present) but the data needs to be in a consistent format before being deposited in the database. A very minimal report will include the observer's name, frequency being monitored, a note on the equipment being used plus the start and stop times of the potential SID event. As a closing remark JC stated that June 2005 had been a quiet month, SID-wise.

3. The magnetometer project is currently static whilst JC is working on his new SID receiver. However, LN enquired as to whether the new PCB design could be started so that there would be a possibility of it being on display at the October meeting. JC responded in the affirmative.

4. Commenting on the status of the 151MHz array, PK informed the officers that all seven antenna groups (four Yagis per group) had now been fitted with reconditioned motors and tests had shown that they were fully steerable. Since the demonstration of its working, Dr. Paul Scott of the MRAO had begun showing an interest in the array and may want to use the outermost antenna groups for an interferometer project in a possible collaboration with Trevor Hill. This would leave the central five antenna groups for our use although working in partnership with PS to have access to the full array may still be an option. The net connection has yet to be sorted out and PK will give the matter his most urgent attention, ideally involving Guy Pooley to "rubber stamp" everything as to being all right.

5. It was agreed that any approach made to the MRAO concerning our use of the 1 Mile Array would have more chance of success if we wait until we are producing results from the 151. This would be the best advert for our sincerity and professionalism.

6. LN's insatiable desire to use more chalk resulted in his blackboard presentation of how a personal computer and a PIC-controlled radio astronomy receiver would be connected using an Ethernet rather than USB protocol. The lengthy and involved description will be summarised in the Group's next Circular. JC was introduced to the DIN41612 series of connectors that will be used in all PIC-receiver interfaces.

7. TA pointed out that Professor Andrew Holland, the husband of KH, sat on many PPARC award panels and LN is to seek advice from AH/KH as to how PPARC might best be approached for funding of our Ethernet and other project developments.

8. It is not clear as to what degree the Group should be concerned with CE compliance, RoHS or WEEE regulations. KH is a manager of an electronics company producing state-of-the-art CCD cameras and will be asked to advise us on any action we should be considering before we start to market any of our radio astronomy products.

Observing Programmes

1. The SID observing programme is currently the only programme that is operational by the Group and so it is essential that this is highlighted in the annual report as published in the BAA Journal. SID phenomena have previously been dismissed by some papers secretaries as not being astronomy and so the link between SID events and solar flares cannot be over emphasised.

AOB

1. TA apologised for the break in the daily e-mailing of SREFs to the Group's officers and stated that normal service will be resumed just as soon as is possible.

Action Lists

Laurence Newell

Confirm Meeting charging arrangement with Tom Boles and Bob Marriott
Initiate bank account by obtaining mandate form, send to Team
Investigate prototyping the Ethernet board for October Meeting
Ask KH about applying for PPARC Grants
Enquire at BT re. PDF scanning of archives
Discuss Intellectual Property issue with BAA President
Write Report to Council
Provide John Cook with Powerpoint

Terry Ashton

Resume sending daily technical notes to the team
Confirm that 2006 is really the 75th anniversary of Karl Jansky's discovery
Contact BAA President re. Karl Jansky event feasibility
Contact Jocelyn Bell-Burnell re. speaking at the KJ event
Investigate Radio Bygones article
Enquire about re-publishing Gordon Brown's article
Liaise with Alan Morgan on 1.42Ghz Receiver

John Cook

Provide PCB layouts to KH for VLF and Magnetometer modules
Try to obtain all original VLF:SID data in electronic form, for database
Publish monthly VLF:SID Reports to the membership (as PDFs)

Peter King

Attend to the 'net connection for the 151Mhz array
Enquire if we can advertise meeting in MRAO Lecture Room

Karen Holland (in absentia)

Advise the team about RoHS and WEEE regulations
Arrange production of sample VLF and magnetometer PCBs (from JC)

All

Make suggestions for Meeting Questionnaire
Solicit donations for raffle prizes for the Meeting
Connect to James Wilhelm's database using Navicat, to access Members list

Terry reminds us that even a 3 micron misalignment of the dilithium crystals can give rise to a 3% reduction in warp drive efficiency. John then used his Scots accent to great effect.

The British Astronomical Association

Founded in 1890

Harold Ridley Grants

Grant Application

Please print clearly and return the completed form to the Business Secretary, BAA, Burlington House, Piccadilly, London, W1J 0DU, marking your envelope RIDLEY GRANT.

Name Dr L M Newell **BAA Membership No.** Not yet issued

Address 25F York Road, Martlesham Heath, Ipswich, Suffolk IP5 3TL

Laurence.newell@btinternet.com **Telephone No.** (01473) 635461

If a group project, please give details of other applicants (continue on a separate sheet if necessary).

2. Name T J Ashton **Address**

Space Research Group, University of Leicester

3. Name P D King **Address**

38 St. Bedes Gardens, Cambridge.

Total cost of project £ Probably 500? **Sum applied for £** 250

Have you previously applied for a Ridley Grant? [Yes] [No]

Please summarise what the grant would be used for.

To support the development of a hardware project for the recently re-formed Radio Astronomy Group. The intention of the project is to create a simple-to-use radio telescope system which may be connected to a PC via the USB interface. Control and data logging software on the PC configures a 'post-detector module' (PDM) which contains analogue to digital (A2D) converters, signal conditioning and data interfaces. The PDM A2Ds accept detected output signals from a variety of receivers (initially 2.8Ghz and VLF). The receiver (RX) modules also contain PIC devices for further local control and configuration management. The end result is a self-configuring radio telescope usable by someone with no in-depth technical knowledge, with an extensible architecture. The attached diagrams show the proposed architecture of the PDM and receiver modules, and of how such observing stations could be combined in a simple network to collect data into one central BAA database (which could be shared with e.g. The Variable Star Section and the UKARAnet Group).

The funds provided by the Grant would be used to purchase PIC programmers and software for use by the development team, sets of prototype components, and to facilitate the initial production of printed circuit boards. Any shortfall in funding will be met by the development team members (above).

I / we apply for a Ridley grant for the purposes described above. In the event of my / our application being accepted I / we agree to prepare a written report for publication in the Journal if appropriate.

Signature(s) LMNewell **Date** 2004-11-05

Beyond the Fringes

Laurence Newell

Ok, so I couldn't resist the name for this section... This is just a light-hearted end to the Circular, to show that we radio astronomers do have a human side! Please send your entries to me, and I will pass them on to the judge without revealing your name. All entries must be received by 2005 October 1st.

Caption Competiton

No entertainment section is complete without a caption competition. I am offering a Waterstones book token or a bottle of wine to the value of £10 for the best caption to this photograph. The entries will be judged by Karen Holland.

Your caption goes here!

Bumper Sticker

Another competition, with the same prize as the caption competition above. The prize goes to the 'bumper sticker' which makes Terry Ashton laugh the most (a tricky task). Risque is acceptable, technical in-jokes may be better. It's up to you! Who knows, we could make a real bumper sticker, tee shirt, coffee mug... A couple of examples to get the little grey cells churning:

Radio Astronomers do it very quietly

Radio Astronomers do it as far apart as possible

We hope that you have enjoyed reading the *Circular*. Please let us have your feedback; any comments, be they positive or negative, are most valued. All your suggestions will be carefully considered. Please send any articles and photographs to Karen Holland.

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Baseline is set in 9pt. Lucida Sans Unicode, using Serif's PagePlus 10. It is intended for distribution in PDF format, or for printing at A4 size at 300dpi.

The Group blue is R000, G067, B191.
The Group yellow is R234, G225, B014.

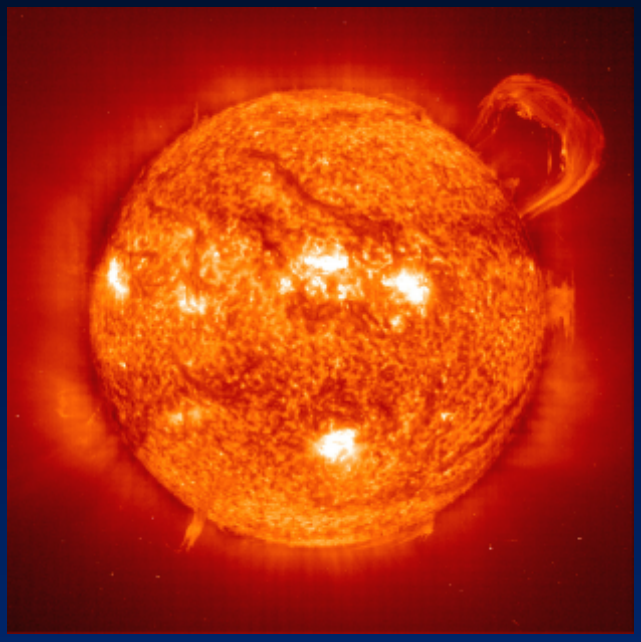
STARBASE CLIENT CONFIGURATION FORM

Observatory
ObservatoryName
CountryCode
TimeZone
Longitude
Latitude
Eastings
Northings
HeightAboveSeaLevel
Telephone
Email
WebsiteURL
ServerIPAddress
PostalAddress0
PostalAddress1
PostalAddress2
PostalAddress3
PostalAddress4
PostCode
IconFilename
HelpFilename
MapFilename
MapTopLeftLongitude
MapTopLeftLatitude
MapBottomRightLongitude
MapBottomRightLatitude
Description

Observer
Title
FirstName
LastName
CountryCode
LanguageCode
Telephone
Email
WebsiteURL
ServerIPAddress
PostalAddress0
PostalAddress1
PostalAddress2
PostalAddress3
PostalAddress4
PostCode
BAAMembershipNumber
IconFilename
Description

Instrument
InstrumentType
InstrumentName
InstrumentIsCalibrated
CalibrationDate
CalibrationTime
Description

Notes
This form is preliminary! Some experimentation may be required... Country codes and Language codes follow the ISO standard e.g. Country=GB, Language=en (case-sensitive). Time Zones are defined relative to Greenwich (e.g. GMT+3). Provide a simple description for each Instrument (e.g. type=receiver, name=2.695Ghz etc.) and we will register it in the database in a standardised way. If multiple instruments are to be registered, please continue on another sheet. Geographical positions in the format (e.g. Longitude) +1:23:45. Height above Sea Level in metres. You may supply icons (32 by 32 pixels, PNG format) of the Observatory and Observer, and provide a Help file for the Observatory as HTML. You may also provide a map image of your local area, defined by the coordinates of its top left and bottom right corners. An image size of about 1500 pixels wide by 1000 pixels high would be ideal (JPG, PNG or GIF). Beware of copyright rules! Please photocopy this page if you do not wish to cut the Circular.



This SOHO Extreme Ultraviolet Imaging Telescope full sun image, taken on 14 September 1999 in the He II emission line at 30.4nm, shows the upper chromosphere/lower transition region at a temperature of about 60,000 K.

Courtesy of SOHO/EIT consortium. SOHO is a project of international cooperation between ESA and NASA.

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