The RAGazine

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Dec 2013

Photo: Sunrise on the Plateau de Bure, showing two of the six 15 m dia. mm-wave antennas 2,550 m up on the Hautes-Alpes. Courtesy of IRAM

www.britastro.org/radio/

British Astronomical Association
Radio Astronomy Group

The RAGazine

The quarterly newsletter of the British Astronomical Association, Radio Astronomy Group (BAA RAG)

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Publication is around the first day of Sep, Dec, Mar and June. Subscribers receive an e-mail alert containing the download links when each new issue is available. A small number of paper copies may be made available on request. We solicit items of news; articles on construction and observing projects; on outreach and educational areas; book reviews; historical descriptions; anecdotes etc. which are of potential interest to amateurs in radio astronomy and geophysics. We also encourage inclusion of relevant individual and commercial adverts, for sale and wanted, and volunteer appeals (all at no charge). The deadline for contributions is normally 3 weeks before the publication date. To contact the editor:

dave@greenover.net

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Most common file and picture formats are acceptable; where possible please contact the editor with advance notice of any contribution. The intended print/view size is A4.

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Editor's Remarks

View from the kitchen

As I wrote in the first issue, *RAGazine* aims to be a little different from many newsletters, and in particular the fairly short and often quite formal ones produced by some BAA Sections - and to some extent the four *Baseline* issues published in 2005/6. *RAGazine* is quarterly and intended to be informally user-friendly. As expected, this second issue is a little shorter than the launch one.

Paul Hyde and I did receive some useful feedback from readers last time, and we always welcome that. Generally the style, mix and format seems to have been well received, in particular the single column format which aids on-screen reading at the expense of a slightly slicker look. As noted last time, *RAGazine* does not purport to be a learned or professional journal; it is for amateurs involved in or interested in radio astronomy and geophysics. I am happy to work with contributors to help complete suitable material. Articles covering work in progress are very much welcomed, too. I am quite flexible over text and picture file formats, but please remember that a single .pdf file will rarely suffice on its own.

We have an understanding with US-based SARA (Society of Amateur Radio Astronomers) to usefully share experience and content in the publishing of their Journal and this. This is reflected in this issue, and we hope this encourages interaction with our transatlantic friends. So to make room for a several interesting and timely items from that source this time, I've held back the start of the promised 'back to basics' articles by Jon Wallace and the first of these will now appear in the next issue of *RAGazine*.

These are extraordinarily productive times for astronomy, astrophysics and cosmology. There is a renewed public awareness of all this, but also of the importance of geophysics, too. It is part of our overall intention here to convey a little of developments in these professional areas, and whilst it is most unlikely that amateurs in these areas will again emulate the extraordinary pioneering success of Grote Reber, we can still derive much satisfaction by building our own instruments and in observing at the amateur level. This is sometimes hard for amateur optical astronomers to appreciate, for on a clear night it's possible in their case to get instant optical gratification that is awe-inspiring and beautiful, often readily recorded by affordable digital cameras and even with a little extra effort and delay enhanced by digital processing on a PC. Our pleasure is thus a little more cerebral and we generally need to build or customise our instruments ourselves, and derive ways to record and display. But we can remind our colleagues that it is reckoned that some 80% of all astronomical knowledge has now been derived by techniques other than those conventional ones involving use of visible light, and of course these techniques include radio astronomy (RA). In that, there is a revival of professional RA interest in lower frequencies, whilst mm-wave frequencies and especially their real-time measuring bandwidths reach ever-astonishing levels - and prompt some amazing improvements in digital and semiconductor technologies.

Family, computer and other issues have slightly delayed my completion of this issue this time, for which I apologise. There are several regular topics that are still not yet included here, but it is planned to remedy this over the next one or two issues. For a free subscription to *RAGazine*, see the simple but revised instruction in the left hand box on p.2

Finally, I would also like to remind readers that I wish to find one or two contributing editors or correspondents for specific areas. I did request this last time, but have had no offers as yet. PLEASE take note and consider volunteering !

And have a great Christmas and New Year !

Best wishes

Dave James **Editor** dave@greenover.net

Coordinator's Remarks

View from the top

The first edition of *RAGazine* was very well received and I'd like to add my congratulations and appreciation for Dave James' contribution to this. Please give some thought as to what material you can provide for future issues. A key objective of *RAGazine* is to give visibility of what people are doing, including those who are in the early days of exploring the subject, as help and encouragement for others.

One of the pieces in the first edition was a report on the RAG 2012 General Meeting in Leicester, an event which proved to be very popular with more than 120 attending. I'm pleased to say that there will be a RAG 2014 event, once again held at the National Space Centre in Leicester, on Saturday 17 May. Our two keynote speakers will be Dr Eloy de Lera Acedo from the Cavendish Laboratory who will talk about modern low-frequency (that's below UHF in the professional world !) antenna and LNA design, and Dr Klaas Wiersema from the University of Leicester who will talk about observing Gamma Ray Bursts via the radio part of the spectrum.

I've already had offers for supporting papers but if you would like to add something, please let me know as soon as possible. We also want to put on a good display of posters and equipment for amateur radio astronomy applications, including associated areas of geophysics such as magnetometry. We need to know how much space to allocate for this and it would be helpful if people could let me know by the end of the year if they will be bringing something along. The arrangements for ticket sales are still being worked out and I expect to be able to announce these following the next RAG Committee meeting on 23rd November.

Since the last issue of *RAGazine* RAG has held its first practical Workshop, another sell-out event despite relatively little publicity. The task was to modify a low-cost satellite finder for use as a simple solar radiometer. This required both mechanical and some quite delicate soldering work. Everyone enjoyed the day and my thanks go to Tony Abbey for developing the technical design and running himself ragged in supporting the 20 individuals doing the modification, and to Jeff Lashley for preparing the supporting science lectures and then undertaking a mammoth five hours of presentations. Please let me know if you would like to attend a future workshop, have ideas for topics, or are prepared to help organise something at a local venue.

I'm pleased to say that Ian Williams has volunteered to help in the distribution of information and support to new members. We are always on the lookout for help in promoting amateur radio astronomy, whether to help with organising events or simply as an extra pair of hands on the day. Something that I started to do but have not had the time to keep up was a RAG Twitter feed of RA-related news items. I intended to contribute 2 or 3 items per month, gleaned from the huge collection of internet resources out there. If anyone would like to pick this up, or do some more general work in building a catalogue of resources, please get in touch !

Best wishes

Paul Hyde **BAA RAG Coordinator** g4csd@yahoo.co.uk

Coordinator's RAG contribution to the 2012/3 BAA Annual Report

The year began with a very successful General Meeting held at the National Space Centre. The move to the larger venue followed the previous year's sell-out event, but with 120 people attending we again had to turn down late applications. A packed agenda included keynote presentations from Prof Andrew Lyne (Jodrell Bank) and Dr Chris North (Cardiff/The Sky at Night) supported by nine talks from Group and guest speakers. The lunchtime interval saw displays of hardware and software systems for amateur radio astronomy applications, with particular contributions from David Morgan, David Farn, Mark Byrne and Andrew Thornett. The event was organised by Paul Hyde and Jeff Lashley with on-the-day support from Karen Holland, Helena Abbey, Sue Williams, and Margaret Morgan. Diane Swan provided a comprehensive meeting report for the BAA Journal.

This year the Group is organising a practical Workshop event with content developed by Tony Abbey and Jeff Lashley. Other work has included organisation for supporting the Daytime Astronomy event held at the National Museum of Computing (reported elsewhere in the Journal) and providing a stand at the Manchester Exhibition meeting. This was popular and several visitors expressed surprise at the simplicity of the meteor scatter system that was on display. Norman Pomfret and Ian Williams provided the manpower here, with John Cook sharing his expertise between the RAG and Solar Section stands.

SID and magnetometry observations continue to be coordinated by John Cook. His workload has decreased following the surge of solar activity in 2012 July, though there was a significant upturn in 2013 April and May. John is supported by a dedicated team of observers and a more detailed description of their work can be found in the 2013 June edition of the Journal.

The RAG website has seen several papers added or updated, with a particularly interesting one from Peter East on observing Hydrogen Line emissions using a relatively compact antenna and low cost receiver. Martyn Kinder maintains the site and regularly updates our archive of VLF reports which now go back over 8 years.

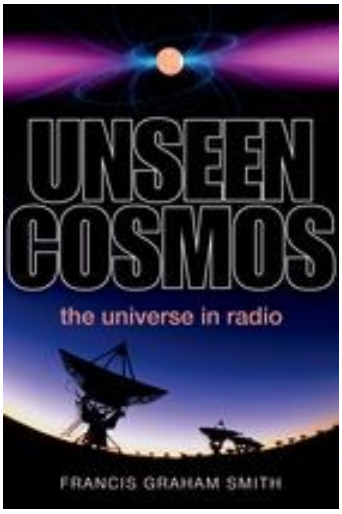
We had a net gain of 27 members for the RAG Yahoo! Group which now stands at 185 members, although usage of the account remains low.

UKRAA is a not-for-profit company set up to make radio astronomy equipment available to the wider community. The company passed a significant milestone this year in clearing its original start-up loan. To date over £22,500 worth of instruments, accessories and books has been sold to customers across five continents, a major achievement for the volunteer team of Andrew Lutley, Alan Melia, Norman Pomfret, Mark Horn, and Ian Williams. UKRAA hopes to extend its product range in the coming year and additional help is always welcome. No radio astronomy expertise is required, just a willingness to lend a hand. Please contact them at info@ukraa.com for further details.

The Starbase software observatory has seen the addition of several new features: a facility to allow the direct comparison of observational recordings by their superposition on a single display; software to use the computer's sound card to measure the frequency response of a UKRAA VLF receiver; a much needed user interface to reconfigure serial ports and the instruments to which they are connected; a simple utility to display the audio devices connected to the system; enhancements to capture signals in real time, using the host computer as a data logger. Development of an Ethernet-based controller also continues, with the project's Staribus protocols now written in open source C, for use on any computer system. More information, expressions of interest and offers of assistance to starbase@ukraa.com.

"Unseen Cosmos" by F Graham-Smith: Book Review
- Paul Hyde

Books



Unseen Cosmos:
the universe in radio
by F Graham-Smith, Oxford Univ. Press, 2013
238 pp., £20 rrp

In 1946, following his wartime work on radar at the Telecommunications Research Establishment, Malvern, Francis Graham-Smith returned to Cambridge to complete his studies, joining Martin Ryle's team in its pioneering research into radio astronomy. Thirty-six years later he succeeded Ryle as Astronomer Royal. He has written several academic texts covering optics, photonics and radio astronomy and in 1988 he co-authored (with Bernard Lovell) *Pathways to the Universe*, an explanation for the layman of the general astronomical knowledge of the time. In 2009 he co-authored (with Bernard Burke) *An introduction to Radio Astronomy*, a graduate-level book which has proved an invaluable source for many amateur astronomers finding their way into the subject. He is well qualified to write a book describing how radio astronomy has led to a transformation in our understanding of the Universe: he was there as the story unfolded and he has made significant contributions to many of its chapters.

Unseen Cosmos begins in 1932 with Karl Jansky placing the source of the mysterious radio noise he was hearing in the direction of the centre of the Milky Way. This made no sense to the astronomers of the day as, like those before him, Jansky found no significant radio emissions from the Sun. At the time the developing understanding of quantum mechanics pointed towards thermal (black body) radiation as the source of radio emissions in nature, so in a galaxy full of stars it should have been our nearest one that was most prominent. In the following chapters Graham-Smith recounts how radio astronomy revealed the importance of the synchrotron mechanism over thermal radiation, which in turn led to the first appreciation of the importance of magnetic fields and cosmic rays in the dynamics of the Milky Way.

Sir Graham-Smith similarly follows the trail leading from the recognition that some radio sources were incomprehensibly (at the time) distant to the conclusion that black holes are fact, not speculation, whilst closer to home the radio signatures of complex molecules reveal the chemistry associated with the Giant Molecular Clouds formed in the death of stars. Some of these trails are still being forged. The investigation of how radio waves are affected by the plasma of our ionosphere and the solar wind resulted in the discovery of pulsars and hence the promotion of neutron stars from the list of theoretical possibilities to observed reality. Graham-Smith then goes on to explain how these objects have opened new chapters in the exploration of relativity and cosmology.

There are plenty more of these historical journeys: Reber's single-minded pursuit of Jansky's original work; Oort and van der Hulst's search for a radio spectral line; the magnificent work carried out in Australia; the discovery of the Cosmic Microwave Background etc.. There is much on the contributions made by individuals, including Alfven, Baade, Bolton, Ginzburg, Lovell, Shapiro and Zel'dovich. The book shows how ideas arose and evolved, with some reference to the personalities and events that shaped the process, for instance in the debate over the Big Bang versus Steady State models of the universe.

The first part of the book takes us on a journey across the Solar System and the Milky Way to distant galaxies. Although this provides a familiar frame of reference, I found it a little frustrating due to the number of references to topics to be covered in later chapters. On the way we learn of the various mechanisms whereby nature generates radio emissions, how the appearance of the Sun varies with wavelength, and the basics of interferometry. The book does not assume detailed knowledge of radio technology and Graham-Smith goes some way in linking concepts to familiar objects such as mobile phones and television aerials, though the reference to the dipoles used in satellite LNBs is confusing. There is also a tendency to generalise references to wavelengths as 'longer' or 'shorter' which may be appropriate when considering the EM spectrum as a whole, but leaves the radio enthusiast wondering whether the reference is to metres or centimetres.

Some topics do require an extension of everyday understanding: the way that the outputs from two antennas can be combined to enable dramatically increased angular resolution is fundamental to why observing 'in the radio' has revealed so much. The book concludes with the latest development of this technique through the description of the current 'big beasts' of radio astronomy: LOFAR, ALMA and the SKA. However, although the level of detail here is appropriate for a general readership, anyone who has been following the development of these instruments will not learn anything new.

The book's title is apt: even discounting dark energy and dark matter, a great deal of the remainder of the Universe does not radiate at optical wavelengths, yet it still dominates its workings. The book targets those who are interested in the way that the Universe works and how observations at different parts of the electromagnetic spectrum combine to reveal the full story. It is not entirely confined to the radio part of the spectrum and the author includes supporting observations from IR, optical and X-ray telescopes plus digressions into subjects such as adaptive objects, Cerenkov radiation and gravitational lensing.

The book is a serious read, covering a broad range of subject matter and a variety of complex celestial objects and processes. It does flit backwards and forwards along the time line and, at just over 200 pages, it does not delve too deeply into individual areas. By comparison, Sullivan's *Cosmic Noise* (reviewed last month) is more than five times the length of *Unseen Cosmos* despite only covering a quarter of the period. However, I thoroughly enjoyed this exploration of the Cosmos based upon what eighty years of radio observations have told us.

VLF Quarterly Observing Report, to October End 2013

- John Cook jacook@jacook.plus.com

The last report ended with a rise in recorded SIDs in 2013 July. As shown in the updated activity chart (Fig 1.), SID numbers fell away again in August and September. However, October recorded a magnificent jump in SID numbers. As I write this in early November I do not yet have all of the observations to hand, but it looks as if a total of over 80 SIDs were recorded including two from X-class flares.

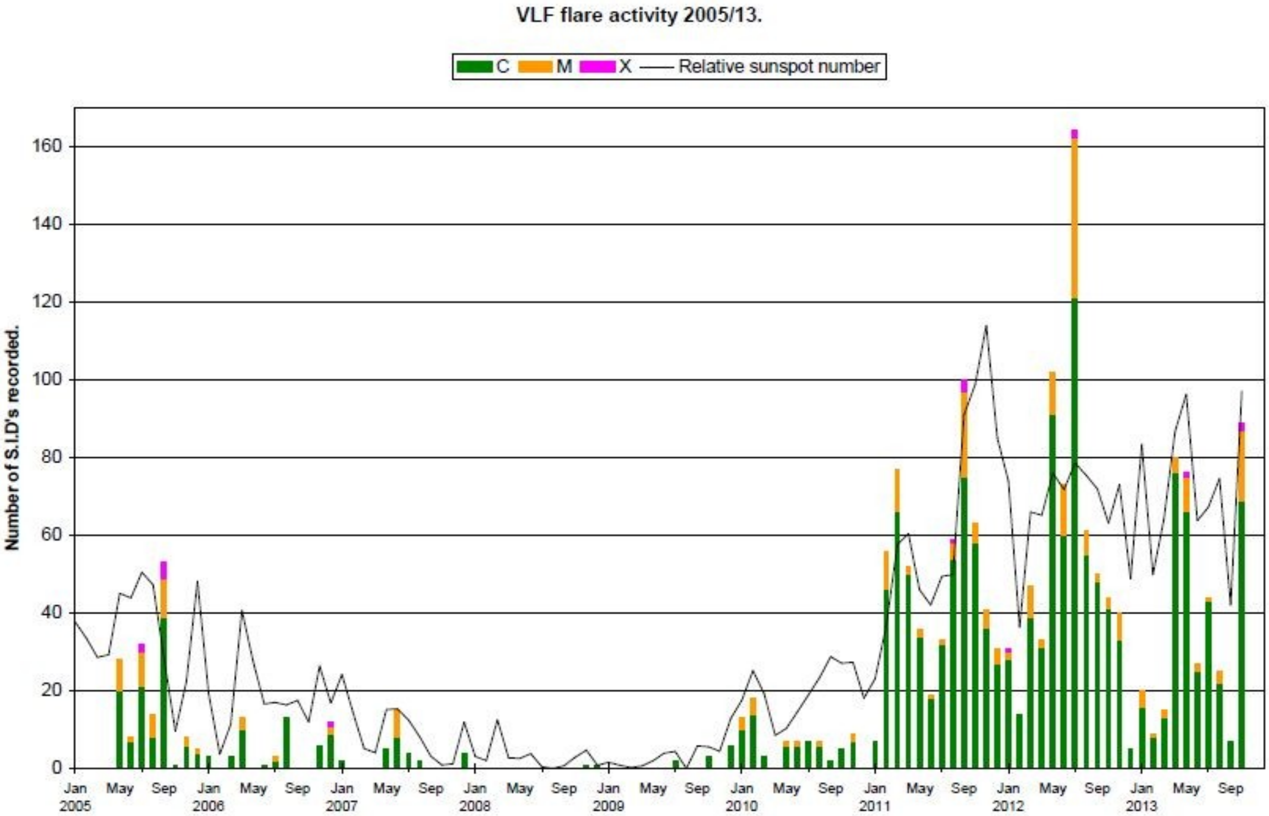


Fig 1: Activity chart

August began quietly, with nothing recorded in the first 10 days. A few small C-class flares were followed by an M1.5 peaking at about 10:45UT on the 12th. This was the most widely recorded event of the month. It showed up well at all frequencies, as shown in the chart by Mark Edwards (Fig 2.). These multi-frequency charts show clearly the variety of SID shapes recorded for the same event, including in this case a break in transmission at 24kHz.

SIDs can also be well disguised when the transmitter power level changes during a flare, as was the case on August 13th. The Ramsloh signal at 23.4kHz often has small changes in signal level, and this C2.8 flare occurred just two minutes before such a signal level drop. In addition to this small drop, at the peak of the flare (11:40) the signal dropped momentarily to zero, followed by a similar dropout at 12:26. Fig 3 (Colin Clements) shows the two dropouts on a SID rising in amplitude, while Fig 4 (Paul Hyde) shows a SID falling in amplitude together with the various signal level changes. The result is a well disguised SID that is rather difficult to interpret.

The most energetic event in August was the M3.3 flare peaking at 18:28UT on the 17th. This was followed by an M1.4 flare at 19:20, just before local sunset. The M1.4 flare also produced a CME that reached earth late on the 20th. With only a glancing blow, we did not record any significant magnetic disturbance. The active period shown in the Bartels Diagram on the 23rd was due to a filament eruption seen in satellite images early on the 20th.

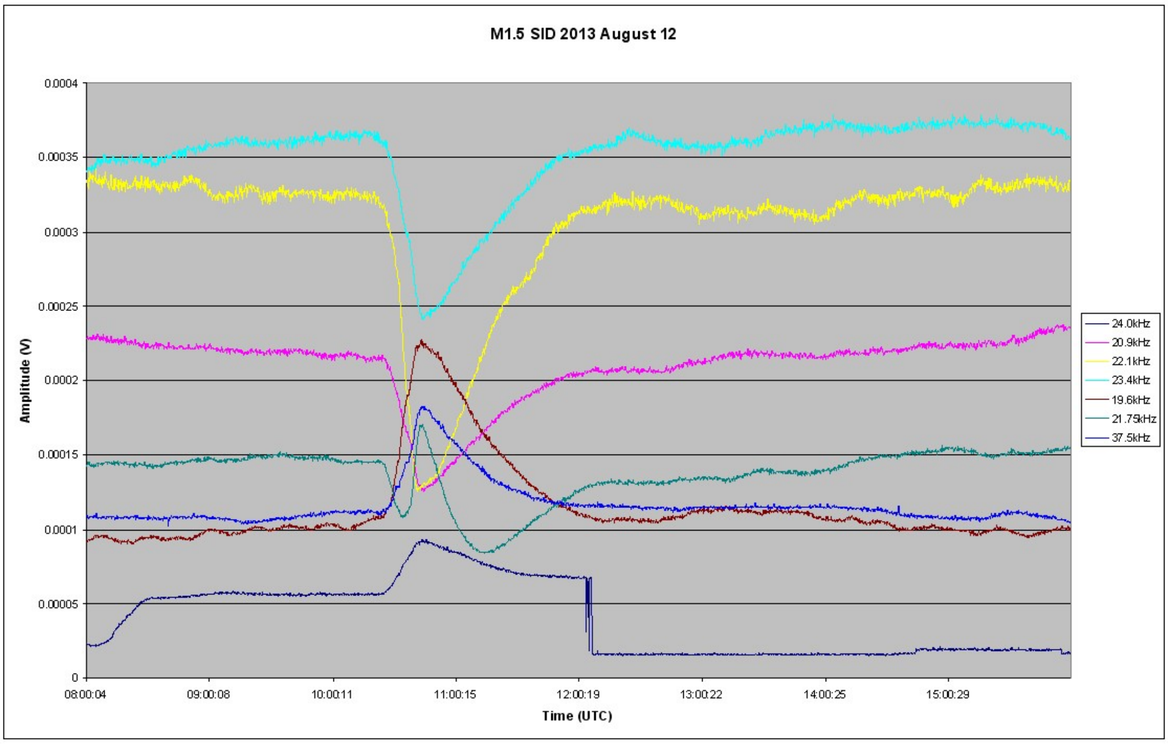
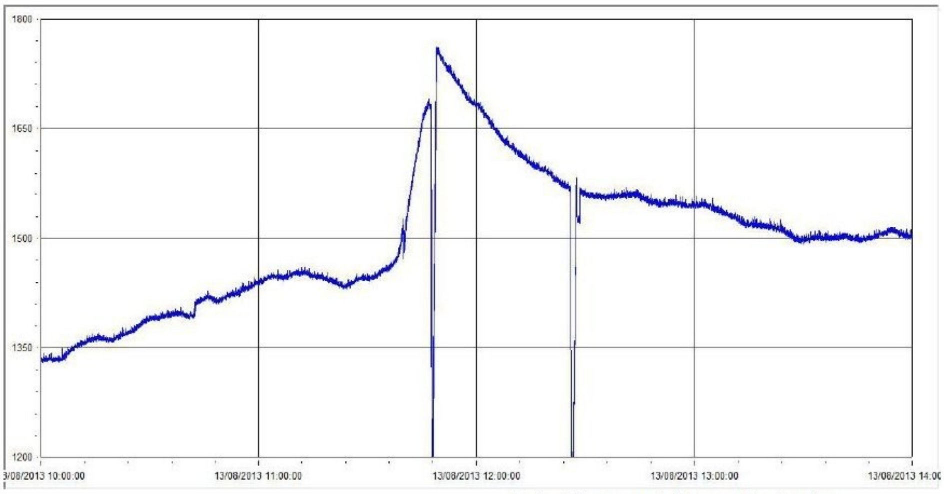
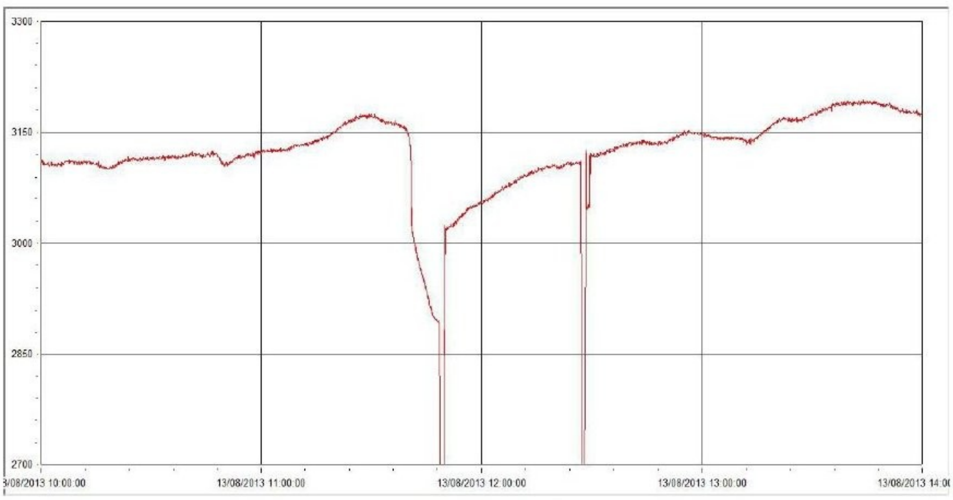


Fig 2: Mark Edwards August 12th



Colin Clements, Lisburn, Co. Antrim

Fig 3: Colin Clements August 13th



Paul Hyde, Basingstoke, Hants

Fig 4: Paul Hyde August 13th

Solar flare activity in September was even lower than in August, with just eight SIDs recorded (7 C-class and 1 B-class). There were no M or X-class flares in the GOES record, and over the week of the 9th to 15th just 3 minor B-class flares are shown. The 20th was the highlight in September with 4 SIDs recorded. The first three of these show well in the recording by Colin Clements (Fig 5). The fourth was from a C1.3 flare at 17:02UT, too late to show on Colin's chart.

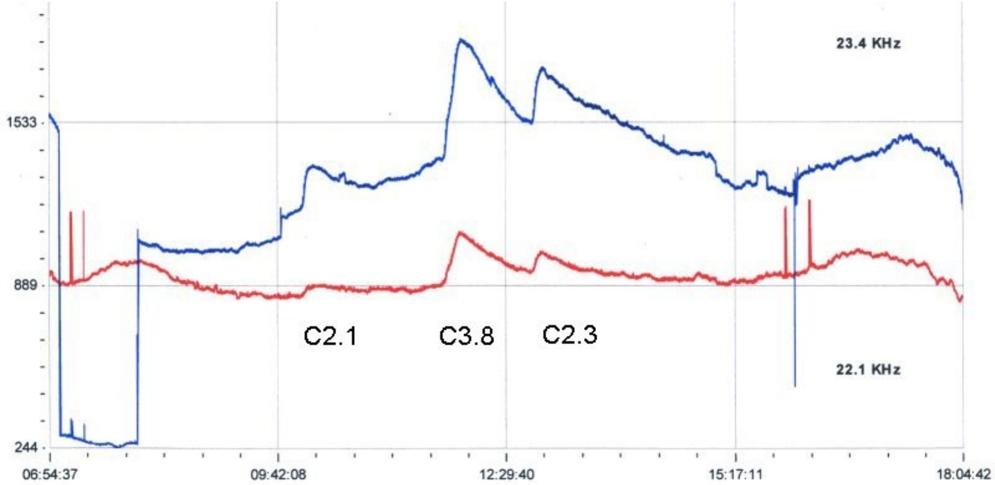


Fig 5: Colin Clements September 20th

Magnetic activity was also very low in September, with no CME's listed by the SWPC. Coronal hole effects were responsible for the few disturbances shown in the Bartels Diagram.

After this period of low activity, it is nice to be able to show a chart that includes two X-class flares (Fig 6, Mark Edwards). The appearance of several large and complex sunspot groups in October heralded a rise in the number and magnitude of X-ray flares. This recording is from October 25th, showing an X1.7 flare at 08:06UT and an X2.1 flare at 15:00. Six smaller flares are also present.

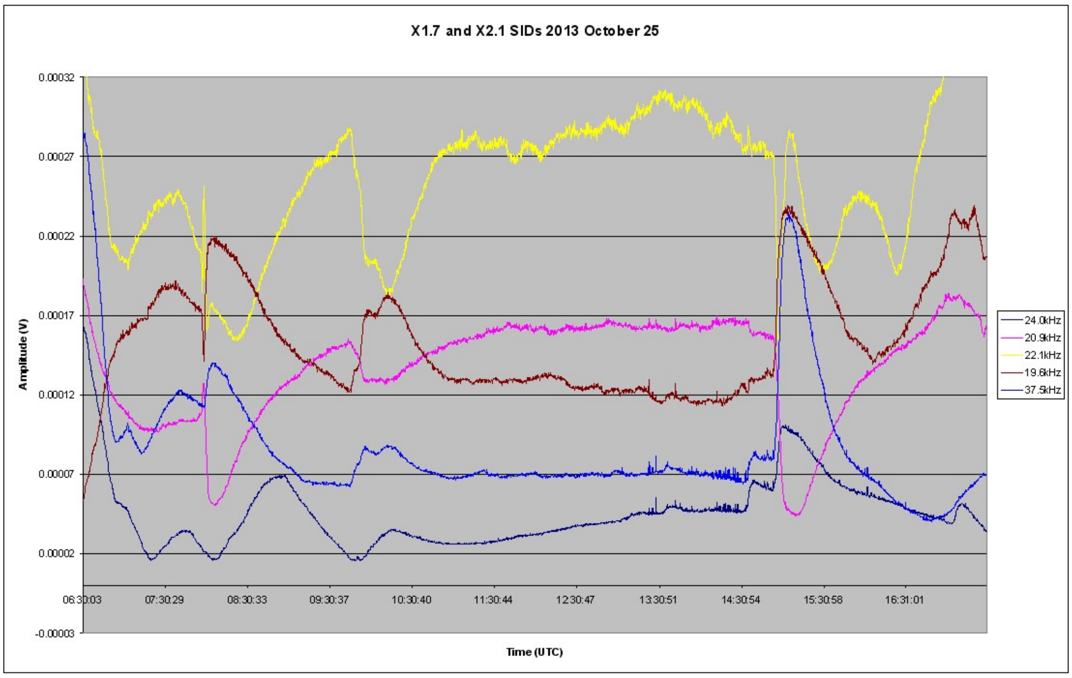


Fig 6: Mark Edwards October 25th

With the large number of SIDs recorded, magnetic activity in October was surprisingly low. I recorded the largest disturbance starting at 01:55UT on the 2nd, with a 45nT transient. This was created by a filament eruption on September 29th. By 04:30 a peak disturbance of 55nT was recorded (Fig 7). After a lull during the day, activity increased again in the evening with a 100nT pulse at 20:33. By 02UT on the 3rd the disturbance had faded back to normal diurnal levels.

Looking at the Bartels diagram, there are only five SFEs observed since our recording began.

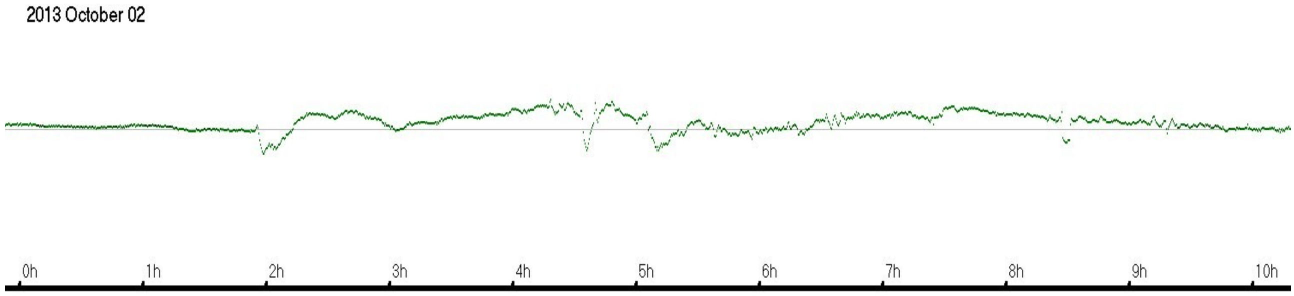


Fig 7: John Cook October 2nd

Solar Flare Effects occur when the ionosphere intercepts sufficient X-ray flux from a fast energetic flare to rapidly increase its conductivity. The sudden increase in ionospheric current flow produces a magnetic disturbance that can be detected by a ground-based magnetometer as a 'crochet' or SFE. A possible SFE was detected at 15:00UT on the 25th simultaneously with the X2.1 flare. Fig 8 shows the event as recorded by Roger Blackwell's magnetometer. The dip at 15:00 is quite clear in the red trace (Y-axis). Although this event has the characteristics of an SFE, I have not yet seen confirmation from professional observations. My own magnetometer recorded a small disturbance, but not as distinct as in Roger's.

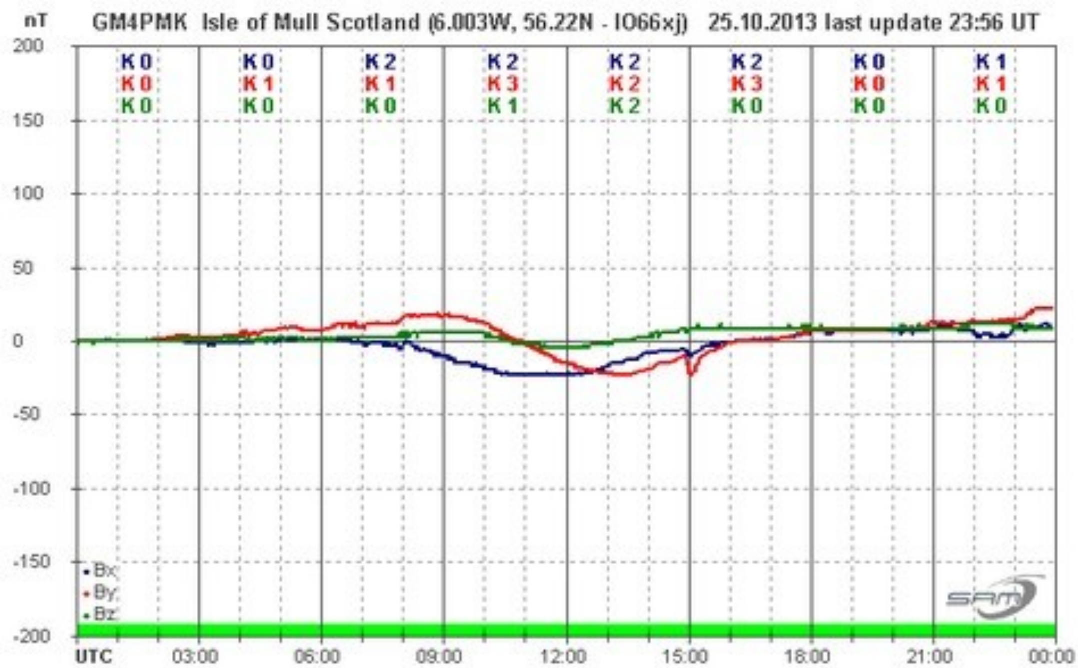


Fig 8: Roger Blackwell October 25th

Observers: Roberto Battaiola, Roger Blackwell, Colin Clements, Mark Edwards, John Elliot, Paul Hyde, Richard Kaye, Bob Middlefell, Steve Parkinson, Gonzalo Vargas, John Cook.

My thanks to all contributors.

/overleaf/ Fig 9: Bartels Diagram (2 pp)

BARTEL DIAGRAM

ROTATION	KEY:	DISTURBED.	ACTIVE	SFE	B, C, M, X = FLARE MAGNITUDE.	Synodic rotation start (carrington's).

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F	CCC	C	CCCC	CMCC	M		X	CMC	C	MC	CCB	C	C	CCCC	CCC	CCCC	CC	CCC	CC	CCCC	CMCC	CMXC	CCCC	CXMM	MMCM	CCMC	CCCC
2431	28	29	30	2011 October 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	2116 20	21	22	23	24
F	CCM	CC	M	MC	CCMC		C	CCCB	C			C	CCC		CCCC	CCC	CCC	CCCC	CCCC	CC		CC	C	CMC	MC	C	
2432	25	26	27	28	29	30	31	2011 November 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	2117 17	18	19	20
F		C		C	CCCC	CCC	M	C	CCCC	CCM	C	CMCC	CC			M		C	C	CC	CCC	MM	C	CCC			CCCC
2433	21	22	23	24	25	26	27	28	29	30	2011 December 1	2	3	4	5	6	7	8	9	10	11	12	13	2118 14	15	16	17
F		C	C				C	C	C		C				C				C			B	C	CCC			
2434	18	19	20	21	22	23	24	25	26	27	28	29	30	31	2012 January 1	2	3	4	5	6	7	8	9	2119 10	11	12	13
F	B		C	CCCC		C		CCM	CC	C	CCC	M	CCC	MBM		C		CC	C	C		CC	CC		C	CC	
2435	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	2012 February 1	2	3	4	5	6	2120 7	8	9
F	CMC	C	CC		CC	CM		C	CC		C		C	CCX	C										C		C
2436	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	2012 March 1	2	3	4	2121 5	6	7
F	CC	CCCC	C							C	C	C					C				C	M		MC	CCCC	MCMC	
2437	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	2012 April 1	2	3
F	C	CC	CCM		C	M	M	MC	CC			C		BCCC	CCC	C	C					CCCC					
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F	C	BC		C		C	B						M		CCBCC	C	CCC	CB	CC	C	CC	C		MCC	C	CC	CCCC
2439	2012 May 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	2124 26	27
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2440	28	29	30	31	2012 June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	2125 22	23
F	BB		C	CCCC	C		C	M	CC	CCM	CCCC	CCMCMCMCMC		M	CCCC	CCCC	CMCC	CCCM	CC	C	CC		CC	CC			
2441	24	25	26	27	28	29	30	2012 July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	2126 19	20
F			C	CCCC	CMC	CCMC	CCMCM	CCCM	CMCM	CCCC	MMMM	MMMM	MMMX	MMMC	MMMM	CCCC	MMCC	CCCC	CX	CCCC	MCCC	C	CCC	M	C	M	
2442	21	22	23	24	25	26	27	28	29	30	31	2012 August 1	2	3	4	5	6	7	8	9	10	11	12	13	14	2127 15	16
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2443	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	2012 September 1	2	3	4	5	6	7	8	9	10	11	2128 12
F	CMCM	MCCM											C	CCM	CCCC	CCC	CCC	CCC	C	CCC	MCCC	C	M	CC	CCC	CB	CC
2444	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	2012 October 1	2	3	4	5	6	7	8	2129 9

BAA Radio Astronomy Group

BARTEL DIAGRAM

F	CCC				CCC	CC	CC					C	CC		C		CCCC	CCC	CCCC	C						CCMC	CCCC
																						2012 November					2130
2445	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5
F	CMBC	CCC	CB	B			C	CCCC			CM	CCC	C	CCC	CCCC		CC					C					B
																										2012 December	
2446	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2
F					C		CC	CMMC	CMC	CCCC	C		CC		CCMC	MCM		C	C		CCC	CCCM	C	CC	C	CC	
	2131																										
2447	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
F										C		C											C				
	2132		2013 January																								
2448	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
F							MC	CC	C		CC	CC	MM	MCCC		C	C			CC		C					
	2133						2013 February																				
2449	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
F											C												CM		C	CC	B
	2134							2013 March																			
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F	C	C	C						C			M		C					CC	C		MC		C	C	CC	
	2135											2013 April															
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F	C	CBC											B	CBC	C	M	CCC	CC	C	CCCC	CCC	MCCC	CM	C		C	CC
	2136														2013 May												
2452	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13
F		C	C	CC	CCCC	M	CCCC	CCCC	CCCC	CCCC	CCCC	CCCC	CC	CCC	CCCC	MC	CCMM	CCCC	CCCM		CBC		CCC	CMCC	CCCC	CCC	CCMX
		2137																	2013 June								
2453	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9
F	C		CC	M	C	CCCC	CCCM			CCCC		C	C					M			C		M		CC	C	
		2138																				2013 July					
2454	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6
F	BC									CC	CCC	CC	C	M	CCCC	B	C	CBC	C		CCCC	CC	CC	MCCC	CCCC	CCCC	
		2139																								2013 August	
2455	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2
F	CB		C	C	CC	C	C	C	CC	C	C	CC			CC						C	CCCC	C				
		2140																									
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F									CCC	M	CCCC	CCC	CC	CC	CMM	C	C	C	CC	C							
			2013 September																								
2457	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
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			2142			2013 October																					
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F											C	C		C	CCCC	MCCC	CCC	C	C	CMCC	CCC	CCM	CCCC	CCC	CC		CCCM
			2143							2013 November																	
2459	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
F	CCCC	CMMC	XMXM	MMMM	CCMC	MMMM	CCCC	C	MCC																		

New HGOL Group tracks Milky Way Hydrogen emission

Readers will remember the appeal for volunteers from the last *RA-Gazine* and from the BAA RAG web site etc. Well, this most worthwhile, flagship project is picking up momentum fast now, and has prepared its first newsletter.

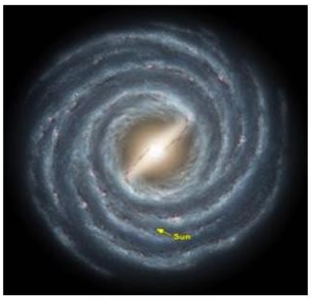
After proving that the remote control measures work fine, the group is training the observers through on-line methods, and measurements start in earnest very shortly. It is understood that there are near a dozen observers signed up already, including a couple of undergraduate students.

We reproduce below the first edition of this group's newsletter (Nov. '13), in full. Contact details are clearly provided. A wonderful, public-spirited effort by all those involved, the whole effort is based on Brian Coleman's 3.7m station that he has been building and refining for some years (see his article, too, on the improved feed unit in the first issue of RAGazine).

The Galactic Observer

Newsletter of the Hydrogen Line Observing Group

November 2013



Editorial

Welcome to the first ever edition of the *Galactic Observer*, the newsletter of the Hydrogen Line Observing Group – hereafter to be referred to by the inevitable acronym 'HLOG'.

This is just a very brief edition to kick of the project following quite a bit of preparation by the Steering Group.

(Who are they? See Meet the Steering Group).

The whole project is of course based around the 3.7m steerable dish designed and built by Bran Coleman, located near Andover in Hampshire. The key early milestone achieved in October has been the proving out of remote access capability. The chief worry was whether a rural "broadband" connection would in fact offer sufficient bandwidth. In the event, the trial was completely successful and we will shortly be open for business.

Day jobs and storms have delayed us slightly (all of Brian's comms were down for a whole week) so the start of the Observing Program will now be on Monday, December 2nd, a little later than we had hoped.

I hope that this brief newsletter is interesting and I look forward to online collaboration with the whole team.

Here's to observing our Galaxy !

Gordon Dennis

The Galactic Observer

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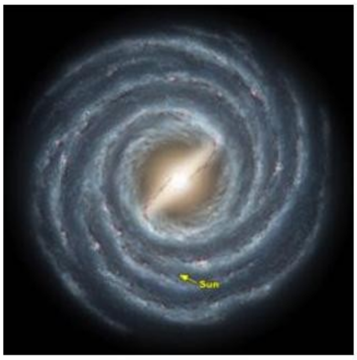


Successful Remote Access Trial

The trial took place on October 16th and consisted of remotely accessing the telescope control software located at G4NNS QTH[1] near Andover from Richard Burdens' office near Wotton-under-Edge, South Gloucestershire.

The prime concern was whether sufficient bandwidth would be available using LogMeIn, so to evaluate this was the main objective of the trial. In addition, we had a three way hook-up using GoToMeeting (GtM) enabling Brian, Richard and Gordon Dennis to discuss the trial as it progressed.

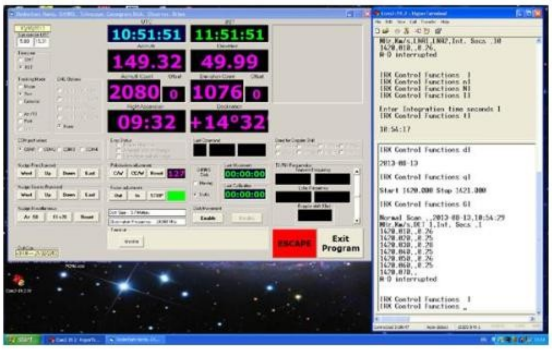
GtM was first established with no apparent problems. Richard than accessed the control software using LogMeIn. While we collectively held our breath, Brian confirmed the telescope was moving as expected. An actual observation trial was then done. Again this functioned without problems, despite the fact that the bandwidth was being shared with GtM.

Richard copied and pasted the observational data from NotePad to OpenOffice. It was noted that there is a significant latency in defining the copy area and this will need to be allowed for in briefing observers. The results were plotted using the OpenOffice graphing function.

Conclusion: the trial confirmed that there is no bandwidth issue for remote observing using the G4NNS telescope. This was proven true even with the added overhead of GoToMeeting (which would not normally be used during observing sessions).

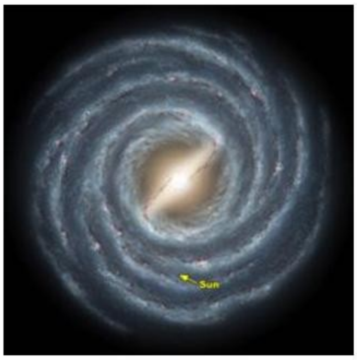
Observing program schedule

The objective of our first Observing Program (OP-01) is to observe the hydrogen line emissions from our own Galaxy. For those unfamiliar with hydrogen line emission, or maybe needing a general re-cap, we will be running an online tutorial using GoToMeeting (GtM) at **2000hrs, Monday December 2nd 2013** – see Online Tutorial for more details . This will represent the formal start of OP-01.



Over the next few days we will be forwarding documentation to you. This will include:

[1] For those (like the editor) who are not licensed Radio Amateurs: 'QTH' is an example of radio amateur shorthand called 'Q-codes'. 'QTH' means 'home' or 'base location'.



- OP-01 Program Handbook – including getting Started, observing calendar access and guidelines for recording observations.
- Observation procedure - Step by Step
- Scanning Receiver Users Guide
- Tracking Users Guide

Since the telescope is essentially a single user device – it can't point to two or more places in the sky at once – each member of the team has to book dedicated observing sessions. Unlike visual astronomy which is done mainly during the hours of darkness, radio astronomy can be done anytime, even in broad daylight. We must qualify that statement a bit by adding that for our project, observing slots can only be available when the part of our Galaxy to be observed is above the horizon and therefore observable.

To coordinate observing sessions, we have established an Observing Schedule based on Google, to which each member of the observing team will be given access.

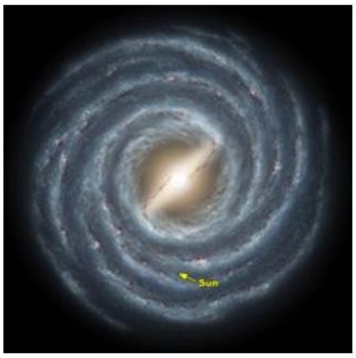
The current program schedule is as follows:

Monday December 2nd	Online tutorial (GtM) *Introduction to Radio Astronomy*
Monday November 9th	Online Tutorial (GtM) *Objectives, Methods and Procedures in OP-01*
Monday December 16th	Observing Program commences – subject to final confirmation

Online Tutorial

OP-01 is being run using as much electronic communications as possible, eliminating time wasting and expensive travel. In fact this means the project is being conducted along similar lines to a professional observing project where team members may be scattered all over the world and collaborate electronically.

Tutorials, starting with *Introduction to Radio Astronomy* on Monday December 2nd at 2000 hrs GMT will be run on GtM. If you've not used this before, don't worry – we will be publishing a detailed step by step guide. The system requires you to install viewer software – again don't worry: the installation is very simple; the footprint isn't that large on your computer; and since it comes from a very large Corporation (Citrix) there's no risk of virus attack.



The tutorial will be as non-technical and as non-mathematical as possible. We appreciate that the majority of the observing team do not have detailed knowledge of radio equipment, and let's face it, those of us who do *enjoy* mathematics are in a minority!

The tutorial will cover several interesting subjects including:

- Very brief historical background to radio astronomy
- Introduction to RA principles
- Telescope beam width
- Signals and noise
- The Doppler Effect

Joining instructions for the GtM session will be emailed to you a few days before the event.

The second tutorial will cover specific aspects of the observing program in detail and will include descriptions of the software that you will use remotely to control the telescope and record observations. We are attempting to construct a "3D" image of a part of our Milky Way galaxy by observing the "brightness/temperature" and the Doppler shift of radiation from neutral Hydrogen that resides in the spiral arms. This involves a large number of observations. Currently we plan 6 or 7 observations at different latitudes for every 2 degree step along that part of the Galactic Equator that we will be able to observe. Each set of 6 or 7 observations takes about one and a half hours to complete. By making the telescope available on-line, we will be giving others interested in Radio Astronomy the opportunity to learn how to use the telescope and make observations that will contribute to the mapping project. All data collected will be available to all participants to use as they wish. The "management team" will be using the data to construct the "3D" map and plan to write a paper for publication in the amateur astronomy press, describing the project.

When the observations actually start, those participating in the project will be provided with one to one instruction on using the telescope and making their first observations. Subject to telescope availability, after these observations are completed, participants will be able to propose other observing projects which will be considered by the steering group bearing in mind the limitations of the telescope and the available time.

The Galactic Observer

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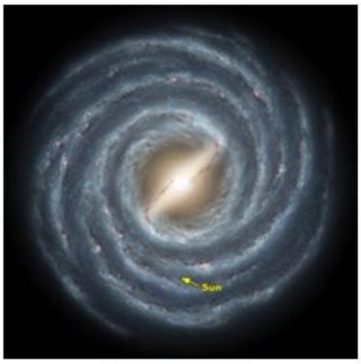


Meet the Steering Group

We've talked in previous communications about the OP-01 Steering Group. We don't want this group to be in any way mysterious, so here they all are:

Richard Burden IT manager info@nexcen.co.uk 07976 740 910	 Brian Coleman, G4NNS Telescope manager brian-coleman@tiscali.co.uk 07798 770266
 Gordon Dennis OP-01 Project Coordinator gordon.dennis@koalapub.co.uk 077774 628110	Phil Hopkins OP-01 Science Director pjh@talk21.com 0798 030 1493
Paul Hyde, G4CSD Coordinator, BAA Radio Astronomy Group g4csd@yahoo.co.uk 01256 470135	

Brief note on the comparison of bright meteors

- Simon Dawes, with comparison images contributed by Paul Hyde

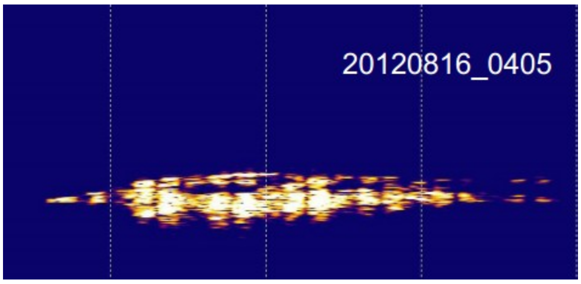
Observing, meteors

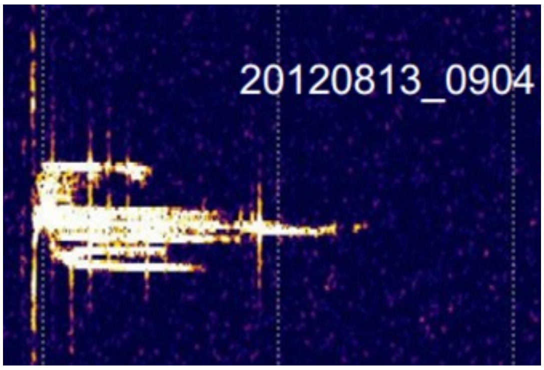
I'm a novice when it comes to radio astronomy, and have relied heavily on the BAA RAG for guidance; I have now been observing meteors using radio for 3 years using a cheap and simple set-up of a Yupiteru MVT 7100 hand scanner tuned to the GRAVES radar, 4 element Yagi and *Spectrum Lab* software running on an old laptop.[1] This set-up runs 24/7 and I access the logs using TightVNC.

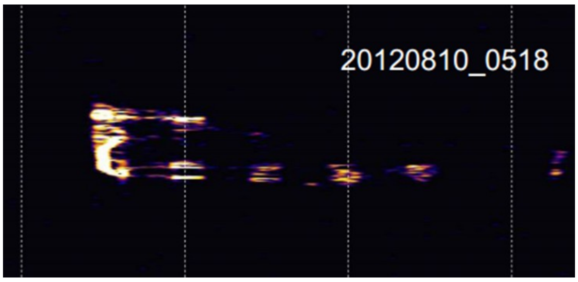
When sharing my results with my local radio society I regularly get asked if they can be verified by other radio observations, and I had always believed that due to different locations and instrumental set-ups the individual observational records I had would always be different to other observers and thus difficult to verify. However as this question came up so regularly, I decided to contact Paul Hyde and ask for some of his strong meteor traces from the 2012 Perseid meteor shower to see if I could match any with my own observations.

Working from screenshots it was immediately clear that I would need to 'calibrate' the images as I use a different waterfall rate and direction to Paul. Having done this I took Paul's date-stamps and looked around the time of his observation for similar traces in my observations and much to my surprise, I was able to find a matching trace for every observation Paul had provided. The figures below show three traces from two different observers of the same meteors

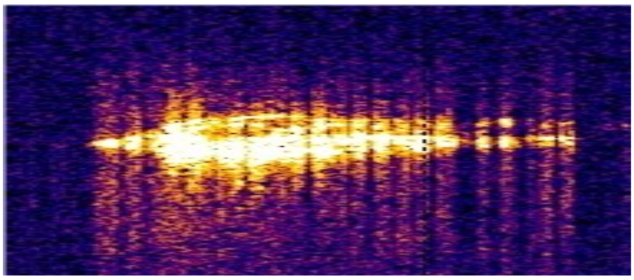
Paul Hyde Observations

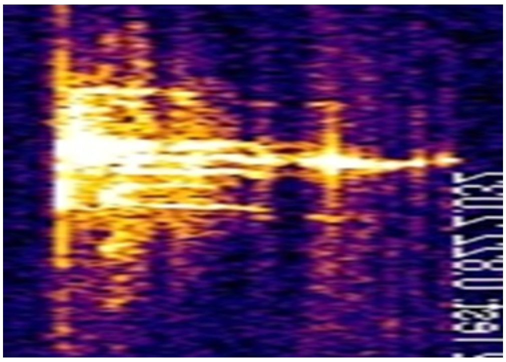


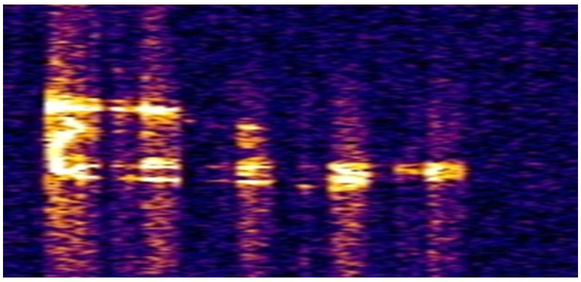




Simon Dawes Observations







1 Meteor scatter is of course strictly geophysics rather than RA, no matter to us - Editor :-)

Conclusion

Taking into account the different sample rates, waterfall settings and equipment the correlation of events is remarkable. The durations measured for each event are identical within ±0.3s, the limitation of the measurement system.

The trace of each event show significant similarities in their shape, despite the very different equipment and locations.

Improvements are needed to synchronise the times for the start of the events. *Spectrum Lab* uses two clocks, one for the conditional actions and one for display of time on the waterfall. What seems to happen is the clock used in 'conditional actions' uses the operating system's time, but the clock on the waterfall uses time as determined by *SpectrumLab*; these times are synchronised at the time *Spectrum Lab* starts but over months and years begin to drift apart. The times are further confused because the operating system will update the time from an NTP server 'randomly' – it probably isn't random, but how often and how much seems not documented.[2] As a result, I now rely on the operating system time, printing the time onto the waterfall using conditional actions. I also keep the operating system up to date using *nettime* (http://www.timesynctool.com) which is fully configurable and I synchronise the time every hour and update the time if the difference is >1s, but further investigation is required to see how this impacts the overall synchronisation of time with other observers.

2 Use Meinberg PC s/w with Stratum 2 or 3 servers ? - Editor

The Horn Antenna in Radio Astronomy
By

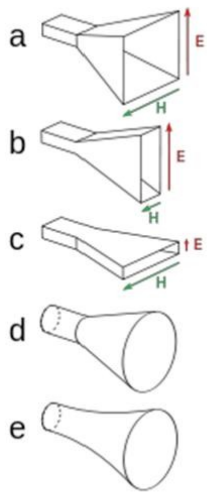
Jeffrey M. Lichtman
Radio Astronomy Supplies
Founder Emeritus (Society of Amateur Radio Astronomers)

A horn antenna or microwave horn is an antenna that consists of a flaring metal waveguide shaped like a horn to direct radio waves in a beam. Horns are widely used as antennas at UHF and microwave frequencies, above 300 MHz. An advantage of horn antennas is that since they have no resonant elements, they can operate over a wide range of frequencies, a wide bandwidth.

Horn History

One of the first horn antennas was constructed in 1897 by Indian radio researcher Jagadish Chandra Bose in his pioneering experiments with microwaves. In the 1930s the first experimental research (Southworth and Barrow, 1936) and theoretical analysis (Barrow and Chu, 1939) of horns as antennas was done. The development of radar in World War 2 stimulated horn research to design feed horns for radar antennas. The corrugated horn invented by Kay in 1962 has become widely used as a feed horn for microwave antennas such as satellite dishes and radio telescopes.

Horn Descriptions



Pyramidal horn (a, right) – a horn antenna with the horn in the shape of a four-sided pyramid, with a rectangular cross section.

Sectoral horn – A pyramidal horn with only one pair of sides flared and the other pair parallel. It produces a fan-shaped beam, which is narrow in the plane of the flared sides, but wide in the plane of the narrow sides. These types are often used as feed horns for wide search radar antennas.

> **E-plane horn (b)** – A sectoral horn flared in the direction of the electric or E-field in the waveguide.
> **H-plane horn (c)** – A sectoral horn flared in the direction of the magnetic or H-field in the waveguide.

Conical horn (d) – A horn in the shape of a cone, with a circular cross section. They are used with cylindrical waveguides.

Exponential horn (e) – A horn with curved sides, in which the separation of the sides increases as an exponential function of length. Also called a scalar horn, they can have pyramidal or conical cross sections.

1

These horns have minimum internal reflections, and almost constant impedance and other characteristics over a wide frequency range. They are used in applications requiring high performance, such as feed horns for communication satellite antennas and radio telescopes.

Corrugated horn – A horn with parallel slots or grooves, small compared with a wavelength, covering the inside surface of the horn, transverse to the axis. Corrugated horns have wider bandwidth and smaller sidelobes and cross-polarization, and are widely used as feed horns for satellite dishes and radio telescopes.

Ridged horn – A pyramidal horn with ridges or fins attached to the inside of the horn, extending down the center of the sides. The fins lower the cutoff frequency, increasing the antenna's bandwidth.

Septum horn – A horn which is divided into several subhorns by metal partitions (septums) inside, attached to opposite walls.

Aperture-limited horn – a long narrow horn, long enough so the phase error is a negligible fraction of a wavelength, so it essentially radiates a plane wave. It has an aperture efficiency of 1.0 so it gives the maximum gain and minimum beamwidth for a given aperture size. The gain is not affected by the length but only limited by diffraction at the aperture. [10] Used as feed horns in radio telescopes and other high-resolution antennas.

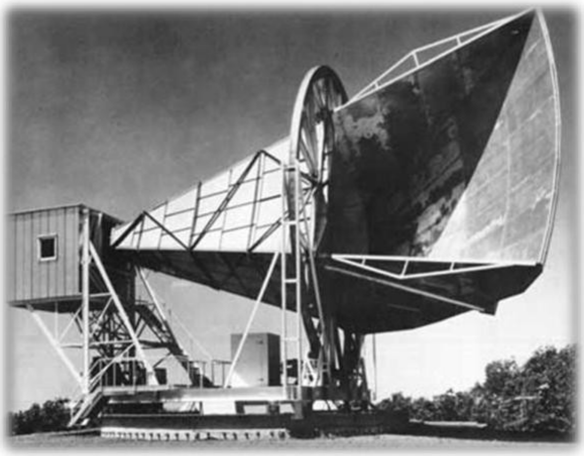
The Discovery of Hydrogen Radio emission by Ewen and Purcell

In 1950, "Doc" Ewen was working 40 hours a week designing and building apparatus for the new cyclotron at Harvard. In addition, during nights and weekends, he was working on completing a doctorate in physics by building a receiver to detect the 21 cm line of neutral hydrogen, supervised by Purcell.

This horn antenna, now displayed in front of the Jansky Lab at NRAO in Green Bank, WV, was used by Harold Ewen and Edward Purcell, then at the Lyman Laboratory of Harvard University, in the first detection of the 21 cm emission from neutral hydrogen in the Milky Way. The emission was first detected on March 25, 1951.

		
Original Photo at Harvard	**Actual Horn at NRAO. Green Bank, West Virginia (Friend, Kerry Smith)**	**H.I. ("Doc") Ewen pictured with his horn on the occasion of a visit to NRAO-Green Bank May 22, 2001. He had not seen his horn antenna since 1956!**

Penzias & Wilson (1965, ApJ, 142, 419) showed that the zenith antenna temperature of the Bell Labs horn was 3.5 K higher at 4 GHz than expected—the first detection of the cosmic microwave background radiation.



Horn Antenna — Holmdel, New Jersey.
Horn Antenna, circa 1960.
(Photo Credit: Bell Labs)

Period: 1964-1965
Builder: Mr. A. B. Crawford

3

The Horn Antenna at Bell Telephone Laboratories in Holmdel, New Jersey, was constructed in 1959 to support Project Echo--the National Aeronautics and Space Administration's passive communications satellite project.

The antenna is 50 feet in length with a radiating aperture of 20 x 20 feet and is made of aluminum. The antenna's elevation wheel is 30 feet in diameter and supports the weight of the structure by means of rollers mounted on a base frame. All axial or thrust loads are taken by a large ball bearing at the apex end of the horn. The horn continues through this bearing into the equipment cab. The ability to locate receiver equipment at the apex of the horn, thus eliminating the noise contribution of a connecting line, is an important feature of the antenna. A radiometer for measuring the intensity of radiant energy is found in the equipment cab.

The triangular base frame of the antenna is made from structural steel. It rotates on wheels about a center pintle ball bearing on a track 30 feet in diameter. The track consists of stress-relieved, planed steel plates which are individually adjusted to produce a track flat to about 1/64 inch. The faces of the wheels are cone-shaped to minimize sliding friction. A tangential force of 100 pounds is sufficient to start the antenna in motion.

To permit the antenna beam to be directed to any part of the sky, the antenna is mounted with the axis of the horn horizontal. Rotation about this axis affords tracking in elevation while the entire assembly is rotated about a vertical axis for tracking in the azimuth.

With the exception of the steel base frame, which was made by a local steel company, the antenna was fabricated and assembled by the Holmdel Laboratory shops under the direction of Mr. H. W. Anderson, who also collaborated on the design. Assistance in the design was also given by Messrs. R. O'Regan and S. A. Darby. Construction of the antenna was completed under the direction of Mr. A. B. Crawford from Freehold, New Jersey.

When not in use, the antenna azimuth sprocket drive is disengaged, thus permitting the structure to "weathervane" and seek a position of minimum wind resistance. The antenna was designed to withstand winds of 100 miles per hour and the entire structure weighs 18 tons.

The Horn Antenna combines several ideal characteristics it is extremely broad-band, has calculable aperture efficiency, and the back and sidelobes are so minimal that scarcely any thermal energy is picked up from the ground. Consequently it is an ideal radio telescope for accurate measurements of low levels of weak background radiation.

A plastic clapboarded utility shed 10 x 20 feet, with two windows, a double door and a sheet metal roof, is found next to the Horn Antenna. This structure houses equipment and controls for the Horn Antenna and is included in this nomination.

4

Little Big Horn (NRAO GREEN BANK)

The Calibration Horn Antenna, also known as "Little Big Horn." First observations were made in October 1959, and absolute flux measurements of Cass A began in March 1960. NRAO/AUI image.

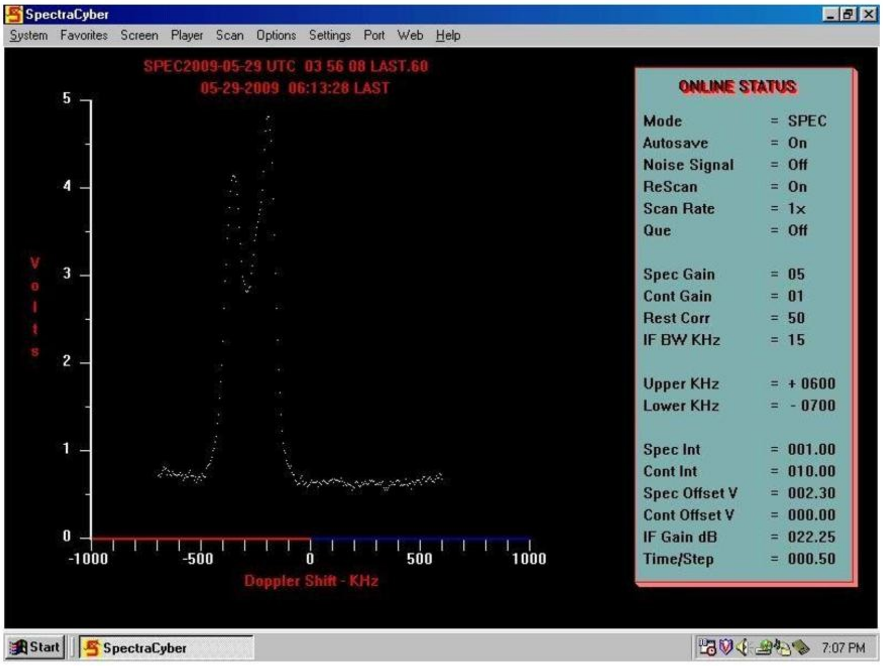
Some of the early SARA conference attendees had the extreme pleasure of seeing this horn. As the years went by, vegetation and time had taken its toll. The site is located north of the main site. If one passes the motor pool, there is a dirt road via an old cemetery. When you reach the street, turn left and head west till you get to a field, follow the dirt road. ***Be careful of critters and poison ivy!***

SARA members, Jim Sky and Jim Carroll actually connected a receiver to the horn. When they removed the termination, they were greeted to a torrent of water that had collected in the horn. Kerry Smith scaled the horn on our first visit and became known as the "Kerryometer" due to the heat of his body. A great calibration Source!

Below are some horns built by amateurs

	
21 cm Horn built by Clint Jeffries in Australia	**21 cm Horn built by Jeff Lichtman**

5



Red Shifted Hydrogen scan detected by Ryan Lane, using a RAS Spectracyber at the University of North Texas

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References

I would like to thank all those who contributed information on the following sites.

http://search.nrao.edu

http://www.cr.nps.gov/history/online_books/butowsky5/astro4k.htm

http://search.nrao.edu/?q=ewen+purcell&ie=&oe=

http://en.wikipedia.org/wiki/Horn_Antenna

Home Observer of the Quarter: Jonathan Rawlinson

Observer of the quarter

We had planned to feature David Morgan this issue, but as can be seen below events persuaded us to change our plan, so look out for David in the next issue. Few readers would have failed to be impressed by the subject of this spot in our first issue; we described in the Home Observatory of the Quarter the young Jonathan Rawlinson, and showed some of his experiments at his farming home. He also wrote an excellent article on 12 GHz solar measurements. Indeed somehow that article rapidly came to the attention of the organisers of the annual ARMMS RF and Microwave Society, and they immediately offered Jonathan their Young Engineer Sponsorship award, which included £100 cash and free conference participation. He presented that same paper to this conference, a great achievement for this young enthusiast. Congratulations, Jonathan !

In his own words, he now reports on his ARMMS experience and what he is up to next.

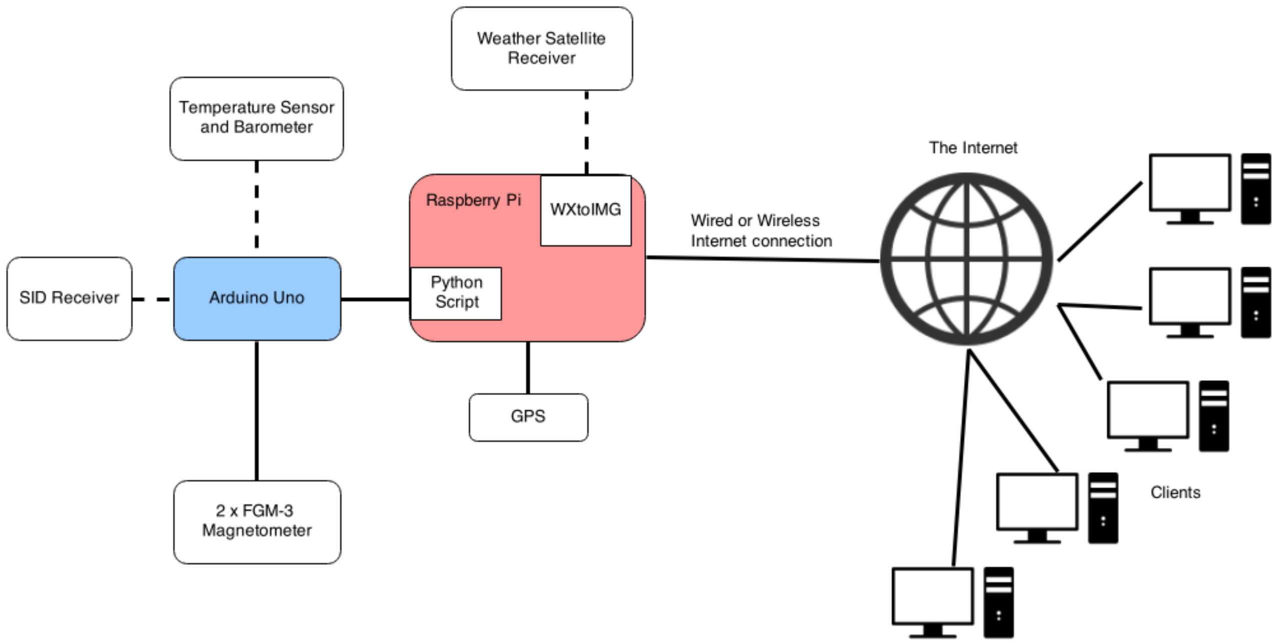
The ARMMS RF and Microwave Society Conference, Autumn 2013 - J Rawlinson

The ARMMS Conference this year was very exciting and covered a wide range of areas and industries. It was held in the Wybosten lakes executive centre. I was kindly asked by Dr Stepan Lucyszyn to come along and present the article I wrote for the previous issue of the *RAGazine* (Solar Imaging in the Ku Band). I was also offered the young engineer sponsorship; this included free access to the conference and £100.

There were some extremely interesting presentations on a variety of topics such as a solar powered 3G signal boosting umbrella, 3D Smith charts and W-band photonic crystal filters. There was also a very interesting paper about RF operated and powered sensors within the body, which won the best paper award. This was written and presented by Dr Olive Murphy. Overall I really enjoyed the conference and am looking forward to the next one ! I met a lot of great people and learned a lot ! I would like to pass on my thanks to the ARMMS RF and Microwave Society for allowing me to take part.

Future plans

In addition to the above, below is a taste of my next article for the next issue of *RAGazine*. It will be about an internet enabled magnetometer station that is able to report its results to a website for easy viewing and for further analysis. The system will be extendable to support many different data sources such as SID receivers and weather satellite receivers (APT). In the future I also plan to allow it to connect to the mobile phone networks or to WiFi networks to report the results in the absence of a wired internet connection. The magnetometers are both type FGM3. The FGM3 is a highly sensitive magnetic field sensor that is encapsulated in a simple 4 pin package. The output from these sensors is a square wave whose period is directly proportional to the field strength. The magnetometers will be buried underground and placed at right angles to each other. The setup will also include a GPS receiver for accurate timekeeping, as shown overleaf.



Thanks for reading, stay tuned !

If you would like to contact me please email me at m0zjo@qsl.net

Jonathan Rawlinson/M0ZJO

BAA RAG Solar Radiometry Workshop

[Editor's note: there is a more formal report by Diane Swan of this successful event in the Dec. 2013 issue of the J. Brit. Astron. Assoc. (pp. 370-1). But this report below was prepared very soon after the event and nicely conveys the productive, informal style of the workshop - and some useful technical circuit details …. and the decent results with potential for further development !]

Results and Further Information from the Workshop on the 7th September 2013 at the National Space Centre Leicester

- Tony Abbey

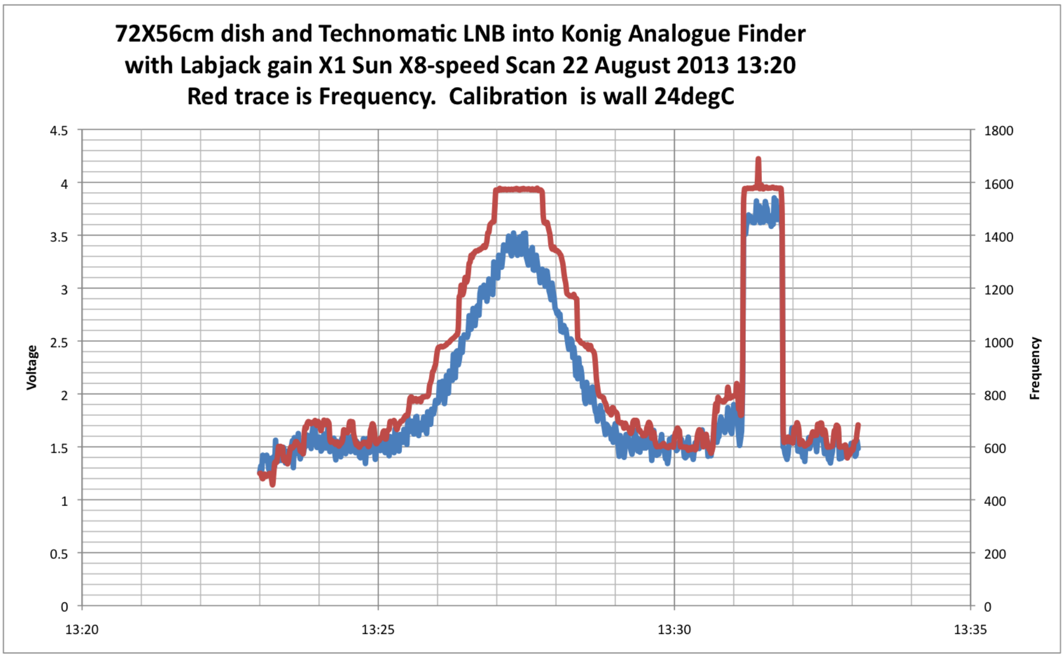
The Day's Activities

The day was divided into an introduction and description of the satellite finder modifications we were going to perform, then splitting into two groups. The first group of nine modified their sat finders and we started testing them with a dish and LNB in the 'back-yard' of the NSC, while the second group had lectures from Jeff Lashley on the more theoretical aspects of what we were doing. Then the groups swapped over. Testing of the finders was done with a 72 X 56cm satellite dish and Technomatic 0.1dB noise factor LNB mounted on a telescope mount which could track the sun or be driven at X8 sidereal rate. The analogue output of each finder was fed into a Lab-jack USB datalogger which was configured to be able to digitize signal strength outputs from three units via Low Pass Filters consisting of a series 22kohm resistor and 1uF capacitor to ground. The logger also monitored a signal from the frequency output of the V-F converter in one sat finder. Note that the signal from the finders can be as much as 8V, which might need to be attenuated if fed into the UKRAA logging system with max i/p of 5V.

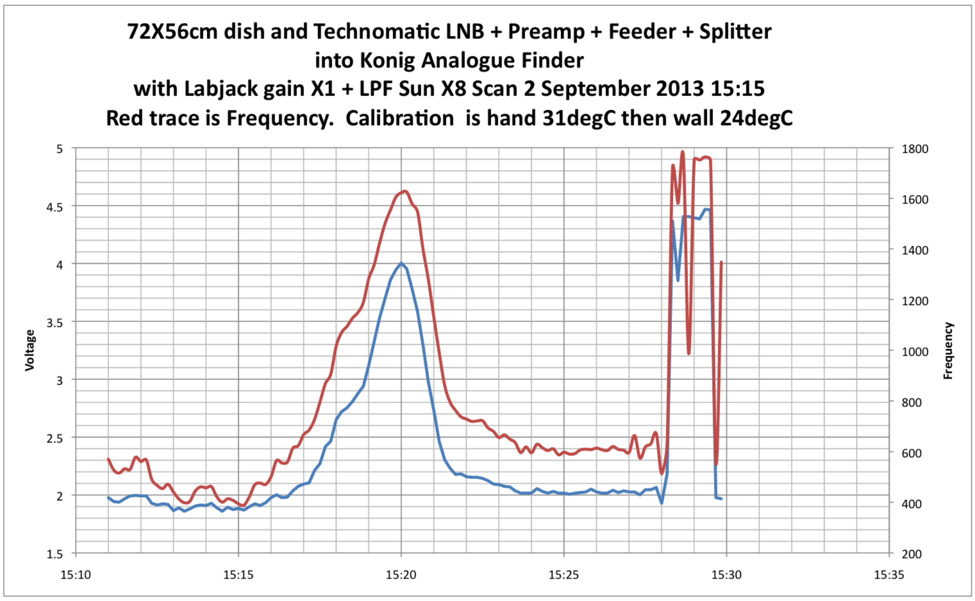
The modification of the sat finders took somewhat longer than was planned, so the testing ran into the end of the day when the sun was getting hidden behind the building. In order to test as many modified sat finders as possible, three at a time were tested with one frequency output also being logged, and the satellite dish was driven at X8 sidereal rate causing the sun to pass through the beam in just a couple of minutes, so the curves are not as good as we might have wished for from a normal sun drift scan. Also there were obstructions such as a lamp post in the way, so because the dish was moving the obstructions could also be picked up instead of a fixed dish position with the sun moving through the beam as the earth turned.

The results from the six testing runs were recoded in separate spreadsheets numbered data25 to data30 – each plot on the graph showing the name of the sat finder's owner. The one frequency plot per three analogue outputs has the initials of the owner. The first set of results (data25) was performed without a line amplifier to overcome the feeder and 3-way splitter loss, so the signal strength output from the three finders is much less than on the subsequent tests. Despite the deficiencies in the test method, the spreadsheets show that all the finders performed in a similar way, so the modifications were successful. The last file (data30) was a manual scan using an Aldi portable dish and Ross high gain LNB mounted on a photographic tripod, but the sun had already disappeared behind the building, so only dark sky and hot building was available.

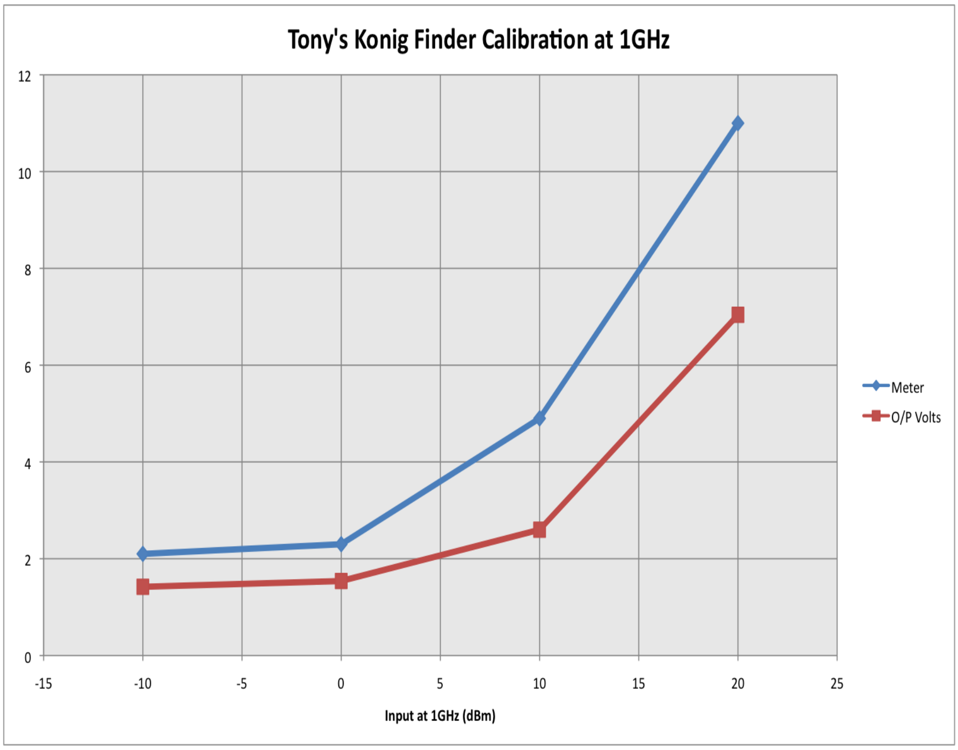
I had previously tested various set ups in my back garden where the environment is better controlled than the NSC, and the following graph shows the expected result of the x8 drift scan and static pointing at dark sky and warm wall.



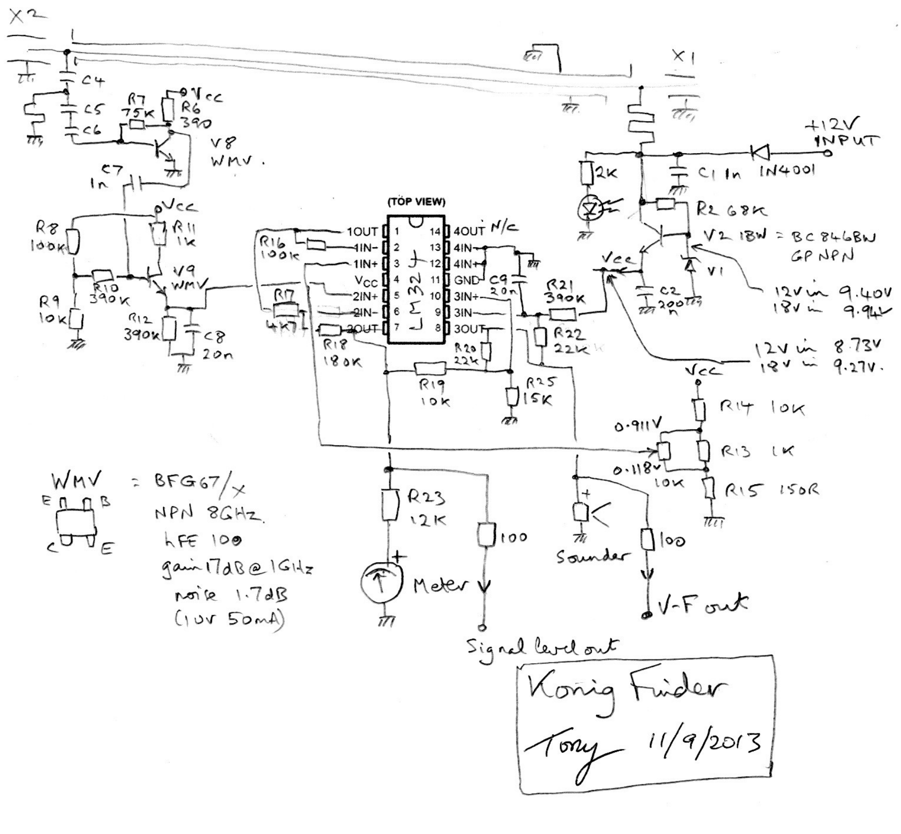
You will notice in the above graph that the frequency output from the finder jumps in discrete steps. This was cured by loading the frequency output with a 2k2 resistor and series 1uF capacitor. This also had a serendipitous effect of allowing the oscillator to work over a wider range. The following scan was obtained with this modified configuration, and also the feeder and splitter used for the NSC tests.

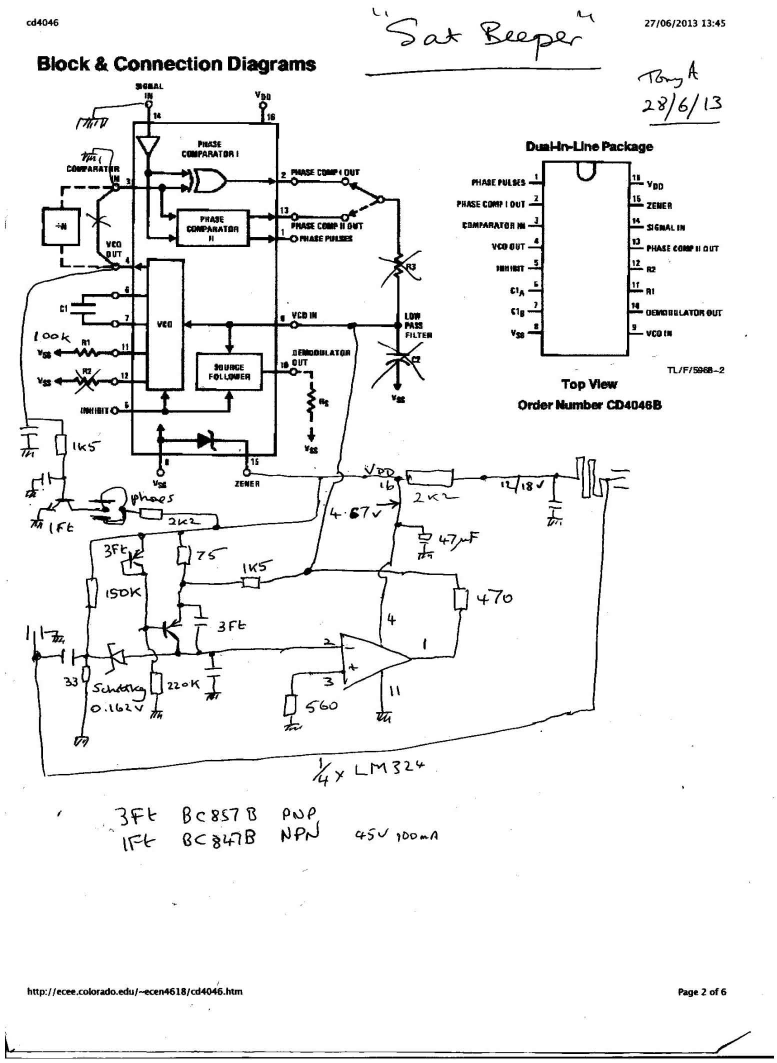


I was also able to test my Konig finder that I had already modified with Alan Melia's 1 GHz signal generator and attenuator. The following graph shows the calibration curve for a particular setting of the front panel potentiometer. Note that the pot is an offset control – the limited dynamic range of the sat finders of 20dB or so can be positioned with this control over a wide range of absolute signal strengths.



I have studied the Konig finder extensively and here is the circuit diagram showing where the output connections were made. As I mentioned in my talk, I have also investigated the performance of the "Sat Beeper" which produces a frequency output to an earpiece, and uses a logarithmic amplifier so it is able to cover the full signal range without needing an offset control. Since a log amplifier may be more compatible with the data needed for scientific measurements of the sun, this is an area I will be looking into. I may be able to publish a further modification to the finder to enable this type of response. I have also studied the Sat Beeper, and its circuit is also shown below. Surprisingly, extensive searches of the internet have not revealed any previous circuits of these items.





Further Enhancements

It was mentioned in the talks that a way of ensuring stability of the system against thermal effects is to use so-called "Dicke" switching. This means that the input of the LNB is constantly switched between the wanted signal and a dummy load. The dummy load aims to maintain the same noise performance of the front end as when it is connected to the wanted signal. This can be done on an LNB by using the channel which would normally be used for receiving the 90 degree rotated satellite channels but removing the connection to the waveguide signal pickup. The switching is done by switching the LNB power from 12V to 18V. We propose to investigate how easy modern LNBs can be modified, and develop a suitable microcontroller system to perform this switching and perform the necessary signal subtraction to stabilise the system.

At the end of the day I was also able to show a small demonstration of the use of a Raspberry Pi computer for measuring the frequency of the voltage-to-frequency output of the sat finder. In this case I was using a USB sound card as the interface, but, in principle, a timer-counter circuit in the RPi should be able to achieve this measurement without further hardware.

Another area I would like to investigate is the use of the DiSeqC system for rotator control. This works by injecting a 22kHz signal on the LNB feeder which is used for serial communication with suitably equipped peripherals. These rotators along with larger dishes can sometimes be picked up on eBay for a fraction of their original cost. Such a system would allow for unattended operation of a system to monitor the solar output.

Although time doesn't allow now, the combination of a known rate of traverse across the sun will give the beamwidth of the dish plus the calibration from pointing at an object of known temperature (wall) allows the solar temperature to be measured. Jeff covered this in his talk. I will see if I can also calculate this figure from the setup we had at the NSC. If any of the participants are able to do this, I would be pleased to hear of your results.

Conclusion

I hope that all participants learnt something and enjoyed the practical aspects of these simple modifications to a low cost consumer item to convert it into a scientific instrument. I wish you the best of luck in further development of your instrumentation.

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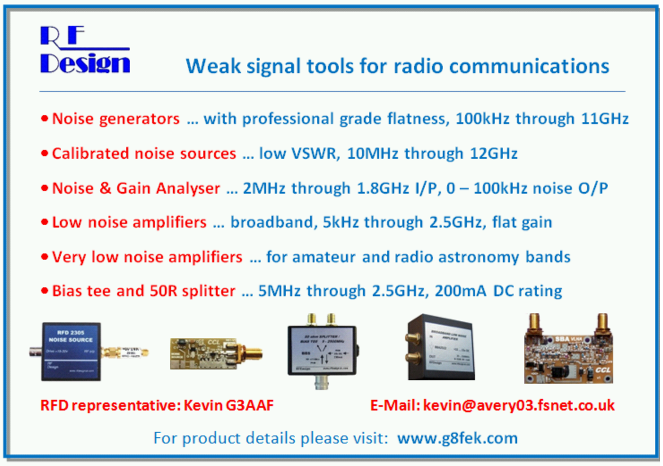

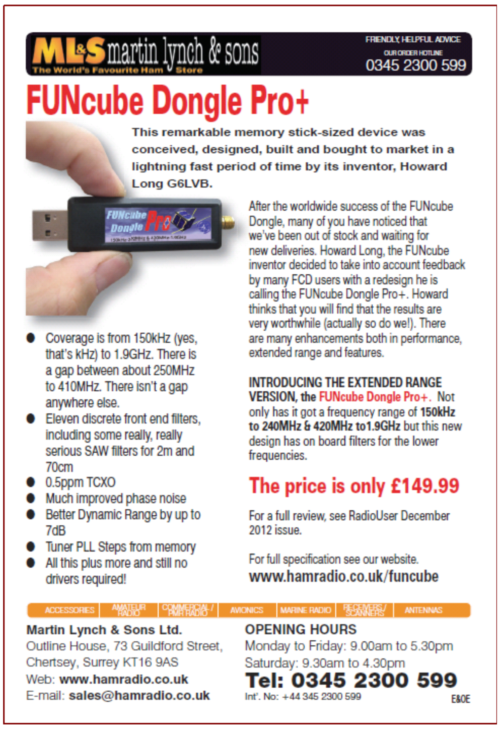

[Advertisement feature]

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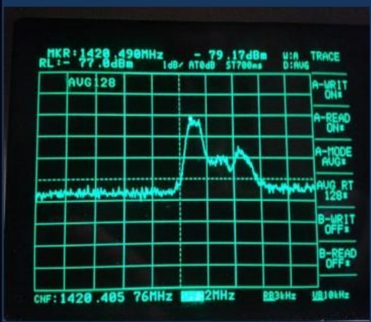

Actual data (Cygnus) from converter Circuitry within a Spectracyber. (John McKay)

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Noise Figure	<1.0 dB
Connectors RF/IF	N, BNC
Power DC	Feedthru
Power	+12 Vdc., 200ma

Note: Converters shown are all housed in identical cases.

406.7 MHz. Converter

Frequency Cf	406.7 MHz.
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Engineering Maths, and more ….

A Mathematician (M) and an Engineer (E) attend a lecture by a Physicist. The topic concerns Kulza-Klein theories involving physical processes that occur in spaces with dimensions of 9, 12 and even higher. M is sitting, clearly enjoying the lecture, while E is frowning and looking generally confused and puzzled. By the end E has a terrible headache. Finally, M comments about the wonderful lecture. But E says, "How do you understand this stuff?"

M: "I just visualize the process."

E: "How can you POSSIBLY visualize something that occurs in 9-dimensional space ?"

M: "Easy, first visualize it in N-dimensional space, then let N go to 9."

——

A bunch of Polish scientists decided to flee their repressive government by hijacking an airliner and forcing the pilot to fly them to a western country. They drove to the airport, forced their way on board a large passenger jet, and found there was no pilot on board. Terrified, they listened as the sirens got louder. Finally, one of the scientists suggested that since he was an experimentalist, he would try to fly the aircraft.

He sat down at the controls and tried to figure them out. The sirens got louder and louder. Armed men surrounded the jet. The would-be pilot's friends cried out, "Please, please take off now ! Hurry, hurry !" The experimentalist calmly replied, "Have patience. I'm just a simple pole in a complex plane."

——

How many physicists does it take to change a light bulb ?
Eleven. One to do it and ten to co-author the paper.

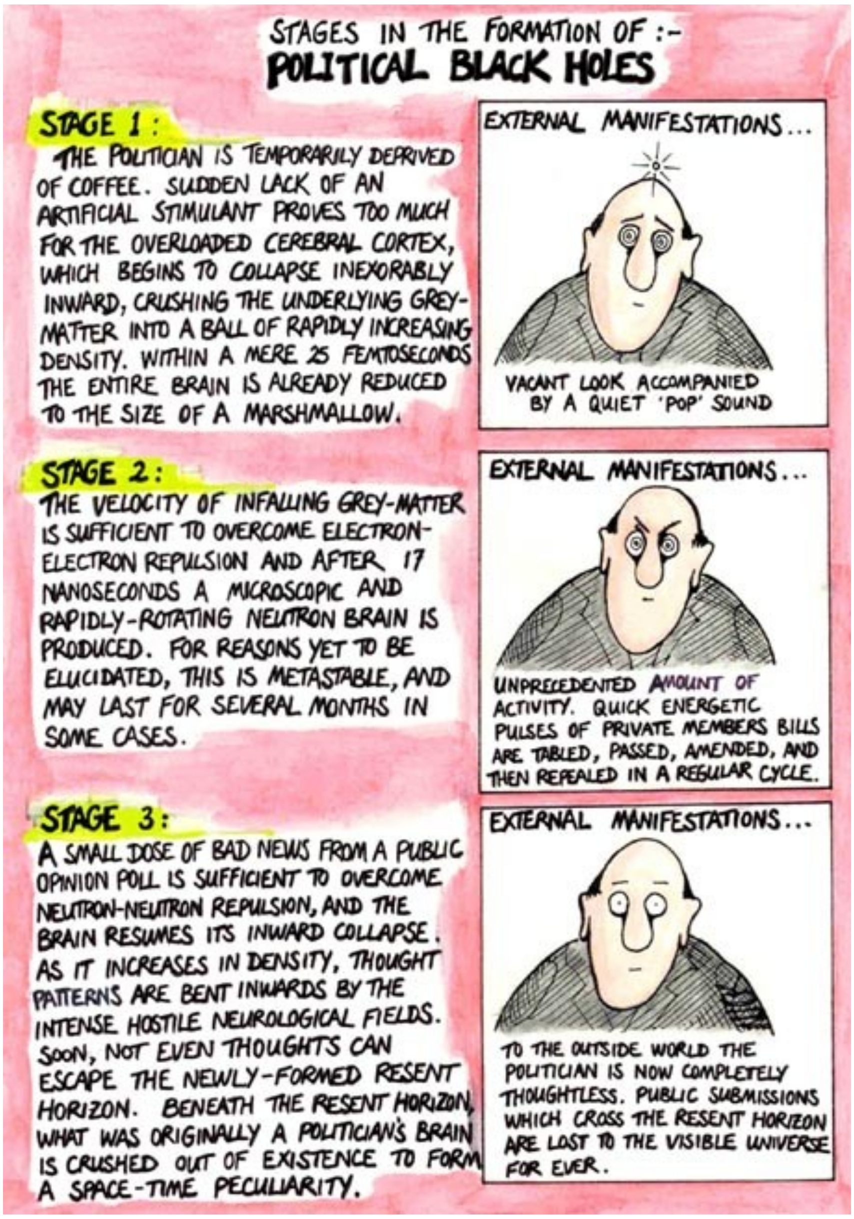
How many astronomers does it take to change a light bulb ?
None, astronomers prefer the dark.

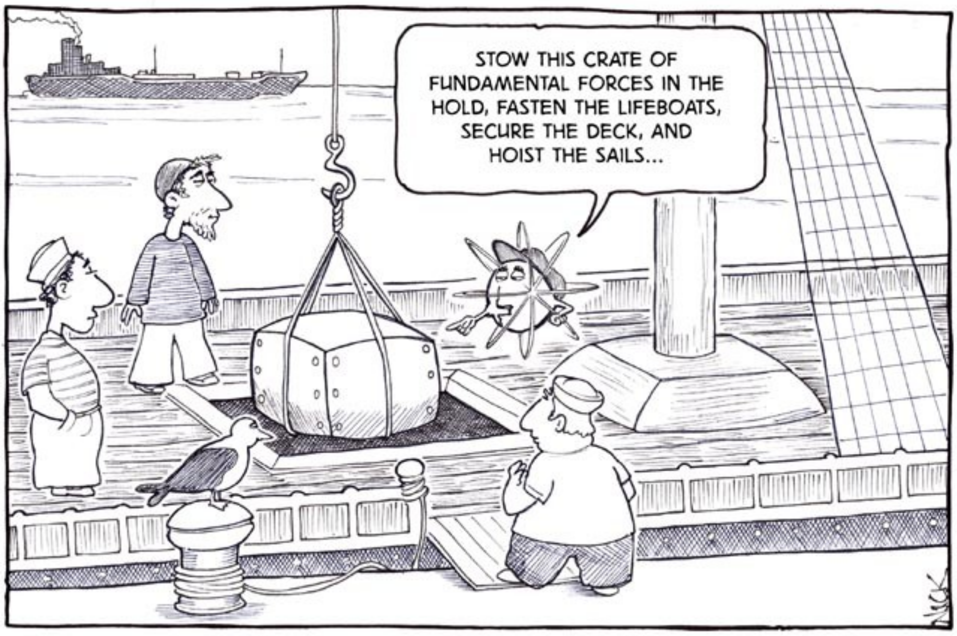
How many radio astronomers does it take to change a light bulb ?
None. They are not interested in that short wave stuff.

How many general relativists does it take to change a light bulb ?
Two. One holds the bulb, while the other rotates the universe.

——

and more ….



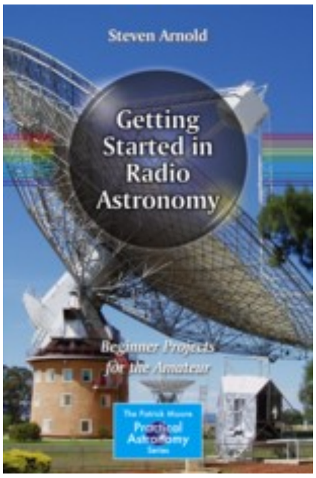


A Higgs Bosun

“Getting Started in Radio Astronomy” by S Arnold: Book Review

Books

- Dave James dave@greenover.net



Getting Started in Radio Astronomy: Beginner Projects for the Amateur
by S Arnold, Springer, 2013
208 pp., £20 rrp

This slim effort is yet another paperback in the Patrick Moore Practical Astronomy series. Inside the cover it actually states 2014 as the publication date ! The title is about right. If you know nothing about radio or electronics, I suppose this book may help you some. For instance it explains what a soldering iron is, how to use it, likewise a multimeter, a magnifying viewer and so on.

It gives the reader first an introduction to the history of radio astronomy. For a reader who has no other book on the subject at all and is averse to the internet, this history is not badly done, in fact it’s probably the best part of the book. Basic electricity and magnetism is covered by the next chapter, then magnetic fields and magnetospheres. The treatment is elementary, but possibly alright for a complete novice. But the quality of the physical text layout, use of sub-headers and of the figures is nothing like that from Springer’s professional stable.

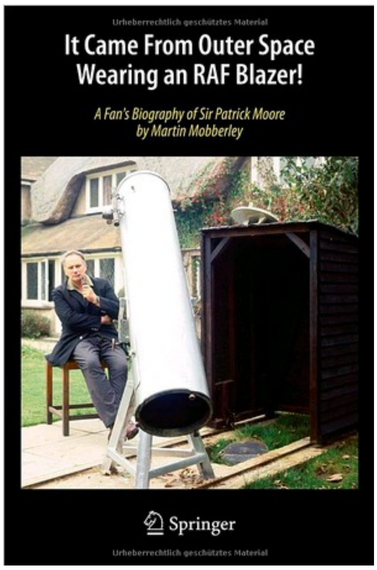
A crash course in electrical components educates the reader on the nature of common wire-ended components, the colour code, the nature of transistors and ICs, and there is a tolerable photo of a pair of headphones in case the reader had any hidden fears there. There is no mathematics here except the single equation relating *c* to wavelength (but without the units defined or properly explained !)

The main meat of the book for most readers is probably the four chapters which describe the SuperSID monitor; the INSPIRE receiver and a bit about VLF more generally including the “VLF chorus”; the JOVE receiver for Jovian and solar emissions; and meteor detection using an economical ‘scanner’ type receiver. The pace is pedestrian and a tad over-conversational in places.

Of course much of this is strictly not radio astronomy, but geophysics. Nothing wrong with that, but the author should really explain how all this relates to the physics more, and how any of this relates to what is being done by professional astronomers. To be fair, when my nine-year old grandson is a few years older, this is probably a book for him if he likes science. Which is fine. For most of us, is it worth the tenner or so one can buy it for ? Yes, one can always learn interesting or even useful snippets, and I think this makes decent light reading when waiting for a train or similar. This book could have been a lot better, and it’s clear that Springer spent no money on proof-readers or help with figures and layout. I think the author missed a key point: it would have been better to try to produce this like a Haynes workshop manual type book. At least it would then have been appealing to the eye. It could yet inspire some youngsters, though; I hope so. For my part, I’d still recommend Lashley’s book for a newcomer - or just use of the internet.

"It Came From Outer Space Wearing an RAF Blazer !: Book Review

- Dave James dave@greenover.net



It Came From Outer Space Wearing an RAF Blazer !: A Fan's Biography of Sir Patrick Moore
by M Mobberley, Springer, 2013
640 pp., paperback, £23 rrp

This is an enormously satisfying book, about a larger-than-life public figure by one who knew him extremely well for over thirty years. Mobberley had interviewed countless individuals for something like a decade before Sir Patrick's sad death just a year ago, but like PM he had been keeping logbooks recording not only astronomical observations, but anecdotes and meetings of all sorts for longer than that. Mobberly was 35 years younger, and was inspired into astronomy by the great man. They both joined the BAA at age 11 !

Mobberley's style is extraordinary. He still retains enormous respect and love for PM, but he also knew all his foibles, his near racist and misogynistic tendencies, and his outrageous put-downs. The level of intimate detail described here is most unusual, especially so soon after PM's death. He debunks several of the silly myths that have grown up, and gives real detail of PM's life in all its facets - not just the TV appearances and the writing that just about sustained him financially. No stone is left unturned, so this is a rich treasure-trove of biographical detail that is rare these days. Unsurprisingly, almost every one of the 640 pages is brimmed with content that will make the reader chuckle, protest, admire and pity.

Interestingly my father, who was a navigator bomb-aimer on Lancasters during WWII did meet PM more than once, even though PM was on Wellingtons. My father was interested in astronomy and I guess that was the subject that led them to be in the same place together, probably on the edge of an airfield. In notebooks recently I found my dad's short reference to PM as a 'twit'; that was strong vocabulary for my dad ! There is the debunking of the myths over his fiancee, the visits to the concentration camps, the wartime clandestine missions and activities, and so on. In most cases this turns out to be arising from earlier Biggles style bravado, but it all later returned to haunt him as his fame and stature grew.

We British love an eccentric, but in PM's case some of it was particularly well exposed through the media, and in later years at time this became nearly intolerable. As the years went by, his weight grew and mobility suffered and he came to rely on an ever changing number or personal carers. And it is sad to read how even towards the end of his life there were many cases of charlatans trying - a few successfully - to gain favours or simply steal items from him. It's all here: the personal long feuds with several senior luminaries within the BAA and (all !) women within the BBC, for example, and over the magazine *Astronomy Now* that he had started in 1987.

PM was eccentric, irascible and could be quite devious according to Mobberley, and could also be far from objective over scientific matters. For example, he insisted on pushing the TLP story throughout his life, against all good evidence, and stubbornly persisted over lunar vulcanism to the end. His tremendous generosity is well documented here and in later life this meant he needed financial help from friend Brian May to stay in his beloved Selsey home. There are thousands of glorious exchanges and adventures recorded, many quite dotty by any standards. Mobberley has even included three very tightly spaced pages of *Some of Patrick's Favourite Expressions.* A few of my cherished choices are here:

- About Creationists, who believe the world was created by God 6,000 years ago and who dispute Darwinian evolution: "If ignorance is bliss, they must be very happy"

- About the Archbishop of Canterbury (for refusing to condemn blood sports): "That bewhiskered old coot has neither the brains, nor the ability, to run a whelk stall"

- "A Kraut, is a Kraut, is a Kraut !"

- "Ban all women teachers."

Countless stories of political un-correctness are presented, also accounts of PM's membership of the Raving Loony Party, of UKIP and so on. But for me one of the most delicious sagas described arose from PM's long friendship with Frank Hyde, the foremost UK (and international) amateur radio astronomer of the '60s and who was my personal inspiration on RA when at school (see the Sullivan book review in the last *RAGazine* issue). Here there is the full story of the mistress, the caravan sited in the Clacton field and containing the copying machine, the corruption introduced into the top echelons of the BAA, the ensuing court case over the resulting shoddy print quality of the BAA's Memoirs, and so on. One couldn't make it up, except in a Tom Sharpe book ! This was not the only time PM had to rapidly distance himself from close friends.

Patrick Moore did a power of good in inspiring several generations to take up astronomy, and in many cases they are now professionals. He was a consummate, idiosyncratic author, journalist and presenter of the modern TV age, who brightened our lives despite his political un-correctness and outrageous championing of lost causes - or perhaps partly because of this. To think that the Russians relied heavily on his lunar maps for their early missions is for us today extraordinary, for PM was an amateur. It's all here, and more.

This is a book to read, re-read and savour, to dip into time and again: a wonderful, easily digestible detailed biography of Sir Patrick, warts and all. You will not learn an enormous quantity of new astronomy, perhaps, but you will enjoy every page - and that makes for a grand book on a grand man.

Papers from SARA: the RASDR and the SIDruino

To fit in two interesting articles from SARA, each has been quite drastically edited, but this seems better than delaying them. The first summarised item is derived from the article in the latest SARA J on development status of the RASDR (Radio Astronomy SDR). The second covers usage of an Arduino for data processing the output from a SID (Sudden Ionospheric Disturbance) monitor, but could equally be applied to many other sensors. It was presented at the 2013 Green Bank conference. Apologies to the authors for possibly too aggressively shortening their work.

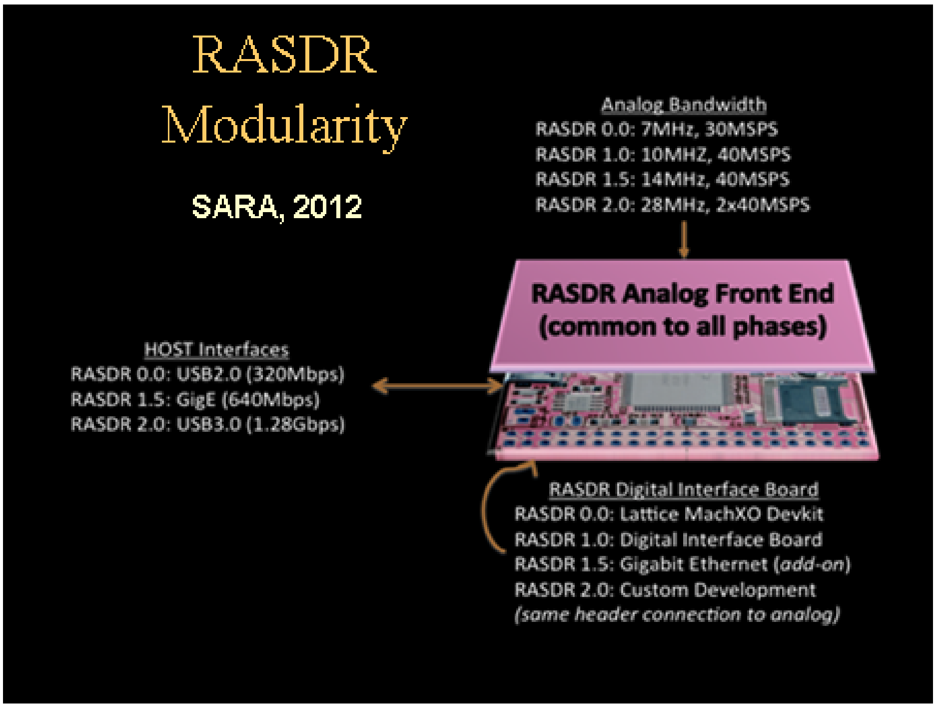
RASDR development update – October 2013

SARA

- David Fields, Stan Kurtz, Carl Lyster, Paul Oxley, Bogdan Vacaliuc and Zydrunas Tamosevicius

Introduction and Status

The Radio Astronomy Software Defined Receiver (RASDR) is a project undertaken by SARA members to develop a low cost, high performance software defined receiver for use by SARA members and others. RASDR0 hardware and software development is complete. RASDR2 hardware development is complete and the first version of radio astronomy software is near release.
RASDRviewer v.1, our radio astronomy software, is in final development – note the performance test results later. The current version does not have a waterfall display, so we'd like to have someone on the team to add this functionality; if anyone has OpenGL expertise, we'll package and share a code development package.



Project Update

The RASDR development path, shown below, was discussed at the last two SARA annual conferences. The RASDR development plan included RASDR0 in 2012, followed by versions that would give higher bandwidth and Ethernet/USB3.0 speeds in 2013 and 2014.
RASDR0 was our 2012 benchmark, while RASDR1 was expected in 2013. RASDR2 was a 2014 goal. Development of the RASDR0 hardware configuration and computer code is complete.
With the powerful technology available with the Lime 6002 chip in the Myriad (Myriad-RF) and Nuand (bladeRF) boards, we won't invest developmental time on RASDR1.0 and RASDR 1.5.
With RASDR2, we are ahead of our planned schedule. The RASDR team has been working with Myriad to develop an SDR package (RASDR2 hardware and software) that will support radio astronomy educational and research activities. This is based on their Myriad-RF board shown on the right side in the following figure. The configuration shown is a good development package, but is not optimized for SDR or other astronomy applications.

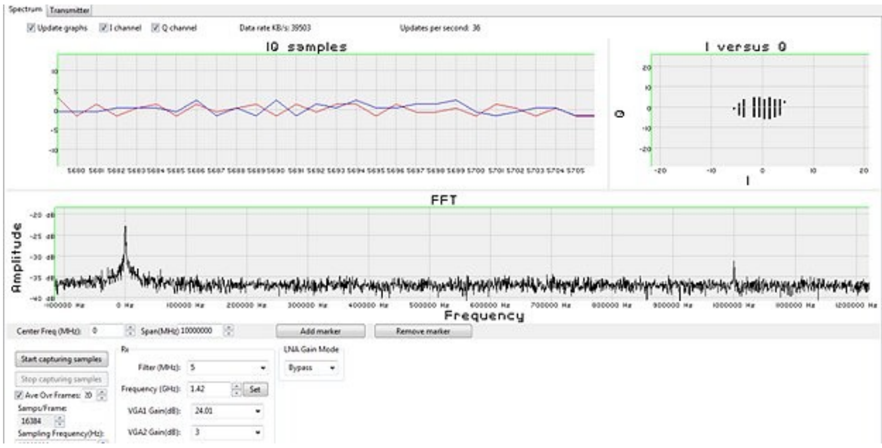
The Myriad/Lime team suggested that they could make a very low cost SDR that might fit our RASDR2 needs by omitting an FPGA, and using two FX3 (USB3) chips, one for receive and one for transmit. The FX3 chips would be contained on a “DigiRed” board that would mate with the existing Myriad RF board. DigiRed would also contain the missing reference frequency locking components. DigiRed would avoid the need for a FPGA by using the inherent FX3 General Purpose Input / Output (GPIO) pins to provide the necessary Serial Programming Interface (SPI), I2C interface and handshaking between the USB stream and the Lime chip. The PC driving the data collection will need to have a minor amount of additional code to initiate the handshaking at the appropriate time. The RASDR team worked with the Myriad/Lime team toward a design that would satisfy multiple objectives.

The RASDR2 hardware configuration, consisting of a DigiRed board combined with the Myriad-RF board, has settled down to a stable receiver configuration, with the basic RF board shown on the right side of the figure below, combined with a new DigiRed board. This figure thus shows the RASDR2 configuration, which uses the Myriad-RF board and the DigiRed board.

We have been working with Myriad engineers to develop software to support the radio astronomy community. Two codes are FFTViewer and RASDRviewer. FFTViewer is a multi-purpose code and like our RASDR0 code, is intended to permit control of both transmit and receive functions. RASDRviewer is our Radio Astronomy code and provides receiver and data processing functions. Both codes have been tested on Windows 7.

RASDRviewer performance

RASDRviewer is our primary radio astronomy code, which runs in Windows and permits front-end control and receiver parameter optimization. The RASDRviewer GUI permits data visualization, FFT averaging, and tweaks for processing – the code does not support transmit functions. The figure below shows RASDRviewer output during a low-signal (-100dBm) FFT averaging test (number of samples = 20). The central peak is the baseband 0-frequency, set to 1420MHz, while the test injection frequency was 1421MHz, power level -100dBm. Internal 6002 chip amplification was about 30dB and bandwidth was 10MHz. The screen was expanded to show about 1.5 MHz, resolving the hash left after FFT averaging of 20 frames. This run used 12bit A/D conversion and each FFT was performed using 16384 points.



The 1421MHz input signal is the small peak on the right, while the center frequency (0 Hz baseband central value) is at 1420MHz. The current version of RASDRviewer has additional functionality and a cleaner display.

Initial data collection runs show that the package has significant utility, although we haven't finished with display changes or implemented code functions that we regard as necessary for a radio astronomy package. RASDRViewer v.1 will be released when these changes are implemented.

It should be noted that the measurement above was made without an external LNA, so adding one should reduce the noise floor and increase the sensitivity.

Needs

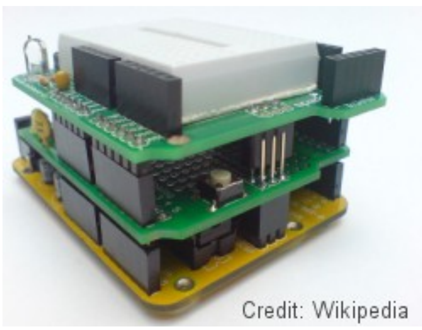
RASDRviewer v.1 is being prepared for release with power calculation functions and an upgraded display. A waterfall display would be a useful addition and we'd like to find a volunteer with OpenGL knowledge, who might implement this capability.

The SIDruino

- Ciprian Sufitchi N2YO

Arduino and SID

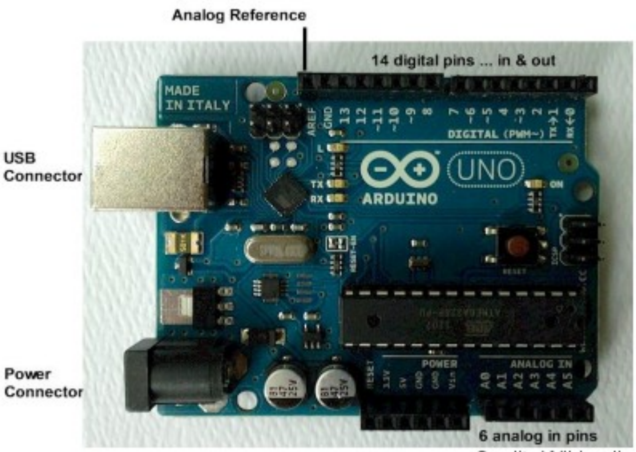
The original Arduino hardware is manufactured by the Italian company Smart Projects. So far 16 versions of the Arduino hardware have been commercially produced to date, but Arduino Uno is currently the most popular. An important aspect of Arduino is the standard way that connectors are exposed, allowing the CPU board to be connected to a variety of interchangeable add-on modules known as shields. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus, allowing many shields to be stacked and used in parallel. Virtually all computing and communication functions are covered by commercial shields available from various manufacturers. Some examples include: TFT touch screen shield, Ethernet shield, Wi-Fi shield, Bluetooth shield, GPS shield, Data logging shield, RGB LCD shield, Motor control shield, SD card shield, GPRS shield, and more.



Generally the sensors are not specifically designed for Arduino boards. Usually no special interfaces are needed to connect sensors to the board. Some examples of popular sensors include: physical pressure, light, environmental temperature, motion/vibration and orientation, IR signals from remote controls, magnetic field, hall effect, sound, humidity, air pressure, and more.

Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as pulse width modulation outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button.



Credit: Wikipedia

Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

The SID Monitor

The SID (Sudden Ionospheric Disturbance) Monitor has been developed at Stanford University under funding from the Center for Integrated Space Weather Modeling (CISM), a National Science Foundation (NSF) Science and Technology Center. The SID Monitor is able to detect indirectly solar flares stronger than C.2 by monitoring signals in VLF band reflected by the ionosphere. Essentially when a solar flare occurs on the Sun a blast of intense ultraviolet and X-ray radiation hits the dayside of the Earth after a propagation time of about 8 minutes. This high energy radiation is absorbed by atmospheric particles, raising them to excited states and knocking electrons free in the process of photo ionization. The low altitude ionospheric layers (D region and E region) immediately increase in density over the entire dayside. The ionospheric disturbance enhances VLF radio propagation.

Based on AAVSO (American Association of Variable Star Observers) original concept, the SID monitor is an AM receiver that is tuned to one VLF station. The inputs are for power and antenna and outputs are one audio and one signal strength. Inside the box the signal is detected/filtered, amplified, rectified, and integrated to measure signal strength.

The output DC signal can be converted to numeric values using an external analog-to-digital converter (ADC) device. Together with the SID Monitor device the Stanford University provides software for PCs to measure, store and report the signal received. The software currently supports only the DI-194RS ADC device from DATAQ Corp. Importantly a dedicated PC is required for 24/7 monitoring, although it need not be fast.

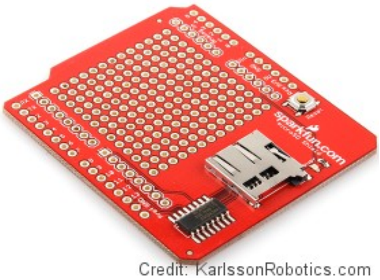
The ADC and the computer can both be replaced by a microcontroller which will to the same tasks and even more, for a fraction of a price, maintenance virtually free and very low power requirements. Arduino Uno is the ideal candidate. The combination between the SID Monitor and Arduino could be referred to as “SIDruino”.

SIDruino: SID Monitor + Arduino

At a minimum, the SIDruino system should be able to read at certain moments of time the voltage value detected by the SID Monitor and report that value together with the current date and time somewhere where it could be taken later for analysis, graphical representation, etc.
Remotely operated systems should be able to send the measured voltage values with appropriate techniques: Bluetooth, Wi-Fi, Ethernet, UHF radio or GSM.

Since Arduino Uno does not have a real time clock (RTC) on board, an additional real time clock “shield” should be connected to the circuit. Inexpensive RTC units (as low as $3 per piece) can be found on market, such as DS 1302.

The Arduino Uno board has a very limited amount of flash memory, so data storage should be carried out somewhere else. Special SD (Secure Digital) shields have been developed specifically for Arduino boards and they are available on the market for low prices. Sparkfun produces a very popular microSD shield which can be purchased for about $15, as below.



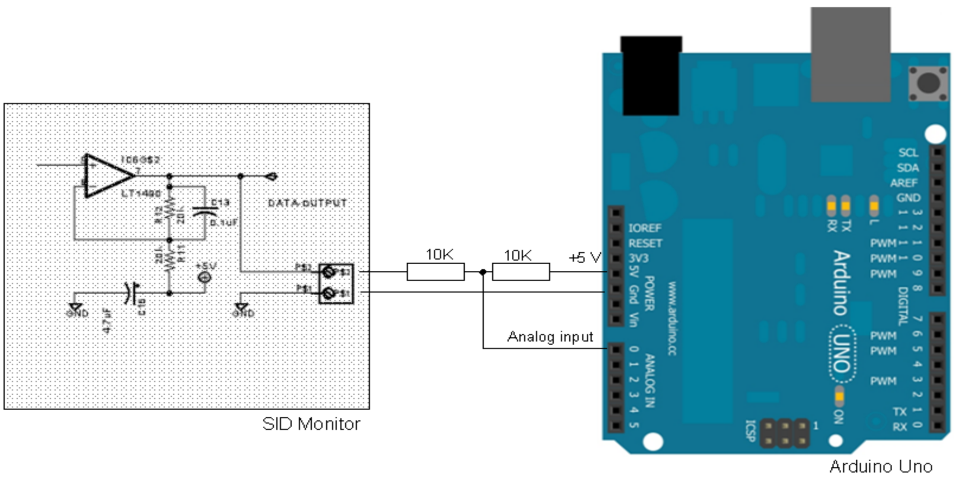
Credit: KarlssonRobotics.com

However there are many other less expensive choices to store data on SD or microSD cards. Small size SD cards (1, 2 or 4 GB) are available for less than $5 per each and can store continuously data for many years without the need of a memory replacement.

The minimal configuration for SIDruino is thus:

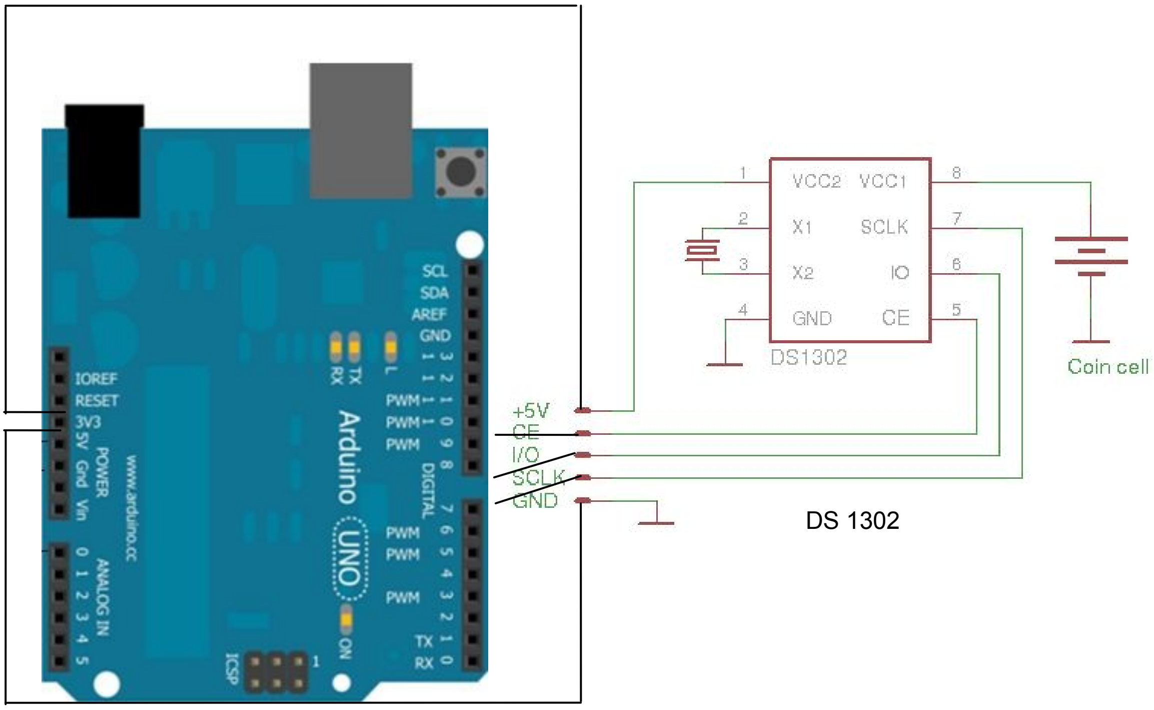
SID Monitor
Arduino Uno board
RTC (e.g. DS 1302 shield)
microSD logging storage (e.g. Sparkfun microSD shield)
microSD card (e.g. 2 GB)

SIDruino should monitor the VLF channel, read the voltage value from the SID Monitor every 10 seconds, convert it from analog to digital, then store the measured value in a file on a SD card. Arduino Uno has up to six analog inputs. For this project only one is required, however the voltage range is limited 0-5 V. By design the SID Monitor has a DC output ranging between -5 V to +5 V. One immediate solution could be a simple resistive adapter, while the circuitry of the monitor could be improved in the future so that the output range is optionally 0-5 V.



The real time clock with DS 1302 should use digital I/O connectors and it could have this possible configuration:

CE_PIN - pin 8
IO_PIN - pin 7
SCLK_PIN - pin 6



DS 1302

Arduino Uno

Finally the microSD shield (not pictured) should have the following pin assignments:

MOSI - pin 11
MISO - pin 12
CLK - pin 13
CS - pin 4

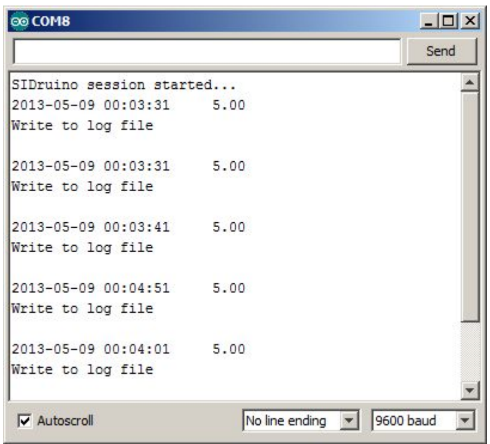
The code

The code required for SIDruino to work is written in Wiring, which is a programming language very similar to C/C++. It requires two open source libraries to handle functions for RTC and microSD. To monitor the health of the system an LED has been added between pin 13 and ground to briefly Flash when data is reported.

```
#include <SdFat.h>
#include <stdio.h>
#include <string.h>
#include <DS1302.h>
const int chipSelect = 8; // This is for Sparkfun board
SdFat sd;
SdFile myFile;
int led = 13;
/* Set the appropriate digital I/O pin connections for DS 1302 */
uint8_t CE_PIN   = 8;
uint8_t IO_PIN   = 7;
uint8_t SCLK_PIN = 6;

char buf[50];

/* Create a DS1302 object */
DS1302 rtc(CE_PIN, IO_PIN, SCLK_PIN);

void sid_report()
{
      /* Get the current time and date from the chip */
      Time t = rtc.time();
      /* Format the time and date and insert into the temporary buffer */
      snprintf(buf, sizeof(buf), "%04d-%02d-%02d %02d:%02d:%02d",
            t.yr, t.mon, t.date,
            t.hr, t.min, t.sec);
```

```
	if (!myFile.open("log-sid.txt", O_RDWR | O_CREAT | O_AT_END))
	{
		sd.errorHalt("Opening log-sid.txt for write failed");
	}
	// read the input on analog pin 0:
	int sensorValue = analogRead(A0);

	// Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
	float voltage = sensorValue * (5.0 / 1023.0);

	// write the value on SD card
	myFile.print(buf);
	myFile.print("\t");
	myFile.print(voltage);
	myFile.print("\n");
	myFile.close();

	// print out the value on serial connection
	Serial.print(buf);
	Serial.print("\t");
	Serial.print(voltage);
	Serial.print("\n");
}

void setup()
{
	Serial.begin(9600);
	pinMode(led, OUTPUT);

	// Initialize SdFat or print a detailed error message and halt
	// Use half speed like the native library.
	// change to SPI_FULL_SPEED for more performance.
	if (!sd.init(SPI_HALF_SPEED, chipSelect)) sd.initErrorHalt();
	// open the file for write at end like the Native SD library
	if (!myFile.open("log-sid.txt", O_RDWR | O_CREAT | O_AT_END))
	{
		sd.errorHalt("opening log-sid.txt for write failed");
	}
	// if the file opened okay, write to it:
	Serial.print("SIDruino session started...\n");
	myFile.println("SIDruino session started...\n");
	myFile.close();
}

void loop()
{
	sid_report();
	Serial.println("Write to log file\n");
	digitalWrite(led, HIGH);   // turn the LED on (HIGH is the voltage level)
	delay(10000); // 10 seconds delay between readings
	digitalWrite(led, LOW);   // turn the LED off (LOW is the voltage level)
}
```

Immediately after the code is compiled and loaded into the board via the USB connector, SIDruino starts running, recording data every 10 seconds. The serial monitor is showing:



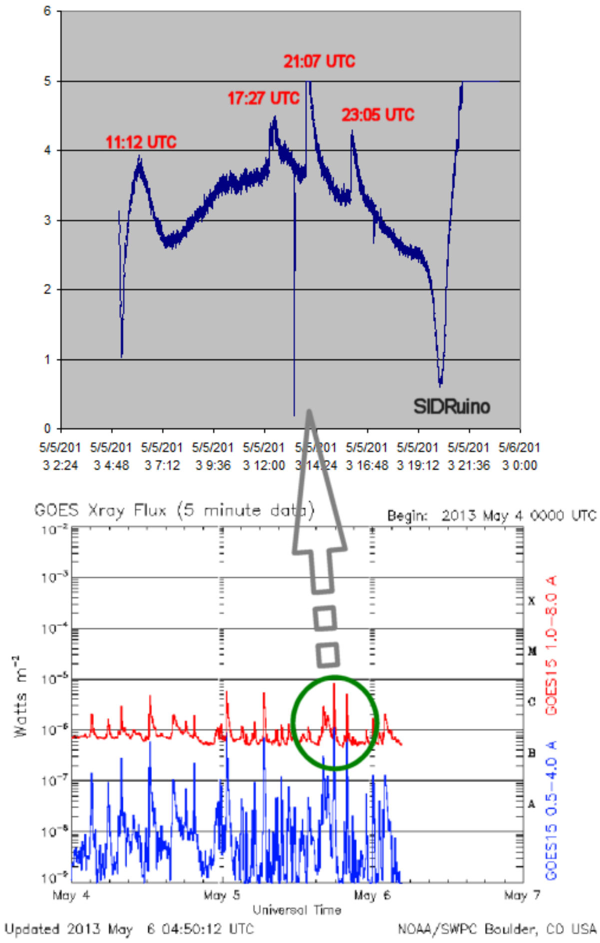
At the same time the log-sid.txt file on the microSD has the following information:

```
SIDruino session started...

2013-05-09 00:03:31     5.00
2013-05-09 00:03:31     5.00
2013-05-09 00:03:41     5.00
2013-05-09 00:04:51     5.00
2013-05-09 00:04:01     5.00
```

Conclusion

The SIDruino project described here has been configured as an experimental model using real VLF signals originating from station NAA in Maine on 24 KHz. The band-pass filter in the SID Monitor has been carefully aligned and output level calibrated. The system accurately recorded variations of the signal strength showing a very good correlation with weak solar X-ray events.

A relevant example could be the C-class solar flares recorded on May 5, 2013. The graphic plotted based on the values stored on the microSD card has been compared with the official GOES X-ray Flux on May 5, the match being almost perfect:



The SID Monitor is an excellent VLF receiver. A combination with a microcontroller such as Arduino could provide great advantages for the system. The Arduino Uno board, including the shields, could easily fit in the SID Monitor enclosure. With minimal electrical modifications of the original circuitry, SIDruino could become a very popular, low power, portable tool for researchers, teachers, students, radio-astronomers, and hobbyists.

Awe-inspiring Technology

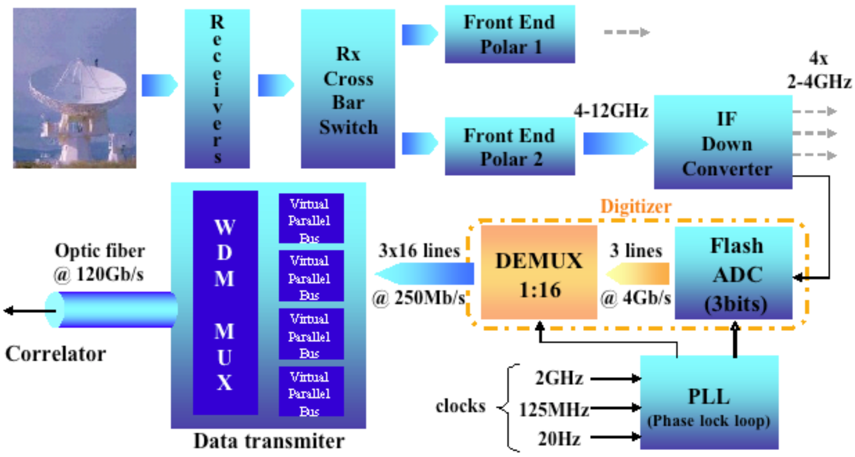
- D James

ALMA and ADCs

The latest clutch of Big Science radio telescopes are driving some amazing technological developments. For we amateurs who are interested in SDRs, recent developments for ALMA are startling - and not available to us ! Consider this paper, which describes the new ALMA design, in SiGe with <2W dissipation. It uses 3-bits (8 level), and >4 GSps for the 2-4 GHz input range:

https://science.nrao.edu/facilities/alma/aboutALMA/Technology/ALMA_Memo_Series/alma532/memo532.pdf ("The ALMA 3-bit 4 Gsample/s, 2-4 GHz Input Bandwidth, Flash Analog-to-Digital Converter")

Mind blowing for most of us to contemplate, the whole per-telescope processing involves down-conversion to 4-12 GHz, then down again to four times the 2-4 GHz slots. It all ends up into a 120 Gbps fiber output to the correlator. There is a 4GHz clock system for PLL locking all telescopes in the array. Mind blowing for us amateurs, the whole system is shown here:



In case the reader needs a little revision over modern quantisation approaches, here are three useful URLs to suitably enlighten:

http://repository.upenn.edu/cgi/viewcontent.cgi?article=1144&context=ese_papers
http://electronics.howstuffworks.com/question620.htm
http://www.triadsemi.com/2007/01/25/how-to-design-a-16-bit-sigma-delta-analog-to-digital-converter/

The latter one nicely deals with the over-sampling / bit# issue etc. See also sec. 4.1.5 of Wilson et al's *Tools of RA* (Springer, 5th ed.)

Proba-3 mission

Announced earlier this year, and targeted for launch in 2017, Spanish industry is leading the Proba-3 mission, a world first in precise formation flying. This European Space Agency (ESA) project aims to demonstrate that two satellites can move as one single object with sub-millimetre precision. This configuration will enable the creation of enormous space telescopes with the lens and detector hundreds of metres apart. Or there are interesting possibilities for arrays of radio telescopes.

From ESA: “The operations associated with precise formation flight will take place on the most distant section of the orbit, the apogee, over 60,000 km away, as here the gravitational disturbances are minimised and do not complicate or make the manoeuvres too costly. The formation [flying] technology will be tested and the planned tests will be conducted in this region of the orbit.

One of the relevant experiments including scientific application of Proba-3 will be blocking out the Sun with one of the craft in such a way that the other, 150 m away, can examine the Sun's corona in unprecedented detail. The first satellite, the blocker, will create an artificial solar eclipse in order to facilitate its companion satellite, the coronograh, in gathering the data. A similar technique was already tried in 1975 on the Apollo-Soyuz mission.

"In any case, the primary objective of this mission is to validate the precision formation flight technology, and to be able to position both craft between 20 and 250 metres apart, yet always working together as if they formed a rigid structure," Llorente emphasised.

The researcher highlighted one possible application of this configuration: "If you wanted to build telescopes with long focal length, you could mount the lens on one of the satellites and the detector on the other, which was already proposed -for instance- in the case of the Xeus x-ray telescope." In this way you can avoid the need for large deployable structures and reduce the mass of the launch, apart from improving the position stability when compared with thermo-elastic distortion with such a large structure. . “

The new mission features two satellites weighing approximately 340 kg and 200 kg.

Historical byways: M Humason

The Mule Driver Who Measured the Universe

Milton Humason seems little known outside the USA, but his story is remarkable: a former mule driver and janitor who rose to work with Edwin Hubble to establish the distance scale of the universe.

Milton Humason was born in Dodge Center, Minnesota in 1891. When he was 14 years old, his parents sent him to a summer camp on Mount Wilson, near Los Angeles. The mountain's forests and soaring views of southern California stole the heart of the prairie boy. He convinced his parents to let him take a year off school to stay on the mountain and find work. He never returned to school. Instead, Humason took up work as a mule driver, hauling lumber up a trail from the Sierra Madre to Mount Wilson to build the new astronomical observatory, an enormous project organized by the astronomy pioneer George Ellery Hale.

In 1911, he became engaged to Helen Dowd, the daughter of the chief engineer of the observatory on Mount Wilson, and they married shortly after. He left to work as a foreman on a ranch in nearby LaVerne, but he missed the mountain. In 1917, Humason saw his chance to return and to impress his father-in-law, he took a position as observatory janitor. This was a big step up from mule driver and ranch hand.

Soon after, the new observatory posted a position for "night assistant", essentially a helper for astronomers who need to operate the telescope and observatory dome. Humason took up the role. His patience and skill and diligence brought him to the attention of Hale himself. In 1919, in the face of stern protests, Hale appointed Humason, a high-school dropout to the scientific staff of the observatory. Humason remained in the role until 1954.

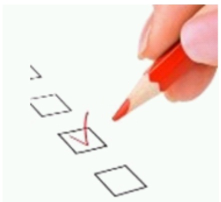
Humason worked with Hubble, and later Hubble's protégé Allan Sandage, to study the spectral redshift of hundreds of galaxies to determine how fast they were receding. Hubble correctly believed the radial velocity of a galaxy was related to its distance, a relationship now named Hubble's Law.

But these far-away galaxies had low surface brightness, and were notoriously hard to measure. So Humason developed techniques to optimize the photographic exposures and plate measurements. He determined the radial velocities of 620 galaxies, and helped set the distance scale and age of the universe. Much of Hubble's success was attributed to Humason's painstaking measurements.

Humason was awarded an honorary doctorate from the University of Lund in Sweden. He retired in 1957, and died at 80 in 1972. He has a lunar crater named after him.

Sources http://en.wikipedia.org/wiki/Milton_L._Humason
http://oneminuteastronomer.com/1562/mule-driver-measure-universe/

What's On



Diary

March	1-8	2014	National Astronomy Week - with a Jupiter focus
March	22-23	2014	SARA Western Conf., OVRO nr Bishop, Ca: see SARA web site
April	11-13	2014	BAA Winchester Weekend, Sparsholt, Hants.: see BAA web ite or Dec '13 J Brit Astron. Assoc.**
May	17		RAG2014 at NSC, Leicester
June	29– 2 July	2014	SARA Annual Conf., Green Bank, WV: see SARA web site*
July	TBA	2014	Possible BAA RAG Workshop on Meteor Scatter

** Includes SKA lecture by Prof Wilkinson, Manchester U

* Star Quest (optical) immediately precedes, 25-29 June at same location, NRAO. And immediately following is the Radio Jove Conf., 2-4 July at same NRAO location.
