The RAGazine

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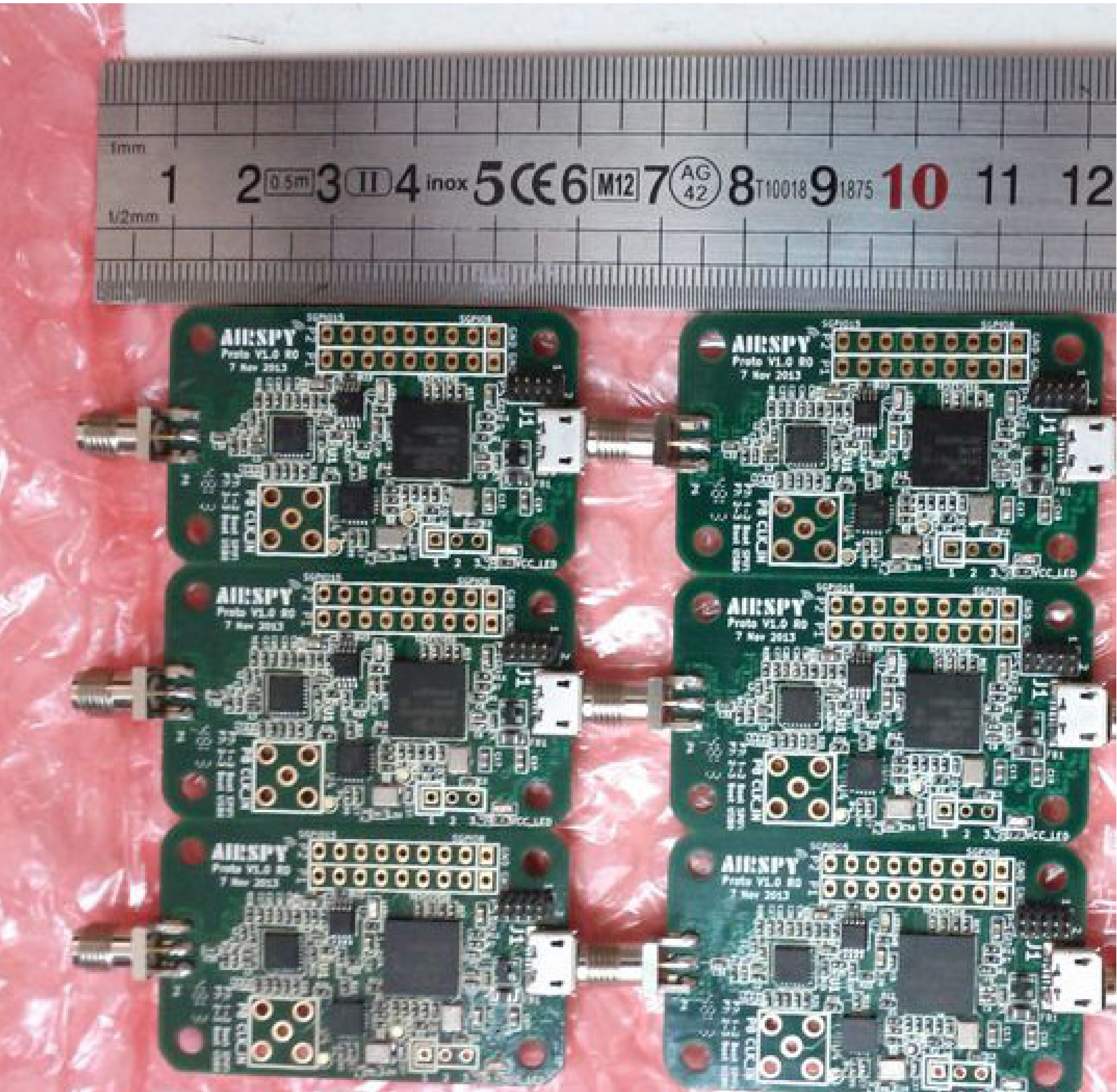

The long awaited Airspy sdr, will it be available soon?

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The RAGazine

British Astronomical Association
Radio Astronomy Group

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Web : http://www.britastro.org/radio

Notes for content submission

Content should be emailed to the Ragazine editor a minimum of fourteen days before the next publication date. Content submitted after that may not appear the next issue, but will be held for a later issue.

Observational reports are very welcome on topics where radio techniques are applied to observe astronomical objects, or geophysical events.

Articles are welcome on topics of radio astronomy observational techniques, radio hardware and related technology, scientific programming, events, data processing, educational out-reach, book reviews, radio astronomy history etc.

The preferred format for submissions is Microsoft Word (.doc or .docx format). However I know that not everyone has access to Microsoft Office, note that the free office suite LibreOffice is available for Windows, Linux and Mac OS. Note that LibreOffice can save documents in Microsoft Word .docx format. If neither of these applications are available then plain text (.txt) is fine. Images can be supplied embedded in the document or as separate files.

Please include the author credits you require to be included in the article, and indicate whether you want your email address to be shown in the publication.

2015 Publication dates and submission deadlines

Release Date	Submission deadline
February 9th 2015	26th January 2015
11th May 2015	27th April 2015
10th August 2015	27th July 2015
9th November 2015	26th October 2015

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In the next Issue:

Observing meteors by backscatter radar

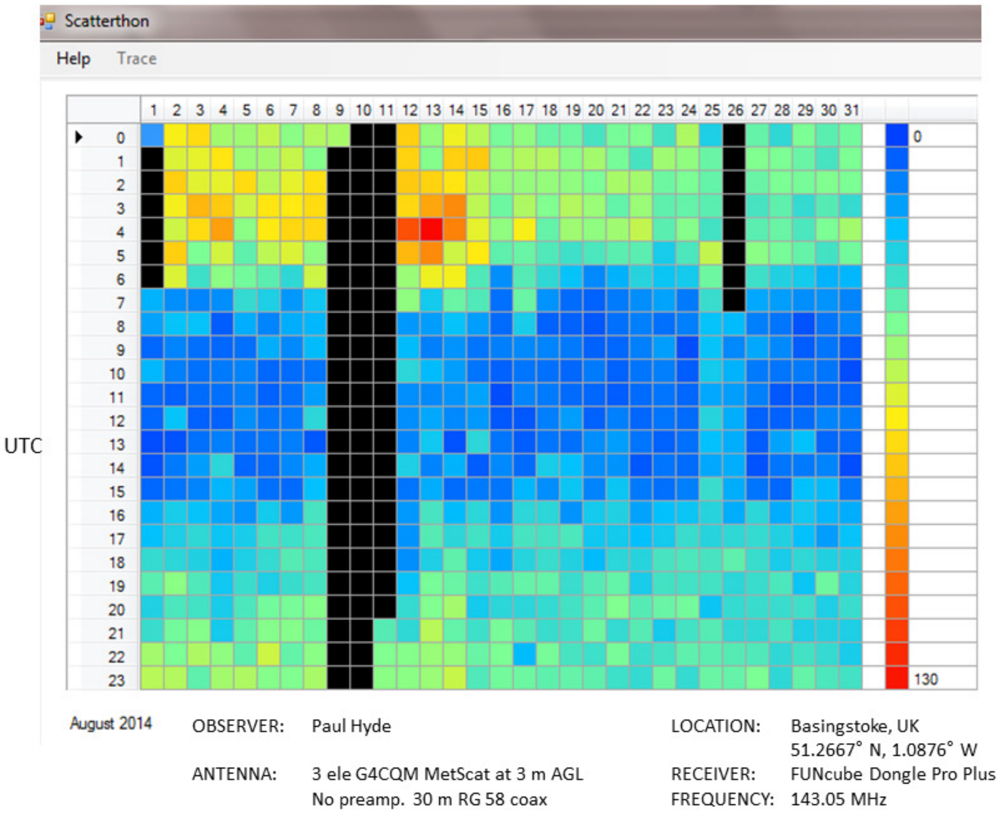
Advertising Policy

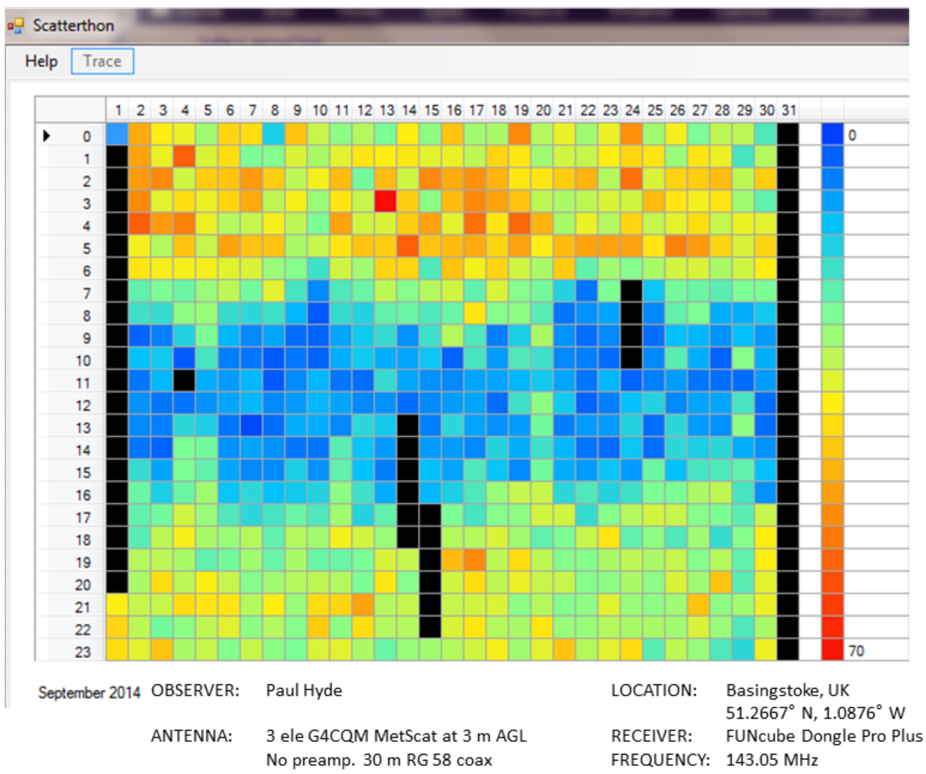
Please note no advertising content appears in this issue. We are currently reviewing our advertising policy.

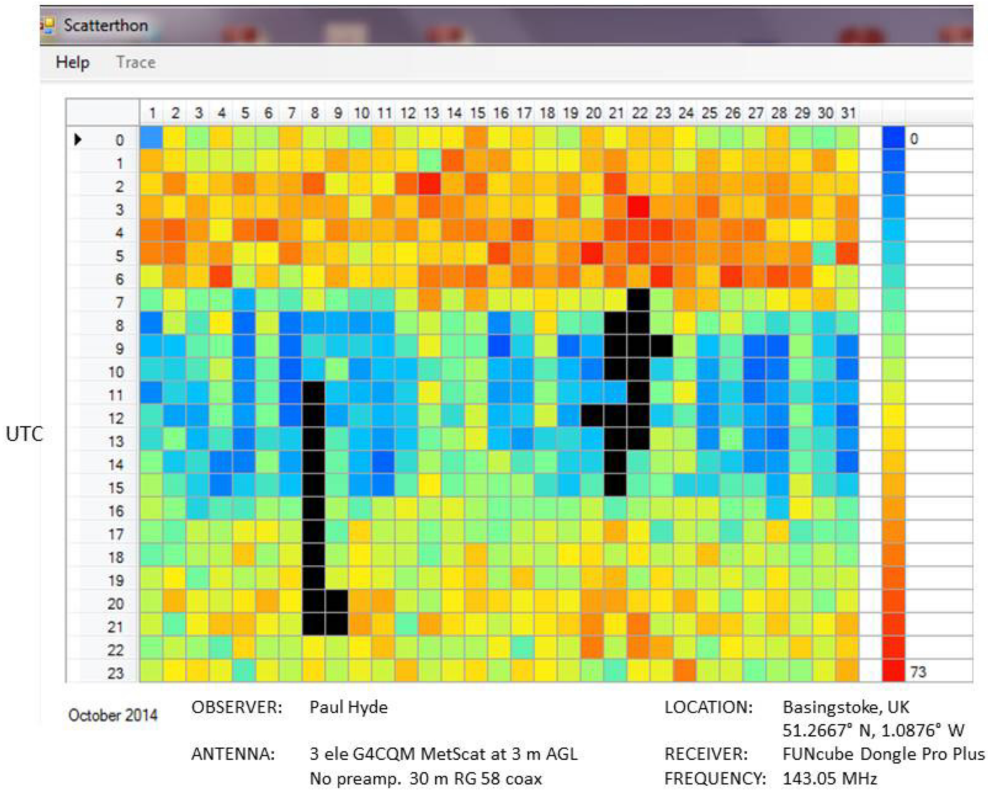
Observing reports

Meteor Scatter

Paul Hyde, Chris Jackson, Victoria Penrice



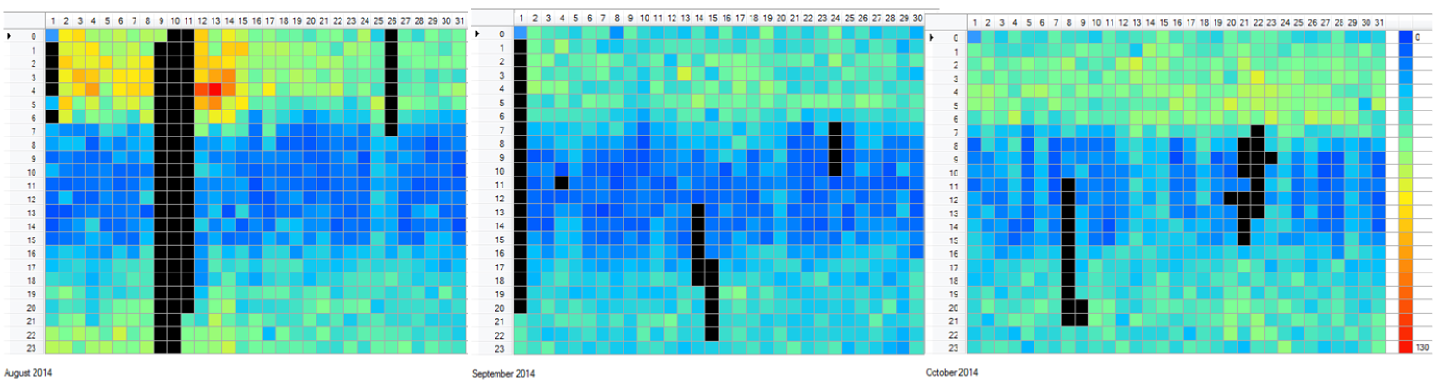




Editors Note: The observational data was compiled by Paul Hyde, data was collected using Spectrum Lab and a conditional actions script. The results were then filtered and processed using Scatterthon software developed by Victoria Penrice and Chris Jackson.

Note the clear diurnal variation in rates, which reach peaks in the early morning hours. Note the high rates around August 13th corresponding with the Perseid maximum.

The large images above show standard colorgrammes, where the colour scale changes each month. A more realistic view is displayed below showing the same data with the colours normalized to the same scale.



VLF Observing Report

July to September 2014

John Cook

Fig 1 shows activity levels since 2005. Sunspot numbers are courtesy of the BAA Solar Section. SID numbers since the last report are as follows:-

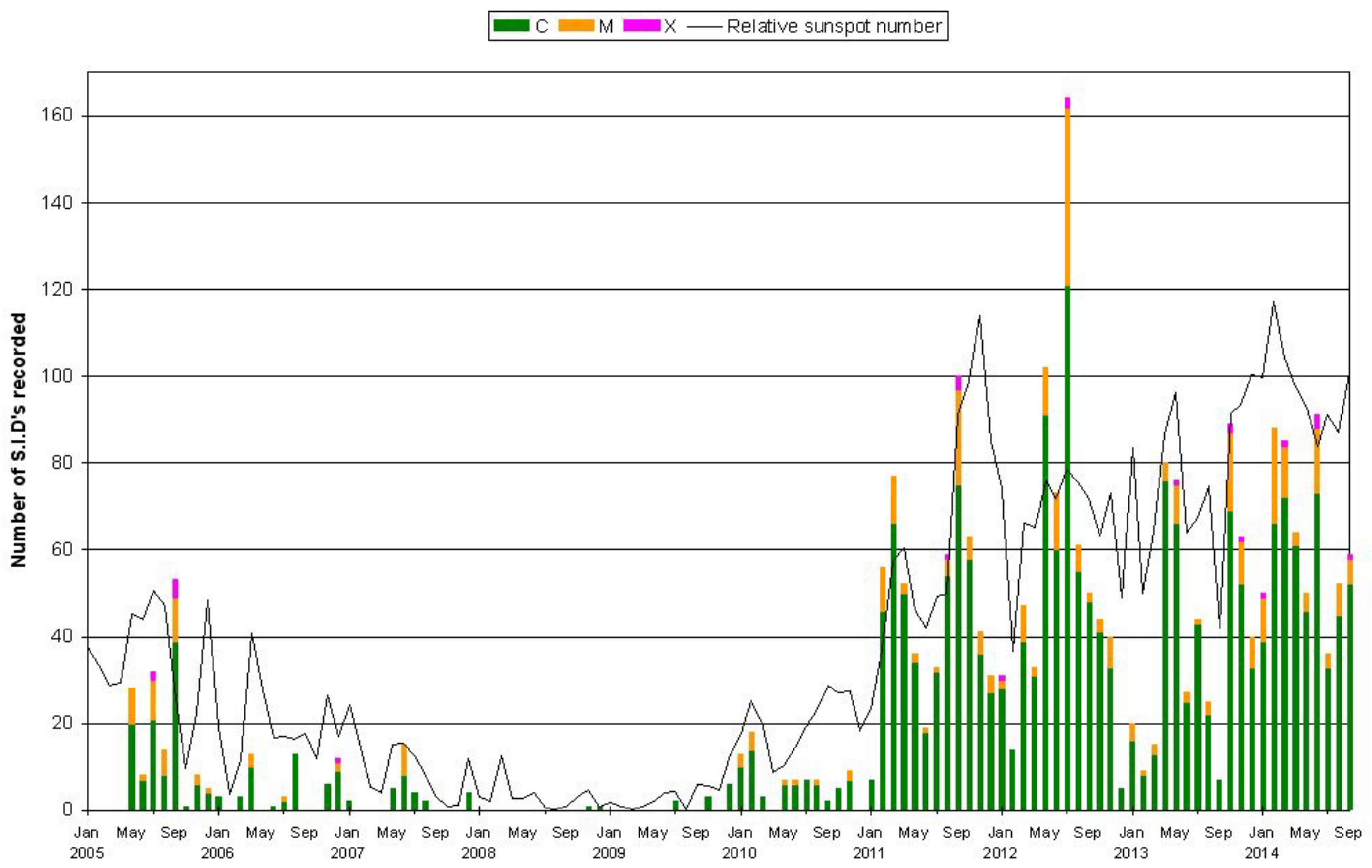
July = 38

August = 54

September = 59 (Provisional)

July was the least active month, although there were a number of slow multiple-peaked flares recorded. These multiple peaks are often recorded as separate SIDs. The numbers shown above are the number of flares that have been recorded rather than the number of individual SIDs. In July 62 separate SIDs were reported, nearly double the number of flares. In August 65 separate SIDs were reported. Fig 2 illustrates this problem. The C2.9 flare has a first peak at 08:16UT, followed a few minutes later by a slightly smaller peak. The C2.0 flare is a much slower event with several peaks. My

Figure 1 VLF flare activity 2005/14.



SID numbers have risen over the last 3 months, despite being close to what ought to be the downward phase of cycle 24. Unfortunately we do not have SID data for the corresponding period of cycle 23.

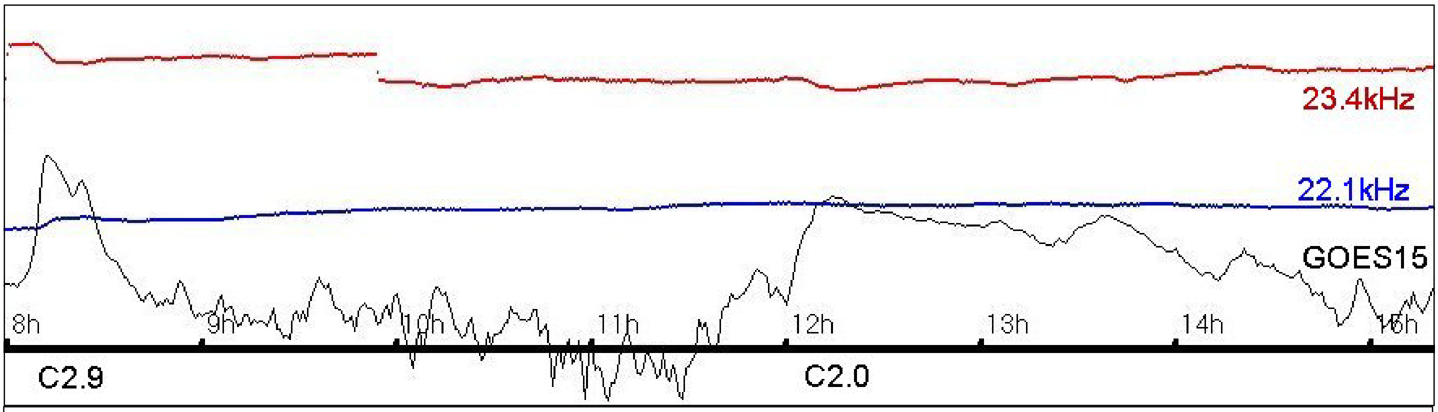


Figure 2 6th July 2014

own recording at 23.4kHz shows some very weak SIDs from this flare. In total, observers noted eight SIDs on this day.

The most energetic flare in July was an M6.5 on the 8th. This was widely recorded as a SID peaking around 16:20UT. Most observers saw the disturbance lasting for an hour or more.

Although there were a few CMEs in July, none were Earth-directed, and just a couple of very minor magnetic disturbances were recorded.

For most of August the 22.1kHz transmitter in Cumbria was off air although its near neighbour at 19.6kHz was still active. The magnitude of flares recorded was rather higher than in July, with seven of M-class. Again no X-class flares were present.

Although multiple-peaked flares were less of a feature in August, an unusually symmetrical triple flare was recorded on the 26th. Fig 3 shows three clear SIDs recorded by Mark Edwards. They show particularly well at 19.6kHz (Brown) and 20.9kHz

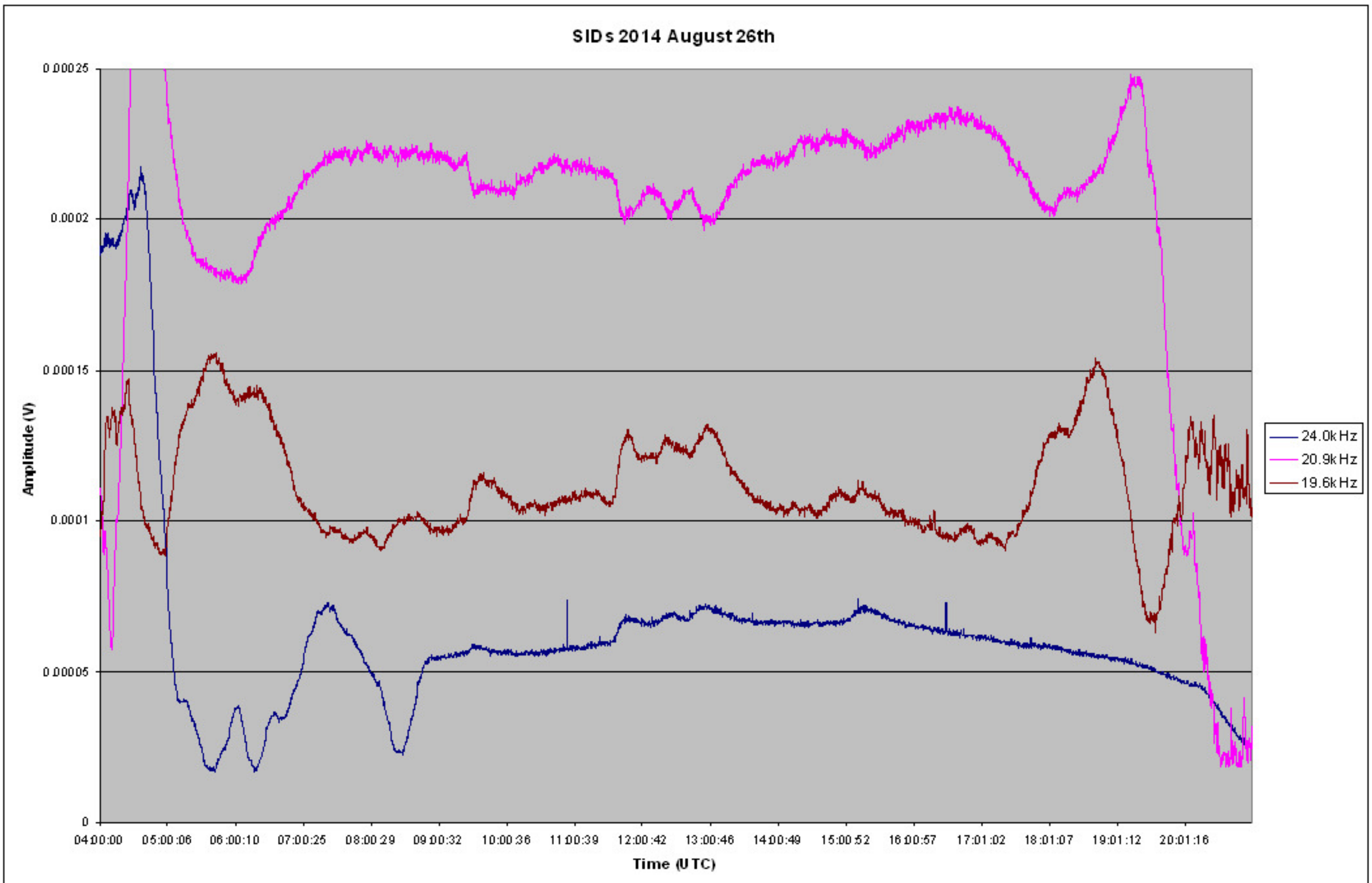


Figure 3

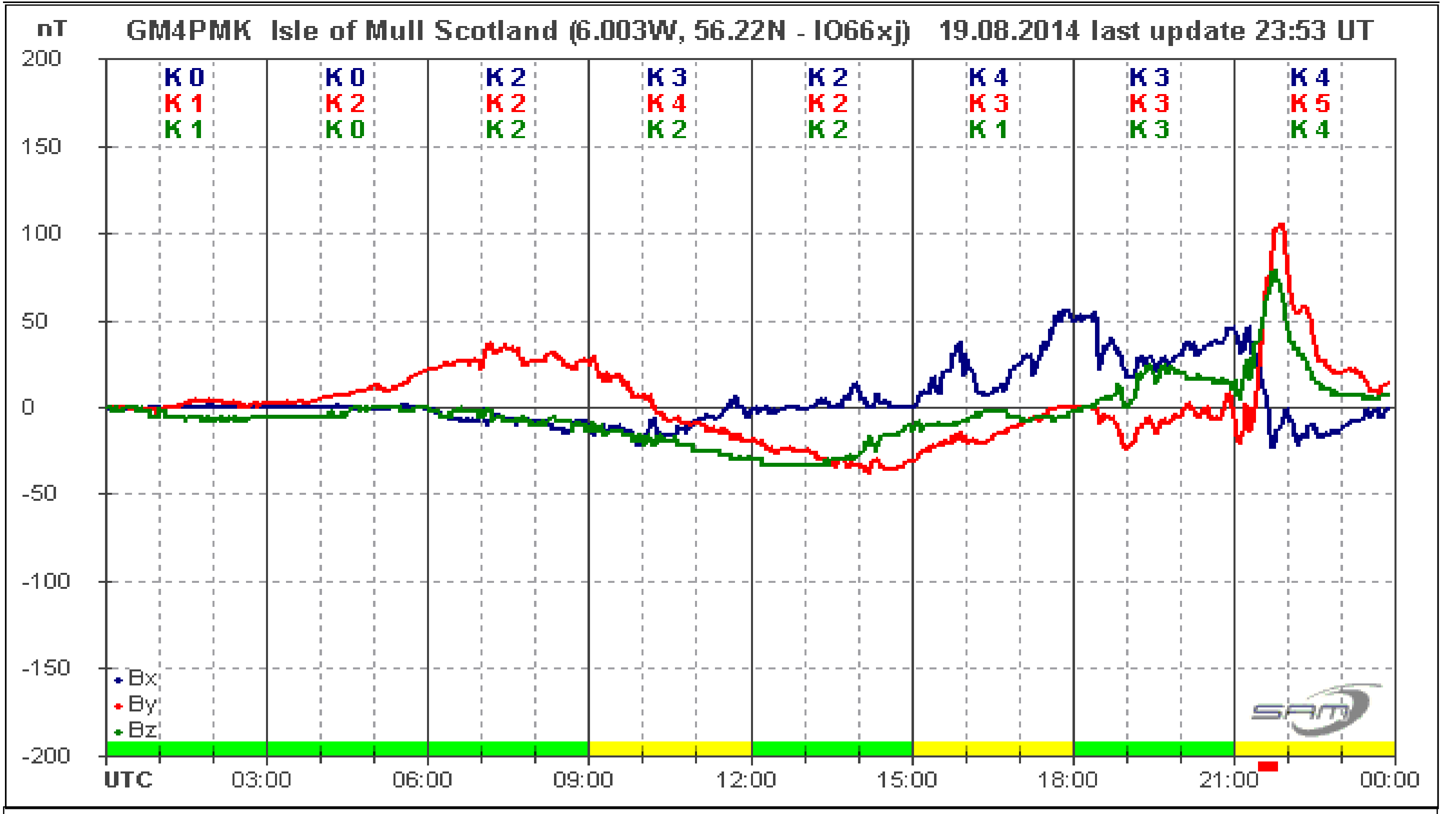


Figure 4

(magenta). The blue trace is at 24kHz. The X -ray magnitudes were C1.6 at 11:47, C1.5 at 12:28 and C1.7 at 12:56UT.

There was also a much higher level of magnetic activity in August. Several flares on the 22nd created CME's that were Earth-directed. Disturbances were recorded starting around 12UT on the 27th, and lasting for several hours. Using the C6.4 flare at 13UT as a starting point gives a CME transit time of 119 hours, amongst the slowest that we have recorded. There was also a significant filament eruption at 17UT on the 15th. This led to a strong disturbance on the 19th, shown in Fig 4 by Roger Blackwell.

A very rapid M5.9 flare close to mid-day on the 24th produced a very small SFE measuring just 6nT on my own recording.

Activity again increased in September, with an X1.6 flare recorded late on the 10th. With a peak at about 17:40UT, it occurred just

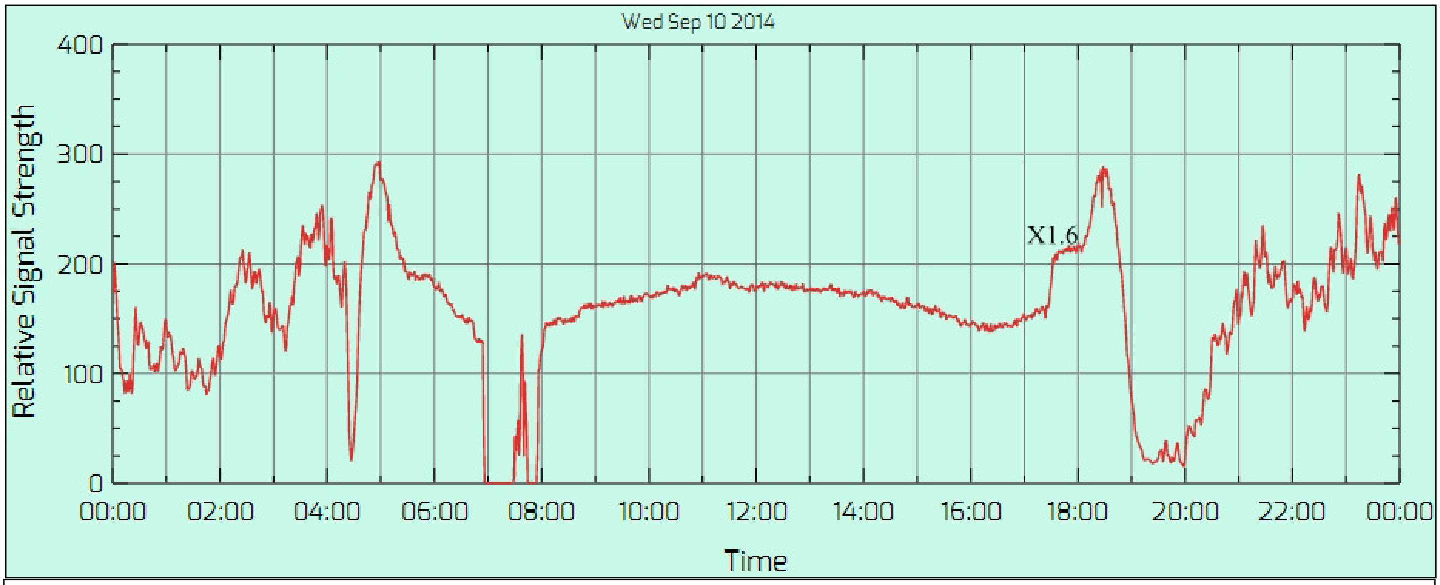


Figure 5

before local sunset in the UK and so the SID almost became lost as the ionosphere changed back to night-time conditions. Fig 5 was recorded by Peter Meadows.

interference from 13:00 to 13:30UT. The disturbance continued at a much lower level through the morning of the 13th.

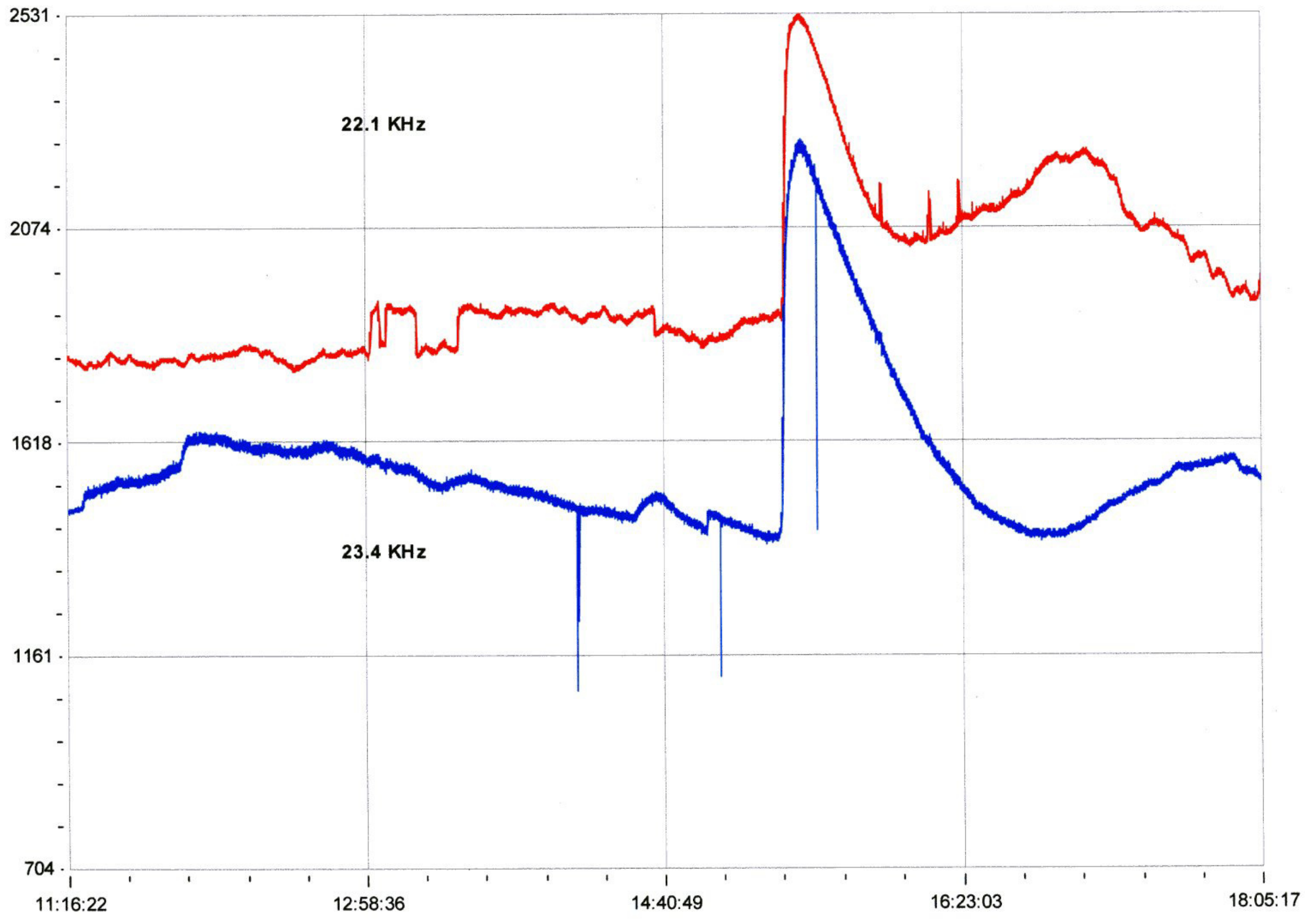


Figure 6

Fig 6 shows the SID recorded by Colin Clements from an M2.1 flare at 15:30 on the 11th. Both 22.1kHz and 23.4kHz signals show a very rapid rise in signal strength in response to the flare.

The X1.6 flare on the 10th also produced an Earth-directed CME that arrived on the 12th. Colin Clements has recorded the Sudden Storm Commencement at 15:57UT, giving a transit time of 49h 17m. This was much faster than the August CME, and becomes the sixth fastest that we have recorded. Fig 7 shows Colin's magnetic recording from the 12th, note that there is some local

For those interested in the X-ray flare data, there are two good sources. The Space Weather Prediction Centre of the NOAA produces a weekly bulletin that can be found at www.swpc.noaa.gov/weekly. These are 'pdf' files that give lots of detail for each event. The raw GOES15 X-ray data can also be found at www.swpc.noaa.gov/ftpmenu/lists/xray.html with 1 minute or 5 minute resolution. These are text files, but can be loaded into Starbase to be viewed as activity charts.

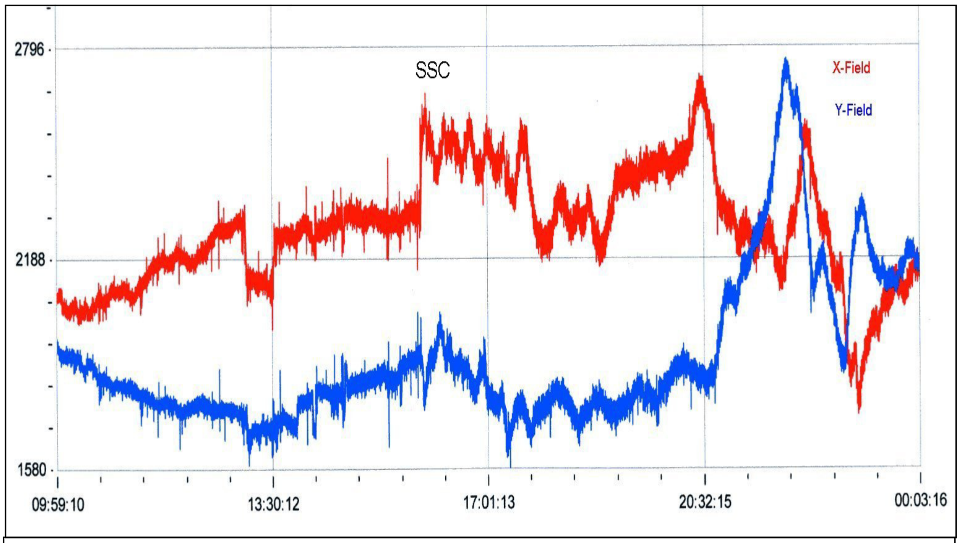


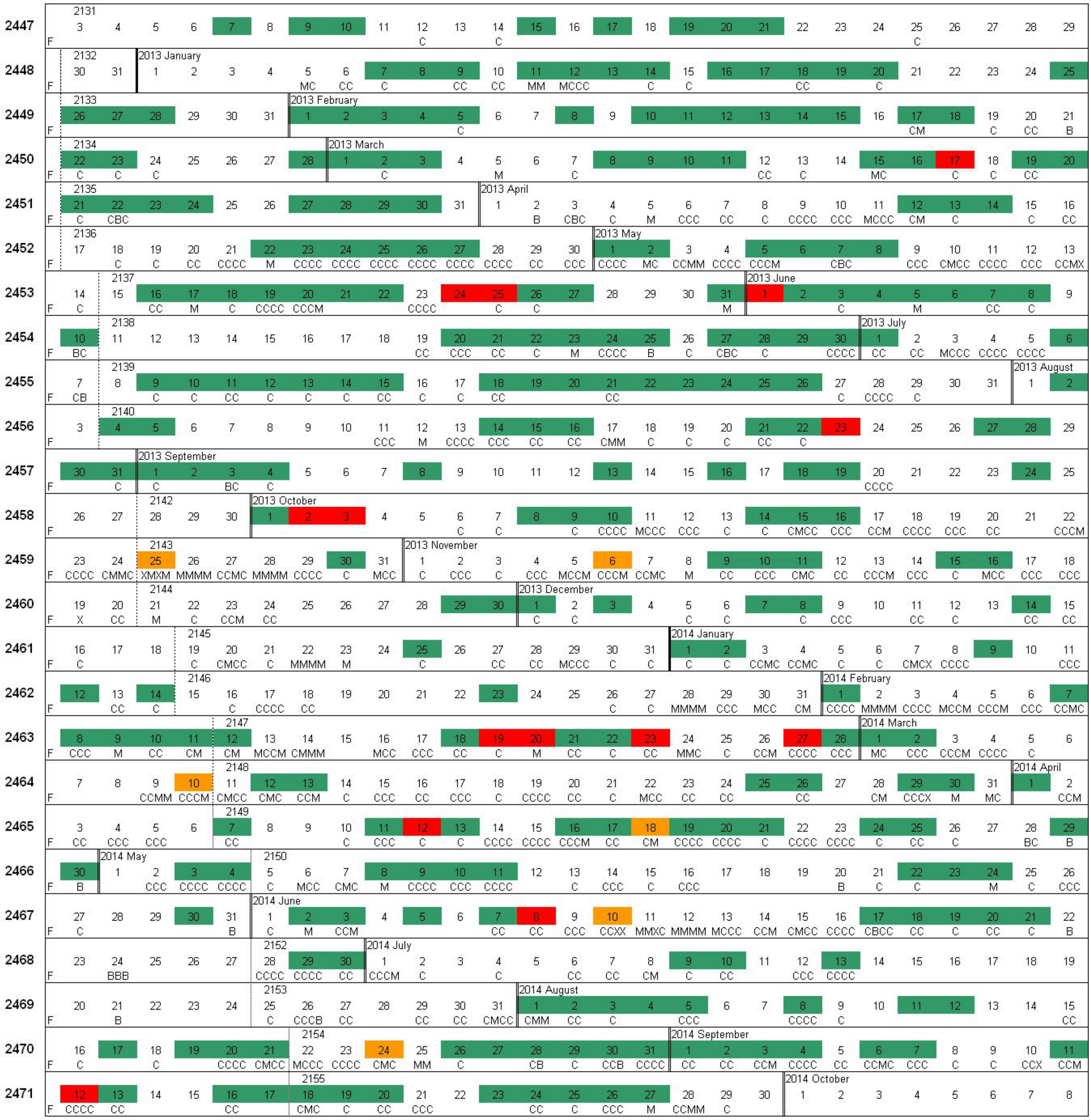
Figure 7

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

My thanks to all contributors. If you would like to add your own observations, please contact jacook@jacook.plus.com.

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

ROTATION																											
2423	24 MCC	25 C	26 C	27	28 MC	[2011 March] 1 CCC	2 C	3 CC	4 C	5 CCCC	6 CCCC	7 CMMM	8 CMM	9 CMMM	10 CCCC	11 CCC	12 BCCC	13 CC	14 CBCM	15 CCCC	[2108] 16 CC	17	18	19	20	21 CC	22 C
2424	23 BC	24 MCB	25 C	26	27	28 C	29 C	30	31	[2011 April] 1	2	3	4	5	6 CC	7 C	8	9 C	10	11 BC	[2109] 12 C	13 CCCC	14 CCCC	15 CCCM	16 CBCC	17 CB	18 B
2425	19 B	20 BBC	21 CCC	22 CCMCC	23 CC	24	25 B	26	27	28 CCCC	29	30 CCCC	[2011 May] 1 CB	2 C	3 C	4	5	6	7	8	[2110] 9 C	10	11	12 C	13	14	15 C
2426	16	17	18 CCC	19	20	21	22	23	24	25	26	27 BCCC	28 CCCM	29 CBCM	30 CCC	31	[2011 June] 1	2	3	4	5	[2111] 6	7	8	9	10	11
2427	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	[2011 July] 1	2	[2112] 3 C	4	5	6	7	8 CCCC
2428	9	10	11 C	12 C	13	14	15	16	17	18 C	19	20	21	22	23	24	25	26	27 CCCM	28 CCBCC	29 CCCB	[2113] 30 CCCC	31 CBCC	[2011 August] 1 CCCC	2 MCCB	3 MCCM	4 CCCC
2429	5 CCCB	6 CCCC	7 CCC	8 CMC	9 CMXC	10 CCCC	11 CC	12	13	14	15 CB	16	17 CC	18 BC	19	20 BB	21 BC	22 C	23	24 C	25 BC	26 C	[2114] 27	28	29 CCC	30 CBC	31 C
2430	[2011 September] 1 CCC	2 C	3 CCCC	4 CMCC	5 M	6	7 X	8 CMC	9 C	10 MC	11 CCB	12 C	13 C	14 CCCC	15 CCC	16 CCCC	17 CC	18 CCC	19 CC	20 CCCC	21 CMCC	22 CMXC	[2115] 23 CCCC	24 CXMM	25 MMCM	26 CCMC	27 CCCC
2431	28 CCM	29 CC	30 M	[2011 October] 1 MC	2 CCMC	3	4 C	5 CCCB	6 C	7	8	9 C	10 CCC	11	12 CCCC	13 CCC	14 CCC	15 CCCC	16 CCCC	17 CC	18	19 CC	[2116] 20 C	21 CMC	22 MC	23 C	24
2432	25	26 C	27	28 C	29 CCCC	30 CCC	31 M	[2011 November] 1 C	2 CCCC	3 CCM	4 C	5 CMCC	6 CC	7	8	9 M	10	11 C	12 C	13 CC	14 CCC	15 MM	16 C	[2117] 17 CCC	18	19	20 CCCC
2433	21	22 C	23 C	24	25	26	27 C	28 C	29 C	30	[2011 December] 1 C	2	3	4	5 C	6	7	8	9 C	10	11	12 B	13 C	[2118] 14 CCC	15	16	17
2434	18 B	19	20 C	21 CCCC	22	23 C	24	25 CCM	26 CC	27 C	28 CCC	29 M	30 CCC	31 MBM	[2012 January] 1	2 C	3	4 CC	5 C	6 C	7	8 CC	9 CC	[2119] 10	11 C	12 CC	13
2435	14 CMC	15 C	16 CC	17	18 CC	19 CM	20	21 C	22 CC	23	24 C	25	26 C	27 CCX	28 C	29	30	31	[2012 February] 1	2	3	4	5	6	[2120] 7 C	8	9 C
2436	10 CC	11 CCCC	12 C	13	14	15	16	17	18	19 C	20 C	21 C	22	23	24	25	26 C	27	28	29	[2012 March] 1 C	2 M	3	4 MC	[2121] 5 CCCC	6 MCMC	7
2437	8 C	9 CC	10 CCM	11	12 C	13 M	14 M	15 MC	16 CC	17	18	19 C	20	21 BCCC	22 CCC	23 C	24 C	25	26	27	28	29 CCCC	30	31	[2012 April] 1	2	3
2438	4 C	5 BC	6	7 C	8	9 C	10 B	11	12	13	14	15	16 M	17	18 CCBCC	19 C	20 CCC	21 CB	22 CC	23 C	24 CC	25 C	26	27 MCC	[2123] 28 C	29 CC	30 CCCC
2439	[2012 May] 1	2 CBCC	3 CC	4 CC	5 CCMCC	6 MCMC	7 CCMC	8 CCMC	9 CBMM	10 MCCC	11 CCCC	12 CCCC	13 CC	14 CCCC	15 CBC	16 CC	17 M	18 CCCC	19 C	20	21	22	23	24 CBBC	25 CC	[2124] 26 CC	27
2440	28 BB	29	30 C	31 CCCC	[2012 June] 1 C	2	3 C	4 M	5 CC	6 CCM	7 CCCC	8 CCMCM	9 CMCMC	10 M	11 CCCC	12 CCCC	13 CMCC	14 CCCM	15 CC	16 C	17 CC	18	19 CC	20 CC	21	[2125] 22	23
2441	24	25	26 C	27 CCCC	28 CMC	29 CCMC	30 CCMCM	[2012 July] 1 CCCM	2 CMCM	3 CCCC	4 MMMM	5 MMMM	6 MMMX	7 MMMC	8 MMMM	9 CCCC	10 MMCC	11 CCCC	12 CX	13 CCCC	14 MCCC	15 C	16 CCC	17 M	18 C	[2126] 19 M	20
2442	21	22	23 CB	24 CCCC	25	26 C	27 CCCM	28 CCM	29 MCC	30 CCCM	31 CCCC	[2012 August] 1 CCCC	2 C	3 CCC	4 C	5	6 CCCC	7 CCCC	8 CCCC	9 CCC	10 CC	11 MC	12	13 CCC	14 C	[2127] 15	16 C
2443	17 CMCM	18 MCCM	19	20	21	22	23	24	25	26	27	28	29 C	30 CCM	31 CCCC	[2012 September] 1 CCC	2 CCC	3 CCC	4 C	5 CCC	6 MCCC	7 C	8 M	9 CC	10 CCC	11 CB	[2128] 12 CC
2444	13 CCC	14	15	16	17 CCC	18 CC	19 CC	20	21	22	23	24 C	25 CC	26	27 C	28	29 CCCC	30 CCC	[2012 October] 1 CCCC	2 C	3	4	5	6	7	8 CCMC	[2129] 9 CCCC
2445	10 CMBC	11 CCC	12 CB	13 B	14	15	16 C	17 CCCC	18	19	20 CM	21 CCC	22 C	23 CCC	24 CCCC	25	26 CC	27	28	29	30	31 C	[2012 November] 1	2	3	4	[2130] 5 B
2446	6	7	8	9	10 C	11	12 CC	13 CMMC	14 CMC	15 CCCC	16 C	17	18 CC	19	20 CCMC	21 MCM	22	23 C	24 C	25	26 CCC	27 CCCM	28 C	29 CC	30 C	[2012 December] 1 CC	2



Update from the Hydrogen Line Observing Group (HLOG)

Brian Coleman, Gordon Dennis

gordon.dennis@koalapub.co.uk , brian-coleman@tiscali.co.uk

HLOG now have a data base of some 750 or more observations along the Galactic Equator and a few degrees above and below it. These take the form of 1.2MHz wide spectra in 10KHz steps for 2 degree square pixels.

By examining the spectra it is possible to build an impression of the shape of the galaxy in 2 and 3 dimensions. The quality of our data is checked against the professional LAB data (Ref 1) adapted for the beam width of our 3.7m back yard radio telescope.

In Fig 1 the HLOG data is Blue and the LAB data is Red.

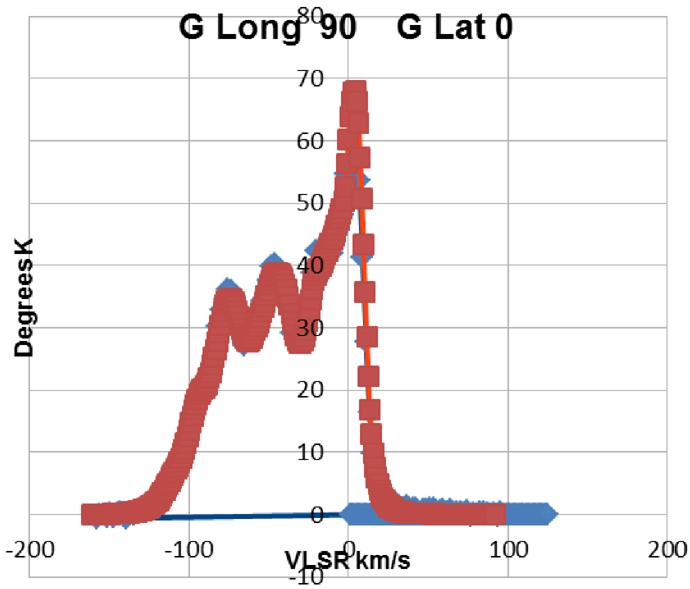


Figure 1

We are now keen to visualise our data in different ways and would welcome folk to join the group brining their own ideas on how to do this. There are many possibilities.

Fig 2 is an example of an impression of a 2 dimensional cross section or slice looking "out" through the Galaxy at Galactic Longitude =90. The radial extent of each body of hydrogen illustrated uses "artistic licence" but is based on the antenna temperature at the distinct velocity peaks that have been observed. The distance in kly to the "centre" of each body has been estimated by reference to the Spitzer derived artists impression that can be found at APOD 6th June 2008. (Ref 2)

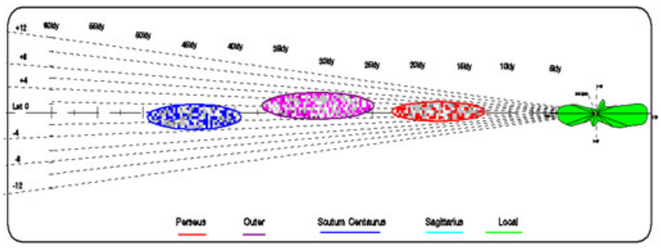


Figure 2

Our impression has been constructed manually using very limited graphic skills. But it is hoped that group members will develop their own , much better ways of visualising the data in both two and three dimensions. Fig 3 illustrates how this kind of plot might be built into a 3D image.

Meanwhile, we want to press on with more observations and can provide some opportunities for HLOG members, and those who would like to join, to make observations themselves using the telescope by remote control on-line. This has to be done by arrangement in advance with Brian.

We have been amazed at how flat the Galaxy appears to be and in particular how flat the local arm, in which the solar system is located, is. One observation, out of the plane of the Galaxy towards a known H Line "Quiet Spot" resulted in Ta of just 3-4K, See

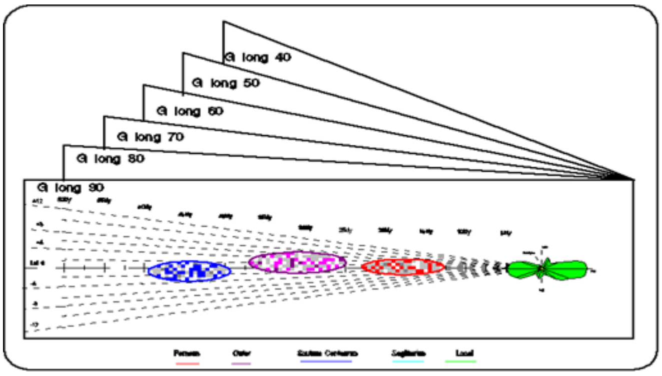


Figure 3

Fig 4. The red line is the prediction from the LAB data (Ref 1).

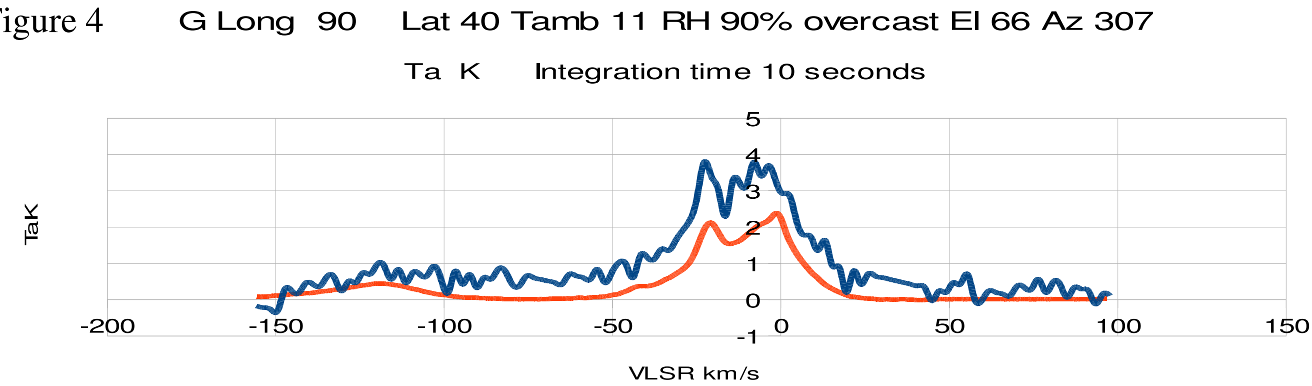
There is an honourable tradition of combining art and astronomy and it would be good to carry this on into Radio Astronomy.

Finally, it is a sobering thought that most of the stars and other objects our optical astronomer cousins can see, unless they own a very big telescope, lie within what we describe as the Local Arm of the Galaxy.

So if you would like to develop your own ways of visualising the HLOG data please join the group by emailing Gordon Denis :

Ref 1 Kalberla, P.M.W., Burton, W.B., Hartmann, Dap, Arnal, E.M., Bajaja, E.,

Figure 4



This prompted a series of observations of local hydrogen (VLSR close to zero) at different latitudes and the construction of the plot of Fig 5 where the radial distances are based on antenna temperatures at different latitudes. Those observations in directions not visible from our Northern Hemisphere location were taken from the LAB survey data.

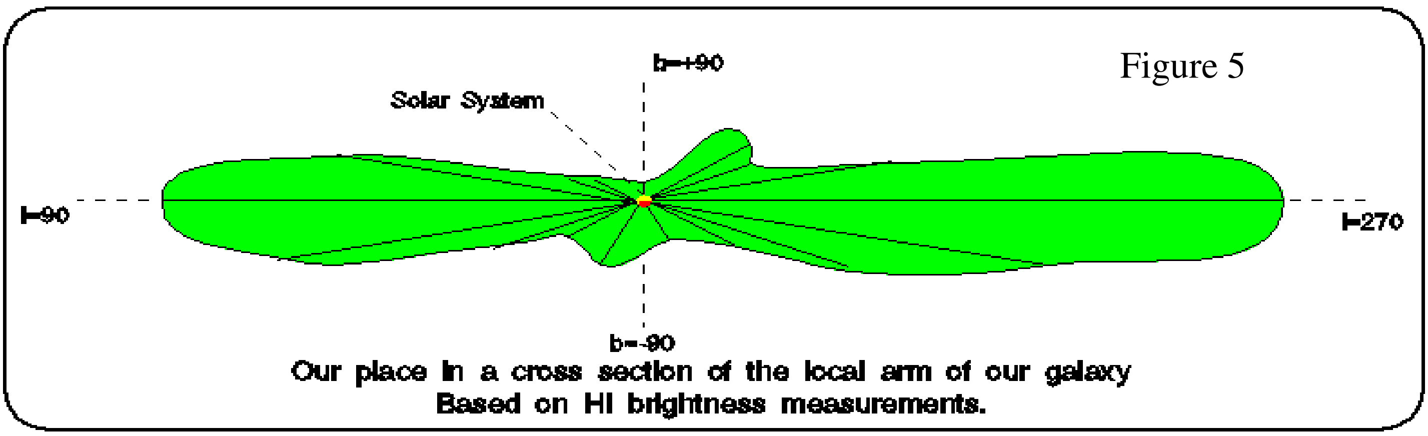
Fig 5 provided some insight into the vertical dimensions used in Figures 2 and 3.

Morras, R., & Pöppel, W.G.L. (2005), A&A, 440, 775

(http://adsabs.harvard.edu/abs/2005A%26A...440..775K)

LAB Data can be accessed at:-
http://www.astro.uni-bonn.de/hisurvey/profile/index.php

Ref 2 *APOD 2008 June 6 Spitzer Space Telescope.*
Illustration Credit: R. Hurt (SSC), JPL-Caltech, NASA
Survey Credit: GLIMPSE



S7 and S8 Calibration Point Observations.

Brian Coleman

I have been making observations of S7 and S8 once a week, when I can, since August, recording barometric pressure, temperature, relative humidity, subjective cloud state, azimuth and elevation along with the peak antenna temperature recorded for the source. In fact a spectral plot of 1.2MHz roughly centred on the peak has been recorded for each observation. See examples in Fig 1 and Fig 2. The objective being to better understand system variability including possible meteorological effects.

Tsys has been carefully calibrated and checked periodically although some variation is possible. At one check Tsys was found to have increased by about 10K (from the normal 54K). This was found to be due to a spiders nest and cobweb in the feed horn!

The location of the Redenham telescope is far from ideal as it is surrounded by trees giving a very high horizon / tree line especially to the North. I located it in the garden to provide optimum usage for Earth Moon Earth communications, which does not require the telescope to point North, whilst retaining the tree cover to avoid offending the neighbours. This means I have a very limited window for observing circumpolar objects such as S7 and this is becoming harder, as autumn progresses. To continue these observations during October and November would require me to get up at 04:00. I prefer Radio Astronomy to optical astronomy because I can get a good night's sleep and don't have to stand around in the cold, so observations will now stop until December when I should be able to catch S7 rising to the North East in the early evening.

Table 1 shows a summary of results to date. My S7 observations give a consistently higher Ta than predicted by the LAB Survey while the S8 observations are consistently lower. I can see no obvious pattern of variation with weather conditions although much more careful analysis is required. For example, perhaps the elevation, Temperature and RH could be used to calculate a more useful indicator of the quantity of water in the beam such as TPW (Total Precipitable Water).

S7		LAB Pk / Dif	Az	El		**S8**	LAB Pk / Dif	Az	El		Pressure	Temp	RH	Sky
Date	Redenham pk Ta	60.94	308	65		Redenham Pk Ta	65.95							
06/08/14						59.11	-6.84	186	36		1011	18	87	o/c
13/08/14						59.71	-6.24	207	34		994	17	97	o/c light rain
15/08/14	64.91	3.97	308	62							1015	11	89	o/c
20/08/14	65.97	5.03	308	62							1018	6	62	o/c
03/09/14	61.35	0.41	308	63		59.19	-6.76	176	37		1023	14	99	o/c
10/09/14	66.99	6.05	308	600		60.33	-5.62	182	37		1021	10	97	clear
18/09/14						57.91	-8.04	195	36		1008	15	92	o/c
19/09/14	63.24	2.30	309	67							1010	17	92	o/c +driz
01/10/14	61.8	0.86	308	58		60.15	-5.8	185	36		1023	15	95	o/c
08/10/14	66.07	5.13	308	65		62.45	-3.5	211	32		998	11	95	hvy o/c
15/10/14	67.52	6.58	308	59		66.22	0.27	184	37		1007	11	99	Fog
		Average dif					Average Dif							
		3.79					-5.32							

Calibration of System Temperature has been quite difficult lately as, for small telescopes such as mine, the most practical reference source is the Sun and this has been very active making it difficult to predict the Sun Y factor (dBs above Cold sky) as the Solar Flux is changing all the time. Other sources such as Cygnus A and Cassiopeia A produce Y factors of only around 0.3dB for my 3.7m dish and 54K Tsys. This is difficult to measure, with sufficient precision, in a relatively narrow bandwidth, to be useful as a calibration reference, although these sources do seem to confirm that the calibration is about right.

In Figs 1 and 2, the blue traces are the spectra produced by my system whilst those in Red are the predicted spectra for a telescope with a 5 degree beam width based on the LAB data which can be found at:- http://www.astro.uni-bonn.de/hisurvey/profile/index.php along with full credits.

I am reasonably happy with the correlation but continue to work on calibration and particularly on detector performance including linearity. I am keen to work with anyone with SDR skills to develop an SDR based system to replace my “steam radio” one. The Data interface will need thought though !

☆

Figure 1

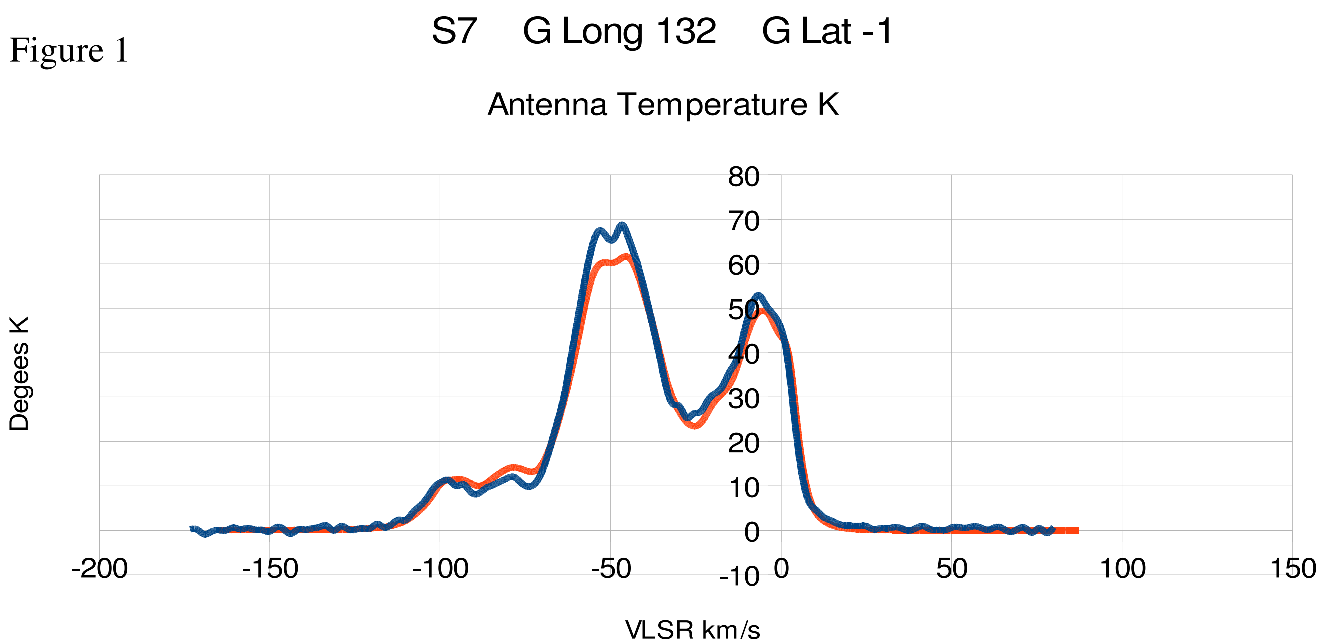
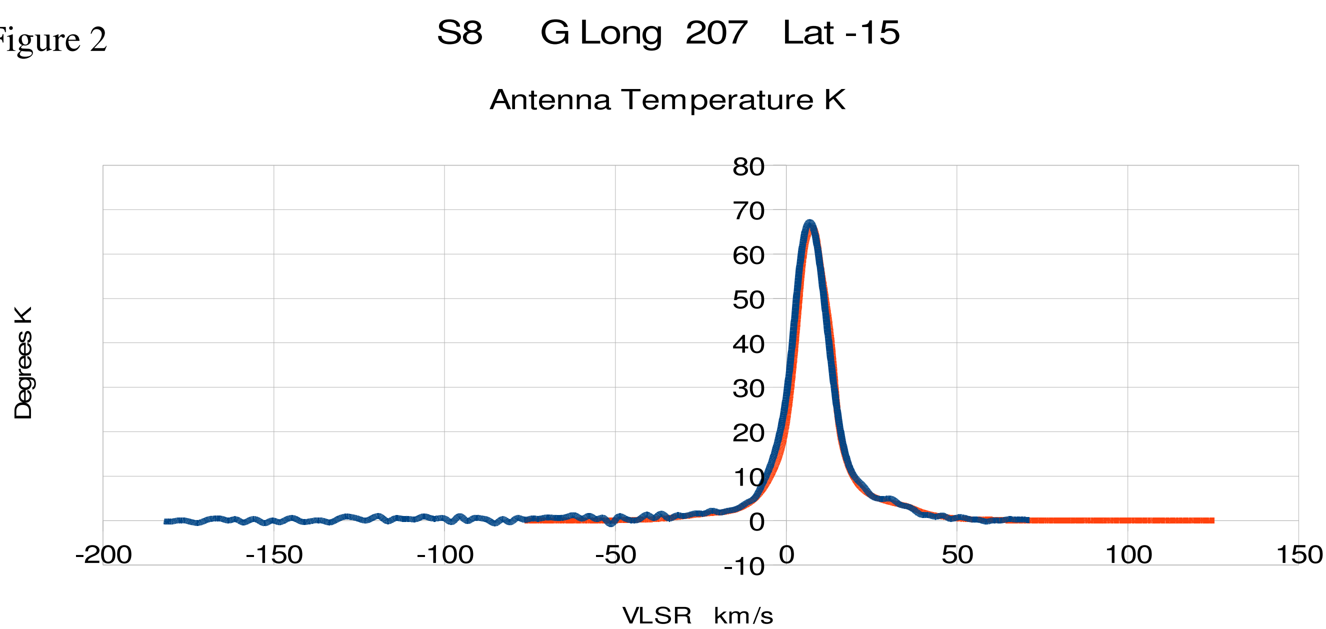


Figure 2



Technology Review

Tony Abbey

Airspy SDR Dongle

Website: http://airspy.com/

Yahoo discussion group: https://uk.groups.yahoo.com/neo/groups/airspy/info

The Airspy receiver should be available from the middle of November. Pre orders are now being taken (http://imall.iteadstudio.com/im141027001.html) at a price of $199.

The big selling point for radio astronomy is :

- Continuous 24 – 1750 MHz RX range with no gaps
- 3.5 dB NF between 42 and 1002 MHz
- External clock input (10 MHz to 100 MHz via MCX connector) – Ideal for phase coherent radios
- 10 MHz panoramic spectrum view with 9MHz alias/image free

The built in high spec Cortex M4F ARM processor running at 204MHz with 20MHz 12 bit ADC means specialist RA applications can be built and take the load off a host, so perhaps the Raspberry Pi will be able to host some applications for a wideband low power receive set up - would be good for Solar observations. The external clock input means that interferometric RA antennas can be used by synchronising the clocks to a common source. Like the FunCube Dongle it also has a bias tee feed built in for powering preamps or converters.

Scientific Coding
Chosing a Programming Language

Jeff Lashley

There is no doubt that you can't avoid computers and computer software in radio astronomy. Whether you write your own, or use existing packages, there are a vast array of choices available. This new column is intended to inspire you to begin writing your own code. It will include tutorials on useful programming languages, software for scientific data analysis and reviews to mostly open source software.

This first instalment begins by looking at several programming languages, and their advantages, and disadvantages to scientific programming. Later instalments will then explore them with practical tutorials.

Programming will be explored using the Raspberry Pi as our computer. After all that is exactly what the Raspberry Pi (I will refer ro it as the RPi) was designed to do. As such, this series will also explore Linux as an operating system, so if you have not used Linux before, don't worry, this will be covered too. The RPi is very accessible as it is one of the cheapest computers available which can run a full Linux operating system, and the choice of Linux as an operating system offers vast choice of free open source code.

The languages of choice will include:

- Python
- C, C++
- Haskell
- Lisp, Clojure
- R
- Ada
- Fortran
- Julia

Other languages may be covered in future, but we will start here.

Don't panic, some of these languages are new to me too, but they all have something to offer in scientific programing.

To begin with lets start looking at each in turn to find out why these are on the short list.

Python

Python is often viewed by many as a scripting language, or as 'glue' code to wrap other code. It is however a powerful programming language in it's own right, with a vast array of pre existing library code to allow rapid application development.

It's features are:

- Object-Oriented
- Interpreted
- Interactive
- Modular
- Dynamic
- High-level
- Portable
- Extensible in Python, C and C++
- Free and open source

If you are not familiar with any of these features things will become clearer in later tutorials.

Python is a great language to learn if you are new to programming. Its syntax is simple, it is very readable, yet it packs a lot of potential even for experienced programmers.

The fact that Python is interpreted does mean it is not always the best solution. Languages are either interpreted compiled, or a mix of the two. Interpreted means that the program in it's raw text form is converted to raw binary code that the cpu can handle live while the program is running. This means in general that interpreted programs run much more slowly than compiled ones, where code is converted at compile time to raw binary code that can run directly.

This is not a reason to dismiss python as a useful scientific language for data processing. The most commonly used libraries for data processing are numpy for matrix mathematics, scipy for signal and image processing, matplotlib for producing graph diagrams. All of these libraries are precompiled and written in c for speed. So if your code involves a high degrees of matrix or vector processing then Python is fine. If the code involves a lot of decision making in repetitive loops then it is not so great.

C, C++

C and C++ are the same language, where c is a simpler subset of C++ instructions.

The main difference is that C++ is object-oriented, where C is not. Object-oriented programming (OOP) is a programming technique that implements 'objects', code fragments which contain data fields (attributes that describe the object) and have associated methods. Within a program objects can be called by creating an instance of it which has been passed some data, and methods within that object can be called to process that data. It is somewhat like a set of subroutines, within a subroutine that can be passed some data.

It is a compiled language, which generates executable code, and is considered to be one of the fastest around. Modern C compilers are good at optimizing the code for performance.

The compilers to use on Linux are GCC for C applications, and G++ for C++ code, note G for GNU not C for C++.

Again there are many libraries of code available to the C programmer, including FFTW for fast Fourier transforms, GSL the GNU scientific library, BLAS and LAPACK for mathematics.

Haskell

Haskell is an advanced purely functional programming language, therefore lending itself to processing of mathematical functions. It is open source, and has been around for over 20 years. It is great for rapid application development, producing robust, concise and correct software. It integrates with other languages well, especially with C, and has built in support for parallel processing, debugging and code profiling. It contains a rich library of functions, and has an active community. The aim of Haskell is to produce high quality reliable code.

Haskell is a compiled language and for many things is close behind C for speed.

Lisp, Clojure

Lisp and Clojure are not quite the same thing. Clojure is a dialect of Lisp, but is implemented quite differently. Clojure for example targets the Java Virtual Machine, where Lisp does not.

Lisp exists in a number of different dialects such as Common Lisp, Lush and Clojure. Common Lisp is extremely flexible, high performance, compiled and ANSI standardized.

Lisp is multi-paradigm, so it can be objected oriented, or even functional depending on your requirements. It contains a very powerful macro system, so that functions you write integrate into the language like it was a built in feature. It even allows modification and debugging of running applications!

R

R is a language for statistical computing and graphics. It consists of a language plus a run-time environment, with graphics, a debugger, access to some system function, and the ability to run programs stored in script files.

The design of R has been influenced by two other languages, S and Scheme.

R is an interpreted language, allowing branching and looping, as modular programming using functions. It is possible to interface with C, C++ or FORTRAN languages for efficiency in a similar to Python.

R contains a large library of statistical procedures, which include:

- Linear models
- Nonlinear regression models
- Time series analysis
- Classical parametric and non-parametric tests
- Clustering
- Smoothing
- Graphing and data presentation
- Wide variety of add on packages

As with most of the languages presented here, it is available on multiple platforms including Windows, Linux and Mac OS.

Ada

Ada is an internationally standardized general purpose programming language used in a wide variety of applications, from missile control to payroll processing.

Ada encourages good programming practices by incorporating software engineering principles with strong typing, modularity, portability, reusability and readability.

Ada is portable, so code is easy to port to other systems and re-compiled, since all Ada compilers are validated up-front, and standardized.

It is modular. Code modules are self-contained, and written and tested separately, modules can be produced by separate teams in parallel and later combined into the final product. This is made possible by a very powerful type definition system. User generated data types can and should be tightly specified. For example instead of just creating a variable to represent a length in mm, which is say a floating point type. Ada allows you to create your own type and call it what you want such as 'jeffs_length' specifying that is a floating point, which can only have values from 1.16 to 7.77 say. So that if in the wider application, if a variable with type float is assigned to a variable with a type 'jeffs_length' compilation will fail. Even if the types match, if a value less than 1.16 or greater than 7.77 is assigned compilation or run time errors will occur. This yields potentially much higher reliability in the code, with far fewer chances for error. As such Ada is one of few languages allowed to create safety critical software for industries such as aerospace, including the flight software the Space Shuttle used.

From the outset, Ada design was created to encourage parallelism in application design.

FORTRAN

Many people may have thought that FORTRAN was a dead language. It was after all one of the earliest programming languages produced. This is not the case, it is still respected and used, and still useful for scientific programming. It has under gone a number of revisions over the years.

There are several implementations of

FORTRAN from expensive commercial varieties to free and open source ones. The free versions include gfortran, G95, and OpenWatcom.

Modern FORTRAN is similar to c and c++. Not only can it be object-oriented, but it natively supports I/O and mathematics without the need to import libraries (as in c).

FORTRAN supports multi dimensional array constructs, in c arrays are one dimensional and require the use of pointers to form multi-dimensional arrays, though pointers are also supported but commonly not used.

Another reason FORTRAN pointers are rarely used is because all subroutine parameters are passed by reference. This means that operations on the argument modify the values of the actual variable or array in memory. Therefore there is no need for referencing and de-referencing of addresses as is commonly seen in c. This is much more convenient in numerical code.

Julia

Julia is a high level, high performance dynamic programming language for technical computing. It's syntax is similar to other technical computing environments such as Python. It provides a sophisticated compiler, distributed parallel execution, numerical accuracy and an extensive mathematical function library. This library is largely written in Julia, bust also integrates best of breed mature C and Fortran libraries for linear algebra, random number generation, signal processing, and string processing.

There is an expanding number of external packages available through Julia's built –in package manager. There is also an interactive IJuila, a collaboration between the IPython and Julia communities, that provides a browser based graphical notebook interface to Julia.

In many ways Julia combines the best of many languages such as the speed of C, the macro abilities of Lisp, shell like capabilities of Python, user defined types like Ada. Python libraries can be called using the PyCall package, and C functions can be called directly without wrappers or API's.

This one is new to me, but then it is a brand new youngster having been developed within the last 2 years.

So there is a lot to think about here. If all you want to do is operate radios then coding is not for you. If however like me you like to explore the possibilities then coding is a fascinating way to further your interest in science. Coding is not always about producing flashy complex graphical applications. In scientific investigations there is a need to rapidly develop applications to control equipment, and process raw data. Such applications may well be simple command line driven.

Next time the series continues with a beginners Python Tutorial.

☆

The RTL_POWER application

Jeff Lashley

When you install the osmocom rtl-sdr package you now get a powerful tool for radio astronomy called rtl_power. Its purpose is to measure the spectral power distribution over a specified bandwidth. It can be run from the command line or it can be incorporated into programs.

Assuming you are using a Ubuntu or Debian based Linux distribution it can be installed by typing:

```
sudo apt-get install rtl-sdr
```

Then you simply insert your RTL SDR dongle and run the rtl_power command.

For example to make a spectral plot of the entire band which the RTL dongles can receive (24MHz to 1700MHz) type:

```
Rtl_power –f 24M:1700M:1M –i 100 –g 50 –e 5m data.csv
```

This will scan the range 24MHz to 1700MHz with a 1MHz resolution, integrating for 100 seconds setting a gain of 50db and running for 5 minutes. The resulting data will be written to a text file called data.csv.

However be careful of reducing the integration time with such wide bandwidths, as it takes time for the software to scan the range, undocumented weirdness is likely!

The rtl-sdr package is also available for Windows PC's but you need to use the Zadig drivers. (A google search will reveal them)

The manual reference page for rtl_power is included here:-

Complete Reference

If you want to stream directly to a file, provide the file name as the final argument. On some platforms this may hit a 2GB file limit. Use output redirection (rtl_power ... > log.csv) for unlimited file size.

`-f lower:upper:bin_size [Hz]`

Set a frequency range. Values can be specified as an integer (89100000), a float (89.1e6) or as a metric suffix (89.1M). The bin size may be adjusted to make the math easier. Valid bin sizes are between 0.1Hz and 2.8MHz. Ranges may be any size.

`-i <integration_interval>`

Collect data for this amount of time, report it and repeat. Supports 's/m/h' as a units suffix. Default is 10 seconds. Minimum time is 1 second, but for extremely large ranges it may take more than 1 second to perform the entire sweep. Undefined behavior there.

`-e <exit_timer>`

Run for at least this length of time and exit. Default is forever. Like the other times, this supports 's/m/h' units.

`-1`

Enable single-shot mode, default disabled. Perform a single integration interval, report and exit. It is not necessary to use -e with this option.

`-d <index>`

When using multiple dongles, this indicated which. You can also identify dongles by the text in the serial number field of the EEPROM.

`-g <gain>`

A floating point gain value. The dongle will use the closest gain setting available.

-p <error>

Correct for the parts-per-million error in the crystal. This will override a ppm value retrieved from eeprom.

-w <window>

The window is a shaping function applied to the data before the FFT. Each will emphasize or deemphasize certain aspects. The default is none (aka boxcar, rectangular). Options include: Hamming, Blackman, Blackman-Harris, Hann-Poisson, Partlett, and Youssef.

-c <crop_percent>

The crop sets how much of the bandwidth should be discarded. 0% discards nothing, 100% discards everything. The edges of the spectrum are lower quality than the middle. There is less sensitivity, gain roll-off and out-of-band aliasing. Higher values of crop will produce a better spectrum, but do so more slowly. Values may be a decimal (-c 0.1) or a percent (-c 10%). Default crop is 0%, suggested crop is between 20% and 50%.

This setting has no effect on bins larger than 1MHz.

-F 0 | 9

Not exactly the best named option, this configures the down sampler and the down sample filters. Down sampling is only used when the total bandwidth range is under 1MHz. (Like in the radar example above.) Omitting the -F option uses the default down sampler, rectangular. This down sampler is very fast but has bad spectral leakage.

Filters with minimal leakage are -F 0 and -F 9. 0 is a plain filter, but has bad droop at the edges of the spectrum. 9 uses the same filter as 0, but has a 9-point FIR filter to correct the droop. Rectangular needs the least cpu, 0 needs more, and 9 most of all. It is suggested to use 0 with -c 50%.

-P

Enables peak hold. The default behavior is to average across time. Peak hold uses the maximum value across time. Note that averaging improves the SNR, and peak hold will tend to make a spectrum look much worse.

-D

Enable direct sampling. Requires that you have first modified the dongle for direct sampling.

-O

Enable offset tuning. Only applies to E4000 tuners.

Output Format

Rtl_power produces a compact CSV file with minimal redundancy. The columns are:

date, time, Hz low, Hz high, Hz step, samples, dB, dB, dB, ...

Date and time apply across the entire row. The exact frequency of a dB value can be found by (hz_low + N * hz_step). The samples column indicated how many points went into each average.

RAG Coordinator report

Paul Hyde

Welcome to the sixth edition of RAGazine and the first with Jeff Lashley as Editor. My thanks go to Dave James for his previous work and to Jeff for volunteering to take over. Once again, please think whether you can offer any material for RAGazine, whether it's from personal work or progress on a club/society project. Your experience helps to inform and inspire others.

It has been a busy period since the last edition with RAG events at Bletchley Park, Leicester Maker Fair, the RSGB Convention at Milton Keynes, plus supporting the BAA events at Macclesfield and Glasgow. Looking forward, there are radio astronomy talks at Milton Keynes Amateur Radio Society (Dec 1st) and Kernow Astronomers, near Newquay (Nov 21st).

I and about 30 others had a very enjoyable two days at the EUCARA event at the beginning of September. The Astropeiler Stockert team, under Wolfgang Herrmann, laid on a very well organised conference with a wide range of talks and excellent demonstrations. For those not aware of the Stockert telescope, this is a 25 m diameter instrument that was the predecessor to the magnificent Effelsberg dish to the south of Bonn. It is now operated be a dedicated team of volunteers who are doing impressive observational work as well as outreach activities. See later for a more detailed report of the EUCARA event.

RAG Workshop event at Astropeiler Stockert, April 2015

Following discussions with the Astropeiler Stockert team we are planning a two-day Workshop event at the Stockert Observatory on either the 18/19th or 25/26th April 2015. The exact arrangements are still to be confirmed but will be based around a practical workshop with attendance limited to 10 people. The cost will be €40/person plus the cost of any catering. Attendees will need to organise their own transport and accommodation, though I can help with advice. There are a number of hotels in the area and I paid €60 per night for a single room, including breakfast. I travelled from Heathrow to Cologne Bonn airport using Germanwings, Lufthansa's budget airline, for about £100, but there are cheaper flights available from other airports.

During the weekend we will have demonstrations of various aspects of pulsar observations, e.g. dispersion, mode-switching, and giant pulses. There will be a demonstration of the Raspberry Pi Hydrogen Line receiver that the Stockert team have developed and if you would like to bring your own version along you can try it out with the 25 metre dish. I hope to organise some small aperture work as a comparison, perhaps using versions of Peter East's antenna/front-end, but this will depend upon whether it is practical to get the hardware over to Germany. We will also have a demonstration of the Ku band interferometer system described in the EUCARA article and a tutorial on how to modify the LNBs.

Please let me know immediately via email if you would be interested in attending this event or if you have any questions. Places will be available on a first-come basis and I plan on confirming the details by early December so that people can make their travel arrangements.

Paul Hyde
g4csd@yahoo.co.uk

Improving the accuracy of meteor data using the Scatterthon application

Victoria Penrice and Chris Jackson

Inspired by Paul Hyde's articles on meteor scatter (published in May/June editions of BBC Sky at Night magazine), a number of observing stations sprung up around the UK, successfully recording meteor data following Paul's recipe. Taking it a step further, amateur radio astronomers wanted to know how their collected data could be presented, and one of the ideas for this was borrowed from the Radio Meteor Observing Bulletin website (RMOB).

RMOB represent their meteor observing data as colorgrammes: a colour chart spanning 24 hours on the vertical axis, and covering 28-31 days of the month on the horizontal axis. Colours range from deep blue (corresponding to 0) to red (corresponding to the highest number of detected meteor events per hour during that month). This way, the overall picture of meteor activity on any given month comes across visually very well.

However, on closer examination of data submissions to the RMOB website, from the very high counts (which do not agree with the typical expected data) it seems that the submitted data is very likely to contain non-meteor events, and therefore data quality could be improved.

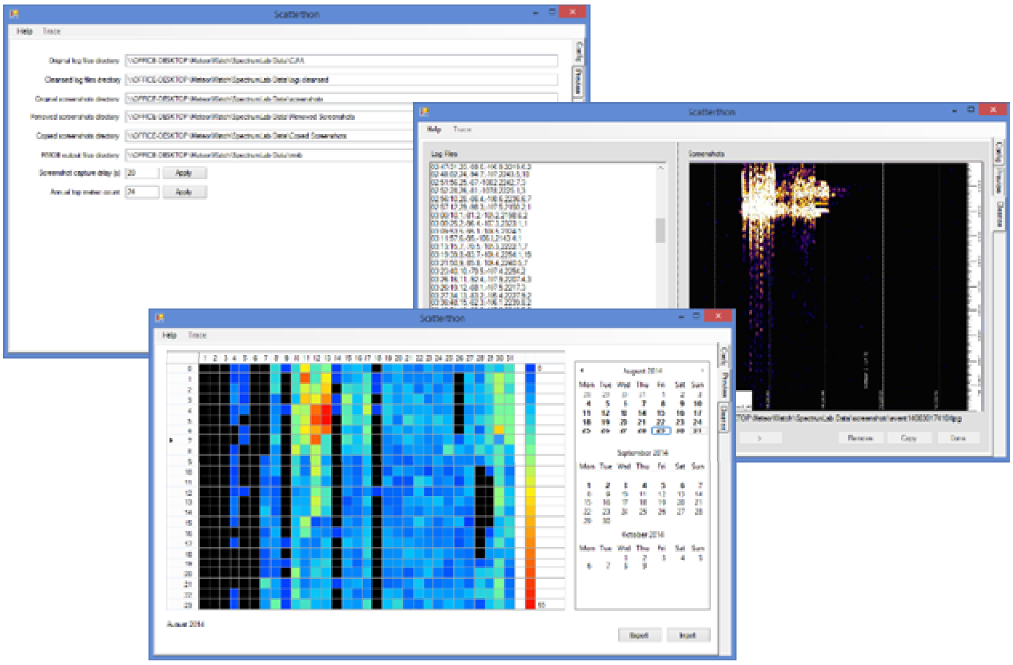


Figure 1: Screenshots of Scatterthon

The way it could be improved is by doing what is known as "data cleansing", i.e. ensuring that no event other than a true meteor event is counted towards hourly totals. This can be achieved by examining screenshots (captured as part of the SpectrumLab script) one by one, and removing log file entries corresponding to non-meteor events, such as atmospheric or human-induced interference, ISS captures and moon bounce records. Whilst helping with making meteor data more rigorous, data cleansing is a very labour-intensive process.

The free Scatterthon software application was created to help with this process (Figure 1). Scatterthon allows amateur radio astronomers to work with log files and screenshots created by SpectrumLab scripts,

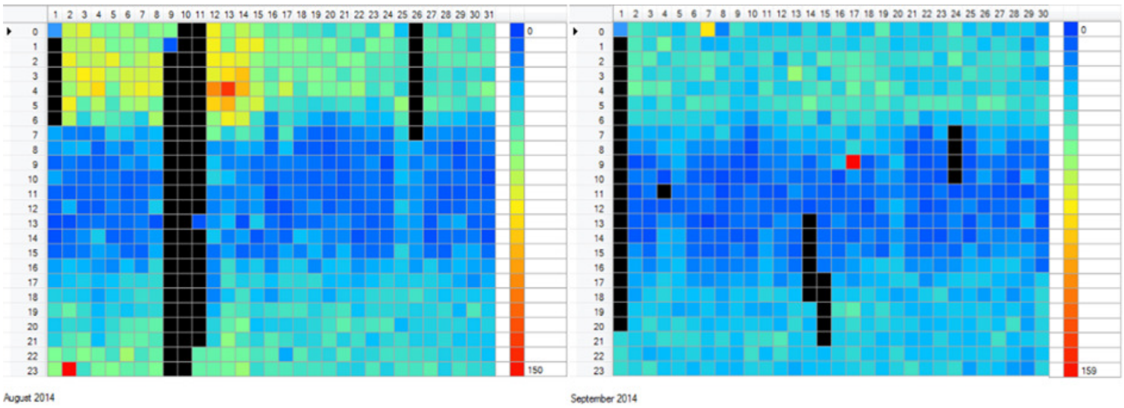


Figure 2: Data before Cleansing

distributed as part of Paul's publication on meteor observing (*and these scripts only*). Its users can scroll through screenshots, deleting screenshots with false events, and watching log file entries corresponding to deleted screenshots being automatically removed from log files in the application's "Cleanse" pane.

Scatterthon application can also take the totals and represent them in the form of an RMOB colorgramme in its "Preview" pane. If required, it can generate a csv file for submission to the RMOB website.

Improving on RMOB visualisation facilities, Scatterthon enables its users to visually express their data consistently against the same scale across any chosen period, not just one month.

For example, if we wanted to visually compare our data for August (top count of 130/hour) and September (top count of 70/hour), we can fix the scales to range from 0 to 130.

Before fixing the scale's top range at 130

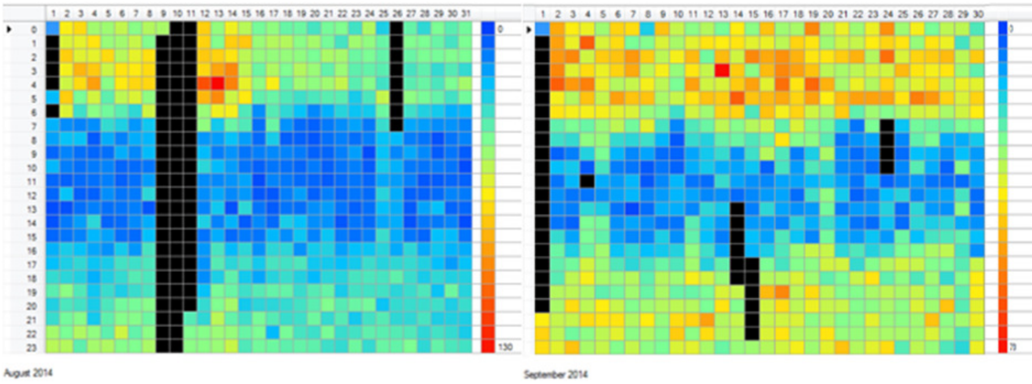


Figure 3: Data after Cleansing

(i.e. before "normalising" the data), both August and September would have one or more red cells each, representing their top counts of 130 and 70 respectively (see Figure 3, courtesy Paul Hyde).

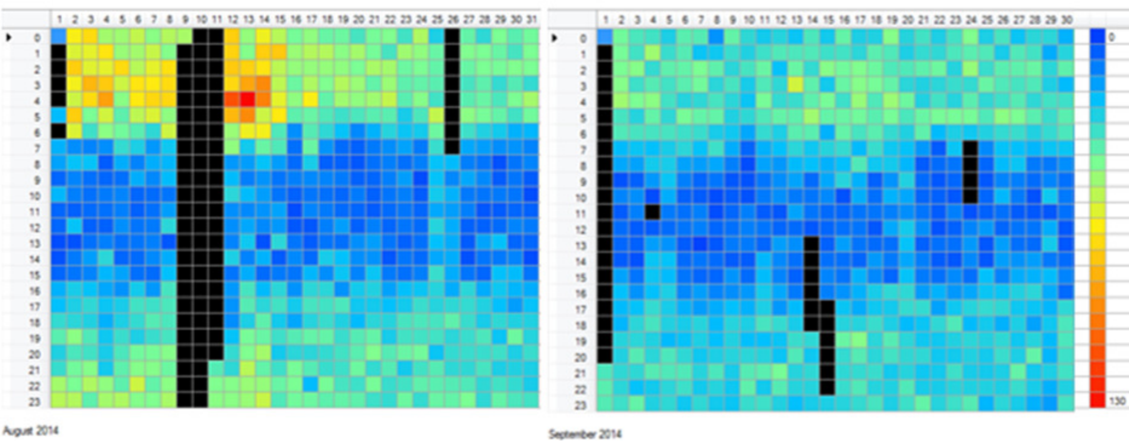


Figure 4: Data after normalisation

Fixing both scales at the specified maximum for the period of interest (in this case a top count of 130) forces the application to remap September colours, correctly showing the relatively lower meteor shower intensity in September (see Figure 4, courtesy Paul Hyde).

The software is undergoing final testing of additional features (including merging of complex events and classification of non-meteor events), and will be available for distribution in January 2015.

It is intended for deployment on Windows OS (both 32- and 64-bit versions), including Windows Vista, Windows 7 and Windows 8. Windows XP version is also available on request, but is not supported. Please also keep in mind that Scatterthon works only with the SpectrumLab scripts distributed as part of Paul Hyde's publication at BBC Sky at Night.

To get your free copy of Scatterthon software (alongside Paul Hyde's SpectrumLab scripts and accompanying instructions), please email us at info@radioastro.org.uk. To get a reprint of Sky at Night magazine articles, please go to the RAG website at www.britastro.org/radio.

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European Conference on Amateur Radio Astronomy 2014

Astropeiler Stockert, Sept 5/6, Paul Hyde

Wurther Tor, one of the original gates into the medieval town

The first of what are expected to be regular two-yearly meetings was organised by Dr Wolfgang Hermann of Astropeiler Stockert. The observatory is located near to the medieval walled town of Bad Munstereifel, in a picturesque region of Germany known as the Eifel. Recent (geologically-speaking!) volcanic activity has left a landscape of steep hills and valleys which are now densely wooded and popular with walkers during the summer months.

Bad Munstereifel

Although you need three trains to reach Bad Munstereifel from Cologne – Bonn airport, the connections are easy and the total journey time is just over 90 minutes. However once there you do need to find transport from the town up to the observatory site.

to

Astropeiler Stockert

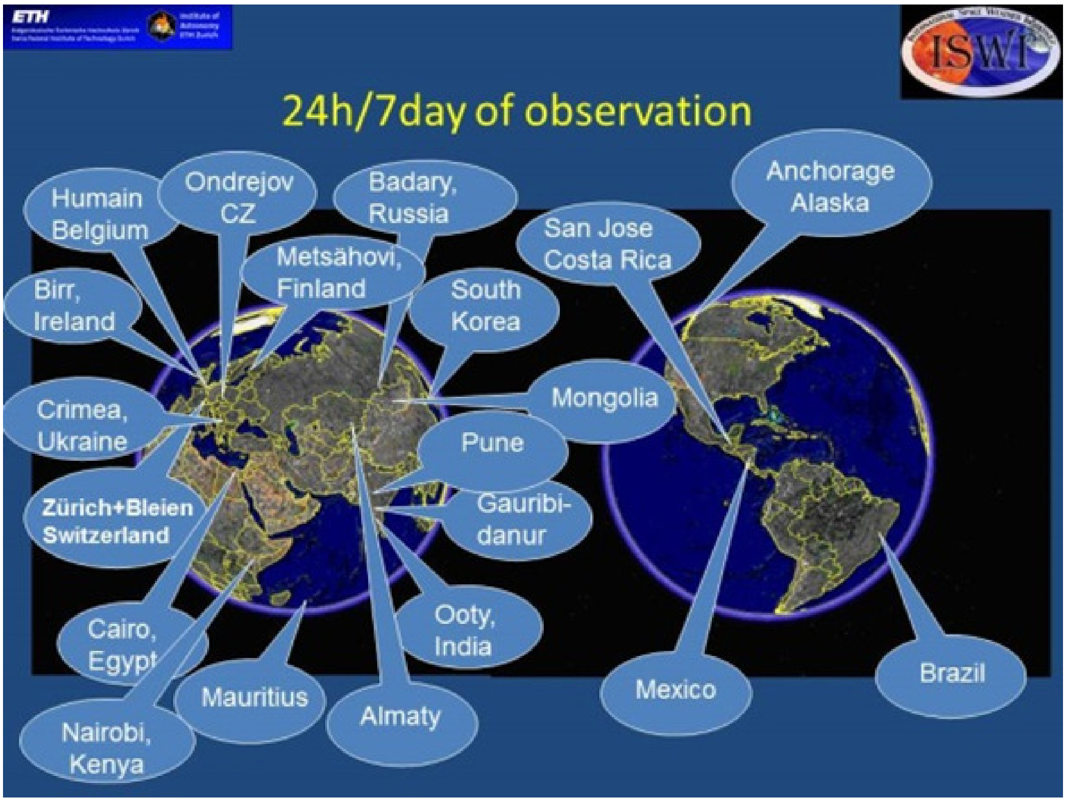
The 25 metre diameter Stockert Radio Telescope has a distinguished history since first light in 1956, being one of the two largest dishes in the world prior to the opening of Jodrell Bank. It was the main research instrument of the Max Planck Institute for Radio Astronomy (MPIfR) prior to the completion of the 100-metre Effelsberg dish in 1972. It is now owned by the North Rhine-Westphalia Foundation and operated by an enthusiastic group of volunteers who are keen retain this historic instrument as a working radio observatory. The telescope is fully functional and has a particular interest in pulsar observations work. The Stockert team is also active in the outreach area with plans for a remotely controlled 3-metre dish for school use. As part of that work they have developed a Hydrogen Line spectrometer instrument based upon one of the budget RTL DTV receiver sticks running on a Raspberry Pi computer board and copies of the software were available to conference delegates.

Astropeiler Stockert, showing the original 25 metre dish and observatory, with the later 10-metre diameter solar instrument in the foreground.

The observatory continues to have a close association with both the MPIfR and Bonn University and has state-of-the-art equipment on loan from these bodies. In return, the Astropeiler Stockert team provide training facilities for university students and also undertake serious observing work on pulsars, doing exactly what this type of operation is best qualified for, the long-term monitoring of objects which would otherwise not qualify for time on professional instruments.

EUCARA 2014

The conference took place on the 6th and 7th September and was attended by some 30 delegates from all over Europe. The schedule included 8 short talks on various aspects of radio astronomy plus a keynote presentation from Dr Silke Britzen of MPIfR. There were also guided tours of the Stockert dish, Control Room and supporting accommodation.



The current e-CALLISTO network

The CALLISTO network

Christian Monstein ETH Zurich

The e-CALLISTO solar spectrometer was a Swiss contribution to IHY 2007 and is a low-cost scanning spectrometer built around a commercial cable-TV front end. Since then nearly 70 instruments have been deployed across 40 observatories, the majority being in the developed world where the low-tech approach matches local circumstances. Christian Monstein provided an around-the-world tour of installations revealing the wide variation in cultural, economic and political circumstances.

For several observatories a lack of funds means using what is to hand. Making the most of the e-CALLISTO capabilities requires a sizeable Log Periodic antenna, with commercial products costing several hundred dollars. For equatorial locations, substitute constructions use local trees and aluminium section purchased from the local hardware store. Away from the Equator, abandoned satellite dishes are sometimes used purely for their tracking capabilities, with the e-CALLISTO antenna bolted to the side of the dish. At one site the mount is a 12-metre diameter dish, whilst the antenna is built from titanium left behind by the departing military which neglected to leave any suitably sized aluminium.

Funding remains an issue with the project seen as more of an outreach activity than delivering real science, which is totally inaccurate. The original objective of a global network providing 24-hour coverage of solar activity has been achieved and every additional instrument increases the Signal to Noise ratio and provides higher immunity from RFI. Noise is an increasing problem and Zurich is now an unusable location for solar monitoring. The real science being addressed by the network includes the investigation of coronal heating mechanism, which is still poorly understood yet faces severe competition for instrument time.

BRAMS: Listening to the meteors

Stijn Calders, Belgium Institute for Space Aeronomy

Radio meteor scatter started with the Russians in the 1950s and research has been continuing ever since. Initial observing used simple pen and paper recording methods but the current BRAMS network includes 25 monitoring stations, predominantly in Belgium, with GPS-based timing systems accurate to a millisecond or better. A dedicated beacon produces a 150 W circularly polarized signal at 49.97 MHz. Spectrum Lab is used for the initial processing but with bespoke software for back-end analysis.

The simplest application is activity profiling but it is also possible to investigate the height of the meteor through the rate of diffusion of the plasma which is a function of air pressure. This part of the atmosphere (90 – 110 km) is too high for balloon-based observations and too low for satellites making meteors the only tool for investigating the behaviour of the atmosphere at these heights. A further study looks at the mass distribution of meteor showers based upon the duration of meteor reflections. Initial measurements suggested that changes in polarisation occur as the meteor trail dissipates but these results are now open to question due to uncertainties about the polarisation of the transmitted signal.

Python, a useful Programming Language for Radio Astronomers

Roland Gaudig

This was a short introduction to Python, although it was evident that many in the audience already had experience with this language. Roland provided worked examples of calculating azimuth and elevations for driving antennas and recording and plotting analogue sound signals using standard Python library tools such as skymap.py and matplotlib.

A high-end dual channel L band astronomy receiver

Henk Peek

This development project is aimed at creating an open source wideband receiver based upon a front end RF unit with a standard FPGA board providing the back end functionality, with a 160-pin FMC connector as the physical interface between the two. Channel bandwidths in excess of 100 MHz will be provided by using high-speed multi-mode ADCs (HMCAD1511) preceded by configurable Bias Tee power insertion and filtering stages. The ZED FPGA board was proposed as a possible back end solution with the target price for the receiver being of the order of €1,000. The project is now entering the final schematic/layout stage with an estimated further year's work to production.

Amateur Radio Astronomy in the UK

Paul Hyde

This was a short presentation about current activity in the UK and the work of the BAA's Radio Astronomy Group. The Group's general meetings attract over 100 delegates demonstrating the level of interest in the

Wolfgang Herrmann demonstrating pulsar observing with the 25 metre Stockert dish.

subject, which he felt sure could be repeated within mainland-Europe.

Work at the Stockert Radio Telescope

Wolfgang Herrmann, Astropeiler Stockert

During the conference Dr Herrmann provided two presentations on the work carried out at Astropeiler Stockert.

Over the past three years the Stockert instrument has been used for a variety of observations to demonstrate its effectiveness and value as an inspirational science project operating within the volunteer sector.

The Stockert 25-metre dish is fitted with a 21 cm receiver at the prime focus with dual linear polarisations, one of which can be switched to 18 cm. This produces a 150 – 200 MHz IF output. There is also a C-Band LNB mounted alongside the main receiver. For pulsar work a dual FFT back end can operate in either a 6 kHz per channel mode, with a 1 second time resolution, or a 500 kHz per channel mode with a 54 us resolution. A 10 MHz Rubidium clock is used for the timing reference.

Measurements have been made of continuum sources such as supernova remnants and HII regions, plus 16 AGN sources down to 6.7 Jy. Spectral observations have included neutral Hydrogen, Hydrogen alpha and Hydroxyl lines, with the latter observed in emission, absorption and maser modes. The team have observed 52 pulsars to date, measuring spin-down rates and dispersion across 1.4 GHz and 4 GHz, as well as phenomena such as scintillation, mode-switching and giant pulses.

Radio Astronomy at Dwingeloo

Paul Boven, CAMRAS

(and JIVE in his spare time)

The Dwingeloo radio observatory is located near Westerweld in the north east of the Netherlands and also has an identically sized 25 metre dish, though its design has both the dish and the main building rotating together. It was also completed in 1956, pre-dating the Stockert instrument by a few months. Once its research career had finished it looked as if the observatory would be demolished but it was then realised that this would trigger a costly obligation to return the site to its original condition. This led to a rethink, resulting in its preservation as a working observatory, though this has required nearly €1 million for restoration work. CAMRAS has 300 sponsors

The 1.2 m dishes used in the interferometer

and about 50 active participants using the dish for a variety of amateur radio and radio astronomy applications and for stimulating interest in science and technology amongst the public, particularly for the younger generation.

CAMRAS has been observing pulsars since 2008 using a receiver based upon the Xilinx Spartan-3A FPGA-based DSP board. This provides 4096 bins across a 125 MHz bandwidth and is also by a Rubidium clock. The Dwingeloo team undertake the same type of measurements made at the Stockert dish and pulsar observations are very popular in the CAMRAS outreach activities.

Observational results with a Ku-band interferometer

Horst Thum, Evgeny Ulanov and Noah Schneiders, Astropeiler Stockert e.V.

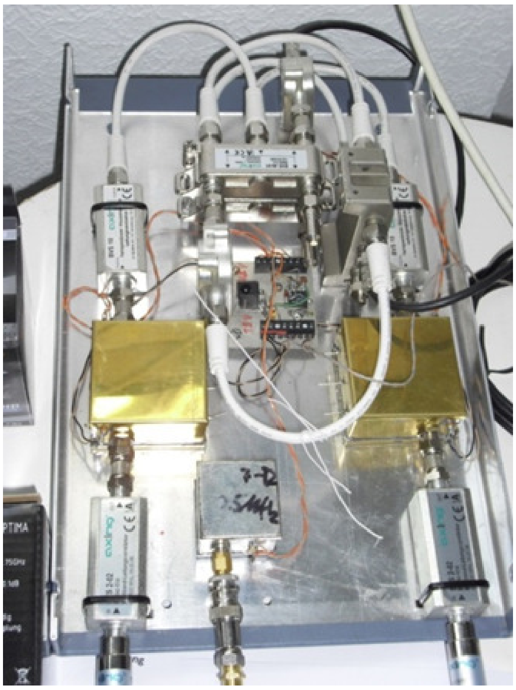
The Stockert team have been working with local sixth form students on a Ku band interferometer instrument using 1.2 m dishes with standard broadcast CATV and DTH components such as splitters and filters. The novel aspect of the project is the use of LNB units with Phase Locked Loop (PLL) local oscillators which have been modified to accept a common 25 MHz reference source. A simple phase measurement system based upon a standard Analogue Devices AD8302 chip provides increased sensitivity over simply comparing the amplitude of the two signals. A number of radio sources have been successfully detected at 10 GHz including Taurus A (518 Jy), Virgo A (39 Jy), Cyg A (132 Jy), Sgr A (100 Jy) and Orion A (315 Jy

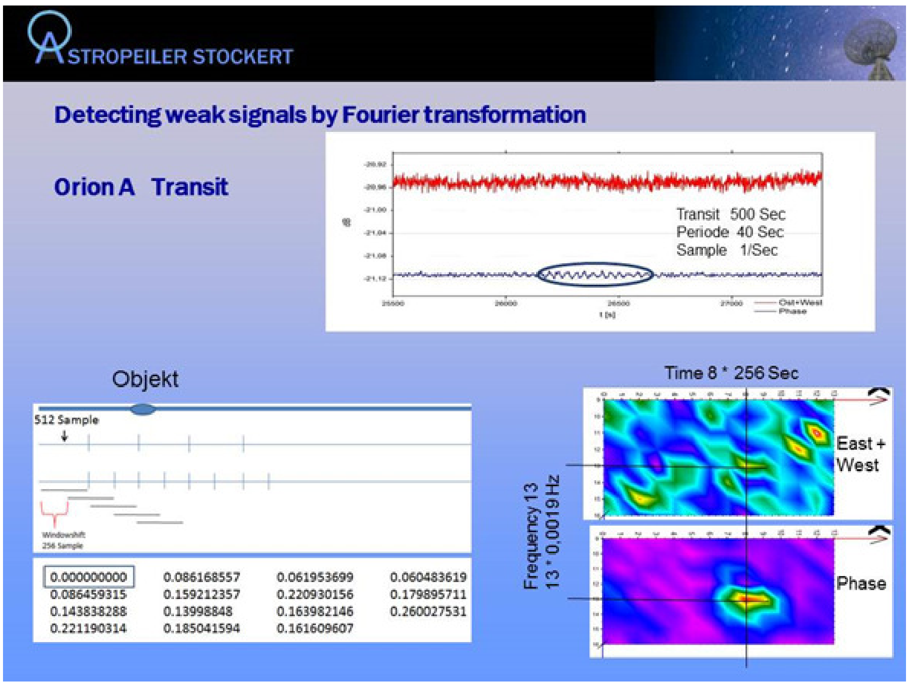
Keynote Speech by Dr. Silke Britzen, MPIfR

As well as being an artist and writer, Silke's research interest is in Black Holes, with a particular emphasis on cross—disciplinary collaborations as the field has split into specialist areas, from micro to super-massive Black Holes. Her presentation took us through the 100-odd objects constituting the Sagittarius A radio source at the centre of the Milky way, with Sagittarius A* being the Black Hole at its centre.

Internet-based applications using satellite dishes Per Dudek and Nils Dohse

Per Dudek described an impressive installation of dish hardware at Ronne, to the south of Kiel.





The indoor part of the interferometer and observations of the Orion A source

The authors are committed dish collectors, the first being a 9 metre dish with a fixed mounting. A first attempt at a motorised version disintegrated in a stiff breeze. A possible solution, based upon a tank turret mount, fell foul of a 1.2 million Dm quote, but then they became aware of several hundred tanks being decommissioned as part of the START disarmament process. This resulted in the acquisition of a suitable mount at an acceptable price - zero!

This dish is primarily used for EME work at 23 cm but it has now been supplemented by other dishes – a 6 m dia dish for 13 cm, a 7.2 m dish for 8 GHz and a 3.7 m dish for 24 GHz. A fibre-optic based network provides interconnectivity between the dishes and remote operation via the internet. As well as moon-bounce they have been successful with Venus and Mars-bounce, plus reception of signals from the Cassini probe. They also receive data from the STEREO satellites and forward to NASA.

SIDI: working towards amateur VLBI
Marko Cebokli and Pavel Reberc

This presentation covered further work on the VLBI project described in the August 2014 edition of RAGazine. The main problem with long baseline interferometry is obtaining phase coherence for the local oscillators, something that requires a Caesium clock for L band signals. The SIDI concept is to use post processing using a reference signal from the EGNOS satellite system. This uses geostationary satellites which have several advantages over the GPS system. At each of the VLBI stations the signals from both the target and the EGNOS satellite are saved to disk. This entails saving some 40 GB of raw data per hour, something unimaginable for amateurs a few years ago but now achievable with USB interfaces and Terabyte drives. The raw data is then processed to derive data, frequency and time on a millisecond basis. A second stage of processing will then correlate the two data files to produce the output.

The system is still in development with some success in decoding and correlating the EGNOS data. It is hoped to obtain some VLBI fringes in the near future.

Visit to the Effelsberg Observatory

The Sunday afternoon was taken up with a visit to the successor to the Stockert dish, the Effelsberg 100-metre telescope which is about 40 minutes' drive from the Stockert observatory. This huge dish is 70% larger in collecting area than Jodrell Bank, only just beaten to the world's largest fully-steerable radio telescope by the 110 x 100 m Green Bank dish. It seems to have been shoe-horned into a deep depression in the surrounding hills, deep enough for your ears to pop as the coach descends the access road. Even so, RFI is an increasing problem for the site. We were given a guided tour of the Control Building and then taken down to the dish itself, walking around the huge azimuth drive bogeys and then taking a lift up onto the Elevation Drive platform. It was quite an experience when the dish slewed to a new pulsar target. The instrument is very nimble for its size!

Conclusion

The conference was a great success, due to the excellent presentations but also to the efforts of Wolfgang Herrmann and a very dedicated and enthusiastic Astropeiler Stockert team. The intention is that the EUCARA event will become a regular 2-yearly event with the expectation that the next one will be hosted by the Dwingeloo team, but I hope that there will be an opportunity to return to the Stockert site in the near future.

View from the Elevation Drive platform showing the surrounding hills and with the LO-FAR outstation in the distance

A Radio Astronomy Renaissance Man

By
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A Renaissance man is defined as (http://dictionary.reference.com/browse/renaissance+man):

1. a cultured man of the Renaissance who was knowledgeable, educated, or proficient in a wide range of fields.
2. (Sometimes *lowercase)* a present-day man who has acquired profound knowledge or proficiency in more than one field.

I first heard from Robert Stephens in the early 1980s. Rob had picked up a book on ***"Amateur Radio Astronomers Notebook"*** authored by myself and Robert M. Sickels, published in 1975.

Robert (Rob) Stephens phoned me, a mid winter phone call, late one evening. Why do I remember that call? The person on the other end of the line was calling from 750 miles north of Alberta, BC. The actual location, a **DEW LINE** - over the horizon radar site in Hay River on the shores of Great Slave Lake.

The **Distant Early Warning Line**, also known as the **DEW Line** or **Early Warning Line**, was a system of radar stations in the far northern Arctic region of Canada, with additional stations along the North Coast and Aleutian Islands of Alaska, in addition to the Faroe Islands, Greenland, and Iceland. It was set up to detect incoming Soviet bombers during the Cold War, and provide early warning of any sea-and-land invasion.

The DEW Line was the northernmost and most capable of three radar lines in Canada and Alaska; the joint Canadian-US Pinetree Line ran from Newfoundland to Vancouver Island, and the Mid-Canada Line ran somewhat north of this.

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

Robert W. Stephens, Founder and President of IEI, developed a plan to establish a professional caliber astronomical radio observatory to conduct Canada's first full-time SETI (Search for Extraterrestrial Intelligence) microwave space exploration program. In 1985 Stephens was able to realize his goal by establishing the interstellar Electromagnetics Institute (IEI), a federally incorporated non-profit research corporation. Simultaneously, he was able to acquire a decommissioned DEW line tropospheric scatter communications site with two large 18 meter, parabolic dish antennas located in Canada's Western Arctic, and after an enormously ambitious and resourceful retrofit, operated the newly established Hay River Radio Observatory (HRRO)

A close and old friend of 30 plus years, I'm constantly amazed by his work with Tesla coils, Radio Astronomy, Mechanical and Electro engineering and Wind Generators. Rob, an amazing one man, knowledge filled individual. Over the years, he has demonstrated what one can do and achieve with little to no help.

Rob is self-taught in astronomy, physics as well as mechanical areas and welding. He told me that while he was employed as a technician for the Northwest Tel, one of his outings led him to the area. Being interested in Radio Astronomy and the SETI program, his thoughts was to see what could be a possible electronic lab and radio observatory. A little investigating and it became a reality.

	
Rob Stephens pre Hay River	**HRRO at first**

The First Winter

Rob had accumulated surplus electronic test equipment and various receiving equipment which would come in handy in his new venture.

Rob decided his work and research needed to be a full time venture and with his real interest in Radio Astronomy and SETI (Search for Extraterrestrial Intelligence). This was the best place to do it. So, the big tropposcatter antennas and receiving equipment were put in place.

There were many cold lonely days and nights but, Rob kept the lights on and the equipment warm. This was financed mostly by him and some donations.

In the beginning of the 1980's, the facility had the distinction of operating the second largest collection aperture microwave radio telescope in Canada, next behind the National Research Council's (NRC) 46 meter telescope at its Algonquin Radio Observatory (ARO). HRRO promoted public education and experience in radio astronomy, as interest amongst public media grew around Stephens' work. The project was covered in various media including Omni magazine, the Globe and Mail, the Edmonton SUN, the Nova Scotia Monitor, TV and radio including CBC and NBC to name but a few. The HRRO even hosted an undergraduate student under Professor Bill Lonc for two months in 1986, from St. Mary's University of Halifax, Nova Scotia. H. Peter White, then Bachelor of Science Honors student in Physics and Astronomy has since earned his Ph.D. from York University and is employed as a research scientist at Natural Resources Canada. Dr. White presently sits on the IEI Board.

Algonquin Radio Observatory (ARO)

In 1988, Stephens managed to secure the donation of a 20-metre radio telescope dish from the Department of Astronomy of the University of Toronto. The large antenna was located in a specially selected radio quiet location deep in Algonquin Provincial Park next to the NRC's own radio telescopes. With a special arrangement negotiated with the NRC, by the fall of 1988, the relocated Hay River SETI Program was installed at Algonquin Radio Observatory (ARO) and operating under the formal name Project TARGET (Telescope Antenna Researching Galactic Extraterrestrial Transmissions). Operating in near ideal circumstances, Project TARGET operated successfully for three years, making important astronomical observations and maps of the Milky Way while searching for artificially generated signals. In 1991, the program met an untimely and abrupt end when the Canadian Federal Government closed ARO as part of a brutal, across the board, cost cutting measure. Project TARGET, Canada's only full time SETI program may have temporarily been put on hold but Stephens wasn't about to give up. Following ARO Stephens spent a couple of years at Professor John Kraus' famous "BIG Ear" radio telescope of Ohio State University where he applied his knowledge and talents improving systems on the giant radio telescope the size of three football fields, and home to the USA's longest running SETI search program. His significant contributions included a 250 foot long railway track feed positioning system that allowed the telescope to track radio sources of interest across the sky for extended periods of time and a thermal shielding system for the receiver which improved stability and sensitivity.

First Amateur Detection of the 21cm Line

Stephens was the first amateur astronomer in the world to detect an atomic emission line from deep space in the microwave spectrum (see the following page). His prize, the 21 cm emission line from cold ground state neutral hydrogen atoms out in the spiral arms of the Milky Way Galaxy. Stephens published a paper in the February 1986, Journal of The Society of Amateur Radio Astronomers which he was a member of at the time entitled, "**Early Observations of Neutral Atomic Hydrogen in Emission at the Hay River Radio Observatory**" written December 1985. From the paper the first sentence following the Abstract reads, ***"The Neutral Atomic Hydrogen (H1) spectral line (1,420,405,751.800 +/-0.028 Hz) has at long last been detected by this researcher in emission during the early morning hours of November 05, 1985"***.

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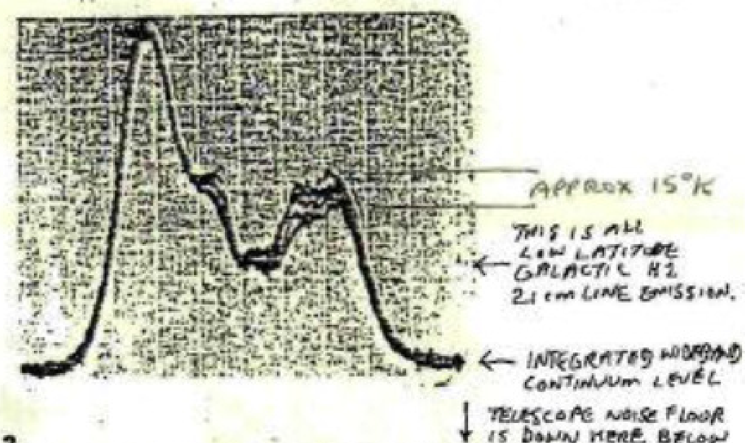

Figure 2.
Actual photo from spectrometer storage display. Five consecutive 58 second sweeps between 20h15m to 20h19m RA inclusive. +36.5 deg.N.dec. Note fine detail changes in only a portion of the spectra occuring from sweep to sweep. This verifies good RA resolution of the telescope!

Conclusion

It has been demonstrated that a steerable radiotelescope of sufficient sensitivity and angular resolution to produce data useful for research purposes has been established.

Efforts concentrated now at improving "back end" instrumentation and related data processing will only result in improved sky maps, and awareness for sought after anomilies in the search space available to HRRO.

A fully automated, contiguous 58 channel spectrometer search system under Z-80 microprocessor control has been under development. Conceptually similar to the SETI search system employed by Robert Dixon, OSURO (Big Ear), the author's system is nearing completion of both hardware and software, and should be processing actual sky noise early in 1987. At such time, a full time domestic SETI program, Canada's first, should at long last be operational.

This was long before off the shelf equipment and computers makes this task easy for today's advanced amateurs. Stephens had no mentor at the time to teach him the ropes and he did it entirely with custom built instrumentation he figured out how to and then proceeded to build by himself by modifying telephone company surplus gear originally used to carry long distance telephone circuits between microwave towers. The resulting DIY microwave spectrometer became the heart of the HRRO SETI telescope and received glowing praise for its quality of output data from NASA professionals including Dr. Bernard Oliver, VP of the Hewlett Packard Corporation, and Head of the NASA SETI Program office.

Currently, Stephens resides a day's drive from Toronto. In the past couple of years, Stephens took on another massive project, the building of a couple of wind generators one of which seen here, prior to the propeller assembly.

A Collection to be proud of!

Robert Stephens can be reached at:

rcavictim@gmail.com

The Author – Jeffrey M. Lichtman is the Founder and Owner of Radio Astronomy Supplies and Founder Emeritus of the Society of Amateur Radio Astronomers.