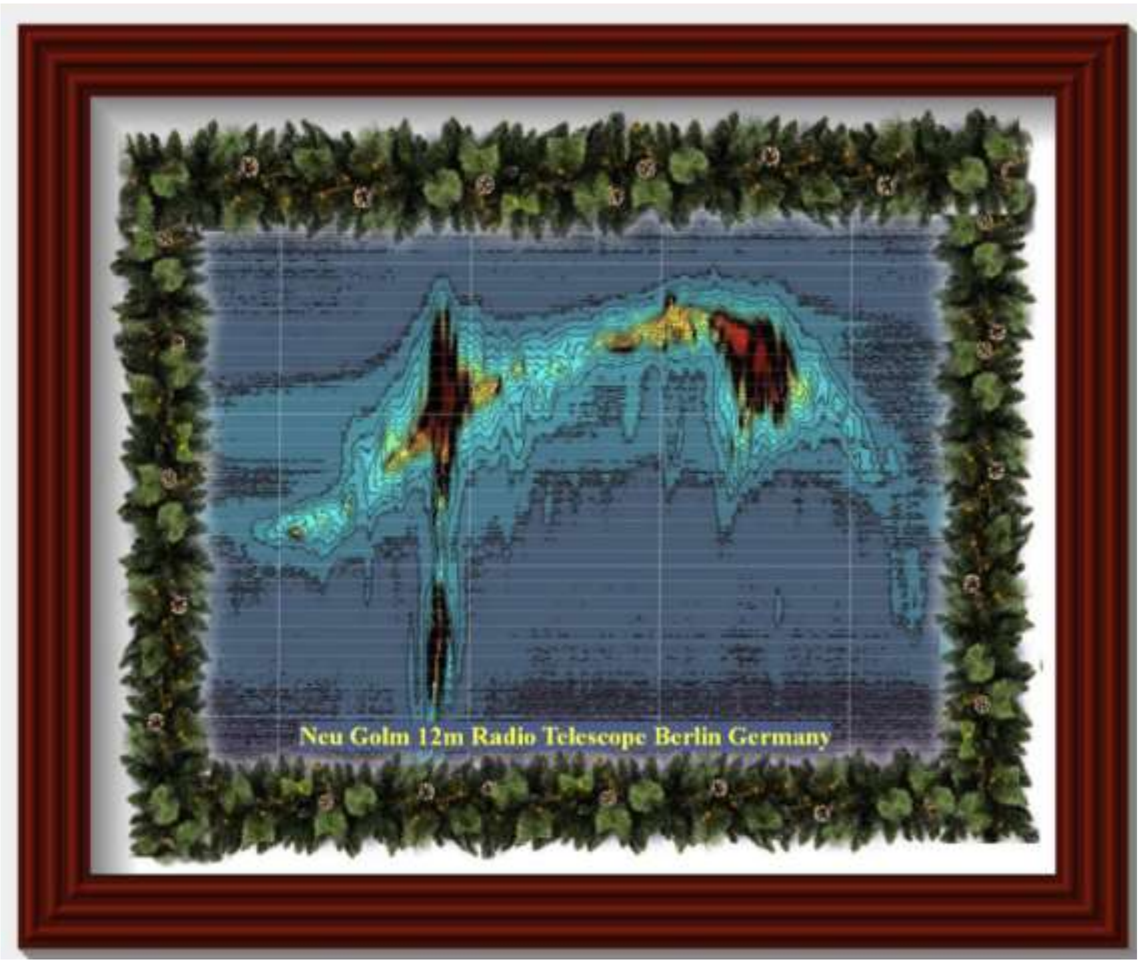
RADIO ASTRONOMY

Journal of the Society of Amateur Radio Astronomers
November – December 2025



Dr. Richard A. Russel
SARA President and Editor

Bogdan Vacaliuc
Contributing Editor

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It is the mission of the Society of Amateur Radio Astronomers (SARA) to: Facilitate the flow of information pertinent to the field of Radio Astronomy among our members; Promote members to mentor newcomers to our hobby and share the excitement of radio astronomy with other interested persons and organizations; Promote individual and multi station observing programs; Encourage programs that enhance the technical abilities of our members to monitor cosmic radio signals, as well as to share and analyze such signals; Encourage educational programs within SARA and educational outreach initiatives. Founded in 1981, the Society of Amateur Radio Astronomers, Inc. is a membership supported, non-profit [501(c) (3)], educational and scientific corporation.

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Cover Photo:
Alex Pettit

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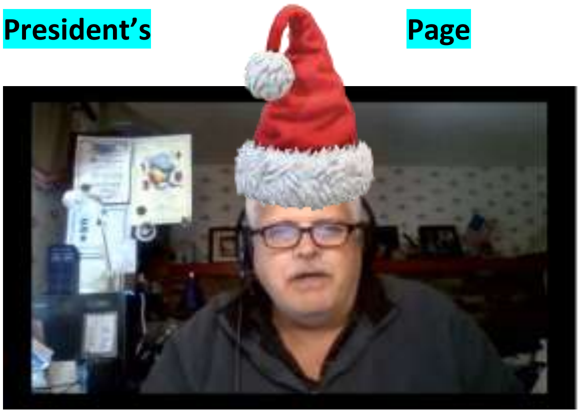


Another fantastic year for SARA!

I would like to start with a quote from Wolfgang;

" SARA was organized over 40 years ago to provide a resource and forum for amateur radio operators to expand their skills in the design of advanced antennas, receivers, and processing equipment. With advances of technology over time weaker and weaker sources became accessible to amateurs. Observations are possible today which people back in the founding time of SARA could only dream of."

• Smithsonian Institute Collaboration – granted an IBT and Scope in the Box for the Smithsonian team to demonstrate to the crowds.
• SARA Grant Committee – Tom Crowley has organized several grants for qualifying organizations
• SARA Store – Lester Veenstra (Store Manager) has done an outstanding job with the Scope-in-a-Box radio telescope program.as well as James Pettingale – SuperSID program coordinator, and Dr. Chuck Higgins – Radio Jove Coordinator
• Chip Sufitchi – Outstanding support as the SARA Web administrator
• Special thanks to VP Marcus Fisher, Treasurer Tom Jacobs, Interim Treasurer Dennis Farr, Secretary Brian O'Rourke, and Contributing Editor Bogdan Vacaliuc.
• Dr. Marcus Fisher and Ken Redcap for their significant efforts in organizing the Eastern and Western conferences this year!

Other Accomplishments:
• SARA Journal (Radio Astronomy) – published six times per year
• Fully indexed references to all journals, conference proceedings and video presentations – invaluable for doing research for your radio astronomy project.
• Monthly Zoom session – Drake's Lounge (forum to discuss technical challenges with leading experts)
• Monthly Zoom session – Radio Telescope Observation Party (forum to discuss how to observe astronomical sources)
• Monthly Zoom session – Australia Drake's Lounge (forum to discuss radio astronomy with Australia members)
• SARA – Listserv – real-time forum to provide 24/7 technical interchange between members.
• SARA YouTube Channel – provides presentations on all aspects of amateur radio astronomy. This includes tutorials and radio astronomy observations. https://www.youtube.com/@radio-astronomy
• Two major conferences each year (East Coast and West Coast) in which the members meet and present results from the past year.
• SARA members wrote the first Radio Astronomy Section of the 2025 ARRL Handbook

We appreciate everyone's involvement in making SARA a premier international amateur radio astronomy organization.

Thanks!

Rich
Dr. Richard Russel
SARA President

Editor's Notes

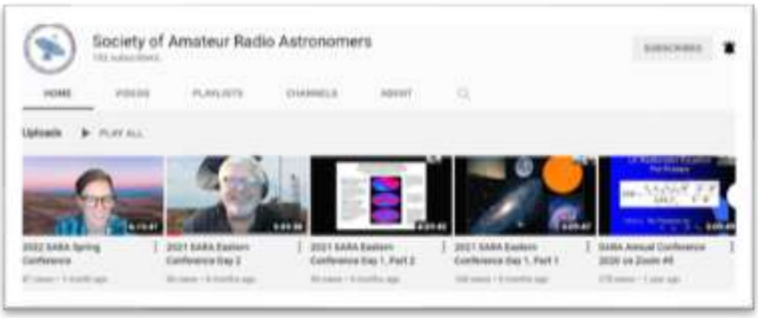
We are always looking for basic radio astronomy articles, radio astronomy tutorials, theoretical articles, application and construction articles, news pertinent to radio astronomy, profiles and interviews with amateur and professional radio astronomers, book reviews, puzzles (including word challenges, riddles, and crossword puzzles), anecdotes, expository on "bad astronomy," articles on radio astronomy observations, suggestions for reprint of articles from past journals and other publications, and announcements of radio astronomy star parties, meetings, and outreach activities.

Subscribe to the SARA YouTube Channel

SARA has a YouTube channel at: https://www.youtube.com/@radio-astronomy

Don't forget to LIKE  the videos! It helps with the YouTube distribution algorithm.

We are also looking to add content to the site. Anyone who wants to help produce a series of 5 - minute videos relating to radio astronomy technology or observations please contact me. (drrichrussel@netscape.net)



Observation Reports

We are now accepting 1-2 page observation reports. These reports should include the astronomical object's RA/DEC plus UTC of the observation. Also include the telescope configuration, process used to observe the object and results. Picture of the setup and plots of the observation are a plus to the report.

If you would like to write an article for Radio Astronomy, please follow **the newly updated Author's Guide** on the SARA web site:
http://www.radio-astronomy.org/publicat/RA-JSARA_Author's_Guide.pdf.

Let us know if you have questions; we are glad to assist authors with their articles and papers and will not hesitate to work with you. You may contact your editors any time via email here: edit@radio-astronomy.org.

The editor(s) will acknowledge that they have received your submission within two days. If they do not reply, assume they did not receive it and please try again.

Please consider submitting your radio astronomy observations for publication: any object, any wavelength. Strip charts, spectrograms, magnetograms, meteor scatter records, space radar records, photographs; examples of radio frequency interference (RFI) are also welcome.
Guidelines for submitting observations may be found here: http://www.radio-astronomy.org/publicat/RA-JSARA_Observation_Submission_Guide.pdf

SARA NOTES

2026 SARA Western Conference

March 21, 2026
ZOOM Conference Only
Send presentation abstracts to Ken Redcap i.c.o
pres@radio-astronomy.org

2026 SARA Eastern Conference

August 1 (Sat) – August 5 (Wed) 2026
Green Bank Observatory (GBO) West Virginia (WV)

Block your calendars and start thinking about next year's travels. The 2026 Eastern Conference has been set to occur the first week in August 2026 back in Green Bank WV!

- 2026 SARA and Radio Jove Eastern Conference
- August 1 (Sat) – August 5 (Wed) 2026
- Green Bank Observatory (GBO) West Virginia (WV)

We will be following a similar format as years past. For example:

- Saturday (8/1): Guided tours of public exhibits, Dave Lacko and Jay Wilson discussion on "What is Radio Astronomy Anyhow?", hands on workshop assembling Scope in a Box and eZRA software
- Sunday (8/2): hands on workshop for 40' telescope and 20-meter telescopes, with attendees able to plan and make observations
- Monday – Tuesday: Technical discussions
- Wednesday (8/5): Guest Speaker and technical tours of GBO
- Evenings: Drake lounge discussions, flea market, and observations using Scope in a Box, Radio Jove, Super SID, 40', 20 meter telescopes

Any comments and/or suggestions please reach out to the committee chair Marcus Fisher (vicepresident@radio-astronomy.org)

SARA Student & Teacher Grant Program

All, SARA has a grant program that is, sad to say, very underutilized. We will provide kits or money for students and teachers, including college students, to help them with a radio telescope project. SARA can supply any of the following kits:

[1] SuperSID
[2] Scope in a Box
[3] Radio Jove kit
[4] Inspire
[5] Sky Scan

We can also provide up to five hundred dollars ($500.00 USD) for an approved radio telescope project.

We have on occasion provided more money based on the merits of the project and the SARA Grant Committee approval.

More information on the grant program can be found at the URL below.
SARA Student and Teacher Project Grants | Society of Amateur Radio Astronomers (radio-astronomy.org)

All that is required is the SARA grant request form to be filled out and sent in. If it needs more work for approval, we will work with the students to help ensure their success.

Please pass the word that SARA will fund any legitimate radio telescope project anywhere in the world.

If you have a question, contact me at crowleytj@hotmail.com .
Tom Crowley - SARA Grant Program Administrator

Drake's Lounge Australia

This new zoom forum is geared to the Melbourne, Australia time zone (UTC+10) in order to improve coordination with our Australia, New Zealand, and Japanese members. The meetings are scheduled for the 4th Friday of every month, 9 AM Melbourne time. A zoom announcement will be sent out to all SARA members before the meeting.

Radio Telescope Observation Party (RTOP)

RTOP is designed to demonstrate how to take observations using various radio telescopes. It will also cover how to record and analyze data.
RTOP is every month on the 1st Sunday at 2 pm Eastern time (1800 UTC). ZOOM email notifications will be sent to all members.

Drake's Lounge

Join the SARA community as we discuss the latest astronomy and radio astronomy news. The lounge also provides a forum to share and get advice on your radio astronomy projects from very experienced amateur radio astronomers.

Drake's Lounge is every month on the 3rd Sunday at 2 pm Eastern time (1800 UTC). ZOOM email notifications will be sent to all members.

New Members

July	August	September	October	November	December
Brian Fredrickson	Robert Kiendl	Phillip Hudson	John Blasing	Ayushman Tripathi	Matthew Helt
William Dyer	Kenneth Lord	Frank Briola	Michael Thomas	Jeffery Biss	Srikanth Krishnamurthy
Luca Bicego	Harm Munk	Karl Spielmann	Victor Bao	Thomas Oglesby	Erin Nicole Cannon
Dale Nichols	Sarah Renner	Ignacio Muñoz López	Harry Gray	John Anderson	Robert Moseley
Ennio Cellucci	Christopher Aiken	Kamal Jabbour	Tony Byerly	Christopher Chaney	
	Dominic Robinson	Douglas Datwyler	George Cannon	Bjoern Ludwar	
	Dana Davidsen	Steve Hawker	Conrad Cardano	Andrew Selden	
	Joe Thobald		Larry Dalton	Jeff Dillon	
	James Robinson		John Sode	Dykes Cupstid	
	Anoj Khadka		David Kerr		
	Ant Allen		Bent Pedersen		
	Andre Powell				
	William Weiss				
	Mark Sproul				
	Paul-Emile Leger				
	Tyrone Bradford				

British Astronomical Association
Supporting amateur astronomers since 1890
Radio Astronomy Section


Director: Paul Hearn

The Radio Astronomy Section aspires to encourage and support the construction of radio telescopes by amateurs, their use for observing programmes, and the development of a deeper understanding of the science underlying what is being observed. Programmes can be aimed at any radio astronomical phenomenon, at any radio frequency. This encouragement will be through the operation of continuing group programmes, and through building communication and information exchange between individuals and groups pursuing their own projects. The main purpose of the Group is to act as a reservoir and clearing house for information on radio telescope design, construction and debugging, and how to use these instruments effectively. This will include the discussion of observing techniques and data analysis. Members should be able to exchange ideas, give advice and help each other. Establishing a pool of design information and software suitable for use in observing and data processing is a priority.

BAA Radio Astronomy Section Seminar programme.
These seminars are on Zoom, if you are not on the BAA RA Section email list please contact Paul Hearn – Section Director – paul@hearn.org.uk

Our next meeting will be 'An evening at Dwingeloo' some live observing on Friday Jan 23rd..

Friday December 5th 19:30 (19:30 UTC) - postponed until next year.
Diane Swan
Exploring the radio emission of Core Collapse Supernova SN2017eaw, and glimpse at the eMERLIN array.

On the 15th of May 2017, a new supernova in the galaxy NGC6946, (the Fireworks Galaxy), was reported from visual observation by Peter Wiggins, and at a distance of approximately 5.5Mpc, this is in our cosmic back yard. Consequently, this supernova has been well observed at frequencies across the EM spectrum, but unusually we have detailed radio observation in the ranges, L, C, X U and K. Interpretation of the radio data, provides a range of information about the progenitor, its behaviour in the final years prior to the explosion, and the physical processes linked to the radio emission.
Dian will explore: The nature of Core Collapse Supernovae, Progenitor behaviour and its influence on radio emission, Why is it unusual to have radio observation at all!

Friday 23rd Jan. 2026 19:30 GMT (19:30 UTC)
An evening at Dwingeloo - Live observations.
Tammo Jan Dijkema and Thomas Telkamp

With the historic Dwingeloo 25m radio telescope, we can observe many interesting sources: pulsars, OH masers, continuum sources, galactic and extragalactic neutral hydrogen to name a few. We will present from the cabin of the Dwingeloo telescope.

Friday 27th February 19:30 GMT (19:30 UTC)
LOFAR and exoplanet environments
Dr Joseph R. Callingham
Associate Professor, Anton Pannekoek Institute for Astronomy, University of Amsterdam

Join the RA conversation
Join the muon conversation
Join the UK Beacon conversation
Society of American Radio Astronomers
UK Radio Astronomy Association (UKRAA)
BAA RA YouTube channel

Paul Hearn
BAA Radio Astronomy Section Director
UKRAA Trustee

¦¦¦ British Astronomical Association ¦¦
https://britastro.org/section_front/24

Where Art and Science Meet

Alex Pettit – Radio Astronomy Art

Rage Against the Machine: A Tale from the L-Band Trenches.

Andrew Thornett

After unboxing the bargain board, I felt triumphant and bold,
But Ubuntu just stared back at me, frosty, distant, cold.
Cables tangled like spaghetti as I muttered in despair,
Drivers? Nowhere to be found—just error boxes everywhere.
Each tutorial contradicted what the last one tried to teach,
Forums mocked me quietly with wisdom out of reach.
Gurus claimed, “It’s trivial!” (which filled me with unease),
Hell-bent, I typed commands that made the kernel wheeze.
Intermittent blinking LEDs teased me with false hope,
Joy fled my mini PC as I watched the logs elope.
Kernel modules bickered like they had personal vendettas,
Linux screamed in dmesg: *“Stop sending weird vend requests!”*
My patience shrank to nothing as the relay clicked in spite,
Nefarious little toggle, mocking me all night.
Over and over I recompiled—insanity by choice,
Perhaps the board was laughing, if circuits can find a voice.
Quite sure I smelled something: was it burning? Was it fear?
Rage brewed like strong espresso as the truth became too clear.
Surely no mere mortal could make this gadget obey,
Thus I raised my mini PC in ritual display.
Utterly defeated, I hurled it with a shout,
Vaulting past my desk—an elegant, arcing route.
With thunderous authority, it smacked against the floor,
Xenial spirits cheering as I stamped it twice (or more).
Yes, at last sweet catharsis! No more drivers to amend—
Zero regrets, dear reader: a perfect, poetic end.

SuperSID

SuperSID
Collaboration of Society of Amateur Radio Astronomers and Stanford Solar Center

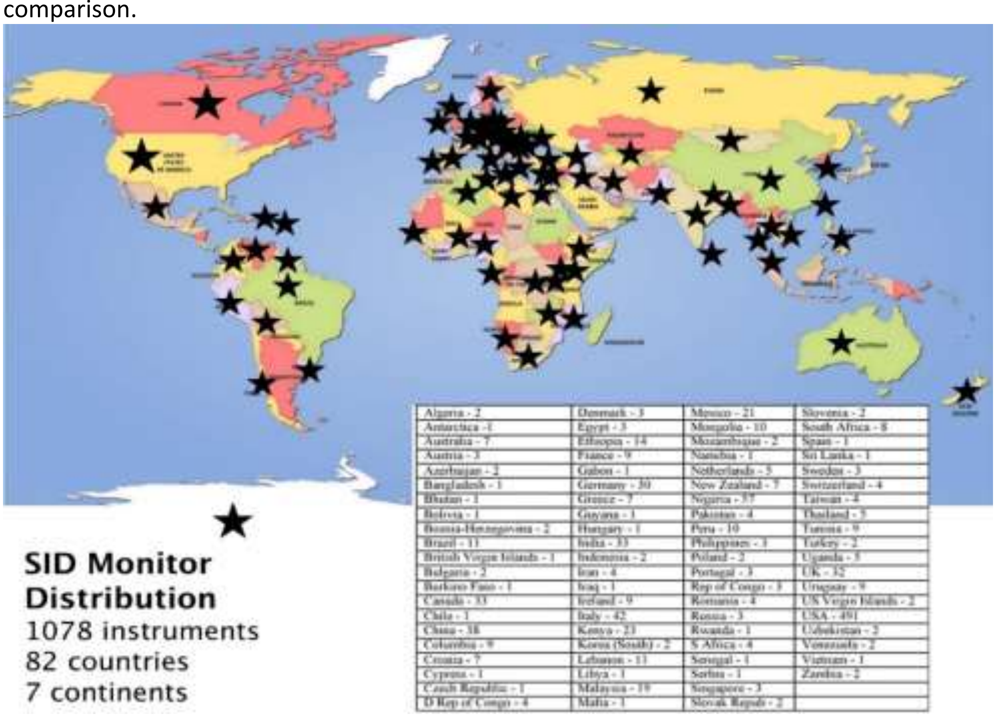
- Stanford provides data hosting, database programming, and maintains the SuperSID website
- Society of Amateur Radio Astronomers (SARA) sells the SuperSID monitors for 48 USD to amateur radio astronomers and the funds are then used to support free distribution to students all over the world (image below as of Fall 2017)
-
- Jonathan Pettingale at SARA is responsible for building and shipping the SuperSID monitor kits: SuperSID@radio-astronomy.org
- SuperSID kits may be ordered through the SARA SuperSID webpage: http://radio-astronomy.org/node/210

- Questions about the SuperSID project may be directed to Steve Berl at Stanford: steveberl@gmail.com

- Jaap Akkerhuis at Stanford is responsible for the SuperSID software and SARA has provided financial support for his efforts

- SuperSID website hosted by Stanford: http://solar-center.stanford.edu/SID/sidmonitor/
- SuperSID database: http://sid.stanford.edu/database-browser/

- The data is searchable by time, station, date, and multiple plots may be placed on the same graph for comparison.



Algeria - 2	Denmark - 3	Mexico - 21	Slovenia - 2
Antarctica - 1	Egypt - 3	Mongolia - 10	South Africa - 8
Australia - 7	Ethiopia - 14	Mozambique - 2	Spain - 1
Austria - 3	France - 9	Namibia - 1	Sri Lanka - 1
Azerbaijan - 2	Gabon - 1	Netherlands - 5	Sweden - 3
Bangladesh - 1	Germany - 30	New Zealand - 7	Switzerland - 4
Bhutan - 1	Greece - 7	Nigeria - 37	Taiwan - 4
Bolivia - 1	Guyana - 1	Pakistan - 4	Thailand - 5
Bosnia-Herzegovina - 2	Hungary - 1	Peru - 10	Tunisia - 9
Brazil - 11	India - 33	Philippines - 1	Turkey - 2
British Virgin Islands - 1	Indonesia - 2	Poland - 2	Uganda - 5
Bulgaria - 2	Iran - 4	Portugal - 3	UK - 32
Burkino Faso - 1	Iraq - 1	Rep of Congo - 3	Uruguay - 9
Canada - 33	Ireland - 9	Romania - 4	US Virgin Islands - 2
Chile - 1	Italy - 42	Russia - 3	USA - 491
China - 38	Kenya - 23	Rwanda - 1	Uzbekistan - 2
Columbia - 9	Korea (South) - 2	S Africa - 4	Venezuela - 2
Croatia - 7	Lebanon - 11	Senegal - 1	Vietnam - 1
Cyprus - 1	Libya - 1	Serbia - 1	Zambia - 2
Czech Republic - 1	Malaysia - 19	Singapore - 3	
D Rep of Congo - 4	Malta - 1	Slovak Repub - 2	

-

For official use only
Monitor assigned: ___________
Site name: _________________
Country: ___________________

SuperSID Space Weather Monitor

Request Form

	Your information here		
Name of site/school *(if an institution)*:			
Choose a site name: *(3-6 characters) No Spaces*			
Primary contact person:			
Email:			
Phone(s):			
Primary Address:	Name School or Business Street Street City State/Province Country Postal Code		
Shipping address, if different:	Name School or Business Street Street City State/Province Country Postal Code		
Shipping phone number:			
Latitude & longitude of site:	Latitude: _____________________________ Longitude: _____________________________		

I understand that neither Stanford nor the Society of Amateur Radio Astronomers is responsible for accidents or injuries related to monitoring use. I will ensure that a surge protector and other lightning protection devices are installed if necessary.

Signature: ____ **Date:** ____________________ ________

I will need:

What	*Cost*	*How many?*
SuperSID distribution USB Power	$48 (assembled)	
USB Sound card 96 kHz sample rate *(or provide this yourself)*	$40 *(optional)*	
Antenna wire (120 meters) *(or you can provide this yourself)*	$23 *(optional) with connectors attached and tested*	
RG 58 Coax Cable (9 meters) *(or provide this yourself)*	$14 *(optional) with connectors attached and tested*	
Shipping	US $12 Canada & Mexico $40 all other $60	
	TOTAL	$

____ **I have included a $____________ check** (payable to SARA)

____ **I will make payment thru** www.paypal.com to treas@radio-astronomy.org

or

____ If you are a Minority-serving institution, in a Developing or economically deprived nation, and/or you are using the monitor with students for educational purposes, you may qualify for obtaining a monitor at reduced or no cost. Check here if you wish to apply for this designation. Then tell us how you want to use the SuperSID monitor. Include type of site, number of students involved, whether public or private school, grade levels, etc. and describe your program. The goal of the SuperSID project is to provide as many students with systems as possible. If you are able to pay for a system, even if you qualify for a free one, please do so and help support our goal.
For more details on the Space Weather Monitor project, see: **http://sid.stanford.edu**

To set up a SuperSID monitor you will need:

1 Access to power and an antenna location that is relatively free of electric interference (could be indoors or out)

2 A **PC**** with the following minimal specifications:
   a. A sound card that can record (sample) up to 96 kHz, or a USB port to connect such a sound card (for North and South America)
      i. All other countries can use AC97 sound card with 48 kHz record (sample) rate. Most computers made after 1997 will have AC97.
   b. Windows 2000 or more recent operating system
   c. 1 GHz Processer with 128 mb RAM
   d. Ethernet connection & internet browser (desirable, but not required)
   e. Standard keyboard, mouse, monitor, etc.

3 An inexpensive antenna that you build yourself. You'll need about 120 meters (400 feet) of **insulated** wire. Solid wire is easier to wind than stranded. Magnet wire will work but be more fragile. You can use anything from #18 to #26 size wire. The antenna frame can be made of wood, PVC pipe, or similar materials. We'll provide instructions. You can purchase the wire from us or obtain your own.

4 RG58 coax cable with a BNC connector at one end to run from the antenna to the SuperSID receiver. 9 meters is recommended, but the length will depend on where you place the antenna. You can purchase the coax from us or obtain your own.

5 Surge protector and other protection against a lightning strike

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Return this form to: SuperSID@radio-astronomy.org
or mail to:

SARA Treasurer
c/o Thomas Jacobs
P. O. Box 4245
Wilmington, NC 28406.

Announcing Radio JOVE 2.0

The Radio JOVE Team

Radio JOVE students and amateur scientists from around the world observe and analyze natural radio emissions of Jupiter, the Sun, and our galaxy using their own easy to construct radio telescopes.

Our Project announces Radio JOVE 2.0, where participants assemble a 16-24 MHz radio spectrograph to observe solar, Jupiter, Galactic, and Earth-based natural radio emissions and share their observations with fellow participants.

In the Beginning

Radio JOVE started as a NASA sponsored educational outreach project in 1999. We developed a radio telescope kit suitable for receiving signals from Jupiter, the Sun, the Galaxy, and Earth-based radio emissions. The original kit comprised a radio receiver (RJ1.1) and a dual dipole antenna for 20.1 MHz. An important goal was to teach electronic principles including how to build, solder, and assemble the radio receiver and antenna.

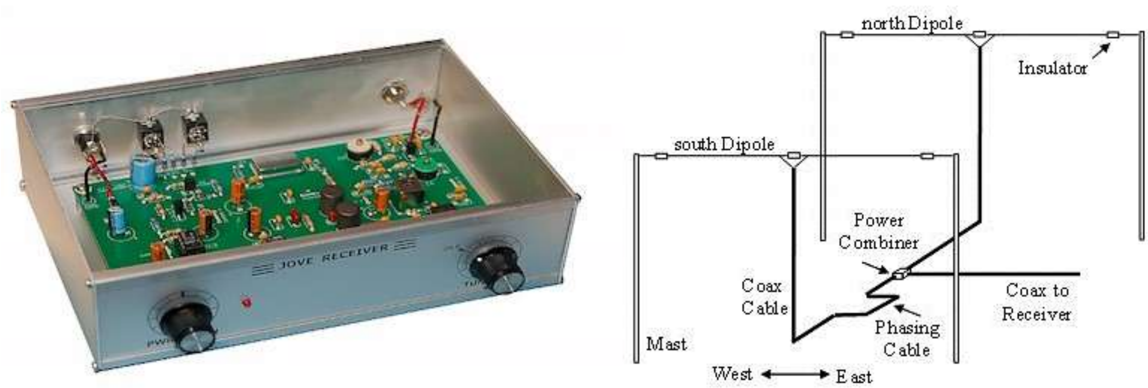

Figure 1. A Radio JOVE RJ1.1 receiver and a schematic of the dual-dipole antenna.

In addition to the hardware, three software packages were developed. These were Radio Jupiter Pro (Jupiter emission prediction program), Radio-SkyPipe (strip chart program) and Radio Sky Spectrograph (control and display of radio spectrograph data).

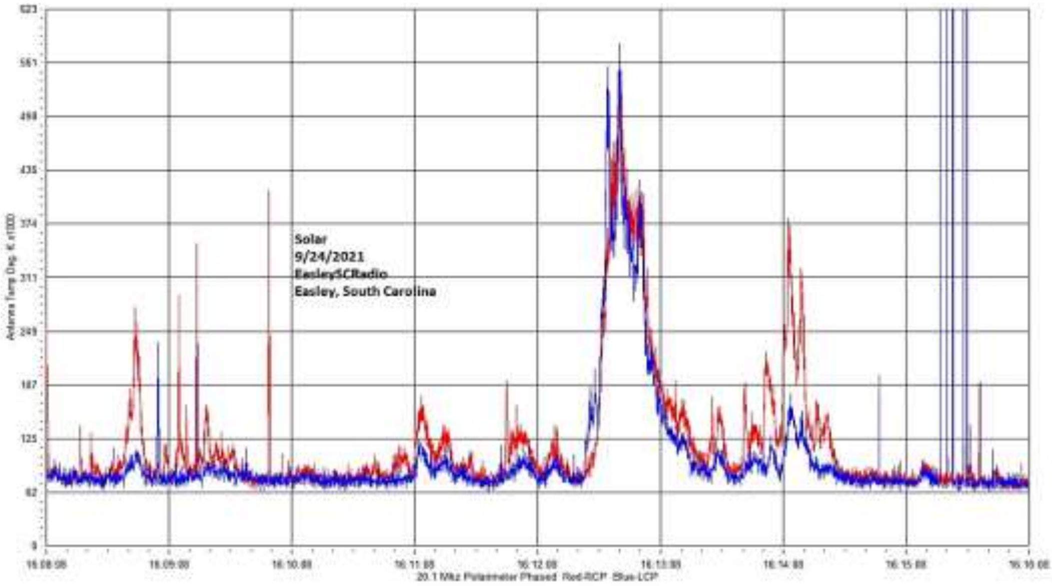

Figure 2. A SkyPipe strip chart showing multiple solar bursts using a JOVE receiver. John Cox, SC.

The Growth of Radio JOVE

As of Autumn 2021, over 2,500 kits have been sold at cost to schools and individuals around the world. Thousands of data submissions from observers have been made to the Radio JOVE data archive.

The Radio JOVE web site has always provided a wealth of information describing observation methods and various educational materials intended to teach radio astronomy techniques and scientific methods. Biannual newsletters are produced, and several telephone help sessions are held each year.

A sub-group of experienced observers known as the Spectrograph Users Group (SUG) evolved from the core JOVE group. These observers developed data collection and analysis techniques using more advanced equipment and techniques. SUG members have contributed to articles published in peer-reviewed scientific journals. This group remains active under the Radio JOVE listserv at https://groups.io/g/radio-jove/.

Moving Forward with New Technology

In the past, Radio JOVE provided the hands-on experience of building a radio kit. We have many RJ1.1 receivers in operation successfully contributing scientifically valuable data. It has, however, become increasingly difficult to obtain parts for the RJ1.1 receiver kits and we therefore decided to replace the RJ1.1 receiver with a new SDR-based design for the receiver portion of our radio telescope kits. While we continue to support the hardware and software for the original RJ1.1 receivers, the only kits now available for purchase from Radio JOVE contain this newly designed system.

In recent years, new technologies have made software defined radios (SDRs) ever more affordable. These radios can operate on a single frequency like the original JOVE receiver but can also generate spectrograms which depict radio activity as a function of both time and frequency. Such displays offer new insights into our studies of the Sun, Jupiter, the Galaxy, and both natural and artificial Earth-based radio emissions.

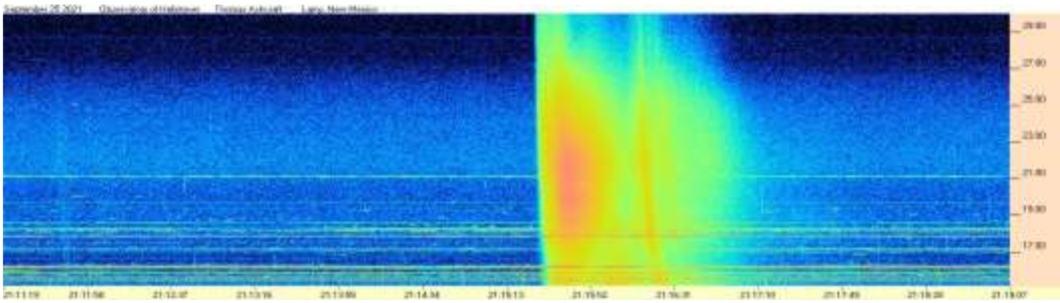

Figure 3. Radio spectrogram showing multiple solar bursts received by Tom Ashcraft in New Mexico. Horizontal scale is time, and the vertical scale is frequency. Amplitude is displayed using different colors corresponding to the strength of signals.

Radio JOVE continues to sell radio telescope packages including an antenna, receiver, and software; however, the receiver is now a commercially built SDR.

Figure 4. The JOVE team has had considerable success with the SDRPlay RSP1A unit and will provide support for using this instrument for our radio astronomy program. Not all SDR types can be supported, but it is our intent to provide support for some other SDRs as they become available during this period of rapid SDR development.

It continues to be our goal to introduce new observers to the scientific method and help them experience the thrill of receiving cosmic radio signals. Through a series of educational training modules and observing and analysis projects we aim to guide new observers to levels where they can contribute to Citizen Science projects.

We continue to support our large user base that uses JOVE RJ1.1 receivers – both in terms of technical support for the receivers but also with new and exciting observing projects for both RJ1.1 and SDR users.

We welcome both new and experienced observers to the JOVE 2.0 program as we share the excitement of receiving, studying, and understanding radio signals from our corner of the galaxy.

Please see the Radio JOVE web site at https://radiojove.gsfc.nasa.gov for more information.

RADIO JOVE 2.0 RADIO TELESCOPE KIT ORDER FORM

Order Online using PayPal™
* * * Please allow 2 to 3 weeks for delivery. * * *

IMPORTANT: Before you order the Jove receiver kit and/or the antenna kit, we suggest that you read the on-line manuals. You will need to provide additional materials and tools to complete the antenna. The cost of additional materials for the antenna support structure (masts, etc.) may be in the range of US$75 to US$100. Also note that the optimal antenna height can be up to 20ft, depending upon your latitude.

Item # RJK2u – Complete 2.0 Kit: Receiver + Unbuilt Antenna Kit + Software This kit includes an SDRplay RSP1A, USB Cable, SMA/BNC cable, F-adapter, unbuilt Antenna Kit (RJA), printed assembly manuals, and Radio-Sky Spectrograph (RSS) software. Note: Kit does not include antenna support structure. **Price: $215 + Shipping (See reverse for shipping)**	**Item # RJK2p** – Complete 2.0 Kit: Receiver + Professionally Built Antenna Kit + Software This kit includes an SDRplay RSP1A, USB Cable, SMA/BNC cable, F-adapter, Professionally Built Antenna Kit (RJA2), printed assembly manuals, and Radio-Sky Spectrograph (RSS) software. Note: Kit does not include antenna support structure. **Price: $384 + Shipping (See reverse for shipping)**
Item # RJA – Unbuilt Antenna Kit The RJA Radio JOVE Antenna Kit includes a printed construction manual, stranded copper easy-to-solder antenna wire, ceramic insulators, RG-59 easy-to-solder coax cable, screw-on F connectors, and a power combiner. Note: Kit does not include antenna support structure. Assembly requires a soldering gun and other tools. **Price: $90 + Shipping (See reverse for shipping)**	**Item # RJA2** – Professionally Built Antenna Kit The RJA2 Radio JOVE Antenna Kit includes a printed installation manual, two professionally assembled dipole antennas constructed of #14 Copperweld wire with Budwig center insulators and center support rope attachment points, high quality RG-6 coax with pre-installed commercial grade connectors, and a power combiner. Note: Kit does not include antenna support structure. **Price: $249 + Shipping (See reverse for shipping)**
Item # LTJ2 – Listening to Jupiter, 2nd Ed. by R. S. Flagg PDF download of Richard Flagg's book "Listening to Jupiter, 2nd Ed., 2005". The file is downloaded from a secure website. **Price: $10 + $0 shipping (PDF file download)**	**Item # RJR2** – Radio JOVE 2.0 Receiver-Only Kit This kit includes one SDRplay RSP1A SDR receiver, USB Cable, SMA/BNC cable, and F-adapter, printed assembly manuals, and Radio-Sky Spectrograph (RSS) software. **Price: $135 + Shipping (See reverse for shipping)**

RADIO JOVE 2.0 RADIO TELESCOPE KIT ORDER FORM (continued)

Order Online at
https://radiojove.net/kit/order_form.html OR
Complete this form and mail with payment

Payment may be made by Credit Card via PayPal™, U.S. Check, U.S. Money Order, International Money Order in U.S. funds drawn on a U.S. bank, or Western Union Money Transfer made payable to **The Radio JOVE Project**. No bank-to-bank wire transfers are accepted. Purchase Orders are accepted from U.S. Institutions.

Send to: The Radio JOVE Project
1301 East Main St
MTSU Box 412
Murfreesboro, TN 37132, USA
email: chiggins@mtsu.edu
FEIN: 20-5239863

Item	Description	Quantity	Item Price	Shipping (see below)	Subtotal
RJK2u	Complete Radio JOVE 2.0 Kit Receiver + unbuilt Antenna		$215		
RJK2p	Complete Radio JOVE 2.0 Kit Receiver + Professionally Built Antenna		$384		
RJA2	Professionally Built Antenna-Only Kit		$249		
RJA	Unbuilt Antenna-Only Kit		$90		
RJR2	Receiver-Only Kit		$135		
LTJ2	Listening to Jupiter, 2nd Ed., by R.S. Flagg (PDF download)		$10	$0	
				Total:	

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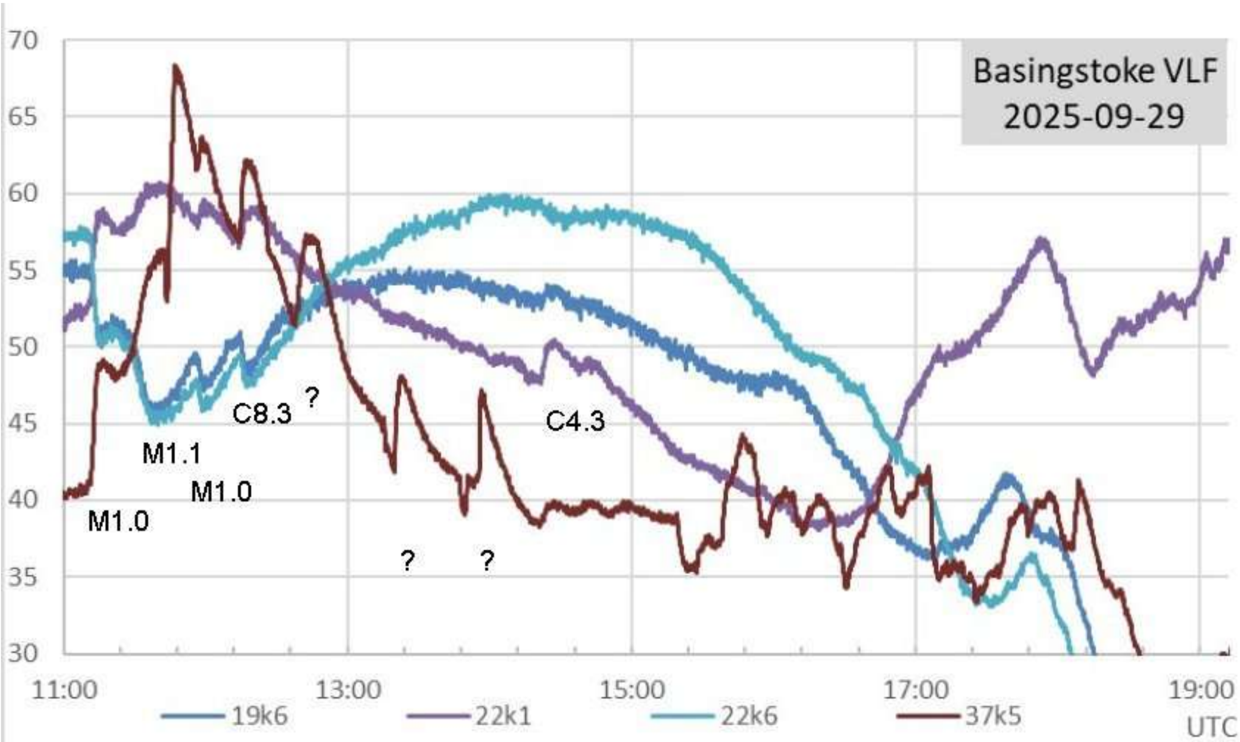
BAA Radio Astronomy Section, Director: Paul Hearn

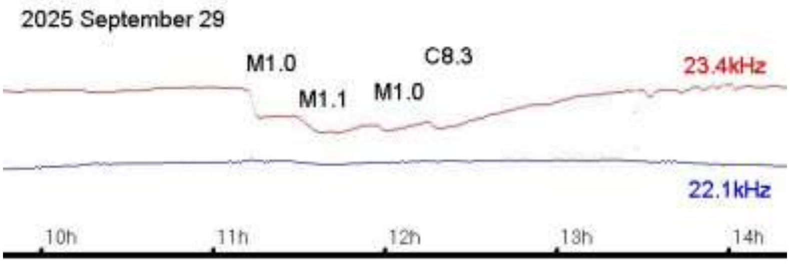
RADIO SKY NEWS **2025 SEPTEMBER**

VLF SID OBSERVATIONS

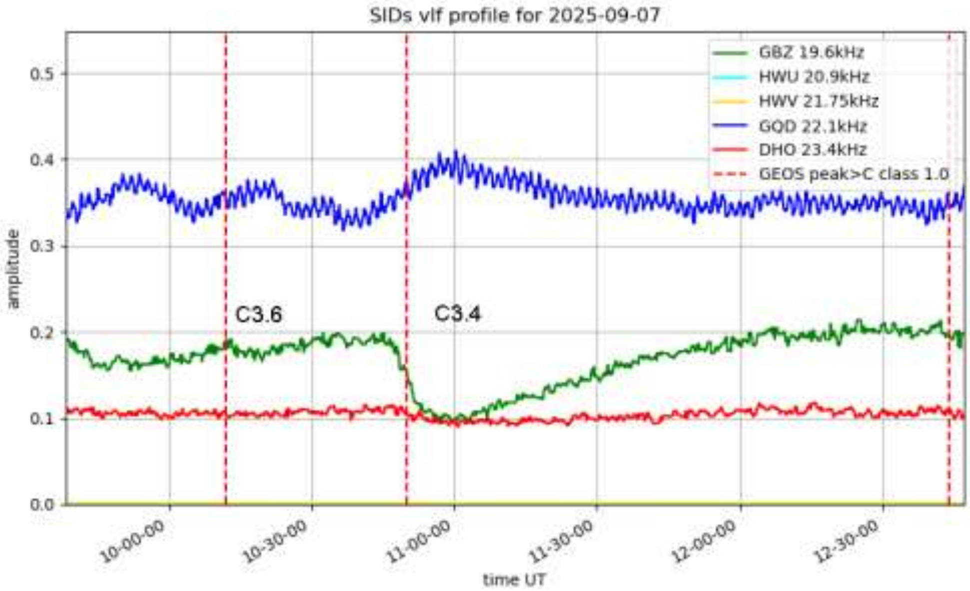
Flaring activity in September was again very low, approaching levels last recorded in 2022. We recorded 26 C-class flares and 10 M-class. There were no X-flares shown in the GOES satellite data. The shorter day length at this time of year does reduce our observing period, so counts will generally be a little lower than during the summer months. Visual observations of sunspot counts have also shown less activity, so the effect is real.



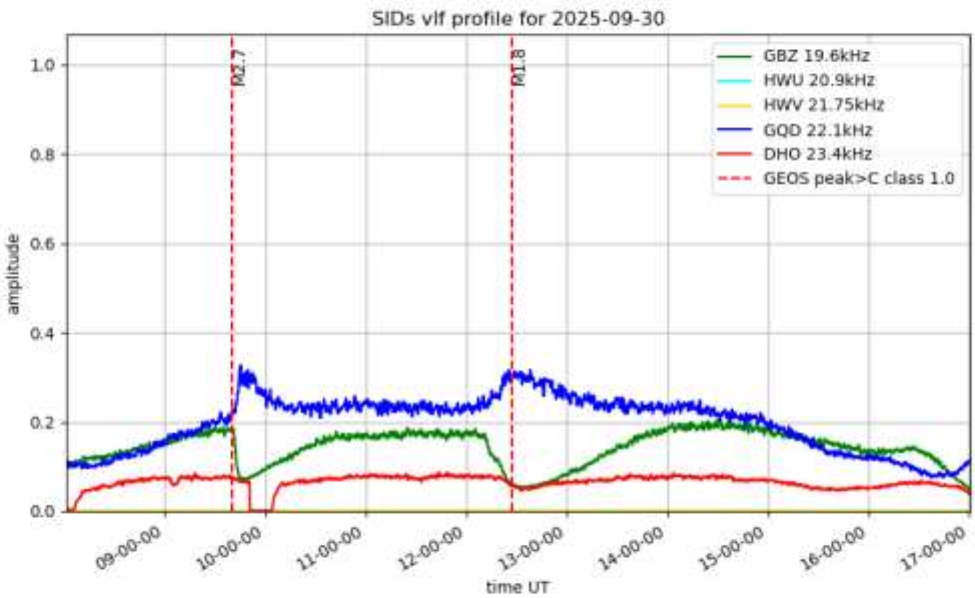
Flaring did increase in the last week of the month, the 29th being particularly active. Paul Hyde's recording shows a very complex series of M-flares around 11 to 12UT. These were all from different active regions. The 37.5kHz signal from Grindavik also shows some SID-like effects that are not seen on the other signals, so presumably not solar related. The 37.5kHz activity after 15:00UT may well be from active magnetic conditions, see the chart on page 5 of this report.



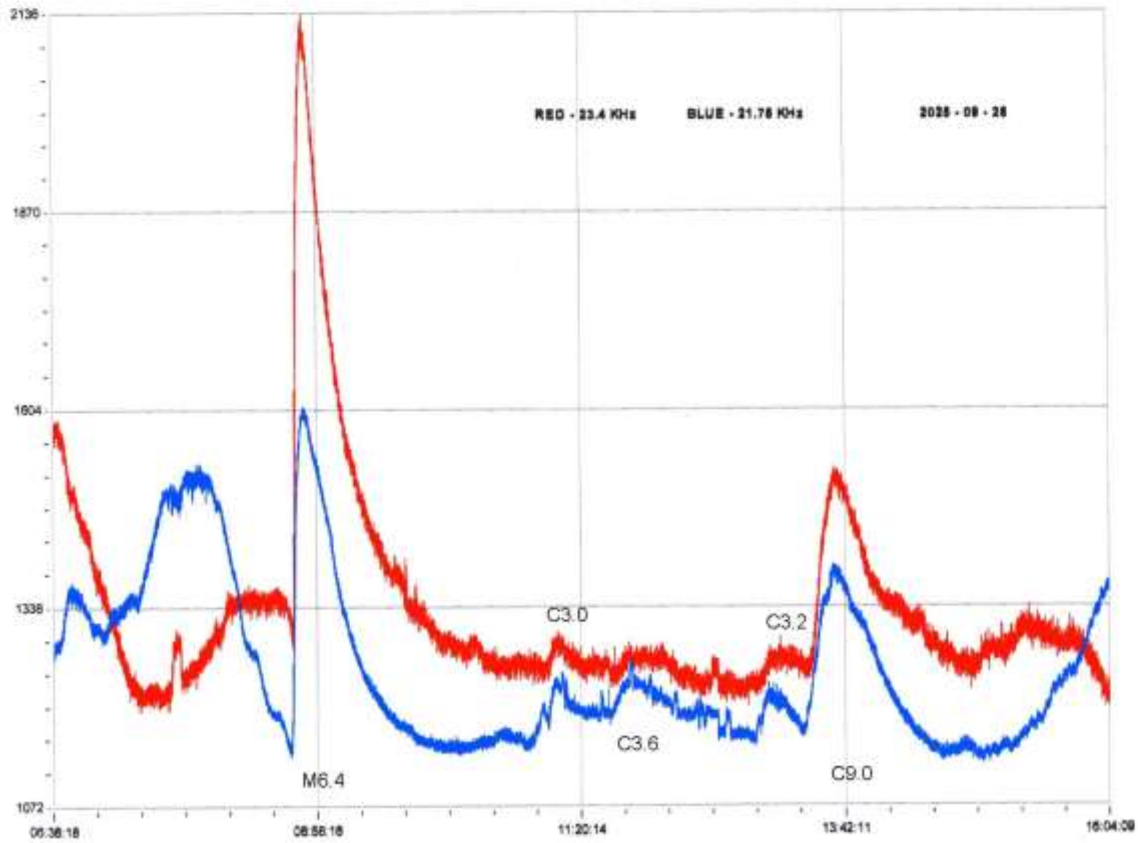
My own recording shows all four flares merging at 23.4kHz, with almost no evidence at 22.1kHz.



Mark Prescott recorded some unusual oscillations on the 22.1kHz signal on the 7th. There appears to be about thirty-four cycles per hour. The signal had been off-air during August but came back on September 4th. There have not been any other reports of this, so it may be local interference.

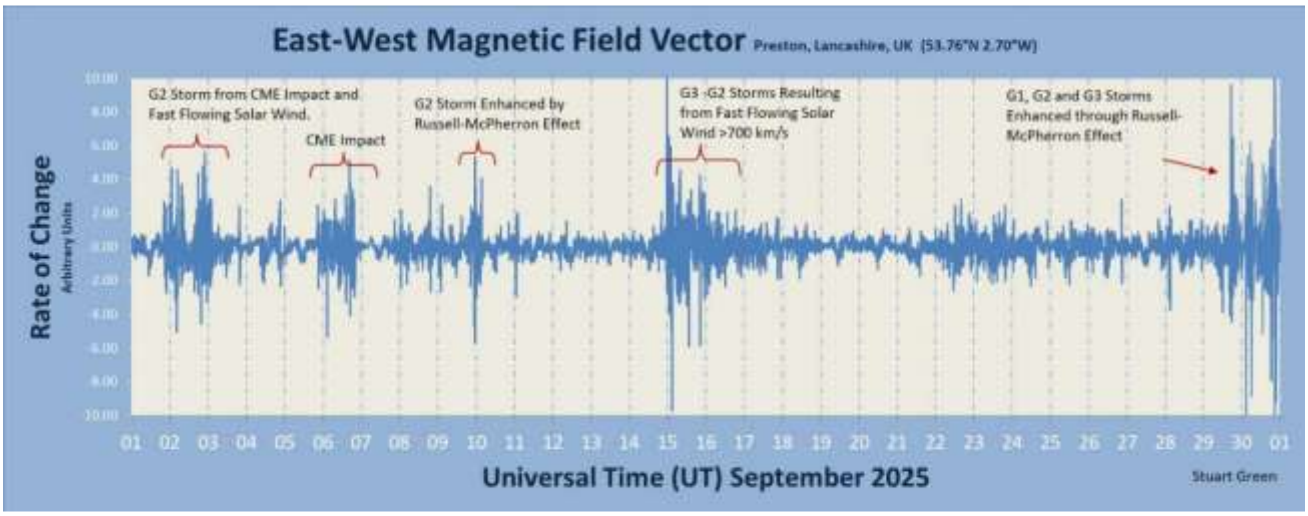


The month ended with a pair of M-flares, producing clear mirror-SIDs in Mark's recording on the 30th. 22.1kHz shows some very mild instability, but not as clear as on the 7th.



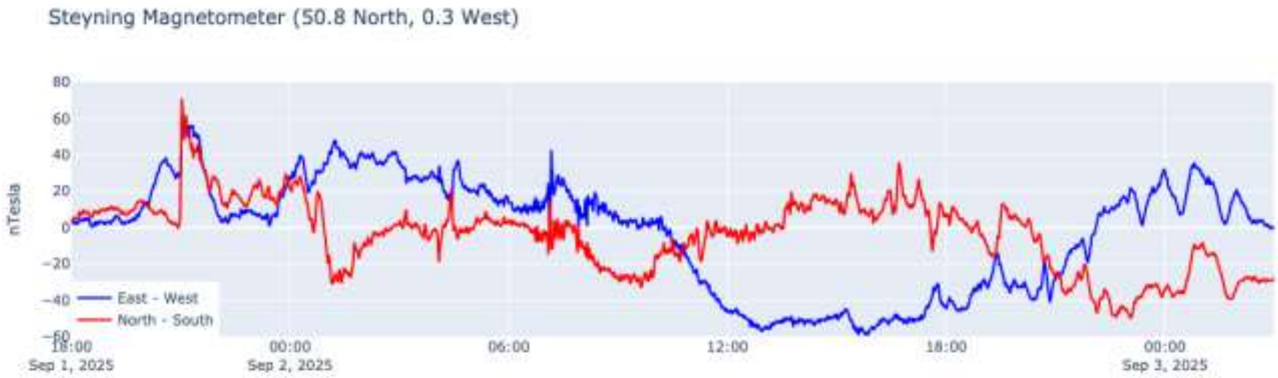
The strongest flare recorded in September was the M6.4 early on the 28th, shown here recorded by Colin Clements. It was followed by three small C-flares and then a C9.0 flare, all with clear SIDs on both signals.

MAGNETIC OBSERVATIONS

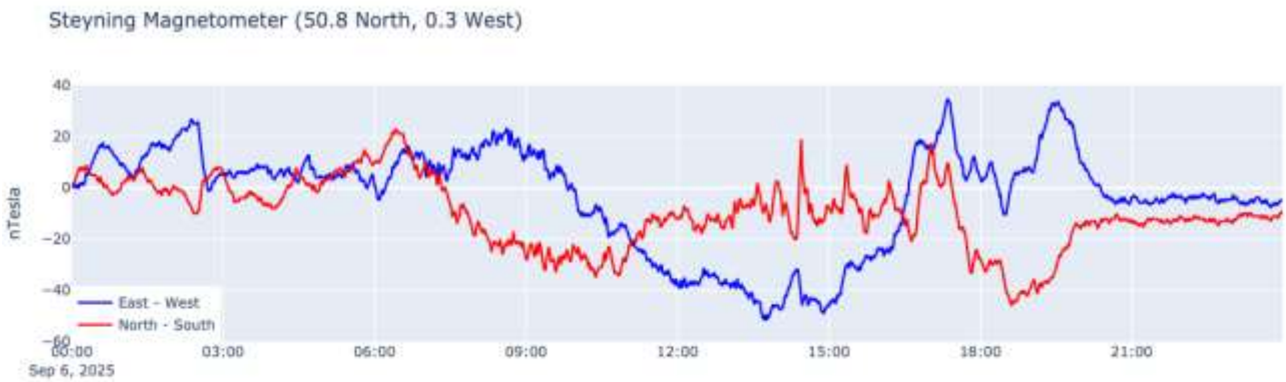


Stuart Green's summary of magnetic activity in September shows several periods of disturbance. Most of the activity was from coronal hole solar winds, made more effective by the alignment of the Sun's magnetic field with the Earth's field at this time of year. This is known as the Russell-McPherron effect. There were also CMEs from some of the stronger flares.

The first CME impact was recorded at 07:05UT on the 2nd, with a clear spike shown in Nick Quinn's recording:



The source of the CME is not clear, as several were detected in satellite images. The impact is also seen in Roger Blackwell's recording. The strong solar wind had started late on the 1st, causing a mild disturbance before the CME arrived. Its effect did not last very long though, fading out by 3AM on the 3rd.

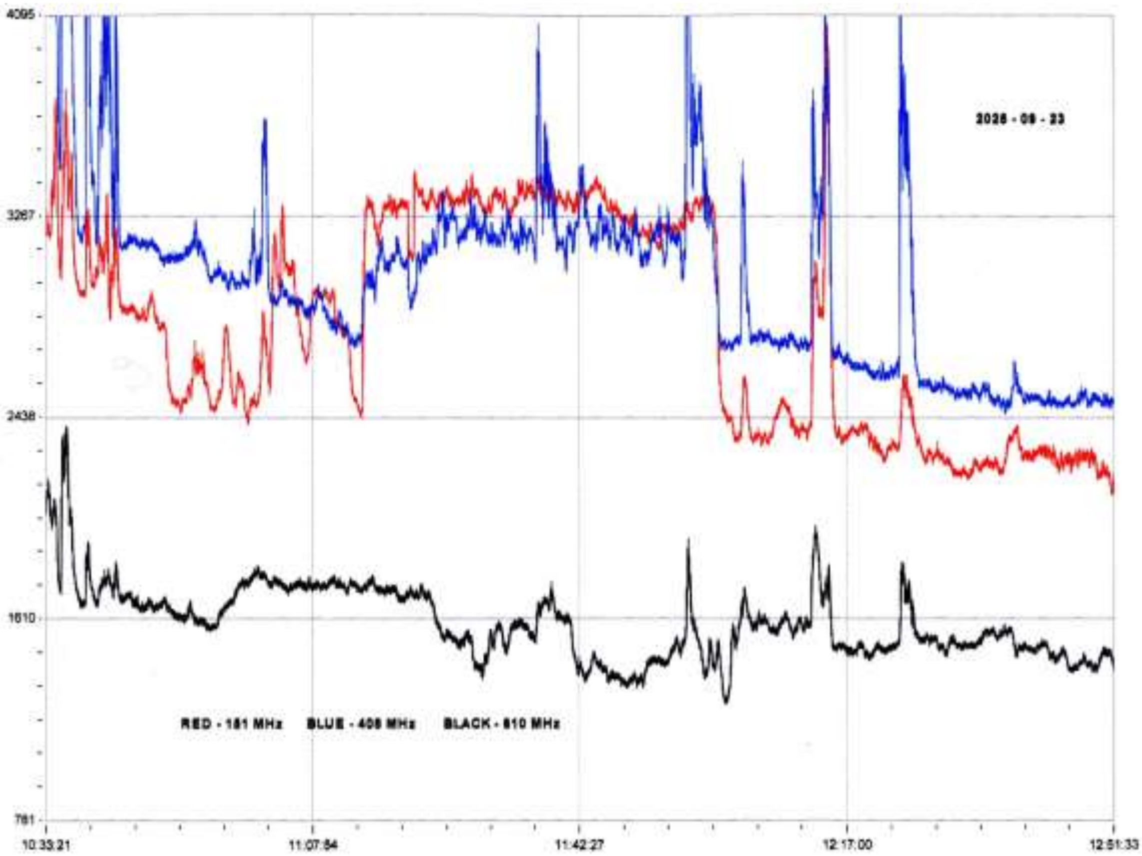


The CME on the 6th does not seem to have a clear impact recorded. Nick Quinn’s chart shows a small disturbance through most of the day, but without any clear spike to mark the impact time. The STCE bulletin gives a source for the CME as a flare in the evening of the 4th, rather too late for us to record as a SID.

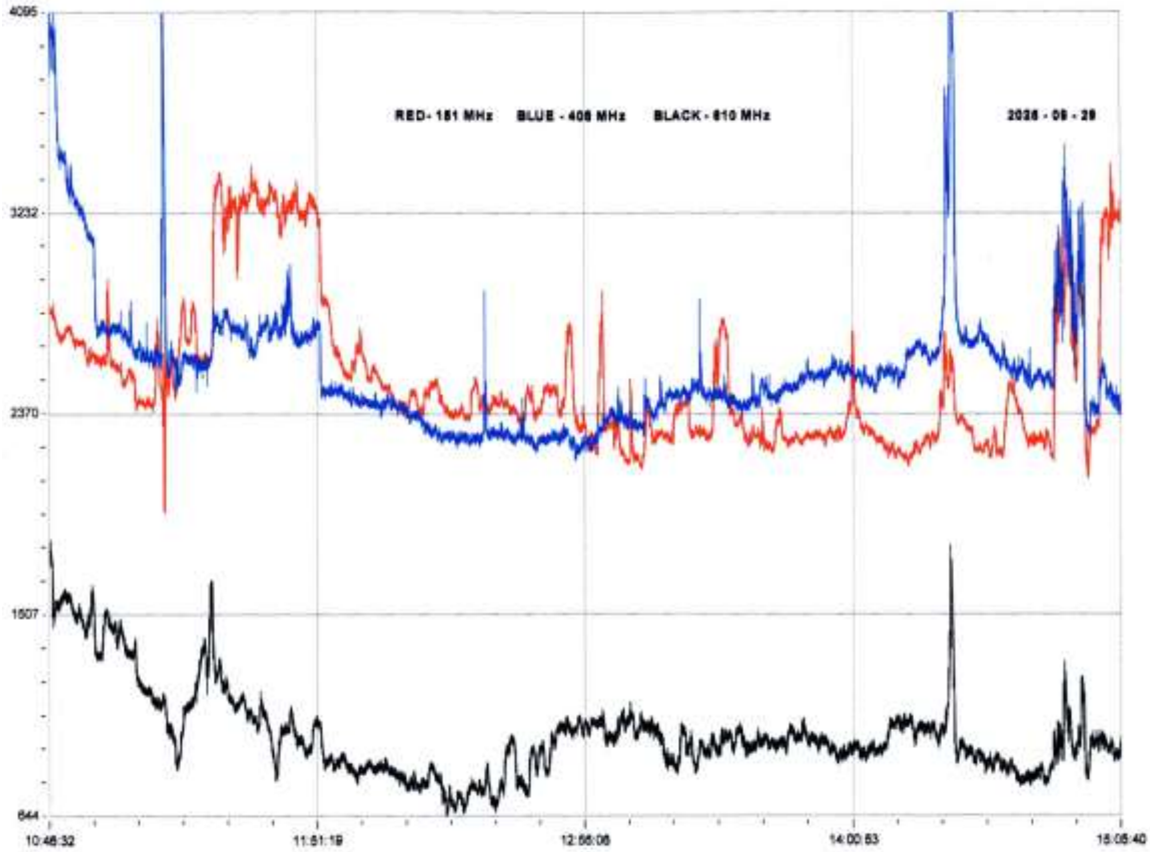
The most active period began in the afternoon of the 29th with a very strong solar wind well aligned with the Earth’s magnetic field. Roger Blackwell’s charts on the next page show a very rapid turbulence around 18UT on the 29th, followed by +100nT /-200nT swings on the 30th. This continued into the start of October.

Magnetic observations received from Roger Blackwell, Stuart Green, Nick Quinn, and John Cook.

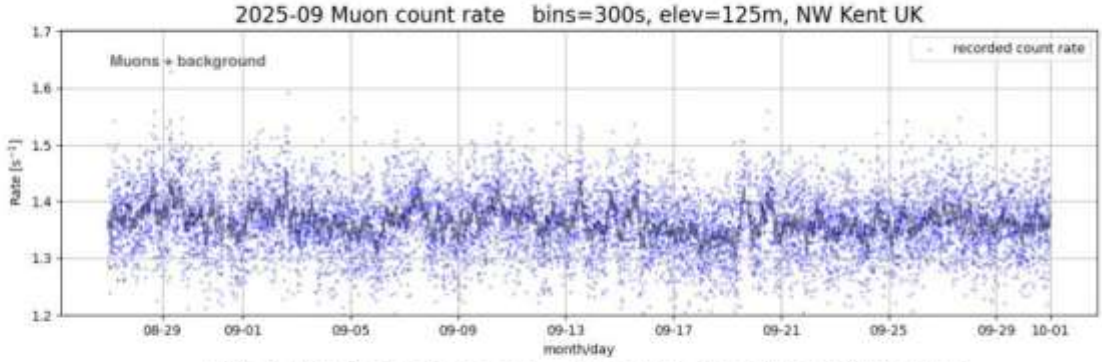
SOLAR EMISSIONS

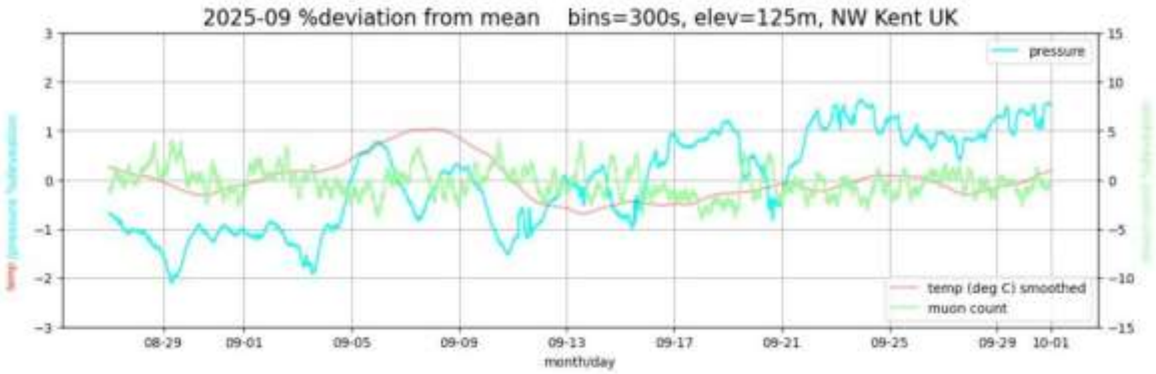


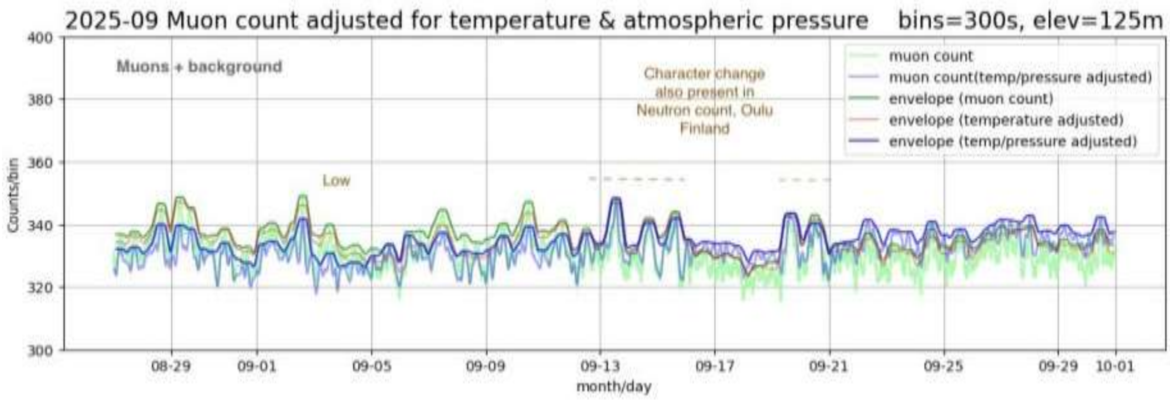
Colin Clements' VHF/UHF recording from the 23rd shows quite a strong emission at all three frequencies from the M1.0 flare peaking at 10:35UT. There is also a series of peaks at intervals up to 12:30. There are no other flares listed in the satellite data, so they appear to be linked to the M1.0 flare. Colin also made a recording on the 29th, although its link to the flaring activity is less clear. The 151MHZ and 408MHz emission starts with the first M1.0 flare, continues through the M1.1 flare, and stops near the peak of the second M1.0 flare. 610MHz shows a small peak at the start of the sequence but does not last long. The weaker C4.3 flare at 14:25 does match the strong 408MHz / 610MHz peaks in the recording.

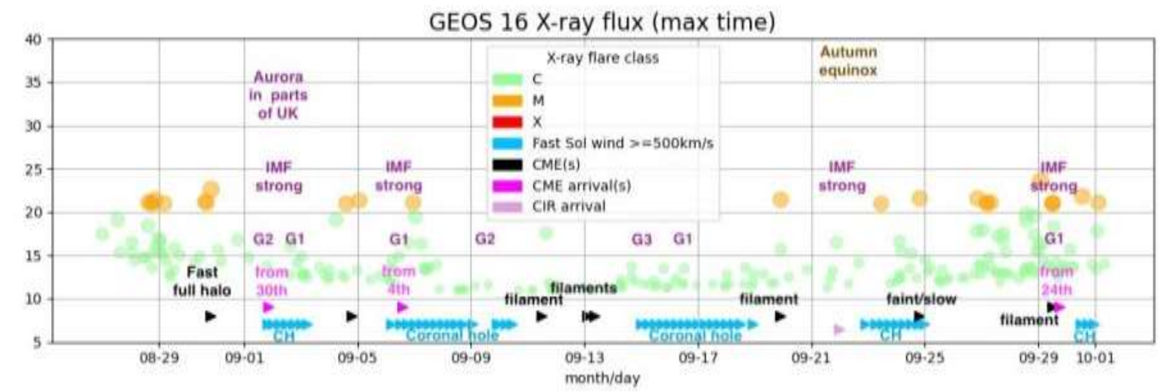


MUONS


2025-09 Muon count rate bins=300s, elev=125m, NW Kent UK
Muons + background
recorded count rate
Rate [s⁻¹]
month/day


2025-09 %deviation from mean bins=300s, elev=125m, NW Kent UK
pressure
temp (deg C) smoothed
muon count
month/day


2025-09 Muon count adjusted for temperature & atmospheric pressure bins=300s, elev=125m
Muons + background
Character change also present in Neutron count, Oulu Finland
Low
muon count
muon count(temp/pressure adjusted)
envelope (muon count)
envelope (temperature adjusted)
envelope (temp/pressure adjusted)
Counts/bin
month/day


GEOS 16 X-ray flux (max time)
X-ray flare class
C
M
X
Fast Sol wind >=500km/s
CME(s)
CME arrival(s)
CIR arrival
Aurora in parts of UK
Autumn equinox
IMF strong
IMF strong
IMF strong
IMF strong
G2 G1
G1
G2
G3 G1
G1
Fast full halo
from 30th
from 4th
from 24th
filament
filaments
filament
faint/slow
filament
CH
Coronal hole
Coronal hole
CH
CH
month/day

Mark Prescott's chart of muon flux shows a lot of variation through the month. The general rise in flux between the 5th and 14th matches the period of very low flare activity, while the rise after the 21st matches the stronger flaring. Magnetic activity has also been quite strong, making the picture more complicated. Mark has noted that the changes do match those recorded at the Oulu neutron monitor in Finland. The pressure chart shows some rapid changes in atmospheric pressure along with a general rise through the month.

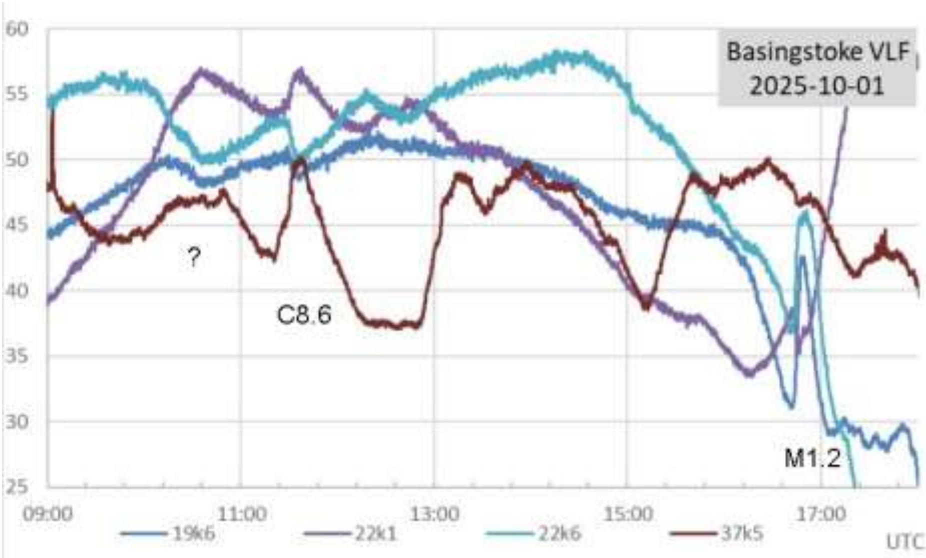
GPS ERRORS

Thomas Mazzi has recorded the effects of solar activity on the accuracy of GPS data with his SHARE MY SKY project. His chart for September shows large errors during the storms on the 3rd and 29th/30th seen in our magnetic data. There are also smaller errors through the month as the activity increased.

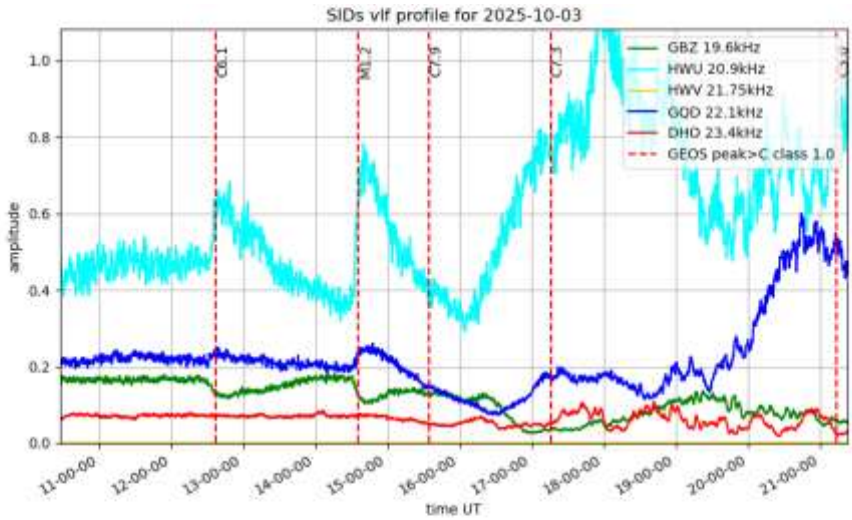
RADIO SKY NEWS **2025 OCTOBER**

VLF SID OBSERVATIONS

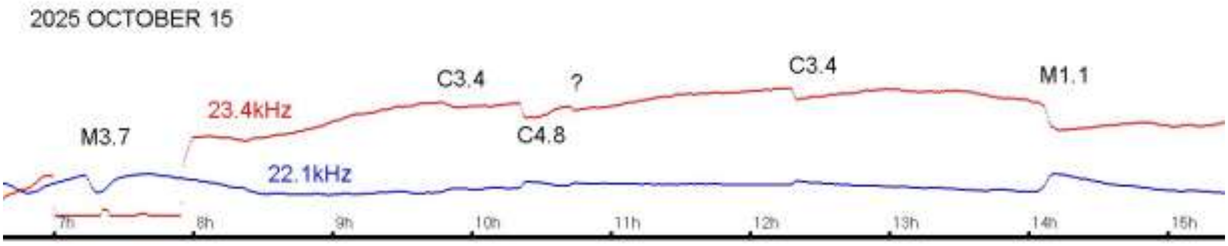
Flaring activity in October was a little higher, with 29 C and 14 M-class flares recorded as SIDs. Most of this activity occurred over the 9th to 18th, with nothing recorded after the 20th. There were a few flares at the start of the month, Paul Hyde's recording showing the 1st:



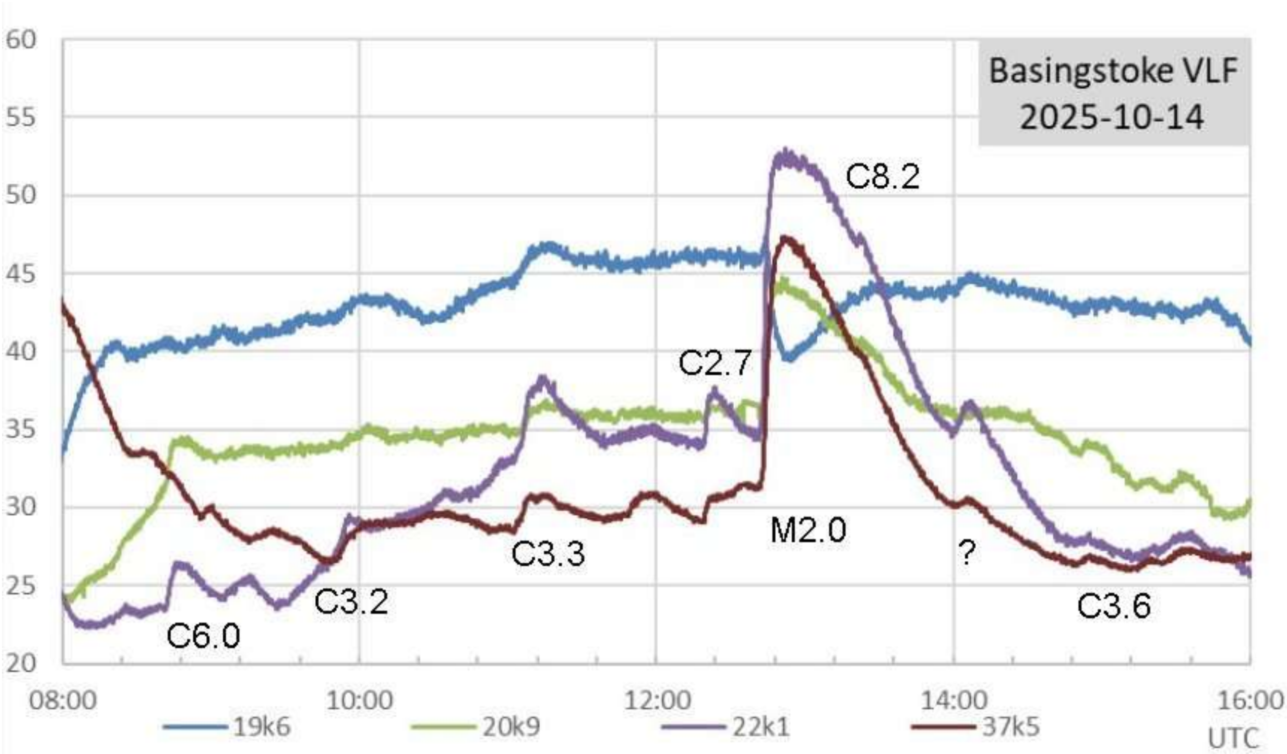
37.5kHz shows additional peaks around 13 to 15UT, most likely from magnetic activity. Mark Prescott's chart shows the 3rd:



The strong M1.2 flare mid-afternoon shows well at all the frequencies on Mark's recording. The C7.3 was rather too late, hidden by the early October sunset.



The strongest flare was the M3.7 peaking at 07:19UT on the 15th. My own recording shows a dip in the 22.1kHz signal, but 23.4kHz was taking its usual morning break. The M1.1 flare later in the afternoon has a good matching pair of SIDs. The chart also shows the undocumented event at 10:44, marked with a **?**. This shows on both signals, and was recorded by other observers, so appears to be genuine.

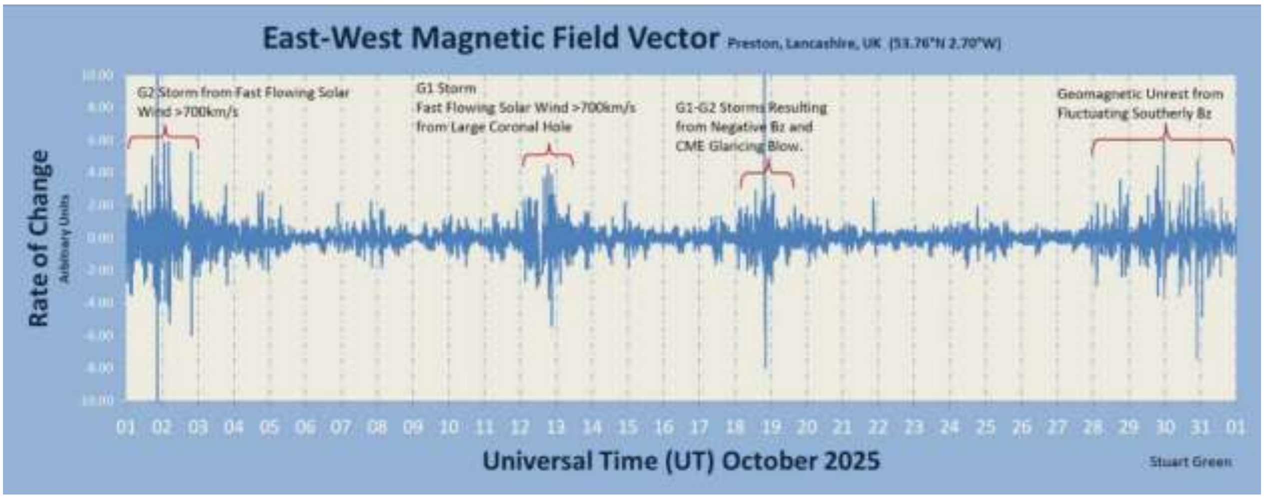


The 14th was also very active, shown in Paul Hyde's recording. The M2.0 flare was widely recorded, but the C8.2 flare has been hidden in its decay phase. There is a smaller event just after 14:00. It is listed in the satellite data, but without any magnitude. The small C3.6 at 15UT was also missed, as sunset was starting to affect most of the signals.

Over the years many forms of VLF interference have been reported, but we now have a new one. Andrew Thomas had a new heat pump fitted recently, its control electronics in line with his VLF loop aerial. The CE regulations did not cover frequencies below 150kHz, allowing some solar panel installations to cause problems. The circuitry in a heat pump would be very different but appears to be a problem. Andrew's 23.4kHz signal recorded on the 15th is shown on the next page:

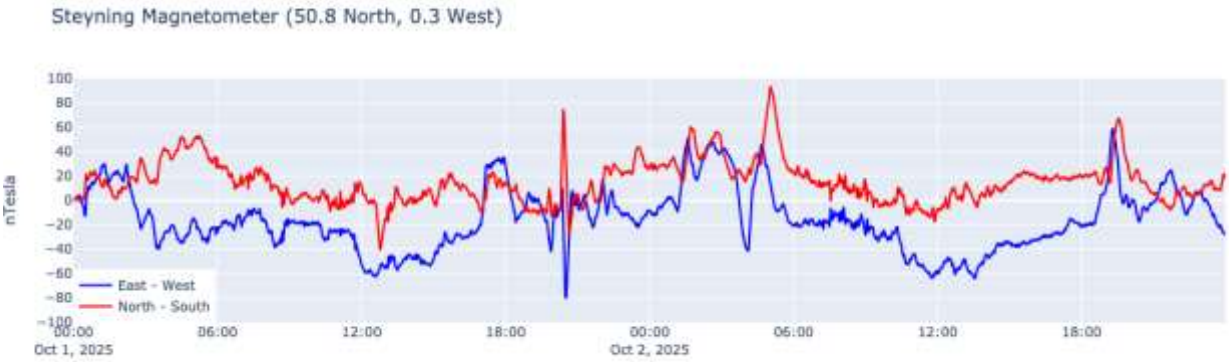
The pulses are clearly visible, much stronger than the flares. Andrew is experimenting with ways to avoid the problem.

MAGNETIC OBSERVATIONS

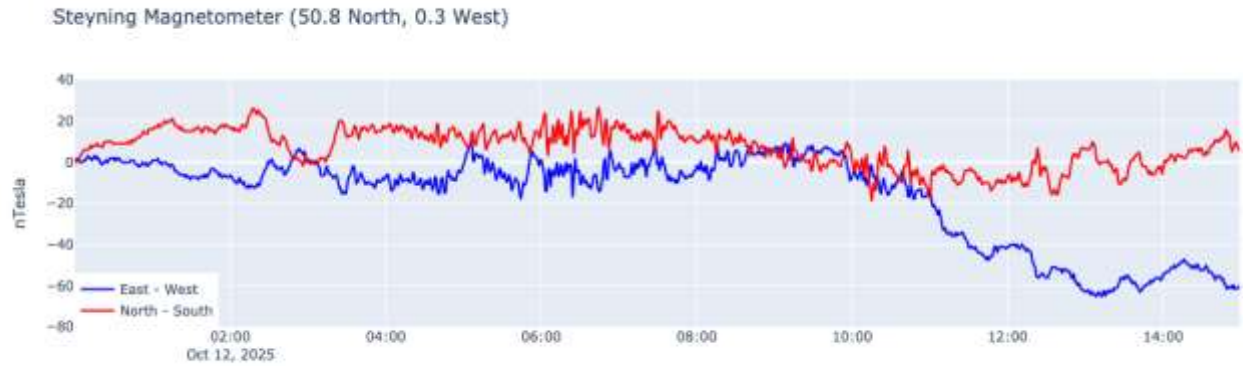


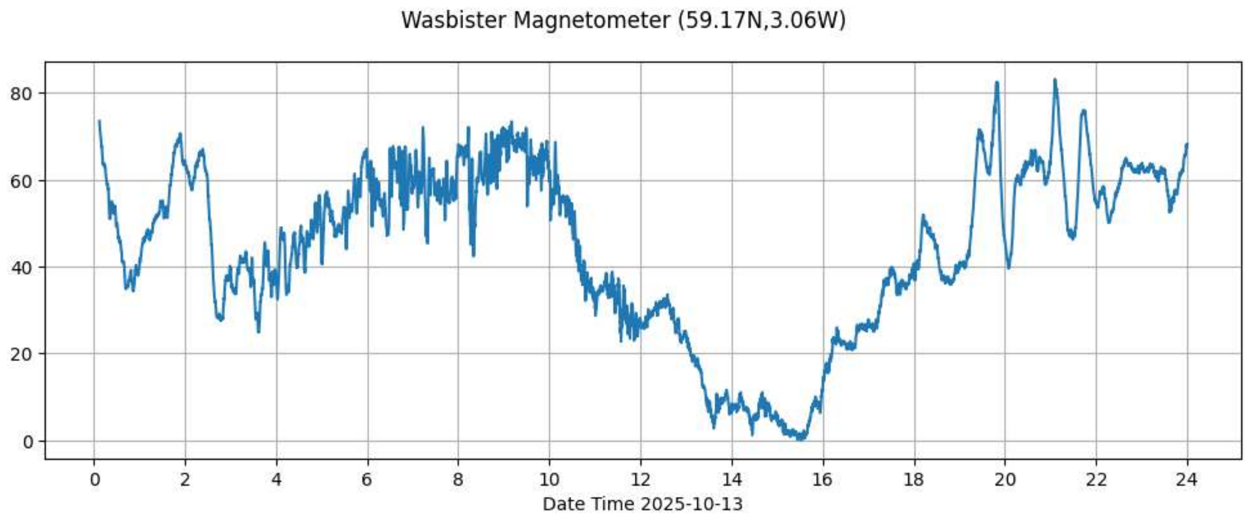
Stuart Green's summary of magnetic activity in October shows a few periods of strong disturbance. Most of this was associated with fast solar winds from coronal holes. The September summary showed an active period on the 29th and 30th from a coronal hole. This continued into October with a very active period on the 1st and 2nd. Nick Quinn's recording shows this disturbance, including a strong spike at about 20:30UT. Satellite data does show a number of CMEs at the end of

September, although it is not clear whether this spike is from a CME arrival. Some of this disturbance was seen on the 37.5kHz signal in Paul Hyde's recording on page 1. Activity then faded out during the 3rd.

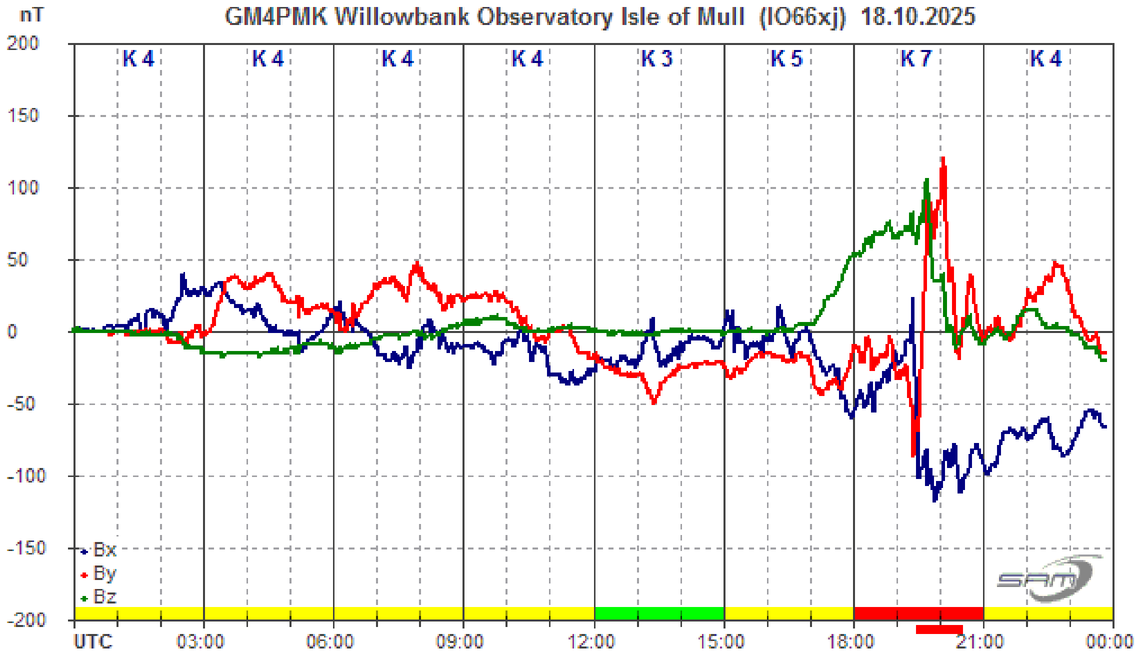


High speed solar wind from a large coronal hole produced more disturbance on the 12th and 13th, shown in recordings by Nick Quinn and Callum Potter:

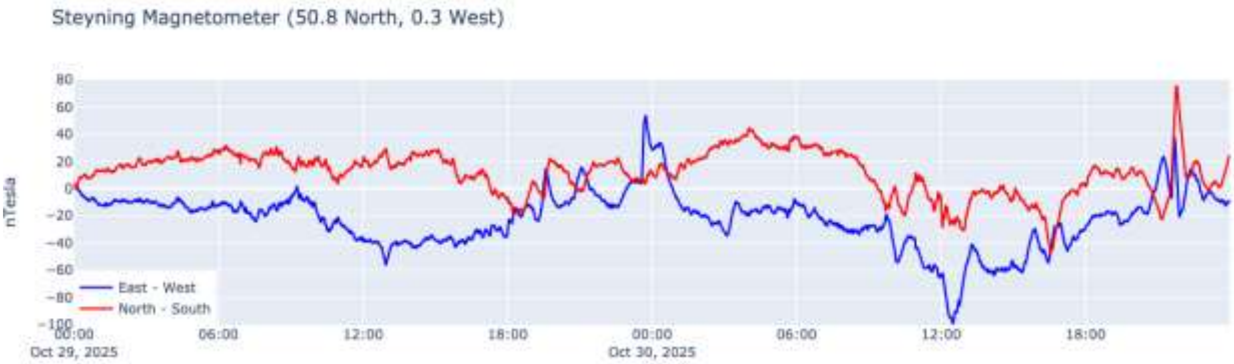


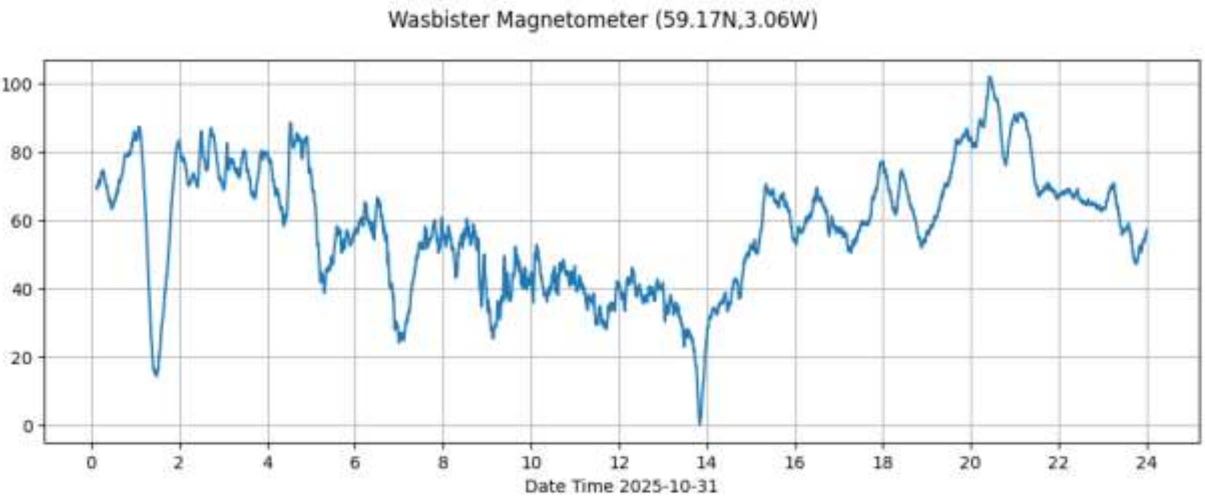


A very rapid turbulence is seen from 04 to 08UT on the 12th, slowing down in the afternoon. This was repeated on the 13th, the rapid turbulence lasting a little longer. The magnitude of the disturbance increased to +/-20nT after 19UT but had faded out by the end of the day.

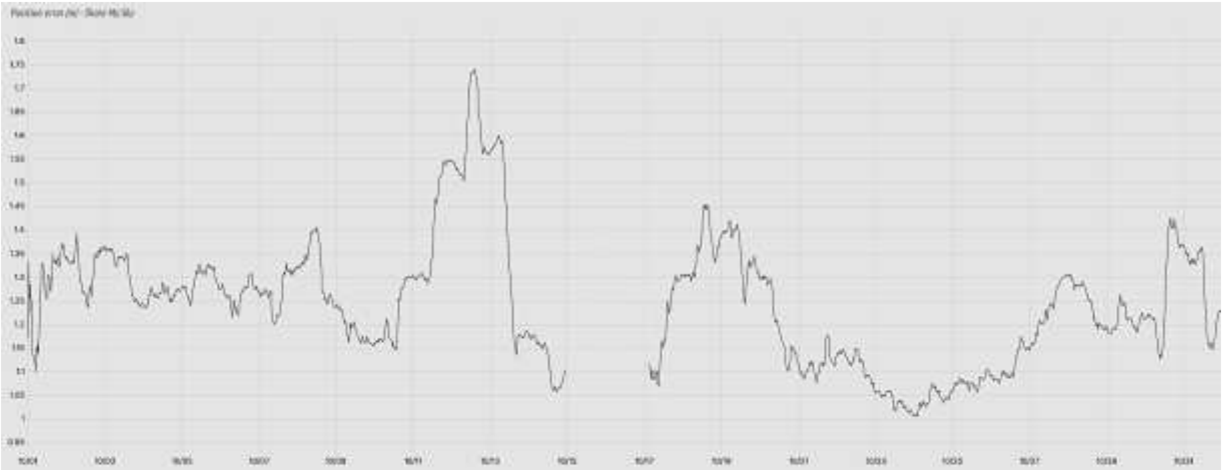


More coronal hole high speed winds produced a minor disturbance early on the 18th, shown in Roger Blackwell's recording. A glancing blow from a CME arrived later, with a strong +/-100nT spike in the magnetic field around 19:30. This did not last long, activity fading out early on the 19th.





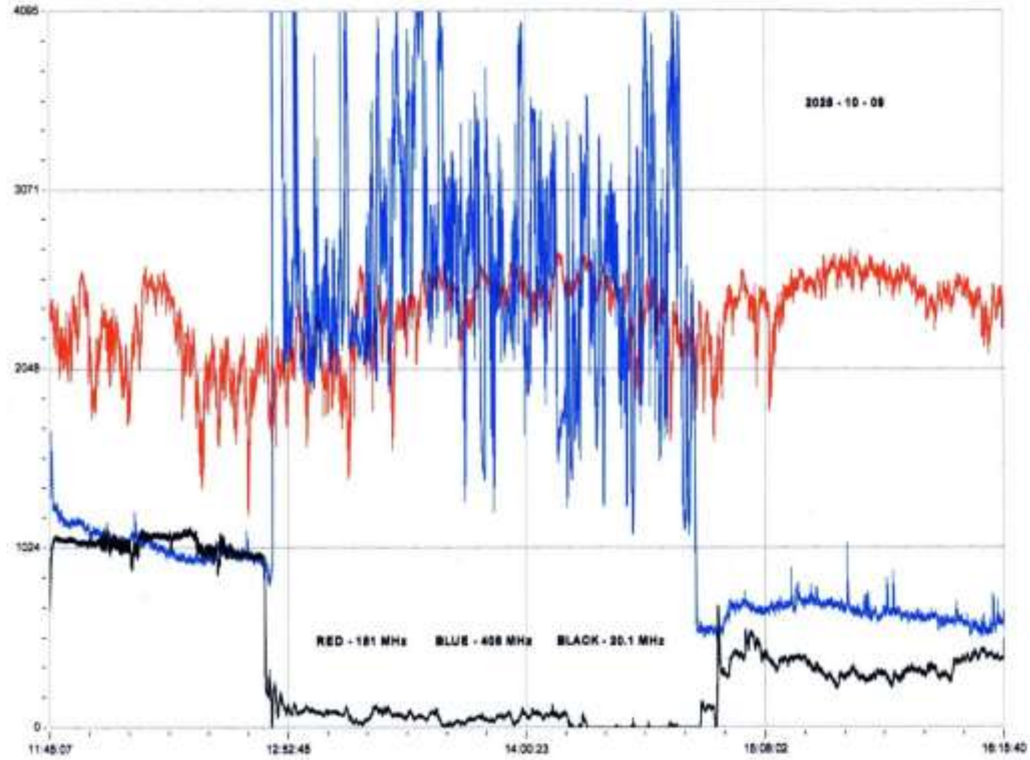
Solar wind speed increased again at the end of October, shown in recordings from Nick Quinn and Callum Potter, above. A minor disturbance began early on the 29th, increasing around midnight, and continuing on the 30th and 31st. There was another period of rapid turbulence from 08 to 13UT on the 31st, the activity fading away by the end of the day.



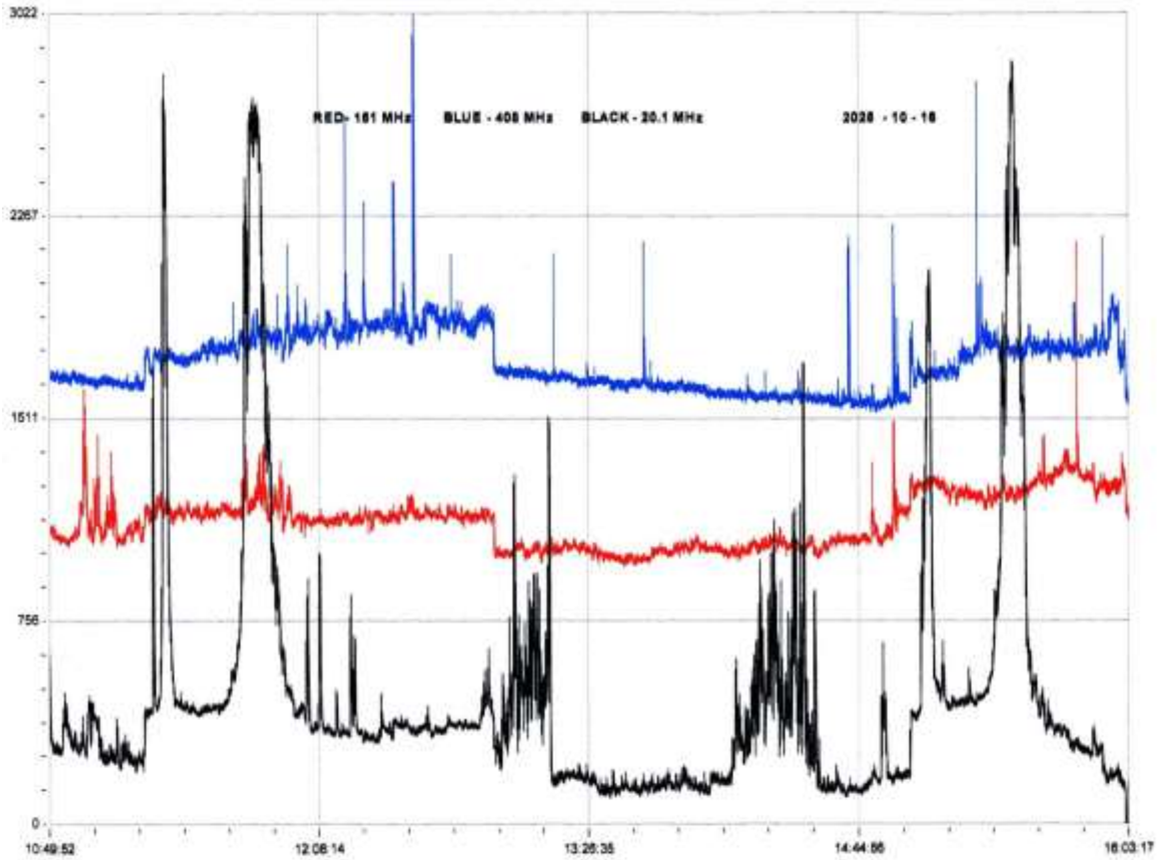
Thomas Mazzi has made a chart of GPS positioning errors through October from his Share My Sky project. The vertical axis shows the error in metres, covering 1m to 1.8m at the top. The magnetic disturbance at the start of October shows some minor effects, but the storm over the 11th to 13th has produced a larger error. The other magnetic storms also show significant effects on positioning accuracy.

Magnetic observations received from Roger Blackwell, Stuart Green, Thomas Mazzi, Callum Potter, Nick Quinn, and John Cook.

SOLAR EMISSIONS

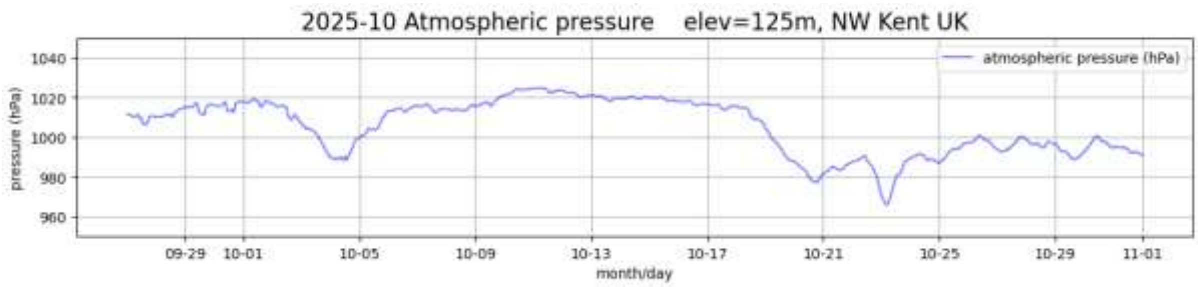


Colin Clements recorded this strong 408MHz burst from the M2.0 flare on the 9th. 151MHz (red) shows only a minor effect, while 20.1MHz (black) has actually dropped during the flare. His usual 610MHz antenna is now shaded due to the low winter sun and so has switched to a loft-mounted 20.1MHz antenna. There were also some strong signals on the 16th:

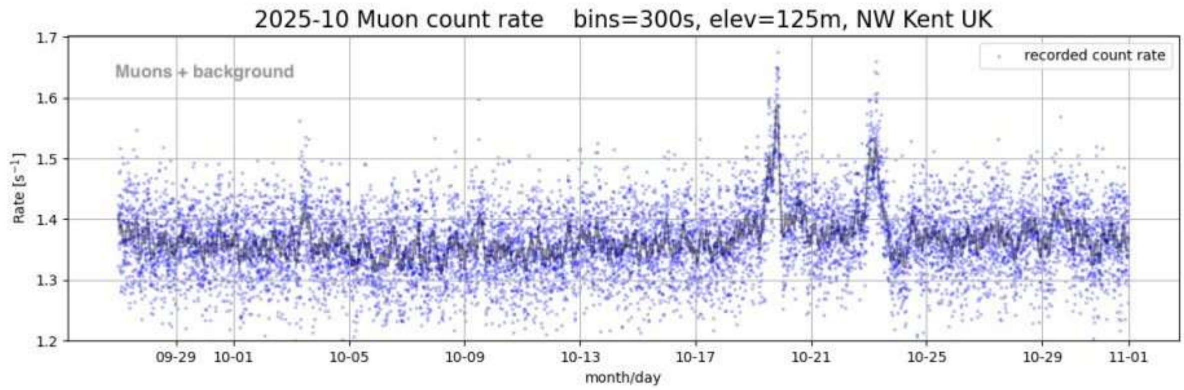


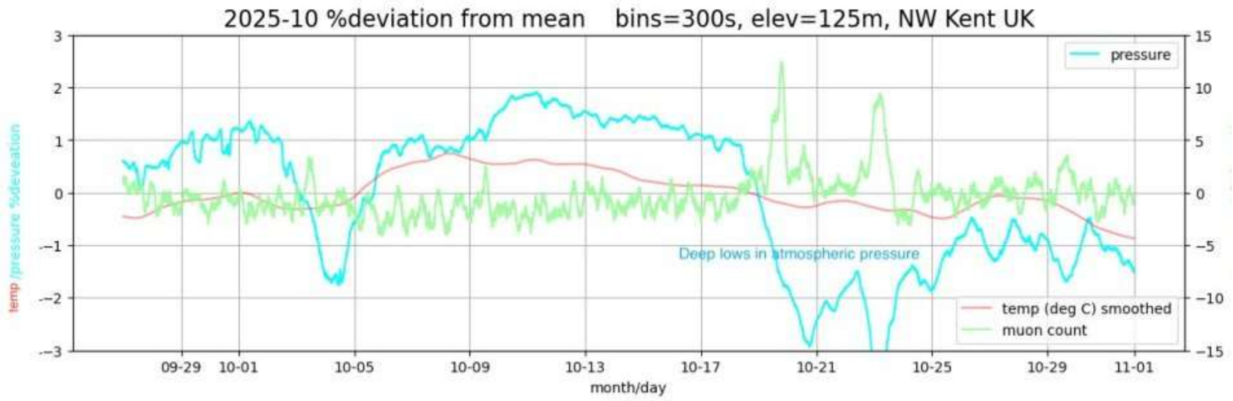
Activity on the 16th was much higher, 20.1MHz showing bursts for all the flares that we recorded. The early C8.4 has a very strong signal, while the M1.3 (14:10UT) is weaker but with more rapid variation in strength. The last event on the chart does not seem to link directly to flare timings, so its source is unclear. Colin also recorded radio noise on the 3rd, 13th, 15th, 17th, and 18th, with a very noisy 20.1MHz burst for the M1.5 flare on the 18th.

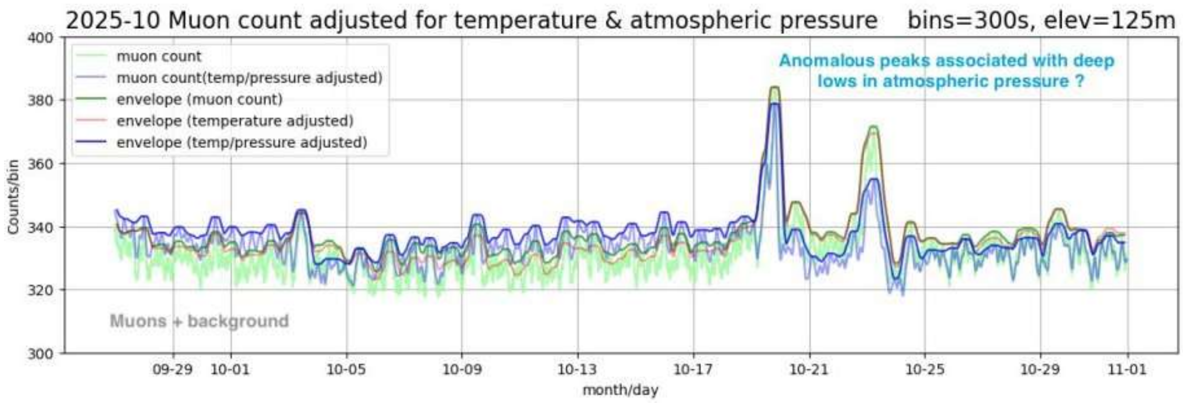
MUONS

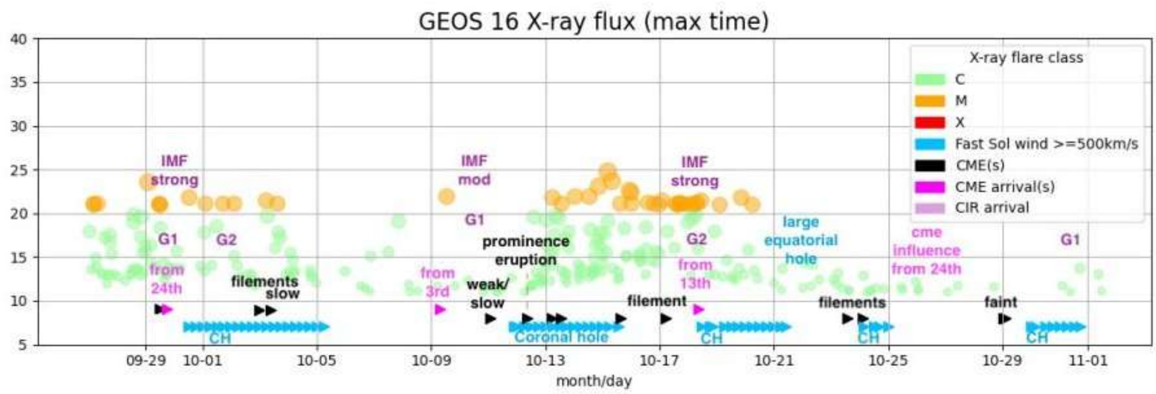


Mark Prescott recorded some very large atmospheric pressure variations during October, particularly low from the 20th to 27th. This has had a very strong impact on his Muon measurements.



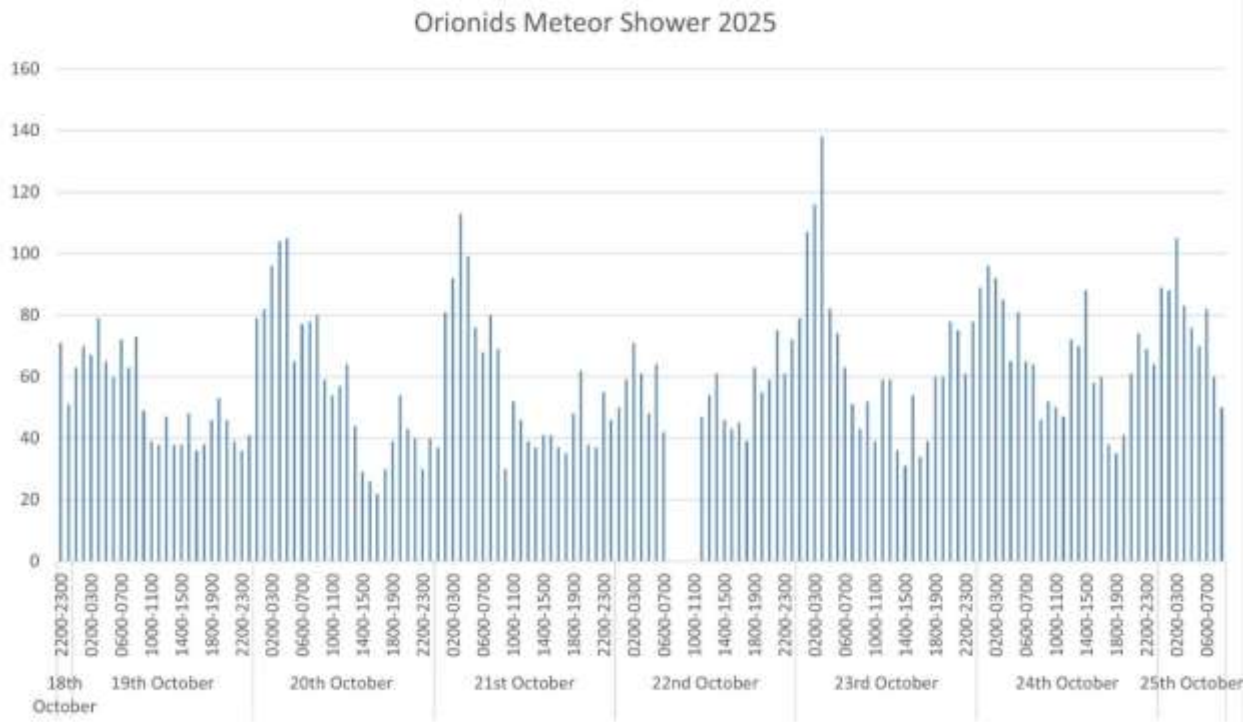






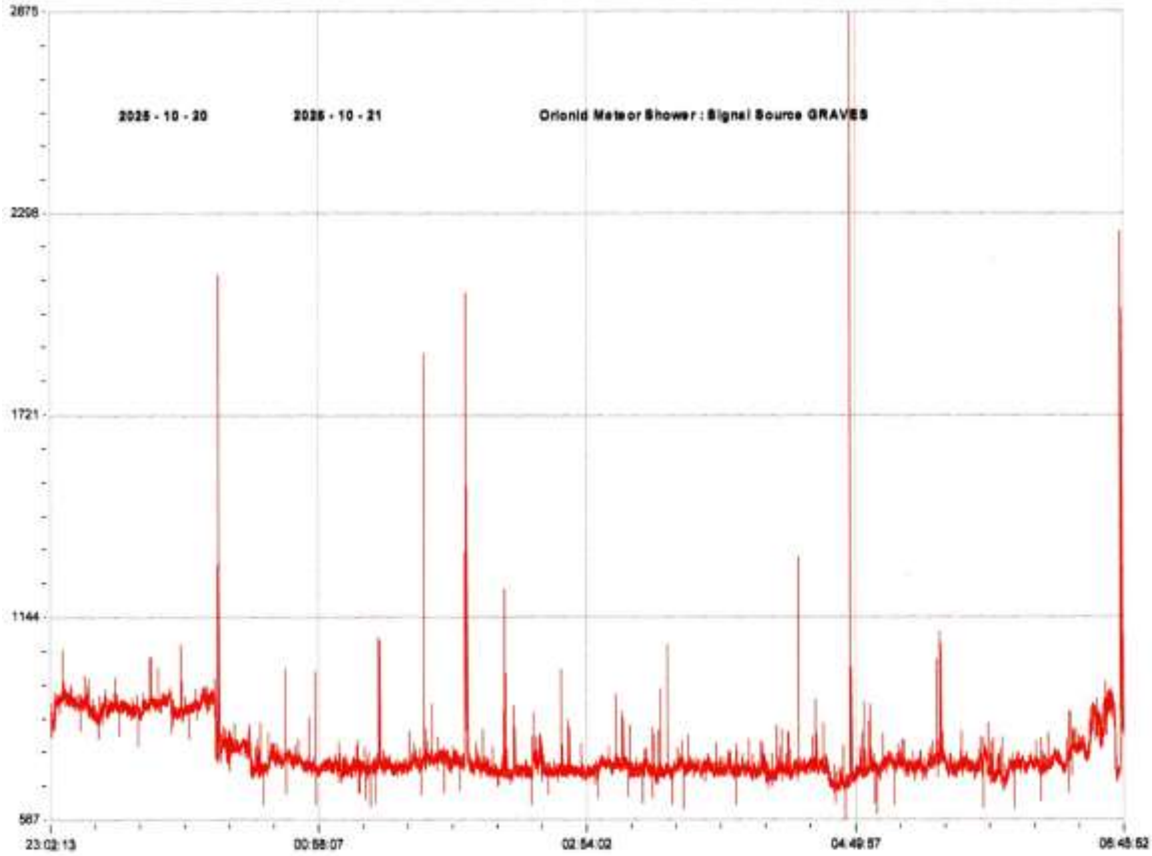
Mark has used his usual adjustment method to produce the chart above, but there is still a very strong increase on the 20th and 23rd. The mixture of strong coronal winds and minor CMEs may be responsible for the general trend of falling and rising of the muon count seen in the recording.

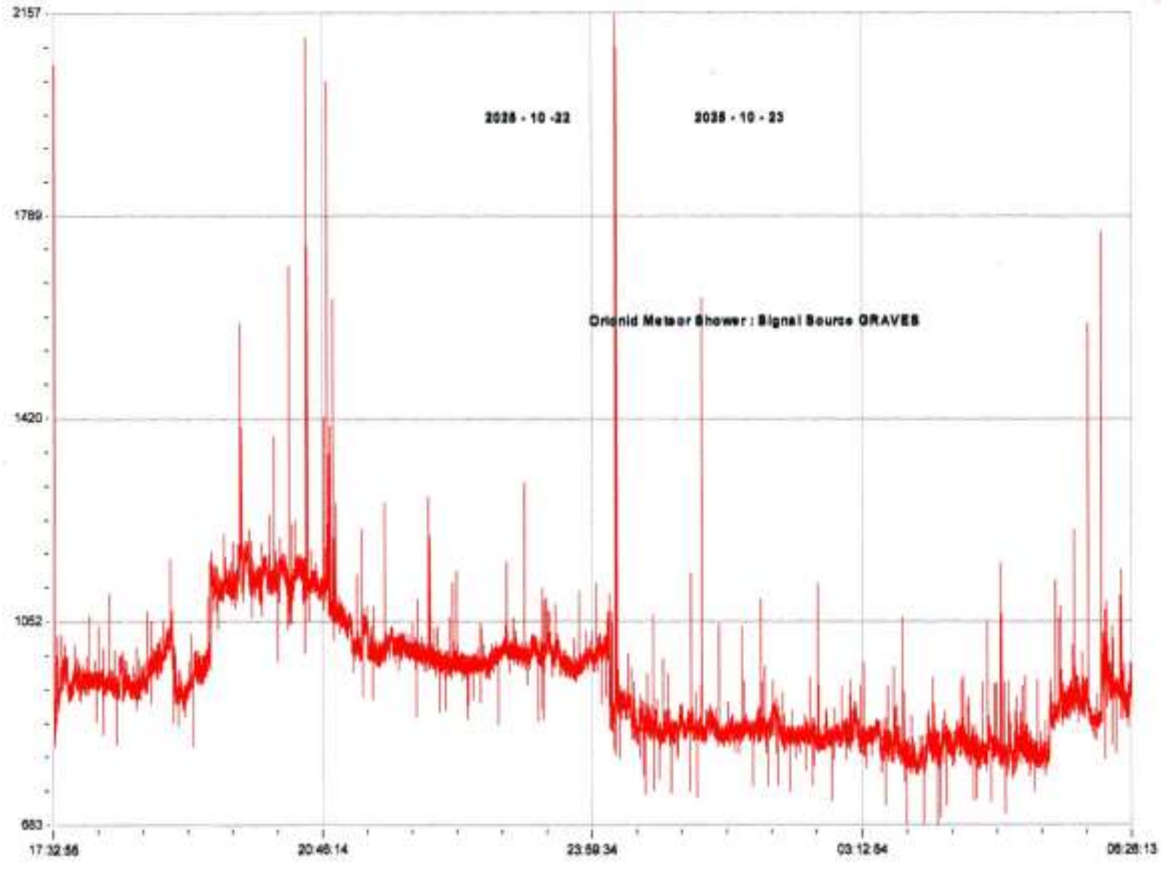
ORIONID METEORS



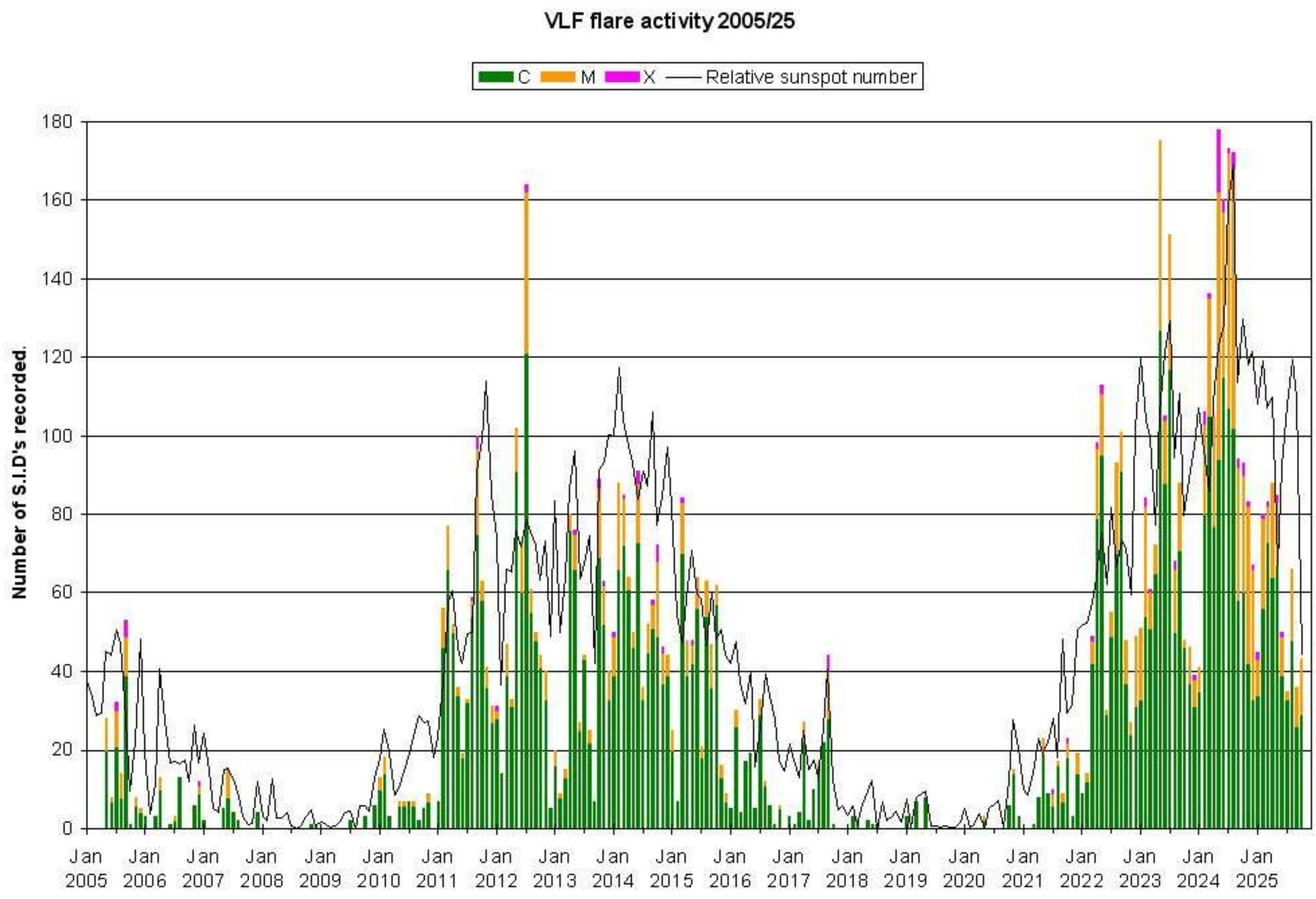
Chris Bailey made recordings of the Orionid meteors using the Graves radar signal. This seems to have taken a break during the morning of the 22nd. The peak in activity was around 04-05UT on the 23rd, with more peaks recorded from the 20th to 25th. The lower chart compares counts from 2020, and 2024 with 2025. General activity seems to have been lower this year, although the peak is at a similar level.

Colin Clements also made recordings, shown on the next page. The first chart covers 23UT on the 20th to 06:45 on the 21st, the second from 17:30 on the 22nd to 06:26 on the 23rd.


2025 - 10 - 20
2025 - 10 - 21
Orionid Meteor Shower : Signal Source GRAVES
2875
2298
1721
1144
567
23:02:13
00:58:07
02:54:02
04:49:57
06:45:52


2025 - 10 -22
2025 - 10 - 23
Orionid Meteor Shower : Signal Source GRAVES
2157
1789
1420
1052
683
17:32:56
20:46:14
23:59:34
03:12:54
06:26:13

BARTELS CHART


VLF flare activity 2005/25
C
M
X
Relative sunspot number
Number of S.I.D's recorded.
0
20
40
60
80
100
120
140
160
180
Jan 2005
Jan 2006
Jan 2007
Jan 2008
Jan 2009
Jan 2010
Jan 2011
Jan 2012
Jan 2013
Jan 2014
Jan 2015
Jan 2016
Jan 2017
Jan 2018
Jan 2019
Jan 2020
Jan 2021
Jan 2022
Jan 2023
Jan 2024
Jan 2025

Featured Articles

First Light for My Three x 3M Dish Interferometer
By Mike Otte W9YS

Otte Observatory
42.2N 89.9W mike.otte96@gmail.com
12/6/2025

As you remember from my last article, I could not differentiate sources near RA 1800 and Declination -10 to -34. So, I needed additional methods or instruments. So, I added another dish to my interferometer. Two of the dishes are "movable" for different baselines and different configurations like delta or right triangle or 'Y'. All are drift scan and do not have azimuth control. Three antennas may or may not help me to identify these sources.

Interferometry has increased the number of radio sources that I can identify. It gives me added sensitivity. Instead of 5 sources with positively identity on one antenna, I have a list of 26 sources I have identified on two antennas including the Sun everyday and the moon surprise visits. I do live west of Chicago airports and get a lot of interference from airplane radars.

Interferometry gives me additional chores maintaining alignments. Leveling the post, determining south, making sure the feed is centered and not skewed. I use a sighting across the edges of the face of the dishes to align them in azimuth. At the moment they lie on an E-W line and are spaced 10.6M, 20M, 30.6M which give three different fringe periods for every observation. Being on an east slope of a hill geographically (2 deg) makes the RA about 8 minutes early at some declinations. Have to check this against data.

Image 1: Showing the 3 dishes spaced 10.6 M (1-2), 20M (2-3), and 31M (1-3) in an E-W line

The antennas are TVRO dishes. Dish 1 (East down the hill) is a Birdview steel dish. Dish 2 and dish 3 are aluminum. All 3 are solid surfaces. All 3 have an F/D of ~.35 and are ~109 inches in diameter, not quite 3 M. Each of dishes feed horn is 6" galvanized HVAC duct slid-able in a 1" band support attached to 3 arms. So focus is adjustable both by sliding in the band and more grossly moving the supports. Right now dish 1 & 2 have kumar choke rings to help adjust the beam width of the feed. Dish 3 will also have a choke ring soon.

All 3 dishes are in drift scan mode. Azimuth is not motorized but is adjustable and has "set" bolts that lock it into place. Declination is set by flipping a toggle switch locally feeding the satellite jack motor and watching the angle gauge. Two of the dishes angle gauges are $3 aluminum carpenter squares from HF with string "plumb bobs" (metal nuts) hanging down for indicators. The TVRO satellite "skew" angle mounting has been taken out either by drilling another hinge hole or putting spacers in to adjust. Beyond the plug of the feedhorn is a 1# coffee can (metal) with a sandwiched in metal, plastic lid that houses the SawBird H1 LNA. The two holes through the "lid" are on the bottom so any moisture runs out. One hole goes to the feed monopole through sma cable, adapter, N connector 90deg, and N connector holding the 1.8" wire antenna. The other hole is the RG6 cable running into the Observatory and getting power for the LNA and sending signal back to the observatory. The plastic lid in the lid sandwich in the holes is not drilled out but 'Xed" providing some blockage for insects but still letting moisture out, Not RTV'ed. Power on the LNA provides the dew chasing heat.

Dish 1 is mounted on a tripod pedestal and has concrete piers into the ground. Dish 2 is mounted on a baler farm implement and is movable with a tractor. Dish 3 is mounted on a manure spreader farm implement and is movable with a tractor. These were old equipment repurposed. I worry most about snow loads and do not put the dishes in "birdbath" position (Cyg A)for snow days. I put them down in satellite elevation (40 deg) so the snow sloughs off. Wind has had enough force to overcome the set bolts on the azimuths sometimes but not to cause damage.

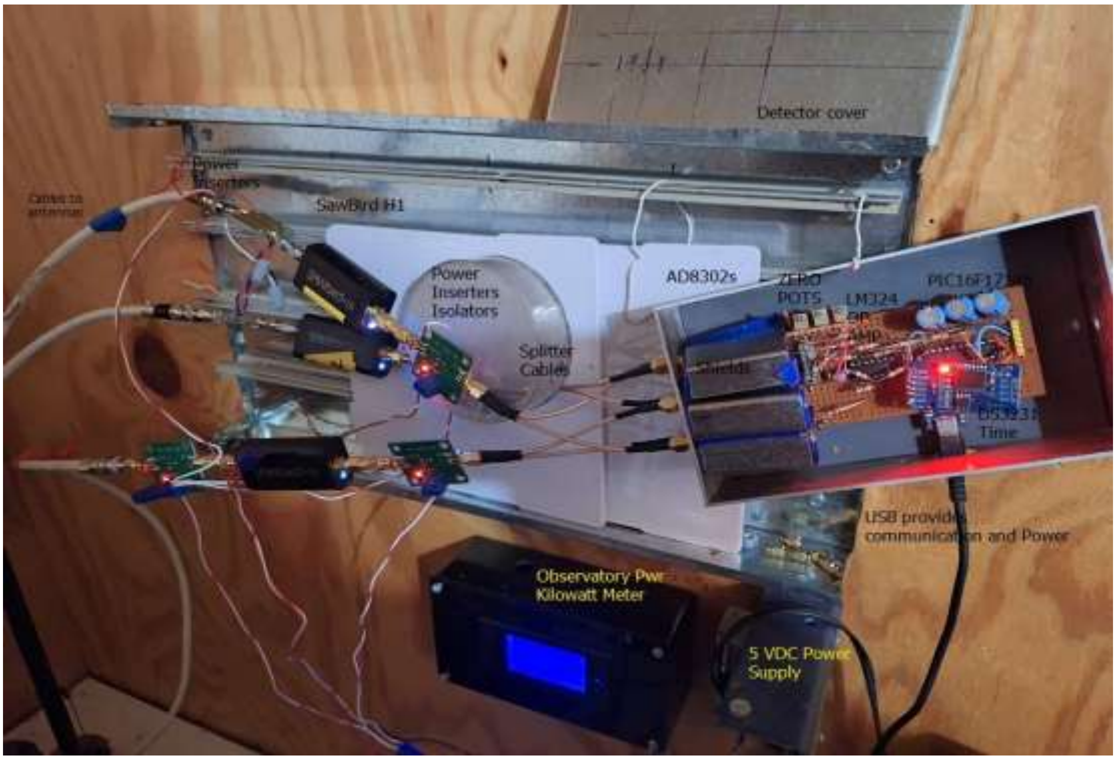


Image 2: Inside the observatory - Receiving detector layout

The 3 cables from the dishes enter through a 1 ½ PVC chase tube on the left. The cables are RG-6 rated to 3Ghz. The first set of Power Inserters feed 5 vdc down the cable to the LNA's at the dishes. Next are the three nooelec Sawbird H1 LNA's which make up for some of the loss of the cables, give more signal to the AD8302s and have a second bandpass for "tuning" the system to 1420Mhz. This is basically like the old TRF radios from 100 years ago. So the only tuning for frequency is the Band Pass Filters in the two LNA's on each antenna and the feed horn. Then next is the second set of power inserters. These not only power the previous LNAs using the power supply below but also ISOLATE the inputs to the AD8302s because there is a 50 ohm resistor on each of the 6 inputs. I**2/R = 5*5/50 = .5watts on a 1/8 watt resistor. Next is the signal splitters. These are just 6 inch cables providing 2 inputs for each of the 3 antennas. I could have used TV splitters or Wilkinson dividers but chose this way because it would be way fewer connections and adapters which all cause losses. Now we made it to the AD8302 phase detectors.

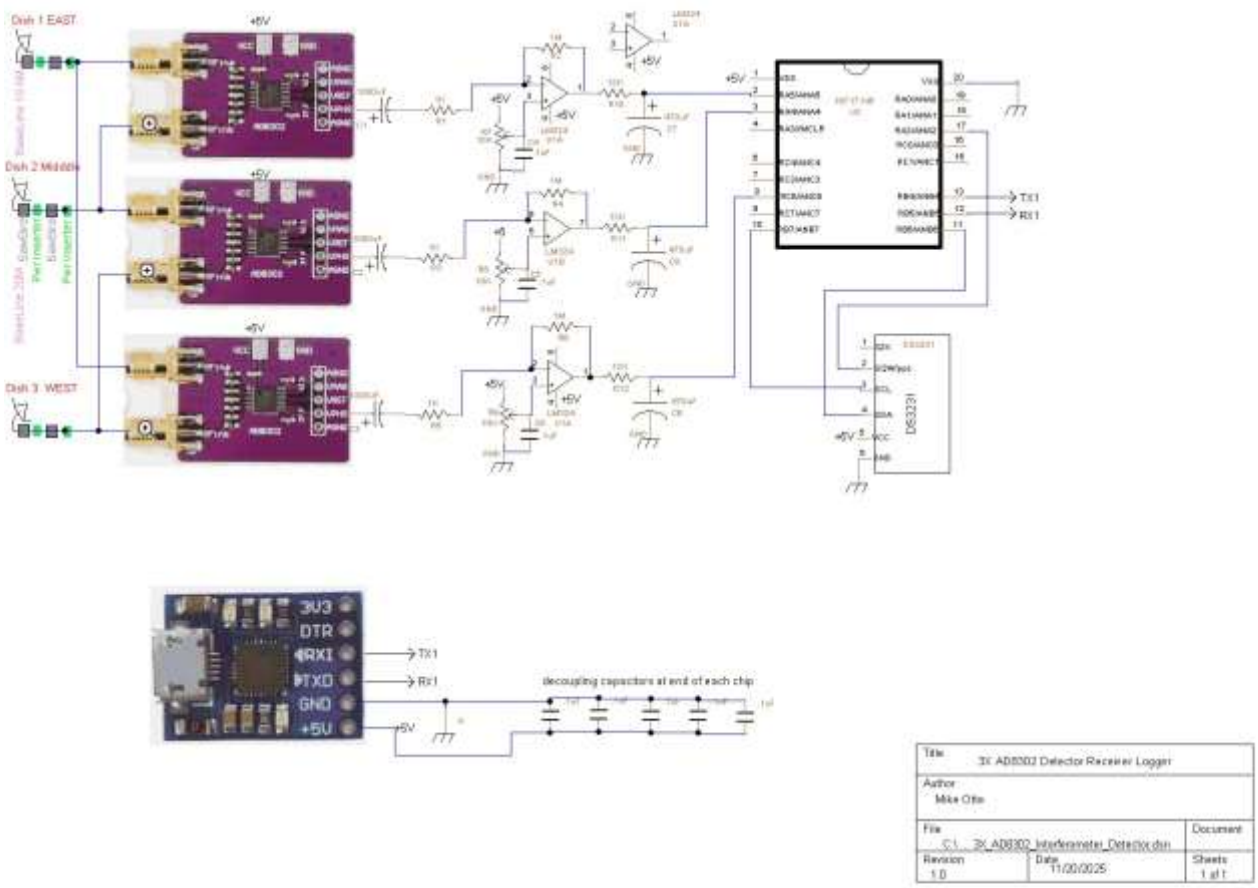


Image 3: Schematic of 3X AD8302 phase detectors, OP AMP amplifiers, PIC16F17145 micro controller, and DS3231 Time clock

This unit was put into a metal box to lower interference from the monitor of the PC, the usb cable, my presence and every other radio source in the Observatory. In addition U shaped shields were made to cover the three AD8302s and shield them from each other.. The Ad8302s were mounted perpendicular to the proto board with the power side soldered with jumpers to the power strips of the proto board. Holes were drilled into the end of the box giving support so the cable strain did not distort the boards and connectors. A 1000uF tantalum capacitor provided isolation between the ratiometric output of the AD8302s and the input to the OP AMPs. We only want the AC slow varying signal to come through and it is small so we amplify it 1000X using the OP AMPs and feed the A/D inputs of the PIC 16F17145 through a 12K isolating resistor and smoothed with a 470 uF capacitor. Don't get excited if you only see noise, walk away and let the system settle.

The PIC chip runs a program created by me in Great Cow Basic to do several jobs. It measures the 12 bit A/Ds periodically and puts the values into a smoothing table. The program keeps sidereal time through an pulse per second (pps) interrupt from the DS3231 time chip. I don't do a calculation to convert to sidereal time but put in extra seconds every 6 minutes and every 6 hours, works good, not too complicated. The program checks if there is any commands from the PC terminal to change parameters like sample interval, filter constant, time setting. Finally the most important is to assemble the packet of data called the "sample". The sample is composed of the sidereal time, phase 1, phase 2, phase3 which I have been gathering at 2 second intervals. The data is in CSV format so it can be imported by various analysis programs like Libre Calc, Octave, or python. These are sent through a ttl to USB adapter to the PC. The PC has a terminal program running that logs the data into a file. The USB adapter also powers this whole board including the AD8302s, the LM324 Op Amp, the PIC and the DS3231. I change the file name daily to keep the size down and to explore what I have caught during the previous 24 hours or so.

Filenames is how I keep track of some meta data about the observation. First because I am drift scanning the Declination is important. I use 'p' for positive and 'm' for negative declinations, ie. "Decp41". Next I put in the date. Important parameters like the device, the filtering, and any big change I made. Sometime I put in the target of the radio source and even the RA. File names can be long but watch out for special chars that can mess with your file system, like "/,\|,*,|" A file everyday runs into a lot of files, so keep them in separate folders, I make a folder for each month/year.

The Data

So ,what does that gain you? Three dishes can give you three different baselines. Three baselines should be able to be combined a give greater Right Ascension accuracy. They should be able to be simply added into a 1 dimension picture. Using fast Fourier tranforms, more than one source should be able to be resolved.

RA,	base1,	base2,	base3
5:16:51,	894,	987,	1010
5:16:53,	894,	985,	1015
5:16:55,	894,	982,	1022
5:16:57,	891,	978,	1028
5:16:59,	892,	976,	1035

This is what the raw data looks like. I chose 2 sec sample intervals to keep the file size down. FFT would like more samples for more resolution. The three measurements are A/D values, and I tried to keep them in order of baseline and increasing value. The increasing value separates them on a chart. The three "zeroing" pots on the board move the A/D values. When doing a FFT the first step is to subtract the average of that data point to get plus and minus values around zero. Remember each baseline will have a different Fringe Period.

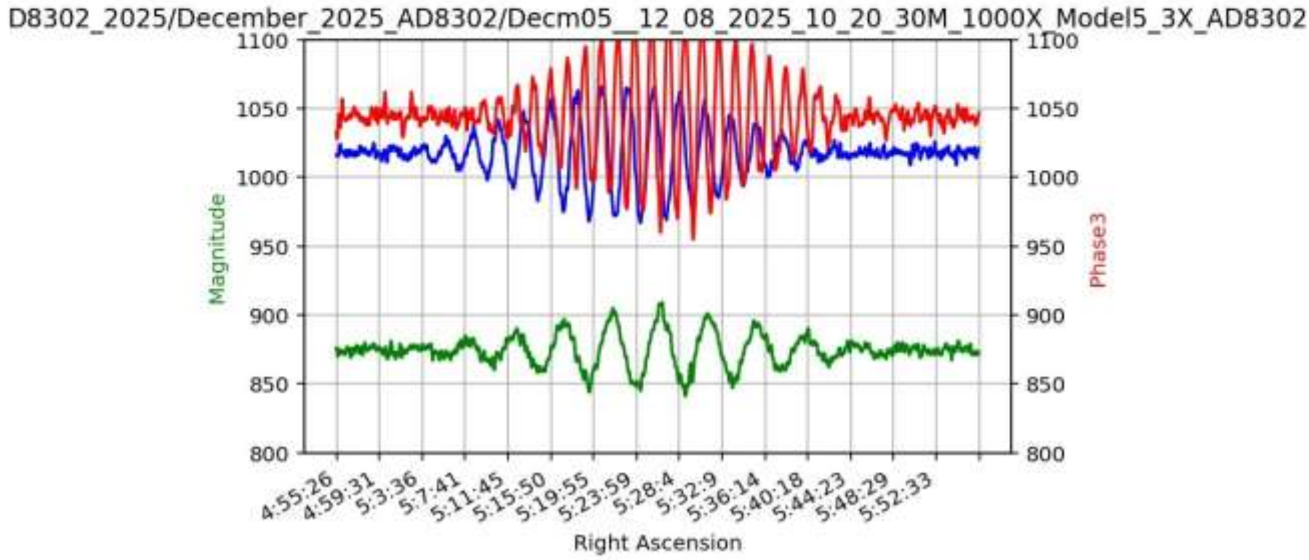


Image 4: This is a one hour plot of the M42's data

In the image above, I notice the three different fringe periods. Green is 10M baseline, Blue is 20M, and Red is 30M. This is a python plot in my Data Explorer Program. I can step forward or backwards 30 minutes on an overlapping 60 minute plot. This same data can be analyzed with a calc program like Libre Calc or Octave.

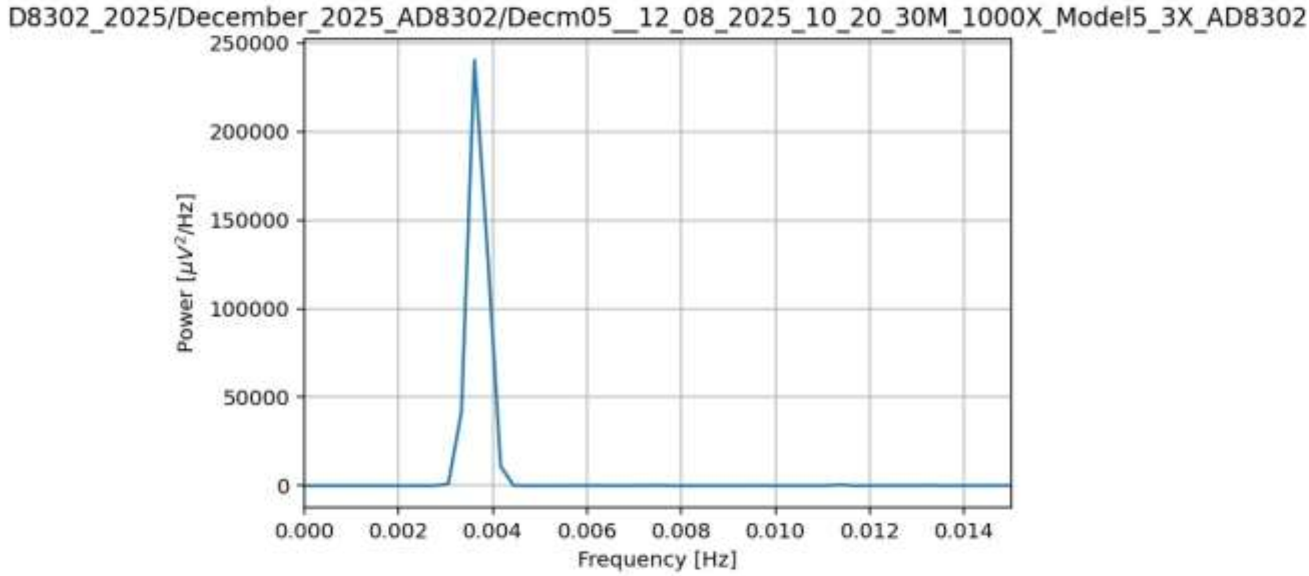


Image 5: FFT plot of the 10M baseline Green trace in the previous picture

This looks nice. One peak is not as noisy as the A/D plot. To figure the declination you take the inverse of the frequency to get the fringe period. But for source in the low declinations like 20 to -20 this FFT plot is not accurate enough to get within 10 deg. The plot has a resolution of .000277 hz per step(freq bin). Remember we are looking for more peaks to see more sources.

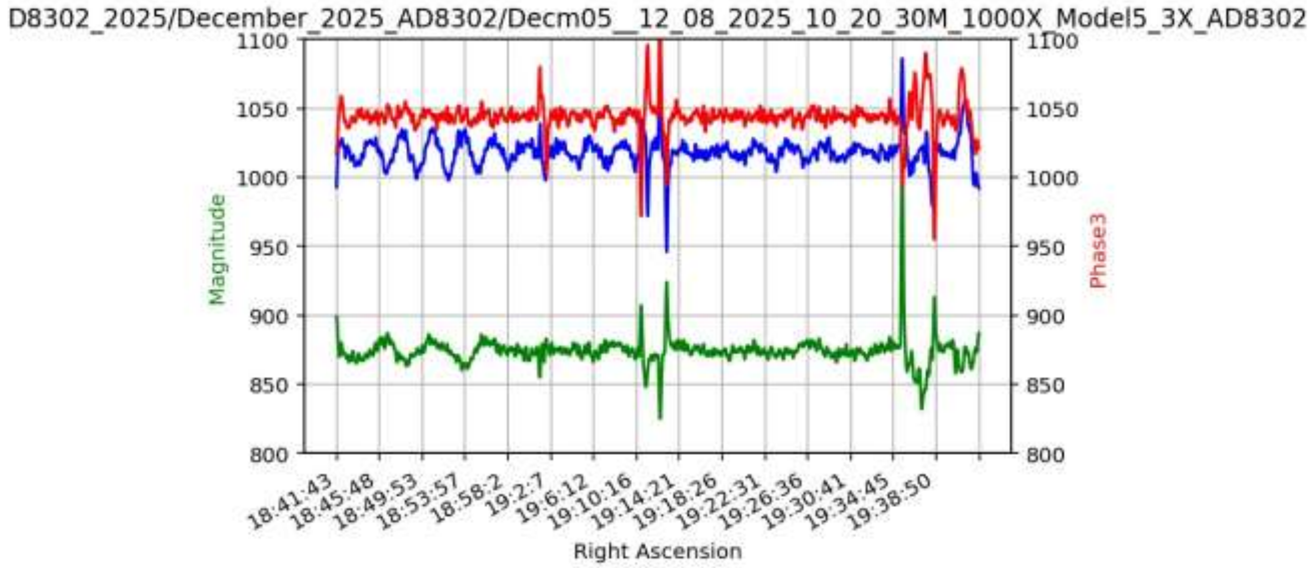


Image 6: This might be 3C290.2 and is near many other things including the Sun at dec -23 deg

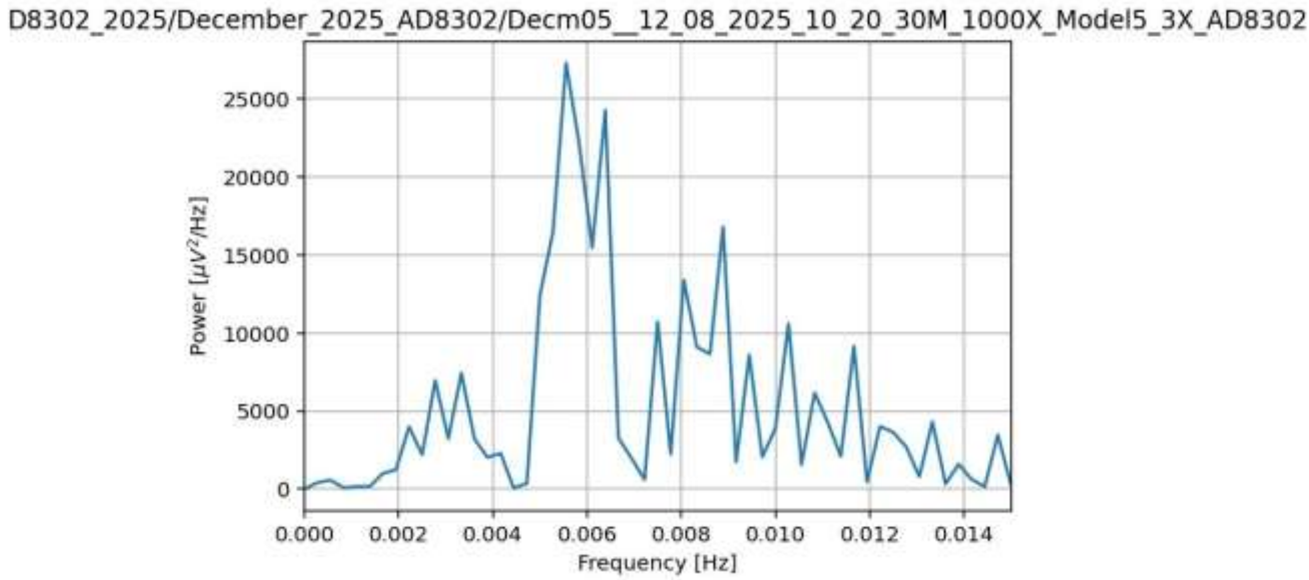


Image 7: Here is the FFT of the blue trace above

Now we have lots of peaks. Some of the peaks are because of the interference of “airplanes”. Near 0.006 Hz are two tall peaks, one of which is the Sun and I think the other is 3C290.2. Yeah, this may not be the way to find things?

M42 Orion Neb 3X interferometer

Otte Obs 90W 42N

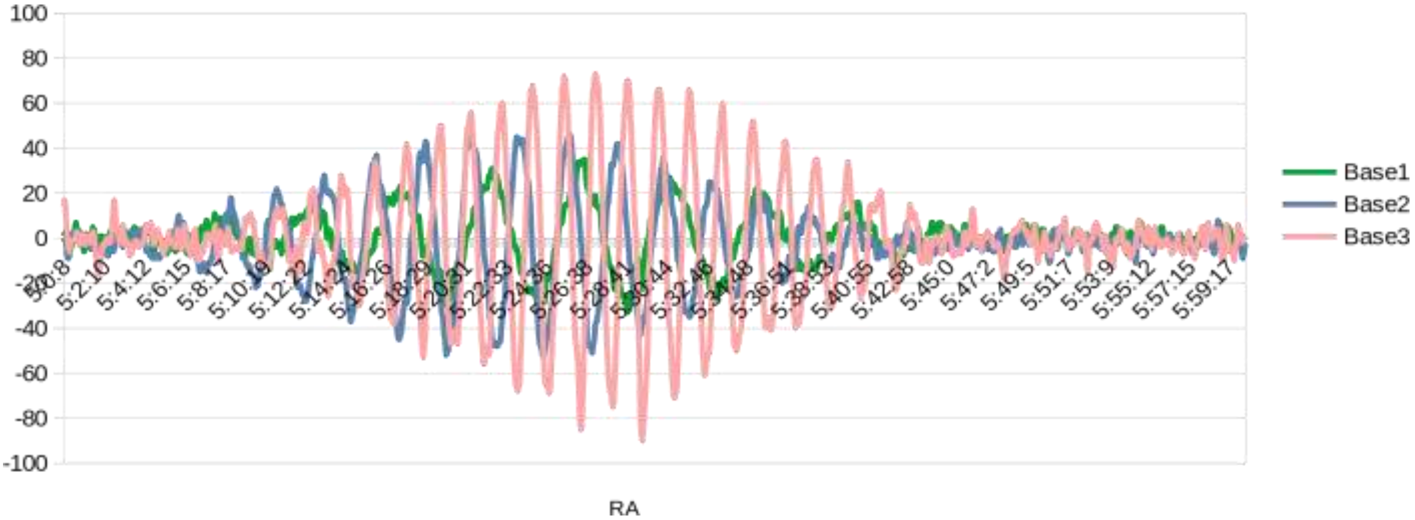


Image 8: Normalizing the three traces to zero. M42's Ref. location is RA 05:35 Dec -05:23

I think at some point all the traces should be on the same side of zero and line up but I don't see it. If you look back at image 4 you see hey don't seem to start nor end at the same time. I am trying to understand why. There is no RF oscillator, the samples are taken within microsecs of each other, I think the cables all reference from the east to west in phase.

M42 Orion neb
3X interferometer Summed into 1Dim image

Otte Obs 90W 42N

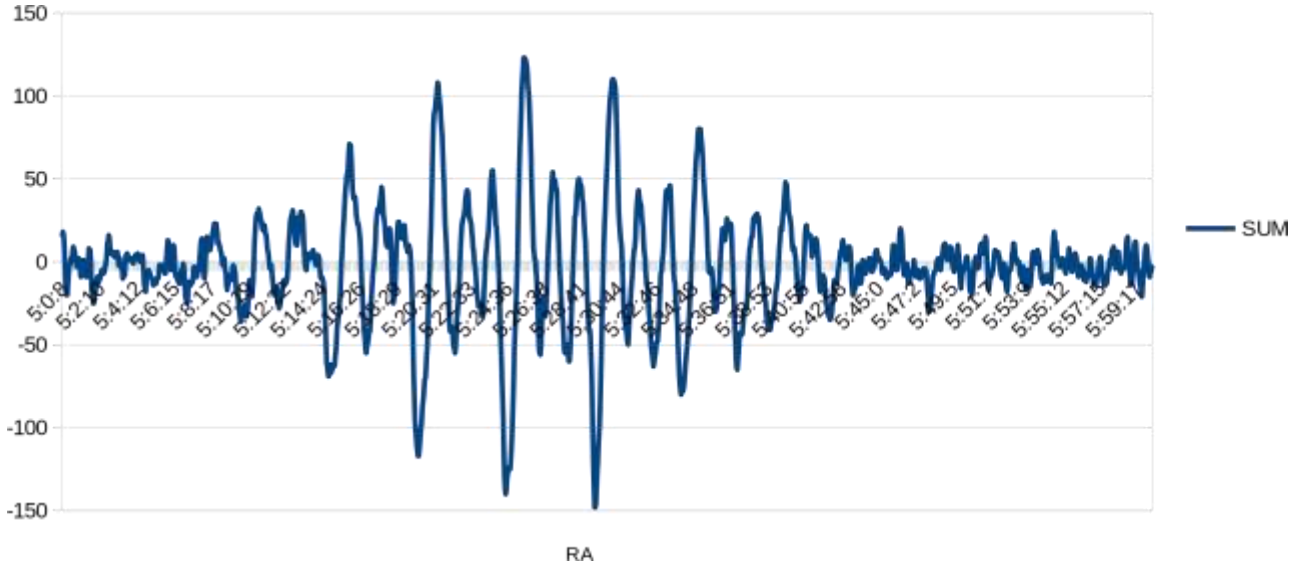


Image 9: Trace Summed together into 1 trace

Here again nothing conclusive. The last two traces were using LibreOffice Calc.

Finally
I have the hardware, electrical, and software working. Now I have to understand what it is telling me. It's early in this campaign; I have only had it running a month now. Any comments or tips are welcome. My email address is above.

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Jan Lustrup on Facebook "Amateur Radio Astronomy"
https://www.facebook.com/groups/1819174114777651 Astropeiler Stockert
https://www.astropeiler.de/en/info-zum-2-x-12-meter-interferometer/

Analog Devices AD8302
https://www.analog.com/media/en/technical-documentation/data-sheets/ad8302.pdf

Observations of evolved stars over the background of a star-forming region

by Dimitry Fedorov UA3AVR

This report continues the work started in the article [1] on observations of evolved stars in several hydroxyl OH lines in the L-band. Observations were made with 20 m Green Bank telescope in Skynet [2], see the telescope dish in Figure 1.

The dominant 1612 MHz line with a double peak spectrum is a distinctive feature of the hydroxyl radiation from evolved stars. Weaker 1665 and 1667 MHz lines ("main" lines) are sometimes observed in their spectra, but much depends on specific mass loss rate $\dot{m}$ or, speaking commonly, how collisional excitations and de-excitations are effective in the circumstellar molecular envelope [1,3]. Higher mass loss rates are often associated with higher mass loss flux densities and denser stellar envelopes, which favor the dominance of infrared excitations rather than collisions [1,3].

Figure 1. Green Bank 20 m telescope dish.

Considered case of observations IRAS 18450-0148 (OH 31.0+0.0, W43A) and IRAS 18460-0151 (OH 31.0-0.2) is interesting because these stars radiation are observed over the background of OH radiation from the star-forming region W43, where "main" lines 1665/1667 MHz are dominating, i.e. are really main. The angular separation between these stars is 0.26°; the offset of W43A relative to the center of W43 is 0.16°. The W43 size is about 1° in the HII and microwave continuum [4] and smaller ≈300″ × 180″ in the OH absorption spot [5]. IRAS 18450-0148 is positioned closer to W43 center than IRAS 18460-0151. The instrument beamwidth ≈ 0.6 °; thus, we can expect a source confusion and OH spectra aliasing.

Both stars are in late stages of evolution; IRAS 18450-0148 (OH 31.0+0.0, W43A) is in the post Asymptotic Giant Branch (AGB) stage with forming Proto-Planetary Nebula (PPN), and IRAS 18460-0151 (OH 31.0-0.2) is somewhat younger by the evolutionary stage – in the late AGB/early post AGB. The first star is already fading in 1612 MHz OH emission, see Figure 2, but the second evolutionary younger star is still bright in dominating OH 1612 MHz lines without clearly seen pulsations.

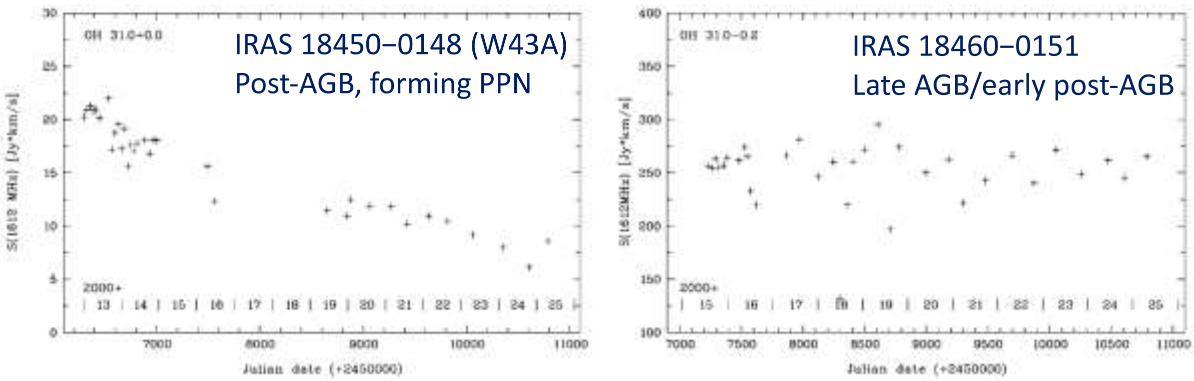


Figure 2. Integrated flux density of the stars by Nançay telescope monitoring data.

Estimations of density indicators were made using ChatGPT 5.1, see Appendix. Expected velocity ranges of OH clouds of both stars are IRAS 18450-0148 (W43A) – 24 … 44 km/s (a central velocity =34 km/s [6]), IRAS 18460-0151 – 110 … 140 km/s [7]; for W43 OH clouds – 50 … 120 km/s [8]. Assumed distance to W43 is 6 kpc [9], distance to IRAS 18450-0148 – 2.6 kpc [6,10], distance to IRAS 18460-0151 – 2.1 kpc [7,11]; thus, both evolved stars are located in the foreground of W43. Both stars have a remarkable feature: high velocity H_2O jets – "water fountains" in the range 145 … 160 km/s.

Observed spectra

Telescope and observations parameters are collected in Table 1.

Table 1. Parameters of the telescope (in two linear polarizations, adopted from [1]) and parameters of present observations

Dish diameter	**D**	20 m
Half Power Beam Width	HPBW	0.63°
Aperture Efficiency	η_A	0.6
System Temperature	$\mathbf{T_{sys}}$	60 K (X pol), 62 K (Y pol)
Forward Gain (dish sensitivity)	Γ	0.068 K/Jy
System Equivalent Flux Density (=$\mathbf{T_{sys}}$ /Γ)	SEFD	880 Jy (Xpol), 910 Jy (Y pol)
Resolution Bandwidth	RBW	15.26 kHz
Resolution in velocities		< 3 km/s
Integration Time	Δt	100 s (1612 MHz), 400 s (1665/1667 MHz)
Minimal Detectable Peak Flux Density (max level of background noise peaks)	$\mathbf{F_{peak}}$	≈2 Jy (1612 MHz), ≈1 Jy (1665/1667 MHz) averaging data of two linear polarizations

Observations were performed by directing the antenna beam toward each star consequently.

The 1612 MHz spectrum with the beam direction toward IRAS 18450-0148 (W43A) is shown in Figure 3. No traces of 1612 MHz lines are found in the expected velocity range 24 … 44 km/s. The peaks at velocities >100 km/s do not belong to this star. There is a remarkable absorption dip near 90 km/s.

Interesting and intriguing spectra were obtained for "main" lines 1665/1667 MHz, see Figure 4.

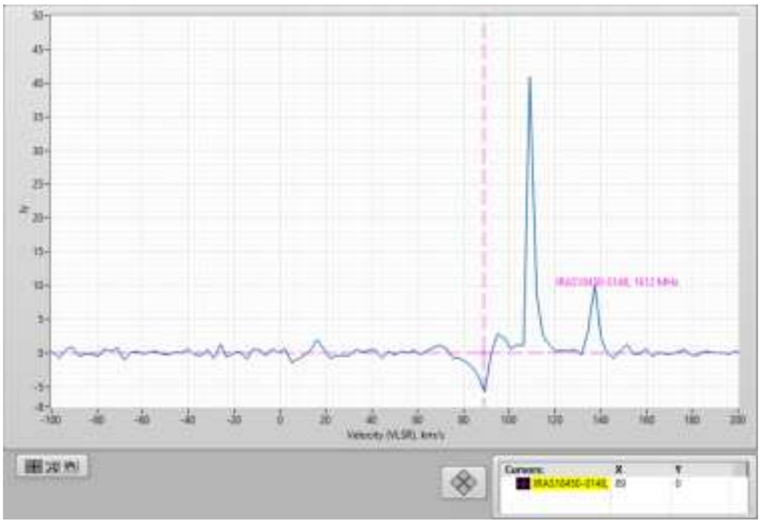


Figure 3. OH 1612 MHz spectrum, the antenna beam is directed toward IRAS 18450-0148 (OH 31.0+0.0, W43A). Tracking (integration) time 100 s, average of 2 linear polarizations, raw observation data, 2025-11-19.

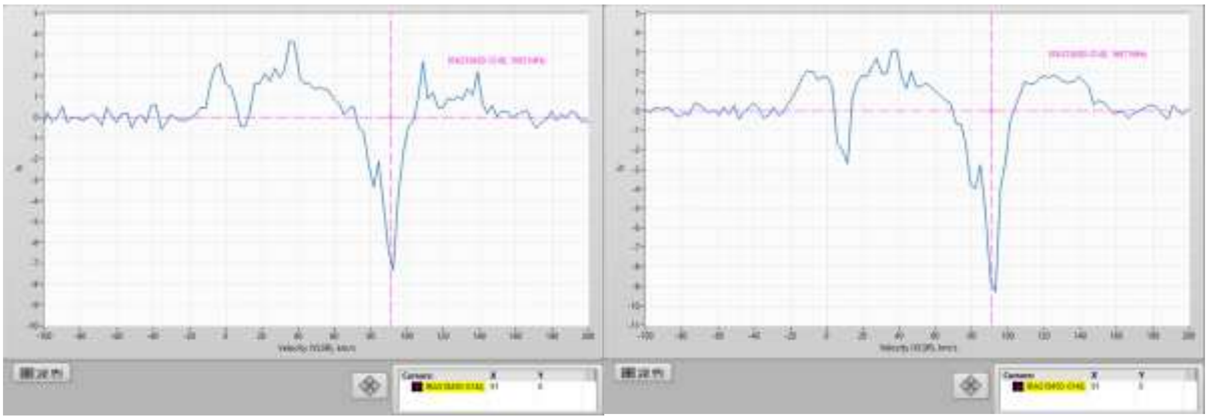
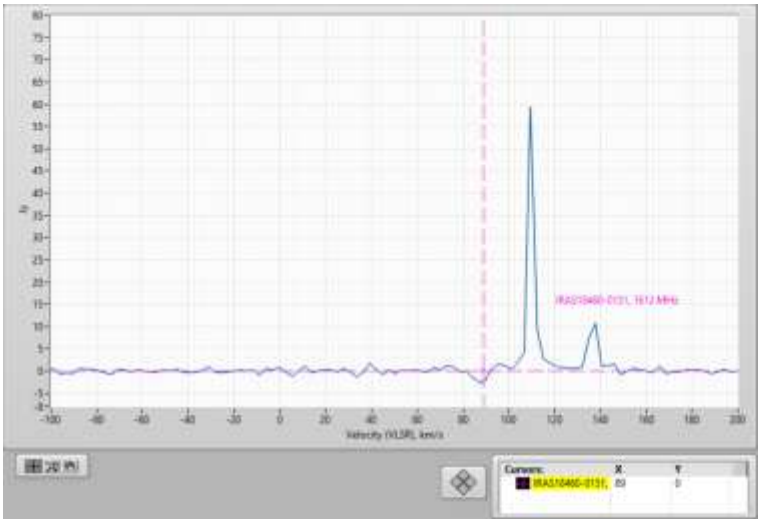


Figure 4. OH 1665 MHz spectrum (left) and 1667 MHz (right), the antenna beam is directed toward IRAS 18450-0148 (OH 31.0+0.0, W43A). Tracking (integration) time 400 s, average of 2 linear polarizations, [raw observation data, 2025-11-19](#).

The 1665/1667 MHz spectra also exhibit absorption dips near 90 km/s. Furthermore, the 1667 MHz spectrum clearly exhibits an absorption dip near 10 km/s, while the 1665 MHz spectrum exhibits a dip from the floor of the wide range OH emission. Two spikes >100 km/s in the 1665 MHz spectrum coincide in velocities with 1612 MHz peaks. The wide range emission spans from -10 to 140 km/s.

Other group of spectra is obtained with beam direction toward IRAS 18460-0151. The 1612 MHz spectrum, see Figure 5, shows stronger peaks typical for evolved stars. This fact points to their origin from IRAS 18460-0151. The absorption dip near 90 km/s appeared shallower. The spectrum gives no additional clues about possible presence of W43A emission in OH 1612 MHz.

The "main" lines spectra toward IRAS 18460-0151 also show higher double peak profiles near 110 and 140 km/s.



18460-0151 (OH 31.0-0.2). Tracking (integration) time 100 s, average of 2 linear polarizations, [raw observation data, 2025-11-28](#).

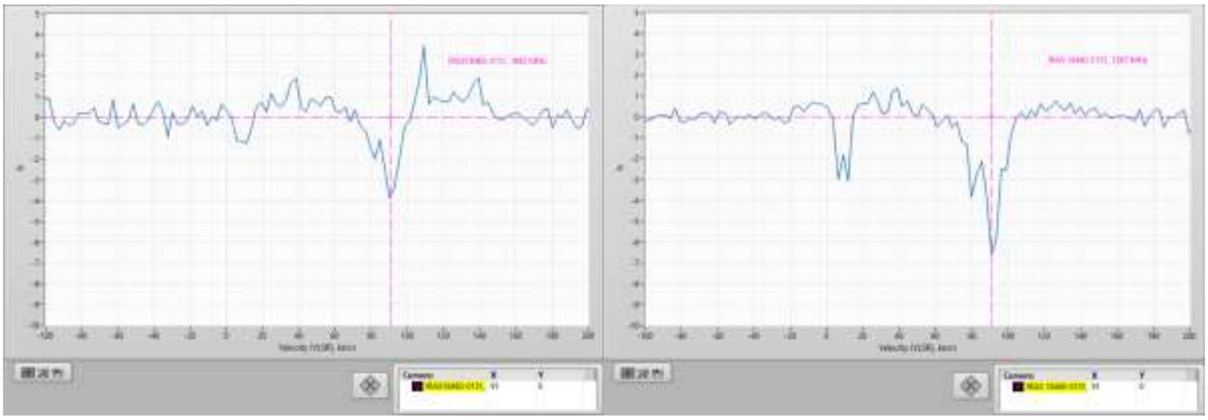


Figure 6. OH 1665 MHz spectrum (left) and 1667 MHz (right), the antenna beam is directed toward IRAS 18460-0151 (OH 31.0-0.2). Tracking (integration) time 400 s, average of 2 linear polarizations, [raw observation data, 2025-11-28](#).

This is consistent with these peaks originating from this star [7]. The absorption lines near 90 km/s and 10 km/s are shallower too. The wide range emission from -10 to 140 km/s weakens in the direction toward IRAS 18460-0151. It is also worth noting the presence of a small peak near 37 km/s up to 3-3.5 Jy toward W43A (Figure 4) and weaker one up to 2 Jy toward IRAS 18460-0151 (Figure 6), which may represent the OH 1665/1667 MHz emission line of the IRAS 18450-0148 with PPN.

Interpretations of spectra, discussion, and concluding notes

The double peak spectra near 110 and 140 km/s belongs to IRAS 18460-0151 (OH 31.0-0.2) surely [7]. A rare case is the 1665 MHz lines from this star replicate the shape of 1612 MHz lines. Interpretation of other features is not too straightforward and unambiguous.

A probable origin of absorption lines is the star-forming region W43 itself. Rugel et al. [5] analyzed the 1665/1667 MHz absorption lines from W43. They found absorption lines at about 100 km/s; depths of lines are somewhat lower than obtained here or have comparable values. However, their velocity does not quite match the 90 km/s of observed absorption spectra Figure 4, Figure 6. Data extraction from [5] and recalculation to Jy were performed using ChatGPT 5.1.

The absorption is also observed in OH 1612 MHz at the same velocity near 90 km/s. Depths of all lines, including OH 1612 MHz, are shallower toward IRAS 18460-0151, i.e. when moving out from IRAS 18450-0148 (W43A) or from the W43 center. The same is observed in absorption lines OH 1665/1667 MHz near 10 km/s. This fact may point to their origin in W43. However, Rugel et al. [5] do not note absorption in OH 1612 MHz for W43, but list other sources with observed absorption at 1612 MHz (see Table 4 in [5]). Some of these sources have velocities near 90 km/s and can be separated from W43A by a small angular distance with possible source confusion and spectra aliasing (for antenna beamwidth $\approx 0.6^o$).

On the other hand, the star-forming region W43 is definitely located at the observation background and have to be seen well with its absorption lines at least toward IRAS 18450-0148 (W43A) direction. Absorption dips at exactly 100 km/s are not observed, and if the observed absorption 1665/1667 MHz belongs to W43, the difference in velocities 10 km/s needs additional explanations.

Analysis of opacities in the 1612, 1665, 1667 MHz lines 90 km/s and in the 1665, 1667 MHz lines 10 km/s indicated that the conditions in the absorbing OH cloud are far from Local Thermodynamic Equilibrium (LTE), which is typical for a star-forming region. Calculations were also carried out by ChatGPT 5.1 under the assumption >25 Jy of the continuum background.

All above questions are a subject of future research. The nature of the wide range emission in the range of -10…140 km/s, which also weakens moving out from the W43 center or from W43A, is another subject of research.

Appendix

Density indicators how dense and powerful the stellar outflow is. The true envelope density is presented by the indicator ρ,

$$\rho = \dot{m}/(4\pi\, v_*\, R_*^2)\,, \tag{1}$$

where $\dot{m}$ – the mass loss rate of evolved star, v_*– is the stellar wind velocity, R_* – the stellar radius. The simpler indicator $=\dot{m}/R_*^2$ corresponds to the mass-loss flux density and can approximately characterize the density of the stellar envelope if we compare them under the assumption that the velocity v_* do not change significantly from star to star. The stellar wind velocity v_* can be easily estimated as a half of velocities of the red- and blue-shifted peaks [12] in the 1612 MHz spectrum (a typical spectrum is shown in Figure 7),

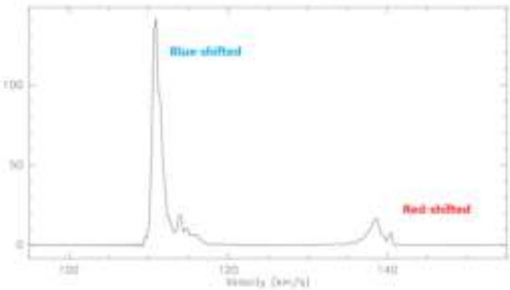


Figure 7. Typical OH 1612 MHz spectrum of evolved stars. Picture taken from Nançay telescope monitoring data, OH 31.0-0.2 (IRAS 18460-0151).

$$v_* = \frac{1}{2}(v_{red} - v_{blue})\,. \tag{2}$$

The stellar radius R_* can be estimated from the luminosity L_* and temperature T_* using the Stefan-Boltzmann law as

$$R_* = \sqrt{L_*/(4\pi\, \sigma\, T_*^4)}\,, \tag{3}$$

where **σ** – is the Stefan-Boltzmann constant. The temperature T_* is usually taken according the star position on the Hertzsprung–Russell diagram in the current evolutionary stage or according observed spectral class. Estimated density indicators are collected in Table 2.

Table 2. Density indicators for the evolved stars.

Parameter Units Star	R* R⊙	$\dot{m}$ (min) M⊙/yr	$\dot{m}$ (max) M⊙/yr	v_* km/s	$\dot{m}/R_*^2$ (min) M⊙/(yr R⊙²)	$\dot{m}/R_*^2$ (max) M⊙/(yr R⊙²)	ρ (min) M⊙ sec / (yr R⊙² km)	ρ (max) M⊙ sec / (yr R⊙² km)
IRAS 18450−0148	330	3×10^{-6}	3×10^{-5}	10	2.75×10^{-11}	2.75×10^{-10}	2.19×10^{-13}	2.19×10^{-12}
IRAS 18460−0151	194	0.0001	0.0001	15	2.66×10^{-9}	2.66×10^{-9}	1.41×10^{-11}	1.41×10^{-11}

Calculations are performed by ChatGPT 5.1; if the necessary data are missing from the measurements or could not be found, they are taken in the typical range for the current stage of stellar evolution.

The star IRAS 18450−0148 (post AGB with forming PPN) with fading OH 1612 MHz luminosity has lesser density indicators than the evolutionary younger IRAS 18460−0151 with rather high OH 1612 MHz luminosity and active mass loss winds.

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About the author

Dimitry Fedorov, UA3AVR was first licensed as a radio amateur in 1982. In 1990 Dimitry graduated with MS in electronics from Moscow Power Engineering University. Now he works as research and development engineer in the wireless industry and SAT communications. He also has previous scientific experience in nuclear and particle physics, while working at Moscow State University, Institute of Nuclear Physics and Universität Tübingen, Institut für Theoretische Physik, see his profile blog at https://www.researchgate.net/profile/Dimitry-Fedorov-2. Radio Astronomy has been a hobby since 2012, mainly in applications for weak signals reception. You can contact Dimitry at ua3avr@yandex.ru.

Sudden Frequency Deviations & Other Phenomena Observed on December 6, 2025

Whitham D. Reeve

An M8.1 x-ray flare erupted at 20:29 UTC producing radiation over a very wide frequency range and lasted at least until 20:50 UTC. The flare immediately altered Earth's dayside ionosphere, producing a Sudden Frequency Deviation (SFD) on the signals received at Anchorage, Alaska from the time-frequency stations WWV in Colorado on 15, 20 and 25 MHz and WWVH in Hawaii on 15 MHz (figure 1). The flare also launched a coronal mass ejection (CME), part of which collided with Earth's magnetosphere a few days later.

Sudden Frequency Deviation

SFD technical concepts are explained in {Reeve15a} and {Reeve15b} but, very briefly, two ionospheric conditions are attributed to sudden frequency deviations, both caused by the x-ray, extreme ultraviolet and ultraviolet energy released by a solar flare. First, a slab of ionosphere below the reflection region undergoes a rapid change in refraction index and, second, the ionosphere's reflection region undergoes a rapid vertical movement. Both conditions introduce a Doppler shift in the radio wave by changing the effective path length (wave number). Either one or both together can cause a sudden frequency deviation.

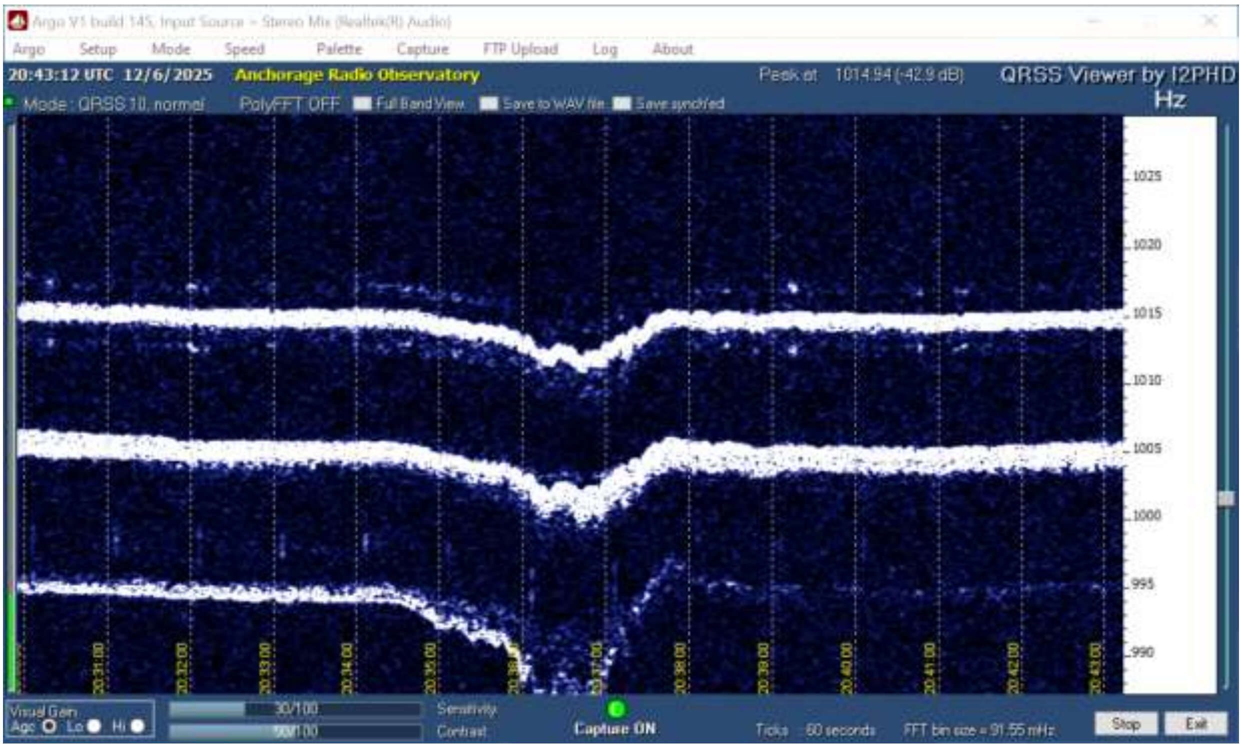


Figure 1 ~ Argo plot above showing the demodulated signals received from WWV and WWVH. The SFD starts about 2034 with estimated 10 Hz deviation at 15 MHz (lower trace) and progressively less deviation at 20 MHz (middle trace) and 25 MHz (upper trace). The 15 MHz trace disappears as a result of the radio blackout from the solar flare radiation increasing the D-region absorption. The higher frequencies did not appear to be as affected. The three receivers were offset tuned by nominal 1 kHz and set to lower sideband (LSB).

Radio Blackout

The SFD was followed by a radio blackout observed at Anchorage on 15 MHz. It is not known if both WWV and WWVH were being received prior to the flare, but WWV on 15 MHz usually is very weak compared to WWVH. The D-RAP plot (figure 2) indicates that the blackout was more likely on the WWVH path. A blackout is caused by excessive ionization and collisions in the D-region that absorb and attenuate the radio waves as they enter the D-region on their way up to a higher refractive region and then are attenuated again on their way back down.

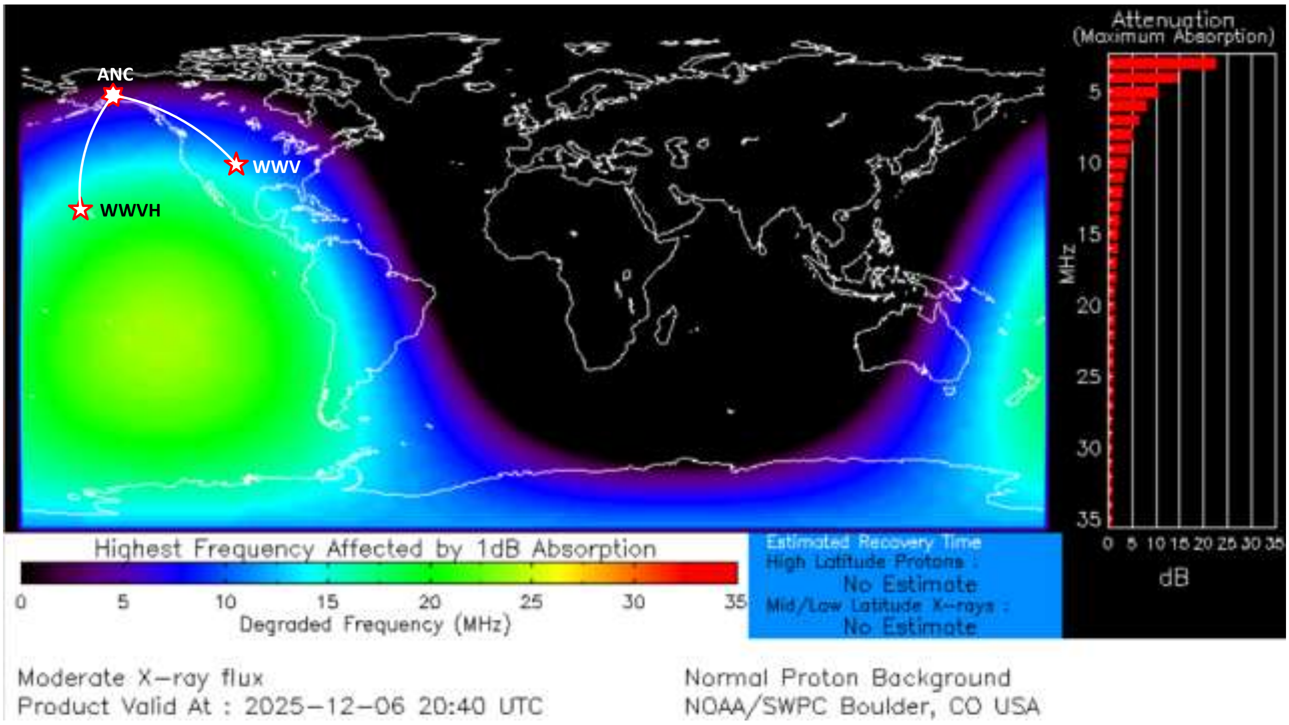


Figure 2 ~ D-Region Absorption Prediction (D-RAP) plot above for 2040 UTC. The three stations involved in this observation report are seen at upper-left. The predicted absorption at 15 MHz shown on the left histogram is less than 5 dB at 15 MHz but, whatever it actually was, it blacked out the path from WWVH. Underlying image source: https://www.swpc.noaa.gov/products/d-region-absorption-predictions-d-rap

Solar Radio Emissions

The Space Weather Prediction Center (SWPC) listed Type II slow radio sweeps and Type V fast radio sweeps in their Events report; see Appendix and {Events}. These emissions were received at the e-CALLISTO stations in Alaska {e-CALLISTO}; the spectral observations at the HAARP station were made while the Sun was only 4° above the horizon (figure 3). Other e-CALLISTO stations on Earth's dayside received the emissions as well.

The Type II slow radio sweep is the signature of a CME as it moves outward through the Sun's corona and encounters decreasing electron density and associated decreasing plasma frequency. The appearance of multiple overlaid Type II bursts could indicate the CME encountered varying density layers in a disturbed corona or different parts of the CME produced additional emissions as they moved through the corona.

The Type V radio burst consists of Type III fast radio bursts followed by a continuum emission lasting a few minutes. Type III bursts are the signature of near lightspeed electrons that are accelerated by a flare and beamed through the corona. The continuum that is associated with the Type III and gives it the Type V classification is not as well understood. Some explanations are low energy electrons traveling along different magnetic field lines, positional variations in the beaming process, or electron-cyclotron maser instability [Reid14].

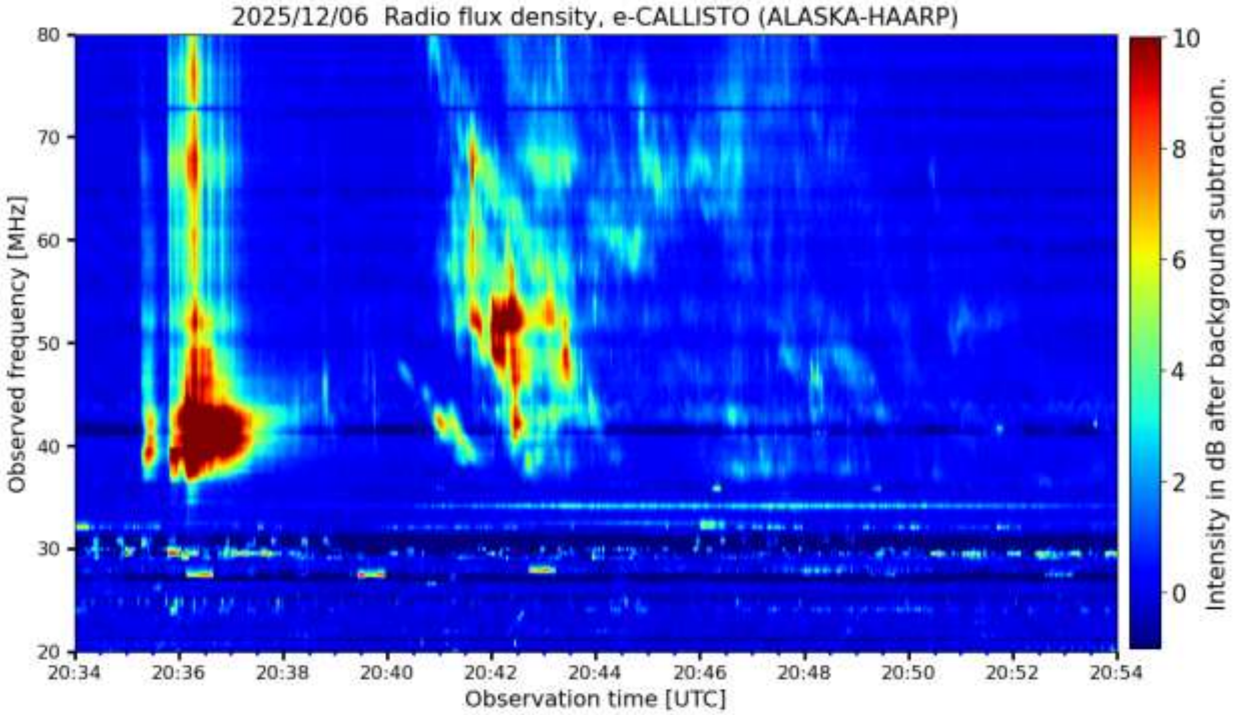


Figure 3 ~ Radio spectra received at HAARP Radio Observatory from 20 to 80 MHz. Note ionospheric cutoff around 35 MHz. The Type V from 2035 to 2039 with the characteristic continuum blob, and multiple Type II with harmonics and split bands from 2040 through 2052. The spectra below 35 MHz is from unknown terrestrial sources. Image courtesy of Christian Monstein from ALASKA-HAARP data at {e-CALLISTO).

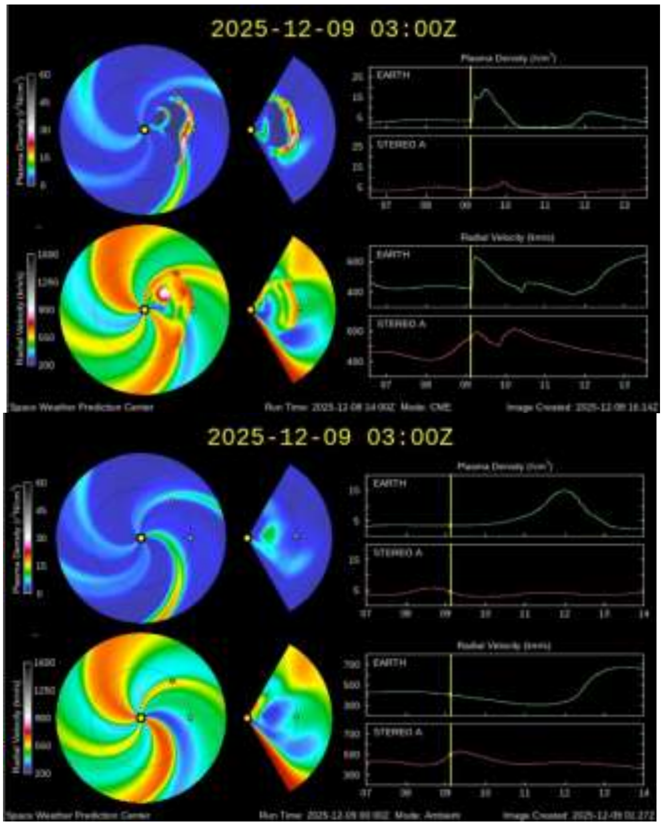


Figure 4 ~ WSA-ENLIL models of the CME prepared by Space Weather Prediction Center. The left image shows the prediction based on the initial review of satellite imagery; it shows significant effects at 0300 on 9 December (see yellow vertical cursor on the charts). However, the right image, which was based on a revised prediction run at 0000 on 9 December, shows no significant effects before or after 9 December. The circular plots are an overhead view of the Sun-Earth system, and the pie-shaped plots are a view from Earth's orbital plane. The yellow Sun is at center and Earth is the small green circle right of center in both circular plots. The Sun is on the left and Earth in the center of the pie-shaped plots. The upper plots are plasma density, and the lower plots are solar wind radial velocity. Image source: https://www.swpc.noaa.gov/products/wsa-enlil-solar-wind-prediction

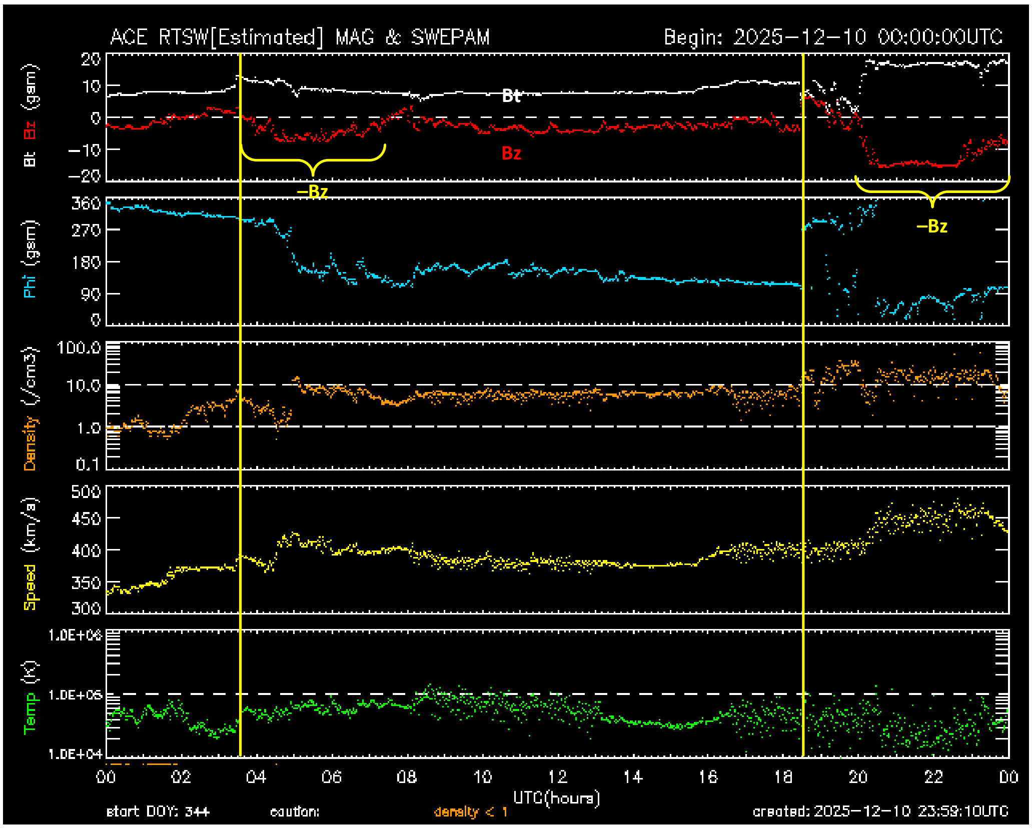


Figure 5 ~ Measurements at the ACE spacecraft 1.5 million km from Earth along the Earth-Sun line. A small magnetic field transient was detected at 0328 (left vertical yellow line) on 9 December followed by a negative transition of the Bz magnetic field component that lasted around 4 hours. Additional transient effects were detected around 1830 (right vertical yellow line) and also followed by negative Bz that persisted through 0300 the next day. SWPC reported the later activity as resulting from a *reverse shock* in the heliospheric current sheet.

Geomagnetic Effects

There were no instantaneous geomagnetic effects from the flare itself, but Space Weather Prediction Center initially predicted the CME would cause an increase in both the plasma density and solar wind speed at Earth on 9 December, potentially causing a magnetic disturbance. Later predictions showed no significant effects (figure 4). As it turned out, there were magnetic transients measured at the ACE spacecraft (figure 5), which preceded some unsettled activity measured by the SAM-III ground magnetometer at Anchorage on 10 December during the 0600 – 0900 and 2100 – 2400 synoptic periods (figure 6). The activity briefly increased to storm levels (K5) early the next day.

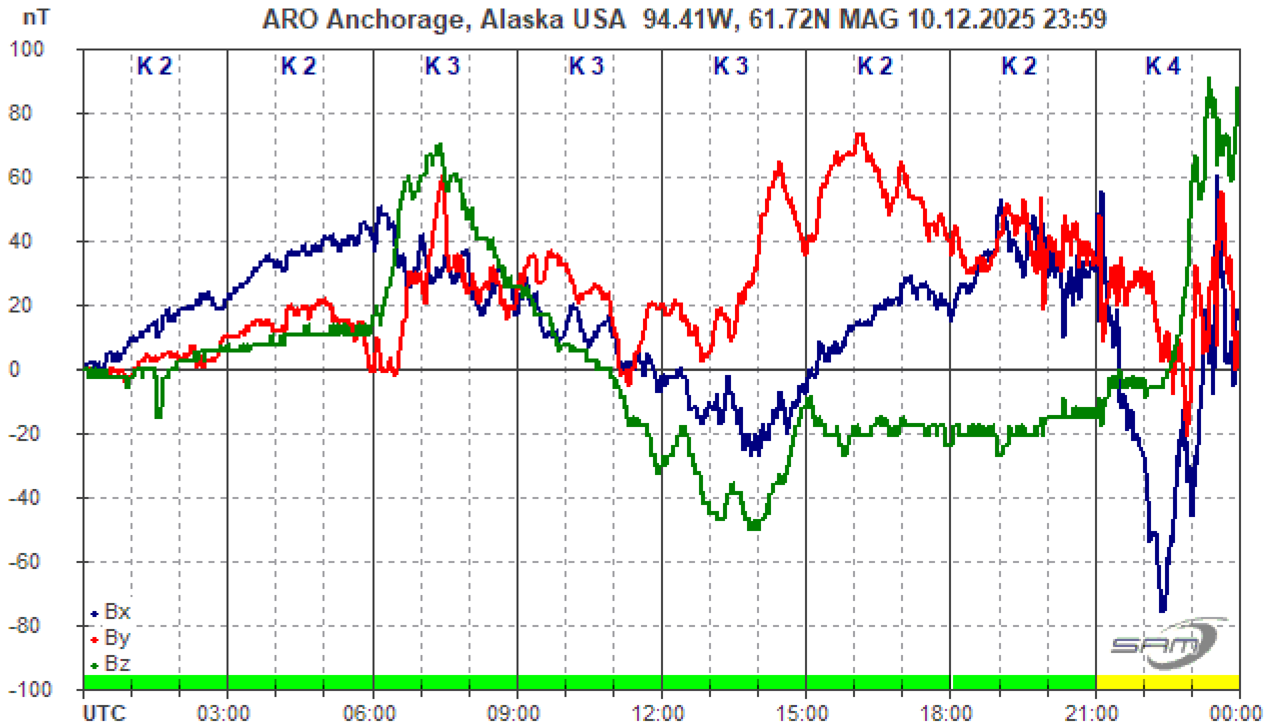


Figure 6 ~ SAM-III magnetogram for 10 December, four days after the flare and associated radio effects, showing relatively minor magnetic disturbances starting at 0600 and again at 2100. Both probably were related to the episodes of negative Bz seen in the ACE spacecraft magnetic field and solar wind data above and due to the CME. The activity shown at the end of day continued for three hours on 11 December with storm conditions (K5) reached at 0230 and followed almost immediately by quiet conditions. The magnetogram for 9 December (not shown) indicated a magnetically quiet day.

References

{e-CALLISTO} https://e-callisto.org/

{Events} ftp.swpc.noaa.gov/pub/indices/events/

{Reeve15a} Reeve, W. Sudden Frequency Deviations Caused by Solar Flares, Part I ~ Concepts, Available at: https://www.reeve.com/Documents/Articles%20Papers/Propagation%20Anomalies/Reeve_SuddenFreqDevConcepts_P1.pdf

{Reeve15b} Reeve, W. Sudden Frequency Deviations Caused by Solar Flares, Part II ! ~ Instrumentation and Observations , Available at: https://www.reeve.com/Documents/Articles%20Papers/Propagation%20Anomalies/Reeve_SuddenFreqDevMeas_P2.pdf

[Reid14] Reid, H.A.S., Ratcliffe, H., A Review of Solar Type III Radio Bursts, Research in Astronomy & Astrophysics, RAA 2014 Vol. 14 No. 7, 773–804 doi: 10.1088/1674–4527/14/7/003

Appendix

Space Weather Prediction Center Events Report, partial from {Events}

#Event	Begin	Max	End	Obs	Q	Type	Loc/Frq	Particulars		Reg#
2320 +	2029	2039	2049	G18	5	XRA	1-8A	M8.1	5.3E-02	4299
2340	2031	////	2055	HOL	3	DSF	N23W00	10	B.9A	4299
2320	2035	////	2039	PAL	C	RSP	025-180	V/3		
2320	2035	2036	2039	PAL	G	RBR	2695	1100		
2320	2035	2035	2039	PAL	G	RBR	410	12000		
2320	2035	2036	2037	PAL	G	RBR	1415	1700		
2320	2035	2036	2039	PAL	U	RBR	4995	900		
2320	2035	2036	2043	PAL	G	RBR	610	1100		
2320	2035	2036	2039	PAL	G	RBR	8800	580		
2320	2036	2037	2039	PAL	G	RBR	15400	310		
2320	2040	////	2056	PAL	C	RSP	025-180	II/3	1143	
2320 +	2048	2048	2050	PAL	G	RBR	245	660		

Starter Guide to Using the RTL2832U TV Dongle for Detecting the B0329+54 Pulsar.

Peter W East

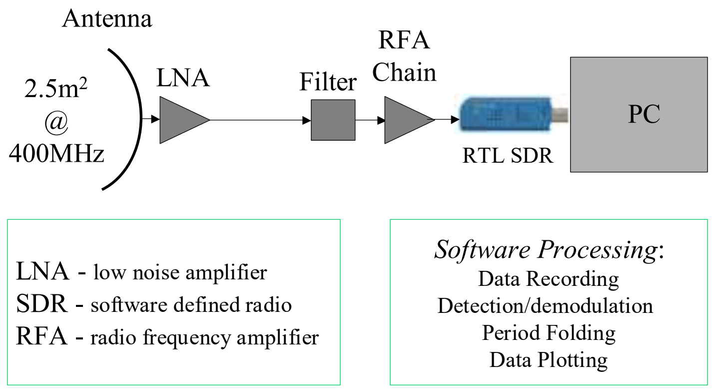
Introduction

The well-proven 400Mhz frequency band is chosen for pulsar signal strength reasons; the relevant Radio Astronomy band 406-410MHz and Radio Amateur band 430-440MHz are possible <u>but the range should be scanned before selecting your antenna design and operating band to find the region of lowest local radio frequency interference (RFI).</u> Using the RTL SDR with free ***SDR#*** software downloaded from https://airspy.com/download/ is useful for a low RFI spectrum search.

Sources for purchasing some receiver components are noted below, but some mechanical build experience is necessary for the antenna and filter. However, on-line design tools are available as listed to guide this process.

For actual measurements, experience shows that lowest RFI occurs with night-time observations although propagation variation in the interstellar medium may conspire to impact successful results. Persistence will be rewarded.

Basic Pulsar Radio Telescope - low-cost entry



"The real killer is wideband RFI noise, so do the simple test of replacing the antenna with a 50Ωload while pointing the antenna at the elevation that you intend using - hopefully the noise level rises with the load but if it goes down significantly ....!" PK Blair(G3LTF)

***Antenna Options** - self build, 2.5m^2 effective aperture around 400MHz required*

3D

Twin Yagi

$A_e \fallingdotseq 1.2L\lambda$

$L=2.5m$, $A_e = 2.2m^2$

@ 400MHz

3-D Corner Reflector

$A_e = 5\lambda^2$

$= 2.5m^2$ @ 400MHz

Dish

$A_e \fallingdotseq 0.55A$

$D = 2.4m$,

$A_e = 2.5m^2$

@ 400MHz

Corner reflector design:
https://blog.freifunk-mainz.de/wp-content/uploads/2013/08/Shortened-3D-Corner-Reflector-Antenna.pdf

Yagi design:
https://www.yagicad.com/
https://www.qsl.net/dk7zb/70cm/70cm-kurz.htm

Dish Feed design: https://www.changpuak.ch/electronics/cantenna.php

Code:-
A_e= effective area; L= length; D= diameter; λ= wavelength
***RF Components** - NF<0.5dB for the first LNA, close coupled to antenna feed*

Filter Bandwidth
5MHz, Loss 2.5dB

LNA: Minicircuits type,
ZX60-P103LN+
~ 20dB gain and
0.5dB noise figure

RF Chain: Ebay/Aliexpress
Packaged low noise RF amplifiers
~25dB gain, 0.6dB noise figure

Self-build the narrow-band-defining filter. *Filter Design Tool:* https://www.wa4dsy.net/cgi-bin/idbpf/

RTL 2832U TV dongle - *low-cost entry*

The RTL device is available from a number of sources, but it is important for this application that it is of the right quality and in particular frequency and temperature stable.

The Noolec NESDR SMArt v5 is a good choice.

RTL Software - *Osmocom rtl-sdr software tools for Windows*

OsmoCom has produced an '*rtlsdr*' library & capture tool. The data capture tool, *rtl_sdr.exe* produces binary files (.bin) containing raw IQ 8-bit data for analysis.

A link for the rtlsdr tools download versions is given in reference 1, below.

The USB driver (zadig) for the RTL SDR is downloaded and installed as reference 2.

The Osmocom RTL tools for 'Windows', the zadig driver and folding software are all in the .zip file reference 3.

Software References:-

1. Osmocom RTL Software, https://downloads.osmocom.org/binaries/windows/rtl-sdr/
2. Zadig Windows Driver, https://zadig.akeo.ie/
3. Zipped 1+2, 32bit Package Including a Folding Program *at:* http://www.y1pwe.co.uk/RAProgs/winrtl.zip

Antenna Directing - *drift scan or tracking*

Programs such as *Stellarium* or *Radio Eyes* can locate B0329+54 and help direct the antenna.

Optimum time for small antenna drift-scan measurements is at culmination, the highest target elevation at due North. Observation data collection times of 2 to 3 hours may be required.

Recording Data Files - test observation

First, unzip *winrtl.zip* files (reference 3) to your working directory.

The data recording procedure is:- Open Windows command terminal *cmd.exe* and initialize to the working directory. To record data to a binary file, *capture1.bin*, type on the command line…

rtl_sdr.exe capture1.bin –f 425e6 –s 2400e3 –g 42

This command tunes the rtl dongle to 425MHz, samples both I and Q measures at 2.4MHz rate, sets the dongle gain

at 42dB and records 8-bit bytes of *I* and *Q (in-phase and quadrature)* samples interlaced to the .bin file. This output file, *capture1.bin* grows at 17.28GB per hour and is stored in the current folder; user-terminated at the end of observation by pressing the keys 'Cntrl C'.

***Analyzing Data Files** - observed topocentric period*
Due to the Earth rotation and orbit round the sun, the pulsar pulse frequency and indicated pulse period will be Doppler shifted. This is called the topocentric period and is relative to the observer’s position and observation time; the observed period can be found from the professional astronomer's program, TEMPO.

A Windows on-line TEMPO calculator with instructions is available from Joe Martin (K5SO) at the browser address:

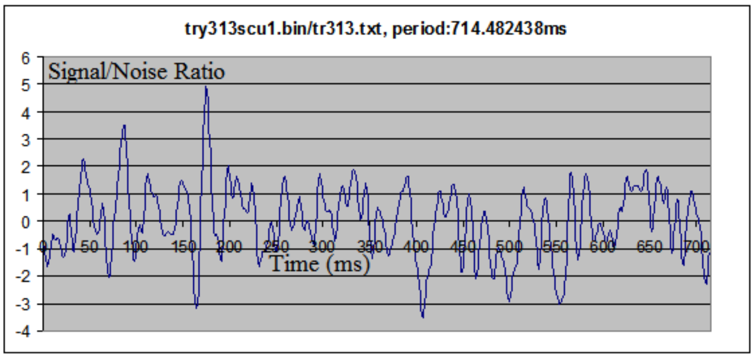
http://www.k5so.com/documents--and-downloads/download-tempo_calc.html

***Data Plotting** - basic integrated period plot*
A basic data folding analysis program for Windows using the TEMPO-derived topocentric period is available in reference 3 above, ***rapulsar2con.exe.*** This program folds and integrates the data at the noted pulsar topocentric period, filters the data to pass the pulsar pulse bandwidth and outputs the data in .txt form of bin number versus instantaneous signal-to-noise ratio. Warning: Large binary files take a long time to process.

The program command line for Windows working directory, *cmd.exe* terminal is:-

rapulsar2conv.exe <infile> <outfile> <data clock rate (MHz)> <output data points> < pulsar topocentric period(ms)> <pulsar pulse width(ms)>

Example: ***rapulsar2con.exe try313scu1.bin tr313.txt 2.4 1024 714.482438 6.5***



The example text file *tr313.txt* from a 611MHz acquisition using a pair of 2.5m Yagis, is opened in Windows Excel, selecting columns A, B and clicking on the Chart Wizard + XY Scatter produces the above plot.

Notes: 1. The frequency stability of the RTL2832U SDR is not all that great and you may have to tune the period value by + or - a few parts per million to optimise the pulse amplitude.
2. In this basic guide the data is not de-dispersed so some broadening and pulse amplitude reduction will be evident.
3. The displayed plot bandwidth is matched to the video pulse and is independent of the chosen data points/bins number.
4. Other tests are necessary to positively prove true pulsar detection in this case.

The Next Stage..... for more in depth pulsar analysis, RFI reduction and detection proving, go to:-
M. Klaassen: Windows, 3pt analysis tools for RTL SDR , http://parac.eu/projectmk17b.htm

A & G. Dell'Immagine, Linux, Pulsar-Distro-Guide, https://github.com/gio54321/pulsar-distro-guide

M. Leech: Linux/Windows, GNURadio pulsar data collection and processing, https://github.com/ccera-astro/pulsar_filterbank

TEMPO: Linux, TEMPO, http://pulsarastronomy.net/pulsar/software/tempo

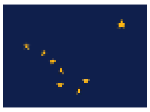
PRESTO: Linux, PRESTO, Pulsar Analysis Software, https://www.cv.nrao.edu/~sransom/presto/

PW East May 2025

TinySA Ultra Spectrum Analyzer Trace Detectors & Bandwidth Settings

Whitham D. Reeve

Introduction



This article focuses on the trace detectors and video bandwidth filter settings used in the TinySA Ultra spectrum analyzer. It is not an overall review. The TinySA Ultra is very popular, small, battery operated, inexpensive (< 200 USD) and has many features (figure 1). It is handy for fieldwork involving antennas, amplifiers, and locating interference because of its size and portability. There are several operationally similar models of the TinySA Ultra and mine is the ZS405.

Figure 1 ~ TinySA Ultra. The touchscreen size is 4 inch diagonal with 480 x 320 pixel resolution. The spectrum analyzer RF input is the lower SMA connector on the left. The upper connector is for the signal generator RF output (primarily used for calibration). The On-Off power switch is on the top along with a *jog* switch for menu control. A USB-C connector for battery charging and connection to a PC, microSD memory card connector and earphone jack are on the bottom. The unit is based on the Silicon Labs Si4468 RF transceiver and STMicroelectronics STM32F302 processor ICs. Image source: https://www.tinysa.org/wiki/

The motivation for this article was my recent work to compare the trace detectors and associated nomenclatures used by the manufacturers of laboratory spectrum analyzers. I decided to also look at the TinySA Ultra trace detector implementations because it is such an interesting instrument.

This article is based on the *genuine* TinySA Ultra with the latest firmware at the time of writing (December 2025), which is tinySA4_v1.4-216. The TinySA Ultra developer, Erik Kaashoek, in The Netherlands, often adds new features through regular firmware updates, so units with earlier or later firmware may have fewer or more trace handling features. The genuine TinySA Ultra has extensive built-in self-test and calibration routines and is well-supported. Many cheap clones exist so the developer provides a *Where to Buy* list in the TinySA Wiki (see References) for genuine units. He does not support the clones.

I assume readers have a basic knowledge of how swept spectrum analyzers work and are motivated to study the TinySA Wiki and the referenced weblinks and documents.

Trace Detectors

The TinySA Ultra is a swept spectrum analyzer. Up to four traces can be simultaneously displayed and each trace can use a different detector. A given trace detector determines the value displayed for each sweep point associated with that trace. Conceptually, the measurement of the input signal produces data for each frequency as the analyzer is swept. The data are placed in a *bucket* whose width is *[frequency span/(sweep points – 1)]*. The detector then applies one or more mathematical operations to the data and displays the results. The mathematical operations are determined by the user-selected trace detector and may include various types of averaging, scaling and peak determination.

Averaging detectors are commonly used in spectrum analyzers because they lower the displayed noise produced by the analyzer or external sources, making it easier to view a weak signal. There are many types of averaging in spectrum analyzers, including linear averaging, logarithmic averaging, power averaging, quasi-peak averaging, video averaging, sweep averaging and several others, but the TinySA Ultra only supports linear averaging.

In linear averaging, the sampled linear voltage measurement values are summed, and the sum is divided by the number of samples associated with a sweep point, giving V_{AVG}. The display uses logarithmic scaling so, after the power has been calculated from $P_{AVG} = (V_{AVG})^2/R$, the power units are converted to dBm and displayed.

In the TinySA Ultra, the detectors are set through the *Trace* → *Calc* menu for each trace. The *Trace Type*, such as Hold, and *Trace Detector*, such as Max, are combined in one setting, in this case Max Hold. The available detectors are Min Hold, Max Hold, Max Decay, Aver 4, Aver 16, Aver, Quasi-Peak, and Trace Table. Each detector is briefly described along with typical applications in table 1.

Video Bandwidth Settings

Although not a specific trace detector, the Video Bandwidth filter can provide a form of averaging to reduce trace noise. For noise-like signals (for example, true random noise and most digital modulations), setting the Resolution Bandwidth-to-Video Bandwidth ratio, RBW/VBW = 10 (VBW = 0.1 x RBW) generally reduces the displayed noise variation to an acceptable level but higher ratios such as 100 (VBW = 0.01 x RBW) may be used if needed.

Some averaging can be attained by any setting where VBW < RBW, not just ratios of 10 or 100. The TinySA Ultra allows five discrete RBW/VBW ratios, which are accessed through the *Frequency* → *VBW* menu. The TinySA Ultra does not provide VBW settings in terms of frequency but as a multiplier of the RBW, as in 1.0, 0.33, 0.10, 0.03, or 0.01 x RBW. For example, if the RBW is set to 100 kHz and the VBW is set to 0.03 x RBW, the VBW filter is 3 kHz. The VBW is actually enunciated on the display as a frequency, in this example **VBW: 3kHz**.

If the Video Bandwidth is narrower than the Resolution Bandwidth, that is, VBW < RBW, the sweep time generally is longer than when VBW ≥ RBW. This quickly becomes apparent when the VBW is reduced below the RBW in any swept spectrum analyzer.

For sinusoidal signals such as CW, the RBW/VBW ratio usually is set to 1 (VBW = 1.0 x RBW). When the TinySA Ultra VBW is set to Auto, it uses a ratio of 1.0. The TinySA Ultra does not have any settings for VBW > RBW. Although it does not apply here, a setting with VBW > RBW is commonly used in spectrum analyzers when noise is not the primary concern, a faster sweep time is needed or pulses are being measured. Many laboratory spectrum analyzers will automatically choose an optimum ratio when the user selects the type of spectrum to be measured, such as noise, pulse, or sinusoid.

Table 1 ~ TinySA Ultra Trace Detectors

Detector Type	Comment	Description & Use
None	Trace Off	
MIN HOLD	Combination of Minimum (–) Peak and Trace Hold	Displays and holds the Minimum value measured in each bucket. The Hold is reset by selecting again. Useful for making an unmodulated carrier (CW) visible in a composite signal. Also useful for differentiating between CW and impulsive signals in EMI measurements and testing. Enunciated as **MINH**.
MAX HOLD	Combination of Maximum (+) Peak and Trace Hold	Displays and holds the Maximum value measured in each bucket. The Hold is reset by selecting again. Best for locating CW signals well above the noise. Ensures that the true amplitude of sinusoidal signals is reported but does not give a good representation of random noise because the true randomness of noise is not detected. For CW signals, the shortest possible measurement time may be used. For pulsed signals, the measurement time must be > than the expected pulse length (that is, the time must cover at least one pulse). The Max Hold detector provides correct levels when measuring noise-like signals. Enunciated as **MAXH**.
MAX DECAY	Combination of Maximum (+) Peak and Trace Hold with Decay	Displays and holds the Maximum value measured in each bucket for a certain number of scans after which the maximum will start to decay. The Hold is reset by selecting again. The default number of scans is 20 but can be changed. This setting may be used instead of MAX HOLD to reduce the effect of spurious signals in the TinySA Ultra. Enunciated as **MAXD**.
AVER 4	Average power $(V_{AVG})^2/R$	Displays the weighted average of 4 measurements according to Displayed value = (Previous value x 3 + Current value)/4. Restarted by selecting again. The averaging is linear power averaging in which the calculations are done on linear values and not logarithmic (dB) values. Useful for observing sinusoidal signals near noise and the power of complex signals. Does not affect measurements of a CW signal. Enunciated as **AVER4**.
AVER 16	Average power $(V_{AVG})^2/R$	Displays the weighted average of 16 measurements according to Displayed value = (Previous value x 15 + Current value)/16. Restarted by selecting again. Provides more averaging than AVER 4 and is useful for the same types of signals and noise. The average processing is the same as AVER 4. Enunciated as **A16**.
AVER	Average power $(V_{AVG})^2/R$	Displays a continuous average. Restarted by selecting again. Useful for the same types of signals and noise as AVER 4 and AVER 16 but when more averaging is needed to smooth the noise floor. The average processing is the same as AVER 4 and AVER 16 except it is continuous. Enunciated as **AVER**.
Quasi-Peak	QP or QPD	Displays a weighted form of peak detection. The value measured by the detector drops as the repetition rate of the input signal decreases. For example, an impulsive signal with a given peak amplitude and 10 Hz pulse repetition rate will have a lower quasi-peak value than a signal with the same peak amplitude but 1 kHz repetition rate. Most often used for EMI measurements and testing and is meant to mimic the response of a damped analog voltmeter with a fast-attack (charge) time and slow-decay (discharge) time. Enunciated as **QUASI**.
Table Trace	User Defined	Obtains data from a user defined table and may be used to draw limit lines on the display. Also, when used with the Subtract menu (*Trace → Subtract*), the Table Trace may be used to modify or normalize the measurement trace. For example, current probe or antenna factors may be entered in the Trace 2 Table and then subtracted from Trace 1 so that the displayed units are converted from dBµV to dBµA for a current probe or dBµV to dBµV/m for an antenna. Enunciated as **TABLE**.

Example Trace Detector Application

All examples (figure 2) show the signal received from the KLEF FM broadcast station transmitter about 2.5 miles away using the supplied adjustable whip antenna. I purposely lowered the signal-to-ratio by shortening the antenna so the effects of averaging would clearly show. The images are screenshots taken with the TinyRemote screenshot tool (see references) and are shown 125% of true scale.

Analyzer setup for all images:

- ✓ Antenna extension length: 3 inches (76 mm)
- ✓ Center frequency/span: 98.1 MHz/1 MHz (start 97.6 MHz, stop 98.6 MHz)
- ✓ RBW/VBW: 10 kHz/10 kHz (RBW/VBW ratio 1.0)
- ✓ Attenuation: 0 dB (automatically determined)
- ✓ Reference level: –30 dBm
- ✓ Sweep points: 450 (maximum available on local screen, see Comments section)
- ✓ Sweep time: 616 ms (automatically determined)

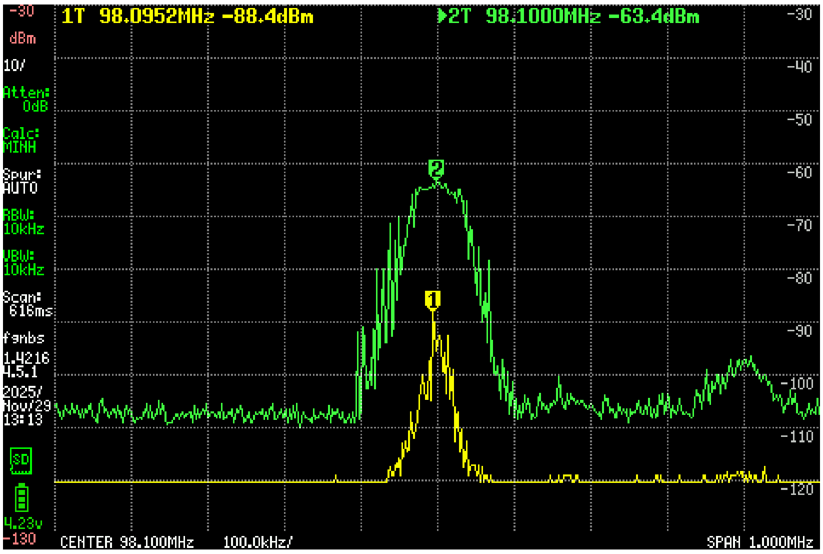


Figure 2.a ~ Trace Detector:

MAX HOLD (green)
MIN HOLD (yellow)

In this example, the difference between the maximum and minimum noise is on the order of 15 dB but a true minimum is not apparent especially at frequencies below the center frequency.

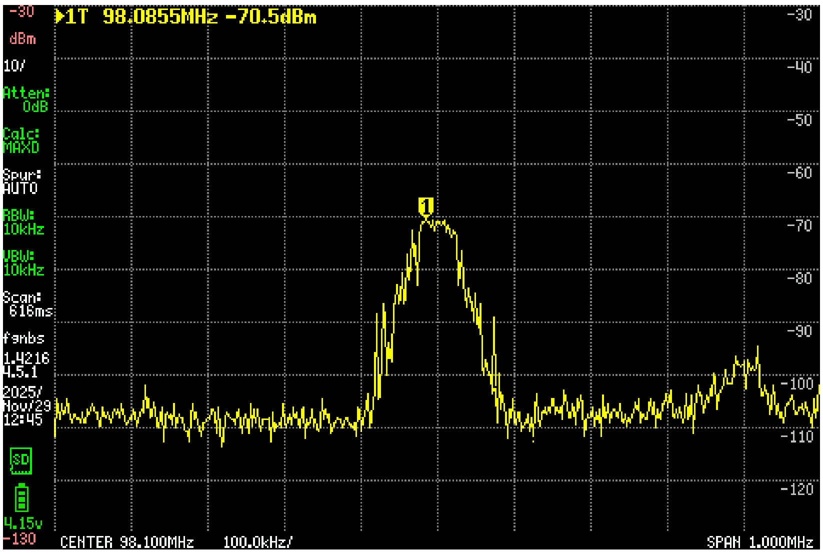


Figure 2.b ~ Trace Detector:

MAX DECAY

No change is discernible in the single screenshot shown here; a peak is held for 20 sweeps and then is slowly reduced to the ambient level after the peak signal disappears. MAX DECAY does not show a shadow line or fill for peak signals as in many analyzers, but it still is useful for observing transient noise or signal bursts that would be masked by the MAX HOLD detector.

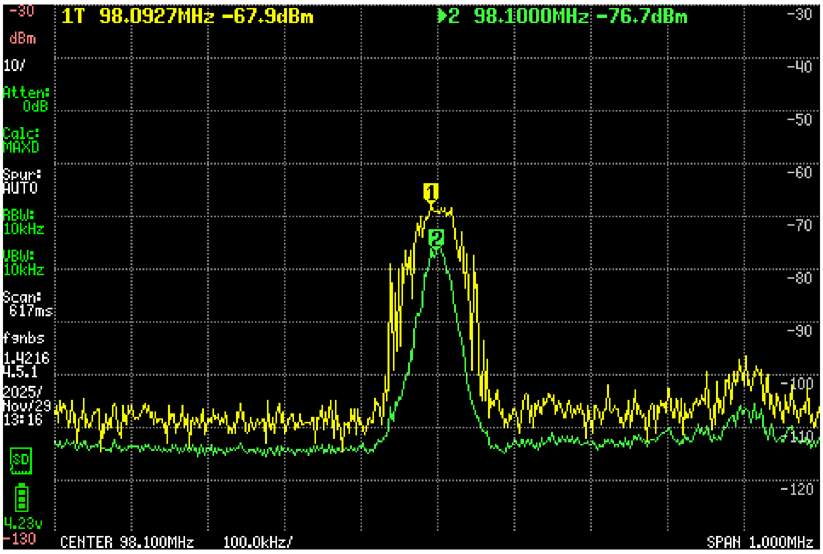


Figure 2.c ~ Trace Detector:

AVER 4 (yellow)
AVER 16 (green)

Note lower displayed noise floor and smoother trace with the AVER 16 detector.

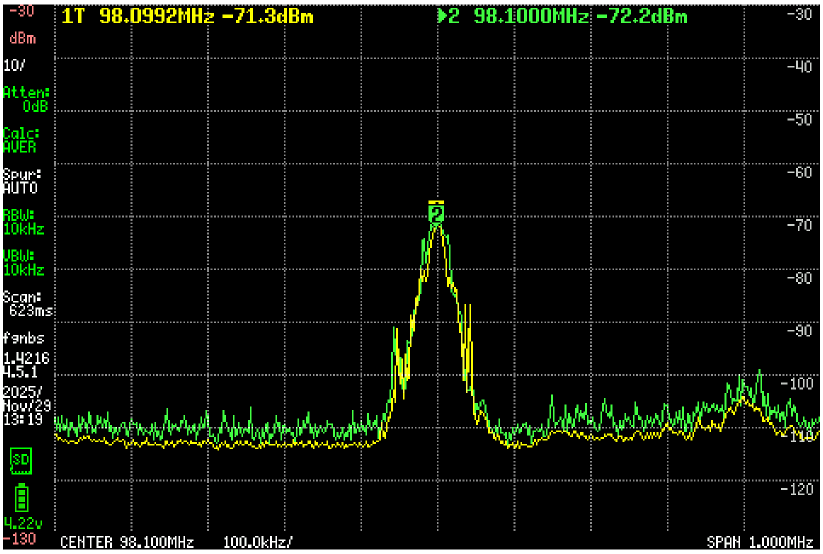


Figure 2.d ~ Trace Detector:

AVER (yellow , ~97 sweeps)
Quasi-Peak (green)

In this example, the Quasi-Peak trace shows about 5 dB higher amplitude than the Average trace where noise is the only signal but about the same amplitude for the FM signal itself.

Comments

The TinySA Ultra itself can be set to one of six sweep point values. The maximum is 450 points, which corresponds to the number of horizontal pixels in the trace display area and is the best available setting for most work. On the other hand, the software applications available for controlling the TinySA Ultra allow any practical number of sweep points; higher values provide a smoother display in the application window but not on the TinySA Ultra screen.

The analyzer is well-supported through the Groups.io/g/tinysa user support group, and there are many video demonstrations of the TinySA Ultra features and functions on YouTube (see References).

References

- Keysight: Spectrum Analysis Basics – Application Note 150, 5952-0292, November 2, 2016
- Microwaves & RF: Techniques for Making measurements of Noise-Like Signals with a Spectrum Analyzer, Bob Nelson, 2012-07-02

- Microwaves & RF: Eight Errors Common to Spectrum Analyzers, Bob Nelson, 2014-06-12
- R&S: FPL Spectrum Analyzer User Manual, 1178.3370.02–17
- R&S: Instrument Fundamentals: Spectrum Analyzer Basics, slide presentation
- R&S: Measuring with Modern Spectrum Analyzers, Education Note 1MA201_09e
- TinySA on groups.io: https://groups.io/g/tinysa
- TinySA Wiki: https://tinysa.org/wiki/
- TinyRemote screenshot software tool: http://athome.kaashoek.com/tinySA4/Remote/
- TinySA-App software application: http://athome.kaashoek.com/tinySA/Windows/
- YouTube: https://www.youtube.com/playlist?list=PL5ZELMM2xseNkwVBtyAG00uZevwWUdVIg

Observation Reports

Observation report: A brightening of the water masers in W49 observed with the 1-metre "Mini Maser Telescope"

Eduard Mol

Introduction and background

The "mini maser telescope" is a small 1 metre radio telescope built for observing the brightest methanol masers at 12.2 GHz and water masers at 22.2 GHz. A more detailed description of the 22 GHz setup and methods for collecting and processing the spectra can be found in an earlier article in the August 2022 SARA journal [1].

One of the main activities with the 1-metre telescope is the regular (every 4-8 weeks) observation of the star forming region Westerhout 49 (W49) at the 22.2 GHz water line to track changes in its spectrum. Water masers are typically highly variable on timescales of weeks to years [2]. W49 is also one of the few star forming regions where several water maser flare events have been reported. During these maser flares one or more features in the maser spectrum exhibit a rapid brightening over a period of several weeks or months [3, 4, 5].

Such a brightening was observed on November 26, 2025. The brightening event has independently been observed and confirmed by Wolfgang Herrmann at Astropeiler, see also the other article on W49 in this SARA journal [6].

Observations and results

Figure 1 shows the five most recent observations from the period August- December 2025. One observation from December 10th was not included, because it was later determined that this observation was affected by a pointing error. The spectrum of W49 at 22.2 GHz is very complex, with at least several tens of different maser features at any given time spread out over a wide velocity range. These features correspond to distinct maser clouds within the star forming region.

Note that the vertical scale is not calibrated, and at least some of the variability may be explained by factors such as pointing errors and variations in atmospheric absorption. However, these external factors would impact all features in the spectrum to the same extent. In the W49 observations the features in the 5-10 km/s range clearly exhibit a brightening while another cluster of features at -4- -10 km/s mostly remained at similar levels, at least since September 26th. This indicates that the variability is most likely from the maser source itself. Additionally, the brightening of the features at 5-10 km/s was confirmed by Wolfgang Herrmann using the 10-metre dish at Astropeiler.

However, according to the observations done at Astropeiler the brightened feature had substantially dimmed by December 3rd . This decrease cannot simply be attributed to pointing errors or other external factors, because the other group of features at -4 to -10 km/s showed very little change [6]. My most recent observation from December 11th does not show a similar dimming, but rather a continued brightening. This suggests a very short dimming of the maser between November 26th and December 11th.

Rapid changes in brightness occurring on timescales of weeks or even days during maser flaring events are not unusual. A detailed light curve of an earlier flaring event in W49 in 2017-2018 shows that this flare event was composed of several “sub-flares” occurring every few weeks, with periods in which the maser decreased in brightness in between [3]. During another double flare event in the star-forming region G25.65+1.05 in 2018, the peaks of the flare only lasted for a few days [7].

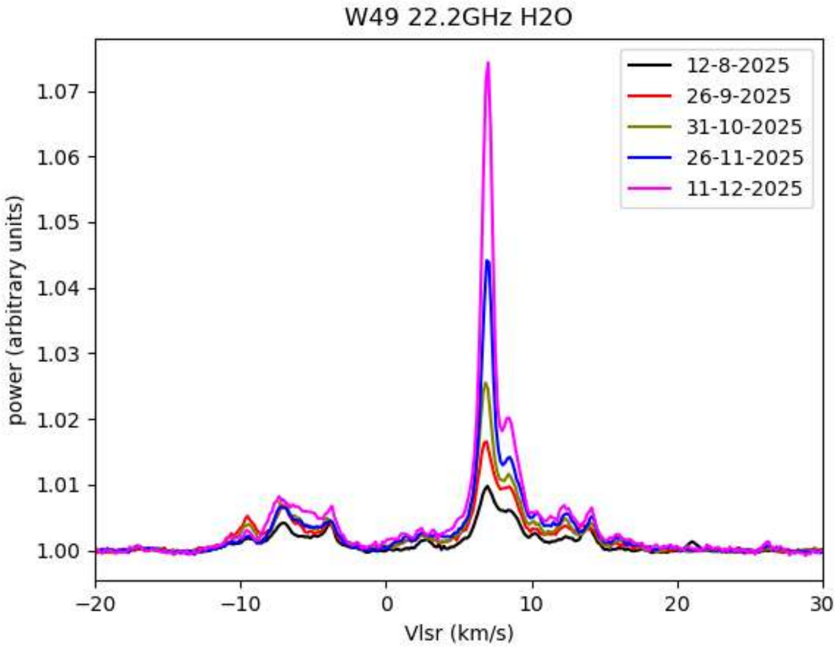


Figure 1: W49 water maser observations from August- December 2025

Figure 2 shows a waterfall plot of all spectra collected since February 2022. Brightening events similar to the one reported here have occurred before at +5, -4.5 and -10 km/s in 2022 and 2023. Whether any of these events are related or if they have a common cause remains unclear. The 6.9 km/s feature of the current brightening has been present since at least September 2024. The feature at +8.5 km/s, which brightened as well albeit to a lesser extent, can be traced back to at least April 2024.

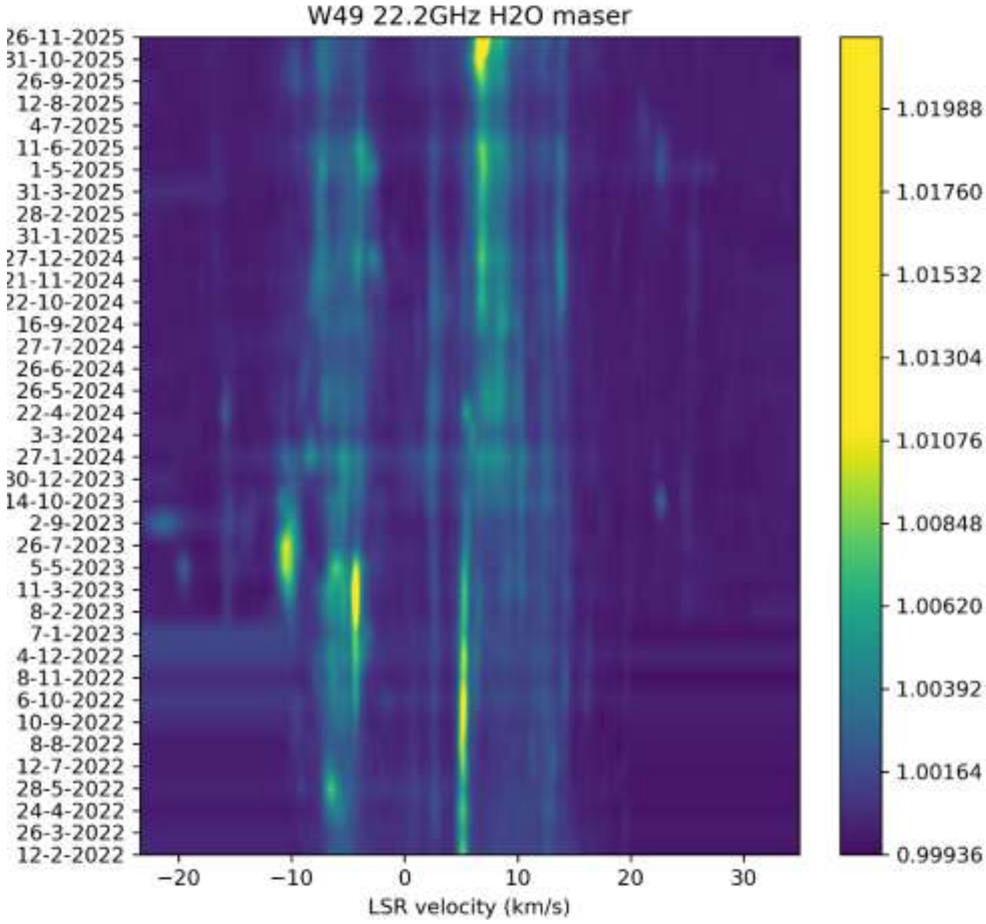


Figure 2: waterfall plot of all spectra of W49 recorded since February 2022

On December 11th the maser was observed in two different linear polarizations. The results are summarized in figure 3. Normally the polarization of the LNB feed is oriented roughly east-west, referred to as “horizontal” in Figure 3. Because the dish is mounted on an equatorial mount the sky polarization angle does not change while the mount tracks the target across the sky. First, a 30-minute observation was done with the LNB in the regular “horizontal” orientation. Then, the LNB was rotated 90 degrees so that the polarization was in the roughly north-south oriented “vertical” orientation and another 30 minute observation was done. Off-target spectra for bandpass correction were recorded for 15 minutes before and after the observations. The results demonstrate that there is no significant difference in the maser spectrum between the two polarization angles.

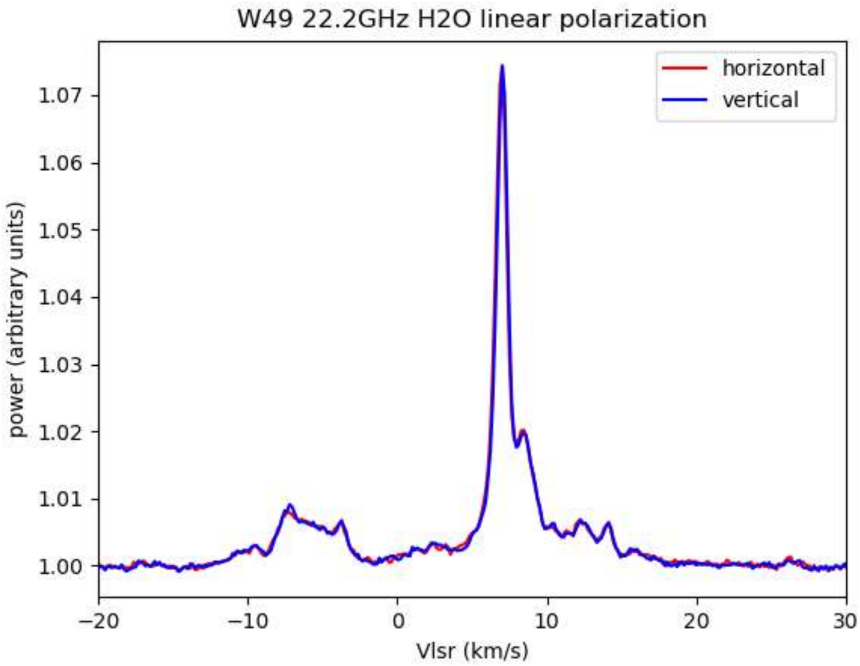


Figure 3: spectra of W49 on December 11 2025 in two orthogonal linear polarizations.

References

1) Mol, E. (2022). Observations of the water maser sources W49 and W51. August 2022 SARA journal
2) Felli, M., Brand, J., Cesaroni, R., Codella, C., Comoretto, G., Di Franco, S., ... & Valdettaro, R. (2007). Water maser variability over 20 years in a large sample of star-forming regions: the complete database. Astronomy & Astrophysics, 476(1), 373-664.
3) Volvach, L. N., Volvach, A. E., Larionov, M. G., Wolak, P., Kramer, B., Menten, K., ... & Mel'nikov, A. (2019). An Unusually Powerful Water-Maser Flare in the Galactic Source W49N. *Astronomy Reports*, *63*(8), 652-665.
4) Volvach, A. E., Volvach, L. N., & Larionov, M. G. (2020). Unusually powerful flare activity of the H2O maser feature near a velocity of− 60 km s− 1 in W49N. *Monthly Notices of the Royal Astronomical Society: Letters*, *496*(1), L147-L151.
5) Kramer, B. H., Menten, K. M., & Kraus, A. (2017). Variability of water masers in W49N: results from Effelsberg long-term monitoring programme. *Proceedings of the International Astronomical Union*, *13*(S336), 279-280.
6) Herrmann, W. (2025). Brightening of the W49 water maser. December 2025 SARA journal
7) Volvach, L. N., Volvach, A. E., Larionov, M. G., MacLeod, G. C., Van den Heever, S. P., Wolak, P., & Olech, M. (2019). Powerful bursts of water masers towards G25. 65+ 1.05. Monthly Notices of the Royal Astronomical Society: Letters, 482(1), L90-L92.

Brightening of the Water Maser in W49

Wolfgang Herrmann

1. Introduction

W49 is a star forming region in the Milky Way at a distance of 11.11 kpc [1]. It contains a strong water maser source at 22.3 GHz. This source is observed from time to time with the Stockert 10-m dish as water masers can be quite variable. The setup for these observations has been described in the November-December 2024 issue of the SARA journal [2]. Here we report on a recent brightening of certain spectral features of this source.

2. Observations

On November 26th, 2025, Eduard Mol notified the community via the SARA newsgroup about a potential flare titled "Possible new water maser flare in W49". This triggered a follow up observation at Astropeiler Stockert which was conducted on Nov. 30th, 2025. Another observation was conducted on Dec. 3rd, 2025. Both these observations were compared to a recording taken on Nov. 4th, 2025.

3. Results

Fig. 1 below shows a comparison of these three observations.

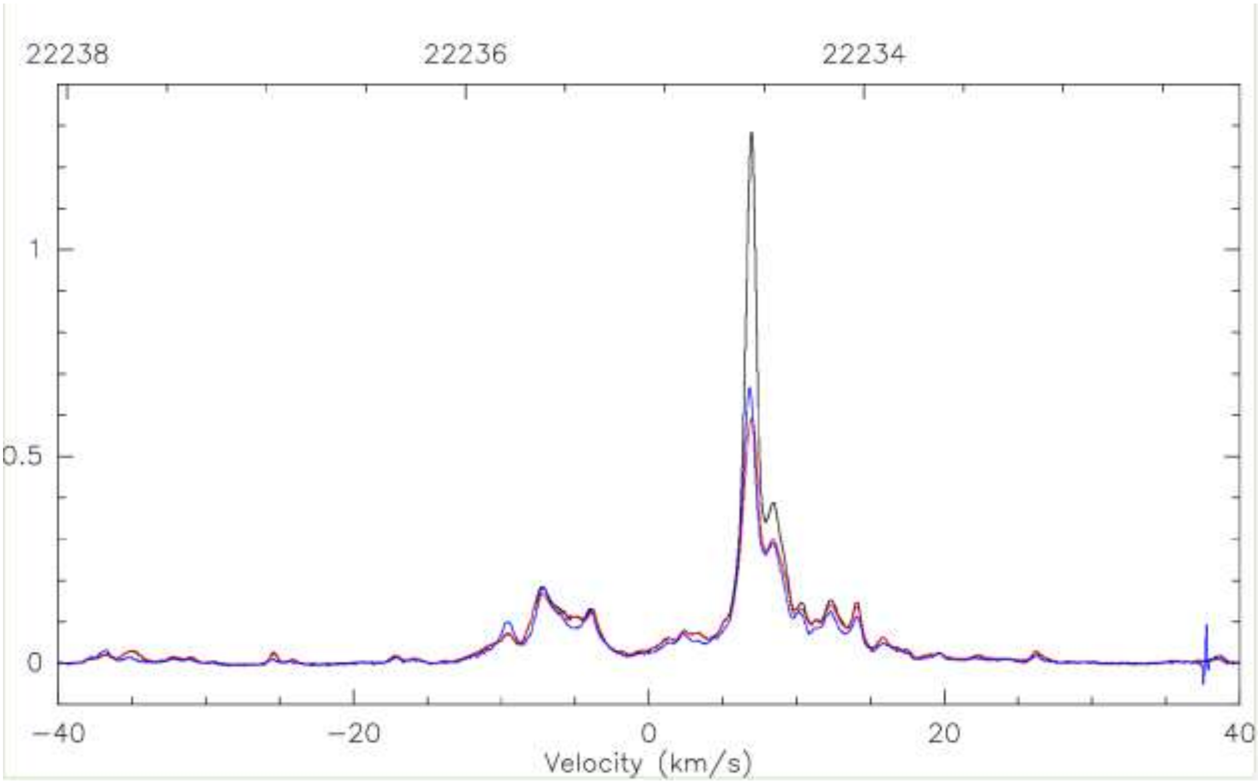


Fig.1 Spectra of the water maser emission from three observations

The horizontal coordinates are the velocity, corrected to the local standard of rest (lower axis) and the frequency in MHz (upper axis). The vertical axis is the received power in arbitrary units.

The red curve is the spectrum obtained on Nov. 4th, 2025. The black curve is the spectrum from Nov. 30th, which clearly shows a brightening of the spectral features in the 5 to 10 km/s range. On Dec. 3rd, the brightening has decreased to almost the original level as shown in the blue curve.

This brightening event seems to be relatively short, which is not unusual for water masers. Also, we may not have captured the maximum of the brightening as we only started the observation after having been notified.

We believe the brightening is restricted to the velocity range mentioned. This can be explained by the fact that actually there are several water masers in W49 at different locations. These cannot be distinguished due to the limited resolution of our 10-m dish which is about 0.12° at the observing frequency. It is quite reasonable that only one of these masers brightens whereas the others remain constant.
We will conduct further follow up observations from time to time.

Literature:

[1] Zhang B, Reid M J, Menten K M, Zheng X W, Brunthaler A, Dame T M and Xu Y
2013 Astrophys. J. 775 79
[2] W. Herrmann, SARA Journal, Nov.-Dec. 2024

Journal Archives and Other Promotions

The rich and diverse legacy of member contributed content is available in the SARA Journal Archives. Table of contents for journals is available online at: SARA-Journal-Master-Index.xlsx (live.com)

The entire set of The Journal of The Society of Amateur Radio Astronomers is available by online download. It goes from the beginning of 1981 to the present (over 6000 pages of SARA history!)

All SARA journals and conference proceedings are available through the previous calendar year.

SARA Store (radio-astronomy.org/store.)

SARA Online Discussion Group

SARA members participate in the online forum at http://groups.google.com/group/sara-list. This is an invaluable resource for any amateur radio astronomer.

SARA Conferences

SARA organizes multiple conferences each year. Participants give talks, share ideas, attend seminars, and get hands-on experience. For more information, visit http://www.radio-astronomy.org/meetings.

What is Radio Astronomy?

Radio Astronomy is just what the name implies…. Astronomy observed at radio wavelengths instead of optical. But why do radio astronomy? Radio astronomy has expanded the knowledge of the universe about as much since its discovery in 1932 as optical has since humans first looked up at the sky. (The sky in the different frequencies or colors of radio are as different and varied as all of the flowers on Earth. Each frequency has its own information about what is happening in the universe.) This knowledge has been gained by both professional astronomers as well as amateurs, with amateurs contributing to this day.

Do I need a big dish and expensive equipment?

No. Complete beginner projects are available at the SARA store at very reasonable prices. You can monitor the Sun's effects upon our planet with SuperSID. This information is gathered for Stanford for research into our ionosphere and radio signal propagation. Another project is the detection the hydrogen line just like Dr. Ewen had done in 1951 for a fraction of the cost using the Scope in a Box kit.

That said, radio astronomy is like optical astronomy in that you can spend as much as you want to. Many amateurs push the lower boundaries of cost by using very low-cost receivers and low-noise low-cost amplifiers that were not available even a few years ago. (See the Scope in a Box kit in the store for examples of both.)

Is everything 'plug and play' and boring?

The kits mentioned above are a starting point which are mostly plug-and-play… that gets you started. After you have mastered the basics, where you go from there depends upon your interests. Monitoring pulsars is done by amateurs. (One even noticed a pulsar glitch before the professionals!) These amateurs are pushing the boundaries of what can be done. Papers are being published and discussions had about pulsar detection as well detection of a MASER with a 50-inch dish. Techniques on new detection methods are posted in the SARA forum and elsewhere. You are free to build your own equipment to receive the signals as well as software to collect and analyze the data.

What is SETI?

SETI is the Search for Extra-Terrestrial Intelligence. Some amateurs scan the sky and search for signals that might be from aliens. To date no one has received a definitive alien signal (professional or amateur), but the search continues. The search has resulted not just in better receiving equipment but also wide and lively discussions about how aliens might communicate and how they might be trying to contact us. Some of these techniques have interesting ideas for our own communication techniques here on Earth!

What should I do to get started?

You should start with reading our Introduction to Radio Astronomy and joining our online SARA Forum. Look at the SARA store to get a project to get your feet wet without much expense and minimal risk. We will work with you so you can succeed.

Administrative

Officers, directors, and additional SARA contacts

The Society of Amateur Radio Astronomers is an all-volunteer organization. The best way to reach people on this page is by email with SARA in the subject line SARA Officers.

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Vice President: Marcus Fisher, https://www.radio-astronomy.org/contact/Vicepresident
Secretary: Brian O'Rourke, https://www.radio-astronomy.org/contact/Secretary
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Founder Emeritus and Director: Jeffrey M. Lichtman, KI4GIY, jeff@radioastronomysupplies.com

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Resources

Great Projects to Get Started in Radio Astronomy

Radio Observing Program

The Astronomical League (AL) is starting a radio astronomy observing program. If you observe one category, you get a Bronze certificate. Silver pin is two categories with one being personally built. Gold pin level is at least four categories. (Silver and Gold level require AL membership which many clubs have membership. For the bronze level, you need not be a member of AL.)

Categories include.

1) SID
2) Sun (aka IBT)
3) Jupiter (aka Radio Jove)
4) Meteor back-scatter
5) Galactic radio sources

This program is a collaboration between NRAO and AL. Steve Boerner is the Lead Coordinator and a SARA member.

For more information:
Steve Boerner
2017 Lake Clay Drive
Chesterfield, MO 63017
Email: sboerner@charter.net
Phone: 636-537-2495
http://www.astroleague.org/programs/radio-astronomy-observing-program

Radio Jove

The Radio Jove Project monitors the storms of Jupiter, solar activity and the galactic background. The radio telescope can be purchased as a kit, or you can order it assembled. They have a terrific user group you can join. http://radiojove.gsfc.nasa.gov/

INSPIRE Program

The INSPIRE program uses build-it-yourself radio telescope kits to measure and record VLF emissions such as tweeks, whistlers, sferics, and chorus along with man-made emissions. This is a very portable unit that can be easily transported to remote sites for observations.
http://theinspireproject.org/default.asp?contentID=27

SARA/Stanford SuperSID

Stanford Solar Center and the Society of Amateur Radio Astronomers have teamed up to produce and distribute the SuperSID (Sudden Ionospheric Disturbance) monitor. The monitor utilizes a simple pre-amp to magnify the VLF radio signals which are then fed into a high-definition sound card. This design allows the user to monitor and record multiple frequencies simultaneously. The unit uses a compact 1-meter loop antenna that can be used indoors or outside. This is an ideal project for the radio astronomer that has limited space. To request a unit, send an e-mail to supersid@radio-astronomy.org

Radio Astronomy Online Resources

SARA YouTube Videos: https://www.youtube.com/@radio-astronomy	Pisgah Astronomical Research Institute: www.pari.edu
AJ4CO Observatory – Radio Astronomy Website: http://www.aj4co.org/	A New Radio Telescope for Mexico - ORION 2021 01 20. Dr. Stan Kurtz https://www.youtube.com/watch?v=Q9aBWr1aBVc
Radio Astronomy calculators https://www.aj4co.org/Calculators/Calculators.html	National Radio Astronomy Observatory http://www.nrao.edu
Introduction to Amateur Radio Astronomy (presentation) http://www.aj4co.org/Publications/Intro%20to%20Amateur%20Radio%20Astronomy,%20Typinski%20(AAC,%202016)%20v2.pdf	Exotic Ions and Molecules in Interstellar Space -- ORION 2020 10 21. Dr. Bob Compton https://www.youtube.com/watch?v=r6cKhp23SUo&t=5s
RF Associates Richard Flagg, rf@hawaii.rr.com 1721-1 Young Street, Honolulu, HI 96826	The Radio JOVE Project & NASA Citizen Science – ORION 2020.6.17. Dr. Chuck Higgins https://www.youtube.com/watch?v=s6eWAxJywp8&t=5s
RFSpace, Inc. http://www.rfspace.com	UK Radio Astronomy Association: UK Radio Astronomy Association (UKRAA) - Home
CALLISTO Receiver & e-CALLISTO http://www.reeve.com/Solar/e-CALLISTO/e-callisto.htm	CALLISTO software and data archive: www.e-callisto.org
Deep Space Exploration Society http://DSES.science	Radio Jove Spectrograph Users Group http://www.radiojove.net/SUG/
Deep Space Object Astrophotography Part 1 -- ORION 2021 02 17. George Sradnov https://www.youtube.com/watch?v=Pm_Rs17KlyQ	Radio Sky Publishing http://radiosky.com
European Radio Astronomy Club http://www.eracnet.org	The Arecibo Radio Telescope; It's History, Collapse, and Future - ORION 2020.12.16. Dr. Stan Kurtz, Dr. David Fields https://www.youtube.com/watch?v=rBZlPOLNX9E
British Astronomical Association – Radio Astronomy Group http://www.britastro.org/baa/	Shirleys Bay Radio Astronomy Consortium marcus@propulsionpolymers.com
Forum and Discussion Group http://groups.google.com/group/sara-list	SARA Twitter feed https://twitter.com/RadioAstronomy1
GNU Radio https://www.gnuradio.org/	SARA Web Site http://radio-astronomy.org
SETI League http://www.setileague.org	Simple Aurora Monitor: Magnetometer http://www.reeve.com/SAMDescription.htm
NRAO Essential Radio Astronomy Course http://www.cv.nrao.edu/course/astr534/ERA.shtml	Stanford Solar Center http://solar-center.stanford.edu/SID/
NASA Radio JOVE Project http://radiojove.gsfc.nasa.gov Archive: http://radiojove.net/archive.html https://groups.io/g/radio-jove	https://www.csiro.au/ There's a wealth of info on this site of the Australian National Science Agency. It's much more than just radio astronomy. Looking under "Research" opens a real family tree of interesting pages of things they are involved with.
Green Bank Observatory https://greenbankobservatory.org/ .	

Found an interesting Grote Reber link: https://www.utas.edu.au/groterebermuseum Their gallery is interesting, but sure wish they had some captions to indicate who and what some of it is about. I can guess, knowing some of Grote's stories, but others might need more info. Several pictures show the University of Tasmania 26m dish that was once one of the NASA worldwide Satellite Tracking and Data Network (STDN) dishes like the ones at the Pisgah Astronomical Research Institute (www.pari.edu). PARI's dishes were the first qualification units for that network.

For Sale, Trade and Wanted

At the SARA online store: radio-astronomy.org/store.

New on-demand store for SARA SWAG! https://saragifts.org/

Scope in a Box

radio-astronomy.org/store.

Kit of parts and software to build a working Radio Telescope to detect Hydrogen Line emissions. Available to USA addresses only at this time.

SuperSID Complete Kit

radio-astronomy.org/store.

SARA Publication, Journals and Conference Proceedings (various prices)

radio-astronomy.org/store.

SARA Journal Online Download

radio-astronomy.org/store.

The Journal archive covers the society journal "Radio Astronomy" from the founding of the organization in 1981 through the present. Articles cover a wide range of topics including cosmic radiation, pulsars, quasars, meteor detection, solar observing, Jupiter, Radio Jove, gamma ray bursts, the Itty Bitty Telescope (IBT), dark matter, black holes, the Jansky antenna, methanol masers, mapping at 408 MHz and more.

New! **SARA On-Demand Store: https://saragifts.org**

These are the current items – more to come in the future!

(Note: No returns or refunds possible because of the on-demand production approach)








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about my
antennas


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CONFERENCE

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SARA Brochure

Membership Information

Annual SARA dues Individual $20, Classroom $20, Student $5 (US funds) anywhere in the world. Membership includes a subscription to Radio Astronomy, the bimonthly Journal of The Society of Amateur Radio Astronomers, delivered electronically (via a secure web link, emailed to you as each new issue is posted). We regret that printing and postage costs prevent SARA from providing hardcopy subscriptions to our Journal.

We would appreciate the following information included with your check or money order, made payable to SARA:

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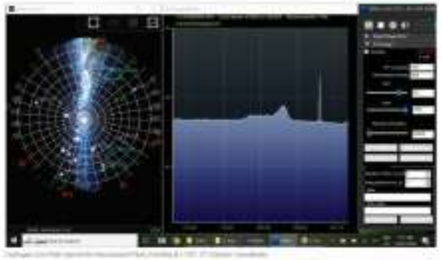
Please include a note of your interests. Send your application for membership, along with your remittance, to our Treasurer.

For further information, see our website at:
http://radio-astronomy.org/membership

How to get started?

SARA has a made a kit of software and parts to detect the Hydrogen line signal from space. This is an excellent method to get started in radio astronomy. It teaches the principles of antenna design, signal detection, and signal processing. Read more about this and other projects on our web site.



Society of Amateur Radio Astronomers, Inc.

Founded 1981

Membership supported, nonprofit [501(c) (3)]
Educational and Radio Astronomy Organization

Knowledge through Common Research, Education and Mentoring

SARA members have been privileged to use this forty foot diameter drift-scan hydrogen line radio telescope every year at their annual meeting in Green Bank.

http://radio-astronomy.org

Why Radio Astronomy?

Because about sixty five percent of our current knowledge of the universe has stemmed from radio astronomy alone. The discovery of quasars, pulsars, black holes, the 3K background from the "Big Bang" and the discovery of biochemical hydrogen/carbon molecules are all the result of professional radio astronomy.

The Society of Amateur Radio Astronomers

SARA was founded in 1981, with the purpose of educating those interested in pursuing amateur radio astronomy.

The society is open to all, wishing to participate with others, worldwide.

SARA members have many interests, some are as follows:

SARA Areas of Study and Research:

- Solar Radio Astronomy
- Galactic Radio Astronomy
- Meteor Detection
- Jupiter
- SETI
- Gamma Ray/High Energy Pulse
- Detection
- Antennas
- Design of Hardware / Software

The members of the society offer a friendly mentor atmosphere. All questions and inquiries are answered in a constructive manner. No question is silly!

SARA offers its members an electronic bi-monthly journal entitled Radio Astronomy. Within the journal, members report on their research and observations. In addition, members receive updates on the professional radio astronomy community and, society news.

Once a year SARA meets for a three-day conference at the Green Bank Observatory in Green Bank West Va.

There is also a spring conference held at various cities in the Western USA. Previous meeting have been at the VLA in Socorro, NM and at Stanford University.

How do I get started?

Just as a long journey begins with the first step, the project you elect must start with a clear idea of your objectives. Do you wish to study the sun? Jupiter? Make meteor counts? Do you wish to engage in imaging radio astronomy? What you decide will not only determine the type of equipment you will need, but also the local radio spectrum.

How do amateurs do radio astronomy?

Radio astronomy by amateurs is conducted using antennas of various shapes and sizes, from smaller parabolic dishes to simple wire antennas. These antennas are connected to receivers and most of these receivers are software defined radios these days. Data from the receivers are collected by computers, and the received signals will be displayed as charts, graphs or maybe even sky maps. As diverse as the observed objects, so is are the instruments and tools used. SARA members will always be supportive to find good solutions for what one wishes to observe.

Is amateur radio astronomy instrumentation expensive?

Technical information freely circulated in our monthly journal helps amateurs to obtain good low noise equipment from off the shelf assemblies, or to build their own units. The actual cash investment in radio astronomy equipment need not exceed that of any other hobby.

What are amateurs actually looking for in the received data?

The aim of the radio amateur is to find something new and unusual. Just as an amateur optical observer hopes to notice a supernova or a new comet, so does an amateur radio observer hope to notice a new radio source, or one whose radiation has changed appreciably.

The Reber Telescope at NRAO. Constructed by Grote Reber in 1937 in his back yard in Wheaton, Illinois

SARA Members discussing the IBT (Itty Bitty Telescope)