



Andy's Ham Radio Linux®



Andy Stewart
KB1OIQ
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Presented to
Hampden County Radio Association
Agawam, MA USA

Biographical Info

Tech: 1/07, General 1/08, Extra 1/09

President: PART of Westford, MA (9/09 - 8/19)

ARRL EMA: Assistant Section Manager (2016), ACC (2017)

Founder: Worcester Linux Users' Group (1997)

Founder and Acting President:

Chelmsford Linux Meetup Group (2006-2020)

Linux Instructor:

Chelmsford Community Education (2004 - 2011)

Linux user since 1997

Computer Engineer – digital logic verification

Most Recent Interests

- Antique radios
 - Electrical restoration, especially 1920s/1930s radios
- Homebrewing
 - Many kits
 - Built a 1920s style regenerative receiver with plugable coils for different frequency ranges
- FT-8, GridTracker
- Fox hunting, M17 Project
- Of course: Andy's Ham Radio Linux

Goals

- Promote Linux
- Give back to ham radio and Linux communities
- Build on top of an existing Linux distribution
- Create a software collection containing as much ham radio software as possible – nothing proprietary
- Goal: Everything just works!
- Focus on the radio hobby!
- The idea of "Andy's Ham Radio Linux" began this way

Andy's Ham Radio Linux

- V25a is Xubuntu 22.04.* remastered
- Download the ISO file from SourceForge
 - Search for: Andy's Ham Radio Linux
 - Software is GPL or similarly free license
- Ways to get started:
 - Download the ISO first, then.....
 - Boot it in Virtualbox, or.....
 - Create a bootable USB thumb drive
- Install to the hard drive once you decide you like it
- ---> Be sure to read the GETTING_STARTED guide(!!!) <---

Target Computer

- Any x86_64 computer 10 years old or less
- Minimum: 4 GB of memory
- Disk Space: 20 GB after installation
- Processor speed is not an issue for most ham radio programs, Exception: SDR
- Networking: wired or wireless
- USB required for installation

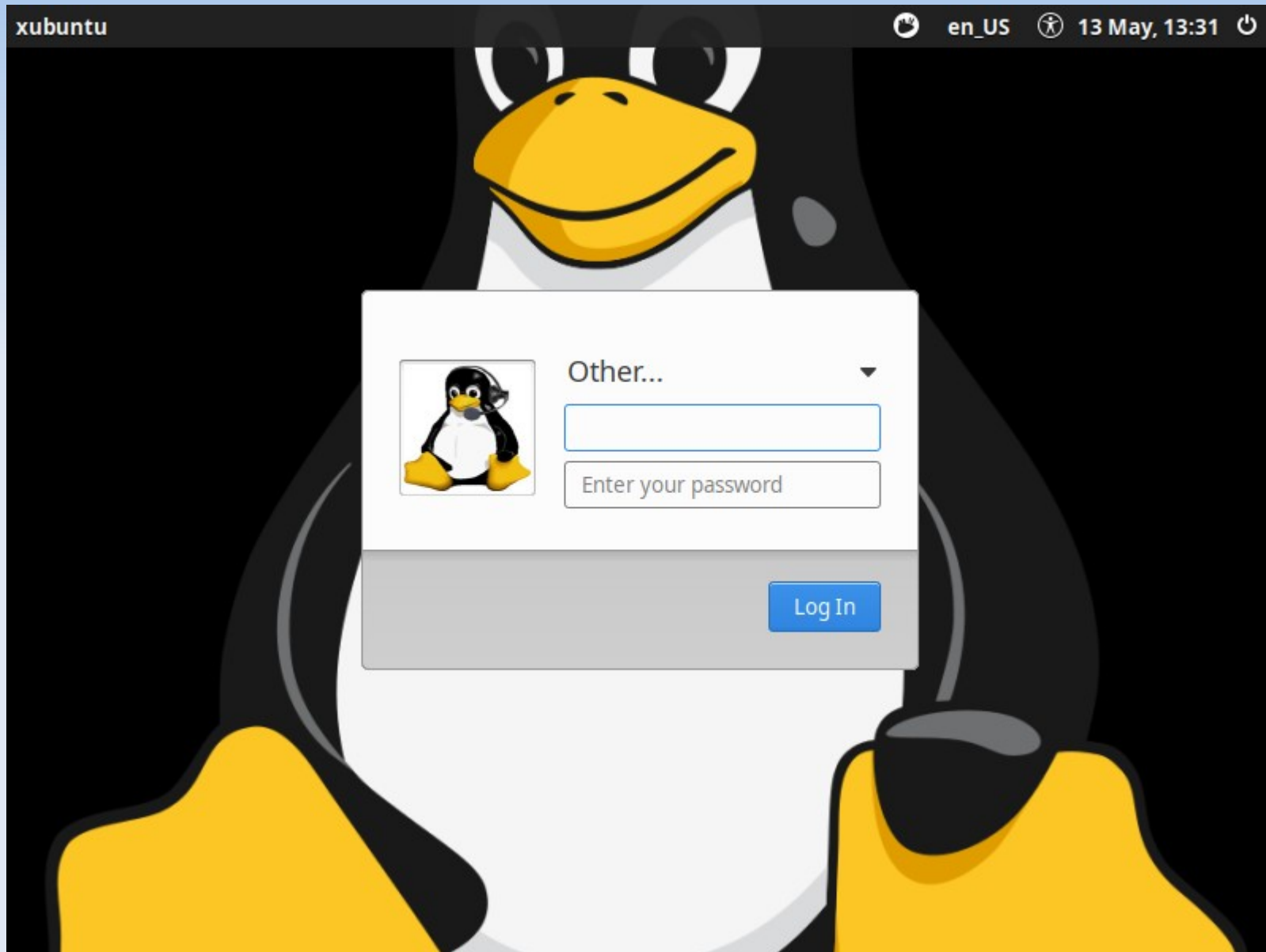
Initial Boot before Installation



GETTING_STARTED

- PLEASE - PLEASE - PLEASE:
 - Be sure to download and read the GETTING_STARTED document BEFORE you begin the installation.
 - Follow the helpful hints!
- If you have problems logging in, you likely didn't read or properly follow the instructions in the document.

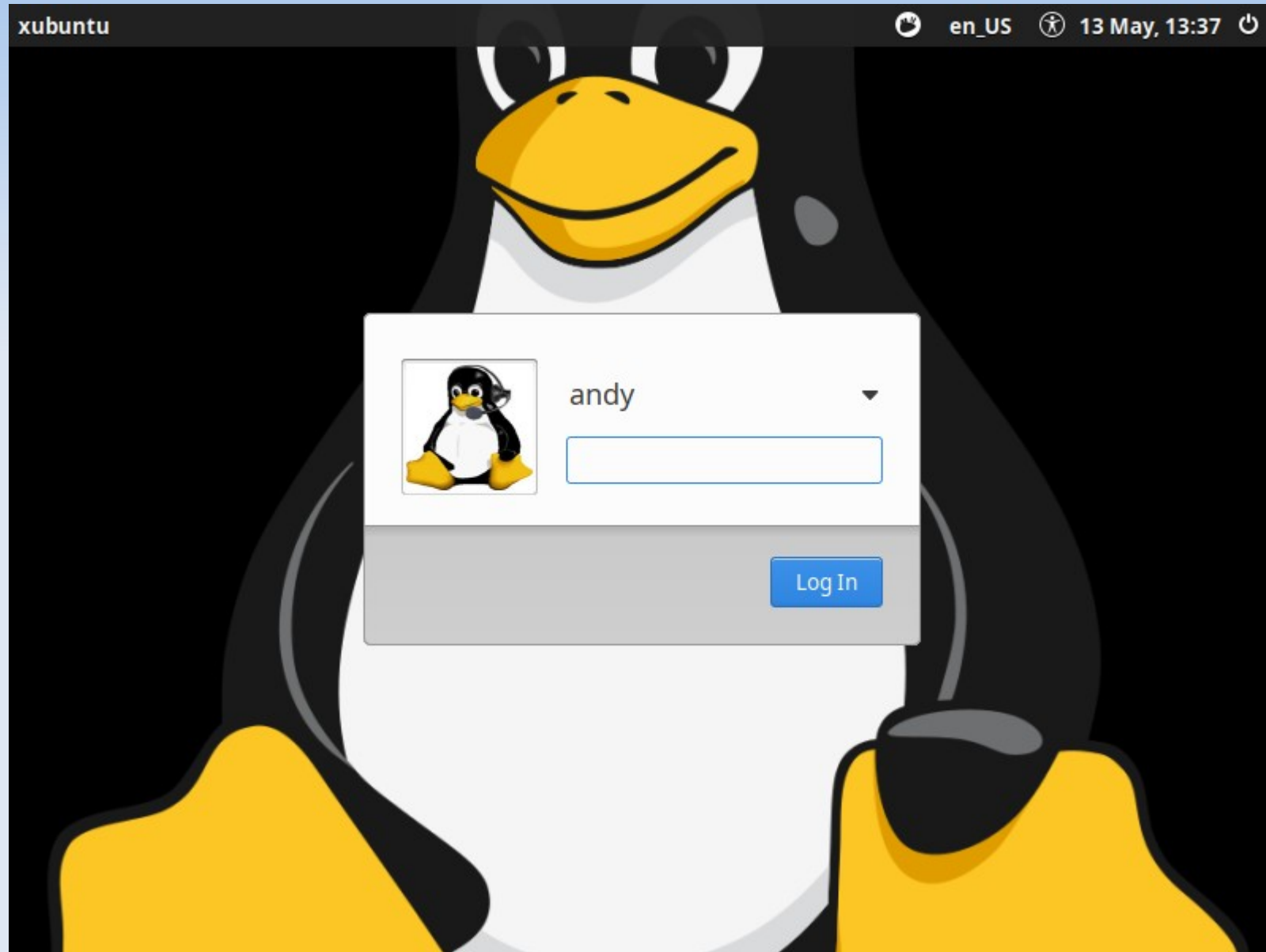
Initial Login Screen After Installation



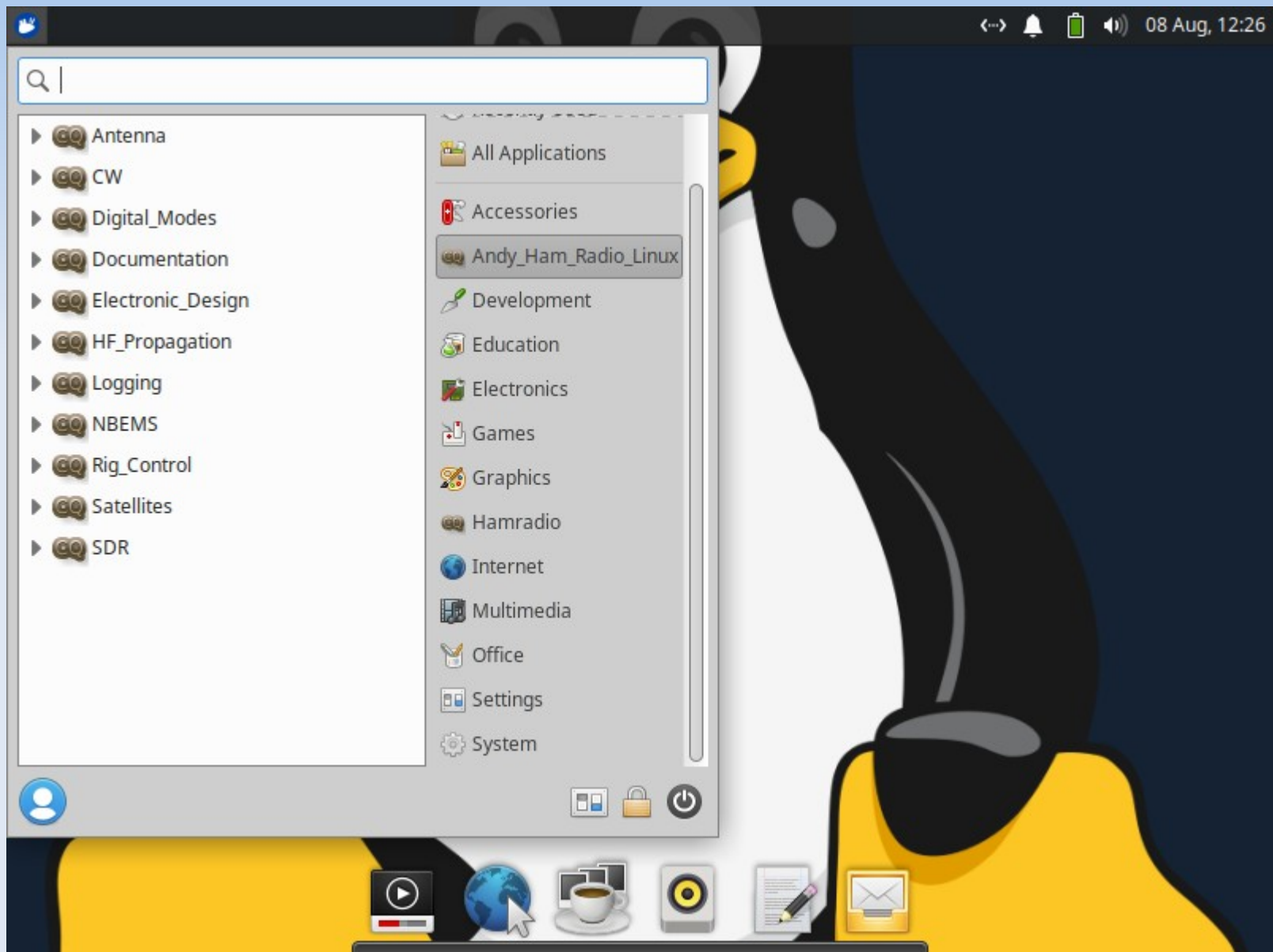
fix_account

- Login as user: xubuntu
- Hit enter
- Hit enter again or click "Log In" (no password)
- Open a terminal window
- `sudo /root/bin/fix_account`
- Log out, log in using updated account
- Done! That was easy!

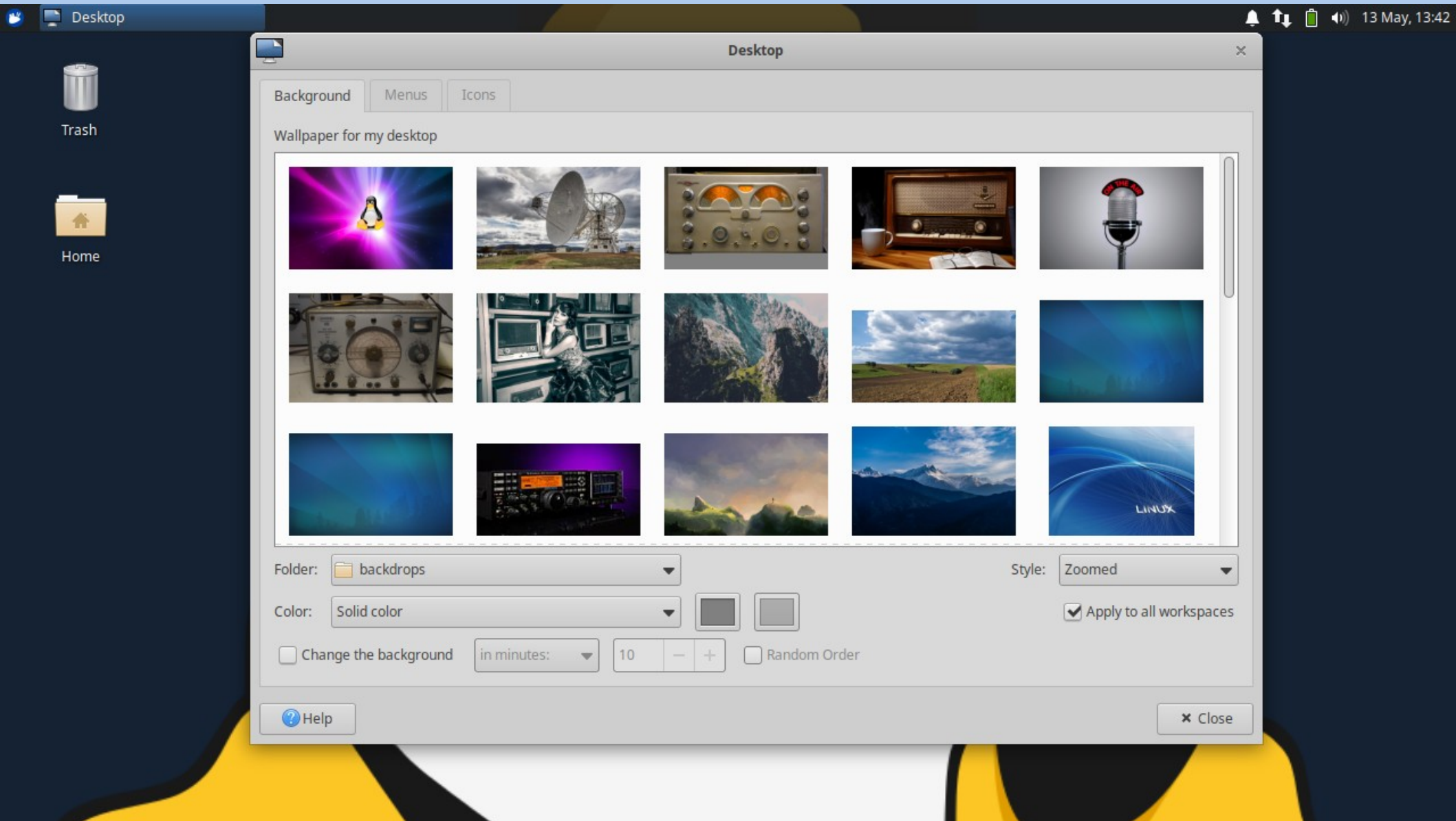
Initial Login Screen after fix_account



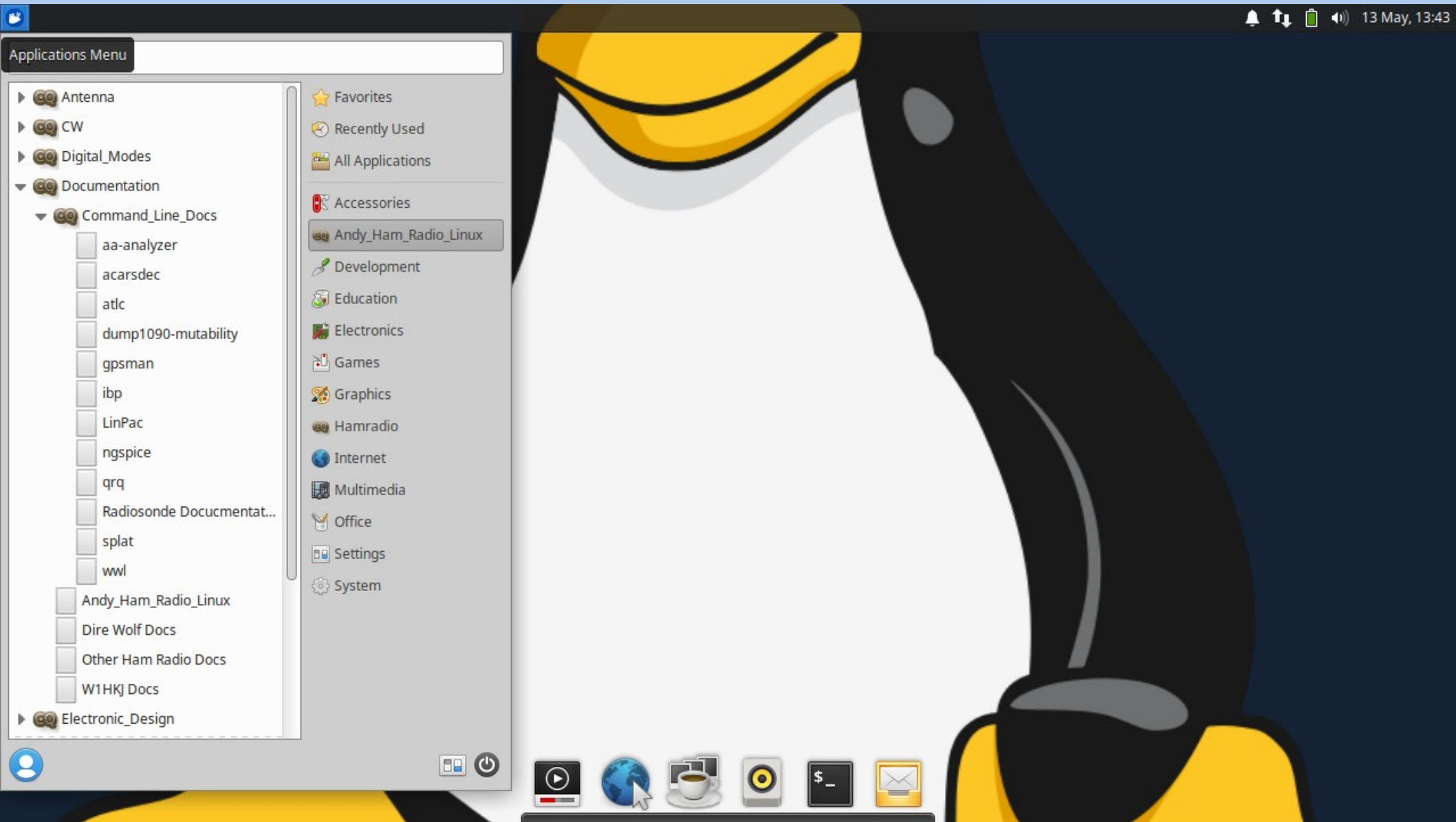
Initial Desktop



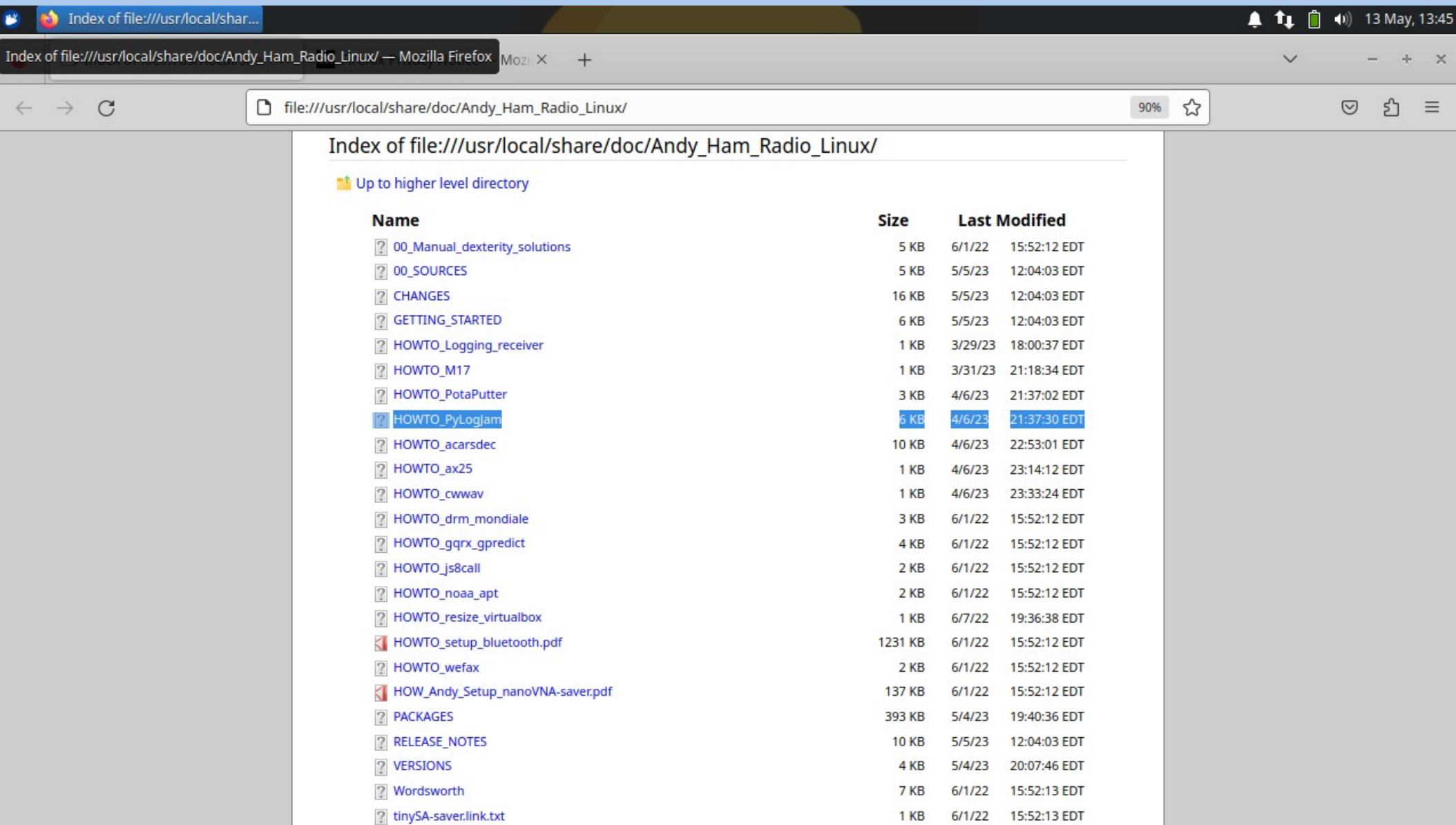
Desktop Backgrounds



Documentation



AHRL Documentation

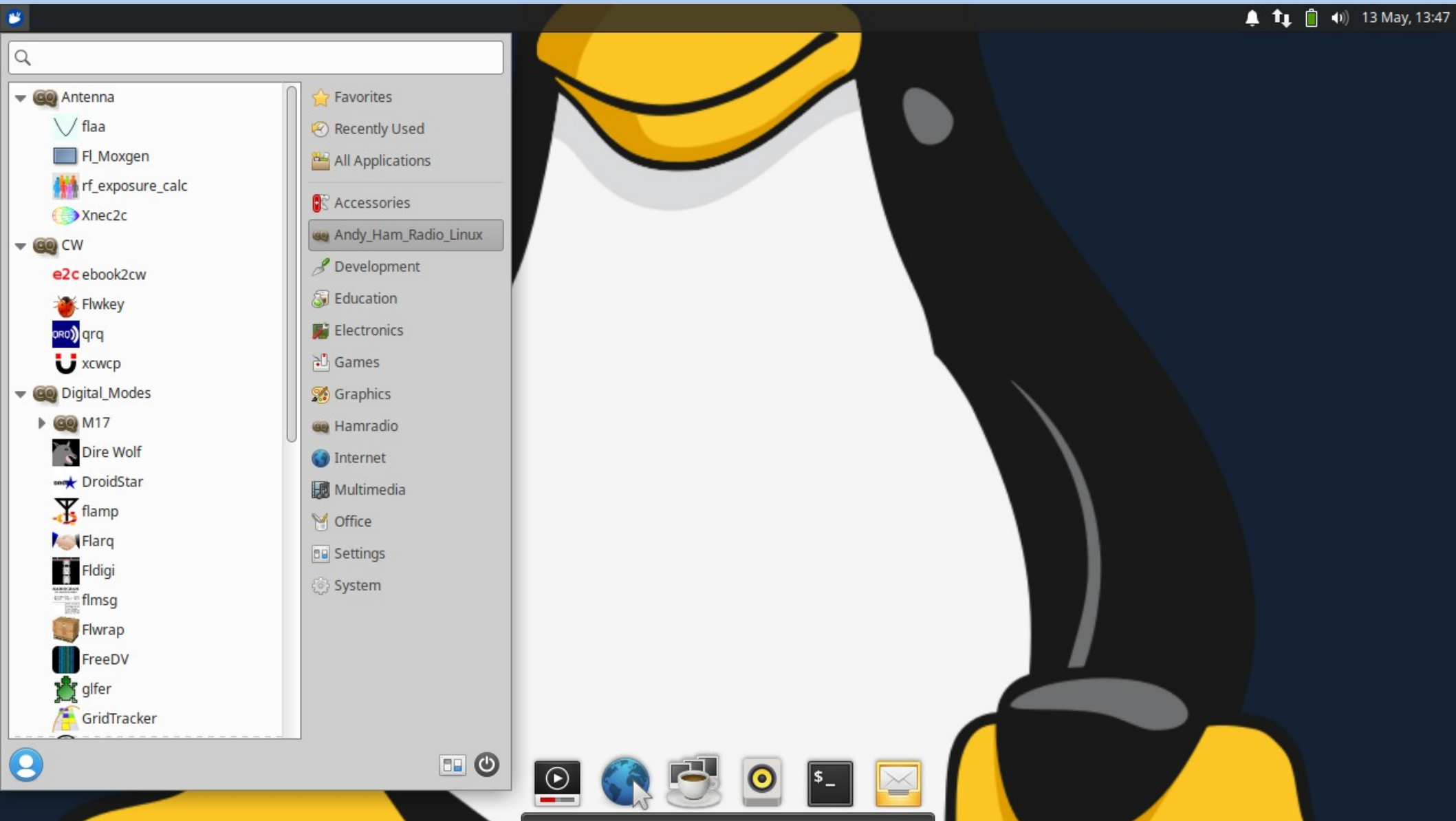


Index of file:///usr/local/share/doc/Andy_Ham_Radio_Linux/

Up to higher level directory

Name	Size	Last Modified
00_Manual_dexterity_solutions	5 KB	6/1/22 15:52:12 EDT
00_SOURCES	5 KB	5/5/23 12:04:03 EDT
CHANGES	16 KB	5/5/23 12:04:03 EDT
GETTING_STARTED	6 KB	5/5/23 12:04:03 EDT
HOWTO_Logging_receiver	1 KB	3/29/23 18:00:37 EDT
HOWTO_M17	1 KB	3/31/23 21:18:34 EDT
HOWTO_PotaPutter	3 KB	4/6/23 21:37:02 EDT
HOWTO_PyLogJam	6 KB	4/6/23 21:37:30 EDT
HOWTO_acarsdec	10 KB	4/6/23 22:53:01 EDT
HOWTO_ax25	1 KB	4/6/23 23:14:12 EDT
HOWTO_cwwav	1 KB	4/6/23 23:33:24 EDT
HOWTO_drm_mondiale	3 KB	6/1/22 15:52:12 EDT
HOWTO_gqrx_gpredict	4 KB	6/1/22 15:52:12 EDT
HOWTO_js8call	2 KB	6/1/22 15:52:12 EDT
HOWTO_noaa_apt	2 KB	6/1/22 15:52:12 EDT
HOWTO_resize_virtualbox	1 KB	6/7/22 19:36:38 EDT
HOWTO_setup_bluetooth.pdf	1231 KB	6/1/22 15:52:12 EDT
HOWTO_wefax	2 KB	6/1/22 15:52:12 EDT
HOW_Andy_Setup_nanoVNA-saver.pdf	137 KB	6/1/22 15:52:12 EDT
PACKAGES	393 KB	5/4/23 19:40:36 EDT
RELEASE_NOTES	10 KB	5/5/23 12:04:03 EDT
VERSIONS	4 KB	5/4/23 20:07:46 EDT
Wordsworth	7 KB	6/1/22 15:52:13 EDT
tinySA-saver.link.txt	1 KB	6/1/22 15:52:13 EDT

Menu #1



Moxon Rectangle - fl_moxgen

The screenshot displays the `fl_moxgen` application window. The interface includes a menu bar with `File` and `Help`. The main input area contains:

- Frequency (MHz):
- Wire Size:
- Unit: **AWG** (dropdown menu)
- Calculate** button

The central diagram shows a Moxon Rectangle antenna layout with the following components and dimensions:

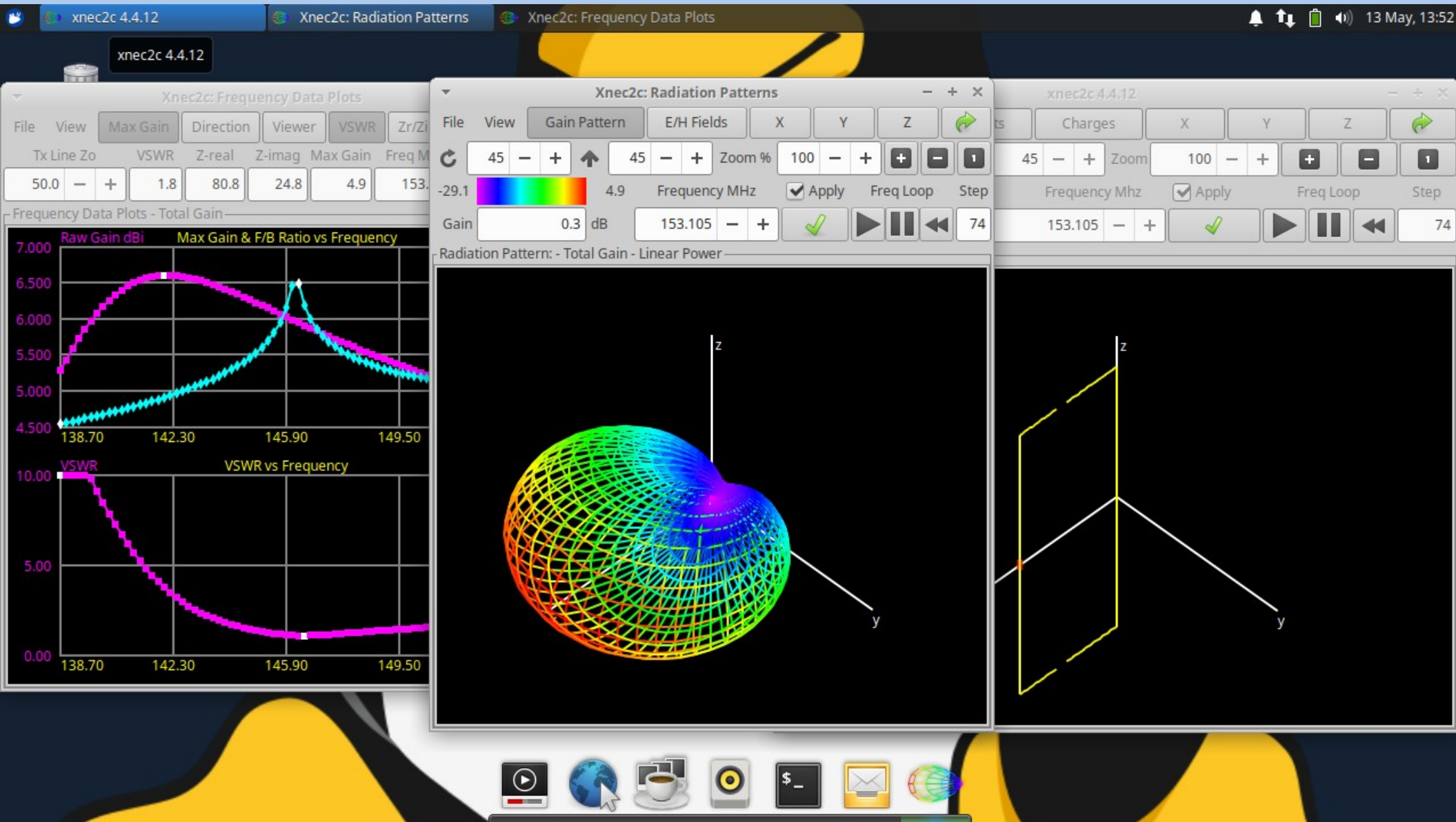
- A**: Total length of the antenna.
- B**: Distance from the center of the driven element to the center of the reflector.
- C**: Length of the driven element.
- D**: Length of the reflector.
- E**: Total length of the antenna (A).
- Feedpoint**: Located at the center of the driven element.
- Driven Element**: The top horizontal wire.
- Reflector**: The bottom horizontal wire.

On the right side, the calculated dimensions are displayed:

Dimension	Value	Unit
A	29.172	in
B	4.048	in
C	1.172	in
D	5.561	in
E	10.781	in

Below the dimensions, the **Result Units** are set to Inches, with other options being Feet, Millimeters, and Meters. A **Quit** button is located at the bottom right of the application window.

Antenna modeling - xnec2c



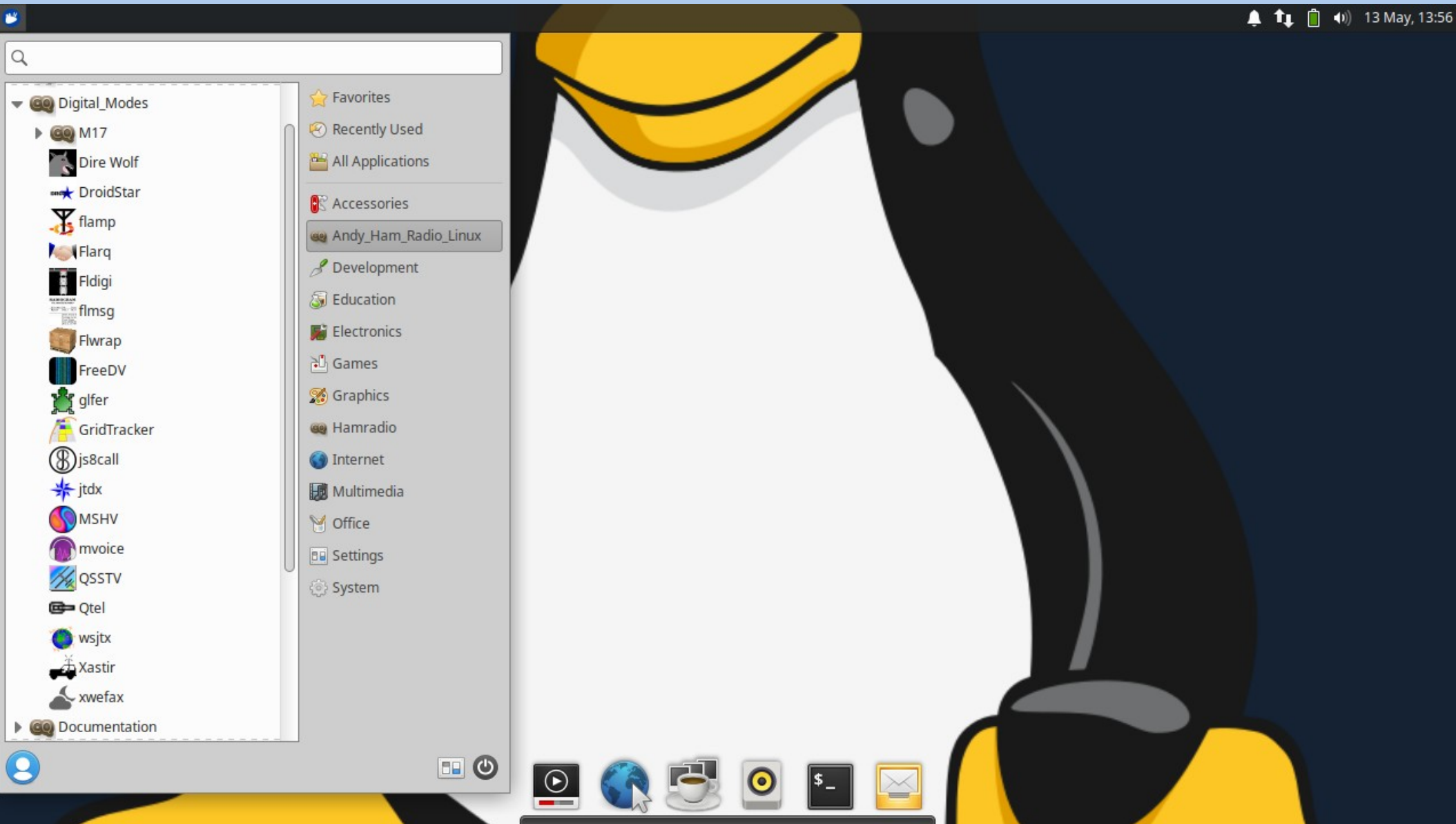
CW and Fox Hunting

The screenshot displays a Linux desktop environment with a yellow and black penguin-themed background. The desktop includes icons for 'Trash' and 'Home'. The taskbar at the bottom contains icons for a media player, a globe, a coffee cup, a hard drive, a terminal, an email client, and a USB drive.

Two windows are open:

- Micro-Fox Config GPL:** A configuration window with a menu bar (File, Help) and several settings:
 - Tone Speed: 50 ms
 - Tones Duration: 15 sec
 - Loop Time: 30 sec
 - Initial Delay: 0 sec
 - Frequency: 146.565 MHz
 - Calibration: 0.000 %
 - Tones:** A list of Morse code patterns: 1, 5, 1, 5, 1, 3, 3, 3, 1, 5, 1, 5, 1, 3, 3, 3, 1, 6, 1, 6, 1, 4, 4, 4, 1, 6, 1, 6, 1, 4, 4, 4, 1, 7, 1, 7, 1, 5, 5, 5, 1, 7, 1, 7, 1, 5, 5, 5, 1, 8, 1, 8, 1, 6, 6, 6, 1, 8, 1, 8, 1, 6, 6, 6
 - Morse Code ID:** Text: MICROFOX, Speed: 20 WPM, Tone: 7, Enable LED
 - Configure:** A dropdown menu set to /dev/ttyUSB0, and buttons for Read Config, Read Version, Write Config, Save, Load, and Quit.
- Xcwcp:** A terminal window with a menu bar (Program, Settings, Help) and a status bar (Output: PulseAudio). The terminal displays the text: TAUAC ZCPWU JNQTA ROTER VAUNJ FOZAG PTGLV KMXCI RLYIG YBUTH NPHIE

Menu #2



Digital Modes - wsjtx

The screenshot displays the WSJT-X v2.5.4 software interface. The main window is titled "WSJT-X v2.5.4 by K1JT, G4WJS, K9AN, and IV3NWV". It features a menu bar with "File", "Configurations", "View", "Mode", "Decode", "Save", "Tools", and "Help".

The interface is divided into several sections:

- Band Activity:** A table showing received signals. The selected mode is 20m. The table has columns for UTC, dB, DT, Freq, and Message. The selected entry is: UTC: 172630, dB: -6, DT: 0.3, Freq: 687, Message: N2DMI N0JZ -16.
- Rx Frequency:** A table showing received signals. The selected mode is 20m. The table has columns for UTC, dB, DT, Freq, and Message. The selected entry is: UTC: 172515, dB: -4, DT: -1.1, Freq: 1415, Message: CQ N8HCS EN63 U.S.A.
- Controls:** Includes buttons for "Log QSO", "Stop", "Monitor", "Erase", "Decode", "Enable Tx", "Halt Tx", and "Tune". There are also checkboxes for "CQ only", "Tx even/1st", and "Hold Tx Freq".
- Frequency and Mode:** The current mode is 20m and the frequency is 14.074 000. The transmit rate is 1423 Hz.
- DX Call and Grid:** The DX Call is EA8J and the DX Grid is IL18. The distance is 3161 mi and the azimuth is 89. The report is -15. There are checkboxes for "Auto Seq" and "Call 1st".
- Generate Std Msgs:** A list of standard messages with "Next" and "Now" buttons. The selected message is "CQ KB1OIQ FN42".
- Wide Graph:** A spectral display showing signal activity over time. The x-axis represents frequency from 500 to 3000 Hz, and the y-axis represents time from 17:24:45 to 17:26:30. A red box highlights a signal at approximately 1400 Hz.

GridTracker

- As of v25a: GridTracker is installed by default
- This is a MOST EXCELLENT program!
- Graphically manage grids:
 - Needed, Contacted but not confirmed, Confirmed
- Talks to wsjtx (and wsjtx talks to xlog)
- Logs sent to LoTW and others

GridTracker

GridTracker 1.22.0503 [Band: 20m Mode: FT8 Layer: Grids - Worked 498 Confirmed 445]

GridTracker
 14.074.000 Hz (20m) FT8
 Mon 08 Aug 2022 17:33:37 UTC
 EA8J IL18 -15
 Canary Is. 3154mi 89°

RECEIVE

Rx Calls 47 QSO 22607
 Rx DXCC 4 QSL 7744
 Clear Live Clear Log

Map View Filters
 Band Auto
 Mode Auto
 Prop Unknown
 Data Logbook & Live

Legend
 QSO QSL
 QSX CQ CQDX
 QRZ QTH WSPR

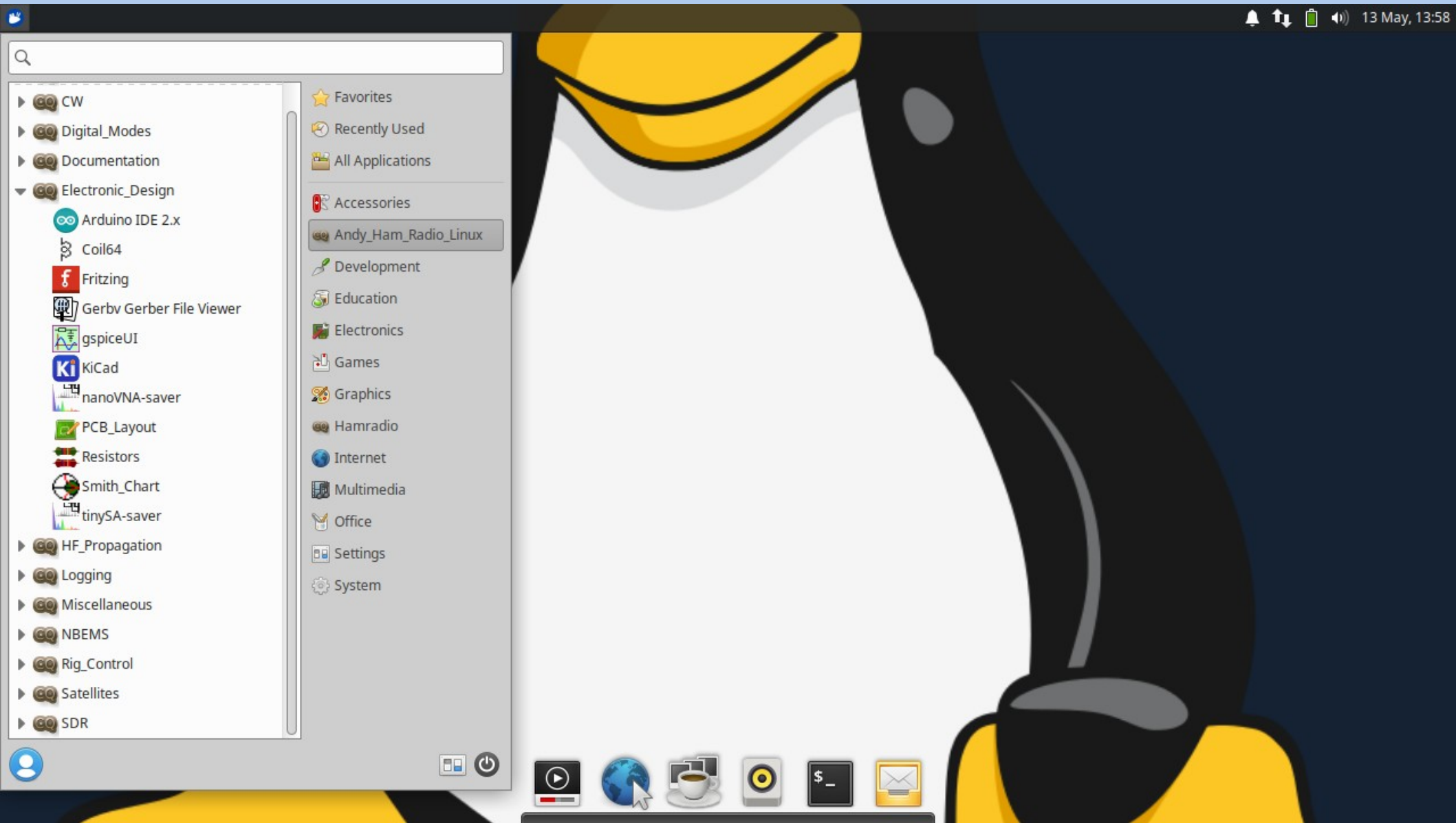
Call Roster: 47 heard • 11 in roster • 3 wanted

RECEIVE Halt Tx Logbook Live Band & Mode Callsigns All Traffic/Only Wanted Hunting New+Unconfirmed More Controls

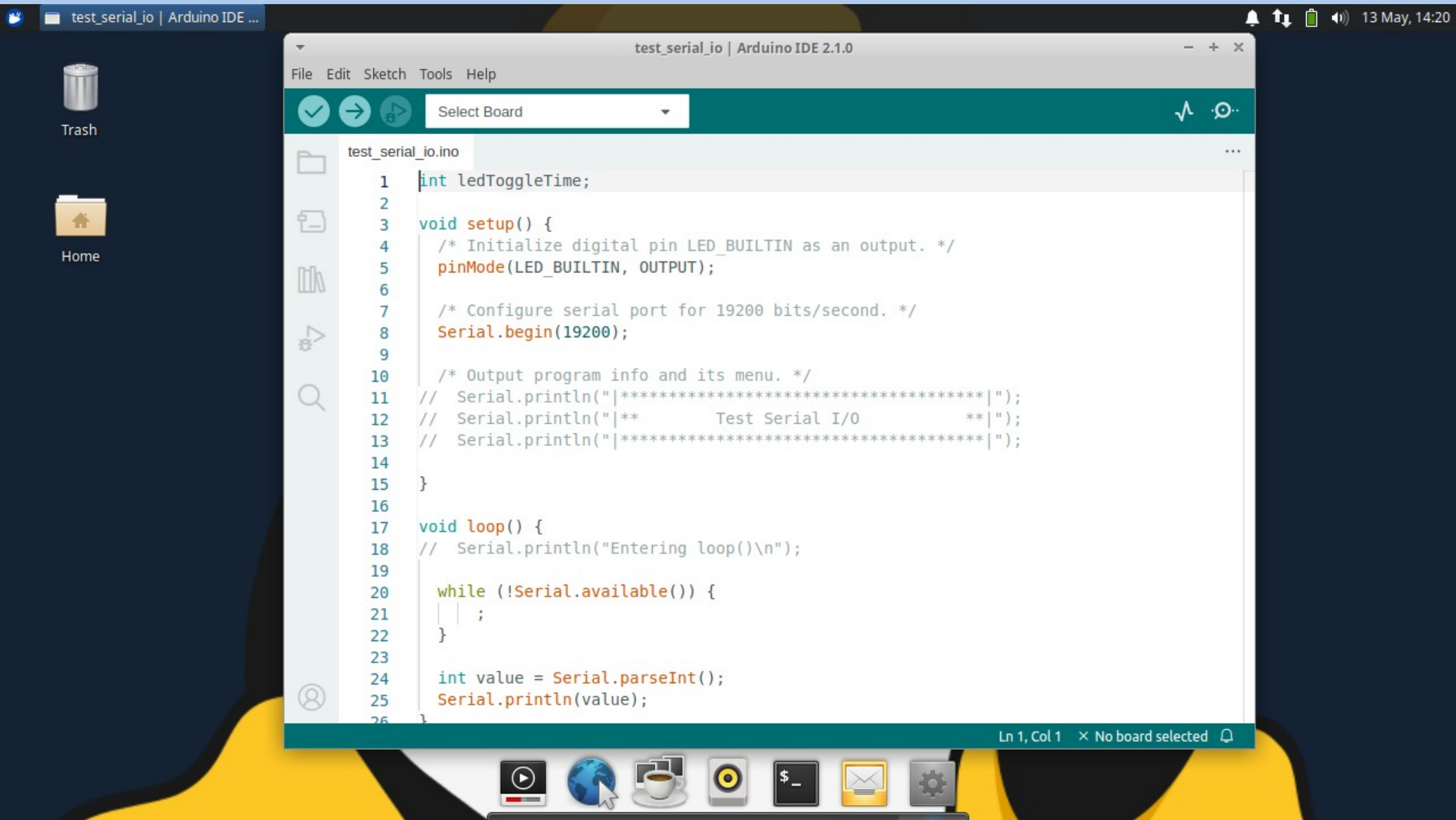
Callsign	Grid	Calling	DXCC	Flag	State	County	Cont	dB	Azim	PX	OAMS	Age
K9FE	EN51	CQ	United States		IL	Dupage	NA	-11	271	K9		0s
KF9UG	EN71	CQ	United States		IN	Allen ?	NA	10	268	KF9		0s
LZ3CB	KN32	CQ	Bulgaria				EU	-12	52	LZ3		15s

20m / FT8
 GridTracker
 v1.22.0503

Menu #3



Electronic Design - arduino



Electronic Design - coil64

The screenshot displays the Coil64 v2.1.26 software interface. On the left, a 3D model of a coil is shown with dimensions: D (former diameter), l (winding length), d (wire diameter), and k (wire diameter with insulation). Below the model is a list of coil forms, with "One layer close-winding coil" selected.

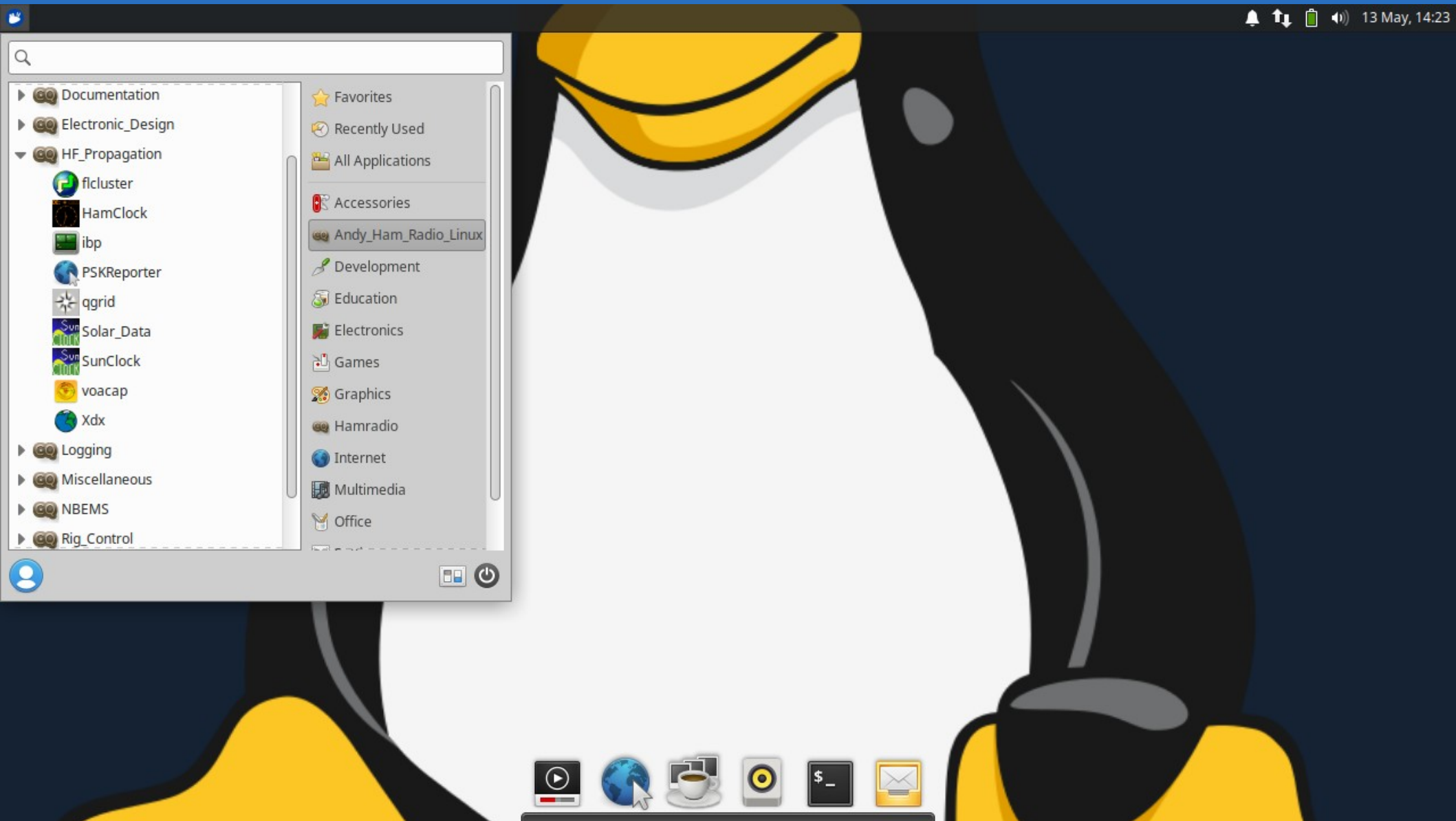
The main window contains the following input fields and options:

- Coil: Inductance, LC circuit
- Inductance L: 50 microH
- Frequency f: 0.6 MHz
- Former diameter D: 37 mm
- Wire diameter d: 3 mm
- Wire diameter with insulation k: 3.27 mm
- Select initial data of the calculation:
 - Former diameter and wire diameter
 - Former diameter and winding length
- Wire material:
 - Copper
 - Silver
 - Aluminum
 - Tin

A "Calculate" button is located at the bottom of the main window.

On the right, a calculation window titled "Coil64 v2.1.26 - One layer close-winding coil" shows the input parameters: Inductance L: 50 microH and Frequency f: 0.6 MHz. It also includes a 3D model of the coil and a toolbar with various icons.

Menu #4



HF Propagation #1

ImageMagick: solar.gif

Solar-Terrestrial Data - <http://www.n0nbh.com>

08 Aug 2022 1838 GMT

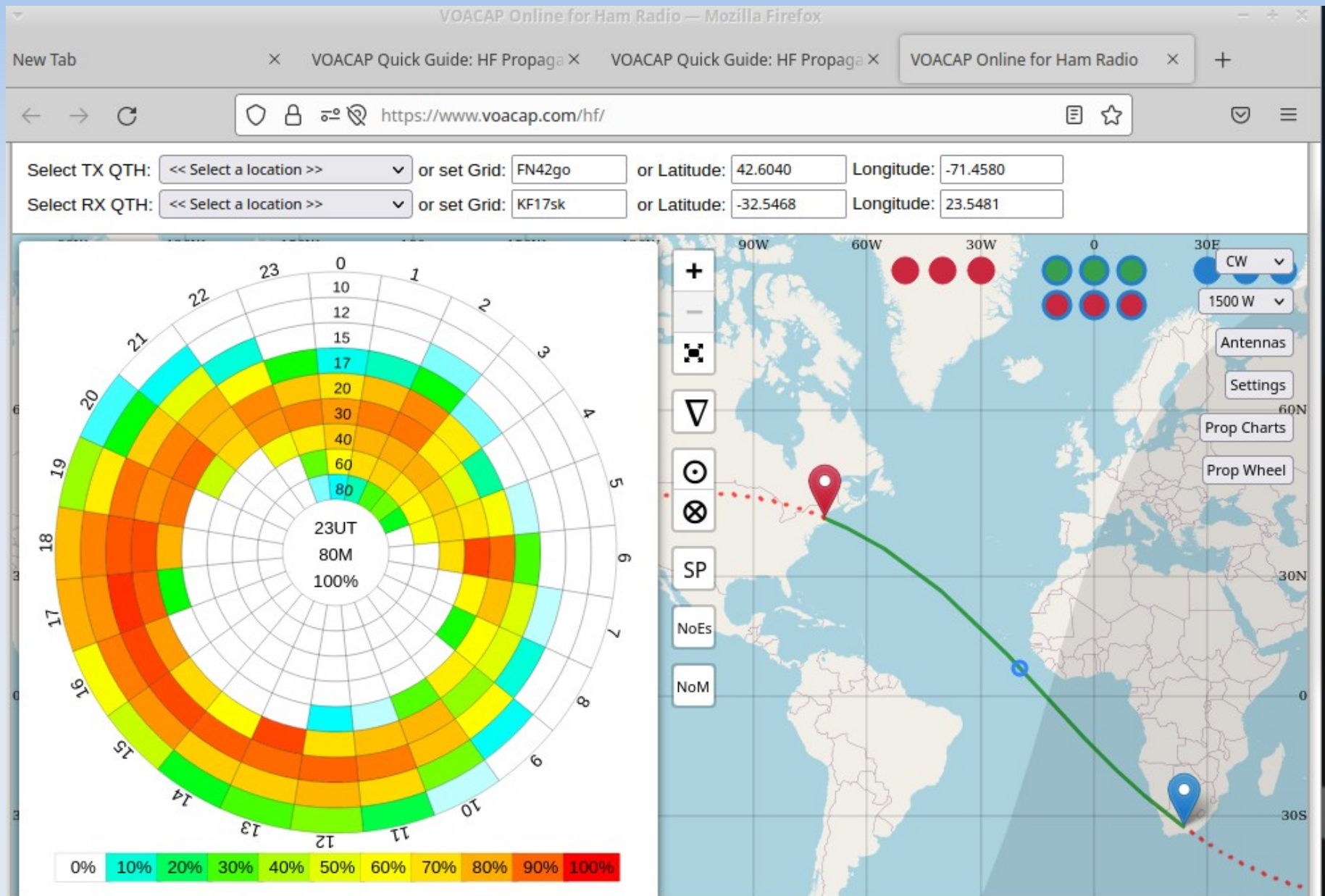
SFI 116	SN 74	VHF Conditions		HF Conditions	
A 24 K 3 / Pintry	X-Ray B4.5	Item	Status	Band	Day Night
304A 129.8 @ SEM	Ptn Flx 16	Aurora	Band Closed	80n-40n	Poor Fair
Elc Flx 976	Aurora 5/n=1.99	6n EsEU	50MHz ES	30n-20n	Good Good
Aur Lat 62.5°	Aur Lat 62.5°	4n EsEU	Band Closed	17n-15n	Fair Fair
Bz -3.3 SW 575.6	MUF	2n EsEU	High MUF	12n-10n	Poor Poor
	MS	2n EsNA	Band Closed	Geomag Field	UNSETTLD
		EME Deg	Poor	Sig Noise Lvl	S2-S3
				MUF US Boulder	18.05
				Solar Flare Prb	20%
				(C) Paul L Herrman 2021	

QGrid 3.2

File Help

Locator	Home	Remote	Compass		
	FN42GO	FN32LL			
Latitude	42	36 15	42	28	45
Longitude	-71	27 30	-73	2	30
Bearing	264	Distance	131		
To Lat/long		To Locator	Clear		

HF Propagation #2



Logging SW: Xlog




Log Edit Options Tools Page Settings Help

Write Update Delete

QSO 691

Date: 16 Aug 2010
UTC: 0023
Call: AB1HD
MHz: 50
Mode: SSB
TX(RST): 59
RX(RST): 59
 QSL out QSL in
Locator: FN42ho
Remarks: Rich, Chelmsford, MA 01824 USA

NR	DATE	UTC	CALL	BAND	MODE	RST	MYRST	QSLOL	QSLIN	LOCATOR
691	16 Aug 2010	0023	AB1HD	50	SSB	59	59			FN42ho
690	16 Aug 2010	0023	WA1KBE	50	SSB	59	59			FN42ho
689	08 Aug 2010	2035	VE3CWU	7	CW	579	229			FN03
688	08 Aug 2010	2000	N2JNZ	7	CW	459	559			FN24
687	08 Aug 2010	1910	KL7GLL	7	CW	459	449			FM18
686	31 Jul 2010	2145	I5ZSS	18	SSB	59	58			JN53ku
685	12 Jul 2010	0016	WA1KBE	50	SSB	59	59			FN42ho
684	11 Jul 2010	2151	WM4X	7	CW	579	579			FM18
683	11 Jul 2010	2140	W8JRA	7	CW	559	559			EN80
682	11 Jul 2010	1627	N8KZH	7	CW	359	559			EN90
681	11 Jul 2010	1305	W1ZX	7	CW	599	419			FN30
680	11 Jul 2010	1240	VA2NB	7	CW	359	579			FN25

Ready.    22 Aug 2010 1330 UTC

CQRLOG

New QSO ... (CQRLOG for Linux), database: Log 001

File View Window Statistics Online log Help

qsodate	time_on	time_off	callsign	freq	mode	rst_s

QSO nr. 1 QTH profile: New country!!

Call: Frequency: Mode: AUTO RST sent: RST rcvd:

Name: QTH: GRID: PWR: QSL_S: QSL_R:

ITU: WAZ: IOTA: State: County: Award:

DXCC ref.: Comment to QSO: QSL VIA:

Offline

Date: Start time: End time:

Comment to callsign:

DXCC statistic

	1.8	3.5	7	10.1	14	18	21	24	28	50	144	430
SSB												
CW												
DIGI												

DXCC info

USA, Massachusetts

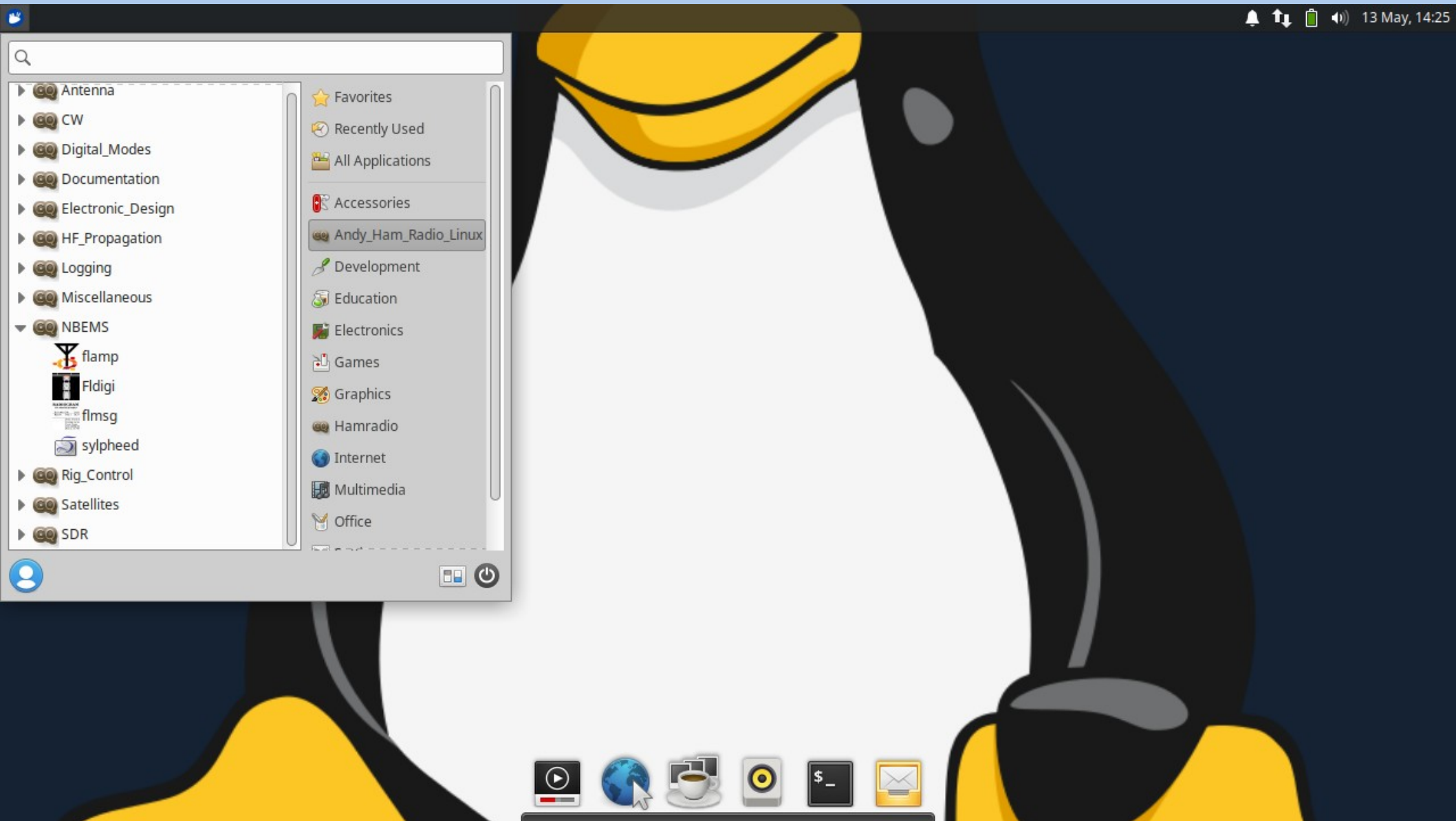
WAZ: 05 Cont: NA
 ITU: 08 DXCC: W
 LAT: 42.2373N LONG: 71.5314W
 DIST.: AZIM:
 10:17:51 23:14:24
 2019-09-05 22:08:41 GE
 Local:

Callbook (HamQTH.com)

Save QSO [enter] Quit program

My grid (to change press CTRL+L) Ref. call (to change press CTRL+R) KB1OIQ Ver. 2.3.0 (001)

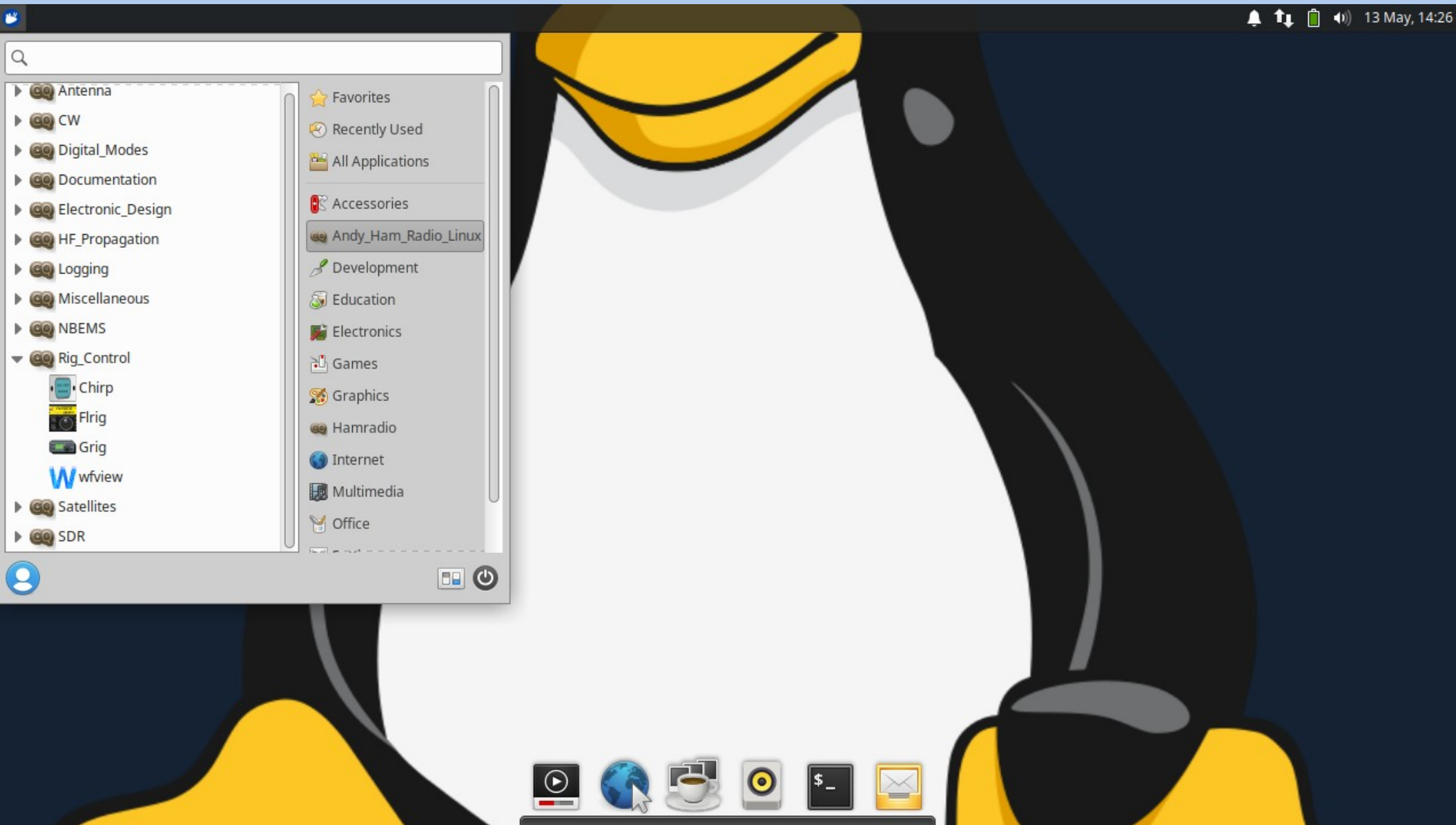
Menu #5



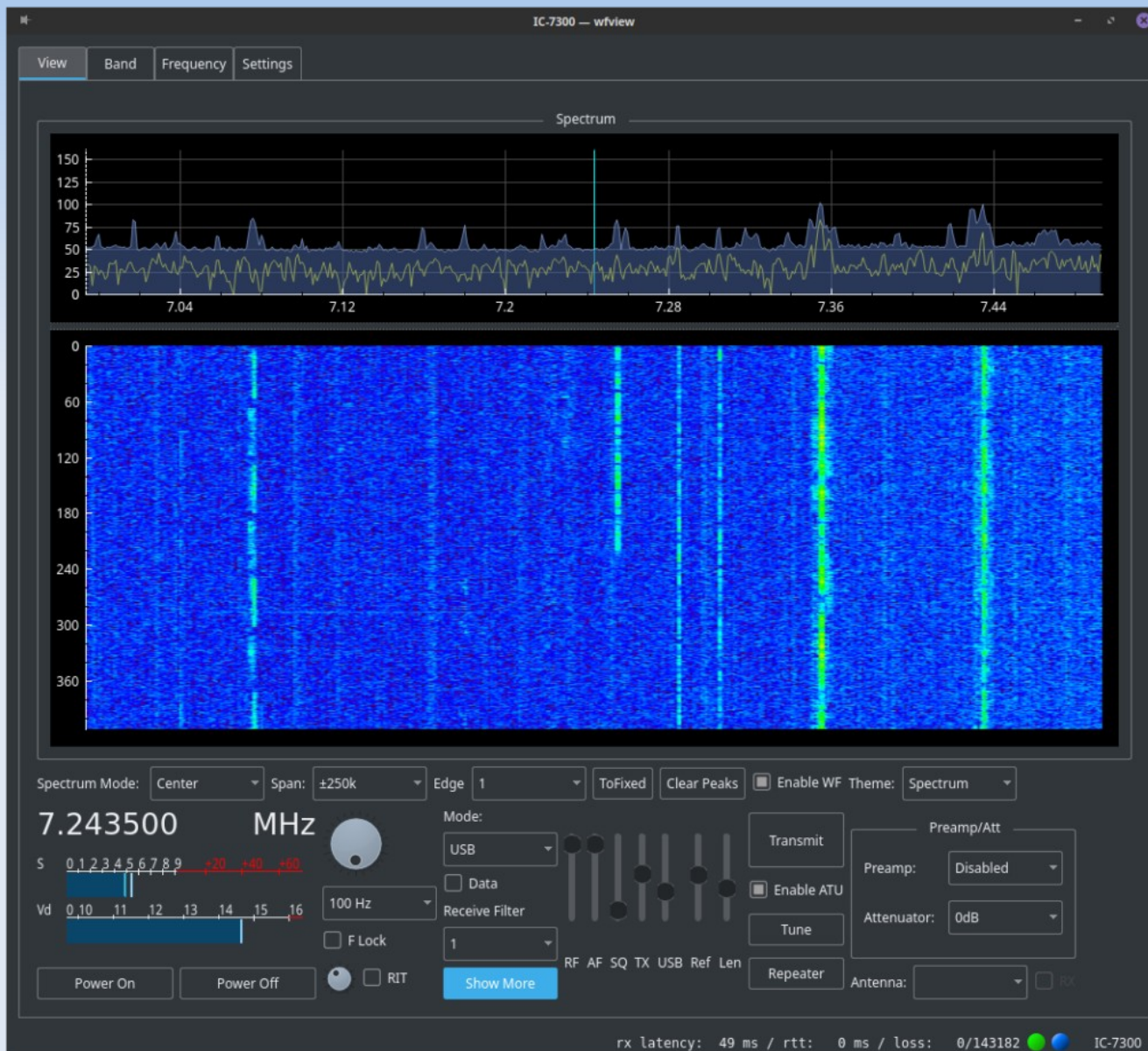
NBEMS

- Narrow Band Emergency Messaging System
- Open Source software suite
- Runs on the 3 major operating systems
- No infrastructure required
- Used by EMCOMM folks
- Ties in with sylpheed email program

Menu #6



Rig Control - wfview



Satellites - FoxTelem

AMSAT Telemetry Analysis T... 13 May, 14:29

Applications Menu
Trash
Home

AMSAT Telemetry Analysis Tool

File Decoder Spacecraft Help

Input Fox-1E

Health WOD VU Rad (1E) VU Rad WOD Measurements

Satellite Mode: Telemetry Payloads Decoded:
Latest Realtime: Epoch: Uptime: Max: Epoch: Uptime: Min: Epoch: Uptime:

Radio			
	RT	MIN	MAX
TX Temperature (C)	0000	0000	0000
PA Current (mA)	0000	0000	0000
RSSI (dBm)	0000	0000	0000
Fwd Power (mW)	0000	0000	0000
Ref Power (mW)	0000	0000	0000
VGA Control (V)	0000	0000	0000
TX Antenna	0000		
RX Antenna	0000		

Computer Hardware			
	RT	MIN	MAX
Temperature (C)	0000	0000	0000
Battery I2C	0000		
PSU1 I2C	0000		
PSU2 I2C	0000		
RF I2C	0000		
Ground Resets	0000		
IHU Hard Error Data	0000		

Computer Software			
	RT	MIN	MAX
Spacecraft Spin (rpm)	0000	0000	0000
Diagnostic Info	0000		
WOD Stored (000s)	0000		
Safe Mode	0000		
Auto Safe Mode	0000		
Auto Safe Allowed	0000		
Science Mode	0000		
Soft Error	0000		

Battery			
	RT	MIN	MAX
Cell A (V)	0000	0000	0000
Cell A + B (V)	0000	0000	0000
Cell A + B + C (V)	0000	0000	0000
Temperature A (C)	0000	0000	0000
Temperature B (C)	0000	0000	0000
Temperature C (C)	0000	0000	0000
Current (mA)	0000	0000	0000
Board Temp (C)	0000	0000	0000

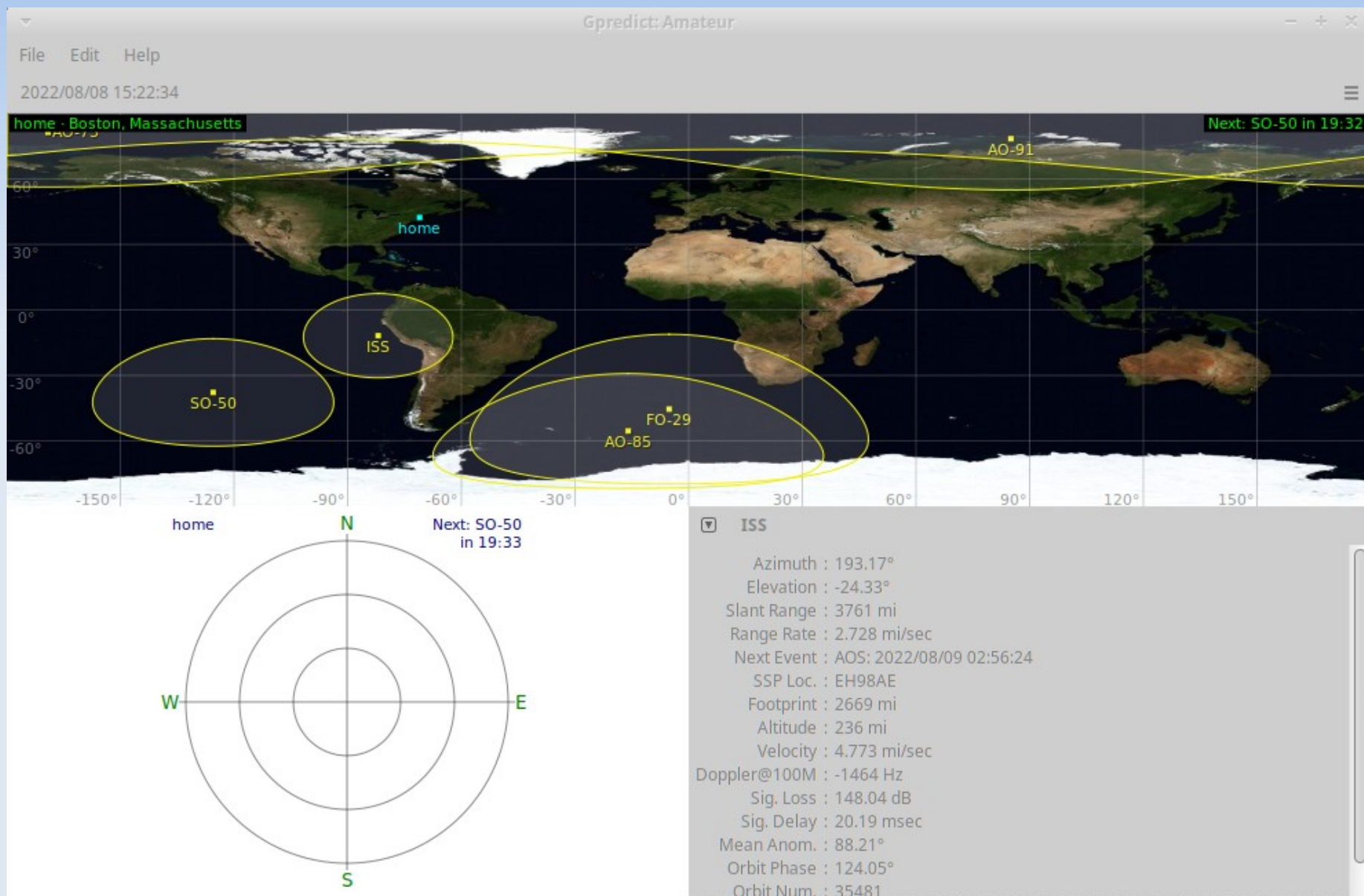
MPPT			
	RT	MIN	MAX

Experiments			
	RT	MIN	MAX
EXP4 Temp (C)	0000	0000	0000
Vanderbilt Radiation	0000		

Current RT MAX MIN Display Raw Values Display UTC Time Last 180 samples Captured:

Version 1.12z3 - 27 Oct 2022 Logs: /home/andy/ SDR Errors: 0 / 0 Audio missed: 0.0% / 0 Frames: 0 Payloads: 0 Queue: 0 / 0

Satellites - gpredict



SDR – GNU Radio Companion

- SDR = Software Defined Radio
- Draw a block diagram of your signal processing
- GRC will write the Python code and execute it
- Supports SDR devices such as:
 - RTL-SDR dongle
 - HackRF
- Many tutorials are available online

SDR – GNU Radio Companion #1

hackrf_lesson_1.grc - /home/andy/grc

File Edit View Run Tools Help

hackrf_lesson_1 x hackrf_lesson_2 x

Options
Output Language: Python
Generate Options: QT GUI

Variable
ID: samp_rate
Value: 2M

QT GUI Range
ID: freq
Label: Freq
Default Value: 99.5
Start: 88
Stop: 108
Step: 100m

QT GUI Chooser
ID: freq
Label: Station
Num Options: 4
Default option: 99.5
Option 0: 99.5
Label 0: WCRB
Option 1: 100.7
Label 1: WZLX
Option 2: 104.5
Label 2: WXLO
Option 3: 105.7
Label 3: WROR

QT GUI Range
ID: volume
Label: Volume
Default Value: 250m
Start: 0
Stop: 1
Step: 25m

RTL-SDR Source
Sync: Unknown PPS
Number Channels: 1
Sample Rate (sps): 2M
Ch0: Frequency (Hz): 99.5M
Ch0: DC Offset Mode: 0
Ch0: IQ Balance Mode: 0
Ch0: Gain Mode: False
Ch0: RF Gain (dB): 10
Ch0: IF Gain (dB): 20
Ch0: BB Gain (dB): 20

Low Pass Filter
Decimation: 10
Gain: 1
Sample Rate: 2M
Cutoff Freq: 75k
Transition Width: 25k
Window: Hamming
Beta: 6.76

Rational Resampler
Interpolation: 12
Decimation: 5
Taps:
Fractional BW: 0

WBFM Receive
Quadrature Rate: 480k
Audio Decimation: 10

Multiply Const
Constant: 250m

Audio Sink
Sample Rate: 48 kHz

QT GUI Frequency Sink
FFT Size: 2048
Center Frequency (Hz): 99.5M
Bandwidth (Hz): 2M

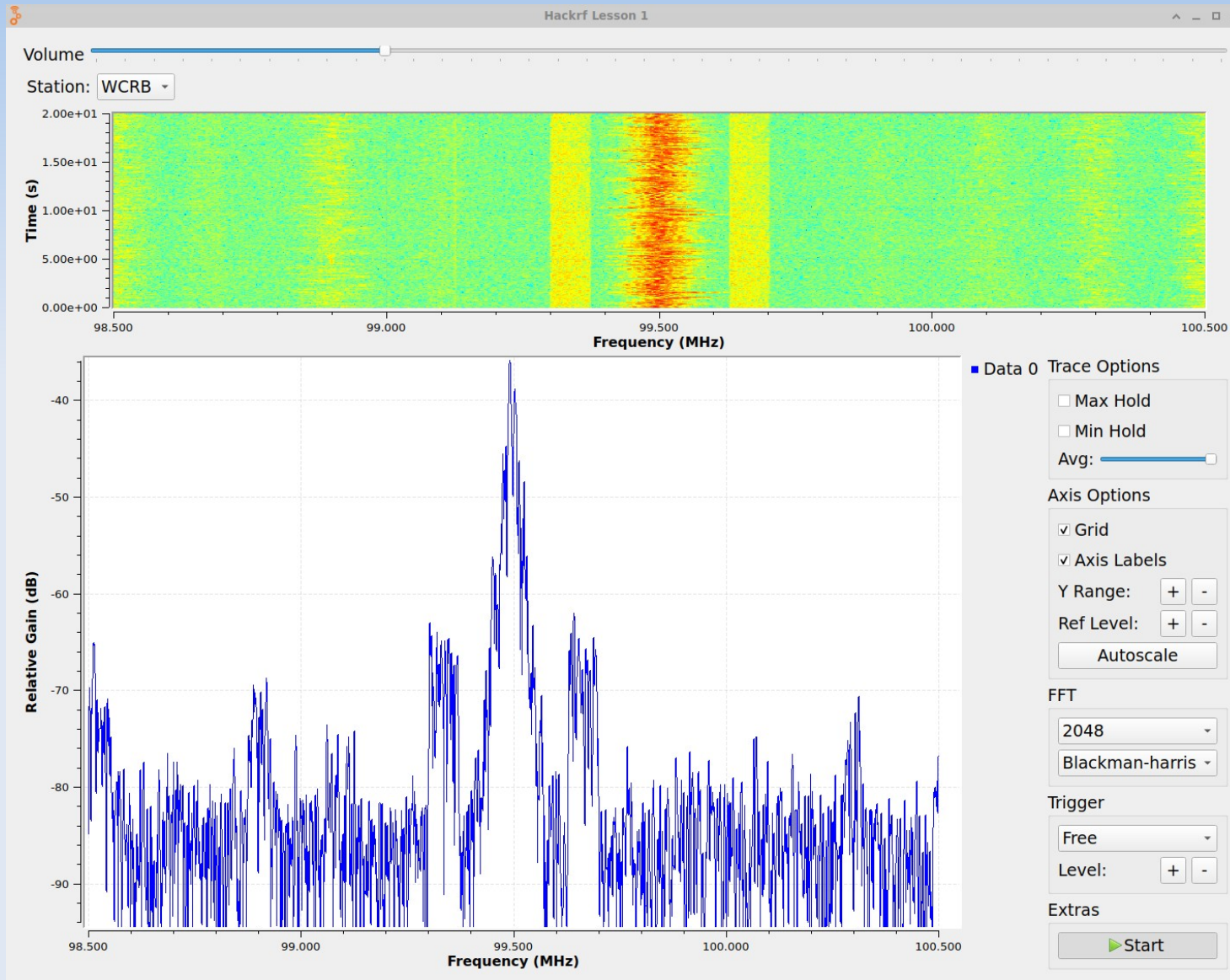
QT GUI Waterfall Sink
FFT Size: 1024
Center Frequency (Hz): 99.5M
Bandwidth (Hz): 2M

00000001
Detached kernel driver
Found Rafael Micro R820T tuner
[R82XX] PLL not locked!
Exact sample rate is: 2000000.052982 Hz
[R82XX] PLL not locked!
Allocating 15 zero-copy buffers
aU

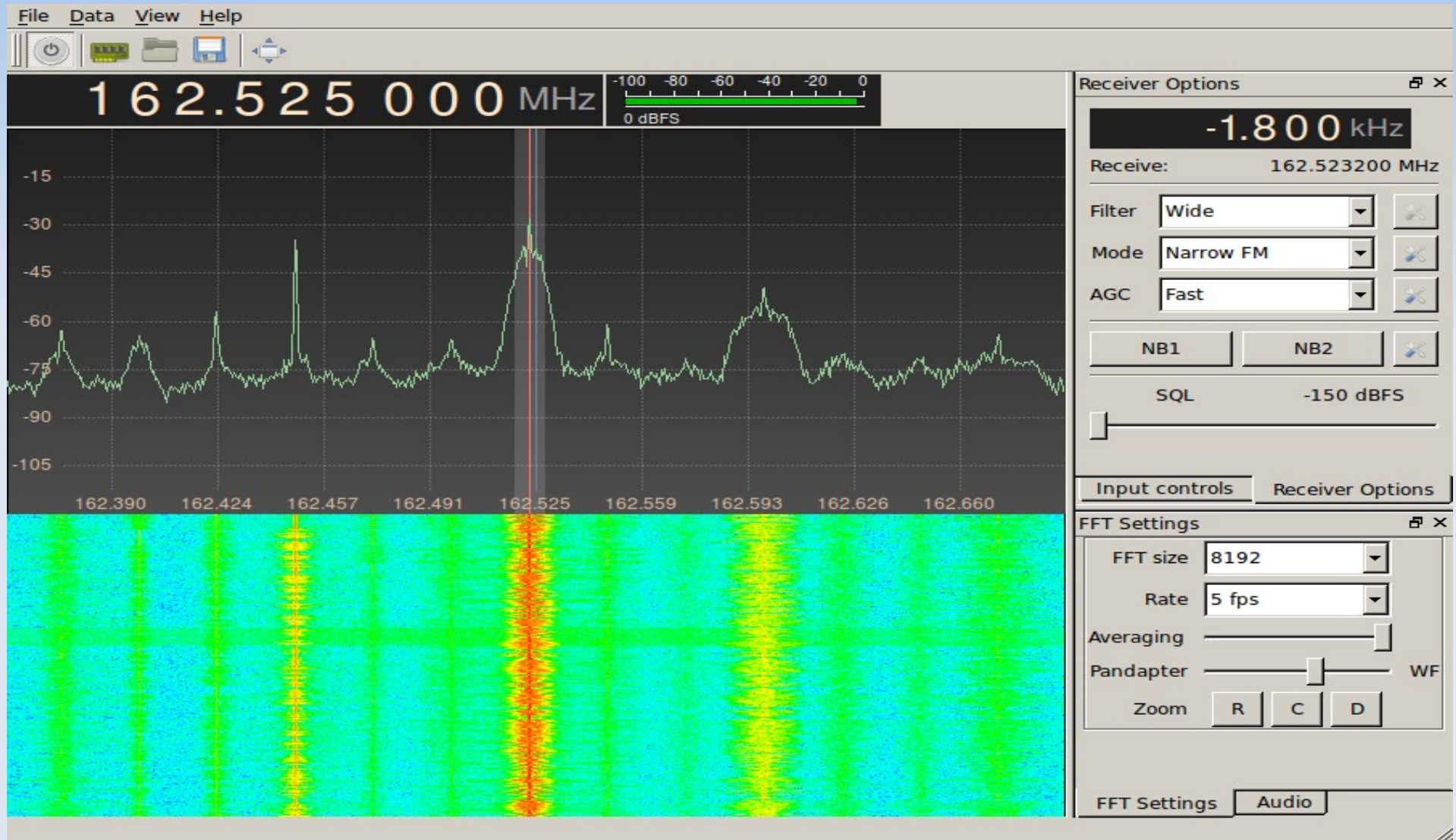
ID	Value
Imports	
Variables	
freq	99.5
freq	99.5
samp_ra	2000000.0

- Core
 - Audio
 - Boolean Operators
 - Byte Operators
 - Channelizers
 - Channel Models
 - Coding
 - Control Port
 - Debug Tools
 - Deprecated
 - Digital Television
 - Equalizers
 - Error Coding
 - File Operators
 - Filters
 - Fourier Analysis
 - GUI Widgets
 - Impairment Models
 - Industrial I/O
 - Instrumentation
 - IQ Balance
 - IQ Correction
 - Level Controllers
 - Math Operators
 - Measurement Tools
 - Message Tools
 - Misc
 - Modulators
 - Networking Tools
 - OFDM

SDR GNU Radio Companion #2



SDR - gqrx



SDR - sdrangel

The screenshot displays the SDRangel v7 software interface. The main window is titled "SDRangel v7" and features a menu bar (File, View, Workspaces, Preferences, Help) and a toolbar. The interface is divided into several sections:

- RTL-SDR[0] Section:** Shows the current frequency as 0,444,500 kHz. It includes controls for sample rate (1,024,000 S/s), decimation (16), and RFBW (2,500 kHz). The gain is set to 43.9 dB with AGC enabled.
- NFM Demodulator Section:** Shows a frequency offset of +0,012,500 Hz and a signal level of -52.7 dB. It includes settings for carrier spacing (12.50 k), RF gain (12.5k), AF gain (3.0k), and CTCSS (023N).
- Waveform and Spectrum View:** The top right shows a waveform plot with a frequency range from 444.470 to 444.530 MHz. The bottom right shows a spectrogram with a time axis from 0.0 to 2.5 seconds.
- Bottom Panel:** Contains playback controls (play, stop, volume), a filter bank (Han), and various filter settings (1k, 0, No, 1, A, -20, 65, 20).

The status bar at the bottom indicates the version (SDRangel 7.0.0-alpha.1-10-g632378205), the operating system (Qt 5.15.2, OpenGL 4.6, x86_64, Ubuntu 21.10), and the timestamp (2022-04-27 19:25:40 CEST).

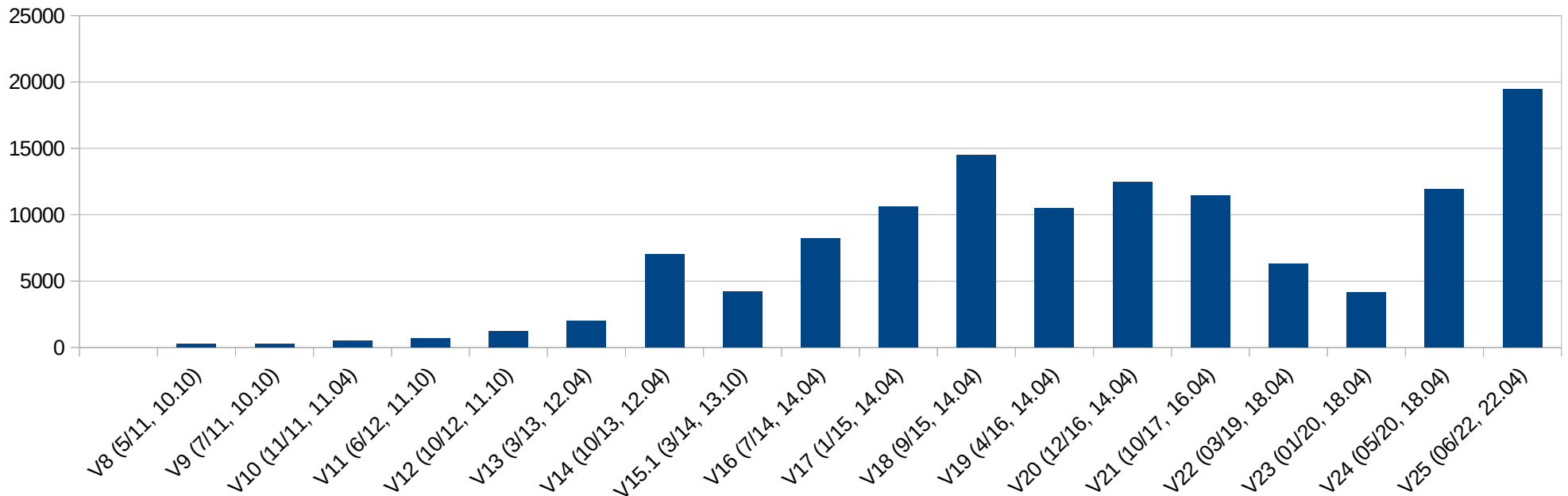
What's new and cool?

- Free Digital Voice (FreeDV)
 - Codec2: David (VK5DGR) Rowe
 - <https://freedv.org/>
- M17 Project
 - Low level protocols using Codec2
 - <https://m17project.org/>
 - Jan 2023: liberated two TYT MD-380s which now run M17(!)
 - M17 software available in AHRL v25a
 - I'm eager to learn more about M17

Downloads

Number of Downloads

Andy's Ham Radio Linux



Awarded 03/2022

- 11 years and 100,000 downloads later.....
- <https://nediv.arri.org/2022/03/02>



Sourceforge

- Go there: <http://www.sourceforge.net>
- Search for KB1OIQ
- Other ham radio programs are there:
 - uBITX modified for blind amateur radio users
 - Bionics configuration programs
 - MicroFox, TinyTrack
 - Wordsworth – collaboration with K1IG
 - a way to learn CW
 - aa-analyzer for older Rig Expert analyzers

Related Online Videos

- Online video of a similar talk to RATPAC:
 - Radio Amateur Training Planning and Activities Committee
 - <https://youtu.be/BOlHi73zY74>
- Online Review of AHRL by KB9RLW Kevin, "The Old Tech Guy"
 - <https://www.youtube.com/watch?v=HEd5uMoksa8>

Last Slide!

- Questions?
- Slides available:
 - Email: kb1oiq@arri.net
- Thanks for coming to this talk!
- Have a lot of fun, and 73 de Andy KB1OIQ