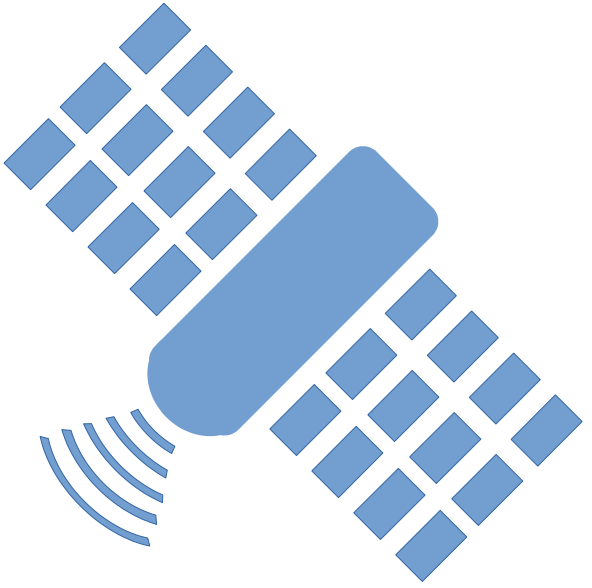
Ham Radio via Satellites

Hardware, Software, Experiences

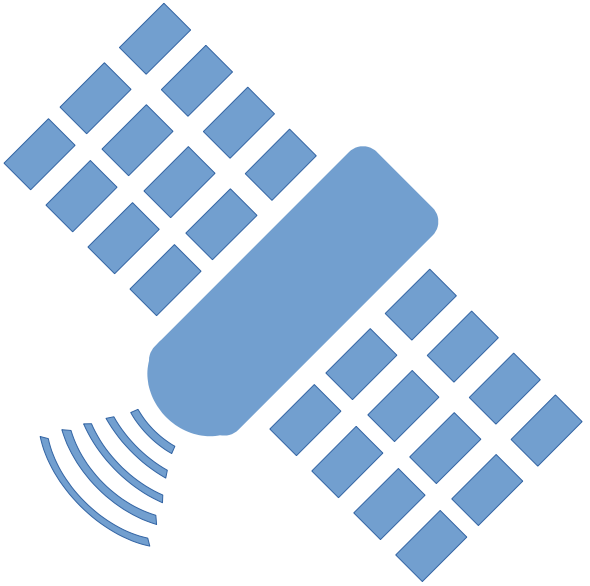
by 9V1KG

Jul 2021



Disclaimer

- I only started a year ago with satellites in DU using FTM-400 and vertical antenna – APRS via ISS and PCSAT2
- I listened to the FM satellites, but don’t like the way of operation (“fish market”)
- Today I focus on linear satellites (CW/SSB)
- Presentation is showing basic concepts and some challenges I faced on the way
- Emphasis lies on portable operation



Content

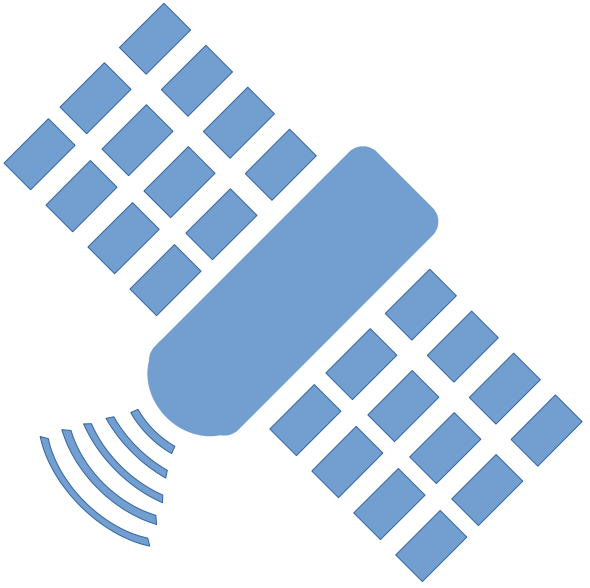
Introduction

Hardware

Software

Operation

Telemetry



Introduction

Terminology

- **AMSAT**: Amateur radio satellite organization
- **LEO**: Low earth orbiting – 128 min per orbit and/or lower 2000 km
- **NORAD**: North American Aerospace Defense Command
- **NORAD Catalogue Number**: Unique satellite identifier
- **TLE**: orbital parameters in Two-Line Element format
- **AOS**: Aquisition of Signal
- **LOS**: Loss Of Signal
- **TCA**: Time of closest approach
- **TLM: Telemetry**
- **DUV**: Data under Voice
- Footprint: Coverage – depends on height of orbit, something around 5000 km dia

```
CUTE-1.7+APD II (CO-65)
1 32785U 08021C   21195.41890081  .00000228  00000-0  30067-4 0  9997
2 32785  97.6123 173.2173 0011359 274.9832  85.0089 14.88749237716189
```

Satellite Names

Confusing!

- Diwata 2B = PO-101
- CAS 4A = ZHUHAI-1 01
- Nexus = FO-99
- CAS-6 (TQ1) = TO-108
- XIWANG-1 = HOPE-1 = HO-68
- FS-3 = Falconsat 3

- Orbiting Satellites Carrying Amateur Radio

Amsat Oscar (AO), Fuji Oscar (FO), Cube Oscar (CO), ...

Satellite band & frequency modes

Mode X/Y: X uplink, Y downlink. Example: V/V, V/U, U/V, V/V, ...

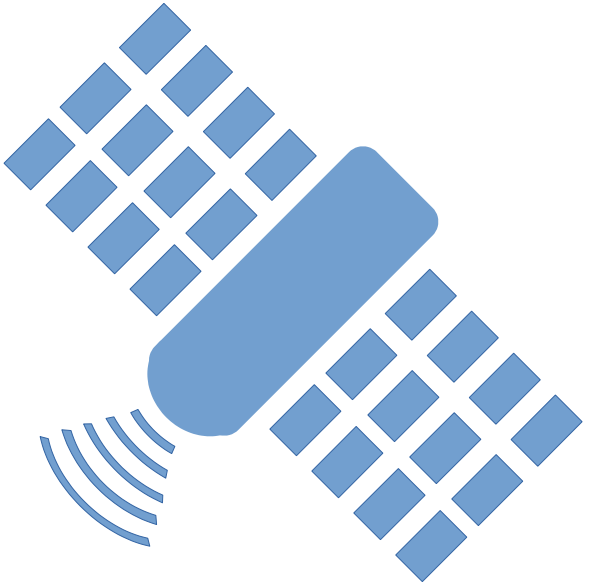
Designator	H	A	**V**	**U**	**L**	S	S2	C	X	K	R
Band	15 m	10 m	2 m	70 cm	23 cm	13 cm	9 cm	5 cm	3 cm	1.2 cm	6 mm
Freq.	15 MHz	29 MHz	145 MHz	435 MHz	1.2 GHz	2.4 GHz	3.4 GHz	5 GHz	10 GHz	24 GHz	47 GHz

Source: PE0SAT

Historically: Mode A = V/A, Mode B = U/V (Oscar 7)

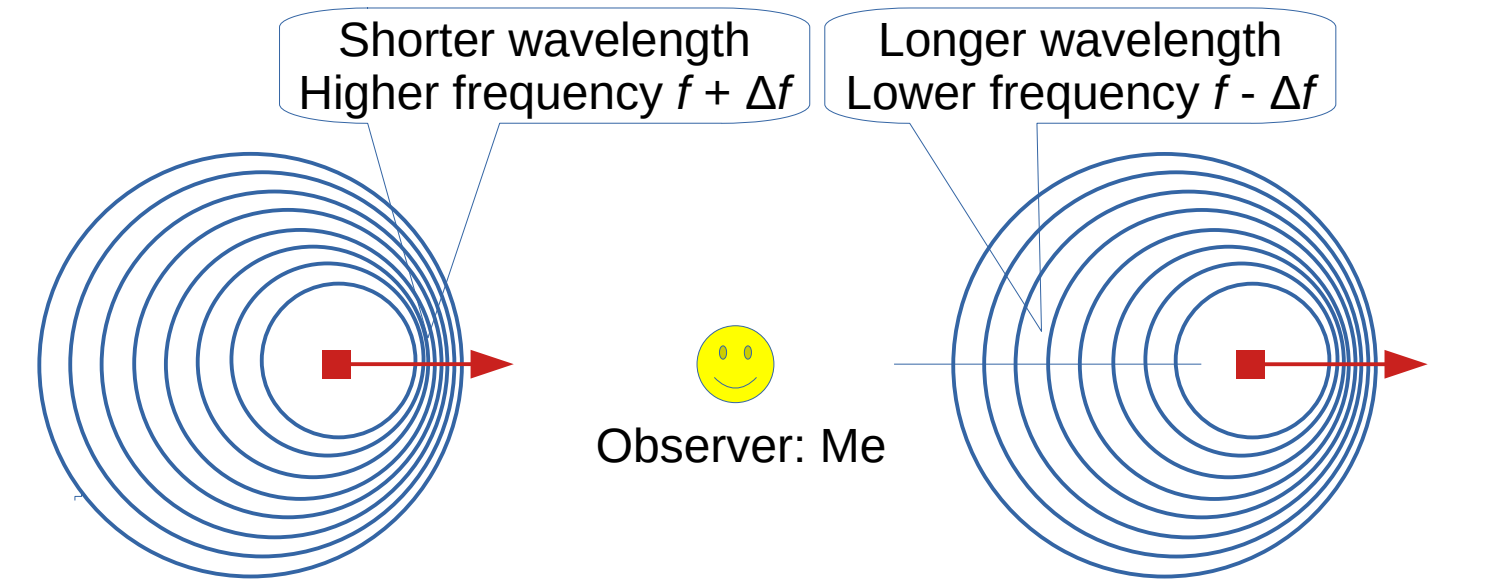
Satellite Modes

- 2-way Communication
  - FM
  - Linear (SSB, CW)
  - Data (APRS, PSK, experimental FT4)
- Beacon (CW)
- Telemetry (Data, Pics)



Never ever use CW modes like FM, AM, FT8 on linear satellites!

Doppler Effect

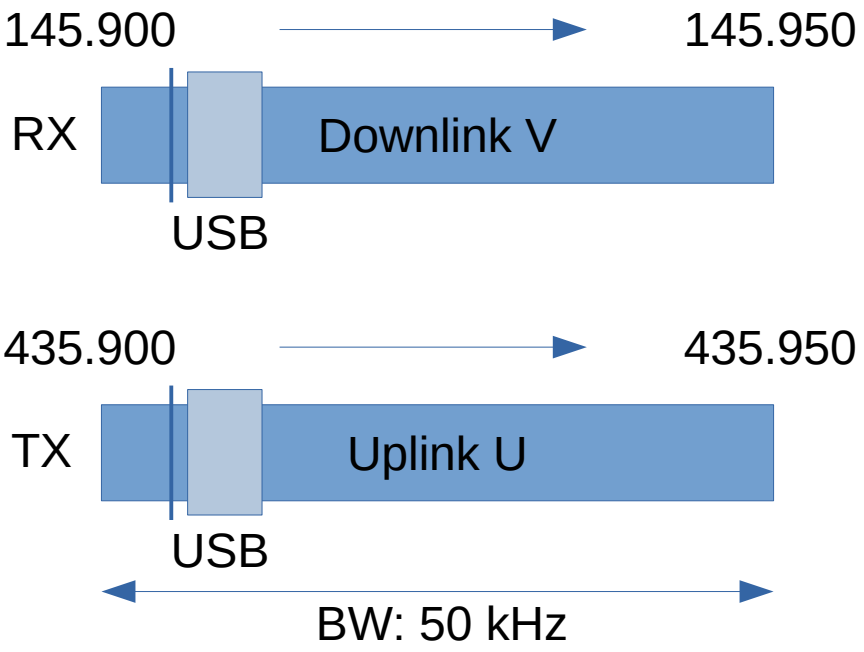


Higher shift at higher frequencies, important for SSB/CW,
Doppler shift can be several kHz on 70 cm

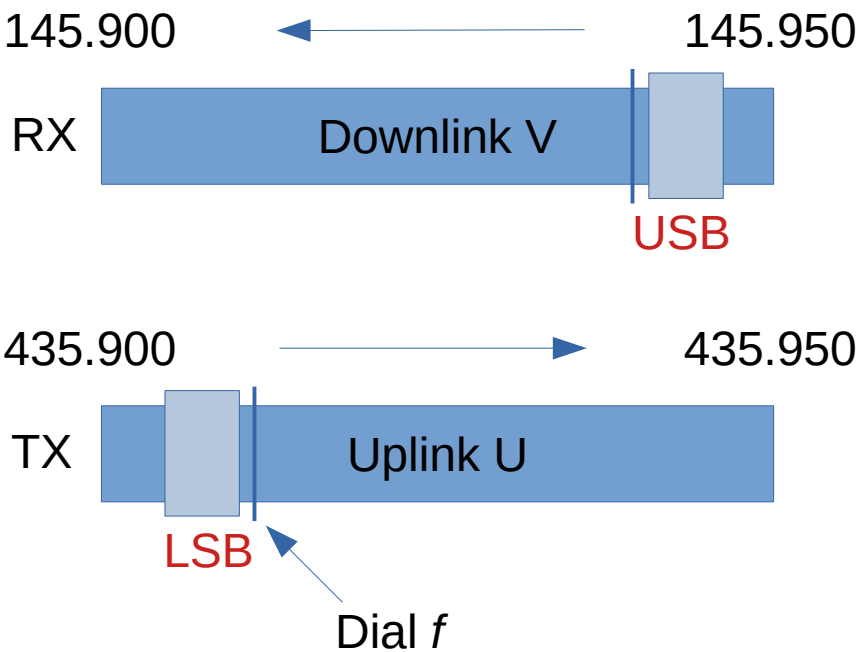
9V1KG

Linear Transponder

Normal (*e.g.* all FM Sats, AO-7 Mode A)

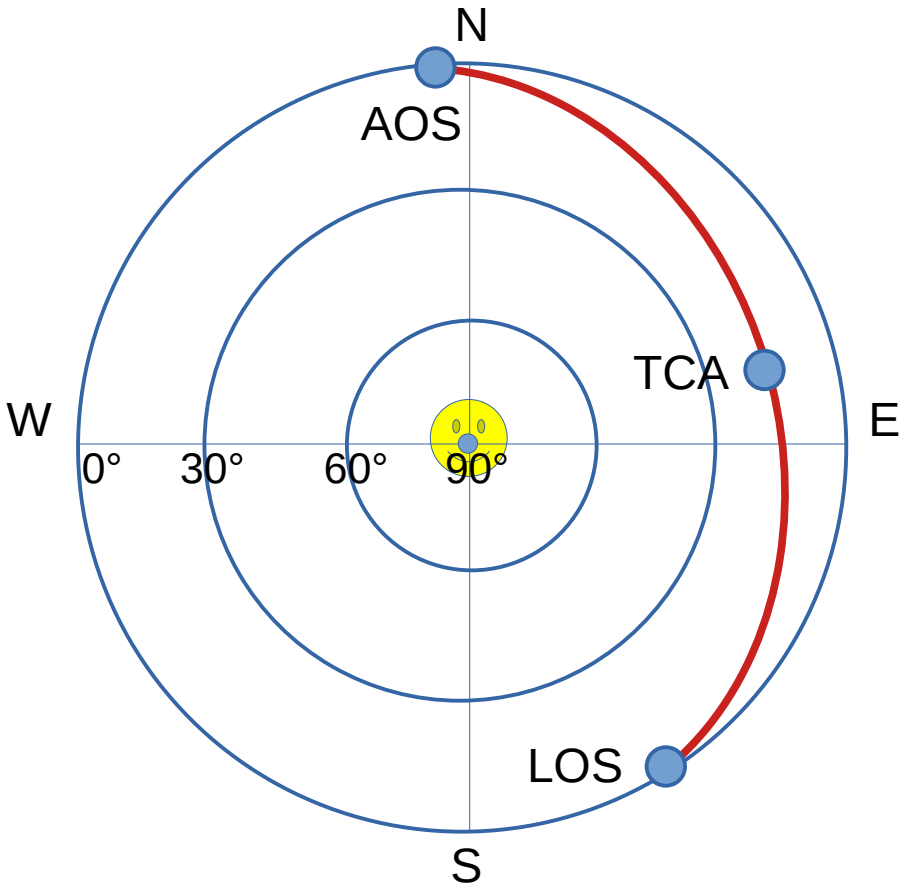


Inverting (usual case)



9V1KG

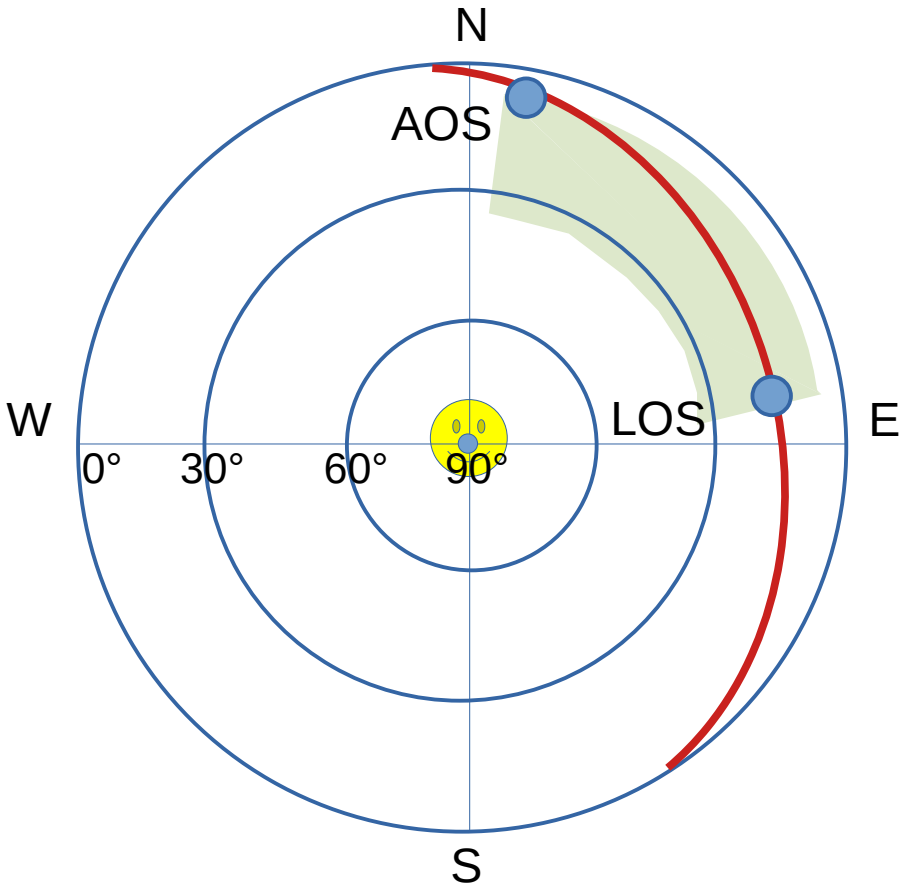
Polar Diagram



AOS to LOS: 6 - 20 min

Minimum El: 5° ... 10°

Polar Diagram



AOS to LOS: 6 - 20 min

Minimum El: 5° ... 10°

From my balcony:
AOS to LOS: 3 to 6 min

9V1KG

Reporting

Satellite Status Reporting
https://www.amsat.org/status/
shows current status of most amateur radio satellites.
Please submit!

Submit Report

Satellite HO-68

Status Report
- (•) Uplink and Downlink Active
- ( ) Downlink Only
- ( ) Not Heard
- ( ) ISS Crew (Voice) Active

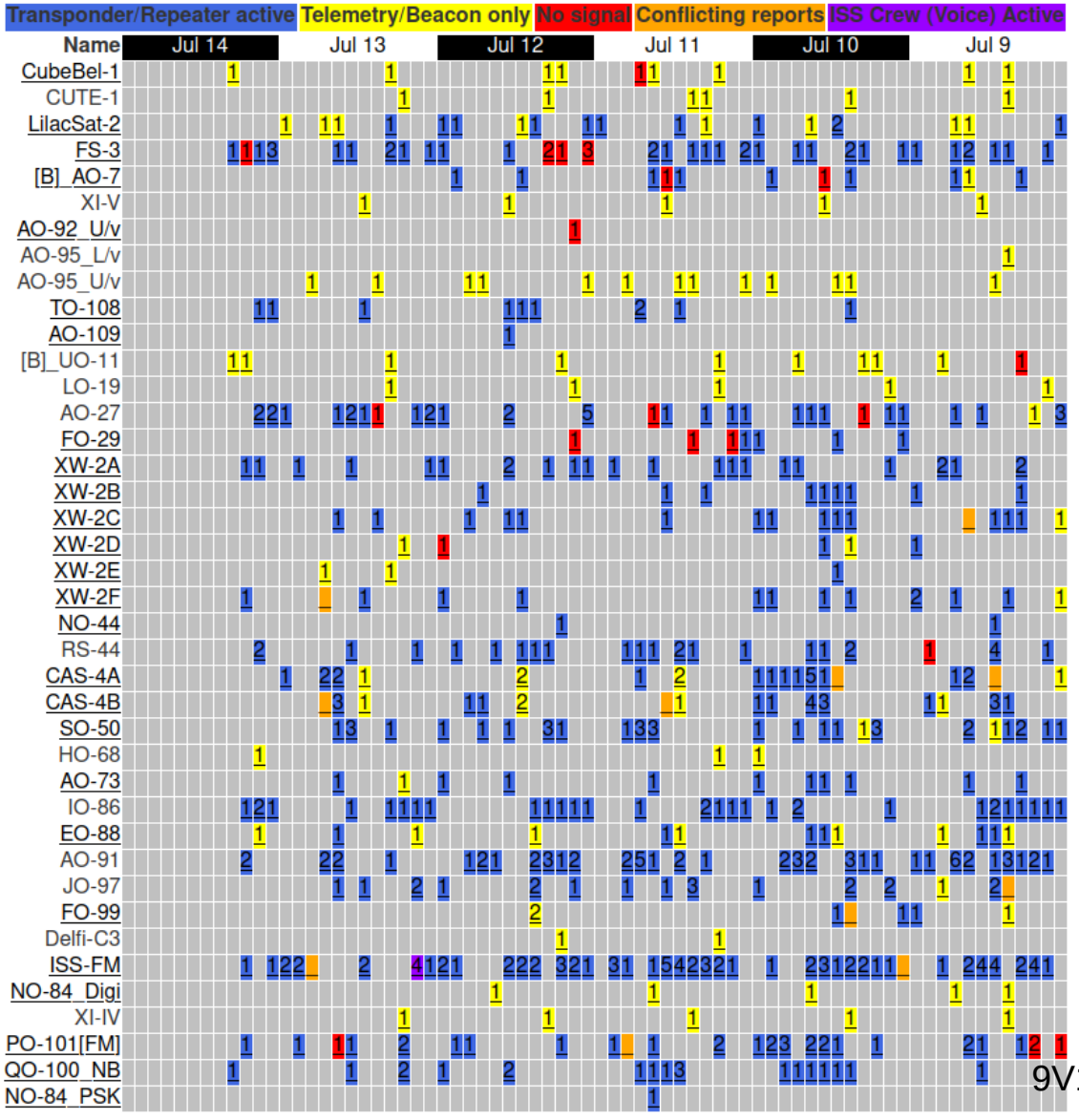
Date Heard Jul , 14 2021

Time Heard (UTC) 7 :46-:59

Your Callsign 9V1KG

Your Grid Square OJ11xi

Submit Data



9V1KG

Hardware

Hardware

If you plan to work via linear sats in SSB or CW, Duplex operation is mandatory

Duplex:
You listen to your own signal from the satellite

Solution for Duplex:

- Some HT can do full duplex FM (not CW, SSB)
- Use two tranceivers
- Use one transceiver + SDR
- IC-9700 is full duplex

Hardware

Transceiver

- HT (FM sats only)
- Portable: FT-818, IC-705, ...
- SDR: RTL, Airspy, ...
- IC-9700, ...

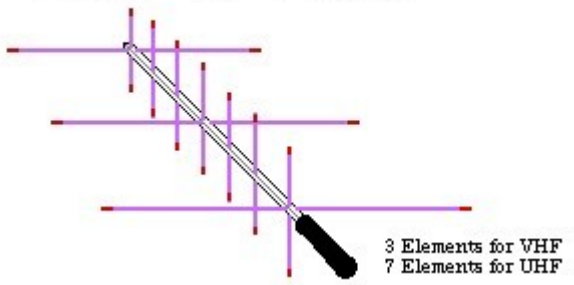
Antennas

- Omnidirectional
  - Eggbeater, Turnstyle
- Directional
  - Two single band or one dual band
  - Yagi, Log per

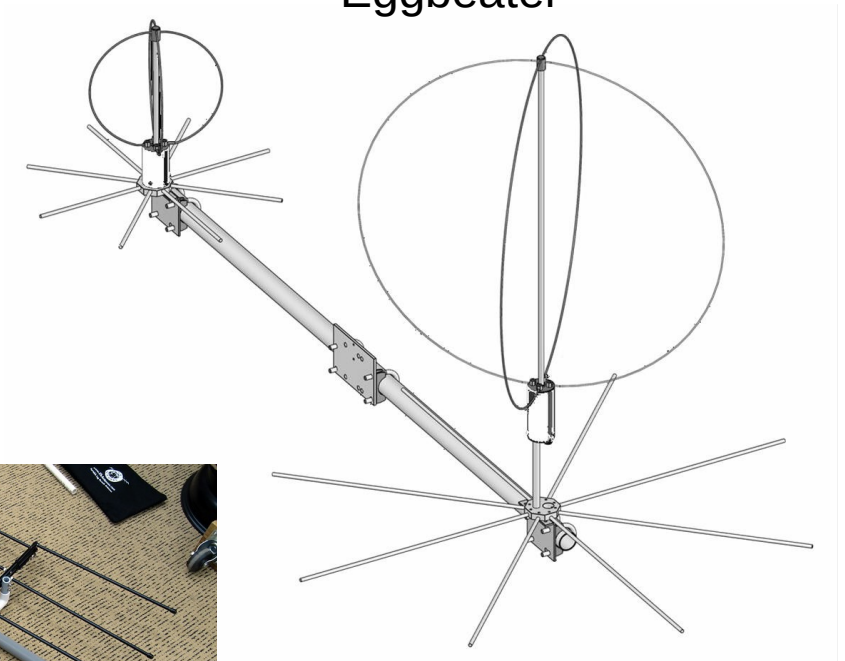
Antenna Polarisation: circular would be optimal!

Antennas

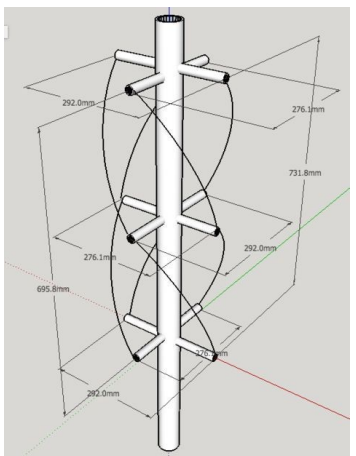
Yagi



Eggbeater



Turnstyle



Dual band log. per

Hardware

Rotator

- Required for directional antennas
- Azimuth 0° to 360°
- Elevation 0° to 90° or 0° to 180°
- Interface!

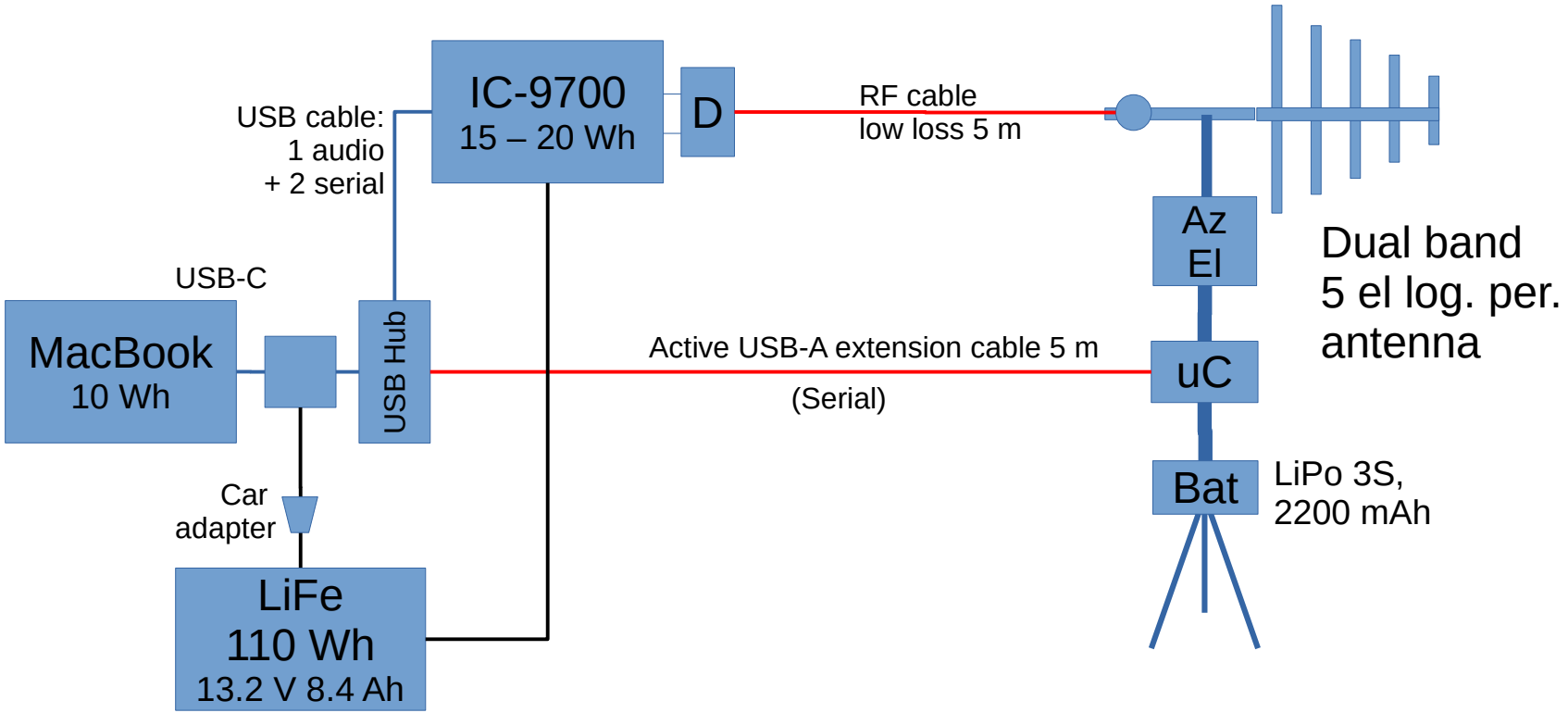
Interface: Serial or WiFi?

- RF cable needed anyway
- WiFi needs a hotspot
- Portable setup: 3 to 5 m between antenna & radio
- Active USB extension (5 to 10 m possible)

Portable Satellite Ground Station

- Requirements
  - Lightweight antenna only
  - Battery operated 3h min
  - Max. Dimension packed: 65 cm (size of bag)
  - Easy and fast setup
  - Some rain protection
- 9V1KG setup
  - IC-9700!
  - 5 el dual band log per
  - MK1 homebrew rotator
  - MacBook
  - LiFe4Po 8.4 Ah (110 Wh)

Portable Satellite Ground Station (1)

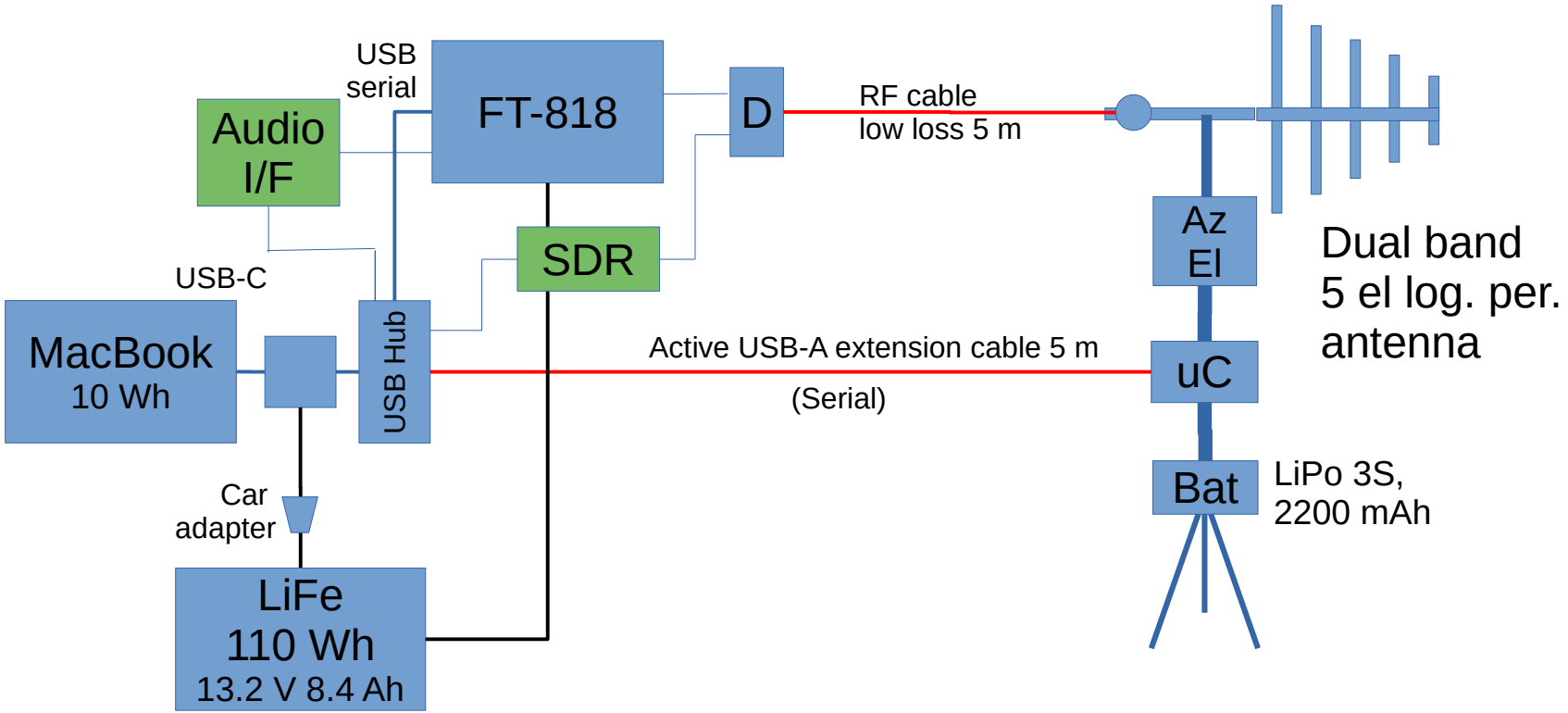


9V1KG

Hardware

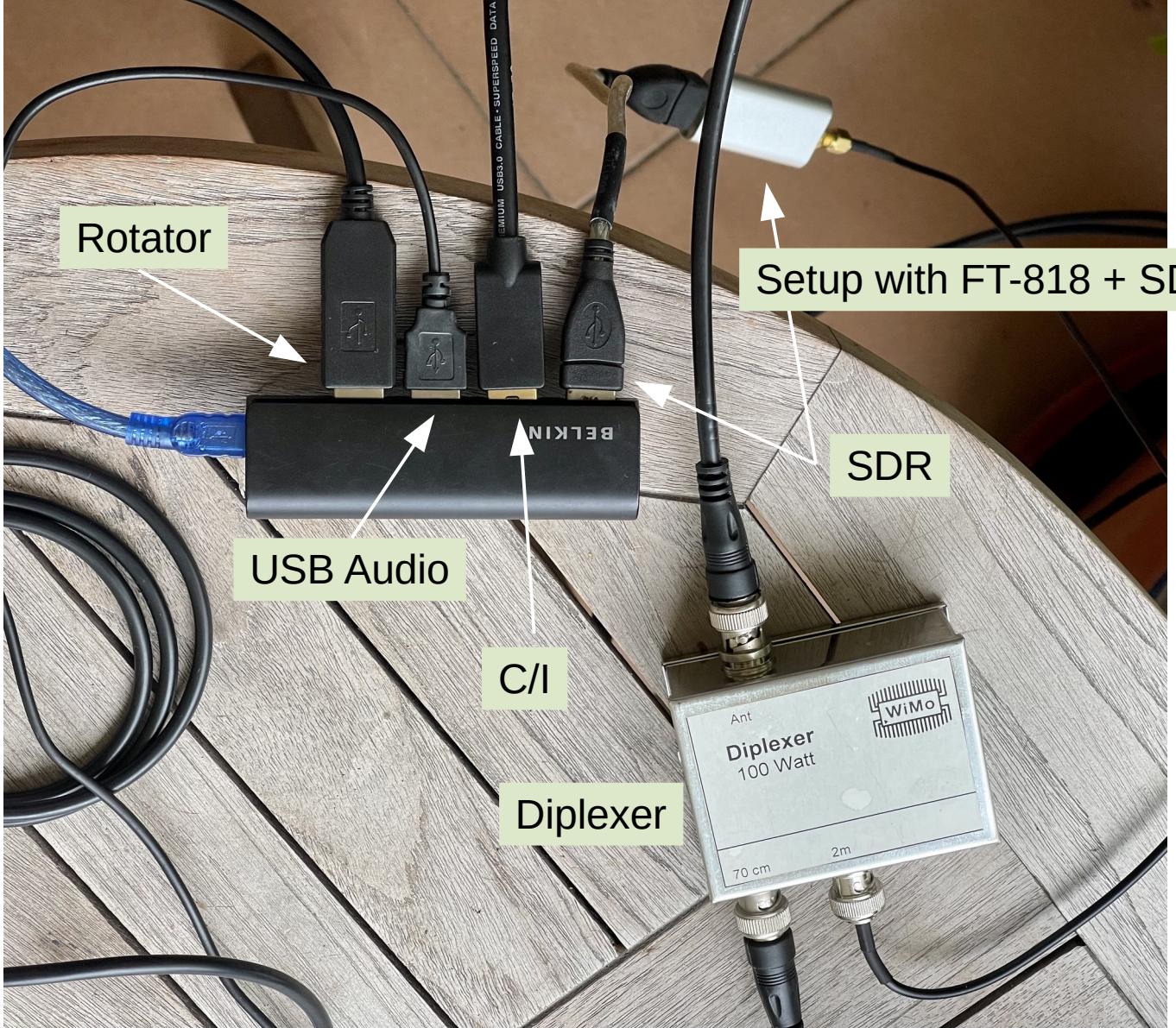
9V1KG

Portable Satellite Ground Station (2)



9V1KG


Alternative
Setup using FT-818 + SDR
435.647.559
MacBook
YAESU
9V1KG


Rotator
Setup with FT-818 + SDR
SDR
USB Audio
C/I
Diplexer
BELKIN
Ant
Diplexer
100 Watt
WiMo
70 cm
2m

9V1KG

Software

- Open source SW
  - Hamlib
  - Gpredict
  - GQRX (SDR)
  - Direwolf (TNC)
- Free SW
  - Rotor (MacOS) by DL2RUM

- Software from AMSAT
  - SATPC32 (Windows) USD 45 - 50
  - MacDoppler (Mac) USD 80 – 100

Why AMSAT does not show/support Open Source?

Hamlib: rigctl, rotctl

```
rigctl --version

rigctl Hamlib 4.2 Mon May 17 02:40:24 2021 +0000
SHA=cdad07

rotctl --version

rotctl(d), Hamlib 4.2 Mon May 17 02:40:24 2021
+0000 SHA=cdad07
```

Hamlib 4.2

rigctld and rotctld
to be started before starting Gpredict

Model numbers changed!

Model

Port

Serial

```
rotctld -m 202 -t 4533 -r /dev/tty.usbmodem1411201

-s 9600  -C timeout=2000
```

Baud rate

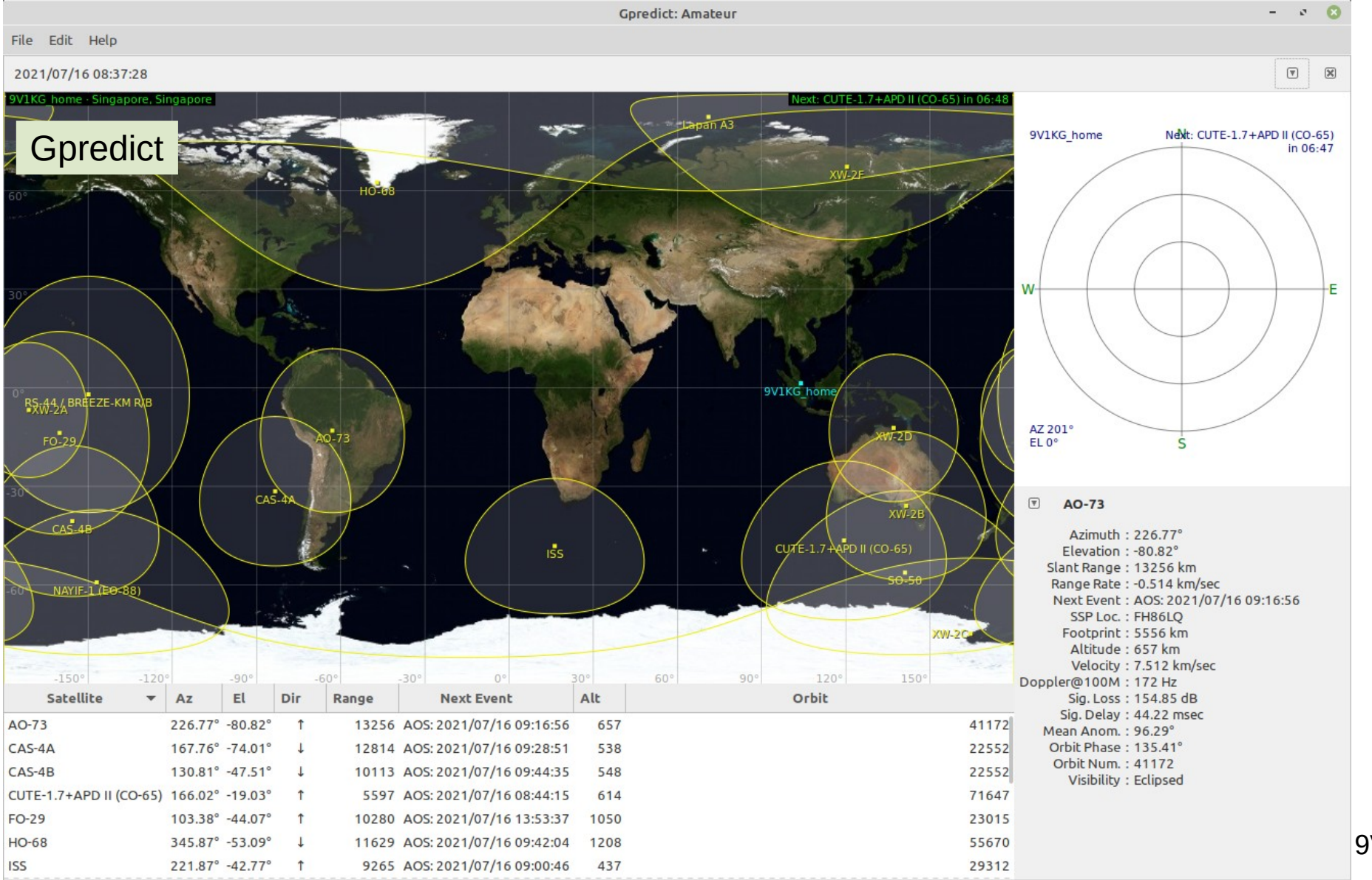
FT-818

```
rigctld -m 1020 -r /dev/tty.usbserial-AQ01DAS9
-t 4532 -s 38400

rigctld -m 3081 -r /dev/tty.usbserial-1411120
-t 4534 -s 19200
```

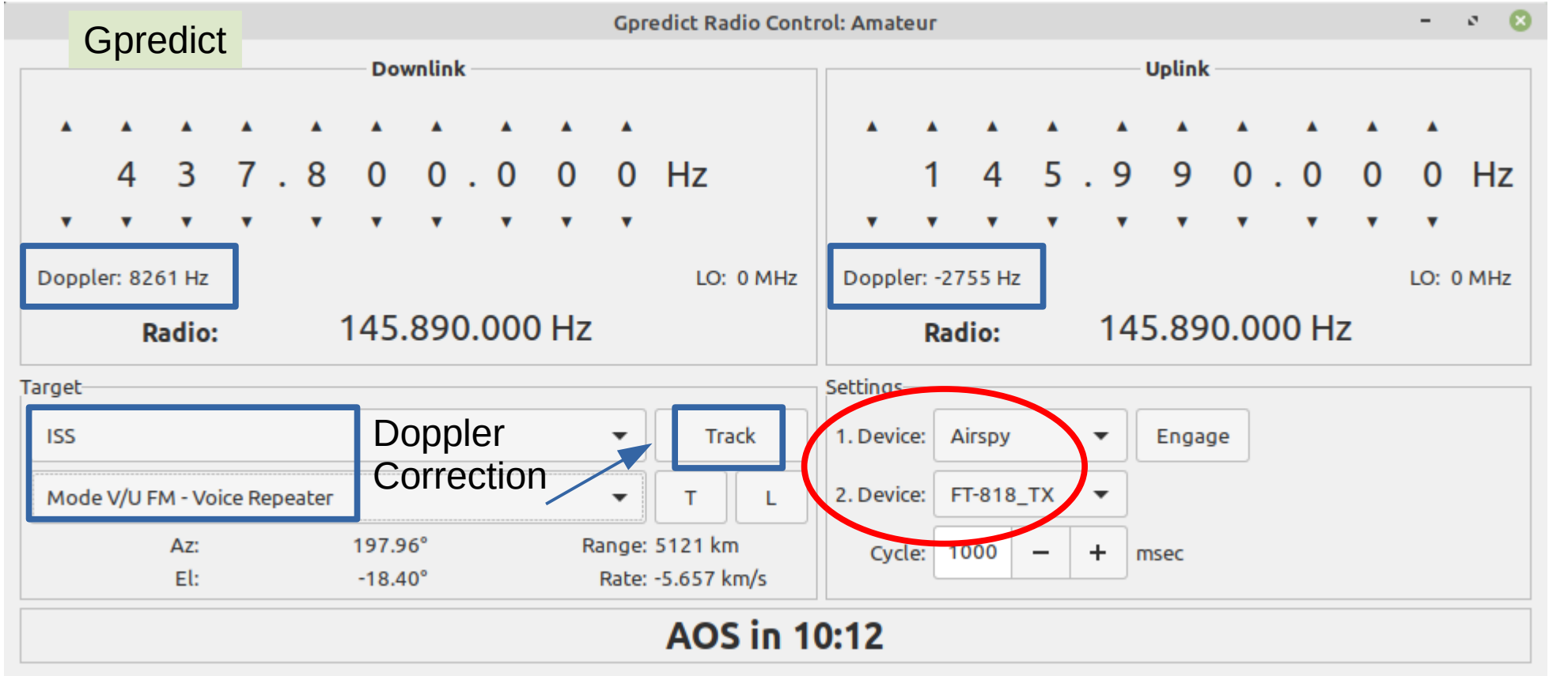
IC-9700

9V1KG

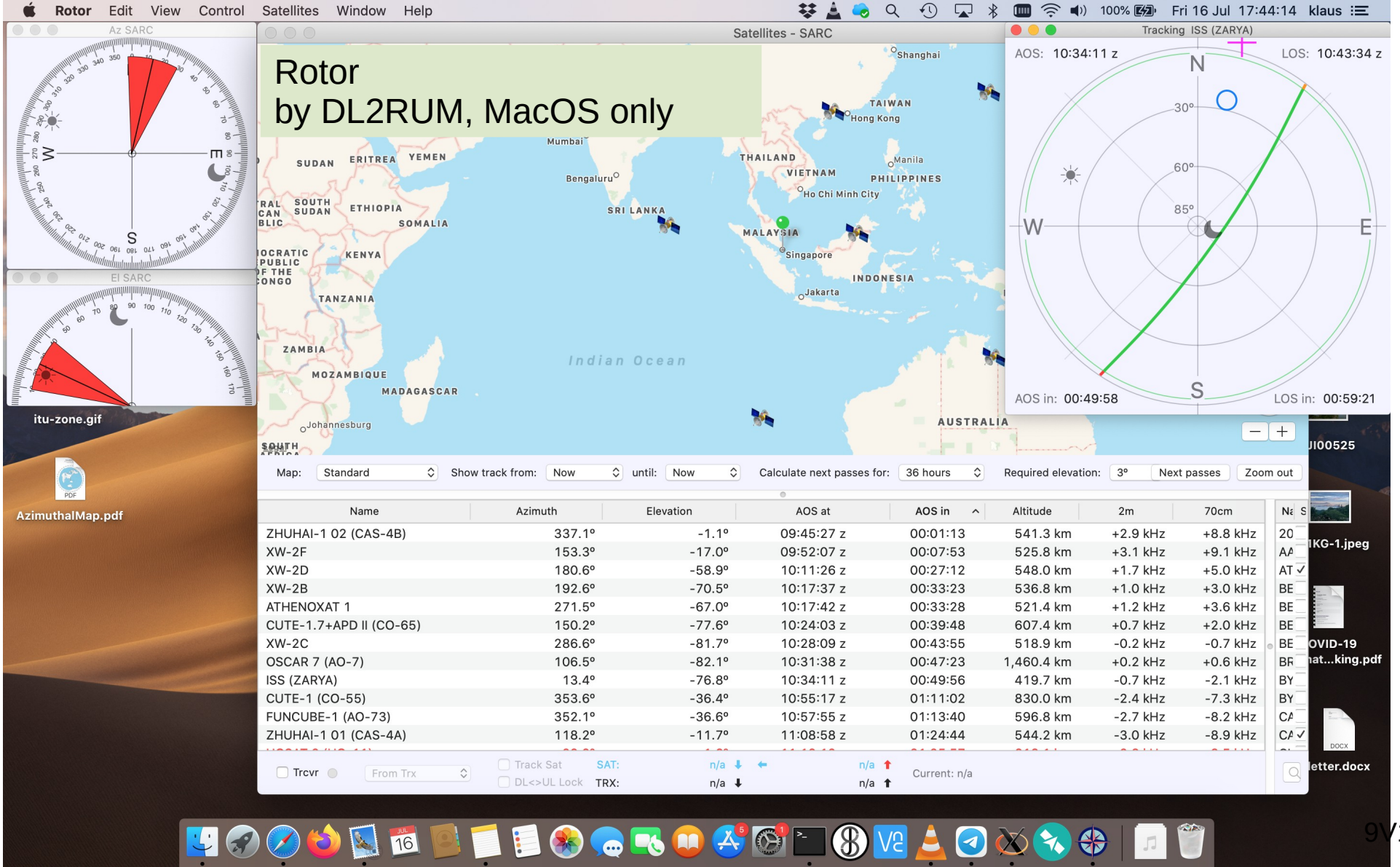


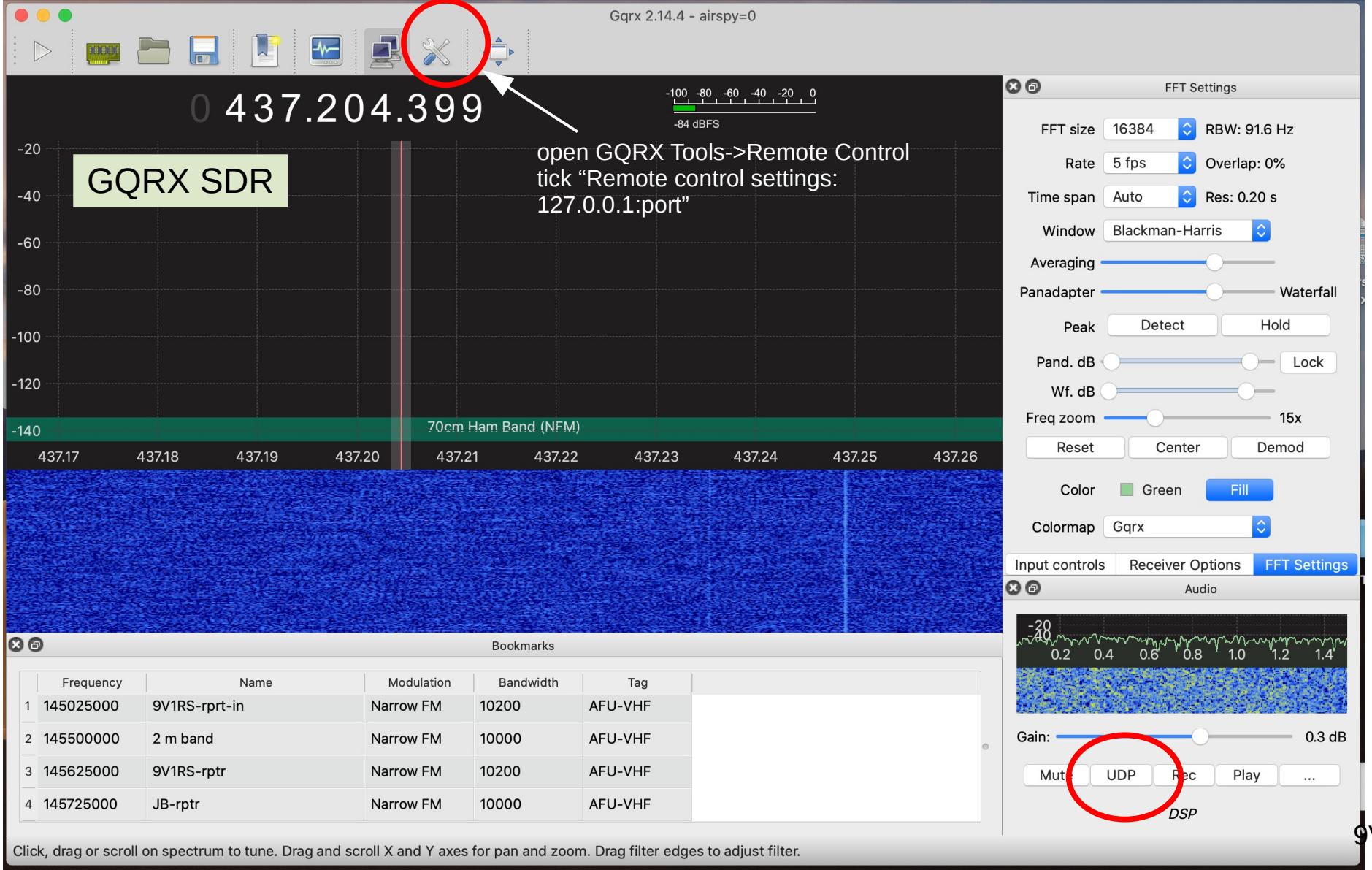
Satellite	Az	El	Dir	Range	Next Event	Alt	Orbit
AO-73	226.77°	-80.82°	↑	13256	AOS: 2021/07/16 09:16:56	657	41172
CAS-4A	167.76°	-74.01°	↓	12814	AOS: 2021/07/16 09:28:51	538	22552
CAS-4B	130.81°	-47.51°	↓	10113	AOS: 2021/07/16 09:44:35	548	22552
CUTE-1.7+APD II (CO-65)	166.02°	-19.03°	↑	5597	AOS: 2021/07/16 08:44:15	614	71647
FO-29	103.38°	-44.07°	↑	10280	AOS: 2021/07/16 13:53:37	1050	23015
HO-68	345.87°	-53.09°	↓	11629	AOS: 2021/07/16 09:42:04	1208	55670
ISS	221.87°	-42.77°	↑	9265	AOS: 2021/07/16 09:00:46	437	29312

9V1KG


Gpredict
Gpredict Radio Control: Amateur
Downlink
437.800.000 Hz
Doppler: 8261 Hz
LO: 0 MHz
Radio: 145.890.000 Hz
Uplink
145.900.000 Hz
Doppler: -2755 Hz
LO: 0 MHz
Radio: 145.890.000 Hz
Target
ISS
Mode V/U FM - Voice Repeater
Doppler Correction
Track
T
L
Az: 197.96°
El: -18.40°
Range: 5121 km
Rate: -5.657 km/s
Settings
1. Device: Airspy
Engage
2. Device: FT-818_TX
Cycle: 1000
msec
AOS in 10:12

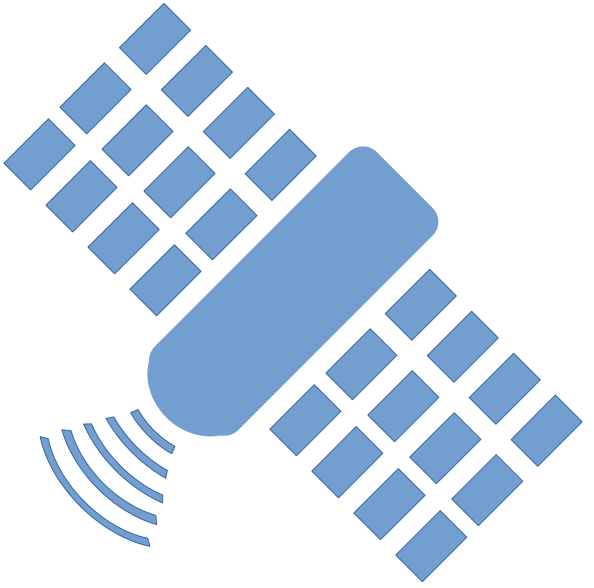
9V1KG


Rotor Edit View Control Satellites Window Help
100% Fri 16 Jul 17:44:14 klaus
Az SARC
El SARC
itu-zone.gif
AzimuthalMap.pdf
Satellites - SARC
Rotor
by DL2RUM, MacOS only
Tracking ISS (ZARYA)
AOS: 10:34:11 z
LOS: 10:43:34 z
AOS in: 00:49:58
LOS in: 00:59:21
Map: Standard
Show track from: Now
until: Now
Calculate next passes for: 36 hours
Required elevation: 3°
Next passes
Zoom out
Name | Azimuth | Elevation | AOS at | AOS in | Altitude | 2m | 70cm
ZHUHAI-1 02 (CAS-4B) | 337.1° | -1.1° | 09:45:27 z | 00:01:13 | 541.3 km | +2.9 kHz | +8.8 kHz
XW-2F | 153.3° | -17.0° | 09:52:07 z | 00:07:53 | 525.8 km | +3.1 kHz | +9.1 kHz
XW-2D | 180.6° | -58.9° | 10:11:26 z | 00:27:12 | 548.0 km | +1.7 kHz | +5.0 kHz
XW-2B | 192.6° | -70.5° | 10:17:37 z | 00:33:23 | 536.8 km | +1.0 kHz | +3.0 kHz
ATHENOXAT 1 | 271.5° | -67.0° | 10:17:42 z | 00:33:28 | 521.4 km | +1.2 kHz | +3.6 kHz
CUTE-1.7+APD II (CO-65) | 150.2° | -77.6° | 10:24:03 z | 00:39:48 | 607.4 km | +0.7 kHz | +2.0 kHz
XW-2C | 286.6° | -81.7° | 10:28:09 z | 00:43:55 | 518.9 km | -0.2 kHz | -0.7 kHz
OSCAR 7 (AO-7) | 106.5° | -82.1° | 10:31:38 z | 00:47:23 | 1,460.4 km | +0.2 kHz | +0.6 kHz
ISS (ZARYA) | 13.4° | -76.8° | 10:34:11 z | 00:49:56 | 419.7 km | -0.7 kHz | -2.1 kHz
CUTE-1 (CO-55) | 353.6° | -36.4° | 10:55:17 z | 01:11:02 | 830.0 km | -2.4 kHz | -7.3 kHz
FUNCUBE-1 (AO-73) | 352.1° | -36.6° | 10:57:55 z | 01:13:40 | 596.8 km | -2.7 kHz | -8.2 kHz
ZHUHAI-1 01 (CAS-4A) | 118.2° | -11.7° | 11:08:58 z | 01:24:44 | 544.2 km | -3.0 kHz | -8.9 kHz
Trcvr
From Trx
Track Sat
DL<>UL Lock
SAT:
TRX:
Current: n/a
Indian Ocean
AUSTRALIA
Shanghai
Hong Kong
TAIWAN
Mumbai
Bengaluru
THAILAND
VIETNAM
Manila
PHILIPPINES
Ho Chi Minh City
SRI LANKA
MALAYSIA
Singapore
INDONESIA
Jakarta
SUDAN
ERITREA
YEMEN
ETHIOPIA
SOMALIA
KENYA
TANZANIA
ZAMBIA
MOZAMBIQUE
MADAGASCAR
Johannesburg
9V1KG


Gqrx 2.14.4 - airspy=0
0 437.204.399
-84 dBFS
GQRX SDR
open GQRX Tools->Remote Control
tick “Remote control settings:
127.0.0.1:port”
70cm Ham Band (NFM)
437.17 437.18 437.19 437.20 437.21 437.22 437.23 437.24 437.25 437.26
FFT Settings
FFT size 16384 RBW: 91.6 Hz
Rate 5 fps Overlap: 0%
Time span Auto Res: 0.20 s
Window Blackman-Harris
Averaging
Panadapter Waterfall
Peak Detect Hold
Pand. dB Lock
Wf. dB
Freq zoom 15x
Reset Center Demod
Color Green Fill
Colormap Gqrx
Input controls Receiver Options FFT Settings
Audio
Gain: 0.3 dB
Mute UDP Rec Play ...
DSP
Bookmarks
Frequency Name Modulation Bandwidth Tag
1 145025000 9V1RS-rprt-in Narrow FM 10200 AFU-VHF
2 145500000 2 m band Narrow FM 10000 AFU-VHF
3 145625000 9V1RS-rptr Narrow FM 10200 AFU-VHF
4 145725000 JB-rptr Narrow FM 10000 AFU-VHF
Click, drag or scroll on spectrum to tune. Drag and scroll X and Y axes for pan and zoom. Drag filter edges to adjust filter.

9V1KG

Operation



9V1KG

What (linear) satellites to work?

Nr	Name	Cat No	Launch	Type	Mod	Dir
1	**RS-44** (DOSAAF-85)	44909	2019	lin	V/u	INV
2	**CAS 4A** (ZHUHAI-1 01)	42759	2017	lin	U/v	INV
3	**CAS 4B** (ZHUHAI-1 02)	42761	2017	lin	U/v	INV
4	XW-2A (CAS-3A)	40903	2015	lin	U/v	INV
5	XW-2C (CAS-3C)	40906	2015	lin	U/v	INV
6	XW-2F (CAS-3F)	40910	2015	lin	U/v	INV
7	**JY1SAT** (JO-97)	43803	2018	lin	U/v	INV
8	AO-7 (OSCAR 7)	7530	1974	lin	U/v	INV

Satellites to monitor

Nr	Name	Cat No	Info	Type		Dir	BW/kHz
11	FO-99 (Nexus)	42017	2019	lin	V/u	INV	30
12	HO-68 (Xiwang-1/Hope-1)	36122	Beacon	lin	U	INV	50
13	TO-108 (CAS-6)	44881	interm	lin	U/v	INV	20
14	XW-2B (CAS-3B)	40911	Beacon	lin	U/v	INV	20
15	XW-2D (CAS-3D)	40907	Beacon	lin	U/v	INV	20
16	XW-2E (CAS-3E)	40909	Beacon	lin	U/v	INV	20
17	AO-73 (FUNcube-1)	39444	TLM	lin	U/v	INV	20
18	EO-88 (Nayif-1)	42017	TLM	lin	U/v	INV	30
19	Athenoxat-1 (9V1FC Giulio)	41168	TLM		U	-	-

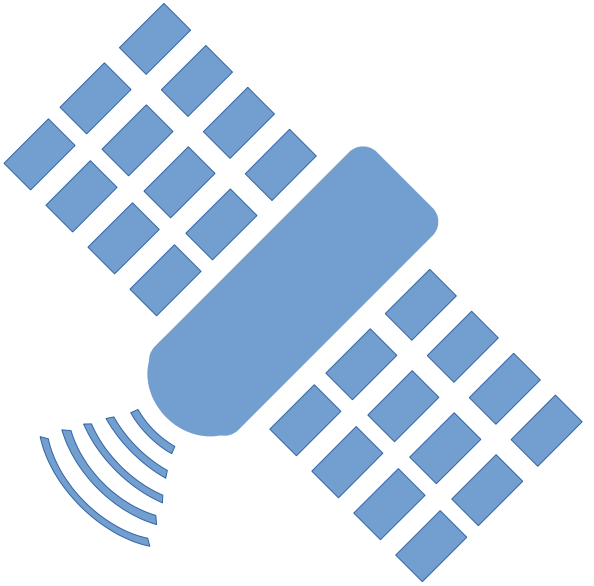
Operation planning

Find the best timeslot during a day
to work as many satellites as possible:
“Satellite operation outdoor planning” SOOP

Python program

https://github.com/9V1KG/soop

Demo



Sked

Satellite(s):

RS-44

☐ Show Extra Options (All extra inputs are optional)

Grid1:

PK04lc

Grid2:

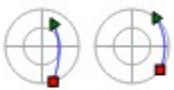
OJ11xi

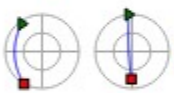
Submit

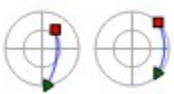
Satmatch:
https://www.satmatch.com

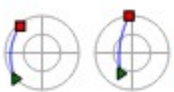
Overlapping passes between PK04lc and OJ11xi (2346km) using RS-44

Searching for 24 hours starting 2021-07-19 at 03:59:07Z


RS-44-2021-07-19 13:23:48Z(+16 min 41 seconds)


RS-44-2021-07-19 15:13:28Z(+18 min 41 seconds)


RS-44-2021-07-20 01:39:31Z(+13 min 40 seconds)


RS-44-2021-07-20 03:34:51Z(+13 min 59 seconds)

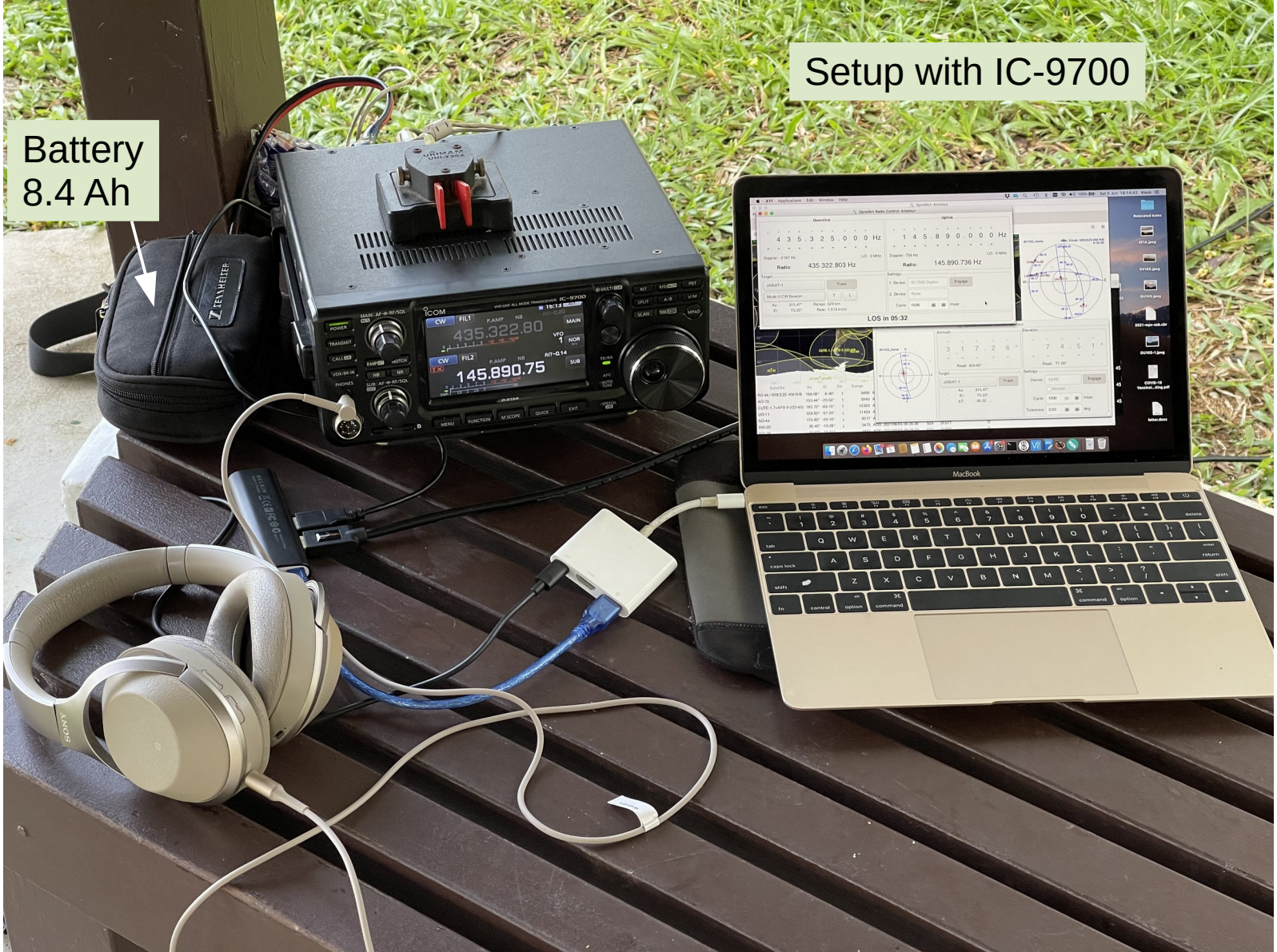
9V1KG


9V1KG
Ready to go!

Active USB Extension

Az/El Rotator
+ Antenna

Dual Band
Log per ant


Setup with IC-9700
Battery
8.4 Ah
TELWIN
ICOM
IC-9700
435.322.80
145.890.75
MacBook

9V1KG

9V1KG

IC-9700 Sat Mode

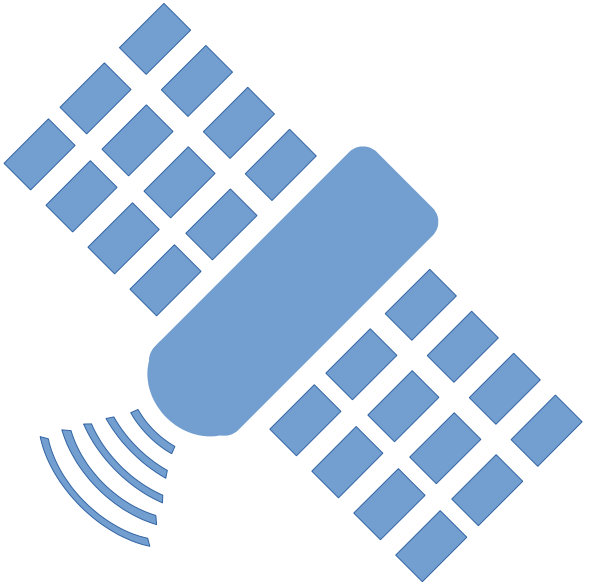
- Use Sat Mode
- Settings
  - Main: RX (Downlink)
  - Sub: TX (Uplink)
  - Rev/Nor
  - RIT

FT-818

- There is a special FT-818 interface mode in Gpredict “FT-817 auto”

- Use VFO A (RX) and VFO B (TX) in split mode
- In receive periods Gpredict will switch between A and B to set Doppler shift

Audio samples



APRS

- Lapan-A2, ISS
- 145.825 Mhz, simplex
- Use VFO A and B in split mode
- Path: ARISS,SGATE,WIDE2-1
- For IC9700 use 2nd serial I/F with DTR for PTT
  - Set Connectors -> USB SEND/Keying -> USB(B) DTR
- Interface
  - IC-9700: USB interface
  - FT-818: Soundcard Interface
  - SDR: UDP from GQRX
  - Direwolf as SW TNC
- Xastir

Direwolf for AFSK, GFSK

GQRX settings for udp

Direwolf software modem via udp

```
dire-airspy.conf:

# Airspy mini
ADEVICE  udp:7355  default
ARATE  48000

~$direwolf -c dire-airspy.conf -t 0

Reading config file dire-spy.conf
Audio input device for receive: udp:7355  (channel 0)
Audio out device for transmit: default  (channel 0)
Channel 0: 1200 baud, AFSK 1200 & 2200 Hz, E+, 48000
sample rate, DTMF decoder enabled.

Note: PTT not configured for channel 0. (Ignore this if
using VOX.)
Ready to accept AGW client application 0 on port
8080 ...
Ready to accept KISS TCP client application 0 on port
8081 ...
```

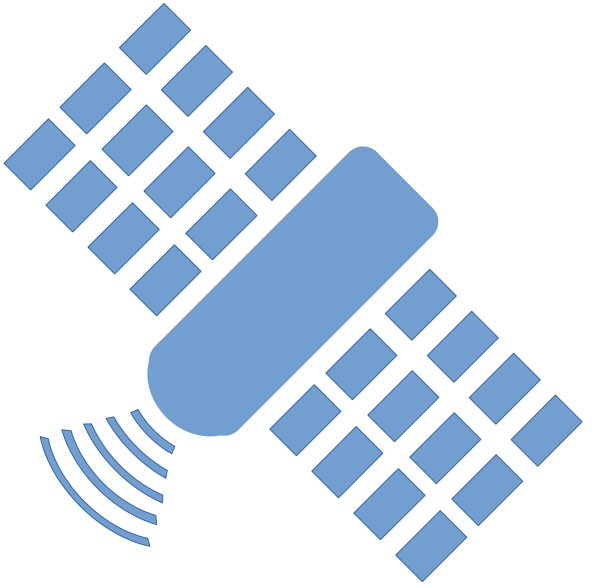
Practical Experiences (1)

- FT-818 & SDR
  - Working duplex with FT-818 & SDR: delay of received signal, you cannot do CW and listen to your own signal from the satellite
  - Setup requires lots of cable connections, always risk of failures
- IC-9700
  - Heavy (4.5 kg), but very convenient to operate in SAT mode
  - 15 to 20 Wh power consumption reasonable, 3 h operation with 110 Wh battery
  - Use RIT to tune RX frequency
  - Don’t forget to switch correct mode (INV/NOR)

Practical Experiences (2)

- Macbook
  - All necessary software runs under MacOS
  - Macbook can be powered by the battery via car adapter – consumption 9 - 10 Wh
  - In sunshine Macbook can get extremely hot and reduces performance
- Raspberry
  - You can run the same software packages as shown for Mac
  - You need additional tablet (VNC) or keyboard & display ...
- Satellites
  - RS-44 my favorite (footprint!)
  - As with many other “special” ham radio modes, very low activity in Asia

Telemetry



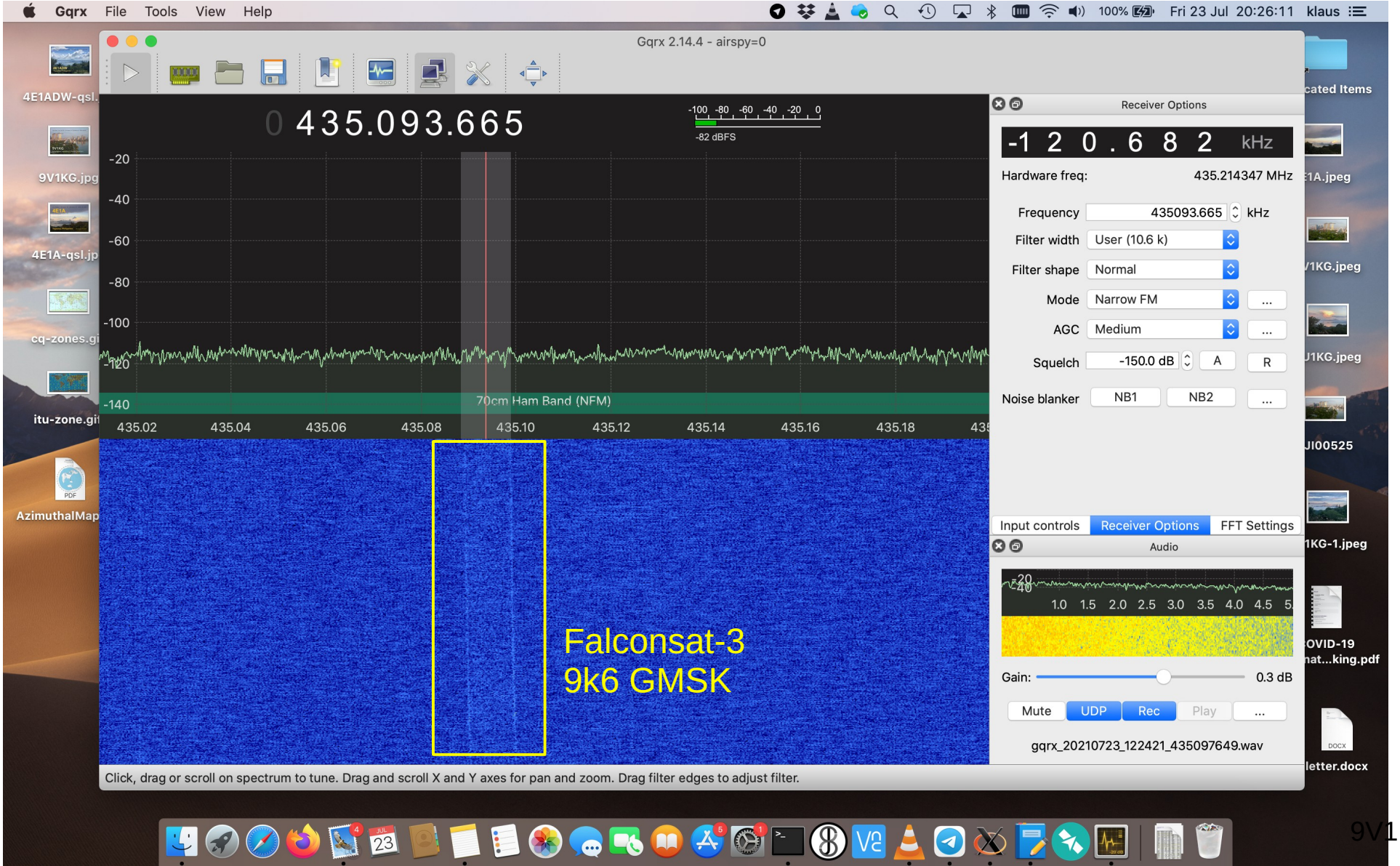
Telemetry

Mode	Mod	BW	Remark
CW	CW USB	1 kHz	
BPSK 1200	USB	10 kHz	
BPSK 2400	USB	15 kHz	
BPSK 9600	USB	20 kHz	
BPSK/ AX25	USB	10 kHz	Delfi-C3 DO-64
BPSK/ FEC	USB	10 kHz	FUNcube AO-73

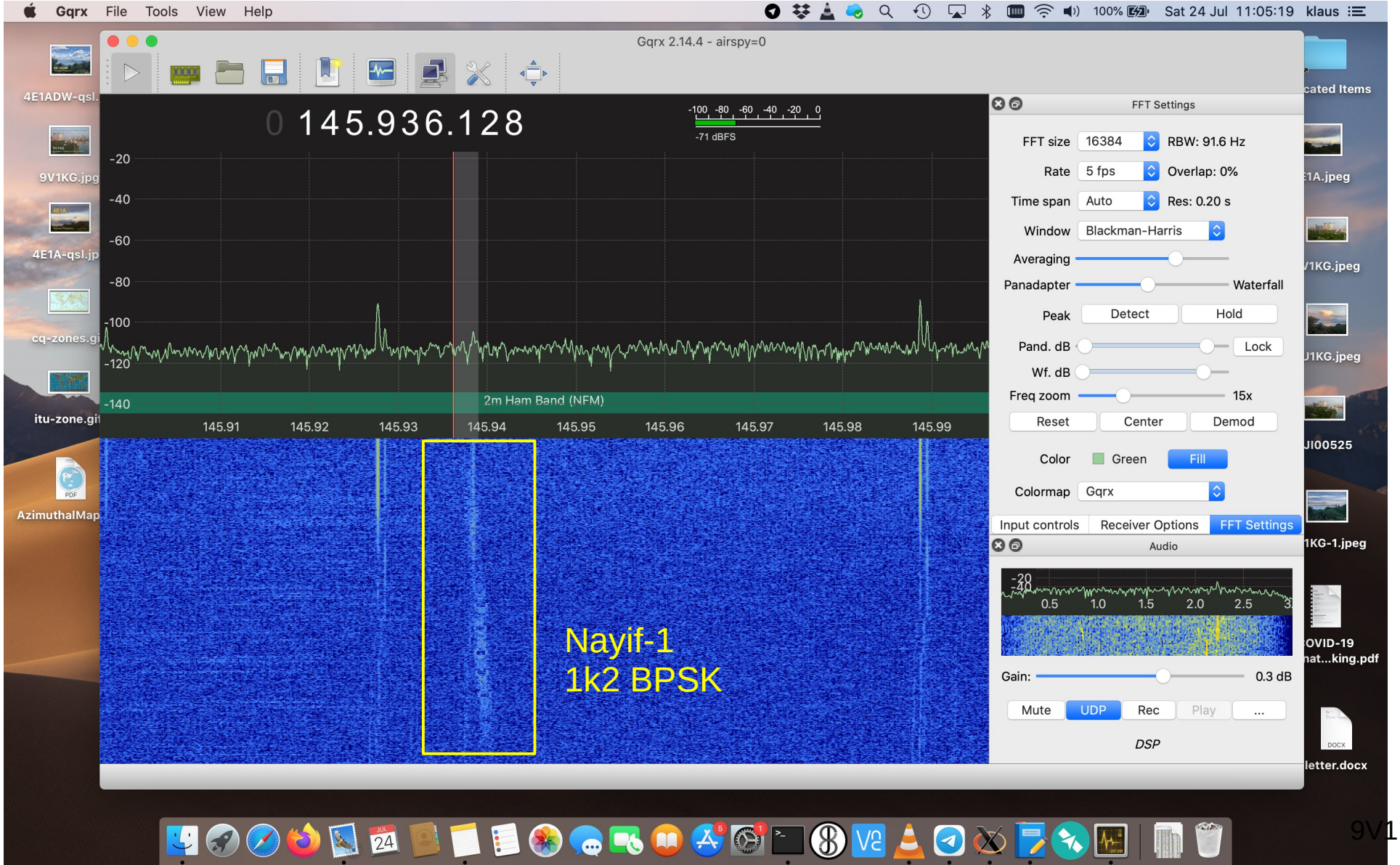
Mode	Mod	BW	Remark
AFSK 1200	NFM	10 kHz	AX25 and non-AX25
GMSK 2400	NFM	15 kHz	FEC
GMSK 4800	NFM	15 kHz	FEC/Mobitex
GMSK 9600	NFM	15 kHz	FEC
GMSK 19200	NFM	25 kHz	
GMSK 9600	NFM	10 kHz	AX25 and non-AX25

Source: PE0SAT

9V1KG

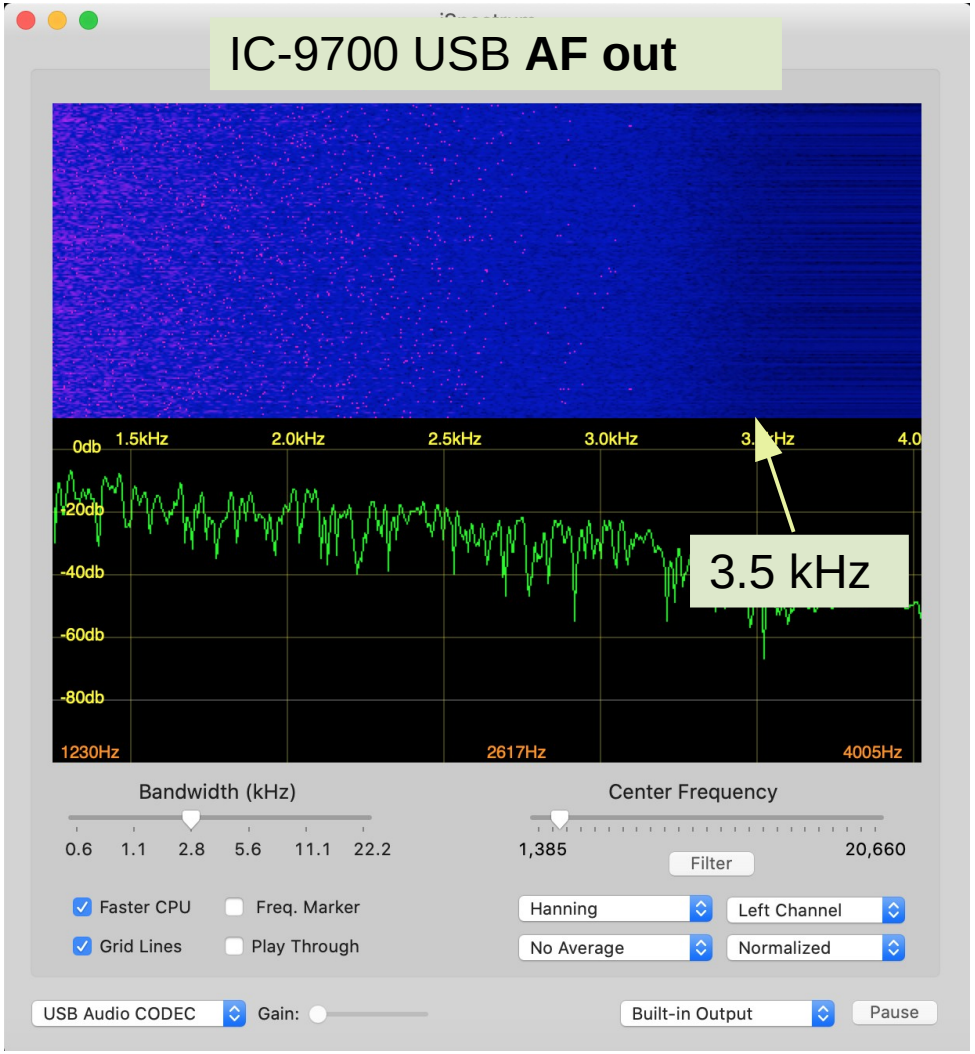

Gqrx File Tools View Help
Fri 23 Jul 20:26:11 klaus
Gqrx 2.14.4 - airspy=0
0 435.093.665
-82 dBFS
70cm Ham Band (NFM)
435.02 435.04 435.06 435.08 435.10 435.12 435.14 435.16 435.18
Falconsat-3
9k6 GMSK
Receiver Options
-120.682 kHz
Hardware freq: 435.214347 MHz
Frequency 435093.665 kHz
Filter width User (10.6 k)
Filter shape Normal
Mode Narrow FM
AGC Medium
Squelch -150.0 dB A R
Noise blanker NB1 NB2
Input controls Receiver Options FFT Settings
Audio
Gain: 0.3 dB
Mute UDP Rec Play
gqrx_20210723_122421_435097649.wav
Click, drag or scroll on spectrum to tune. Drag and scroll X and Y axes for pan and zoom. Drag filter edges to adjust filter.
4E1ADW-qsl...
9V1KG.jpg
4E1A-qsl.jp
cq-zones.gi
itu-zone.gif
AzimuthalMap
cated Items
E1A.jpeg
V1KG.jpeg
J1KG.jpeg
JI00525
1KG-1.jpeg
OVID-19
hat...king.pdf
letter.docx

9V1KG

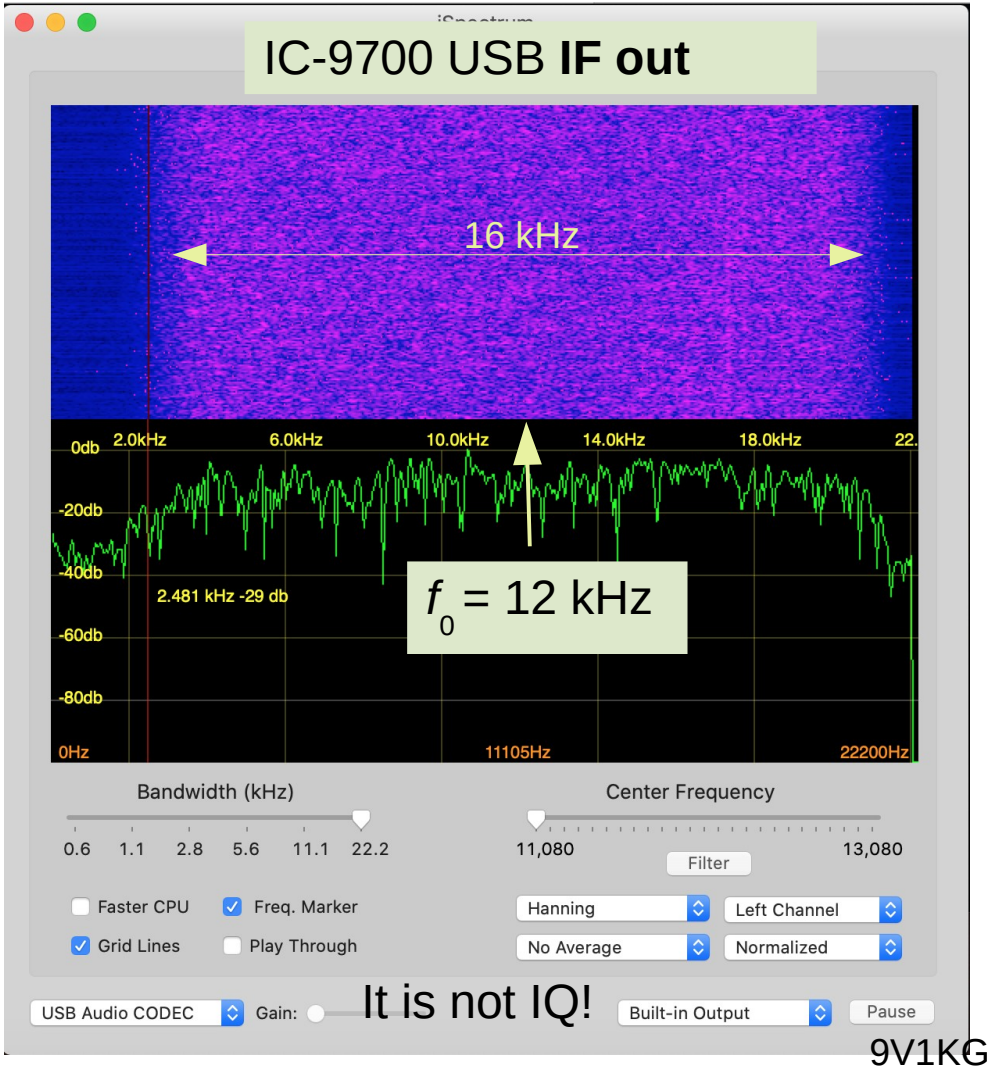

Gqrx File Tools View Help
Sat 24 Jul 11:05:19 klaus
Gqrx 2.14.4 - airspy=0
0 145.936.128
-71 dBFS
2m Ham Band (NFM)
145.91 145.92 145.93 145.94 145.95 145.96 145.97 145.98 145.99
Nayif-1
1k2 BPSK
FFT Settings
FFT size 16384 RBW: 91.6 Hz
Rate 5 fps Overlap: 0%
Time span Auto Res: 0.20 s
Window Blackman-Harris
Averaging
Panadapter Waterfall
Peak Detect Hold
Pand. dB Lock
Wf. dB
Freq zoom 15x
Reset Center Demod
Color Green Fill
Colormap Gqrx
Input controls Receiver Options FFT Settings
Audio
Gain: 0.3 dB
Mute UDP Rec Play ...
DSP
4E1ADW-qsl...
9V1KG.jpg
4E1A-qsl.jp
cq-zones.gi
itu-zone.gif
AzimuthalMap
cated Items
E1A.jpeg
V1KG.jpeg
U1KG.jpeg
UI00525
1KG-1.jpeg
OVID-19
hat...king.pdf
letter.docx

9V1KG

IC-9700 USB **AF out**



IC-9700 USB **IF out**



It is not IQ!

9V1KG

Telemetry

gr_satellites

Collection of telemetry decoders that supports many different amateur radio satellites

Software:
https://github.com/daniestevez/gr-satellites

Documentation:
https://gr-satellites.readthedocs.io/en/latest/

```
~$ gr_satellites Nayif-1 -udp -samp_rate 48E3
```

```
-> Packet from 1k2 BPSK downlink
Frame type HR5
----------------------------------------
Realtime telemetry:
----------------------------------------
Container:
   eps = Container:
        photovoltage = ListContainer:
            4415
            4425
            4086
        batteryvoltage = 8299
        photocurrent = ListContainer:
            370
            181
            338
        totalphotocurrent = 403
        systemcurrent = 258
        rebootcount = 16
        resetcause = 3
        MPTTmode = 1
```

Nayif-1 2021-07-14 2:40

Telemetry

EPS: Electronic Power System

Container:
eps = Container:
photovoltage =
ListContainer:
3658
3596
3717
batteryvoltage = 8309

photocurrent = ListContainer:
176
317
568
totalphotocurrent = 403
systemcurrent = 283
rebootcount = 162

boostconvertertemp = ListContainer:
6
7
8
batterytemp = 5
latchupcount5v = 0
channelcurrent5v = 3
resetcause = 3
MPTTmode = 1

IMTQ: Attitude determination & control

imtq = Container:
imtqmode = (enum) selftest 1
imtqerrorcode = 5
imtqconfigurationset = 1
imtqmcutemperature = 85

asib = Container:
sunsensor = ListContainer:
18
51
65
25
66
191
3v3voltage = 2044
imtquptime = 69905
5voltage = 3042

ASIB: AMSAT Special Interface board

rf = Container:
rxdoppler = 117
rxrssi = 255
temp = 35.98400000000001
rxcurrent = 40.704
tx3v3current = 50.88
tx5vcurrent = 55.968

pa = Container:
revpwr = 27.468122006568784
fwdpwr = 427.7894173336508
boardtemp = 184
boardcurr = 122.35629999999999

ants = Container:
temp = ListContainer:
150
149

deployment =
ListContainer:
True
True
True
True

sw = Container:
seqnumber = 1166597
dtmfcmdcount = 0
dtmflastcmd = 0
dtmfcmdsuccess = False

datavalid = ListContainer:
True
True
True
True
False
True
True
eclipse = False
safemode = False
hwabf = True
swabf = False
deploymentwait = False

9V1KG

Summary

- Ham radio via satellites is an interesting part of our hobby
- Try out the linear satellites with CW or SSB instead of FM – more challenging, but rewarding
- Duplex is a must!
- Portable operation is possible
- Decoding of TLM requires better antennas than a simple portable yagi or log. per. (e.g. circular pol., more elements)

References (1)

- Satellites
  - Satellite database (N2YO): https://www.n2yo.com/
  - Celestrak (TLE data): https://celestrak.com/
  - Satlist JE9PEL: http://www.ne.jp/asahi/hamradio/je9pel/satslist.htm
  - Communication Satellites (AMSAT): https://www.amsat.org/two-way-satellites/
  - Satellite Status (AMSAT): https://www.amsat.org/status/
  - SatNOGS Network: https://network.satnogs.org/

References (2)

- Hardware
  - SARC MK1 rotator: https://www.sarcnet.org/rotator-mk1.html
- Software
  - Gpredict: http://gpredict.oz9aec.net/index.php
  - Hamlib: https://hamlib.github.io/
  - Direwolf: https://github.com/wb2osz/direwolf
  - GQRX: https://github.com/csete/gqrx
  - Rotor: https://apps.apple.com/us/app/rotor/id1559024873

References (3)

- Software Utilities & Others
  - Satellite operation outdoor planning (SOOP): https://github.com/9V1KG/soop
  - Satmatch: https://www.satmatch.com
  - gr-satellites (TLM decoders): https://github.com/daniestevez/gr-satellites
  - gr-satellites documentation: https://gr-satellites.readthedocs.io/en/latest/
  - Skyfield (Python module): https://rhodesmill.org/skyfield/

Thank You!

9V1KG