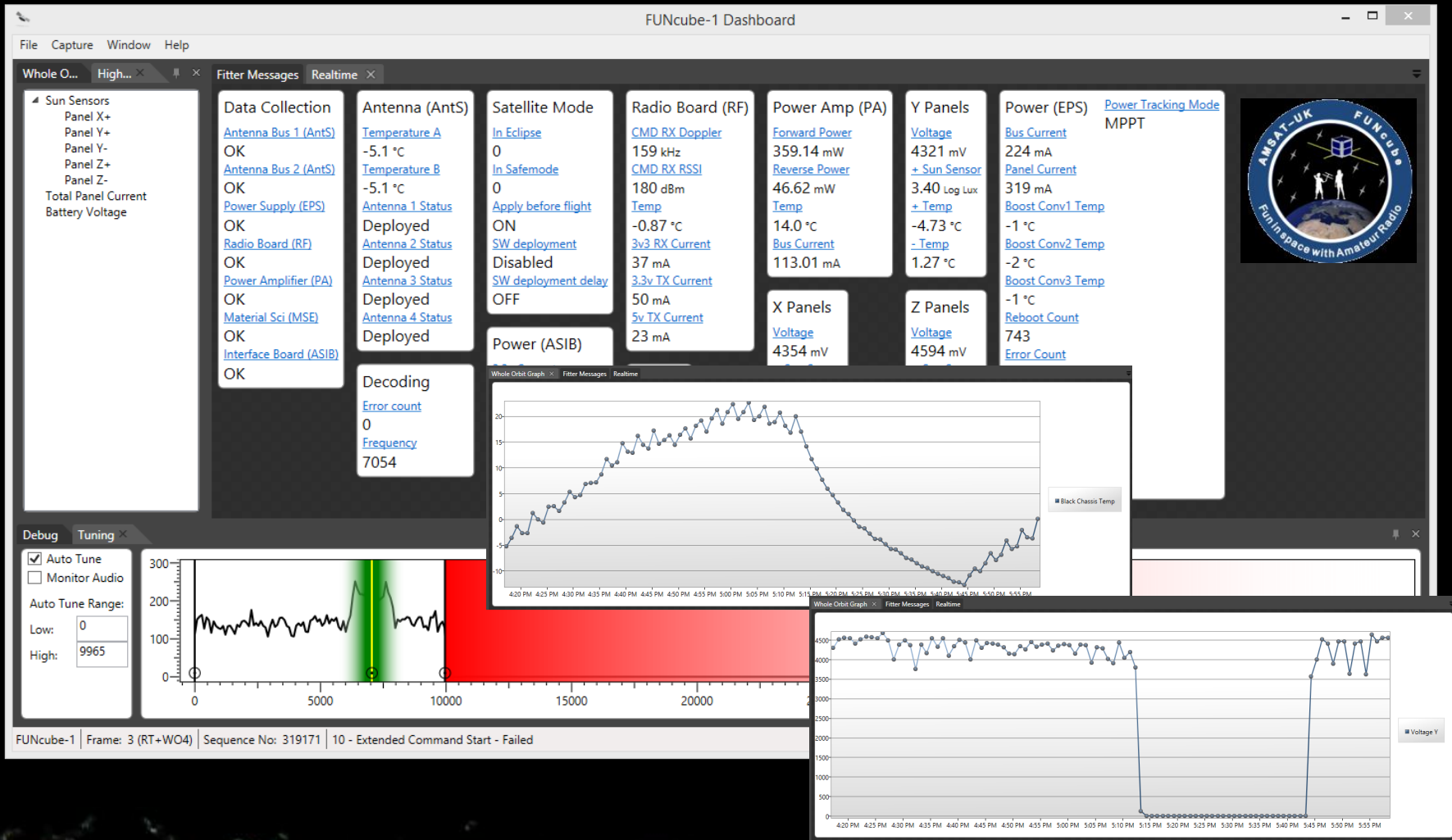


FUNcube-1 (AO-73)

2 Meter Satellite Telemetry



David Haworth, WA9ONY
www.stargazing.net/david

CubeSat: Small Standard Size Satellites

- Standard sizes
 - 1U: 10 cm cube, mass <1.33 kilograms
 - 2U: 2x1U
 - 3U: 3x1U
- Common deployment system
 - Poly-PicoSatellite Orbital Deployer (P-POD)



Image Credit: CubeSat Design Specification Rev. 13

FUNcube-1 Satellite

👁️ AMSAT-UK

👁️ <http://amsat-uk.org/>



AMSAT-UK

Radio Amateur Satellites

👁️ FUNcube

👁️ <http://funcube.org.uk/>

👁️ FUNcube Warehouse

👁️ <http://warehouse.funcube.org.uk/>



👁️ AMSAT-NL

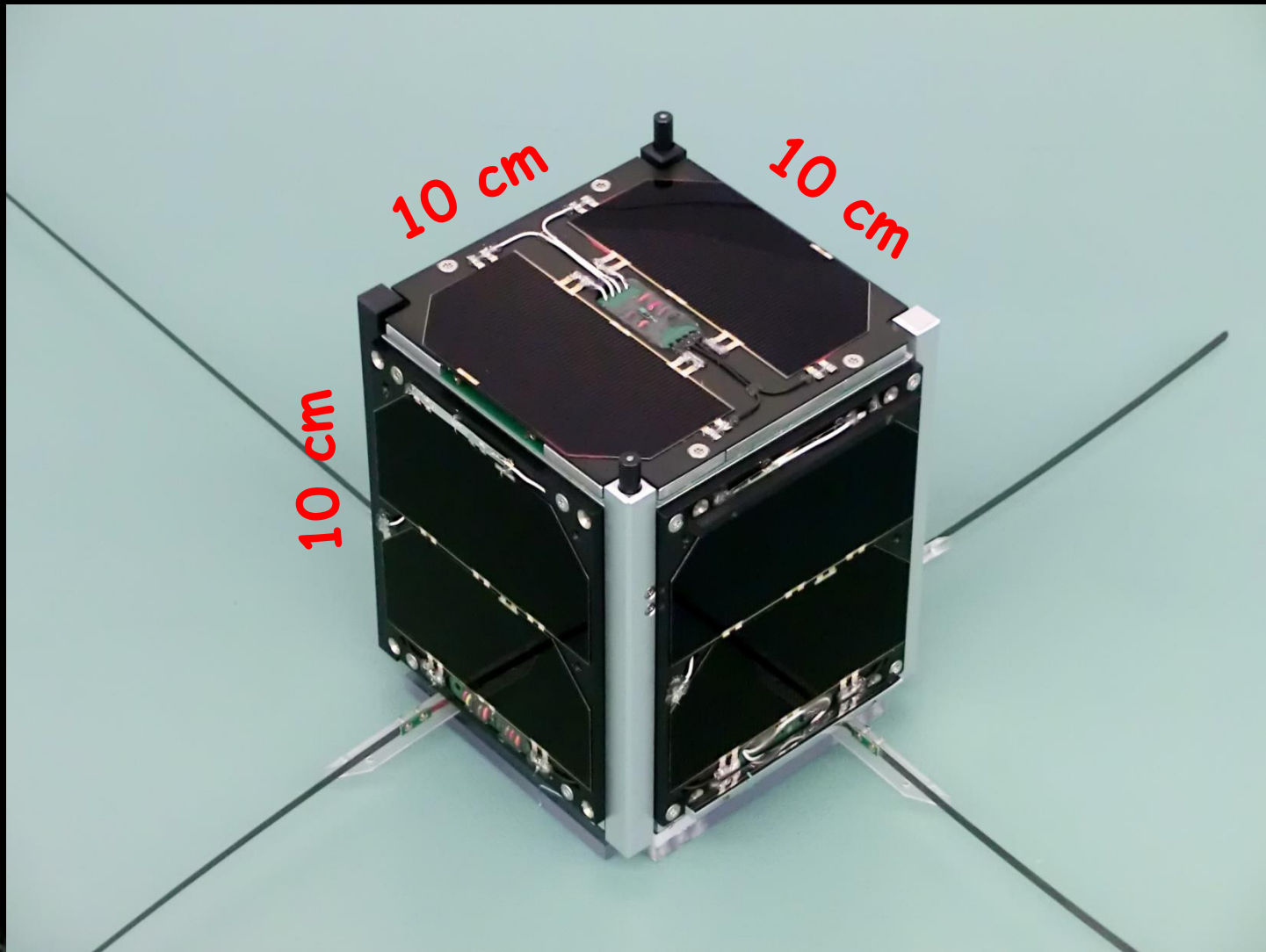
👁️ <http://amsat-nl.org/>



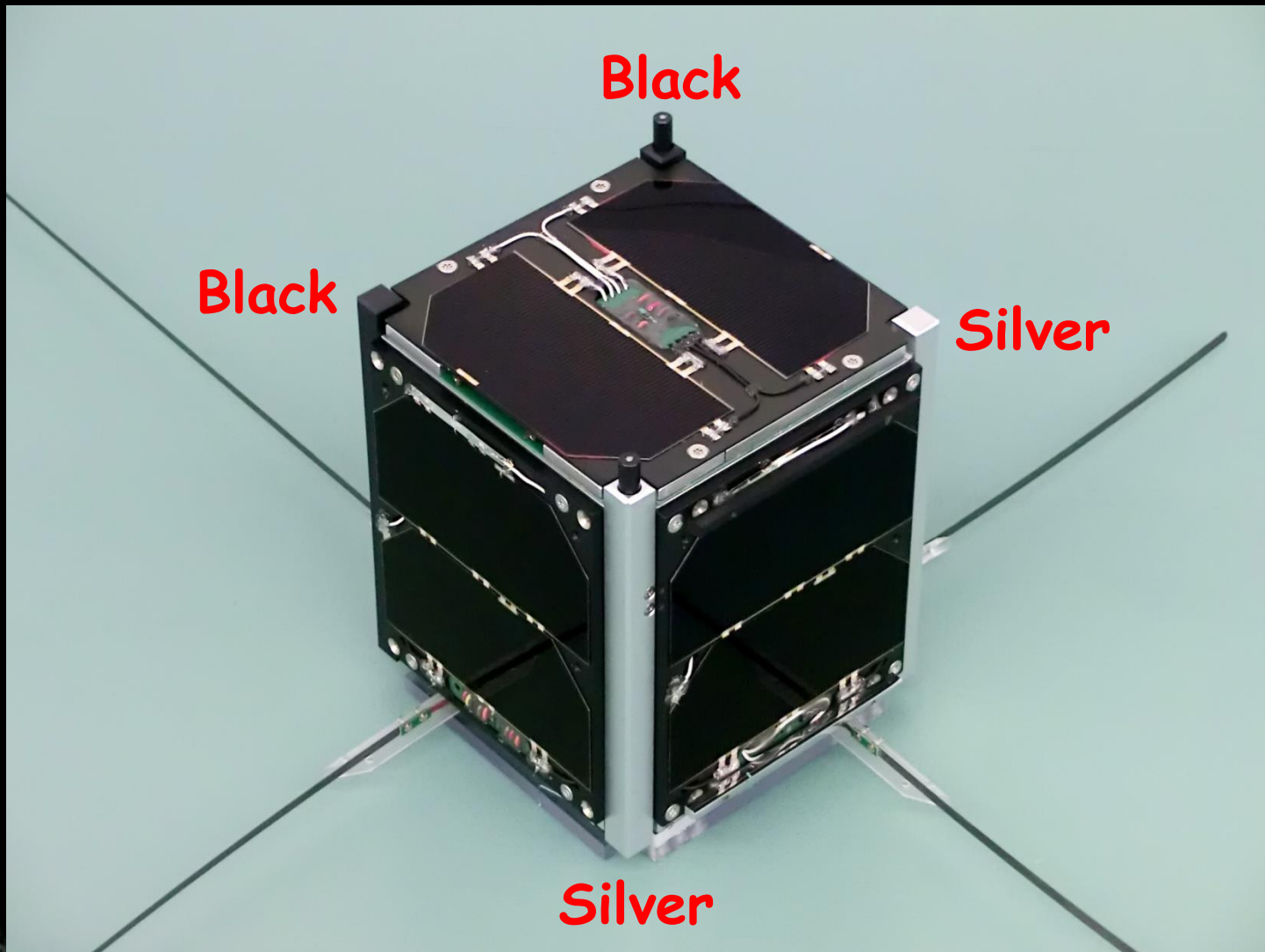
AMSAT-NL

Radio Amateur Satellites

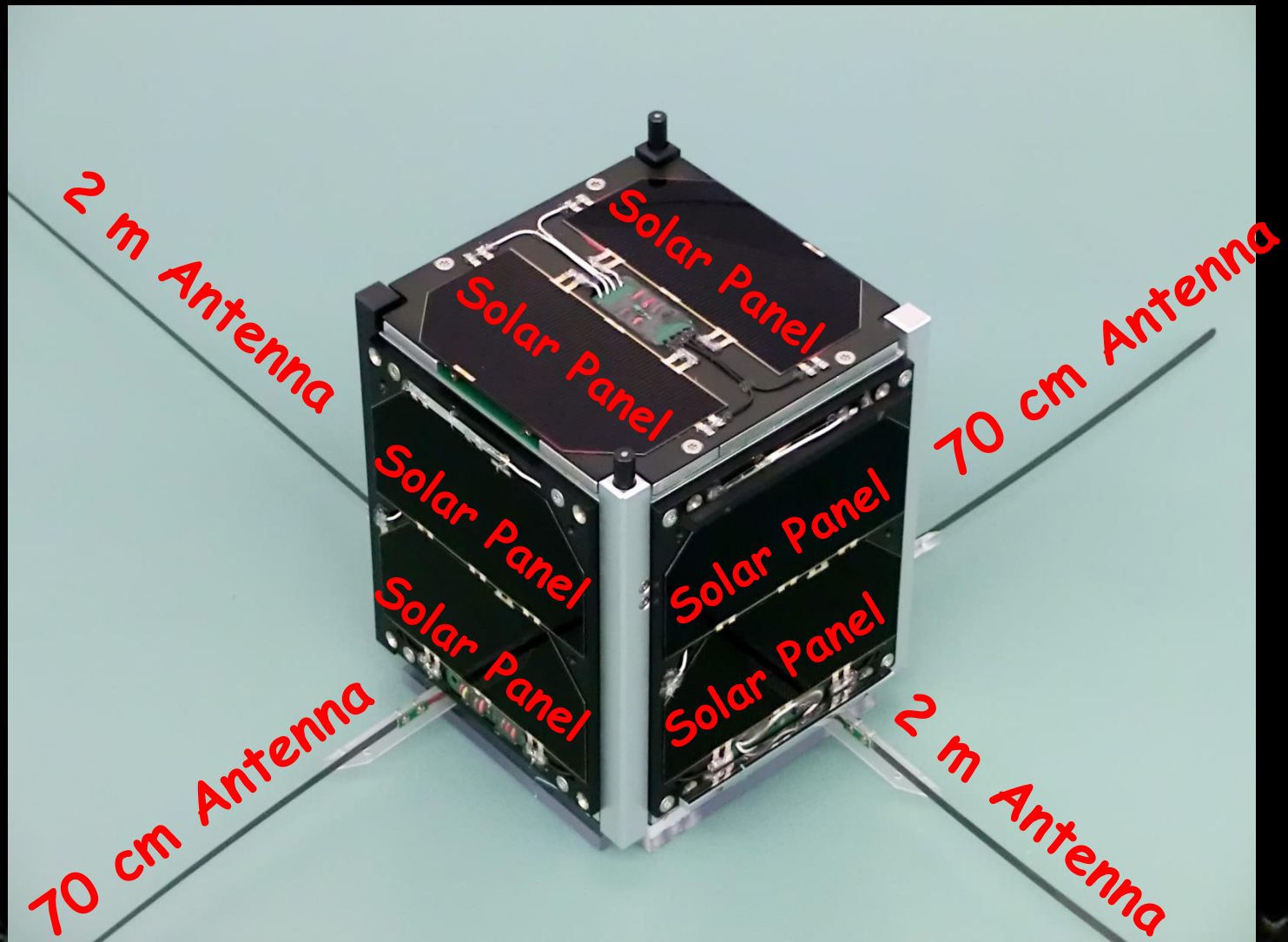
1U CubeSat: FUNcube-1, AO-73



1U CubSat: FUNcube-1, AO-73



1U CubSat: FUNcube-1, AO-73



FUNcube-1, AO-73

Launch Date: November 2013, Mission Goal 1 Year



Mission type	Amateur Radio
Operator	AMSAT-NL
COSPAR ID	2013-066AE
SATCAT №	39444
Website	funcube.org.uk 
Spacecraft properties	
Bus	1U CubeSat ^[1]
Manufacturer	ISIS-BV, AMSAT-NL, AMSAT-UK
Launch mass	0.98 kilograms (2.2 lb)
Power	2.2 watts
Start of mission	
Launch date	21 November 2013
Rocket	dnepr
Launch site	Yasny Launch Base
Contractor	ISL
Orbital parameters	
Reference system	Geocentric
Regime	Low Earth

FUNcube-1 Telemetry (TLM)

2 Modes: High Power M-F Mornings, Low Power Other Times

- ☉ In sunlight full power 300 mW TLM
 - ☉ TLM down link freq 145.935 MHz +/- Doppler
 - ☉ Monday - Friday mornings Europe time
 - ☉ Transponder off

Satellite Status
Mode switching: Auto
Transponder state: Off

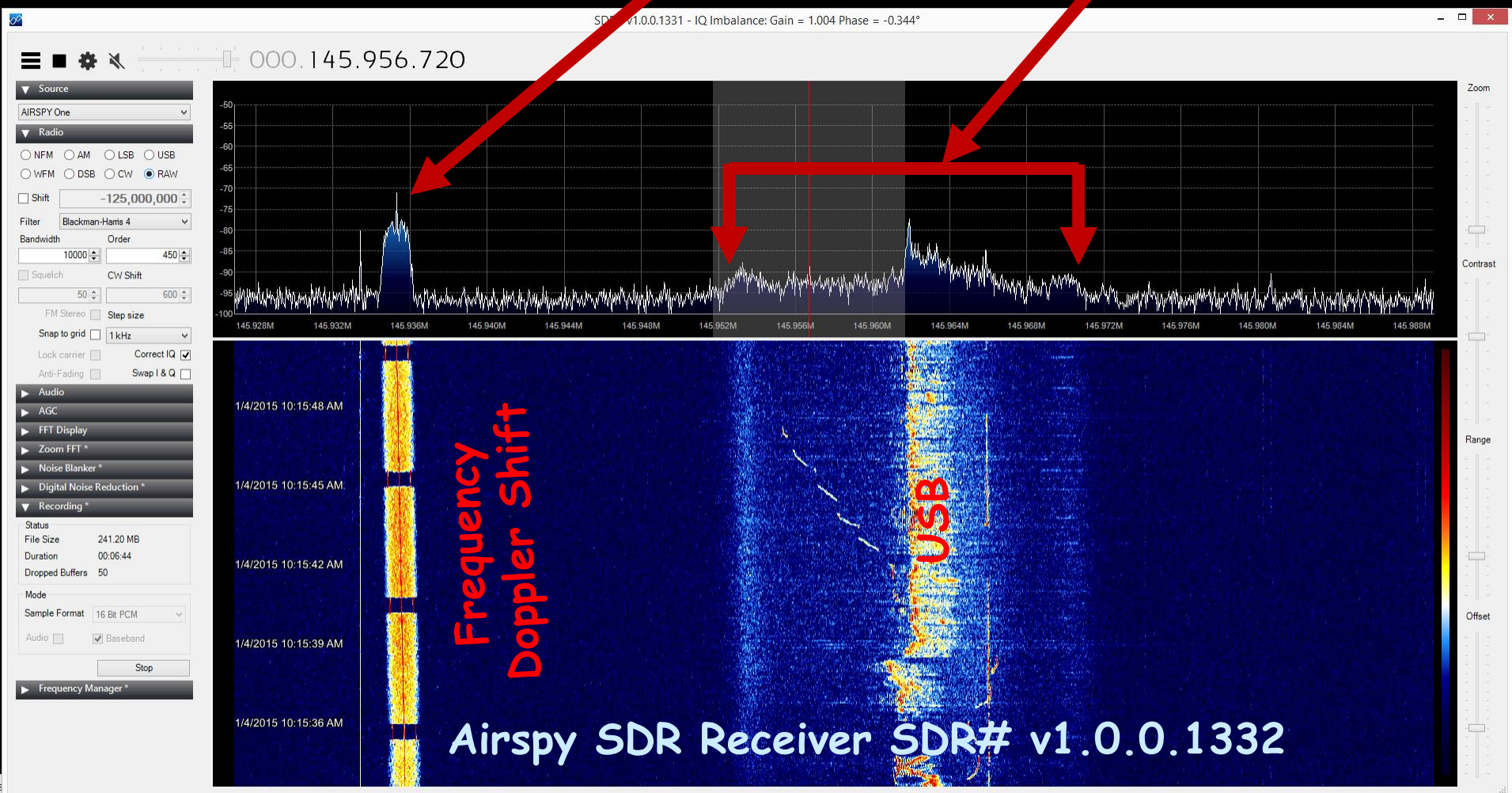
- ☉ In eclipse low power 30 mW TLM plus
 - ☉ Transponder evenings & weekends
 - ☉ Surface to satellite to surface communications
 - ☉ Uplink 435.150 - 435.130 MHz CW & LSB (Inverting)
 - ☉ Downlink 145.950 - 145.970 MHz CW & USB

Satellite Status
Mode switching: Manual
Transponder state: On

FUNcube-1 Telemetry (TLM)

Low power TLM beacon with transponder

Satellite Status
Mode switching: Manual
Transponder state: On



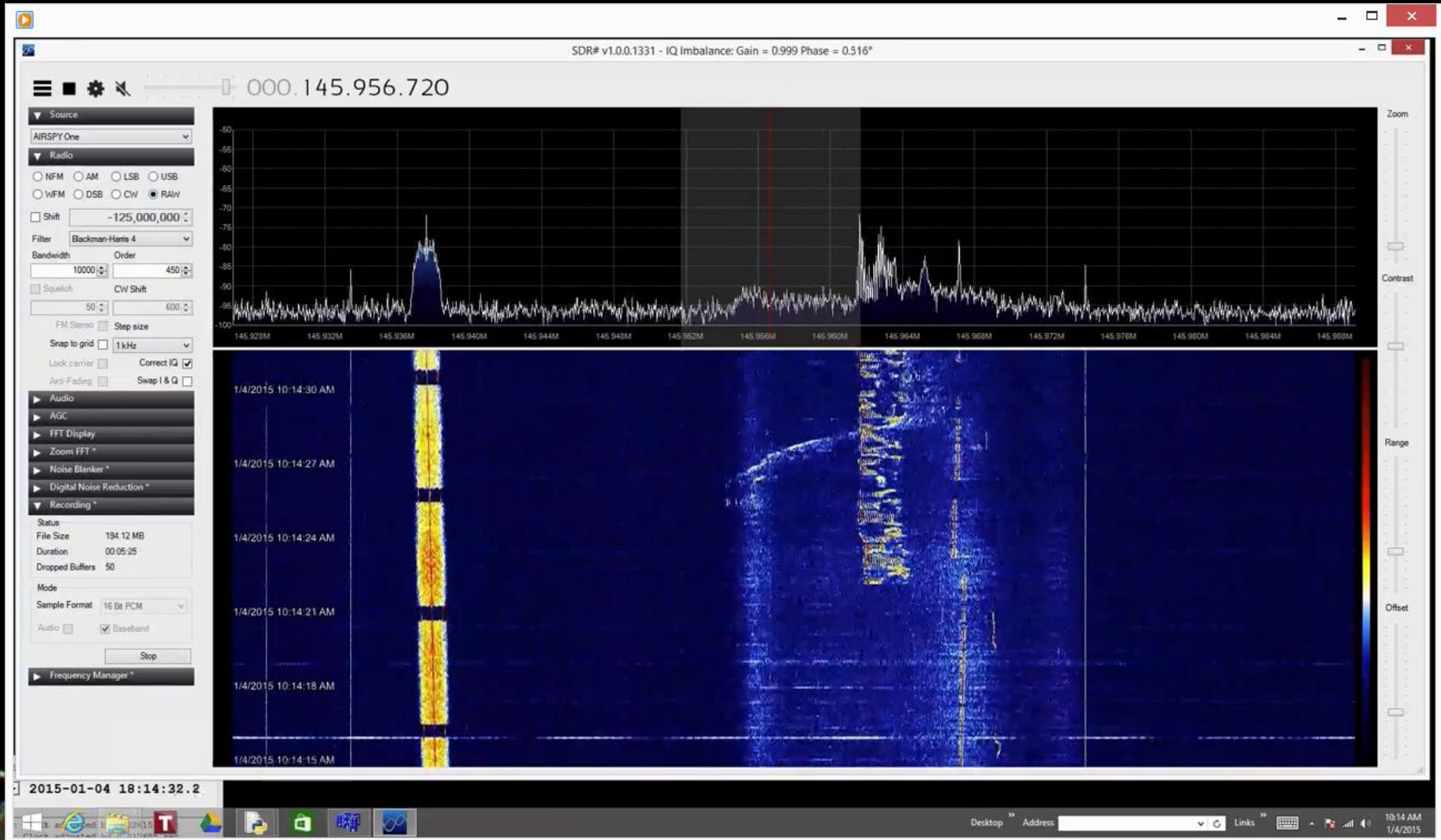
Frequency
Doppler Shift

USB

Airspy SDR Receiver SDR# v1.0.0.1332

Satellite FUNcube-1 with Airspy

<https://youtu.be/A52CzLLtbTY>



What is Needed to Receive TLM

- ② 2 m antenna
- ② 2 m USB receiver
- ② Windows PC
 - ② With audio line input
 - ② Internet connection
- ② FUNcube-1 Dashboard software
- ② Satellite position information

WA9ONY Receiving Equipment

SDR with a 4 element Yagi antenna

- Antenna: 4 elements Yagi Arrow II Portable Antenna Model 146-4 II
- <http://arrowantennas.com/arrowii/146-4ii.html>



WA90NY Receiving Equipment

SDR with a 4 element Yagi antenna

- ◉ Receiver: Airspy software defined radio (SDR)
 - ◉ SDR# V1.0.0.1337 software for Airspy
 - ◉ <http://www.sdrsharp.com/>
 - ◉ Optional
 - ◉ Preamp: Mini-Circuits ZFL-500LN+ Amplifier 24 db.
 - ◉ Filters: after the preamp
 - ◉ Mini-Circuits VHF-145+ 140 to 1150 MHz high pass filter.
 - ◉ Mini-Circuits BLP-200 190 MHz low pass filter.

WA90NY Receiving Software

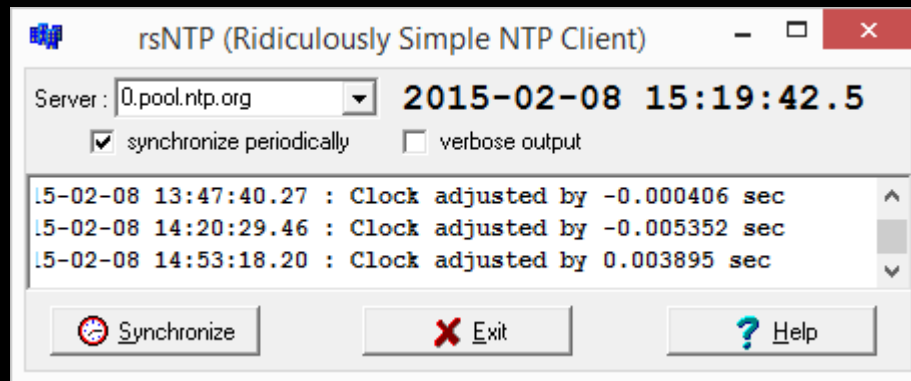
i7 core laptop with Windows 8.1

- Behringer XENYX 302 USB audio mixer to USB
 - Audio line input
 - <http://www.behringer.com/EN/Products/302USB.aspx>
- FUNcube Telemetry Dashboard v848
 - <http://funcube.org.uk/working-documents/funcube-telemetry-dashboard/>

WA90NY Software

i7 core laptop with Windows 8.1

- Ridiculously Simple Network Time Protocol (NTP) Client
 - by Wolfgang "Wolf" DL4YHF for time keeping
 - <http://www.qsl.net/dl4yhf/rsNTP/rsNTP.htm>



- IrfanView 4.38 for taking screen captures
 - <http://www.irfanview.com/>

SDR# & Dashboard

MOVE-1 CW Beacon

The screenshot displays a Windows desktop environment. On the left, a dashboard window titled 'Fitter Messages Realtime' shows various sensor data:

- Sun Sensors:** Panel X+, Panel Y+, Panel Z+, Total Panel Current, Battery Voltage.
- Data Collection:** Antenna Bus 1 (AntS) OK, Antenna Bus 2 (AntS) OK, Power Supply (EPS) OK, Radio Board (RF) OK, Power Amplifier (PA) OK, Material Sci (MSE) OK, Interface Board (ASIB) OK.
- Antenna (AntS):** Temperature A (5.8 °C), Temperature B (5.8 °C), Antenna 1 Status (Deployed), Antenna 2 Status (Deployed), Antenna 3 Status (Deployed), Antenna 4 Status (Deployed).
- Decoding:** Error count (25), Frequency (5220).

The central window is SDR# v1.0.0.1331 - IQ Balance: Gain = 1.001 Phase = -0.057°. The frequency is set to 000.145.933.529. The interface includes a spectrum plot at the top and a waterfall plot below. A red arrow points from the title 'SDR# & Dashboard' to the SDR# window. The waterfall plot shows a CW beacon signal at the specified frequency. The status bar at the bottom indicates 'Capturing | 17/1 | 14/3 - OK | Detected Frequency 5220 Hz'.

FUNcube-1 Signal Fading

MOVE-1 CW Beacon

The screenshot displays the SDR# v1.0.0.1331 interface. The main window shows a waterfall plot of the signal at 145.933.518 MHz. A red arrow points to a vertical dashed line in the waterfall plot, indicating the signal's position. The signal is a CW beacon, and its amplitude is shown to be fading over time. The interface includes various controls for source, radio, filter, bandwidth, and audio. A status bar at the bottom shows the detected frequency as 2653 Hz. A taskbar at the bottom of the screen shows various system icons and the system clock.

SDR# v1.0.0.1331 - IQ Imbalance: Gain = 0.996 Phase = 0.229°

000.145.933.518

Source: AIRSPY One

Radio: NFM, AM, LSB, USB, WFM, DSB, CW, RAW

Filter: Blackman-Harris 4

Bandwidth: 10000, Order: 500

Resolution: 4096

View: Both

Window: Blackman-Harris 4

rsNTP (Ridiculously Simple NTP Client)

Server: 0.pool.ntp.org 2015-05-03 20:09:01.7

5-05-03 14:23:14.60 : Clock adjust by 0.000000 sec

FUNcube-1 Dashboard, Real Time Data

Name	Value	Min.	Max.
Solar Panel Voltage X	4606 mV	0	5237
Solar Panel Voltage Y	4589 mV	0	5103
Solar Panel Voltage Z	4589 mV	0	5109
Total Photo Current	342 mA	0	426
Battery Voltage	8333 mV	8079	8374

FUNcube-1, AO-73 Position


<http://warehouse.funcube.org.uk/satmap.html?satelliteId=2>

Current Satellite Position



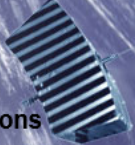
FUNcube-1, AO-73 Position

<http://www.amsat.org/amsat-new/tools/predict/index.php>



AMSAT™

AMSAT Online Satellite Pass Predictions



10605 Concord St, #304
Kensington, MD 20895
1-888-322-6728

AMSAT Online Satellite Pass Predictions - AO-73

[View the current location of AO-73](#)

Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
08 Feb 15	03:58:46	00:11:07	116	14	55	5	04:09:53
08 Feb 15	05:33:17	00:13:36	169	75	240	346	05:46:53
08 Feb 15	07:12:19	00:09:43	229	8	270	321	07:22:02
08 Feb 15	17:20:18	00:11:16	28	17	90	153	17:31:34
08 Feb 15	18:56:16	00:12:39	7	46	276	210	19:08:55
08 Feb 15	20:34:01	00:07:44	345	5	319	270	20:41:45
09 Feb 15	04:18:34	00:12:06	128	21	68	0	04:30:40
09 Feb 15	05:53:57	00:13:32	181	46	271	342	06:07:29
09 Feb 15	07:34:31	00:07:04	247	3	273	311	07:41:35
09 Feb 15	17:40:34	00:12:11	23	27	82	166	17:52:45

Your results are shown above
Use the form below to request more pass predictions

Show Predictions for: for Next Passes

Calculate Latitude and Longitude from Gridsquare:

Or

Enter Decimal Latitude:*

Enter Decimal Longitude:*

Elevation (Metres):

Save my location for later use



Satellite Tracking for AO-73

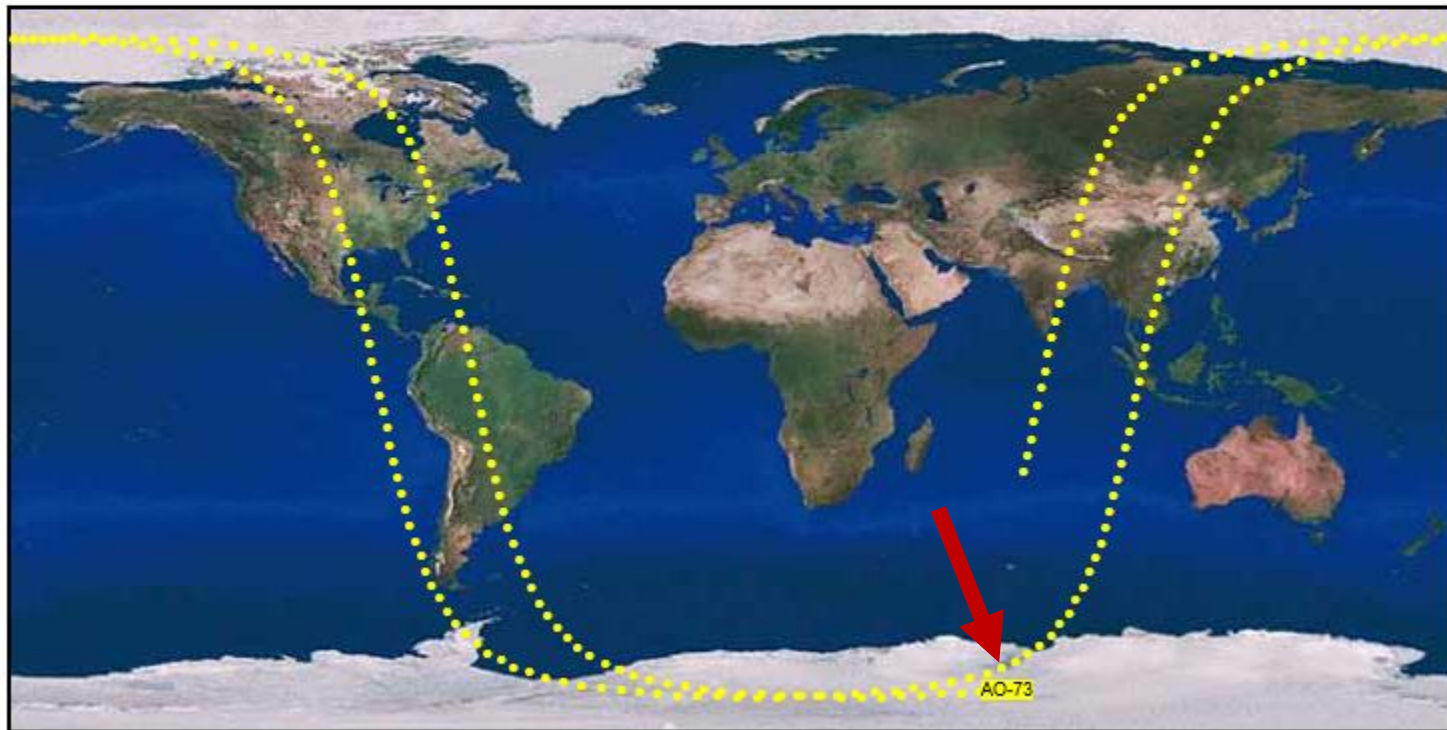


10605 Concord St, #304
Kensington, MD 20895
1-888-322-6728

Current Position of AO-73

Sun, 08 Feb 2015 01:46:43 GMT (17:46:43 local time)

Current Location: 70E 81S



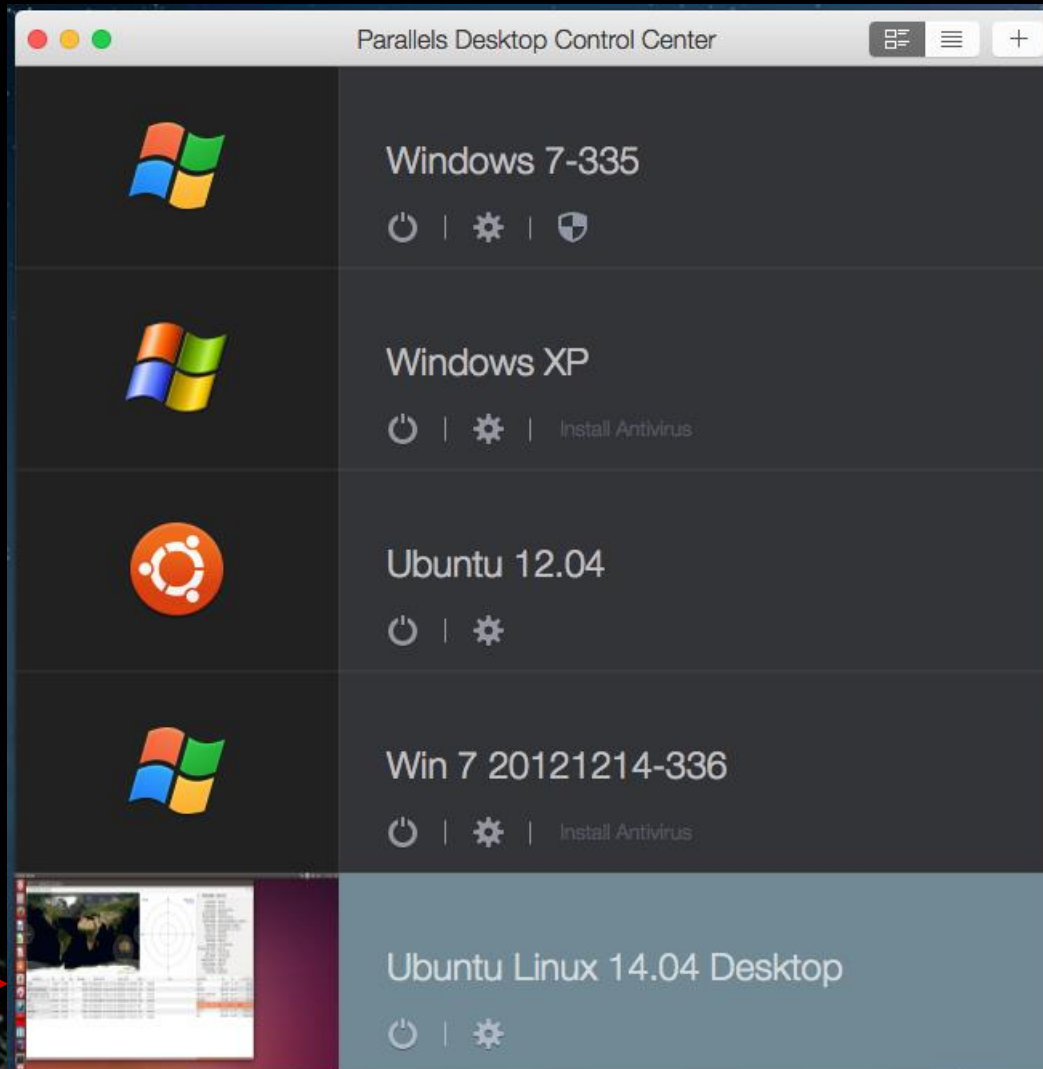
Select a Different Satellite: ▼

Note: Position is approximate and depends on your computer's performance.



Gpredict on MacBook Pro

Ubuntu Linux 14.04 on Parallels Desktop 10





Gpredict on MacBook Pro

Ubuntu 14.04 Software Center Easy Install

GNOME Predict
Satellite tracker
★★★★★ (8 ratings)

✓ Installed on 2014-12-27 Remove

Gpredict is a real time satellite tracking program for GNOME, based on the tracking engine of John Magliacane's excellent satellite tracker Predict.

Gpredict includes the following features:

- Tracking an infinite number of satellites limited only by the physical memory and processing power of the computer.
- Display the tracking data in lists, maps, polar plots or any combination of these.
- You can have many modules open at the same time, either in a notebook or in their own windows. The module can also run in full-screen mode.
- You can use many ground stations. Ground station coordinates can be entered manually or you can get some approximate values from a list with more than 2000 predefined locations worldwide.
- Predict upcoming passes for satellites, including passes where a satellite may be visible and communication windows open.
- Very detailed information about both the real time data and the predicted passes.
- Gpredict can run in real-time, simulated real-time (fast forward and backward), and manual time control.
- Doppler tuning of radios via Hamlib rigctld.
- Antenna rotator control via Hamlib rotctld.

Version gpredict 1.3-2ubuntu2

About GPREDICT

GPREDICT 1.3

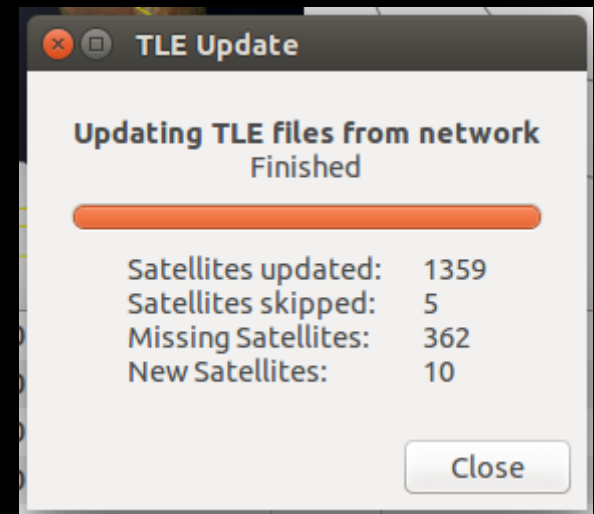
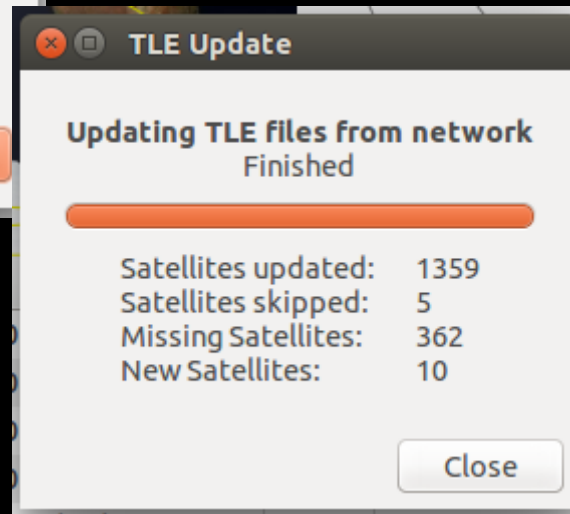
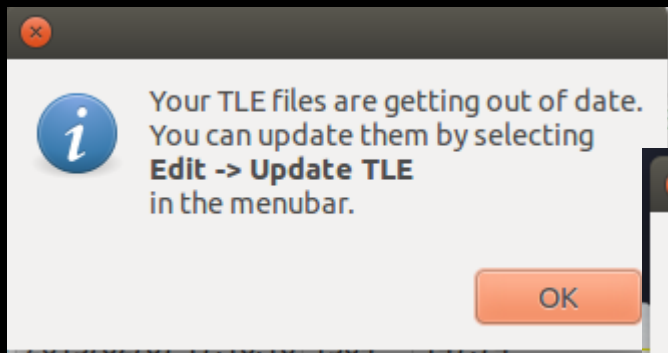
Copyright (C) 2001-2011 Alexandru Csete OZ9AEC

Gpredict is available free of charge from:
<http://gpredict.oz9aec.net/>

Credits License Close

Gpredict Keplerian Elements

Elements define the satellite orbit





Gpredict Custom Layout

Main window has 5 panels

Ubuntu Linux 14.04 Desktop

GNOME Predict

GPREdict: Amateur

2015/02/07 18:42:12
Camas - Camas, WA, USA

FUNCUBE-1 (AO-73)

- Azimuth : 287.60°
- Elevation : 78.13°
- Direction : Approaching
- Slant Range : 630 km
- Range Rate : -0.123 km/sec
- Next Event : LOS: 2015/02/07 18:48:34
- Next AOS : 2015/02/07 20:12:56
- Next LOS : 2015/02/07 18:48:34
- SSP Loc. : CN85BX
- Footprint : 5402 km
- Altitude : 618 km
- Velocity : 7.565 km/sec
- Doppler@100M : 41 Hz
- Sig. Loss : 128.39 dB
- Sig. Delay : 2.10 msec
- Mean Anom. : 211.90°
- Orbit Phase : 297.99°
- Orbit Num. : 6426
- Visibility : Daylight

Satellite	Az	El	Dir	Range	Next AOS	Next LOS	Dop	Loss
AO-7	106.17°	-45.97°	↑	11043	2015/02/07 19:08:05	2015/02/07 19:18:56	1194	153.26
DELFI-C3 (DO-64)	177.25°	-82.54°	↓	13227	2015/02/07 19:27:48	2015/02/07 19:38:04	-287	154.83
FUNCUBE-1 (AO-73)	287.60°	78.13°	↑	630	2015/02/07 20:12:56	2015/02/07 18:48:34	41	128.39
ISS	224.77°	-50.06°	↑	10282	2015/02/08 01:33:29	2015/02/08 01:42:56	69	152.64
NO-44	301.64°	-81.18°	↑	13400	2015/02/07 19:21:42	2015/02/07 19:37:21	301	154.94
UKUBE-1	189.09°	-81.67°	↓	13240	2015/02/07 19:28:17	2015/02/07 19:40:15	-339	154.84
UO-11	11.12°	-14.64°	↑	4937	2015/02/07 18:47:17	2015/02/07 18:59:33	2215	146.27

Gpredict Radio Control: Amateur

Downlink		Uplink	
145.936.100 Hz		145.890.000 Hz	
Doppler: 60 Hz	LO: 0 MHz	Doppler: -60 Hz	LO: 0 MHz
Radio: 145.936.172 Hz		Radio: 145.889.928 Hz	
Target: FUNCUBE-1 (AO-73) <input type="button" value="Track"/>			
Settings			
1. Device: IC-9100 <input type="button" value="Engage"/>		2. Device: None <input type="button" value="Engage"/>	
Az: 287.60° Range: 630 km		Cycle: 1000 msec	
El: 78.13° Rate: -0.123 km/s			

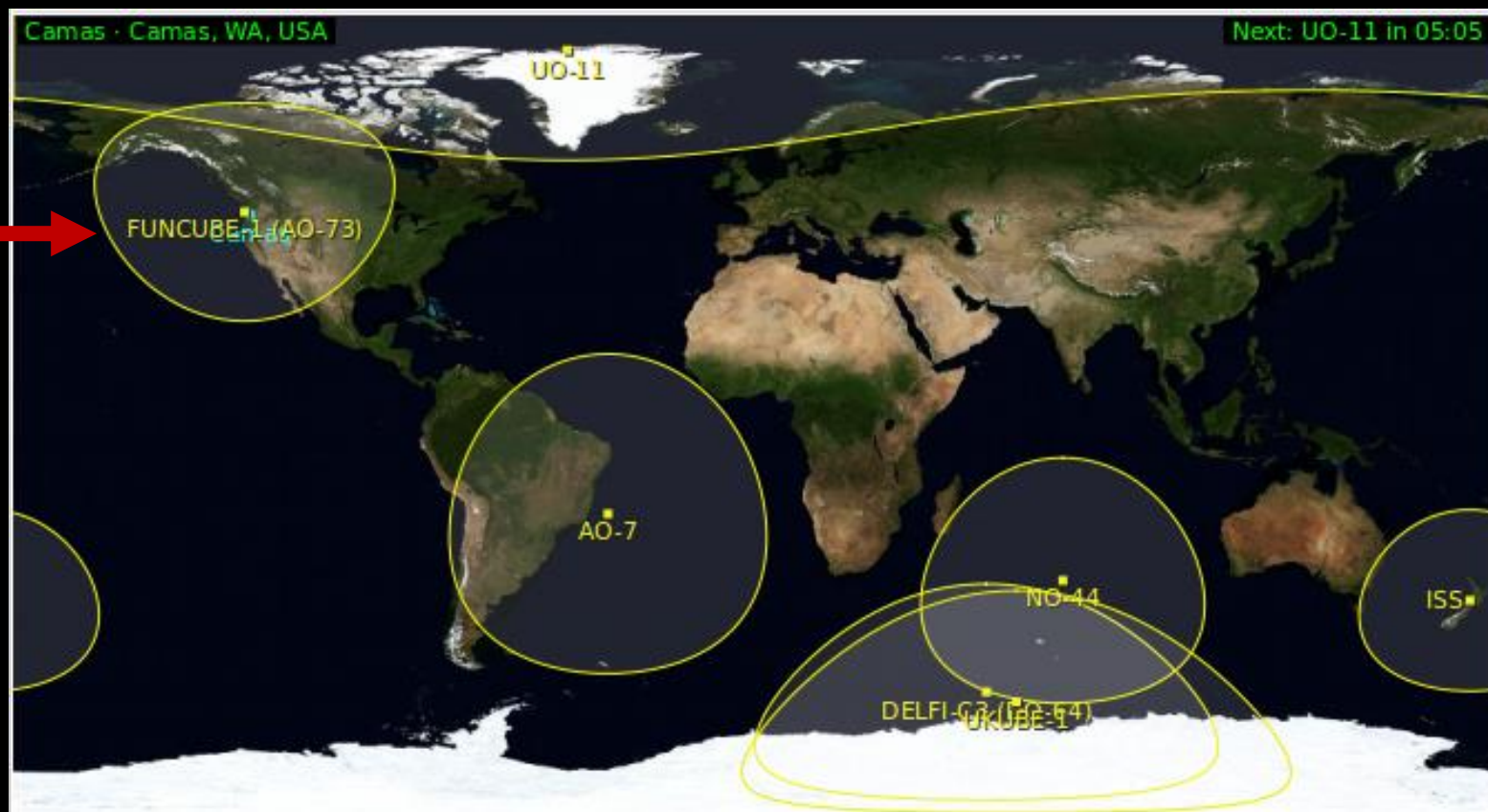
LOS in 06:21

Main Window

Floating Window

Gpredict Satellites Footprints

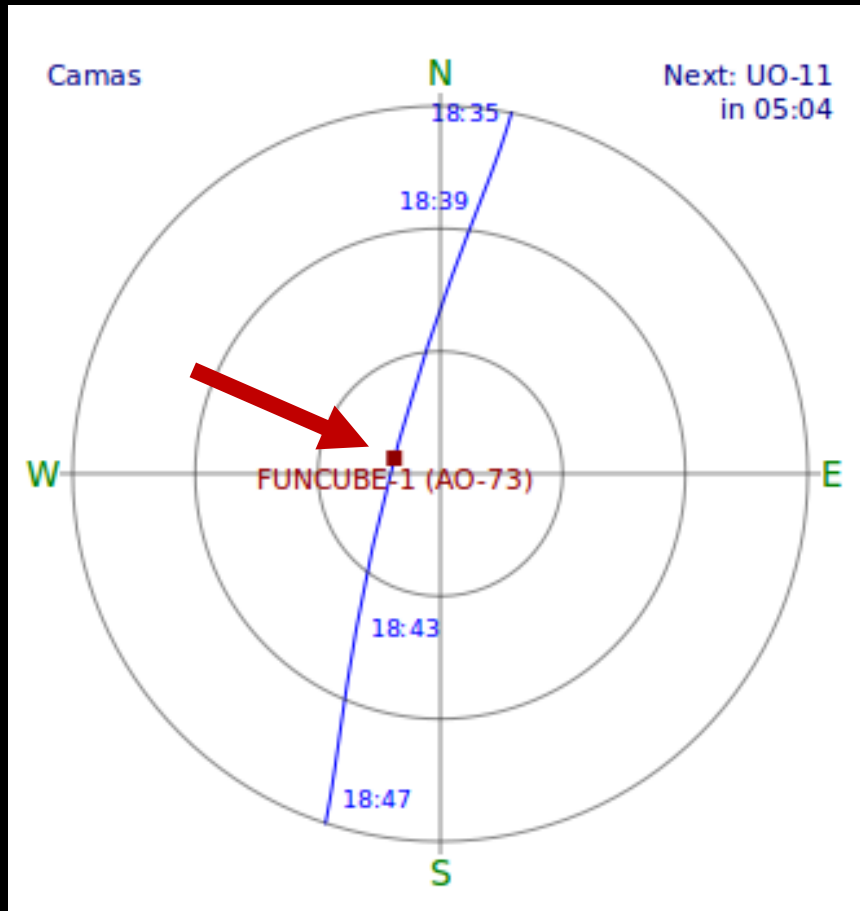
Can the satellite & you see each other





Gpredict Satellite Location in Sky

Altitude-Azimuth Position for pointing the antenna




Azimuth : 287.60°
Elevation : 78.13°
Direction : Approaching
Slant Range : 630 km
Range Rate : -0.123 km/sec
Next Event : LOS: 2015/02/07 18:48:34
Next AOS : 2015/02/07 20:12:56
Next LOS : 2015/02/07 18:48:34
SSP Loc. : CN85BX
Footprint : 5402 km
Altitude : 618 km
Velocity : 7.565 km/sec
Doppler@100M : 41 Hz
Sig. Loss : 128.39 dB
Sig. Delay : 2.10 msec
Mean Anom. : 211.90°
Orbit Phase : 297.99°
Orbit Num. : 6426
Visibility : Daylight



Gpredict Satellite Prediction

Acquisition of signal (AOS) & Lost of signal (LOS)



Satellite	Az	El	▲ AOS/LOS
UO-11	11.12°	-14.64°	05:04
FUNCUBE-1 (AO-73)	287.60°	78.13°	06:21
AO-7	106.17°	-45.97°	25:52
NO-44	301.64°	-81.18°	39:28
DELFI-C3 (DO-64)	177.25°	-82.54°	45:35
UKUBE-1	189.09°	-81.67°	46:04
ISS	224.77°	-50.06°	06:51:16



Gpredict

List of satellites on 2 meters band

Satellite	▲	Az	El	Dir	Range	Next AOS	Next LOS	Dop	Loss
AO-7		106.17°	-45.97°	↑	11043	2015/02/07 19:08:05	2015/02/07 19:18:56	1194	153.26
DELFI-C3 (DO-64)		177.25°	-82.54°	↓	13227	2015/02/07 19:27:48	2015/02/07 19:38:04	-287	154.83
FUNCUBE-1 (AO-73)		287.60°	78.13°	↑	630	2015/02/07 20:12:56	2015/02/07 18:48:34	41	128.39
ISS		224.77°	-50.06°	↑	10282	2015/02/08 01:33:29	2015/02/08 01:42:56	69	152.64
NO-44		301.64°	-81.18°	↑	13400	2015/02/07 19:21:42	2015/02/07 19:37:21	301	154.94
UKUBE-1		189.09°	-81.67°	↓	13240	2015/02/07 19:28:17	2015/02/07 19:40:15	-339	154.84
UO-11		11.12°	-14.64°	↑	4937	2015/02/07 18:47:17	2015/02/07 18:59:33	2215	146.27

2 Meters 144-148 MHz Band Plan

144.00-144.05	EME (CW)
144.05-144.10	General CW and weak signals
144.10-144.20	EME and weak-signal SSB
144.200	National calling frequency
144.200-144.275	General SSB operation
144.275-144.300	Propagation beacons
144.30-144.50	New OSCAR subband
144.50-144.60	Linear translator inputs
144.60-144.90	FM repeater inputs
144.90-145.10	Weak signal and FM simplex (145.01,03,05,07,09 are widely used for packet)
145.10-145.20	Linear translator outputs
145.20-145.50	FM repeater outputs
145.50-145.80	Miscellaneous and experimental modes
145.80-146.00	OSCAR subband
146.01-146.37	Repeater inputs
146.40-146.58	Simplex
146.52	National Simplex Calling Frequency
146.61-146.97	Repeater outputs
147.00-147.39	Repeater outputs
147.42-147.57	Simplex
147.60-147.99	Repeater inputs

Satellites



2 Meters 145.8-146.0 MHz Satellites

January 2015

145.800-146.000 MHz

Frequency MHz +/- Doppler	Satellite	Notes	Observations
145.825	Navy-OSCAR 44, NO-44, PCsat	FM FSK, AX.25, 1k2 and 9k6 in Sun only	
145.825	ISS	FM FSK, AX.25 packet	
145.825	UoSAT OSCAR, UO-11	FM 1k2 AFSK ASCII	
145.870	DELFI-OSCAR 64, DO-64, DELFI-C3	CW and 1k2 BPSK AX.25	
145.915	FUNcube-2, UKube-1	30mW or 300 mW Telemetry Beacon 1200 bps BPSK, same as FUNcube-1 AO-73	
145.935	FUNcube-1, AO-73	30mW or 300 mW Telemetry Beacon 1200 bps BPSK	20150104 1809UT
145.925 - 145.975	AMSAT OSCAR 7, AO-7	Mode U/V (B) Linear Transponder (Inverting) alternates with Mode A USB and CW when in the Sun	
145.950 - 145.970	FUNcube-1, AO-73	Transponder Downlink USB and CW	20150104 1809UT
145.9775	AMSAT OSCAR 7, AO-7	CW Beacon when in the Sun	



Gpredict Doppler Shift

+ Frequency Coming, - Frequency Going

The image displays three overlapping screenshots of the Gpredict Radio Control: Amateur software interface, illustrating the Doppler shift and frequency changes over time. Each screenshot shows the 'Downlink' and 'Uplink' frequency controls, Doppler shift values, and target information for the satellite FUNCUBE-1 (AO-73).

Screenshot 1 (Left): Shows a Doppler shift of 3380 Hz and a Radio frequency of 145.939.480 Hz. The target is FUNCUBE-1 (AO-73). The time remaining is LOS in 12:34.

Screenshot 2 (Middle): Shows a Doppler shift of 60 Hz and a Radio frequency of 145.936.172 Hz. The target is FUNCUBE-1 (AO-73). The time remaining is LOS in 06:21.

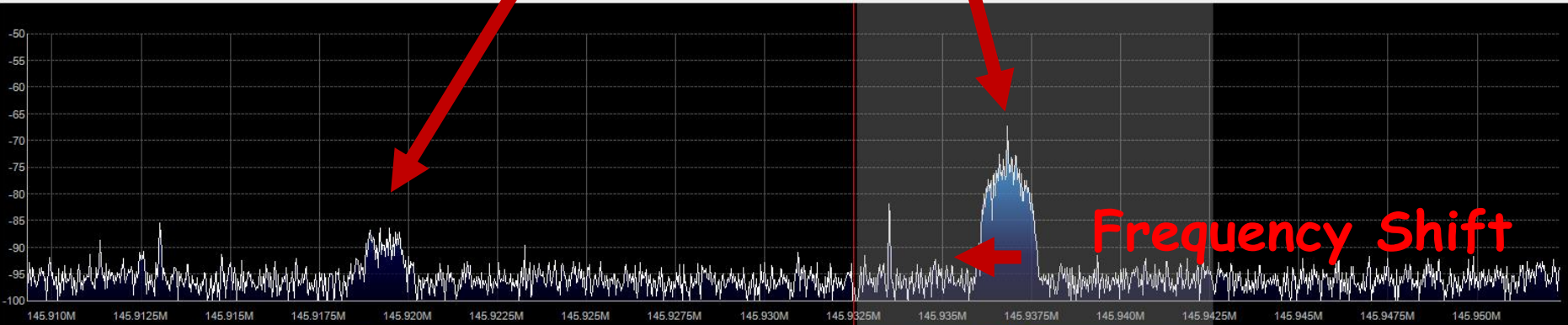
Screenshot 3 (Right): Shows a Doppler shift of -3399 Hz and a Radio frequency of 145.932.701 Hz. The target is FUNCUBE-1 (AO-73). The time remaining is LOS in 00:01.



Frequency Doppler Shift

UKube-1 TLM, FUNcube-1 TLM

000.145.932.506



1/13/2015 9:05:53 PM

1/13/2015 9:05:50 PM

1/13/2015 9:05:47 PM

1/13/2015 9:05:44 PM

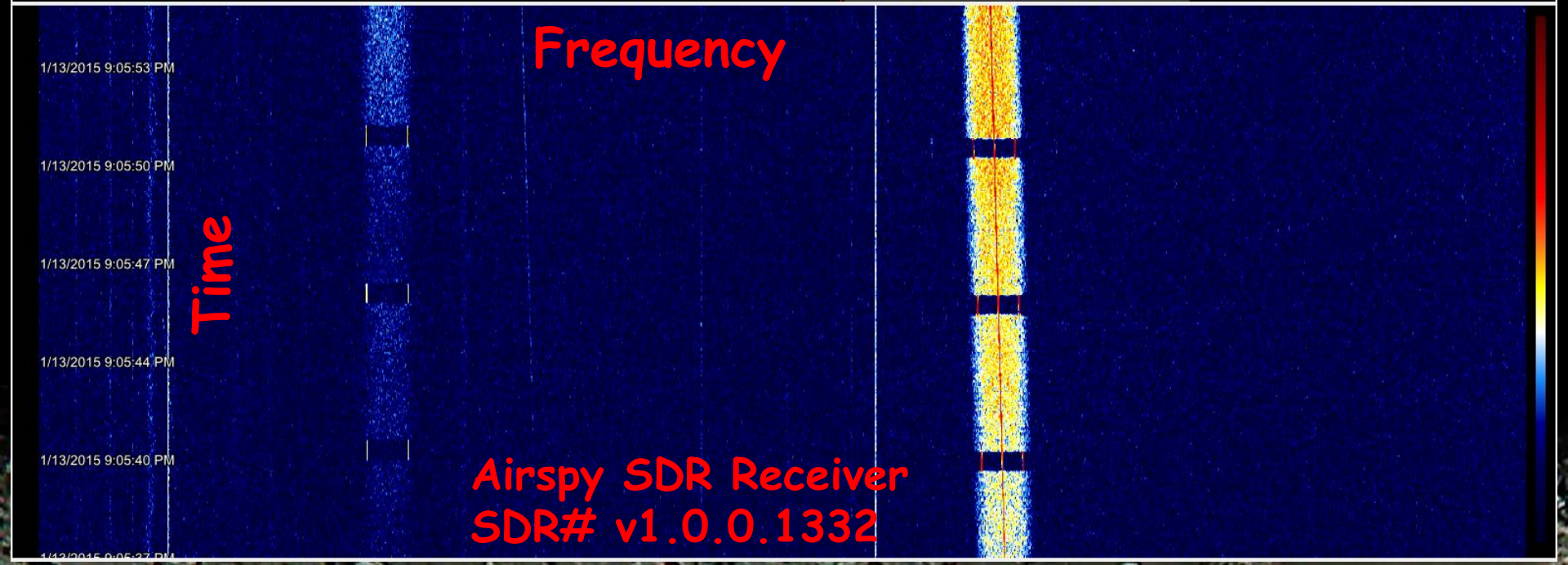
1/13/2015 9:05:40 PM

1/13/2015 9:05:37 PM

Time

Frequency

Airspy SDR Receiver
SDR# v1.0.0.1332

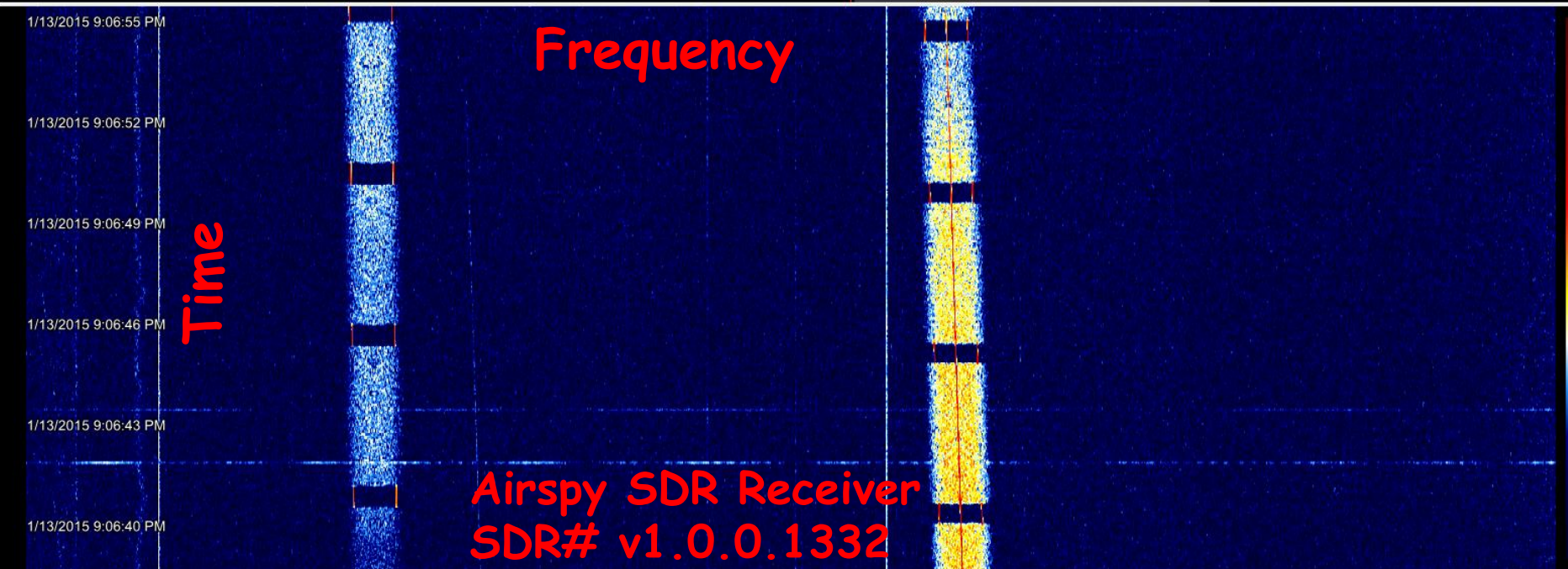
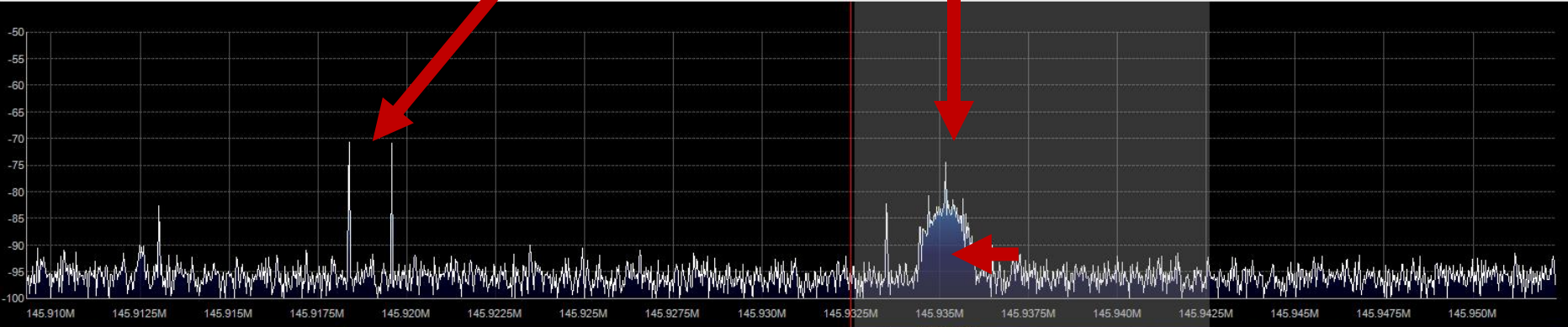




Frequency Doppler Shift

UKube-1 TLM, FUNcube-1 TLM

000.145.932.506



FUNcube-1 & UKube-1 signals with Airspy

<https://youtu.be/UCxnG6GdvtU>

The screenshot displays the GNOME Predict application window on an Ubuntu Linux 14.04 Desktop. The interface includes a world map with satellite footprints, a detailed view of the FUNcube-1 (AO-73) satellite, and a table of satellite data. A Time Controller window is also visible in the foreground.

GNOME Predict
2015/01/14 05:07:51
Camera: Camer, WA, USA

FUNcube-1 (AO-73)
Next AOS: 11 in 01:06:22

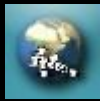
Cameras
N
W
E
S

Satellite	Az	El	Dir	Range	Next AOS	Next LOS	Dop	Loss
AO-7	300.01°	-18.24°	↑	6984	2015/01/14 11:12:07	2015/01/14 11:32:18	502	149.28
DELFI-C3 (DO-64)	349.01°	-15.08°	↓	4919	2015/01/14 06:27:01	2015/01/14 06:37:19	-2252	146.24
FUNcube-1 (AO-73)	23.73°	35.37°	↓	1063	2015/01/14 06:37:07	2015/01/14 05:13:10	-1394	132.93
ISS	214.52°	-51.12°	↑	10419	2015/01/14 10:22:48	2015/01/14 10:28:39	318	152.76
NO-44	195.59°	-35.84°	↓	8677	2015/01/14 14:18:34	2015/01/14 14:29:11	-1392	151.17
UKUBE-1	133.80°	52.65°	↑	770	2015/01/14 06:40:07	2015/01/14 05:15:16	1222	130.12
UO-11	349.59°	-43.24°	↓	9626	2015/01/14 06:14:14	2015/01/14 06:25:31	-1680	152.07

FUNcube-1 (AO-73) Details:
Azimuth: 23.73°
Elevation: 35.37°
Direction: Receiving
Slant Range: 1063 km
Range Rate: 4.180 km/sec
Next Event: LOS: 2015/01/14 05:13:10
Next AOS: 2015/01/14 06:37:07
Next LOS: 2015/01/14 05:13:10
SSP Loc: DO12CB
Footprint: 5603 km
Altitude: 669 km
Velocity: 7.512 km/sec
Doppler@100M: -1394 Hz
Sig. Loss: 132.93 dB
Sig. Delay: 3.34 msec
Mean Anom.: 95.69°
Orbit Phase: 134.56°
Orbit Num.: 6063
Visibility: Eclipsed

Time Controller / Amateur
January 2015
Sun Mon Tue Wed Thu Fri Sat
1 2 3
4 5 6 7 8 9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30 31
Hour: 5
Min: 7
Sec: 51
Msec: 986
Throttle: 1
Manual Control Reset

<http://gpredict.oz9aec.net/>



Saturday 2015-2-7 Passes

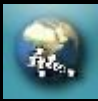
Camas WA, USA

Upcoming passes for FUNCUBE-1 (AO-73)

AOS	LOS	Duration	Max El	AOS Az	LOS Az
2015/02/07 17:00:11	2015/02/07 17:10:14	00:10:03	10.46°	34.99°	138.87°
2015/02/07 18:35:39	2015/02/07 18:48:34	00:12:54	77.20°	11.16°	198.18°
2015/02/07 20:12:56	2015/02/07 20:22:27	00:09:30	9.41°	351.10°	255.42°
2015/02/08 03:58:45	2015/02/08 04:09:52	00:11:06	14.23°	115.73°	4.71°
2015/02/08 05:33:16	2015/02/08 05:46:52	00:13:36	76.21°	169.41°	346.14°
2015/02/08 07:12:17	2015/02/08 07:22:01	00:09:43	8.19°	228.45°	321.22°

3 in Morning

3 in Evening



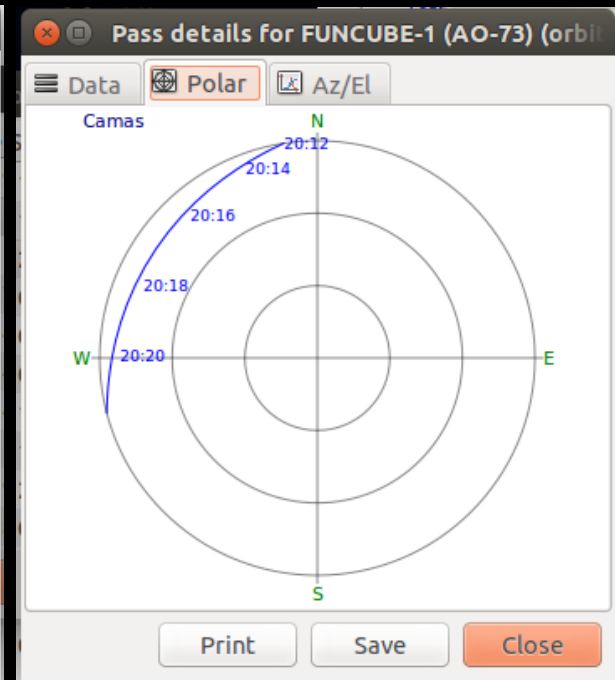
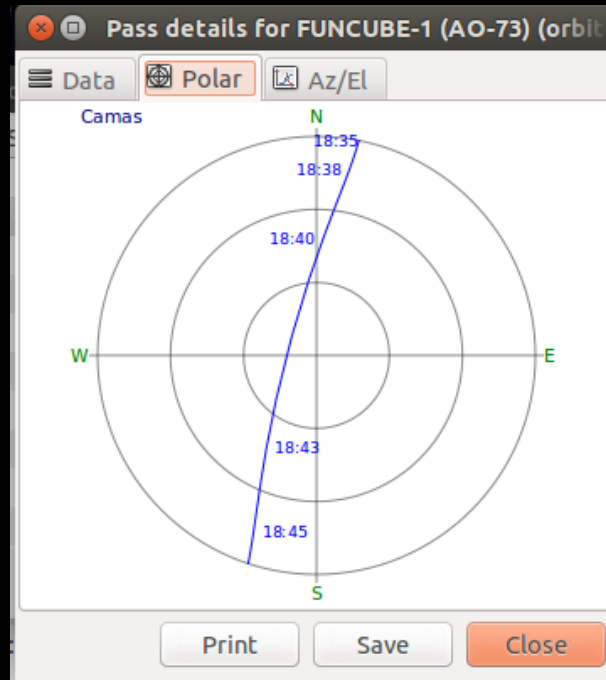
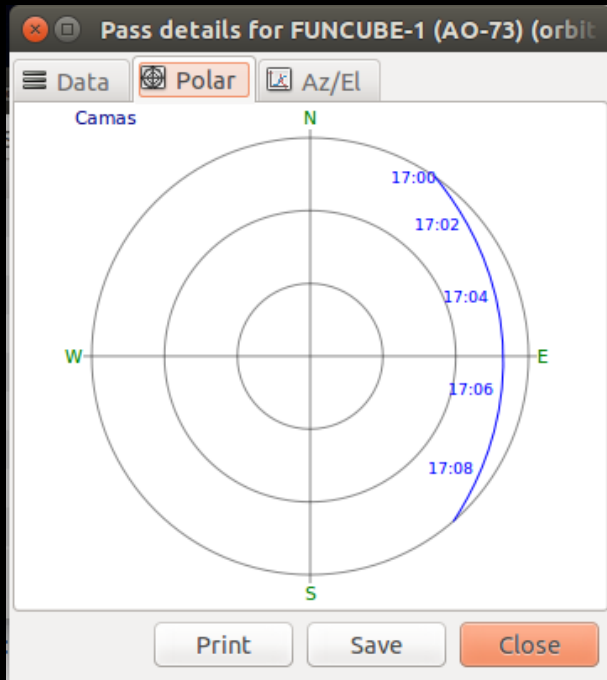
Saturday Morning 2015-2-7 Passes

Camas WA, USA

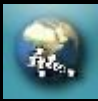
2 Frames

46 Frames

3 Frames



AOS	LOS	Duration	Max El	AOS Az	LOS Az
2015/02/07 17:00:11	2015/02/07 17:10:14	00:10:03	10.46°	34.99°	138.87°
2015/02/07 18:35:39	2015/02/07 18:48:34	00:12:54	77.20°	11.16°	198.18°
2015/02/07 20:12:56	2015/02/07 20:22:27	00:09:30	9.41°	351.10°	255.42°



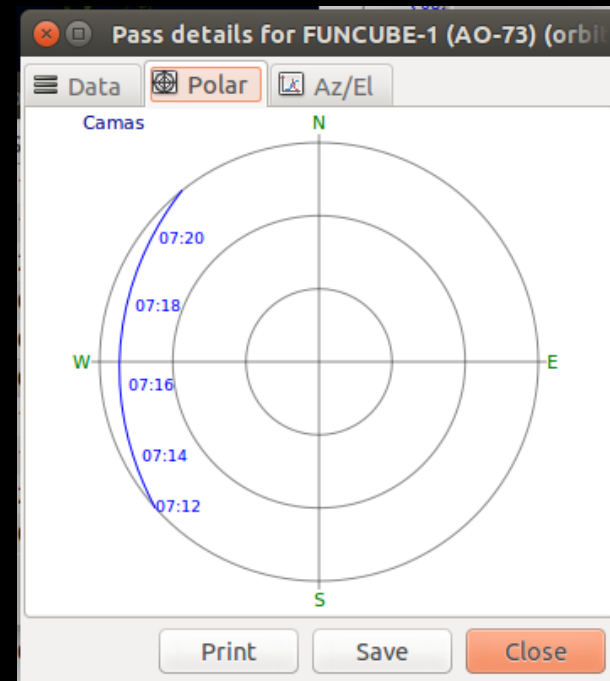
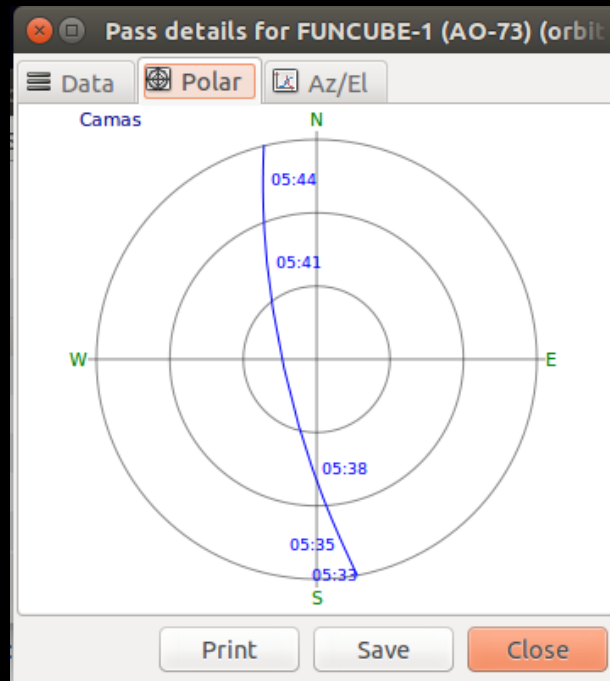
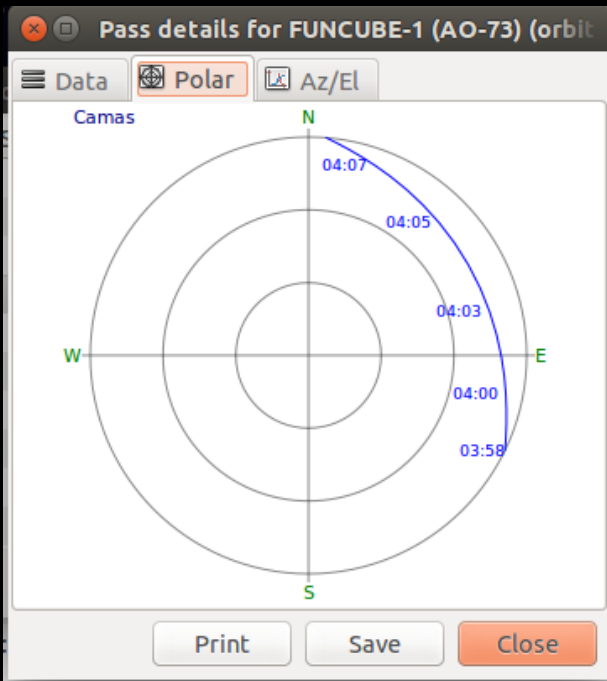
Saturday Evening 2015-2-7 Passes

Camas WA, USA

0 Frames

74 Frames

3 Frames



AOS	LOS	Duration	Max El	AOS Az	LOS Az
2015/02/08 03:58:45	2015/02/08 04:09:52	00:11:06	14.23°	115.73°	4.71°
2015/02/08 05:33:16	2015/02/08 05:46:52	00:13:36	76.21°	169.41°	346.14°
2015/02/08 07:12:17	2015/02/08 07:22:01	00:09:43	8.19°	228.45°	321.22°



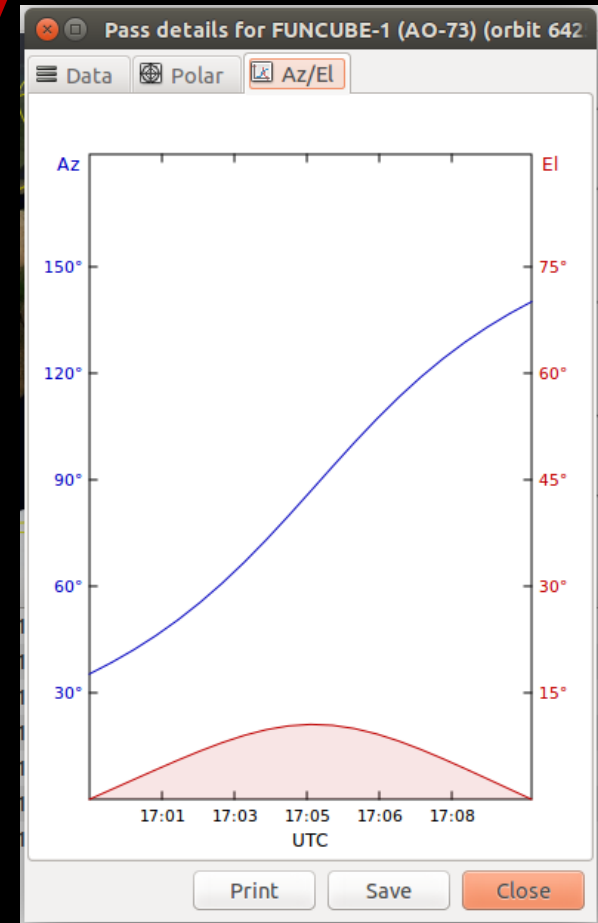
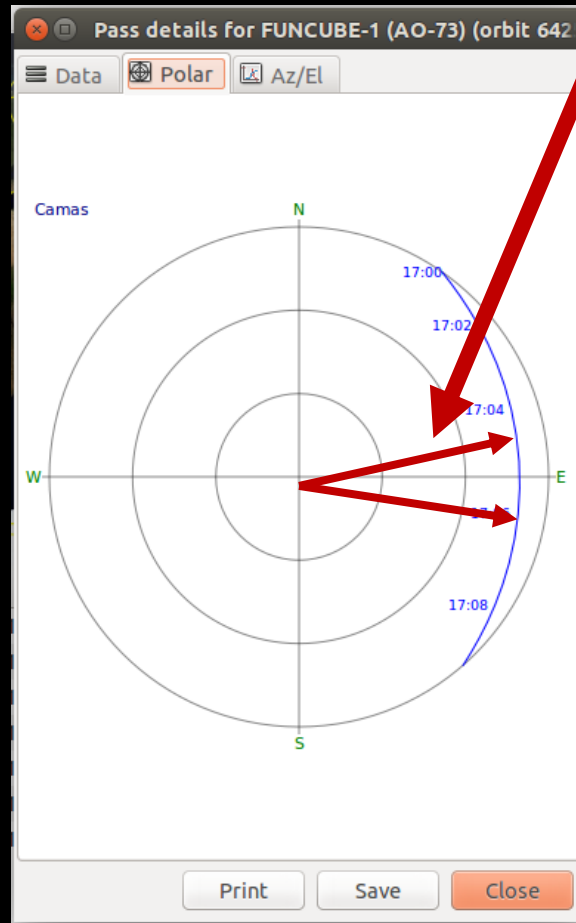
Low Pass in the East at 30 mW

2 frames with 2 receivers 2 antennas

Pass details for FUNCUBE-1 (AO-73) (orbit 642)

Time	Az	El	Range	Footp
2015/02/07 17:00:11	34.99°	0.00°	2913	5466
2015/02/07 17:00:42	38.18°	1.37°	2760	5459
2015/02/07 17:01:12	41.72°	2.75°	2615	5452
2015/02/07 17:01:42	45.67°	4.12°	2479	5445
2015/02/07 17:02:12	50.06°	5.46°	2353	5438
2015/02/07 17:02:42	54.93°	6.74°	2240	5431
2015/02/07 17:03:12	60.29°	7.91°	2142	5424
2015/02/07 17:03:42	66.14°	8.92°	2060	5418
2015/02/07 17:04:13	72.44°	9.72°	1998	5411
2015/02/07 17:04:43	79.09°	10.25°	1958	5404
2015/02/07 17:05:13	85.96°	10.46°	1940	5398
2015/02/07 17:05:43	92.87°	10.33°	1945	5391
2015/02/07 17:06:13	99.66°	9.87°	1973	5385
2015/02/07 17:06:43	106.16°	9.12°	2023	5378
2015/02/07 17:07:14	112.26°	8.12°	2095	5372
2015/02/07 17:07:44	117.88°	6.95°	2184	5366
2015/02/07 17:08:14	123.00°	5.65°	2290	5361
2015/02/07 17:08:44	127.63°	4.27°	2410	5355
2015/02/07 17:09:14	131.79°	2.86°	2542	5350
2015/02/07 17:09:44	135.52°	1.43°	2684	5344
2015/02/07 17:10:14	138.87°	0.00°	2835	5339

Print Save Close



Two 4 Element Yagi Antennas

East at 30° alt & west at 30° alt



Arrow II-Portable Antenna Model 146-4 II



High Pass at 30 mW

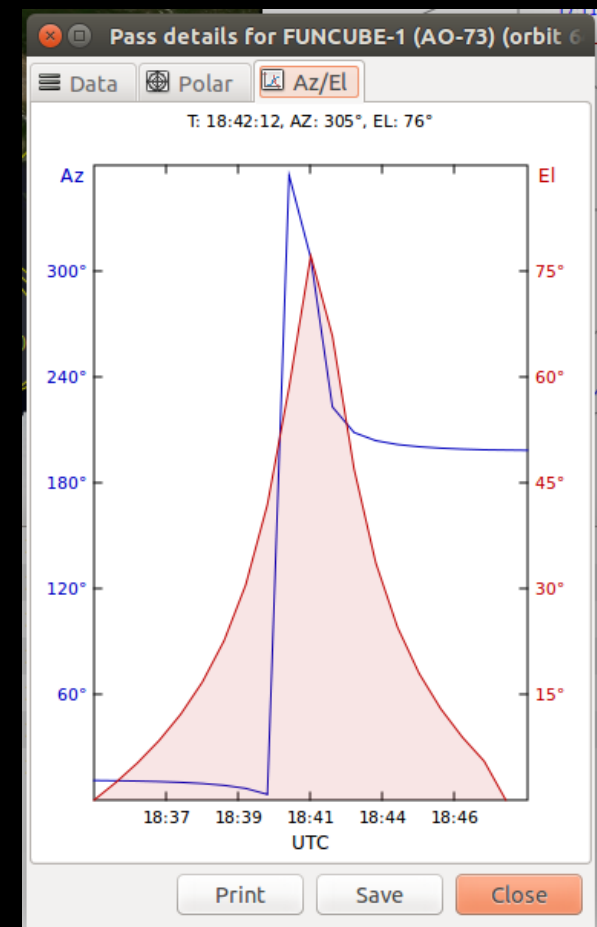
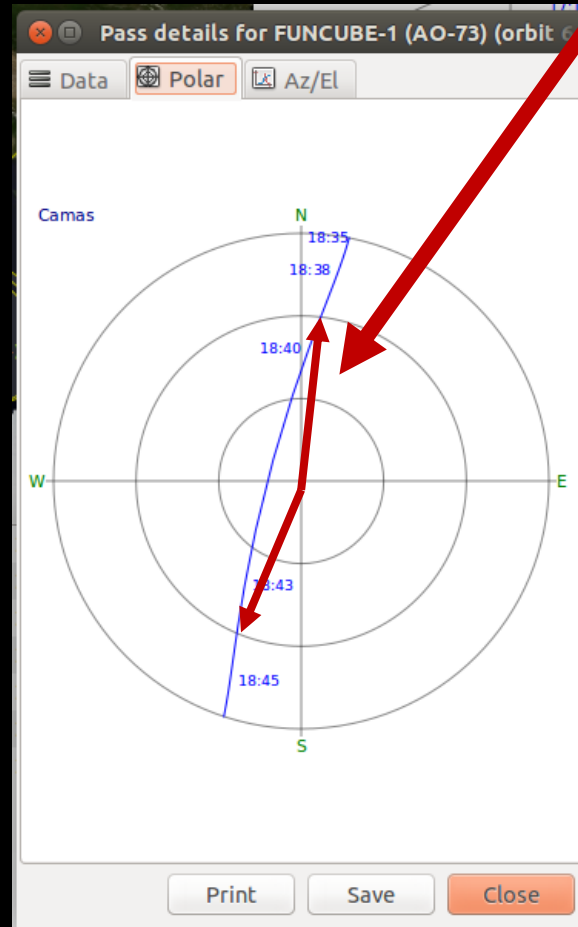
46 frames with 2 receivers 2 antennas

Pass details for FUNCUBE-1 (AO-73) (orbit 6

Data Polar Az/El

Time	Az	El	Range	Footp
2015/02/07 18:35:39	11.16°	-0.00°	2928	5491
2015/02/07 18:36:18	11.03°	2.48°	2659	5482
2015/02/07 18:36:56	10.82°	5.26°	2390	5474
2015/02/07 18:37:35	10.52°	8.43°	2123	5465
2015/02/07 18:38:14	10.08°	12.17°	1858	5456
2015/02/07 18:38:53	9.42°	16.74°	1597	5447
2015/02/07 18:39:31	8.40°	22.60°	1343	5438
2015/02/07 18:40:10	6.66°	30.53°	1102	5430
2015/02/07 18:40:49	3.27°	41.91°	885	5421
2015/02/07 18:41:28	354.42°	58.53°	715	5412
2015/02/07 18:42:06	307.53°	77.18°	632	5403
2015/02/07 18:42:45	223.01°	65.80°	669	5395
2015/02/07 18:43:24	208.49°	46.94°	810	5387
2015/02/07 18:44:03	203.88°	33.65°	1012	5379
2015/02/07 18:44:41	201.69°	24.53°	1246	5371
2015/02/07 18:45:20	200.43°	17.96°	1496	5363
2015/02/07 18:45:59	199.63°	12.94°	1756	5356
2015/02/07 18:46:38	199.08°	8.90°	2020	5349
2015/02/07 18:47:16	198.69°	5.52°	2288	5342
2015/02/07 18:47:55	198.40°	2.60°	2558	5336

Print Save Close



Upload Ranking of 859 Submitters

We should like to thank all the groups and individuals who have uploaded data to the FUncube data warehouse.

The following list gives the site names of those who have uploaded the most data frames:

Key: **Within 1 week**, **within 2 weeks**, greater than 2 weeks

Site Id	Count	Position
g0mjw	333189	1
OM3BC	276570	2
W0JW	222598	3
HB9MFL	204458	4
VK5HI	194222	5
g4ovr	29014	104
GW1FKY	28876	105
WA9ONY	27969	106
JO1PTD	27967	107
VK2EVB	27511	108

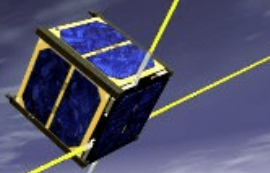
Started Jan. 2015

Real Time Data

4 data providers for Seq. #319,173 Packet #1,861,411

FUNcube

UK Amateur Radio Educational Satellite



[Register]

FUNcube-1 Flight Model FC1 Engineering model UKube FC2 Payload

Navigation

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- [High Resolution Data](#)
- [Whole Orbit Data](#)
- [Fitter Messages](#)
- [Amateur Radio Info](#)
- [Satellite Position](#)
- [Upload Ranking](#)
- [About](#)

Real Time Data

This page shows the latest value of all the housekeeping parameters in the spacecraft. The data has been collected by one or more of the ground stations who are submitting this data from all around the world.

To download a .csv file which contains Realtime data, please click [here](#). This data is generated every hour, on the hour and contains the preceding 250 minutes of information

The date/time in the csv file is 'SatelliteTime' It is based on the number for sequences / frames it has transmitted since spacecraft initialisation after separation (2013-11-21 07:38:16). This time will drift as it is based on the MCU clock which is not temperature controlled. In the future we may be able to give realtime if we can model the drift...

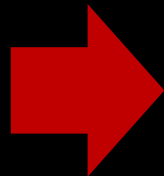
Data Providers

- wa6fwf
- NH6Y
- Kc7ces
- WA9ONY

Warehouse Info

Seq. No.: 319173
Packets: 1861411 (476.5MB)

EPS	ASIB	RF	PA	ANTS	SW
Electrical Power Subsystem					
Satellite Latitude: 37.1 N, Longitude: 140.5 W					
Uploaded at: 2015-02-05 19:40:30 UTC, MinMax from: 2015-02-04 20:53:41 UTC					
Name		Value	Min.	Max.	
Solar Panel Voltage X		4583 mV	0	5288	



NH6Y 2,577.1 mi Distance from WA9ONY

NH6Y



THOMAS K WORTHINGTON
1035 NAALAE RD
KULA, HI 96790
USA

Email: Use mouse to view..

Ham Member

Lookups: 19997

Label



Biography

Detail

Logbook 9

Log a NEW contact with NH6Y...

Lookups 19997 (28890)

QRZ Record# 1786998

QRZ Admin NH6Y

Date Joined 2009-01-28 22:59:17

Last Update 2014-12-10 21:19:41

Class E

Effective 2011-08-12

Latitude 20.756000 (20° 45' 21" N)

Longitude -156.342000 (156° 20' 31" W)

Grid Square BL10ts

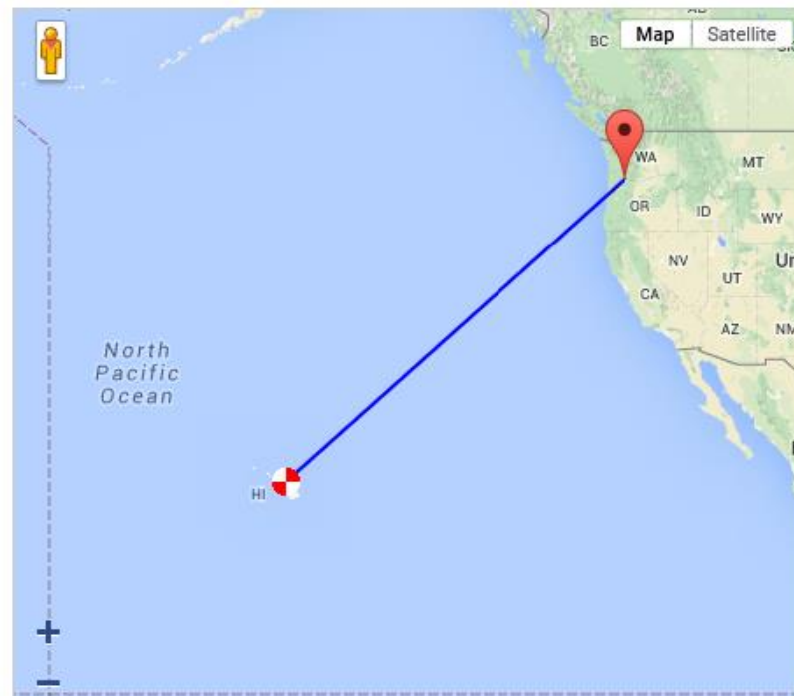
Geo Source User supplied

US State Hawaii

US County Maui

Bearing 239.6° WSW (from WA9ONY)

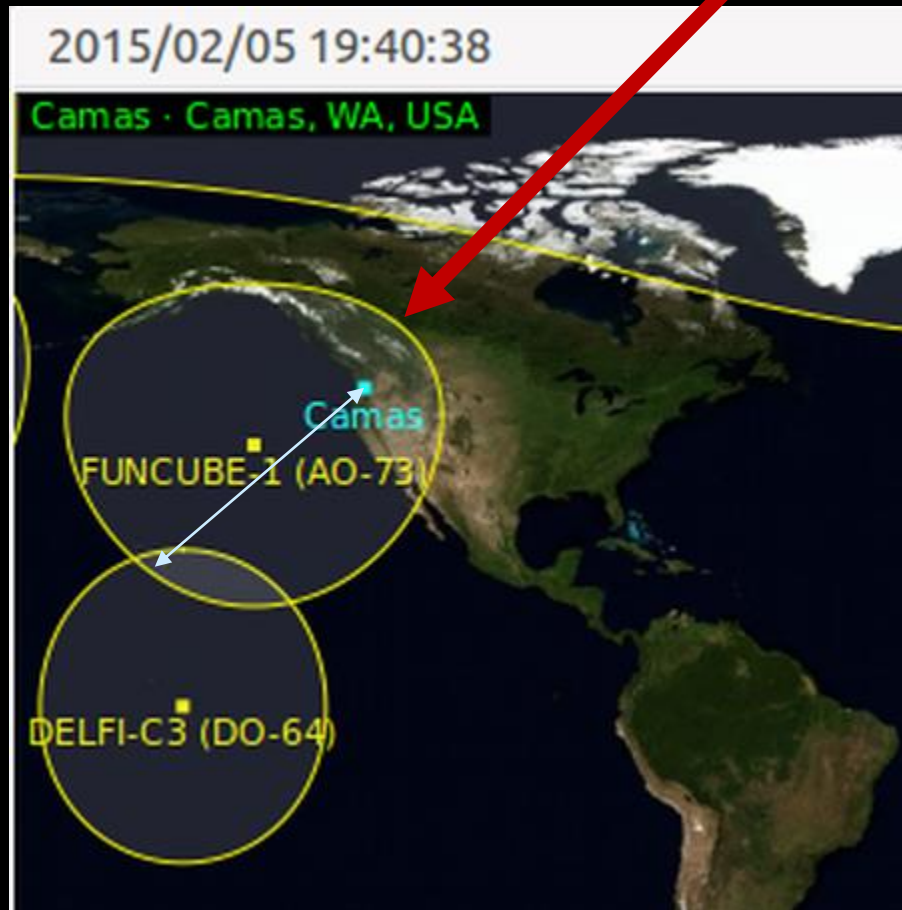
Distance 2577.1 mi (4147.4 km)





FUNcube-1 Footprint

Both WA9ONY & NH6Y see FUNcube-1 TLM at the same time

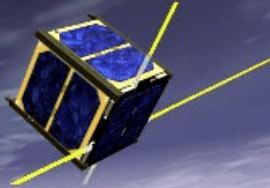


Real Time Data

WA9ONY only data provider for Seq. No.: 319,454

FUNcube

UK Amateur Radio Educational Satellite



[Register]

FUNcube-1 Flight Model FC1 Engineering model UKube FC2 Payload

Navigation

- [Real Time Data](#)
- [High Resolution Data](#)
- [Whole Orbit Data](#)
- [Fitter Messages](#)
- [Amateur Radio Info](#)
- [Satellite Position](#)
- [Upload Ranking](#)
- [About](#)

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Data Providers

WA9ONY

Warehouse Info

Seq. No.: 319454
Packets: 1863161 (477.0MB)

Satellite Status

Name	Value	Min.	Max.
Solar Panel Voltage X	0 mV	0	5288

FUNcube-1 Satellite Telemetry Upload

<https://youtu.be/jUP6vdjaS9o>

The screenshot shows the website warehouse.funcube.org.uk in a Safari browser window. The page features a navigation menu on the left with links such as 'Real Time Data', 'High Resolution Data', and 'Data Providers'. The main content area is divided into sections: 'Real Time Data' with a description of housekeeping parameters and a download link; 'Current Satellite Position' with a map showing the satellite's location over North America and its coordinates (LAT: 54.20, LNG: -125.82, ALT: 599.41, SRD: 7.65); and 'Warehouse Info' with details for sequence number 331426 and 492.8MB of data. A table titled 'Electrical Power Subsystem' displays real-time voltage readings for solar panels X, Y, and Z. Red arrows point to the 'Data Providers' link, the 'Warehouse Info' section, and the 'RF' tab in the table.

FUNcube

UK Amateur Radio Educational Satellite

[Register]

FUNcube-1 Flight Model

FC1 Engineering model UKube FC2 Payload

Real Time Data

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The date/time in the csv file is 'SatelliteTime' It is based on the number for sequences / frames it has transmitted since spacecraft initialisation after separation (2013-11-21 07:38:16). This time will drift as it is based on the MCU clock which is not temperature controlled. In the future we may be able to give realtime if we can model the drift...

Current Satellite Position

FUNcube 1 (AO-73)
LAT: 54.20
LNG: -125.82
ALT: 599.41
SRD: 7.65

Map Satellite

Google

No visible upcoming passes

Warehouse Info

Seq. No.: 331426
Packets: 1925140 (492.8MB)

Satellite Status

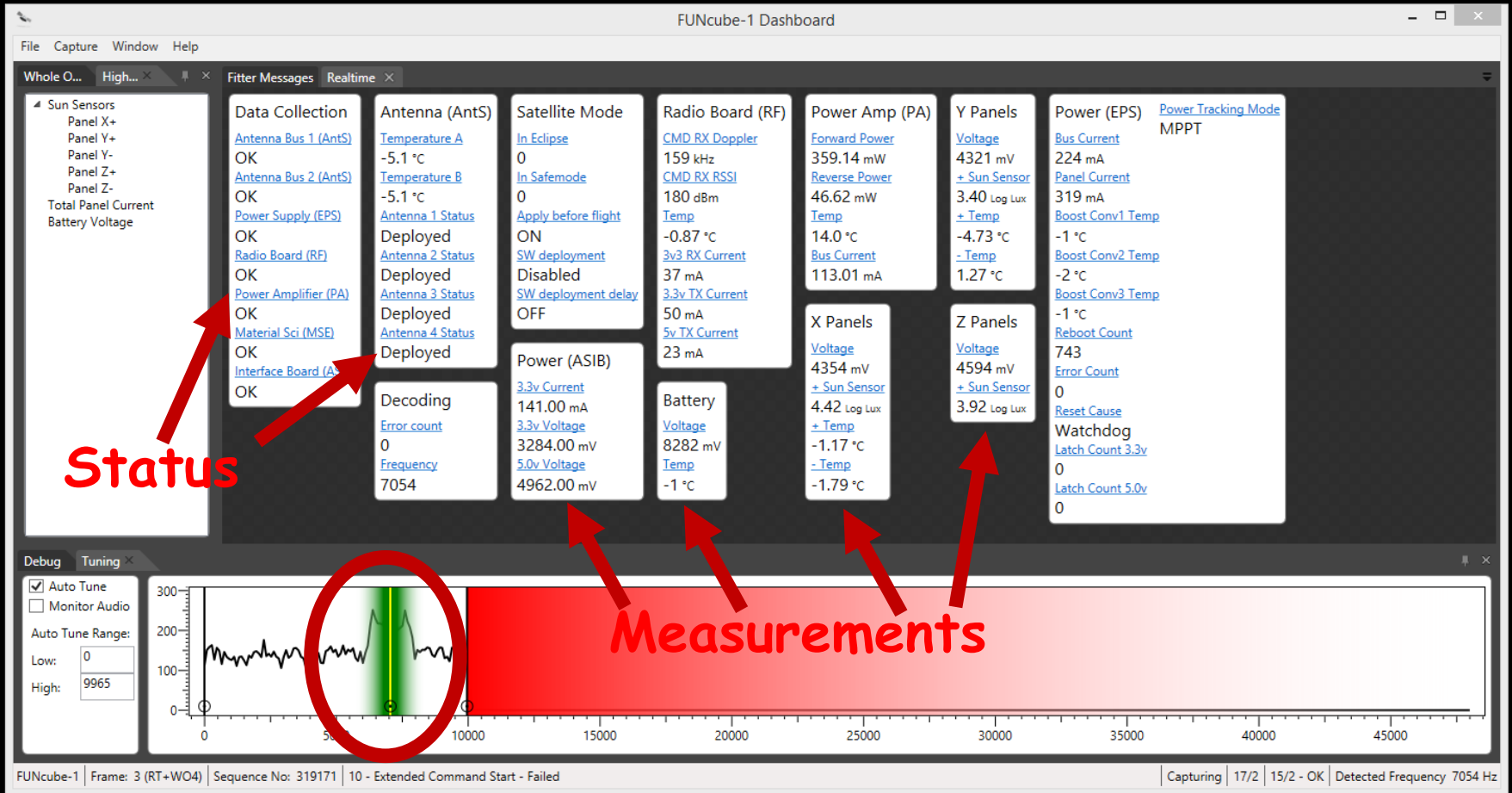
Mode switching: Manual
Transponder state: On

Name	Value	Min.	Max.
Solar Panel Voltage X	4656 mV	0	5248
Solar Panel Voltage Y	4594 mV	0	5176
Solar Panel Voltage Z	4701 mV	0	5176

<http://warehouse.funcube.org.uk/realtime.html?satelliteId=2>

58 Telemetry Channels

FUNcube-1 Dashboard decodes the TLM BPSK with FEC



58 Telemetry Channels

- Real-time measurements every five seconds
- High resolution data
 - Satellite stores last 60 real-time measurements
- Whole orbit data
 - Satellite stores 104 measurements
 - One measurement per minute

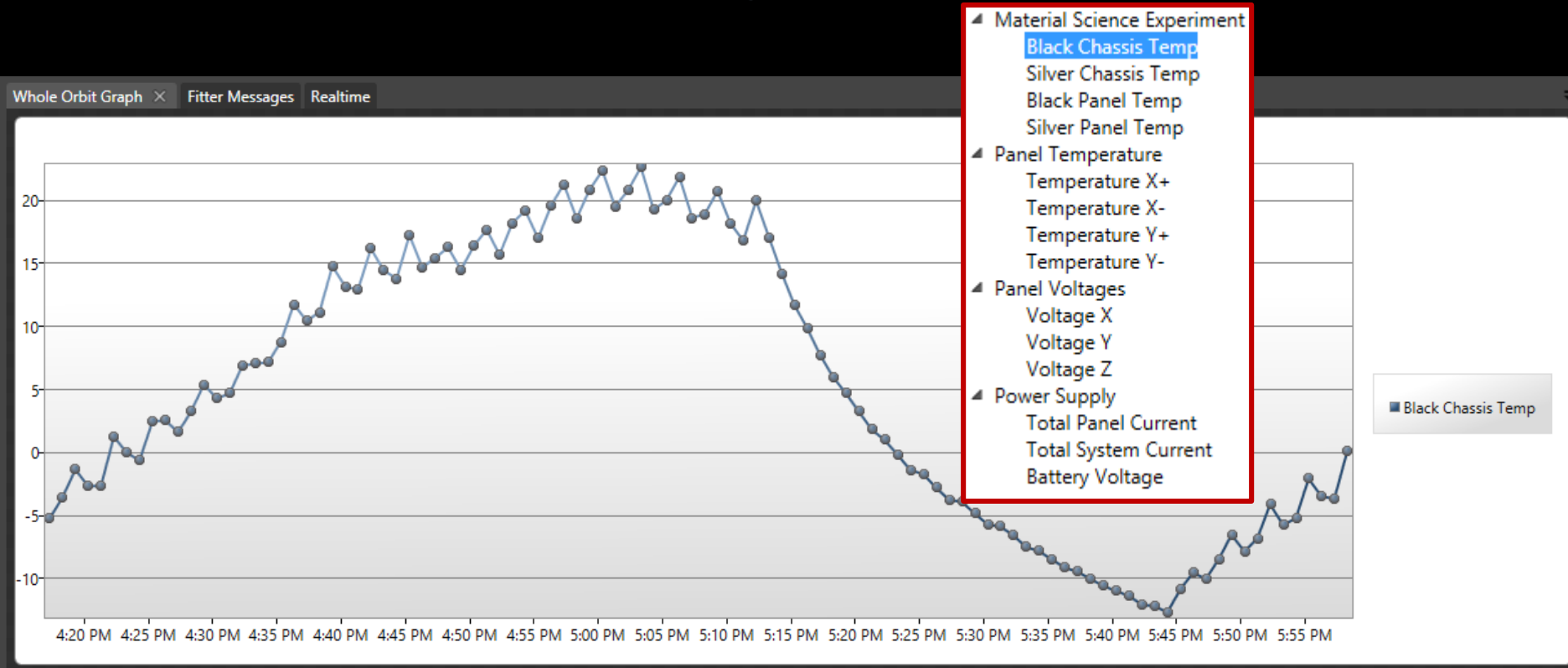
Telemetry Transmission Organization

2 minutes for sequence, 5 seconds per frame

- Sequence is composed of 24 frames
- Frame is composed of 256 bits of data after decode
 - Frame always contains real-time data
- Sequence structure
 - 12 whole orbit frames WO1 to WO12
 - 1 high resolution frame HR1
 - 3 Fitter messages FM1 to FM3
 - 1 high resolution frame HR2
 - 3 Fitter messages FM4 to FM6
 - 1 high resolution frame HR3
 - 3 Fitter messages FM7 to FM9

14 Whole Orbit Data Sets

104 Measurements During 1 Orbit, 1 Minute Intervals

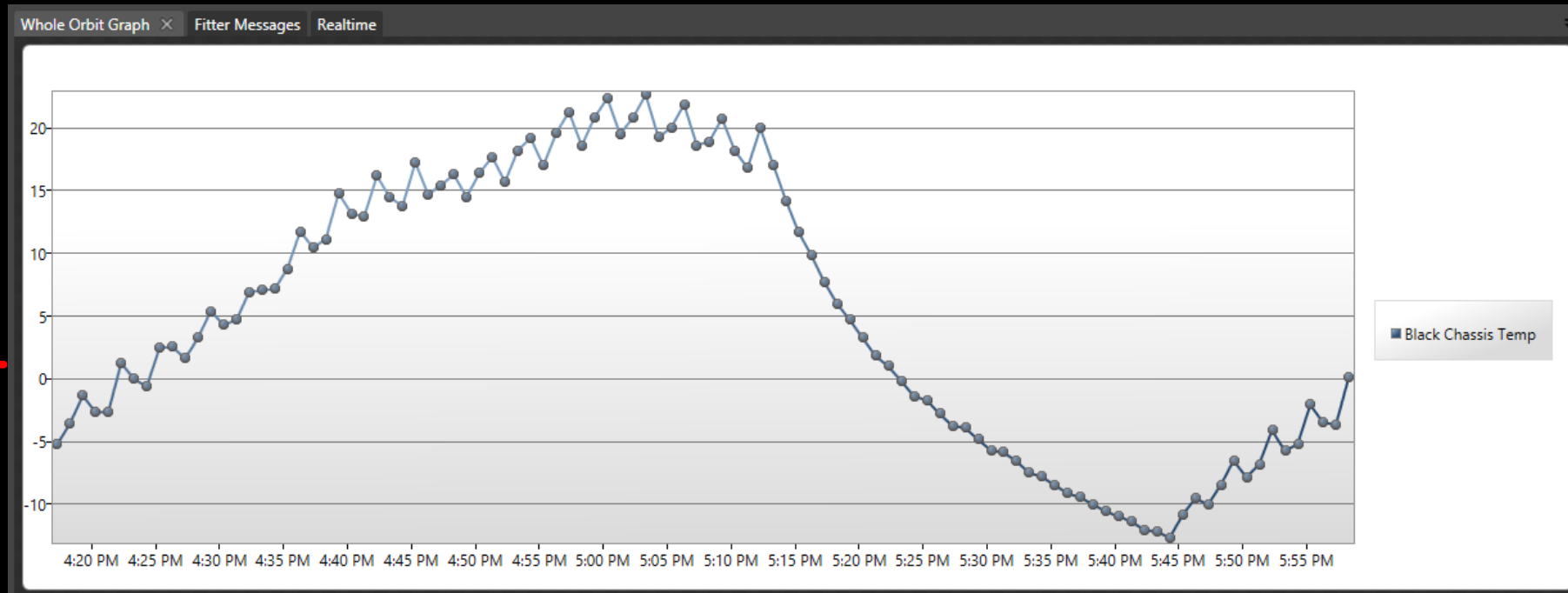


Satellite Saves 1 Orbit of Data Onboard

Black Chassis Temp Whole Orbit Graph

Measurements During 1 Orbit, 1 Minute Intervals

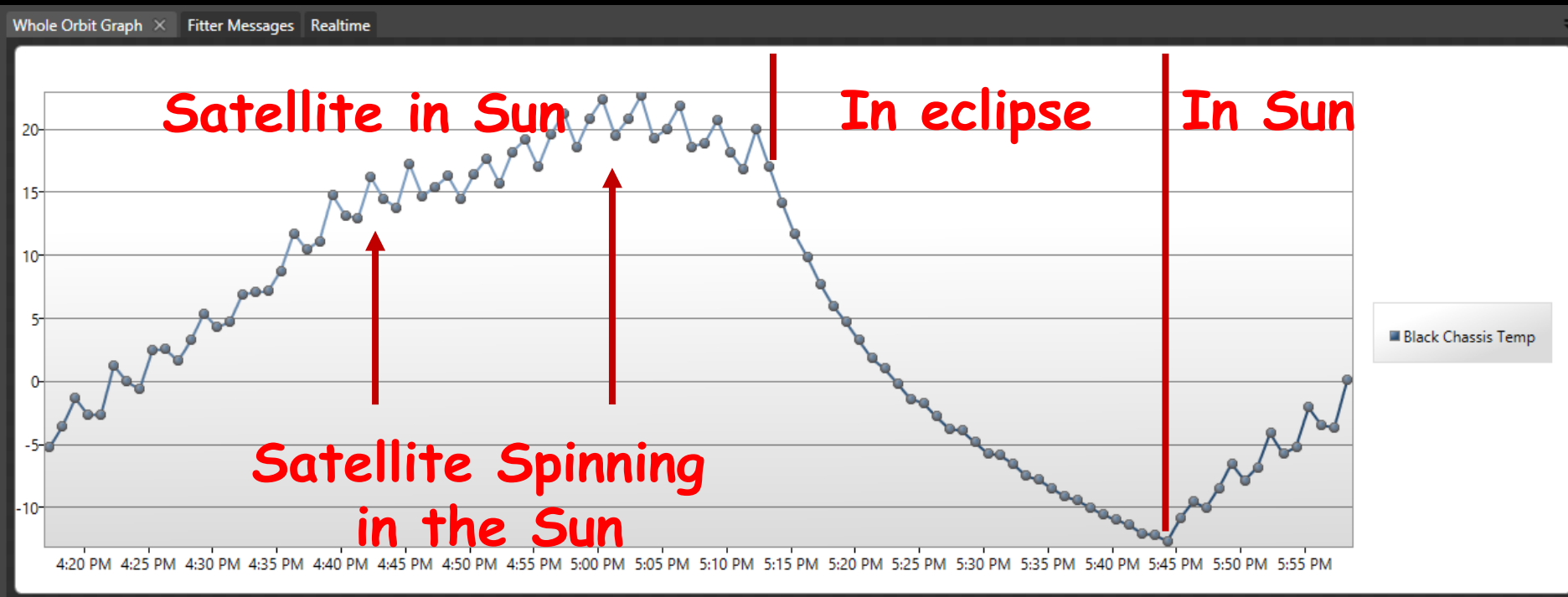
Temperature



Time

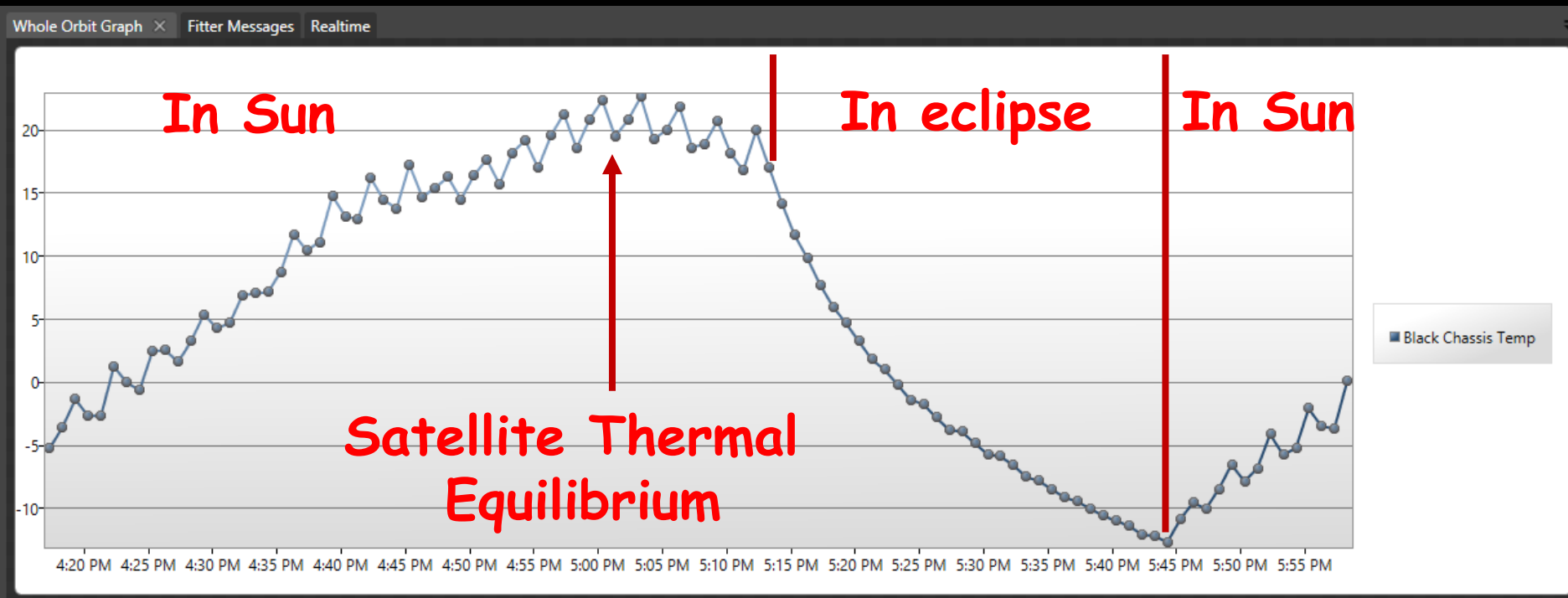
Black Chassis Temp

Whole Orbit Graph



Black Chassis Temp

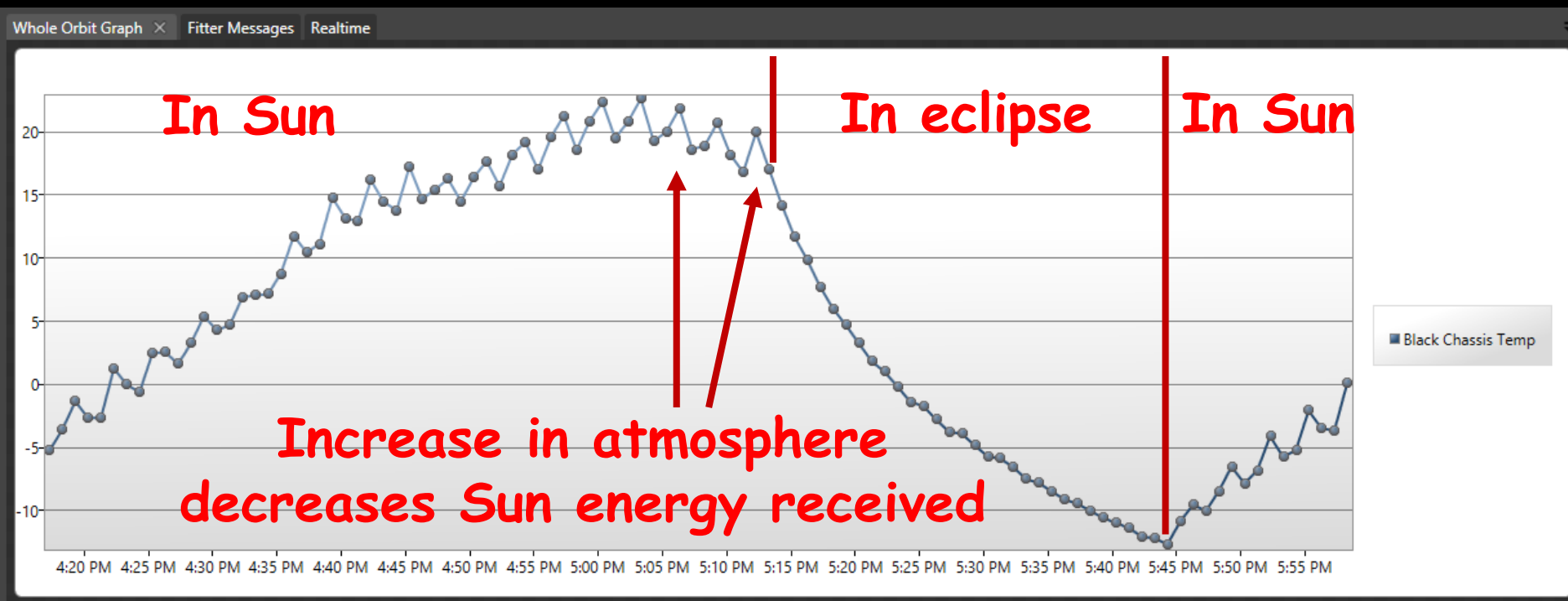
Whole Orbit Graph



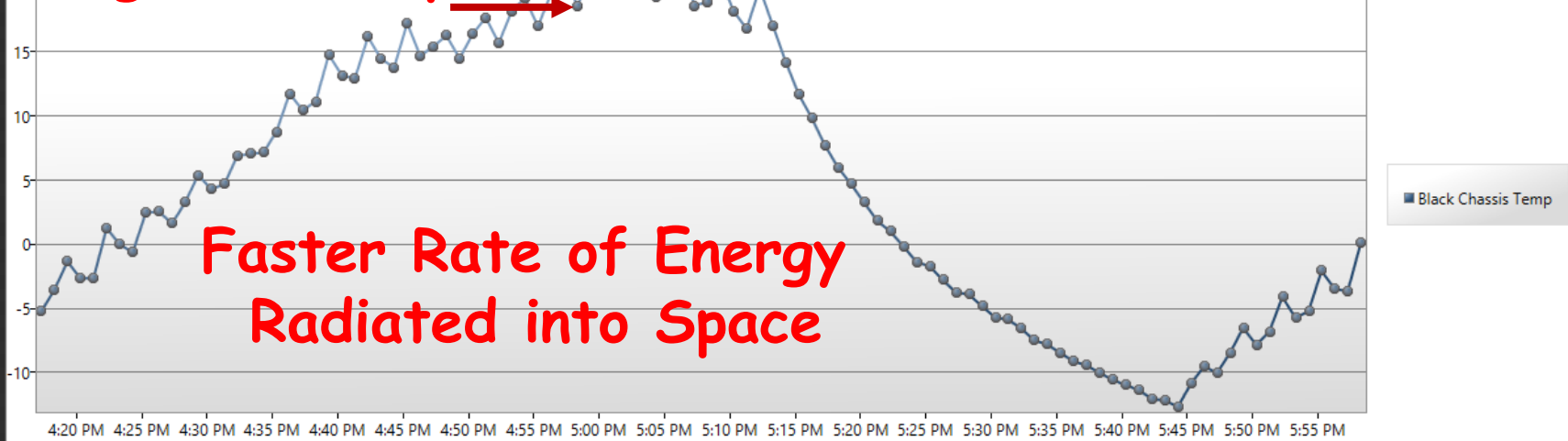
Sun Energy Received Equals Energy Radiated into Space

Black Chassis Temp

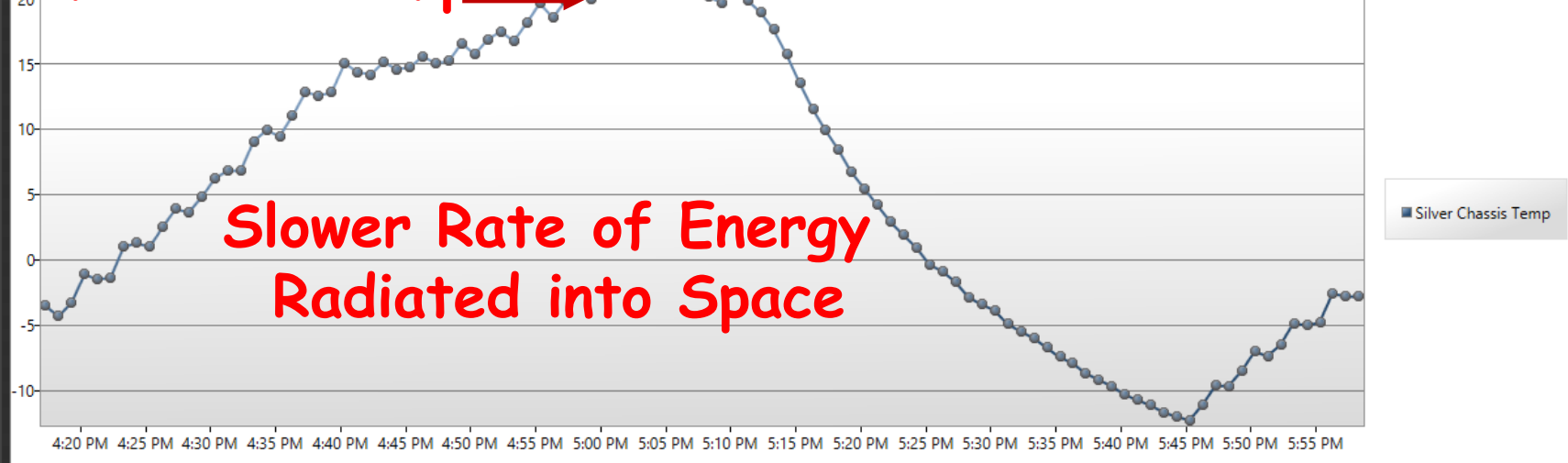
Whole Orbit Graph



Larger Δ Temp \rightarrow Black Chassis Temp



Smaller Δ Temp \rightarrow Silver Chassis Temp



Solar Panel Voltage Y

Whole Orbit Graph

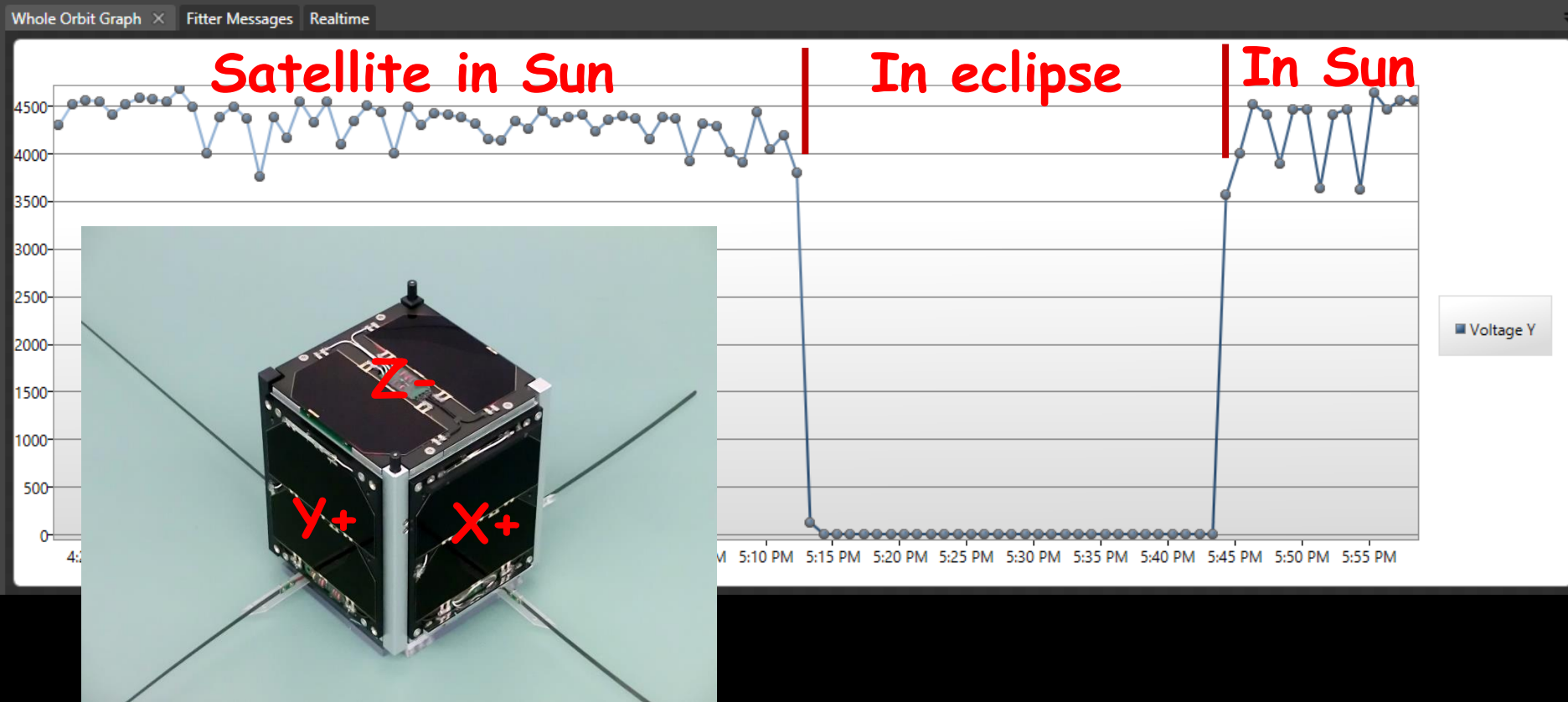


Image Credit: Wouter Weggelaar PA3WEG

FUNcube-1 Data Received by WA9ONY 2015-2-5

<http://funcube.org.uk/working-documents/funcube-telemetry-dashboard/>

Fitter Messages (FM)

9 FM 200 characters each transmitted by the satellite

Receive Time	Sequence	Packet	Message
2/5/2015 6:02:01 PM	319123	FM9	2 d * V E & & " & e395m 94e73e 94e73e 94e73e 94e73e 94e73e072c541c 94e73e 94e73e 94e73e 94e73e 94e73e072c541c 94e73e 94e73e 94e73e
2/5/2015 6:01:49 PM	319123	FM7	For details of the education resources check www.funcube.org.uk/education-outreach .
2/5/2015 6:01:38 PM	319123	FM6	Hello world, this is 5JW from Central Walker primary in Newcastle upon Tyne, UK
2/5/2015 6:01:32 PM	319123	FM5	The 73 on 73 Award is organised by by Paul N8HM see http://amwat-uk.org/2014/08/18/73-on-73-award-announcement
2/5/2015 6:01:26 PM	319123	FM4	If you can read this you are receiving FUNCube fine. Please register with the FUNCube data warehouse at http://api.funcube.org.uk/
2/5/2015 6:01:15 PM	319123	FM3	AMSAT-UK Colloquium 24-26 July 2015, Guildford, UK
2/5/2015 6:01:09 PM	319123	FM2	Call all schools - if you would like a Fitter message uploaded please email operations@funcube.org.uk
2/5/2015 6:01:03 PM	319123	FM1	The main FUNCube tech team is: Dave G4DPZ, David G0MRP, Duncan M6UCK, Gerard Aalbers, Graham G3VZV, Jason G7OCD, Jim G3WGM, Howard G6LVB, Phil M6IPX, Wouter PA3WEG & Wouter Jan PE4WJ
2/5/2015 6:00:01 PM	319122	FM9	z 2 d * V E & & " & e395m 94e73e 94e73e 94e73e 94e73e 94e73e072c541c 94e73e 94e73e 94e73e 94e73e 94e73e072c541c 94e73e 94e73e 94e73e
2/5/2015 5:59:55 PM	319122	FM8	More information about this spacecraft, orbital details, etc an the telemetry decoder and dashboard can be downloaded from http://www.funcube.org.uk
2/5/2015 5:59:49 PM	319122	FM7	For details of the education resources check www.funcube.org.uk/education-outreach .
2/5/2015 5:59:38 PM	319122	FM6	Hello world, this is 5JW from Central Walker primary in Newcastle upon Tyne, UK
2/5/2015 5:59:26 PM	319122	FM4	If you can read this you are receiving FUNCube fine. Please register with the FUNCube data warehouse at http://api.funcube.org.uk/
2/5/2015 5:59:15 PM	319122	FM3	AMSAT-UK Colloquium 24-26 July 2015, Guildford, UK
2/5/2015 5:59:09 PM	319122	FM2	Call all schools - if you would like a Fitter message uploaded please email operations@funcube.org.uk
2/5/2015 5:59:03 PM	319122	FM1	The main FUNCube tech team is: Dave G4DPZ, David G0MRP, Duncan M6UCK, Gerard Aalbers, Graham G3VZV, Jason G7OCD, Jim G3WGM, Howard G6LVB, Phil M6IPX, Wouter PA3WEG & Wouter Jan PE4WJ

Send school messages to operations@funcube.org.uk

http://www.stargazing.net/david/satellites/2meters.htm ISS and Satellites on 2 Meters

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ISS & Satellites on 2 Meters

Summary

Listening to the [International Space Station \(ISS\)](#) and [satellites](#) in [orbit](#) with a focus on [radio signals](#) in the [amateur radio 2 meter](#) band comprising frequencies from 144.000 MHz to 148.000 MHz.

The satellite radio signals are classified into two groups: voice and data transmissions.

Presentation

- [FUNcube-1 \(AO-73\) 2 Meter Satellite Telemetry](#) presentation at [SEA-PAC](#) June 6, 2015

2 Meters Band Satellite Plan