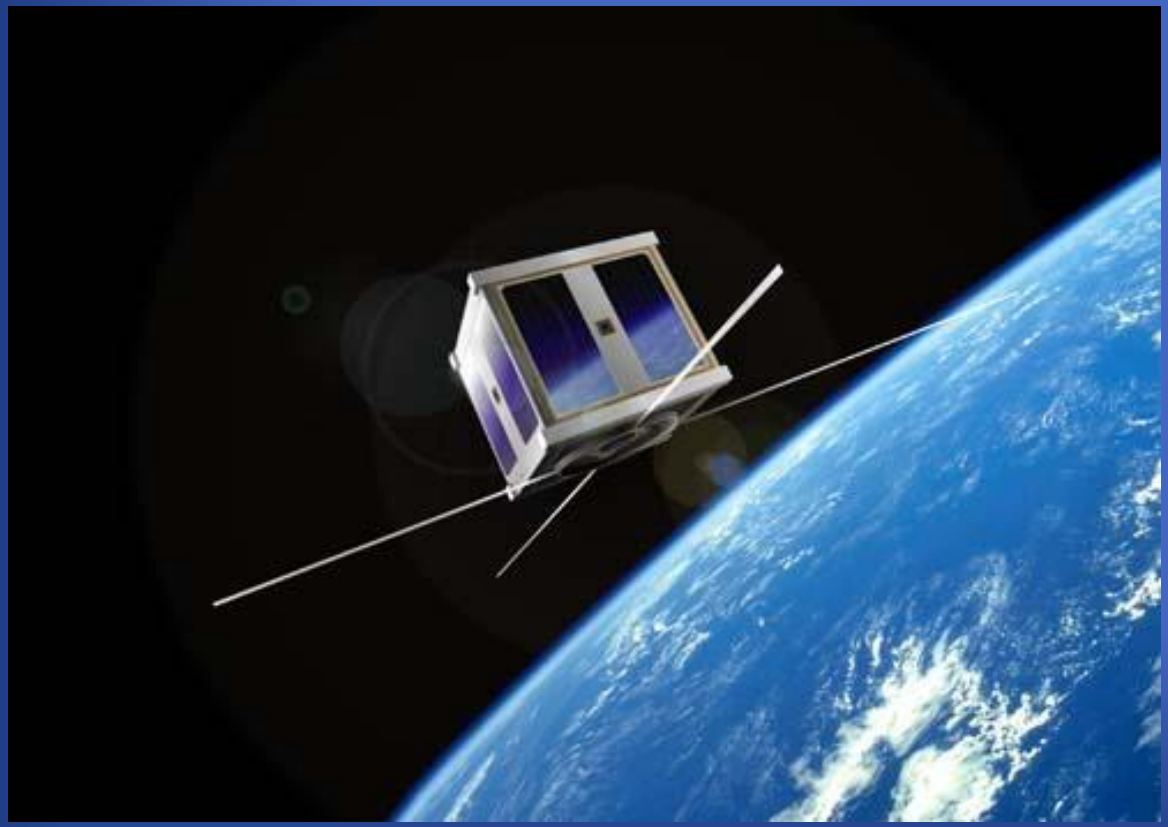
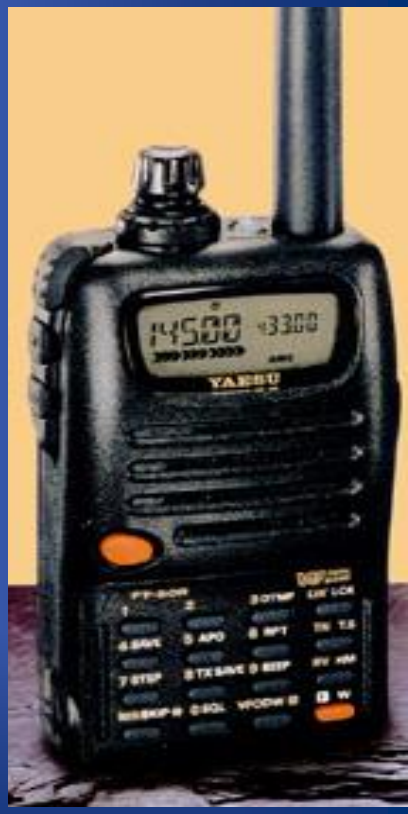
Orbiting the Earth: A Beginners Guide to Amateur Radio Satellites

Peter Portanova- W2JV- Amsat Ambassador



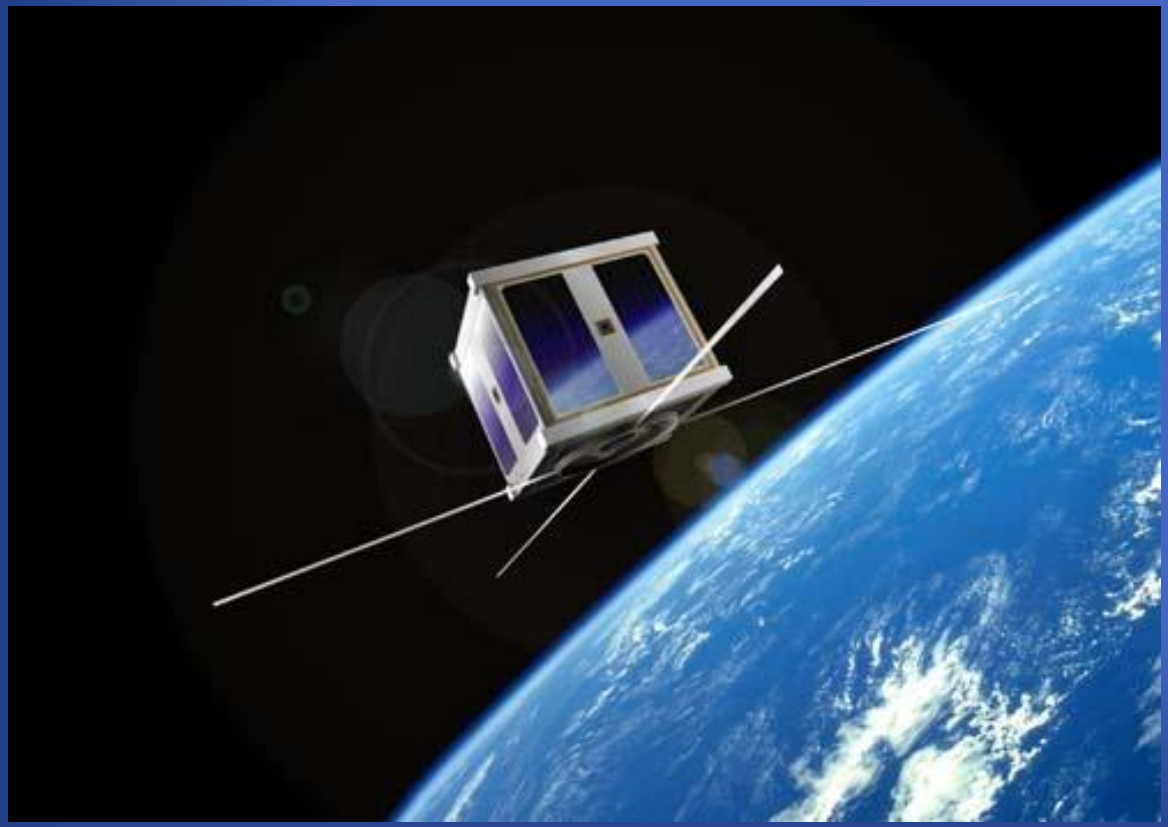


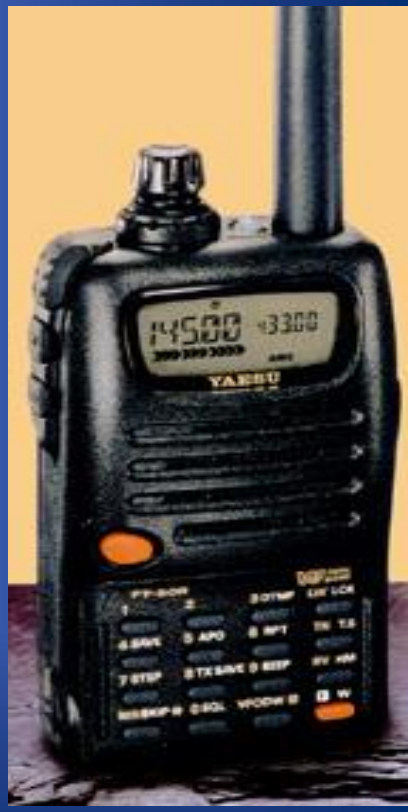
W2JV@AMSAT.ORG

Radio Amateur Satellite Corporation (AMSAT)

Keeping Amateur Radio in Space

About Your Presenter





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THE HIGHLIGHTS

W2JV

He talks so loud on the radio- I can't sleep

Neighbors wonder – why is he outside – waving that antenna

What is he really doing- in that ham room all day?

HACKED

What is needed to get started with the FM satellites?

Technician license
Transmit to


UNITED STATES OF AMERICA
FEDERAL COMMUNICATIONS COMMISSION
AMATEUR RADIO LICENSE

KB3IFH

DORMAN, RANDY J
4522 FOXTAIL RD
HAMPSTEAD, MD 21074

FCC Registration Number (FRN): 0007081581

Special Conditions / Endorsements
NONE

Grant Date	Effective Date	Print Date	Expiration Date
06-12-2002	04-17-2003	04-18-2003	06-12-2012

File Number	Operator Privileges	Station Privileges
001279265	Amateur Extra	PRIMARY

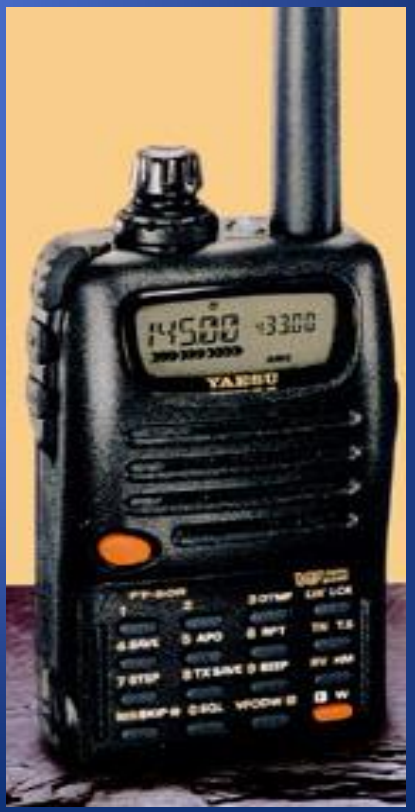
THIS LICENSE IS NOT TRANSFERABLE

Randy Dorman
(Licensee's Signature)

FCC 660 - May 2007

SMILEY 2/220/440-
high gain whip

Dual-VFO, HT

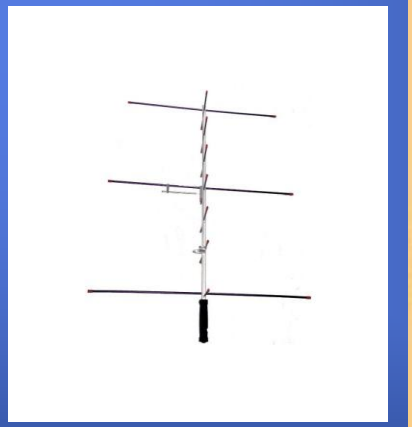


Amsat.org

AMSAT Online Satellite Pass Predictions - SO-50
View the current location of SO-50

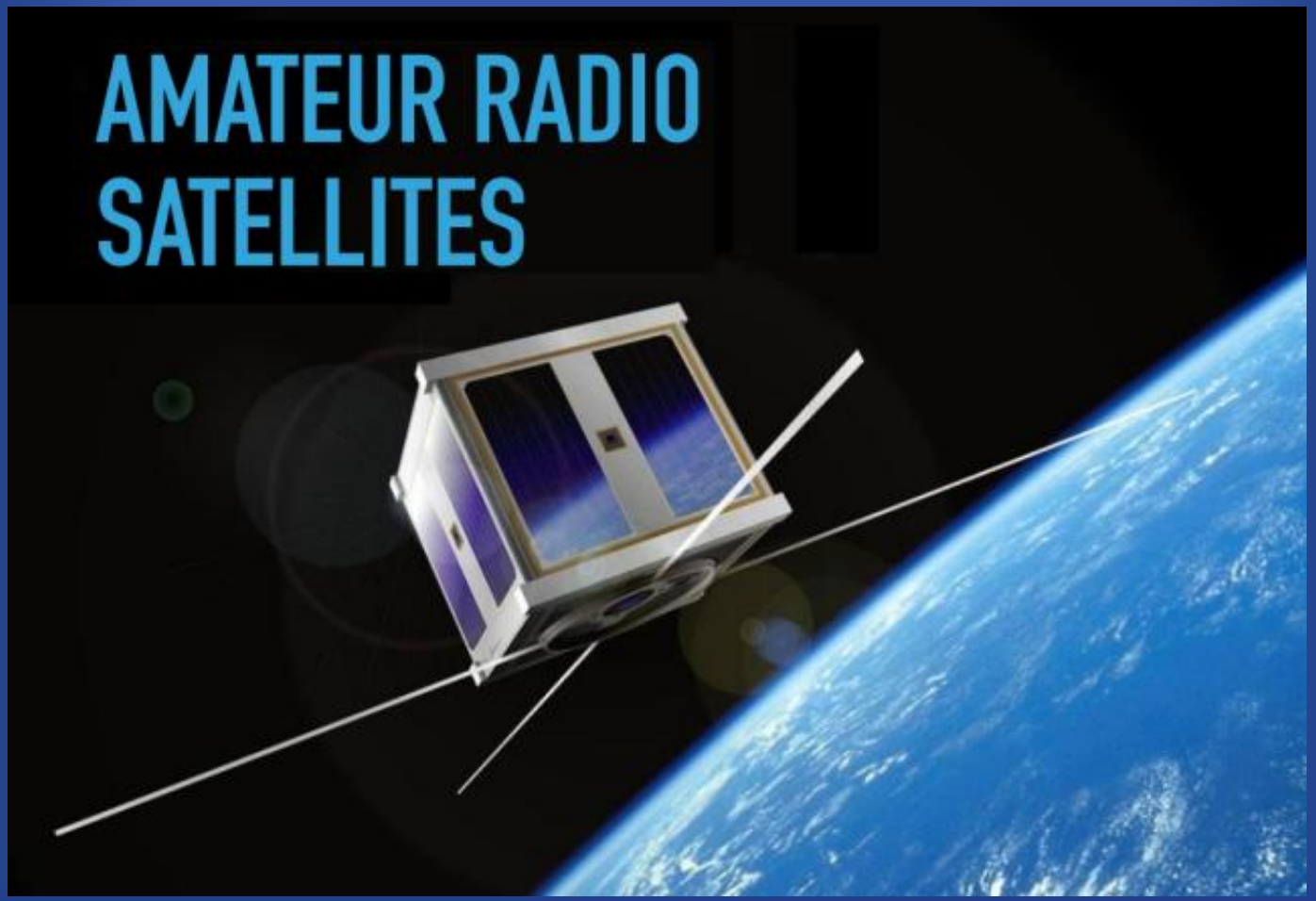
Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
05 Jan 18	14:40:31	00:13:31	216	72	284	32	14:54:02
05 Jan 18	16:23:01	00:11:01	269	12	328	19	16:34:02
05 Jan 18	18:08:34	00:05:50	324	2	350	15	18:14:24
05 Jan 18	19:51:39	00:06:26	347	3	13	44	19:58:05
05 Jan 18	21:31:34	00:11:57	340	15	38	98	21:43:31
05 Jan 18	23:11:37	00:13:59	327	88	212	149	23:25:36
06 Jan 18	00:53:11	00:10:22	302	9	262	205	01:03:33
06 Jan 18	13:25:55	00:12:42	185	28	131	43	13:38:37
06 Jan 18	15:06:09	00:13:01	238	31	324	26	15:19:10
06 Jan 18	16:50:07	00:08:41	292	6	333	13	16:58:48
06 Jan 18	18:35:46	00:04:24	342	1	354	20	18:40:10
06 Jan 18	20:16:45	00:08:51	345	6	26	66	20:25:36
06 Jan 18	21:56:34	00:13:21	335	28	59	120	22:09:55
06 Jan 18	23:36:58	00:13:32	319	36	235	171	23:50:30
07 Jan 18	01:21:23	00:02:59	273	1	260	248	01:24:22
07 Jan 18	12:13:17	00:08:50	147	7	106	63	12:22:07
07 Jan 18	13:50:35	00:13:29	207	75	146	35	14:04:04
07 Jan 18	15:32:26	00:11:46	259	16	318	21	15:44:12
07 Jan 18	17:17:37	00:06:29	315	3	341	13	17:24:06
07 Jan 18	19:01:42	00:05:23	347	2	13	34	19:07:05

ARROW or
ELK or HH ant.



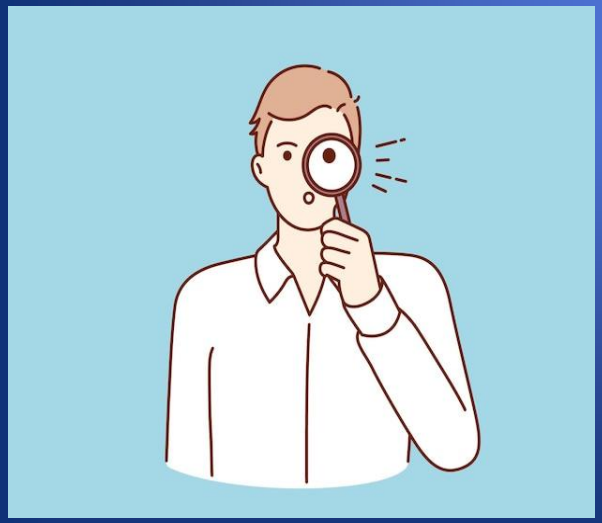
linearly polarized antenna vs. circular

What Is The Biggest Challenge



The Public

It’s Okay After a Pass!!



Satellite Quiz Time

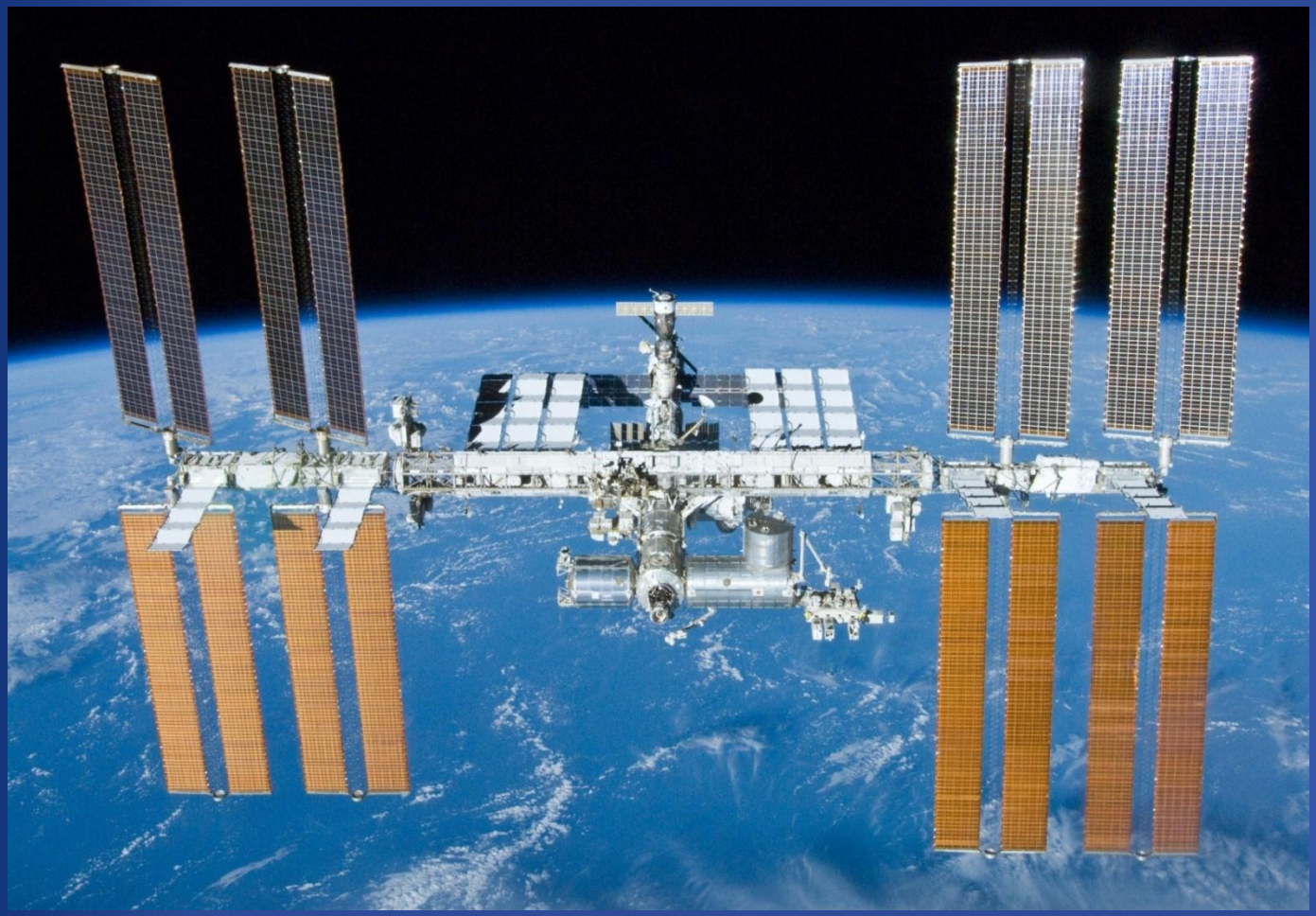
Name of the First Amateur Satellite Launched

Which Is The Largest Satellite that Amateur Operators Use?

Which Amateur Satellite is the longest Operating?

Oscar 1- 1961

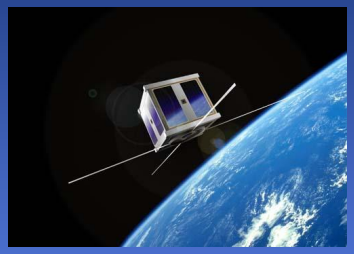
ISS Largest Satellite in Space



https://www.ariss.org/current-status-of-iss-stations.html

AO-7- Launched 1974
Linear Satellite

What Are we Going to Learn?



How to Program our Radios to Hear/transmit to the ISS

How to know When a Satellite is in our Footprint

How to Track a Satellite thru its Orbit

Using Software to do all the Math

Satellite Terms

What Is An Oscar?

…. .. …. .. …. .. …. ..

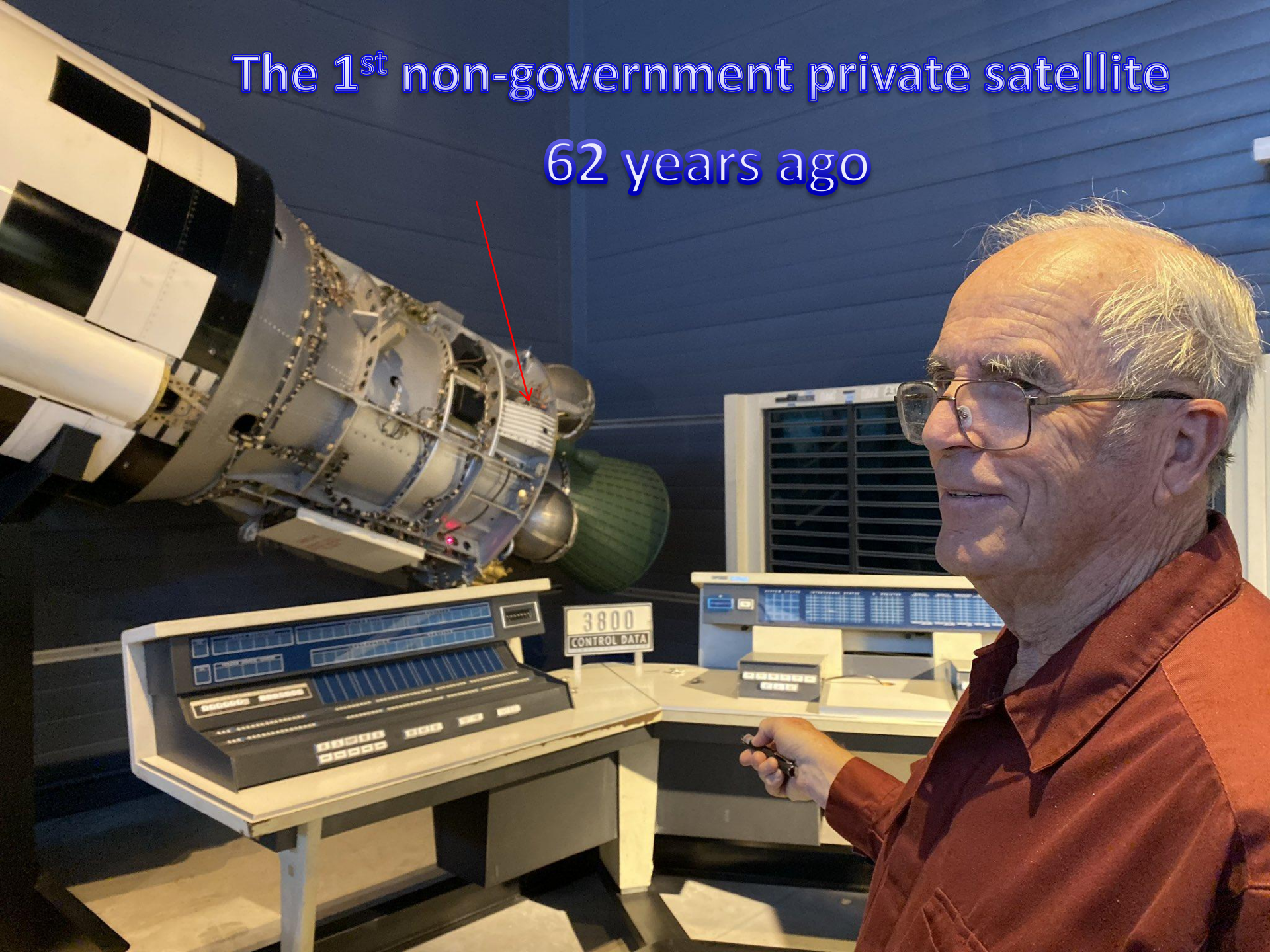
Don Stoner- 1959

Lance Ginner-K6GSJ-Lockheed
Bringing Oscar 1 to Vandenberg AFB

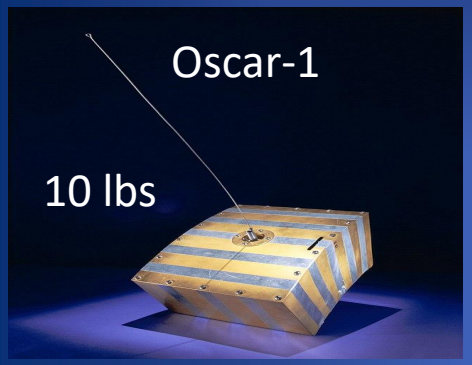
Project OSCAR formed 1960

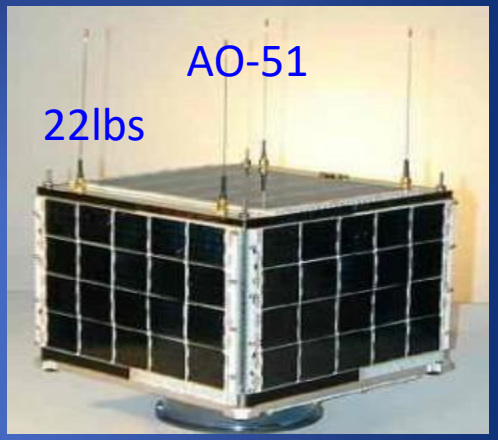
Oscar 1 launched 1961

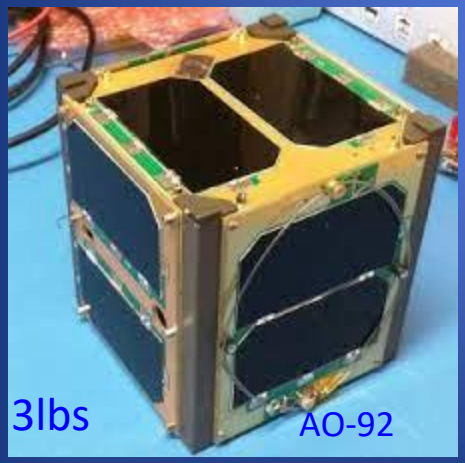
AMSAT formed -1969

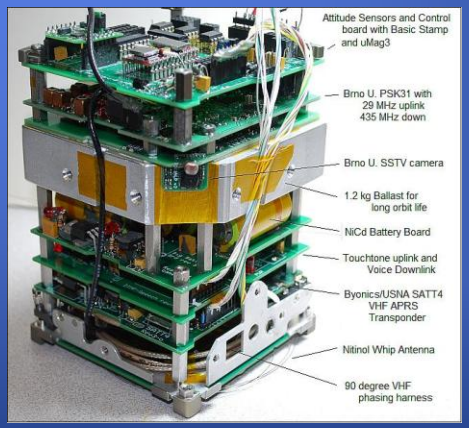

The 1st non-government private satellite
62 years ago
3800
CONTROL DATA

Evolution of Satellites









1U-cubesat- 10cm x 10cm x 10cm- 1.3 KG

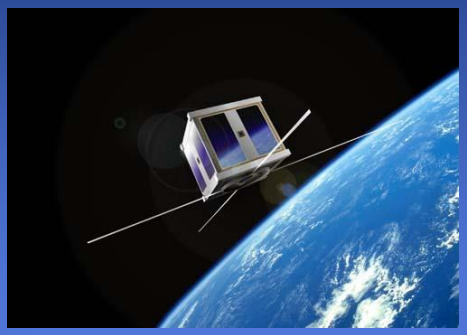
FM Repeater Satellite

Single-channel; only one person can talk at a time-
145.990 uplink- 436.800 down- ISS- w/Doppler correction
Acts like a local repeater- difference it has an uplink/downlink
Operate using a dual band FM Radio- FT-65R Two preferred-

Linear or SSB/CW/Digi Satellite Transponder

100 KHz Wide Passband- with a mixer stage
Capable of SSB/CW/Digital Operations
Operate using an all mode radio- IC-9700

Satellite Lingo



OSCMIL

Low Noise Block Downconverter

OSCAR

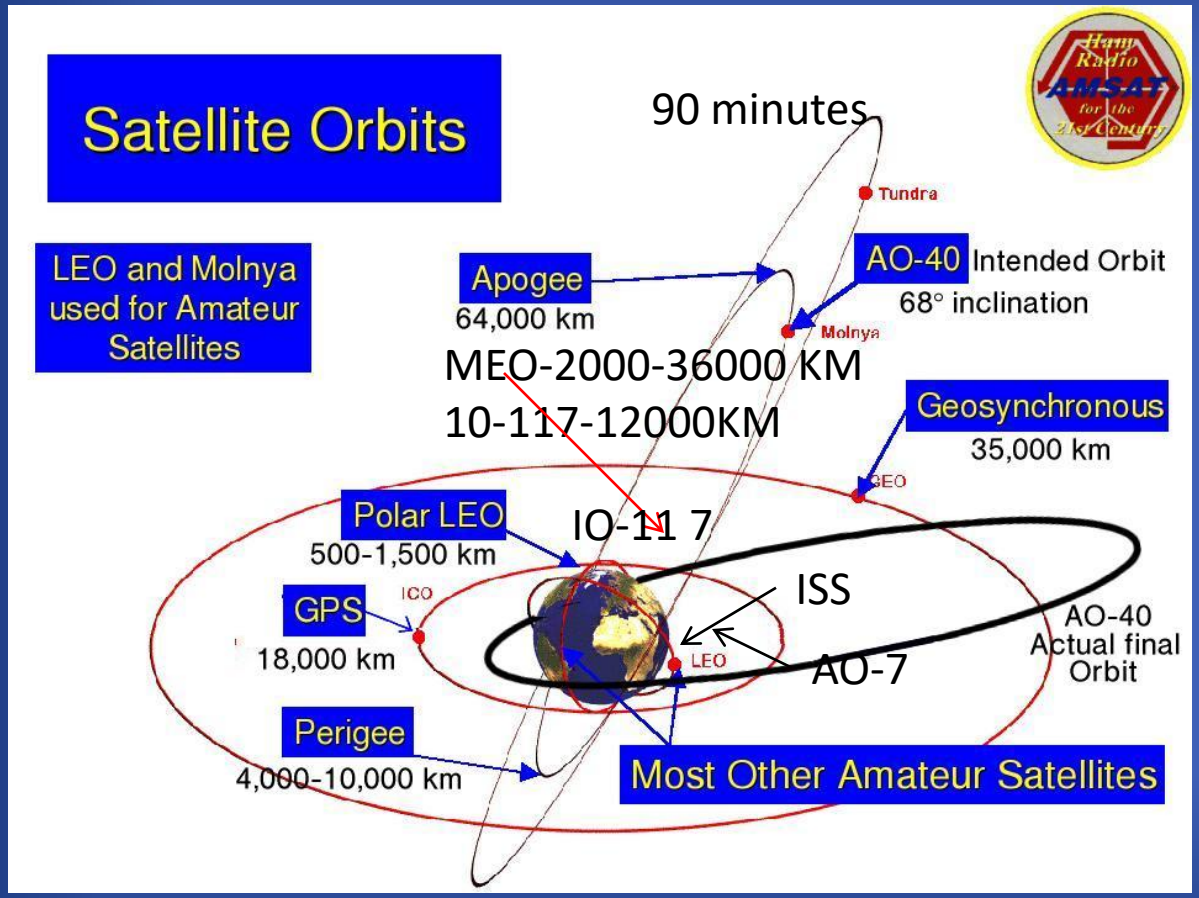
Bent Pipe Transponder

Clarke Belt

ORBIT-The Path of a Satellite
Doppler-Shift in Frequency caused by satellite motion
LEO- Low Earth Orbit- 500-2000km
Uplink– Frequency to transmit
Downlink-Frequency to receive
Footprint-When Satellite can be received
Duplex- uplink & downlink received

How high can you fly

LEO- 400-2000km MEO- 2000-36000km HEO >36000km

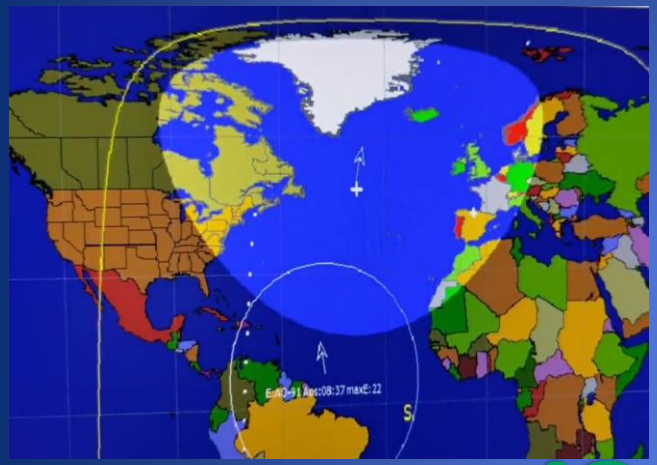


The FM satellites we work will be in a LEO orbit

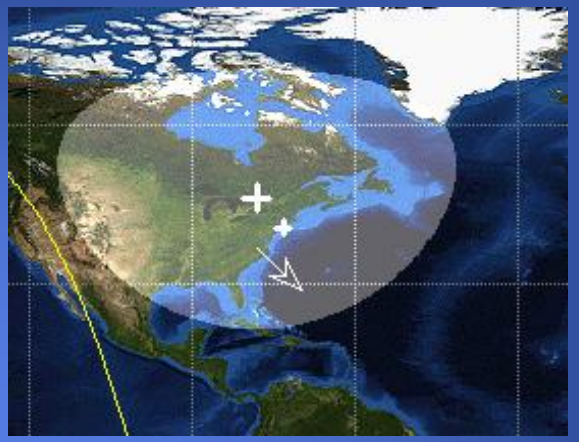
Pass Times- LEO-20 minutes MEO- 90 minutes HEO- 12-18 hrs
ISS- AO-7- IO-117

Satellites Footprint

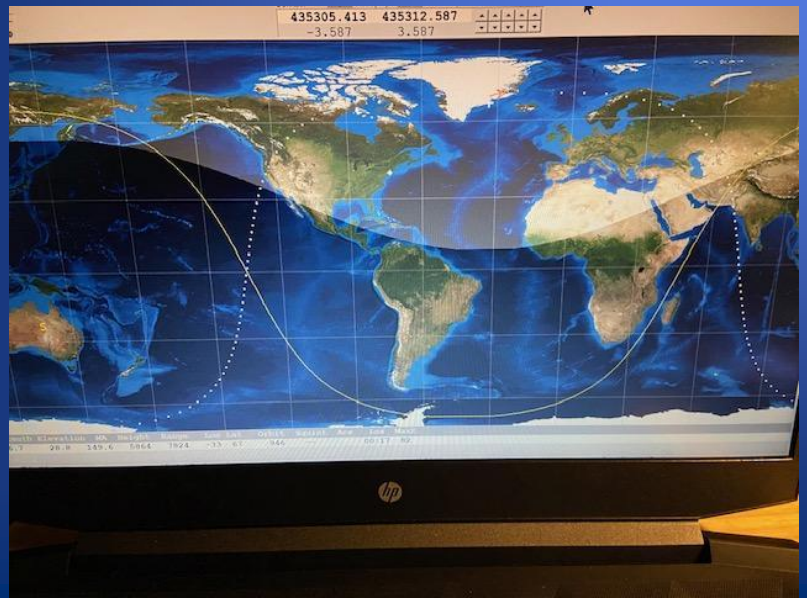
RS-44-linear



SO-50-FM



IO-117-linear



What's up there?

AO-7- SSB/CW

AO-91-FM-UP-435.250-DOWN-145.960-PL-67Hz-ctcss

IO-117-DIGITAL

ISS-FM- UP-145.990 DOWN-437.800 –PL-67Hz- ctcss

JO-97-SSB/CW

RS-44-SSB/CW

SO-50-FM-UP-145.850-DOWN-436.795-PL-67Hz-ctcss

TEVEL-1 TO 7-FM- UP-145.970-DOWN-436.400- NO PL

SO-121-FM-UP-145.875-DOWN-436.633- NO PL

https://www.amsat.org/FM-satellite-frequency-summary/

PREPARING FOR A SATELLITE PASS

KISS Method

What do we need to know- Where to Go?

Radios frequency & programmed for Doppler correction
Satellite Status
Time the Satellite will be in our Footprint
Does the Elevation of pass match our surroundings
Trace the path the Satellite will follow

Tools Needed

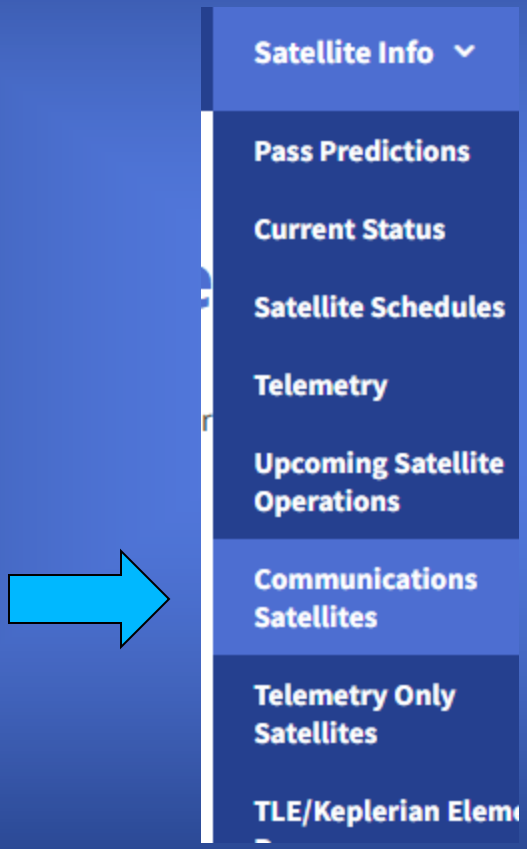
Phone /Compass- before pass-landmarks- to follow from AOS to LOS
Recorder- to remember call signs
Headset for hands free operation
Elk or Arrow Antenna
Two radios- one for uplink and one for downlink- not required initially

Let’s begin to plan for a successful pass

One Stop Searching

https://www.amsat.org/

Satellite information



Satellite uplink + downlink

What is the Frequency?

Communications Satellites

Links to information about two-way communications satellites carrying repeaters, transponders, and digipeaters can be found here

FM Repeater Satellites

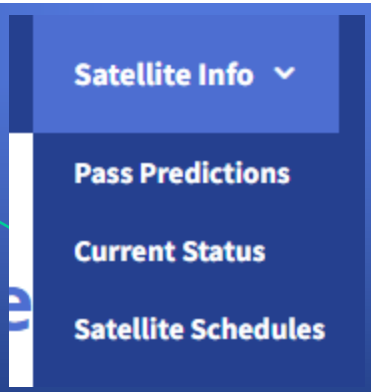
(Click here for frequency chart, follow links below for satellite details)

- SO-50 (SaudiSat-1C)
- AO-91 (RadFxSat / Fox-1B) Do not attempt to access in eclipse
- AO-92 (Fox-1D) Sporadically active
- LilacSat-2 (CAS-3H) Transponder activations sporadic
- IO-86 (LAPAN-A2) In equatorial orbit, activations by schedule
- PO-101 (Diwata-2) Active by schedule, see here for schedule updates
- AO-27 Currently on for four minutes on ascending and descending passes over mid-latitudes of the Northern Hemisphere
- ISS Crossband Repeater Click here for schedule updates.
- FO-118 (CAS-5A)

Wow this is Easy!

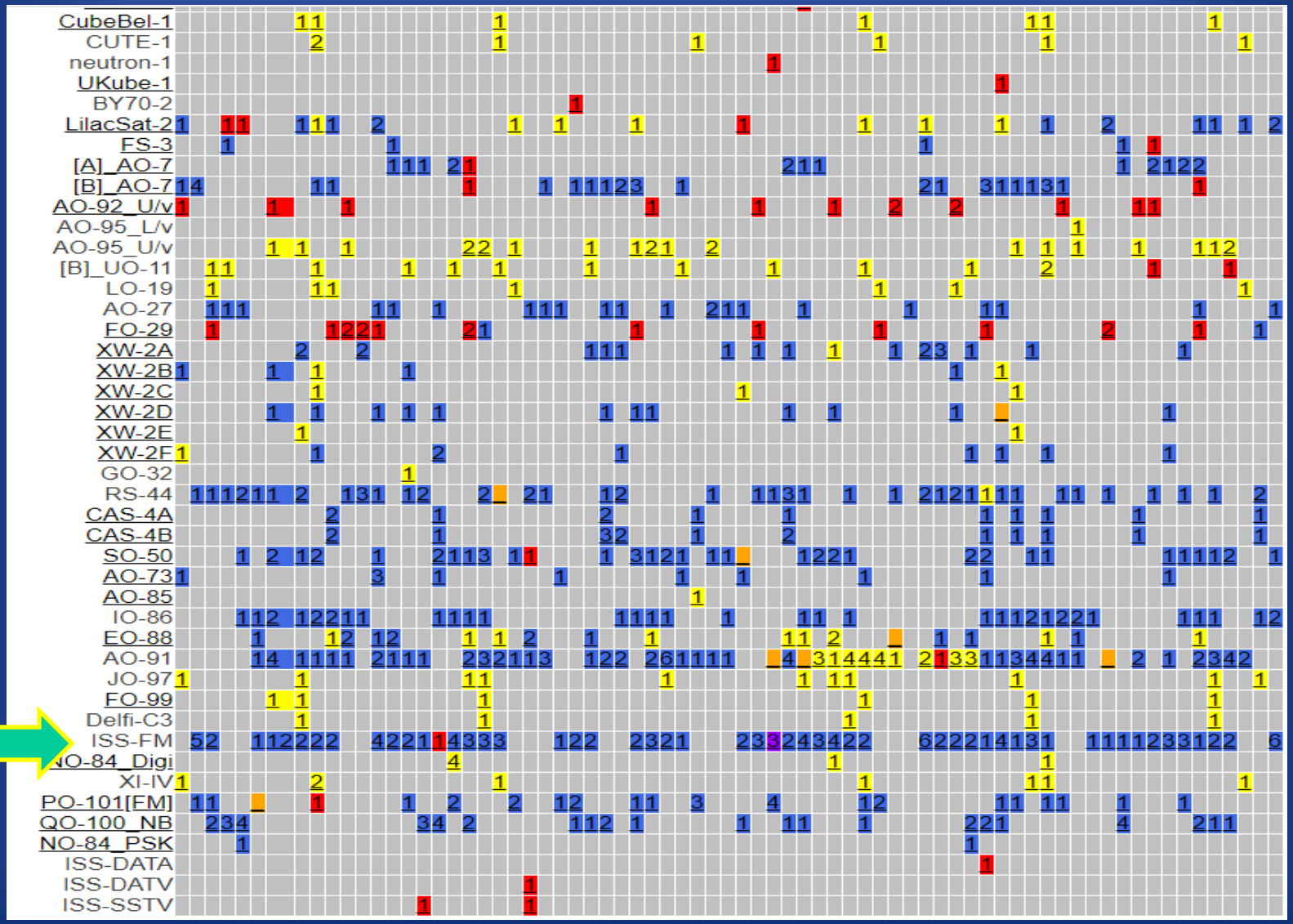
Frequency Chart

ISS Crossband Repeater				
		Uplink FM (67 Hz CTCSS)	Downlink FM	Comments
ISS Crossband Repeater	1	145.990 MHz	437.800 MHz	w/o Doppler correction Operational
See ARISS Status for status information	2			



Is it operational?

SATELLITE STATUS



Getting Started

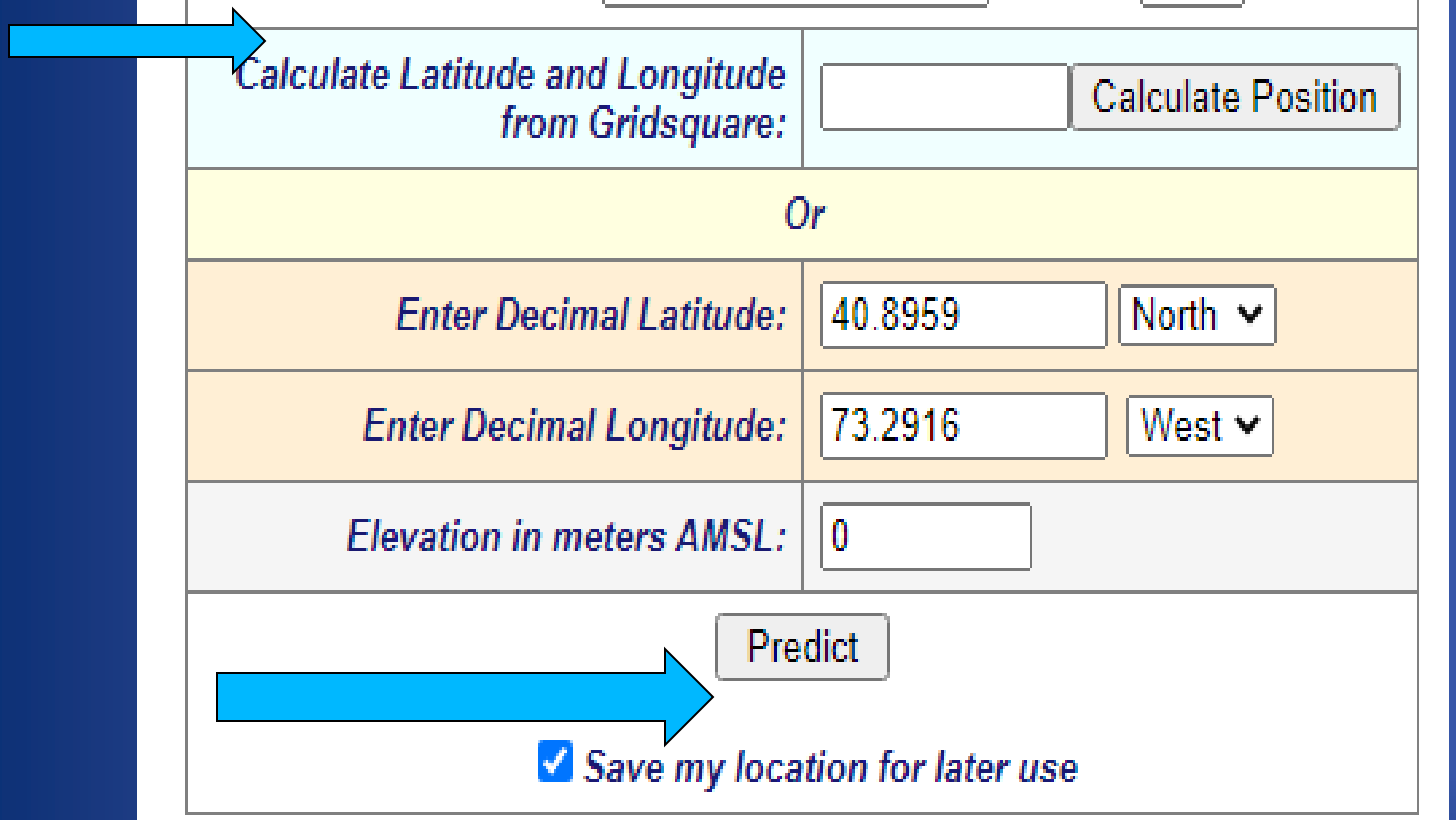
Radio Programming -ISS CBR

CH #	NAME	TX FREQ	CTCSS (TX)	RX FREQ
101	ISS- CBR	145.990	67.0	437.815
102	ISS-CBR	145.990	67.0	437.810
103	ISS-CBR	145.990	67.0	437.805
104	ISS-CBR	145.990	67.0	437.800
105	ISS-CBR	145.990	67.0	437.795
106	ISS-CBR	145.990	67.0	437.790
107	ISS-CBR	145.990	67.0	437.785

ADJUSTING FOR DOPPLER

https://ka7fvv.net/PDF/FM_Sat_Reference.pdf

Pass Prediction- ISS-CBR



https://levinecentral.com/ham/grid_square.php

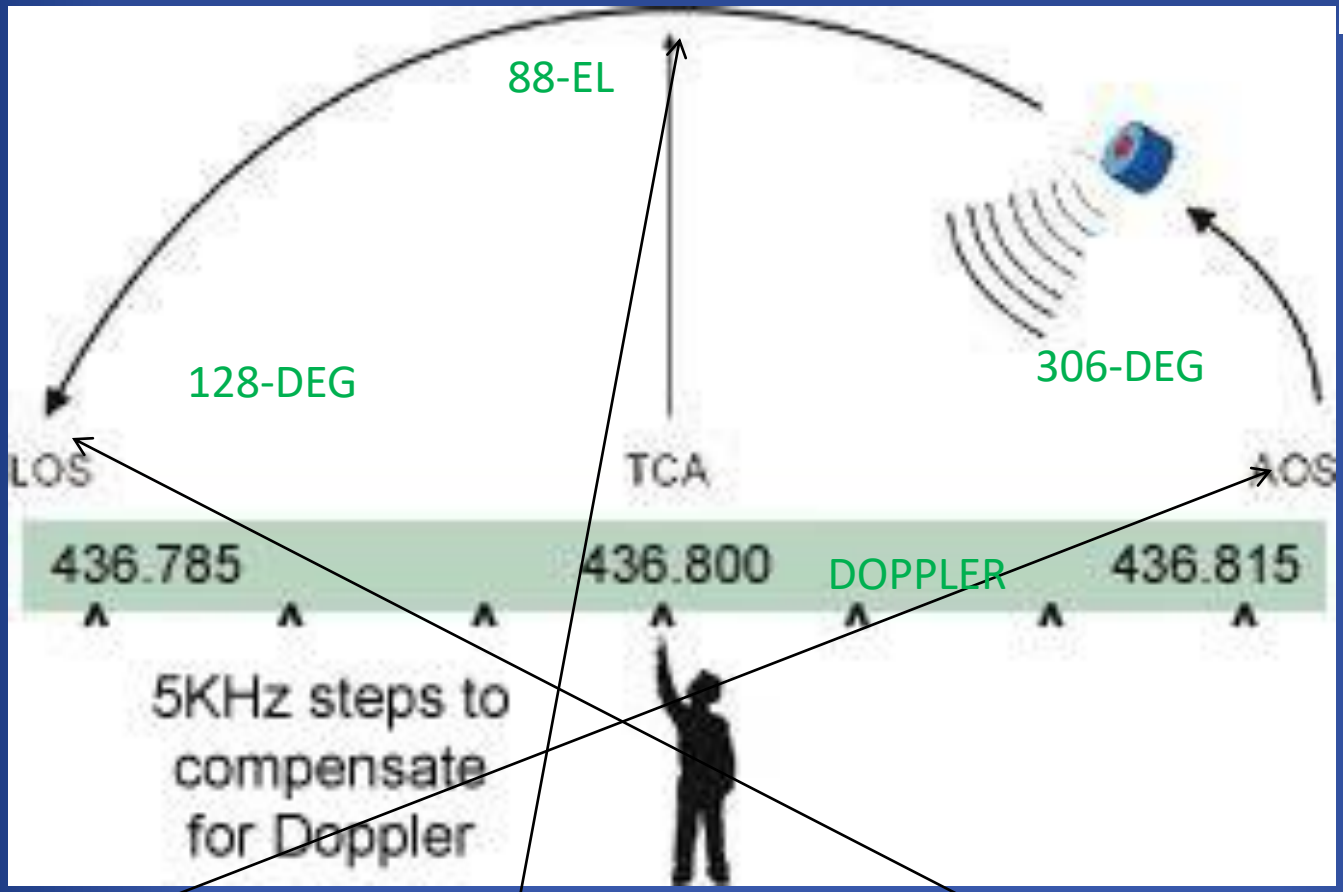
Tracking A Pass

AMSAT Online Satellite Pass Predictions - ISS

View the current location of ISS

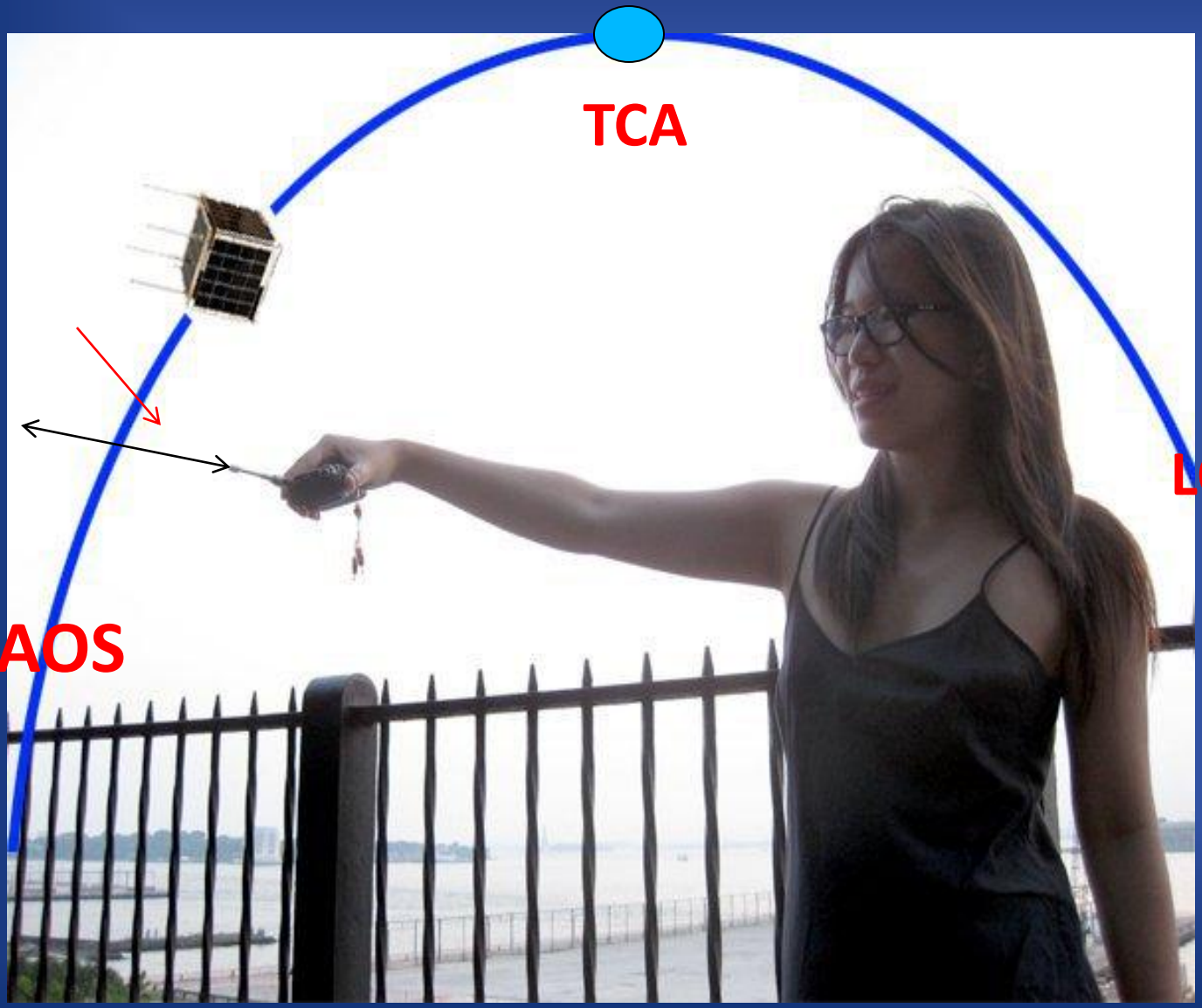
Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
04 Nov 23	02:34:45	00:07:25	169	6	128	82	02:42:10
04 Nov 23	04:09:10	00:10:49	225	65	134	56	04:19:59
04 Nov 23	05:46:28	00:10:11	268	21	327	48	05:56:39
04 Nov 23	07:24:38	00:09:13	300	12	0	57	07:33:51
04 Nov 23	09:02:00	00:09:59	312	19	11	86	09:11:59
04 Nov 23	10:38:40	00:10:57	306	88	332	128	10:49:37
04 Nov 23	12:16:06	00:08:29	284	10	225	180	12:24:35
05 Nov 23	01:48:08	00:04:15	146	2	119	99	01:52:23
05 Nov 23	03:20:54	00:10:32	213	34	119	60	03:31:26
05 Nov 23	04:57:40	00:10:30	258	29	350	49	05:08:10

Hand Held Satellite Tracking



AOS-Acquisition of Signal- TCA-Time of closest approach- LOS-Loss of signal

KISS METHOD OF SATELLITE OPS



CHECKLIST for a Successful ISS-CBR Pass

- Go to WWW.AMSAT.ORG
- BE EARLY
- Show predictions for ISS
- "Passes" - 50 degrees minimum
- Radio Programmed
- Squelch Open
- WATCH- UTC Time
- COMPASS/phone- to trace pass-landmarks
- Grid Square- Yours- FN30?
- Voice Recorder

AMSAT Online Satellite Pass Predictions - ISS

View the current location of ISS

Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
20 Dec 20	09:13:58	00:04:03	144	1	131	100	09:18:01
20 Dec 20	10:46:38	00:10:32	212	32	119	61	10:57:10
20 Dec 20	12:23:23	00:10:37	257	31	349	50	12:34:00
20 Dec 20	14:01:31	00:09:23	292	14	352	53	14:10:54
20 Dec 20	15:39:11	00:09:49	310	16	9	78	15:49:00
20 Dec 20	17:16:01	00:10:51	308	56	41	117	17:26:52

CH #	NAME	TX FREQ	CTCSS (TX)	RX FREQ
101	ISS- CBR	145.990	67.0	437.815

https://www.levinecentral.com/ham/grid_square.php

The Art Of Making Contacts

- Make sure you can hear other stations
- LISTEN-LISTEN-LISTEN
- Adjust antenna for best signal- YAGI WRIST
- Change frequency when signal is not clear
- Try not to call early in pass- elevation too low
- Wait for pause in the activity
- Give you call sign once- say-HH-Listen
- Or Call a specific station, DO NOT CALL CQ!
- Know your Grid Square
- Repeat the process as the satellite moves
- You can schedule a contact with another

MAKING CONTACTS

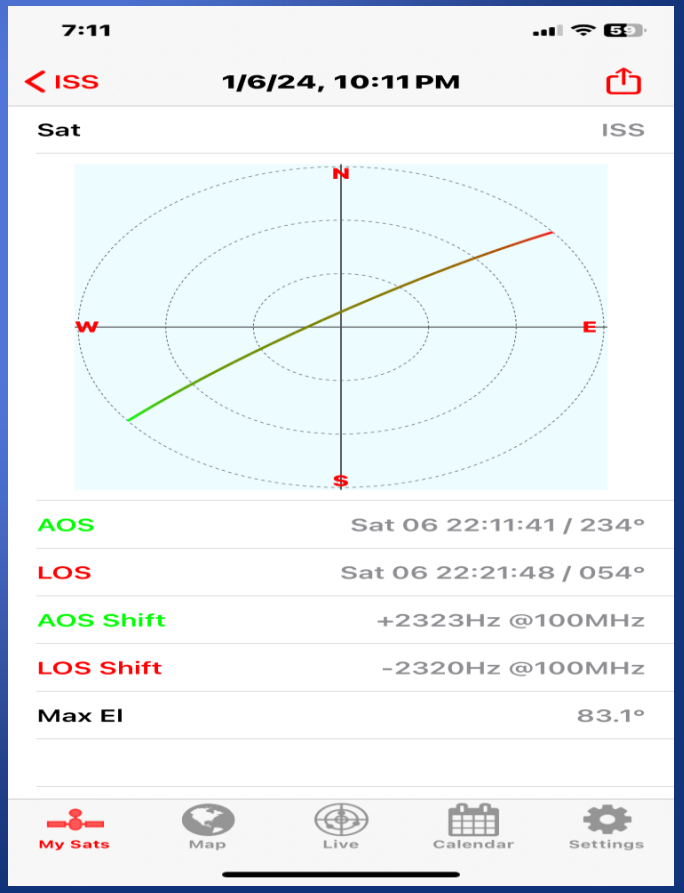
A0.51.TRIM.mp4

Using a linearly polarized antenna-wrist twist

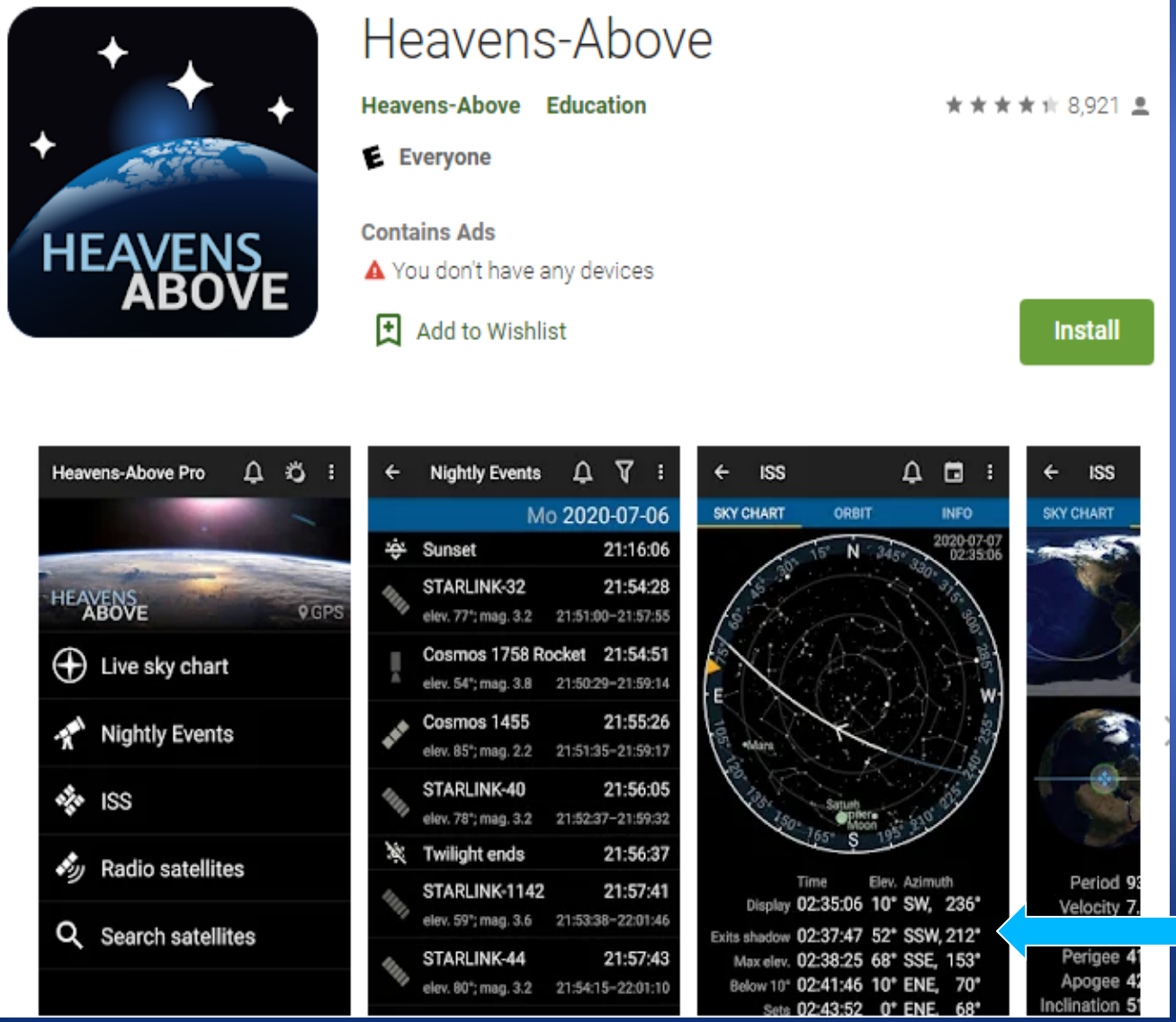
Satellite Tracking Software

I-Phone- SAT-SAT App- store

AMSAT Droid Free



Pass Track


Heavens-Above
Heavens-Above Education
8,921
Everyone
Contains Ads
You don't have any devices
Add to Wishlist
Install
Heavens-Above Pro
Live sky chart
Nightly Events
ISS
Radio satellites
Search satellites
Nightly Events
Mo 2020-07-06
Sunset 21:16:06
STARLINK-32 21:54:28
Cosmos 1758 Rocket 21:54:51
Cosmos 1455 21:55:26
STARLINK-40 21:56:05
Twilight ends 21:56:37
STARLINK-1142 21:57:41
STARLINK-44 21:57:43
ISS
SKY CHART
ORBIT
INFO
Time Elev. Azimuth
Display 02:35:06 10° SW, 236°
Exits shadow 02:37:47 52° SSW, 212°
Max elev. 02:38:25 68° SSE, 153°
Below 10° 02:41:46 10° ENE, 70°
Period
Velocity
Perigee
Apogee
Inclination


9:41
228
297° NW
37°46'20" N 122°29'33" W
San Francisco, CA
140 ft Elevation

PROGRESSION

Kenwood TH-D72
Full duplex

Yaesu FT-60R

BAOFENG/TWO PACK

ONE DUAL BAND HT/ FM SIMPLEX- yagi antenna

TWO HT'S/DUPLEX/ FM-SO-50- I HEAR MY DOWNLINK!

ALL MODE VHF/UHF/SSB 2 RADIOS- AO-7-FO-29-AO-73

ALL MODE VHF/UHF- BASE STATION- AZ-EL ANTENNAS

Satellite Resources

AMSAT.ORG

https://www.qrz.com/db/WD9EWK

http://www.k6lcs.com/Home.html

http://www.amsat.org/mailman/listinfo/amsat-bb

https://ke0pbr.wordpress.com/

https://www.pe0sat.vgnet.nl/satellite/amateur-radio-satellites/

https://levinecentral.com/ham/grid_square.php

KEEPING AMATEUR RADIO IN SPACE

PLEASE CONSIDER JOINING

Founded 1969-501 C-3 charity in DC- all Volunteer
Mission to develop and provide satellites and Technology used for amateur radio use
Partners with schools and universities for Launch opportunities thru NASA- ELANA

WWW.AMSAT.ORG

Future Satellite Launches

Greater Orbit Larger Footprint (GOLF)

- Successor to the Fox series of Cubesats
- Larger 3U (30x10x10 cm) footprint
- First two satellites in series
  - GOLF-Tee
    - Technology demonstrator
    - LEO
  - GOLF-1
    - Enhanced capabilities
    - LEO, but possibly MEO/HEO
      - Orbital debris regulations went into effect. It's crowded up there!

2025 launch

Satellite Challenges

Faster launch opportunities

FOX-PLUS

- Overview
  - 1U CubeSat (10 cm x 10 cm x 10 cm)
  - Commercially Acquired Components
    - Frame
    - Electrical Power System — Supposed to Arrive Any Day Now!!!
    - UHF/VHF Antenna
    - Solar Panels
  - AMSAT Components
    - Fox-Plus A Will Be a Linear Transponder Module, V/U Linear
    - Working on a FM Transponder as an ASCENT Project

How will you operate the Satellites?

ROVER/GRID EXPEDITION

TRAVEL/W RADIO

Backyard

BASE

What Is ARISS?

Amateur Radio On the International Space Station

1996 Formed- To design, build an operate Amateur Radio equipment in space for educational purposes

Schools apply to Host a Scheduled Contact

Purpose to promote STEM initiatives and a mental break for the Astronauts to speak to the public

ARISS

Amateur Radio on the International Space Station

AMSAT® AMATEUR RADIO IN SPACE

School 145.800

SSTV-437.800

Current Status of ISS Stations

•*as of December 29, 2021*
Columbus Module radio's: IORS (Kenwood D710GA) – STATUS - Configured. Current mode set to packet operation (145.825 MHz up & down). Next mode change to support cross band repeater (145.990 MHz up {PL 67} & 437.800 MHz down) targeting Jan 4

ISS Digipeater 145825

```
RS0ISS>CQ:>ARISS - International Space Station
2018-08-25 14:21:00 received
N5DGK-9>S0RT6U,RS0ISS*:`w8#l  >/`"3u}_%
2018-08-25 14:20:52 Bluetooth OK (±13m)
AA0AN-7>APDR14,ARISS,RS0ISS:=3902.84N/09437.91W[/A=000826 Ahoy from EM29.  KCK
2018-08-25 14:20:41 received
N5DGK-9>S0RT5W,RS0ISS*:`w8Gl  >/`"3p}_%
2018-08-25 14:20:37 Bluetooth OK
AA0AN-7>APDR14,ARISS,RS0ISS::KC5ILO-2 :qsl 599 em29 qsl?{1
2018-08-25 14:20:24 received
N5DGK-9>S0RT4Y,RS0ISS*:`w8hl  >/`"3o}_%
2018-08-25 14:20:10 received
AA0AN-7>APDR14,RS0ISS*,RS0ISS:=3
```

ISS CBR

145900 up 437800 down

https://www.ariss.org/current-status-of-iss-stations.html

ARISS-SSTV-2023

Which is the best radio ?

Assumptions: HH Portable

Preferred: Duplex?

Choices: Kenwood TH-D72-A- Yaesu-FT-470-FT-51R-FT-530-Icom-IC-W32-A, W32 – Wouxan-KG-UV8-UV9—only-AO-92- Alinco-DJ-G7-UV/-LV-1.2Ghz

Best options: VHF/UHF Radios-

Kenwood-Icon -Baofeng- Wouxun- Better Radio for RX-

Two Radio Option:

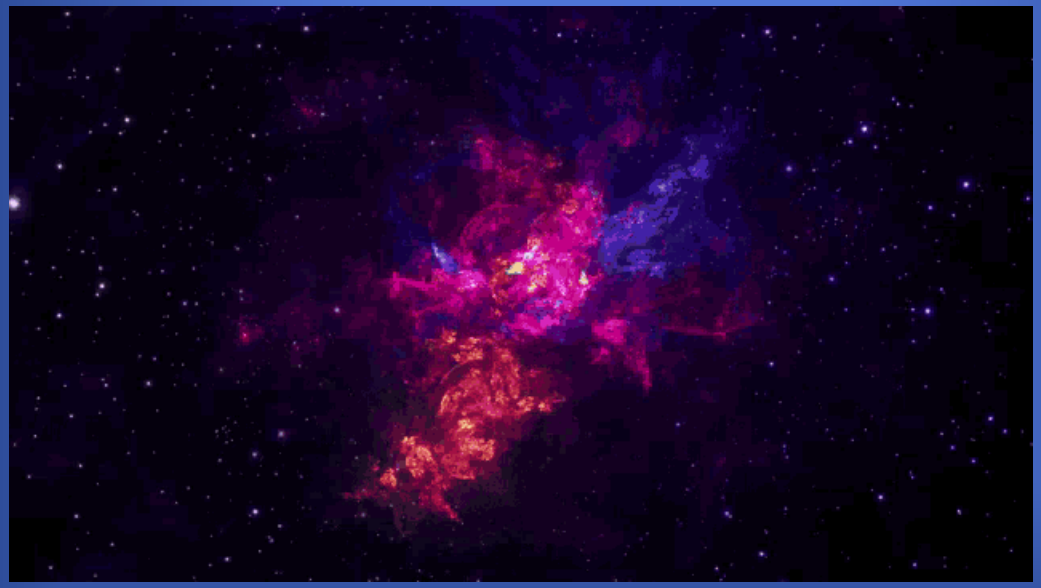
Yaesu FT-65- RX- Baofeng- UV-5R-TX

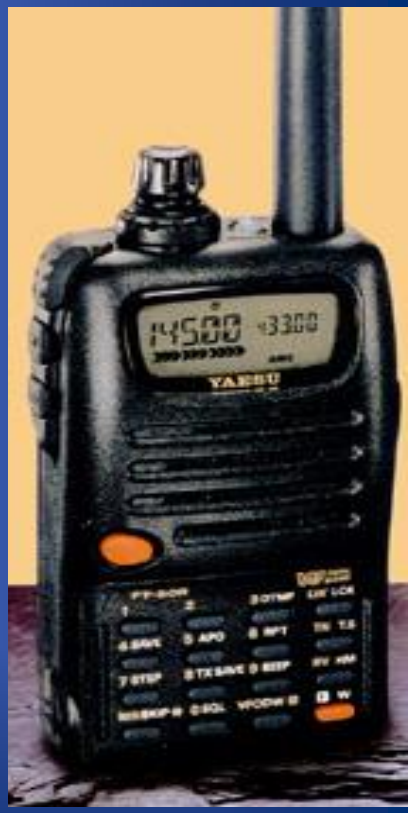
N5DUX Sat Guide- https://n5dux.com/ham/satellites/

- AMSAT - the Radio Satellite Corporation who coordinates and oversees amateur radio satellites in the US.
- ARRL - the National Association for Amateur Radio
- Arrow Antennas - perhaps the most popular handheld antenna for working VHF/UHF satellites
- Elk Antennas - easily the second most popular handheld antenna for working satellites
- Bioenno Power - popular battery manufacturer for LiFePO batteries
- ABR Industries - custom, quality coax cable assemblies (often when you buy coax from vendors, they're getting them here)
- DX Enginnering - source for most all ham radio equipment
- PortableZero - maker of the dual 817 frame I use
- MiniCircuits - maker of the VHF Low Pass Filter I use
- Heavens-Above - satellite (and celestial body) tracking website
- N2YO - graphical satellite tracking website
- Satellite Tracking App Wiki - Wiki page listing the more common satellite tracking apps
- SatSat iOS app - my preferred phone tracking app (for now)
- YouTube: Tips on Operating Linear Amateur Radio Satellites (Part 1) - Sean, KX9X's fantastic video series sponsored by DX Engineering, explaining satellite operation
- YouTube: Tips on Operating Linear Amateur Radio Satellites (Part 2) - Sean, KX9X's fantastic video series showing linear satelite operating (probably better than all the words here)
- Twitter #amsat Hashtag - Most active satellite ops use Twitter and the #amsat hashtag
- Twitter @GridmasterHeatMap - showing heat map of most needed gridsquares for Gridmaster
- Paul, KE0PBR's Frequency Cheat Sheet - updated to show active satellites uplink and downlink frequencies throughout the passband
- WxToImg - free software to decode APT Weather Satellite signals like NOAA 19
- OnAllBands Blog - Sean, KX9X's blog entries

THANK YOU- KEEP LOOKING UP

QUESTIONS?





THANK YOU @73'S

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