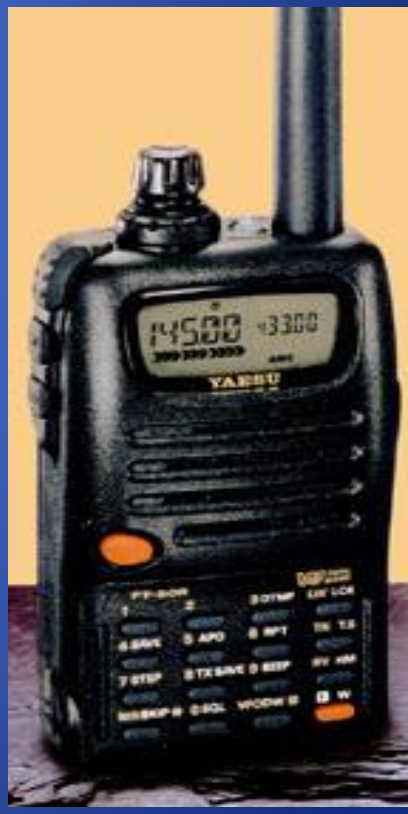

Advancing the Art and Science of Radio—Since 1914
ARRL
The national association for
Amateur Radio®
CENTENNIAL

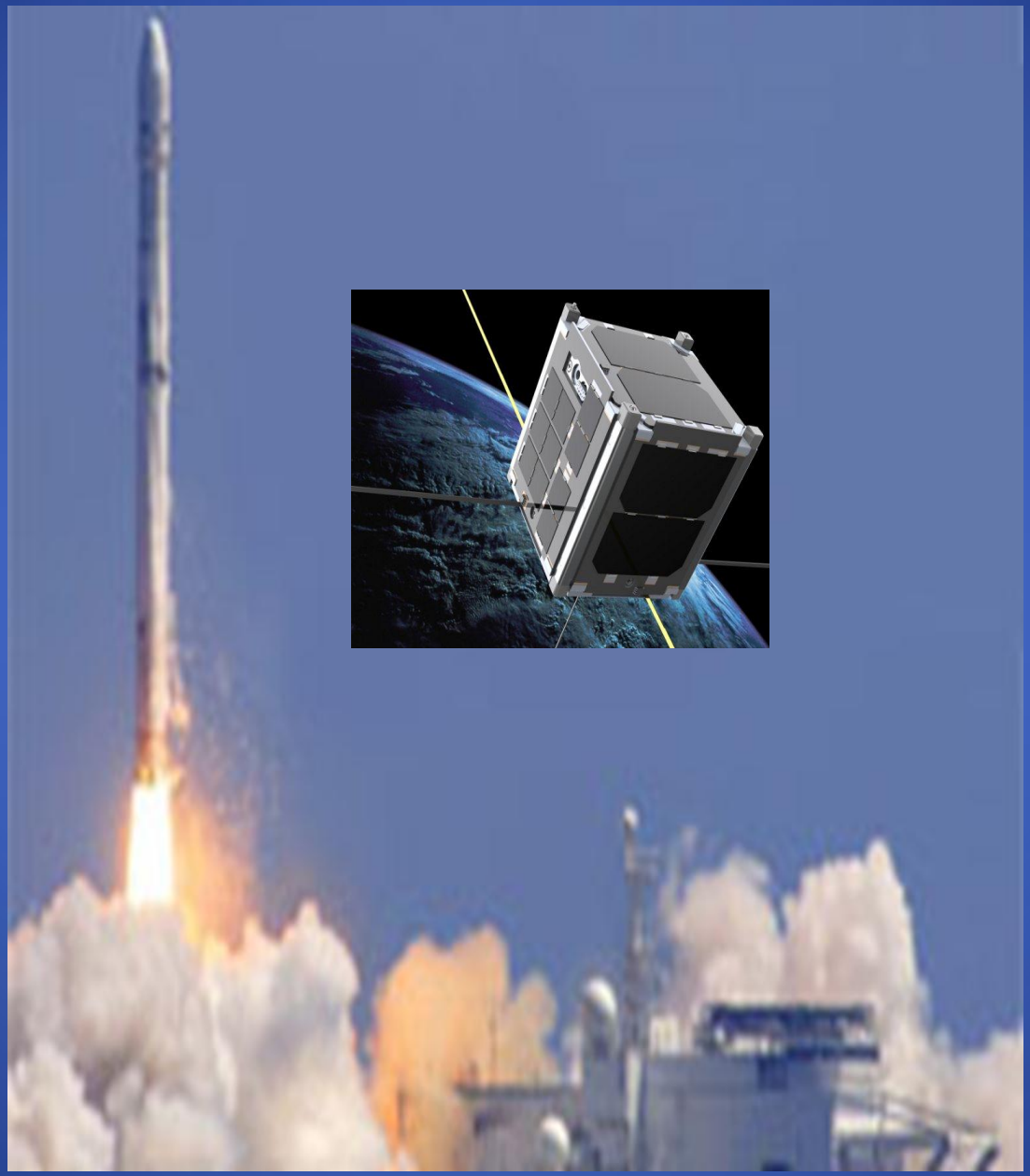
Introduction To Amateur Satellites



Peter Portanova, W2JV – AMSAT Area Coordinator

Patrick Stoddard, WD9EWK/VA7EWK – AMSAT Area Coordinator and Director of Field Operations

CAPTAIN VIDEO- I AM READY TO BLAST OFF



The Extraordinary History of Amateur Radio Satellites

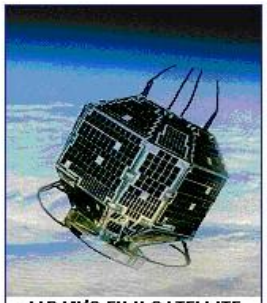
START
1960s
1970s
1980s
1990s
2000s
THE FUTURE
HAMSAT LAUNCHES
NAMES
FREQS
ARISS
SAREX
MIR
PACSATS
MOON BOUNCE
SPACE & BEYOND

Here's a startling fact — more than 70 Amateur Radio satellites have been launched over four decades. The number is astonishing because these sophisticated and groundbreaking spacecraft are little known outside the ham radio fraternity.

In fact, private groups of Amateur Radio operators around the globe have built and sent dozens and dozens of Amateur Radio communications and science satellites to orbit since the first, OSCAR-1, was launched on December 12, 1961.

The major group involved in space activity is the Radio Amateur Satellite Corporation (AMSAT) headquartered at Washington, D.C. It's membership is composed of volunteer spacecraft designers, builders and operators across America and around the world.

In the beginning. Following the Soviet Union's launch of the first-ever space satellite, Sputnik 1, on October 4, 1957, there was a great deal of interest in the United States in rushing an American satellite to orbit.



JAPAN'S FUJI SATELLITE

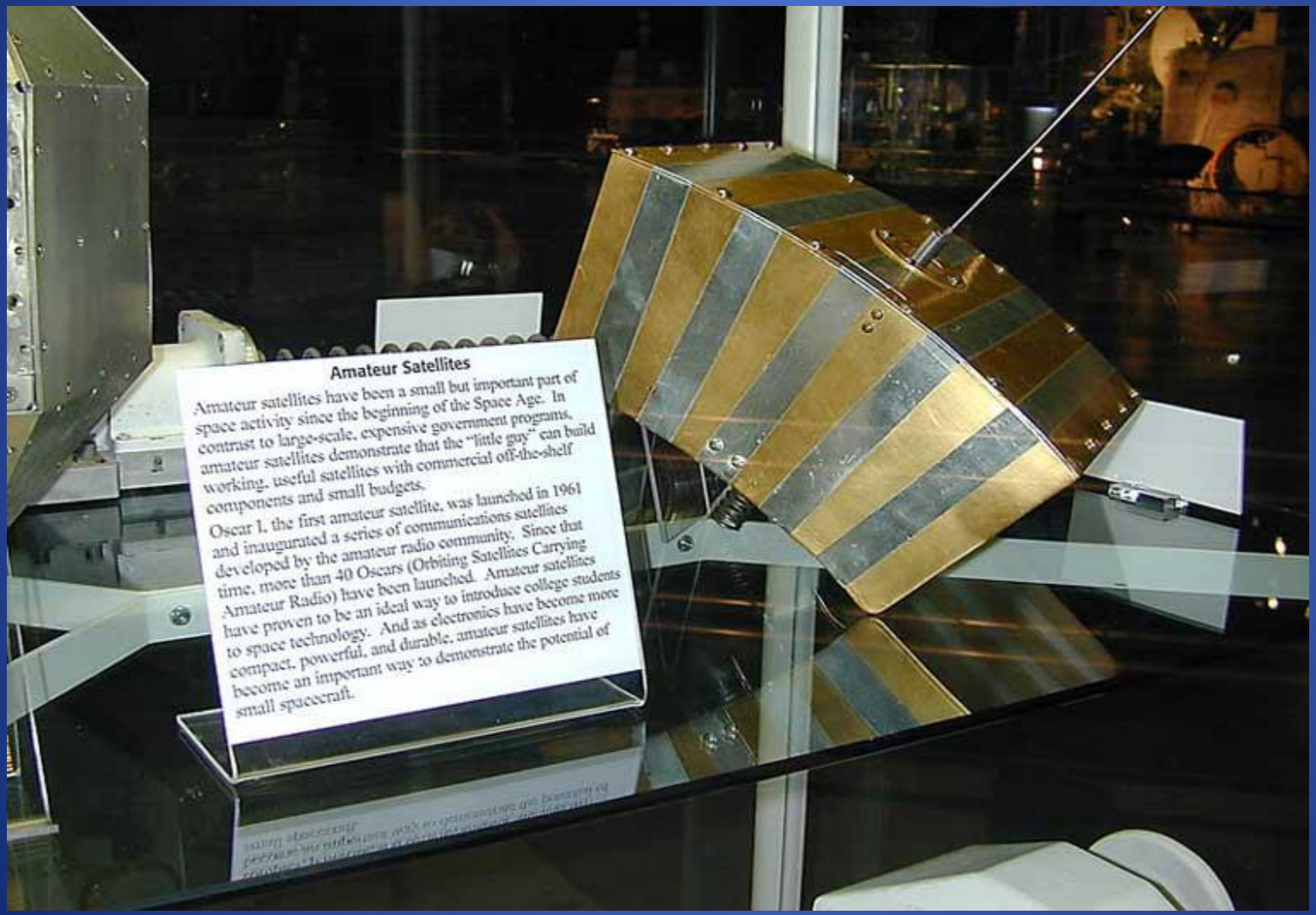
At the time, the Jet Propulsion Laboratory (JPL) of the California Institute of Technology, at Pasadena, was a research lab for the U.S. Army. A month after the Sputnik launch, the Army asked JPL to develop a satellite with a science package and communications system. The result was a tiny, 20-lb. spacecraft named Explorer 1.

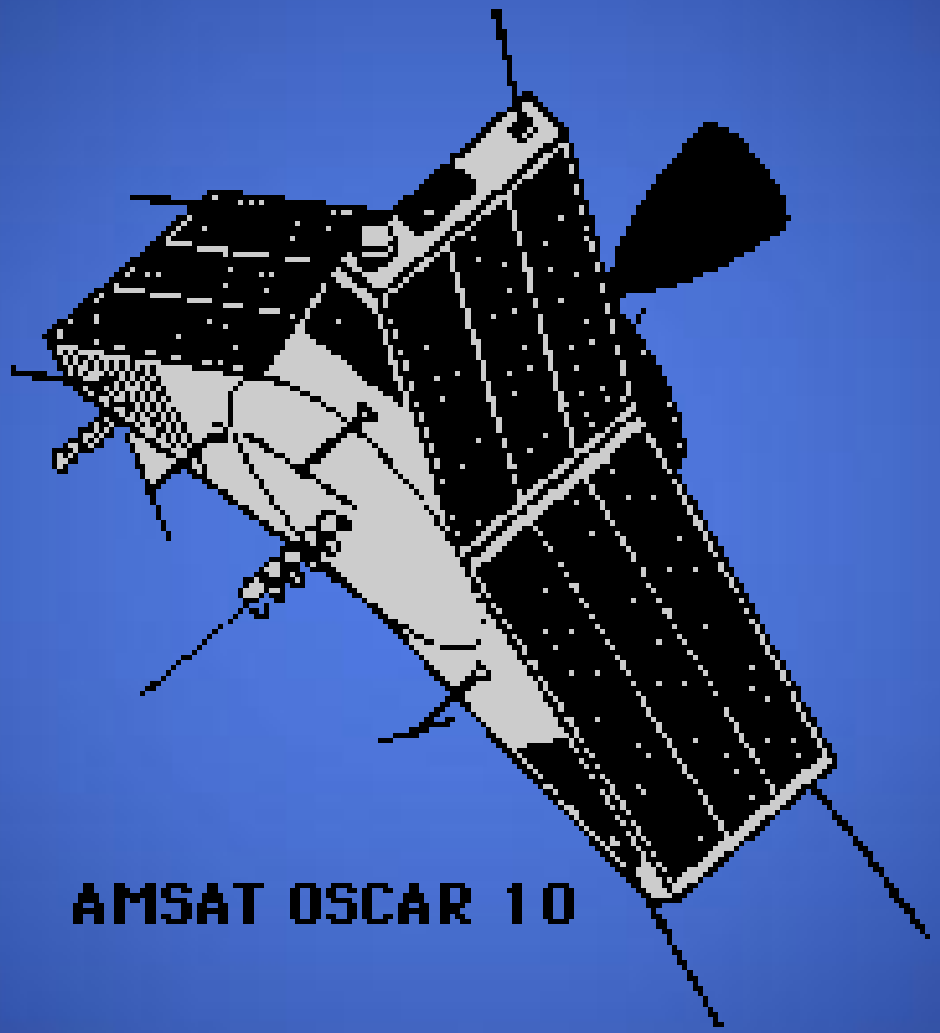
JPL and the Army Ballistic Missile Agency, at Huntsville, Alabama, blasted the satellite to space on one of the Army's Redstone rockets from the missile test center at Cape Canaveral, Florida, on January 31, 1958. That historic flight of the first U.S. satellite to orbit the Earth launched the nation into the Cold War space race and led to the establishment of the civilian space agency NASA. Today, JPL is a space research center for NASA.

Hams get involved. Amateur radio operators around the world – excited by the beep-beep-beep radio signal they overheard coming down from Sputnik – willing accepted an invitation to tune in Explorer's radio signals. One of the thousands of ham stations searching for signals from space was

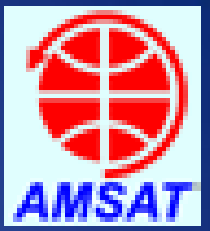
Lance Ginner- K6GSJ

OSCAR 1


Amateur Satellites
Amateur satellites have been a small but important part of space activity since the beginning of the Space Age. In contrast to large-scale, expensive government programs, amateur satellites demonstrate that the "little guy" can build working, useful satellites with commercial off-the-shelf components and small budgets.
Oscar I, the first amateur satellite, was launched in 1961 and inaugurated a series of communications satellites developed by the amateur radio community. Since that time, more than 40 Oscars (Orbiting Satellites Carrying Amateur Radio) have been launched. Amateur satellites have proven to be an ideal way to introduce college students to space technology. And as electronics have become more compact, powerful, and durable, amateur satellites have become an important way to demonstrate the potential of small spacecraft.



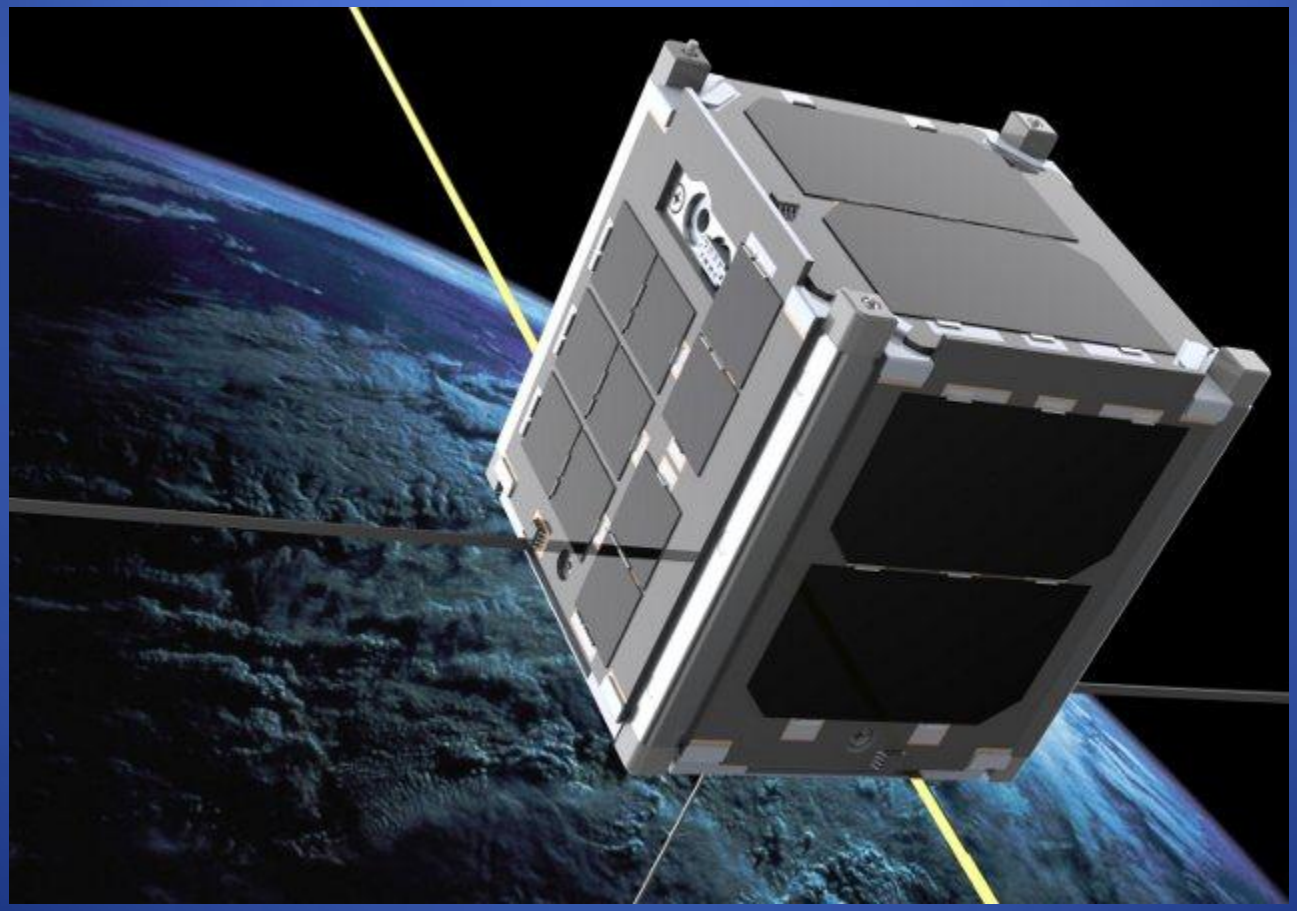
AMSAT OSCAR 10



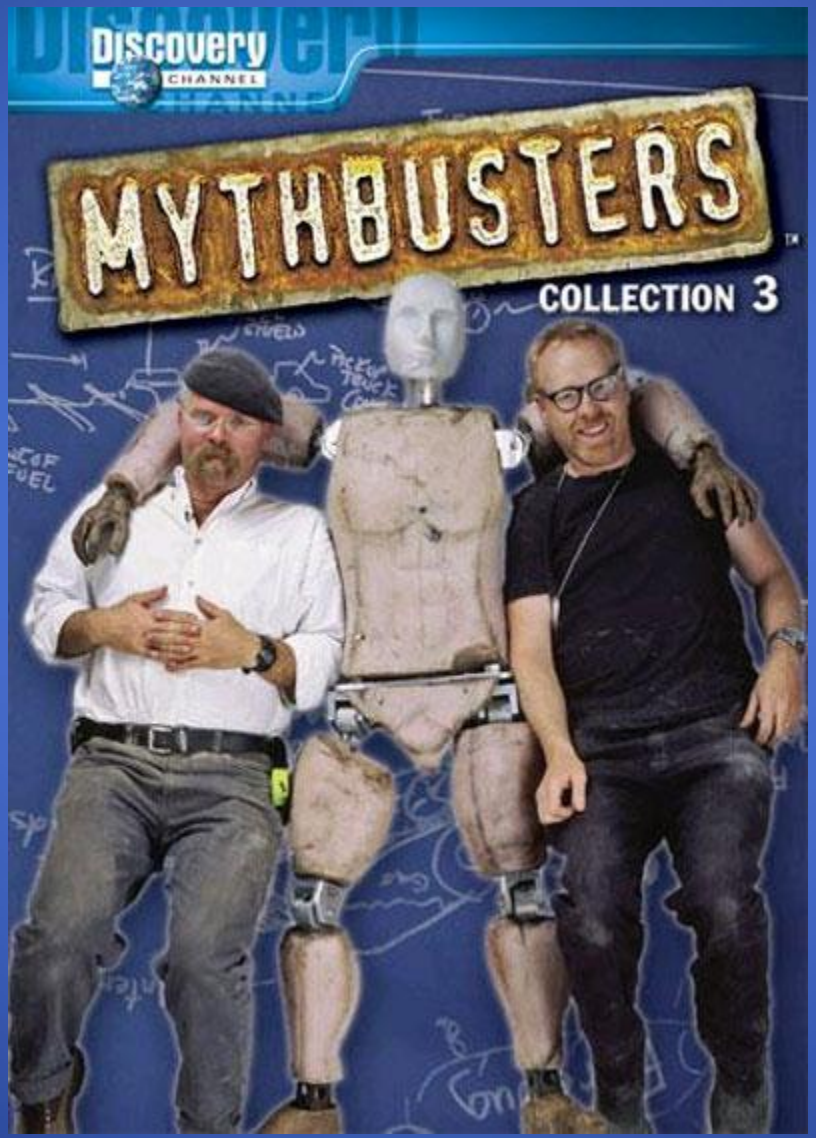
WWW.AMSAT.ORG

What is an Amateur Satellite?

How Satellites differ from Terrestrial Repeaters

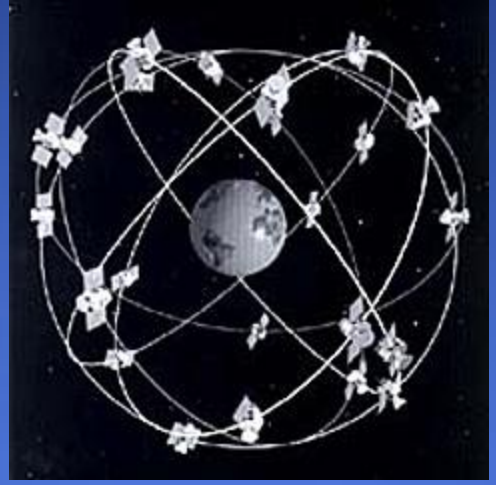


Satellite Myths Busted at ARRL Centennial



Sheldon Smart

OSCBIL



AMSAT

Low Noise Block Downconverter

Bent Pipe Transponder

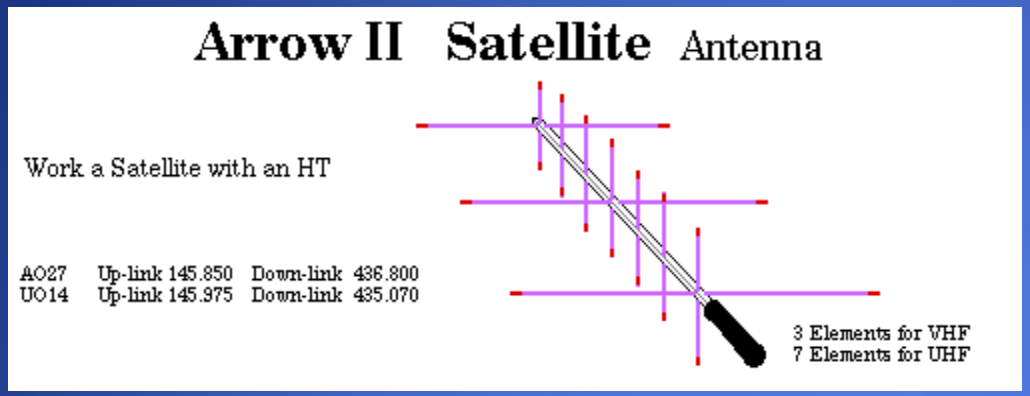
OSCAR

Clarke Belt


YAESU VHF/UHF ALL MODE TRANSCEIVER FT-736R
433.736.0
www.rigpix.com

AMSAT

Typical Equipment Used in FM/TX Satellite Ops



2-FT-50R's
Dual-band, 2 VFOs
Split-frequencies

ADVANTAGES OF USING 2 HT'S

DIGITAL RECORDER, COMPASS,

Radios etc.

Transmit:

Dual-Band Radio- Program Split Freq.

Including- Yaesu-Kenwood- Baofeng- Wouxun

Receive:

Scanners- Capable of RX- VHF-UHF

Dongles- FUNcube, RTL-SDR

ANTENNAS

- ½ to ¼ Wave ground-plane
- ¼ - 5/8 WAVE VERTICALS
- “EGGBEATER” OMNIDIRECTIONAL
- Discone
- Hand Held Yagi (or other directional antenna)

PLAN FOR SUCCESS

- **PREPARING FOR A SATELLITE PASS**

WWW.AMSAT.ORG

AMSAT-NA

The Radio Amateur Satellite Corporation

AMSAT STORE | KEPLERIAN ELEMENTS | PASS PREDICTIONS | SAT STATUS | MAILING LIST SERVICES | SITE ARCHIVE

CONTACT US | AMSAT DOCUMENTS AND POLICIES | AMSAT YOUTUBE CHANNEL | VOLUNTEER FOR AMSAT | FOX PROJECT

AMSAT NEWS SERVICE WEEKLY BULLETIN | 2013 HOUSTON AMSAT SYMPOSIUM

AMSAT Field Day 2013

Satellite tent at the United Amateur Radio Club, K6AA site in 2012. (Click to enlarge)

Every year AMSAT promotes a satellite version of Field Day during the ARRL annual operating event which is held on the 4th weekend in June. This year Field Day will take place from 1800 UTC on Saturday June 22, 2013 through 2100 UTC on Sunday June 23, 2013.

Continue reading →

RECENT POSTS

AMSAT Field Day 2013

Barry Baines, WD4ASW Interview with Amateur Radio Newsline

May/June 2013 AMSAT Journal is Ready

Joe Spier K6WAO Joins ANS Editorial Staff

Fox-1 has a Launch Date!

RECENT COMMENTS

SO-50

AMSAT™

850 Sligo Ave. Suite 600
Silver Spring, MD 20910
1-888-322-6728

Satellite Detail - Saudi-OSCAR 50

Saudi-OSCAR 50
(Saudisat-1C)

Spacecraft Summary

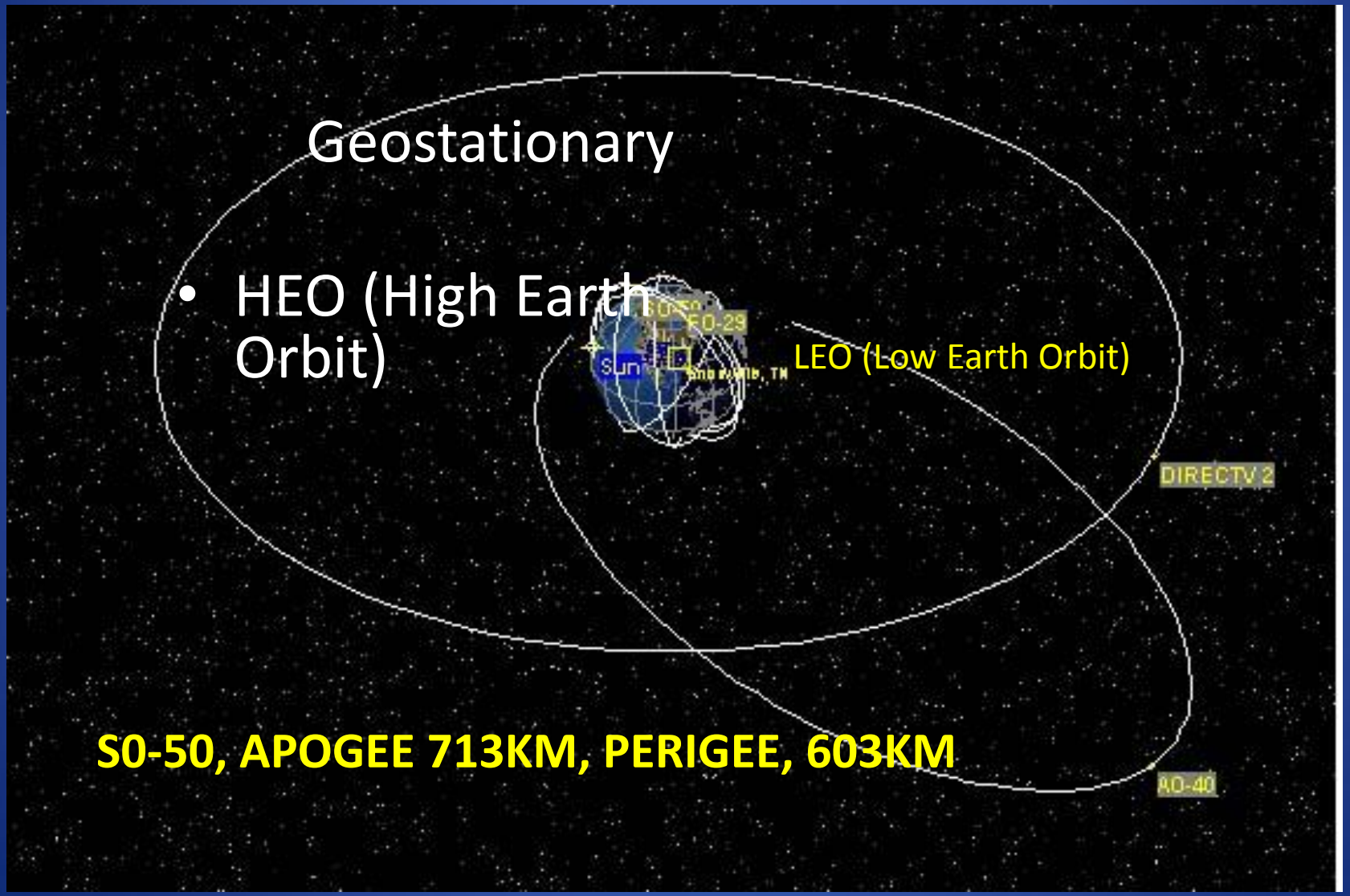
OSCAR Designation:	Saudi-OSCAR 50	**Oscar Number:**	SO-50
International Designator:	2002-058C	**Norad Number:**	27607
Common Name:	Saudisat-1C	**Satellite Type:**	Microsatellite
Launch Date:	20 December, 2002	**Launch Location:**	Baikonur Cosmodrome
Launch Vehicle:	Dnepr	**Apogee:**	713.00
Perigee:	603.00	**Inclination:**	64.56
Period:	97.89	**Dimensions:**	~25cm cube
Weight:	10.000 Kg		
Organization:	King Abdulaziz University for Science & Technology		

Frequency Information

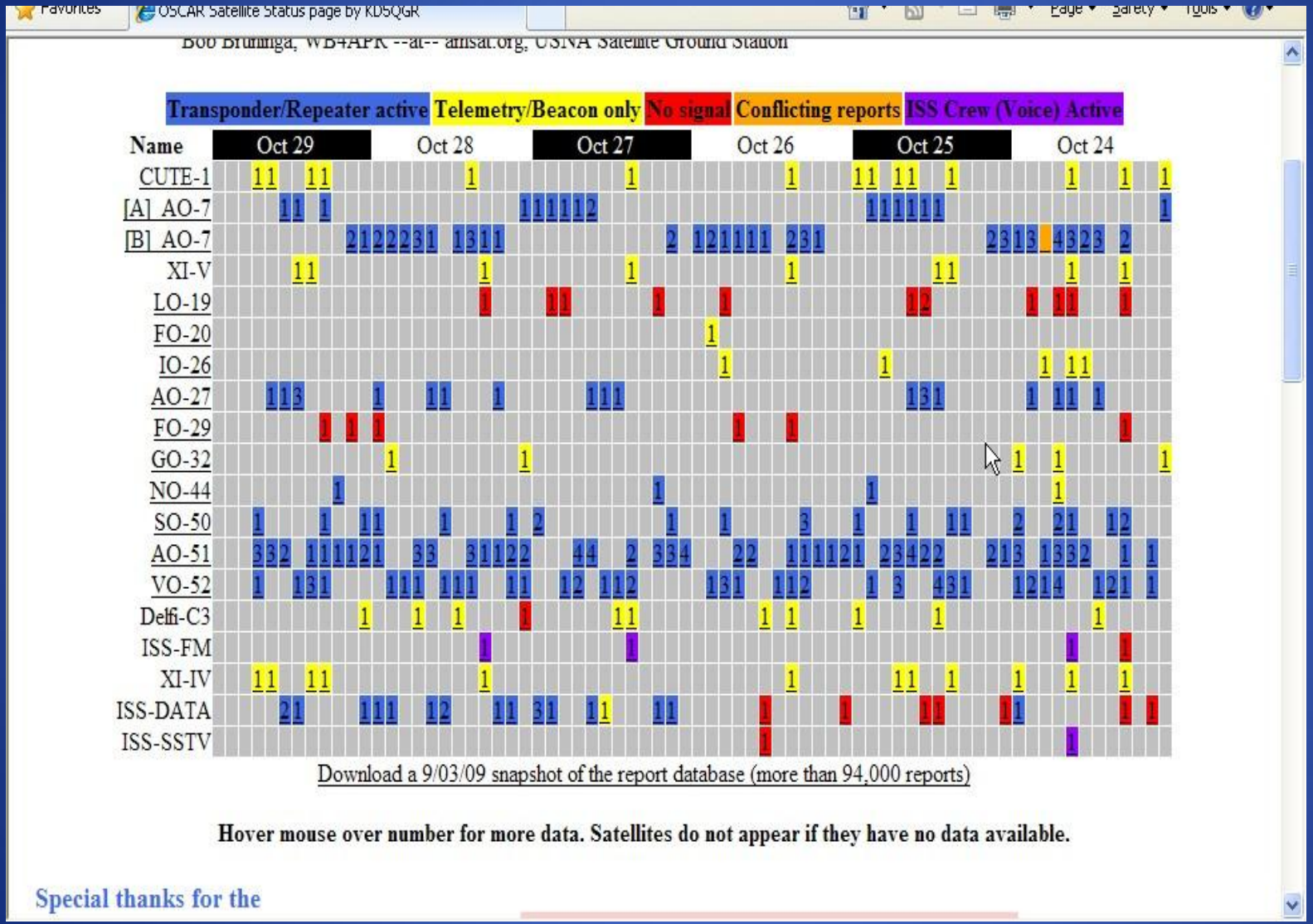
Mode V/U (J) FM Voice Repeater: Operational

Mode V/U (J) FM Voice Repeater (Downlink is sometimes ~5 kHz lower): Operational
Uplink: 145.8500 MHz FM, PL 67.0 Hz.
Downlink 436.7950 MHz FM

Satellite Orbits



When are the satellites available?



http://oscar.dcarr.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)
04 Jan 13	01:27:48	00:13:34	183	28	131	44	01:41:22
04 Jan 13	03:08:03	00:14:06	234	37	316	27	03:22:09
04 Jan 13	04:52:05	00:10:10	286	8	325	17	05:02:15
04 Jan 13	06:38:04	00:05:10	335	1	347	19	06:43:14
04 Jan 13	08:19:58	00:08:39	345	5	10	62	08:28:37
04 Jan 13	10:00:07	00:13:00	336	25	30	116	10:13:07
04 Jan 13	11:40:43	00:13:18	320	39	237	168	11:54:01
04 Jan 13	13:25:06	00:02:54	275	1	263	250	13:28:00
05 Jan 13	00:17:40	00:09:51	148	8	108	61	00:27:31
05 Jan 13	01:55:08	00:14:28	206	72	93	35	02:09:36

PROGRAMMING RADIOS

RX

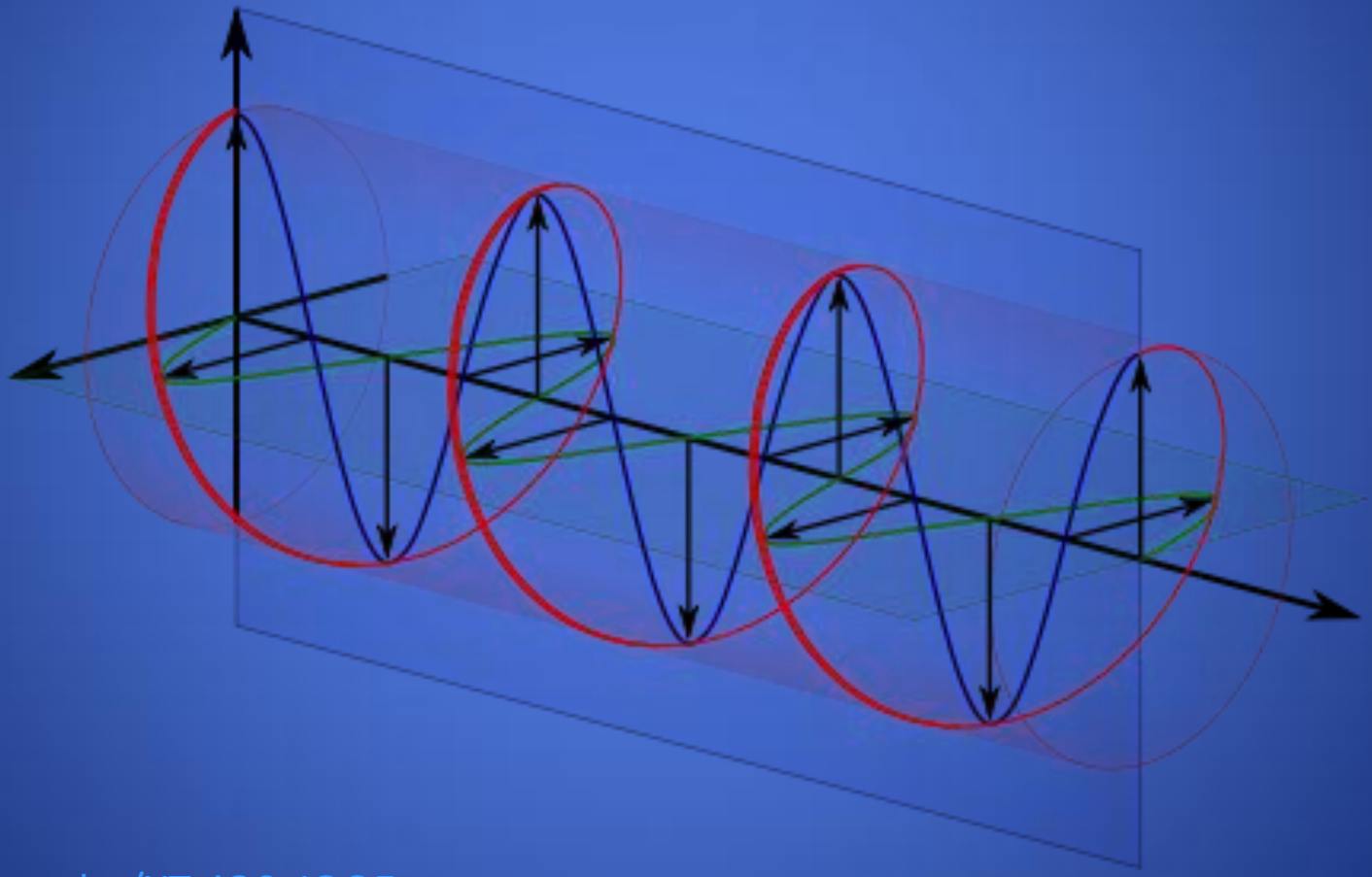
TX

ADJUSTING FOR DOPPLER

CH #	NAME	TX FREQ	CTCSS (TX)	RX FREQ
101	SO50 ON	145.850	74.4	436.810
102	SO50-1	145.850	67.0	436.810
103	SO50-2	145.850	67.0	436.805
104	SO50-3	145.850	67.0	436.800
105	SO50-4	145.850	67.0	436.795- dlink
106	SO50-5	145.850	67.0	436.790
107	SO50-6	145.850	67.0	436.785

DOPPLER EFFECT ON SATELLITES

FARADAY EFFECT ON SATELLITES



http://youtu.be/XTqjQ9xIQQE

Prepare for A Successful SO-50 Pass

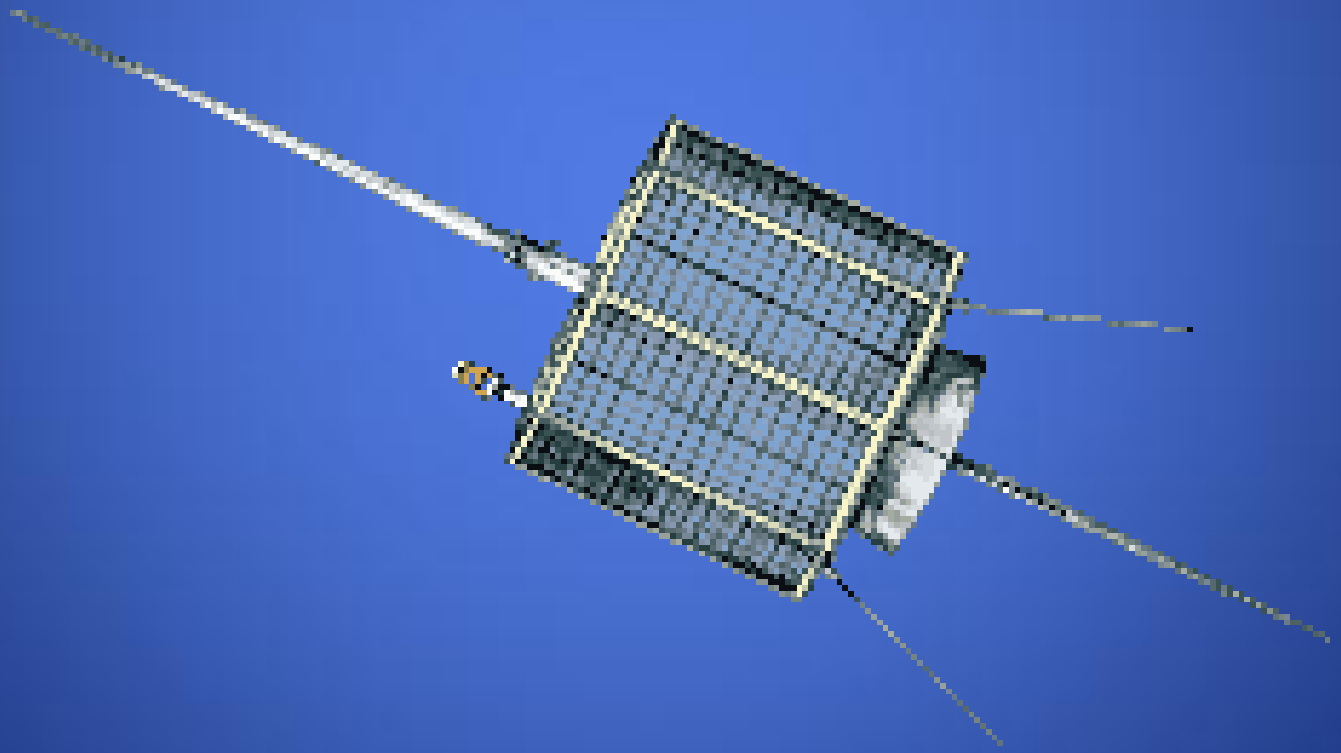
- Go to WWW.AMSAT.ORG
- “Passes” top menu- 30 degrees minimum when starting out
- Show predictions for SO-50
- Add Grid Square- FN31 for the ARRL Centennial Convention
- RADIO- SPLIT FREQUENCIES
- Squelch Open
- WATCH- UTC
- COMPASS
- DIGITAL RECORDER
- Grid Square
- Predict
- Set your watch
- Compass to trace path
- Check watch
- Set radio for downlink- Uplink
- Listen for quieting
- Squelch open
- Doppler shifts fast

Making Contacts

- Listen to the satellite, pick out some callsigns
- Give your call-/ handheld
- Call a specific station, or just transmit your callsign - DO NOT CALL CQ!
- Contacts are usually quick - callsign, location, maybe your name (similar to HF contests or DXpeditions)
- Regular operators can recognize new operators, and are happy to make contacts and help with operating advice
- Satellite operators like to exchange “grids” for awards

Satellite Contact

- ao51.112410.flv



5:56

WHAT WENT WRONG?

- FORGOT OUR GLASSES
- WATCH NOT SYNCHRONIZED
- INCORRECT LATITUDE, LONGITUDE
- NOT ON THE CORRECT PATH OF SATELLITE
- ANTENNA
- UPLINK, DOWNLINK FREQUENCIES OFF
- NOT TUNING FAST ENOUGH
- SATELLITE PASS TOO LOW
- SQUELCH IS MUTED
- XYL IS YELLING- “THE NEIGHBORS ARE LOOKING”
- MEET LAW ENFORCEMENT, UP CLOSE & PERSONAL

Expand your Horizons

Linear Satellites- SSB/CW

SSB/CW via satellite

Some differences…

- **Instead of one channel, transponders with 20 to 100 kHz – like a small HF band!**
- **Transponders support multiple QSOs**
- **Must deal with Doppler on both uplink and downlink**
- **Computer control of radio(s) preferred by many, but manual control is possible – using "One True Rule"**
  - **Manually adjust higher of the two frequencies, to deal with Doppler**

SSB/CW via satellite

Two satellite-ready transceivers in production:

- Icom IC-9100
- Kenwood TS-2000

Many older satellite-ready transceivers on resale market still used by satellite operators….

- Icom IC-910, IC-821, IC-820
- Kenwood TS-790
- Yaesu FT-847, FT-736, FT-726
- FlexRadio FLEX-5000 with VHF/UHF module

SSB/CW via satellite

Some use separate radios for transmit and receive…

HF/VHF/UHF transceiver for transmit:

- Icom IC-706Mk2/Mk2G, IC-7000, IC-7100
- Yaesu FT-817, FT-857, FT-897, FT-100
- or monoband all-mode transceiver

Many options for receive:

- Another HF/VHF/UHF transceiver for receive
- Wide-band, all-mode receiver
- Kenwood TH-F6A HT (all-mode RX up to 470 MHz)
- SDR receiver/dongle

SSB/CW via satellite

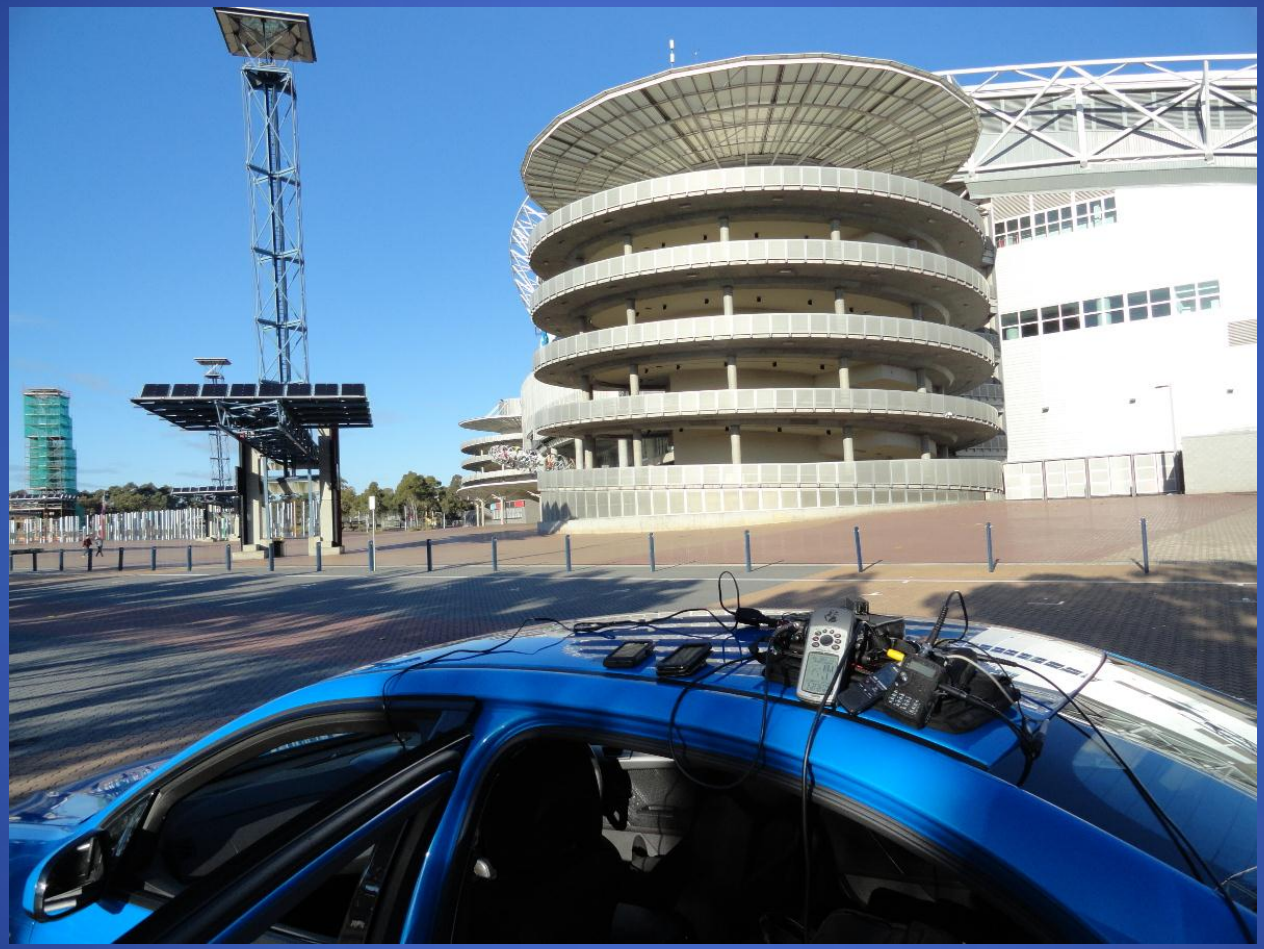
With our current satellites in lower orbits, even 5W from FT-817s can be adequate for working these satellites. Lower power levels are recommended, as not to overpower these transponders.

Two FT-817s, or an FT-817 with a portable all-mode receiver (or TH-F6A), and an antenna like a dual-band Yagi or log periodic, can make a small and very portable all-mode satellite station.

SSB/CW via satellite

FT-817ND/TH-F6A combo on rental car (with Elk log periodic, not in view). Where is this??

SSB/CW via satellite



VK/WD9EWK, parked next to Olympic stadium in Sydney (Australia) Olympic Park - 28 May 2011

Telemetry Only Satellites

$50SAT (MO-76)

ARTSAT Invader (CO-77)

SPROUT

While we build this section of the website, please visit http://www.dk3wn.info /satellites.shtml and http://www.ne.jp/asahi/hamradio/je9pel/satslist.htm for the latest in telemetry only and cubesat news.

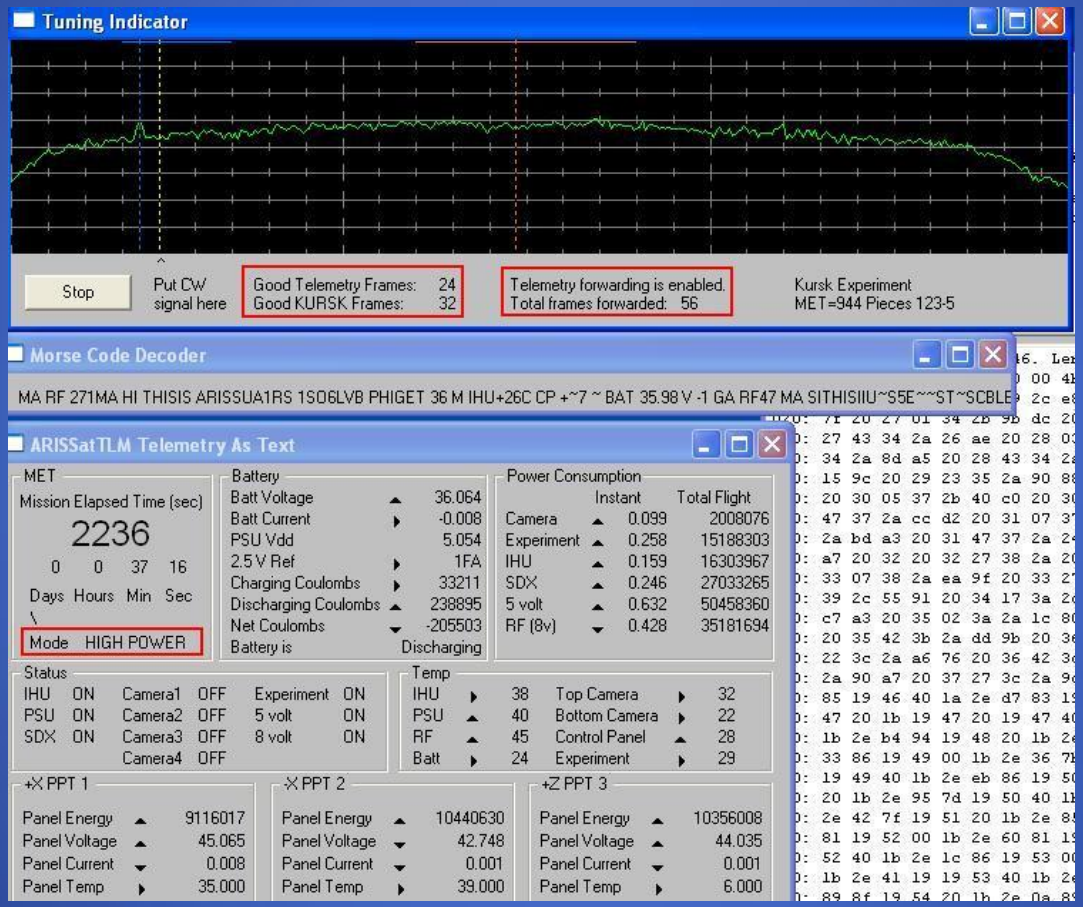
Telemetry

- **Available in many formats**
  - **CW**
  - **RTTY**
  - **AX.25 packet**
  - **FSK, BPSK, and other digital protocols**
- **<u>Even OSCAR I sent telemetry</u>**
  - CW speed keyed to satellite temperature
- Some satellites send telemetry in multiple formats

Telemetry

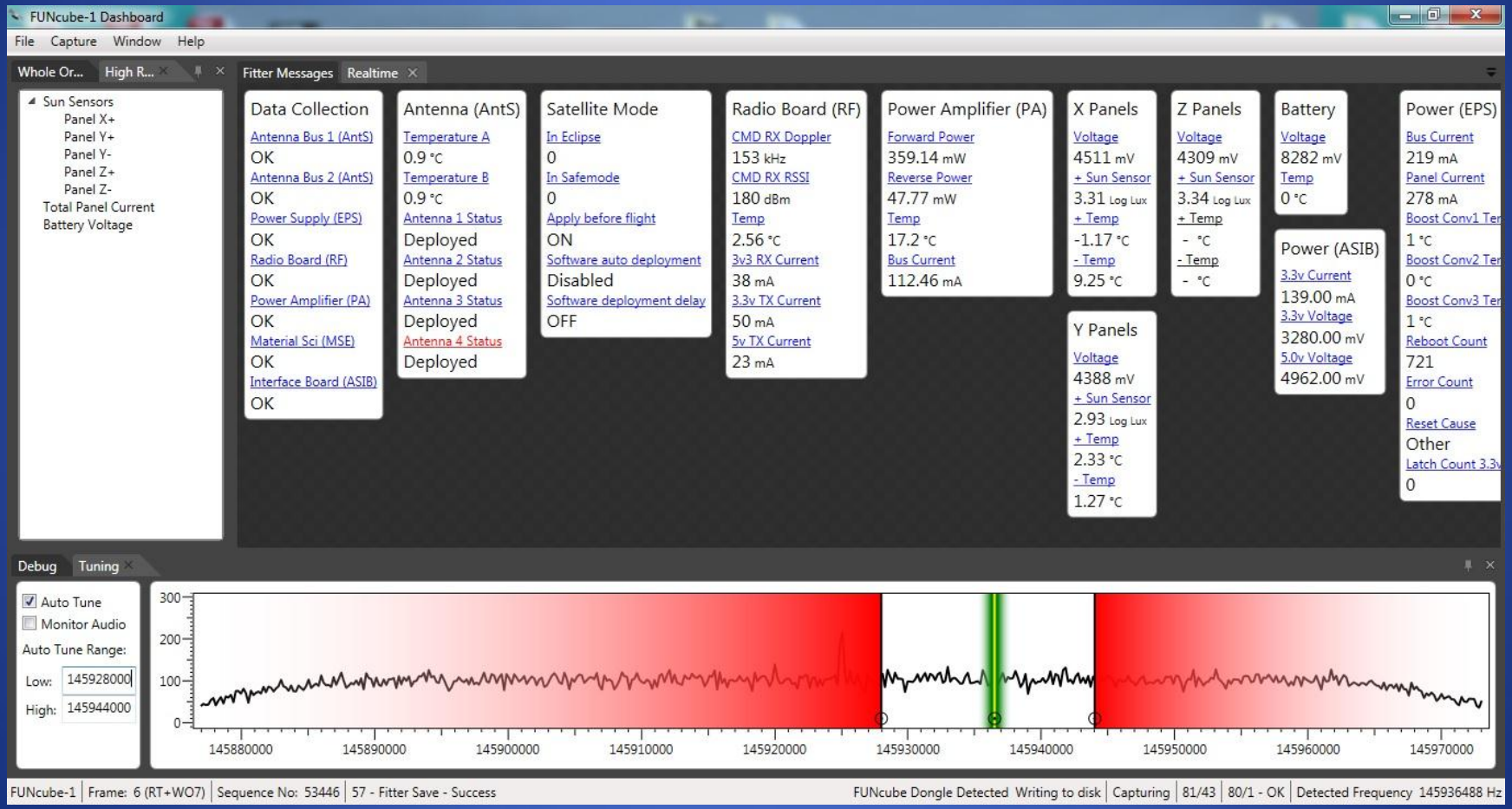
- Provides information on health of satellite's systems
- Examples of telemetry from different satellites…
  - AO-27 used 1200bps AX.25 packet
  - HO-68 uses CW
  - $50Sat uses CW and RTTY
  - ARISSat-1 used, and FUNcube satellites use, BPSK
  - Fox-1 will use FSK simultaneously w/FM downlink
- Copying telemetry – another great way to evaluate performance of stations used for satellite operating

Telemetry



ARISSat-1 software

Telemetry



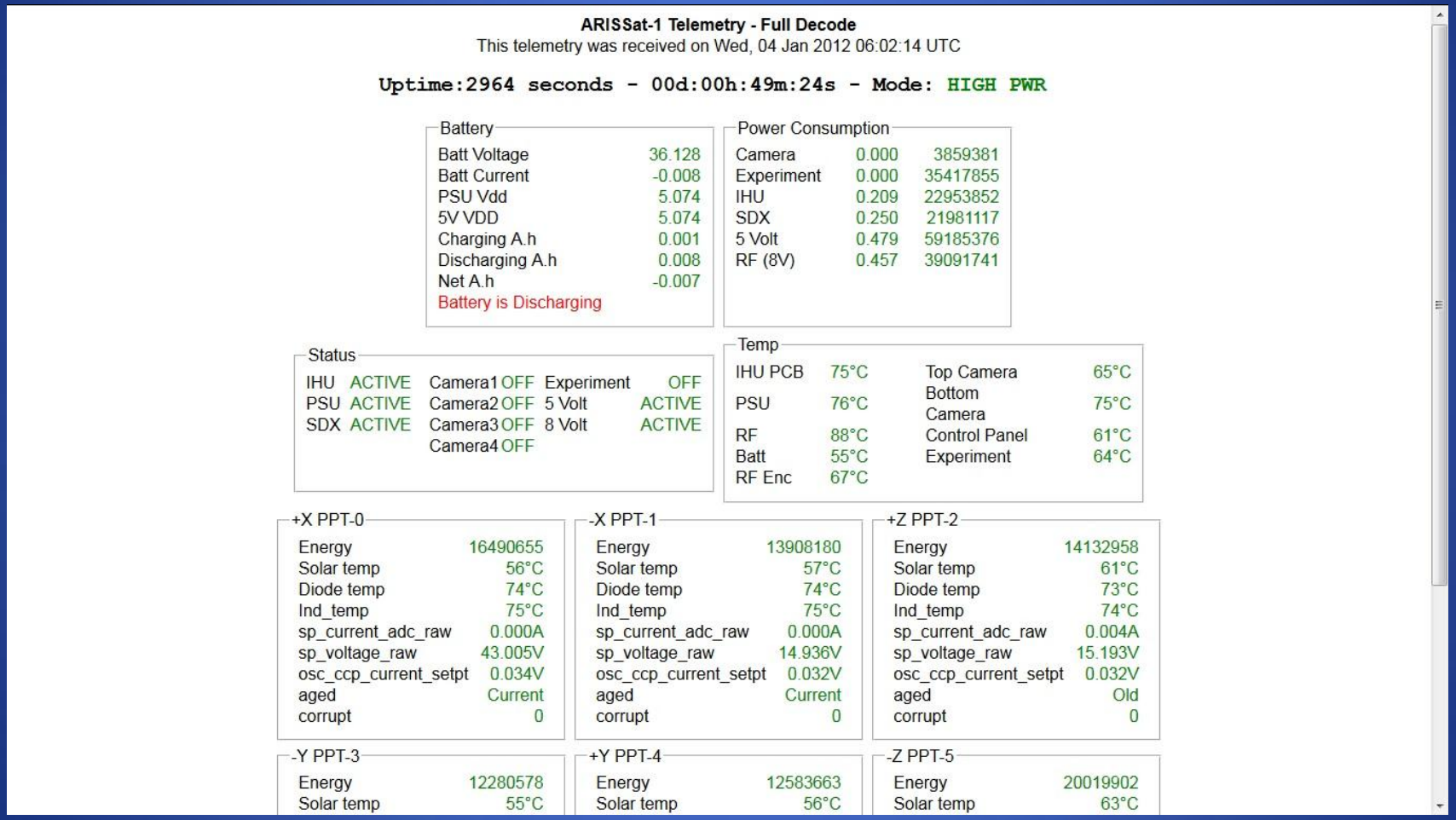
FUNcube-1 Dashboard

Telemetry

Some software only needs audio from a receiver to decode telemetry, where other software can even control the receiver to decode the telemetry.

Once decoded, telemetry can be sent to satellite maintainers, or the software can upload it in real time to a central server.

Telemetry



ARISSat-1 Telemetry - Full Decode

This telemetry was received on Wed, 04 Jan 2012 06:02:14 UTC

Uptime:2964 seconds - 00d:00h:49m:24s - Mode: HIGH PWR

Battery

Batt Voltage	36.128
Batt Current	-0.008
PSU Vdd	5.074
5V VDD	5.074
Charging A.h	0.001
Discharging A.h	0.008
Net A.h	-0.007
Battery is Discharging	

Power Consumption

Camera	0.000	3859381
Experiment	0.000	35417855
IHU	0.209	22953852
SDX	0.250	21981117
5 Volt	0.479	59185376
RF (8V)	0.457	39091741

Status

IHU	ACTIVE	Camera1	OFF	Experiment	OFF
PSU	ACTIVE	Camera2	OFF	5 Volt	ACTIVE
SDX	ACTIVE	Camera3	OFF	8 Volt	ACTIVE
		Camera4	OFF		

Temp

IHU PCB	75°C	Top Camera	65°C
PSU	76°C	Bottom Camera	75°C
RF	88°C	Control Panel	61°C
Batt	55°C	Experiment	64°C
RF Enc	67°C		

+X PPT-0

Energy	16490655
Solar temp	56°C
Diode temp	74°C
Ind_temp	75°C
sp_current_adc_raw	0.000A
sp_voltage_raw	43.005V
osc_ccp_current_setpt	0.034V
aged	Current
corrupt	0

-X PPT-1

Energy	13908180
Solar temp	57°C
Diode temp	74°C
Ind_temp	75°C
sp_current_adc_raw	0.000A
sp_voltage_raw	14.936V
osc_ccp_current_setpt	0.032V
aged	Current
corrupt	0

+Z PPT-2

Energy	14132958
Solar temp	61°C
Diode temp	73°C
Ind_temp	74°C
sp_current_adc_raw	0.004A
sp_voltage_raw	15.193V
osc_ccp_current_setpt	0.032V
aged	Old
corrupt	0

-Y PPT-3

Energy	12280578
Solar temp	55°C

+Y PPT-4

Energy	12583663
Solar temp	56°C

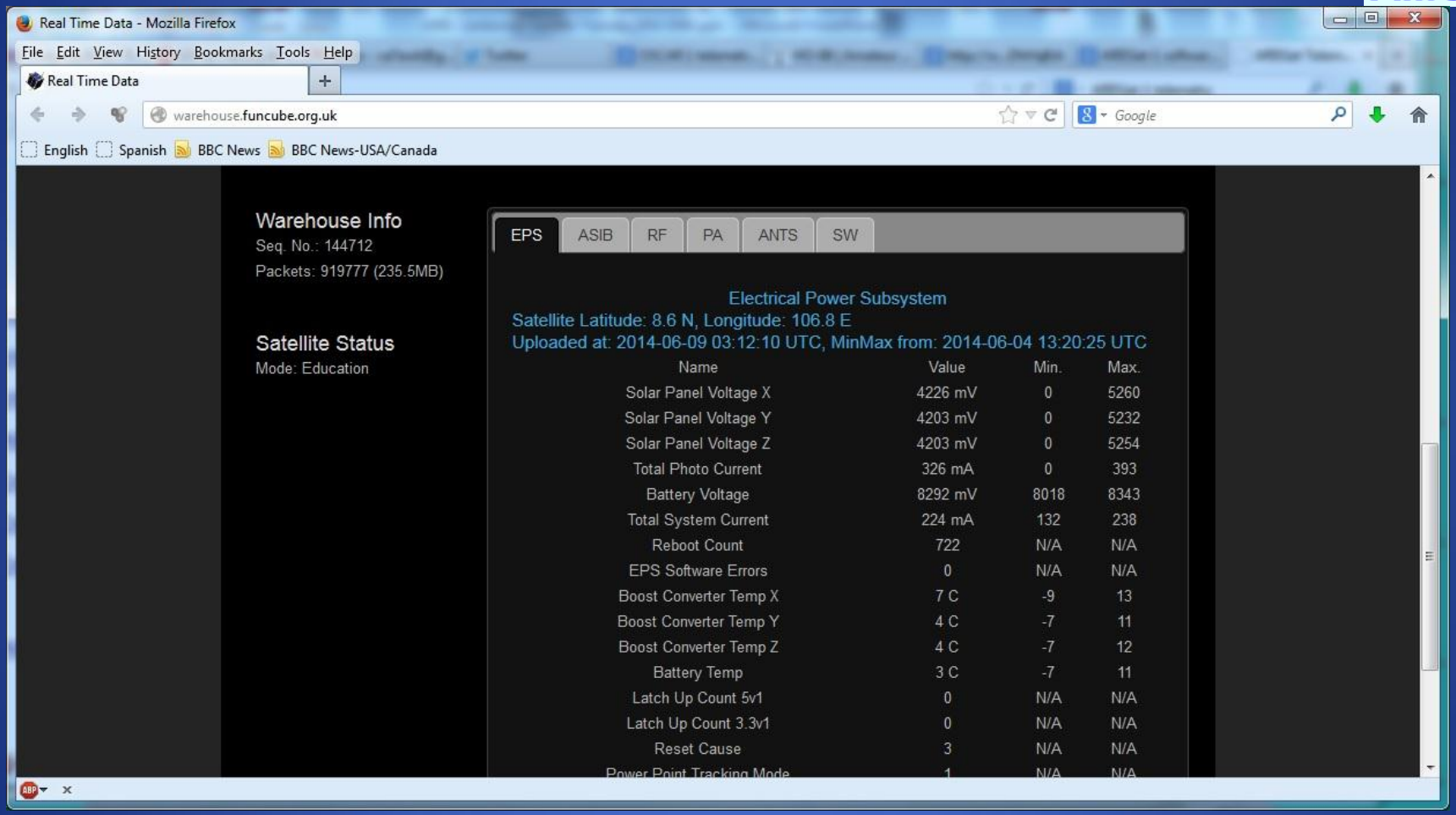
-Z PPT-5

Energy	20019902
Solar temp	63°C

Telemetry from ARISSat-1 web site

http://www.arissattlm.org/live

Telemetry



Telemetry from FUNcube-1 data warehouse web site
http://warehouse.funcube.org.uk/

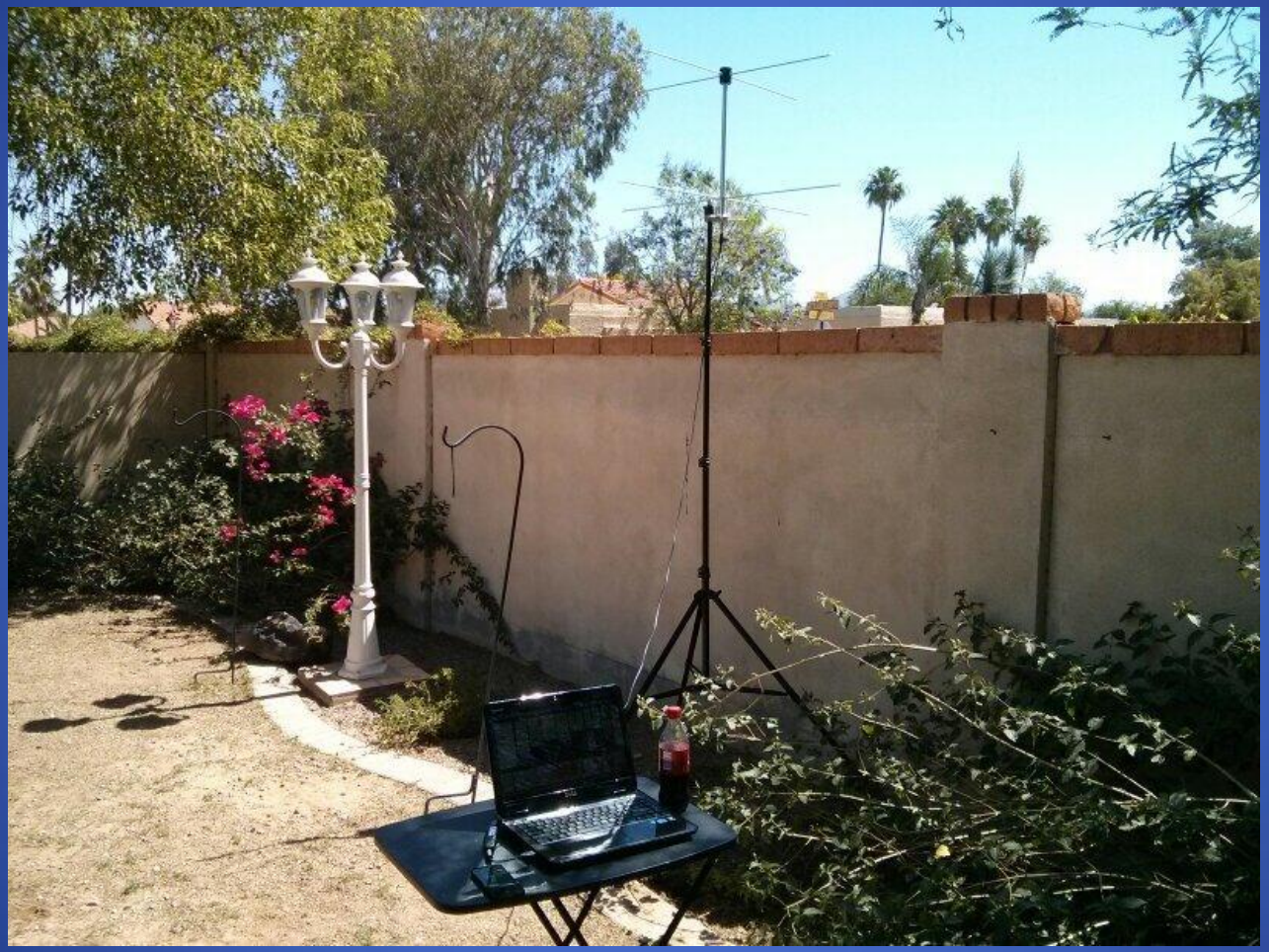
Telemetry

Stations capable of working satellites can be used to copy satellite telemetry. Some will set up separate stations for receiving telemetry with a simpler combination of radio and antenna. For example, antennas….

Telemetry

W2BFJ's antennas: 70cm AA2TX Lindenblad on left, 2m Eggbeater on right, both omnidirectional

Telemetry



WD9EWK's 2m turnstile on mast/tripod, laptop with FUNcube Dongle & Dashboard software in yard

Telemetry

SDR dongles are very popular for copying telemetry, thanks in large part to FUNcube Dongles and availability of inexpensive DVB TV dongles that can act as wide-band receiver for other signals. Depending on the type of telemetry downlink, other receivers and scanners are useful for copying telemetry.

http://www.issfanclub.com

AMSAT

ISS Fan Club

get in touch with the International Space Station

Frequencies QSL IAA NA1SS DXCC About this site

Ham Radio Contacts Images from Space Forum Polls Guestbook Search this site: Search

ISS Position

Predict Passes

User login

Username: *

Password: *

Log in

- Create new account
- Request new password

Navigation

- Top rated contacts
- Top rated images
- Create content

During 1996, a group of amateur radio operators involved in the communications with the MIR Space Station, decided to join into the "Mir Fan Club". In a very short time over 1200 enthusiasts from all over the world asked to participate, including Cosmonaut Valery Korzun, while leading crew #22. Nowdays MIR is not flying anymore, but here we are again with the same spirit and the same enthusiasm for the ISS, the new International Space Station.

ARISS Status October 18, 2010

Topics in this report:
1. Upcoming School Contact
2. George Observatory Contact Successful
3. ARRL Article on ARISS Contacts
4. Amateur Radio Newsline Covers ARISS
5. ARISSat-1 Safety Review Held

Ariss

1. Upcoming School Contact

N5VHO – Mon, 2010 – 10 – 18 12:14
ARISS
Login or register to post comments Read more 125 reads

Voice

Add your report

Last ACTIVE: 6 days 9 hours ago
Downlink: VHF
Uplink: VHF
Description:
Name: KB5AAM

more

Follow the ISS on Twitter

All ACTIVE reports are also tweeted. Please follow us at twitter.com/rs0iss

Packet Radio

Add your report

Status: ACTIVE
Date/Time: 1 hour 24 min ago from now
Downlink: VHF
Uplink: VHF
Description:
Over Europe
Name: iw0fko

more

SSTV

Add your report

start | AMSAT - Outlook Exp... | Microsoft PowerPoint ... | limarc11.7.10 - Notepad | ISS Fan Club | get in ... | 7:27 PM

ISS Contact- Col. Doug Wheelock

Amateur Satellite Resources

- www.amsat.org
- ARRL
- www.starcommgroup.org

Satellite Tracking Software

iPhone- Satellite Tracker

Android- FREE AMSAT Droid

Web- Orbitron.com

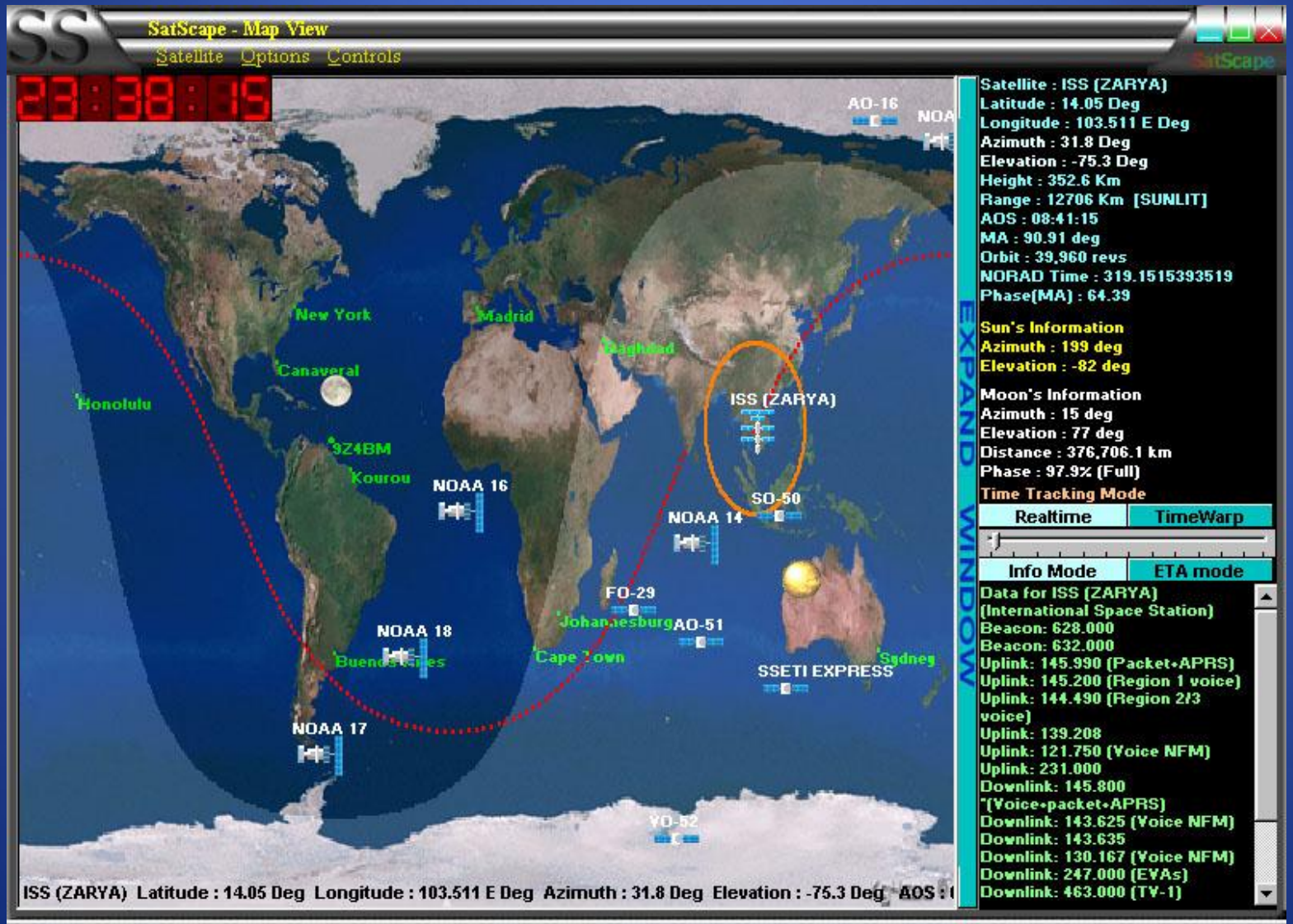
Heavens-Above.com

N2YO.com

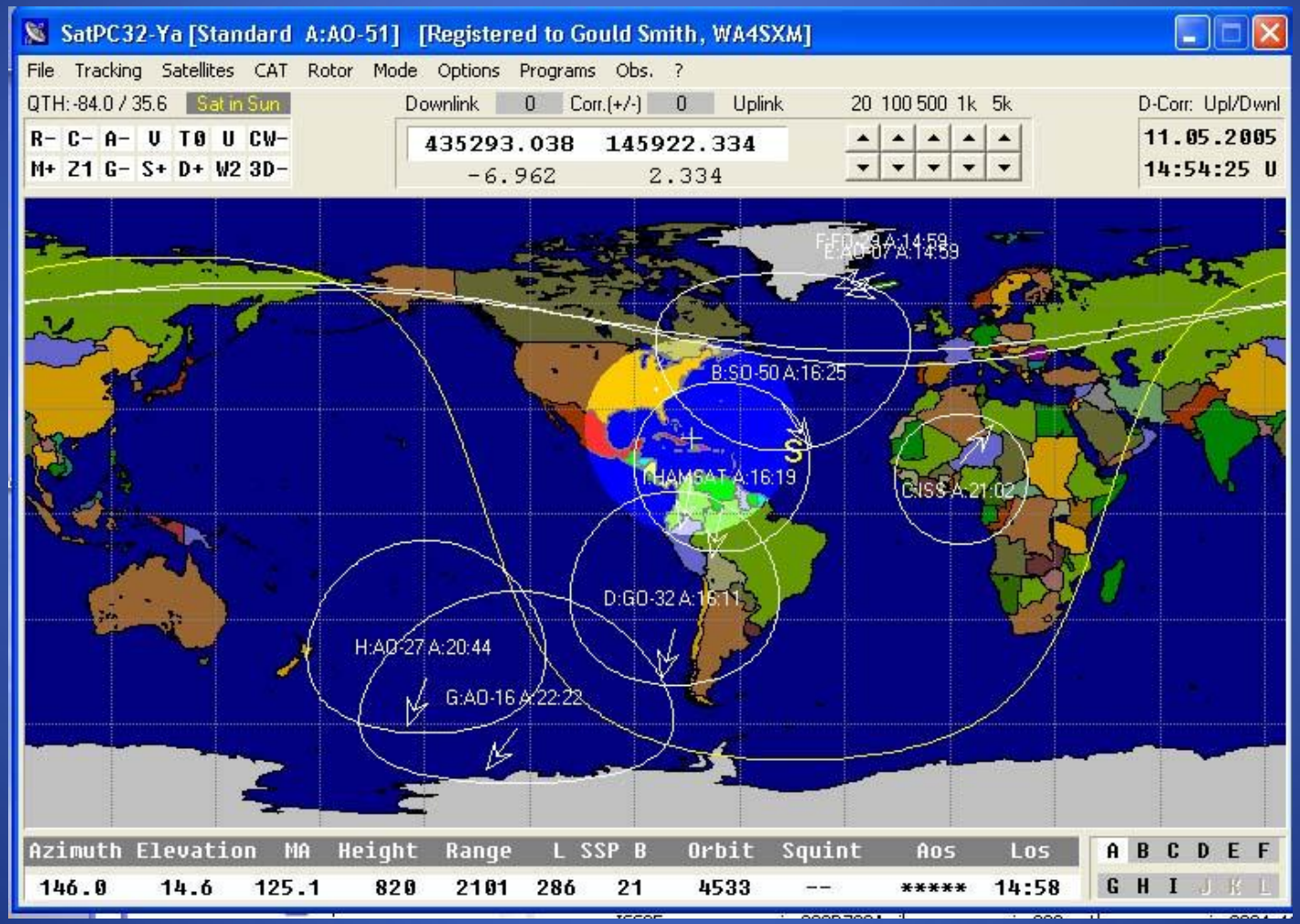
www.amsat.org

SatPC32

SATSCAPE

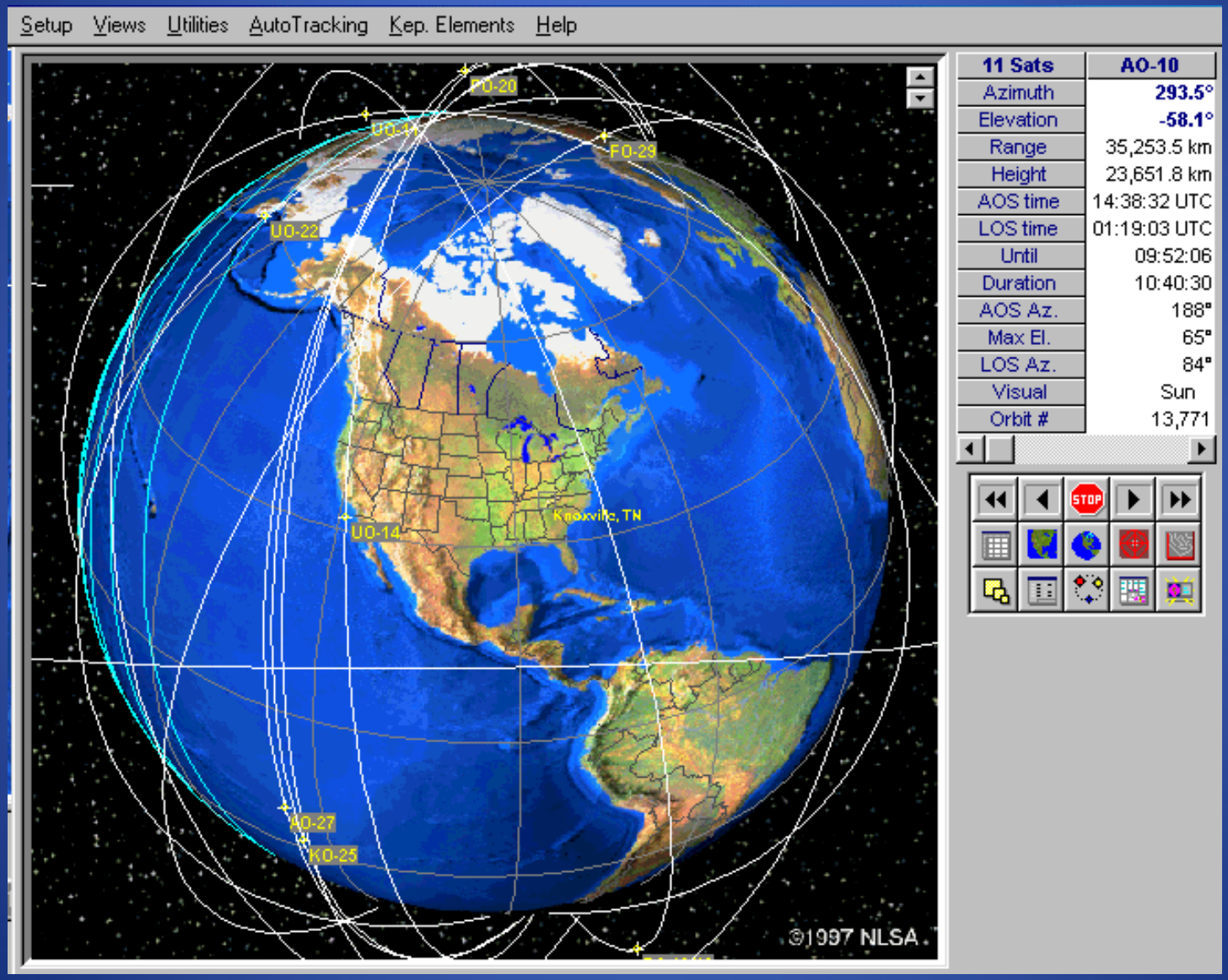

SatScape - Map View
Satellite Options Controls
23:38:15
AO-16
NOA
New York
Madrid
Baghdad
Canaveral
Honolulu
ISS (ZARYA)
9Z4BM
Kourou
NOAA 16
SO-50
NOAA 14
FO-29
Johannesburg
AO-51
NOAA 18
Cape Town
Sydney
SSETI EXPRESS
NOAA 17
VO-52
EXPAND WINDOW
Satellite : ISS (ZARYA)
Latitude : 14.05 Deg
Longitude : 103.511 E Deg
Azimuth : 31.8 Deg
Elevation : -75.3 Deg
Height : 352.6 Km
Range : 12706 Km [SUNLIT]
AOS : 08:41:15
MA : 90.91 deg
Orbit : 39,960 revs
NORAD Time : 319.1515393519
Phase(MA) : 64.39
Sun's Information
Azimuth : 199 deg
Elevation : -82 deg
Moon's Information
Azimuth : 15 deg
Elevation : 77 deg
Distance : 376,706.1 km
Phase : 97.9% (Full)
Time Tracking Mode
Realtime
TimeWarp
Info Mode
ETA mode
Data for ISS (ZARYA)
(International Space Station)
Beacon: 628.000
Beacon: 632.000
Uplink: 145.990 (Packet+APRS)
Uplink: 145.200 (Region 1 voice)
Uplink: 144.490 (Region 2/3 voice)
Uplink: 139.208
Uplink: 121.750 (Voice NFM)
Uplink: 231.000
Downlink: 145.800
*(Voice+packet+APRS)
Downlink: 143.625 (Voice NFM)
Downlink: 143.635
Downlink: 130.167 (Voice NFM)
Downlink: 247.000 (EVAs)
Downlink: 463.000 (TV-1)
ISS (ZARYA) Latitude : 14.05 Deg Longitude : 103.511 E Deg Azimuth : 31.8 Deg Elevation : -75.3 Deg AOS :
Start
Site Builder - ...
SatScape v2.02
SatScape...
11:38 PM

SatPC32 software

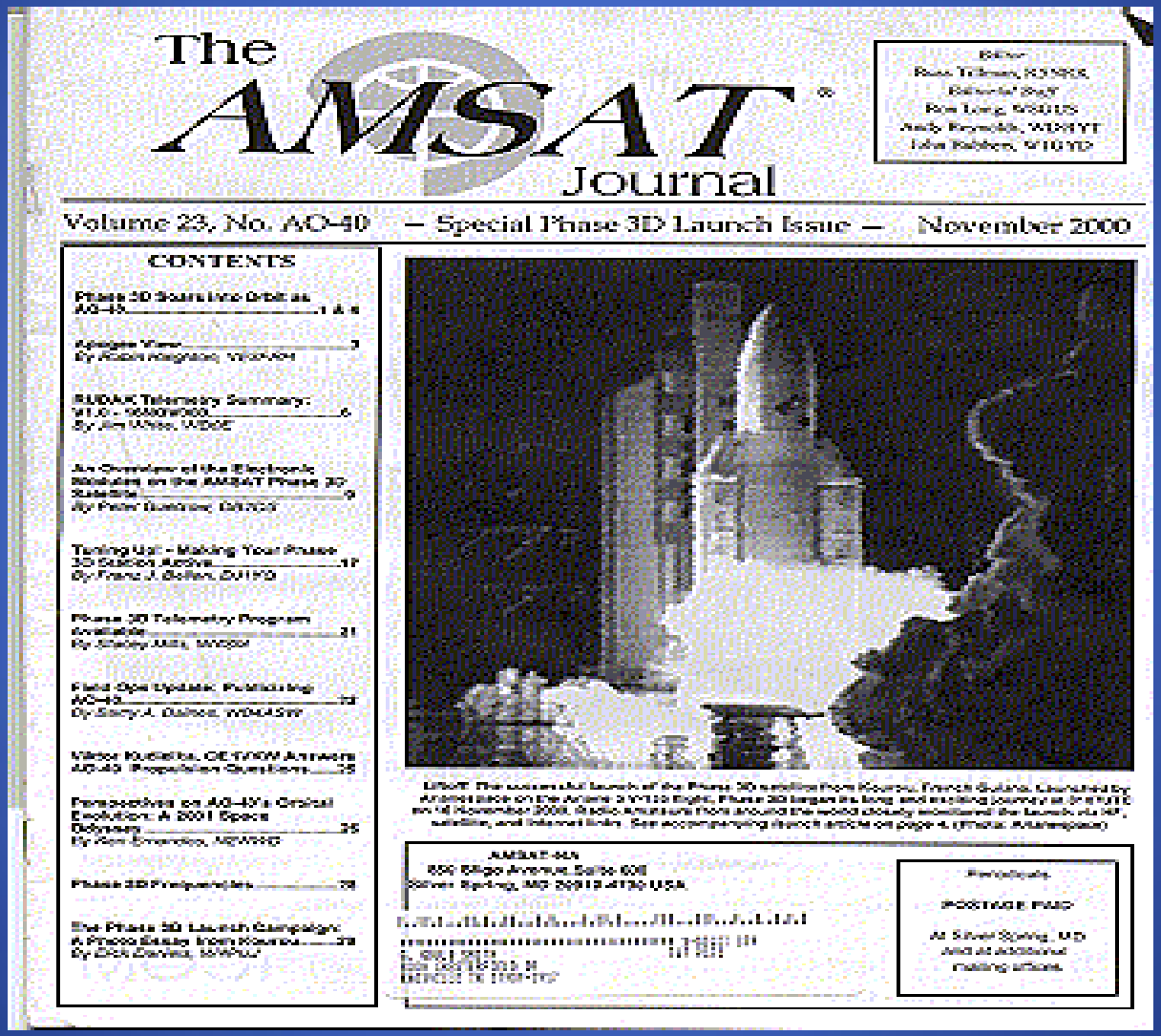


Will also do antenna and radio control

Nova


Setup Views Utilities AutoTracking Kep. Elements Help
FO-20
UO-1
FO-29
UO-22
UO-14
AO-27
KO-25
©1997 NLSA
11 Sats
AO-10
Azimuth 293.5°
Elevation -58.1°
Range 35,253.5 km
Height 23,651.8 km
AOS time 14:38:32 UTC
LOS time 01:19:03 UTC
Until 09:52:06
Duration 10:40:30
AOS Az. 188°
Max El. 65°
LOS Az. 84°
Visual Sun
Orbit # 13,771
STOP

Periodicals



The AMSAT Journal

Volume 23, No. AO-40 — Special Phase 3D Launch Issue — November 2000

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Silver Spring, MD 20910-4750 USA

Periodicals
POSTAGE PAID
At Silver Spring, MD
and at Additional
Mailing Offices

How do we keep Amateur Radio in Space?

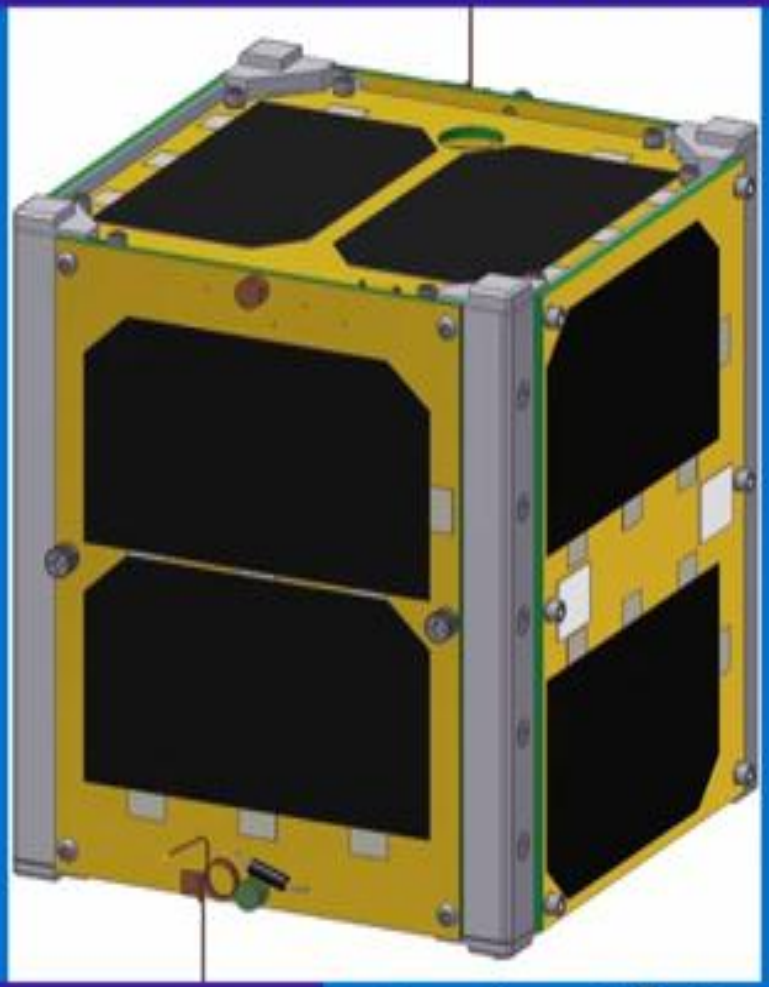
Background

- AO-51 was the most popular ham satellite
- Could be worked with simple equipment - HT and a hand held antenna
- Widely used in recruiting, scouting, educational and demonstration events
- Failed in November 2011

A New Reality

- P3E to GTO - $10M
- Small Sat to LEO - $3M
- ARISSat to ISS - $1M
- MicroSat to LEO - $500K
- 1U CubeSat to LEO - $100K

Assembled *Fox-1* Satellite



More Satellites on the way

FUNcube-1
Delfi-n3Xt
Ukube-1
Triton-1
Triton-2
Fox-1
RadFXSat

Get started right now!

WWW.AMSAT.ORG

AMSAT-BB

The new AMSAT Web Site has it all!

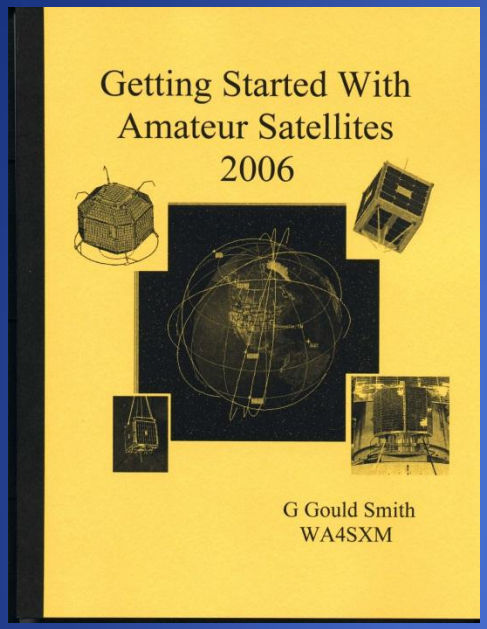
Join AMSAT

Buy Getting Started books

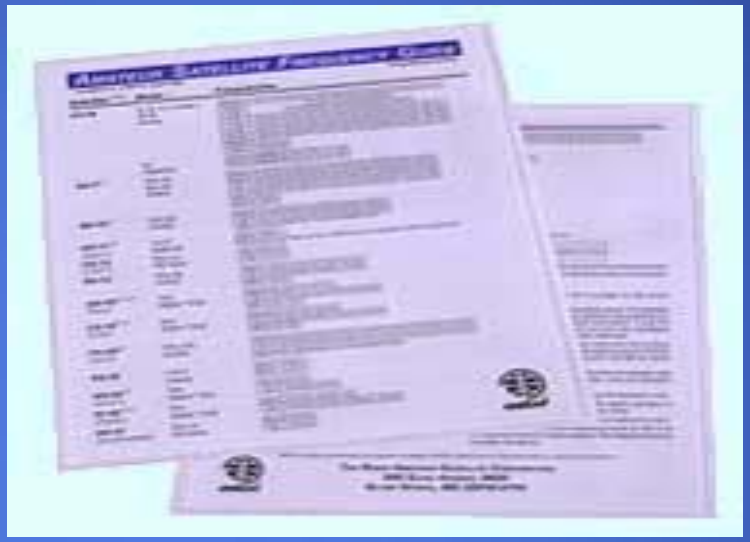
Use Satellite positioning tools online

Easy Satellite status & Frequency charts

Books for Specific Satellite Types



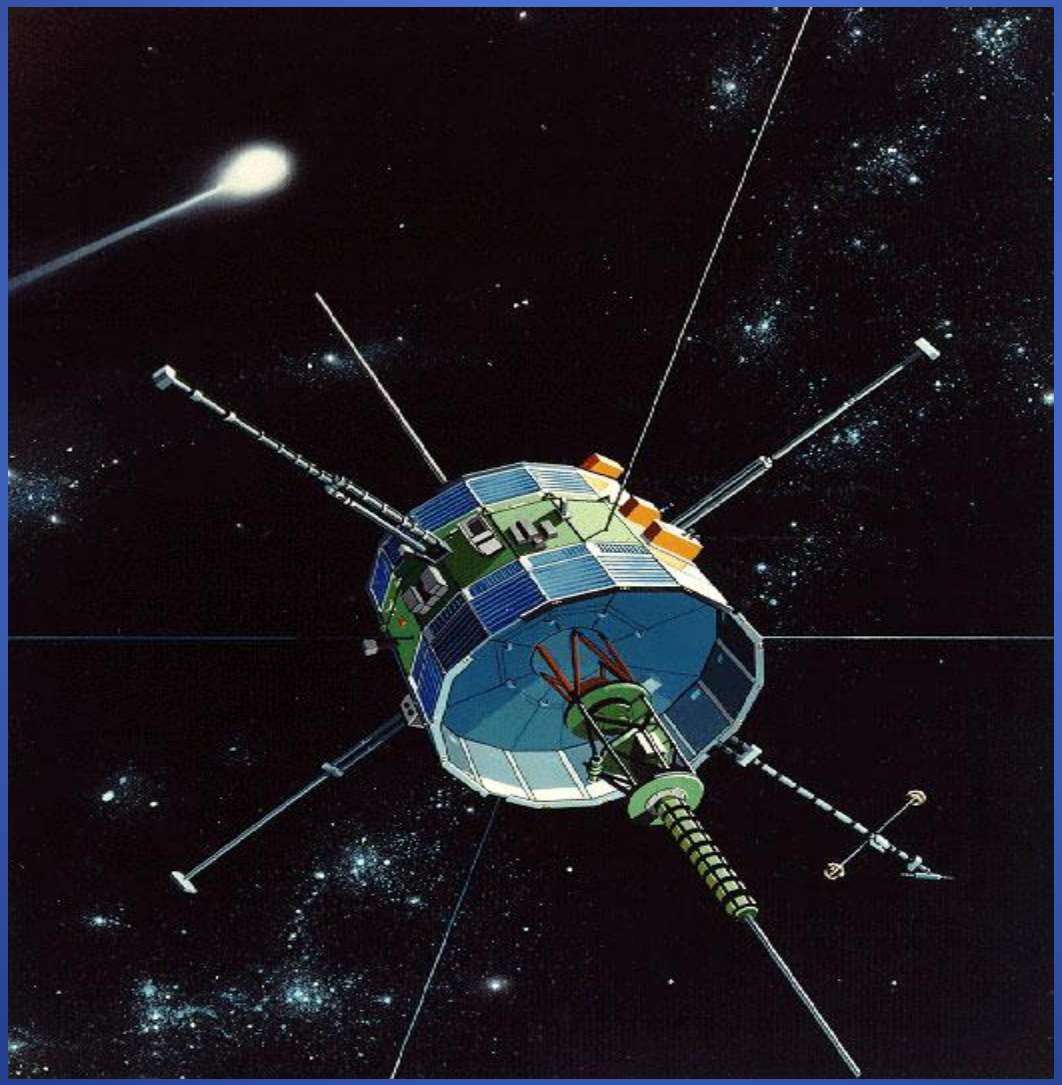
Getting started

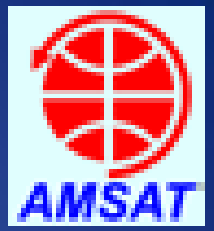


Satellite frequency guide

SatPC32

Questions?

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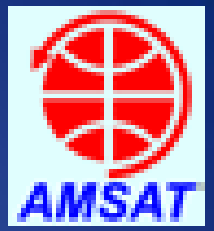
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