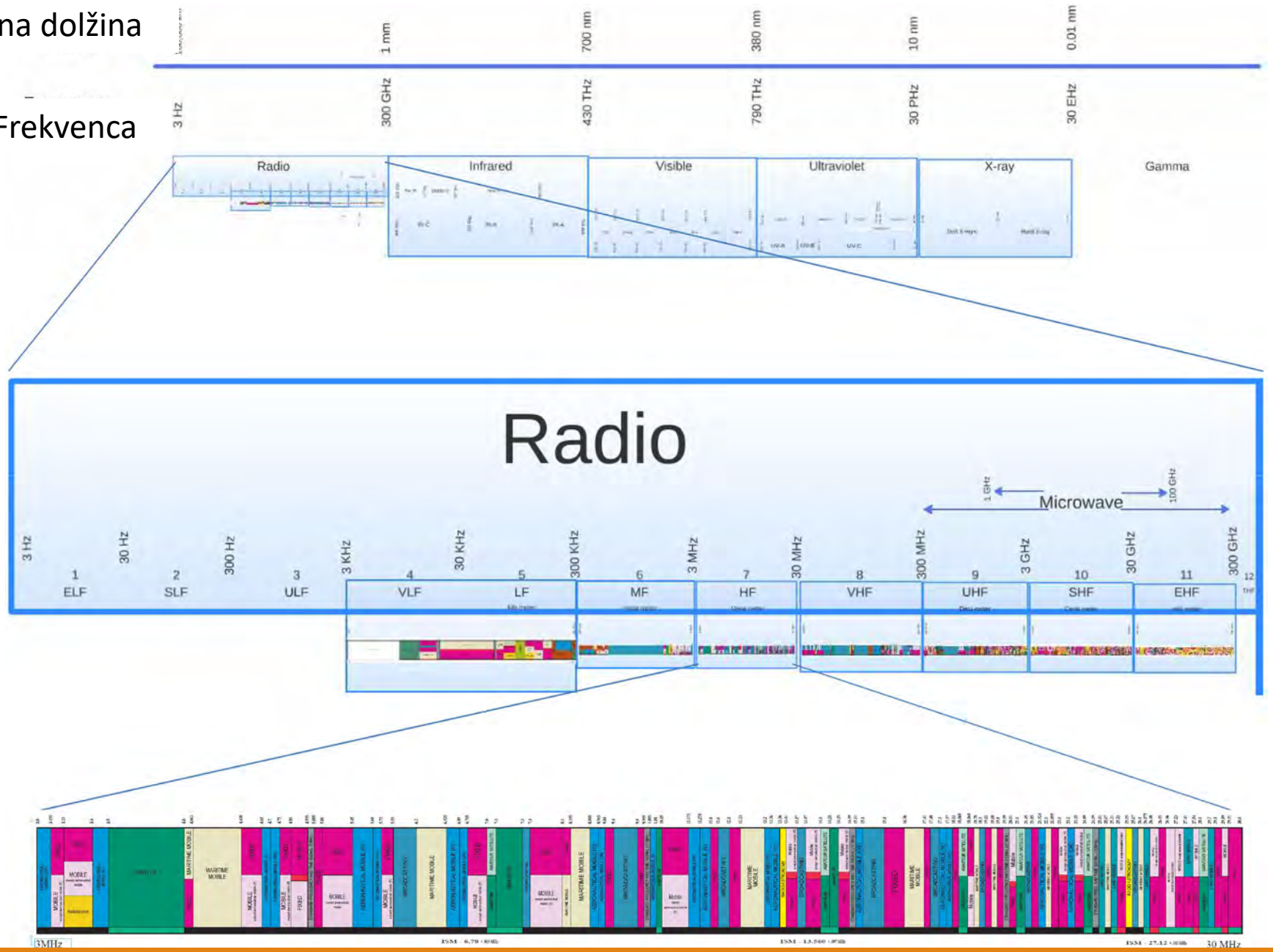
Radioamaterski sateliti

ANDREJ SOUVENT

28. Slovenski festival znanosti
11.1.2022

Frekvenčni spekter

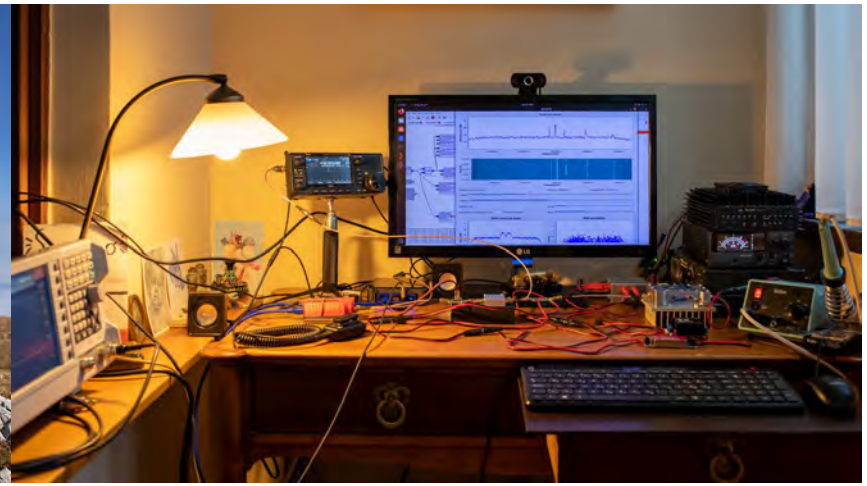


Ref. https://en.wikipedia.org/wiki/High_frequency#/media/File:HighFrequency.png

Radioamaterstvo

Radioamaterski frevenčni pasovi

Frekvenčni pas	Maksimalna oddajna moč za radioamaterja razreda	
	A	N
135,7 – 137,8 kHz	eirp 1 W	
472 – 479 kHz	eirp 5 W	
1 810 – 2 000 kHz	1 500 W	
3 500 – 3 800 kHz	1 500 W	100 W
5351,5 – 5366,5 kHz	eirp 15 W	
7 000 – 7 200 kHz	1 500 W	100 W
10 100 – 10 150 kHz	300 W	
14 000 – 14 350 kHz	1 500 W	
18 068 – 18 168 kHz	1 500 W	
21 000 – 21 450 kHz	1 500 W	100 W
24 890 – 24 990 kHz	1 500 W	
28 000 – 29 700 kHz	1 500 W	100 W
40,66 – 40,70 MHz	100 W	
50 – 52 MHz	100 W	25 W
70 – 70,45 MHz	100 W	25 W
144 – 146 MHz	1 500 W	25 W
430 – 432 MHz	50 W	25 W
432 – 438 MHz	1 500 W	25 W
438 – 440 MHz	50 W	25 W
1 240 – 1 300 MHz	300 W	
2 300 – 2 450 MHz	300 W	
3 400 – 3 410 MHz	100 W	
5 650 – 5 830 MHz	100 W	
10 – 10,5 GHz	100 W	
24 – 24,05 GHz	50 W	
24,05 – 24,25 GHz	50 W	
47 – 47,2 GHz	50 W	
47,2 – 48,5 GHz	50 W	
75,5 – 77,5 GHz	50 W	
77,5 – 78 GHz	50 W	
78 – 81,5 GHz	50 W	
122,25 – 123,00 GHz	50 W	
134 – 141 GHz	50 W	
241 – 250 GHz	50 W	

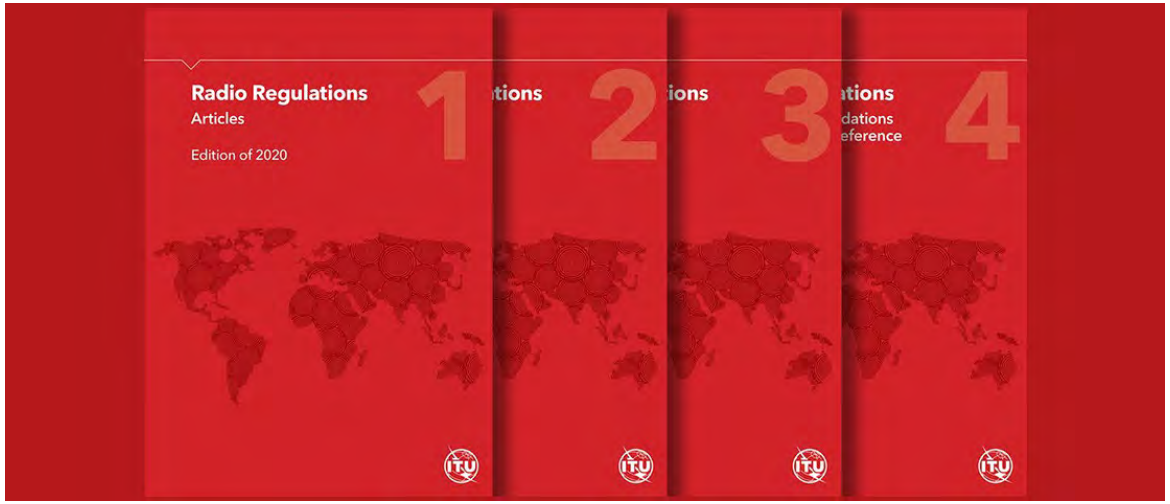


Osnovni namen zakaj imamo radioamaterji na voljo te frekvenčne pasove je "nadaljevanje in razširitev dokazane sposobnosti amaterjev, da prispevajo k napredku radijske tehnike" (Federal Communications Commission rules, USA).

Za oddajanje rabimo licenco oz. radijsko dovoljenje!

Prej je treba opraviti izpit.

Opredelitev amaterske in amaterske satelitske storitve, kot je določena v členih 1.56 in 1.57 ITU Radio Regulations



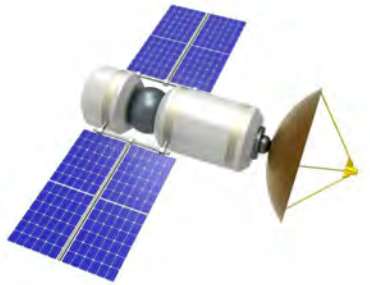
1.56 Radioamaterska storitev - radiokomunikacijska storitev za namene samoizobraževanja, medsebojnega komuniciranja in tehničnih raziskav, ki jih izvajajo amaterji, tj. ustrezno pooblaščene osebe, ki jih radijska tehnika zanima izključno z osebnim namenom in brez premoženjskega interesa.

1.57 Radioamaterska satelitska storitev - radijska komunikacijska storitev, ki uporablja vesoljske postaje na zemeljskih satelitih za iste namene kot radioamaterska storitev.

<u>Slovenska zakonodaja:</u>

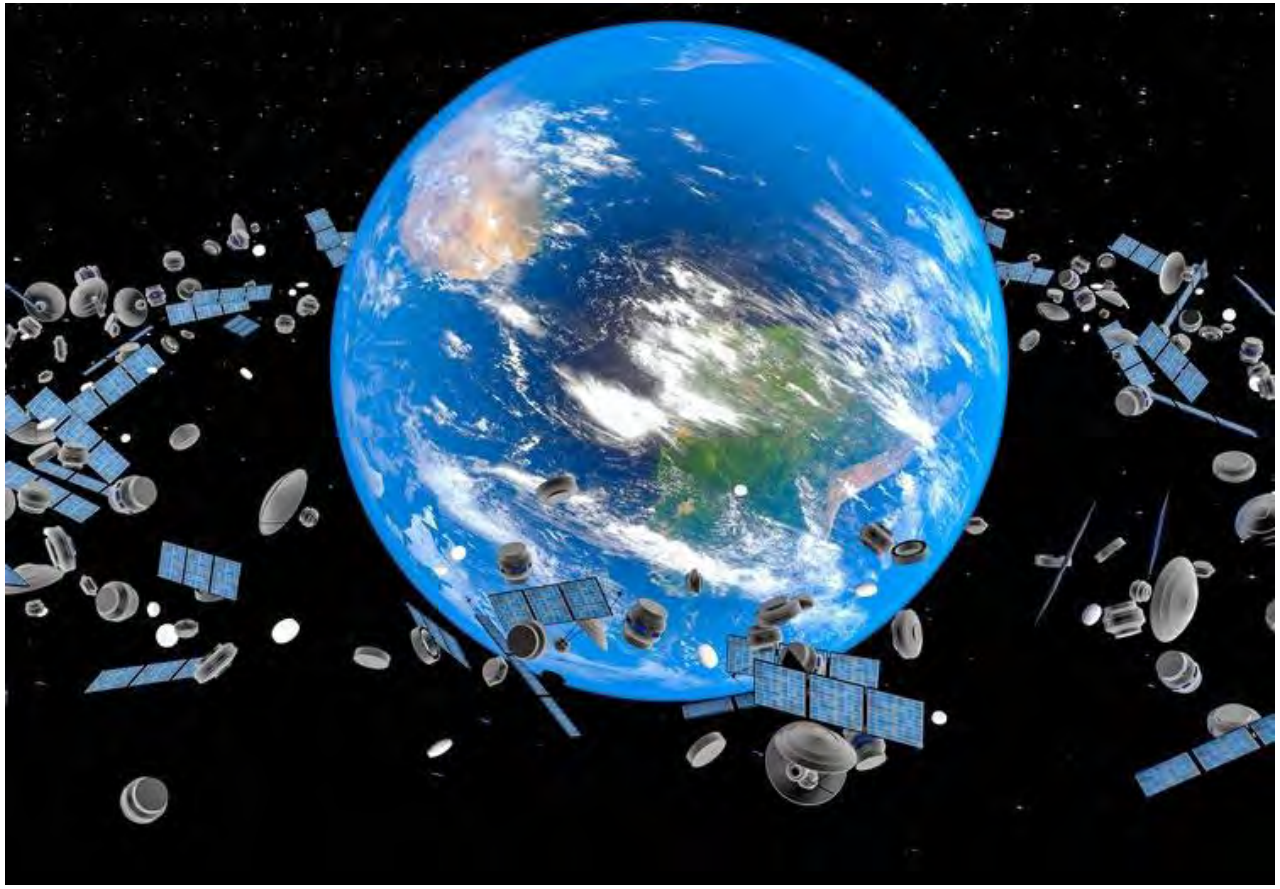
- Zakon o elektronskih komunikacijah
- Splošni akt o pogojih za uporabo radijskih frekvenc, namenjenih radioamaterski in radioamaterski satelitski storitvi

Sateliti

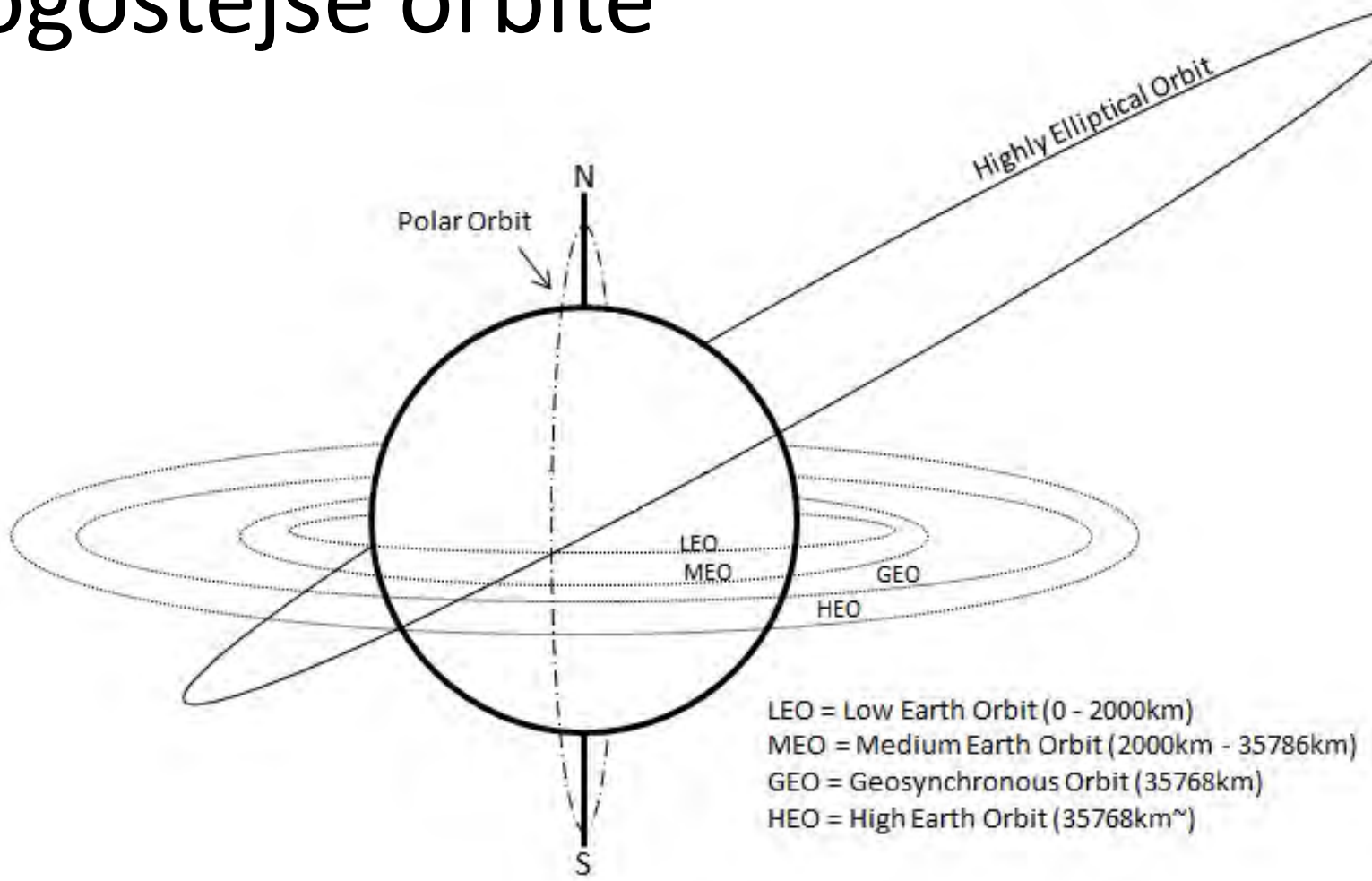


Okoli zemlje kroži več kot 4500 umetnih satelitov. So del različnih sistemov, ki omogočajo telekomunikacije, navigacijo, posredovanje televizijskih signalov, znanstvena opazovanja in eksperimente, meteorološka opazovanja, vohunske in vojaške aplikacije, idr.

Med njimi pa jih je tudi kar nekaj, ki jih lahko uporabljamo tudi radioamaterji.



Najpogostejše orbite

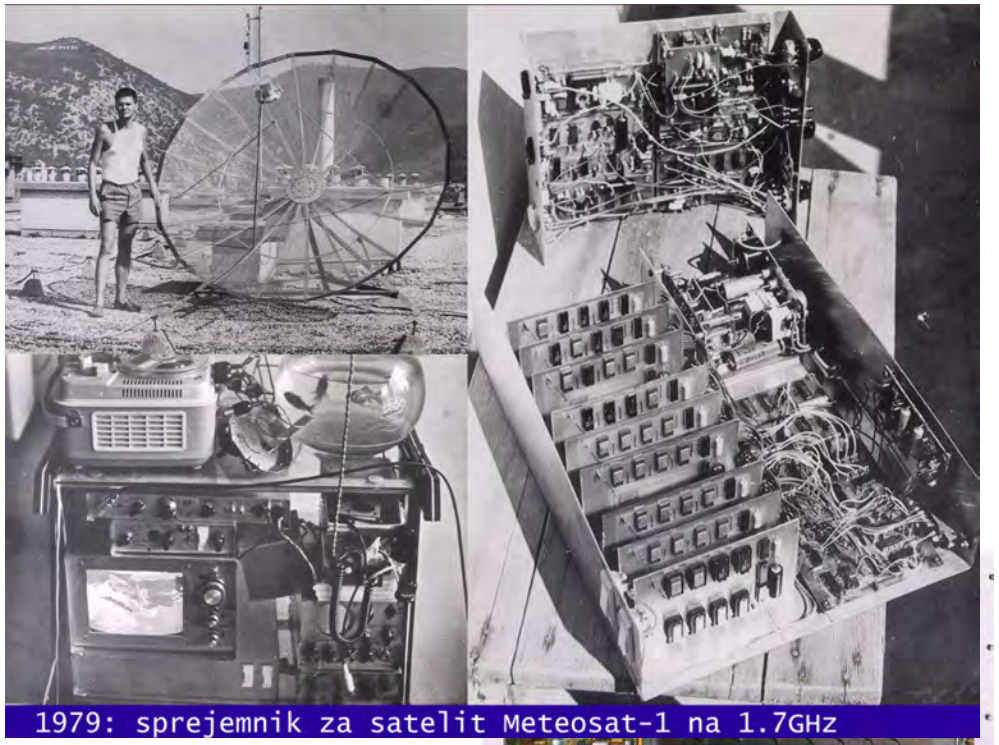


Ref. https://www.polyu.edu.hk/proj/gef/index.php/glossary/satellite-orbit/

Prof. dr. Matjaž Vidmar, S53MV:
“Kratka zgodovina naših poskusov z umetnimi sateliti”
http://lea.hamradio.si/~s53mv/archive/p096.pdf

Matjaževa spletna stran: http://lea.hamradio.si/~s53mv/
- bogato nahajališče izvrstnih člankov, tudi za začetnike!

Laboratorij za sevanje in optiko:
- predavanja http://antena.fe.uni-lj.si/video/
- gradiva http://antena.fe.uni-lj.si/gradiva/

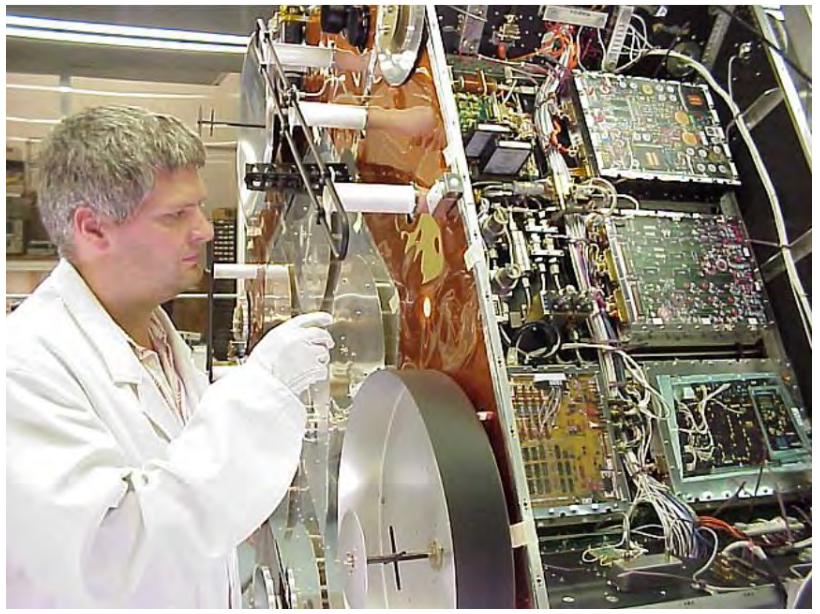

1979: sprejemnik za satelit Meteosat-1 na 1.7GHz

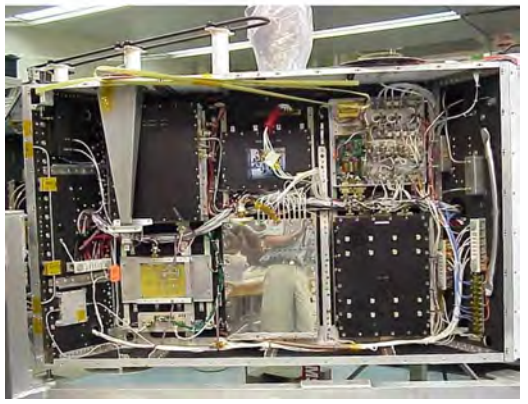
Zemeljska postaja


1988: izračun tirnice satelita in vodenje anten

Microsats 1989

Amsat P3D 1993



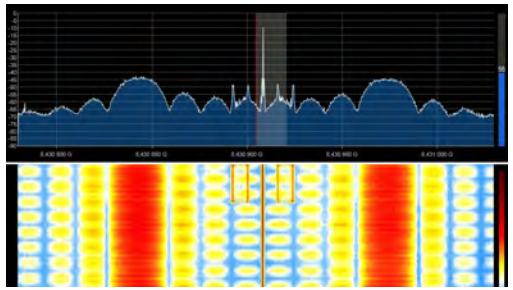


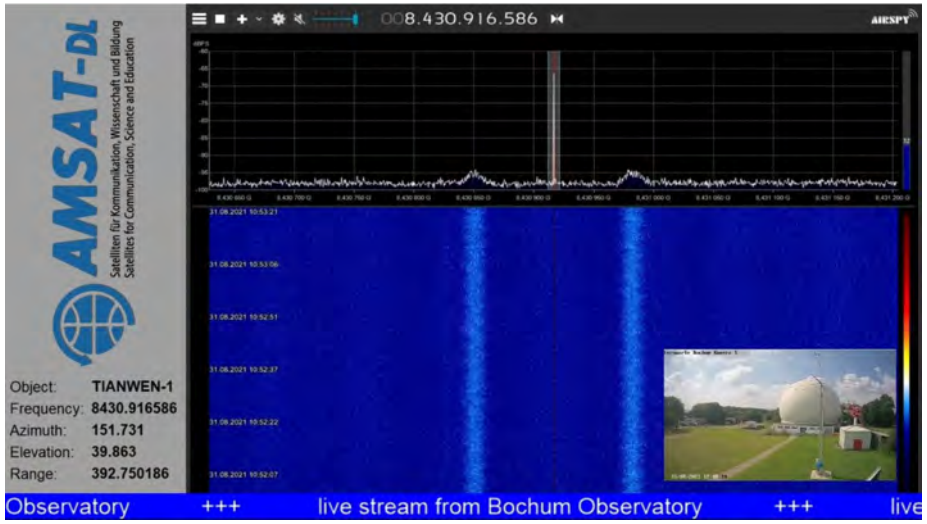
AMSAT® AMATEUR RADIO IN SPACE

AMSAT-DL

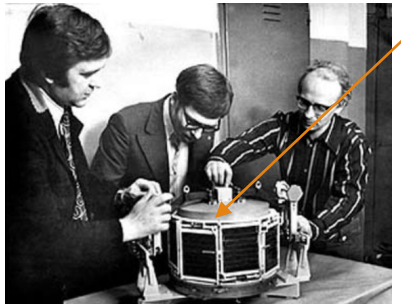
AMSAT-UK

20 m antena AMSAT-DL v Bochumu





AMSAT Oscar 1
1961



Radio Sputnik 1

AMSAT AO-13 P3C

Prvi **geostacionarni** satelit za radioamaterje

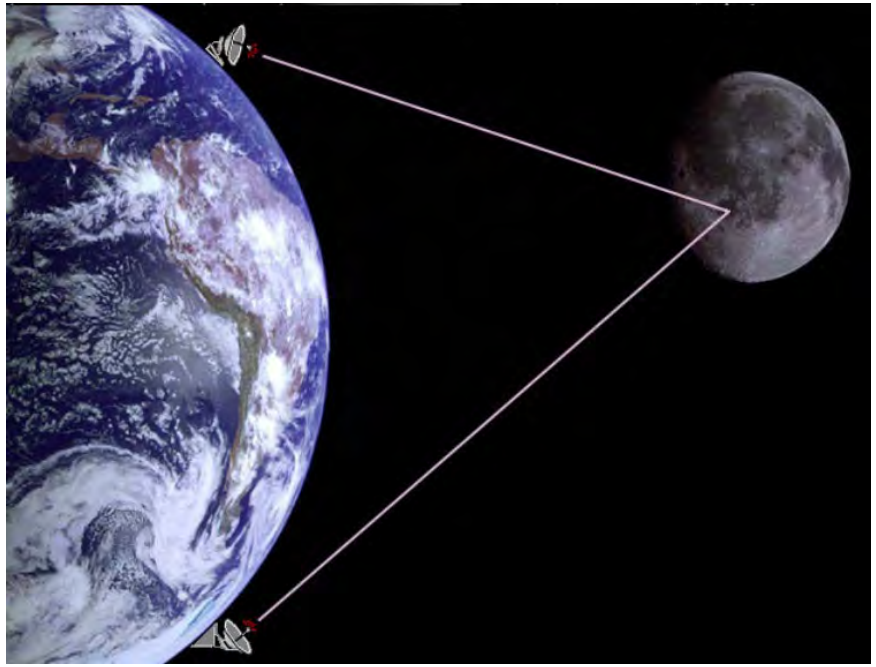
Launches (past and current)			
Name	Status	Launched	Country
OSCAR (OSCAR 1)	Decayed	1961-12-12	United States
OSCAR II (OSCAR 2)	Decayed	1962-06-02	United States
OSCAR III (OSCAR 3, EGRS-3)	Non-Operational	1965-03-09	United
OSCAR IV (OSCAR 4)	Decayed	1965-12-21	United
Australis-OSCAR 5 (OSCAR 5, AO-5, AO-A)	Non-Operational	1970-01-23	Austr
AMSAT-OSCAR 6 (OSCAR 6, AO-6, AO-C, P2A)	Non-Operational	1972-10-15	United
AMSAT-OSCAR 7 (OSCAR 7, AO-7, AO-B, P2B)	Semi-Operational	1974-11-15	United States
AMSAT-OSCAR 8 (OSCAR 8, AO-8, AO-D, P2D)	Non-Operational	1978-03-05	United States
Radio Sputnik 1 (RadioSkaf-1, RS-1)	Non-Operational	1978-10-26	Soviet Union
Radio Sputnik 2 (RadioSkaf-2, RS-2)	Non-Operational	1978-10-26	Soviet Union
UoSat-OSCAR 9 (UOSAT 1, UO-9)	Decayed	1981-10-06	United Kingdom
Radio Sputniks RS3 through RS8	Non-Operational	1981-12-17	Soviet Union
AMSAT-OSCAR 10 (Phase 3B, AO-10, P3B)	Non-Operational	1983-06-16	United States West Germany
UoSat-OSCAR 11 (UoSat-2, UO-11, UoSAT-B)	Semi-Operational	1984-03-01	United Kingdom
Fuji-OSCAR 12 (JAS 1, FO-12)	Non-Operational	1986-08-12	Japan
...			
QB50P2	Operational	2014-07-19	Belgium
ARTSAT2-DESPATCH	Operational	2014-12-03	Japan
Shin'en-2	Operational	2014-12-03	Japan
BRICSat-P (OSCAR 83)	Operational	2015-05-20	United States
ParkinsonSAT (OSCAR 84)	Operational	2015-05-20	United States
Fox-1A (OSCAR 85)	Operational	2015-10-08	United States
Lapan-A2	Operational	2015-09-28	Indonesia
ÑuSat-1 (LUSEX OSCAR 87)	Operational	2016-05-30	Argentina
Nayif 1	Operational	2017-02-15	United Arab Emirates
ITF 2	Operational	2016-12-09	Japan
LilacSat-1	Operational	2017-04-18	China
Fox-1B (OSCAR 91)	Operational	2017-11-18	United States
Fox-1D (OSCAR 92)	Semi-Operational[10]	2017-01-12	United States
DSLWP-A (OSCAR 93, LO-93)	Non-Operational	2018-05-20	China
DSLWP-B (OSCAR 94, LO-94)	Operational	2018-05-20	China
Fox-1Cliff (OSCAR 95, AO-95)	Operational	2018-12-03	United States
ExseedSat-1 (VUsat-OSCAR 96, VO-96)	Operational	2018-12-03	India
JY1Sat (Jordan-OSCAR 97, JO-97)	Operational	2018-12-03	Jordan
OrigamiSat (Fuji-OSCAR 98, FO-98)	Operational	2019-01-18	Japan
NEXUS (Fuji-OSCAR 99, FO-99)	Operational	2019-01-18	Japan
Es'hail 2 (Qatar-OSCAR 100, QO-100)	Operational	2018-11-15	Qatar
Diwata-2 (Philippines-OSCAR 101, PO-101)	Operational	2018-10-29	Philippines
CAS-7B (BIT Progress-OSCAR 102, BO-102)	Decayed	2019-07-25	China
BricSat-2 (Navy-OSCAR 103, NO-103)	Operational	2019-06-25	United States
PSAT-2 (Navy-OSCAR 104, NO-104)	Operational	2019-06-25	United States
SMOG-P (Magyar-OSCAR 105, MO-105)	Decayed	2019-12-06	Hungary
ATL-1 (Magyar-OSCAR 106, MO-106)	Decayed	2019-12-06	Hungary
SMOG-1 (Magyar-OSCAR 110, MO-110)	Operational	2021-03-22	Hungary

https://en.wikipedia.org/wiki/Amateur_radio_satellite

Echoes from the moon on 10GHz

Autumn 2017, new 10GHz setup, 400W power amplifier, SDR RedPitaya radio, 1.4dB preamp. See more photos or listen to the Moon echoes in the Video...

Vir: http://lea.hamradio.si/~s57ra/

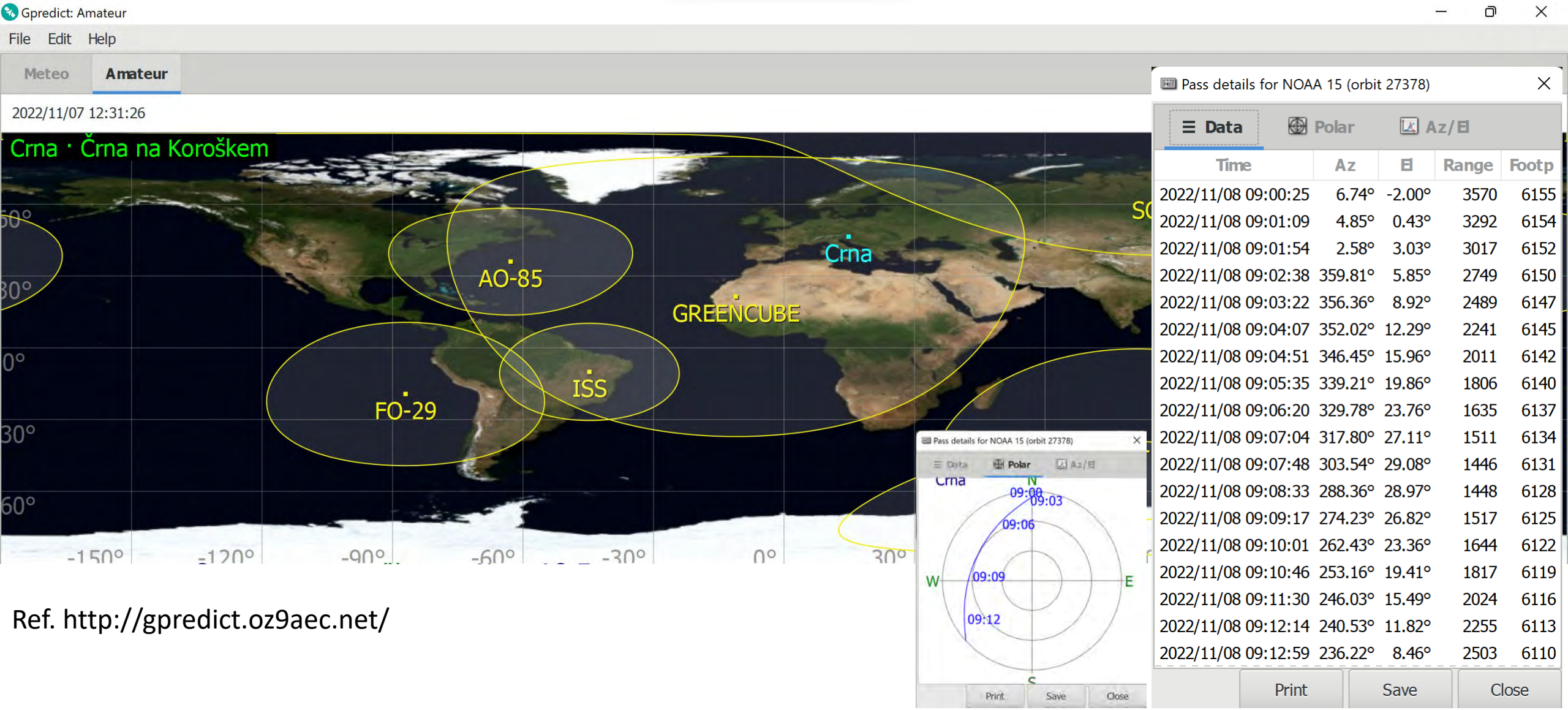


Vir: http://lea.hamradio.si/~s56uuu/

Vir: http://lea.hamradio.si/~s53rm/

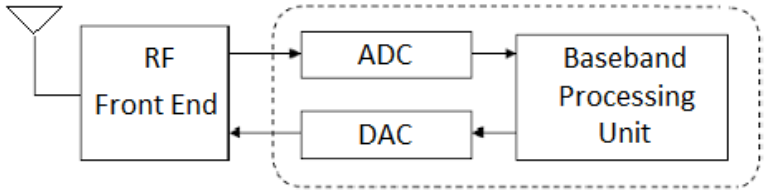
Vir: RK Slovenj Gradec

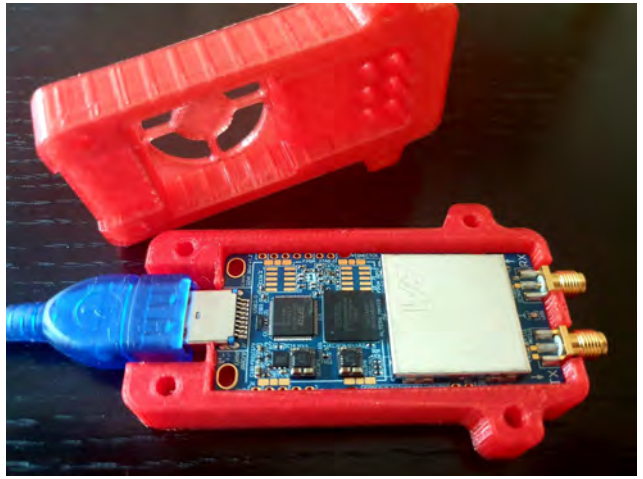
Sledenje satelitom



Ref. http://gpredict.oz9aec.net/

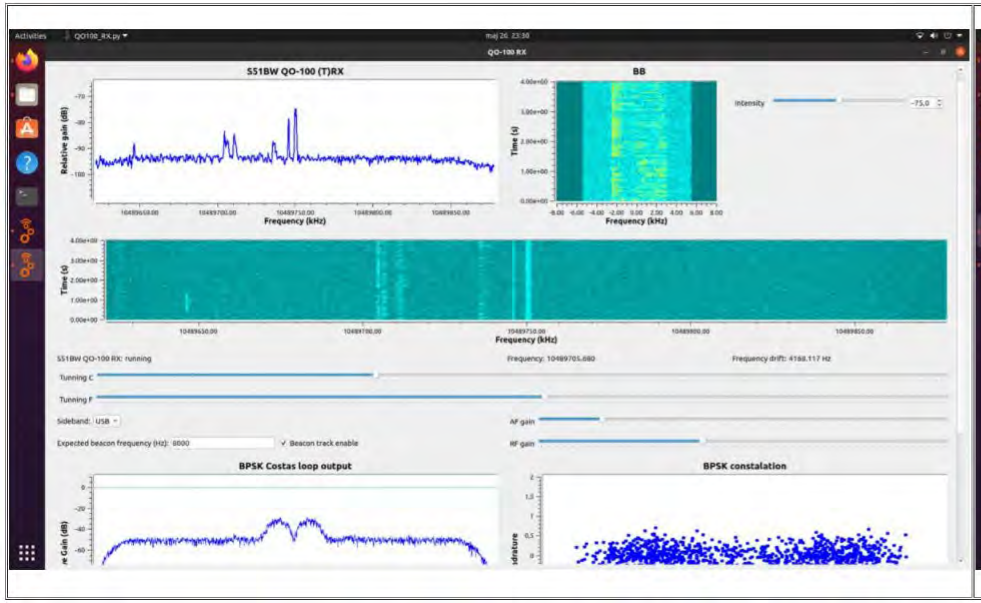
Oprema za eksperimentiranje – SDR – Software Defined Radio

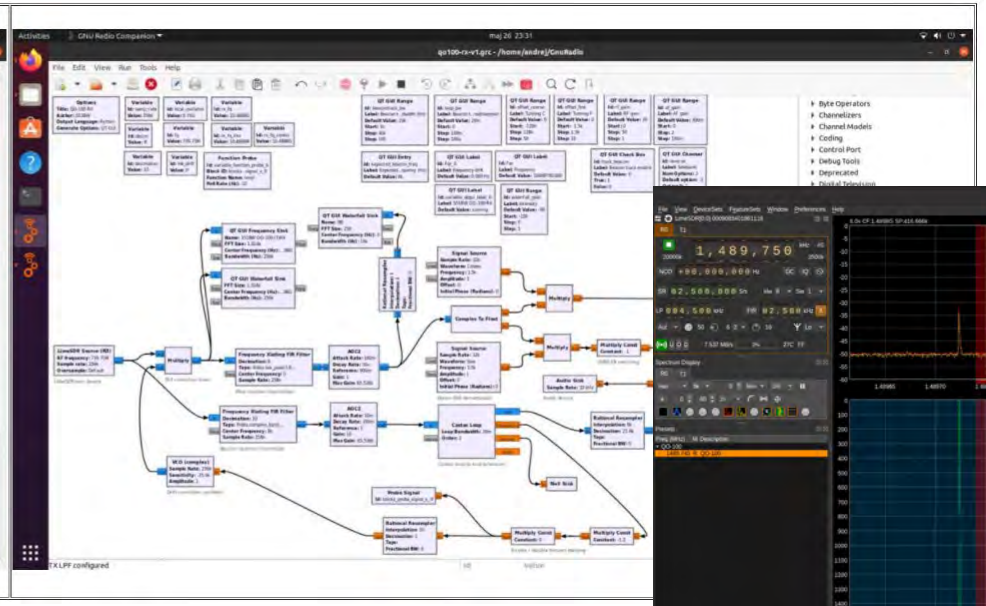


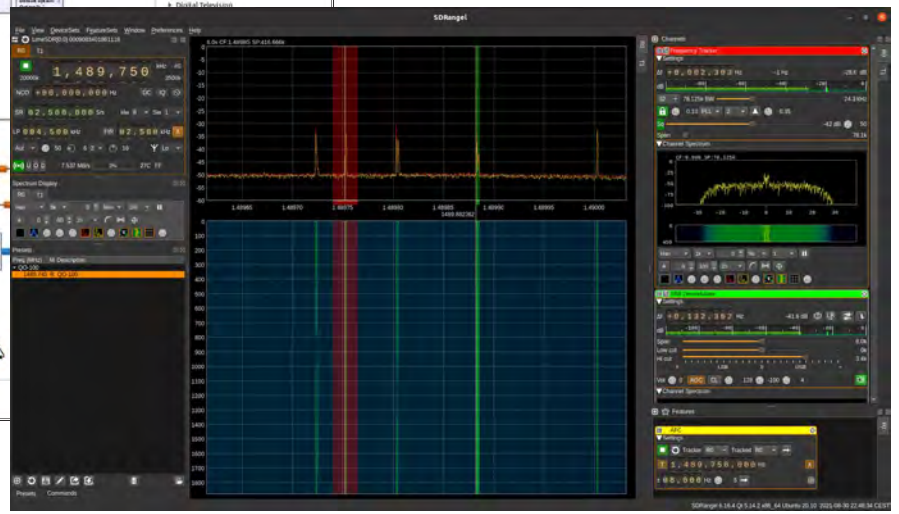


10 MHz – 3.5 GHz
BW 30.72 MHz
RX
TX 10 dbm
fullduplex

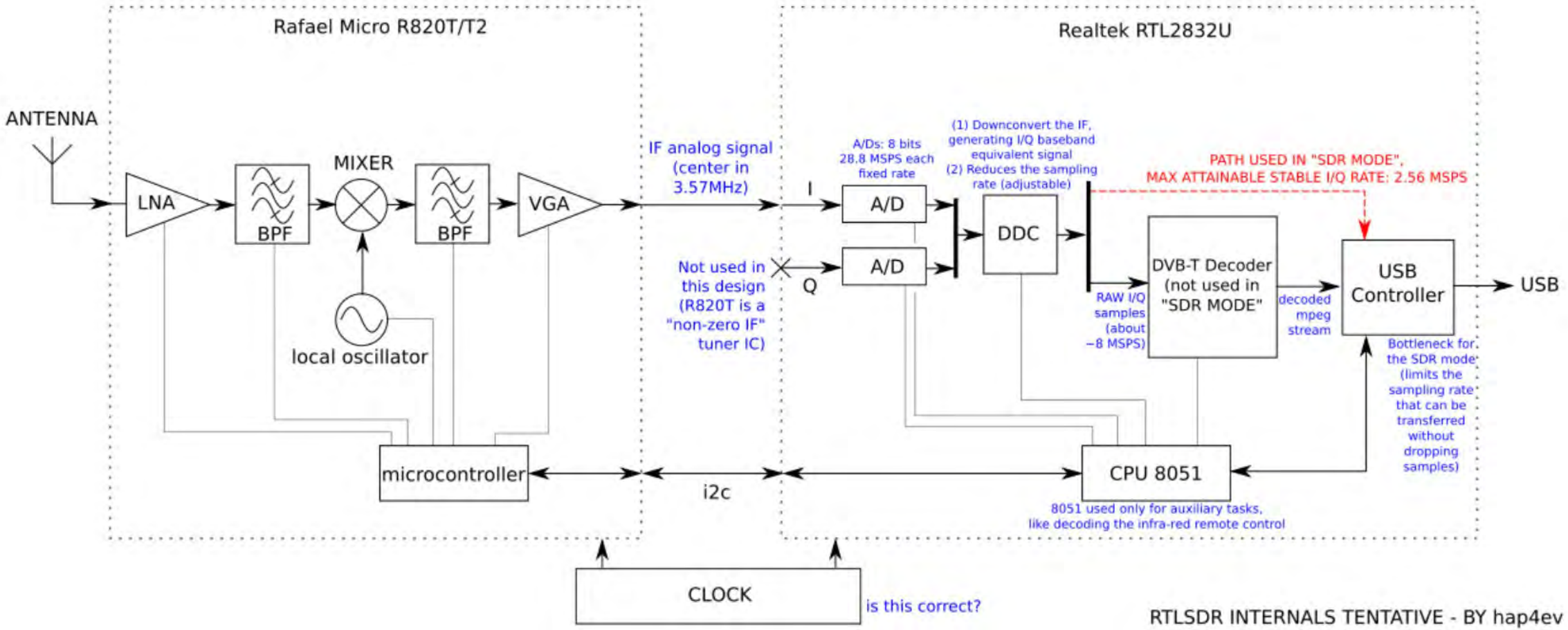
25 MHz – 1.7 GHz
BW 2.56 MHz
RX only



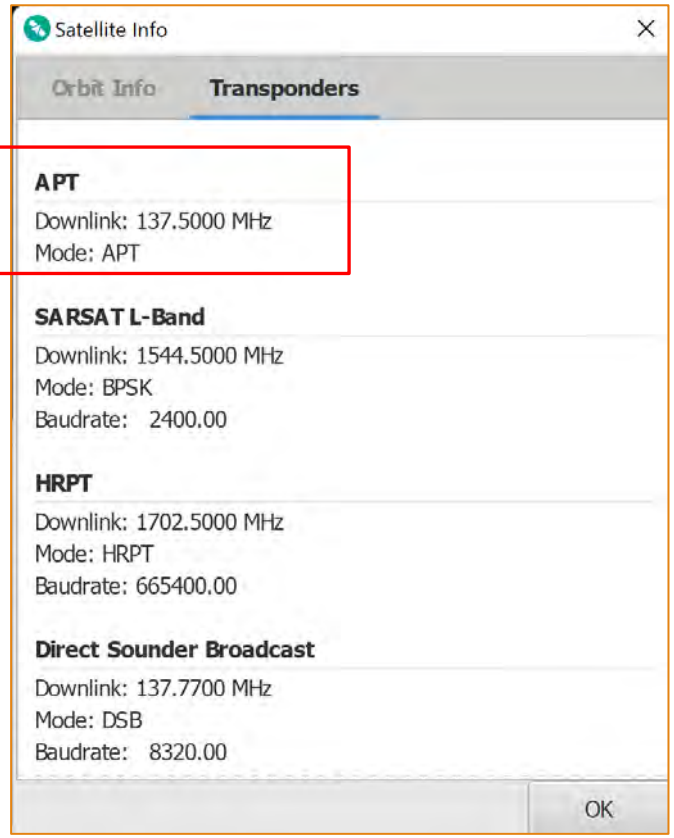




R820T2+RTL2832U SDR sprejemnik



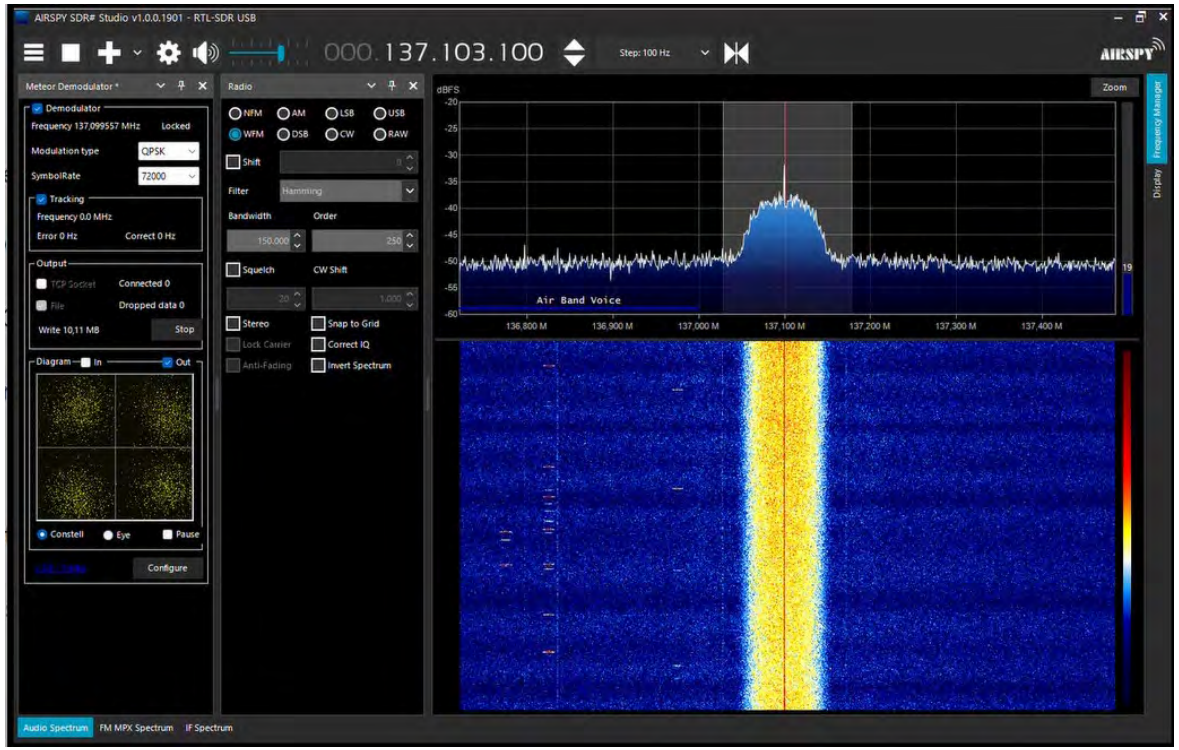
Kako začeti?


Satellite Info
Orbit Info
Transponders
APT
Downlink: 137.5000 MHz
Mode: APT
SARSAT L-Band
Downlink: 1544.5000 MHz
Mode: BPSK
Baudrate: 2400.00
HRPT
Downlink: 1702.5000 MHz
Mode: HRPT
Baudrate: 665400.00
Direct Sounder Broadcast
Downlink: 137.7700 MHz
Mode: DSB
Baudrate: 8320.00
OK

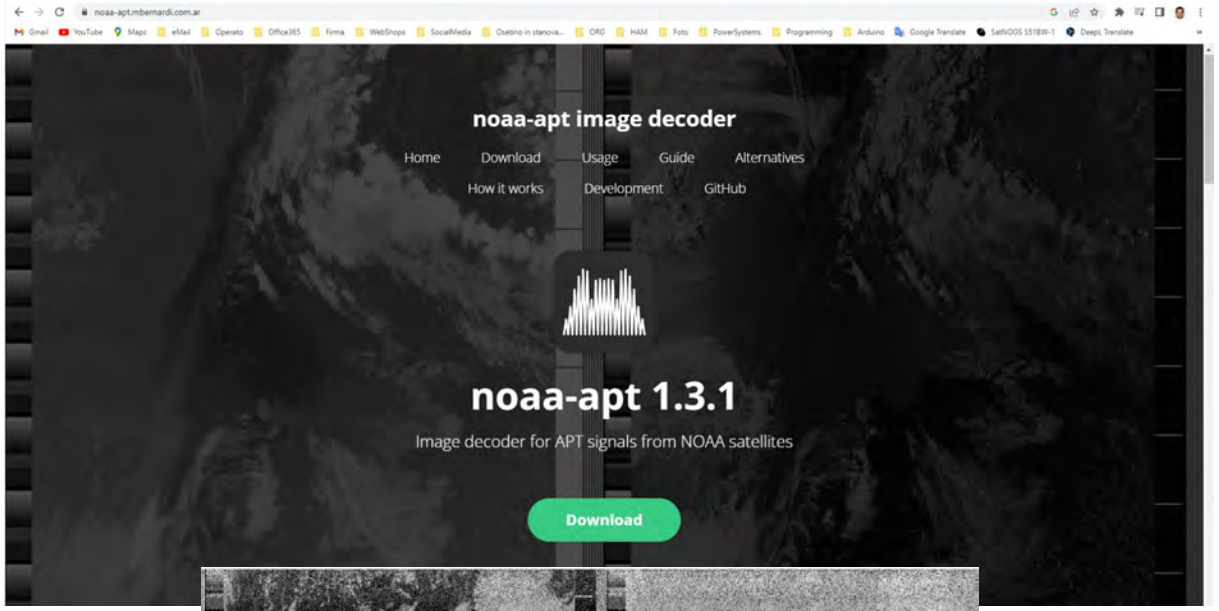
Programska oprema

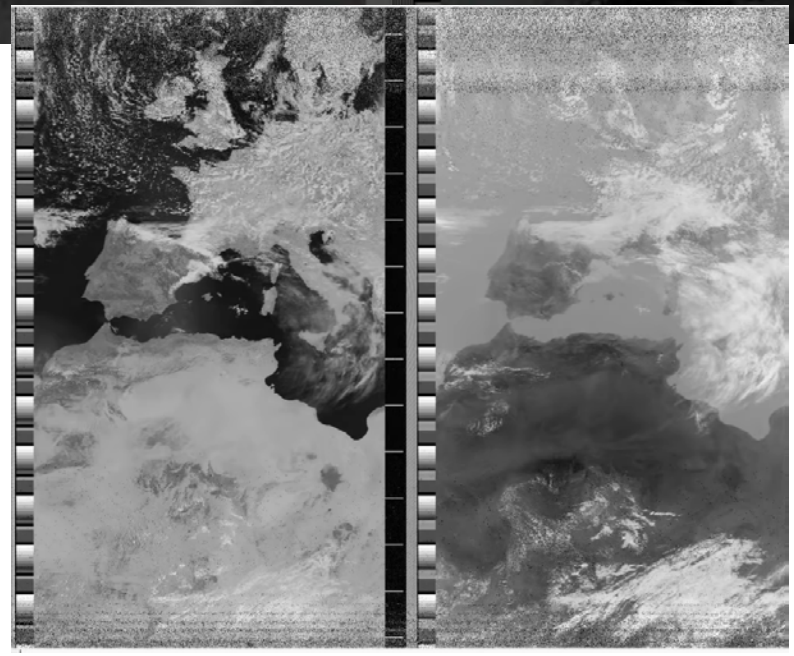
Radio SDR:

- SDRSHARP (Windows)
- GQRX (Linux)

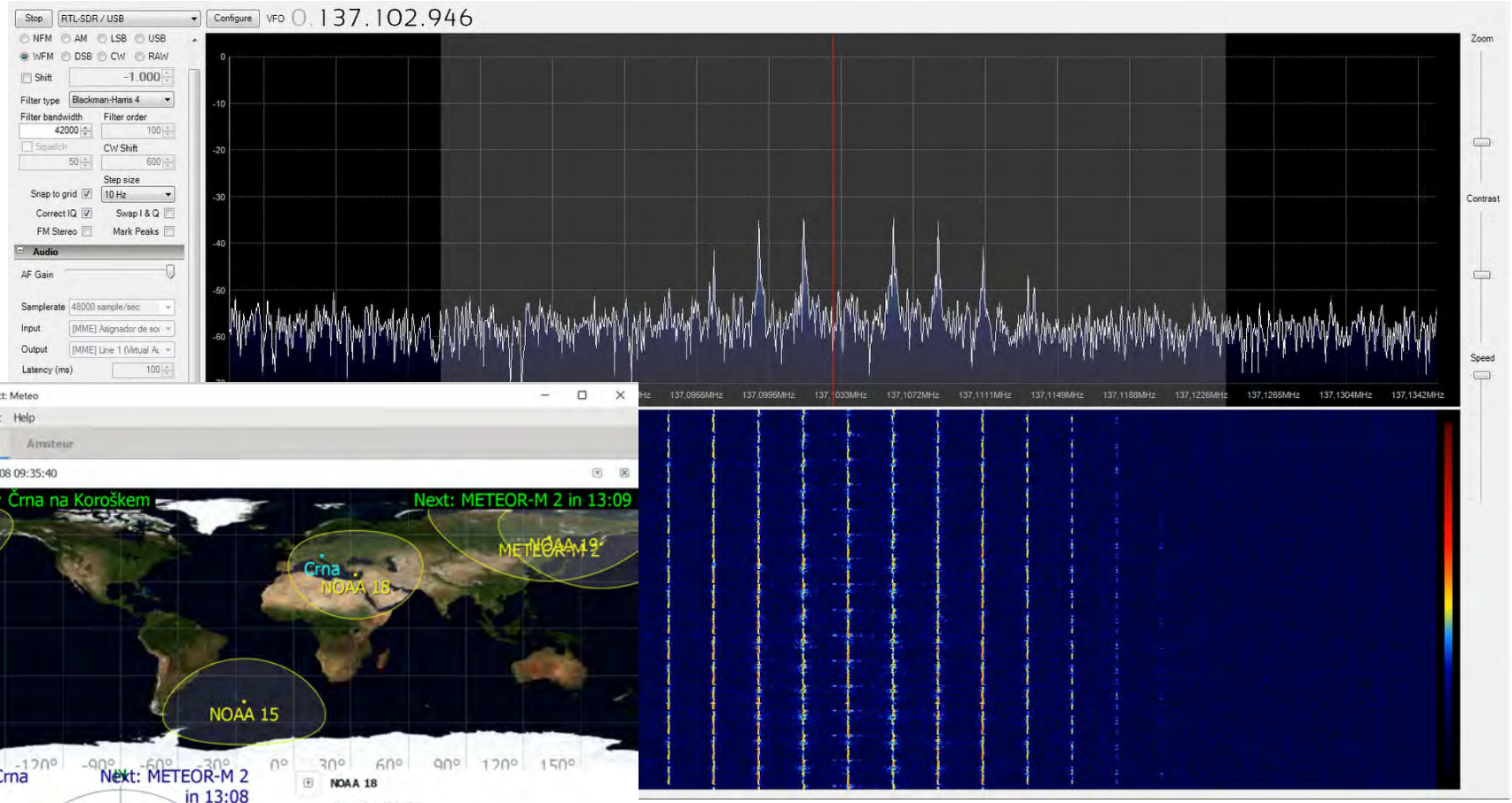


Dekodiranje in vizualizacija slike

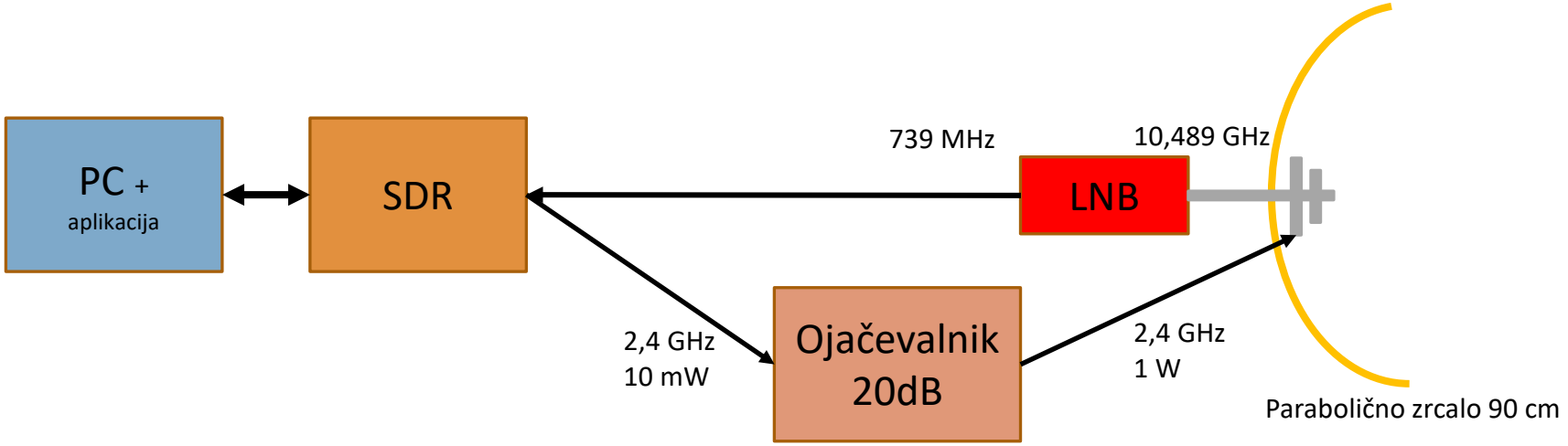


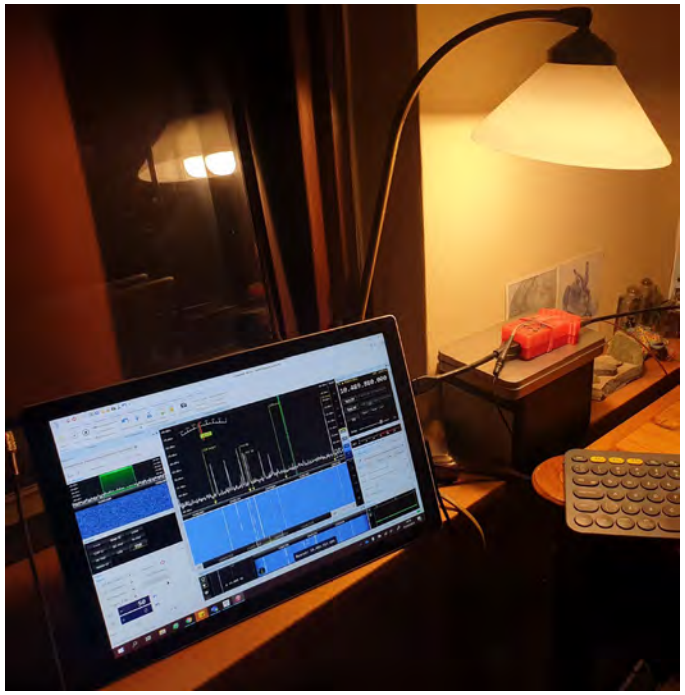


Poizkus: sprejem meteo satelita na 137 MHz

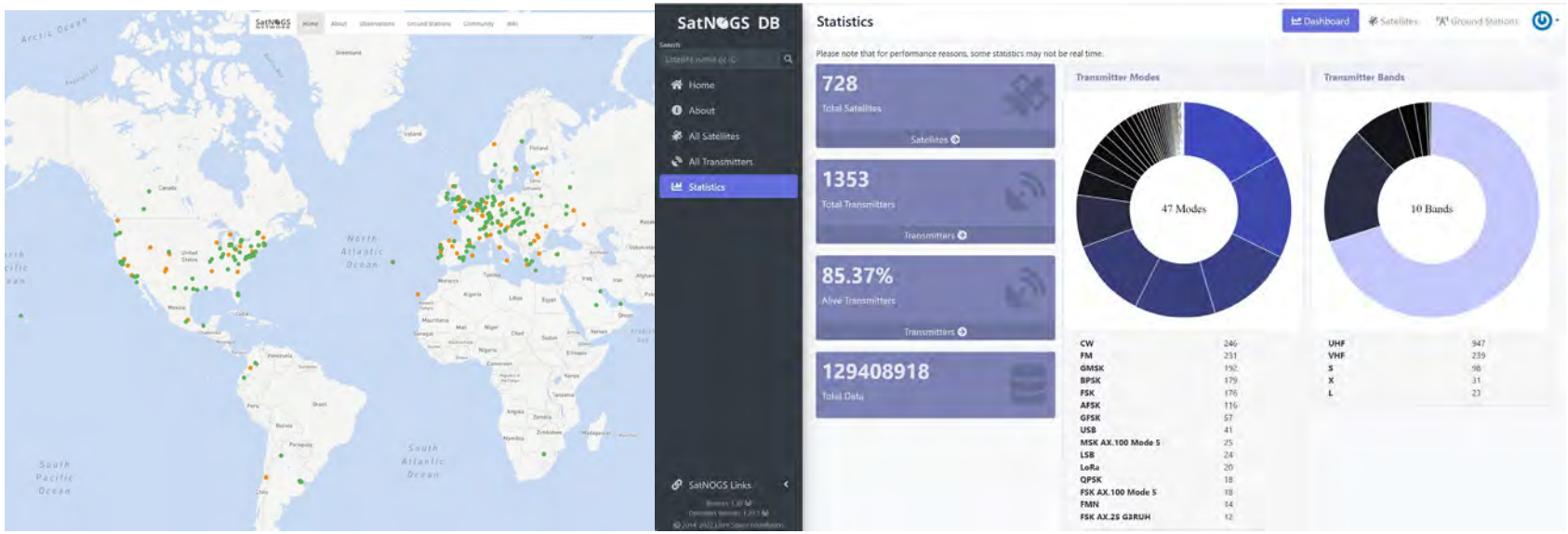


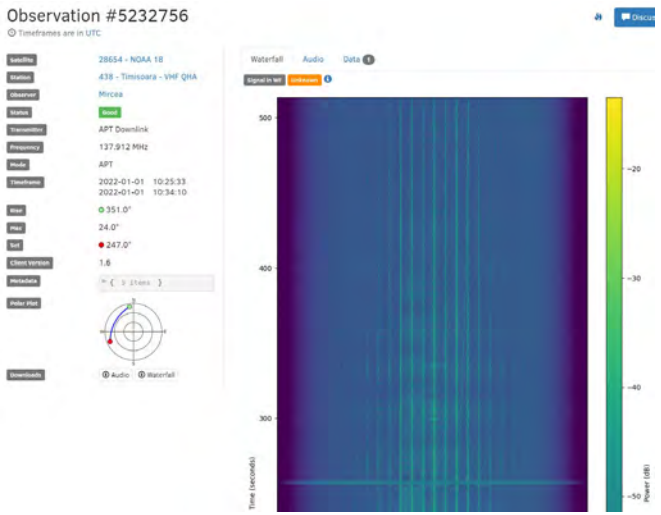
Poizkus: geostacionarni satelit QO-100

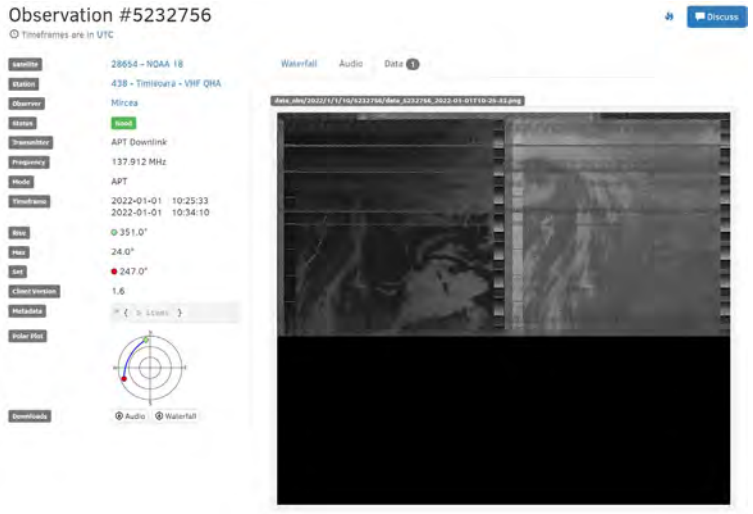


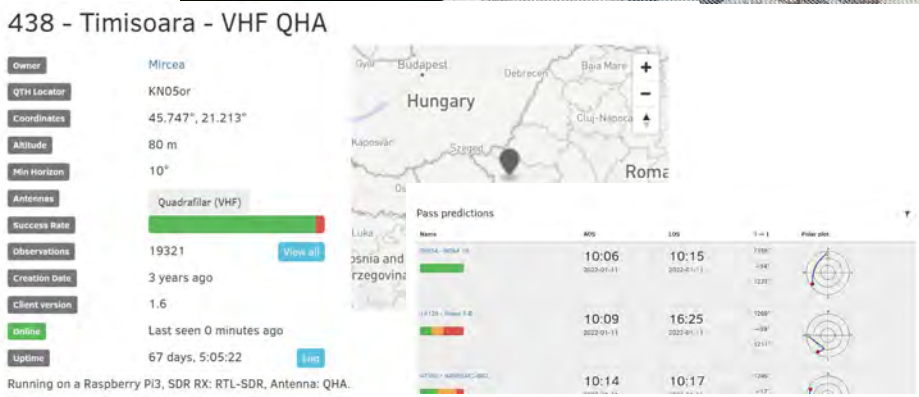


SatNOGS - odprtokodna platforma za omrežje satelitskih zemeljskih opazovalnic

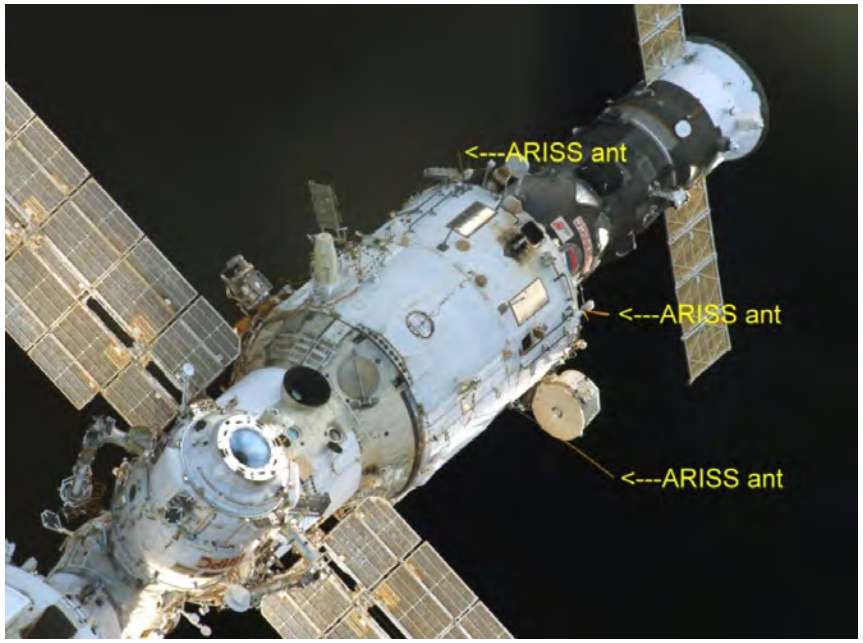








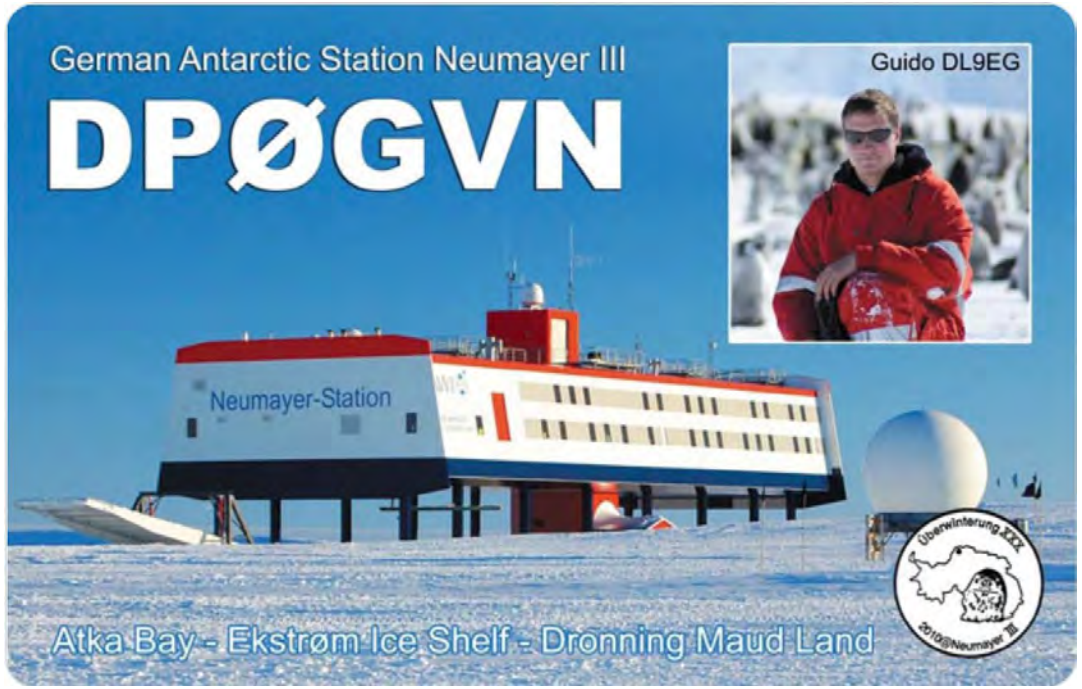
Amateur Radio on the International Space Station (ARISS)



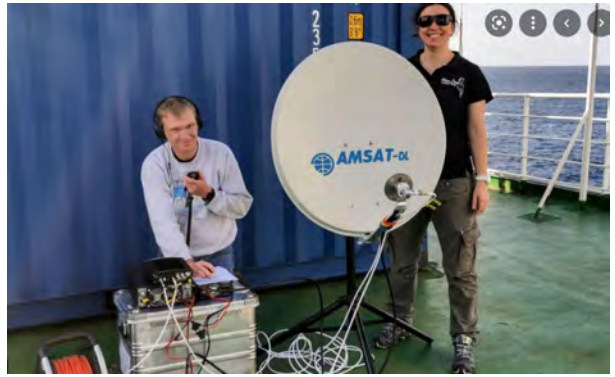
Goals of the ARISS Program

- Inspire an interest in science, technology, engineering and math (STEM) subjects and in STEM careers among young people;
- Provide an educational opportunity for students, teachers and the general public to learn about space exploration, space technologies and satellite communications;
- Provide an educational opportunity for students, teachers and the general public to learn about wireless technology and radio science through Amateur Radio
- Provide an opportunity for Amateur Radio experimentation and evaluation of new technologies.
- Provide a contingency communications system for NASA and the ISS crew.
- Provide crew with another means to directly interact with a larger community outside the ISS, including friends and family.

Vir: https://www.ariss.org/



Vir: https://www.dd1us.de/spacesounds%202h.html



Jamboree-on-the-Air

Vir: Facebook JOTA-JOTI Slovenija

Študentski in izobraževalni projekti z nano|mikrosateliti

AGENCY

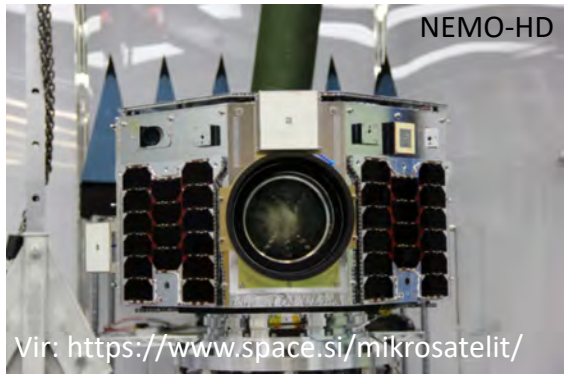
Fly Your Satellite! programme

TABLE I. LIST OF INDIAN STUDENT SATELLITES.

Sl.N	Satellite Name	Institution	Launch Mass	Launch Vehicl PSLV	Launch Date
1	ANUSAT	Anna University	40	C12	Apr 20, 2009
2	STUDSAT	Consortium o colleges	<1	C15	Jul 12, 2010
3	JUGNU	IIT Kanpur	<3	C18	Oct 12, 2011
4	SRMSAT	SRM University	10.9	C18	Oct 12, 2011
5	SWAYAM	University Pune	1	C34	June 22, 2016
6	Sathyabamasat	Sathyabama University	1.5	C34	June 22, 2016
7	PISAT	PES University	5.25	C35	Sept. 26, 2016
8	PRATHAM	IIT Bombay	10	C35	Sept. 26, 2016
9	NIUSAT	Nurul Isla University	m 15	C38	June 23, 2017
10	Kalamsat-V2	Space Kids	1.26	C44	Jan. 24, 2019

Vir: https://www.ijert.org/satellite-projects-by-indian-students

Vir: https://www.trisat.um.si/



Vir: https://www.space.si/mikrosatelit/

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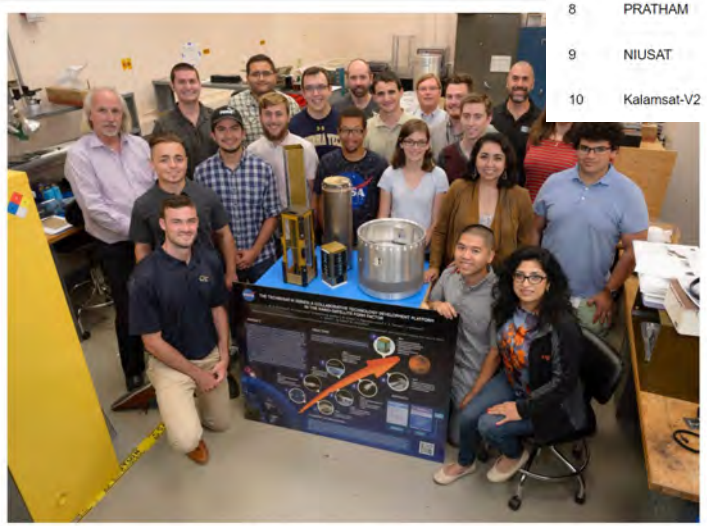
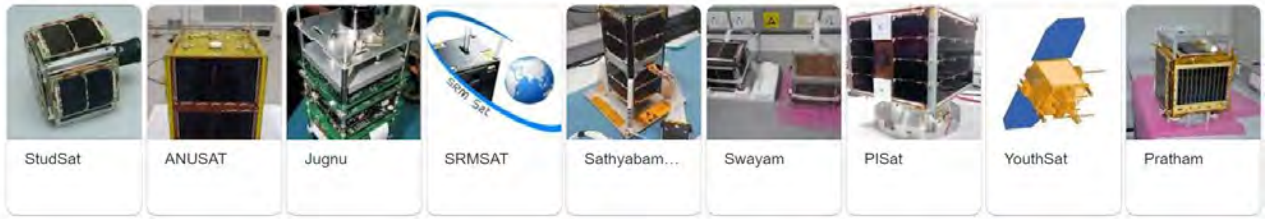


TechEdSat group in N-244 Lab 9 with mentors Mark Murbach (standing back left) and Ali Guarneros Luna (kneeling on right). Photo courtesy of NASA Ames Research Center.



Hvala za pozornost!

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