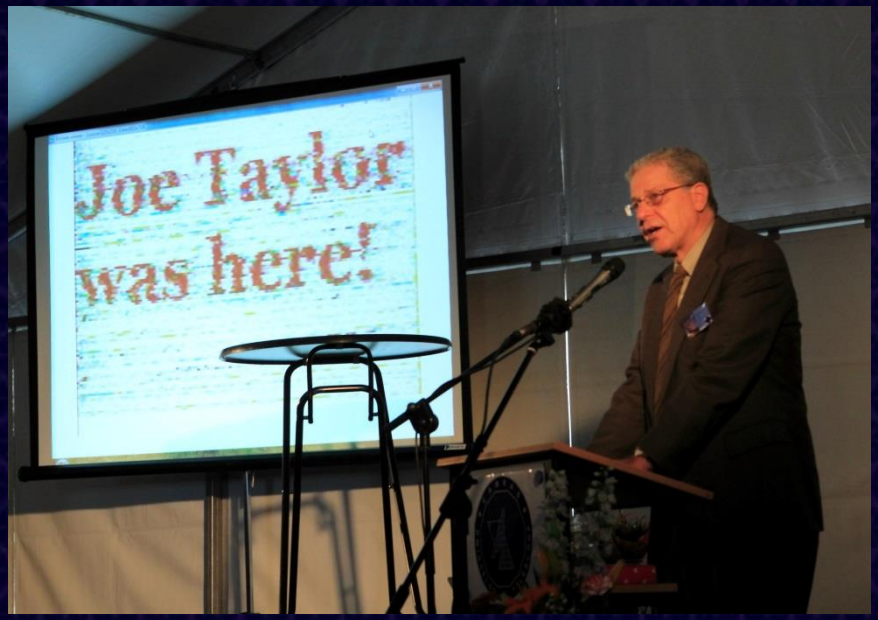
Let’s bounce!

New frontiers at PI9CAM

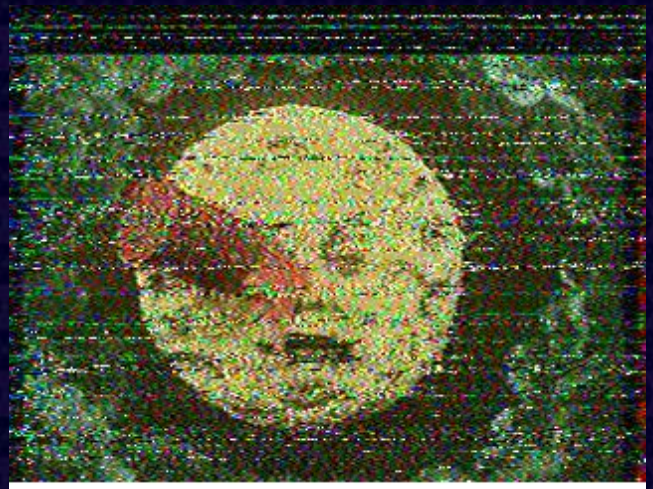
DJ5AR & PA3FXB

Restoration was completed in 2013
Reopening was done by Joe Taylor in 2014
Many nice things were done.

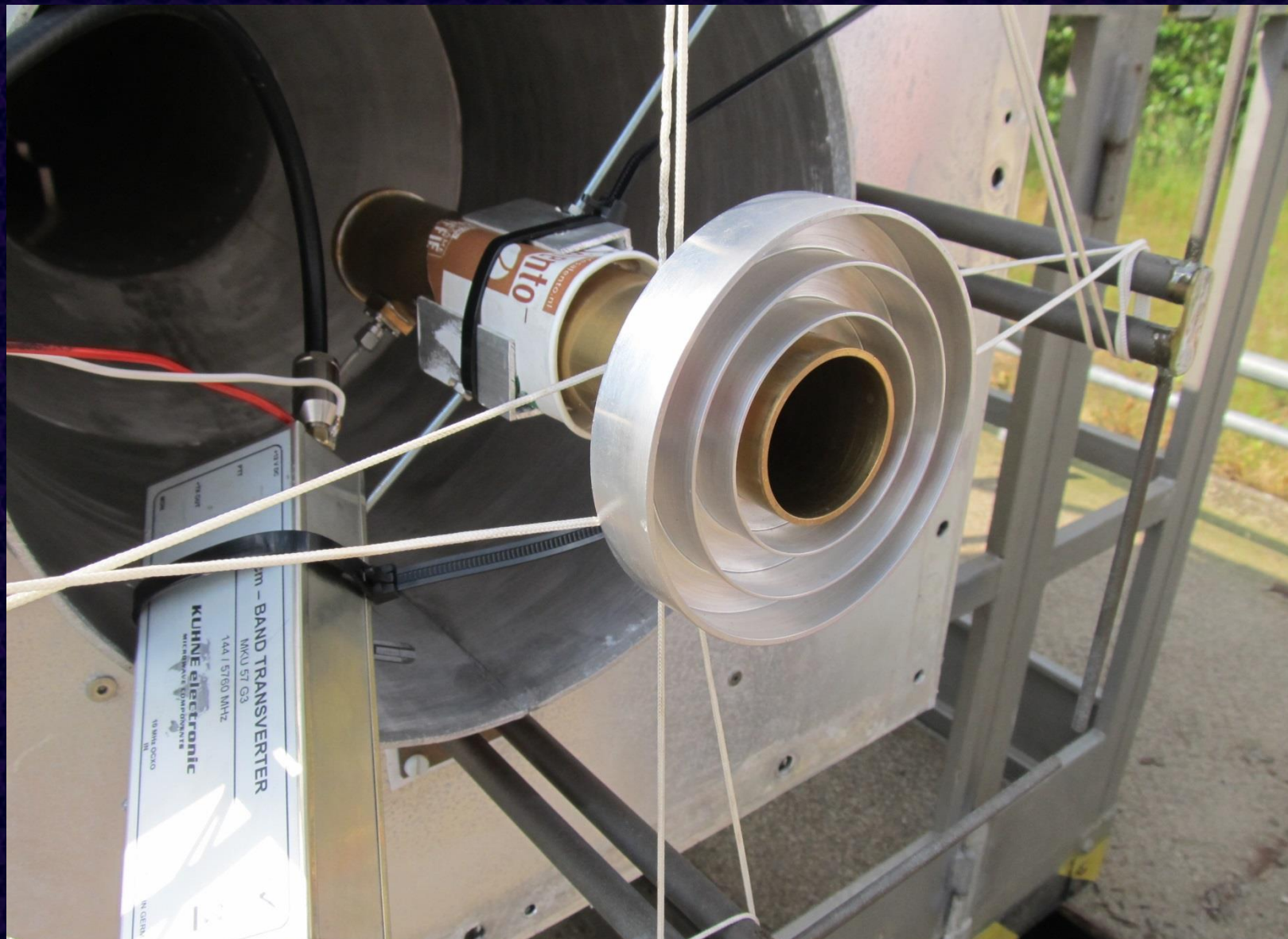
To mention a few:
- A moonbounce wedding



EME SSTV art projects with Daniela de Paulis



Test on 6 cm



Where to go next?

- A new challenge
- Satellite bounce!
- How it started

DJ5AR & PA3FXB

ISS bounce on 23 cm

- ISS is big (52 x 93 m)
- Our (DJ5AR & PA3FXB) dishes are small (3 m)
- Yet, it worked very nicely!
- Not easy…
- Fast tracking
- Huge and fast changing Doppler shift (60 kHz)
- Surprisingly strong signals

Example of ISS bounced 23 cm signal without Doppler correction

- After several tests we succeeded in 2013 on May 23
- Now let’s go to the next level of this bouncing game
- Using ‘normal’ small satellites to bounce off signals
- Our own dishes are too small
- So let’s use a bigger one….
- PI9CAM

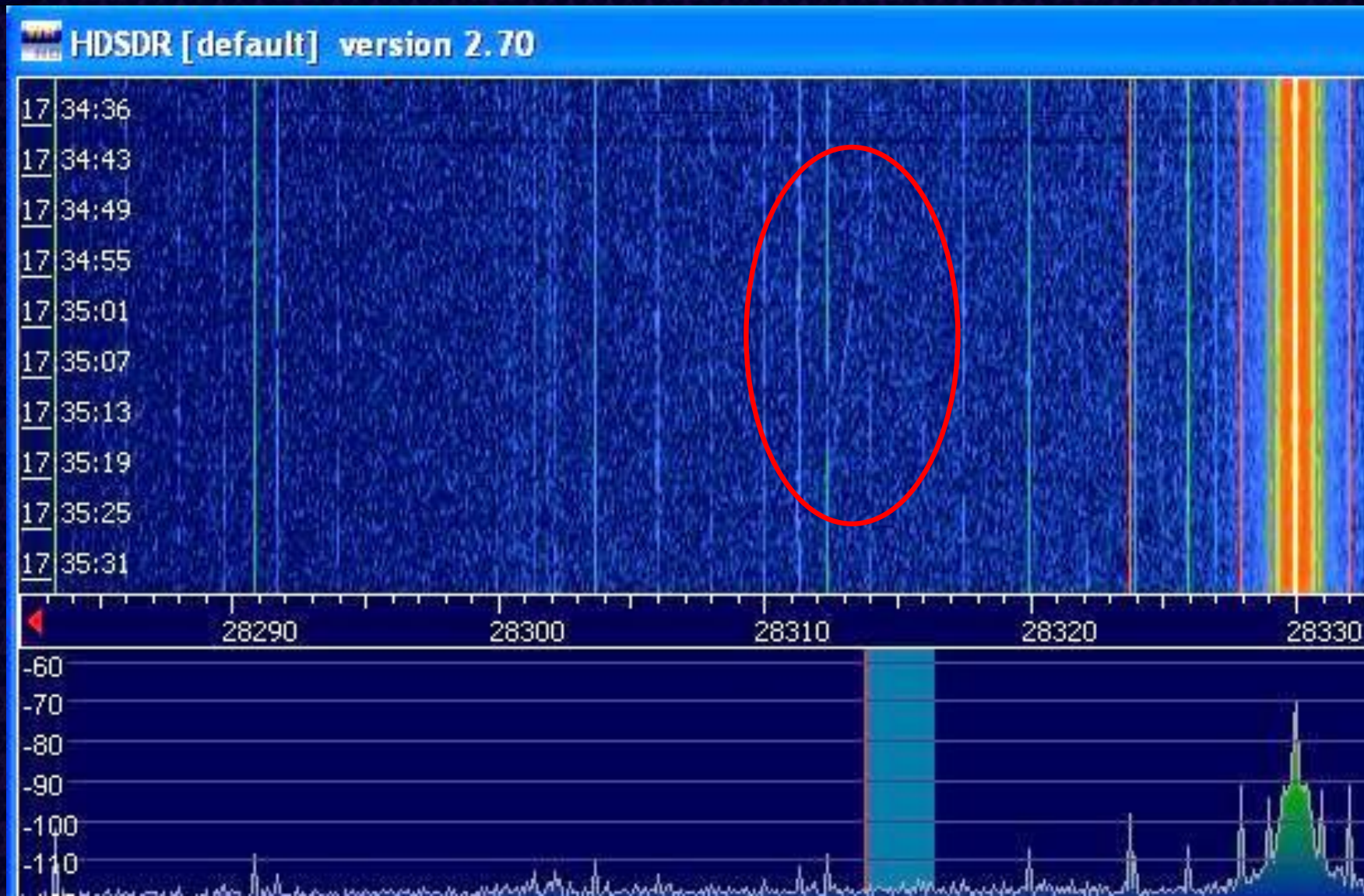
But….

- Can this old lady move fast enough?
- She weighs 120 tons…
- Yes!

- Is the pointing accurate enough?
- Beamwidth is only 0.5 degree on 23 cm…
- That we had to test
- We first tried an ISS bounce QSO
- It worked!

Now for the smaller satellites!

- First test in February 2014
- Several big stations listened for our sat bounced signal
- HB9Q, G4CCH, I1NDP, OE5JFL, PA3DZL, DJ5AR
- Only Hannes saw something…


HDSDR [default] version 2.70
17 34:36
17 34:43
17 34:49
17 34:55
17 35:01
17 35:07
17 35:13
17 35:19
17 35:25
17 35:31
28290
28300
28310
28320
28330
-60
-70
-80
-90
-100
-110

So, it’s possible!

- Next steps
- Finding the best ‘small’ satellite
- Radar cross section
- Best common window given all constraints
- DJ5AR wrote a special software for this!

Radio Assistent for Space Communication by DJ5AR Debug-Version

File Extras Settings Help

	Callsign	Locator / 349 km	Gain [dBi]	Power [W]
1	DJ5AR	JN49CV	28	150
2	PI9CAM	JO32ET	48	120

Operating Frequency: 1296300 kHz

NORAD # 40107 RCS [m²] 5,07

```
ASIASAT 8
1 40107U 14046A   16020.37640474 -.00000347  00000-0  00000+0 0  9995
2 40107   0.0601 269.6276 0001550   8.2135  82.1154  1.00267321  5399
```

Reload TLE | Reinit TLE

Designator	Epoch Time	Inclination	RAAN	Delta RAAN	Excentricity	ArgOfPerigee	MA	MM	Type	Source
2014-046A	2016-01-20 09:02	0,06	269,63	-0,01	0,0001550	8,21	82,12	1,00	HEO	CelesTrack

Tracking | Window Analyzer | Window Finder | Candidates | Extras

ASIASAT

Limits of Radar Crosssection: 5 to 999 m² Check 20 Orbits Limit for Unit Budget: -250 dBm Skip HEO Objects 15746/15746/535

Survey

NORAD	Name	RCS [m²]	max. Unit-Budget [dBm]	Sum Slant Ranges [km]	max. Elevation 1 [°]	max. Elevation 2 [°]	Type	mean Motion [rev/d]	Inclination [°]	TimeStamp
16881	COSMOS 1766	9,17	-235,0	1185	66,8	75,5	LEO	15,09118819	82,5073	22.01.2016 13:1..
16953	SL-8 R/B	6,51	-241,7	1600	76,6	76,3	LEO	14,37199379	74,0122	23.01.2016 10:2..
16986	COSMOS 1782	9,51	-235,7	1253	56,8	72,6	LEO	15,05765237	82,5062	21.01.2016 09:1..
17129	ARIANE 1 DEB	5,55	-242,9	1647	86,8	71,6	LEO	14,24717635	98,7569	21.01.2016 09:1..
17191	COSMOS 1805	9,45	-236,7	1325	53,4	58,9	LEO	15,1078301	82,475	24.01.2016 13:4..
17241	COSMOS 1809	7,86	-244,2	1943	79,0	85,5	LEO	13,84064463	82,5289	23.01.2016 19:3..
17242	SL-14 R/B	5,15	-247,4	2100	59,9	70,2	LEO	13,83268173	82,5295	21.01.2016 20:1..
17295	COSMOS 1812	7,43	-235,1	1133	82,4	66,6	LEO	15,13266889	82,5167	21.01.2016 10:3..
17528	N-2 R/B	8,69	-237,8	1374	76,7	79,2	LEO	14,50576491	97,4023	23.01.2016 05:4..
17535	COSMOS 1823	13,9	-250,0	3120	77,7	79,2	LEO	12,41313386	73,6025	23.01.2016 07:0..
17566	COSMOS 1825	8,97	-234,8	1167	57,0	77,3	LEO	15,17198516	82,5051	23.01.2016 20:3..
17590	SL-16 R/B	9,6	-241,5	1750	76,9	79,3	LEO	14,16715245	71,0031	21.01.2016 10:4..
17911	COSMOS 1842	7,99	-235,0	1146	75,4	87,5	LEO	15,1023463	82,5274	24.01.2016 13:2..
17973	COSMOS 1844	15,3	-239,8	1782	68,1	85,3	LEO	14,14015747	70,8976	23.01.2016 10:2..
17974	SL-16 R/B	9,46	-241,8	1769	62,3	81,8	LEO	14,17191657	71,0081	23.01.2016 10:1..
18096	SL-8 R/B	5,47	-242,1	1570	81,1	79,6	LEO	14,36334528	74,0424	22.01.2016 21:3..
18130	SL-8 R/B	5,16	-246,5	1997	75,5	85,3	LEO	13,76502664	82,9225	22.01.2016 05:1..
18152	COSMOS 1862	8,66	-235,7	1219	61,0	81,6	LEO	15,04786858	82,4945	21.01.2016 20:2..
18214	COSMOS 1869	9,53	-234,3	1149	80,9	81,8	LEO	15,06695826	82,5004	23.01.2016 06:4..
18313	SL-14 R/B	5,26	-246,0	1950	79,4	84,2	LEO	13,841568	82,5569	23.01.2016 20:0..
18421	COSMOS 1892	6,94	-235,2	1117	78,7	89,4	LEO	15,14677955	82,4995	22.01.2016 06:2..
18710	SL-8 R/B	6,92	-245,0	1964	82,7	81,9	LEO	13,76007669	82,9119	23.01.2016 14:1..
18748	COSMOS 1908	8,79	-234,9	1168	79,0	65,6	LEO	15,12609336	82,4732	22.01.2016 05:0..

2016-01-21 09:37:35 | JD: 2457408,90111 | Candidates Survey finished | No Rotor connected | Az: -.-° | El: -.-° | Turning: -.-°/s | -.-°/s | D -.-°

Radio Assistent for Space Communication by DJ5AR Debug-Version

File Extras Settings Help

	Callsign	Locator / 349 km	Gain [dBi]	Power [W]
1	DJ5AR	JN49CV	28	150
2	PI9CAM	JO32ET	48	120

Operating Frequency: 1296300 kHz

NORAD # 28528 RCS [m²] 7,14

```
BREEZE-M DEB [TANK]
1 28528U 05003C   16019.57573343  .00001727  00000-0  40171-3 0  9990
2 28528  49.5441 353.2067 5181970  82.9257 330.8470  5.30591194206611
```

Reload TLE Reinit TLE

Designator	Epoch Time	Inclination	RAAN	Delta RAAN	Excentricity	ArgOfPerigee	MA	MM	Type	Source
2005-003C	2016-01-19 13:49	49,54	353,21	-1,83	0,5181970	82,93	330,85	5,31	MEO	CelesTrack

Tracking | Window Analyzer | Window Finder | Candidates | Extras

BREEZE-M DEB [TANK]

Start Date: 2016-01-21 19:00 Now + 2 hours Limit for Unit Budget: -240 select all from Candidates 535 checked: 29 Windows

Find Windows

NORAD	Name	RCS	Open	Close	Unit Budget	Budget 1	Budget 2	min. Height	min. Slant Ranges	max. EL 1	max. EL 2
38341	H-2A R/B	18,6	2016-01-21 19:15	2016-01-21 19:27	-236.6	-141.8	-140.8	591.8	1555.6	47.5	51.1
12465	SL-3 R/B	5,7	2016-01-21 19:23	2016-01-21 19:34	-236.5	-141.8	-140.8	532.2	1153.4	75.5 (N)	74.7 (N)
28931	ALOS (DAICHI)	12,9	2016-01-21 19:35	2016-01-21 19:48	-239.5	-144.7	-143.7	685.5	1677.1	53.1	57.2
33500	H-2A R/B	15,6	2016-01-21 19:45	2016-01-21 19:58	-239.2	-144.4	-143.5	634.8	1736.3	39.2 (N)	53.1 (N)
38249	PSLV R/B	6,15	2016-01-21 19:51	2016-01-21 20:00	-236.3	-141.6	-140.6	390.8	1162.3	40.5	45.6
19046	SL-3 R/B	6,68	2016-01-21 20:04	2016-01-21 20:16	-239.1	-144.3	-143.3	577.3	1388.0	55.8	59.8
4394	SL-3 R/B	7,39	2016-01-21 20:05	2016-01-21 20:15	-237.7	-142.9	-141.9	471.0	1311.0	43.1	50.0
39186	RESURS P1	7,85	2016-01-21 20:16	2016-01-21 20:25	-239.1	-144.3	-143.3	458.1	1444.1	38.8 (N)	38.2 (N)
13770	COSMOS 1437	7,88	2016-01-21 20:18	2016-01-21 20:28	-239.0	-144.2	-143.3	438.3	1455.5	30.2 (N)	42.6 (N)
28528	BREEZE-M DEB [TANK]	7,14	2016-01-21 20:23	2016-01-21 20:32	-229.9	-135.1	-134.1	313.8	851.9	72.0	38.7
37731	CZ-2C R/B	8,51	2016-01-21 20:31	2016-01-21 20:43	-236.7	-142.0	-141.0	613.0	1288.5	81.6 (N)	81.3 (N)
39679	SL-4 R/B	15,4	2016-01-21 20:31	2016-01-21 20:43	-230.8	-136.0	-135.0	487.8	1060.0	72.7 (N)	61.2
39364	CZ-2C R/B	11	2016-01-21 20:42	2016-01-21 20:52	-235.2	-140.4	-139.4	498.0	1255.3	55.8 (N)	52.8 (N)
36510	SL-24 DEB	8,73	2016-01-21 20:42	2016-01-21 20:55	-239.5	-144.7	-143.7	699.4	1520.6	73.6 (N)	67.9 (N)
21397	OKEAN-3	9,28	2016-01-21 20:45	2016-01-21 20:56	-238.1	-143.3	-142.3	579.2	1420.9	52.2	59.1
38046	ZIYUAN 3 (ZY 3)	5,41	2016-01-21 20:53	2016-01-21 21:04	-238.5	-143.7	-142.7	500.9	1272.2	54.9 (N)	53.4 (N)
25695	SS-18 R/B	10,1	2016-01-21 20:54	2016-01-21 21:07	-235.8	-141.0	-140.0	602.0	1273.8	73.1 (N)	84.7
39450	SL-24 DEB	5,25	2016-01-21 20:58	2016-01-21 21:09	-240.0	-145.2	-144.2	584.7	1374.9	61.2 (N)	59.5 (N)
28813	SL-24 DEB	9,56	2016-01-21 21:00	2016-01-21 21:11	-235.9	-141.1	-140.1	533.0	1261.1	61.1 (N)	59.8 (N)
18152	COSMOS 1862	8,66	2016-01-21 21:01	2016-01-21 21:13	-235.8	-141.0	-140.0	554.1	1224.6	61.5 (N)	82.0 (N)
28499	ARIANE 5 R/B	17,3	2016-01-21 21:17	2016-01-21 21:28	-234.3	-139.5	-138.5	567.6	1335.8	58.3	62.6
28499	ARIANE 5 R/B	17,3	2016-01-21 21:17	2016-01-21 21:28	-234.3	-139.5	-138.5	567.6	1335.8	58.3	62.6
39177	COSMOS 2486	18,5	2016-01-21 21:23	2016-01-21 21:36	-237.9	-143.1	-142.1	718.9	1671.0	58.3	61.9

2016-01-21 09:49:06 | JD: 2457408,90910 | Candidates Survey finished | No Rotor connected | Az: -,-° | El: -,-° | Turning: -,-°/s | -,-°/s | D -,-°

Radio Assistent for Space Communication by DJ5AR Debug-Version

File Extras Settings Help

	Callsign	Locator / 349 km	Gain [dBi]	Power [W]
1	DJ5AR	JN49CV	28	150
2	PI9CAM	JO32ET	48	120

Operating Frequency: 1296300 kHz

NORAD # 28528

RCS [m²] 7,14

```
BREEZE-M DEB [TANK]
1 28528U 05003C   16019.57573343  .00001727  00000-0  40171-3 0  9990
2 28528  49.5441 353.2067 5181970  82.9257 330.8470  5.30591194206611
```

Reload TLE Reinit TLE

Designator	Epoch Time	Inclination	RAAN	Delta RAAN	Excentricity	ArgOfPerigee	MA	MM	Type	Source
2005-003C	2016-01-19 13:49	49,54	353,21	-1,83	0,5181970	82,93	330,85	5,31	MEO	CelesTrack

Tracking | Window Analyzer | Window Finder | Candidates | Extras

BREEZE-M DEB [TANK]

Start Date: 2016-01-21 22:33 Now max. unit Budget: **-228.8**

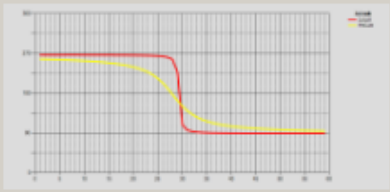
Interval: 10 seconds Zoom: 4 Window opens: **2016-01-21 20:23**

closes: **2016-01-21 20:32**

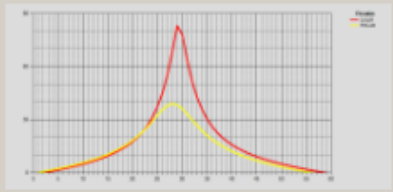
Next Window

Save Track

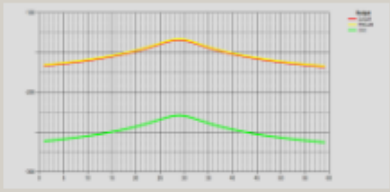
Overview | Azimuth | Elevation | Budget | SlantRange | Doppler | DeltaDoppler | Ground Track | Data



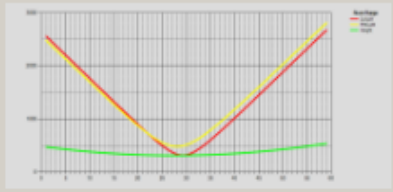
Azimuth



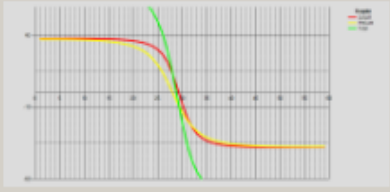
Elevation



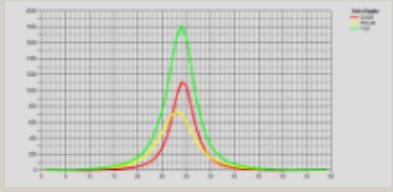
Budgets



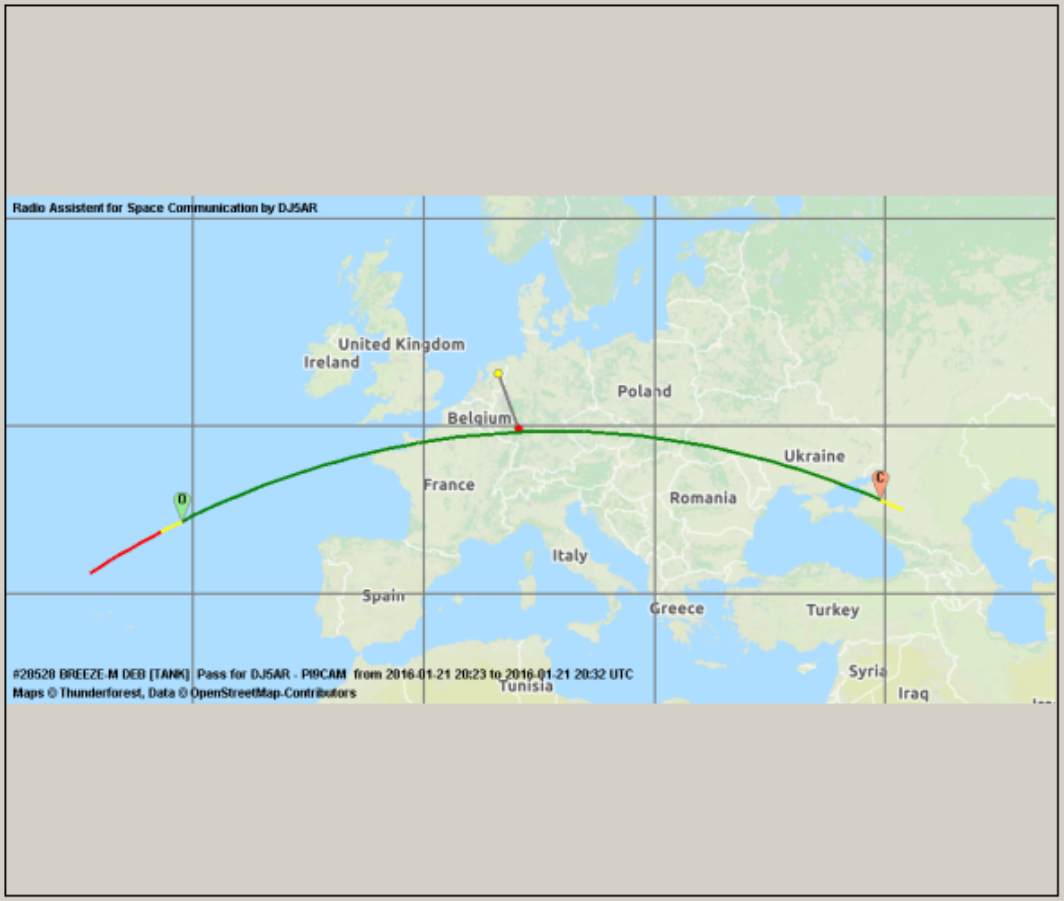
Slant Ranges



Doppler



Delta Doppler



2016-01-21 09:51:22	JD: 2457408,91068	Candidates Survey finished	No Rotor connected	Az: -,-°	El: -,-°	Turning: -,-°/s	-,-°/s	D -,-°

More software

Tracking

- DJ5AR: home made by Andreas
- PI9CAM: home made by PE1RXQ

Doppler control

- DJ5AR: home made by Andreas
- PI9CAM: SatPC32 controlled TS2000X

Dwingeloo console in

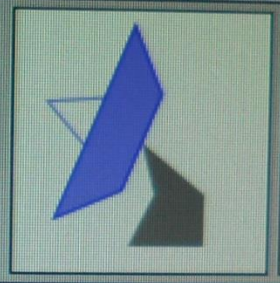
Dwingeloo console interface | Dwingeloo Mech console inte... | NORAD Catalog Number 17535

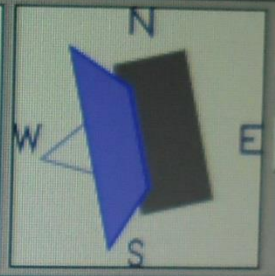
host

Position: 78.0563

Position: 23.4781

Position: 0.72





Enable

Enable

horized: console/sattracker

setpoint generator

t TLE:
1 17535U 87020A 14032.25249969 .00000017 00000-0 25358-3 0 5804
2 17535 73.6054 345.5825 0029273 236.5719 228.8042 12.41294723221305

TLE:
1 17535U 87020A 14032.25249969 .00000017 00000-0 25358-3 0 5804
2 17535 73.6054 345.5825 0029273 236.5719 228.8042 12.41294723221305

Actions:

Set new TLE

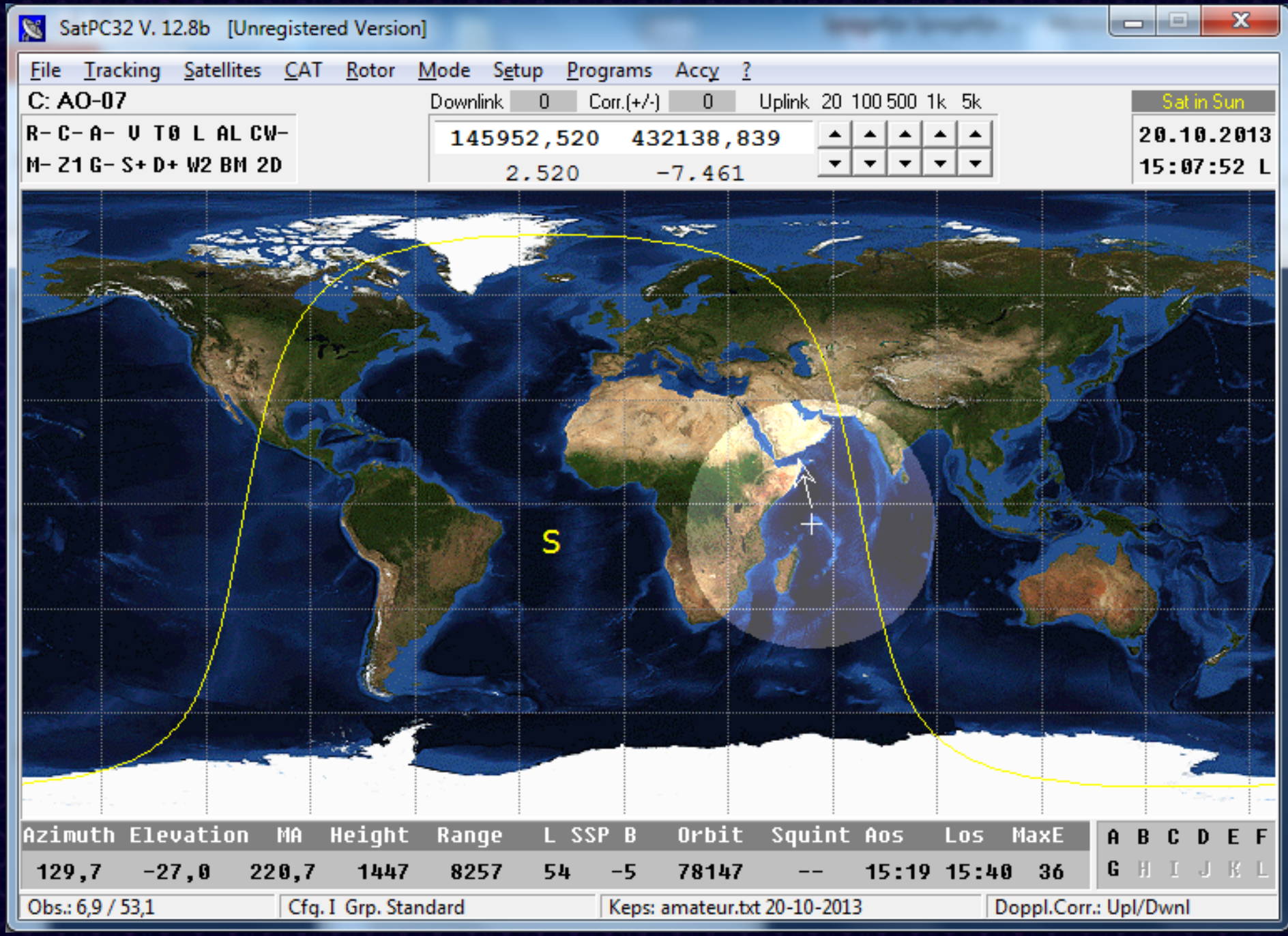
Offset

Current Offset:

Set

Set

Set


SatPC32 V. 12.8b [Unregistered Version]
File Tracking Satellites CAT Rotor Mode Setup Programs Accy ?
C: AO-07
R- C- A- V T0 L AL CW-
M- Z1 G- S+ D+ W2 BM 2D
Downlink 0 Corr.(+/-) 0 Uplink 20 100 500 1k 5k
145952,520 432138,839
2.520 -7.461
Sat in Sun
20.10.2013
15:07:52 L
S
Azimuth Elevation MA Height Range L SSP B Orbit Squint Aos Los MaxE
129,7 -27,0 220,7 1447 8257 54 -5 78147 -- 15:19 15:40 36
A B C D E F
G H I J K L
Obs.: 6,9 / 53,1
Cfg. I Grp. Standard
Keps: amateur.txt 20-10-2013
Doppl.Corr.: Upl/Dwnl

The long road to a QSO

We started trying and we learned a lot…

- Some sats give nice reflections some don’t
- Some sats tumble
- The same sat sometimes reflects fine, sometimes not
- PI9CAM can track up to approx. 45 deg. elevation
- Fading is too deep for random timing
- Signals are often too weak for CW
- Time window is too short for 1 min or 30 sec periods

- How to solve the problems?

What can be changed?

- Not the sats…
- Not the speed of PI9CAM…

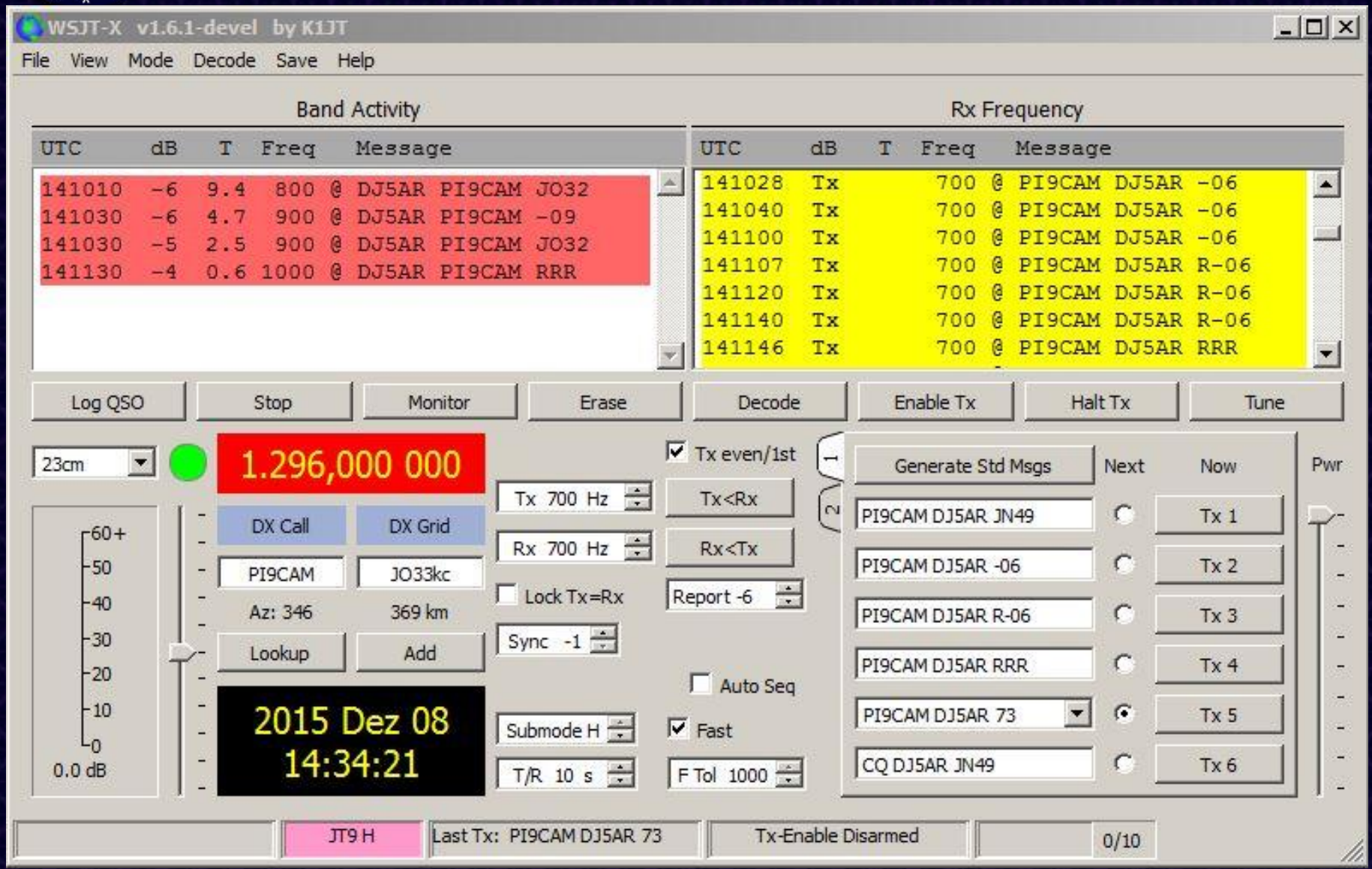
- We need timed RX/TX periods
- We need short RX/TX periods

- WSJT-X is the solution!
- JT9H using 10 second RX/TX periods

All tests between DJ5AR and PI9CAM

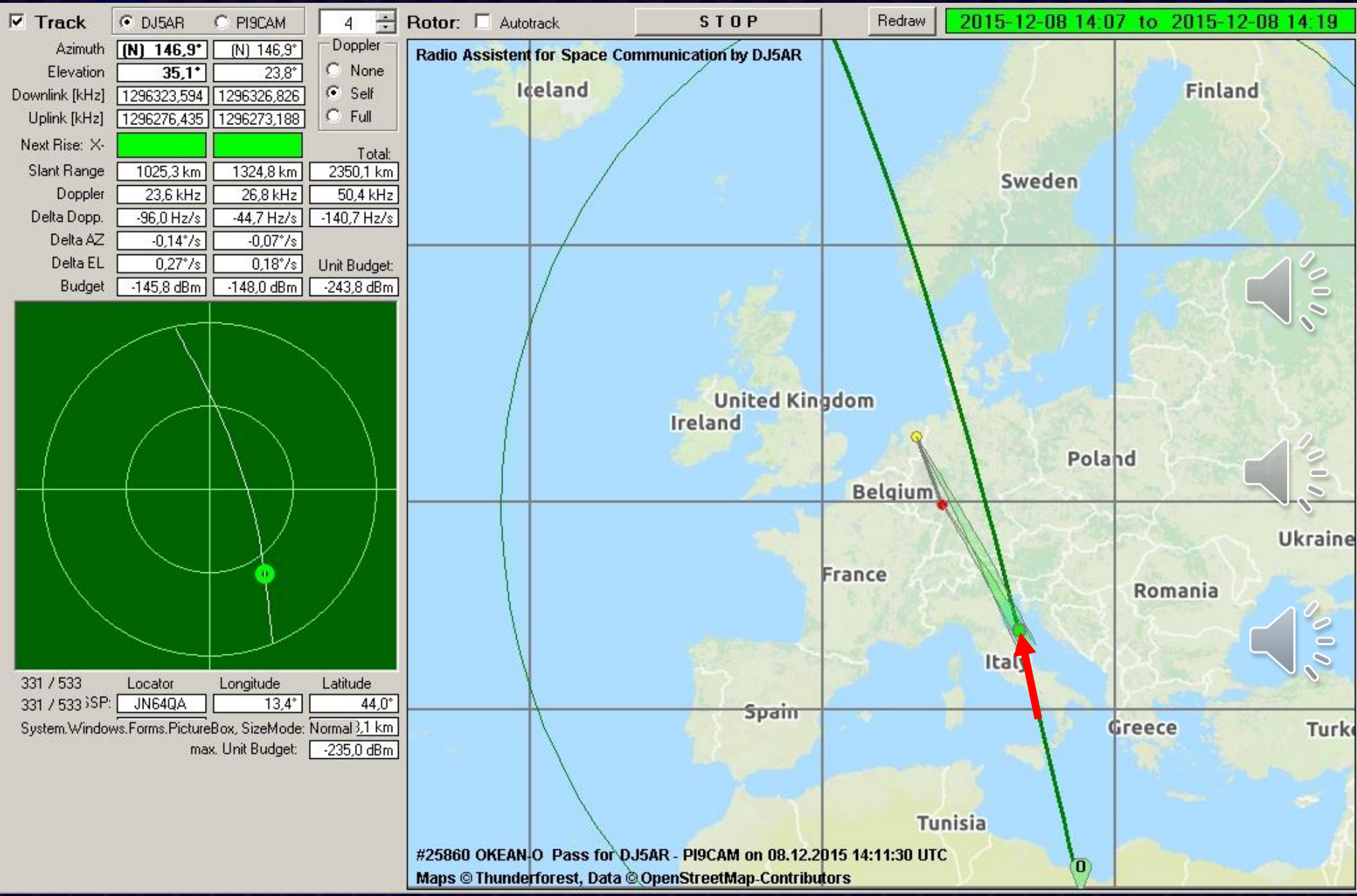
2	February	2014
22	March	2015
7	April	2015
25	April	2015
30	April	2015
9	June	2015
28	July	2015
27	October	2015
17	November	2015
8	December	2015

8 December 2015: QSO completed!!!



And the winner is…..

OKEAN-O


Track
DJ5AR
PI9CAM
4
Rotor:
Autotrack
STOP
Redraw
2015-12-08 14:07 to 2015-12-08 14:19
Azimuth
(N) 146,9°
(N) 146,9°
Elevation
35,1°
23,8°
Downlink [kHz]
1296323,594
1296326,826
Uplink [kHz]
1296276,435
1296273,188
Doppler
None
Self
Full
Next Rise: X-
Total:
Slant Range
1025,3 km
1324,8 km
2350,1 km
Doppler
23,6 kHz
26,8 kHz
50,4 kHz
Delta Dopp.
-96,0 Hz/s
-44,7 Hz/s
-140,7 Hz/s
Delta AZ
-0,14°/s
-0,07°/s
Delta EL
0,27°/s
0,18°/s
Unit Budget:
Budget
-145,8 dBm
-148,0 dBm
-243,8 dBm
331 / 533
Locator
Longitude
Latitude
331 / 533 SP:
JN64QA
13,4°
44,0°
System.Windows.Forms.PictureBox, SizeMode: Normal
3,1 km
max. Unit Budget:
-235,0 dBm
Radio Assistent for Space Communication by DJ5AR
Iceland
Finland
Sweden
United Kingdom
Ireland
Poland
Belgium
Ukraine
France
Romania
Italy
Spain
Greece
Turkey
Tunisia
#25860 OKEAN-O Pass for DJ5AR - PI9CAM on 08.12.2015 14:11:30 UTC
Maps © Thunderforest, Data © OpenStreetMap-Contributors

Mission accomplished!

- What will be our next challenge ?
- We hope to tell you in 2018 ☺