RFI Measurements and Monitoring at “Quasar” Network Observatories.

Gennadii Ilin, Alexey Tsaruk, Sergey Grenkov.
Institute of Applied Astronomy of RAS

Contents

RFI Monitoring

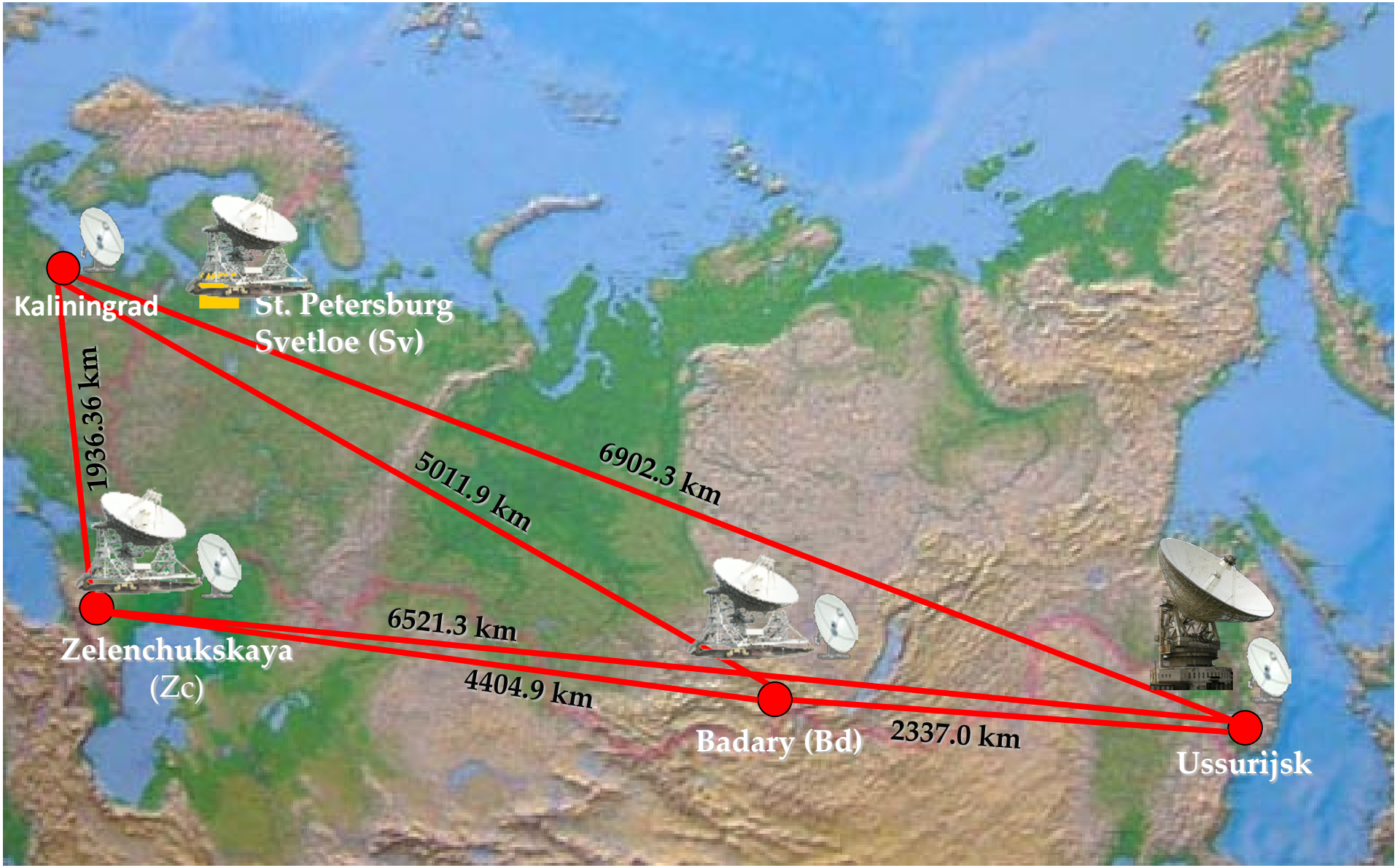
RFI types

Interaction with the state RF spectrum regulation services (state and local)

RFI and Wideband spectrum analyzer

New generation Russian VLBI network

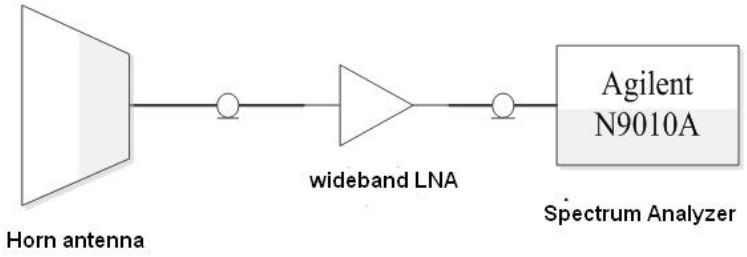
(proposed location)

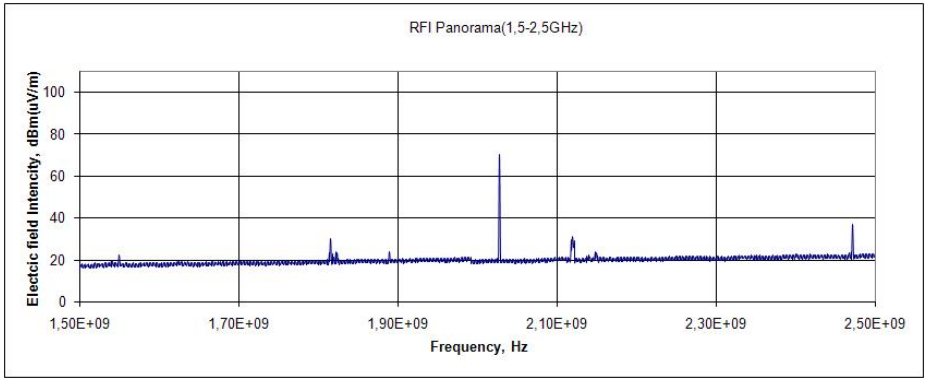


RFI Monitoring

Wavelength, cm	Frequency band	Bandwidth, GHz	LO freq. GHz	IF Bandwidth, MHz
18—21	L	1.38—1.72	1.26	130—470
13	S	2.15—2.50	2.02	130—480
6.2	C	4.60—5.10	4.50	100—600
3.5	X	8.18—9.08	8.08	100—1000
1.35	K	22.02—22.52	21.92	100—600

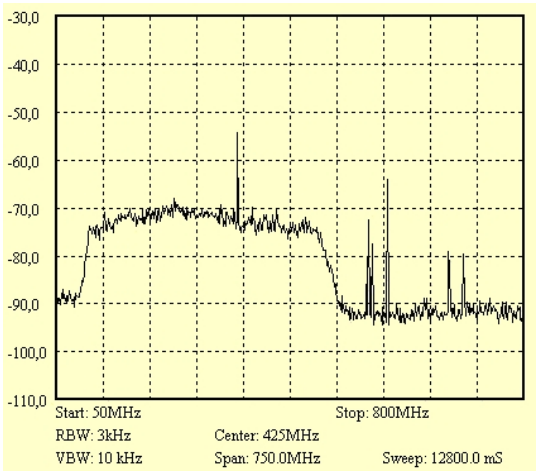
Wideband RFI Measurement



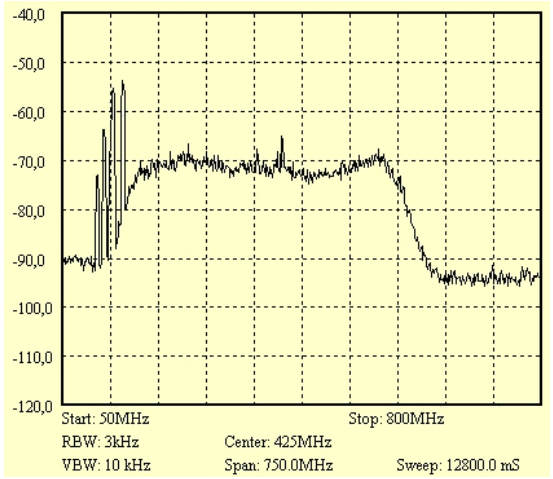


RFI Monitoring

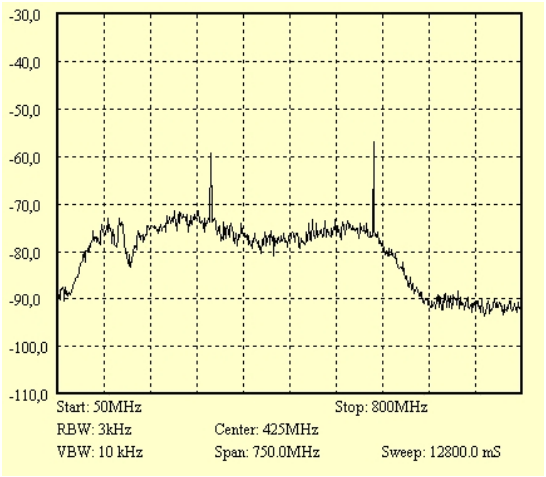
RFI Measurement in receiver IF bands. Made regular, 4 times a year.



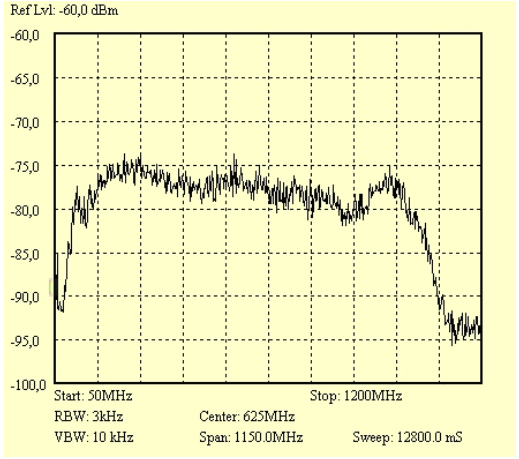
L-band



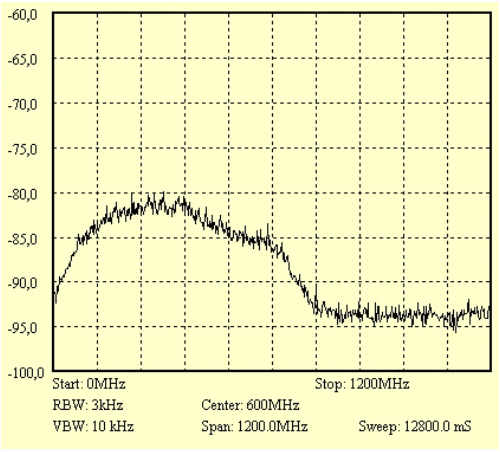
S-band



C-band



X-band

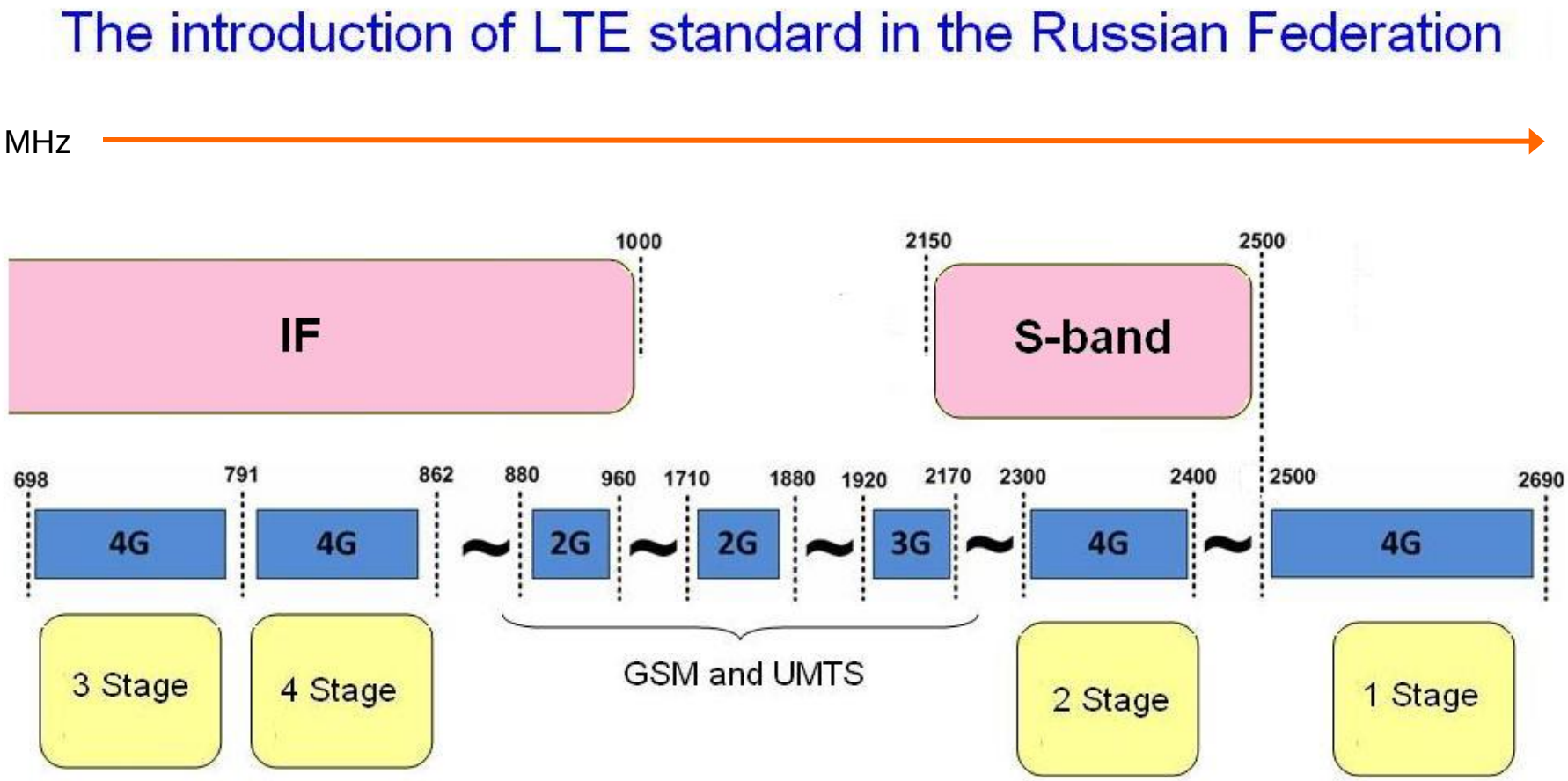


K-band

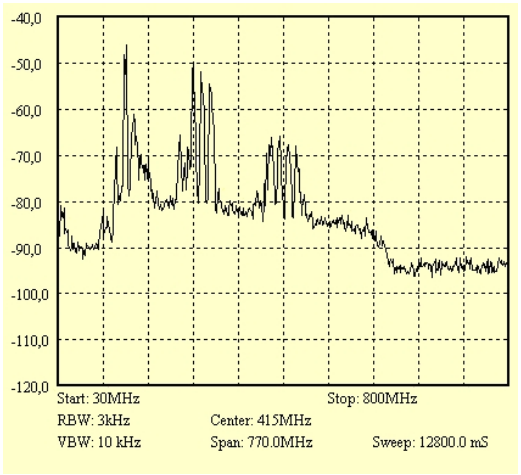
RFI types

RFI	Source	Input frequency, MHz	Level, over system noise, dBm	Notes
L - band	Radionavigational satellite (GLONASS L1, GPS L1)	1598,0625-1608,75 1575,42	25-30	Maximum value
	Mobile (GSM)	1710-1720	25	Azimuth depended
S - band	Mobile (UMTS)	2134-2139	1-5	high-pass filter added
	Fixed service , MW oven (Svetloe only)	2400-2500	15	Direction on resort, 2km distance
C - band	Spurious harmonics PLL	4800, 4900	30	Will be removed after PLL upgrade
	DORIS (Badary only)	401,2510	10	
X - band	Clear			
K - band	Clear			

RFI types


The introduction of LTE standard in the Russian Federation
MHz
1000
2150
2500
IF
S-band
698
791
862
880
960
1710
1880
1920
2170
2300
2400
2500
2690
4G
4G
2G
2G
3G
4G
4G
3 Stage
4 Stage
GSM and UMTS
2 Stage
1 Stage

Interaction with the state RF spectrum regulation services

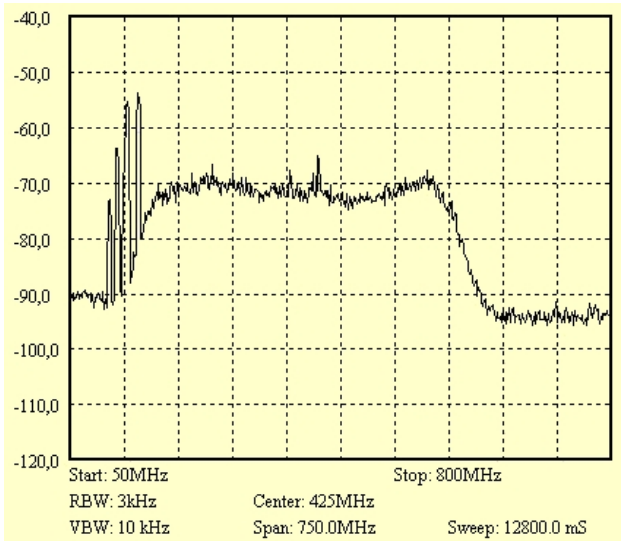


Information about EMC problems at “Quasar” Observatory

ROSCOMNADZOR

The General Radio Frequency Centre

An expertise of the radio electronic facilities and their EMC. RFI level control and recovery EMC



Interaction with the state RF spectrum regulation services

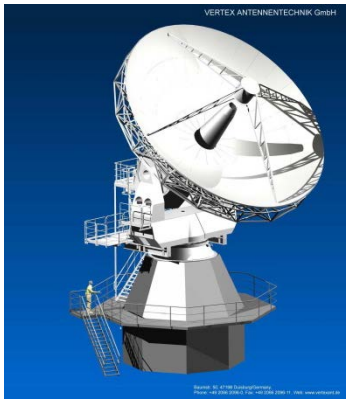
Megafon			Tele2			Beeline			MTS		
№	Downlink freq.	Uplink freq.	№	Downlink freq.	Uplink freq.	№	Downlink freq.	Uplink freq.	№	Downlink freq.	Uplink freq.
1	935,2	890,2	512	1805,2	1710,2	636	1830	1735	760	1854,8	1759,8
2	935,4	890,4	513	1805,4	1710,4	637	1830,2	1735,2	761	1855	1760
3	935,6	890,6	514	1805,6	1710,6	638	1830,4	1735,4	762	1855,2	1760,2
4	935,8	890,8	515	1805,8	1710,8	639	1830,6	1735,6	763	1855,4	1760,4
5	936	891	516	1806	1711	640	1830,8	1735,8	764	1855,6	1760,6
6	936,2	891,2	517	1806,2	1711,2	641	1831	1736	765	1855,8	1760,8
7	936,4	891,4	518	1806,4	1711,4	642	1831,2	1736,2	766	1856	1761
8	936,6	891,6	519	1806,6	1711,6	643	1831,4	1736,4	767	1856,2	1761,2
9	936,8	891,8	520	1806,8	1711,8	644	1831,6	1736,6	768	1856,4	1761,4
10	937	892	521	1807	1712	645	1831,8	1736,8	769	1856,6	1761,6
11	937,2	892,2	522	1807,2	1712,2	646	1832	1737	770	1856,8	1761,8
12	937,4	892,4	523	1807,4	1712,4	647	1832,2	1737,2	771	1857	1762
13	937,6	892,6	524	1807,6	1712,6	648	1832,4	1737,4	772	1857,2	1762,2
14	937,8	892,8	525	1807,8	1712,8	649	1832,6	1737,6	773	1857,4	1762,4
15	938	893	526	1808	1713	650	1832,8	1737,8	774	1857,6	1762,6
16	938,2	893,2	527	1808,2	1713,2	651	1833	1738	775	1857,8	1762,8
17	938,4	893,4	528	1808,4	1713,4	652	1833,2	1738,2	776	1858	1763
18	938,6	893,6	529	1808,6	1713,6	653	1833,4	1738,4	777	1858,2	1763,2
19	938,8	893,8	530	1808,8	1713,8	654	1833,6	1738,6	778	1858,4	1763,4
20	939	894	531	1809	1714	655	1833,8	1738,8	779	1858,6	1763,6
21	939,2	894,2	532	1809,2	1714,2	656	1834	1739	780	1858,8	1763,8
22	939,4	894,4	533	1809,4	1714,4	657	1834,2	1739,2	781	1859	1764
23	939,6	894,6	534	1809,6	1714,6	658	1834,4	1739,4	782	1859,2	1764,2
24	939,8	894,8	535	1809,8	1714,8	659	1834,6	1739,6	783	1859,4	1764,4
25	940	895	536	1810	1715	660	1834,8	1739,8	784	1859,6	1764,6
26	940,2	895,2	537	1810,2	1715,2	661	1835	1740	785	1859,8	1764,8
27	940,4	895,4	538	1810,4	1715,4	662	1835,2	1740,2	786	1860	1765
28	940,6	895,6	539	1810,6	1715,6	663	1835,4	1740,4	787	1860,2	1765,2
29	940,8	895,8	540	1810,8	1715,8	664	1835,6	1740,6	788	1860,4	1765,4
30	941	896	541	1811	1716	665	1835,8	1740,8	789	1860,6	1765,6
31	941,2	896,2	542	1811,2	1716,2	666	1836	1741	790	1860,8	1765,8
32	941,4	896,4	543	1811,4	1716,4	667	1836,2	1741,2	791	1861	1766
33	941,6	896,6	544	1811,6	1716,6	668	1836,4	1741,4	792	1861,2	1766,2
34	941,8	896,8	545	1811,8	1716,8	669	1836,6	1741,6	793	1861,4	1766,4
35	942	897	546	1812	1717	670	1836,8	1741,8	794	1861,6	1766,6
36	942,2	897,2	547	1812,2	1717,2	671	1837	1742	795	1861,8	1766,8
37	942,4	897,4	548	1812,4	1717,4	672	1837,2	1742,2	796	1862	1767
38	942,6	897,6	549	1812,6	1717,6	673	1837,4	1742,4	797	1862,2	1767,2
39	942,8	897,8	550	1812,8	1717,8	674	1837,6	1742,6	798	1862,4	1767,4
40	943	898	551	1813	1718	675	1837,8	1742,8	799	1862,6	1767,6
41	943,2	898,2	552	1813,2	1718,2	676	1838	1743	800	1862,8	1767,8
42	943,4	898,4	553	1813,4	1718,4	677	1838,2	1743,2	801	1863	1768
43	943,6	898,6	554	1813,6	1718,6	678	1838,4	1743,4	802	1863,2	1768,2
44	943,8	898,8	555	1813,8	1718,8	679	1838,6	1743,6	803	1863,4	1768,4
45	944	899	556	1814	1719	680	1838,8	1743,8	804	1863,6	1768,6
46	944,2	899,2	557	1814,2	1719,2	681	1839	1744	805	1863,8	1768,8
47	944,4	899,4	558	1814,4	1719,4	682	1839,2	1744,2	806	1864	1769
48	944,6	899,6	559	1814,6	1719,6	683	1839,4	1744,4	807	1864,2	1769,2
49	944,8	899,8	560	1814,8	1719,8	684	1839,6	1744,6	808	1864,4	1769,4
50	945	900	561	1815	1720	685	1839,8	1744,8	809	1864,6	1769,6
51	945,2	900,2	562	1815,2	1720,2	686	1840	1745	810	1864,8	1769,8
52	945,4	900,4	563	1815,4	1720,4	687	1840,2	1745,2	811	1865	1770
53	945,6	900,6	564	1815,6	1720,6	688	1840,4	1745,4	812	1865,2	1770,2
54	945,8	900,8	565	1815,8	1720,8	689	1840,6	1745,6	813	1865,4	1770,4
55	946	901	566	1816	1721	690	1840,8	1745,8	814	1865,6	1770,6
56	946,2	901,2	567	1816,2	1721,2	691	1841	1746	815	1865,8	1770,8
57	946,4	901,4	568	1816,4	1721,4	692	1841,2	1746,2	816	1866	1771
58	946,6	901,6	569	1816,6	1721,6	693	1841,4	1746,4	817	1866,2	1771,2
59	946,8	901,8	570	1816,8	1721,8	694	1841,6	1746,6	818	1866,4	1771,4
60	947	902	571	1817	1722	695	1841,8	1746,8	819	1866,6	1771,6
61	947,2	902,2	572	1817,2	1722,2	696	1842	1747	820	1866,8	1771,8
62	947,4	902,4	573	1817,4	1722,4	697	1842,2	1747,2	821	1867	1772
63	947,6	902,6	574	1817,6	1722,6	698	1842,4	1747,4	822	1867,2	1772,2
64	947,8	902,8	575	1817,8	1722,8	699	1842,6	1747,6	823	1867,4	1772,4
65	948	903	576	1818	1723	700	1842,8	1747,8	824	1867,6	1772,6

Frequency distribution of mobile operators in Svetloe Observatory

L-band frequency

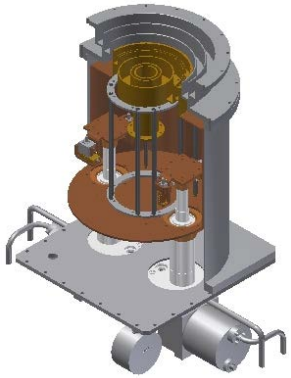
The Radio Frequency Centre of the North-West Federal Area decided to disable the mobile operators in the range of 1710-1720 MHz because of EMC violation with the radio telescope RT-32-01 of “Quasar” Network

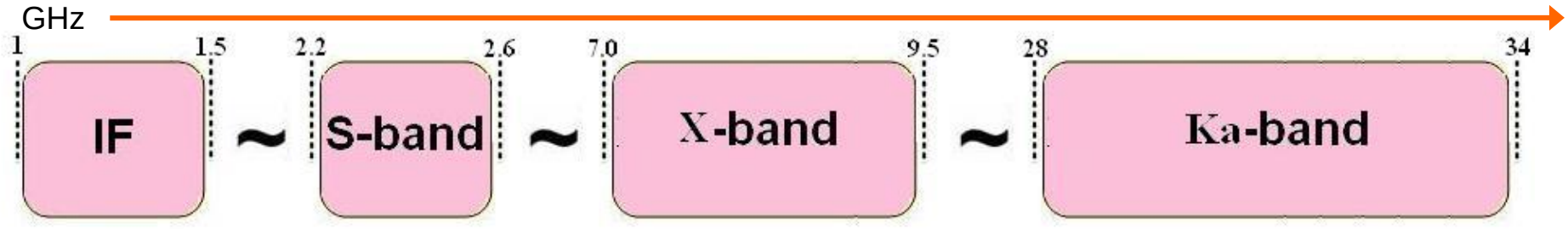
Receiver frequency bands for the new generation VLBI network.



Vertex antenna (Twin type)

Construction in Badary and Zelenchukskaya is started





Status: Doc's sent for registration to the State Radio Frequency Comission

Wideband spectrum analyzer

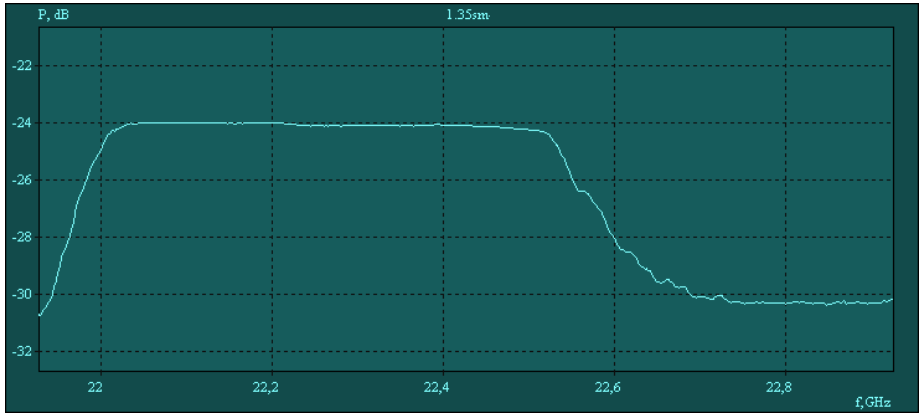
FFT technique is tested for implementation into the wideband registration system (VLBI2010)
This system consists of a broadband spectrum computation module that connects to the computer with the software.

The spectrally selective system of registration allows to do:
- **Measurement of receiving and amplifying channel;**
- **Radiometry in the continuum;**
- **Registration of radio emission in the spectral lines;**
- **Registration of radio interference.**

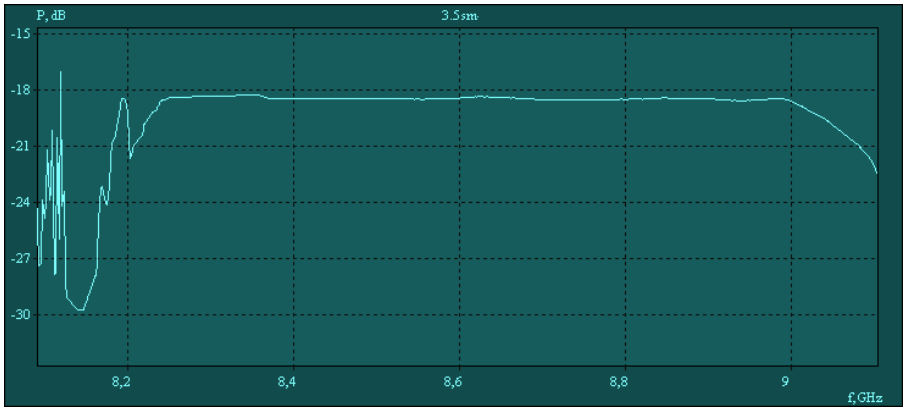
The spectrum computation module was built using ultra-fast wideband ADC, demultiplexer and FPGA with configuration which allows to calculate (using Fast Fourier Transform (FFT)), collect and transmit to the computer averaged spectrums.

Characteristics of the developed module:
- **Number of channels: 1 or 2;**
- **Input bandwidth, MHz: 1024, 512, 256**
- **The number of spectral channels (FFT points): 1024**
- **Spectral resolution, MHz: 1, 0.5, 0.25**
- **Supports both the modulation and full power mode;**
- **Integrating time, s: 0.5 - 1800**

Wideband analyzer

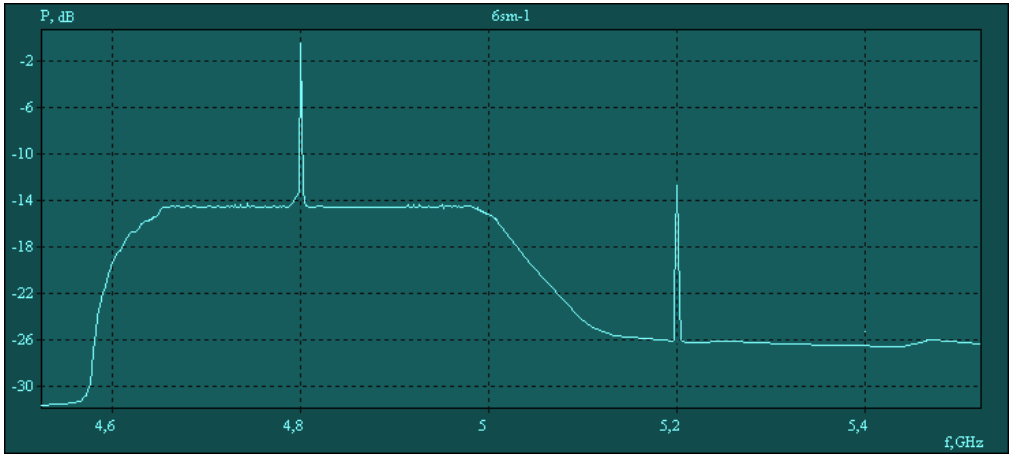


K-band



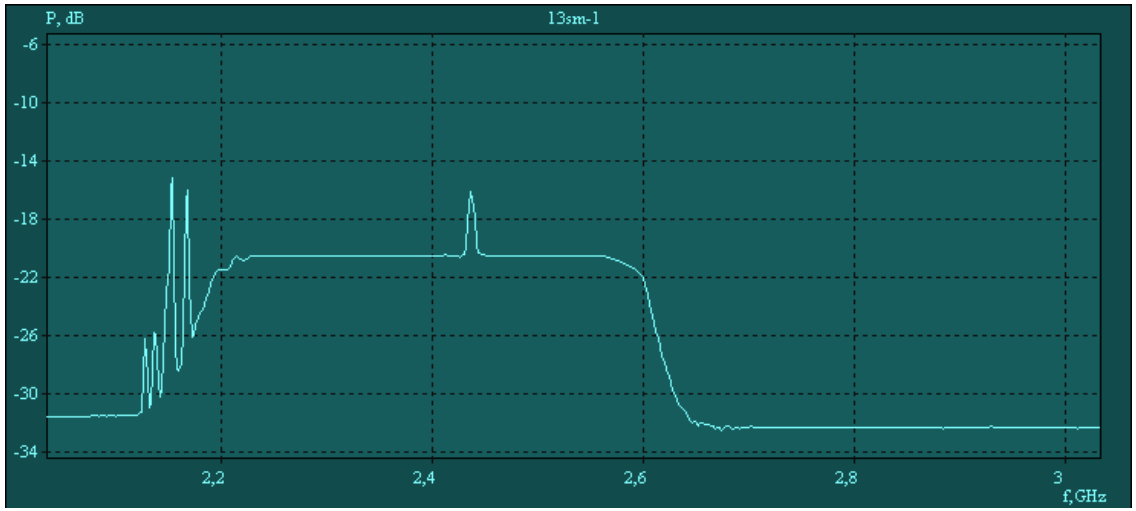
X-band

Δf=1GHz



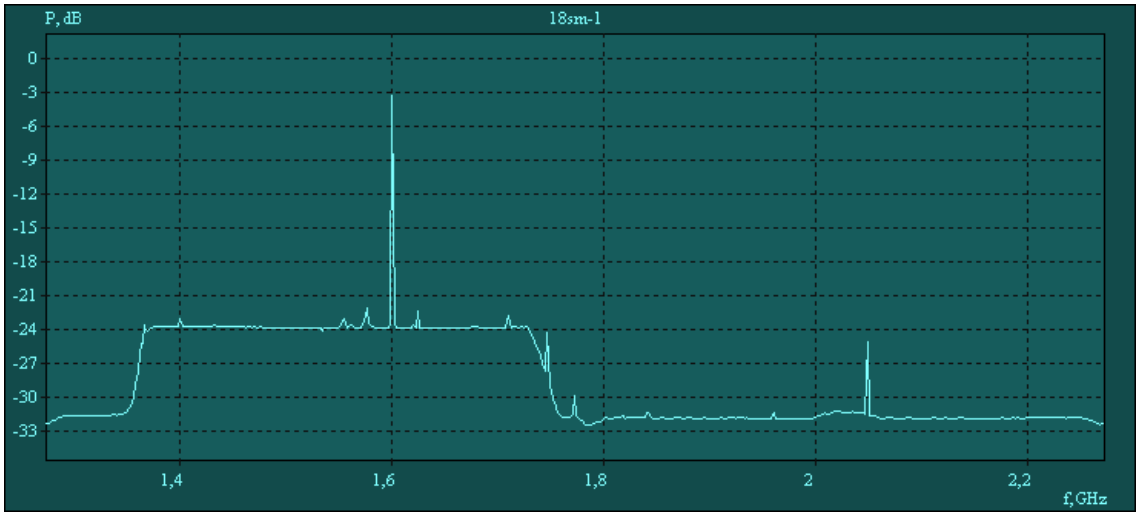
C-band

Wideband analyzer



S-band

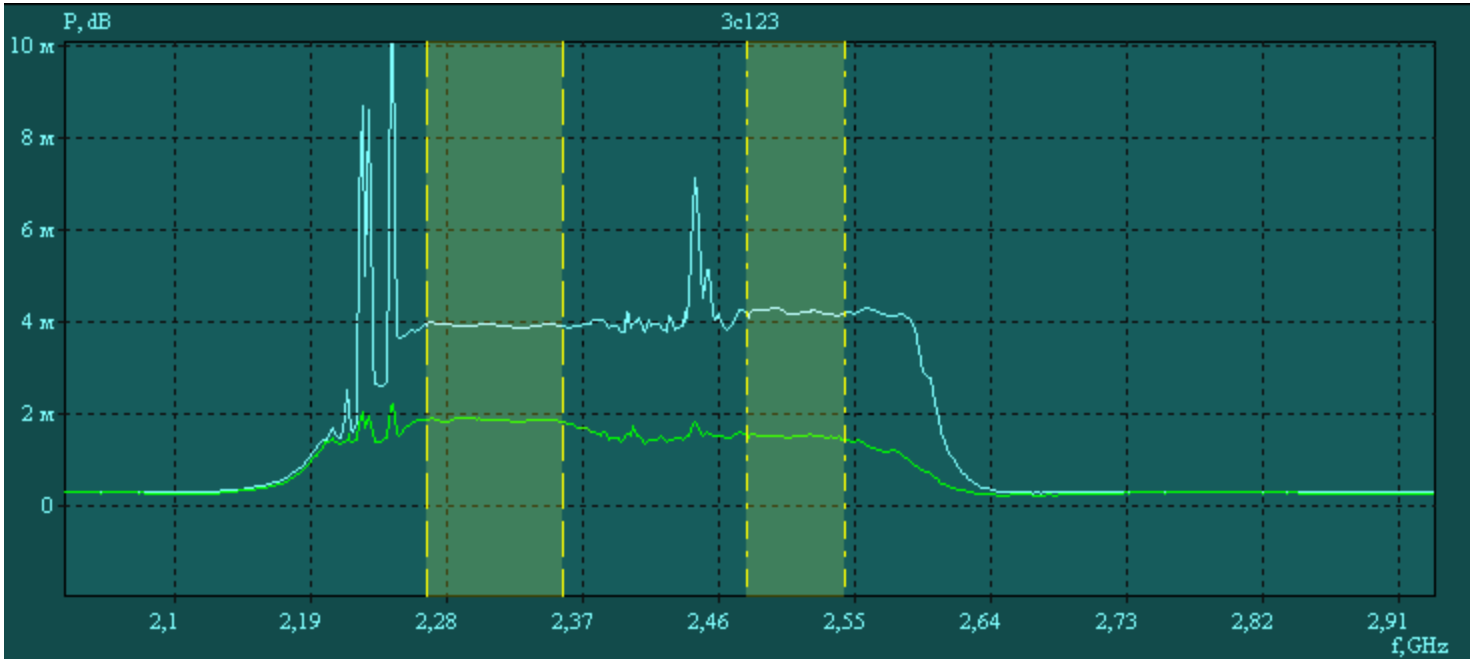
Δf=1GHz



L-band

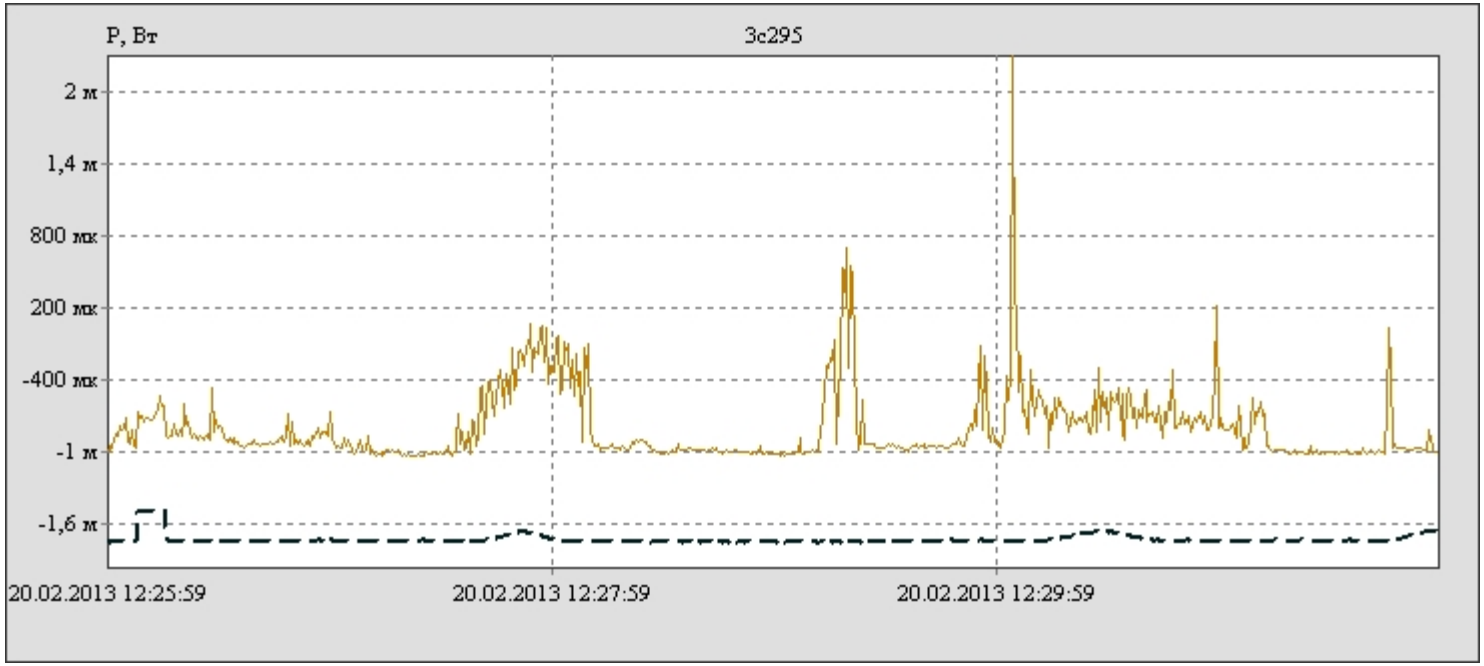
Wideband analyzer

RFI Selection



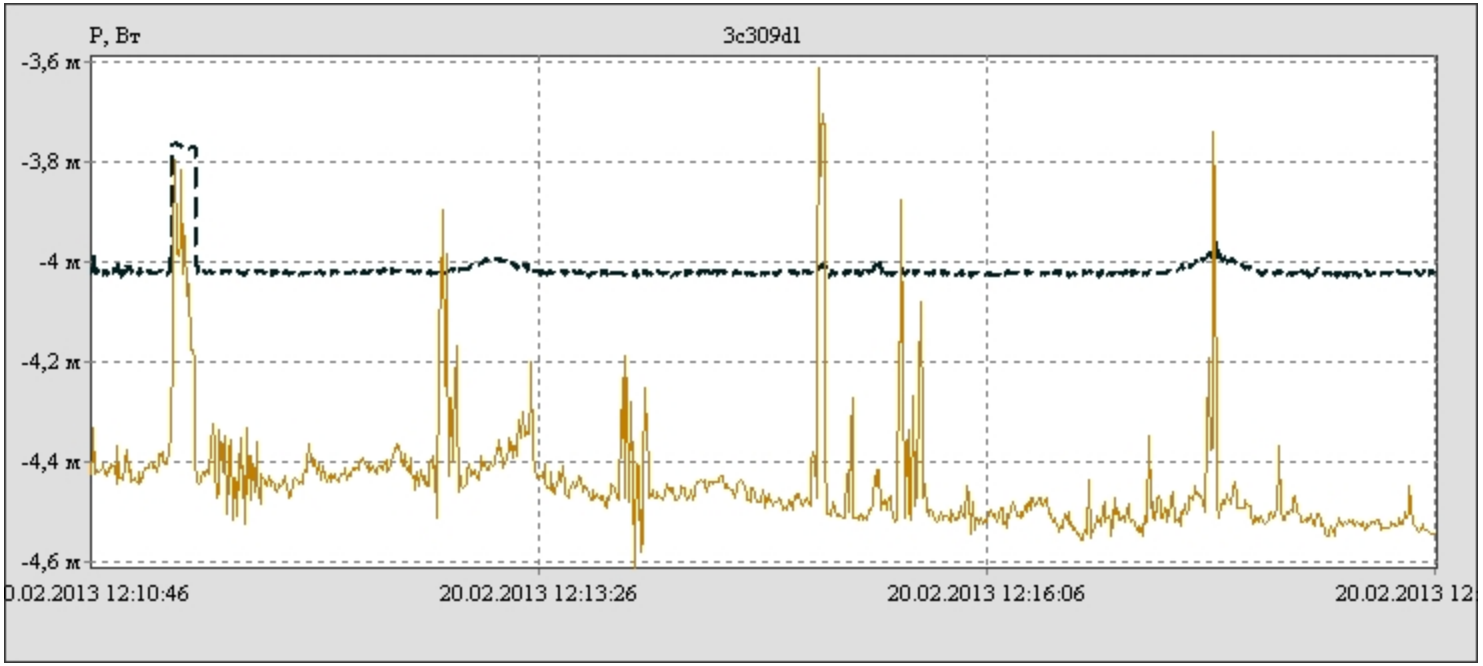
Wideband analyzer

Source	Frequency band	Date and Time	Azimuth and elevation	Flux, Jy	T, K	Δ*f*, MHz without RF	Integration time, s	Ts min calc, K	Ts min meas, K
3c295	L	20.02.13 12:33:12	342; 24.7	20.49	3.57	112	0.5	0.054	0.059



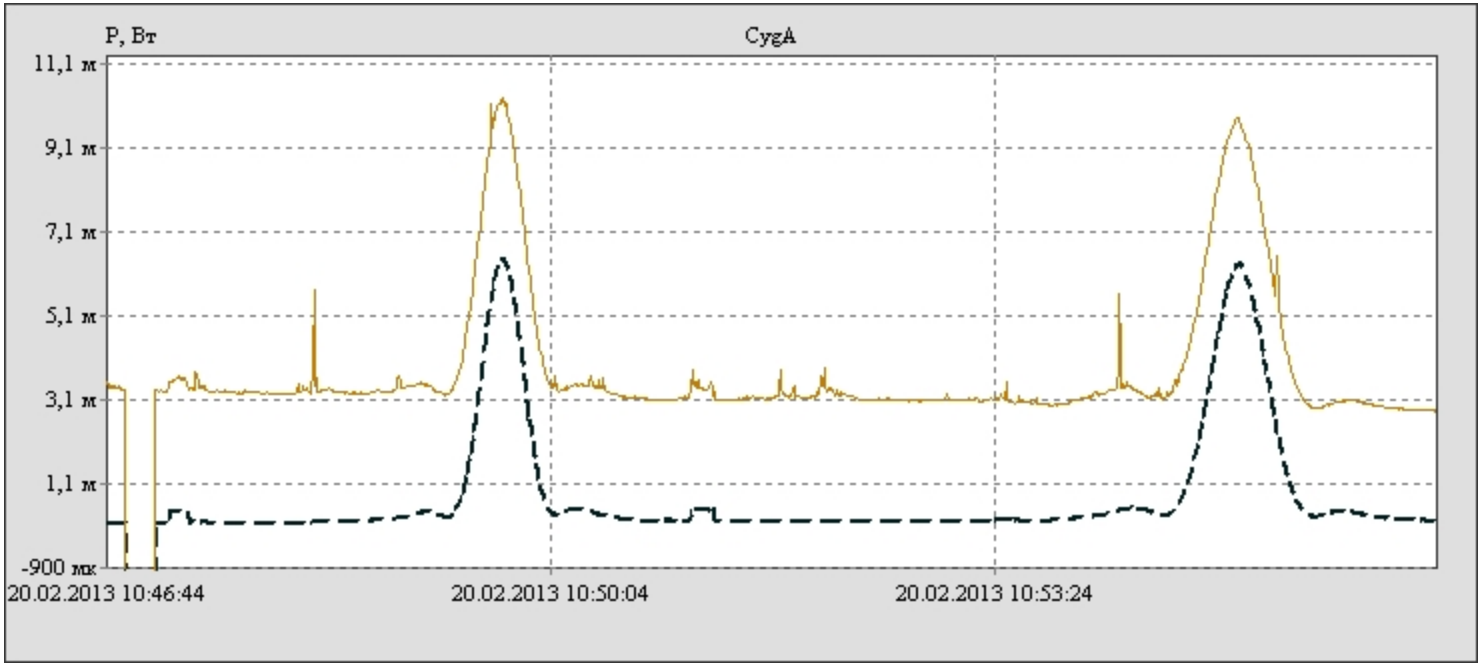
Wideband analyzer

Source	Frequency band	Date and Time	Azimuth and elevation	Flux, Jy	T, K	Δ*f*, MHz without RF	Integration time, s	Ts min calc, K	Ts min meas, K
3c309'1	L	20.02.13 12:18:02	342.2; 45.3	6.97	1.217	52	0.5	0.119	0.129

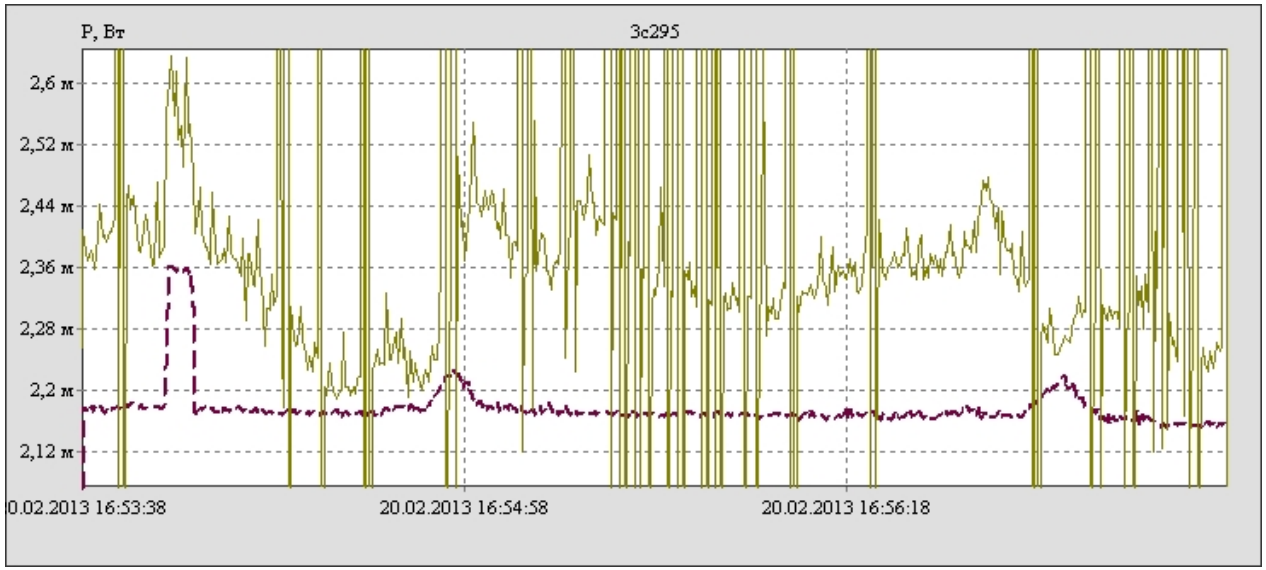


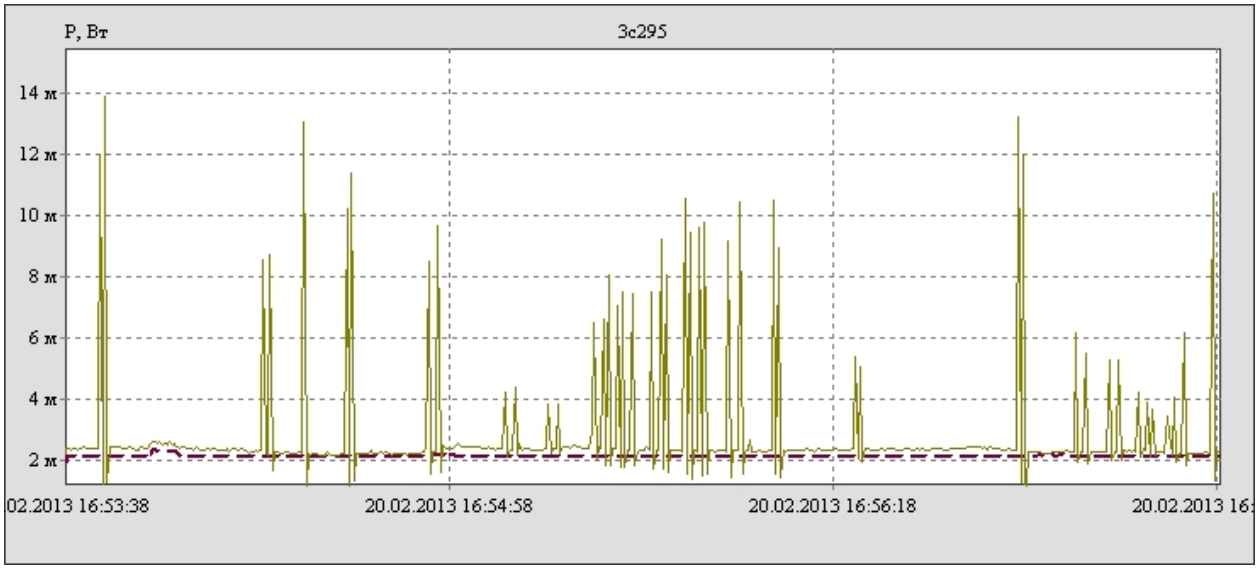
Wideband analyzer

Source	Frequency band	Date and Time	Azimuth and elevation	Flux, Jy	T, K	Δ*f*, MHz without RF	Integration time, s	Ts min calc, K	Ts min meas, K
CygA	L	20.02.13 10:56:04	249.7; 58.4	1600	279.4	250	0.5	0.057	0.058



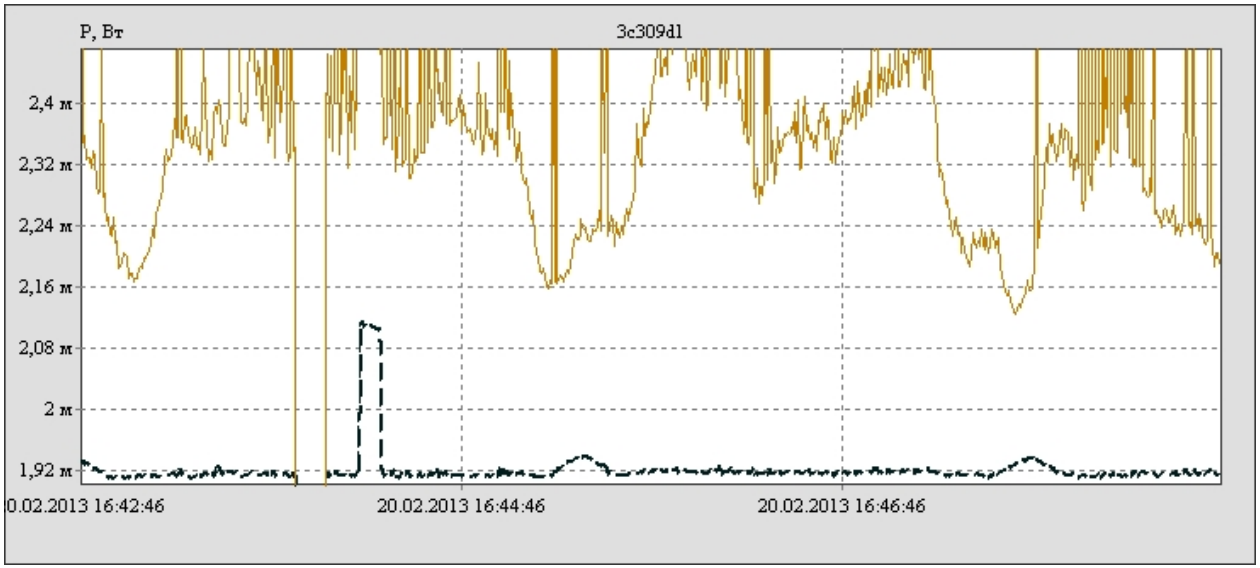
Wideband analyzer

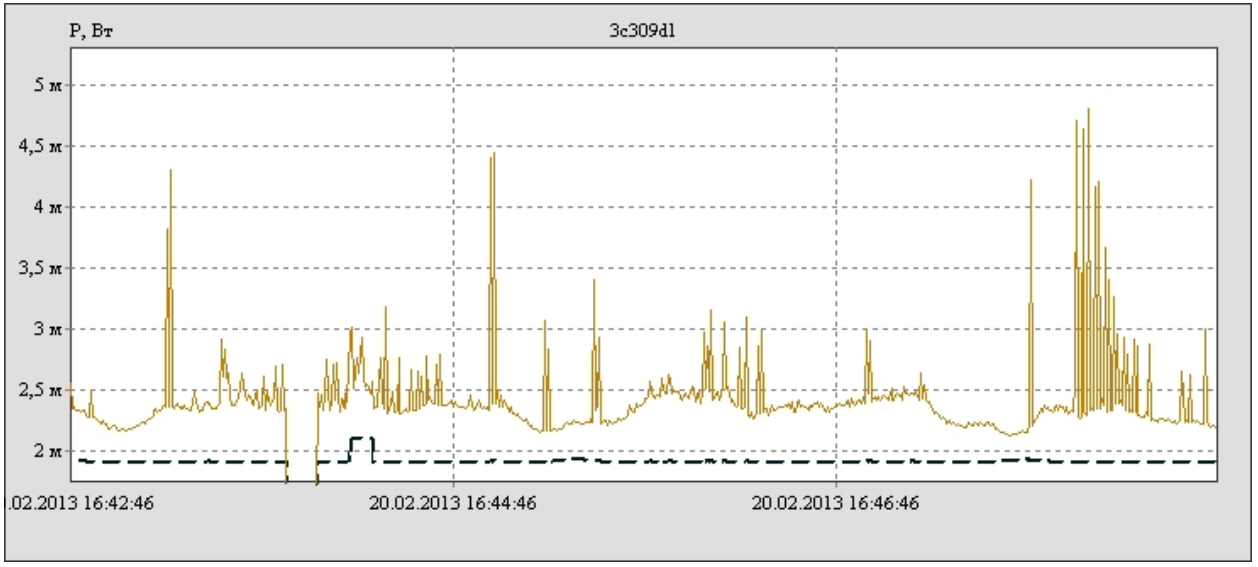




Source	3c295
Frequency band	S
Date and Time	20.02.13 16:55:14
Azimuth and elevation	25.9; 27.1
Flux, Jy	13.9
T, K	1.944
Δ*f*, MHz without RFI	28
Integration time, s	0.5
Ts min calc, K	0.126
Ts min meas, K	0.133

Wideband analyzer





Source	3c309'1
Frequency band	S
Date and Time	20.02.13 16:48:10
Azimuth and elevation	10.6; 43.3
Flux, Jy	5.22
T, K	0.733
Δ*f*, MHz without RFI	126
Integration time, s	0.5
Ts min calc, K	0.056
Ts min meas, K	0.061

Conclusion

At the moment, the most effective method to protect and save current RFI level at “Quasar” Network Observatories:

- Active interaction with the local state RF spectrum regulation services for regulation EMC problems.
- In perspective: RFI selection with digital data registration system.

Thank you for attention!