



Latvian radio astronomy – from the idea of a national radio interferometer to being part of radio interferometry network

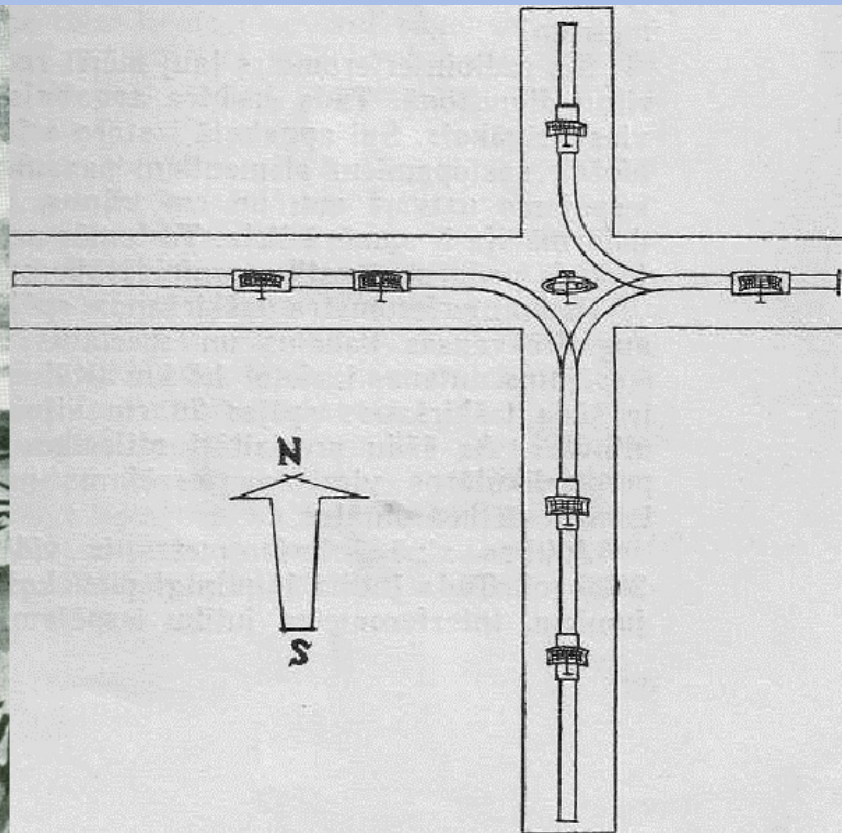
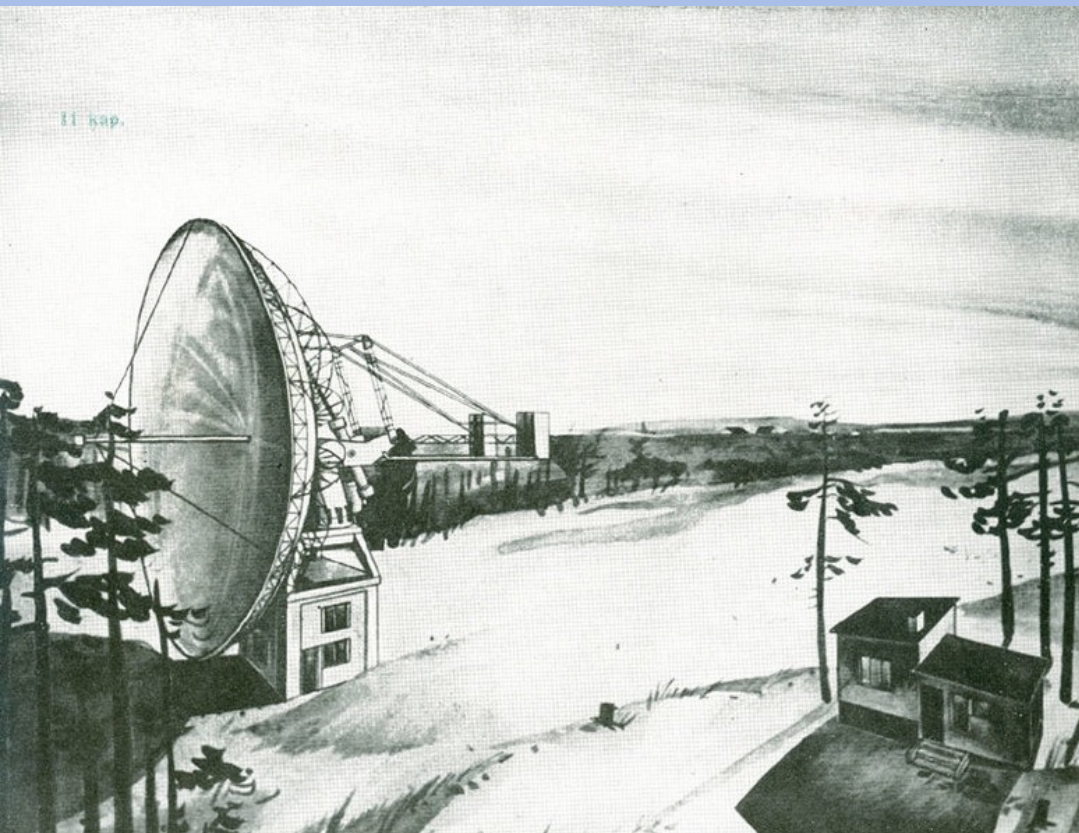
(Radio Astronomy in Latvia – Through the Circles of Time)



Ivars
Šmēlds
18.08.2026

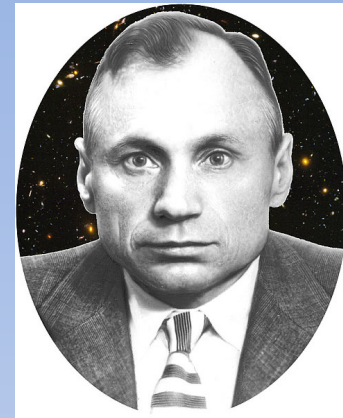


1st circle – the Latvian stellar radio interferometer

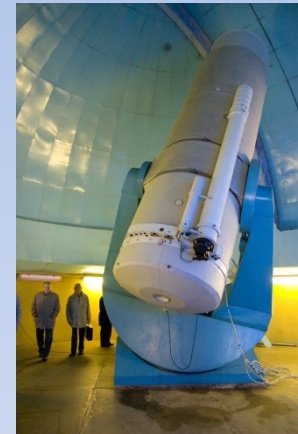


1952 – 1970

1952 – Jānis Ikaunieks proposes including radio astronomy in the work plans of the Institute of Physics and Mathematics of the Academy of Sciences of the Latvian SSR.

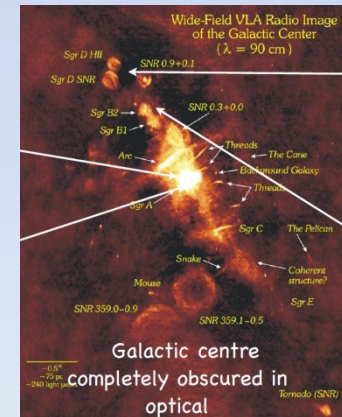


Optical astronomy – Schmidt-system telescope, studies of carbon stars.



Radio astronomy makes it possible to study what is invisible in optical light:

- gas-and-dust envelopes of late-type stars;
- star-forming regions inside cosmic gas-and-dust clouds;
- galactic nuclei;
- distant objects.



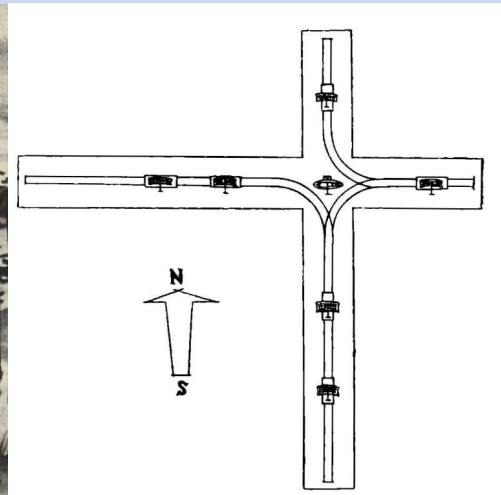
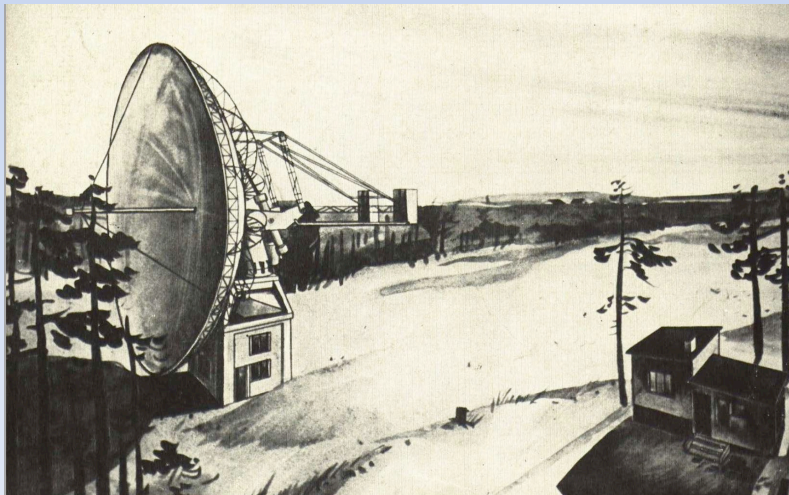
In 1961:

PROJECT OF A RADIO INTERFEROMETER

1. Maximum resolving power in two mutually perpendicular directions. A cross-shaped interferometer of maximum length is needed.
2. Decimetre and metre wavelength ranges. Surface accuracy must be at least **1.5 cm**.
3. The total area of all antennas was to be no less than 1500 m².

A project for the complex of radio-interferometer facilities was developed.

At the northern and eastern ends of the cross there would be one movable antenna each, while at the opposite ends there would be two symmetrically truncated paraboloid antennas each. All six of these antennas would move along rails.



Construction work began in 1960 and was initially planned to be completed as early as 1962.

However:

- The project was very expensive, and the USSR Academy of Sciences approved the construction only in 1962.
- In the meantime, radio astronomy had also developed, and the project had to be revised both in line with new trends and in the direction of reducing costs.
- **A new project appeared in 1969.**

The minimum wavelength was reduced, thereby making it possible to observe the Universe in a wavelength range that was then far less explored, and with higher resolution. A version was chosen **with only three movable, fully steerable 30 m parabolic antennas: one fixed at the centre of the cross and two movable on the arms. The minimum operating wavelength would be 5 cm.**

In parallel, work was carried out on developing the equipment.

Senior engineer M. Eliass and radio technician J. Licis tune a parametric amplifier intended for receiving cosmic radio emission. (Starry Sky, summer 1971)



Vizualization of the 1969 year project



All these plans received high recognition among USSR astronomers, and this was also reflected in official decisions.

In 1964, the Radio Astronomy Council of the USSR Academy of Sciences adopted an extensive decision on the further development of radio astronomy in Latvia. The prepared design assignment for a radio interferometer with a variable baseline of 2 to 12 km received a positive assessment from a special expert commission established by the Radio Astronomy Council of the USSR Academy of Sciences.

However:

- It must be acknowledged that in implementing a project of this scale, and even of a smaller scale, an important role is often played not only by the scientific quality of the project, and not even only by its cost and the difficulties of implementation, but also by the charisma, drive and personal contacts of the leader or leaders of the implementing group.
- **This time the decisive blow to the project was the death of the director of the Radioastrophysical Observatory, Jānis Ikaunieks, in 1969.** Unfortunately, his successors had less of the qualities mentioned above, and soon afterwards, with the high cost of construction cited as the official reason, the USSR Academy of Sciences halted implementation of the interferometer construction project, even though the frame of a 30 m antenna had already been manufactured and brought to the installation site.
- **On 10 November 1970, the Scientific Council of the Radioastrophysical Observatory was therefore forced to decide to liquidate the interferometer group and merge it with the Solar Radio Emission researchers.**

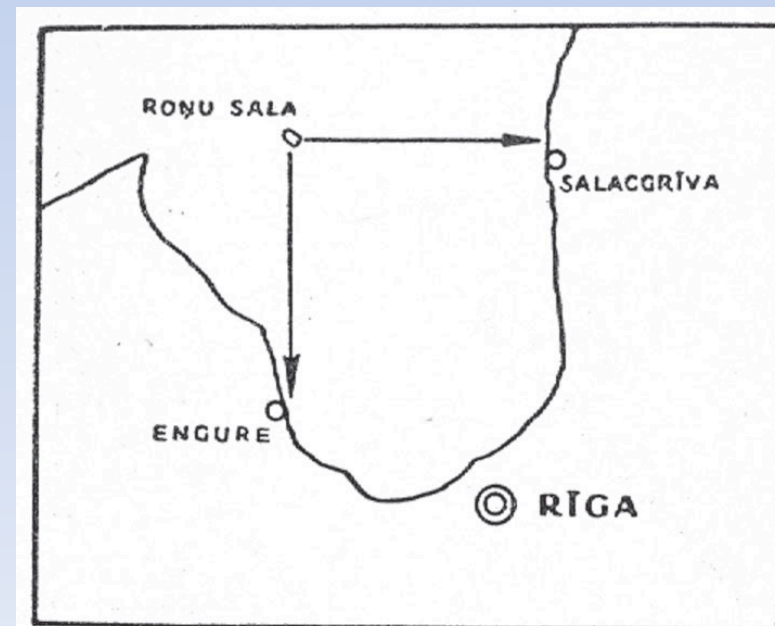
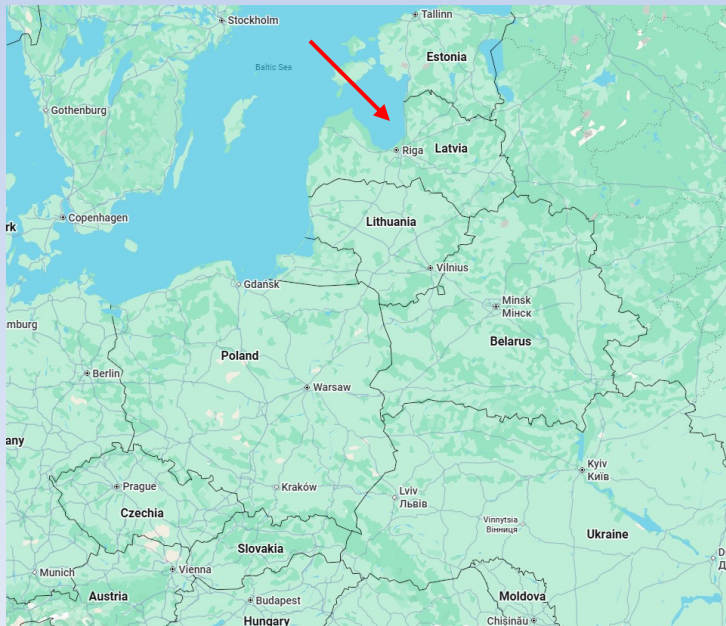
Thus, unfortunately, the first circle came to an end. Only a small digression remains.

This was not the only stellar radio-interferometer project cherished by J. Ikaunieks.

In the 1960s there was also the idea of a Baltic Sea interferometer. Antennas would have been placed 70 km apart from one another in Engure, Salacgrīva and on Ruhnu Island. The antennas would be interconnected by radio links. At a wavelength of 1 m the resolution would have been 30", and in the 21 cm line already 6".

With the participation of several astronomers from Moscow and Leningrad, now Saint Petersburg, the idea was discussed at a field meeting of the Observatory's Scientific Council in Engure in the summer of 1963.

The project did not move forward. Apparently even J. Ikaunieks was unable to advance both this project and the Riekstukalns interferometer project at the same time.



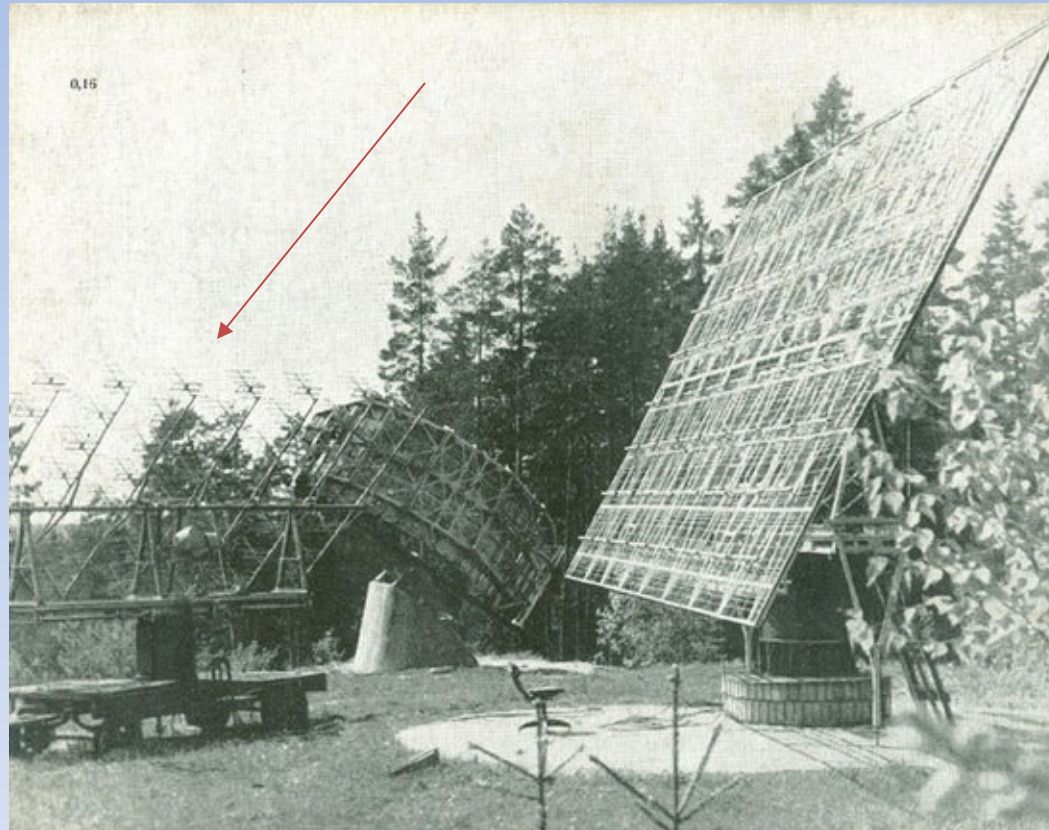
2nd circle – Solar radio observations at Riekstukalns, Baldone 1955–1993



1955 – 1993.

The beginning:

- Two American SCR-527 radar stations were obtained and rebuilt as receivers.
- The conversion was completed in 1959 and Solar radio emission was first received in the summer of that year.



The picture also shows two other antennas.

Beginning with the third quarter, measurement results were published in *The Quarterly Bulletin of Solar Activity*, and the Baldone Observatory joined research carried out within the framework of International Geophysical Cooperation in 1959.

IV. SOLAR RADIO EMISSION

CO-OPERATING OBSERVATORIES

Details relating to the contributors to the third quarter of 1959 are as follows:-

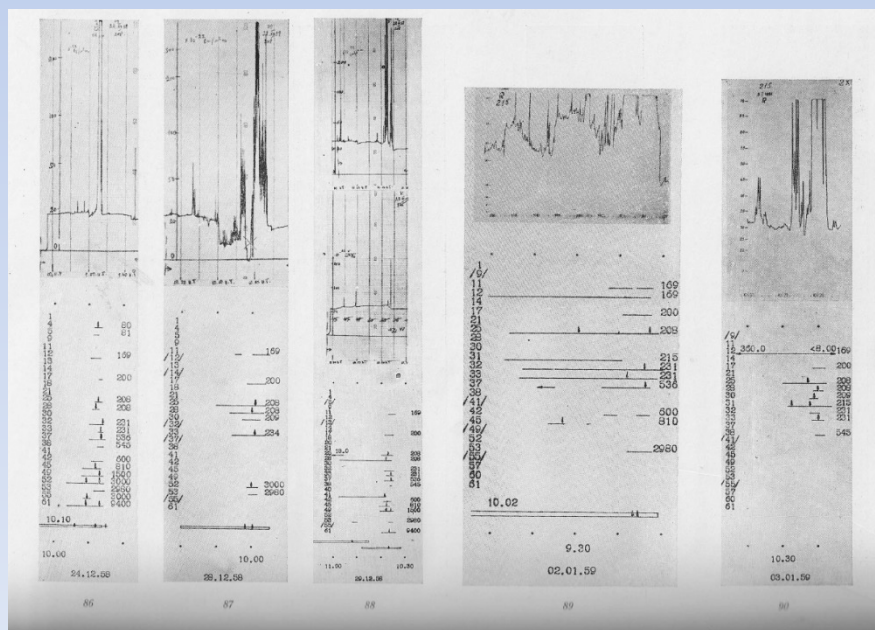
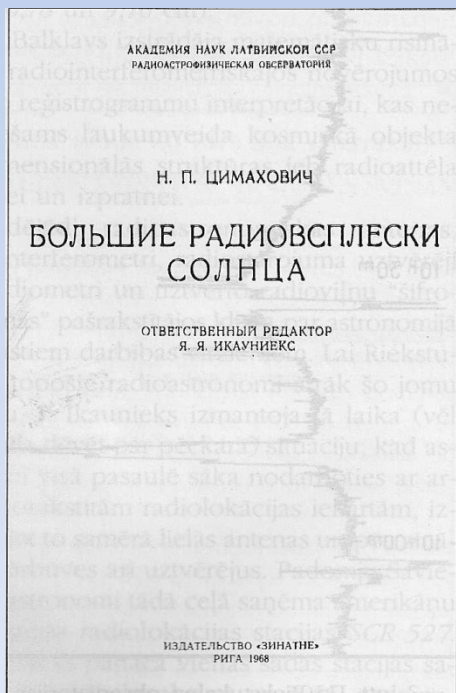
OBSERVING STATION	ABBREVIATION	FREQUENCIES USED	NORMAL OBSERVING PER
		Mc/s	(Hours U.T.)
Astrophysikalisches Observatorium Potsdam Trensdorf b. Potsdam, Germany	AOP	23 234	09 - 15 09 - 15
Chalmers Institute of Technology, Gothenburg, Sweden	CIT	150	06 - 18
Harvard Radio Astronomy Station, Fort Davis, Texas, U.S.A.	Har	Spectrum 100-580	14 - 24
University of Hawaii, Honolulu, Hawaii	Haw	200	
Heinrich Hertz Institute, Berlin Adlershof, Germany	HHI	1500 3000 9400	06 - 18 06 - 18 06 - 18
Hiraiso Radio Wave Observatory, Nakaminto-shi Ibaraki-ken, Japan	Hir	200	00 - 09
Research Institute of Atmospherics, Nagoya University Toyokawa, Japan	Nag	1000 2000 3750 Strip-scan 4000 9400	22 - 08 22 - 08 22 - 08 22 - 08 22 - 08
Observatoire de Paris, Meudon, Nancy Field Station	Nay	Strip-scan 169	11 - 13
National Bureau of Standards, Central Radio Propagation Laboratory, Boulder, Colorado	NBS	167	14 - 23
Radio Astronomy Section, P.T.T., The Hague, Netherlands: Observing Station Nederhorst, Den Berg - Radio (Nera)	Ned	200 Strip-scan 250 545 2980 200 545 200 545	05 - 18 09 - 12 08 - 15 08 - 15 21 - 08 21 - 08 10 - 21 10 - 21
Hollandia	Hol	200	21 - 08
Paramaribo	Par	200	21 - 08
Institutt for Teoretisk Astrefysikk, Universitetet, Blindern, Oslo, Norway	Osł	200	04 - 19
National Research Council Ottawa, Canada	Ott	2800	11 - 24
Astronomical Institute of the Czechoslovak Academy of Sciences, Ondrejov, Prague	Pra	231 536 808	04 - 15 04 - 15 04 - 15
Radiophysics Laboratory, Sydney, Australia	Syd	Spectrum 40-200 600 1420 Spot-scan 1420	23 - 06 21 - 07 21 - 07 00 - 04
Tokyo Astronomical Observatory, Mitaka, Tokyo	Tok	67 100 200 3000 9500	00 - 07 00 - 07 00 - 06 00 - 06 00 - 08
Astronomical Observatory, N. Copernicus University, Torun, Poland	Tor	127	06 - 15
Observatoire Royal de Belgique, Uccle, Bruxelles, Belgium	Ucc	600	04 - 19
National Committee for I.G.T., Ulitsa Chkalova 64, Moscow 4, U.S.S.R.			
Abastumani	Aba	209	06 - 12
Bjurakan	Bju	203	06 - 09
Oracov	Ora	810	07 - 12
Gorky	Gor	9375 19000	06 - 12 06 - 12
Irkutsk	Irk	209	02 - 09
Kislovodsk	Kis	178	07 - 12
Moscow	Mos	545 208	06 - 12 09 - 12
Riga	Rig	215 208	12 - 15 09 - 12
Simferopol	Sim	3000	09 - 12
Ussuriysk	Uss	208	21 - 24
Vorushilov	Vor	208	21 - 03

Single-Frequency Observations											
(3) OUTSTANDING OCCURRENCES											
Station and frequency	Date	Starting time	Time of Max.	Duration	Type	Max. Flux Density	Pol.	Position	Remarks		
Mc/s		U.T.	U.T.	Minutes		$10^{-22} \text{ w}^{-2} (\text{c/s})$		angle dist.		deg.	unit E
Nag 3750 Aug. 7	0211	0211	>10.0	CD	-	30	1	77 0.76			
HLR 200 7	0250.6	0251.9	2.7	CD	260				Also Hol, Irk 200		
Hol 545 7	0251	-	0.9	CD	210	80			Flare 0255-30502		
Syd 400 7	0251	0252.5	2.5	CD	132	108	0		Also Tok 3000		
Nag 3750 7	0251.5	0252.5	1.5	CD	-	32					
Nag 1000 7	0252x	0252.5	1.0	CD	-	10	0				
Nag 2000 7	0252x	0252.4	1.0	CD	-	12	0				
Pra 231 7	0251	0251	0.5	CD	-	30					
Mos 208 7	<0600	0718	>560.0	K	159	-	0				
Pra 231 7	0715	-	1.0	CD	-	10			Flare 0616-0627		
Pra 231 7	0719	-	0.5	CD	40	-			Sub-flare 0709		
Pra 231 7	0717.5	-	0.5	CD	65	-			Sub-flare 0716		
Nag 200 7	0849	-	1.5	CD	90	-	1		Also Mos, Pra 200, Flare 0847-0919		
ADP 23 7	0849.9	0850.1	1.4	0	1000	-					
Pra 808 7	0922	-	1.0	S	80	-					
Mos 208 7	1117	1119	3.0	F	268	-			Also Osł, Sln 200		
Pra 231 7	1249	-	121.0	K	40	19			Also Mos 208 at <0600, (sl)		
Utt 2800 7	1330	1351.5	8.0	CD	-	9			Flare 1326-1402		
Nag 215 7	1333	1334	24.0	KCD	60	1					
NBS 167 7	1335.9	1334.1	1.6	F	>100	-			(gIII)		
Nag 200 7	1337.5	-	1.0	PD	320	-	1		Also ADP 234, (bIII)		
NBS 167 7	1458	1458.2	0.6	CD	>100	-			(gIII)		
Rig 215 7	1458	1458	1.0	CD	15	-			Also NBS 167		
NBS 167 7	1504	1504	0.2	CD	>100	-			(gIII)		
NBS 167 7	1529.2	1529.4	0.8	CD	>100	-			(gIII)		
Nag 200 7	1529.5	-	0.2	CD	270	140	1				
NBS 167 7	1531.5	1535.5	2.5	F	>100	-			(gIII, cont.), Flare <1530-1550		
Nag 200 7	1533	-	0.5	CD	430	210	0		(gIII), Flare, Sub-flare 1534-1544		
HLI 1500 7	1535	1535.8	2.0	F	210	8					
Utt 2800 7	1539	1539.5	2.0	CD	-	68			Flare 1551-1636, Fade 1600		
Utt 2800 7	1600	1601	43.5	CD	-	38					
Nag 200 7	1600	1600	2.5	CD	293	68					
HLI 1500 7	1600	1600	22.7	F	333	-					
NBS 167 7	1618	1618	0.2	CD	-	-			(gIII)		
NBS 167 7	1708.5	1708.5	0.5	CD	>100	-			(gIII), Flare <1734-1750, Fade 1737		
NBS 167 7	1733	1734	6.2	CD	>1000	-			Also Nag 545		
Ucc 600 7	1735	-	3.0	KCD	215	55					
Nag 200 7	1735.5	-	2.0	CD	650	42					
NBS 167 7	1734	1734.8	3.0	CD	254	21			Also HHI 1500		
Nag 200 7	1734	-	1.0	CD	254	21					
NBS 167 7	1739	1739.2	3.0	CA	>1000	-			(gIII)		
NBS 167 7	1906.7	1907	0.8	CD	>100	-			(gIII)		
NBS 167 7	2108.5	2109	0.2	CD	170	60			Sub-flare 2108		
NBS 167 7	2108.9	2109	1.1	F	>100	-			(gIII)		
NBS 167 7	2202.4	2202.4	0.2	CD	>100	-			(gIII)		
NBS 167 8	0028.2	0028.2	0.2	CD	>100	-			(bIII)		
NBS 167 8	0140.2	0141	0.8	CD	>100	-					
Nag 3750 8	0234	0234.7	1.5	CD	-	19	0				
NBS 167 8	0237	0238	2.0	CD	82	16					
Nag 3750 8	0430	0430.8	1.0	CD	-	11	1	77 0.58	Flare 0445-0510		
Nag 3750 8	0449	0502	40.0	CD	-	27	1	77 0.58	Flare 0445-0510		
HLI 1500 8	0547	0547	3.0	CD	166	-			Also Hol, 200, Sub-flare, Flare 0554-0555		
Nag 3750 8	0547	0548.2	5.0	CD	-	12	0	77 0.58	Flare 0653-0737		
Pra 231 8	0651	0654	3.0	CD	>155	50			Also Hir, Mos, Osł 200		
Nag 200 8	0652	-	2.0	CD	>480	220	0		Also Nag 545, Syd, Dec 600		
Mos 545 8	0652	0653	2.0	KCD	244	8					
Ora 810 8	0652	0652.5	2.5	PD	85	9					
Nag 1000 8	0652	0653	2.0	CD	-	25	1				
Nag 2000 8	0652	0653.5	2.0	CD	-	85	1				
Pra 808 8	0656	0658	3.5	CD	95	25			Sub-flare 0704		
Nag 3750 8	0703	0705	7.0	CD	>450	12	0				
Nag 200 8	0818	-	0.0	CD	>100	-					
Sln 208 8	<0900	1041	>180.0	K	>47	-			Also Mos 208 at <0600		
Pra 536 8	0938	-	0.5	CD	95	-			Flare 0936-0950		
Nag 200 8	1038	-	2.0	CD	180	60	0		Also Ucc 600, Pra 200		
Mos 208 8	1040	1042	4.0	KCD	248	12					
Nag 200 8	1050	-	2.0	CD	251	14			Also Pra 536		
Ucc 600 8	1050.5	-	1.5	KCD	15	6					
Ora 810 8	1050.5	1050.5	2.0	PD	65	-					
HLI 1500 8	1051.8	1052	0.4	CD	235	100	8		Also Osł, Rig 200		
Nag 200 8	1204	-	1.0	CD	200	4					
Rig 215 8	1204	1204	6.0	KCD	40	4					
NBS 167 8	1424.8	1425.2	1.2	CD	>100	-			(gIII)		
Nag 200 8	1425	-	0.4	CD	290	120	0				
NBS 167 8	1556.8	-	1.2	CD	<100	-			(gIII)		
NBS 167 8	1617	1617.8	1.6	F	<100	-			(gIII)		
NBS 167 8	1717	1719.2	2.5	F	>100	-			(gIII)		
Nag 200 8	1719	-	0.0	CD	210	100					
NBS 167 8	1730	-	382.0	KCD	>100	-			Also Haw 200, (sl)		
Hol 200 8	2148.5	-	1.0	CD	>450	-			Also Nag, Hir 200		
NBS 167 8	2149	2150	1.8	CD	>1000	-			(gIII, cont.), Sub-flare 2149		
Utt 2800 8	2149.2	2149.7	1.0	CD	-	32			Also Hol, 200, Sub-flare 0124		
Utt 2800 8	0124.3	0124.8	3.0	CD	194	-			(gIII)		
NBS 167 9	0124.3	0126.2	3.4	CD	>100	-					
Utt 209 9	0414	0418	10.0	CD	>227	260			Also Hol, 200, Syd 600		
HLI 200 9	0418	-	0.7	CD	950	60					
Osł 200 9	0415.5	0420	0.8	CD	>200	100					
Mos 208 9	0640	0926	300.0	K	155	-					
Pra 231 9	0757	-	0.5	CD	50	-			Flare 0756-0811		
Mos 208 9	0820	0822	3.0	CD	1445	20			Also Pra 231, Sub-flare, Flare 0817-0827		
Ora 810 9	0820.5	-	<0.3	PD	78	-					
ADP 234 9	0821.3	0821.5	0.7	CD	2600	90					
Nag 200 9	0822	-	0.8	CD	>75	15	1,8		Also Hir 200		
Ora 810 9	0826	-	0.3	CD	80	-					
Nag 200 9	0825	-	0.7	CD	>75	15			Also ADP 234		
Utt 208 9	1104	1108	4.0	CD	37	22	0				
Ora 810 9	1107	1107	0.5	PD	91	-					
Nag 200 9	1108.5	-	0.7	CD	300	140	0		Also Mos, Pra 200		
Sln 208 9	1139	1139	1.0	CD	23	15					
Rig 215 9	1225	1224	2.0	D	25	-			Flare 1214-1235		
Rig 215 9	1225	1230	2.0	D	30	-					
Utt 2800 9	1230	1232	7.0	CD	-	15					

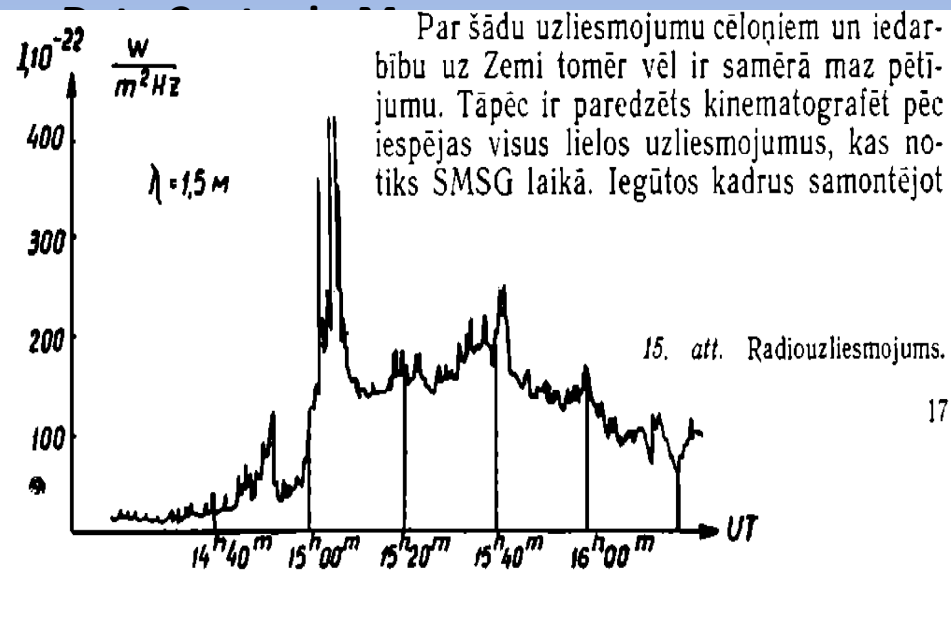
The work of Latvian radio astronomers was highly appreciated.

In order to evaluate at least part of the results of solar radio flux measurements obtained during the International Geophysical Year (July 1957 – December 1958) and later, the Solar Research Commission of the USSR Academy of Sciences decided to entrust the radio-astronomy specialists of the Latvian Academy of Sciences with compiling the results of solar observations made at USSR observatories.

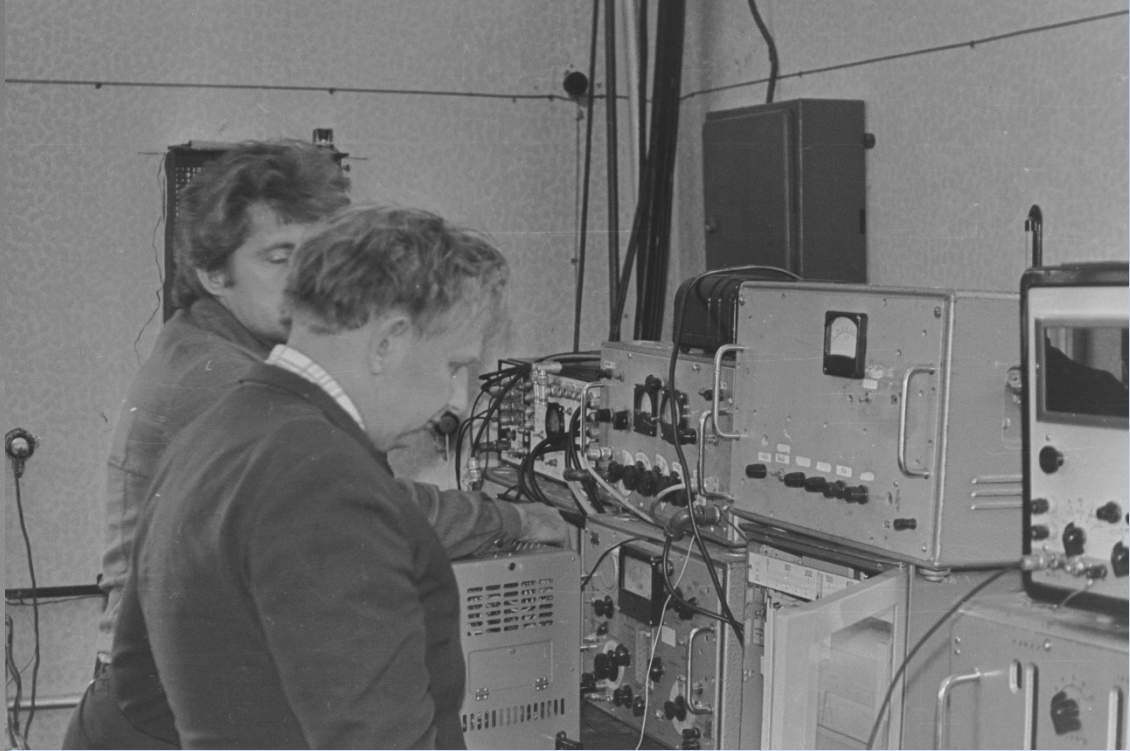
This is the only summary of the joint results of USSR observatories from the International Geophysical Year.



➤ During the International Year of the Quiet Sun, 1964, Latvian radio astronomers were entrusted with collecting data from USSR observatories and delivering them to the World



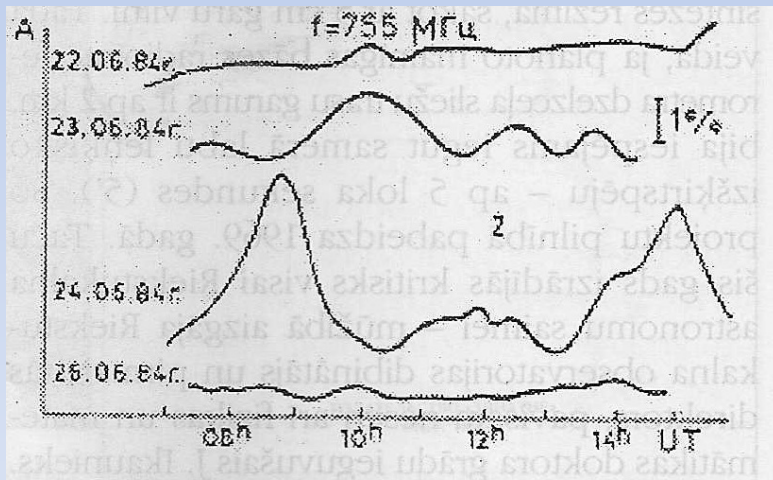
An important turning point: the 10 m antenna in 1972, manufactured in Vladimir (Russia).
It was placed where the centre of the “cross” had originally been planned.
Observations were made at three frequencies: 326, 612 and 755 MHz.



Studies of quasiperiodic fluctuations Determining the so called variability index

It was found that one hour, and in some cases even two days, before proton flares, small but characteristic almost-periodic oscillations appeared in the solar radio-wave flux. Their amplitude was 1–2.5% of the basic flux level, and the pulsation periods were in the range from 5 to 20 minutes. One hour before a flare, short-term changes in the fluctuation amplitudes occurred; the flare probability was 68%. Several days before especially large flares, oscillations with periods of 40–160 minutes also occurred.

(E. Averjanykhina, M. Paupere)



Pre-flare indicators were also sought in irregular, short-lived microbursts of radio flux from the solar corona – peaks of signal increase observed with RT-10 at 326 MHz. According to a special rule, a flux variability index was calculated for each day, providing a parameter for quantitative assessment of the dynamics of the solar corona. Analysis of the data showed that an increase in the variability index was often associated with an increase in the area of a sunspot.

(N. Cimahoviča, I. Šmelds)

*Averaged records of solar radio emission at
755 MHz for June 22 – 26, 1984*

The Soviet military-industrial complex was also interested in that research.

- Support for spacecraft flights.
- The “Dreif” station: cooperation with the Applied Geophysics Institute of the USSR State Committee for Hydrometeorology in Moscow.
- Generous funding and material support: equipment and computing technology.

But:

- Local resources were directed to optical astronomy, and solar studies became fully dependent on Moscow.
- With the collapse of the USSR, funding ended, and optical astronomy no longer wanted to “repay the debt”.

On 3 May 1993, the Scientific Council of the Radioastrophysical Observatory decided to disband the Solar Physics Division.

Today, at the former location of the RAO Solar Physics Division, at the “Cross” – a name that still survives from the time of the radio-interferometer construction plans – nothing remains, not even the foundations of buildings, to testify to the scientific activity once carried out there. As late as the end of 1989, a staff of 20 people worked there, including three Dr.Ph.



The “Dreif” station

With a more favourable combination of circumstances, the Baldone Observatory could have become a world-known solar research centre, just as the Baldone Observatory is known in the world today for its research in optical astronomy.

Unfortunately, this was not to be, even though the research carried out fully corresponded to the scientific level of its time.

3rd circle – Ventspils International Radio Astronomy Centre



1994.– ∞

1993

The public learns of the existence of previously secret antennas in Latvia. Negotiations are held on the withdrawal of the former Soviet armed forces from Latvia and on the status of their property. The international astronomical community supports preserving the antennas and transferring them to civilian scientists.

1994 July

Under the agreement on the withdrawal of the Russian armed forces from Latvia, the last Russian servicemen leave the site, which is then placed under Latvian guard. **The Latvian government get the antennas and transfers them to the Latvian Academy of Sciences. The Ventspils International Radio Astronomy Centre is established**



22 July 1994. Headquarters of the Russian army group at Irbene site; the commission of the Latvian Academy of Sciences and representatives of the Russian army sign an agreement on transferring the former Space Communications Centre to the Latvian Academy of Sciences.
(Photo by M. Zirņīte)

Latvia got two fully steerable parabolic antennas, 32 m and 16 m in diameter, which are located in north-west of Latvia, approximately 30 km from Ventspils.

They were handed over without receiving equipment or technical documentation. Before the transfer, the antennas had been deliberately damaged.



Cut and torn power and control cables



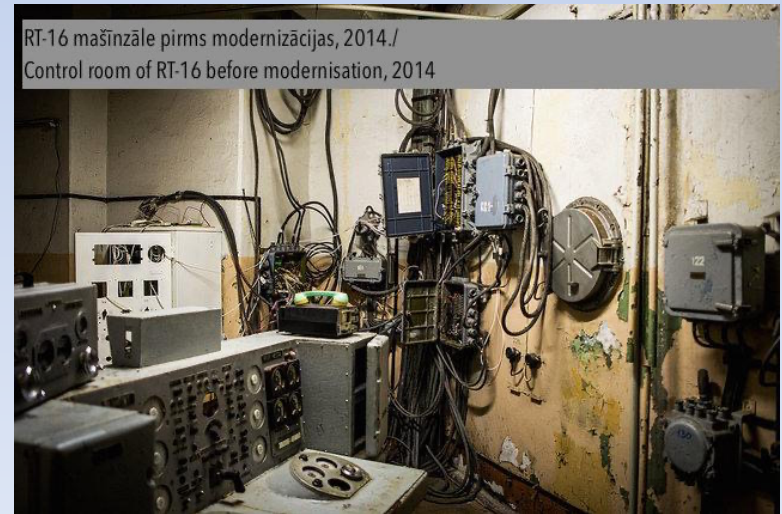
RT-32



RT-16



RT-16 mašīnzāle pirms modernizācijas, 2014./
Control room of RT-16 before modernisation, 2014



1994

October. A working group is formed to restore the 32 m antenna.

14 November. Assessment of the damage inflicted on the antennas begins.

16 December. Electricity supply is restored. Red signal lights come on above the antenna dish.

24 December. RT-32's first civilian Christmas.

1995

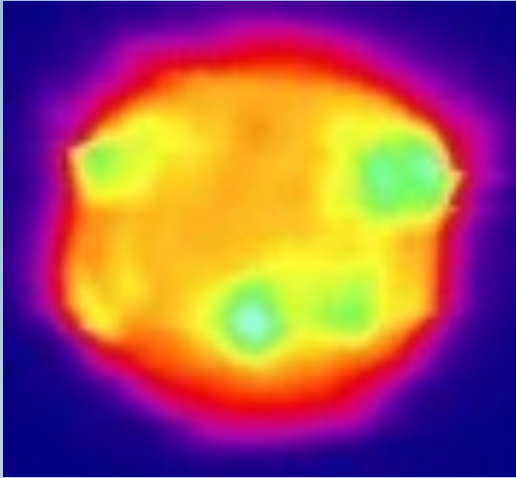
27 April. An important milestone is reached – the antenna's ability to move is restored and may be directed not only in zenith



This is what the first 12 GHz radio receiver and cosmic radio emission recorder of the Ventspils International Radio Astronomy Centre looked like in 1996. Some of the equipment came from the now-defunct Baldone Solar Radio Observatory, while the rest was designed and built in-house.



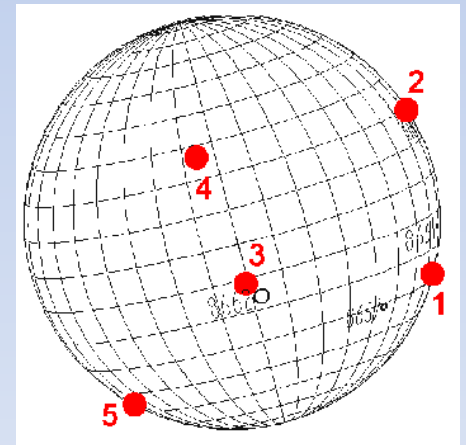
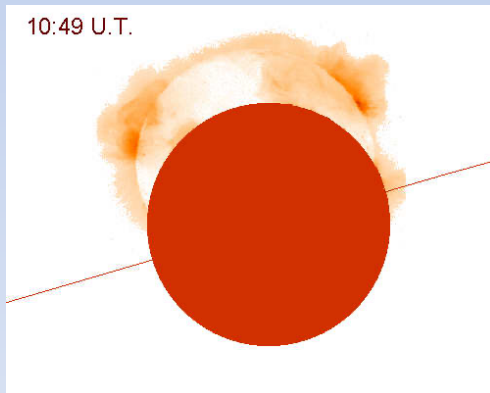
First observations

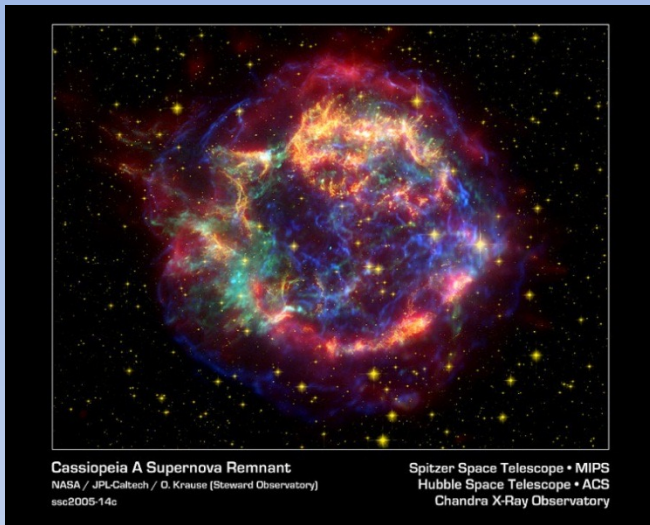


9 June 1996 – solar radio emission is received. (First light!)

2 July 1999 – solar radio map

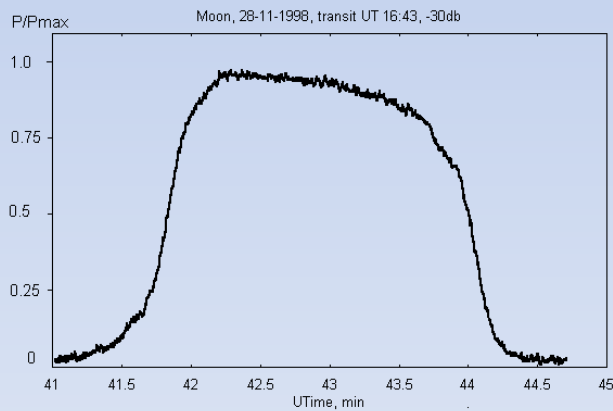
11 August 1999 – observations of the solar eclipse



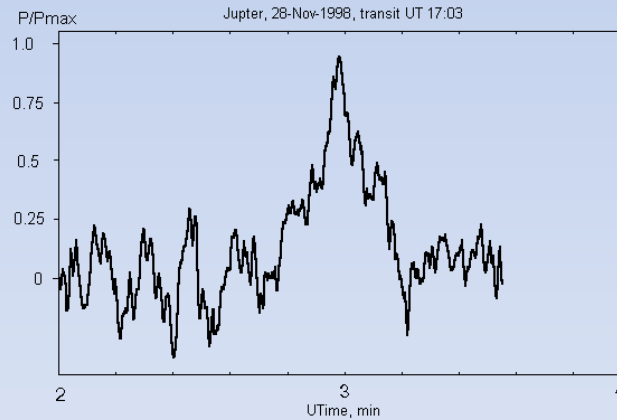


15 September 1996 – First observations of the strongest galactic radio sources: Cas A and Cyg A.

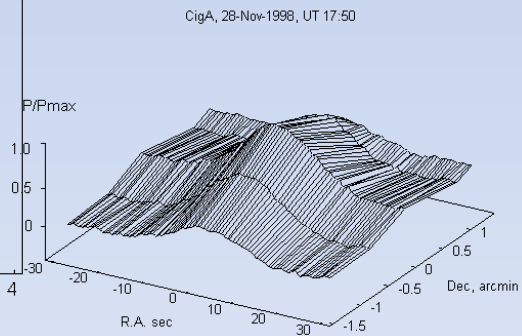
Transit observations in 1998



The Moon



Jupiter



Cyg A



9–14 November 1999 – first VLBI observations: space debris (327 MHz)

A custom-built dipole antenna and receiver were used, while the Mark II VLBI recording system was supplied by Russian colleagues.

The space debris was illuminated by a transmitter installed at the Yevpatoria radio telescope, while the other stations received the reflected signal.

Cooperation with this network of radio telescopes, involving also researchers from the Radiophysical Research Institute in Nizhny Novgorod, continued until the middle of the second decade of this century.

The collaboration also included radar observations of asteroids, reception of satellite signals in VLBI mode, and ionospheric studies.

Radio Telescopes:

- Bear Lakes RT-64
- Pushchino RT-22
- Zimenki RT-15
- St. Pustyn RT-14 (Russia)
- Evpatoria RT-70
- Simeiz RT-22 (Ukraine)
- Noto RT-32
- Medicina RT-32 (Italy)
- Urumqi RT-25 (China)
- **Ventspils RT-32 (Latvia)**



However, the period up to the beginning of this (XXI) century should be regarded primarily as a time when the infrastructure was restored and the first test and trial observations were carried out. The development of substantial scientific research in observational radio astronomy was hindered by insufficient funding, the need to repair the damage caused before the withdrawal of the Russian armed forces, and the lack of modern equipment.

It should be emphasised that, throughout this period and during the institute's subsequent development, up to the point when it became a full member of the EVN, **the generous support of European radio astronomers and radio astronomy institutes was of great importance.** This support included expert advice, the involvement of the Irbene facility in various European-scale projects—among them RadioNet, RadioNet2 and later RadioNet projects — and assistance in acquiring essential equipment, including equipment donated from the institutes' own reserves.

Unfortunately, the limited scope of this presentation and the extensive scale of the international support do not allow us to discuss its specific details.

In this context, two particular aspects of this much broader support should be highlighted:

- ✓ From the very beginning, every effort was made to enable the Irbene radio telescopes to carry out VLBI observations and, in due course, to join the European VLBI Network, EVN.
- ✓ One of the first recommendations concerning research topics was to study cosmic masers.

Reorganisation and Integration into Ventspils University College

Persistent underfunding had prevented the renovation of the infrastructure and the improvement of working and living conditions. Although at least RT-32 remained operational, several buildings were in critical condition. Staff numbers had fallen to only ten full-time employees, just one of whom held a doctoral degree, while the involvement of researchers and students had declined to a minimum.



A working group therefore developed a new strategy for VIRAC. The Ministry of Education and Science approved a proposal **to integrate the Centre into a higher education institution. Owing to its proximity and the potential benefits for both organisations, Ventspils University College agreed to incorporate VIRAC.**

On **11 November 2004**, VIRAC Ltd was formally dissolved. On **16 December 2004**, it became a research institute within Ventspils University College.

3–14 November 2006 – first VLBI test observations in the European EVN network. So called fringe test

Digital BBC and PC-EVN systems were used in cooperation with colleagues from Noto and Metsähovi, using a personal computer they had brought with them.)

Three stations: Irbene, Noto, Torun participated

2 objects observed, 2007+777 (cont), W3(OH)
(maser) (each scan 15 min)

No cross correlation observed, autocorrelations in Irbene, Torun and Noto successful.



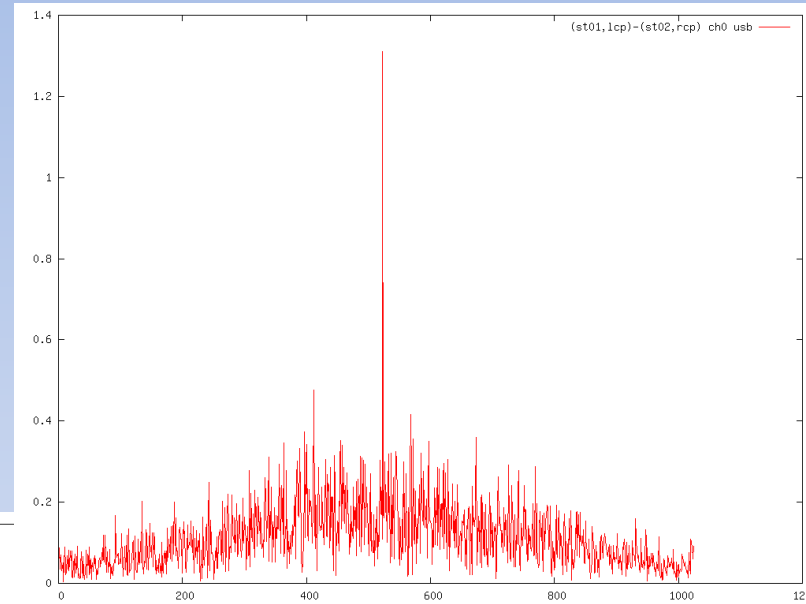
- At that time, and for many years afterwards, the lack of a suitable **VLBI baseband converter** was a major limiting factor in our participation in EVN observing sessions and in organising other VLBI experiments.
- Our entry into VLBI coincided with a transitional period when other EVN stations were phasing out **Mark IV-format equipment**. Such devices were no longer being manufactured, while the next generation of VLBI converters was still under development; consequently, for a long time, neither the old nor the new systems were available for purchase.
- Progress was also hindered by limited experience and insufficient funding. As I recall, one of the reasons why no cross-correlation fringes were obtained was the absence of a phase-stable cable between the front end and the back end.

As a result the first genuinely successful VLBI experiment involving the Irbene RT-32 took place only more than five years later.

FR012A - Irbene ftp fringe test - selected results from the JIVE software correlator

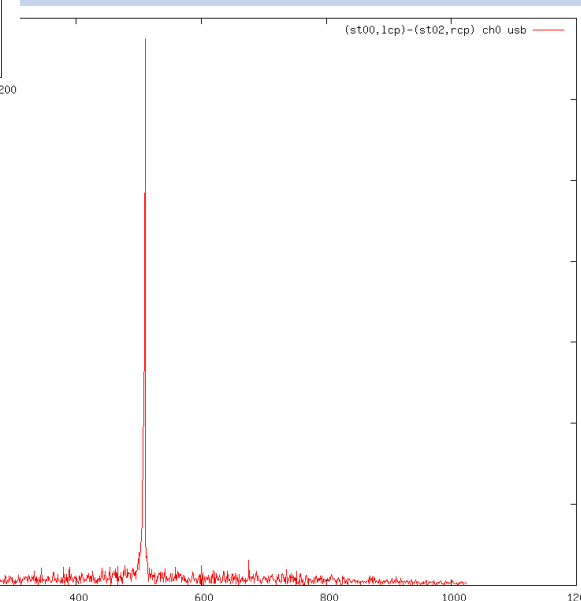
April, 12 2012 - 64 Mbps, 1 BBC * 8 MHz * 2-bit sampling

[scan18](#) On, Tr, Ir: 4 sec integration time, source = 3C84

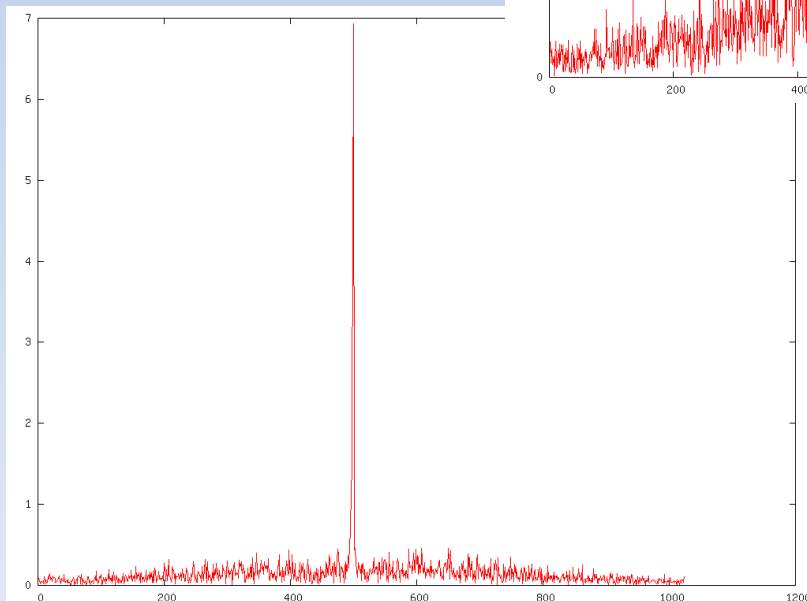


Torun - Onsala

Irbene - Torun



Irbene - Onsala



First e-VLBI observations with Irbene RT-32

The EVN has been expanded with RT-32

Experiment: **eg069c**
Date: **Tue 19 Mar 2013,09-17:45 UT**
Antennas: **EFLSBERG, JODRELL2, MEDICINA, NOTO , ONSALA85, TORUN, YEBES40M, WSTRBORK, HART, **IRBENE****
Frequency: **4926.49 - 5054.49 MHz;**
Channels: **16 @ 16 MHz;**
Pollarizations: **LCP, RCP**
Data speed **@512 Mbps (Irbene)**

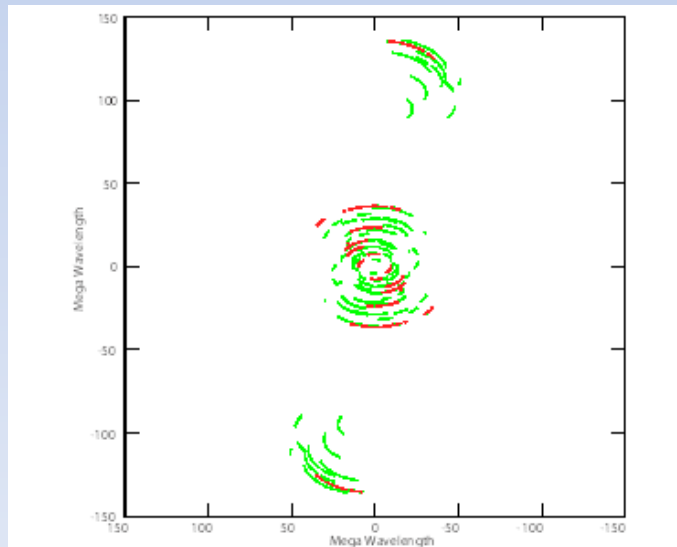
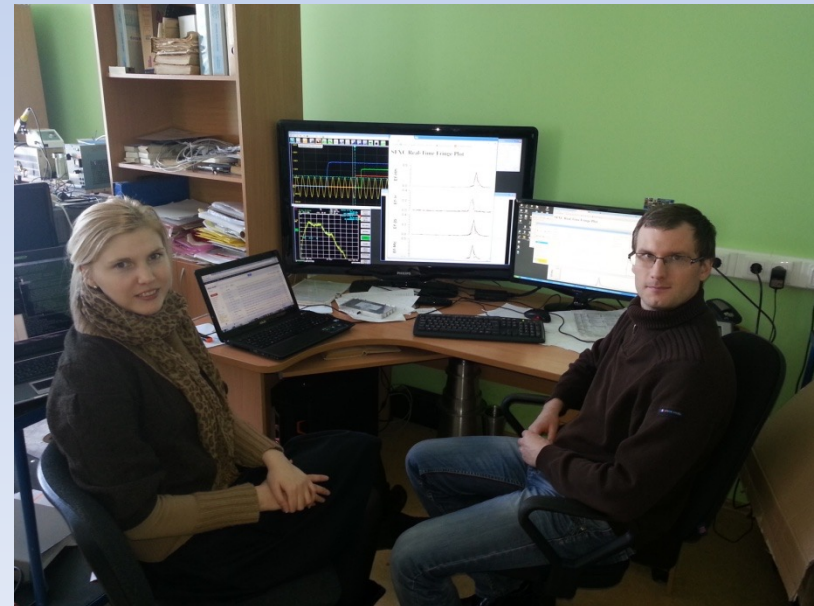


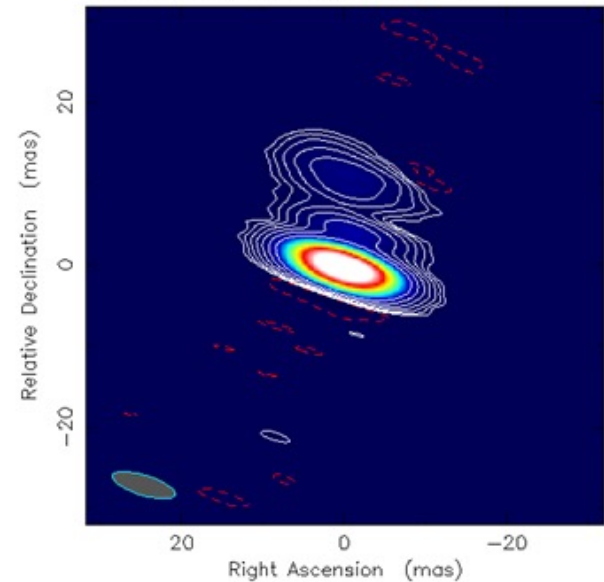
Fig. 1. The u,v plane coverage of the EVN network (in Mega wavelengths) obtained from observations of the source 0234+285 during the e-VLBI experiment EG069C. Red dots mark the results of the baselines with the Irbene radio telescope.



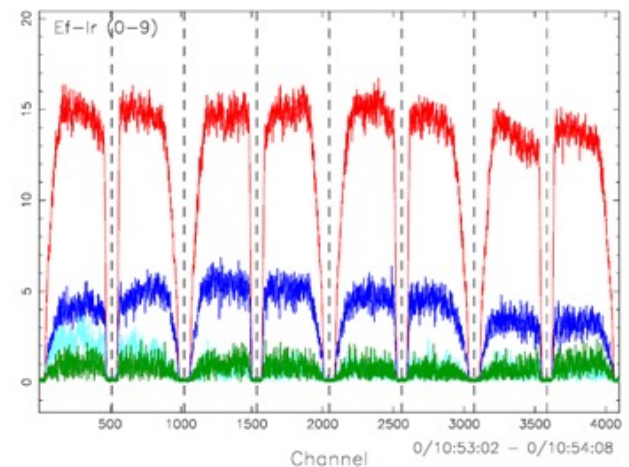
Source: 0234+285. The e-EVN + Irbene



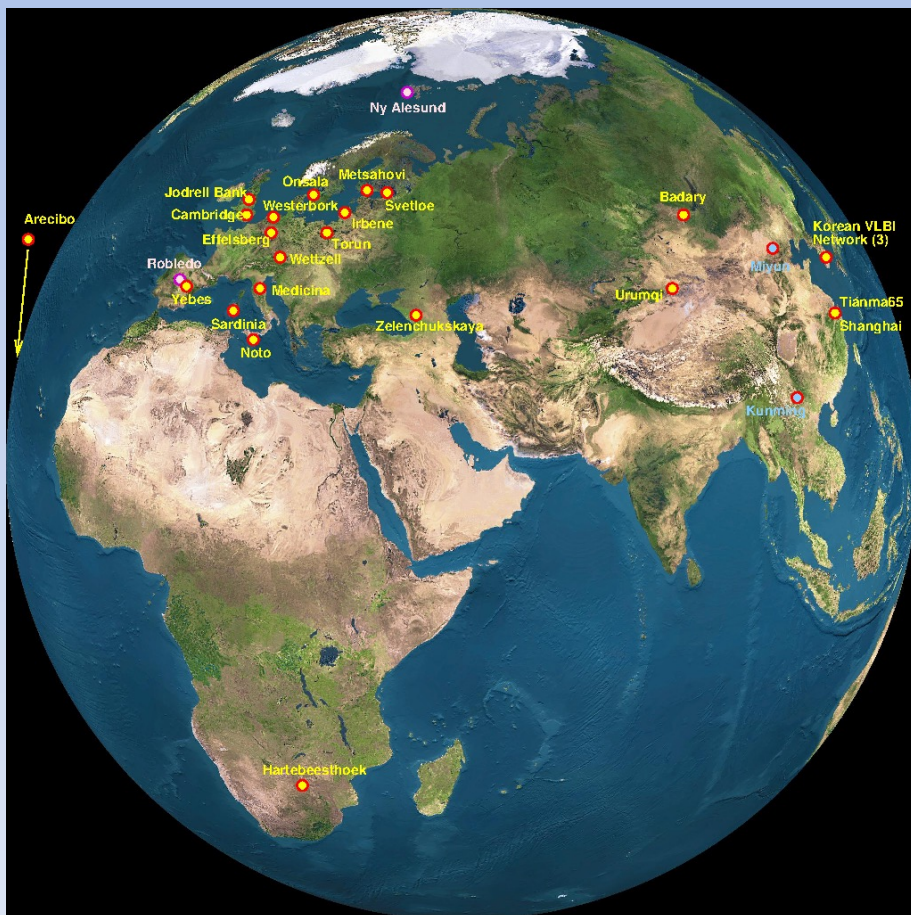
Clean RR map. Array: EVN
0234+285 at 4.990 GHz 2013 Mar 19



Amplitude for No0008.ms



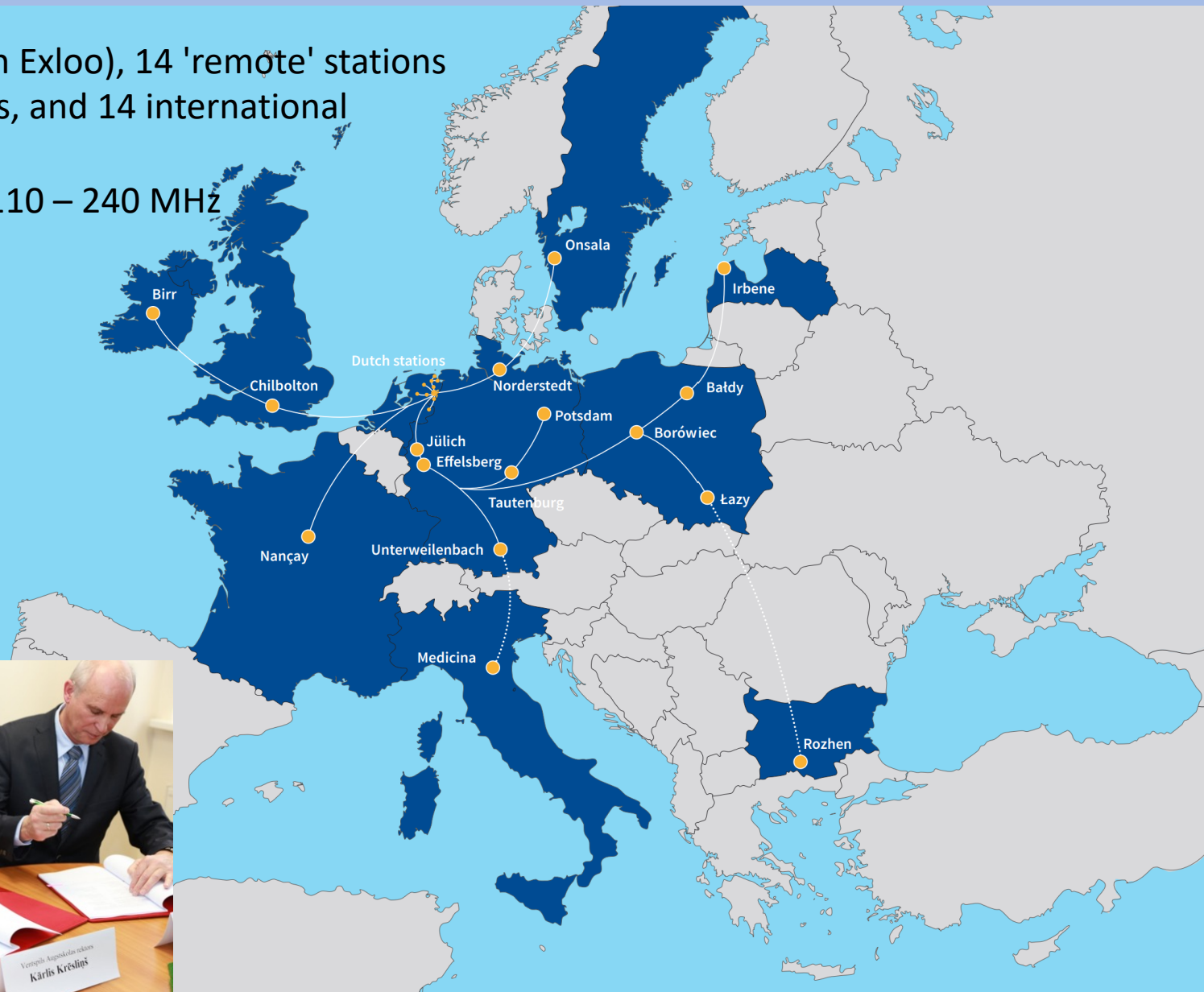
26 October 2016. VIRAC joined the EVN and JIVE ERIC.



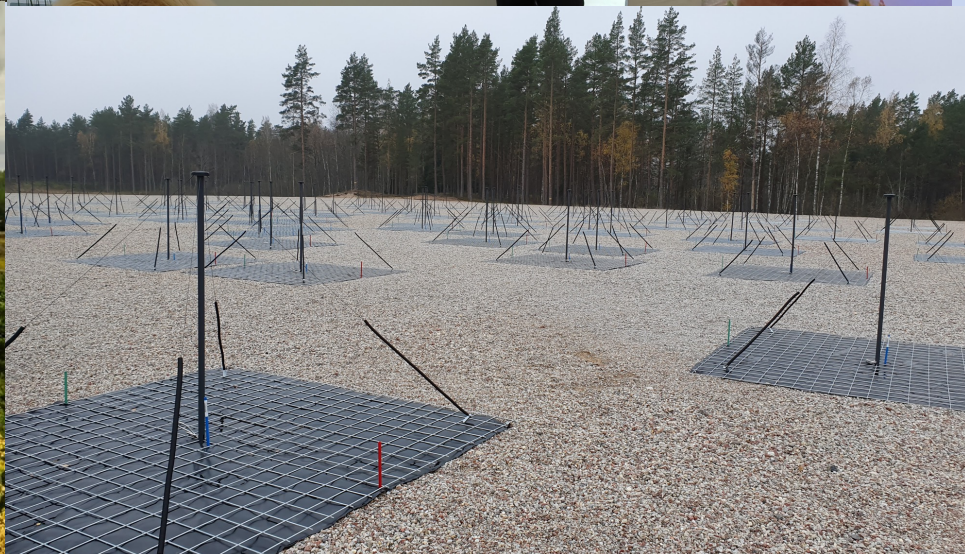
5 December 2017 one more door opened. An agreement was signed on the construction of LOFAR station on the Irbene site.

24 core stations (in Exloo), 14 'remote' stations in The Netherlands, and 14 international stations (total 52).

10 – 80 MHz and 110 – 240 MHz



The inauguration of the LOFAR station at the observatory's observing site took place on 25 October 2019.



Almost everything has now been covered, in keeping with the title of this presentation. Only a few details remain, without which the story would not be complete

VIRAC obtained its first serious **5 GHz receiver from the Medicina Radio Astronomy Observatory in Italy**. The receiver had been built in the **early 1990s** for the Medicina 32 m radio telescope and was used there in a **cryogenic configuration until 2008**. After it was dismantled, the Italian colleagues transferred the receiving system to VIRAC. Installation in the secondary-focus cabin of the Irbene RT-32 began in **2009**, although without the cryogenic unit.

To install the receiver on RT-32:

- the secondary-focus cabin was rebuilt and sealed;
- equipment racks, power supplies and radio-frequency connections were installed;
- a precise receiver-positioning system was developed;
- the 5 GHz horn and the receiver itself were installed.

Even with this “warm” receiver, RT-32 was already able to:

- participate in a space-debris radar experiment on **30 June 2010**;
- obtain its first successful EVN fringes with Toruń and Onsala on **12 April 2012**;
- participate successfully in an e-EVN observation for the first time on **19 March 2013**.



VIRAC: Modernisation Programme, 2012-2015

*Decision on support for Irbene radio telescope complex made by national government,
Co-financing granted by EU structural fund, National government and Ventspils City Council
VIRAC acts as a lead partner of national level consortium of research institutes for information and
communication technologies and signal processing*

- RT-32: Refurbishment of antenna surface and back-up structure, refurbishment of rooms, cabins for receiving equipment, replacement of control and drive system, new wide band cryogenic receiver
- RT-16: Replacement of control and drive system, new wide band cryogenic receiver, new antenna
- Cluster for HPC tasks (*int.al. to be used for VLBI data (online) correlation*)
- Internet - 10 Gbps via national academic network, year 2015 (*equipment installed, establishment of connection to GEANT in progress*)
- **Frequency converter: DBBC-2, Recording system: Mark5C**



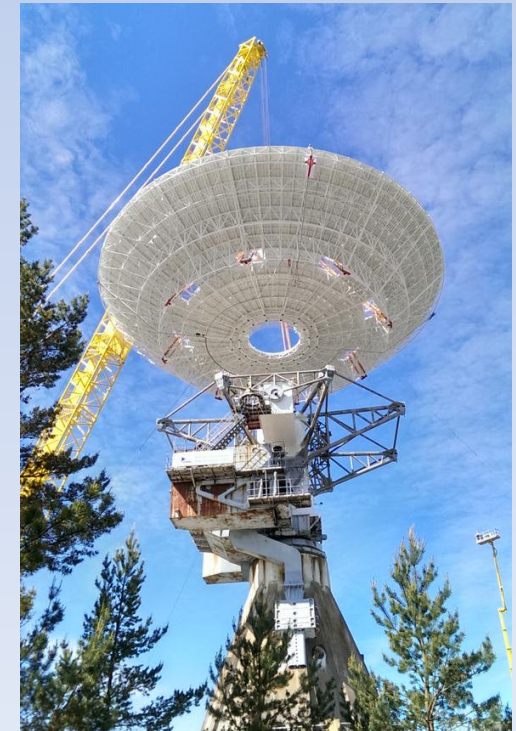
RT-32 existing receivers
5 GHz (*astrophysics, EVN*)
327 MHz (*Solar observations, ionosphere*)
6 ÷ 9 GHz (*Solar observations*)
12 GHz (*masers, quasars*)

RT-32 upgrade
4.5 ÷ 8.8 GHz (*cryogenic preamplifiers (<50K)*)

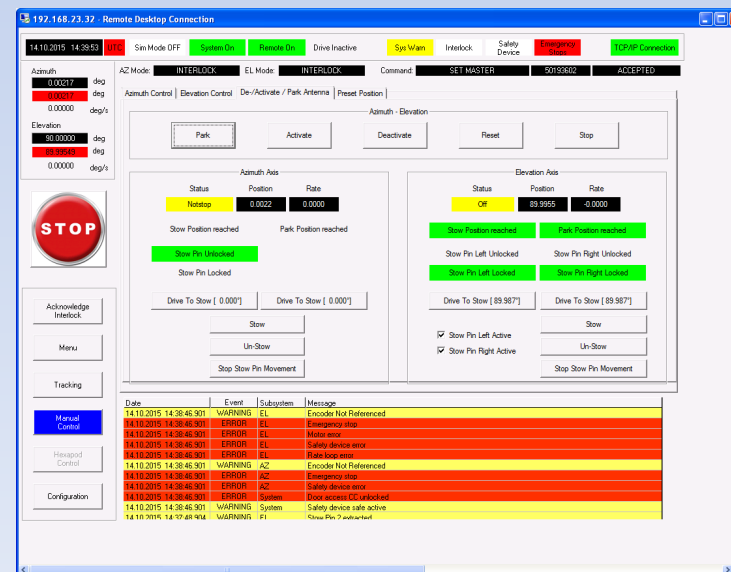
RT-16 existing receivers
none

RT-16 upgrade
1,6; 4.5 ÷ 8.8 GHz
(*cryogenic preamplifiers (<50K)*)

RT-32 antenna surface and backup structure renovation



RT-32 Antenna Control Units



RT-32 old and new motors in the azimuth and Elevation

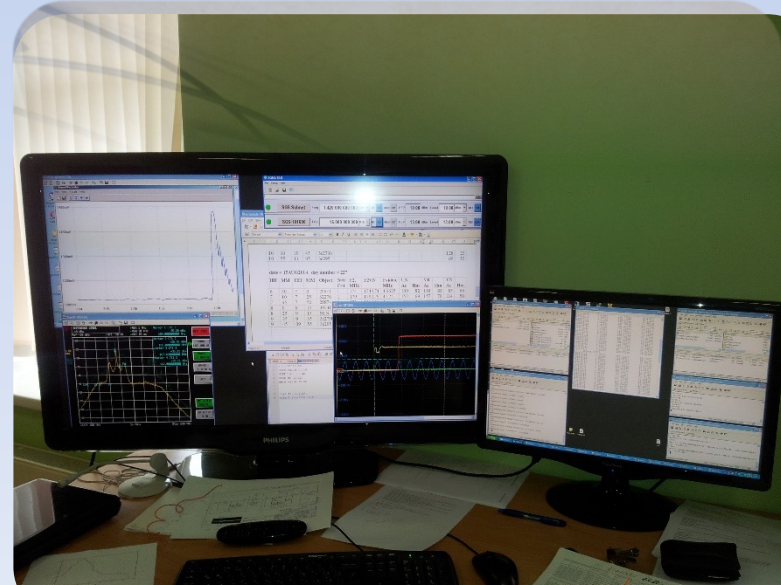


RT-32 horizontālās ass motoru komplekts, 2008/
RT-32 azimuth drives, 2008



RT-32 azimuta piedziņas dzinējs un reduktors pēc modernizācijas, 2015
RT-32 azimuth drive and gear box after modernisation, 2015

RF laboratory and telescope control system



RT-16: new 16 m antenna dish



RT-16 reflektora uzcelšana, 2015/
Lift-on of reflector of RT-16, 2015

RT-16: new 16 m antenna



RT-16 antenna control units

RT-16 mašīnzāle pirms modernizācijas, 2014./
Control room of RT-16 before modernisation, 2014



RT-16 mašīnzāle ar tiko uzstādītiem jaunajiem vadības un piedziņas sistēmas blokiem, 2015./
Control room of RT-16 with newly installed components of control and drive systems, 2015

YEAR – 2015

Radio telescope **RT-32**

32 meters Cassegrain antenna



Azimuth maximum velocity:
2.8 deg/sec 5 deg/sec

Elevation maximum velocity:
1.8 deg/sec 5 deg/sec

Azimuth range:
-328 - +328 deg

Elevation range:
2.7 – 90 deg

Az/El pointing precision: ~10
arcsec

Surface accuracy (RMS):
1.0 mm 0.1 mm

Working frequency range:
0.3 – 22 GHz 1.4 – 40 GHz

Radio telescope **RT-16**

16 meters Cassegrain antenna



Broadband cryogenic receiver 4.5 – 8.8 GHz

RF Sub-band	RF band (GHz)	IF Output (GHz)	Local Oscillator (GHz)	Image Band (GHz)	Main Working frequencies (GHz)
1	4.5 – 5.5	0.4 – 1.4	4.1	2.7 – 3.7	5.01
2	5.4 – 6.4	0.4 – 1.4	5.0	3.6 – 4.6	6.10
3	6.4 – 7.6	0.3 – 1.5	6.1	4.6 – 5.8	6.70
4	7.6 – 8.8	0.3 – 1.5	7.3	5.8 – 7.0	8.40 & 8.535 – 8580



2022

RT-32 performance overview:

C/M/X band system	Developer: TTI Frequency range: 4500 – 8800 MHz RHCP/LHCP Bandwidth: 1000 - 1200 MHz SEFD (C/M/X): 300 - 1300 Jy G/T: 44 dB/K Gain: ~0.1 K/Jy, 61 dBi System temperature: 30 - 50 K
L band system	Developer: VIRAC Frequency range: 1370 – 1720 MHz RHCP Bandwidth: 100 MHz SEFD : 1385 Jy G/T: 28 dB/K Gain: ~0.06 K/Jy, 49 dBi System temperature: 80 - 200 K

RT-16 performance overview:

C/M/X band system	Developer: TTI Frequency range: 4500 – 8800 MHz RHCP/LHCP Bandwidth: 1000 - 1200 MHz SEFD (C/M/X): ~700 - 800 Jy G/T: 41 dB/K Gain: ~0.05 K/Jy, 57 dBi System temperature: 30 - 50 K
L band system	Developer: VIRAC Frequency range: 1400– 1800 MHz RHCP Bandwidth: 60 MHz SEFD : 8600 Jy G/T: 20 dB/K Gain: ~0.02 K/Jy, 43 dBi System temperature: 180 - 250 K



Most interesting molecular maser lines:

OH – 1.6, 4.7, 6.035 GHz

CH₃OH – 6.7, 12.2, 25, 44... GHz

H₂O – 22.2 GHz



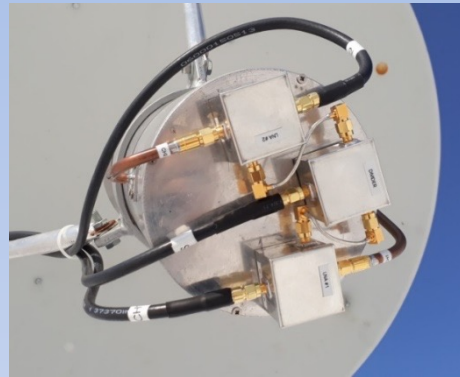
European Regional Development Fund (ERDF) project No.
1.1.1.1/16/A/213 “Studies of physical and chemical processes in the
interstellar medium”

L band receiver

- Frequency ranges: **1.4-1.6 & 1.6-1.72 GHz**
- LCP+ RCP polarizations
- Sensitivity: 700...800 Jy
- Noise injection cal., network remote ctl.



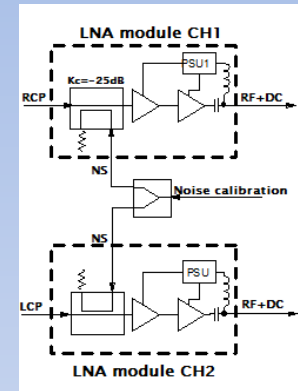
Feed antenna at secondary focus of RT-32 – tripple mirror system



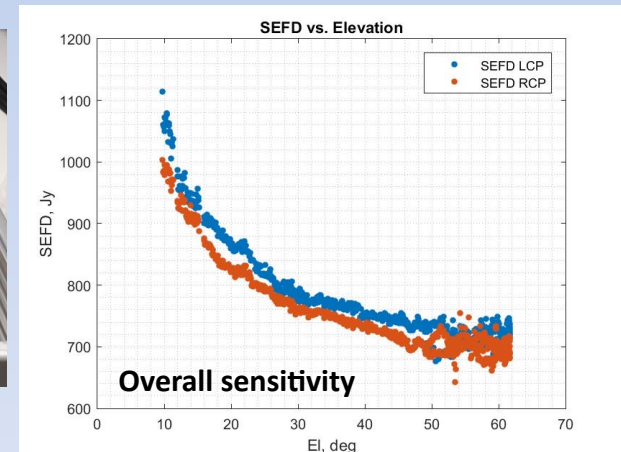
Dual circular pol. 'warm' front-end



IF Unit

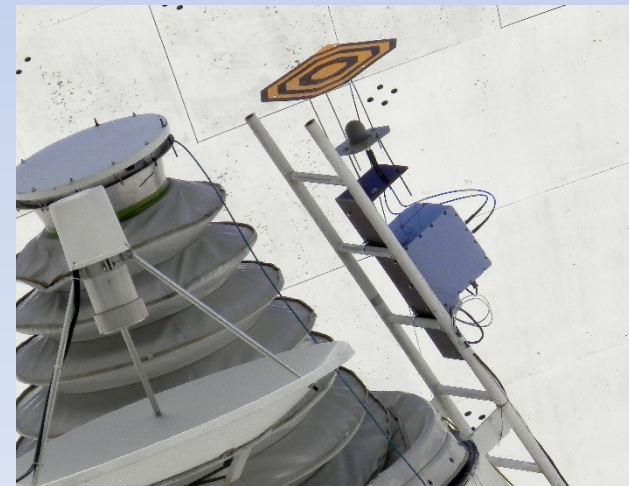
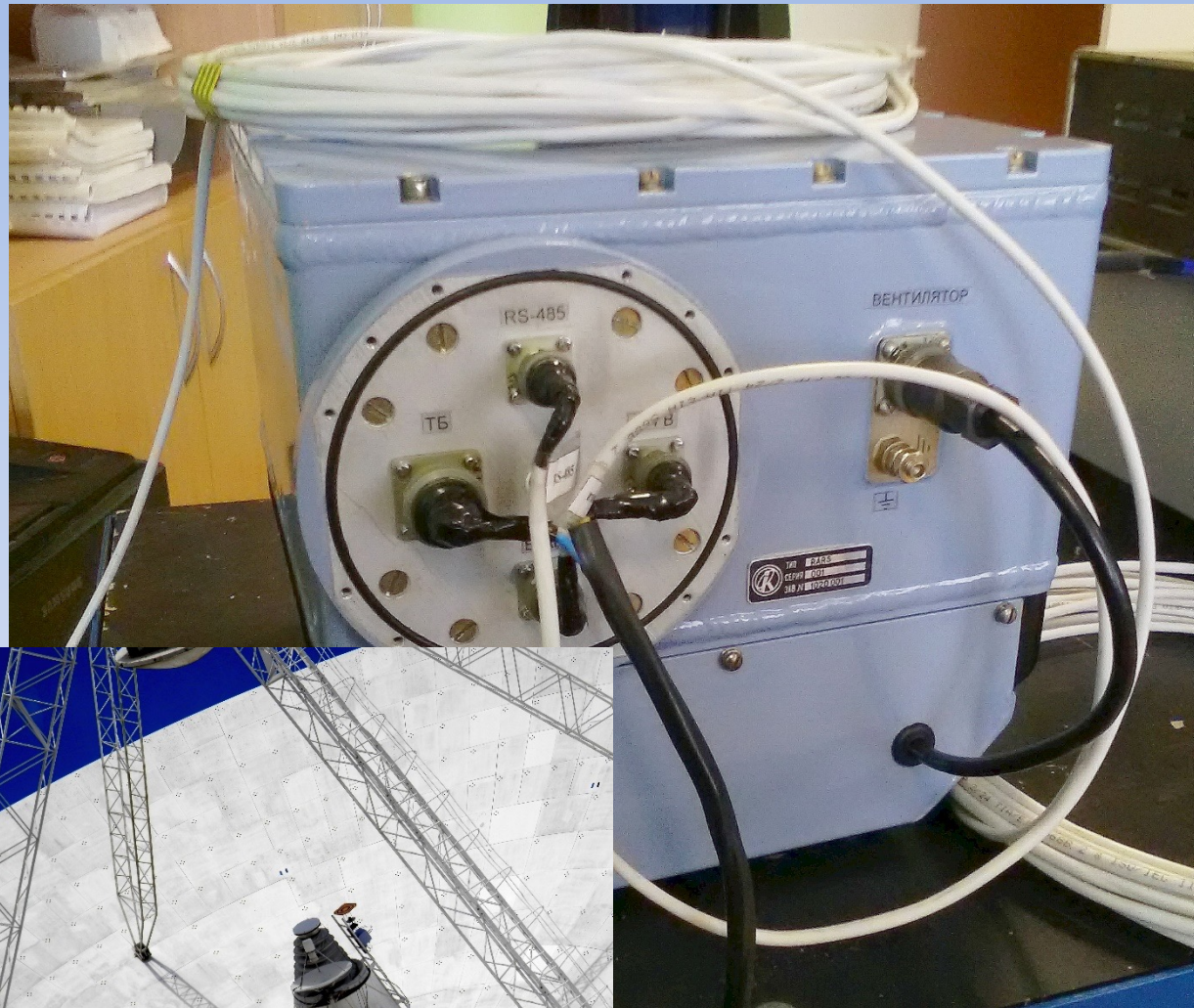


Block diagram of front-end



Bleiders, M., Berzins, A., Jekabsons, N., Skirmante, K., & Bezrukovs, V. (2019). Low-cost L-band receiving system front-end for irbene RT-32 cassegrain radio telescope. *Latvian Journal of Physics and Technical Sciences*, 56(3), 50-61. doi:10.2478/lpts-2019-0019

Microwave spectral polarimetric observations of the Sun with VIRAC RT-32 radio telescope (Dmitrijs Bezrukovs et al)



The new Low Noise Spectral Polarimeter ver. 4 (VIRAC LNSP4) for 2.1-7.4 cm under tests in the laboratory and onto the RT-32 radio telescope

Main developments and new capabilities after 2019:

- **Improved infrastructure resilience** – redundant power supply with diesel generators; backup connectivity via Starlink.
- **New computing and timing infrastructure** – 2nd-generation HPC (2019), active hydrogen maser and White Rabbit timing distribution network.
- **RT-32 upgrades** – secondary mirror positioning system (hexapod) and an enlarged receiver cabin enabling multiple off-axis receiving/transmitting systems.
- **In-house receiver development** – cryogenic X- and Ka-band receivers, with L/S-band development planned; in-house IF/up-down converters and SDR-based backends.
- **In-house feed systems** – concentric S/X- and X/Ka-band feeds developed, installed and operational.
- **Towards deep-space communications** – cooperation with SSC since 2020; SLA signed in 2024 for lunar and deep-space mission support.



Thank you for your attention!

Outside the scope of this overview:

- ☐ Activities not directly related to integration into radio interferometry networks
- ☐ Developments following accession to the EVN and LOFAR networks
- ☐ Single-dish observations
- ☐ Theoretical studies and the interpretation of observational results
- ☐ More recent after first, happened at 1999, solar research

