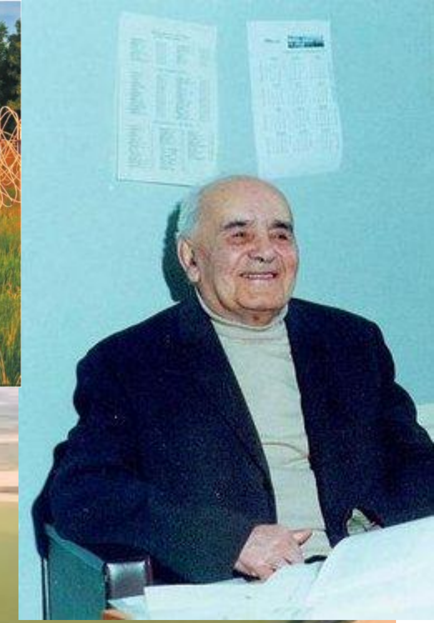
Universiteit Leiden

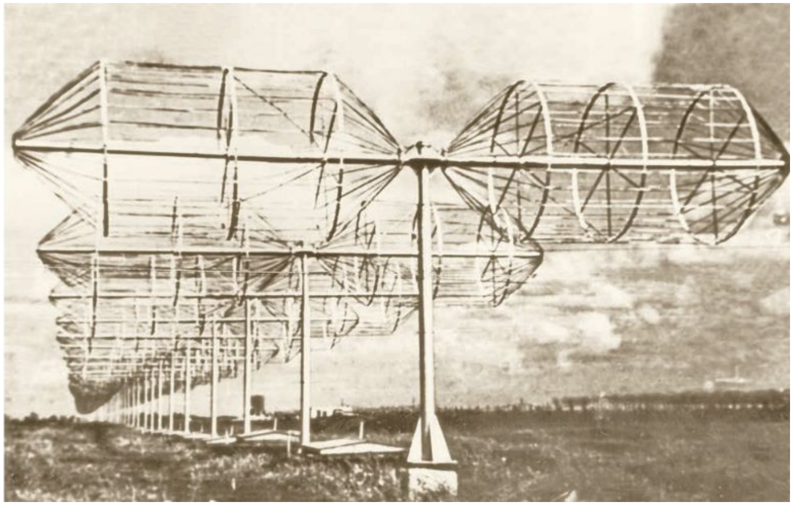
Institute of Radio Astronomy of the National Academy of Sciences of Ukraine

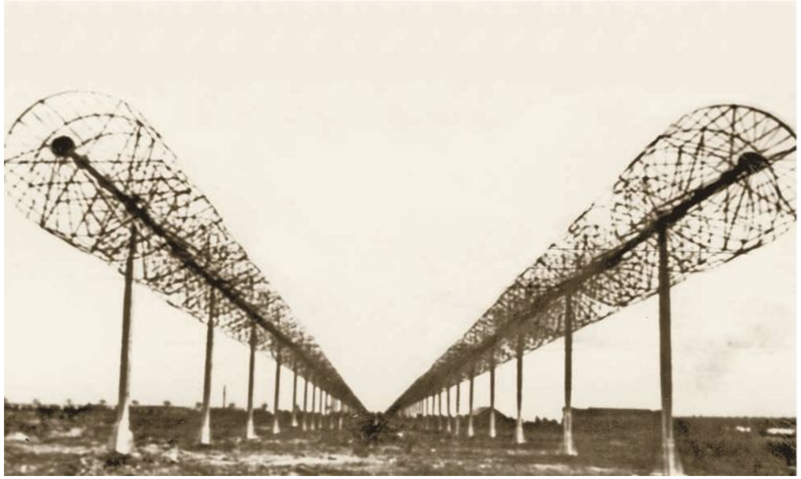
Vyacheslav Zakharenko, Oleksandr Konovalenko and Division of low-frequency radio astronomy of IRA NASU



Observatory named after S.Ya. Braude. UTR-2 radio telescope, A_{EFF} = 150,000 m^2

Institute for Radio Physics and Electronics of AS of UkrSSR Laboratory of Radio Astronomy, 1955





North-South and East-West Antennas of the UTR-1 Radio Telescope (**early 60s**)

1985 – Institute of Radio Astronomy of the National Academy of Sciences of Ukraine

Core areas of astronomical research - All freq., all distance, but main - Low-frequency **radio astronomy.**
Role in Ukraine's national research ecosystem - a leading institute in the field of **radio astronomy**

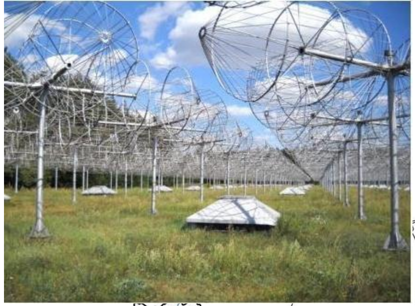
Staff structure (researchers -119, engineers > 30, admin – 6, additional staff ~ 60)

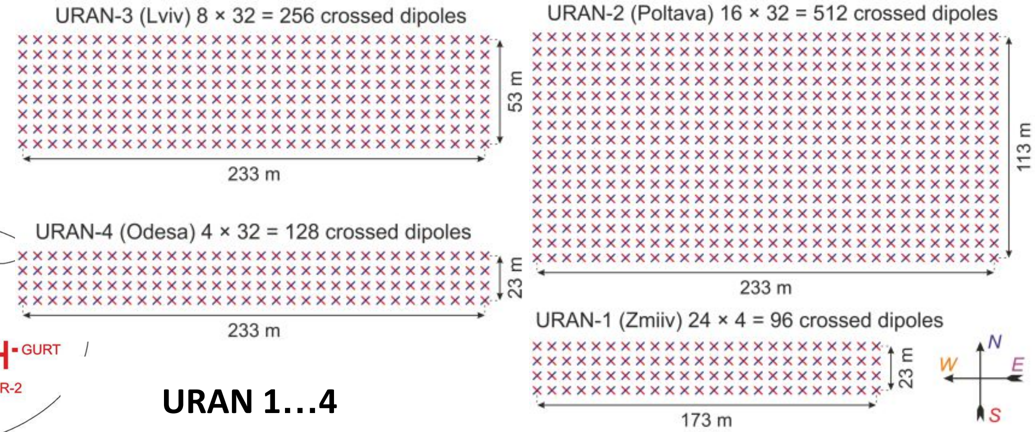
Main infrastructure (e.g. telescopes, data centres, laboratories):

- Radio telescopes **UTR-2, URAN 1-4 (National heritage), GURT**. **NenuFAR**
- **Radio observation data base**

Other departments: LF-observatory (geocosmos investigations), spectrometers, cryoelectronic center, etc.

Anniversary of the commissioning of the UTR-2 radio telescope. June 04 2021





URAN 1…4

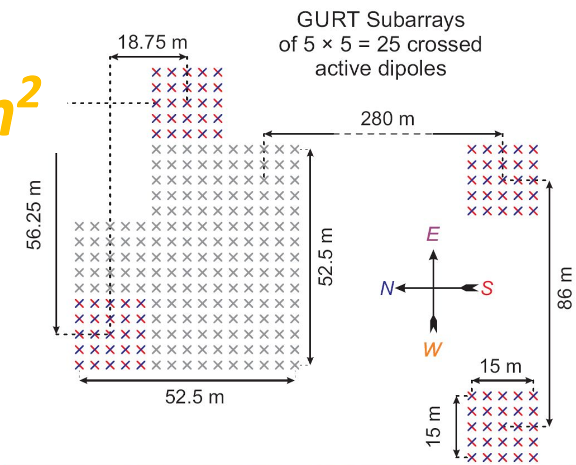
~ 55 000 m^2

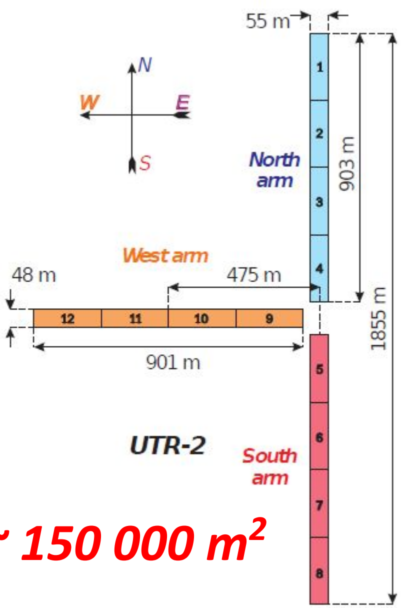
Σ ~ 200 000 m^2

GURT

N*400 m^2

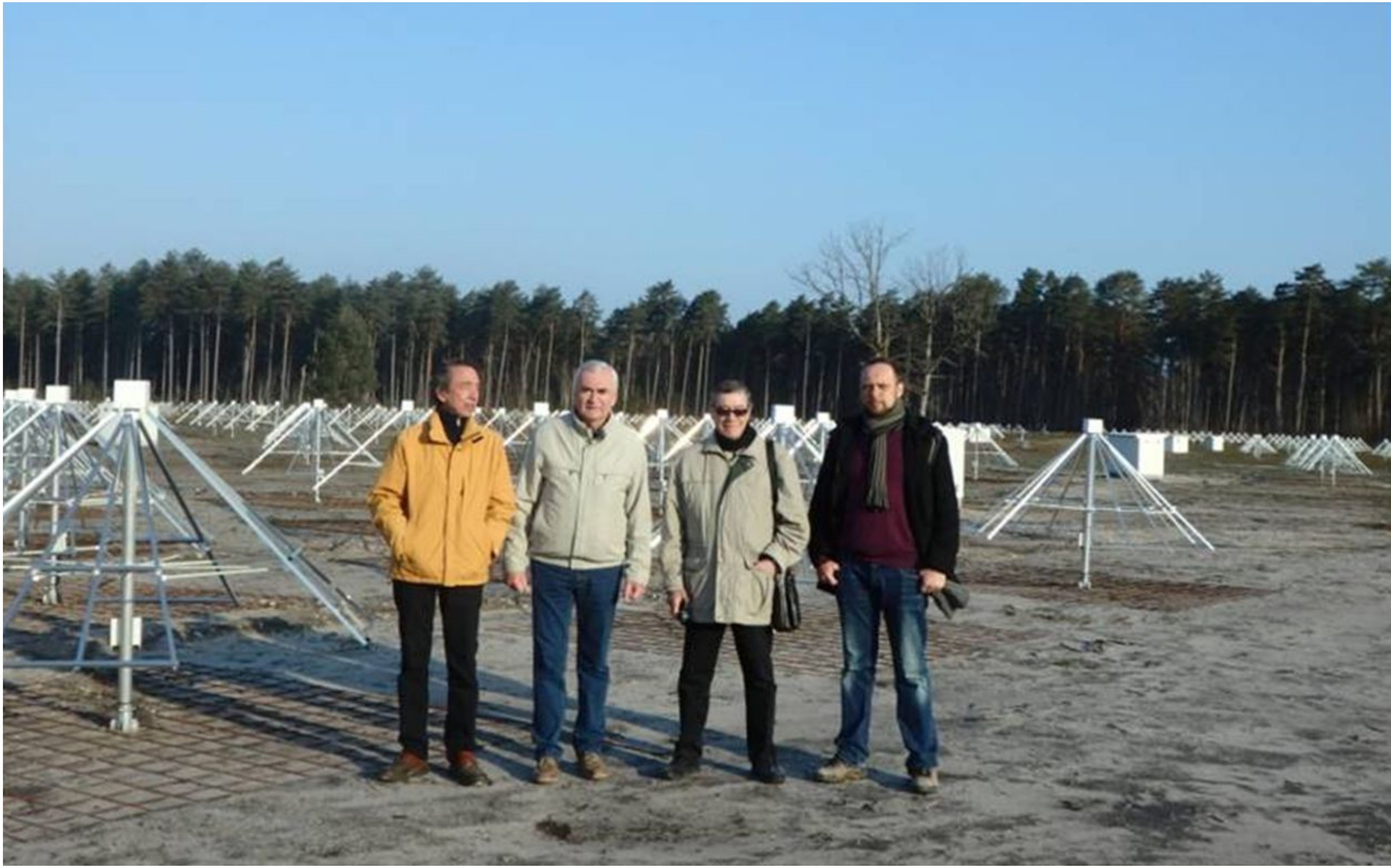
N = 11 (-> 40…100…)



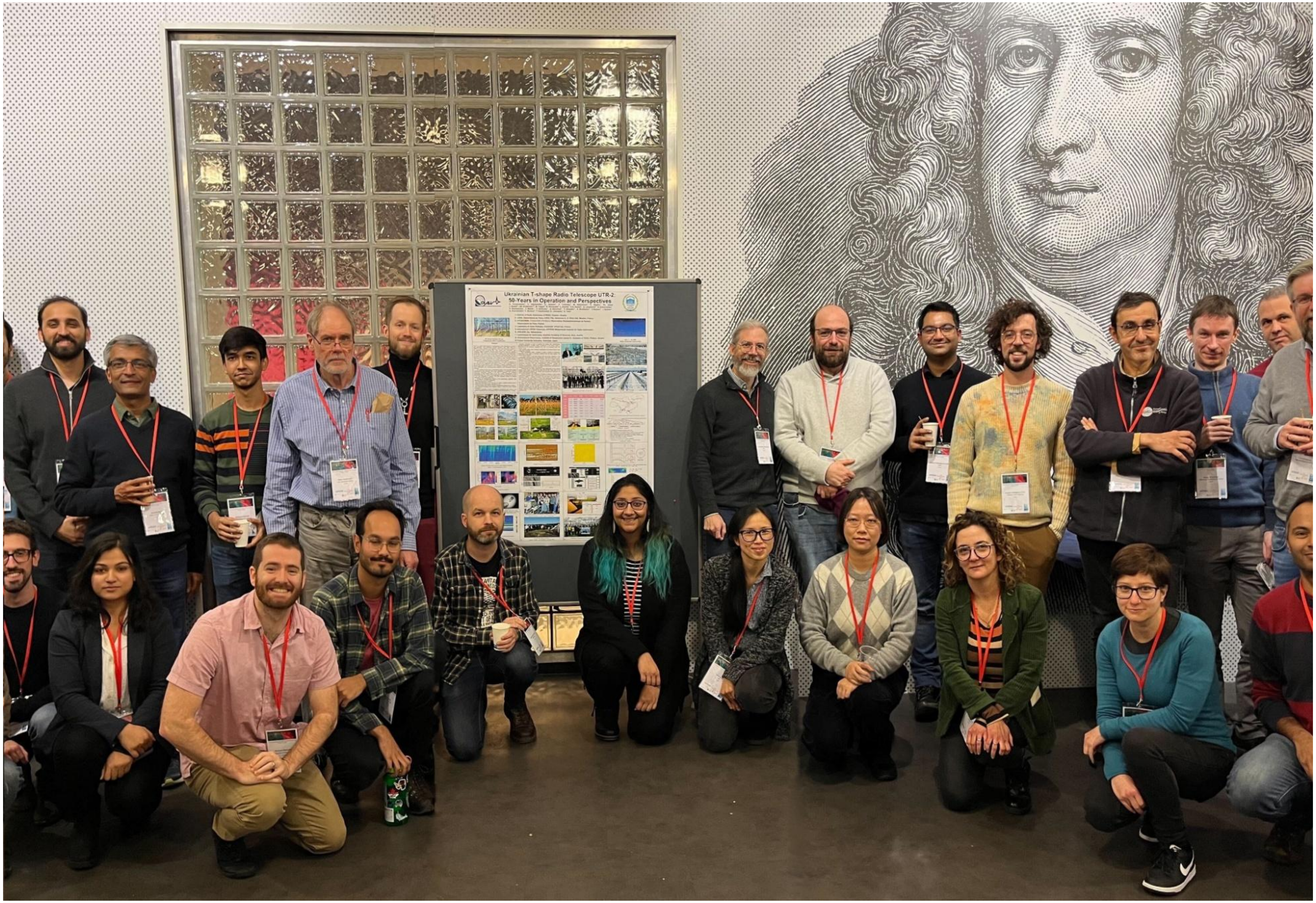


~ 150 000 m^2

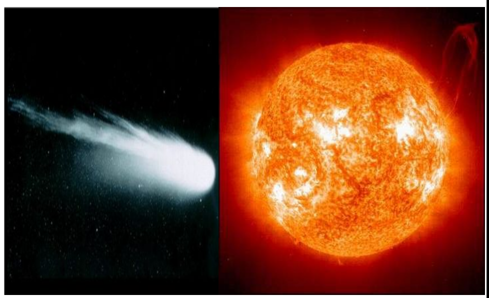
NenuFAR: created partly thanks to and with the participation of radio astronomers of Ukraine

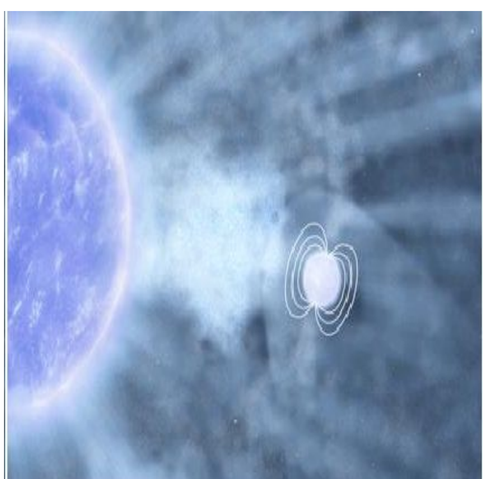


International support: near the Ukrainian poster at the 9th Annual Science at Low Frequencies (SALF) Conference (Netherlands)



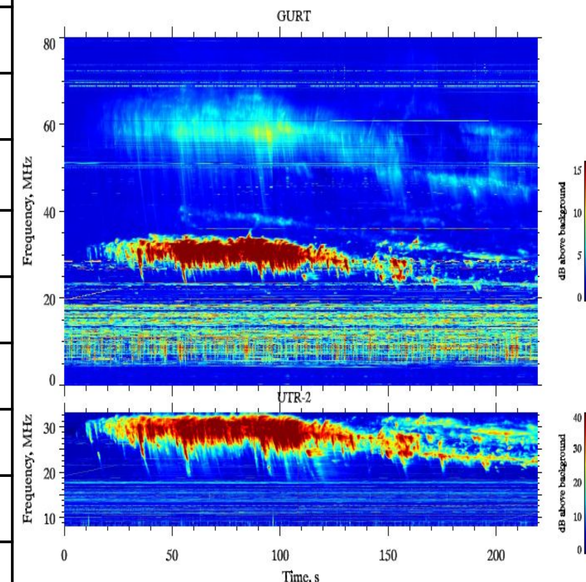
Main topics for low-frequency radio astronomy…



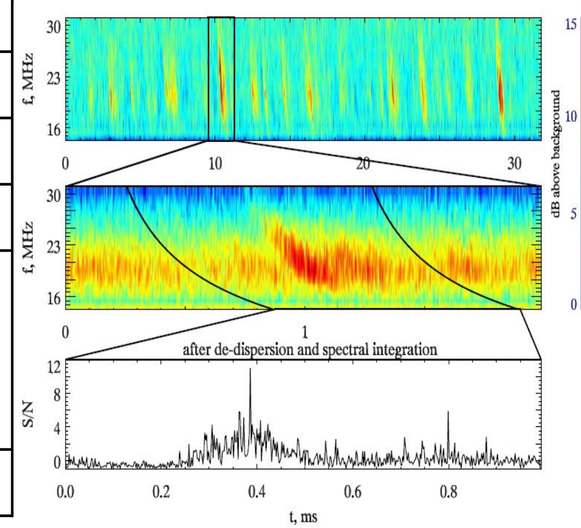


EARTH	Ionosphere	
	Magnetosphere	
	Cosmic ray air shower	
	Meteor events	
	Ground parameters	
SOLAR SYSTEM	The Sun	quite
		active
		radar
	Jupiter	
	Planets (Saturn): lightning	
	Interplanetary medium	scintillations
		VLBI
		RRL
	The Moon	occultation
		radar
		Cosmic ray Secondary radio emission
	Comets	

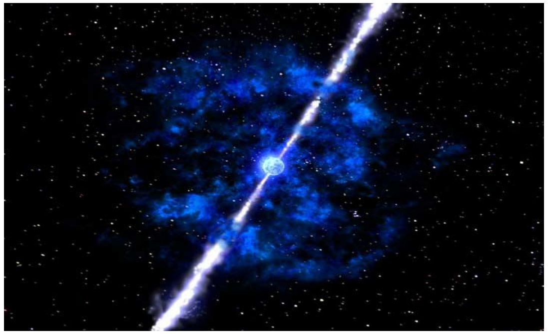
Sun: type II burst

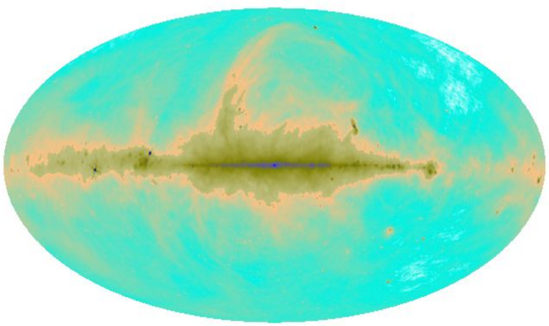


Saturn's lightning



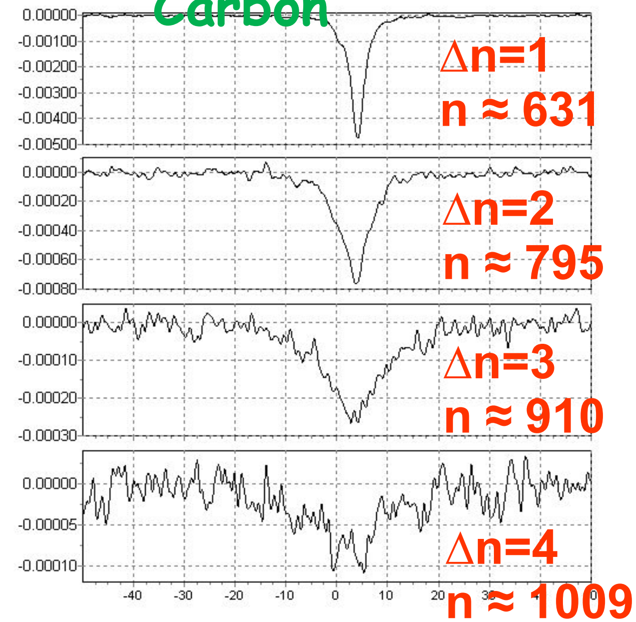
…main topics for low-frequency radio astronomy



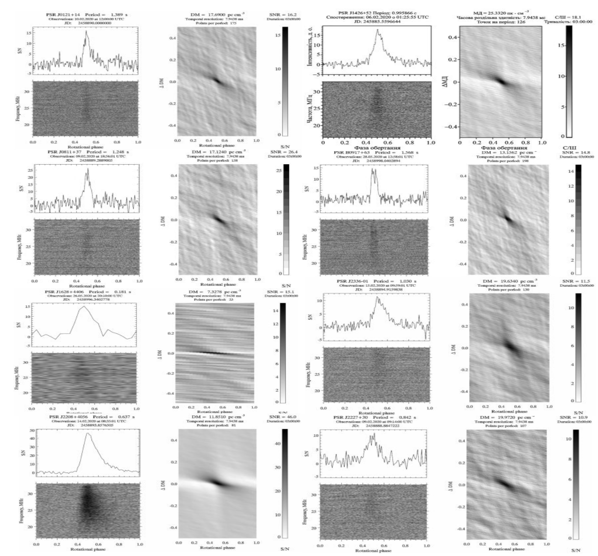


GALAXY	Pulsars
	Active stars
	Exoplanets
	Transients
	Non-thermal background
	Supernova remnants
	HII regions
EXTRA GALAXIC OBJECTS	Galaxies
	Radio galaxies
	Quasars
	Radio source catalogue
	Galactic cluster
	Unidentified objects
	Transients

The low-frequency radio re-combination lines of Carbon

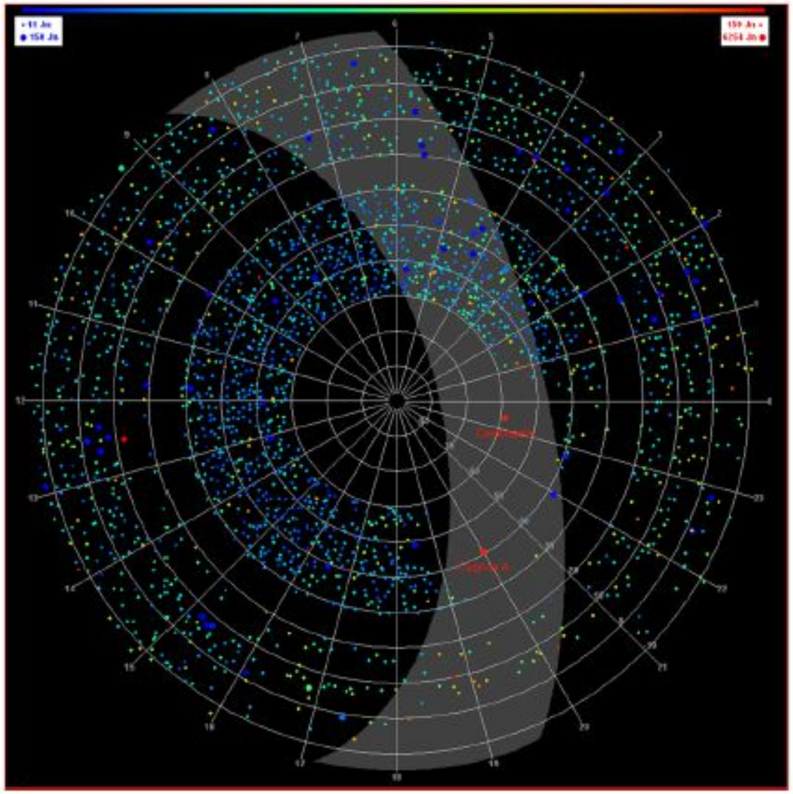


Pulsars



UTR-2: catalog of sources at frequencies of 10-25 MHz

Fig. 22 The Northern sky coverage by UTR-2 catalogues. Colors and sizes of individual sources represent their flux densities at 16.7 MHz. Note that the same color scale (shown at the top of the figure) is used to display the sources with flux densities from 11 to 150 Jy (small dots) and from 150 to 6254 Jy (larger dots). 167 sources are not displayed in the diagram as unreliable ones, not detected at the frequency of 16.7 MHz (see [8]). The Galactic disk area is indicated with grey color: $|b| < 15°$



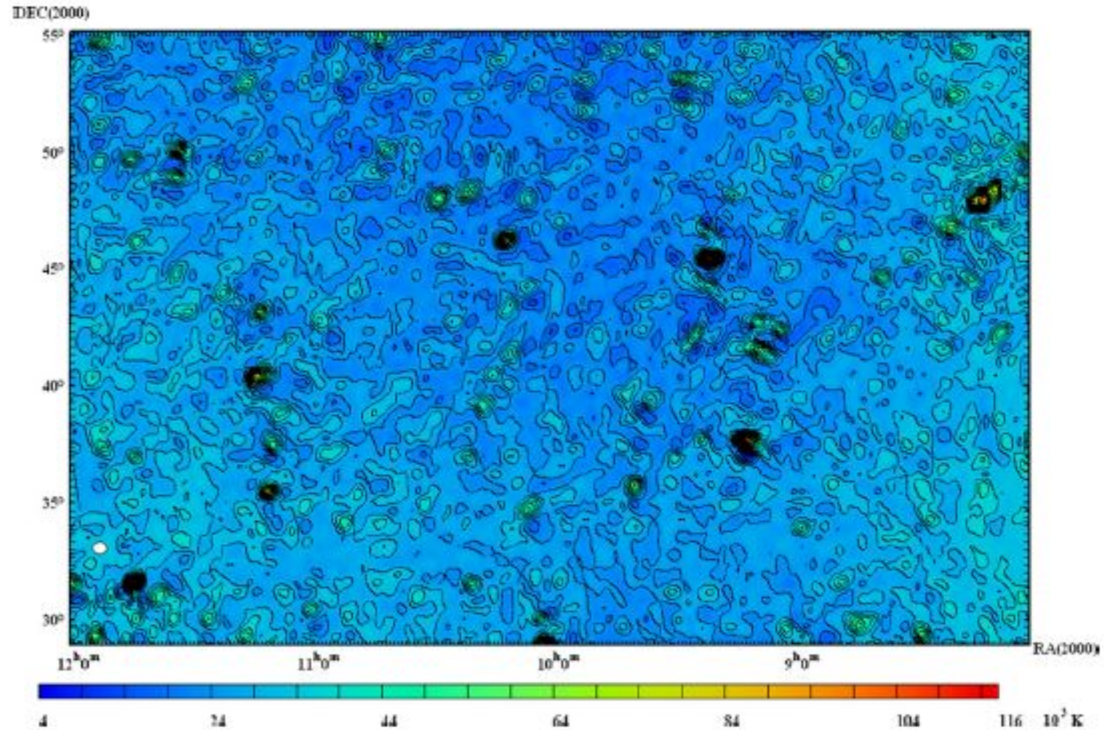


Fig. 23 UTR-2 full resolution image. HPBW is $\sim 34' \times 38'$ that is indicated with a white ellipse close to the left bottom corner of the map. It represents a brightness temperature map of a part of Northern sky outside the Galactic disk where temperatures do not exceed 50×10^3 K at 20 MHz. The contour lines start at the level of 5×10^3 K and have a 5×10^3 K contour interval

UTR-2 * URAN-2: background map at frequencies of 10-25 MHz

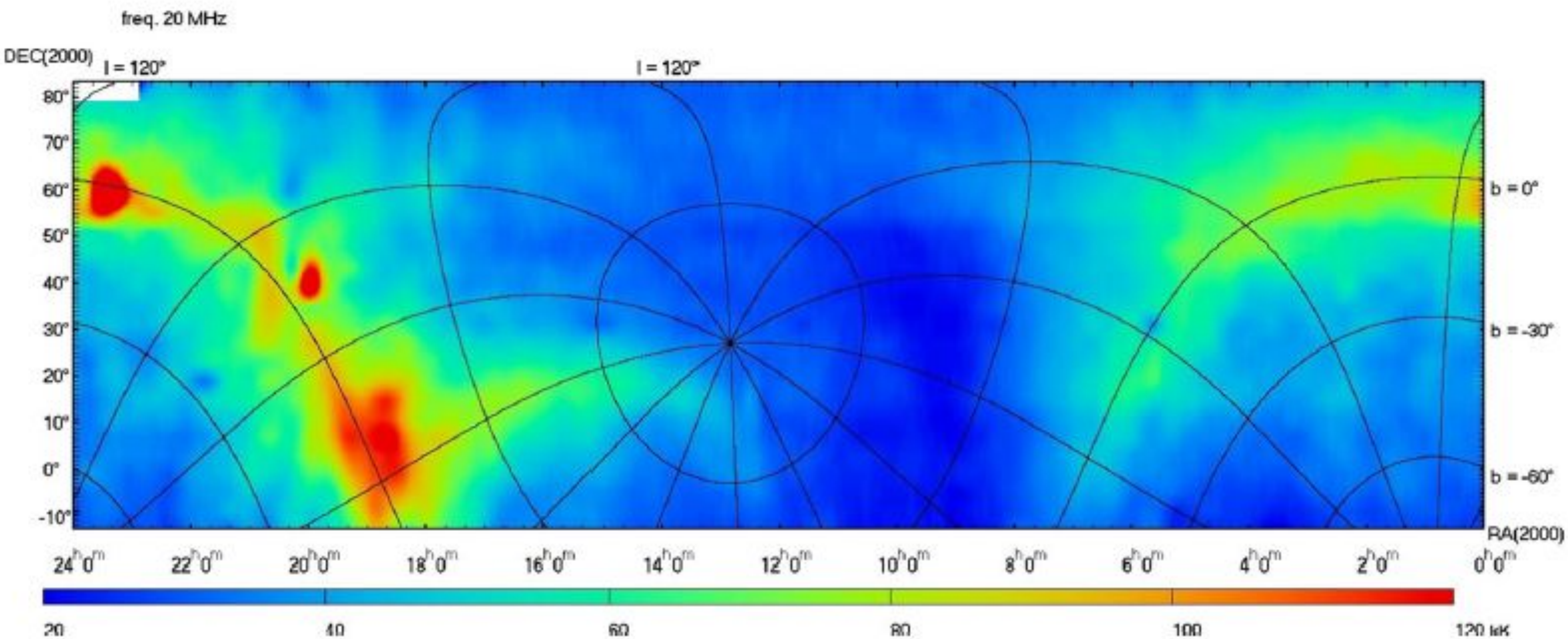
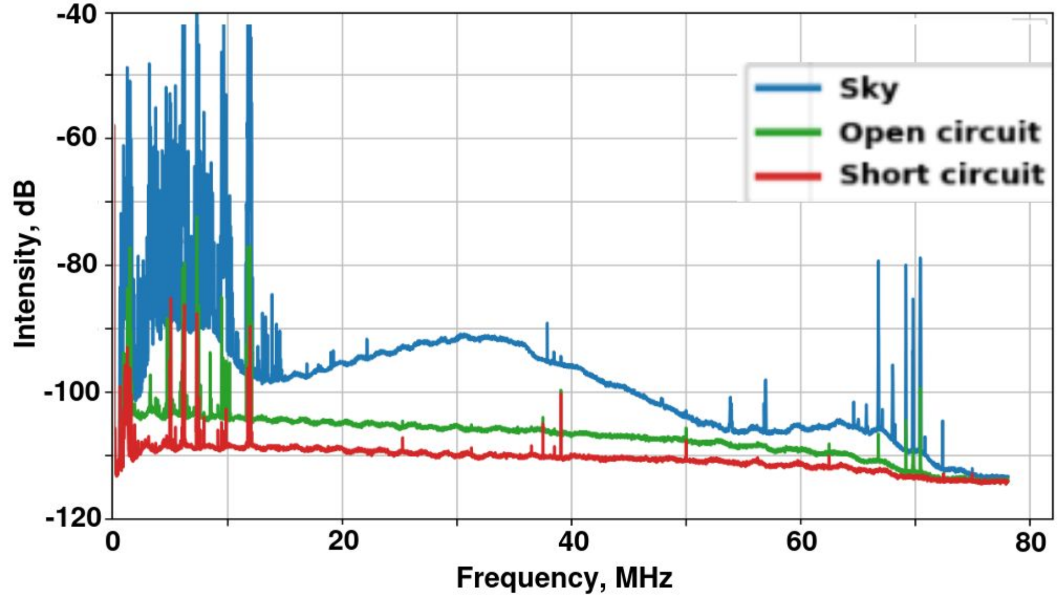


Fig. 21 Large-scale brightness temperature map of the Northern sky at 20 MHz. The map was produced by observing with one of the UTR-2 North–south sections combined with the entire URAN-2 radio telescope. HPBW ($\alpha° \times \delta°$) was ~ 11° × 7° near the zenith direction (~50°). Map is represented in equatorial coordinates superimposed on galactic coordinates (l and b) with angular step of 30°. The color scale is in units of kilo-Kelvin

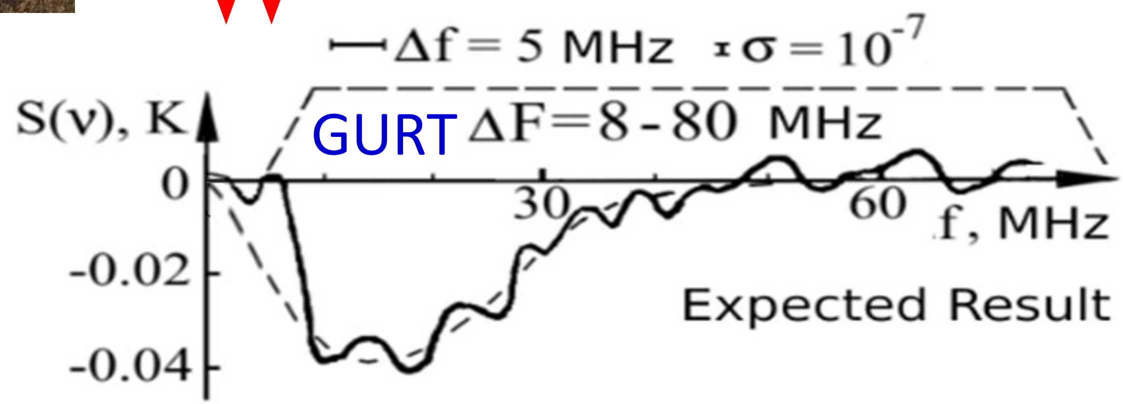
Frequency capabilities of «Far side RT»-antenna

Bubnov et al. Radio phys. radio astron. 2021, 26(3)



Night Day

NenuFAR



1. Antenna characteristics,
2. Underlying surface,
3. Impedance matching (VSWR),
4. Intrinsic noise,
5. **Calibration.**

Dark Ages HI redshirted line: $z \sim 87$, $f_c = 16$ MHz

Observatory named after S.Ya. Braude. Of the 17 buildings of the observatory, 1 was completely destroyed, 1 burned down. The others were partially destroyed

Before 24.02.2022

After 04.09.2022

The control panel (power supplies) was destroyed and the beam forming unit was damaged.

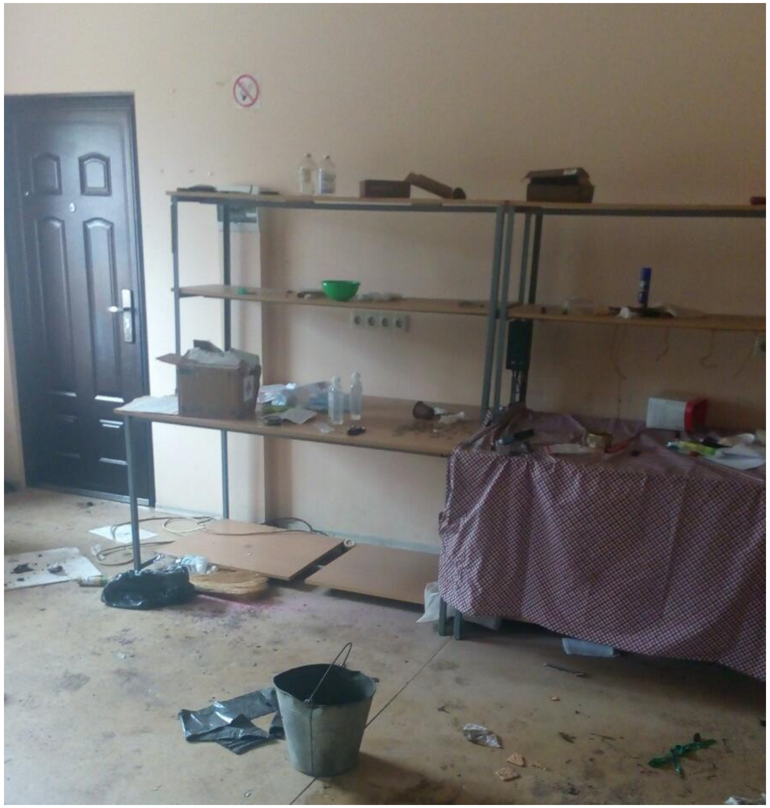
Before 24.02.2022

After 04.09.2022

All digital receiving equipment was dismantled and stolen.

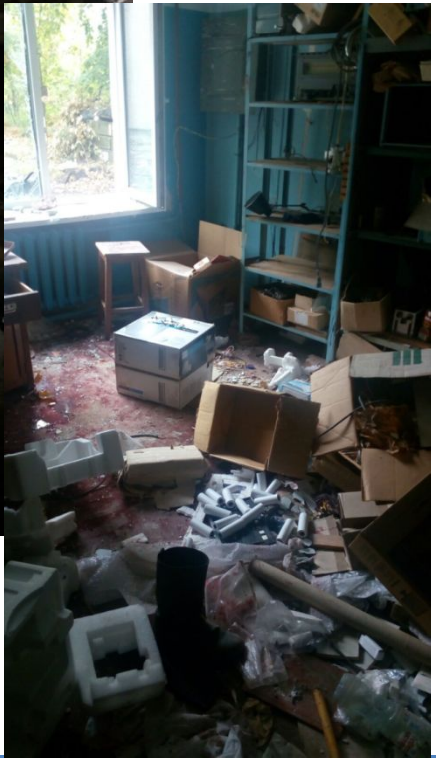
Before 24.02.2022

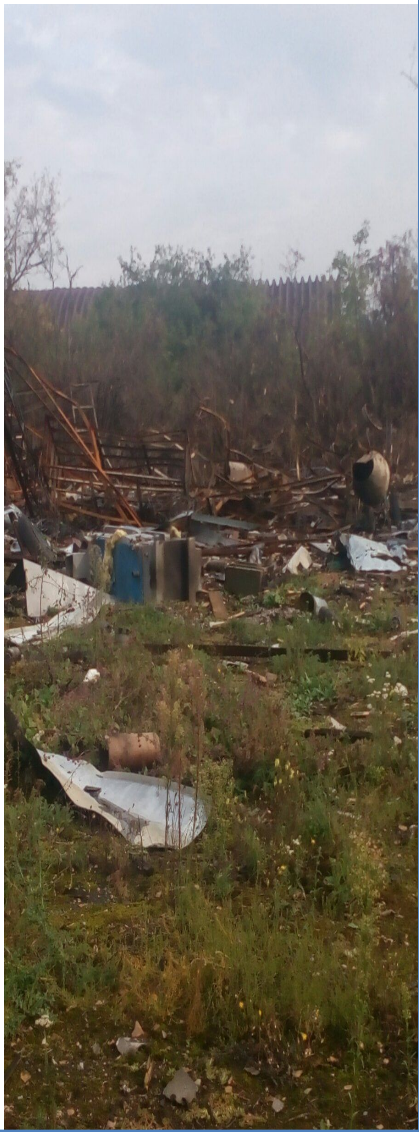
After 04.09.2022



1 receiver for GURT was saved and a frequency synthesizer for the receiver was repaired and installed on URAN-2

Destruction and disorder in the hall and laboratory, the demolished roof of the central building and the disappearance of the "cold" warehouse

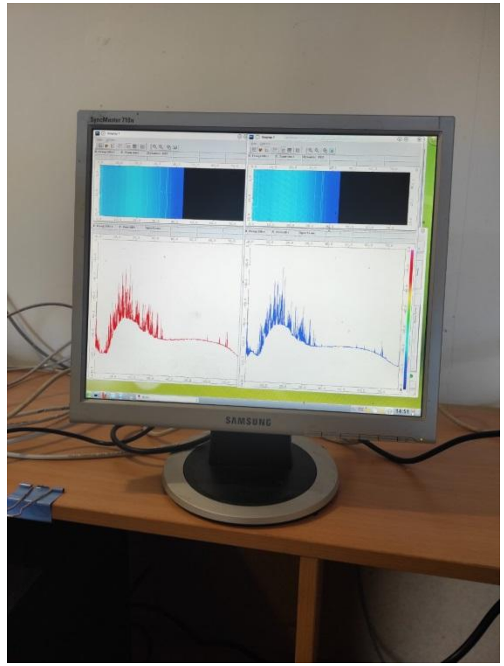



After 04.09.2022

A solar power plant was installed at the Radio Astronomical Observatory named after S.Ya. Braude

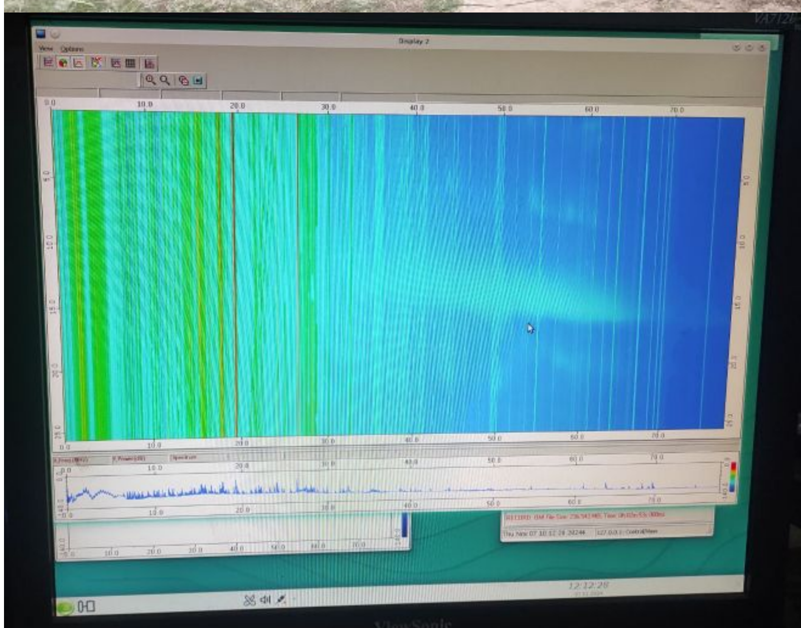
Current GURT status: RESTORED



GURT sections on URAN-2 radio observatory

First section

2nd section
(Jun 02, 2025)



GURT. Poltava. Sun.
(Nov 03, 2024)

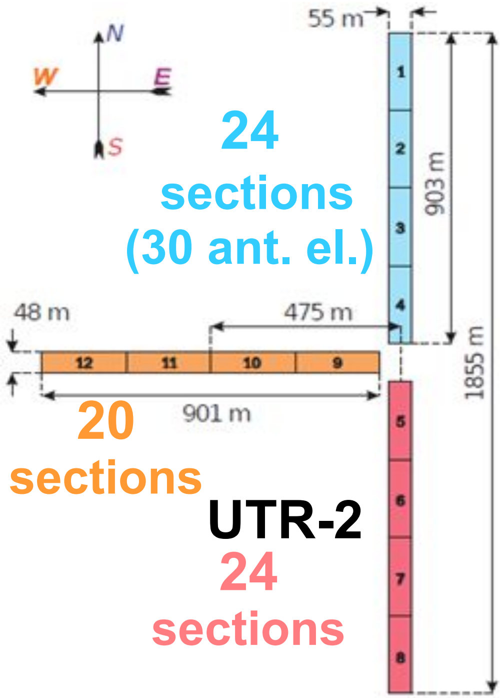
Restoration/modernization of UTR-2: expansion of phasing capabilities (as in GURT and NenuFAR); interaction with LOFAR

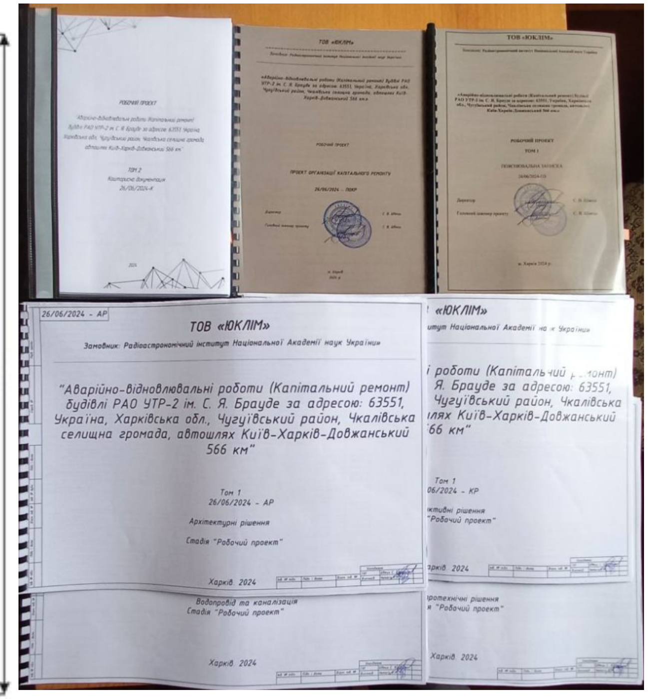
UTR-2

Currently: 12 sections, analog phasing, 5 beams.

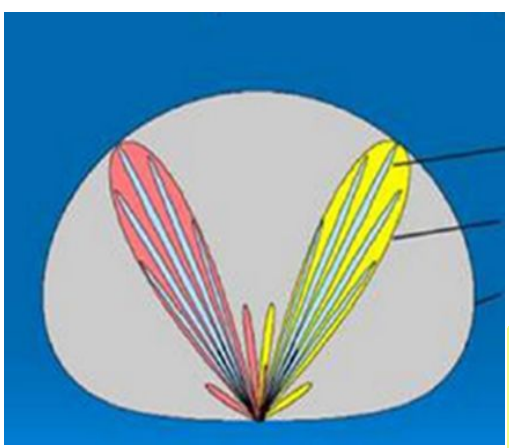
Proposed:

68 subsections of 30 antenna elements with digital phasing using the **digital phase system** like the LOFAR “Cabinet” (also used in the NenuFAR radio telescope), ~1000 beams (image pixels).





Major renovation project (~0.5 million Euros)



Directionality diagrams :

telescope (digital phasing)

subsection (analog phasing)

antenna element

Radio images at the lowest frequencies

A Horizon Europe grant (Netherlands, France, Poland, Ukraine) has been prepared **to restore and modernize UTR-2.**

(1.5 million Euros, 3 years) «UPSCALE»

UKRAINIAN RADIO TELESCOPES. “UPSCALE” IS THE PATH TO RECOVERY

UPSCALE

Ukrainian Participation in the Science Community for Astronomy at Low frequencies in Europe

IAU Meeting, Leiden 10-13 June 2025

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2025

Vision for recovery and development in the next 3-5 years.
Potential contributions to international networks.
Specific needs and proposals for partnership (e.g. joint research, equipment, staff exchanges).

- **IRA NASU** continue to work on the **URAN, GURT, NenuFAR** radio telescopes and the **UTR-2 observation database**.

- The restoration of **UTR-2**, which is - without exaggeration - a scientific heritage of humanity, requires:

- 1) restoration of buildings and infrastructure elements, which requires only funding, and

- 2) modernization of **the phasing system** and new **digital receivers**.

- Proposals such as **UPSCALE** are the most appropriate both in terms of the **effectiveness** of restoration and modernization, and in terms of **international cooperation**.


Thank you for
attention!