Advances in solar bursts observations by the low-frequency radio telescopes of a new age

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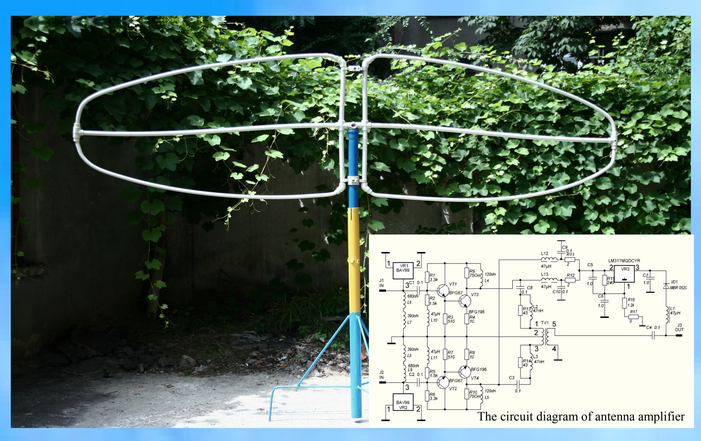
Introduction. Observations of solar radio emission and the influence of solar activity on interplanetary medium, magnetosphere, ionosphere and atmosphere of the Earth is one of the most important task today. Such observations should be carried out in a wide frequency range and with high time-frequency resolution to detect a fine structure of sporadic radio bursts. A great variety of the bursts is observed at frequencies below 100 MHz. This is one of the main reasons to devote so much observational time for the study of solar radio emission in scientific programs at modern low-frequency instruments such as LOFAR, LWA and so on [1].

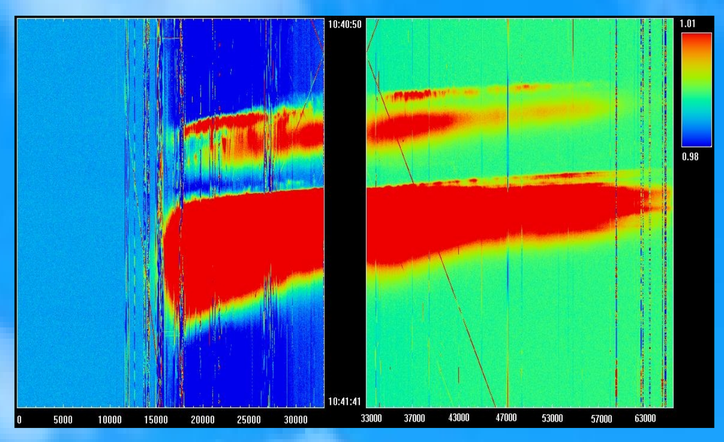
- **Observations.** A short description of the sub-array of new low frequency Giant Ukrainian Radio Telescope (called briefly GURT) and recent results of radio astronomy observations with help of this instrument within 10-70 MHz range are presented [2,3]. Examples of solar III and III-B type bursts are shown. A very rare phenomenon, the solar low-frequency U-burst, which is generated by electrons moving along closed magnetic field lines at solar corona, has been registered [4]. Wideband observations in decameter and meter wavelengths ranges considerably raise the probability of burst registrations in harmonic pairs. Such pairs are generated at first and second harmonics of electron plasma frequency. Examples of the phenomena registered in 2012 and 2014 are given. In addition the records of ionosphere scintillations of cosmic radio sources which can be used for studies of ionosphere conditions in the place of radio astronomy observations are presented.



The outward appearance of the active dipole (one linear polarization) [2]. Its arm is 1.4 m long, the width near the feed point is 0.9 m, and the height above ground is 1.6 m.

The parameters of the antenna element

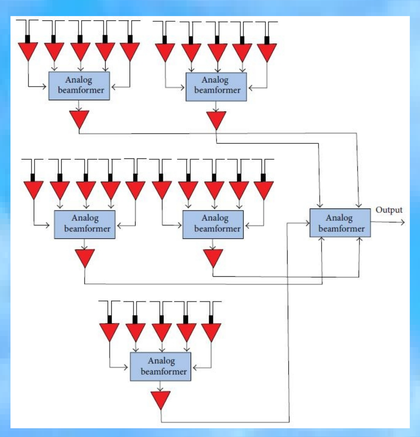
Frequency range 10-70 MHz
Gain of amplifier 16 dB
Output IP2 - 86 dBm; input IP2 - 70 dBm
Output IP3 - 47 dBm; input IP3 - 31 dBm
Output P1dB - 19 dBm



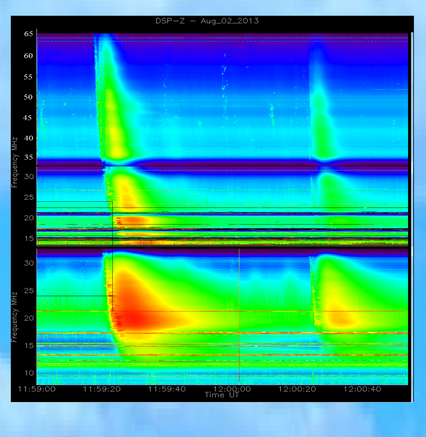
An example of the registration of the sporadic solar radio emission. The dynamic spectra of III type solar burst on the output of the active dipole.

The sub-array of GURT is a square regular antenna array using active dipole techniques. Antenna array represents flat rectangular construction, consists of 5 rows along the East-West line, 5 active dipoles in each row. The distance between active dipole centers along and across rows equals 3:75m. All the active dipoles in the antenna array located on the height 1.6 m above the ground and oriented under the angle 45 degrees to the East-West direction. Wideband highlinear active dipoles are using as entrance vibrators of array to provide a work band equal to 10 - 70MHz.

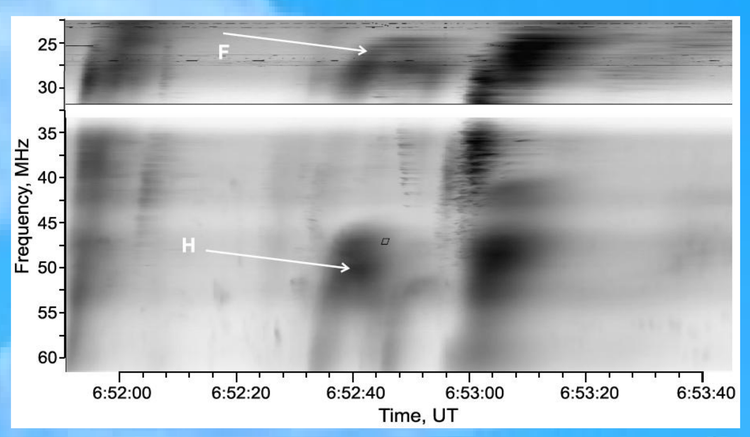
Active antenna array of 5 × 5 elements as a basic part of the GURT radio telescope.



Block diagram of the active antenna array in one polarization.

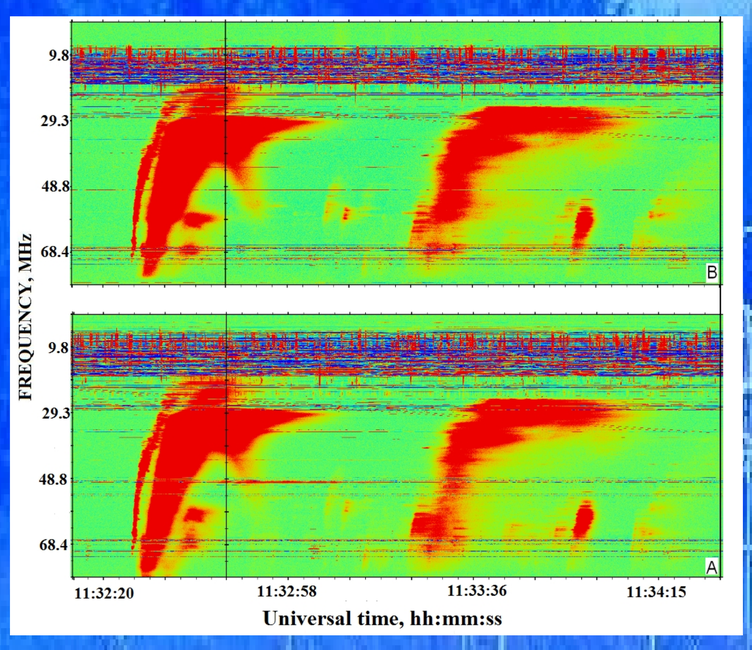


Test of the new radio telescope GURT(10-70 MHz) in the comparing with well-known radio telescope UTR-2 (1-30 MHz)

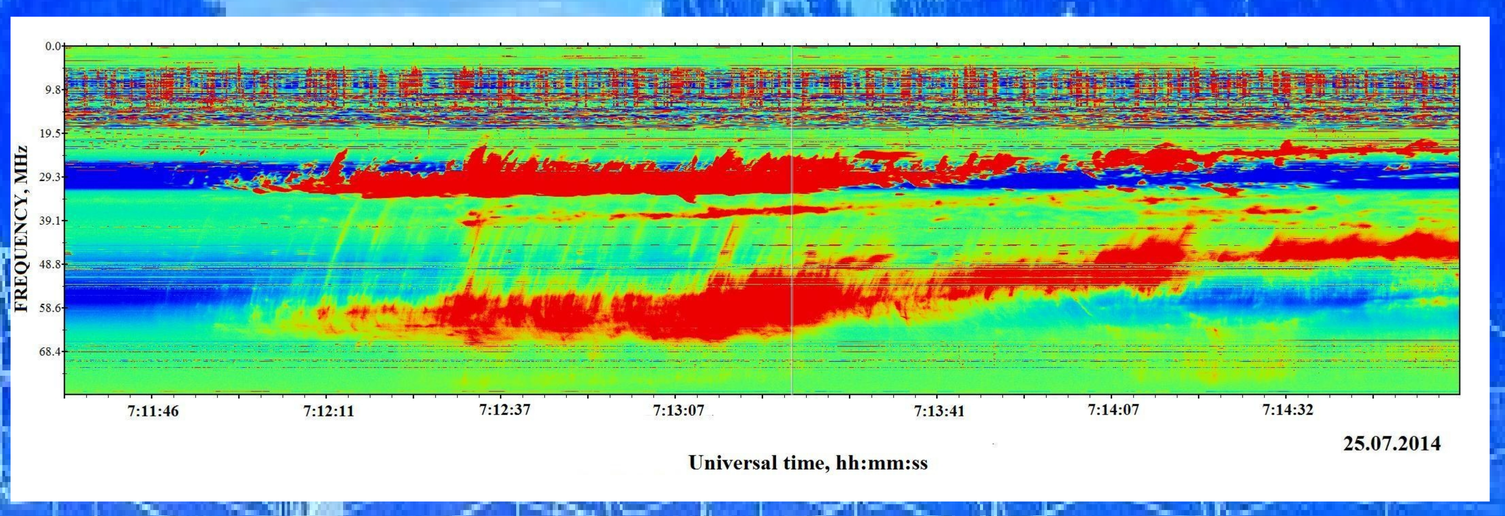


Dynamic spectrum of the solar low-frequency U-burst harmonic pair observed on 8 August 2012. The fundamental component is marked as F, the harmonic component as H [4].

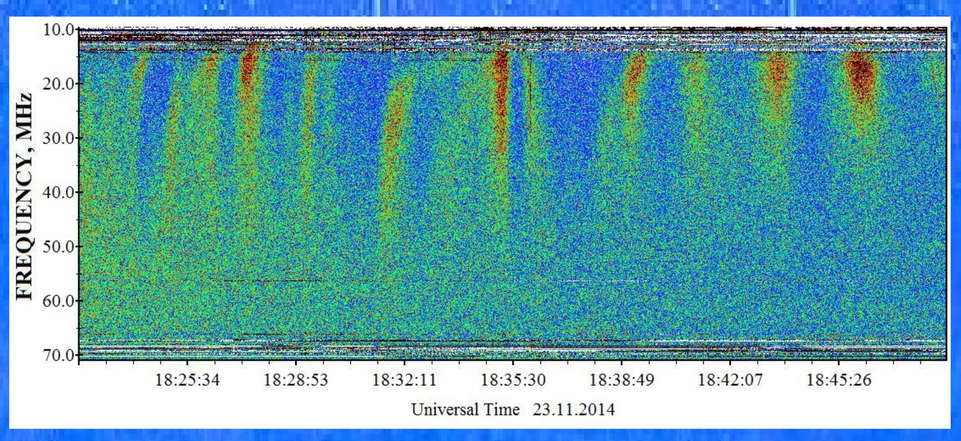
We continue to observe the radio emission from the Sun at the new radio telescope. Its design allows to make observations using two polarizations. Below you can see the Solar bursts registered in summer of 2014.



The types IIIb-III and III solar radio bursts obtained from observations with GURT on July 24, 2014. The panels show 2-minute records of dynamic spectra of these events. The records were obtained within 0 – 80 MHz at the same time resolution under 20 kHz frequency resolution for two orthogonal polarizations.



The type II solar radio bursts obtained from observations with GURT on July 25, 2014. The burst observed not only at the the fundamental frequency, but also at doubled fundamental or harmonic frequency (fundamental-harmonic structure). Both harmonics have got a “herringbone” structure. Fundamental frequency also have got a band-splitting. The panels show 3.5-minute records of dynamic spectra of these events.



Dynamic spectra of the signal from radio source 3C461 (Cas A) with typical ionosphere scintillations. Dynamic spectra obtained at sub-array of GURT in the course of observation of radio source 3C461 on Dec. 2014.

- **Conclusion.** The presented results show that the built GURT sub-array can be used for intensive studies of sporadic solar radio emission as well as ionosphere scintillations. Further extending of GURT radio telescope effective area with building new additional sub-arrays will allow increasing the spatial resolution for solar observations and using methods of both ionosphere and interplanetary scintillations for measuring the parameters of ionosphere and interplanetary media (study of solar wind).

- **References.**

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