THE DAILY 110 MHZ SURVEY (BSA FIAN) IN THE ON-LINE MODE: DATABASE AND PROCESSING METHODS

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ABSTRACT. From 2012 on radio telescope BSA FIAN multi beams diagram was started. It capable at July 2014 daily observing by 96 beams in declination -8 .. 42 degrees in the frequency band 109-111.5 MHz. The number of frequency bands are from 6 to 32, the time constant are from 0.1 to 0.0125 sec. In receiving mode with 32 band (plus one common band) with a time constant of 12.5 ms (80 times per second) respectively produced 33x96x80 four byte real and so daily we produced 87.5 Gbt (yearly to 32 Tbt). These data are enormous opportunities for both short and long-term monitoring of various classes of radio sources (including radio transients) and for space weather and the Earth's ionosphere monitoring, for search for different classes of radio sources, etc.

Key words: radio survey, monitoring, database.

1. Observation

From 2012 on radio telescope BSA of LPI multi beams diagram was started. It capable at July 2014 daily observing by 96 beams in declination -8° < δ <+ 42° in the frequency band 109.0 – 111.5 MHz (Oreshko et al., 2012).

The number of frequency bands are from 6 (417 kHz for each band, "small observational mode") to 32 (78 kHz for each band, that called "big observational mode") and the time constant of observational data from 0.1 sec ("small observational mode") to 12.5 ms ("big observational mode"). Thus continuous daily survey for most of the observed part of the sky is not yet over none observatories worldwide. Observations are carried out for more than two years, in a day is usually written from 2.3 GBT (small observational mode that have 6 bands and a time constant of 0.1 seconds) and per year – 0.8 TBT data. In big observational mode with 32 band (plus one common band) with a time constant of 12.5 ms (80 times per second) respectively produced 33x96x80 four byte real numbers and so daily we produced 87.5 GBT (yearly to 32 TBT).

In May 2014 work was completed for updating of our soft and multi-channel digital recording complex was rebuild. It is now possible to register at the same time in two different modes: small mode (6 bands of 10 times per second for 96 beams-channels) and big mode of observation (32 frequency bands 80 times per second for 96 beams-channels).

The big observational mode is need in the near future for the purpose of searching radio transients of different species. At the end of October 2014 we accumulated over three months of observations "heavy" format (total volume of about 10 TBT).

2. Database and data processing

The big observational data need in constructing special database. Already an experimental database for the period from 7 July 2012 up to the 20th of October 2013for more than 20 parameters are calculated for each beam for every 5 seconds (more than 8 million time points). By these data almost one million images was built (see Figure 1). By the end of 2014 will be finished work on the base data in on-line on the site http://astro.prao.ru/. From the database can be produce different ways of processing the observations, including by remote observers.

Highlight the fact that it was placing the compressed data in the sql database formats allows us to use the power of selection, sorting, matching, filtering and initial processing of data by means mechanism of standard sql commands. This will greatly simplify the interaction and the comparative analysis of the data for different sorts of data and their cross-temporal analysis, averaging etc. These data are enormous opportunities for both short and long-term

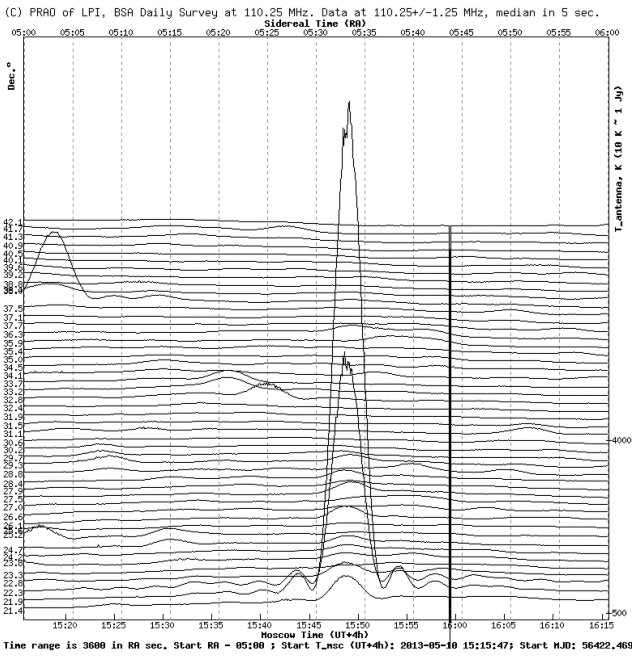

Figure 1: Example of multi beams observational data from BSA of LPI at 13 May 2013 (shows the source 3C 144 in bottom of the figure and calibrating signal to the right).

monitoring of various classes of radio sources (including radio transients) and for space weather and the Earth's ionosphere monitoring, for search for different classes of radio sources, etc.

As a result, as shown by preliminary estimates, we may reach the velocity of data processing practically in on-line mode (with a time lag of no more than 2-3 hours after the observations). All data – like the original observations and the results of processing on various scientific objectives will be continuously displayed on the PRAO of LPI web-site. For public use, it will be displayed in graphical form, as participants work will be available and the data in digital form.

In the total database and data reduction it can be also included on the basis of mutual benefit and the most low-frequency survey observations in word from the Ukrainian radio telescope UTR (Vasylieva I.Y. et al).

3. The future results of data processing and scientific aims

From a scientific point of view, the data held by the observations allow a high sensitivity to capture all sources of cosmic radio emission from a specified portion of the sky.

The classes of problems that can be solved in this monitoring system is unusually wide, and it is not only the fundamental scientific problems, but also problems of applied sciences. The proposed project allows to continuously monitor the celestial radio sources in most parts of the sky on time scales from milliseconds to years (this feature is implemented first time in the history of astronomy). Only briefly list the main science aims:

1) Monitoring of the ionosphere state and its fluctuations (with a characteristic time scale of tens of seconds). The task is closer to the applied sciences, but we will to solve it for searching the sources coordinate shifts in the process of solving the problem of monitoring radio sources fluxes.

2) Monitoring of active phenomena on the Sun (sporadic outburst on every some tens days, the time scale of outburst – from seconds to hours), and the state of the near-solar plasma. This broad class of problems of research on near-solar source flicker interplanetary plasma, and we will monitor and display in graphical form at least the most common parameters of its condition at the site PRAO of LPI.

3) Radio monitoring transient (flare) phenomena in the solar system, and ionospheres storm effects on the giant planets, tracking radio transients phenomena on the moon, other possible radio phenomena in the solar system. To our knowledge, the mass daily monitoring of such phenomena on the time scale of the order of years nobody has yet been made.

4) Monitoring of transient phenomena in our Galaxy: this class of problems is unusually wide – from studies of outbreaks of radio emission from cataclysmic variables to search for candidates in exoplanets (planets around other stars). Not all of them can be implemented on our radio telescope, but some events (for example it is flash cataclysmic variables on the scale of seconds) available to us.

5) Monitoring of extragalactic radio sources fluxes. In the literature, there are some indications of the variability of radio sources on scales of months at frequencies of hundreds of megahertz. However, work on long-term observations on the complete sample of radio sources at one hundred megahertz available not yet (only conducted studies of individual sources – see., Volvach A.E. et al). For aims of extragalactic radio sources monitoring (the 15 degrees from the plane of the Galaxy) inside the existing 96-beems diagram of BSA we can select about of 400-500 sources for daily monitoring.

6) Monitoring and searching of the many years variations of radio sources in our Galaxy. Although these variations are small enough (e.g., radio flux of the Crab Nebula in the year varies by about 0.3%), but based on the results of daily data statistics monitoring on the scale of months and years, can significantly clarify these data.

7) Extragalactic transient phenomena. The most interesting problems are searching of fast radio transients (on the scale of a few milliseconds) in other galaxies. Similar radio transients under some papers found in the decimeter range in the last few years. Theorists associated with them, such as the possible merger of neutron stars. Phenomena of this magnitude are energetic and highly to be detected in our antenna even for very distant galaxies at a distance of up to hundreds of Mpc. This problem is currently very topical for Astrophysics, meanwhile in the meter band fast radio transients no was looking.

In total multi beam observation on BSA of LPI will exploit the wide-field survey capabilities to enable the discovery and investigation of variable and transient phenomena from the local to the cosmological, including flare stars, intermittent pulsars, X-ray binaries, magnetars, extreme scattering events, interstellar scintillation, radio supernovae, and orphan afterglows of gamma-ray bursts. In addition, it will allow us to probe unexplored regions of parameter space where new classes of transient sources may be detected.

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