Siberian Solar Radiotelescope - a Management, Informativity, Telecommunication Data Access

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Abstract

In this paper are presented short description of information system of Siberian Solar RadioTelescope (SSRT), considered collection of scientific problems, decided on the telescope. Brought information on management, data acquisition systems, processing and organizations of integration given subsystems in to Intranet. Here described organization of telecommunication data access problems to archives of data obtained at the SSRT.

1. Introduction

For the studying of different manifestations of the Solar activity, which determine condition of interplanetary ambience, near-earth space and geophysical condition highly informativity turns out to be a microwave Solar radio emission, for studying which in ISTP SD RAS was designed and engineered unique Siberian Solar RadioTelescope [1].

There are some big radioastronomical instruments — RATAN-600 (Russia), VLA (USA), Nobeyama radioheliograph (Japan) and others in the world at present time. As for the SSRT, so it is a special-purpose solar radio telescope designed for studying solar activity in the microwave range (5.7 GHz) where the processes occurring in the solar corona are accessible to observation over the entire solar disk. The SSRT is a crossed interferometer, consisting of two arrays of 128x128 parabolic antennas 2.5 meters in diameter each, spaced equidistantly at 4.9 meters and oriented in the E-W and N-S directions. The length of each linear baselines of the interferometer is 622.3 meters (figure 1).

\[ \text{Figure 1 Siberian Solar RadioTelescope (view from helicopter)} \]

Radio images at the SSRT are generated by an ingenious method, unlike most present-day radio telescopes where the aperture analysis method is used. Since the orientation of interference maxima depends on the emission frequency, it is possible to scan the solar disk by re-tuning the receiving system's frequency to the desired values and to obtain 2-dimentional image of the Sun for 4-6 minutes in polarized and nonpolarized emissions [2]. Spatial resolution of the radiotelescope is near 20 angular seconds. Inphase adding the signals, accepted by antennas of one line, is ensured by the feeder tract, built on storey-parallel scheme.

Primary tasks of the SSRT are:
• review of condition of solar activity within the range of waves lengths, in which active regions and flares reveal itself the most intensive;
• study of structure of active regions at a rate of, corresponding generation of emission on the working wave length of the SSRT;
• study of three-dimensional picture of development of active regions and flares;
• study of dynamics of corona of active regions within a day and on the background of solar disk intensive emission day by day;
• study of flare processes in active regions;
• a synoptical study of solar activity during the turn and from the turn to the turn of the Sun;
• study an fine structure of active regions and observations of fast active processes in solar atmosphere in the one-dimensional mode with a time resolution of up to 14 msec.

2. The SSRT local information system

The base receiving system is a multichannel filter receiver for a simultaneous recording in 180 channels with the 500 kHz band each, adjusted at steps of about 600 kHz. Recordings with this system are accomplished in either of two modes: the transit one-dimensional mode by recording the response of one of the linear interferometers with a time resolution of up to 14 ms, and the two-dimensional mode using a classic procedure of signal multiplication by means of phase modulation.

Presence territorial-portioned antenna-feeder system with the big amount of elements, using several receiving devices with different features has required a making number of subsystems responsible for separate problems - an antenna management, data acquisition, data processing, visualizing the information and etc. In designing the complex subsystems to automations SSRT appear difficulties connected with variety problems, decided by radiotelescope, necessity of simultaneous execution the observations on different scientific programs. Increasing of cost of observations requires raising reliability of equipments, possibility of performing the separate functions on different subsystems, operative checking efficiency of a radiotelescope systems. Automated complex of the SSRT was developed and put into exploitation in parallel with radiotechnical systems of the radiotelescope. In the process of designing, building and adjustments automated complex of the SSRT has suffered a row essential updating, particularly in part of change of morally growing old computers. At 1976 the model of SSRT was adjusted - 8-an element interferometer, on which strategies of observing, technical deciding the separate blocks and elements of radiotelescope were tested. Majority CAMAC modules were developed and tested, which subsequently were used on SSRT. Regular observations of Sun with the spatial resolution about 4 arc minutes were carried out. These were perfected strategies of system building for data acquisition and antenna system control.

Considering this experience, in the base local information system of the SSRT making were founded following principles:

• system openness on software and hardware levels for adapting to new tasks and conditions of observations;
• designing a computer system was produced "from top to bottom" - from tasks to structures-algorithmic organizations and software hardware realization;
• organization of complex stipulates a phased development, realization and system modernization;
• using the general acceptance and methods at the development of different subsystems that though and can bring about certain redundancy, but allows to reduce time for the new system development;
• organization of multicomputer system, comprising of itself central PC and removed information management subsystems;
• fireware deciding of local network organizations.

Data acquisition subsystem for registrations the signals from output of the SSRT multifrequency receiver is designed for registrations of 360 analog signals of distribution radiobrightness on the solar disk. The volume of recording information is up to 10-15 Ìbyte, depending on the season. Connection to the exact time system "GPS" was realized. At present time, subsystem functions on PC base and CAMAC interfaces.

The other receiving system is an acousto-optic spectrum analyser with the 28 MHz band, divided by 96 channels. The total receiving band is sampled consecutively in 4 steps (112 MHz - 384 channels). This receiving system was used to carryout an additive-correlation processing of signals to obtain, concurrently with radio maps, also one-dimensional radio brightness distributions (also Stokes parameters I and V), with 56 ms resolution. Currently this system is employed to take continuous records in the two-dimensional mode. Its sensitivity is still four times lower compared to the filter receiving system because of a consecutive signal processing in the total reception band. The volume of recording information is up to 250 resolution of SSRT was improved to 14 msec after a fast data acquisition system (FDAS), developed at the University of Bern, was connected to the 180 receiver output of the SSRT [3]. This setup enables us to observe and analyze short-lived bursts. The typical volume of information is up to 80 Mbyte per event.

SSRT antenna management subsystem is designed for following for the Sun by the radiotelescope antenna units, checking their spatial positions, control of polarization modulators. We used principle of group controlling antennas...
of SSRT: the whole antenna system consists from 16 groups of 16 antennas each. Distance between the control room of SSRT and extreme groups reaches 400 meters. Control from 16 antennas is realized by means of local subsystems, basing in the underground tunnel of SSRT. Local subsystem is kept hardware, allowing execute the following functions: control of crossbar engines of antennas drives, checking receipts of antennas in extreme positions; translation of modulating signal to the modulators, operative checking efficiency of a modulators. Subsystem is built on PC base and 4-h consequent branches CAMAC, uniting on the access and control local subsystems each of SSRT base lines.

Subsystem for control and diagnostics of the SSRT parameters was designed for the measurement amplitude and phase allocation of field on the aperture of SSRT antenna lattice. Given subsystem functions on the base of control antenna system and allows to carry out studies of SSRT beam by algorithmic methods. Results of studies are used for correction solar images obtained at the SSRT.

Local subsystems are united in the SSRT information system using the TCP/IP protocol in Windows NT and Windows 95. Intranet ensures a synchronous performing number of registration and control tasks, transmitting obtained data between the SSRT computers, storing data in archive and transmission ones to Internet network.

Data acquisition and control of condition of receivers are referred to real-time tasks. In the software development process for these tasks, were was explored operating system characteristics Windows NT4.0 as a real-time system. Shown, that for required correlation of time and volume of data: hardware interruption each 14 msec, data volume 6 Kbyte on each interruption, it is possible to consider Windows NT 4.0 as a real-time system. For synchronizing a dataflow with the process by exhibit are used referred to as objects of kernel. This allow to avoid losses of data. Application, concerning with data acceptance and their transmitting in local network, requires 15-20 % resources of Pentium-133 PC.

3. Solar data archives

Archives of solar data consists from:

- one-dimensional radio brightness distributions in two directions (from the linear E-W and N-S interferometers) for the entire observing time at intervals from 2.5 to 40 min;
- two-dimensional radio maps - every hour + all input data;
- tabulated data: coordinates and fluxes of active regions and flares [4];
- burst observations: all raw information is stored.

Volume of data per observing day, depending on a season of year, is up to 300 Mbytes. There is an 80 Gbyte solar data archive for a present time on CD disks. Investigations of microwave subsecond bursts have been carried out at the SSRT since 1992. Over 150 bursts with a subsecond time structure (spikes) were recorded. Microwave spikes are observed in ~ 15 % of bursts recorded. High time and spatial resolution of the SSRT permit to astronomers to study fine structure of microwave bursts. Spikes are categorized, according to their duration, into two classes, with the average values 50 and 150 ms. They were observed during the burst growth and decay phases alike, and predominantly in groups rather than uniformly. The apparent size of the spike sources can exceed 1'. It was found that their size depends on the distance from the solar disk center, which is accounted for by the scattering of radio emission from a compact source in the lower corona. The values of the flux and size of the spike sources correspond to their brightness temperatures which exceed considerably the burst continuum temperature [5].

4. Data access

For deciding fundamental tasks of solar activity and forecast it is necessary to have data both - with other radiotelescopes of the world, and data in other ranges of wave lengths. Data of the SSRT organic fall into the data collection of world centers. Algorithms and programs, developed at the SSRT are used in number of foreign observatories, as evidenced by the development of international exchange and participation in international conferences. Information system of Siberian Solar Radio Telescope is developed in two directions: the first is designing Observatory Web-server located in Irkutsk; second - Web-server on the SSRT just, located in 250 km from Irkutsk.

The First direction will be realized within the framework of the building of information system ISTP and at present it is available to "rao.iszf.irk.ru". Were is information about Radioastrophysical Observatories of ISTP and the SSRT on this server. There are archives of data, presented in the world network of data. Archives and databases contain treat SSRT data and processing software. The second direction is presented at this moment by only possibility of exchange data by means of the e-mail ssrt@eastsb.ru (figure 2).

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1 Windows are trademarks of Microsoft Corporation.
Ensuring a telecommunication access to the information system SSRT will allow to use data from the SSRT operatively for cooperative studying solar physics phenomenas, buildings of short and long time forecast of solar activity, prediction of strong solar flares from SSRT observations and participate in international cooperation programs. Unique data got by the SSRT in the monitoring process must become component part of national information resource of Russia. Now information Web-server of Radioastrophysical Observatory is created using Sun Sparcstation-10 (http://rao.iszf.irk.ru). The principle possibility of integration Observatory Web-server of with Web-server of the SSRT was tested.

The software of Web-server was designed and debugged. This software was designed on Java, CGI Perl languages. Provided by FTP access to small part of the archive of data a solar activity on the Observatory server. Well-timed reception of full volume data from SSRT Web-server at this moment impossible in view of the absence of facilities on Internet service payment and insufficiency of resources of server.

5. Conclusion

As a result the SSRT is include to global World Network for deciding fundamental tasks of solar physics and solar activity forecast. Data of the SSRT organic fall into the data collection of world centers. We hope, that this paper gives information about the SSRT facilities and all scientists of our observatory welcome any interest and cooperation.

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References


