

PANORAMIC ANALYZER OF RADIO SPECTRA — INSTRUMENT FOR MEASUREMENTS OF CORONAL MAGNETIC FIELDS ON THE SUN

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INTRODUCTION

The study of solar radio emission in a wide (covering many octaves) wavelength range is of great importance for plasma diagnostics of all types of solar activity. Here we describe a new spectroanalyzer covering a wide range in frequency from 1 to 18 GHz, which is used at the RATAN-600 radio telescope beginning 1991 December 20. Coronal magnetic fields have been measured with the various radio astronomical methods presented in these proceedings by Gelfreikh et al. and Bogod et al.

Of special value are collaborative spectral-polarization observations using the RATAN-600 and high-spatial resolution observations with the VLA and WSRT (Akhmedov et al. 1986; Bogod et al. 1992; Alissandrakis et al. 1992).

OVERVIEW OF THE PANORAMIC ANALYZER OF SPECTRUM (PAS)

The PAS consists of six microwave line receivers with bandwidths of about 40% covering the range from 30 to 1.7 cm. Each line receiver has two main parts (Figure 1): An analog part (microwave feed system and multichannel receivers), and a digital part (personal computer). The analog part consists of a multiwave feed system (1), wide-band pin-diode switchers (2), wide-band microwave tracks (3), microwave channel filter cards (4) with eight channels each and detectors, and the low-frequency outputs (5). The digital part consists of a fast digital multichannel system collecting observational information and the PAS controller (6), and a personal computer (7) with necessary peripheral equipment.

A basic idea of PAS is to combine all input feeds at the minimum possible number of foci. We constructed the combination of feed systems using two phase centers which are situated 55 mm on both sides of the main antenna focus for the frequency range (1-18 GHz). The effect of aberrations may be minimized by calculations. The full wavelength range is covered by six line receivers which

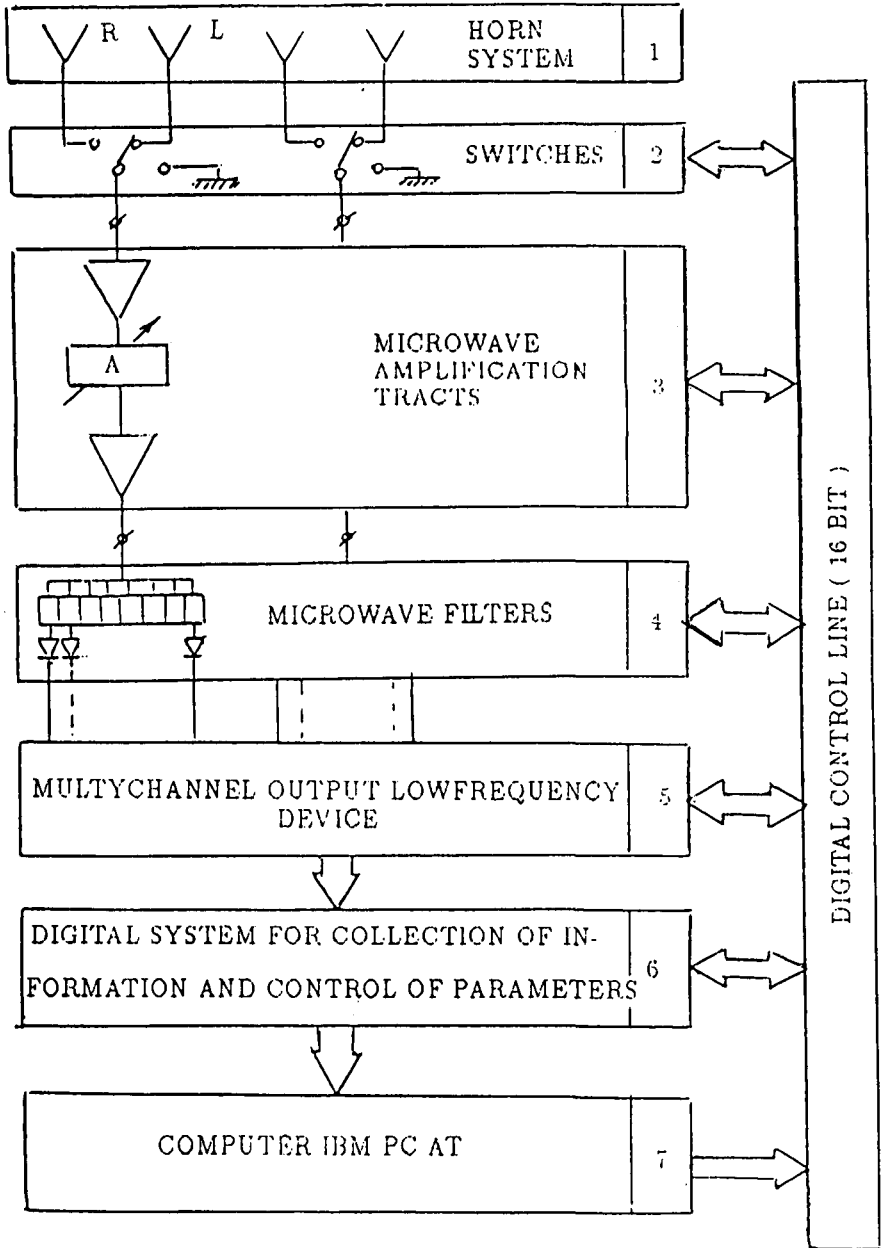


Fig. 1. Scheme of the panoramic analyzer of spectrum for solar observations at the radio telescope RATAN-600.

work in the following frequency-bands: 12-18, 8-12, 5.5-8, 3.5-5.5, 2.5-3.5, and 1.5-2.5 GHz.

At present, the first four receivers together with three single frequency receivers at the wavelengths 11.6 cm, 20.0 cm, and 31.6 cm are in use (Table I). The pin-diode input switch in each receiver has three outputs for connection to an R-output and an L-output of a feed system and a matching load, which is used for calibration and is controlled by a computer. To obtain a good dynamic range, there are 20-db microwave attenuators in each microwave track and a 27-db low-frequency attenuator in block (5). Both types of attenuators are controlled by the computer during the observations.

THE MAIN CHARACTERISTICS OF PAS

TABLE I Wavelengths and spatial resolution of PAS

λ (cm)	E-W (arcsec)	N-S (arcmin)	λ (cm)	E-W (arcsec)	N-S (arcmin)
30.0	270.0	187	3.86	34.0	24
20.0	180.0	125	3.65	33.0	23
12.0	108.0	75	3.45	31.0	21
8.21	75.0	52	3.22	29.0	20
7.79	70.0	48	3.10	28.0	19
7.24	65.0	45	2.94	26.5	18
6.86	61.0	42	2.80	25.0	17
6.49	58.0	40	2.68	24.0	17
6.10	55.0	38	2.56	23.0	16
5.83	52.5	36	2.40	21.6	15
5.58	50.0	34	2.30	20.7	14
5.28	47.5	33	2.20	20.0	14
5.00	45.0	31	2.10	19.0	12
4.73	42.6	30	2.00	18.0	12
4.60	42.0	29	1.90	17.1	12
4.36	40.0	27	1.80	16.2	11
4.15	37.0	26	1.71	15.4	10
4.02	36.0	25			

TEMPORAL RESOLUTION: 1-3 ms/channel.

DYNAMIC RANGE: 20 db.

FLUX SENSITIVITY: 0.1% of the quiet-Sun level (200 MHz bandwidth, 1 s integration).

ISOLATION: 17 db between adjacent channels.

POLARIZATION SENSITIVITY: 0.5-2 % (Stokes V parameter).

DURATION OF OBSERVATIONS: usually one scan per day (for special programs 4 hours per day at 15 minute scan cadence is possible).

DIGITAL EQUIPMENT

The digital part of the PAS is based on an IBM PC AT computer with some peripheral devices, a multichannel analog-to-digital system for input and output signals, and software which controls the PAS in various modes. Eight multiplexers with 8 channels each increases the number of channels to a total of 64. In order to achieve a high measurement speed, two hard disks of 42 MByte are used for recording. A continuous data rate of about 500 kByte/s is possible. We use a special record file structure which permits us to control the parameters of the receiver during observations. In this case the recording speed is 50 kByte/s. To archive the data, a streamer is used with 60 and 250 Mbyte cassettes. During the observations the data and the parameters of PAS are displayed on a color monitor screen.

SOFTWARE FOR OBSERVATIONAL REDUCTION

At present, each observation provides 70 scans of the Sun (35 for left-handed and 35 for right-handed polarization) with a volume of about 1 MByte. The main functions of the software are:

- treatment of the primary data (sorting of data by channel, application of the calibration for each channel) and creation of archives of the data,
- presentation of the data on a monitor, printer, or plotter in 16 colors,
- calculation of the parameters of a solar source such as: one-dimensional coordinate, value of emission flux, the antenna temperature and brightness temperatures, size of the source, etc.

Examples of solar observations made with the new spectroanalyzer are shown in the papers by Gelfreikh et al. and Bogod et al. in these proceedings. The measurement of circular polarization emission in a wide wavelength range using developed analysis methods (Gelfreikh et al. 1987; Gelfreikh 1972; Akhmedov et al. 1982; Bogod & Gelfreikh 1980) allows investigation of the magnetic atmospheres of active regions.

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