THE 6-METER OPTICAL TELESCOPE OF THE USSR: INSTRUMENTATION AND OBSERVATIONAL POSSIBILITIES

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I. INTRODUCTION

This report offers a short description of observational facilities used at the 6-meter optical telescope BTA* of the Special Astrophysical Observatory of the Academy of Sciences of the USSR.

The purposes of the report:

- to give an idea on the general strategics for the development of the observational facilities of the BTA;
- to present the principle information on the achieved observational possibilities. The first point may prove to be useful for the projects of Very Large Telescopes (VLT), that are discussed at this meeting.

II. INSTRUMENTATION AND OBSERVATIONAL POSSIBILITIES OF BTA

The site, the name and the detector of the equipment used at the BTA are shown in the first three columns of the scheme in Fig.1. The following four columns present the operating characteristics of the telescope for various combinations of the foci, optical equipment and detectors. The last column contains the references to the publications, where one can find more complete information about the telescope, spectral and optical facilities, equipment and its characteristics.

*) BTA - Bolshoi Alt-azimuth Telescope

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Fig.1

Instruments and BTA observational possibilities

Focus	Eguipment	Detector	Stellar magnitude	S/N	Resolution	Integration time	References
Prime Focus f/4	Prime Focus Camera	Direct Photographic Plates	B=24	3	1"	90 min	Ioannisiani et al. 1982; Shabanov and Korovyakovskij, 1978
	Fast Spectrograph SP-160	2-stage Image Tube +Plates	V=20,5	12	4Å	30 min	Kopylov and Rylov, 1979; Gyavganen et al., 1984
	Fast Spectrograph UAGS(Zeiss-Jena, DDR)	2-stage Image Tube +Plates	B=20	2	4Å	45 min	Gyavganen et al., 1984
	Fast Spectrograph UAGS(Zeiss-Jena, DDR)	3-stage Image Tube +Plates	V=19,5	3	5Å	30 min	Afanasjev and Pimonov, 1980
	Fast Spectrograph UAGS(Zeiss-Jena, DDR)	1-D TV Scanner	B=18,5	29	2 Å	400 min	Somova et al., 1982
	Fast Spectrograph UAGS(Zeiss-Jena, DDR)	Hydrogen-line Magnetograph	V=8,6	±200 G	10 Å	180 min	Bychkov et al., 1981; Shtol et al., 1984
	Slitless Spectrograph	Direct Plates	V=21,5*	10	100Å	60 min	Ioannisiani et al., 1982

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Fig. 1 (continued)

Focus	Equipment	Detector	Stellar Magnitude	S/N	Resolution	Integration Time	References
Prime Focus F/4	Channel Photometer	Photomultiplier Tube	B=19	10^4	$3\cdot10^{-7}$ s	50 s	Neizvestnyi and Pimonov, 1978
	Photometric Complex	Channel Photometer	V=19	10^{6**}	$3\cdot10^{-7}$ s	60 min	Shvartsman, 1977 Plakhotnichenko, 1983 Beskin et al., 1982
	Speckle Interferometer	2-D TV Scanner	V=12	10	0.″025	12 min	Balega et al., 1982
	Multi-Slit Field Spectrograph	Image Tube +Plates (baked)	$V=23,5^*$	3	35 Å	120min	Dodonov, 1982 Curtes et al., 1982 Afanasjev et al., 1984
Nasmyth Focus 1 F/30.7	Planet Spectrograph	1-D TV Scanner	B=19	15	3 Å	150min	Somova et al., 1982
		Intensified Image Dissector Scanner	V=12	10	5 Å 0.01 s	60 min	Alekseyev, 1978 Alekseyev et al., 1983
		3-stage Image Tube +Plates	V=19.5	3	5 Å	30 min	Afanasjev and Pimonov, 1980

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Fig. 1 (continued)

Focus	Eguipment	Detector	Stellar Magnitude	S/N	Resolu tion	Integ ration Time	References
Nasmyth Focus 1 F/30.7	Speckle Inter ferometer	2-D TV Scan ner	V=12	10	0".025	12 min	Balega et al.,1982
	Speckle Inter ferometer	3-stage Image Tube +Plates	V=7	-	0".025	3 s	Dudinov et al., 1982 Dudinov et al., 1983
Nasmyth Focus 2 F/30.7	Main Stellar Spectrograph	Intensified Image Dissec tor Scanner Camera F/11.4 D=5.2 Å/mm	V=8	10	0".25Å 0.01 s	90 min	Alekseyev et al., 1983
		Fabry-Perot Magnetograph	B=4,1	±10G	0.25Å	300 min	Glagolevskij et al 1979
		Camera f/11.4 D=1.8 Å/mm	B=8.6	±80G	0.25Å	300 min	
		Achromatic Zeeman Analy ser Camera F/2.3 D=9Å/mm	B=9	±150G	0.2Å	60 min	Najdenov and Tchuntonov,1976 Glagolevskij et al 1978
		Photographic Camera F/11.6 D=1.8 Å/mm (3900-4900)Å	B=6.5	40	0.06Å		
		D=2.8 Å/mm (3000-4500)Å	V=6	40	0.08Å		
		D=2.8 Å/mm (5000-6900)Å	V=3.5	40	0.08Å		Kopylov and Rylov, 1979

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Fig. 1 (continued)

Focus	Eguipment	Detector	Stellar magnitude	S/N	Resolution	Integration Time	References
Nasmyth Focus 2 F/30.7		D=5.2Å/mm(4000–5000)Å	B=6	40	0.16Å		
		D=5.2Å/mm(5000–6900)Å	V=4.5	40	0.16Å		
	Main Stellar Spectrograph	Photographic camera F/2.3 D=7Å/mm (3000–3900)Å	V=5.8	20	0.21Å	60 min	
		D=9Å/mm(3900–4900)Å	B=8.1	20	0.27Å	60 min	
		D=14Å/mm(3000–4500)Å	V=7.5	20	0.42Å	60 min	
		D=14Å/mm(3900–5000)Å	B=8.8	20	0.42Å	60 min	
		D=14Å/mm(5000–6900)Å	V=6.5	20	0.42Å	60 min	
		D=28Å/mm(310066900)Å	B=9.6	20	0.9 Å	60 min	
		D=28Å/mm(5000–6900)Å	V=7.6	20	0.9 Å	60 min	
		Photographic camera F/1.15 D=56Å/mm(3500–4900)Å	B=12.2	15	1.8 Å	60 min	

* predicted

** for range $10^{-4} - 10^{-5}$ s

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All the configurations and combinations of the equipment presented in the Table are rendered at the observer's disposal after the preliminary request. The main peculiarity of this scheme is that an observer can choose during one night the devices which suit best to the problems and observational conditions (type and brightness of the object resolution, phase of the object variability, seeing, phase of the moon etc.).

It allows to make a more effective use of the observing time and to fulfil two - three scientific programs simultaneously. On the other hand, simultaneous installation at the three foci of various devices has opened a new opportunity of unification of some programs for a long time, up to 2 - 3 weeks. In this case the dependence of one program upon the weather is considerably weakened. We believe that this conception of the telescope equipment and its use may become perspective for Very Large Telescopes.

III. DATA ACCUMULATION AND REDUCTION

At all large telescopes it is necessary to secure and maintain high balance between the amount of observational data obtained and the possibilities of its fast reduction. Proceeding from this, parallel to the development of instrumentation for the BTA, equipment for laboratory data processing has been created at SAO. As can be seen in Fig.1 the greater part of information at BTA can be obtained with the photoelectron detectors. For this purpose the central data accumulation system is available at the telescope, which consists of a complex of instrumental and program means intended for ensuring observations with all the detectors of SAO USSR AS, and also with the visitors' instrumentation.

The system includes:

- computer CM 1401 : 700 thousand operations per second, opera-

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tive memory 128 K, display, graphic devices, disks, magnetic tapes, printing;

- CAMAK with a wide nomenclature of modula;
- soft-ware (data recording, communication and data exchange with the equipment CAMAK, equipment control, primary data reduction);
- cable lines, connecting all the foci of the telescope to the Central Apparatus Room.

In the observations with the photographic emulsions used as detectors, the standard image processing and the preliminary estimation of the quality of the obtained material are made in the photolaboratory of the telescope.

Thus, a night's work at the telescope results in a magnetic tape containing the primary or partially reduced data or an exposed emulsion. Further processing of the results is carried out either with the same system of data accumulation at the telescope or with the help of laboratory equipment and computing facilities located in the Laboratory Building at the observatory settlement 17 km away from the BTA. The data on the magnetic tape undergo processing in the laboratory with the computer CM 1401 using the same facilities that are available at the telescope or with the main computer EC - 1035 (150 thousand operations per second, operative memory 512 K, disks 29 M bytes, magnetic tape, graphic devices, soft-ware).

For the photometric processing of images there is a two-coordinate automatic microdensitometer AMD -1 II, 12 with the following characteristics:

- step of scanning is 5 mkm (minimum);
- coordinate accuracy on the 150 mm base is ± 5 mkm;
- photometric accuracy at 0 - 4, 5D is 1% - 1.5%;

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- size of a region being scanned is 17 x 150 mm^2;
- speed of measurements is 1000 readings/s.

AMD together with the soft-ware is oriented to processing of spectra and panoramic photographs and has a wide set of peripheral devices (graphic devices, half-tint printing, isodenses, disks, magnetic tapes). Besides, there is a set of simple laboratory facilities for coordinate and photometrical processing of images: ascorecord (Zeiss, Jena, DDR), astrospidometer, microphotometers.

IV. CONCLUSION

The reported set of instrumental facilities intended for observations with the BTA and for data processing was developed in the process of realization of the 6-meter telescope project, and at present it is continuously added by new devices and improved. This approach, of course, cannot be recomended as a single suitable for other optical telescopes, however, some ideas may prove to be useful for the future projects of the Very Large Telescopes.

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