LOCAL NETWORK OF THE PLATE DIGITIZATION LABORATORY OF THE INSTITUTE OF ASTRONOMY WITH NATIONAL ASTRONOMICAL OBSERVATORY

MOMCHIL DECHEV and MILCHO TSVETKOV

Institute of Astronomy with National Astronomical Observatory,
Bulgarian Academy of Sciences
72 Tsarigradsko Shosse Blvd, Sofia 1784, Bulgaria
E-mail: mdechev @astro.bas.bg, milcho.tsvetkov@gmail.com

Abstract. Here we describe the local network and briefly the equipment of the Plate Digitization Laboratory dedicated to digitization of the existing wide-field plate collection of the Institute of Astronomy with National Astronomical Observatory of the Bulgarian Academy of Sciences during the period 1979 - 1995 of using photographic plates as a detector of the observations. The astronomical plate collection at NAO Rozhen contains more than 10000 wide-field plates received with the 50/70 cm Schmidt telescope and with the 200 cm RCC telescope of the observatory. The plate archives are incorporated in the existing Wide-Field Plate Database (www.wfpdb.org) according to the astronomical standards of Centre de Donnees de Strasbourg (CDS).

1. INTRODUCTION

The Plate Digitization Laboratory of the Institute of Astronomy with National Astronomical Observatory Rozhen is dedicated to digitization of the plate collection of the observatory received mainly during its first 15 years of operation in the period 1979-1995. In this period more than 10000 wide field plates using the 50/70 cm Schmidt telescope and 200 cm RCC telescope of the National Astronomical Observatory Rozhen of the Bulgarian Academy of Sciences were received. The plates received with the 200 cm telescope were taken in RC (Ritchey-Chrétien) focus with size mainly 30x30 cm and scale 12.8 arcsec/mm. In this case the field covered with exposed RC plate was about 1 degree and about 25 degree with used 16x16 cm Schmidt plates.

The photographic plates were extensively used as light detectors in astronomy during last century when the new technology of the CCD detectors has rapidly replaced the photographic plates. A detail description of the digitization of the

wide-filed plate archives worldwide including the plate collection of the existing Bulgarian plate archives is given in the papers of Tsvetkov (2006) and Tsvetkov and Tsvetkova (2006) according to the development of the Wide-Field Plate Database project (WFPDB, www.wfpdb.org). At the present moment in the WFPDB 7021 plates from the Rozhen 50/70 cm Schmidt telescope and 1946 direct plates form the 200 cm RCC telescope are catalogued. About half of the plates is presented in the plate stacks at Rozhen and Sofia and their regular digitization has been started with the support of the Bulgarian National Science Fund of the Ministry of Education and Science – grants DO-02-273 and DO-02-275.

2. PLATE COLLECTION AND DIGITIZATION EQUIPMENT

The plate collection of the Institute of Astronomy is stored at present at National Astronomical observatory Rozhen and in Sofia – in the Sky Archive Data Center of the Institute of Astronomy. More details can be found in Tsvetkova et al. (2010).

Figure 1. Plate Library at the Rozhen National Observatory (status June 2010).

There are two equipped laboratories for plate digitization and plate processing. In Fig. 1 a picture of the plate stacks at NAO Rozhen is shown. The main part of the plate collection consists of the plates received with the Schmidt telescope and 200 cm RCC telescope. Beside the wide-field plates some thousand of spectral plates received with the Coude spectrograph of the 200 cm telescope are also collected at the Rozhen plate library but their inventory is postponed to the future project. At Sofia Sky Archive Data Center some hundreds of wide-field plates received mainly with the Rozhen Schmidt telescope are collected. For their digitization and inventory is equipped the Sofia Plate digitization laboratory (see the part of the plate library of the Sofia Sky Archive Data Center in Fig. 2.)

Figure 2. A part of the 50/70 cm Schmidt telescope plate collection in the Institute of Astronomy in Sofia.

The archive of the 50/70 cm telescope counts about 7500 photographic plates mainly with size 16x16 cm and about 2000 plates with size 30x30 cm obtained with the 200 cm RC telescope.

For the purposes of the digitalization of the NAO plate collection a Laboratory for digitalization, Storage and Access of the Astronomical Photographic Plates (LAPD) has been established . It is a part of the new established forth division - "Laboratory of Astroinformatics and Virtual Astronomical Observatory" (LAVAO) of the Institute of Astronomy and National Astronomical Observatory. One of the urgent tasks for the new division is to develop and unify the facilities of the plate digitization, storage and online access to the information from the photographic plates. Having this is view we list the existing scanners in Sofia (IA) and NAO Rozhen. In LADP there are 3 scanners in Sofia. The first one is the high-accuracy

Perkin-Elmer historic microdensitometer the PDS 1010[plus] received as a present from the European Southern Observatory (ESO) in 1998 (Fig. 3). The second one is the professional flatbed scanner EPSON Expression 1640XL (Fig. 4), and the third one is EPSON V700 (Fig. 5).

Table 1: Available scanners in LAPD in Sofia and Rozhen Observatory and their characteristics.

SCANNERS	Plate Size-maximum (cm)	Density (D)	Pixel size (microns)
PDS 10- Perkin-Elmer	25x25	5.0	2
MDM6 – Joice_Loebl	25x25	4.0	2.5
EPSON Expression 10000 XL	30x30	3.8	10
EPSON Expression 1640XL	30x30	3.6	16
EPSON Perfection V700 Pro	18x18	4.0	10

Using these scanners and the plate digitization method described in Barbieri et al. (2003) we started a regular astronomical plate digitization.

Figure 3. The Perkin-Elmer historic microdensitometer of LAPD in Sofia - PDS 1010[plus] still used for some tests and plates scan calibration.

The archive of the 2 m RCC telescope counts 2115 wide-field plates. About 1000 of them are digitalized with a resolution of 1600 dpi (15.9 µm). About the Schmidt telescope plate archive we digitized approximately 400 of them with a resolution of 2400 dpi (10.0µm/pix).

We estimate that the total amount of information is 4 TB (1.2 TB and 2.8 TB for each plate archive).

Figure 4. The EPSON Expression 1640 XL (A3) flatbed scanner of LAPD in Sofia.

Figure 5. The EPSON Perfection V700 flatbed scanner of LAPD in Sofia.

The NAO Rozhen scanners are:

-	the old one Joyce-Loebl MDM6 (Fig. 6). This scanner can produce scans with high accuracy as fine as minimal step of 2,5 μm and minimal pixel of 5.0 μm. Unfortunately this scanner is very slow and needs e special care. The scanning process of a 30x30 cm plate takes more than 50 hours;

-	the professional flatbed EPSON Expression 10000XL (Fig. 7). It produces preview scans with resolution of 600 dpi (40μm) and 24 bits color for previews and full scans with resolution of 1600 dpi (16 μm) 16 bits grayscale in FITS format.

Figure 6. The microdensitometer Joyce-Loebl MDM6 at NAO Rozhen.

Figure 7. The Rozhen Observatory EPSON Expression 10000XL (A3) professional flatbed scanner.

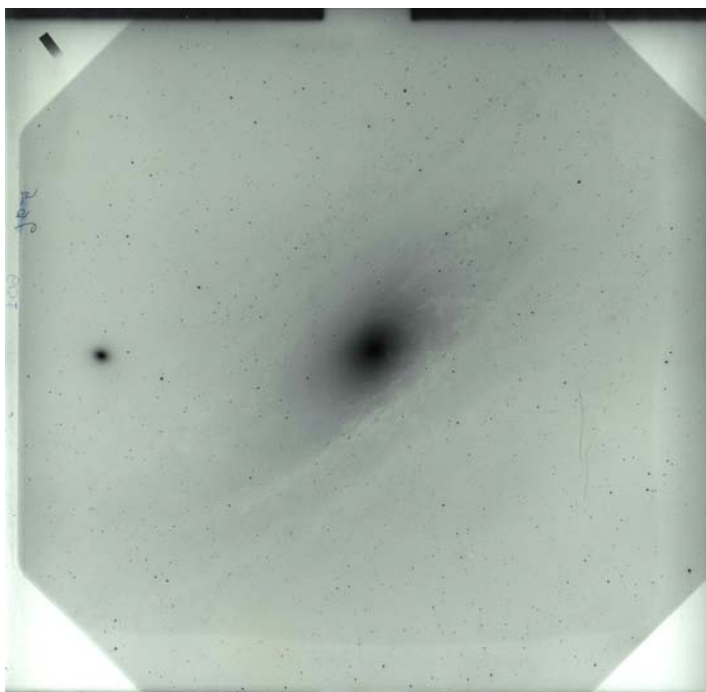An example of digitized plate with the EPSON Expression 10000XL scanner is shown in Fig. 8.

Figure 8. Example of plate preview of the scanned Rozhen 200 cm plate (30x30 cm size) with WFPDB Identifier: ROZ200_000610 taken in the field of M31 (Andromeda nebulae) on August 4, 1983 by T. Georgiev with exposure 20 min, and filter GG385 (B).

3. NETWORK, HARDWARE AND ACCESS TO THE DATA

The received data need a proper structure for access and storage. In Table 2 we list the hardware parameters of the local network infrastructure of the LPD in IA with NAO in Sofia. We list the computer name, type of the processor, and other computer parameters.

Table 2: Computer equipment of the Sofia Laboratory for Plate digitization at IA with NAO.

Computer Name	Processor	RAM	HDD	OS	Service
CORVUS	Core i3,	4GB,	2x2TB	Linux Debian	RAID1, DNS, Mail, Web
COLUMBA	Dual Core,	2GB	2x1TB	Linux Debian	RAID1, German VO backup
AQUILA	AMD	512MB	1x122GB 2x250GB 1x500GB	Linux Debian	DNS Astro server, Data FTP server
FW	Celeron	2GB	2x320GB 1x500GB	Linux Slakwere	Firewall
PHOENIX	Intel Xeon	1GB	3x160GB	Linux Debian	Storage M610p device service
STORAGE	PROMISE-Vtrak M610p, Ultra SCSI	*)	(16x1TB) 6x1TB	See above	*) Storage and access of the digitized astronomical wide-field plates

*) see description below.

The storage* element is a Promise Vtrak M610p. It has possibility to support 16 SATA disks. For the moment there are 6 x 1TB disks. Logically they are organized in 2 volumes – 1 RAID5 massive – 4 disks – 3TB and one RAID0 – 2 disks – 2TB. In the future a reorganization of the network structure is planned (see Fig. 10). The main difference is the existence of VPN, which will allow uniting geographically different networks to work together.

For the moment there are two ways to access the scanned data. The indirect one is through the search engine of the Wide-Field Plate Database (http://www.wfpdb.org/search.html). It is worldwide accessible. The second one is directly to the storage element. The granted users will access http://195.96.237.136. In the future all data from storage element will be also accessible through web access.

Fig. 9 shows the present block scheme status of the network infrastructure. There are 3 servers, one storage element, firewall and internal network behind the firewall. The future development of the local network is shown in Fig. 10.
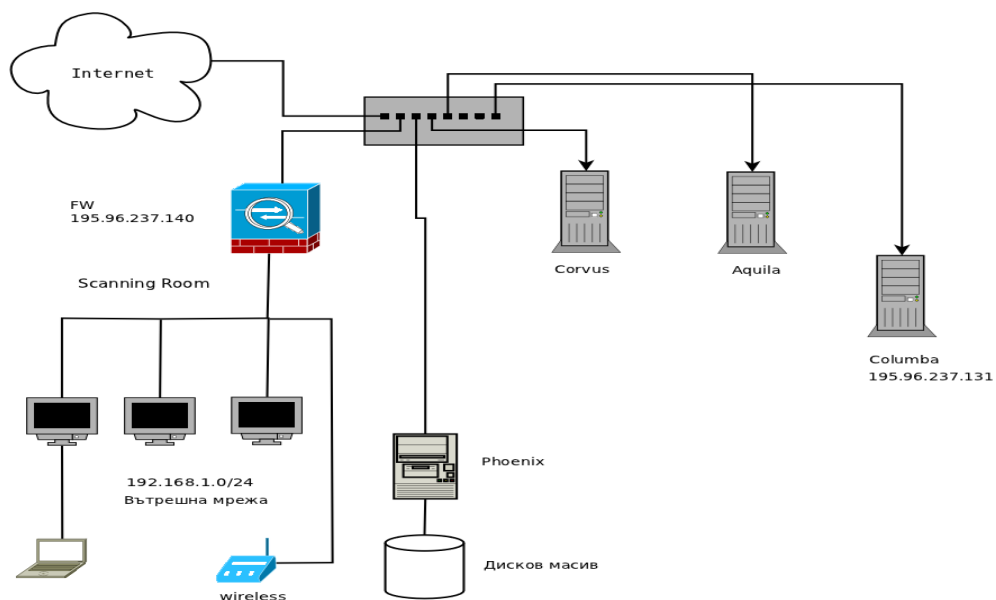

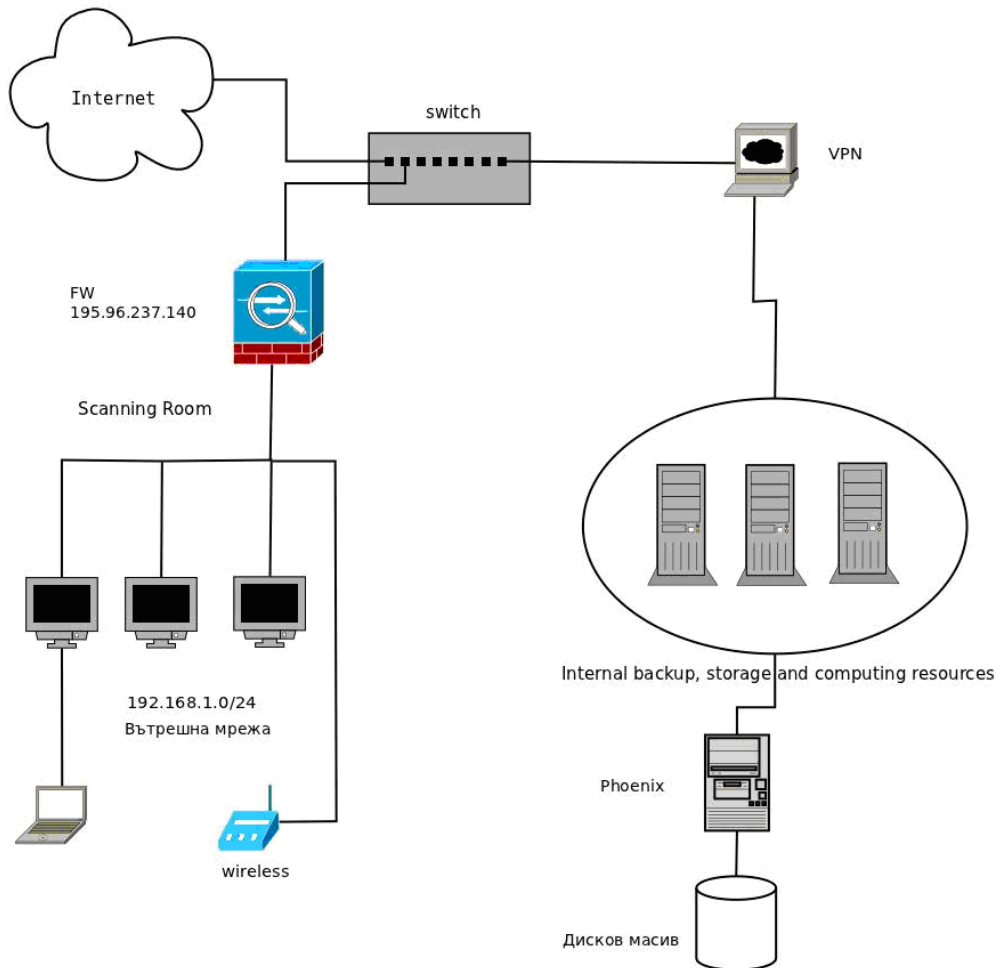**Figure 9.** Present status of the Institute of Astronomy Sky Archive Data Center network infrastructure.

Figure 10. The planned new infrastructure of the IA with NAO network.

SUMMARY

Finally we like to mention that this work shows the present development of the Sofia Sky Archive Data Center and the future plans in connection of the establishment of the new Laboratory of Astroinformatics and Virtual Astronomical Observatory in the Institute of Astronomy with NAO, Bulgarian Academy of Sciences. This work is a step further in comparison with the Sky Archive Data Center Local Network described in Tsvetkov et al. (2007).

Acknowledgements

References

Barbieri, C., Blanco, C., Bucciarelli, B., Coluzzi, R., Di Paola, A., Lanteri, L., Li Causi, G.-L., Marilli, E., Massimino, P., Mezzalira, V., Mottola, S., Nesci, R., Omizzolo, A., Pedichini, F., Rampazzi, F., Rossi, C., Stagni, R., Tsvetkov, M. Viotti, R.: 2003, *Experimental Astronomy*, **15 (1)**, 29.

Tsvetkov, M.: 2005, "Virtual Observatory: Plate Content Digitization, Archive Mining and Image Sequence, Processing", iAstro workshop, Sofia, Bulgaria, Eds. M. Tsvetkov, F. Murtagh, R. Molina, p. 10, 2006 "Wide-Field Plate Database: a Decade of Development" (http://aquila.skyarchive.org/WFPDB/ basic/ 10_ YD_MKTS/MTS_WFPDB-10YD.pdf).

Tsvetkov, M. K., Christov, S., Kalaglarsky, D. G.: 2007, Proceedings of the 5th Bulgarian - Serbian Conference: "Astronomy and Space Science", May 9-12, 2006 Sofia, Bulgaria, Eds. Tsvetkov M., Filipov L., Dimitrijević, M., Popović L., *Bulgarian Journal of Physics*, **34 (2)**, 35, http://wfpdb.org:8181/5_BSAC/presentations/ Tsvetkov.pps

Tsvetkova, K.., Tsvetkov, M., Dimitrijević, M., Protić-Benišek, V., Benišek, V., Jevremović, D.: 2010, Memorie della Societa Astronomica Italiana Supplement, 15, 192 (Wide-field plate archives in Rozhen and Belgrade observatories).

Tsvetkova, K.., Tsvetkov, M.: 2005,"Virtual Observatory: Plate Content Digitization, Archive Mining and Image Sequence, Processing", iAstro workshop, Sofia, Bulgaria, Eds. M. Tsvetkov, F. Murtagh, R. Molina, p. 45, 2006. "Catalogue of Wide-Field Plate Archives: Version 5.0", (http://aquila.skyarchive.org/WFPDB/basic/ CWFPA50/KTS_MTS_CWFPA50.pdf)