

XI BULGARIAN-SERBIAN ASTRONOMICAL CONFERENCE
14-18 MAY, 2018, BELOGRADCHIK, BULGARIA

New capabilities of the software to support digitization of astronomical photographic plates

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Abstract

- In this article, we announce improvements to two applications for digitizing astronomical photographic plates and developing a new one.
- In the software for creating the header of fits file using the data from WFPDB (wfpdb.org) we add feature for processing data for multiexposure plates.
- A new functionality of application for updating fits header allow us to complete fits header for fits files obtained from ImageMagic application.
- The development of virtual observatories has prompted us to realize a convertor of fits header to GAVO (www.g-vo.org) standard.

Content

- Wide-Field Plate Database
- Plate digitization
- Header
 - Header software
 - GAVO
 - Update header
- Processing image
 - tif2fits software
 - UpdataFitsHdr software
- Multiple exposure

Wide-Field Plate Database

- There are about 2 475 000 photographic plates all over the world.
- Wide-Field Plate Database (www.wfpdb.org) is WEB-based database that contains meta-data for more than 600 thousand plates.
- It is one wide-field unique telescope, giving access to unique photographic astronomical observations, done systematically in the period 1880 – 2000!
- The Catalogue of Wide-Field Plate Indexes contains meta-data for plates.
- For every plate many details are stored in the database: the coordinates of the plate center, the date and time of the observation, object name and type, method of observation, duration of exposures, type of emulsion, the size of the plate, the quality of the plate, the name of the observer, etc.

Wide-Field Plate Database

The meta-data of the plates are distributed in 6 plain-text files.

- The most important information is in the `maindata` file:
ES0040 007863 053517-052328 19850114012100 ORION M42-43 NGC1976 S42 6120.OKODAK
IIa0 Pg161611111
- Availability file:
ES0040 007863 PLATE IS AVIALABLE AT THE WFPDB DEPOSITORY, SOFIA, BULGARIA:
milcho.tsvetkov@gmail.com
- Notes file:
ES0040 007863 ORIG_COORD:053400-052400 ST.ST= ST.END=0620 UT.ST=0121
UT.END=0329 MULTIP. EXPOS=6X20 FL! ANON L
EXP1-6_UT_STARTUT_END=01:21-01:41,01:42-02:02,02:03-02:23,02:27-02:47,
02:48-03:08,03:09-03:29;
- Observer file:
ES0040 007863 W.SEITTER
- Quality file:
ES0040 007863 3 ARCSEC SEEINGS
- Digitization file:
ES0040 007863 DIGITISED WITH PDS2020 AT AIM, AND IN THE WFPDB WITH THE
FB SCANNER EPSON PERFECTION V700 20MIC PIXEL(1200DPI)

Plate digitization

Plate image – Digitized plate (16-bit grayscale) image (FITS file), with high resolution aiming photometric and astrometric measurements.

The process of plate digitization:

- Scan the plate (image) – .tif (row-tiff) file
 - Hardware: flatbed scanner
 - Software: VueScan
- Complete metadata (header) – .hdr file
 - Transfer data from WFPDB: header software
 - Add actual data for scanning, time, etc.: header software
- Merge image and header files – .fits file
 - tif2fits software
 - ImageMagic software + UpdateFitsHdr software

Header

Fits header (.hdr) – Plain text file containing FITS file header for easy on-line access to the plate meta-data.

- Most of the data for fits header can be extracted from WFPDB.
- Additional data can be entered manually or automatically.

The screenshot shows a web-based application titled "FITS header 2.3/3.04.2017". At the top, there is a navigation bar with the following elements: "File" (a dropdown menu showing "data"), a path separator "/", a text input field containing "POT015", a checkbox labeled "Sort", a "Plate" label, another text input field containing "POT015", a dropdown menu showing "-", a text input field containing "000317", and three buttons: "Prev", "Next", and "Save".

Below the navigation bar is a list of 13 FITS header parameters, each with a number, a label, a value input field, and a description:

Number	Label	Value	Description
1.	SIMPLE	T	file does conform to FITS standard [T/F]
2.	BITPIX	16	number of bits per data pixel
3.	NAXIS	2	number of data axes
4.	NAXIS1	18656	length of data axis 1
5.	NAXIS2	18542	length of data axis 2
6.	EXTEND	T	FITS dataset may contain extensions
7.	BZERO	65536	
8.	BSCALE	1	
9.	INVERTED	T	T - big-endian, F - little-endian
10.	DATE	2018-04-23 08:10:20	last change of file
11.	FILENAME	POT015_000317.fits	source file name
12.	PLATENUM	317	in original observing catalogue
13.	PLATE-ID	POT015_000317	WFPDB plate identifier

At the bottom of the form, there is a text area containing the following text:

```
POT015 000317 191548+151320 19100802222101 SA 87      F 0101 30.0      202001001
POT015 000317   Direct images
POT015 000317
POT015 000317 W.MUENCH
```

Header

Header "standards":

- Our header
- German Astrophysical Virtual Observatory (GAVO) header

GAVO header sections:

- "Basic data"
- Original data of observation
- Observatory and instrument
- Photographic plate
- Derived observation data
- Scan details
- Data files

Header

Convertors for various "standarts":

- WFPDB → .hdr
- .hdr → .hdrg
- .hdrf → .hdrg

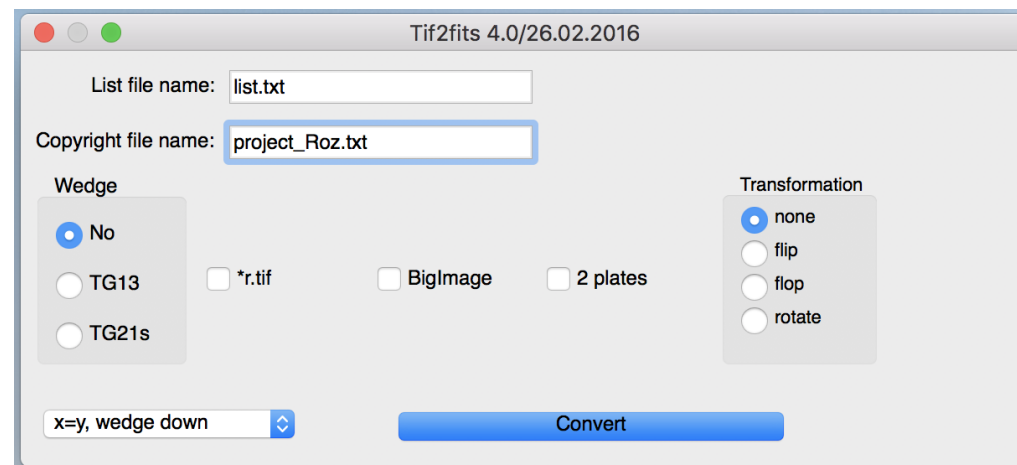
Example.

.hdrf: UT = '1911-02-02 01:31:39' / date and UT at mean epoch

.hdrg: DATE-AVG= '1911-02-02T01:31:39Z' / UT d/t mid-point of observation

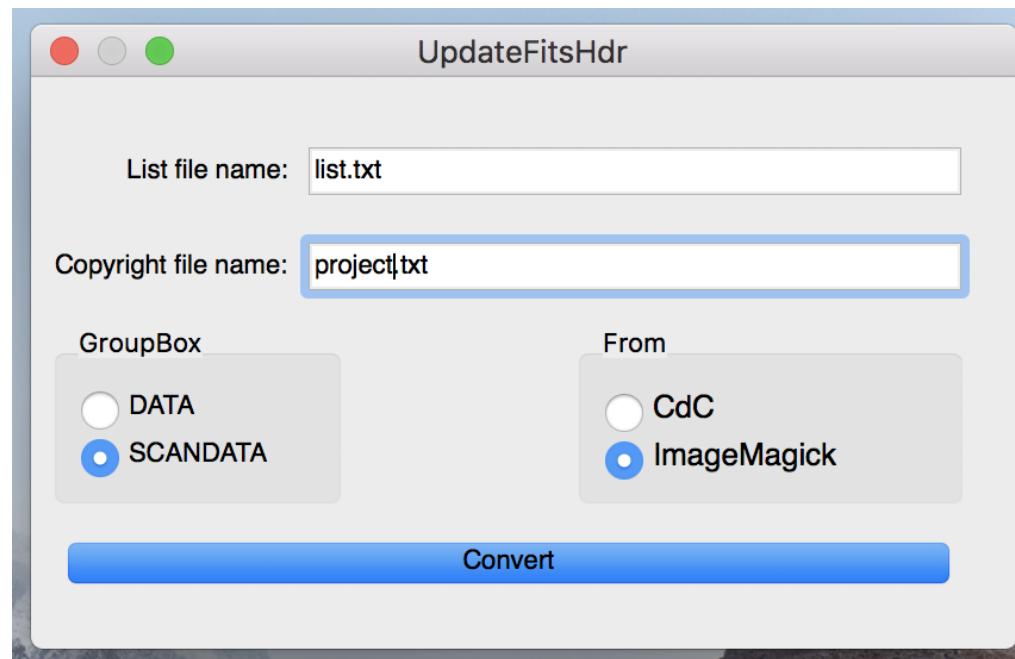
Processing image

- tif2fits software
- .tif + .hdr $\rightarrow$.fits + .hdrf



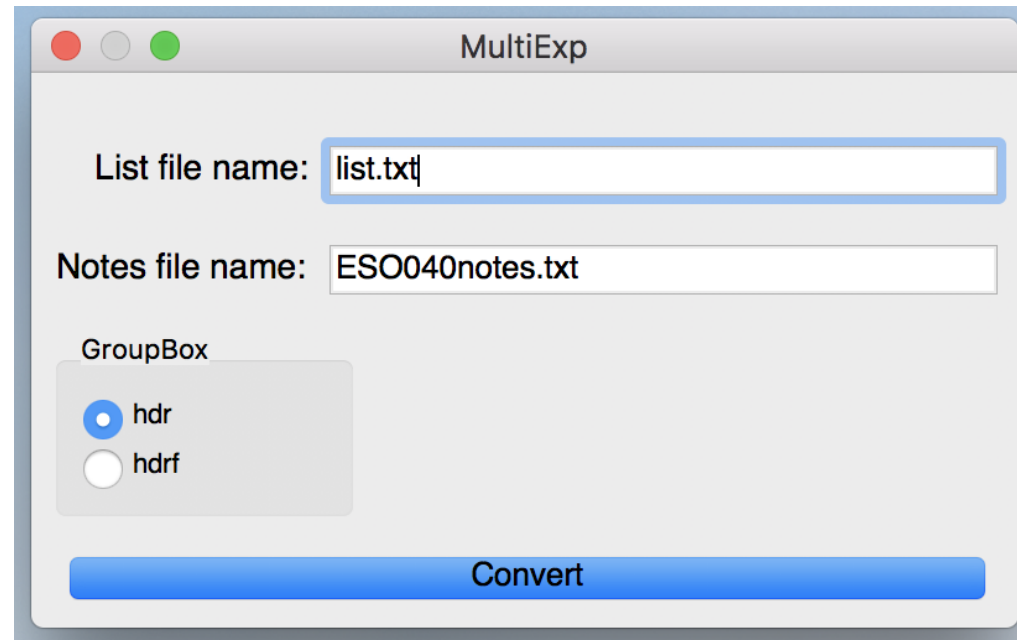
Processing image

- ImageMagic: .tif $\rightarrow$.fits (small header)
- UpdateFitsHdr: .fits + .hdr $\rightarrow$.fits + .hdrf



Multiple exposure

Header with fixed number of lines vs. header with variable number of lines



Notes file

```
UT_STARTUT_END=01:21-01:41,01:42-02:02,02:03-02:23,02:27-02:47,02:48-03:08,03:09-03:29;
```

```
.hdrg
```

```
DT-OBS1 = '1985-01-10T01:21:00Z'
```

```
DT-AVG1 = '1985-01-10T01:31:00Z'
```

```
DT-END1 = '1985-01-10T01:41:00Z'
```

```
EXPTIM1 = 1200.0
```

```
DT-OBS2 = '1985-01-10T01:42:00Z'
```

```
...
```

New capabilities of the software to support digitization of astro photo plates

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Conclusion

`https://github.com/nkirov`

- `plate-FITS-header`
- `tif2fits`
- `update_fits_hdr`
- `multiexpose*`

Qt – a cross-platform application framework based on C++

Thank you for your attention.