

Building up APPLAUSE:

*Digitization of the plate archives at Dr.
Remeis-Sternwarte Bamberg*

U. Heber, H. Edelmann, N. Jansen, H. Drechsel, J. Wilms, I. Kreykenbohm

Dr. Karl Remeis-Observatory & ECAP
Astronomical Institute
Friedrich-Alexander-University Erlangen-Nuremberg
Germany

German Initiative: Preservation and accessibility of scientific collections

- Wissenschaftsrat: Advisory committee of the German federal government issued a memorandum
- Spezial Programme by German Science Foundation (DFG):
Exploitation and Digitisation of object-related scientific Collections
open to Universities, Research Institutions, Museums & Libraries
(e.g. Deutsches Museum, Munich, Senckenberg, Frankfurt)
- Proposal submitted by AIP Potsdam, Hamburger Sternwarte and
Remeis-Sternwarte, Bamberg
*Digitisation of astronomical photographic plates and their
integration into the international Virtual Observatory*

German Initiative: Preservation and accessibility of scientific collections

- 38 proposals funded:
 - Museums & Libraries: 22
 - Universities & Research Institutions: 16
- Wide range of subjects:
 - Archeology, arts, astronomy, botany, geology, history of art, music, numismatics, zoology
 - Digitisation of audio records
- Potsdam/Hamburg/Bamberg proposal the only one from physics that got funded

Point of View



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- observational astronomy
 - today: CCD detectors
 - ≥ 20 years ago: photographic emulsions (mainly on glass plates)
- plate archives
 - Sonneberg (250.000), **Bamberg (40.000)**, Hamburg (35.000), Heidelberg (15.000), Bonn (11.000), Postdam (9.000)
- Bamberg Southern Photographic Patrol Survey (Strohmeier 1963)
 - Boyden, South Africa, 1963-1976 search for variables (14.712)
 - Mount John, New Zealand (1967-1976) (5242 plates)
 - direct images, $B \leq 14.5$ mag, $16\text{cm} \times 16\text{cm} = 15^\circ \times 15^\circ$
 - **scientifically most important part of our archive**

Need for Preservation



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

■ historian's point of view:

- oldest plates at Bamberg from 1903
- photographic emulsions already begin to decompose and dissolve from their glass plates

■ scientist's point of view:

- former results using blink comparators:
 - 1.700 'Bamberg variables'
 - (e.g. Strohmeier & Knigge 1961, Friedrich & Schöffel 1971, Knigge & Sosna 1977)
- only a fraction of observed plates have been looked on
- 25.000 - 200.000 stars on one plate
 - just 'tip of the iceberg'

APPLAUSE



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- equipment become affordable
 - large amount of storage space
- give access to the community (Virtual Observatory)
⇒ **APPLAUSE:**

Astronomical Photographic Plate Archive for scientific USE

in collaboration with the Leibniz Institute for Astrophysics at
Potsdam (AIP) and the Hamburg Observatory

Metadata

■ 10 years ago:

start of project to incorporate all
metadata into Wide-Field Plate
Database (WFPDB)

(Tsvetkov et al. 2005,
Tsvetkova et al. 2006)

→ www.skyarchive.org

WFPDB search page

1

 **Wide-Field Plate Database - Sofia**
 **Search Page**

[WFPDB](#) [WFPDB@VizieR](#) [Aladin](#) [All WFPDB Archives](#) [Active WFPDB Archives](#)

Query Setup
Maximum entries per page: 50 Output layout: htm table Output Order: + - Reset A

Search by Object or Field Coordinates
RA J2000 hh mm ss Star Gazer Visualization
DEC J2000 dd mm ss
Field Size deg
 Instrument Field
 Reduced Instrument
 Field

More constraints
 Plates with previews only Magnitude Limit
Additional display
Angular Distance from Field Centre Preview (if available) JD

Select A [Submit](#) [Clear](#)

Show	Sort	Column	Constraints	Units	Explain
<input checked="" type="checkbox"/>	<input type="radio"/>	IDobs	bam	(char)	WFPDB observatory identifier
<input checked="" type="checkbox"/>	<input type="radio"/>	IDins	010	cm	Instrument aperture
<input checked="" type="checkbox"/>	<input type="radio"/>	-	DSuf1	(char)	Instrument aperture suffix
<input checked="" type="checkbox"/>	<input type="radio"/>	-	IDno	(char)	Original plate number
<input checked="" type="checkbox"/>	<input type="radio"/>	DSuf2		(char)	Original plate number suffix
<input checked="" type="checkbox"/>	<input type="radio"/>	RAJ2000		hh:mm	Right ascension
<input checked="" type="checkbox"/>	<input type="radio"/>	DECJ2000		dd mm	Declination
<input checked="" type="checkbox"/>	<input type="radio"/>	-	CCOD		Code for Error, Missing Data, or Uncertainty of coordinates
<input checked="" type="checkbox"/>	<input type="radio"/>	DATE/UT		YYYY MM DD HH:MM:SS	Date/time of observation
<input checked="" type="checkbox"/>	<input type="radio"/>	-	TCOD		Code for Error, Missing Data, or Uncertainty of observation time
<input checked="" type="checkbox"/>	<input type="radio"/>	-	OBJNAM	(char)	Object name
<input checked="" type="checkbox"/>	<input type="radio"/>	-	OBJTYP	(char)	Object type code
<input checked="" type="checkbox"/>	<input type="radio"/>	-	METHOD		Method of observation code
<input checked="" type="checkbox"/>	<input type="radio"/>	-	MULTEX		Multiplicity of exposure
<input checked="" type="checkbox"/>	<input type="radio"/>	-	EXP	min	Exposure time
<input checked="" type="checkbox"/>	<input type="radio"/>	-	EMULS	(char)	Emulsion type
<input checked="" type="checkbox"/>	<input type="radio"/>	-	FILT	(char)	Filter type
<input checked="" type="checkbox"/>	<input type="radio"/>	-	SPEC	(char)	Spectral band
<input checked="" type="checkbox"/>	<input type="radio"/>	-	DIMx		X dimension of plate
<input checked="" type="checkbox"/>	<input type="radio"/>	-	DIMy		Y dimension of plate
<input checked="" type="checkbox"/>	<input type="radio"/>	-	PQUAL		Link to quality information
<input checked="" type="checkbox"/>	<input type="radio"/>	-	PNOT		Link to note text
<input checked="" type="checkbox"/>	<input type="radio"/>	-	POBS		Link to observer's name(s)

<http://wfpdb.org/search/>

08/22/2013 02:20:12 PM

Scan



ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

NATURWISSENSCHAFTLICHE
FAKULTÄT

- flatbed scanner
EPSON Expression
10000XL
 - resolution:
 $2.400 \text{ dpi} = 10 \mu\text{m} =$
 $3''.6/\text{pix}$
 - duration: 5 minutes
 - size: 400 MByte



Work Flow



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

1. select, fetch, and prepare

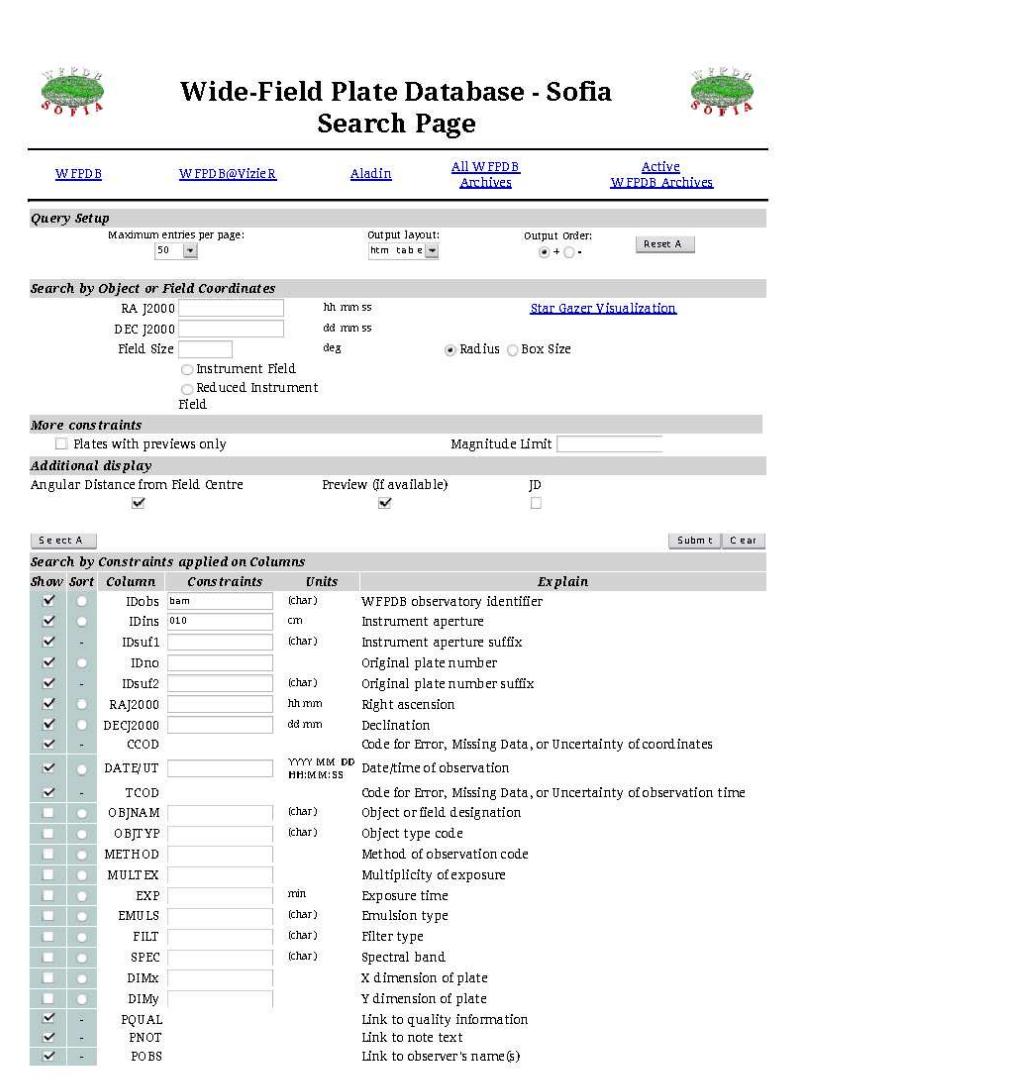
our plates are stored, ordered by coordinates and caption date, within paper envelopes in steel cupboards

2. scrutiny

Is the right plate in the proper envelope?

3. extraction of metadata

WFPDB search page



The screenshot shows the WFPDB search page interface. At the top, there are tabs for "WFPDB", "WFPDB@VizieR", "Aladin", "All WFPDB Archives", and "Active WFPDB Archives". Below the tabs are sections for "Query Setup" (Maximum entries per page: 50, Output Layout: h:m:s, Output Order: ascending), "Search by Object or Field Coordinates" (RA J2000, DEC J2000, Field Size, Star Gazer Visualization, Radius/Box Size), "More constraints" (Plates with previews only, Magnitude Limit), and "Additional display" (Angular Distance from Field Centre, Preview if available, JD). A "Select A" button is present. At the bottom, there is a table titled "Search by Constraints applied on Columns" with columns for Show, Sort, Column, Constraints, Units, and Explain.

Show	Sort	Column	Constraints	Units	Explain
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	IDobs	bam	(char)	WFPDB observatory identifier
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	IDins	010	cm	Instrument aperture
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	IDsufl		(char)	Instrument aperture suffix
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	IDno		(char)	Original plate number
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	IDsufl2		(char)	Original plate number suffix
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	RAJ2000		hh:mm	Right ascension
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	DECJ2000		dd:mm	Declination
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	CCOD			Code for Error, Missing Data, or Uncertainty of coordinates
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	DATE/UT		YYYY-MM-DD HH:MM:SS	Date/time of observation
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	TCOD			Code for Error, Missing Data, or Uncertainty of observation time
<input type="checkbox"/>	<input checked="" type="radio"/>	OBJNAME		(char)	Object or field designation
<input type="checkbox"/>	<input checked="" type="radio"/>	OBJTYPE		(char)	Object type code
<input type="checkbox"/>	<input checked="" type="radio"/>	METHOD			Method of observation code
<input type="checkbox"/>	<input checked="" type="radio"/>	MULTEX			Multiplicity of exposure
<input type="checkbox"/>	<input checked="" type="radio"/>	EXP		min	Exposure time
<input type="checkbox"/>	<input checked="" type="radio"/>	EMULS		(char)	Emulsion type
<input type="checkbox"/>	<input checked="" type="radio"/>	FILT		(char)	Filter type
<input type="checkbox"/>	<input checked="" type="radio"/>	SPEC		(char)	Spectral band
<input type="checkbox"/>	<input checked="" type="radio"/>	DIMx			X dimension of plate
<input type="checkbox"/>	<input checked="" type="radio"/>	DIMy			Y dimension of plate
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	PQUAL			Link to quality information
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	PNOT			Link to note text
<input checked="" type="checkbox"/>	<input checked="" type="radio"/>	POBS			Link to observer's name(s)

Work Flow



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

4. scan of envelope

to document metadata and
possible notes from the
observer and former analyzes

REMEIS OBSERVATORY SOUTHERN STATION			
OBJECT	_____		
R. A.	15h	DEC	-69°
EMULSION	Petits Astro		
FILTER	_____		
SEEING	1-2	QUALITY	2
REMARKS	Jul. Date: 2438195,3125		
Neujahr 1997			

Work Flow



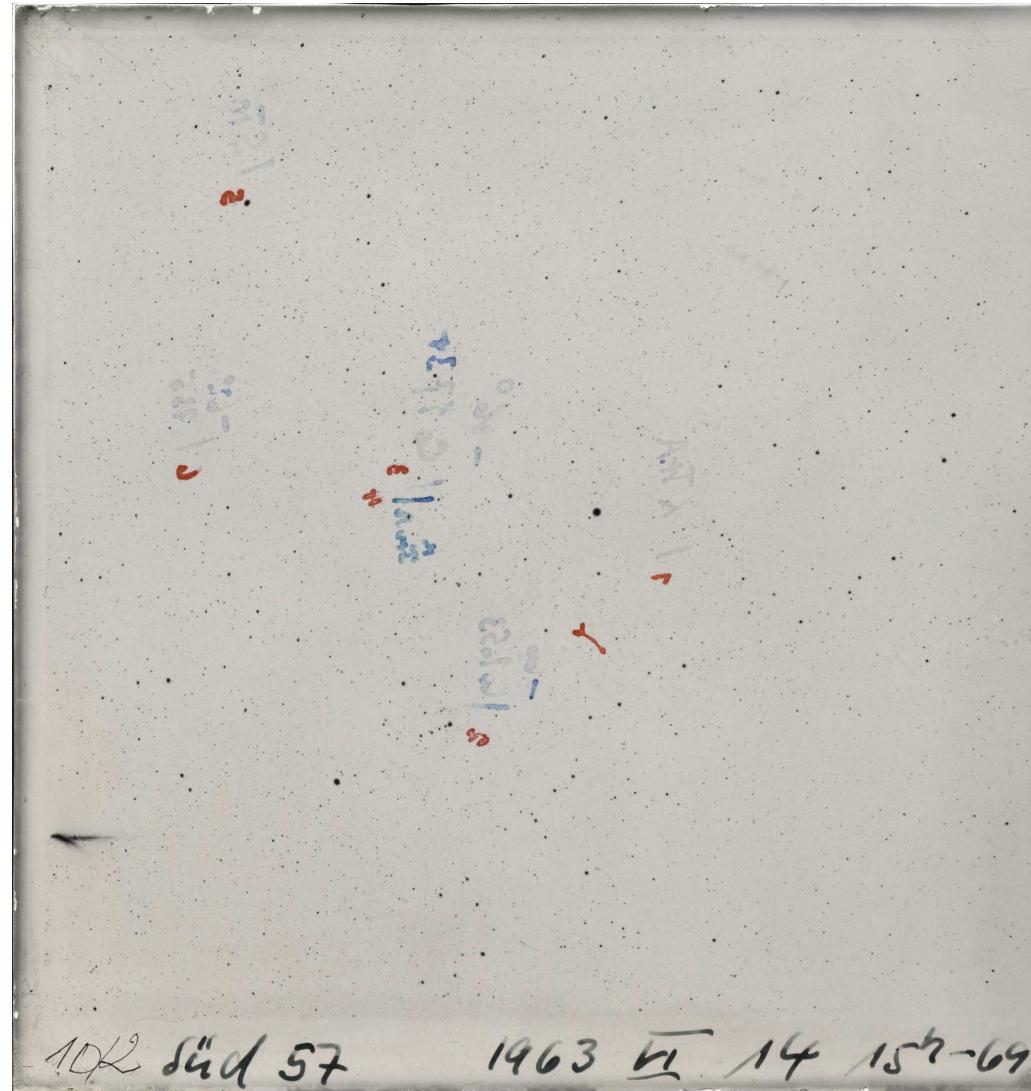
FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

5. low-res scan of plate

to document possible
markings from former
analyzes

6. cleaning of plate

(photo emulsion is untouched!)
to get rid of dust and dirt, using
microfiber cloth and water;
this also removes all markings,
but it is essential for automatic
computer based analyzes



Work Flow



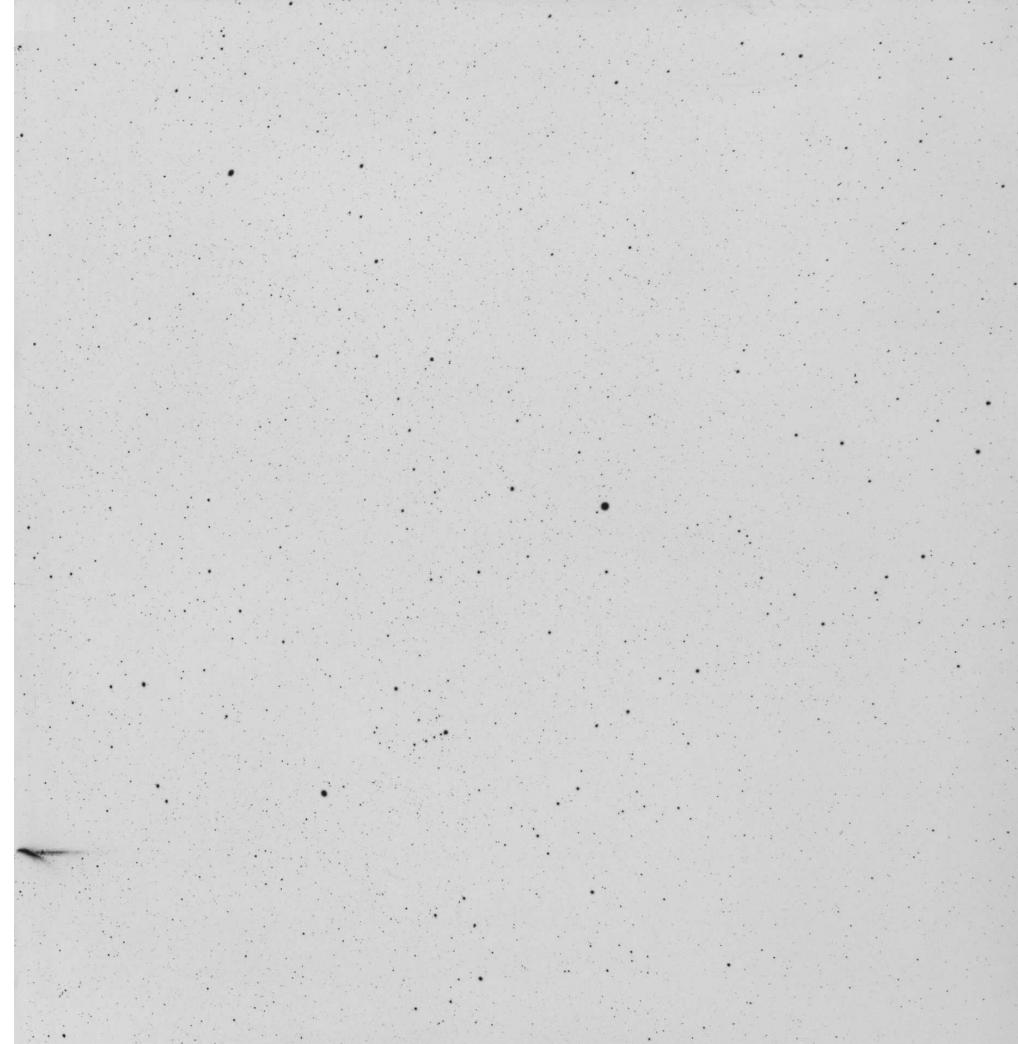
FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

7. high-res scan of plate

$$2.400 \text{ dpi} = 10 \mu\text{m} = 3.6''/\text{pix}$$

→ 400 MByte

a gray wedge is also scanned
to check durability of scanner's
transparency unit



8. store again

Work Flow



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

1. select, fetch, and prepare
 2. scrutiny
 3. extraction of metadata
 4. scan of envelope
 5. low-res scan
 6. cleaning of plate
 7. high-res scan
 8. store again
- process time per plate: 7-10 Mins.
- scanned so far: 8000 plates
→ 3 TByte = 3.072 GByte

Data Preparation



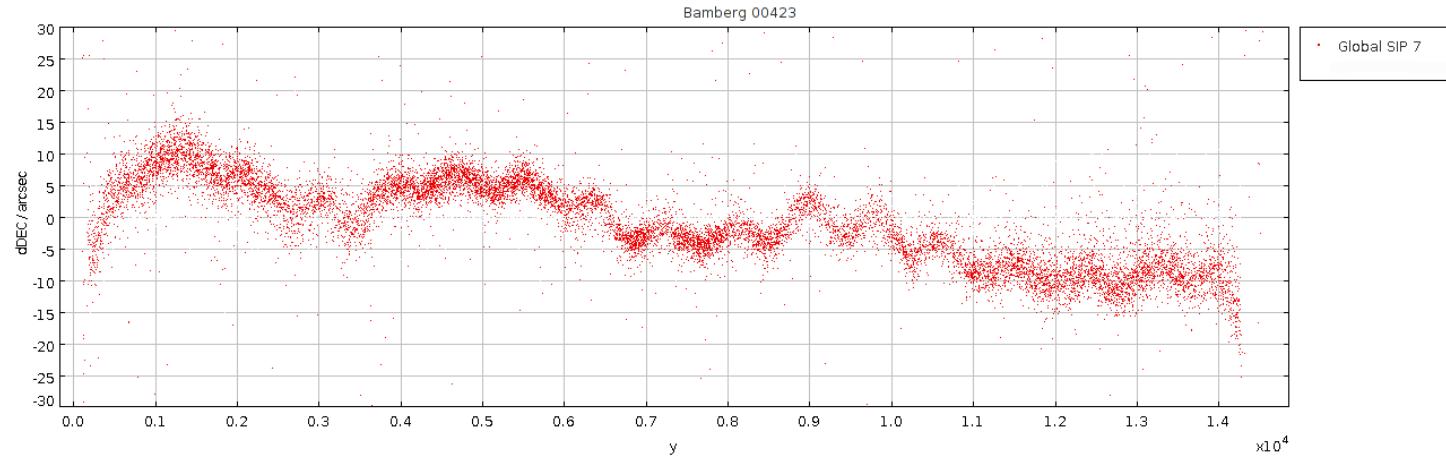
FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- implementation in database (Virtual Observatory)
 - all scanned data (inclusive logbooks) + metadata
 - FITS-header (Wide-Field Plate Database)
 - storage, web based interface
 - Leibniz Institute for Astrophysics at Potsdam (AIP)
- scientific investigations
 - ⇒ **data extraction**
 - astrometry
 - photometry

Astrometry



- SExtractor $\longrightarrow x, y$
- astrometry.net $\longrightarrow \text{RA, DEC}$



⊕ no additional file

FITS header: Simple Imaging Polynomial (SIP)

⊕ $\langle \text{RA, DEC} \rangle = \pm 15''$

⊕ for good solution \rightarrow **2** scans necessary

Astrometry

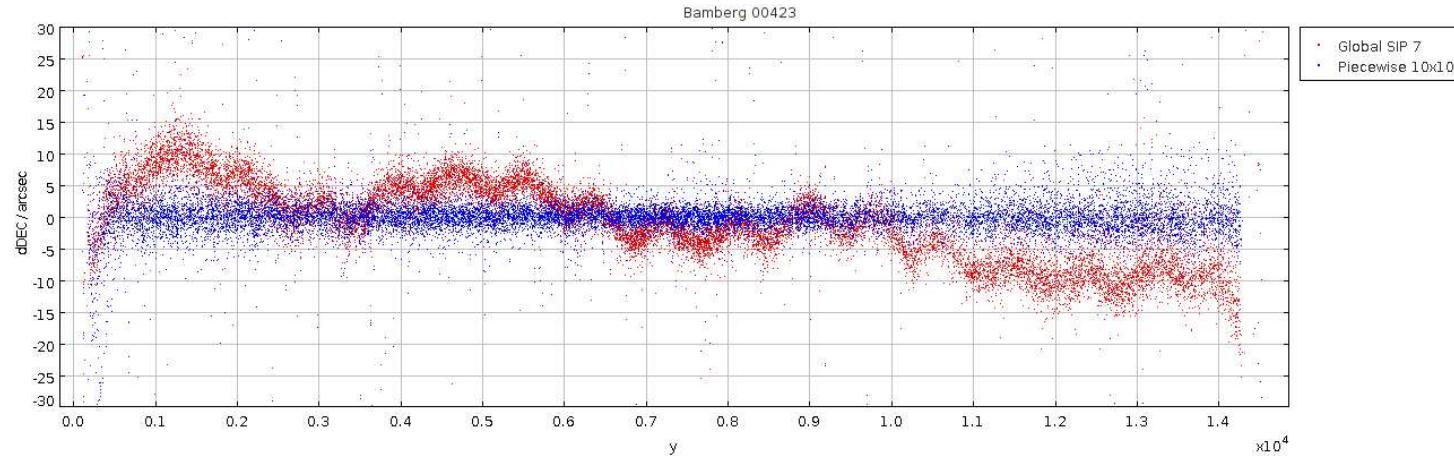


ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- SExtractor $\rightarrow x, y$
- astrometry.net, SCAMP + segmentation \rightarrow RA, DEC



⊕ $\langle \text{RA, DEC} \rangle = \pm 2''$ (note: scan resolution = $3''.6/\text{pix}$)

→ less than expected → search for e.g. asteroids, comets

⊕ for good solution \rightarrow 1 scan necessary

⊖ additional file (source list)

Photometry



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- SExtractor → relative magnitudes (using Zero point value)
- calibration: catalogs → magnitudes

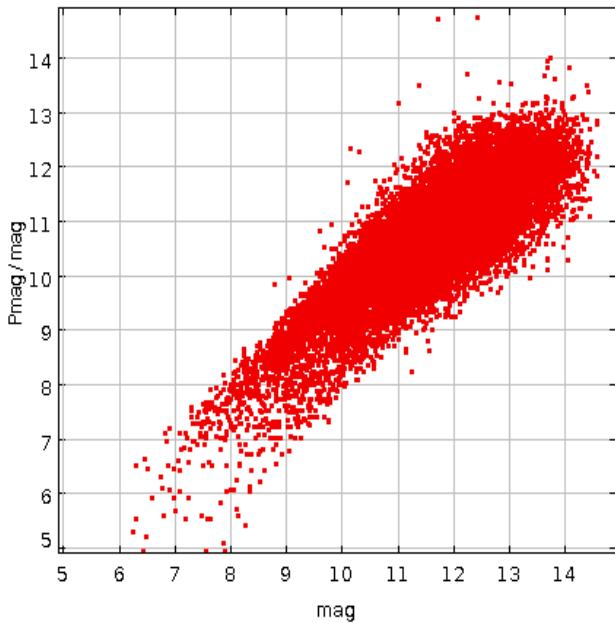


plate vs. HST GSC

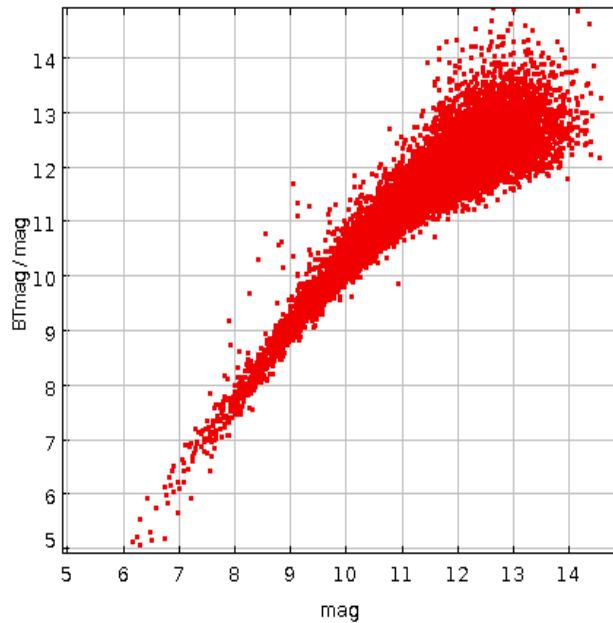


plate vs. Tycho-2

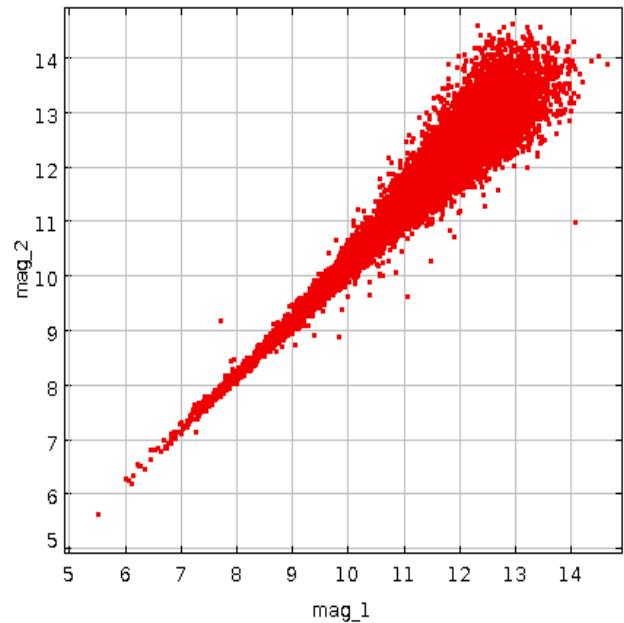


plate1 vs. plate2

Photometry



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- SExtractor → relative magnitudes (using Zero point value)
- calibration: catalogs → magnitudes

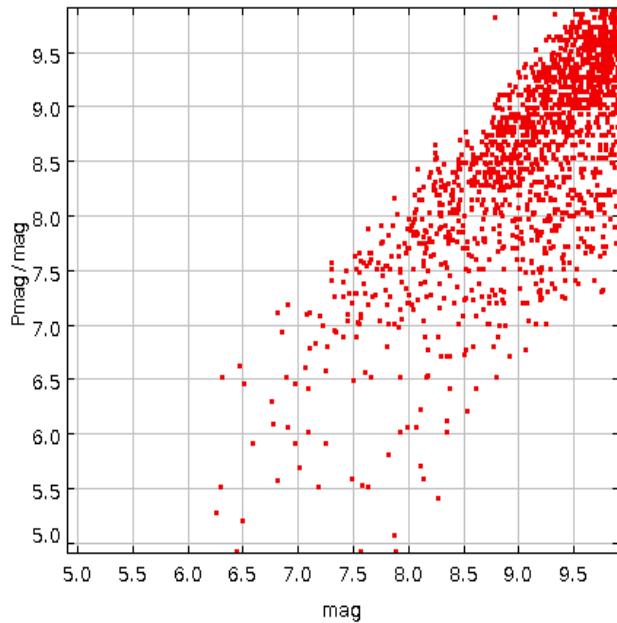


plate vs. HST GSC

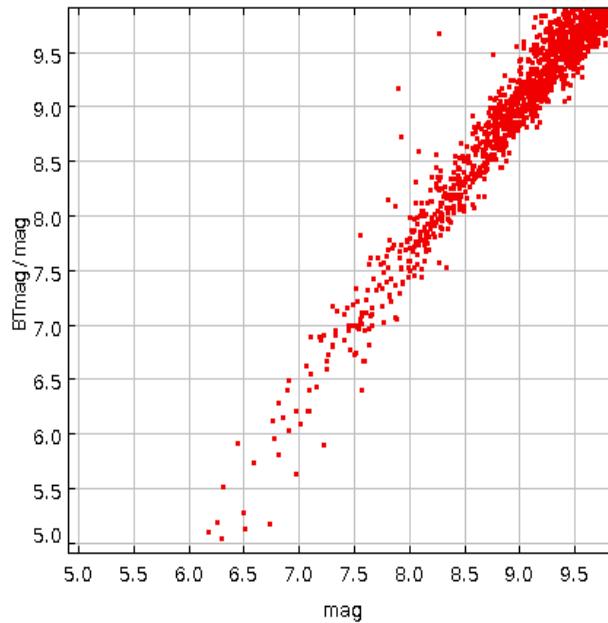


plate vs. Tycho-2

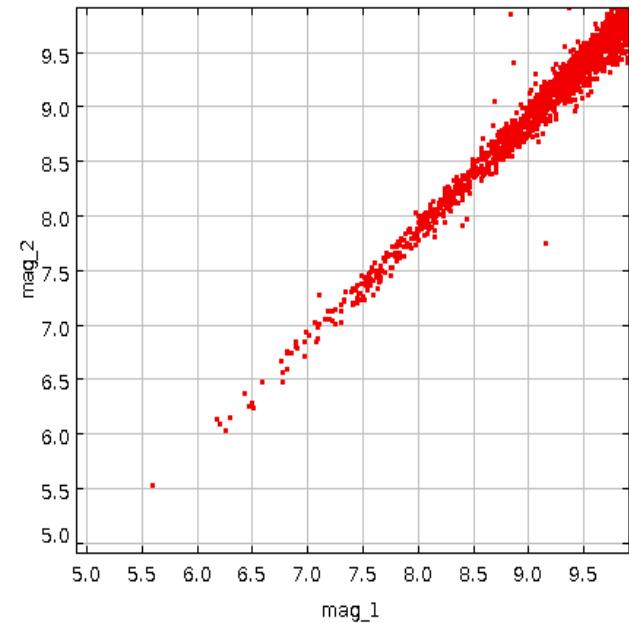


plate1 vs. plate2

First Tests

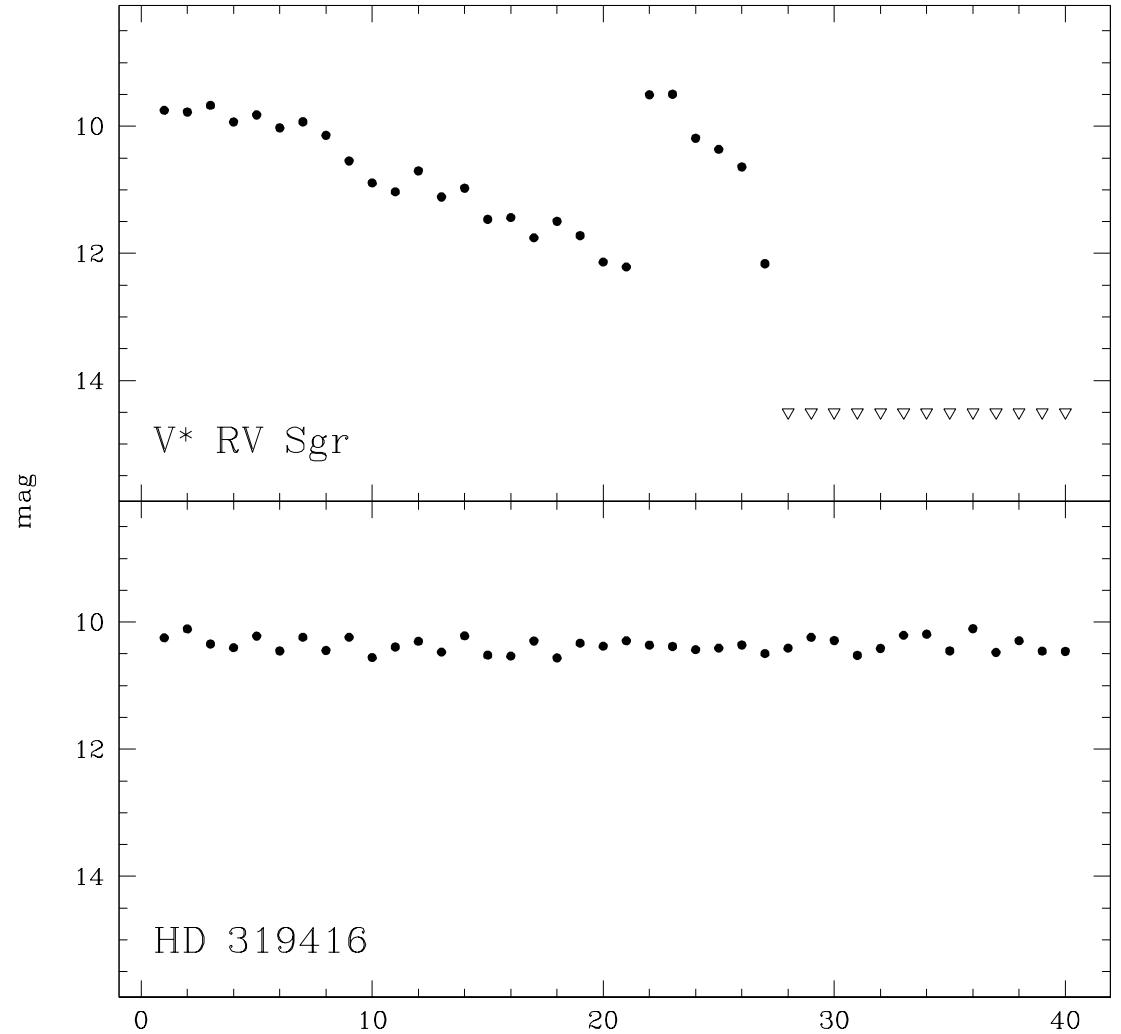


ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- known Mira
- $8\text{mag} \leq V \leq 13\text{mag}$

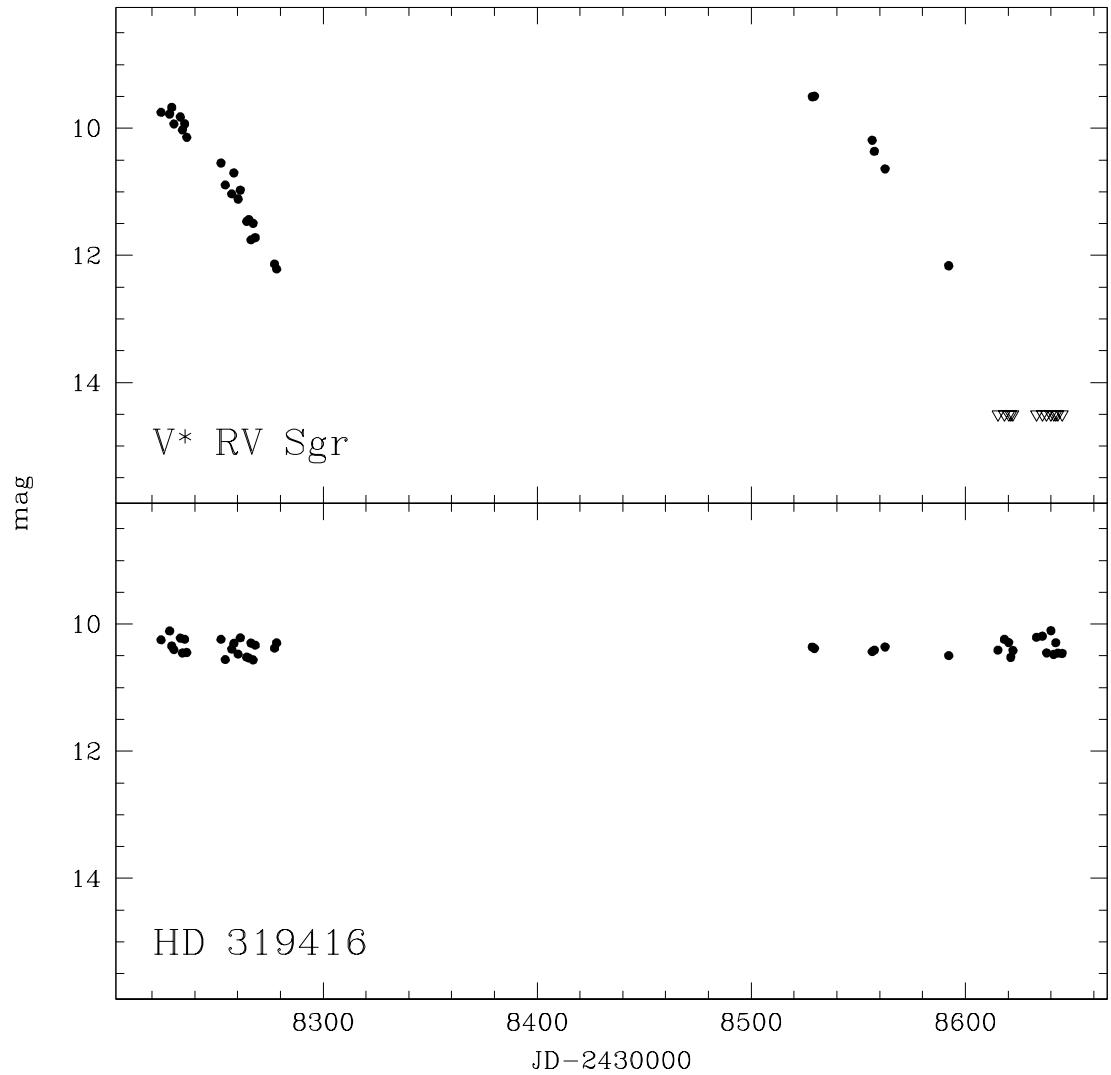


First Tests



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- known Mira
- $8\text{mag} \leq V \leq 13\text{mag}$



References



FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
NATURWISSENSCHAFTLICHE
FAKULTÄT

- Friedrich, D., Schöffel, E. 1971, "Mitteilungen über Veränderliche der Bamberger Liste", Veröff. Remeis-Sternw. Bamberg, Astron. Inst. Univ. Erlangen-Nürnberg, Vol. 8, No. 95, p. 19
- Knigge, R., Sosna, F. M. 1977, "Mitteilungen über Veränderliche der Bamberger Liste. Neue Veränderliche Sterne am Südhimmel", Veröff. Dr. Remeis-Sternw. Bamberg, Astron. Inst. Univ. Erlangen-Nürnberg, Band 12, Nr. 125, p. 7
- Strohmeier, W., Knigge, R. 1961, "Mitteilungen über Veränderliche der Bamberger Himmelsüberwachung", Astronomische Nachrichten, Vol. 286, p. 133
- Strohmeier, W. 1963, "The Bamberg Search for Bright Variable Stars", Sky and Telescope, Vol. 26, p. 264
- Tsvetkov, M., Tsvetkova, K., Borisova, A., Kalaglarsky, D., Bogdanovski, R., Heber, U., Bues, I., Drechsel, H., Knigge, R. 2005, "Bamberg southern photographic patrol survey: incorporation in the WFPDB", Publications of the Astronomical Society "Rudjer Boskovic", Vol. 5, p. 303
- Tsvetkova, K. P., Tsvetkov, M. K., Heber, U., Bogdanovski, R. G., Kalaglarsky, D. G. 2006, "Bamberg Northern Sky Survey: Catalogue and Incorporation into the WFPDB", Virtual Observatory: Plate Content Digitization, Archive Mining and Image Sequence Processing, iAstro workshop, Sofia, Bulgaria, 2005 proceedings, ISBN-10 954-580-190-5, p. 109-114