

Digitizing Harvard's Unique Astronomical Plate Collection: Extending the Virtual Observatory a Century Backward in Time

- Largest: 500,000 plates +/- 100,000
- Most complete sky coverage: Northern and Southern telescopes
- Longest time coverage: 1885-1989
- Basis for fundamental discoveries in astronomy, such as using Cepheid variable stars as cosmic yardsticks
- A legacy of long-term commitment to astronomical photography and research

Without HCO Plate Digitization:

- Astronomy will never have any functional record of the sky, 1885-1989.
- Astronomy will not have an equivalent time frame for accrued CCD observations until 2080.
- Other plate repositories lack the personnel and infrastructure to solve challenges of storage, web display and photometric accuracy which we have in HCO, SAO, and HUL-DRS
- Other plate repositories are hoping that Harvard will take the lead in digitization
- The upcoming National Virtual Observatory, which provides digital access to astronomical data, will lack its only long-term temporal record of the sky to complement the future LSST digital temporal survey.

IAU Resolution B3, 2000

Safeguarding the Information in Photographic Observations

The International Astronomical Union,

Recognising

that unless urgent action is taken, this unique historical record of astronomical phenomena will be lost to future generations of astronomers,

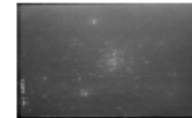
Recommends

the transfer of the historic observations onto modern media by digital techniques, which will provide worldwide access to the data so as to benefit astronomical research in a way that is well matched to the tools of the researcher in the future.

A Half-Million Plates



Harvard-Smithsonian Center for Astrophysics
Harvard University Plate Stacks
Plate Characteristics



Collection Summary rev. 31 October 2002

Code	Aperture (in.)	Scale "/mm	Scale "/inch	+dec	at d=0 +-ra	N/S	Total	Years	Limit	Q	Remarks
A	24	60	0.42	2.9	14.3	S	27504	1893-1950	18	5	primary (Some early plates northern hemisphere)
ADH	30	68	0.48	2.4	9.6	S	7067	1950-1963	18-19	4	Circular plates, north edge at mark
AM,AC, etc.	1.5	600	4.23	21.1	67.7	N/S	75000	1898-1957	13-14	3	primary
B	8	179	1.26	6.3	20.2	S	76874	1885-1954	17	4	primary
BR	8	209	1.46			S	4176	1938-1944	17	4	like MF
C	11	84	0.59	2.4	5.9	N	23270	1886-1947	--	2	Mostly spectra; limited use
DNB,DSB	1.6	580	4.09	20.5	65.4	N/S	9000	1962-1989	15	5	**Patrol (>1962)
FA,AI	1.5	1200	-----	-----	-----	N	70000	1901-1958	--	2	bright_objects
H	24	60	0.42	0.9	3.6	N	6644	1906-1953	--	3	Reflector (small field)
I	8	163	1.14	5.7	18.2	N	59246	1889-1946	17	4	primary
IR	8	162	1.13	5.6	18.0	N	12798	1934-1976	17	4	--
J	24	98	0.68	2.7	10.8	N	4770	1942-1957	--	3	Schmidt; square plates, N-S diagonal
MA	12	97	0.68	3.4	10.9	N	11737	1905-1983	17-18	5	primary
MB	4	193	1.4	6.8	22	N	2722	1914-1932	--	2	MA piggy-back
MC	16	98	0.68	2.7	13.6	N	40596	1909-1992	17-18	5	primary
MD	4	193	1.36	6.8	21.7	N	30000	1911-	11	2	MC piggy-back
MF	10	167	1.17	5.8	18.7	S	40897	1915-1955	17	4	primary(Some early plates N)
RH,RB	3	391	2.76	13.8	44.2	N/S	33000	1928-1963	15	3	primary
RL	4	290	2.05	8.2	32.8	N	5062	1933-1962	--	--	--
SH,SB	60	26	.18	.36	.45	N/S	20000	1934-1989	--	--	Asteroids (Reflectors)
Superschmidt	12	1200	8.4	27	108	N	30000	1953-1968	--	--	Meteor films (circular, molded)
X	13	42	.29	1.2	5.8	S	19090	1888-1951	--	--	primary

Phase 0 (2002): Test scanners

CreoScitex EverSmart \$35,000-\$50,000

High resolution (4800 dpi), but crashed a lot
20 minutes per scan



Phase 0 (2002): Test scanners

UMAX PowerLook 3000 \$5,000

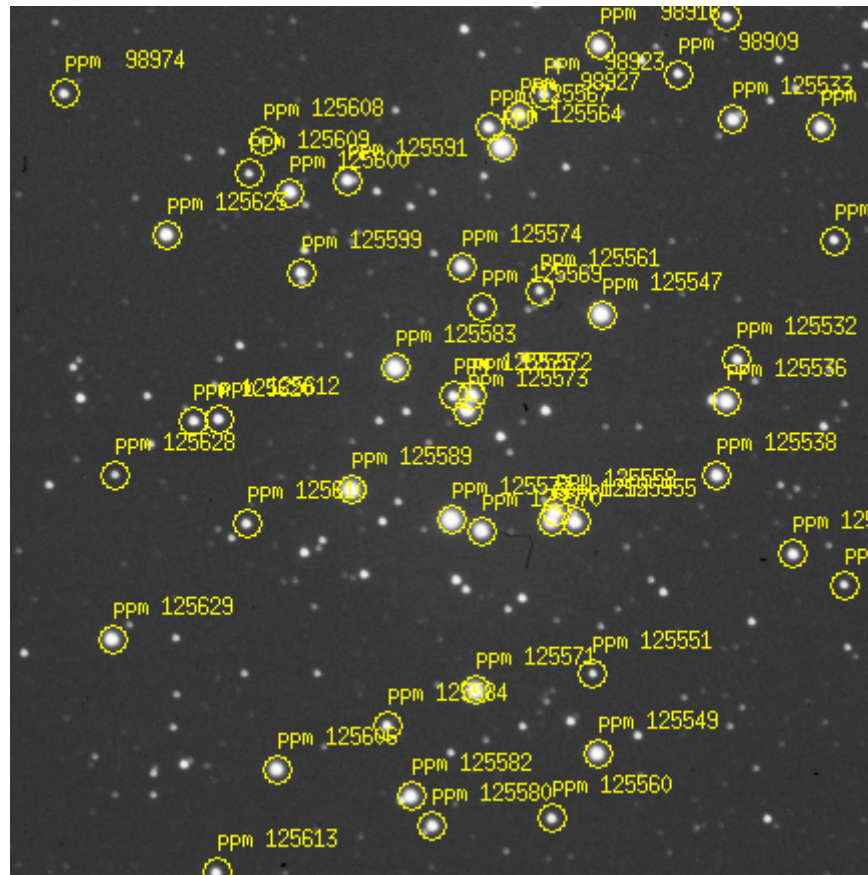
Adequate resolution (1200 dpi), reliable

Under 10 minutes per scan



Phase 0: What we learned

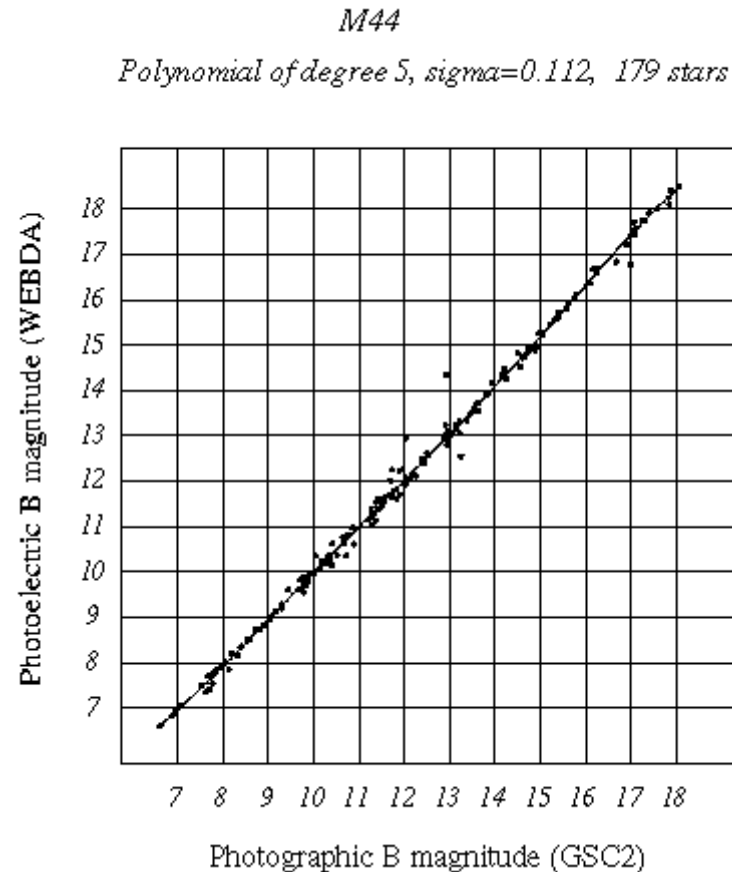
- Plate astrometry using FITS WCS is good enough for source ID, but higher order terms needed.
- 1200 dpi is enough for most of the sky, but 2400 dpi is better for crowded star fields.



Phase 1:

Can science be done with digitized plates?

Verify photometry possible with scans of known sequence in galactic star cluster M44



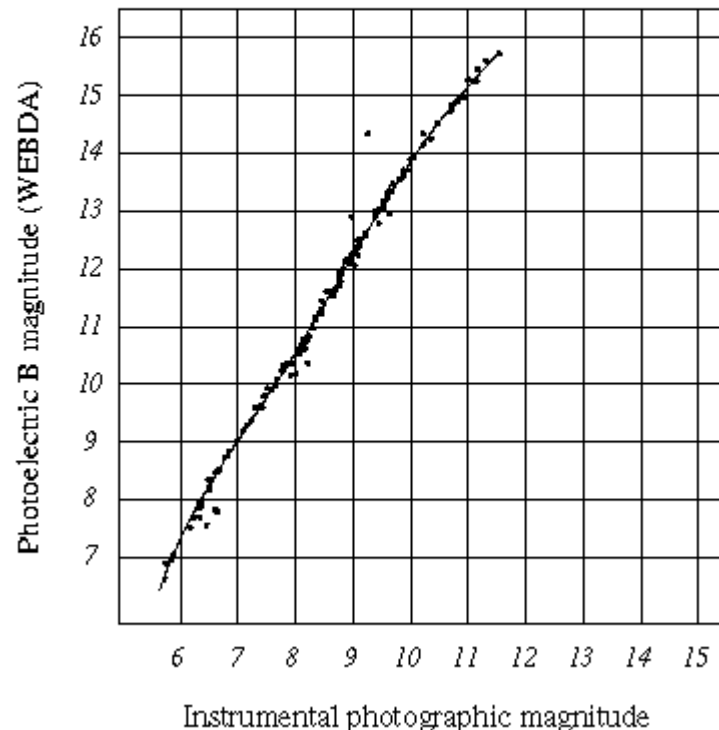
Phase 1:

Can science be done with digitized plates?

Photometry of known sequence in galactic star cluster M44 on 1947 MC series plate

M44 (plate mc35294)

Polynomial of degree 5, sigma=0.083, 136 stars

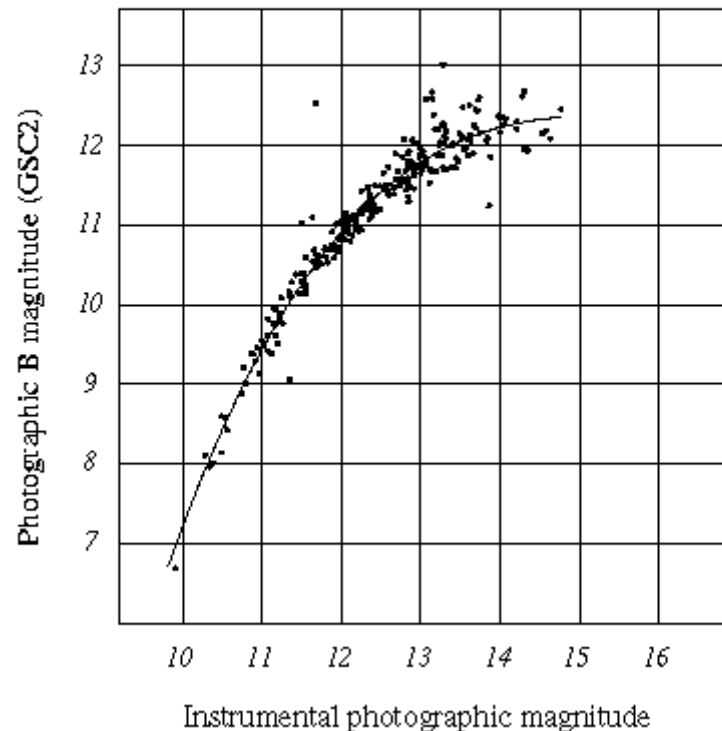


Phase 1:

Can science be done with digitized plates?

Photometry of known sequence in galactic star cluster M44 on 1905 AC series plate

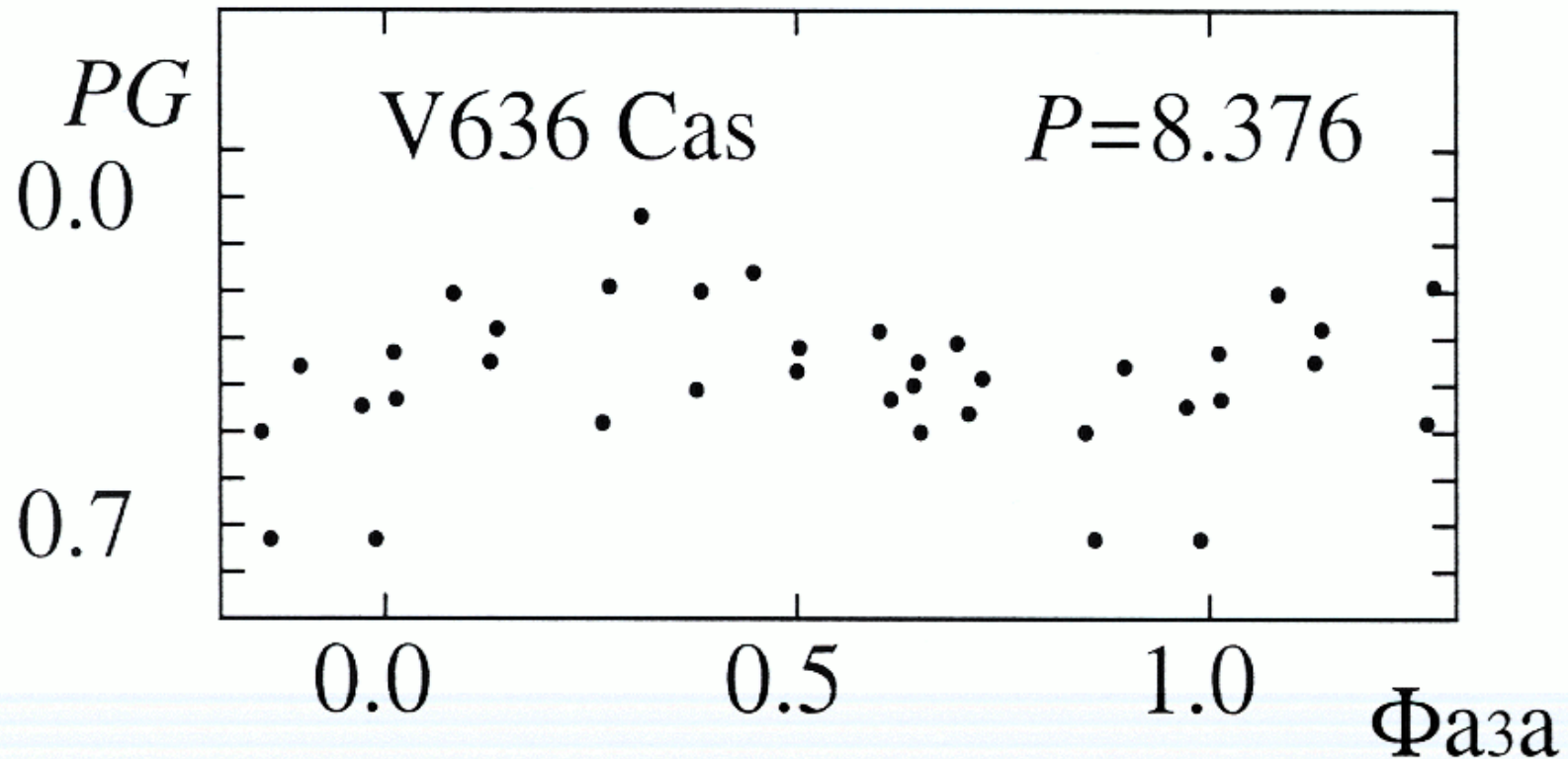
*Plate ac44, 1905, exposure=94min
Polynomial of degree 3, sigma=0.173, 254 stars*



Phase 1:

Can science be done with digitized plates?

Scan multiple plates and study Cepheid variability



Phase 2: Improve access

Move the catalog out of the XIXth century



Phase 2: Improve access

Move the catalog into the 21st century



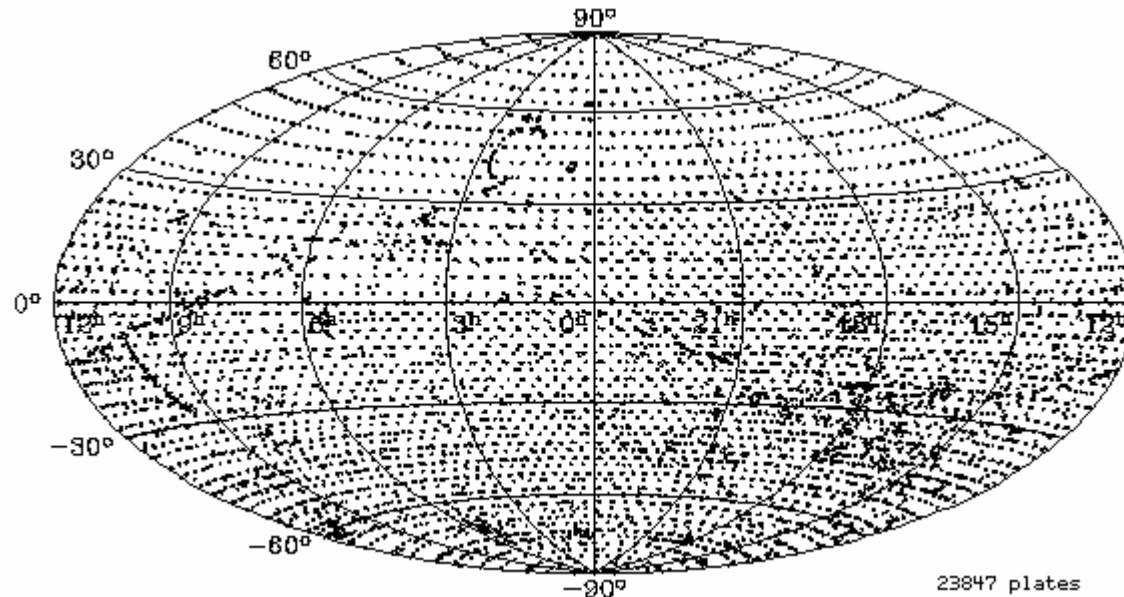
Name 5-digit Sequence or Object Name

J2000 Right Ascension (hh:mm:ss.sss) Declination (dd:mm:ss.sss)

Search Starting date (year or ISO date) Ending date (year or ISO date)


Click on map to see plates from 1890's

· Harvard Observatory A plate centers (aplates)




Phase 2: Improve access

Move the catalog into the 21st century



Telescope Data Center
SMITHSONIAN ASTROPHYSICAL OBSERVATORY



Harvard Plate Stacks
A Series Search

Name 5-digit Sequence or Object Name

J2000 Right Ascension (hh:mm:ss.sss) Declination (dd:mm:ss.sss)

Search Starting date (year or ISO date) Ending date (year or ISO date)

Searching for plates containing 08:40:22.198 +19:40:19.43 J2000 from 1890 to 1910

Plate	RA2000	Dec2000	Exp	Epoch	Arsec
0045	08:34:52.827	+19:55:38.21	18.00	1893-11-26	4738.41
0147	08:33:53.101	+20:07:41.64	59.00	1894-01-02	5728.35
0194	08:33:53.101	+20:07:41.64	16.00	1894-01-26	5728.35
0196	08:33:52.997	+20:01:41.64	60.00	1894-01-31	5638.83
0207	08:32:53.272	+20:13:45.08	15.00	1894-02-02	6639.87
0244	08:32:53.272	+20:13:45.08	10.00	1894-02-17	6639.87
0263	08:33:52.789	+19:49:41.65	14.00	1894-02-25	5526.18
0265	08:49:53.978	+22:06:48.14	21.00	1894-02-25	11892.47
0326	08:52:49.101	+17:18:38.58	13.00	1894-03-08	13606.37
0537	08:32:50.291	+17:19:45.16	10.00	1894-04-18	10604.32
0549	08:35:53.070	+20:13:34.78	60.00	1894-04-26	4287.29
1252	08:47:54.341	+22:18:54.64	20.00	1894-12-24	11429.00
1280	08:31:53.338	+20:13:48.54	68.00	1895-01-30	7450.71
1285	08:35:53.070	+20:13:34.78	60.00	1895-02-15	4287.29
6639	08:32:50.291	+17:19:45.16	10.00	1904-04-05	10604.32
6661	08:52:49.101	+17:18:38.58	10.00	1904-04-16	13606.37
6667	08:52:53.935	+22:18:38.47	10.00	1904-04-17	14178.60
6708	08:32:50.291	+17:19:45.16	10.00	1904-05-03	10604.32
7203	08:32:55.499	+22:19:45.02	60.00	1905-03-07	11428.92
7205	08:32:55.499	+22:19:45.02	10.00	1905-03-07	11428.92
9236	08:52:49.101	+17:18:38.58	62.00	1909-05-13	13606.37

Phase 3: Improve access to images

Move the plates out of the 20th century



Phase 3: Improve access to images

Move the plates into the 21st century

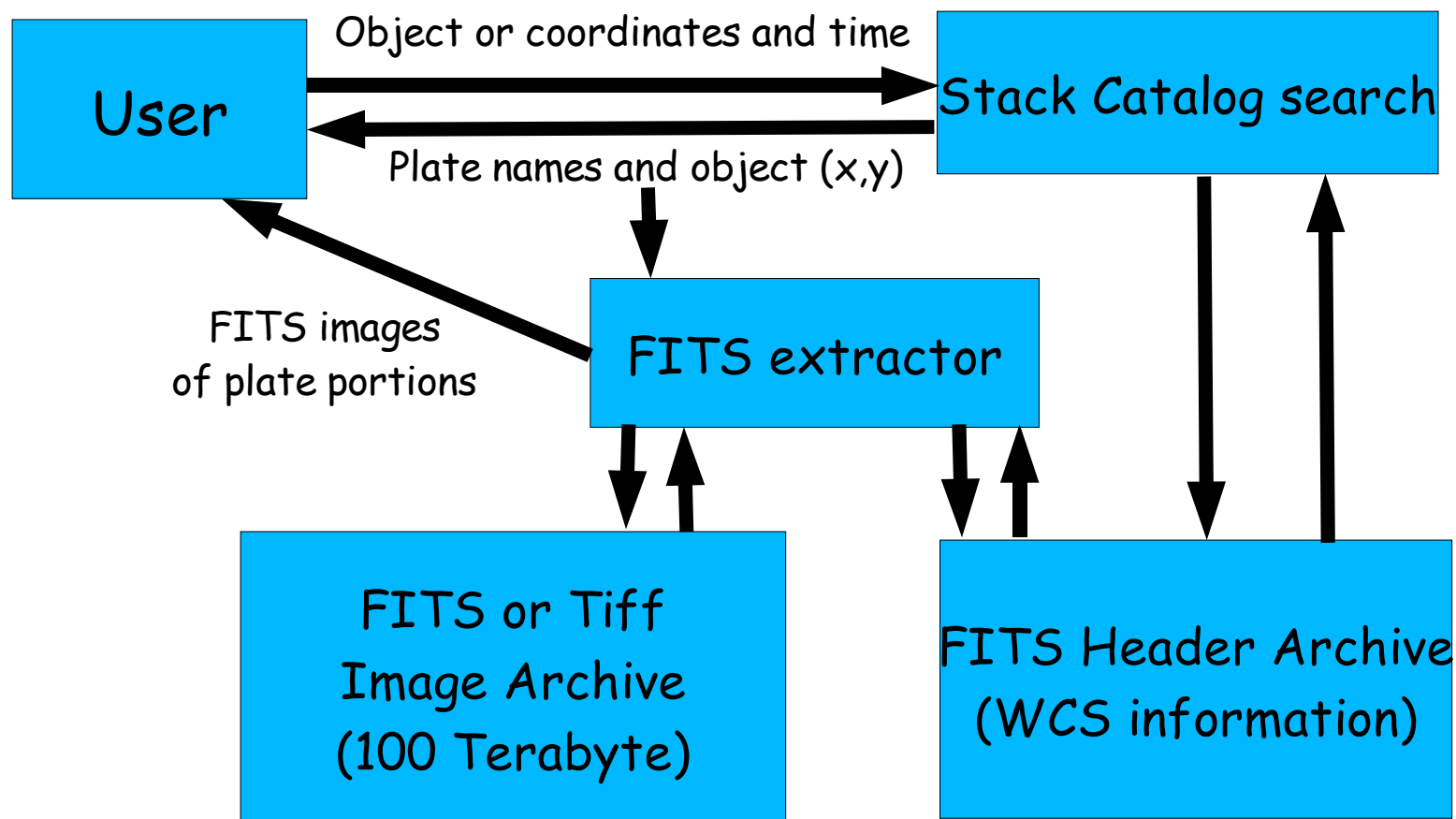


Plate Scanning Pipeline

