

Finding Hidden Treasures: Investigations in US Astronomical Plate/Negative Archives

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FINDING HIDDEN TREASURES INVESTIGATIONS IN US ASTRONOMICAL PLATE ARCHIVES



**CZECH US COLLABORATIVE PROJECT
2008-2012**



Transportable plate scanning device

Plate collections visited:

Carnegie Observatories Pasadena

Lick Observatory

Yerkes Observatory

Mt Palomar Observatory

PARI NC

KPNO Tucson

CFHT Waimea, Hawaii

IfA Manoa, Hawaii

USNO Flagstaff, AZ

USNO Washington, DC & 7 more

About 2 million plates in these archives

**Preferences: transportable,
very fast scanning, high
repeability (no moving
scanner parts)**

Used equipment:

Camera: 21 MPx Canon EOS 5D Mark II (in 2012 replaced by 39
MPx) Lenses: Canon EF 24-70 f/2.8 L USM & Canon 70-200mm F4

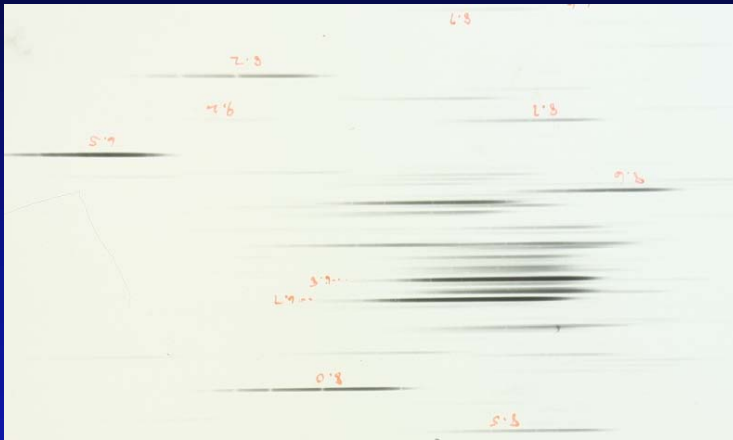
ASTROPLATE2014

Carnegie Observatories Pasadena, CA

2nd largest US astronomical plate archive with half million plates (includes solar astronomical plates)



Carnegie Observatories Pasadena, ~ 500 000 plates



Scanning US
collections of
LDS plates

LDS (Low Dispersion
Spectroscopy) plates from
1909 at Carnegie Obs,
Pasadena, CA, USA

The North Mt Wilson –
Michigan Halpha survey
plates are deposited here



CFHT Waimea Hawaii



Valuable
plates
taken by
3.6 m
CFHT
telescope
Very
deep lim
magn

CFHT Hawaii Waimea II



CFHT was originally designed for photographic plates and has produced plates for ~ 10 years

The CFHT plates available at CFHT Waimea and IfA Manoa were scanned in Oct 2011

Yerkes Observatory

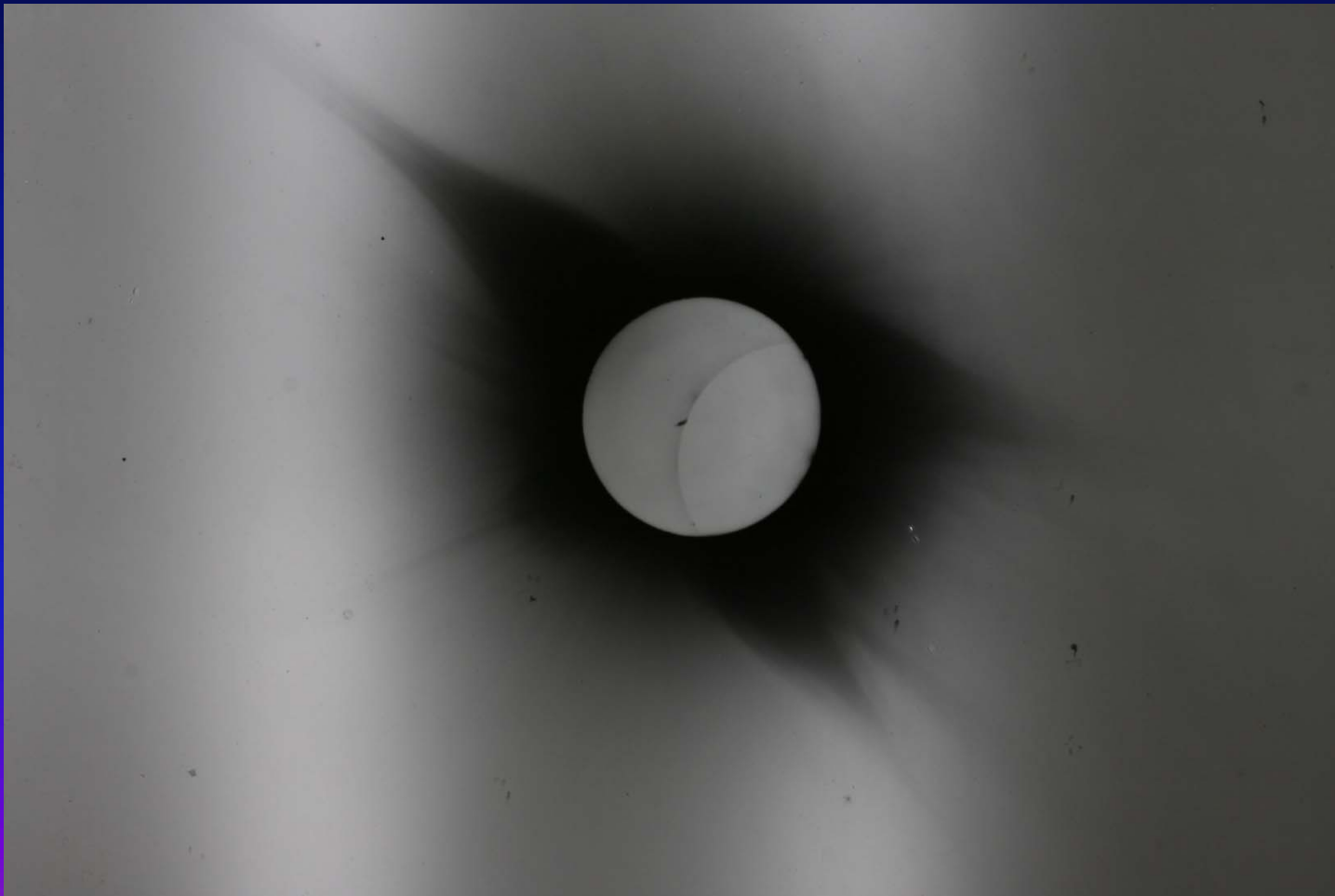


~ 170 000 astronomical archival
plates (including spectra and solar)



ASTROPLATE2014

**Solar Eclipse Einstein relativity theory
tests 1919 (Eddington) – original plate
digitized by us (Yerkes archive)**



KPNO Tucson



**> 30 000
plates, partly
from Chile**

MtPalomar



About 30 000 plates, stored in the observing dome



ASTROPLATE2014

Lick Observatory MtHamilton



**~200 000 plates
including very
valuable collection of
LDS prism plates
taken by Prof Herbig**



Lick Observatory II



**Valuable
collection of
high quality
proper
motion
plates**

20-INCH
PROPER MOTION PLATES

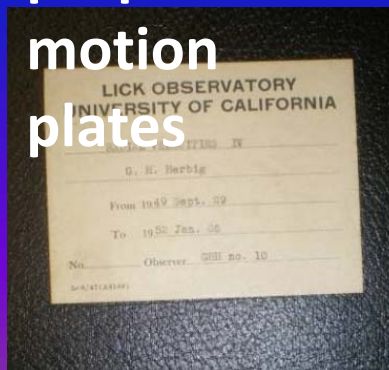
Because of the irreplaceable time value of the 20-inch proper motion plates, every precaution against damage or breakage must be observed. Only the following persons are authorized to remove plates from these cabinets:

Herbig	Vasilevskis
Kinman	Whitford
Shane	Wirtanen

Others who need to refer to these plates should ask one of the above to handle them, both for removal and return to the cabinets.

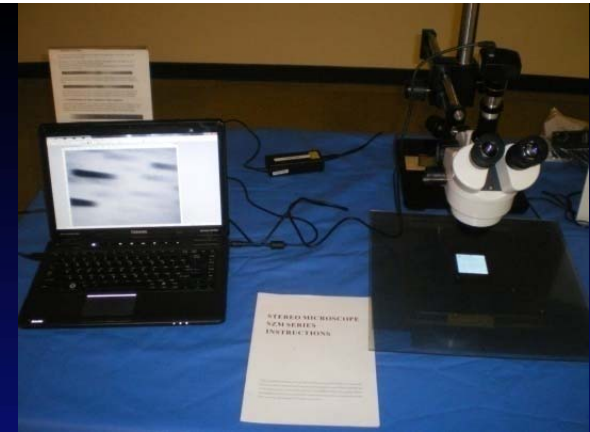
A. E. Whitford
Director

January, 1964



ASTROPLATE2014

PARI, North Carolina



Central repository for US plates
~ 220 000 negatives but more coming



PARI NC – largest plates



Skylab UV spectra experiment



**Original
negatives
are at
PARI, NC**



Karl Henize Mt Wilson-Michigan Southern Sky H α Survey

MICHIGAN-MT. WILSON SOUTHERN H α SURVEY
LAMONT-HUSSEY OBSERVATORY
BLOEMFONTEIN, SOUTH AFRICA

NO. LH α 440
DATE 11 June 51
R. A. 1740
DEC. -55.0
EXPOSURE 6 x 40
EMULSION 103aE
OBSERVER HENIZE



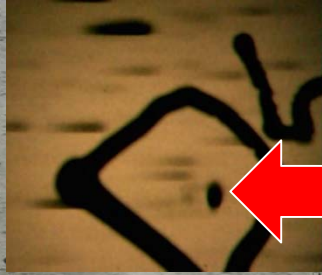
Professor of Astronomy, later NASA Astronaut

290 high quality plates 15 x 15 inches taken in 1950-1952 in South Africa by dedicated telescope by Karl Henize (for his Dissertation)

Now deposited at PARI, NC



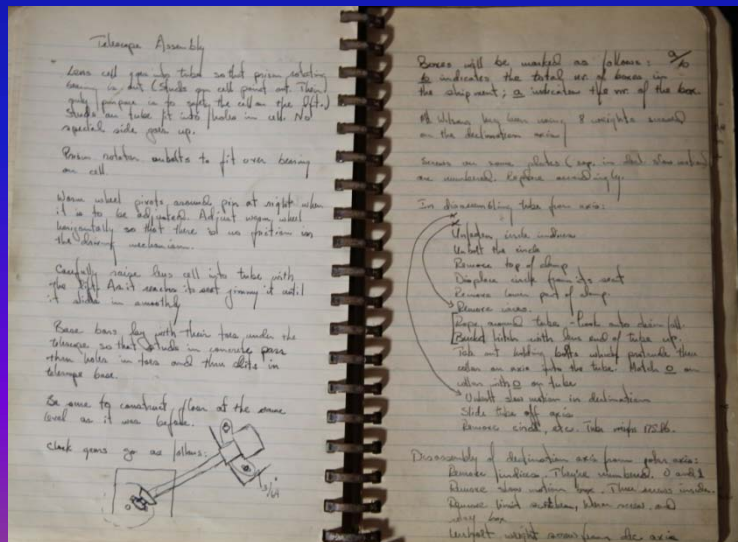
Example of
emission
object
found



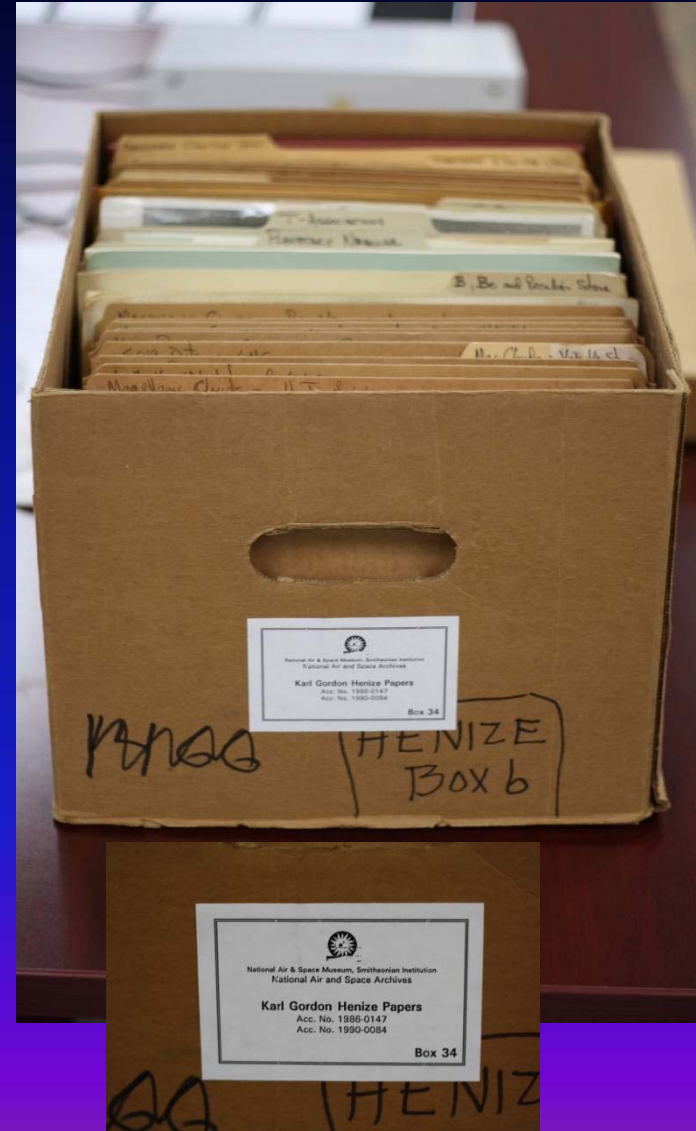
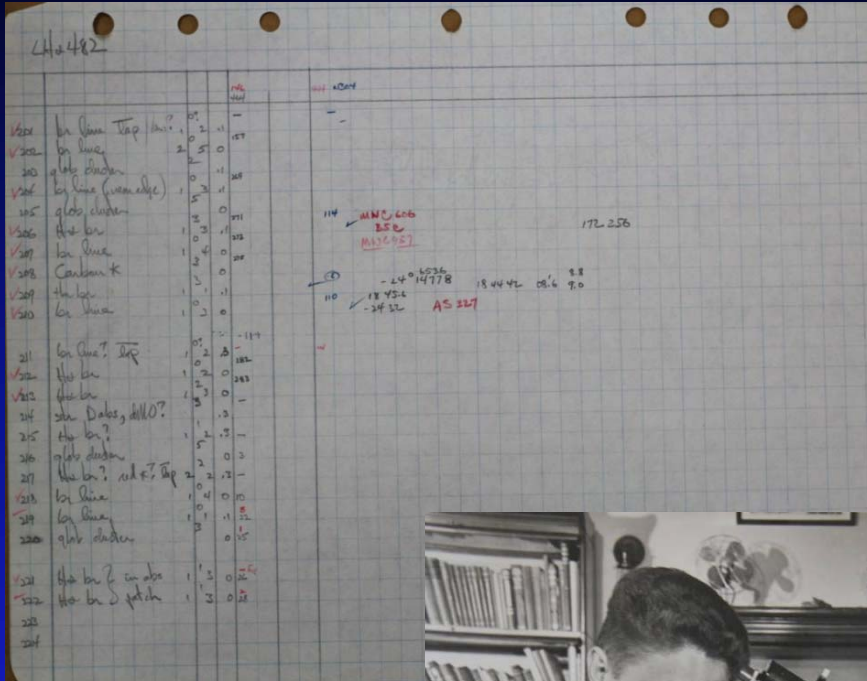
Southern H α Mt Wilson
Michigan Survey Plate

Many spectral surveys in
the US Can be used for
many HEA tasks e.g.
searches for highly
redshifted QAs of GRBs

Treasure hunting with Astronaut Henize family

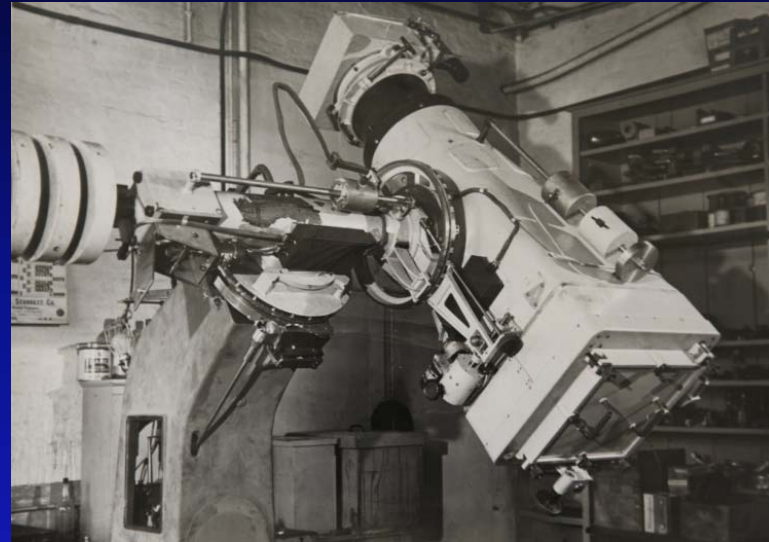


Henize measurements logs recovered and digitized
at Hazy center in Washington DC in Sept 2012



Important for ESA Gaia RP/BP - LDS

Recovering Henize telescope, Africa observatory, and prism



**Photo courtesy: Henize
family**

Two recently found large US archives of astronomical films

- **Baker Super Schmidt camera films**
- 55 deg dia FOV, lim mag 15, dense sampling 20 sec, ~ 110 000 negatives, ~ 10 years coverage
- **Baker-Nunn camera networks negatives**
- FOV 30 x 5 deg, lim mag 16, very dense sampling ~ few sec, >> 1 mil negatives, ~20 years coverage

Two recently found large US archives with major impact on HEA

- Baker Super Schmidt camera films
- 55 deg dia FOV, lim mag 15, dense sampling 20 sec, ~ 110 000 negatives
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Super-Schmidt Baker Camera

About 100 000 films

Limiting magnitude 15,
very sharp images

FOV 55 degrees

1950-1960

Very dense (20 minutes)
sampling

Now deposited at PARI,
NC

Baker-Nunn camera networks (SAO & US military)

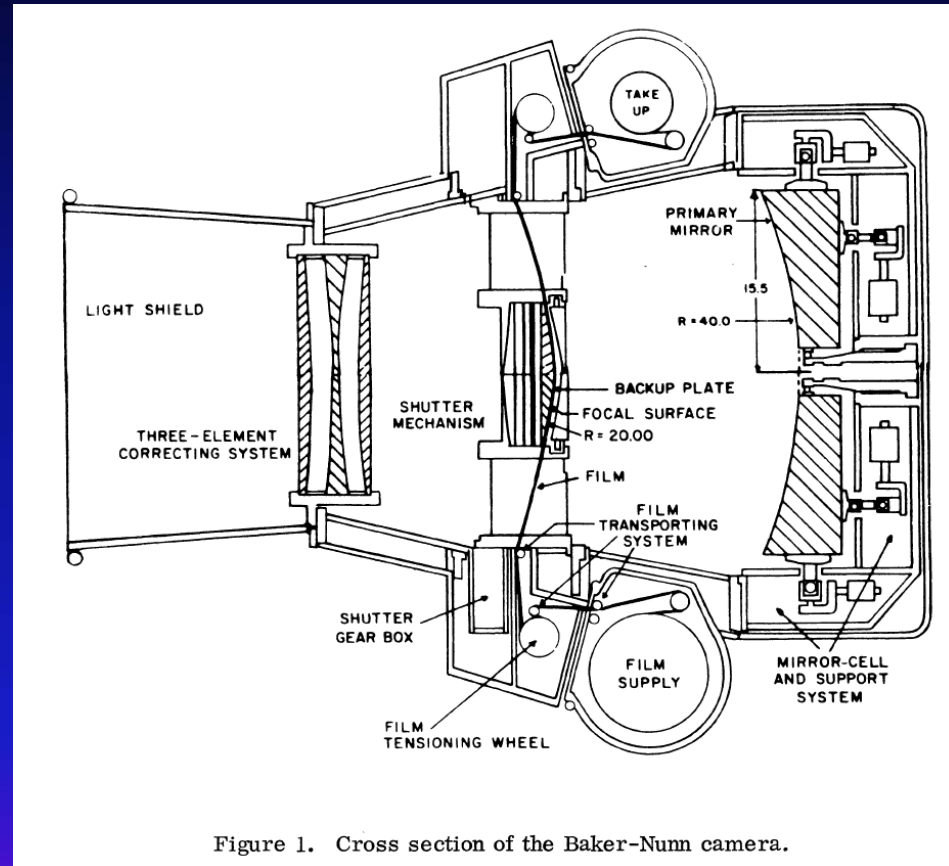
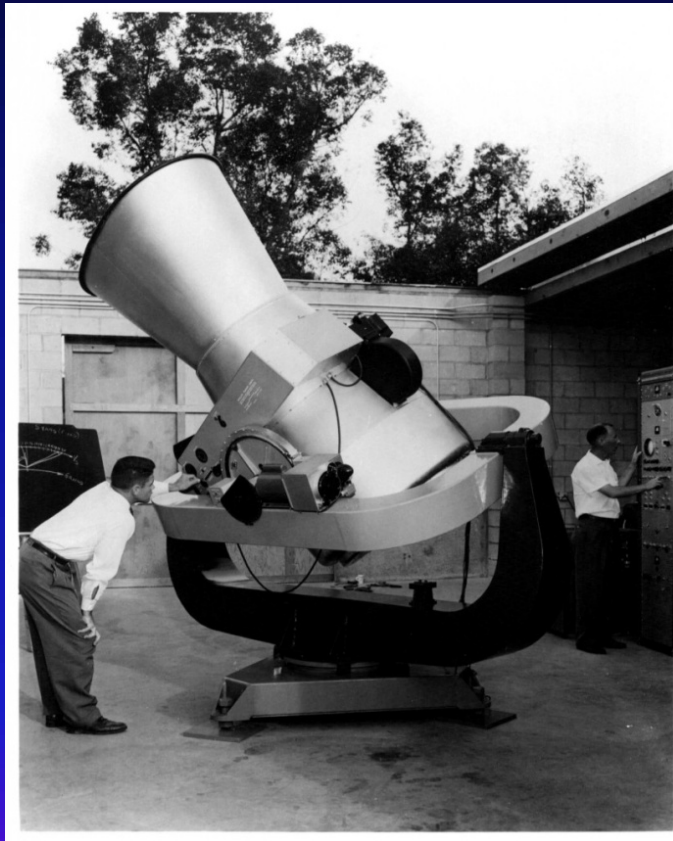


Figure 1. Cross section of the Baker-Nunn camera.

Very fast film camera with $f/1$ designed to detect very faint satellites
Mirror 31 inch correcting lenses 20 inch. Exposures 0.2, 0.4, 0.8, 1.6
and 3.2 sec FOC 5 x 30 deg
15 deg ... 152 mm on film

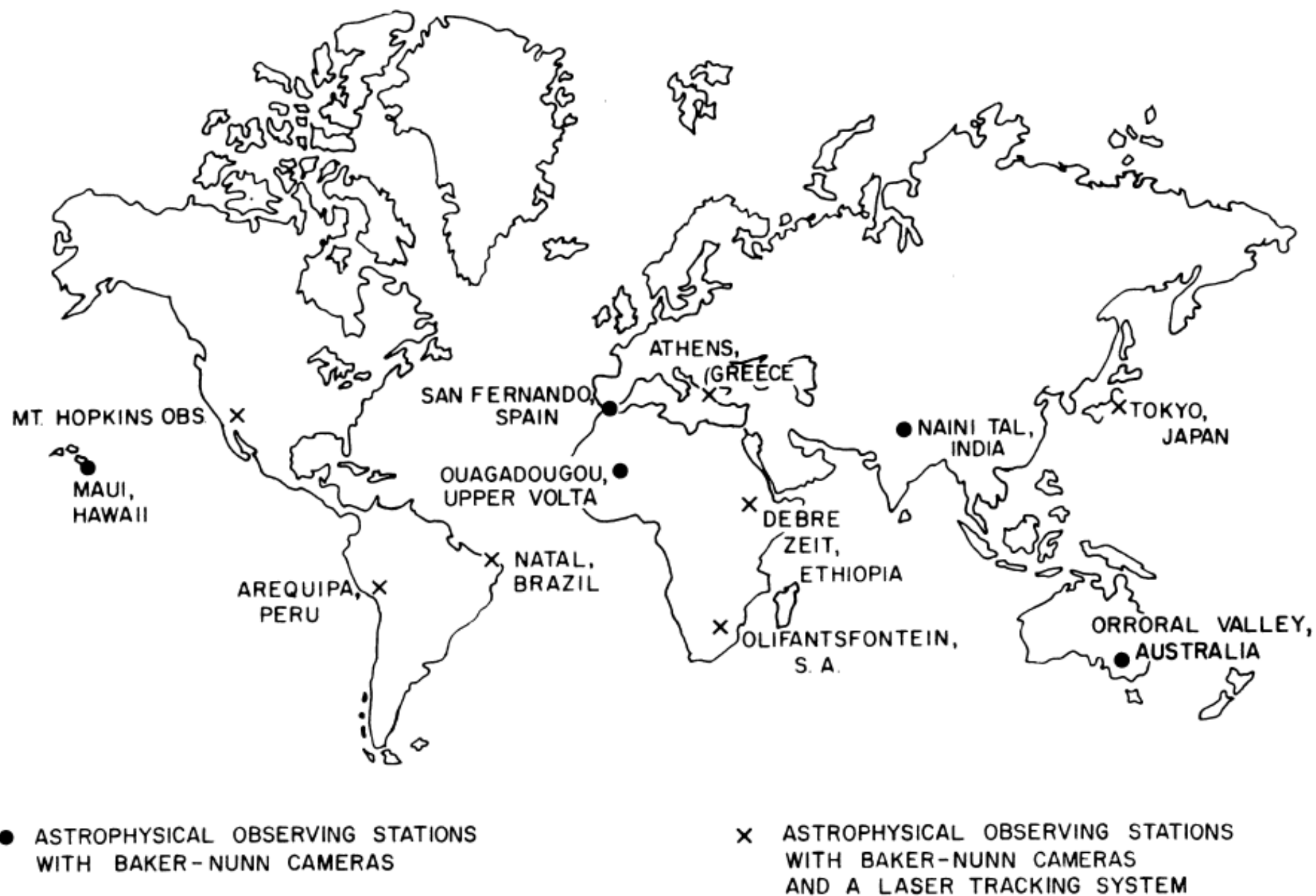


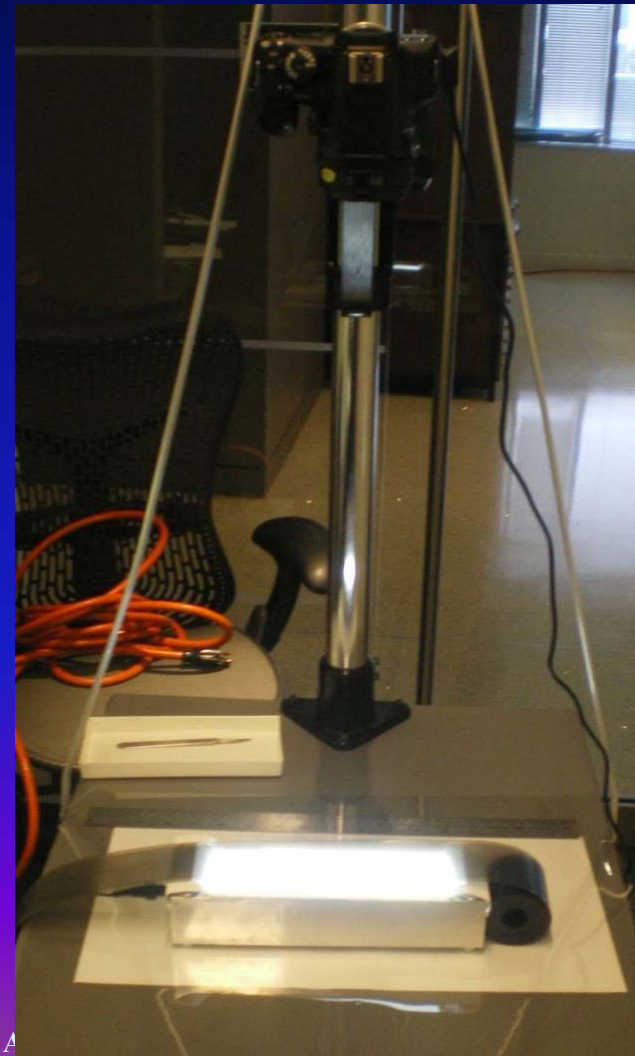
Figure 11. SAO field stations.

Table 5. Air Force Baker-Numm sites.

Station number	Station location	Period of operation
9113	Edwards AFB, California (Rosamund)	December 1960 to present
9114	Cold Lake, Canada (I)	January 1963 to June 1971
9115	Harestua, Norway	December 1959 to July 1967
9116	Santiago, Chile	September 1960 to May 1964
9117	Sand Island (Johnston Island), Pacific	September 1963 to present
9118	Kwajalein Island	Not operational for satellite photography
9119	Mt. John, New Zealand	October 1969 to present
9120	San Vito, Italy	March 1971 to present
9124	Cold Lake, Canada (II)	July 1971 to present
9010 [*]	Jupiter, Florida (AF)	June 1968 to July 1971

* Site previously occupied by SAO Baker-Nunn camera (see Figure 11).

Setup for digitization B-N films



B-N Films



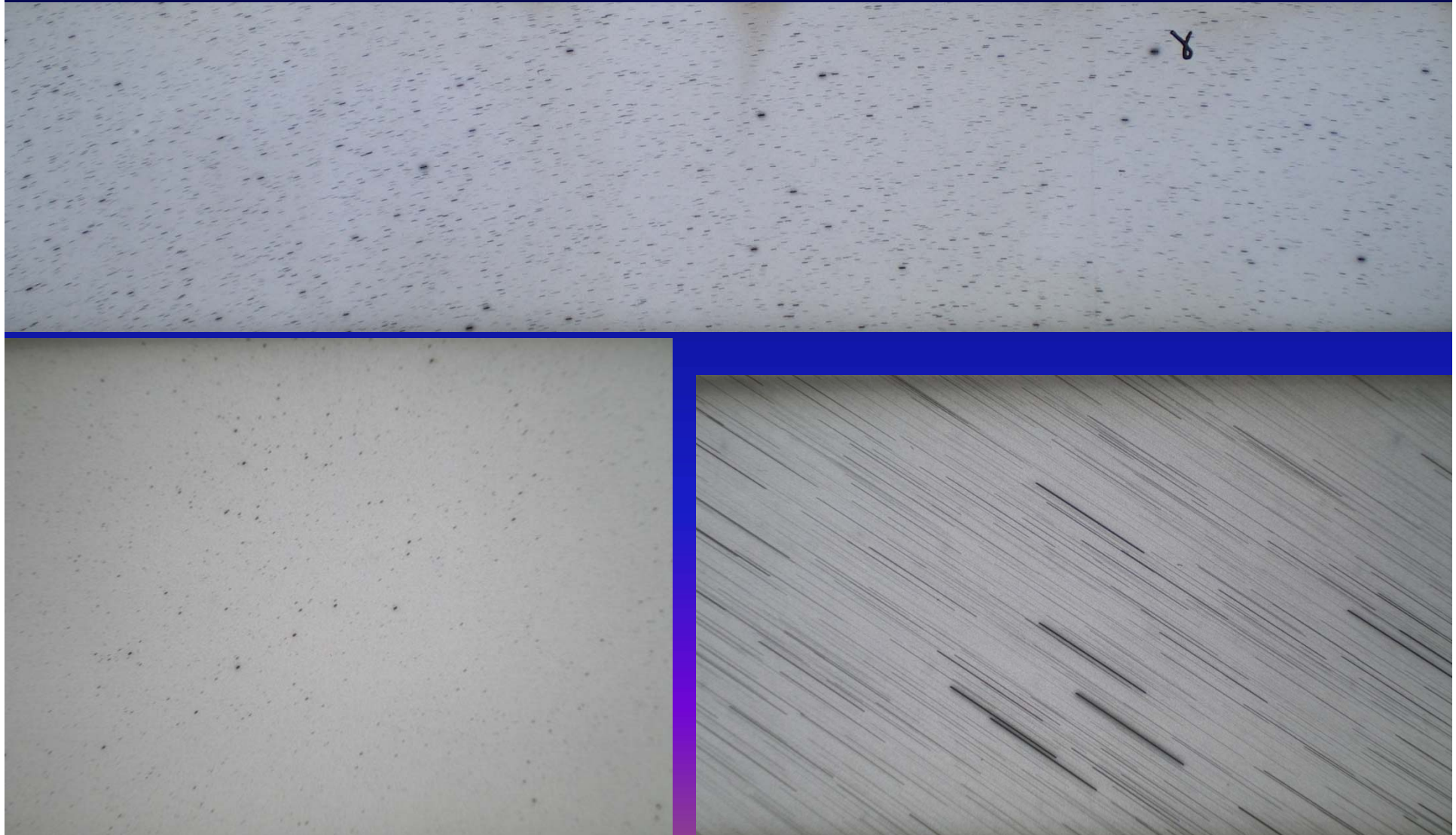
21 boxes with B-N films
recovered in Washington DC,
SI, about 0.5 mil frames
Much more (\gg 10 milion)
probably exist somewhere



B-N Example Images

Data suitable for wide-field studies, OT
searches, fast variability

Up to 100 000 stars per 1 full frame



Example images by B-N camera

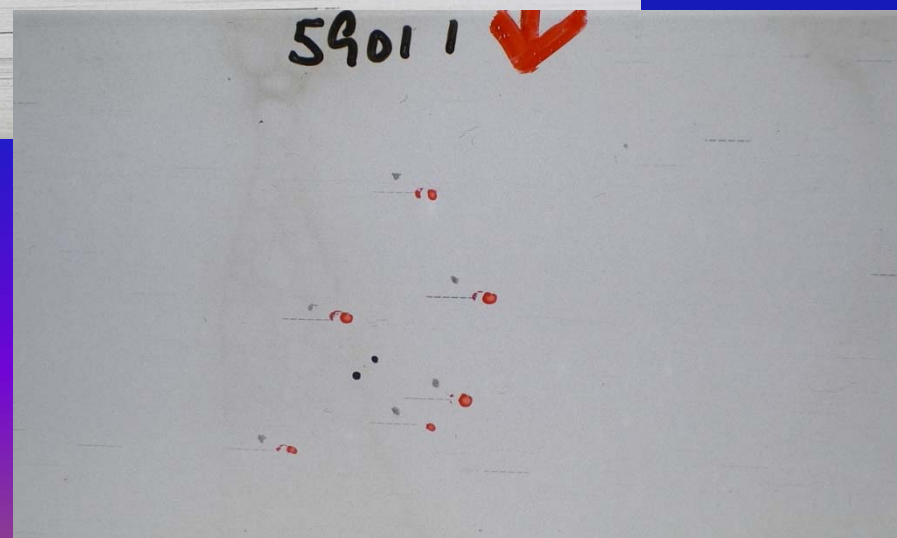
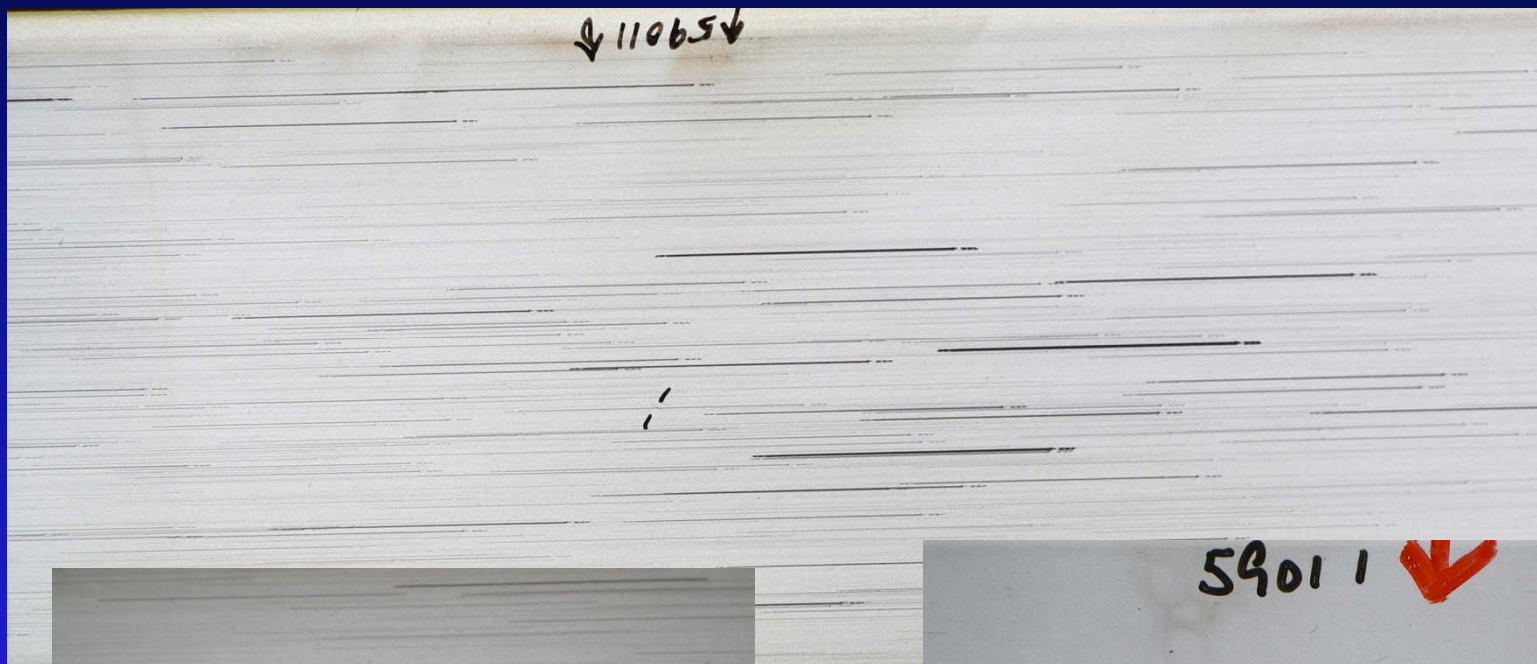


FOV 30 x 5
deg, lim mag
15, sampling
few sec
1 frame 2 x
12 inch





B-N network: example of faint satellite detection



Example of past astronomical results from B-N cameras

SOME RESULTS AT BAKER-NUNN TRACKING STATIONS

L. H. SOLOMON

THE LIGHT CURVE OF NOVA HERCULIS 1963 FROM BAKER-NUNN PHOTOGRAPHS

L. H. Solomon

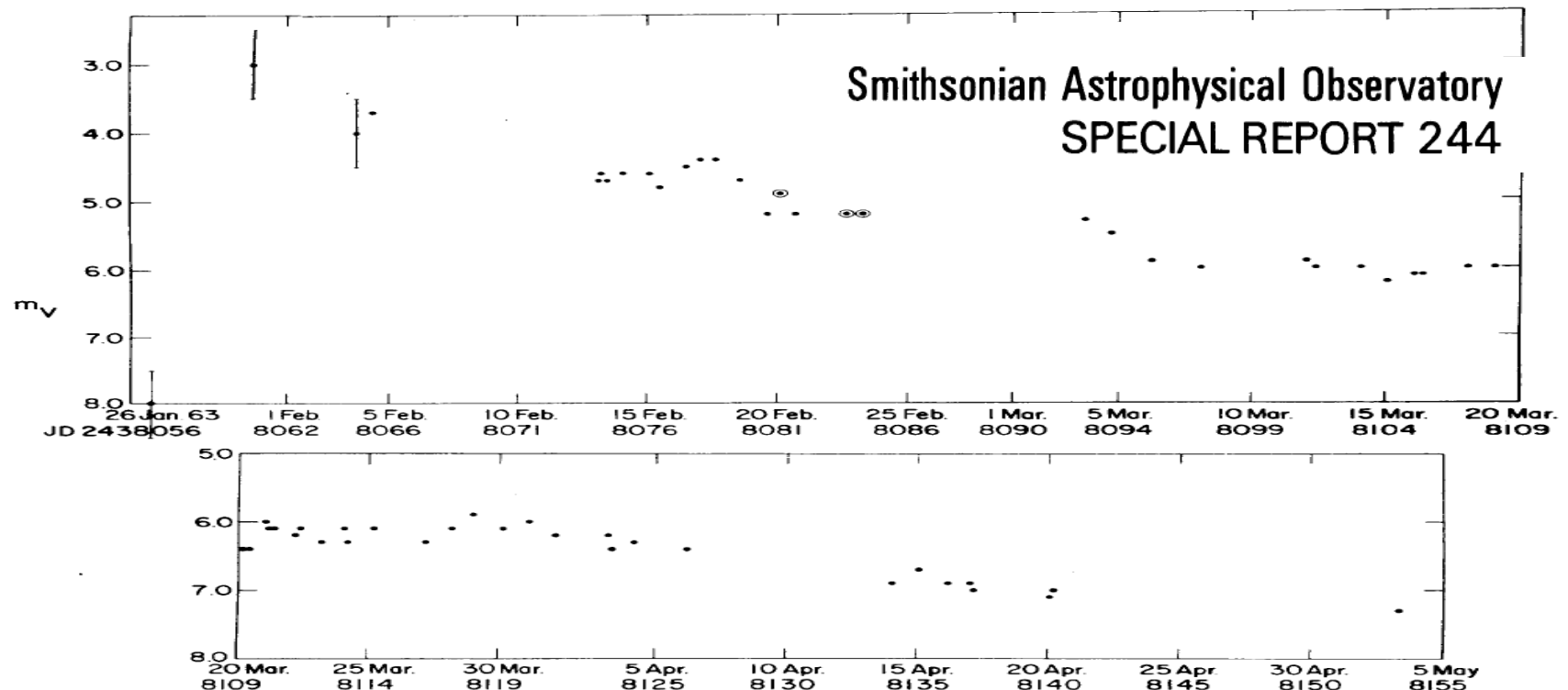
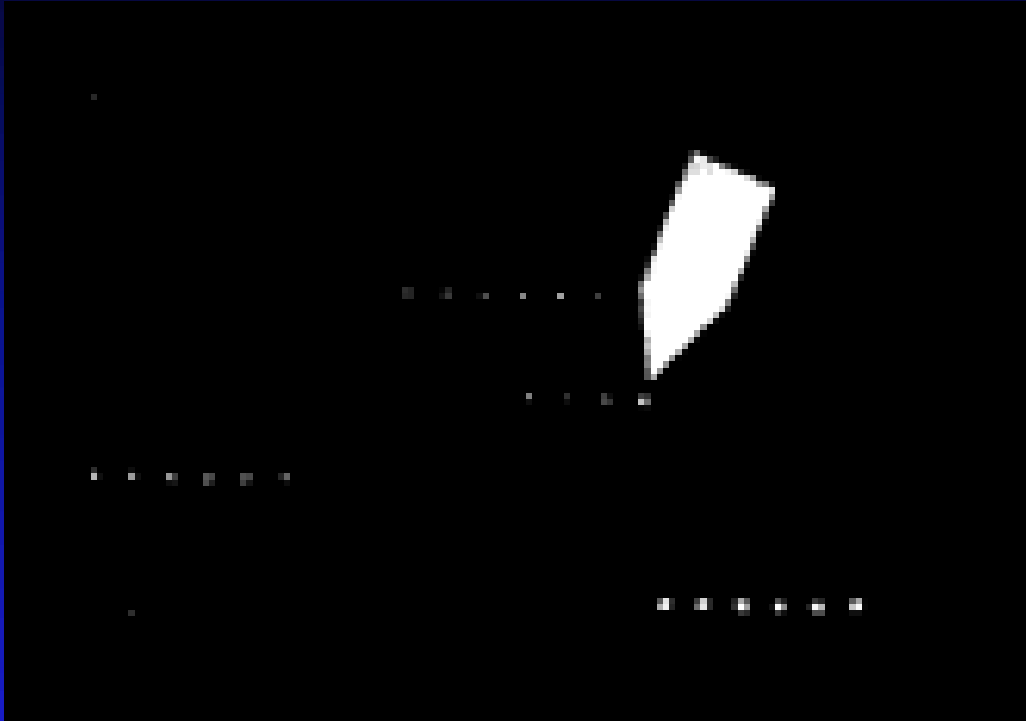
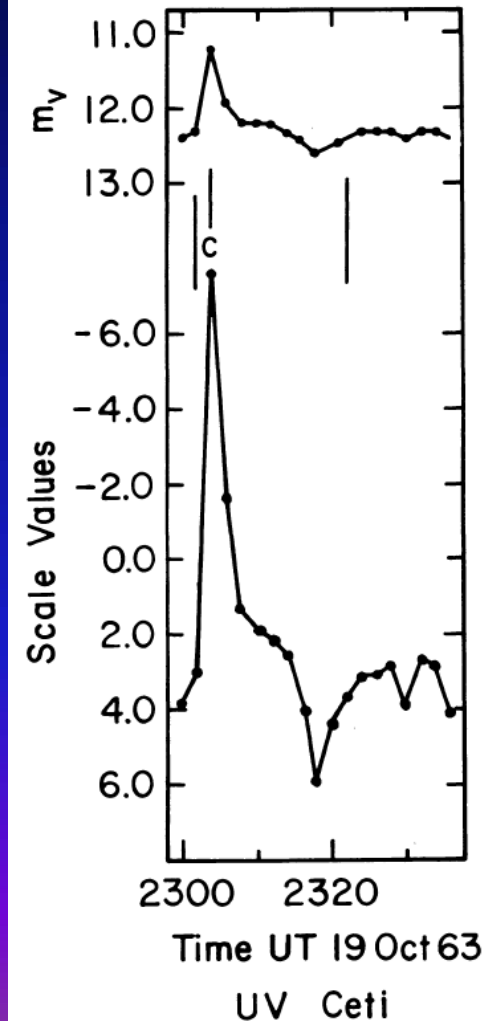


Figure 1. Light curve of Nova Herculis 1963. Bars denote error estimates of low-accuracy observations; circled points indicate duplicate observations.

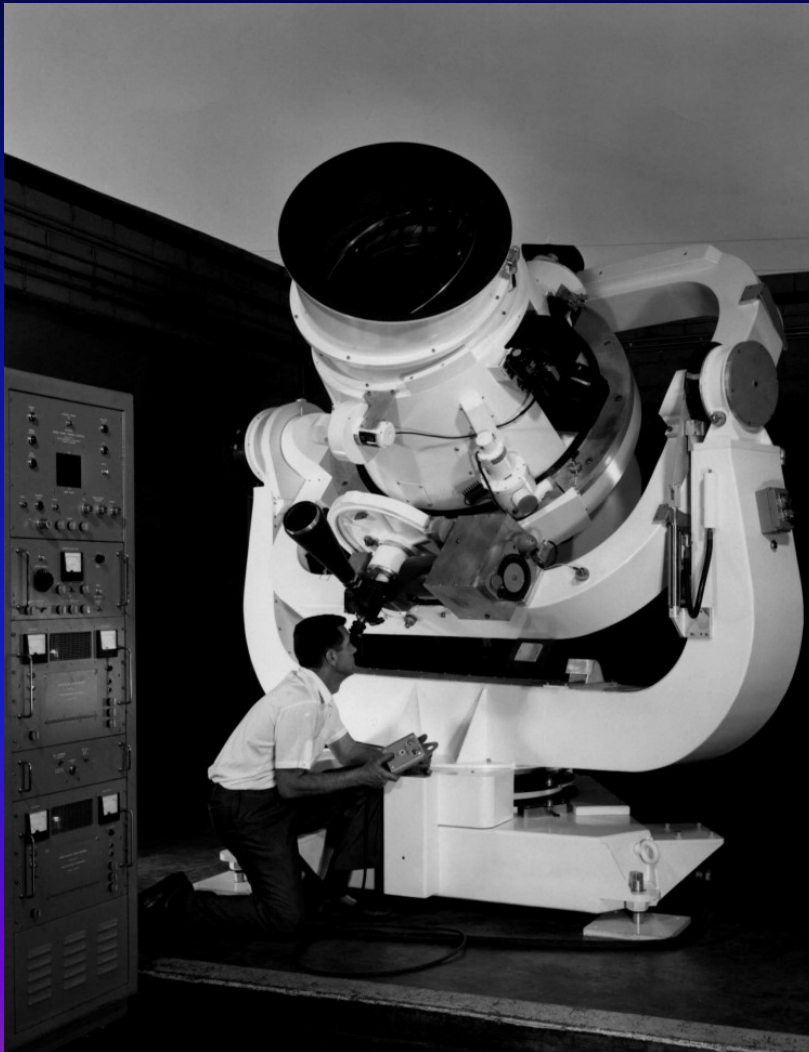
Flare Star past studies with B-N



Multiply exposed photograph of UV Ceti, Baker-Nunn camera. Each exposure time 3.8 sec, time between exposures 19.2 sec. Star appears to brighten almost 4 mag at indicated point. Note time increases left to right.



USAF B-N slittless spectroscopy



The Baker Nunn Missal Reentry Tracking Cameras consists of a three-element 20-inch entrance aperture corrector lens system.

Mounted on top of the corrector lens assembly is a multi-set of triangular prisms converting the incoming sky image into a spectrum image.

It was thought a spectrum image of the incoming missile would determine which was the real missile and which was decoy chaff that had been released prior to reentry.

The corrected spectral image is then projected down to a 31-inch f/1 spherical primary mirror.

The focusing converging image is then reflected back up to a 4-inch x 6-inch x 0.6-inch thick mosaic of fiber-optics making film supporting focusing plate.

- Baker Nunn Kwajalein Slit-less Spectrograph camera for U.S. Air Force

U.S. Armed Forces Baker Nunn Missile Reentry Tracking Camera

10 stations
worldwide

UNCLASSIFIED

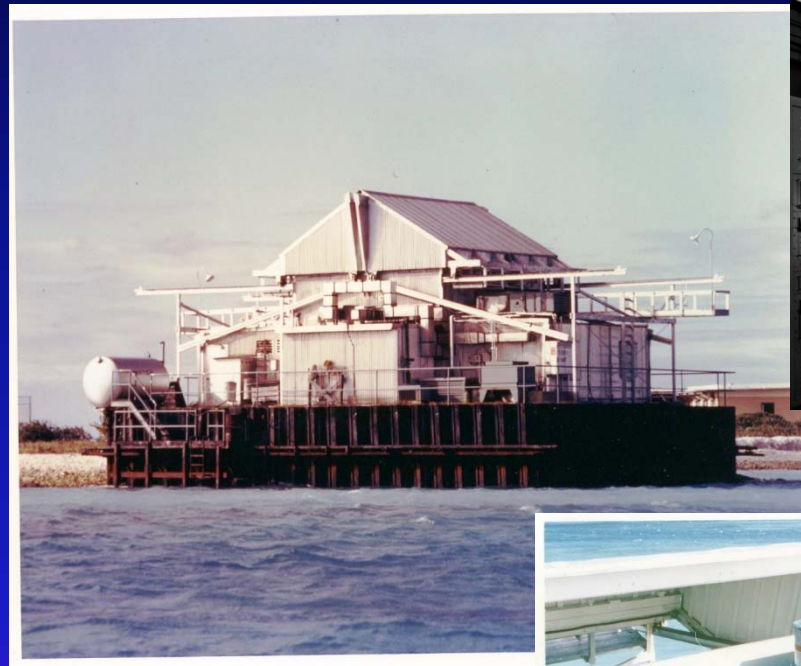
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ARLINGTON 12, VIRGINIA



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1 camera slitless
spectroscopy



ASTROP

Investigating real B-N cameras



**1 military B-N camera is in
Evergreen Aviation and Space
Museum, 3 more destroyed by fire
at the same place**



Dissmantling B-N camera at Evergreen



Conclusions

17 US astronomical plate archives visited and evaluated within Czech US collaborative AMVIS project

Several before unknown plate collections found

Valuable plate archives Henize, Baker Nunn etc.

Transportable scanning device developed and tested

See next talk

At all observatories test scans of plates performed

The End