Palomar Observatory's 48-inch Samuel Oschin Telescope

Owned & Operated by California Institute of Technology

By: Sam Pitts

Palomar Observatory Docent
Non-Profit Educational Use

samsastro.com April 7, 2025

1928

Hale applies to International Education Board (IEB) to fund the 200-inch telescope with a grant from the Rockefeller Foundation

IEB approves 6 Million Dollar Grant to Caltech

A 200-inch reflecting telescope

B a site, including land and land improvements

C an Observatory & other necessary buildings

D auxiliary apparatus

E other expenses in connection with making the Observatory available for use

Palomar Observatory's 48-inch Samuel Oschin Telescope

The Worlds Largest Telescope needs Help

Smaller Widefield Telescopes

Capable of wide-angle images of the Night Sky

No detailed star charts or catalogues

Need for a very Wide-Field Imaging Telescope

It needs to go deep 16-20th Magnitude

Enter

1930 Barnard Schmidt

Palomar Observatory's 48-inch Samuel Oschin Telescope

The Schmidt Camera

Bernard Schmidt invents Schmidt Telescope1930

March 30, 1879,– December 1,1935

The Schmidt Camera

1930

1st Schmidt Camera

14 ½ " (360mm) f/ 1.75

Main mirror of 44 cm (17.3 inch)

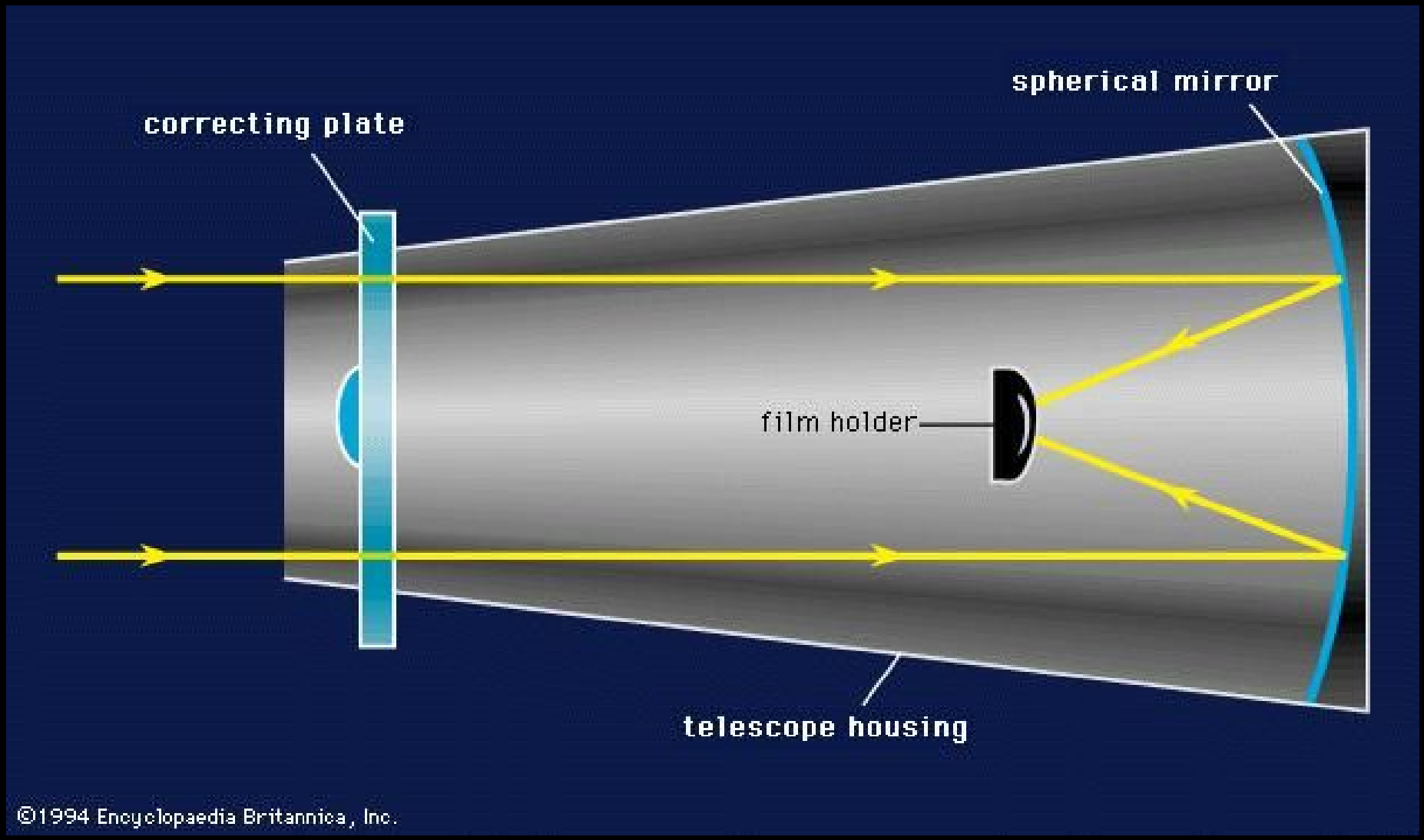
Corrector plate of 36 cm (14 inch).

The focal ratio was f=1.75, the field of view 7.5º

Corrector plate: Warping a parallel glass plate under partial vacuum into a slight sagging curve and then polishing the upper curve flat

Palomar Observatory's 48-inch Samuel Oschin Telescope

The Schmidt Camera



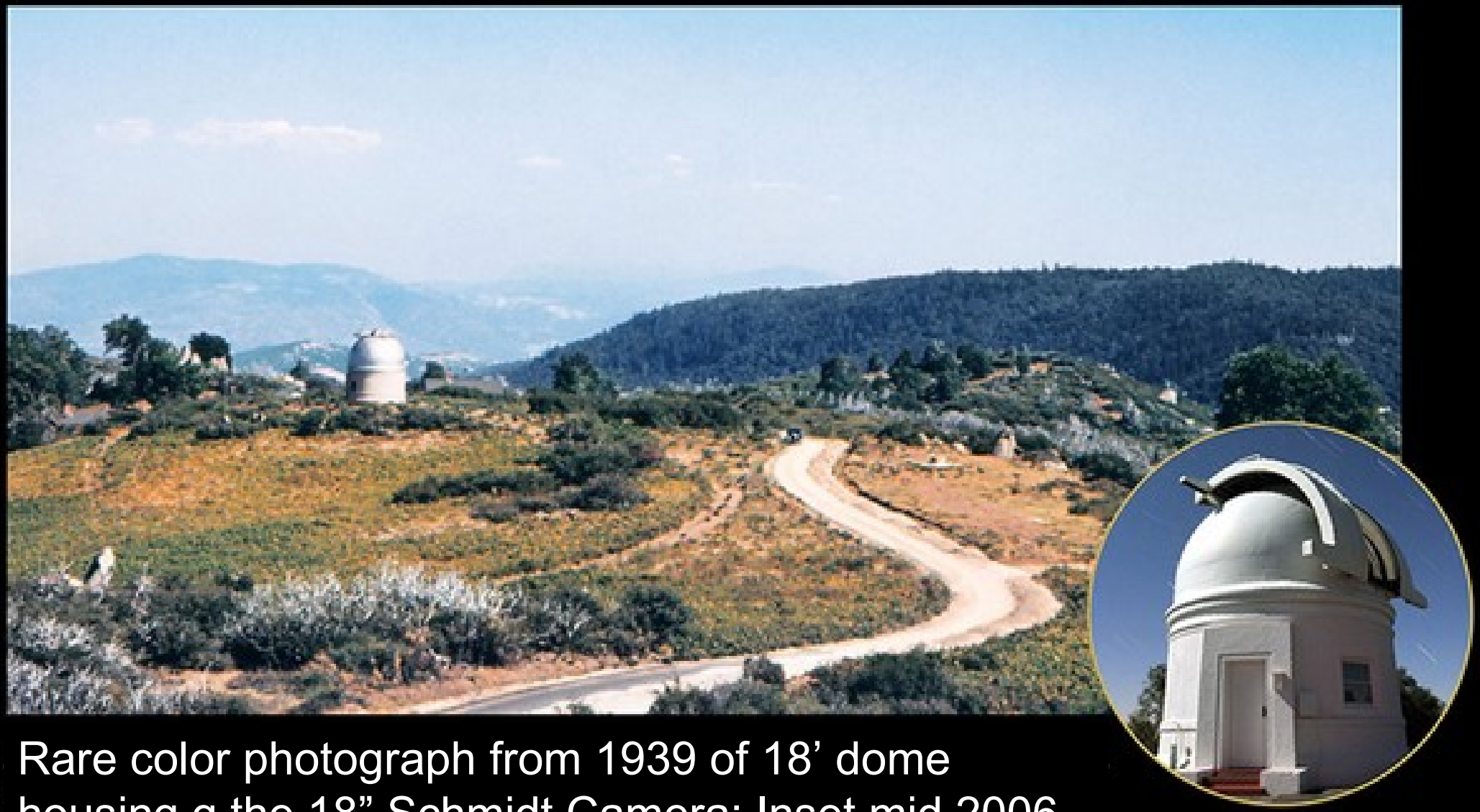
Large swathes of sky with short exposures in minutes versus hours with a reflector.

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera



Rare color photograph from 1939 of 18' dome housing g the 18" Schmidt Camera; Inset mid 2006 dome now houses robotic atmospheric turbulence monitoring system. "Caltech Archives "

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

1st Light September 5, 1936

24" mirror 18" correcting plate f/2

fl 914.4 mm (36") 18.2x

8 ¾ º FOV (film-area of 17 full moons)

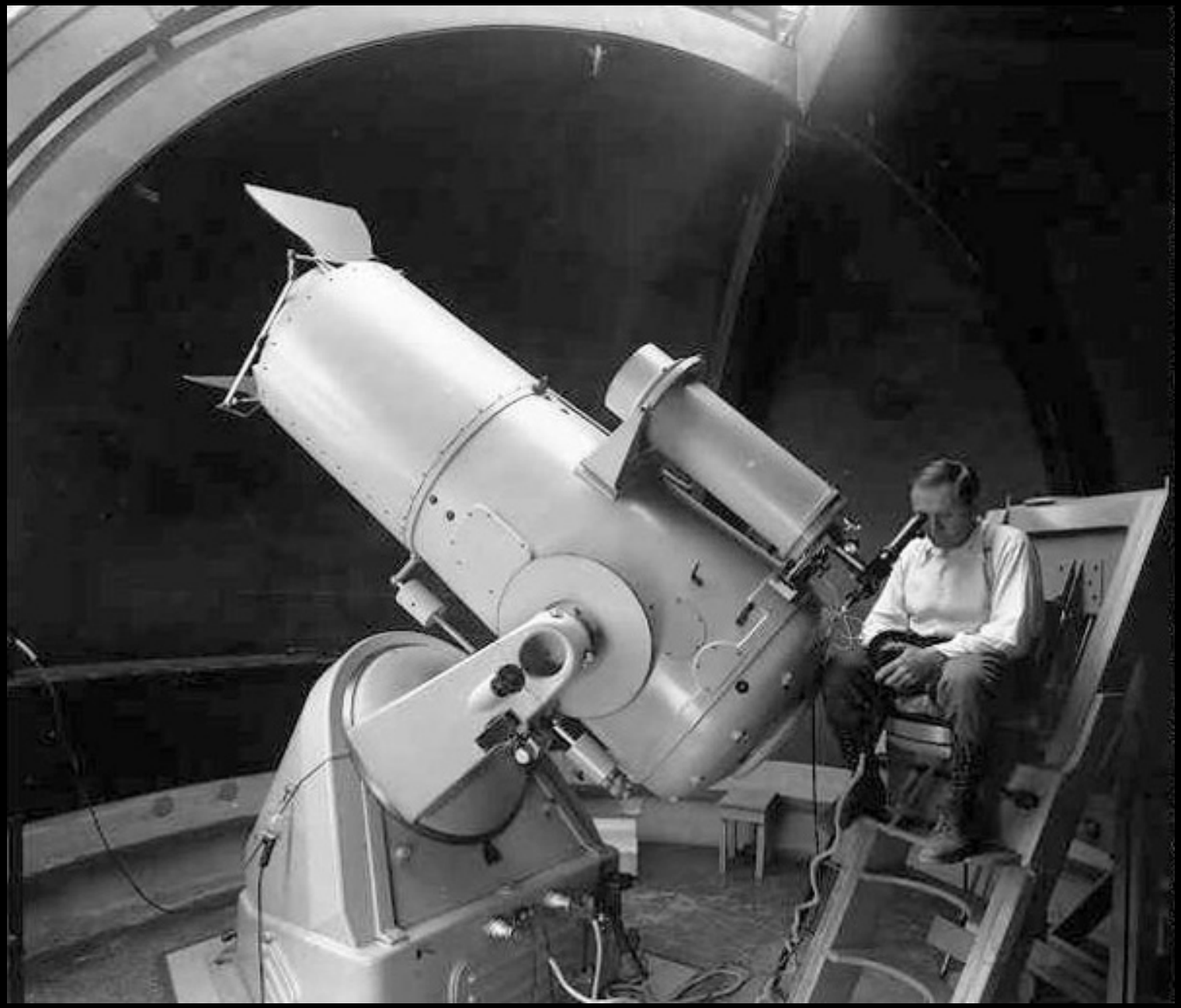
6 ¼-inch circles of unexposed film made with the "cookie cutter" in the telescope's darkroom.

Film circle was placed inside a film holder which applied the appropriate spherical curvature so the entire film would be in focus during exposure.

Small access door to place at prime focus.
Holder's cap was removed, film was ready for exposure.

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera



Fritz Zwicky 18" Schmidt Camera1936 Discovered 120+ Supernovae

. Caltech Archives)

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

200" Palomar Observatory on the Right Caltech Archives-1936

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

18" focusing on200" Palomar Observatory Caltech Archives-1936

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

18" focusing on200" Palomar Observatory Caltech Archives-1936

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

The 18" Schmidt Telescope was funded from the original Rockefeller grant for the construction of the 200-inch.

It was designed by telescope maker Russell W. Porter and engineered at Caltech by John Anderson, Sinclair Smith, and Albert Brower based on a photographic camera invented in 1930 by optician Bernhard Schmidt.

The optics were figured at the Caltech optical shop, while the tube and mounting were manufactured at the Caltech instrument shop. The telescope was finished within a year (1935-1936).

18-inch Schmidt Camera 1st instrument at Palomar Observatory Only operational telescope on site between 1936 and 1949.

Palomar Observatory's 48-inch Samuel Oschin Telescope

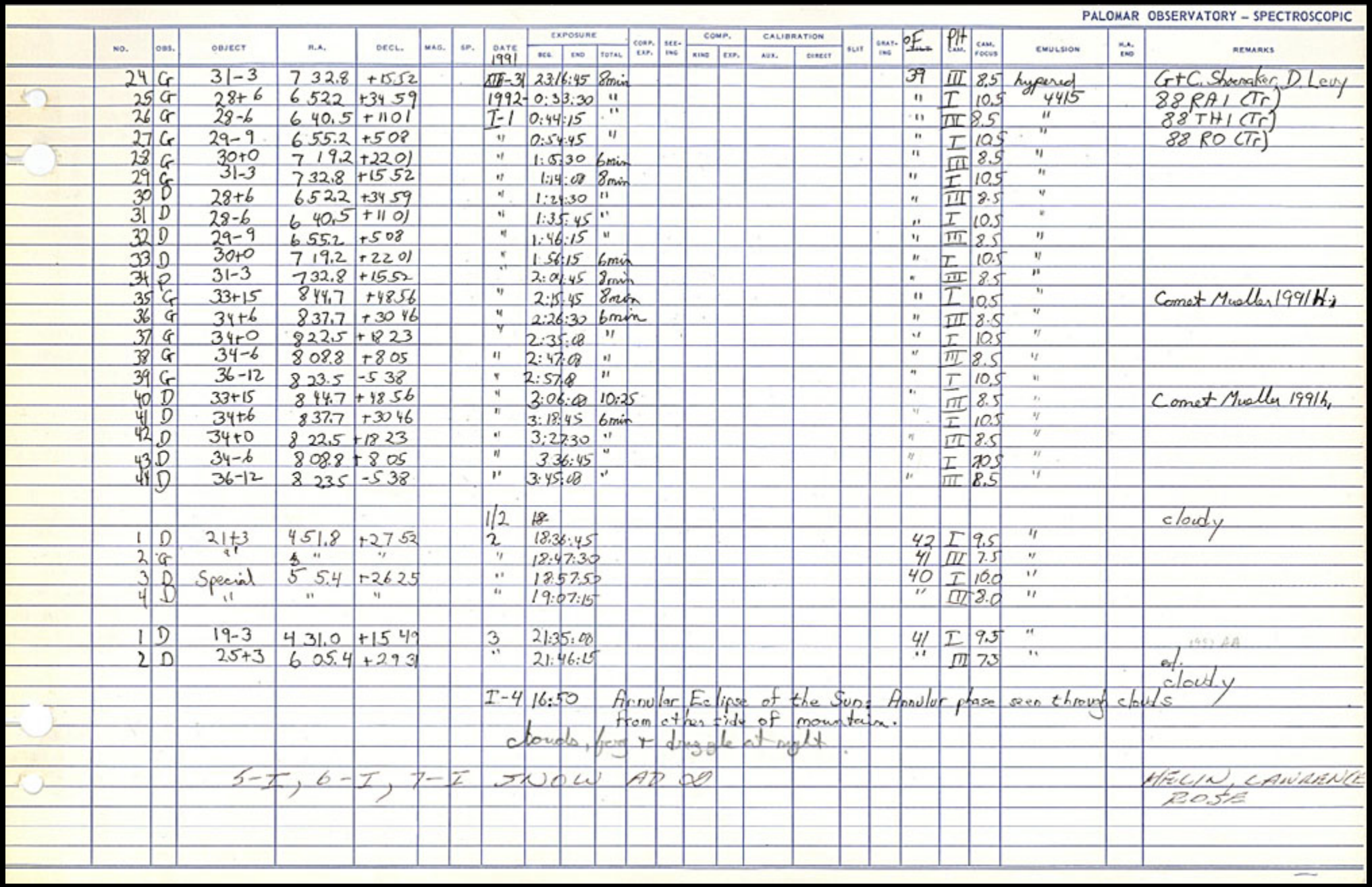
18" Schmidt Camera

Eugene and Carolyn Shoemaker with the 18-inch Schmidt,

Photographed by Jonathan Blair in 1986. (J.Blair/USGS)

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera



PALOMAR OBSERVATORY – SPECTROSCOPIC

NO.	OBS.	OBJECT	R.A.	DECL.	MAG.	SP.	DATE 1991	EXPOSURE BEG.	EXPOSURE END	EXPOSURE TOTAL	CORR. EXP.	SEEING	COMP. KING	COMP. EXP.	CALIBRATION AUX.	CALIBRATION DIRECT	SLIT	GRATING	OF	PLT CAM.	CAM. FOCUS	EMULSION	H.A. END	REMARKS
24	G	31-3	7 32.8	+15 52			Aug-31	23:16:45		8min									39	III	8.5	hypered		G+C. Shoemaker, D. Levy
25	G	28+6	6 52.2	+34 59			1992-	0:33:30		"									"	I	10.5	4415		88 RA 1 (Tr)
26	G	29-6	6 40.5	+11 01			I-1	0:44:15		"									"	III	8.5	"		88 TH 1 (Tr)
27	G	29-9	6 55.2	+5 08			"	0:54:45		"									"	I	10.5	"		88 RO (Tr)
28	G	30+0	7 19.2	+22 01			"	1:5:30		6min									"	III	8.5	"		
29	G	31-3	7 32.8	+15 52			"	1:14:00		8min									"	I	10.5	"		
30	D	28+6	6 52.2	+34 59			"	1:24:30		"									"	III	8.5	"		
31	D	28-6	6 40.5	+11 01			"	1:35:45		"									"	I	10.5	"		
32	D	29-9	6 55.2	+5 08			"	1:46:15		"									"	III	8.5	"		
33	D	30+0	7 19.2	+22 01			"	1:56:15		6min									"	I	10.5	"		
34	D	31-3	7 32.8	+15 52			"	2:07:45		8min									"	III	8.5	"		
35	G	33+15	8 44.7	+48 56			"	2:15:45		8min									"	I	10.5	"		Comet Mueller 1991b
36	G	34+6	8 37.7	+30 46			"	2:26:30		6min									"	III	8.5	"		
37	G	34+0	8 22.5	+18 23			"	2:35:00		"									"	I	10.5	"		
38	G	34-6	8 08.8	+8 05			"	2:47:00		"									"	III	8.5	"		
39	G	36-12	8 23.5	-5 38			"	2:57:00		"									"	I	10.5	"		
40	D	33+15	8 44.7	+48 56			"	3:06:00		10:25									"	III	8.5	"		Comet Mueller 1991b
41	D	34+6	8 37.7	+30 46			"	3:18:45		6min									"	I	10.5	"		
42	D	34+0	8 22.5	+18 23			"	3:27:30		"									"	III	8.5	"		
43	D	34-6	8 08.8	+8 05			"	3:36:45		"									"	I	10.5	"		
44	D	36-12	8 23.5	-5 38			"	3:45:00		"									"	III	8.5	"		
							1/2	18:																cloudy
1	D	21+3	4 51.8	+27 52			2	18:36:45											42	I	9.5	"		
2	G	"	"	"			"	18:47:30											41	III	7.5	"		
3	D	Special	5 5.4	+26 25			"	18:57:50											40	I	10.0	"		
4	D	"	"	"			"	19:07:15											"	III	8.0	"		
1	D	19-3	4 31.0	+15 49			3	21:35:00											41	I	9.5	"		
2	D	25+3	6 05.4	+29 31			"	21:46:15											"	III	7.5	"		cl. cloudy
							I-4	16:50	Annular Eclipse of the Sun; Annular phase seen through clouds from other side of mountain. clouds, fog + drizzle at night.															
		5-I, 6-I, 7-I					SNOW AD 20																	MELIN, LAWRENCE ROSE

Log 1991 G & C Shoemaker Tech Pan 4415 hypered 6-10 min exposures

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

Comet Shoemaker–Levy 9 (D/1993 F2)

The comet was discovered by astronomers Carolyn and Eugene M. Shoemaker, and David Levy in 1993.

Shoemaker–Levy 9 (SL9) had been captured by Jupiter and was orbiting the planet at the time. It was located on the night of March 24 in a photograph taken with the 46 cm (18 in) Schmidt telescope at the Palomar Observatory in California.

It was the first active comet observed orbiting a planet, and had probably been captured by Jupiter around 20 to 30 years earlier.

Broke apart in 1992 and struck Jupiter in 1994

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Comet Shoemaker–Levy 9 (D/1993 F2)

Hubble Space Telescope image 1994

Palomar Observatory's 48-inch Samuel Oschin Telescope

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In its long and productive life, this instrument has yielded many discoveries, including a large number of asteroids, nearly 50 comets and hundreds of Nova.

The telescope was decommissioned in the mid-1990s and was removed from its dome to make room for a robotic atmospheric turbulence monitoring system in 2006.

The 18" Schmidt Camera was refurbished and is now one of the main exhibits at Palomar Observatory Visitor Center

The 18" Schmidt Camera's Success paved the way for the

Famous: **Palomar Observatory 48" Schmidt Telescope**

Palomar Observatory's 48-inch Samuel Oschin Telescope

18" Schmidt Camera

Thanks to a generous gift from the trust of Dr. Helin and her husband Ronald, Palomar Observatory is pleased to announce its new exhibit ***Searching the Sky for Dangerous Neighbors*** at the Palomar Observatory Visitor Center. Caltech

The 48” Schmidt Camera

Urging from astronomers Fritz Zwicky & Walter Baade, the 48-inch telescope was needed for its wide field of view

Need Sky Surveys to locate & map targets of interest for 200”

The 48-inch Samuel Oschin Telescope is one of the largest Schmidt cameras ever built

Palomar was one of the first observatories in the world to utilize this new technology, which enabled astronomers to survey the sky.

Given the success of the 18-inch (0.46-meter) Schmidt telescope during the 1930s, resources for building the larger 48-inch Schmidt were committed in 1937.

Palomar Observatory's 48-inch Samuel Oschin Telescope

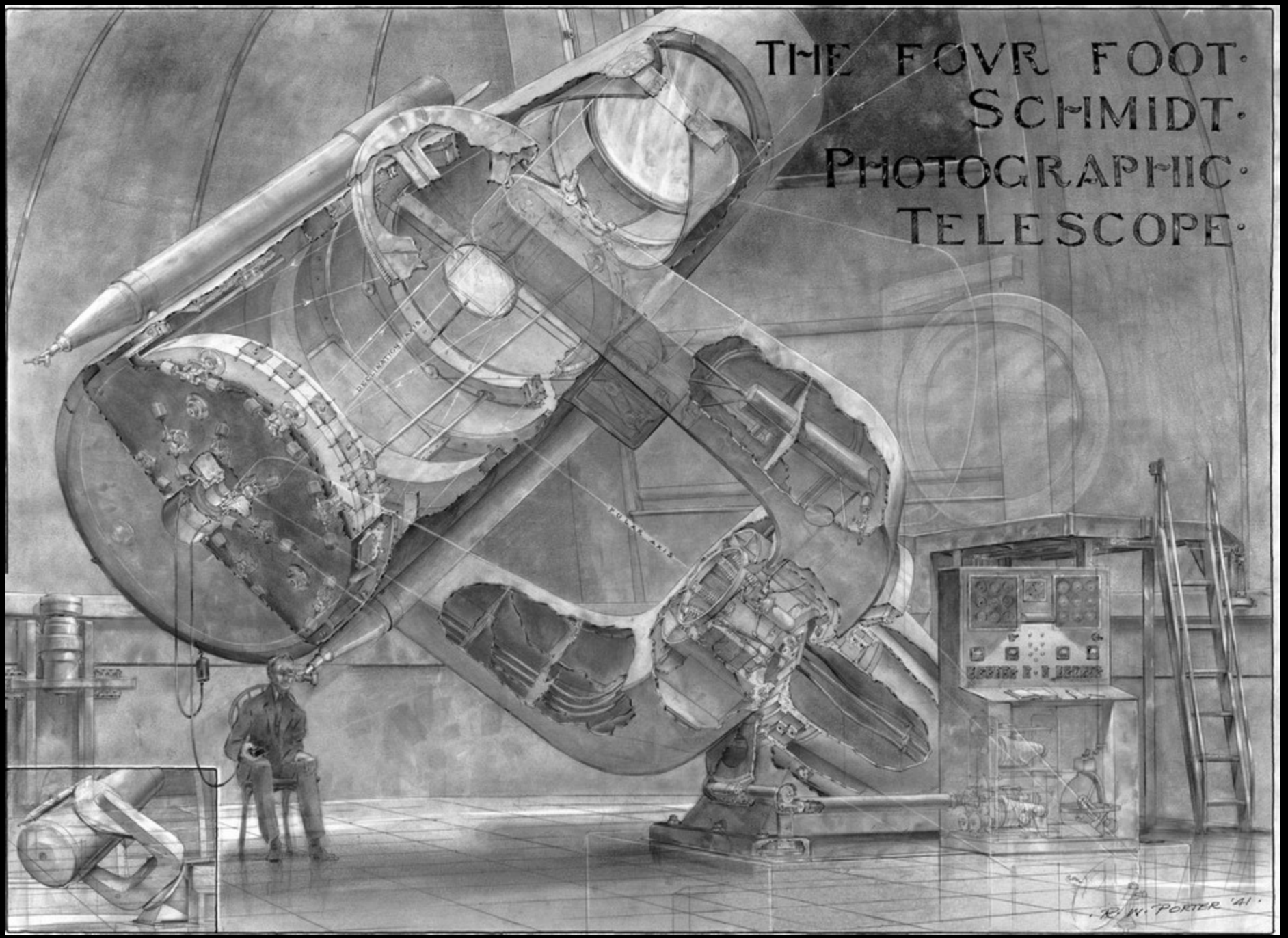
The 48" Schmidt Camera

May 23, 2018 By Sam Pitts

Palomar Observatory's 48-inch Samuel Oschin Telescope

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera



The 48” Schmidt Camera

1938 Corning began work on the 72” Pyrex disk/blank.

48” (1.2m) telescope saw **1st Light** late September 1948

The concave spherical mirror is 72” (1828 mm/1.2 m)

Optical Speed of f/2.5 Plate Holder (2.46) approx. 60x

Corrector Plate 49¾” (1244 mm)

OTA is 20’ long 5/16” Steel

Fork Mount combined weight 12 tons

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

Shutters are behind the Corrector Plate

Designed for 10" x 10" & 14"x 14" Photographic Plates

Formulated by George Eastman, Eastman Kodak Company

Optical Speed of f/2.5 (2.46)
Field of View (FOV) 36 degrees 14" x 14".

Manually Guided by two 10-inch refractors

1st Photographic Plate November 11,1949

Plates were in wide use by the professional astronomical community as late as the 1990s.

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

Palomar Observatory's 48-inch Telescope
one of the most productive survey telescopes ever built
rededicated in 1987 to Samuel Oschin Telescope *Caltech*

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

Astronomer George Abell (1927-1983), a Caltech alumnus and former UCLA professor, at the 48-inch telescope at Palomar.. *Credit: Caltech Archives*

Palomar Observatory Sky Surveys

The most Influential Sky Surveys of their time

1950's Palomar Sky Survey (**POSS-1**)
Palomar Observatory & National Geographic

8 years to complete
November 11, 1949 →June 20,1956 (99%)
Final 1 % completed Dec. 10, 1958

Deepest Photographic record of Northern Sky

1,875 14" x 14" Photographic Plates
937 Pairs

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

1950's Palomar Sky Survey (**POSS-1**)
Palomar Observatory & National Geographic

Each region imaged twice

Red Sensitive Kodak 103a-E Plate

Blue Sensitive Kodak 103a-O Plate

Allowing the Color of Celestial objects to be recorded

Down to Magnitude 22

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

1950's Palomar Sky Survey (**POSS-II**)
Palomar Observatory & National Geographic

Palomar Sky Survey II 1980's – 1990's

Better & Faster Film Plates

Upgraded Optics Achromatic Corrector Plate 1979

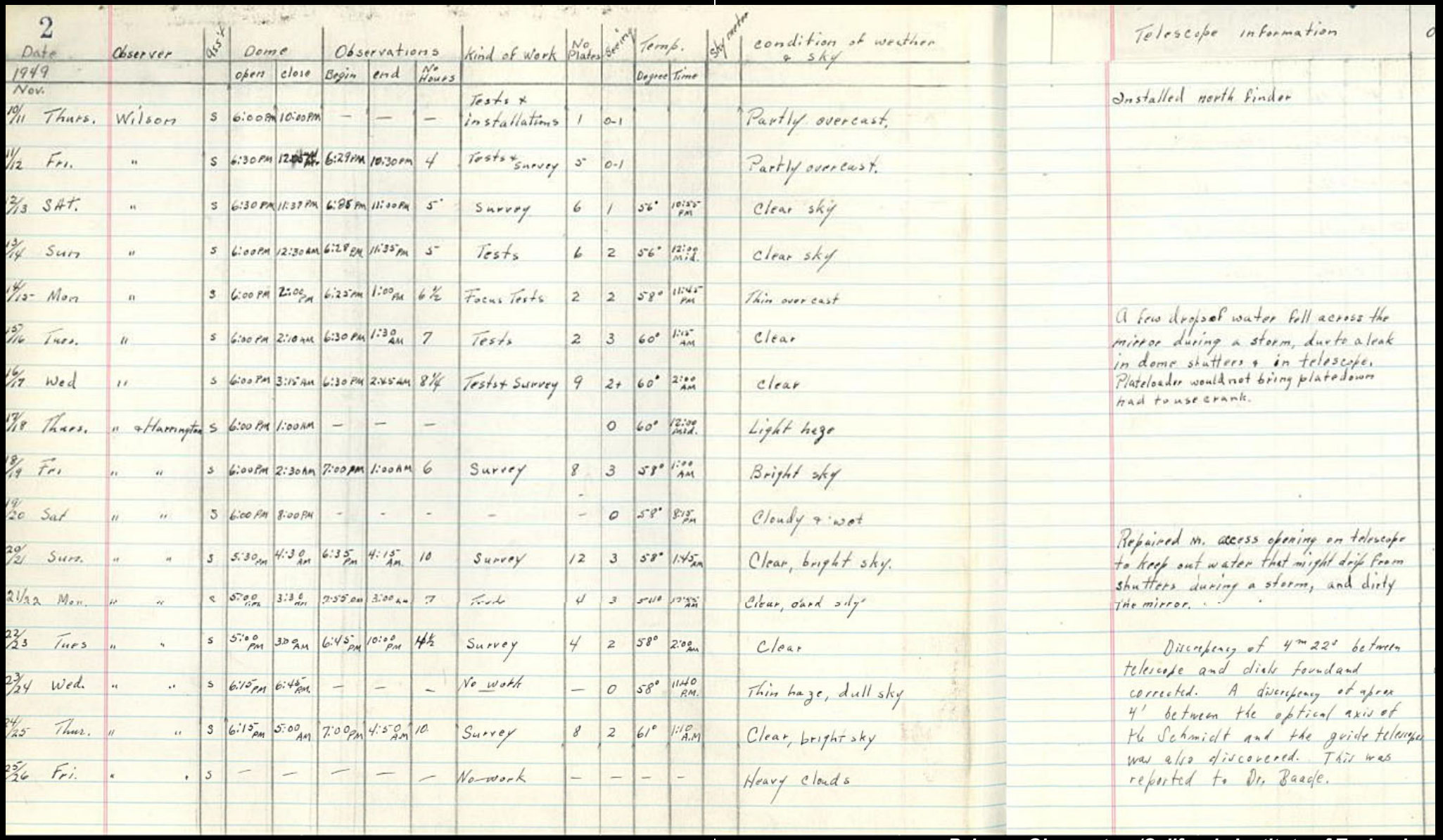
Auto-Guider

3 images of each Region

Blue (IIIaJ. 480 nm), Red (IIIaF, 650 nm), and Near-Infrared (IVN, 850 nm) plates

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera



2

Date	Observer	48" S	Dome open	Dome close	Observations Begin	Observations end	Observations No Hours	Kind of Work	No Plates	Seeing	Temp. Degree	Temp. Time	Sky water	condition of weather & sky	Telescope information
1949 Nov.								Tests & installations							Installed north finder
10/11 Thurs.	Wilson	S	6:00PM	10:00PM	—	—	—		1	0-1				Partly overcast.	
11/12 Fri.	"	S	6:30PM	12:00PM	6:29PM	10:30PM	4	Tests & Survey	3	0-1				Partly overcast.	
12/13 SAT.	"	S	6:30PM	11:37PM	6:28PM	11:00PM	5"	Survey	6	1	56°	10:55 PM		Clear sky	
13/14 Sun	"	S	6:00PM	12:30AM	6:28PM	11:35PM	5"	Tests	6	2	56°	12:00 mid.		Clear sky	
14/15 Mon	"	S	6:00PM	2:00PM	6:25PM	1:00PM	6½	Focus Tests	2	2	58°	11:45 PM		Thin overcast	
15/16 Tues.	"	S	6:00PM	2:10AM	6:30PM	1:30AM	7	Tests	2	3	60°	1:15 AM		Clear	A few droplets water fell across the mirror during a storm, due to a leak in dome shutters & in telescope. Plateloader would not bring plate down had to use crank.
16/17 Wed	"	S	6:00PM	3:15AM	6:30PM	2:45AM	8¼	Tests & Survey	9	2+	60°	2:00 AM		Clear	
17/18 Thurs.	" & Harrington	S	6:00PM	1:00AM	—	—	—			0	60°	12:00 mid.		Light haze	
18/19 Fri	" "	S	6:00PM	2:30AM	7:00PM	1:00AM	6	Survey	8	3	58°	1:00 AM		Bright sky	
19/20 Sat	" "	S	6:00PM	8:00PM	-	-	-	-	-	0	58°	8:15 PM		Cloudy & wet	
20/21 Sun.	" "	S	5:30PM	4:30AM	6:35PM	4:15AM	10	Survey	12	3	58°	1:45 AM		Clear, bright sky.	Repaired N. access opening on telescope to keep out water that might drip from shutters during a storm, and dirty the mirror.
21/22 Mon.	" "	S	5:00PM	3:30AM	7:55PM	3:00AM	7	Tests	4	3	54°	12:55 AM		Clear, cloud sky	
22/23 Tues	" "	S	5:00PM	3:00AM	6:45PM	10:00PM	4½	Survey	4	2	58°	2:00AM		Clear	Discrepancy of 4m 22s between telescope and dials found and corrected. A discrepancy of aprox 4' between the optical axis of the Schmidt and the guide telescope was also discovered. This was reported to Dr. Baade.
23/24 Wed.	" "	S	6:15PM	6:45PM	—	—	—	No work	—	0	58°	11:40 P.M.		Thin haze, dull sky	
24/25 Thur.	" "	S	6:15PM	5:00AM	7:00PM	4:50AM	10	Survey	8	2	61°	1:10 A.M		Clear, bright sky	
25/26 Fri.	" "	S	—	—	—	—	—	No work	—	—	—	—		Heavy clouds	

Palomar Observatory/California Institute of Technology

Actual Log P48 November 1949

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

May 23, 2018 By Sam Pitts

Palomar Observatory's Film Hypering **Lab**

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

1950's Palomar Sky Survey (**POSS-II**)
Palomar Observatory & National Geographic

(POSS II): 3 colors
Digitized Sky Survey, 1 Billion stars 50 million galaxies,
largest catalog ever

Jean Mueller was hired as 48" Schmidt Camera Night Assistant (July 1985) was the operator for the duration of POSS II and took over 5500 photographic plates, final plate removed from 48" by Jean 6/3/2000

1985 48" Schmidt Camera-renamed
"Samuel Oschin Telescope"

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

Jean Mueller with Palomar Observatories 48" Schmidt Camera

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

48" Observatory Work Room *5/13/2023 Sam Pitts*

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

48" Observatory Plate Archives Room *5/13/2023 Sam Pitts*

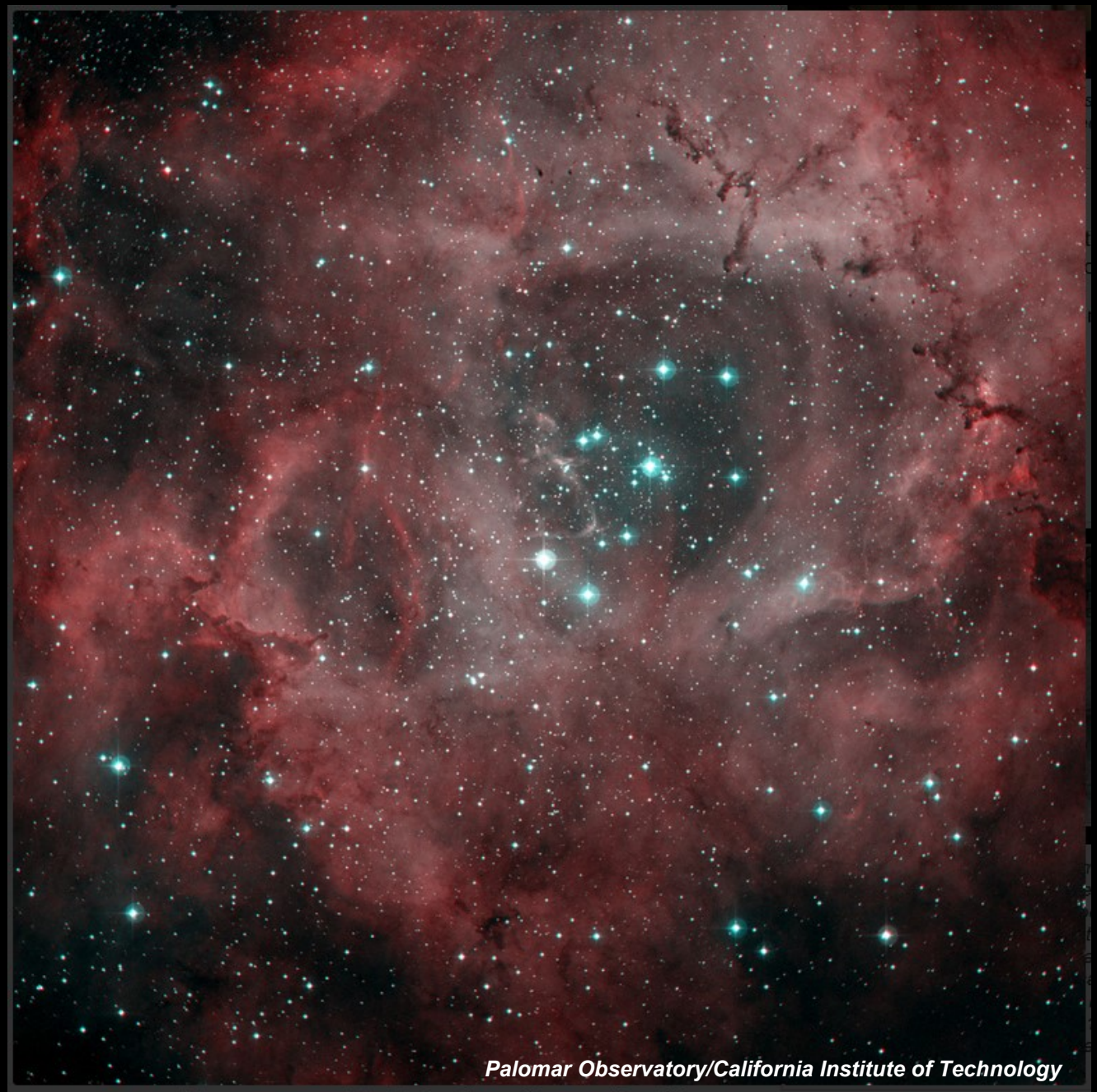
Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

Photo of 14" plates at Palomar Observatory OC *5/13/2023 Sam Pitts*

Palomar Observatory's 48-inch Samuel Oschin Telescope

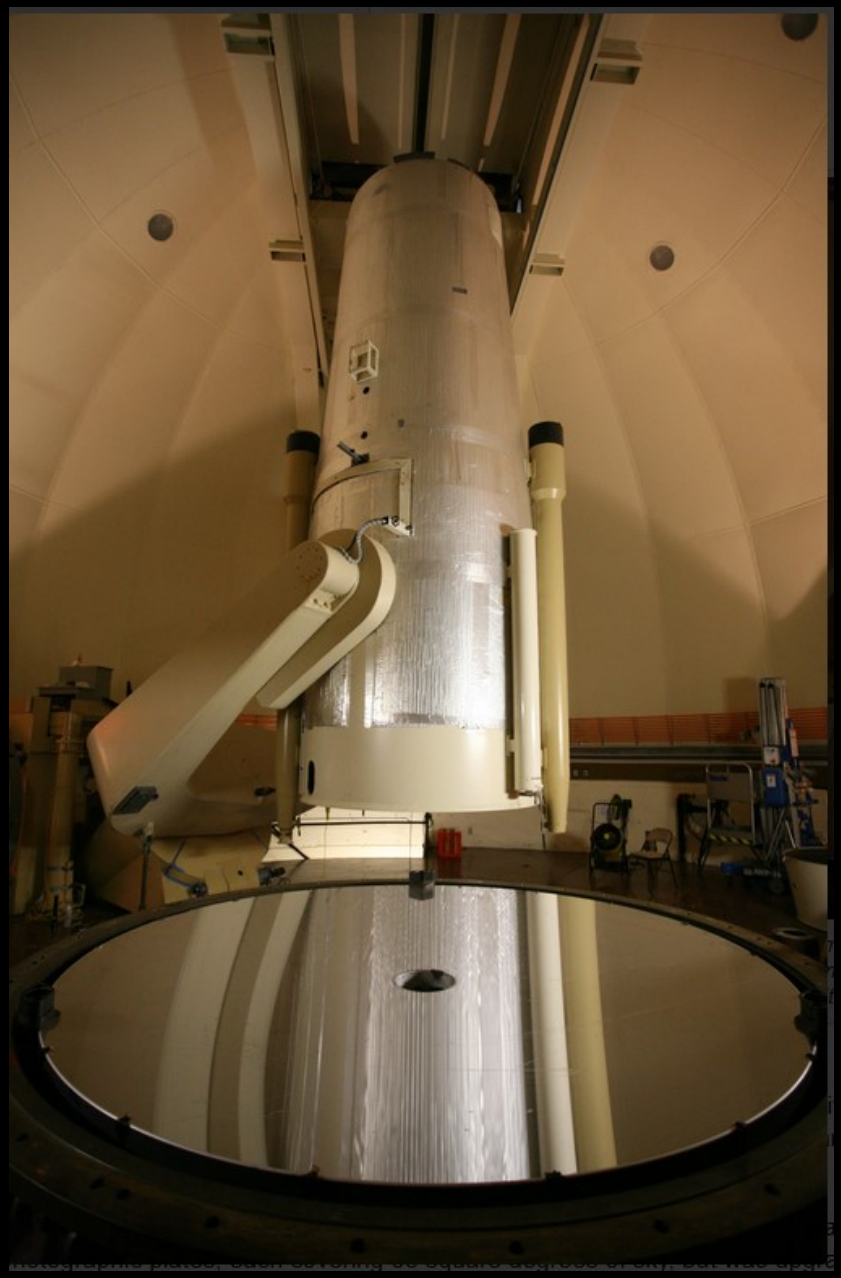
The 48" Schmidt Camera



The Rosette Nebula (NGC 2237) in Monoceros—a composite from two images taken with the Samuel Oschin Telescope as a part of the Second Palomar Observatory Sky Survey (POSS II). (Palomar/Caltech/DSS)

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera



Samuel Oschin Telescope 72" Mirror removed for aluminization.

Palomar Observatory/California Institute of Technology

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

Huge Leap in Astronomy

CCD

June 3, 2000 The Samuel Oschin Telescope's Last Film Plate

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

2000 – 2001 Converted to CCD

Improved Corrector Plate

Wider Range of Wavelengths

Match Sensitivity of CCD chips

Auto-Guiders

Automate the Entire Telescope

Data collected on:

Performance Wireless Research & Education Network (HPWREN)

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

1st CCD installed (2001)

Near Earth Asteroid Tracking

NEAT CCD Camera

3 - 4k x 4k sensors North to South line

Total FOV 3.75 square degrees

Upgraded – Automatic Sky Survey every clear Night

300 near-Earth Asteroids and 13 Comets

Palomar Observatory's 48-inch Samuel Oschin Telescope

The 48" Schmidt Camera

2003 to 2007

Quest 2 Camera

Quasar Equatorial Survey Team Camera

112 CCD's 2400 x 600 pixels each

Arranged in 4 columns of 28 ccd chips with gaps
9.6 square Degrees

Largest Mosaic of CCD chips used in an Astronomical Camera

Palomar Observatory's 48-inch Samuel Oschin Telescope

Palomar Transient Factory

Palomar Transient Factory -2008

Mosaic Camera know as CFH12K96

12,288 x 8,192 Pixel Mosaic
12 Chips each 2048 x 4096 15µm pixels

100,000 pixels 200 MB per image

7.8º FOV every 90 seconds

2009-2012

Palomar Observatory's 48-inch Samuel Oschin Telescope

Palomar Transient Factory

2009 – 2012

The Palomar Transient Factory (PTF):

Fully-automated, Wide-Field Survey

Search for optical transient and variable sources.

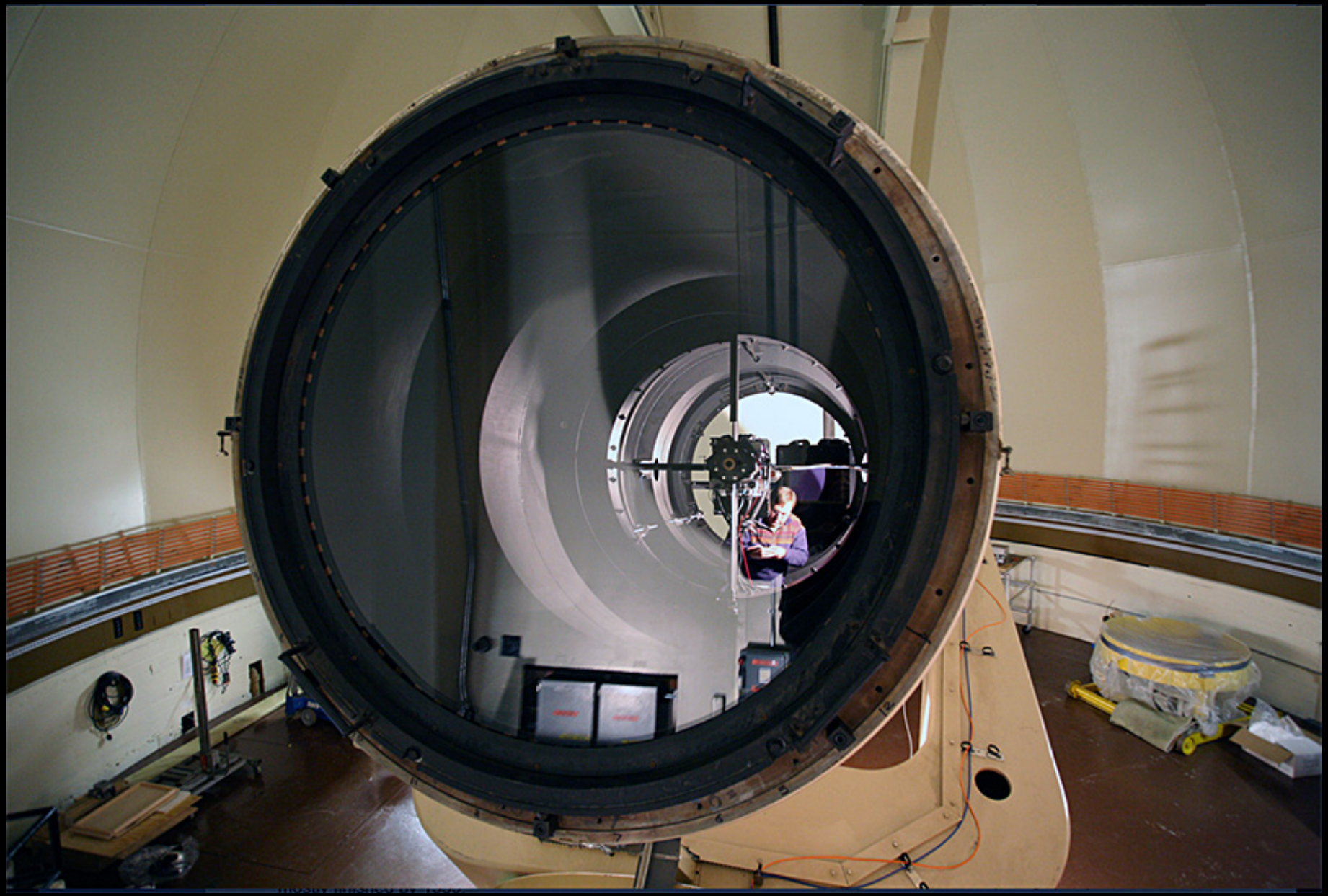
PTF discovered 10,000+ of new transient sources

Thousands of new supernovae, novae and cataclysmic variable stars, flaring young stars

1st detection of a planet orbiting a young star in Orion.

Palomar Observatory's 48-inch Samuel Oschin Telescope

Palomar Transient Factory (PTF)



Installation of the PTF camera - prime focus of the Samuel Oschin Telescope December 2008.

Palomar Observatory's 48-inch Samuel Oschin Telescope

Intermediate Palomar Transient Factory

2012 – 2017

Mosaic of 11 CCD chips 2048 x 4096 pixels each
7.26º FOV
Single exposure 60 seconds 20.5-21.0 Magnitude
Based on 2 arcsecond seeing
Readout & slew overhead of 40 sec.

Total time per field 100 seconds

Fields repeated with different filters

300 to 400 fields per Night

176 MB per image 50-70 GB per Night

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

Zwicky Transient Facility

1st Light October 2017

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

PTF used only 7.3º

48" capable of 47º

Time for a New Camera

Caltech Developed a New System

State of the Art Survey System

Camera will have Worlds Widest FOV

6 times the PTF FOV

Each Image 235x the area of full moon

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

Survey Strategy

3 High level Programs

1- Public Surveys 40%

2- ZTF Collaboration Surveys 40%

3- Caltech Surveys 20%

Each Program has multiple Sub-Programs

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

2017 – Present

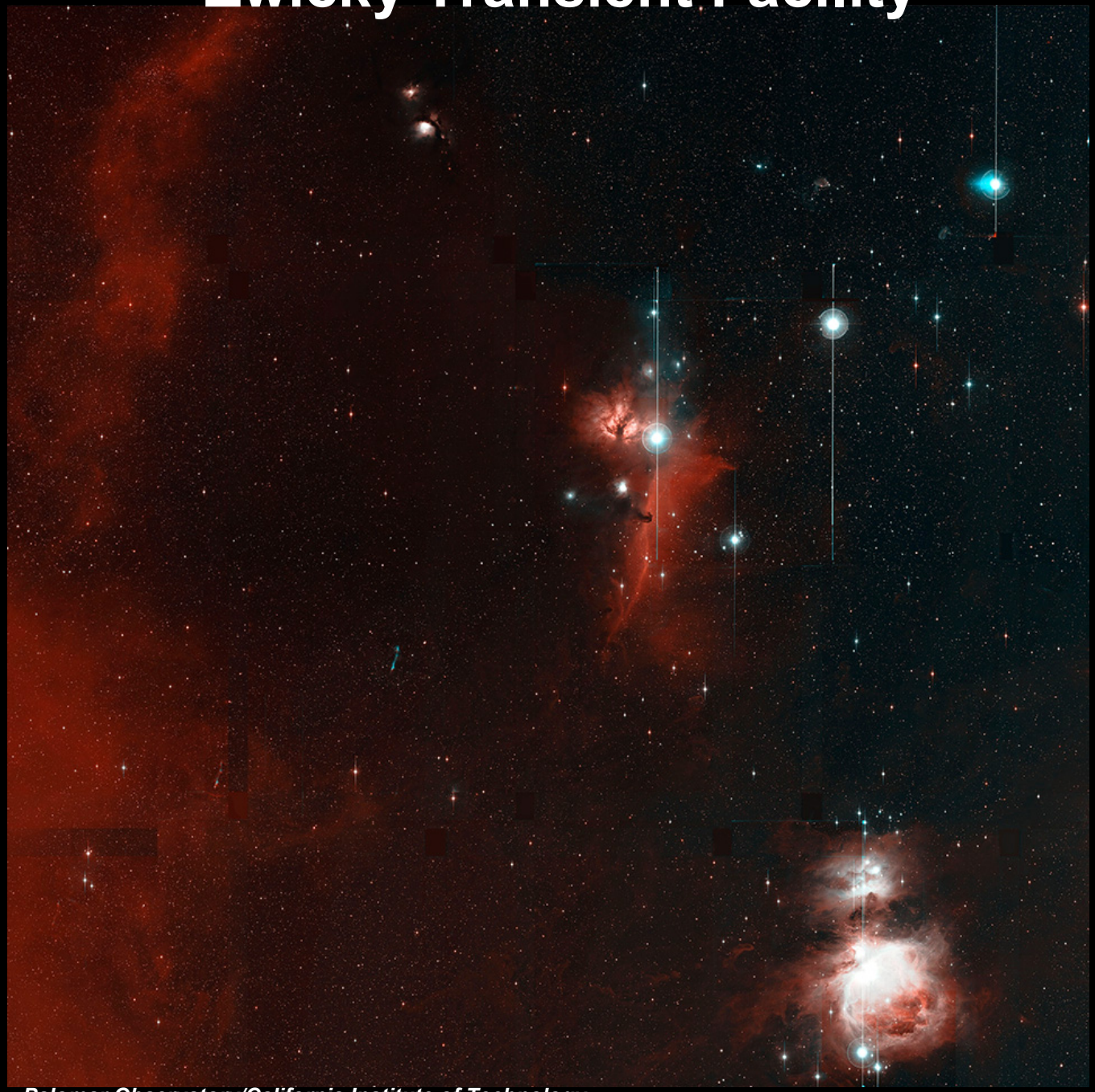
Fall 2018

ZTF Observing System was fully operational
Generating significant numbers of transient alerts in real-time for the US astronomical community every clear Observing Night

Formal survey operations began on March 20, 2018

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

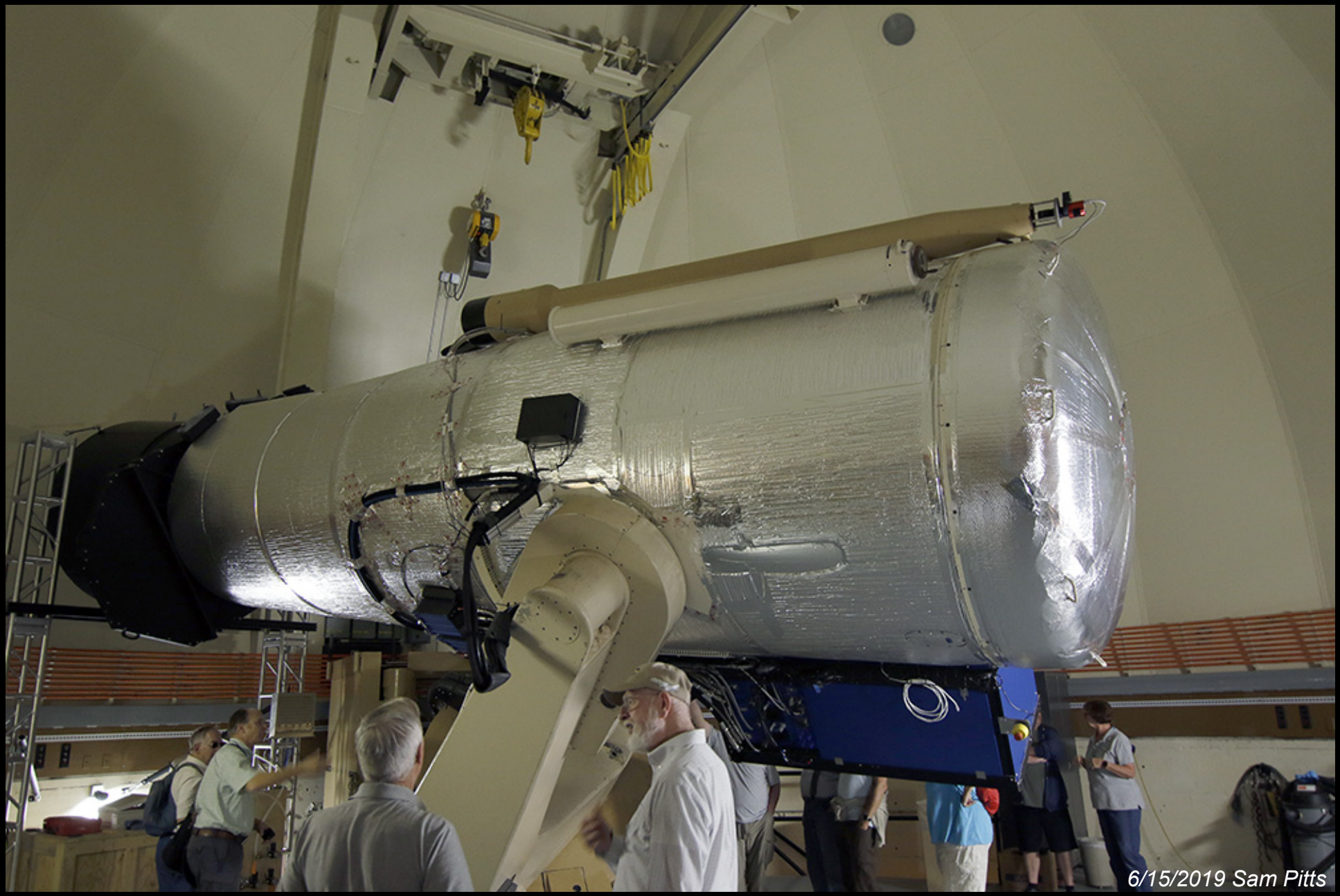


Palomar Observatory/California Institute of Technology

ZTF took this "first-light" image on Nov. 1, 2017 47 Square Degrees

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility



Working f ratio f/2.46 (f/2.5) 48" = 1219.2mm fl-2999.232 approximately 60x

CCD 6144 x 6160 15µm full well 350,000 e- FOV 47º

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

Publications of the Astronomical Society of the Pacific, 132:038001 (26pp), 2020 March

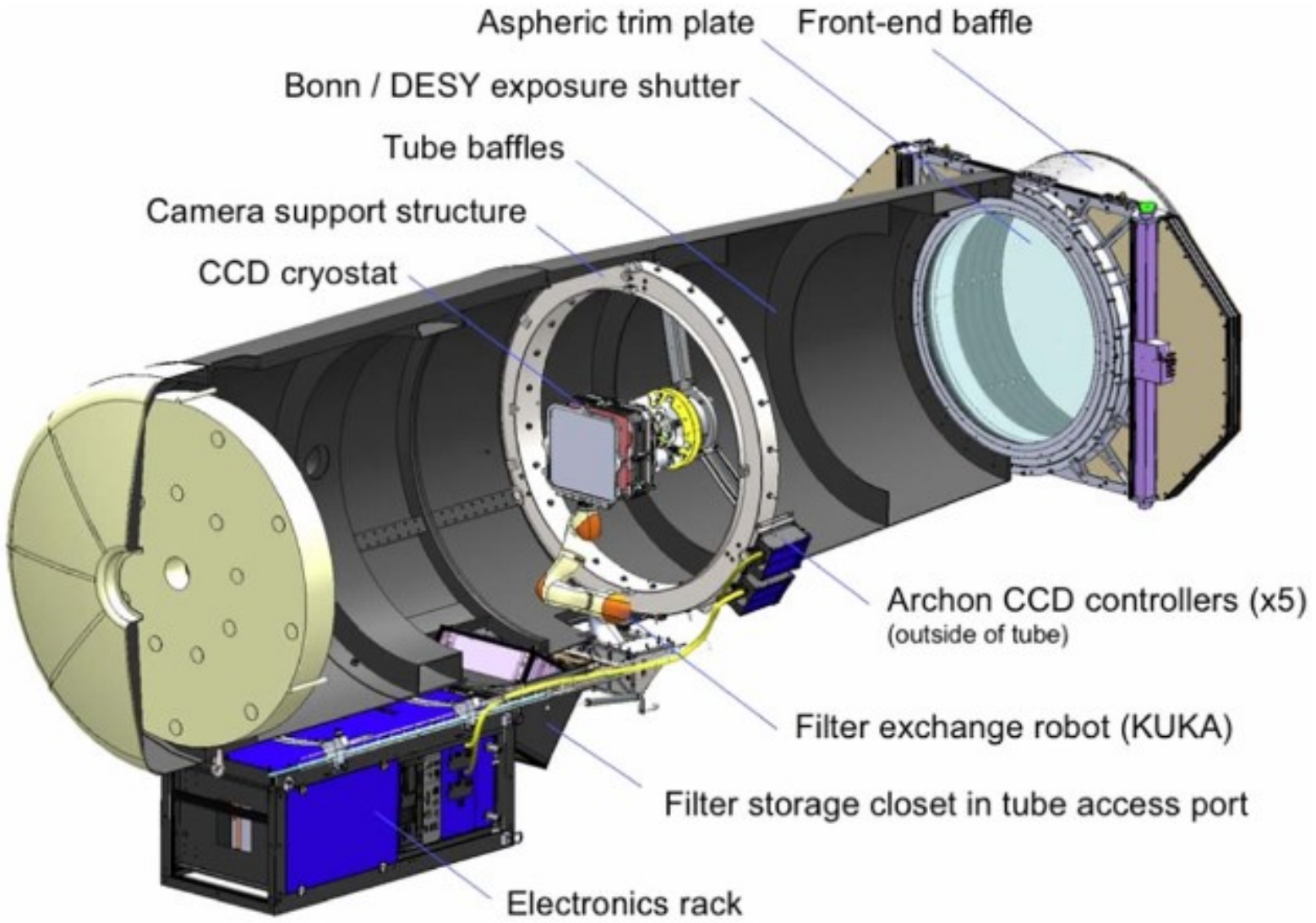


Figure 1. Cutaway view of the Samuel Oschin Telescope highlighting new ZTF subsystems.
(A color version of this figure is available in the online journal.)

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

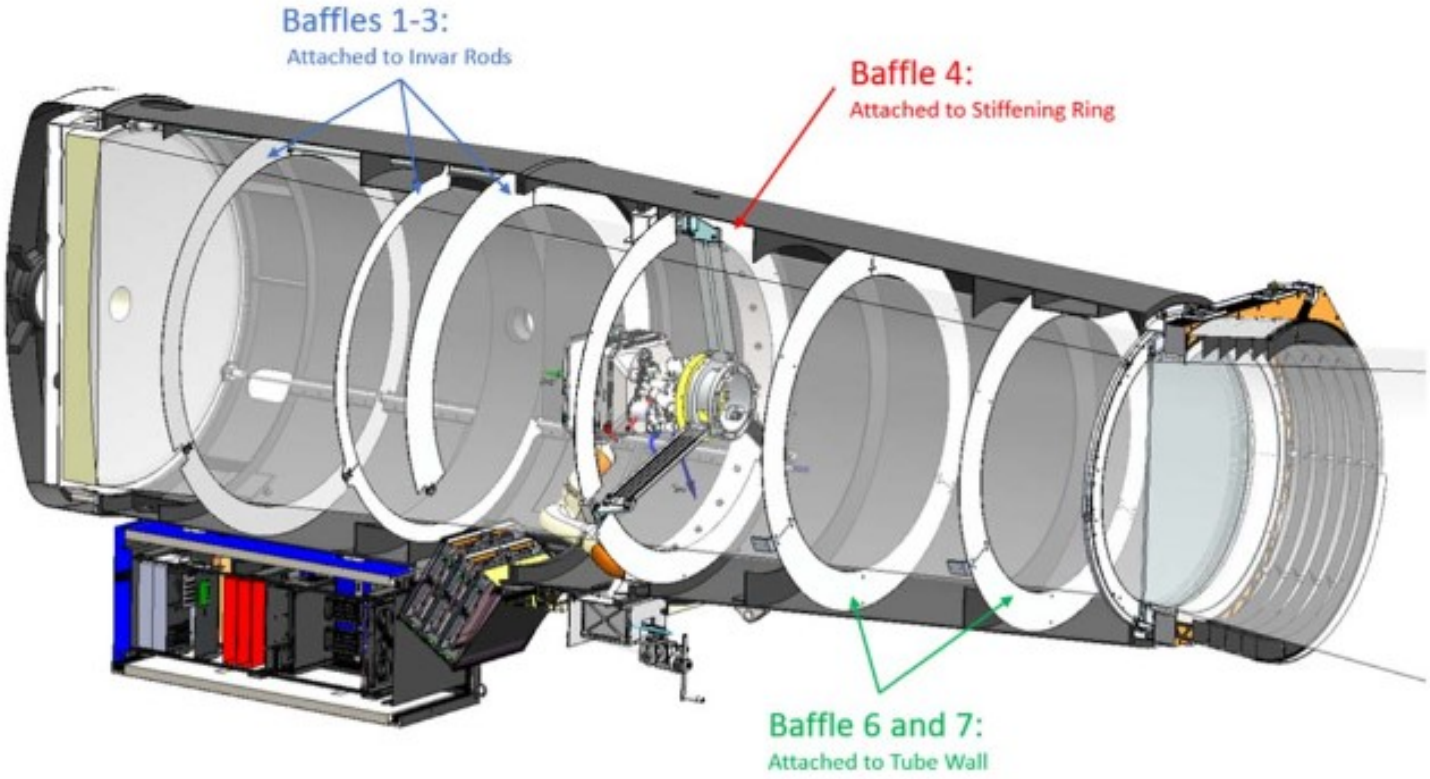


Figure 10. ZTF telescope tube baffling layout consists of 7 concentric baffles arranged so that off-axis scattered (e.g., moon) light cannot reach the primary mirror without scattering at least twice from blackened surfaces.

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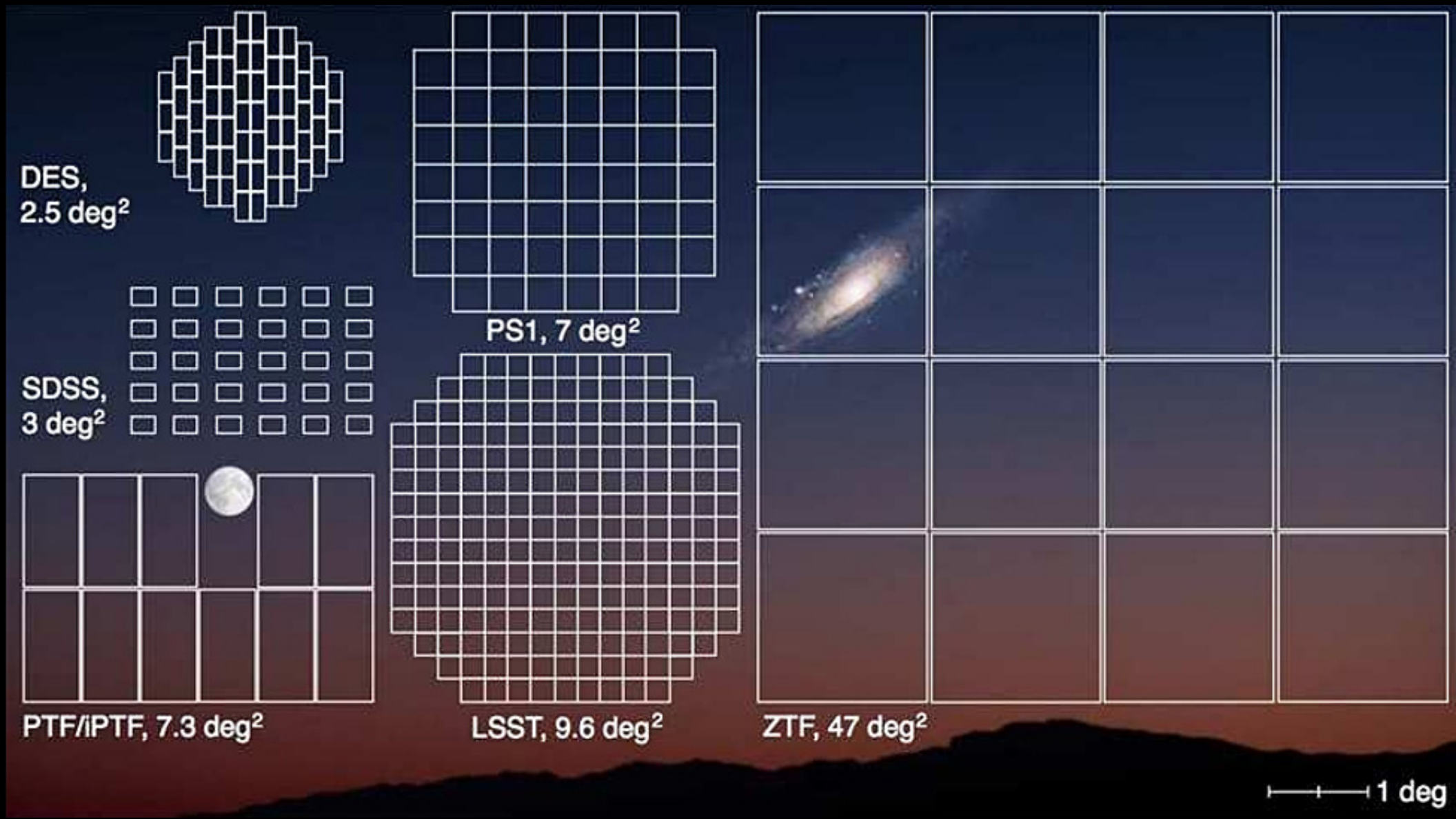
FOV



July 29, 2021 ZTF: The Zwicky Transient Facility at Palomar Observatory

Palomar Observatory/California Institute of Technology

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ZTF will survey an order of magnitude faster than PTF.

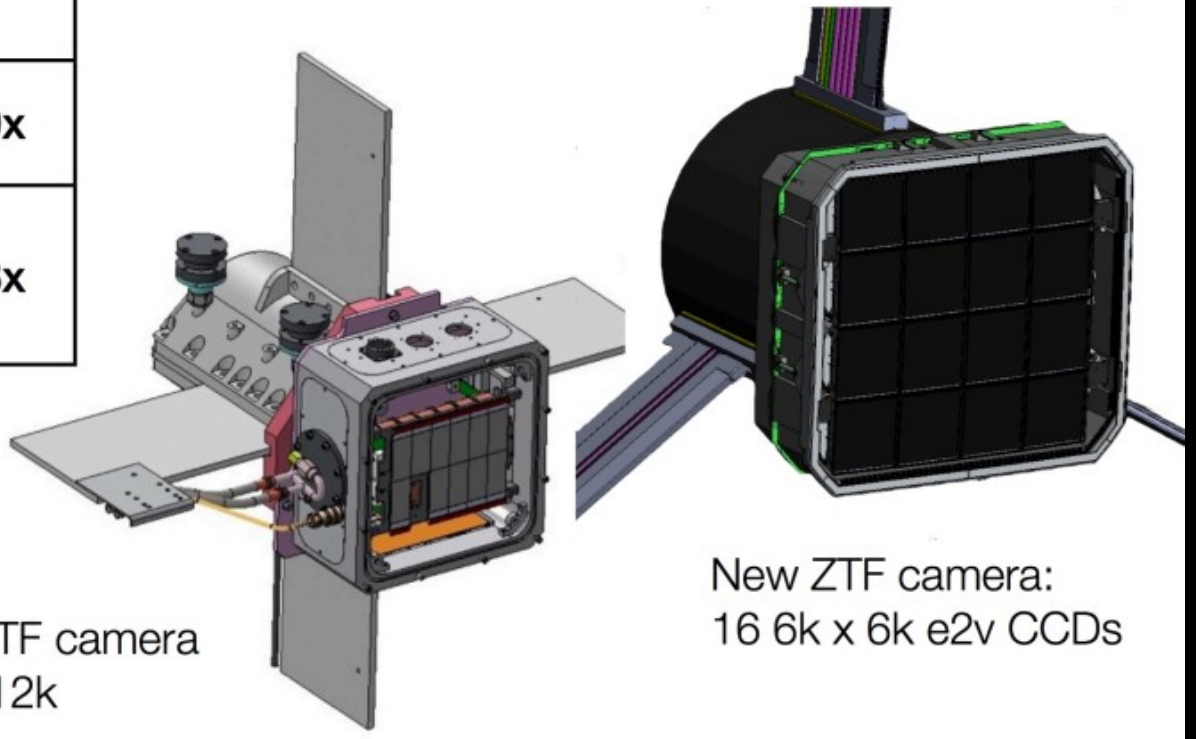
	PTF	ZTF
Active Area	7.26 deg^2	47 deg^2
Overhead Time	46 sec	<15 sec
Optimal Exposure Time	60 sec	30 sec
Relative Areal Survey Rate	1x	**15.0x**
Relative Volumetric Survey Rate	1x	**12.3x**

3750 deg^2/hour

⇒ 3π survey in 8 hours

>250 observations/field/year

for uniform survey



Existing PTF camera
MOSAIC 12k

New ZTF camera:
16 6k x 6k e2v CCDs

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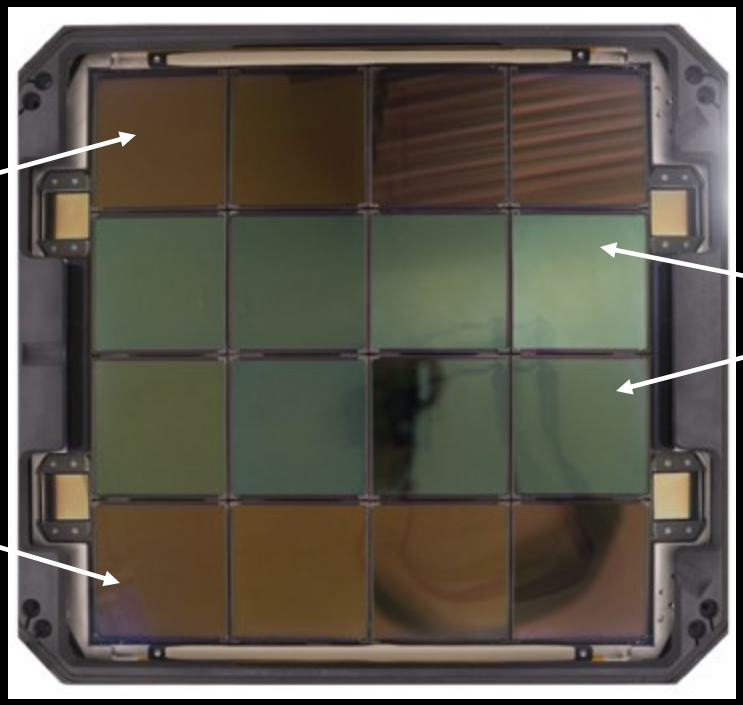
Filter transmission for the ZTF *g*, *r*, and *i*-band filters (blue, orange, and red lines).



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Four 2*k* × 2*k* CCD's are located on the perimeter of the mosaic; one serves as a guider while the remaining three control tip, tilt, and focus. North is up and east is left.

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Field of view	47 sq. degrees
Detectors	16 e2v 6k x 6k CCD231-C6
Pixel size	15 microns
Well Depth	350,000 -e
Pixel scale	1.0"/pixel
Median Delivered Image Quality	2.0" FWHM
Exposure time	30 sec
Readout time	10 sec
Time Between Exposures	15 sec
Median 30 sec (R band)	20.4 mag. (all lunar phases)
Filters	ZTF g, ZTF r, ZTF i
Areal survey rate	3750 square degrees/hour
CCD Cooling	l60K (-171.67º F)

Palomar Observatory's 48-inch Samuel Oschin Telescope

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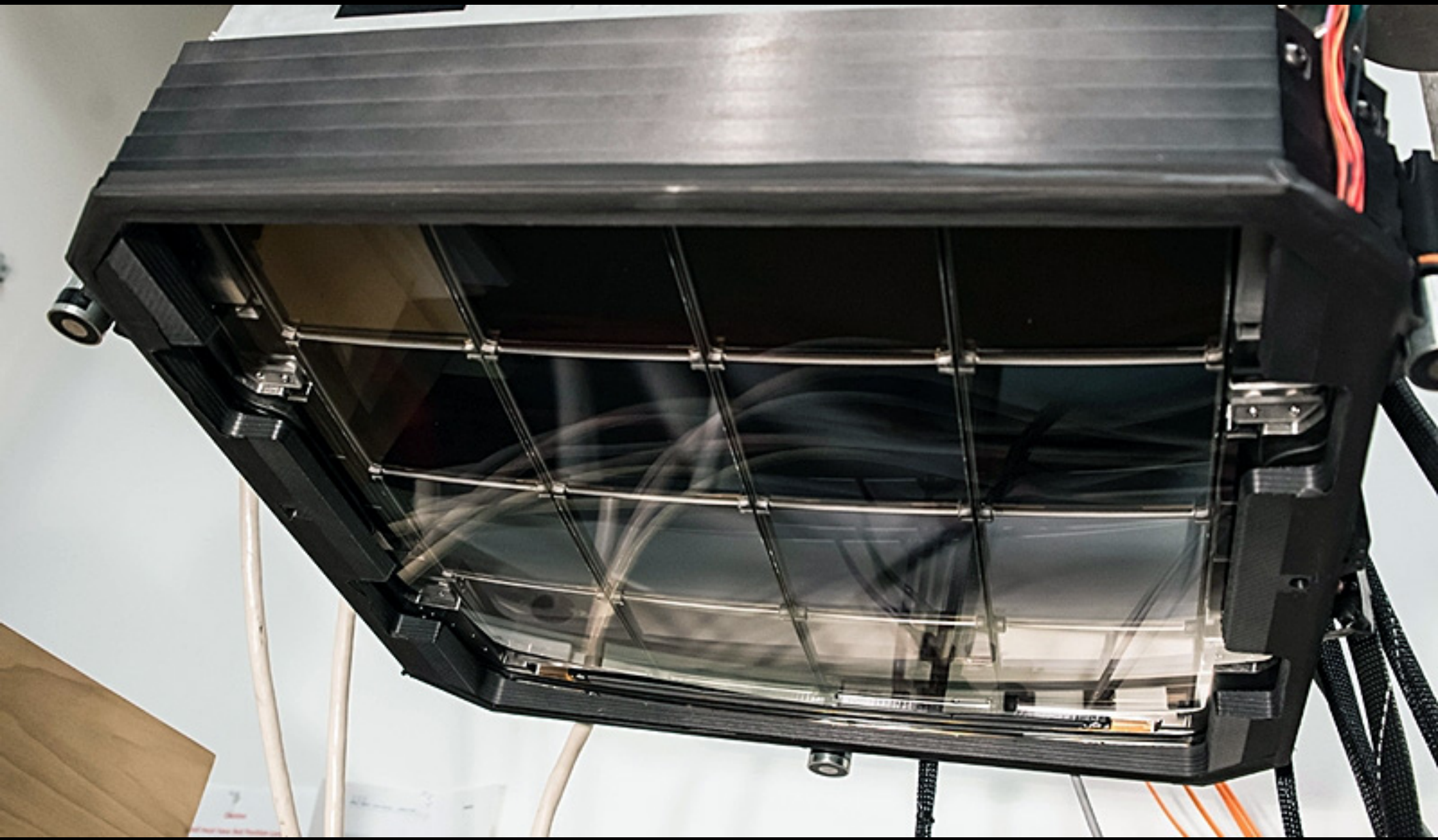

New ZTF Camera 16 6,000 x 6,000 e2v- CCD231-C6

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Palomar Observatory's 48-inch Samuel Oschin Telescope

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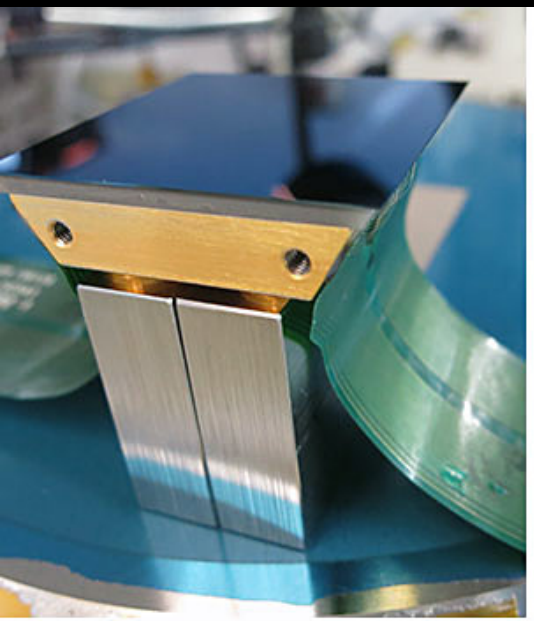

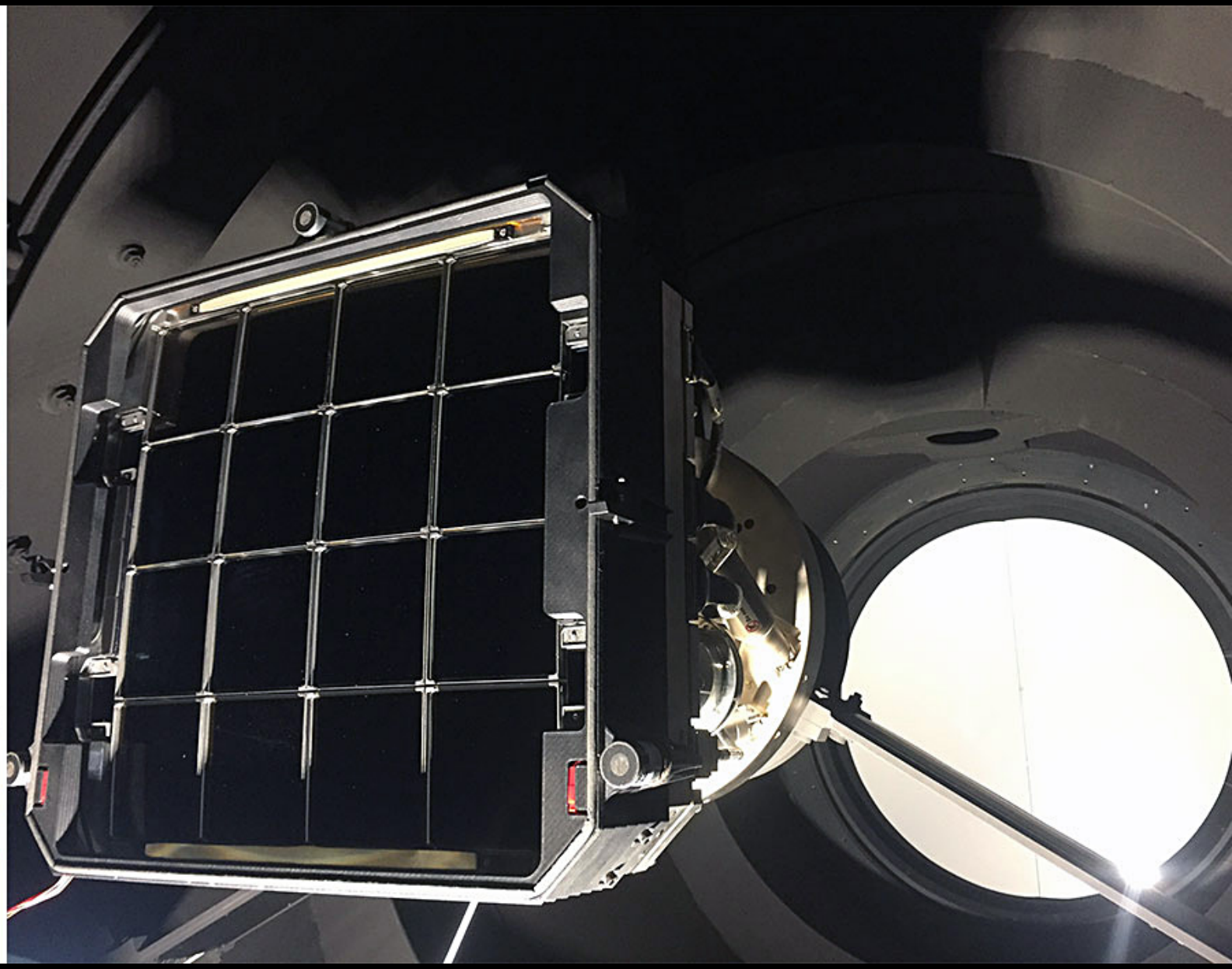

New ZTF 47º FOV Camera in 48" OTA at Focus Plane

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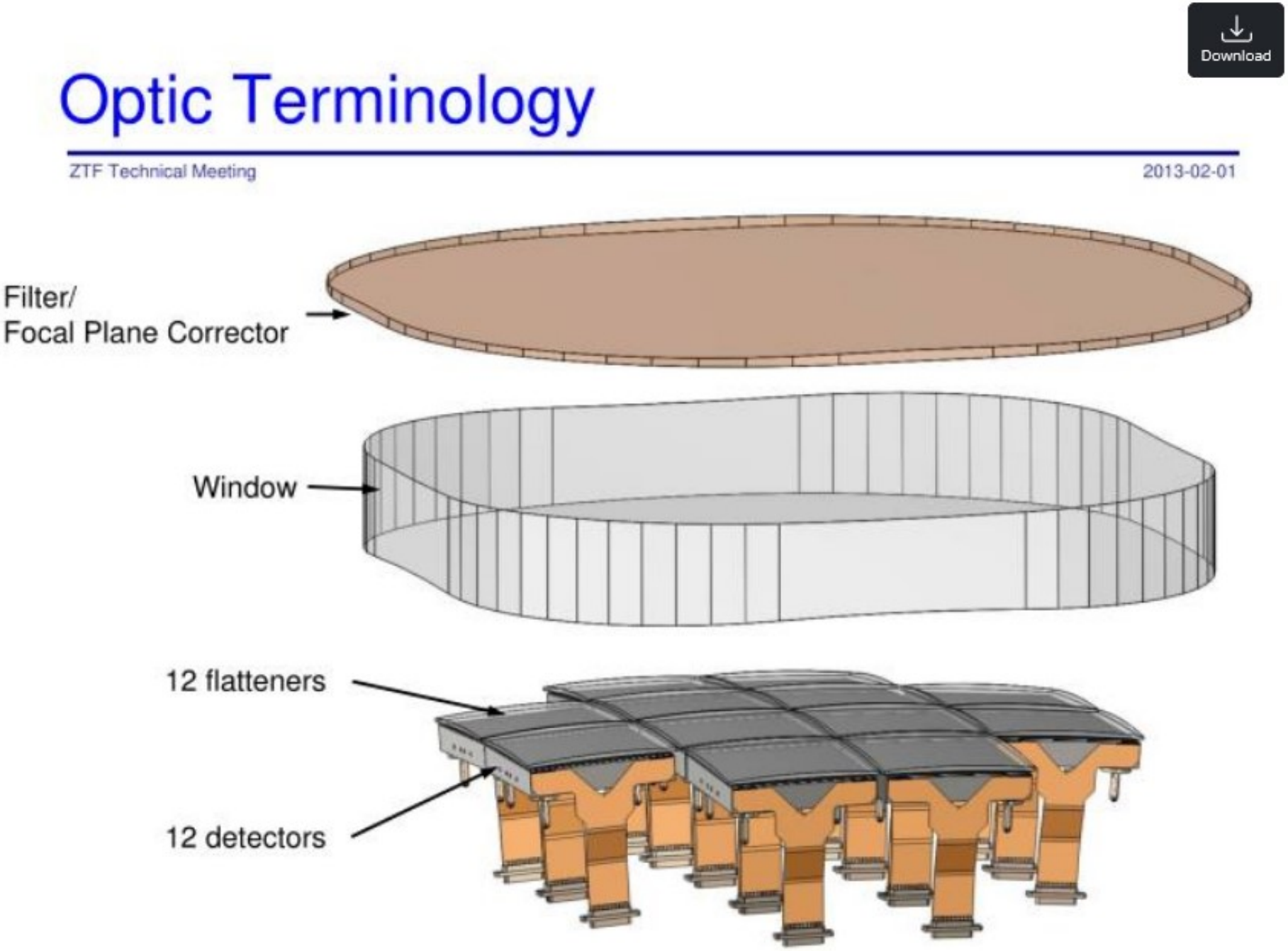
Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility



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Palomar Observatory's 48-inch Samuel Oschin Telescope

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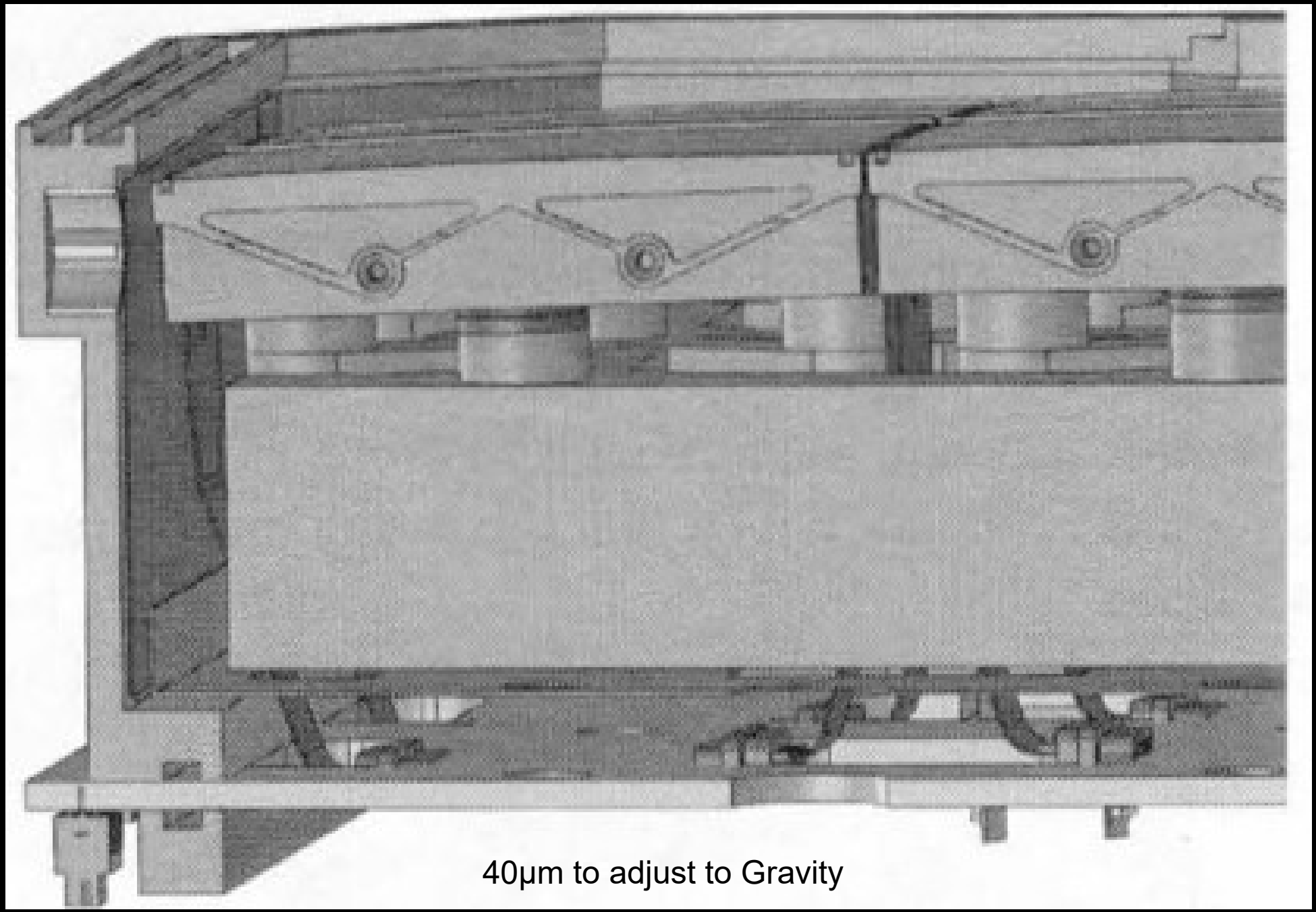

40μm to adjust to Gravity

Palomar Observatory's 48-inch Samuel Oschin Telescope

Zwicky Transient Facility

ZTF Filter

Palomar Observatory/California Institute of Technology

Palomar Observatory's 48-inch Samuel Oschin Telescope

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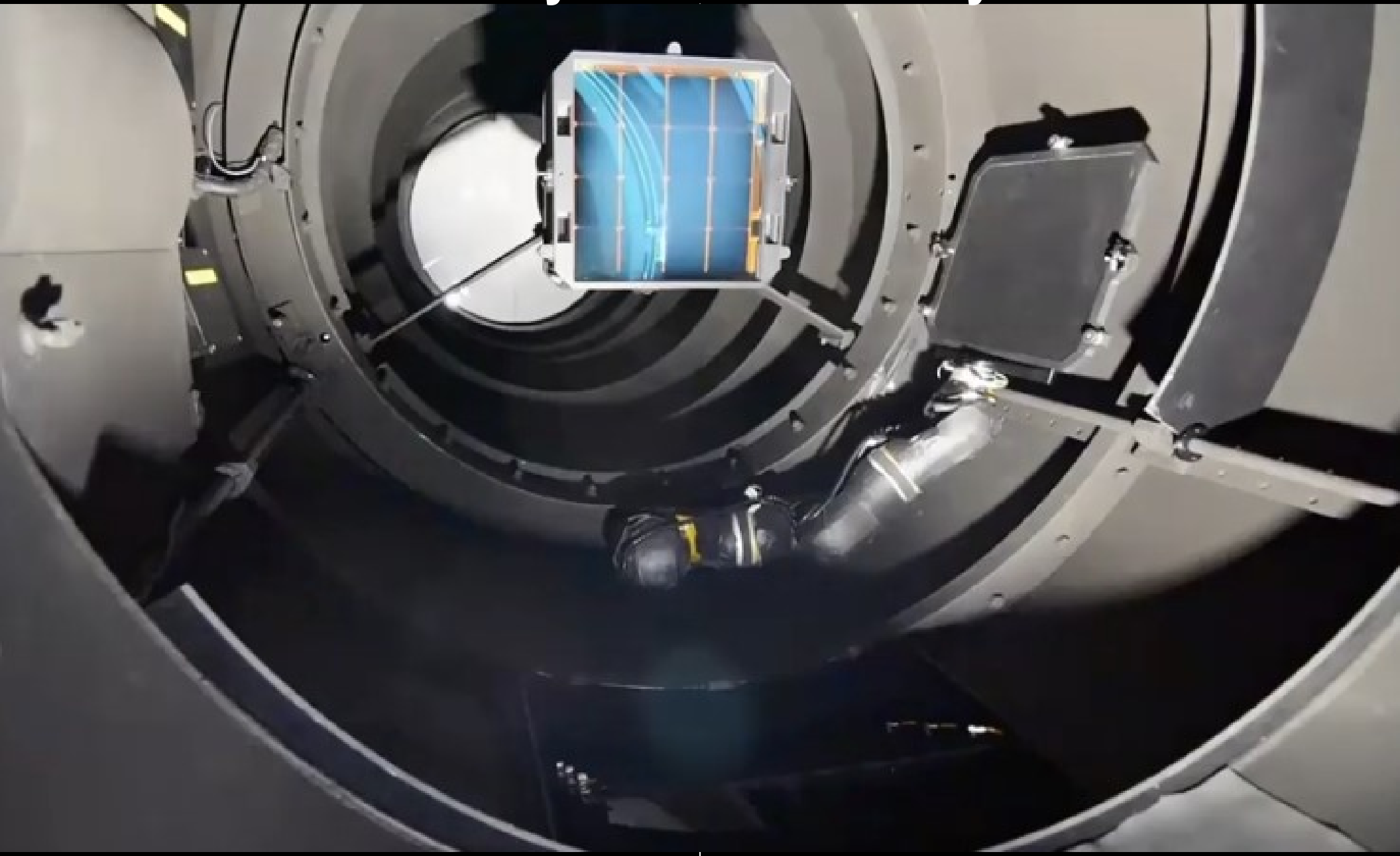

16 x 16 CCD and Robotic Arm for Filters

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CCD Data

San Diego Supercomputing Center (SDSC)

Data to the IPAC servers in Pasadena via HPWREN
High Performance Wireless Research & Education Network

Caltech's Infrared Processing and Analysis Center (IPAC),

The ZTF Science Data System (ZSDS) is housed at IPAC

Converted to 32 bit floating point FITS & Calibrated

650 → 900 exposures per night

Archive Data → 4 terabytes each night

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Programs

ZTF is conducting the two Public surveys

Northern Sky Survey and a
Galactic Plane Survey.

Mid-scale Innovations Program (MSIP):

Galactic Plane Survey is a nightly survey

Northern Sky Survey is a three-day cadence survey
Records Comets & Centaurs
(bodies between Jupiter & Neptune)

Each field is visited twice → g-band & r-band

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1st 5 Years

2018-2023

ZTF discovered and classified over 8000 supernovae

Over 3000 Type 1a supernovae (binaries) events

Hundreds of near-Earth asteroids

Ten's of rare transients like Tidal Disruption events
(*when a star is violently ripped apart by the gravity of a black hole.*)

15,000+ observations of Comets

Palomar Observatory's 48-inch Samuel Oschin Telescope

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Currently 2023-2025

Caltech continues to press the Edge of the Envelope
Improvements & Upgrades continue to emerge

Dome, Telescope and Electronic Upgrades Allow the 48" Samuel Oschin Telescope to slew and settle between adjacent fields separated by 7º during the CCD readout time of 10 seconds

Rumored readout times of 8.66 seconds can be achieved.

Fastest Observing Cadence **38.98 ± 0.14** seconds

Autoguider: ZWO ASI1600MM CMOS sensor

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If it could ignore Daylight ZTF could repeat the entire POSS survey in one day.