American Astronomical Society
213th Meeting in Long Beach
HAD IV: Paper 320.03

The Pierce-Blitzstein Photometer – The PBPHOT

C. Ambruster[1], T. Hull[2], R.H. Koch[3],
R. J. Mitchell[4], R. E. Smith[3]
[1]Villanova University; [2]L-3/Tinsley;
[3]University of Pennsylvania; [4]Gravic, Inc.

Abstract

- This report describes the inception, development and extensive use (over 50 years) of the simultaneous 2-source, pulse-counting photometer named after the two astronomers in this paper's title.
- These men are not, however, the only personalities associated with the lifetime of the photometer and the contributions of other people are explicitly recognized.
- The embellishments and upgrades over time of the original conceptions are detailed for both the optical/mechanical/ electrical hardware and the software.

We did not compose the PBPHOT acronym. Blitzstein did this for a piece of output code but RHK did apply it to the system sometime around 1985 and the name stuck.

Overview(1)

1. The architecture of the PBPHOT was extraordinary, even visionary, for its time.
2. It was an automated two-channel pulse-counting photometer, a thought-out system from the start.
3. Product of initial collaboration between astronomy departments at Princeton and Penn, ultimately developed at Penn.
4. Early collaboration with RCA to provide state-of-the-art electronics.

Overview (2)

5. Ultimately optimized for productive work in problematical skies in two respects:
   a. quality data through variable extinction from cirrus clouds, maintaining better than 0.01 magnitude precision for stars $\leq 9^{th}$ mag.; and
   b. operable through cloud-modulated light-polluted foreground aggravated by proximity to Philadelphia.
6. Blitzstein incorporated electrical and optical calibrations to normalize the detector and filters of each channel to each other.
7. The efficiency of pulse counting electronics was exploited.
8. The intent from the start was to achieve automated observing and this was ultimately realized.

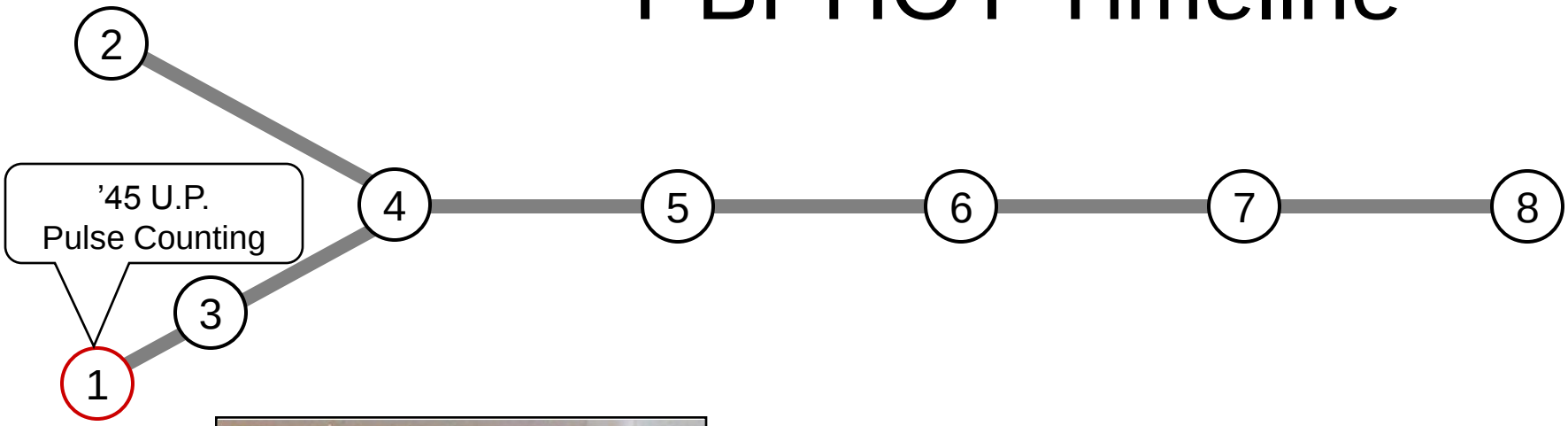
Dual-Channel Heritage

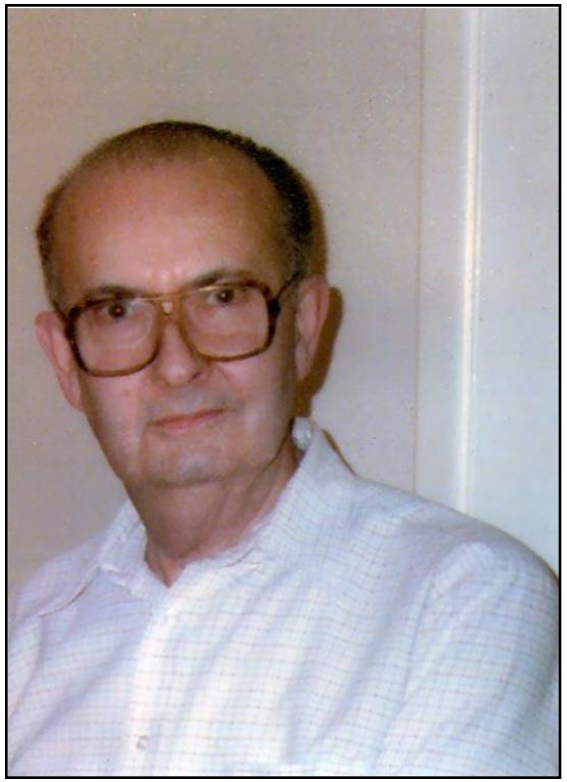
- At Princeton in the 1930s, Raymond S. Dugan used a polarizing 2-channel photometer with the eye as a detector,
- Newton Lacy Pierce and John E. Merrill of Princeton inherited the instrumentation used by Dugan, and became dissatisfied with it due to the limitation of the eye's spectral response and the inefficiency of observing.

Background: Dual Channel Photometry

- Pierce did not invent the concept of 2-channel photometry.
- 2-channel photometry was the technique for the Harvard Revised Photometry by E. C. Pickering (Director of Harvard College Observatory 1877-1919), A. Searle and O. C. Wendell and their collaborators at both Cambridge and Arequipa.
- Earlier, John Herschel invented a device and used it at the Cape to minimize an image of Moon and to present it to the observer at the same time as he was looking at a target star.

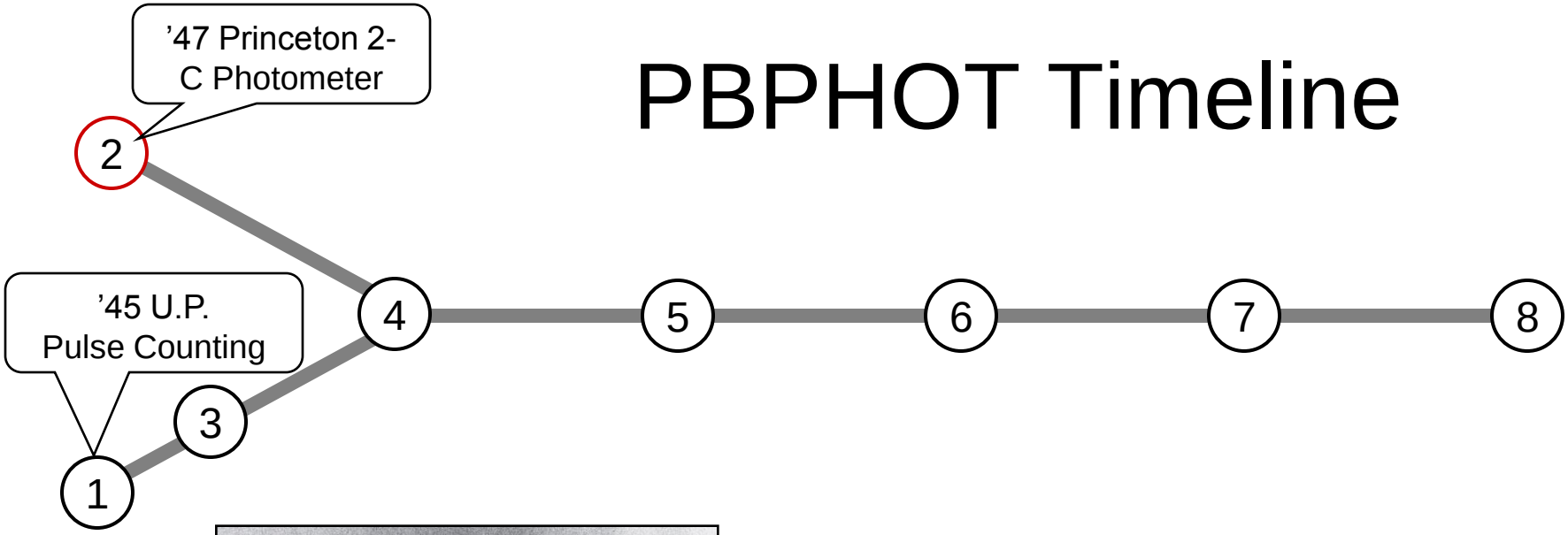
PBPHOT Timeline





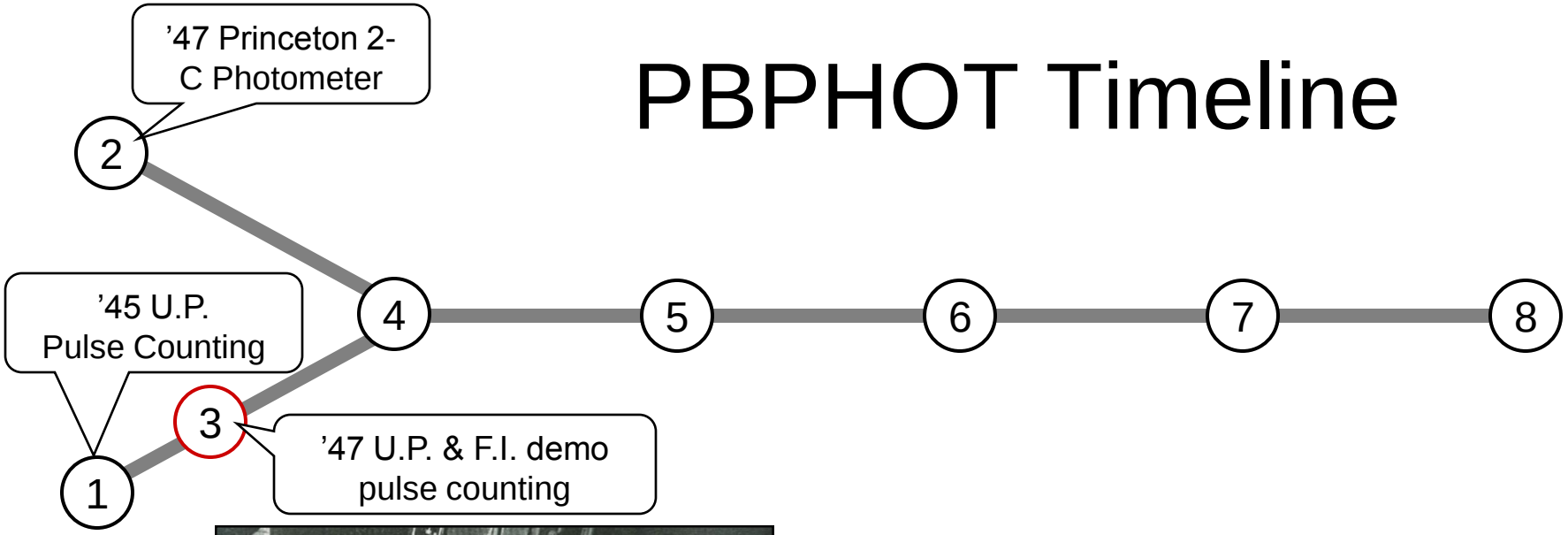
1. 1945 U.P. grad student William Blitzstein conceived intention to move from AC/DC amplification to pulse-counting photometry.

PBPHOT Timeline



2. 1947 Princeton: Newton Lacy Pierce starts development of a 2-channel polarizing photometer.

PBPHOT Timeline



3. 1947 U.P. & Franklin Institute: at Flower Obs., Blitzstein & I. M. Levitt demonstrate pulse counting on stars → Paper at AAS 77.

Blitzstein's light curve of XZ And taken around 1950 at Cook Observatory with single-channel pulse-counting photometer

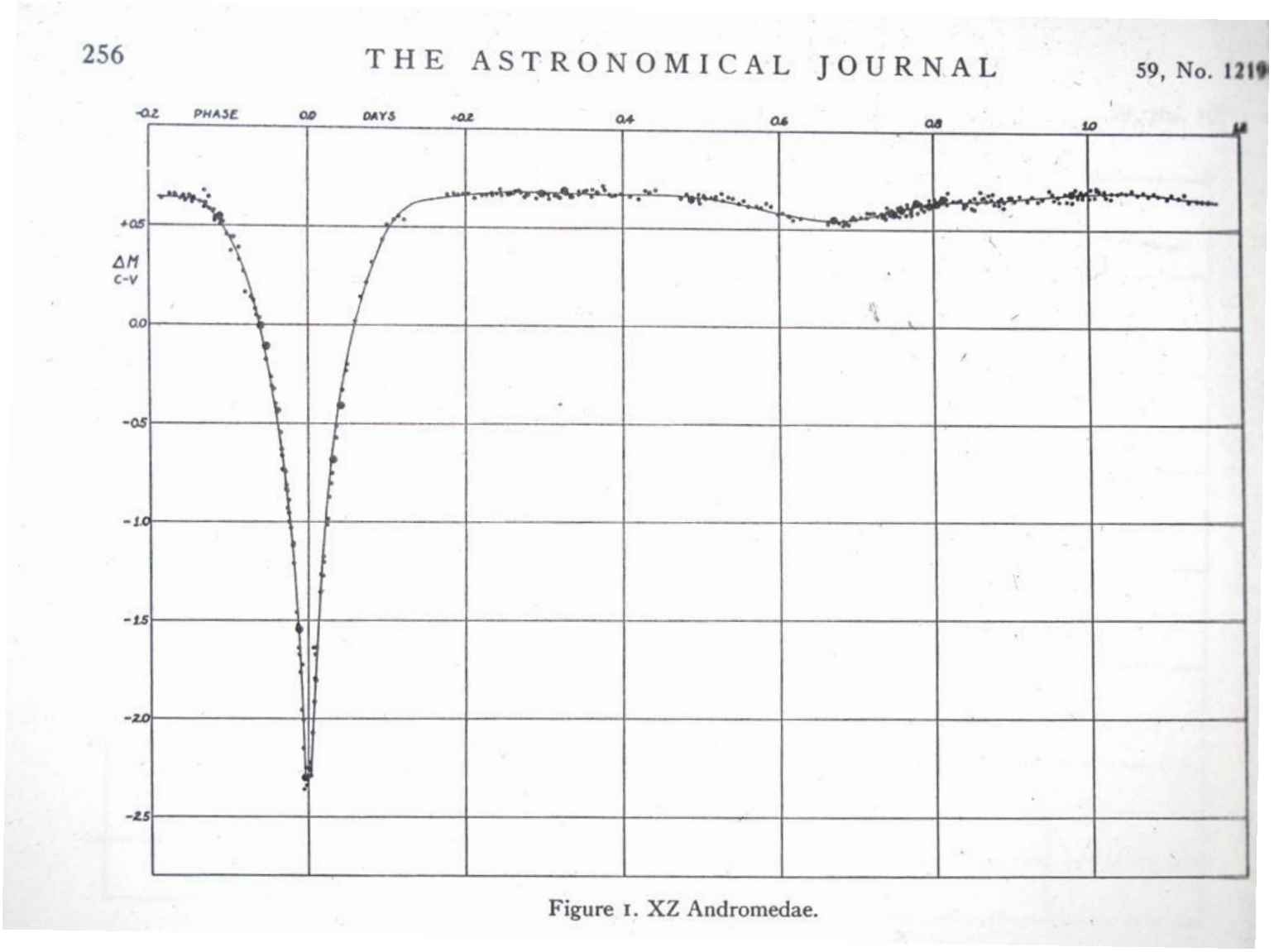
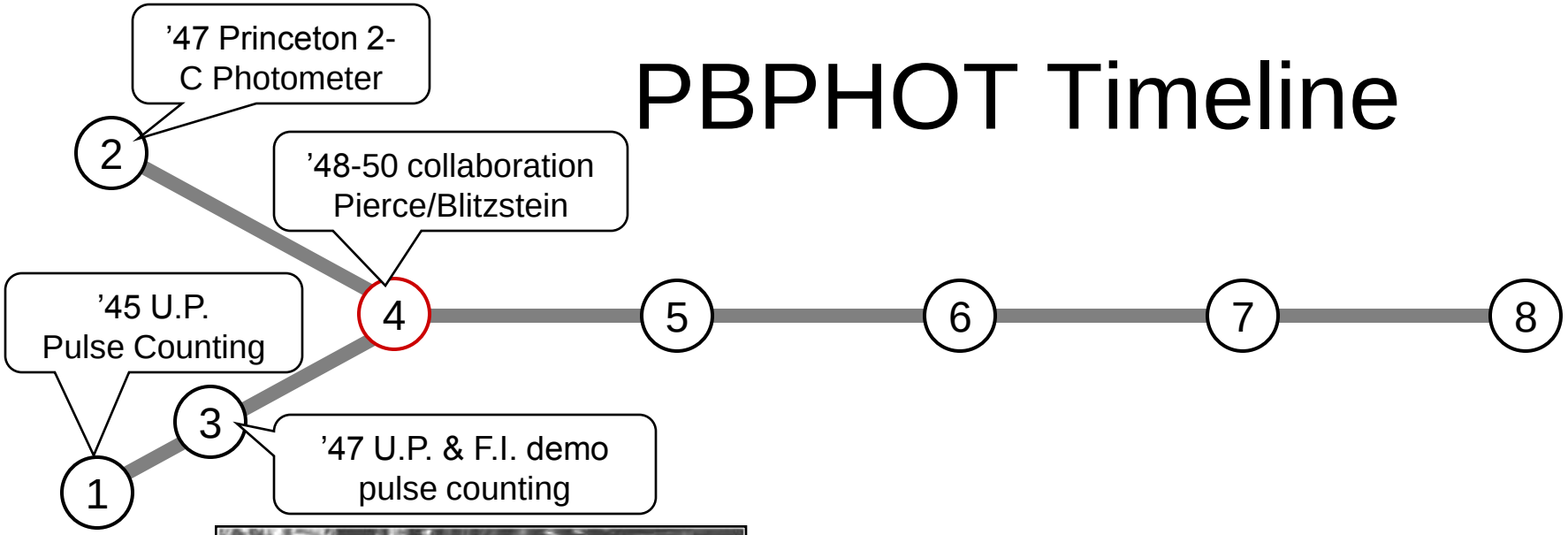


Figure 1. XZ Andromedae.

PBPHOT Timeline

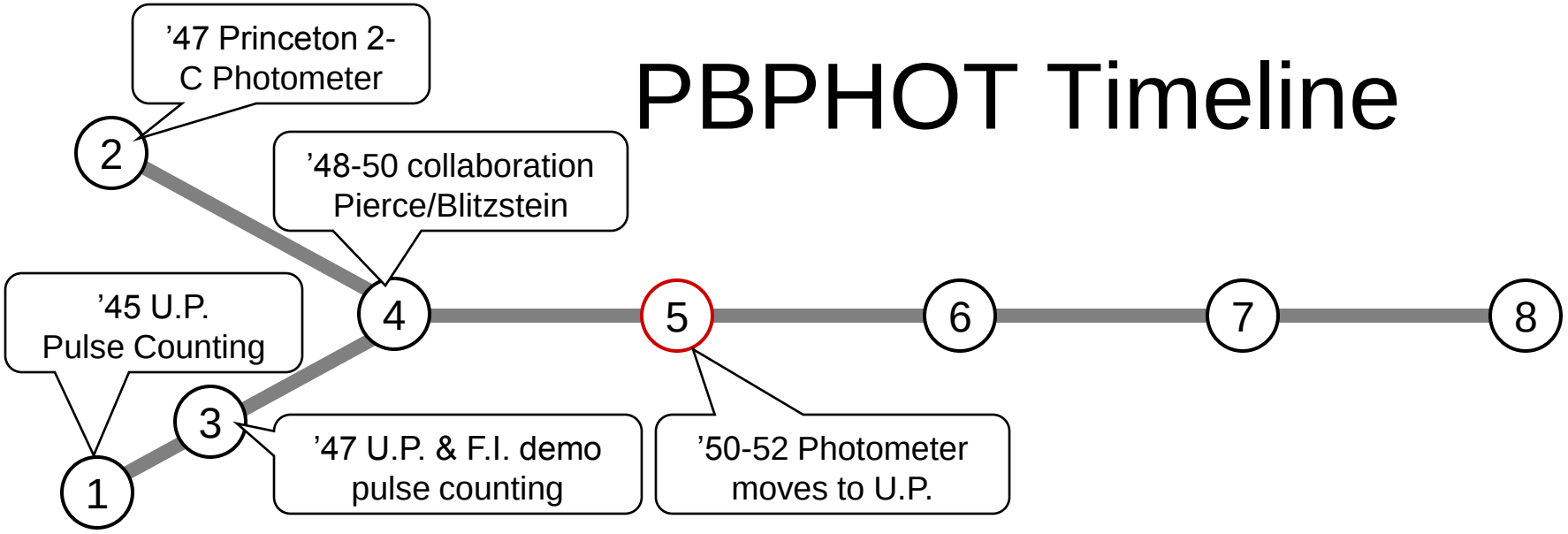


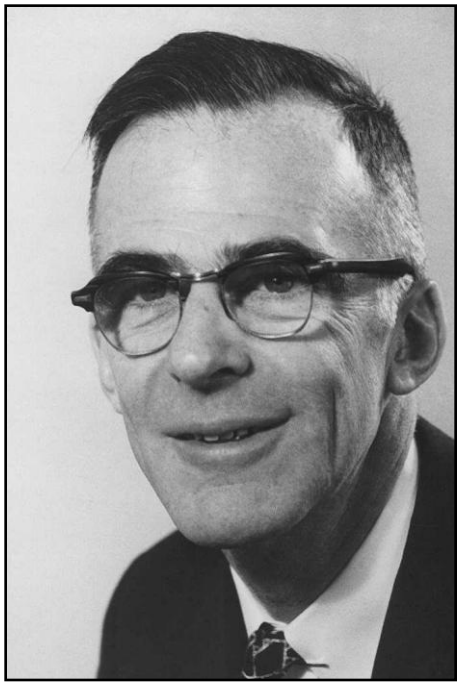
4. 1948-50 Princeton: Pierce & Blitzstein collaborate on design, testing, and construction.
- Pierce dies Aug. 9, 1950 (age 45).
- U.P. Chair C. P. Olivier provides financial support now and for earlier work of Blitzstein and Levitt.

Precursor system moves to U.P.

- Single-channel photometer to be installed at Cook Observatory,
- Components acquired from Princeton for $8,600,
- Incorporated WW II surplus and homemade electronics.

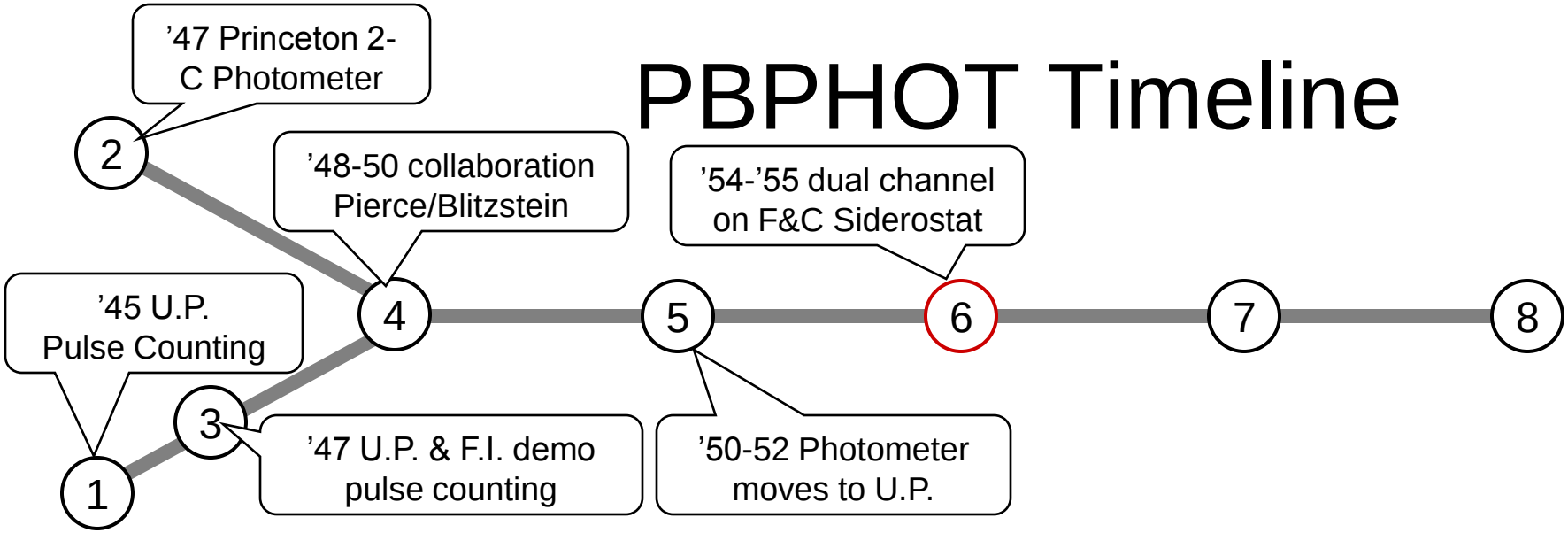
PBPHOT Timeline

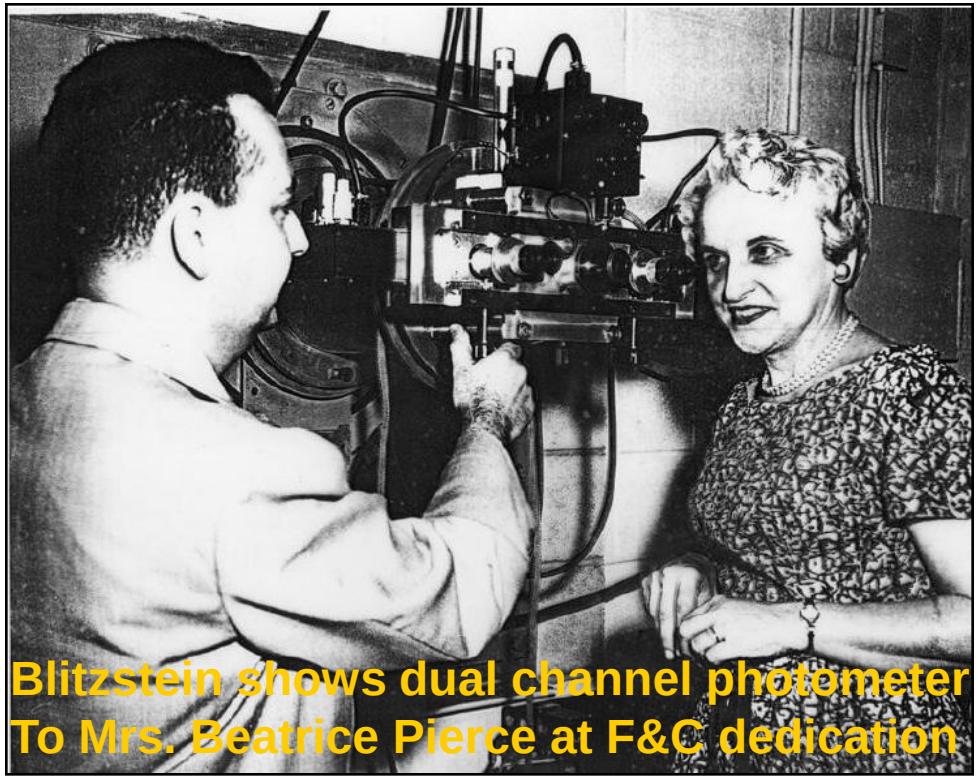




5. 1950-52: Dept Chairs F. B. Wood (U.P.) and Lyman Spitzer (Princeton) facilitate moving single channel photometer to U.P.’s observatories.

PBPHOT Timeline

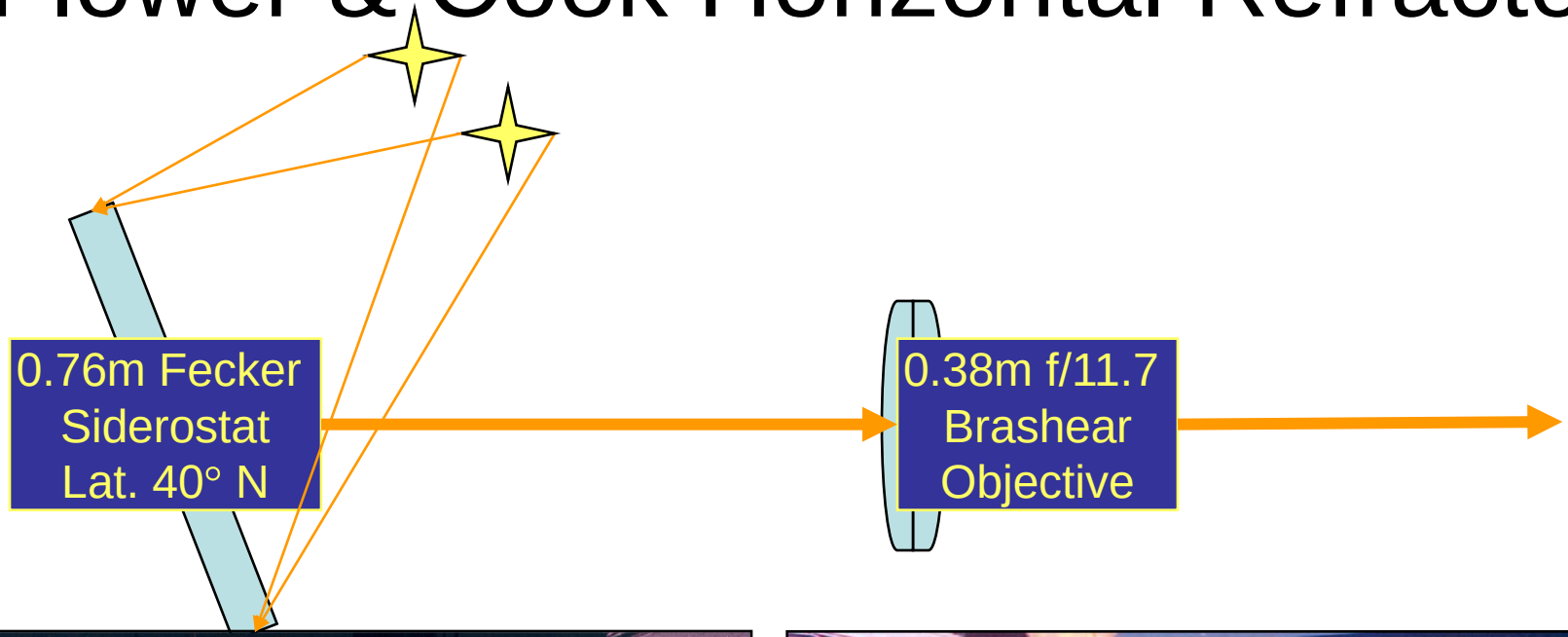


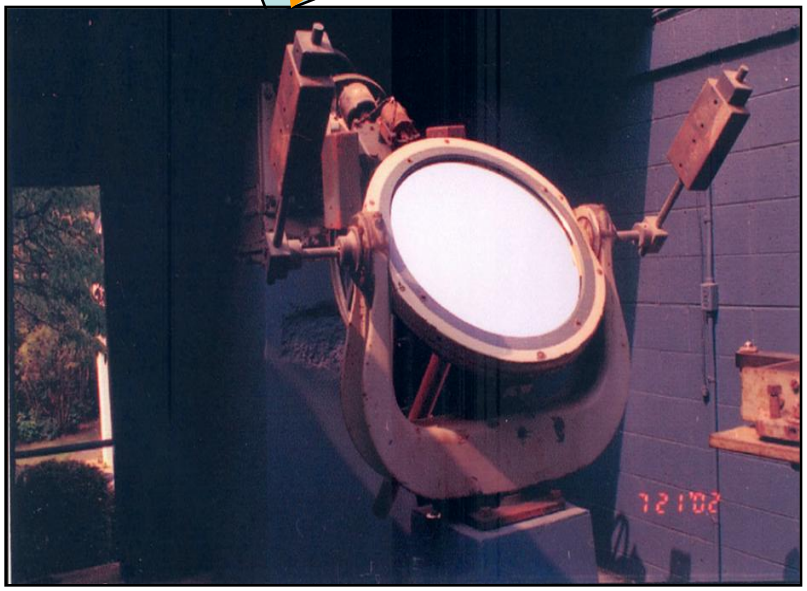


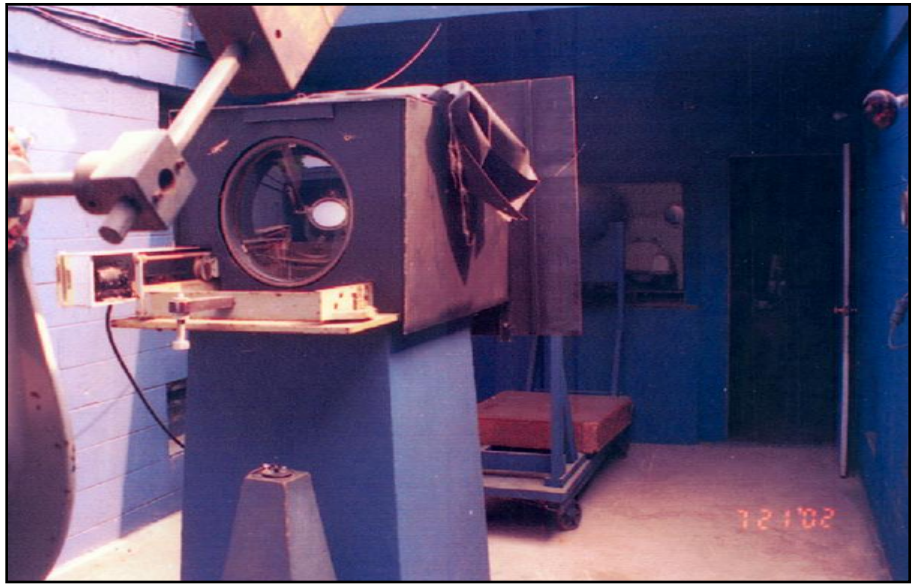
6. Realization:

- 1954: Dual-channel photometer head built by Blitzstein at U.P.
- 1955: Flower & Cook Observatory dedicated with the Cook 0.76 siderostat and the 0.38m horizontal refractor, which feed the photometer.

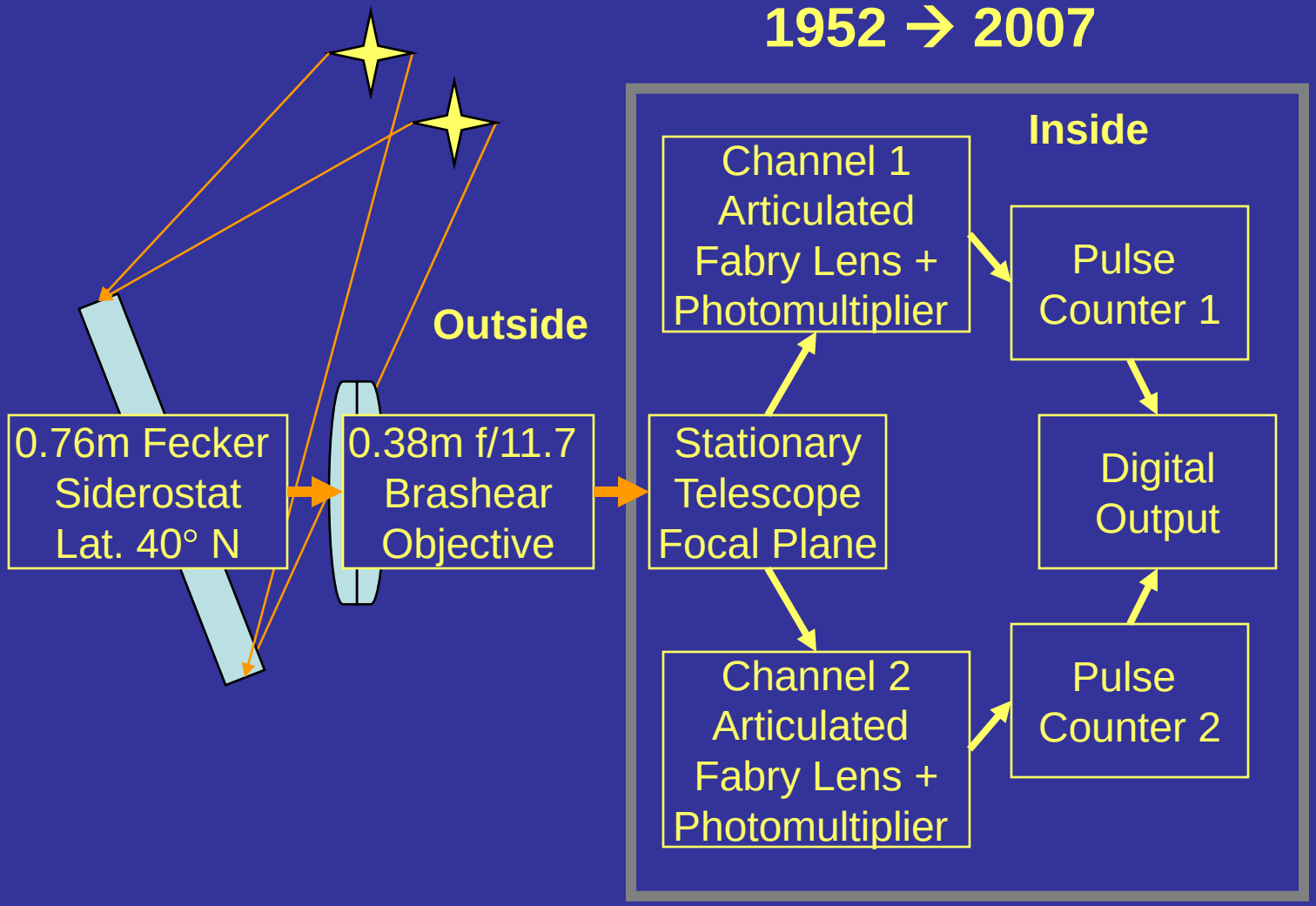
Flower & Cook Horizontal Refractor



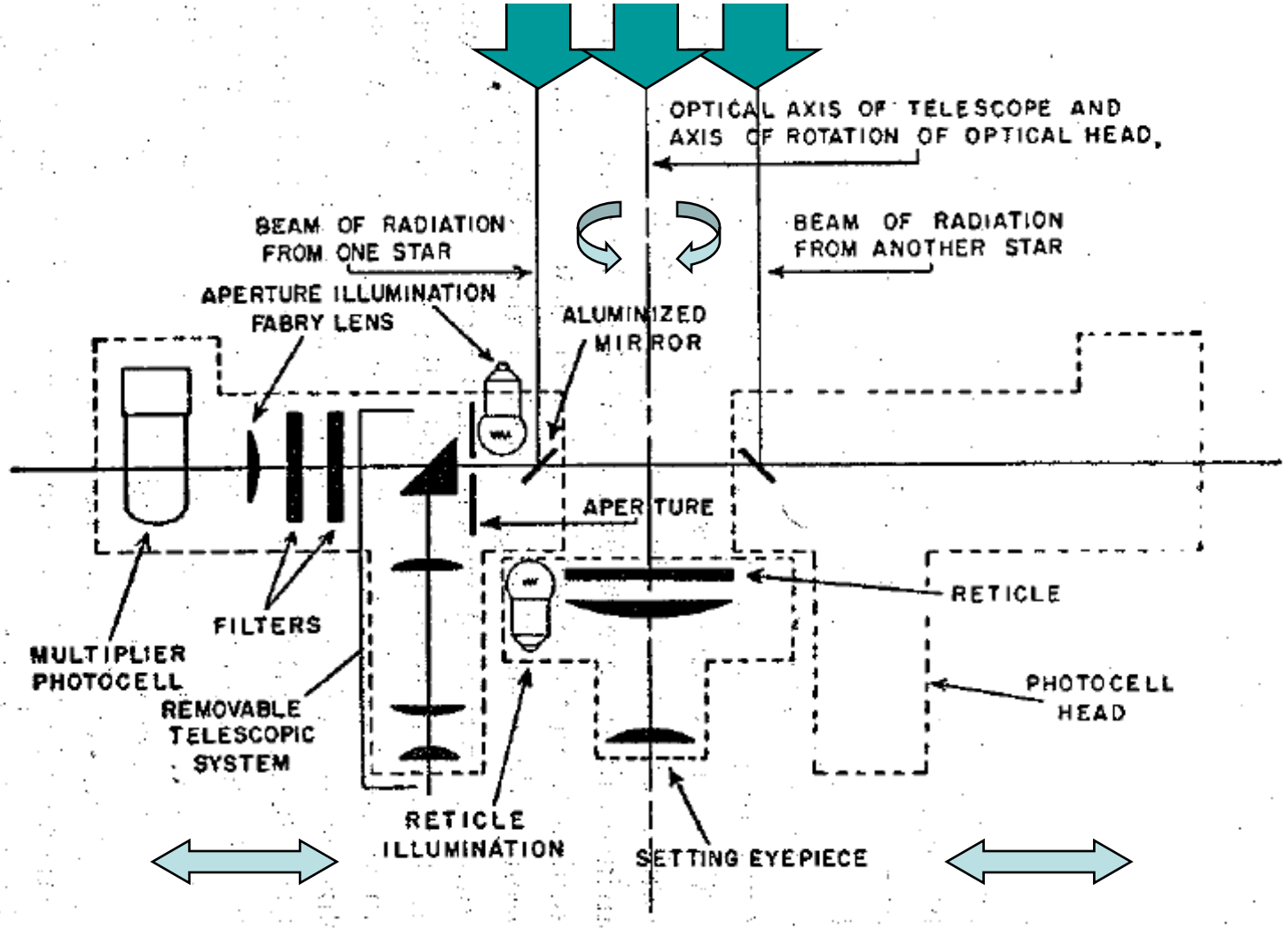




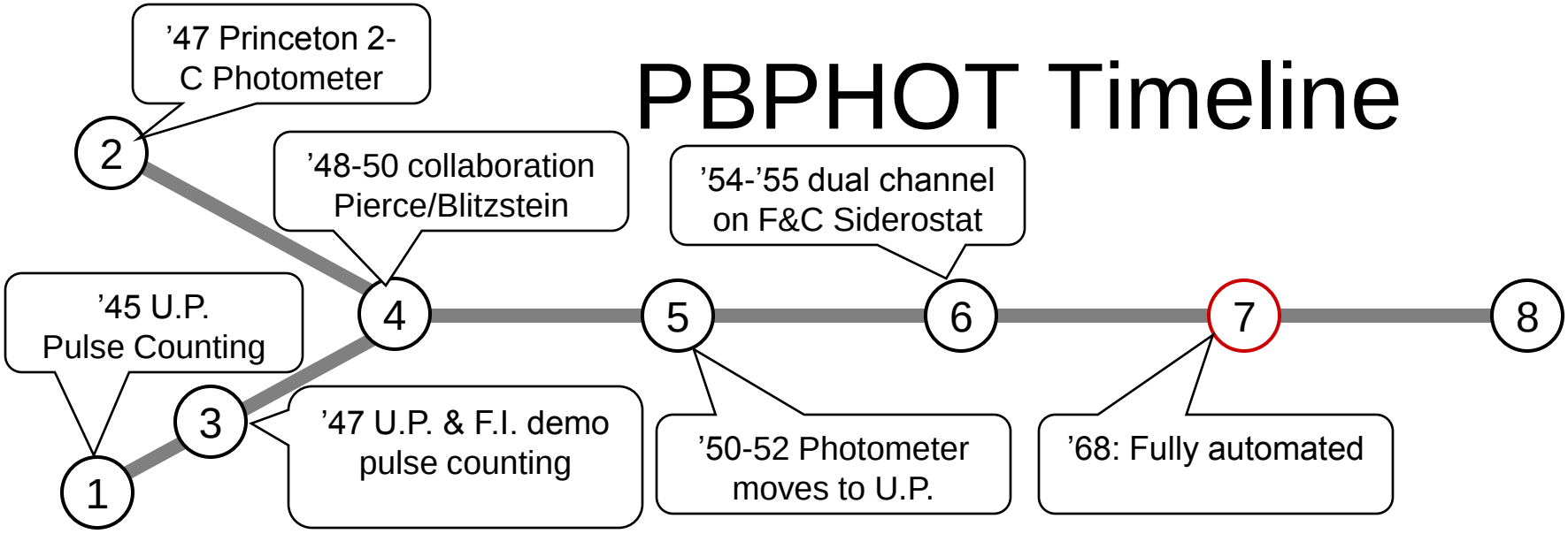
1952 → 2007

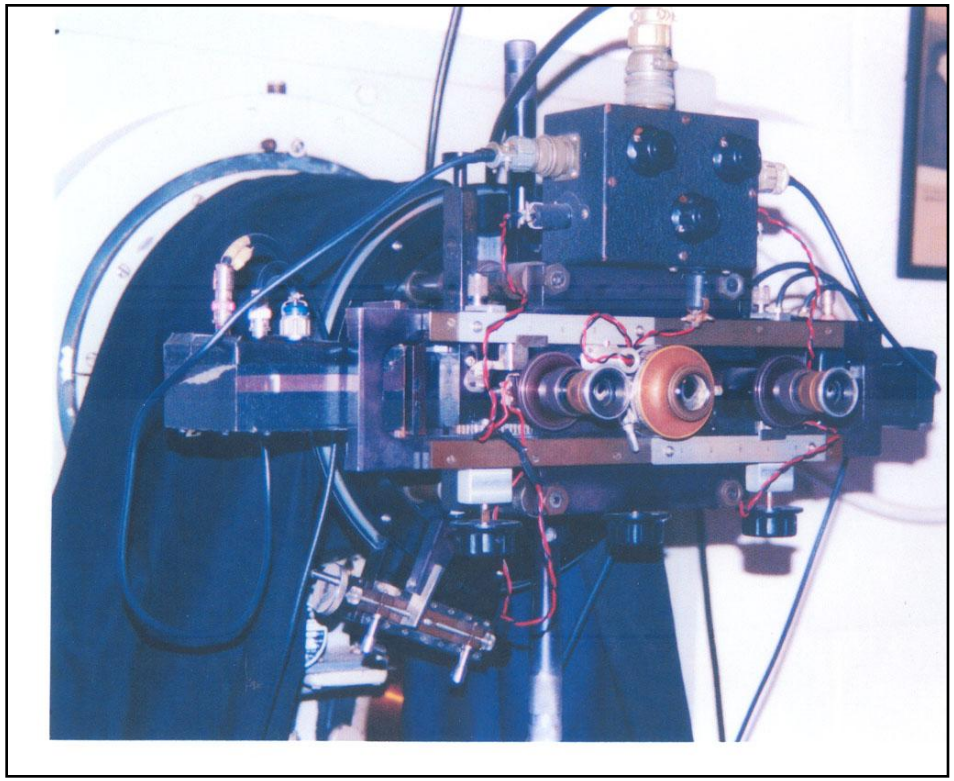

Outside
0.76m Fecker Siderostat Lat. 40° N
0.38m f/11.7 Brashear Objective
Inside
Stationary Telescope Focal Plane
Channel 1 Articulated Fabry Lens + Photomultiplier
Channel 2 Articulated Fabry Lens + Photomultiplier
Pulse Counter 1
Pulse Counter 2
Digital Output

PBPHOT Head Schematic



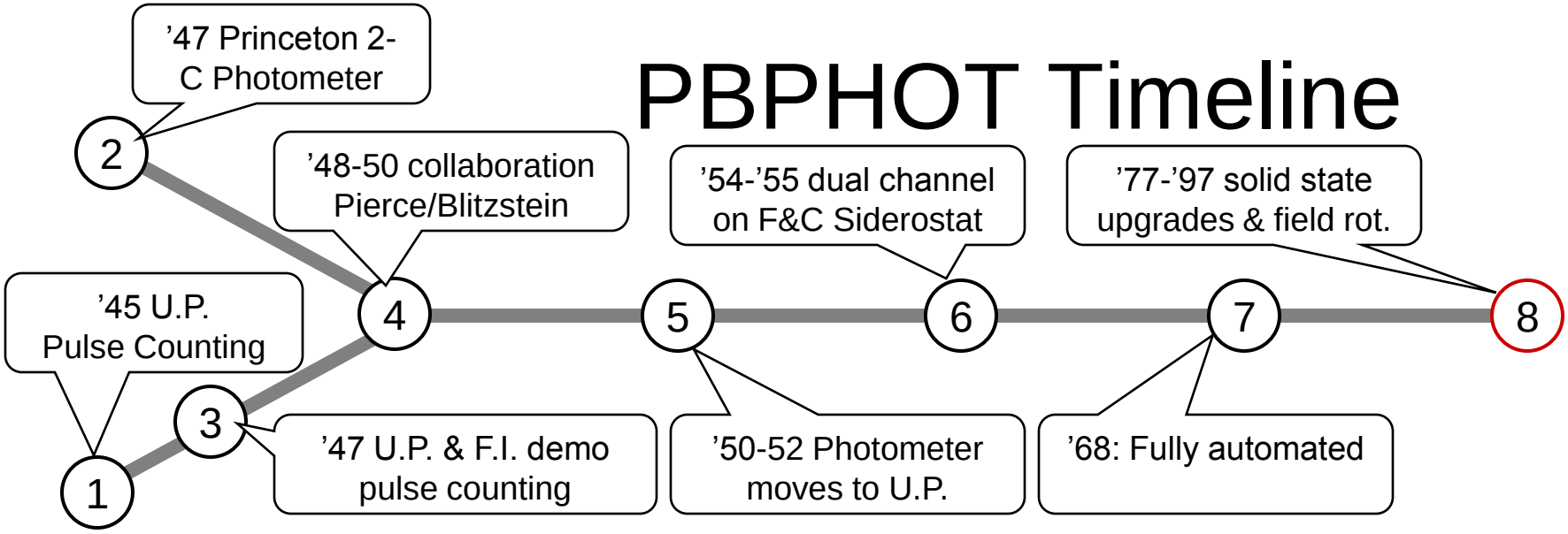
PBPHOT Timeline





7. 1968: Blitzstein achieves full optical and electrical automation envisioned in his original design with the addition of dual-channel calibration.

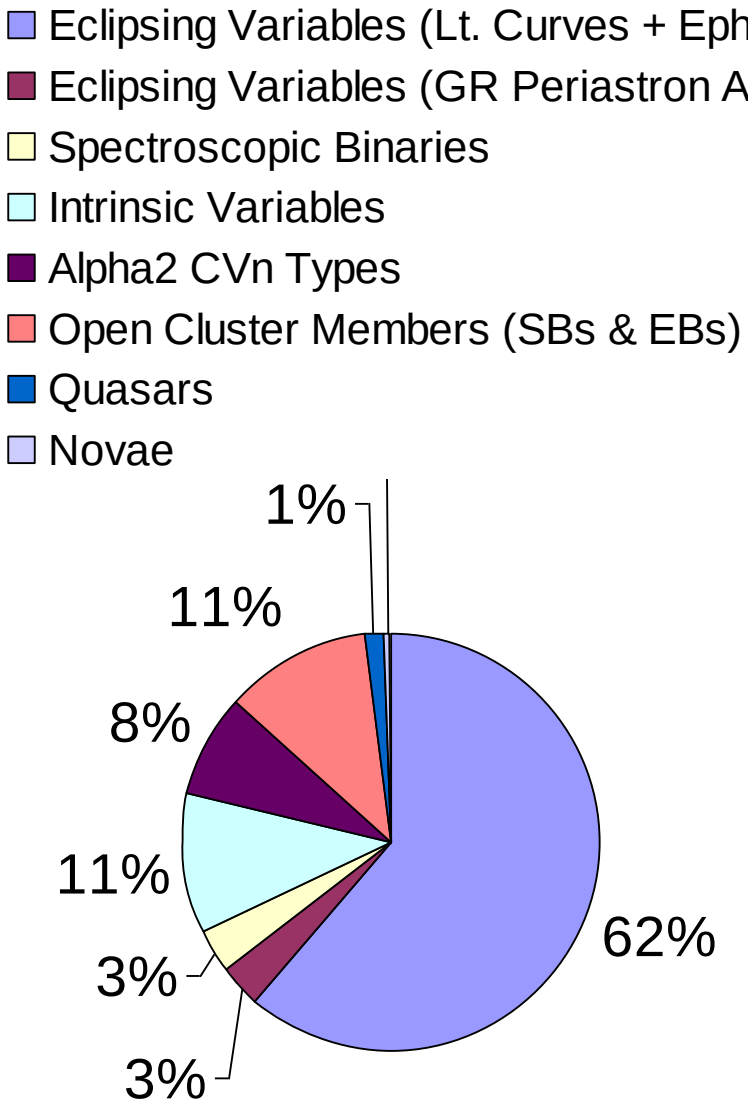
PBPHOT Timeline



8. Enhancements:

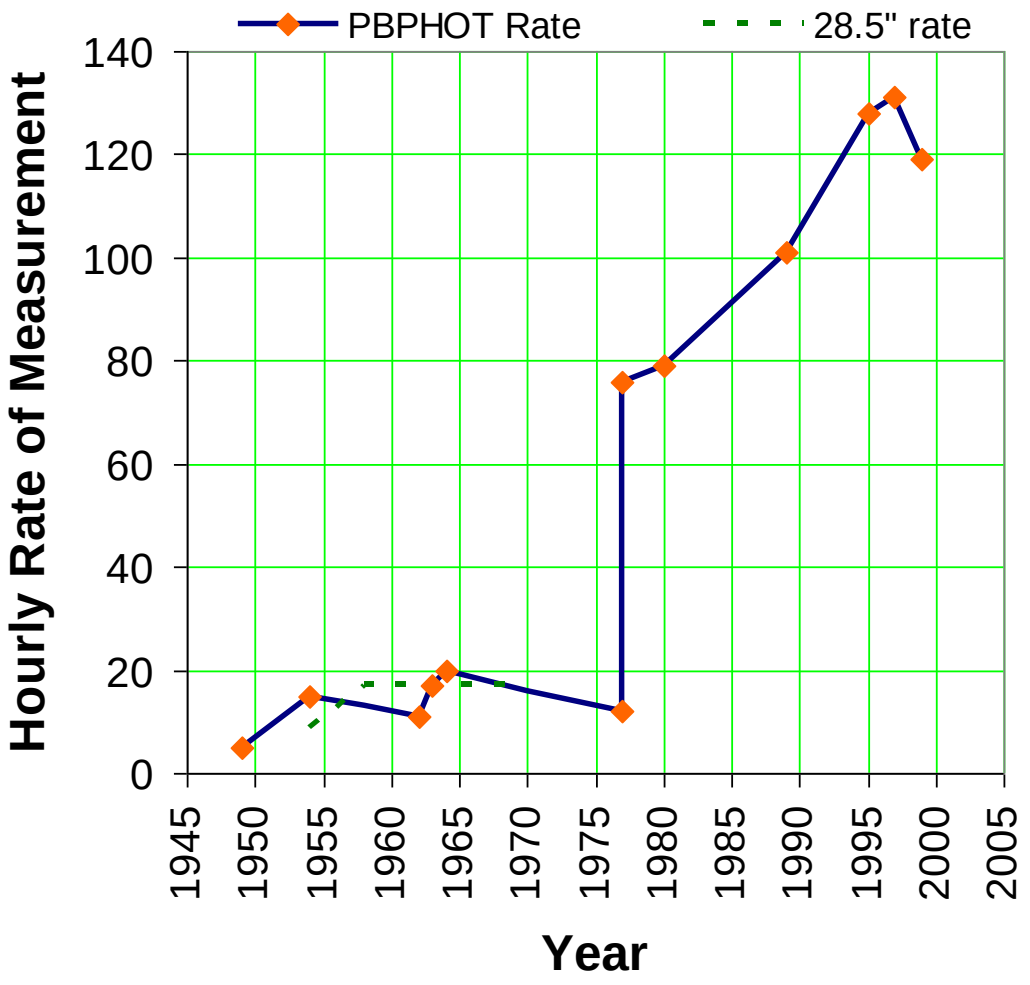
- 1977: Blitzstein upgrades to solid state electronics,
- → 1997: Blitzstein, Koch & Mitchell update photomultipliers, on-line computers, software and add compensation for siderostat field rotation

55 year Contribution to Astronomy



- Dual-channel pulse-counting observing commenced in 1952
- While emphasis was on ~90 eclipsing variables, ~35% of the effort was on other types of targets.

PBPHOT Photometric Productivity



- Through 1977, clear night productivity was comparable to efficient observing with a single channel instrument.[1]
- Observing efficiency potential began to be realized in 1977 with solid state electronics.
- All was enhanced with improved computers and electronically driven correction for siderostat field rotation through 1997.

[1] on FCO 0.72m reflector

Nova Cygni 1975 (V1500 Cyg)

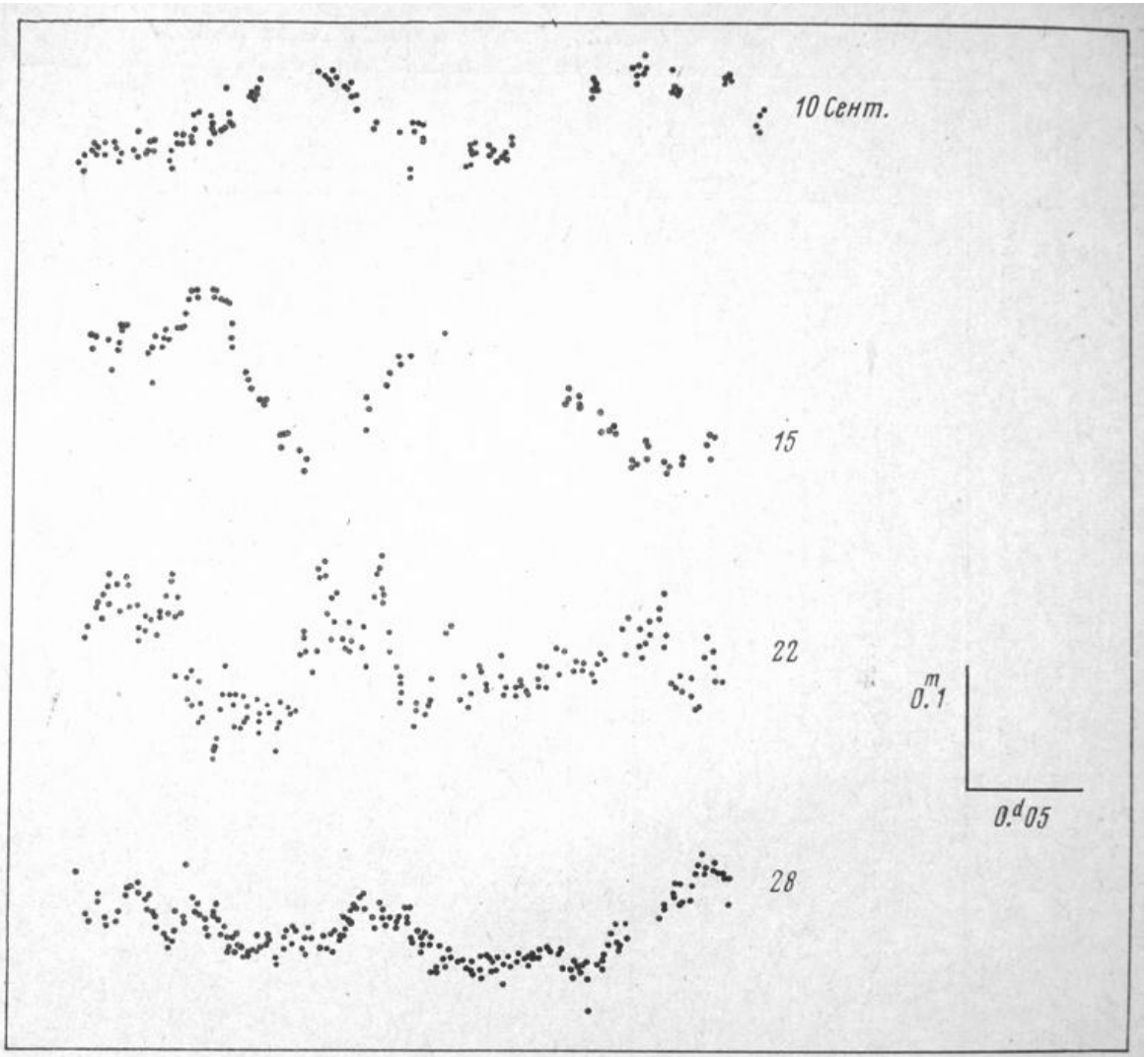
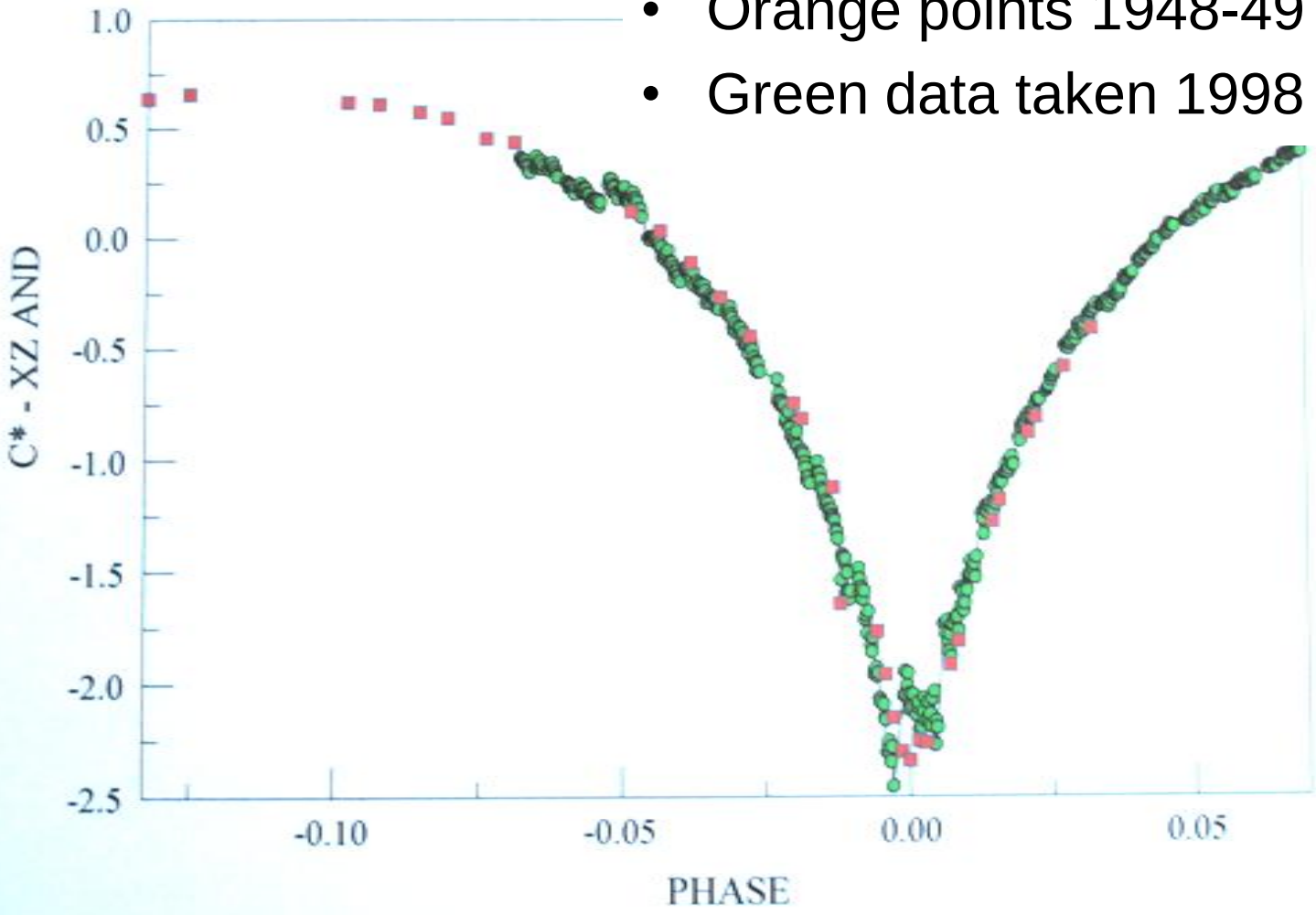


Рис. 1. Кривые блеска V 1500 Лебедя в синих лучах, наблюдавшиеся в Пенсильвании в сентябре 1975 г. Масштаб, общий для всех четырех графиков, показан в правом нижнем углу. Кривые блеска не согласованы ни по времени, ни по фазе

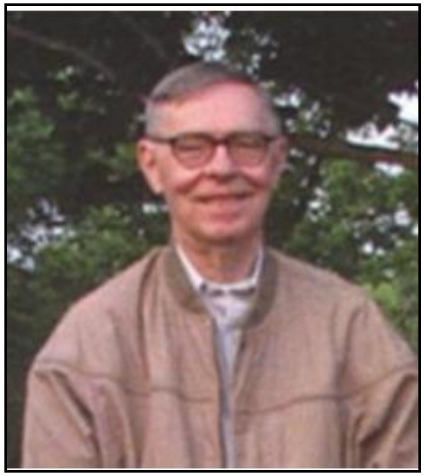
PBPHOT Photometric Productivity

- XZ And has over a 2.5 mag deep minimum
- Orange points 1948-49
- Green data taken 1998



Other key PBPHOT Contributors

- Robert H. Koch
- Robert E. Smith
- Richard J. Mitchell



Summary

- PBPHOT was innovative for its time
- Product of collaboration and ultimately the perseverance of Bill Blitzstein (d. Feb. 27,1999)
- Dual-channel photometry, as implemented, was optimal for Eastern observatory near city lights, a difficult photometric environment!
- PBPHOT productively incorporated dual-channel pulse-counting methods for over 50 years → lights out in 2007!
- A landmark automated photometer!