

# **Public supernova surveys with the Zwicky Transient Facility**

Daniel Perley (LJMU)

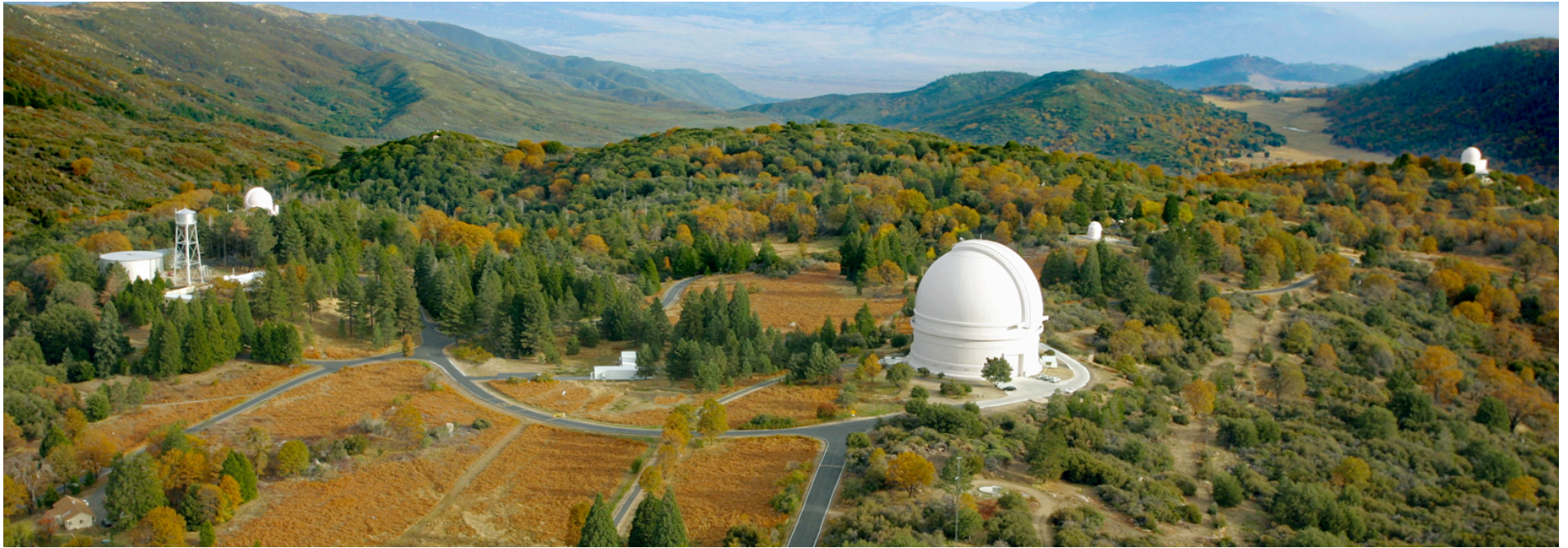
Some slides courtesy Eric Bellm (U Washington)

# Palomar Transient Factory

- The Palomar Transient Factory (PTF) was an **wide-field optical transient survey** led by Caltech, employing the 48" Schmidt at Palomar Observatory.



# Palomar Transient Factory





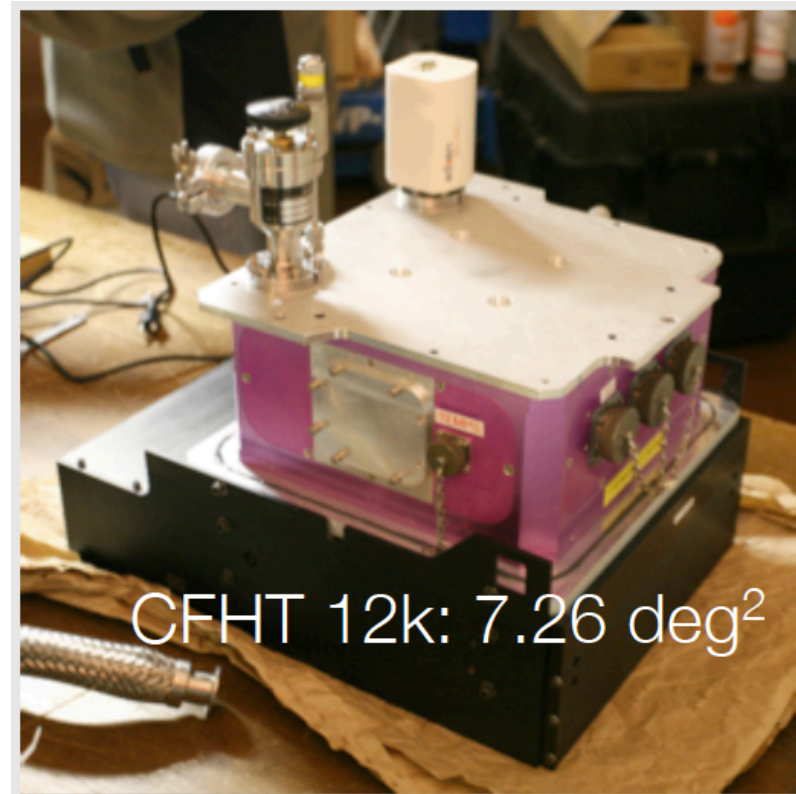
# Palomar Transient Factory



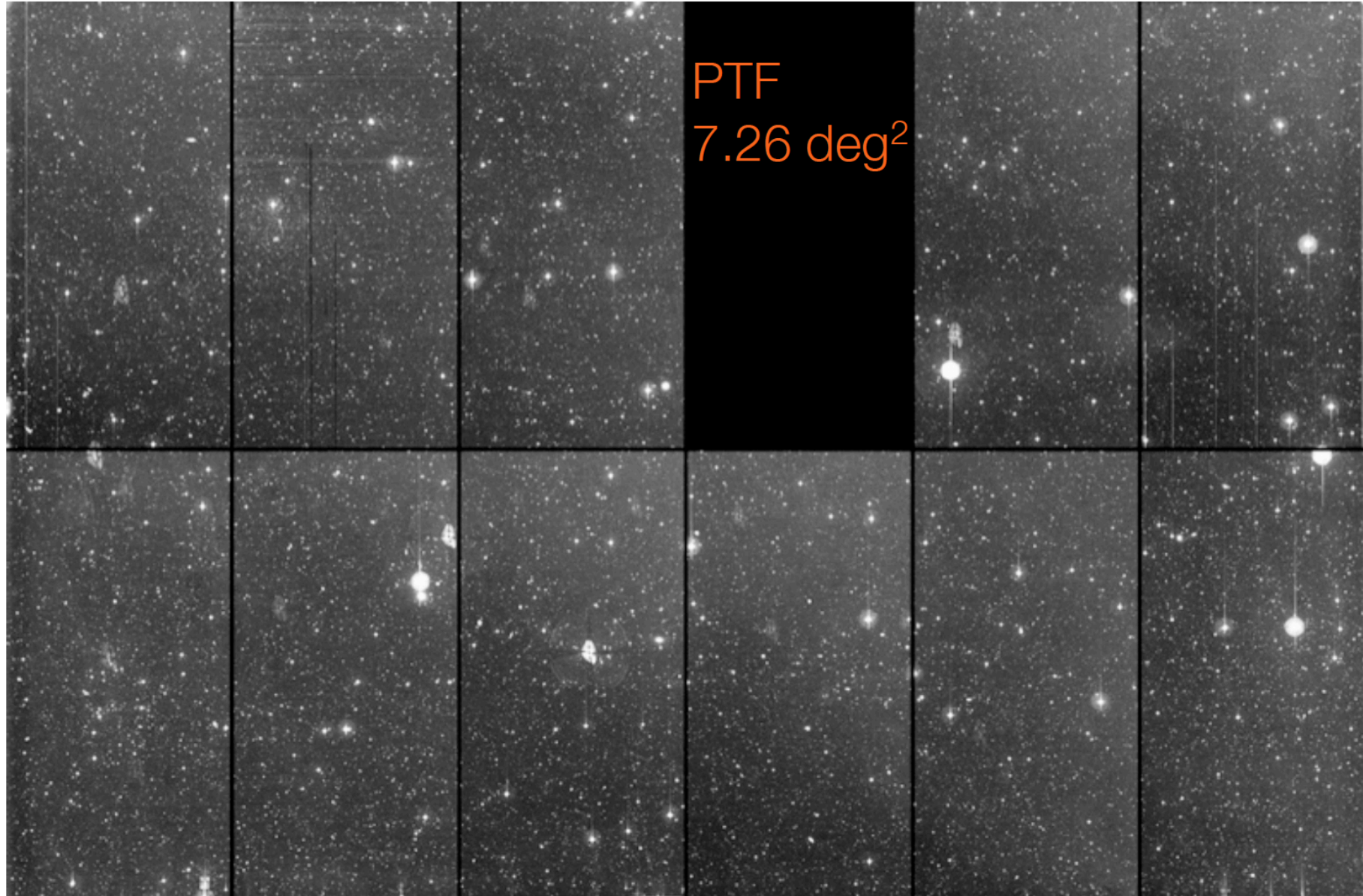


# Palomar Transient Factory

- PTF employed a hand-me-down 12k detector from CFHT, covering 7.8 sq. deg behind the Schmidt 48" at Palomar.



# Palomar Transient Factory



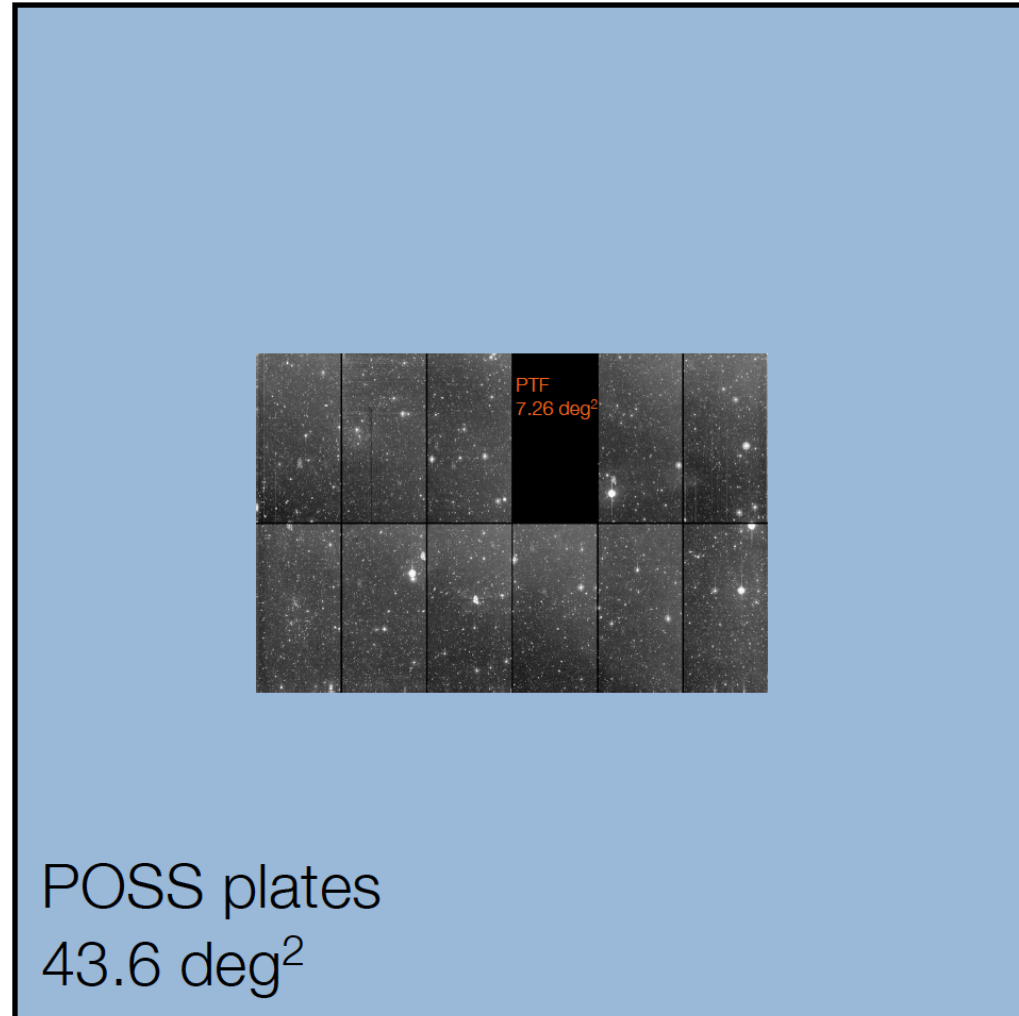


# Palomar Transient Factory

- Ran from 2009 until (January) 2017
  - “PTF”: 2009-2012, original consortium
  - “IPTF”: 2013-2017, improved software, new consortium (all same hardware)
- Discovered ~3000 (classified) supernovae
- Private project (with some public support for data archiving)
- 7.8 square degrees, limiting magnitude  $R \sim 20.6$

# Palomar Transient Factory

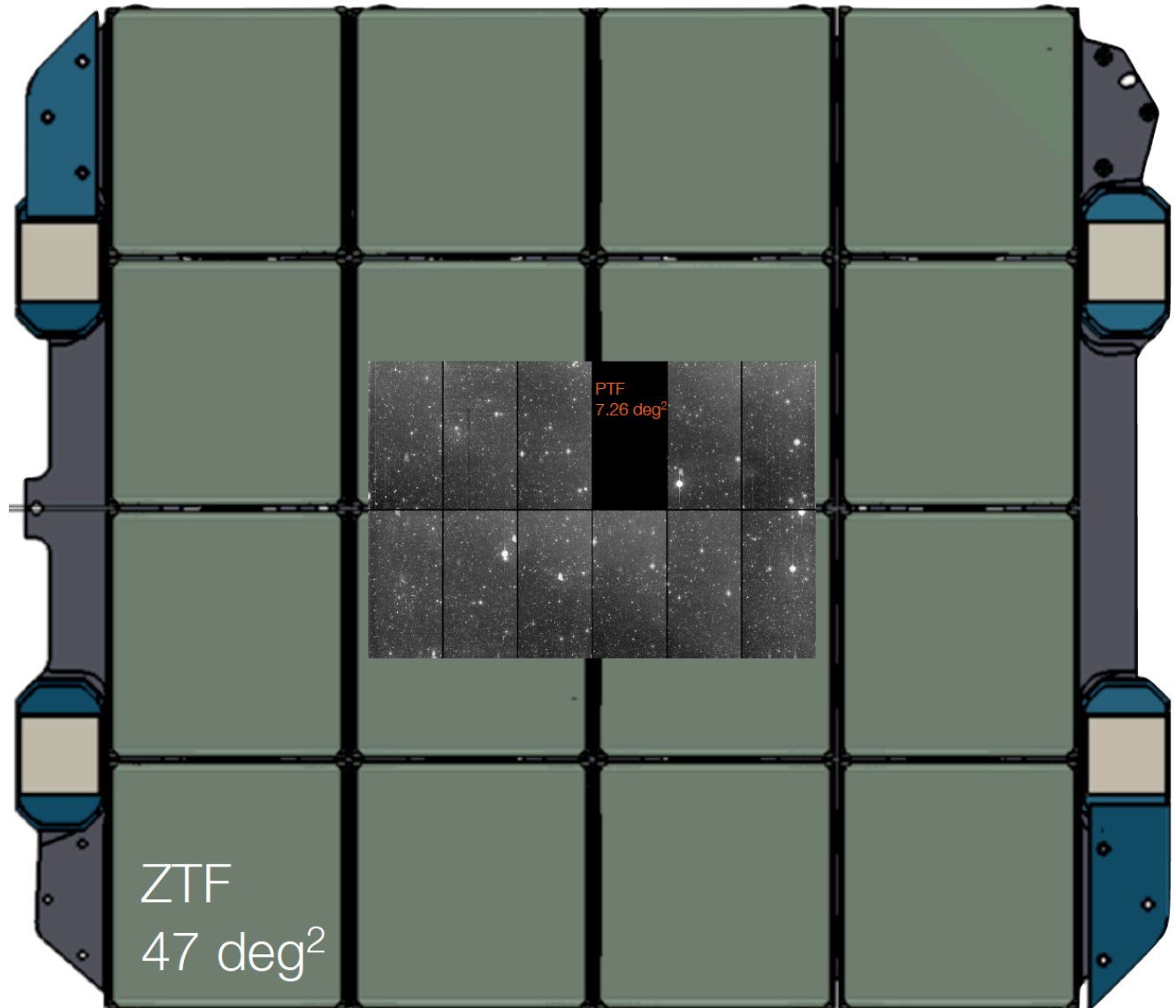
- PTF used only a small fraction of the available focal plane...





# Zwicky Transient Facility: Camera

- ZTF's camera increases the survey area by a factor of  $\sim 7$ .



# Zwicky Transient Facility: Electronics

- Additionally, an upgraded controller improves the readout speed from 36 seconds to **~10 seconds**.
- Improved efficiency and shorter exposures will enable even more areal coverage!





## ZTF: Schedule

- February 2017: CFHT12k camera removed, commissioning begins
- September 2017: First on-sky test images
- 1 November 2017: Official first light
- February 2018: Target start of survey operations

# Private/Public Partnership

- ZTF is **both** a private and a public survey.
  - Funded by the consortium and by a National Science Foundation MSIP grant.
- The time will be divided (nightly) between **partnership time** (proposed for by partner institutions; data and alerts not available to public) and **public time** (alerts, and eventually data, available to all)

# Public Surveys

- The public time is for two surveys:
- “**Celestial Cinematography**”, a once every 3-4 night sweep of the extragalactic sky.
- “**Galactic Plane Survey**”: a nightly sweep of the Galactic plane.

# ZTF Supernova Surveys

- We can expect a truly enormous number of (spectroscopically accessible!) transients:

Mag limit	SNE / year	Ia	Others
17	155	120	35
17.5	300	235	65
18	585	460	125
18.5	1130	890	240
19	2220	1750	470
19.5	4370	3440	940
20	8500	6650	1850
20.5	16500	13000	3500

This requires prioritization...



# ZTF Supernova Survey

- The unique angle of ZTF's public survey is **demographics**. We will be attempting to build **complete** samples of SNe from two subsamples:

## **Flux-limited survey**

(all ZTF SNe with inferred  $m_{\text{peak}} < 18.3$ )

## **Volume-limited survey**

(all ZTF SNe in galaxies at  $< 200$  Mpc)

# Flux-limited Survey Science

With the flux-limited survey we hope to:

- Obtain a gold-standard Ia sample
- Constrain the fraction of star-formation in uncatalogued dwarf galaxies, and the fraction of stellar mass in satellites, the IGM, etc.
- Provide an unbiased estimate of the dependence of common and rare SN types on environment (e.g. host luminosity)
- Identify any new, nearby SLSNe from early times

# Flux-Limited Survey Rates

- Even cutting at 18 mag requires 10+ spectra every week! How will we keep up?

Mag limit	SNE / year	Ia	Others
17	155	120	35
17.5	300	235	65
<b>18</b>	<b>585</b>	<b>460</b>	<b>125</b>
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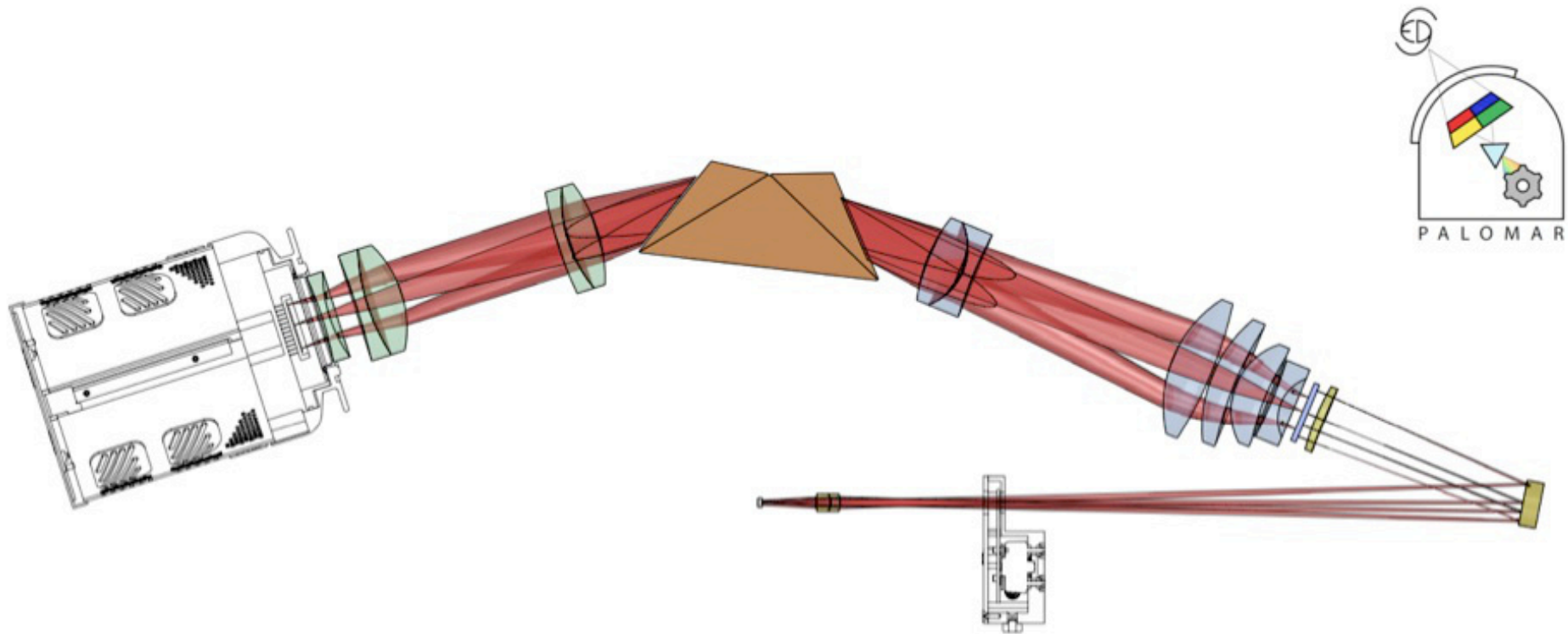
# Palomar 60-inch Telescope





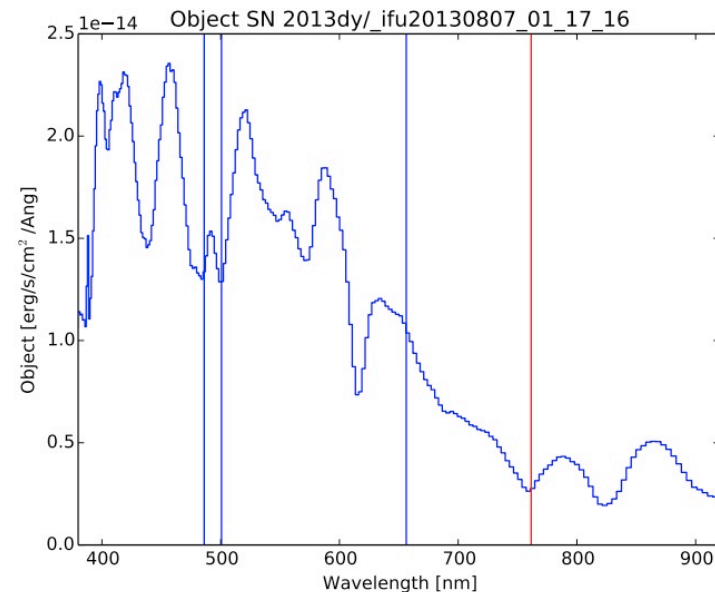
# SED Machine

- Classification is available from a low-resolution ( $R \sim 100$ ;  $\Delta\lambda \sim 50 \text{ \AA}$ ) IFU spectrograph on P60 ( $m_{\text{lim}} \sim 18.5$ )



# Classification for Flux-Limited Survey

- We are planning to request ~2 hours per night (4 spectra), every night, of P60 time to obtain spectra of all 18-mag transients.
- The classifications will be released **instantly** to the world community via ATEL.
- If classification fails or is ambiguous we will turn to other facilities (LT) or the community.



# Volume-Limited Survey Science

Science for the volume-limited survey:

- The rates of faint cc-SNe and the cc-SN luminosity function
- Rates of faint Ia's ("Iax")
- Rates and environments of SN impostors
- Discovery of exotic low-luminosity transients

## Classification for Volume-Limited Survey

- Many SNe in the volume-limited survey will also be bright (can use SEDM)
- The most interesting will **not**.
- ZTF mag limit ensures  $<20.5$  mag. Will use Liverpool Telescope and classical resources (Palomar 200-inch, Keck).
- Community involvement is likely necessary (TBD!)



**ZTF is almost here!**

