

Palomar Observatory

Moving Astronomy with the HPWREN

Patrick Shopbell

(with contributions from Christoph Baranec, Jon Swift, Mansi Kasliwal, and
Jennifer Milburn)

Palomar Observatory

- Constructed in 1948
- Run by the California Institute of Technology; ~25 employees on-site in the mountains north of San Diego
- Cornerstone 200-inch Hale Telescope; still among the largest in the world
- Smaller telescopes including automated (robotic) 48-inch Schmidt and 60-inch

Astronomy in the 21st Century

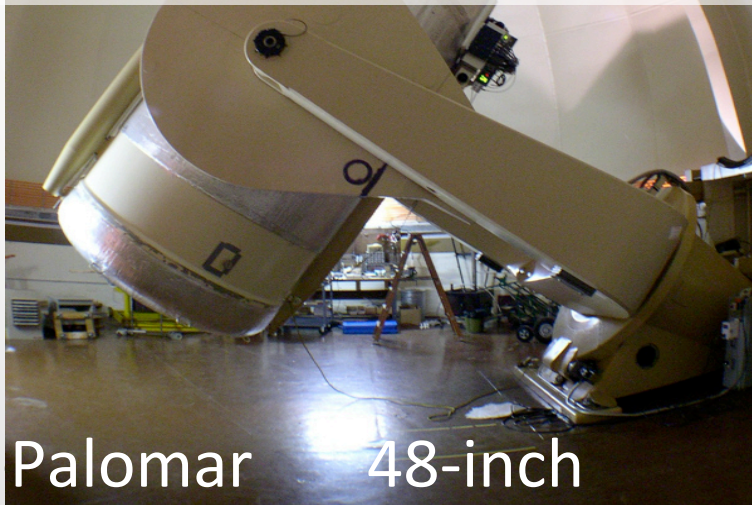
- Increasingly data-driven: new projects and instruments talk in terms of petabytes(!) of data over their lifetimes
- Instrument capabilities and detector sizes increasing just like IT resources: not only your personal digital camera has 10^7 pixels!
- Growing field: time-domain astronomy – analyze temporal variations in astronomical sources; implies monitoring large portions of the sky at frequent intervals
- New technologies also invigorating the 60-year-old observatory: Adaptive Optics (AO), remote operations
- For various projects, network requirements include **adequate bandwidth, low latency, and reliability.**

Palomar Transient Factory

A wide-angle, high cadence survey dedicated to systematically chart the transient sky.



Discovery Machine +

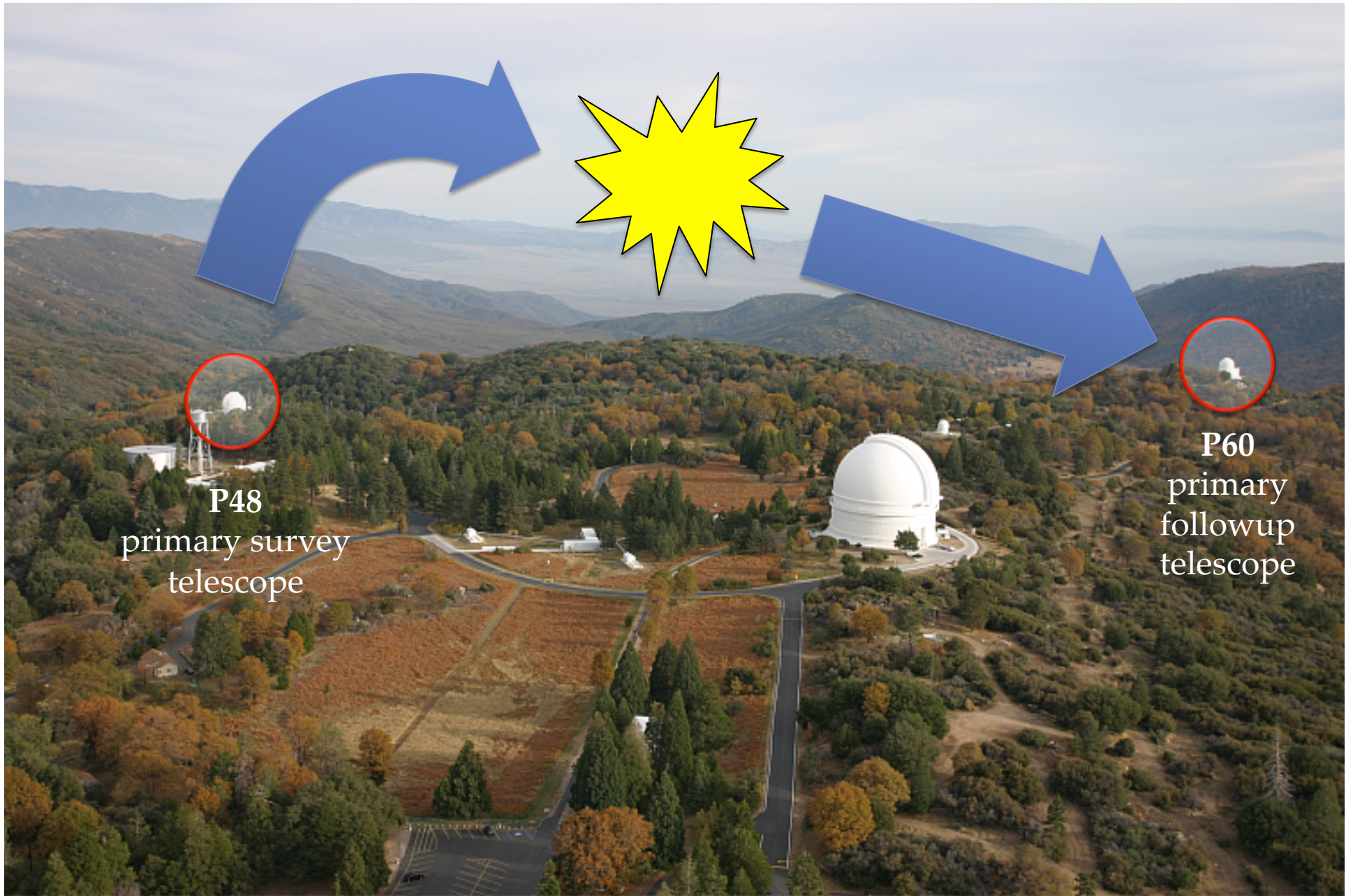


Palomar 48-inch



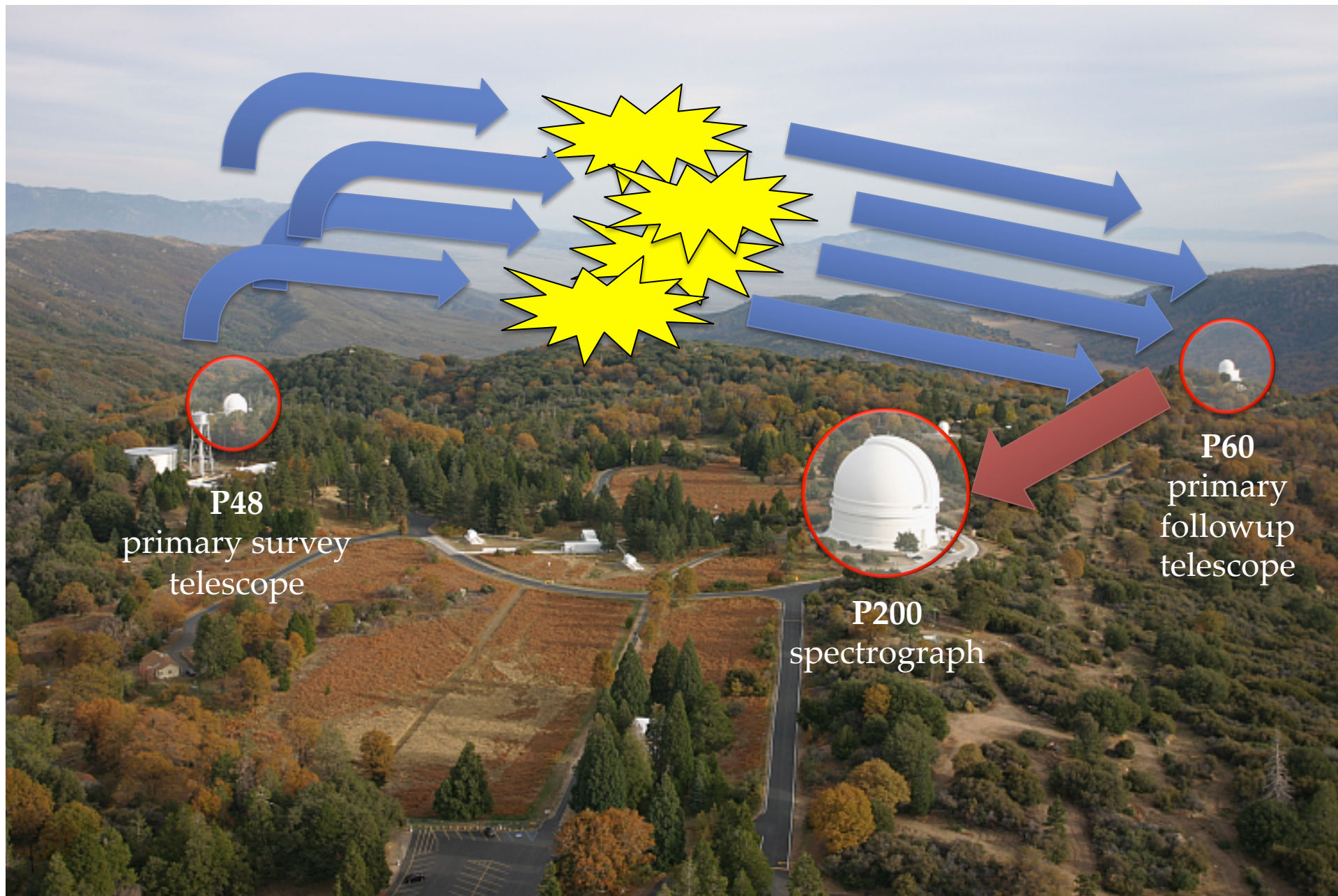
Classification Engine

Palomar 60-inch



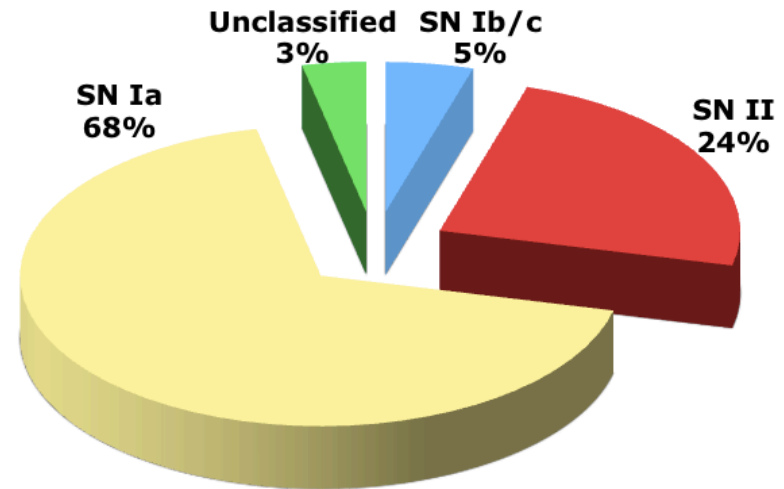
P48
primary survey
telescope

P60
primary
followup
telescope



The PTF Scorecard

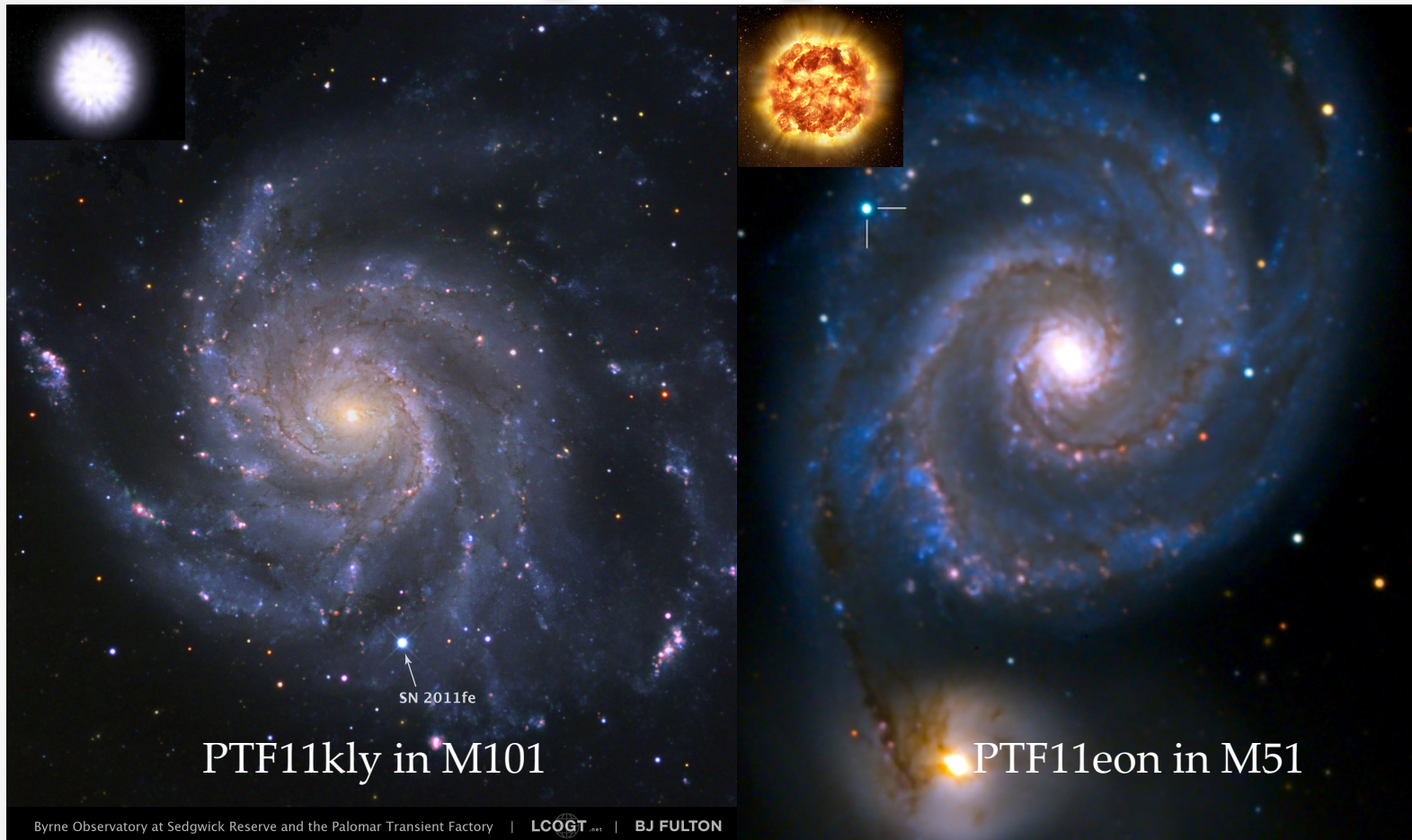
1. PTF11eon/SN2011dh: Discovery of a Type IIb Supernova from a Compact Progenitor in the Nearby Galaxy M51 (ApJL)
2. The Subluminous and Peculiar Type Ia Supernova PTF 09dav;
3. An extremely luminous panchromatic outburst from the nucleus of a distant galaxy (ApJ)
4. PTF10iya: A short-lived, luminous flare from the nuclear region of a star-forming galaxy (MNRAS)
5. PTF 10bzf (SN 2010ah): a broad-line Ic supernova discovered by the Palomar Transient Factory (ApJ)
6. Real-Time Detection and Rapid Multiwavelength Follow-up Observations of a Highly Subluminous Type II-P Supernova from the Palomar Transient Factory Survey (ApJL)
7. The Extreme Hosts of Extreme Supernovae (ApJ)
8. Evidence for an FU Orionis Outburst from a Classical T Tauri Star (ApJ)
9. PTF10nvg: An Outbursting Class I Protostar in the Pelican/North American Nebula (AJ)
10. Hubble Space Telescope Studies of Nearby Type Ia Supernovae: The Mean Maximum Light Ultraviolet Spectrum and its Dispersions (ApJ)
11. Galaxy Zoo Supernovae (MNRAS)
12. Rapidly Decaying Supernova 2010X: A Candidate ".Ia" Explosion (ApJL)
13. Supernova PTF 09uj: A Possible Shock Breakout from a Dense Circumstellar Wind (ApJ)
14. The Palomar Transient Factory Survey Camera: 1st Year Performance and Results (SPIE)
15. PTF10fq: A Luminous Red Nova in the Spiral Galaxy Messier 99 (ApJ)



**1807+ Discovered & Spectroscopically Classified
Extragalactic Transients**

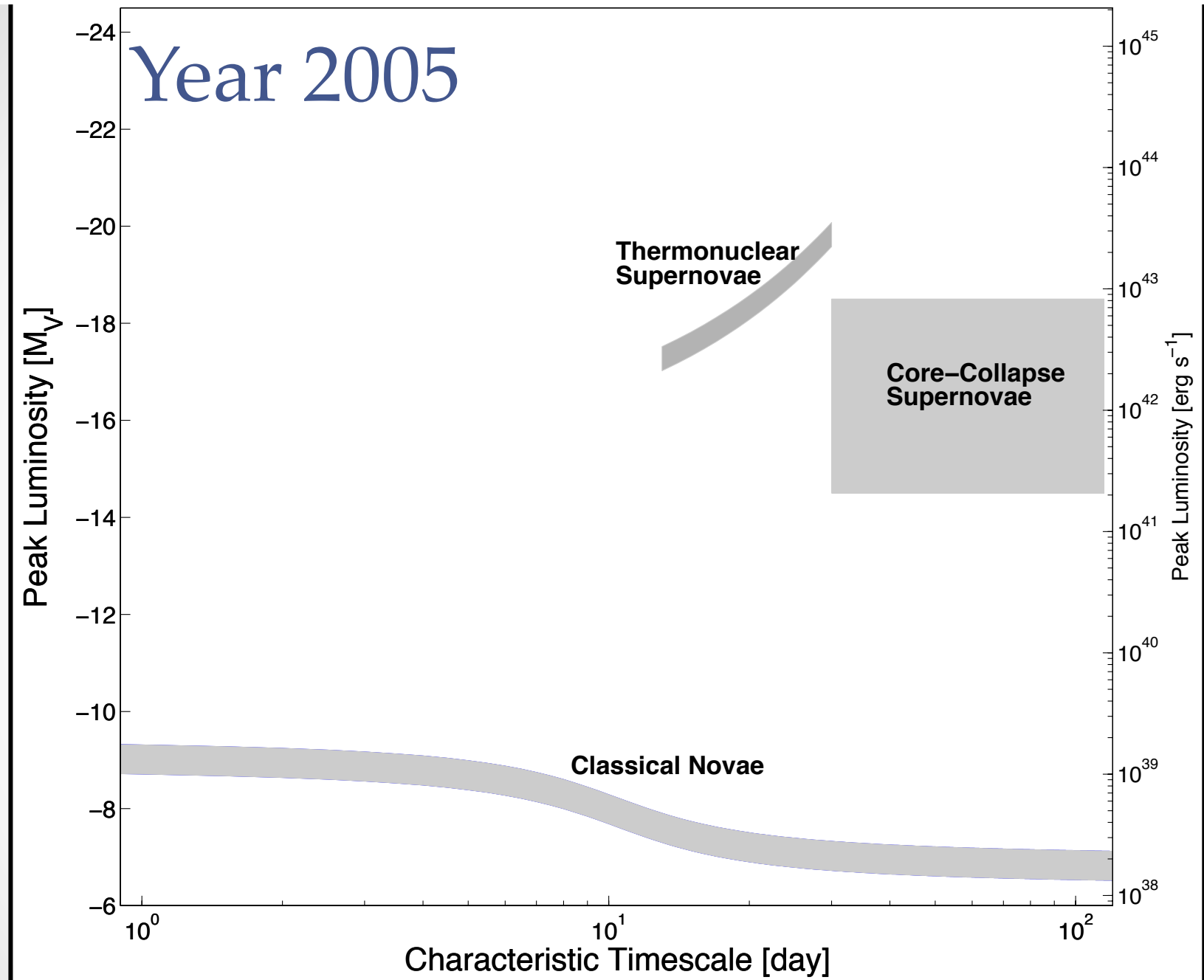
16. Core-Collapse Supernovae from the Palomar Transient Factory: Indications for a Different Population in Dwarf Galaxies (ApJ)
 17. Mysterious transients unmasked as the bright blue death throes of massive stars (Nature)
 18. The Palomar Transient Factory: System Overview, Performance and First Results (PASP)
 19. Exploring the Optical Transient Sky with the Palomar Transient Factory (PASP)
 20. The 12Kx8K CCD mosaic camera for the Palomar Transient Factory (SPIE)
- (AND 14 more.....)

Young Supernovae

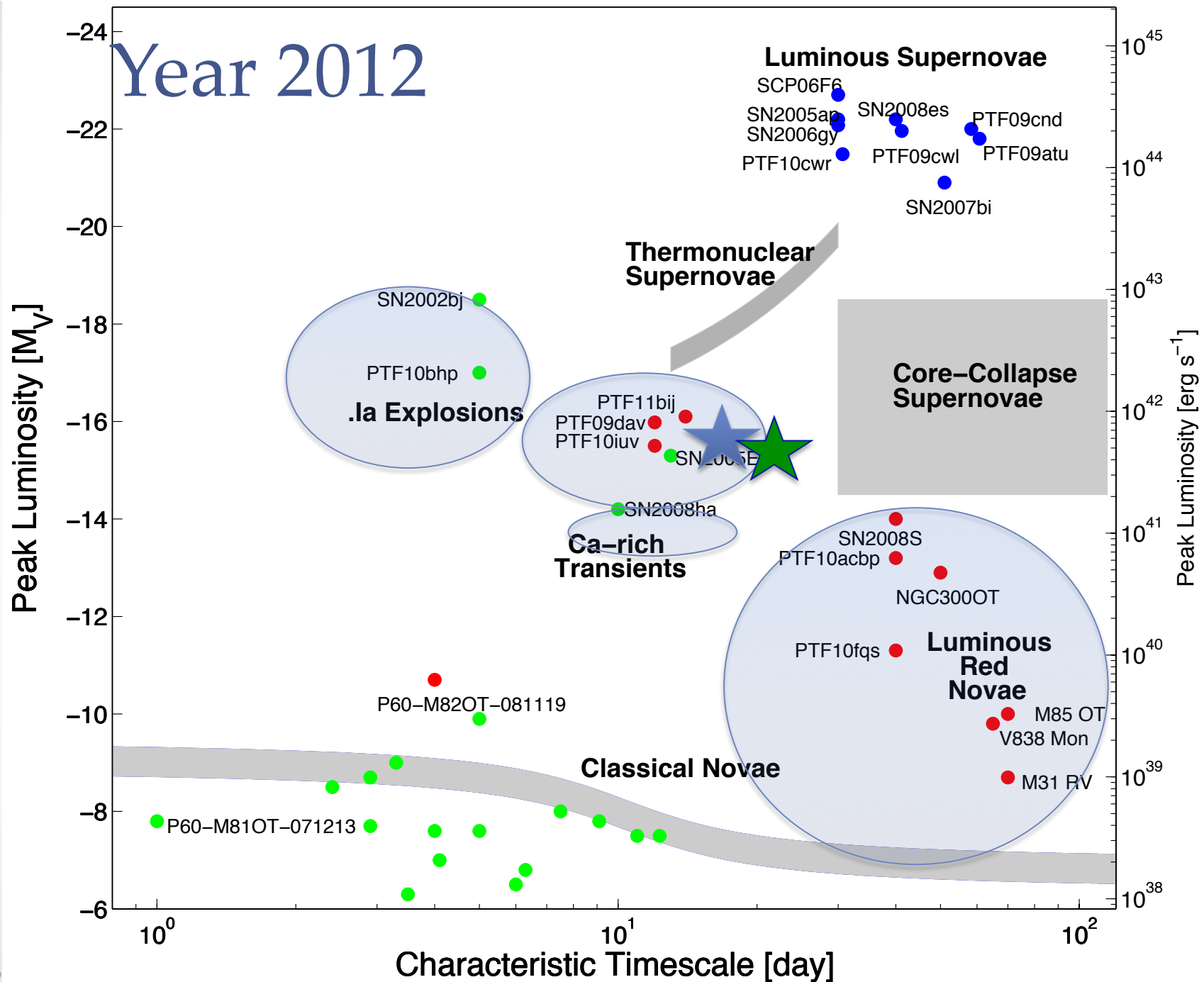


Nugent et al. 2011, Li et al. 2011
Horesh et al. 2012, Bloom et al. 2012 + 20 more

Arcavi et al. 2011, van Dyk et al. 2011
Horesh et al. 2012 + 14 more

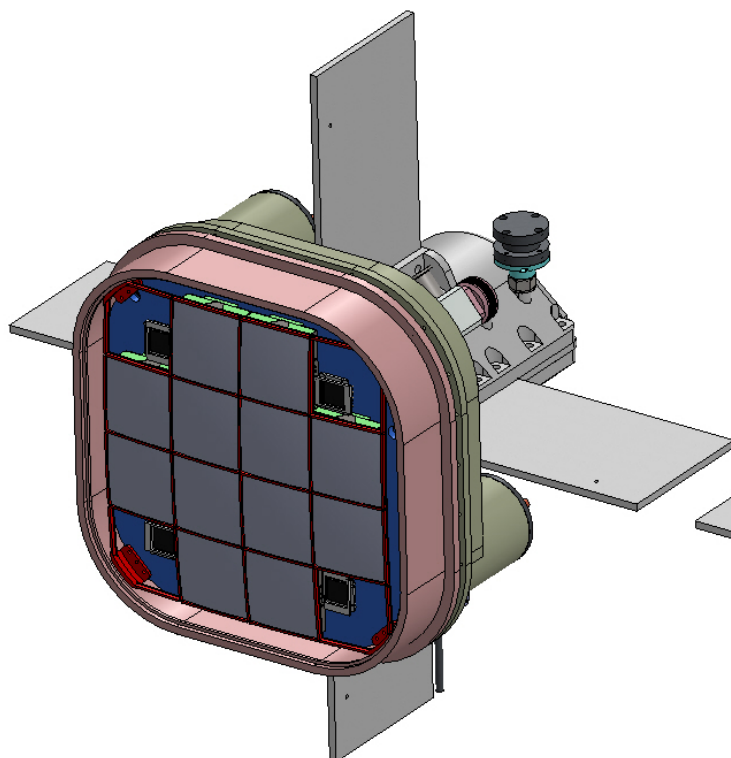


Year 2012

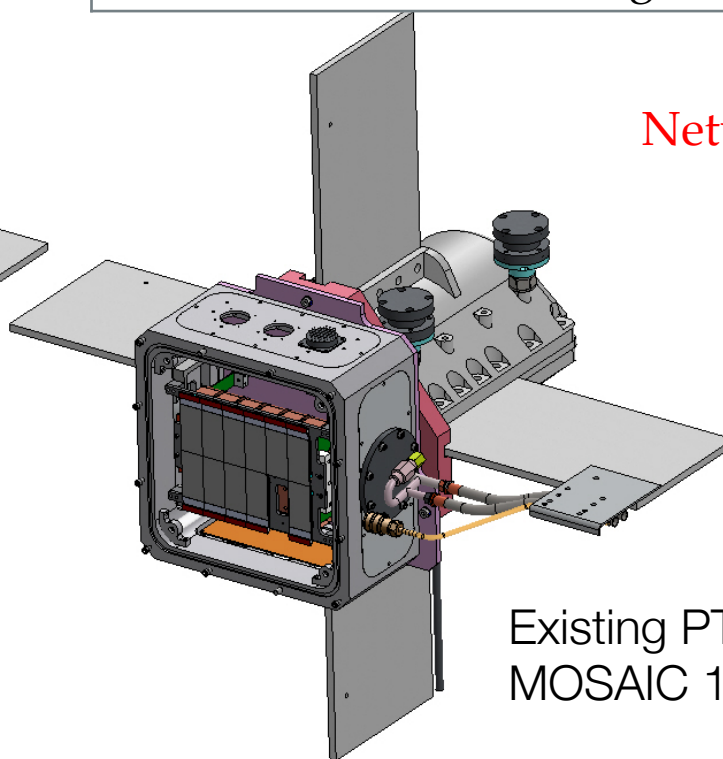


Zwicky Transient Facility (ZTF): 2015

	PTF	ZTF
Active Area	7.26 deg ²	35 deg ²
Readout time	36 sec	10 sec
Survey Rate	1x	9.5x
Filters	R, g'	r', g'



New ZTF camera:
12 6k x 6k e2v CCDs



Existing PTF camera
MOSAIC 12k

Network bandwidth!

Robo-AO: First Light and Operations

Christoph Baranec (PI)

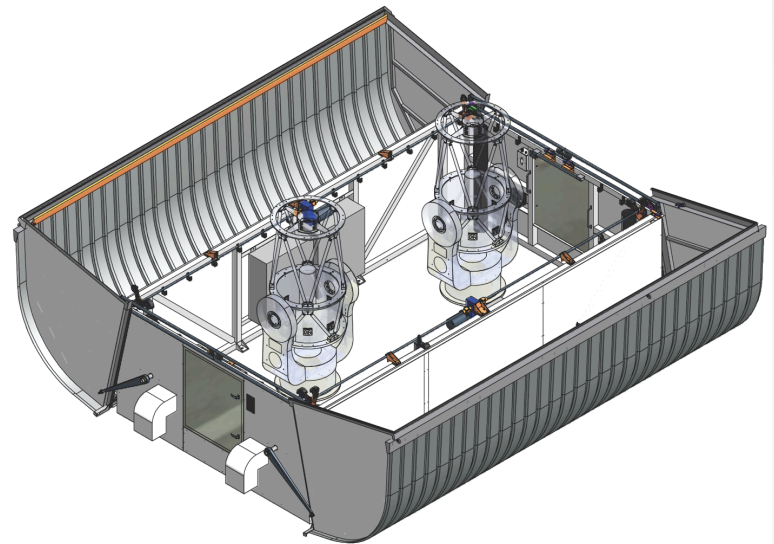


on behalf of the Robo-AO collaboration partners at
the Inter-University Centre for Astronomy and Astrophysics and the California Institute of Technology



Project Minerva: Exoplanet Observatory

- Array of four small-aperture (0.7) robotic telescopes outfitted for both photometry and high-resolution spectroscopy
- Primary science goal: to discover Earth-like planets in close-in (less than 50-day) orbits around nearby stars, and super-Earths (3-15 times the mass of Earth) in the habitable zones of the closest Sun-like stars
- Secondary goal will be to look for transits (eclipses) of known and newly-discovered exoplanets
- Currently under development with initial operation expected in 2013
- Network bandwidth requirement: **moderate**



Palomar Remote Operations

- Many astronomical observatories enabling remote observing by astronomers who are not physically present at the observatory (e.g., Keck, Gemini)
- Telescopes typically in very remote locations (e.g., Hawaii, Chilean mountains) -> saves travel costs and enables observations by those who cannot travel
- Also enables larger and more widely dispersed groups of astronomers to collaborate, including more student involvement
- Palomar approach uses VNC sessions to provide remote astronomers access to the instrument controls, from a pair of Remote Observing Facility (ROF) rooms on the Caltech campus
- Network bandwidth requirement: minimal, but **high reliability**

IT Operations at Palomar

- IT efforts at Palomar Observatory are directed by the on-campus team who manages IT for the Caltech Astronomy Department
- Efforts currently underway:
 - Replacement of aging (10-15 yrs) 3-pair fiber network with new 12-pair fiber network to connect all onsite office and telescope structures
 - Ongoing firewall configuration for increased security, including VPN and private network (NAT) support
 - Ongoing WAP upgrades to better secure the wireless infrastructure
 - Development of upgrade and maintenance procedures which will balance the need for security and reliability with the frequent requirement of long-term stability of observing hardware and software
 - Enabling a more complex network VLAN structure on our Cisco network infrastructure, to enable more secure network operations (e.g., isolate telescope control systems from infrastructure Wi-Fi).