

LCOGT and iPTF

Andy Howell

Iair Arcavi

Stefano Valenti

Griffin Hosseinzadeh

Las Cumbres Observatory
Global Telescope Network

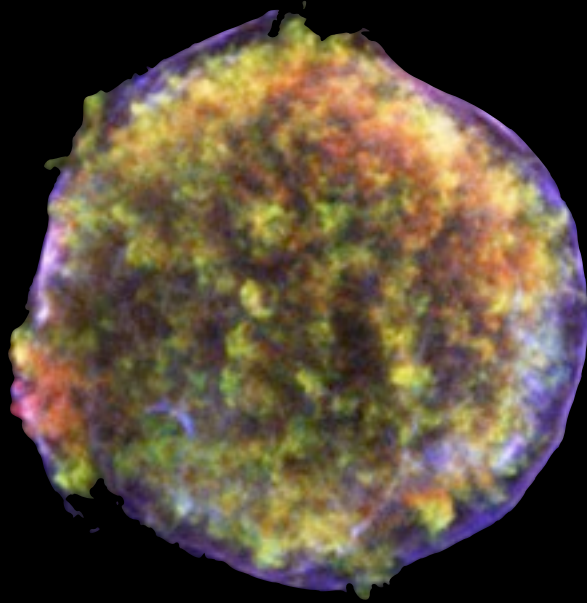
University of California
Santa Barbara



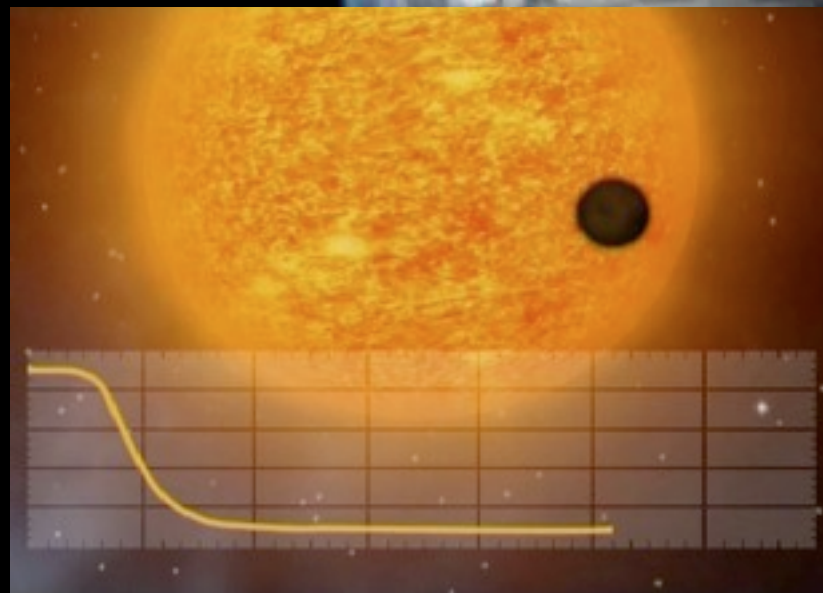
Solution: a global robotic network of telescopes. Spaced around the globe in longitude, hemisphere so that it is always dark or clear somewhere.

We keep you in the dark.

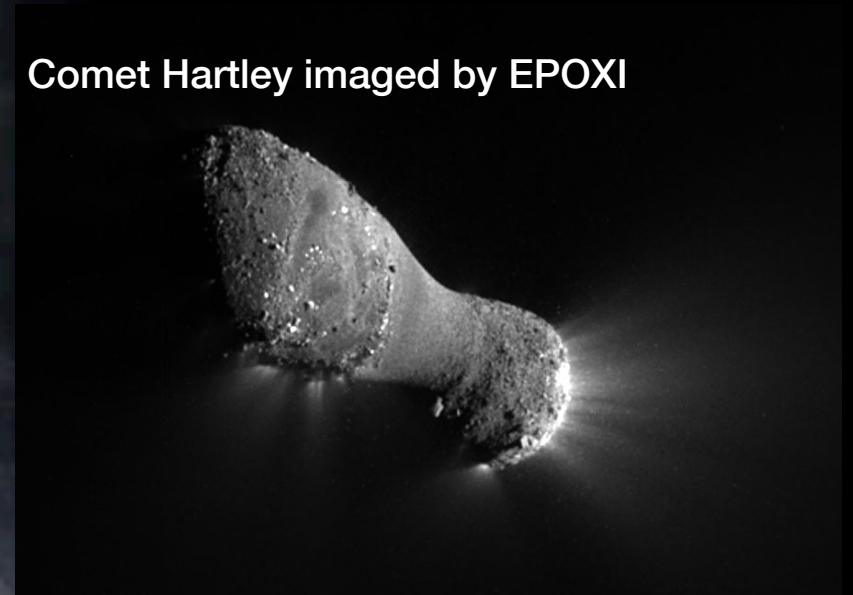
Focus on variability, especially:



Supernovae /
Dark Energy



Extrasolar planets

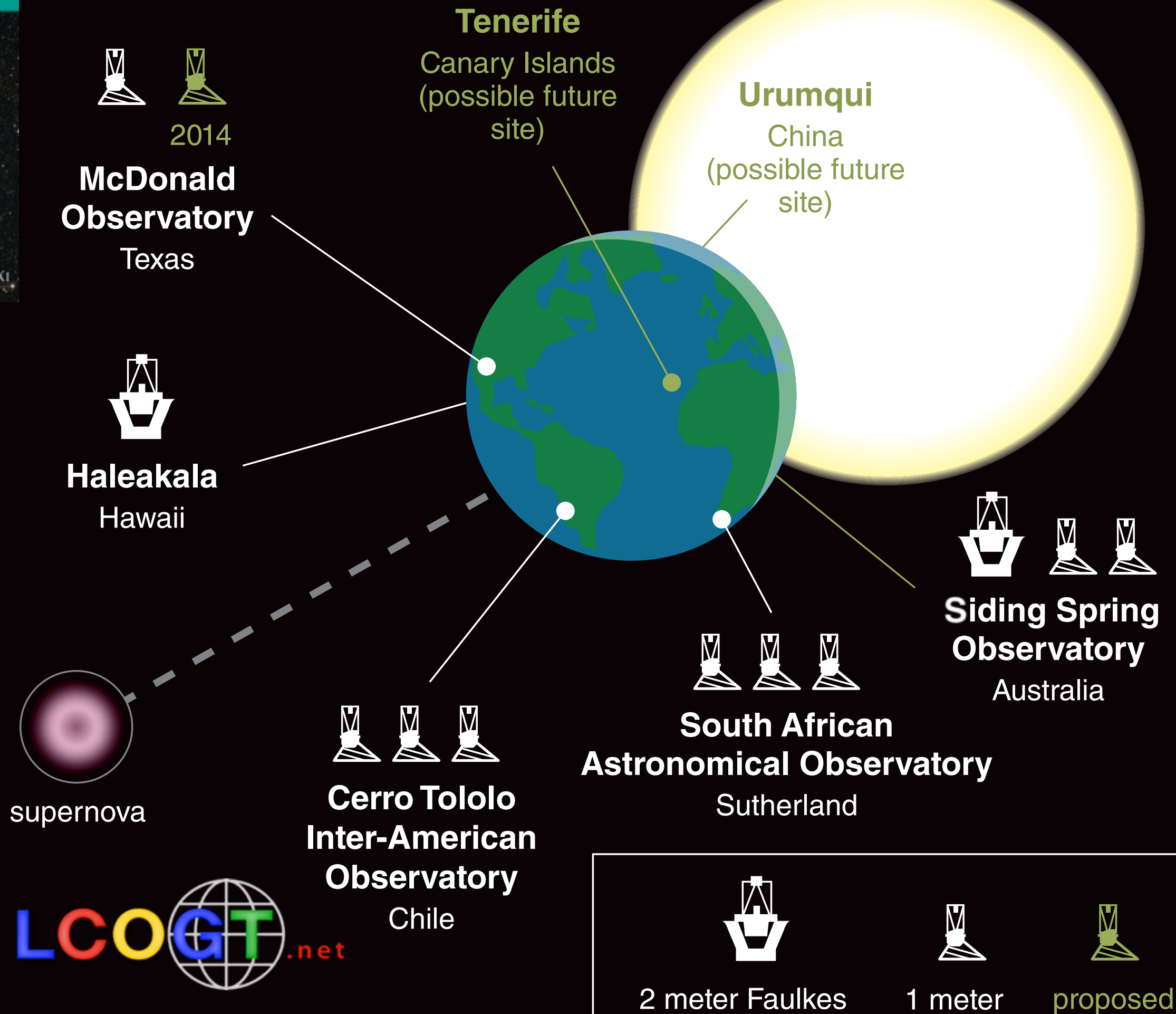


Comet Hartley imaged by EPOXI

Solar system objects



From July/
Aug 2013
**American
Scientist**



Nine one meters deployed

SAAO



McDonald Observatory



CTIO

1m Instrumentation

Imaging



At CTIO:
SINISTRO

Elsewhere:
SBIG
imagers



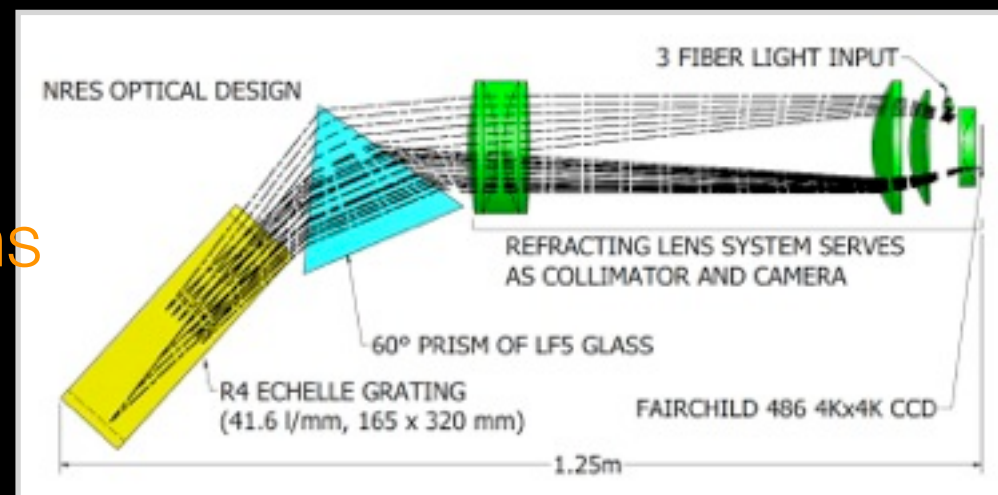
SINISTRO
1st light

Sinistro: 26.4' x 26.4', 0.389"/pixel.
Fairchild CCD486, backside illuminated.
21 position filter wheel, photometric shutter.
16 Mpix; 4 Mpix/s readout at ~10 e-/pix

Spectra

Coming late 2014:
Network Robotic
Echelle Spectrographs
(NRES)

High-resolution
($R \sim 53,000$), precise
(≤ 3 m/s), optical
(380-860 nm)
echelle
spectrographs



One at each 1m site (6 total), can be fiber-fed (2.58" per fiber width) by two 1m telescopes and ThAr calibration source

Will double the radial velocity planet-vetting capacity in the US and achieve accuracy better than 3 m/s to $V = 12$
NSF funded. Prototype is Sedgwick 0.8m

2m: FLOYDS robotic low resolution spectrographs

Designed for supernovae

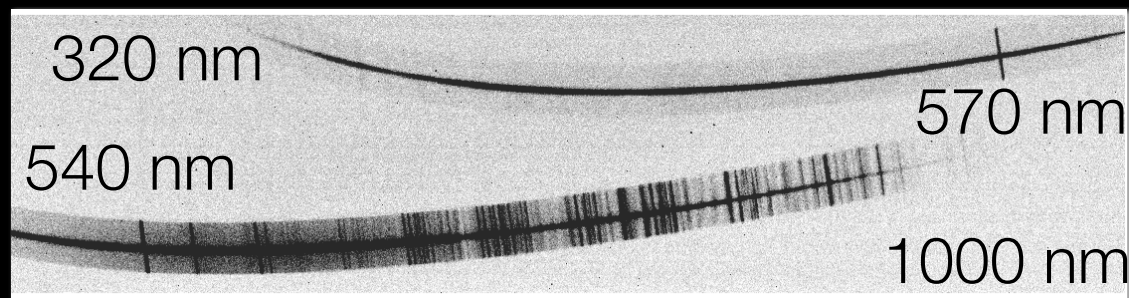
R~400 covering 325nm -- 1000nm in one pointing (cross dispersed).

Can go down to V~20 mag with S/N=10 in 1 hour

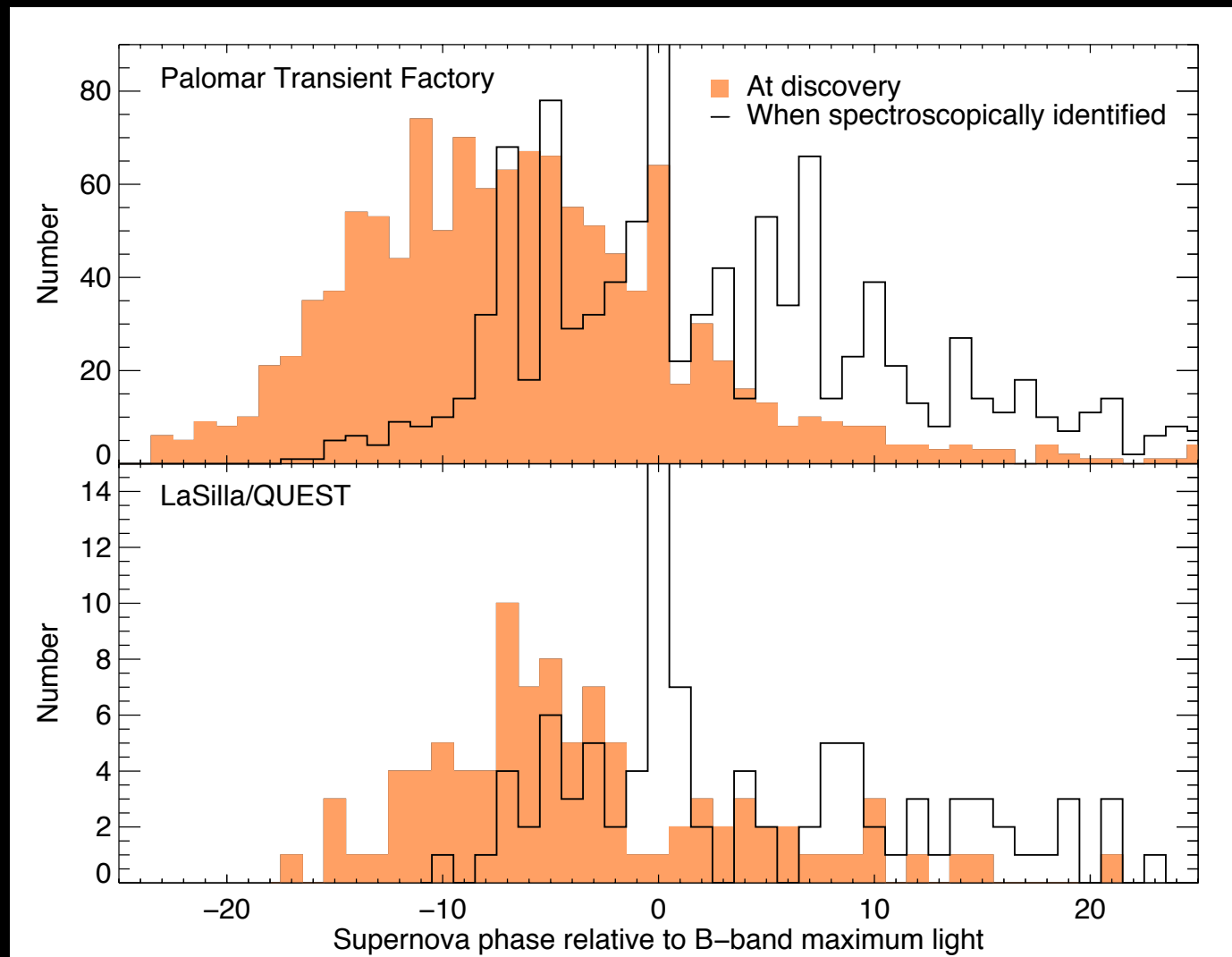


One on each 2m: Faulkes North and South

Spectrographs are in regular nightly operation.
Pipeline reduces data, types SN 40s after readout.



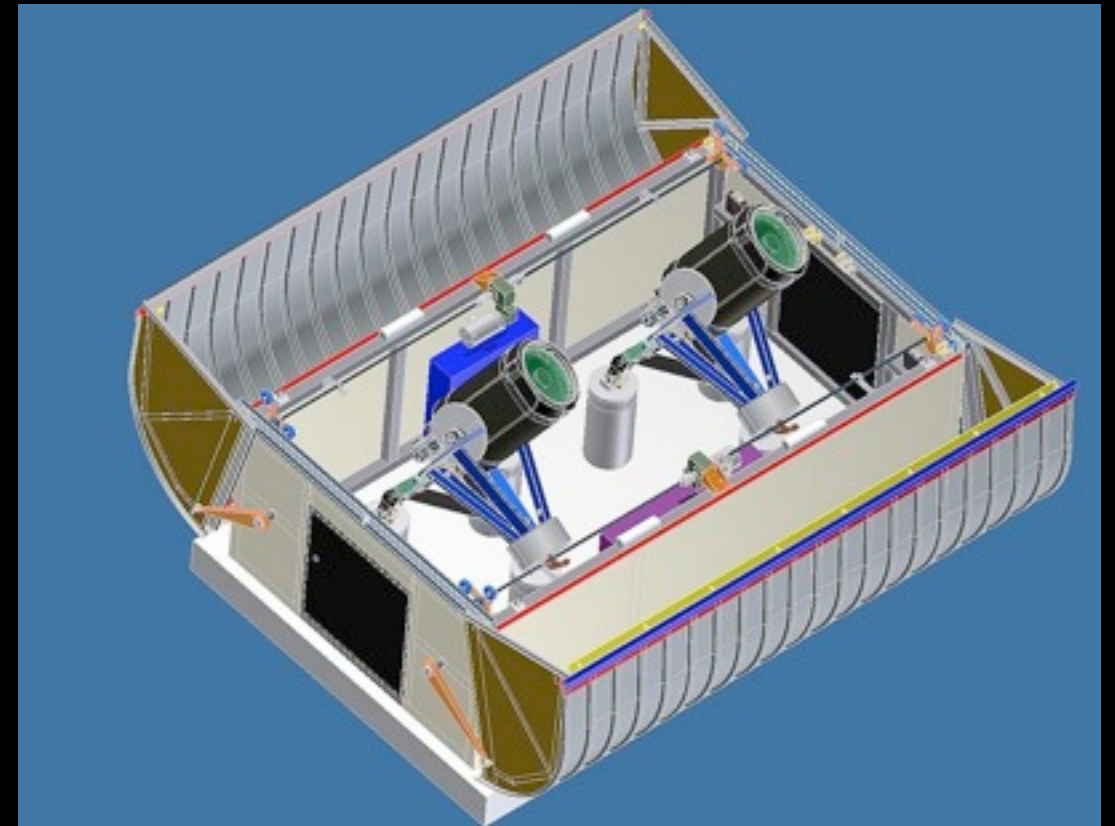
Built by Dave Sand and engineers at LCOGT



0.4m telescopes

For commercial, science, and educational use.

Up to 24 total, deployed in clusters of 2-4 at each site, contingent on funding



Phase 1: testing of a single 0.4m at CTIO

Phase 2: deployment of 4 more 0.4m

Phase 3: deployment of 10 more 0.4m

As of May 1

All LCOGT telescopes scheduled by the network scheduler.

New GUIs, APIs for scheduling telescopes. User documentation, feedback system in place.

All 1m data served by IPAC.

2m telescopes upgraded to new network Telescope Control System, including new guiding, acquisition routines.

Three Key Projects started: Supernovae (PI: Howell), Microlensing (PI: Street), AGN Reverberation mapping (PI: Horne).

Network is open to external users (i.e. site partners and collaborators).

To Do:

Continued commissioning of FLOYDS.

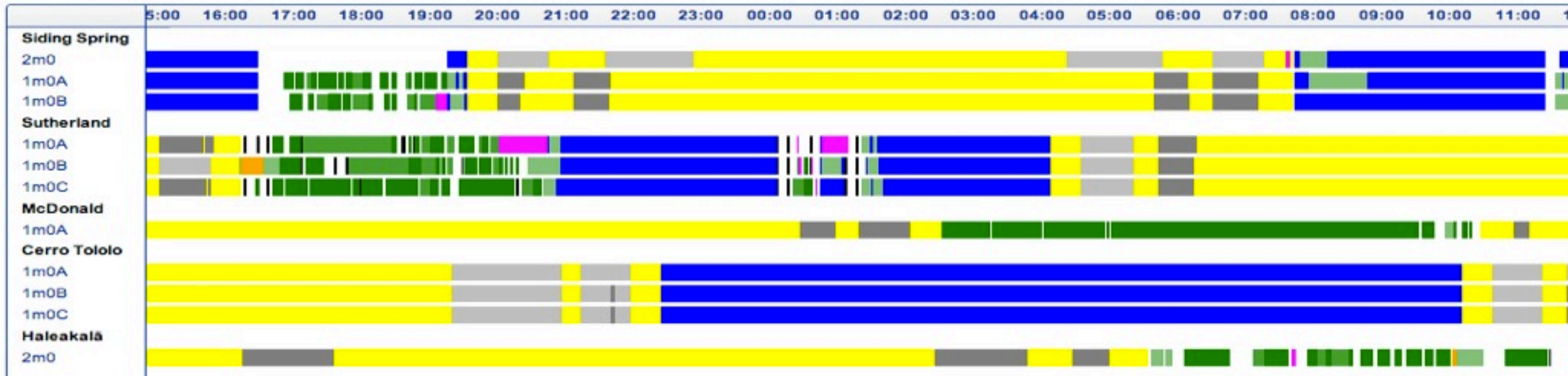
SINISTRO roll-out to other sites besides CTIO.

Network Scheduler

All 11 telescopes scheduled by automated scheduler that solves an optimized whole-network schedule in seconds.

Las Cumbres Observatory Global Telescope Network

Past 24 hours



Next 24 hours



Molecule id:	50807369	Type:	EXPOSE	Priority:	3	Block id:	19984361	Tag id:	SCICOLLAI
User id:	andy.howell	Proposal:	KEY2014A-003	Group:	PSN103448	Instrument:	kb75	Filters:	ip
Exposure time:	300	Exposure count:	2	Status:	completed	Tracking #:	0000045952	Request #:	000011839
Block start:	2014-06-03T17:05:00	Block end:	2014-06-03T17:38:48	Site:	cpt	Observatory:	domc	Telescope:	1m0a
Airmass:	2	Molecule start:	2014-06-03T17:26:52	Molecule end:	2014-06-03T17:37:33				

Supernova Key Project

LCOGT

Iair Arcavi

Andy Howell

Griffin Hosseinzadeh

Stefano Valenti

South Africa

Bruce Bassett

Steve Crawford

Eli Kasai

Roy Maartens

Matthew Smith

Abiy Tekola

University of Colorado

Alexander Conley

Emily Levesque

iPTF

Yi Cao

Avishay Gal-Yam

Ariel Goobar

Mansi Kasliwal

Peter Nugent

Eran Ofek

Robert Quimby

Jesper Sollerman

University of Texas

Howie Marion

Jeffrey Silverman

Jozsef Vinko

Craig Wheeler

LaSilla-QUEST

Charles Baltay

Nan Ellman

Ryan McKinnon

David Rabinowitz

Emma Walker

Australian

National University

Michael Childress

Richard Scalzo

Brian Schmidt

Fang Yuan

Chile?

e.g. Mario Hamuy

Santiago Gonzalez Gaitan

KMTNet

Dae-Sik Moon

Other

Melissa Graham

Eric Hsiao

Mark Phillips

David Sand

China

Guojie Feng

Hubiao Niu

Lifan Wang

Xiaofeng Wang

Other facilities used by the Key Project

Feeder Surveys

Survey	Facilities
iPTF	Palomar 48 (search)
LSQ	La Silla Schmidt
Skymapper	1.3m Skymapper telescope
KMTnet	17% of the time on three 4 sq. deg. 1.6m telescopes for SN Survey.

Also: KAIT, Gaia

Major Followup

Telescope	Ap. (m)	Purpose
NTT	3.6	PESSTO optical and NIR spectra
Keck	10	High and low resolution spectroscopy
Gemini	8	Low resolution optical and NIR spectroscopy
Magellan	6.5	IR spectroscopy
Salt	9.2	Low resolution spectroscopy

Supernova Key Project

Allocation LCOGT time over 3 years:
1m time: 1030 hours / semester
2m time: 250 hours / semester

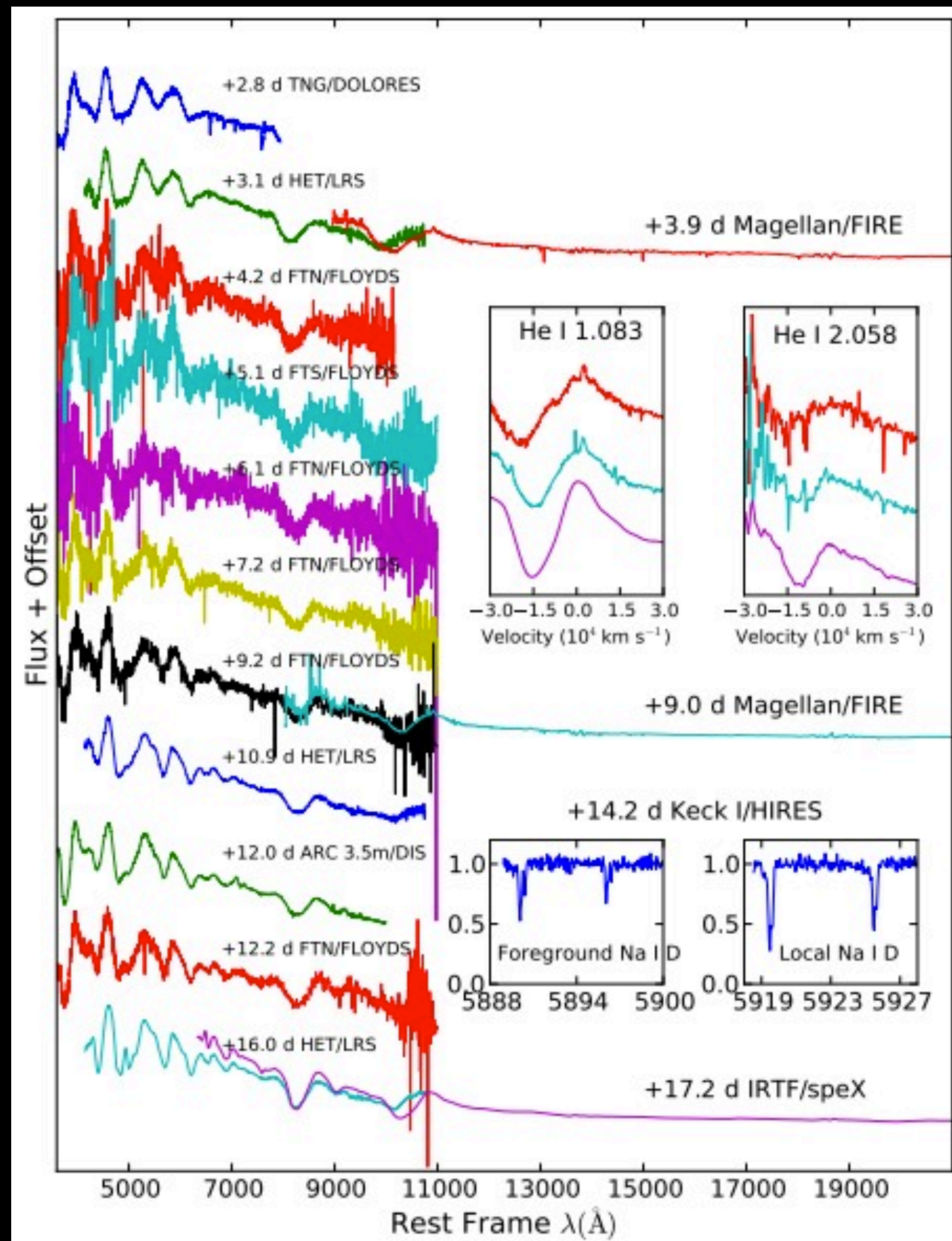
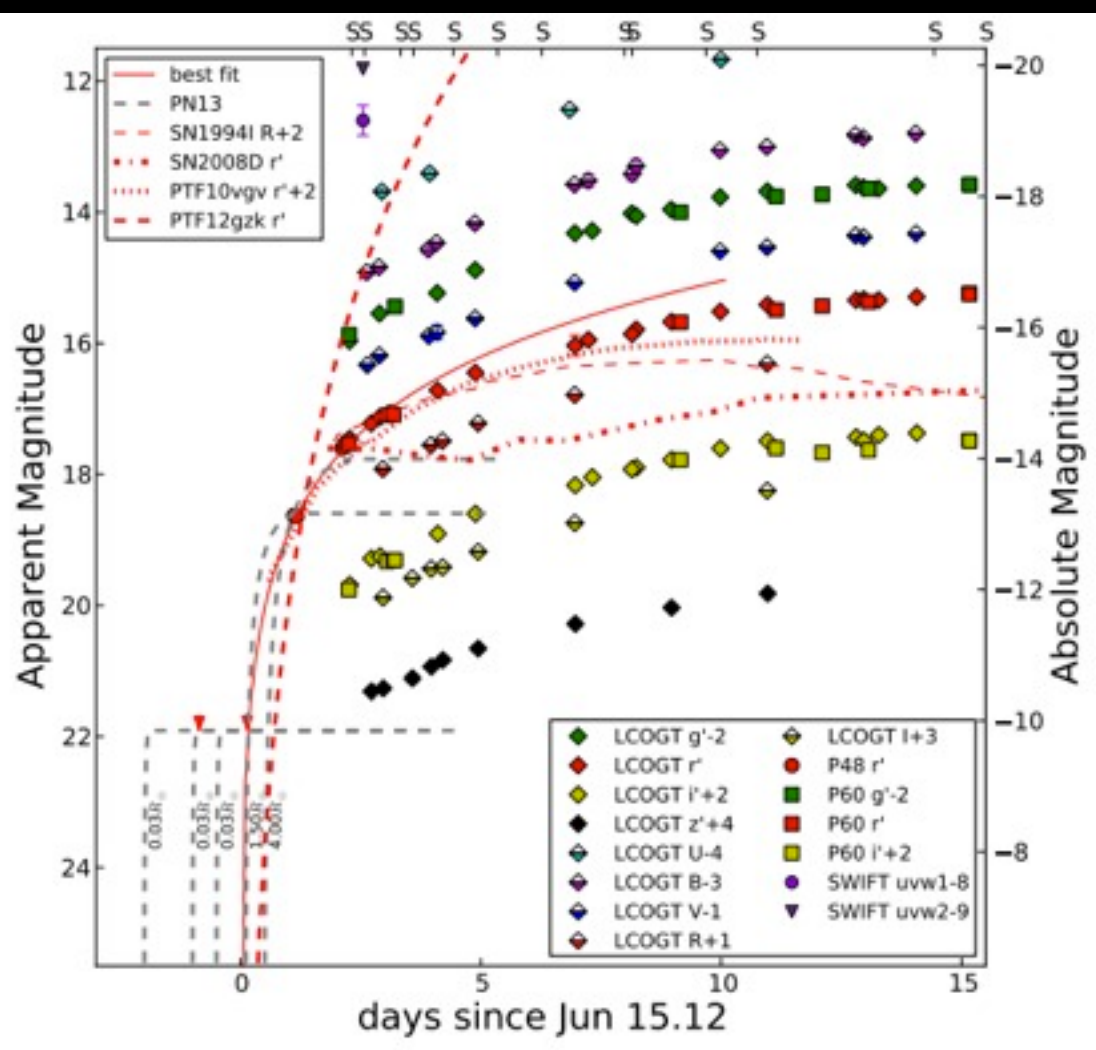
Goals Build a sample of 450 supernovae to:

1. Observe supernovae soon after explosion to search for signs of their progenitors
2. Measure Dark Energy
3. Do statistical population studies
4. Build the first statistical samples of exotic SNe
5. Obtain optical light curves and spectroscopy in support of UV observations, IR imaging and spectroscopy, host galaxy studies, high resolution spectroscopy, and late-time spectroscopy with large telescopes.

iPTF13bvn

Cao et al. 2013

Daily spectra and lightcurves from LCOGT revealed it to be a Type Ib supernova, one where the exploding star has had its outer layer of hydrogen stripped.

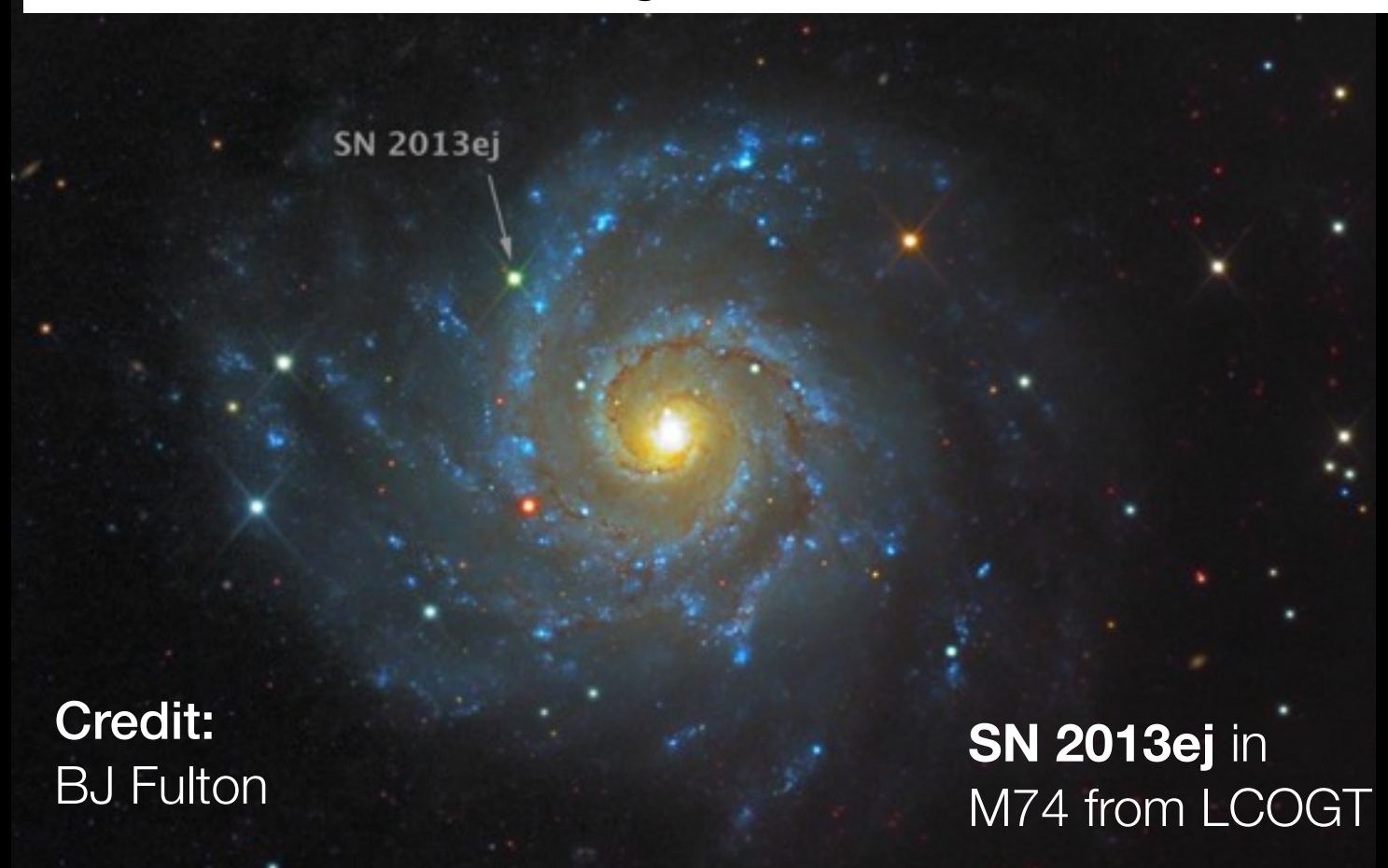
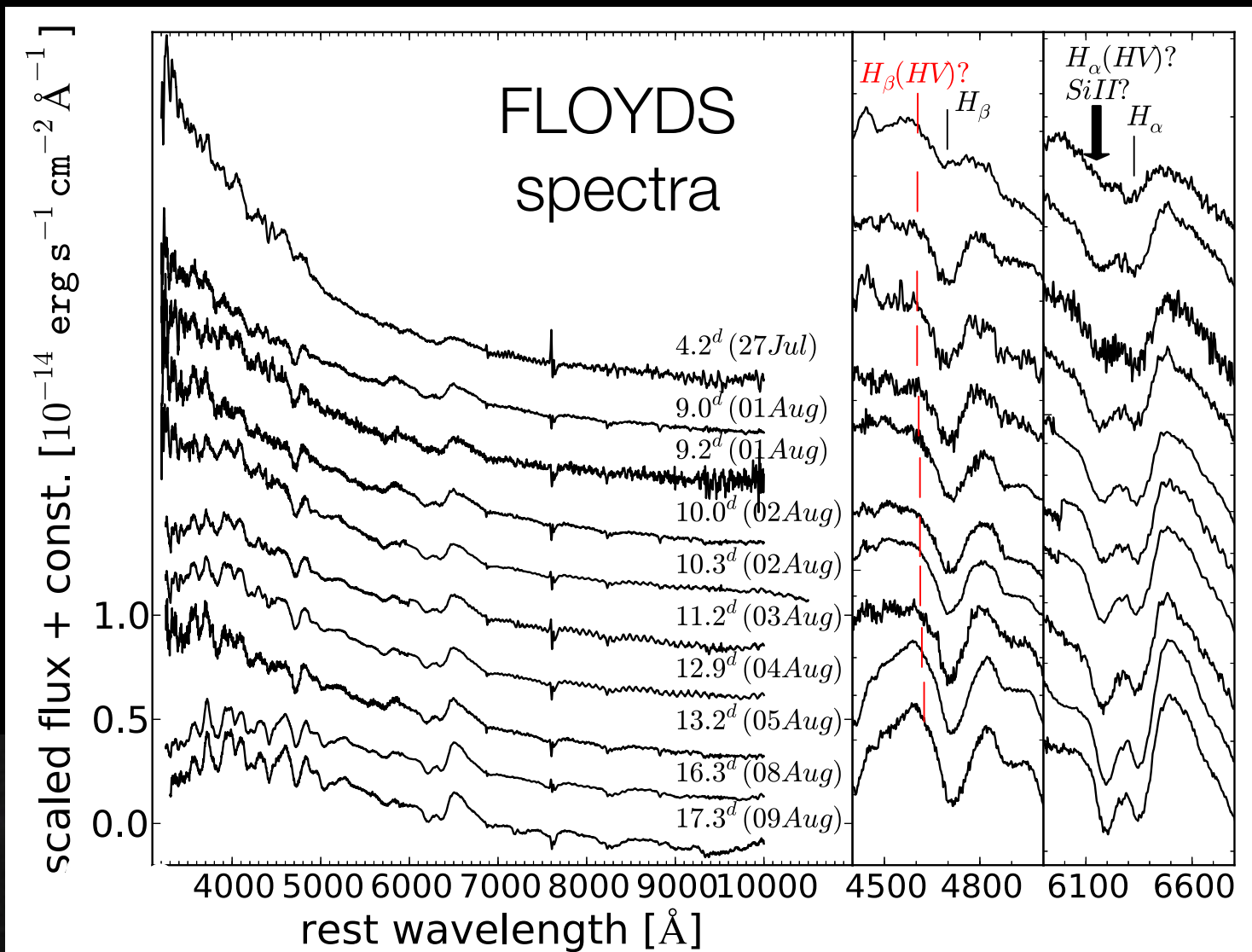
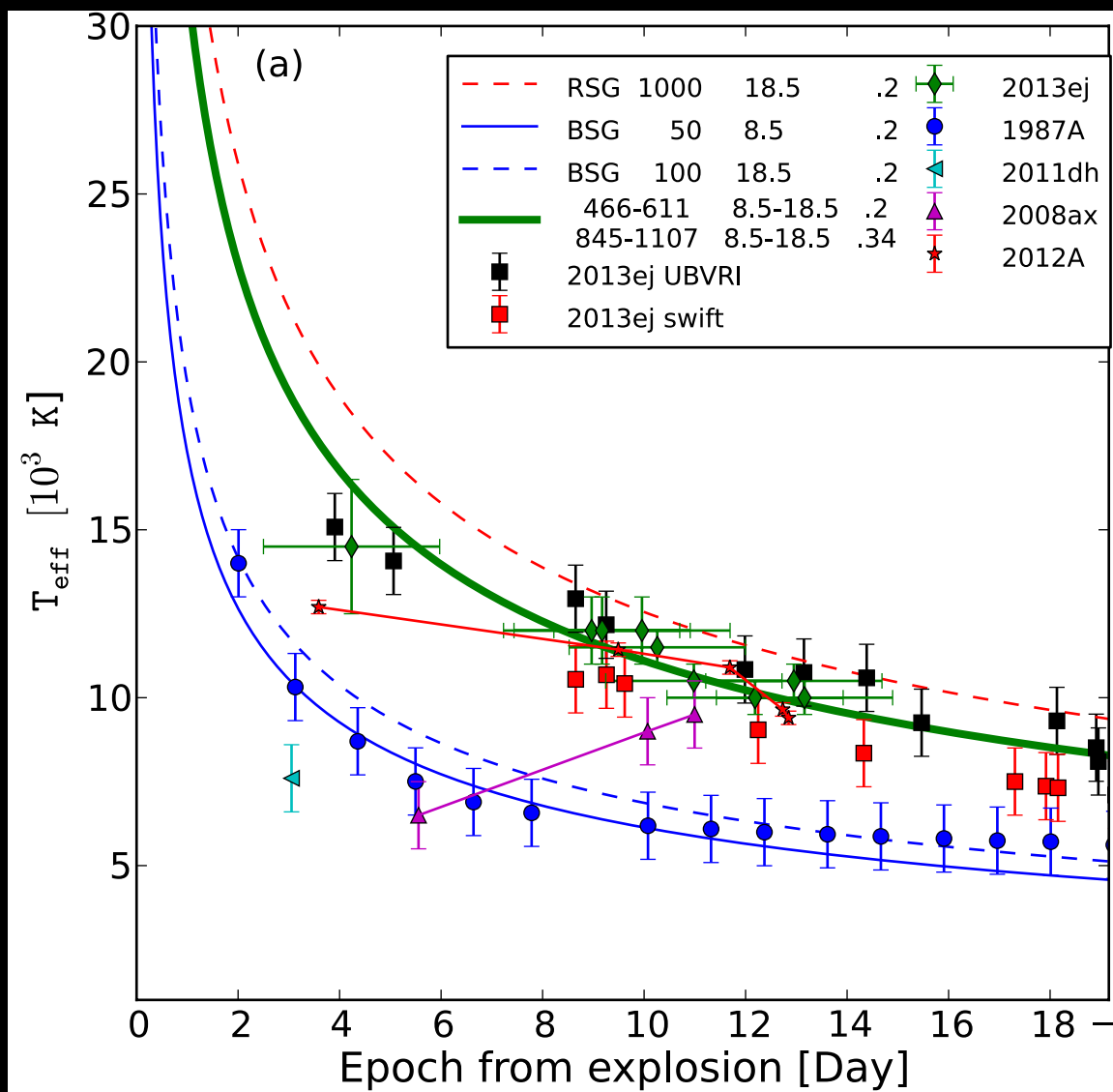


Prompt observations

Valenti et al. 2014

Can get spectra soon after explosion.

Shock cooling measured with FLOYDS (green points), reveals the progenitor of SN 2013ej was a red supergiant with $R=450\text{-}600 R_{\odot}$!



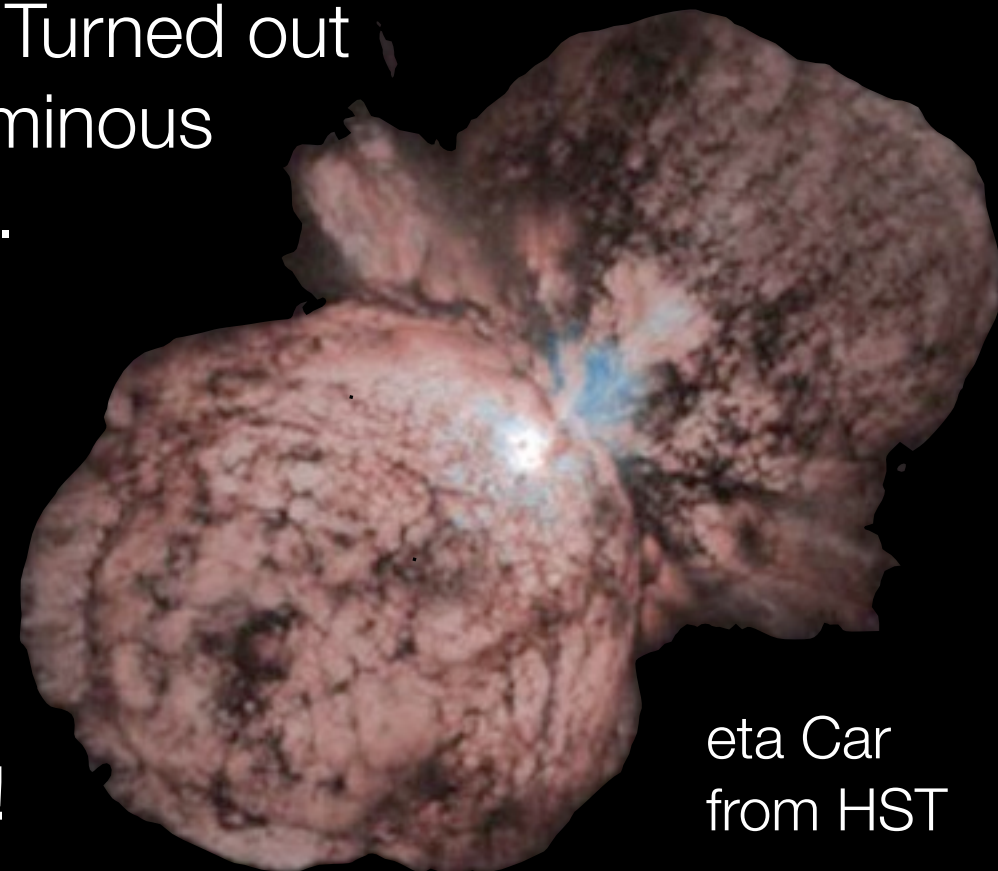
SN 2009ip

Graham et al. 2013.

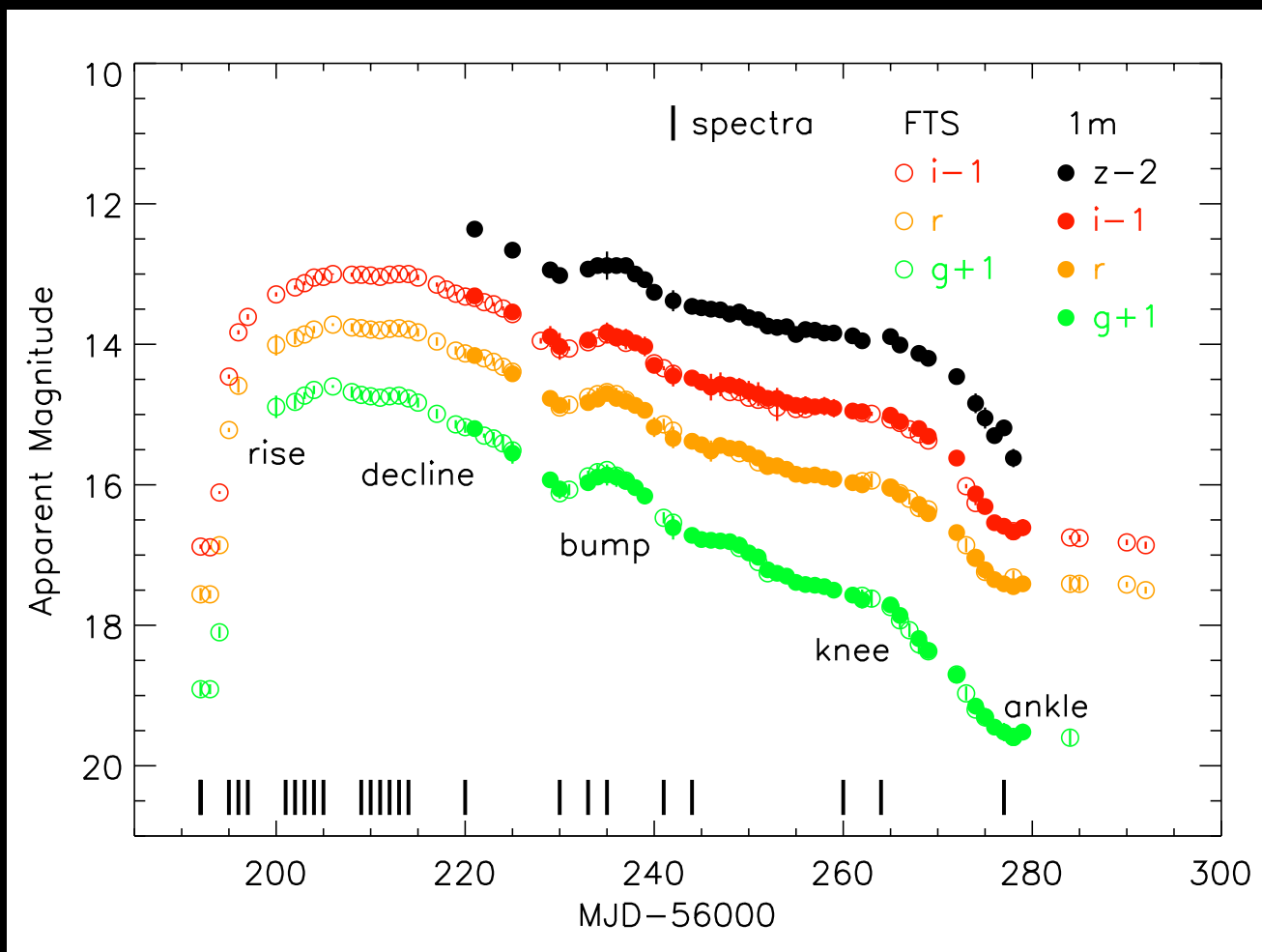
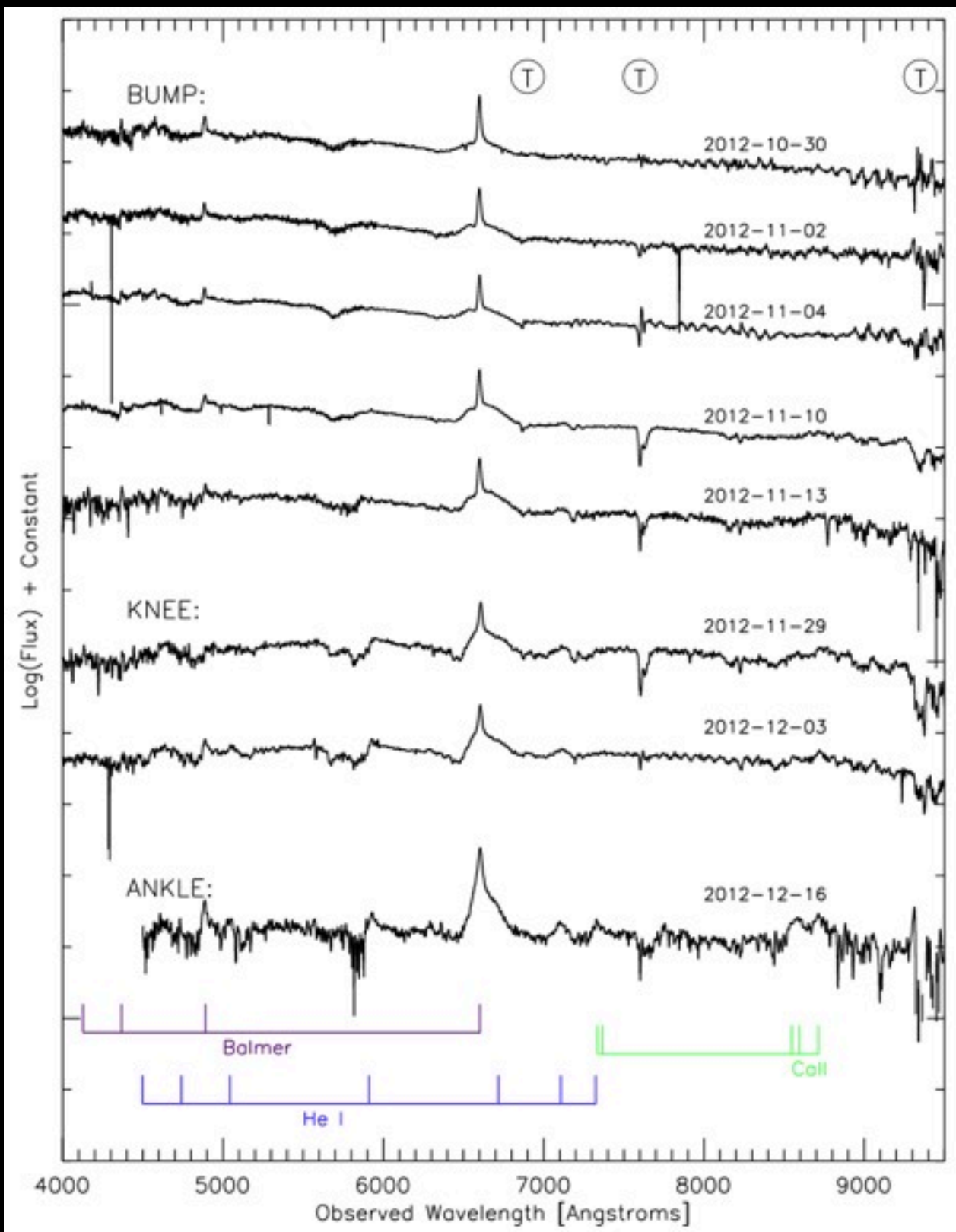
All data from LCOGT

A “SN impostor” from 2009. Turned out to be an explosion from a Luminous Blue Variable like eta-Carinae.

But then in 2012 it exploded as a real Type II supernova! (We think.)



eta Car
from HST



SN2014J SN Ia $z = 0.000677$

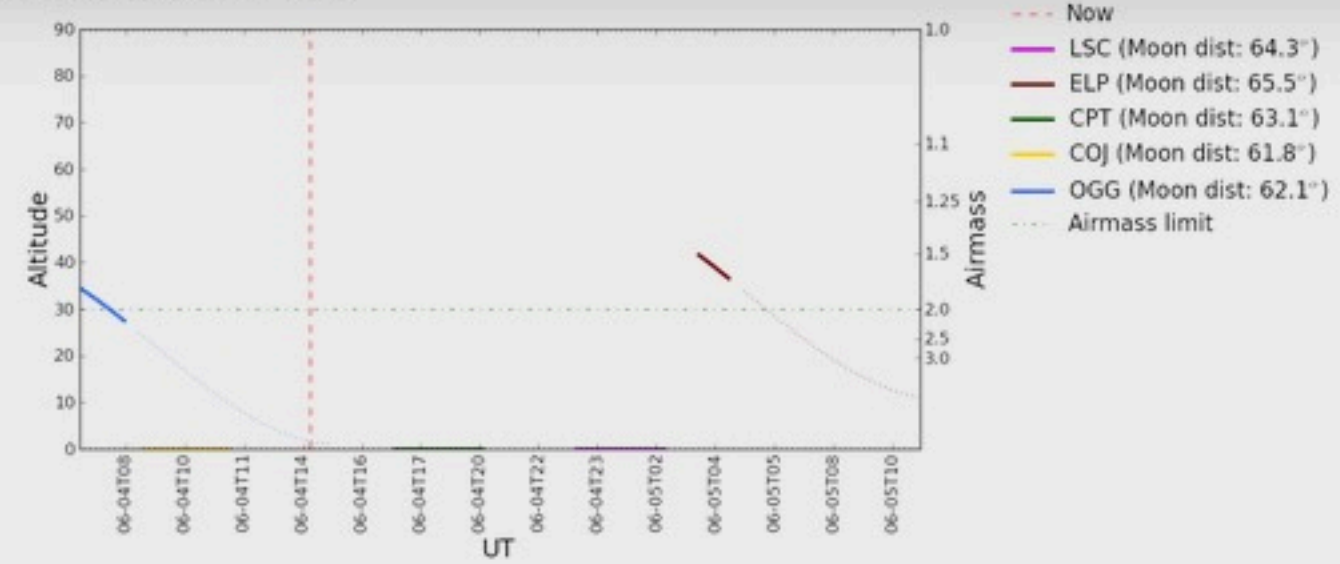
09:55:42.14 +69:40:26.0
148.925583 +69.673889



Latest Comments

- SV** new candidate in M82
2014-01-22 00:00:00
 - SV** Ia at -14 days (typed by PTF) high reddened
2014-01-22 00:00:00
 - SV** last frames in G,R,i saturated, decrease exptime to 15s
2014-01-26 00:00:00
 - SV** in the scheduler page there are some extra trigger with 15s (wrong exposure) that have been cancelled
2014-03-12 00:00:00
 - dsand** I requested one epoch of imaging (many bands) and one epoch of spectroscopy in the next 6 days.
2014-05-04 00:00:00
-

Current Visibility at LCOGT



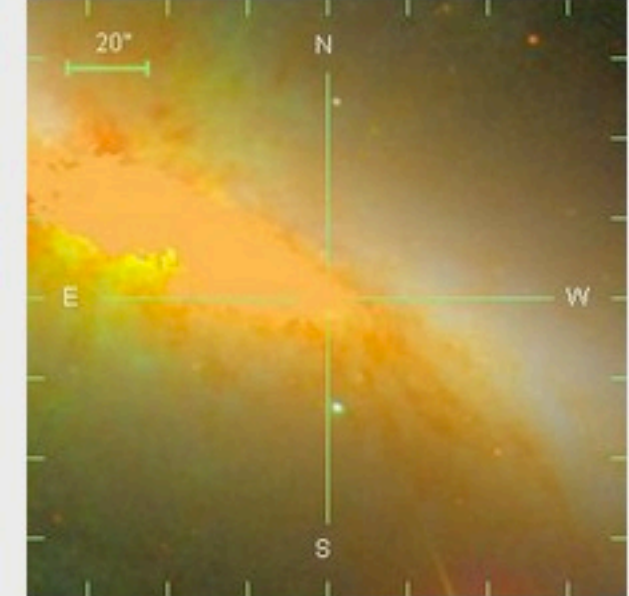
Also known as:

PSN09554214
IPTF14jj
+

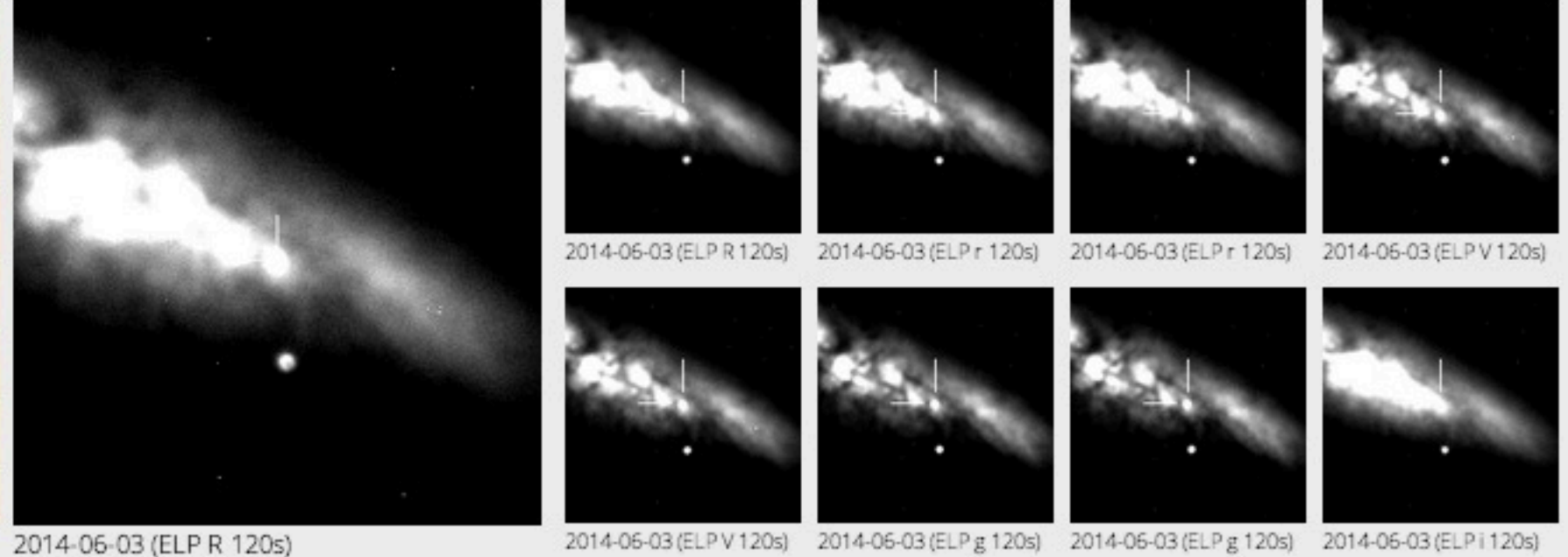
Object visible to:

- ANU
- ASASSN
- CfA
- Chase
- CSP
- ex-LCOGT
- IPTF
- LBNL
- LCOGT
- LSQ
- OKC
- Padova
- PESSTO
- PS1
- PTF
- Public
- QUB
- Skymapper
- UCB
- UT

SDSS



Latest LCOGT Images

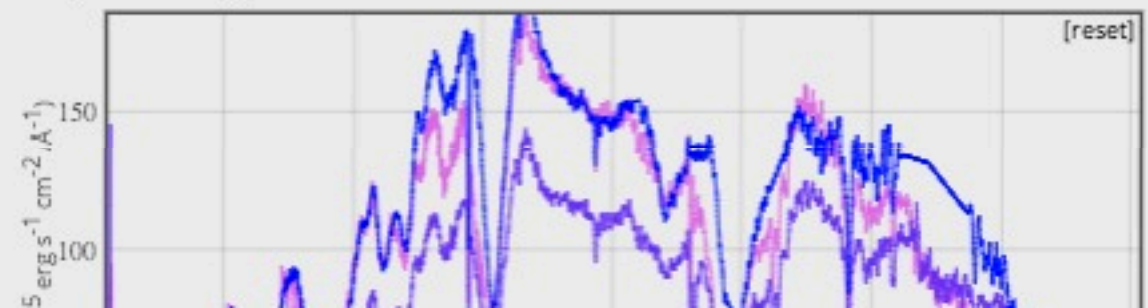


[Browse all 1206 images](#)

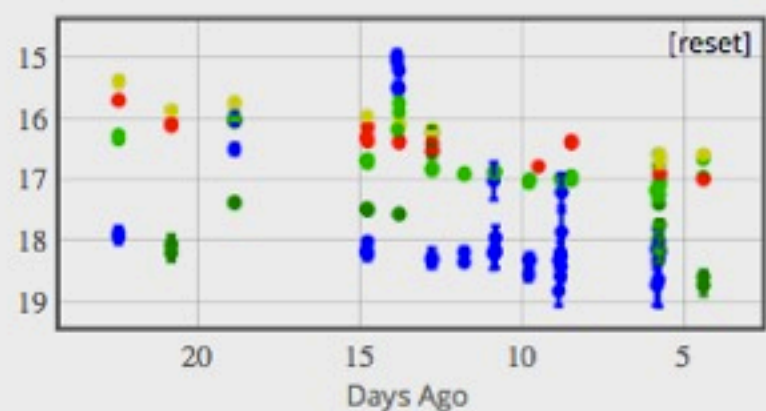
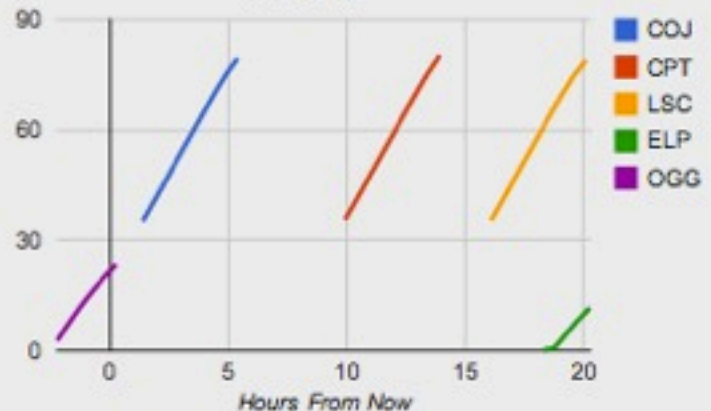
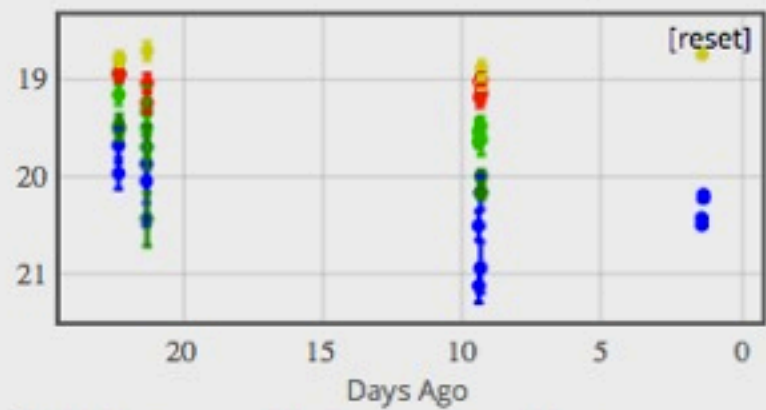
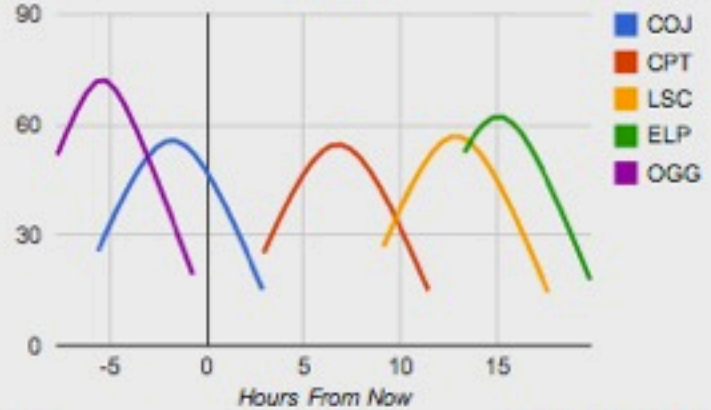
Calibrated Photometry Display instrumental photometry



Spectroscopy



Scheduling

Target	Type	Cadence	Instrument	Exposures	Start	End	Reminder	Comments
PSN225501	Phot	3d	Sbig	B 2x60s V 2x60s g 2x60s r 2x60s i 2x60s	2014-05-28 23:07:49 by iair	Ongoing	2014-06-04 23:07:49	
<div><div></div><div></div><div><div>Stop Sequence</div><div>Continue Sequence</div><div>and display new reminder in <input type="text" value="7"/> days</div></div></div>								
LSQ14bjh IPTF14afz	Phot	7d	Sinistro	B 2x300s V 2x200s g 2x300s r 2x200s i 2x200s	2014-05-08 18:42:59 by iair	Ongoing	2014-06-04 23:10:08	
<div><div></div><div></div><div><div>Stop Sequence</div><div>Continue Sequence</div><div>and display new reminder in <input type="text" value="7"/> days</div></div></div>								
iPTF14atg	Phot	1d	Sbig	B 2x200s	2014-05-07	Ongoing	2014-06-04	

Conclusions

LCOGT has nine robotic one meters deployed around the world with imagers. The network scheduler is operational. High resolution spectrographs and better imagers are coming.

There are two robotic 2m telescopes with imagers and FLOYDS spectrographs.

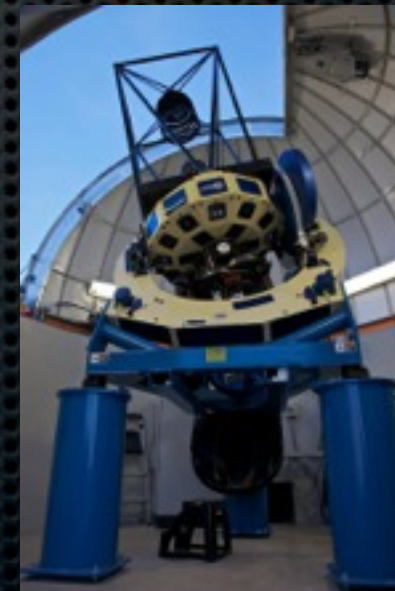
We're taking nightly spectra and lightcurves.

For more see **Brown et al. 2013**

Las Cumbres Observatory Global Telescope Network

Brown, T.M., Baliber, N.¹, Bianco, F.B.², Bowman, M., Burleson, B., Conway, P., Crellin, M., Depagne, É.³, De Vera, J., Dilday, B., Dragomir, D., Dubberley, M.⁴, Eastman, J.D., Elphick, M., Falarski, M., Foale, S., Ford, M., Fulton, B.J.⁵, Garza, J., Gomez, E.L., Graham, M., Greene, R., Haldeman, B., Hawkins, E., Haworth, B., Haynes, R., Hidas, M., Hjelmstrom, A.E., Howell, D.A., Hygelund, J., Lister, T.A., Lobdill, R., Martinez, J., Mullins, D.S., Norbury, M., Parrent, J., Paulson, R., Petry, D.L., Pickles, A., Posner, V., Rosing, W.E., Ross, R., Sand, D.J.⁶, Saunders, E.S., Shobbrook, J., Shporer, A.⁷, Street, R.A., Thomas, D., Tsapras, Y., Tufts, J.R., Valenti, S., Vander Horst, K., Walker, Z., White, G., Willis, M.

Las Cumbres Observatory Global Telescope Network, 6740 Cortona Dr. Suite 102, Goleta, CA 93117, USA



iPTF Northern bias

8/9 one meters can't
do most iPTF targets

