The All-Sky Automated Survey for Supernovae

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on behalf of the ASAS-SN team

Team and partners

Ohio State University: C. Kochanek, K. Stanek, T. Holoien, A. Danilet, G. Simonian, U. Basu, N. Goss, J. Beacom, T. Thompson, J. Brown
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Diego Portales; MAS: J. L. Prieto
LJMU: David Bersier
KIAA-PKU: Subo Dong
LANL: P. R. Wozniak
CfA: E. Falco
Coral Towers Observatory: J. Brimacombe
Warsaw: D. Szczygiel, G. Pojmanski

Amateur astronomers

Support from: CCAPP, NSF, LCOGT, Mt Cuba Astronomical Foundation

Description and Goals

- Build on ASAS (Pojmanski 2004)

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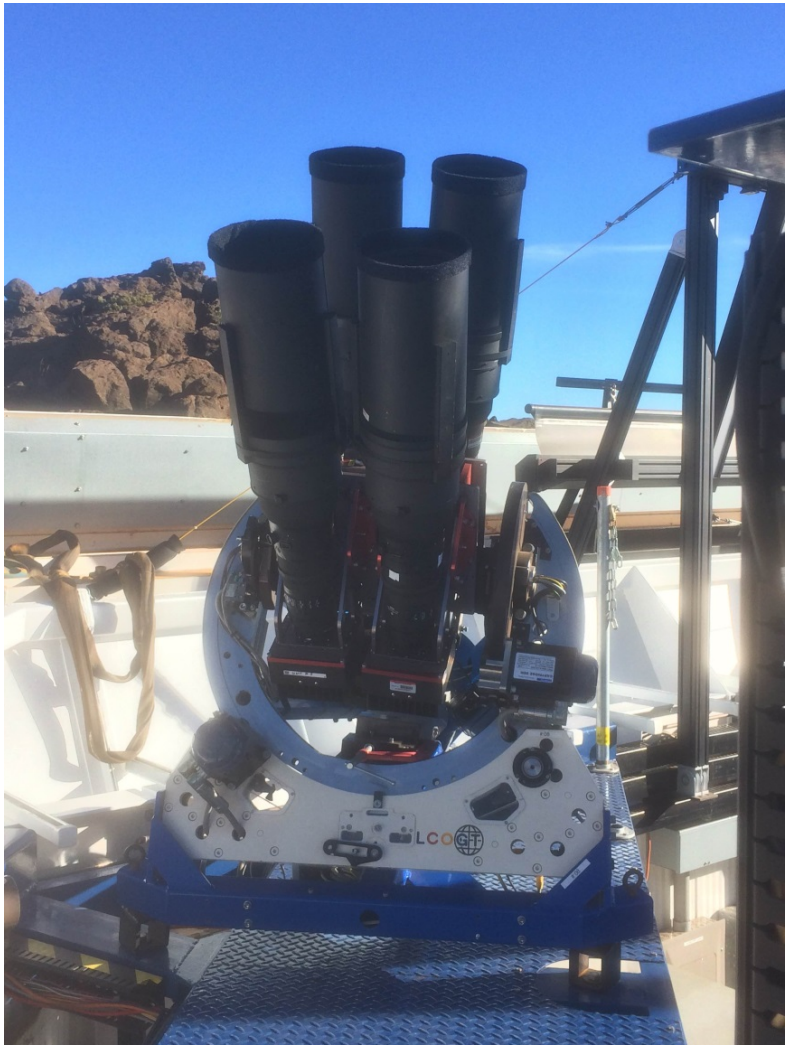
- Monitor the entire sky every few nights in real-time
- Find supernovae in a minimally biased way
- Use commercially available lenses and CCDs

ASAS-SN system

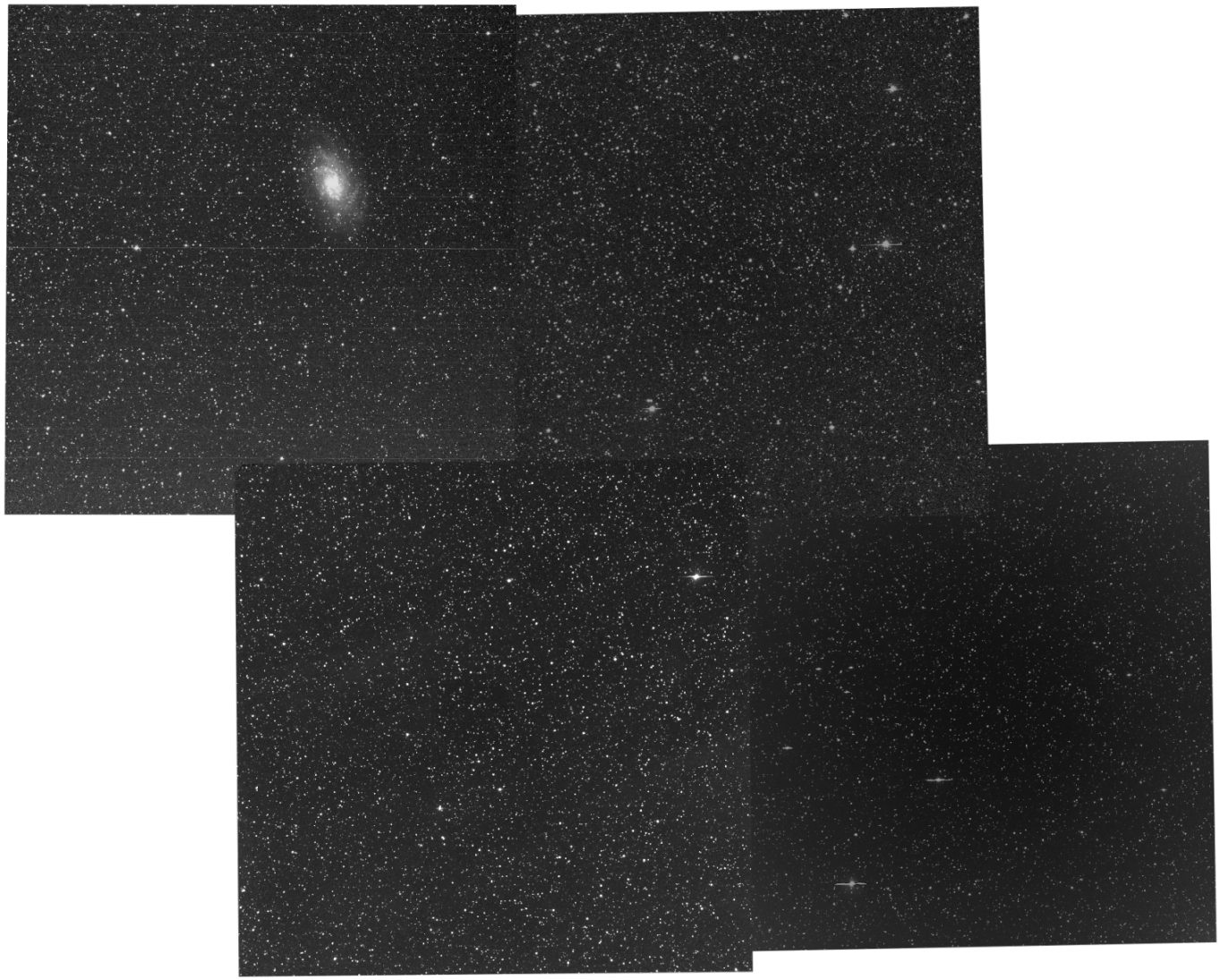
- Site: Haleakala (FTN/LCOGT)
- 4 telescopes on a common mount
- 4 x 14cm lens
- 4 x 2k $\times$ 2k thinned CCD
- 4 $\times$ 4.47° $\times$ 4.47° field-of-view
- 7.8" pixel scale
- V filter, $V_{\rm lim} \simeq 17$
- 10^4 square degrees per night



ASAS-SN system

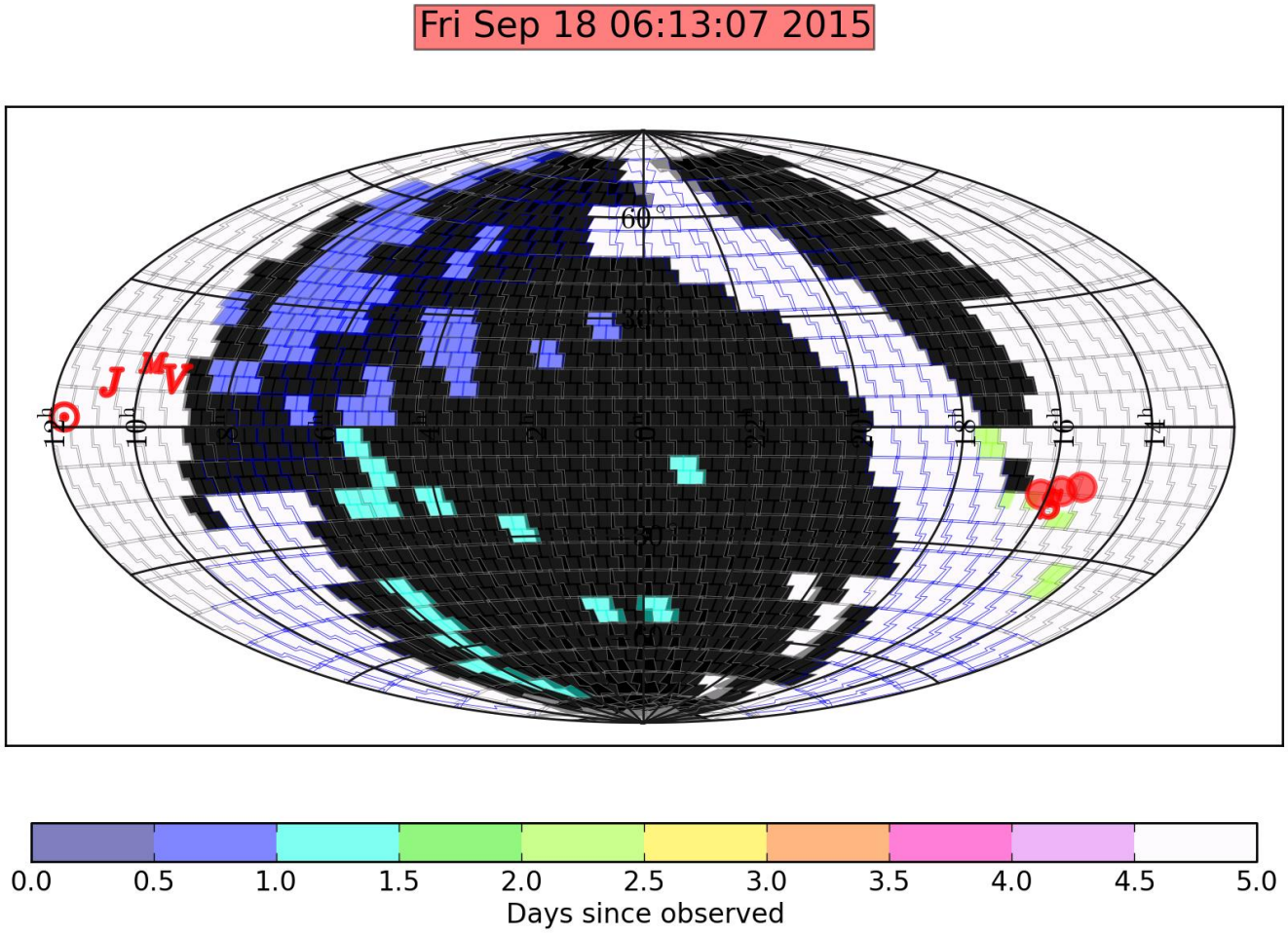
- Site: Cerro Tololo (LCOGT): Same specs as North
- Now four units

Brutus data



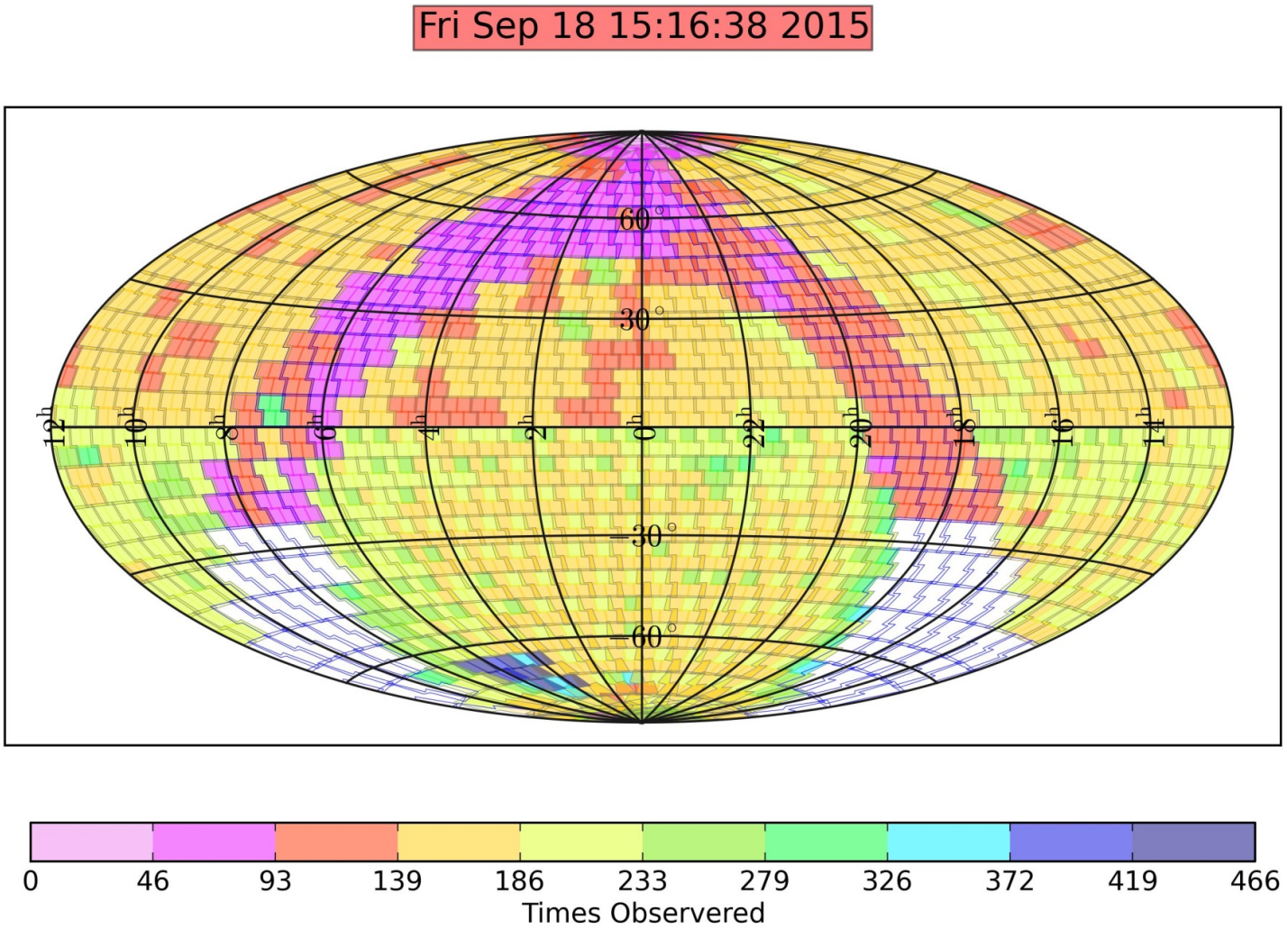
Each image is 4.5×4.5 square degree, 4 cameras per mount

Scheduling



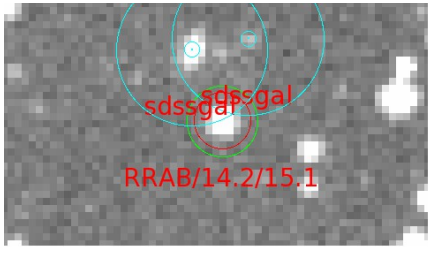
Scheduling algorithm: observations not random, guarantee that fields observed regularly $\Longrightarrow$ The whole (dark) sky in ~ 2 nights.
2×60 sec exposures, now experimenting with 3×60 sec.

Scheduling



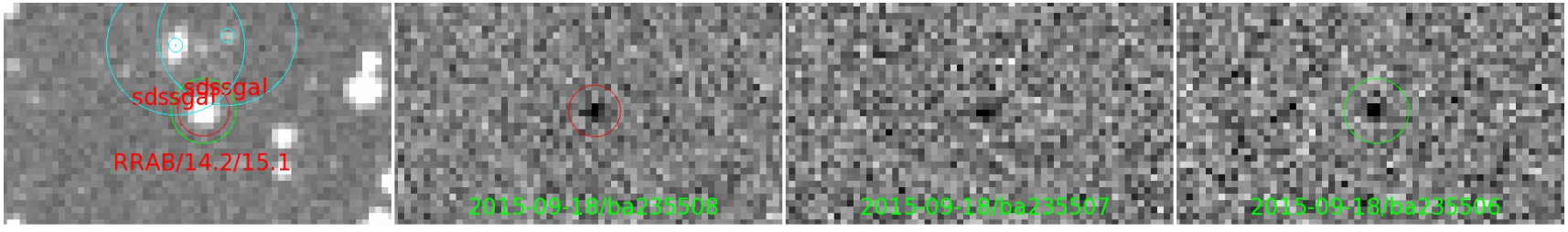
A whole year

Finding transients



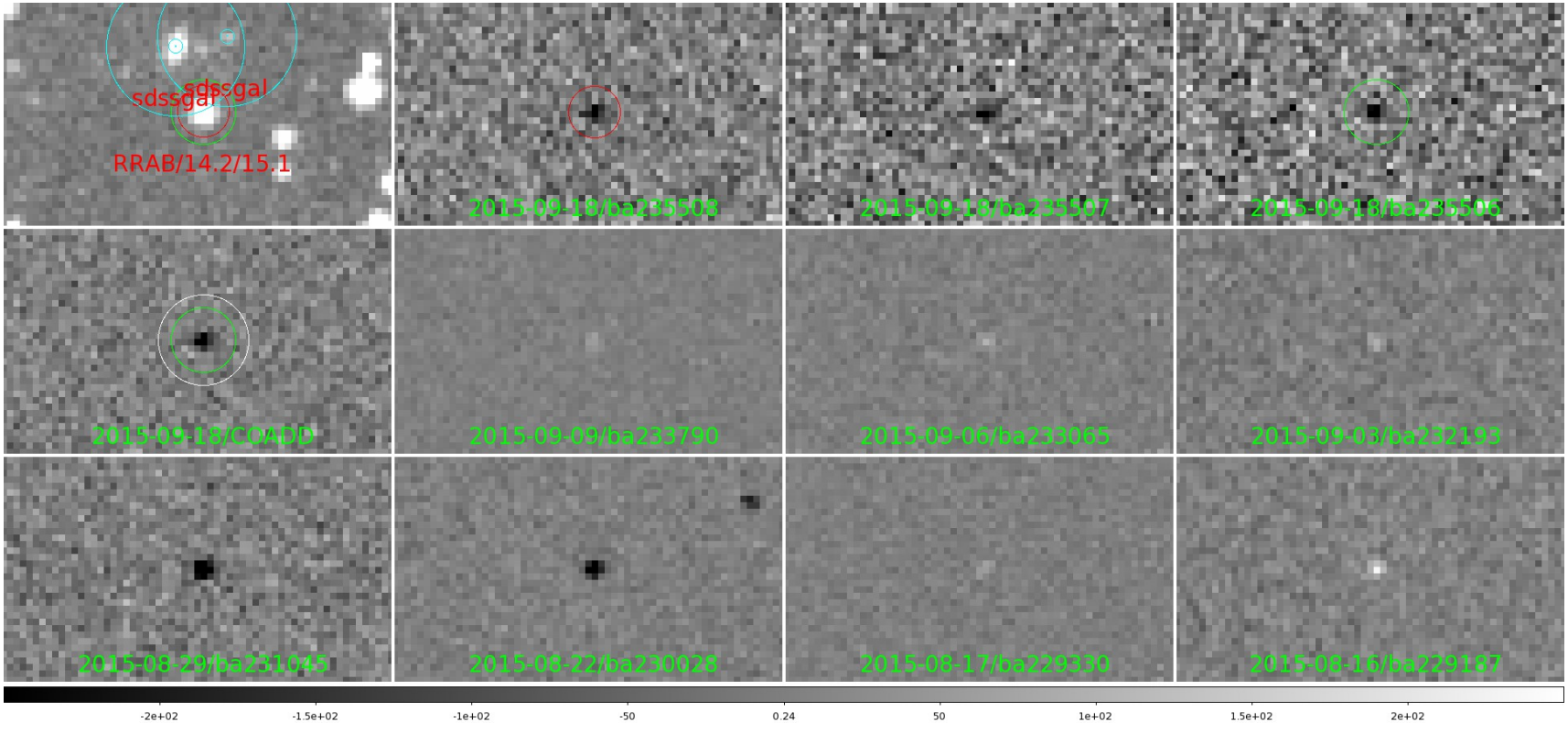
Take a *reference* image

Finding transients



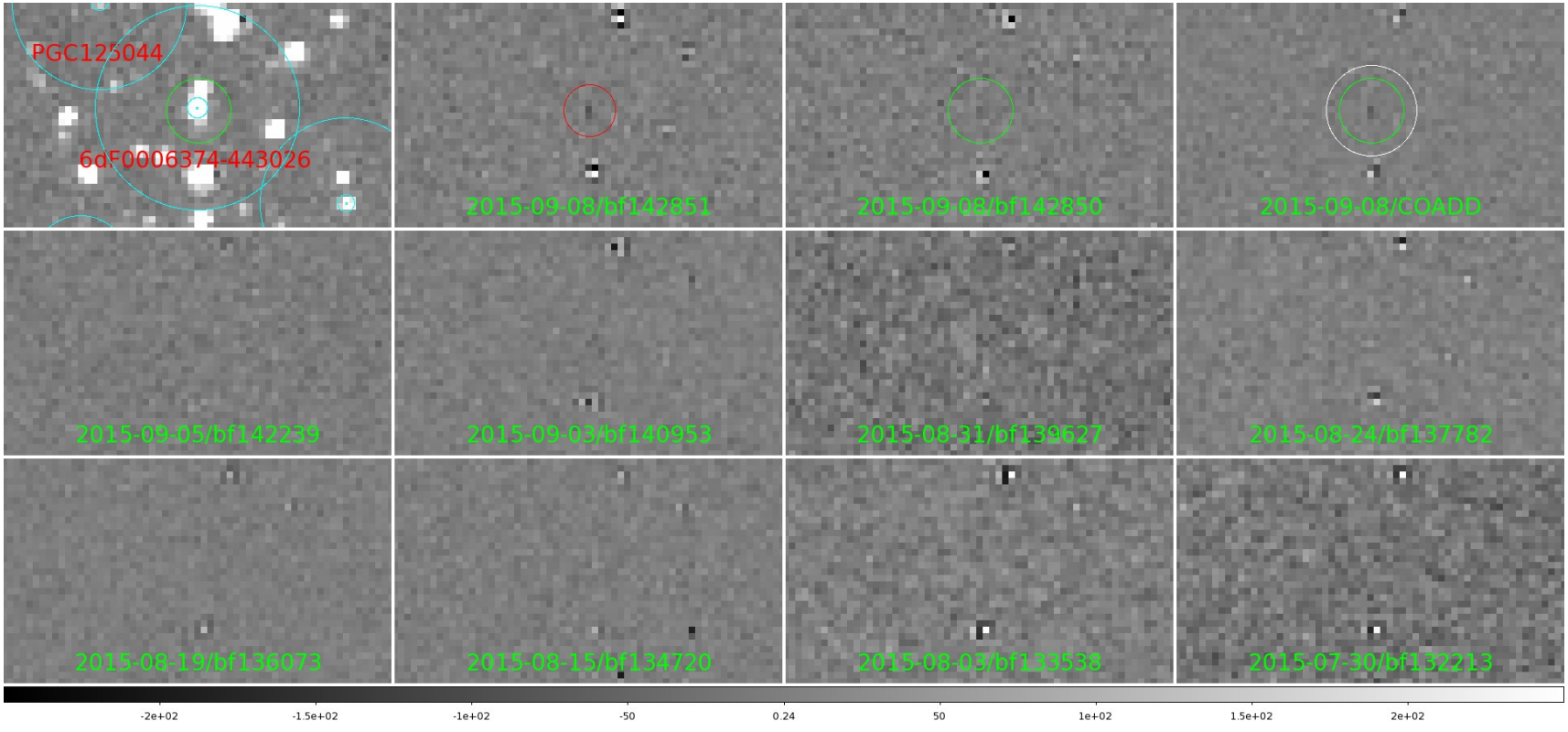
Subtract image from reference, look for transients on 3 sub images

Finding transients



Variable star

Finding transients



Candidate SN, confirmed by amateur astronomer

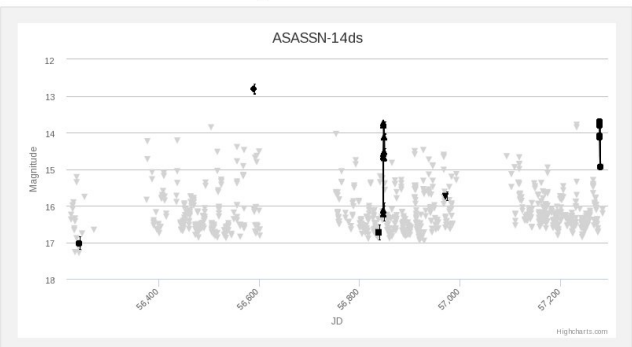
Now experimenting with automated (email) alerts

Patrols

Patrols: "watch list" of specific objects, known/expected variability. Updated in real time with ASAS-SN data.

- CV patrol: *http://cv.asassn.astronomy.ohio-state.edu/*
  All *known* cataclysmic variables are placed on this list. New discoveries are added as they occur.

Outburst on Sept. 12, 2015, 12:41 a.m.



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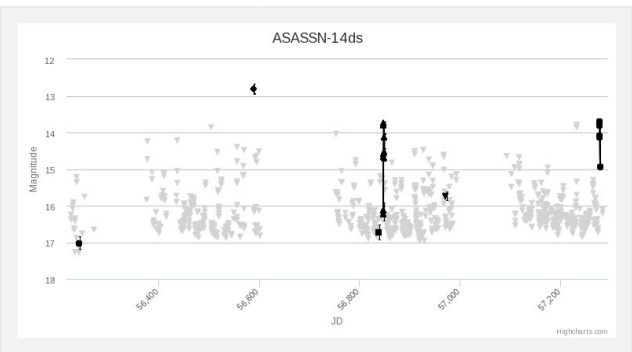

- Blazars, QSO

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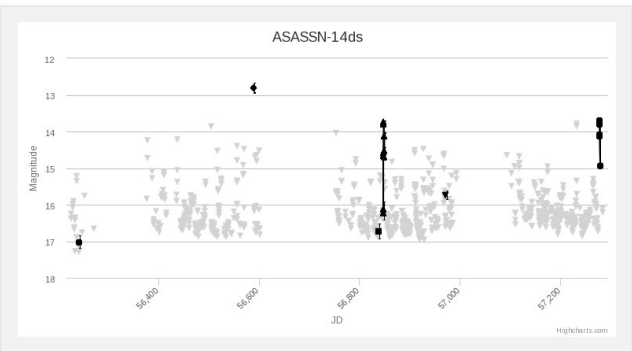

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- M dwarf stars

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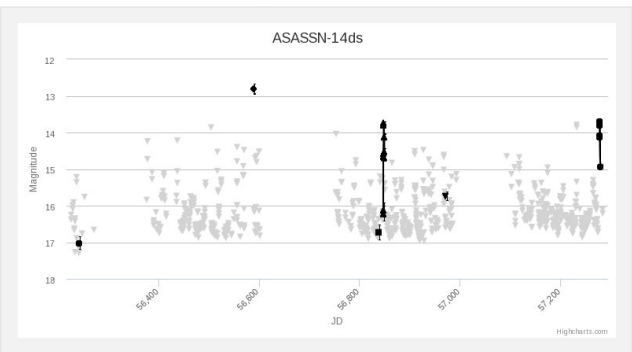


- Blazars, QSO
- M dwarf stars
- Young Stellar Objects. T Tau

Discoveries

300+ ATels over 2+ years of the real-time survey

12 publications with more in preparation

230+ Supernovae ($\sim$ 170 SNe Ia), including the most luminous supernova ever discovered (Dong+ 2015)

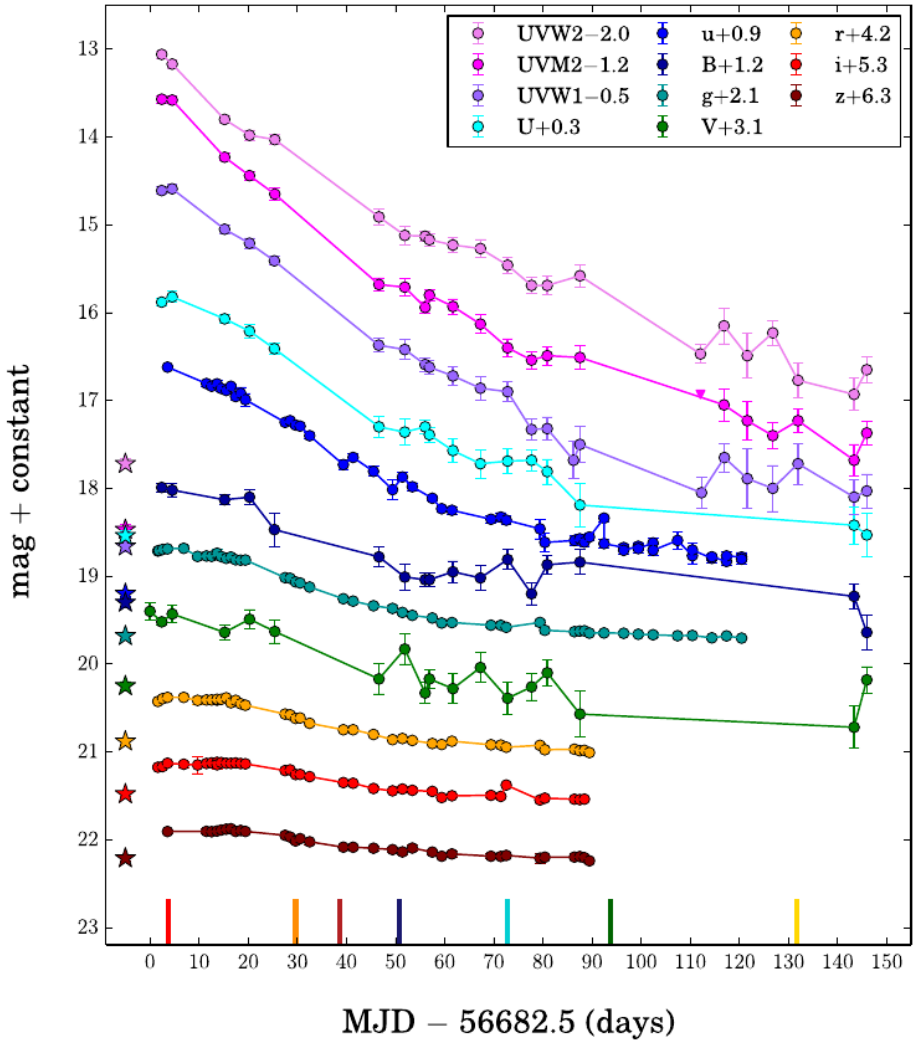
2 (+1) Tidal Disruption Events (Holoien+ 2014, 2015)

500+ new CV discoveries

Many M dwarf flares , including two of the largest ever detected (Schmidt+ 2014)

Many AGN and blazar outbursts, including a changing look AGN (Shappee+ 2014)

Tidal disruption events



ASASSN-14ae

LC evolution unlike SN

$T_{\rm eff} \sim 20,000$ K

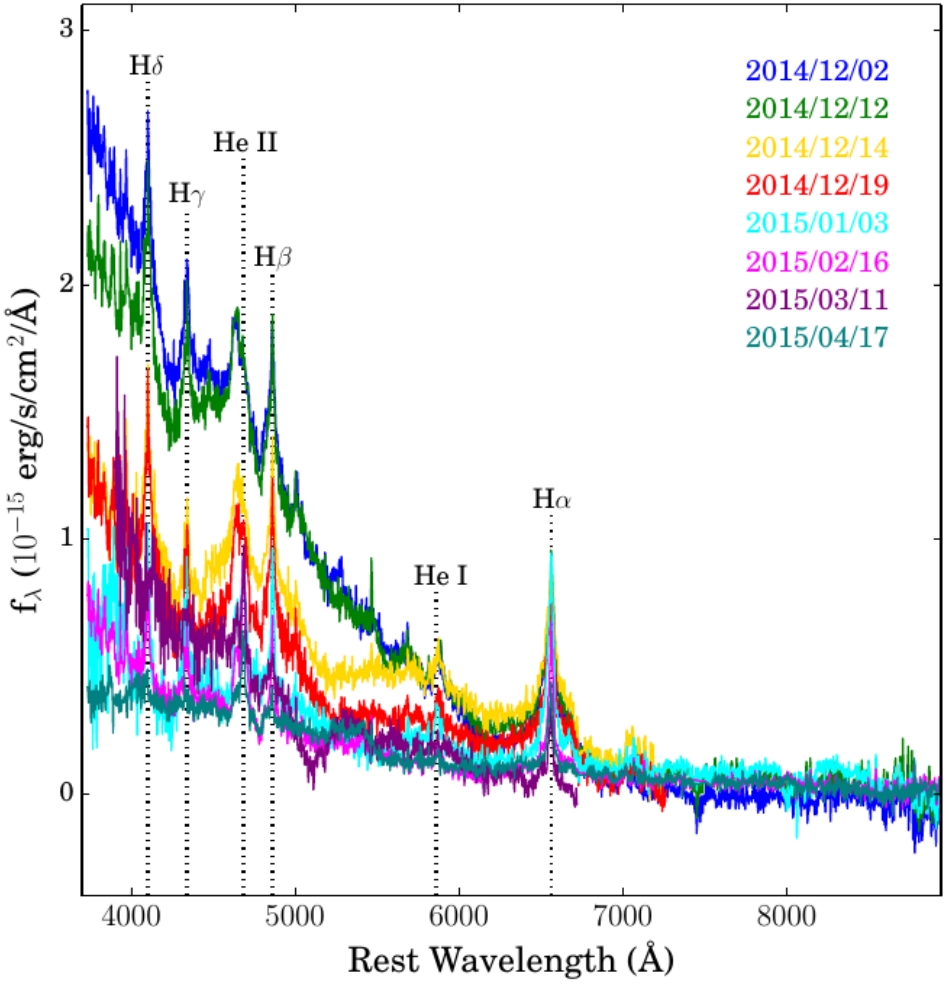
HeII lines

$M_{\rm acc} \sim 10^{-3} M_\odot$

$M_{\rm SMBH} \sim 10^{6.5}\ M_\odot$

(Holoien+ 2014)

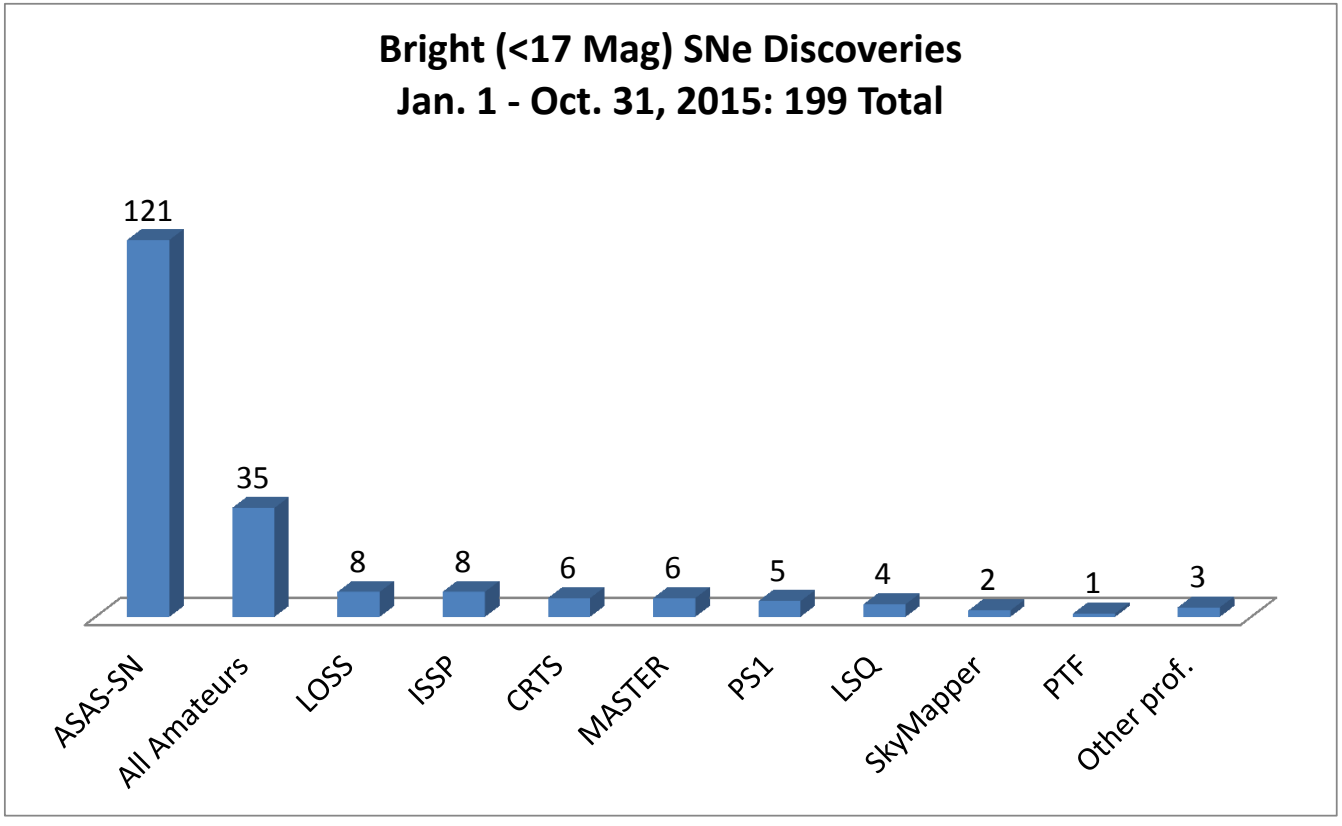
Tidal disruption events



ASASSN-14li

(Holoien+ 2015)

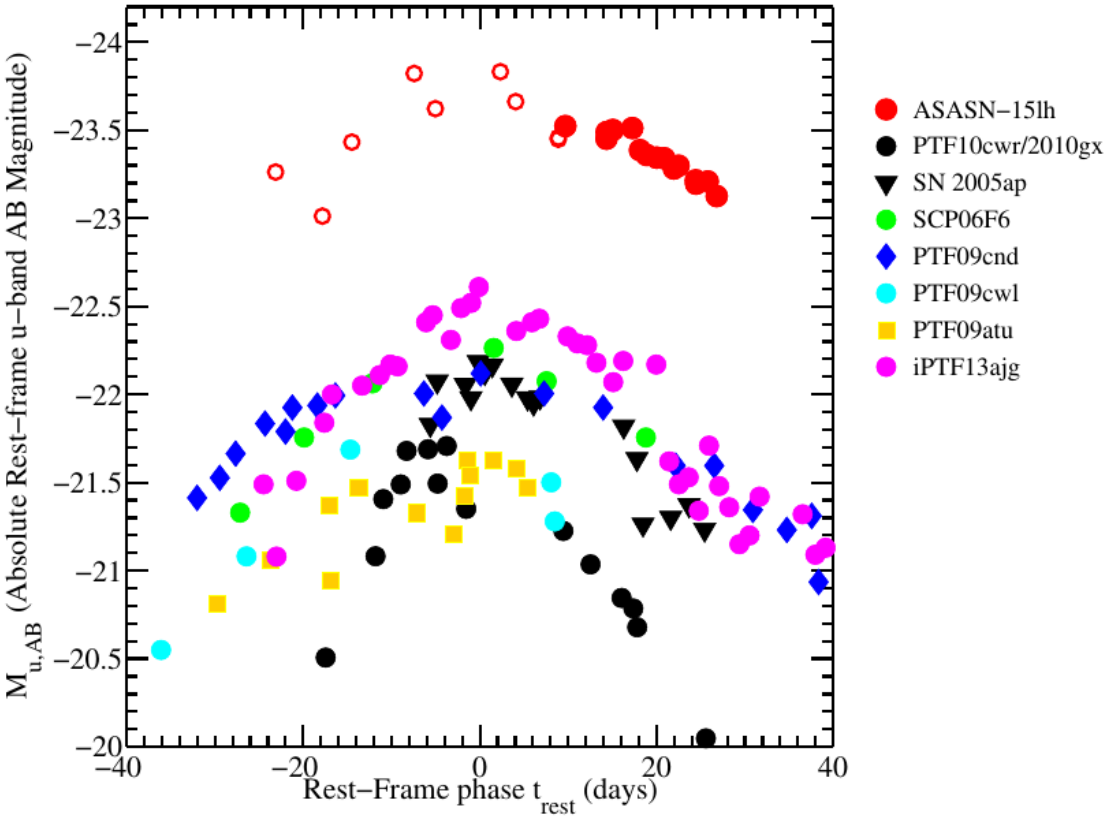
Supernova science



230+ SNe to date, overwhelming majority are *spectroscopically confirmed*

http://www.astronomy.ohio-state.edu/∼assassin/sn_list.html

ASASSN-15lh: The brightest SN ever



At z=0.2326, it has
$M_V \approx -22$,
$M_u(AB) < -23.5$,
$L_{\rm bol} > 2.2 \times 10^{45}$ erg/s,
very blue

brighter than any other SLSN
Dong et al. 2015
(arXiv:1507.03010)

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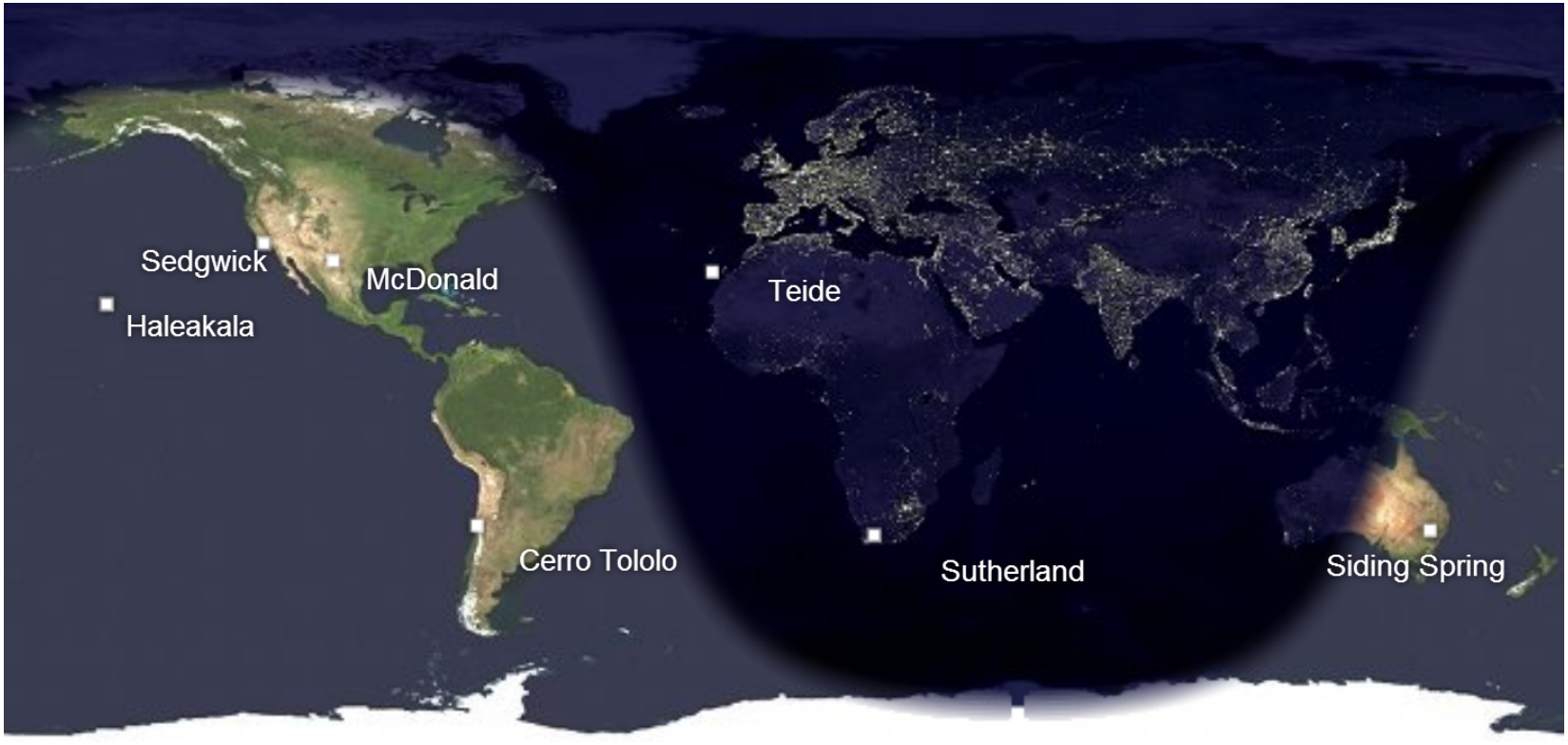
We can't do it all: *ASAS-SN needs you*

Sites



More sites in the future: All the sky, all the time