

The SkyMapper Southern Sky Survey Search for Supernovae & Transients



Richard Scalzo (ANU) for the SkyMapper team
CAASTRO Annual Retreat, Torquay, VIC
22 November 2013

Supernovae: why we care

- Luminous, extreme events (big explosions are cool!)
- Represent end states for stellar evolution
- Many kinds of stars, so many kinds of SNe
(Ia-norm, Ia-91T, Ia-91bg, Iax, Ib, Ic, Ic-BL, IIL, Iib, IIn, SLSNe-{I,II}, ...)
- Drive chemical evolution in our own galaxy and others
- “Ia-norm” can be standardized and used for cosmology
(Hubble diagram: ANU + LPNHE;
peculiar velocities: ANU + UQ;
“key project” status for SkyMapper)



Supernovae: why you might care!

- SN search data could be used for other applications (variable object searches incl. flare stars, RRLe, AGN)
- Constraints: survey strategy is set by SN science (cadence \sim 3-4 days, fields avoid Galactic plane, fields may not be contiguous on sky)
- Pipeline is working and running, catalog of whole survey history is kept on disk for mining
- Come talk to us if you have some science you'd like to do!

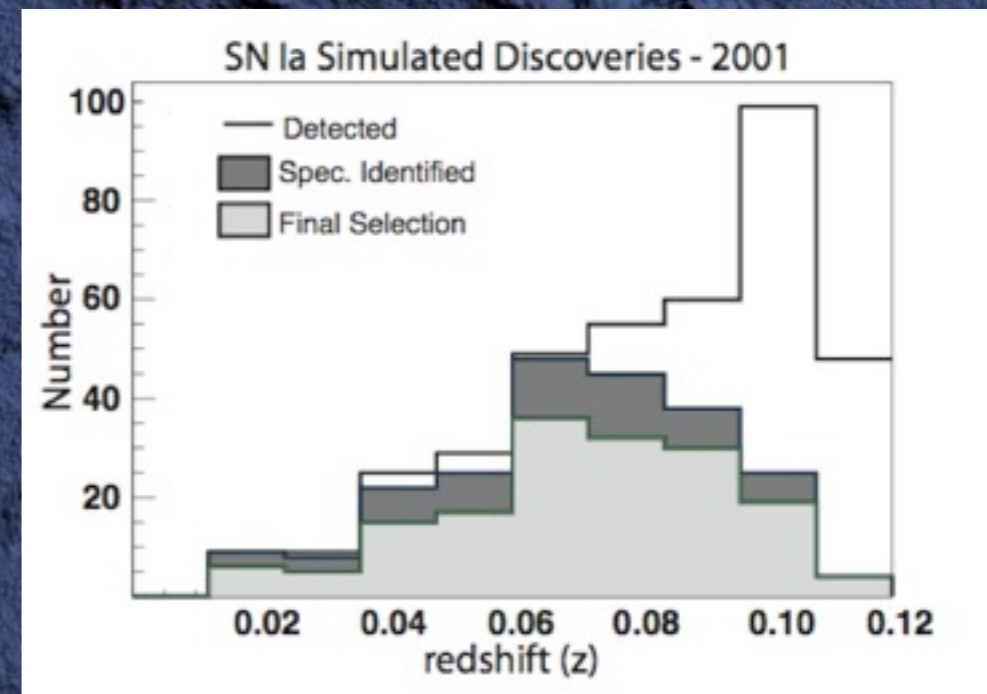
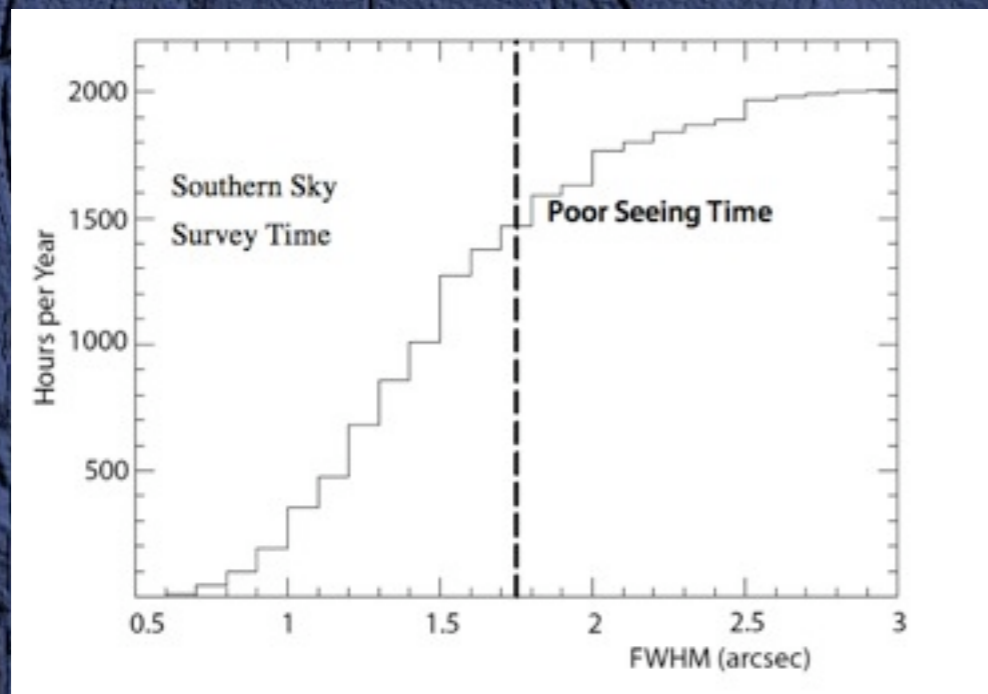


The SN search strategy

team: B. Schmidt, R. Scalzo, F. Yuan, M. Childress

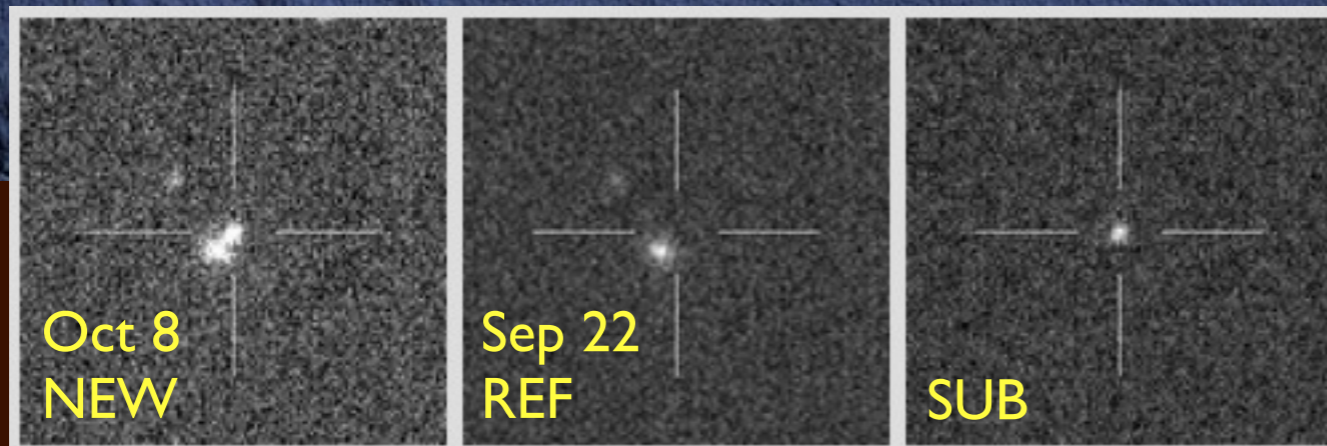
Cover $\sim 1000 \text{ deg}^2$ at a time with 3-4 day cadence.
Monitoring cosmology fields + Shapley, Kepler.

Current strategy: search in *gr*, trigger follow-up in *vi*.
Photometry from SkyMapper (+ PESSTO, LCOGT, CSP);
spectra from ANU/WiFeS (+ PESSTO, LCOGT, ...).



SkyMapper SN search coverage

First SN: SMT J21413915-5643445 (type Ia, $z = 0.14$)



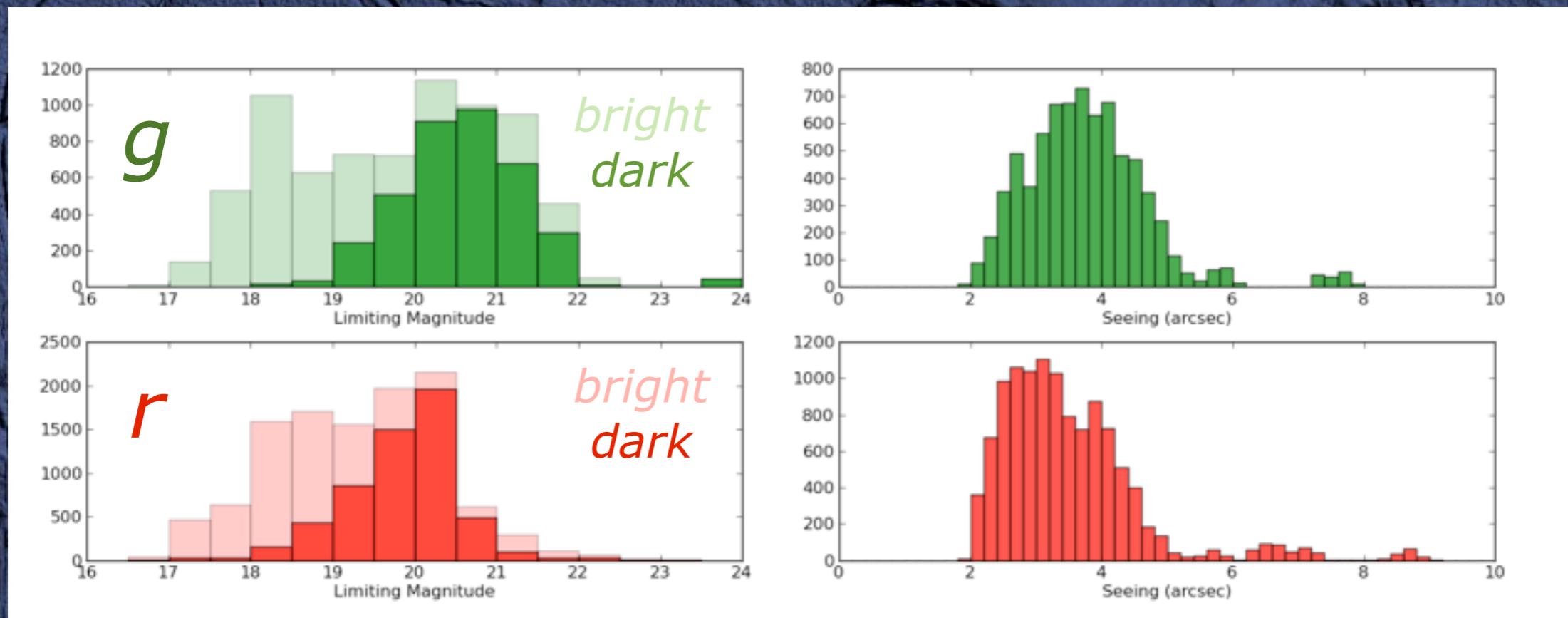
40x visits over
2000 deg² of sky
since starting 2013 Sept 4

Search to ramp
up throughout 2014
as host galaxy REFs are taken

Search performance

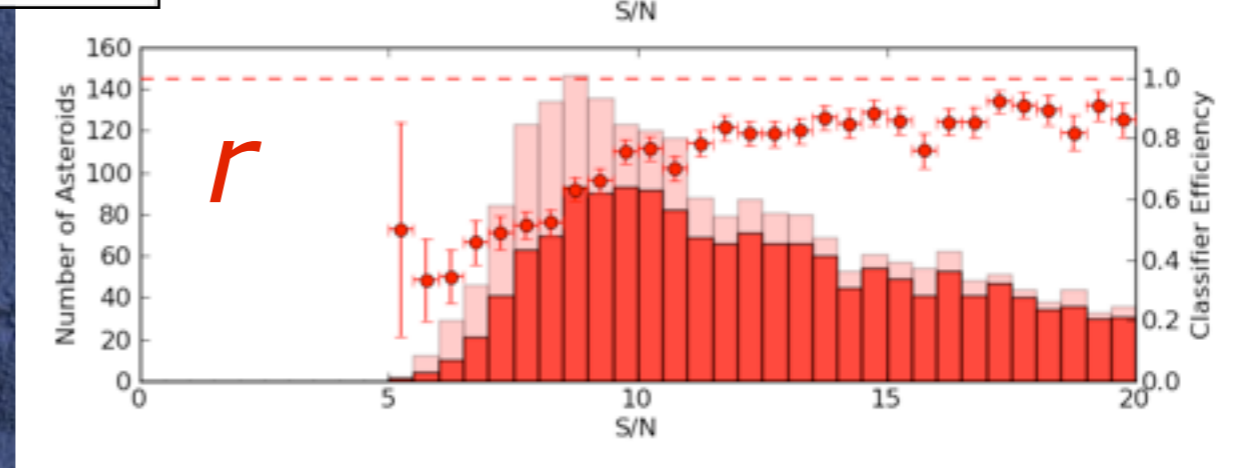
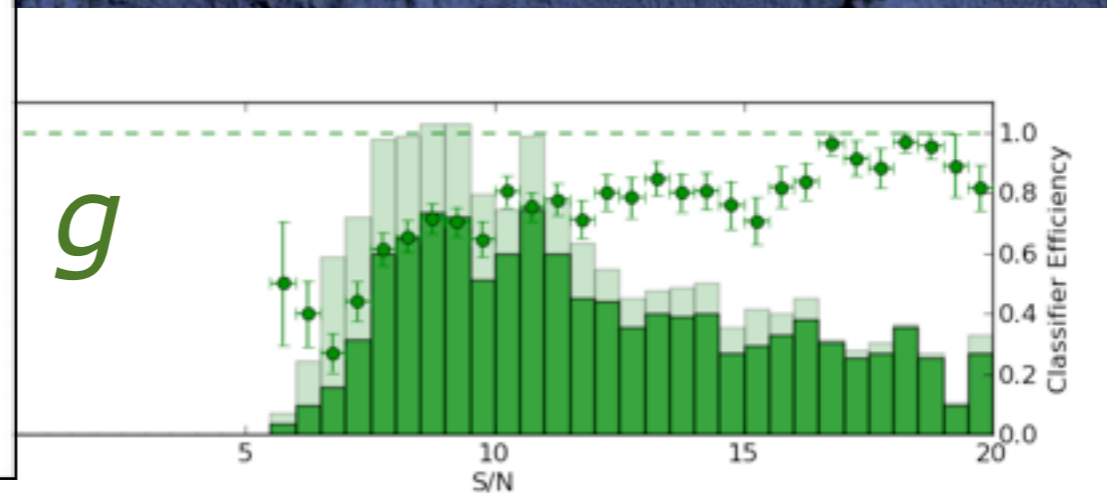
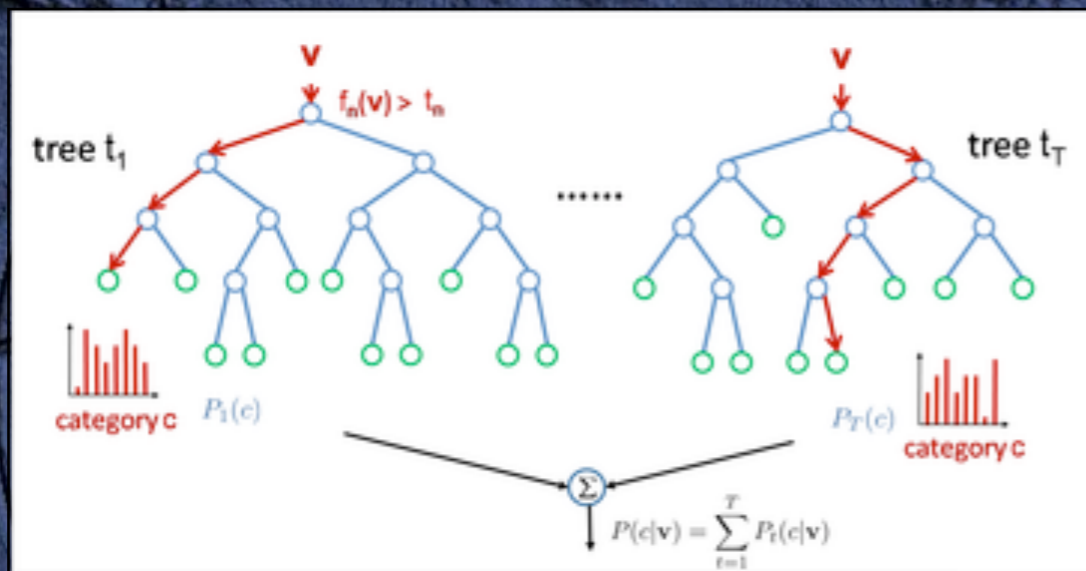
Median PSF width is 3-4 arcseconds (last 2 month avg.); this may continue to improve (cf. Wolf talk).

Best limiting magnitude is ~ 21.5 in g , ~ 21 in r , about what you'd expect for a 60-sec exposure in dark time.



Search performance

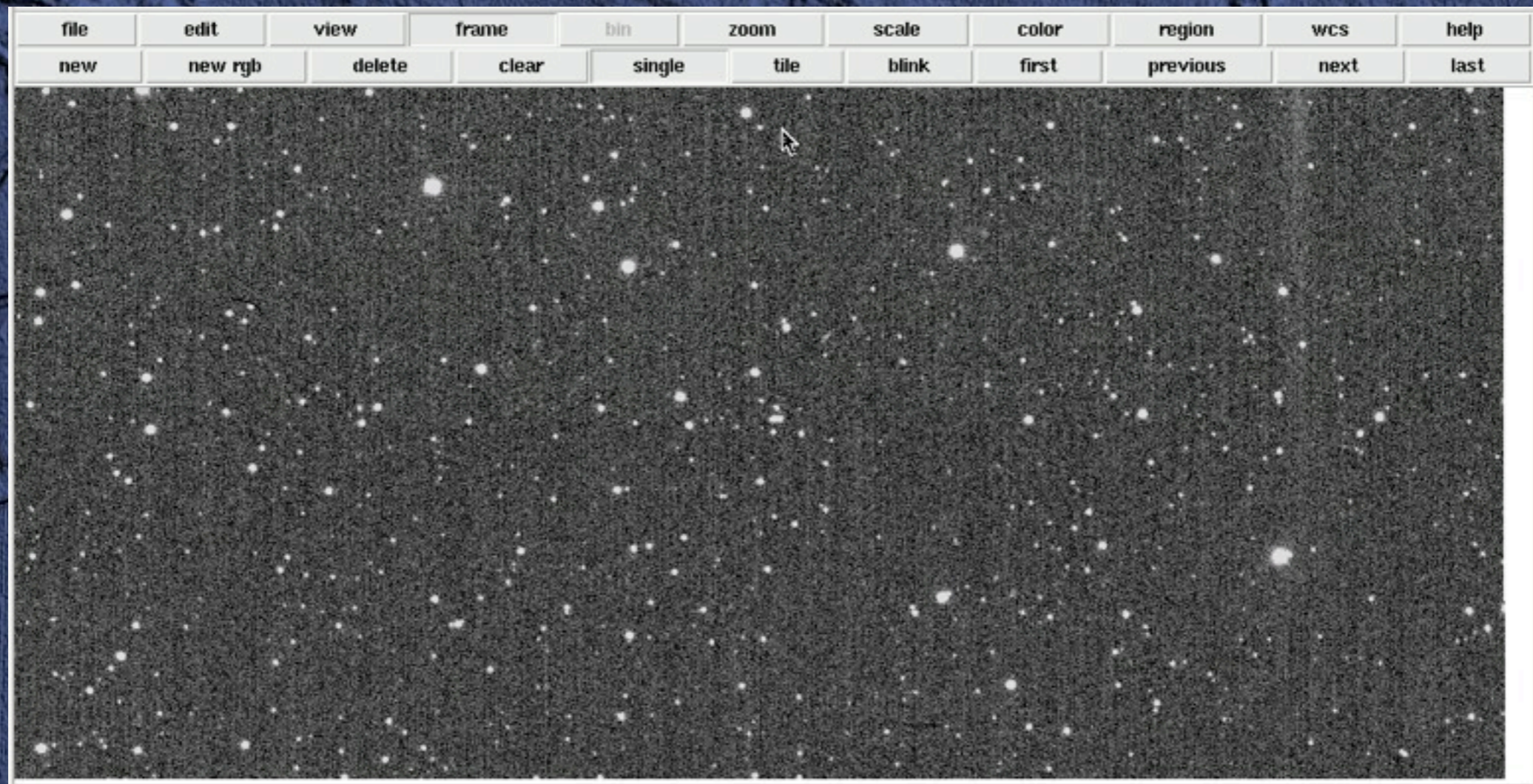
Random forest classifier modeled on Bloom+ 2012.
First 10-fold x-validation: 99% efficient, 85% complete;
may need to re-train now that more data are available.



Search performance

Subtractions (w/swarp, hotpants): already quite clean.

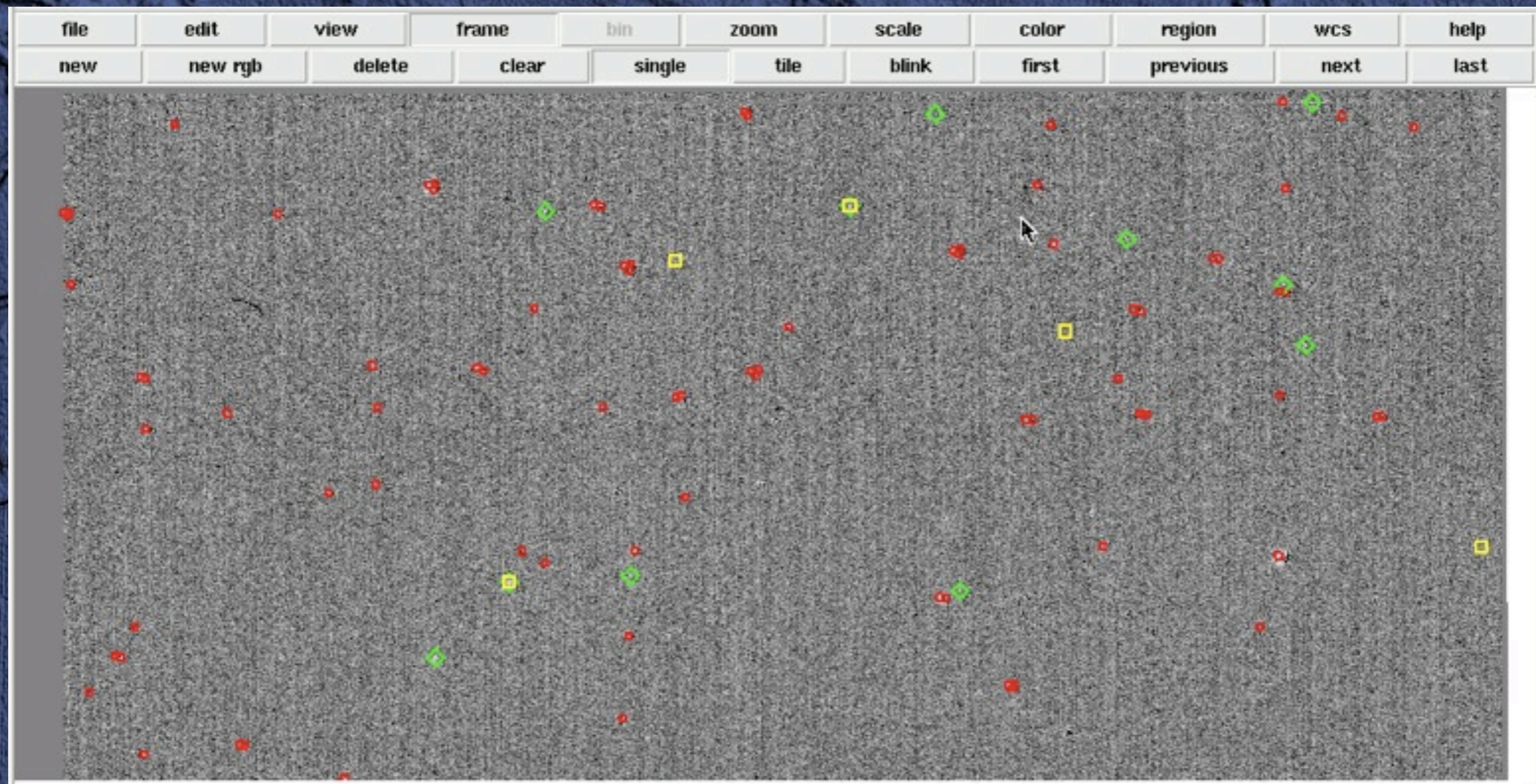
○: Bogus, ◇: Real, □: known asteroid.



Search performance

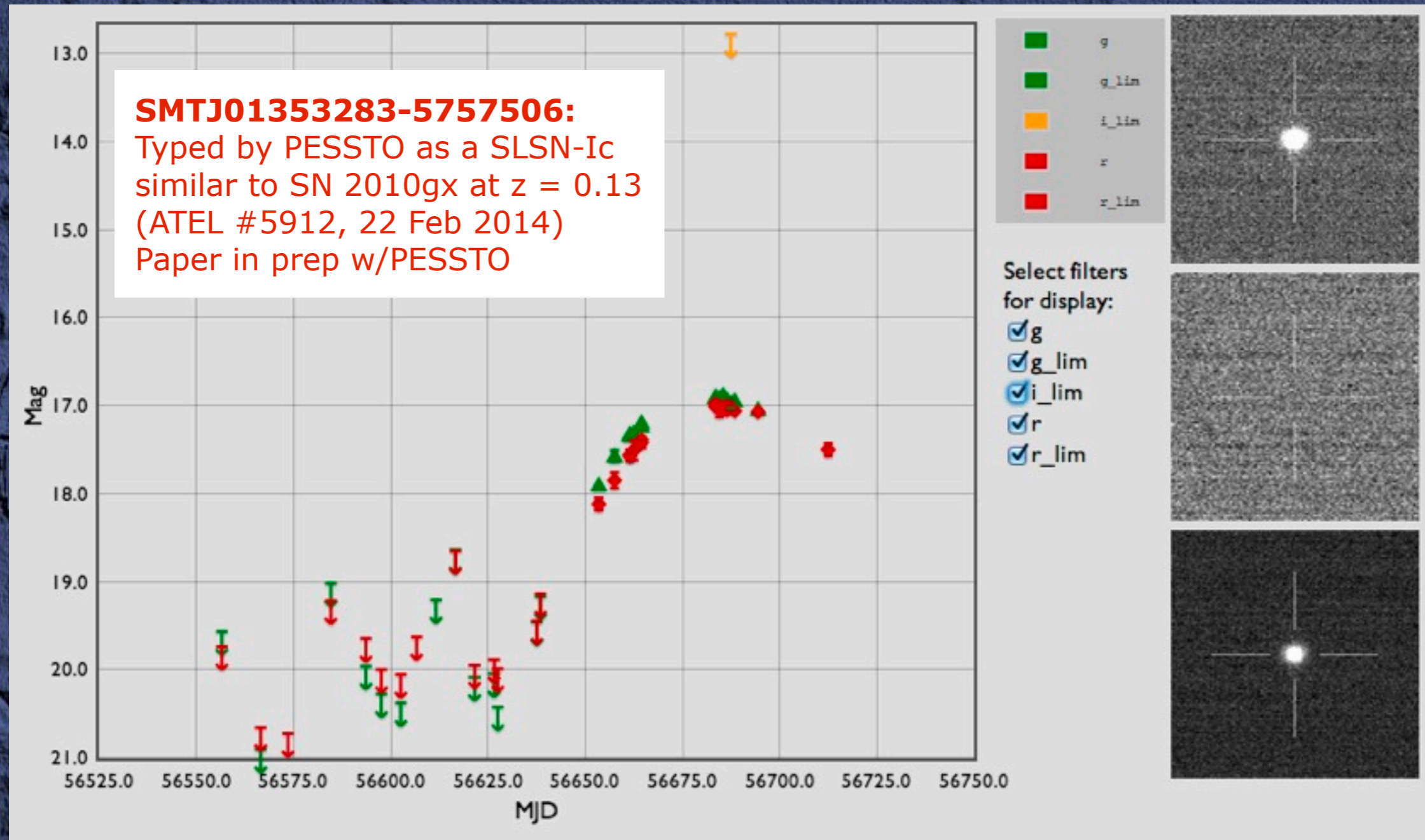
Subtractions (w/swarp, hotpants): already quite clean.

○: Bogus, ◇: Real, □: known asteroid.



10 SNe typed during commissioning

(More to come, esp. rare/exotic SNe like this one!)



CAASTRO FAQ - my answers

Q: Is it working?

A: Yes.

Q: How many SNe will you find?

A: At least 50 good Ia/year, hope for more once we get going (need to build up galaxy REF images).

Q: Can you follow up our radio transients? Just a few?

A: Yes. Ask Fang Yuan re: alert system for GRBs.

Q: Can we follow up your optical transients?

A: Please do! Our discoveries will all be public.

Summary & Conclusions

- We're taking a short break to update simulations of our survey strategy w/final SkyMapper PSF, etc.
- Still building cache of galaxy reference (REF) images so finding SNe may be tough for a while.
- Pipeline is being improved incrementally, but this version is fine for discoveries + quick light curves
- Coming soon: public SN discoveries, rapid follow-up, Ia cosmology and more!



Search design

Lessons learned from other searches:

- Shared resources (disk, SQL, ...) used sparingly, synchronously; I/O-intensive processes use /ramdisk
- OO Python design modular, fault-tolerant
Any stage can easily be re-run interactively



Search design

Quality control: click links to debug problems

SkyMapper Transient search

[Home](#) Logged in as user: rscalzo [Log out](#)

Click on the name of any subtraction to see its log file.
Click on a table header to sort the table by that quantity.
Click on a given failure stage or a failure condition to show only those table entries that have that failure or failure condition.

Results for all 585 jobs in run 20131113_000004

Job Name	Start Time	Wall Time	Exit Stage	Status
ref20131113_000004_0317_q_2013-11-13T00:31:43_01	Nov. 13, 2013, 12:39 a.m.	11.0 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_02	Nov. 13, 2013, 12:39 a.m.	12.0 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_04	Nov. 13, 2013, 12:39 a.m.	11.6 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_05	Nov. 13, 2013, 12:39 a.m.	11.3 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_06	Nov. 13, 2013, 12:39 a.m.	10.7 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_07	Nov. 13, 2013, 12:39 a.m.	11.7 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_08	Nov. 13, 2013, 12:39 a.m.	11.4 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_09	Nov. 13, 2013, 12:40 a.m.	10.8 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_10	Nov. 13, 2013, 12:40 a.m.	11.0 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_11	Nov. 13, 2013, 12:40 a.m.	11.0 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_13	Nov. 13, 2013, 12:40 a.m.	11.1 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_14	Nov. 13, 2013, 12:40 a.m.	11.0 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_15	Nov. 13, 2013, 12:40 a.m.	11.0 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_17	Nov. 13, 2013, 12:40 a.m.	12.5 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_18	Nov. 13, 2013, 12:40 a.m.	12.5 sec		Success
ref20131113_000004_0317_q_2013-11-13T00:31:43_19	Nov. 13, 2013, 12:40 a.m.	10.7 sec		Success

Search design

Quality control: click links to debug problems

The screenshot shows a web browser window with multiple tabs. The active tab is titled "maipenrai.anu.edu.au:8001/jobstats/sublogfile/sub20131113_000004_2569_r_2013-11-13T00:59:31_30/". The browser's address bar and bookmarks are visible. The main content area has a dark blue header with the text "SkyMapper Transient search". Below the header is a navigation bar with links for "Home", "Go to run 20131113_000004", and "Logged in as user: rscalzo Log out". The main heading is "Displaying log file for sub20131113_000004_2569_r_2013-11-13T00:59:31_30". The log content is as follows:

```
-----  
|           Executing stage unzip_REF at Wed Nov 13 01:10:30 2013           |  
-----  
Elapsed user time in unzip_REF: 0.470 sec  
Elapsed CPU time in unzip_REF: 0.040 sec  
Elapsed wall time in unzip_REF: 0.520 sec  
  
-----  
|           Executing stage unzip_REFMASK at Wed Nov 13 01:10:30 2013          |  
-----  
Elapsed user time in unzip_REFMASK: 0.050 sec  
Elapsed CPU time in unzip_REFMASK: 0.010 sec  
Elapsed wall time in unzip_REFMASK: 0.070 sec  
  
-----  
|           Executing stage unzip_REFMASK at Wed Nov 13 01:10:30 2013          |  
-----  
Elapsed user time in unzip_REFMASK: 0.040 sec  
Elapsed CPU time in unzip_REFMASK: 0.010 sec  
Elapsed wall time in unzip_REFMASK: 0.070 sec  
  
-----  
|           Executing stage WCS at Wed Nov 13 01:10:30 2013                   |  
-----  
  
To reproduce this step, run:  
STAP:FWKMR/STAP/STAP_WCS.py SkyMapper_893396069_00000_2013-11-13T00:59:31_30.fits SkyMapper_893396069_00000_2013-11-13T00:59:31_30_wcs.fits  
  
STAP_callexternal running: /export/maipenrai/skymap/rscalzo/subpipe/WCS/bin/WCS-perchip.py SkyMapper_893396069_00000_2013-11-13T00:59:31_30.fits --outname SkyMapper_893396069_00000_2013-11-13T00:59:31_30_wcs.fits  
/export/maipenrai/skymap/rscalzo/subpipe/WCS/bin/runsex.pl SkyMapper_893396069_00000_2013-11-13T00:59:31_30_wcs.fits 10 -mask SkyMapper_893396069_00000_2013-11-13T00:59:31_30.fits.mask  
Number of good stars: 119  
RA DEC read from Header 23:41:25.884 -40:02:52.74  
RA:23:41:25.884 DEC:-40:02:52.74 Scale:0.494 arcsec/pixel  
/export/maipenrai/skymap/rscalzo/subpipe/WCS/bin/readImage.pl SkyMapper_893396069_00000_2013-11-13T00:59:31_30_wcs.fits catalog 23:41:25.884 -40:02:52.74 10 10 10 10 10 10 10 10 10 10
```

Candidate browser/vetter

SkyMapper Transient x SkyMapper Transient x SkyMapper SN Search x 223rd AAS Meeting x IMIS x Current AAS Job Rep x

maipenrai.anu.edu.au:8001/transients/SKY_J21413915-5643445/

Apps Reference Australia Links Skymapper PESSTO OzDES SNfactory Zoo OmniFocus Extras Goggles Other Bookmarks

This transient is currently classified as: Ia

Use the form below to change its type.

Roid Star ? VarStar BadSub Junk BadRef Cand SN Ia other

Additional comment?(no more than 100 characters please):

Submit

Information from SMT database

Select the filters you want to plot. Click data point in the figure to view thumbnails and other details.

Filter	Mag	MJD
g	20.37	56569.5
r	20.00	56573.5

Select filters for display:
 g
 r

RUNTAG	20131012_000653
FILTER	r
SM_FIELD	3274
SUBFIELD	23
SM_CCD	23
DATE_OBS	2013-10-09T13:47:15
JD_OBS	2456574.07448
X_IMAGE	573.17
Y_IMAGE	3818.99
ALPHA_J2000	325.41318
DELTA_J2000	-56.72905
EXPTIME	60
FLUX_AP4	744.87
FLUX_AP4_ERR	59.5
FLAGS	0
RSSCORE	100
APCORR04	0
APCERR04	99.99
IPMAG	27.18
IPMAGERR	0.12
MAG_CAL	20
MAG_CAL_ERR	0.15
THUMB_NEW	SKY_J21413915-5643445_sub20131012_000653_10-09T00:45:21_23_new.p
	SKY_J21413915-