The Pan-STARRS Wide-Field Imaging Survey Current status - early science - future prospects

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Pan-STARRS

PS1 Science Consortium

Institute for Astronomy
University of Hawaii

MPE

NASA

Max-Planck-Institut für Astronomie Heidelberg
Max Planck Institute for Astronomy Heidelberg

VE RI TAS

Las Cumbres Observatory
Global Telescope Network

Johns Hopkins University

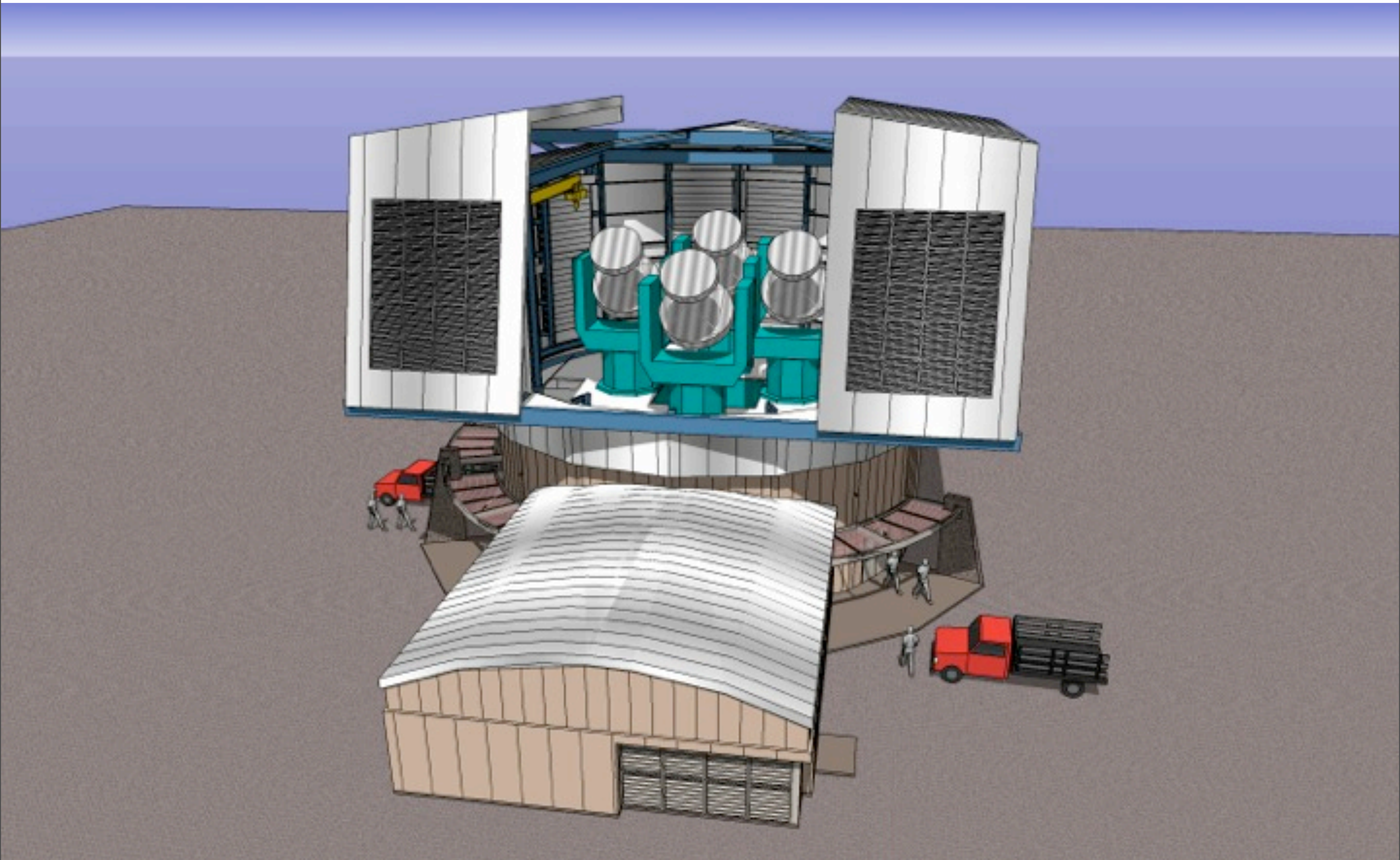
The University of Edinburgh

Durham University

Queen's University Belfast

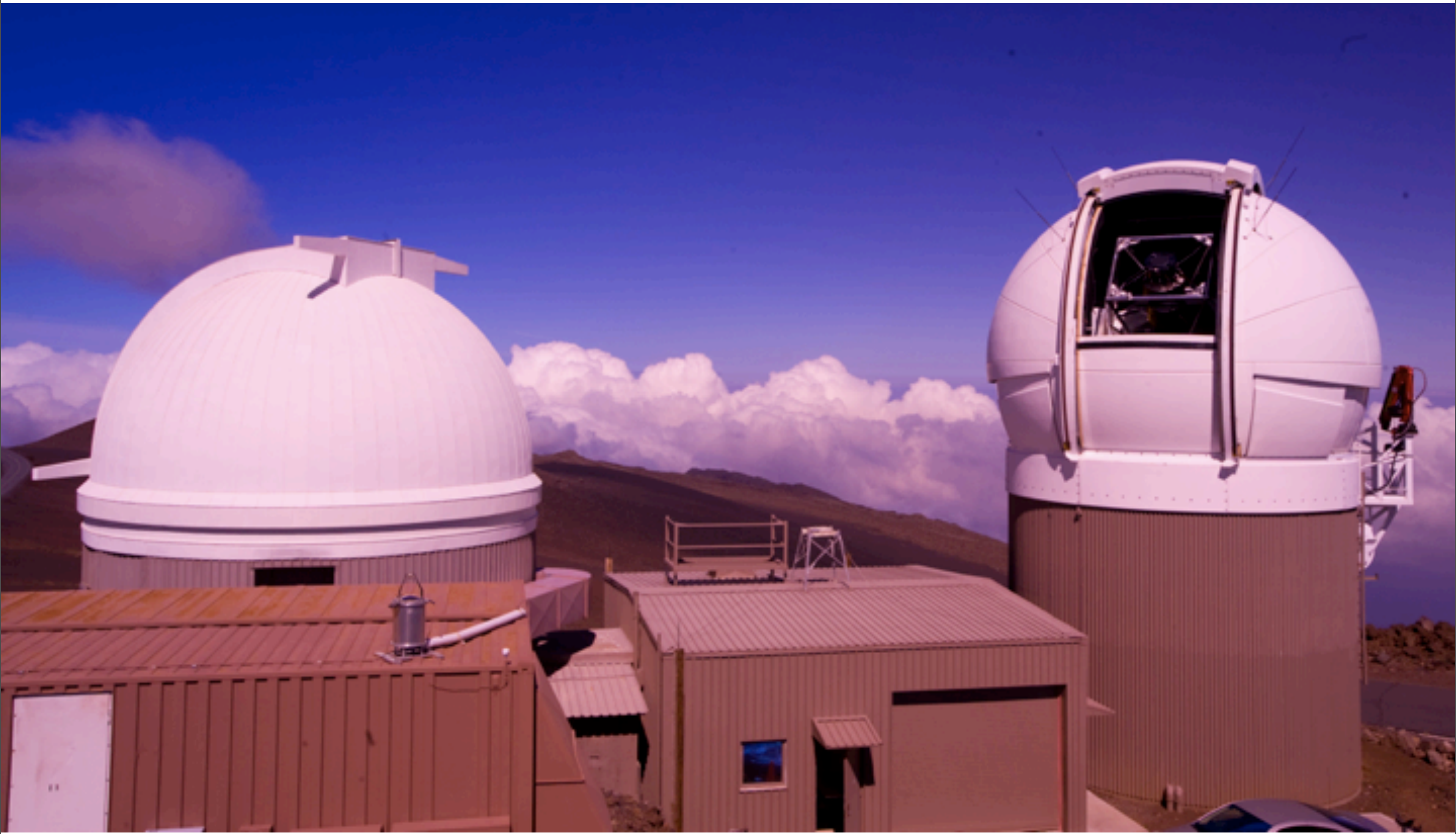
國立中央大學

Pan-STARRS PS4 Observatory

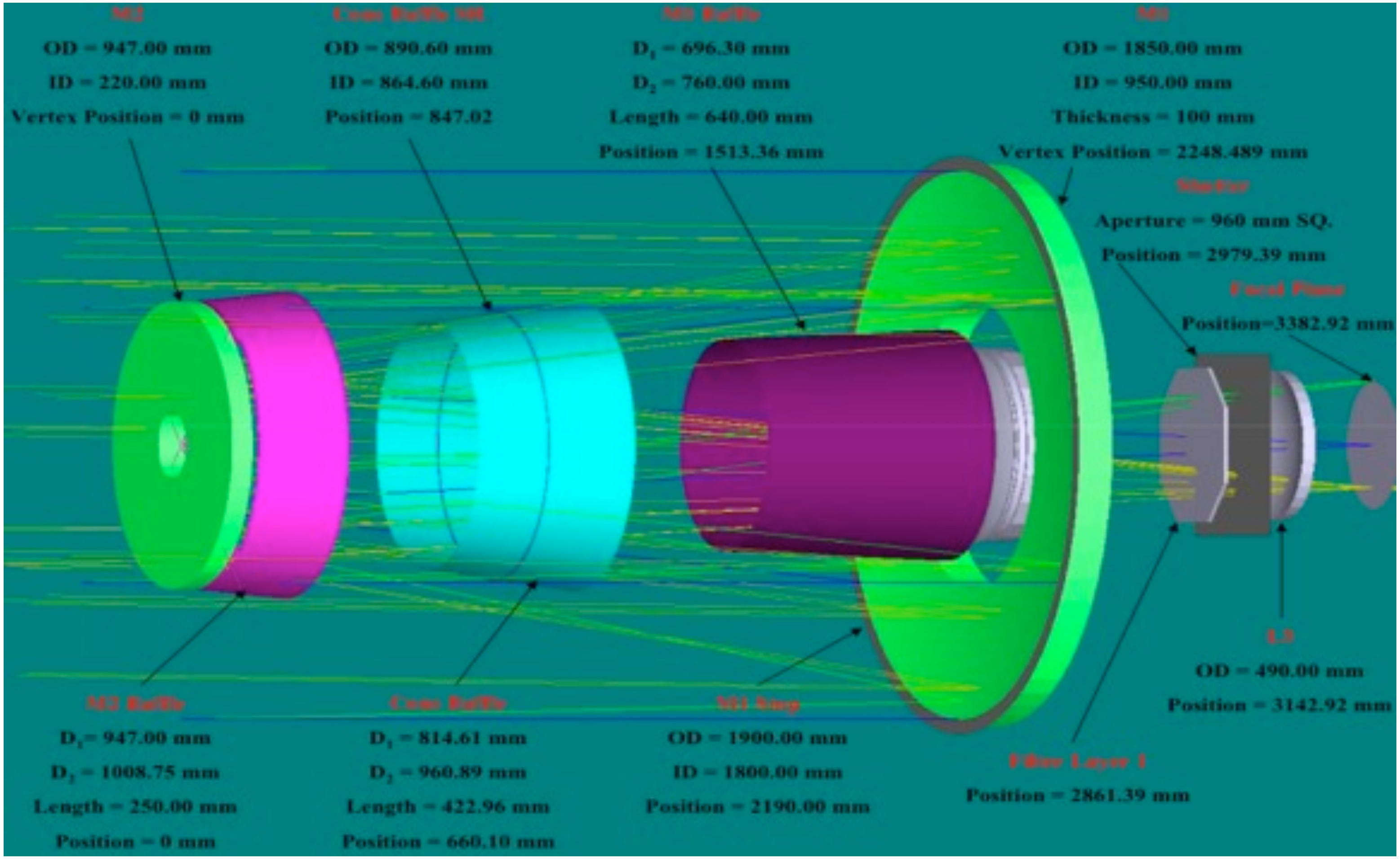


PS1

PS1+2

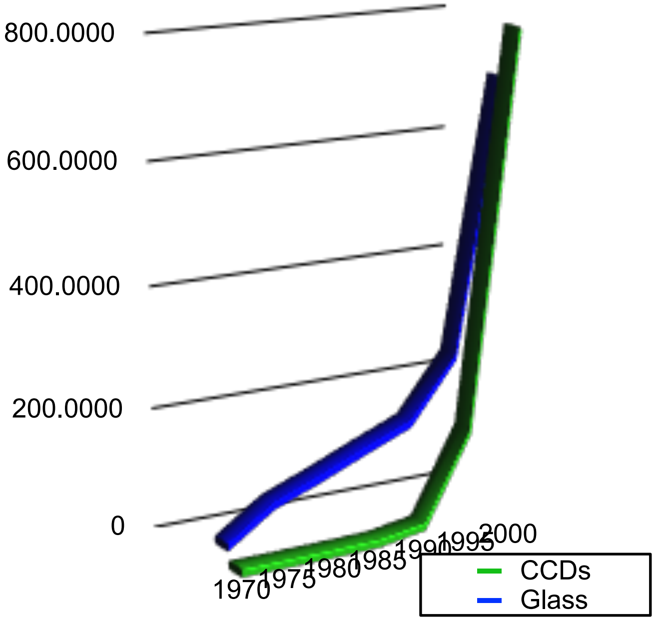


Pan-STARRS Opical Design

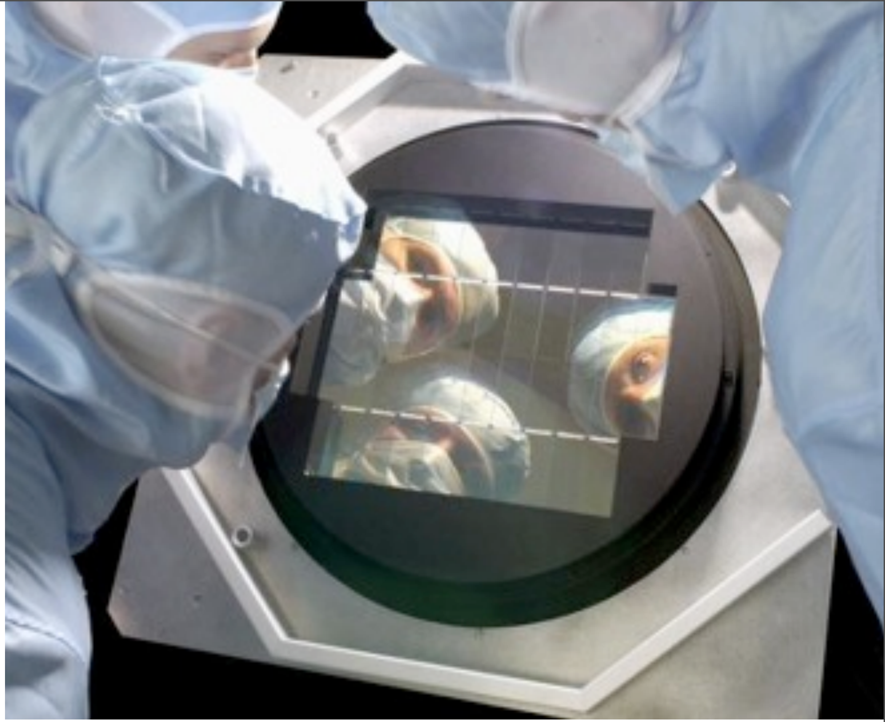


Trends in Astronomy Technology

- Future dominated by detector improvements

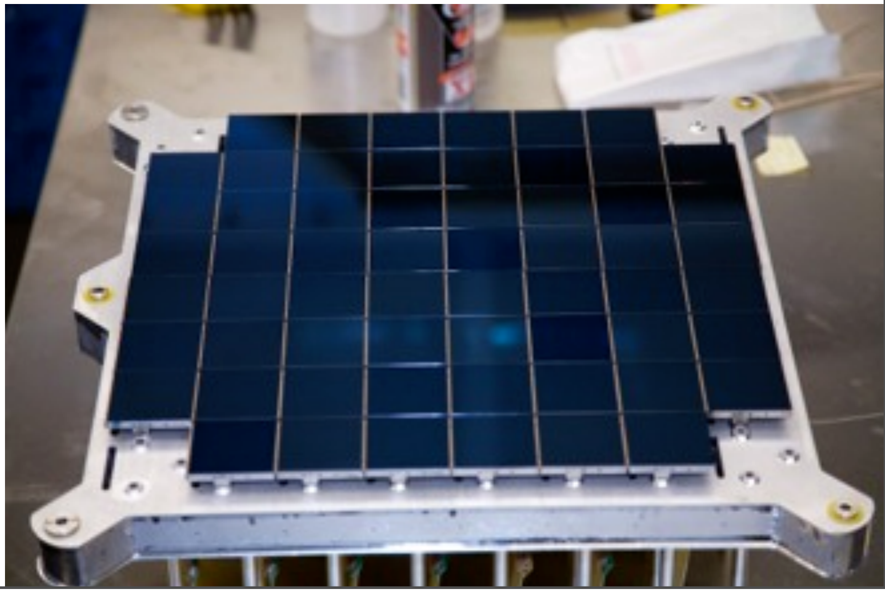


Total area of 3m+ telescopes in the world in m², total number of CCD pixels in Megapix, as a function of time. Growth over 25 years is a factor of 30 in glass, 3000 in pixels.

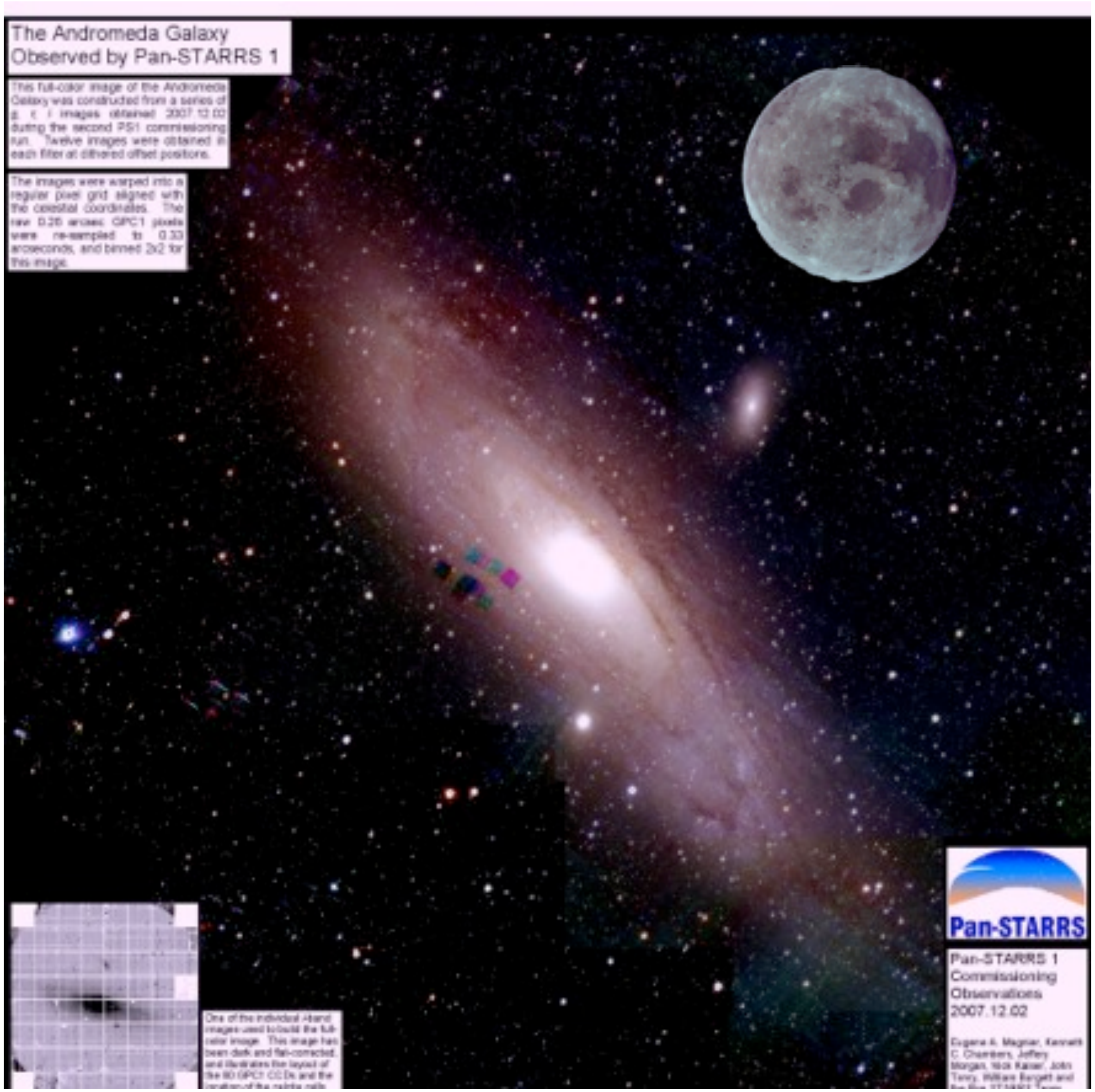


300 Mpix 'megacam' at CFHT

1.4 Billion pixel GPC1 at PS1



PS1 Commissioning Image – M31 inside GPC FOV



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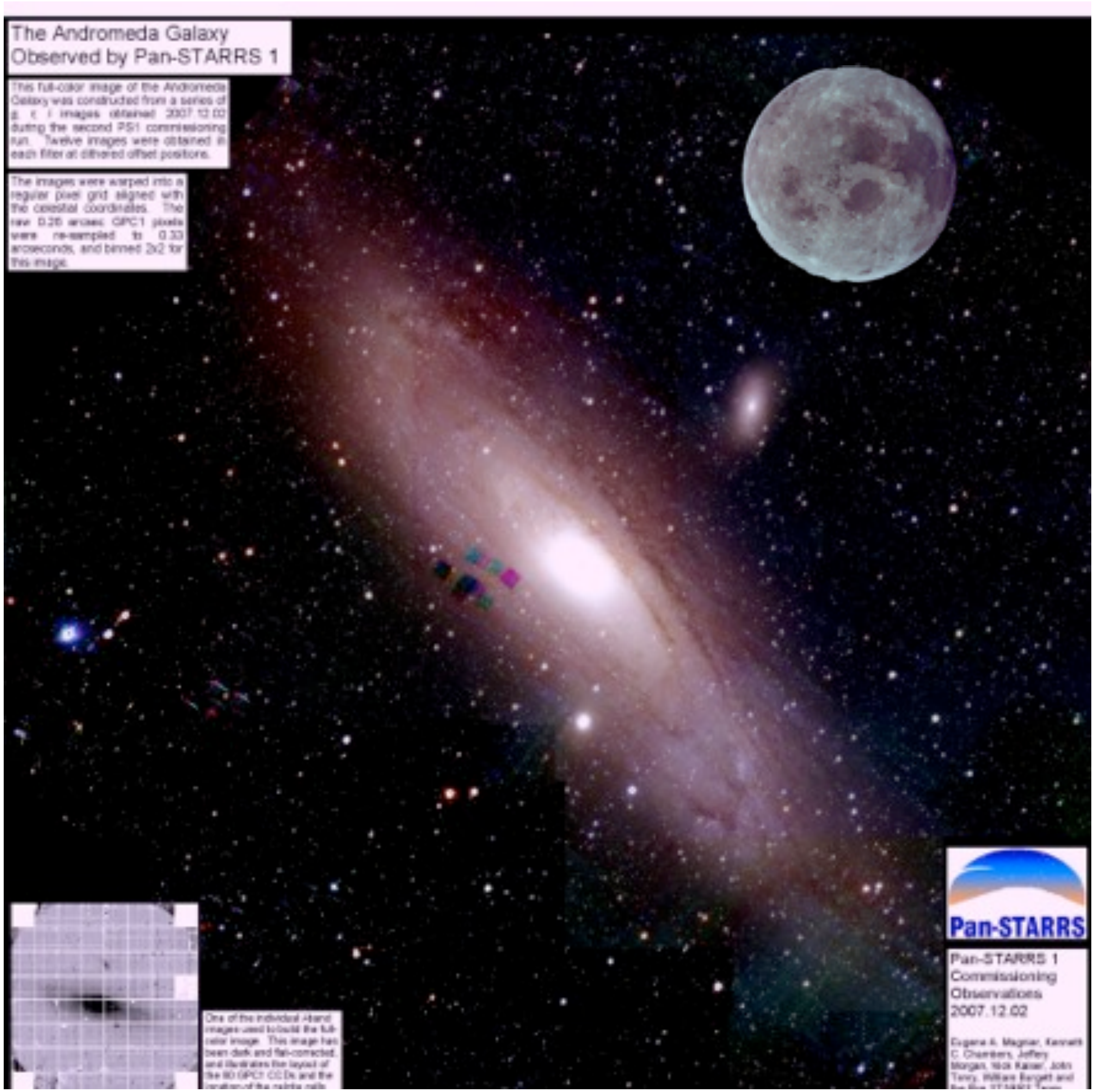
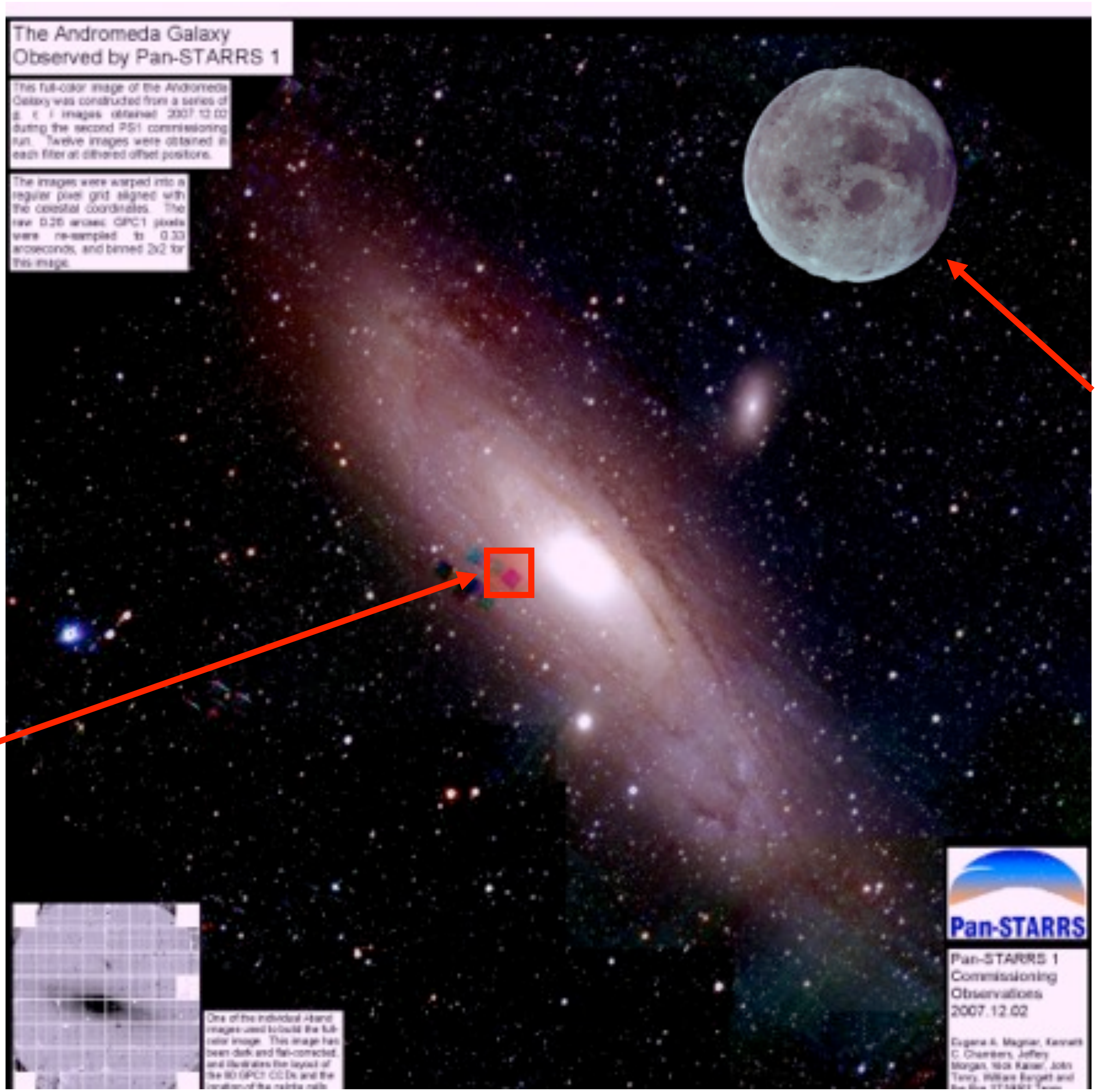


0.5º diameter of Moon only small fraction of GPC FoV

PS1 Commissioning Image – M31 inside GPC FOV

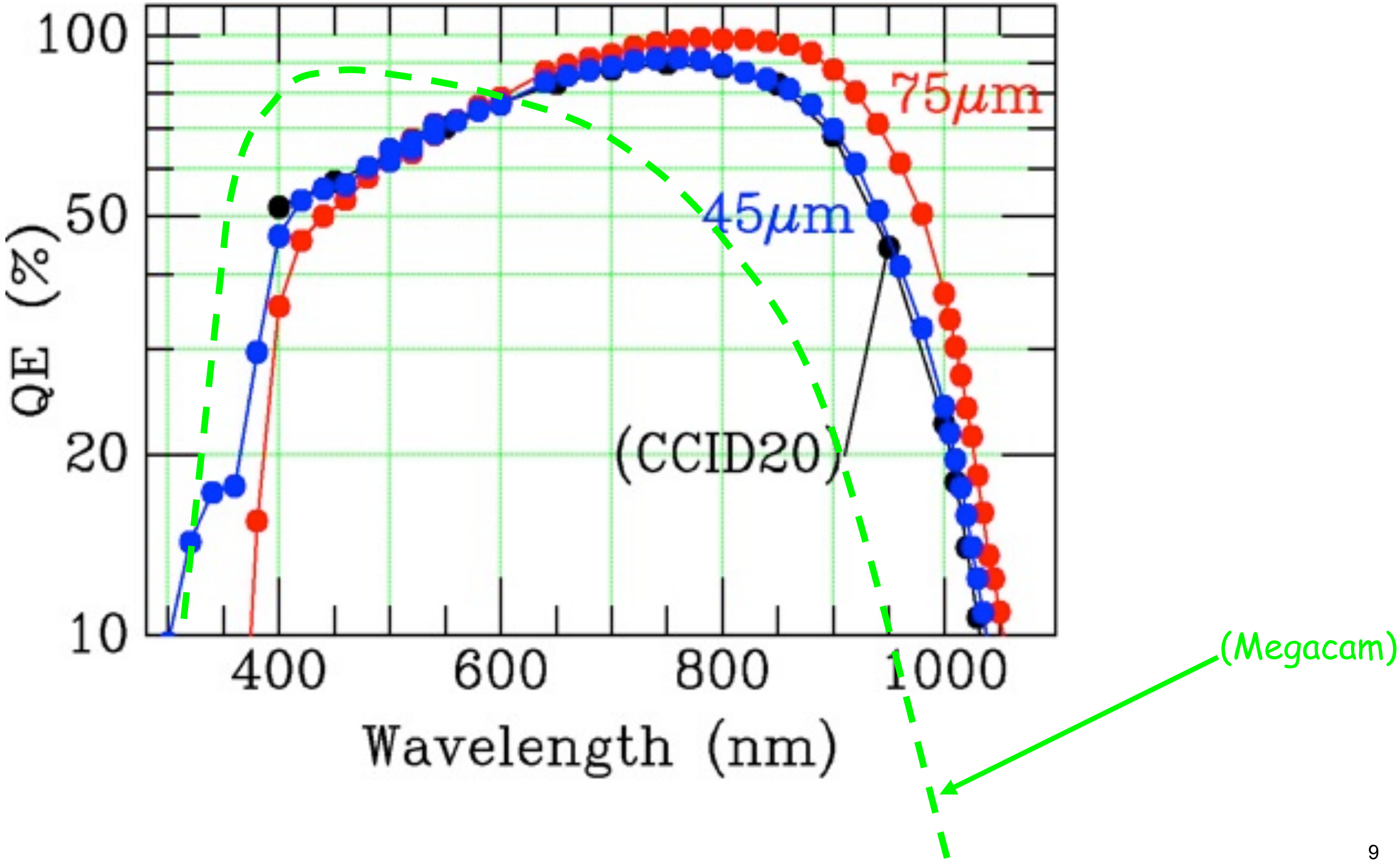


0.5º diameter of Moon only small fraction of GPC FoV

FoV of standard world class research telescope

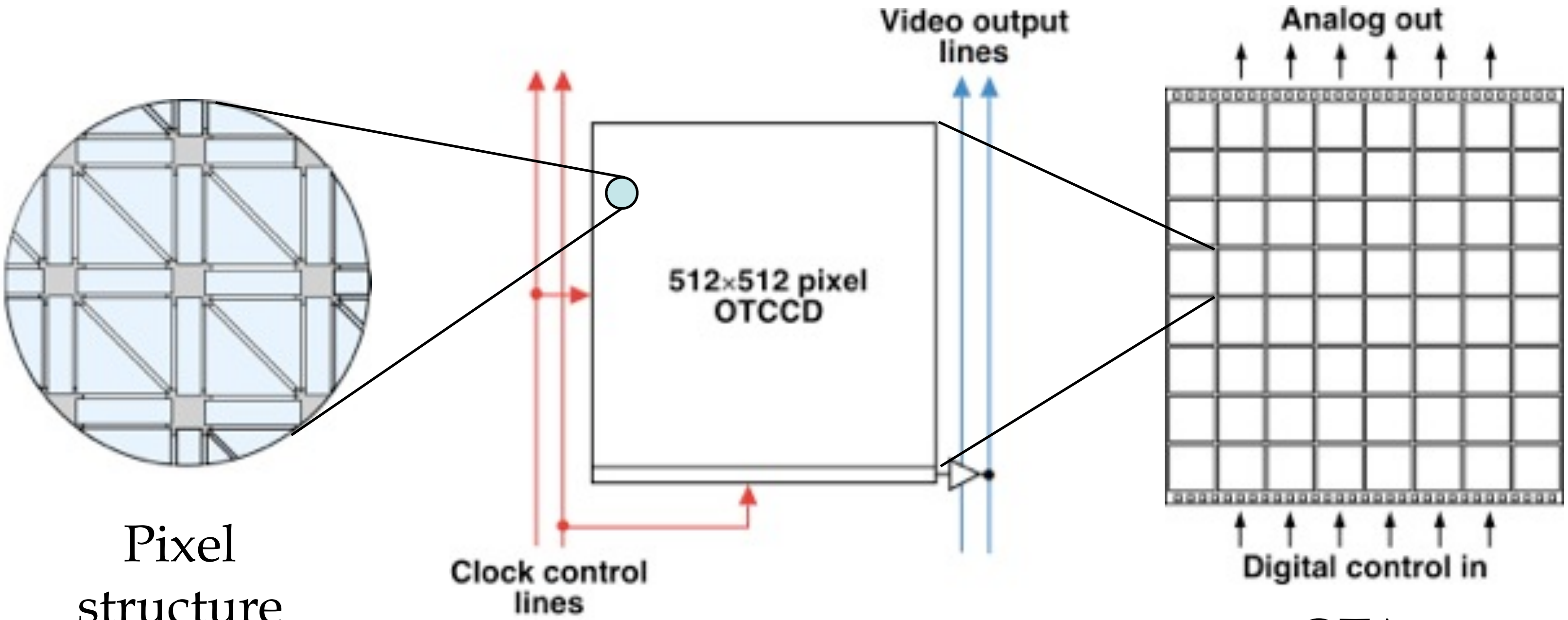
OTA Quantum Efficiency

- OTAs demonstrate expected QE (-65ºC)
  - 70um thick devices have exceptional QE at 1um



Orthogonal Transfer Array

- A new paradigm in large imagers.
- Partition a conventional large-area CCD imager into an array of independently addressable CCDs (cells).
- Massively parallel design allows rapid read-out -> rapid sky coverage



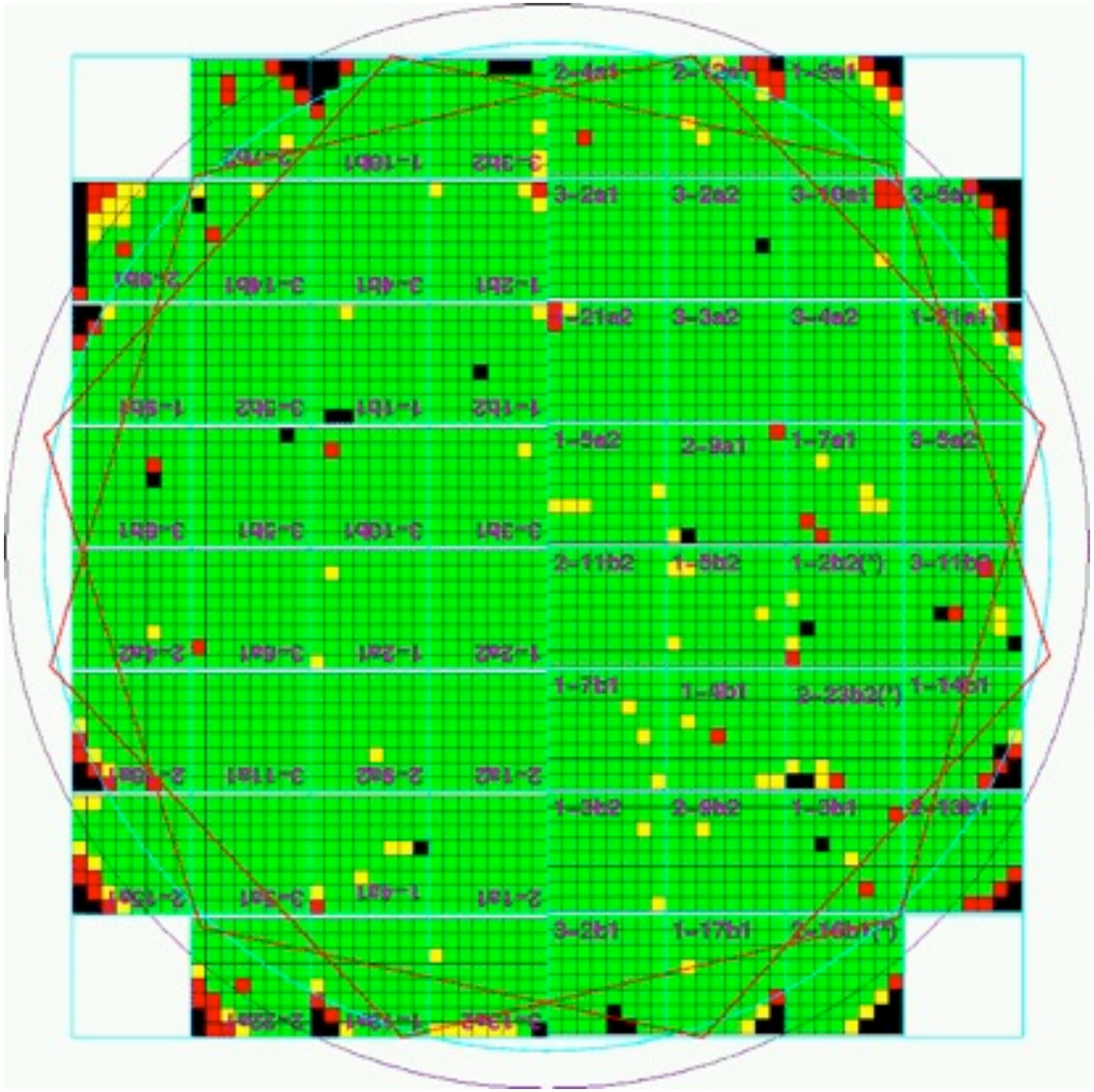
Pixel structure

Independently Addressable Cell

OTA: 8x8 Array of Cells

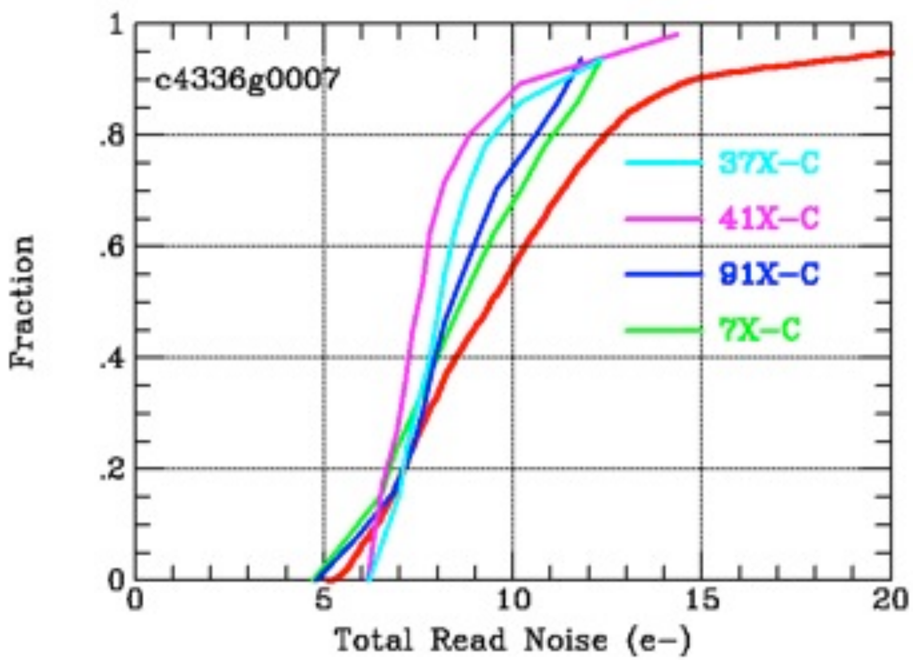
GPC1 Cell Status (post-refurb)

- Cell colors
  - Black = useless
  - Red = probably useless
  - Yellow = probably useful
  - Green = OK
- Cyan circle = 3º
  - 1.7% loss
- Black circle = 3.3º
  - 3.4% loss
- Red = hexagonal sky tesselations



Read Noise Distribution (Nov 2007)

N.B. This is total noise including $1W/m^2$ RFI. Expect to achieve about 6e- with CCID58, 4e- with CCID64

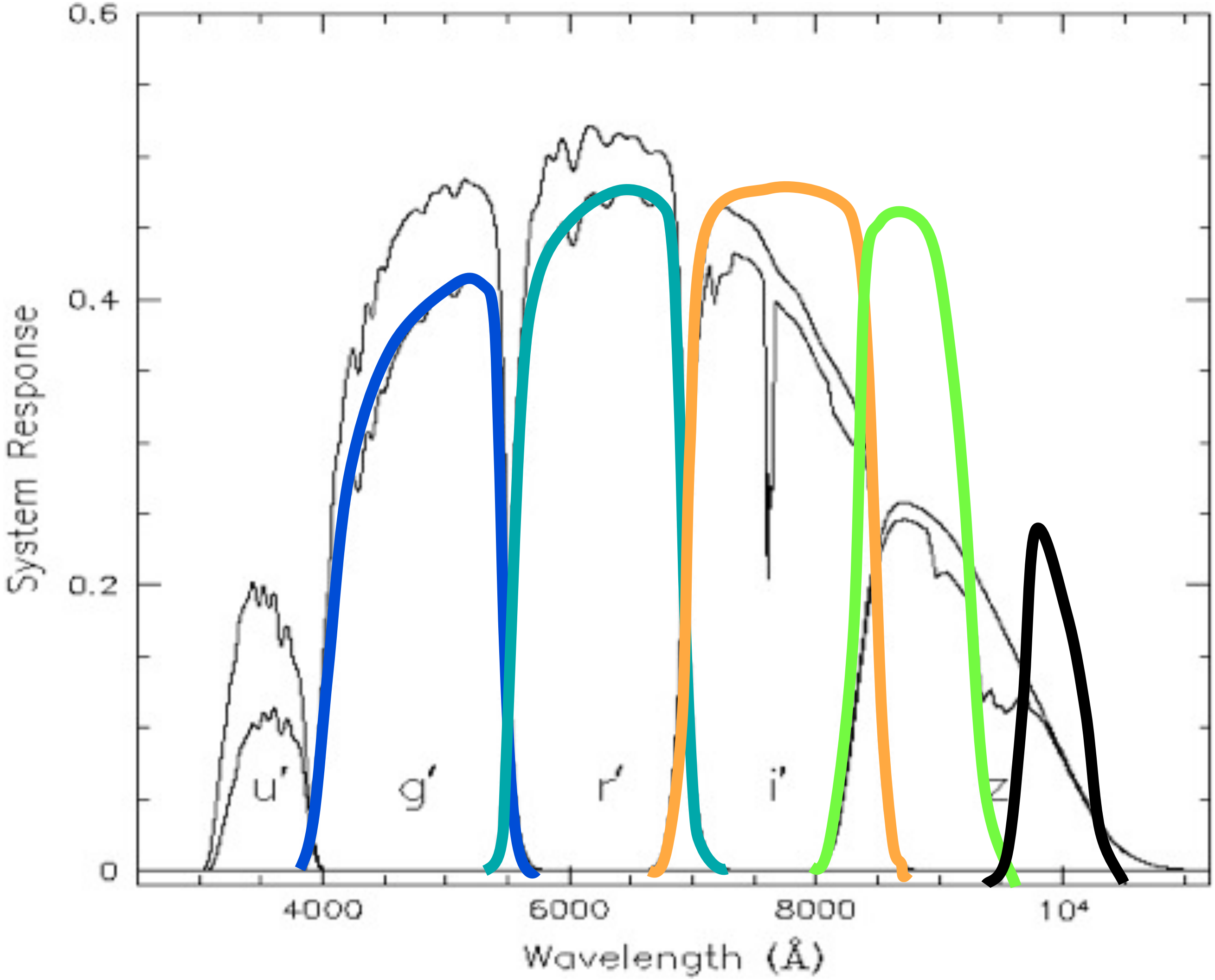


Filter	m1 (mag)	sky (mag/")	sky (e/pix/s)	3pi exp (sec)	3pi sky (e/pix)	MD exp (sec)	MD sky (e/pix)
g	24.90	21.90	1.1	60	63	240	253
r	25.15	20.86	3.5	38	132	240	831
I	25.00	20.15	5.8	30	174	240	1391
z	24.63	19.26	9.4	30	281	240	2246
y	23.03	17.98	7.0	30	209	240	1673

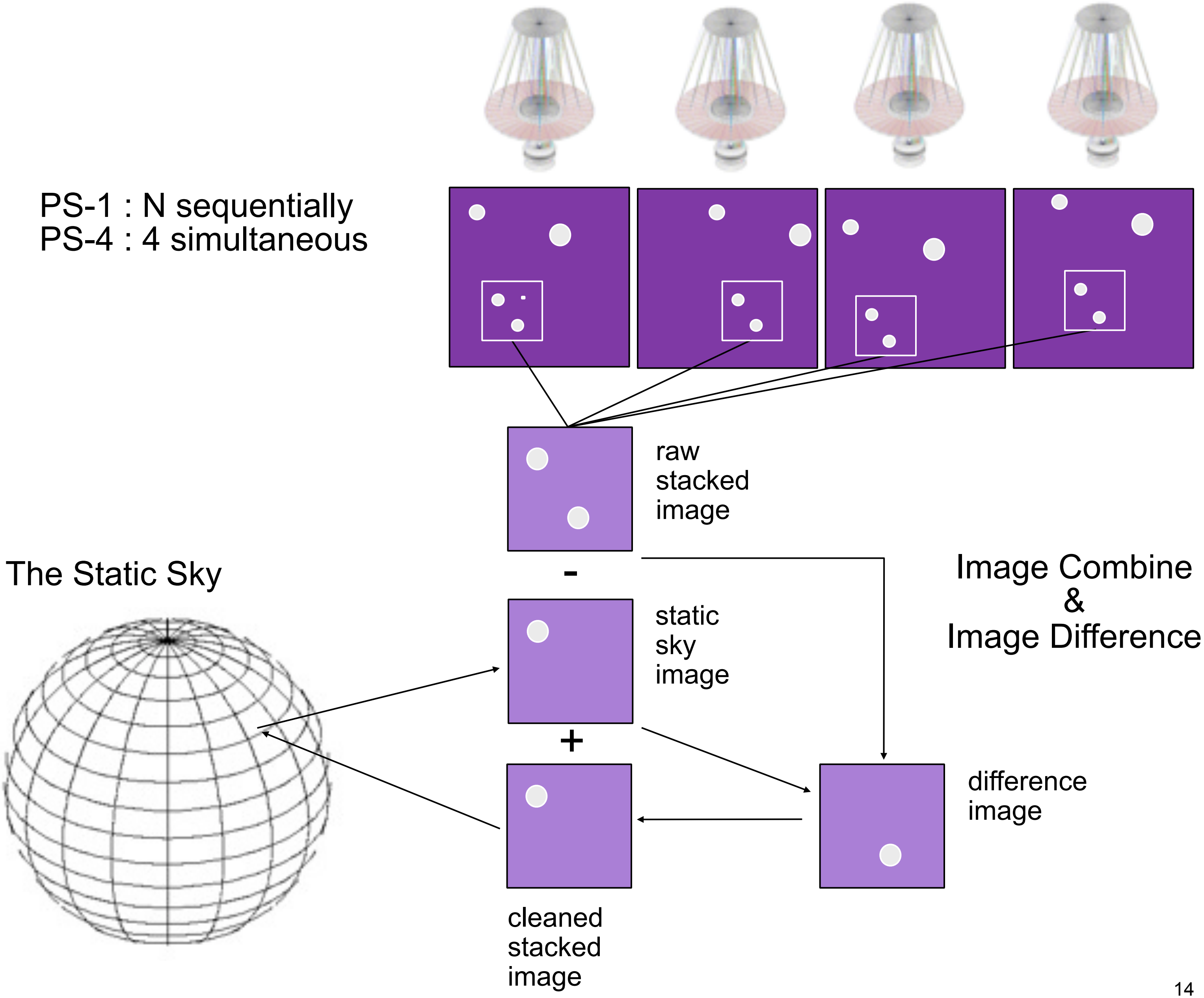
4336 = 07-08-24

SDSS and Pan-STARRS Bandpasses

Filters closely matched to SDSS - no U-band, but added Y-band at 1 micron with exceptional quantum efficiency



IPP: Real-Time Image Analysis



IPP Cluster Hardware

Cores = 820 (present) + 564 (Nov 2011) = 1480 total at MHPCC

Storage = 1.340 Petabytes (present) + 520 TB (Nov 2011) = 1.860 Petabytes at MHPCC

Slow Mirror of raw data = 360 Terabytes (present) + 400 (2012) = 760 TB at ATRC

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Durham
University

Queen's University
Belfast

PS1 Key Science Areas

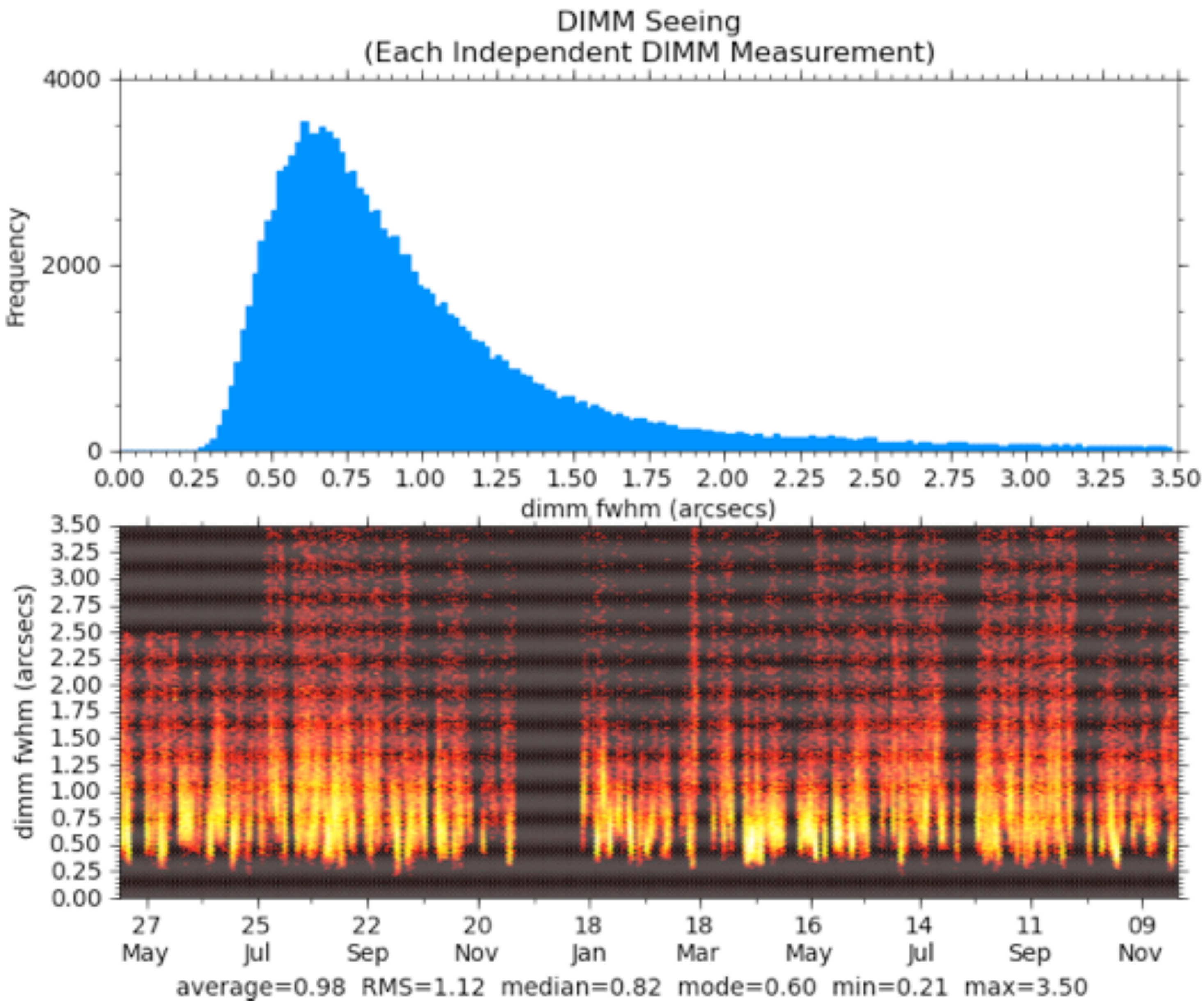
- Populations of objects in the Inner Solar System
- Populations of objects in the Outer Solar System
- Low-Mass Stars, Brown Dwarfs, and Young Stellar Objects
- Search for Exo-Planets by dedicated Stellar Transit Surveys
- Structure of the Milky Way and the Local Group
- A Dedicated Deep Survey of M31
- Massive Stars and Supernovae Progenitors
- Cosmology Investigations with Variables and Explosive Transients
- Galaxy Properties
- Active Galactic Nuclei and High Redshift Quasars
- Cosmological Lensing
- Large Scale Structure

PS1 Surveys

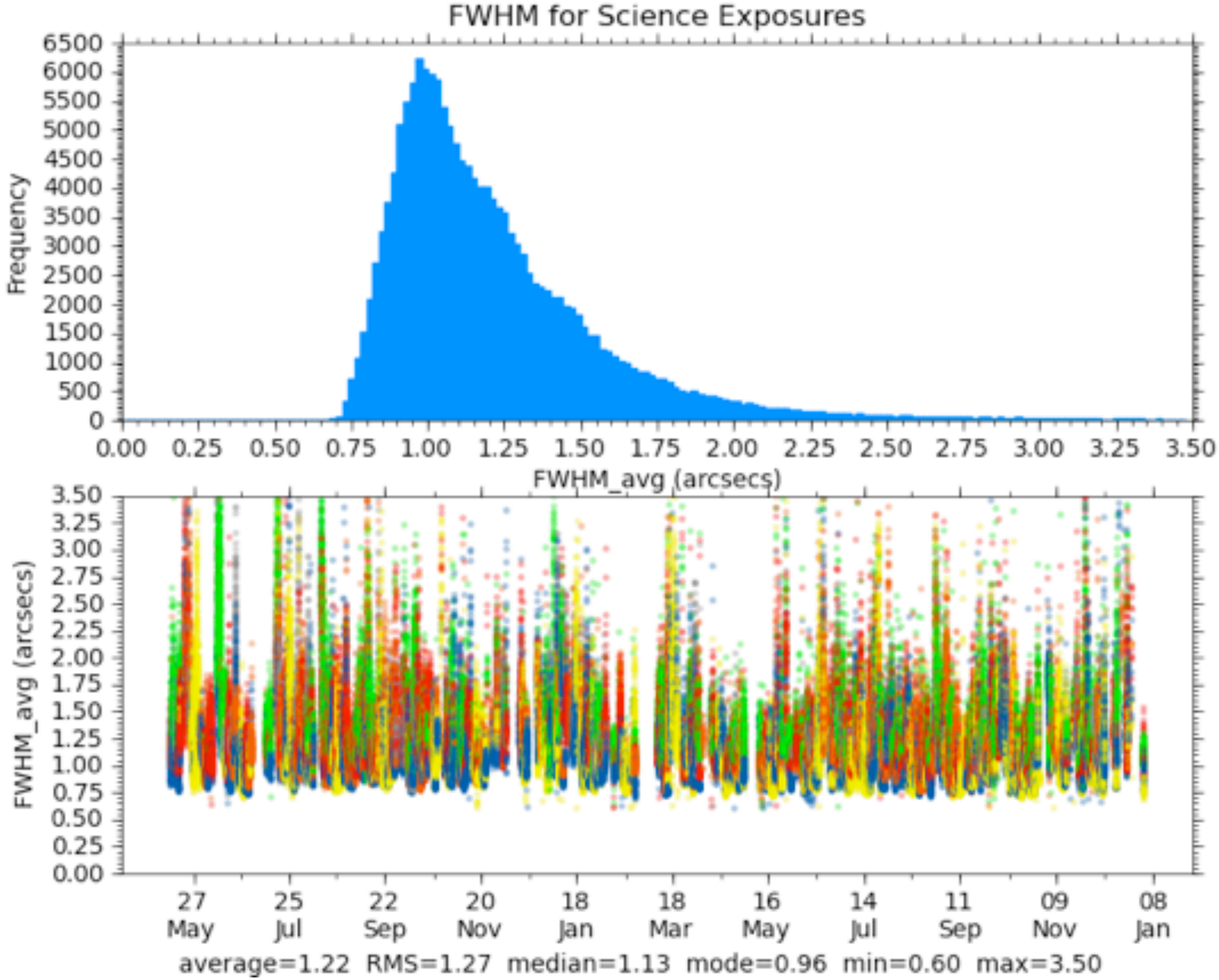
Table 2: *The PS1 Mission Concept Surveys and time distribution.*

PS1 Surveys	Filters	Percent time
3 π Steradian Survey	g, r, i, z, y	56
Calibration Fields	g, r, i, z, y	2
Medium Deep Survey	g, r, i, z, y	25
Solar System "Sweet Spot" Survey	r	5
Stellar Transit Survey -"PanPlanets"	i	4
Microlensing in M31 "Pandromeda" Survey	g, r, i, z, y	2
Principal Investigator Discretionary Time		6

Observing Metrics: May 13 2010 to Jan 1, 2012



Observing Metrics: May 13 2010 to Jan 1, 2012



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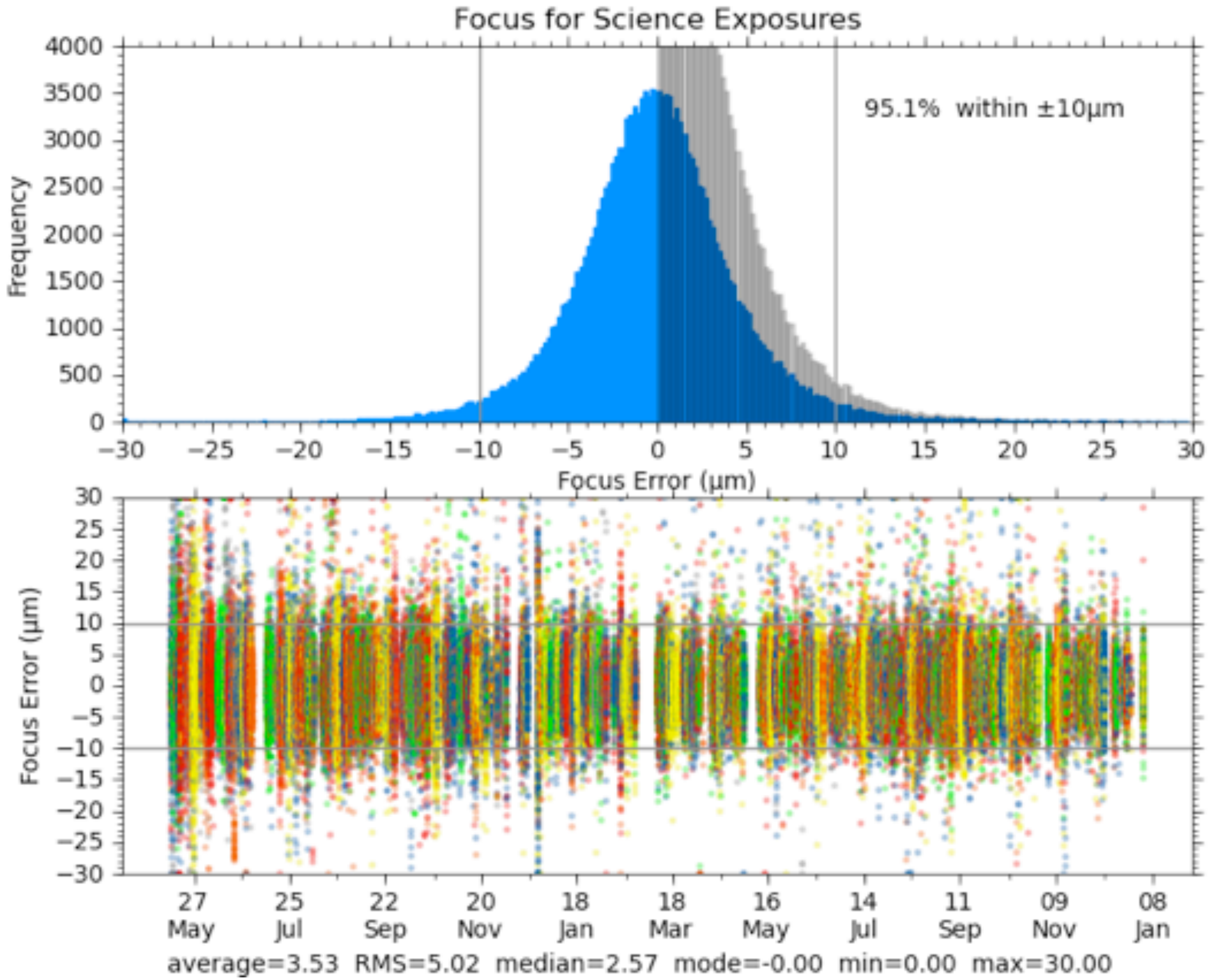
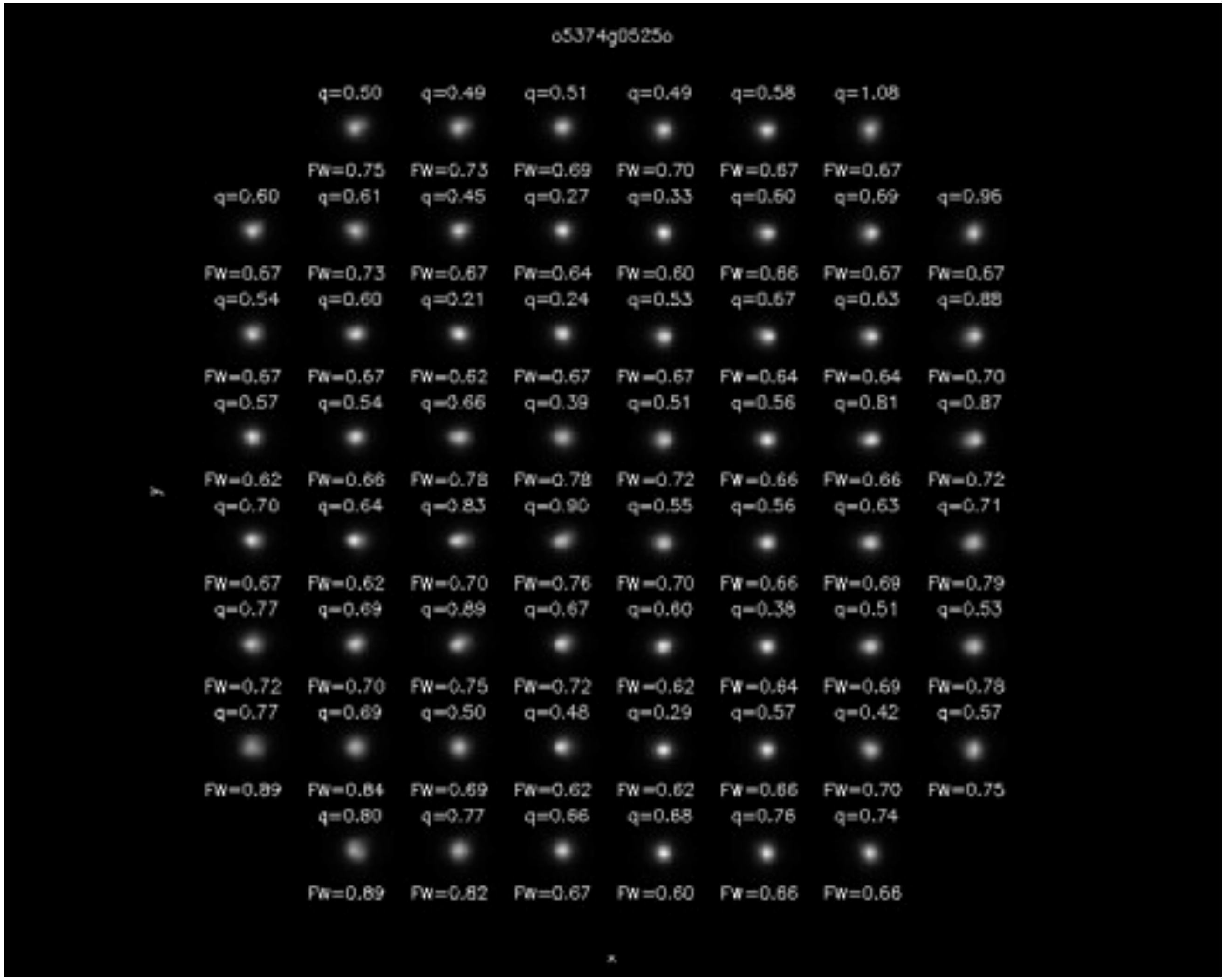


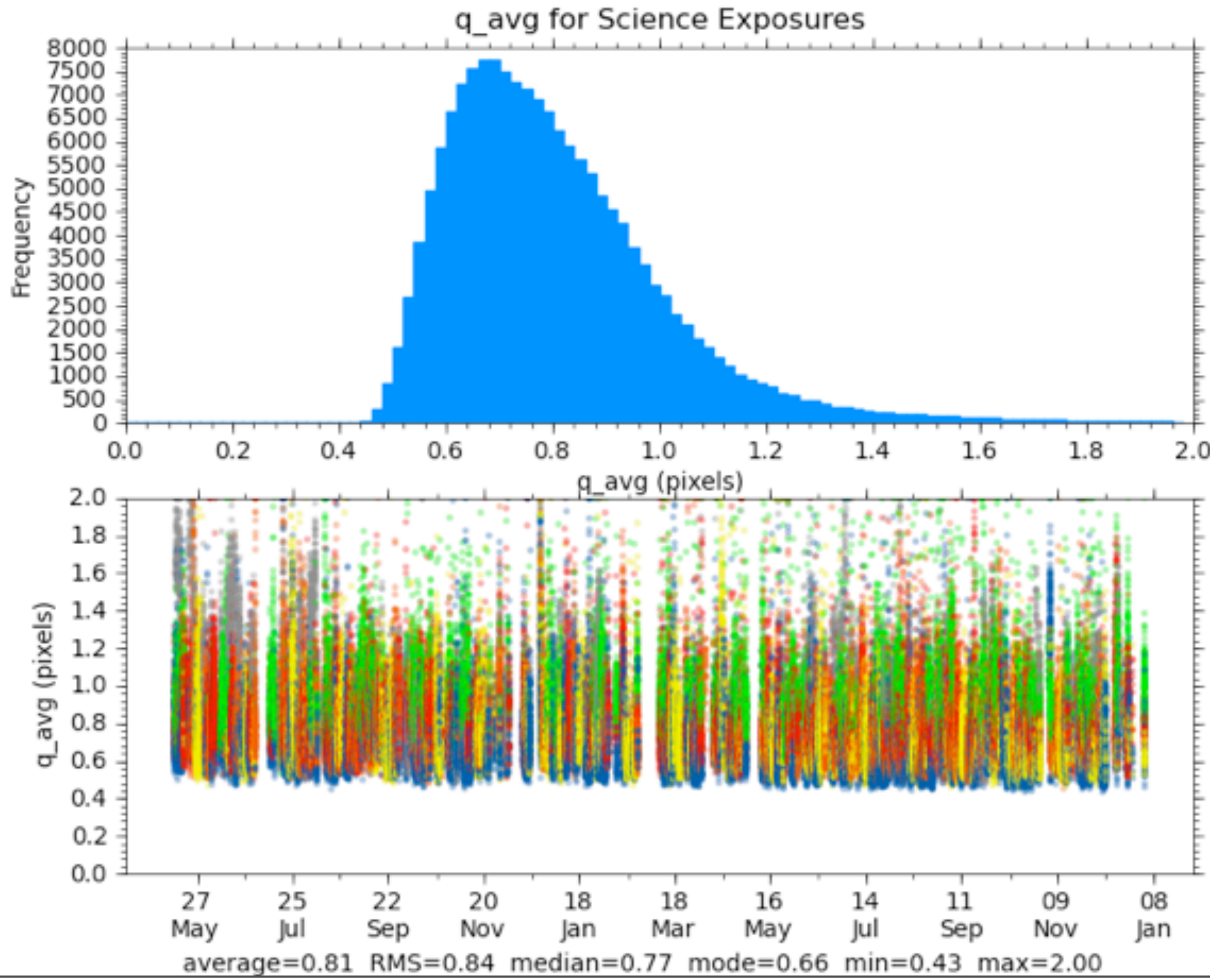
PS1 IQ – Smallest Image Median FWHM to Date



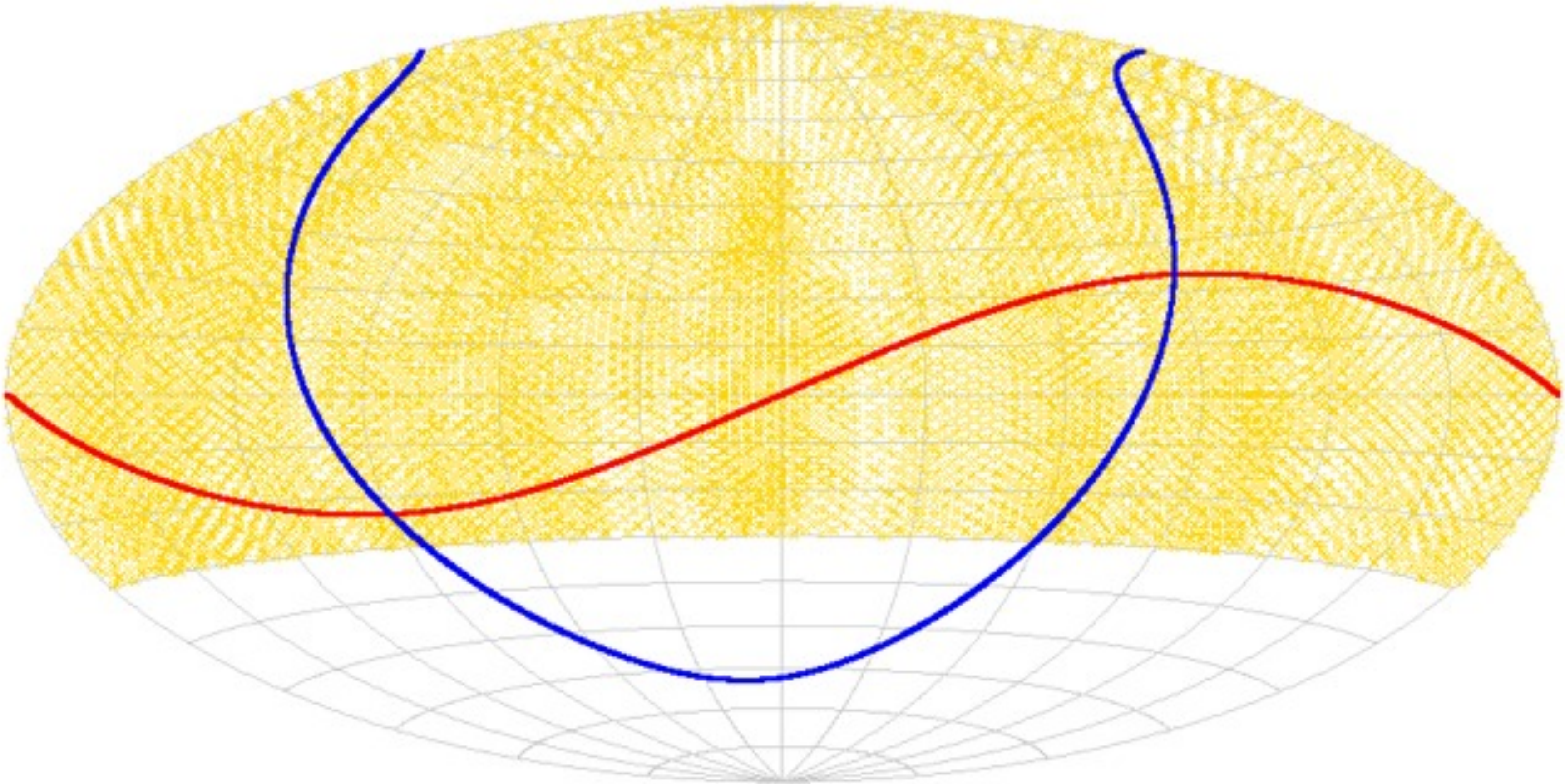
NK FWHM = 0.69", JT FWHM = 0.63″

q = measure of circularity of 2D PSF

Observing Metrics: May 13 2010 to Jan 1, 2012

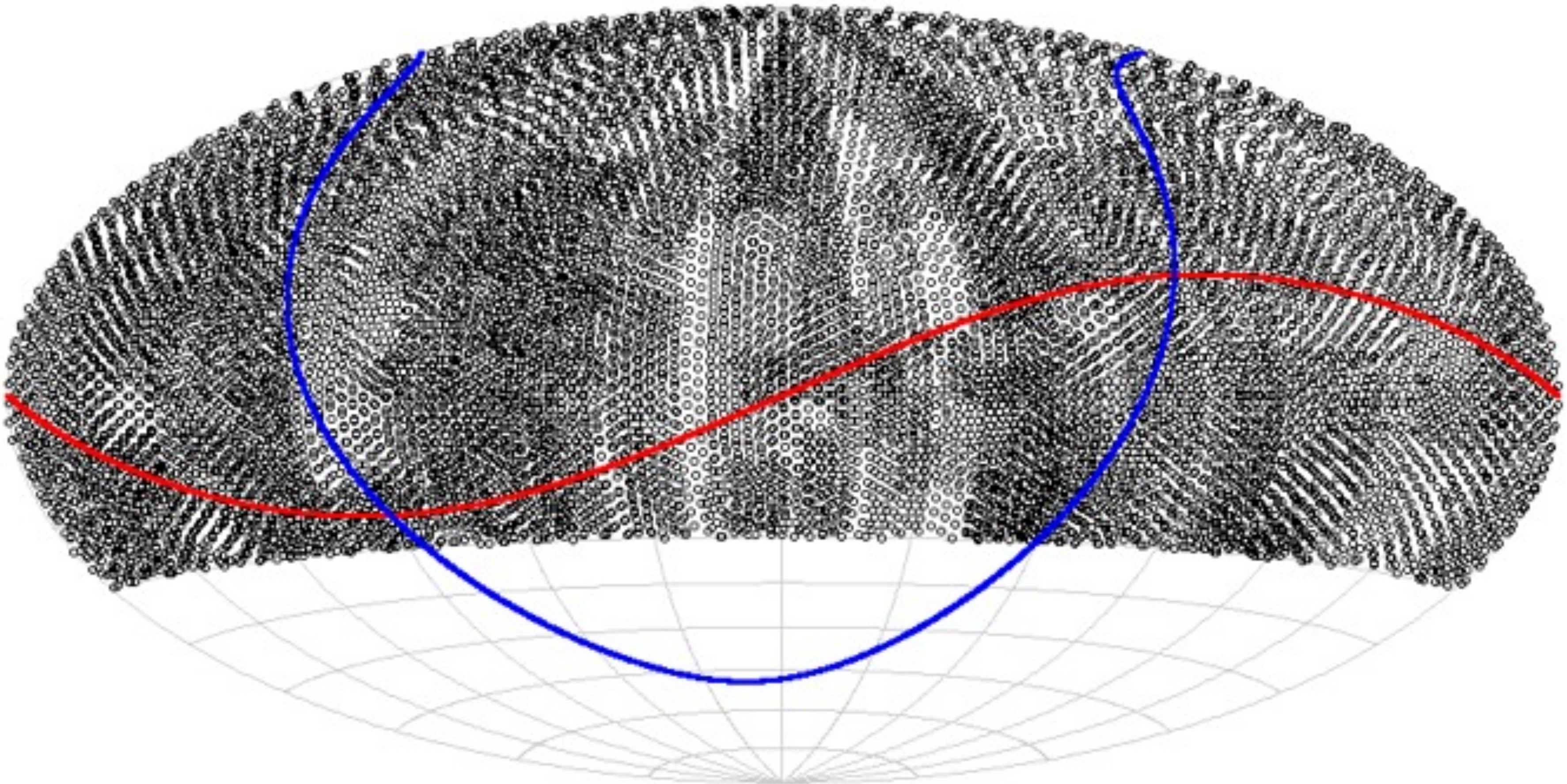


3pi sky coverage to Jan 1, 2012



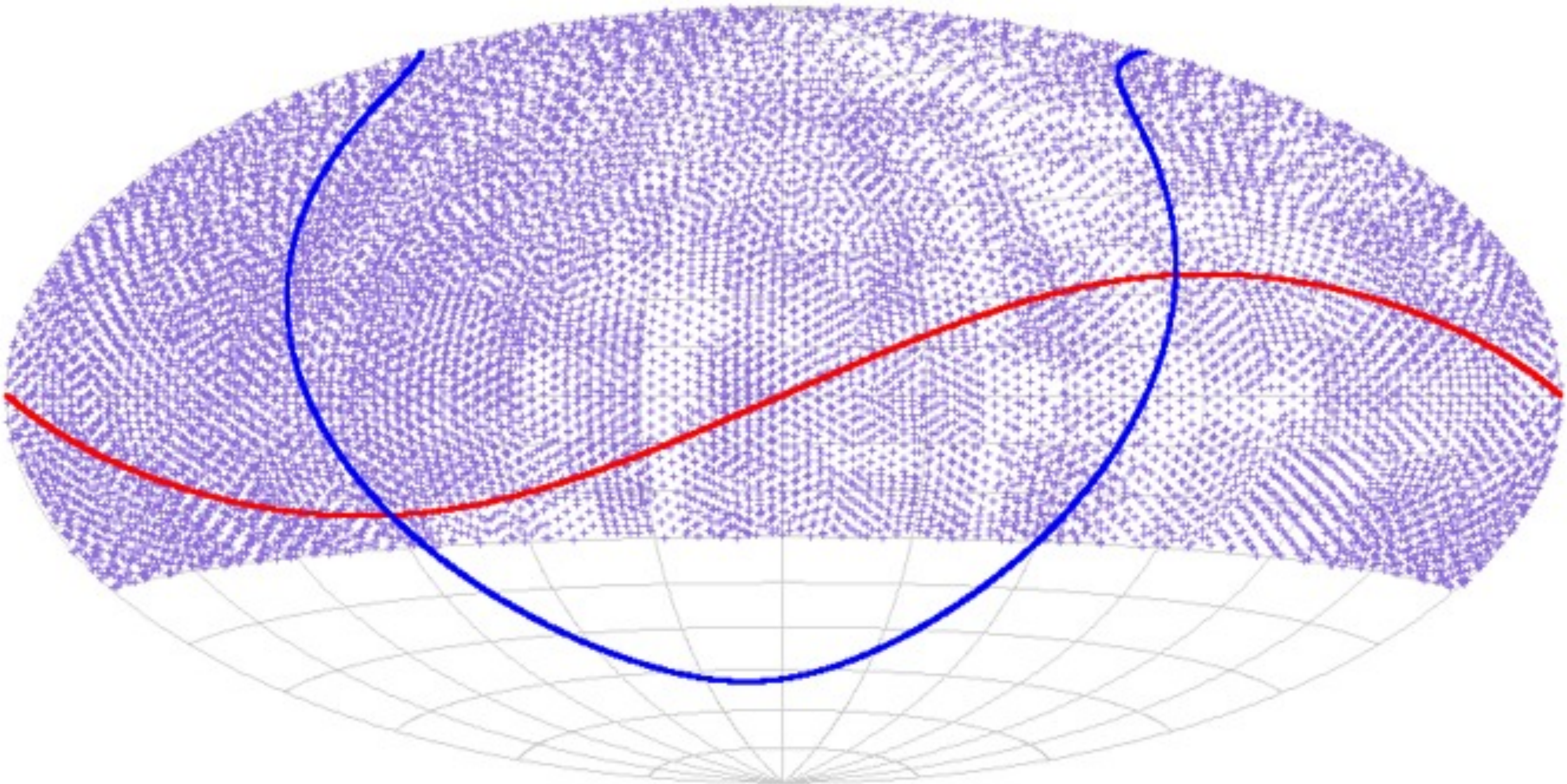
y band

3pi sky coverage to Jan 1, 2012



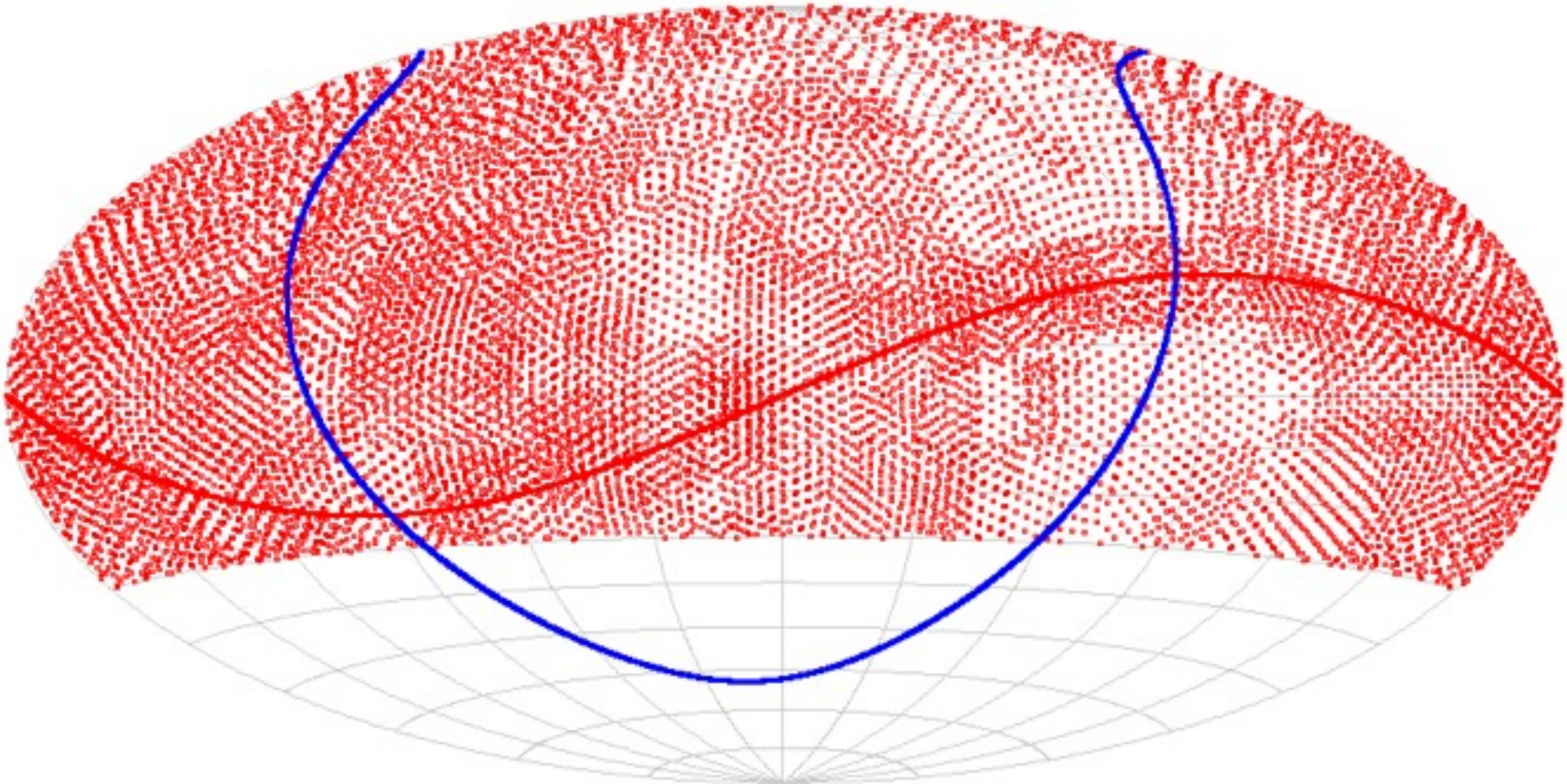
z band

3pi sky coverage to Jan 1, 2012



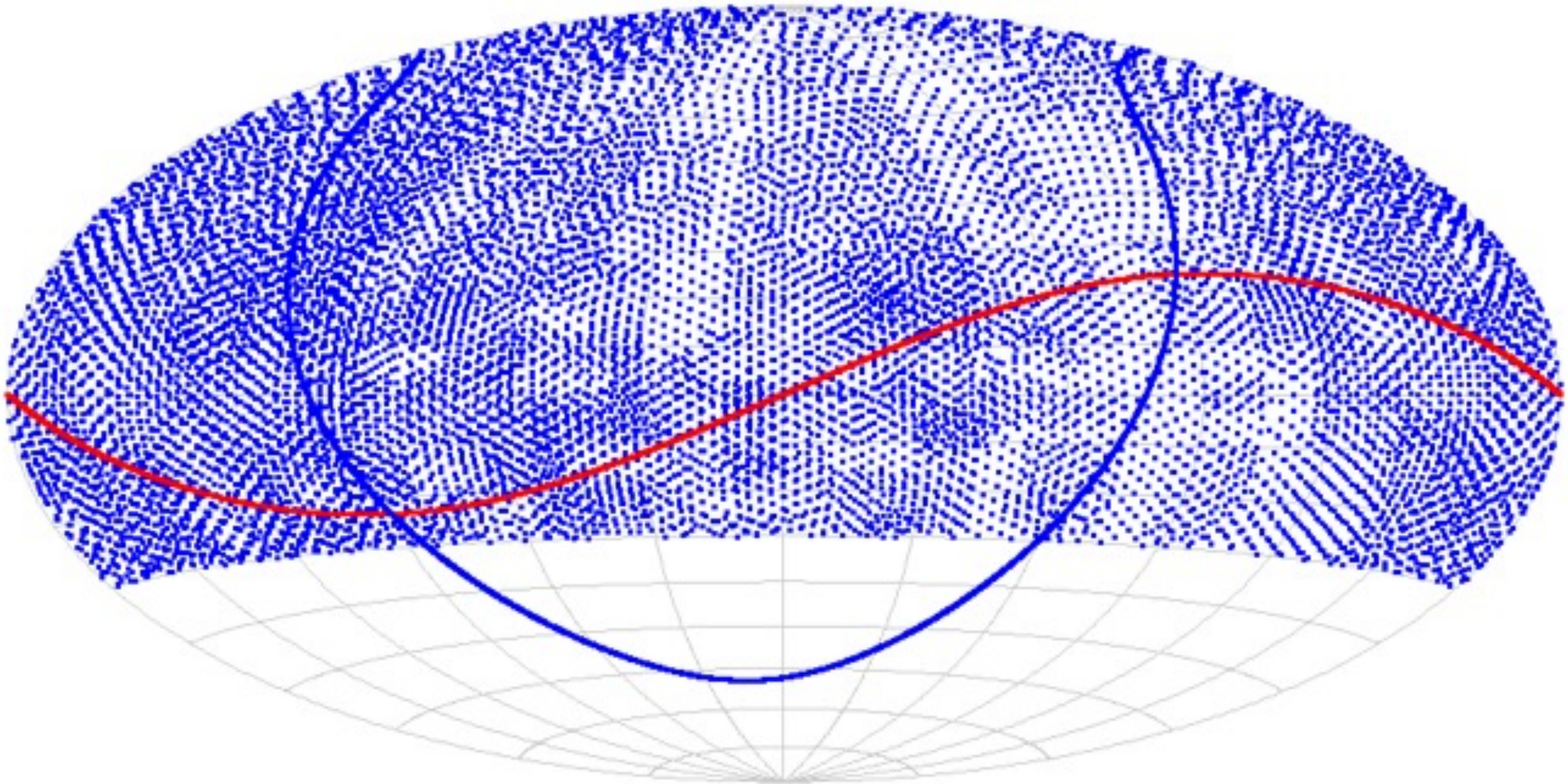
i band

3pi sky coverage to Jan 1, 2012



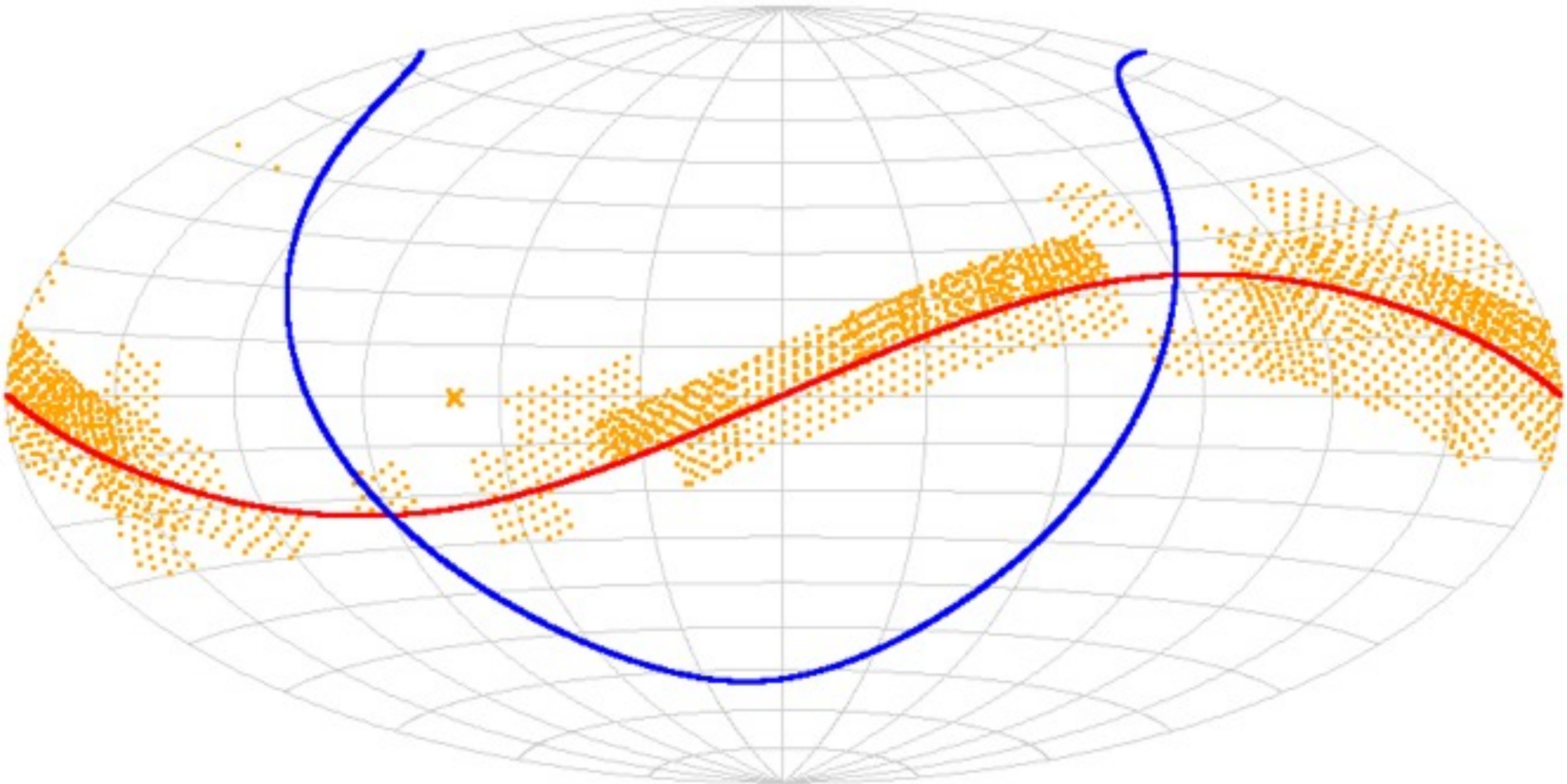
r band

3pi sky coverage to Jan 1, 2012



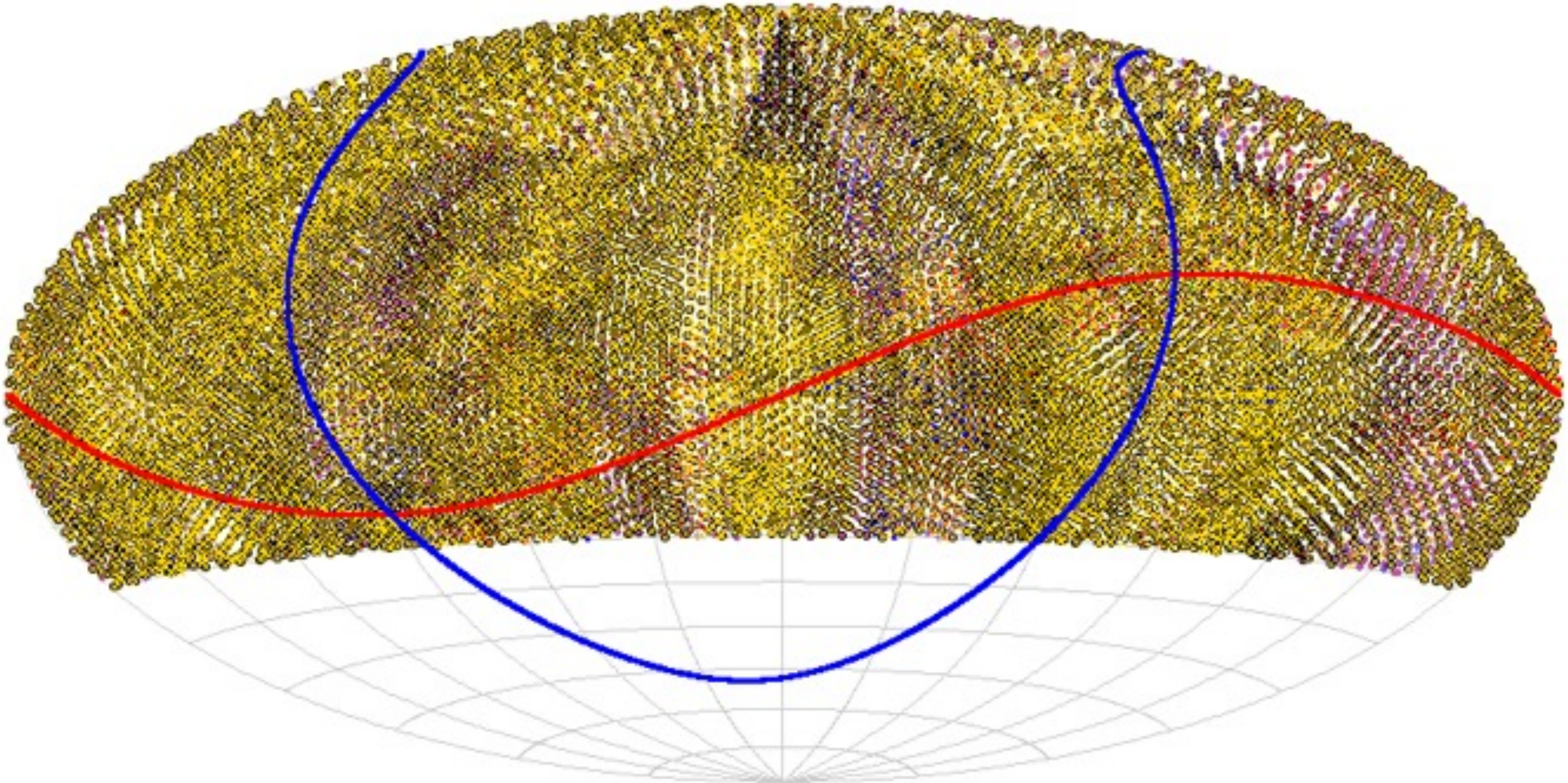
g band

Ecliptic plane coverage to Jan 1, 2012



w band

Total 3pi sky coverage to Jan 1, 2012



grizy bands - more than 33 epochs on average, or >~ 6 per filter

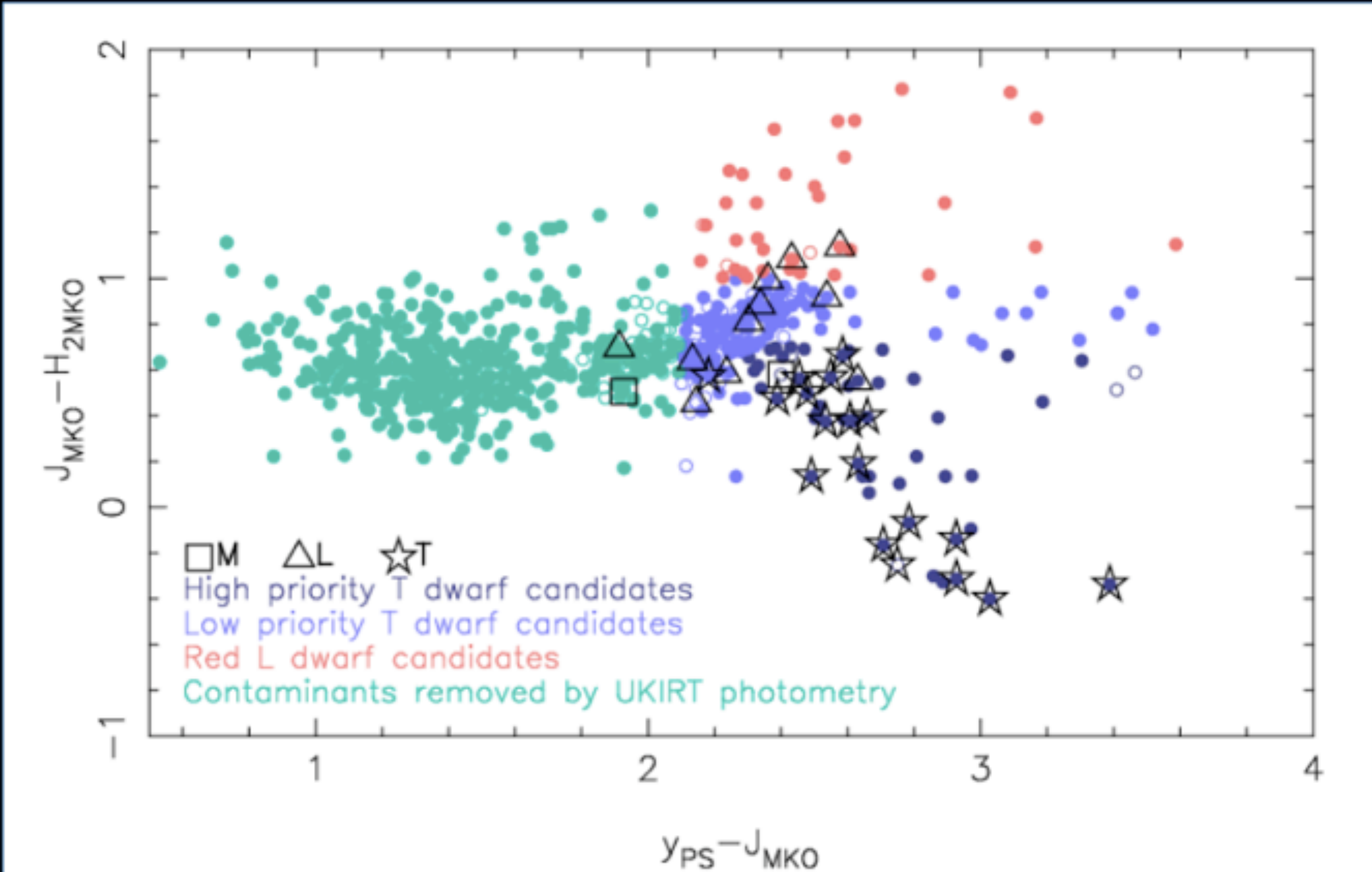
Observing Metrics: May 13 2010 to Jan 1, 2012

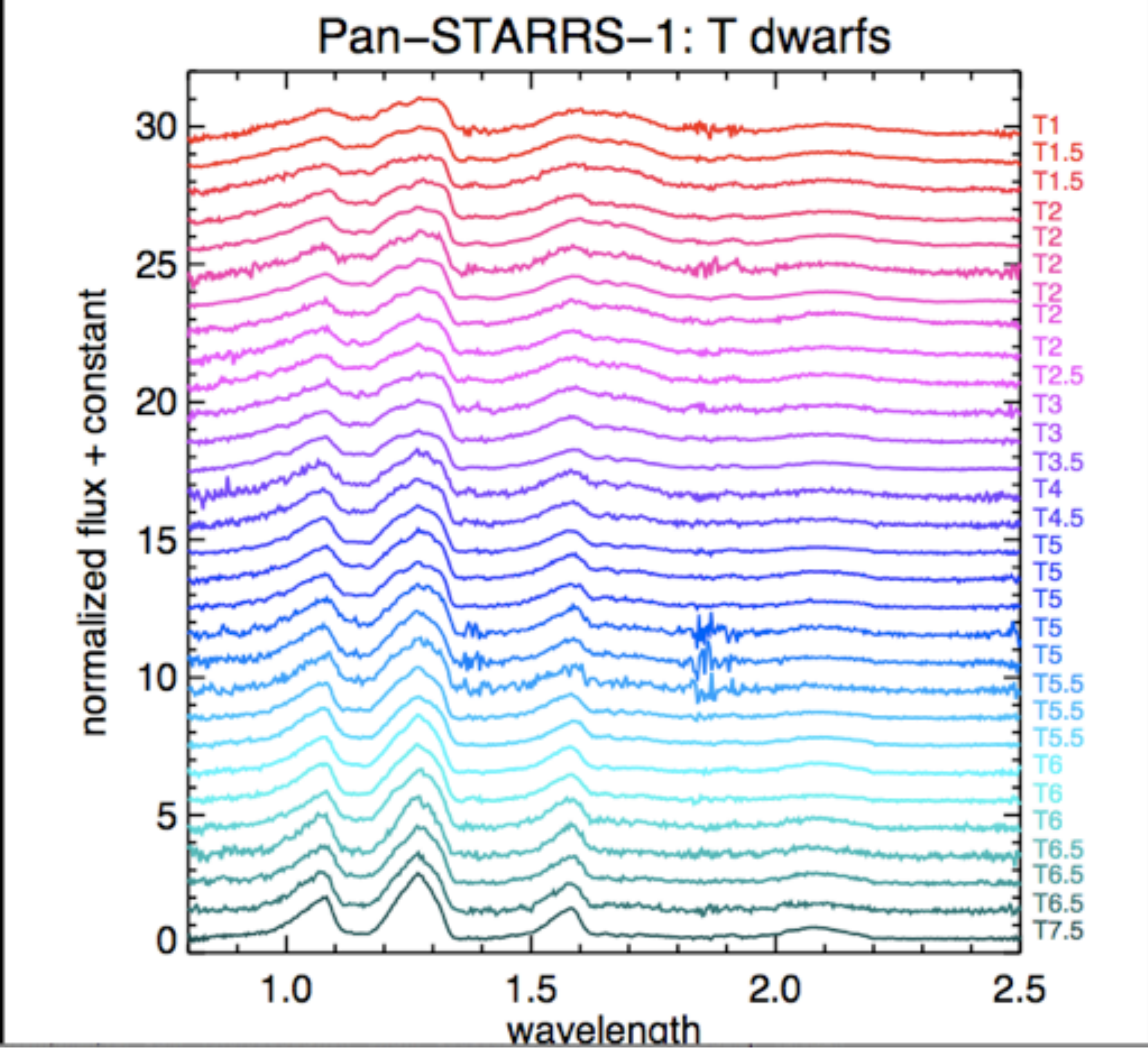
http://ipp0022.ifa.hawaii.edu/ps1sc/metrics.html linked from ps1sc wiki

Summary:

Total night time time	**6031.830 hours**	**100% of night**
Bad Weather time	2083.257 hours	34.54% of night
Downtime time	599.930 hours	9.95% of night
Overhead time	1266.550 hours	21.00% of night
Open shutter on science time	2082.092 hours	34.52% of night
Observing efficiency 52.73%	open shutter on science/clear time	

PS1 (year 1) + 2MASS proper motion search




Pan–STARRS–1: T dwarfs
normalized flux + constant
wavelength
0
5
10
15
20
25
30
1.0
1.5
2.0
2.5
T1
T1.5
T1.5
T2
T2
T2
T2
T2
T2
T2.5
T3
T3
T3.5
T4
T4.5
T5
T5
T5
T5
T5
T5.5
T5.5
T5.5
T6
T6
T6
T6.5
T6.5
T6.5
T7.5

The photometric model:

More specifically, we write Z in terms of the photometric parameters as:

System throughput on night *n*

Flat for season *i*

$$Z = a_n - k_n x + f_i + w(F)$$

Atmospheric transparency on night *n*

Airmass of observation

Quadratic correction for FWHM

Parameter	Number	Note
a	~ 200	system (nightly)
k	~ 200	atmosphere (nightly)
f	$4 \times 60 \times 4$	illumination correction
w	2	FWHM correction (quadratic)

1.2 Residuals of photometric model

By using a rigid photometric model (one a,k per night) we assume the site, camera, etc. are stable over the course of a night. How good is this assumption?

o For each star in each exposure, compute

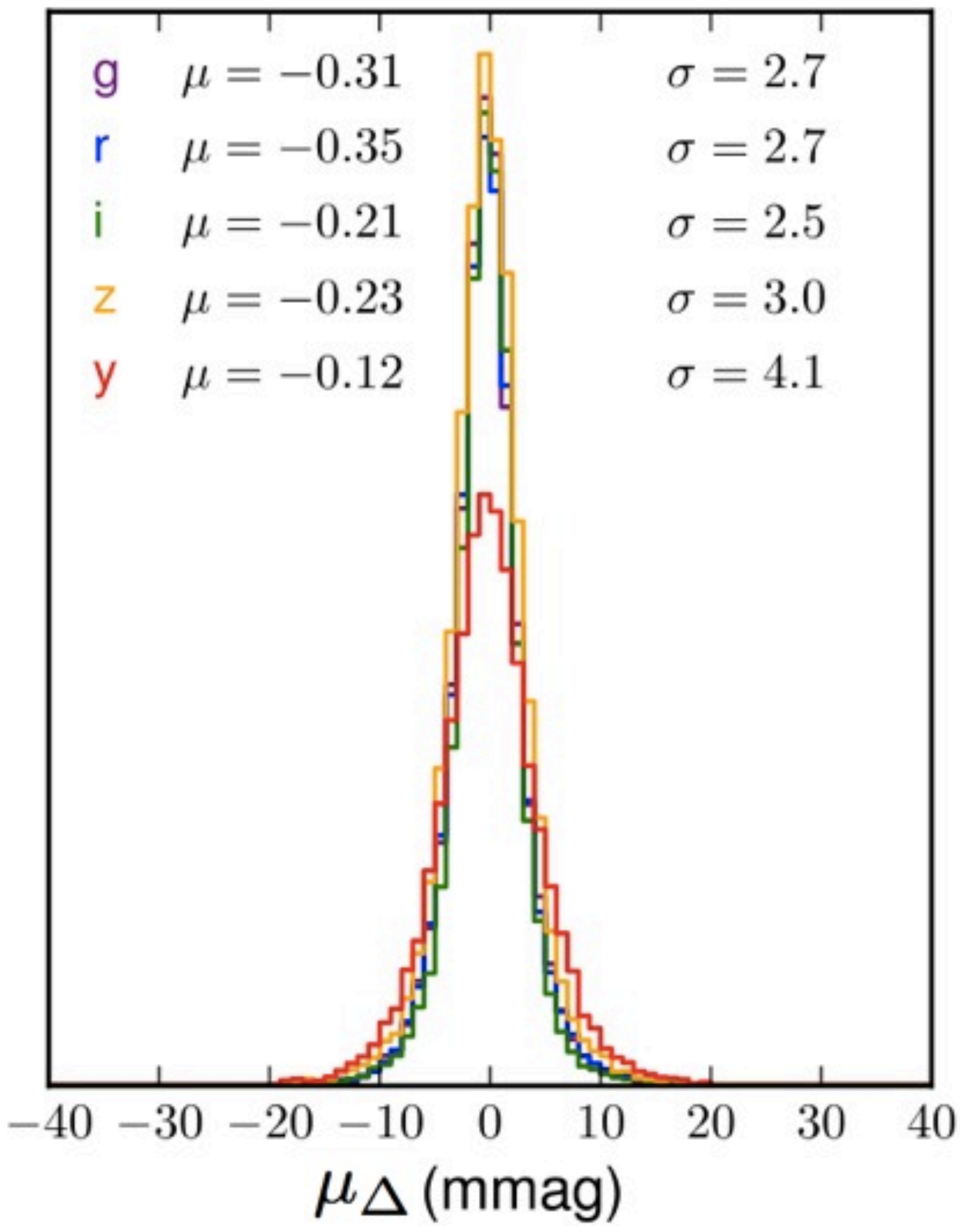
$$\Delta = m - \overline{m}$$

o Compute the mean and standard deviation of these *for each exposure*:

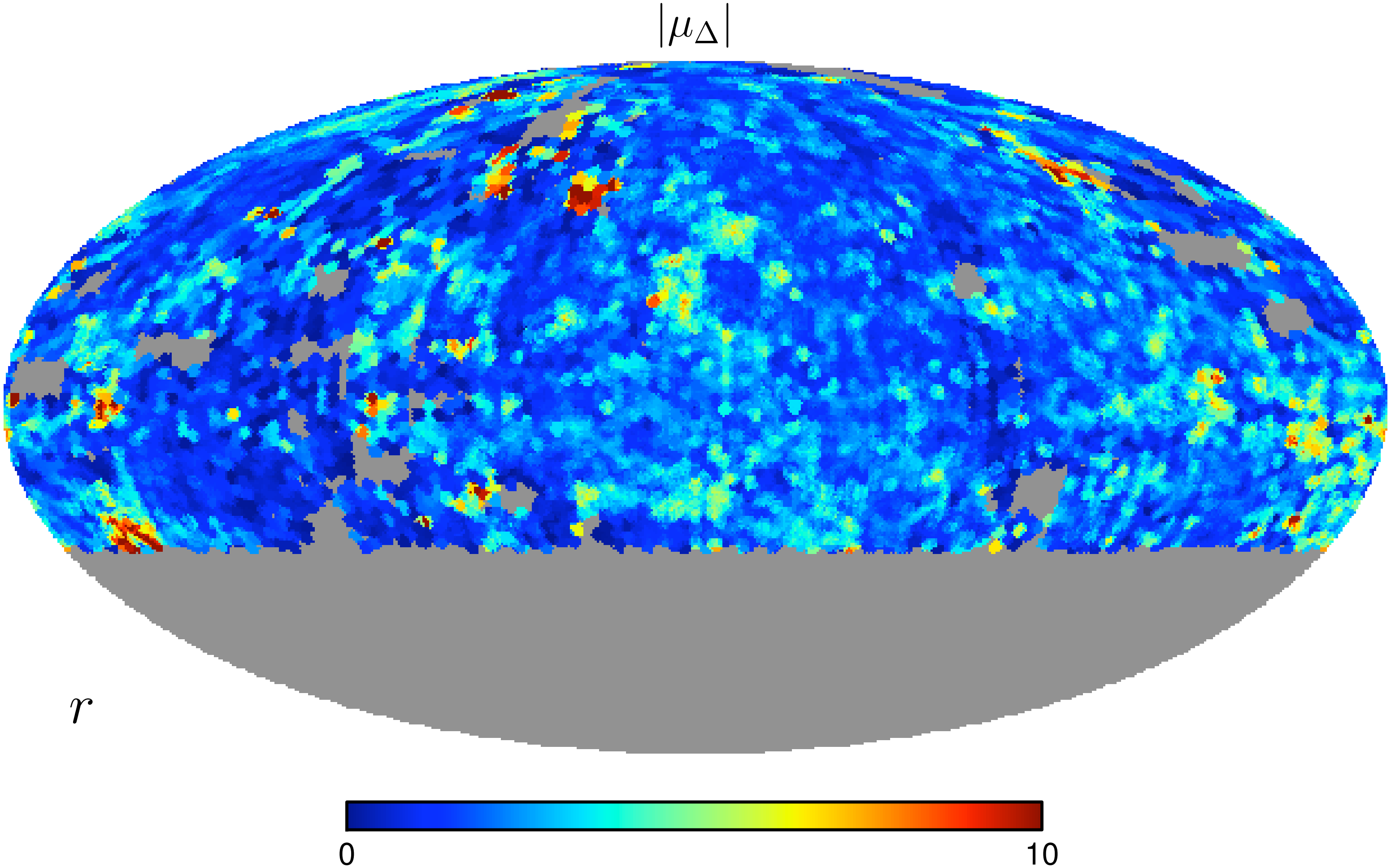
$$\mu_\Delta \text{ and } \sigma_\Delta$$

o Now look at maps and histograms of these.

ZP residuals are ~ 3 mmag (4 mmag in y-band)

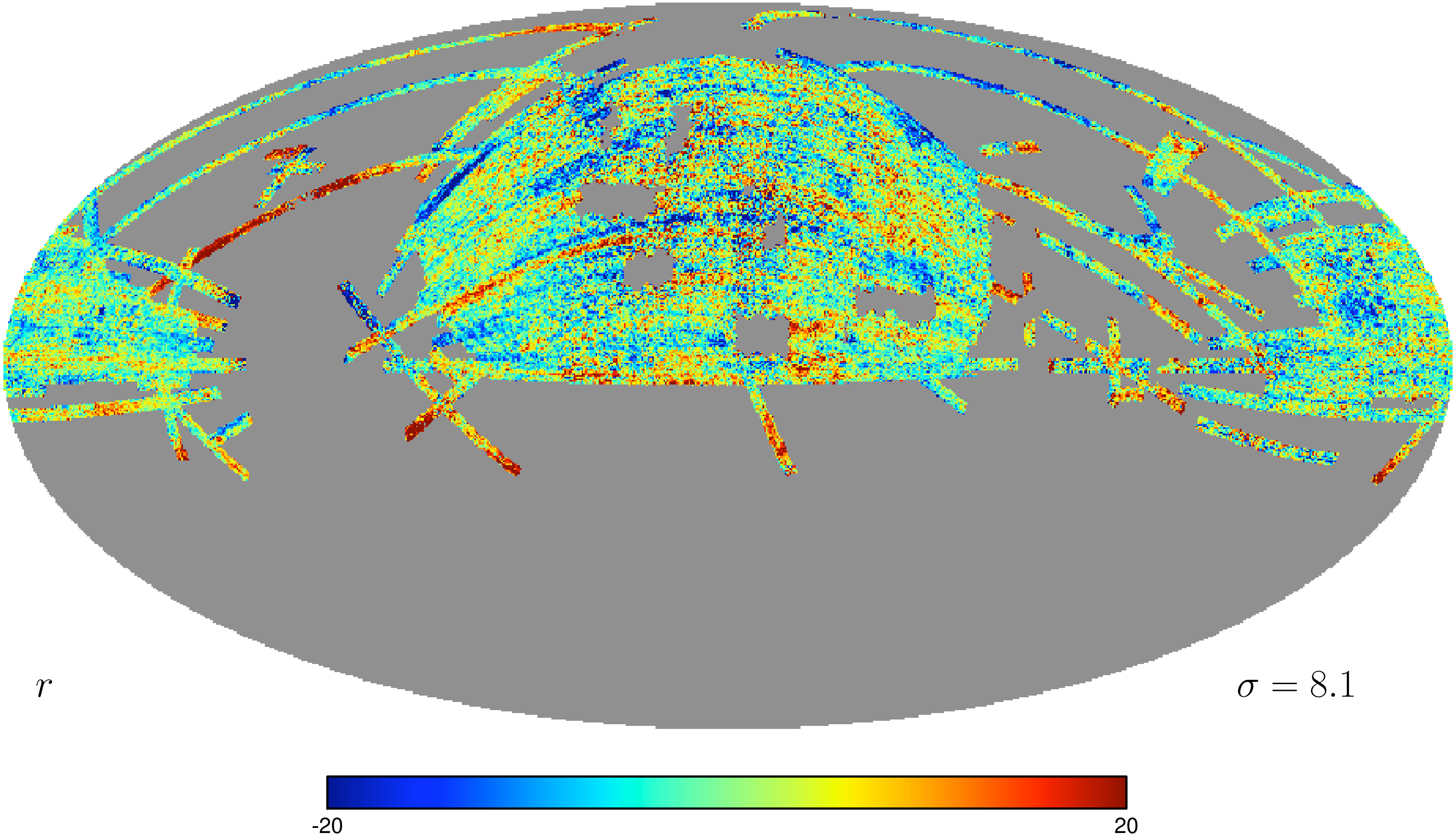


PS1 zero-point rms milli-mags (Jan 2012)



3

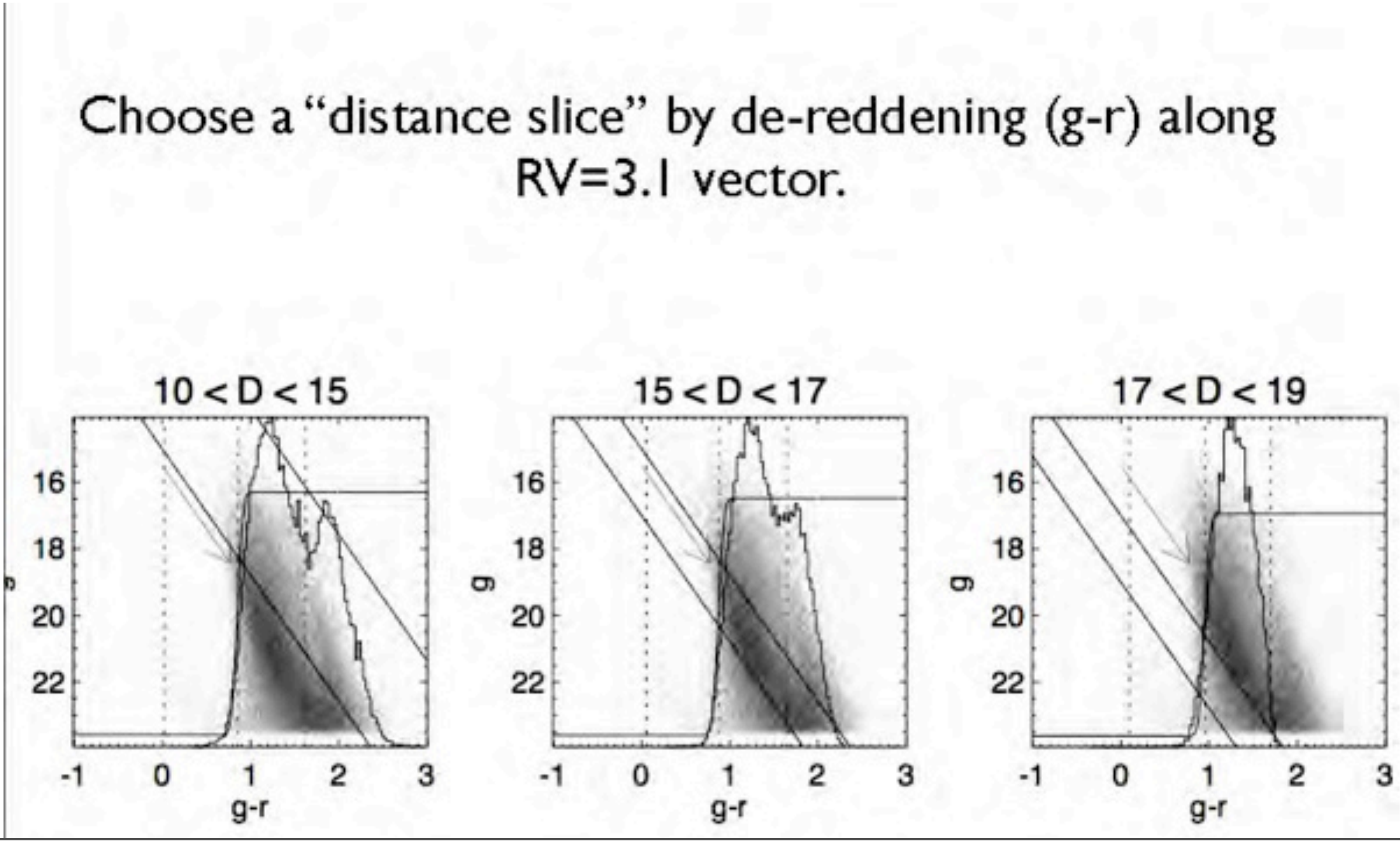
SDSS Comparison



PS1 Early Science:

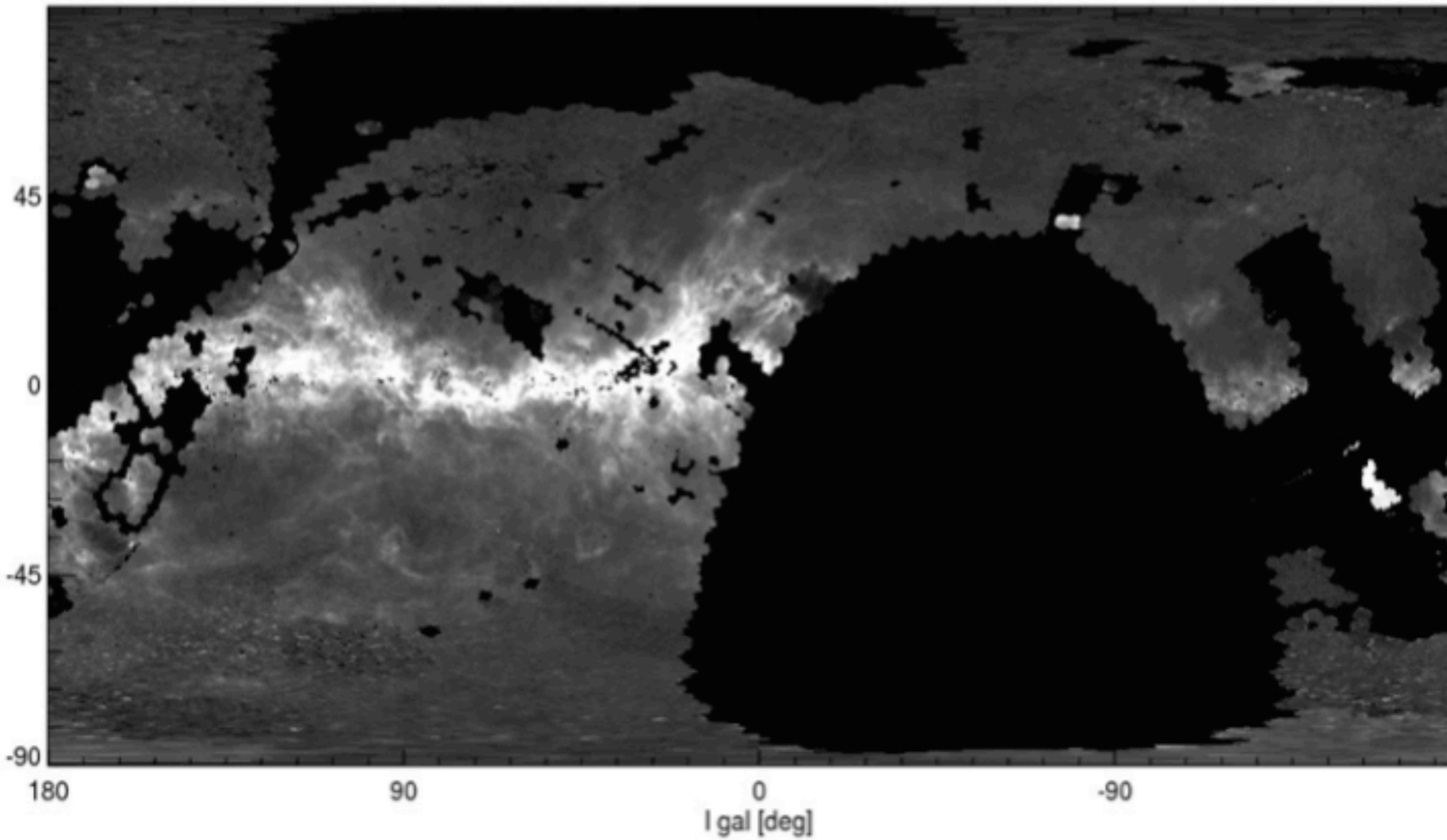
- Mapping the Dust in the Galaxy and eventual 3-D dust map

(Finkbeiner & Schafly et al.) Use procedure of SFD:



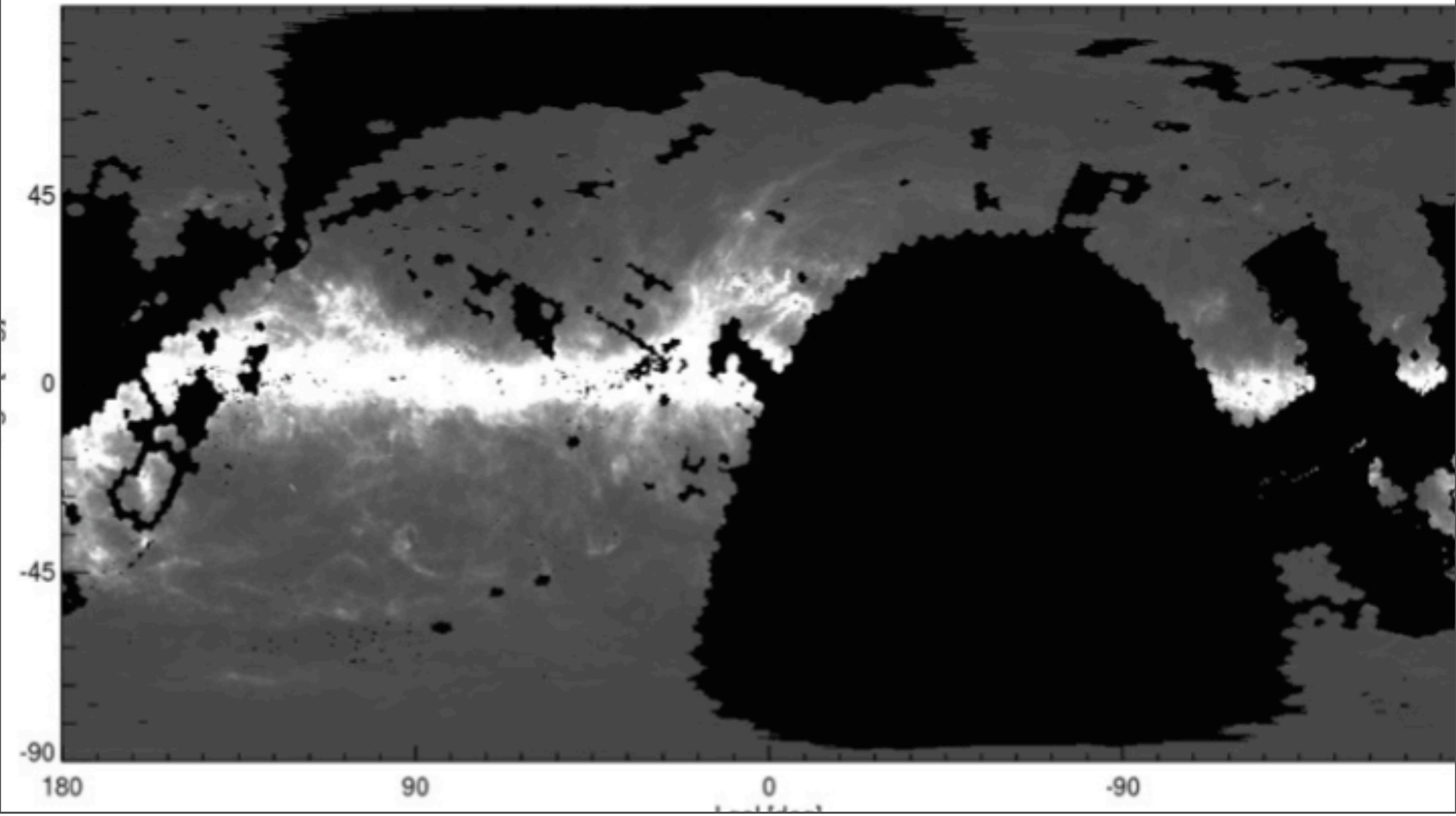
Finkbeiner ubercalibtration test

Whole sky, (g-r) blue tip color, Galactic coordinates



Finkbeiner ubercal test

SFD (g-r) reddening plus +0.25 mag



PAndromeda – Pan-STARRS & Andromeda

Pan-STARRS - Panoramic Survey Telescope And Rapid Response System

PAndromeda
a dedicated deep survey of
M31 with Pan-STARRS 1

A. Riffeser - Honolulu 5/1/2011

PIs: S. Seitz, R. Bender

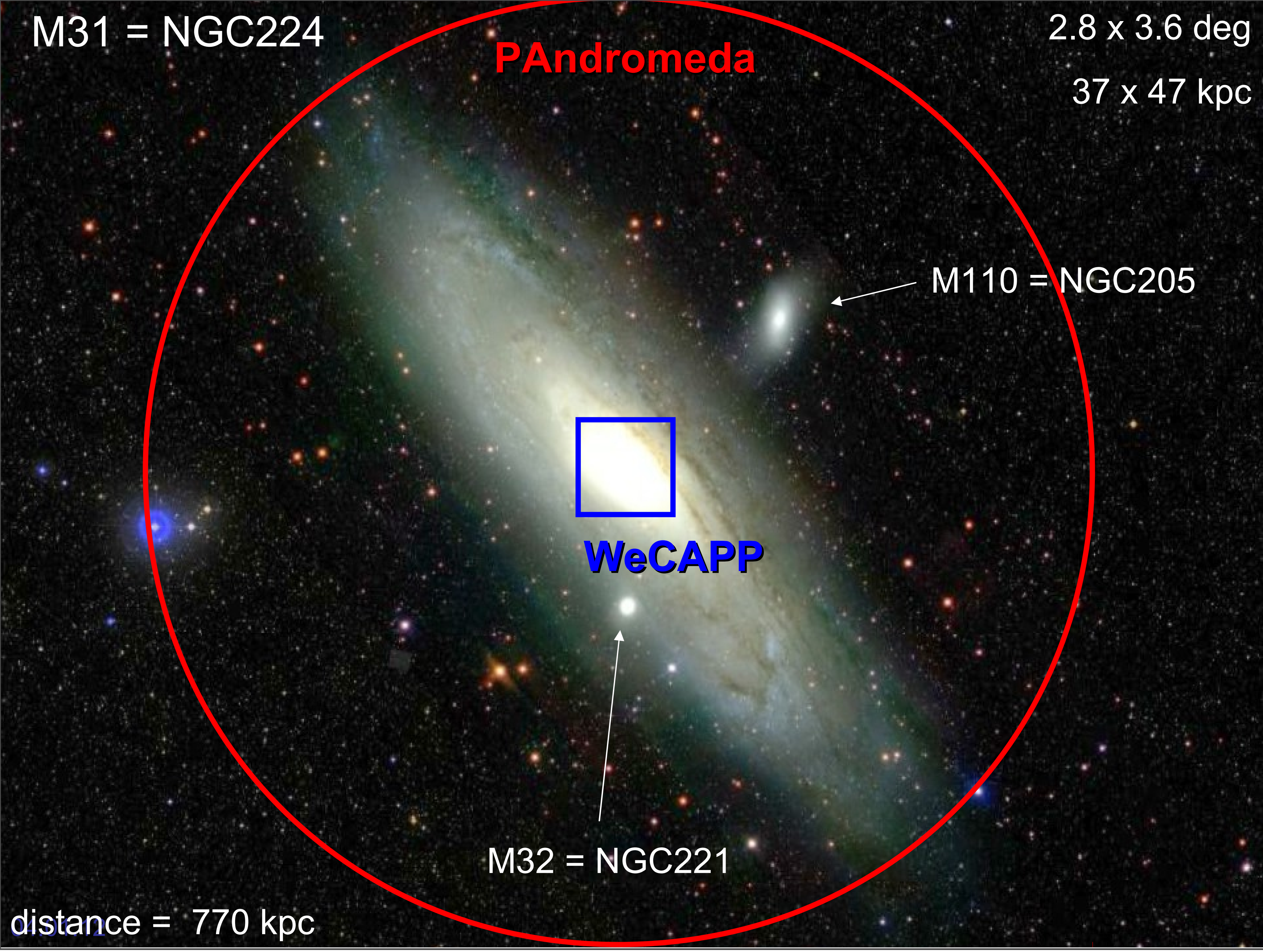
J. Koppenhoefer, C.-H. Lee,

U. Hopp, C. Goessl, J. Snigula, M. Kodric

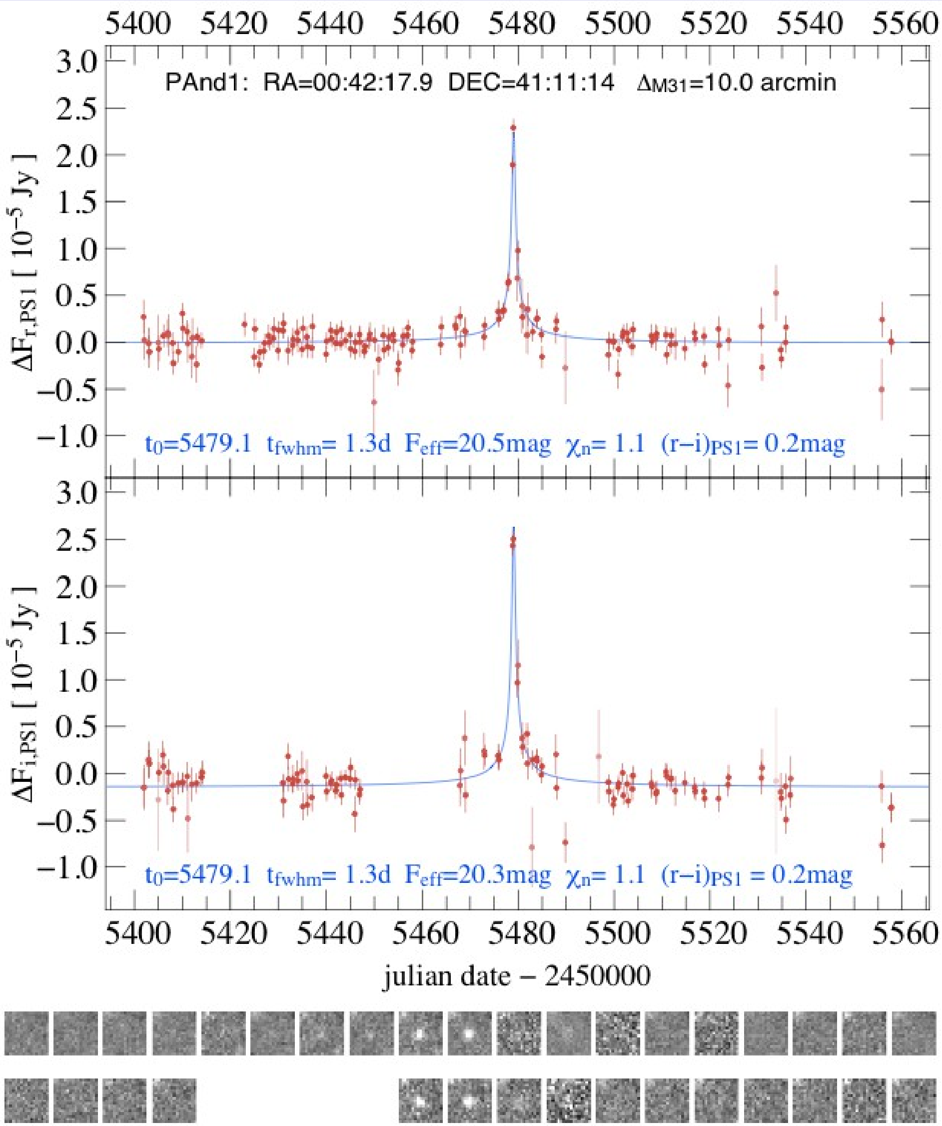
and the PS1 Science Consortium

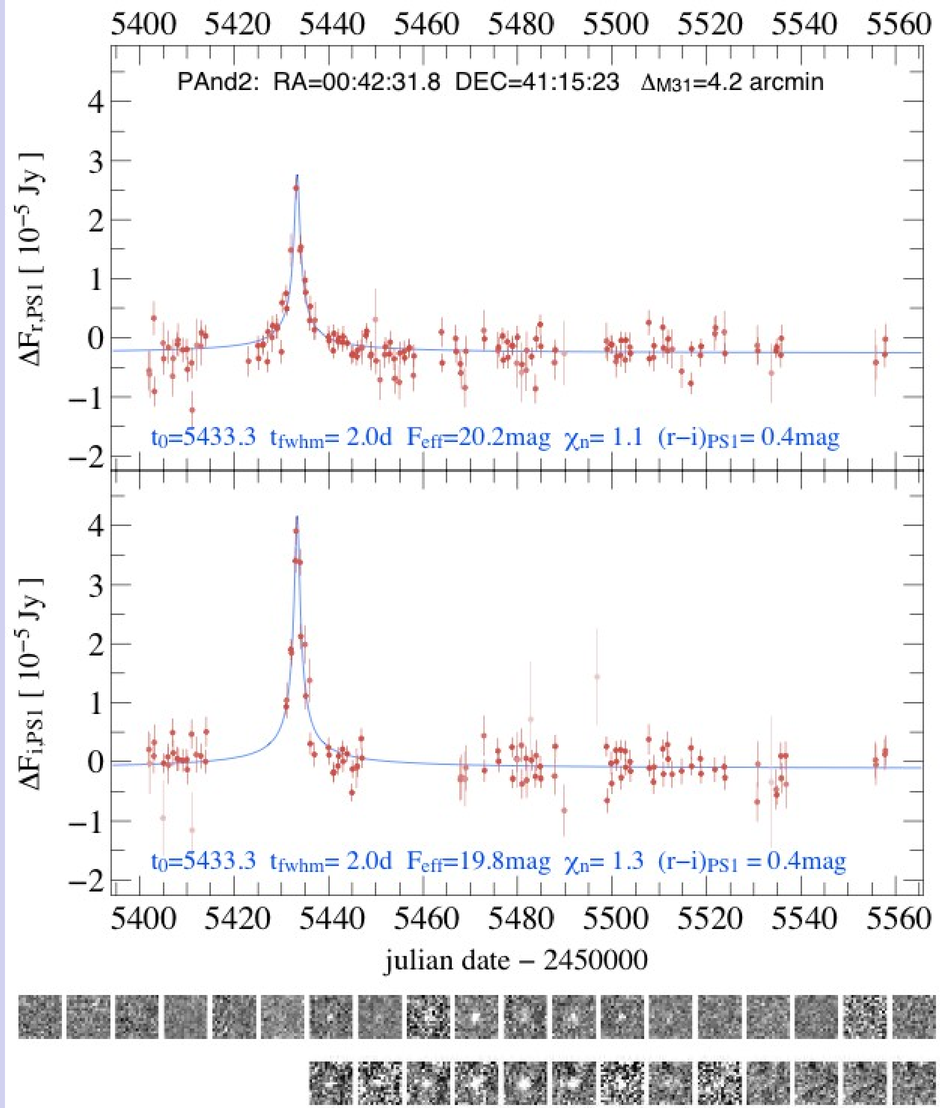
LMC vs. M31 microlensing

MACHO, EROS, OGLE, SuperMacho	**PanSTARRS**
pointings:	
many for 23 sq	one with 7 sqdeg
halo line of sight:	
one MW	multiple M31
blending:	
3, 4 stars or more	hundreds ➔ statistical + model
observables:	
t_E and $F_0(+F_{stars})$	t_{FWHM} and ΔF
SN contamination:	
10/month	<SN 3/month, ~5 Novae/month
star-star self-lensing:	
<10%	bulge: 50%, disk: finite source effects
amplifications:	
moderate	high (planets?)


M31 = NGC224
PAndromeda
2.8 x 3.6 deg
37 x 47 kpc
M110 = NGC205
WeCAPP
M32 = NGC221
distance = 770 kpc

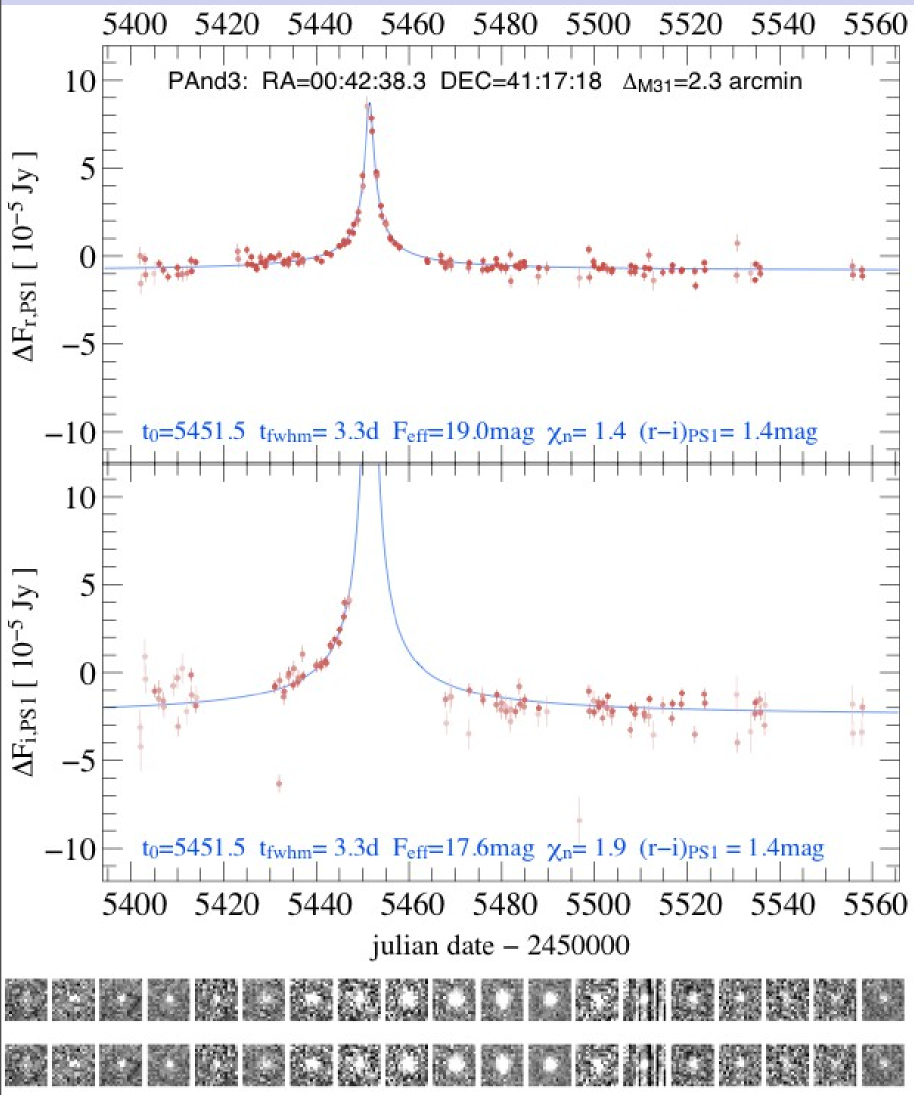
microlensing candidate PAnd 1 + 2

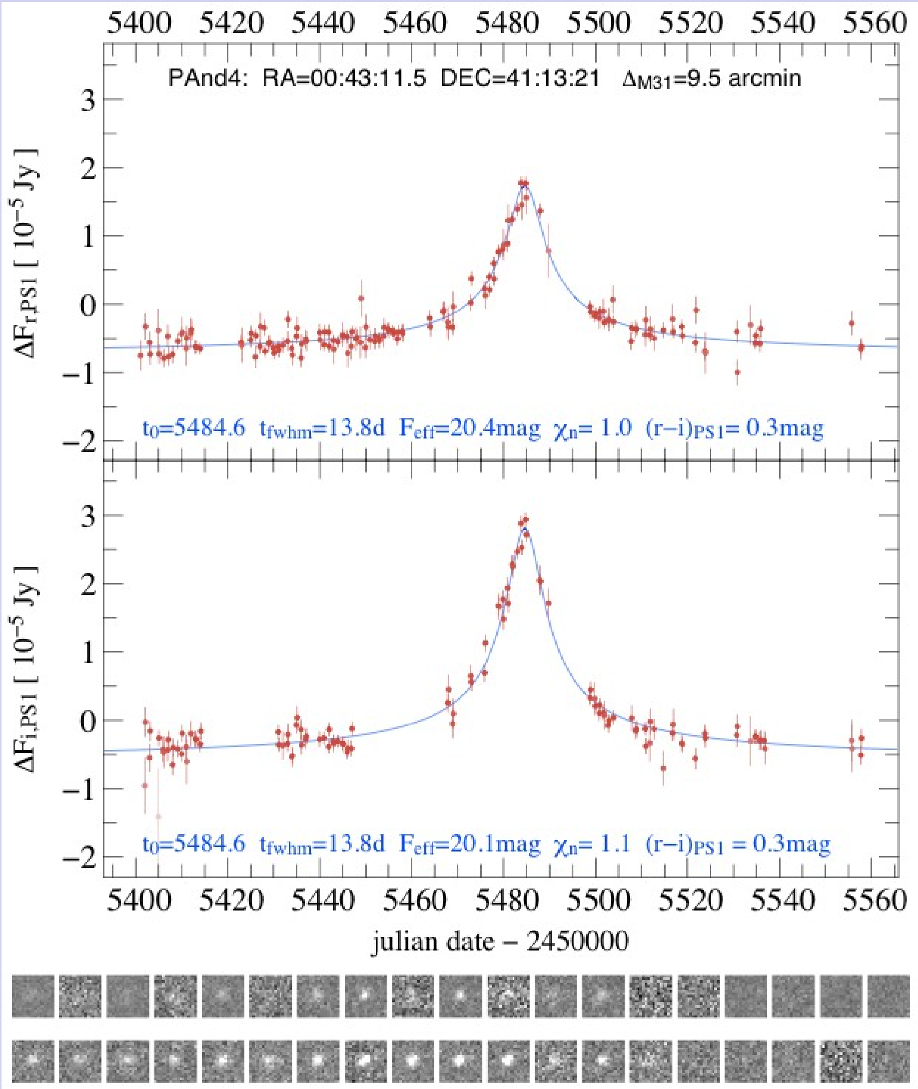




Lee (2011,arXiv,1109,6320)

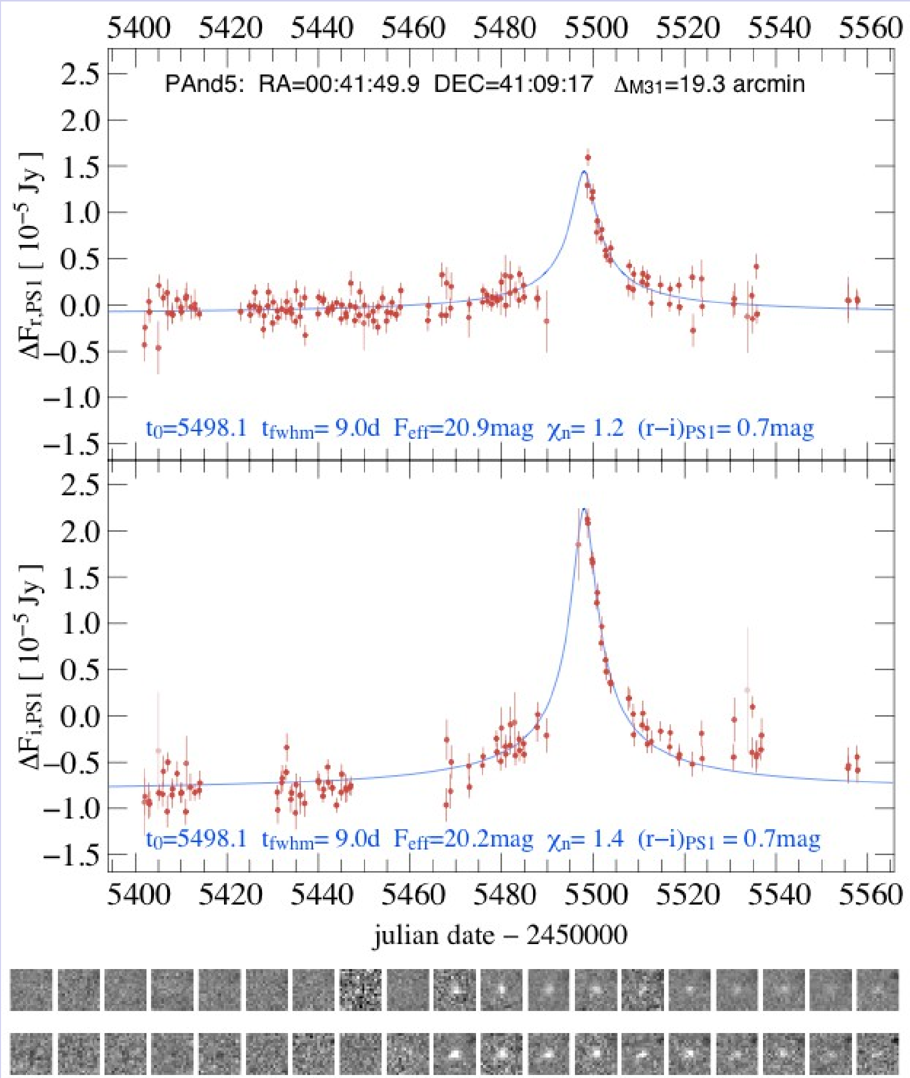
microlensing candidate PAnd 3 + 4

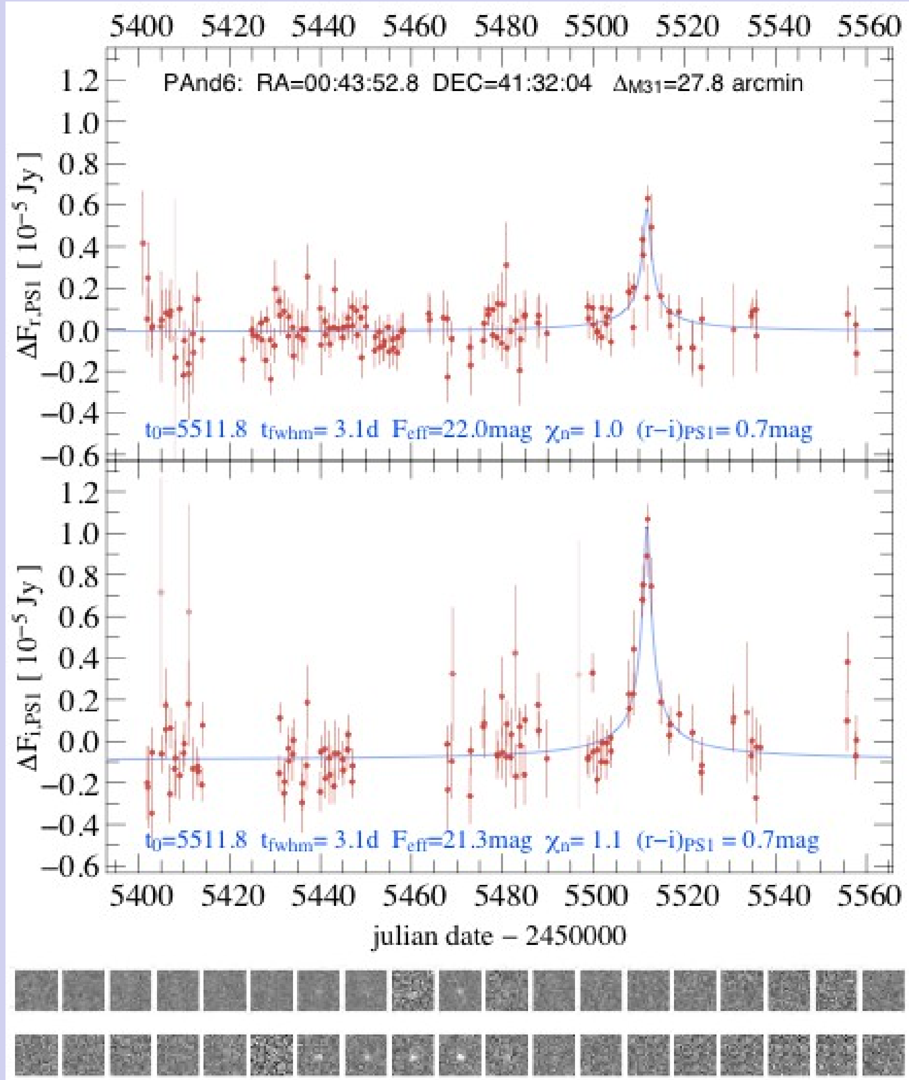




Lee (2011,arXiv,1109,6320)

microlensing candidate PAnd 5 + 6

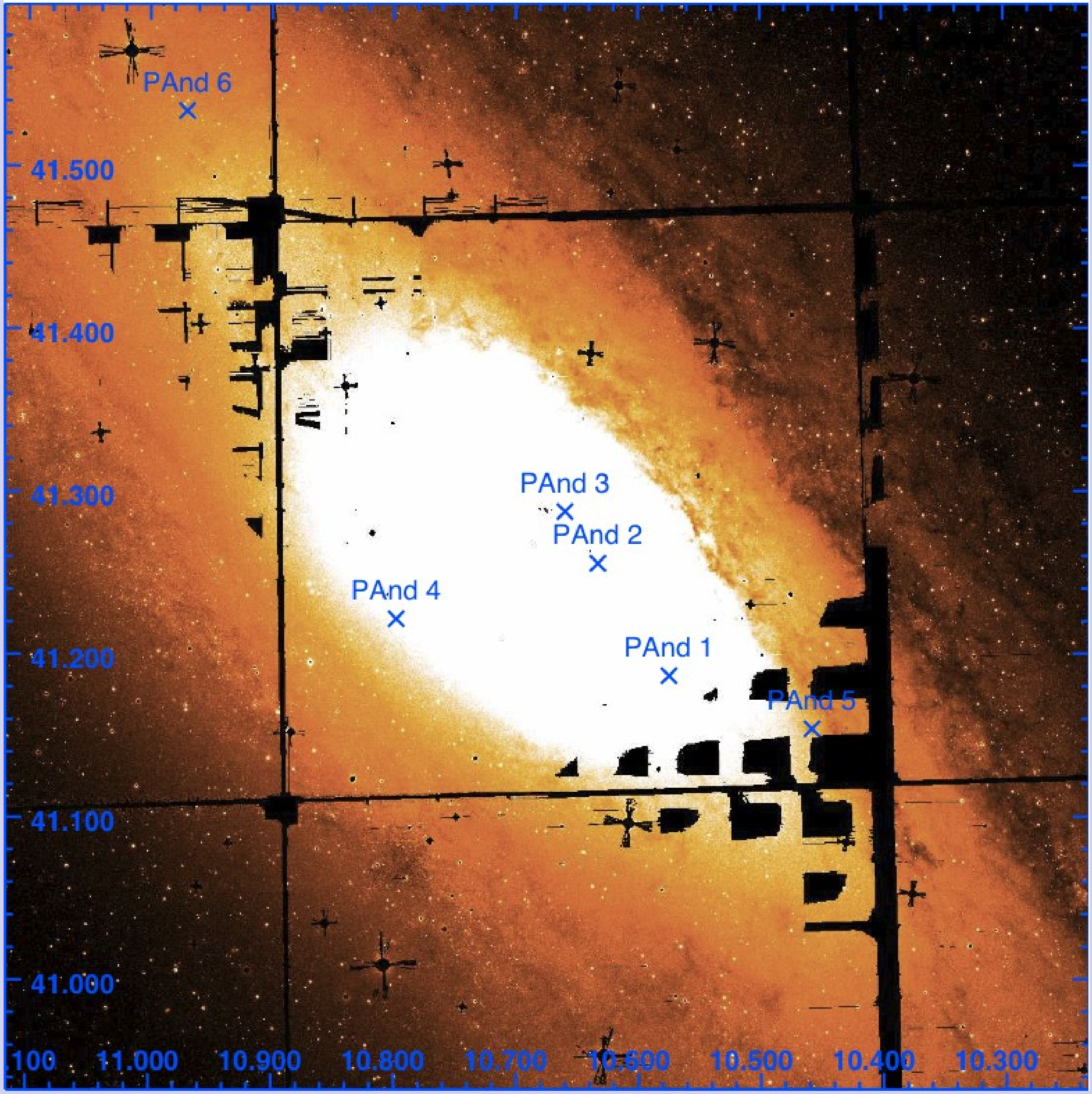




Lee (2011,arXiv,1109,6320)

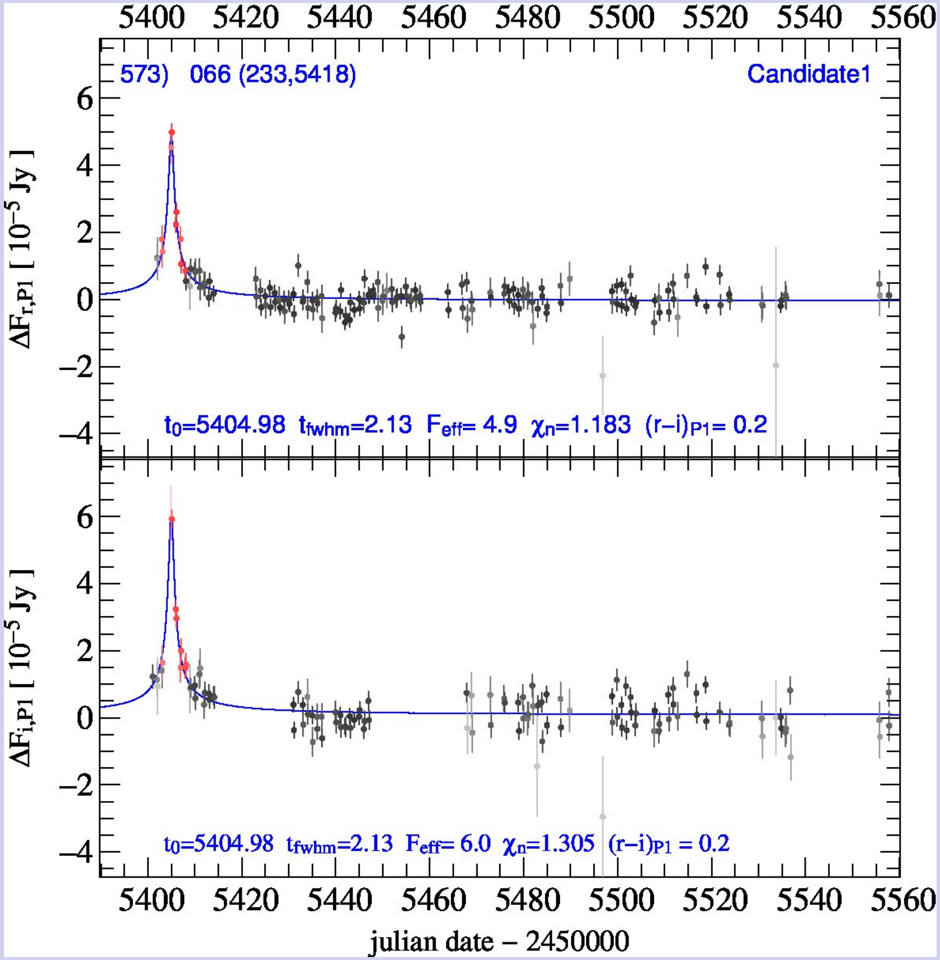
6 microlensing event candidates

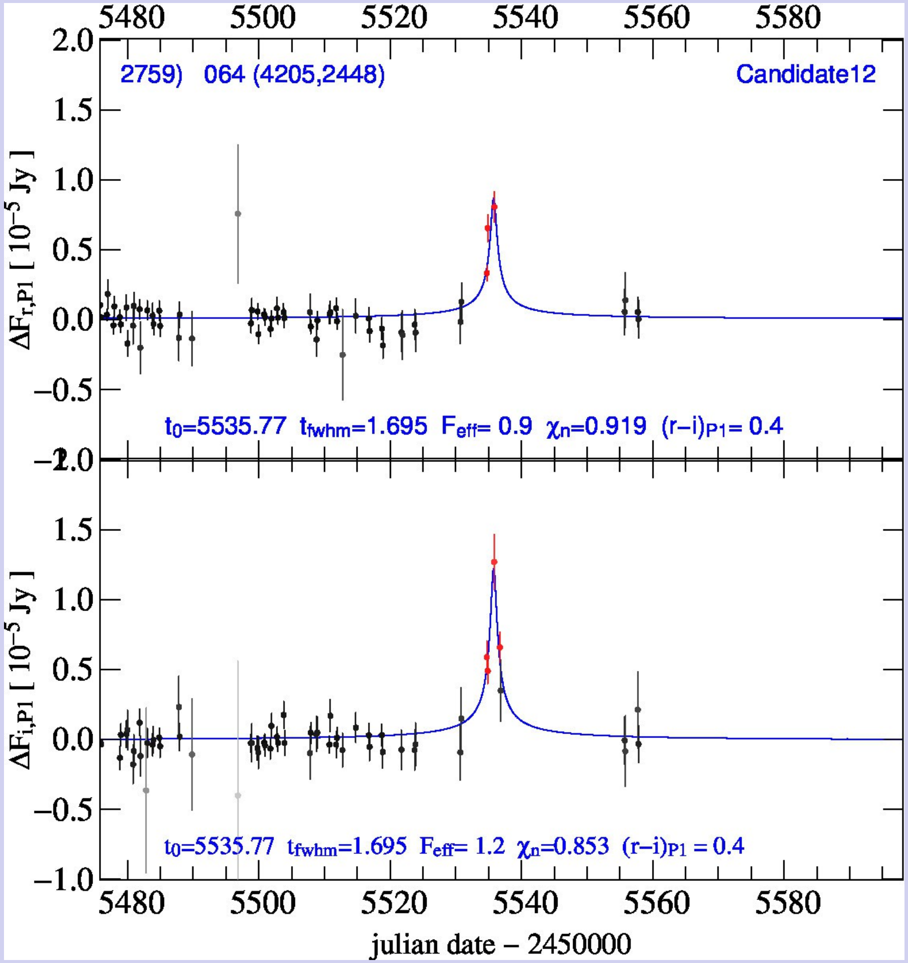
Position of the six microlensing event candidates detected in the central 40'x40' (FOV) region of M31 from PAndromeda. The coordinates, RA (J2000) in hour and Dec (J2000) in degree are also shown in the figure.



Lee (2011,arXiv,1109,6320)

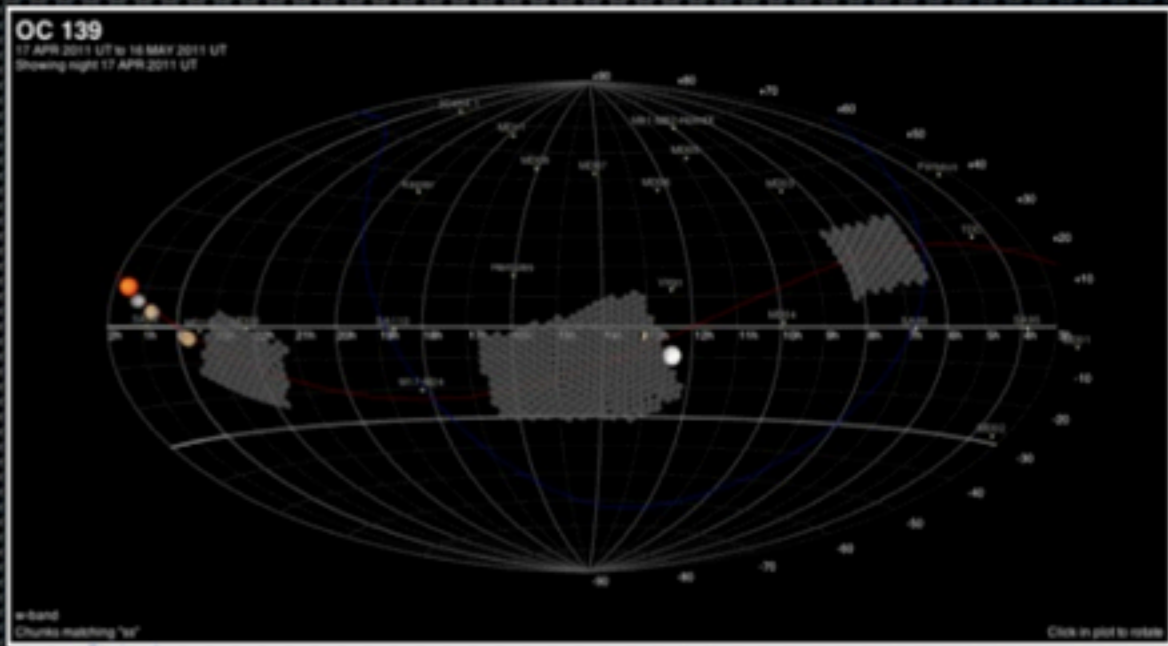
preliminary: new disk candidates



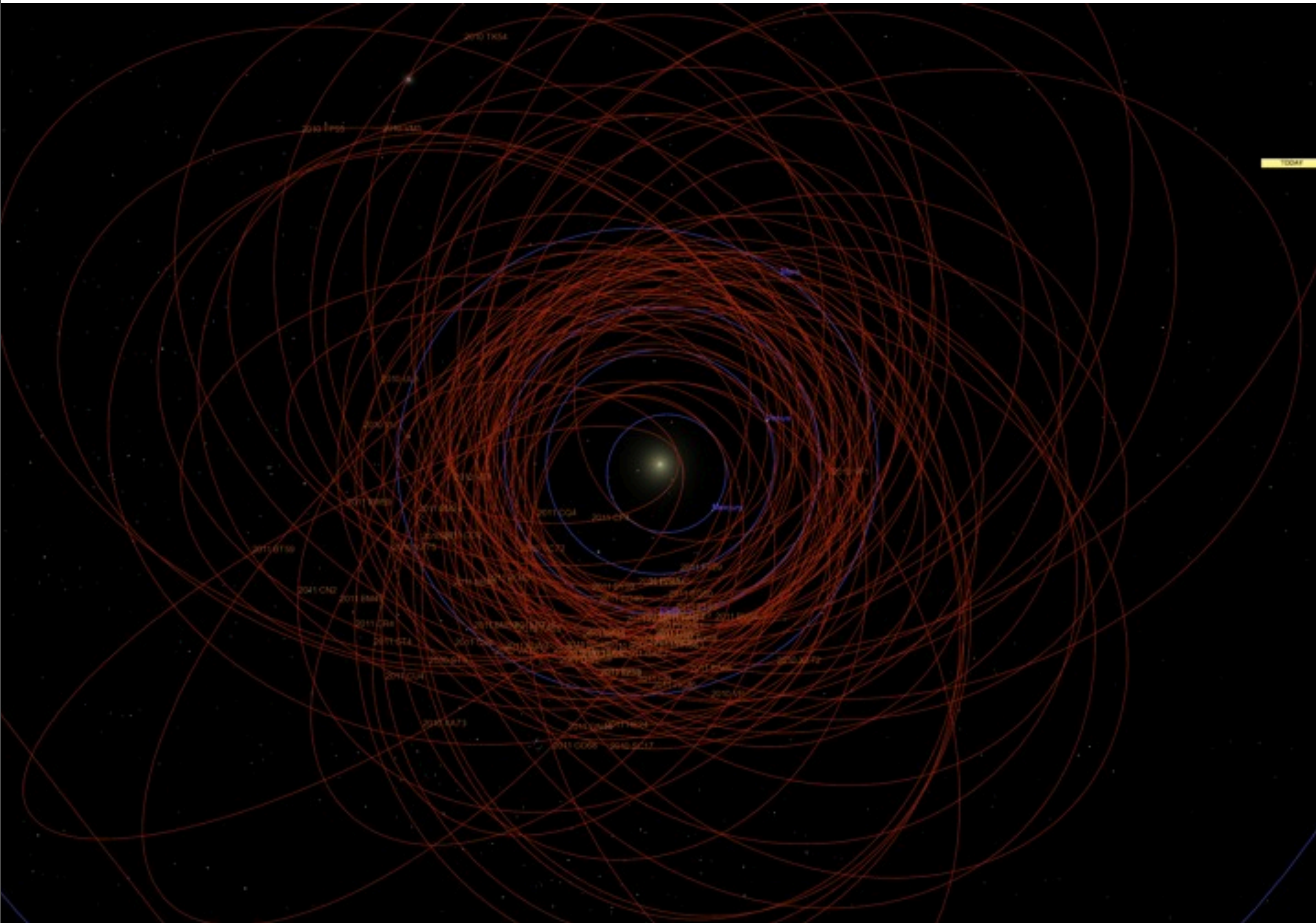


PS1 Solar System Survey

- 5% of PS1 time
- *w*-band for depth
- Evening/morning "sweetspots" for enhanced PHA discovery rates
- Opposition solar system survey (OSS) when sweetspots are poorly placed

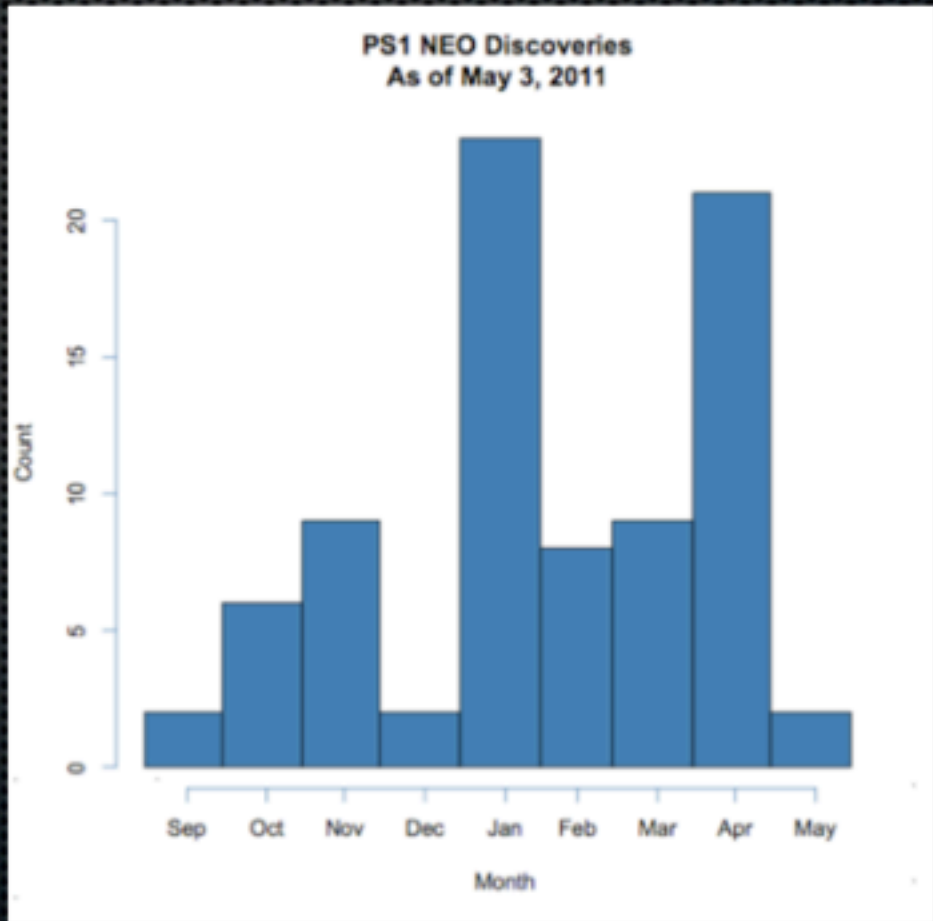


Pan-STARRS



NEO discovery rate

- ~40 NEOs/month, weather permitting
- The weather in 2011 has not permitted much
- Catalina Sky Survey ~50/ month



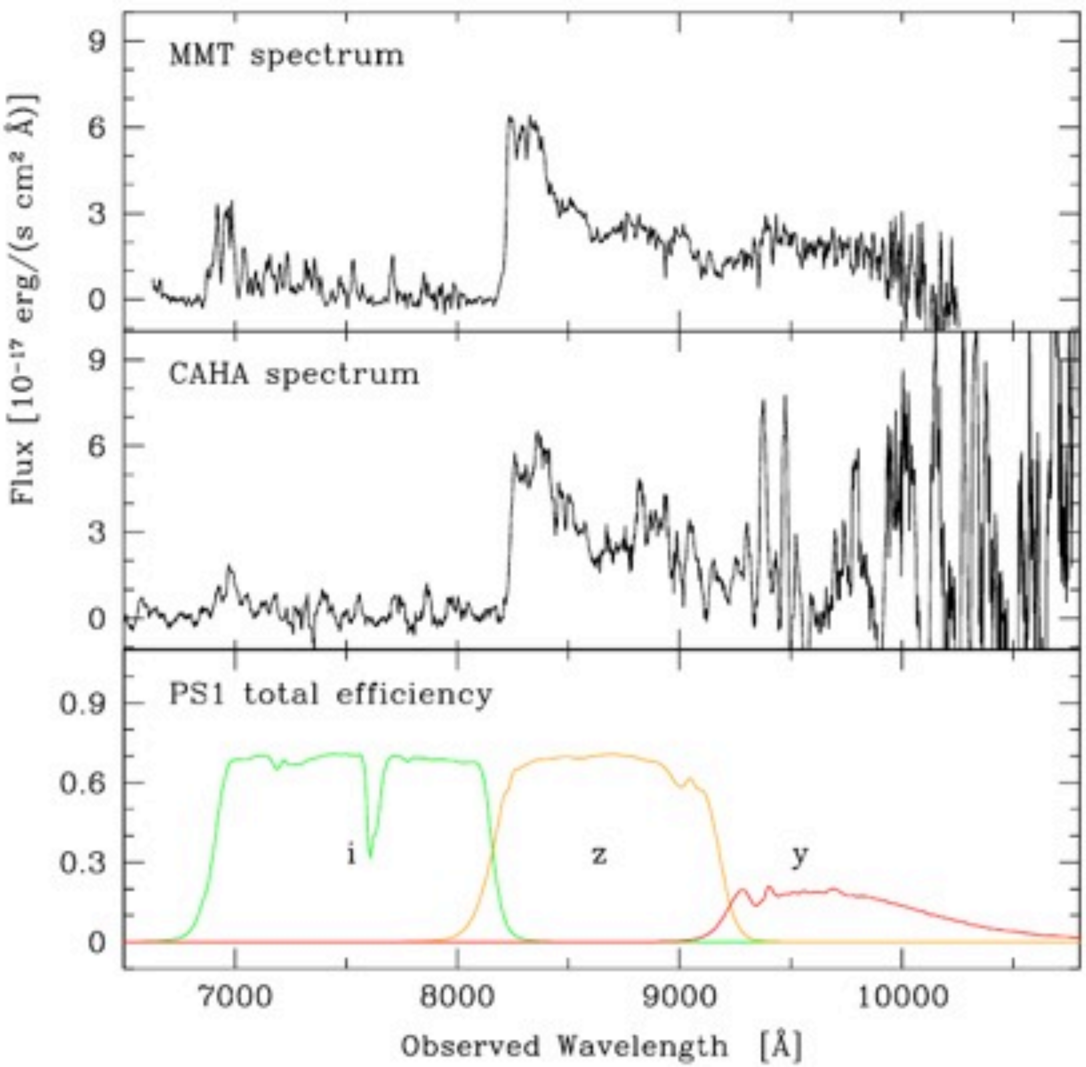
Near Earth Objects

- 173 NEOs were discovered by PS1 in 2011
  - 11 with H magnitude brighter than 18.3 (diameter > approximately 1 km)
  - 16 Potentially Hazardous Asteroids (PHAs) (H < 22.0 (diameter > 150 m and passes closer than 0.05 AU to Earth)

PS1 Early Science: Hi-Z QSOs

Z=5.73
I-band drop-out
sharp GP trough
Expect 100s of z=6
Maybe 10 z=7

Walter, Chambers, Morganson et al



Supernovae and Transients with the Pan-STARRS1 survey

Queen's University Belfast :

S.J. Smartt , M. McCrum, R. Kotak, K. Smith, A. Pastorello, S. Valenti, M.T. Botticella, M. Fraser, S. Mattila (Turku) E. Kankare (Turku), D. Young

CfA , Harvard:

E. Berger, L. Chomiuk, R. Chornock, G. Narayan, R. Foley, A. Soderberg, R. Kirshner, N. Sanders, P. Challis, C. Stubbs, I. Czekala, A. Rest (STScI), M.W. Vasey (Pittsburgh), R. Chevalier (U. Virginia)

JHU :

S. Rodney, A. Riess, D. Scolnic, S. Gezari

IFA:

J. Tonry, M. Huber, K. Chambers, G. Magnier +PS1 Project team

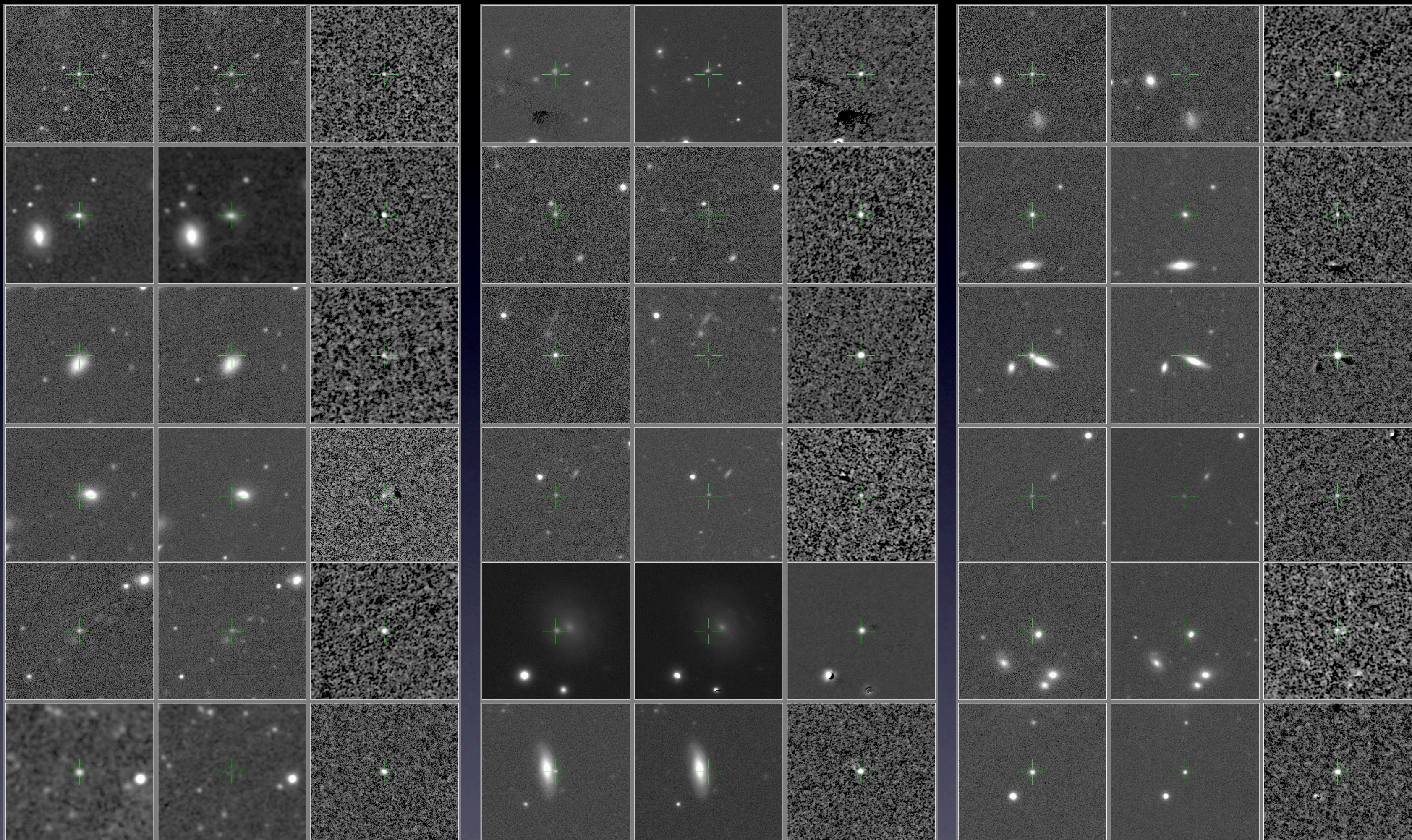
LCOGT:

A. Howell

PS1 consortium members

University of Hawai'i · UH Institute for Astronomy · Max Planck Institute for Extraterrestrial Physics · Max Planck Institute for Astronomy · Johns Hopkins University Department of Physics and Astronomy · Harvard-Smithsonian Center for Astrophysics · Queen's University Belfast · University of Edinburgh · Durham University Institute for Computational Cosmology · National Central University, Taiwan · Las Cumbres Observatory Global Telescope Network

~3x10^3 *transients*, ~250 spectroscopically Confirmed SNe



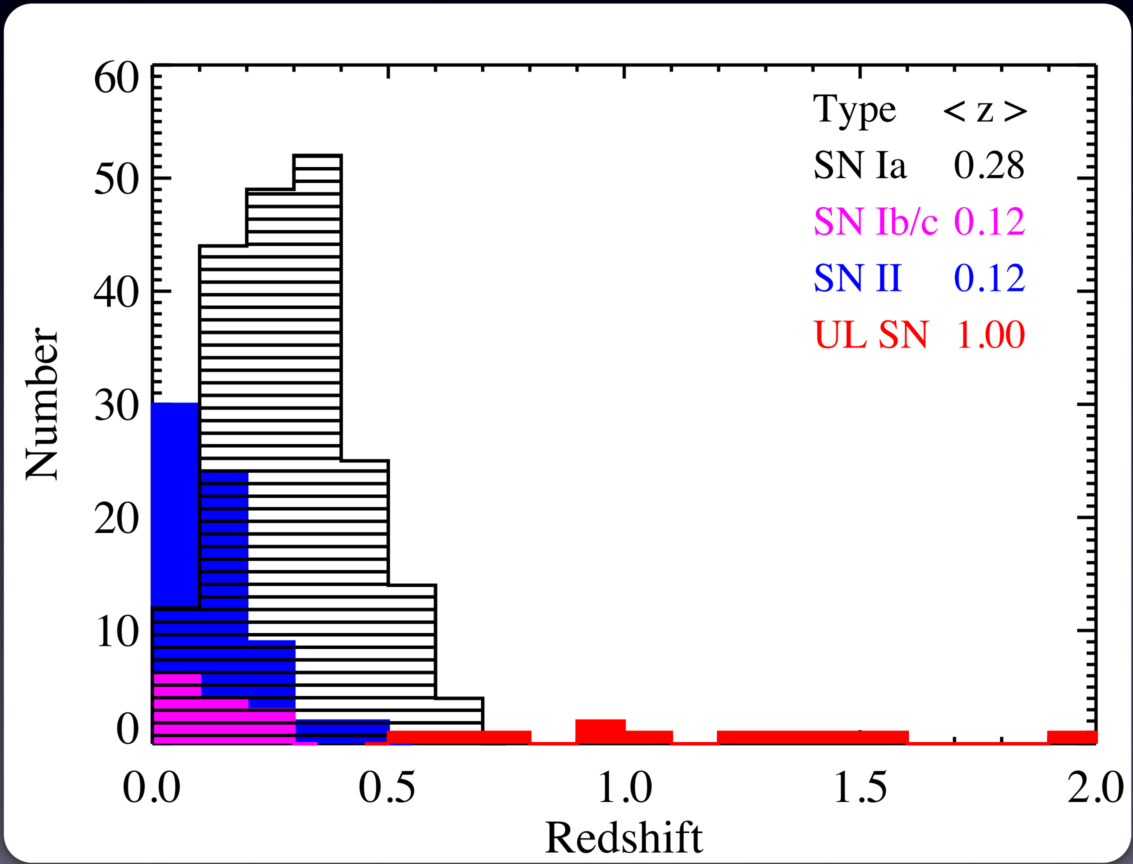
Photpipe team :Huber, Rest, Narayan, Stubbs, Wood-Vasey, Chornock, Foley, Berger, Rodney ++

QUB Team :Smartt,Smith, Kotak, McCrum, Fraser , Magil, Valenti, Botticella, Pastorello, Young

- We're finding ~100-150 new transients per month
- Spectroscopic followup from MMT/Blue Channel and Hectospec, Magellan, and Gemini

300 spectroscopically confirmed supernovae so far, mostly SNe Ia

(talk by Ryan Foley)

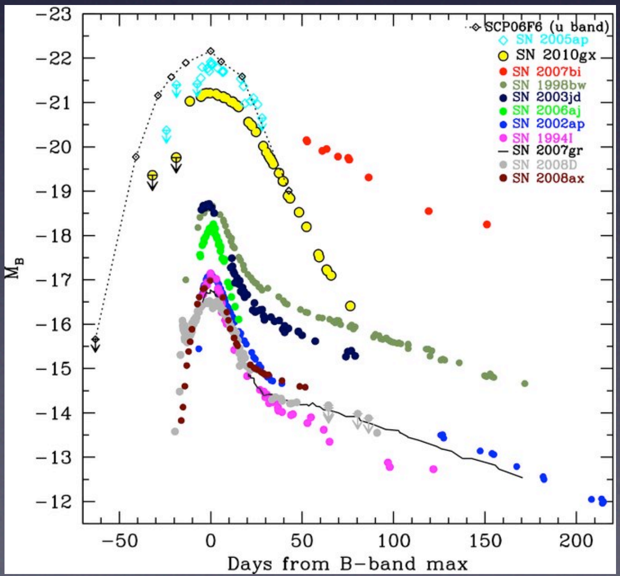


Normal Supernovae

- $E_{\nu} \sim 10^{53}$ erg
- $E_{Kin} \sim 10^{51}$ erg
- $E_{rad} \sim 10^{49}$ erg ($L \sim 10^{42}$ erg/s for 10^7 sec, or $L \sim 10^{43}$ erg/s for few $\times 10^6$ s)

Ultraluminous Supernovae

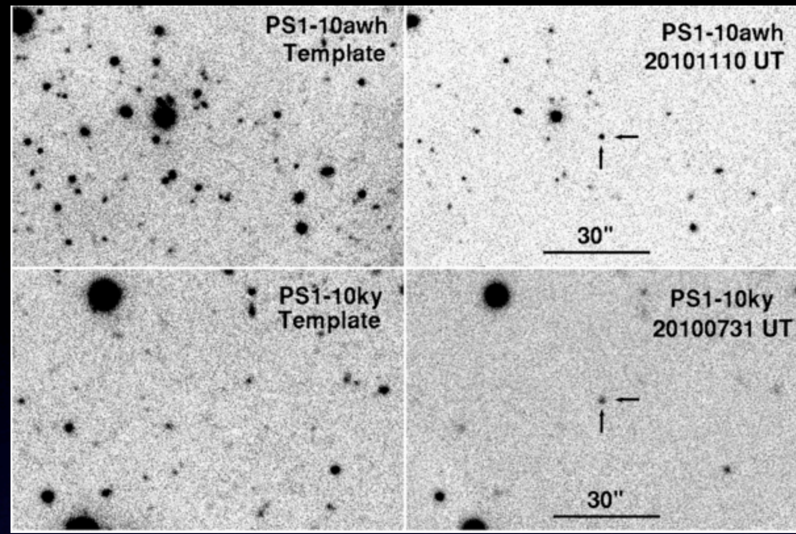
- $L_{peak} <$ few x 10^{44} erg/s
- $E_{rad} <$ few x 10^{51} erg
- $E_{Kin} \sim 10^{52}$ erg?

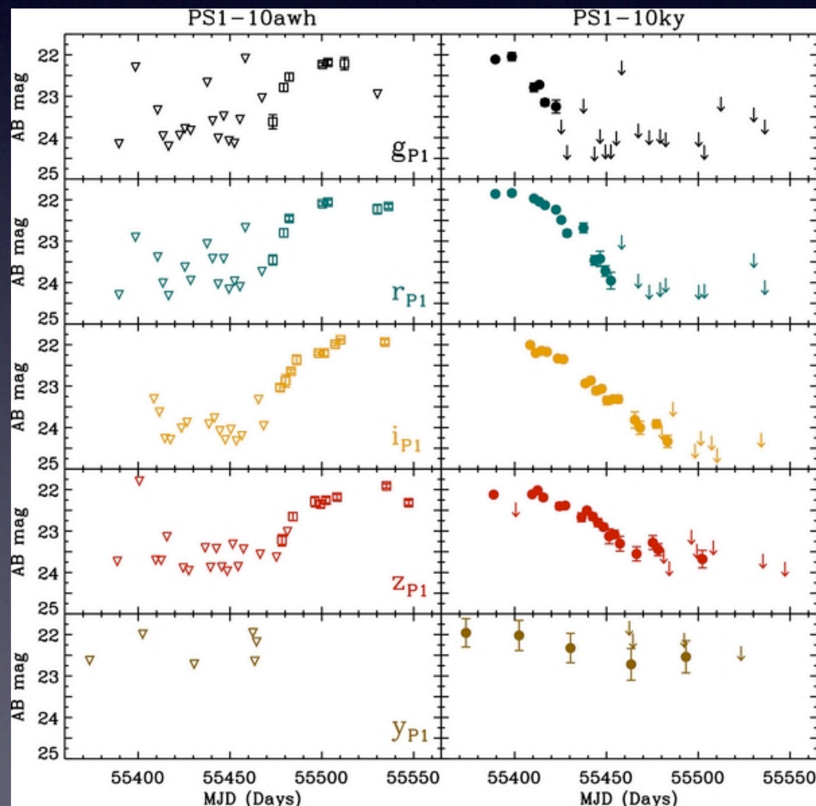


Pastorello et al. 2010

Our first two UL SNe

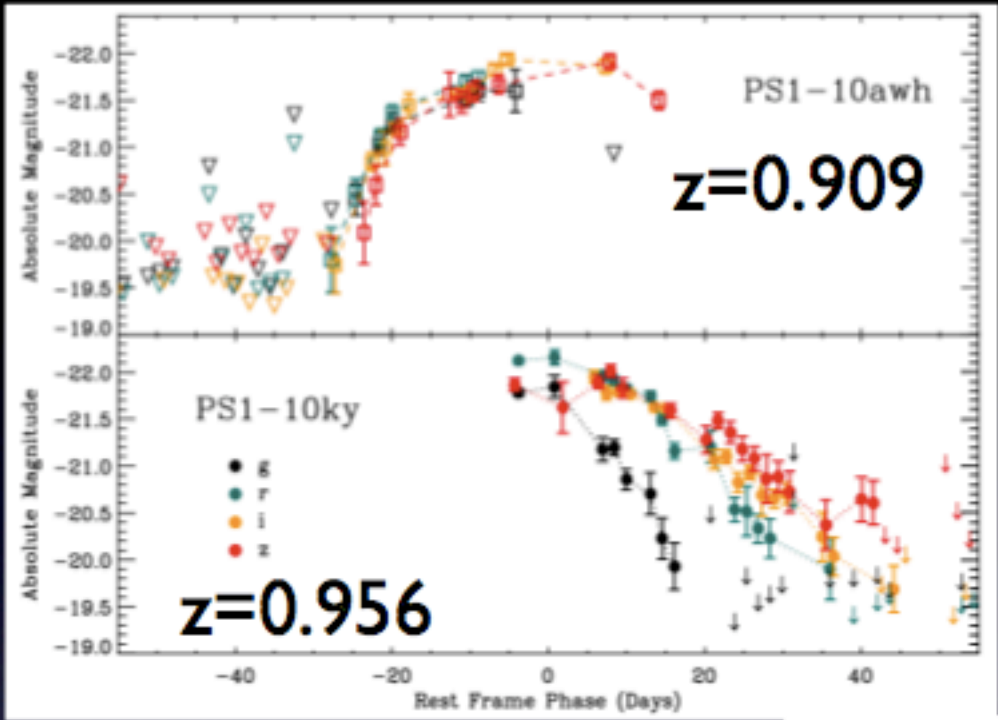
- PS1-10awh (z=0.908)
- PS1-10ky (z=0.956)



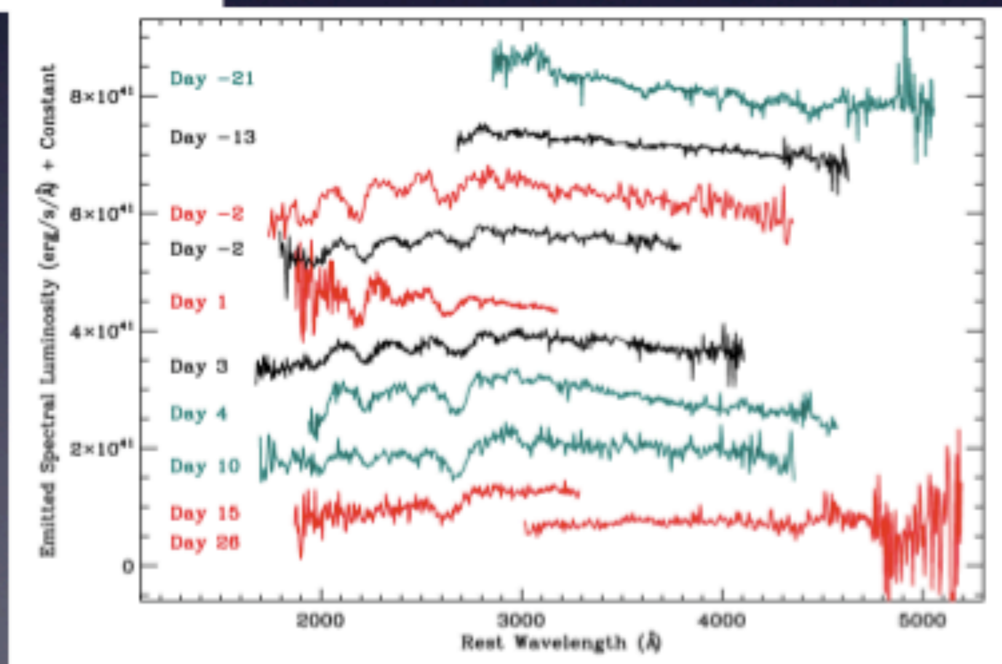


Chomiuk et al., 2011

Two New Ultraluminous SNe at z~0.9

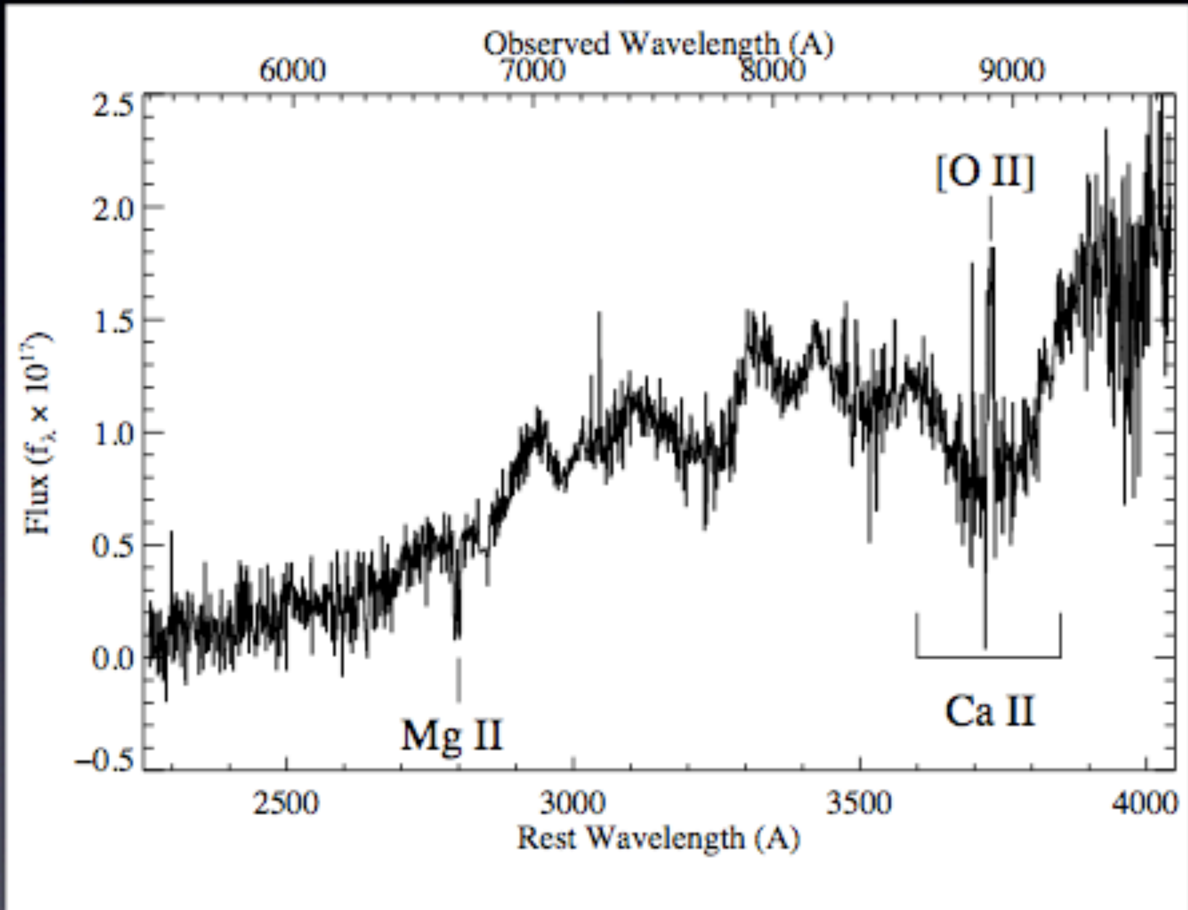


Both are SCP06F6-like (Barbary et al. 2009; Quimby et al. 2009)



Chomiuk et al., in prep.

A High-Redshift SN!



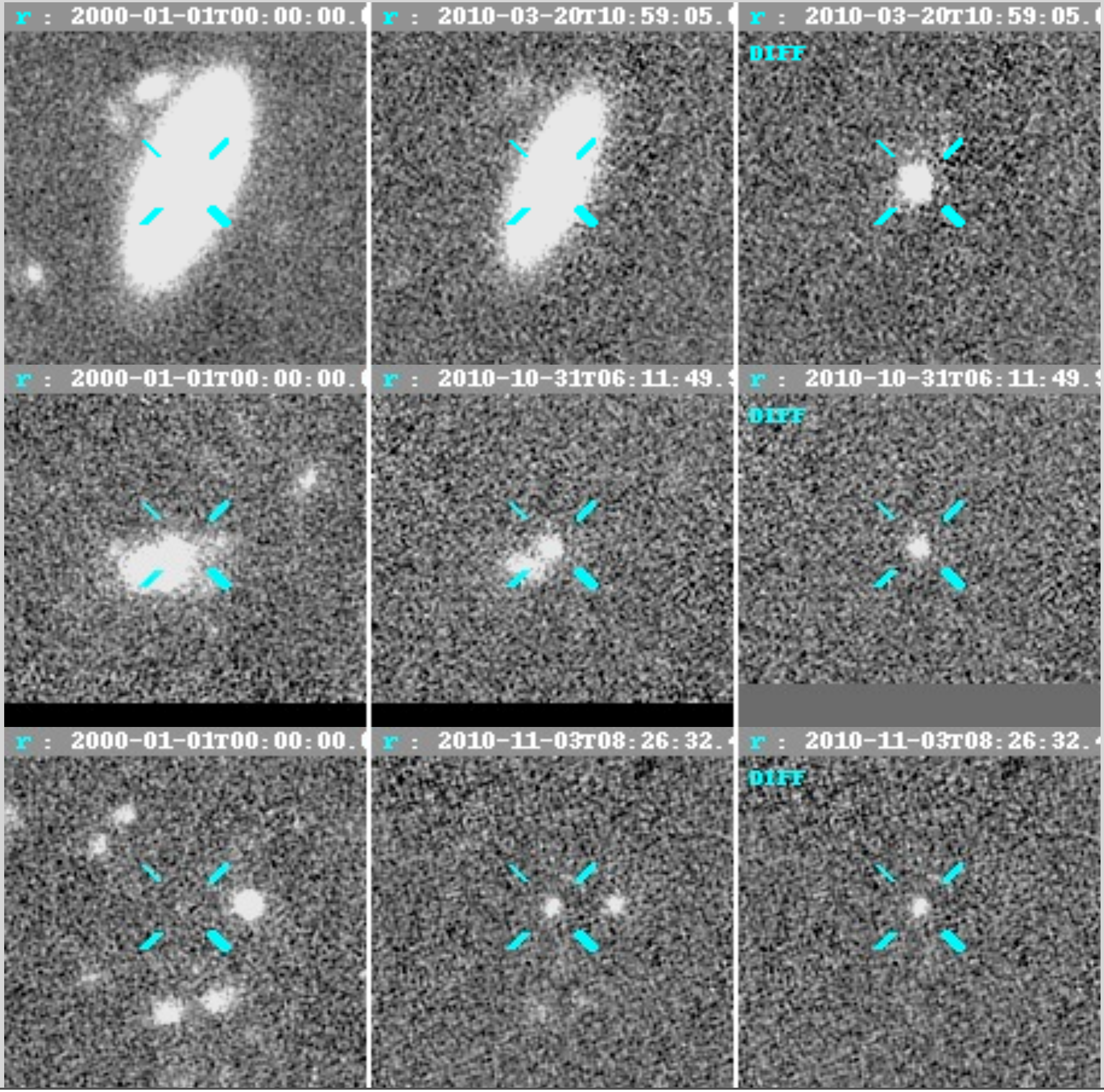
- $z=1.389$
- $z_{peak}=21.6$ (AB)
- m-M=45.0

For comparison:
HST04Sas at z=1.39 peaked at M_{850LP} ~ 24.75 (Vega) (Riess et al. 2007)

PS1 Type Ia Supernovae

Ryan Foley
Clay Fellow
Harvard-Smithsonian
Center for Astrophysics

Armin Rest
Dan Scolnic
Ryan Chornock
Mark Huber
Gautham Narayan
Steve Rodney
John Tonry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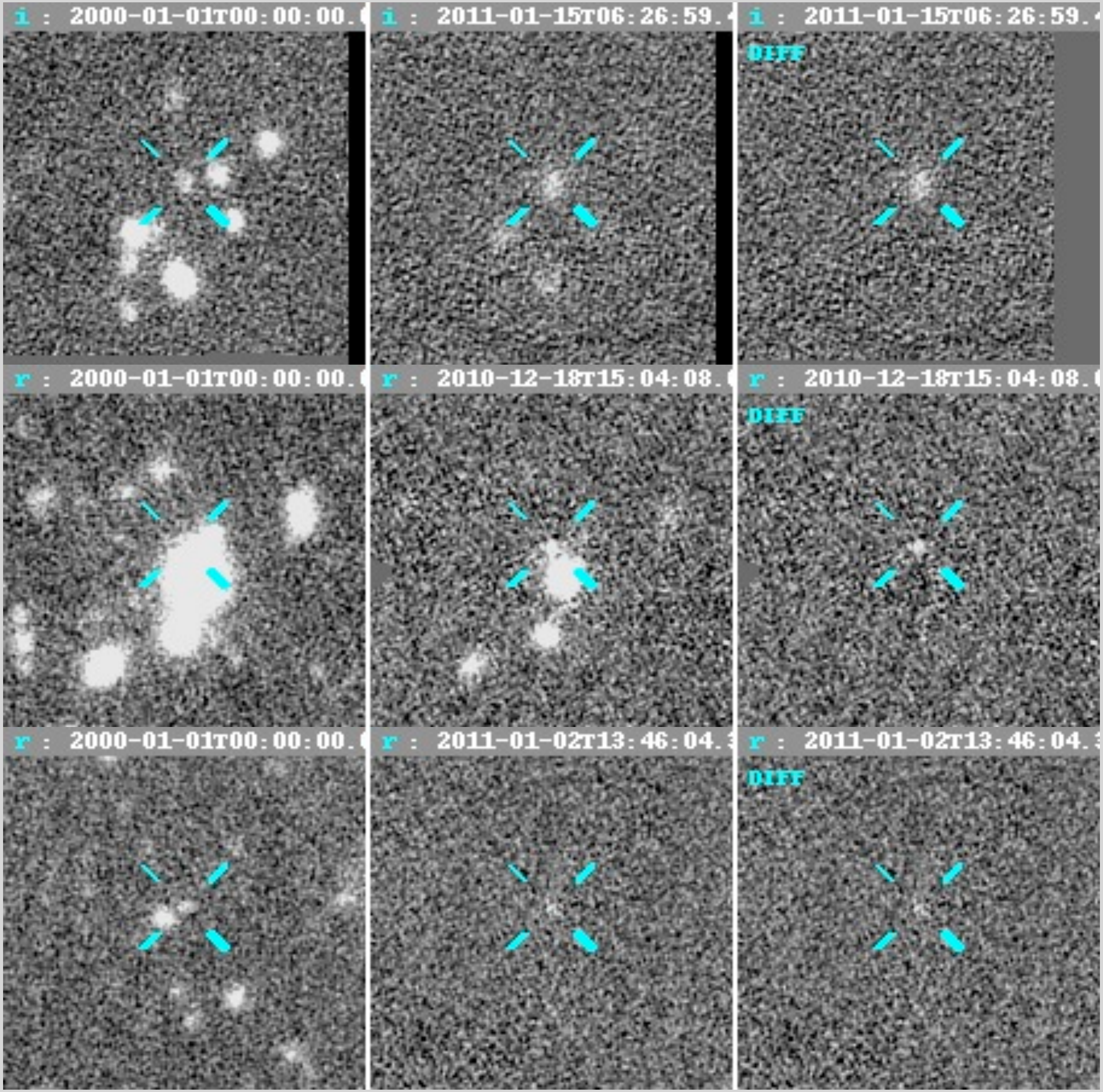
r : 2010-03-20T10:59:05.
r : 2010-03-20T10:59:05.
DIFF
r : 2000-01-01T00:00:00.
r : 2010-10-31T06:11:49.
r : 2010-10-31T06:11:49.
DIFF
r : 2000-01-01T00:00:00.
r : 2010-11-03T08:26:32.
r : 2010-11-03T08:26:32.
DIFF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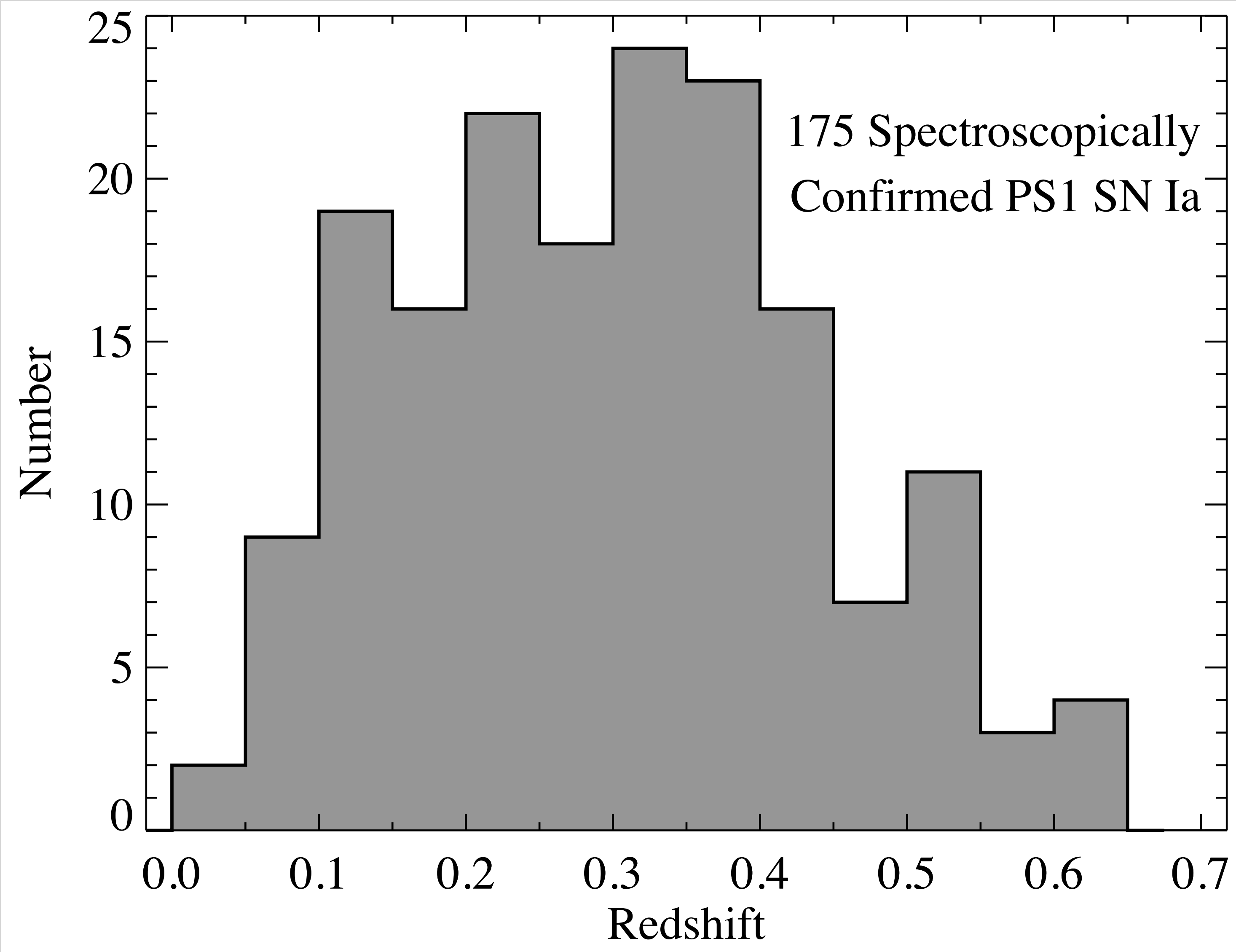
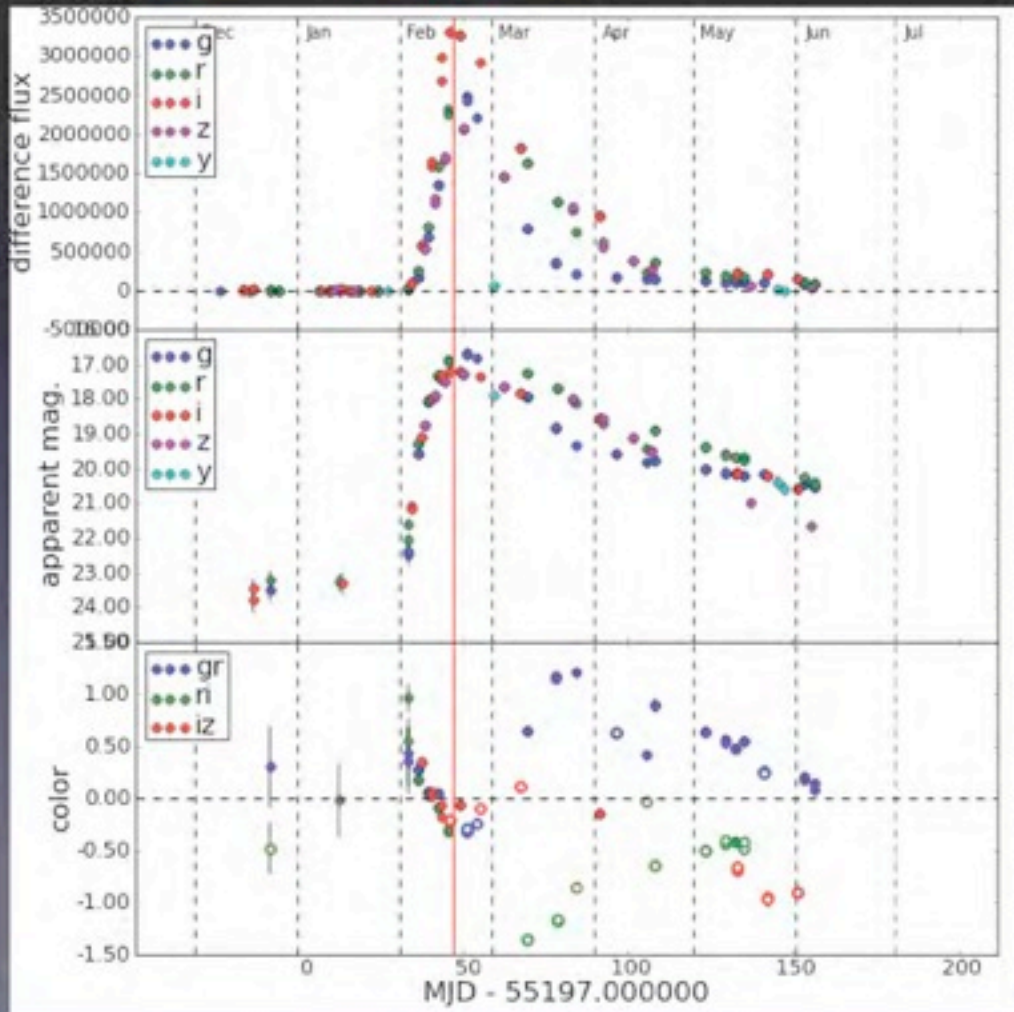
i : 2011-01-15T06:26:59.
DIFF
r : 2000-01-01T00:00:00.
r : 2010-12-18T15:04:08.
r : 2010-12-18T15:04:08.
DIFF
r : 2000-01-01T00:00:00.
r : 2011-01-02T13:46:04.
r : 2011-01-02T13:46:04.
DIFF

PS1 SN Ia Redshift Histogram

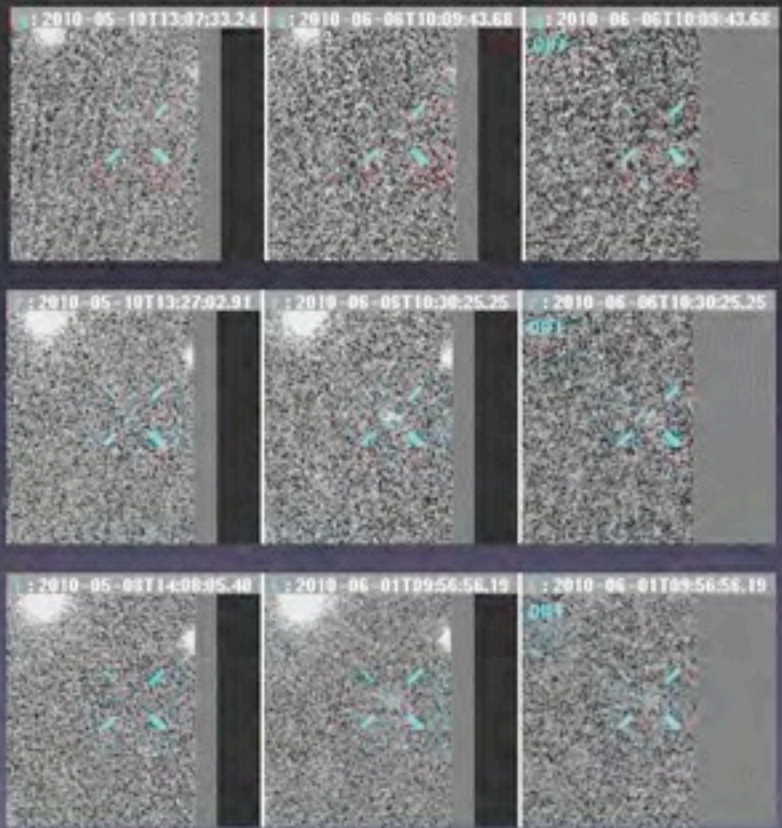


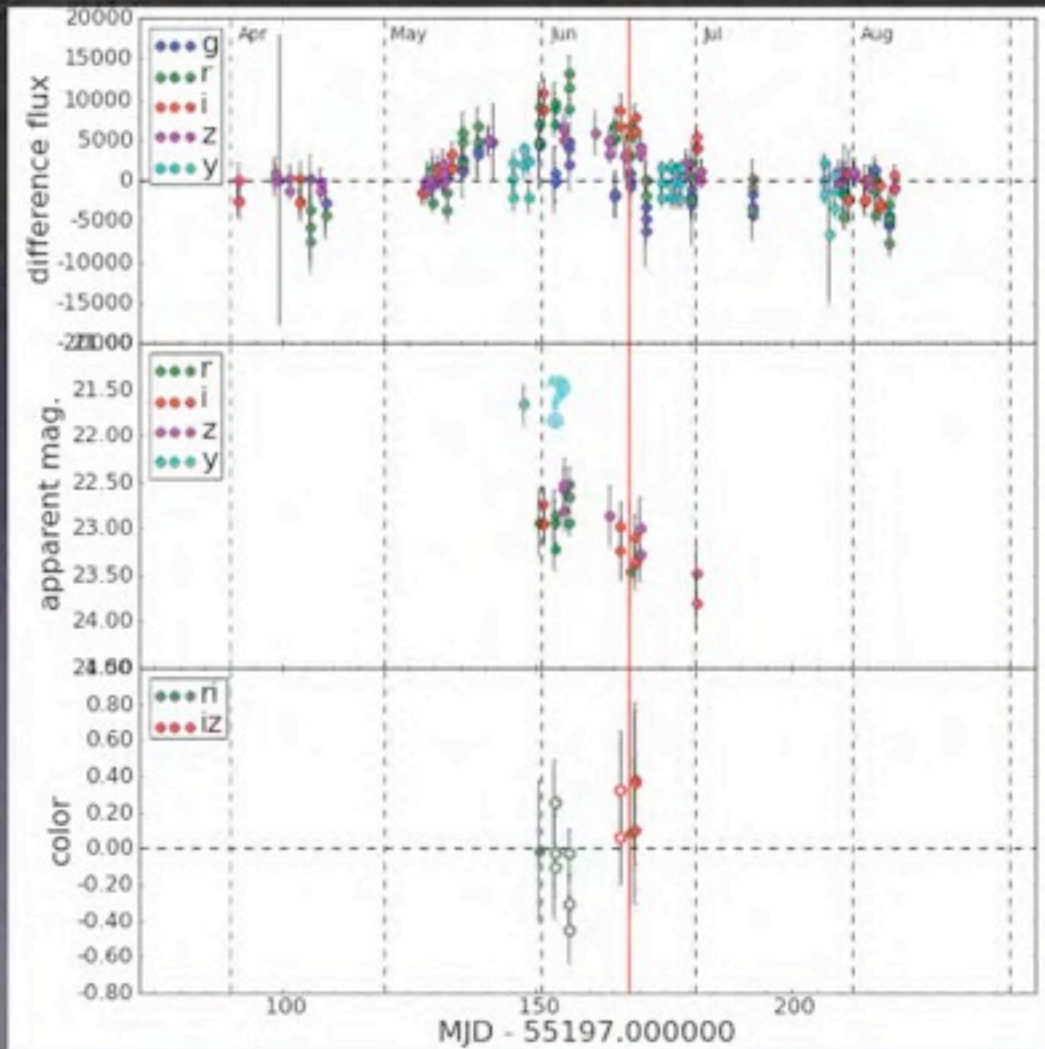
PS1-1000023 SNIa @ z~0.031



- 2010-B-010026, on 20100213 in MD05

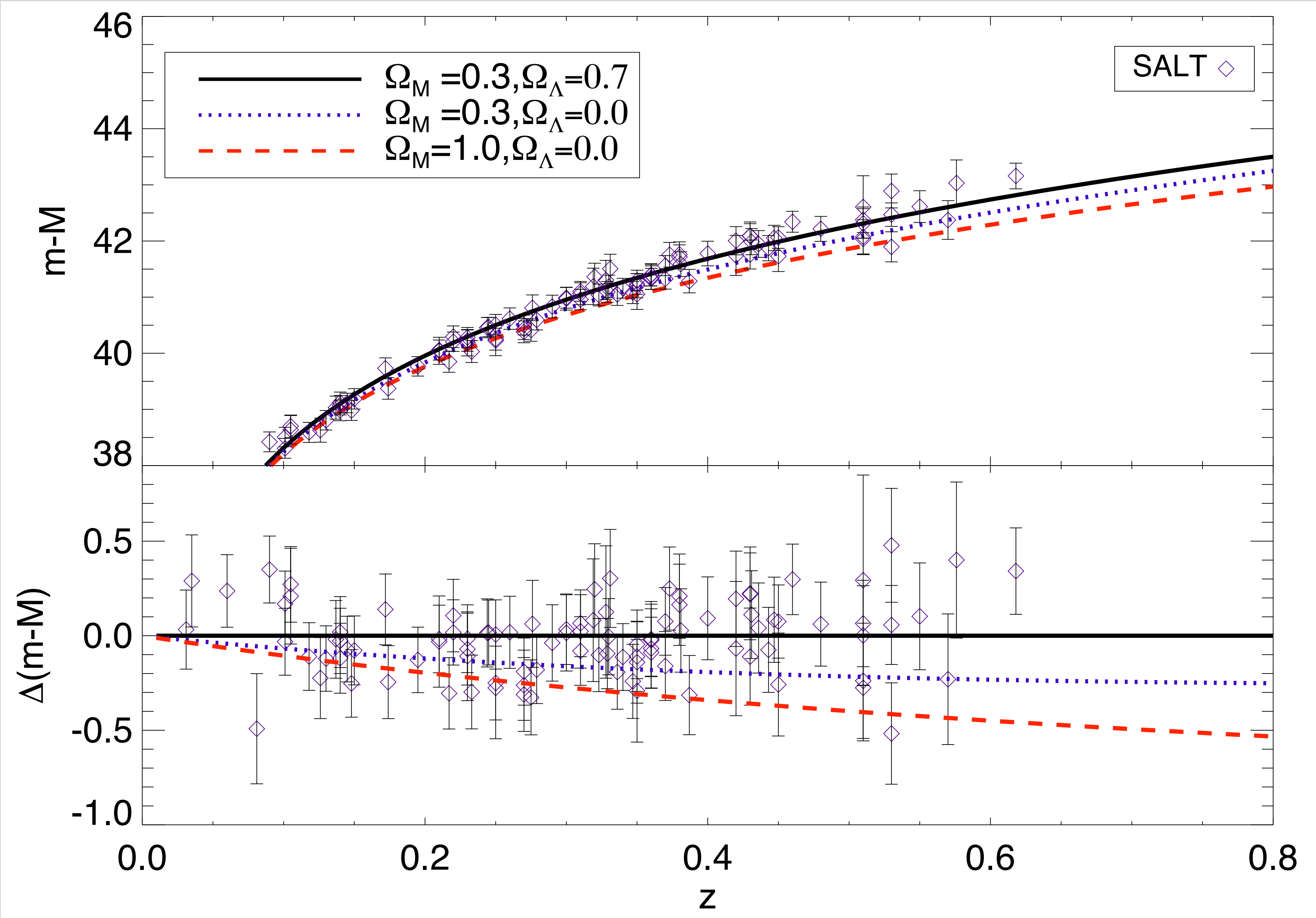
PS1-1000287 SNIa @ z~0.576





- 2010-F-050203, on 20100116 in MD04

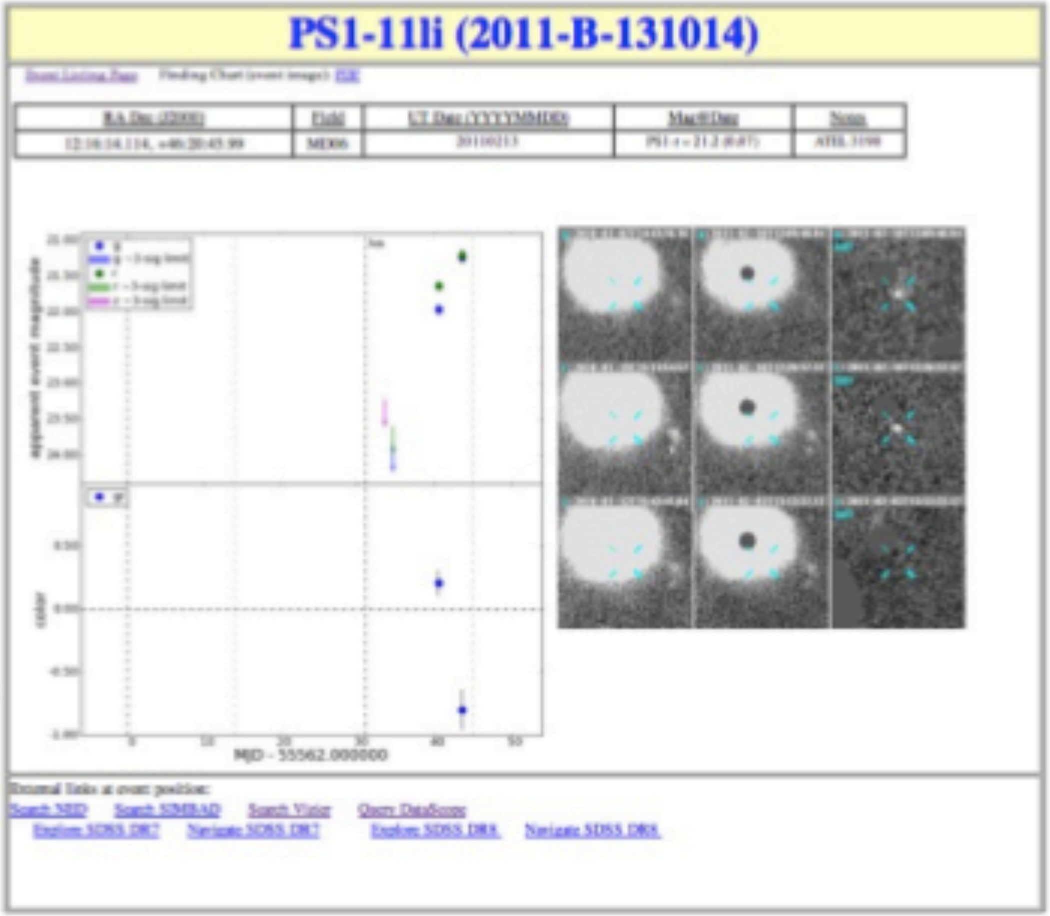
PS1-Only Hubble Diagram (117 SNe)



PS1-MDS Public Release of Transient Candidate Events

Possible events: >15000 since Jan. 2010
Transient alerts: >100/month average
Public release: ~60 (past 1.5 months)

Sample page: PS1-11li announced as SNIIP at z=0.068 via ATel 3190 (Feb. 25, 2011, Chornock et al.)



Basic page contents:

- listing of confirmed and candidate events
- coordinates, PS1-MD field, UT date released, and notes
- event light curve and color plot
- best S/N image, reference, difference image postage stamps
- links to external data sites for associations
- (soon) VOEvent and related alert streams
- (soon) data tables of full listing and photometry

Full details at poster on Wednesday #328.12 and visit http://ps1sc.org/transients

Ultraviolet and Optical Flare from the Tidal Disruption of a Helium-Rich Stellar Core

Gezari+ 2012, Nature, In Review

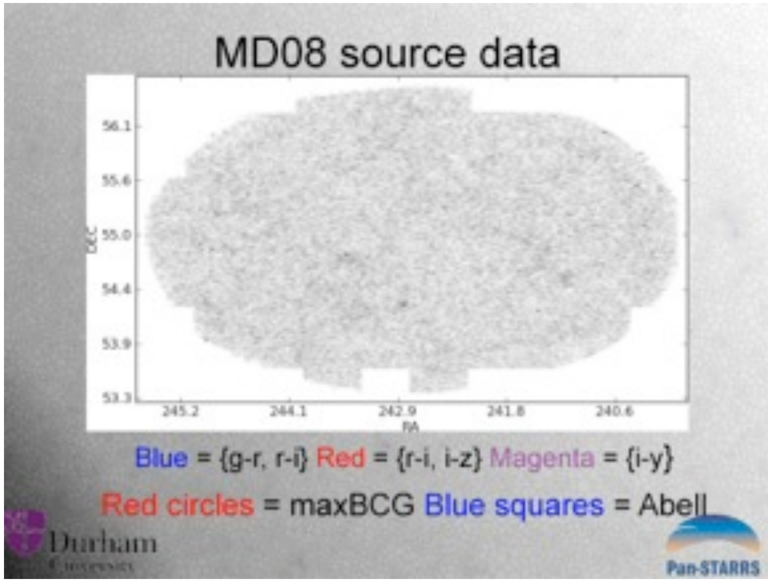
S. Gezari[1,11], R. Chornock[2], A. Rest[3], M. E. Huber[4], K. Forster[5], E. Berger[2], P. J. Challis[2], J. D. Neill[5], D. C. Martin[5], T. Heckman[1], A. Lawrence[6], C. Norman[1], G. Narayan[2], R. J. Foley[2,12], G. H. Marion[2], D. Scolnic[1], L. Chomiuk[2], A. Soderberg[2], K. Smith[7], R. P. Kirshner[2], A. G. Riess[1], S. J. Smartt[7], C.W. Stubbs[2], J.L. Tonry[4], W. M. Wood-Vasey[8], W. S. Burgett[4], K. C. Chambers[4], T. Grav[9], J. N. Heasley[4], N. Kaiser[4], R.-P. Kudritzki[4], E. A. Magnier[4], J. S. Morgan[4], & P. A. Price[10]

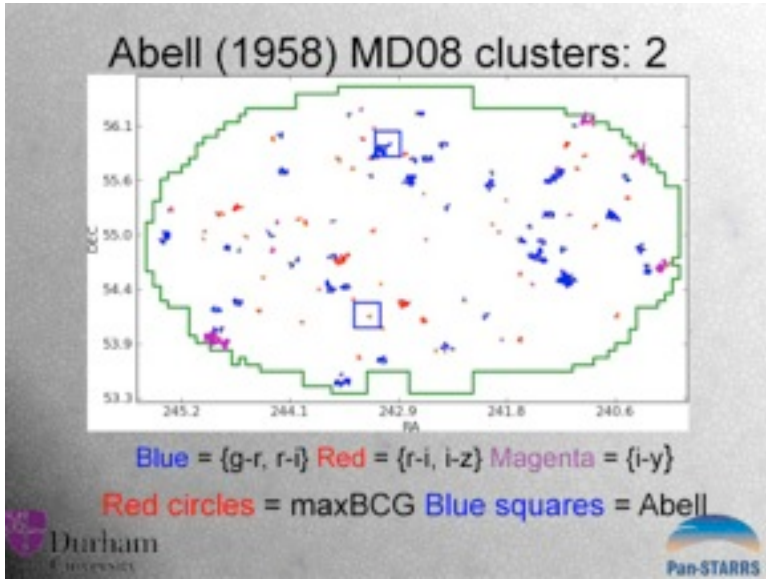
- Extreme UV-to-Xray ratio (α_{ox}) and prolonged UV emission rule out an AGN and SN, respectively.
- Light curve fitted for γ= 5/3 and $M_{BH} = (1.9 \pm 0.1) \times 10^6$ Msun $m_\star^2 r_\star^{-3}$
- Extremely low hydrogen mass fraction (X < 0.2)
- Expelled debris from a tidally disrupted helium-rich stellar core
- Tidally stripped Red Giant (precursor to a helium white dwarf)
- For M = 0.23 Msun, R = 0.33 Rsun:

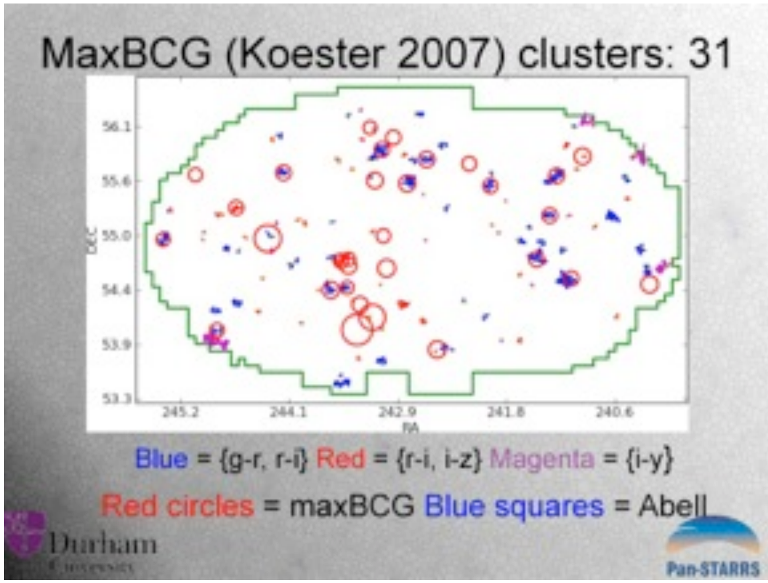
$M_{acc} > 0.012$ Msun , $M_{acc}/M_\star > 0.058$, and $M_{BH} = 2.8 \times 10^6$ Msun

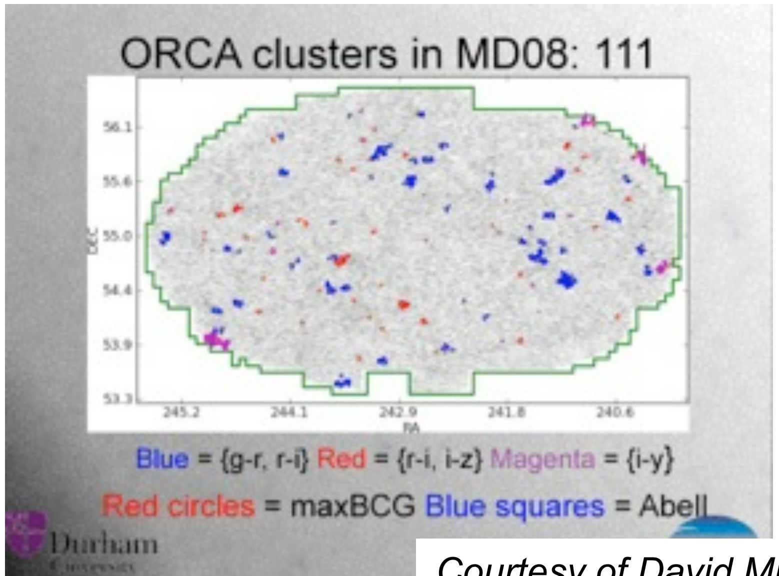
- PS1 is capable of detecting TDEs with excellent precision!

Testing MD08 for Clusters









Courtesy of David Murphy

PS1 KP11 Cosmological Lensing

Active KP11 People:

Edinburgh:

Massimo Viola (PS1 PDRA), Tom Kitching, Catherine Heymans, Richard Massey (moving to Durham), Alina Kiessling (moved to JPL), Eric Tittley, Andy Taylor, Alan Heavens (moving to Imperial), John Peacock.

Durham:

Nigel Metcalfe, Shaun Cole, Richard Bower, Carlos Frenk

Hawaii:

Tom Dixon, Nick Kaiser

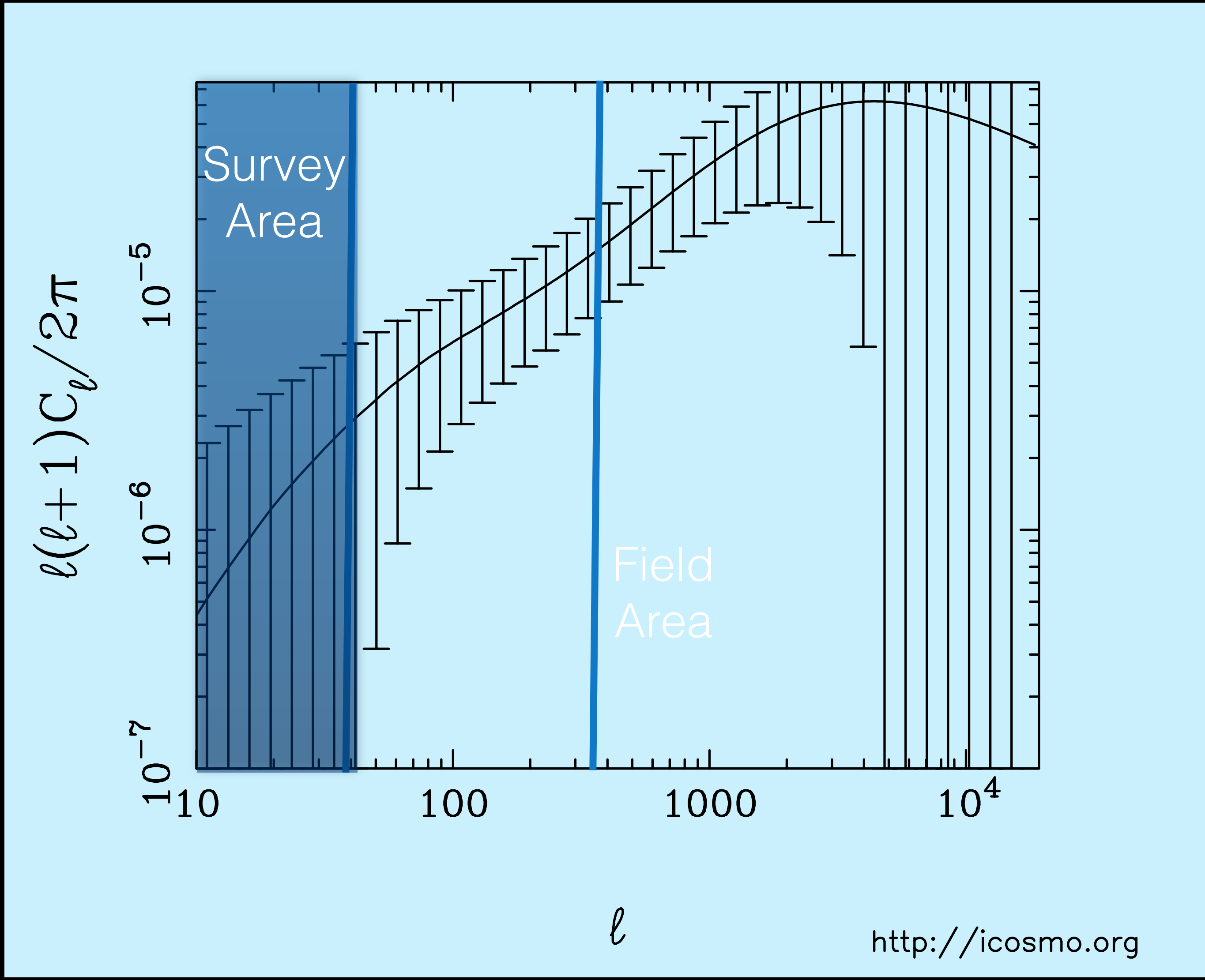
Weak lensing Shear Power Forecasts: CFHTLS

Area
170 sqdeg

n
25/sqarc

Median z
0.7

Seeing
0.7"



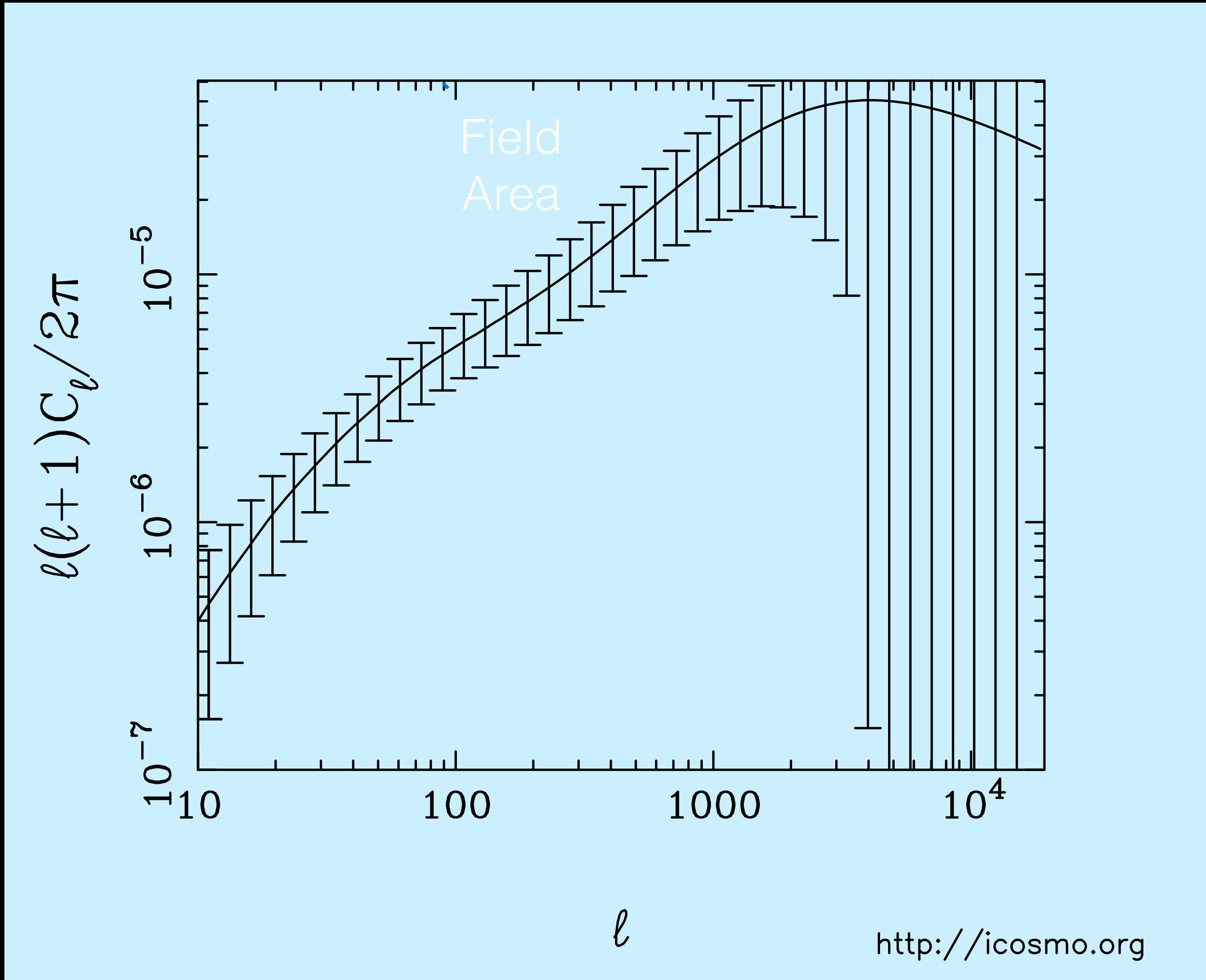
Weak lensing Shear Power Forecasts: PS1

Area
15,000
sqdeg

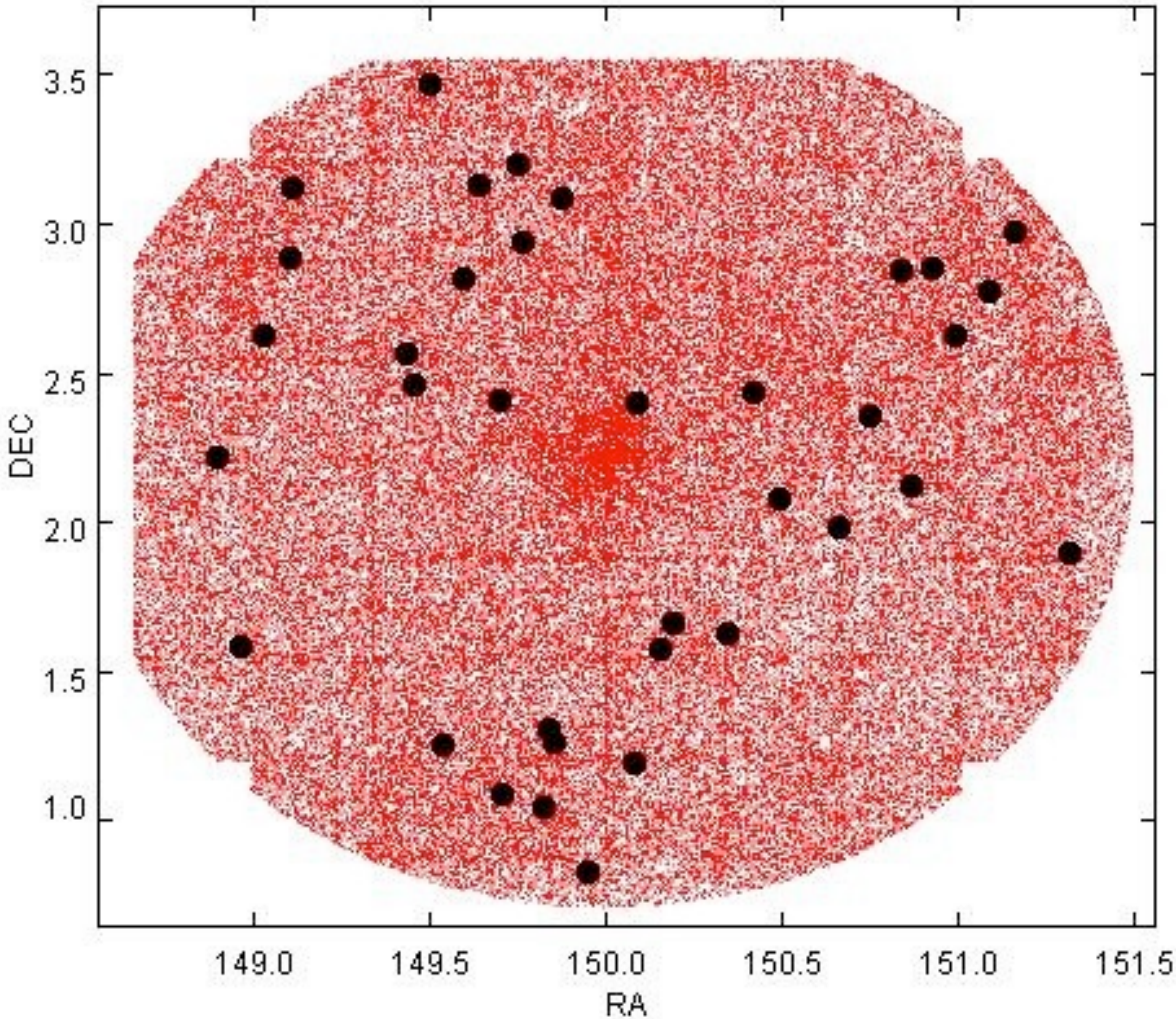
n
2/sqarc

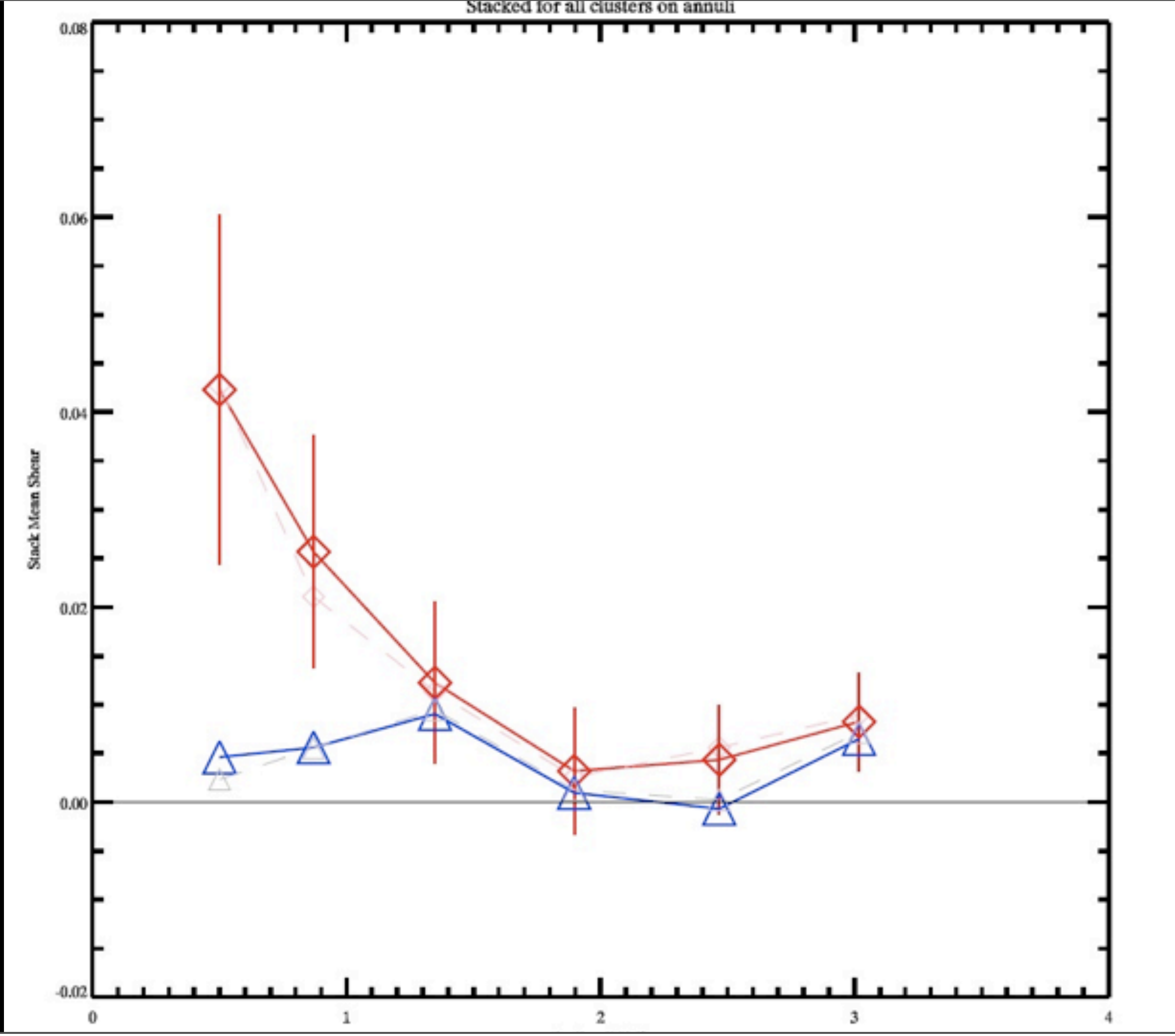
Median z
0.5

Seeing
1.1”



Weak Lensing Analysis of SDSS clusters in MD04




Stacked for all clusters on annuli
Stack Mean Shear
0.08
0.06
0.04
0.02
0.00
-0.02
0
1
2
3
4

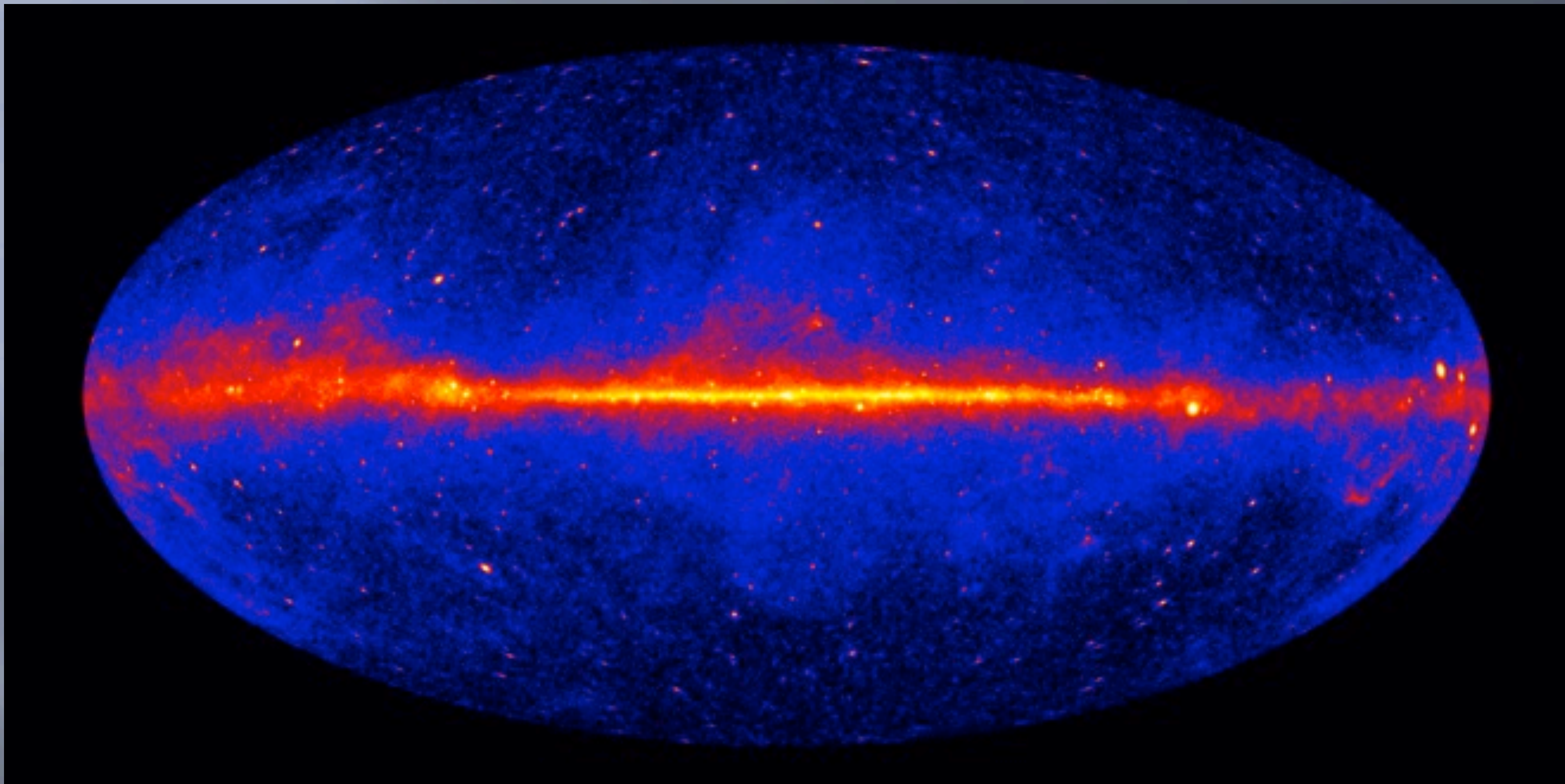
Fermi and Pan-STARRS

status summary slides

Version 3; Feb 8, 2012

K. Wood with edits from P. Michelson

Fermi Sky Map
(Galactic Coordinates)



Unidentified sources in Fermi 2FGL ("UNIDS") are >500 or about 30% of the catalog

Science examples

- Confirming *Fermi* catalog associations to make them full *identifications,* by correlating variability, optical to gamma-ray
- PS1 optical astrometry then gives precise (< 100 m.a.s.) positions for the source component that is variability-correlated with gamma-rays; this is not necessarily the same as radio centroid.
- Finding new candidate associations, by colors in Pan-STARRS, training on the well-established sample. This is a way of identifying *Fermi* UNIDs, going fainter and to higher redshift.
- Galactic transients (e.g., novae such as Nova V407 Cyg 2010, the first gamma-ray nova)
- Studying binary systems of "Black Widow" millisecond pulsars being found by *Fermi,* observing optical modulation over orbital period.
- Searching precursors of GRB or other transients -- Pan-STARRS sometimes observes transient position shortly *before* outburst, by chance. (No other way to do this at all to useful flux level.)

- Also the reverse: looking for Pan-STARRS transients in *Fermi*

Pilot Study Region

- Two rectangles:

R1: RA = 323 to 330

Dec = -30 to +10

This region has 10 blazars

R2: RA = 341 to 355

Dec = -5 to +15

This region has 7 blazars

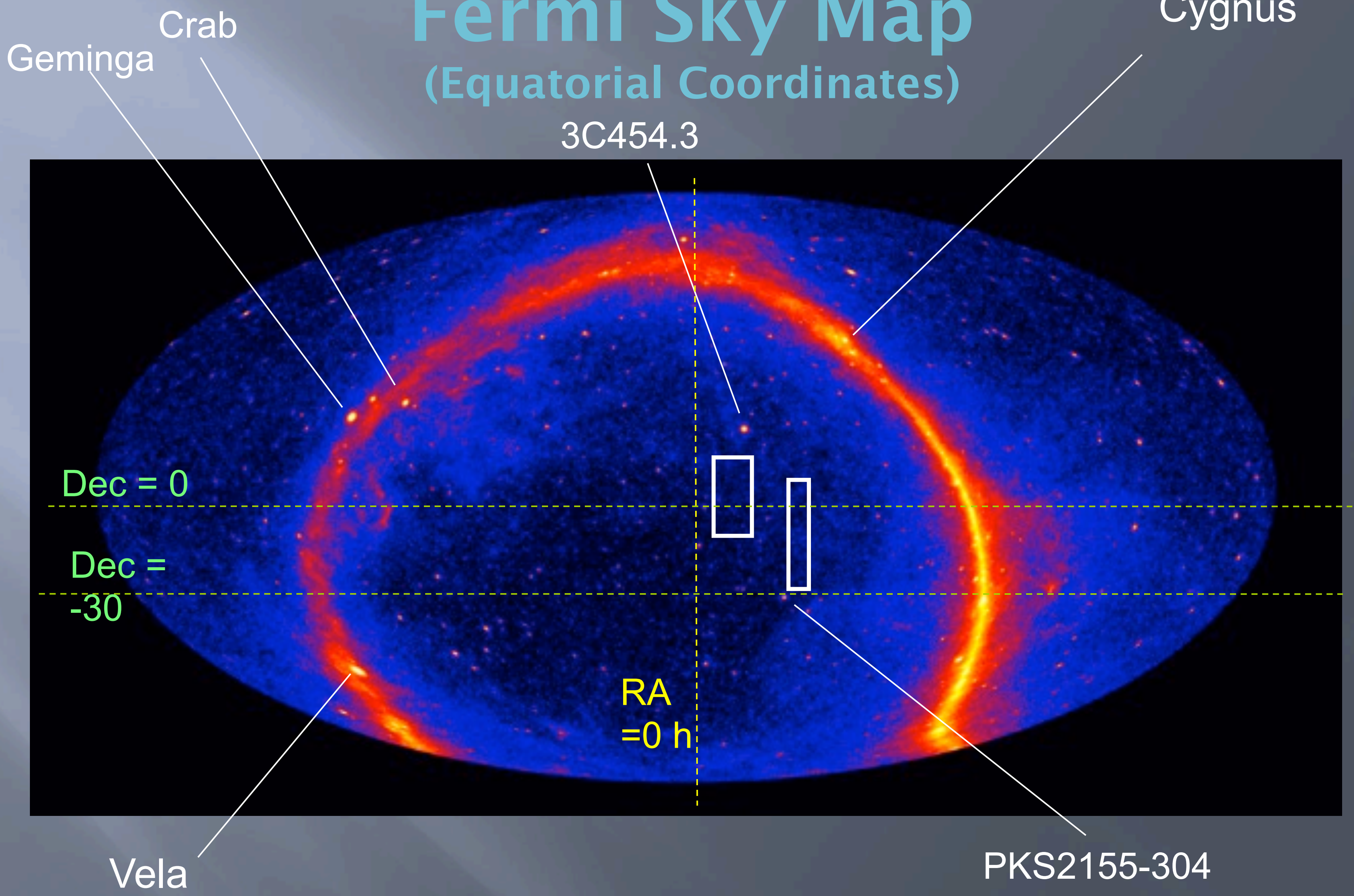
All 17 pilot study sources are well detected at many

- 2FGL=1873 srcs in 40,000 sq deg
- Pan-STARRS covers 30,000 sq deg
- Pilot region is about 1 % of sky
- Naively project ability to see > 1000Fermi LAT counterparts

- Pan STARRS detections have r magnitudes < 19.5, so the signal to noise is always high in all filters on these Fermi 2FGL counterparts

That means PS1 is capable of working with much fainter Fermi sources as work proceeds in the future.

Fermi Sky Map
(Equatorial Coordinates)



Pilot region is in hrs 20-23; has 17 blazar associations; is roughly 45 deg off Gal. plane; ~400 square deg; essentially 2 rectangles in RA, Dec.

Galactic Science: Parallax and Proper Motions from PS1

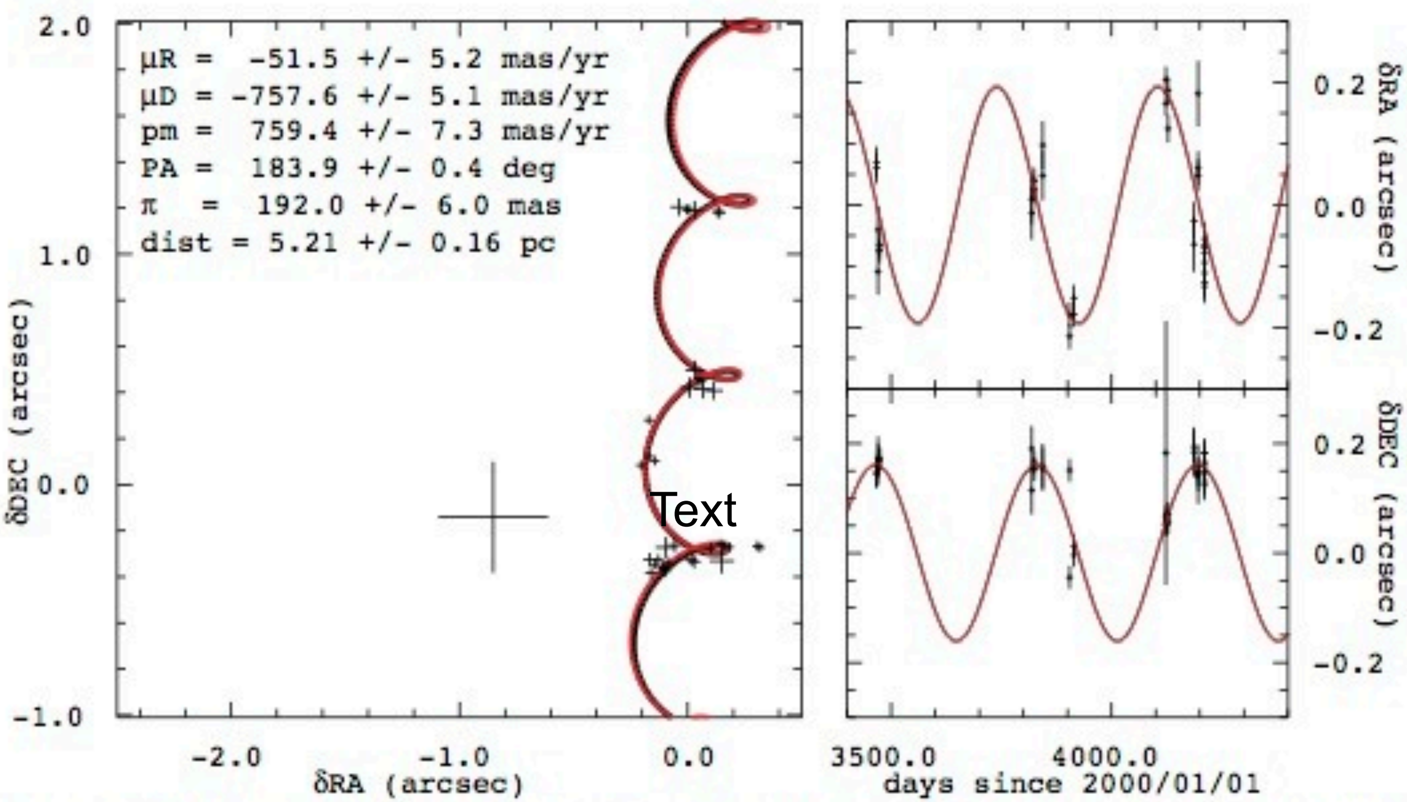


Figure 2: Parallax and proper moton of 2MASS 1835+22 from PS1 data alone. This illustrates the astrometric precision and that the cadencing of the 3π Survey is ideally suited to the parallax search.

PCS:
the Photometric Classification Server

Goals:

- Separation of Stars/Galaxies/Quasars (PanDiSCS, MPIA)
- Estimation of PhotoZ for galaxies (PanZ, MPE)
- Estimation of stellar parameters for stars (PanSTeP, MPIA)
- Automatic processing and publishing of data
- Serve the Science Projects

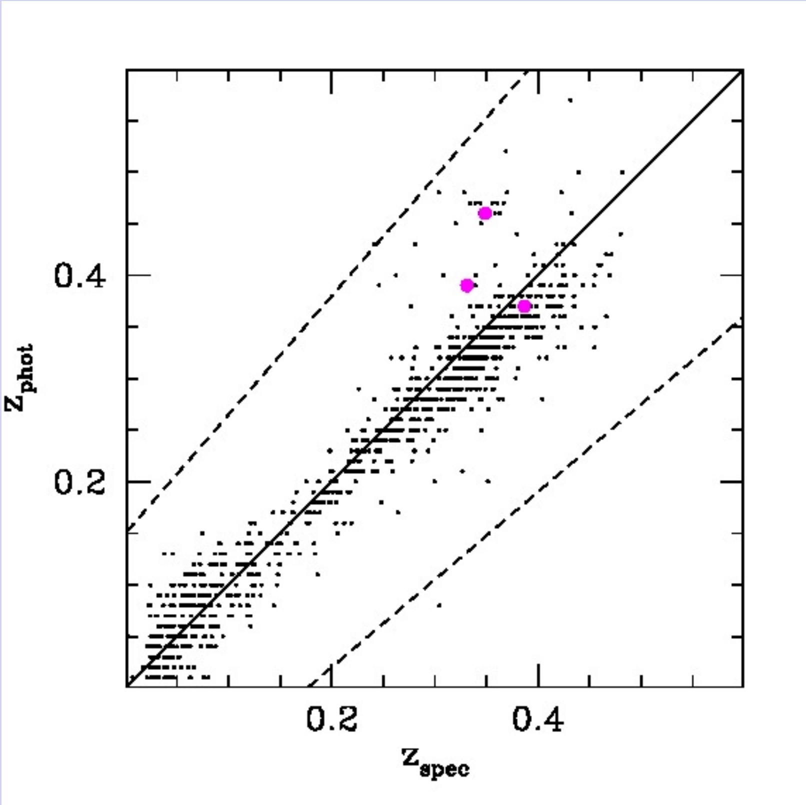
Algorithms:

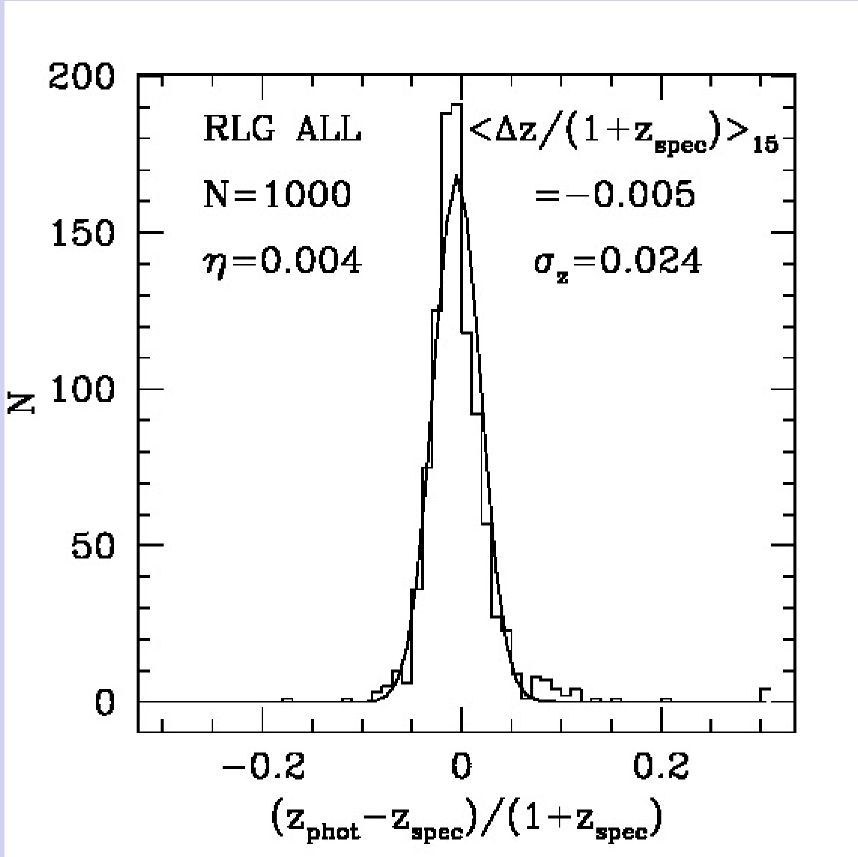
- Support Vector Machine Classifier (PanDiSCS)
- Bayesian PhotoZ estimation based on SED fitting (PanZ)
- Further algorithms possible

Realization:

- MySQL based database system on Linux
- Linux cluster for parallel processing
- External and internal interfaces for data flow control

LRGs in the MDFs





$$\eta : \frac{|\Delta z|}{1 + z_{spec}} > 0.15$$

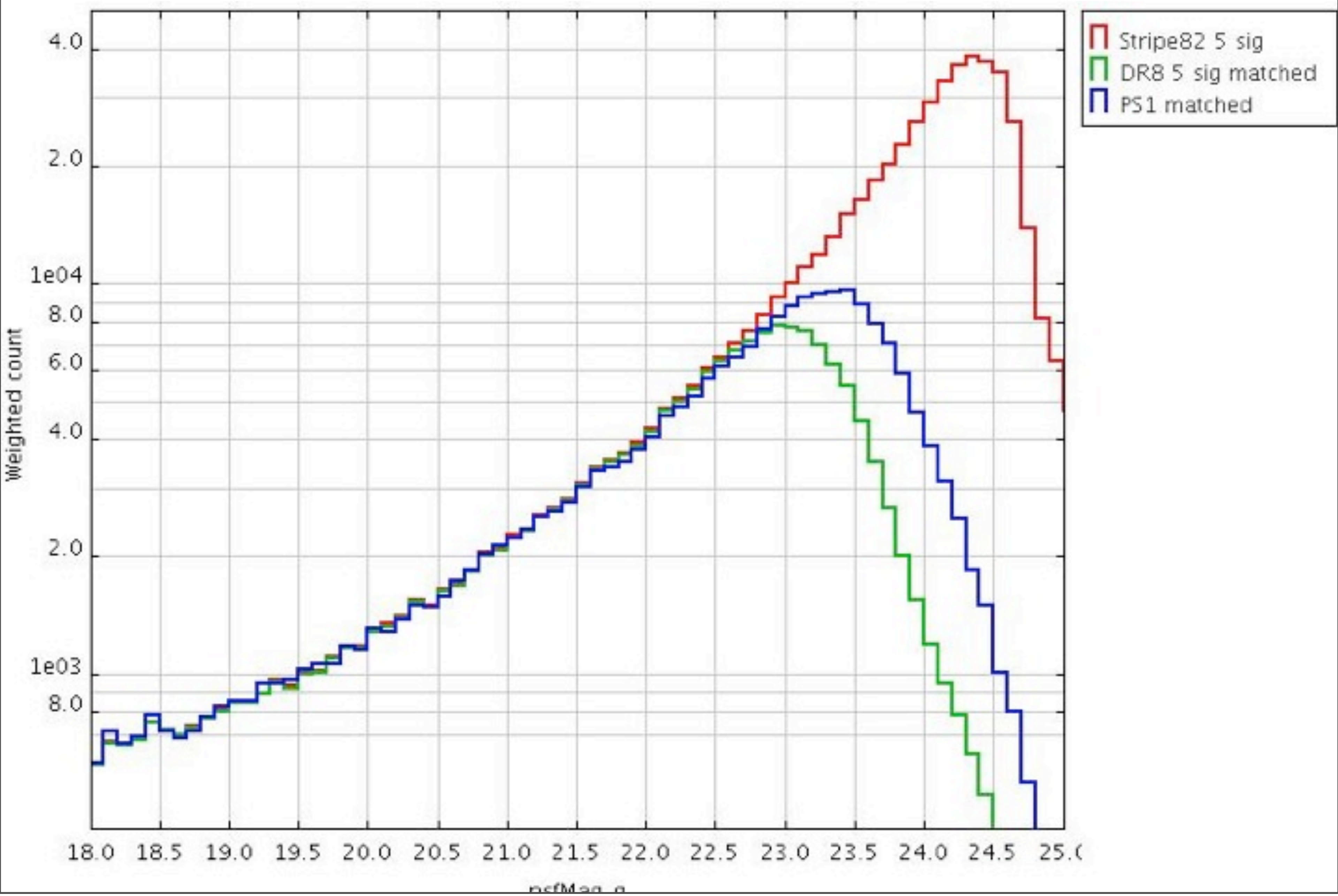
$$\sigma_{\Delta z/(1+z)} = 1.48\, Median \left(\frac{|\Delta z|}{1 + z_{spec}} \right)_{non-outliers}$$

[based on Tonry's reduction of MDFs]

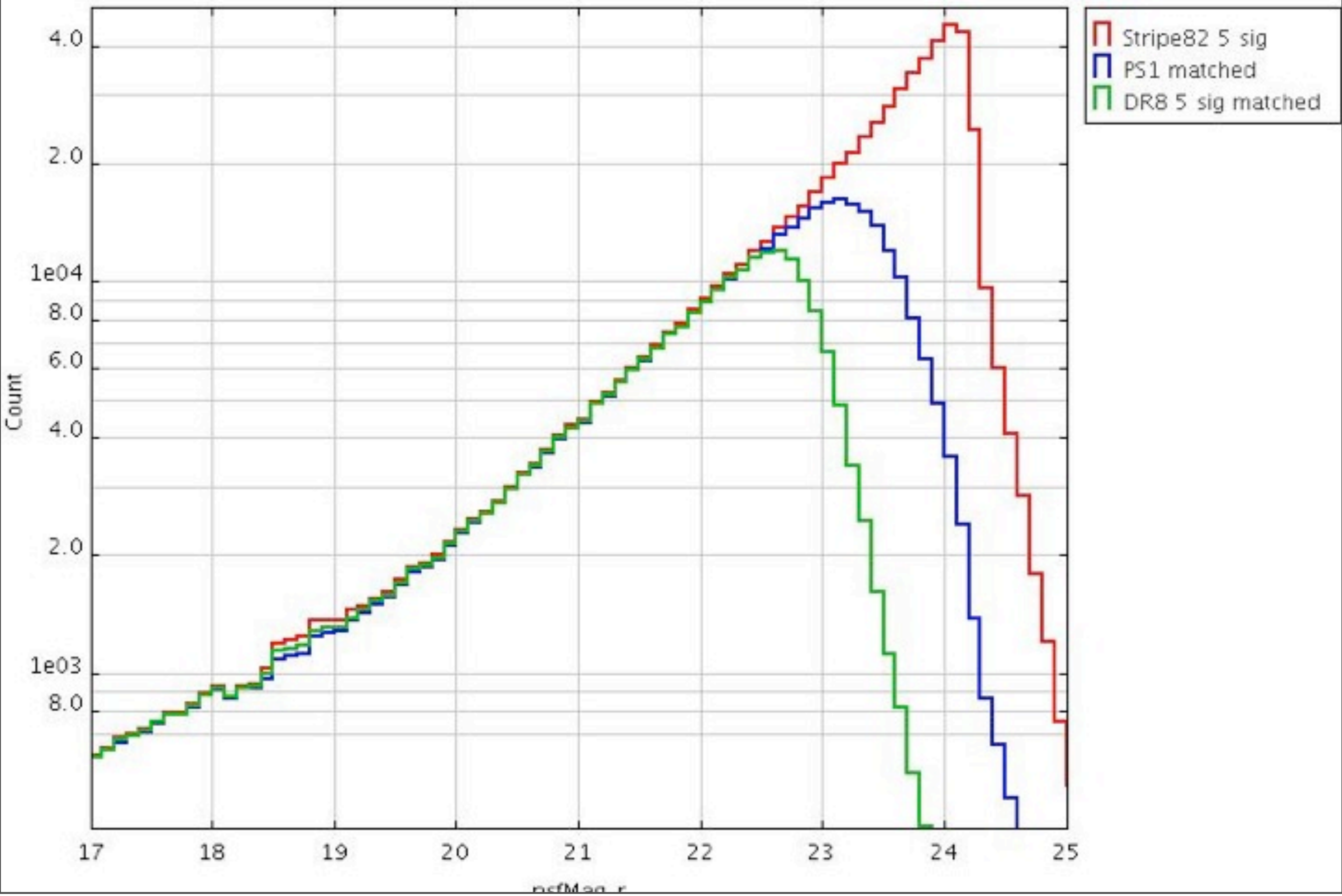
PS1 Photometric Classification Server
Saglia et al (arXiv:1109.5080)

- PCS: automatic classification of catalog objects into star/galaxy/quasar classes; photometric redshifts for extragalactic objects; parameters for stellar objects.
- Tested using SDSS spectroscopic sample
- PCS photo-zs as good as SDSS
- Correct classification of stars (82%), galaxies (98%) and QSOs 80% (false positives below 30%, 1%, 30%)
- Photo-zs for 1000 LRGs to z=0.5 with 2.4% uncertainty with only 0.4% catastrophic outliers
- Bluer galaxies have 4% uncertainty with 1% outliers.
- Photo-z to 5% accuracy for ~ 60% of QSOs

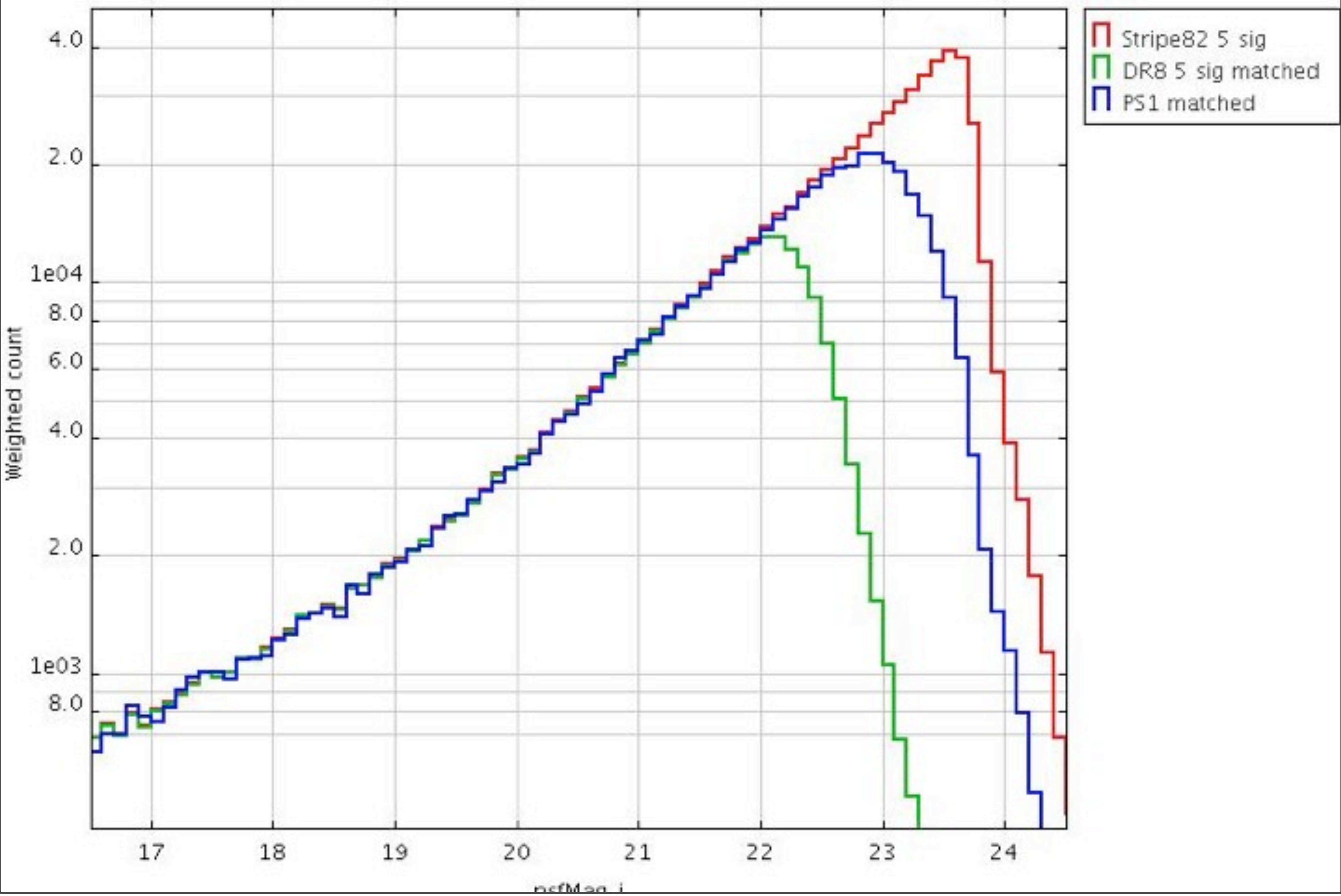
PS1 3-pi Survey Sensitivity from SAS2 (DRAVG)



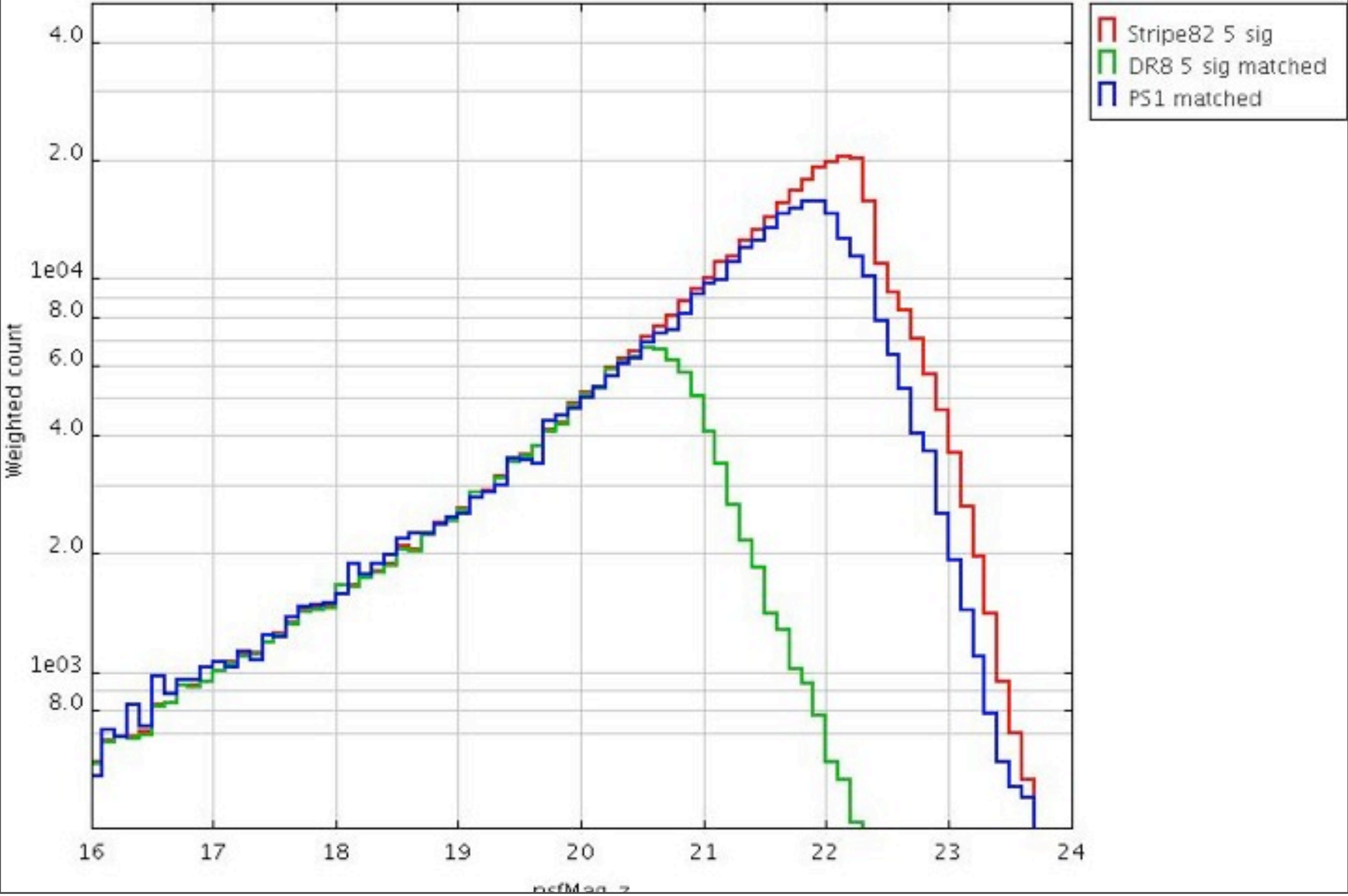
PS1 3-pi Survey Sensitivity from SAS2 (DRAVG)



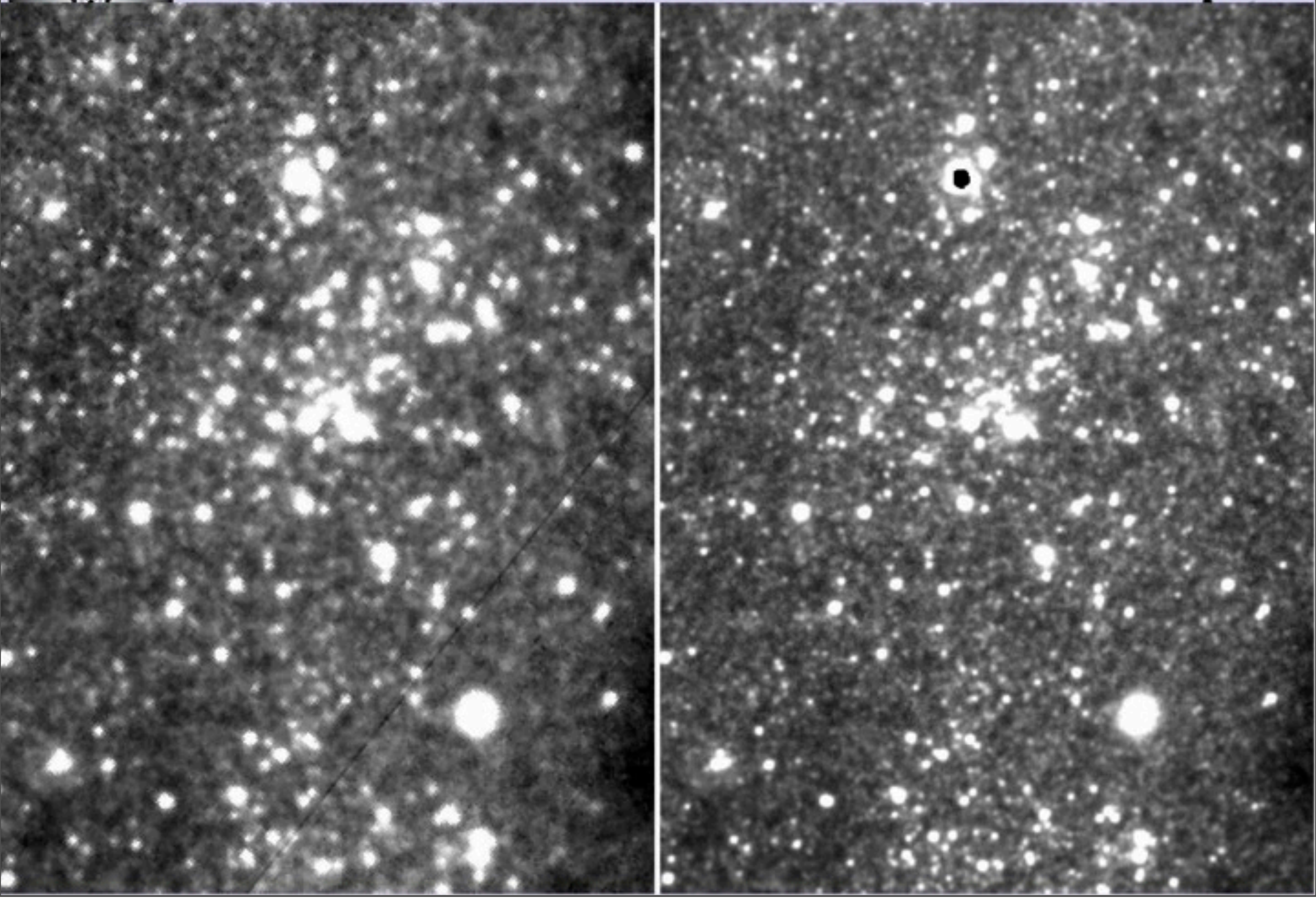
PS1 3-pi Survey Sensitivity from SAS2 (DRAVG)



PS1 3-pi Survey Sensitivity from SAS2 (DRAVG)



SDSS PS1



Wednesday, 11 April, 12

PS1 3-year Survey Depths (DRAVG 2011-08-10) Metcalfe et al

- Three year (SAS2) stacks 0.5 mag better than SDSS (single 57sec exposure) even in g and r
- Even better in redder bands - especially y ;-)
- - partly from QE
- - partly from IQ
- SAS2 5-sigma point source limits: g=23.9, r=23.8 i=23.7; z=23.0
- <u>All depth measurements are consistent with predictions from seeing and sky background</u>
- <u>Comparison to SDSS:</u>
- - SDSS is slightly bigger telescope (2.5m vs 1.8m)
- - PS1 has slightly better IQ
- - PS1 has 7 squ deg FOV; SDSS has 1.5
- - so PS wins on exposure time 10*45s vs 57s
- - and on area 30,000 vs 7000 square degree

Public Release of PS1 3-year Survey Data

- PS1 Science Consortium policy declares all data to be publicly “releasable” 1 year after end of survey observations.
- PS project has developed PSPS object catalog database
- But otherwise no resources for public release.
- Consortium is teaming with STScI archiving team and seeking funds for final year of operations + reprocessing in return for serving data to public
- Some data already going out:
- - Asteroid data => Minor Planet Center
- - transient server
- 3-pi standard stars catalog release following ubercalibration of 2 year data.

The future: PS1+2

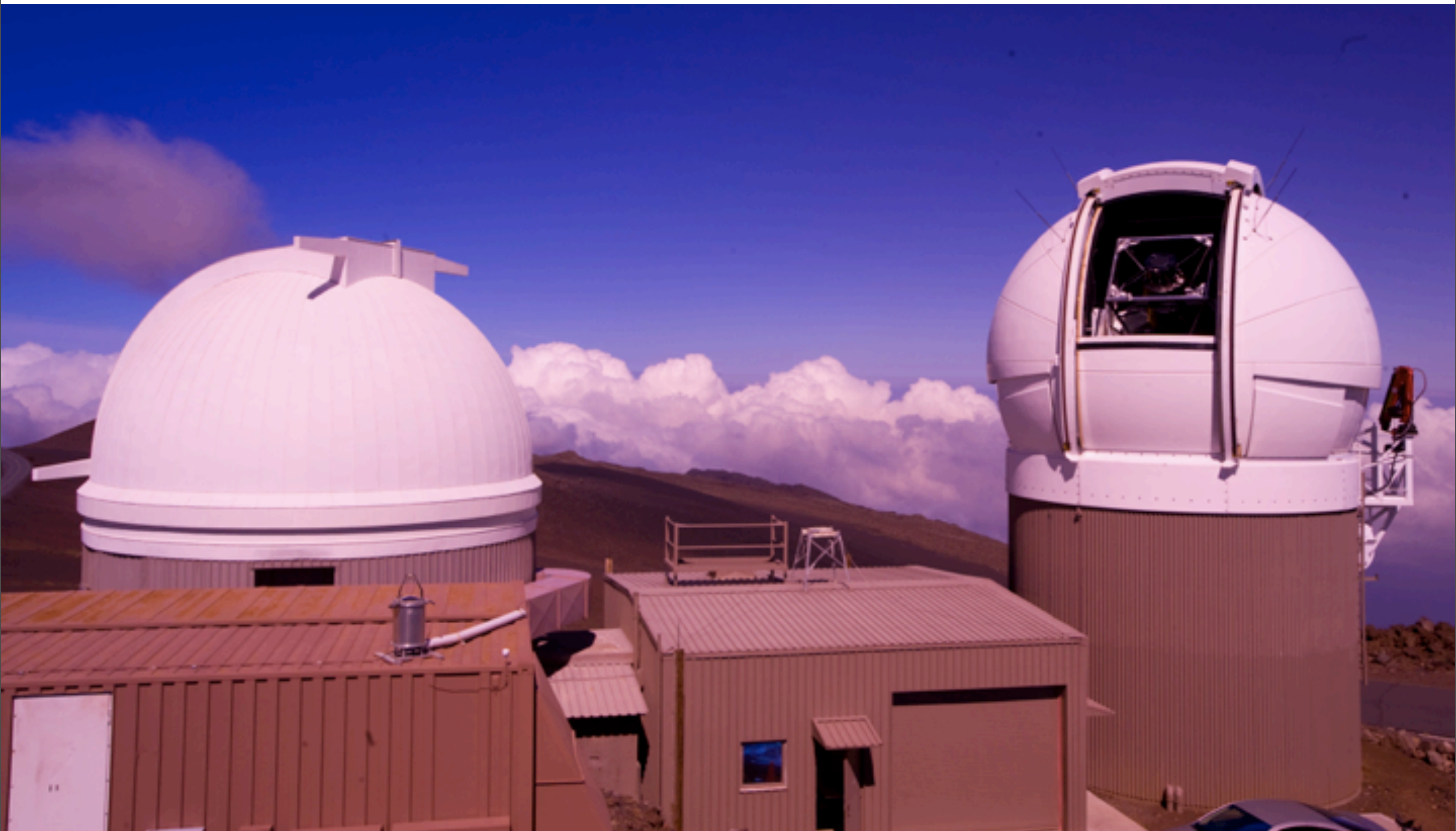
- PS1 survey mission to end 10/2013
- PS2 telescope delivery 10/2012
-   - PS1+2 full operations to start end of 2013
- Improved detectors for GPC2
- Improved optics
-   - possibility to upgrade GPC1, replace PS1 L2 lens
- Etendue (light grasp) similar to Blanco/DEcam
-   - 2 * 1.8m vs 4m; 7 squ deg vs 2.2
-   - PS1 delivers FWHM 1.1” vs DEcam goal of 0.9”
-   - PS1+2 100% dedicated to surveys vs shared facility (500 nights for DES survey)
- Mission:
-   - 7 years @ 50% Euclid photo-z support (g,r,i,z)
-   - 7 telescope years over 7,500 squ dev vs 2 ty over 30,000
-     => 1.4 mag deeper than PS1 3-pi
-   - complement to DES, VST in South
-   - rest is TBD - but strong synergy with other all-sky surveys.

Wide-Field Imaging Surveys in Next Decade(s)

- PS1+2: 2*(D=1.8m; 7 squ deg; 1.4bn pix), 100% survey
- PTF: D=1.25m; 7 squ deg; 100m pix; 100% survey
- DES: D=4m; 2.2 squ deg; 570m pix; 500 nights
- VST: D=2.6m; 1 squ deg; 268m pix; ??? nights
- Skymapper: D=1.35m; 5 squ deg; 268m pix; 100%
- HSC: D=8m; 1.5 squ deg; 900mpix; 300 night
- LSST: D=8m; 9 squ deg; 2bn pix; 100% survey

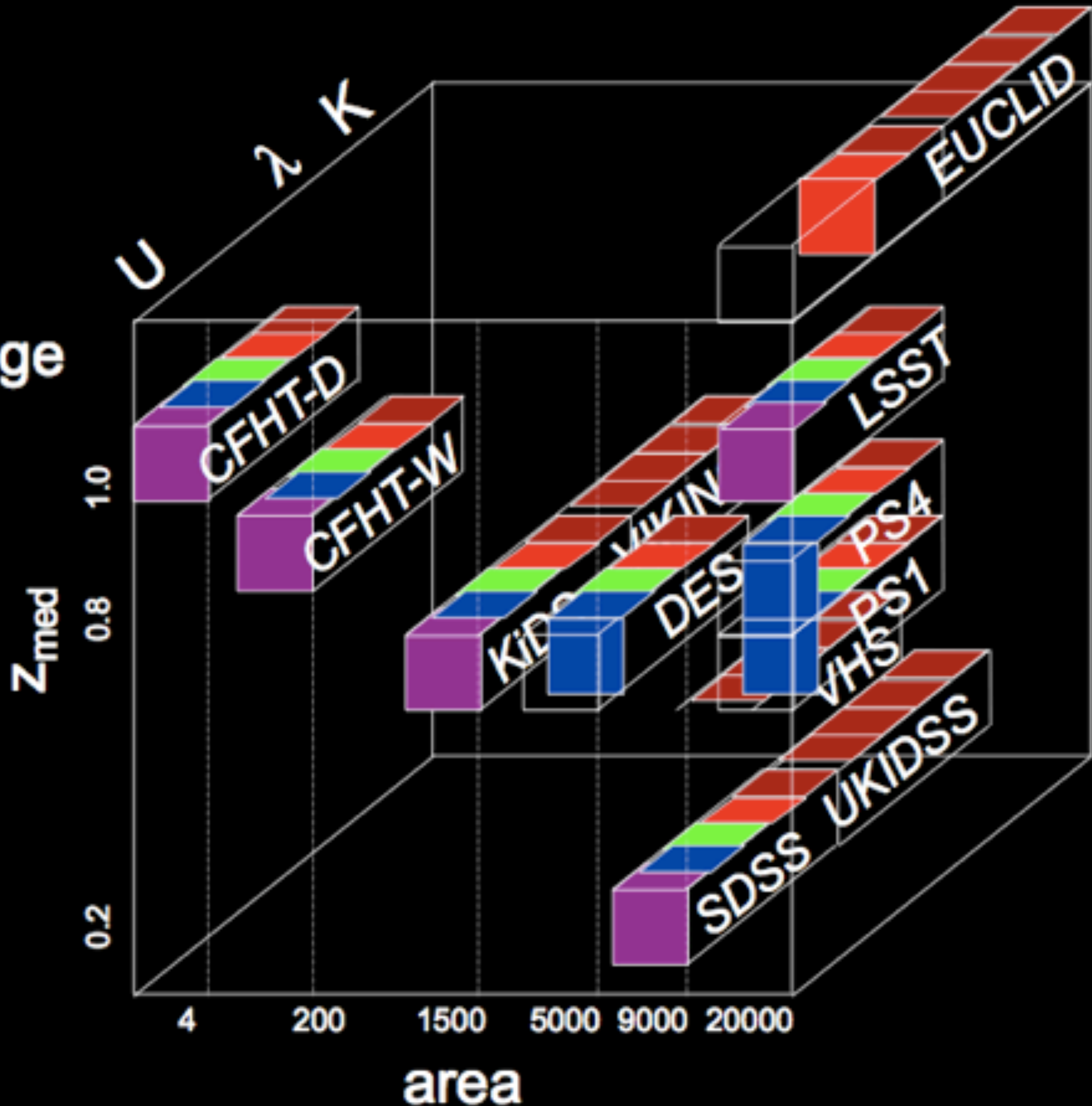
- Synergistic surveys
- eRosita - all-sky X-ray Russian/German; launch 2013
- Euclid - 15,000 squ deg dark energy; launch 2018?
- ASKAP (esp. Wallaby + Westerbork)

PS1+2



Survey parameters

- Area covered
- Median redshift
- Image quality
- Wavelength coverage



Credits

- Telescope: Jeff Morgan; Klaus Hodapp; (Walt Siegmund)
- Detectors: John Tonry; Peter Onaka; (Gerry Luppino)
- OTIS: Ken Chambers; (Ed Pier)
- IPP: Gene Magnier; (Paul Price)
- PSPS: Jim Heasley; Alex Szalay
- MOPS: Rob Jedicke; Larry Denneau
- Project Management: Will Burgett; (Tom Dombeck)

- Cal-Screen: Chris Stubbs; NIST
- Uber-calibration: Doug Finkbeiner; Eric Schafly

- Depth analysis: Nigel Metcalfe; Peter Draper; DRAVG
- PCS: Roberto Saglia