

# The Pan-STARRS Archive at STScI



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# The PS1 public archive

- STScI will provide the public archive for PS1 data
- Planned services:
  - Catalog access
    - Simple form interface
    - Web services (including VO-compatible interfaces)
    - SQL query interface
  - Image access
    - Whole images
    - Image cutouts either as FITS files or JPEG previews
    - Interactive display
  - We will use products from the PS1 project with existing tools developed by MAST and PS1

# MAST and Pan-STARRS

- Pan-STARRS is not a MAST-funded project!
  - STScI research funding for archive development; NSF funding requested for long-term operations
- PS1 images & database are large compared with current MAST data holdings
  - GALEX photon database is ~150 TB
    - Larger than PS1 but simpler data
  - Total MAST holdings currently ~ 300 TB
    - PS1: ~ 2000 TB
    - Large future missions: JWST (4 PB), WFIRST-AFTA (9 PB)
- MAST is very heavily used
  - > 5000 users, 1 million searches/month, 18 TB/month downloaded
- Requires a new scale of infrastructure, but MAST experience is relevant

# PS1 data @ STScI: Images

- Coadded stacked images and single-epoch warps
  - All PS1 surveys will be included:
    - 3PI (30,000 sq deg north of declination  $-30^\circ$ )
    - Medium Deep Surveys (10 fields, 7 sq deg each)
    - Celestial North Pole, Ecliptic Plane, M31
  - Images dominate total data volume (mainly 3PI, MDS)
    - Total data volume without difference images  $\sim 1.8$  PB
  - Includes auxiliary images (wt, expwt, exp, mask, num)

# PS1 data @ STScI: Catalogs

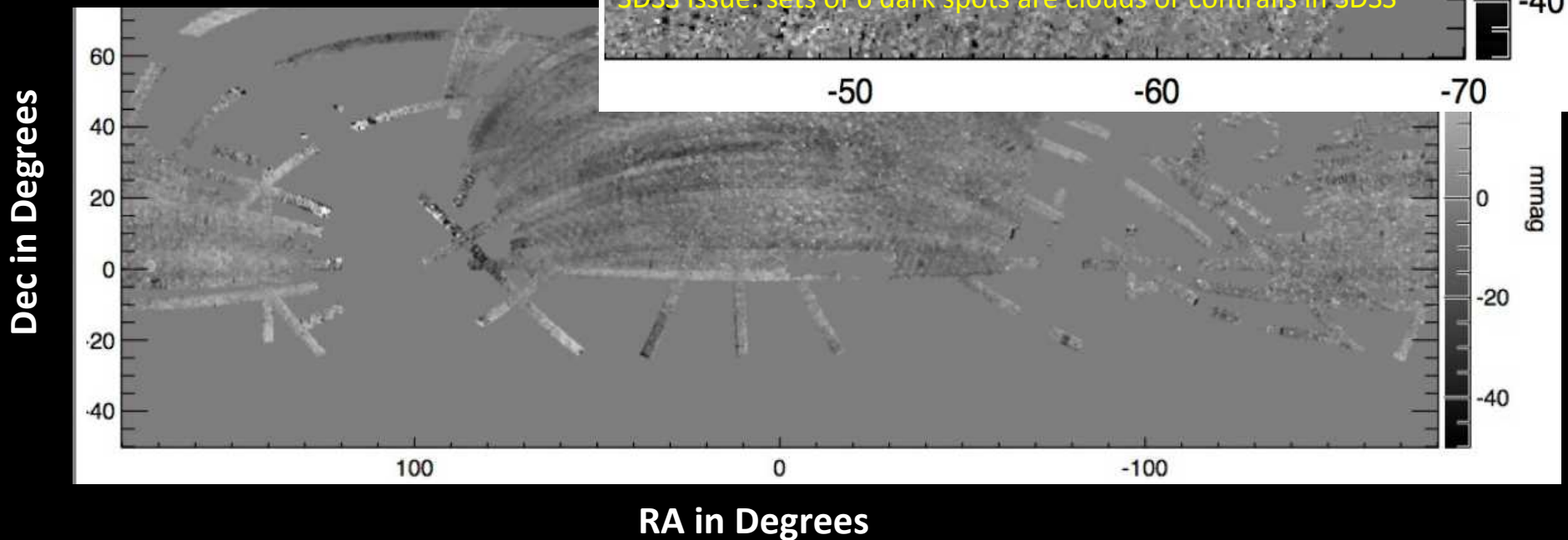
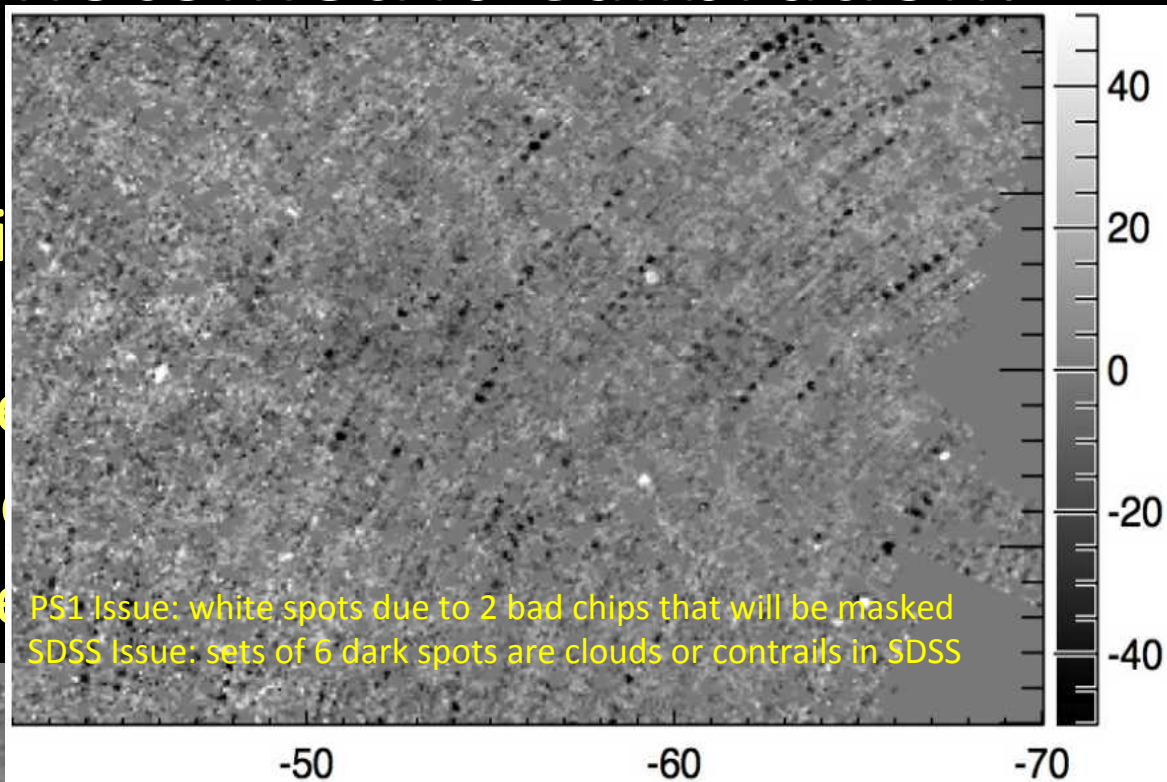
- Catalog databases
  - Including stack detections, single-epoch detections, forced photometry & objects (linking multiple epoch detections)
  - High-quality photometry and astrometry
  - Total database volume ~100 TB
    - Most database volume is in single-epoch detections
    - 3PI database (PV1: ~90% of 3PI sky area, still incomplete in plane):
      - $29.4 \times 10^9$  detections
      - $5.9 \times 10^9$  objects
      - $1.4 \times 10^9$  objects with nDetections > 1
      - For comparison, SDSS DR9: 469 M objects (14,000 sq deg)

# PS1 $3\pi$ survey versus SDSS

	SDSS	Pan-STARRS $3\pi$
Sky area	10,000 sq deg	30,000 sq deg
Sky region	High Galactic latitude	$\delta > -30^\circ$ , includes Galactic plane
Filters and Magnitude limits	u 22.5	
	g 23.2	g 23.4
	r 22.6	r 23.2
	i 21.9	i 22.7
	z 20.8	z 22.0
		y 21.1
Median Seeing FWHM	1.3"	1.1"
Cadence	1 epoch	12 epochs per filter

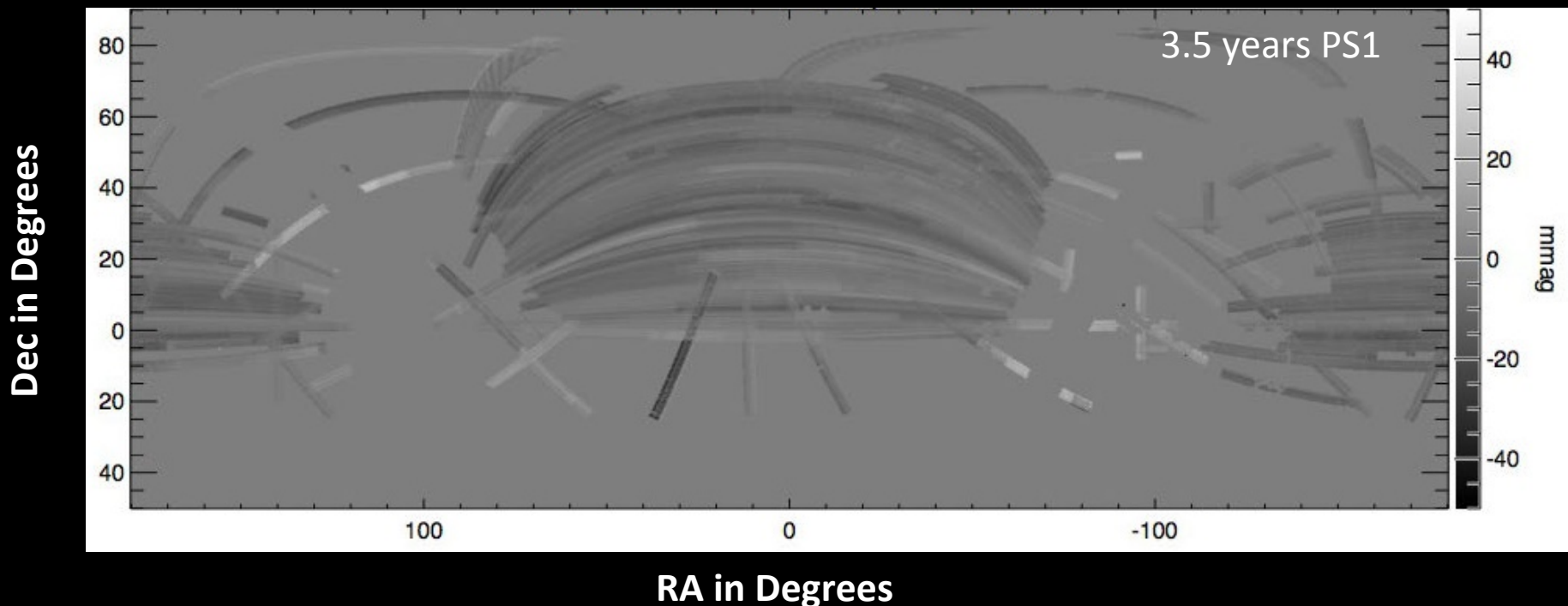
# PS1 Relative Photometric Calibration:

- Uebereal (Finkbeiner) observations of PS1
- Differences between PS1 and SDSS
- SDSS issues: stripes
- PS1 issues: square



# PS1 Relative Photometric Calibration: Ubercal

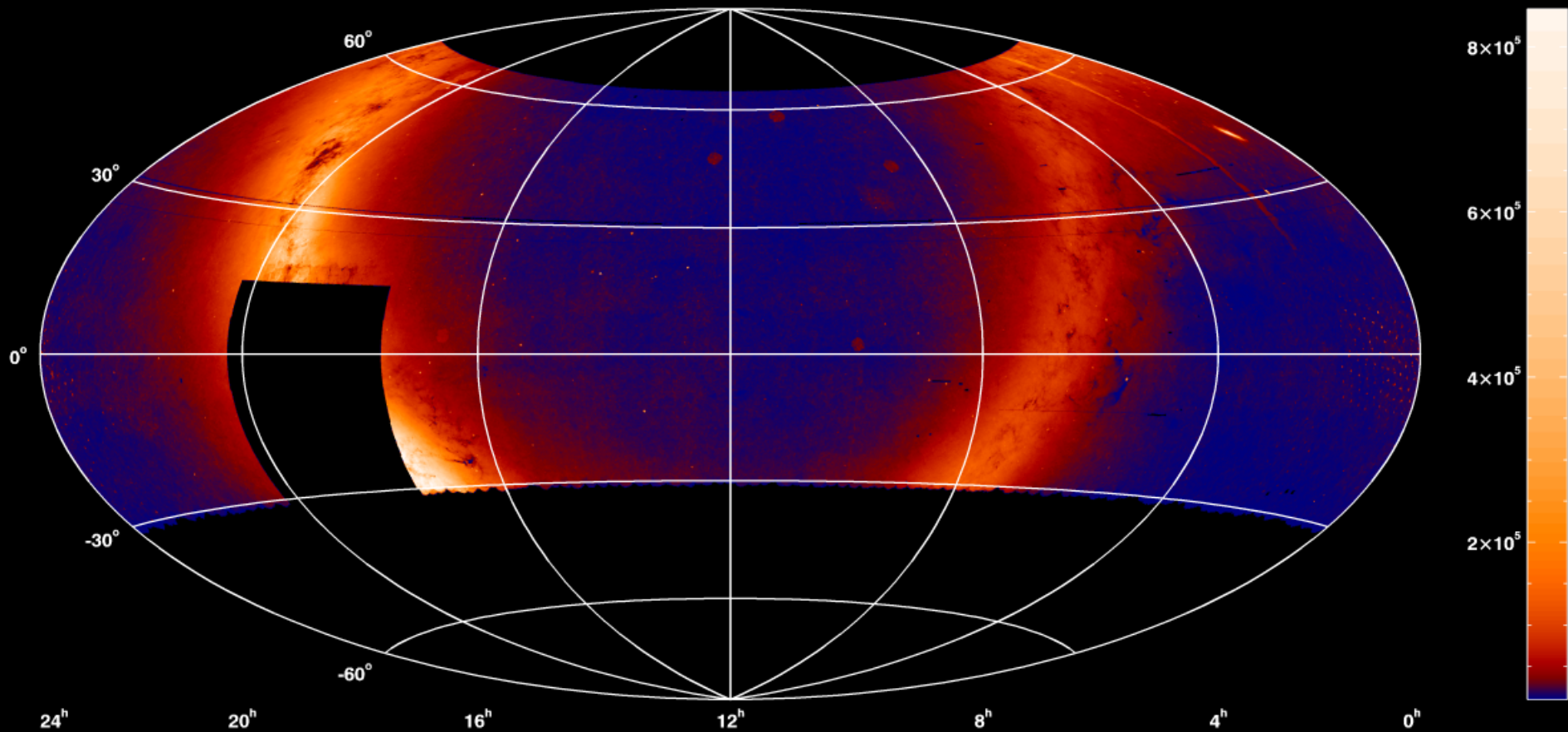
- Ubercal (Finkbeiner, Schlafly): use repeat observations of PS1
- Differences between SDSS and PS1
- SDSS issues: stripes, north-south offsets
- Systematics down to 2-3 mmag!





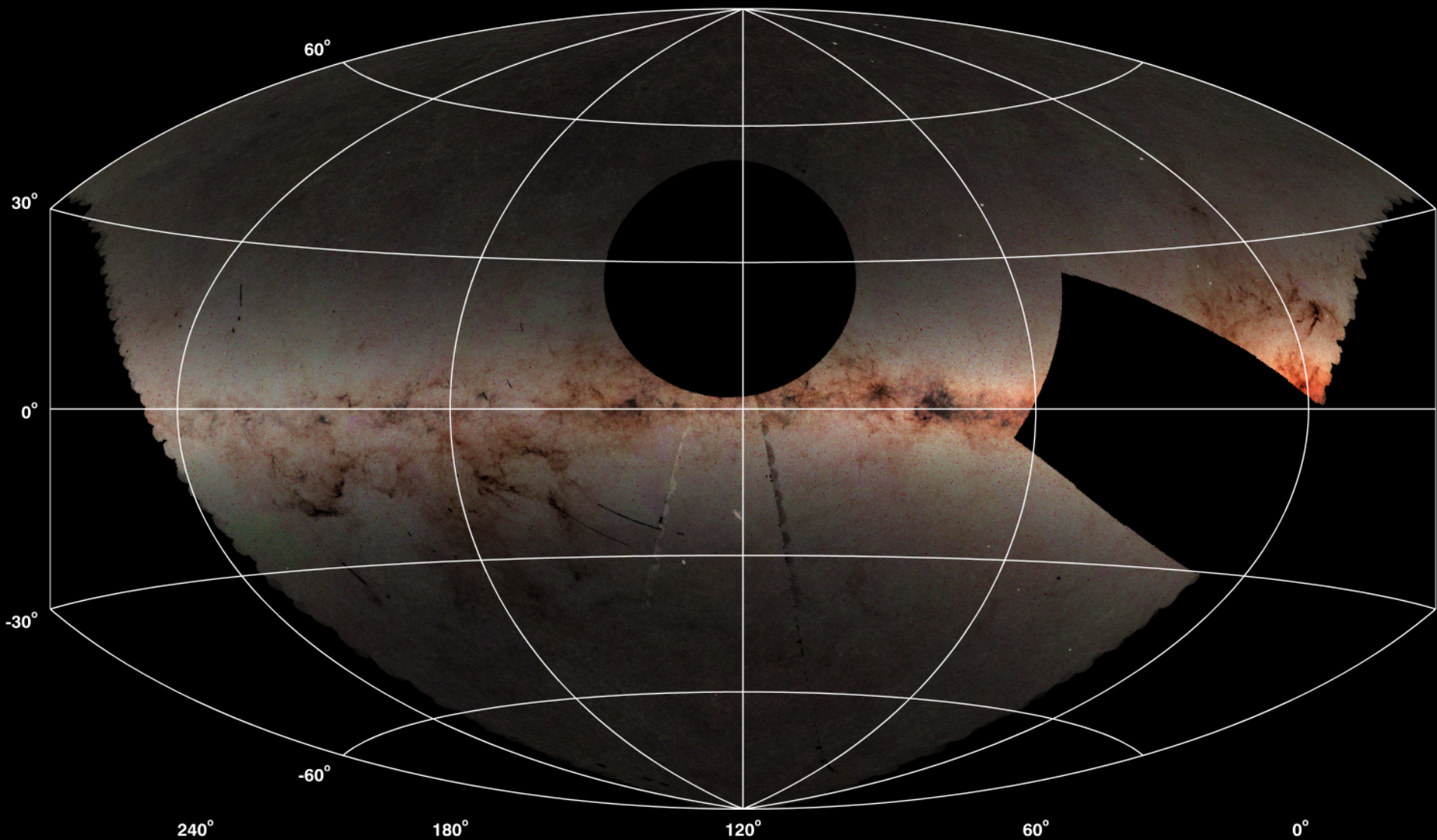
# 3PI Object counts, nDetections>2

## $1.10 \times 10^9$ objects



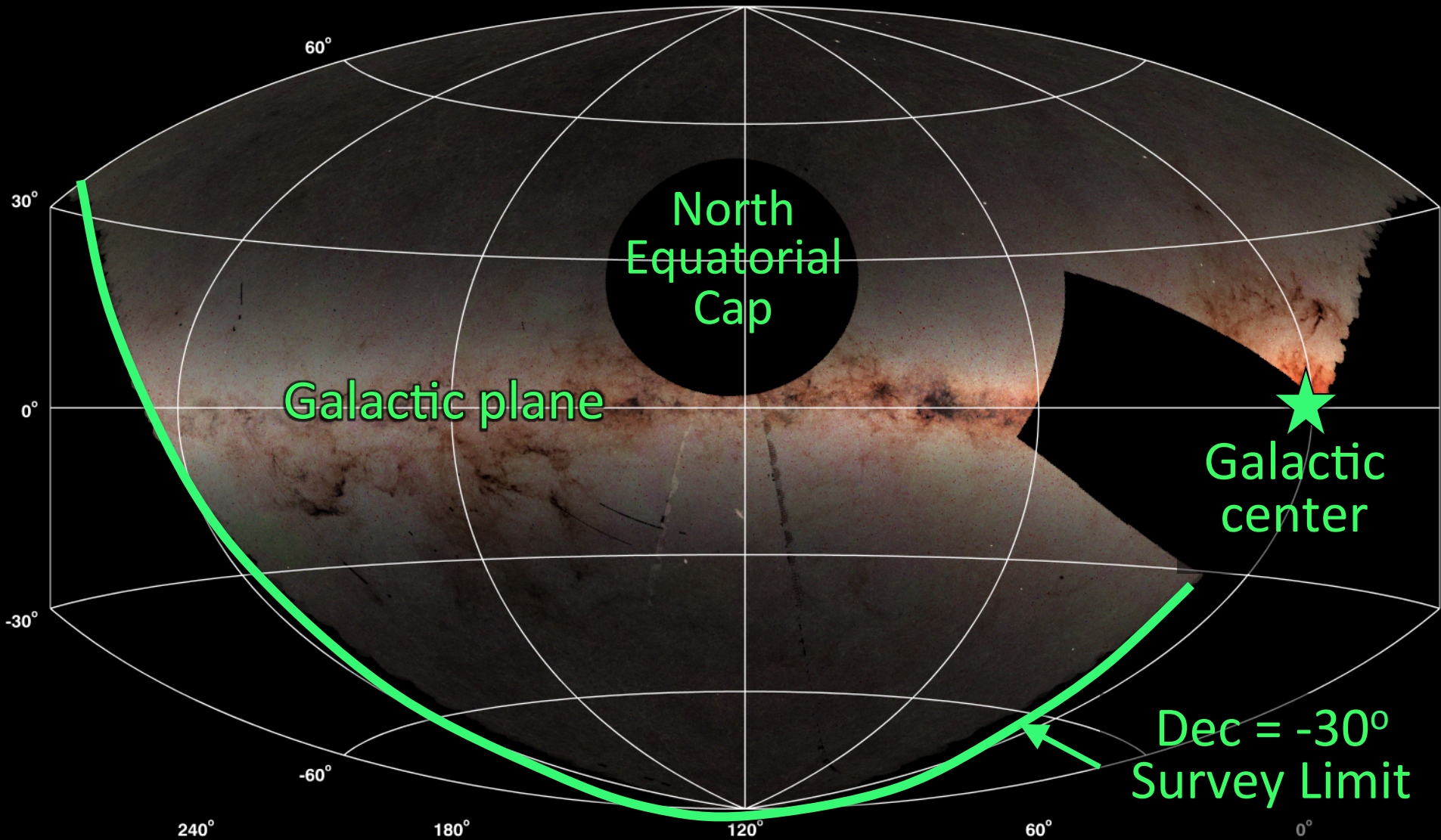
# 3PI g/r/y mean colors

4.57x10<sup>8</sup> objects



# 3PI g/r/y mean colors

$4.57 \times 10^8$  objects



# Status of archive preparations

- 2 PB of disks purchased for image storage
  - Located at Hawaii for use in data processing
  - Will be shipped back to STScI (with data) in January 2015
- Database servers purchased & are now set up
  - Faster, more memory & cores than the current PS1 database machines in Hawaii
  - Current database was transferred via network and is available to PS1 science consortium
  - Final database will be copied in 2015

# High-level schedule

STScI Specific PS1 Milestone	Timeframe	Pan STARRS Project-Wide Milestone
1 PB of STScI disks delivered to Hawaii	<b>2012 May</b>	
1 PB of disks delivered to Hawaii	<b>2013 June</b>	
DB & image subsets at STScI for experiments	<b>2013 November</b>	
	<b>2014 April</b>	Pan STARRS observations complete
Database servers purchased	<b>2014 May</b>	PV1 database complete; PV3 processing begins
Pan-STARRS workshop (@STScI)	<b>2014 June</b>	Pan-STARRS consortium meeting (@STScI)
PV2 database copied to STScI	<b>2014 December</b>	PV2 database complete
Prototype DB and image interfaces available for consortium testing at STScI	<b>2015 January</b>	PV3 images complete
2 PB data-loaded disks shipped from Hawaii; PV3 database copied to STScI	<b>2015 January</b>	PV3 database complete
All disks arrive at STScI, hardware and software integration begins	<b>2015 February</b>	
	<b>2015 April</b>	Public archive opens (1 year after end of obs)

- **PV1, PV2, PV2** are versions of the image & catalog processing
- **PSPS** is the PS1 object catalog database
- Post-ship schedule is optimistic; might release DB only to start, images later

# Sample PS1 image using HLA tools

Simple cutout  
search page  
for SAS2 +  
MDS field  
[demo](#)

**Pan-STARRS1 SAS/MDS Image Access**

ngc 4217

Filters:  color  y  z  i  r  g

Cutout size: 1024 pixels (256.00 arcsec)

Output size: 512 pixels

ngc 4217 (ra = 183.962080, dec = 47.091780)

md06 mosaic y/i/g

md06 mosaic

fits2web image viewer (hisp\_ps1\_sas12\_gpc1\_skycell.1316.022)

archtest.stsci.edu/cgi-bin/hla/display?image=hisp\_ps1\_...

hisp\_ps1\_sas12\_gpc1\_skycell.1316.022

Lighter Darker Invert advanced contrast controls | advanced HSC controls

SDSS  2MASS (762)  GSC2  FIRST  GALEX  HSC (beta)

2368 4761  
22:28:12.795 -02:53:10.49

**Pan-STA**

ngc 4288

Filters:  color  y  z  i  r  g

Cutout size: 512 pixels (128.00 arcsec)

Output size: 256 pixels

ngc 4288 (ra = 185.158790, dec = 46.291670)

md06 mosaic z/r/g

md06 mosaic z

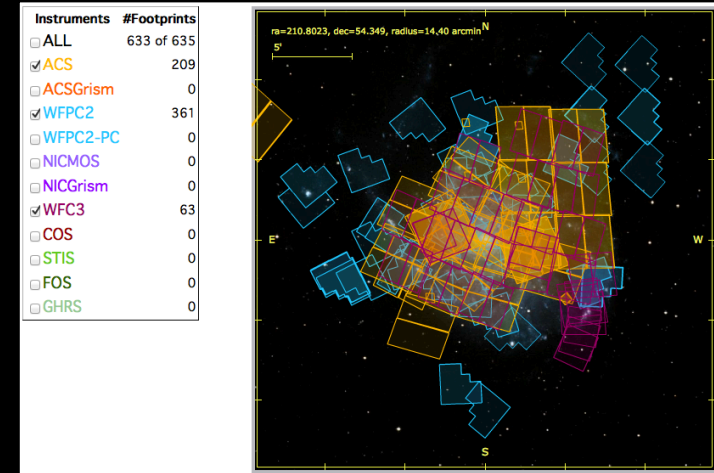
md06 mosaic i

md06 mosaic r

md06 mosaic g

# MAST Portal Catalog/Image Interface

- Hubble Source Catalog portal interface will be adapted for PS1
  - Similar structure: multi-epoch, multi-filter observations integrated with image database
  - Cutout services, interactive display, etc., are also being used for PS1
- MAST will incorporate & benefit from PS1 data
  - PS1 images are a better background for AstroView
  - Current PS1 catalog is already being used as a deep astrometric reference catalog for HSC



Note: Current PS1 catalog was used as astrometric reference for Hubble Source Catalog v0.3

# Summary

- STScI archive will provide an integrated interface for access to PS1 catalogs & images
  - Reuse existing MAST and current PS1 databases and interfaces wherever possible
- MAST will utilize PS1 images and catalogs to improve our other data products
- Pan-STARRS is a step into big data for MAST
  - Valuable experience for future multi-petabyte datasets including JWST, WFIRST



# EXTRA SLIDES

# User Documentation

Confluence is being used to describe sample PS1 database queries in detail

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PanSTARRS1 / Home / PS1 Sandbox Science Projects

## Catalog Cross-Matching

19 Added by Rick White, last edited by Alex Yermolaev on Jun 17, 2014 (view change)

- Catalog Cross-Matching (Rick White)
  - 1. Upload a subset of the FIRST catalog to MyDB in PS1
  - 2. Run the cross match
  - 3. Download the FITS output table
- Large-scale cross-matching with the 3PI database

### Catalog Cross-Matching (Rick White)

Part of my science project requires doing a cross-match between the FIRST catalog and the PS1 data started with [Jim Heasley's example](#) on the PSPS sample query page, but I have made significant imp

#### 2. Run the cross match

On the **Query Page**, select the database (e.g., **PanSTARRS\_SAS21**) and run this query:

```
DECLARE @size FLOAT = 5.0/3600.0;

SELECT f.search_id AS source_id, f.ra AS source_ra, f.dec AS source_dec, o.*
INTO mydb.[first_sas21]
FROM mydb.firstsa3 f
CROSS APPLY dbo.fHtmGetObjFromRectEq(f.ra-@size/cos(radians(f.dec))), f.dec-@size/cos(radians(f.ra)) AS o
JOIN Object o ON o.objID=t.objID
```

# Data products not @ STScI

- Difference images
  - Data volume large, probably fast enough to generate them on-the-fly
- Convolved images
  - Images convolved to match PSFs
  - Have not reached quality of unconvolved images (yet)
  - Could also be generated on demand
- Raw data
  - STScI will not run image processing pipeline