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°)
    - 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 ~ 1.8 PB
  - Includes auxiliary images (wt, expwt, exp, mask, num)

PS1 data @ STScI: Catalogs

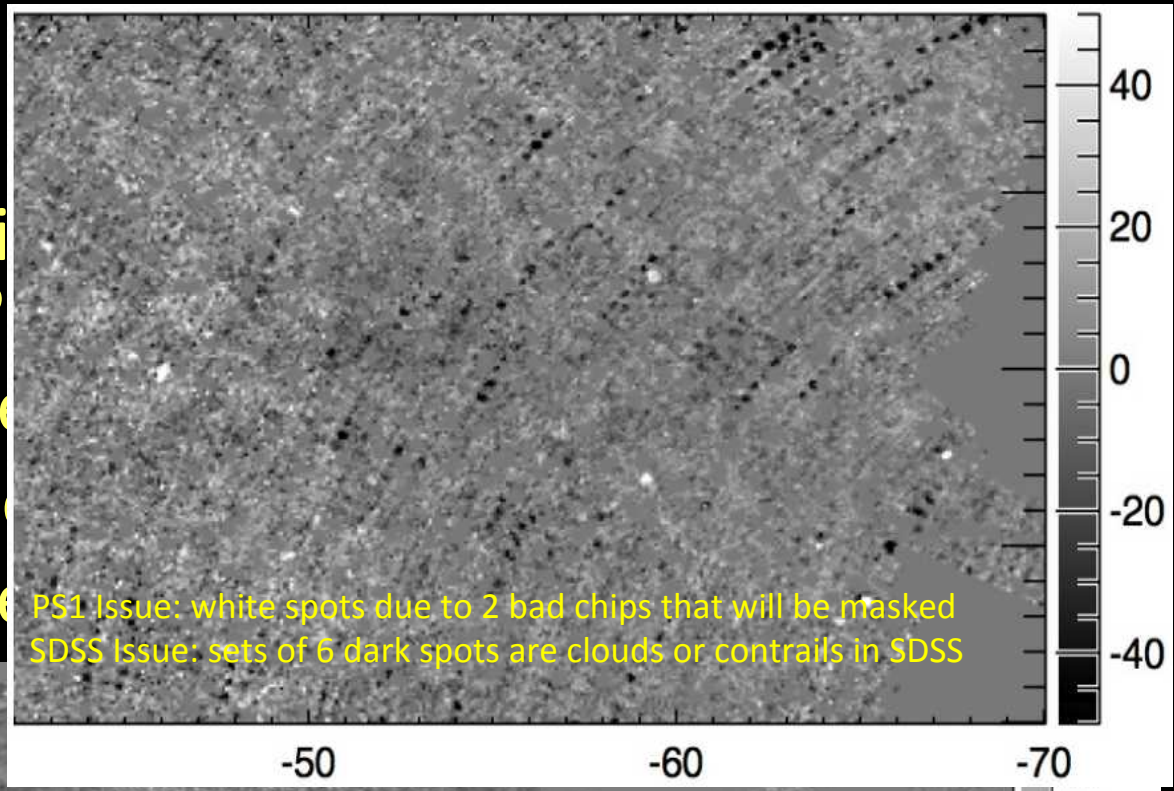
- Catalog databases
  - Including stack detections, single-epoch detections, forced photometry & objects (linking multiple epoch detections)
  - High-quality photometry and astrometry
  - Total database volume ~100 TB
    - Most database volume is in single-epoch detections
    - 3PI database (PV1: ~90%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

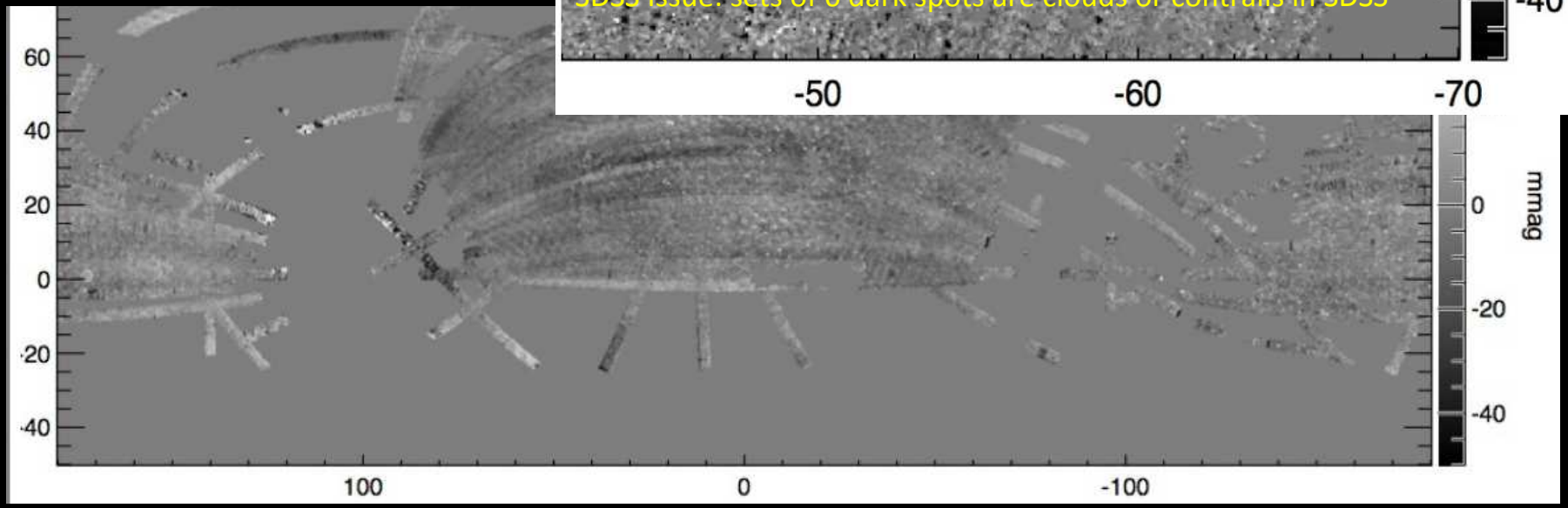
PS1 3π survey versus SDSS

	SDSS	Pan-STARRS 3π
Sky area	10,000 sq deg	30,000 sq deg
Sky region	High Galactic latitude	δ > -30°, 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:

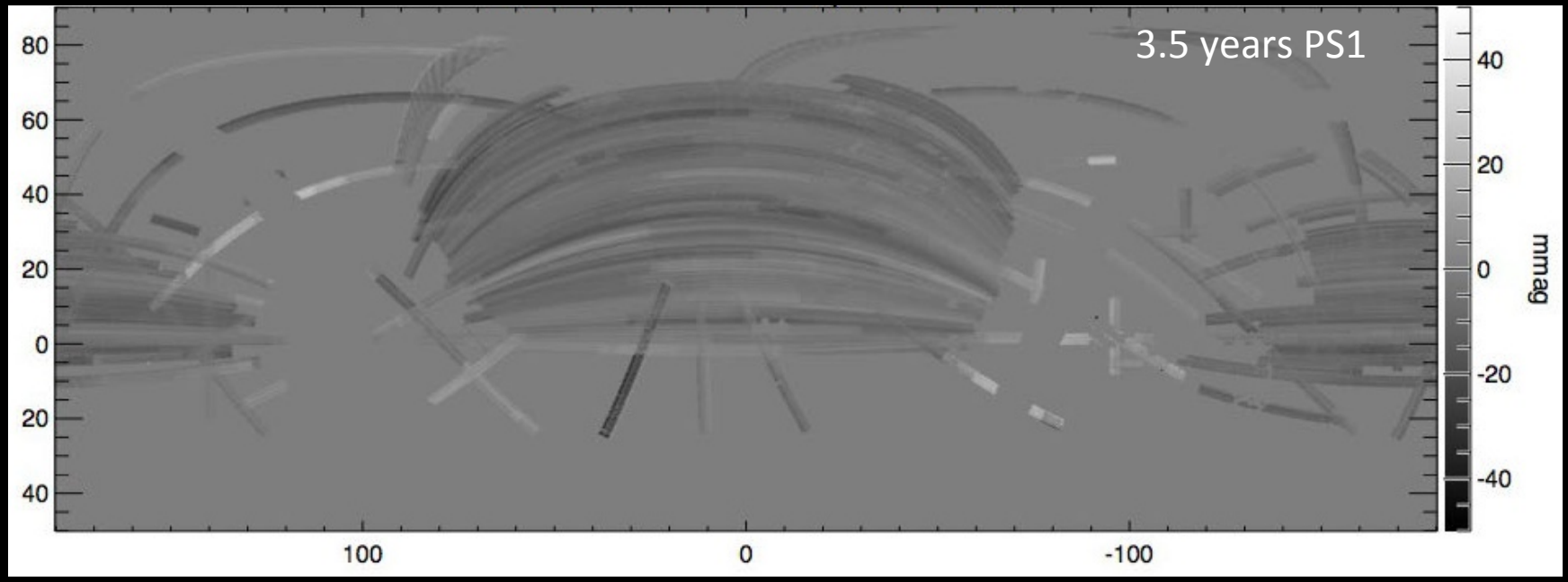
- Uebercal (Finkbei
  observations of P
- Differences betwe
- SDSS issues: strip
- PS1 issues: square



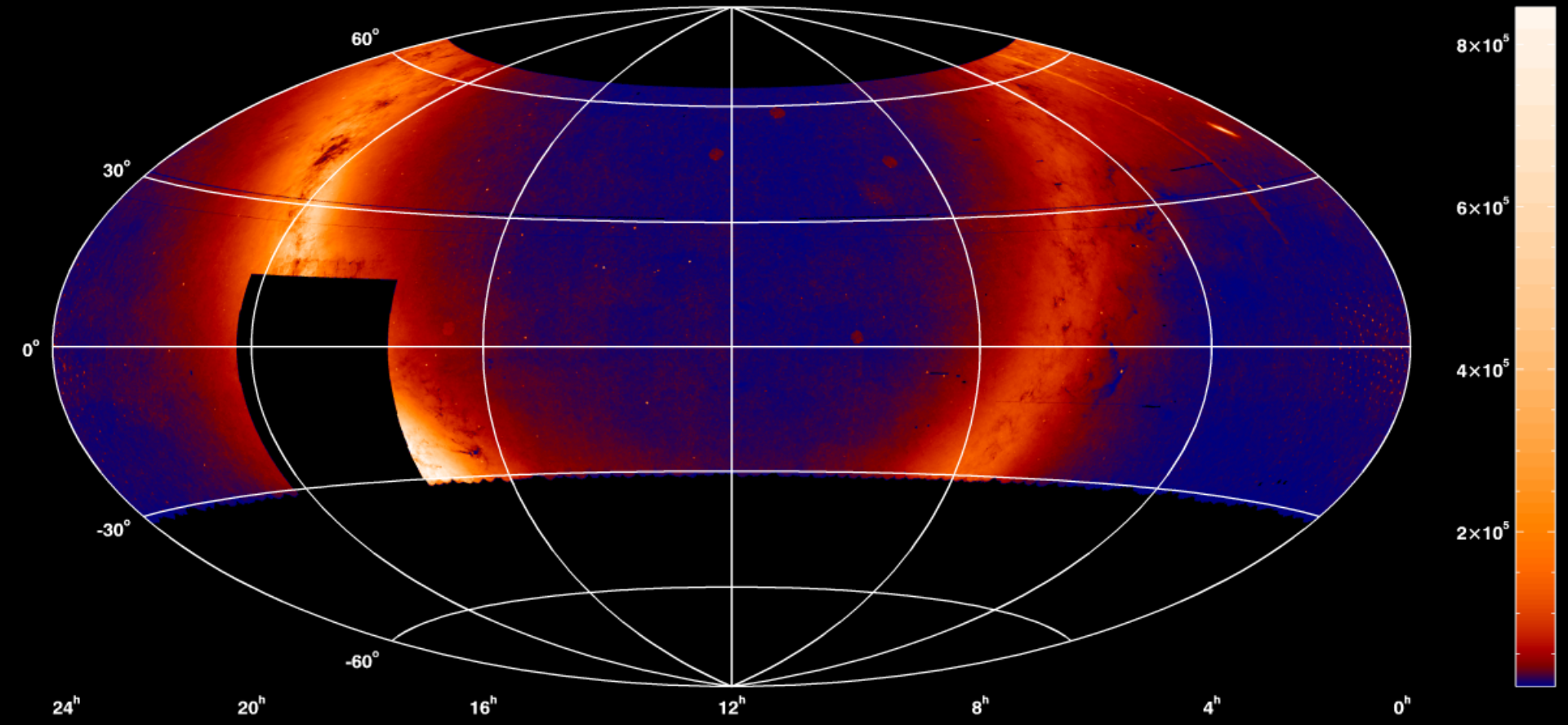


PS1 Relative Photometric Calibration: Ubercal

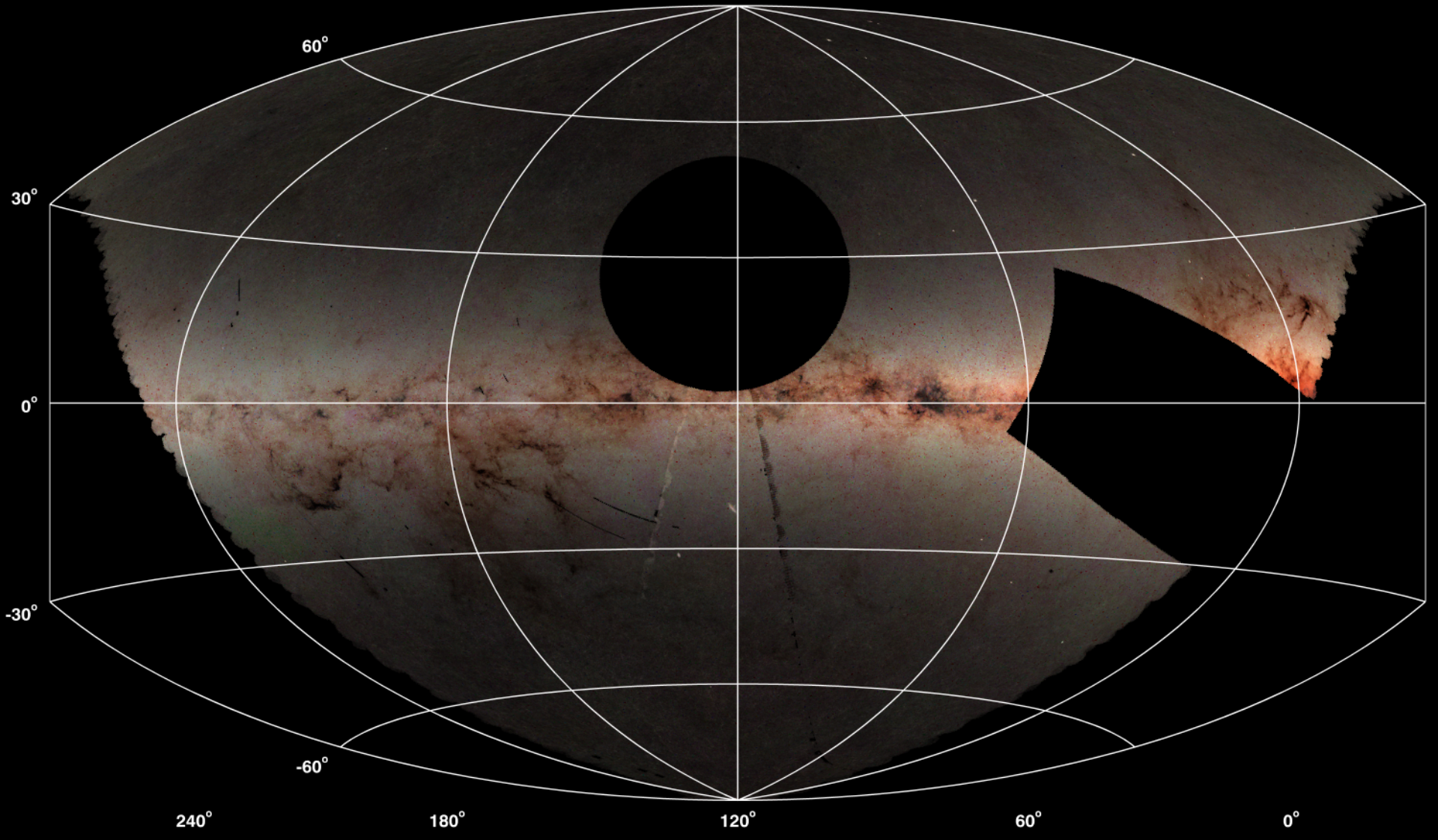
- Ubercal (Finkbeiner, Schlafly): use repeat observations of PS1
- Differences between SDSS and PS1
- SDSS issues: stripes, north-south offsets
- Systematics down to 2-3 mmag!



3PI Object counts, nDetections>2
1.10×10^9 objects



3PI g/r/y mean colors
4.57×10^8 objects



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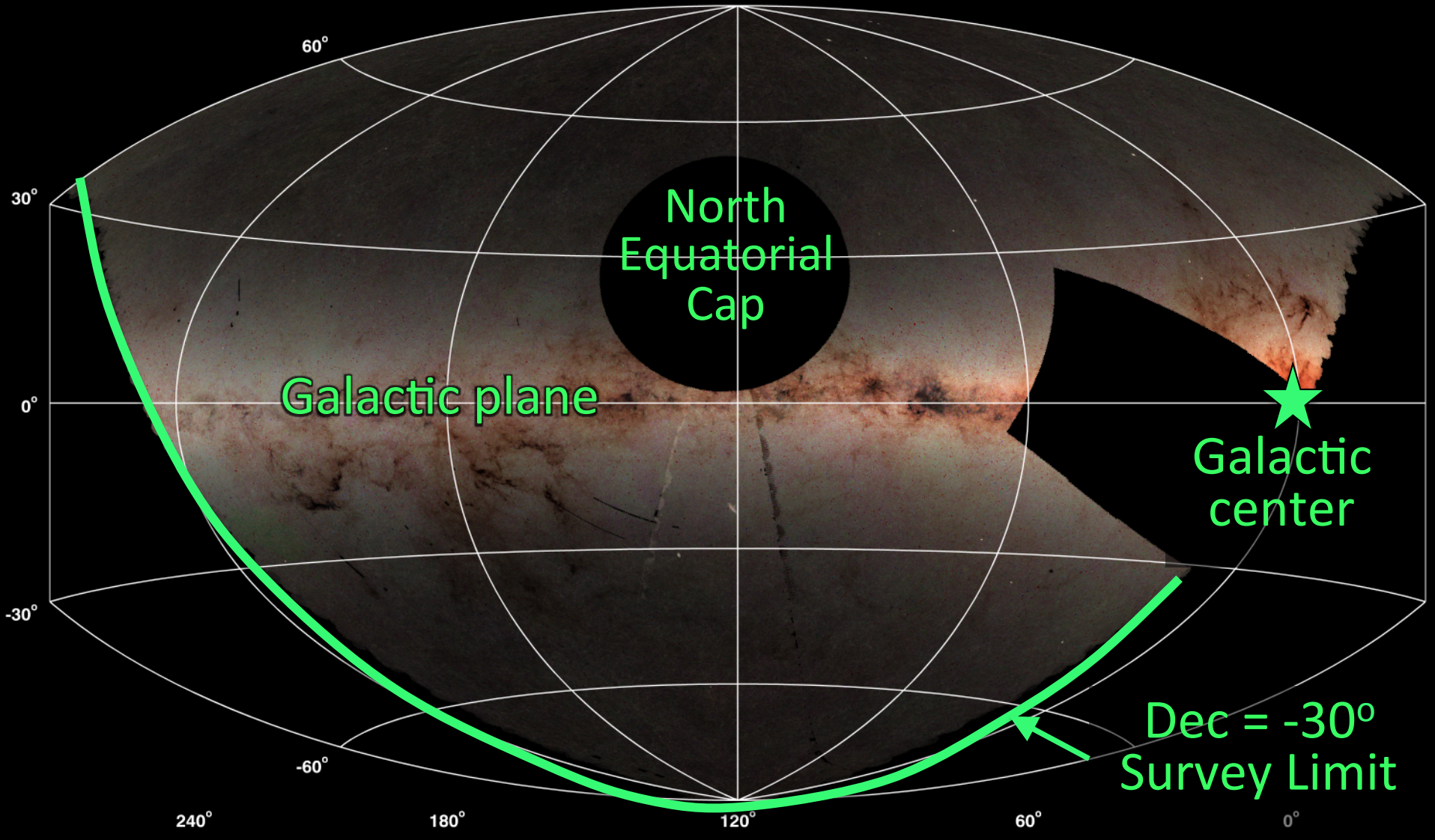


Status of archive preparations

- 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

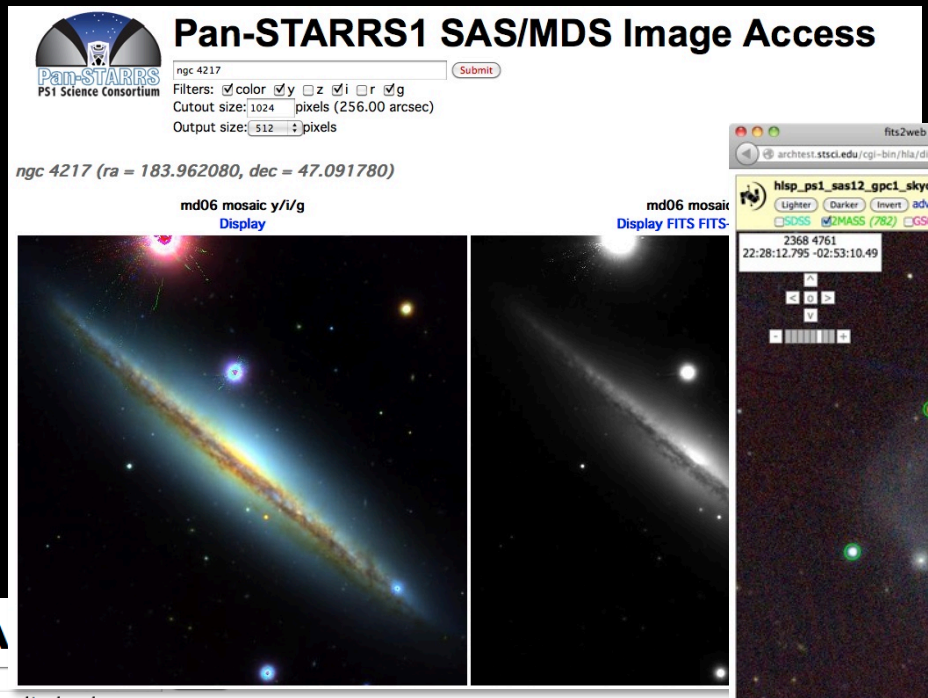
High-level schedule

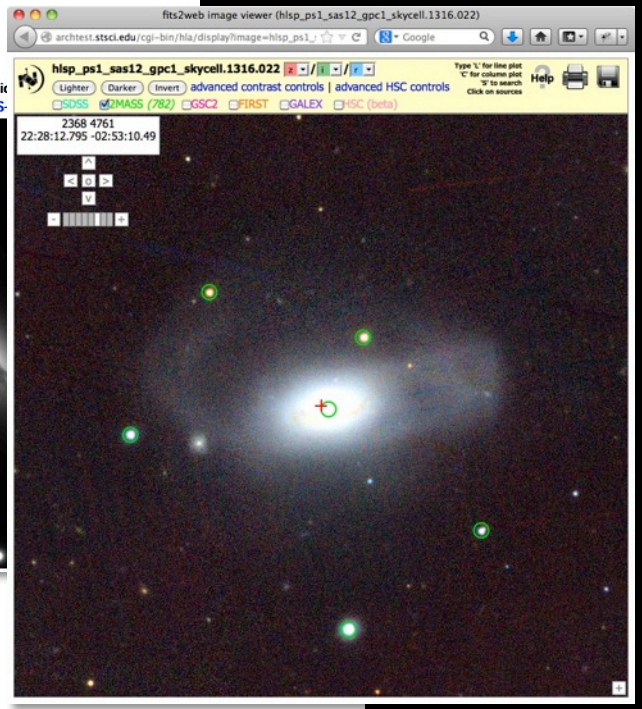
STScI Specific PS1 Milestone	Timeframe	Pan STARRS Project-Wide Milestone
1 PB of STScI disks delivered to Hawaii	**2012 May**	
1 PB of disks delivered to Hawaii	**2013 June**	
DB & image subsets at STScI for experiments	**2013 November**	
	2014 April	Pan STARRS observations complete
Database servers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

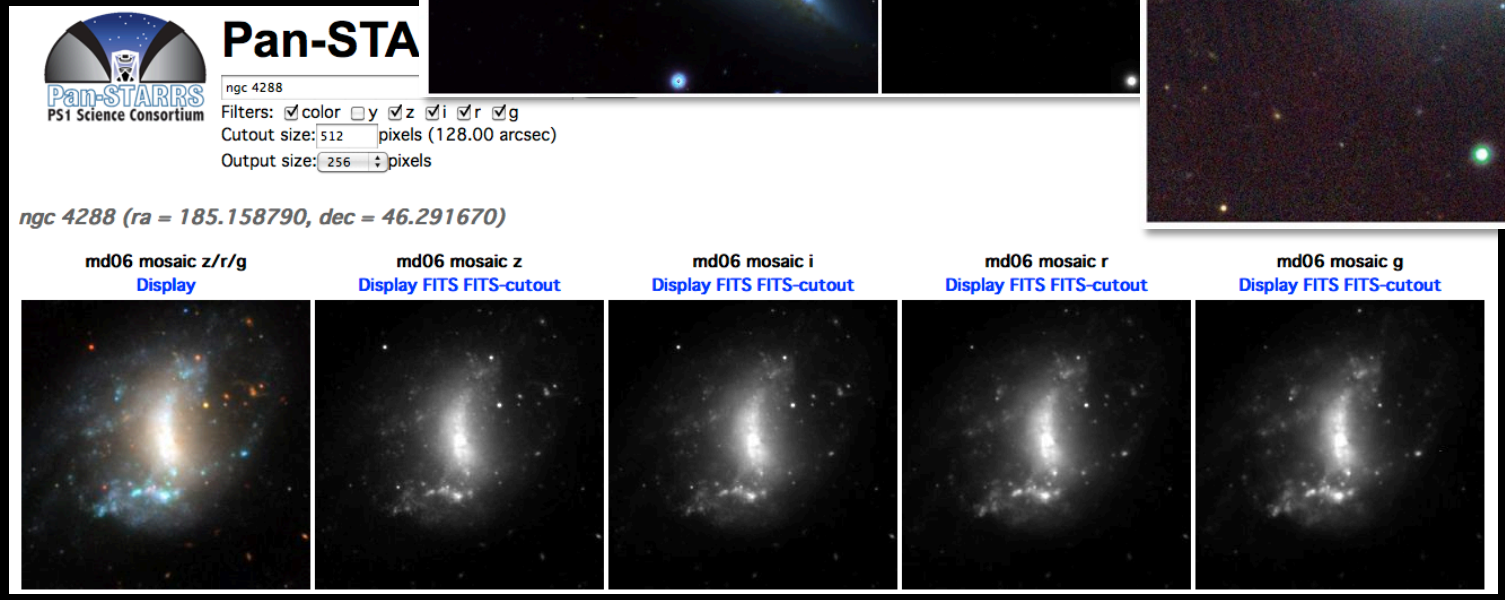
- PV1, PV2, PV2 are versions of the image & catalog processing
- PSPS is the PS1 object catalog database
- Post-ship schedule is optimistic; might release DB only to start, images later

Sample PS1 image using HLA tools

Simple cutout search page for SAS2 + MDS field
demo

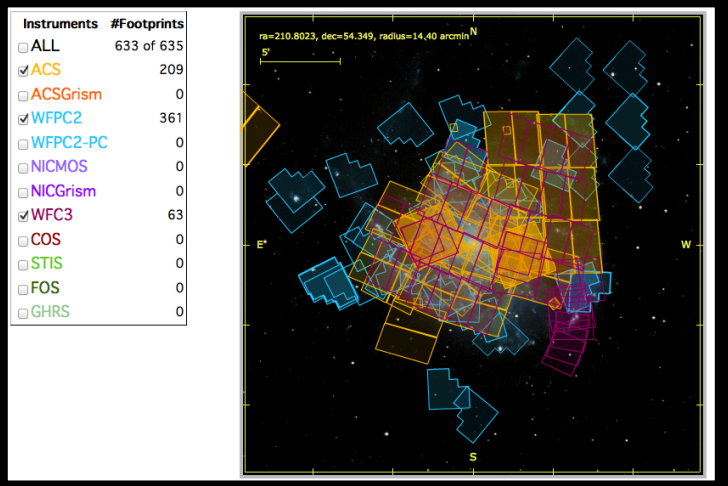






MAST Portal Catalog/Image Interface

- 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



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

- 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

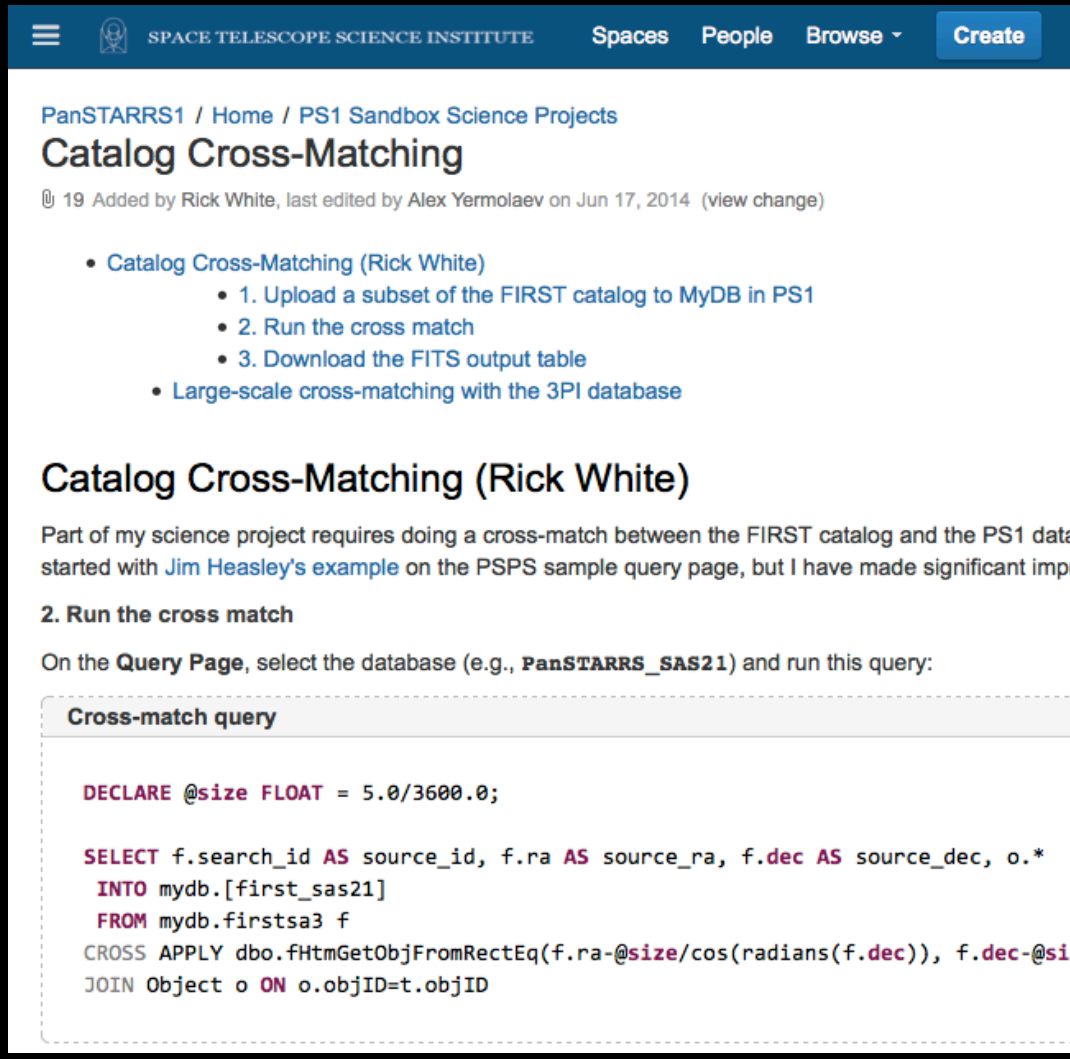
Summary

- 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



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