LSST Resources for the Community

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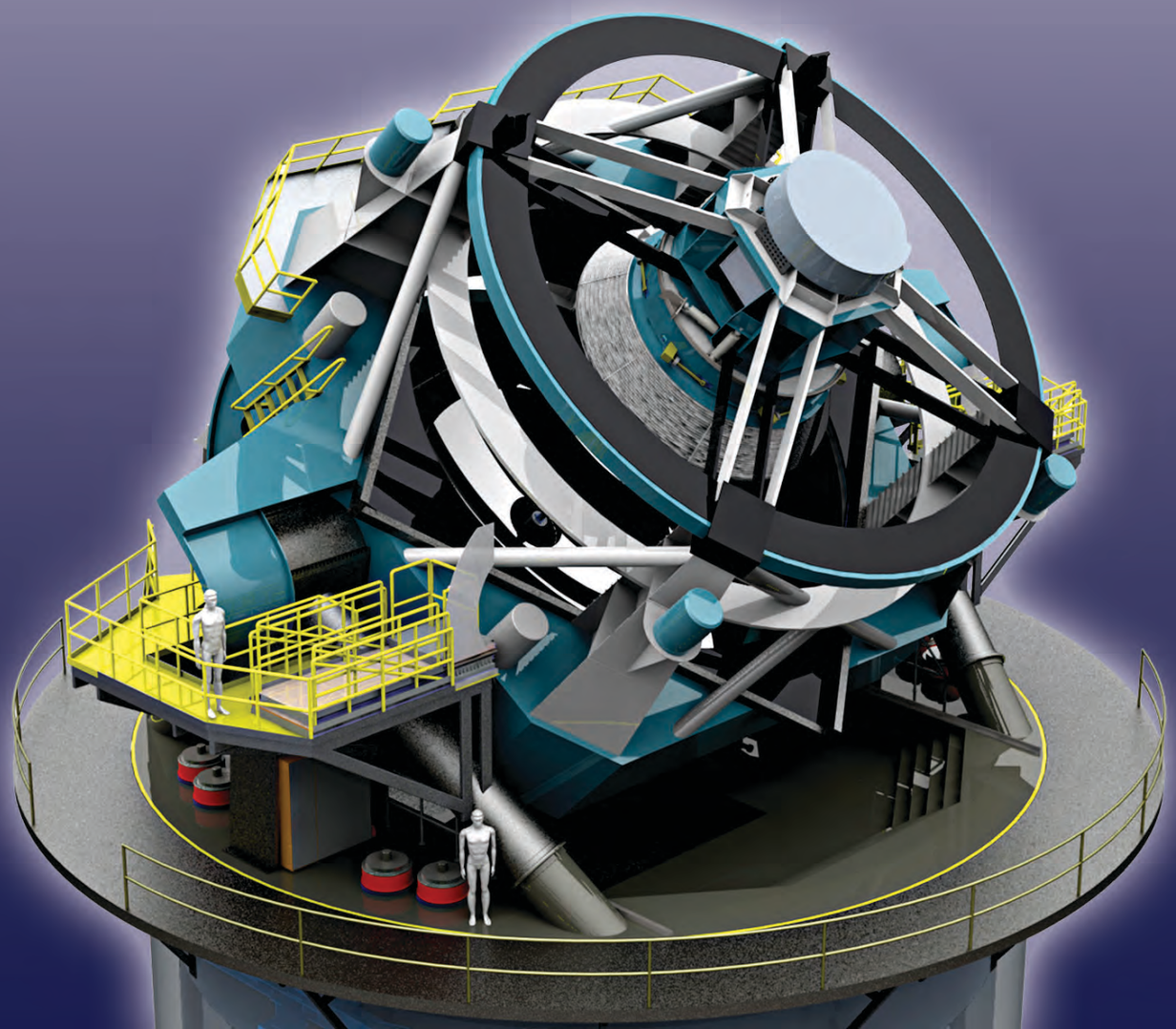
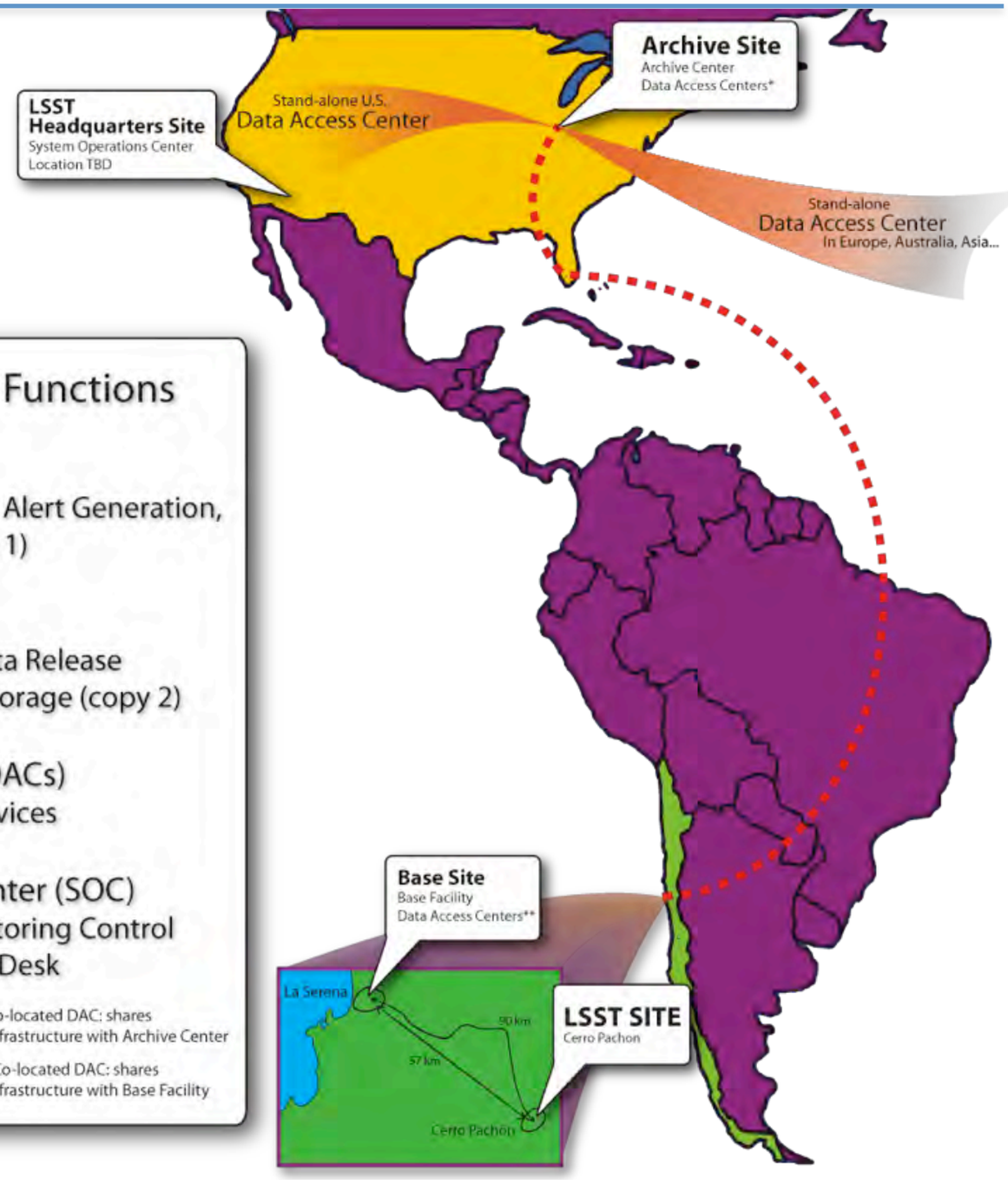


Data Flow

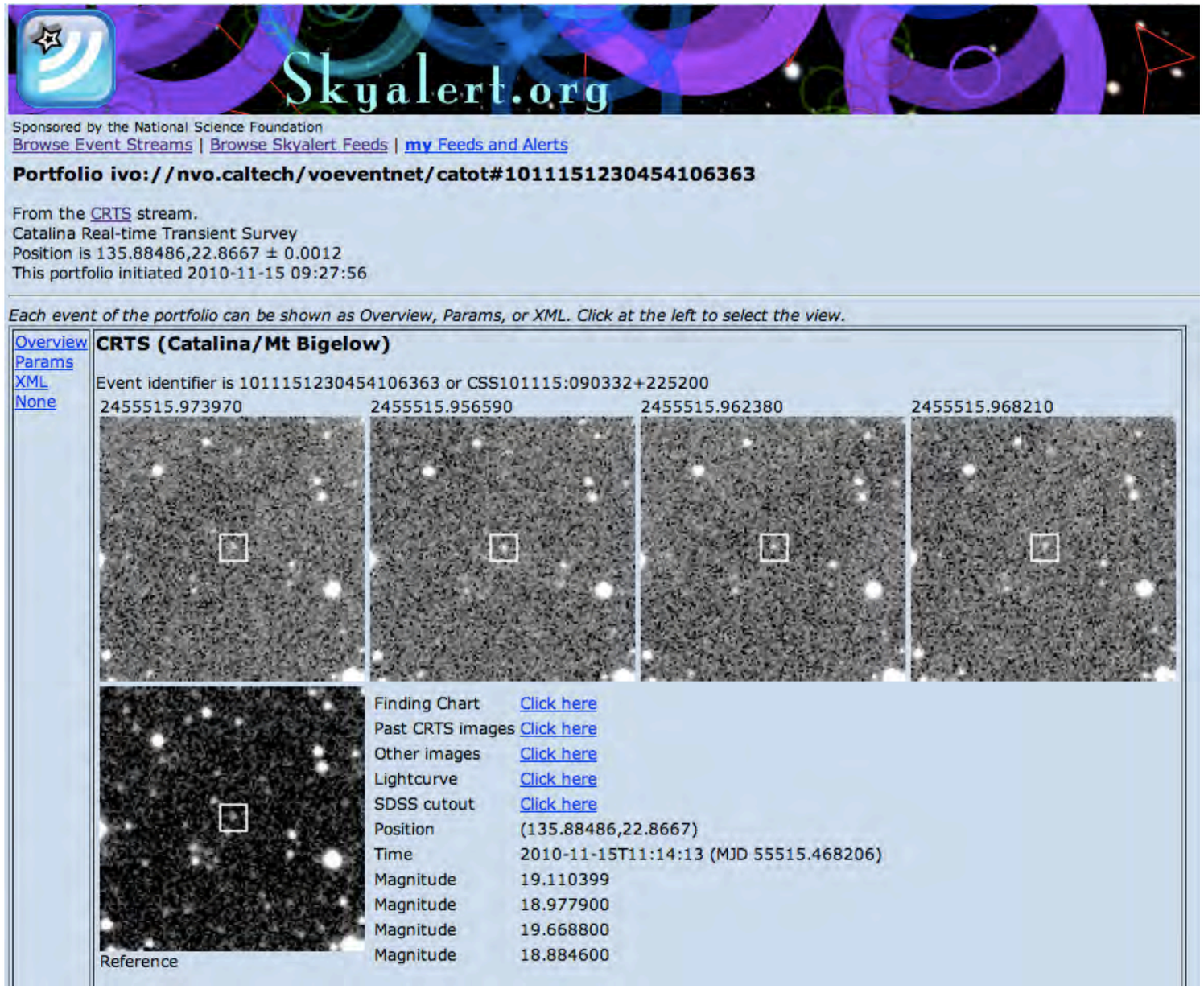
Nightly Operations :
(at base facility)
Each 15s exposure =
6.44 GB (raw)
2x15s = 1 visit
30 TB / night
Generates **alerts**
within 60 seconds
(~10^6 per night)

Data Release:
(at Data Archive)
6-months to 1 year,
reprocessing of all data.
Generates calibrated **catalogs**:
+20 PB end of 10 years
Generates processed **images**:
+200 PB end of 10 years



Data Products: Alerts

- Stream of information from nightly processing – based on single difference image but will contain information on known objects near same location



Example of current VOevent from Skyalert.org

Data Products: Catalogs

- Source catalogs
  - Individual measurement from a single image
  - Position, flux, shape, uncertainty ++
  - http://lsst1.ncsa.uiuc.edu/schema/

LSST Database Schema Browser *alpha*

Schema versions available for browsing: DC3a | **DC3b** | PT1_1 | ImSim (underlined showed)

Table List

AmpMap
CalibSource
CcdMap
Ccd_Detector
DiaSource
Durations
Filter
ForcedSource
FpaMetadata
LeapSeconds
Logs
mops_Event
mops_Event_OrbitDerivation
mops_Event_OrbitIdentification
mops_Event_TrackletAttribution
mops_Event_TrackletPrecovery
mops_Event_TrackletRemoval
mops_MovingObjectToTracklet
mops_SSM
mops_SSMDesc
mops_Tracklet
mops_TrackletToDiaSource
mops_TrackToTracklet
MovingObject
Object
ObjectExtras
ObjectType
prv_Activity
prv_cnf_PolicyKey
prv_cnf_SoftwarePackage
prv_Filter
prv_PolicyFile
prv_PolicyKey
prv_Run
prv_SoftwarePackage
RaftMap
RaftMetadata
Raw_Amp_Exposure
Raw_Amp_Exposure_Metadata
Raw_Amp_To_Science_Ccd_Exposure
Raw_Amp_To_Snap_Ccd_Exposure

Details for table *Source_pt2*

Table to store high signal-to-noise "sources". A source is a measurement of Object's properties from a single image that contains its footprint on the sky. This table is expected to be used in DC3b-pt2.

name	type	not null	default	unit	ucd	description
sourceId	BIGINT	y				Unique id.
ccdExposureId	BIGINT					Pointer to the CcdExpsoure where this source was measured. Note that we are allowing a source to belong to multiple AmpExposures, but it may not span multiple CcdExposures.
filterId	TINYINT	y				Pointer to an entry in Filter table: filter used to take Exposure where this Source was measured.
objectId	BIGINT					Pointer to Object table. Might be NULL (each Source will point to either MovingObject or Object)
movingObjectId	BIGINT					Pointer to MovingObject table. Might be NULL (each Source will point to either MovingObject or Object)
ra	DOUBLE	y		degree		RA-coordinate of the center of the source.
raSigma	FLOAT	y		degree		Uncertainty of ra.
decl	DOUBLE	y		degree		Decl-coordinate of the center of the source.
declSigma	FLOAT	y		degree		Uncertainty of decl.
xAstrom	FLOAT	y		degree		x position computed by a centroiding algorithm for the purposes of astrometry using Dave Monet's algorithm.
xAstromSigma	FLOAT	y		degree		Uncertainty of xAstrom.
yAstrom	FLOAT	y		degree		y position computed by a centroiding algorithm for the purposes of astrometry using Dave Monet's algorithm.
yAstromSigma	FLOAT	y		degree		Uncertainty of yAstrom.
xyAstromCov	FLOAT	y		degree		Covariance between the xAstrom and the yAstrom.
xOther	FLOAT	y		degree		x position computed by a centroiding algorithm for the purposes of astrometry using "other" centroiding algorithm.
xOtherSigma	FLOAT	y		degree		Uncertainty of xOther.
yOther	FLOAT	y		degree		y position computed by a centroiding algorithm for the purposes of astrometry using "other" centroiding algorithm.
yOtherSigma	FLOAT	y		degree		Uncertainty of yOther.

Data Products: Catalogs

- Object catalogs
  - Associated source measurements from multiple images
  - Position, proper motion, average mag in many colors, shapes, variability, uncertainty ++
  - http://lsst1.ncsa.uiuc.edu/schema/

LSST Database Schema Browser *alpha*

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mops_Event_TrackletPrecovery
mops_Event_TrackletRemoval
mops_MovingObjectToTracklet
mops_SSM
mops_SSMDesc
mops_Tracklet
mops_TrackletToDiaSource
mops_TrackToTracklet
MovingObject
Object
ObjectExtras
ObjectType
prv_Activity
prv_cnf_PolicyKey
prv_cnf_SoftwarePackage
prv_Filter
prv_PolicyFile
prv_PolicyKey
prv_Run
prv_SoftwarePackage
RaftMap
RaftMetadata
Raw_Amp_Exposure
Raw_Amp_Exposure_Metadata
Raw_Amp_To_Science_Ccd_Exposure
Raw_Amp_To_Snap_Ccd_Exposure
Raw_Ccd_Exposure

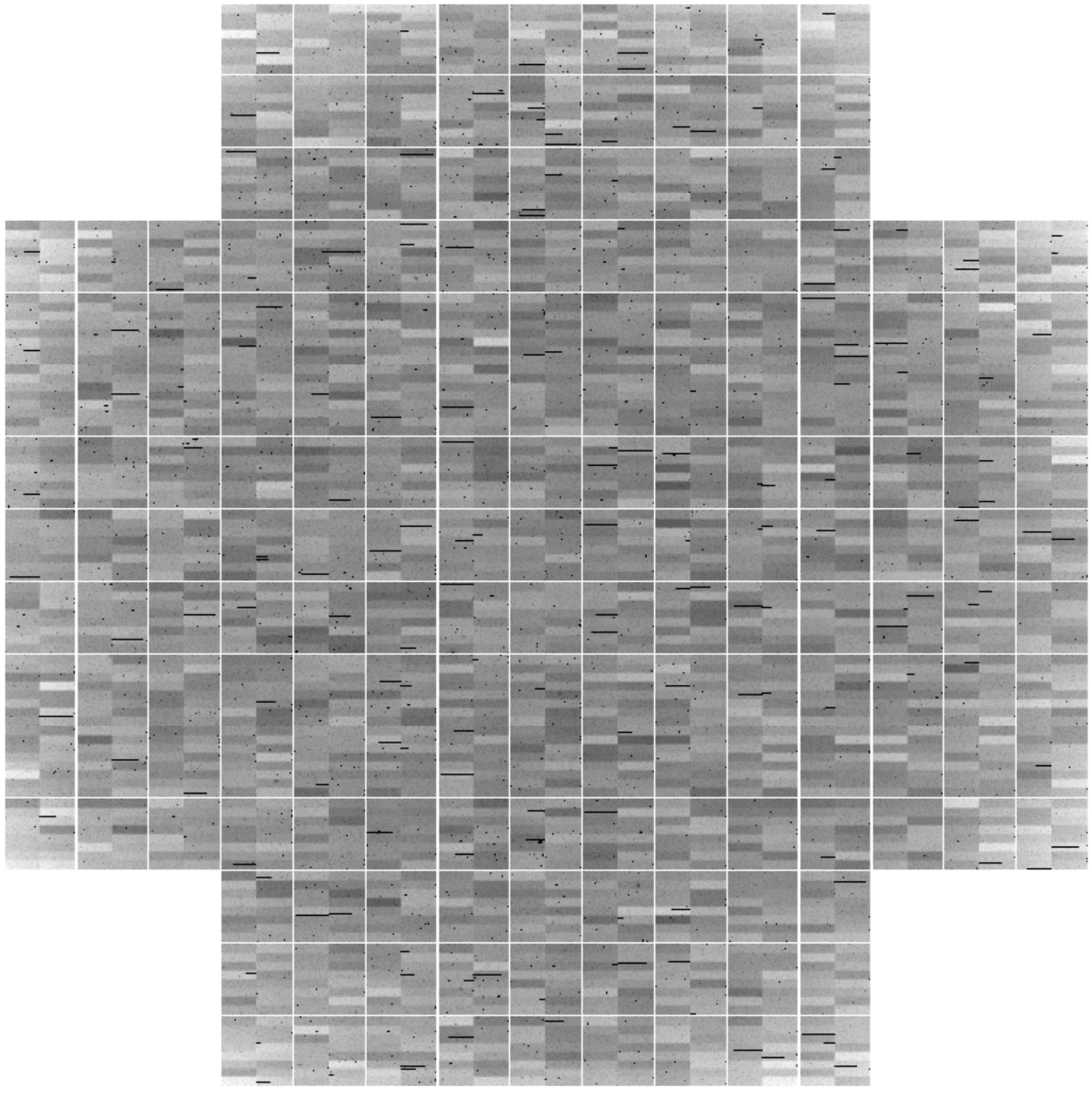
Details for table *Object*

The Object table contains descriptions of the multi-epoch static astronomical objects, in particular their astrophysical properties as derived from analysis of the Sources that are associated with them. Note that fast moving objects are kept in the Moving

name	type	not null	default	unit	ucd	description
objectId	BIGINT	y				Unique id.
iauId	CHAR(34)					IAU compliant name for the object. Example: "LSST-DR11 J001234.65-123456.18 GAL". The last 3 characters identify classification. Note that it will not accommodate multiple classifications.
ra_PS	DOUBLE	y		degree		RA-coordinate of the center of the object for the Point Source model for the cannonical filter.
ra_PS_Sigma	FLOAT			degree		Uncertainty of ra_PS.
decl_PS	DOUBLE	y		degree		Dec-coordinate of the center of the object for the Point Source model for the cannonical filter.
decl_PS_Sigma	FLOAT			degree		Uncertainty of decl_PS.
radecl_PS_Cov	FLOAT					Covariance of ra_PS and decl_PS.
ra_SG	DOUBLE			degree		RA-coordinate of the center of the object for the Small Galaxy model for the cannonical filter.
ra_SG_Sigma	FLOAT			degree		Uncertainty of ra_SG.
decl_SG	DOUBLE			degree		Dec-coordinate of the center of the object for the Small Galaxy model for the cannonical filter.
decl_SG_Sigma	FLOAT			degree		Uncertainty of decl_SG.
radecl_SG_Cov	FLOAT					Covariance of ra_SG and decl_SG.
raRange	FLOAT			degree		Ra part of the bounding box on the sky that fully encloses footprint of this object for the cannonical model (Small Galaxy) and cannonical filter.
declRange	FLOAT			degree		Decl part of the bounding box on the sky that fully encloses footprint of this object for the cannonical model (Small Galaxy) and cannonical filter.
muRa_PS	DOUBLE			degree/year		Proper motion (ra) for the Point Source model.
muRa_PS_Sigma	FLOAT			degree/year		Uncertainty of muRa_PS.
muDecl_PS	DOUBLE			degree/year		Proper motion (decl) for the Point Source model.
muDecl_PS_Sigma	FLOAT			degree/year		Uncertainty of muDecl_PS.
muRaDecl_PS_Cov	FLOAT					Covariance of muRa_PS and muDecl_PS.

Data Products: Images

- Pixels will be preserved and will be accessible
- Postage stamps
- Full images



Data Access Centers (DAC)

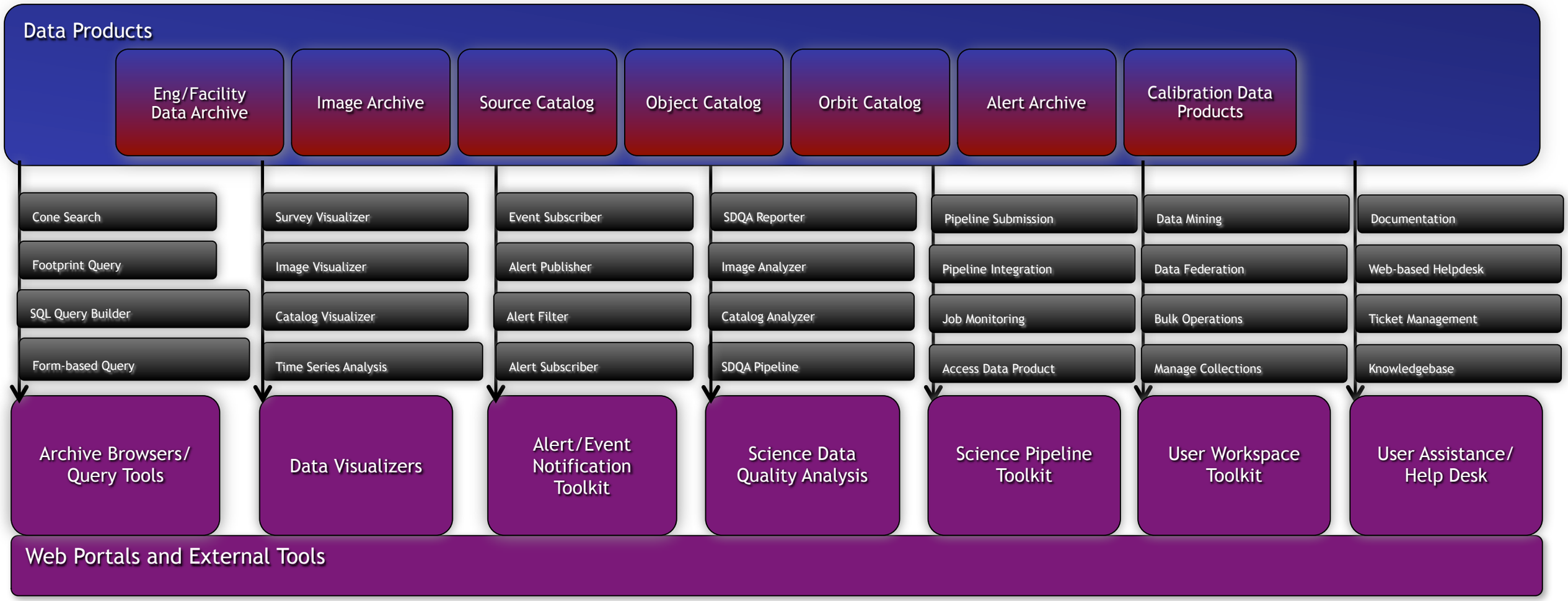
- **Compute resources for users**
- Simple database queries
  - "give me all objects within 2 degrees of RA=6, Dec=-30 with r-i>0.6 that look like stars"
- Larger database queries
  - "give me all objects where the magnitude changes by more than 2 mags in less than 7 days, with a 'y' magnitude>20 that also have a galaxy within 3 degrees"
- Analysis requiring image access

LSST Data Management Software

- Process images from any source
- Extensible by users for additional processing at Data Access Center or elsewhere (or NOW)

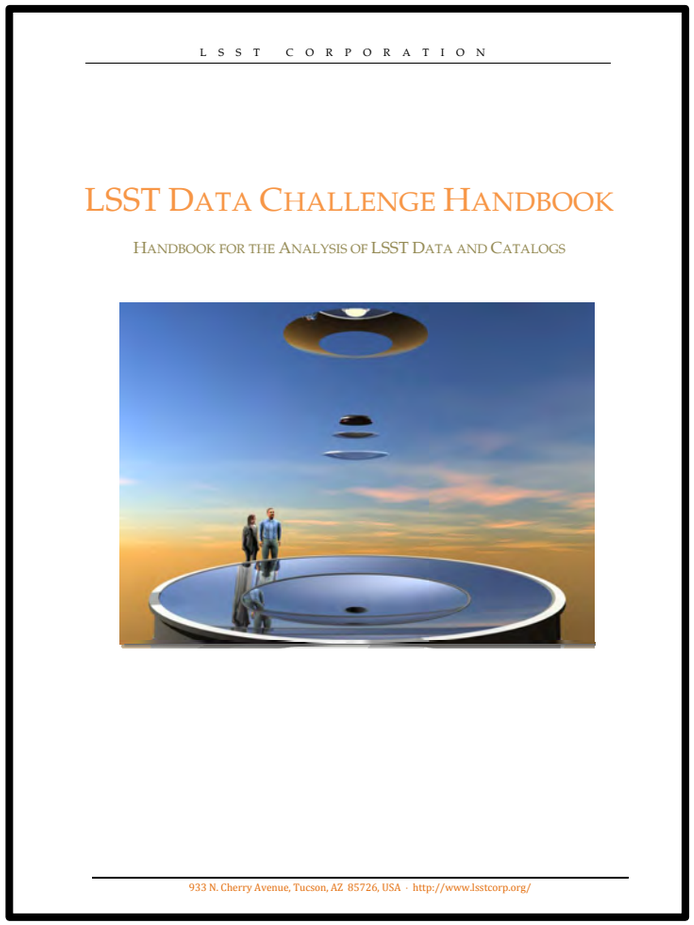
- Publicly available – open source
  - Anyone can build on or use software stack
- Python and C++
- http://lsstdev.ncsa.uiuc.edu/trac/browser

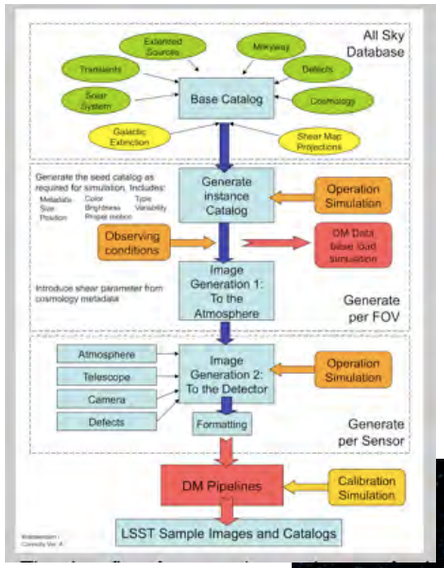
Tools and Resources for users

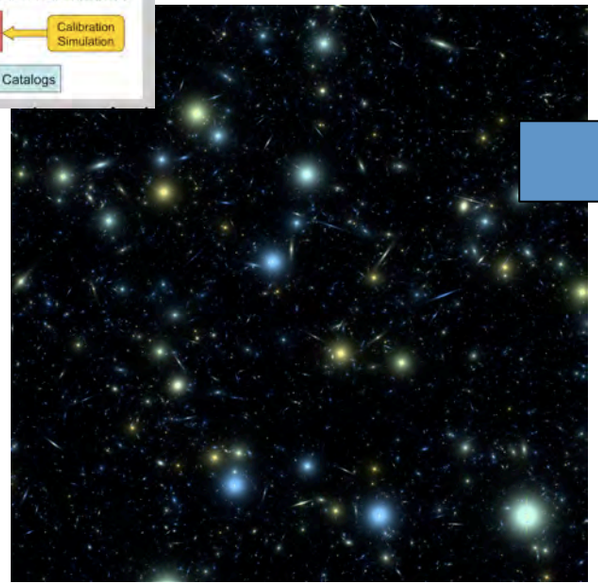


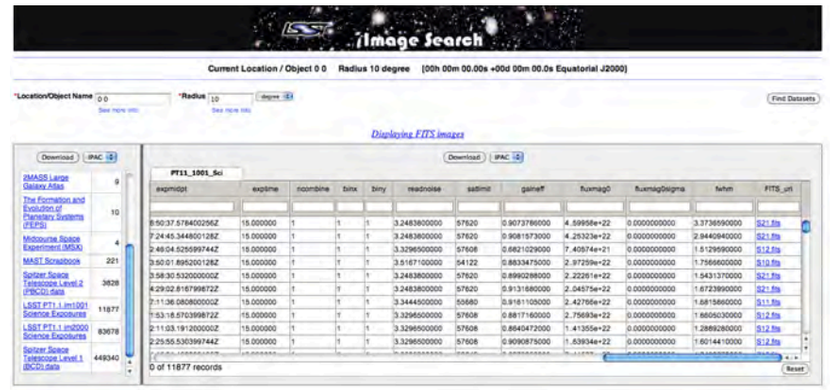
- Developing tools and interfaces with feedback from current ‘best of class’ and ongoing interaction with science collaborations.
- Tools will be used in ongoing data challenges.

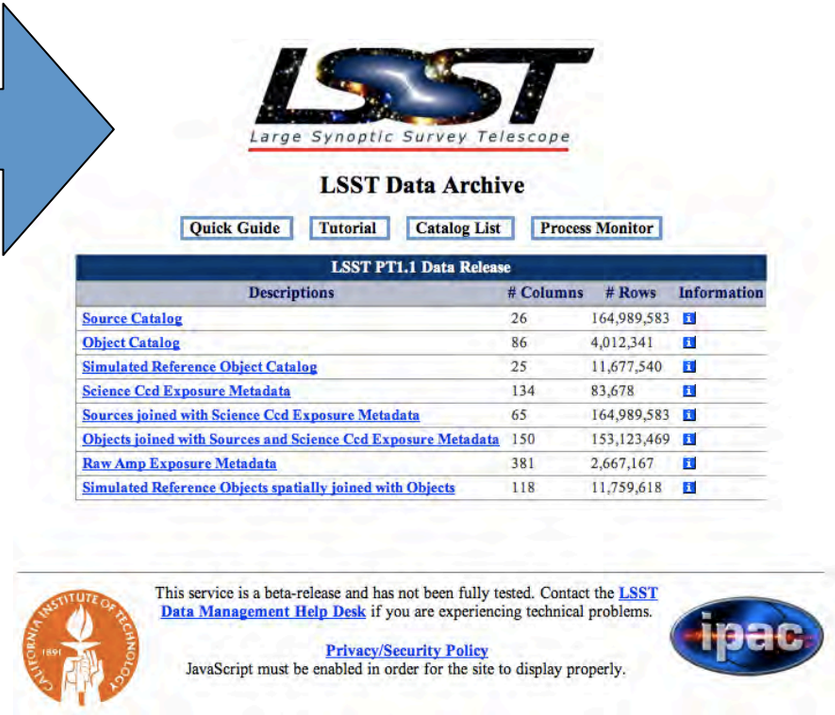
Tools and Resources for users **RIGHT NOW**











- Data Challenges ongoing
- Input images and derived catalogs available, along with reference truth catalogs
- LSST: Provide data and tools and software and help.

Discussion Time

- "I have a great idea to improve LSST data processing. Is there any chance that you can include that enhancement in the base software stack so it's included in every data release?"
- "How will the Data Access Centers handle large numbers of users all wanting to do very intensive data analysis?"
- "Can I download all of the catalogs you've generated so far? What about the images?"
- "How do I get involved?"

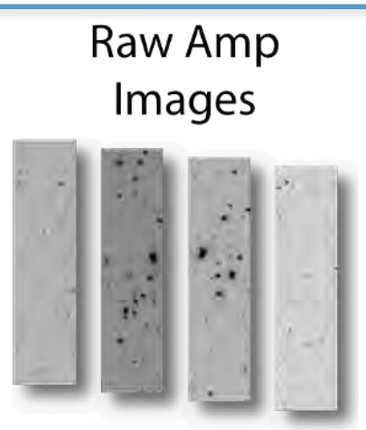
Data Products

Processing Cadence	Image Category (files)	Catalog Category (database)	Alert Category (database)
Nightly	Raw science image Calibrated science image Subtracted science image Noise image Sky image Data quality analysis	Source catalog (from difference images) Object catalog (from difference images) Orbit catalog Data quality analysis	Transient alert Moving object alert Data quality analysis
Data Release (Annual)	Stacked science image Template image Calibration image RGB JPEG Images Data quality analysis	Source catalog (from calibrated science images) Object catalog (optimally measured properties) Data quality analysis	Alert statistics & summaries Data quality analysis

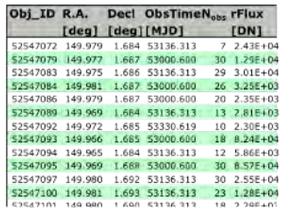
- Millions of Images and Alerts, Billions of Objects, Trillions of Sources

Data Release Production to date

Large Synoptic Survey Telescope

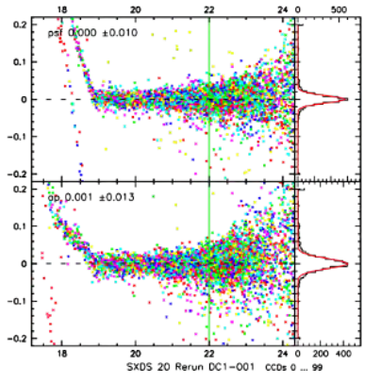


Raw Amp Images



Obj_ID	R.A. [deg]	Decl [deg]	ObsTime [MJD]	N_{obs}	rFlux [DN]
52547072	149.979	1.684	53136.313	7	2.43E+04
52547079	149.977	1.687	53000.600	30	1.29E+04
52547083	149.975	1.686	53136.313	29	3.01E+04
52547084	149.981	1.687	53000.600	26	3.25E+03
52547086	149.979	1.687	53000.600	20	2.35E+03
52547089	149.969	1.684	53136.313	13	2.81E+03
52547092	149.972	1.685	53330.619	10	2.30E+03
52547093	149.966	1.685	53000.600	18	8.24E+04
52547094	149.965	1.684	53136.313	12	5.86E+03
52547095	149.969	1.688	53000.600	30	8.57E+04
52547097	149.980	1.692	53136.313	30	2.55E+04
52547100	149.981	1.693	53136.313	23	1.28E+04

Reference Catalogs



SDQA

ISR

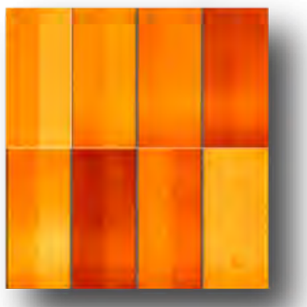
CCD Assembly

CR Split

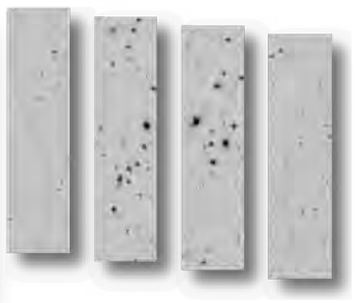
Image Char.

Single Frame Meas.

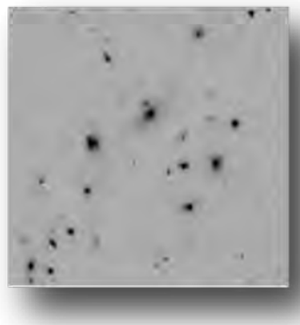
Source Assn.



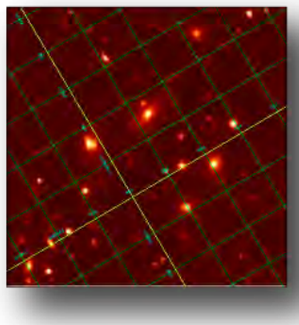
Calib Ref Images



Post-ISR Images



Combined Image



Calibrated Visit Image

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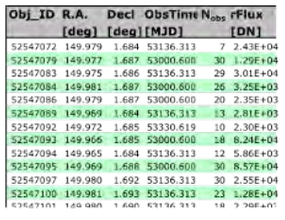
52547100	149.981	1.693	53136.313	23	1.28E+04

Source Catalog



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Object Catalog

Testing the database architecture with “standard” queries

- We have developed and tested with ~65 “standard” queries to represent likely data access patterns and to “stress” the architecture
- Based on SDSS, Science Council, Science Collaboration inputs
- Examples (full list at http://dev.lsstcorp.org/trac/wiki/dbQueries)
  - In a region
    - Cone-magnitude-color search
    - For a specified patch of sky, give me the source count density of unresolved sources (star like PSF)
  - Across entire sky
    - Select all variable objects of a specific type
    - Return info about extremely red objects
  - Analysis of objects close to other objects
    - Find all galaxies without saturated pixels within certain distance of a given point
    - Find and store near-neighbor objects in a given region
  - Analysis that require special grouping
    - Create a count of galaxies for each of the predefined areas which satisfy a certain color cut, generate output adequate for visualization
  - Time series analysis
    - Find all objects that are varying with the same pattern as a given object, possibly at different time$
    - Find stars that have light curves like a simulated one$
  - Cross match with external catalogs
    - Joining LSST main catalogs with other catalogs (cross match)
    - Joining LSST main catalogs with other catalogs (anti-cross match)