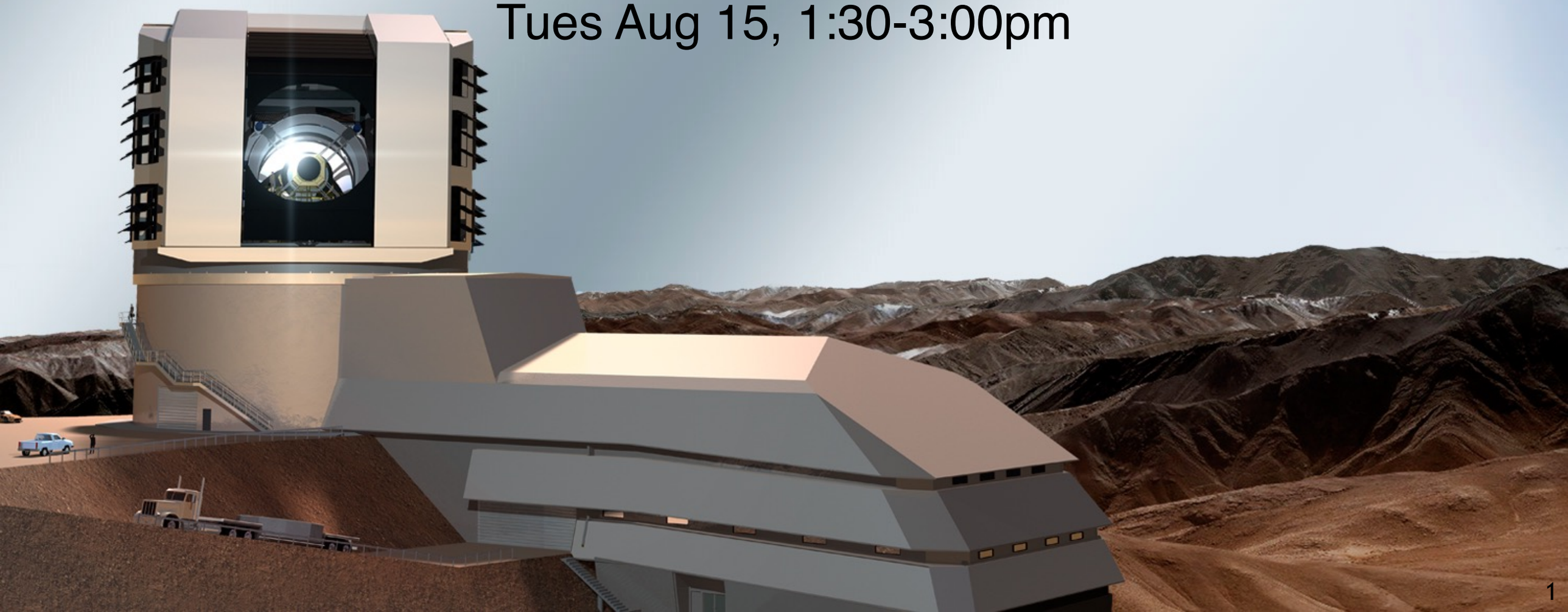
Special Programs

Melissa Graham, University of Washington

LSST Project and Community Workshop
Session: DDF and Mini-Surveys
Tues Aug 15, 1:30-3:00pm

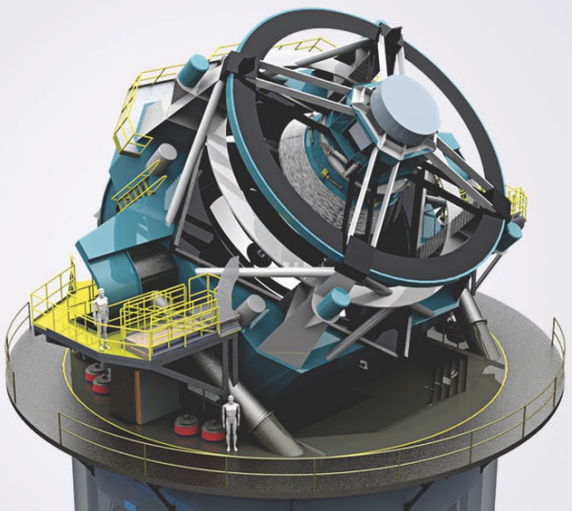


Plans, Opportunities, and Schedule Implications

1) Planned Observations for DDF/MS
2) Scope for new DDF/MS: call for white paper proposals
3) Boundaries for DDF/MS Observations

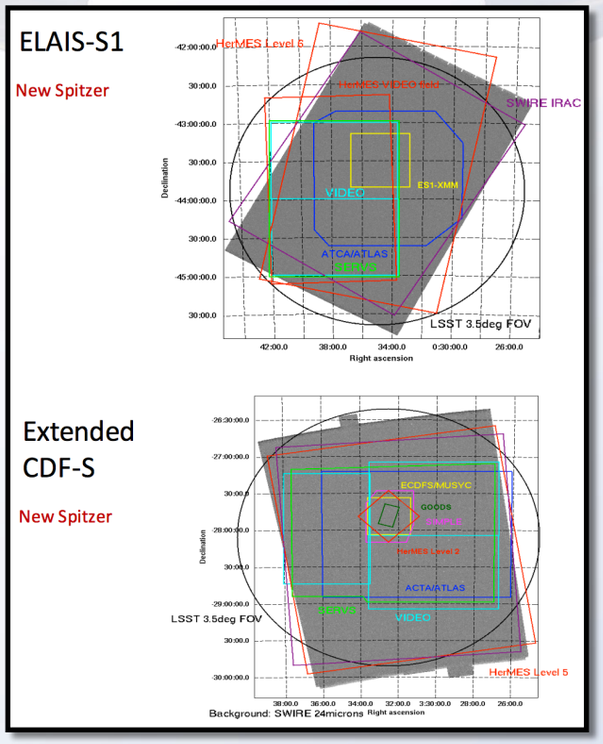
Data Management Considerations for SP

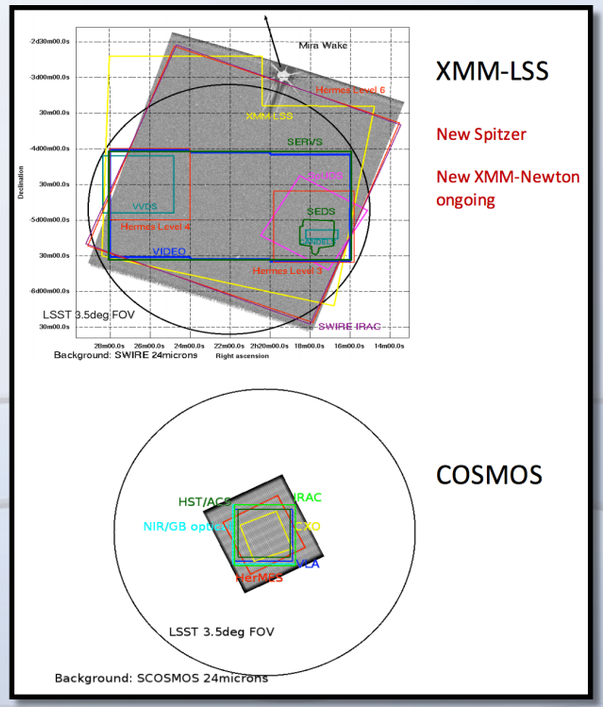
1) Data Management System Science Team
2) Ongoing Study: DM Considerations for SP
3) Suggested DM-Related SP White Paper Content



SP = Special Programs
MS = Mini Surveys
DDF = Deep Drilling Fields
WFD = Wide-Fast-Deep (Main Survey)
DM = Data Management

Plans, Opportunities, and Scheduling





Four approved extragalactic deep fields:

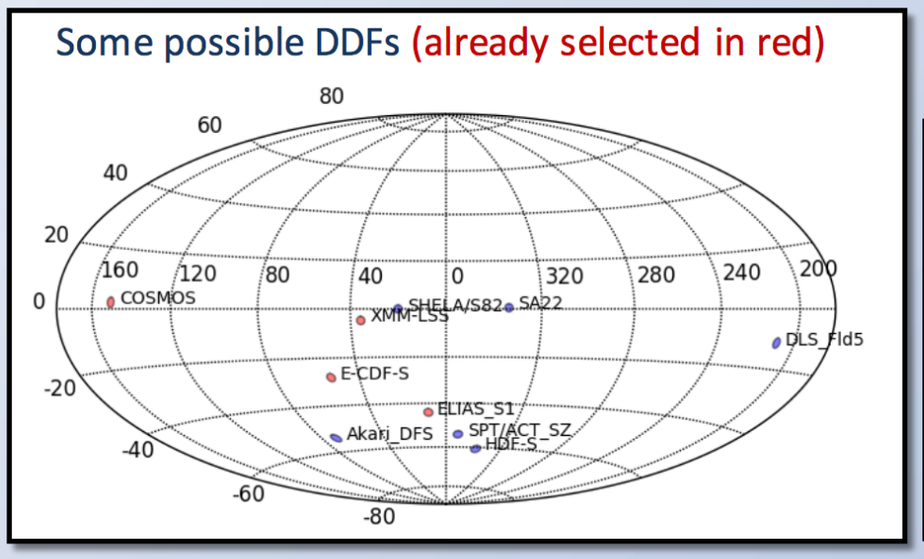
ELAIS-S1, XMM-LSS, Extended CDF-S, COSMOS

Nominal DDF Observing Strategy:

Ivezić et al. (2008) describes a nominal DDF data set as, e.g.:
~50 x 15s exposures in *griz*, every two nights for four months.

single image limit r<24.5
nightly stack limit r<26.5
full stack limit r<28.0

A conservative 60% completion rate (weather) yields ~40 hours of DDF data; stack with the ~180 hours of WFD visits.



	ELAIS S1	XMM-LSS	Extended Chandra Deep Field-South	COSMOS
RA 2000	00 37 48	02 22 50	03 32 30	10 00 24
DEC 2000	-44 00 00	-04 45 00	-28 06 00	+02 10 55
Galactic l	311.30	171.20	224.07	236.83
Galactic b	-72.90	-58.77	-54.47	42.09
Ecliptic l	345.97	31.04	40.29	150.70
Ecliptic b	-43.18	-17.90	-45.47	-9.39

https://www.lsst.org/scientists/survey-design/ddf

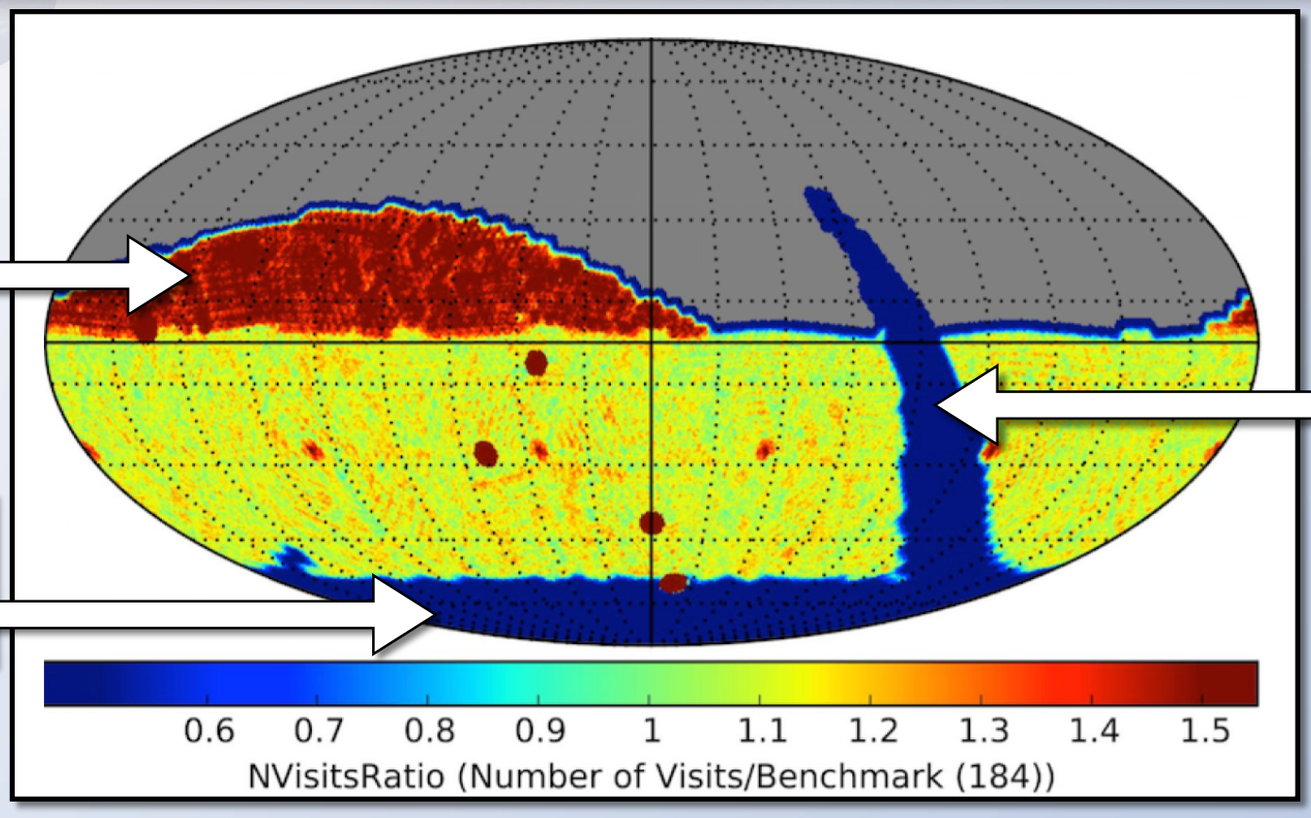
See also Neil Brandt's LSST AHM 2016 talk:
https://project.lsst.org/meetings/lsst2016/sites/lsst.org.meetings.lsst2016/files/Brandt-DDF-MiniSurveys-01.pdf

2011 DDF Whitepapers: https://project.lsst.org/content/whitepapers32012

Plans, Opportunities, and Scheduling

North Ecliptic Spur
(solar system)

South Celestial Pole
(LMC, SMC)



Galactic Plane
(stars and planets)

DDF examples

See also Chapter 10 of the Observing Strategy White Paper:
https://github.com/LSSTScienceCollaborations/ObservingStrategy/tree/pdf/whitepaper

Additional Mini-Survey Concepts:
Mini-Moons (temporary earth-orbiting asteroids)
Meter-Sized Impactors (small earth-crossing asteroids)
Twilight Survey (short exposures for bright objects)
Gravitational Wave Counterparts (extragalactic)

"Simulations, Metrics, and Merit Functions for DDF/MS", Steve Ridgway, LSST AHM, Aug 2016:
https://project.lsst.org/meetings/lsst2016/sites/lsst.org.meetings.lsst2016/files/Ridgway-SimulationsMetrics_1.pdf

Neil Brandt's LSST AHM 2016 talk:
https://project.lsst.org/meetings/lsst2016/sites/lsst.org.meetings.lsst2016/files/Brandt-DDF-MiniSurveys-01.pdf

Ivezić et al. (2008), Figure 18.

Plans, Opportunities, and Scheduling

What is set and what is open to community* proposals?

Set
the four pre-existing deep drilling fields

Open
additional deep drilling fields
refined observing strategies** for deep drilling fields
optimized survey areas for the NES, South Pole, and Galactic Plane
refined observing strategies** for the NES, South Pole, and Galactic Plane
additional mini-surveys

Timeline for future community proposals*.**

Deep Drilling Fields:	Mini-Surveys:
call: Dec 2017	call: Oct 2018
due: April 2018	due: Feb 2019

*Not limited to science collaboration members.
**OpSim runs for proposed DDF/MS expected by late 2019.
***To Be Confirmed (perhaps merged into a single call)

Plans, Opportunities, and Scheduling

	Cadence Optimization	Calls to Community
2017	Start work on tools to run MAF & Opsim at scale	
	Rolling cadence experiments; DDF experiments/examples	Publish Observing Strategy white paper (OSWP) Call for DDF white papers (Dec)
2018	Rolling cadence experiments evaluated with OSWP metrics; Mini-survey experiments/examples	DDF white papers due (Apr)
	DDF WP -> simulated surveys; mini-survey experiments	Call for mini-survey (special programs) white papers (Oct)
2019	Updated baseline with DDF + rolling cadence (June)	Mini-survey white papers due (Feb) Request for white paper and metrics update (Mar)
	Mini-survey WP -> simulated surveys;	White paper with metrics due (Aug)
2020	Finalize MAF and Opsim tools; deliver documentation and a series of simulated surveys to SAC; form SSC	
	Ask SAC and Survey Strategy Committee to recommend the initial observing strategy	
2021	Announce initial survey strategy and publish a baseline simulation that reproduces that strategy	

https://github.com/LSSTScienceCollaborations/ObservingStrategy/tree/pdf/whitepaper

Plans, Opportunities, and Scheduling

How do the upcoming calls for white paper proposals for DDF/MS fit in with the existing Observing Strategy White Paper?

The next round of DDF/MS white papers will be separate from the existing OSWP, but could contribute analysis later (e.g., in 2019 with future OpSim runs).

What is the format and expected content of these white papers?

To be formalized when the call is announced in December — but in addition to science goals and observing strategy, data processing needs should be discussed.

How will these white papers be evaluated and decisions be made?

Proposals would be reviewed by the Science Advisory Council based on criteria set by the Project Science Team, and recommendations would be made to the LSST Director.

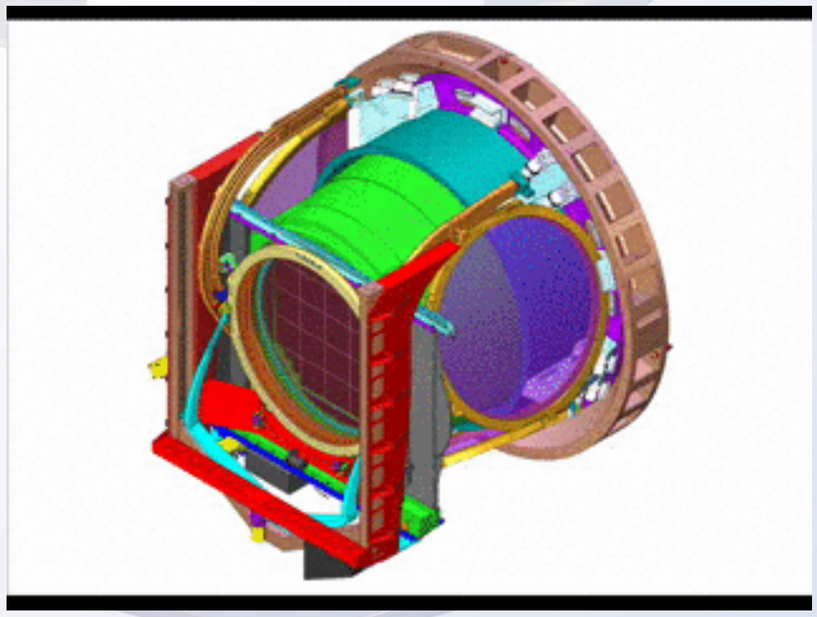
PST Criteria will be clarified in the call for WP, but may include:
-satisfy minimum technical requirements (feasibility, overheads)
-maximize diverse scientific objectives (serve a wide community)
-generate legacy datasets & add value to products of other astronomical facilities

Is it possible that >10% of LSST time could be spent on DDF/MS?

With significant improvements to the science, potentially yes.

"Draft thoughts on selecting DDFs", Beth Willman, LSST SAC Meeting, October 2016:
https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/Willman_DDF.pdf

Plans, Opportunities, and Scheduling



Filter Changes

The maximum time for filter change is 120 seconds (30 seconds for the telescope to reorient the camera to its nominal zero angle position on the rotator, and 90 seconds to the camera subsystem for executing the change; OSS-REQ-0293, ls.st/lse-30).

The minimum time between filter changes has no restrictions from e.g., thermal tolerances. However, based on overheads and efficiency, it is recommended to keep the filter change rate lower than once every 10 minutes.

The maximum total number of filter changes is 100,000 over 15 years, an average of 18 changes per night.

The maximum number of filter swaps in/out of the carousel is 3000 in 15 years, or once every two nights.

Last three points are from Steve Ritz and Zeljko Ivezic, to be incorporated into public-facing documents soon.

Exposure Times

The minimum exposure time is 1 second, with a stretch goal of 0.1 seconds (OSS-REQ-0291, ls.st/lse-30).

1) The minimum exposure time needed to create an image with a PSF that is well-formed enough for difference imaging is a separate question we will consider in later slides.

2) Assuming a 1 second exposure can be reduced and calibrated, its detected point sources will span 13 < r < 21 magnitudes, whereas a 15 second exposure saturates at r~15.8 mag.

The maximum exposure time is not restricted.

However, a 2x150 second image would saturate at r~18.3, perhaps leaving too few stars overlapping with e.g., templates or WFD images, for astrometric and photometric calibrations; additionally, the impact on CR rejection routines is untested for long exposures.

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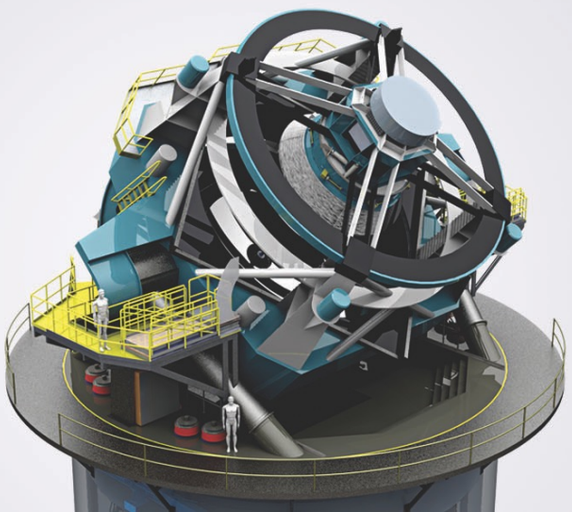

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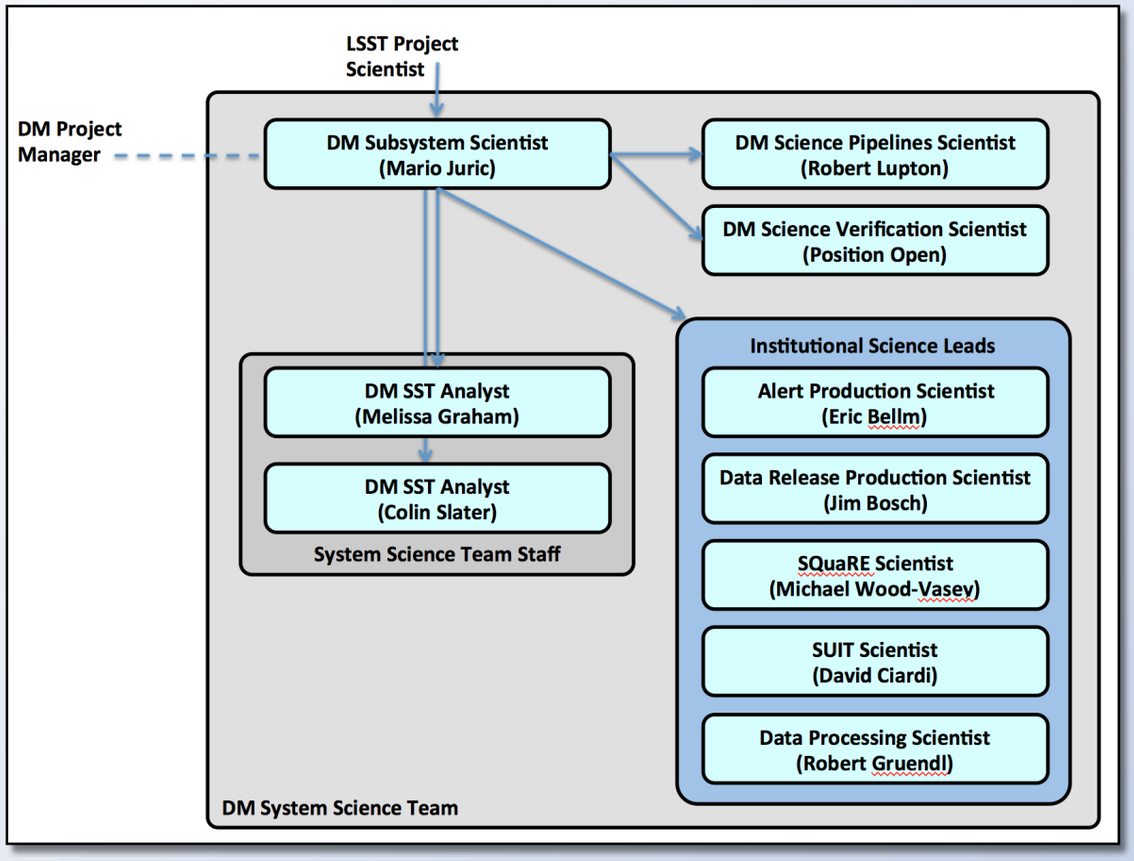
DM Considerations for Special Programs

LSST Data Management System Science Team (DM-SST)
Scientific Validation: ensure that the DM pipelines and products are designed to meet the LSST science goals.



Validation: *do the specifications capture the customer's needs.*

Verification: *does the product meet the specifications.*

The DM-SST endeavors to:

- understand needs of science community
- ensure DM products will meet the needs
- identify scientific opportunities and risks related to DM and initiate change
- evaluate the scientific impact of proposed changes to DM deliverables driven by e.g., schedule, budget

In this talk we're presenting DM-SST work related to Special Programs.

DM Considerations for Special Programs

Level 1: Difference Imaging Analysis & Alert Production
Level 2: Data Release Pipeline
Level 3: Users' Pipelines*

*Level 3 applies to users processing SP data from DDF/MS and reprocessing WFD main survey data.

LSST Processing for Special Programs

LSST will not write unique algorithms for processing Special Programs data or reprocessing Main Survey data,

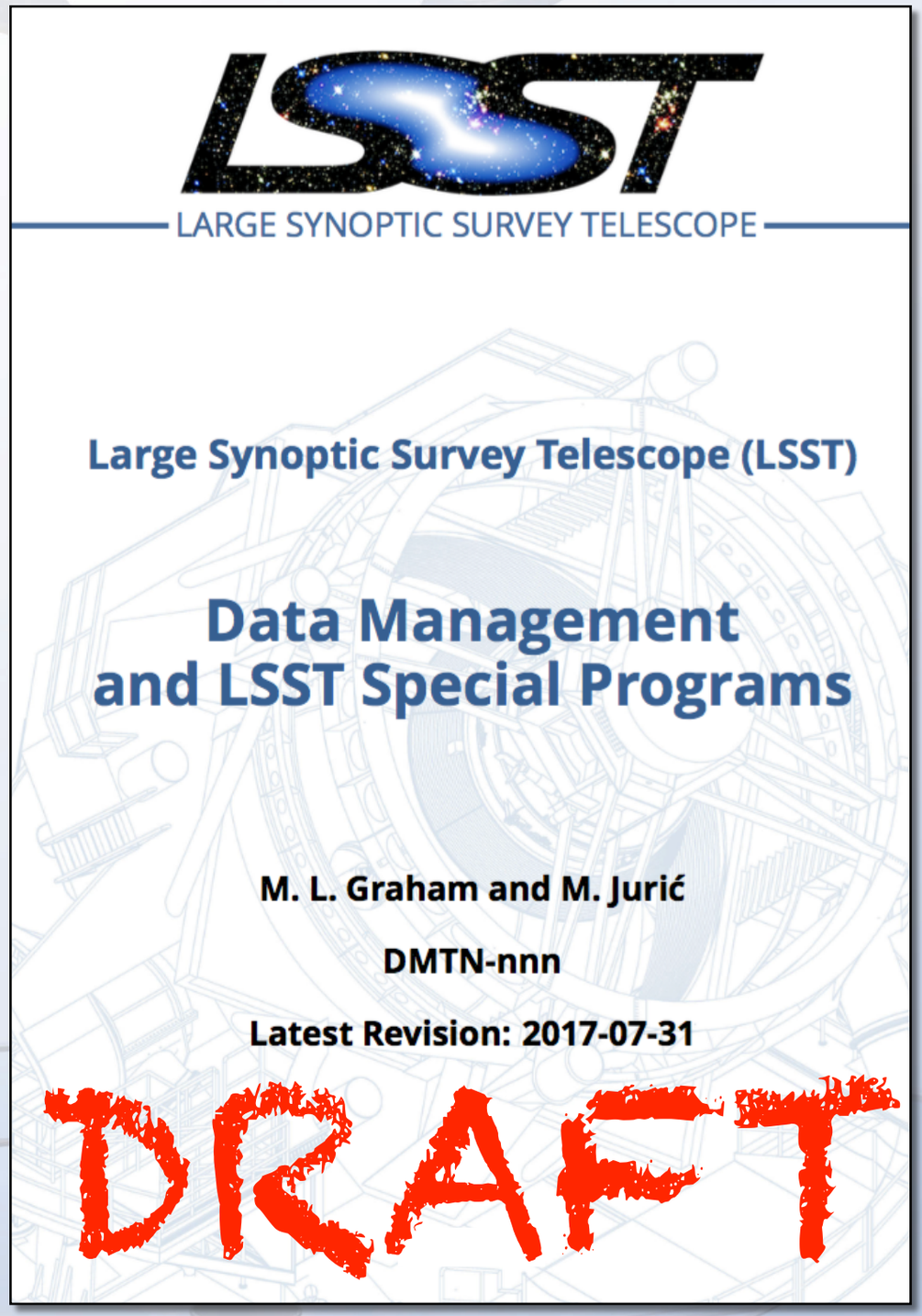
— *but* —

LSST will reconfigure the pipelines to generate imaging and catalog products for Special Programs data, whenever possible,

— *and* —

LSST will commit ~10% of its computing resources toward enabling Level 3 analysis and data product creation, including user-driven Special Programs processing.

DM Considerations for Special Programs

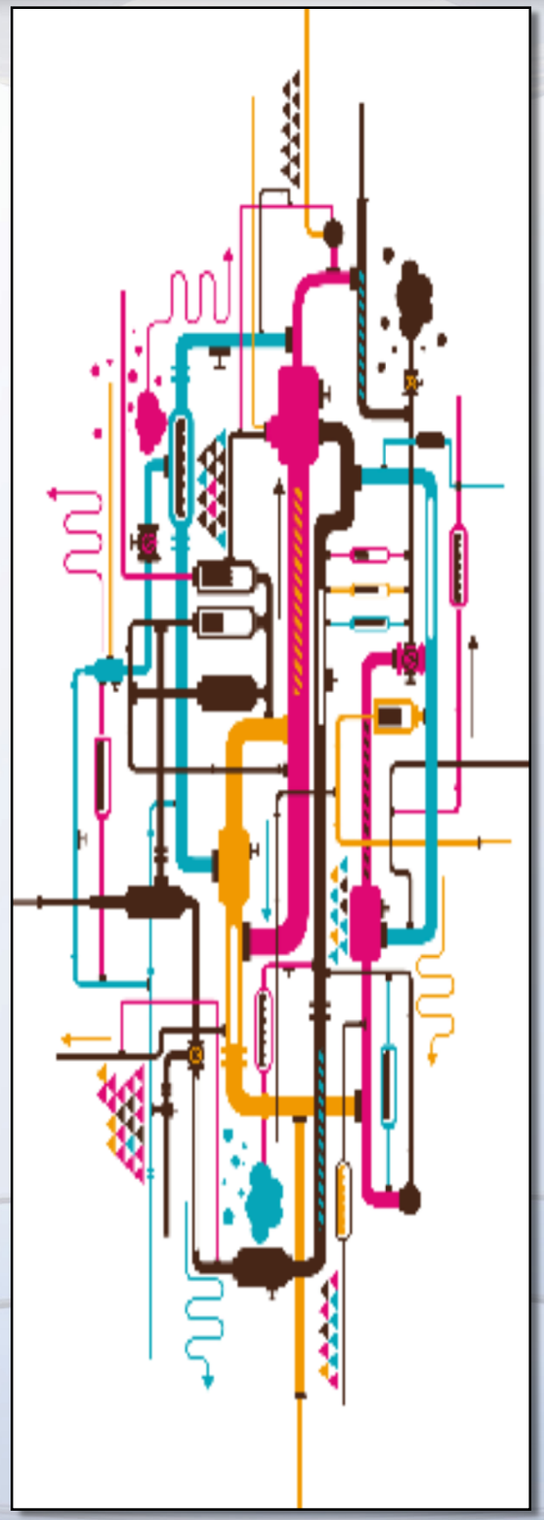


Study Aims:

1) Review DM's plans to incorporate data from Special Programs into the Level 1 and 2 pipelines and products.

2) Evaluate the processing that will be required to enable science with Special Programs, and how DM's existing plans will meet the needs.

See Ch. 6 of ls.st/dpdd



Incorporating SP data into Level 1: Difference Imaging Analysis and Alert Production

Only images that can be processed by the DIA pipeline can contribute to the Alert Stream.

All images that *can* be processed by the DIA pipeline, *should* be.

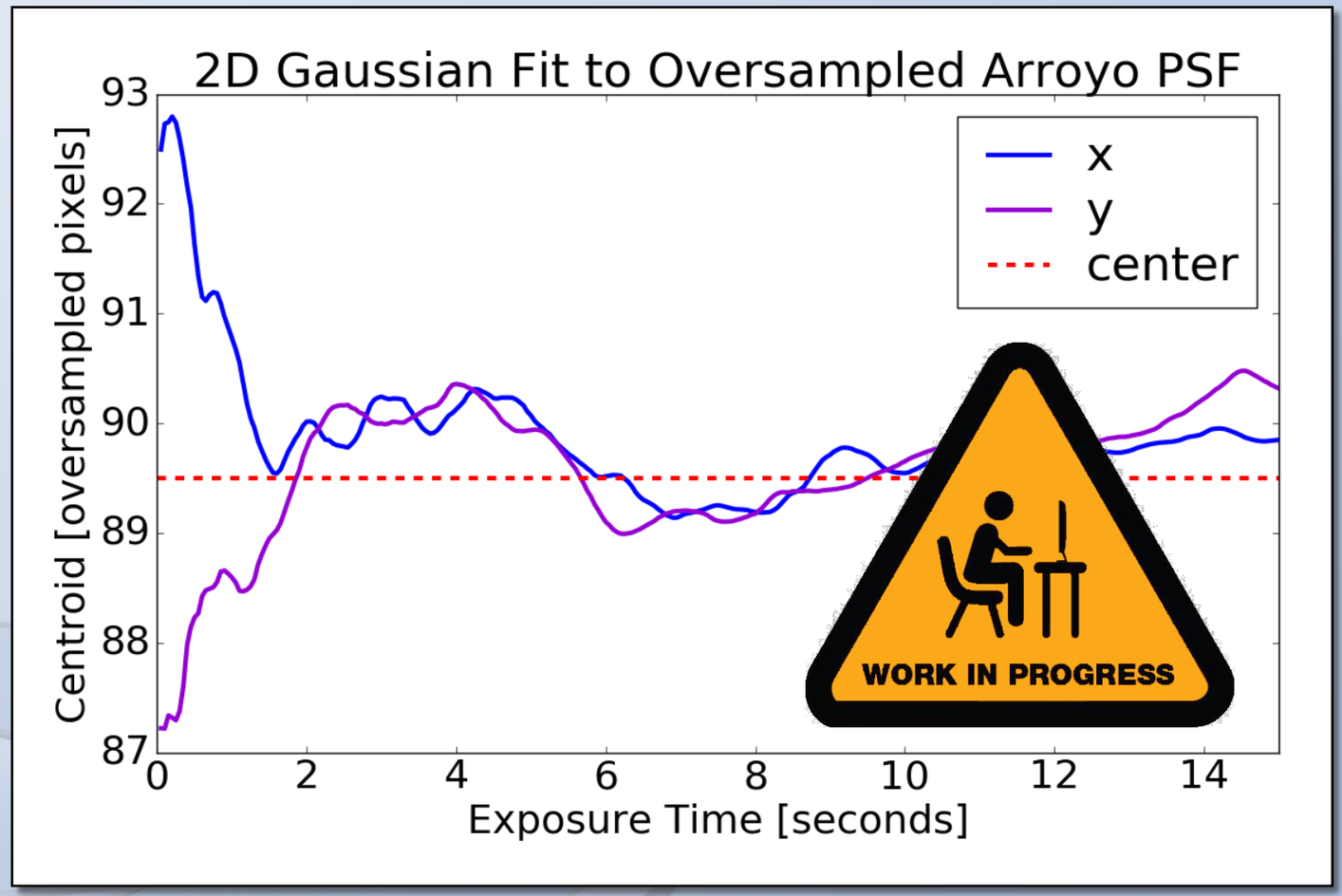
Images can be processed by the DIA pipeline iff:
- a suitable template exists, and
- a DCR correction can be applied, and
- the PSF is well-formed (i.e., PSF-matching is possible), and
- it contains a sufficient number of unsaturated stars

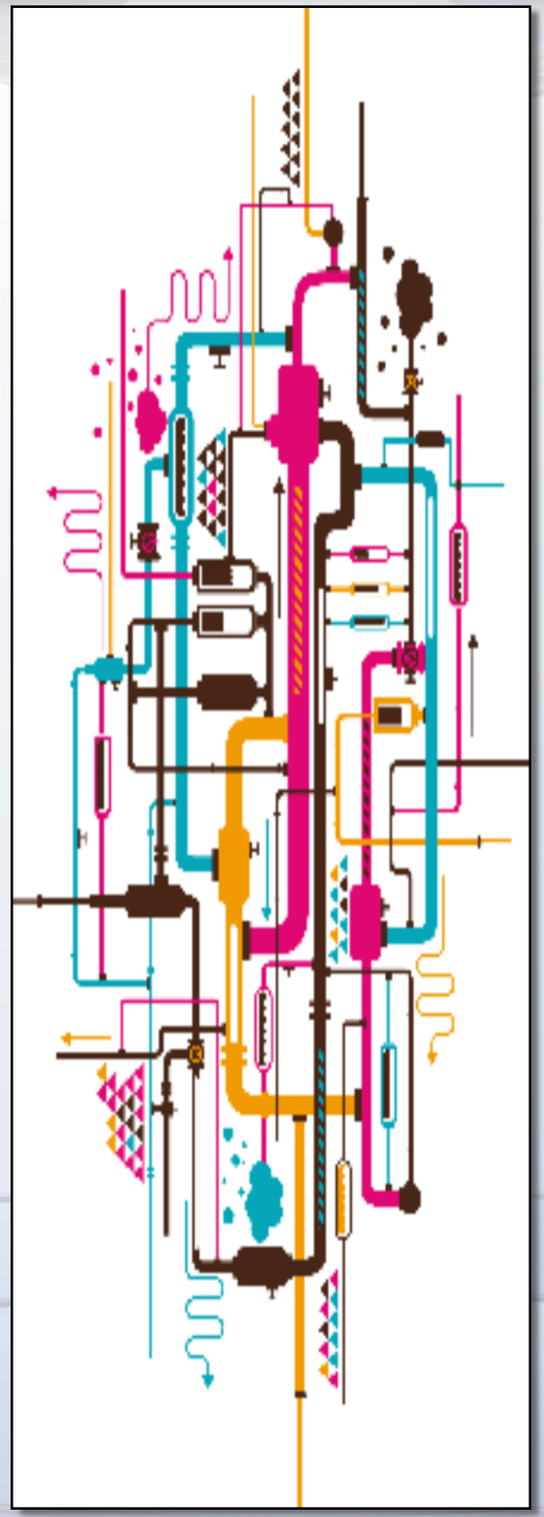
DM might have restrictions based on image exposure time and/or acquisition rates, but incorporating “normal” images from Special Programs into Level 1 should be automatic.

DM Considerations for Special Programs

Arroyo atmosphere-only simulated PSF for LSST, courtesy of Bo Xin.

Example: what is the shortest possible exposure time that a user could apply to e.g., a bright nearby supernova, and still get decent results from DM's difference imaging analysis pipeline?
*(Note that *alerts* on saturated sources will occur naturally; here we're concerned about getting science-grade photometry.)*





Incorporating SP data into Level 2: Data Release Pipeline (DRP) for WFD

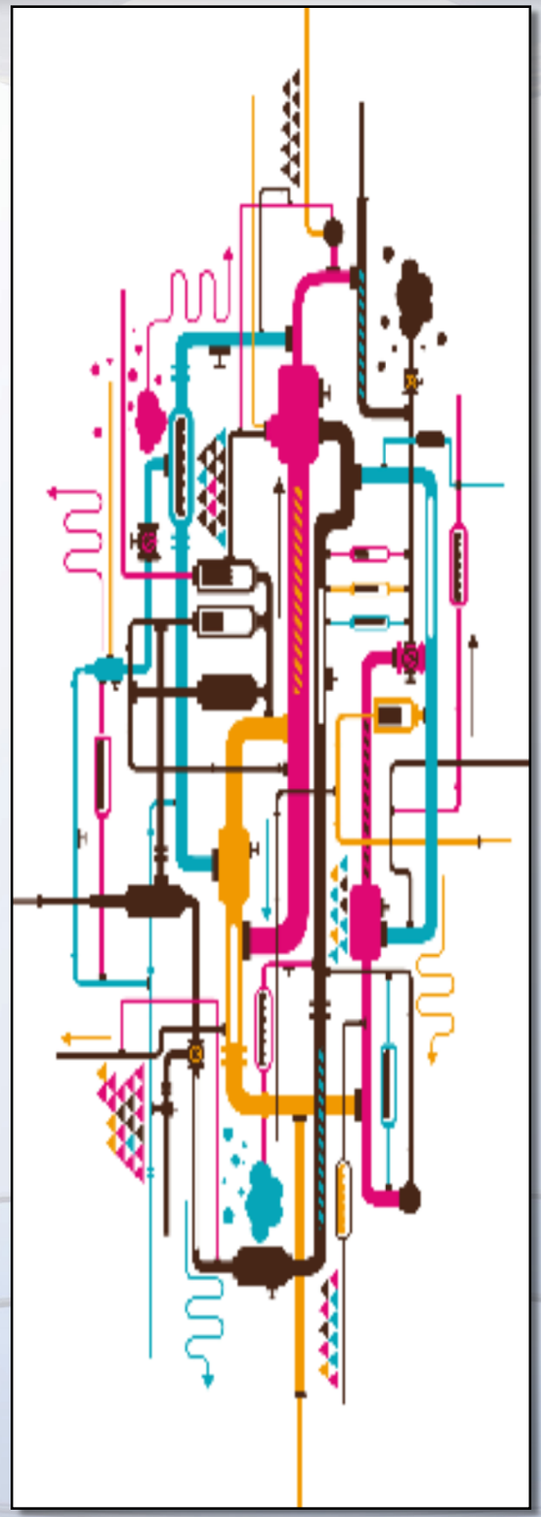
The WFD science goals require an area of constant depth and image quality, so SP data will probably only be incorporated into the Level 2 DRP when it improves product quality.

Examples:

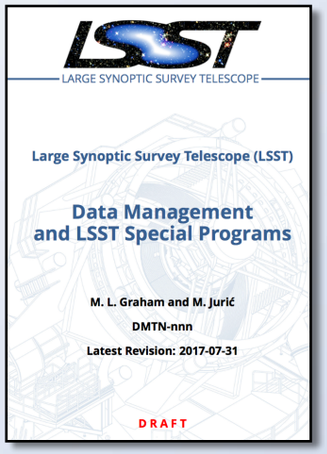
1) Images that bring additional area up to the same level of depth and cadence as the rest of the WFD main survey.

2) Photometric calibrations may require that the (shallower) Galactic Plane survey area be incorporated in order to suppress edge effects and low-order modes in the photometric solutions.

DM Considerations for Special Programs



Regardless of their inclusion in Level 1 & 2, it is anticipated that all SP will have at least one appropriately configured pipeline that produces unique image and catalog products.



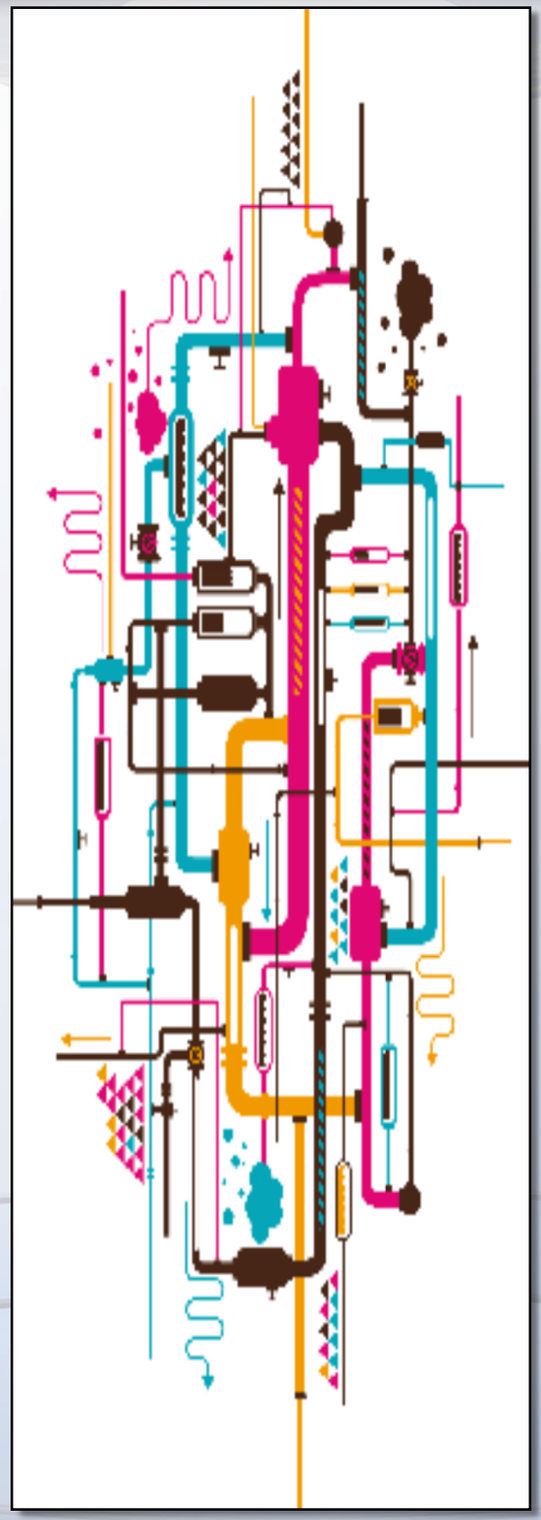
Review L1 and L2 processing codes and catalog schema to improve their use for Special Programs data.

- SP data that is difficult to run through the instrument signature removal, and for which automated reduction and delivery might not be possible with the same latency. *E.g., very short/long exposure, twilight sky background.*

- SP with a significantly different cadence that are processed by L1 may intend to contribute algorithms for elements DIAObject.lcPeriodic and DIAObject.lcNonPeriodic for their variable-of-interest; are these elements properly sized for all?

The community is welcome to bring forward these types of concerns related to their own SP's data processing.

DM Considerations for Special Programs



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The upcoming call for Special Programs white papers will request a ‘processing outline’; the detailed format is TBD.

Typical contents of a ‘processing outline’ might be:

Step 1. Data Acquisition.
Step 2. Inclusion in Level 1 AP.
Step 3. Delivery of LSST Processed Images.
Step 4. Reconfigured DM Processing.
Step 5. Reconfigured DM Products.
Step 6. Inclusion in Level 2 DRP (optional)
Step 7. Level 3 Processing (if necessary)

DM Considerations for Special Programs

Example Processing Description:
Supernova Search in a Deep Drilling Field

Step 1. Data Acquisition.
Scheduler obtains 10 visits of 2x15s in each of *ugrizy* using a small dither pattern.

Step 2. Inclusion in Level 1 AP.
Each 2x15s visit image is processed as L1 and Alerts are released.

Step 3. Delivery of LSST Processed Images.
The raw, reduced, and calibrated exposures and difference images from the L1 DIA pipeline are publicly available within 24h for any Level 3 processing.

Step 4. Reconfigured DM Processing.
- DM image stacking code combines each filter into a nightly CoAdd
- DM image differencing code subtracts CoAdds from previously-made templates
- DM source detection code creates a table of SNR>5 sources
- DM association routine joins table to the L1 DIA and L2 DRP Object catalogs
- DM protocols are used to produce a L3 alert stream delivered to brokers

Step 5. Reconfigured DM Products.
Deep templates, nightly CoAdds and differences, and analogs of the `DIAObject` and `DIASource` catalogs for this DDF are shared publicly through the Science Platform.

DM Considerations for Special Programs

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Examples of what DM learns from this.

LSST and Broker tests should include realistic alert characteristics from a DDF.

Does this latency inhibit science, can/should it be shortened?

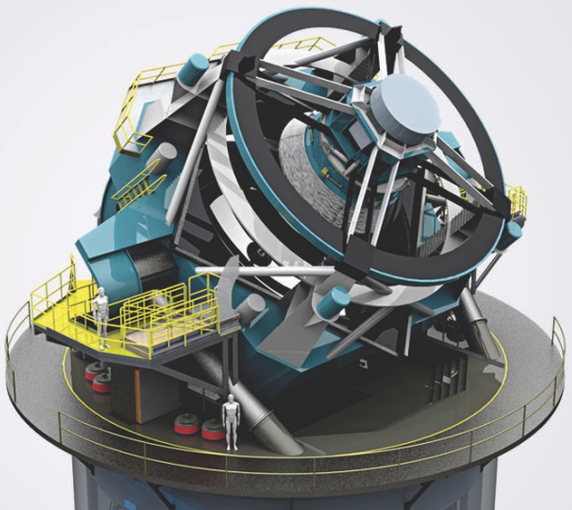
How well might the internal real/bogus routine run on deeper DDF CoAdds?

Is the alert design sufficient for fast-cadence transients? How should non-L1 alerts identify themselves?

How long can such products live on-disk?

https://community.lsst.org/t/deep-drilling-fields-and-data-management/1115

Option to contact DM and the LSST user community regarding LSST Special Programs through this Community forum.



LSST Community

Deep Drilling Fields and Data Management

Science

MelissaGraham LSST — 3 Sep '16

On behalf of the LSST Data Management team, we would like to open up this forum to discuss the processing of proposed "Deep Drilling" and/or "Mini-Survey" programs. This conversation between the science community and the LSST DM team was inspired by the breakout session on "Deep Drilling Fields and Other LSST Mini-Surveys" at the LSST Project and Community Workshop in 2016. The relevant DM-DDF issues are outlined in Gregory Dubois-Felsmann's talk from that session (available at https://zenodo.org/record/61402#.V8mcXJN96Rs 3, or from the breakout session website https://project.lsst.org/meetings/lsst2016/agenda/deep-drilling-fields-and-other-lsst-mini-surveys 5), including these questions that we encourage the community to keep in mind while designing their DDF and Mini-Survey proposals:

1. What additional processing beyond that currently planned by the DM team (alerting relative to an annually created template) would greatly enhance the DDF science goals?
2. Are there DDF or Mini-Surveys specific aspects of the Level 3 system that would add significant value if provided? "Level 3" is the LSST-provided capability that enables non-DM, user-driven, processing of LSST data at the LSST Archive center (or remotely).
3. Are there aspects of the Science User Interface & Tools (SUIT) that need to be developed in order to enhance the usefulness of DDF data products
4. To what degree should the DDF or Mini-Survey imaging could/should be incorporated into the main survey's deep stacks and associated data products (as opposed to being processed as separate data products)?

The following resources may also be of use to the community:
1. LSST Data Products Definitions Document (DPDD). http:ls.st/dpdd
2. The LSST Data Management System, Juric et al. (2015), http://arxiv.org/pdf/1512.07914v1.pdf 1

REFERENCES

PLEASE NOTE

This description of Special Programs processing is a work in progress! It will be fully determined by the time of the first call for DDF/MS proposals.

In the meantime, the DM team is open to hearing from the community how we could make this process work better for their science goals.

REFERENCES

LSST Project Website project.lsst.org
Observing Strategy White Paper github.com/LSSTScienceCollaborations/ObservingStrategy

LSST DDF Information https://www.lsst.org/scientists/survey-design/ddf
Deep Drilling Fields White Papers https://project.lsst.org/content/whitepapers32012
The 2016 LSST Project and Community Workshop project.lsst.org/meetings/lsst2016 (slides available)
"General Review of Proposed DDF/MS", Neil Brandt, LSST AHM, Aug 2016:
https://project.lsst.org/meetings/lsst2016/sites/lsst.org.meetings.lsst2016/files/Brandt-DDF-MiniSurveys-01.pdf
"Simulations, Metrics, and Merit Functions for Mini-Surveys and DDF", Steve Ridgway, LSST AHM, Aug 2016:
https://project.lsst.org/meetings/lsst2016/sites/lsst.org.meetings.lsst2016/files/Ridgway-SimulationsMetrics_1.pdf
"Draft thoughts on selecting DDFs", Beth Willman, LSST SAC Meeting, October 2016:
https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/Willman_DDF.pdf

Science Drivers to Reference Design (Ivezic et al. 2008; arXiv:0805.2366; Version 4 updated in 2014)

LSST Data Management dm.lsst.org
LSST Science Requirements (LPM-17) ls.st/lpm-17
LSST Data Products Definitions (DPDD; LSE-163) ls.st/lse-163
LSST DM Science Pipelines Design (LDM-151) ls.st/ldm-151
LSST System Requirements (LSE-29) ls.st/lse-29
Observatory System Specifications (LSE-30) ls.st/lse-30
DM Subsystems Requirements (DMSR; LSE-61) ls.st/lse-61
Level 2 Photometric Calibration (LSE-180) ls.st/lse-180

Community forum on DM concerns for Special Programs:
https://community.lsst.org/t/deep-drilling-fields-and-data-management/1115