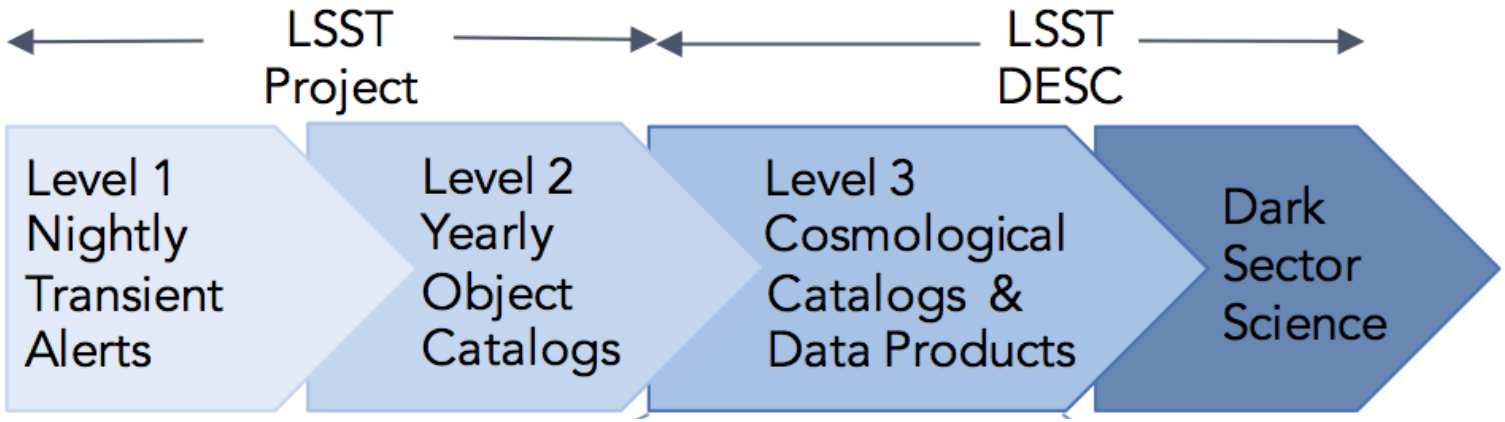
LSST DESC Overview

Rachel Bean
LSST DESC Spokesperson
rbean@astro.cornell.edu

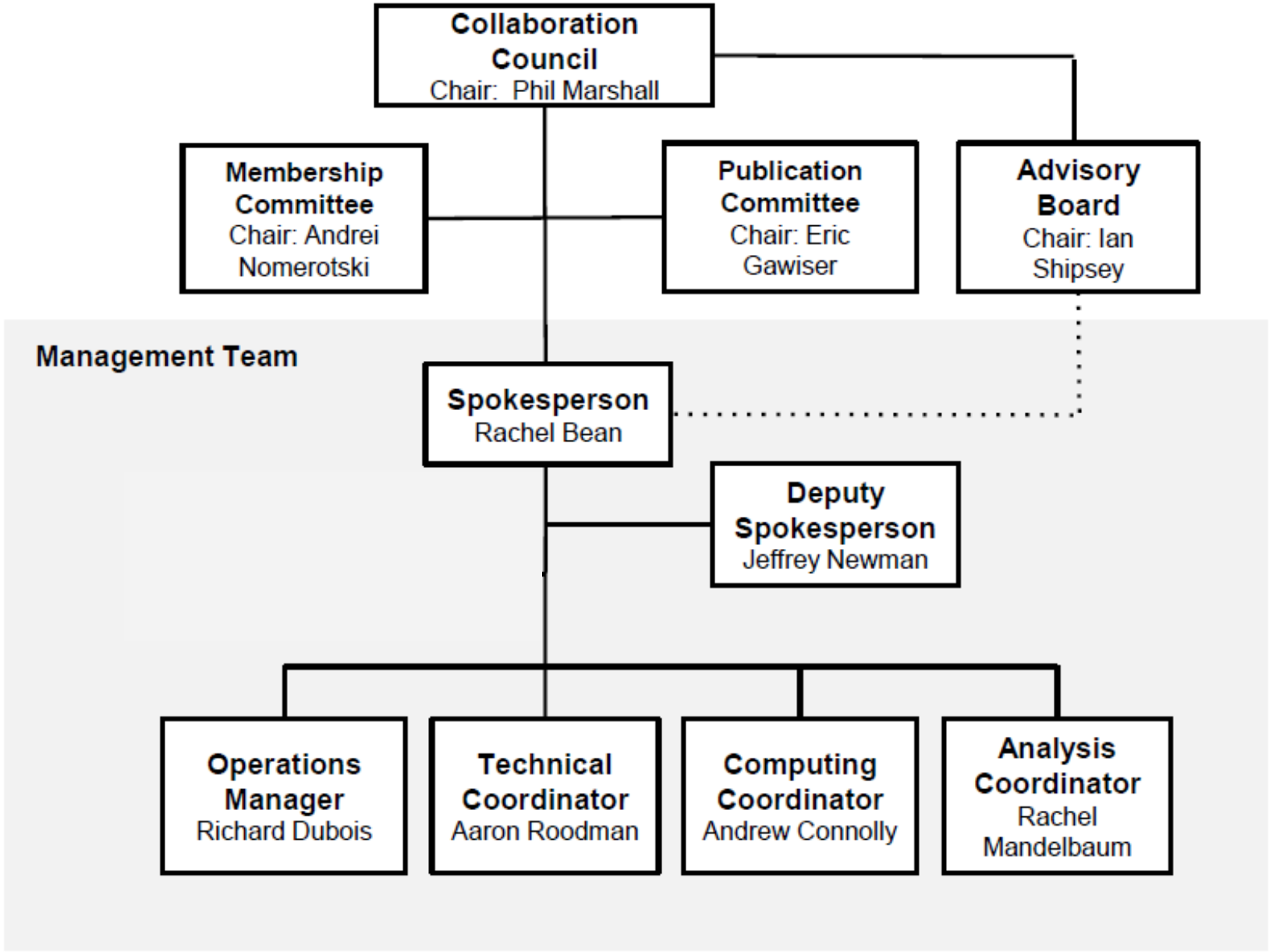
DESC Overview

- LSST Science Collaborations distinct from LSST Project
- DESC focuses on cosmological measurements related to dark energy, dark matter, neutrino mass, modified gravity, etc.



- DESC: Particle physics-style collaboration, inaugurated Summer 2012
- Now, 540 scientists from >50 institutions (~75% US; ~20% France and UK, and growing); with 160 Full Members who've made firm commitments of effort

Organization Structure



Science Working Group Leadership Team

Collaboration Council Chair	Phil Marshall
Spokesperson	Rachel Bean
Deputy Spokesperson	Jeff Newman

Analysis Team *Coordinator: Rachel Mandelbaum*	
Working Group	**Conveners**
Clusters	Anja von der Linden Ian Dell'Antonio
Large Scale Structure	Eric Gawiser Anze Slosar
Photometric Redshifts	Ofer Lahav Sam Schmidt
Strong Lensing	Chris Fassnacht Phil Marshall
Supernovae	Renee Hlozek Saurabh Jha
Theory/ Joint Probes	Elisabeth Krause Andrew Zentner
Weak Lensing	Joe Zuntz Michael Schneider

Computing & Software Infrastructure Team *Coordinator: Andrew Connolly*	
Working Group	**Conveners**
Cosmological Simulations	Katrin Heitman Simon Krughoff
Survey Simulation	John Peterson Chris Walter
Computing Infrastructure	Scott Dodelson Richard Dubois

Technical Team *Coordinator: Aaron Roodman*	
Working Group	**Conveners**
Sensor Anomaly	Pierre Astier Andrei Nomerotski
Photometric Calibration	Eli Rykoff Nicolas Regnault

Building the pipeline in advance of first light. Why?

- **To enable the agile delivery of results**:
  - LSST, has no proprietary period, DESC needs to be ready to both ensure accurate results and make sure they are delivered in a timely fashion.

- **Address systematics mitigation in advance of data releases:**
  - Experience has demonstrated that it is essential to have analysis pipelines in place in advance of the first data to be able to effectively identify and mitigate systematic effects.

- **Provide feedback to the Project e.g. survey strategy & data mgt.:**
  - DESC pre-commissioning work will feed back lessons learned back to Project to help shape the LSST survey design and the data products.

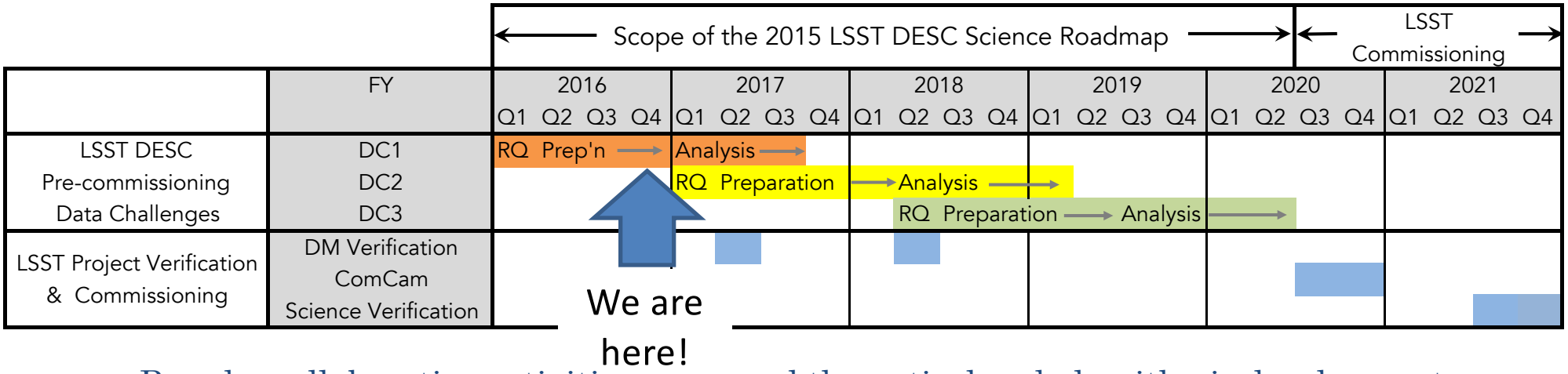
- **Make blind analyses possible:**
  - By constructing and validating pipelines in advance of survey start, blind analyses can be conducted, removing risks of confirmation bias.

Pre-Commissioning Focus

- Build and test/validate the DESC analysis pipeline and its interface with Project data management/delivery pipeline for each science probe

- Use both DESC-generated simulated and Project processed real datasets
  - 3 simulated data challenges (DC1-DC3) provide the validation framework
  - LSST Project pre-commissioning datasets : test pipeline and build interface with Project

- 2015 DESC Science Roadmap (SRM) lays out tasks
  - http://lsst-desc.org/sites/default/files/DESC_SRM_V1.pdf
  - Tasks span multiple working groups and are currently underway



- Broader collaboration activities: e.g. novel theoretical and algorithmic developments and cross-correlation with non-LSST datasets.

2015 DESC Science Roadmap (SRM)

- Lays out WG key projects, deliverables and individual tasks to meet them

DC1 & DC2 Key Project **LSS1**: Preliminary Code for Measuring Power and Cross-power Spectra

LSS1.1 – DC1 SW: Write preliminary flat-sky power spectrum measurement code 06/16

LSS1.2 – DC2 SW: Exte

LSS1.3 – DC2 SW: Exte

DC1 & DC2 Key Project **LS**

LSS2.1 – DC1 RQ: LSS

LSS2.2 – DC1 SW: LSS

LSS2.3 – DC1 VA: Analy

LSS2.4 – DC2 RQ: Prop

LSS2.5 – DC2 RQ: LSS

LSS2.6 – DC2 SW: Dete

LSS2.7 – DC2 VA: Analy

LSS2.8 – DC3 RQ: LSS

DC1 & DC2 Key Project **LS**

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LSS3.1 – DC1 SW: Crea

LSS3.2 – DC1 VA: Valid

DC1 Key Project **WL1**: Requirements on shear estimation

WL1.1 – DC1 SW: Softwa

WL1.2 – DC1 SW: Build a

WL1.3 – DC1 DP: Create

WL1.4 – DC1 RQ: Feedba

WL1.5 – DC1 SW: Null te

DC1 Key Project **WL2**: Syste

WL2.1 – DC1 RQ: System

WL2.2 – DC1 SW: Two-p

WL2.3 – DC1 SW: Model

WL2.4 – DC1 SW: Model

WL2.5 – DC1 SW: Model

DC2 Key Project **WL3**: Imag

WL3.1 – DC2 RQ: Set req

WL3.2 – DC2 DP: Precurs

WL3.3 – DC2 SW: Pipelin

WL3.4 – DC2 SW: Selecti

WL3.5 – DC2 SW: Softwa

WL3.6 – DC2 DP: Shear c

DC1 Key Project **CI1**: Estimate Resource Needs and Recommend the Host for DESC Computing Resources

CI1.1 – DC1 RQ: Estimate CPU and disk space requirements 12/15

CI1.2 – DC1 RQ: Recommend the Computing Resource Host 1/16

DC1 Key Project **CI2**: Define the Initial Elements of the Software Framework

CI2.1 – DC1 RQ: Software Framework Implementation 02/16

CI2.2 – DC1 RQ: Distributed Code Development Environment 2/16

CI2.3 – DC1 RQ: Workflow & Data Management Tools 02/16

DC1 Key Project **CI3**: Targeted Frameworks for Use by the Analysis Working Groups

CI3.1 – DC1 SW: A framework for Twinkles light curve generation (Key Project **DG2**) 06/16

CI3.2 – DC1 RQ: Develop a framework for **CX4** with the TJP WG 06/16

DC1 Key Project **CI4**: Develop a Distributed Code Development Environment

CI4.1 – DC1 SW: Produce an initial development environment 01/16

CI4.2 – DC1 SW: Augment the development environment 06/16

DC2 Key Project **CI5**: Post-DC1 Requirements of the Software and Computing Environment

CI5.1 – DC2 RQ: Updated Requirements for a DESC Software Framework 06/17

DC2 Key Project **CI6**: Develop the WL Framework to handle DC2-level requirements.

CI6.1 – DC2 SW: The WL Shear Pipeline in the Software Framework 06/18

Implementation

- Cross-Working Group collaboration
  - Taskforces
  - Simulations: joint efforts by computing/technical and analysis WGs

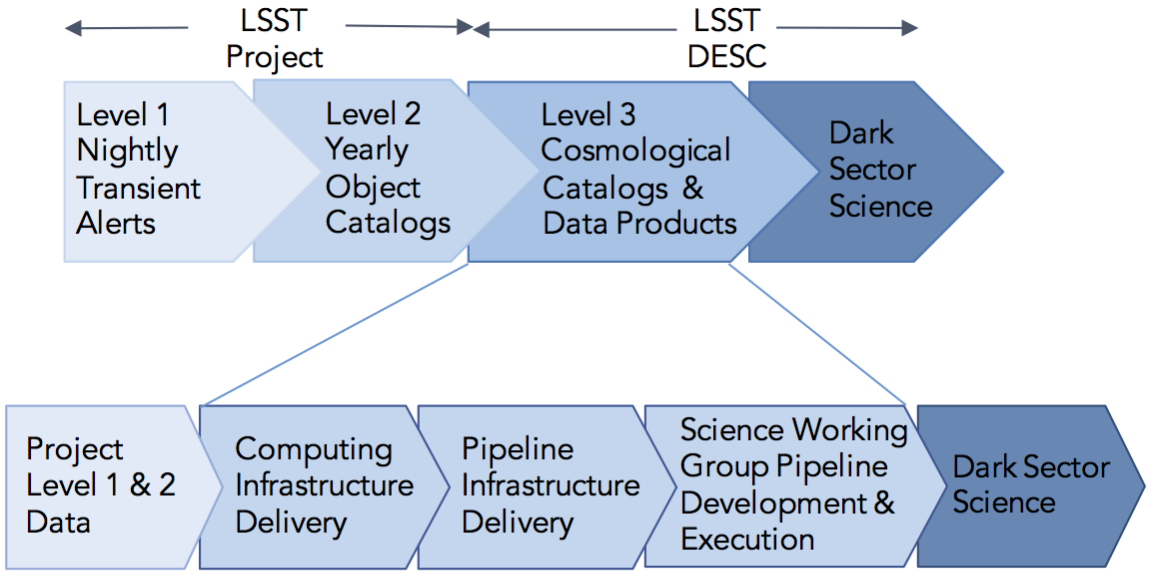
- Leveraging international collaboration
  - Coordination on research, operations
  - Utilization of computing resources
  - Experience and lessons learned from current surveys

- Promoting broad and diverse participation, reflected in many aspects
  - Junior DESC Organization (JuDO)
  - Spokesperson, coordinator and WG lead roles
  - Policies and Practices: Membership and Governance; Publication; Professional Conduct and Meetings

- Connections/coordination across surveys: Euclid, WFIRST, tri-agency

DESC Operations

- Well-planned research *and* operations effort crucial to enable delivery of the dark energy science
  - DESC is seeking DOE operations support to ensure science return on camera investment.



- DESC has been working with the DOE over the last year develop coherent operations plan and governance structure
  - SLAC serves as the DOE Host Lab (Richard Dubois – Ops Manager).
  - Operations support will be located at DOE Labs and DESC university groups.
  - Initial version currently undergoing SLAC review.

LSST DESC Communication

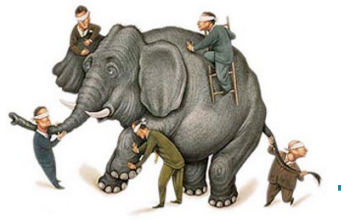
- Communication is essential given distributed science team and separation of DESC and LSST Project.

- DESC uses confluence and github to share information as well as our website to share information about DESC with the public.

- DESC uses a number of methods to maintain an effective interface with the Project at multiple levels:
  - LSST Chief Scientist, Tony Tyson, serves as the formal point of contact for DESC to facilitate coordination between DESC and the Project.
  - DESC Project Liaisons provide formal connections to the LSST Camera (Steve Ritz) and Data Management (Mario Juric and Robert Lupton).
  - DESC Spokesperson coordinates with the LSST Science Collaborations Coordinator, Lucianne Walkowicz on science collaboration wide issues
  - LSST community Slack communication tools and lsst.community.org will facilitate and store conversations within DESC and between DESC, the Project and the LSST broader science collaboration community.

- DESC Liaisons with other projects (WFIRST, Euclid, DES, DESI…) part of the DESC leadership team (attend leadership telecons).

Multiple surveys will give a richer picture

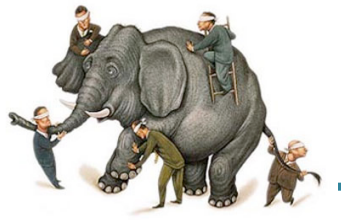


- Trade offs/complementarity in
  - Probes (SN Ia, BAO, RSD, WL, Clusters + lensing, motions, positions)
  - Photometric speed vs. spectroscopic precision
  - Survey area vs depth - repeat imaging, dithering, cadence and overlap.
  - Astrophysical tracers used (LRGs, ELGs, Lya/QSOs, clusters)
  - Epochs, scales and environs being studied (cluster vs. dwarf galaxies)

- Complementarity sensitivity to systematic errors
  - PSF (atmospheric/chromatic effects)
  - Overlapping survey area, at differing depths and wavelengths

- Cross-correlation science
  - Weak lensing + spectroscopic galaxy clustering => gravitational slip
  - CMB +LSS cross-correlations => mitigates lensing bias/contamination and yields additional cosmological science

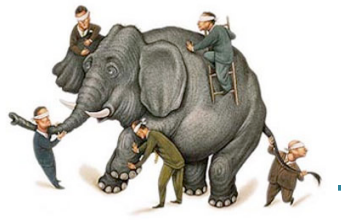
Survey complementarity at a glance



(based on publicly available data)

Stage IV	LSST	WFIRST	Euclid	DESI
Starts, duration	2020, 10yr	~2025, 5-6 yr	2020 Q2, 6.25yr	~2018, 5 yr
Area (deg^2)	20,000 (S)	2,400 (S)	15,000 (N + S)	14,000 (N)
FoV (deg^2)	10	0.281	0.53	7.9
Diameter (m)	6.7	2.4	1.3	4 (less 1.8+)
Photometric galaxies (per sq arcmin)	~30 over 6 bands (ugrizy)	68, in 3 bands into near IR	~30-35, in one broad optical + IR band	
SN1a	10^4-10^5 SN1a/yr z = 0.–0.7 photometric	2700 SN1a z = 0.1–1.7 IFU spectroscopy		
Spectroscopic Survey		Grism R=550-800 1.35-1.95 mm	Grism R=250 1.1-2 mm	Fibers R=3-4000) 360-980 nm
Sample		ELGs: z =1-2 (20m), 2–3 (2m)	ELGs: z~0.7-2.1 (~20m)	LRGs+ELGs z~0.6-1.7 (20-30m), QSOs/Lya 1.9<z<4 (1m)

To conclude



- LSST DESC will use multiple LSST probes to discern the properties of dark energy and gravity on cosmic scales

- DESC is actively preparing now for the cosmological analysis of LSST data
  - Substantial pipeline capabilities and efficiencies need be completed and validated prior to LSST commissioning to fully realize LSST's dark sector science potential in a timely fashion.

- Putting in place practice (& policies) to build scientific team which fully utilizes diverse, international expertise: junior and senior, from HEP and astro, and has strong communication with LSST Project.

- Coordination across surveys (Euclid and WFIRST key to this) invaluable
  - Complementary sensitivity to the fundamental physics & systematics
  - Communication (to a TBD degree) on survey strategy, simulations, data processing