

1

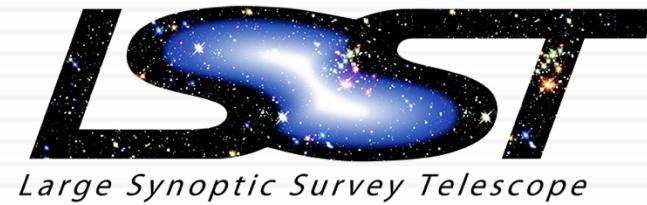
LSST: project status

Jérémie Neveu - Université Paris-Sud - IN2P3/LAL

on behalf of the LSST/DESC collaborations

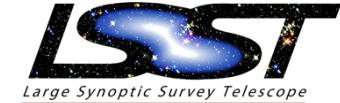


Jérémie Neveu - LAL



EPS-HEP 2017 - Venezia 07/07/2017

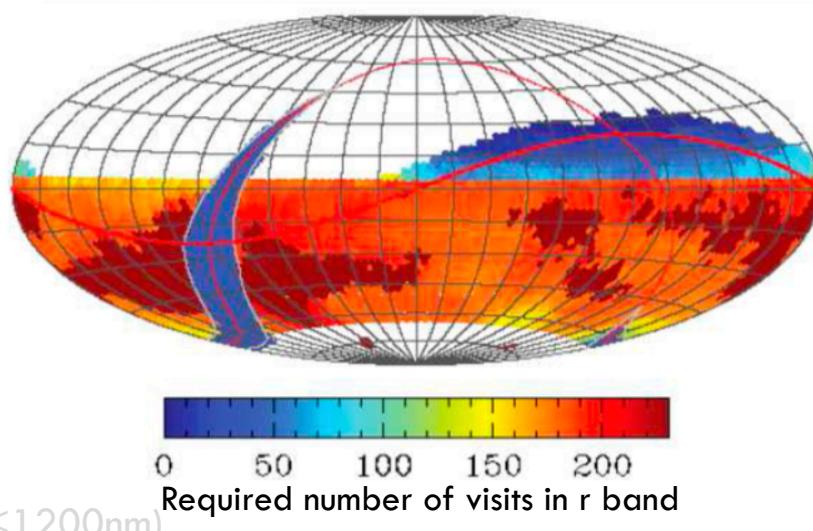
LSST project



2

□ Large :

- all the austral sky every 3 days
- up to magnitude $r < 27.5$



1000 visits for each sky region

□ Synoptic :

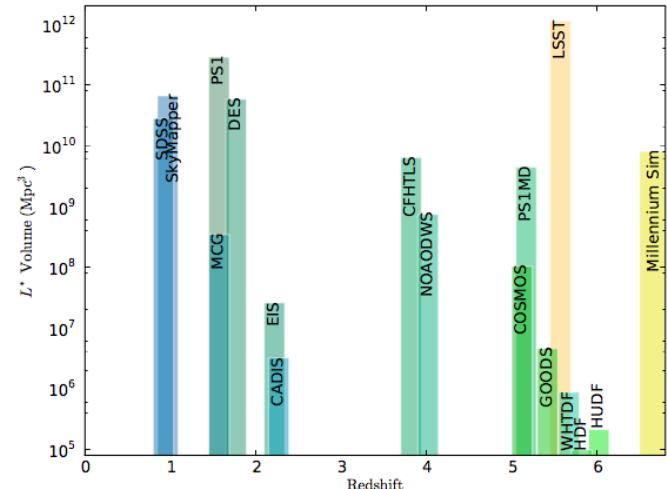
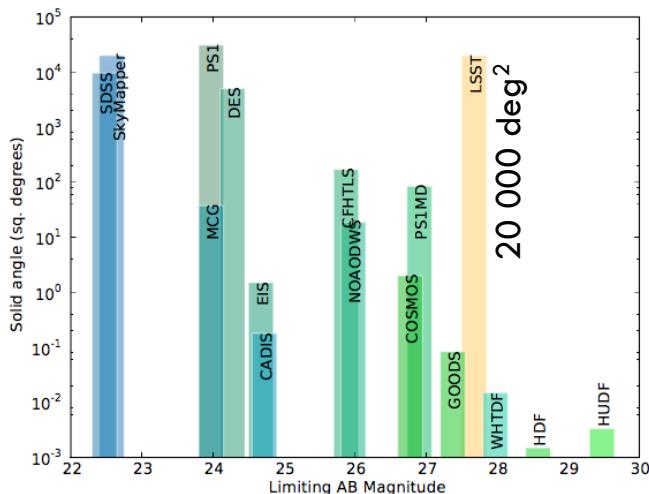
- “taking a general view of the prism”
- multi-probes and science goals
- 6 broad bandpass filters ($350 < \lambda < 1200\text{nm}$)

□ Survey :

- wide field camera
- robot and data

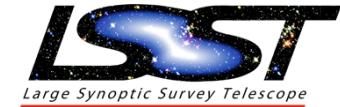
□ Telescope :

- ground-based instrument
- 8.4m diameter
- 10 years operation



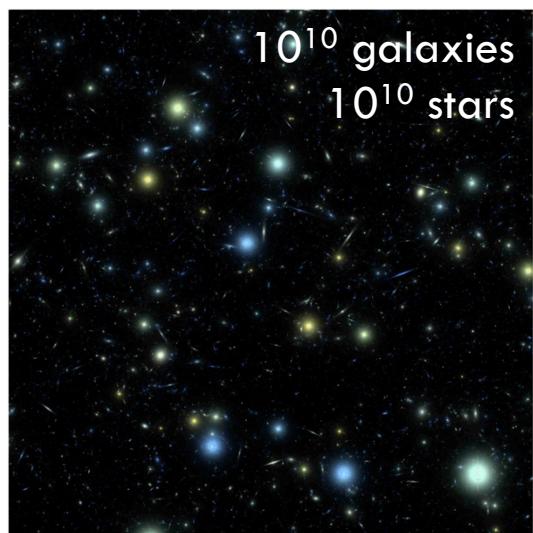
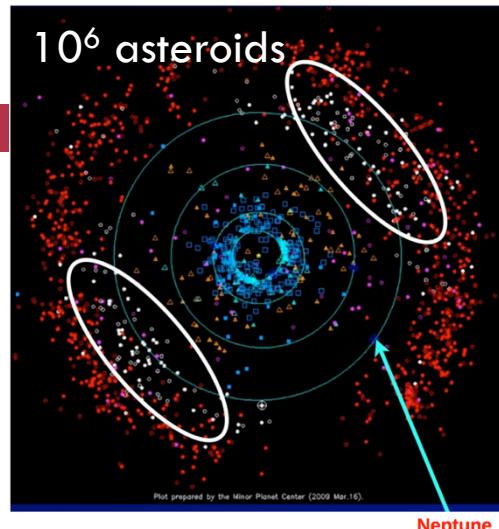
LSST project

3



□ Large :

- all the austral sky every 3 days
- up to magnitude $r < 27.5$

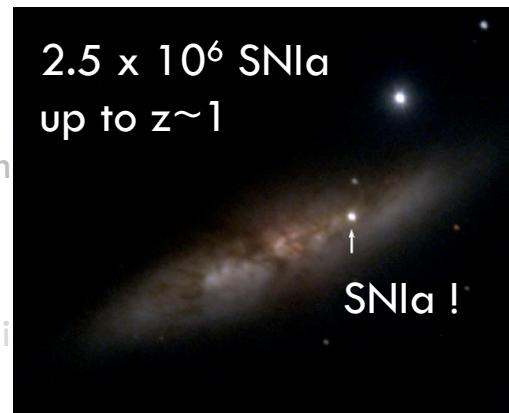


□ Synoptic :

- “taking a general view of the principal parts of a subject.”
- multi-probes and science goals
- 6 broad bandpass filters ($350 < \lambda < 1200\text{nm}$)

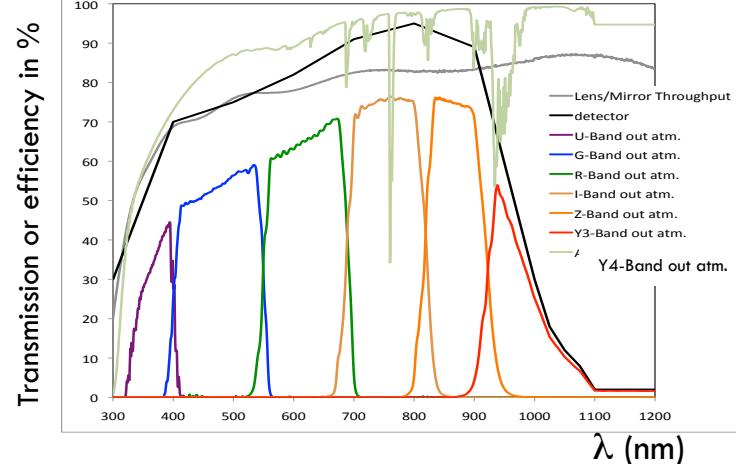
□ Survey :

- wide field camera
- robot and data man

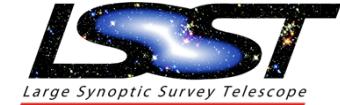


□ Telescope :

- ground-based in Chi
- 8.4m diameter
- 10 years operation



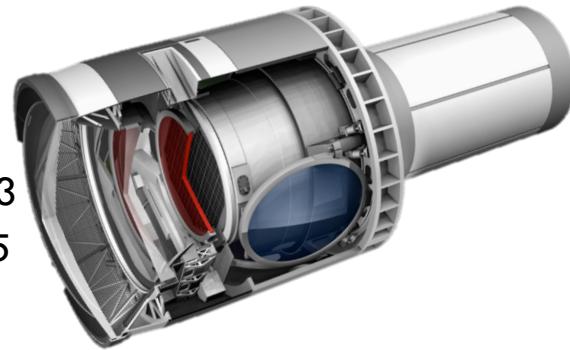
LSST project



4

□ **L**arge :

- all the austral sky every 3
- up to magnitude $r < 27.5$



□ **S**ynoptic :

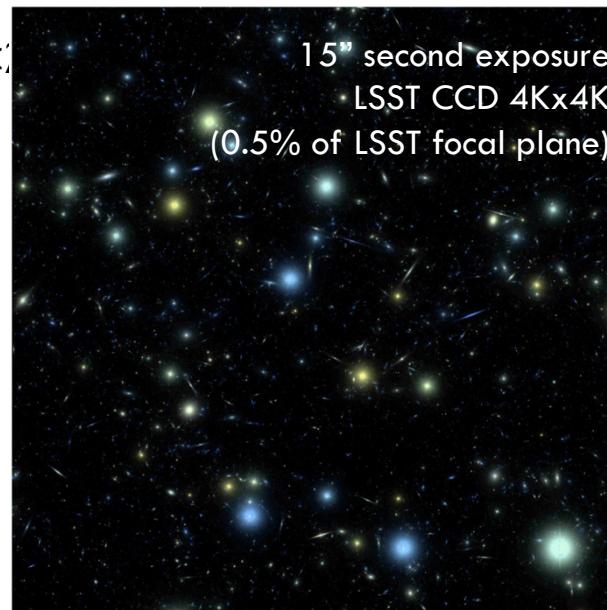
- “taking a general view of the principal parts of a subject.”
- multi-probes and science goals
- 6 broad bandpass filters ($350 <$

□ **S**urvey :

- wide field camera of 3.2 Gpix
- robot and data management

□ **T**elescope :

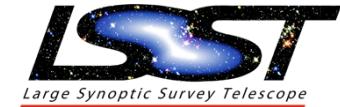
- ground-based in Chili
- 8.4m diameter
- 10 years operation



X 189 for one picture
= 15 TB/night
= 500 PB in 10 years
+100 PB catalogue

LSST project

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□ Large :

- all the austral sky every 3 days
- up to magnitude $r < 27.5$

□ Synoptic :

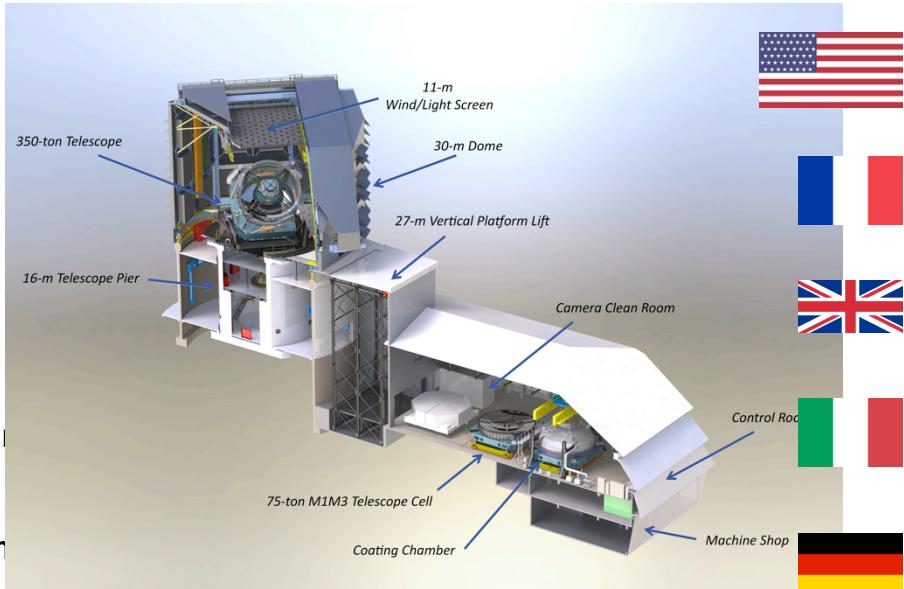
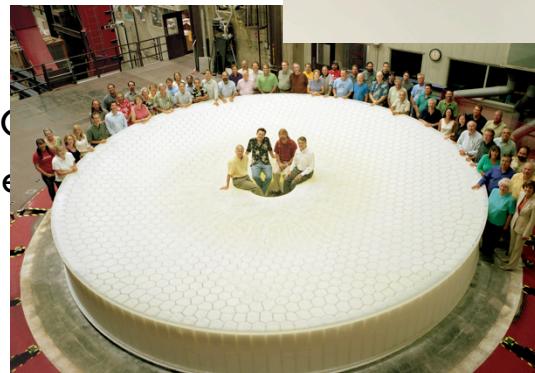
- “taking a general view of the principal parts of the sky”
- multi-probes and science goals
- 6 broad bandpass filters ($350 < \lambda < 1200$ nm)

□ Survey :

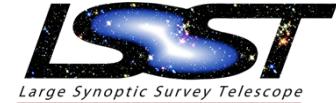
- wide field camera of 3.2 GigaPixels
- robot and data management

□ Telescope :

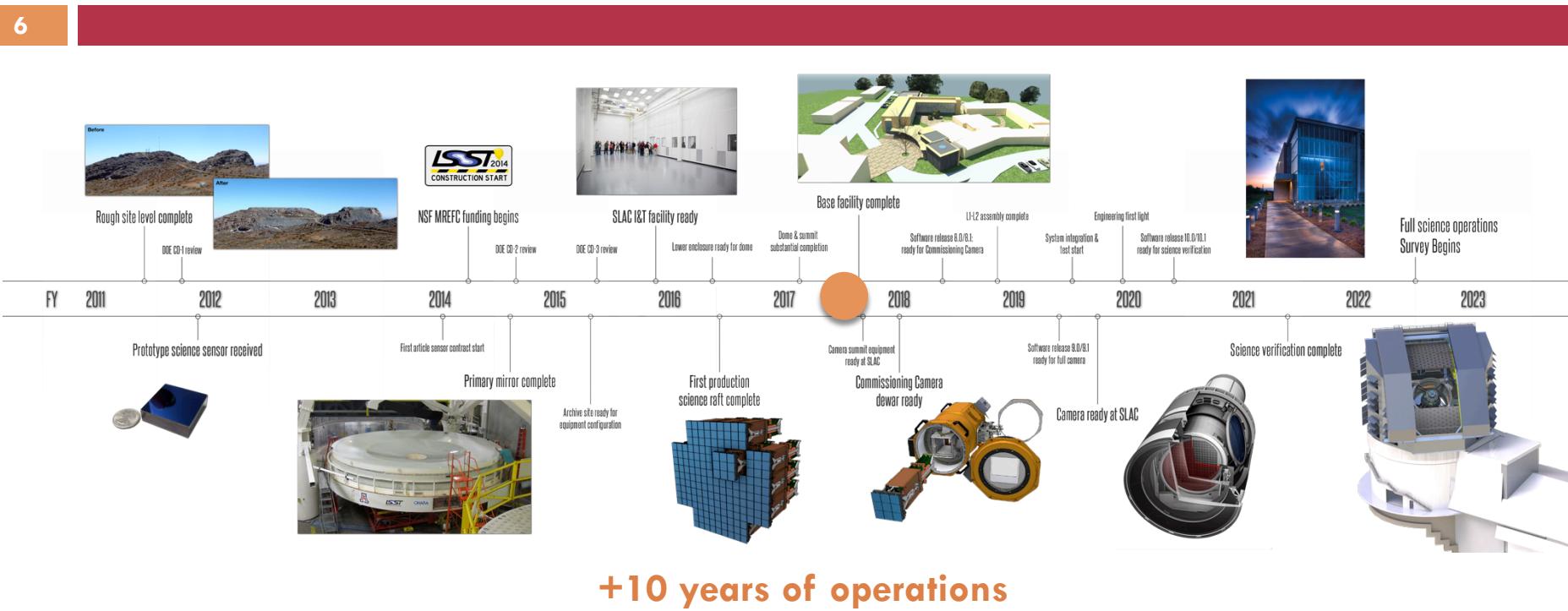
- ground-based in Chile
- 8.4m diameter
- 10 years operation



LSST project: timeline



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Future milestones

First calibration data from Auxiliary Telescope



Completion date

August 2018

First on-sky and calibration images with ComCam

February 2020

First on-sky and calibration images with Camera+Telescope

November 2020

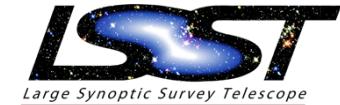
Start Science Verification mini-Surveys

March 2021

Start of the Science Program

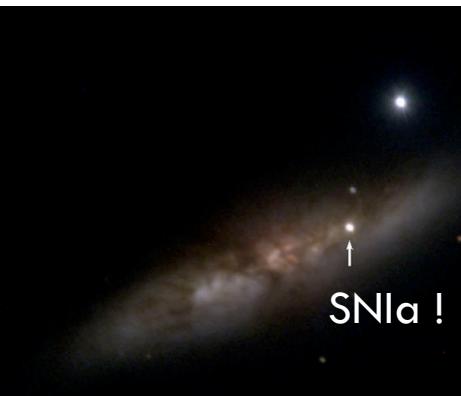
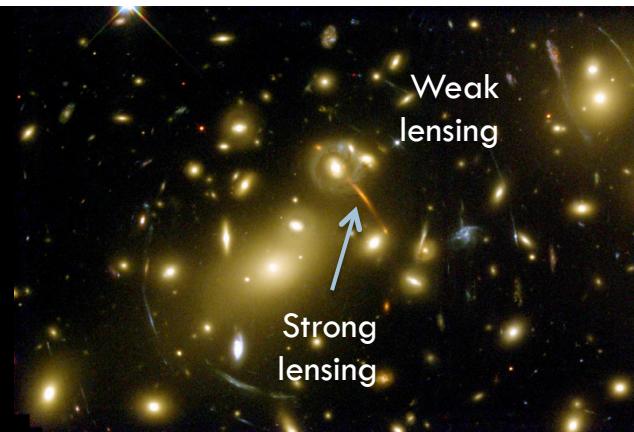
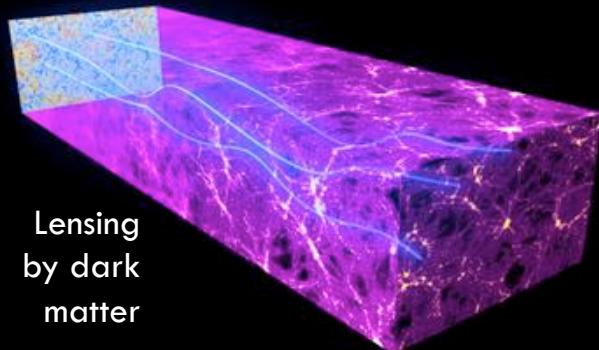
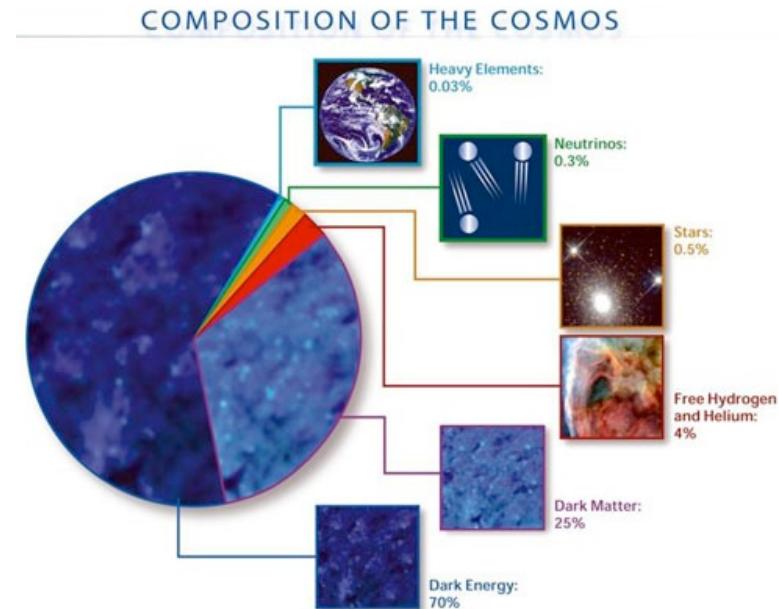
November 2022

LSST project: cosmology

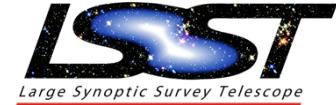


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- Dark energy equation of state parameter constraints
- Dark matter mapping and constraints
- Multi-probe instrument:
 - Large scale structures, weak/strong lensing, SNIa
 - Cross-correlations between them
- LSST cosmological community organised within the DESC collaboration



DESC collaboration



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- Dark Energy Science Collaboration: subgroup of LSST project preparing a variety of cosmological analyses to carry out within the future LSST survey
- 580 Members with 170 Full Members organized by:
 - Governance Plan, Collaboration Council, Publication Policy, etc...
 - [Science Road Map](#) and [White Paper](#) [[arXiv:1211.0310](#)]
- 2 annual collaboration meetings + hack weeks, etc...

Working groups

Main science probes: Weak lensing, Large Scale Structures, Clusters, Strong Lensing, Supernovae, Theory & Joint Probes

Software: Simulations, Computing

Technical: Sensor anomalies, Photometric corrections

Data challenges

DC1: 2016/2017

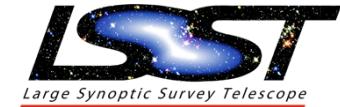
DC2: 2017/2018

DC3: 2018/2019



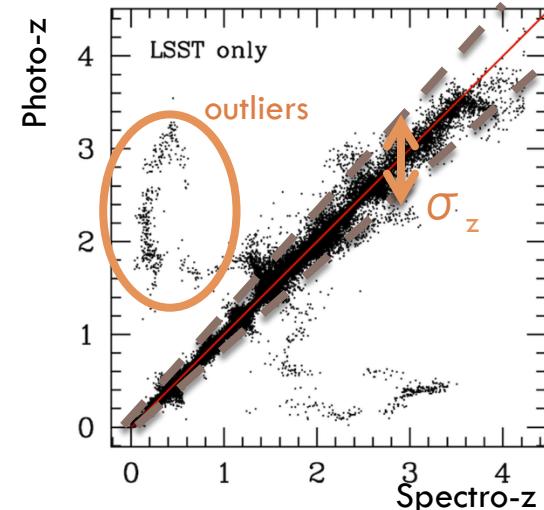
- List of public software repositories : <https://github.com/LSSTDESC>

Photometric redshifts

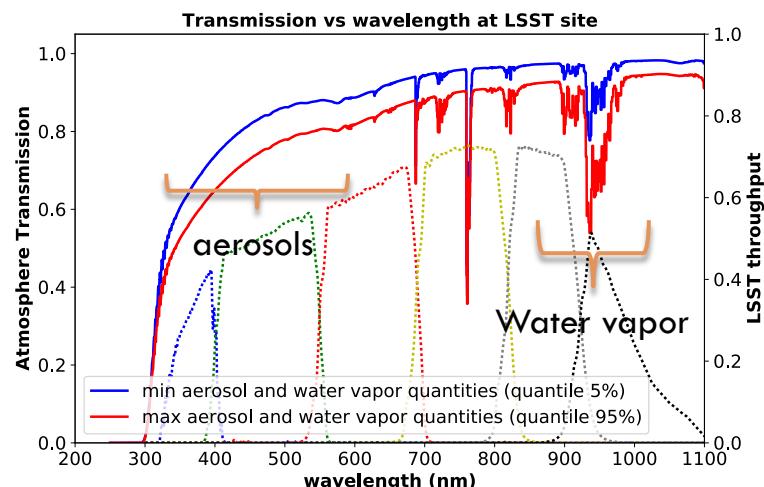


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- Key requirements for all the cosmological probes:
 - $\sigma_z/(1+z) < 0.05$ with a goal of 0.02
 - 3σ outlier fraction below 10% at all z
 - Redshift bias < 0.003
- DC1 (very) preliminary result: $\sigma_z/(1+z) < 0.02$ achievable using known SEDs and first pipelines
- Need for a complete and large spectroscopic galaxy sample to train the color-redshift relationship (DESI southern observations ?)
[Newman et al., arXiv:1309.5384]
- Photometric calibration:
 - Studies to account for local atmospheric conditions on photometry
 - Use of Gaia star catalog ?

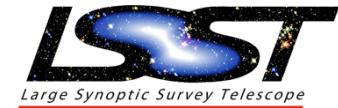


[Jain et al., arXiv:1501.07897]



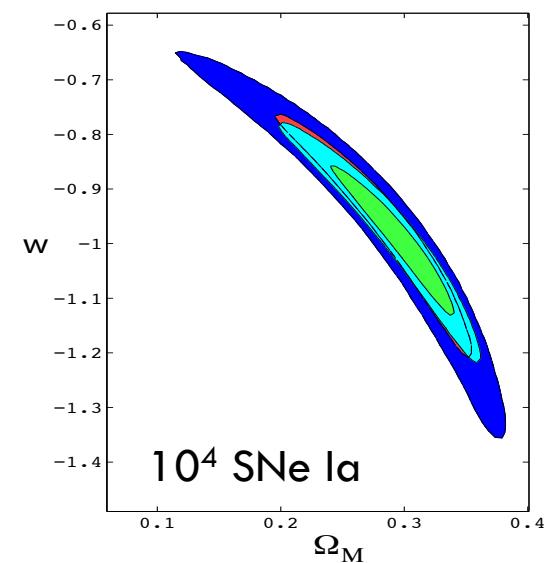
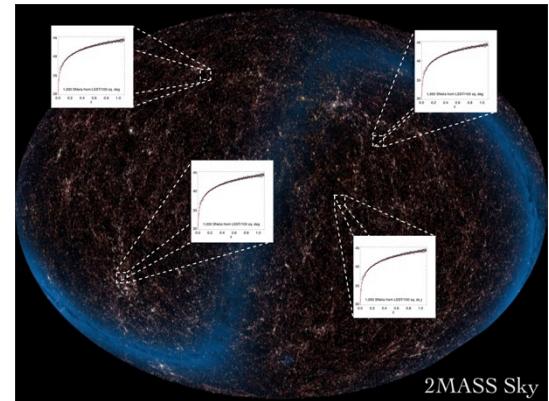
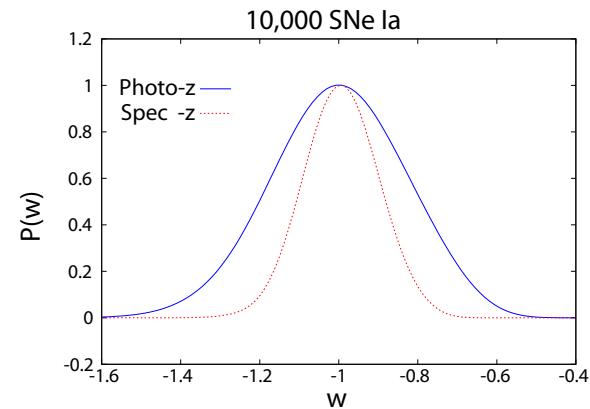
[S. Dagoret-Campagne courtesy]

Supernovae

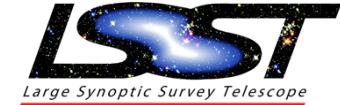


10

- 10^6 supernovae expected, 10^5 well measured for cosmology, from $0.1 < z < 1.2$
 - Only a small fraction with spectroscopic redshifts
- Tests of homogeneity and isotropy
- Detailed investigation of the influence of galaxy type, environment and SNIa evolution as a function of redshift
- SNe Ia BAO reconstruction

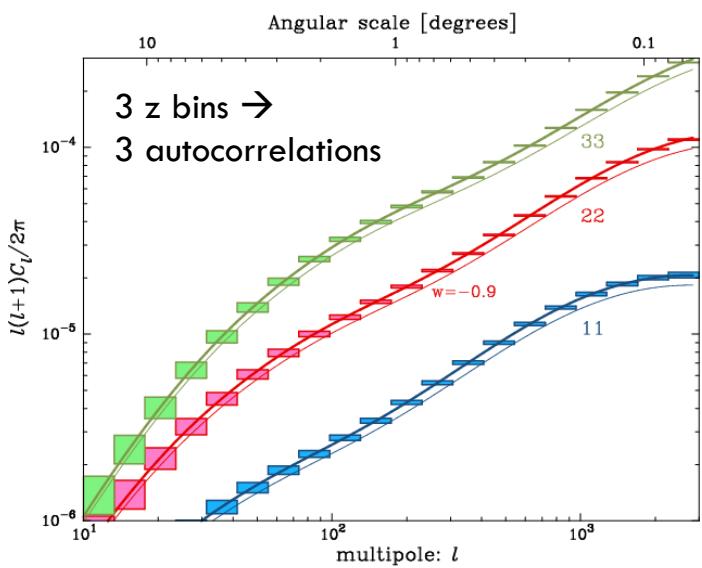
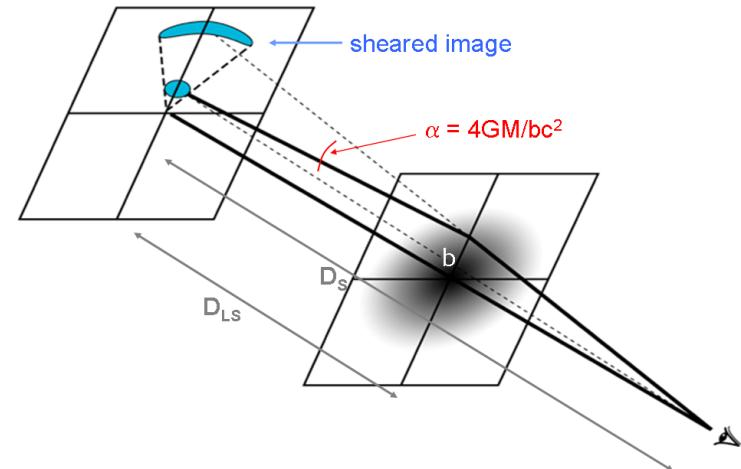


Weak lensing

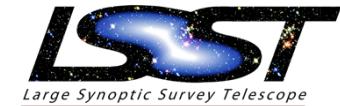


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- Different and complementary lensing objectives:
 - Galaxy-galaxy lensing: direct probe of DM halos
 - Stellar mass functions
 - Halo ellipticities
 - Galaxy clusters: cluster physics and growth of structures
 - Magnification lensing
- Shear map correlations:
 - Two-point correlations: auto and cross-correlations of tens of shear maps from different redshift bins ($0 < z < 3$) → **redshift tomography**
 - Three-point correlations: supplementary information than $P(k)$, control of systematics
- Main systematics:
 - PSF: bias, small-scale variations, wavelength dependence
 - Star/galaxy separation
 - Photometric redshift estimation



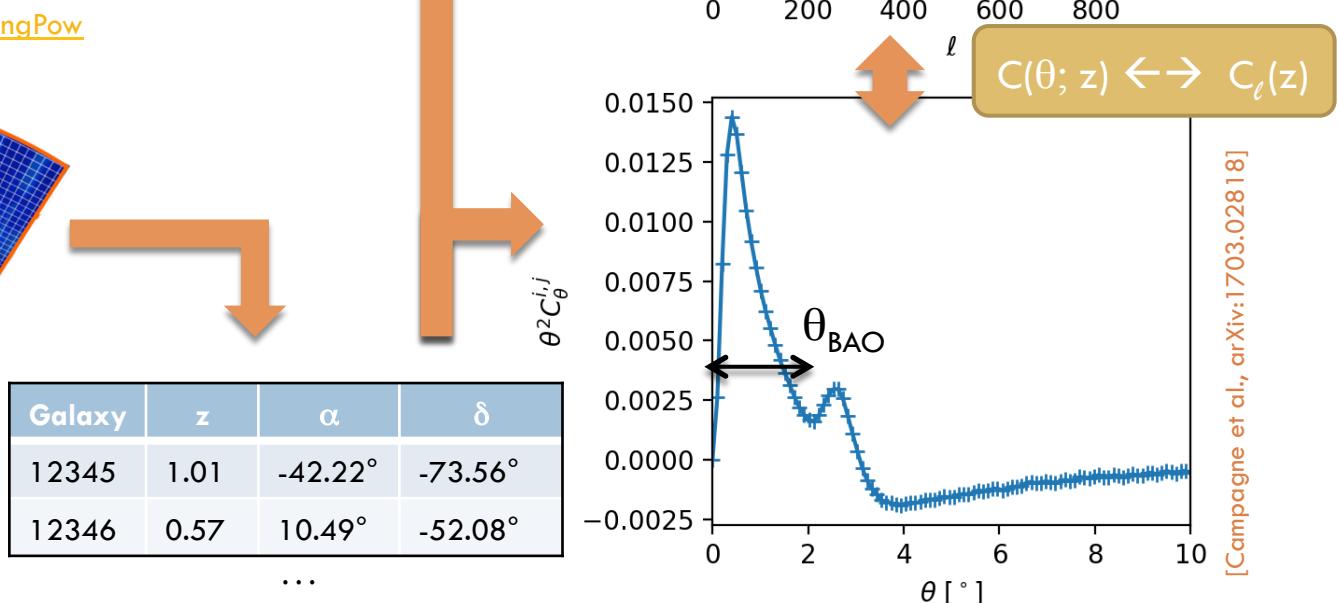
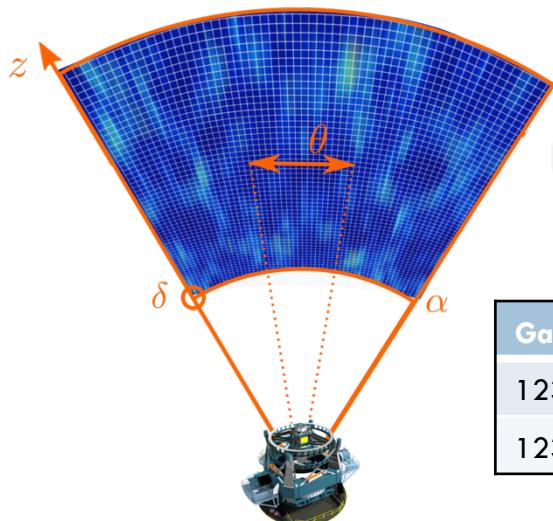
Large Scale Structures



12

- Galaxy distribution in half a sphere
- LSS information directly from observable space:
 - In angular space or multipole space
 - Bins of redshifts: auto and cross correlations
- Pipelines under construction
- Angpow code to produce the observables

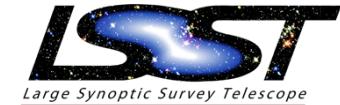
<https://gitlab.in2p3.fr/campagne/AngPow>



[Campagne et al., arXiv:1703.02818]

[Campagne et al., A&A 602, A72 (2017)]

CCL project



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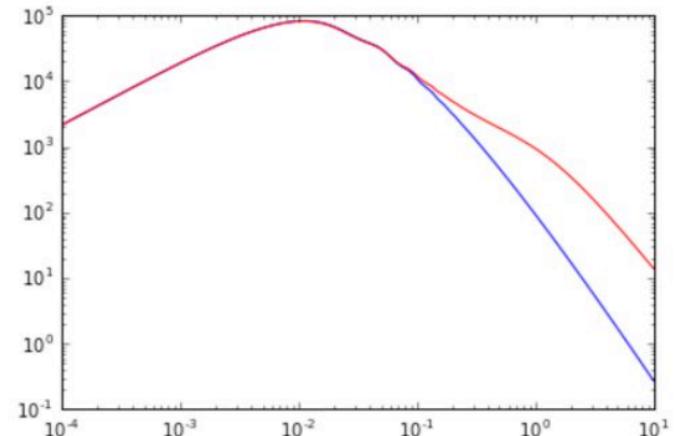
- Core Cosmological Library
 - Framework in C to compute cosmological observables
 - Well-documented **accuracy**
 - **Consistent** with other cosmological codes
 - Well-documented code
- Common and validated tool for all working groups
- Interfaces with CLASS and Angpow
- Python wrapper pycccl
- Successful collaborative effort of more than 10 people from DESC
- Public release soon...

```
In [5]: k = np.logspace(-4., 1., 100) # Wavenumber  
a = 1. # Scale factor
```

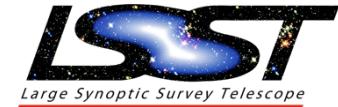
```
In [6]: pk_lin = ccl.linear_matter_power(cosmo, a, k)
```

```
In [7]: pk_nl = ccl.nonlin_matter_power(cosmo, a, k)
```

```
In [8]: plt.plot(k, pk_lin, 'b-')  
plt.plot(k, pk_nl, 'r-')  
plt.xscale('log')  
plt.yscale('log')  
plt.show()
```

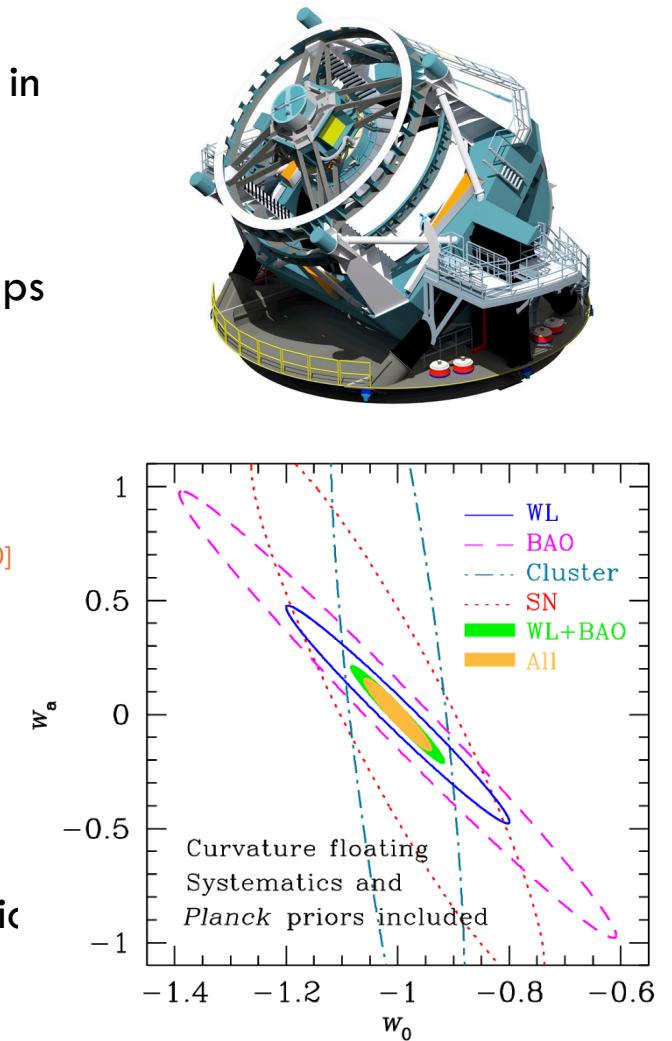


Conclusions

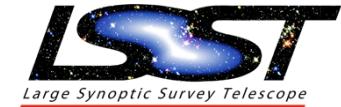


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- Construction on time: starting of the science program in 2022 after a year of calibration and tests
- Multi-probe instrument:
 - Cross-correlations between shear and galaxy maps (e.g. [McLeod et al., arXiv:1612.00307] [Nicola et al., arXiv:1607.01014])
 - Control of the systematics (bias, photo-z, etc...) (e.g. [Rhodes et al., arXiv:1309.5388])
- LSST and DESC white papers [arXiv:0912.0201] [arXiv:1211.0310]
- VIRGO/LIGO/SVOM/LSST synergies for transient research and analysis
- Euclid, WFIRST and SKA synergies: better photometric redshifts, controlled systematics...



DESC and LSST



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