

# Cosmic Vision: Dark Energy

## A Brief Introduction

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Cosmic Surveys 2016, Chicago

# Cosmic Visions –Dark Energy

## Cosmic Visions Dark Energy group:

Established by DOE in August 2015:

Scott Dodelson (Chair), Katrin Heitmann, Chris Hirata, Klaus Honscheid,  
Aaron Roodman, Uros Seljak, Anze Slosar, Mark Trodden.

## Process:

Weekly telecons between August 2015 and January 2016

Attended DESI and LSST DESC Collaboration Meetings

Organized three workshops held to gather input for the three white papers:

- Brookhaven, October 1, 2015. Agenda and slides available at <https://indico.bnl.gov/categoryDisplay.py?categId=124>
- Fermilab, November 10, 2015. Agenda and slides available at <https://indico.fnal.gov/conferenceOtherViews.py?view=standard\&confId=10639>
- SLAC, November 13, 2015. Agenda and slides available at <https://indico.fnal.gov/conferenceDisplay.py?confId=10842>

Face-to-Face meeting at Fermilab in January 2016

Three whitepapers submitted to DOE

Two papers were submitted to the arXiv: 1604.07626 and 1604.07821

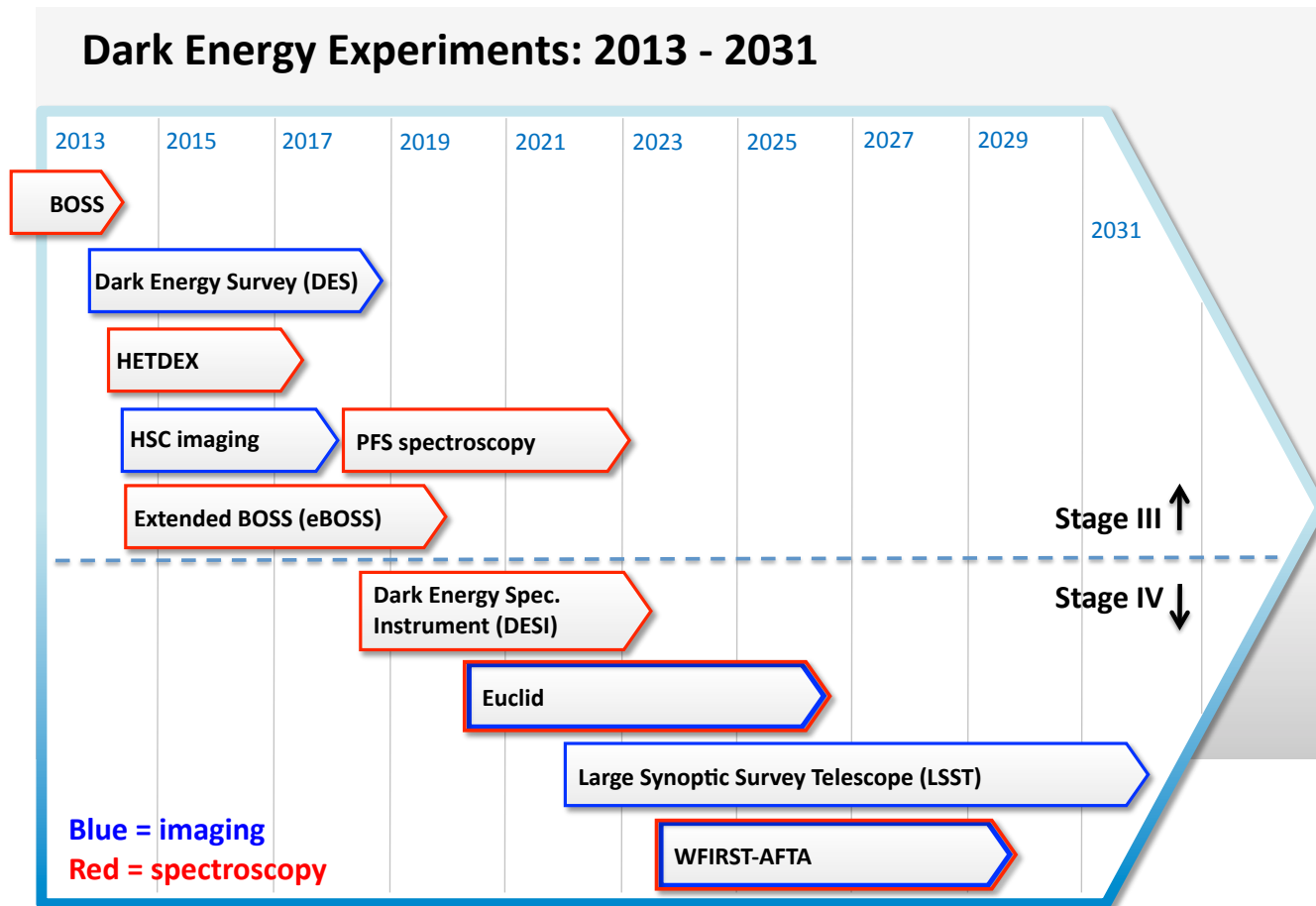
## Workshops:

Low-resolution spectroscopy workshop at Fermilab (February)

SSSI Workshop at ANL (September)

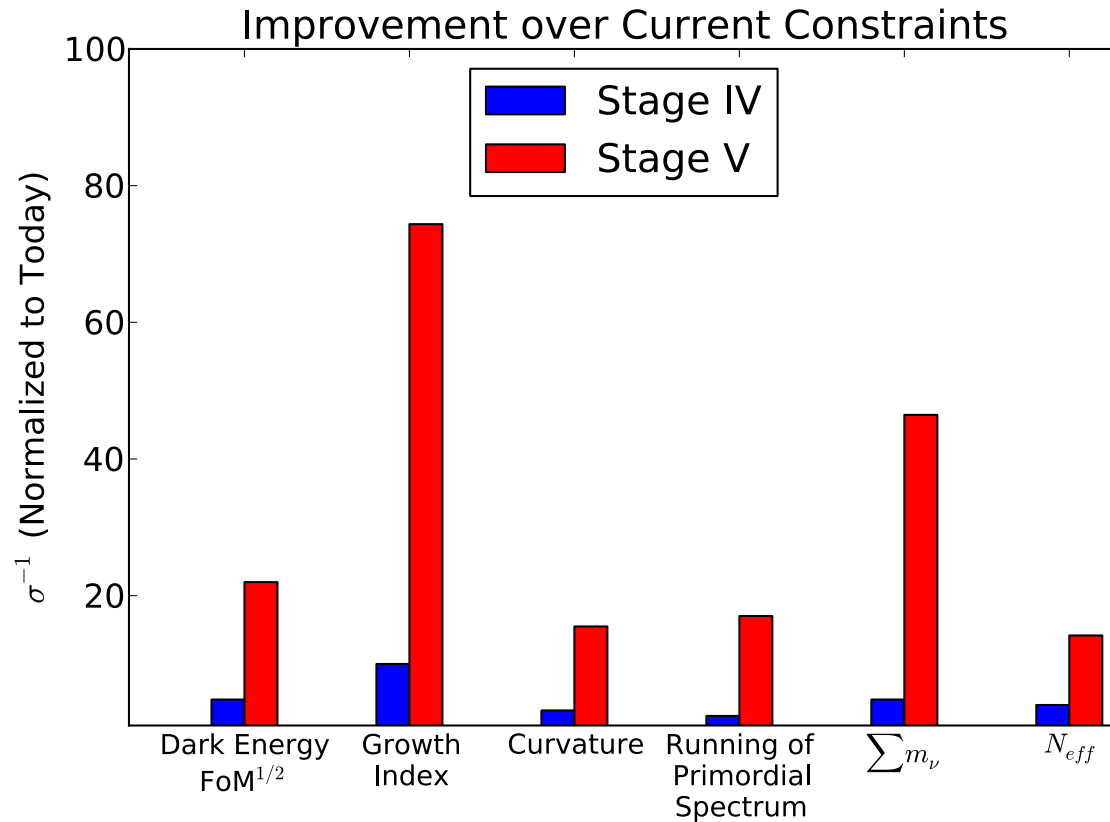
Cosmic Surveys 2016 Chicago

(A) The roadmap for cosmic surveys is very well defined.  
Since Snowmass: LSST, DESI, WFIRST approved\*



A new project cannot be incremental

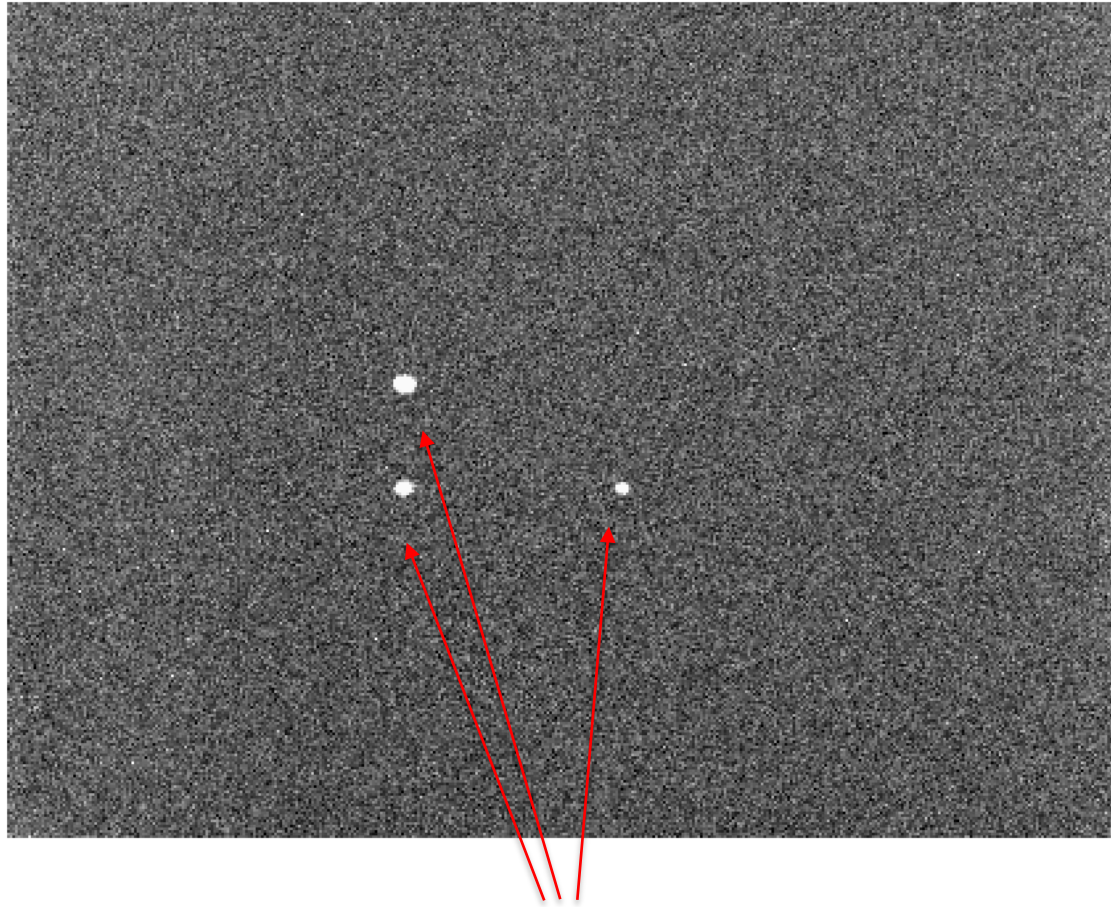
# Cosmic Visions: Dark Energy



(B) Even after DESI and LSST, there will be a lot of information left in the sky

(B\*) But don't forget, we haven't built any Stage IV experiment yet

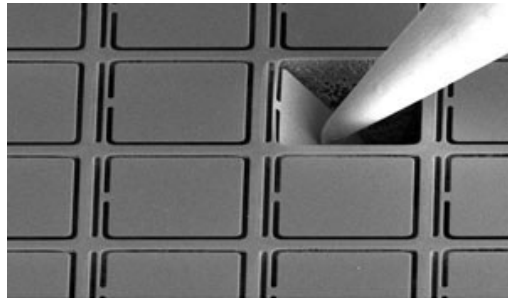




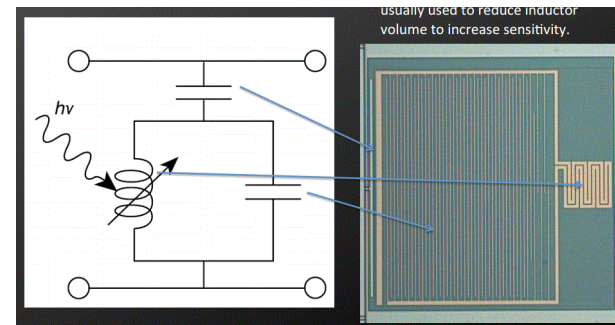
ProtoDESI actuators pointed at three stars.  
Light at the end of optical fibers

(C) Instrumentation R&D and new technologies will be key for many (all) future cosmic surveys

Micro Shutter Arrays developed for JWST



MKIDS Detector Arrays



CV Whitepaper on arXiv 1604.07821

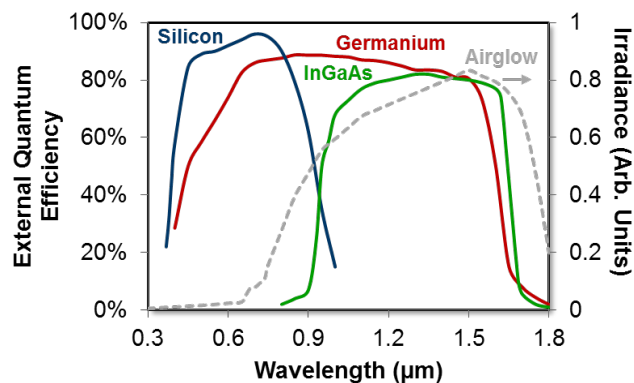
Cosmic Visions Dark Energy: Technology

Scott Dodelson, Katrin Heitmann, Chris Hirata, Klaus Honscheid, Aaron Roodman, Uroš Seljak, Anže Slosar, Mark Trodden

Executive Summary

A strong instrumentation and detector R&D program has enabled the current generation of cosmic frontier surveys. A small investment in R&D will continue to pay dividends and enable new probes to investigate the accelerated expansion of the universe. Instrumentation and detector R&D provide critical training opportunities for future generations of experimentalists, skills that are important across the entire DOE HEP program.

Ge CCDs (MIT LL, LBNL)



C. Leitz



# FUTURE COSMIC

# SURVEYS 2016 • CHICAGO

## SEPTEMBER 22, 2016 - THURSDAY

**9:00 AM** Introduction to Cosmic Visions

**9:15 AM** Introduction to NSF-Kavli

**9:30 AM** What science are we after?

**10:20 AM** DESI-2 Science

**11:00 AM** DESI-2 Programmatics

**11:15 AM** Beyond DESI

**11:40 AM** SSSI Science

**1:30 PM** SSSI Science, Discussion

**1:50 PM** SSSI Programmatics

**2:15 PM** Low-Res Science Reach

**2:45 PM** Technological Challenges

**3:45 PM** 21-cm at  $z > 6$

**4:15 PM** 21-cm at  $z < 6$

**4:45 PM** 21-cm technical challenges

**5:15 PM** Galaxy Survey with Radio Observations

**5:35 PM** Galaxy Survey with Optical Spectroscopy

**5:55 PM** BOA science reach

## SEPTEMBER 23, 2016 - FRIDAY

**9:00 AM** Core Science Goals

**9:30 AM** Structure of Science Book(s)

**10:30 AM** Breakout Sessions

**21 cm: Room 106**

**DESI-2: Room 105**

**SSSI: Room 103**

**low-res spec.: Room 213**

**BOA: Room 206**

**2:00 PM** DESI-2

**2:30 PM** SSSI

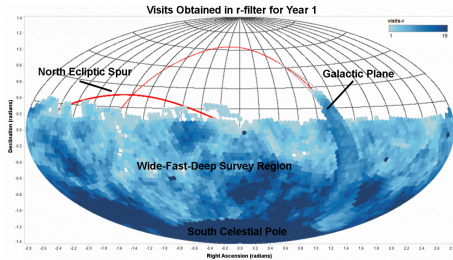
**3:00 PM** 21 cm

**3:30 PM** Low Resolution Spectroscopy

**4:00 PM** Billion Object Apparatus



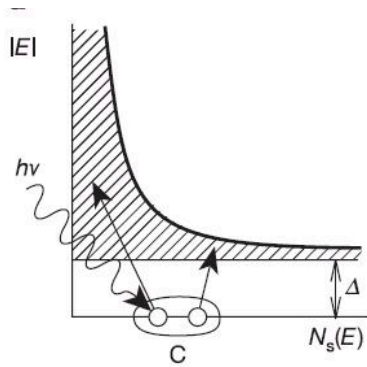
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SSSI

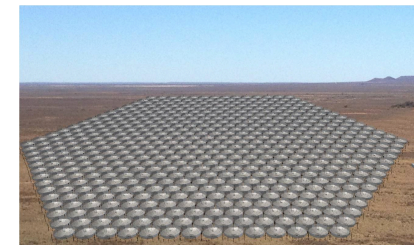
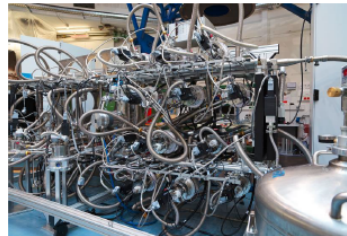


DESI-2



Low Resolution Spectroscopy

Billion Object Apparatus

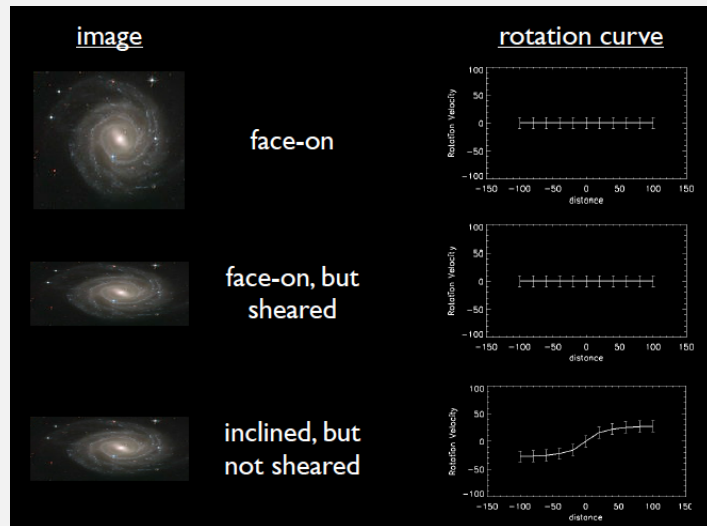


21 cm

All these ideas will be discussed at the workshop

# Many additional ideas, variations and more

Kinematic WL (E. Huff): Get shape priors by measuring rotation curves



Novel Probes (Study Modified Gravity)  
Compare the behavior of gravity in screened and unscreened regions (e.g. infall velocities of nearby galaxies)

Pixel Level Comparison  
Combine data samples at the pixel level across projects, funding agencies and continents.

Theory, Synthetic Sky Maps & Simulations  
Reliable predictions of observables on small Scales; viable fundamental physics models, modeling efforts to match the expected statistical power of LSST and DESI; End-to-end simulations and synthetic catalogs for validation of pipelines and systematics

## Cross – Correlations of Future Surveys with CMB (S4)

*...but it cannot be emphasized enough this this is one of the most exciting topics on observational cosmology, one likely to progress significantly in the coming years.*

CV Science Whitepaper

Large gains can be obtained by combining data from different surveys.

- CMB Lensing and Galaxy samples
- Cluster cosmology (cross-correlate galaxy lensing, CMB lensing, Xray measurements, cluster velocity dispersions, richness...)
- And much more as we will discuss **next**