

# New Observational Windows to Enhance DESI and LSST

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November 14, 2017

# Reminder of context

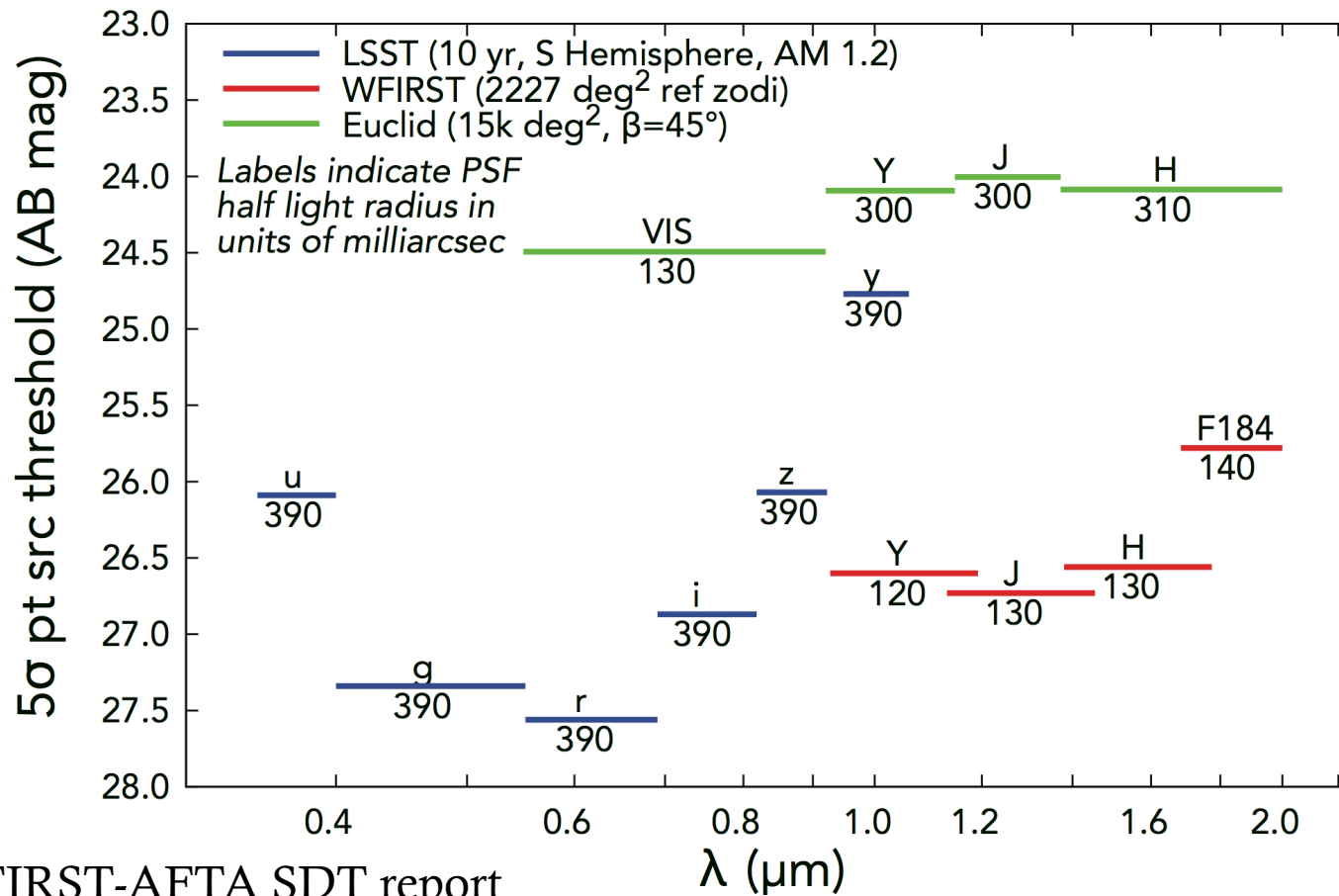
- One goal of this workshop: “identify and develop small-scale ideas to occur concurrently with DESI and LSST that would enhance dark energy science”
  - White paper in Dec 2017 / Jan 2018
- Small-scale ideas were put into 3 categories:
  - Technology development
  - **New observational windows**
  - Theory, analysis, computing (includes cross-correlation analyses)

# Original abstracts in “new observational windows”

- Joint pixel analysis (LSST/WFIRST/Euclid)
- Coordinated observing and joint SN effort
  - E.g., LSST searches, WFIRST follows up
- Coordinated ground/space photo-z calibration
  - How can space-based NIR spectroscopy improve photo-z training and calibration for LSST?
- Spectroscopy on Subaru (PFS)
- Low-resolution spectroscopy (or narrow-band imaging) to improve photo-z

# Survey synergy is a common theme

## Sensitivities of LSST, WFIRST, and Euclid



From WFIRST-AFTA SDT report

# Joint pixel analysis: LSST/WFIRST/Euclid

SCIENTIFIC SYNERGY BETWEEN LSST AND EUCLID

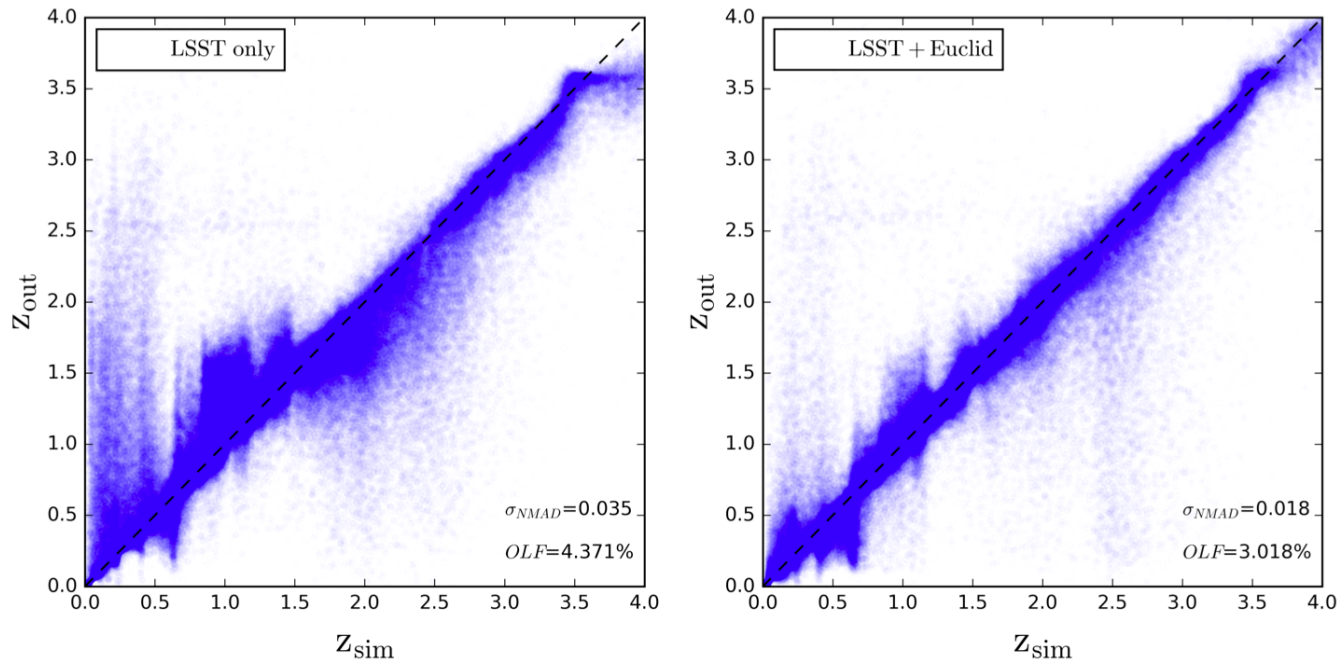
JASON RHODES,<sup>1,2</sup> ROBERT C. NICHOL,<sup>3</sup> ÉRIC AUBOURG,<sup>4</sup> RACHEL BEAN,<sup>5</sup> DOMINIQUE BOUTIGNY,<sup>6</sup>  
MALCOLM N. BREMER,<sup>7</sup> PETER CAPAK,<sup>8</sup> VINCENZO CARDONE,<sup>9</sup> BENOÎT CARRY,<sup>10</sup> CHRISTOPHER J. CONSELICE,<sup>11</sup>  
ANDREW J. CONNOLLY,<sup>12</sup> JEAN-CHARLES CUILLANDRE,<sup>13,14</sup> N. A. HATCH,<sup>11</sup> GEORGE HELOU,<sup>8</sup> SHOUBANEH HEMMATI,<sup>8</sup>  
HENDRIK HILDEBRANDT,<sup>15</sup> RENÉE HLOŽEK,<sup>16</sup> LYNNE JONES,<sup>12</sup> STEVEN KAHN,<sup>17</sup> ALINA KIESSLING,<sup>1</sup> THOMAS KITCHING,<sup>18</sup>  
ROBERT LUPTON,<sup>19</sup> RACHEL MANDELBAUM,<sup>20</sup> KATARINA MARKOVIC,<sup>3</sup> PHIL MARSHALL,<sup>17</sup> RICHARD MASSEY,<sup>21</sup>  
BEN J. MAUGHAN,<sup>7</sup> PETER MELCHIOR,<sup>19</sup> YANNICK MELLIER,<sup>22,23</sup> JEFFREY A. NEWMAN,<sup>24</sup> BRANT ROBERTSON,<sup>25</sup>  
MARC SAUVAGE,<sup>13</sup> TIM SCHRABBACK,<sup>15</sup> GRAHAM P. SMITH,<sup>26</sup> MICHAEL A. STRAUSS,<sup>19</sup> ANDY TAYLOR,<sup>27</sup> AND  
ANJA VON DER LINDEN<sup>28</sup>

## ABSTRACT

*Euclid* and the Large Synoptic Survey Telescope (LSST) are poised to dramatically change the astronomy landscape early in the next decade. The combination of high cadence, deep, wide-field optical photometry from LSST with high resolution, wide-field optical photometry and near-infrared photometry and spectroscopy from *Euclid* will be powerful for addressing a wide range of astrophysical questions. We explore *Euclid*/LSST synergy, ignoring the political issues associated with data access to focus on the scientific, technical, and financial benefits of coordination. We focus primarily on dark energy cosmology, but also discuss galaxy evolution, transient objects, solar system science, and galaxy cluster studies. We concentrate on synergies that require coordination in cadence or survey overlap, or would benefit from pixel-level co-processing that is beyond the scope of what is currently planned, rather than scientific programs that could be accomplished only at the catalog level without coordination in data processing or survey strategies.

1710.08489, accepted to ApJS, further explores topics raised in  
white paper led by Jain & Spergel

# Joint pixel analysis: LSST/WFIRST/Euclid



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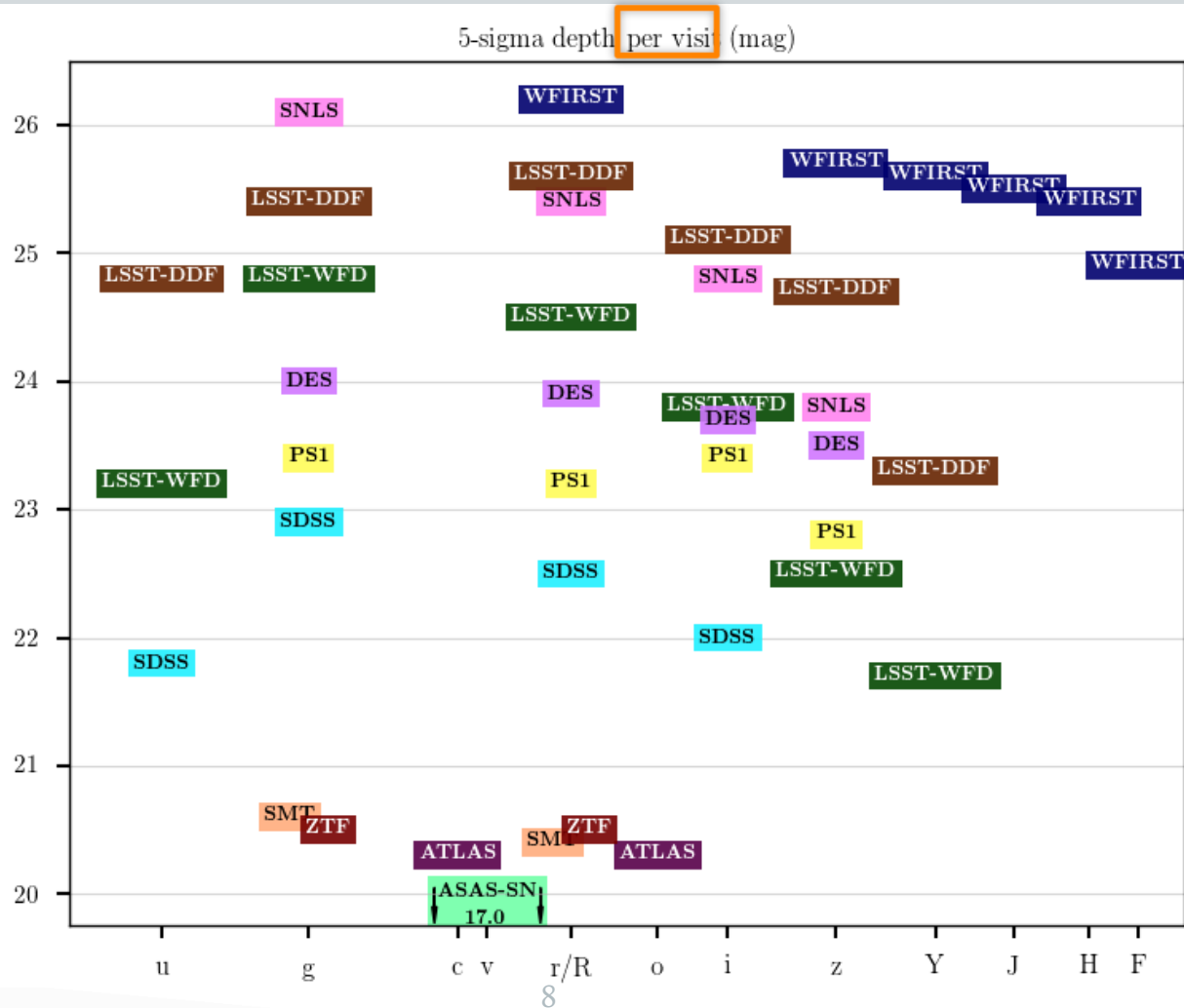
# Joint pixel processing

- Example: forced deblending, photometry could improve shear estimates, photo-z
- Cost/benefit analysis of joint pixel processing is being carried out by task force led by George Helou
- Quantifying benefits can be tricky

Speakers: Will Dawson, Peter Melchior

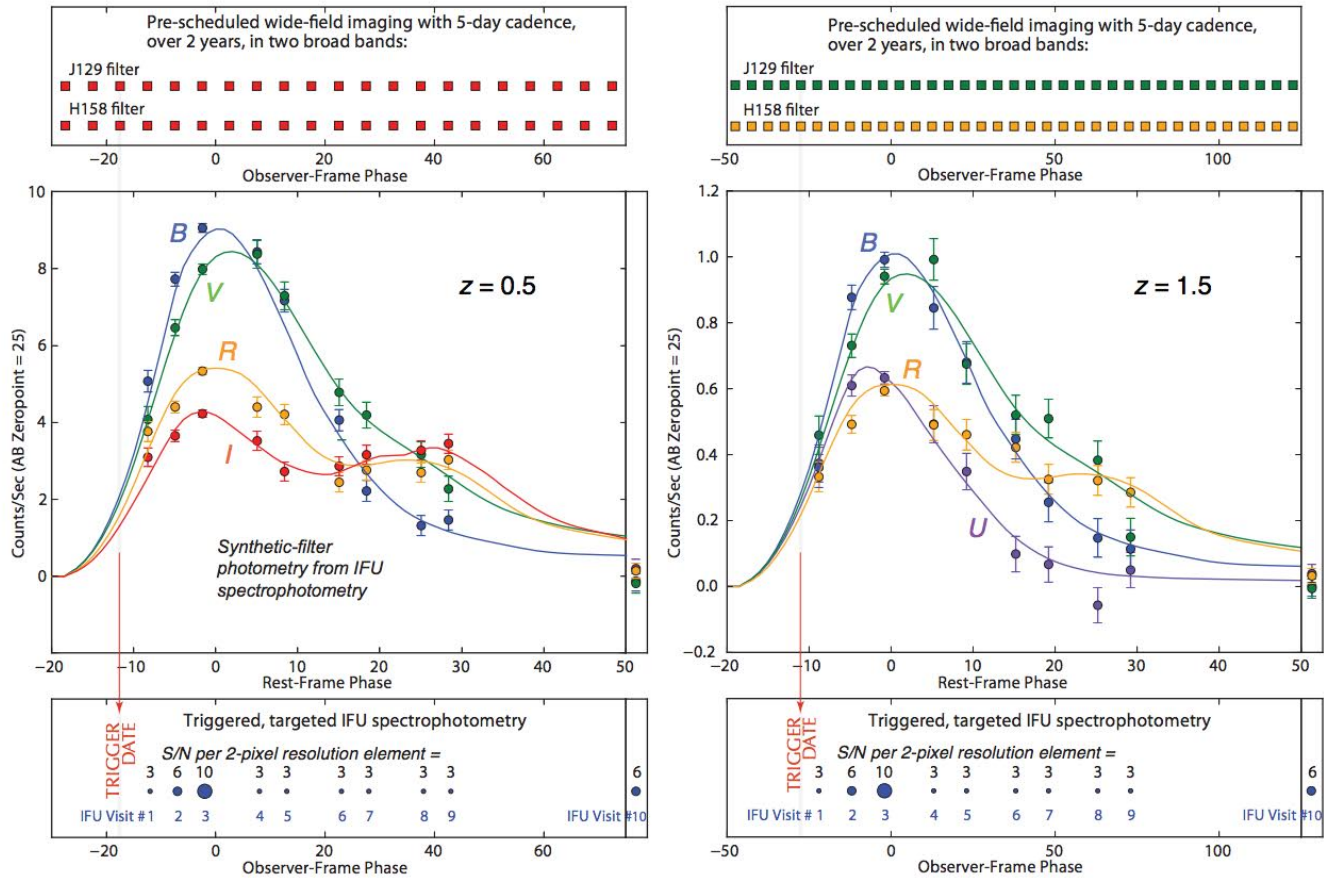
# Coordinated observing and joint SN effort

Image credit:  
Scolnic+17b





# Coordinated observing and joint SN effort



From WFIRST-AFTA SDT report

# Coordinated observing and joint SN effort

- LSST will find of order  $10^5$   $z < 1$  supernovae in the wide survey, of order  $10^4$  in deep-drilling fields
- WFIRST NIR imaging of active LSST-detected SNe: reduced impact of host galaxy dust
- WFIRST optical-NIR integral field spectrograph could provide resolved host galaxy spectra for  $> 1000$  supernovae after the SNe are no longer active
  - More robust cosmology results for that subset of supernovae; serves as training sample for photometric supernova analysis

Speakers: Saul Perlmutter, Dan Scolnic

# Coordinated ground/space photo-z calibration

LSST/WFIRST coordination:

- NIR spectra in parallel mode during imaging survey, focusing on galaxies for which ground-based spectroscopy is challenging
- Build a training sample of order a few  $\times 10^5$  galaxies

Speakers: Peter Capak, Saul Perlmutter

# Spectroscopy on Subaru

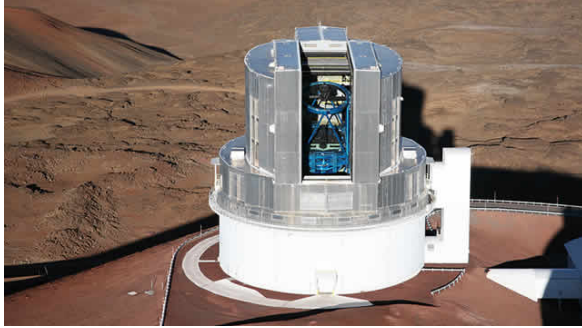
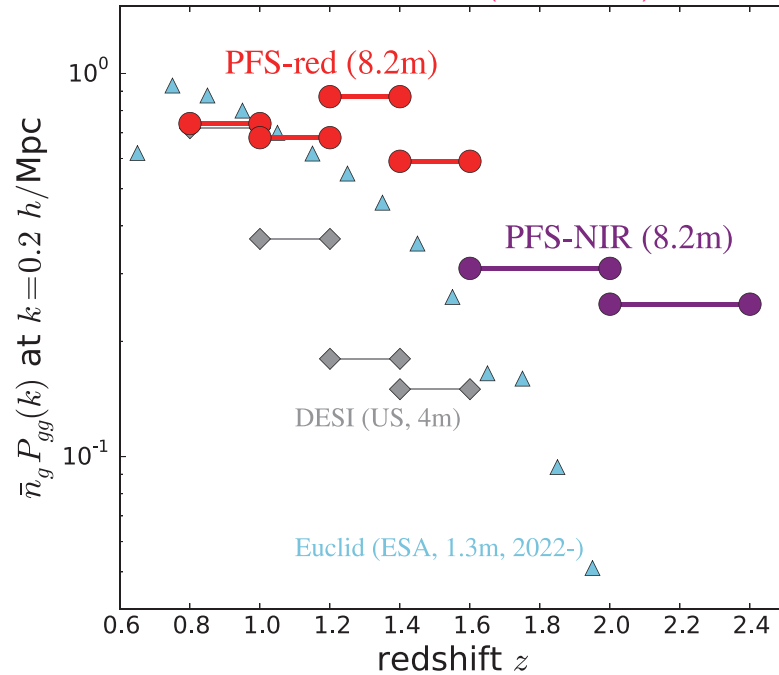


Image credit: NAOJ

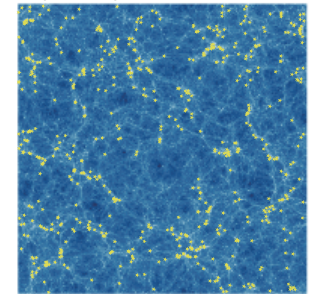
PFS: larger aperture, wider wavelength range, better site

DESI: wider FOV and more fibers

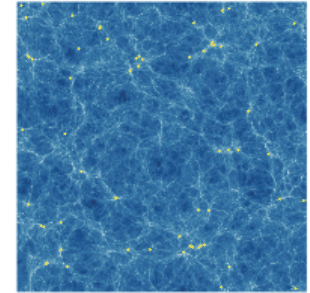
Best datasets at  $z > 1$  ... before WFIRST (NASA: 2025-)



PFS (8.2m) for  $z \sim 1.5$  slice



4m-class tel.



Tamura+16

# Spectroscopy on Subaru

- Use of PFS to get a large, representative spectroscopic training sample for LSST photo-z is a large program
  - See Newman+15 and SSSR session at this workshop
- In our session, we'll discuss smaller PFS programs that would
  - Use LSST imaging for targeting
  - Get redshifts for a non-representative sample at higher  $z$  than DESI can achieve, for cross-correlation studies
  - Effectively leads to larger volume for BAO studies than DESI alone

Speaker: Uros Seljak

# Low-resolution spectroscopy or narrow-band imaging

- Goal: improve LSST photo-z

# Low-resolution spectroscopy or narrow-band imaging

- Goal: improve LSST photo-z

Just kidding.

# ~~Low resolution spectroscopy~~ ~~or narrow band imaging~~

- Imaging in a different set of broad-band filters
  - Example: DECam (filters not quite the same as the LSST filters)
- Also relevant for LSST itself: mixed focal plan with CCDs from 2 vendors (different effective u-band response)

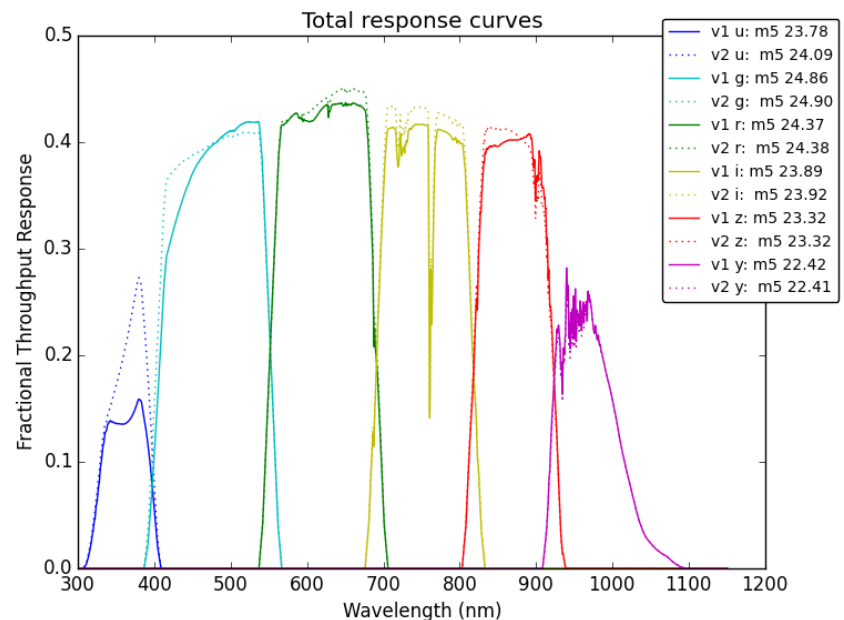


Image credit: LSST project

Speaker: Josh Frieman



But that is not all –  
oh no, that is not all!

# Other abstracts submitted to this workshop include...

- Taipan survey

Speaker: Khaled Said

- Strong lensing time delays

Speakers: Alex Kim, Greg Aldering, Tommaso Treu

- Including strongly lensed supernovae

Speaker: Danny Goldstein

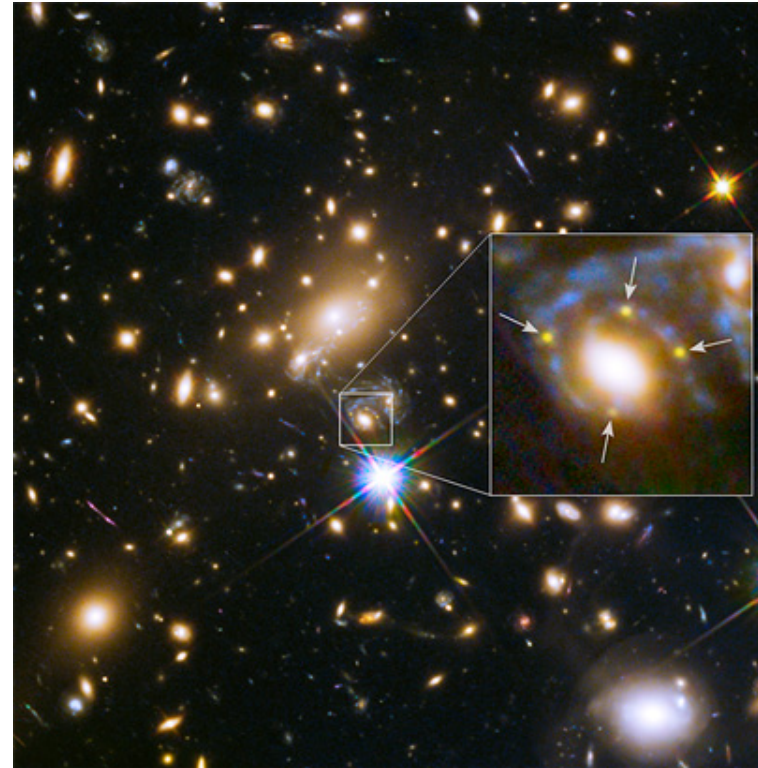


Image credit: NASA, ESA, S. Rodney and the FrontierSN team; T. Treu, P. Kelly, and the GLASS team; J. Lotz and the Frontier Fields team; M. Postman and the CLASH team; Z. Levay

# Other abstracts submitted to this workshop include...

- Standard sirens

Speakers: Marcelle Soares-Santos, Jim Annis

Will be discussed in “New observational windows” sessions, and incorporated into final plenary talk on this topic.

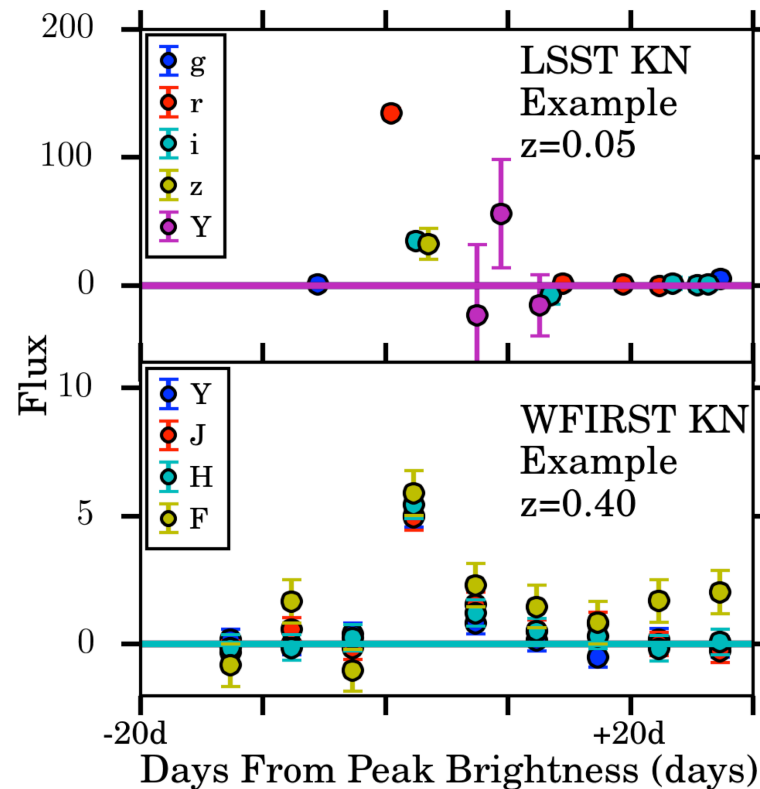


Image credit:  
Scolnic+17b

# Roadmap to “new observational windows” parallels

- Tuesday: spec-z, photo-z calibration, cross-survey coordination
- Wednesday: time-domain studies (mostly)
  - But a bit of that will show up on Tuesday, where relevant for cross-survey coordination
- Session organizers: RM, Dan Scolnic

# Survey synergies theme

- Shows up persistently throughout “New windows” session for a variety of science cases
  - Higher level of coordination than has been considered in the past
- Sounds nice, but there are actually some potentially tough tradeoffs to make
  - Joint analysis vs. loss of independence?
  - Observability (e.g., WFIRST DDFs in north vs. south?)
  - Imaging vs. spec-z synergies: get spec-z for cross-correlation analysis vs. photo-z training samples?

# Summary

- “New observational windows” sessions will involve a variety of thrusts:
  - Different ways to enhance DE science with LSST (mostly), DESI
  - Different ways to use facilities: buying time to gain new access, coordinating observational strategies, processing data jointly instead of in parallel, ...
- Keep the creative ideas coming!