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PRIMARY RESEARCH OR PRACTICE AREA(S):
PRINCIPLE INVESTIGATOR, DARK ENERGY SURVEY DATA MANAGEMENT

PREVIOUS EXPERIENCE (IF RELATED TO WORKSHOP FOCUS)
FERMILAB/ US CMS
FERMILAB/ RUN II
FERMILAB/ SLOAN DIGITAL SKY SURVEY

RELATED WORK (PROJECTS SPECIFIC TO WORKSHOP WITH WEB-SITES)
• DES: HTTP://COSMOLOGY.ILLINOIS.EDU/

CONTACT INFORMATION:
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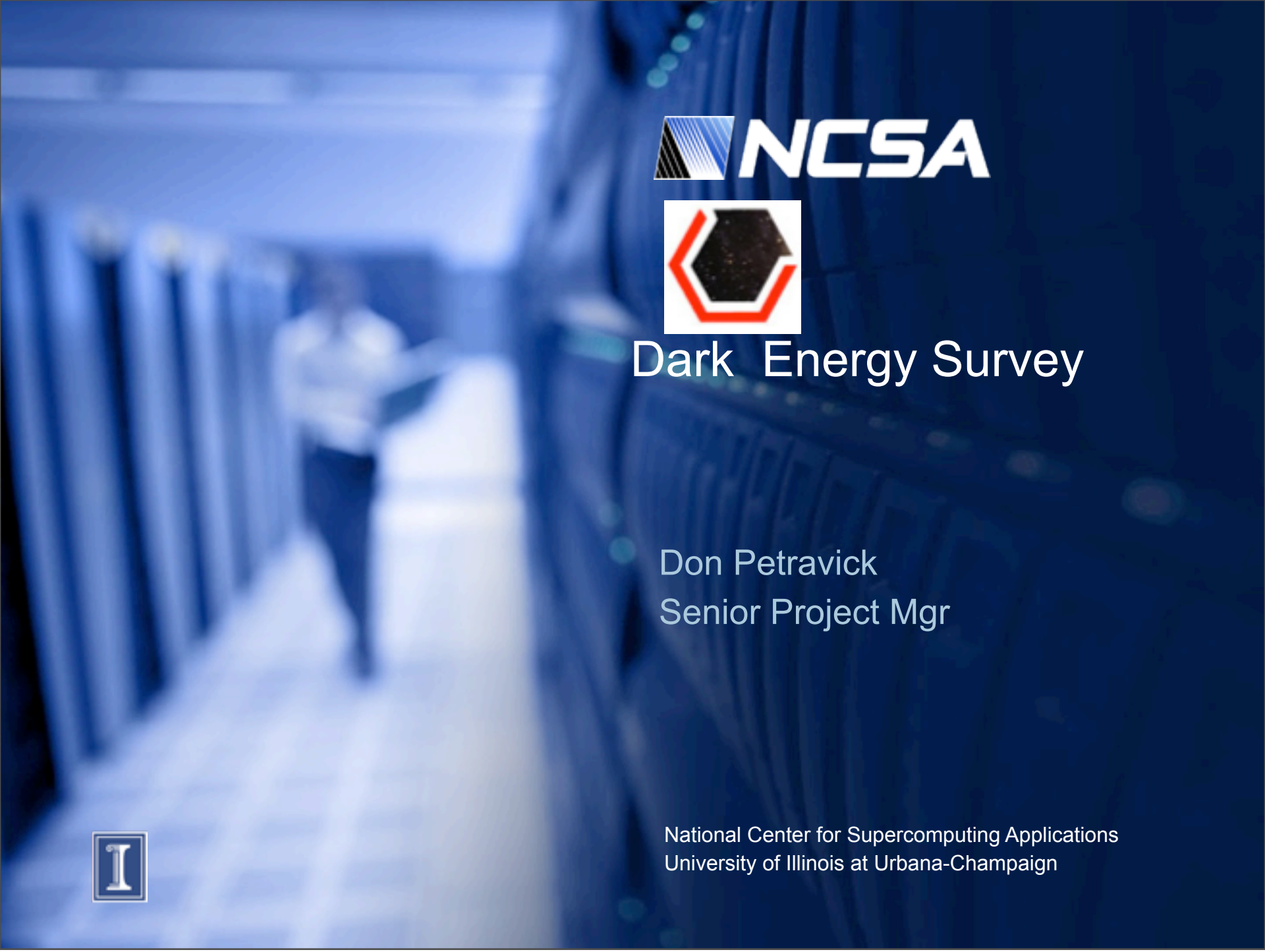

Dark Energy Survey

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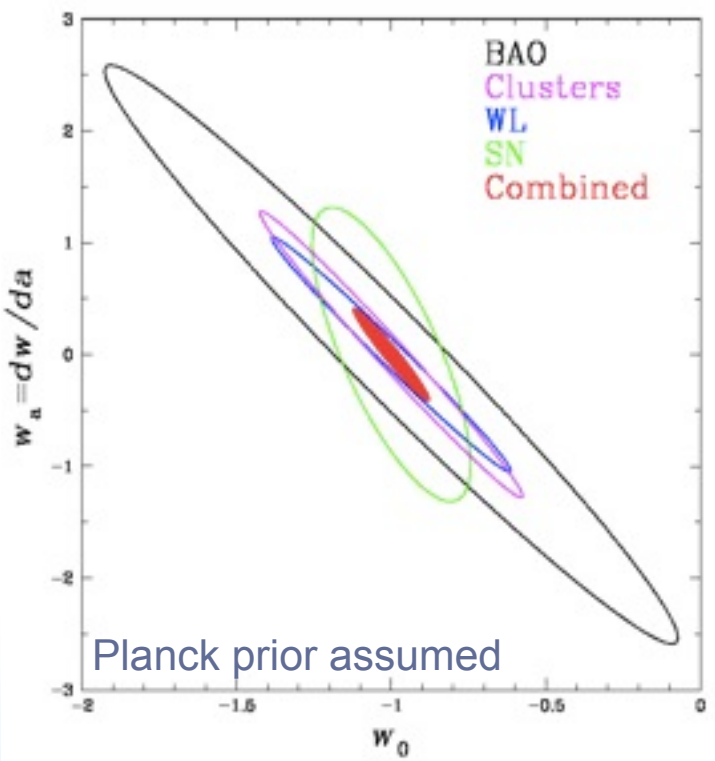
Telescope and Iconic Picture

DES Science Summary

Four Probes of Dark Energy

- Galaxy Clusters
  - ~100,000 clusters to z>1
  - Synergy/overlap with SPT
  - Sensitive to growth of structure and geometry
- Weak Lensing
  - Shape measurements of 200 million galaxies
  - Sensitive to growth of structure and geometry
- Large-scale Structure (BAO)
  - 300 million galaxies to z = 1 and beyond
  - Sensitive to geometry
- Supernovae
  - 30 sq deg time-domain survey
  - ~4000 well-sampled SNe Ia to z ~1

Forecast Constraints on DE Equation of State



Factor 3-5 improvement over Stage II DETF Figure of Merit

Sampling Masks.

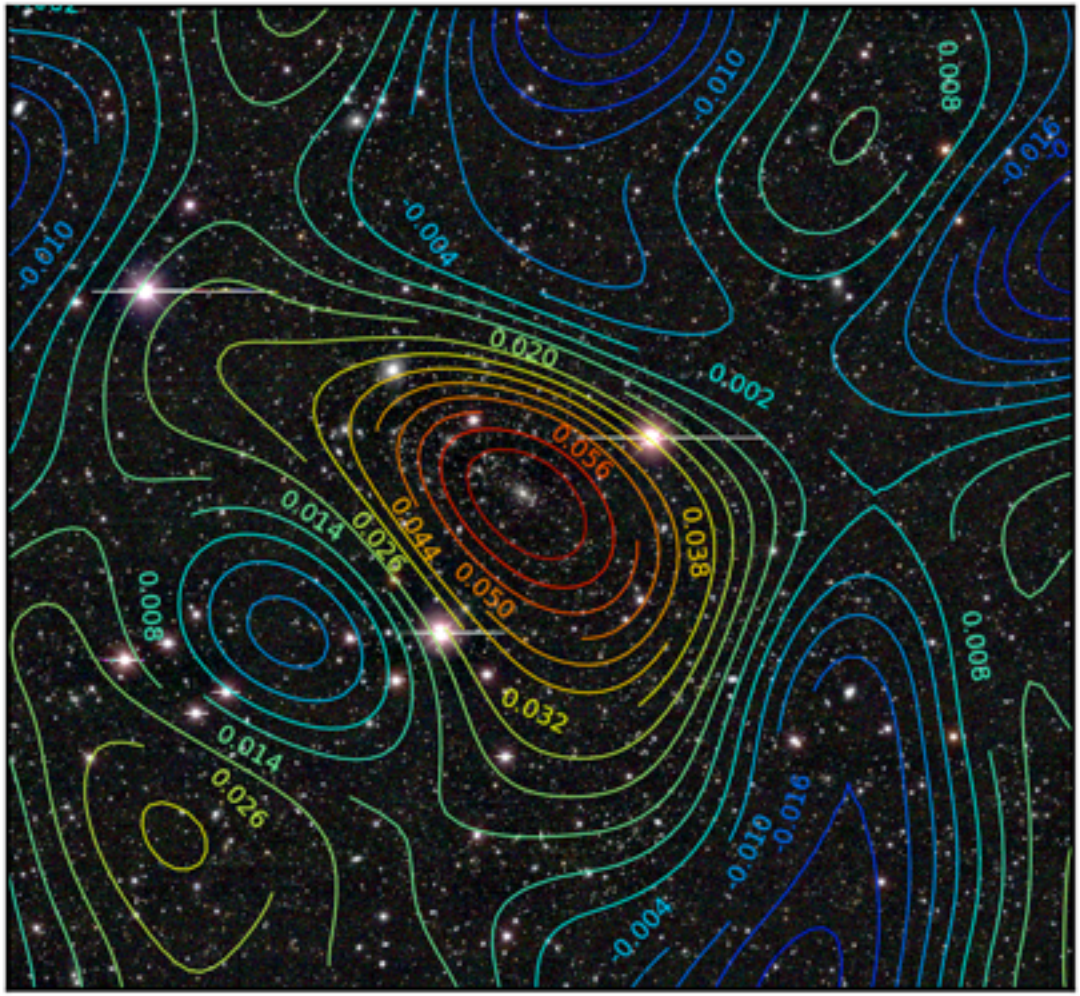
Figure – DECam Mosaic

Mangle Masking partitions the images into polygons consistent with some set of properties. In DES , mangle tracks image defects, bright objects and depth.

Cluster Weak Lensing

Cluster RXJ2238 at z=0.35

Preliminary cluster mass map from DES SV data



Nature of the DESDM effort:

- ~Decade duration (Concept to finish)
- Survey products are broadly re-useable, though the focus of DES is on dark energy science.
- For dark energy studied, the goal is to support statistical analysis based on the distribution and shape parameters for galaxies.
- Acquiring this data implies
  - Detailed Understanding of instrumental
  - Detailed Understanding of atmospheric signature.
  - Detailed Understanding of science code.
  - Systematic understanding of provenance an relationships between data elements.

Processing the DES Observations Produces:

- Reduced single epoch images.
- Catalogs of single epoch detections.
  - ~250 parameters/detection
- Co-added images.
- Catalogs of co-added Detections.
  - ~250 parameters/band/detection.
- Mangle Masks.
  - Account for the non-uniform sampling of a mosaic camera.
- Super Nova Detections.
- Photometric Red Shifts.
- Weak Lensing Catalogs.

DES Pipelines (top level view)

Data Volumes

- ~10,000,000 CCD images.
  - Images – 8 mega-pixel
  - 8 mega-pixels of weights and masks.
- 100 TB of catalogs, w/ billions of object detections, mangle maps, and other data useful for interpretation of the data. Stored in a relational database, as a query capability is needed to provide utility.
- ~40000 “very deep” co-added images.
- 2.5 PB of data.

Beyond the data from DECam, The Analysis Efforts Produces:

- Catalog and other analysis information from **cosmology simulations**.
  - Production is more compute-intensive than the processing of observational date.
  - Example: Blind Cosmology Challenge:
    - Simulation. given some assumptions about cosmology.
    - Sample that universe as if DECam observed it.
- Combining DES data with data from other surveys.
  - Example VISTA (infrared)
- Value added catalogs provided by Science working groups.

Survey Preservation Requirements

- All DES Science images are archived at NOAO, and made pubic after a year.
- All calibration images from any user of DECam are available.
- Transient information immediately available to the community.
- DESDM reduced images are available after a year @NCSA
- Two Releases of Catalogs@NCSA
- Develop documentation at the level of peer-reviewed papers.

A full system would include

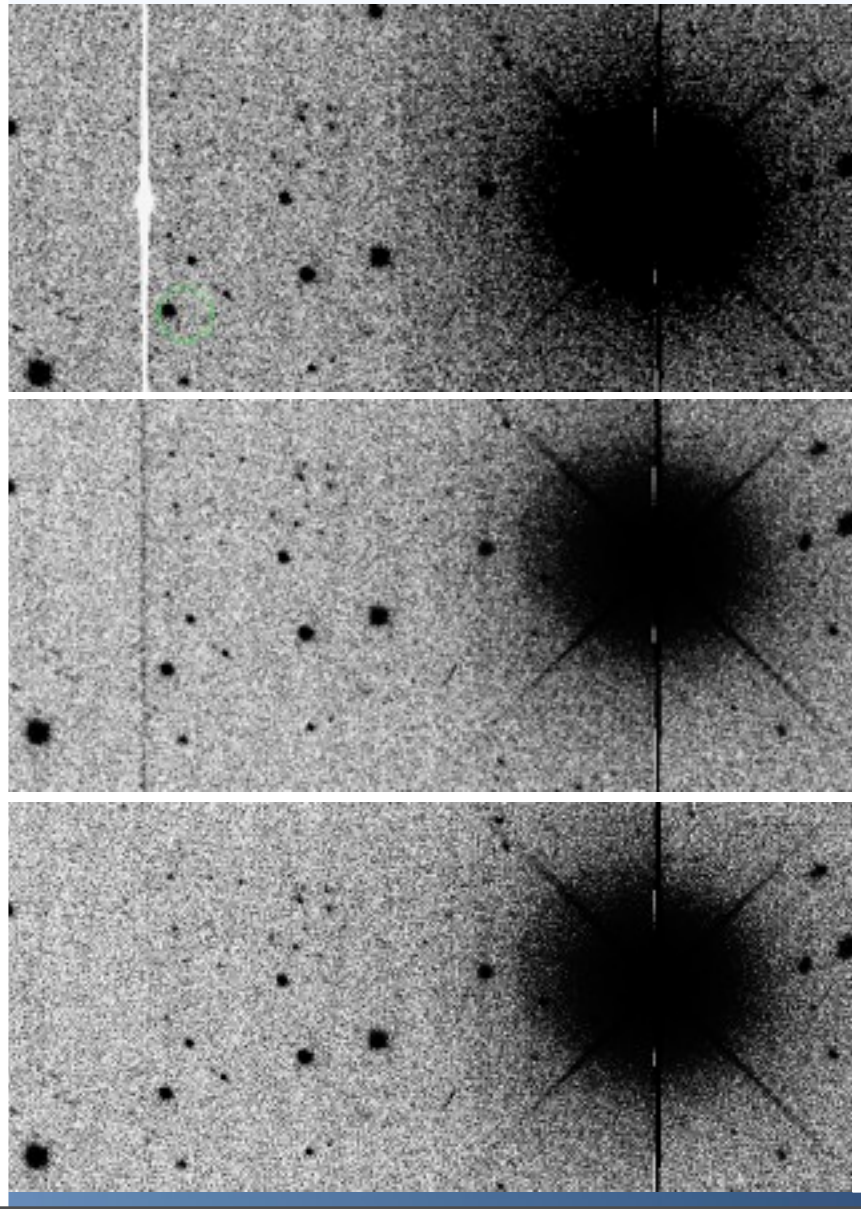
- Technical:
  - Very detailed documentation of all data elements.
    - Including calibrations.
  - Full provenance.
  - Retain instrument and environmental records/ Observer actions
  - Well documented codes in a reasonable technical base.
  - Well documented processes/decisions of the production effort.
  - Inclusion of Value added and other catalogs.
- Support:
  - Suitable access methods.
  - Suitable support.
  - Solid Institution
    - DES data will go to NOAO after the operational period.
    - The University of Illinois is developing a custodial capability in

Summary

- Large investment in the development/application of the acumen needed for a successful survey.
- Use of multi-instrument data is needed in analysis.
  - There are a number of astronomical archive sites.
  - There is a basic body of knowledge and technique in astronomy.
- Underpinning the data are code, calibrations, procedures, instrumental and environmental effects.
- The DES's Current Data Management Plan:
  - Preserves DECam-derived data
  - Preserves acumen at the level of refereed publications.

SPARES.

Example 1: Non-linear crosstalk correction



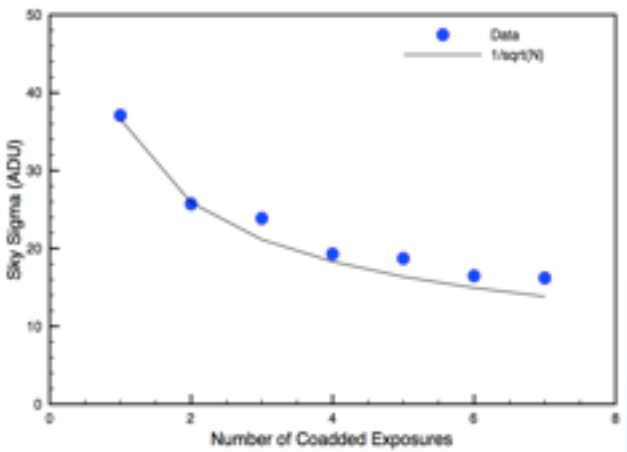
- ***Figure 1 :No crosstalk correction applied.***

Figure 2: Linear crosstalk correction applied (SN requires that the dark band be gone or masked at ~ 2 DN /pixel), this one is at 7DN/pix. K. Paech (Munich)

Figure 3: Nonlinear crosstalk correction applied (in test). R. Gruendl, NCSA

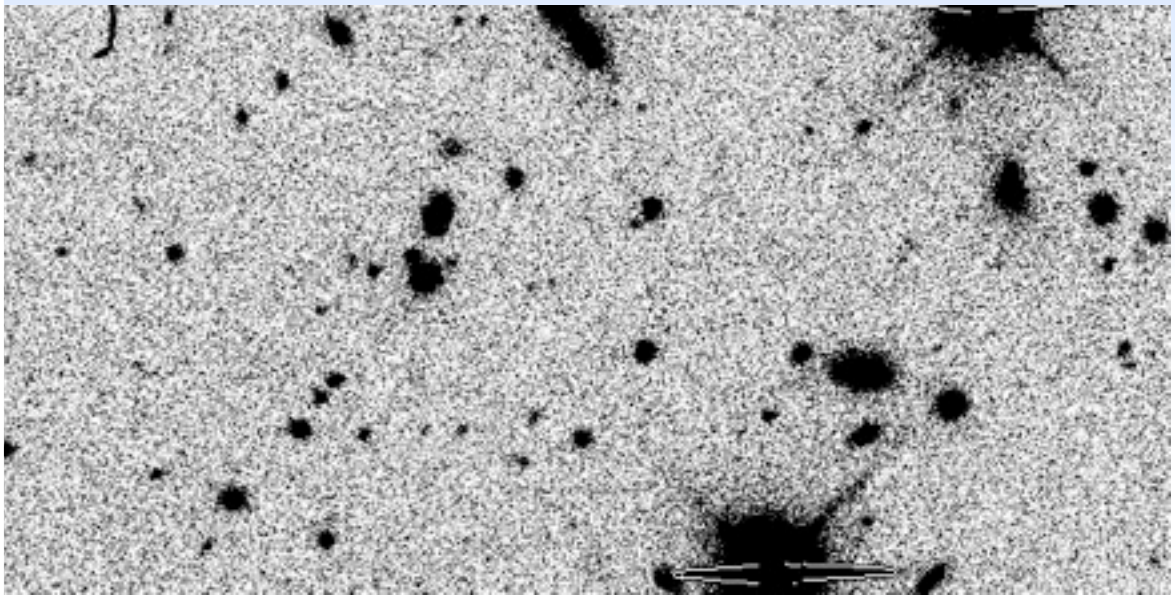
Example 2: Galaxy Depth

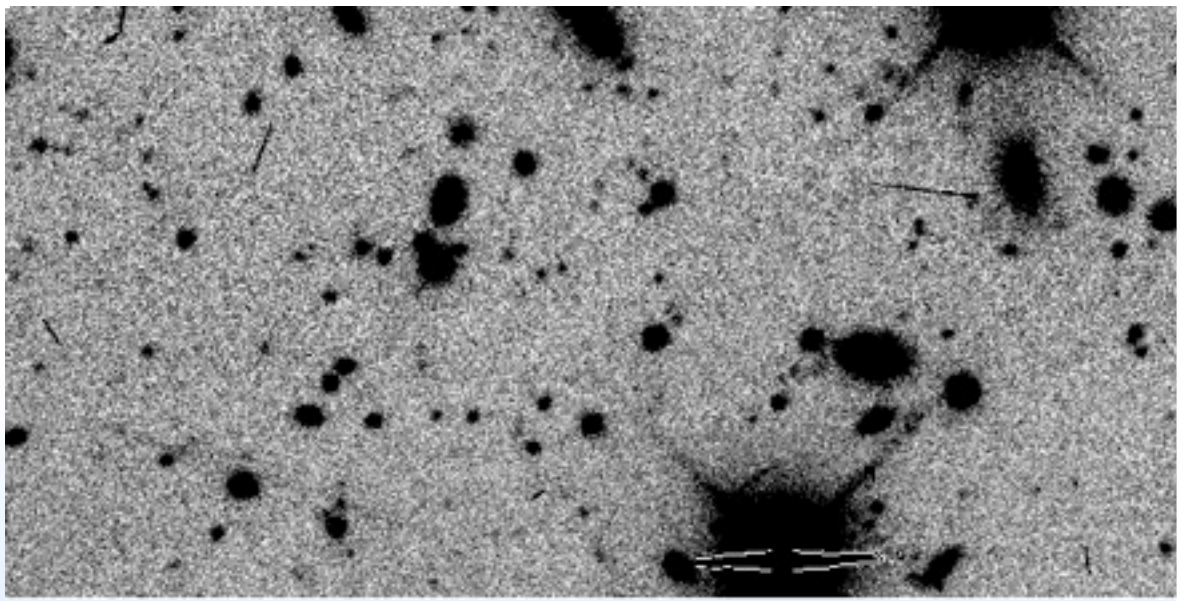
Galaxy photometry Depth: 1 vs. 8 exposures. Requirement is that noise integrates down as ~1/sqrt(N)



(E. Rykoff, SLAC)

N=1





N=8

Database Cluster

- 11 Nodes
- 128 cores
- 736GB RAM
- 135 drives
- 241TB storage
- 6GB SAS2 storage fabric