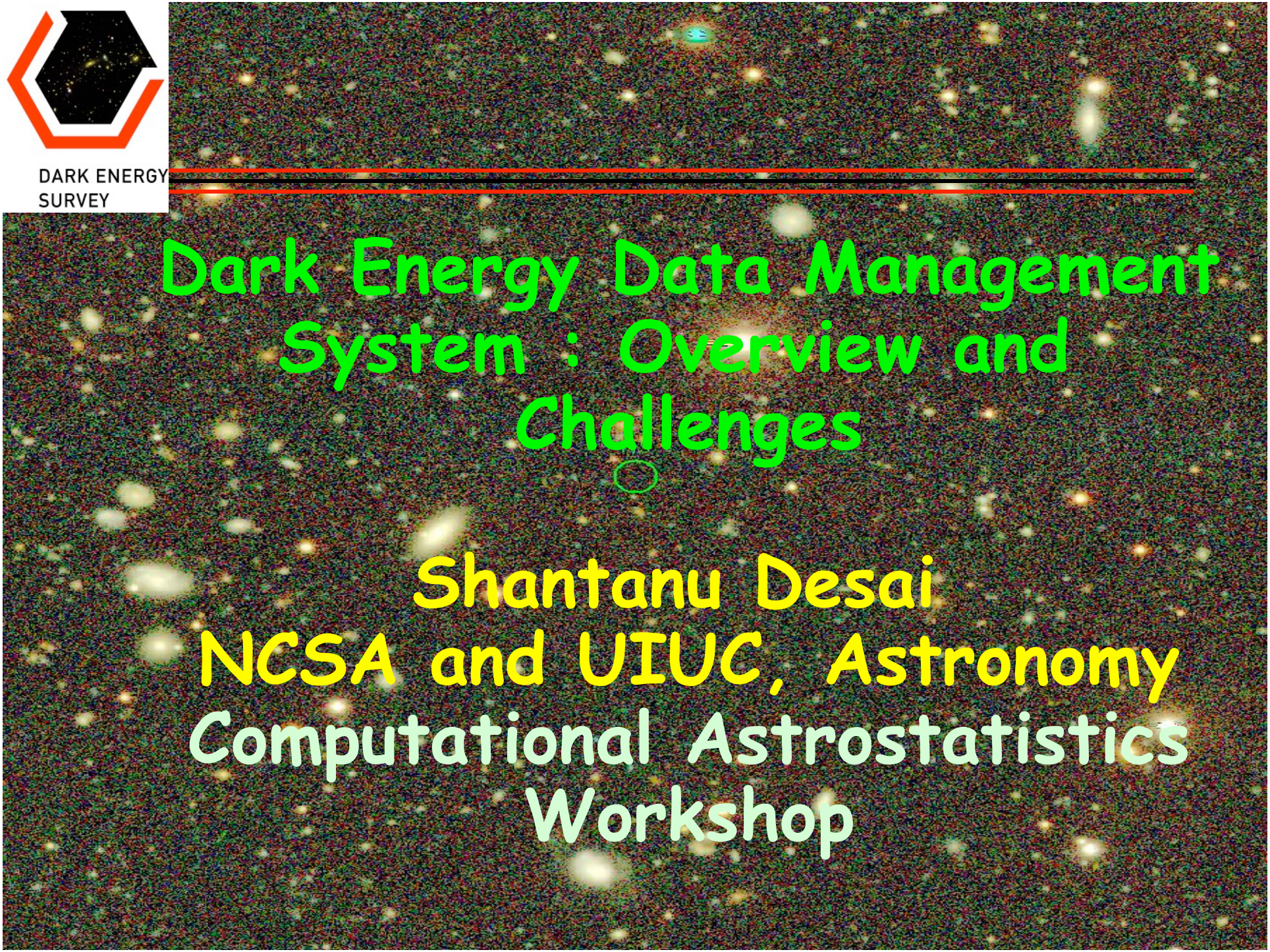
DARK ENERGY
SURVEY
Dark Energy Data Management System : Overview and Challenges
Shantanu Desai
NCSA and UIUC, Astronomy
Computational Astrostatistics Workshop

Dark Energy Survey

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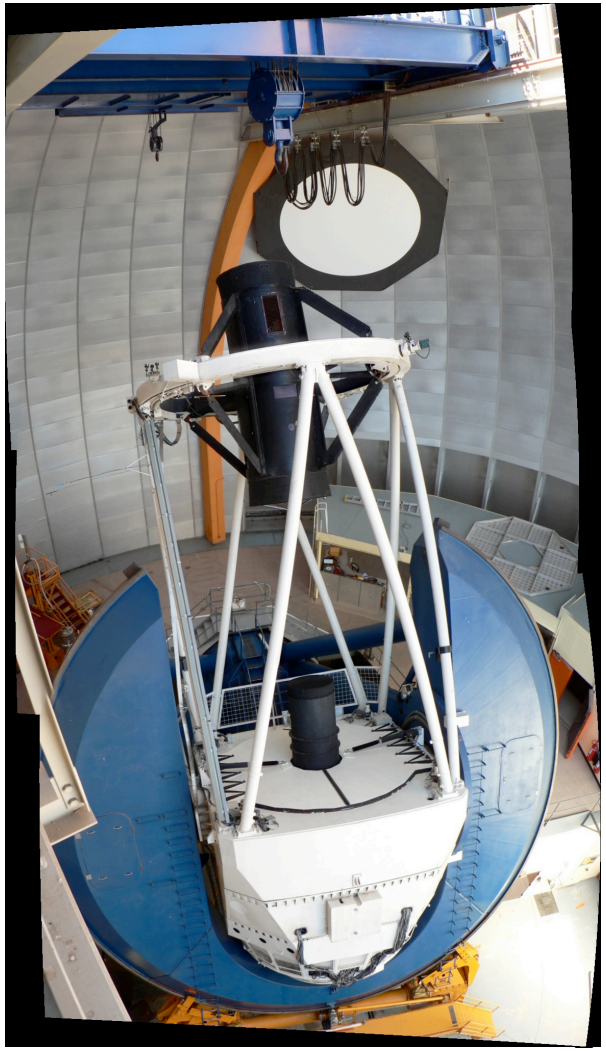
DES is 5000^2 degree grizY
Imaging survey of
Southern hemisphere to map out
dark energy equation of state.

CTIO Blanco 4m telescope. Replace
PF cage with 2.2 deg. FOV 570
Mpixel Camera.

525 nights from Oct 11- Feb 16

(1 TB of compressed data per night)



DES Data Management (DESDM)

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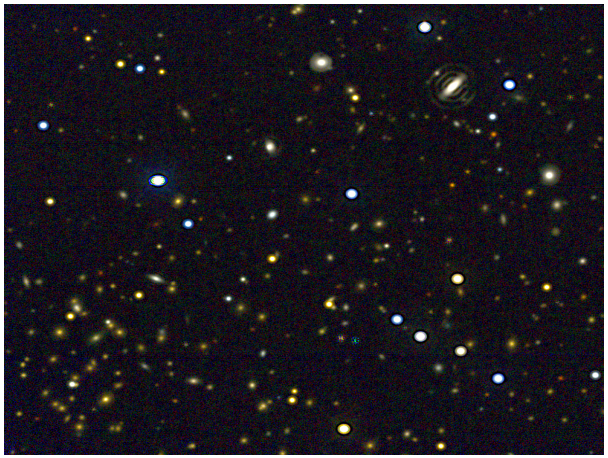
PSF Homogenized Coadd (riz)



DESDM goals

- Process DECam data from DES survey (4 PB of data, 350 TB of database)
- Provide a pipeline to NOAO to process DECam data for non-DES observers.

DESDM as of now

- Process and analysis of simulated DES data (as part of yearly data challenges since Fall 2005). (~6000 CPU hrs for 1 simulated night)

- Process real data from current CTIO 4 m telescope (Blanco Cosmology Survey and more recent data for optical follow-ups of clusters detected by South Pole telescope.)

Pipeline Overview

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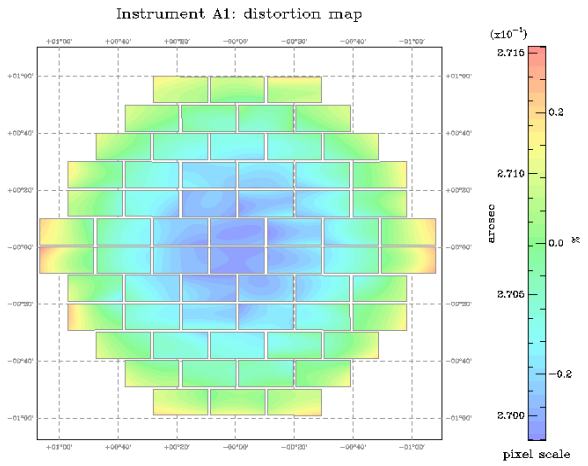
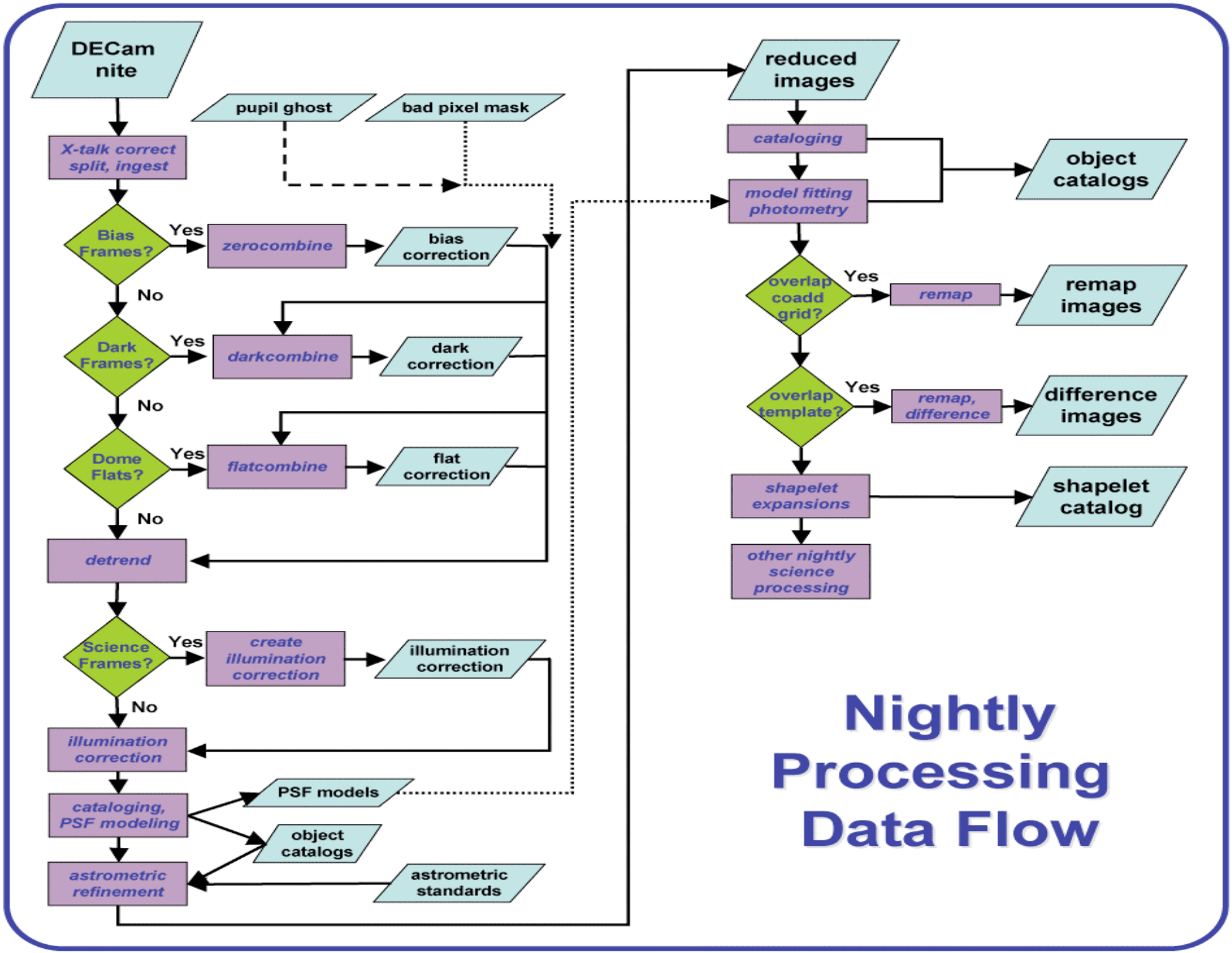
- Basic detrending (crosstalk correction, instrumental signatures)
- Astrometric Calibration (SCAMP)
- Masking (cosmic rays, bright stars, satellite trails) ✓
- Cataloging/Model-fitting (Sextractor)
- Remapping of images to perfect tangent plane (SWARP)
- Global Photometric Calibration.
- Coaddition pipeline

➢ PSF Homogenization (PSFEX)

➢ Image Coaddition (SWARP)

➢ Cataloging/model-fitting of Coadd Images.




DECam nite
pupil ghost
bad pixel mask
X-talk correct split, ingest
Bias Frames?
Yes
zerocombine
bias correction
No
Dark Frames?
Yes
darkcombine
dark correction
No
Dome Flats?
Yes
flatcombine
flat correction
No
detrend
Science Frames?
Yes
create illumination correction
illumination correction
No
illumination correction
cataloging, PSF modeling
PSF models
object catalogs
astrometric refinement
astrometric standards
reduced images
cataloging
object catalogs
model fitting photometry
overlap coadd grid?
Yes
remap
remap images
overlap template?
Yes
remap, difference
difference images
shapelet expansions
shapelet catalog
other nightly science processing
Nightly Processing Data Flow

DES Science Requirements

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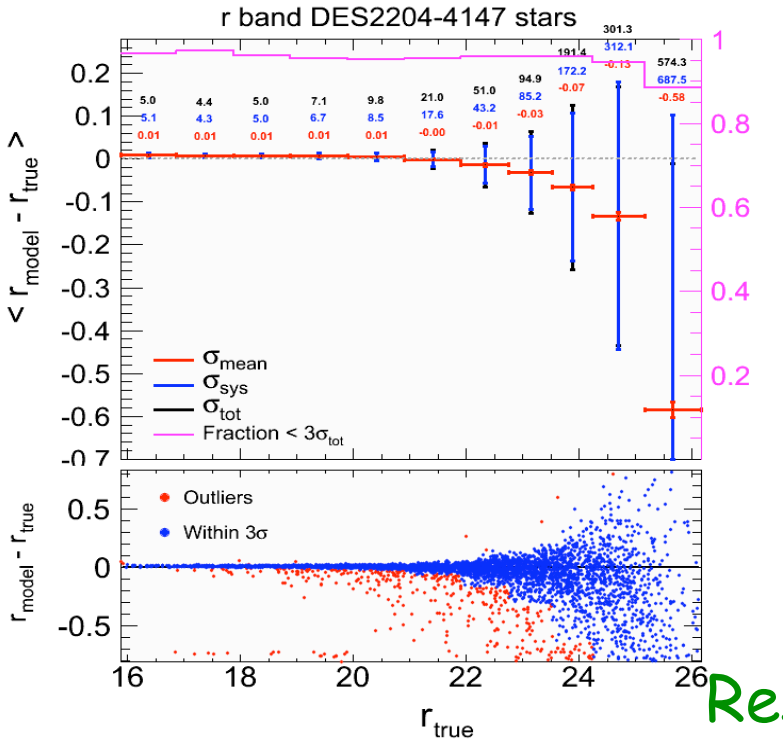
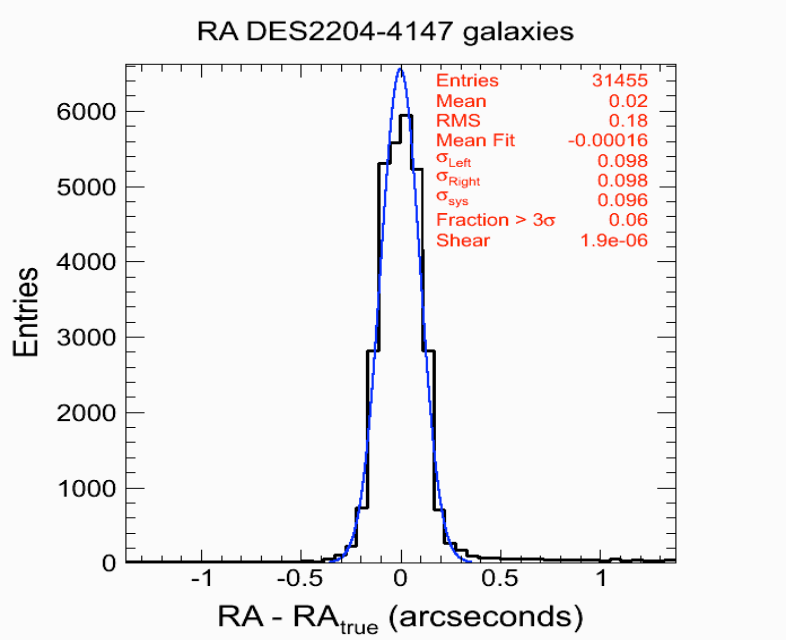
- Limiting magnitudes of 24.6, 24.1, 24.3, 23.8, 21.5 in grizY respectively in 1.5" apertures with >=97.5 % completeness and 95 % purity.

- Position Accuracy ~ 100 milli-". Photometric Calibration : 2 "





Results with simulated DES data

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Cataloging/Model-Fitting

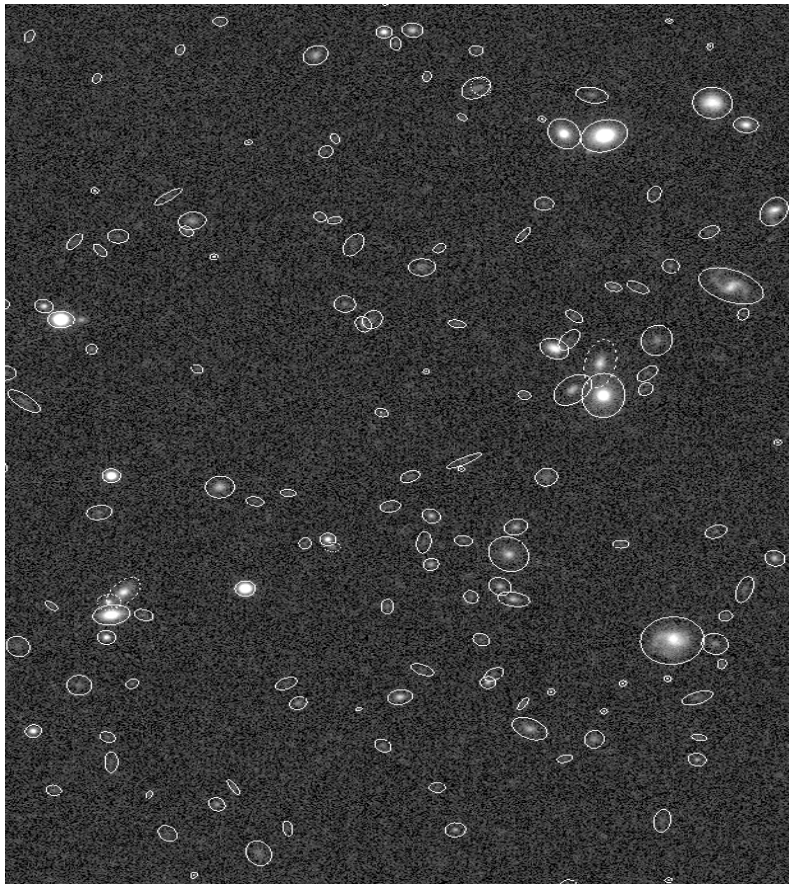
- Use Sextractor (E. Bertin)

Improved Star-Galaxy separation

Improved Background noise Modelling and subtraction.

Better PSF modelling

Deblending



Bright Star Masking

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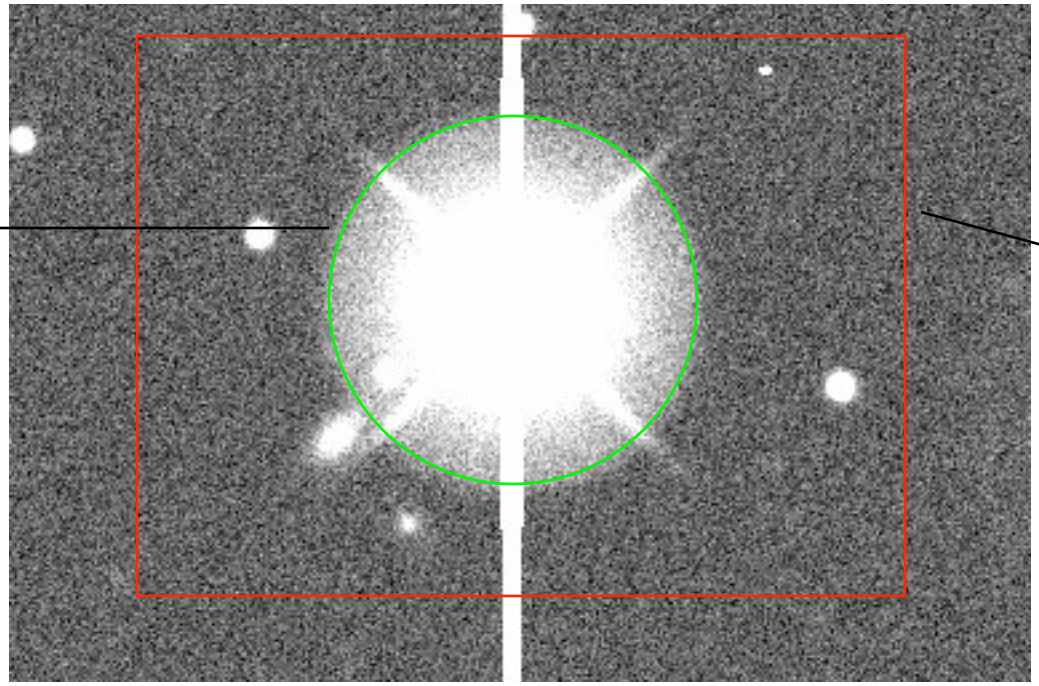
Location and size of circle from USNOB catalog and using a empirical fit



Grid around circle used to calculate Median and Sigma.

Replace the pixel values in the circle with Gaussian noise with mean and sigma that of a square grid around the circle

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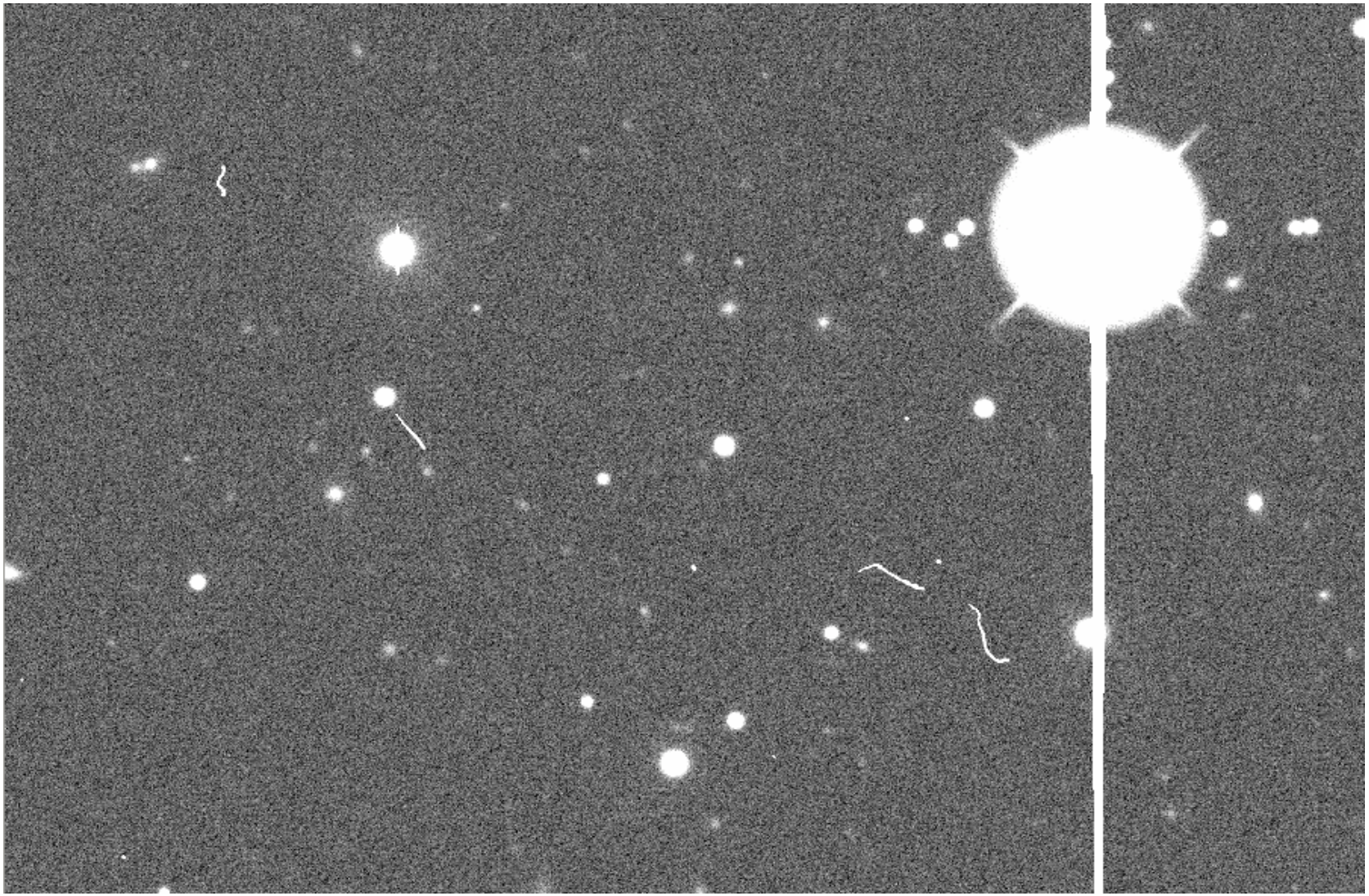
Original Unmasked Image



Masked Image

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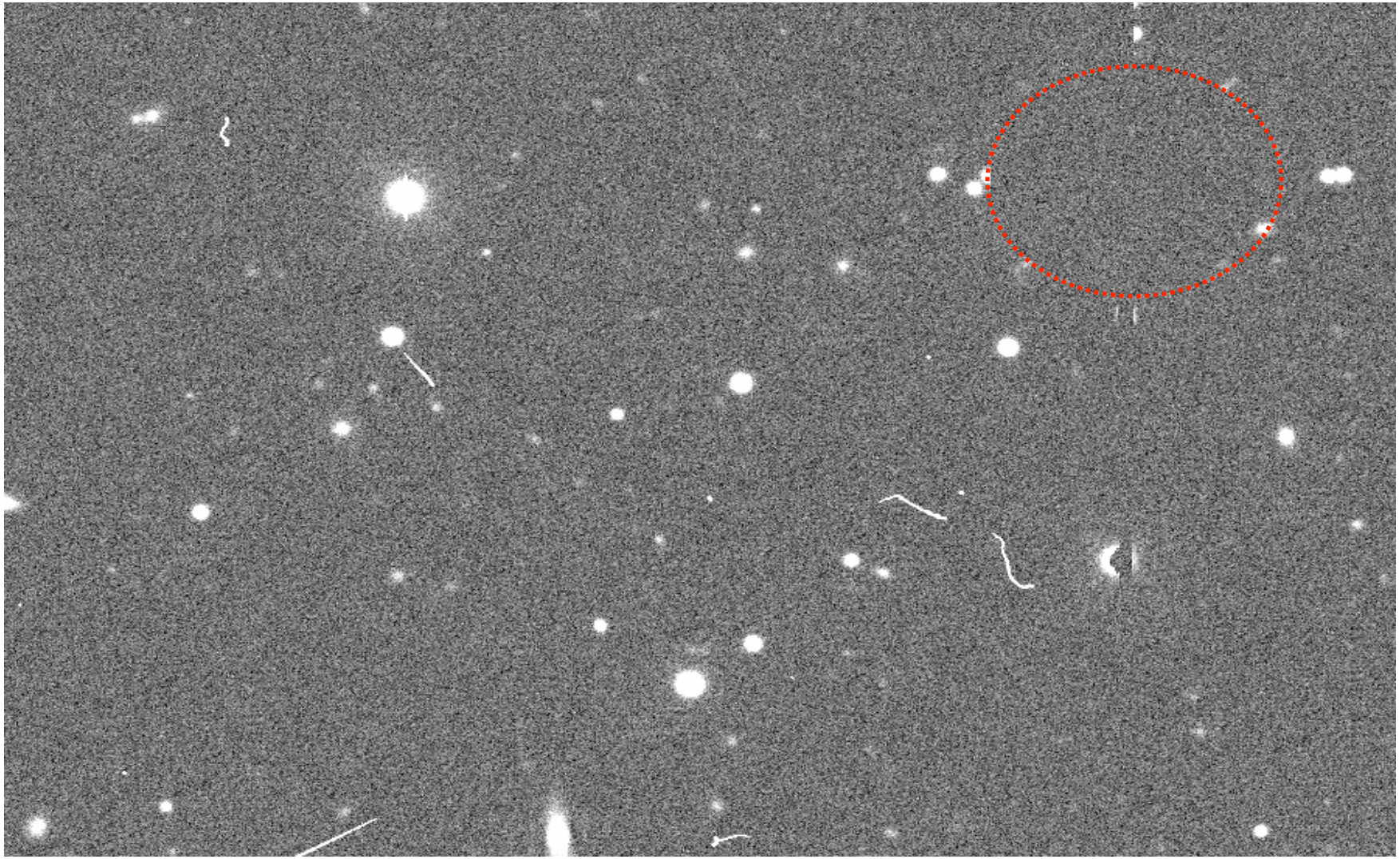

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Cosmic-Ray Masking

- Use `eye` program to create a retina file to model the cosmic rays defects (use `RPROP` neural-network algorithm) by supplying a file with and without cosmic rays. Run `Sextractor` using this retina file to produce a cosmic ray only image.

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Image with Cosmic Rays

Example of Remap Image with cosmic rays

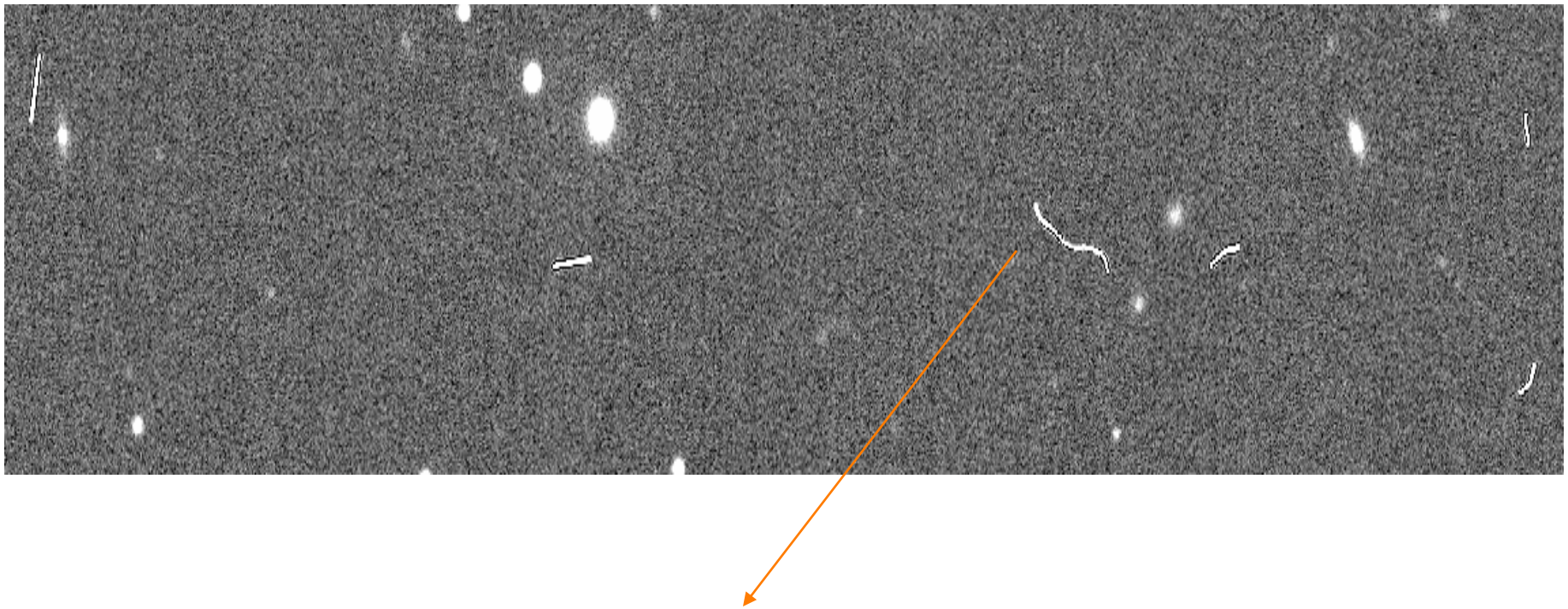

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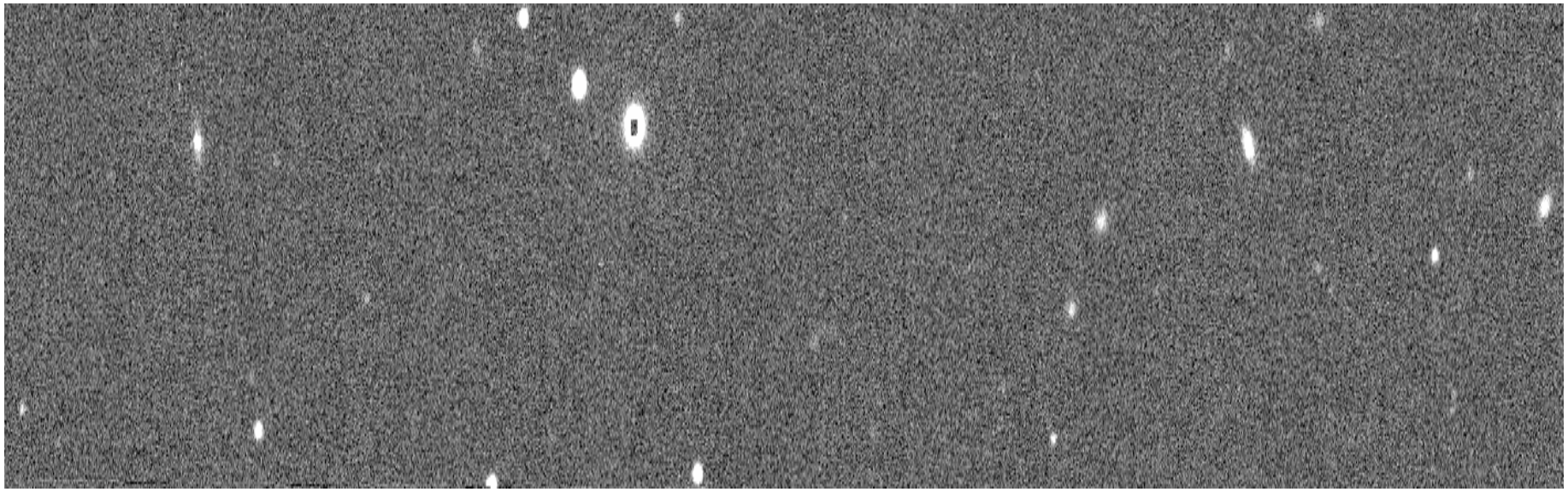
Image without Cosmic rays

Example of Remap image with cosmic rays masked



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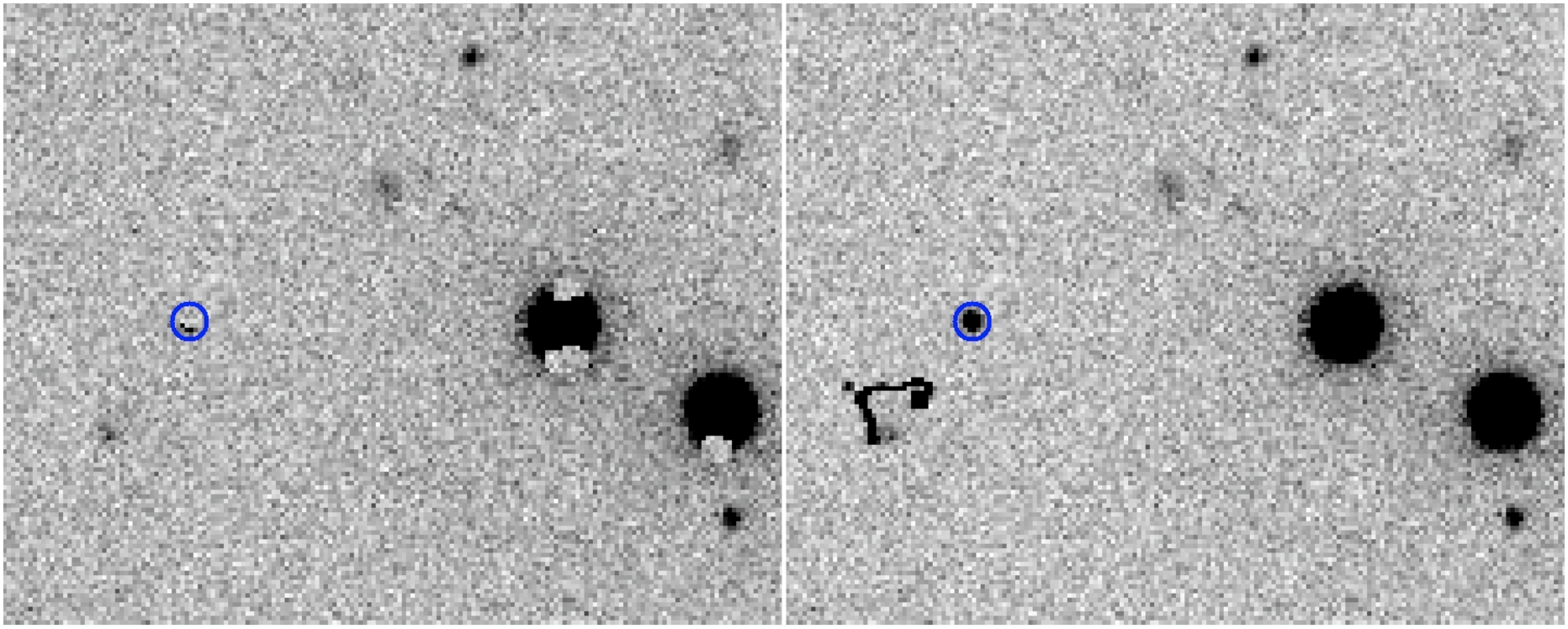
Pacman effect (Huan Lin)



Faint stars masqueraded as cosmic rays due to very low Sextractor thresholds.
Looking for alternate cosmic ray masking algorithms.

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Conclusions and Future Plans

- Stress test with larger size of simulated DES data (this Spring)
- Analysis and release of data from BCS.
- Also will analyze data from other surveys/telescsopes (CFHT, Subaru, Pan-Starrs)

Acknowledgements :

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Dark Energy Survey Collaboration
Blanco Cosmology Survey Collaboration
South Pole Telescope Collaboration
See http://www.usm.lmu.de/~shantanu/schedule.html