

CSST MCI (Multi Channel Imager) and calibration for the main survey

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On behalf of the MCI collaboration

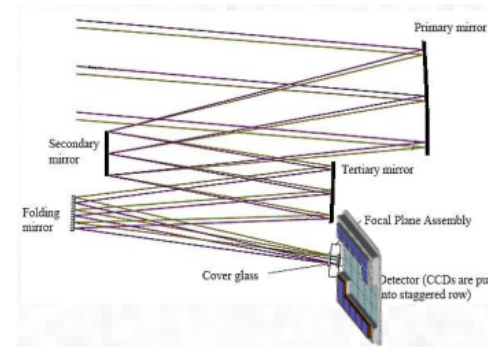
2019.11.4

Outline

- Overview
- MCI Techniques
- MCI Sciences

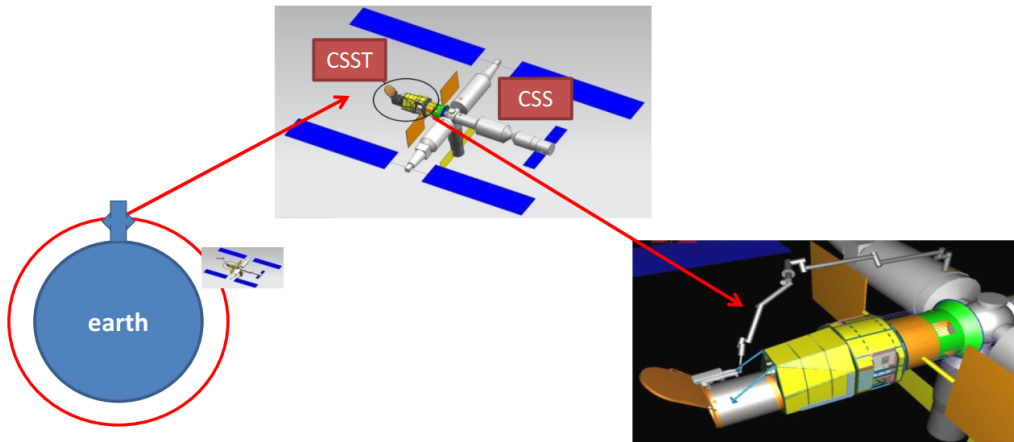
Overview

- Chinese Space Station Telescope (CSST)
- Three-mirror off-axis $D=2\text{m}$
- Same orbit with CSS
- CSS portable for maintenance & service



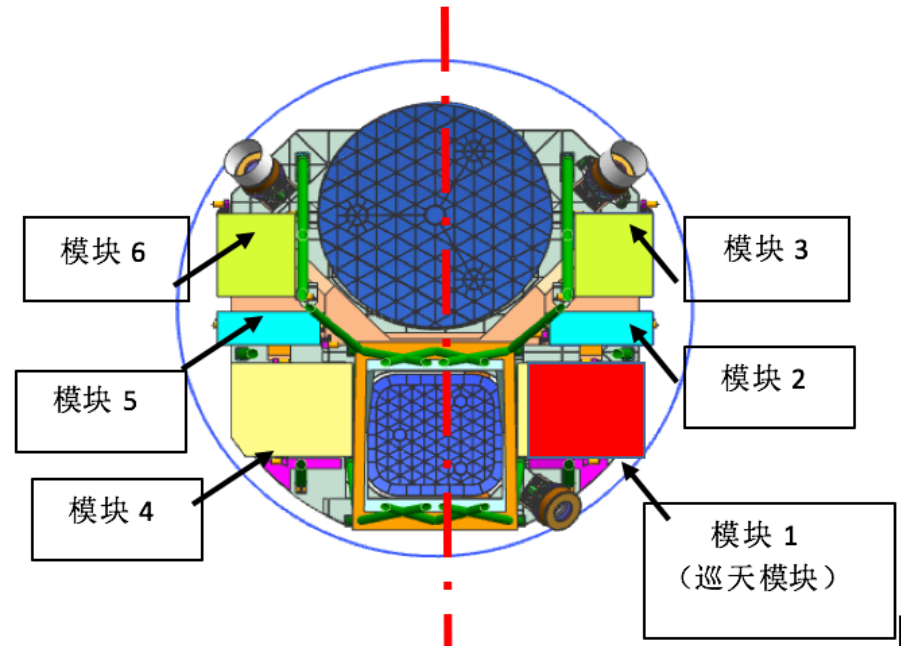
Arrangement of filters & gratings

GI	GV	GU	GU	GV
GI	GV	GU	GU	GV
y	i	g	r	GI
				GI
z	NUV	NUV	u	Y
y	u	NUV	NUV	z
GI	r	g	i	Y
GI				
GV	GU	GU	GV	GI
GV	GU	GU	GV	GI



- Main assembly: large FOV survey camera
- CSS-OS: Cosmology study (WL, SL, BAO, Clusters...)
 - ◆ 17500 deg² wide field, NUV/u/g/r/i/z/y 7 bands imaging+slitless spectra, imaging depth 25.5-26
 - ◆ 400 deg² deep field, NUV/u/g/r/i/z/y 7 bands imaging+slitless spectra, imaging depth 26.5-27
- CSS-OS time: 60-70% operational time of CSST (10yr)

- CAS chose three instruments for CSS Astronomical Precision Assembly in 2018:
 - ◆ Main Survey
 - ◆ IFS
 - ◆ MCI: Multi Channel Imager
 - ◆ Coronagraph
 - ◆ THz
- CSS 20% operational time
($\sim 5\% \times 10$ yr for each instrument)



MCI Technical Plan

Manufacturers: Shanghai Astronomical Observatory Shanghai Institute of Technical Physics

- Multi Channel: two dichroic mirror for three channels (NUV-u, g-r, & i-z)
- Imaging: Each channel equipped w. 9K e2v CCD (0.05"/pixel) and $>\sim 10$ filters (LVF for spectrophotometer)
- Wavelength Range: 0.25-1 micron

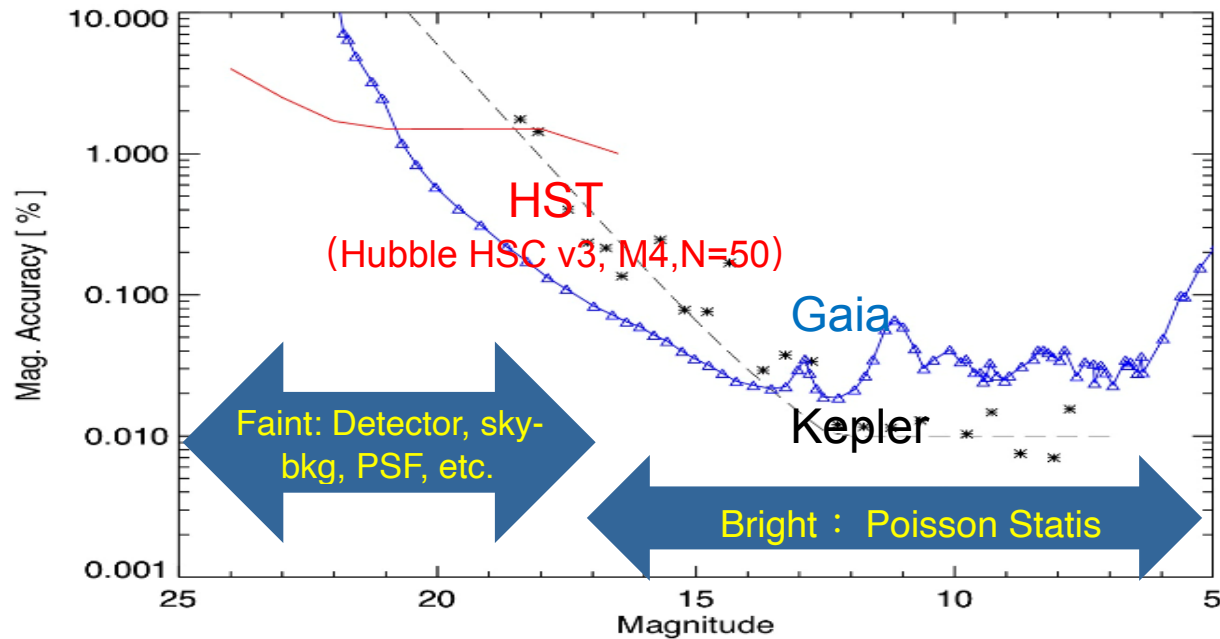
Pros:

- Simultaneous color
- Space-based precision three-band photometry
- Potential for HST-like deep-field capability

	CSST-MCI	CSS-OS
Obs. function	NUV and optical, 3 channel simultaneous FOV: 7.7' x 7.7' ~59 arcmin ²	NUV and optical, single band/slitless spectra FOV: 24 x 11' x 11' ~2900 arcmin ² ~0.8 deg ²
Filters	CSS-OS 6 + other NB/BB filters ~ 30+	6 : NUV/u/g/r/i/z
Imaging Quality (CSST: 0.15")	F-21, scale 0.05"/pixel	F-14, scale 0.074"/pixel
Obs. mode	One field three bands observed simultaneously Diff. T_{exposure} + Diff. filter composition	One field one band Imaging or slitless spectral obs.
High precision photometry	Precision shutter (<0.1s), high-gain Fast readout	Shutter (1.5s open/close) Can't do short exposure for bright sources
Ultra Deep field	Scattered light suppression, Temperature control, low-gain, low-RON	Affected by the bright stars in the full focal plane Can't resolve extremely faint signals

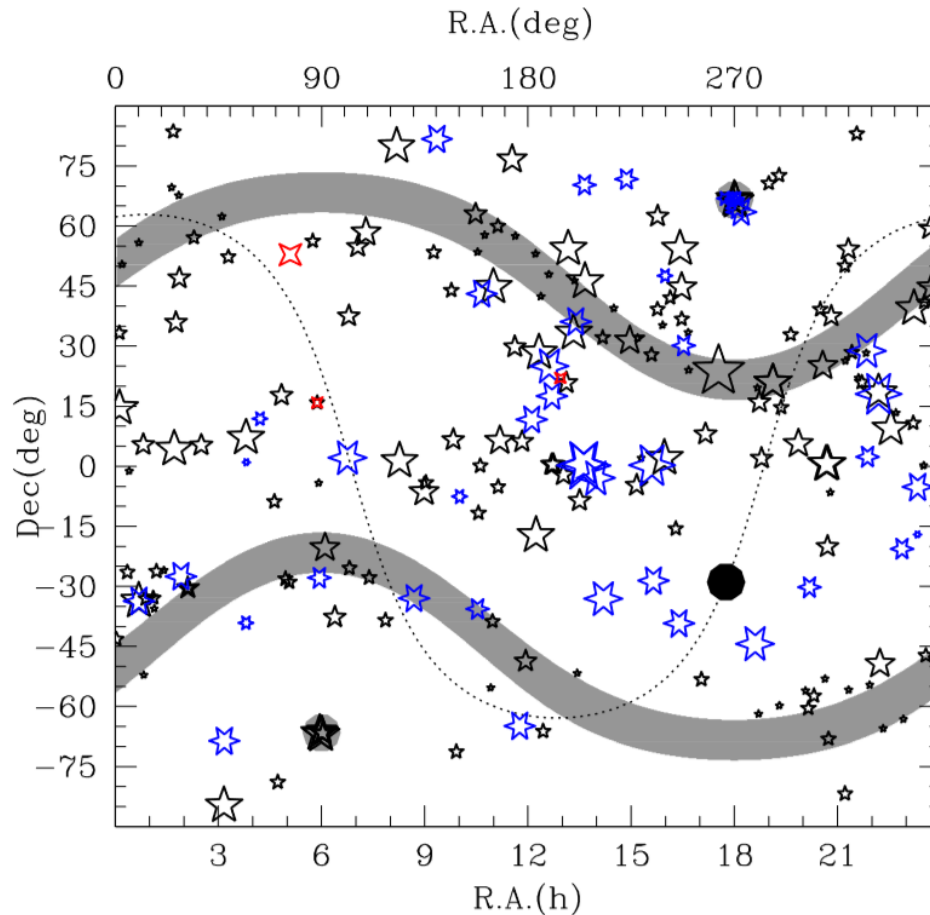
High Precision Photometry

- Limited by atmosphere, the precision of ground-based photometry is hard to reach 1% (systematic uncertainty).

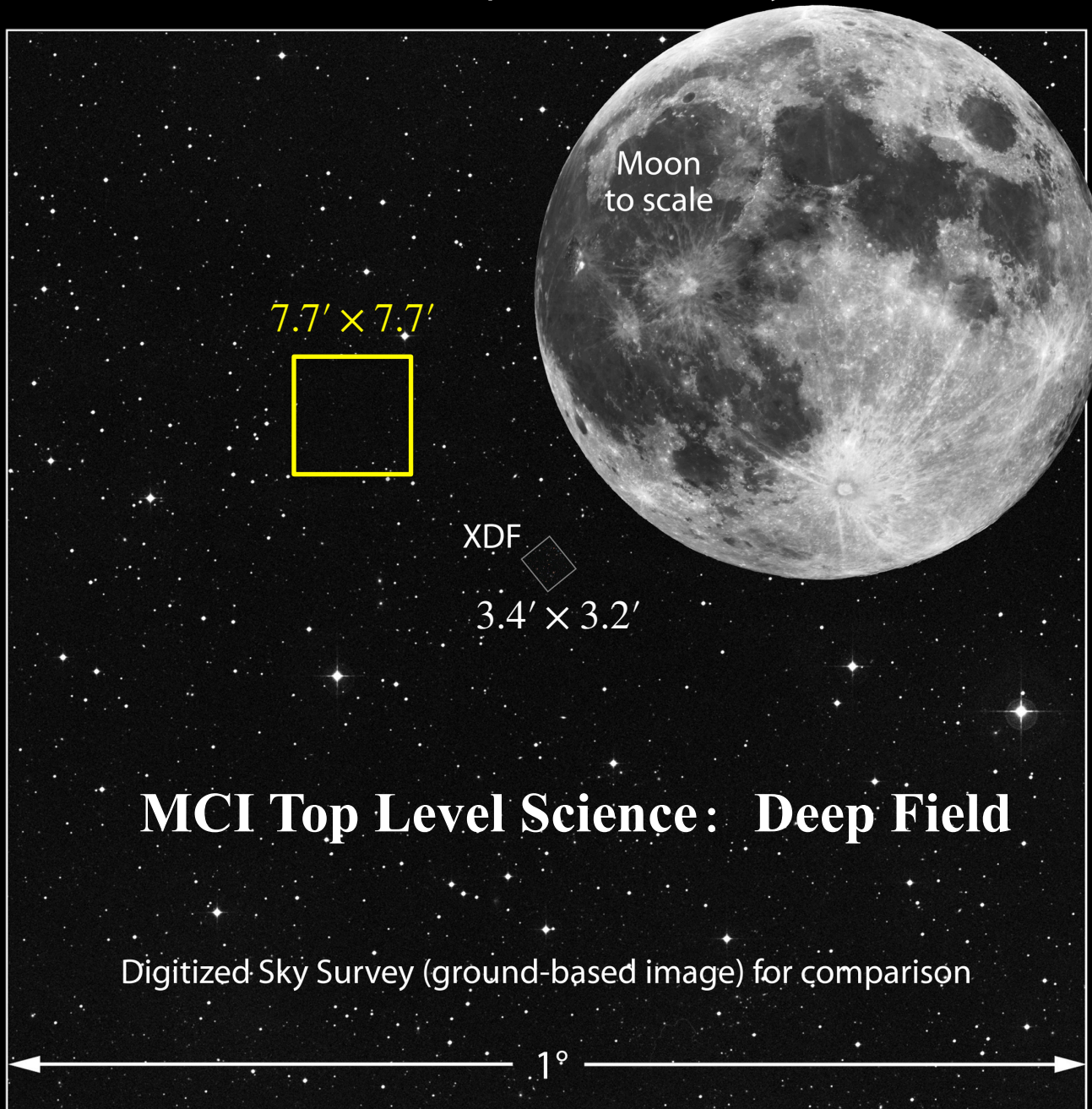


CSS-OS standard star catalog

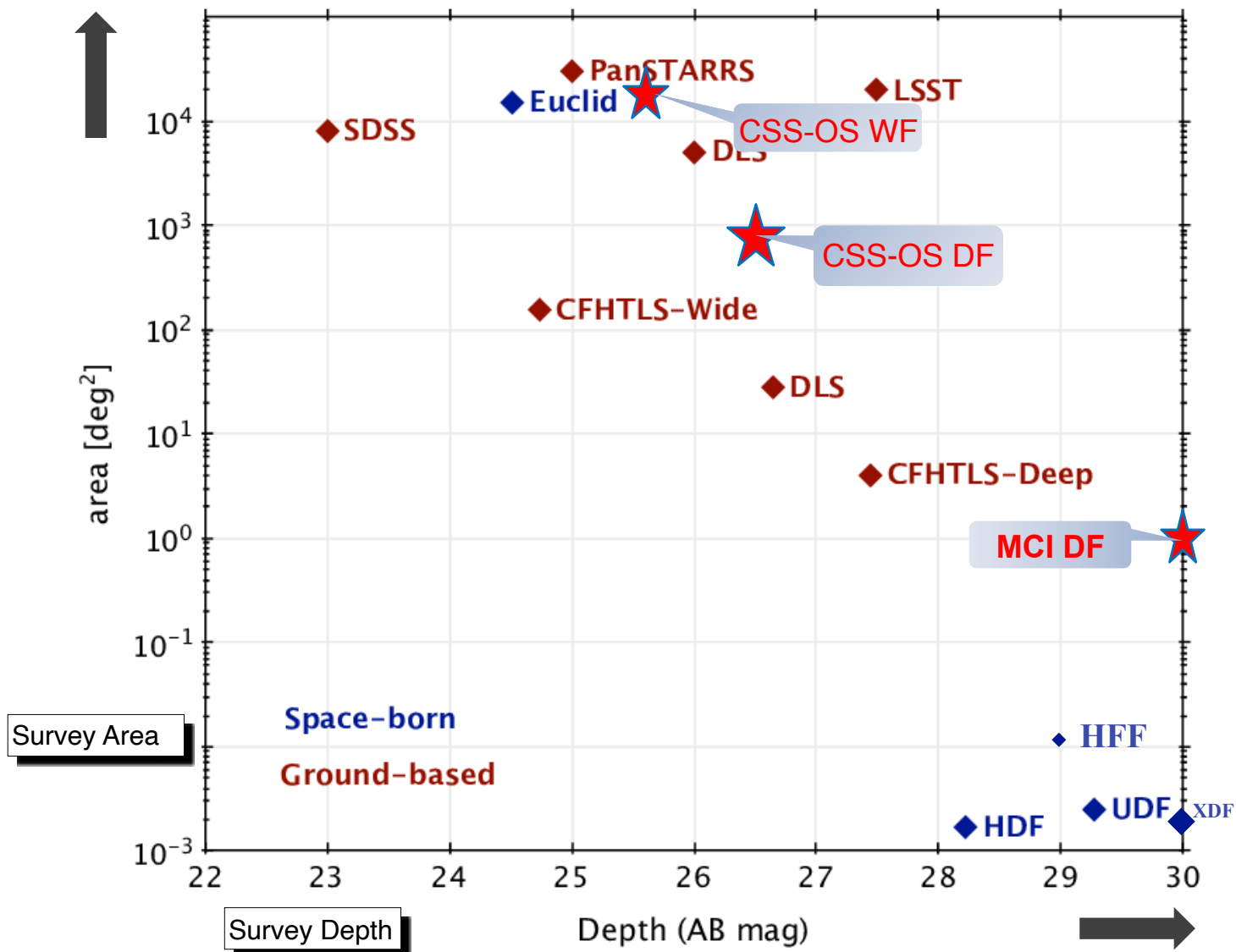
- CSS-OS standard star catalog (17-18 mag) is needed to further improve the photometric accuracy and precision of CSS-OS.



Size of Hubble eXtreme Deep Field on the Sky



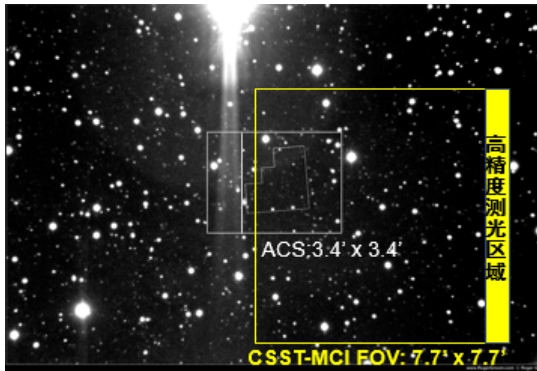
Depth & Area of Optical & Infrared Surveys



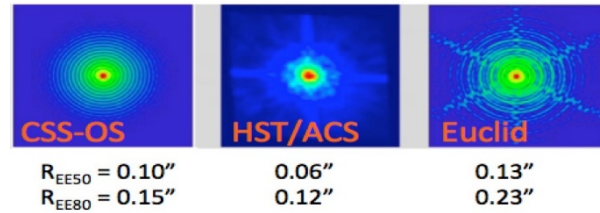
MCI Top Level Science: Deep Field

Technique driven by the top-level science: extremely faint signal detectability

Field Selection

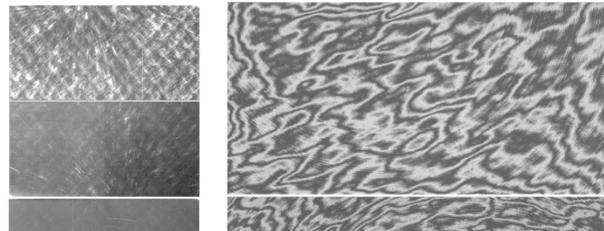


PSF

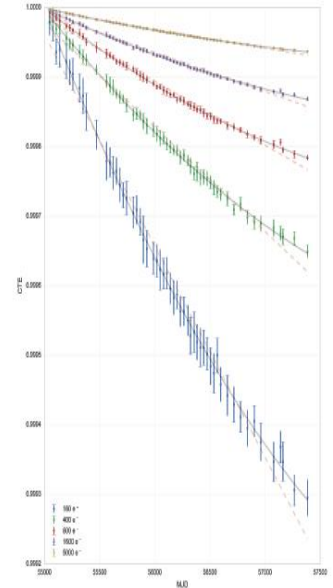


Detector effects

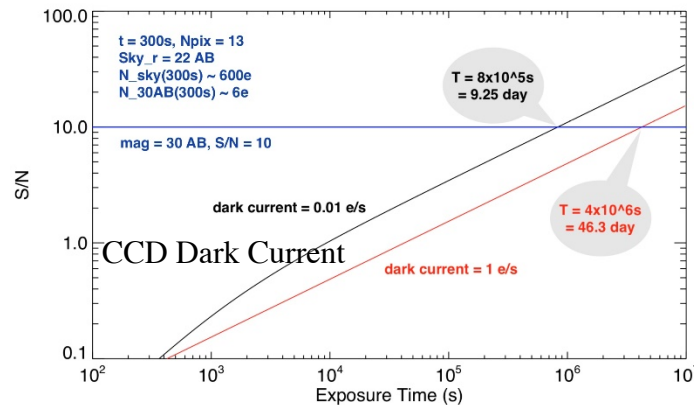
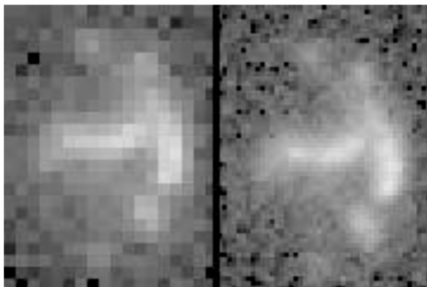
WFC3 Flatfield (L) & fringe (R)



WFC3 CTE

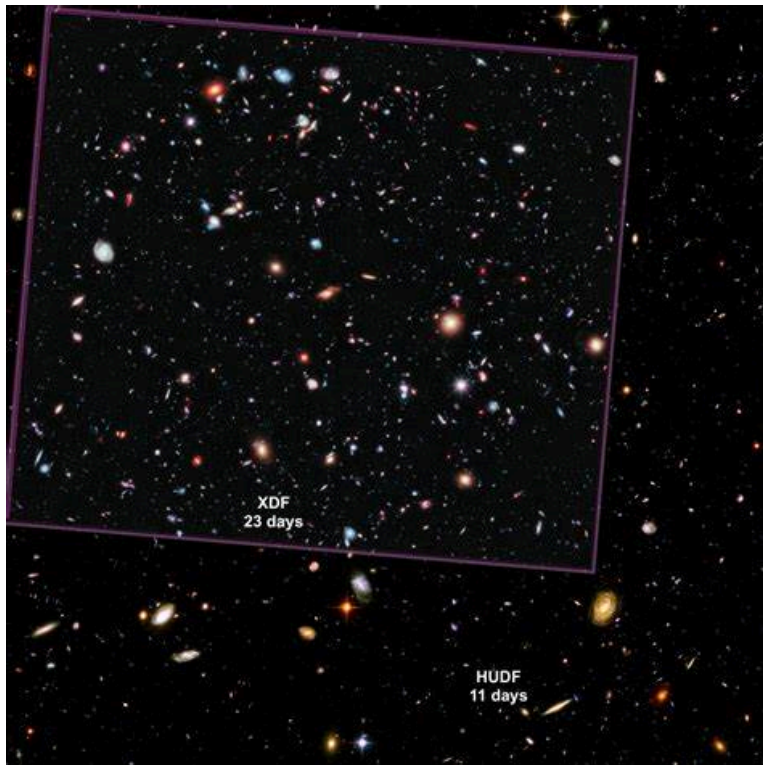


- CCD hot/bad points
- Cosmic ray
- Stacking: Super-Align & Stacking



MCI Deep Field

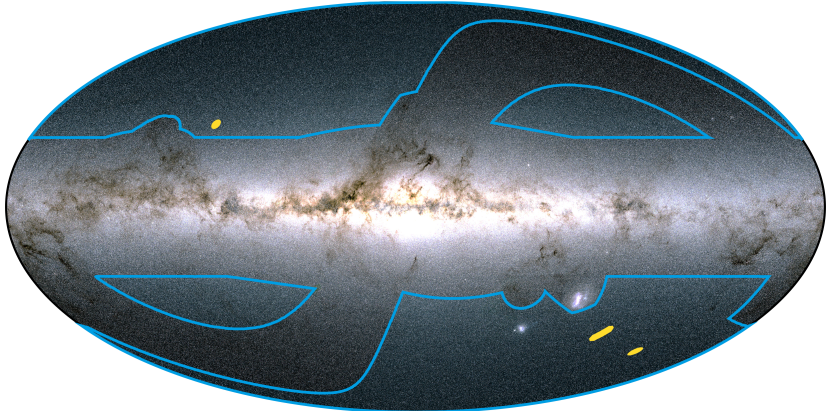
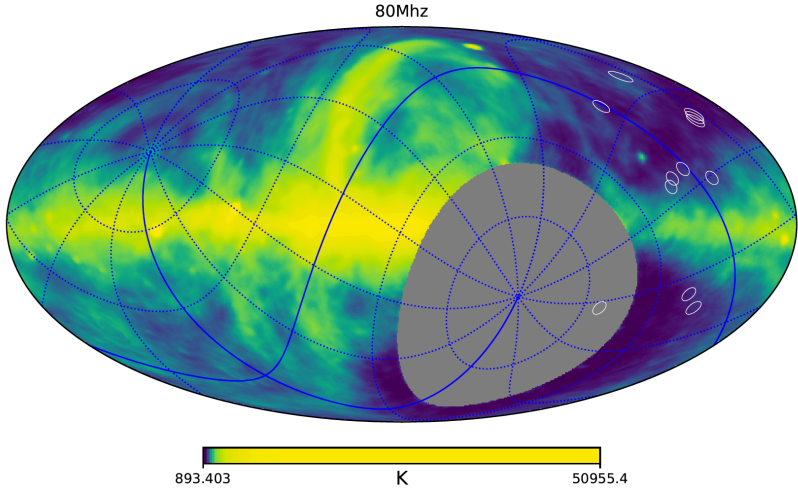
Deep Field



Cluster Deep Field



Deep Fields: Selection



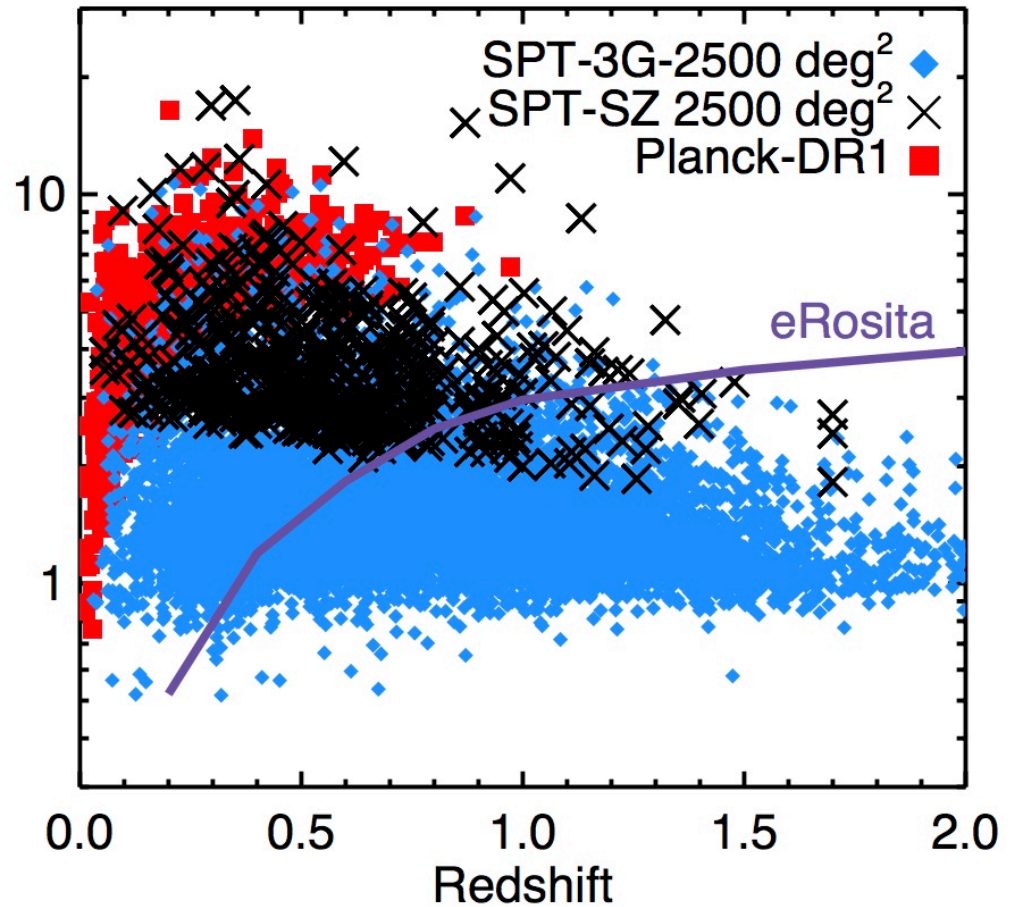
The Euclid Wide Survey and the Euclid Deep Survey [Mollweide Galactic]
Euclid Wide Survey : 15,000 deg.²
Euclid Deep Fields : North=10 deg.², Fornax=10 deg.², South=20 deg.²



Background: ESA-Gaia/DPAC & Euclid Consortium

Zheng et al. 2019

Cluster Deep Field: Selection



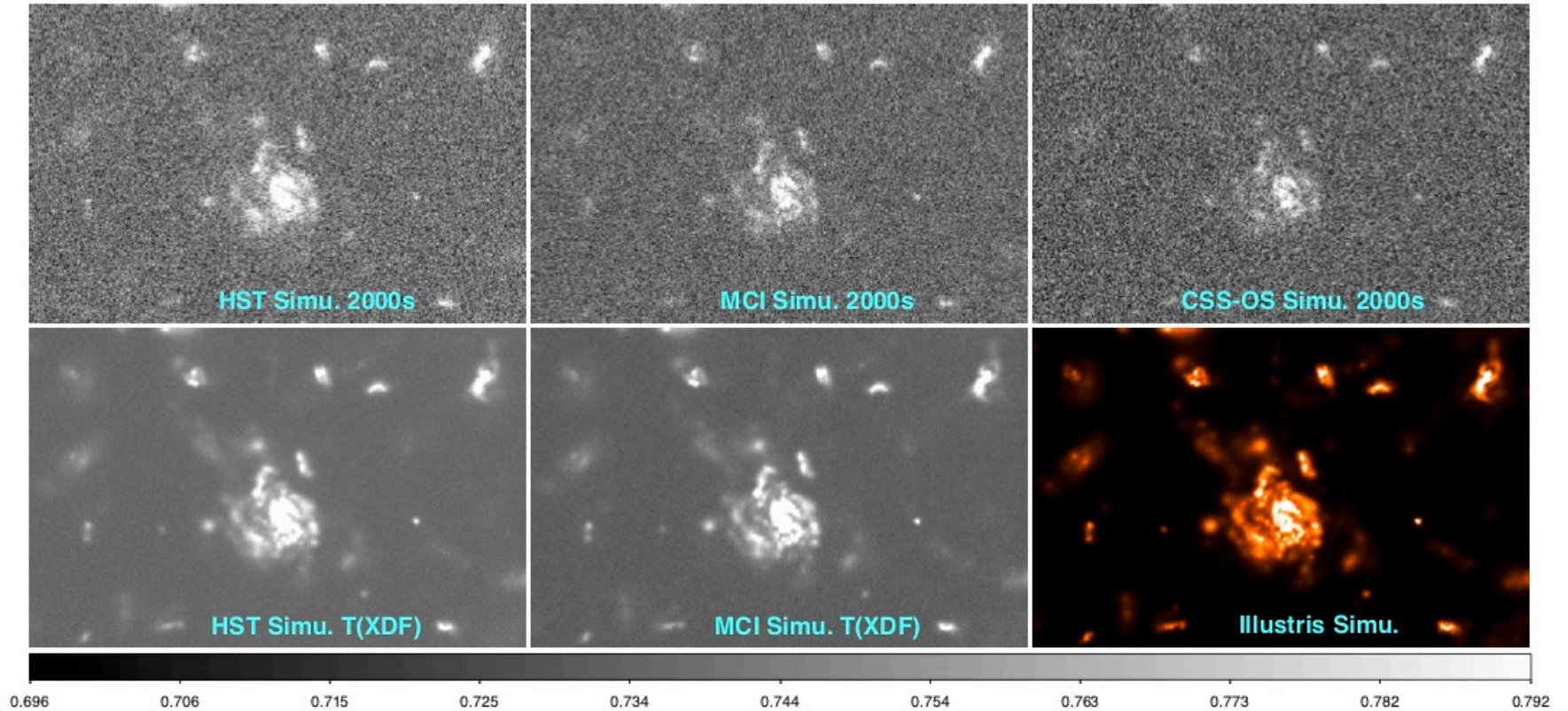
Science topics:

- Calibration for CSS-OS main survey
- SL Cluster

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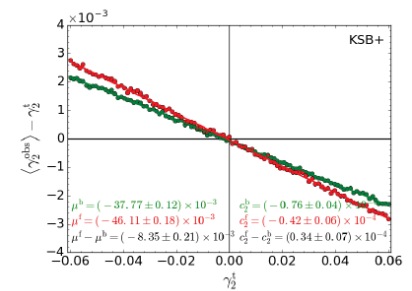
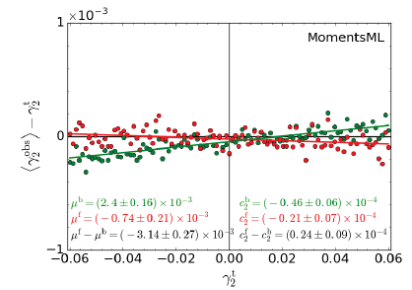
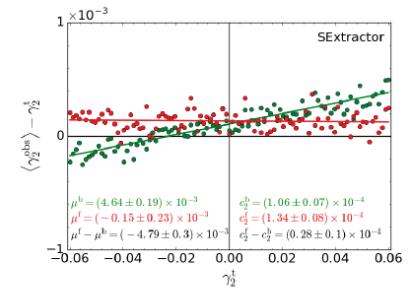
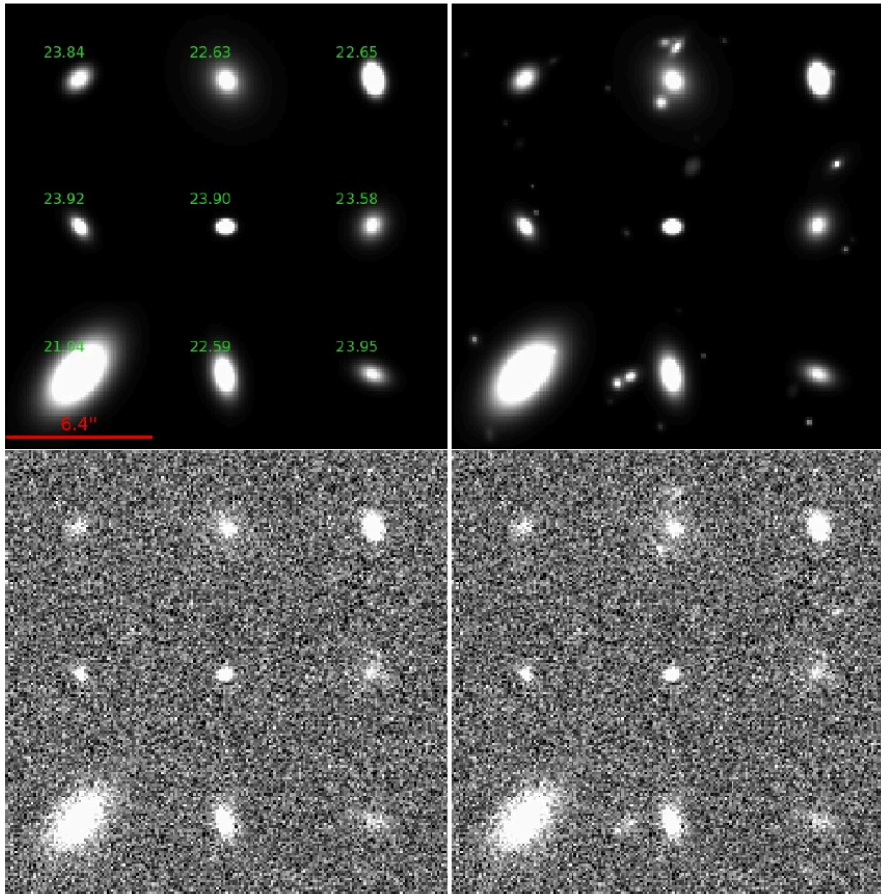
- **Calibration for CSS-OS main survey**
- SL Cluster

Shape measurement

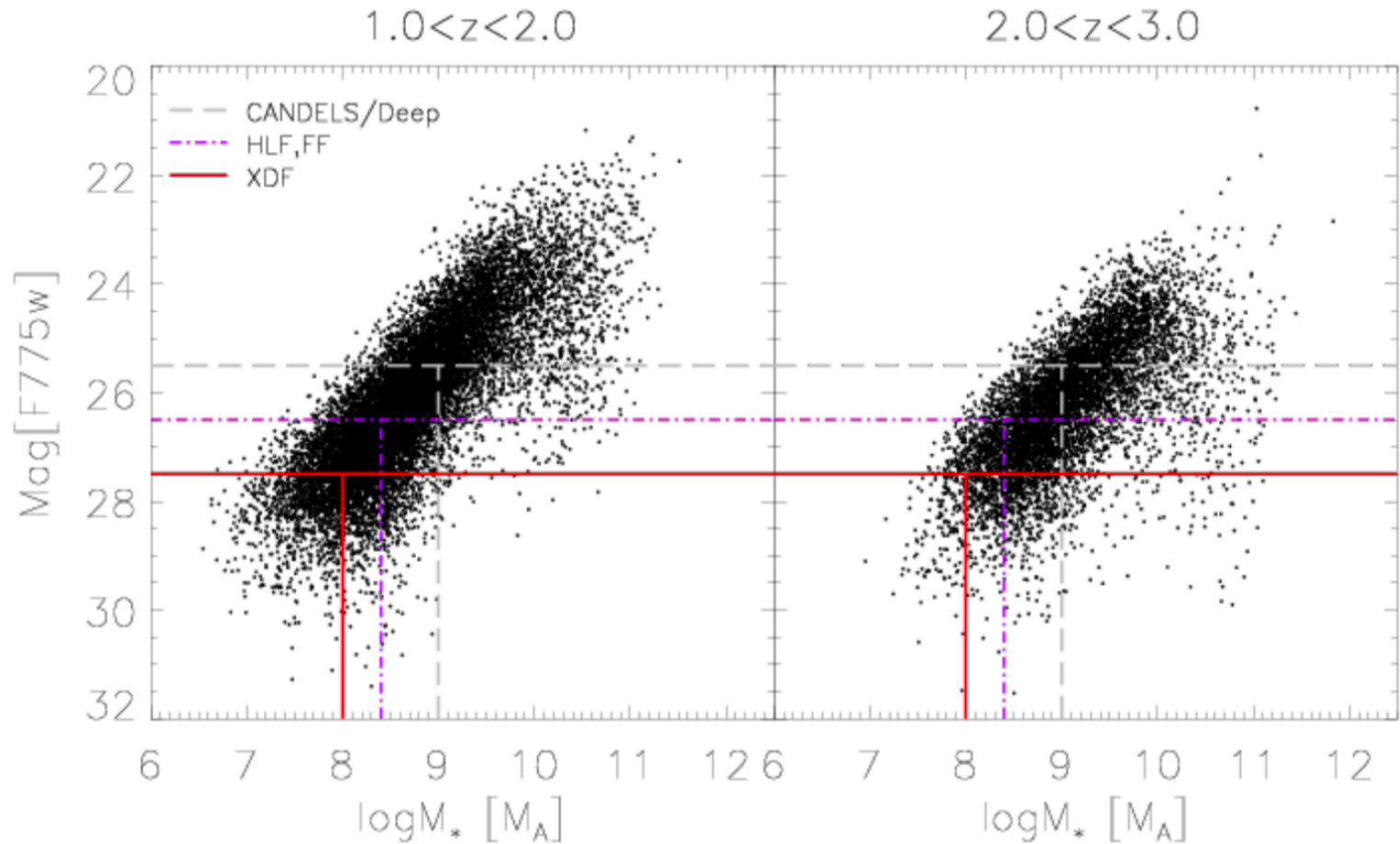


Dezi Liu

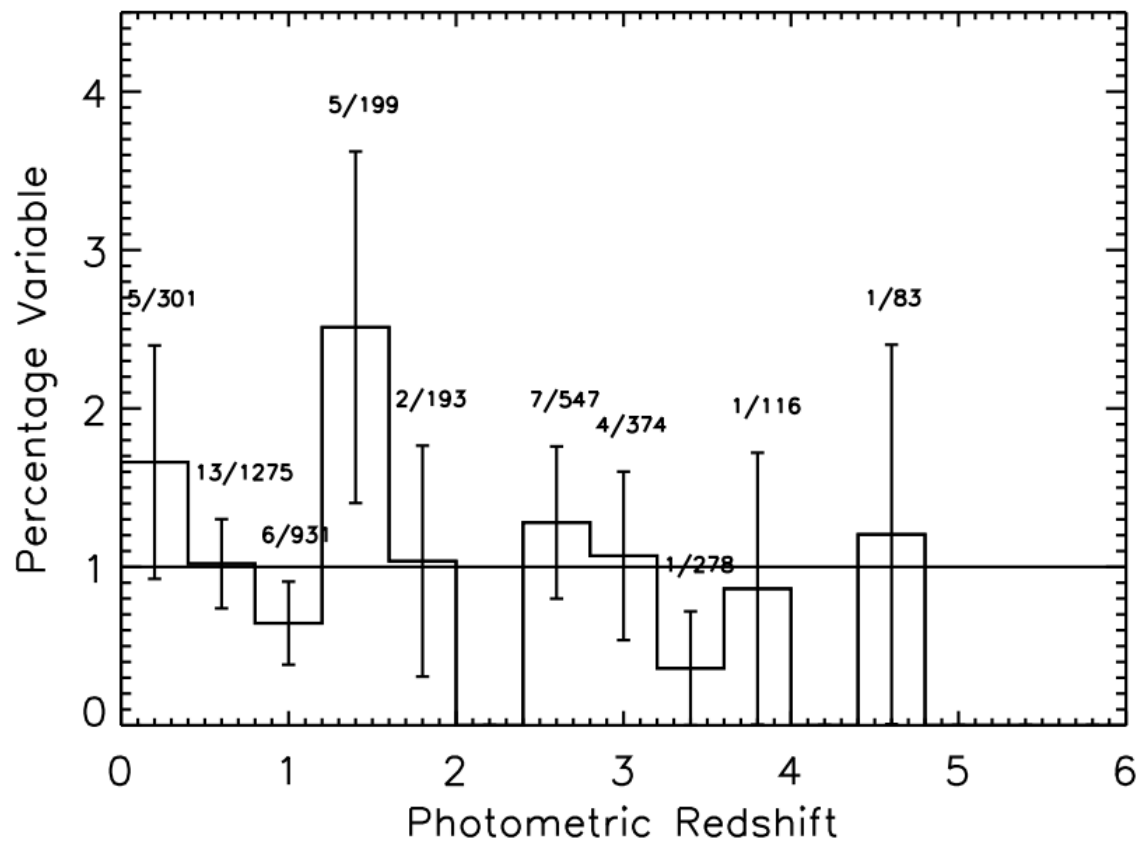
Shape measurement



Galaxy selection function



Photometry Bias by Optical Variability



Summary

- MCI: Multi Channel Imager
- MCI deep field
- Calibration for CSS-OS main survey

Thank you!