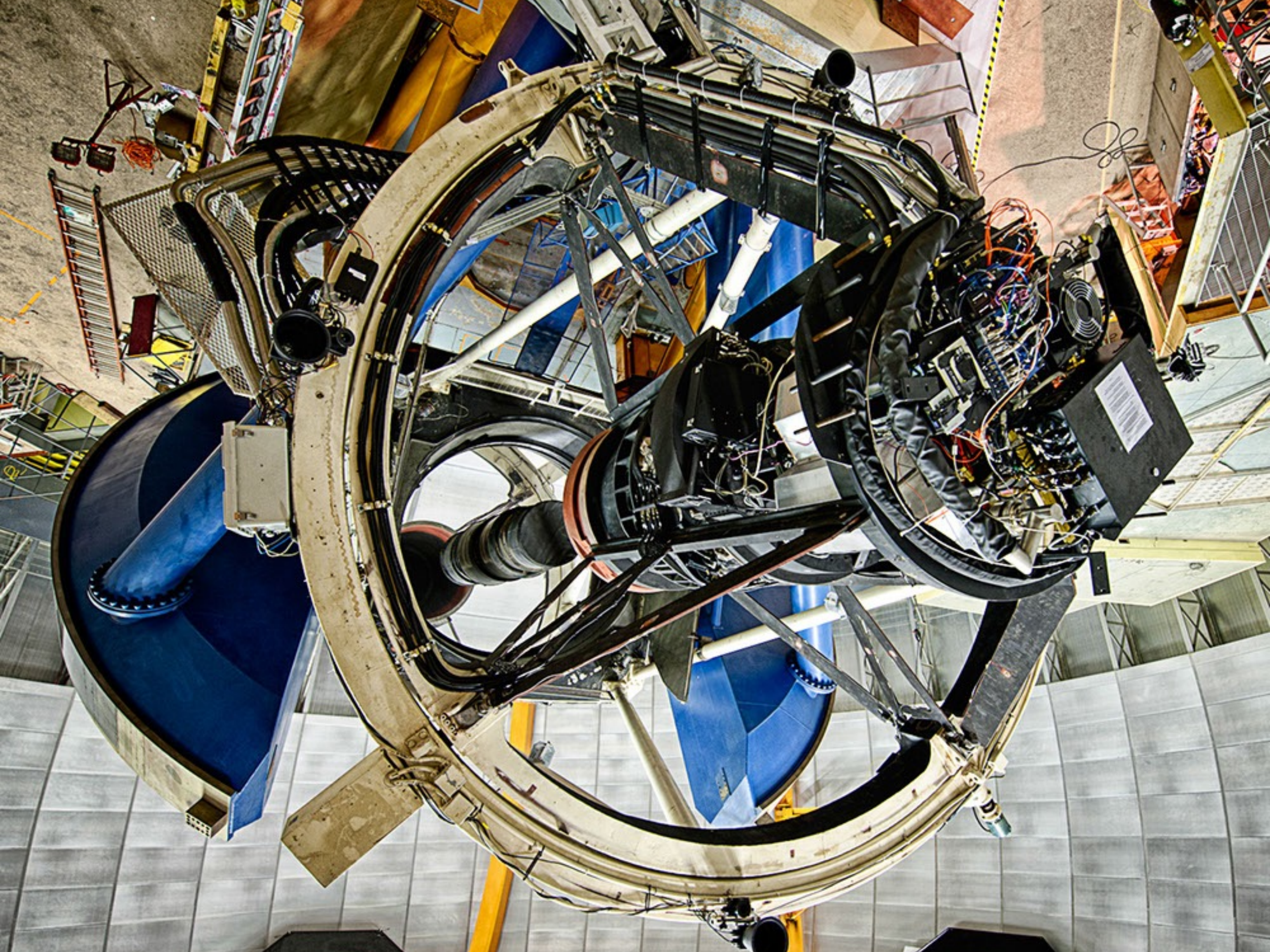
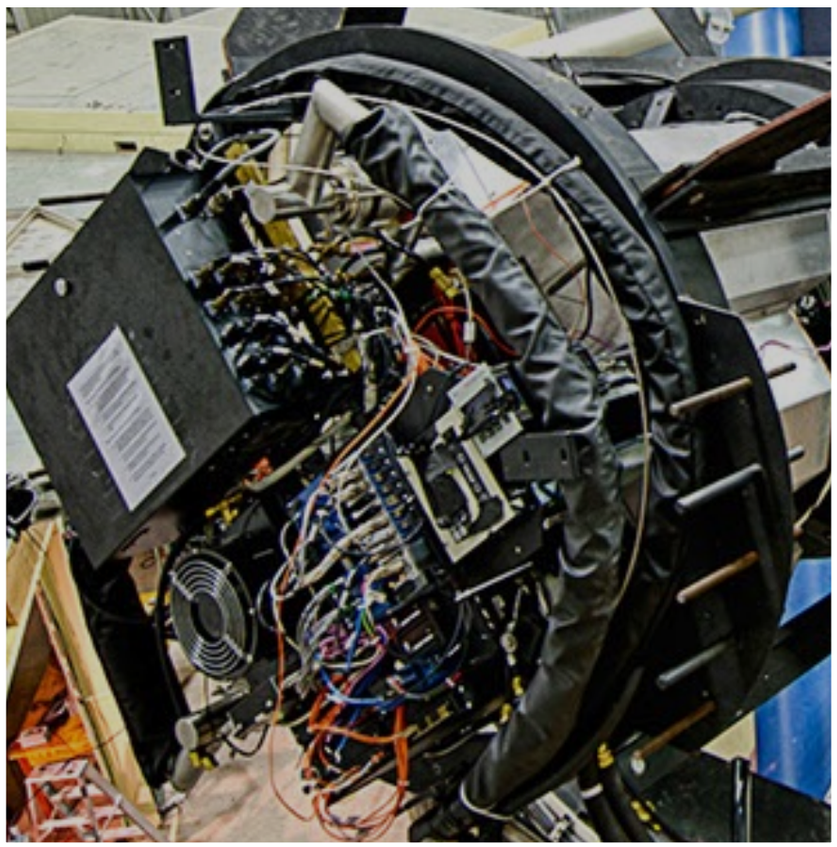
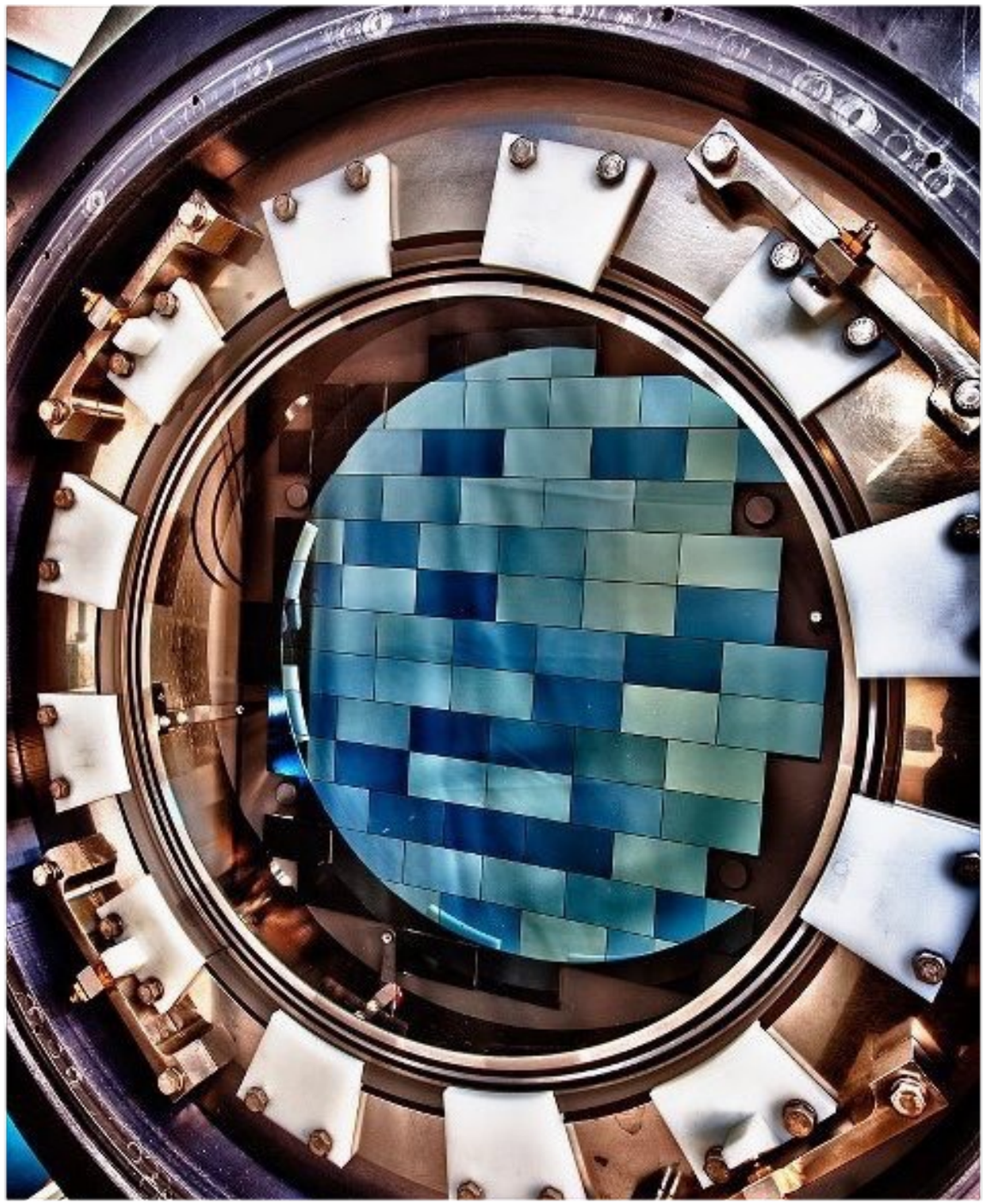
DARK ENERGY SURVEY

STATUS, RESULTS, ALGORITHMIC IMPROVEMENTS

Peter Melchior







1ST LIGHT: 12 SEPT. 2012

Fornax cluster

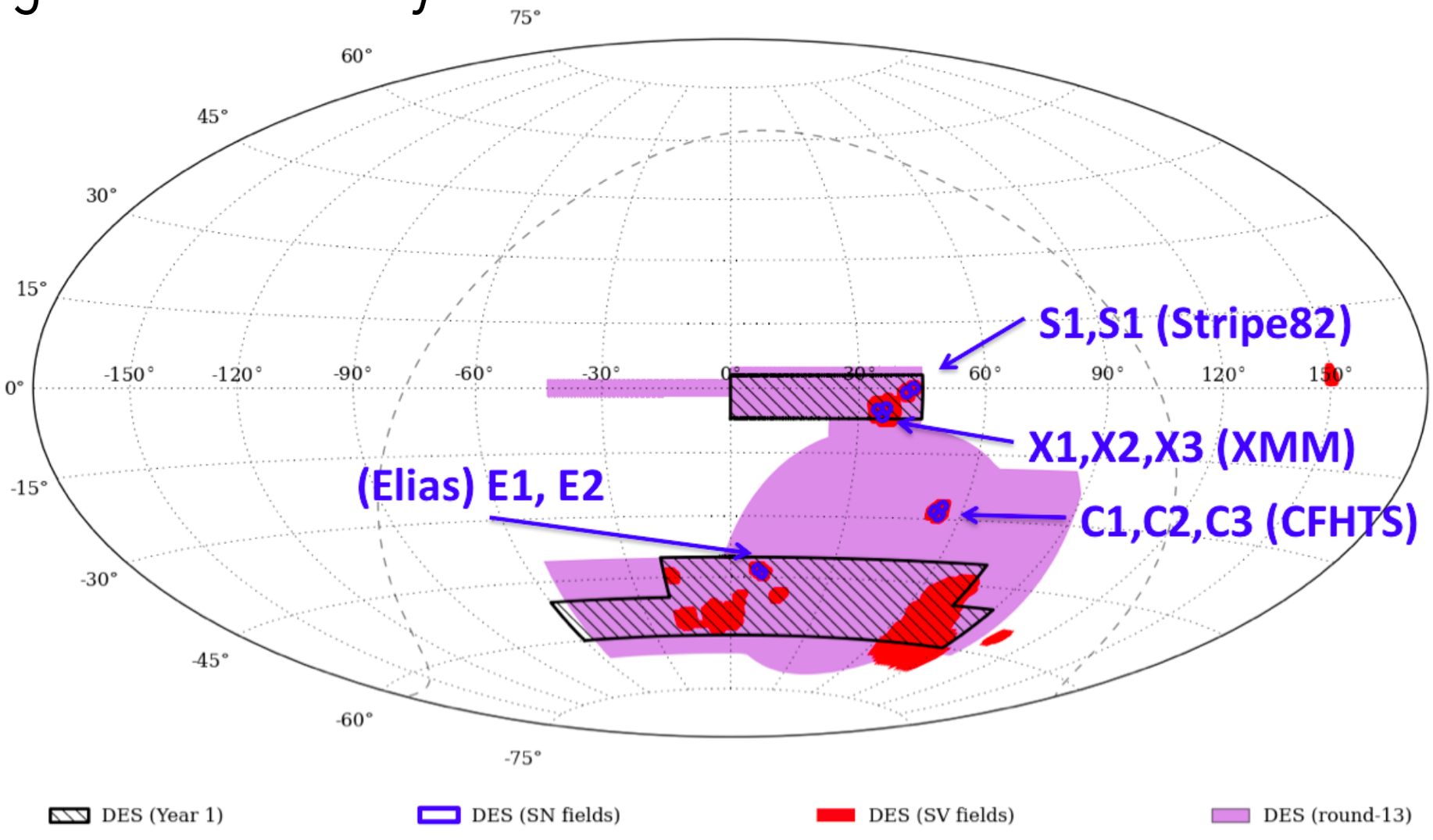
1ST LIGHT: 12 SEPT. 2012

1 chip

SURVEY/OBSERVATION STRATEGY

DARK ENERGY SURVEY

- 525 nights over 5 seasons
- 5000 sq. degrees (main survey) vs. 24 + 6 sq. deg (SN survey)
- Seeing > 1.1″ or 7 days since last observation ⇒ SN

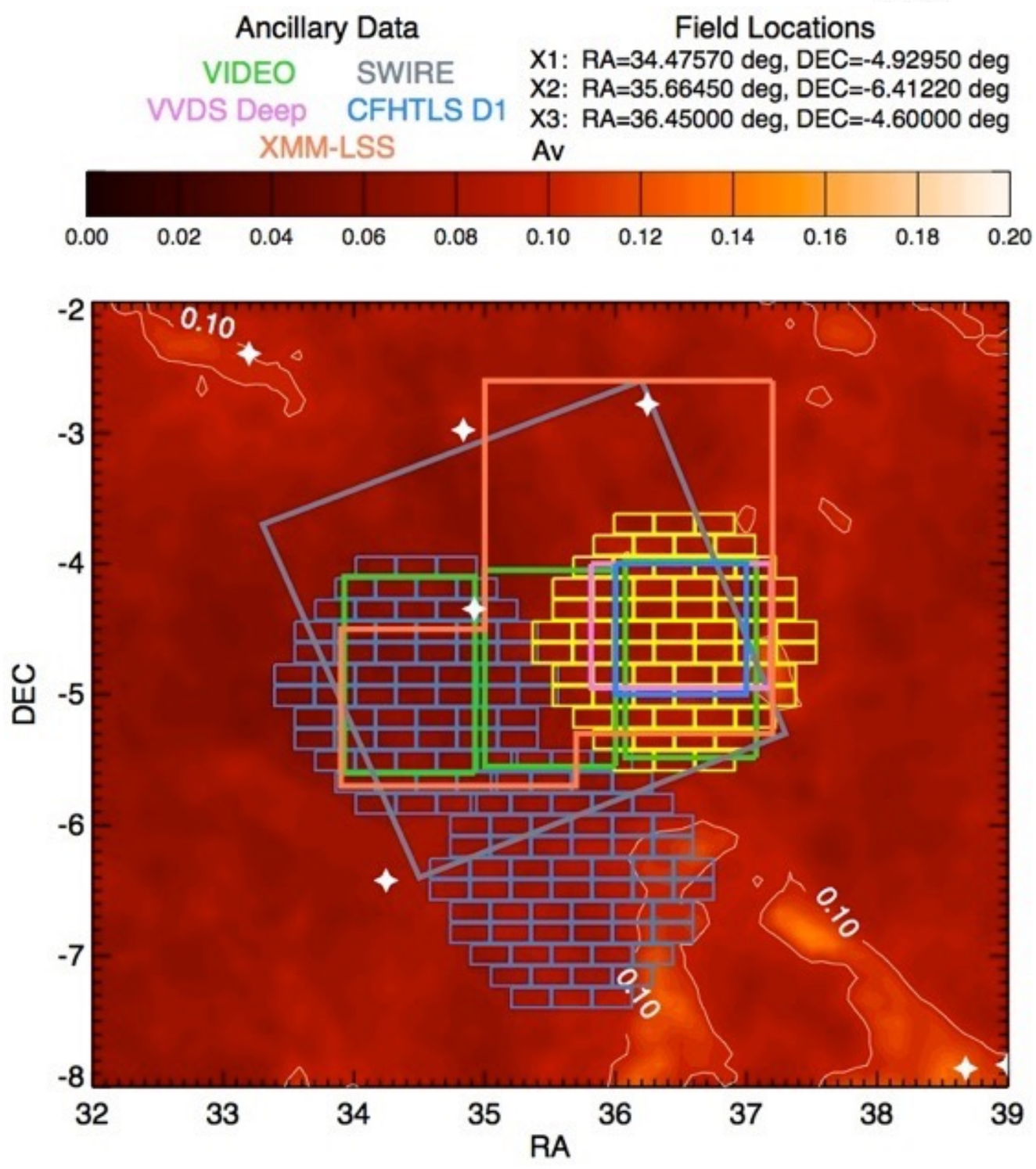


SN SURVEY

- 8 shallow & 2 deep fields

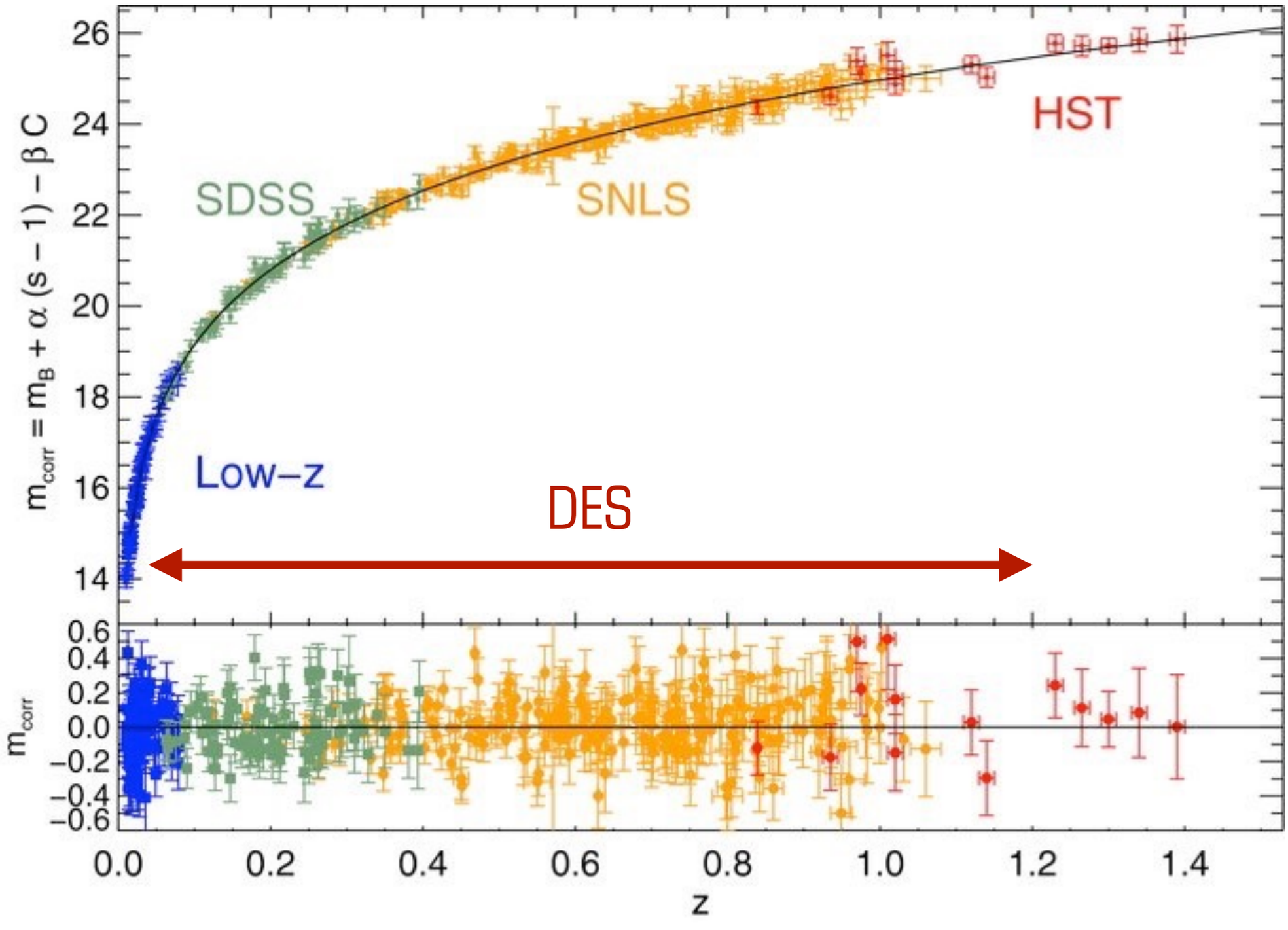
Filter	Shallow Field Exposure Time (s)	Limiting Mag	Deep Field Exposure Time (s)	Limiting Mag
g	175	24.9	600	25.6
r	150	24.3	1200	25.4
i	200	23.9	1800	25.1
z	400	23.8	3630	24.8

- 5 months/season
- 5 day nominal cadence
- 3500 SN Ia expected



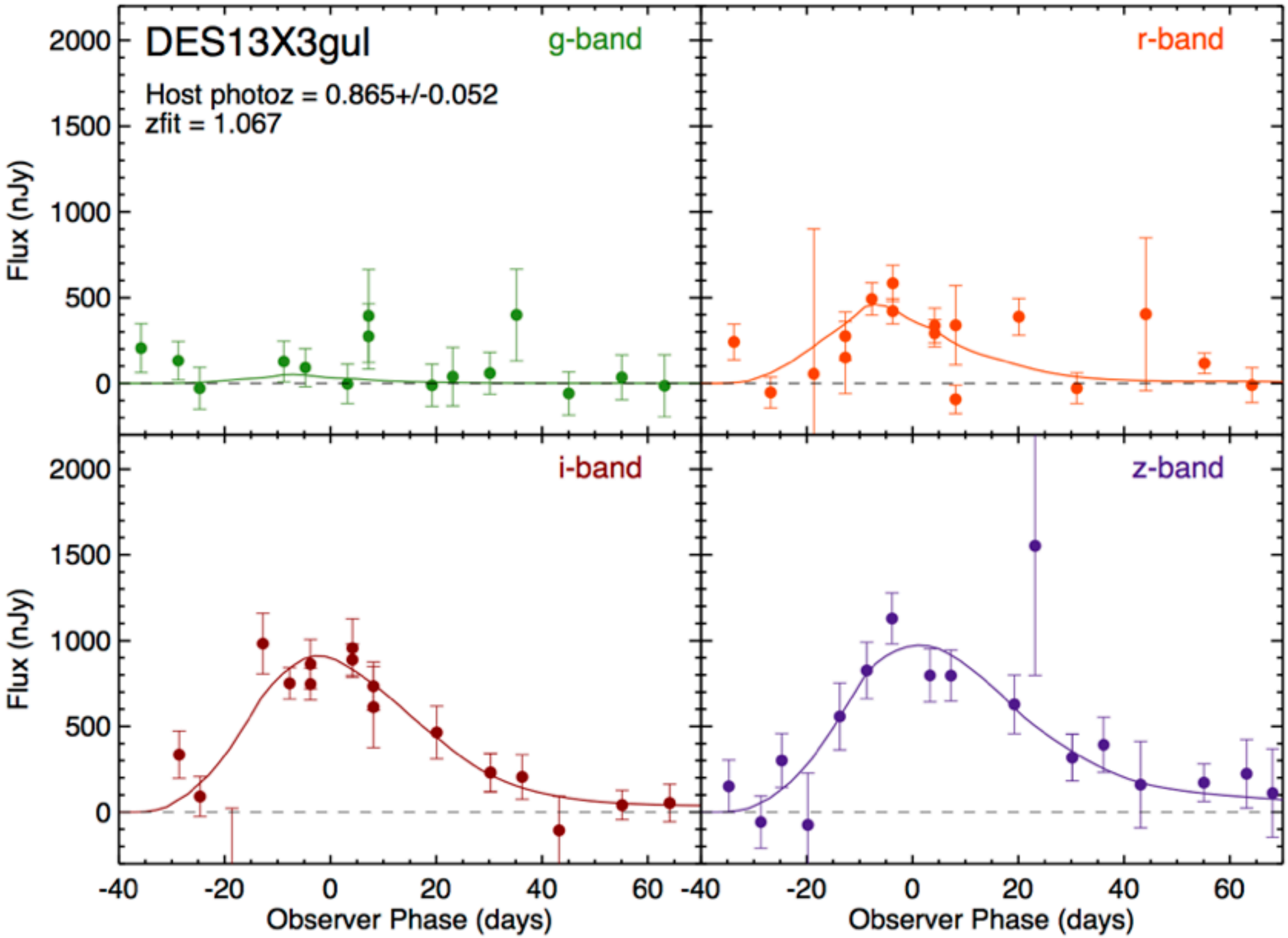
SN IA REDSHIFTS

DARK ENERGY SURVEY

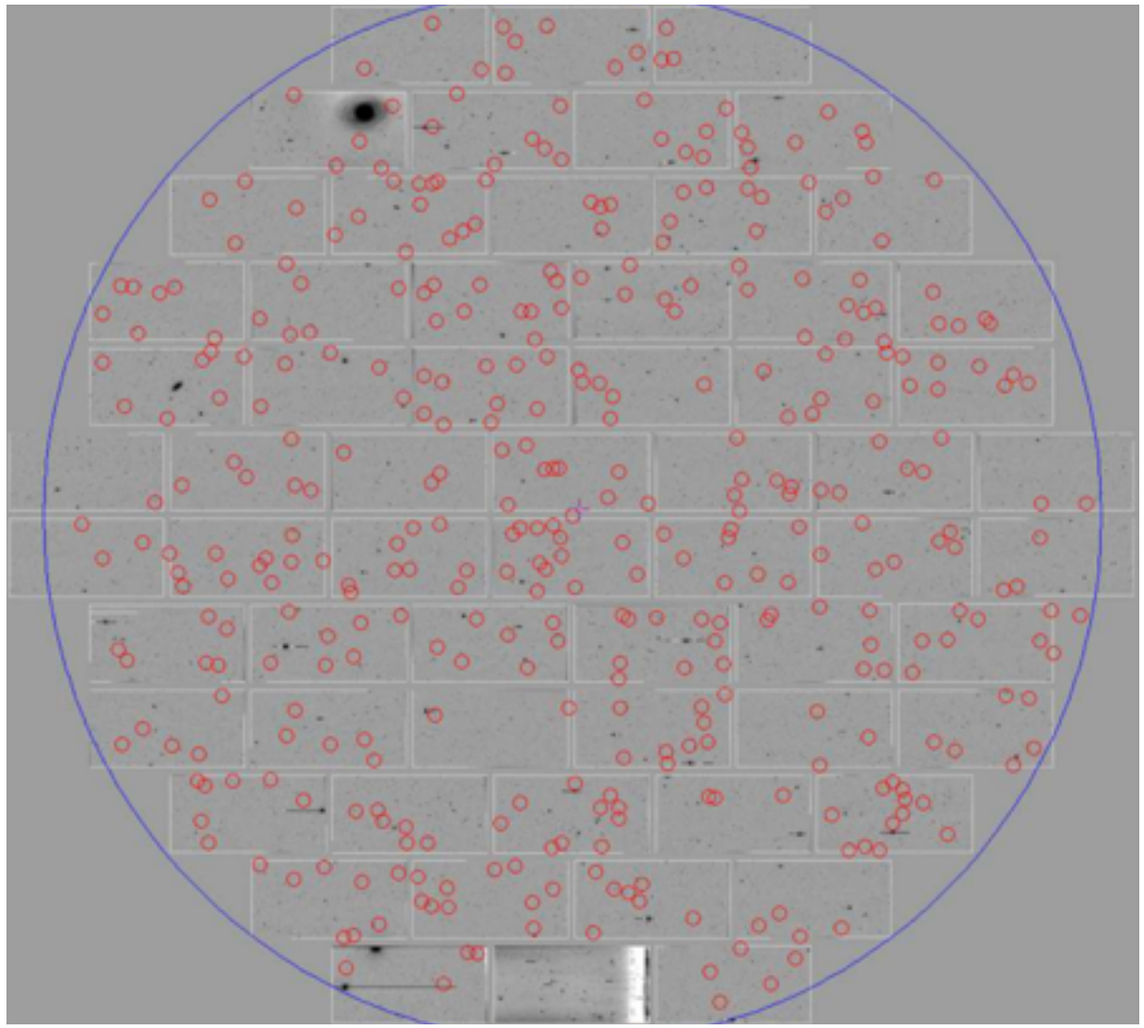


FIRST SN IA DETECTIONS

DARK ENERGY SURVEY



OZDES

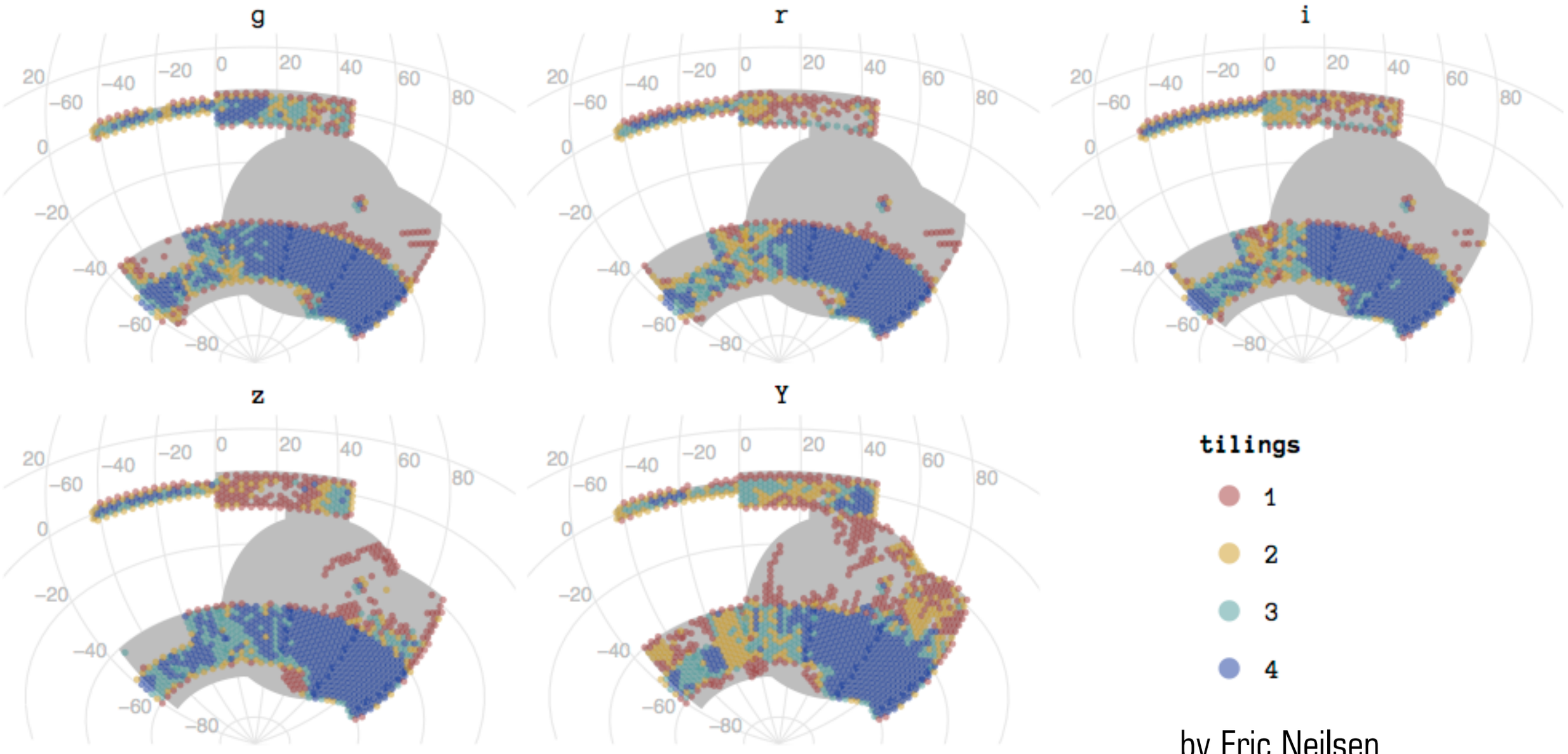


- AAOmega/2dF on AAT:
  near-perfect overlap with DECam FoV
- SN hosts targeted repeatedly to build depth
- 100 nights over 5 years:
  SV: 5 SN Ia & 2 SNother confirmed
  Y1 - Y3: 1300 SN Ia, 251 confirmed

MAIN SURVEY

DARK ENERGY

10 tilings x 90 s ⇒ mag. limit 25.2 (g) .. 23.4 (z)



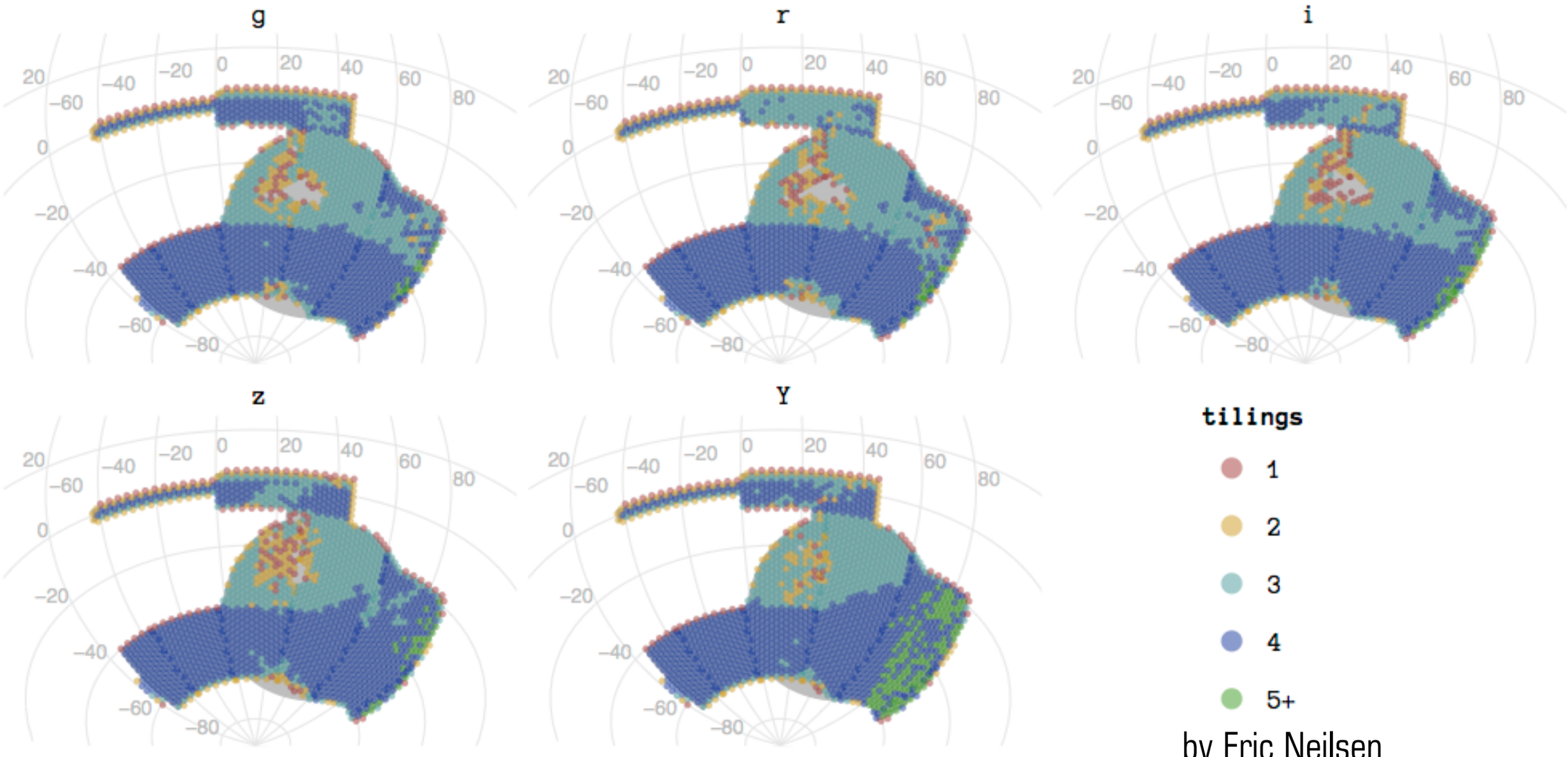
by Eric Neilsen

Survey completeness after Y1

MAIN SURVEY

DARK ENERGY

10 tilings x 90 s ⇒ mag. limit 25.2 (g) .. 23.4 (z)



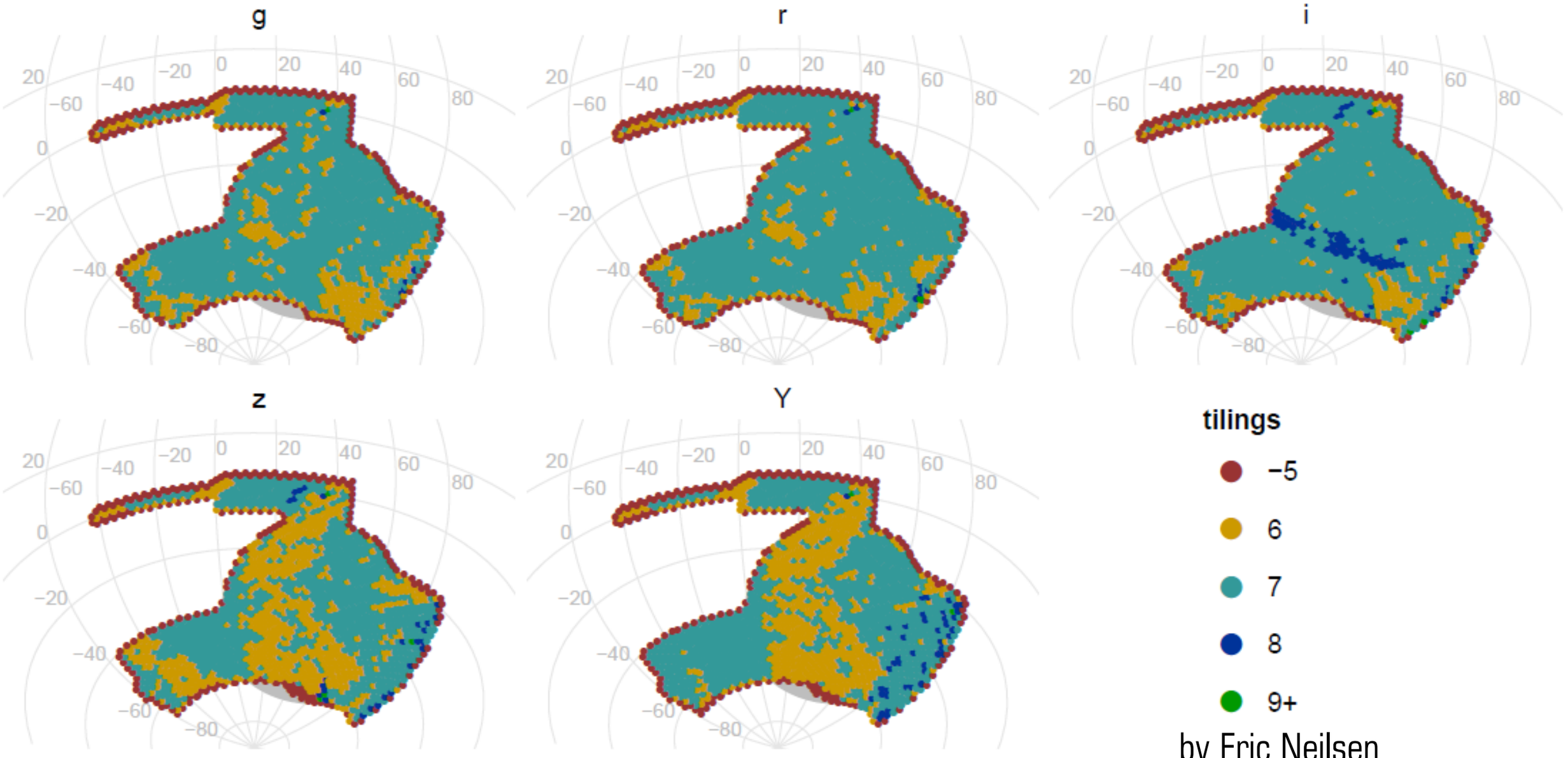
by Eric Neilsen

Survey completeness after Y2

MAIN SURVEY

DARK ENERGY SURVEY

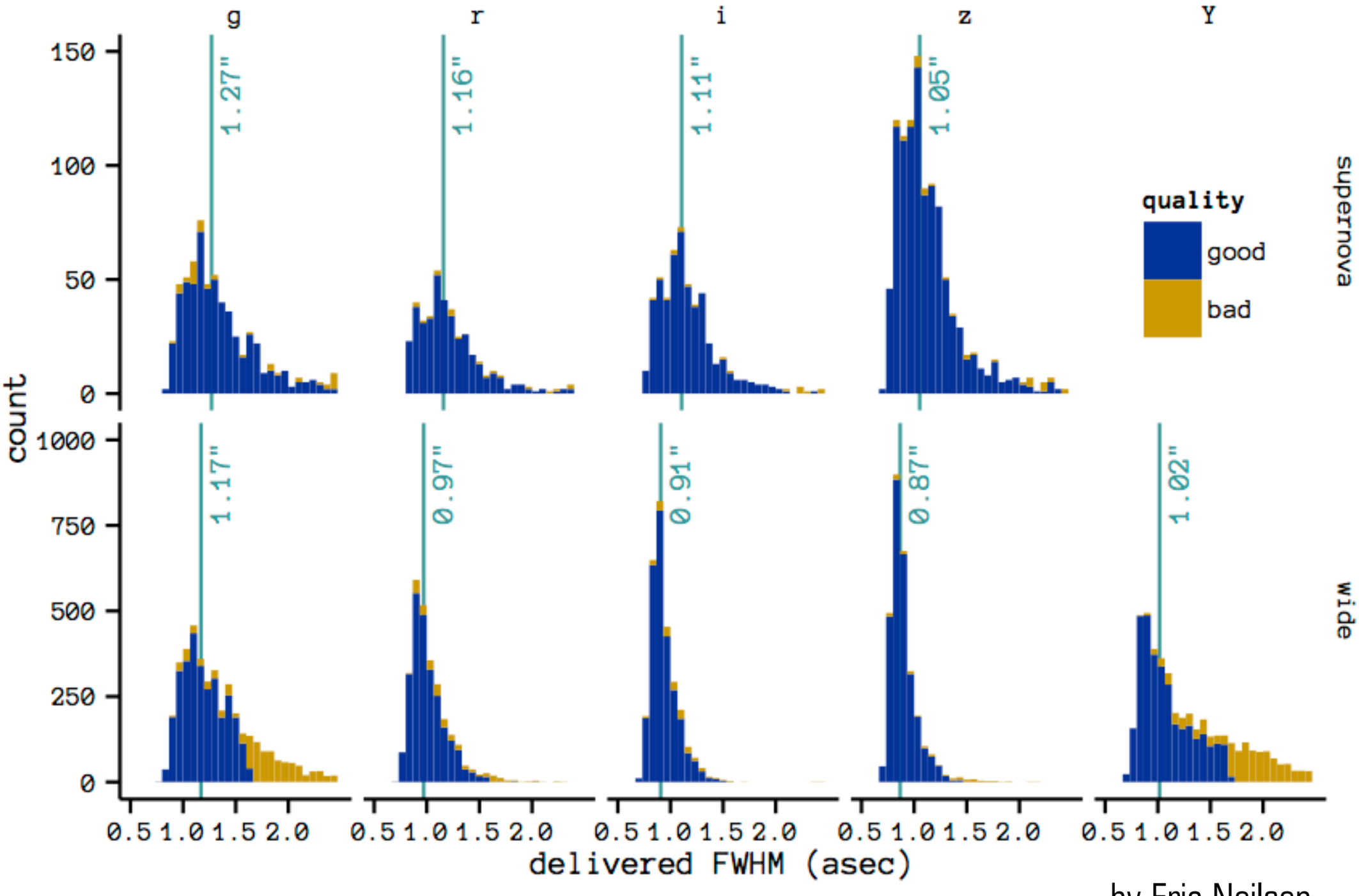
10 tilings x 90 s ⇒ mag. limit 25.2 (g) .. 23.4 (z)



Survey completeness after Y4

IMAGE QUALITY

DARK ENERGY SURVEY

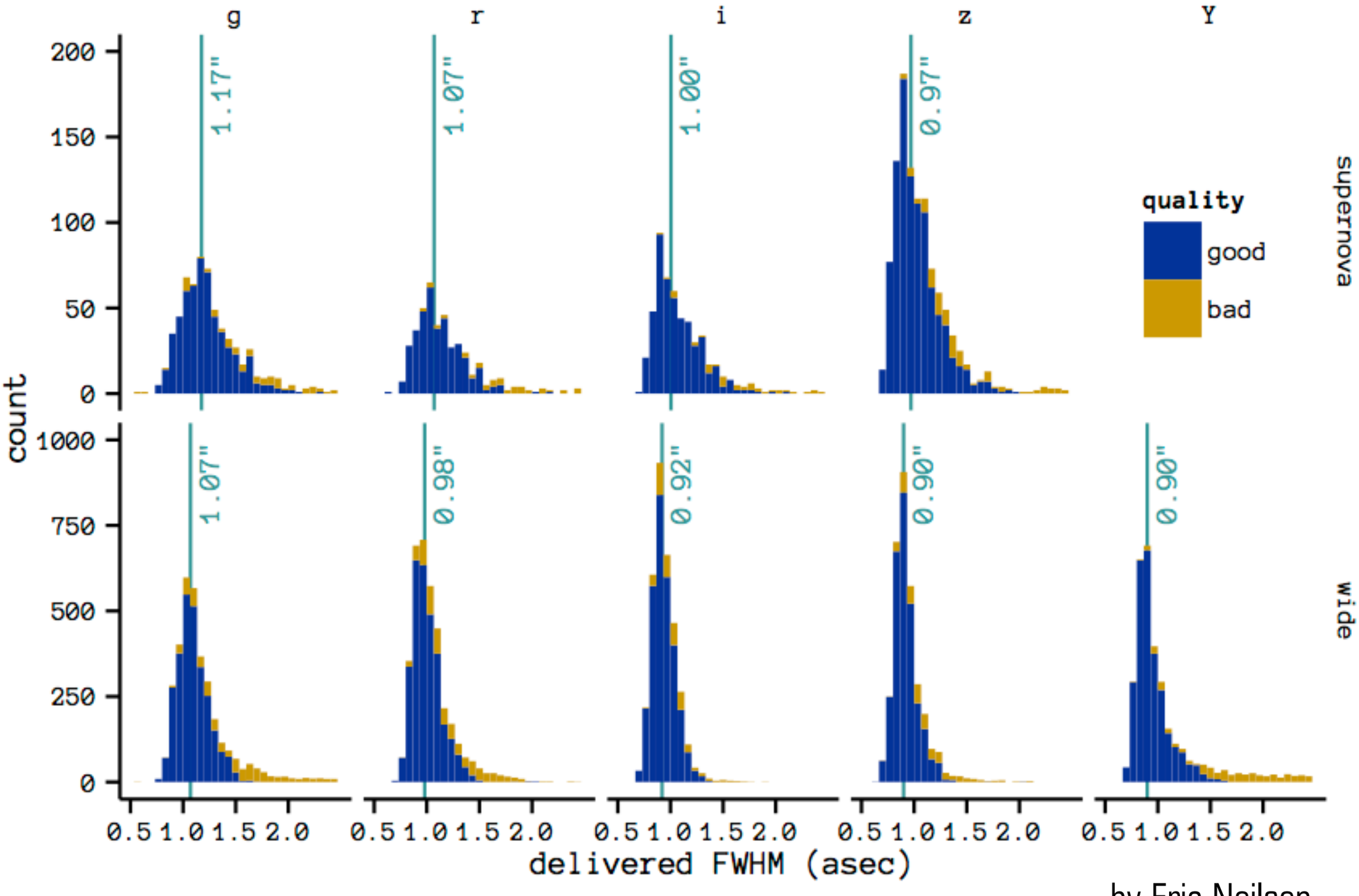


Seeing distribution in Y1

by Eric Neilsen

IMAGE QUALITY

DARK ENERGY SURVEY

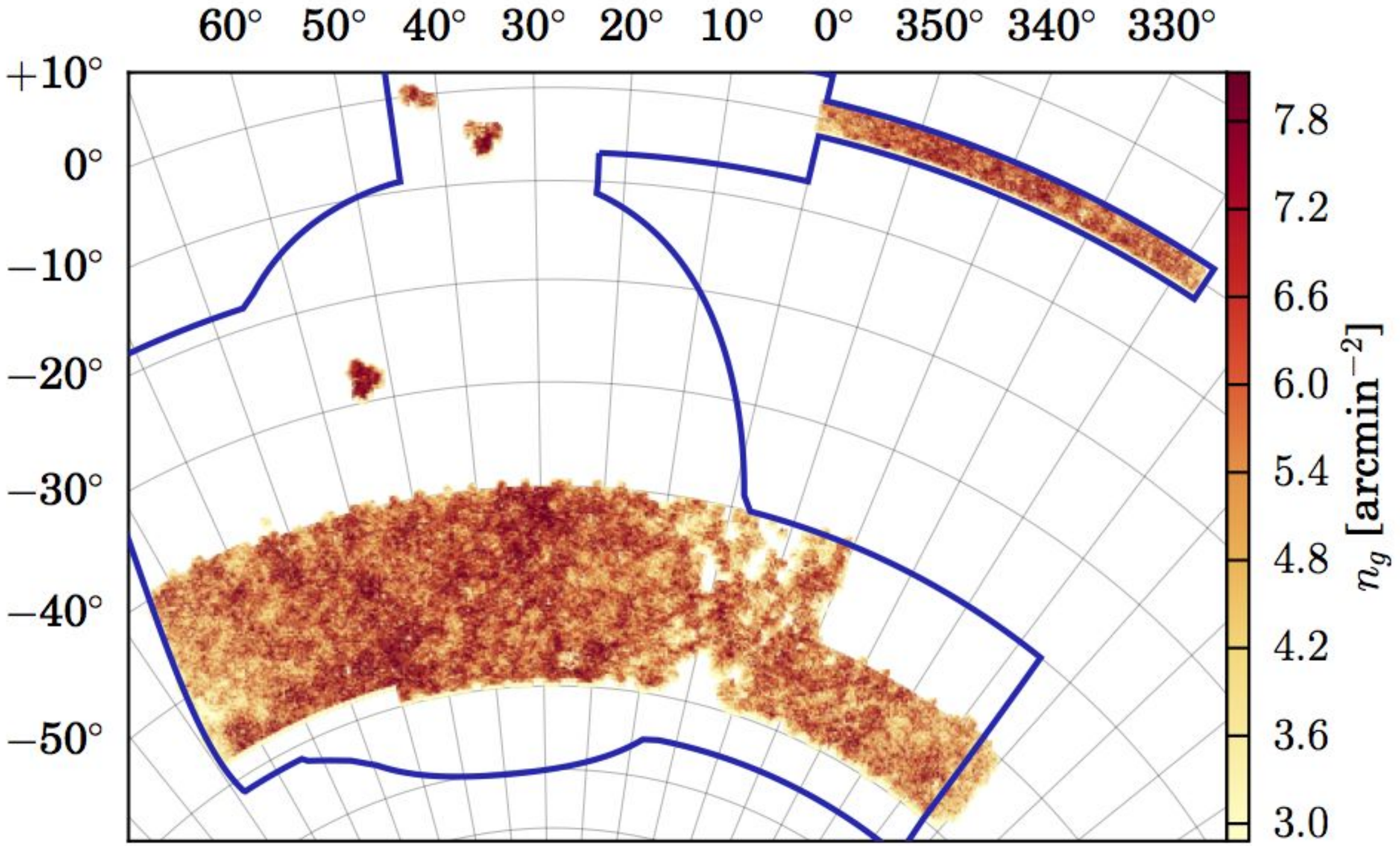


by Eric Neilsen

Seeing distribution in Y2

WEAK-LENSING RESULTS FROM SV AND Y1

DARK ENERGY SURVEY

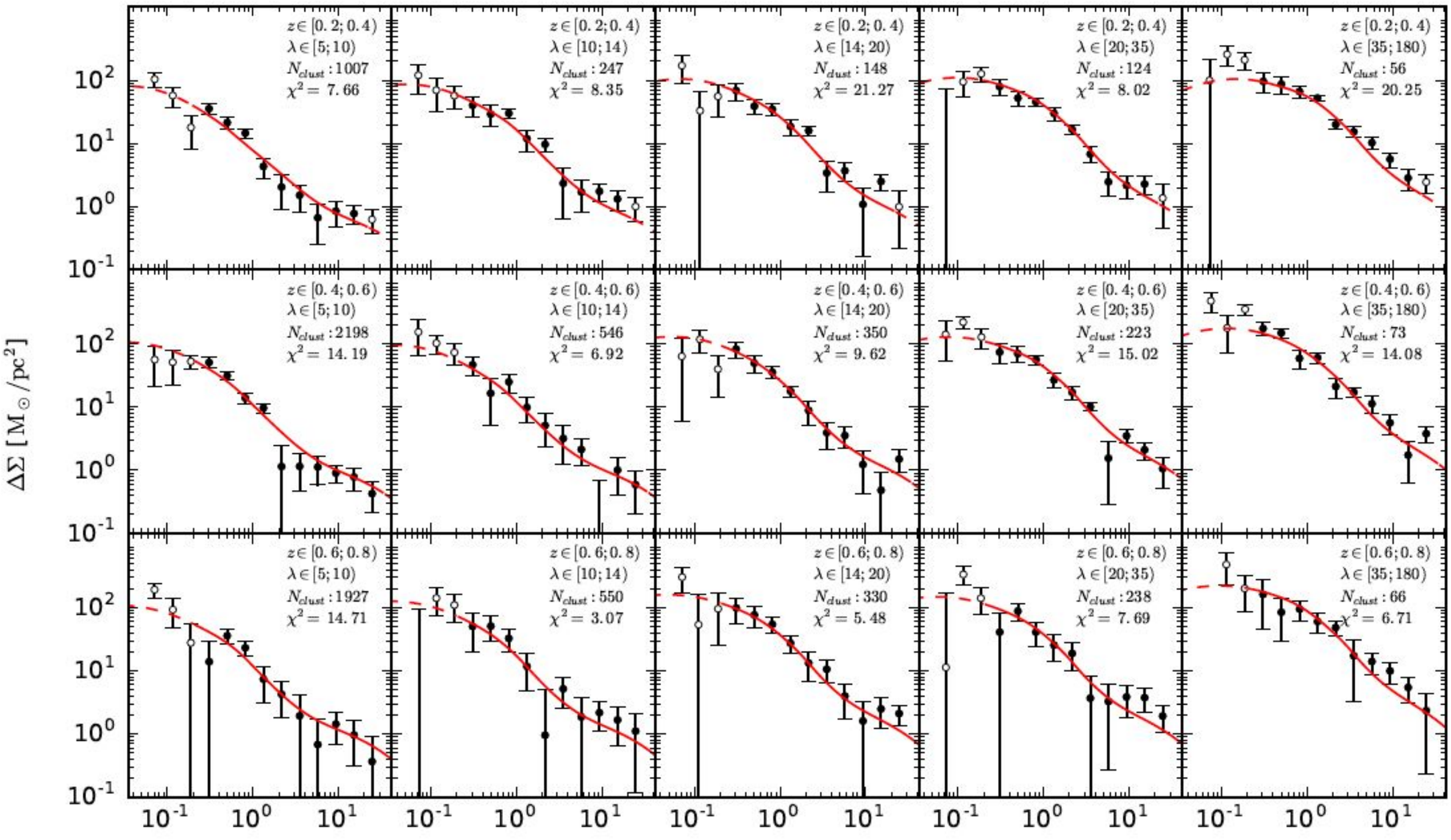


35 M galaxies, 1300 sq. deg

WEAK-LENSING RESULTS FROM SV AND Y1

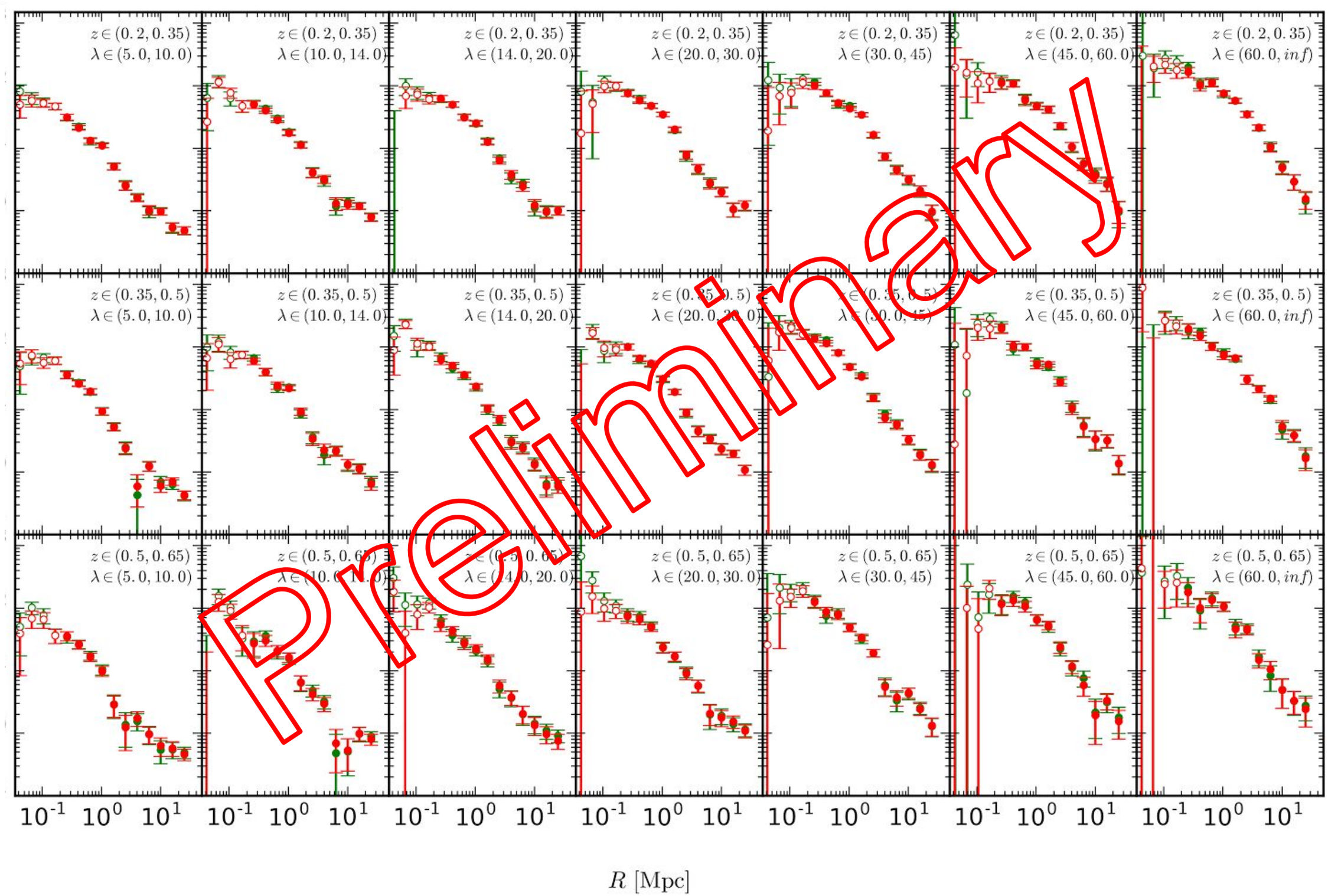
Melchior et al. 2016

DARK ENERGY SURVEY



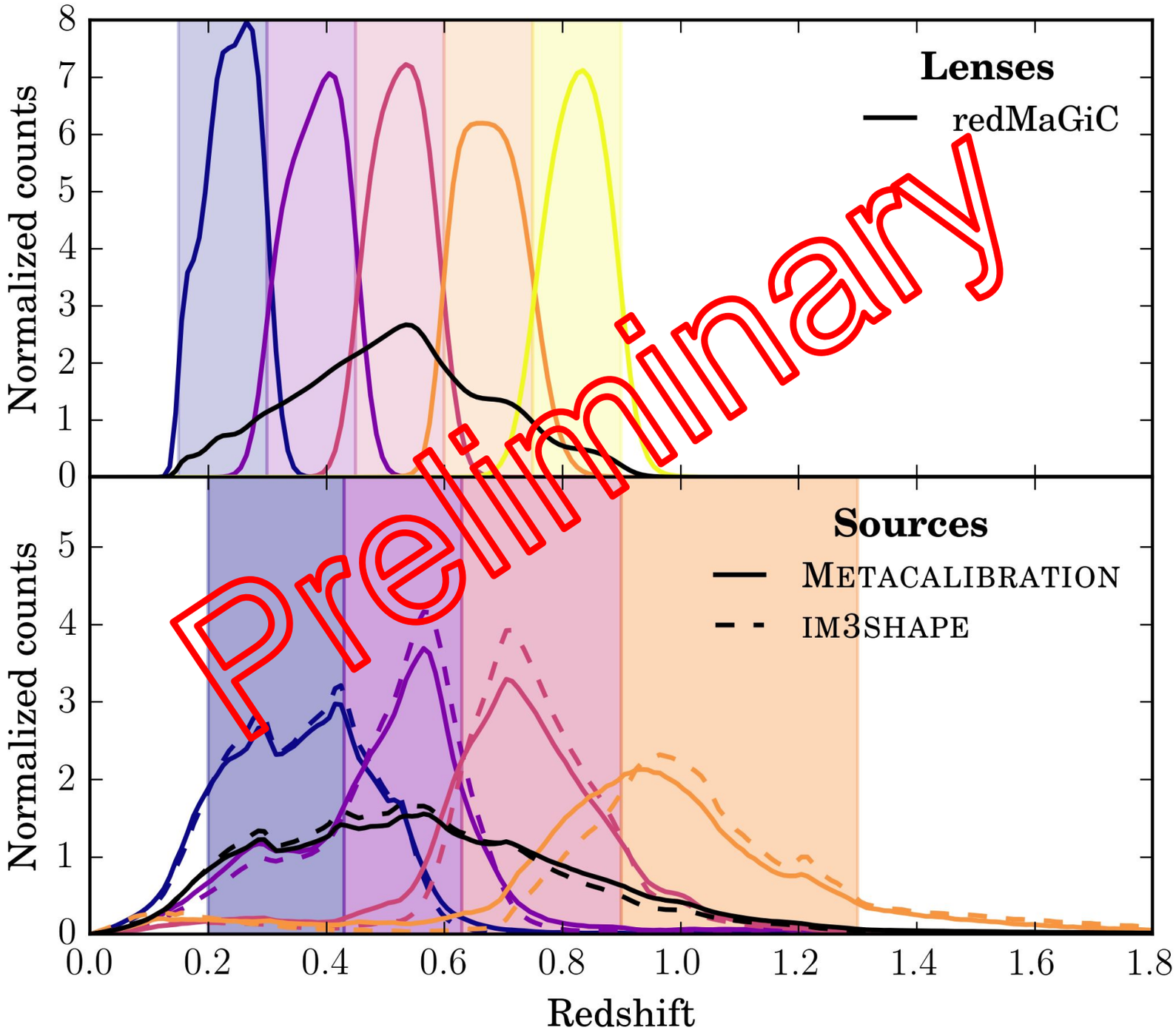
WEAK-LENSING RESULTS FROM SV AND Y1

Varga, McClintock et al. (in prep.)



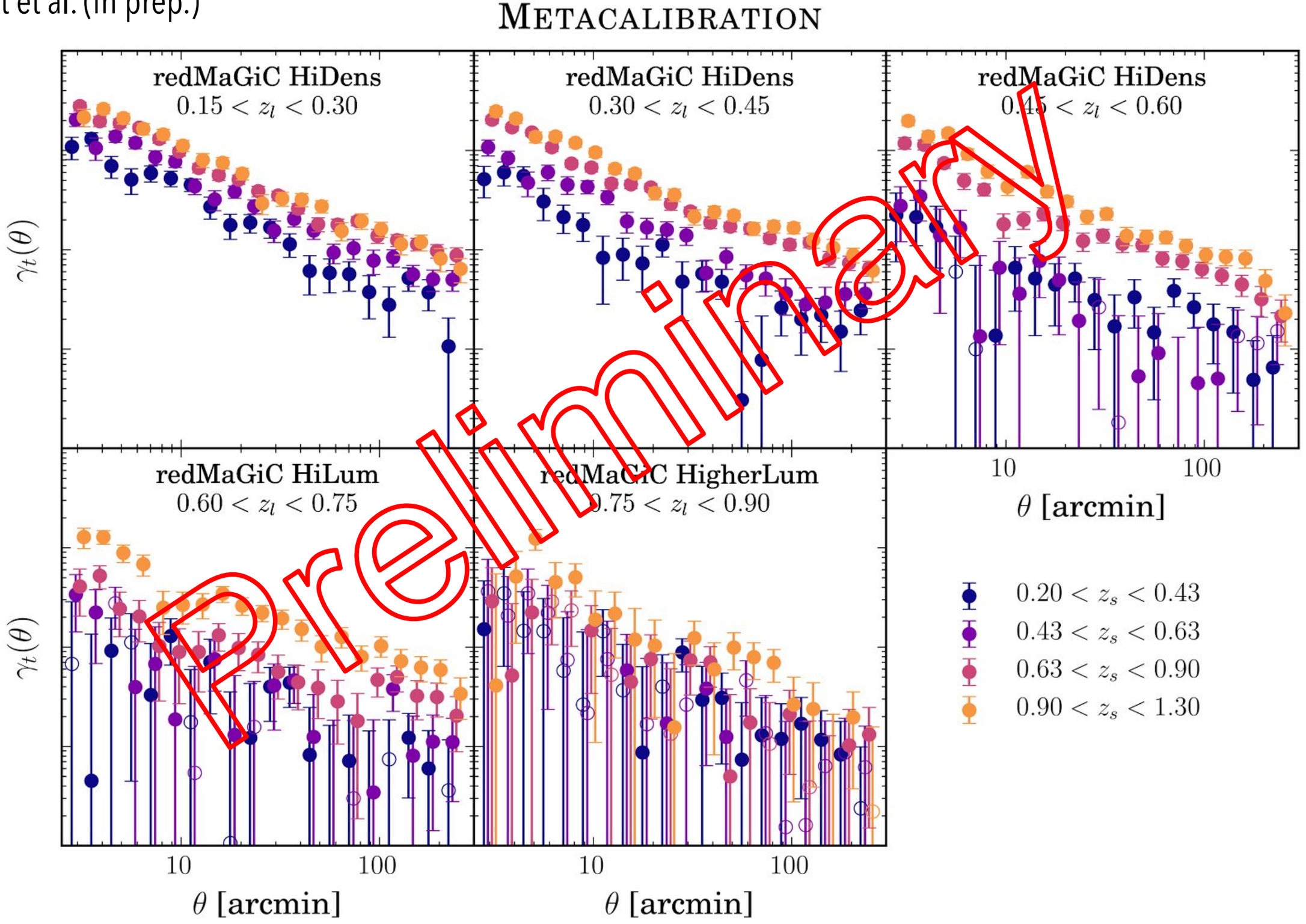
WEAK-LENSING RESULTS FROM SV AND Y1

Prat et al. (in prep.)



WEAK-LENSING RESULTS FROM SV AND Y1

Prat et al. (in prep.)

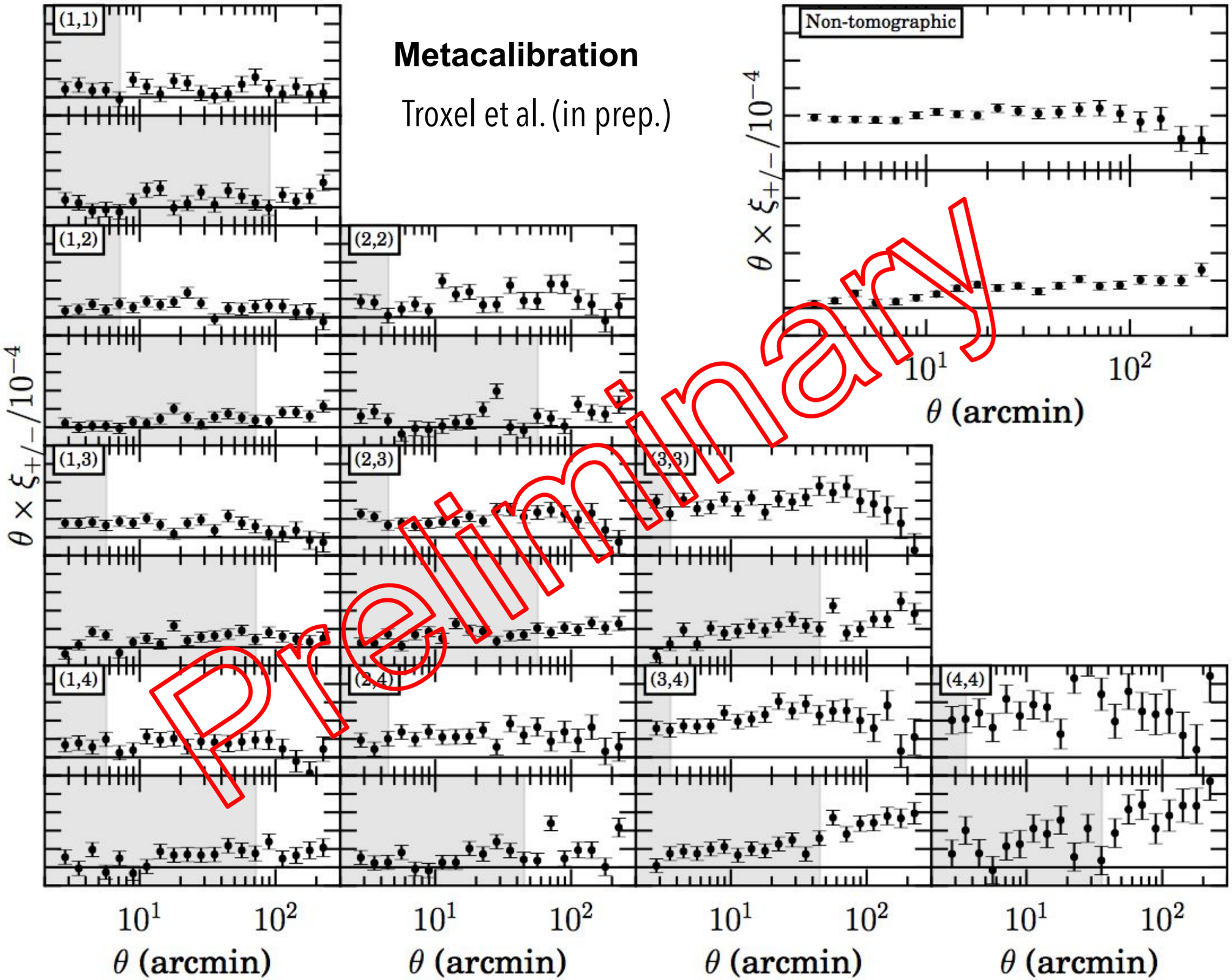


WEAK-LENSING RESULTS FROM SV AND Y1

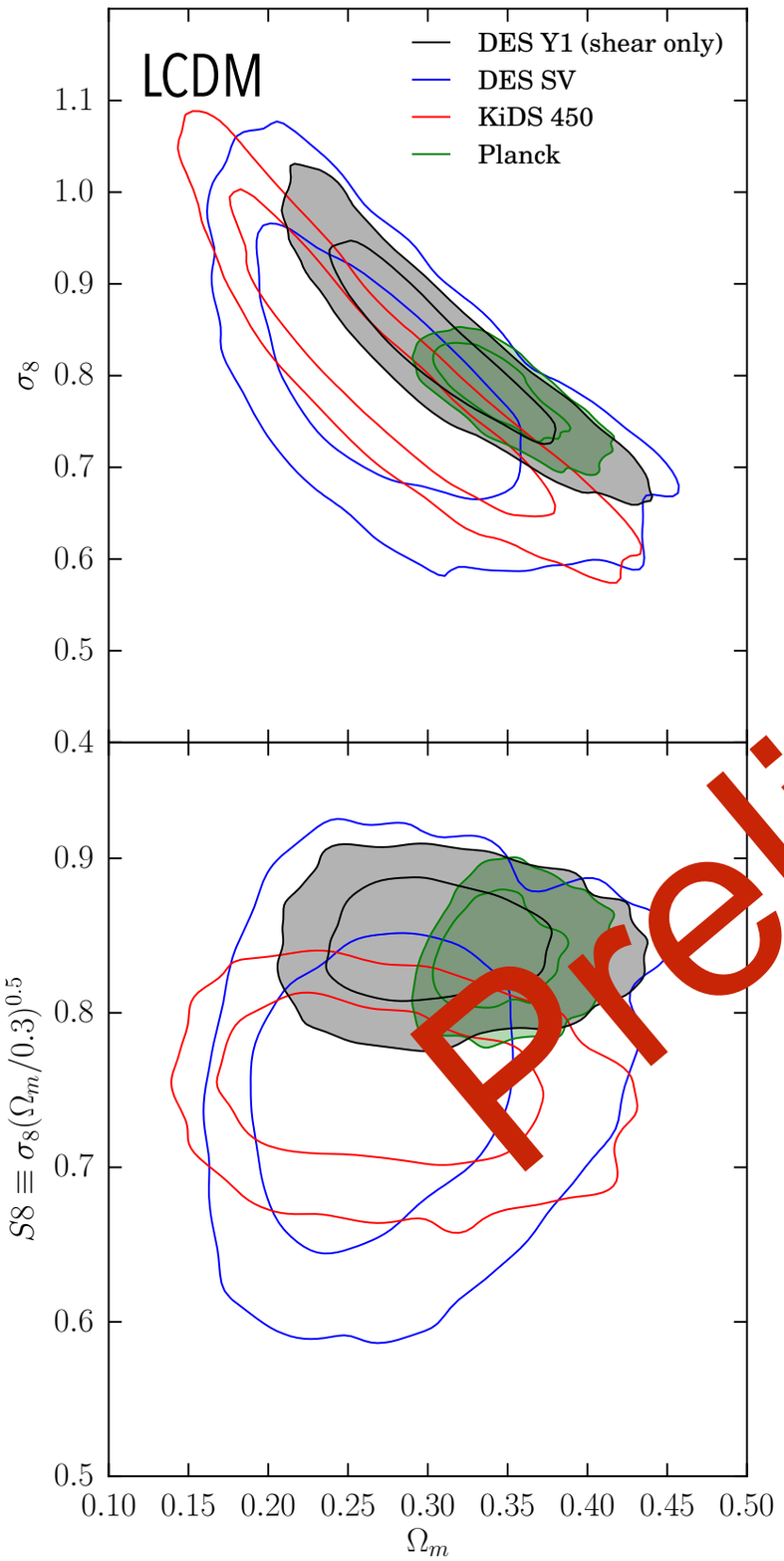
DARK ENERGY SURVEY

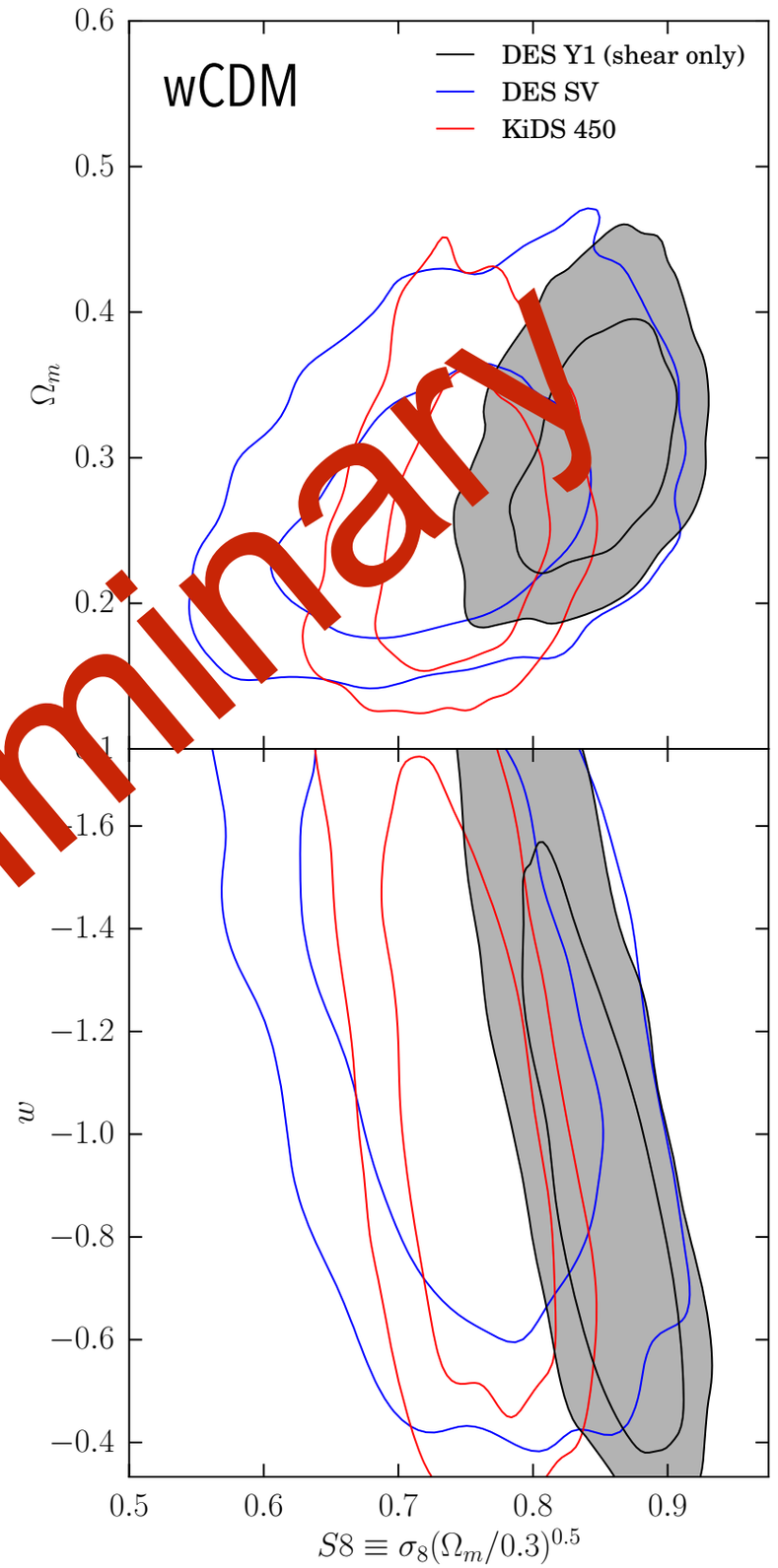
Metacalibration

Troxel et al. (in prep.)



WEAK-LENSING RESULTS FROM SV AND Y1



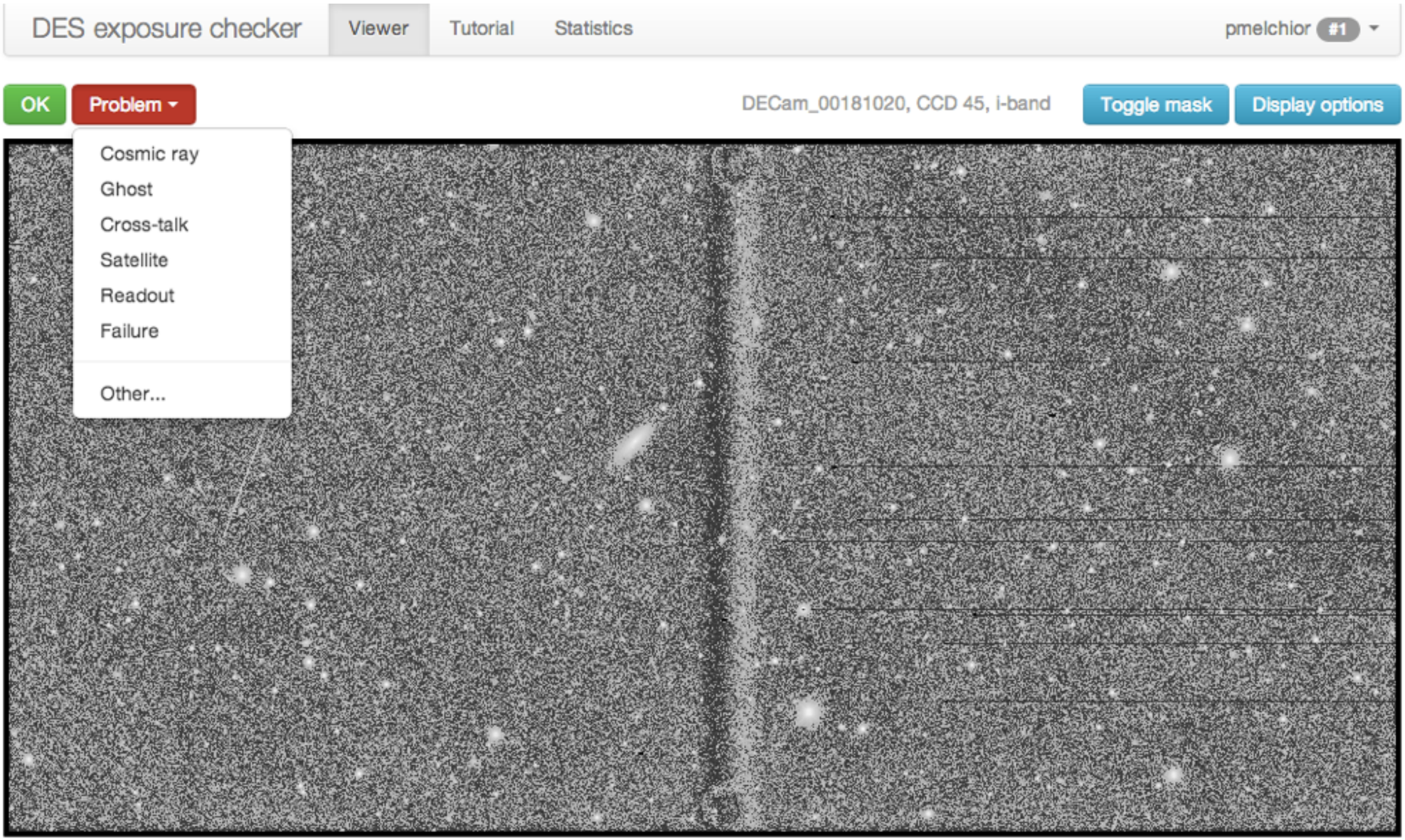


Troxel et al. (in prep.)

ALGORITHMS: LOOK AT THE IMAGES!

Melchior et al. (2016a) http://des-exp-checker.pmelchior.net

DARK ENERGY SURVEY



ALGORITHMS: LOOK AT THE IMAGES!

Melchior et al. (2016a) http://des-exp-checker.pmelchior.net

DARK ENERGY SURVEY

DES exposure checker Viewer Tutorial FAQ Statistics API Gallery Hodge-podge SVA1 Y1A1

DES exposure checker

See how real DES images look. Discover flaws we would otherwise have missed.

Make our data better!

Log in Sign up

1996
images checked

152
today

What's this good for?

We all want to do science with the DES data. However, no data set is perfect, so we need to identify and account for imaging artifacts in our data. This application helps in two ways:

- It gives you convenient access to the DES annual release finalcut images and shows the processing steps that are already in place to identify and correct for known problems.
- It enables everyone to search for undetected artifacts. We gather your submissions, analyze them, and feed them back to the science working groups and DESDM. This way, we can refine the processing pipelines to catch the flaws that we know are there.

How can I start?

Check out our Tutorial and you'll know what to do in no time.

How are we doing so far?

The basic statistics are computed in real time. More detailed analyses will become available once we have gathered enough submissions, but you can go to our API page and download the

Top contributors for Y1A1

# 1	kadrlica	514
# 2	ynzhang	430
# 3	rpoulton	400
# 4	pmelchior	159
# 5	erykoff	137
# 6	pmartini	100
# 7	bellido	82
# 8	menanteau	52
# 9	rgm	39
# 10	mhubbard	28

ALGORITHMS: LOOK AT THE IMAGES!

Melchior et al. (2016a) http://des-exp-checker.pmelchior.net

DARK ENERGY SURVEY

DES exposure checker | Viewer | Tutorial | FAQ | Statistics | API | Gallery | Hodge-podge | SVA1 | Y1A1

Statistics

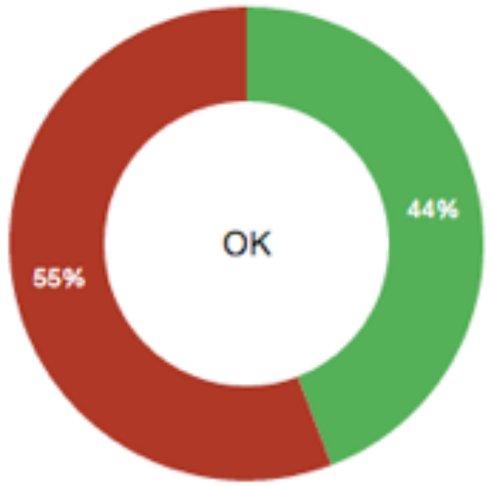
On the right, you can see how many images have been checked so far, and how many of them during the last 24 hours. The pie chart shows how many of the checked images have been found **Fine** or **Problematic**.

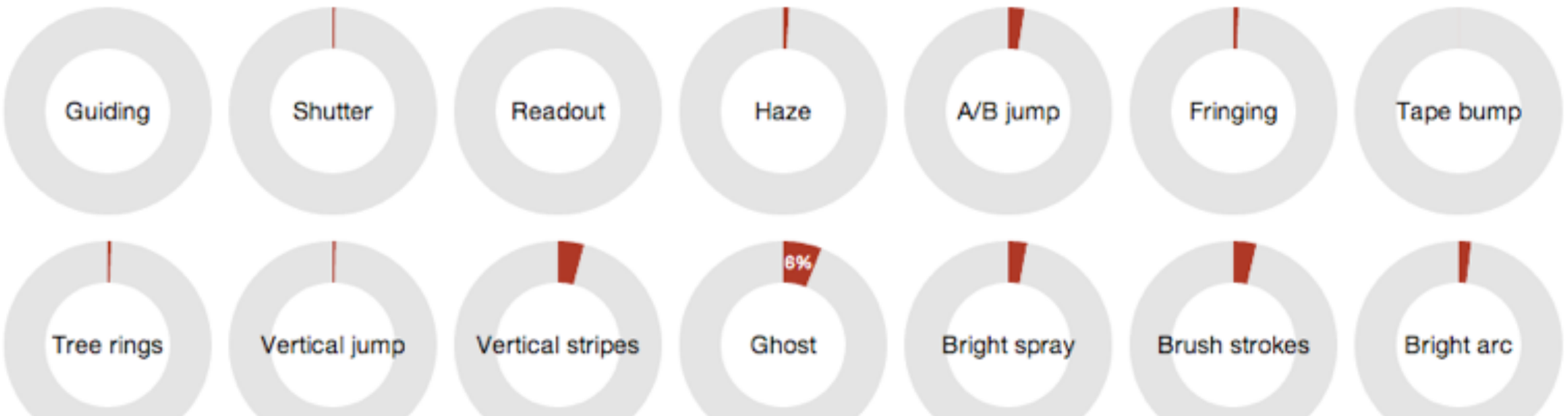
Below you find a break-up of the images that have been found problematic. **Red** areas denote the percentage of those image with a given problem, while **Blue** areas indicate the corresponding false-positive fraction (see our Tutorial if you have questions about the false positives). When you click on any of the pie charts, you can see examples of images that have been found with this kind of problem.

There can be multiple problems in any given image, therefore the proportion do not necessarily add up to one.

1996
images checked

152
today

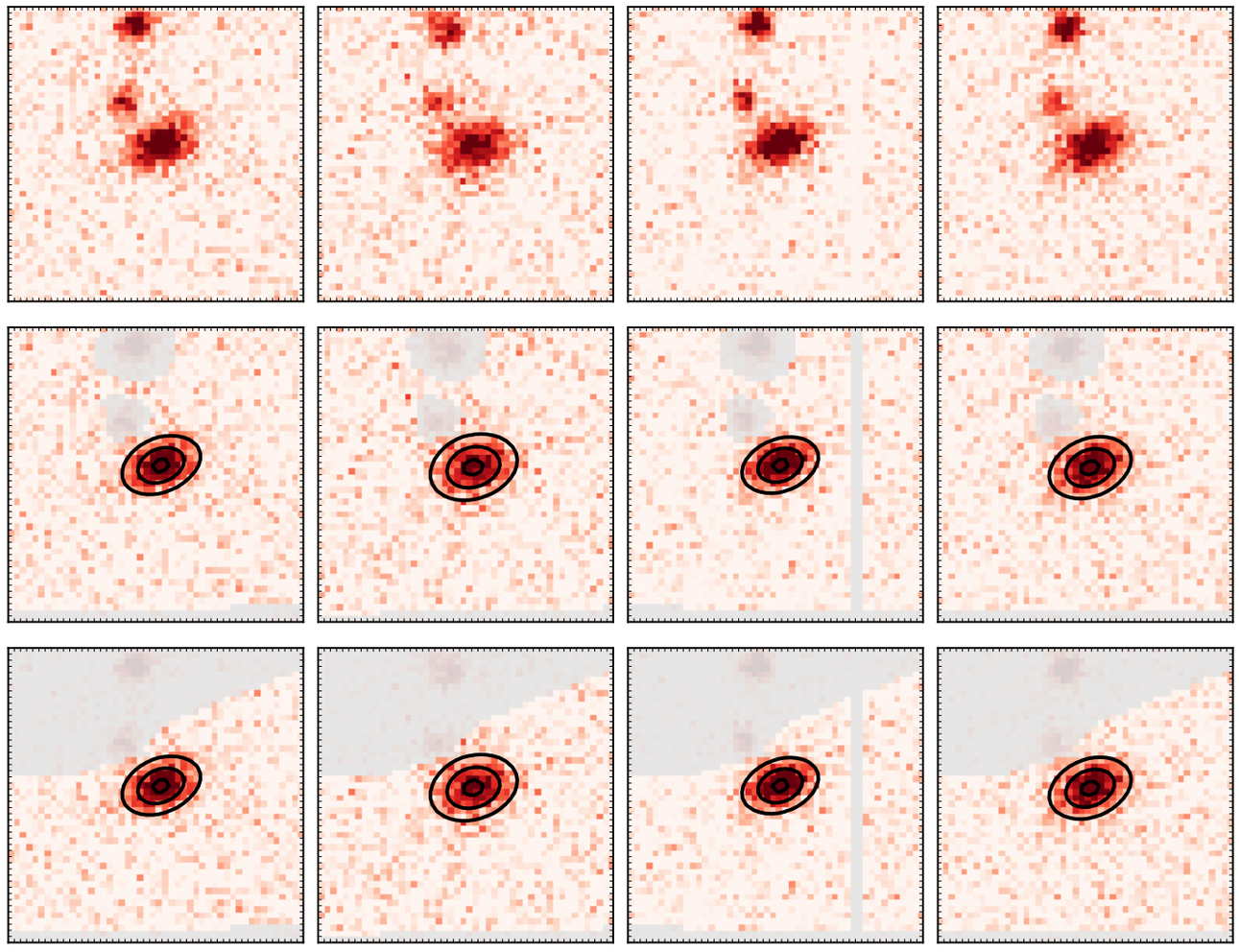




ALGORITHMS: SEGMENT YOUR DATA!

DARK ENERGY SURVEY

- überseg masking of neighbors
- combined with multi-object fitting (MOF) of ngmix https://github.com/esheldon/ngmixer
- Validation against simulations



Jarvis et al. 2016

ALGORITHMS: META-CALIBRATE!

- Calibrating estimators with ab initio sims *very* expensive
- Determine responsivity of estimator to signal:

  Huff & Mandelbaum (2017), Sheldon & Huff (2017)
- Reducing shear calibration errors from ~5% in SV to 1.2% in Y1

$$\begin{aligned} \boldsymbol{e} &= \boldsymbol{e}|_{\gamma=0} + \left.\frac{\partial \boldsymbol{e}}{\partial \boldsymbol{\gamma}}\right|_{\gamma=0} \boldsymbol{\gamma} + ... \\ &\equiv \boldsymbol{e}|_{\gamma=0} + \boldsymbol{R}\boldsymbol{\gamma} + ... \end{aligned} \tag{1}$$

where we have defined the shear response:

$$\boldsymbol{R} \equiv \left.\frac{\partial \boldsymbol{e}}{\partial \boldsymbol{\gamma}}\right|_{\gamma=0}. \tag{2}$$

Note that the derivative is also with respect to the two-component shear $\boldsymbol{\gamma}$, making $\boldsymbol{R}$ a 2×2 matrix:

$$\boldsymbol{R} = \begin{pmatrix} \partial e_1/\partial \gamma_1 & \partial e_2/\partial \gamma_1 \\ \partial e_1/\partial \gamma_2 & \partial e_2/\partial \gamma_2 \end{pmatrix}.$$

We can use the ensemble mean of such measurements $\boldsymbol{e}$, for example, measured from a population of galaxies, as a shear estimator. Assuming the shear is small, we can drop terms of order γ^2 and higher (we explore this approximation in §9), such that

$$\begin{aligned} \langle \boldsymbol{e} \rangle &= \langle \boldsymbol{e} \rangle|_{\gamma=0} + \langle \boldsymbol{R}\boldsymbol{\gamma} \rangle + ... \\ &\approx \langle \boldsymbol{R}\boldsymbol{\gamma} \rangle, \end{aligned} \tag{3}$$

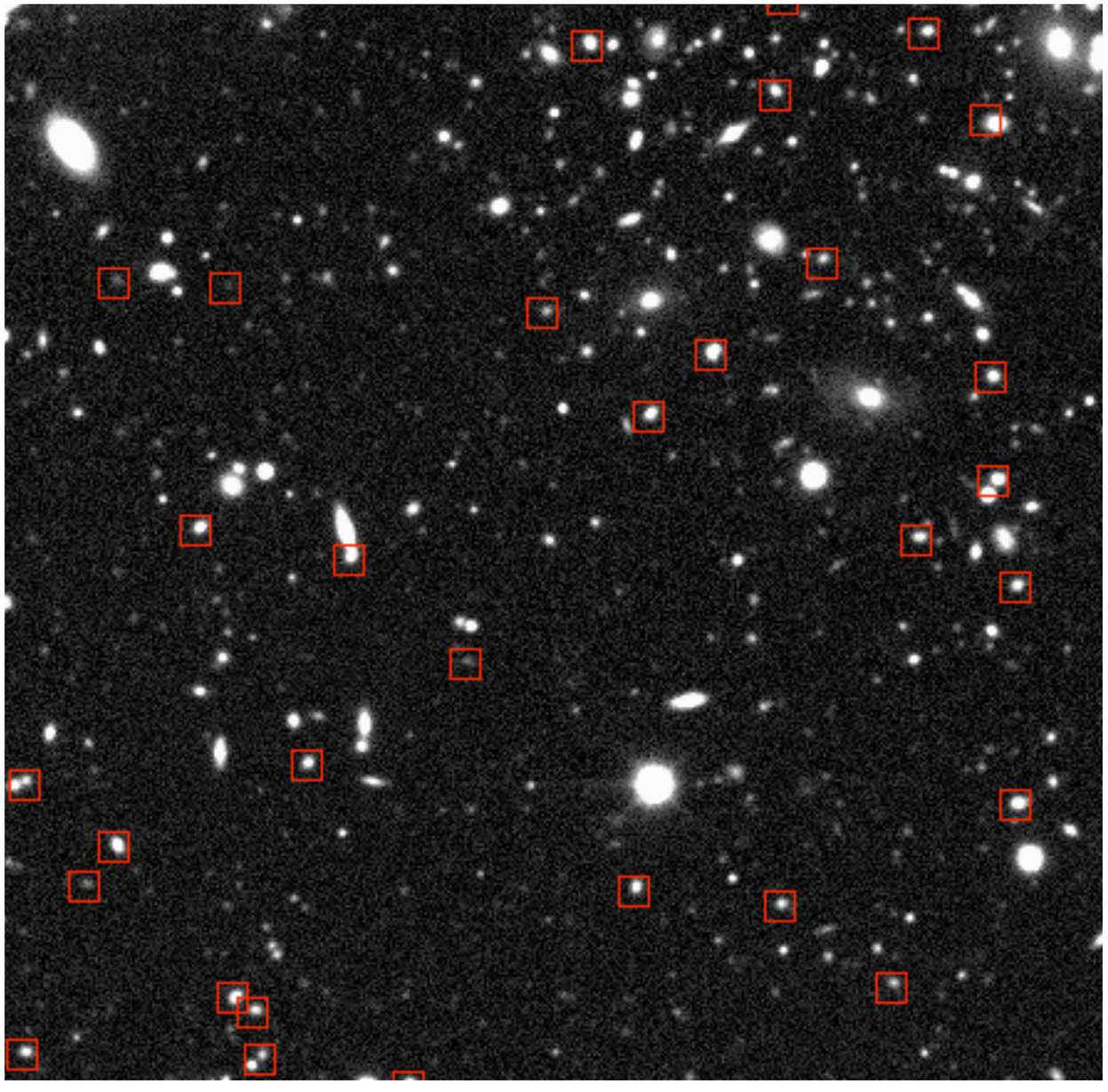
where we have also assumed the intrinsic ellipticities of galaxies are randomly oriented such that $\langle \boldsymbol{e} \rangle|_{\gamma=0} \sim (0, 0)$. If we have estimates of $\boldsymbol{R}$ for each galaxy, we can form a weighted average:

$$\langle \boldsymbol{\gamma} \rangle \approx \langle \boldsymbol{R} \rangle^{-1} \langle \boldsymbol{e} \rangle \approx \langle \boldsymbol{R} \rangle^{-1} \langle \boldsymbol{R}\boldsymbol{\gamma} \rangle. \tag{4}$$

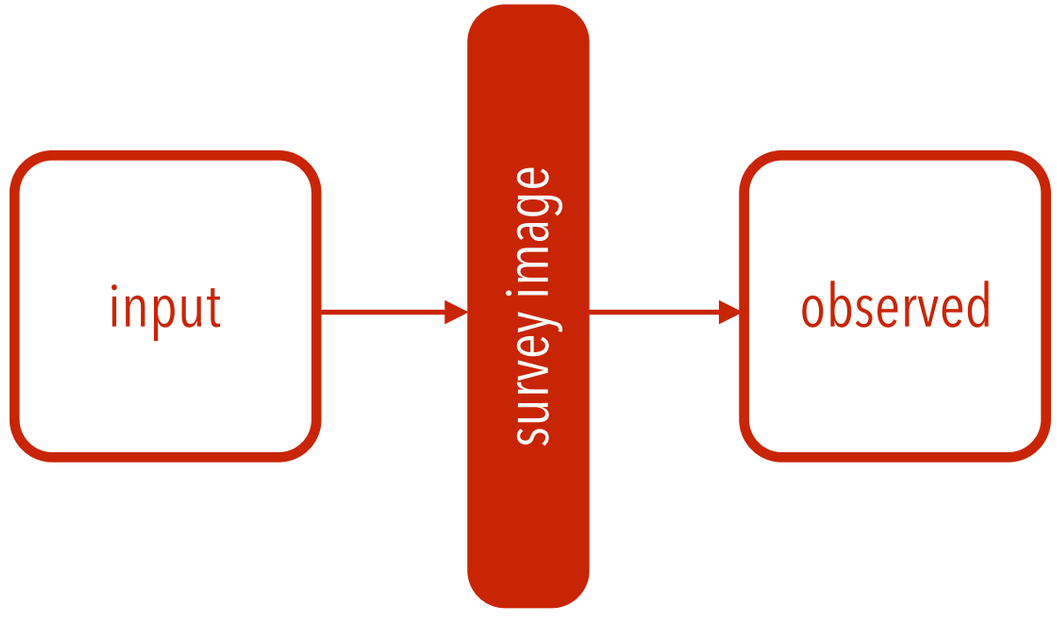
ALGORITHMS: FAKE YOUR DATA!

Suchyta et al. (2016) https://github.com/emhuff/Balrog

DARK ENERGY SURVEY



Inserting mock galaxies and stars into survey images



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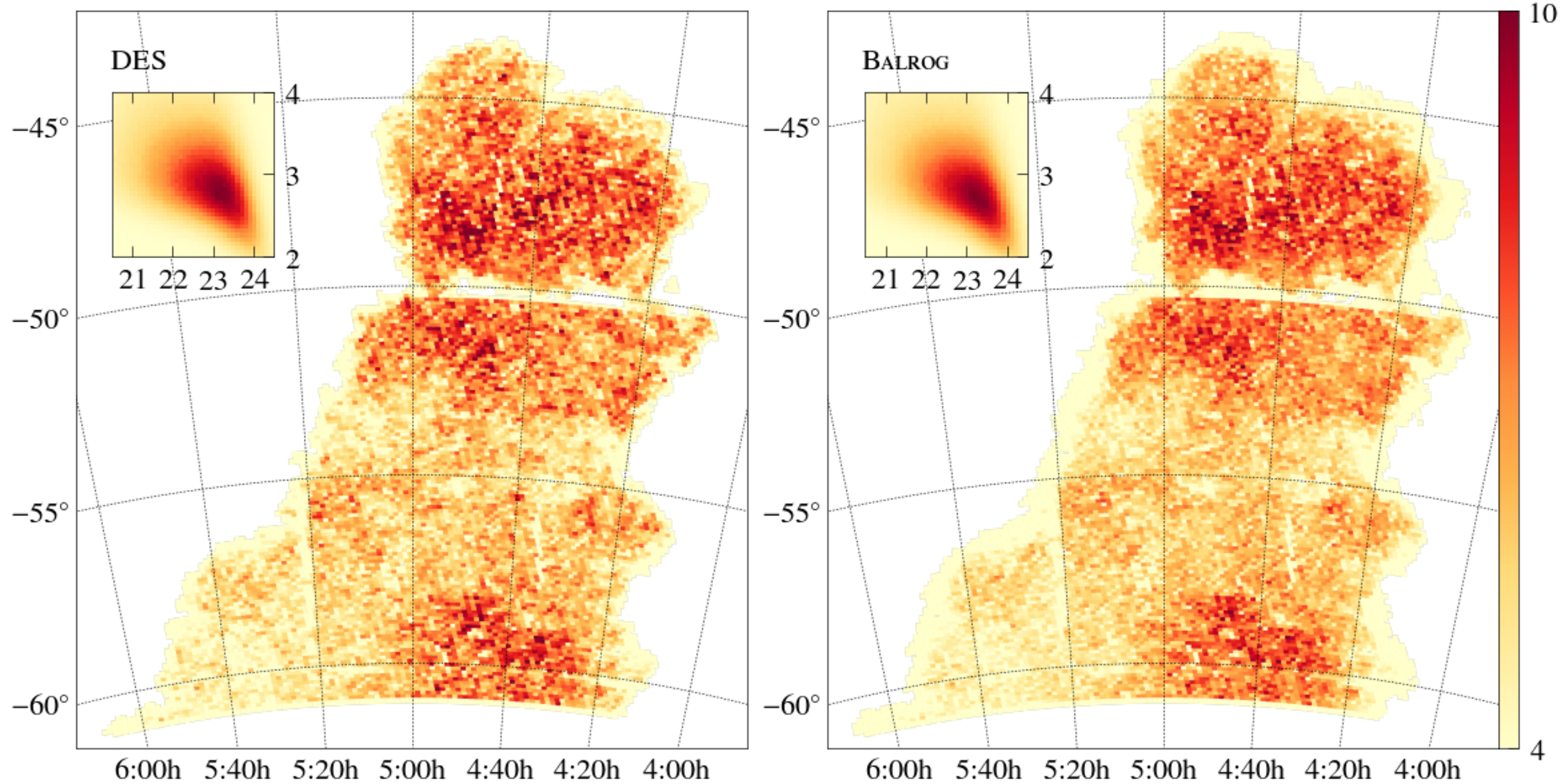
DARK ENERGY SURVEY



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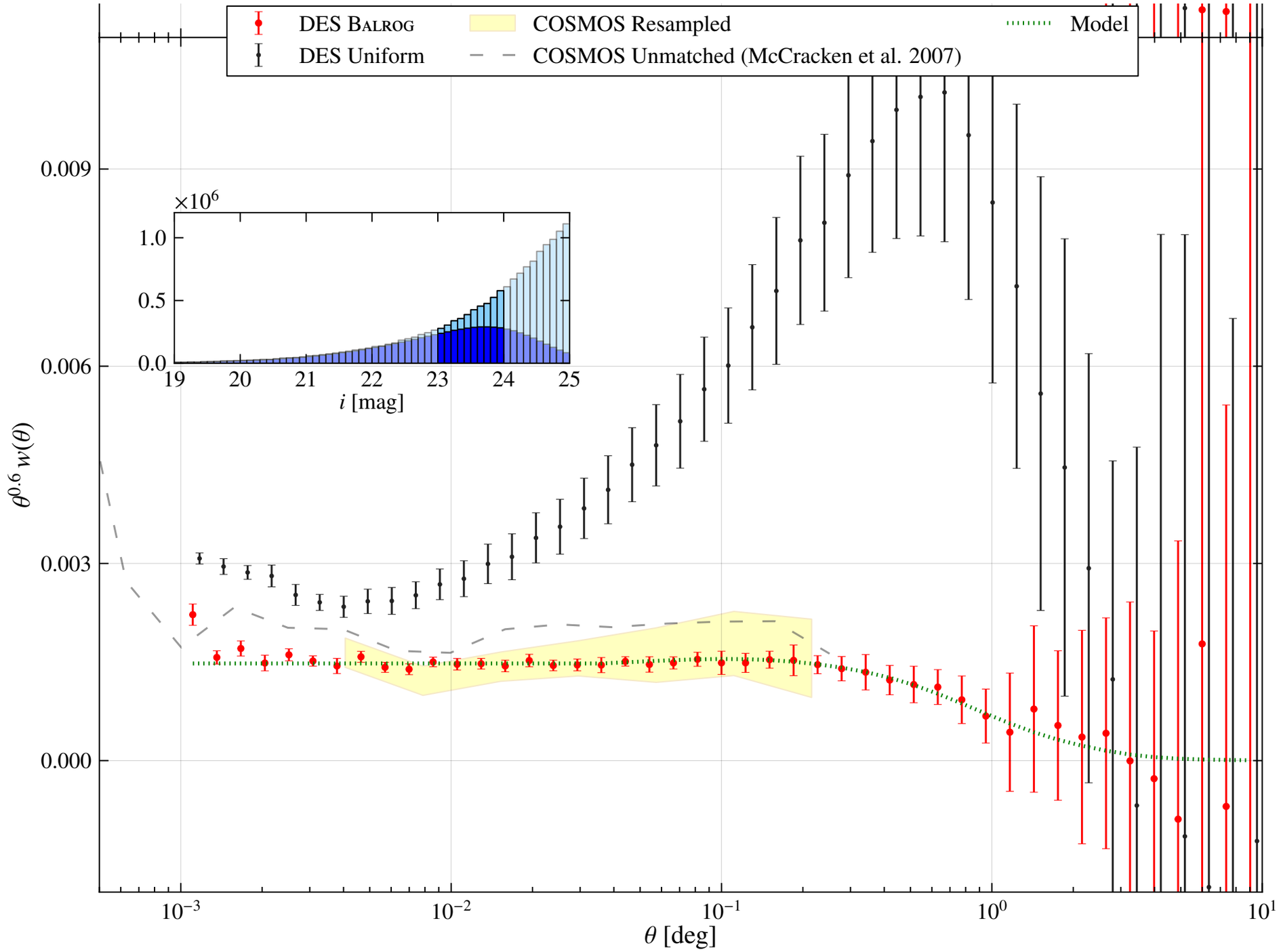
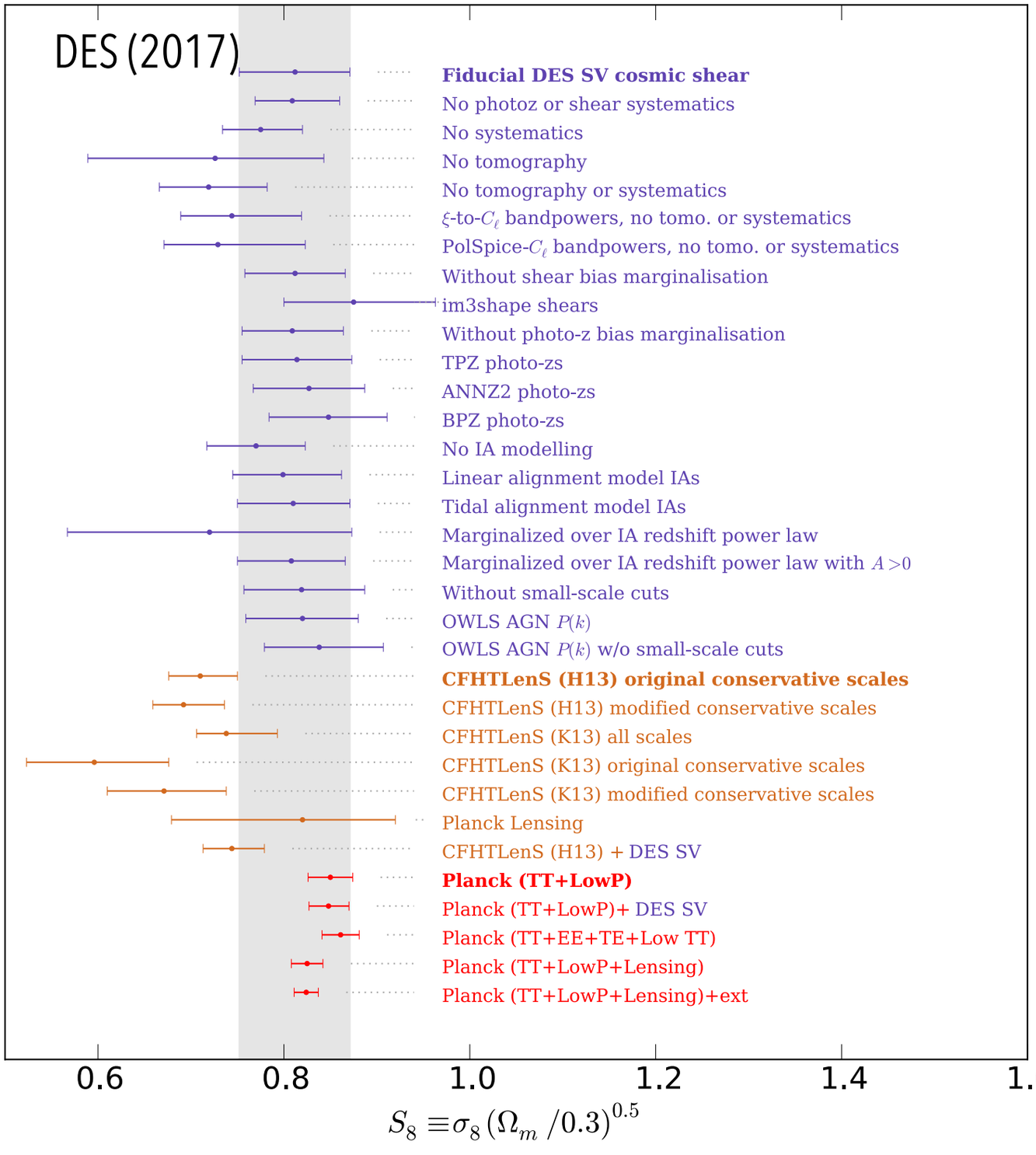


ALGORITHMS: USE MORE THAN ONE!

DARK ENERGY SURVEY

- WL shapes, photo-zs, correlation functions, cosmological analysis
- Facilitated by MEDS https://github.com/esheldon/meds
- Reveals inconsistencies, lower bound on systematics



CONCLUSIONS