The PRIsm MUlti-object Survey (PRIMUS)

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Overview:

- Galaxy evolution to z ~ 1 is still cosmic variance limited: DEEP2, VVDS, COMBO-17, COSMOS spec-z/photo-z samples aren't enough - 1-3 sq. degrees each

- For many questions, 1% redshifts are "good enough": even clustering statistics are projected over these scales

- A low dispersion prism can get this accuracy: and allows you to multiplex in the dispersion direction!

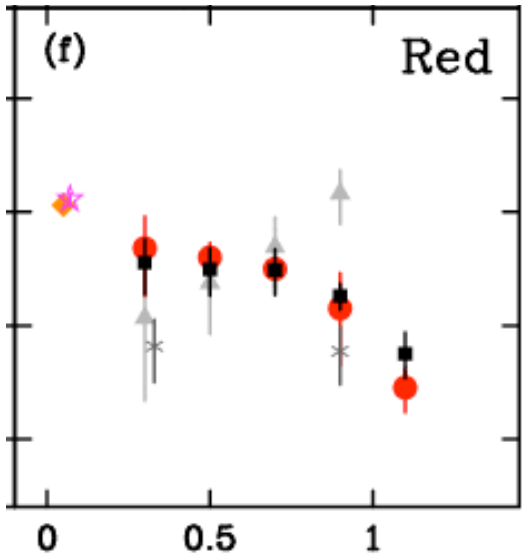
- We've done a huge survey in this mode with a prism on IMACS: PRIMUS

Galaxies have evolved since z=1:

Fewer red galaxies at z=1

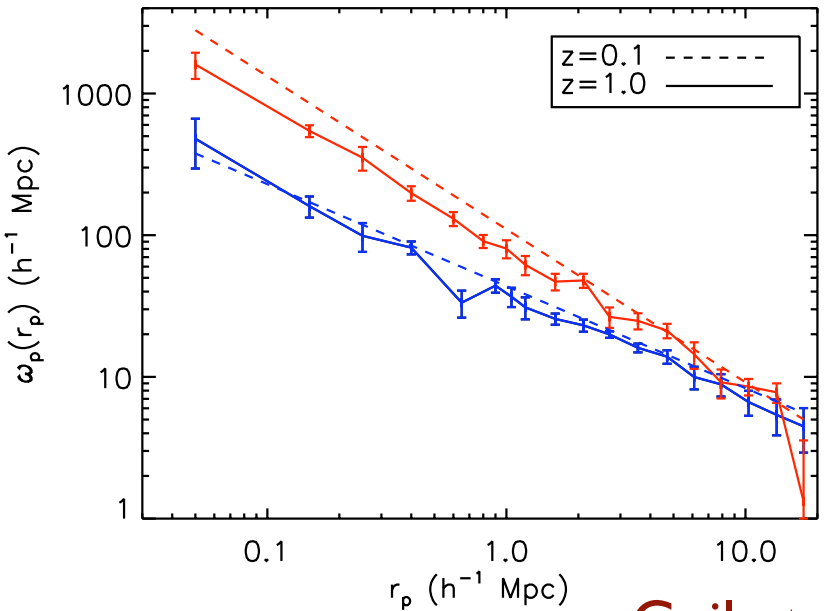
Galaxies are less clustered at z=1

density of red galaxies



redshift

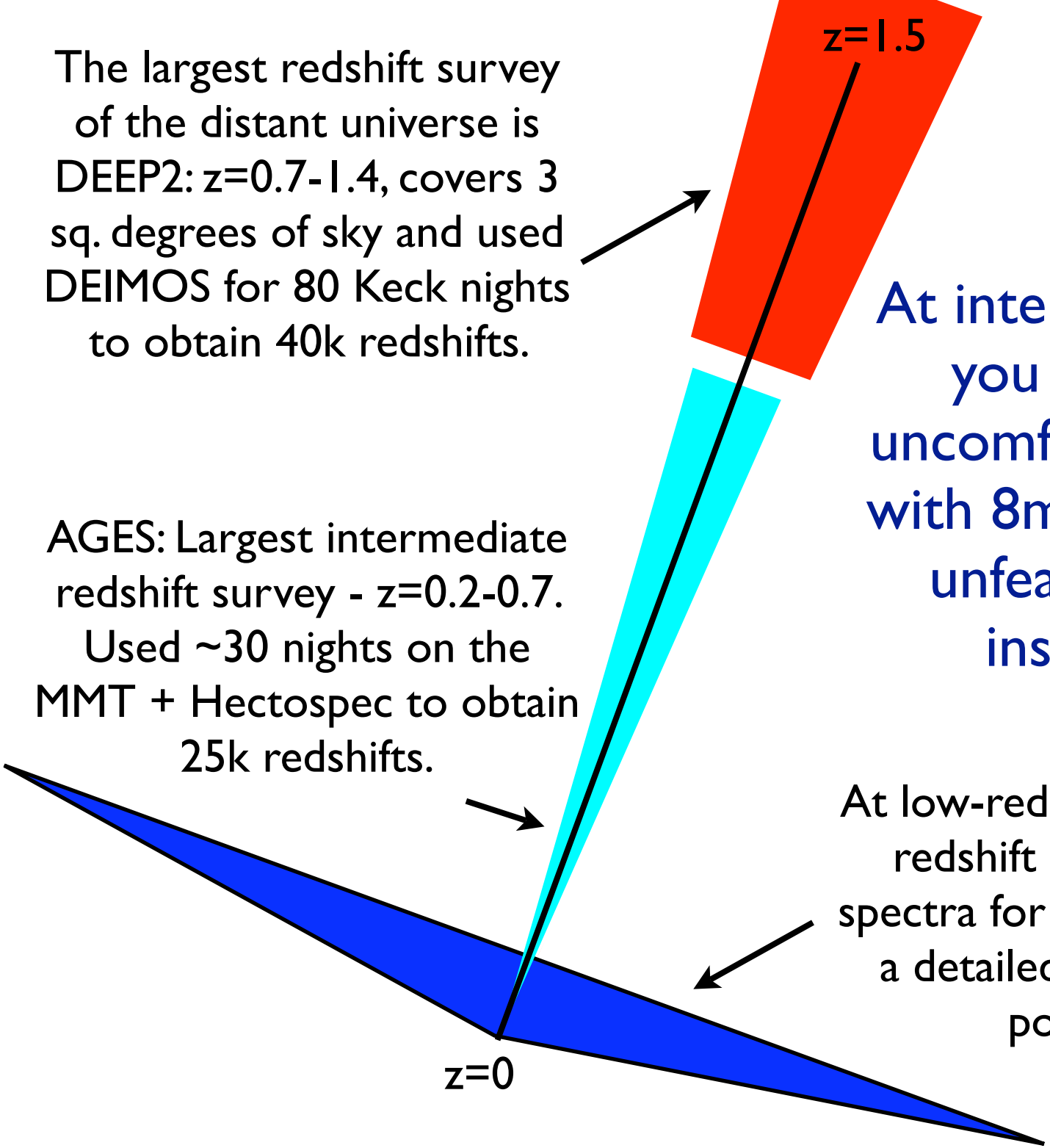
Faber et al. 2007



Coil et al. 2008

The dominant error on galaxy evolution since z=1 is cosmic variance!

The largest redshift survey of the distant universe is DEEP2: z=0.7-1.4, covers 3 sq. degrees of sky and used DEIMOS for 80 Keck nights to obtain 40k redshifts.



At intermediate redshifts, you need to survey uncomfortably large areas with 8m class telescopes - unfeasible w/ current instrumentation.

AGES: Largest intermediate redshift survey - z=0.2-0.7. Used ~30 nights on the MMT + Hectospec to obtain 25k redshifts.

At low-redshift, SDSS is the largest redshift survey to z~0.2. Has spectra for 700k galaxies. Provides a detailed picture of the galaxy population today.

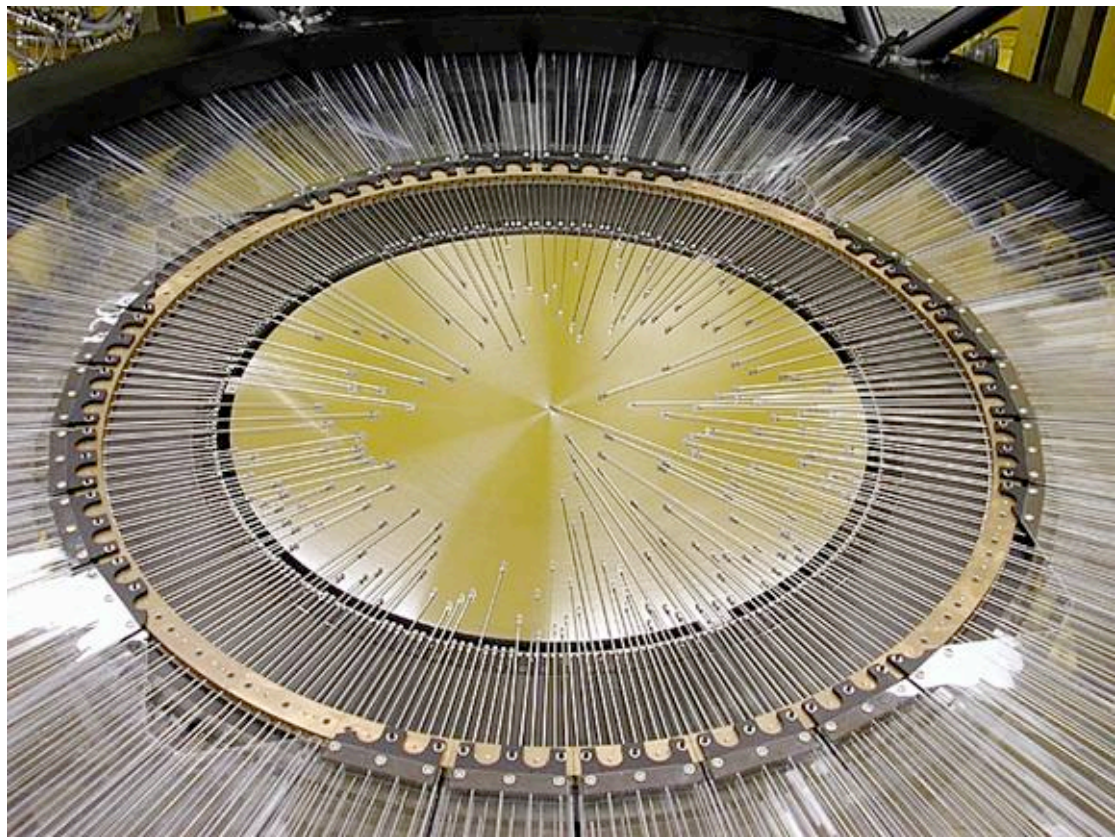
Why hasn't this been done already?

Scaling from AGES - 25,000 galaxies in 30 nights with Hectospec:

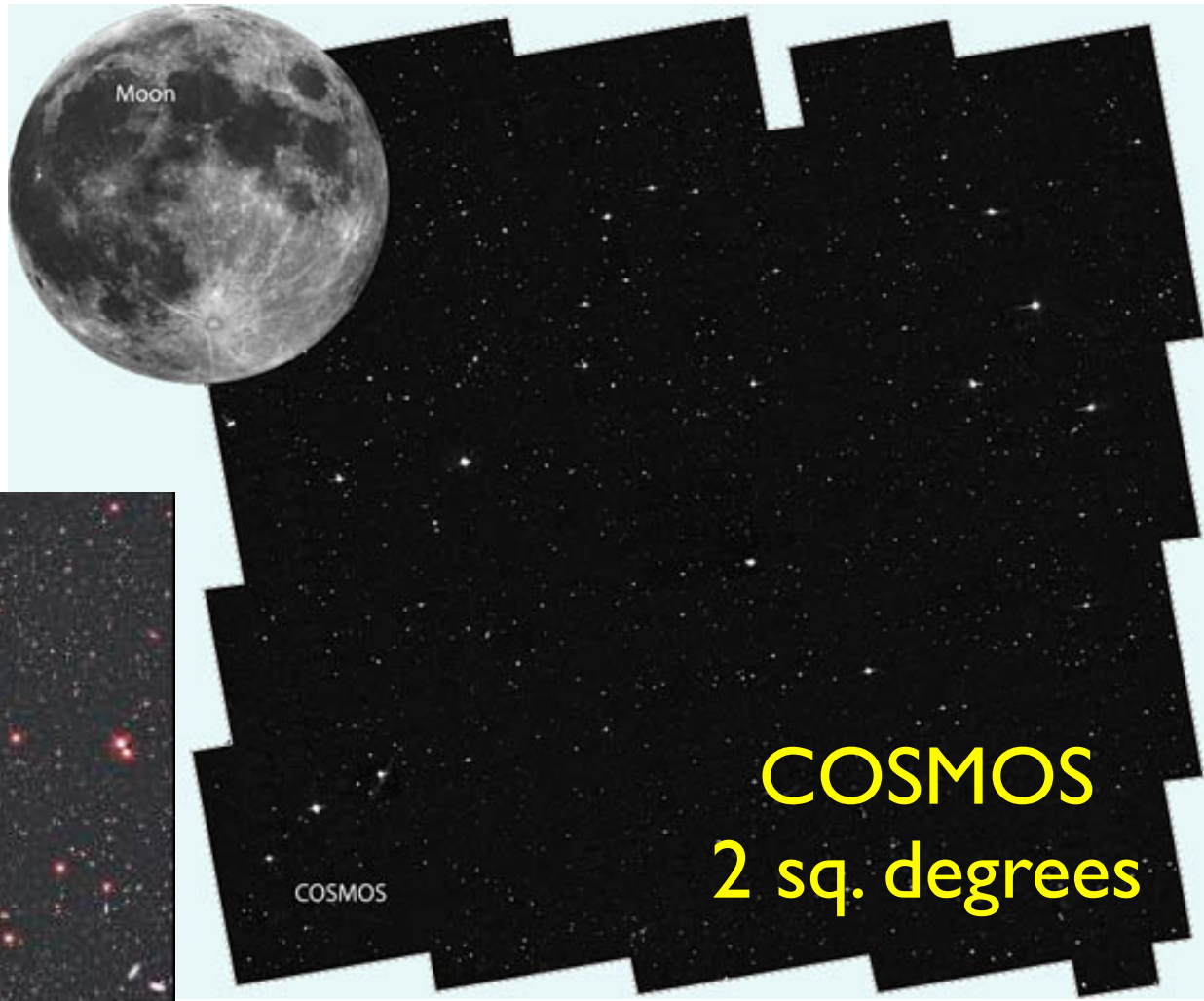
300,000 galaxies to I=23 would require about ~900 dark nights

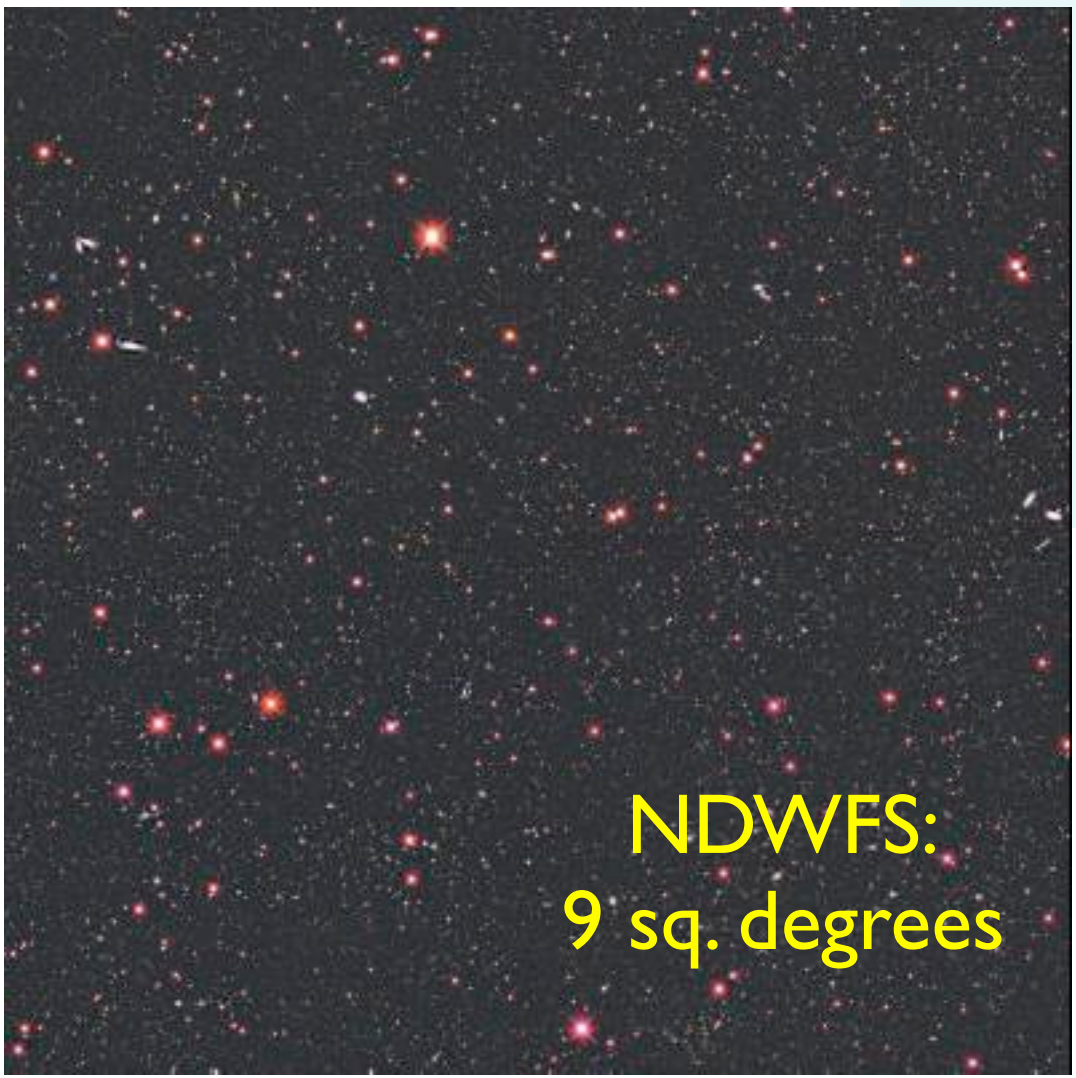
Should we build another instrument?

loads of $$$$$
and
time



The volume probed by deep photometry overwhelms that of spectroscopy





Many square degrees covered by deep multiwavelength observations

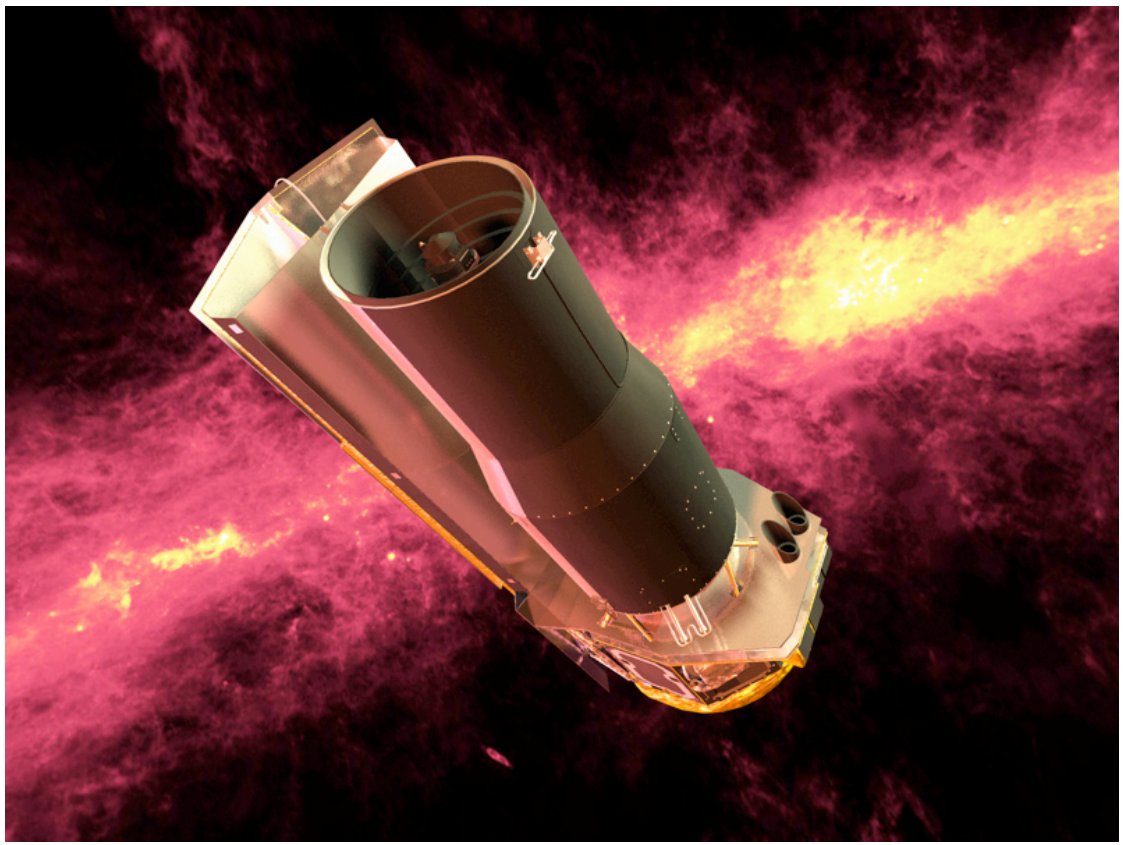
Spitzer XMM-Newton

Chandra GALEX

HST

SWIRE: Spitzer Wide-area Infra Red Extragalactic Survey

SWIRE is a major Spitzer legacy survey:
imaged a 50 sq. degrees of sky in 6 fields (3 north, 3 south)
to a depth of L* at z~2.



Took a month total of Spitzer time.

Main goal is galaxy evolution to z>1.

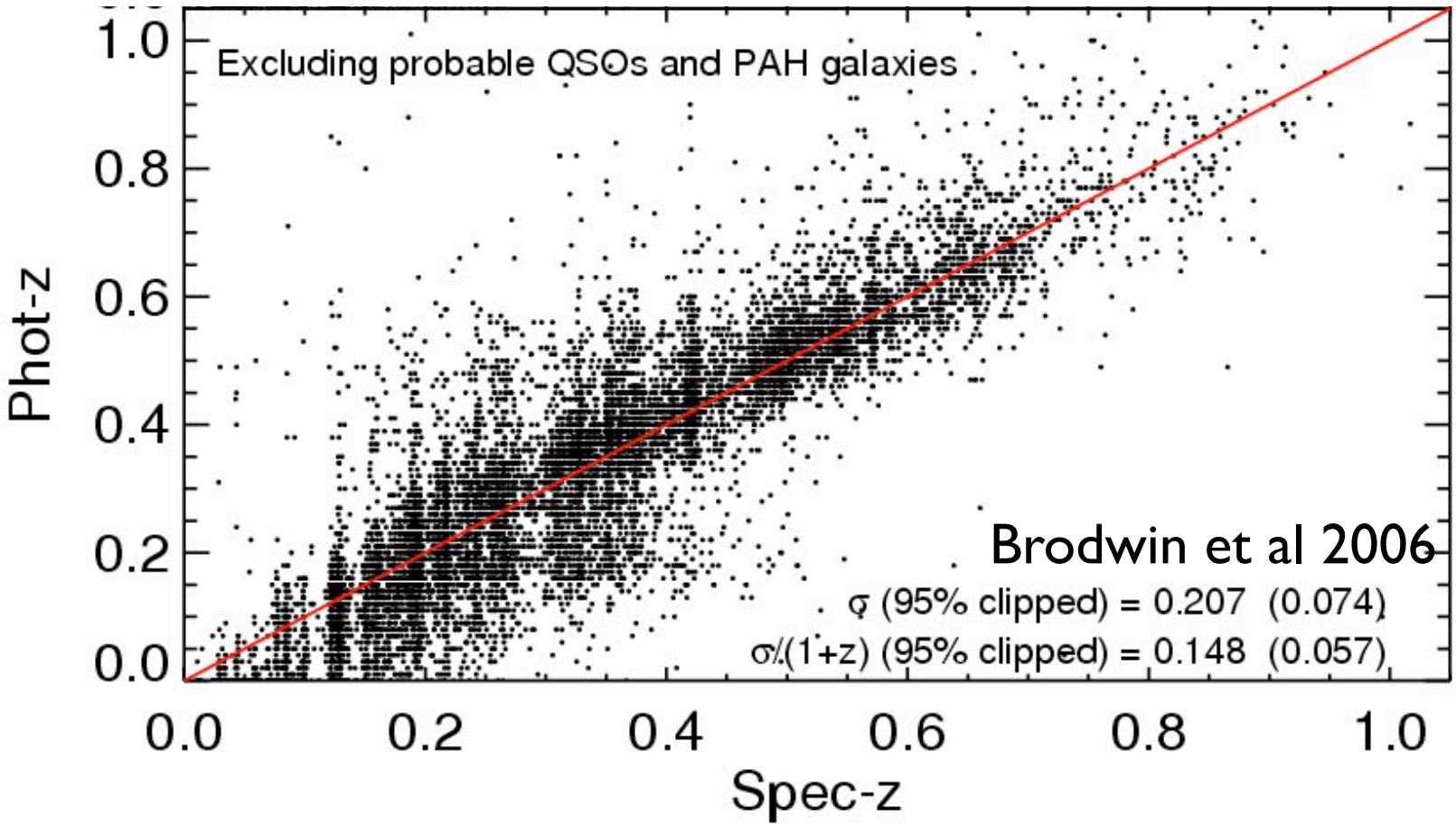
But their fields lack redshifts!!

The idea was to use photometric redshifts...

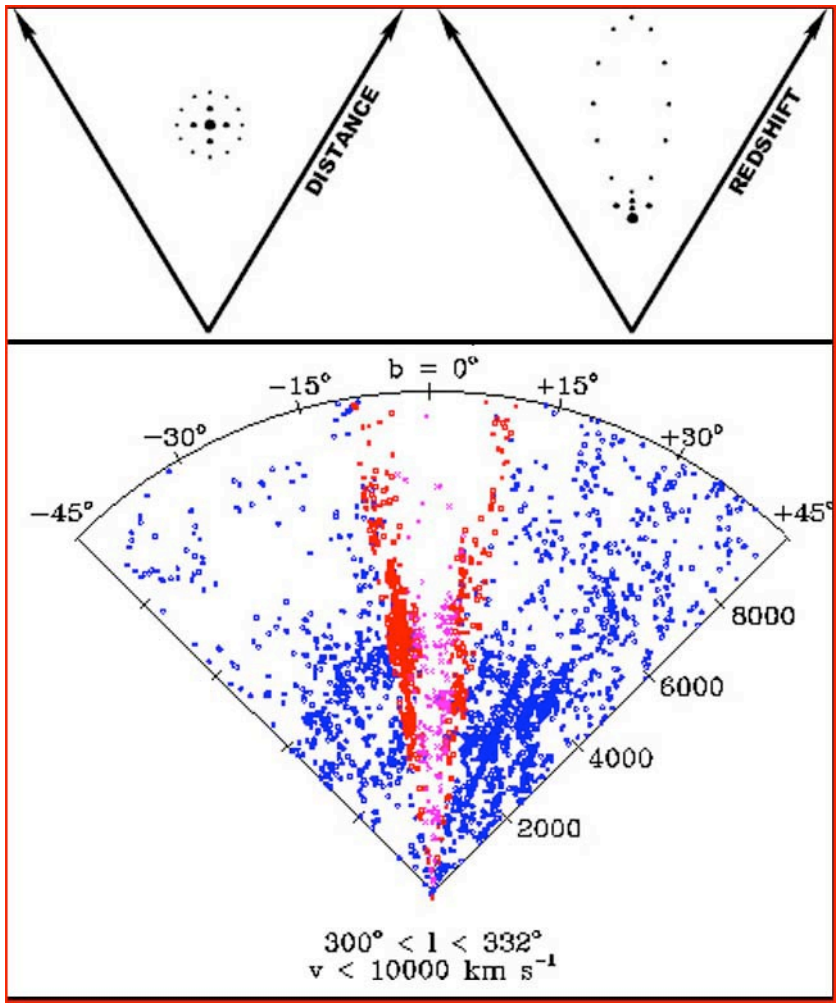
Photometric redshifts have seen great success

Allow redshift estimates for very faint objects and large samples where spectroscopy is observationally too expensive

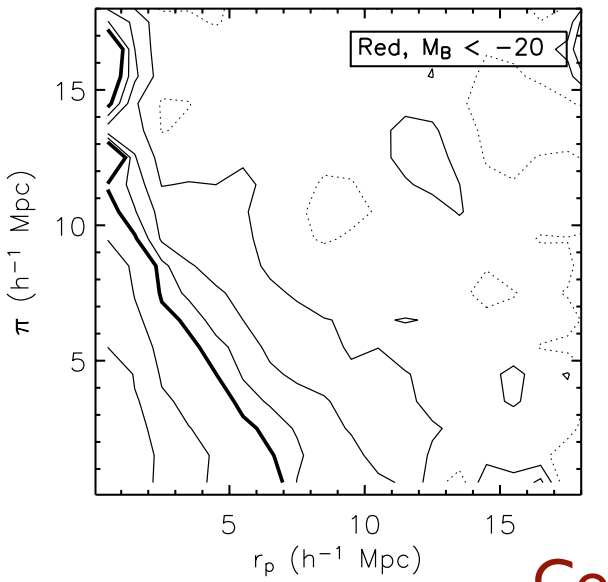
Typical errors of 3-5% are too large to separate populations into all but the most extreme environmental bins and outliers cause systematic errors



1% redshifts are good enough for LSS

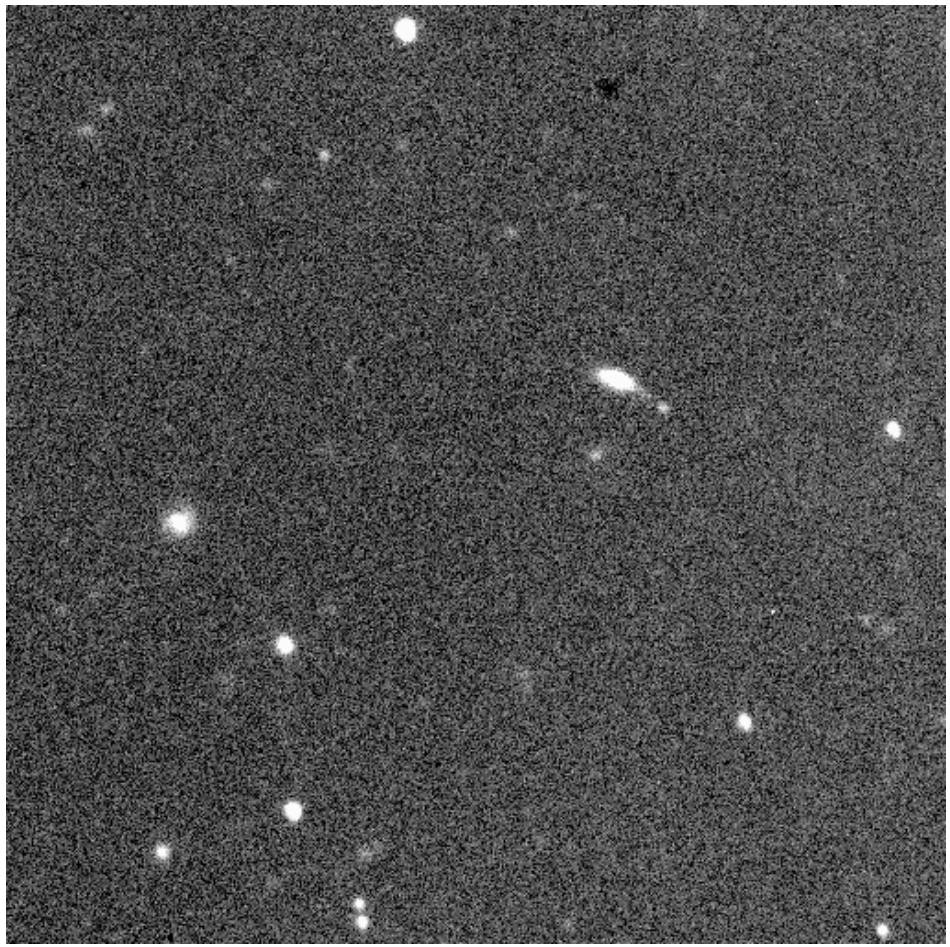


Measurements of large-scale structure (clustering, local density, environment) integrate over 1% in redshift because of redshift-space distortions.



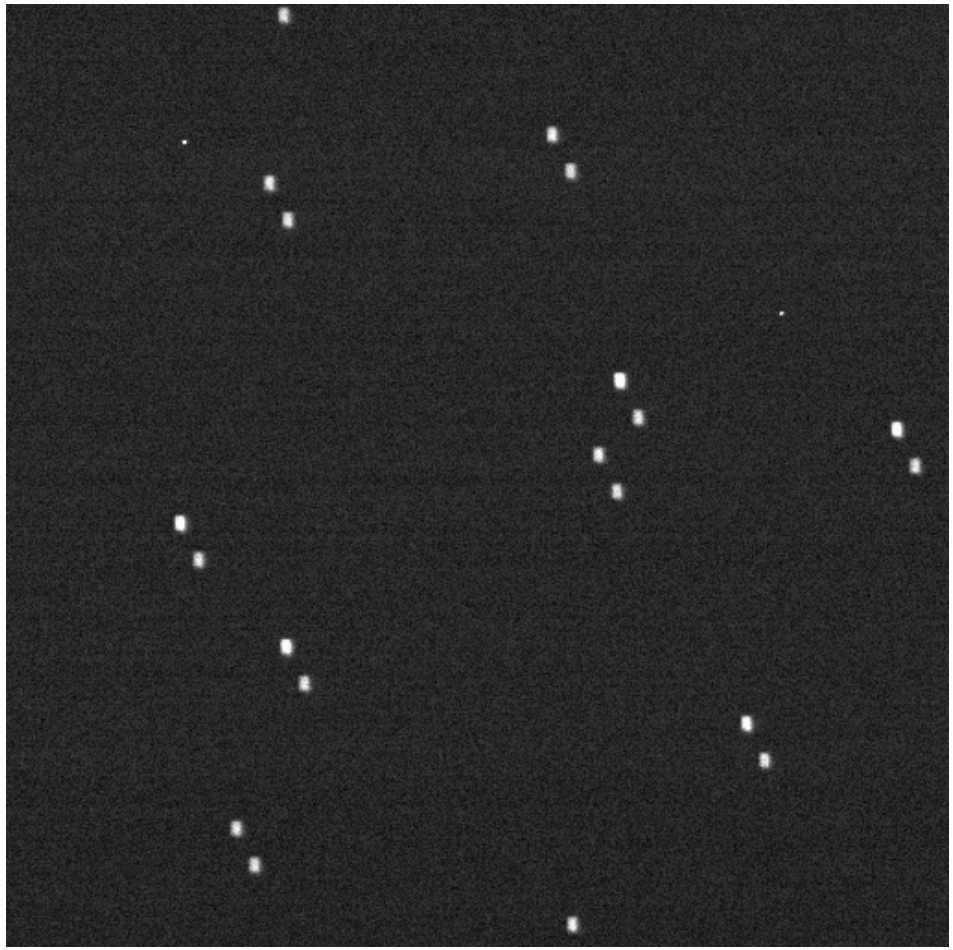
Coil et al. 2008

Photometric redshift surveys are useful



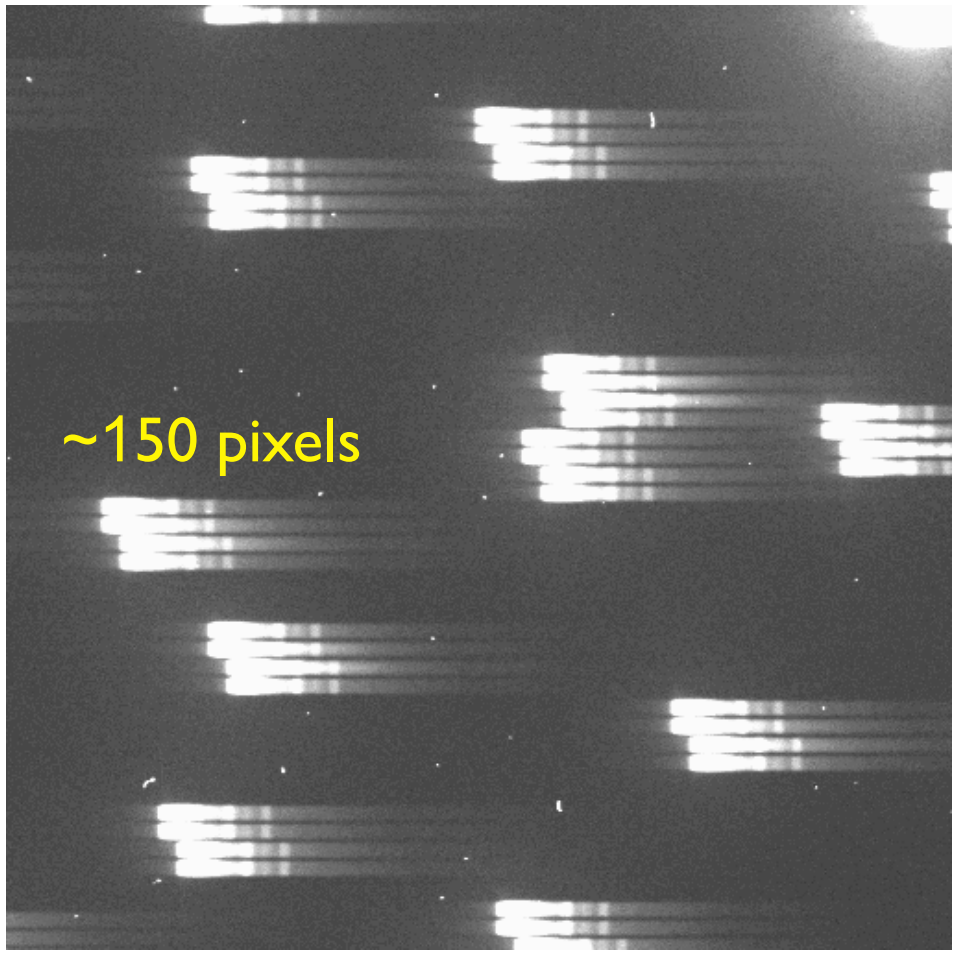
e.g., COMBO-17 achieves 3% accuracy in redshift
w/ 17 bands (broad+narrow bands)

But a slitmask + prism is more efficient



and provides more accurate redshifts!

But a slitmask + prism is more efficient



We achieve 1% redshifts w/ these low-dispersion prism spectra from IMACS on Magellan

PRIMUS Goals:

- Obtain redshifts for an SDSS-like sample of galaxies to z=1
- 300,000 galaxies over 15 deg^2
- Target fields with existing optical imaging
- Target fields with multi-wavelength data to maximize the legacy value of these datasets (hit all southern SWIRE fields with good optical imaging)

PRIMates:

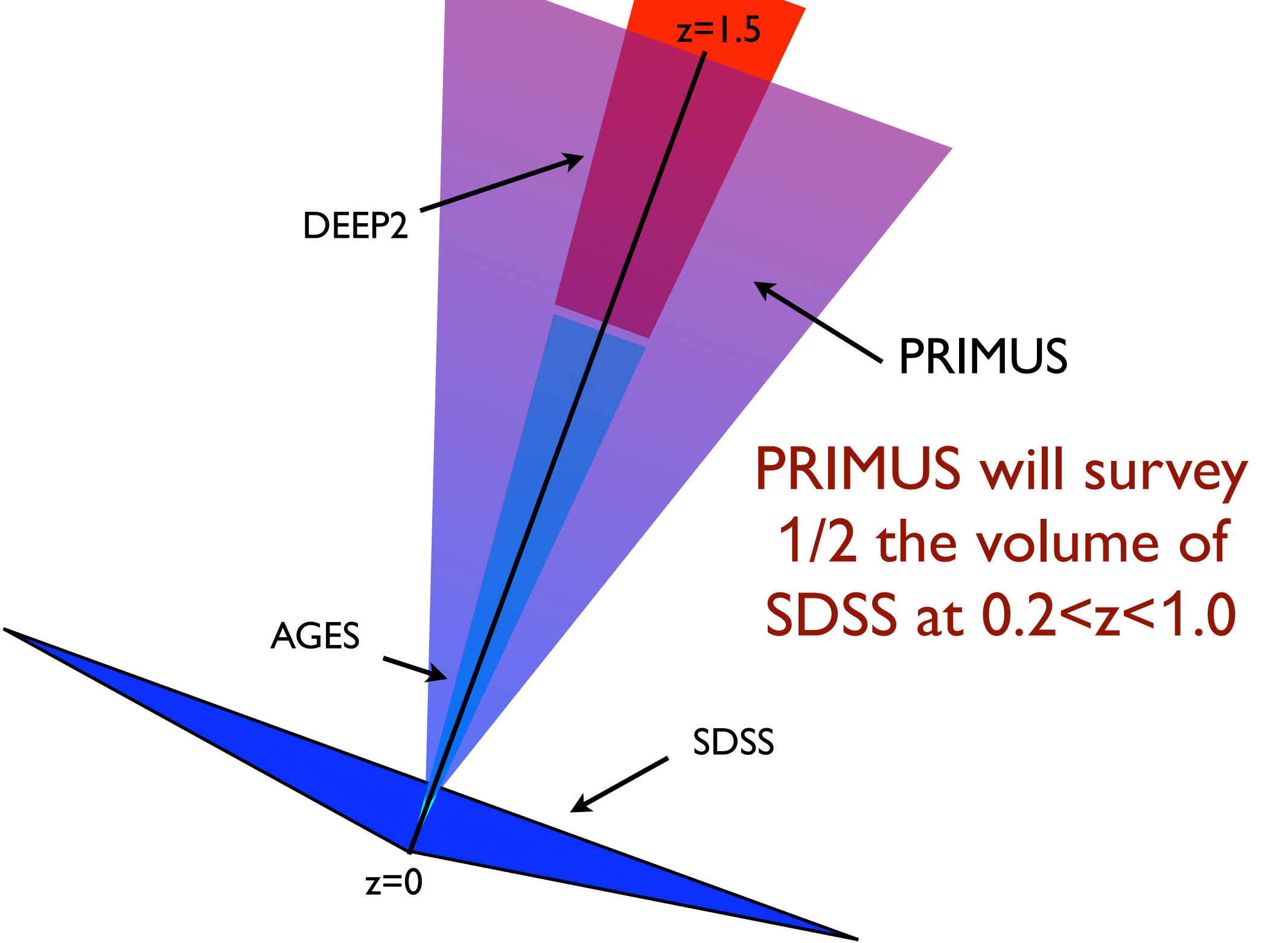
Arizona: Alison Coil, Richard Cool, Daniel Eisenstein (PI), Ken Wong

MIT: Scott Burles

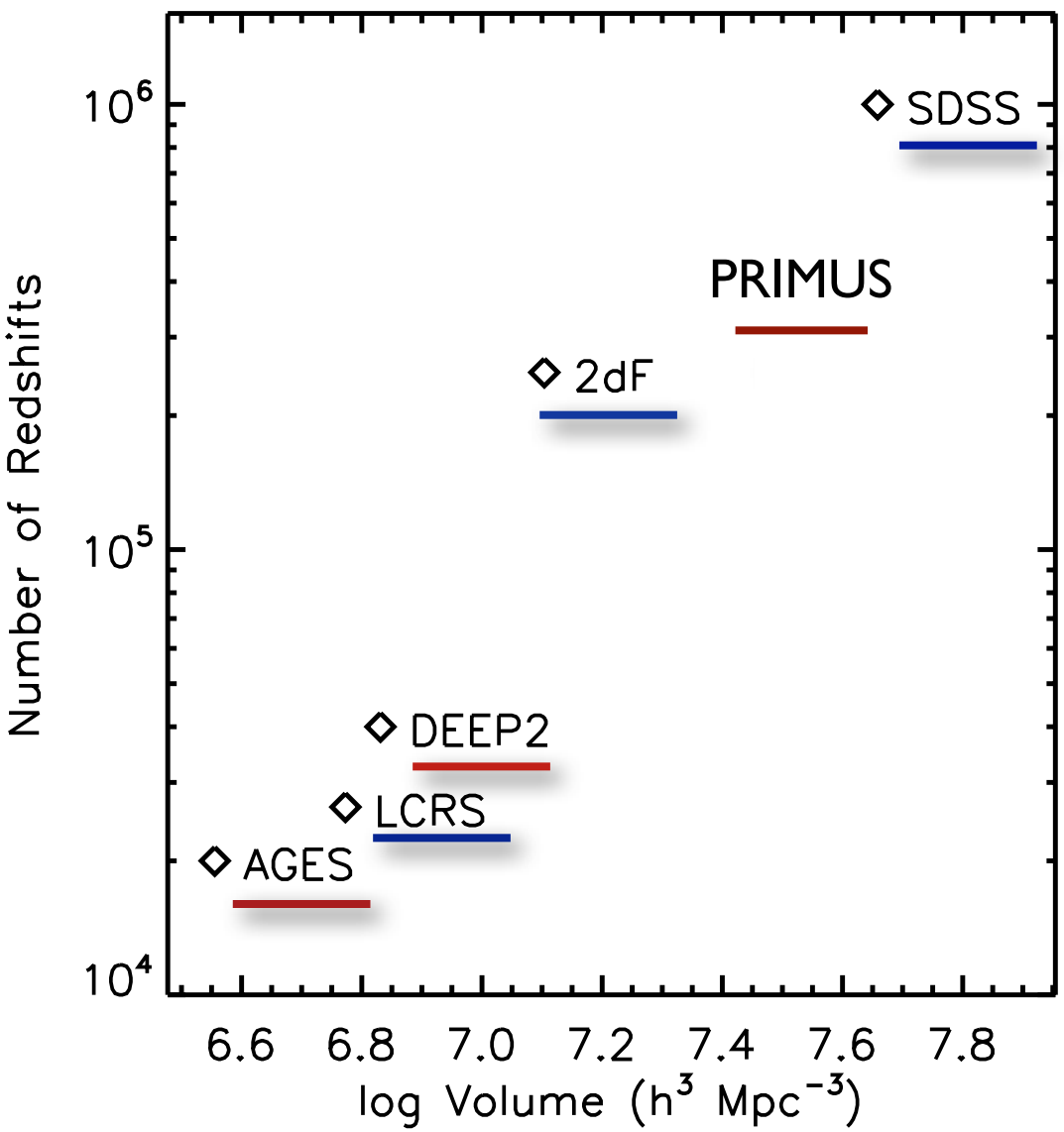
NYU: Michael Blanton, Guangtun Zhu

Hawaii: Adam Bolton

39 dark nights from Jan 2006 - Jan 2008


z=1.5
DEEP2
PRIMUS
PRIMUS will survey
1/2 the volume of
SDSS at 0.2<z<1.0
AGES
SDSS
z=0

Context with other surveys



Current high-redshift surveys have over 10x fewer redshifts and volumes than SDSS

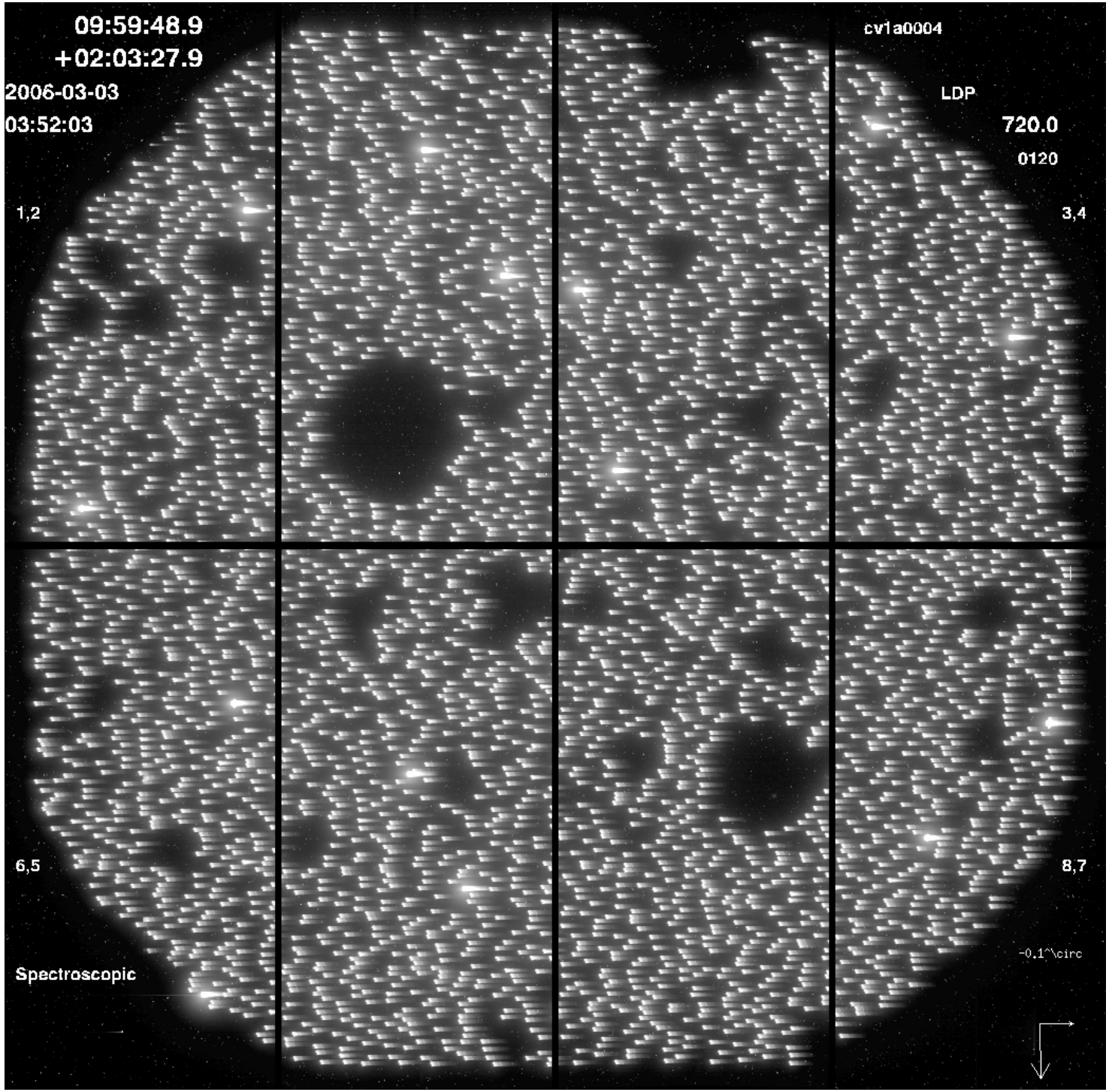
PRIMUS will rectify this difference

5x larger than DEEP2

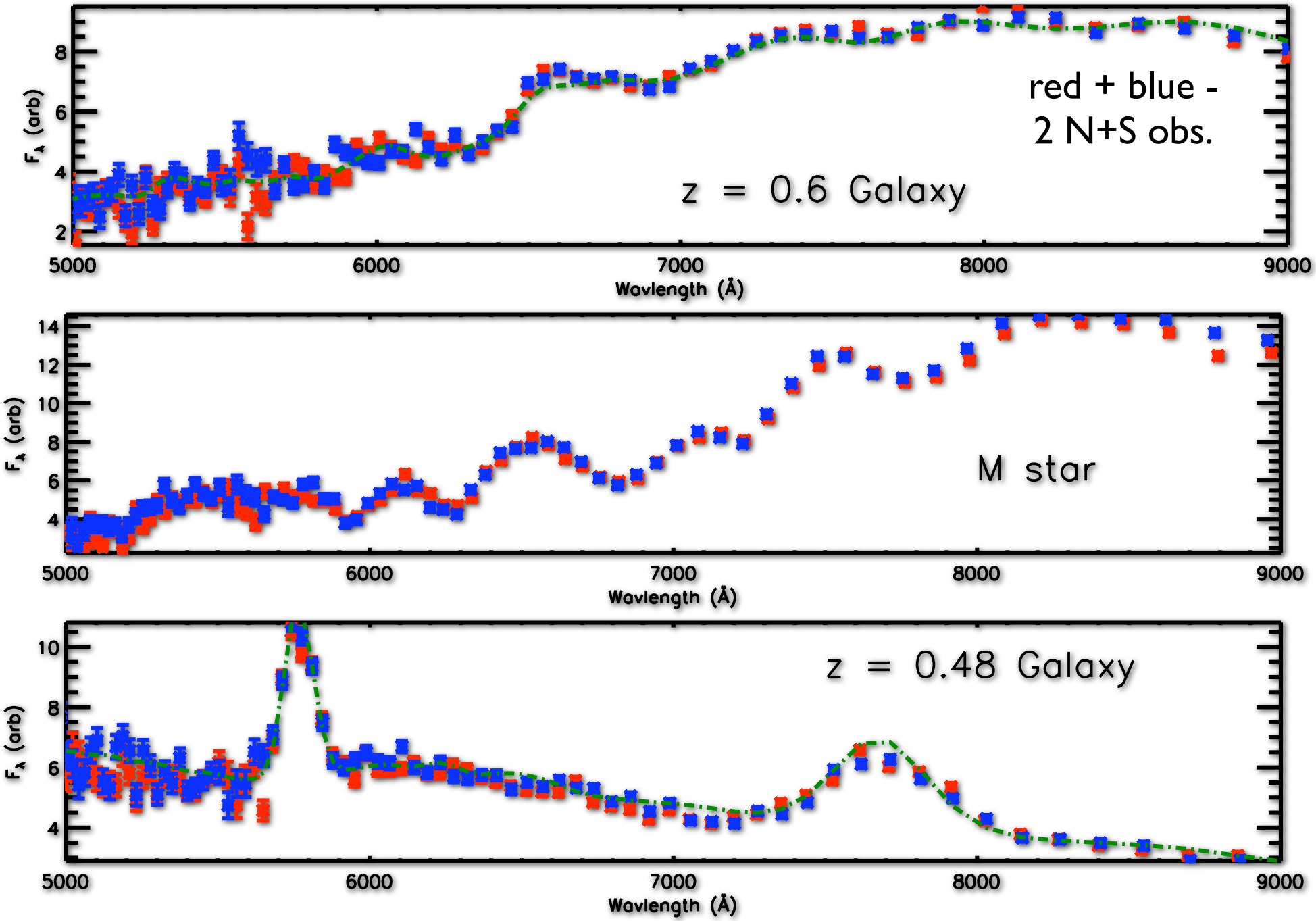
We have designed and commissioned a new prism for IMACS on Magellan

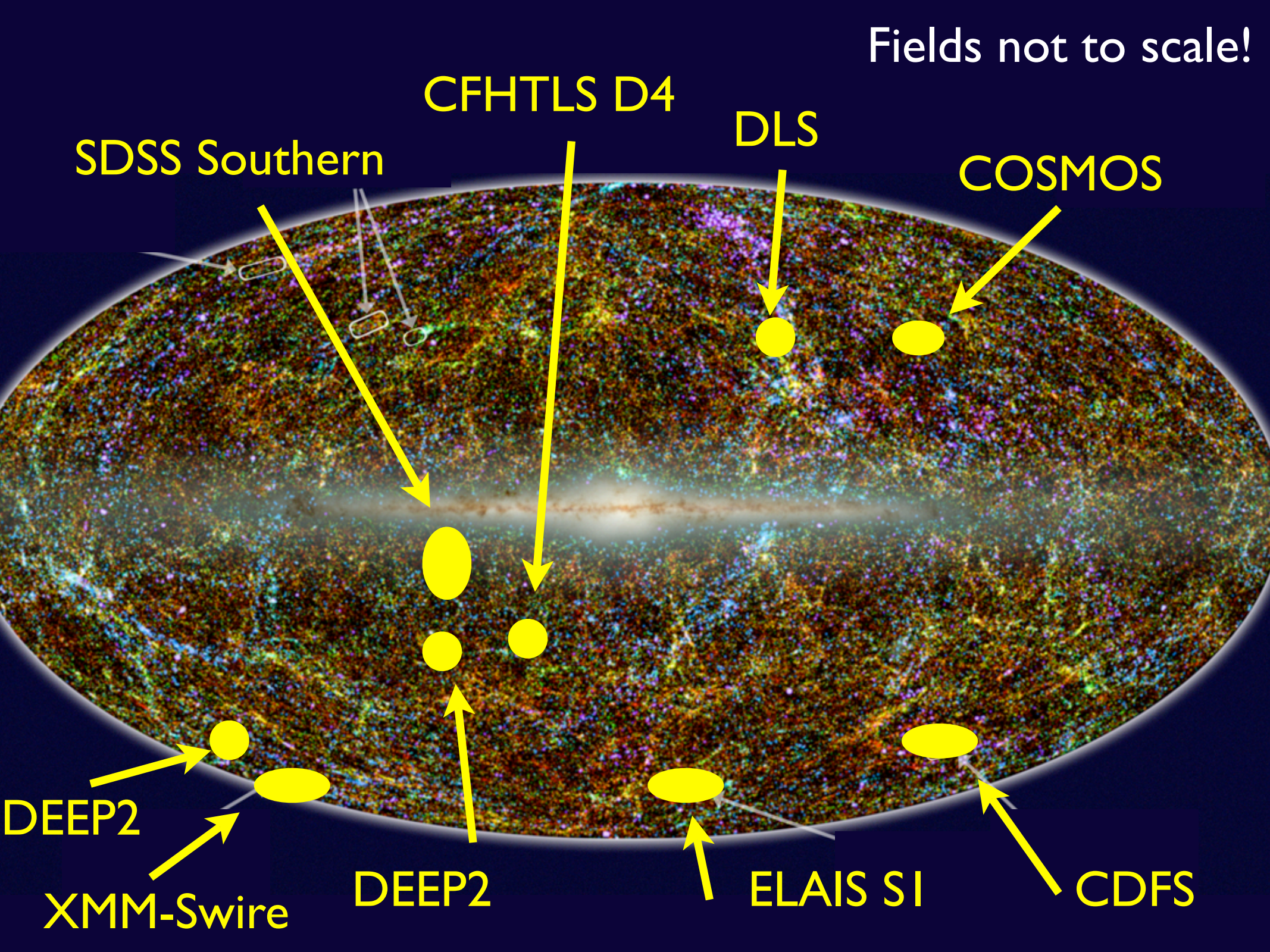
Multiplexing in the spectral direction allows for simultaneous observations of 3000 galaxies

Doing a flux-limited survey (i~23) - no color selection.

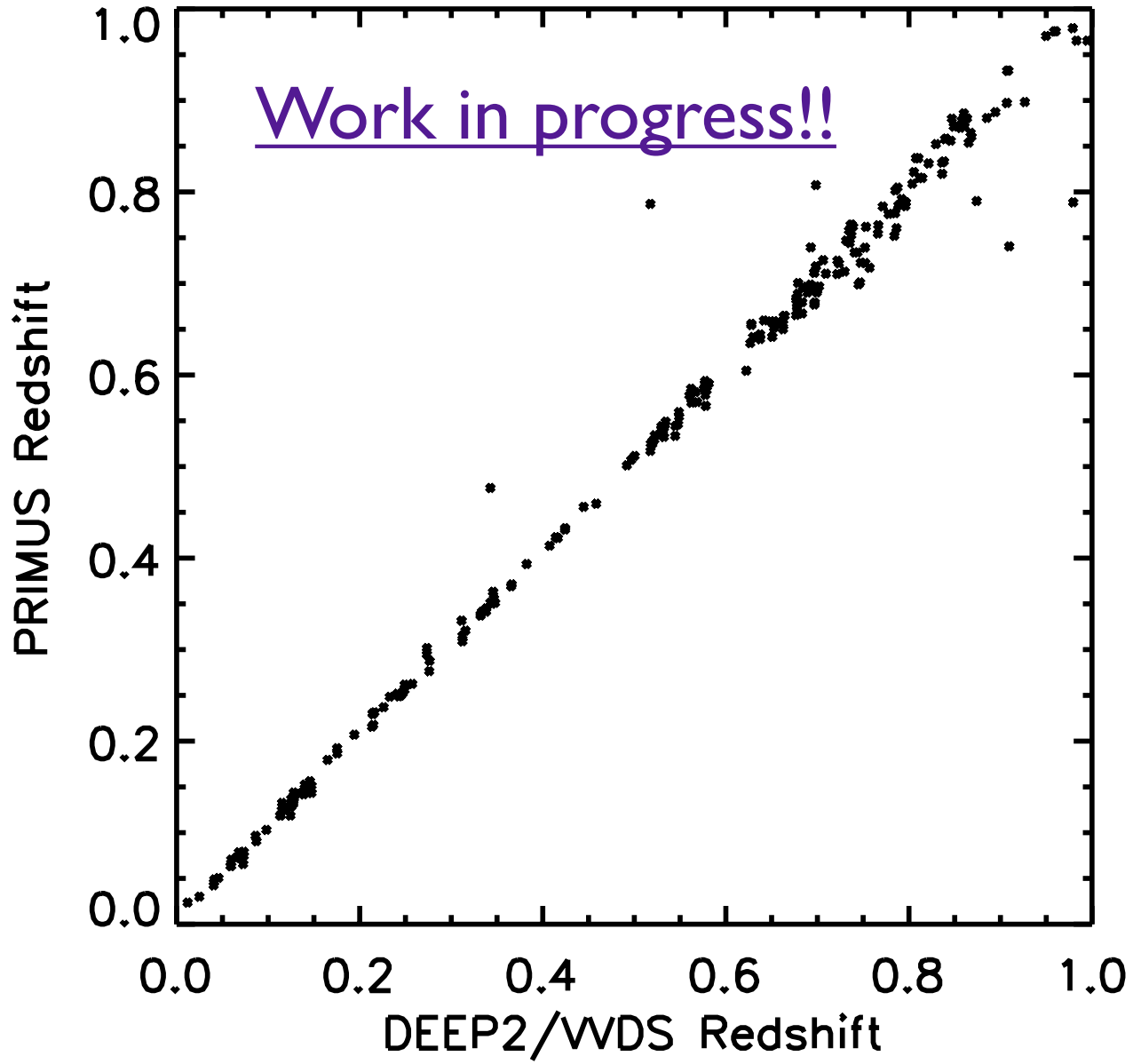


Example Spectra




Fields not to scale!
CFHTLS D4
SDSS Southern
DLS
COSMOS
DEEP2
XMM-Swire
DEEP2
ELAIS S1
CDFS

Redshift Precision



Using high-resolution redshifts from DEEP2 and VVDS to test our z's

Still working on known systematics. This will tighten - haven't corrected for alignment offsets, not using broad-band photometry yet, investigating outliers, etc.

Currently have 6% catastrophic outliers and 1% $\Delta z/(1+z)$ - will improve! Includes both blue and red galaxies.

Current Status:

Observing for 2 years - finished this January
>300,000 spectra over 13 sq. degrees
Most of the survey has Spitzer imaging
Much has X-ray and GALEX imaging as well
Now finalizing reductions and redshifts

Final Survey:

~1/2 the volume of SDSS
5x larger than DEEP2
over 10x faster than Keck or VLT!

By far the largest faint galaxy redshift survey completed and will enable science with the largest sample of Spitzer redshifts!

Just a bit of the PRIMUS science to come:

Evolution of multivariate functions of galaxy properties: color, luminosity, stellar mass (Spitzer), star formation rate (GALEX + Spitzer) from z~0.2 - 1.0

Clustering as function of luminosity and/or stellar mass for red and blue galaxies separately

LIRG/ULIRG evolution: clustering and stellar mass

AGN selected by optical, IR or X-ray emission: comparison of different selections and AGN vs galaxy clustering of various types

...stay tuned!