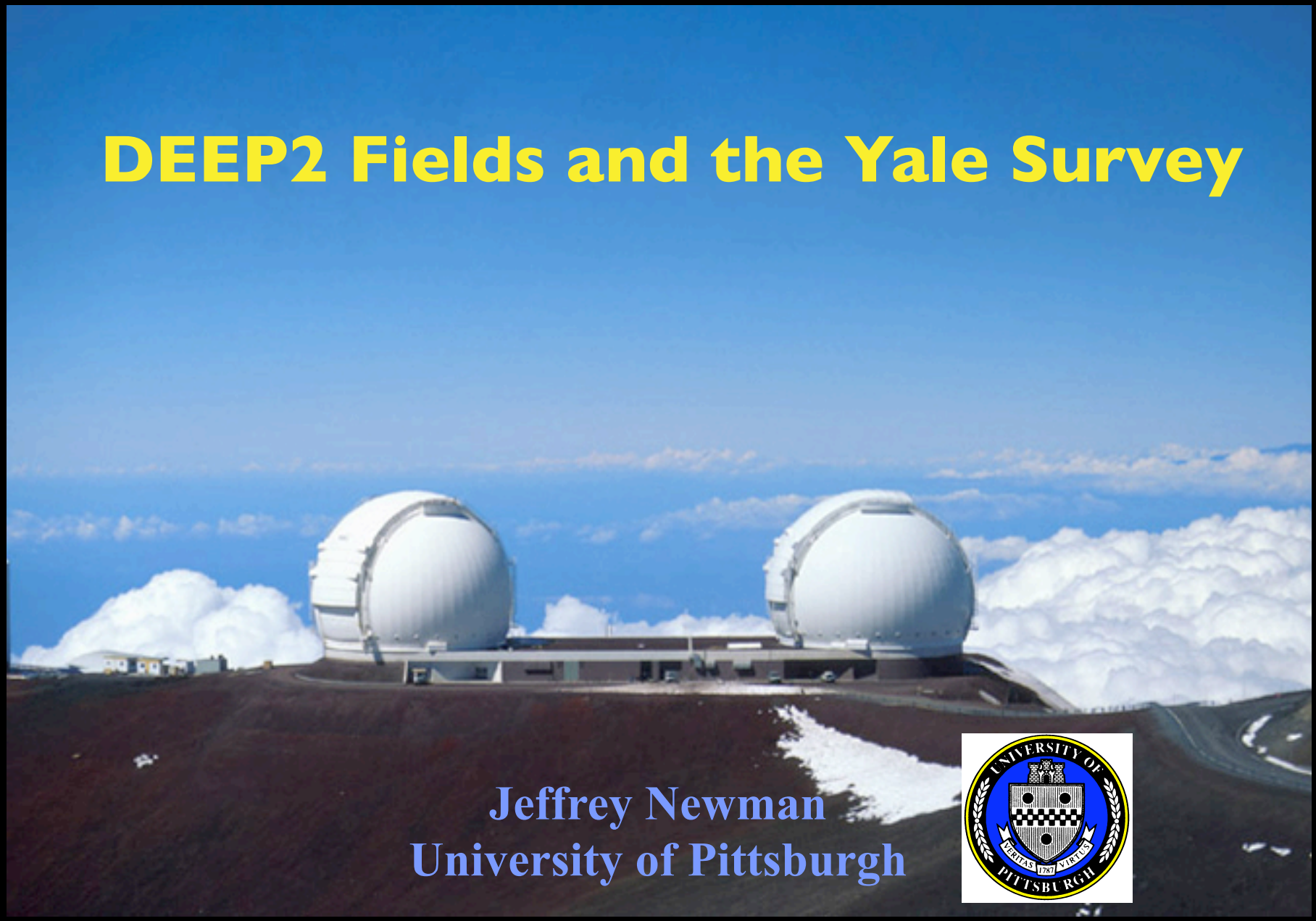
# DEEP2 Fields and the Yale Survey



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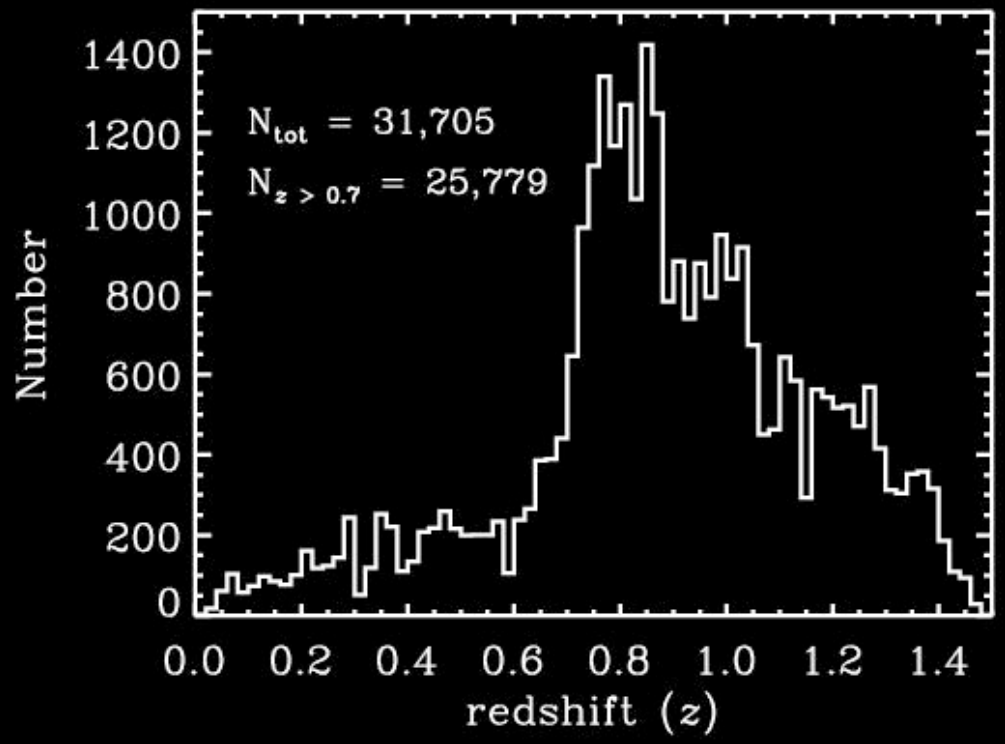
# DEEP2: A z~1 spectroscopic survey

**DEEP2 (= DEEP Extragalactic Evolutionary Probe 2)** studies both galaxy properties and large-scale structure at z~1.

- **Observational details:**
- ~3 sq. degrees
- 4 fields (0.5º x <2º)
- RAB ≤ 24.1
- 80+ Keck nights
- >50k spectra, >37k secure redshifts
- primarily 0.7 < z < 1.4

  (pre-selected using BRI photometry)




All DEEP2 data have been released!

**http://deep.berkeley.edu/DR3**

# The DEEP2 fields

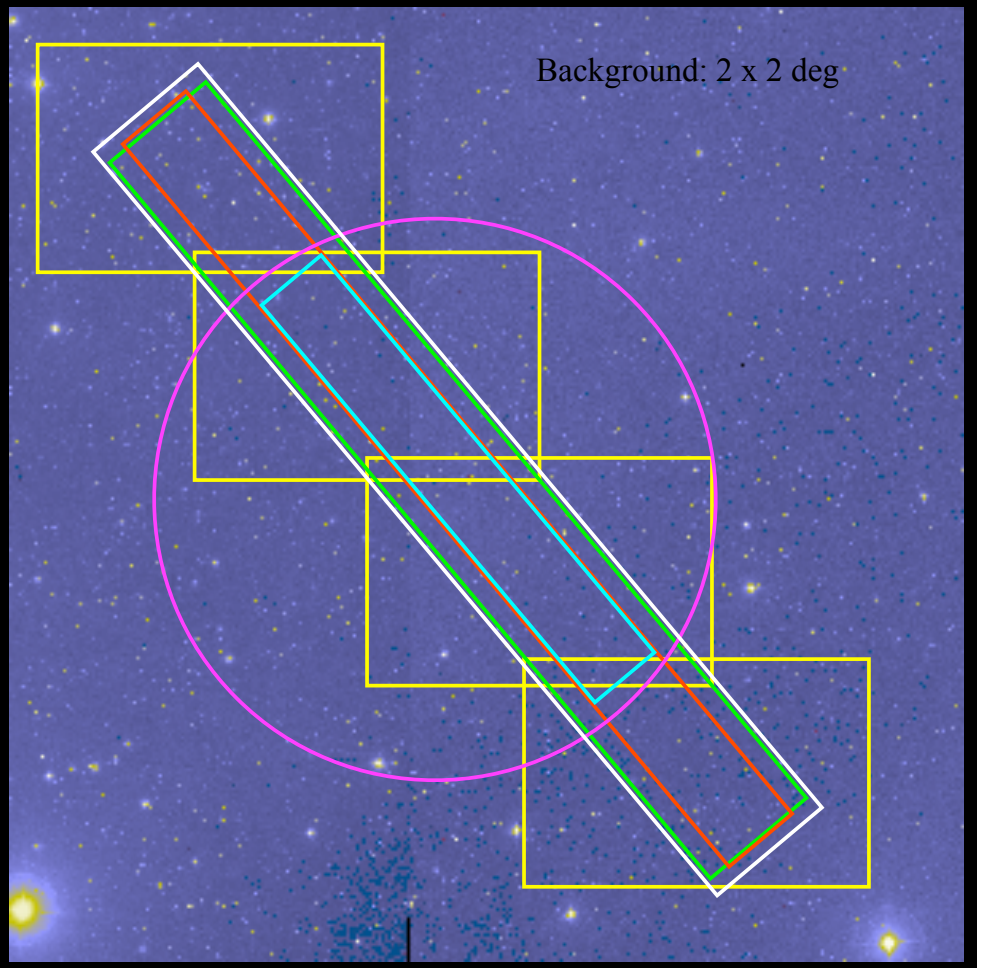
| Field | Notes/Ancillary data |
|---|---|
| **1** (EGS): 14h 17 +52 30 | Target of AEGIS multiwavelength survey: deep imaging at ~all possible wavelengths, inc. 126 orbits HST/ACS; CFHT LS deep & wide<br>**No z>0.7 color cut is applied in EGS** |
| **2**: 16h 52 +34 55 | Spitzer IRAC, MIPS; Chandra/ACIS (10-20 ksec depth), Palomar JHK, CFHT i,z |
| **3**: 23h 30 +00 | SDSS deep strip (Stripe 82); Palomar JHK, CFHT i,z, ~40 orbits HST/ACS or WFPC2 |
| **4**: 2h 30 +00 | Spitzer IRAC; Chandra/ACIS (10-20 ksec depth), SDSS deep strip (Stripe 82); Palomar JHK, CFHT i,z, ~40 orbits HST/ACS or WFPC2<br>Near, but not overlapping, XMM-LSS, VVDS, etc. |

Each field is 0.5 degx2 deg, though embedded in wider RCS/RCS2 imaging

# The All-wavelength Extended Groth strip International Survey

- Spitzer MIPS, IRAC: some of the deepest on the sky
- DEEP2 spectra and Caltech / JPL $JK_s$ imaging
- HST/ACS V&I (126 orbits)
- DEEP2/CFHT B,R,I
- GALEX NUV+FUV (deepest anywhere); CFHTLS deep ugriz
- Chandra/ACIS: 200ksec-800ksec depth (3.4Msec total)

Plus NMBS mid-band IR imaging (van Dokkum), VLA, Scuba2, etc.




## Imaging Data Summary Table

| Mission / Telescope | Band | PSF | λeff | Limiting Magnitude (typically 5σ) | Surface Density ($deg^{-2}$) | Area ($deg^2$) | Exposure Time (ks) |
|---|---|---|---|---|---|---|---|
| Chandra / ACIS | HB | 0.5"-6.0" | 3.1 Å (4keV) | $8.2 \times 10^{-16}$ erg $s^{-1}cm^{-2}$ | 3200 | 0.67 | 200 |
| Chandra / ACIS | SB | 0.5"-4.0" | 3.1 Å (4keV) | $1.1 \times 10^{-16}$ erg $s^{-1}cm^{-2}$ | 2500 | 0.67 | 200 |
| GALEX | FUV | 5.5" | 1539 Å | 25 (AB) [3σ] | 8720 | 1.13 | 58 |
| | NUV | 5.5" | 2316 Å | 25 (AB) [3σ] | $2.35 \times 10^4$ | 1.13 | 120 |
| HST / ACS | F606W (V) | 0.1" | 5913 Å | 28.75 (AB) | $4.0 \times 10^5$ | 0.197 | 2.3 |
| | F814W (I) | 0.1" | 8330 Å | 28.10 (AB) | $3.9 \times 10^5$ | 0.197 | 2.1 |
| HST / NICMOS | F110W (J) | 0.35" | 1.10 μm | 25.7 (AB) [10σ] | $3.3 \times 10^5$ | 0.0128 | 2.6 |
| | F160W (H) | 0.35" | 1.59 μm | 28.10 (AB) [10σ] | $3.3 \times 10^5$ | 0.0128 | 2.6 |
| CFHT12K | B | 1" | 4389 Å | 24.5 (AB) [8σ] | $1.45 \times 10^5$ | 1.31 | 6.5 |
| | R | 1" | 6601 Å | 24.2 (AB) [8σ] | $1.45 \times 10^5$ | 1.31 | 3.6 |
| | I | 1" | 8133 Å | 23.5 (AB) [8σ] | $1.45 \times 10^5$ | 1.31 | 4.7 |
| CFHT/Megacam | u* | <1.1" | 3700 Å | ~ 27 (AB) | $\sim 10^5$ | 1 | 6.1 |
| CFHTLS | g' | <1.0" | 4850 Å | 28.3 (AB) | $\sim 10^5$ | 1 | 6.5 |
| | r' | <0.9" | 6250 Å | ~27.5 (AB) | $\sim 10^5$ | 1 | 15 |
| | i' | <0.9" | 7700 Å | ~27 (AB) | $\sim 10^5$ | 1 | 47 |
| | z' | <0.9" | 8850 Å | 26.4 (AB) | $\sim 10^5$ | 1 | 3.6 |
| Palomar / WIRC | J | 1" | 1.25 μm | 23 (AB) | $7.64 \times 10^4$ | 0.2 | 18 |
| | $K_s$ | 1" | 2.14 μm | 20.6 (AB) | $5.37 \times 10^4$ | 0.7 | 11 |
| IRAC | 1 | 1.8" | 3.6 μm | 0.9 μJy | $1.66 \times 10^5$ | 0.33 | 10.1 |
| | 2 | 2.0" | 4.5 μm | 0.9 μJy | $1.66 \times 10^5$ | 0.33 | 10.1 |
| | 3 | 2.2" | 5.8 μm | 6.3 μJy | $4.9 \times 10^4$ | 0.33 | 10.1 |
| | 4 | 2.2" | 8.0 μm | 5.8 μJy | $4.86 \times 10^4$ | 0.33 | 10.1 |
| MIPS | 24 μm | 5.9" | 23.7 μm | 77 μJy | $1.76 \times 10^4$ | 0.534 | 1.6 |
| | 70 μm | 19" | 71.4 μm | 10.3 μJy | 1275 | 0.498 | 0.8 |
| VLA | 6 cm | 1.2" | 6.17 cm | 0.55 mJy $beam^{-1}$ [10σ] | 88.9 | 5.2 | 0.1 |
| | 20 cm | 4.2" | 21.4 cm | 100 μJy $beam^{-1}$ | 0.64 | 0.64 | 40 |


# Spectroscopic Data Summary Table

| Telescope/Instrument (Mode) | Wavelength Range (Å) | Spec. Res. (FWHM) | Spatial PSF | Lim. Mag ($deg^{-2}$) | Area | # Targ | Exp Time (ks) |
|---|---|---|---|---|---|---|---|
| Keck/DEIMOS | 6400-9100 | 1.4 | 0.6"-1.0" | R=24.1 (AB) | 0.5 | 17,600 | 3.6 |

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# Derived Data Products

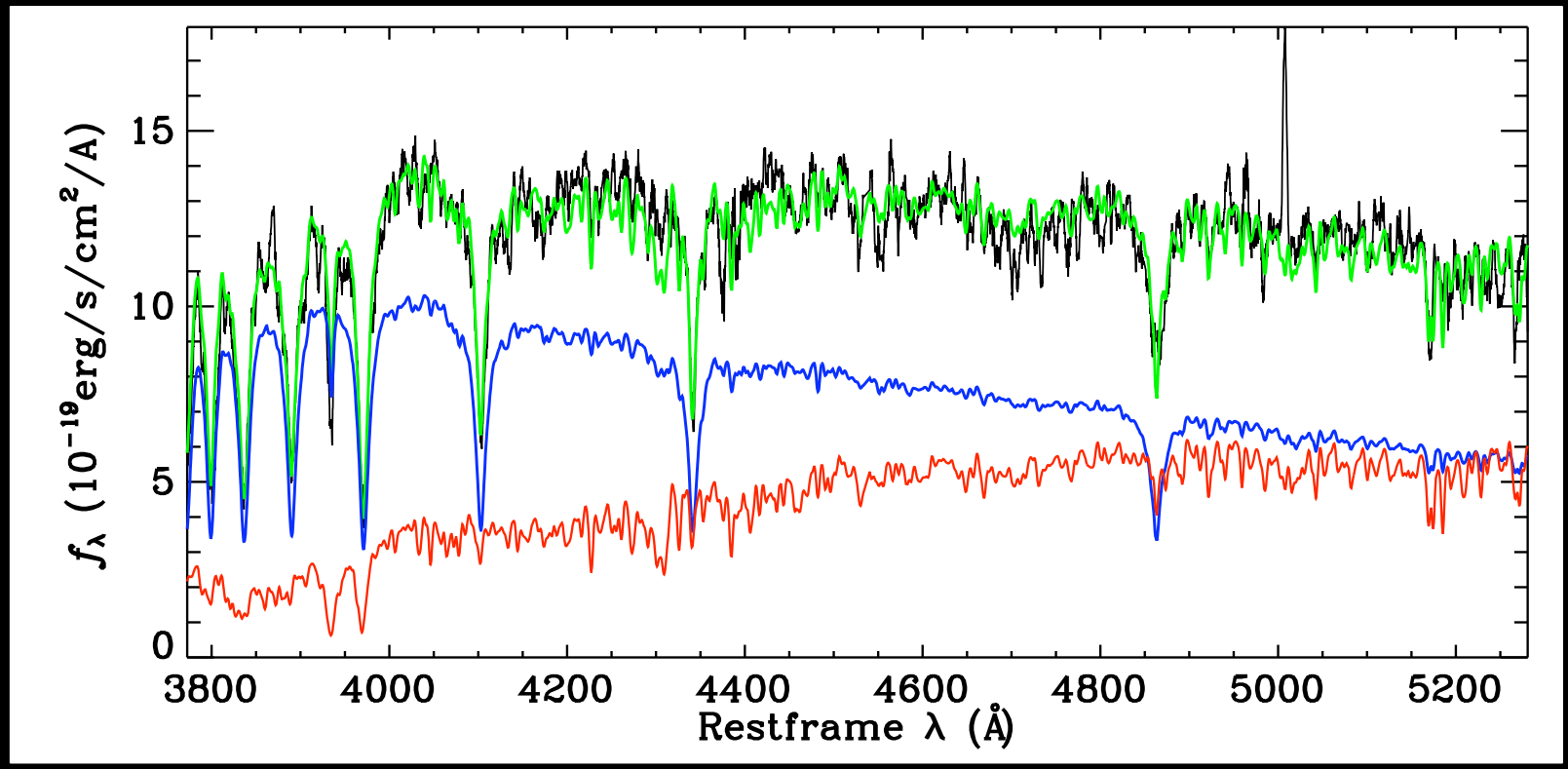
| Measurement | Field | Data Sets Used | Contact | Email | @ |
|---|---|---|---|---|---|
| K-corrections | DEEP2 | CFHT BRI, DEEP2 | Willmer | cnaw | as.arizona.edu |
| Environment Measures | DEEP2 | DEEP2 | Cooper | cooper | astro.berkeley.edu |
| Group Catalog | DEEP2 | DEEP2 | Gerke | bgerke | astro.berkeley.edu |
| K/A Decomposition & EW Measurements | DEEP2 | DEEP2 | Yan | renbin | astro.berkeley.edu |
| EW & Velocity Dispersion Measurements | DEEP2 | DEEP2 | Weiner | bjw | as.arizona.edu |
| Standard EWs | DEEP2 | DEEP2 | Konidaris | npk | ucolick.org |
| SFR measures | EGS | DEEP2, Spitzer, Galex | Noeske | kai | ucolick.org |
| Stellar Masses | Palomar K | DEEP2, Palomar-J,K | Bundy | kbundy | astro.caltech.edu |
| Stellar Masses | DEEP2 | DEEP2, Bundy catalog | Willmer | cnaw | as.arizona.edu |
| Photo-z | EGS | DEEP2, Spitzer | Huang | jhuang | cfa.harvard.edu |
| Photo-z | DEEP Fields 2, 3, 4 | DEEP2, z-band data | Lin | lihwai | ucolick.org |
| GALFIT | EGS | HST/ACS | Griffith, Cooper, Newman | cooper | astro.berkeley.edu |
| GIM2D | EGS | HST/ACS | Simard | Luc.Simard | nrc-cnrc.gc.ca |
| GIM2D | GOODS-N | HST/ACS | Koo | koo | ucolick.org |
| G/M20 | EGS | HST/ACS | Lotz | lotz | noao.edu |
| Visual Morphologies | EGS Red Galaxies | HST/ACS, zs, K-corrections | Konidaris | npk | ucolick.org |
| Rotation Curves | EGS | DEEP2 | Weiner, Kassin | kassin | ucolick.org |
| Hydrogen Column Density | EGS | Chandra + zs | Elise Laird | e.laird | imperial.ac.uk |
| Intrinsic X-Ray Luminosity | EGS | Chandra + zs | Elise Laird | e.laird | imperial.ac.uk |

# Synergies of the Yale Survey with DEEP2 fields

| Goal | Synergies |
|---|---|
| **Deep extragalactic morphology** | Spectroscopic redshifts; photo-z calibration; multiwavelength photo-z's (**1234**); calibration of morphologies vs. HST (**1**34) |
| **Gravitational lensing** | Spectroscopic redshifts; photo-z calibration; multiwavelength photo-z's (**1234**); calibration of shapes vs. HST (**1**34) |
| **Astrometry** | Longer baselines for proper motion studies, esp. with CFHTLS data (**1**234) |
| **Variability** | Longer baselines?; comparison samples of AGN from X-ray, IR, radio (**1**24) & optical emission line (**1234**) selection techniques, + multiwavelength properties of detected variables (**1**234) |

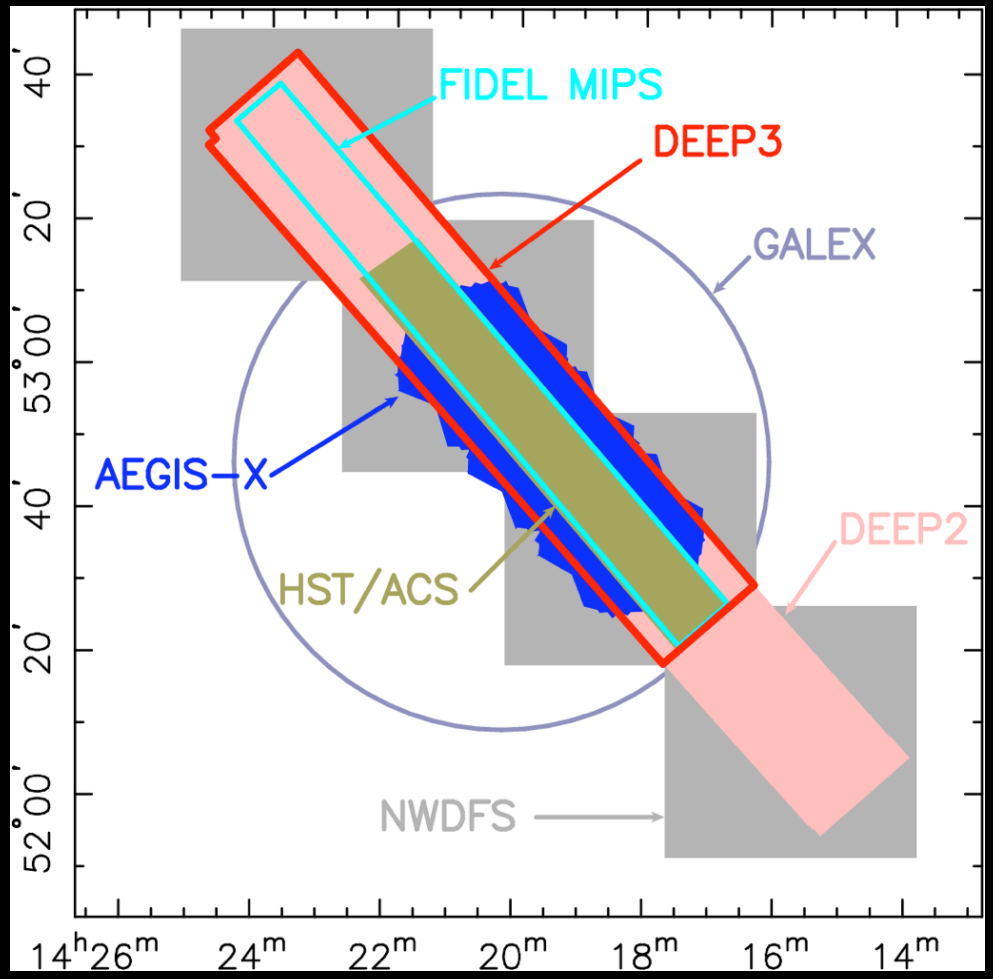
ODI variability studies will test what we find with LSST cadences - complementary observations let us evaluate the completeness of those samples

# Example: A post-starburst AGN




Yan et al. 2008 : SDSS + DEEP2

# DEEP3



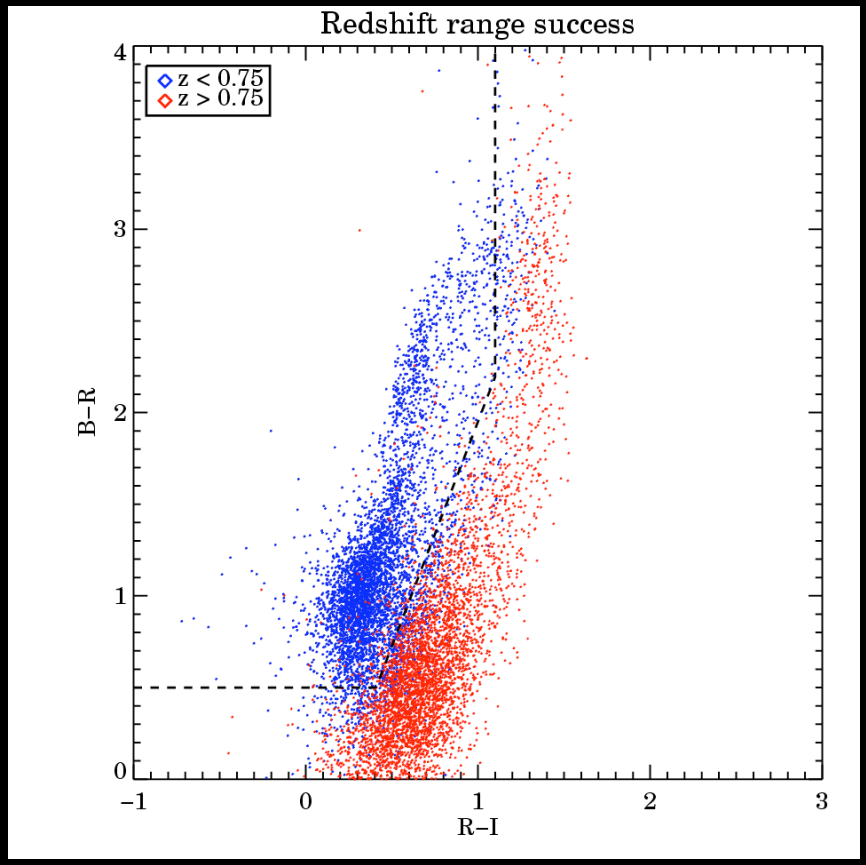

- **18k new spectra, EGS only**
- **Target the 40% of $R_{AB}$<24.1 objects DEEP2 missed, plus:**
  - All FIDEL *Spitzer* 70$\mu$m sources
  - All *Chandra* sources down to $R_{AB}$~24.5
  - "Faint extension" of star-forming galaxies down to $R_{AB}$~25.5
- **Granted 23 nights & long-term status from UC TAC**

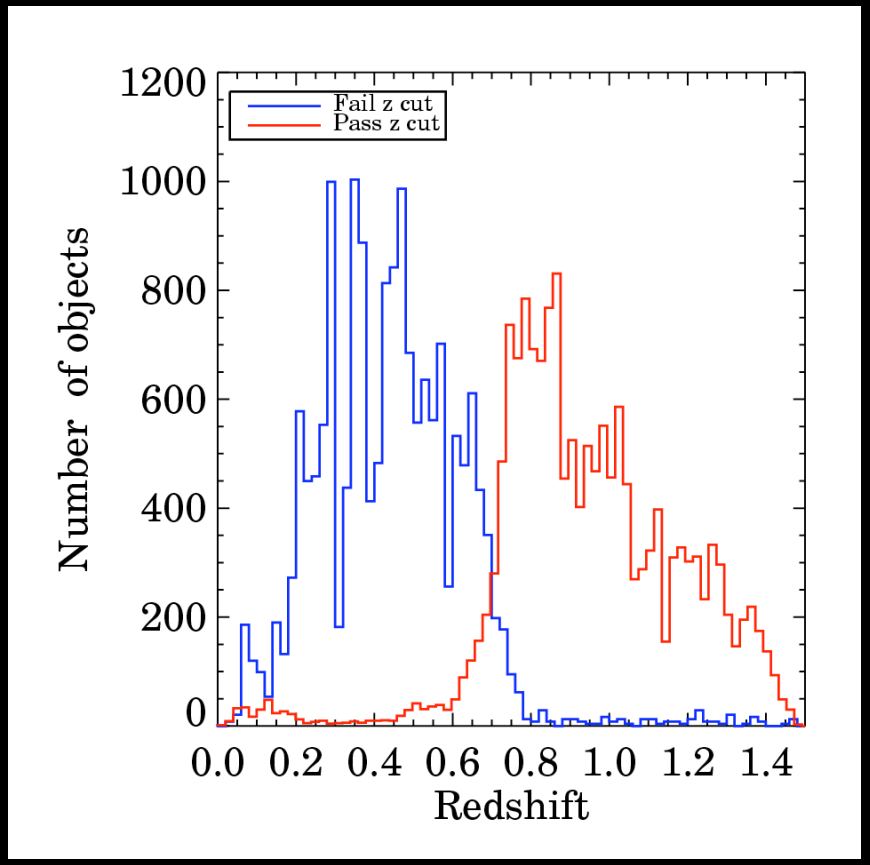
# Conclusions

- DEEP2 & AEGIS data are some of the best anywhere both in terms of spectroscopy (e.g. largest sample of secure redshifts of faint z>1 galaxies by a factor of >4) and multiwavelength imaging
- DEEP2 observations, as well as other complementary data they have attracted, have many synergies with the Yale Survey
- These synergies can only be tapped if ODI observes DEEP2 fields

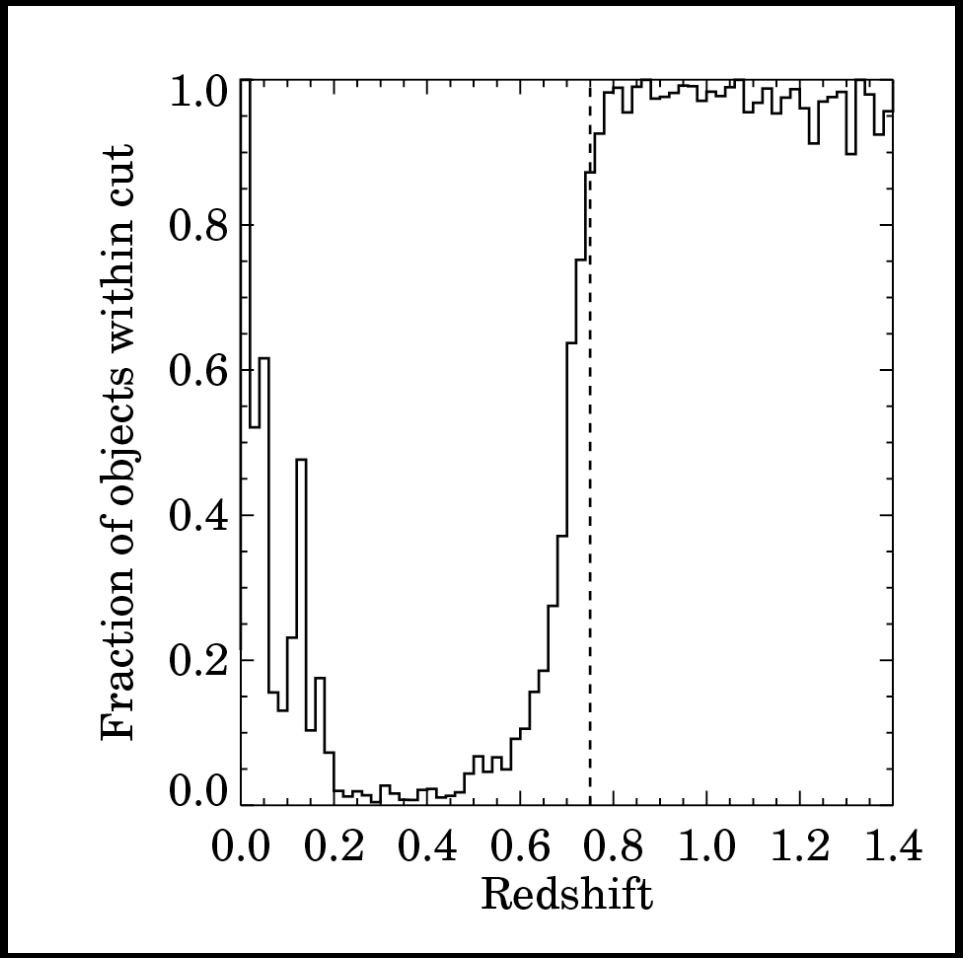

**New data releases!**
http://deep.berkeley.edu/DR3
http://aegis.ucolick.org

# DEEP2 pre-selects high-z galaxies using observed colors

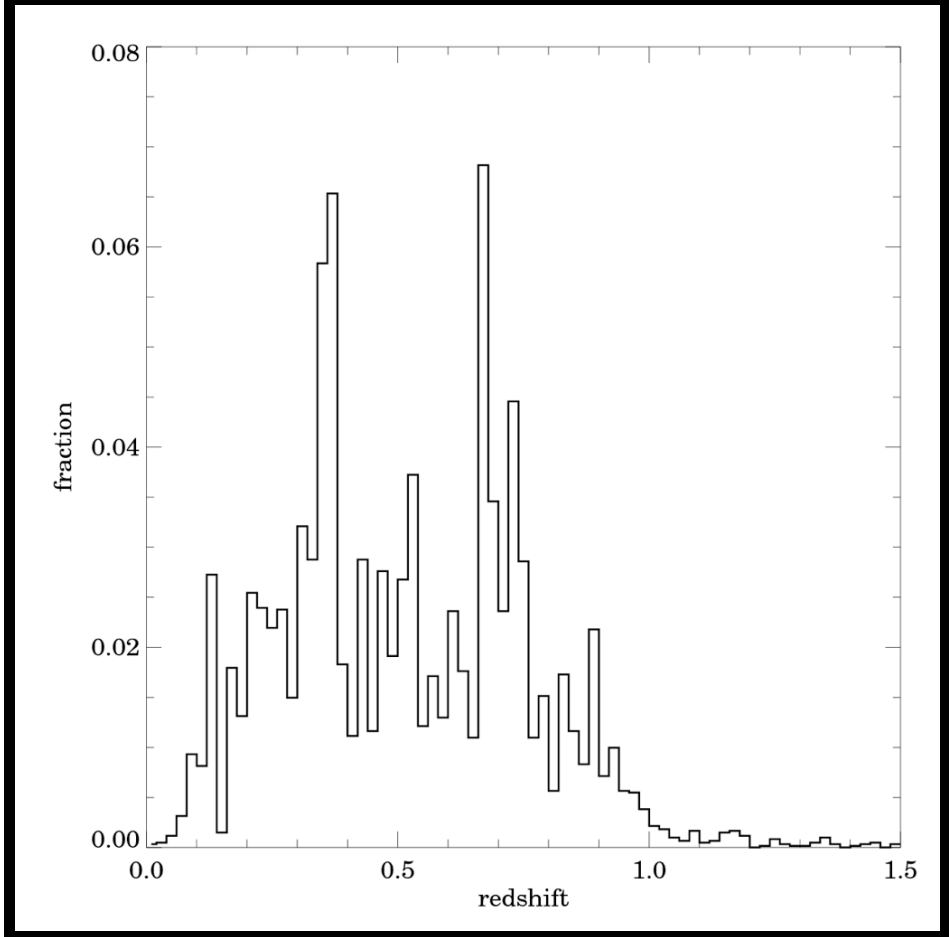


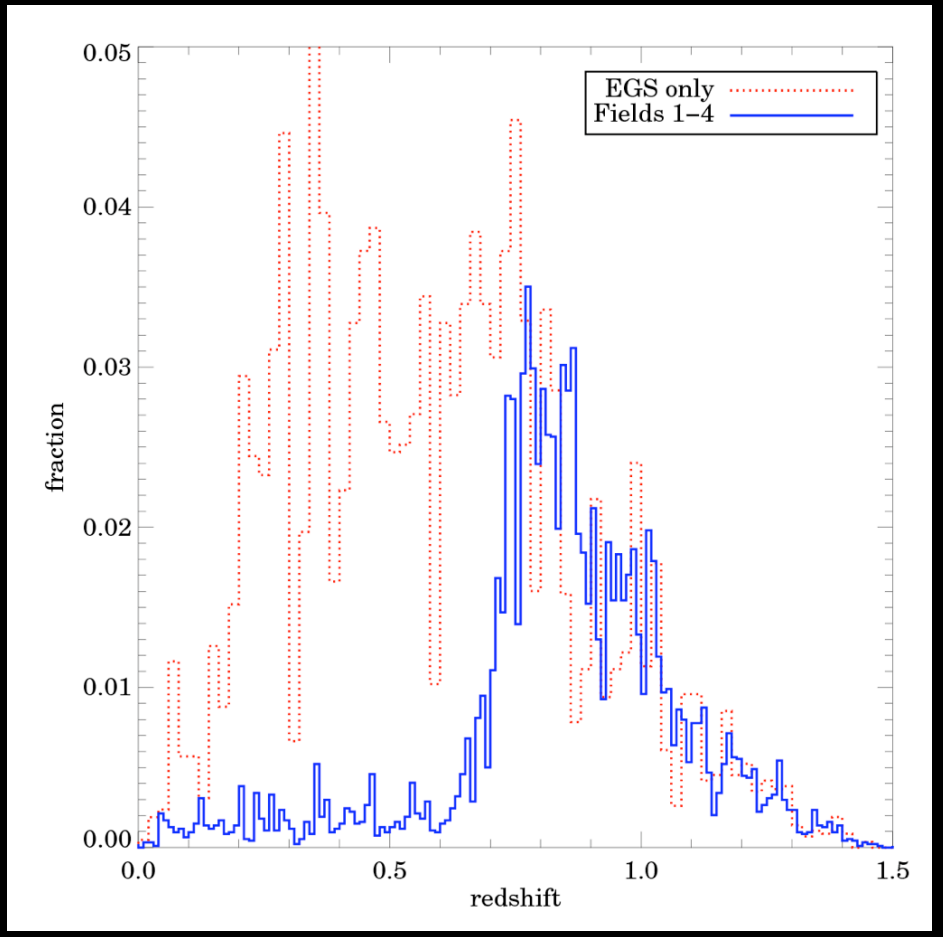



# DEEP2 color cuts give very efficient selection



# zCOSMOS vs. DEEP2

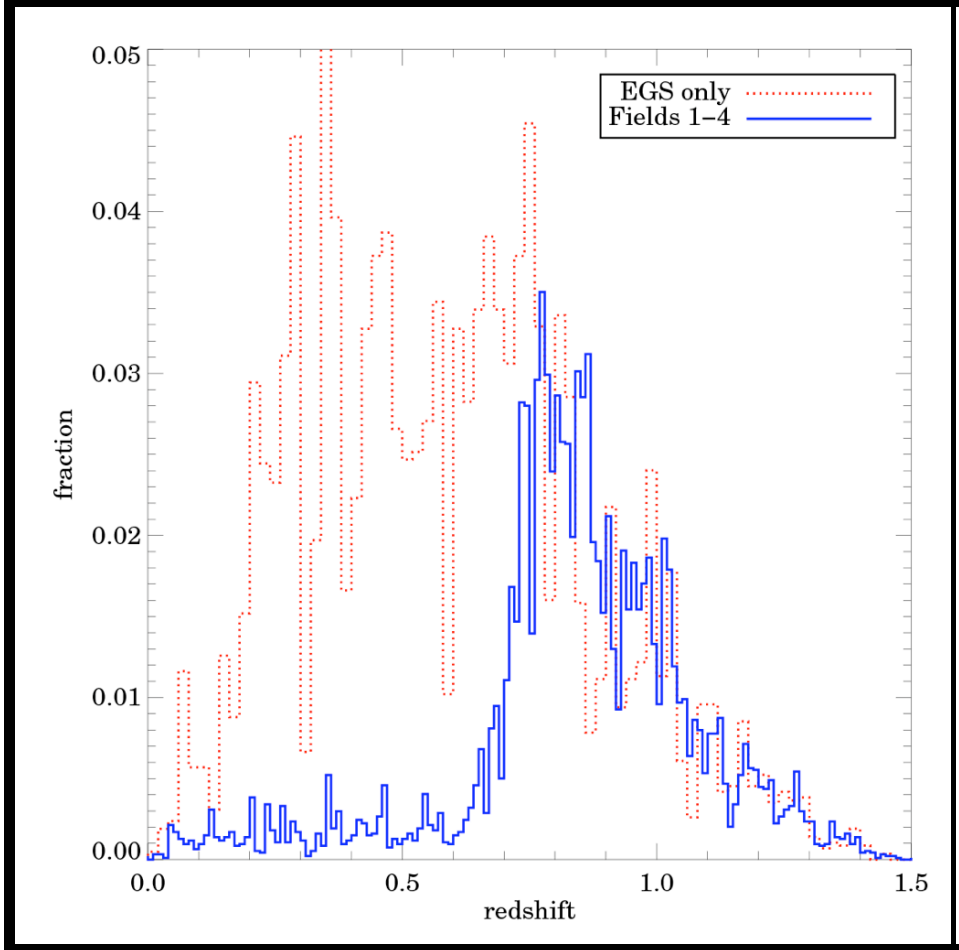



**zCOSMOS finds very few objects at $z>1$, compared to an $I_{AB}<22.5$ subsample of DEEP2.**

# $z$>1 tail is quite substantial for $R$-limited samples

$I_{AB}$<22.5




$R_{AB}$<24.1