# LADUMA with SALT

## SALT/MeerKAT Collaborations Workshop, November 2012

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# LADUMA

The **L**ooking **A**t the **D**istant **U**niverse with the **M**eerKAT **A**rray HI survey was awarded 5000h to observe a single pointing encompassing the Extended Chandra Deep Field South

## Headline science goals:

*To investigate how:*

- the HI Mass Function varies with environment & redshift
- $\Omega_{HI}$ evolves out to z ~ 1.4 (in HI emission)
- galaxies' HI masses vary with stellar & halo mass vs. z
- the (baryonic) Tully-Fisher relation evolves with z
- the OH megamaser population evolves to z~1.8

# LADUMA team

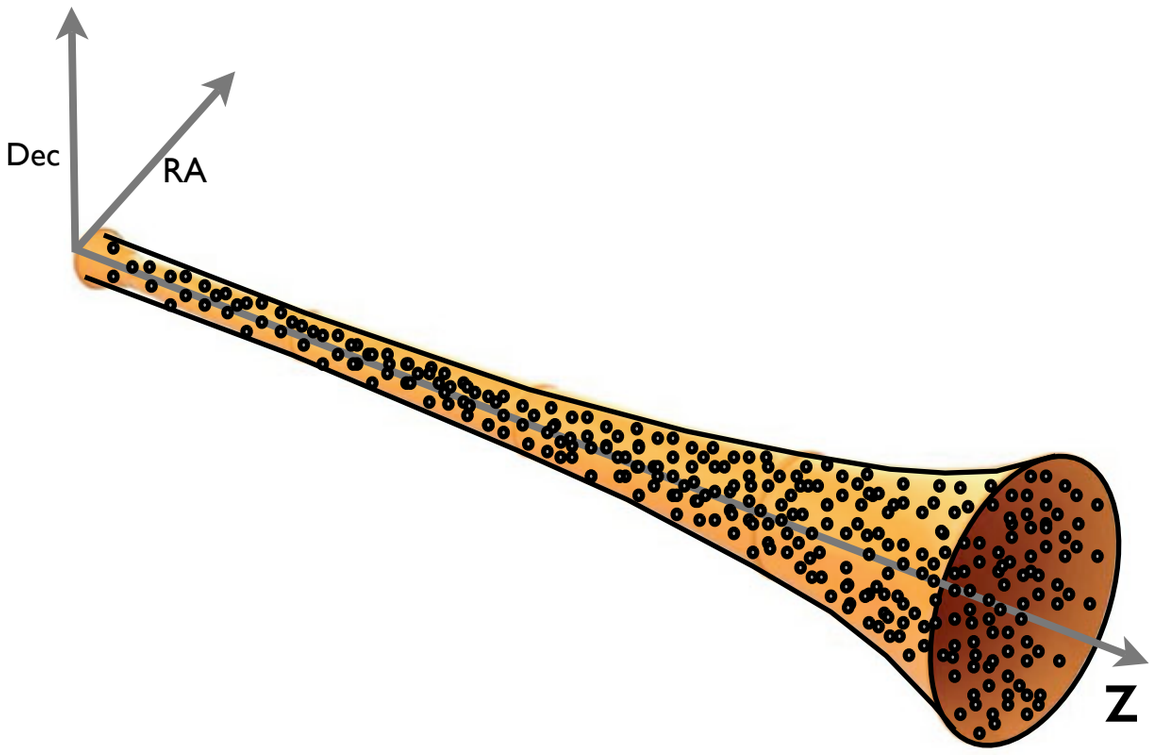
**34 out of 65 LADUMA team members (from 5 different partners) have access to SALT time...**

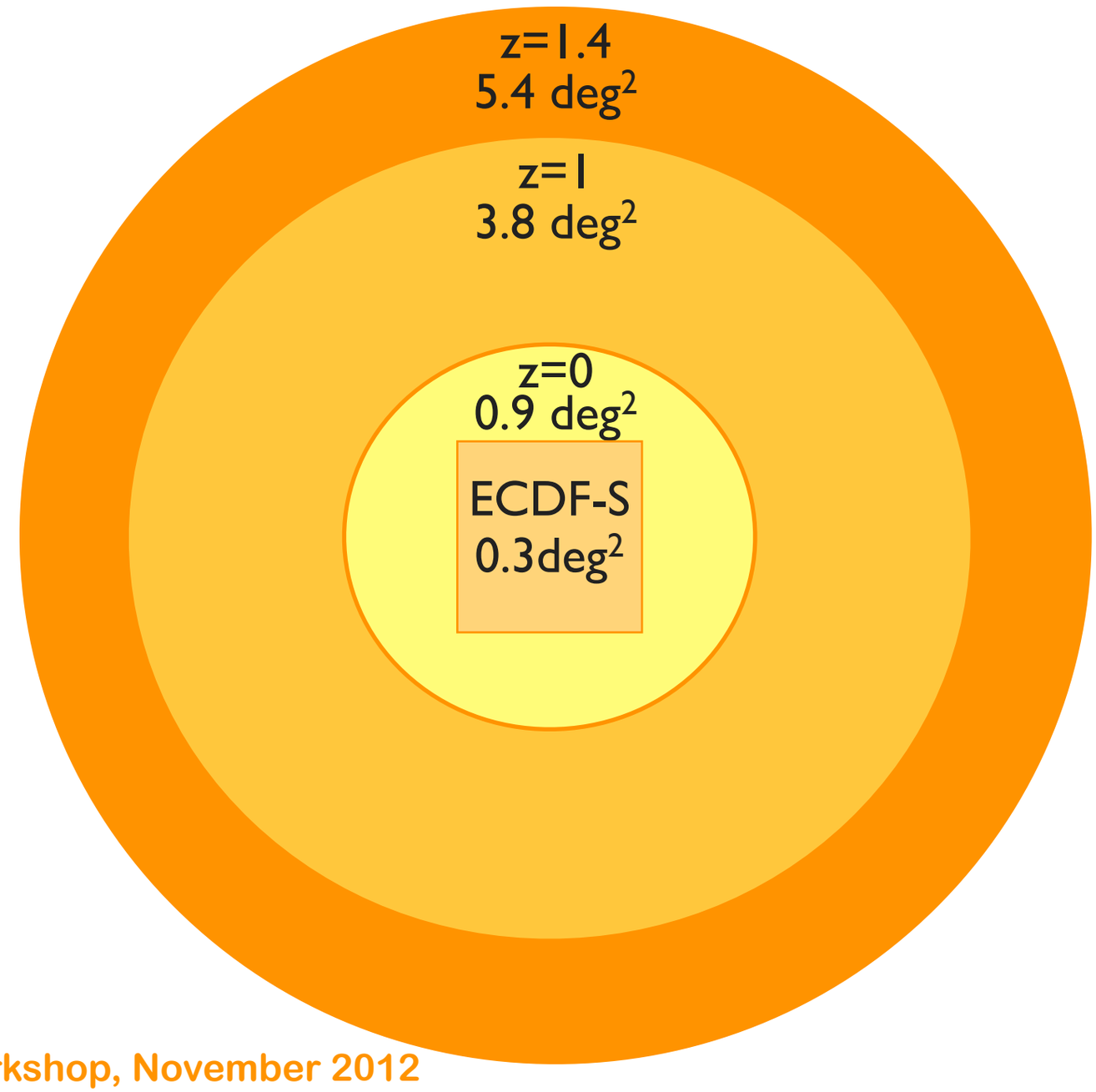
PIs: S.-L. Blyth, B.Holwerda, A.J. Baker

B. Bassett, M. Bershady, A. Bouchard, F.H. Briggs, B. Catinella, L. Chemin, S. Crawford, C. Cress, D. Cunnama, J. Darling, R. Davé, R. Deane, E. de Blok, E. Elson, A. Faltenbacher, B. Frank, E. Gawiser, E. Giovannoli, T. Henning, K. Hess, I. Heywood, J. Hughes, M. Jarvis, R. Johnston, S. Kannappan, N. Katz, D. Kereš, H-R. Klöckner, R.C. Kraan-Korteweg, P. Lah, M. Lehnert, A. Leroy, N. Maddox, G. Meurer, M. Meyer, K. Moodley, R. Morganti, D. Obreschkow, S.-H. Oh, T. Oosterloo, D.J. Pisano, S. Ravindranath, E. Schinnerer, A. Schröder, K. Sheth, M. Smith, R. Somerville, R. Srianand, L. Staveley-Smith, I. Stewart, M. Vaccari, P. Väisänen, K.J. van der Heyden, W. van Driel, M. Verheijen, F. Walter, E. Wilcots, T. Williams, P. Woudt, M. Zwaan, J. Zwart

# Spectroscopic redshifts

**For analyses involving HI stacking, we need a large redshift survey with 1000s of sources and high spectroscopic completeness to z~1.4**

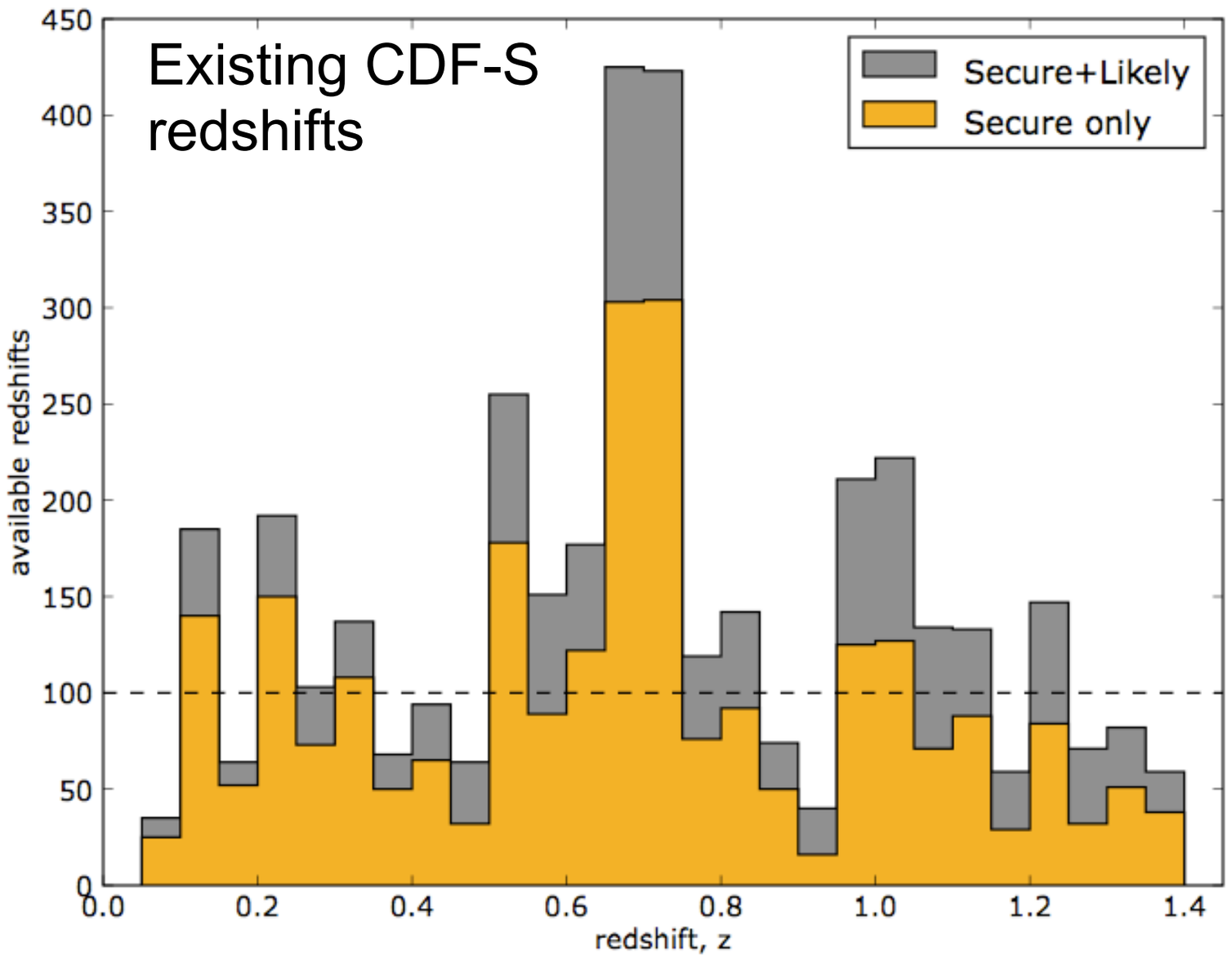



- By z=1, the MeerKAT footprint overwhelms the ECDF-S coverage

# Existing ECDF-S redshifts

**Although ~4000 spec-z's exist in ECDF-S, ~10-20k more are needed across the entire field to enable LADUMA planned analyses**




[CDFS Master Catalog, I. Balestra (2009)]

- Secure redshift total: 2570
- Secure + likely redshifts without duplicates: 3866

# Multi-pronged strategy

## SALT would be ideal to tackle intermediate to deep redshift ranges (team access, good location, 8m class telescope)

- Plan to exploit as many resources as possible (AAT / SALT / VLT)
- Likely need to piggy-back on other AAT & VLT proposals with different priorities (+ extra pressure to address uncertainties in MeerKAT/SKA transition) implies SALT can make major contribution
- In principle, SALT ideal to tackle intermediate to high z

### Possible strategy

| | |
|---|---|
| z<0.5 | AAT/AAOmega |
| 0.5 < z < 1.0 | SALT/RSS |
| 1.0 < z < 1.4 | SALT/RSS + VLT/VIMOS |

# Fiducial SALT survey

**For deep spectroscopy, choose area 2 deg$^2$ including ECDF-S**

**Using SALT alone for 0.5< z <1.4: (scaled from Balestra et al. (2010) for VLT)**

- Aim for 1000 redshifts per $\Delta z$=0.1 shell
  - ~10k sources
- 2 deg$^2$ ≈ 141 SALT pointings
- at ~35 slits/mask → 2 masks/pointing
- 282 masks x 2 h = 564 h

# Pre-survey validation

**Aim to gain input on RSS MOS mode performance to plan a future SALT redshift survey for LADUMA**

- Two proposals (2011-2 + 2012-1)

  (Baker, Holwerda, Gawiser, Blyth, van der Heyden, Maddox, Crawford)

- RSS MOS observations of a single field (ECDF-S and/or MS1054-03 cluster) with some known redshifts to assess reproducibility (e.g. grating, location in FoV, rising/ setting visibility window) for planning a large survey with SALT

## Time awarded (2011-1 & 2012-2):

| | |
|---|---|
| 2700s + 2482s p0/1 | Rutgers |
| 8100s + 11016s p3 | Rutgers |
| 16200s (commissioning time) | SA (commissioning) |

# Pre-survey validation

**Outcomes:**

- Currently with SALT, redshift determination of faint sources is limited by inability to co-add exposures

**See talk by N. Maddox tomorrow (SALT Science meeting) for more details**

# Pre-LADUMA Tully-Fisher

**To prepare ourselves to disentangle rotation from intrinsic v-dispersion in T-F sample in ECDF-S in advance of MeerKAT HI data**

## SALT Role:

- Wilcots, Bershady, Baker, et al.,
- Long slit spectroscopy along major axes of 24 large spiral galaxies in ECDF-S to obtain rotation curves out to large radii

## Time awarded (2012-2):

| | |
|---|---|
| 4428s p1 | Wisconsin |
| 6624s p2 | Wisconsin |
| 22104s p3 | Wisconsin |
| 4658s p3 | Rutgers |

# The RESOLVE survey

**The RESOLVE survey (Kannappan et al.) will be an ideal z=0 reference survey for LADUMA and involves several LADUMA co-Is already**

- RESOLVE aims to make a volume-limited census of stellar, gas, & dynamical mass for all galaxies with $M_{baryonic} > 10^9 M_{sun}$
- 100 nights already guaranteed on SOAR

## SALT Role:

- Kannappan, Baker, Crawford, Vaisanen, Williams, et al.
- Long slit spectroscopy and Fabry-Perot required for ~20% of 1600 galaxies over 5 years

## Time awarded (2012-2):

| | |
|---|---|
| 117146s dark/grey time for LS RSS spectroscopy to obtain rotation curves | UNC / Rutgers / SAAO |
| 72209s bright time for Fabry-Perot spectroscopy to obtain Halpha velocity fields | UNC / Rutgers / SAAO |

# Outlook

- RSS LS and FP observations can fulfill some secondary needs

- RSS MOS share of redshift survey is a primary need, but return on time investment depends on SALT performance (edge sensors, improved optics, co-adding of exposures, less frequent mask realignment?)

- LADUMA needs to have optical spectroscopy in hand by 2016 in time for first MeerKAT data analysis

# Thank you

# SALT RSS/MOS observations

**Field MS1054-03 (ra, dec: 10:56:58, -03:37:19)**

- Centred on a cluster at z=0.8
- 2010-1-RSA_UW-001 (PI Holwerda)
- Mask:
  - 34 slitlets
  - Magnitude range: 17<R<22.4
- Observations:
  - 10May (1x600s, 1x350s exposures (cut short due to cloud)
    - 1 point source and one extended source extractable, others too faint
  - 06Jun (1x700s, 1x343s exposures with realignment in between)
    - 1 point source and one extended source extractable, others too faint

**Field ECDFS (ra, dec: 03:33:00, -27:48:12)**

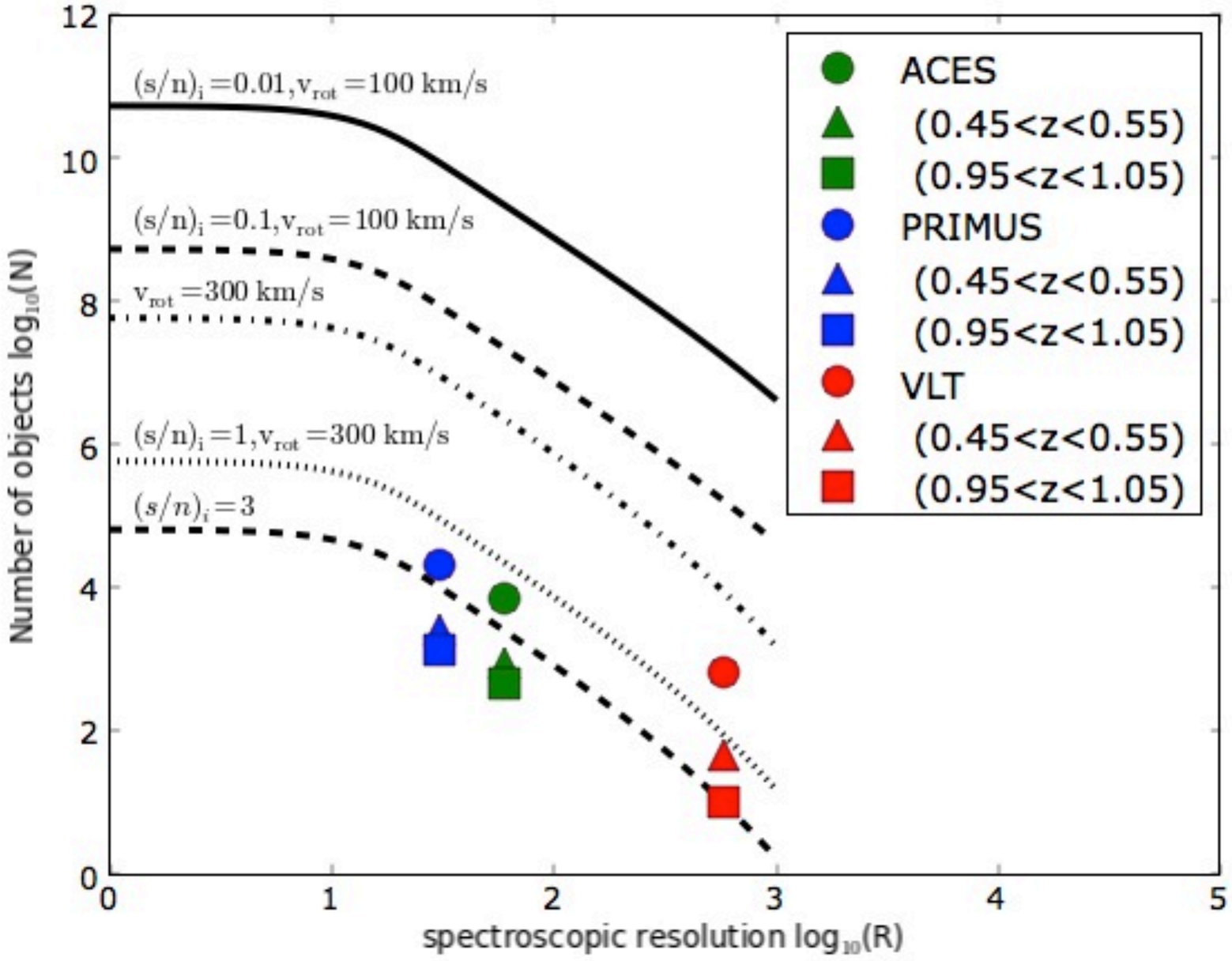
- Within the ECDFS field
- 2012-1-RU_RSA_OTH-002 (PI Baker)
- Mask:
  - 15 slitlets
  - Magnitude range: 16<R<19
- Observations:
  - 12Oct (2x420s, 1x346s exposures)
  - all objects can be extracted

**See talk by N. Maddox tomorrow (SALT Science meeting) for more details**

# ECDF-S source counts

- In an average 8' diameter field of view within the ECDFS, there are:

20 objects with R<=19, (1 mask)
40 objects with R<=20, (2 masks)
120 objects with R<=21,(3-4 masks)
220 objects with R<=22, (7 masks)
420 objects with R<=23, (14 masks)




[Courtesy B. Holwerda]

# VIMOS

## Proposal for VIMOS time:

- 47 pointings X 4 masks/pointing → 188 masks (to cover 2 deg$^2$)
- MR-orange grating
- 4 h x 188 = 752 hours
- ~18 800 redshifts for 0.58 < z < 1.4 and R≤25 (@100 slits/mask)
- (~1000 redshifts per $\Delta z$=0.1)
- OII (3727 Å line)

- @z=1,  OII (7454 A)
- @z=1.4, OII (8945 A)

# ECDF-S coverage