ESO Remote Galaxy Survey

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Availability of deeper images and more sensitive equipment has lead to identification of ever increasing numbers of high-redshift galaxies. Until recently the size of candidate samples with spectroscopic confirmation has been small, limiting the reliability of the statistics of these sources. To remedy this we have begun a spectroscopic survey of 750 arcmin² of sky combining 14 widely spaced private fields with the Chandra Deep Field South public data of GOODS. All fields have deep VLT and/or HST imaging, ground and space based near IR imaging, Spitzer/IRAC imaging and spectroscopic redshifts either taken or with time guaranteed over the next year. When this data is combined it will become the largest sample of z>5 galaxies with spectroscopic confirmation, allowing a huge range of multiwavelength follow-up.

The ESO large program, The ESO Remote Galaxy Survey ("ERGS" P.I Bremer), was commissioned to obtain spectroscopic confirmation of high redshift candidates selected from deep optical imaging, V-, R-, I- and z-bands (VLT), complementary deep J and Ks imaging (NTT) and I-band HST/ACS images. These data were originally obtained to identify clusters as part of the EDisCS project (P.I. S. White). In addition to standard reduction techniques the photometric catalogue extracted from these data were not only corrected for interstellar reddening, but also for the lensing effects of any foreground clusters in the images, using the lensing maps provided by Clowe *et. al.* (2005). An I-band cluster image and its corresponding lensing map can be seen in Fig 1.

High-redshift galaxies were identified using the dropout technique pioneered by Steidel and collaborators, using the fact that emission from these high redshift sources at wavelengths shortward of Lyman alpha is absorbed by the intervening neutral hydrogen in the IGM. The break in the spectrum can be identified using filters shortward and longward of the Lyman break. In practice, for z>5 sources, this means we select objects with $I_{AB}<26.3$ and $R_{AB}-I_{AB}>1.3$. Objects with a $I_{AB}=26$ have a $M_{AB}(1700\,Å)\sim-21$ at z~5.

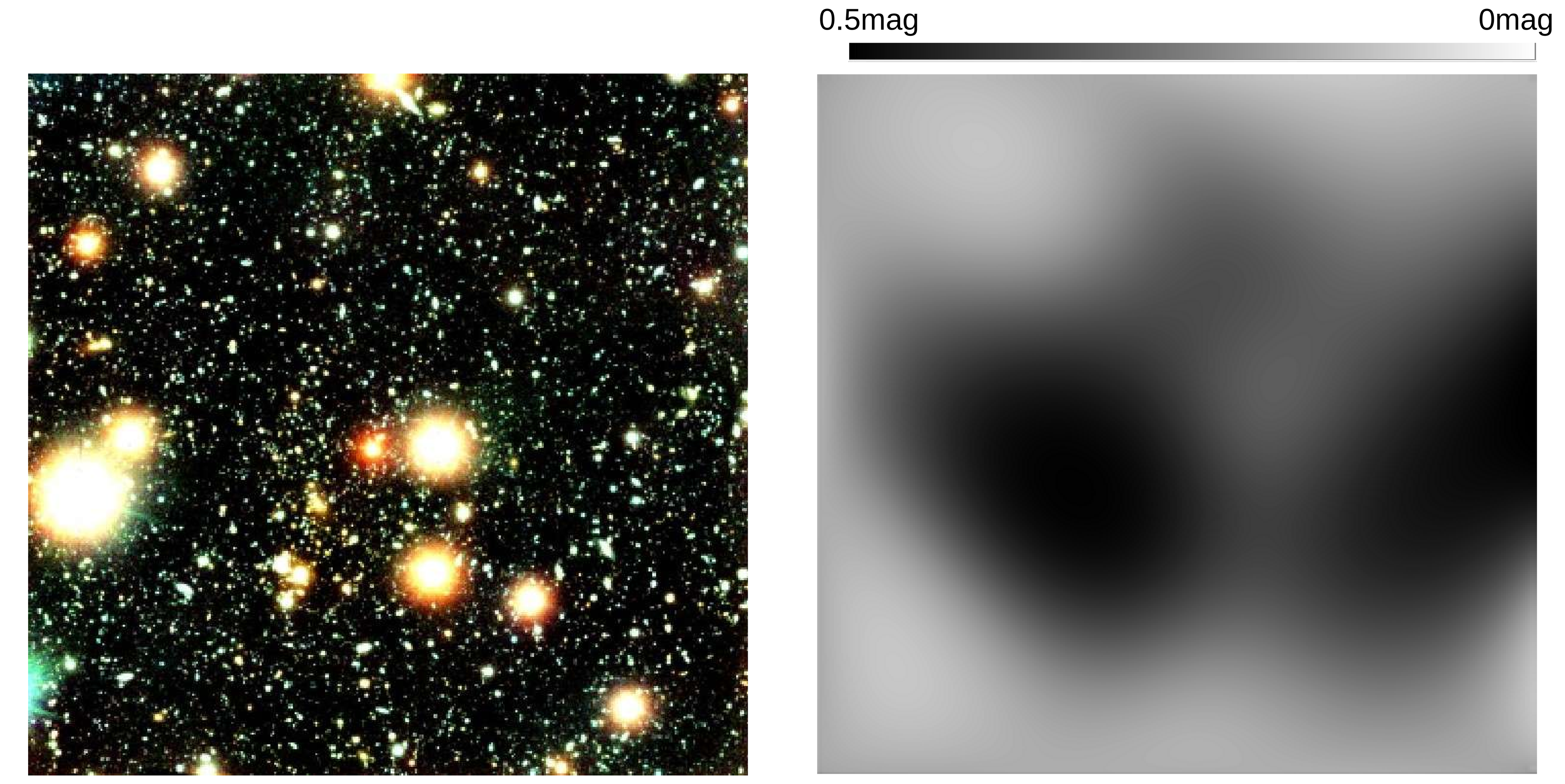

Figure 1: A 3 colour optical composite image of cluster CL1054-1245 and its corresponding lensing map. The lensing map shows the number of magnitudes correction that should be applied as a function of position for z=5 objects.

High Redshift Candidates

An object catalogue was prepared, using Sextractor, from the reduced EDisCS images. Apertures were defined by the I-band image and were then applied to the V-, R-, J- and Ks-band images. High-redshift candidates were selected using the colour cuts above, determined from modelling the expected colours of high-redshift galaxies, and their half-light radii from the high resolution HST images. The complementary near infrared data, although not deep enough to detect high redshift galaxies, was used to identify contaminants such as EROs at z=1-2 or cool stars.

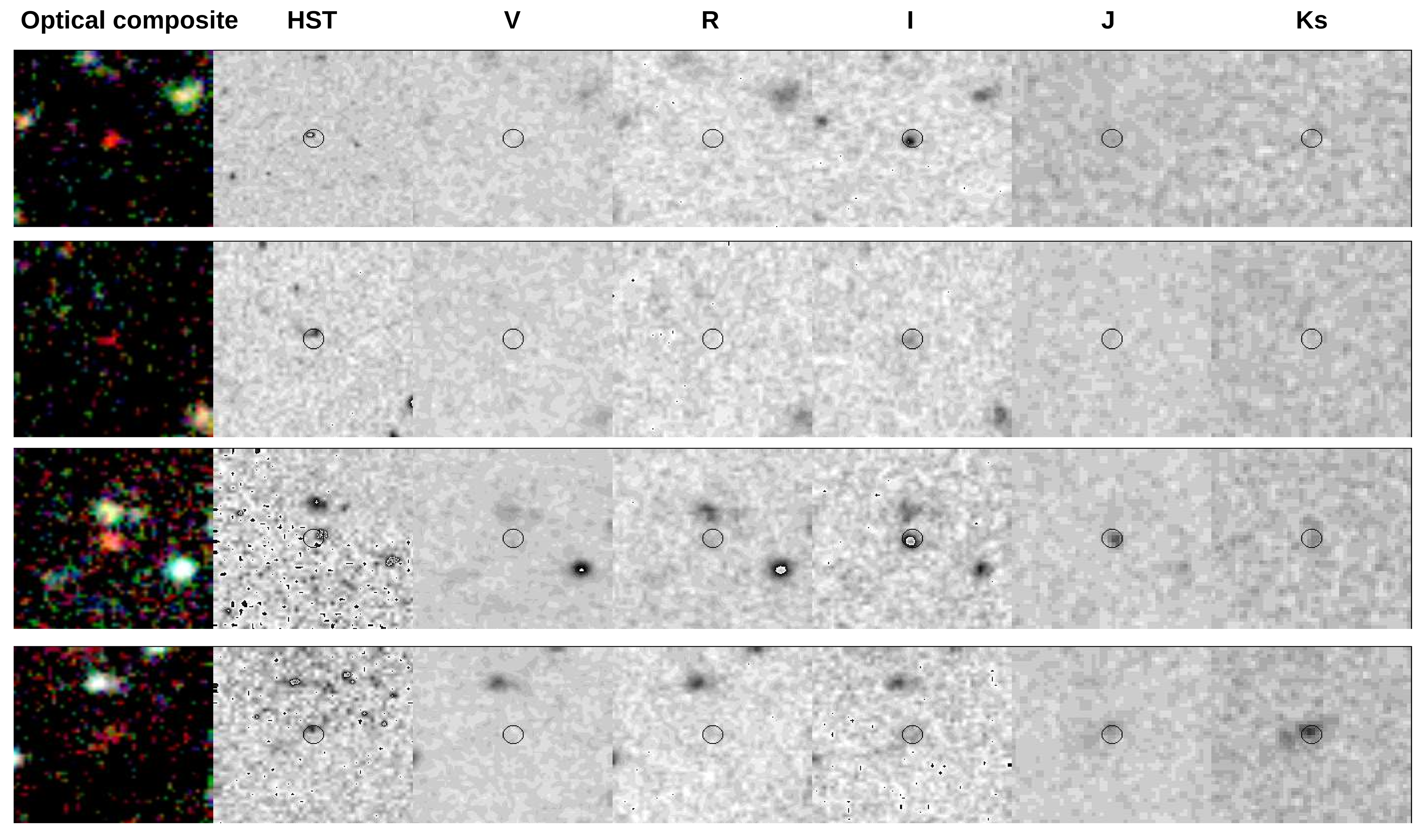

Figure 2: Images of objects in the V-, R-, I-, J- and Ks-bands with composite optical image and HST image. Top two objects are examples of good high-redshift candidates, the middle object is an example of a likely M type dwarf and the bottom object is an example of a likely ERO.

Examples of good candidates and contaminants can be seen in Fig 2. After removing the majority of contaminants we have identified 150 excellent candidates in 430 arcmin². The number of candidates in each field ranges from 5 to 47. There is no correlation between the number of candidates in a field and the expected lensing properties of that field. Fields with strong lensing effects do not necessarily have the most candidates. This variation is a consequence of cosmic variance and large scale structure demonstrating the importance of having a large survey area.

However using these objects to trace large scale structure may be problematic. From rest frame optical-UV spectral energy distribution modelling using the public data from the GOODS survey, we have found that objects selected using the Lyman Break method have young stellar populations, 10s of Myrs. If this is the case the large scale structure is sampled in a biased way. Observing this area a few 10Myrs earlier would produce a different population of objects.

Number Counts and the Bright-end Slope of the Luminosity Function

Lehnert & Bremer (2003, ApJ, 593,630) claimed that the number of z>5 sources selected in a similar manner to this work is less than that expected from the z=3 luminosity function of Lyman break galaxies assuming no evolution between z=3 and z=5, at least at $I_{AB}<26.3$. Our average number counts over 10 separate fields, conclusively shows a lack of bright sources compared to that expected if there was no evolution in the luminosity function between z=3 and z=5 (Fig 3). A caveat is that we removed contaminants from the brighter bins using the IR data but not from the fainter bins. Even without the removal of contaminants and the correction for lensing there is still a lack of sources relative to z~3.

This paucity implies that the unobscured star formation density and the UV density of the brightest galaxies decreases by a factor of ~3 between z=3 and z=5, which has implications for reionisation. Sources brighter than $I_{AB}=26.3$ at z~5 are unable to ionise their own volume, implying that the majority of ionising photons originate from fainter sources.

The next step in this work is to spectroscopically confirm all of our candidates. We will obtain spectra for all of our sources over the next year and have also been granted time on Spitzer/IRAC to observe the 10 fields. By the middle of 2006 we will have spectroscopic confirmation of all z>5 galaxies in 14 separate fields with optical, near infrared and Spitzer /IRAC imaging, enabling us to produce detailed rest frame optical to UV spectral energy distributions of the sources. This combined data set will enable us to perform a wide range of detailed studies on properties of z>5 galaxies ranging from their star formation histories to their 3D clustering statistics.

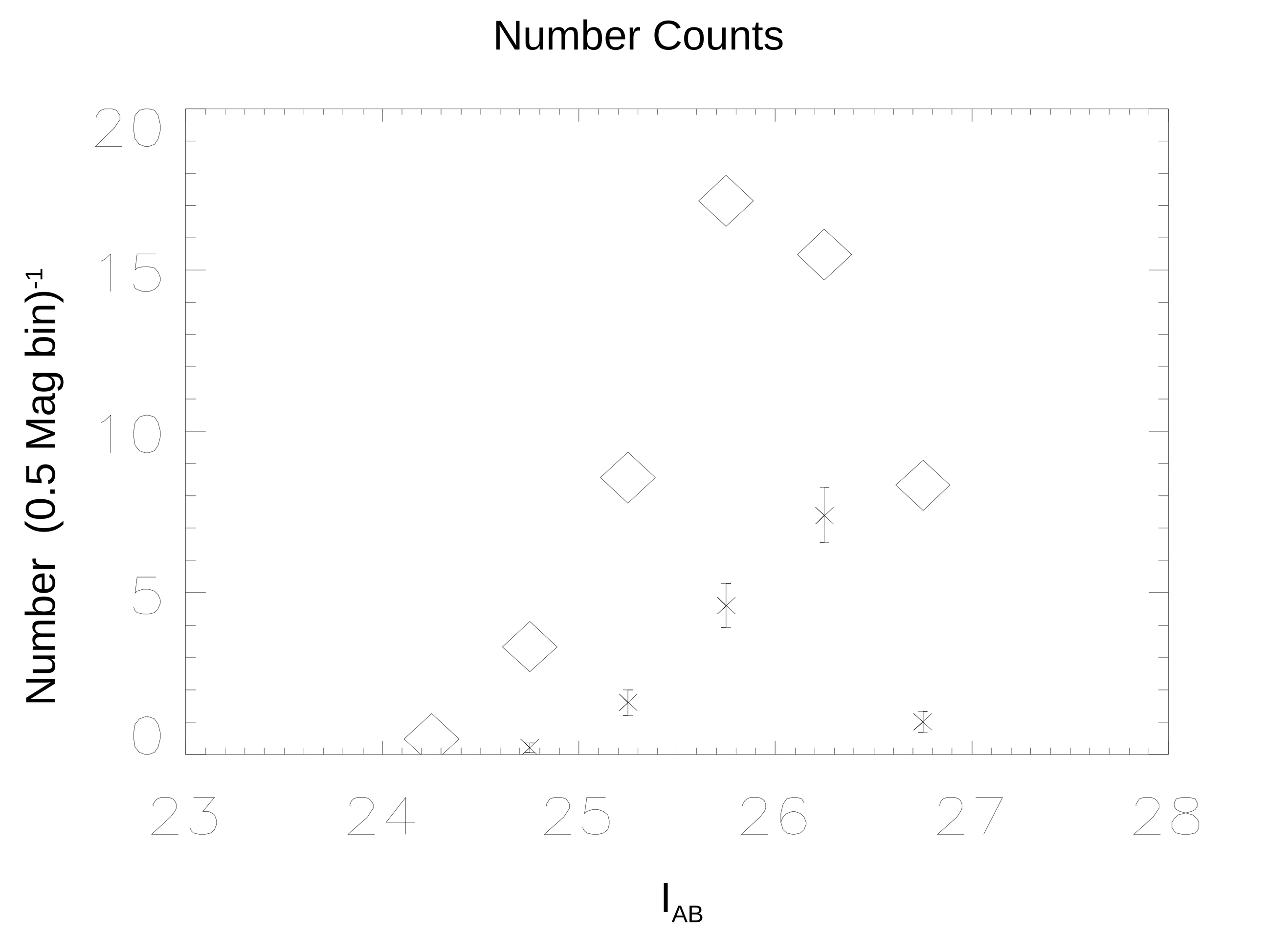

Figure 3: Number count plot where the diamonds are the simulated data assuming no evolution from z=3-4 to z=5 and the crosses are our new data.