

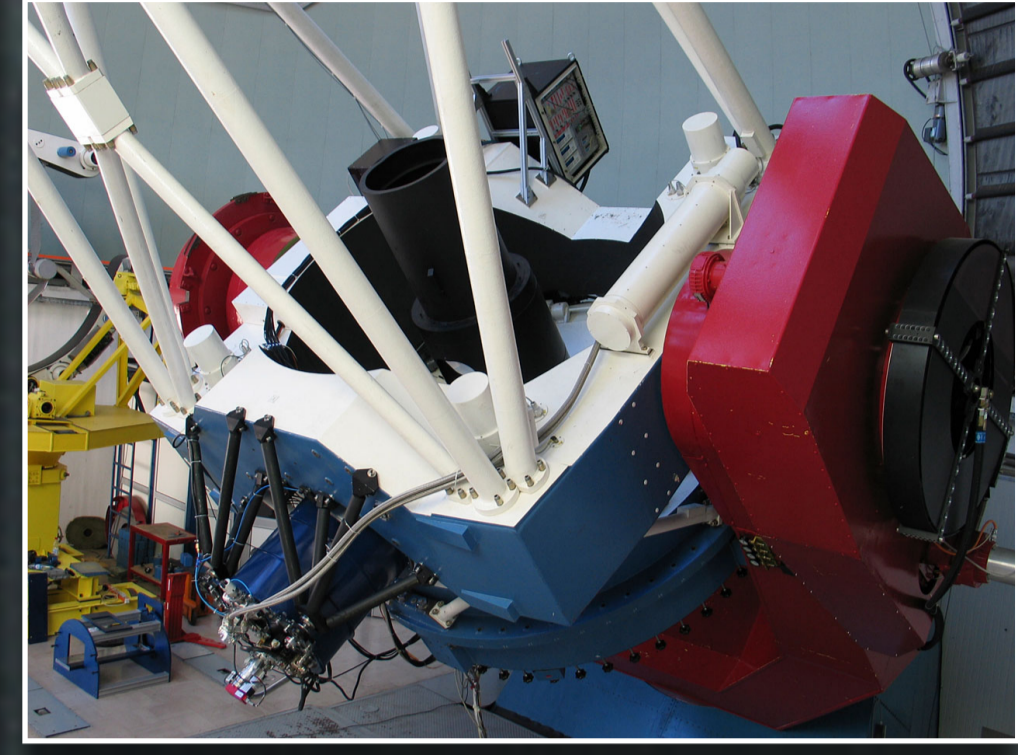


New Redshift Constraints for 130 LAT Blazars

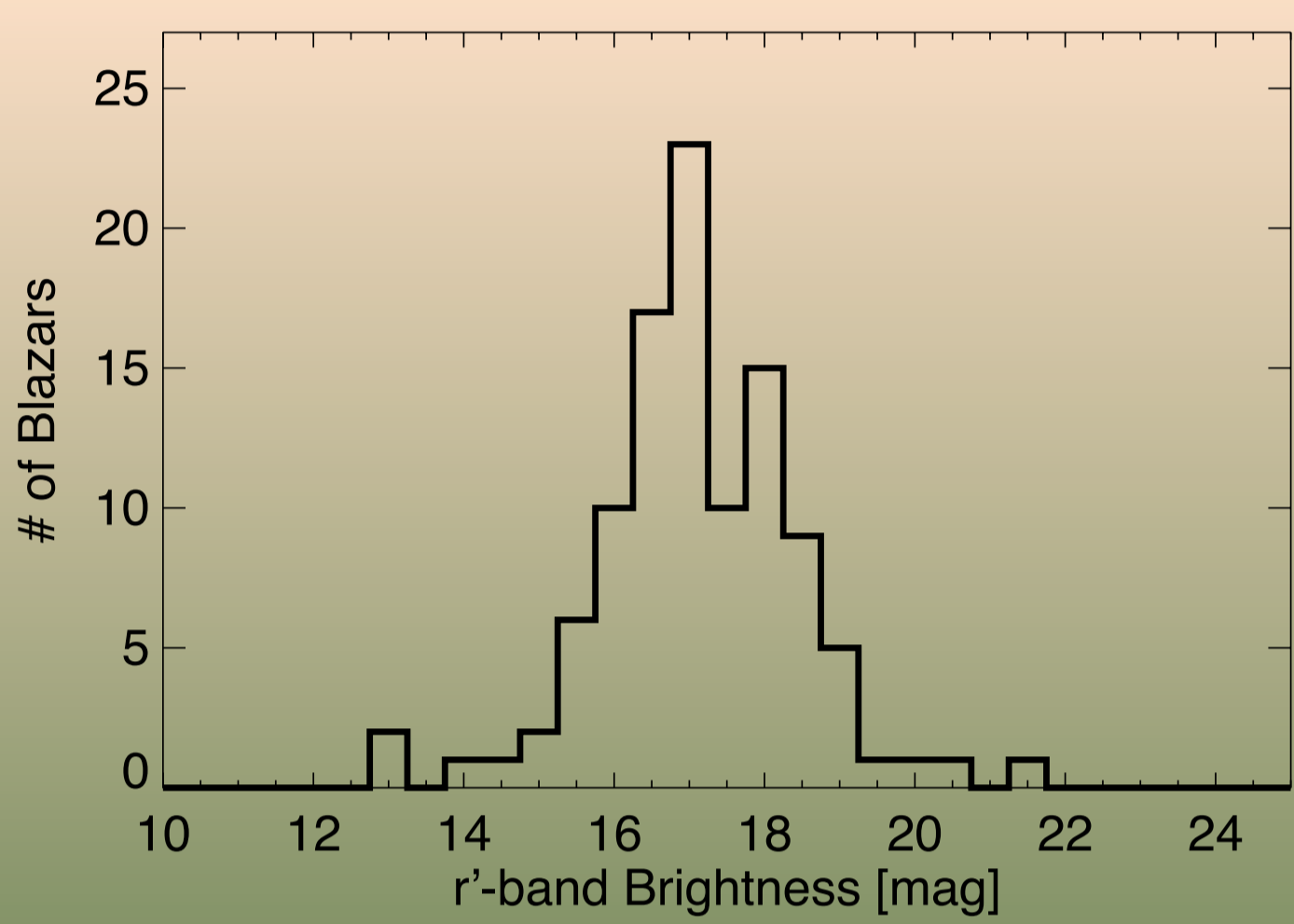
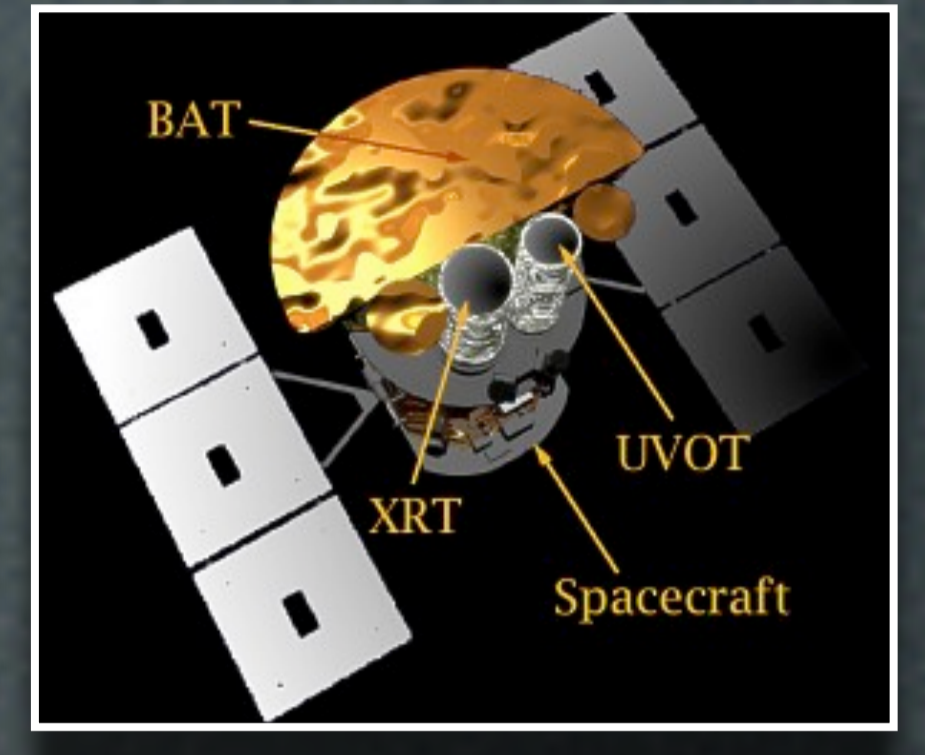


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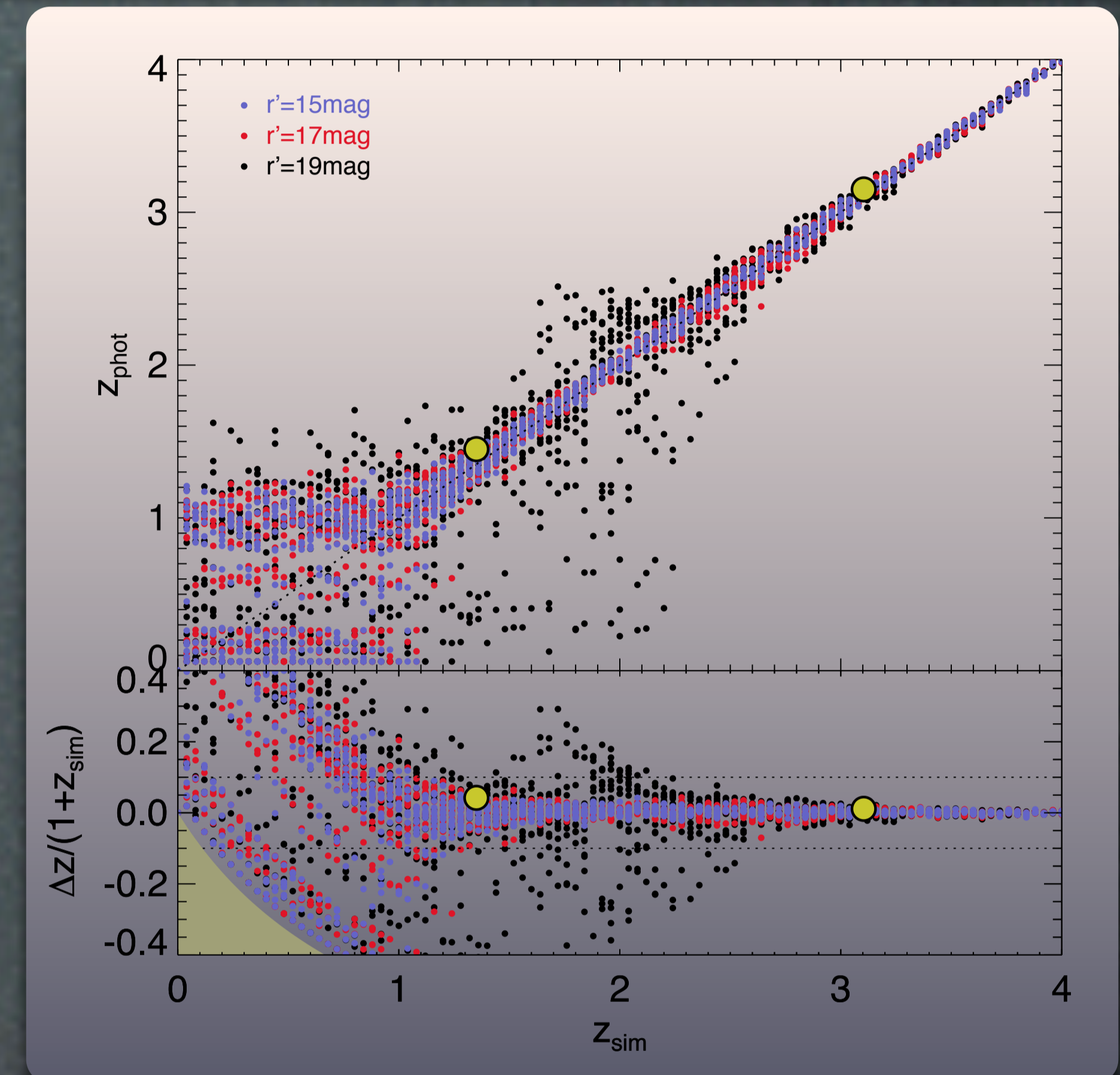
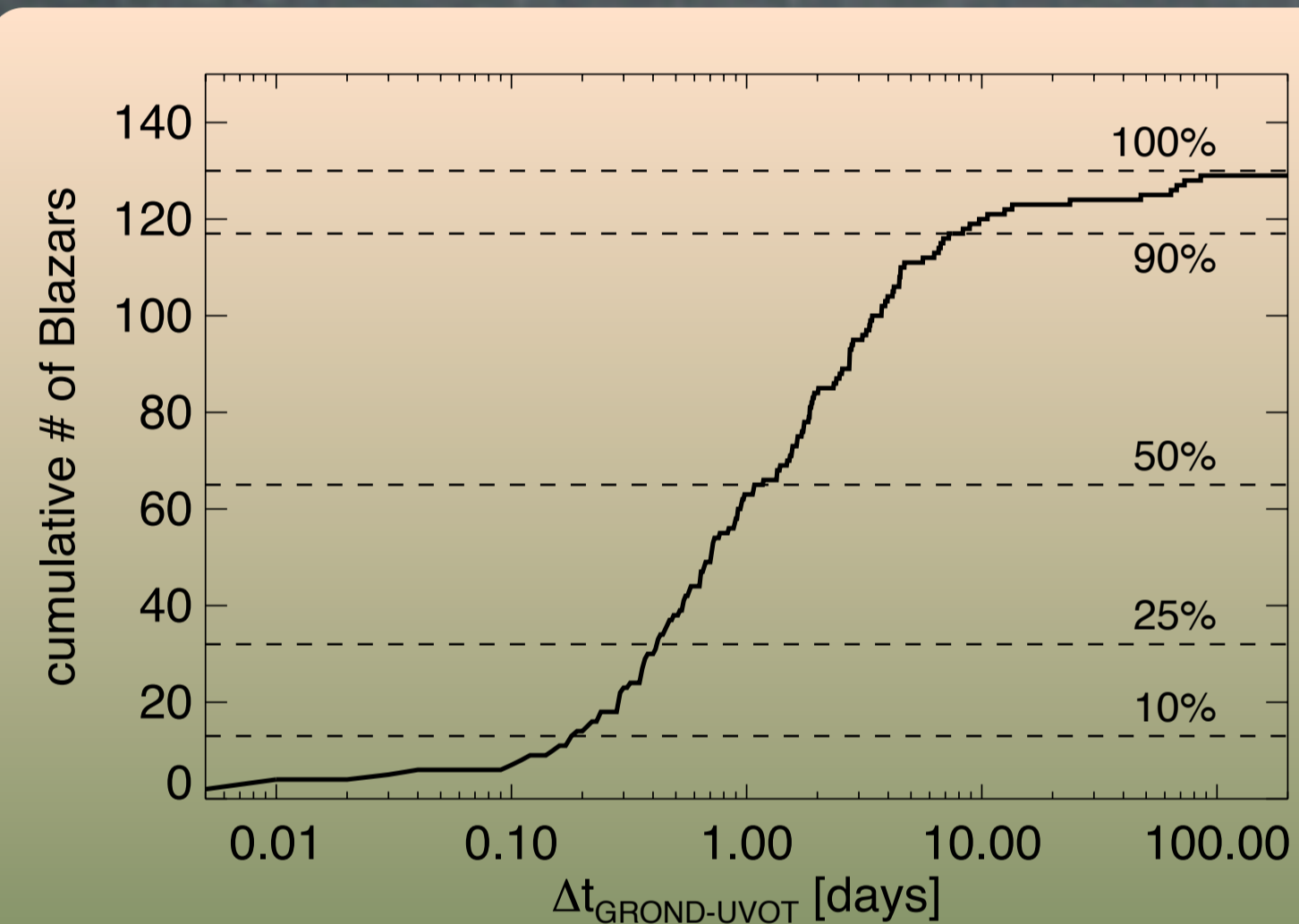


Blazars, in particular those at high redshift, are important probes of the formation of relativistic outflows and, being typically hosted in massive galaxies, also for the formation of galaxies. Furthermore, their high-energy spectral cut-off can be an exciting probe for the ionization of the Universe. Redshifts, however, are often missing and in particular for BL Lacs difficult to obtain. Here we present the results of a dedicated photometric redshift (z_{phot}) campaign for 130 extra-galactic LAT sources that lack a distance scale. Using near-simultaneous 13-band observations from 160-2200nm with Swift/UVOT (right) and GROND at the ESO/MPG 2.2m telescope in La Silla (left), we are sensitive to the Lyman-limit at redshifts of $z > 1.2$.



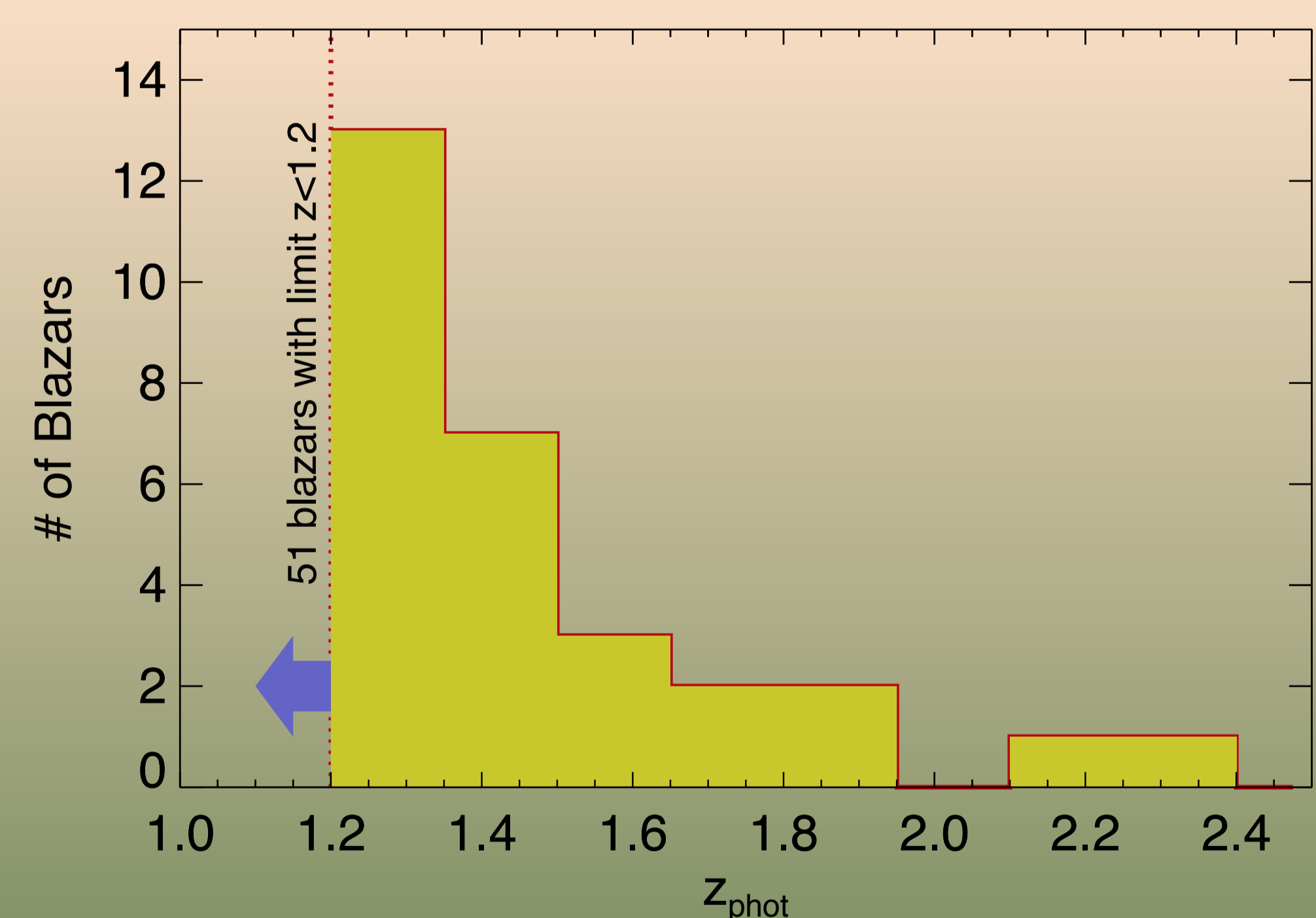
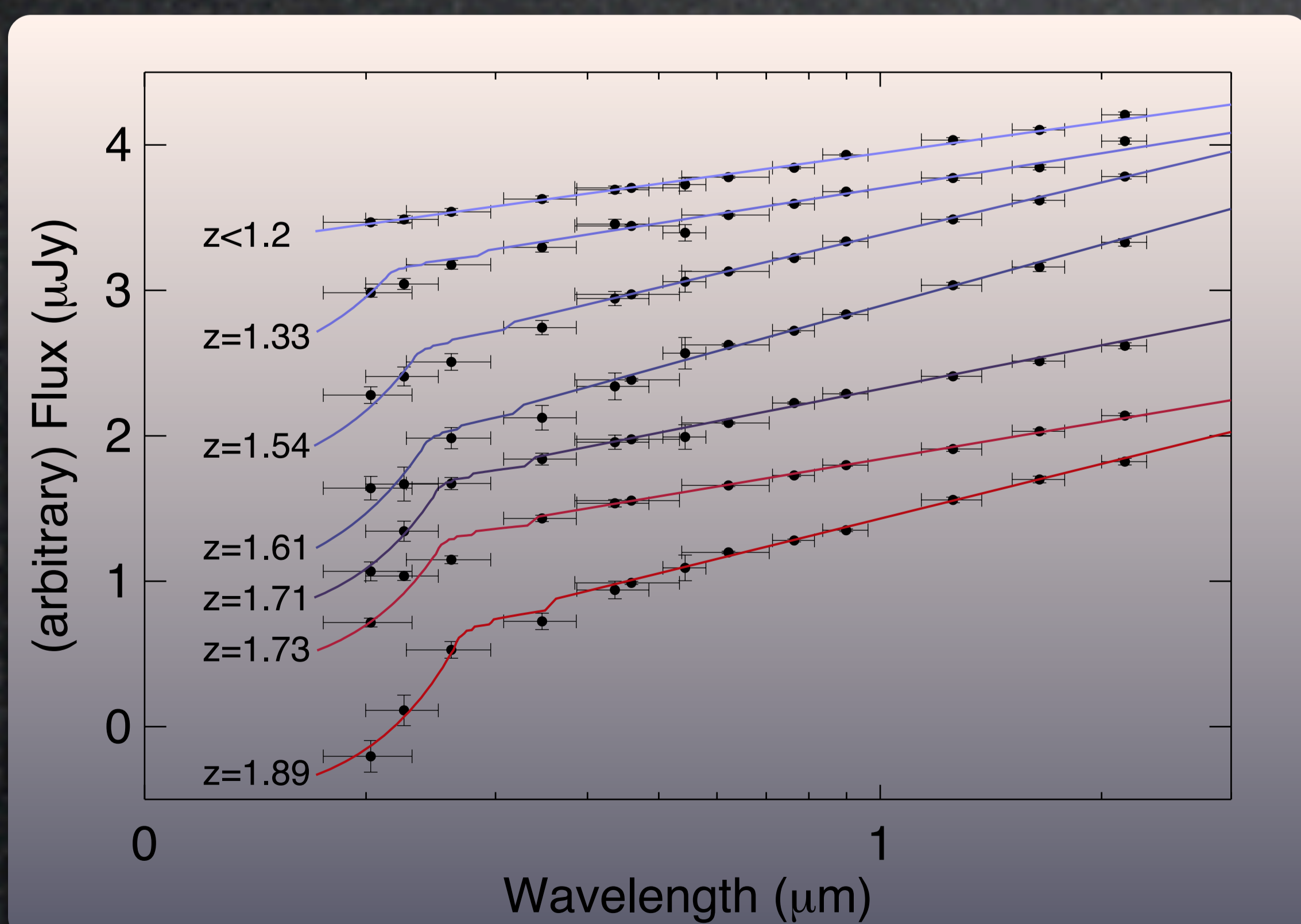
The sample comprises of 130 blazar candidates detected by the Fermi/LAT at high Galactic latitude ($|b| > 10^\circ$) [1] and with an additional cut at $\text{dec}_{J2000} < 25^\circ$. All sources lack published redshift measurements and have optical or radio counterpart associations from Bayesian analysis. The optical counterparts are typically bright (see left figure) and easy to follow-up with medium-sized facilities.

Observations were performed with Swift/UVOT [2] in 6 filters (uvw2, uvm2, uvw1, u, b, v) and with GROND [3] in 7 filters (g', r', i', z', J, H, K_s) spanning the range from 160-2200nm. Variability was taken into account by executing GROND and UVOT observations typically within 1-2d of each other (see right figure) and by using color terms [4] for the spectral range where both instruments overlap (400-600nm).



z_{phot} simulation: Recovered photometric vs input redshift (top) and accuracy (bottom) for 7200 simulated sources with spectral slope of $0.05 \leq \beta \leq 2$ and at three optical magnitudes. The yellow circles indicate the locations of PKS 0537-286 ($z_{\text{spec}}=3.104$, [5]) and PKS 0332-403 ($z_{\text{spec}}=1.351$, [6]).

SED fits: z_{phot} was computed using LePhare v.2.2 [7,8] with a custom template library composed of 60 unextinguished power law SEDs of the form $F_\nu \propto \nu^\beta$ with $0 < \beta < 3$. This simple model is a good approximation for the UV-near-IR SED of BL Lacs, which form the bulk of our sample, and in first order also for FSRQs. The most prominent spectral feature for measuring z_{phot} is the Lyman-limit which starts to lead to a strong flux suppression in the bluest UVOT band at $z \approx 1.2$. Some example SEDs and their best-fit redshifts are shown below.



Results: From 107 fully analyzed sources, 82 are fit well with the simple model described in the left box. The remaining show either stellar or galaxy SEDs, or no optical counterpart was found within 10" from the position given in the LAT catalog. Out of the 82 candidate blazars, 30 (37%) show a clear indication of the Lyman-limit with a redshift distribution as shown above. The observing program is continuing and expected to provide redshift constraints for >200 LAT blazar candidates at conclusion.