# Filter study using SNe simulations

Eda Gjergo[1,2]
Steve Kuhlmann[1], Rick Kessler[3], D. K. Gilmore[4]

**Argonne National Laboratory[1], Illinois Institute of Technology[2], KICP Chicago[3], SLAC[4]**

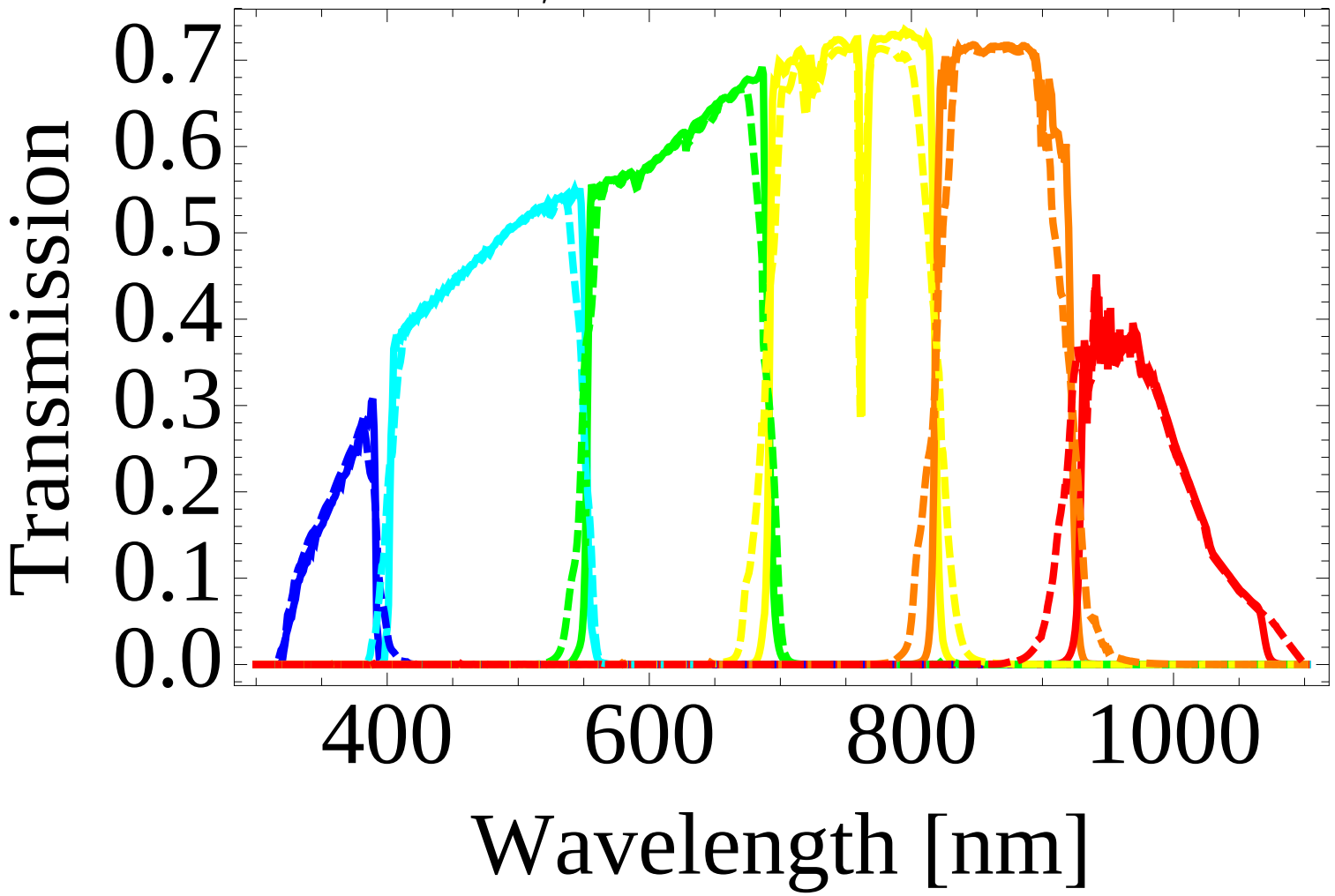
December $4^{th}$, 2013

# Overview

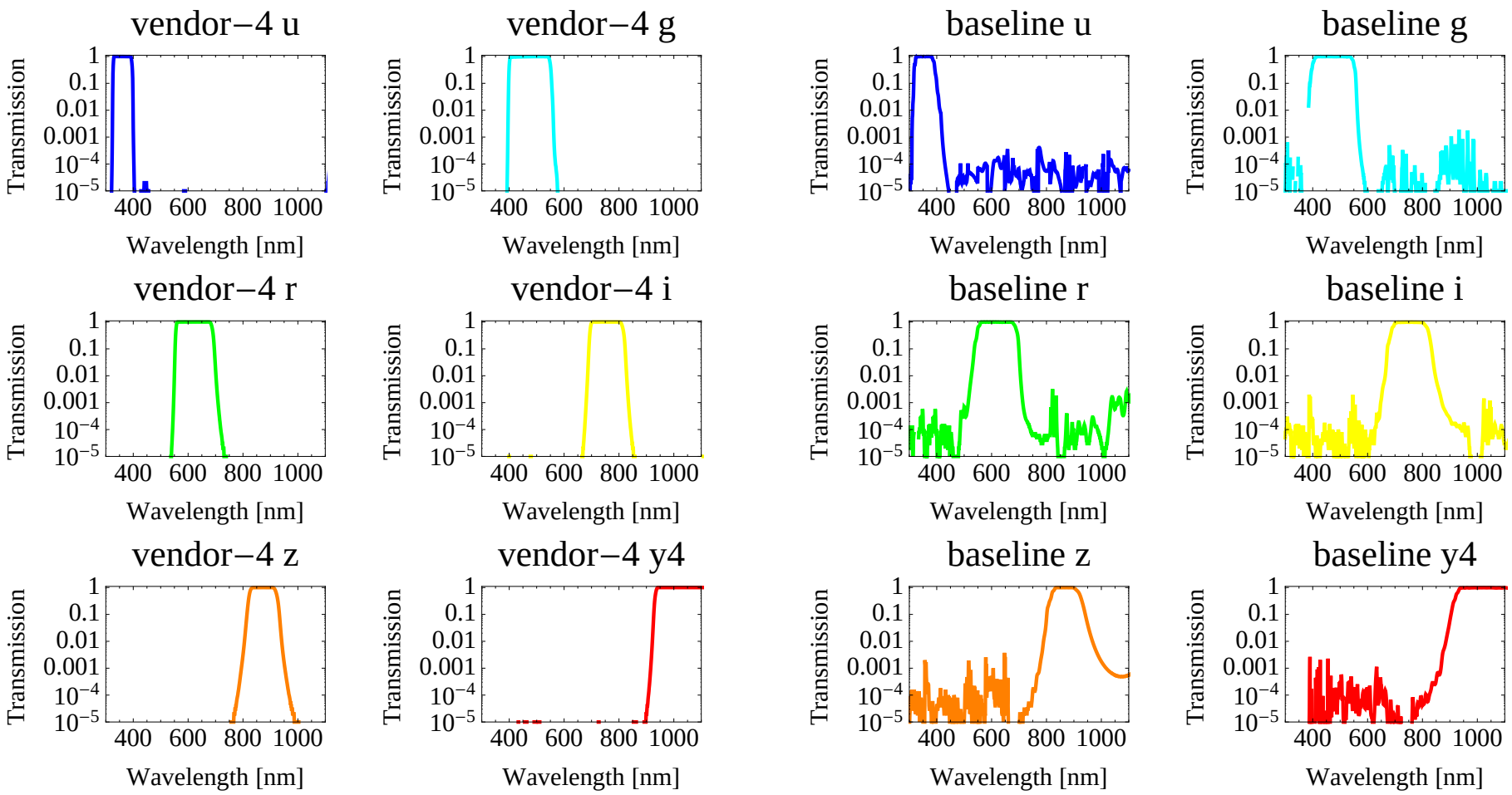
- Using SNANA to simulate supernovae photo-z for 6 filter options (including 4 vendors)
- Simulated 10 seasons of 10 LSST Deep fields (v2_168) all filter options
- Three different photo-z fitting scenarios
  - supernova only
  - supernova + host photo-z prior (Schmidt library)
  - SN + host photo-z increased host photo-z error by a factor of 2.5

# Comparison of vendor-1 to baseline

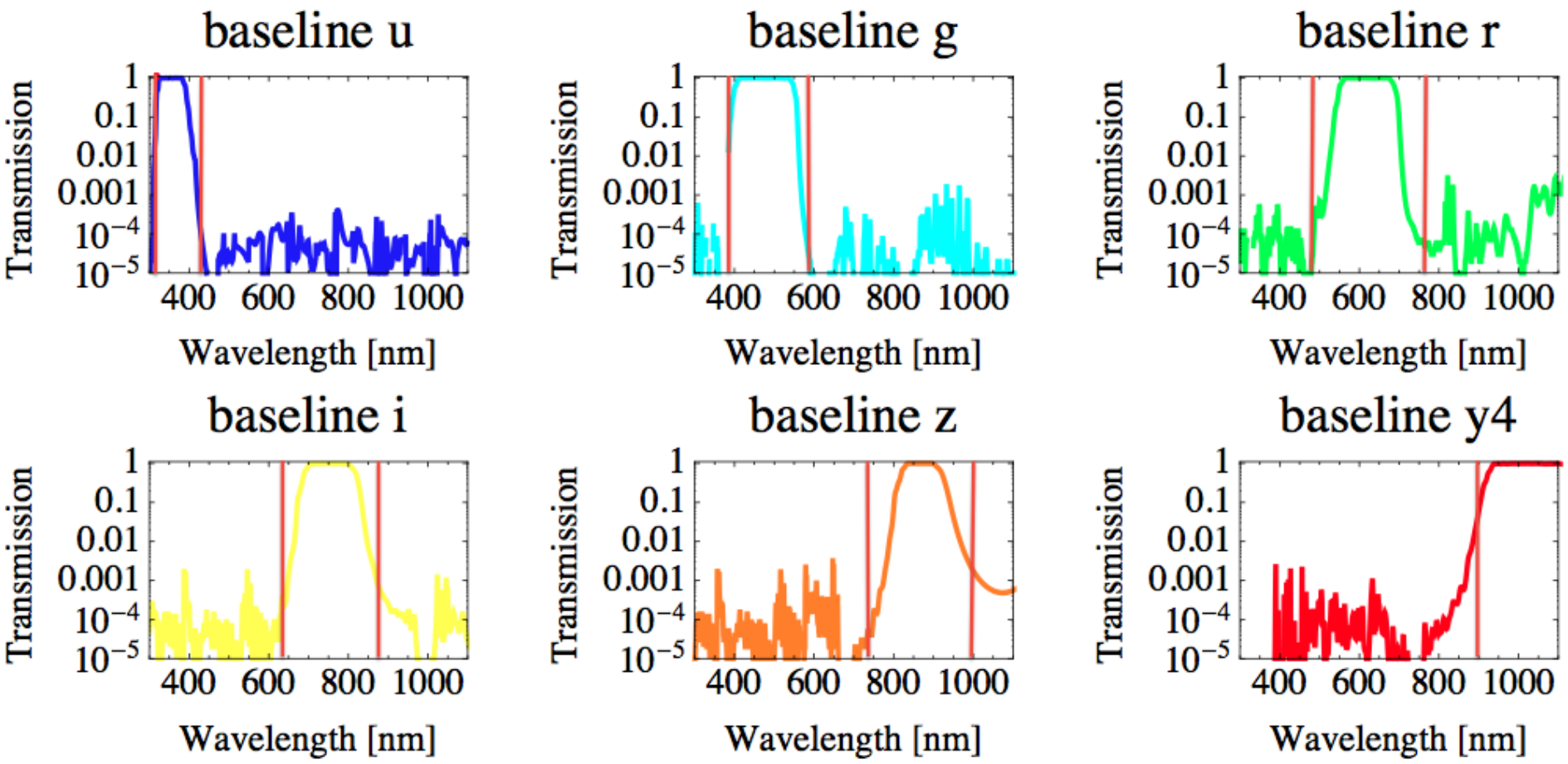
Baseline is dashed curve, vendor-1 is solid curve



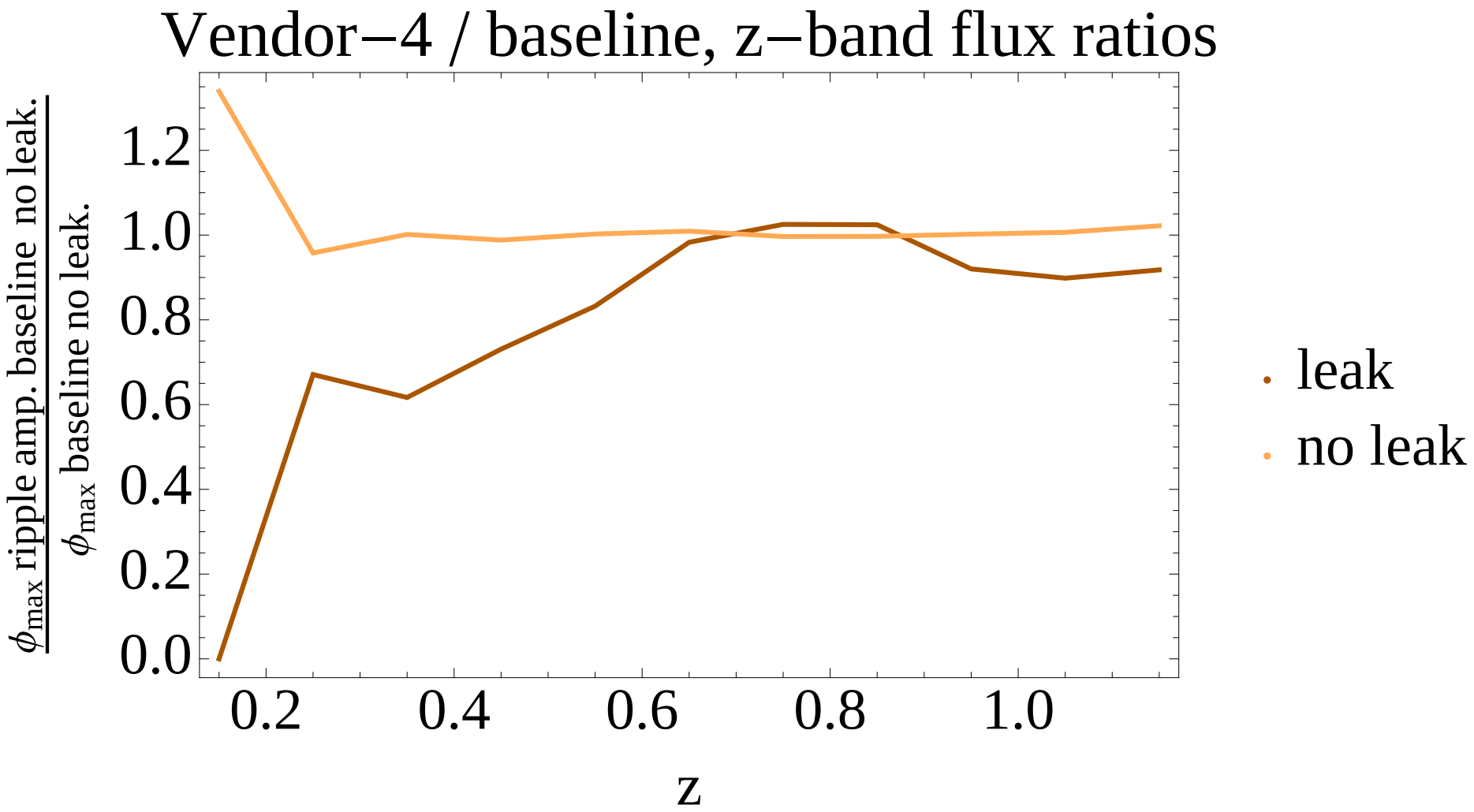
# Vendor-4 leakage (lowest leakage of all vendors)



# Example cuts to remove leakage (on baseline)



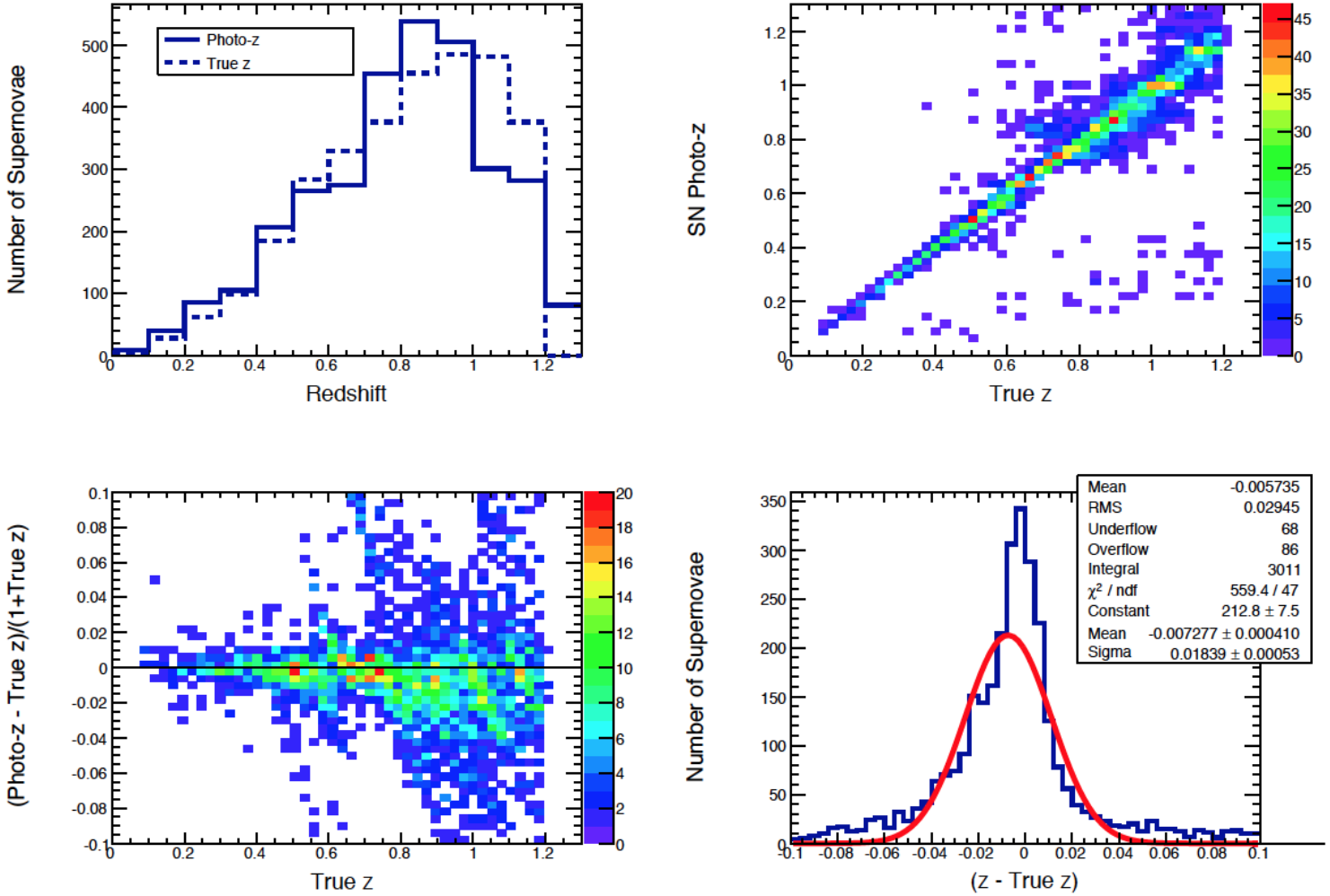
# Vendor-4 / baseline, z-band flux over redshift



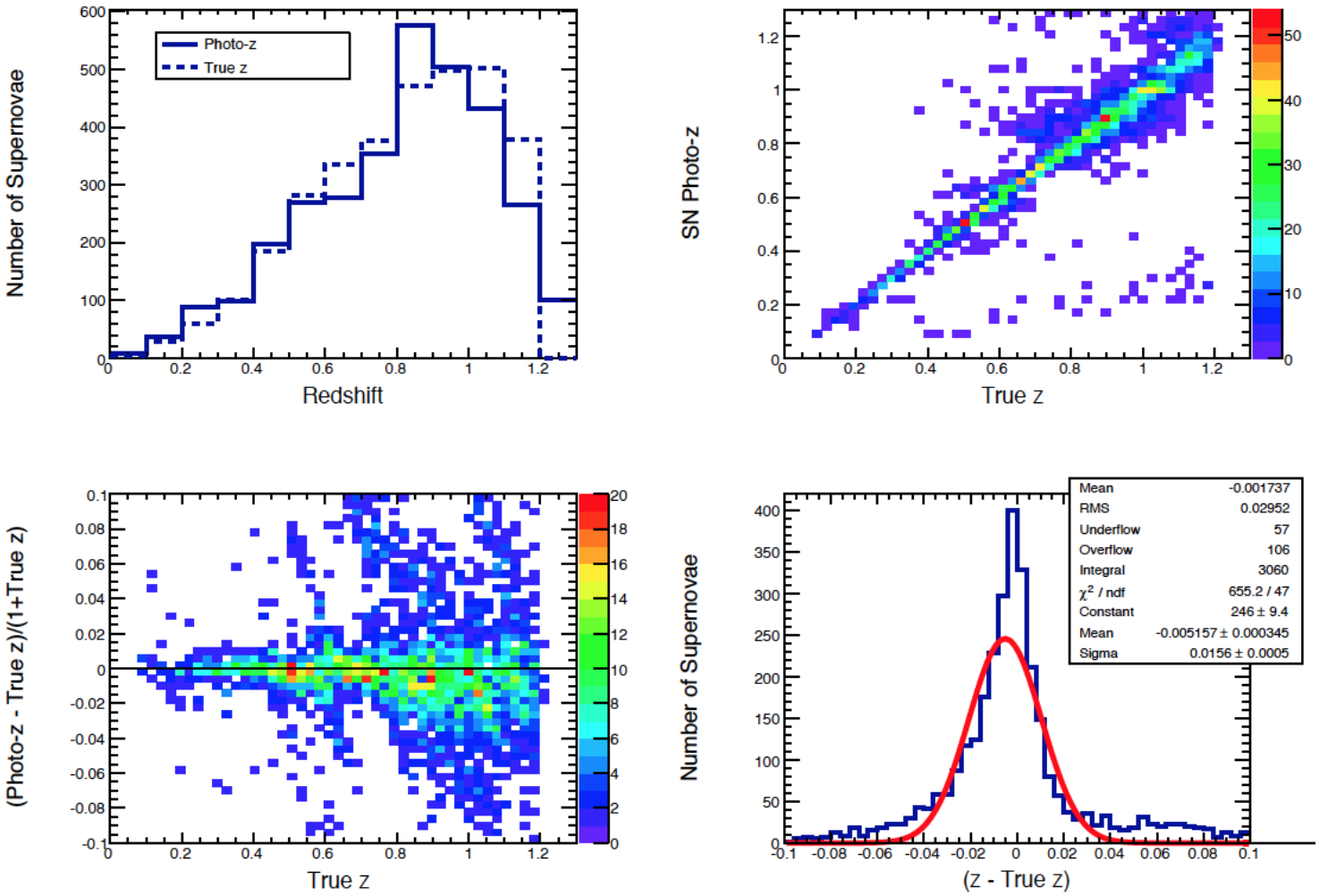
# Photo-z fits

- Using SNANA $\chi^2$ fit (Kessler et al., ApJ 717, 2010) with SALT2 (Guy 2010) model
- No cosmology priors
- Fits performed with and without host photo-z information

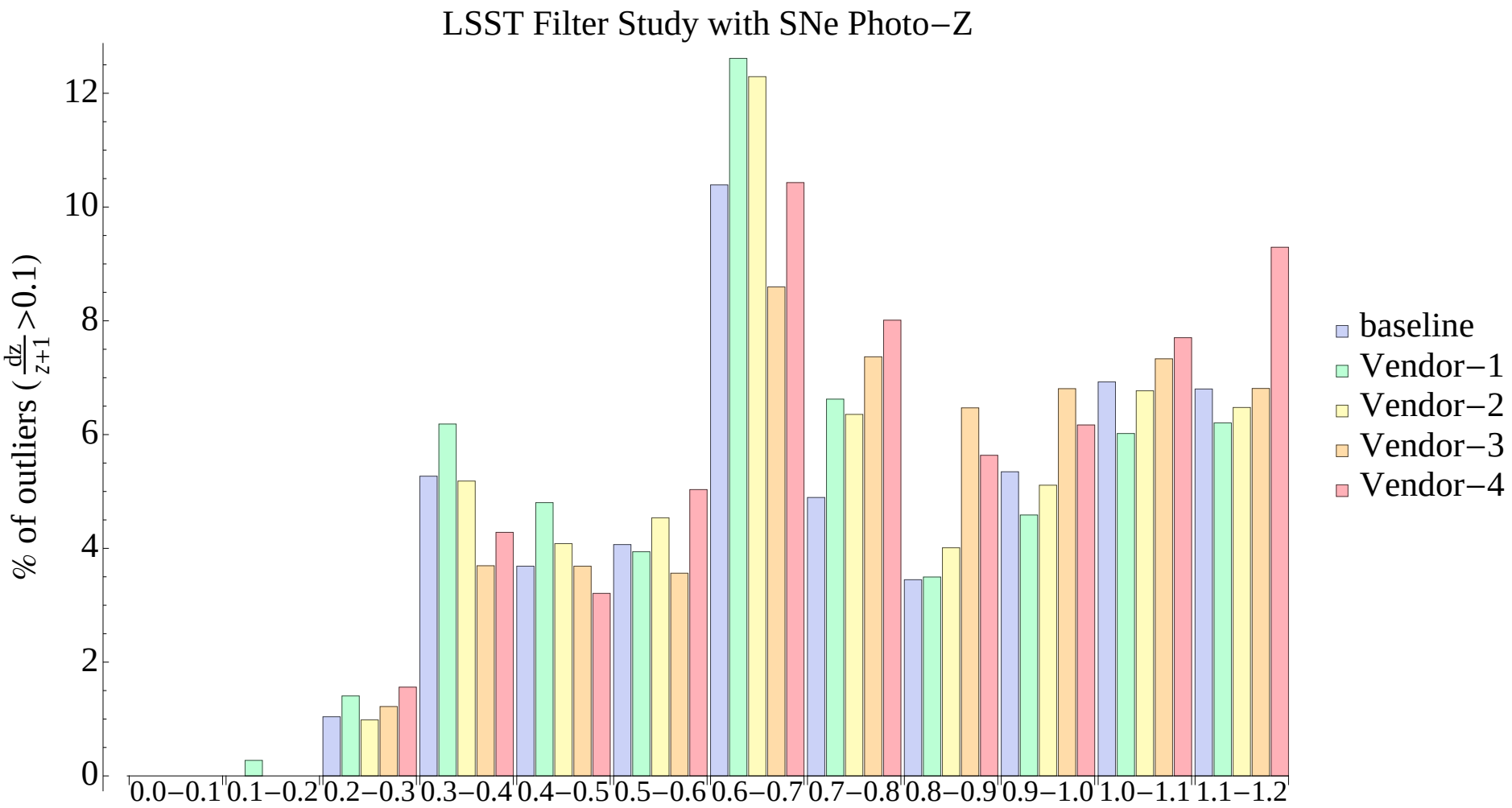
# LSST SN-only photo-z for baseline



# LSST SN-only photo-z for Vendor-1 (similar for other vendors)



# Outlier plot with leakage (no clear trends even with x10 statistics)

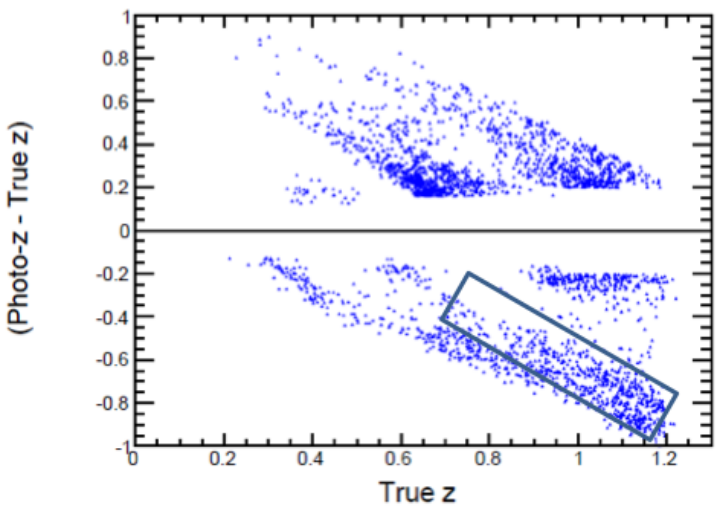


# Various trends seen in the SN-only photo-z plots, are they physical or due to fitter issues, or both?

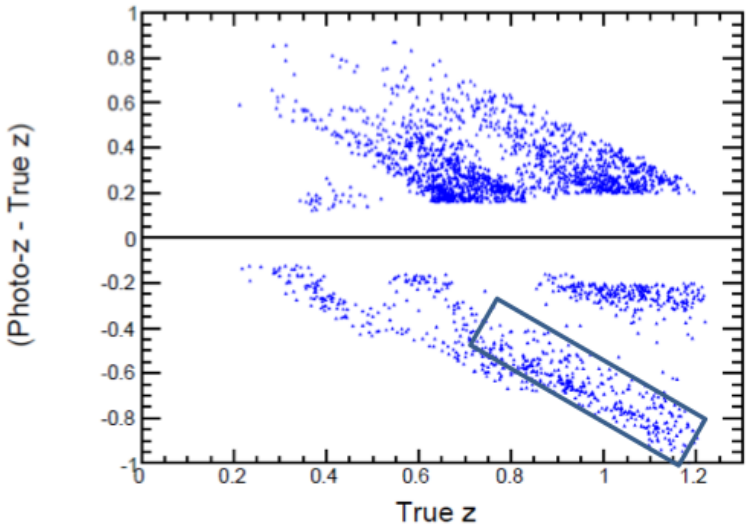
- Closer look at SNANA outliers
- Comparison with another photo-z fitter, SNCosmo
- Comparison for a small number of SNe with SNCosmo nested sampling algorithm

Note: this may just be an academic exercise since fits improve dramatically with host photo-z information (coming in a few slides)

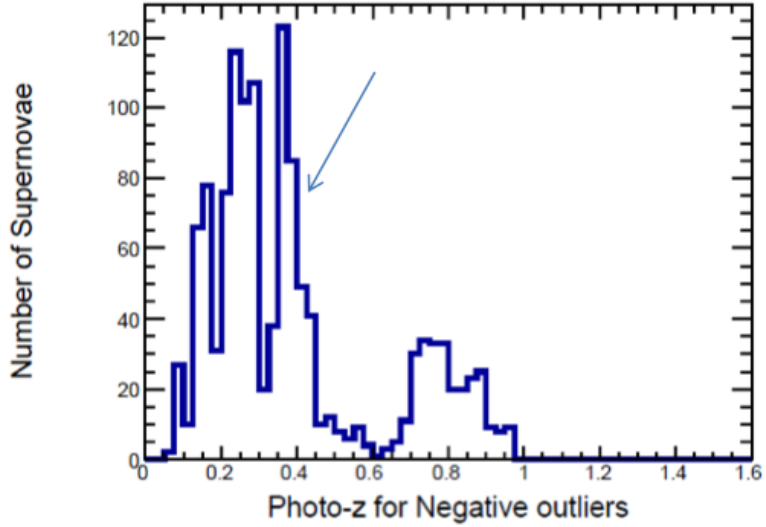
# SNANA outliers

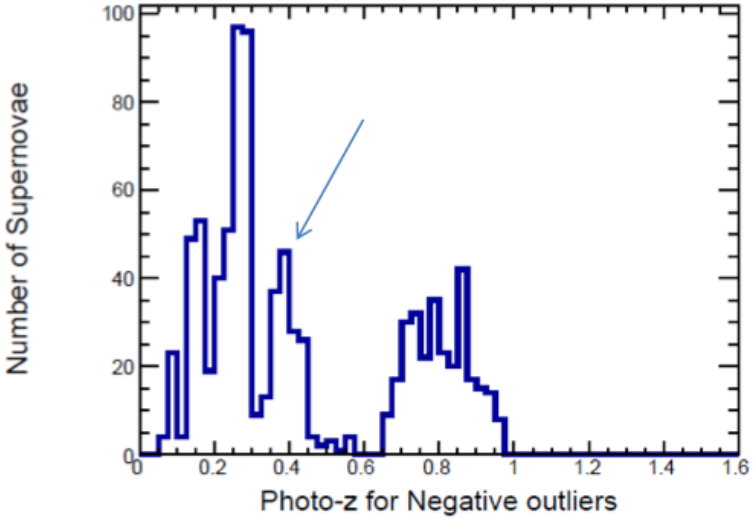



Baseline filters with leakage

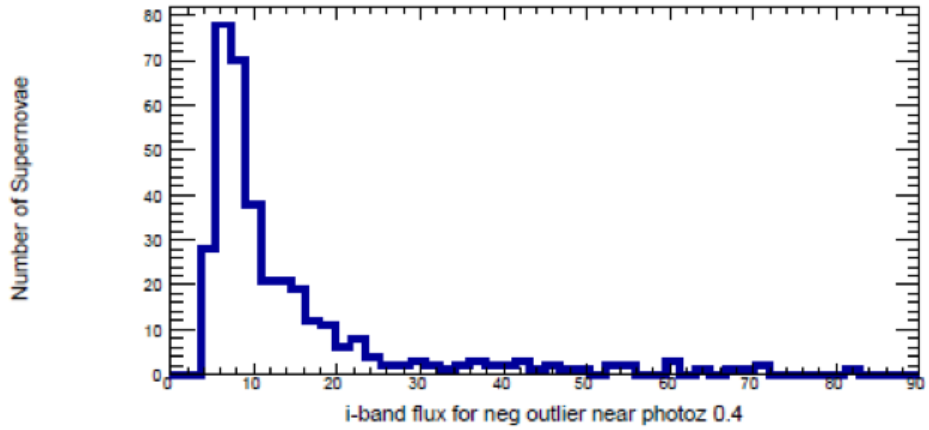



Baseline filters no leakage

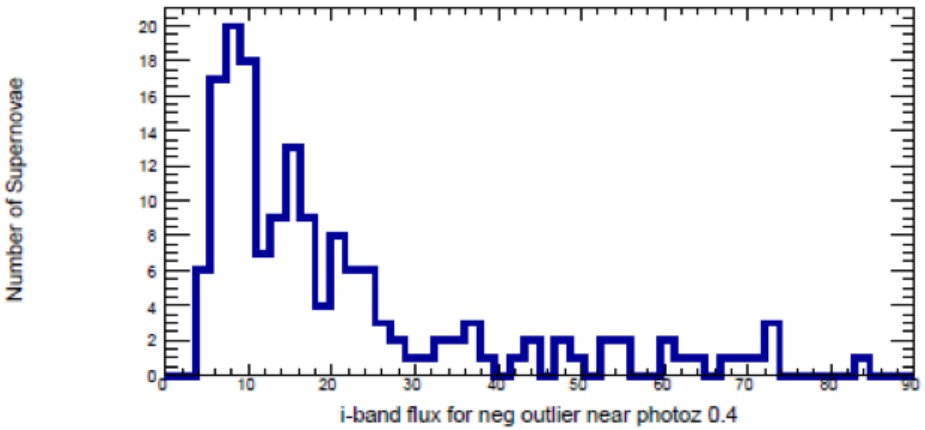


- In general, for the photo-z outliers near photo-z = 0.4, the filter fluxes are very similar with and without leakage.
- Only i-band seems to show a difference, indicating a larger average i-band flux if filter leakage is artificially removed.

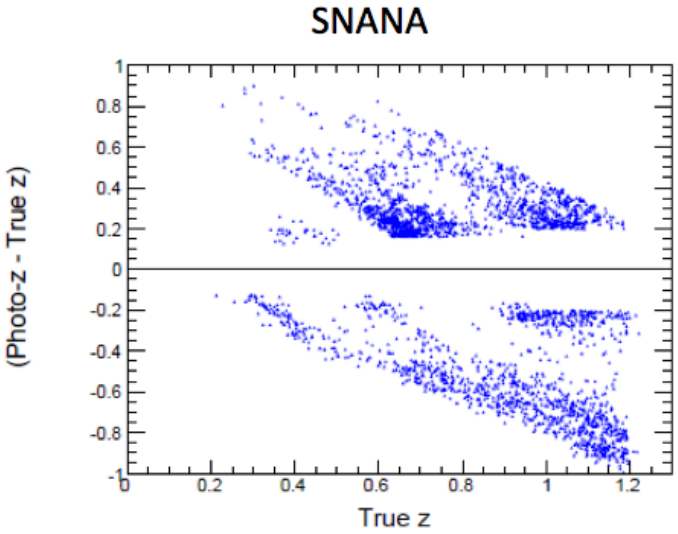


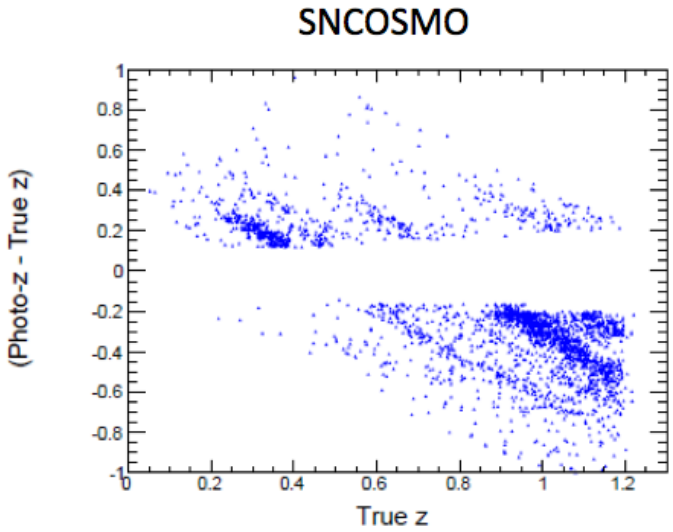

Baseline i-band filter flux including filter leakage

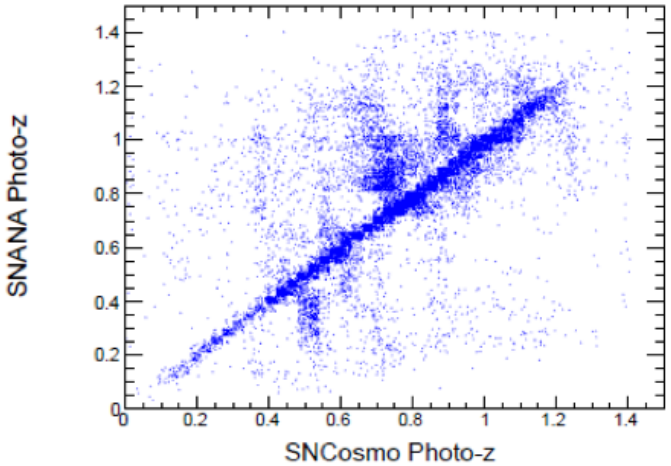



Baseline i-band filter flux excluding filter leakage

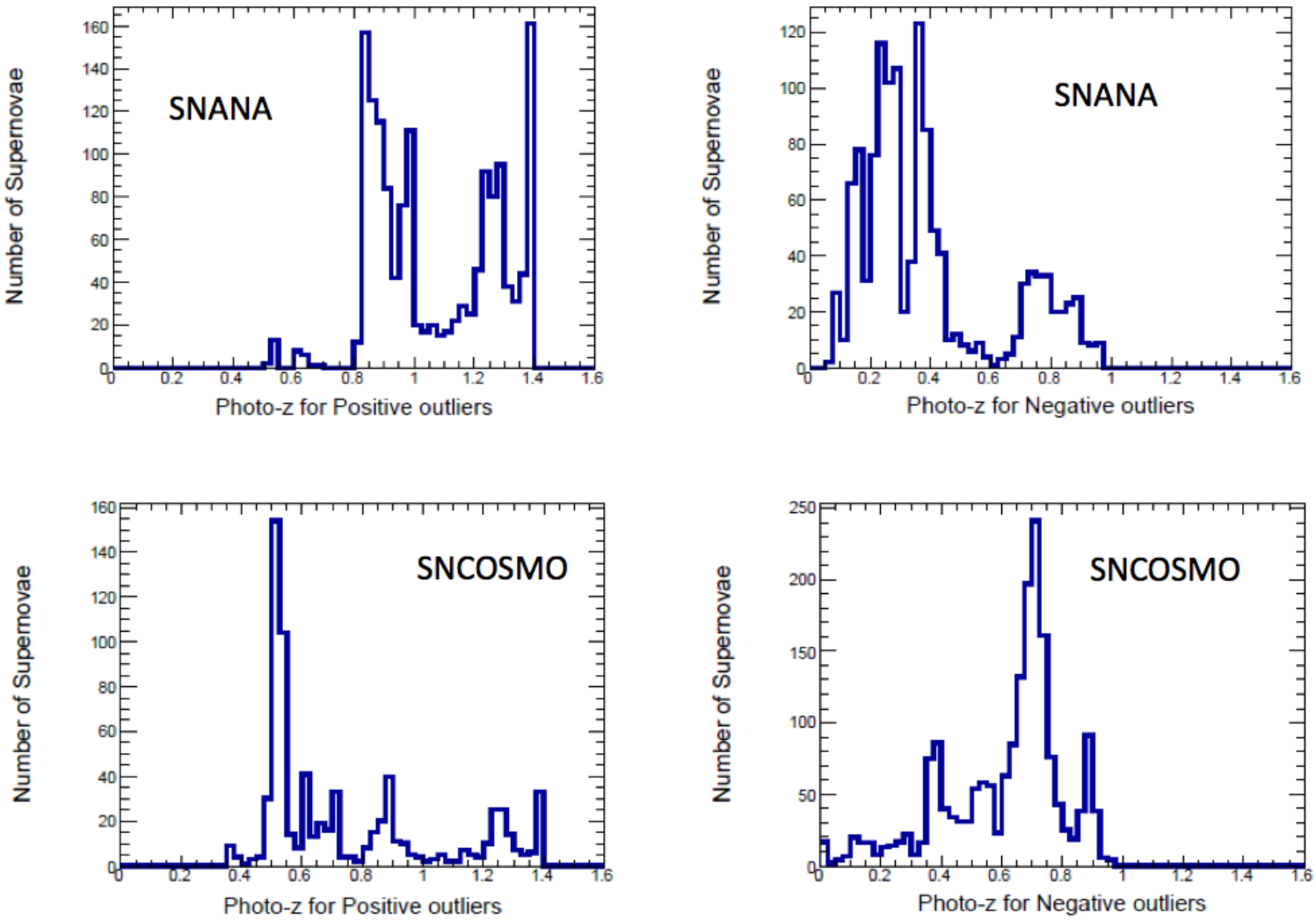
# SNANA to SNCosmo comparison



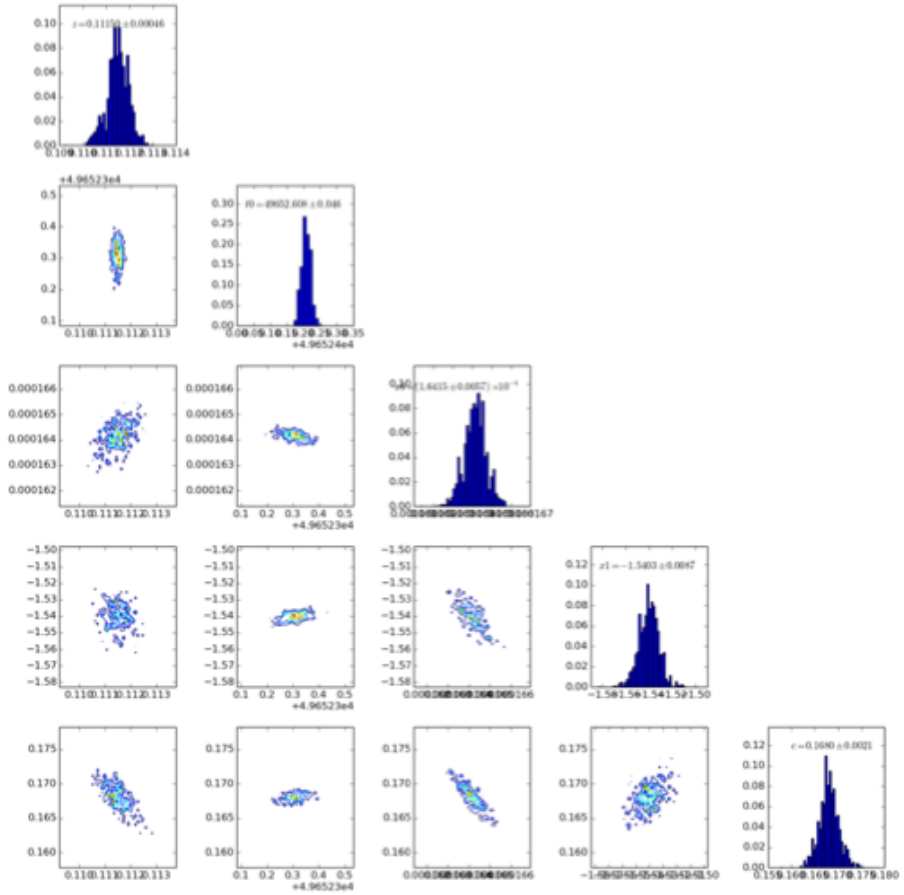



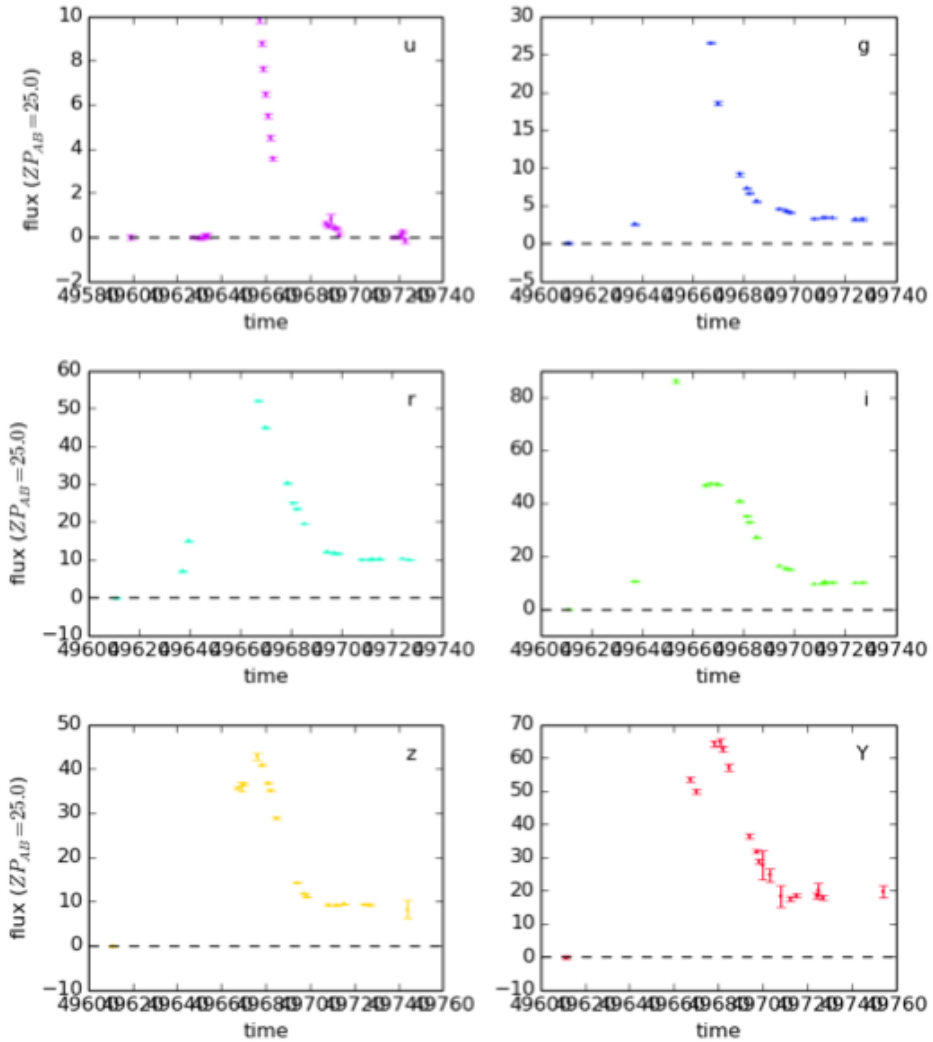



# SNANA and SNCosmo outliers very different!
# Presumably due to different initial starting points



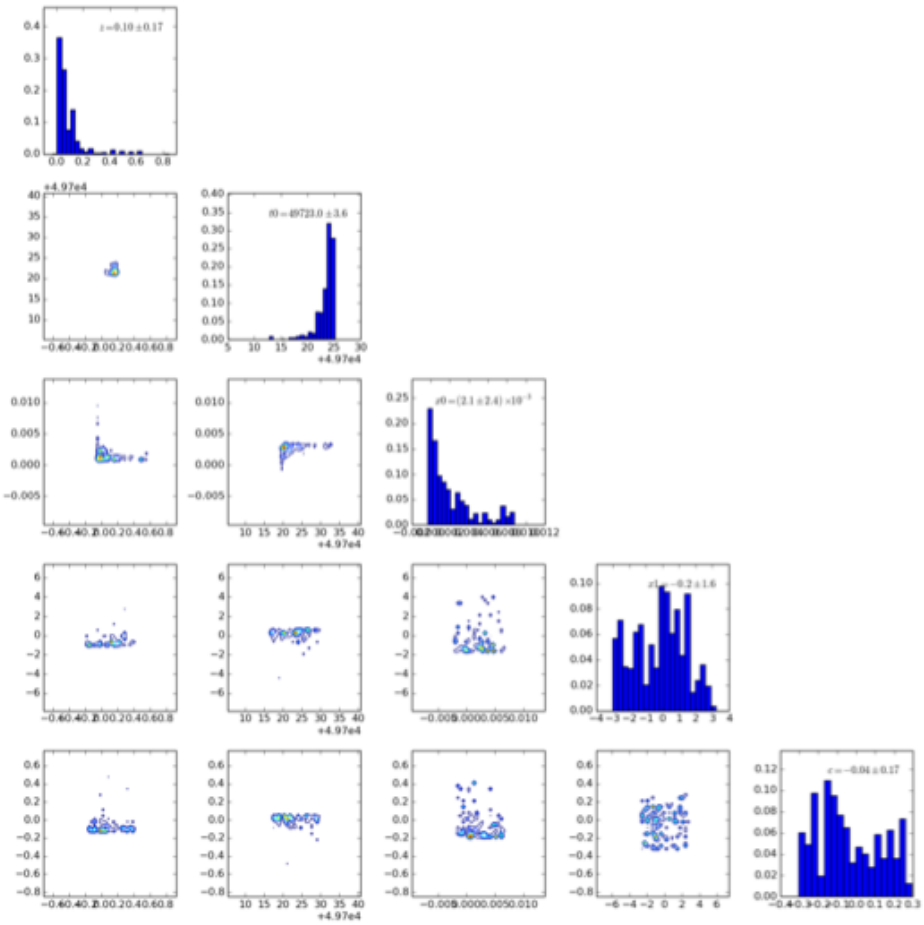
# Most Photo-z failures tested with Nested Sampling improved.

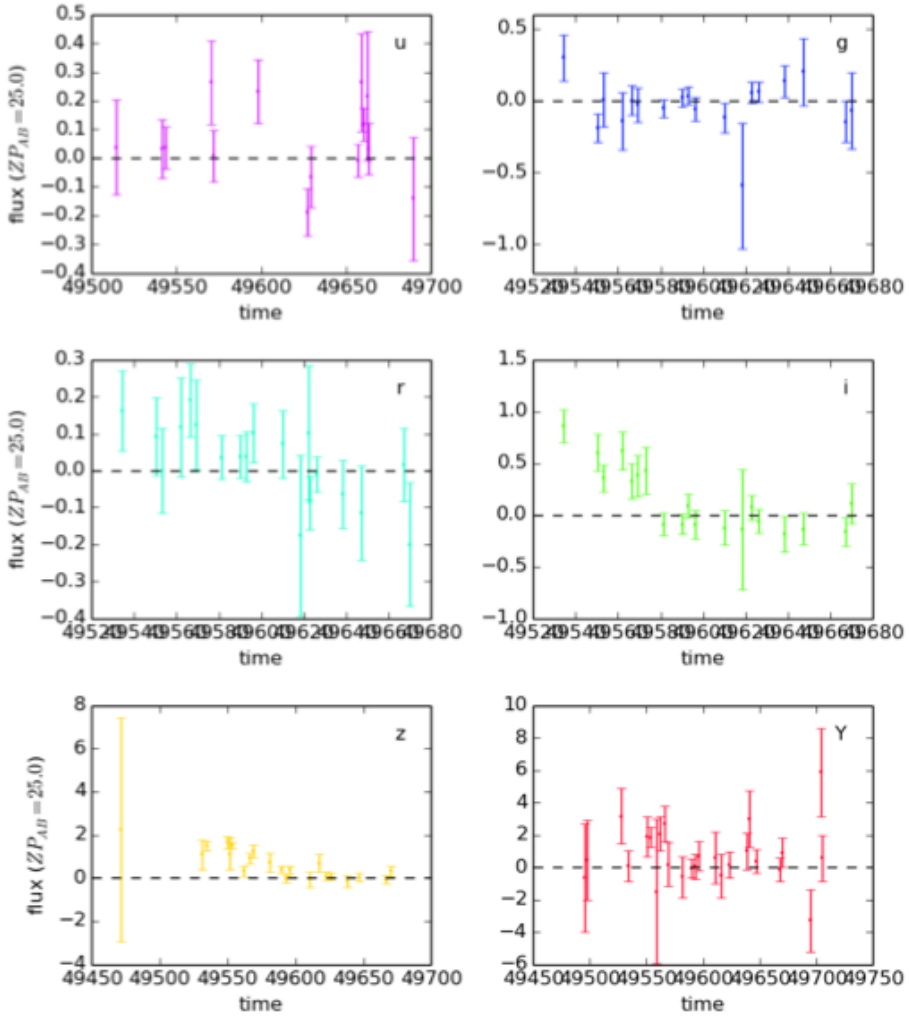





SNCosmo nested sampling on single simulated LSST SNe:
Truz=.12, Photoz=.48, Nested Sampling=$.112 + -0.00046$

# But at high redshift the nested sampling algorithm can fail

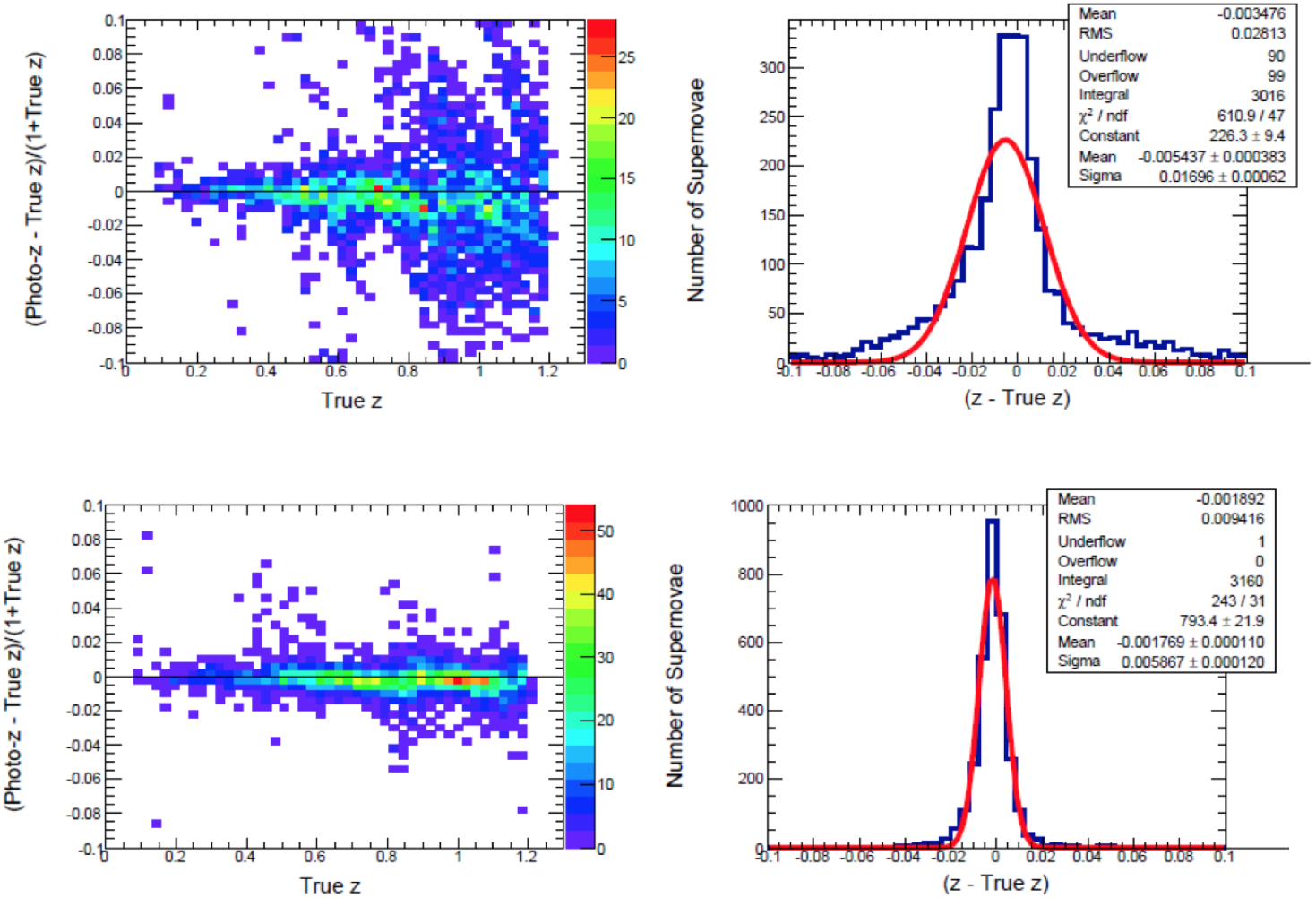




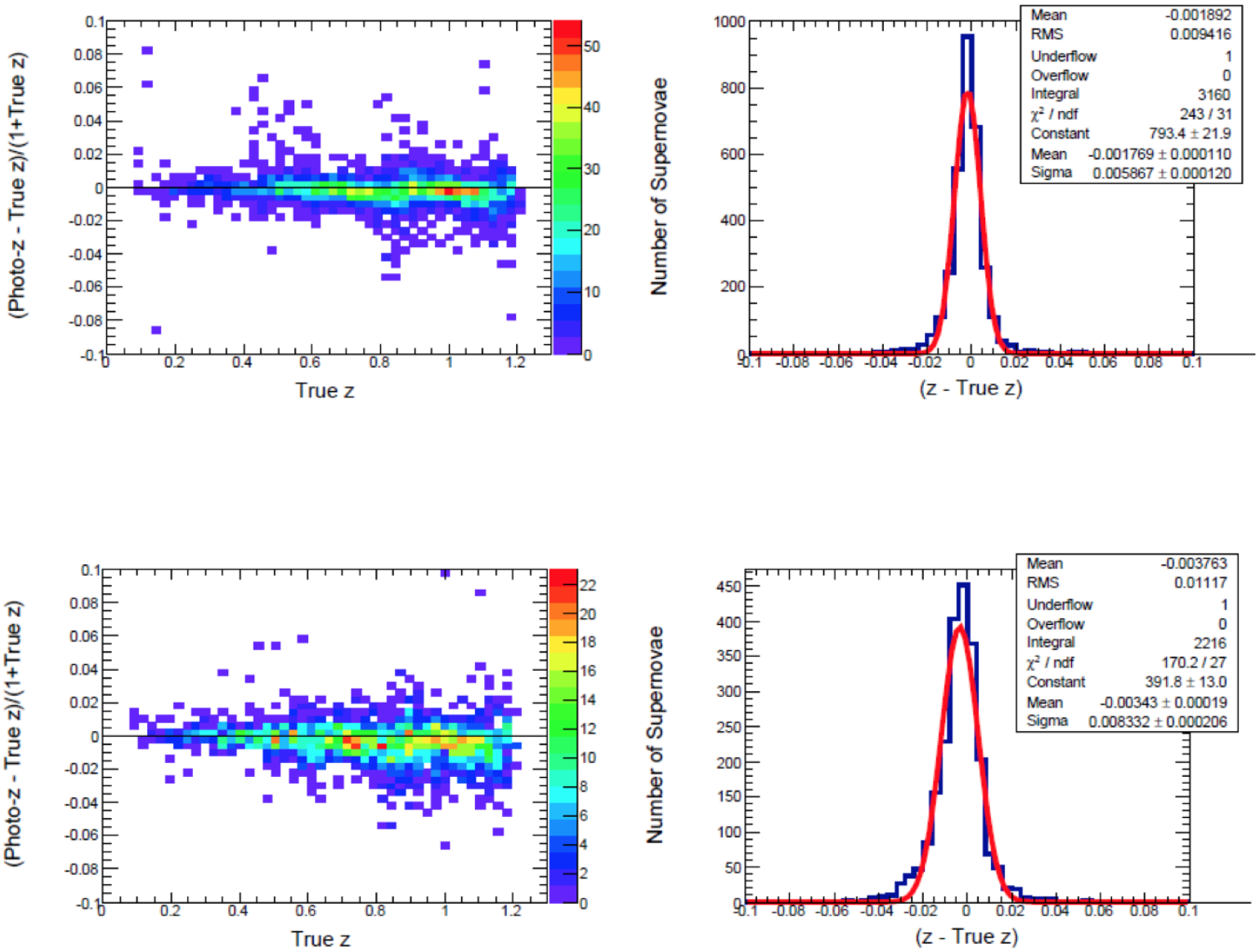

SNCosmo Nested Sampling example mistake, on a poorly measured SN: Truz=1.15, Photoz=.683, Nested sampling = .10 +- 0.17

SNANA provides the capability to add a host galaxy redshift prior as part of its SNe photo-z fit:

# Comparison of SN photo-z without and with host info, for Vendor-1



# Comparison of host and host-err*2.5 for Vendor-1



# Does Supernova add useful information to host PhotoZ?

Yes.

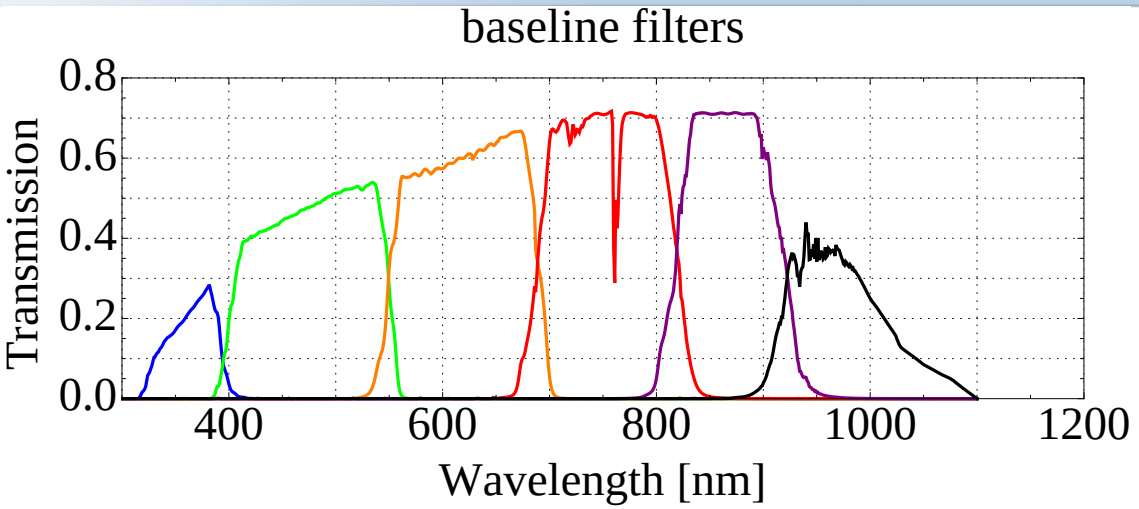
| | RMS |
|---|---|
| Schmidt 2009 Galaxy Library -> PhotoZ-TrueZ | 0.027 |
| Schmidt 2009 Galaxy Library -> Monte Carlo with PhotoZ Error | 0.023 |
| Schmidt 2009 Galaxy Library as prior for Supernova (Photoz-TrueZ) | 0.016 |
| Schmidt 2009 Galaxy Library -> Monte Carlo with PhotoZ Error*2.5 | 0.056 |
| Schmidt 2009 Galaxy Error*2.5 as prior for Supernova (PhotoZ-TrueZ) | 0.021 |

# Conclusions

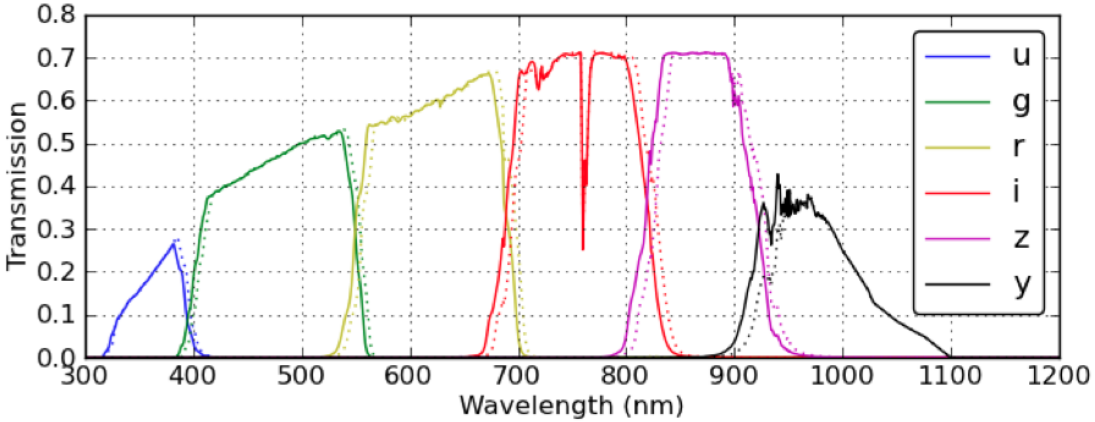
- Current Fitter choices in SN-only Photo-z seemingly more important than physical effects due to filters.
- Adding host photo-z prior dramatically improves fits, and with pessimistic host photo-z errors the addition of SN information makes a significant difference.
- Many backup slides covering other vendors, sample purity tests, etc.

# Backup Slides

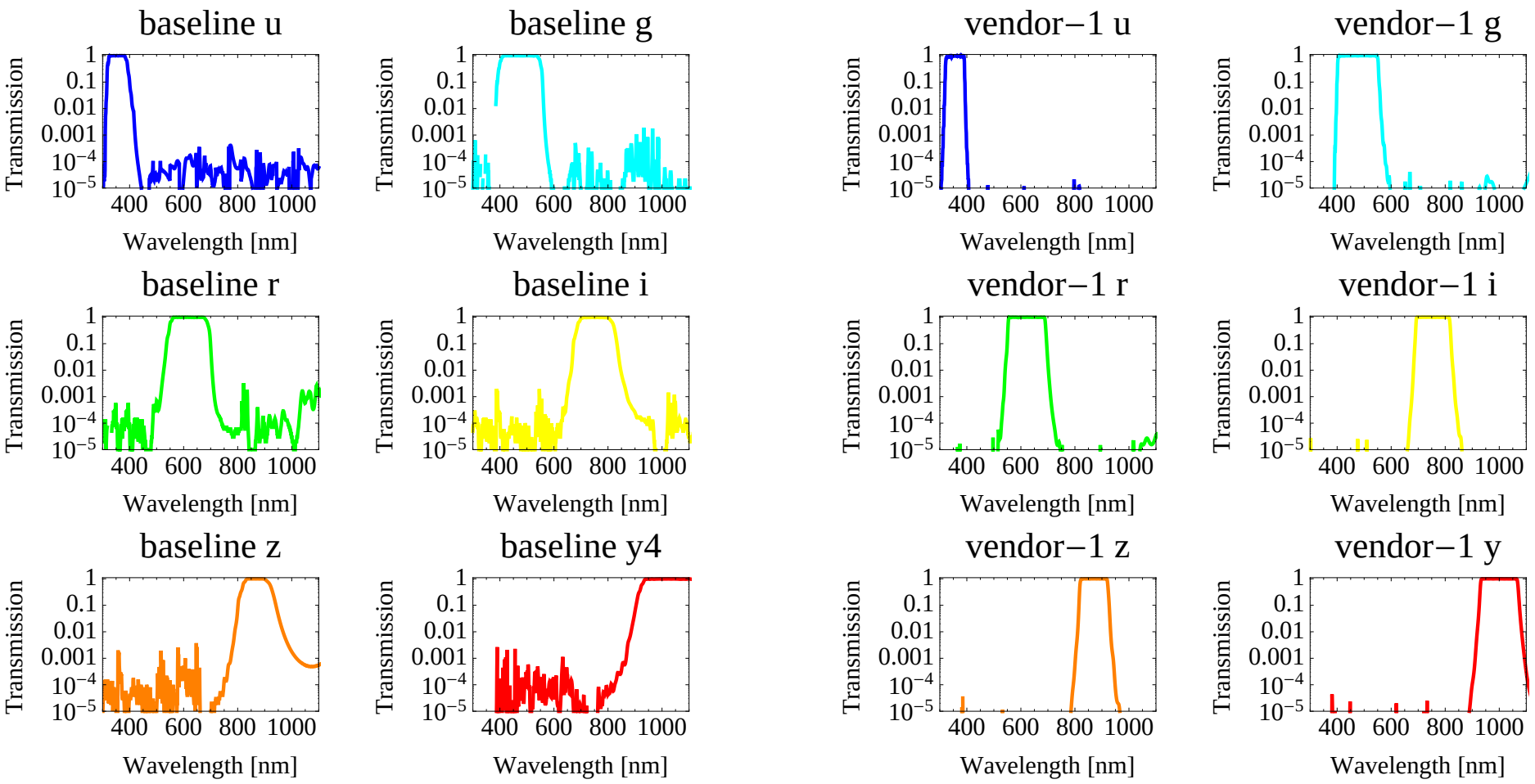
# Total transmission for baseline filters



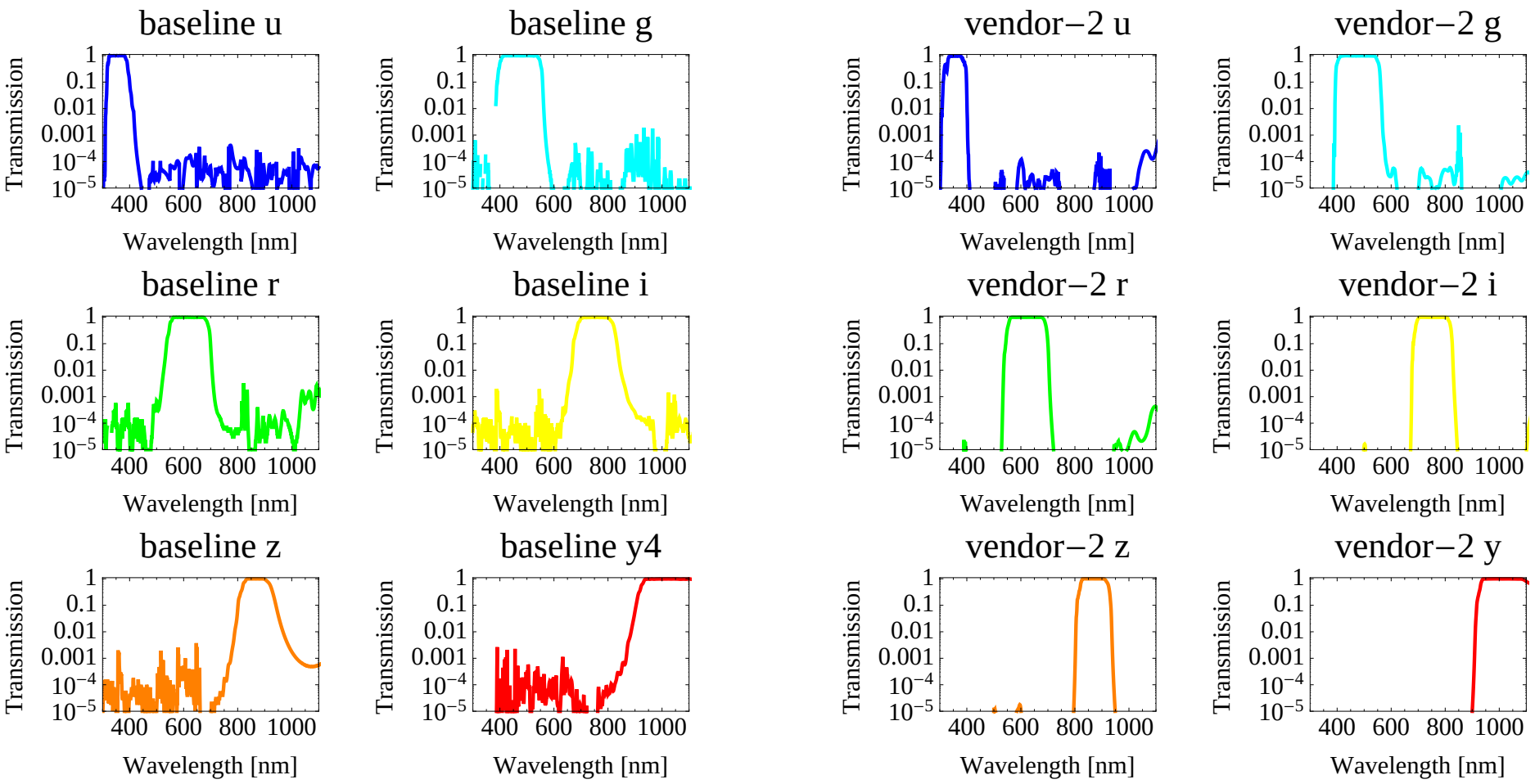

Same, from DKG March presentation



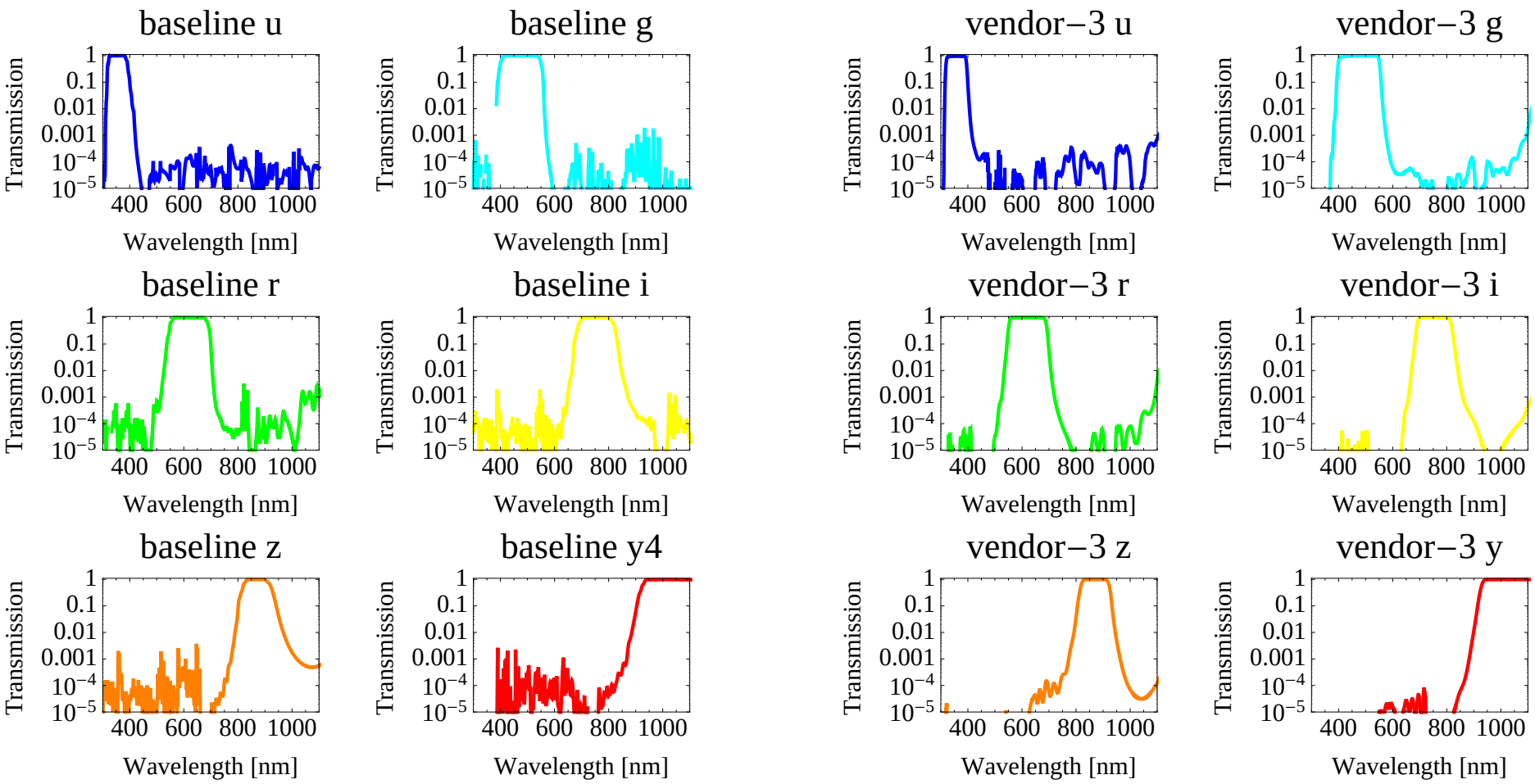
# Comparison of baseline to vendor−1 filters



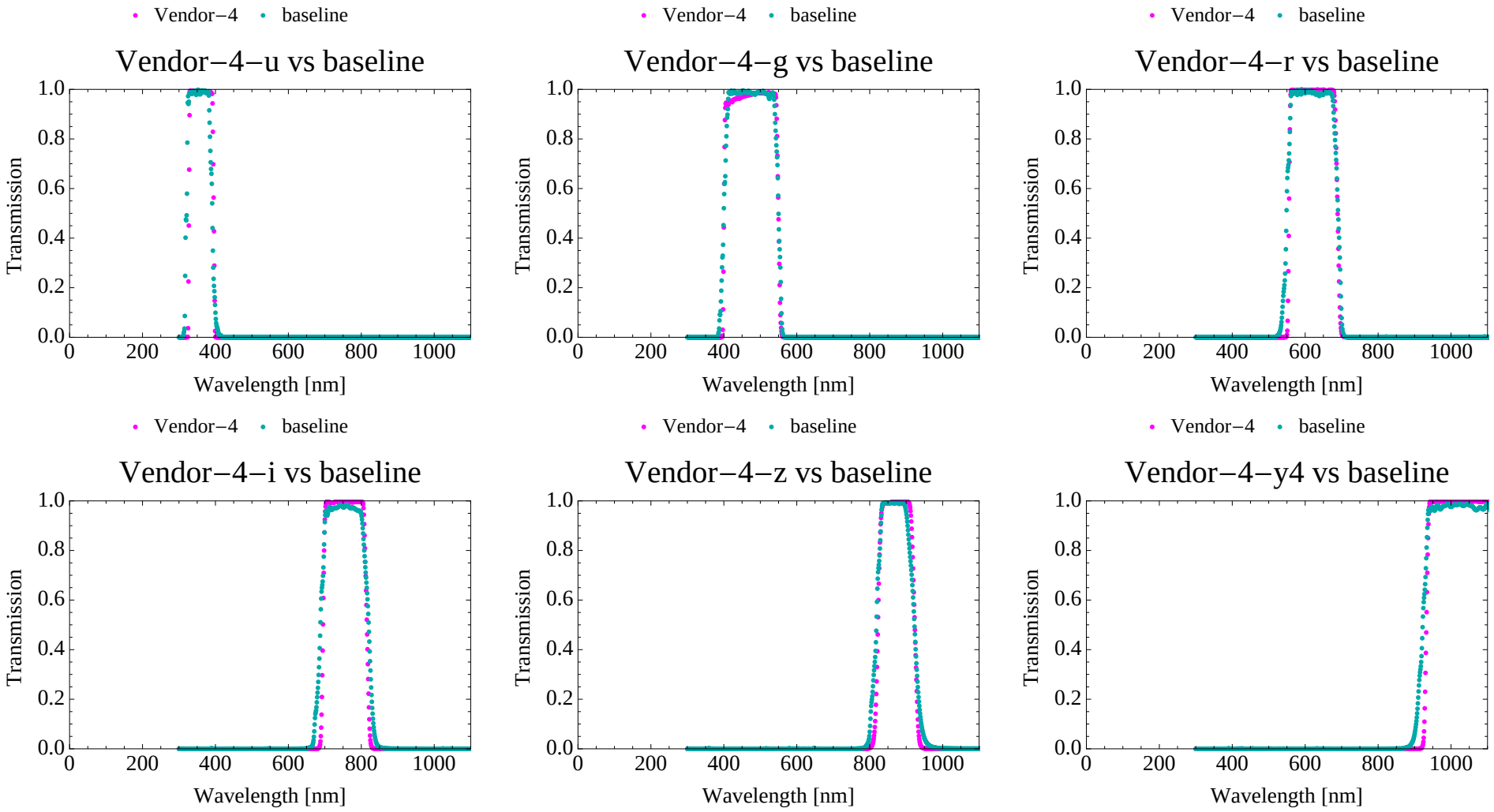
# Comparison of baseline to vendor−2 filters



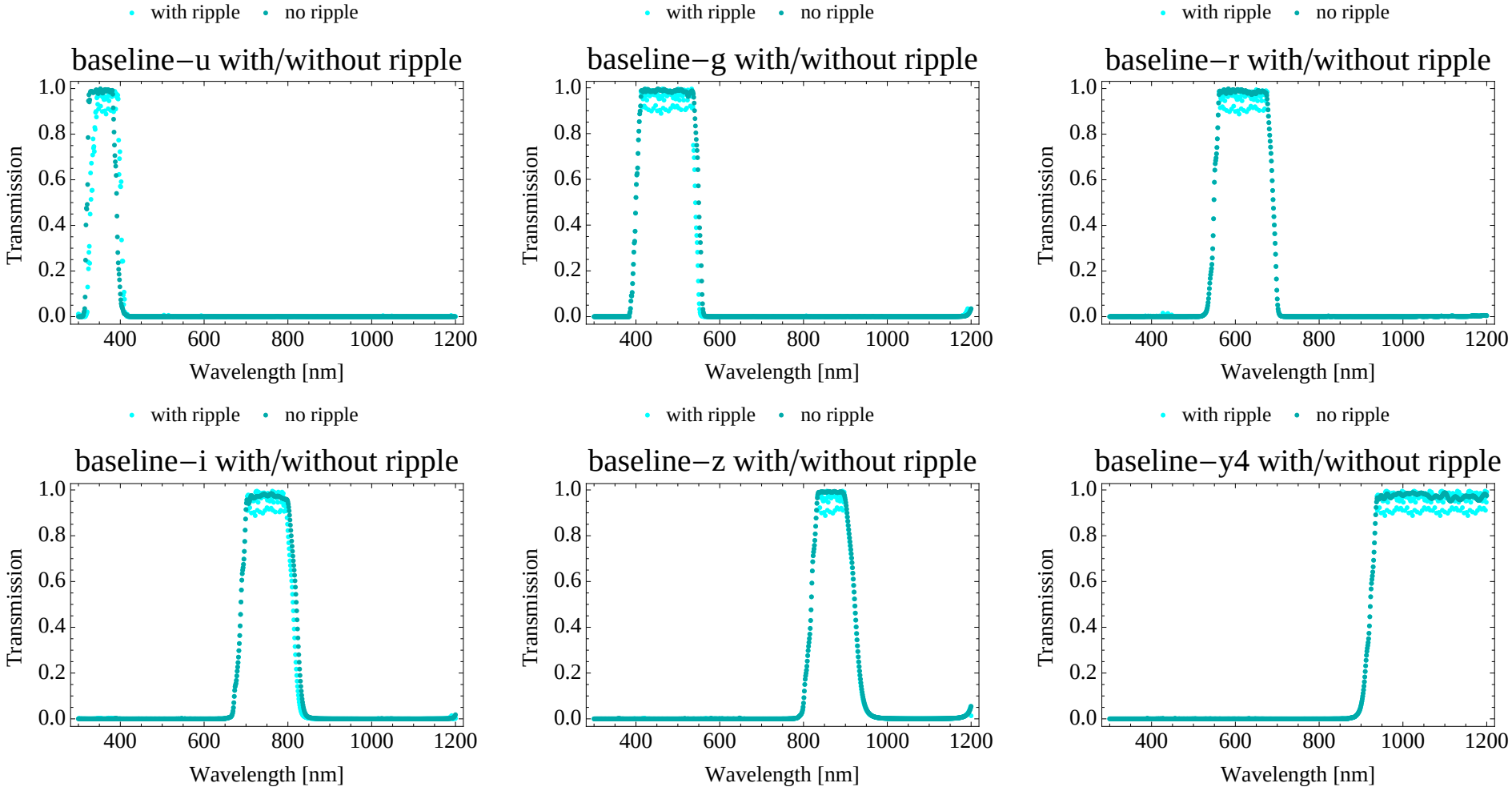
# Comparison of baseline to vendor−3 filter



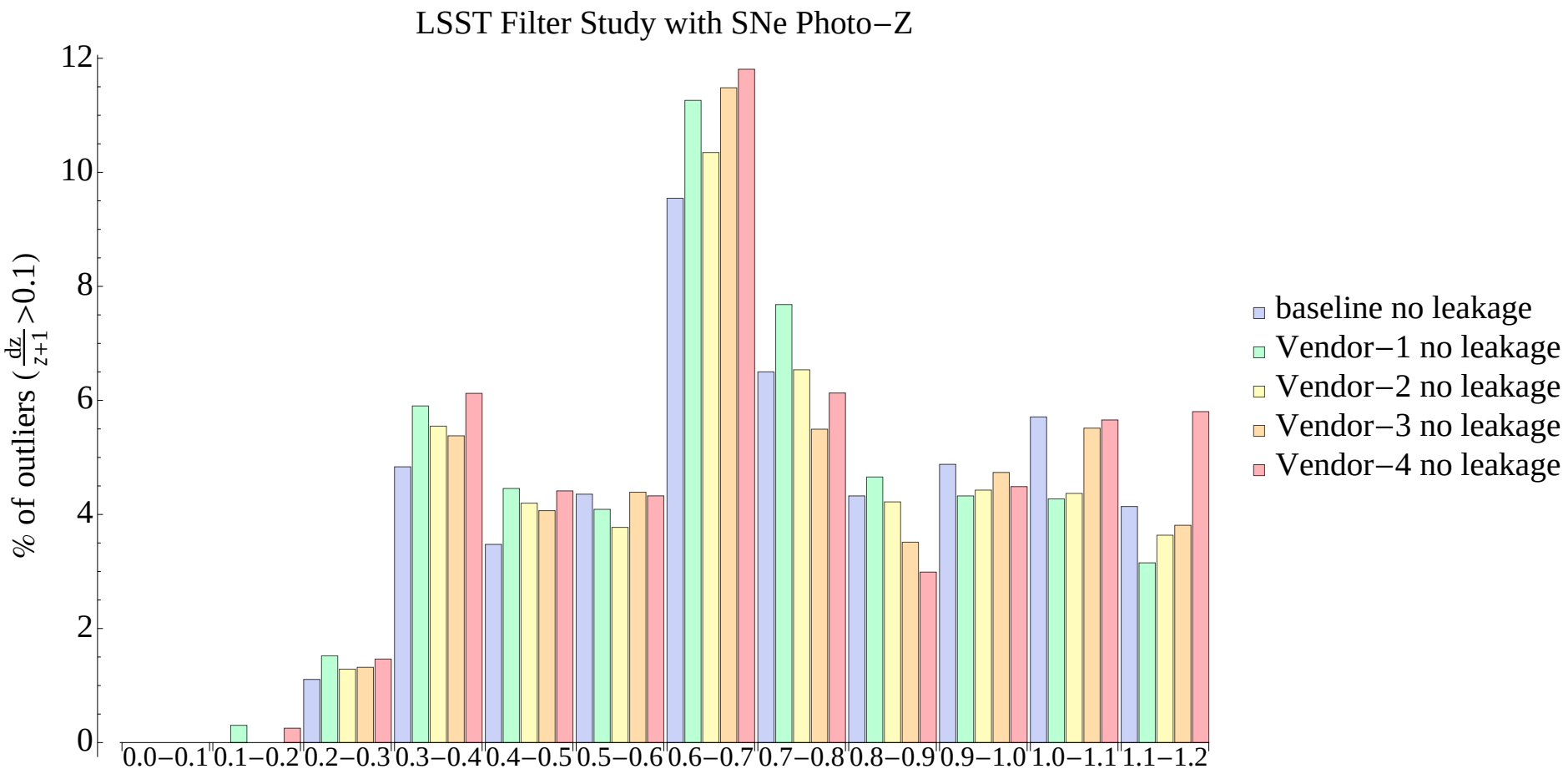
# Vendor-4 transmission vs baseline overlayed



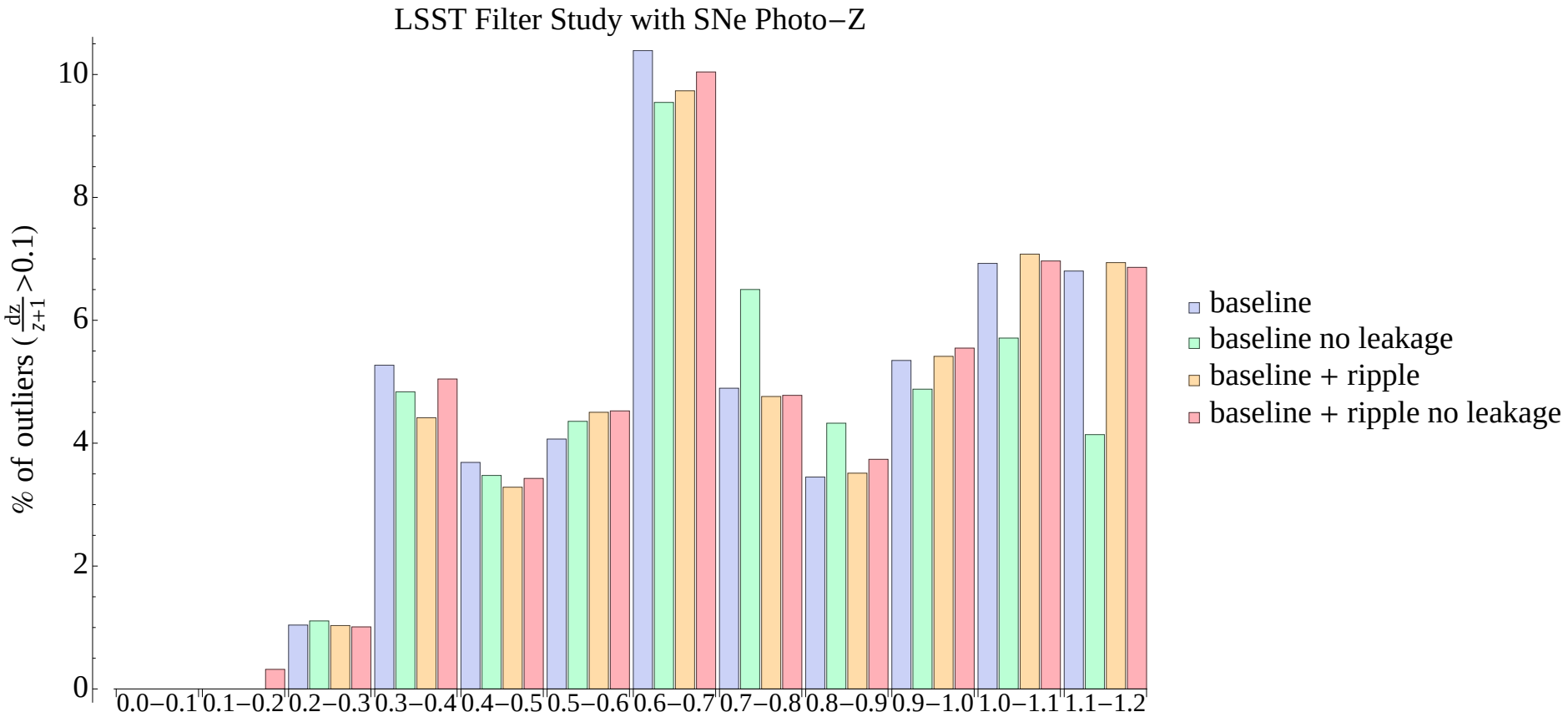
# Transmission of baseline with increased amplitude vs baseline, overlayed



# Outlier plot without leakage (no clear trends even with x10 statistics)

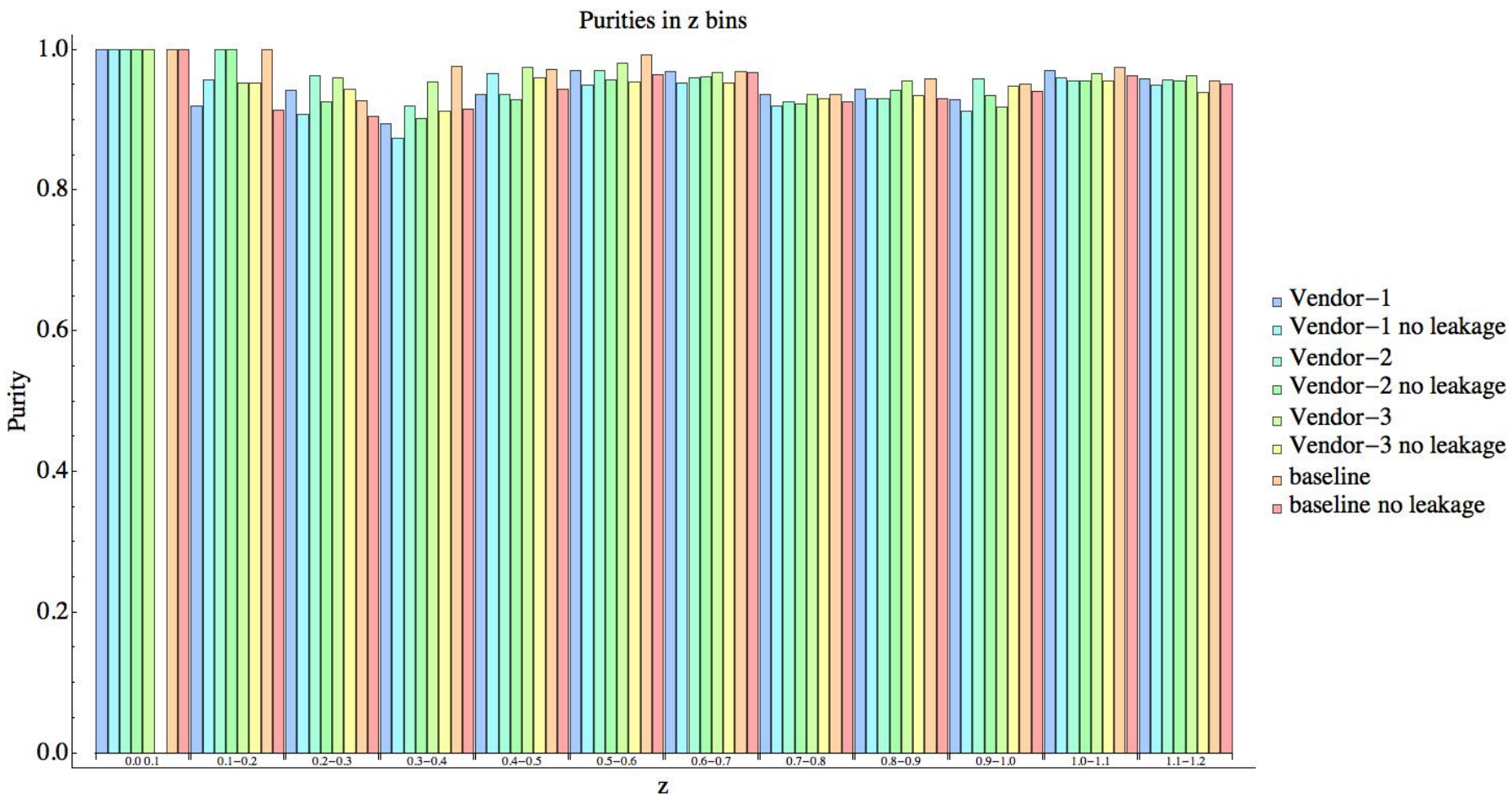


# Outlier plot with and without increased ripple

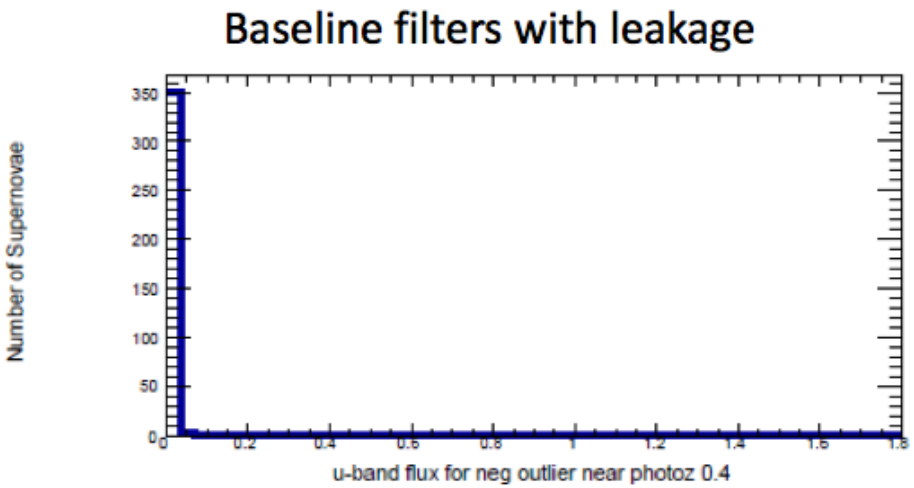


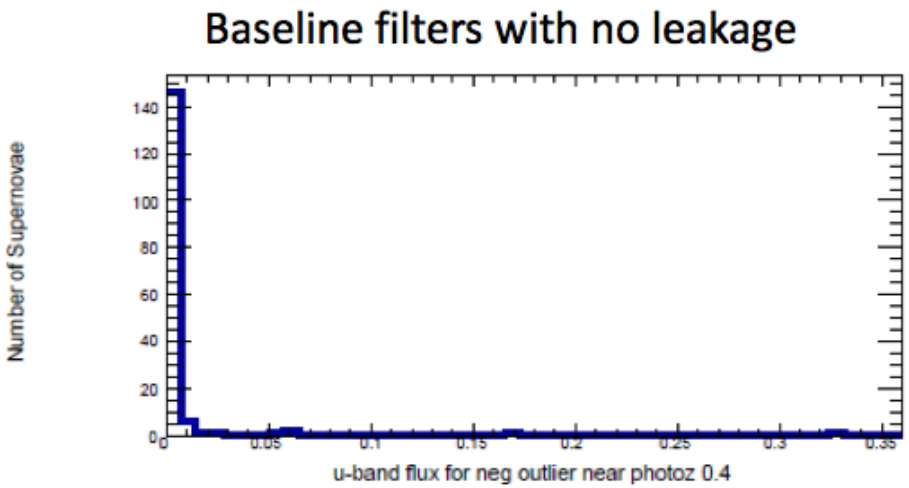
# Purity plots

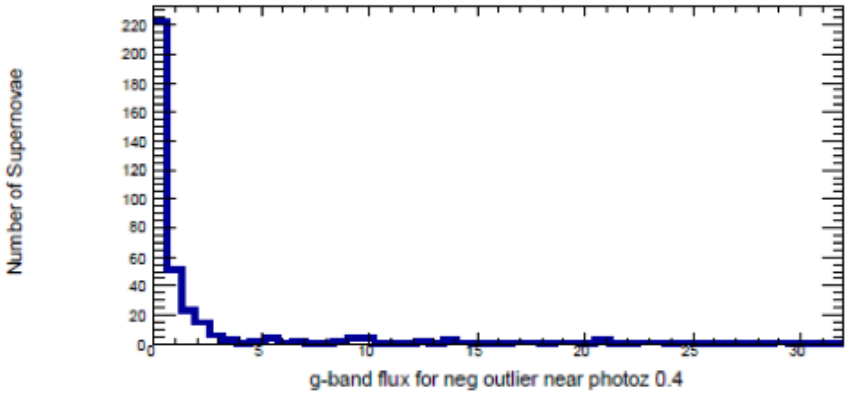
*Purity cuts*: SNR $> 5$ for at least 2 filters, SALT2 fit probability $> 0.1$, x1 and c and color-mag cuts

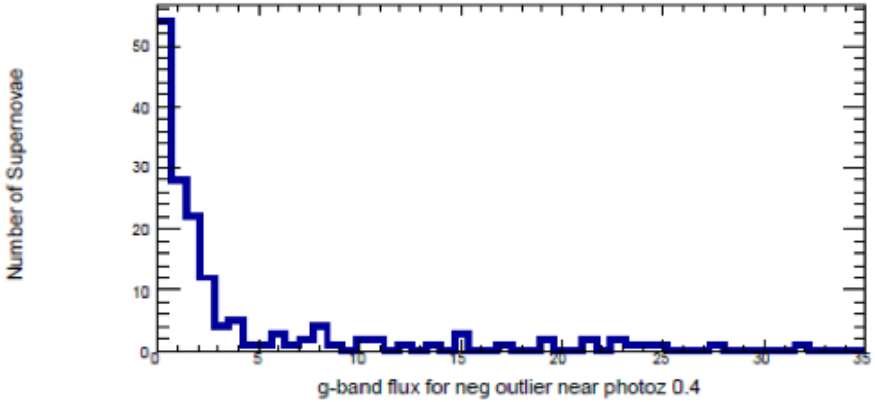


# u and g band for baseline



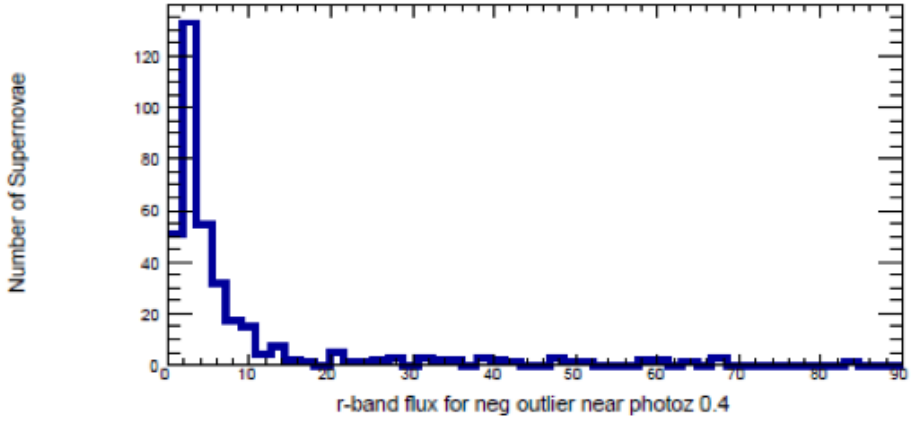



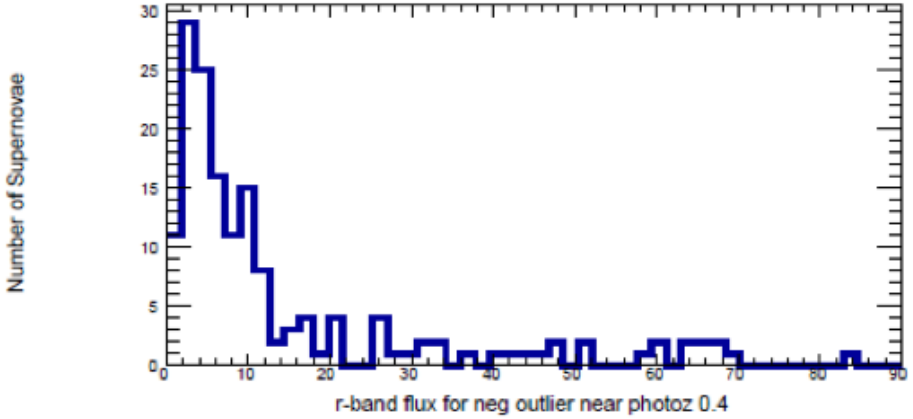



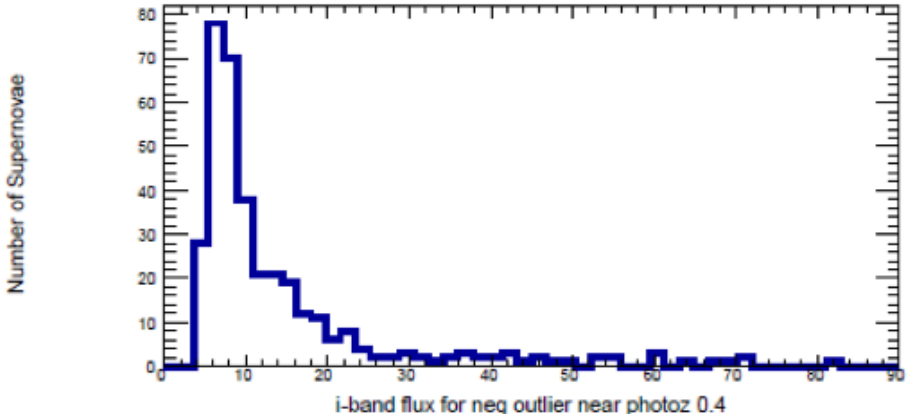
# r and i band for baseline

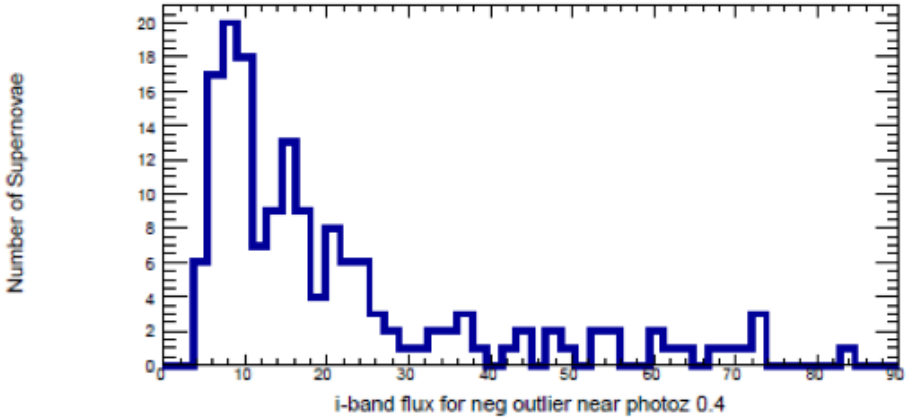
Baseline filters with leakage



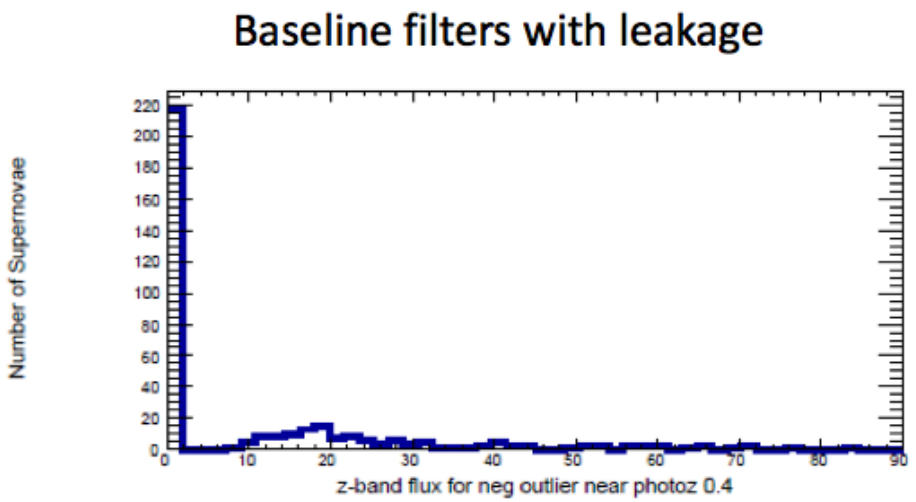

Baseline filters with no leakage

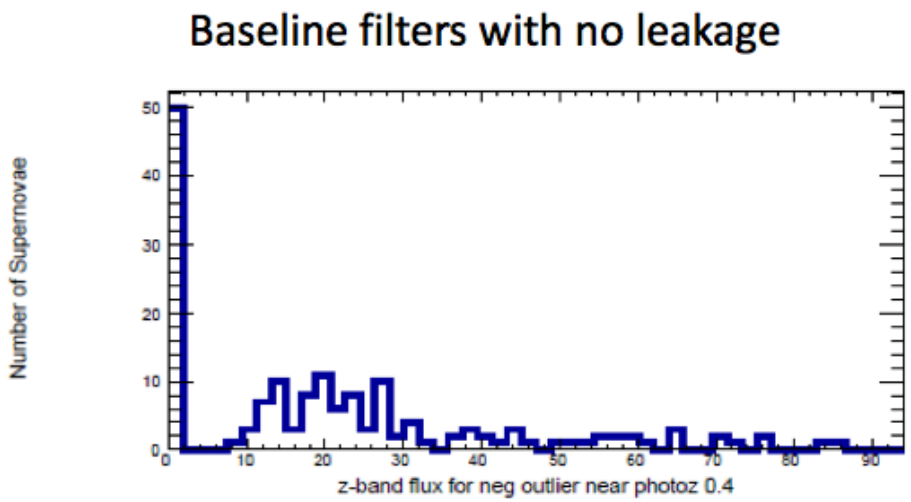


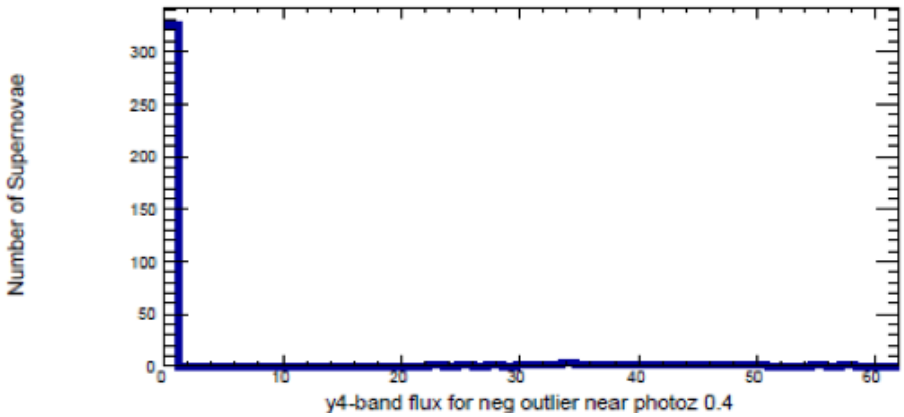



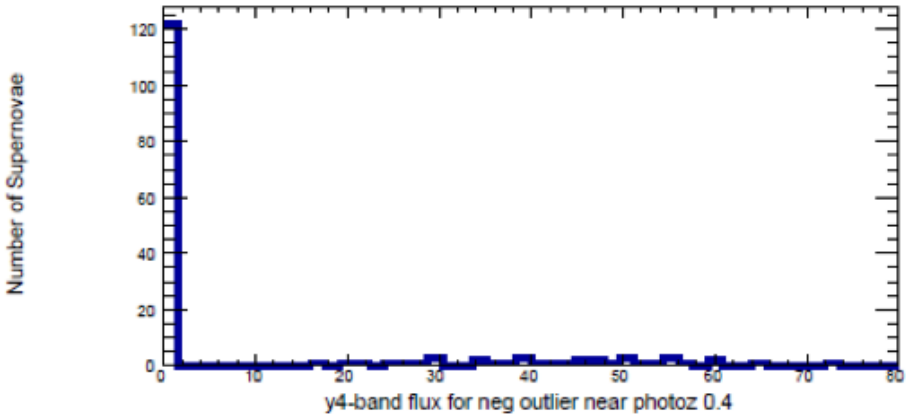



# z and y4 band for baseline

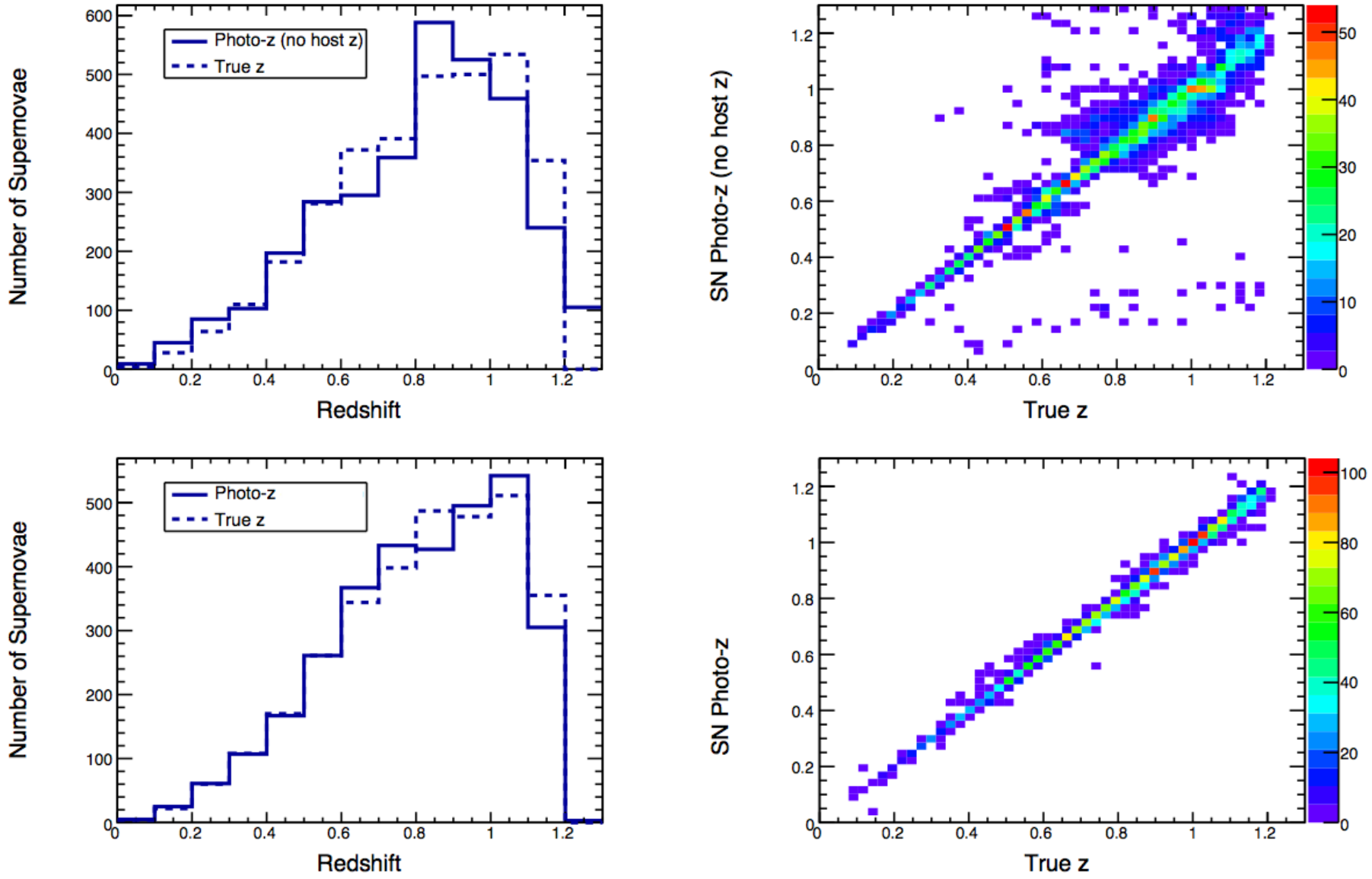


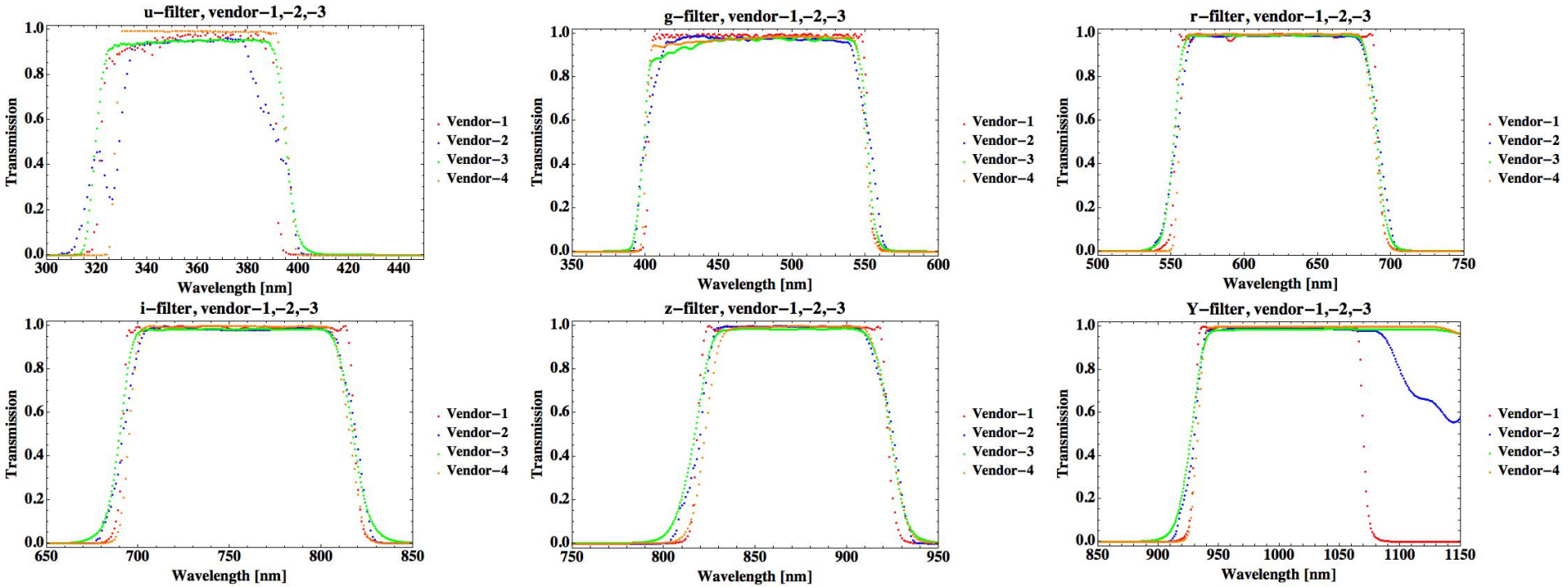



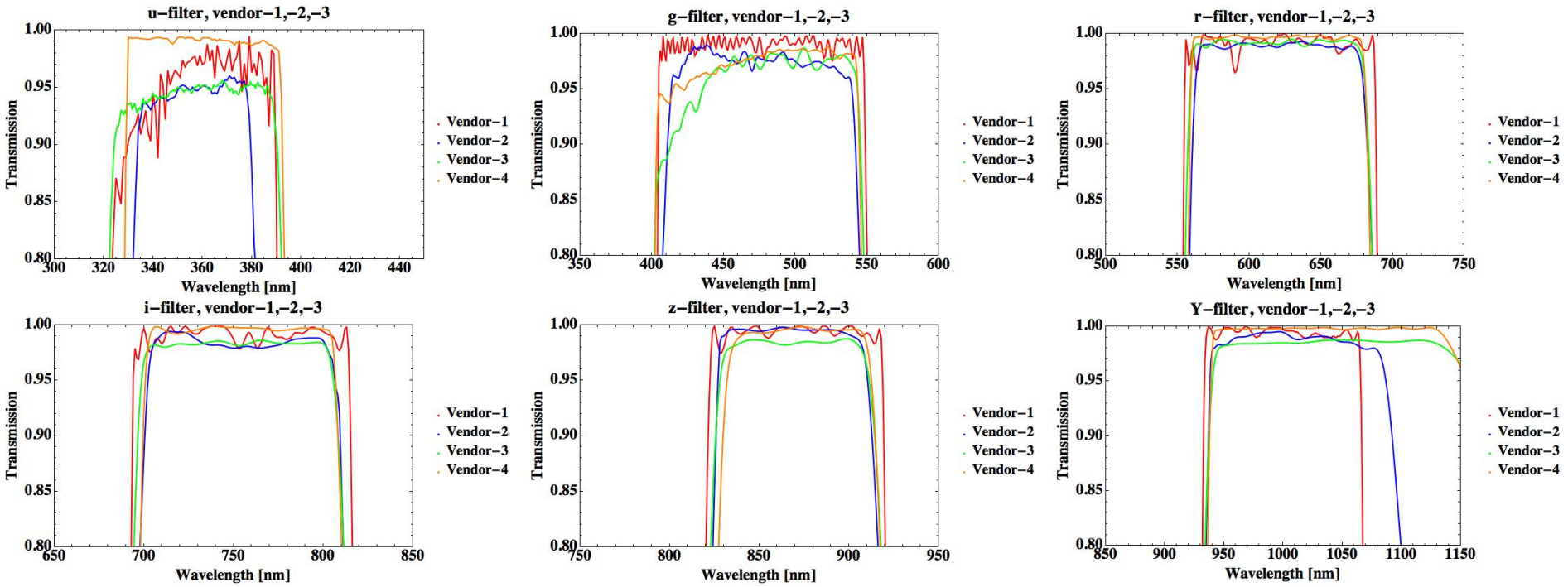
# Photo-z comparison, with and without host



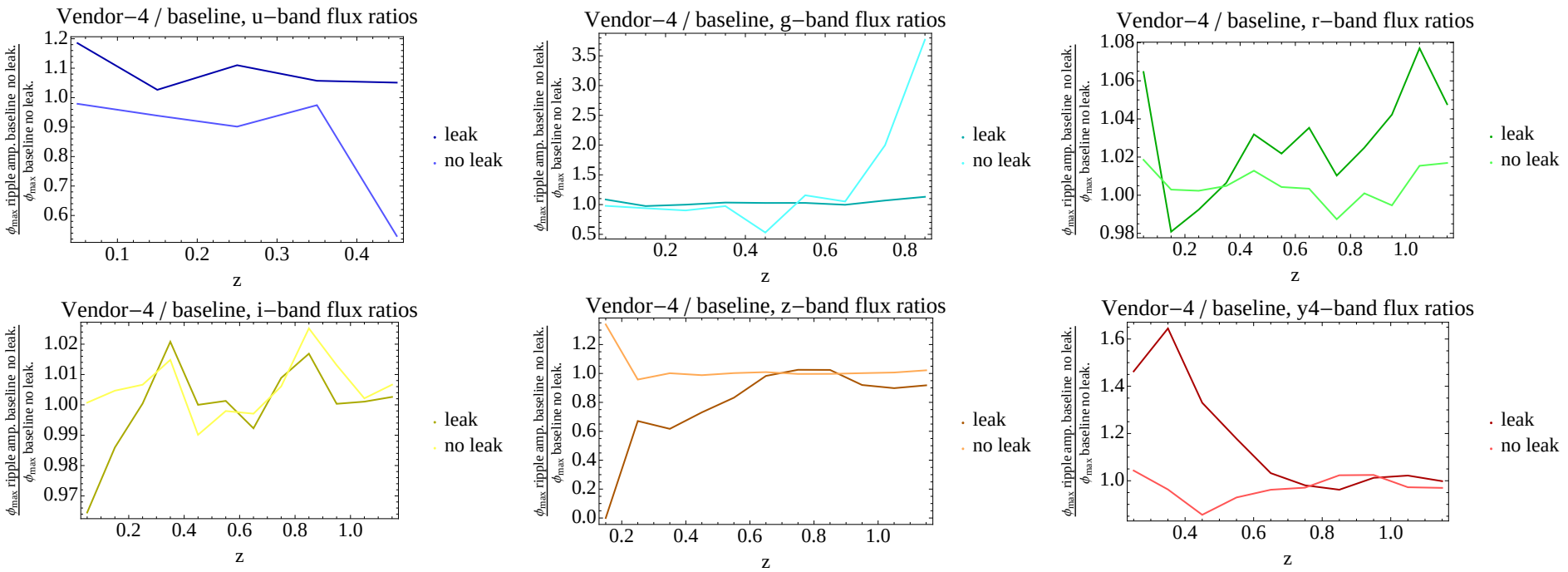
# Overlay of vendors on linear transmission.



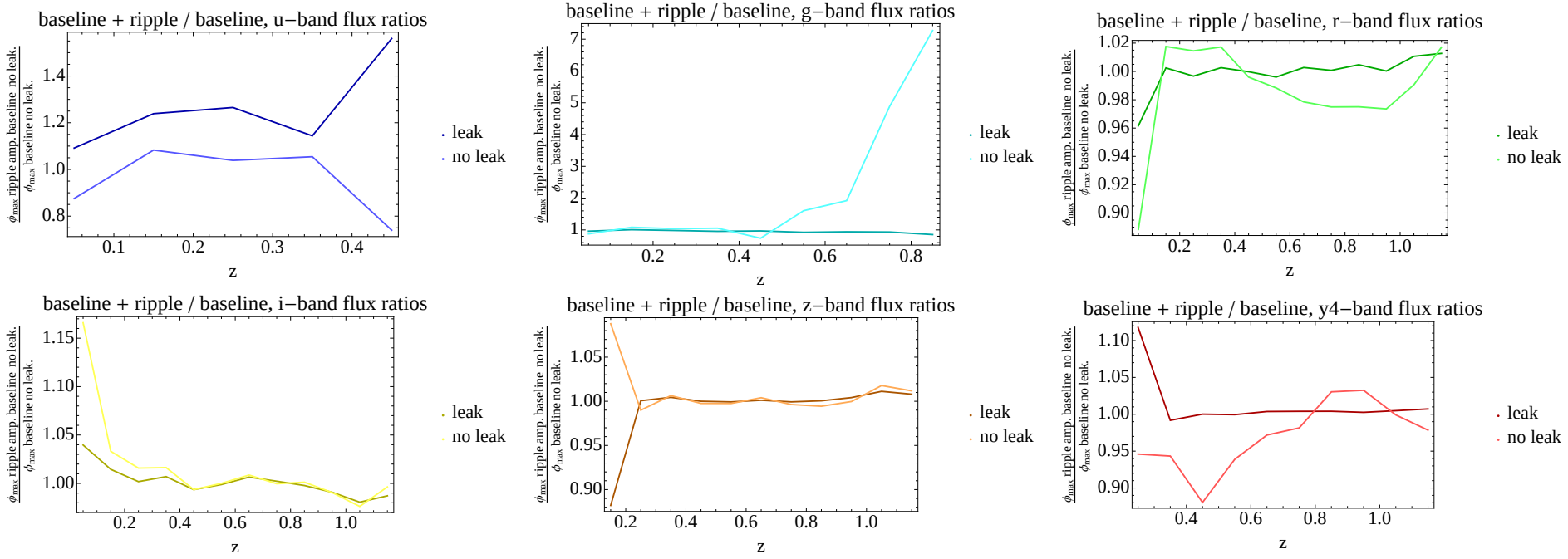
# Ripple overlay in transmission 0.8-1.0



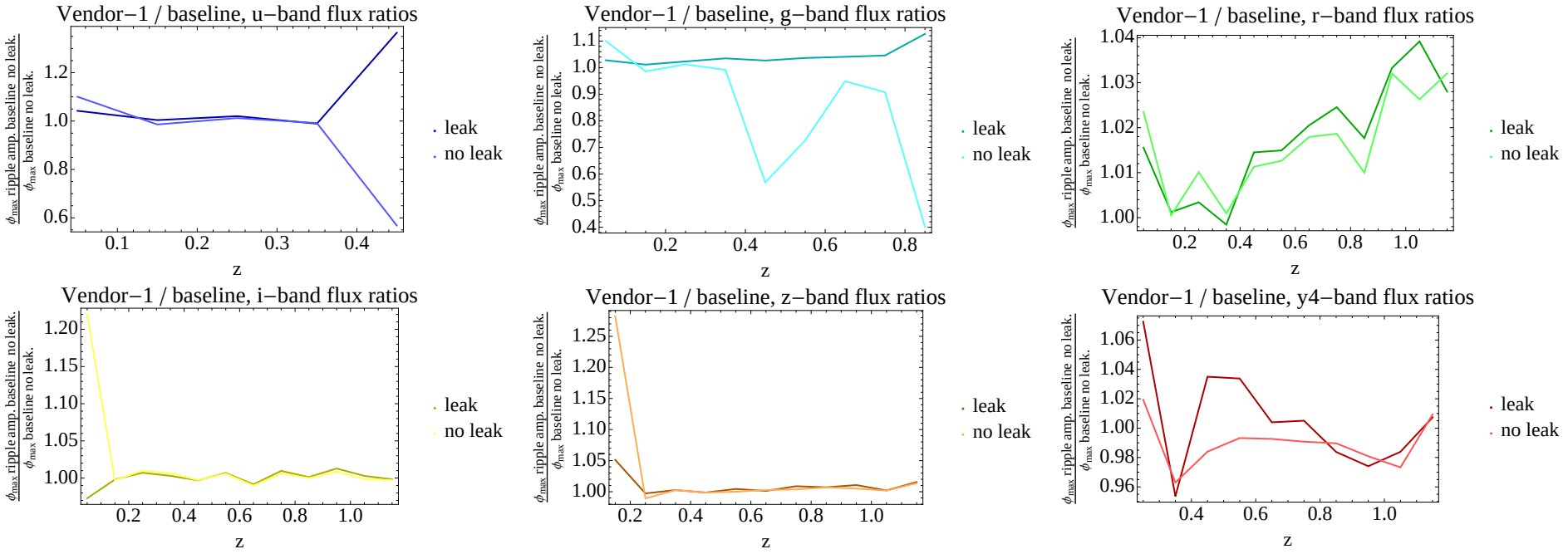
# Vendor-4 / baseline flux over redshift



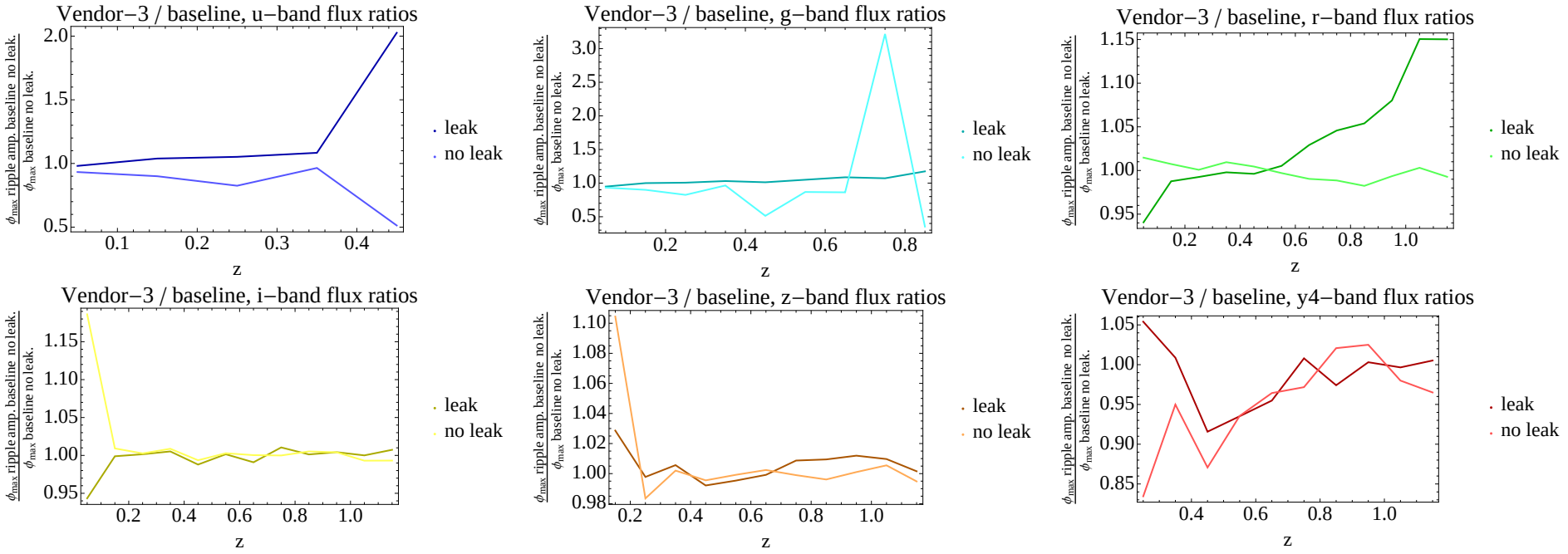
# baseline+ripple / baseline flux over redshift



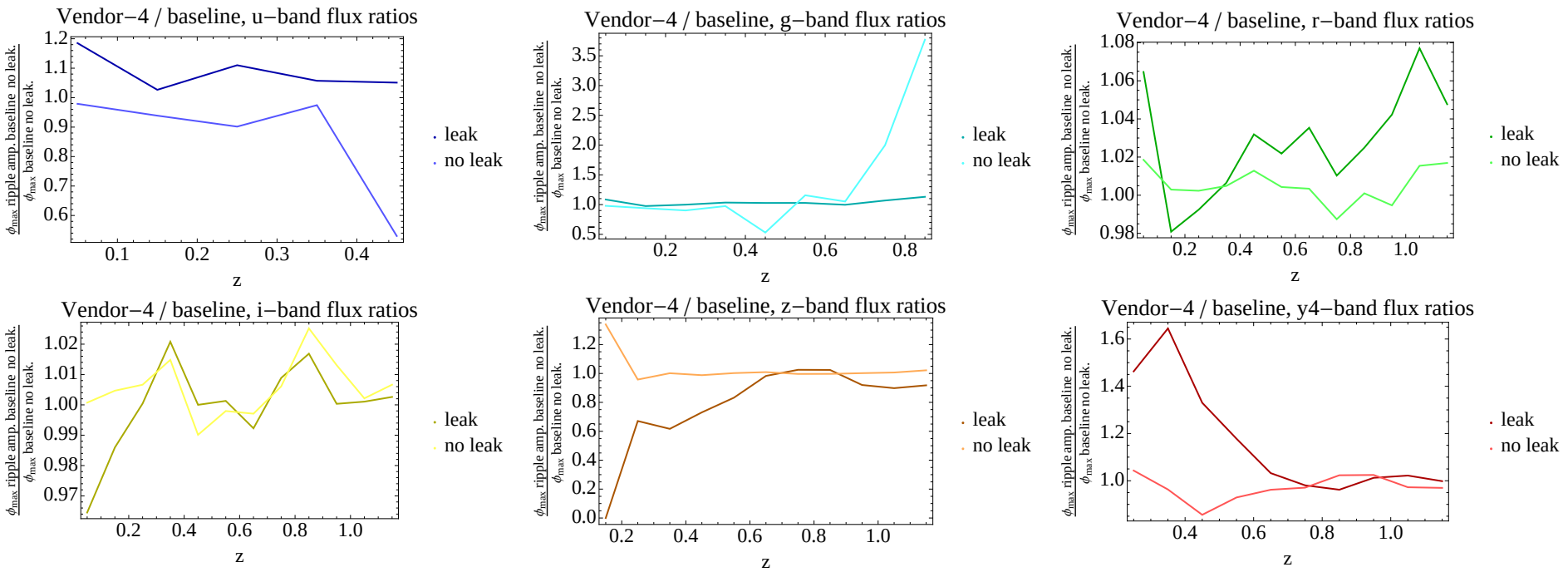
# Vendor-1 / baseline flux over redshift (without leakage)

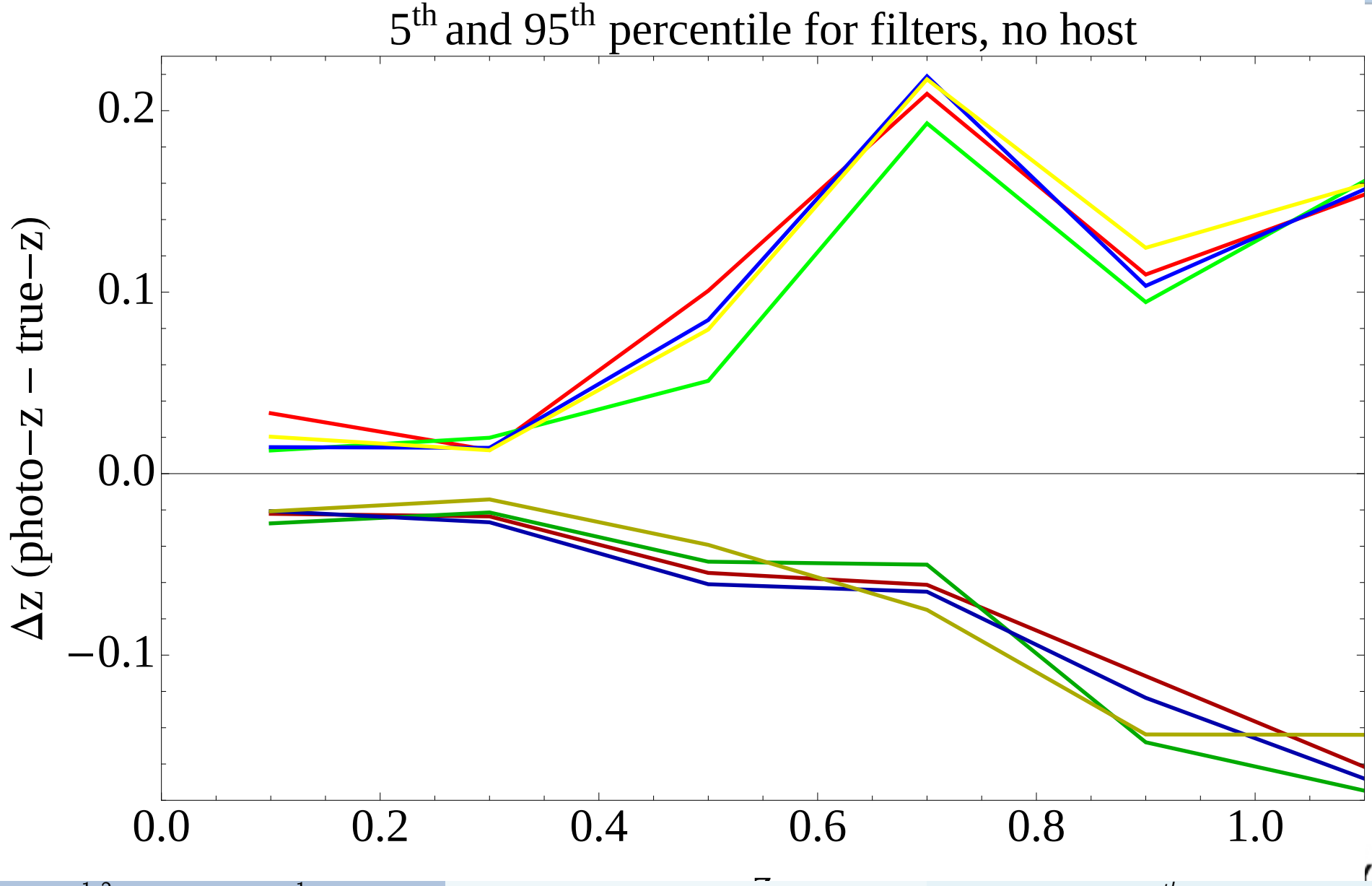


# Vendor-3 / baseline flux over redshift (without leakage)



# Vendor-4 / baseline flux over redshift (without leakage)




5th and 95th percentile for filters, no host
Δz (photo−z − true−z)
0.2
0.1
0.0
−0.1
0.0
0.2
0.4
0.6
0.8
1.0