

Hyper Suprime-Cam Medium Band Filters

Subaru User's meeting / 2023. Jan. 31-Feb. 2 @ NAOJ

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in collaboration with

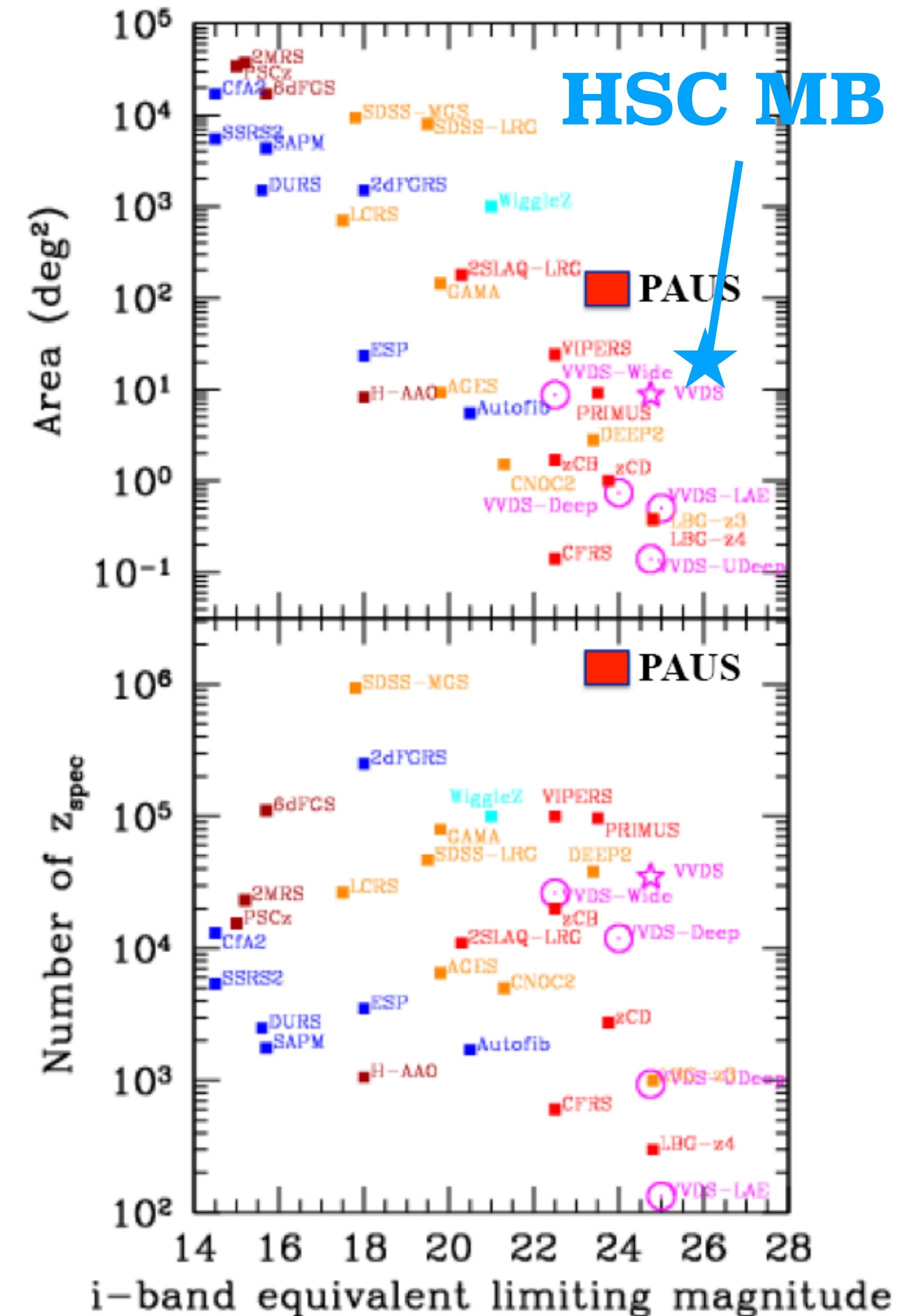
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D. Masters(Caltech), H. Miyatake(Nagoya)

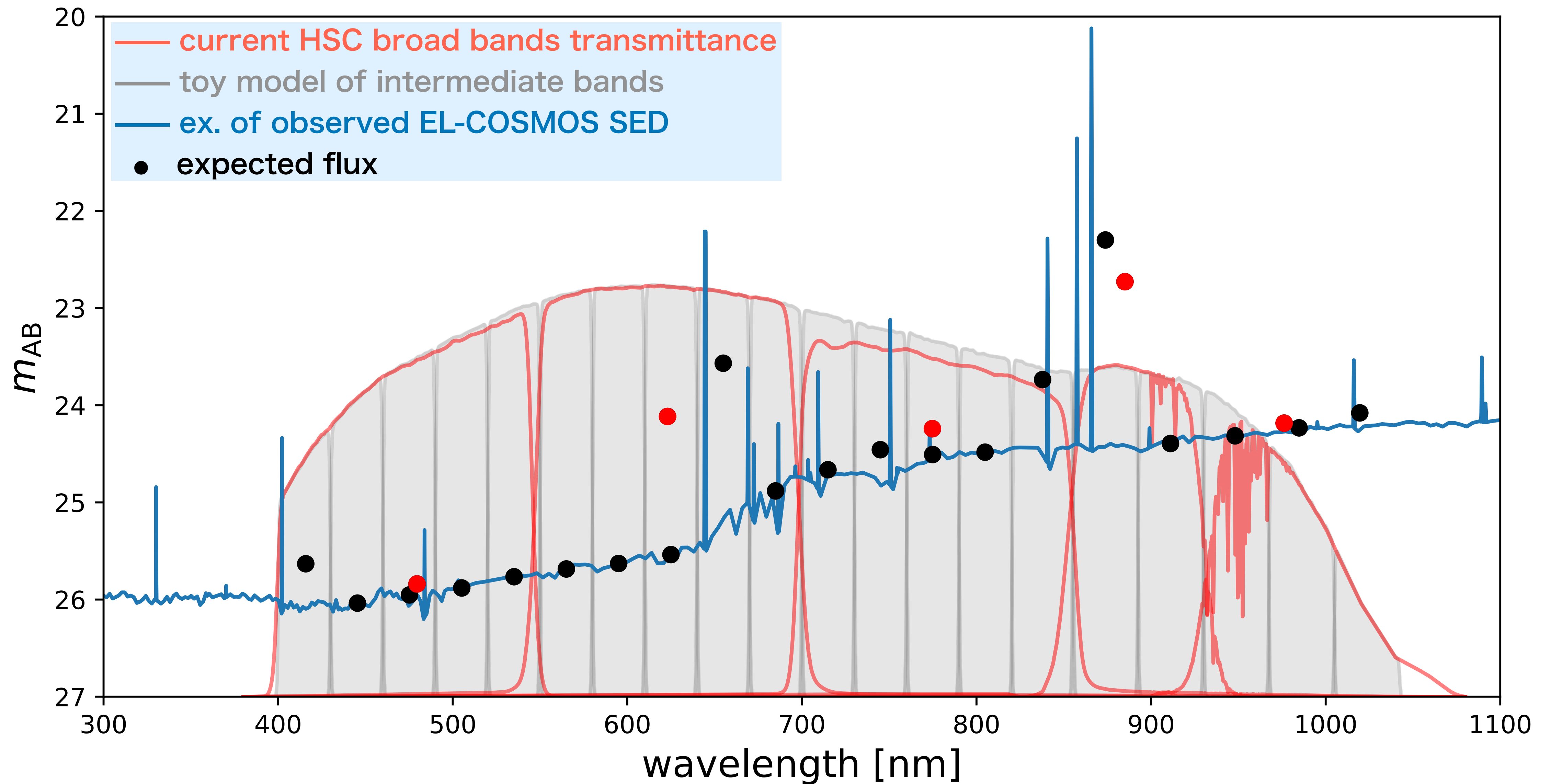
T. Yamamoto (Fujitoku Corp.)

Why Medium Bands?

- In the context of cosmology (or galaxy science), an accurate photometric redshift measurement/calibration is of great importance.
- next generation WL survey, **Roman**, **Rubin/LSST** will need a deep calibration sample for photo-z.
- **PFS** will play a central roll for that purpose but still unreachable to the truly faint sample.
- **HSC-MB** sample can go further deeper than **PFS** and any other spectroscopic surveys.
- Not only photo-z calibration, MB survey will offer a unique opportunity to test an idea of line intensity mapping survey. (e.g. **PAUS**, **SPHEREx**, etc.)



Medium bands spectrum : full spec

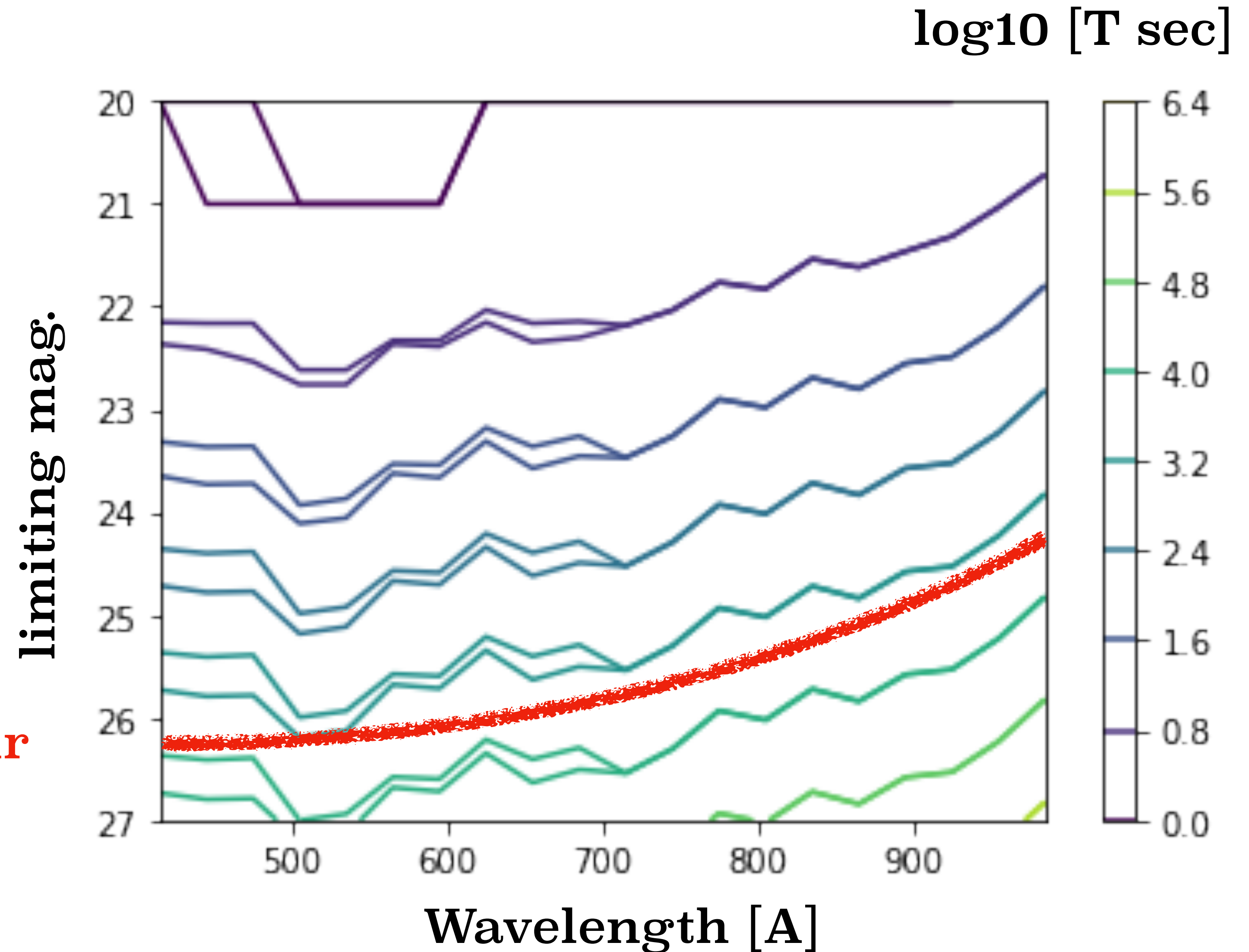


ETC

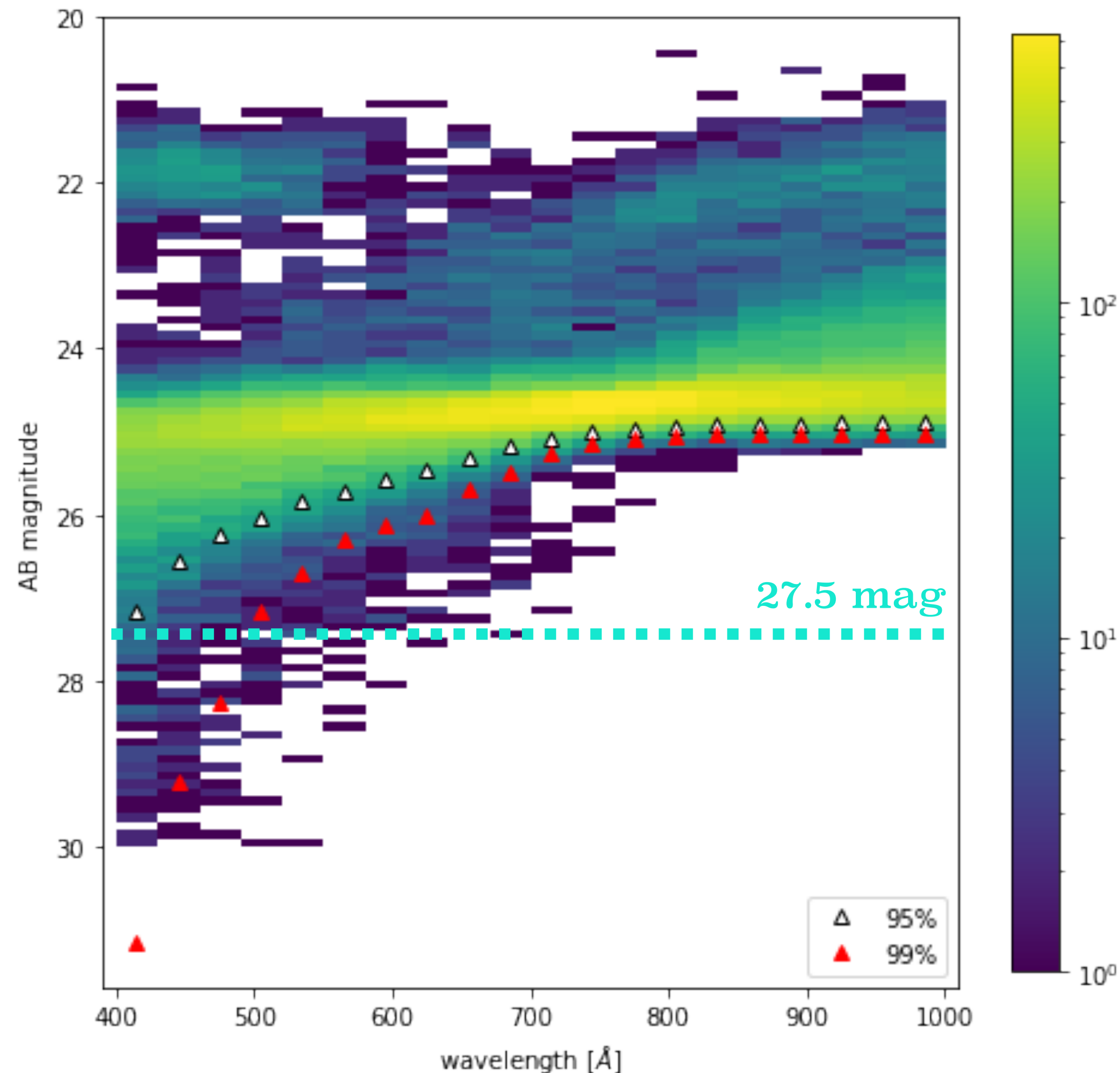
Conditions

- significance = 5 sigma
- 2" aperture point source
- transparency = 0.9
- seeing = 0.8"
- moon conditions
 - phase = 3 or 7
 - distance = 10, 30, 60 deg.

T_{exp} = 1hour



Expected time for EL-COSMOS sample



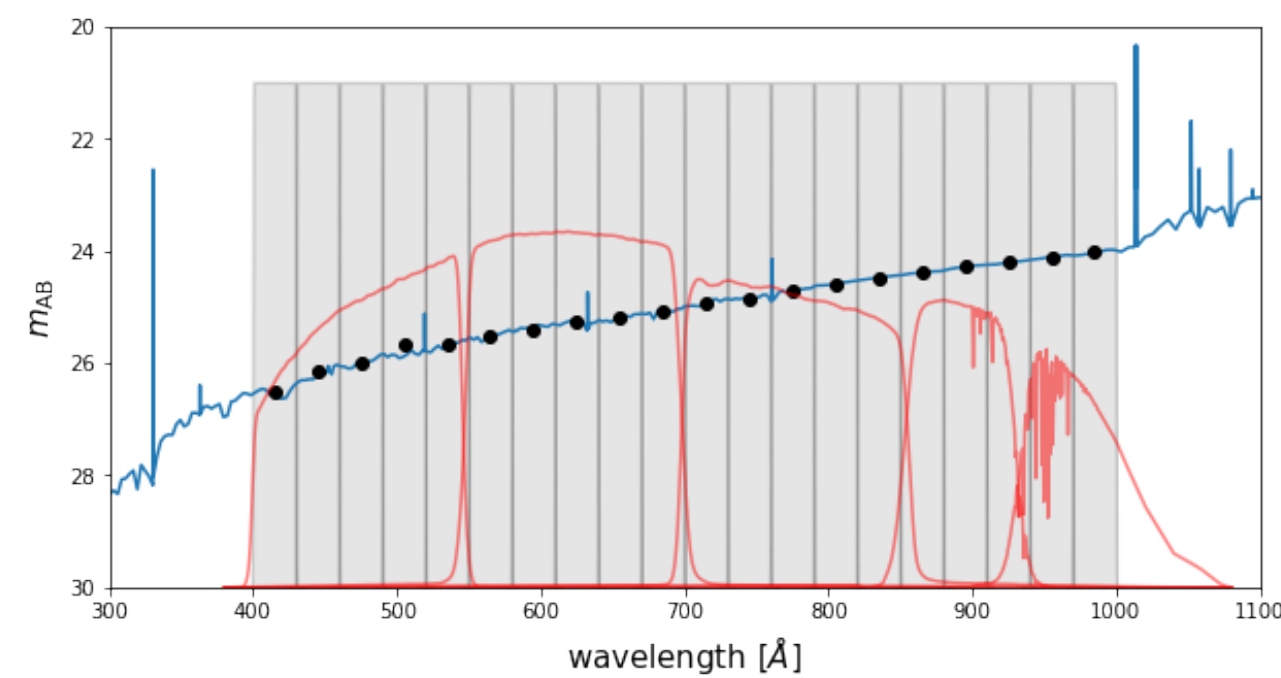
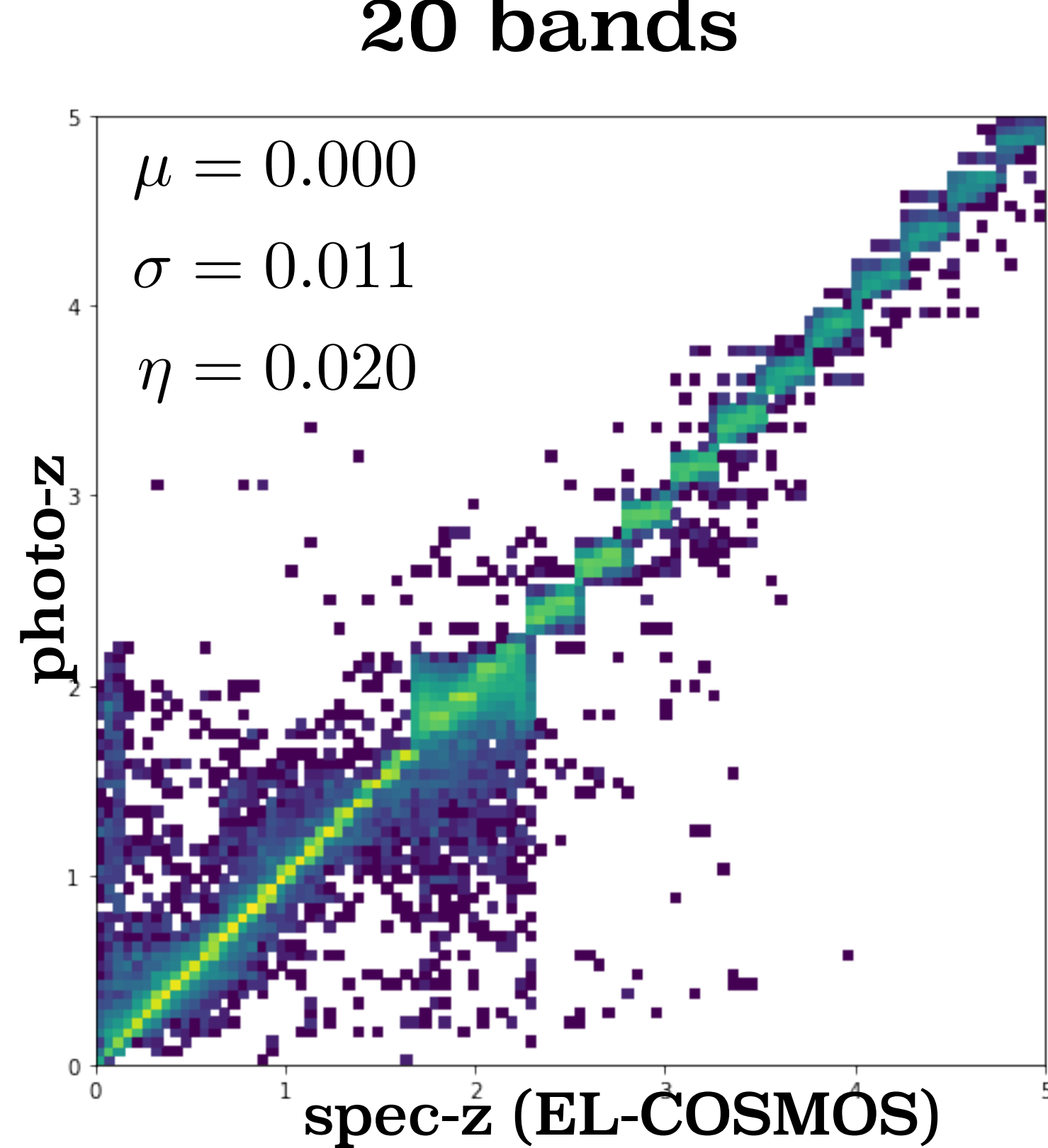
- EL-COSMOS (faint) sample
- Observed SED is converted to the expected flux at each IB filters
- How much fraction of objects we need to observe?
- (*) cut at 27.5 mag at bluer bands
- (**) assume 7 hours / night

nights(**)	95%	99%(*)
/FoV	2.3	4.4
/5 deg ²	7.7	14.7
/25 deg ²	38.3	73.3

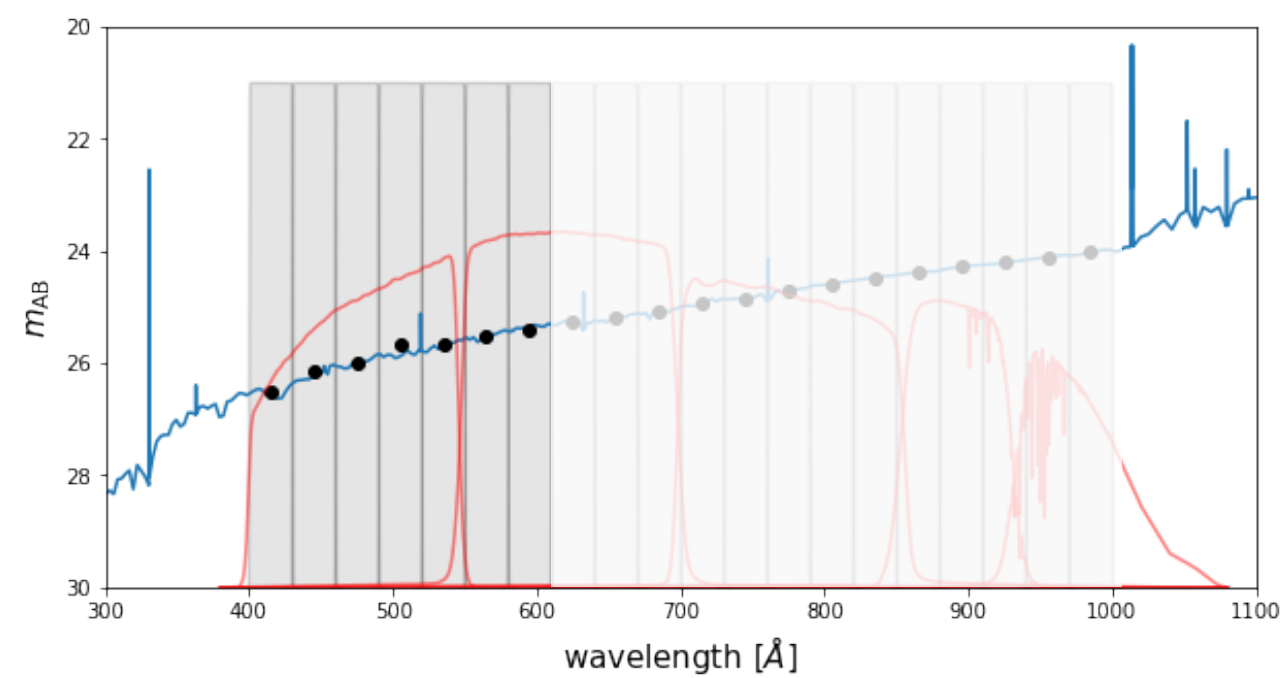
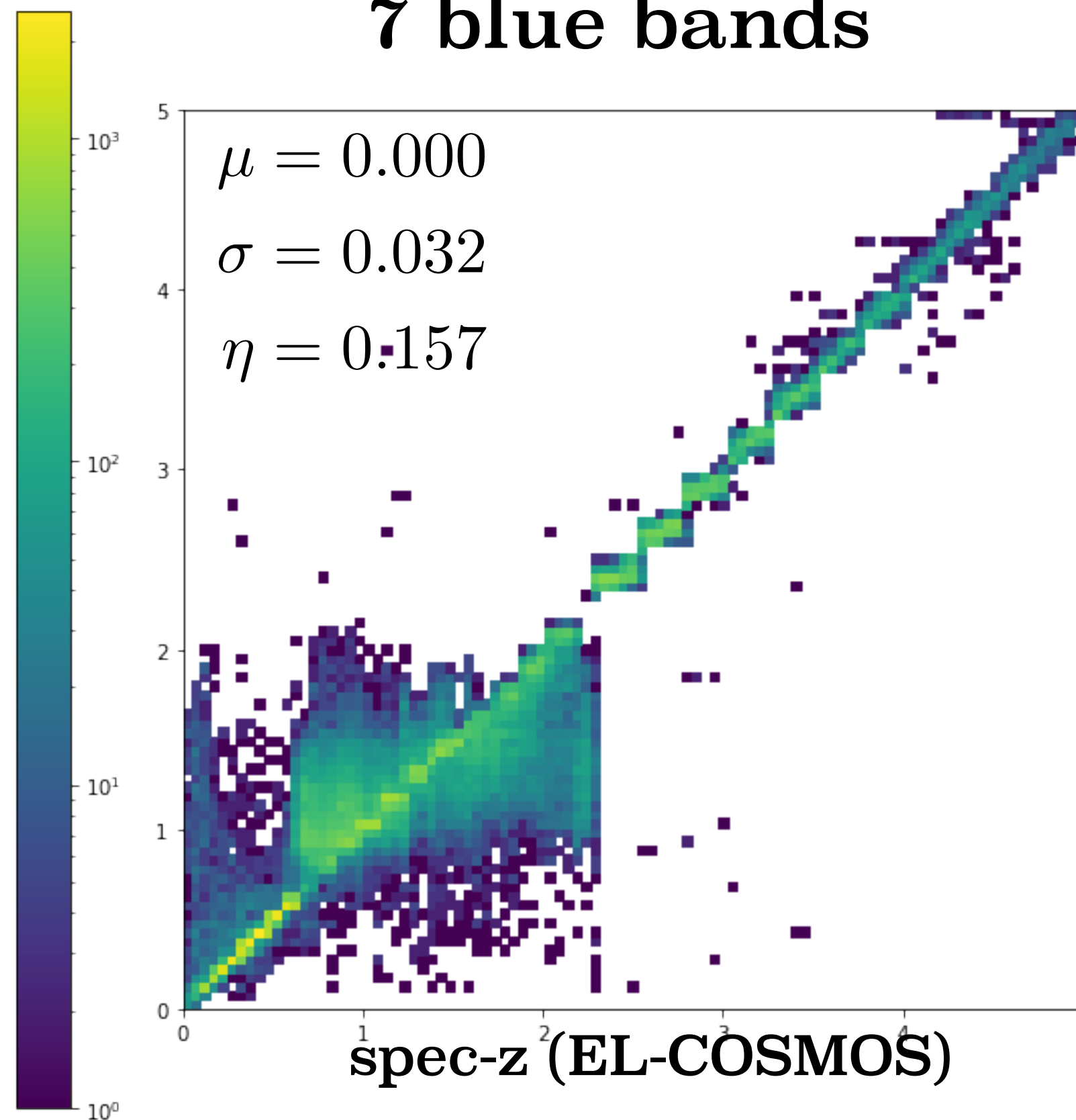
number of nights required

simulated photometric redshift

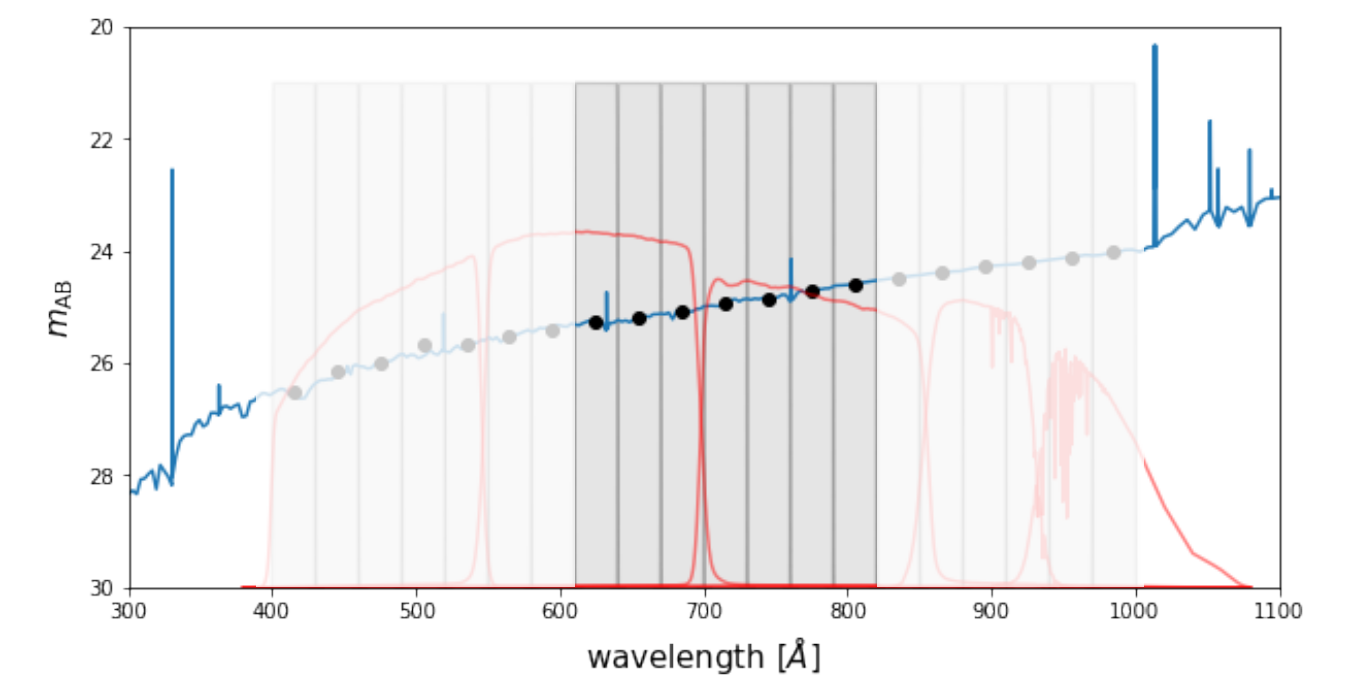
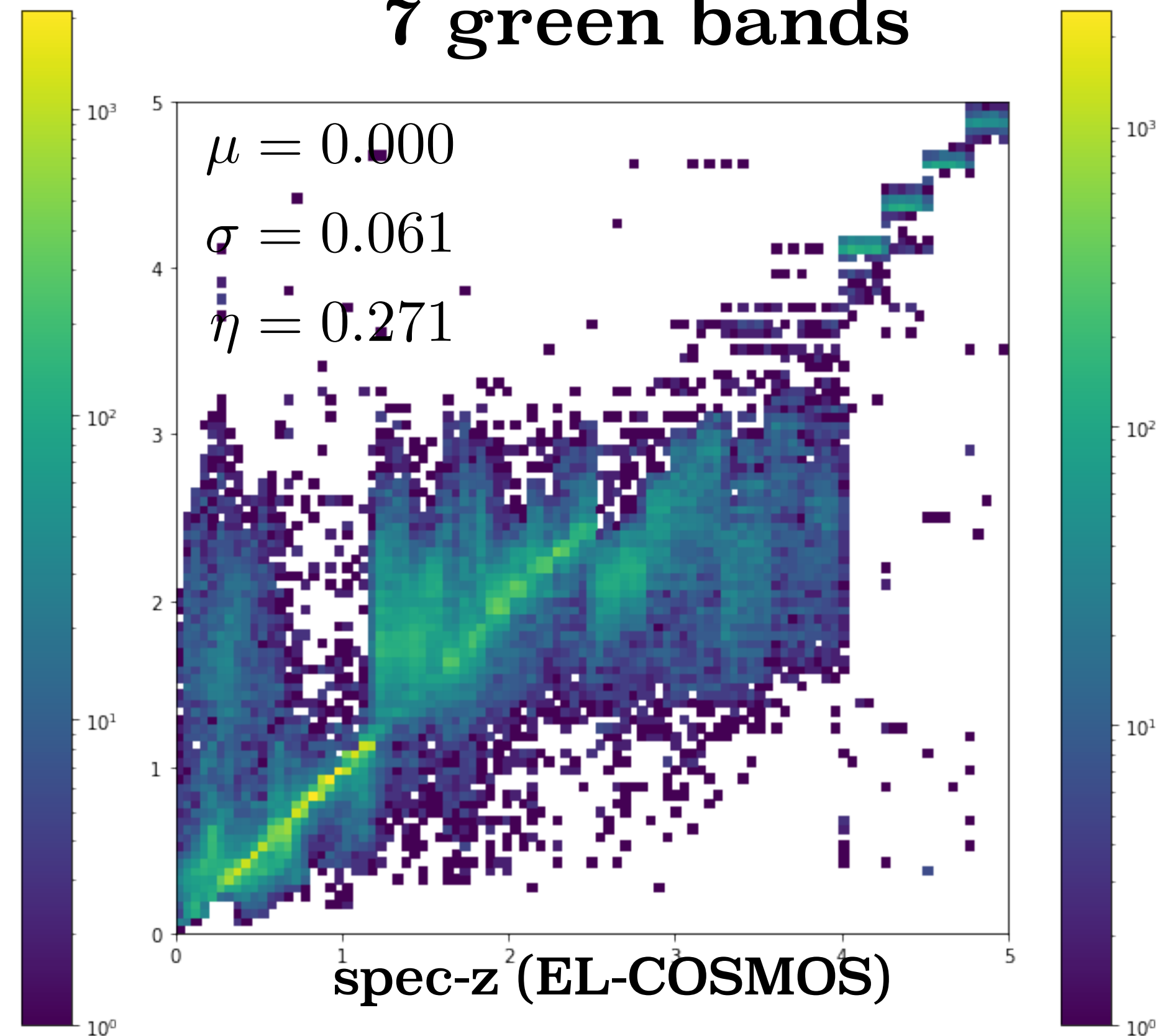
20 bands



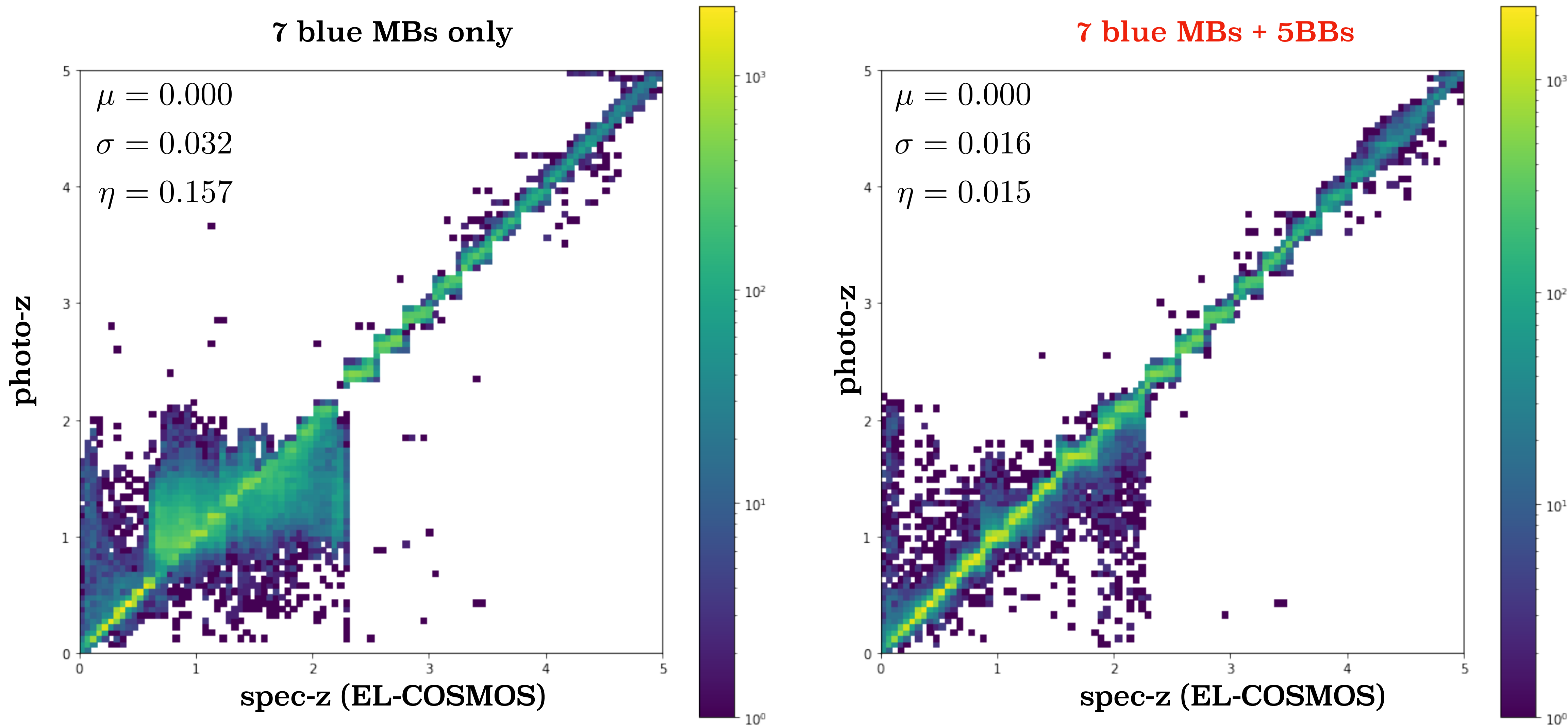
7 blue bands



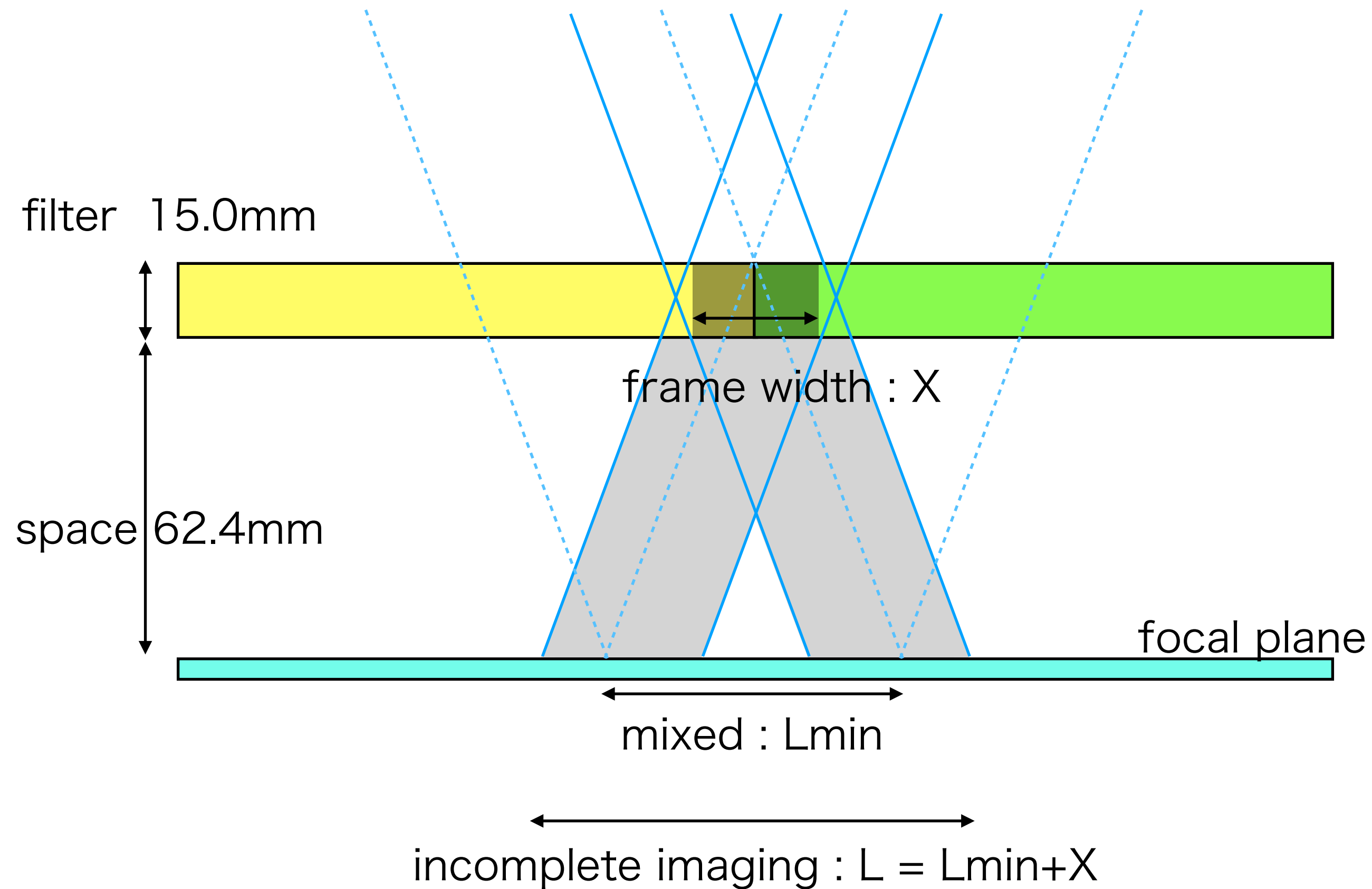
7 green bands



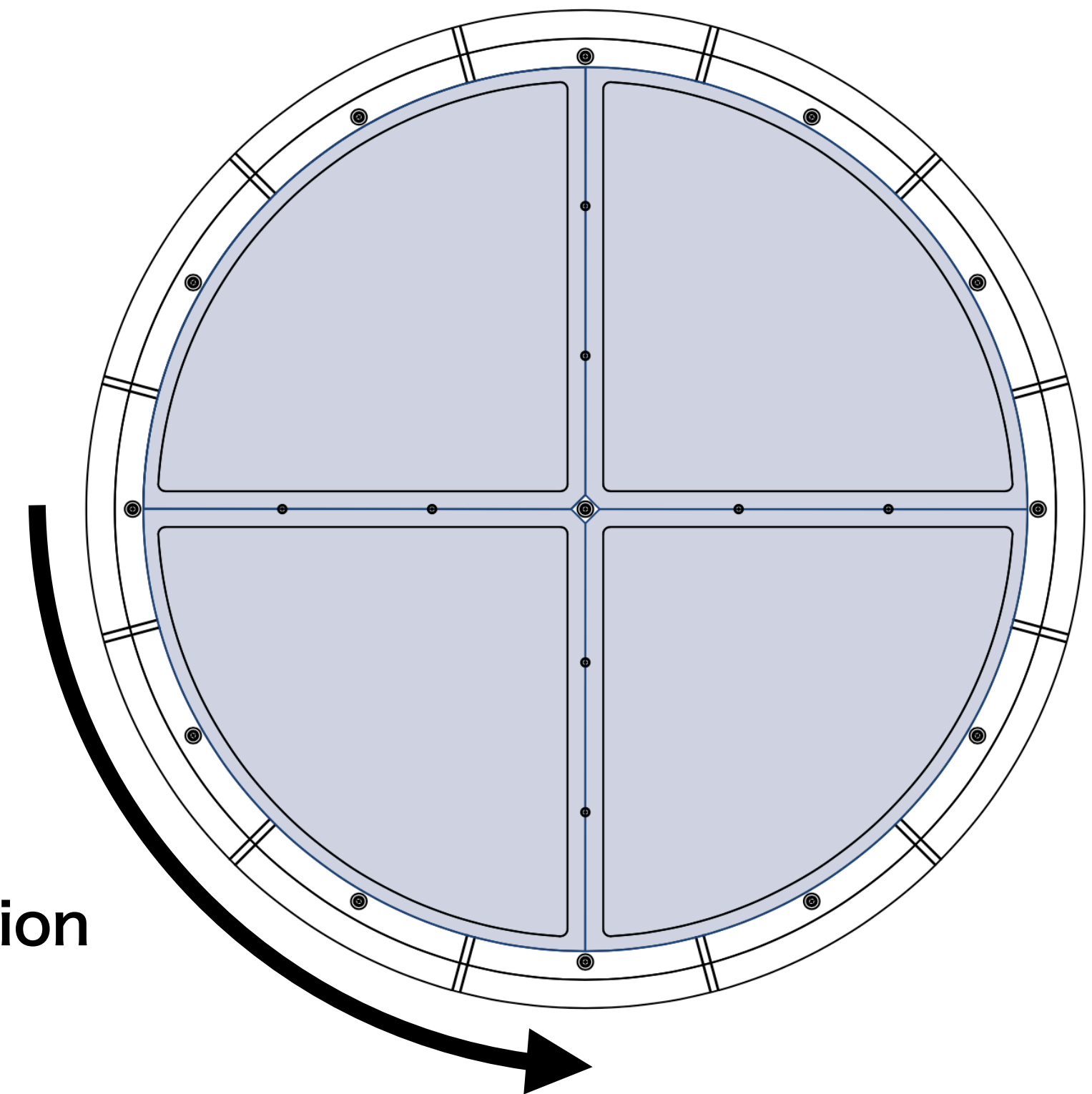
HSC 5 Broad Bands + 7 MBs



Implementation



- Four different wavelength filters at once
- significantly reduce the filter exchange time
- Effective area is ~80% due to the cross-frame



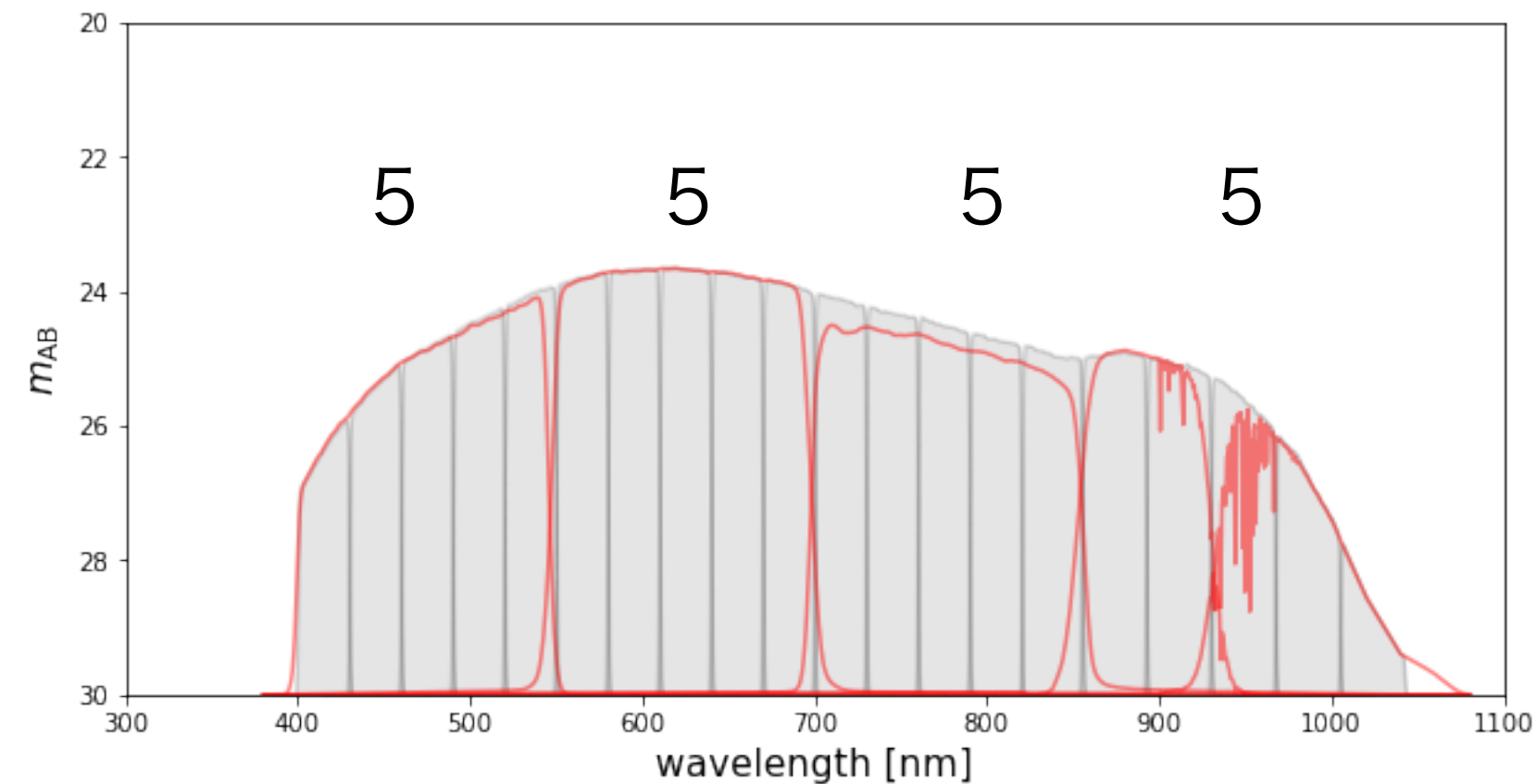
Filter (PA) rotation

c) Fujitoku (Materion)

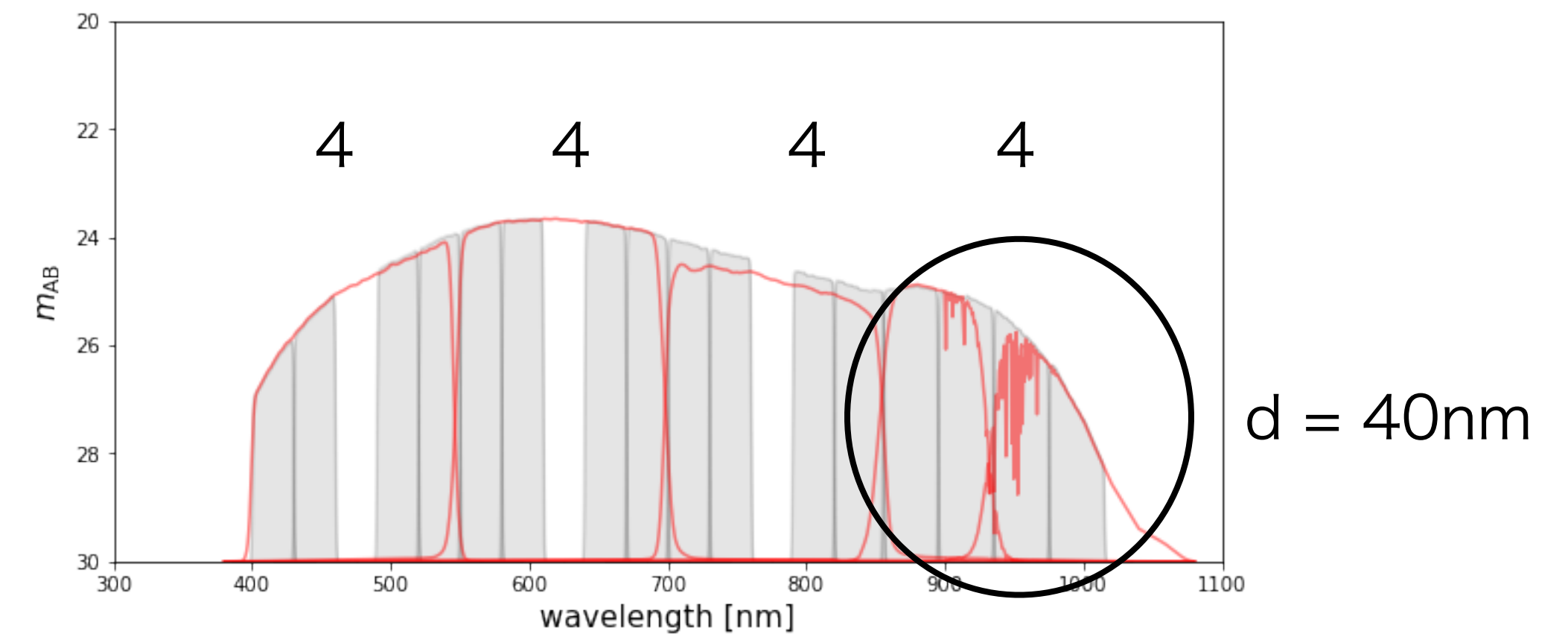
Alternative Filter designs (due to the “financial inflation”)

Currently only 8 filters are funded

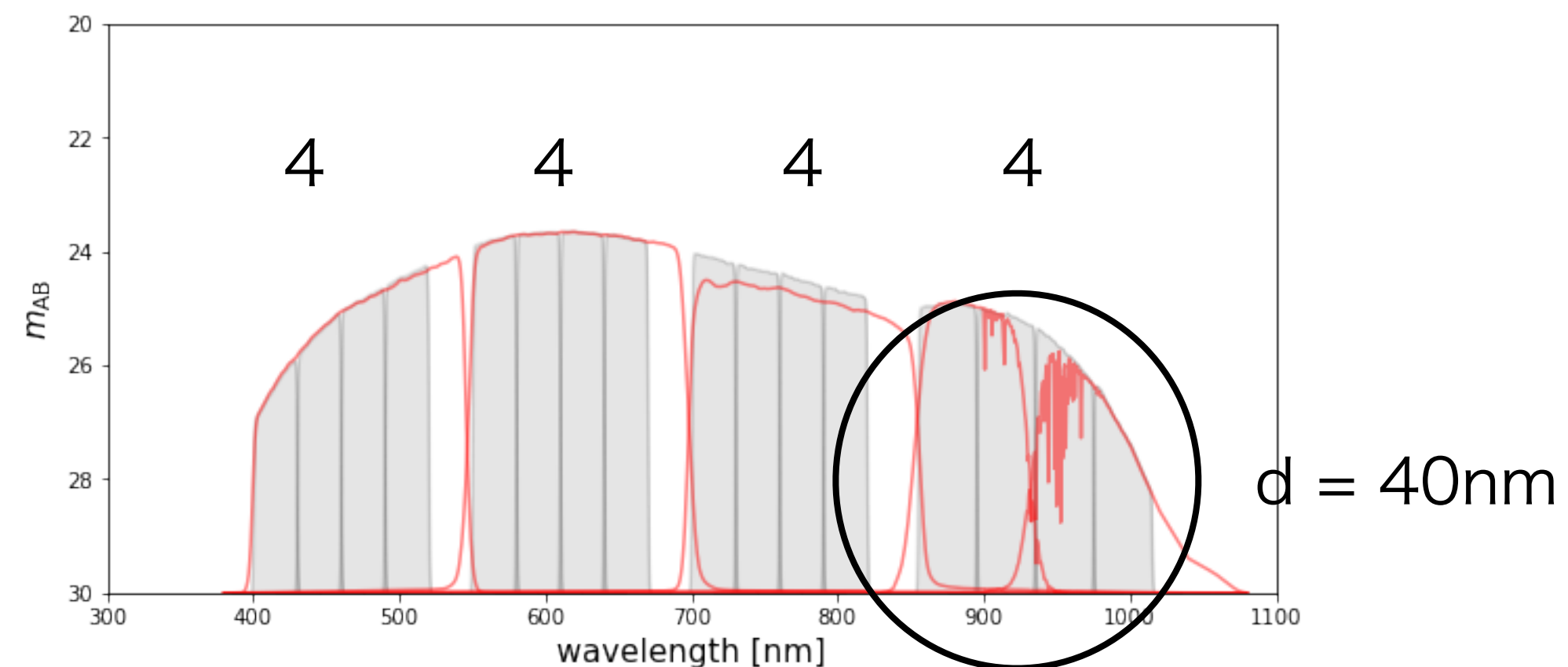
Which configuration will be better for photo-z for given short timescale?



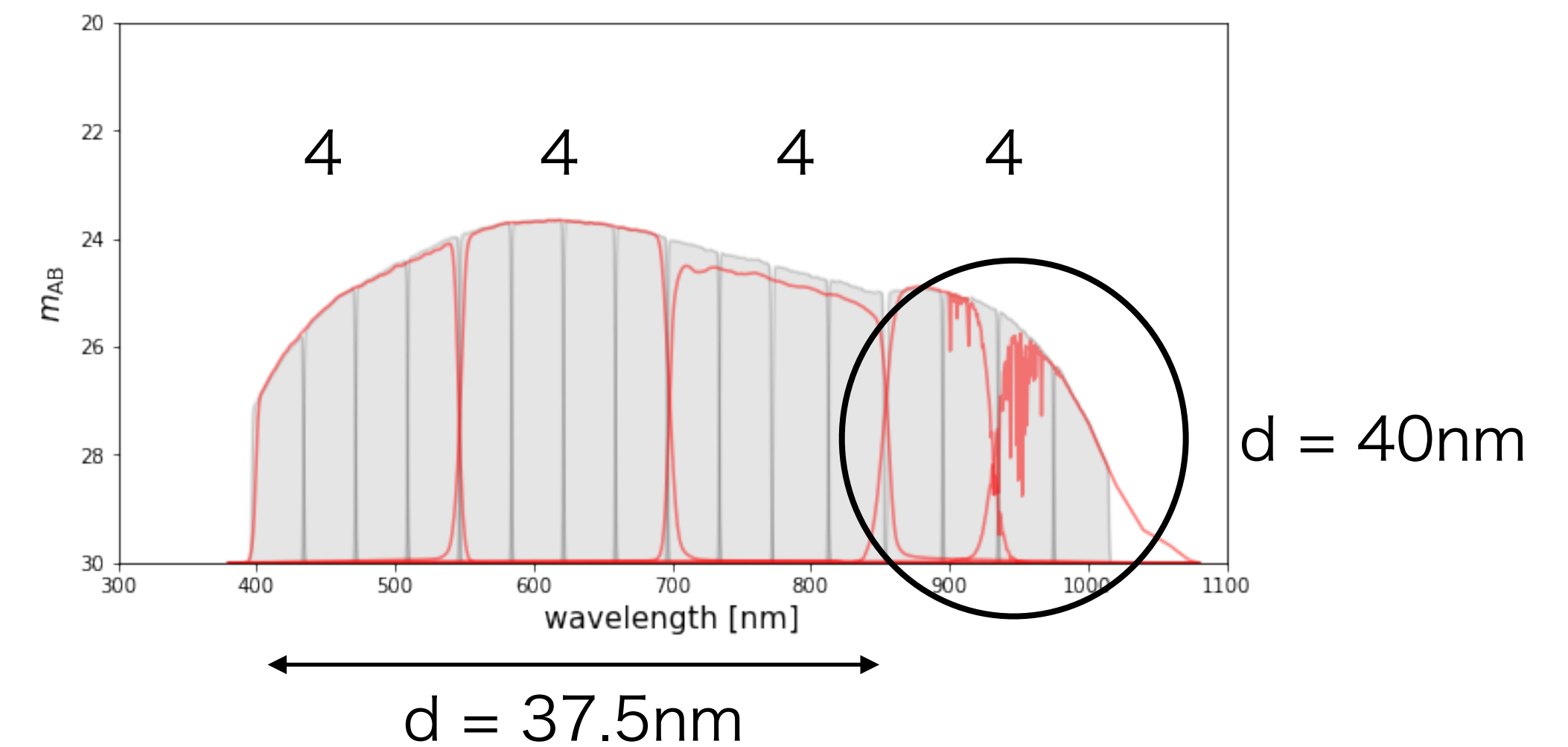
Ground design : 20 filters with $d=30\text{nm}$



sparse design : skip middle filter in each segment



sparse design : skip edge(redder) filter in each segment



Summary

- To complete the EL-COSMOS (faint) sample, we need
 - shallow case : 2 nights/1.5deg² (95%) = 40nights/25 deg²
 - deep case : 4 nights/1.5 deg² (99%) = 30nights/10 deg²
- Photo-z of 20 MBs is quite accurate
- Photo-z with 7 MBs + 5BBs is still high accuracy (sigma~1.5%, outlier~1.5%)
- Currently, all the photo-z calibration fainter than $i > 24.5$ mag highly depends on COSMOS-30 band photo-z.
- HSC-MBs photo-z can push the limit to $i \sim 26$ mag, which may be relevant to Roman/Euclid/LSST surveys.
- If you come up with a good science cases with this MB filters, please let me know.