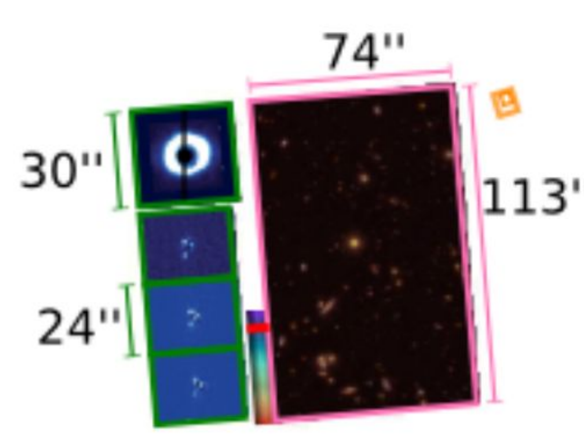
# JWST/MIRI: Insights into distant obscured AGN in deep surveys

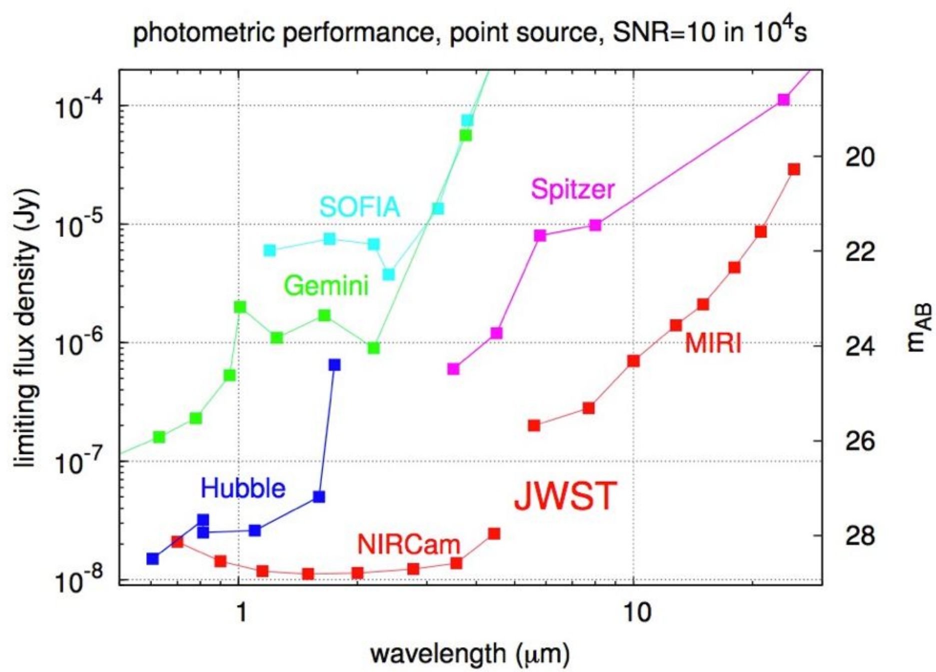
# MIRI will open a new window for distant galaxies

JWST/MIRI will be **~10-100 times more sensitive than Spitzer**

The MIRI PSF has **FWHM=0.24” (8 μm)**, ~8 times better than Spitzer

MIRI has **continuous coverage in 5-28 μm**



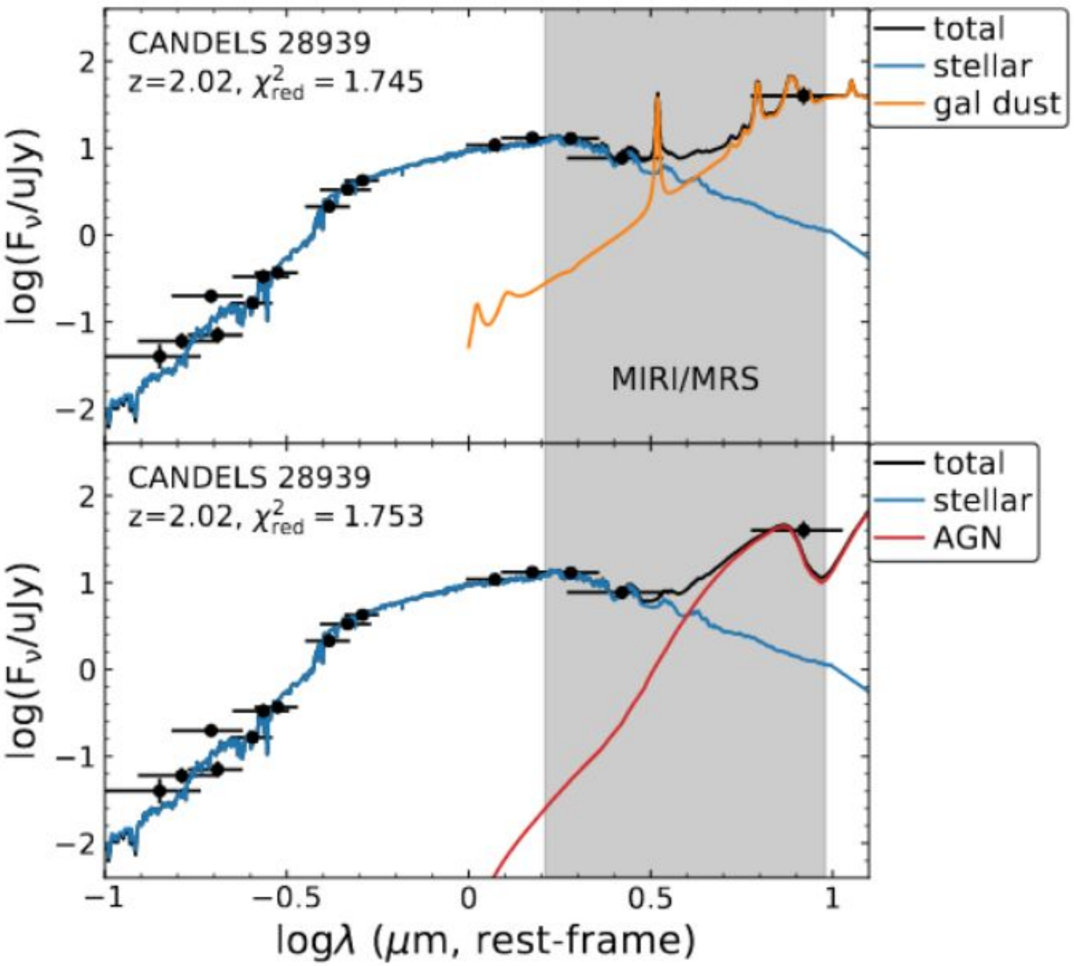



# The importance of continuous wavelength coverage

The current Spitzer data has a “gap” between 8 and 24 μm

This leaves large room for **model degeneracy**

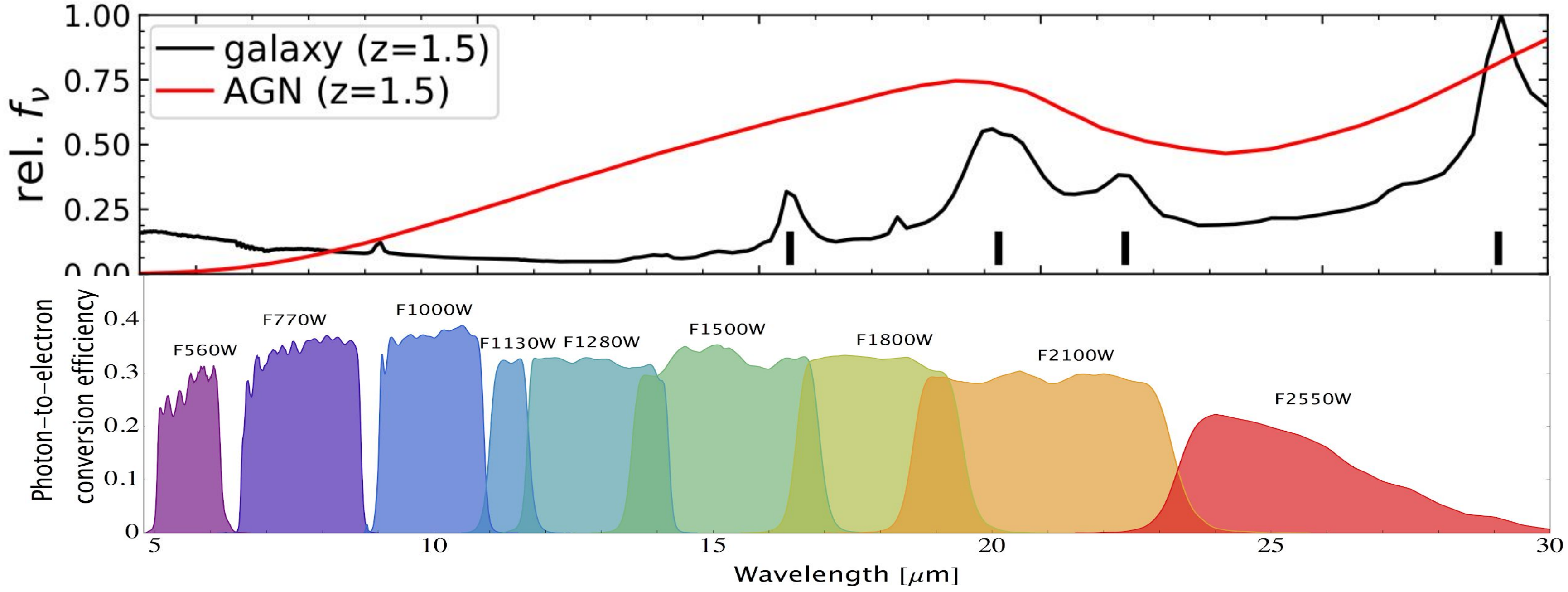
Observed mid-IR data can be either fitted by AGN of galaxy dust



# MIRI will open a new window for distant galaxies

MIRI will have **continuous coverage for 5-28 μm**

It will capture **AGN dust** & galaxy polycyclic aromatic hydrocarbon (**PAH**) emission (potential z indicator)



# Cosmic Evolution Early Release Science (CEERS) Survey (PI: Steve Finkelstein)

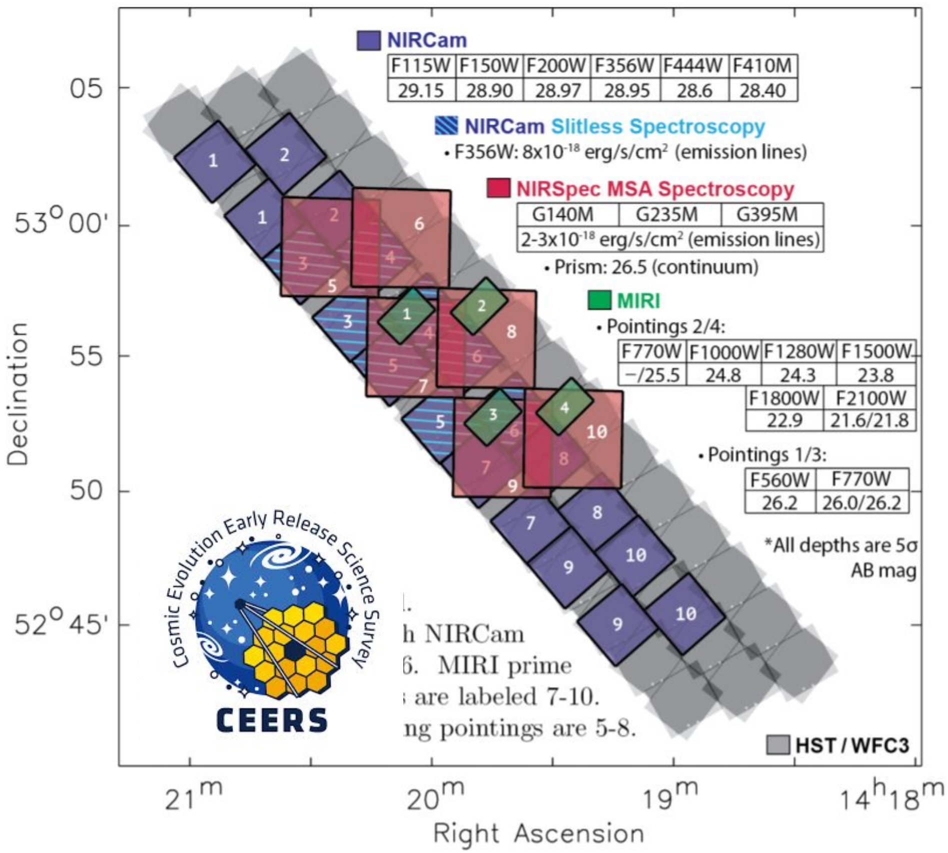
~ 100 arcmin$^2$ JWST coverage at EGS

Involving NIRCam & MIRI imaging, NIRSpec & NIRCam spectroscopy

Four MIRI pointings:

- Two blue with F560W & F770W

- **Two red from F770W/F1000W to F2100W**



# Our work (Yang et al. submitted)

Simulating one of the red MIRI pointing of CEERS

6 bands from F770W to F2100W

1665 seconds/band (except for F2100W: 4662 seconds)

Based on **real sources** (SED & morphology) selected by HST/F160W

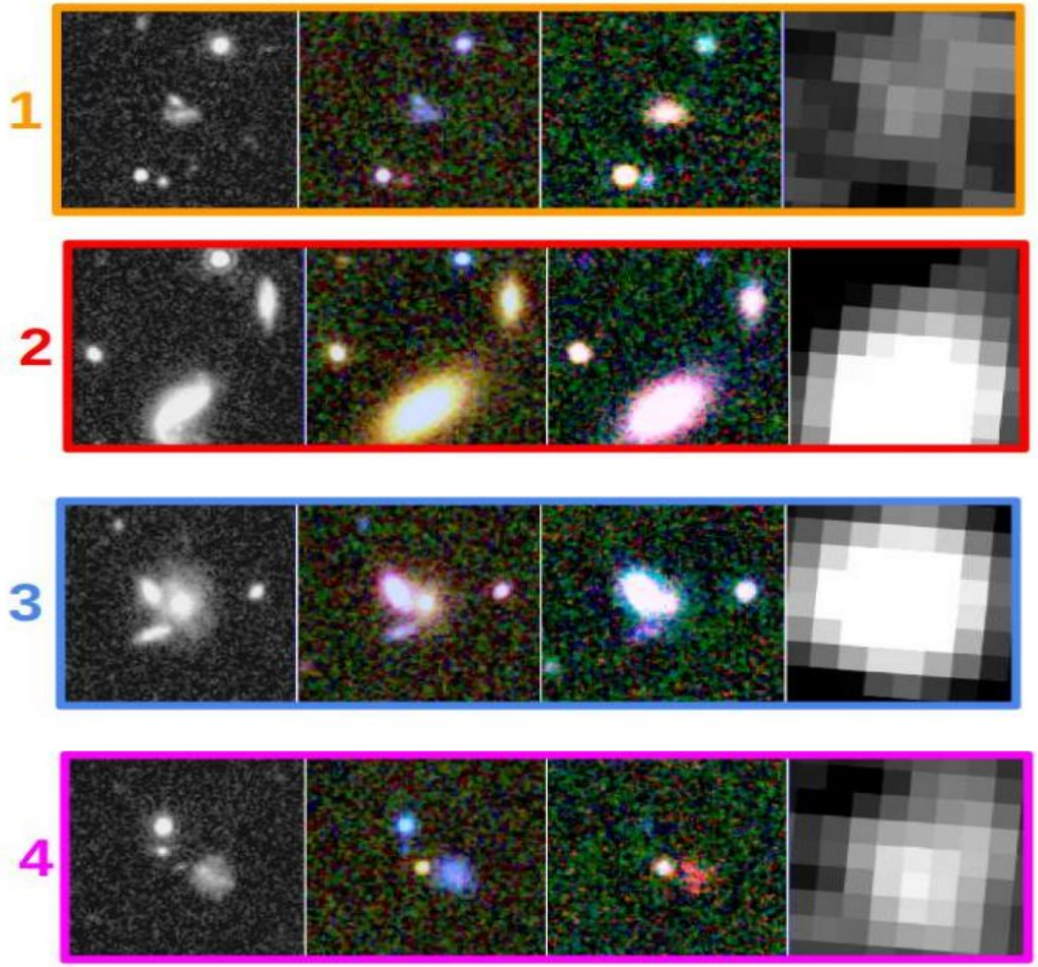
Simulating with MIRISIM (**raw level 0 data**), and then pass through JWST pipeline

# The simulated MIRI pointing (RGB)

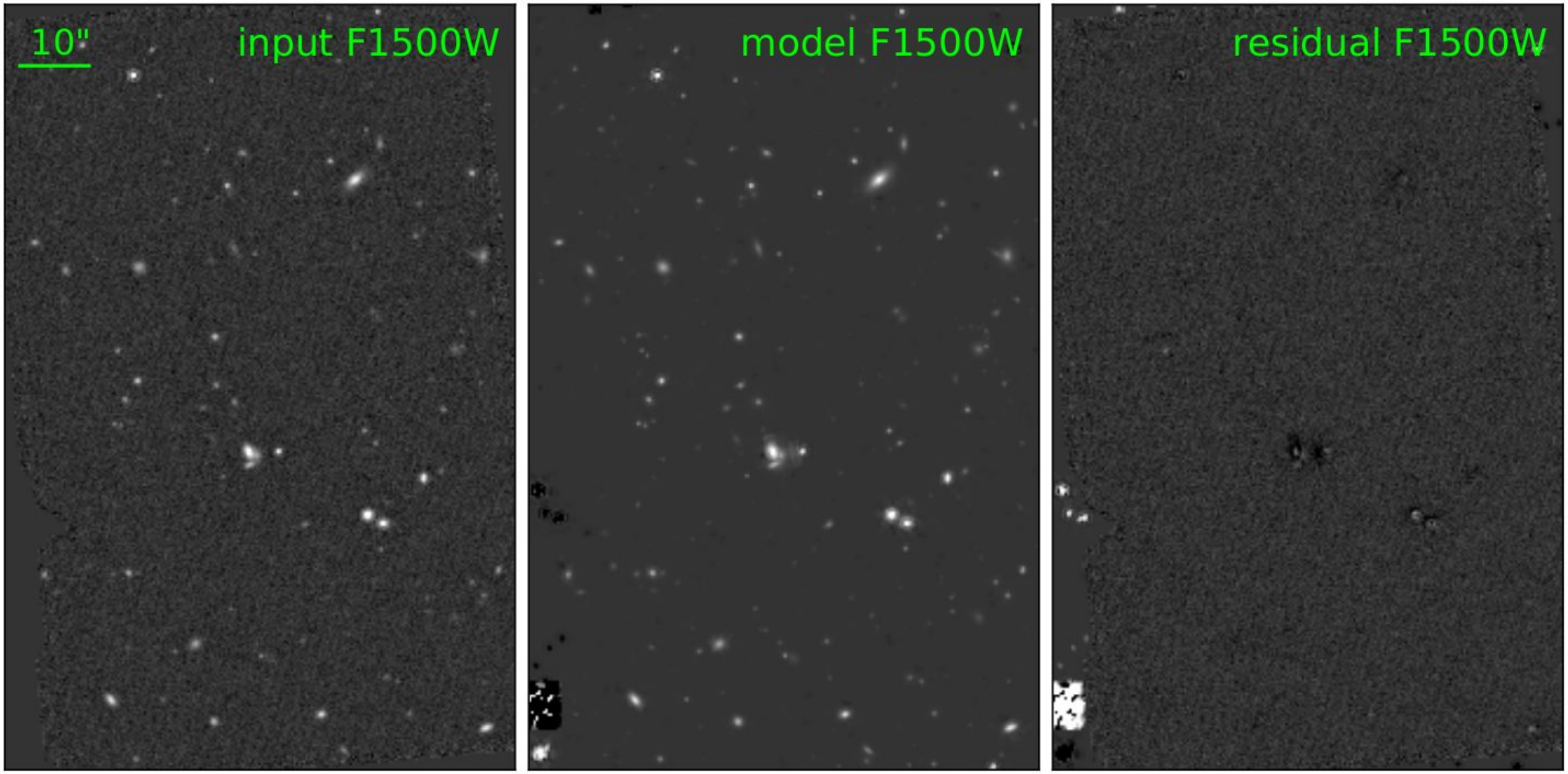
# Zoom-in view

**Mid-IR colors** are clearly revealed

**Mid-IR morphologies** are visible (we adopt smooth Sérsic profiles but more complicated shapes like clumps are expected in real data)



# Perform PSF-matched photometry with TPHOT

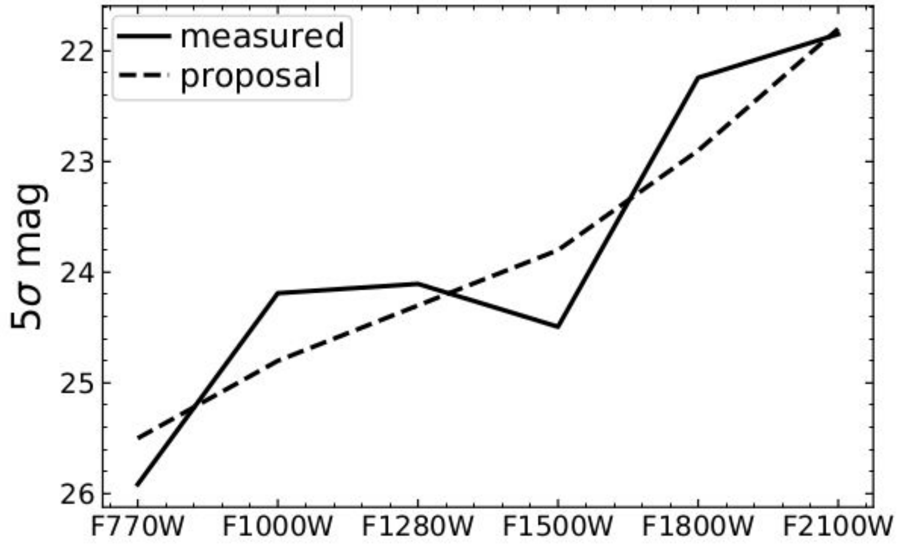


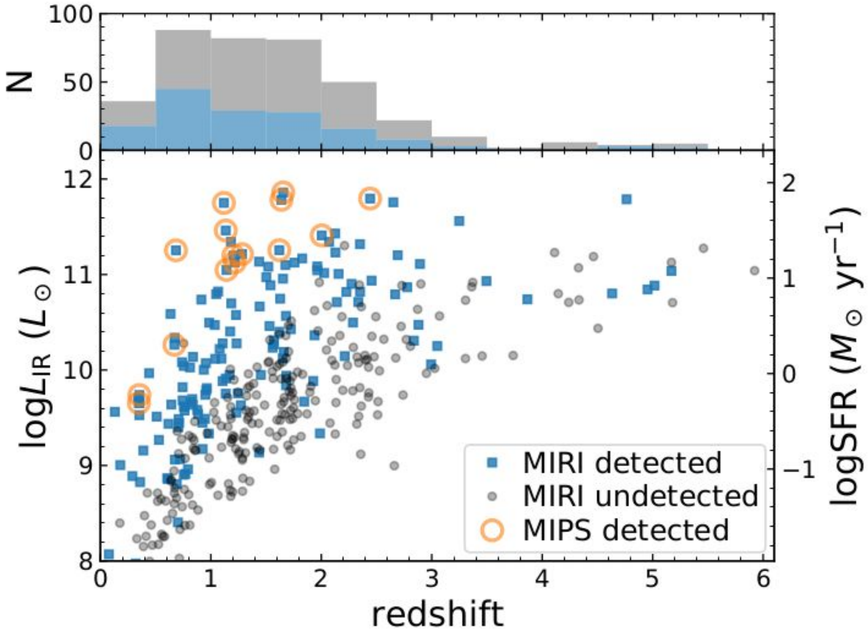
# Photometry performance

Achieving 5σ depths similar to those ETC-estimated

MIRI will detect $L_{IR}$/SFR down to a very low level (e.g., **~$10^{10}$ $L_{\odot}$ or 1 $M_{\odot}yr^{-1}$ at z=2**)

Can even detecting **a few z~5 sources** in a pointing



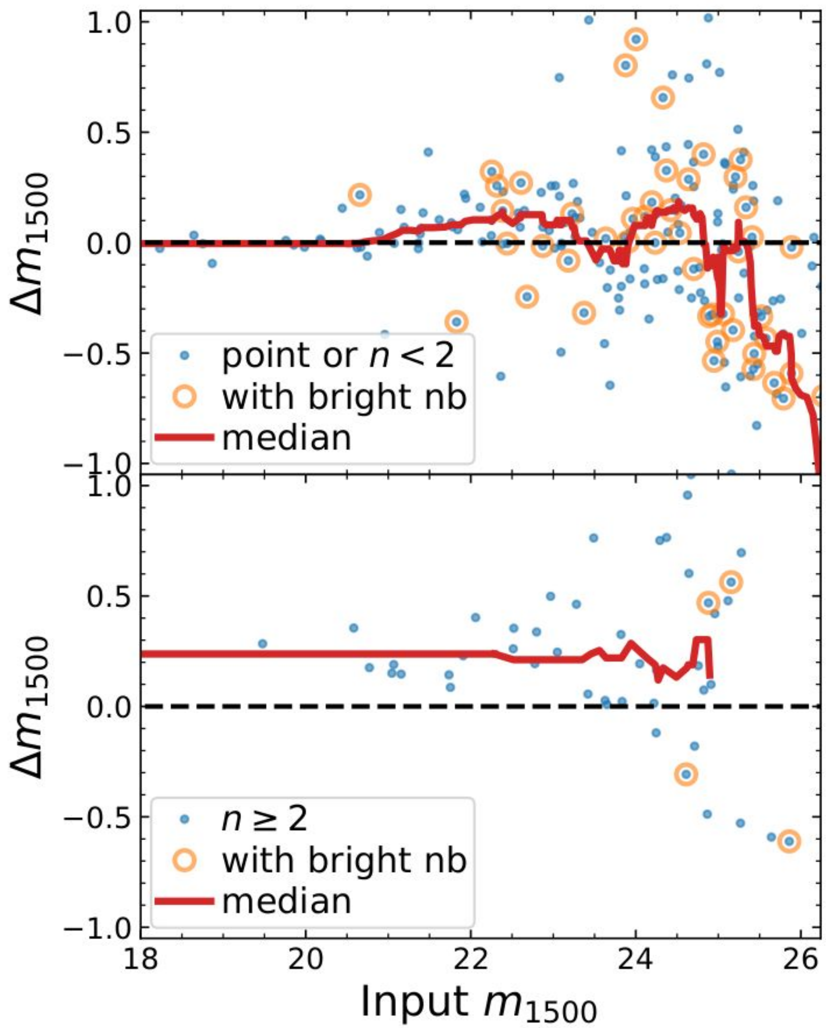



# Dissecting photometry errors

**Source crowding is not a problem**: only $\lesssim$15% have bright neighbors

**Morphology matters**: the measured magnitudes are systematically fainter for Sérsic n>2 sources

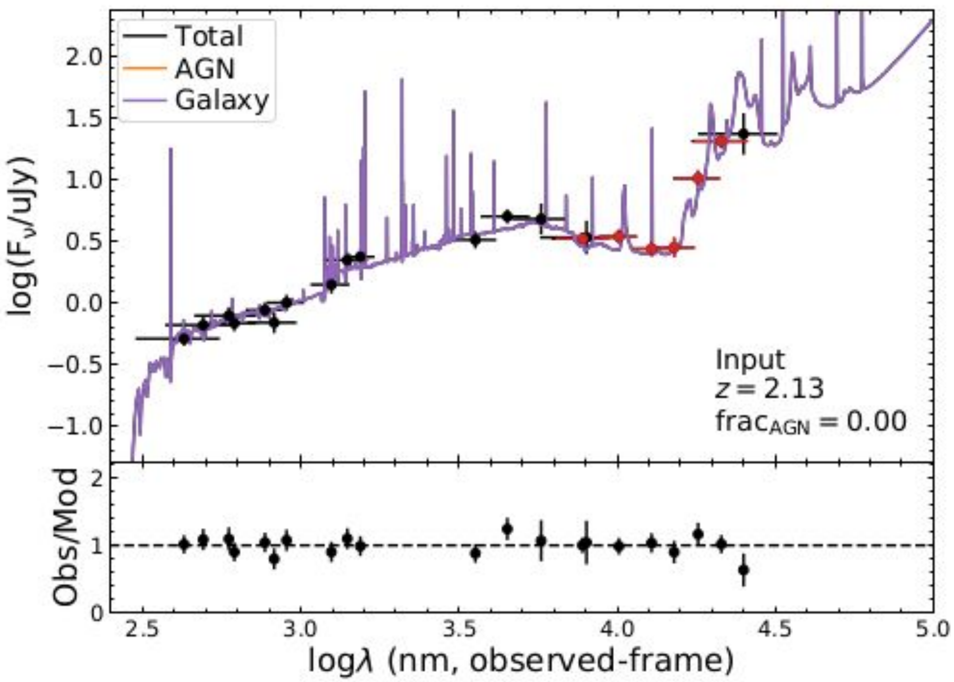
Likely due to their extended wings

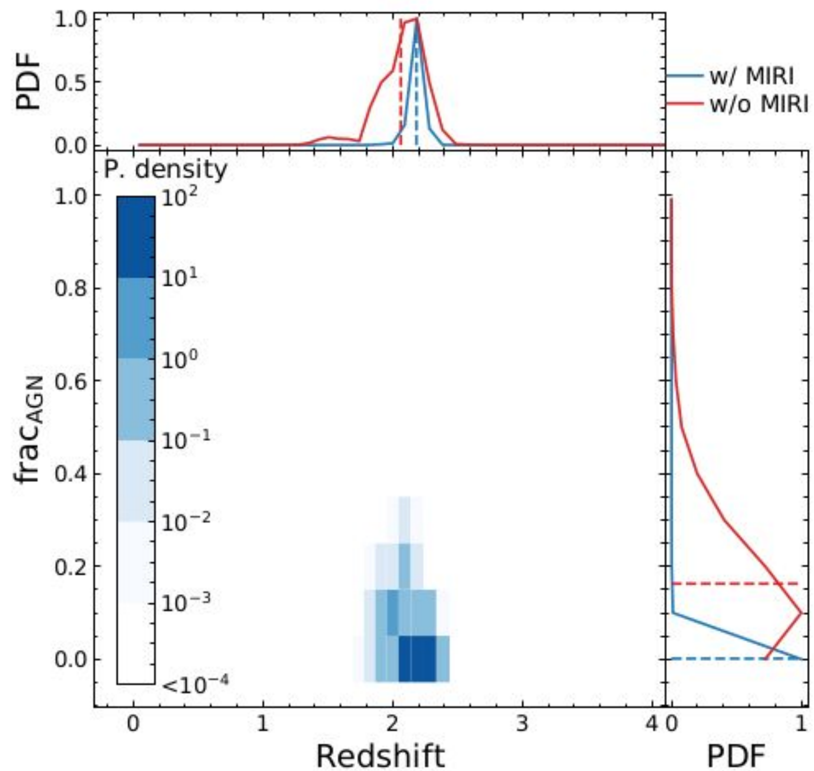


# SED fitting with X-CIGALE (Yang+2020)

**Simultaneously fitting redshift** and other galaxy properties

Take full advantage of **all available data**: MIRI + others



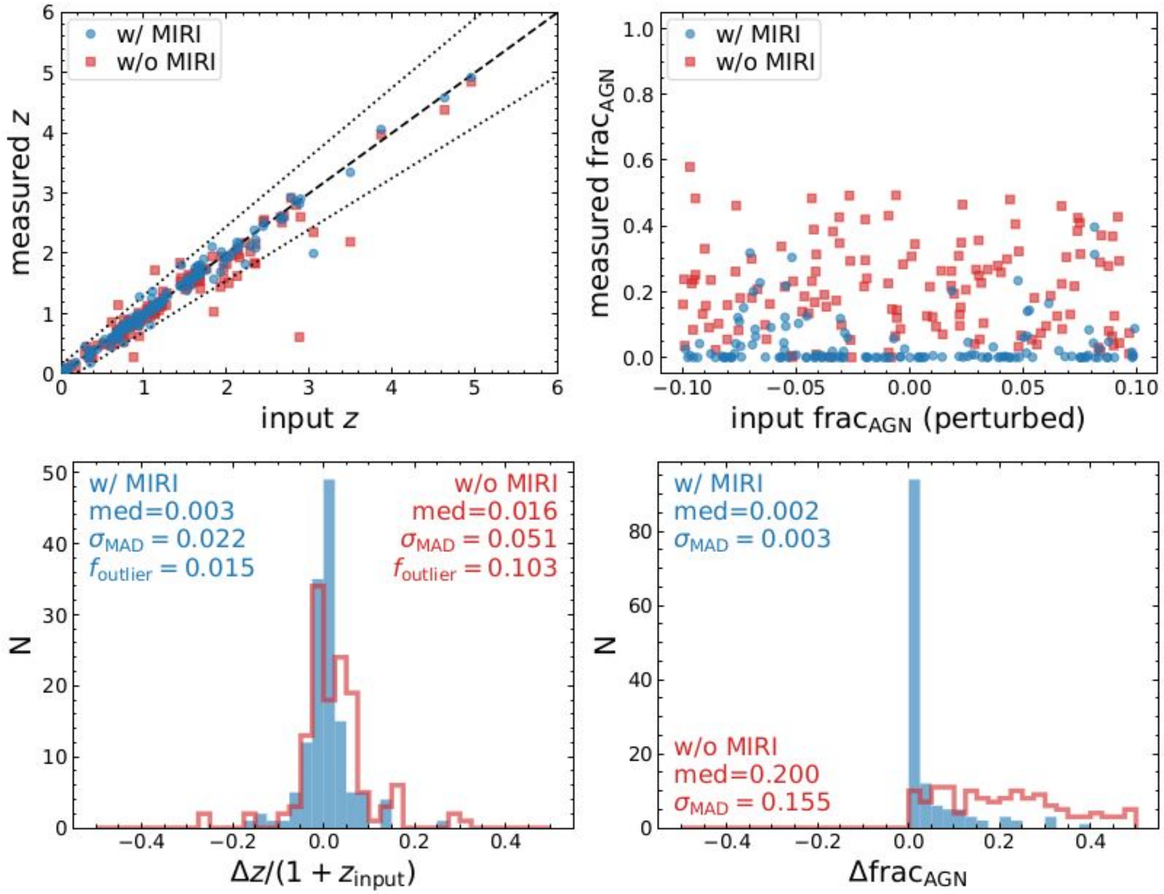



# Quality assessment: fitted vs. true (model)

Adding MIRI, the **redshift scatter (outlier)** has been reduced by 2 (7) times

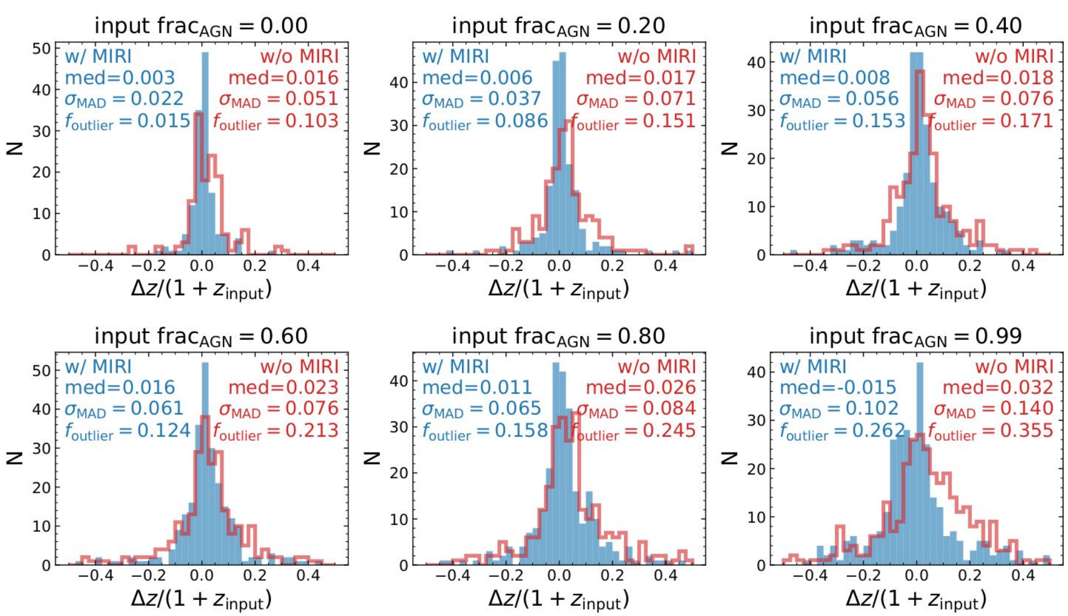
The accuracy of **$frac_{AGN}$** is improved by a factor of **~100**!

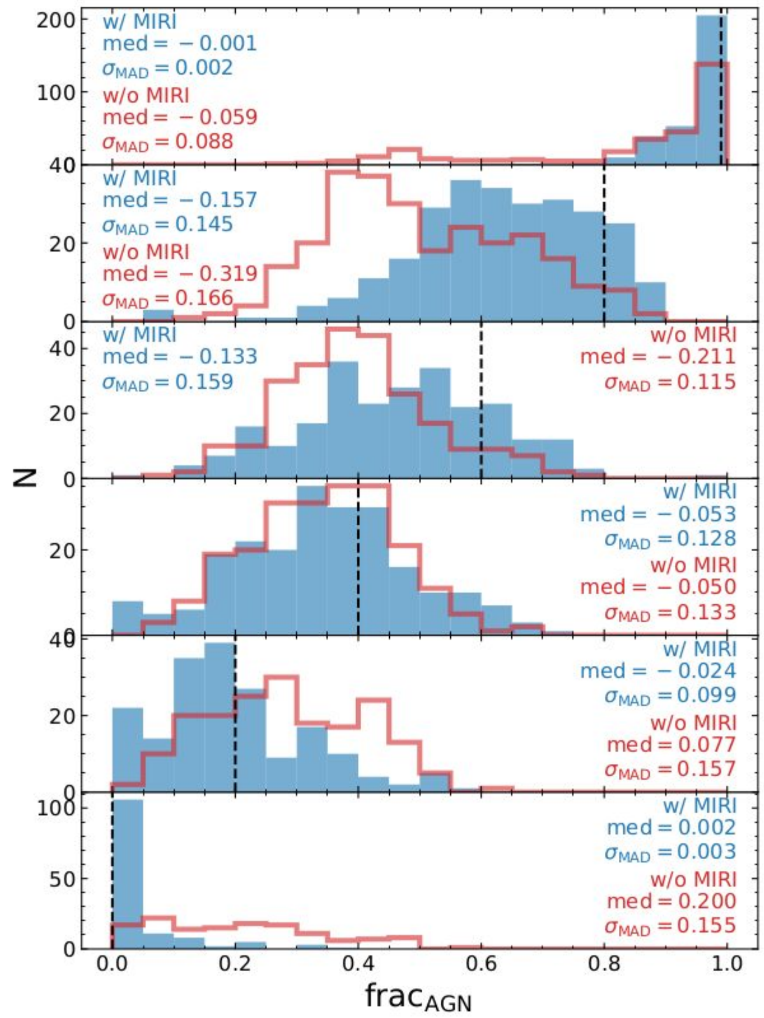
Pure galaxy input



# For models wtih $frac_{AGN}$>0

The accuracies of redshift and $frac_{AGN}$ are improved **by factors of ≳ 2**

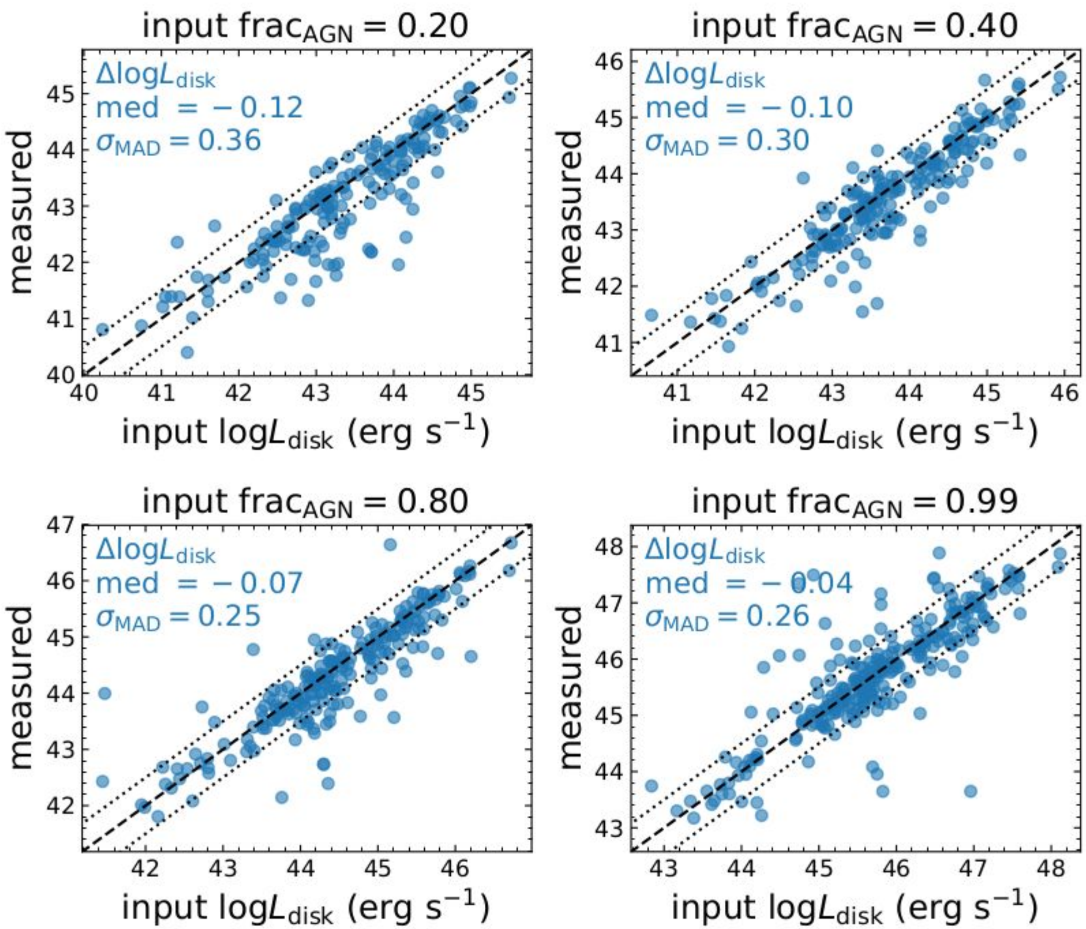


# Constrain AGN power with MIRI

Systematics ~ 0.1 dex

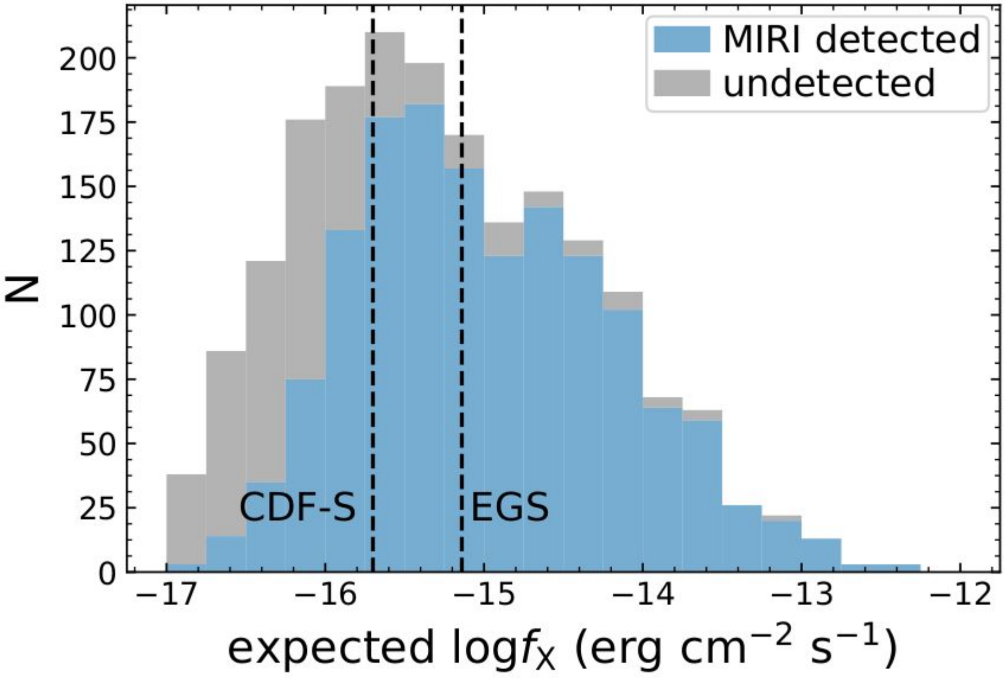
**Scatter ~ 0.3 dex**



# MIRI AGN-detection sensitivity

We convert our simulated AGN IR flux to X-ray flux using $L_X$-$L_{6\mu m}$ relation

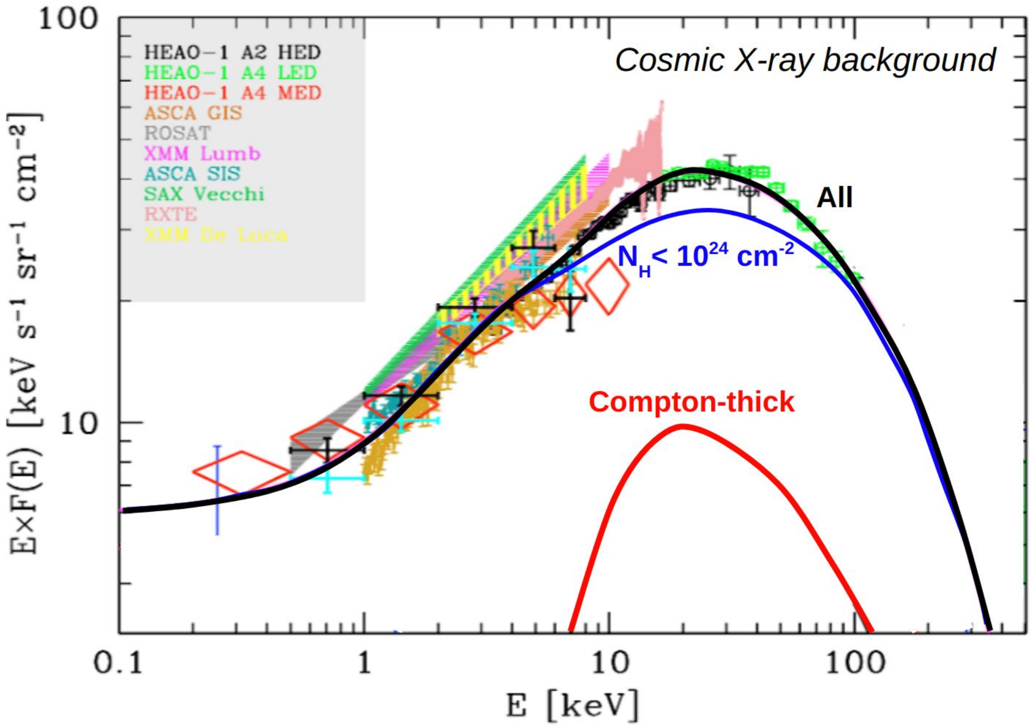
The MIRI equivalent $f_X$ limit is even slightly **deeper than** the Chandra 7 Ms **CDF-S** (Luo et al. 2017)



# Compton-thick AGN: the hidden population

Studies of Cosmic X-ray background (CXB) reveal a Compton-thick population with extreme obscuration

Compton-thick AGNs are **largely missed in X-ray surveys**




Gilli et al. (2007) adapted

## Searching for Compton-thick AGNs with MIRI

CEERS (PI: S. Finkelstein): 2 poinings

MIRI in the HUDF (PI: G. Rieke): 1 pointing

Proposals:

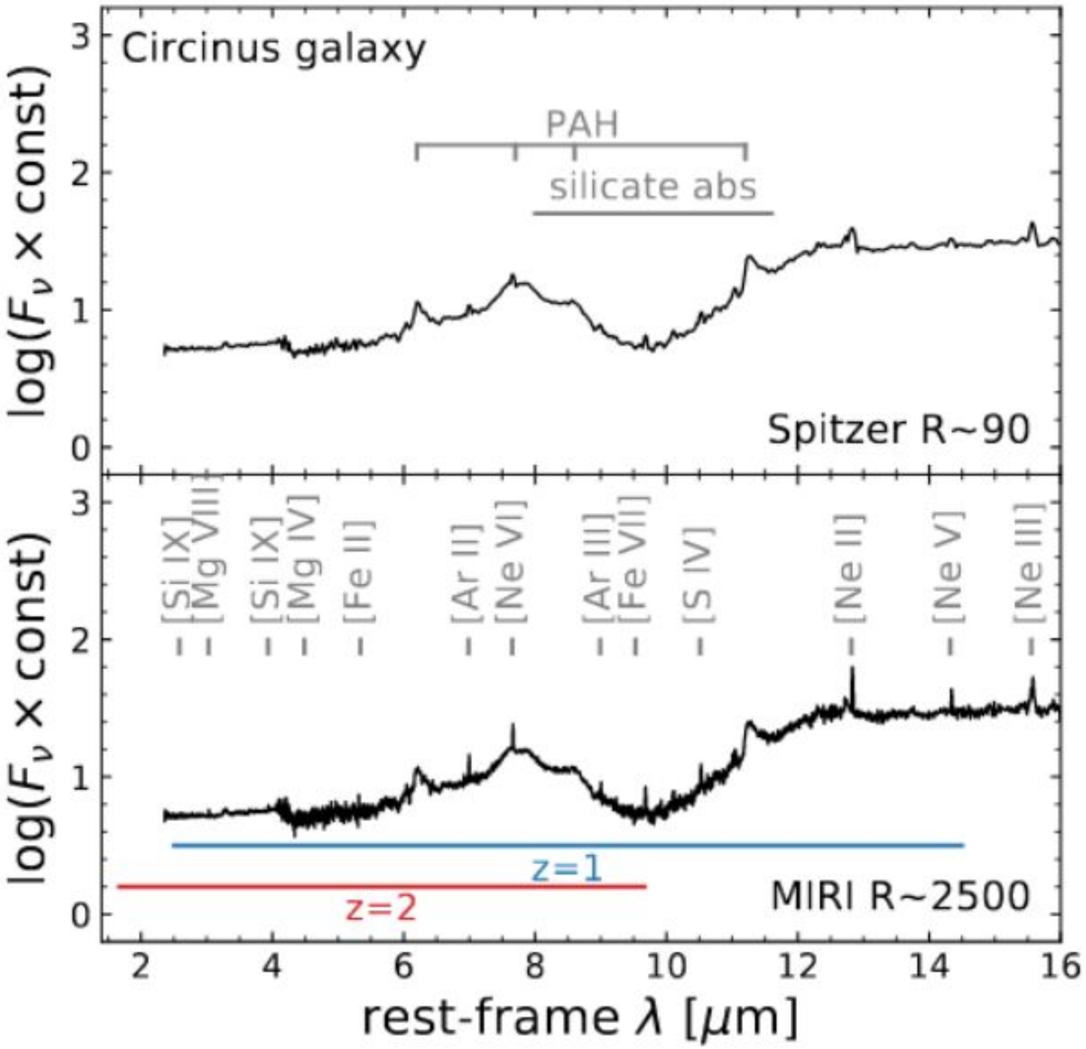
Extended CEERS: **5-8 new pointings**

“Free” (calibration, parallel, etc.) images from other proposals including yours?

# MRS spectroscopy: more insight

Accurate characterization of the **silicate and PAH feature**

Many **AGN-sensitive lines** available: e.g., [Fe VII], [Ne VI], [Si IX] ....



# Summary

- Based on realistic simulations of MIRI multi-band imaging data, we find that MIRI improves the accuracies of photo-z and $frac_{AGN}$ significantly ($\gtrsim$ 2x)
- With MIRI, we can robustly constrain AGN accretion power within ~ 0.3 dex
- With 3.6 hours exposure, MIRI is even more sensitive in AGN detection than CDF-S
- Future MIRI surveys can be used to identify Compton-thick AGNs