CCAT

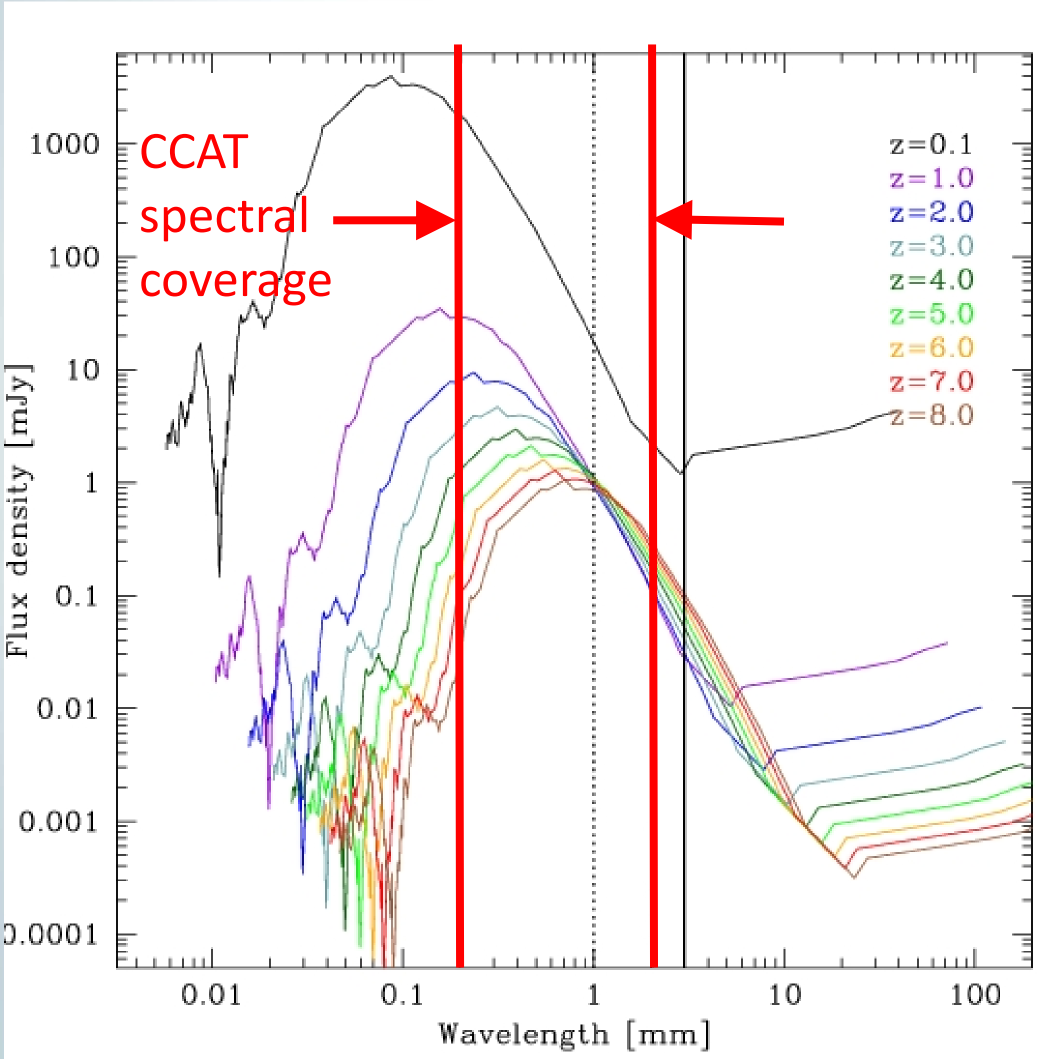
Characterizing Dusty, Star-Forming Galaxies at High Redshifts

Jason Glenn, CCAT Project Scientist
On Behalf of CCAT High-z Galaxy Group

CCAT High-z Galaxy Science Goals via Large-Area Mapping

- Measure the luminosity function of dusty star-forming galaxies to z = 5 (resolving the majority of the CFIRB and identifying multi-λ counterparts)
- Determine the dark matter environments of star-forming galaxies via clustering
- Determine the physical properties of the interstellar media of galaxies

Measuring the Obscured Star Formation in Galaxies

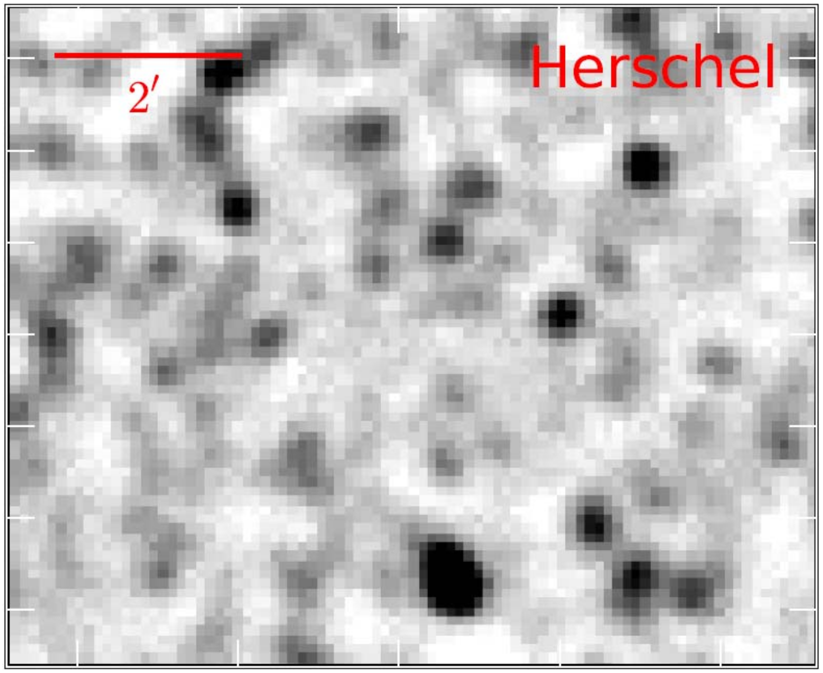


For z > 1, the luminosities of dusty galaxies and their star formation rates can be measured at submillimeter wavelengths without extrapolation from other wavebands.

Arp 220 spectrum figure from http://www.mpia-hd.mpg.de/homes/decarli/science.html

Galaxy Surveys and Counterpart Identification

Large galaxy surveys are required and angular resolution of a few arcseconds is needed to reliably identify multiwavelength counterparts.



Herschel 350 μm beamsize: 25”

350 μm simulations based on Bethermin et al. (2011)

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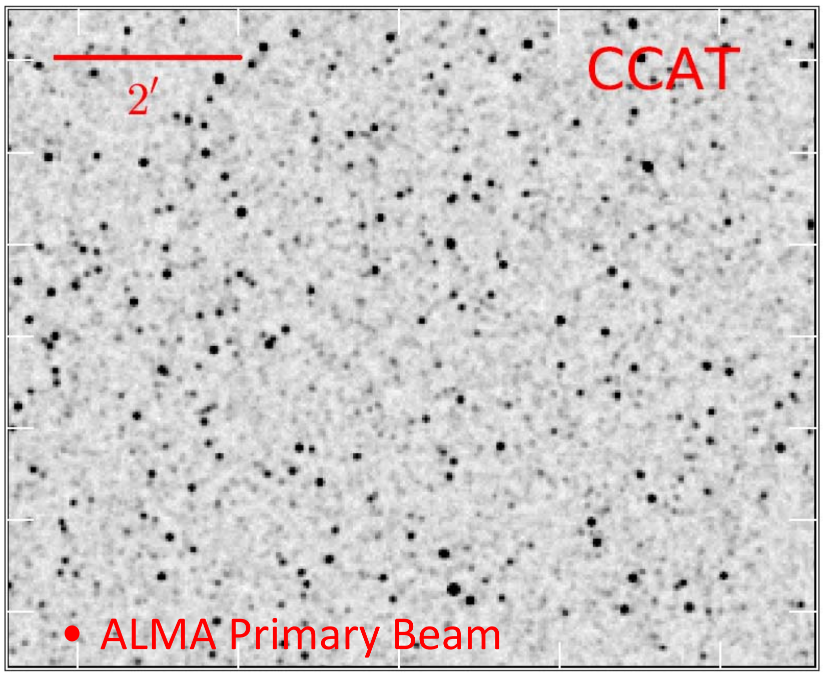
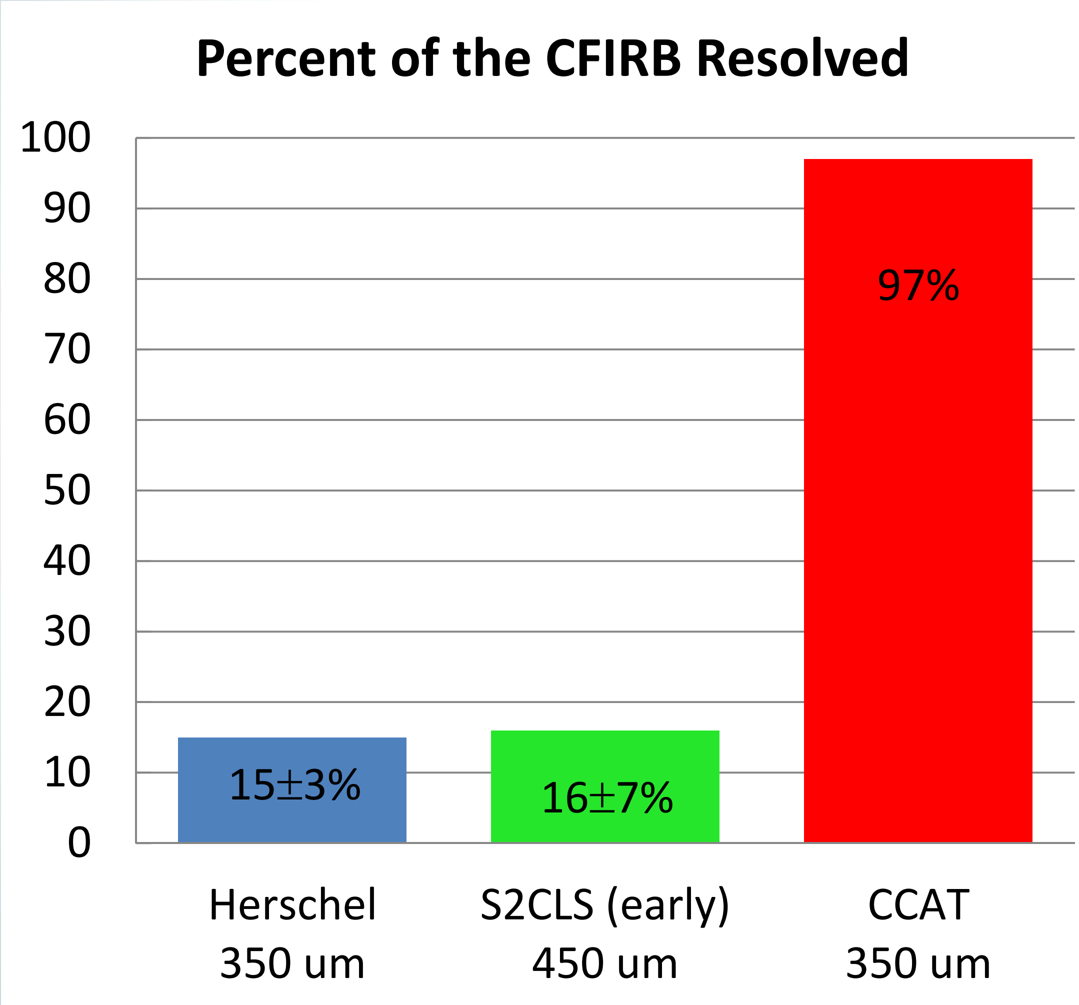


CCAT 350 μm beamsize: 3.5”

350 μm simulations based on Bethermin et al. (2011)

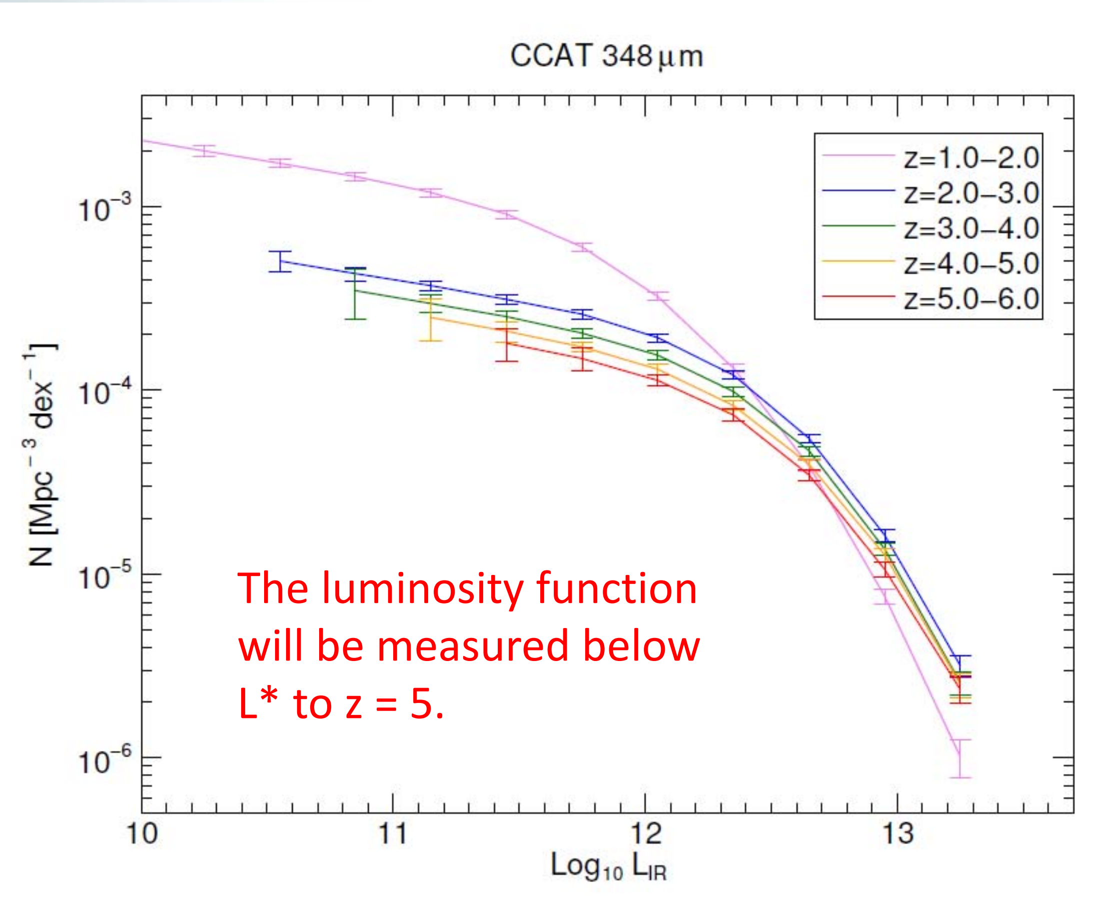
Resolving the Cosmic FIR Background



CCAT will directly detect the galaxies that produce almost all the submillimeter extragalactic background.

Herschel: Oliver, et al. (2010), Bethermin et al. (2012)
SCUBA-2 CLS first results: Geach, et al. (2012), 140 sq. arcmin
CCAT: Based on Bethermin et al. (2011)

Measuring the Luminosity Function of Dusty, Star-Forming Galaxies



Model luminosity functions from Bethermin et al. (2011)

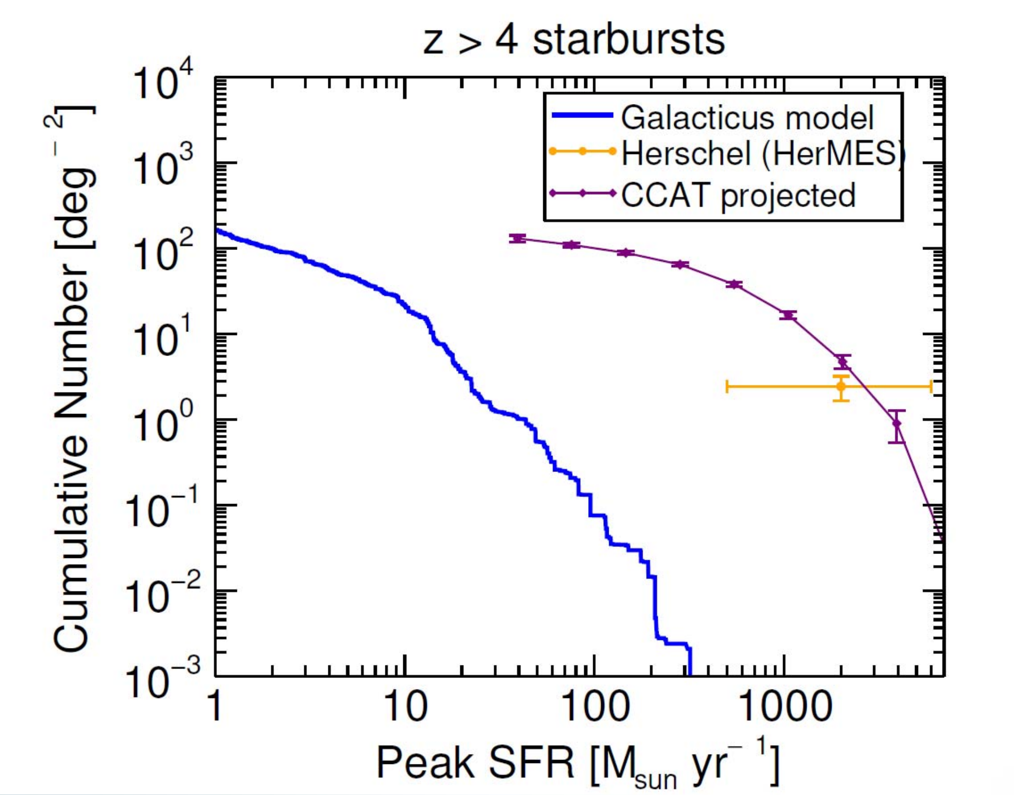
3 tier (0.15, 2, and 10 sq. deg.), 4 color (350, 450, 750, 850 μm), 2000 hour survey with CCAT first-light instruments.

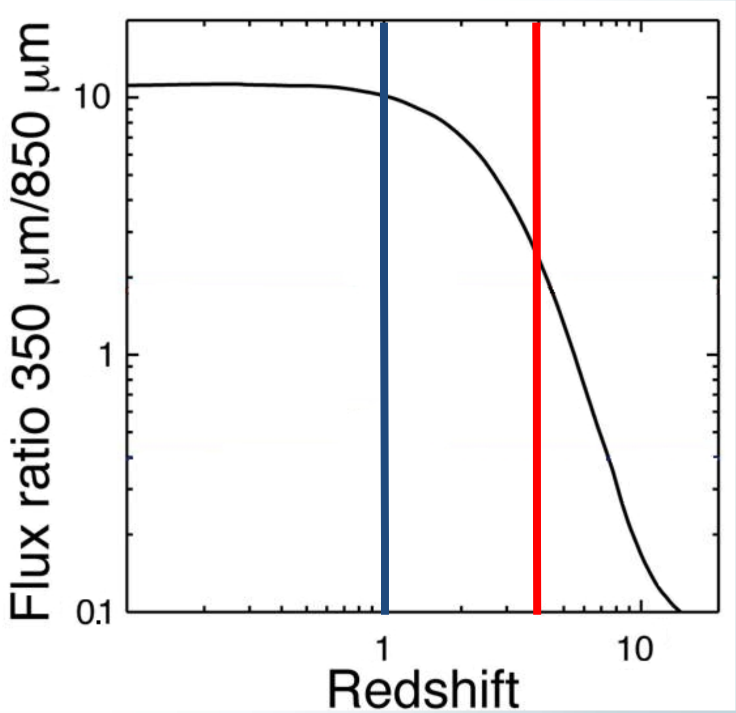
An ALMA survey of the first two tiers *only* at 850 μm with 350 and 450 μm follow-up of detected galaxies would take 5x longer (the 10 sq. deg. survey would not be feasible).

Identifying High-z Galaxies and Challenging Structure Formation Models

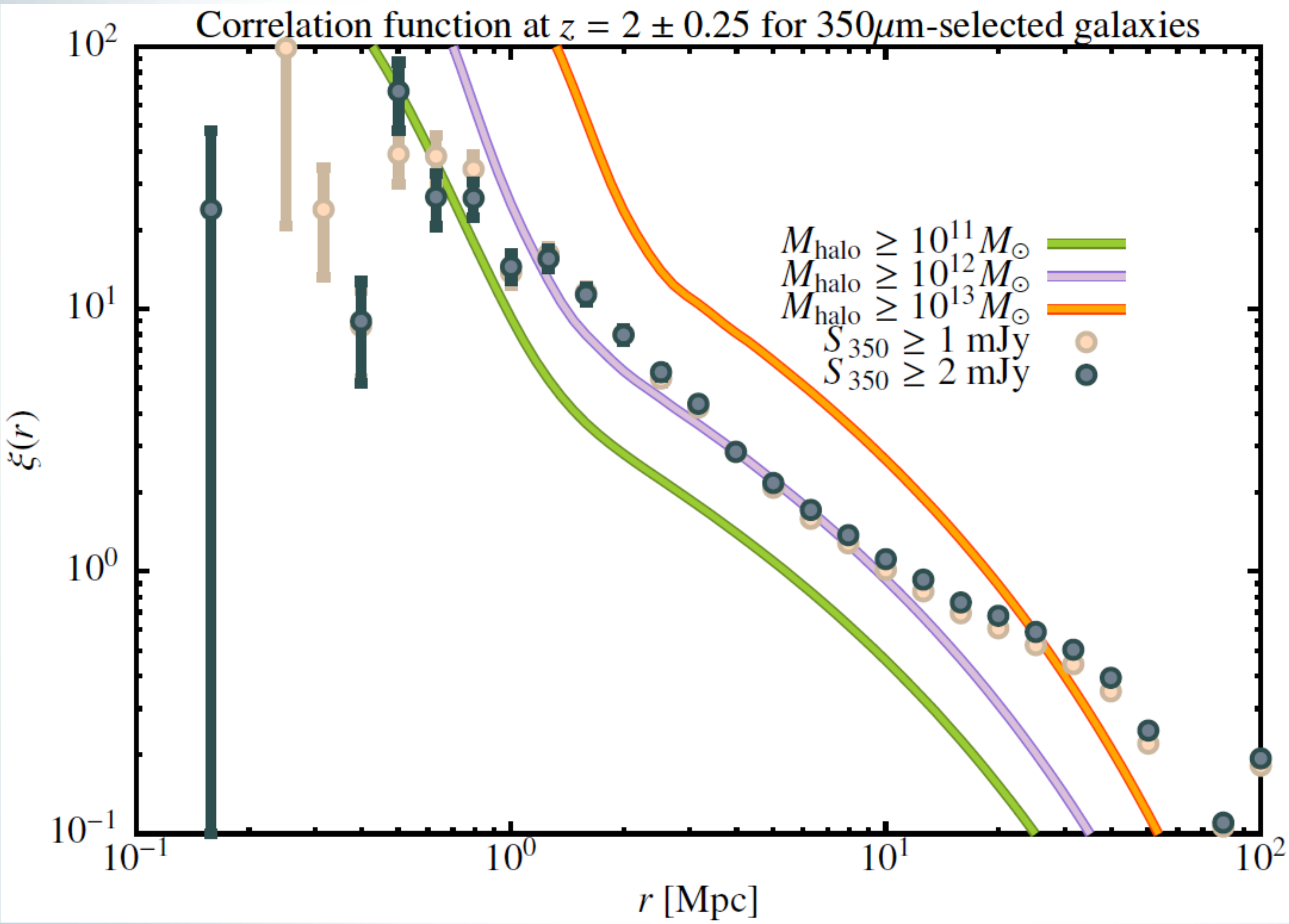
The number of z > 4 SFR ~1000 $M_\odot$/yr discovered by Herschel already stresses galaxy formation models; CCAT will go much deeper.

z > 4 galaxies will be identified as 350 μm "dropouts".





Measuring Host Dark Matter Halo Masses with Clustering

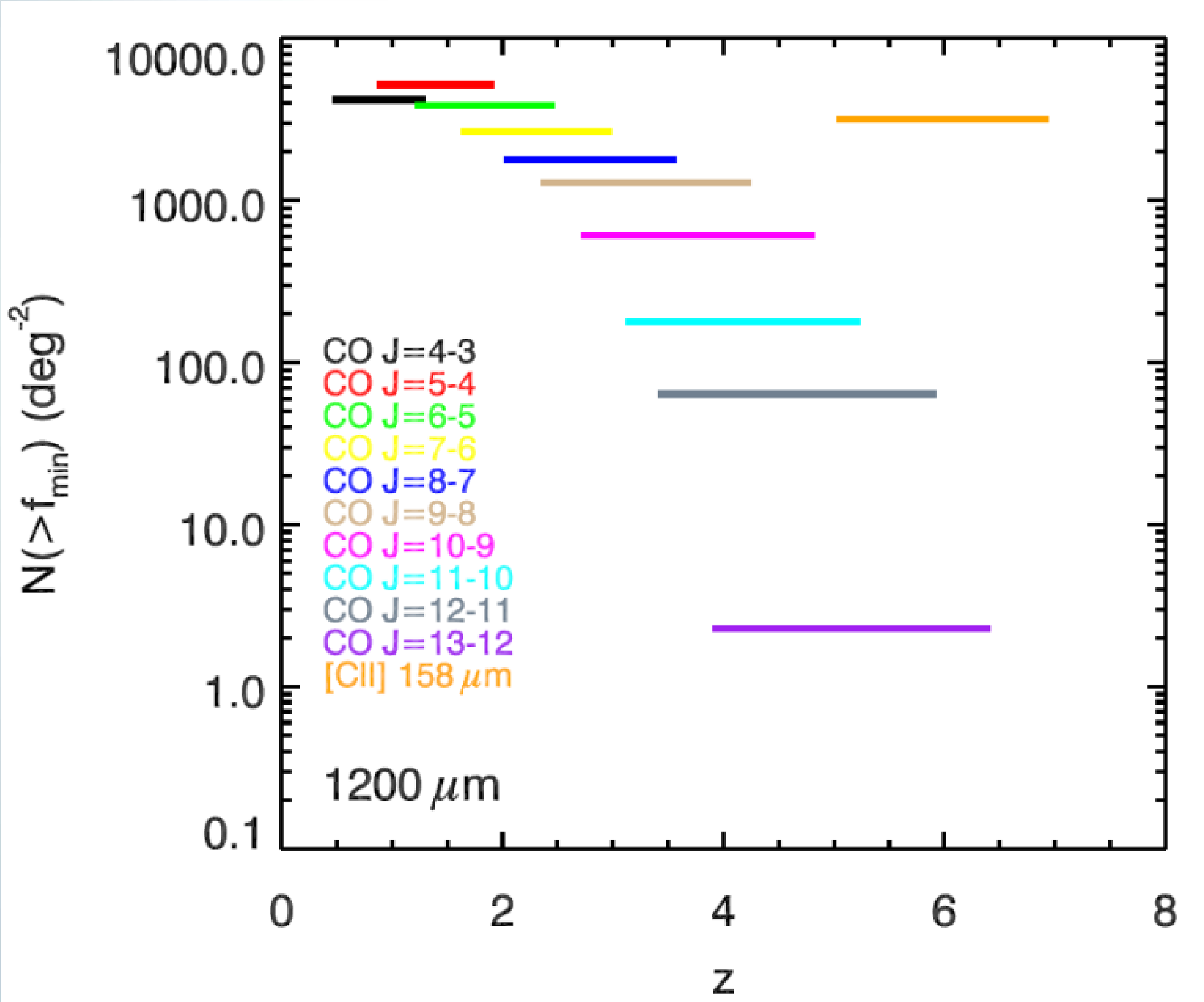


Using clustering measurents, CCAT will link the star formation history and AGN activity of galaxies to the dark matter halos that host them.

Simulations from Galacticus and Grasil (Benson et al).

Redshifts and ISM Physics from Broadband Spectroscopy with X-Spec

CCAT

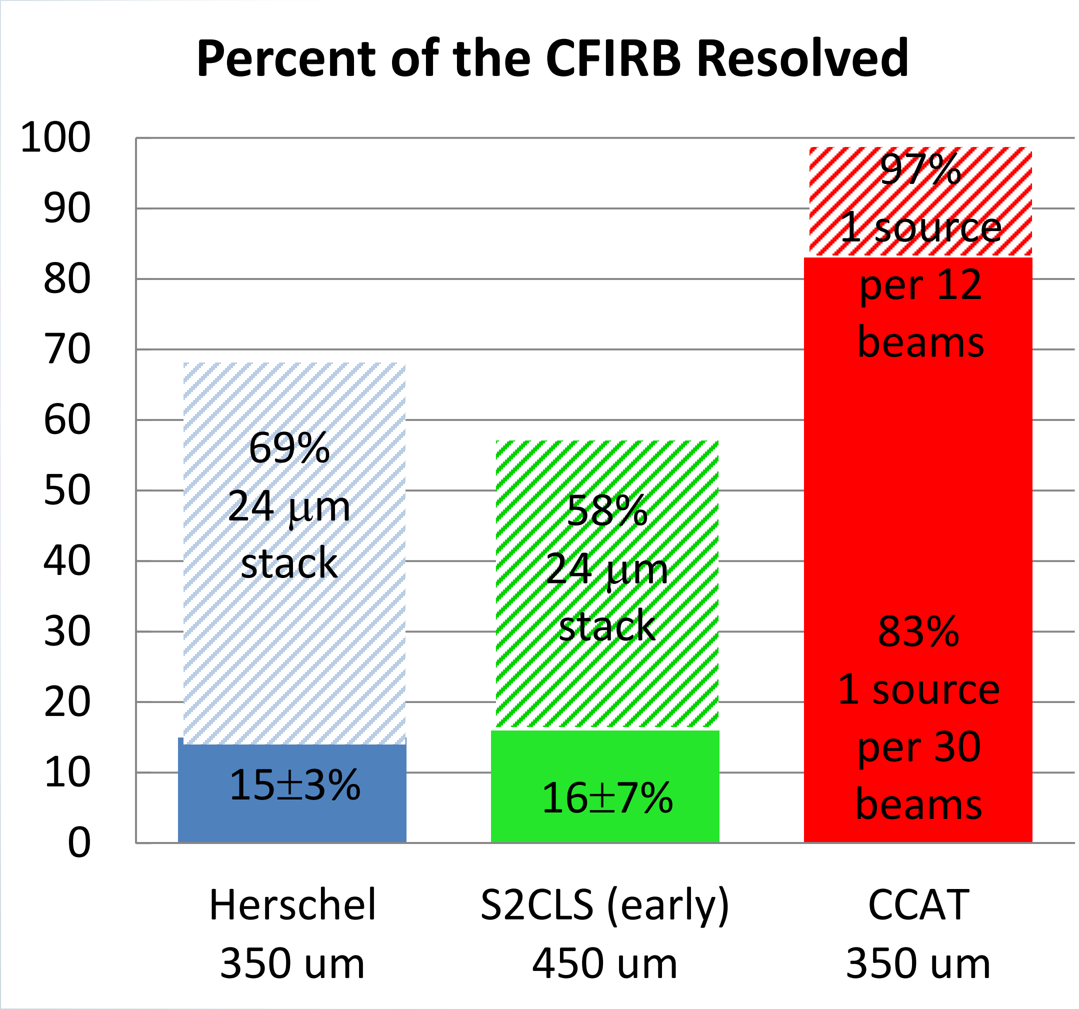


- At the peak epoch of star formation, multiple CO lines will be detectable per galaxy.
- Thousands of galaxies per sq. deg. detectable in [CII] 158 μm (also [OI] 63 and 145 μm, [OIII] at 52 and 88 μm, [NII] 122 and 205 μm).
- With a 70 beam X-Spec, 1500 z's could be obtained at z = 5 for $L_{FIR} = 10^{11.5}\ L_{\odot}$ in 1100 hours.

Conclusions: CCAT High-z Galaxy Science Goals via Large-Area Mapping

- Measure the luminosity function of dusty star-forming galaxies to z = 5 (with counterpart identification and redshifts from spectroscopy)
- Determine the dark matter environments of star-forming galaxies via clustering
- Determine the physical properties of the interstellar media of galaxies

Resolving the Cosmic FIR Background



With stacking, CCAT will resolve all the submillimeter extragalactic background.

Herschel: Oliver, et al. (2010), Bethermin et al. (2012)
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