東京大学 THE UNIVERSITY OF TOKYO

SCHOOL OF SCIENCE THE UNIVERSITY OF TOKYO

南極テラヘルツ望遠鏡で探る宇宙赤外線背景放射の起源

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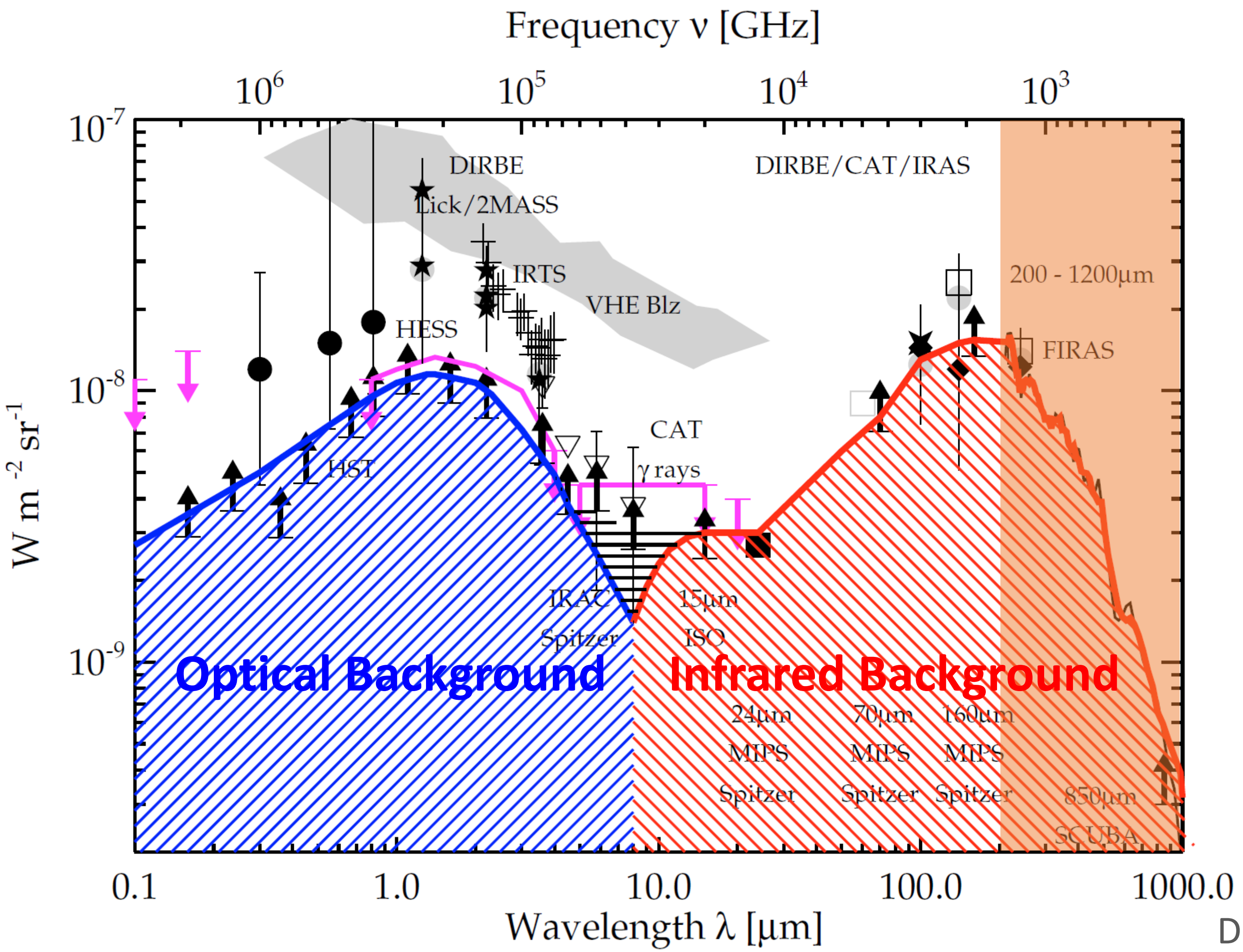
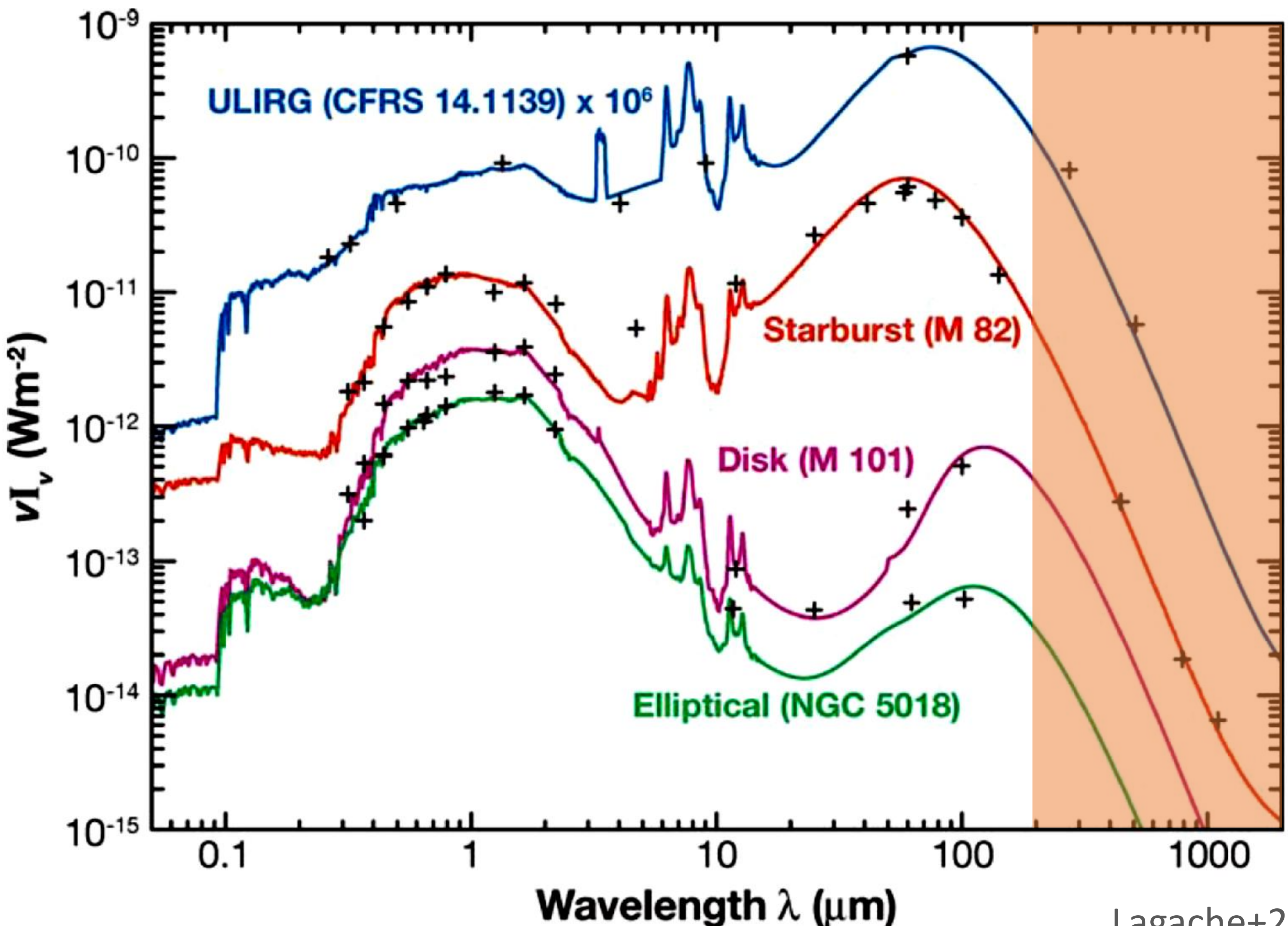
Cosmic Infrared Background



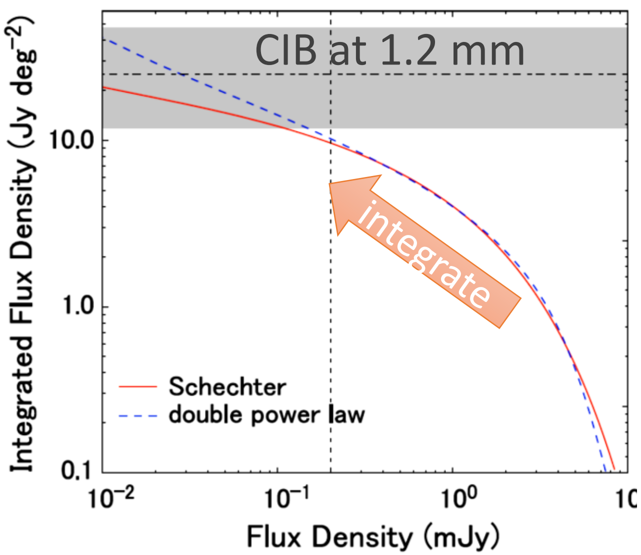
Dole+2006

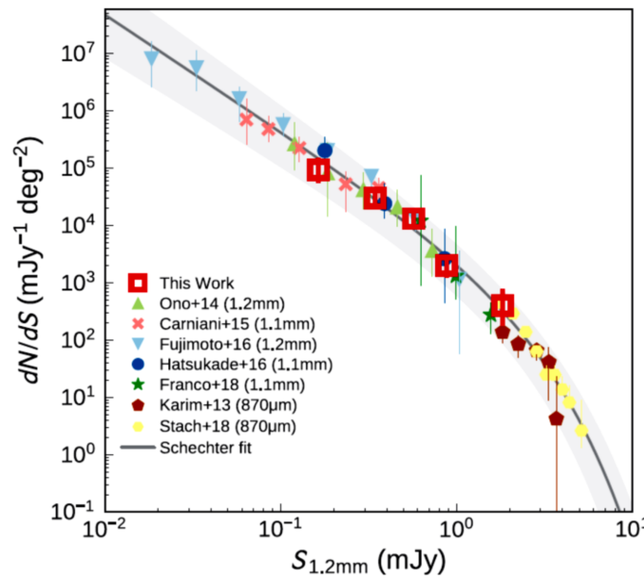
Spectral Energy Distribution

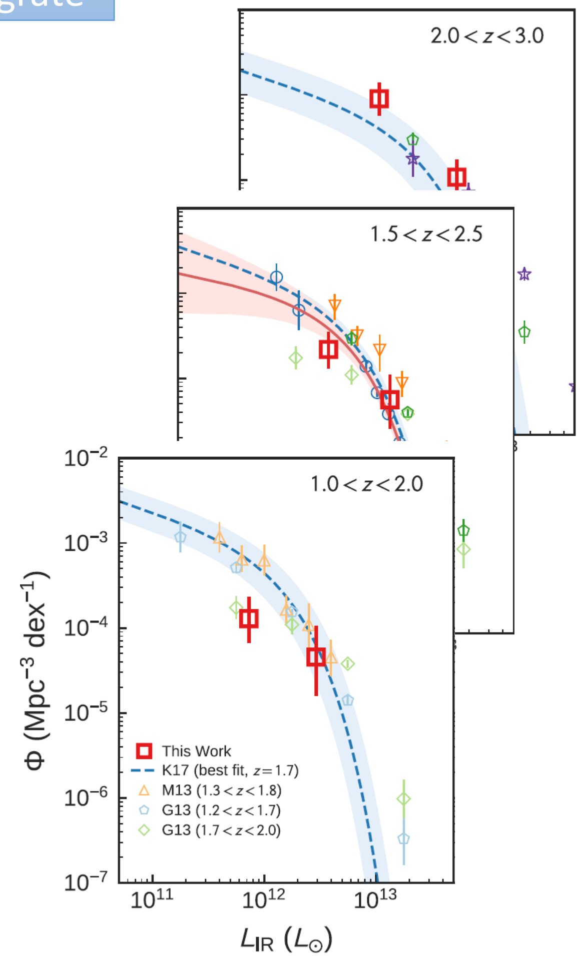


Lagache+2005

Cosmic IR Background ← integrate ← Number Counts ← integrate ← IR Luminosity Functions

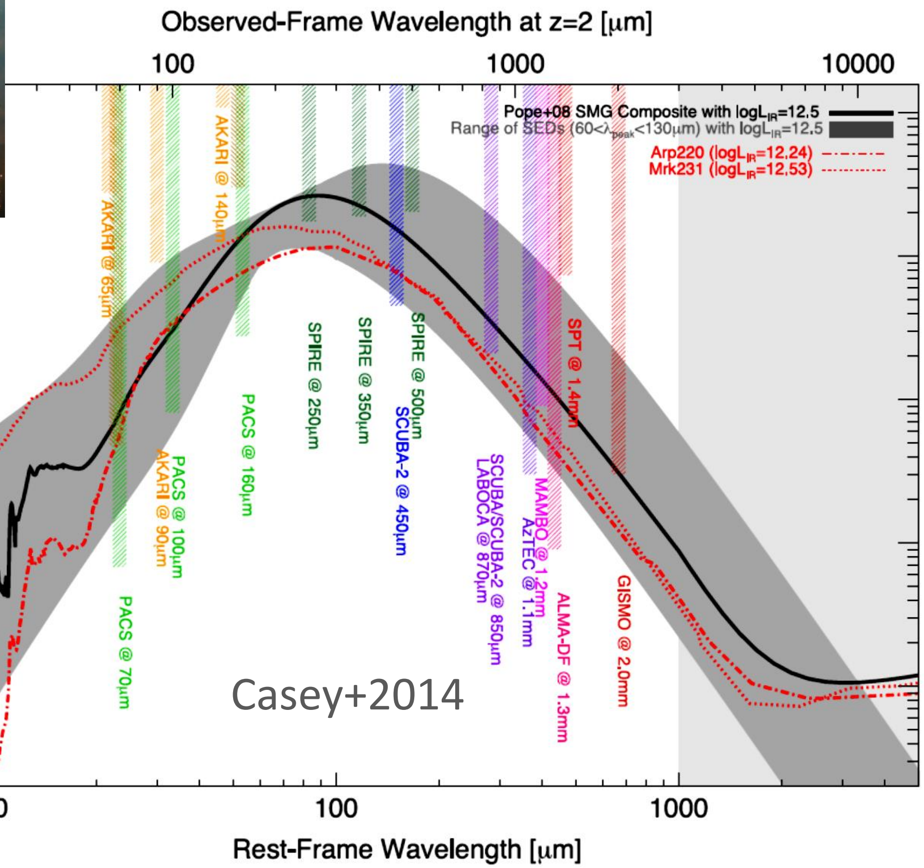


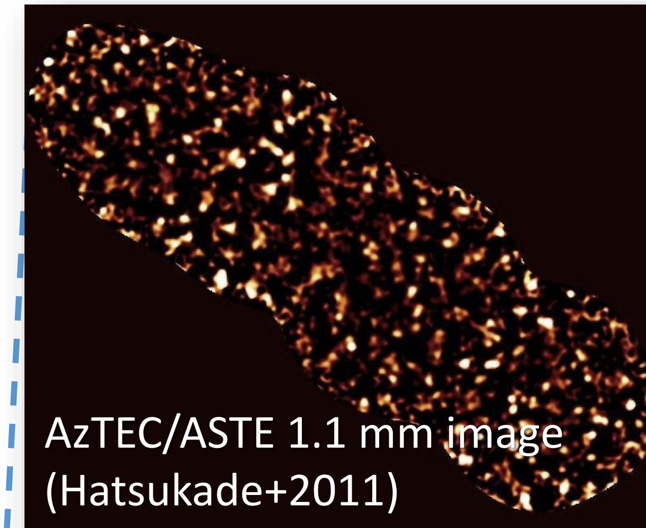




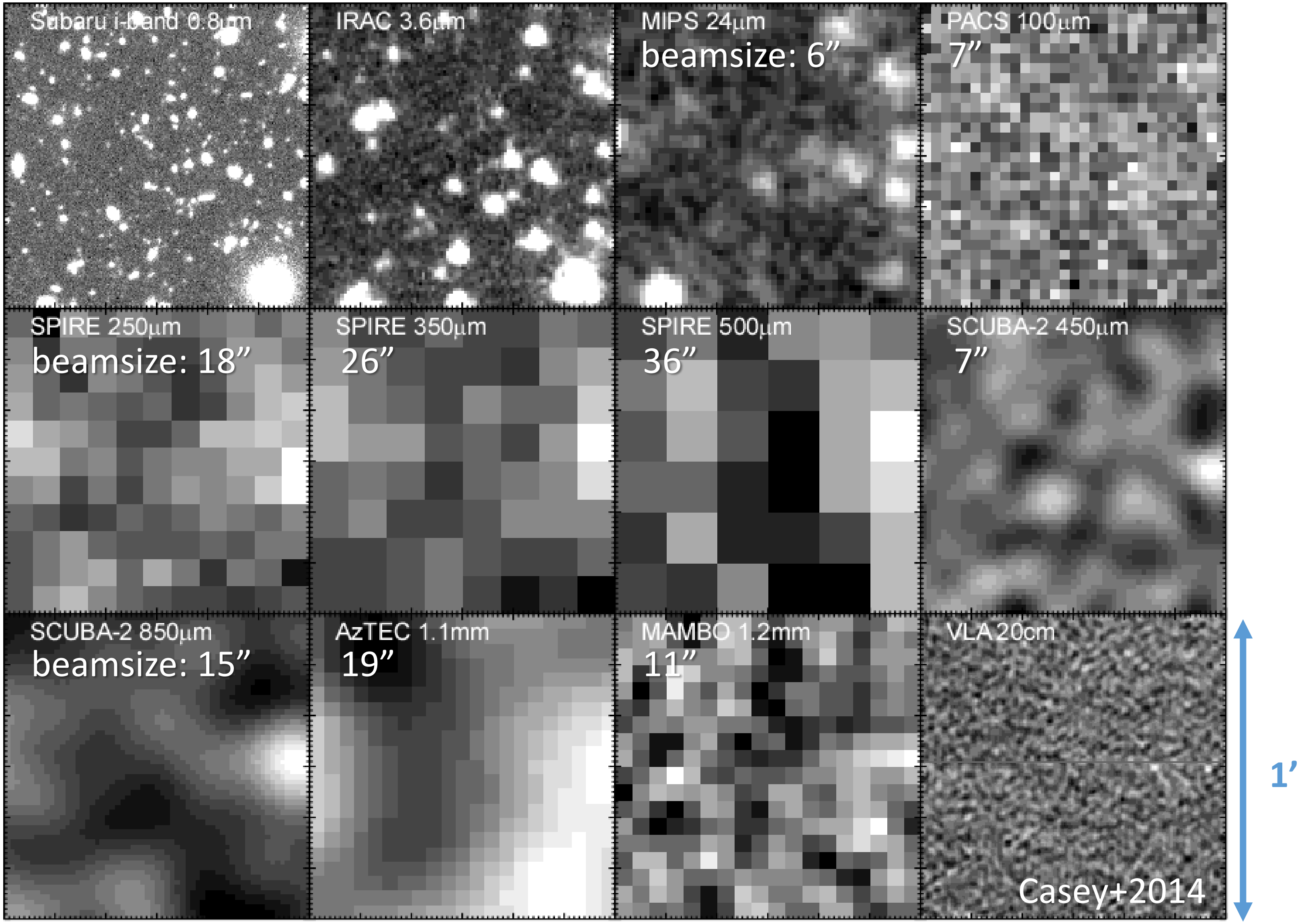
e.g., Hatsukade+2013, 2016, 2018

FIR-millimeter Observations

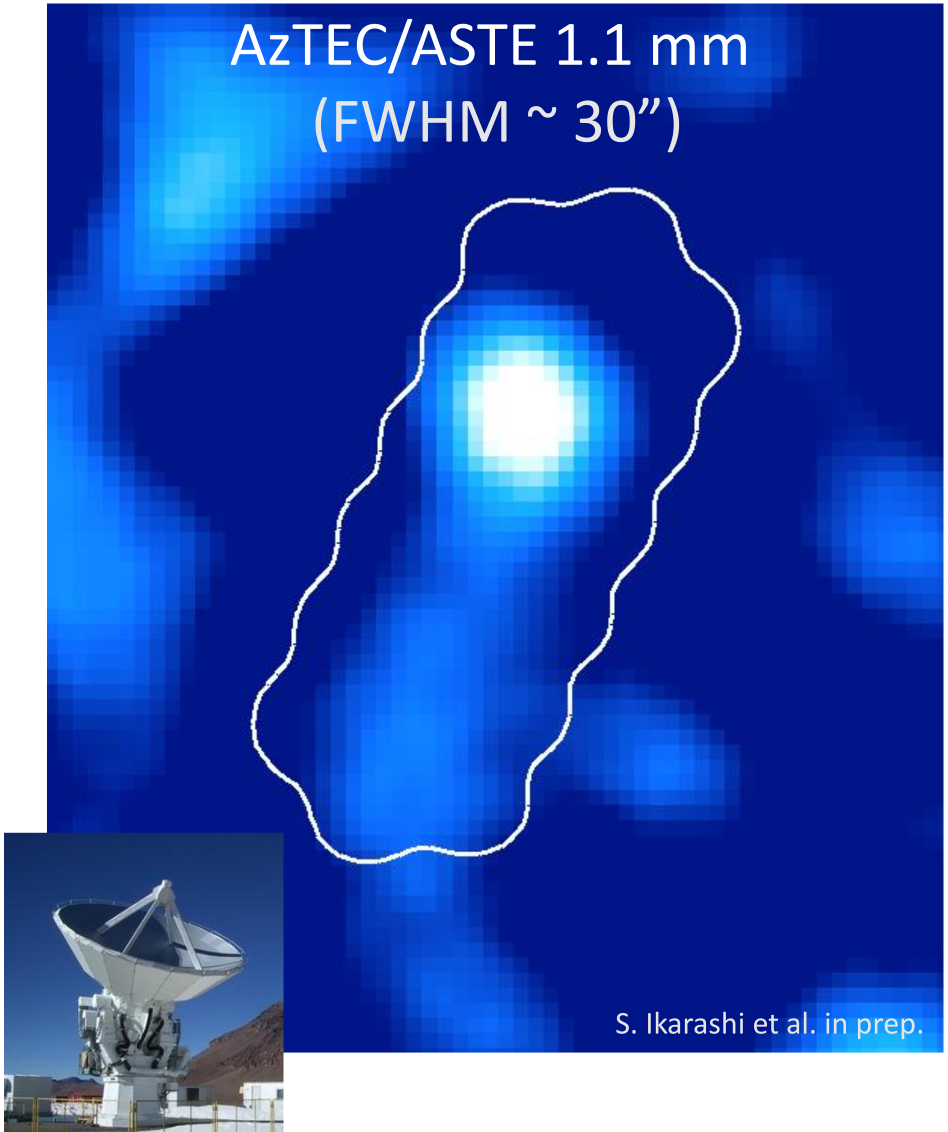


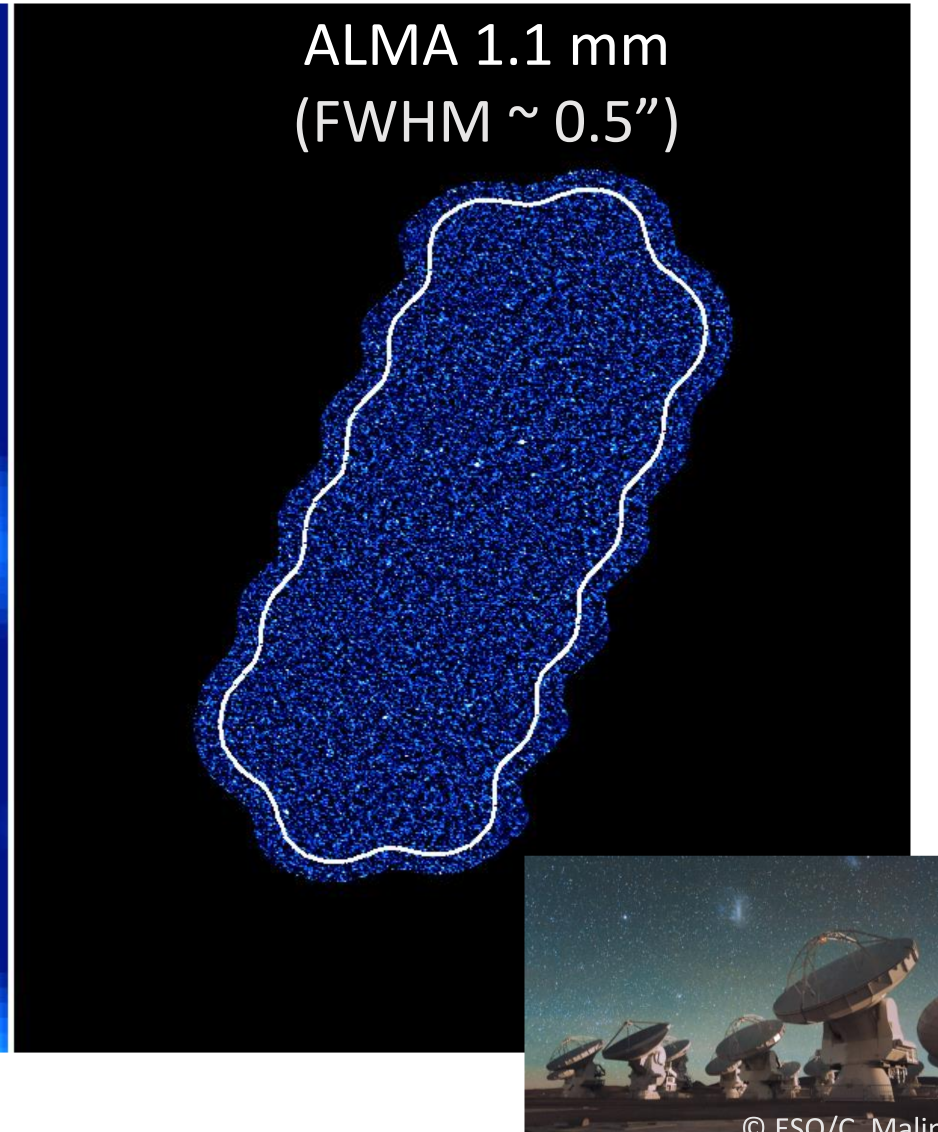


Source Confusion, Blending

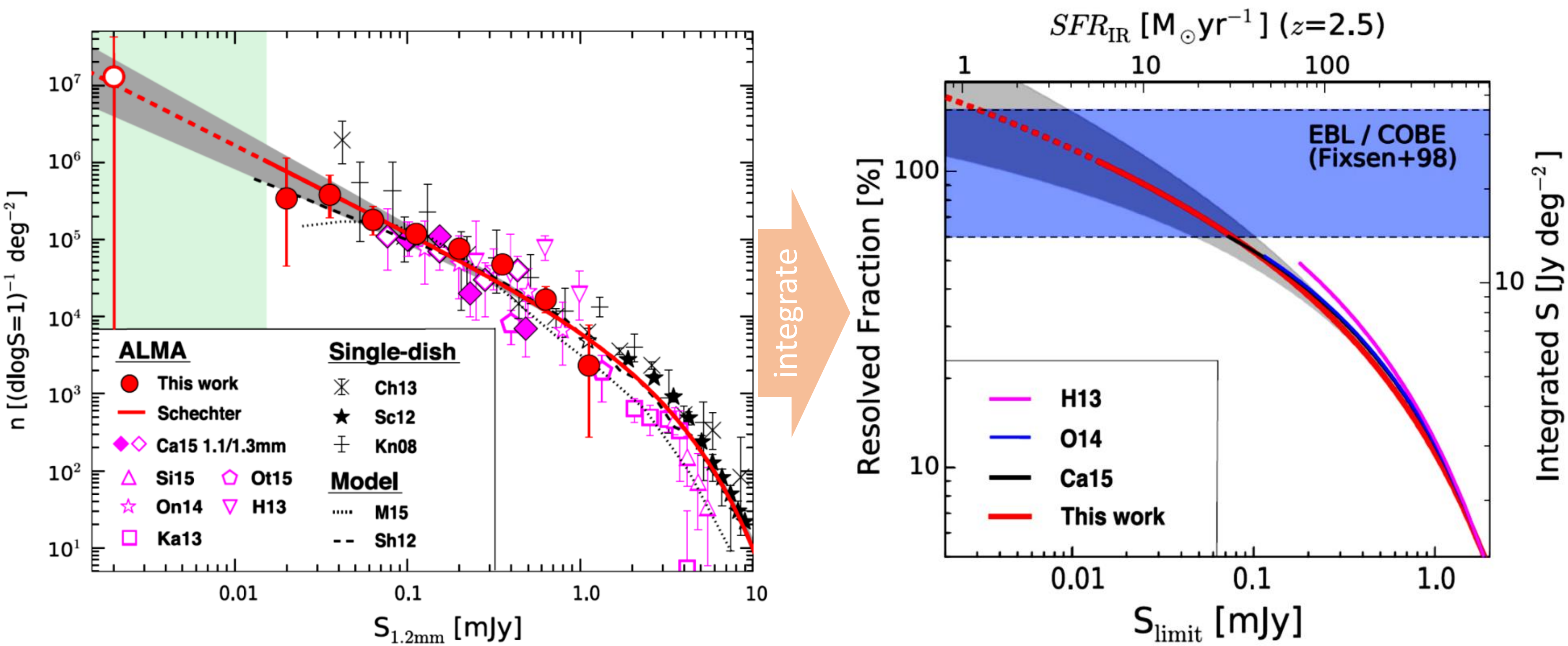


ALMA Resolves the CIB





CIB at 1 mm with ALMA



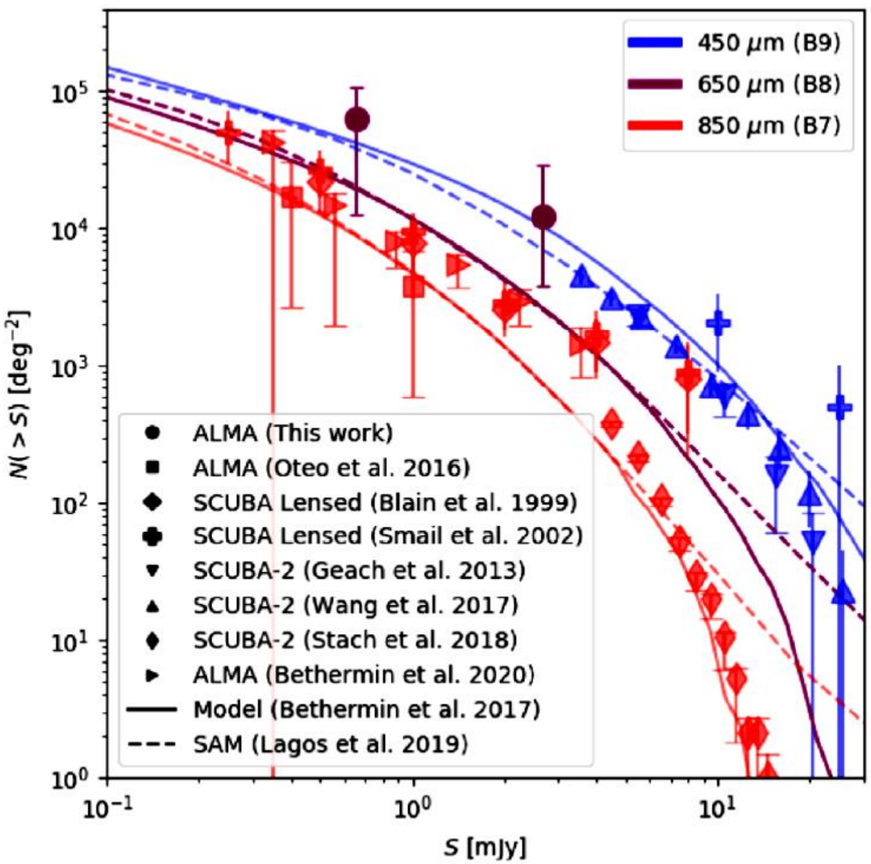
Fujimoto+2015

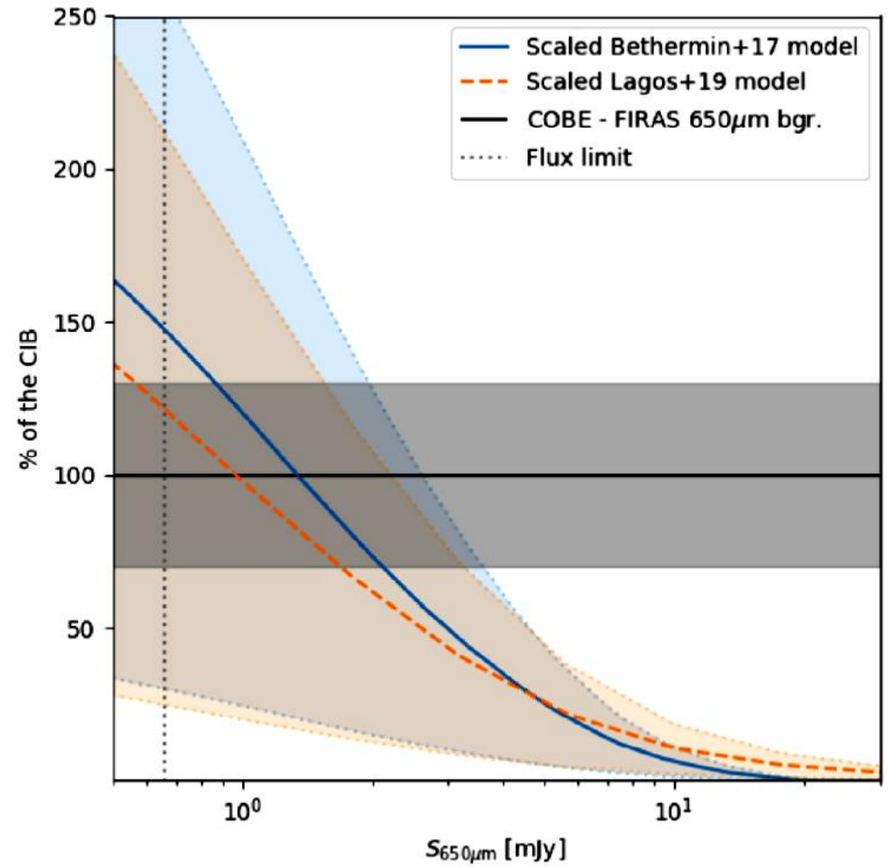
CIB at 650 μm with ALMA

- ALMA band 8 archive data of calibrator fields (**~5.5 arcmin^2** in total)
- **21 sources** (>4.5σ) in the FoVs, down to 0.7 mJy

➔ ≃100% of the CIB at 650 μm is resolved

Klitsch+2020



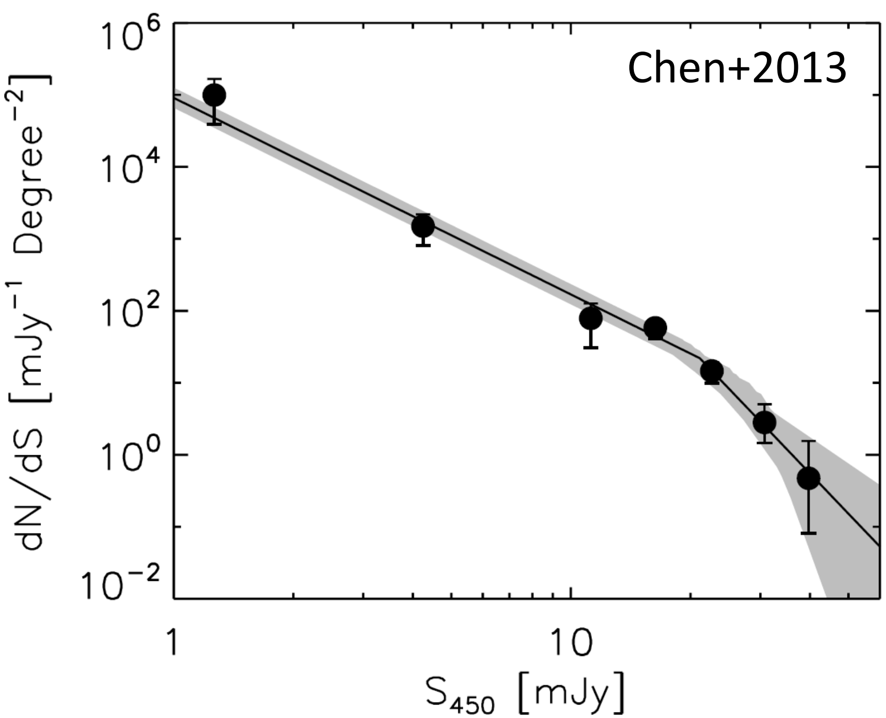


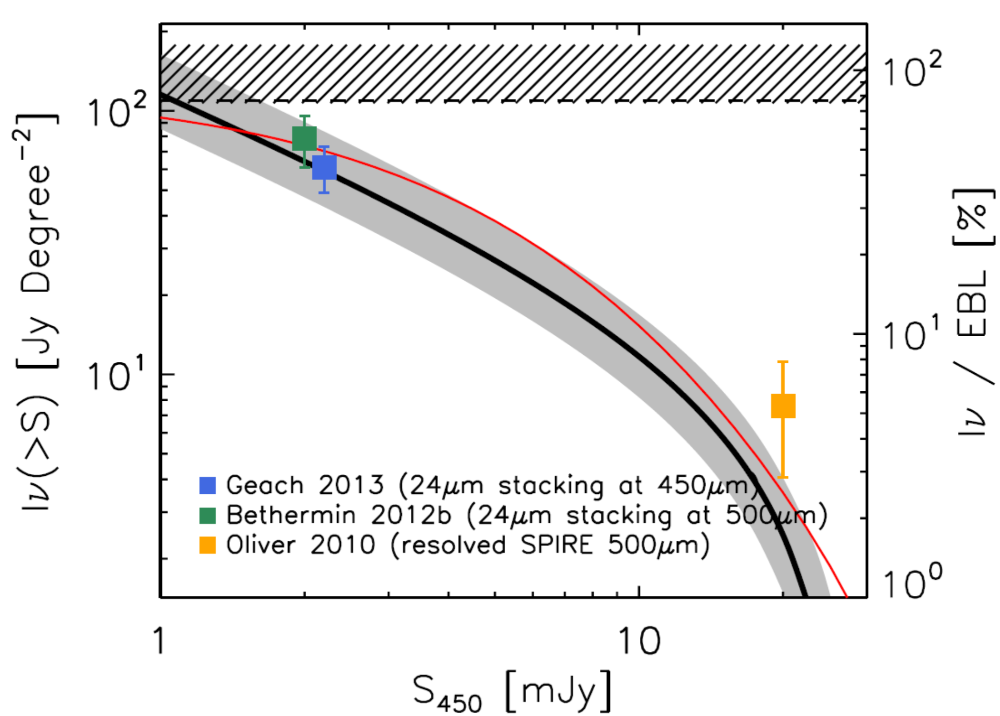
CIB at 450 μm with SCUBA-2

- SCUBA-2 observations down to ~ 1 mJy
  - blank fields (down to ~4 mJy) + cluster lensing fields

➔ The majority of CIB at 450 μm is resolved

- Chen+2013, Casey+2013, Geach+13, Wang+2017



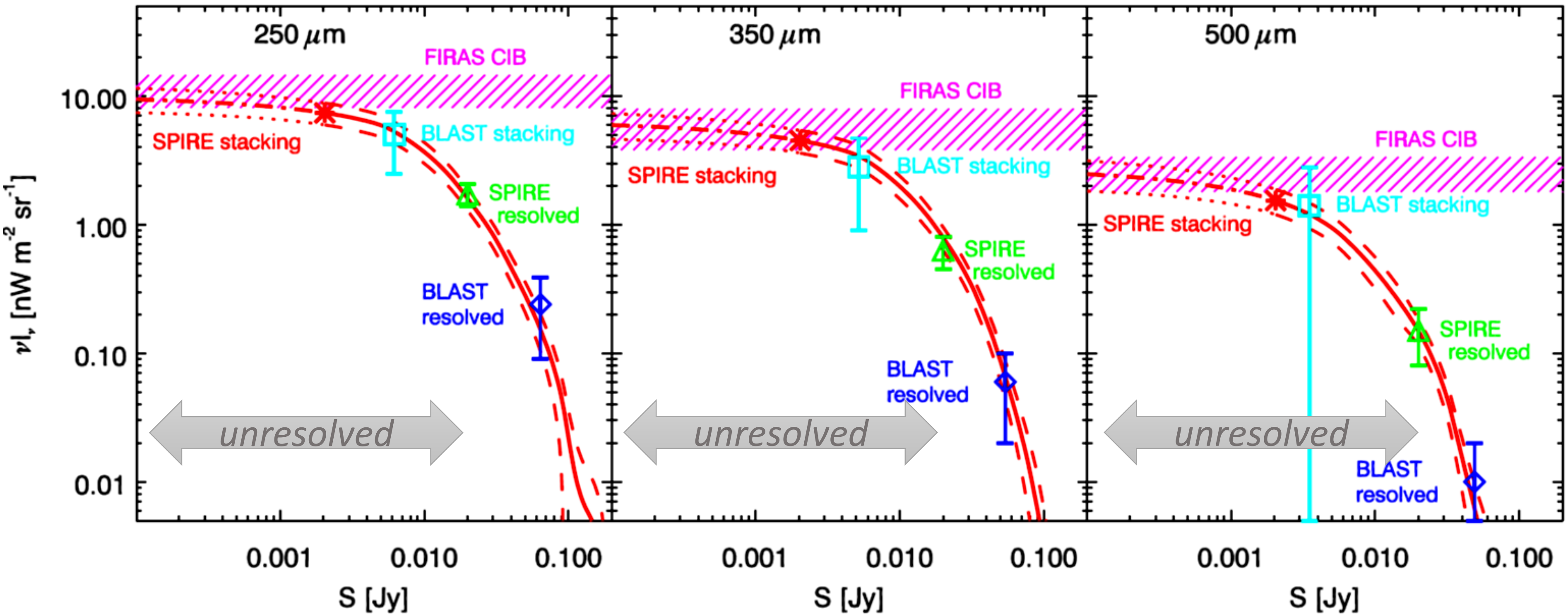


CIB at 250-500 μm with Herschel

- *Herschel*/SPIRE resolved only ~10-20% of the CIB due to confusion (~20 mJy)
- Stacking analysis using *MIPS 24 μm sources as a prior*

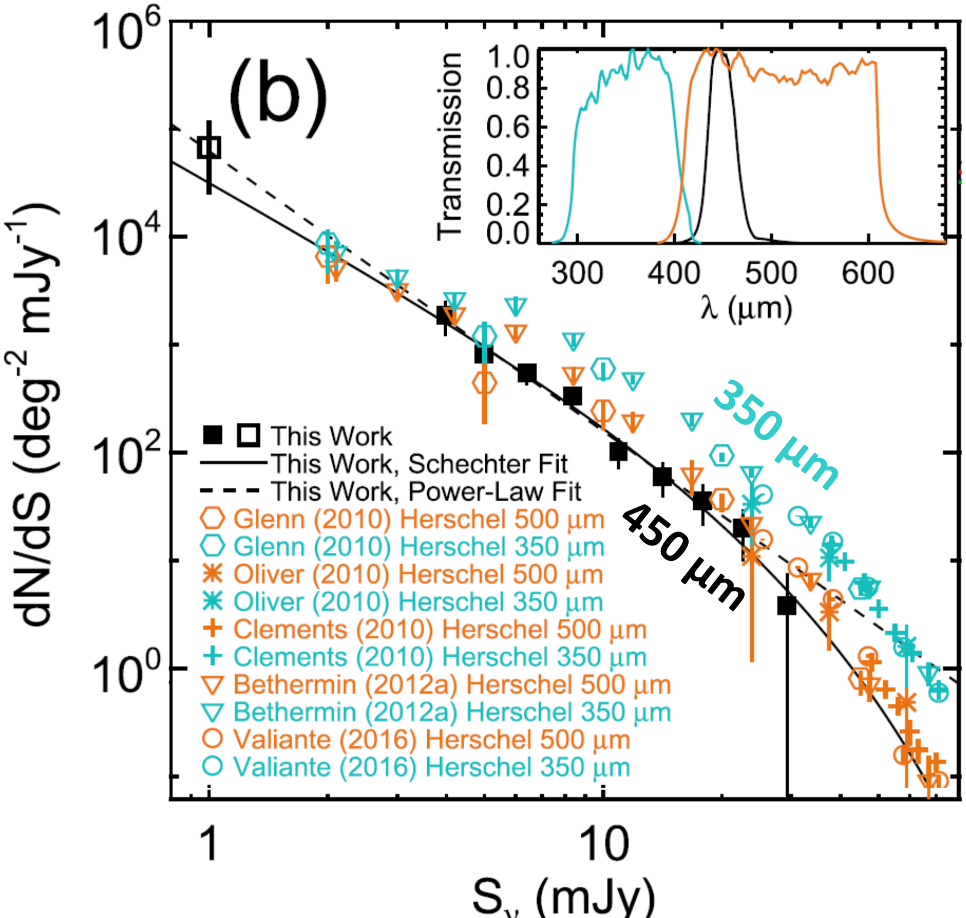
➔ ≃100% of the CIB at 250, 350, and 500 μm is resolved

Bethermin+2012



Discrepancy between *Herschel* and SCUBA-2

- *Herschel* counts at 350 and 500 μm lie significantly above SCUBA-2 450 μm counts ➔ source blending?



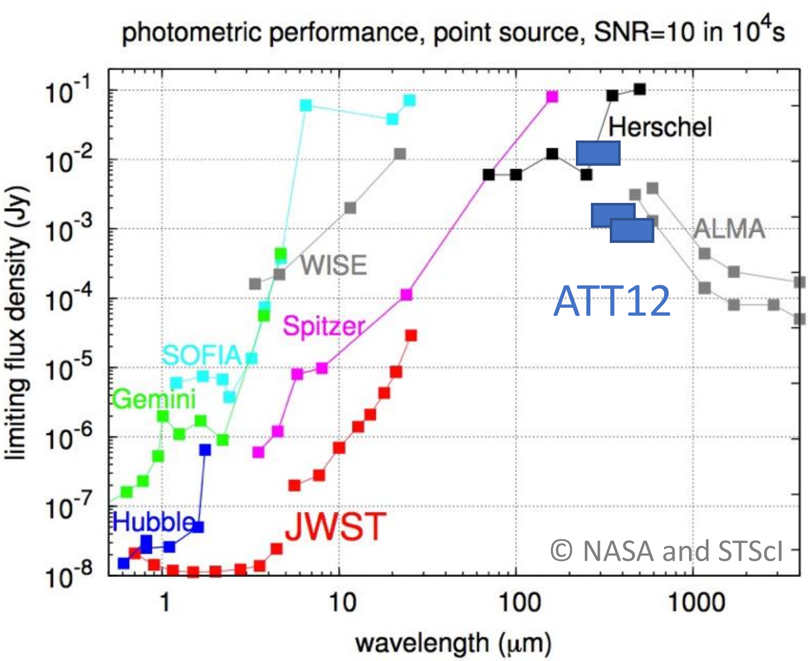
Wang+2017

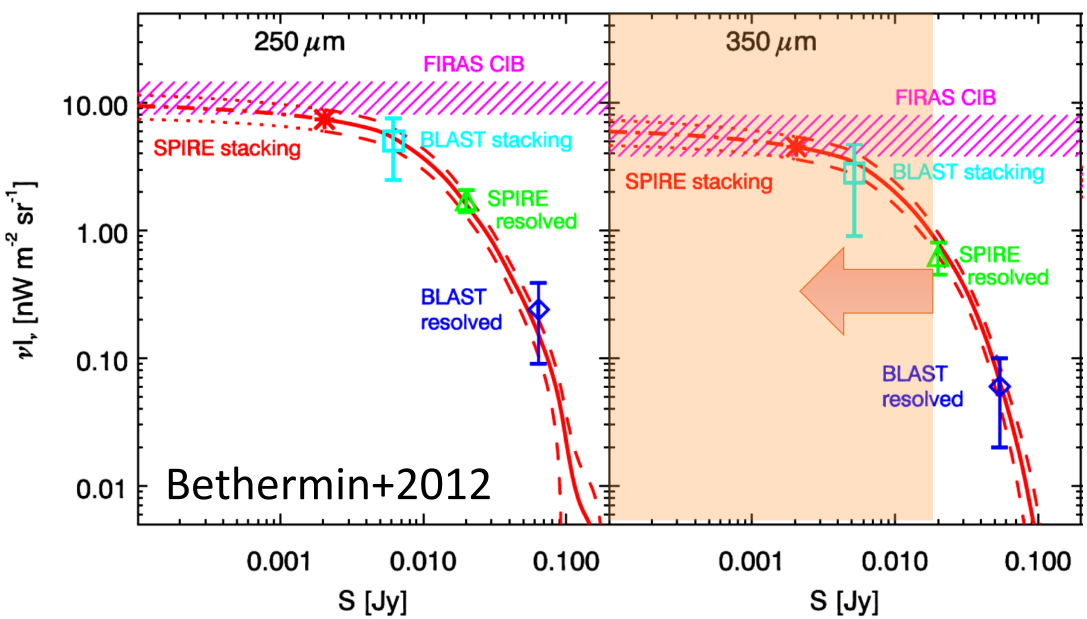
Wavelength	Instrument	Resolved Fraction	Note	Ref.
100 µm	*Herschel*	~75%	Blank field	Magnelli+2013
160 µm	*Herschel*	~75%	Blank field	Berta+2011, Magnelli+2013
		~89%	*P*(*D*) analysis	Berta+2011
250 µm	*Herschel*	**~15-20%**	Blank field	Oliver+2010, Bethermin+2012
		~73%	Stacking (>2 mJy)	Bethermin+2012
350 µm	*Herschel*	**~11-12%**	Blank field	Oliver+2010, Bethermin+2012
		~69%	Stacking (>2 mJy)	Bethermin+2012
500 µm	*Herschel*	~5-6%	Blank field	Oliver+2010, Bethermin+2012
		~55%	Stacking (>2 mJy)	Bethermin+2012
450 µm	SCUBA-2	~20-30%	Blank field	Geach+2013, Wang+2017
		48-153%	Lensing cluster	Chen+2013
		83%	*P*(*D*) analysis	Wang+2017
650 µm	SCUBA-2	≃100%	Calibrator fields	Klitsch+2020
850 µm	SCUBA-2	~30%	Blank field	Coppin+2006, Zavala+2017
		44-178%	Lensing cluster	Chen+2013
1.1-1.3 mm	ALMA	~93%	Blank field	González-López+2020
		≃100%	Lensed source	Fujimoto+2015

Antarctic 12-m Terahertz Telescope

ATT12 resolves the CIB at 350 µm for the first time!

ν (GHz)	λ (µm)	HPBW (“)	$5\sigma_{rms}$ (mJy), 10 hr	Confusion, 5σ (mJy)
650	460	9.5	0.60	1.97
850	350	7.3	1.17	2.49
1000	300	6.2	12.9	1.71

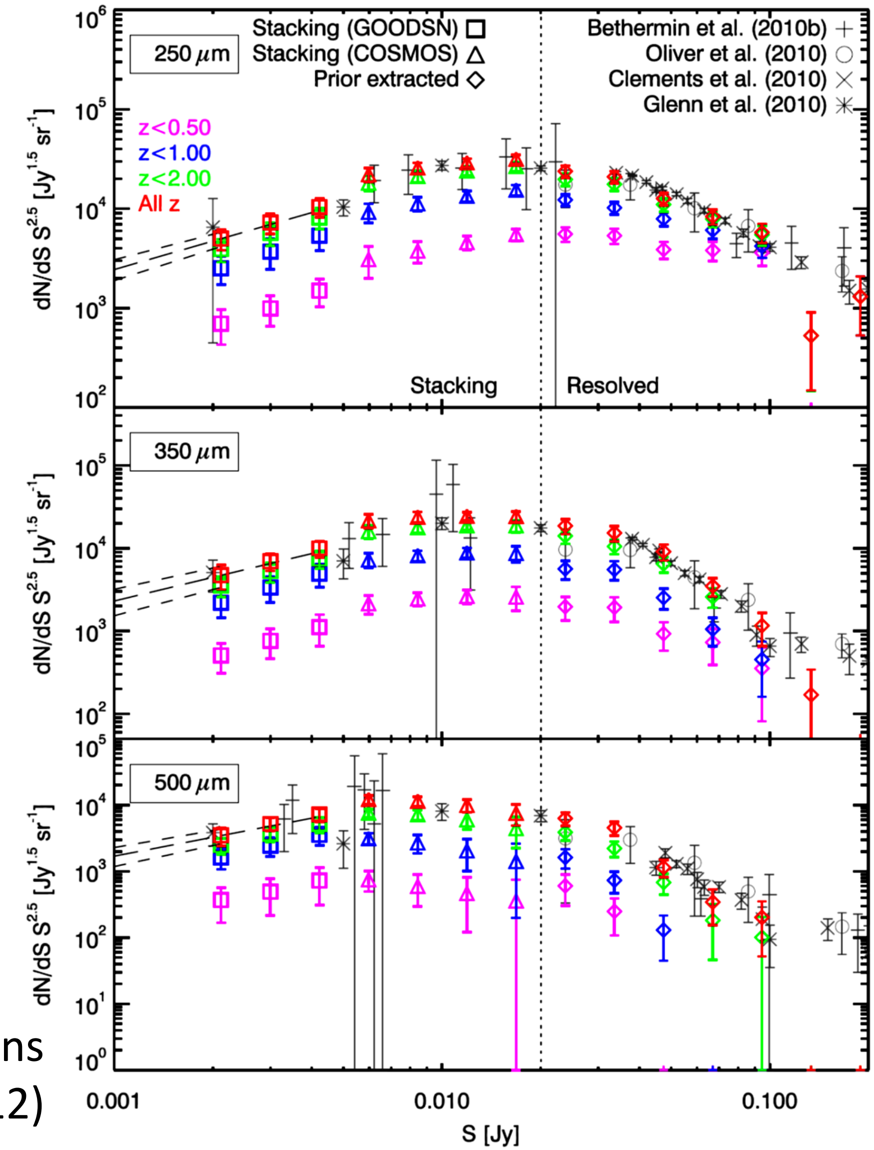




Antarctic 12-m Terahertz Telescope

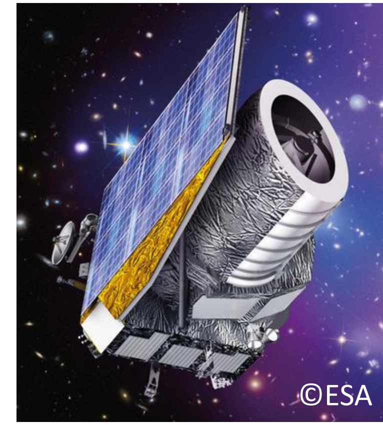
- Probe the faint-end of number counts, luminosity functions at 350-500 µm

Constraints on galaxy evolution models

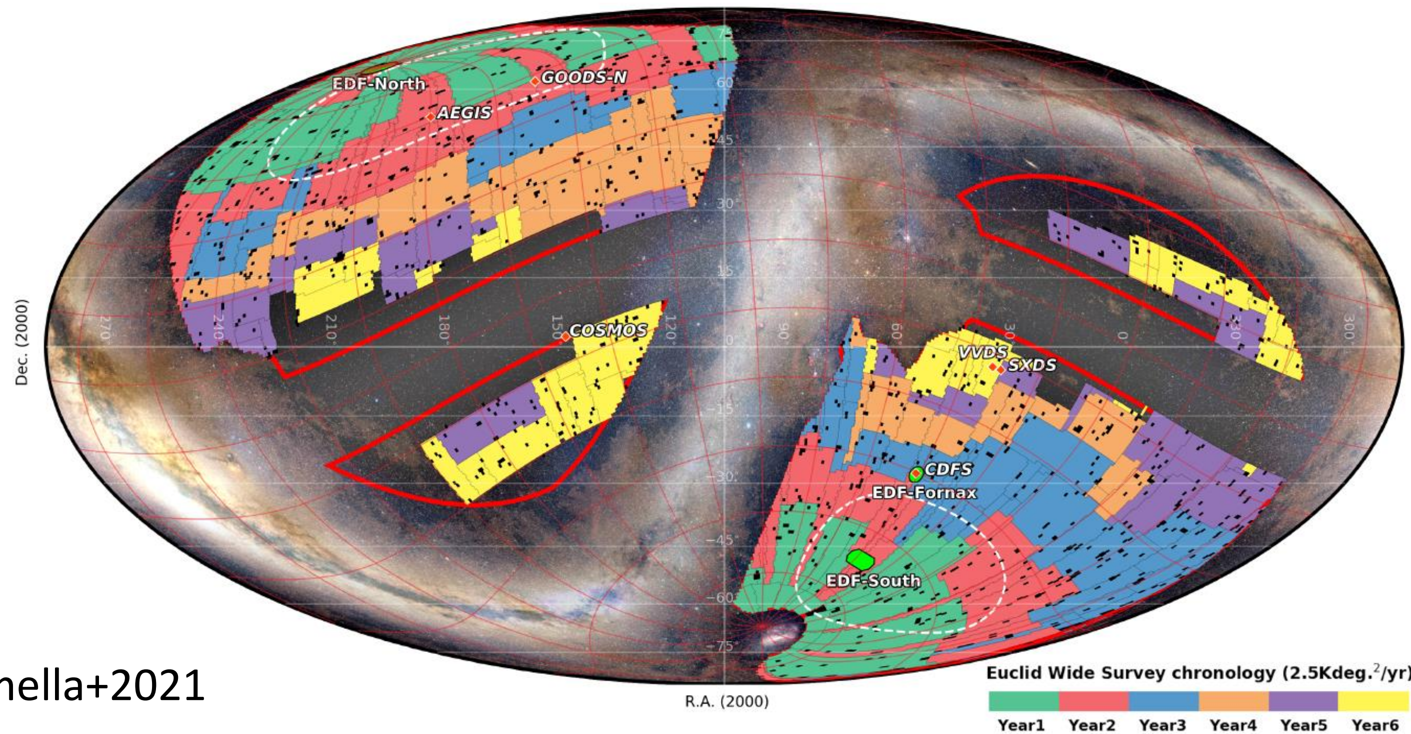


Luminosity functions
(Bethermin+2012)

Euclid



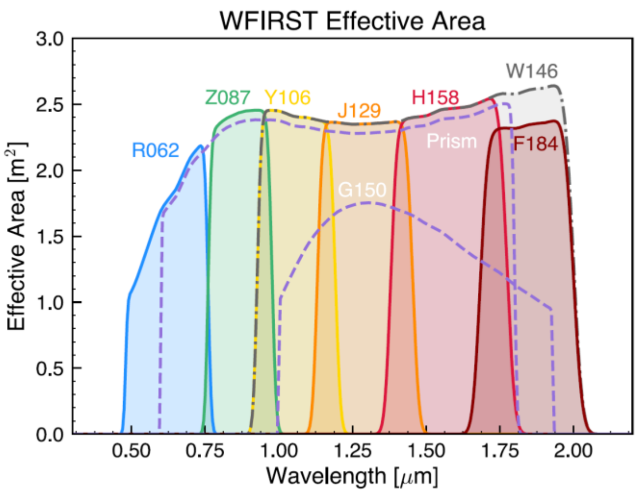
- Launch is planned for 2022
- Broad band filters of *R, I, Z, Y, J, H*
- Euclid Deep Fields (EDF)
  - EDF-North, EDF-Fornax, and **EDF-South** (decl. ~ -50°)



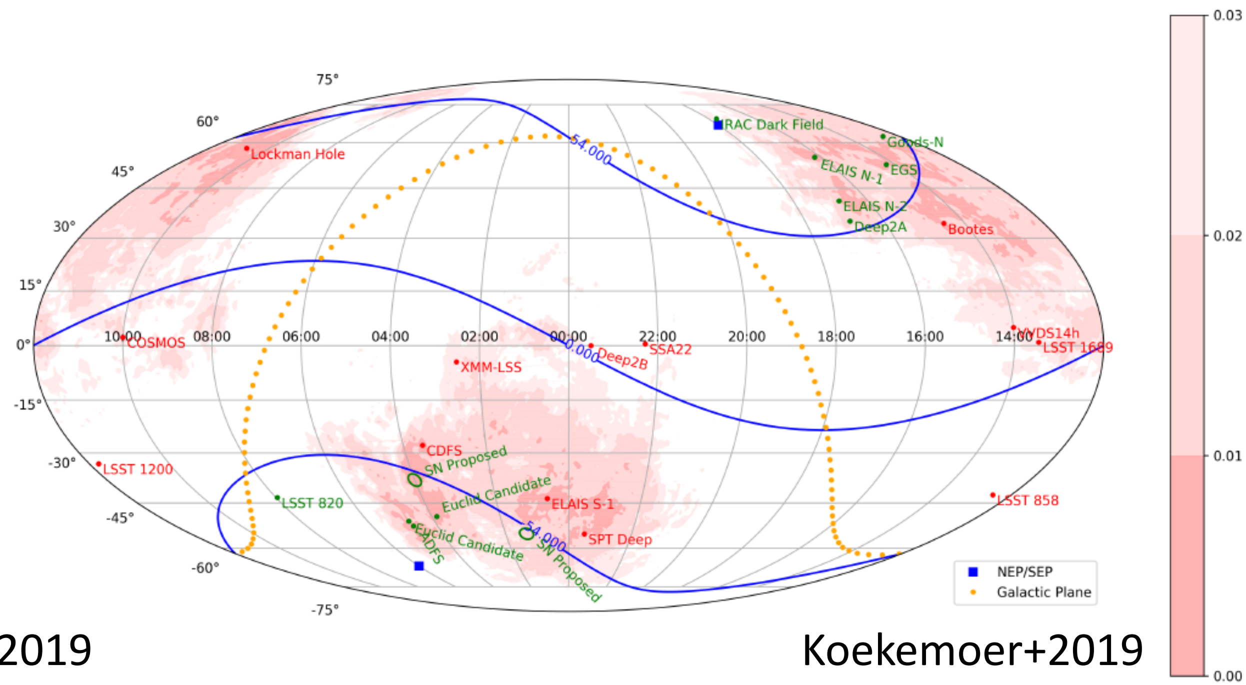
Scaramella+2021

Nancy Grace Roman Space Telescope

- NASA observatory with a 2.4 m primary mirror (same as HST)
- slated to launch in the mid-2020s
- 100x greater FoV than HST IR instrument

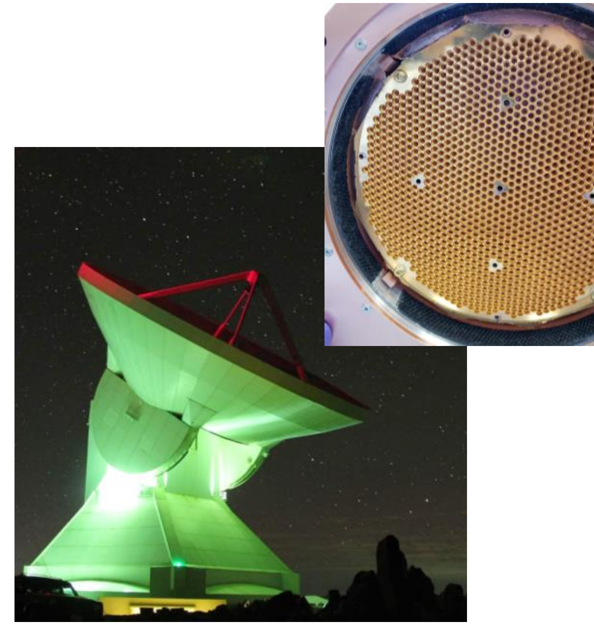


Akeson+2019



Koekemoer+2019

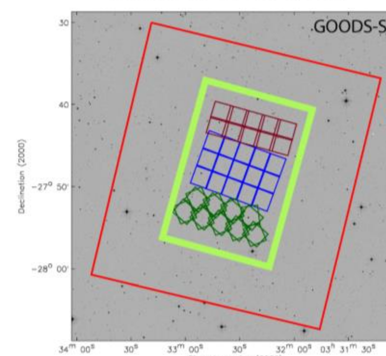
TolTEC Camera on LMT



- Large Millimeter Telescope
  - 50m diameter telescope at 4600 m
- TolTEC
  - 3 colors, 7000 KIDS detectors
  - Large Scale Structure Survey
    - 40-60 sq. deg.
  - Ultra-Deep Galaxy Survey
    - 0.8 sq. deg. in UDS, COSMOS, GOODS-S

λ	FWHM	N_{pix}	RMS in LSSS	RMS in UDGS
2.0 mm	9.5”	450	250 μJy/bm	25 μJy/bm
1.4 mm	6.3”	900	180 μJy/bm	18 μJy/bm
1.1 mm	5.0”	1800	120 μJy/bm	12 μJy/bm

GOODS-S: 10’ X 15’



Summary

- CIB contains important information of galaxy evolution
- The origin of CIB at 350-500 μm is not well understood
- ATT12 will resolve the CIB at 350-500 μm for the first time