SCUBA-2 WORKSHOP SESSION

Focus on Calibration and CO contamination

JCMT Users meeting workshop, Nanjing 2017

SCUBA-2 OUTLINE OF SESSION

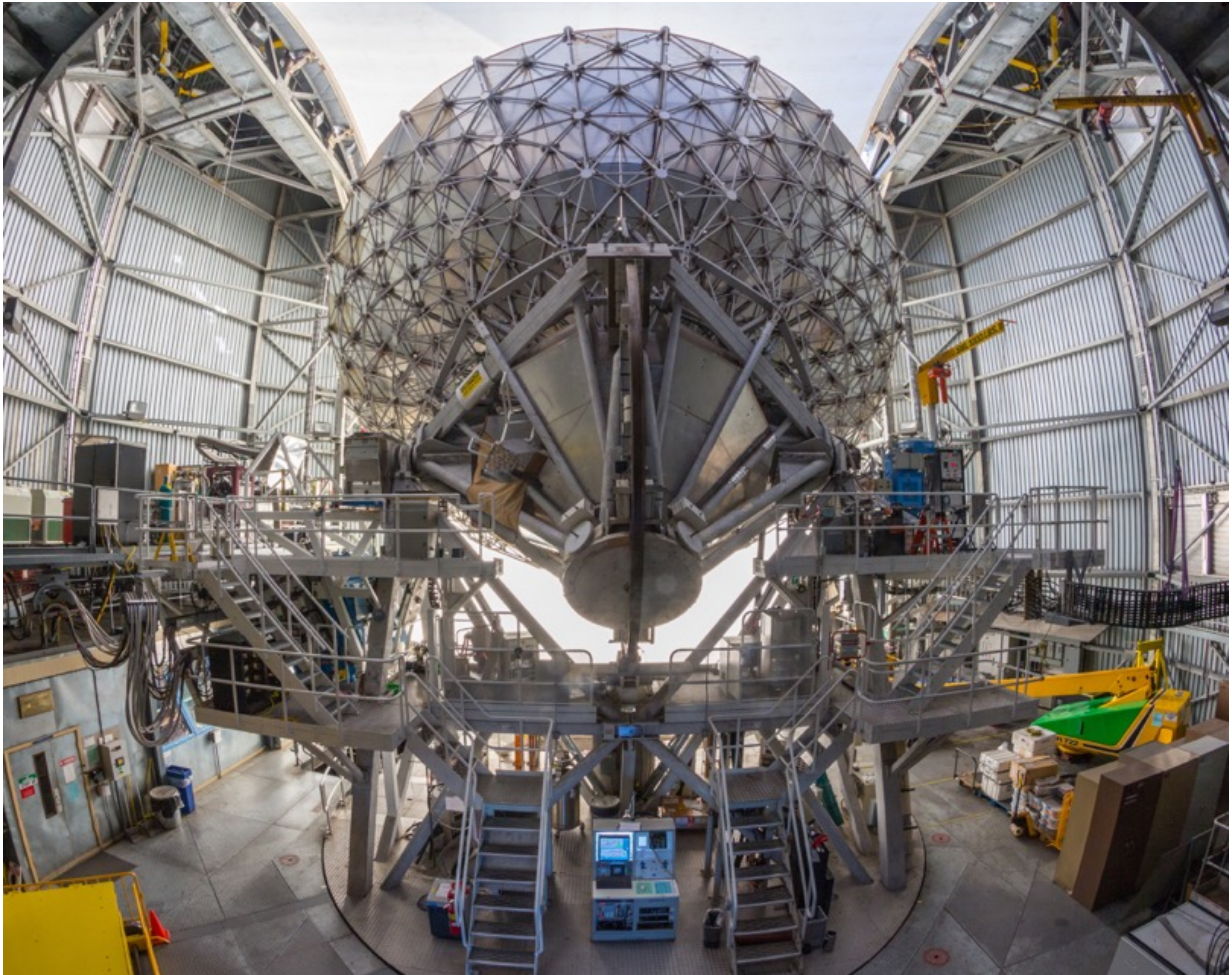
SCUBA-2 Calibration

- A reminder of how and why we calibrate
- A note on future updates to our WVM model and what this will mean

SCUBA-2 what's in the dust?

- a guide to CO contamination estimation using SCUBA-2 and HARP data.
- How to convert HARP data from K to pW (conversion factor)
- Look at how to include information from a HARP CO map during SCUBA-2 reduction.

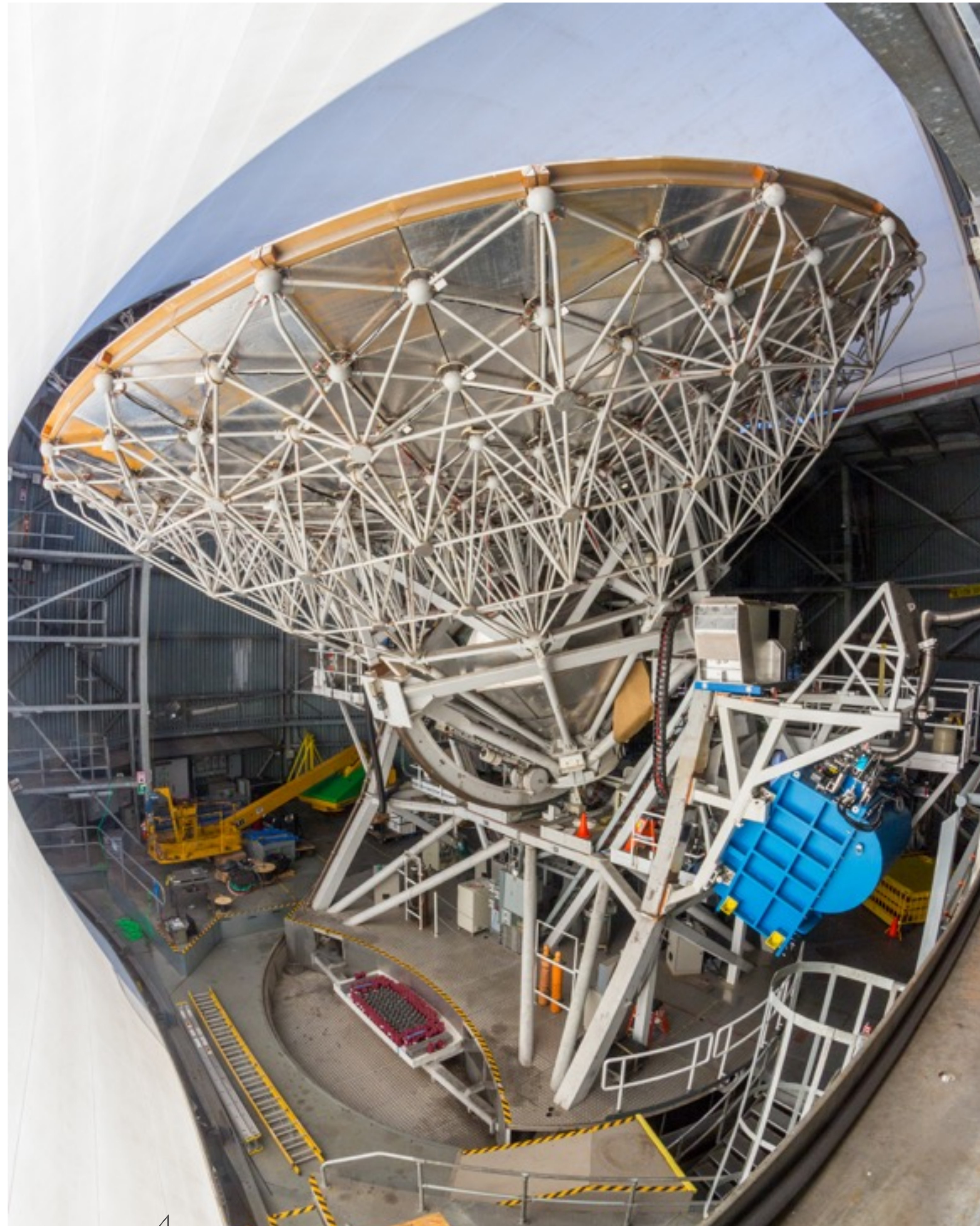
SCUBA-2



SCUBA-2

10240-pixel bolometer camera: 450 & 850 um simultaneously

Transition Edge Sensors



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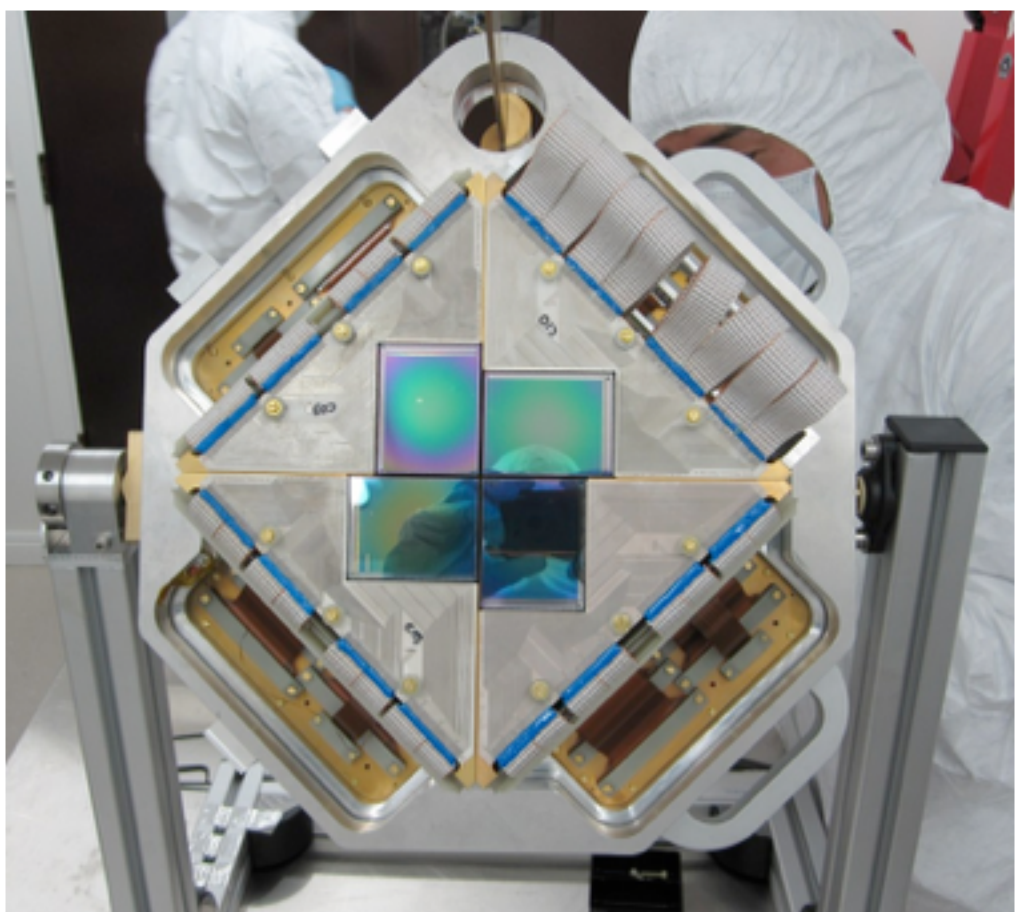

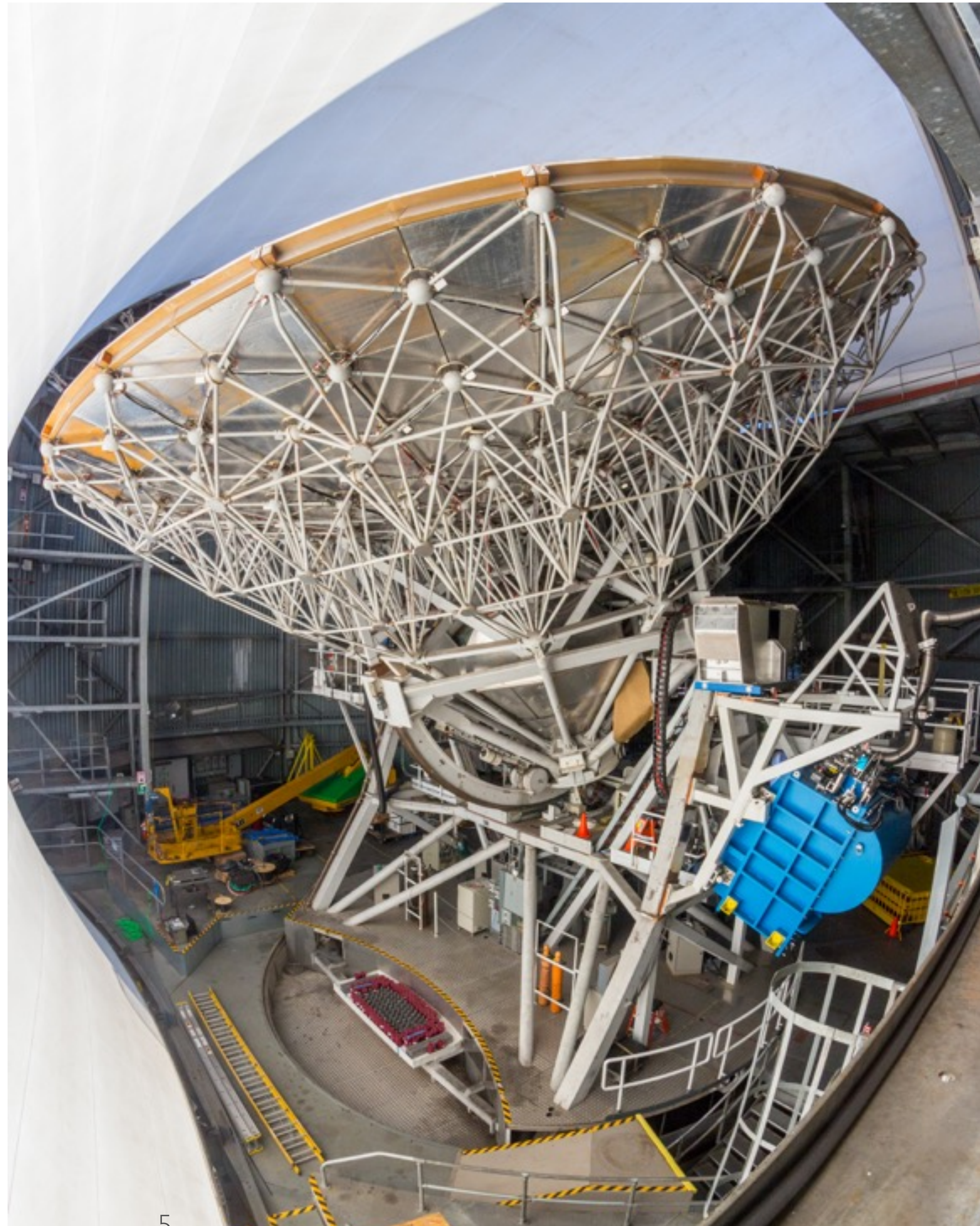

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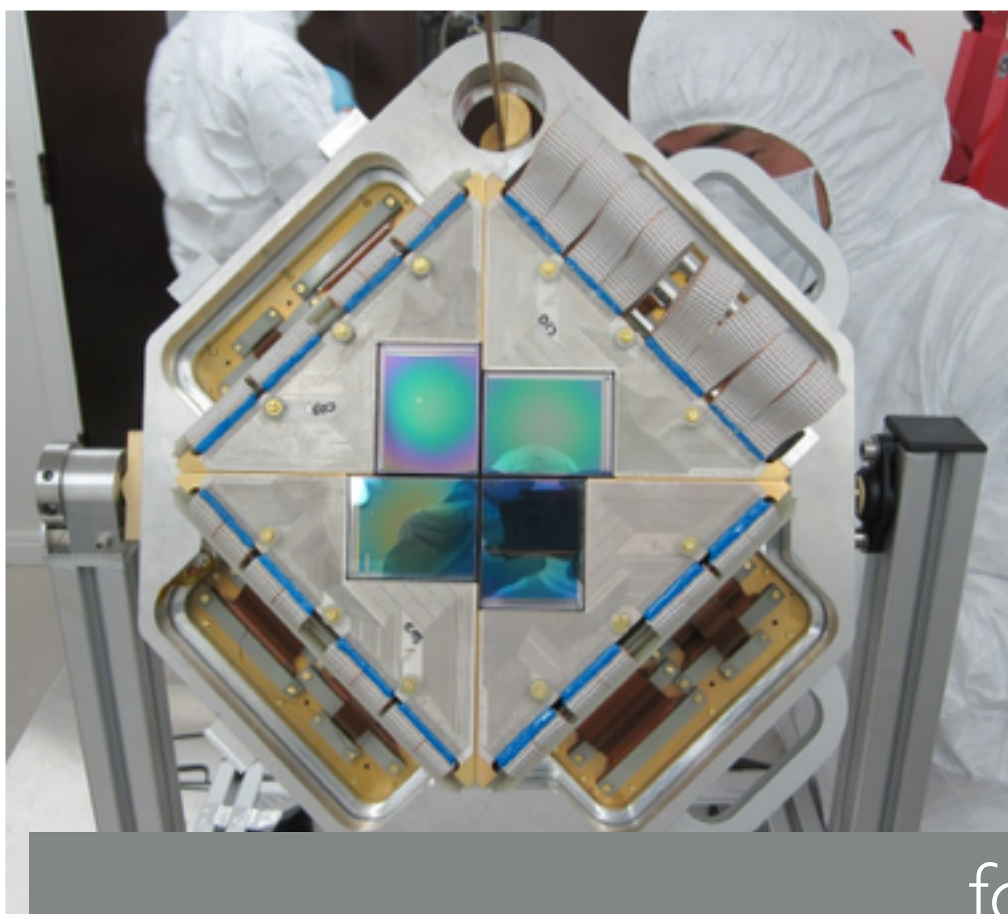

for more details see:
http://www.eaobservatory.org/jcmt/instrumentation/continuum/scuba-2/

SCUBA-2 DATA REDUCTION

http://www.eaobservatory.org/jcmt/science/reductionanalysis-tutorials/

JCMT Data Reduction/Analysis Tutorials

Contents [show]

Tutorials

There are now a number of tutorials offered for new users of the JCMT.

SCUBA-2 Tutorials

1. *SCUBA-2* Data Reduction/Analysis Tutorial 1 – Simple reduction of a *SCUBA-2* dataset using the *ORAC-DR* pipeline software using different data reduction recipes; an introduction to basic *Gaia* use.
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SCUBA-2 DATA REDUCTION

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JCMT Data Reduction/Anal

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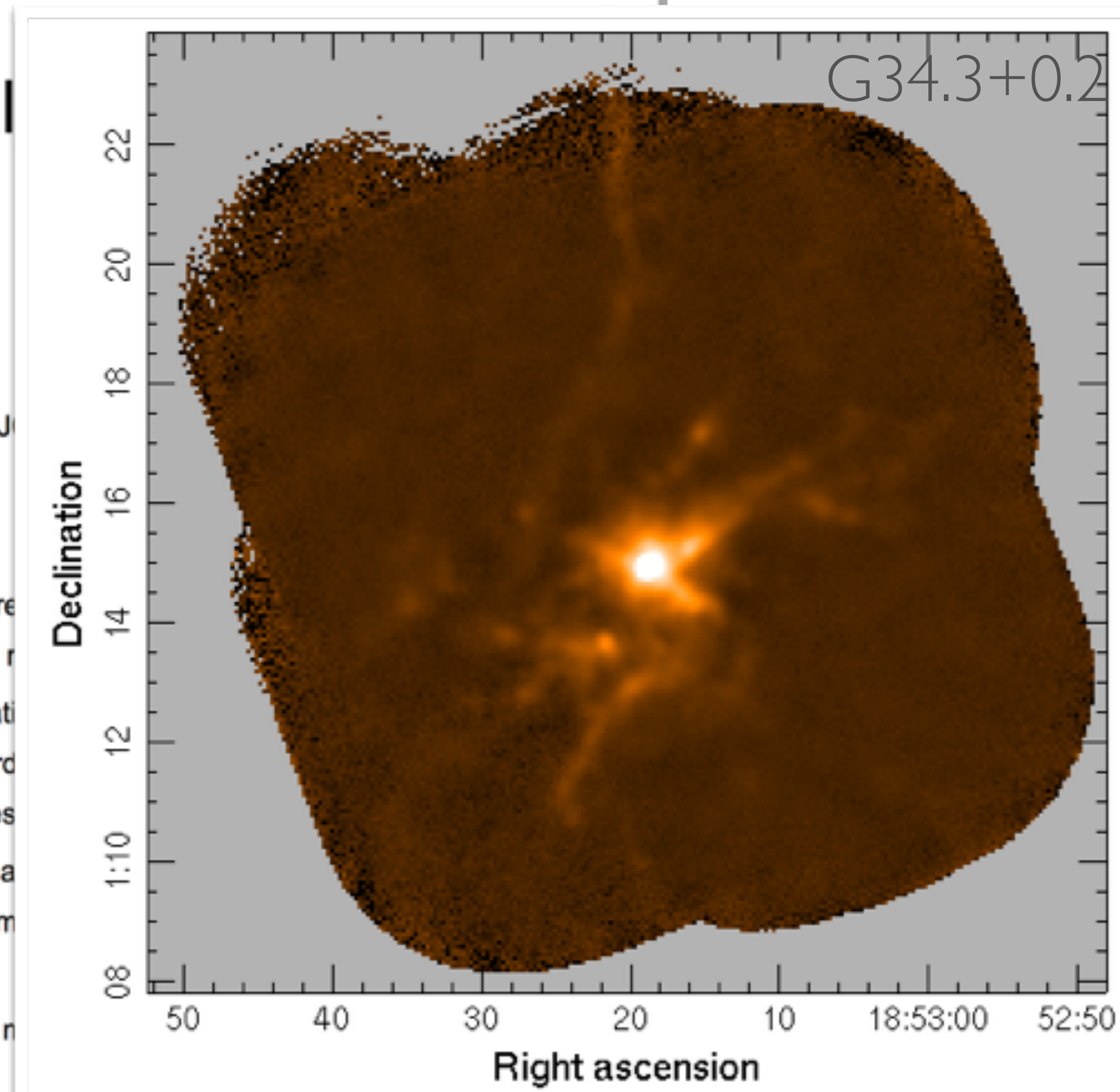

SCUBA-2 CALIBRATION

Two step process:

1) calibrate to the raw data to pW
2) calibrate power to Flux Density

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1) done with a "fast flat"
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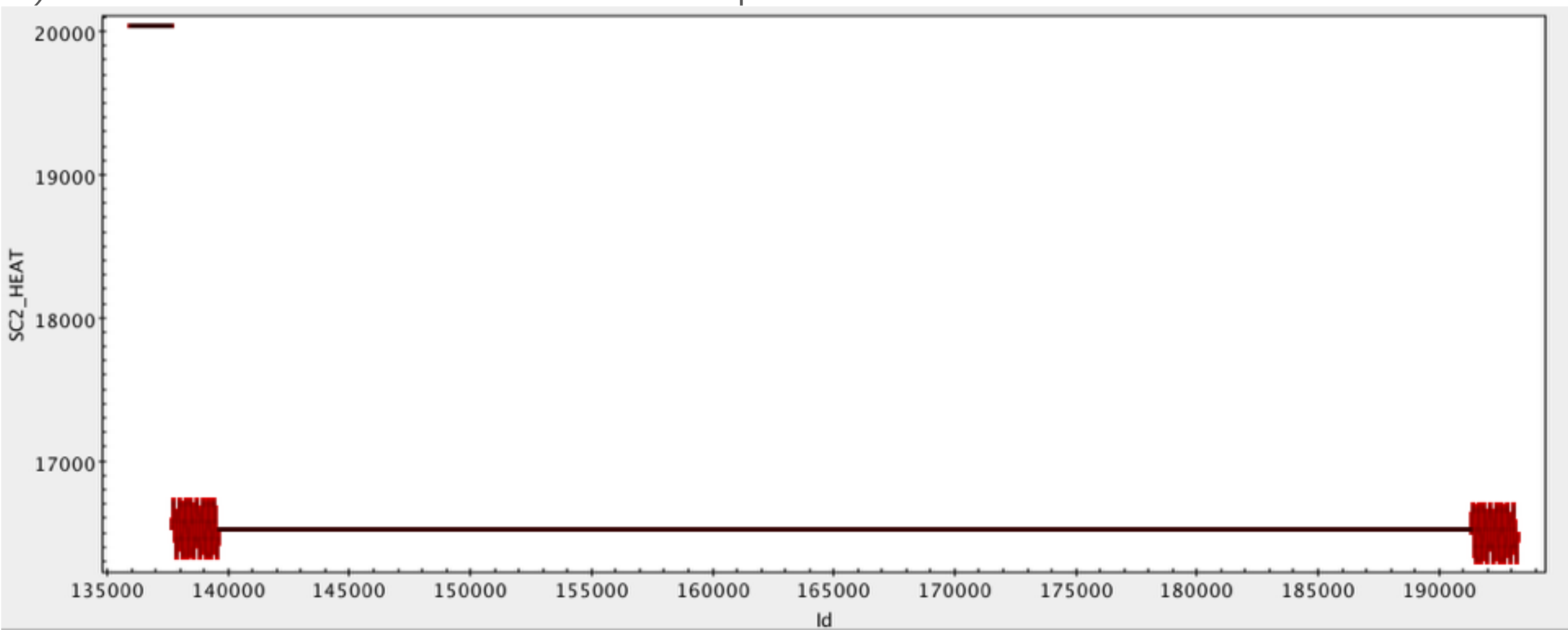


```
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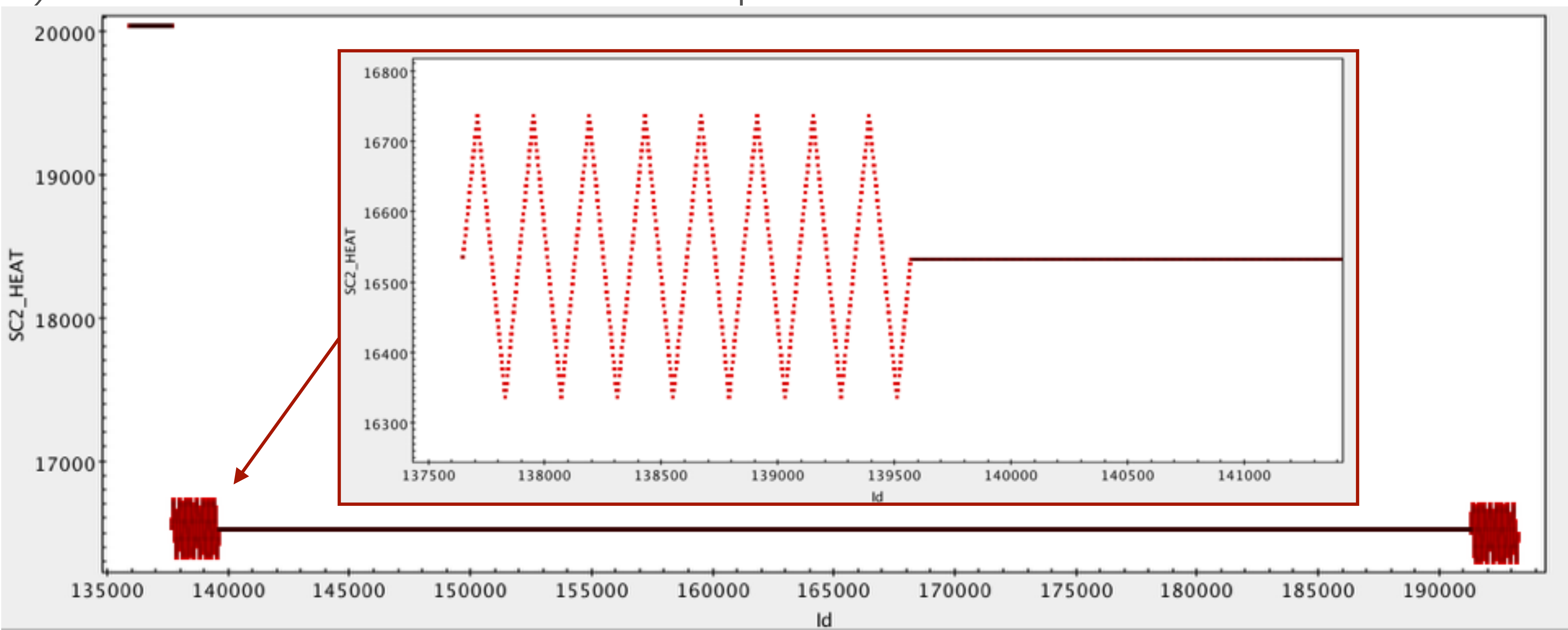


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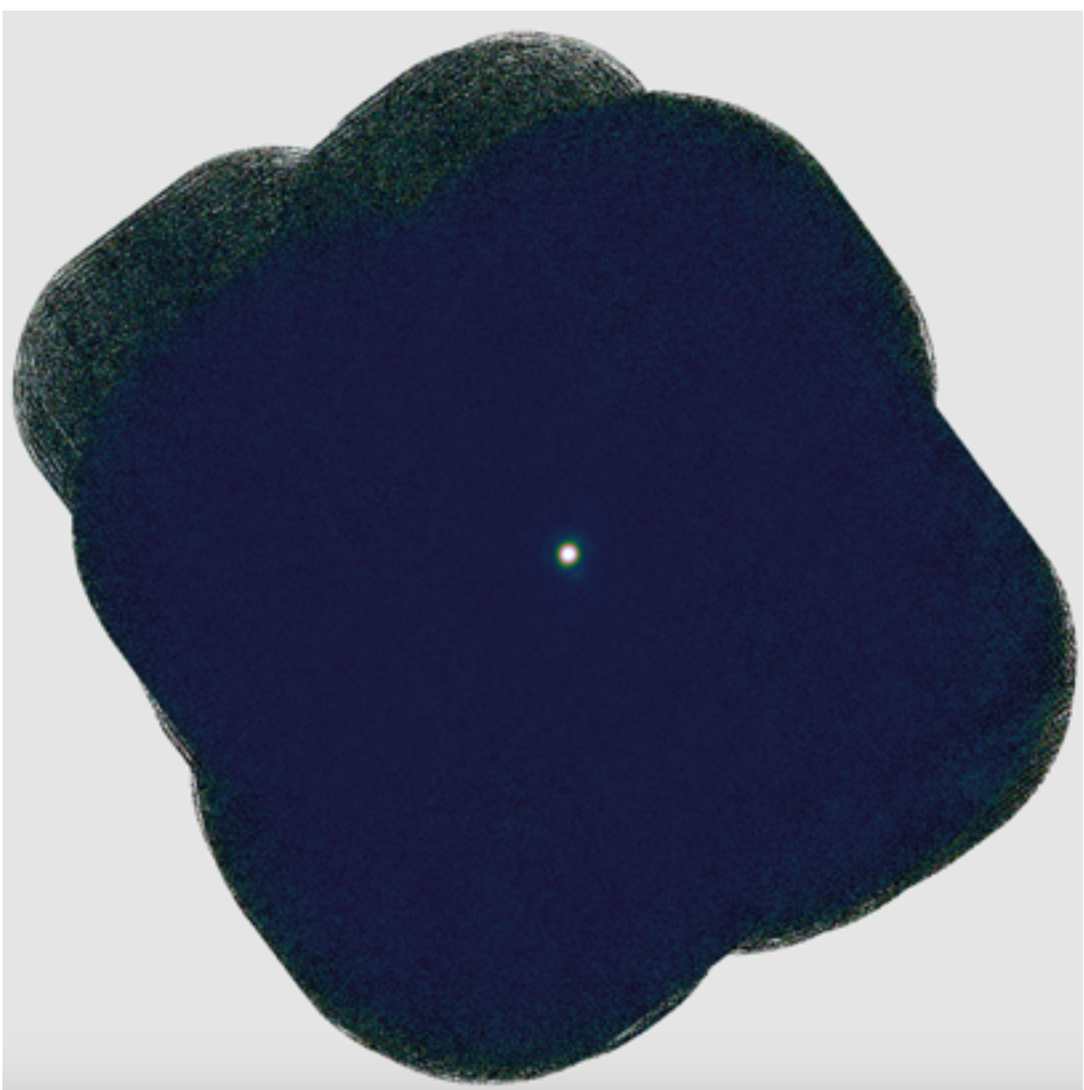

Our primary calibrators are Mars and Uranus, and commonly used secondary calibrators include CRL2688, and CRL618.

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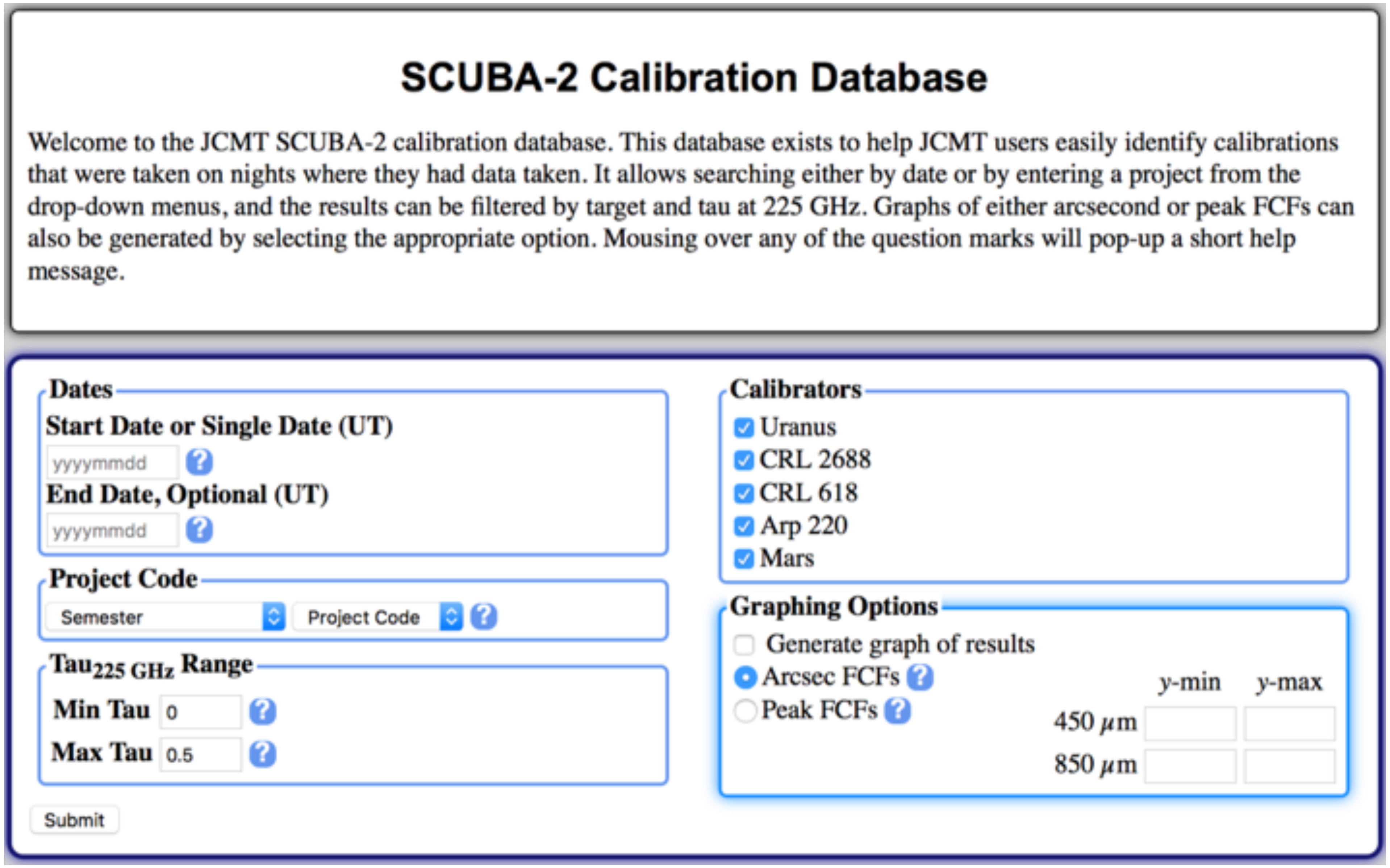
FCF values for any project (ideally) calculated using calibrator closest to project science data (in both time & space)

Both science & calibrator data should be reduced with latest version of *Starlink*, using same configuration file & same pixel size

General advice: reduce all calibrators taken near observations & watch out for major deviations!

SCUBA-2 CALIBRATION

http://www.eaobservatory.org/sc2cal



http://www.eaobservatory.org/jcmt/instrumentation/continuum/scuba-2/calibration/calibrators/

SCUBA-2 CALIBRATION

Nominal values:

	450μm FCF	850μm FCF
Beam	491	537
Arcsec	4.71	2.34

http://www.eaobservatory.org/jcmt/instrumentation/continuum/scuba-2/calibration/

Derived from *makemap* reductions of *Daisy* maps of calibrators using:

- *bright_compact dimmconfig* file
- 1 arcsec map pixel size

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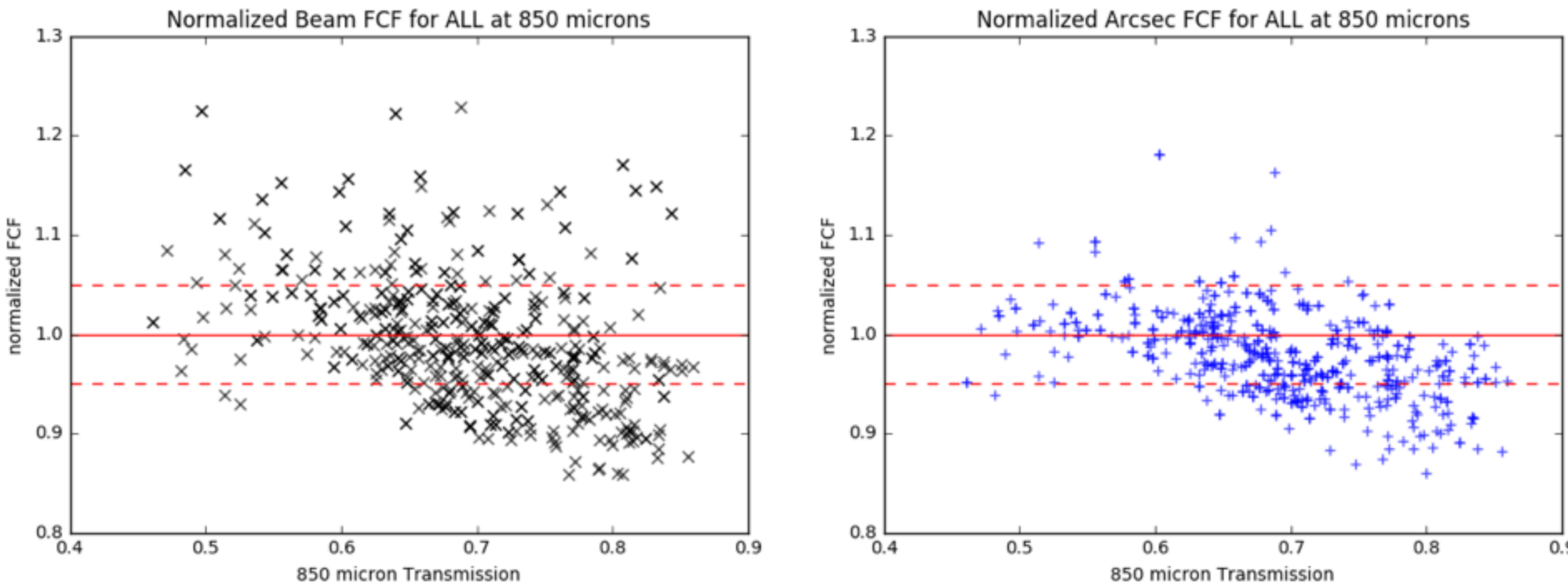
Should be used in one of two ways:

- Check derived FCF values before applying to user data (preferred method)
- Apply as first pass at source & noise strength estimation (not recommended)

To calibrate science data, always re-reduce calibrator observations with same pixel size as science data & **Always reduce archival SCUBA-2 data with latest *Starlink* release!**

SCUBA-2 CALIBRATION



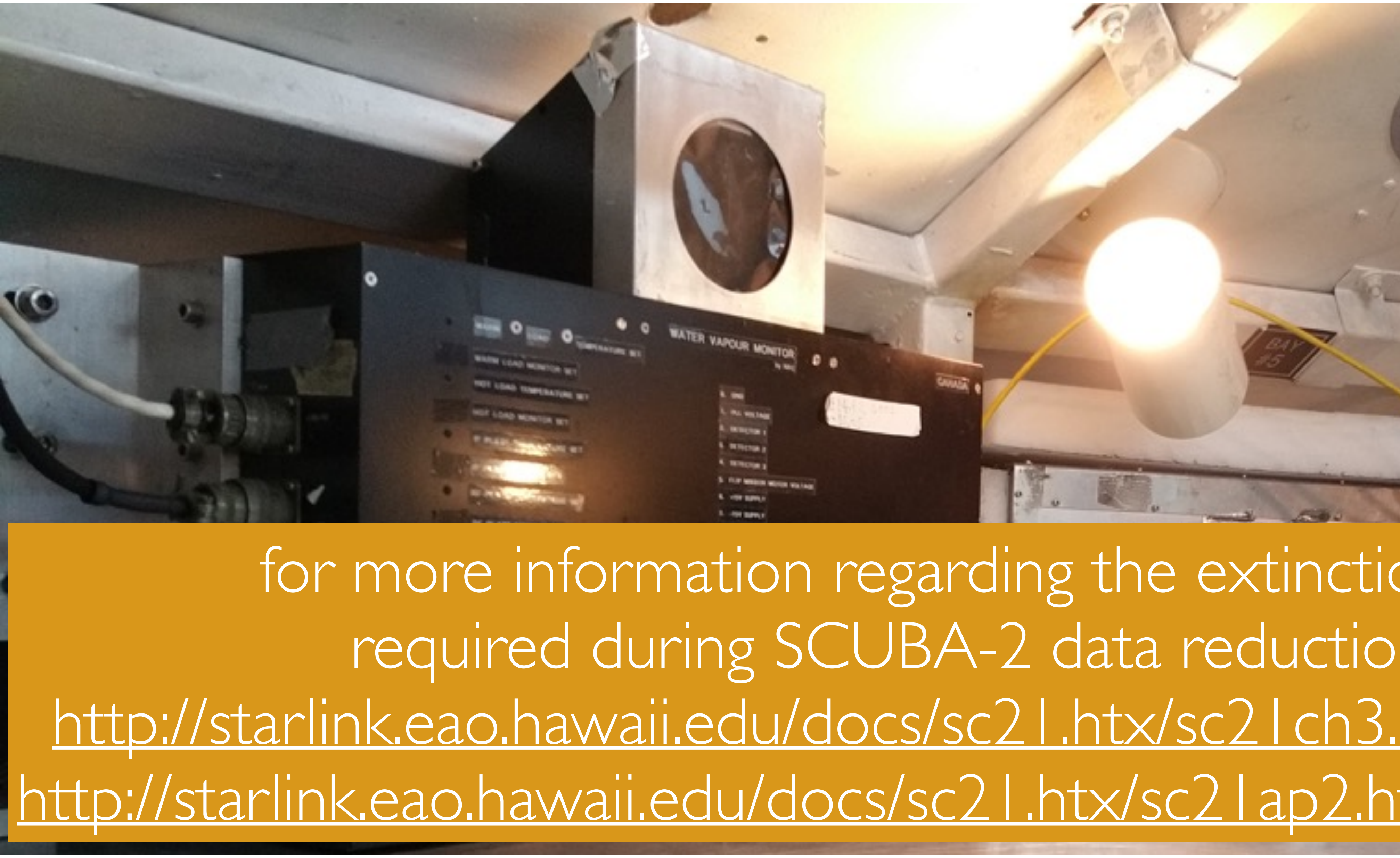
An inspection of the calibrators data taken between March 2015 and November 2016 - calibrators taken with the Black Water Vapor Monitor installed at the telescope indicates an issue with the Water Vapor Monitor as a function of transmission.

SCUBA-2 & THE WVM

WVM = Water Vapor Monitor

The Water Vapor Monitor self calibrates by looking at known warm and hot loads. The sky opacity it calculates is needed for SCUBA-2 reductions - the extinction model.

SCUBA-2 & THE WVM



WVM =
Water Vapor
Monitor

for more information regarding the extinction model
required during SCUBA-2 data reduction see:
http://starlink.eao.hawaii.edu/docs/sc21.htx/sc21ch3.html#x4-300002
http://starlink.eao.hawaii.edu/docs/sc21.htx/sc21ap2.html#x12-121000B

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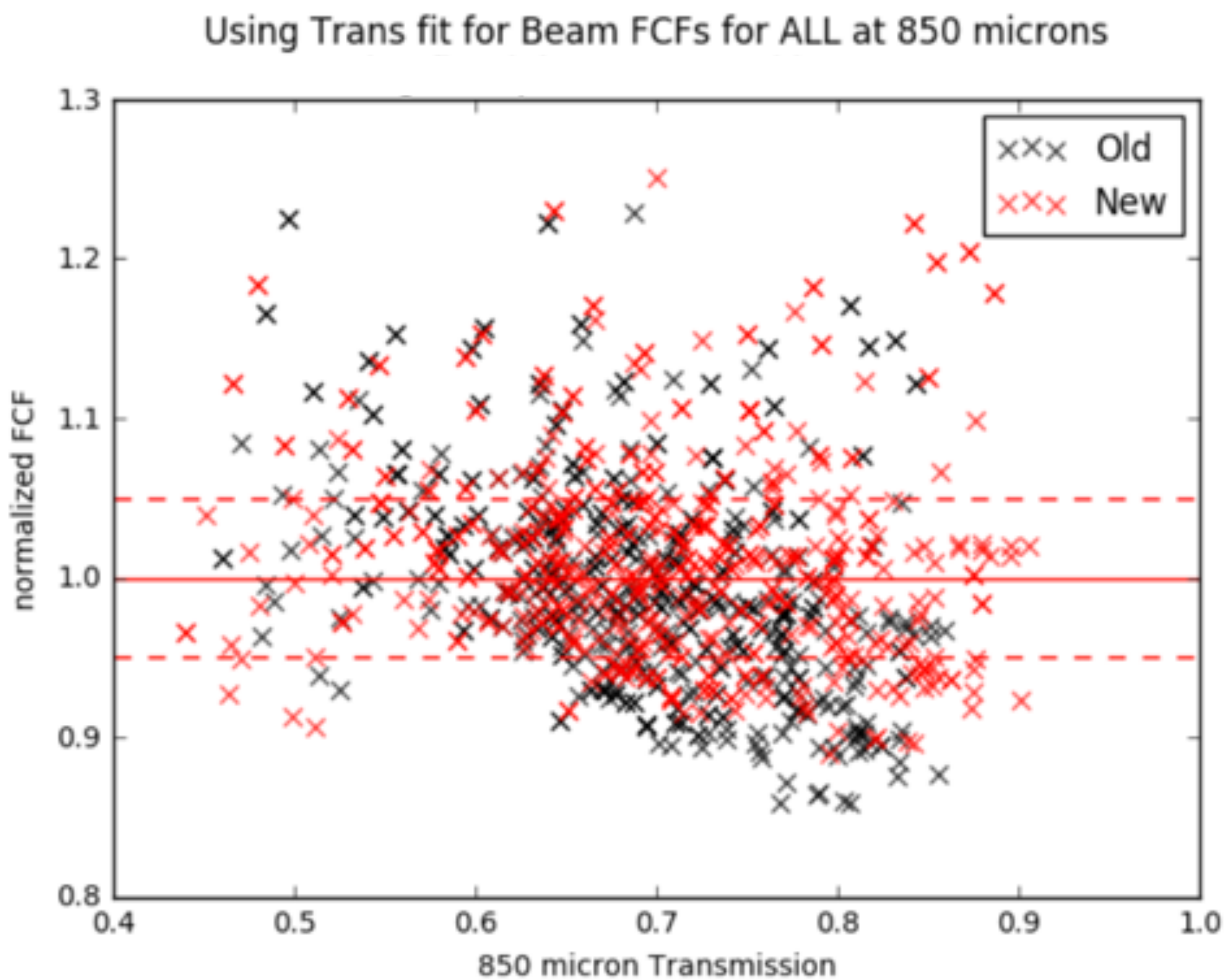
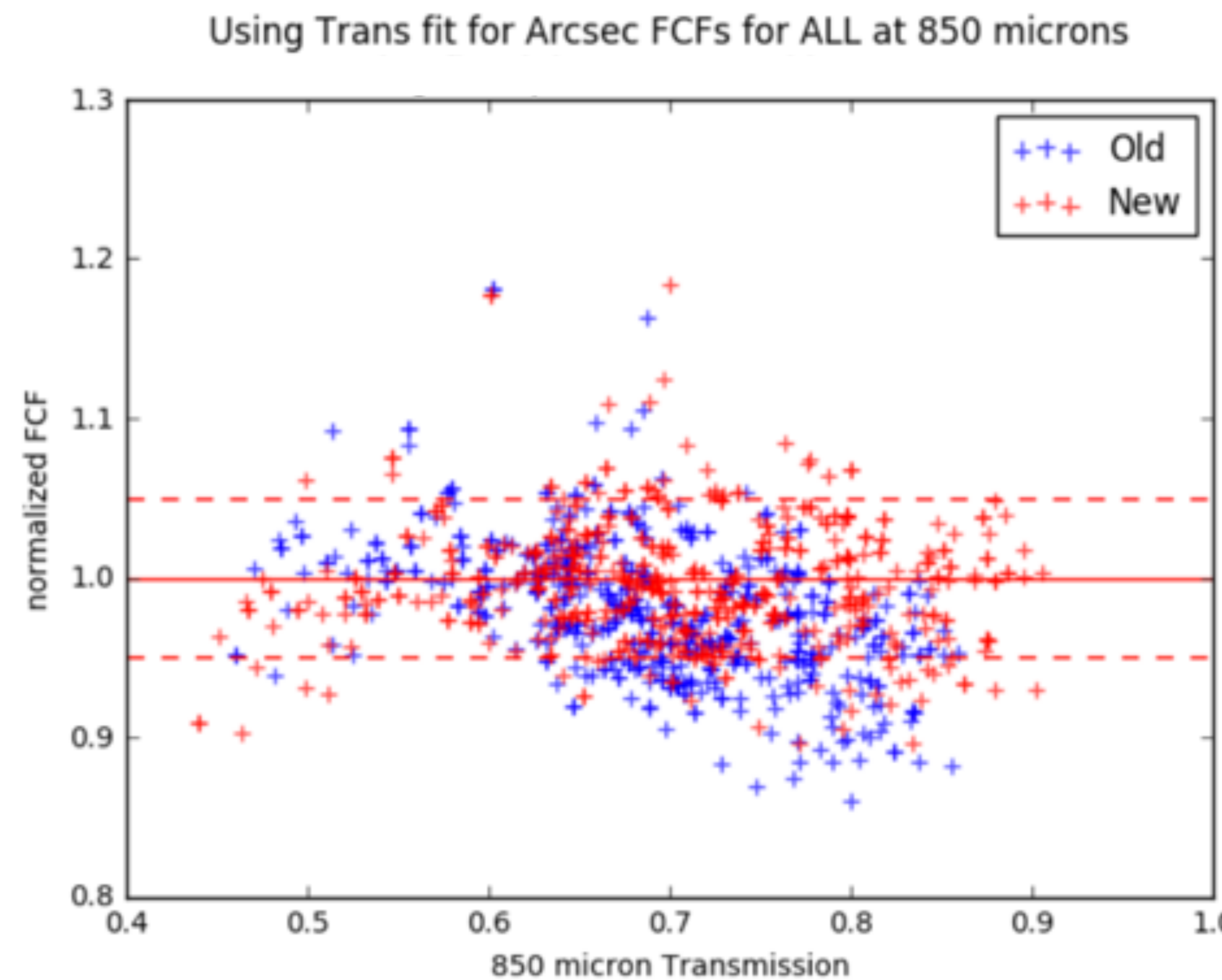
SCUBA-2 & THE WVM

Staff check the performance/ calibrate using ambient & LNe.

SCUBA-2 CALIBRATION





* work in progress *

by updating/improving our atmospheric model produced by our Water Vapor Monitor we will remove this transmission dependency.

SCUBA-2 CALIBRATION

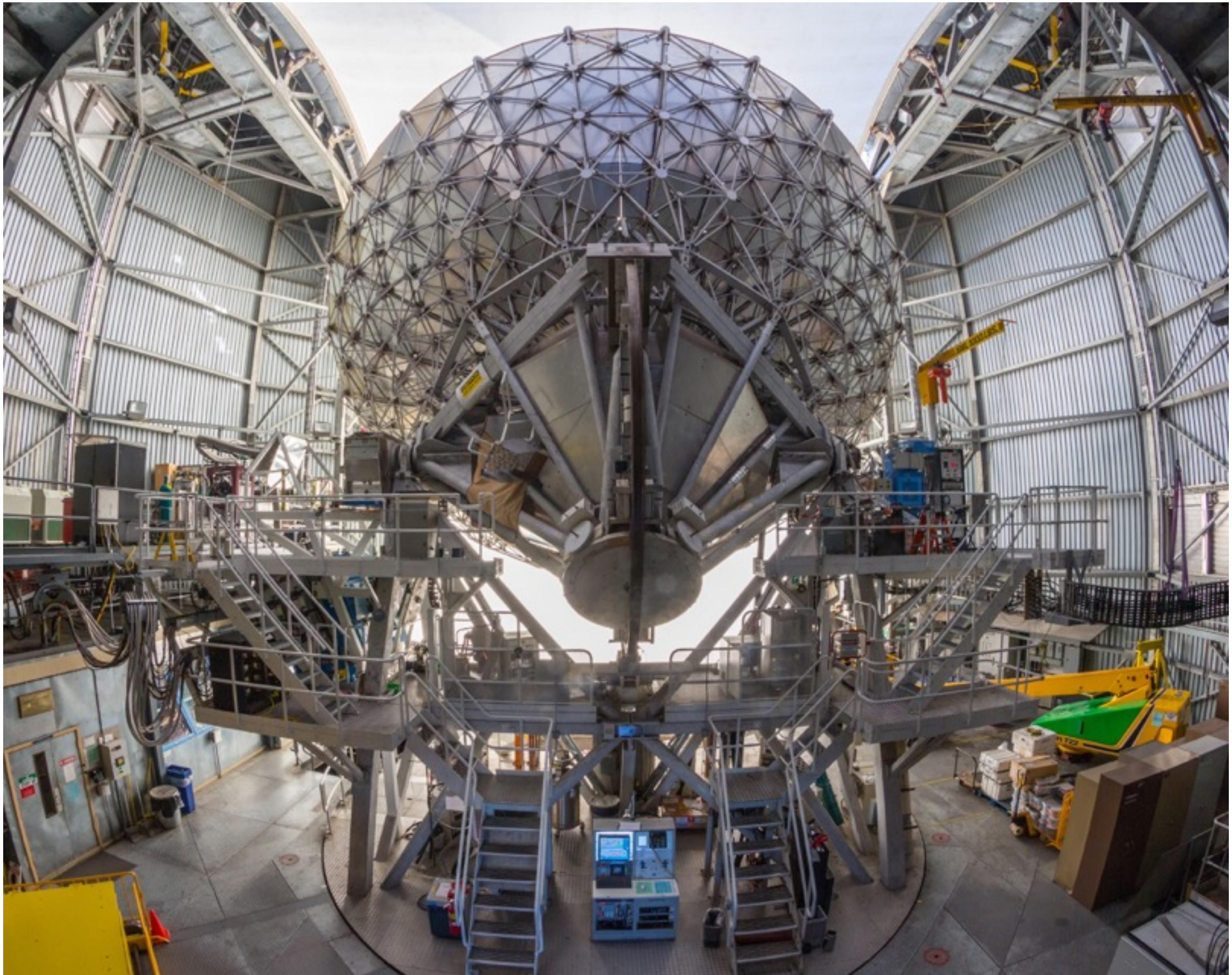
Stay tuned!

if in doubt contact your support scientist

With new filters the SCUBA-2 FCFs may improve SCUBA-2's performance.

Currently need to implement change in the WVM and obtained a larger number of observations to investigate the impact of the new filters.

SCUBA-2 WHAT'S IN THE DUST



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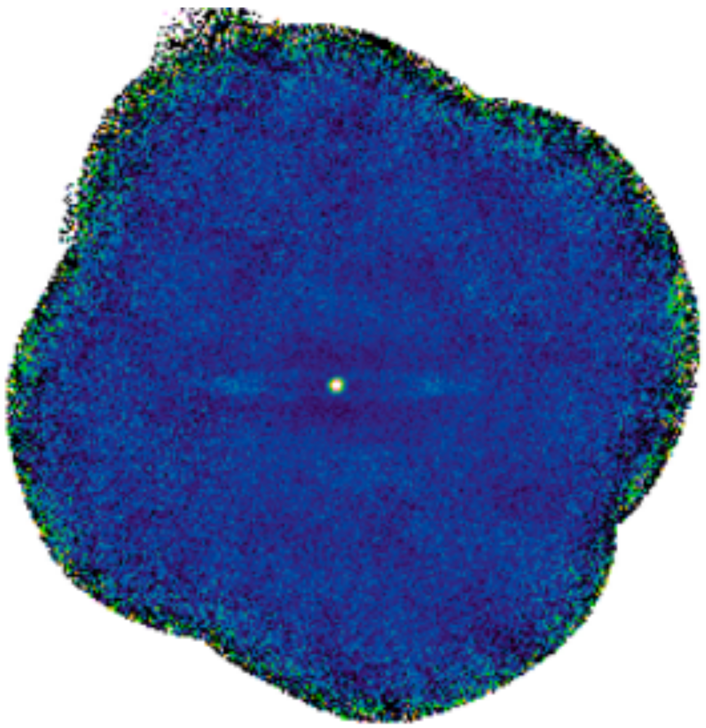
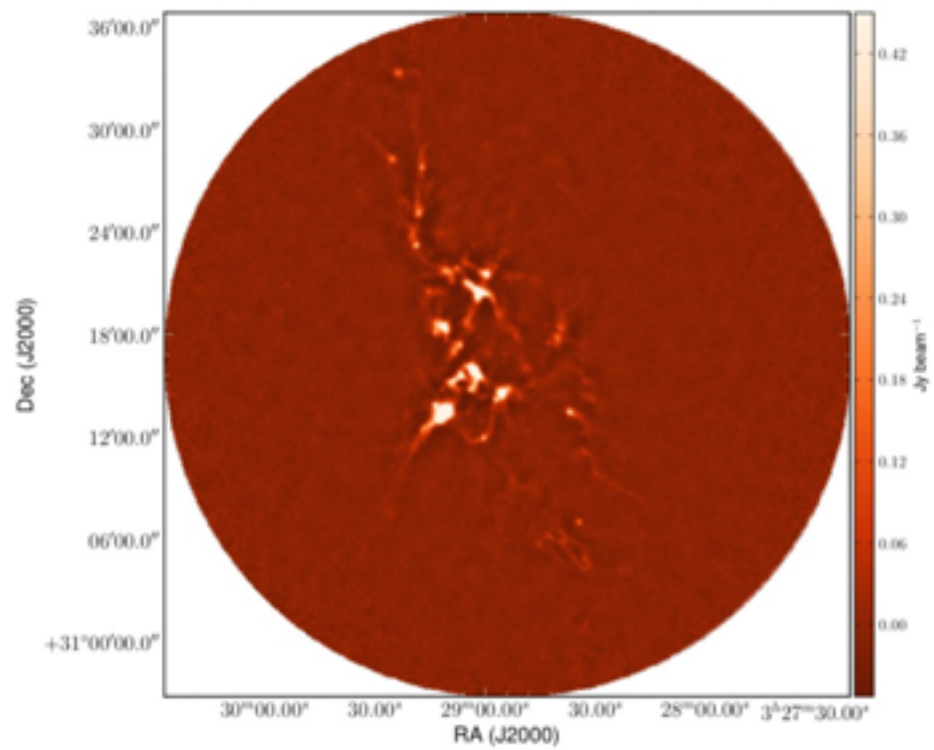
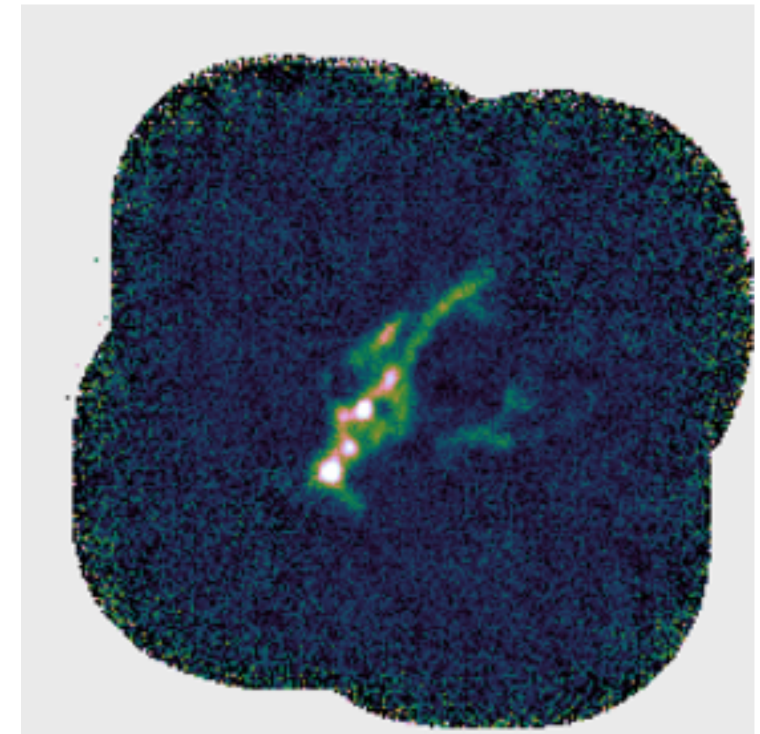


M104 the sombrero Galaxy as observed by the NGLS team



NGC1333 as observed by the Transient team



object G17.37+2.26 as observed by the SCOPE team

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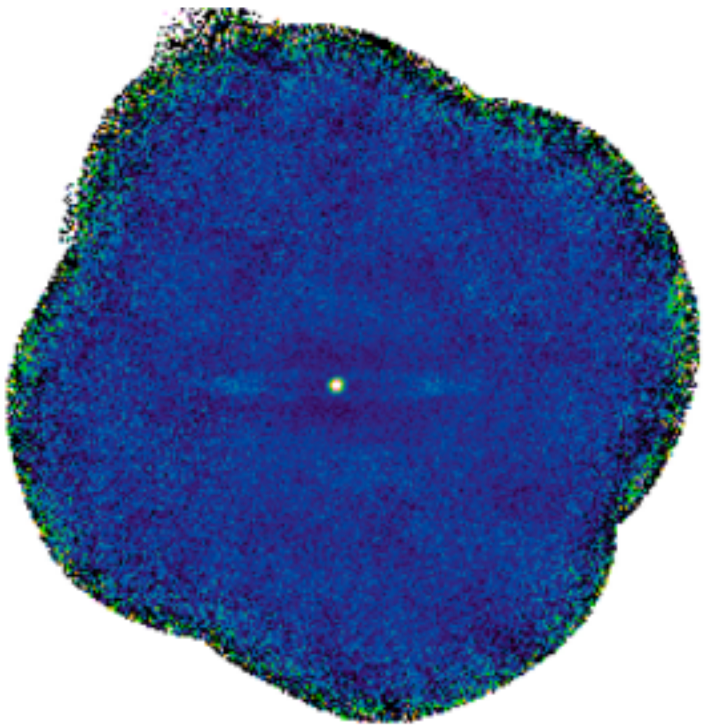

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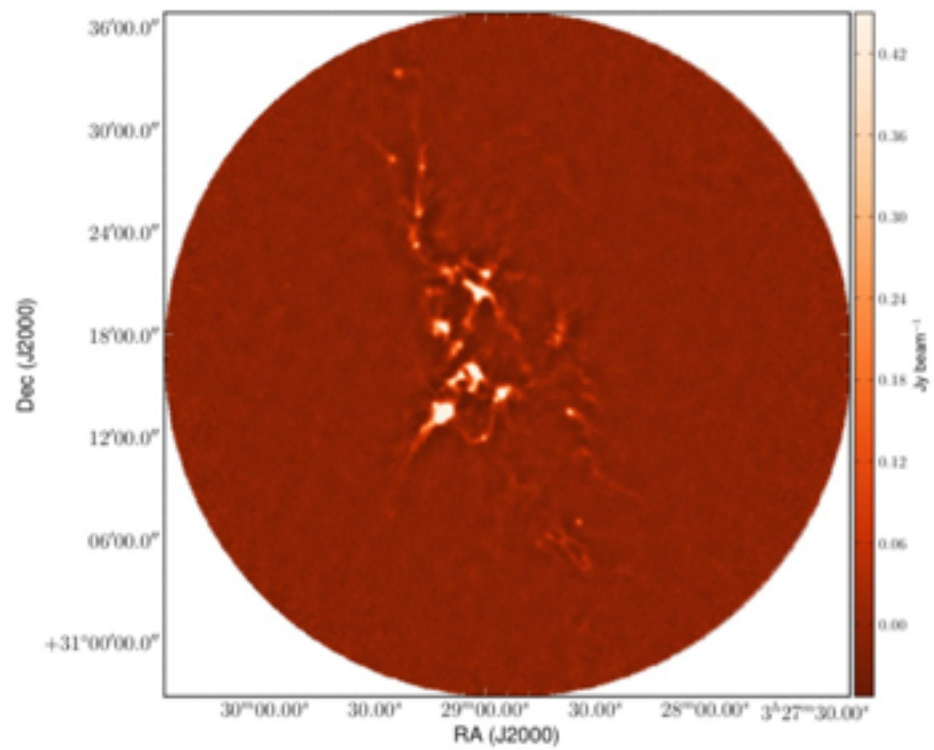

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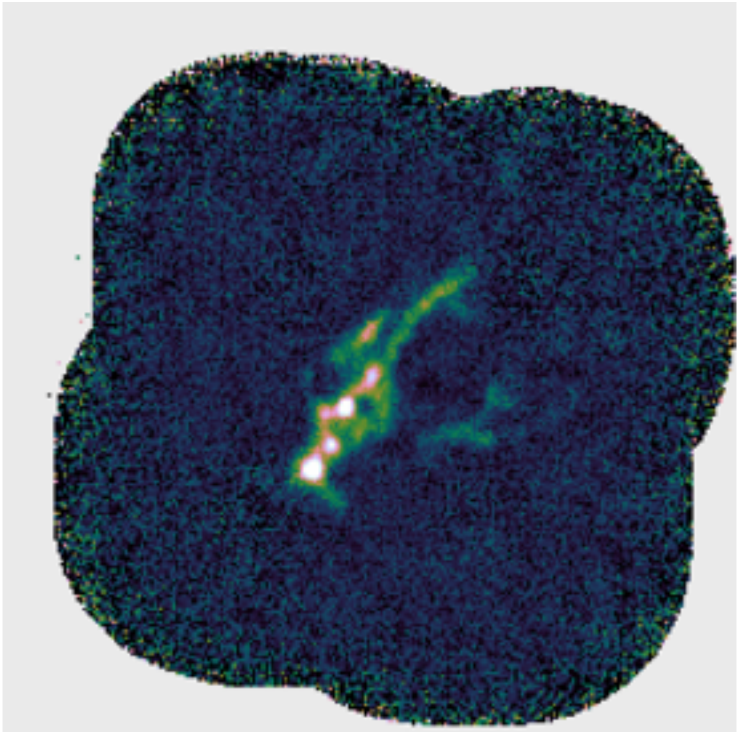

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Contamination in the SCUBA-2 850micron band can come from CO (3-2) line. Contamination in the 450micron band can come from CO (6-5) line (to a lesser extent).

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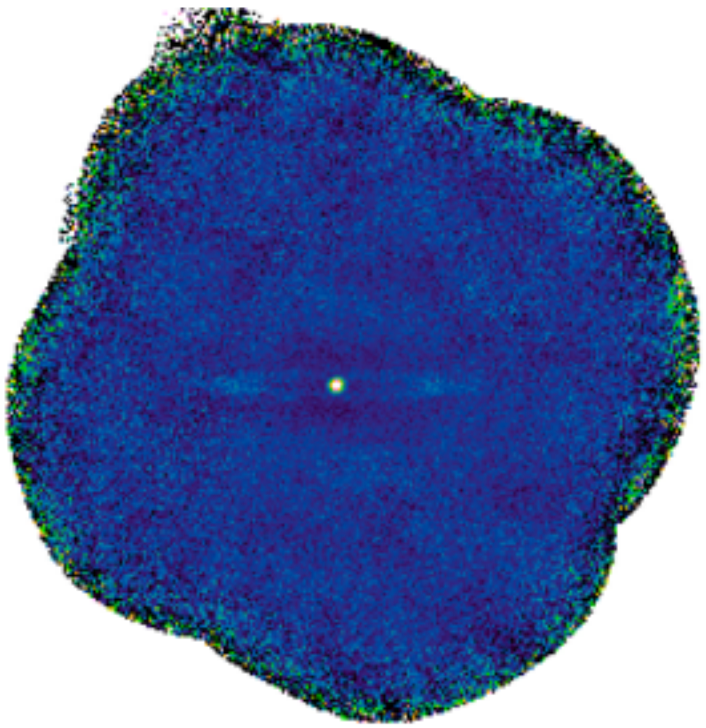

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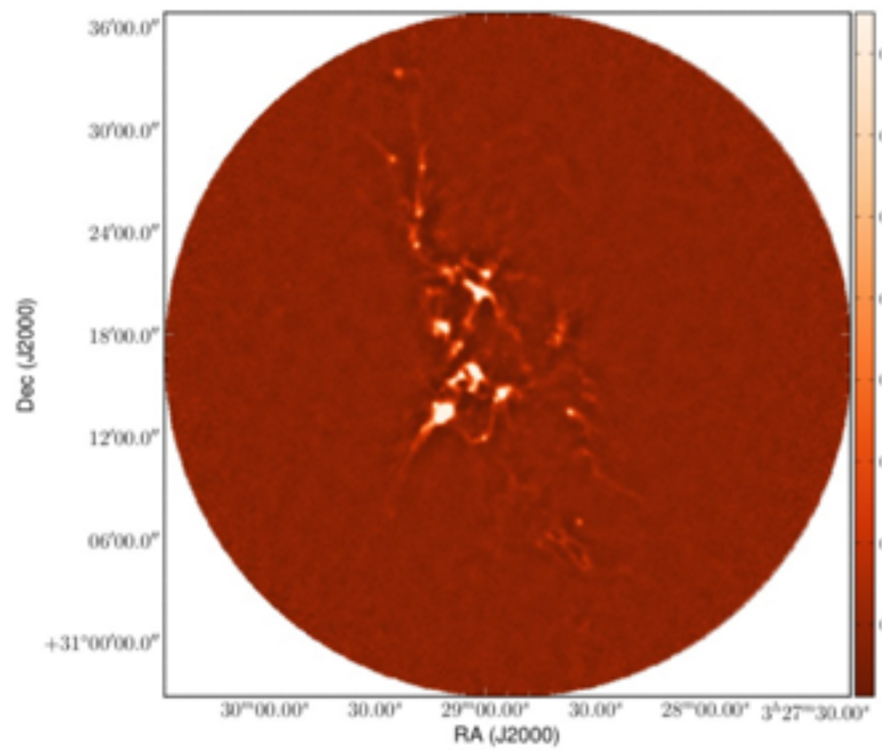

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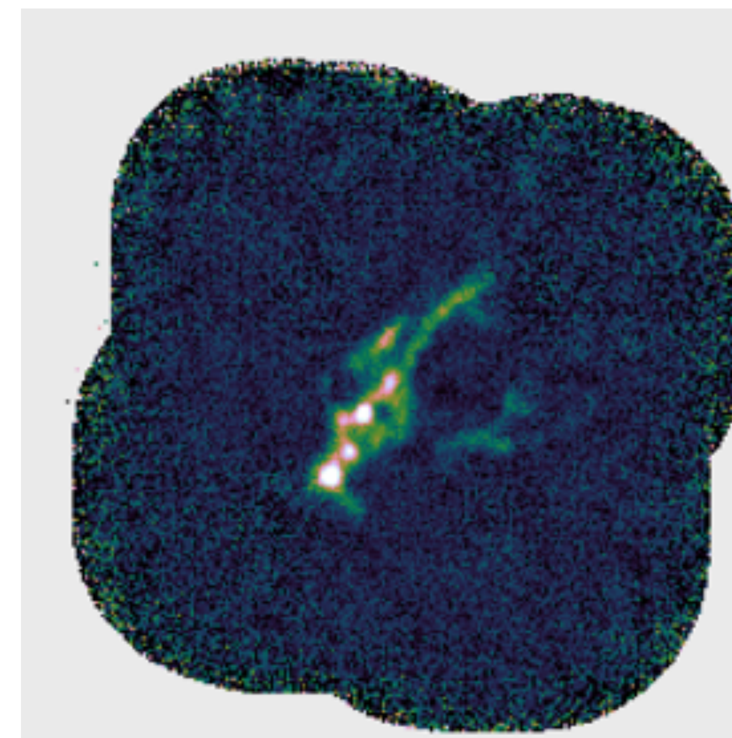

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Johnstone, D., Boonman, A. M. S., & van Dishoeck, E. F. 2003, A&A, 412, 157 - first to discuss typically found at 850microns of the order of 10% depending on the environment - higher values in regions where shocks are present.

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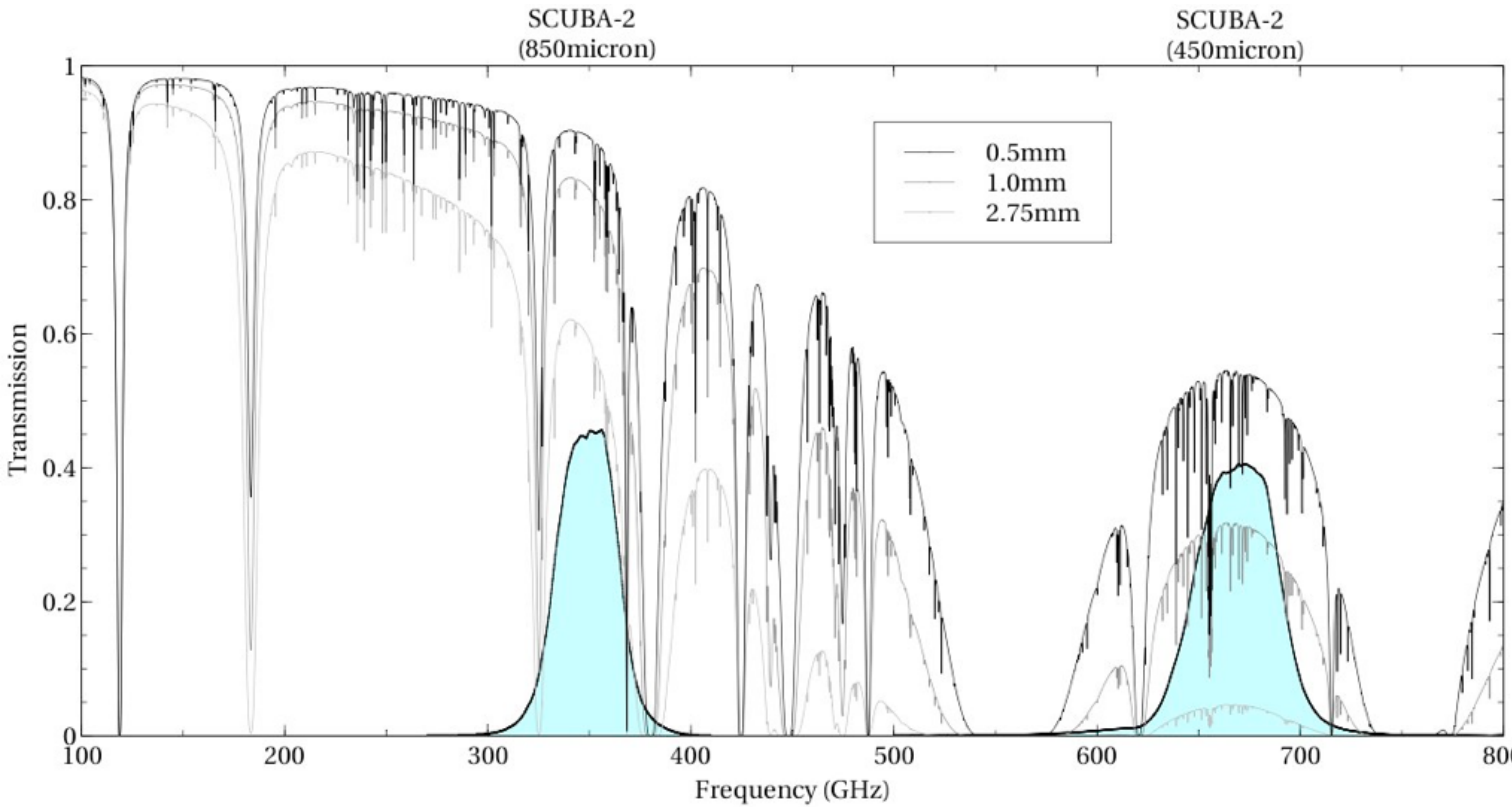

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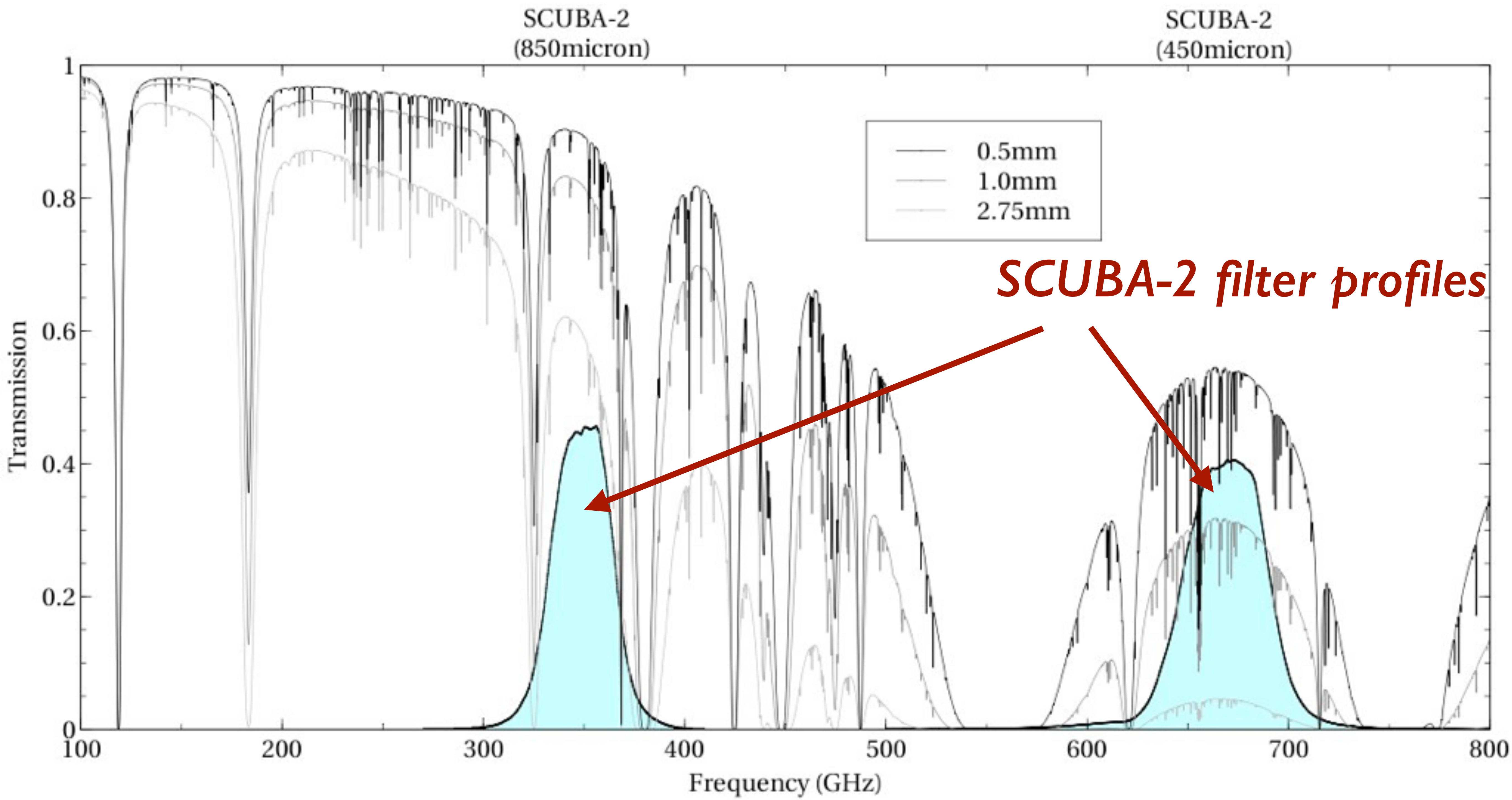

The primary culprit at 850: line emission from ^{12}CO (3-2)

The primary culprit at 450: line emission from ^{12}CO (6-5)

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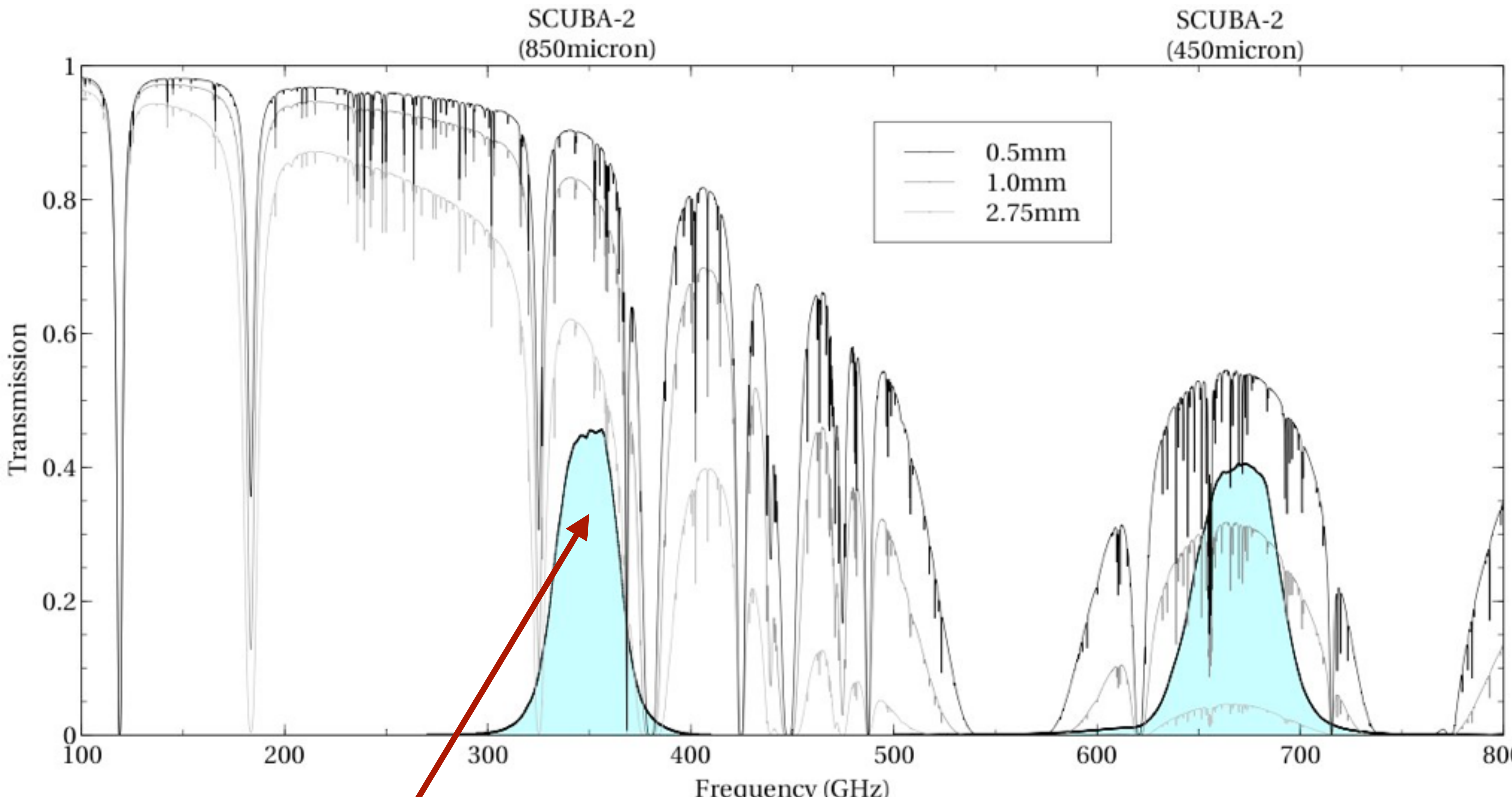

on a positive note at 850um we can estimate this from HARP data

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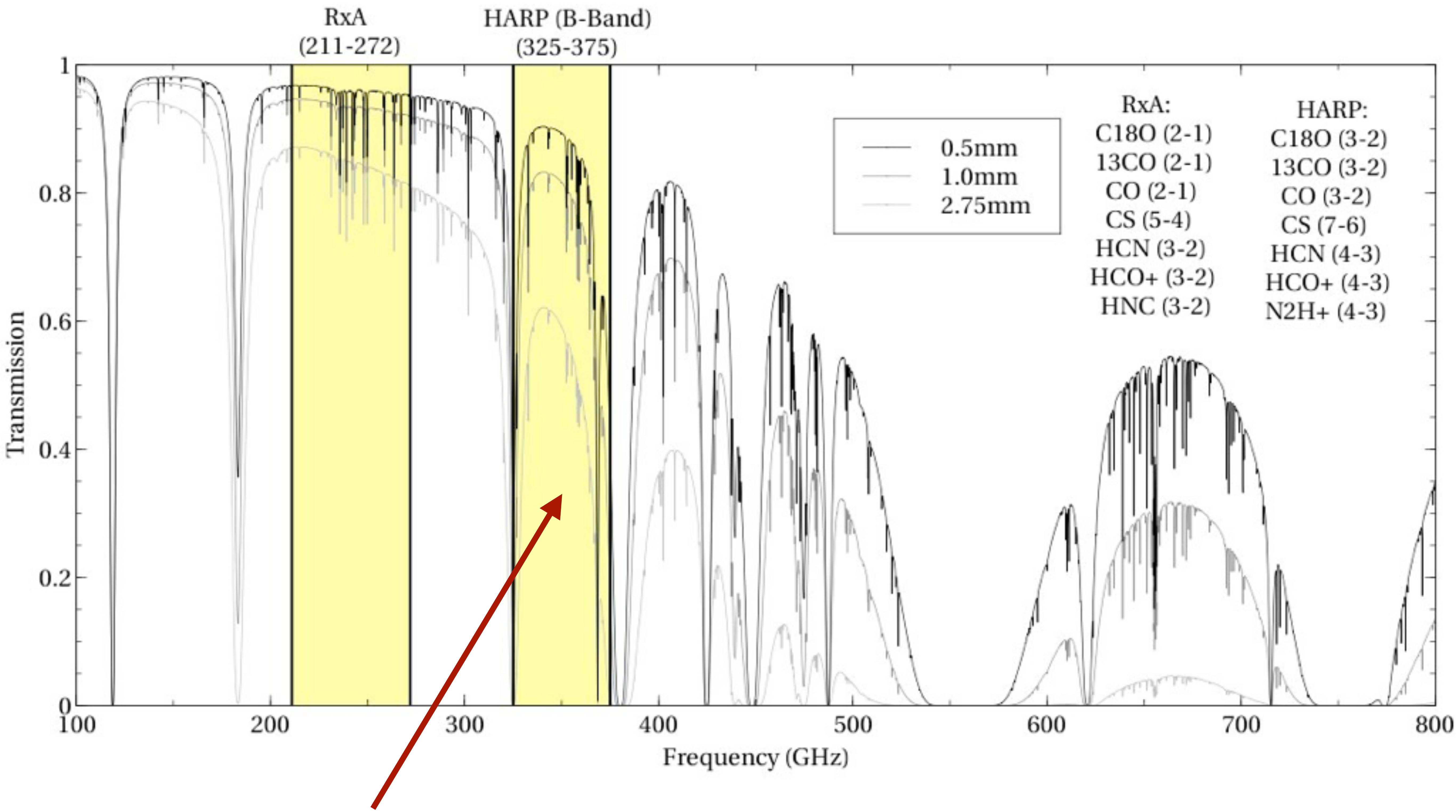

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They key to estimating the contamination from CO (3-2) in SCUBA-2 850 data is two fold:

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The conversion requires knowledge of

- SCUBA-2 filter profiles
- SCUBA-2 beam size
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(the C function)

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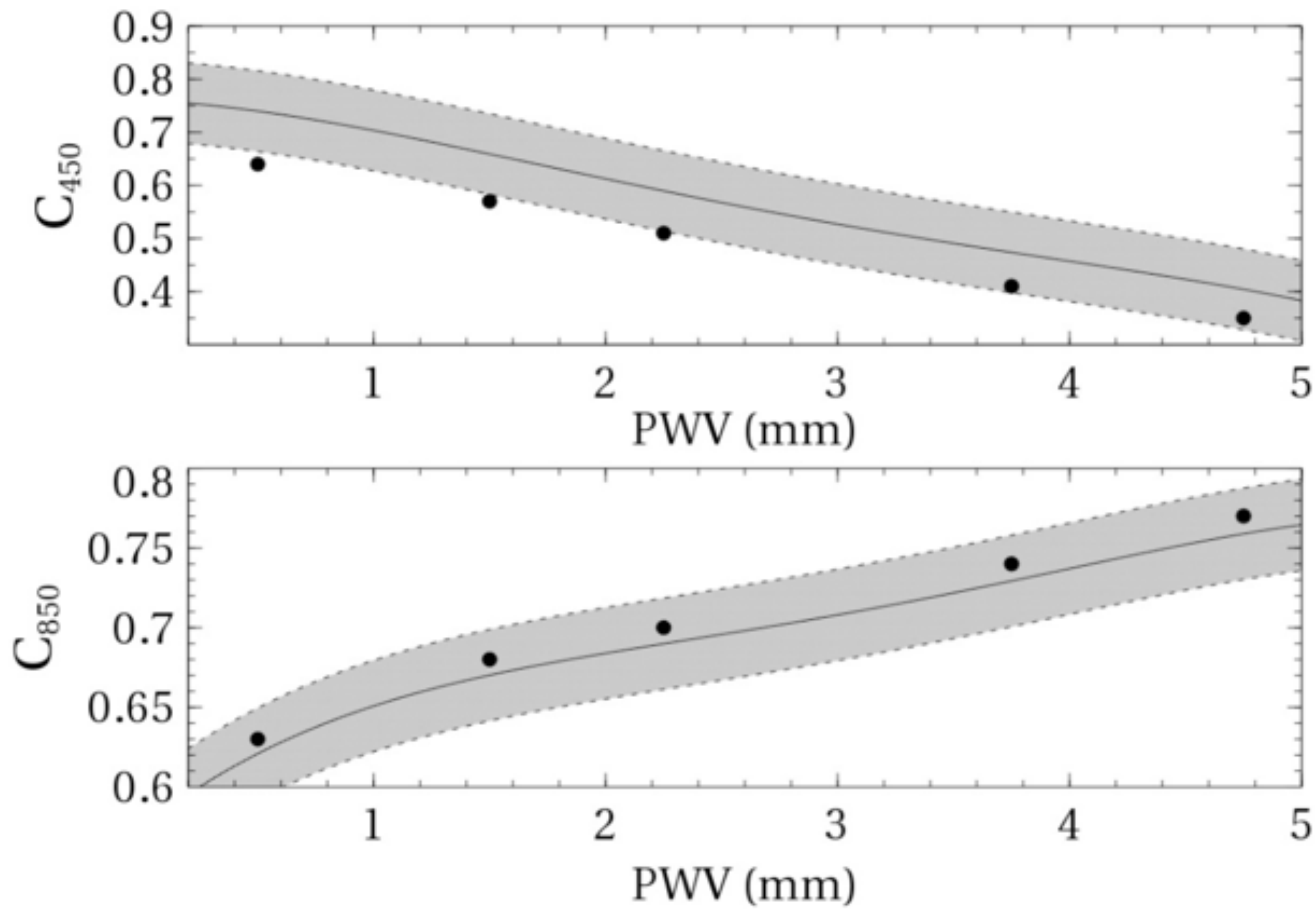
Drabek et al. 2012: http://adsabs.harvard.edu/cgi-bin/bib_query?arXiv:1204.6180

http://www.eaobservatory.org/jcmt/instrumentation/continuum/scuba-2/contamination/

SCUBA-2 THE C FACTOR

Convert HARP line intensities into pseudo-fluxes from K/km/s to mJy/beam need the conversion (C) factor



coefficient	850 μm	450 μm
α	0.574	0.761
β	0.1151	0.0193
γ	0.0485	0.0506
δ	0.0109	0.0141
ϵ	0.000856	0.00125

not a simple factor, but rather a function that is dependent on PWV
Precipitable Water Vapor

$Tau_{225GHz} = 0.04\ PWV + 0.017$

$C_{850} = \alpha + \beta\ PWV - \gamma\ (PWV2) + \delta\ (PWV3) - \varepsilon\ (PWV4)$ mJy/beam / K/km/s

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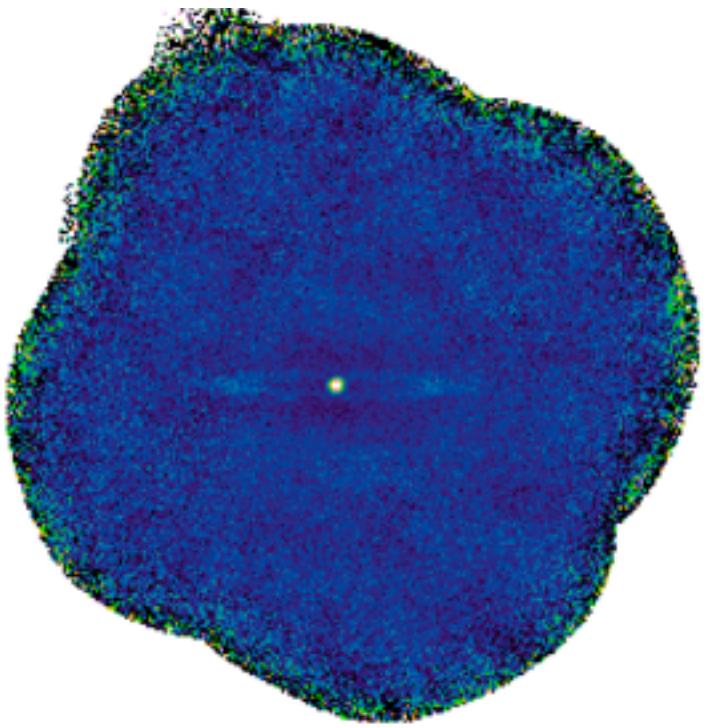

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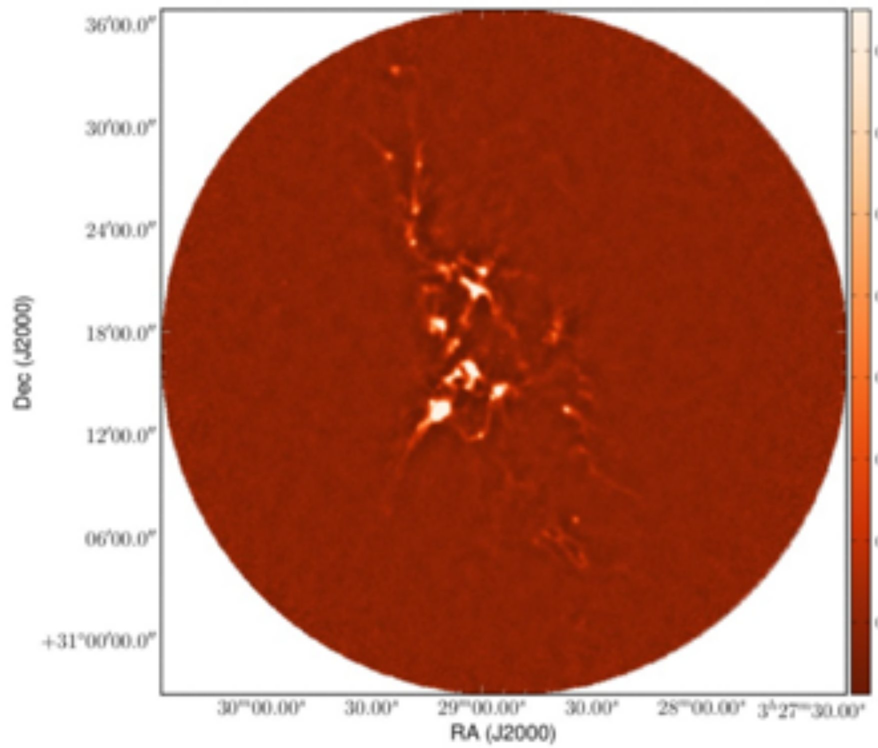

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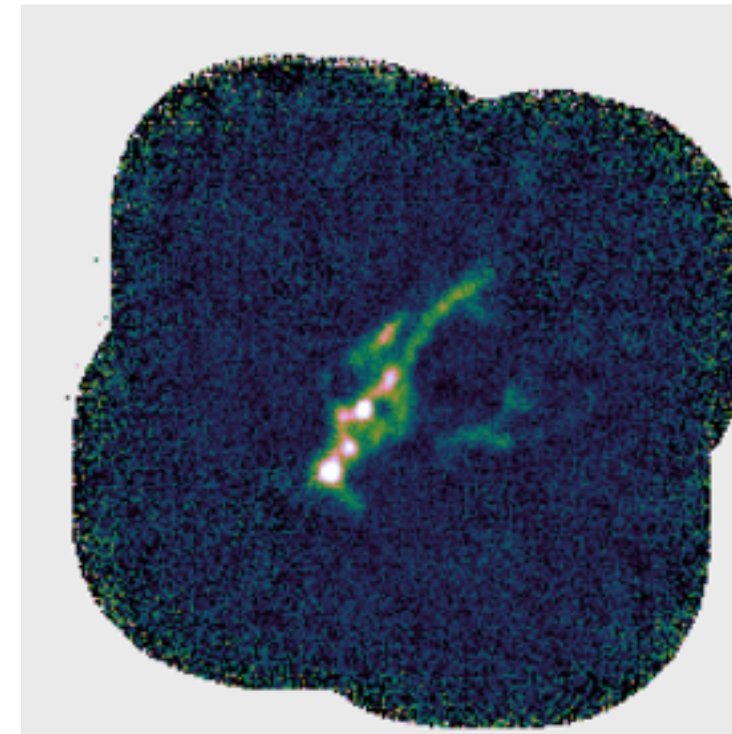

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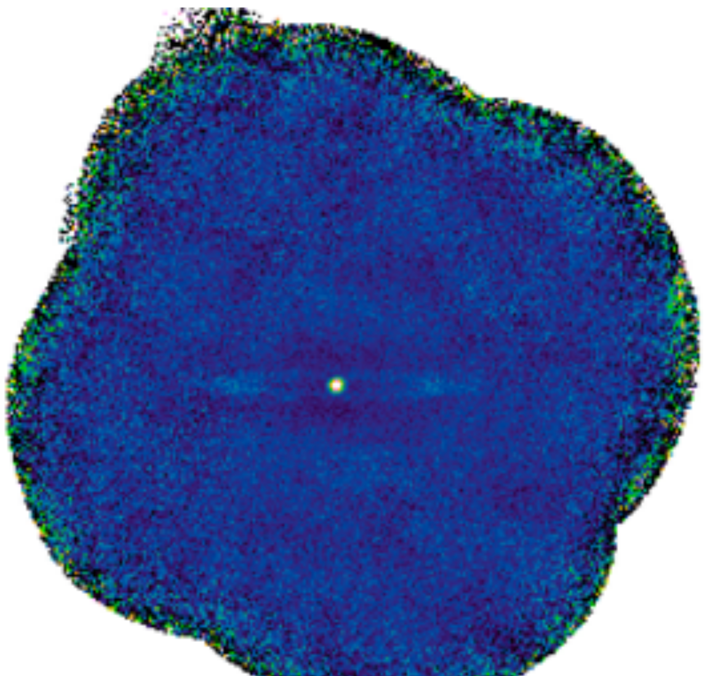

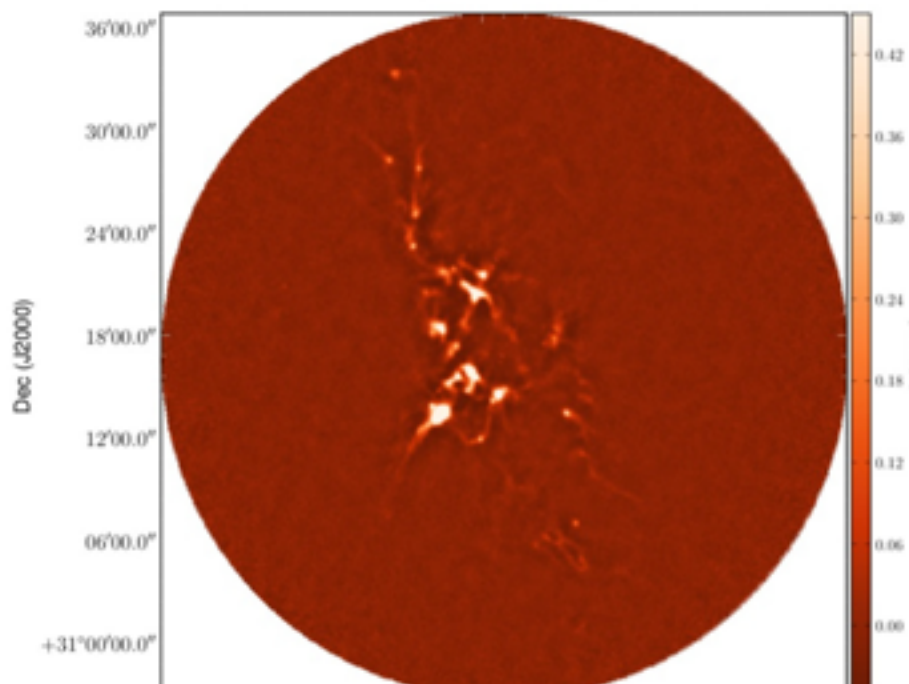

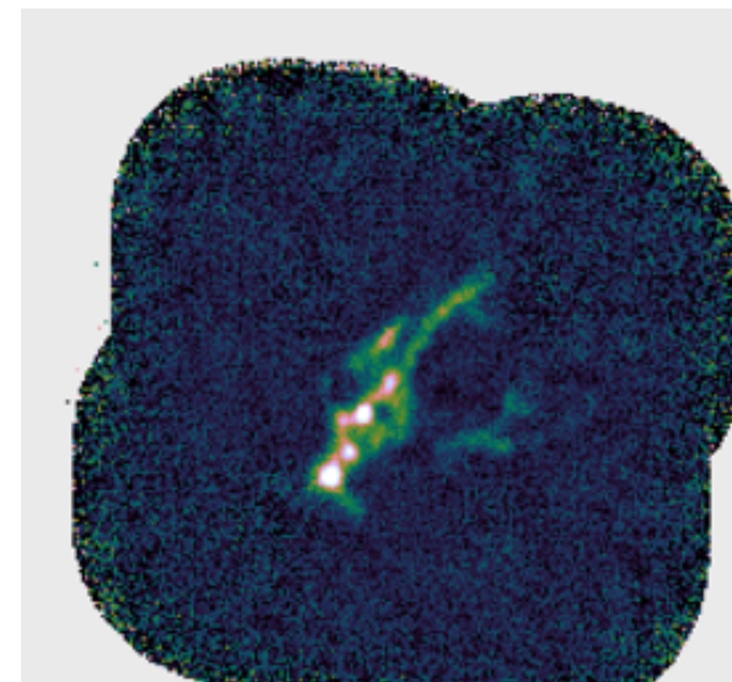

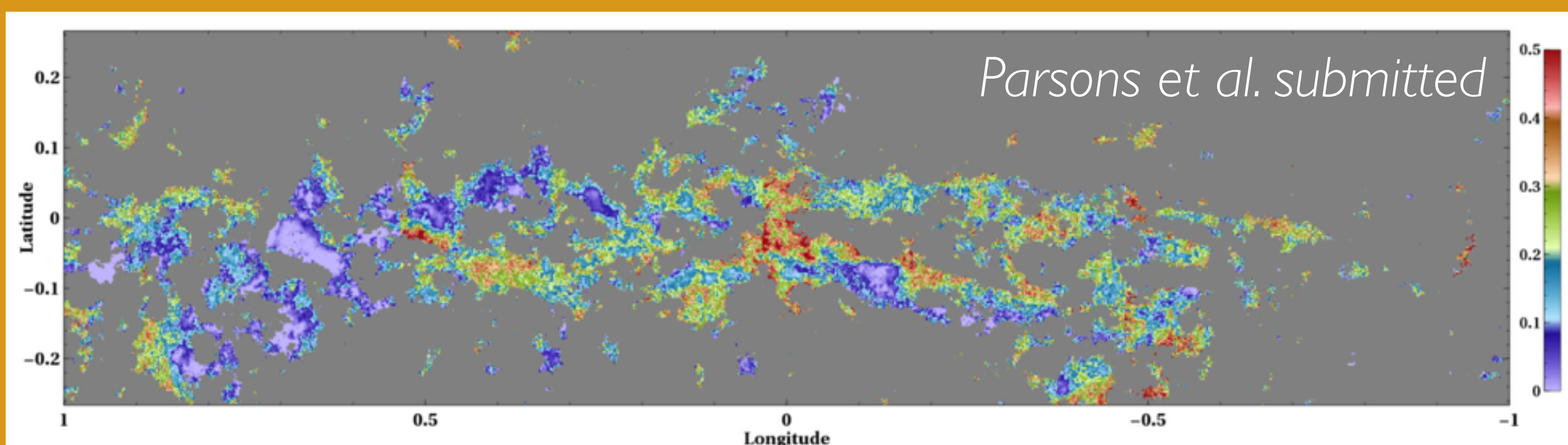

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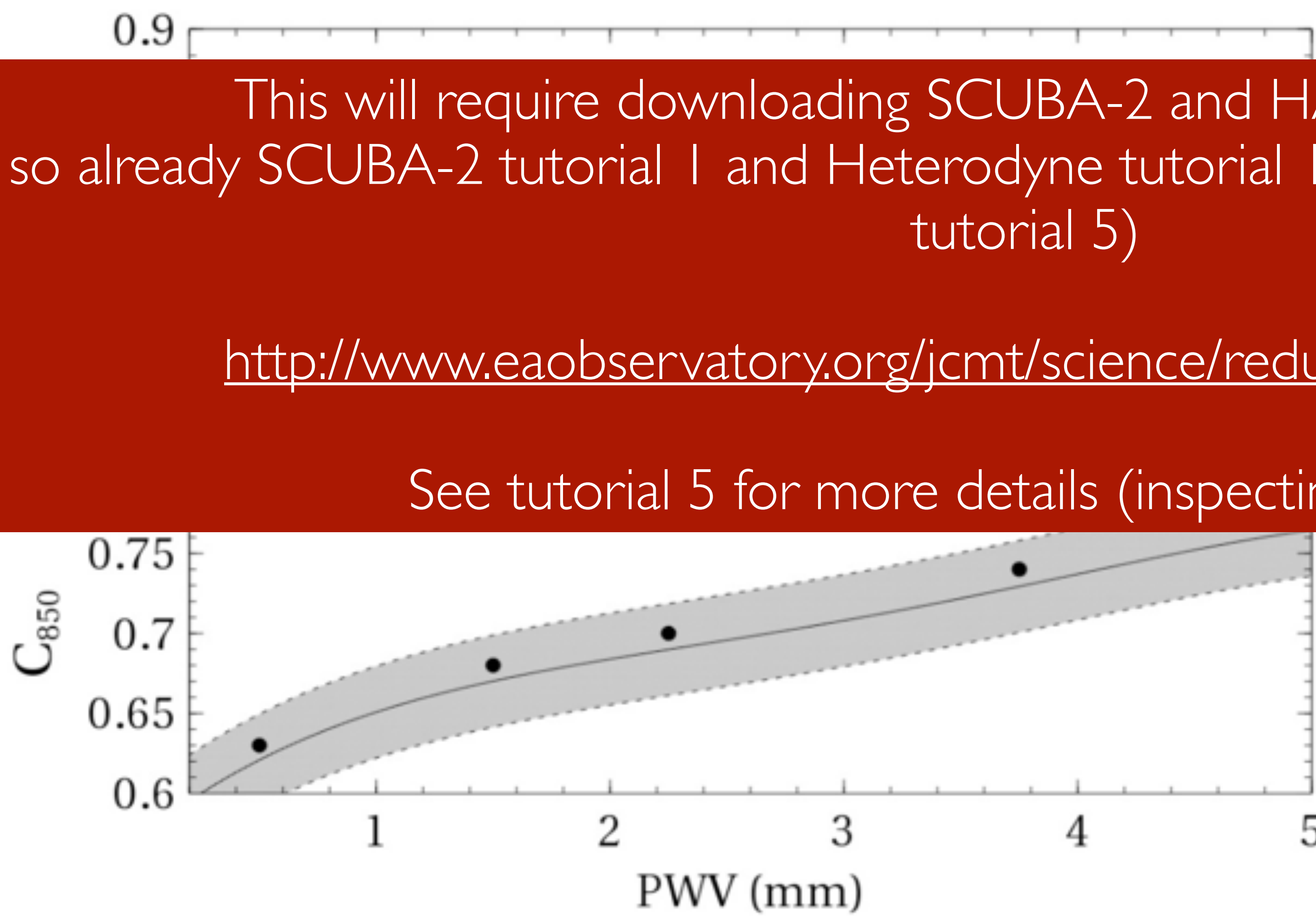

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http://www.eaobservatory.org/jcmt/science/reductionanalysis-tutorials/

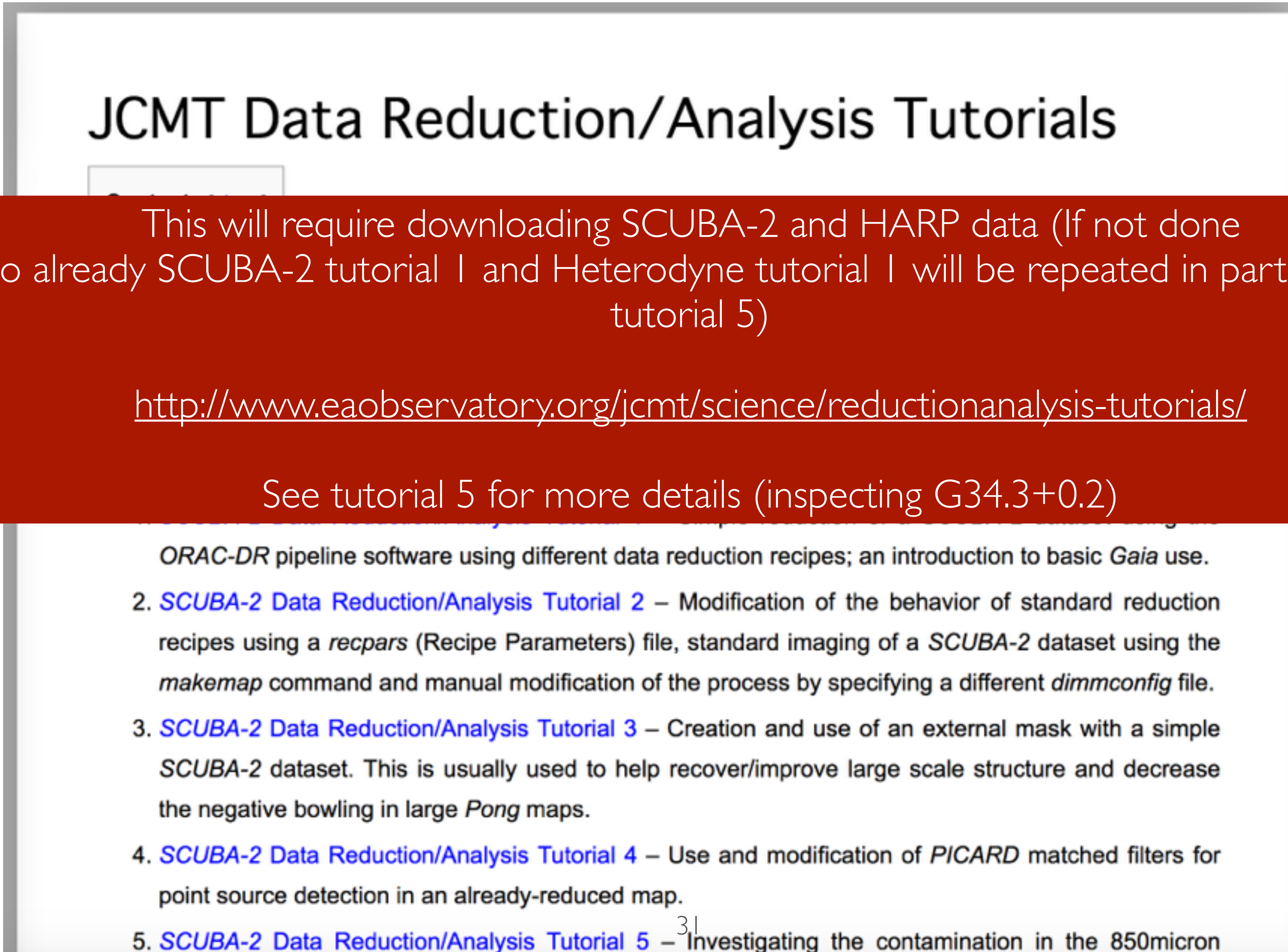
See tutorial 5 for more details (inspecting G34.3+0.2)

but rather a function that is dependent on PWV

Tau_{225GHz} = 0.04 PWV + 0.017

$$\mathbf{C_{850} = \alpha + \beta\ PWV - \gamma\ (PWV2) + \delta\ (PWV3) - \varepsilon\ (PWV4)}$$ **mJy/beam / K/km/s**

SCUBA-2 TUTORIAL 5



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SCUBA-2 TUTORIAL 5

This tutorial follows a six step process:

STEP 1: Creating a HARP reference input file

STEP 2: Masking noise regions in the HARP CO (3-2) integrated intensity map

STEP 3: Convert the HARP integrated data from K to pW

STEP 4: Creating SCUBA-2 850 micron emission reference map

STEP 5: Creating SCUBA-2 with HARP CO subtracted from the 850 micron emission

STEP 6: Comparing SCUBA-2 reductions

http://www.eaobservatory.org/jcmt/science/reductionanalysis-tutorials/scuba-2-dr-tutorial-5/

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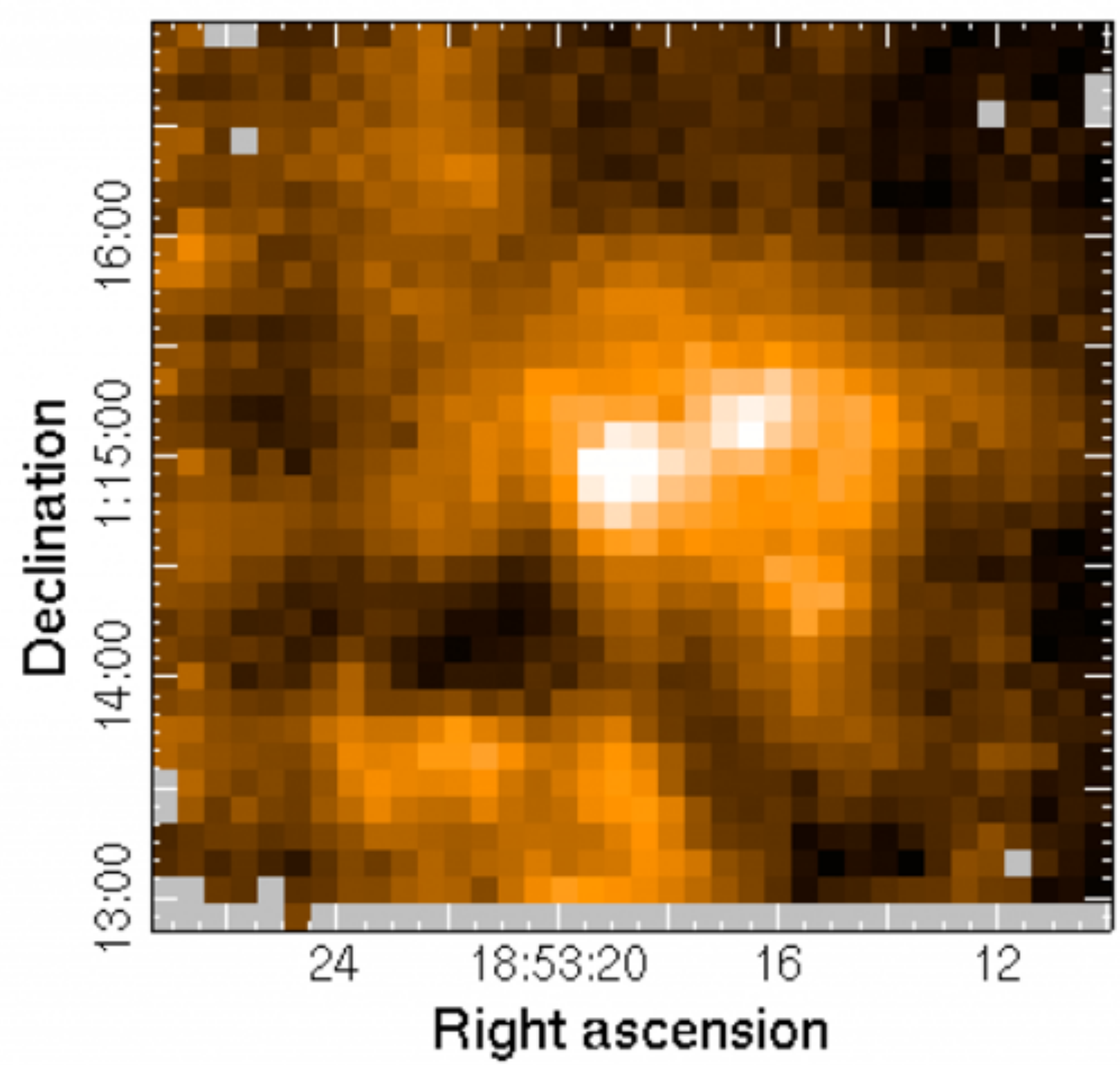
STEP 2: Masking noise regions in the H

STEP 3: Convert the HARP integrated

STEP 4: Creating SCUBA-2 850 micror

STEP 5: Creating SCUBA-2 with HARF n

STEP 6: Comparing SCUBA-2 reductic



http://www.eaobservatory.org/jcmt/scien -5/

SCUBA-2 TUTORIAL 5

This tutorial follows a six step process:

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STEP 2: Masking noise regions in the HARP CO (3-2) integrated intensity map

STEP 3: Convert the HARP integrated data from K to pW

STEP 4: Creating SCUBA-2 850 micron emission reference map

STEP 5: Creating SCUBA-2 with HARP CO subtracted from the 850 micron emission

STEP 6: Comparing SCUBA-2 reductions

http://www.eaobservatory.org/jcmt/science/reductionanalysis-tutorials/scuba-2-dr-tutorial-5/

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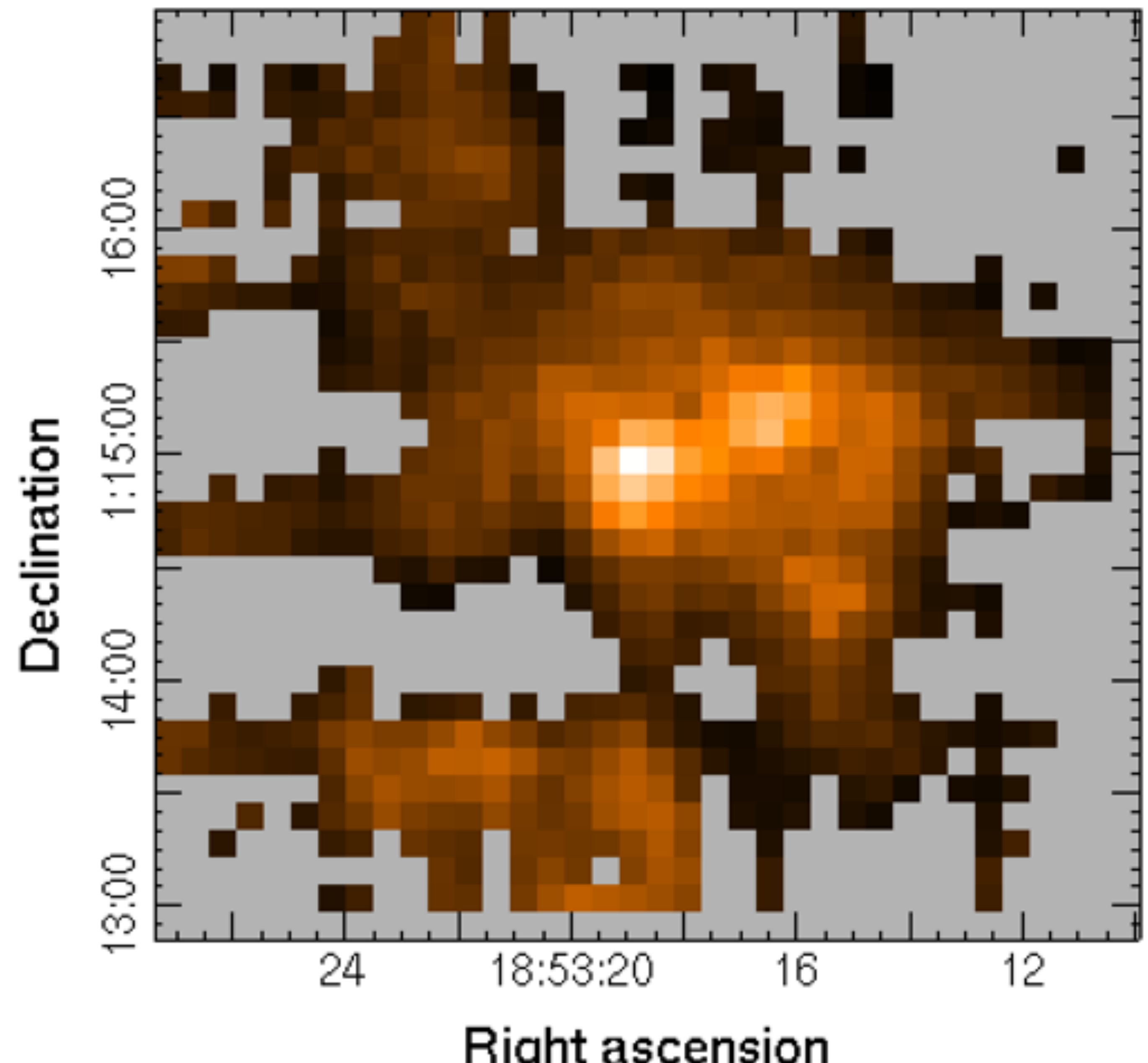

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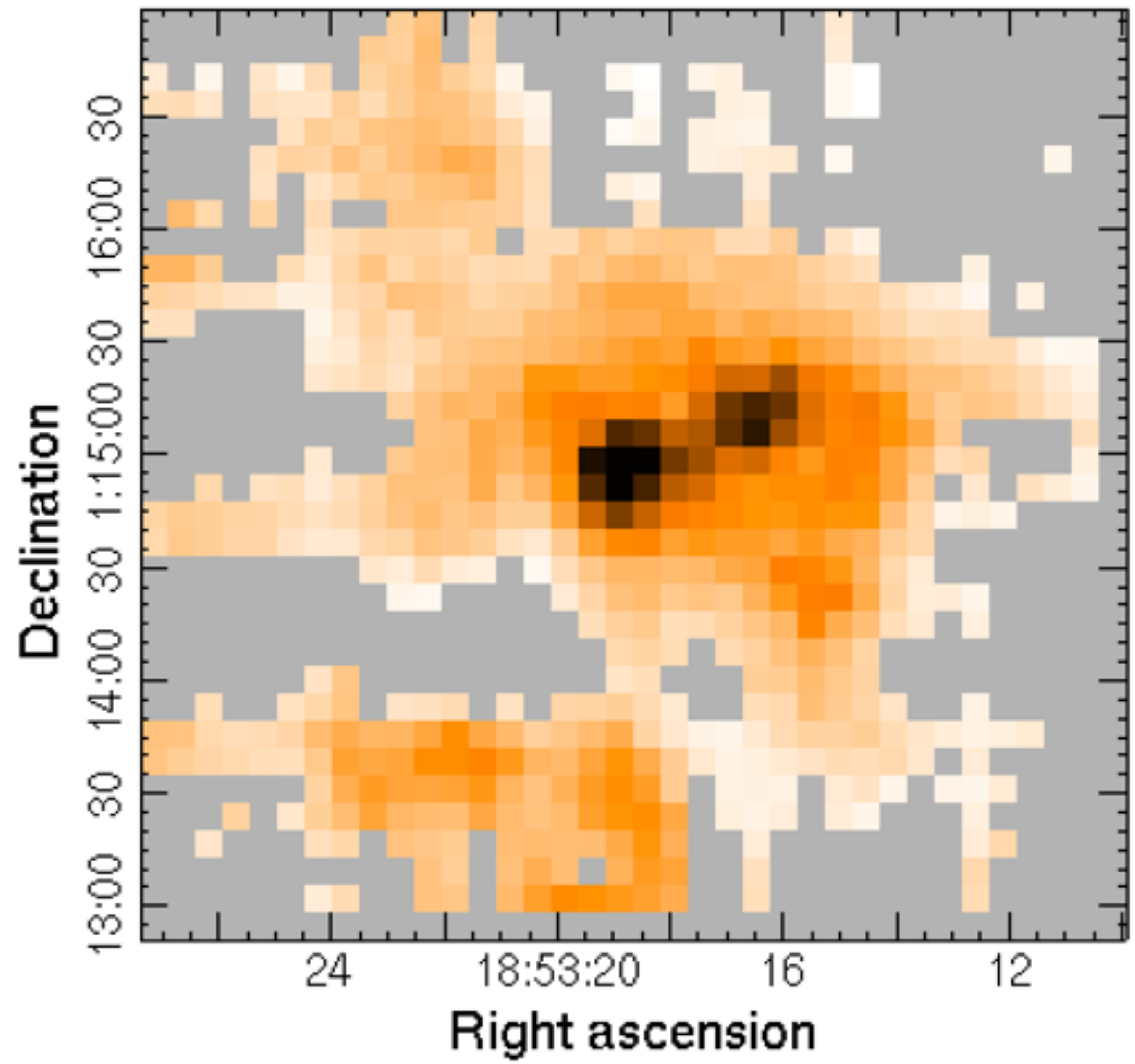

[http://www.eaobservatory.org/jcmt/scienc ... 5/](http://www.eaobservatory.org/jcmt/scienc)

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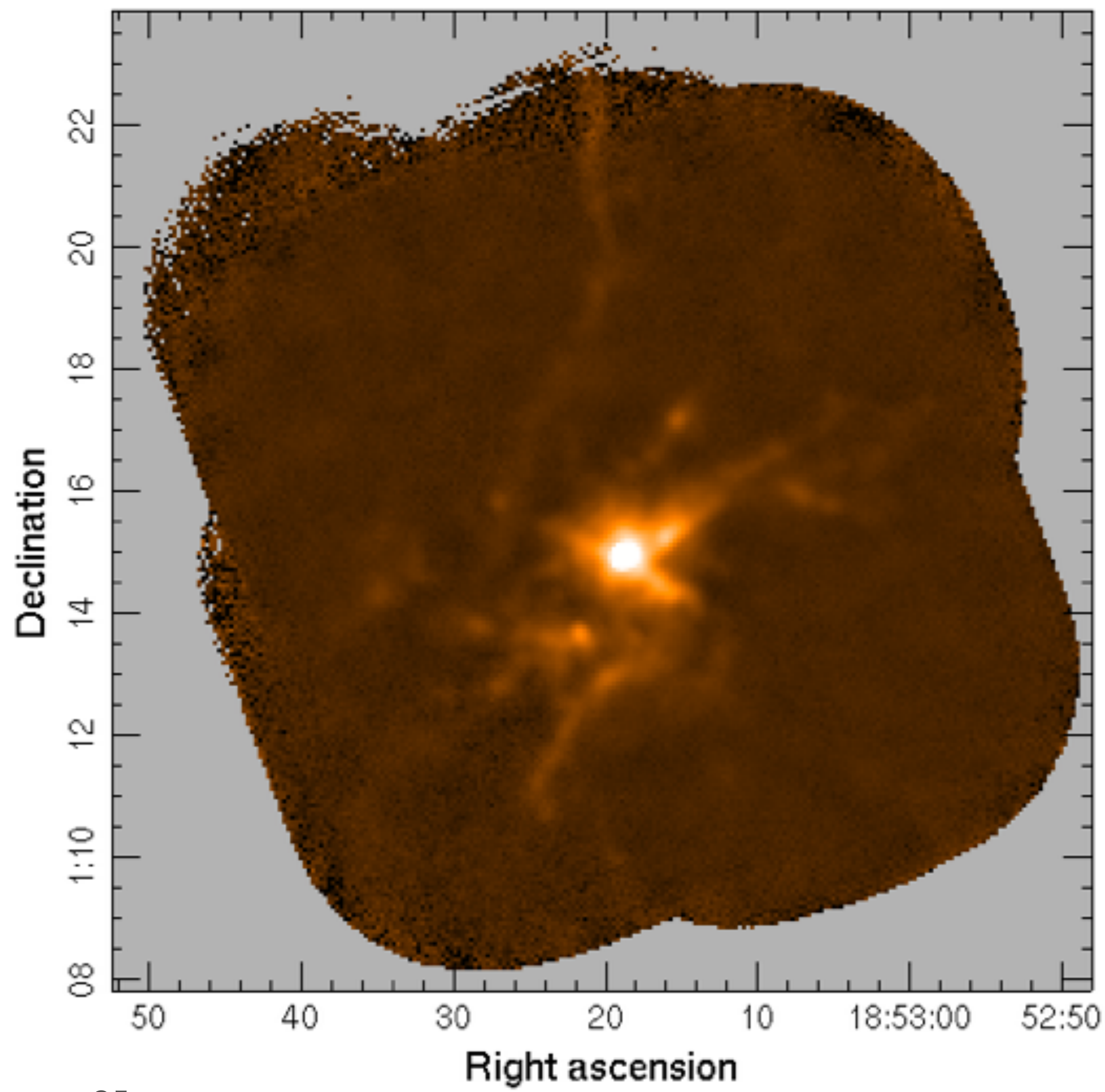

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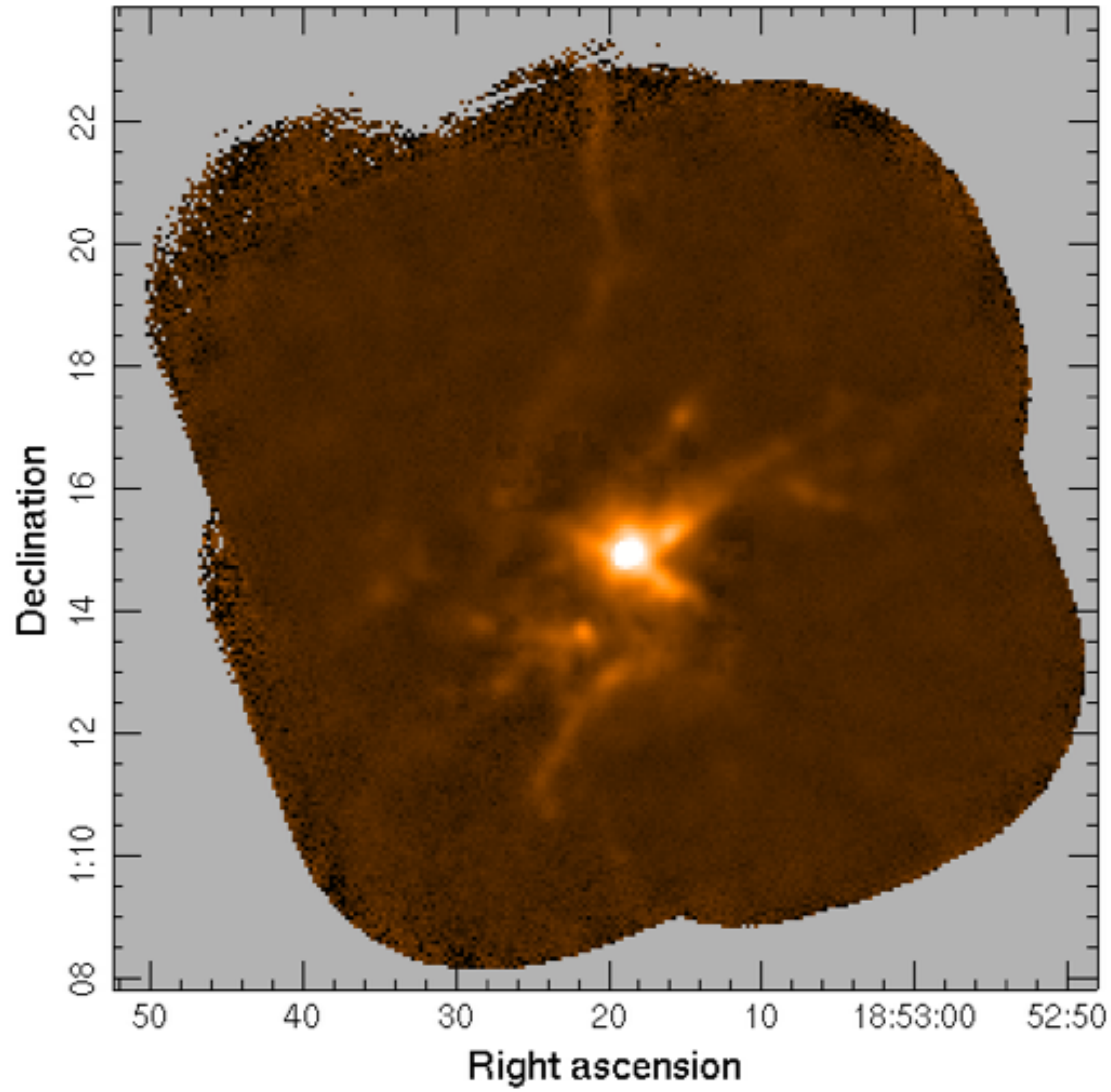

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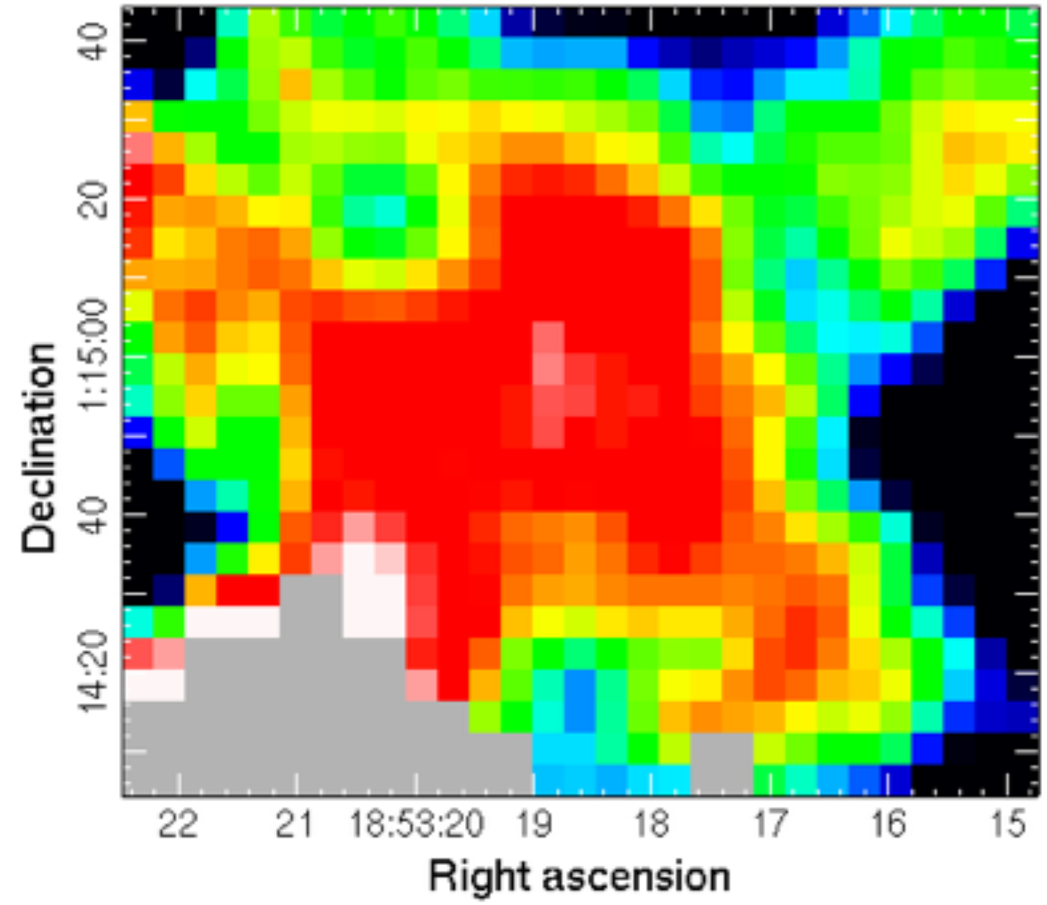
SCUBA-2 TUTORIA

This tutorial follows a six step process:

dust fraction map



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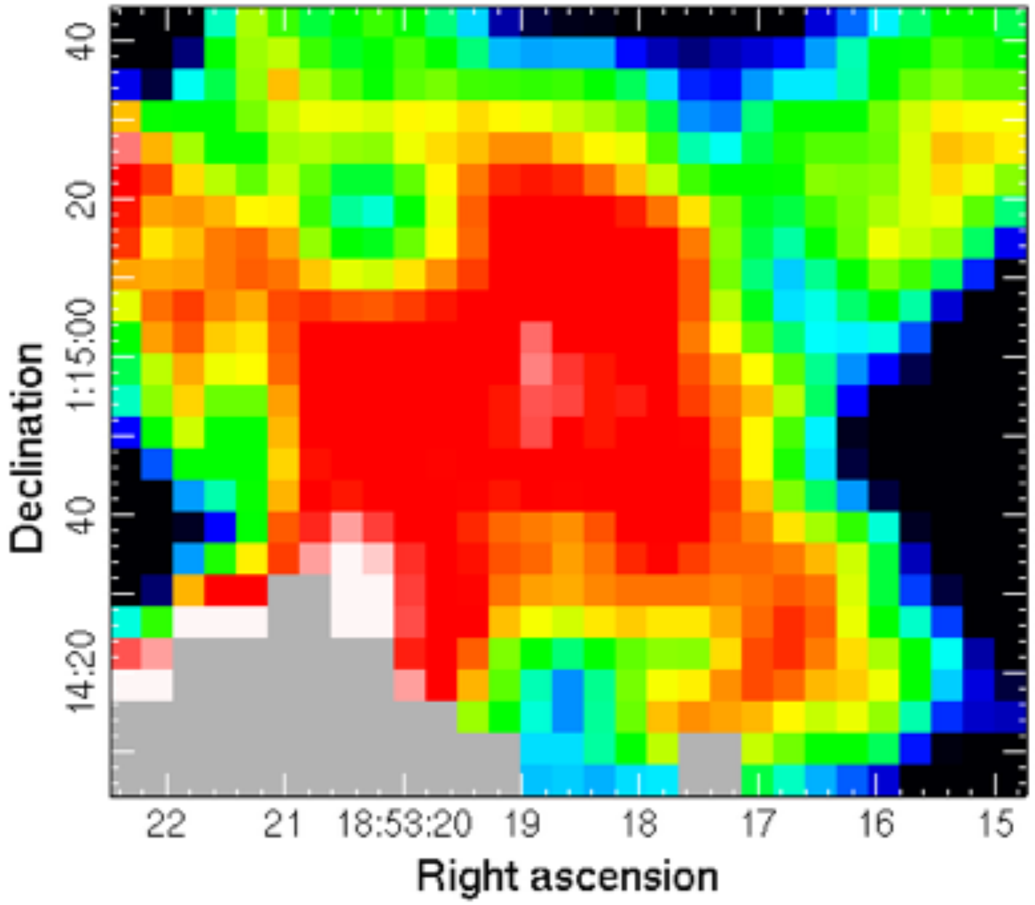

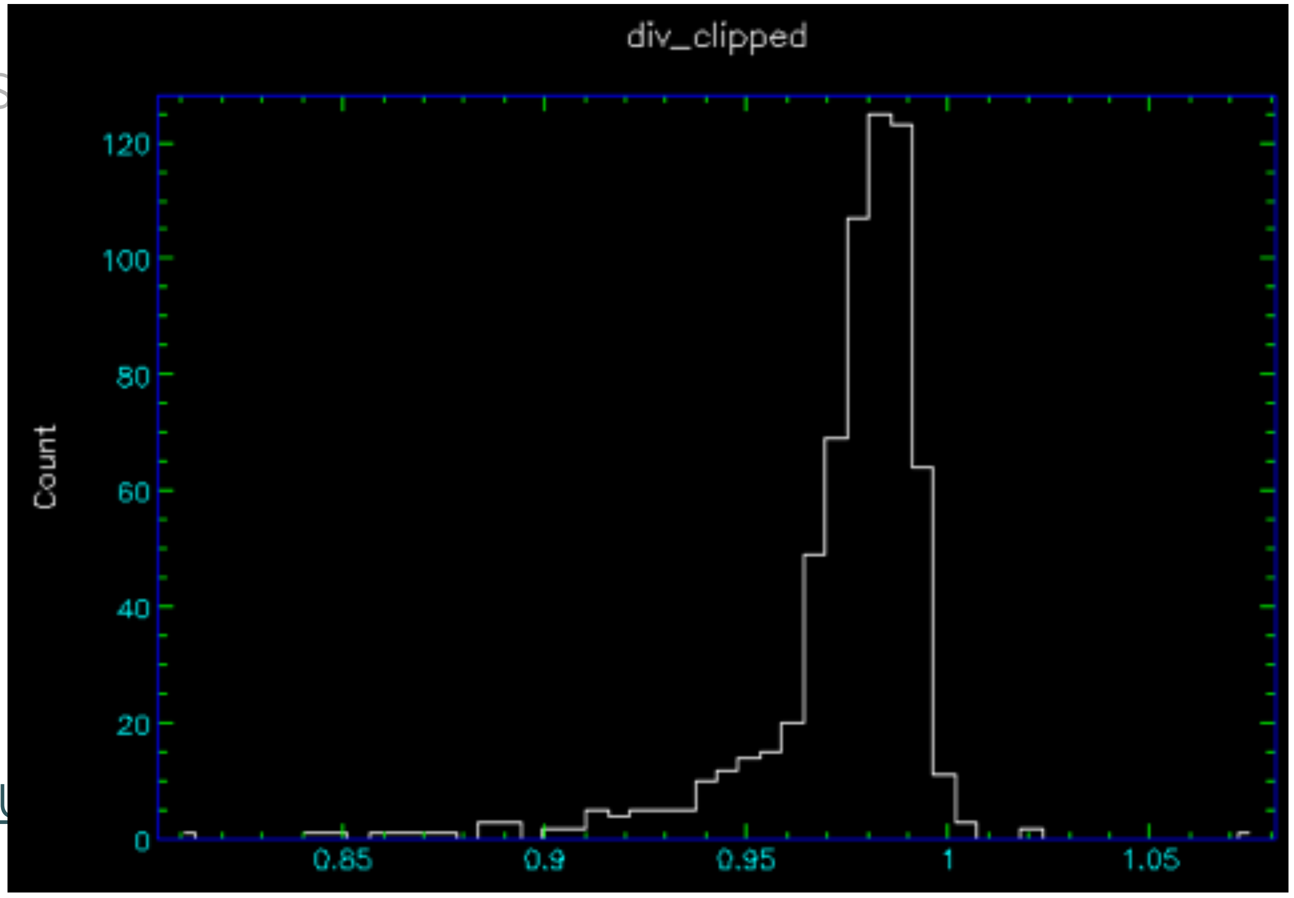

we find a
median contamination of 2%
within the G34.3+0.2

http://www.eaobservatory.org/jcmt/science/redu

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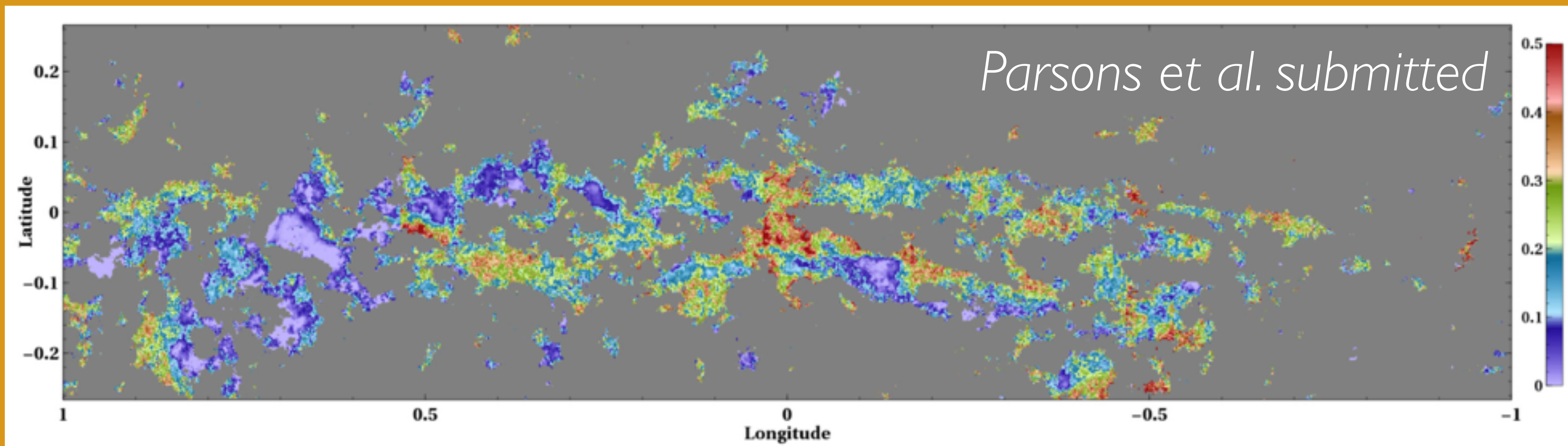
SCUBA-2 WHAT'S IN THE DUST



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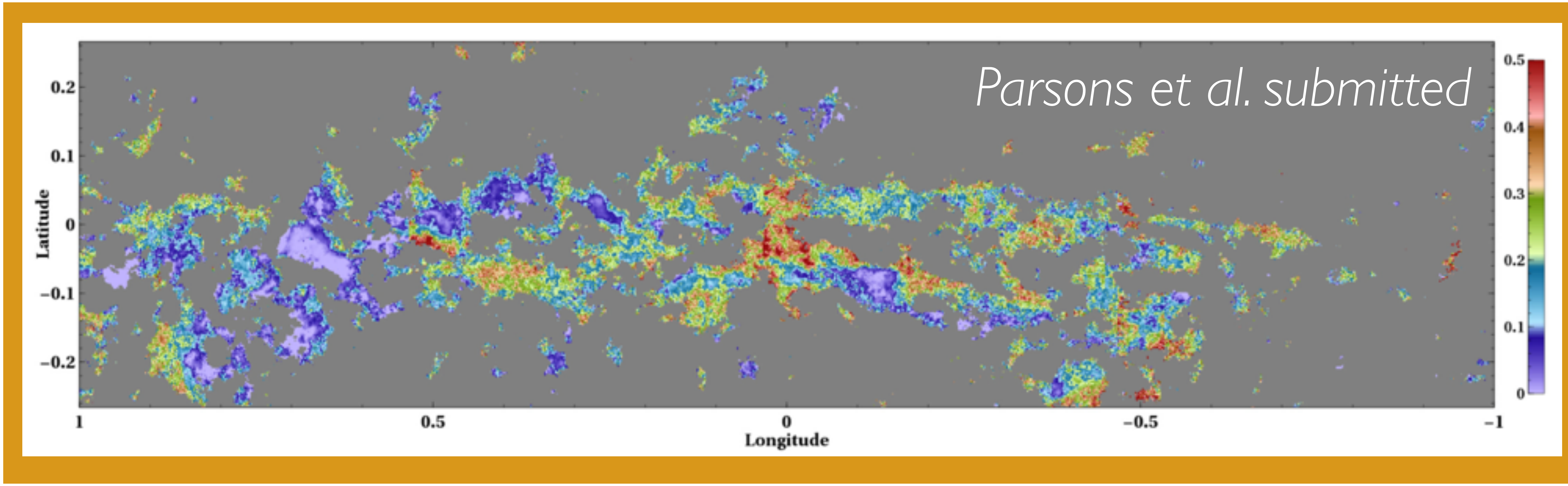
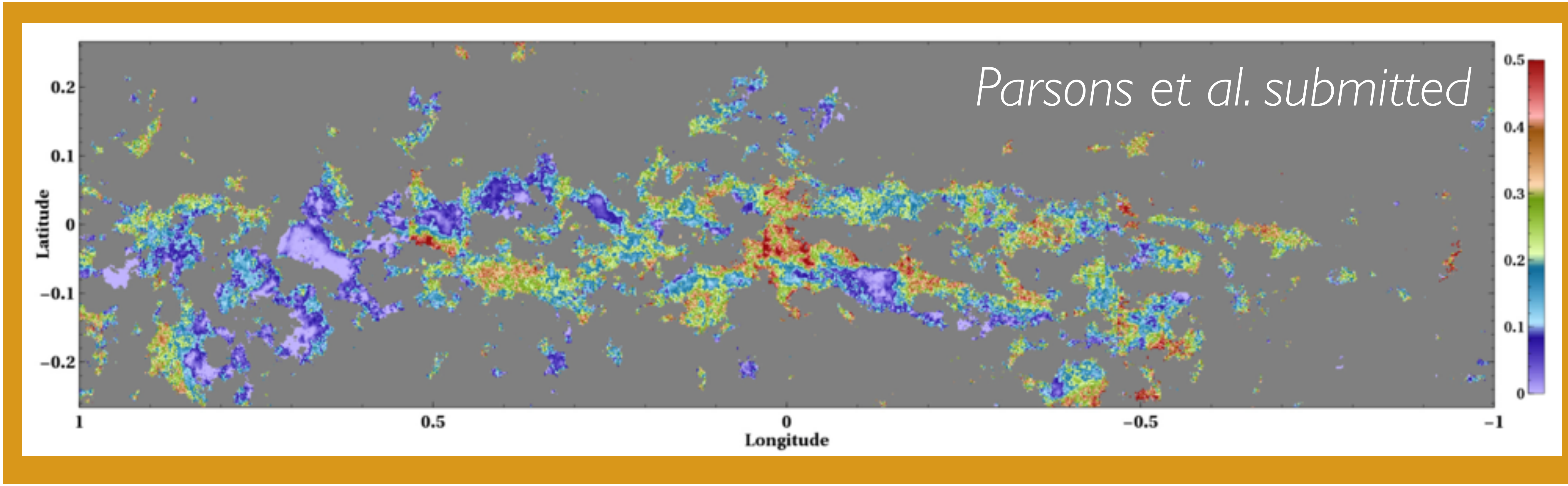


http://www.eaobservatory.org/jcmt/instrumentation/continuum/scuba-2/contamination/

SCUBA-2 WHAT'S IN THE DUST



http://www.eaobservatory.org/jcmt/instrumentation/continuum/scuba-2/contamination/

Rumble http://adsabs.harvard.edu/abs/2016MNRAS.460.4150R
Dust contamination from free-free emission