APEX Extragalactic Science

A. Kovács, A. Weiss, R. Kneissl, R. Guesten & K. Menten

APEX Extragalactic Science: Outline

Molecular Gas (CO) Surveys

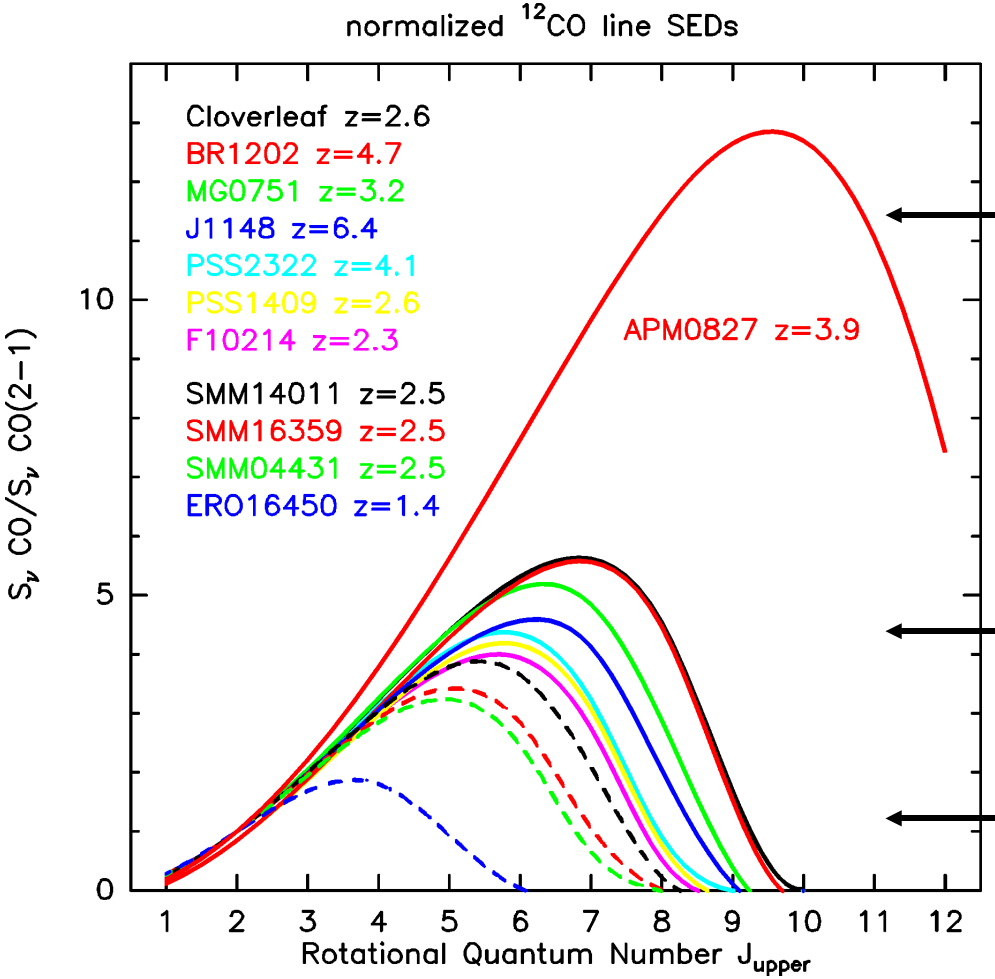
Sunyaev Zel'dovich (SZ) Cluster Survey

Sub-mm Deep Field Survey

Nearby Galaxies in Continuum

CO Survey of Active Galaxy Centers

R. Guesten et al.



T_{kin} ~ 200 K (T_{dust} ~ 200 K)
$n(H_2)$ ~ $10^{4.2}$ cm^{-3}
Strongly lensed (m=80-100) central ~200pc surrounding the QSO. AGN heating!

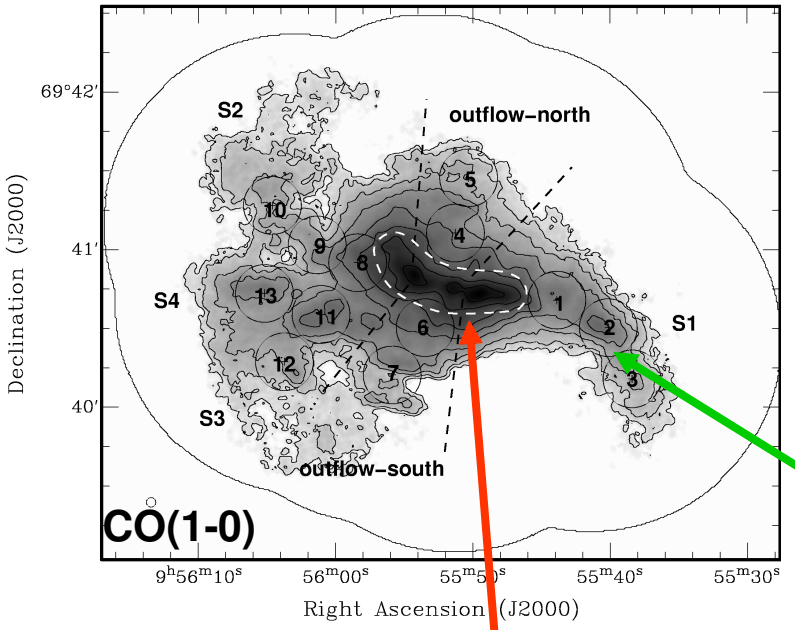
T_{kin} ~40 – 60 K (T_{dust} ~ 50 K)
$n(H_2)$ ~ $10^{3.6\text{-}4.3}$ cm^{-3}

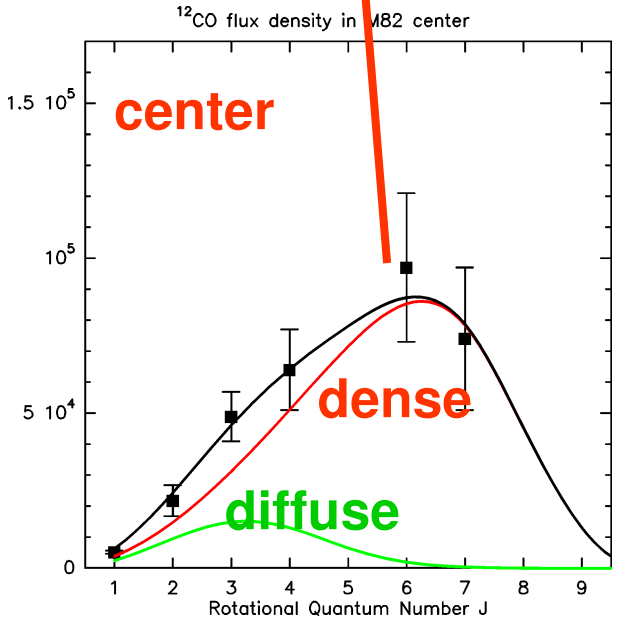
T_{kin} ~ 30-50 K (T_{dust} ~ 30-50 K)
$n(H_2)$ ~ $10^{2.7\text{-}3.5}$ cm^{-3}

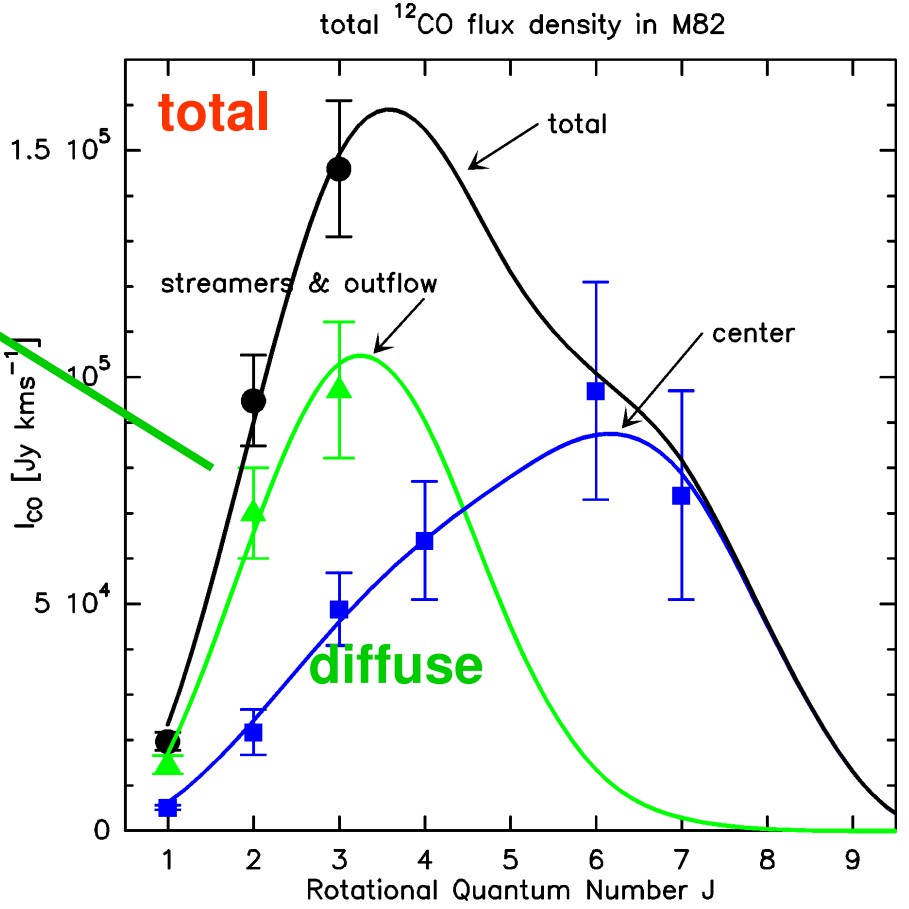
A. Weiss

Survey of Nearby Galaxies

A. Weiss

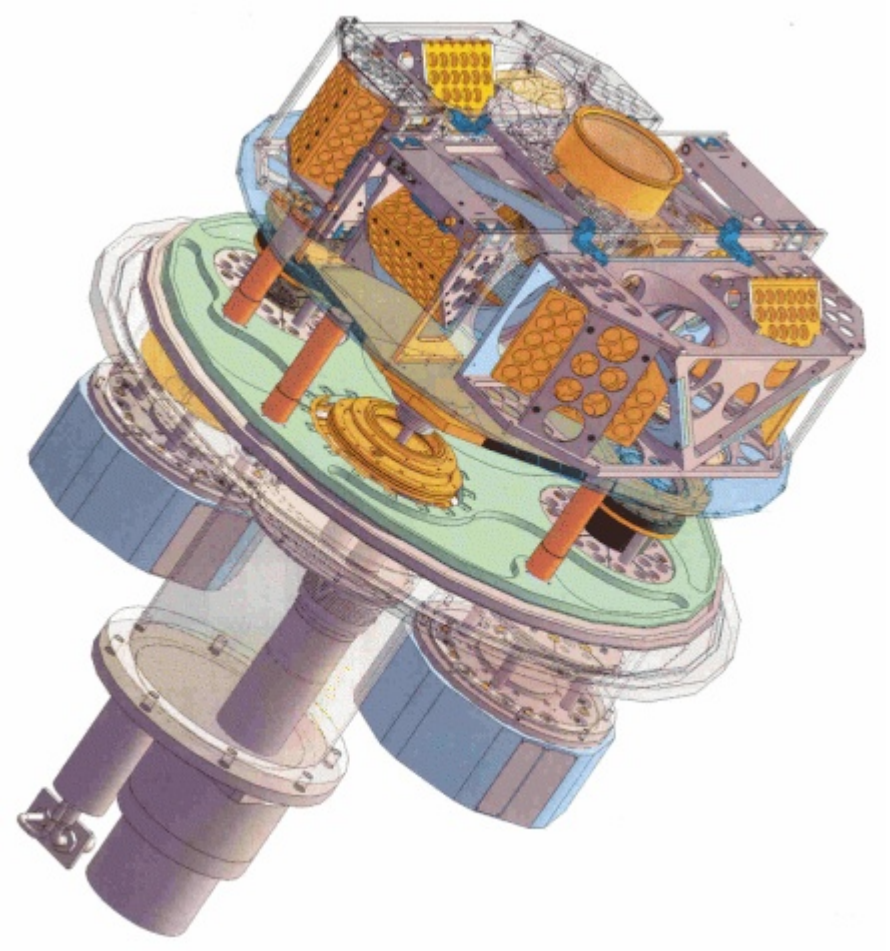






A. Weiss

CHAMP+ Array Receiver



7 beams at 650 GHz

+

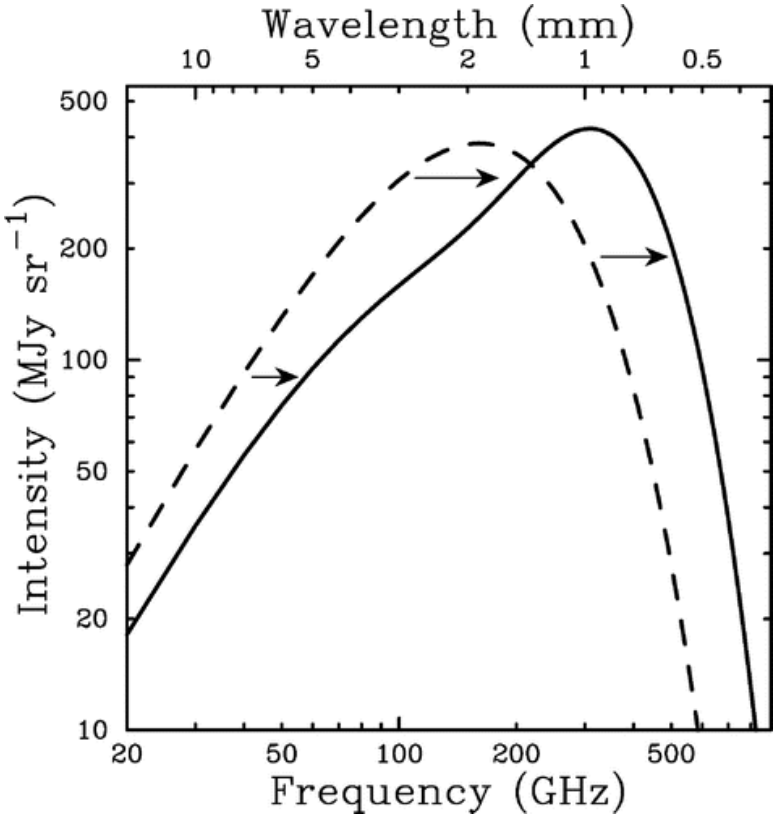
7 beams at 800 GHz

SRON & MPIfR

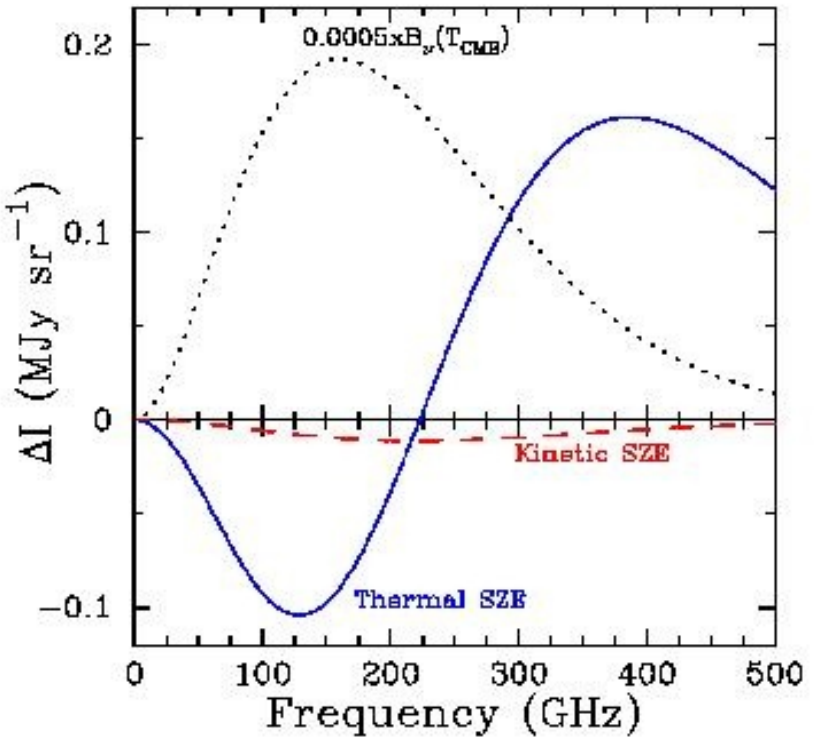
APEX SZ Experiment

The Sunyaev-Zel'dovich Effect

Inverse Compton Scattering of CMB photons in hot plasma



Carlstrom et al. 2002, ARA&A, 40, 643



Courtesy of F. Bertoldi

Redshift Independent Effect

Constraints on Cosmological Parameters (σ_8, Ω_M)

APEX SZ Camera (ASZCA)

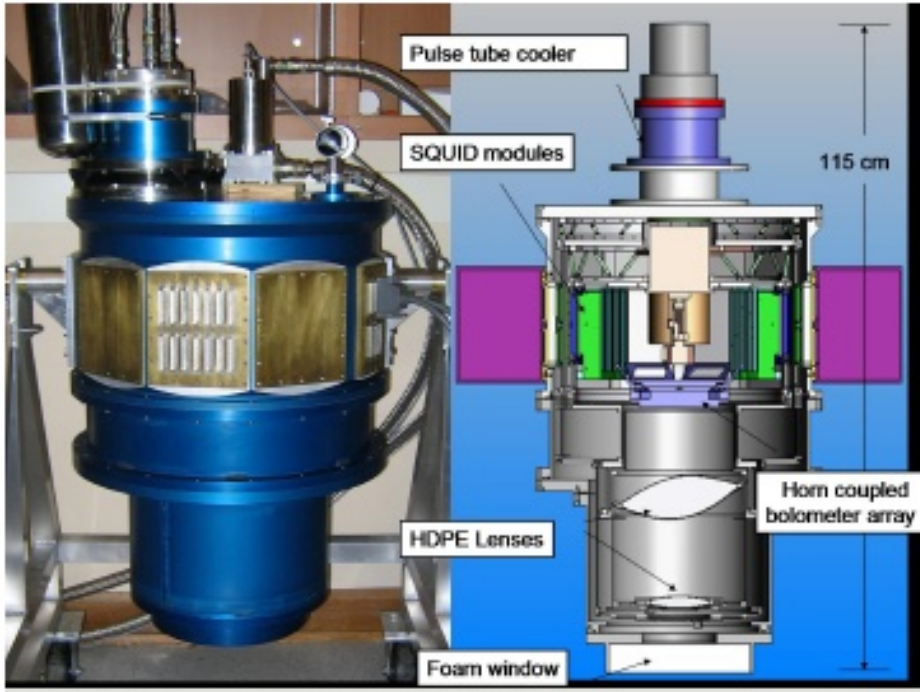
UC Berkeley

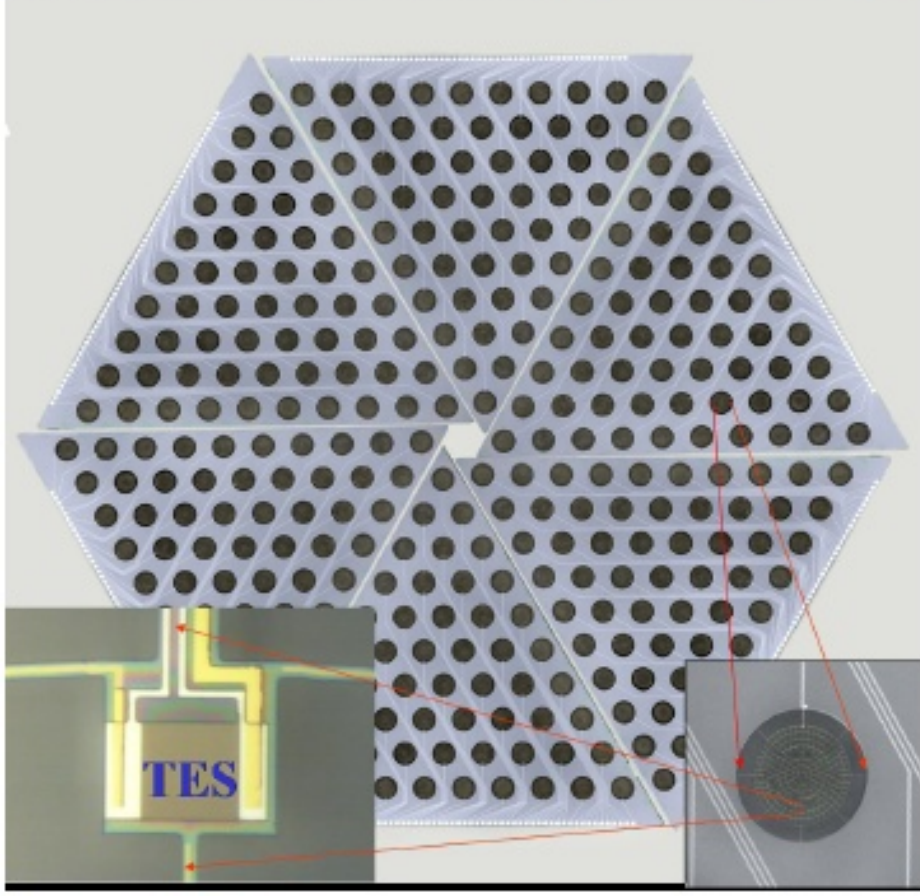
320 Pixels at 150 GHz

Transition Edge Sensors (TES)

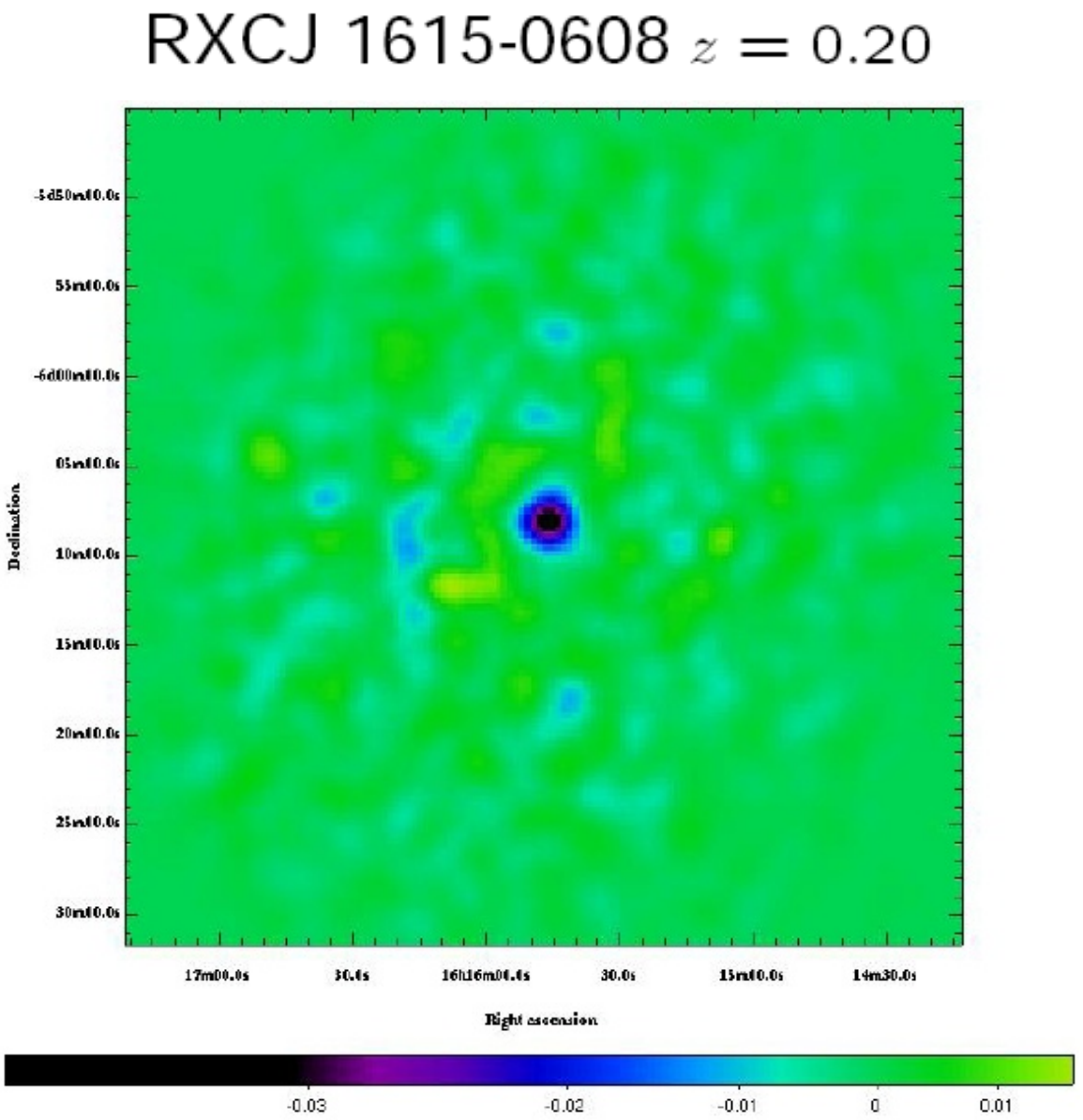
10uK/beam rms over ~100 deg2

(requires several months of integration)



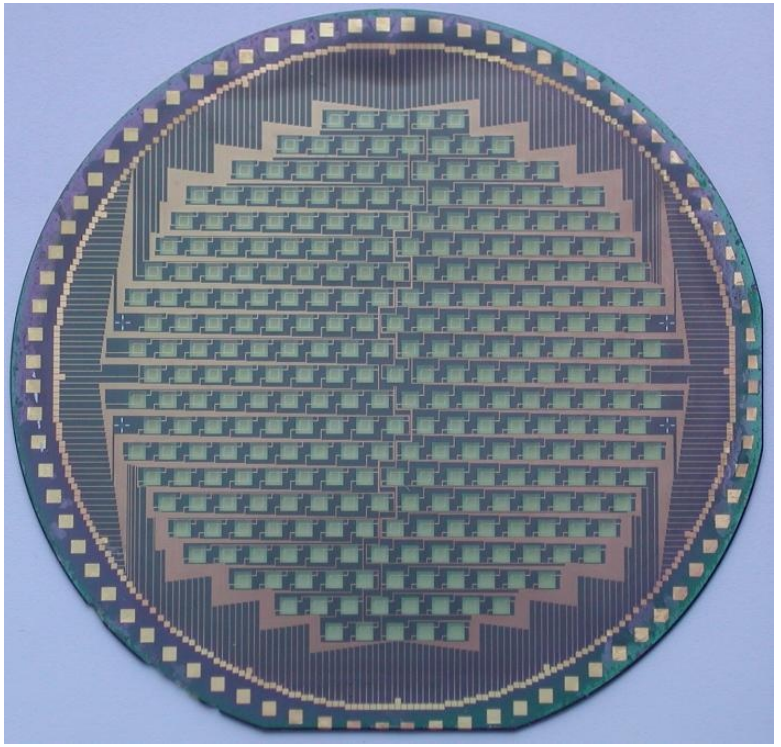


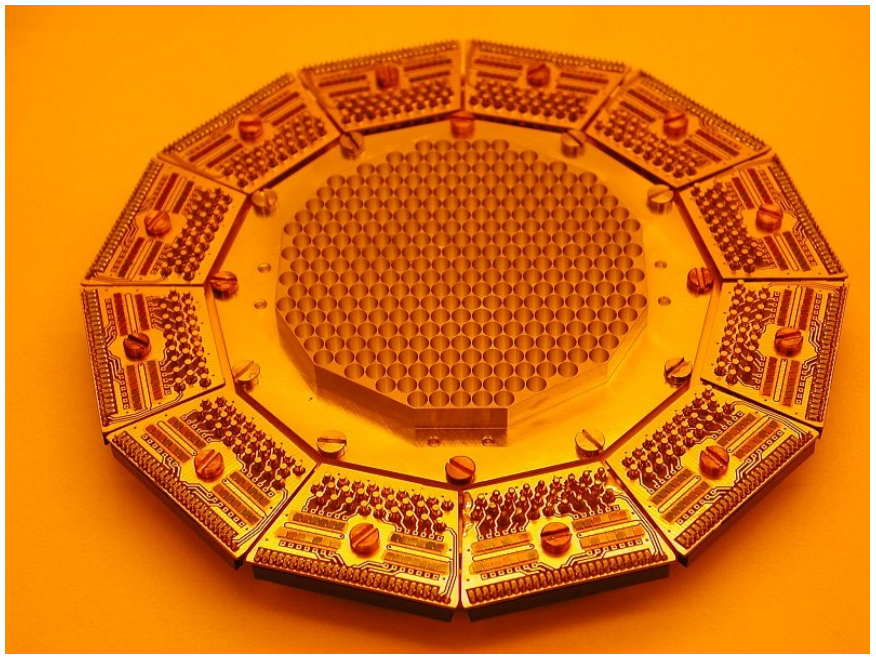
APEX SZ: Early Results...

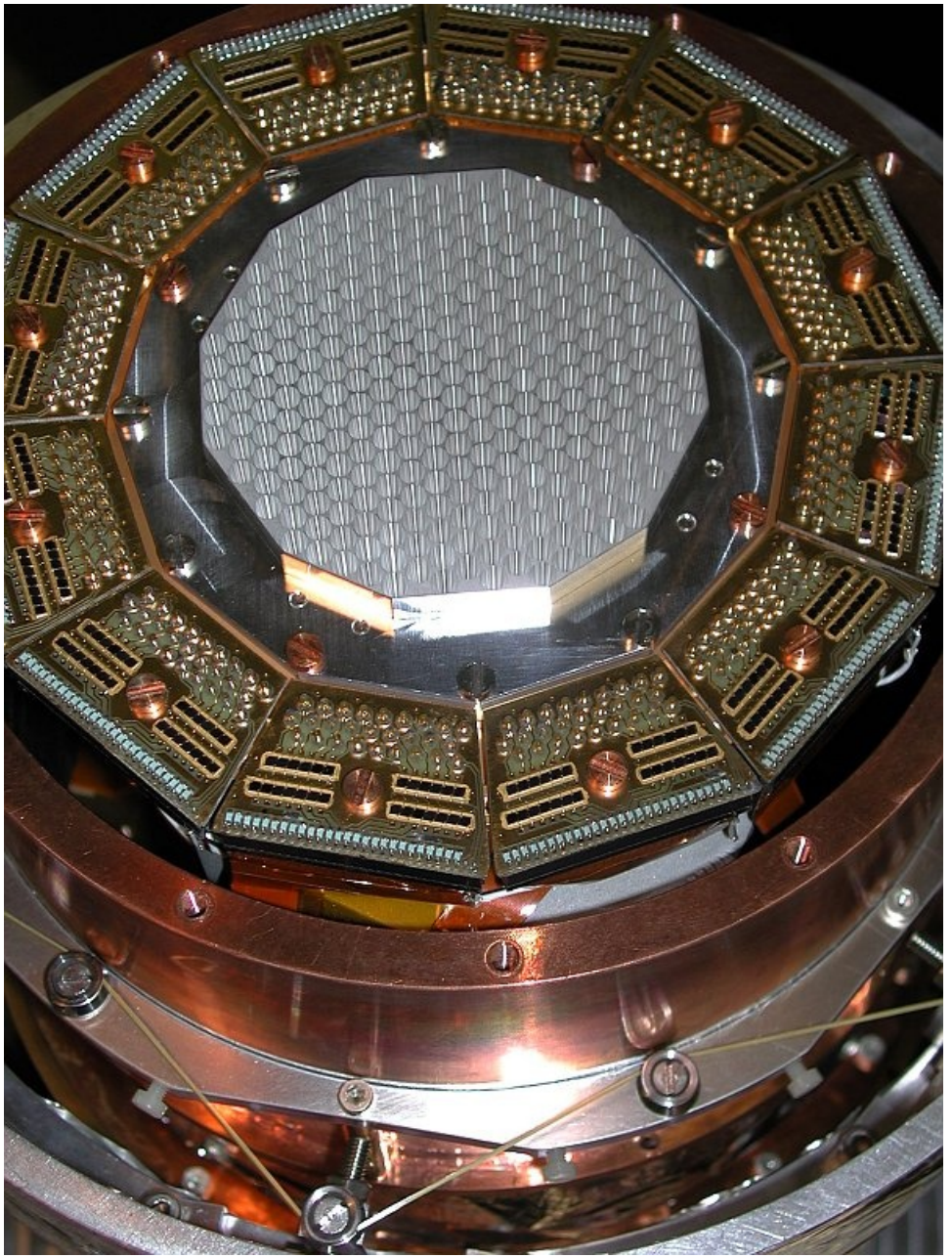


Ruediger Kneissl

LABOCA

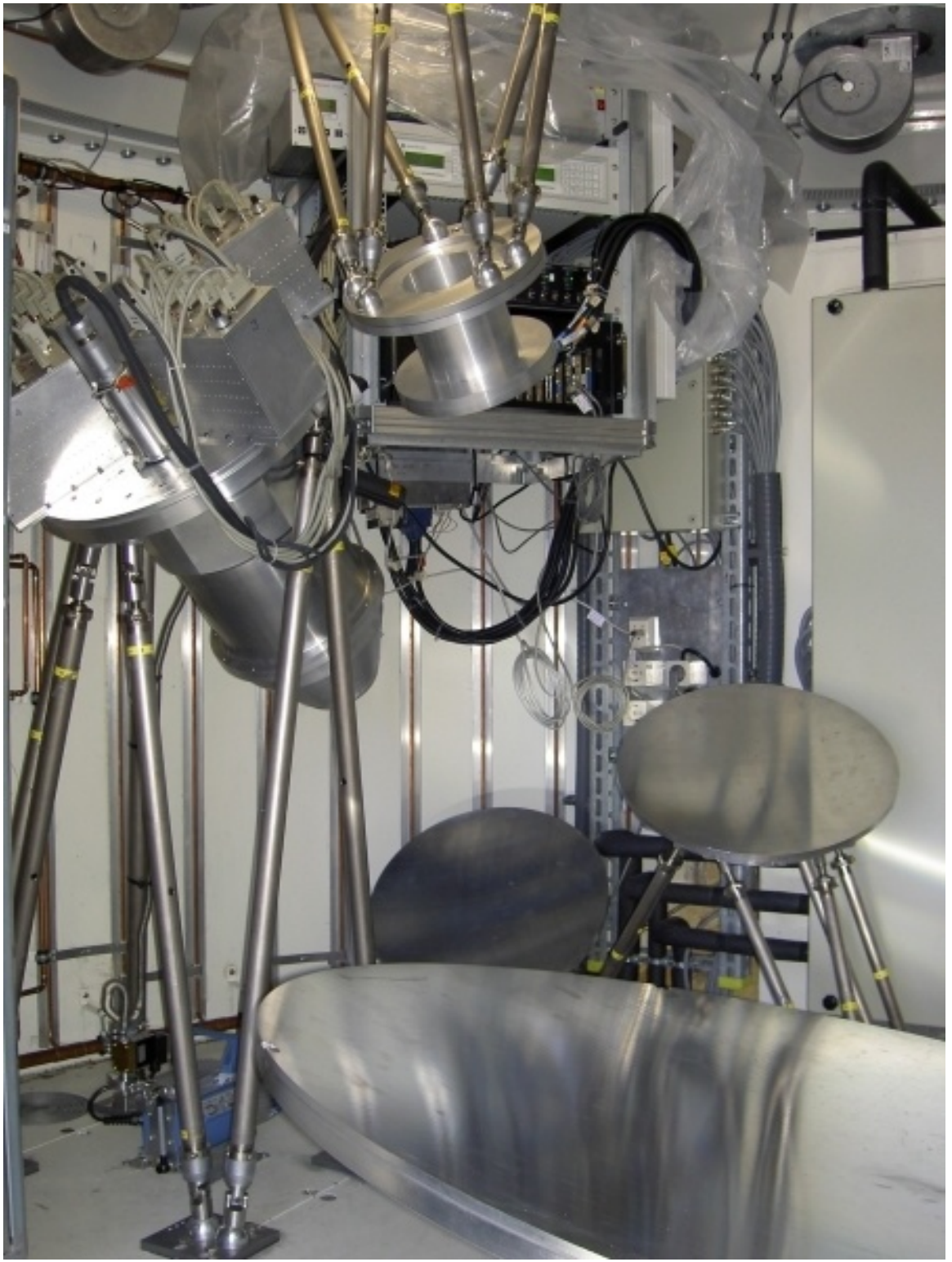






E. Kreysa, G. Siringo

LABOCA

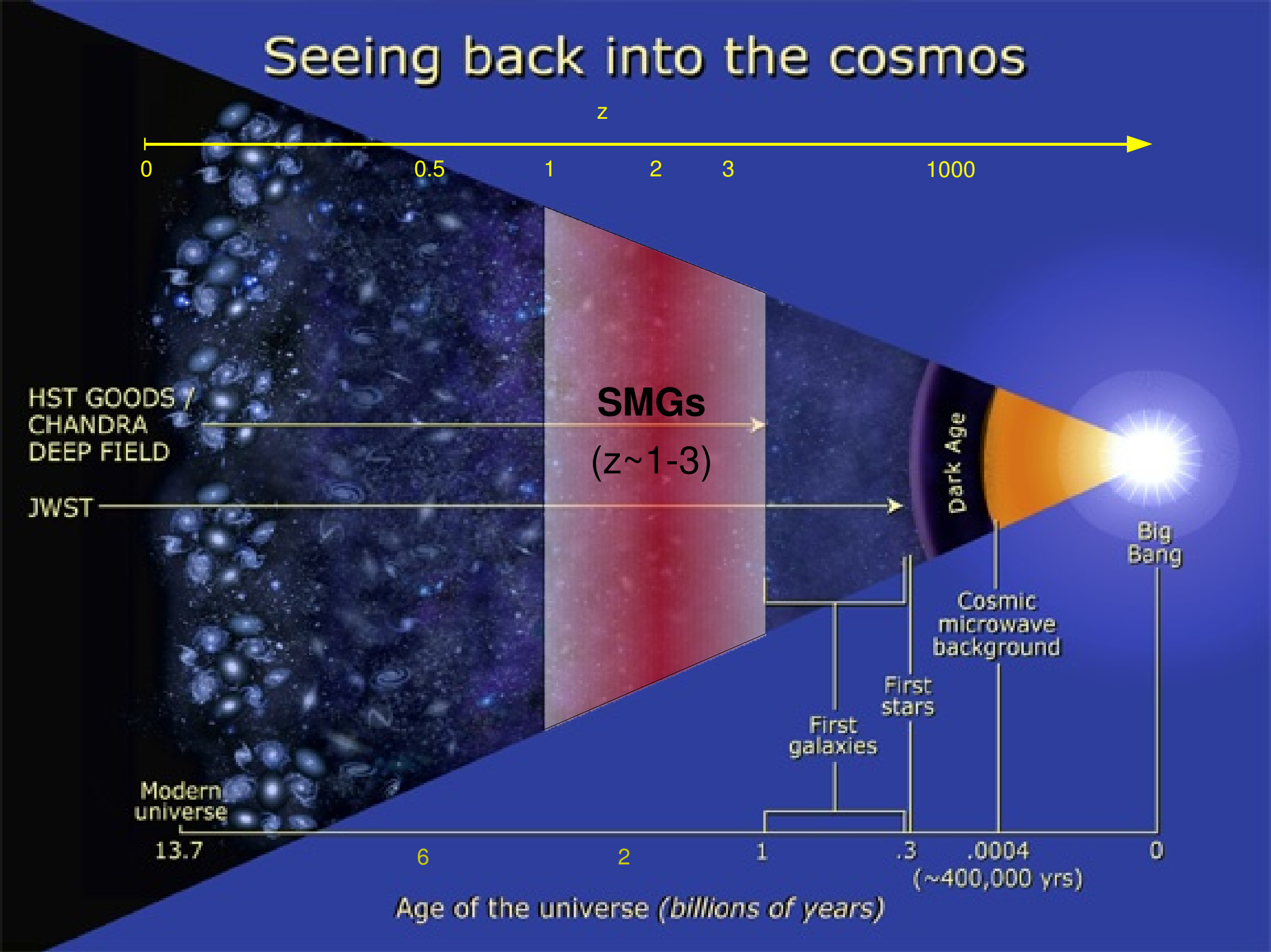


LABOCA Science Case: Deep Fields

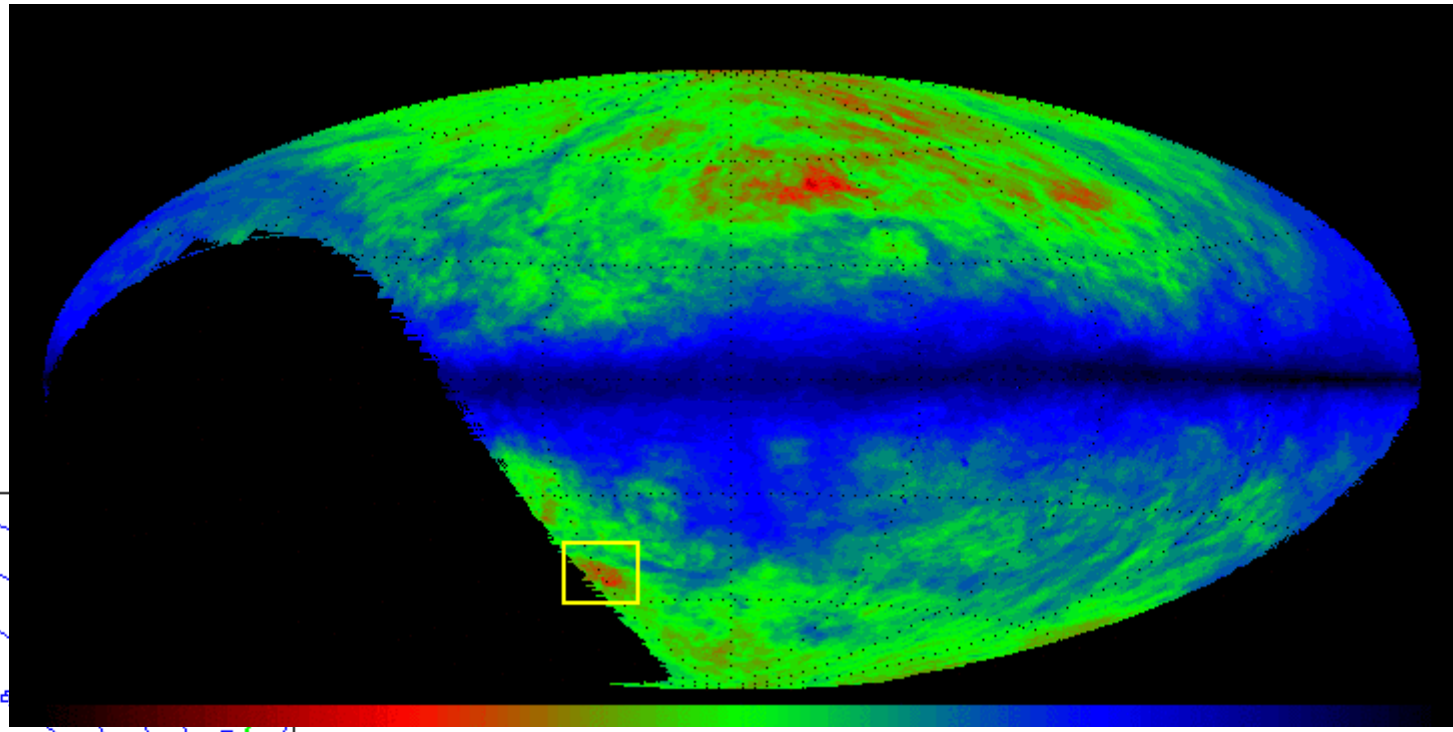
Collecting photons -- The more pixels the better...

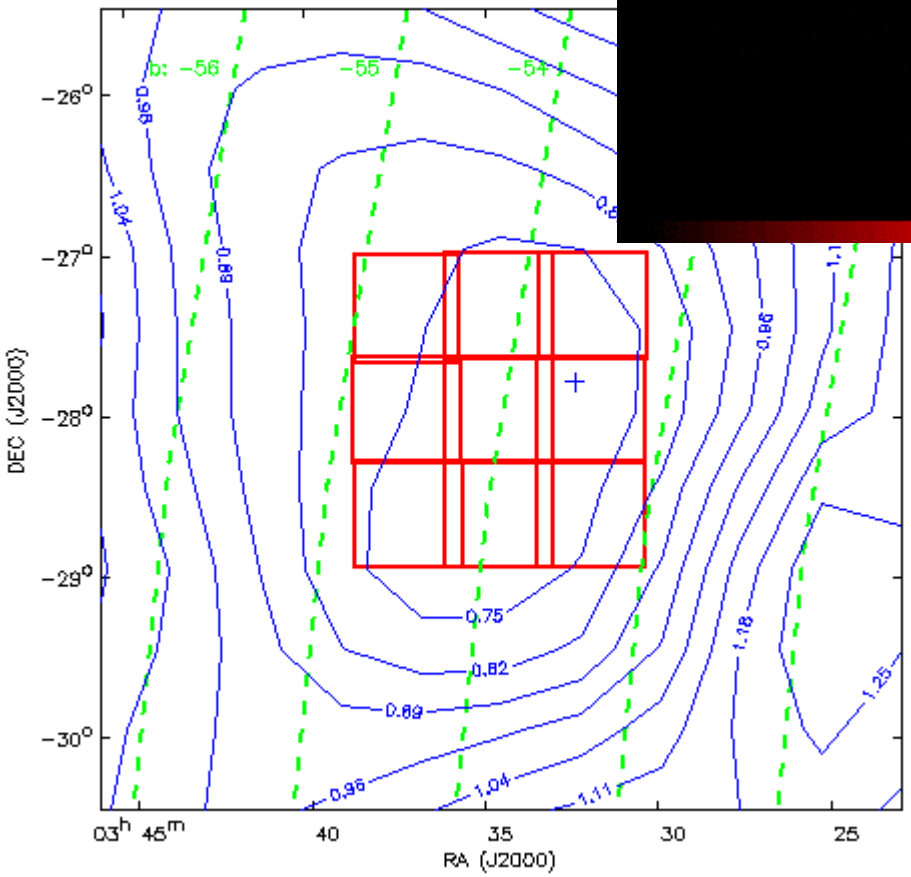
SCUBA	**37**	
MAMBO	**117**	
BOLOCAM	**144**	
LABOCA	**295**	
SHARC-2 (350um)	**384**	
...		
SCUBA-2	**8000+**	**(In a few years...)**

CDFS: An 850um Deep Survey


Seeing back into the cosmos
z
0
0.5
1
2
3
1000
HST GOODS / CHANDRA DEEP FIELD
JWST
SMGs
(z~1-3)
Dark Age
Big Bang
Cosmic microwave background
First stars
First galaxies
Modern universe
13.7
6
2
1
.3
.0004
(~400,000 yrs)
0
Age of the universe (billions of years)

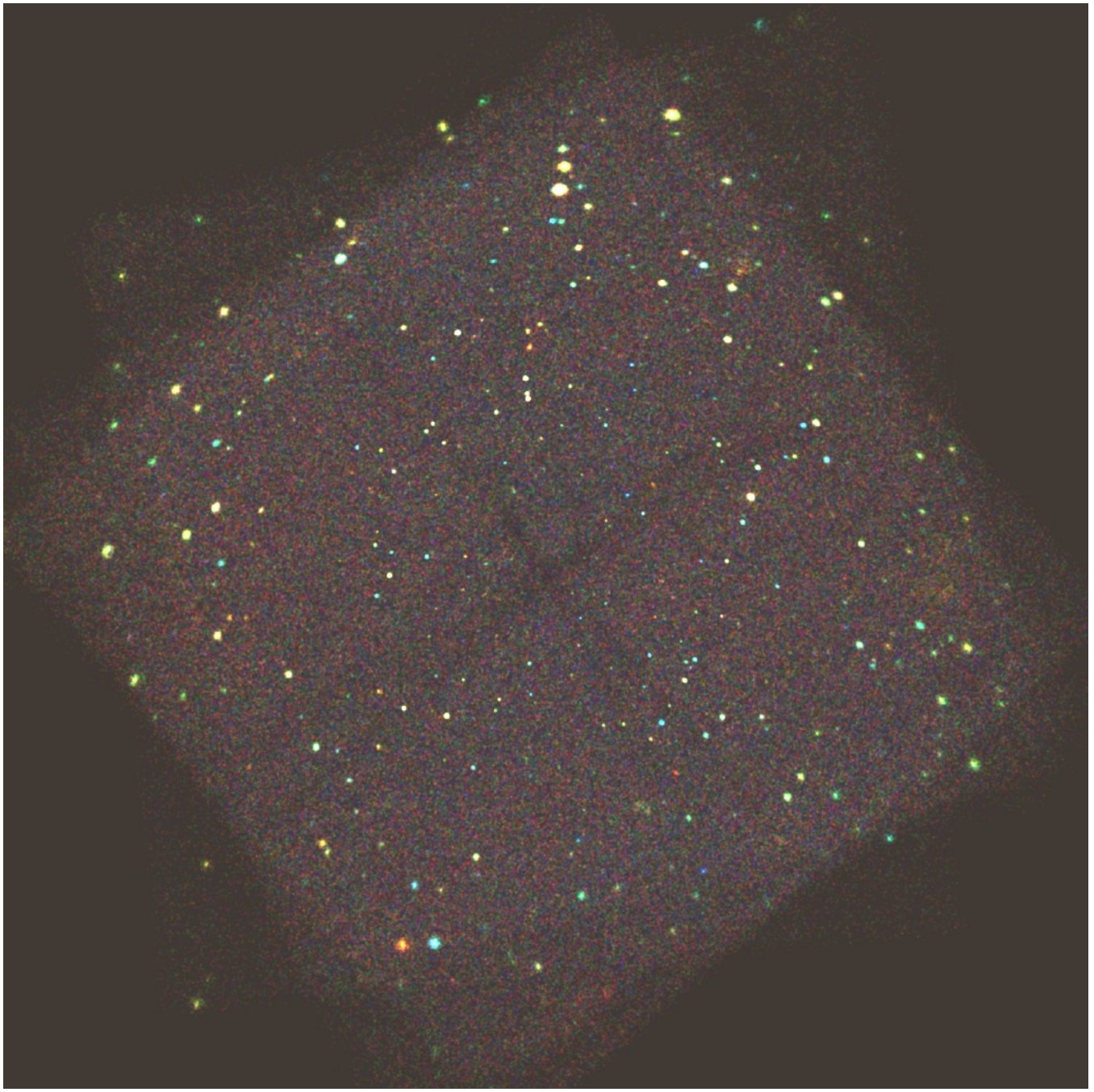
The Chandra Deep Field South (CDFS)



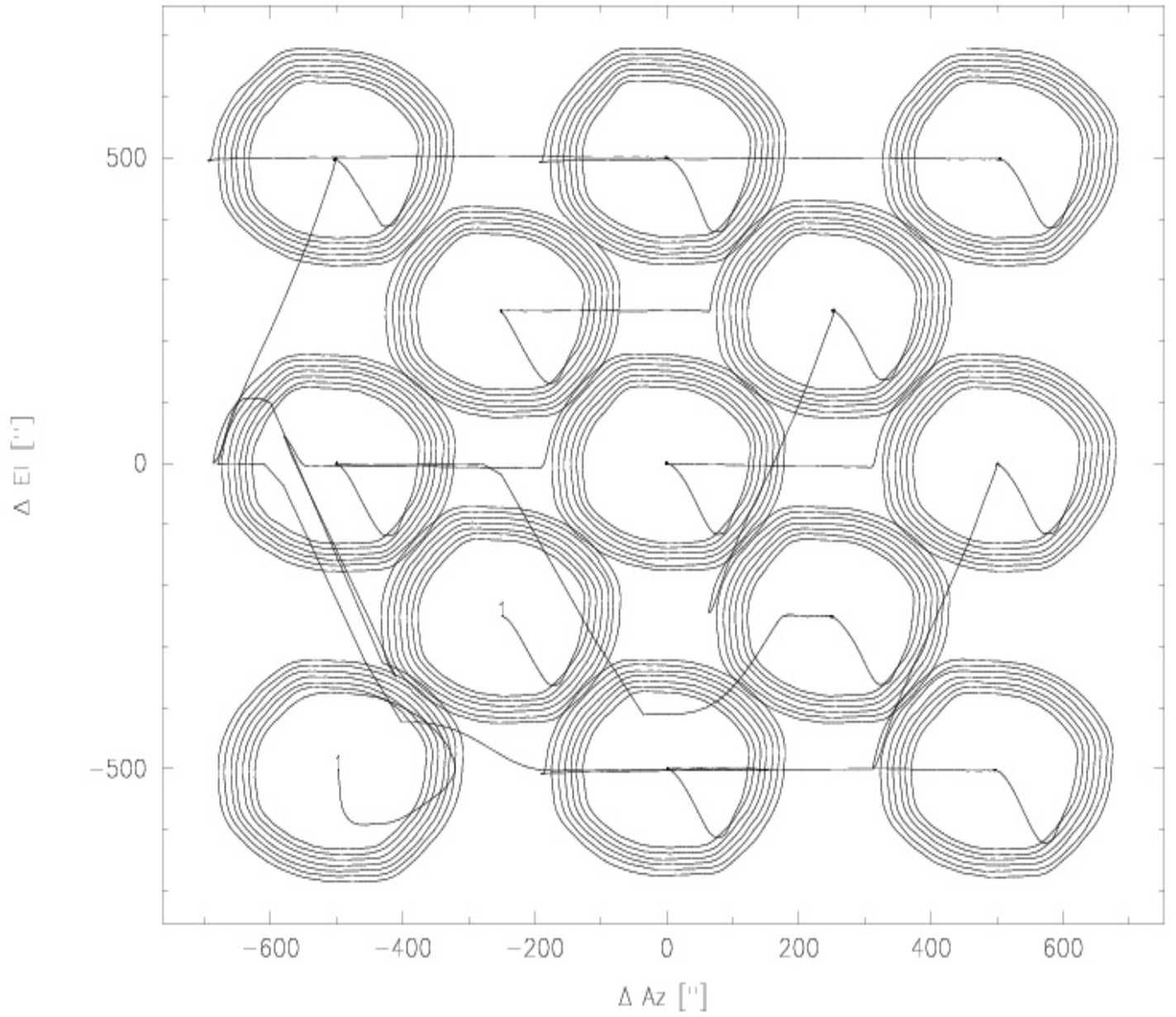


Very Low HI Column Densities

CDFS



Scanning Strategy: A Raster of Spirals



LABOCA CDFS at 850um...

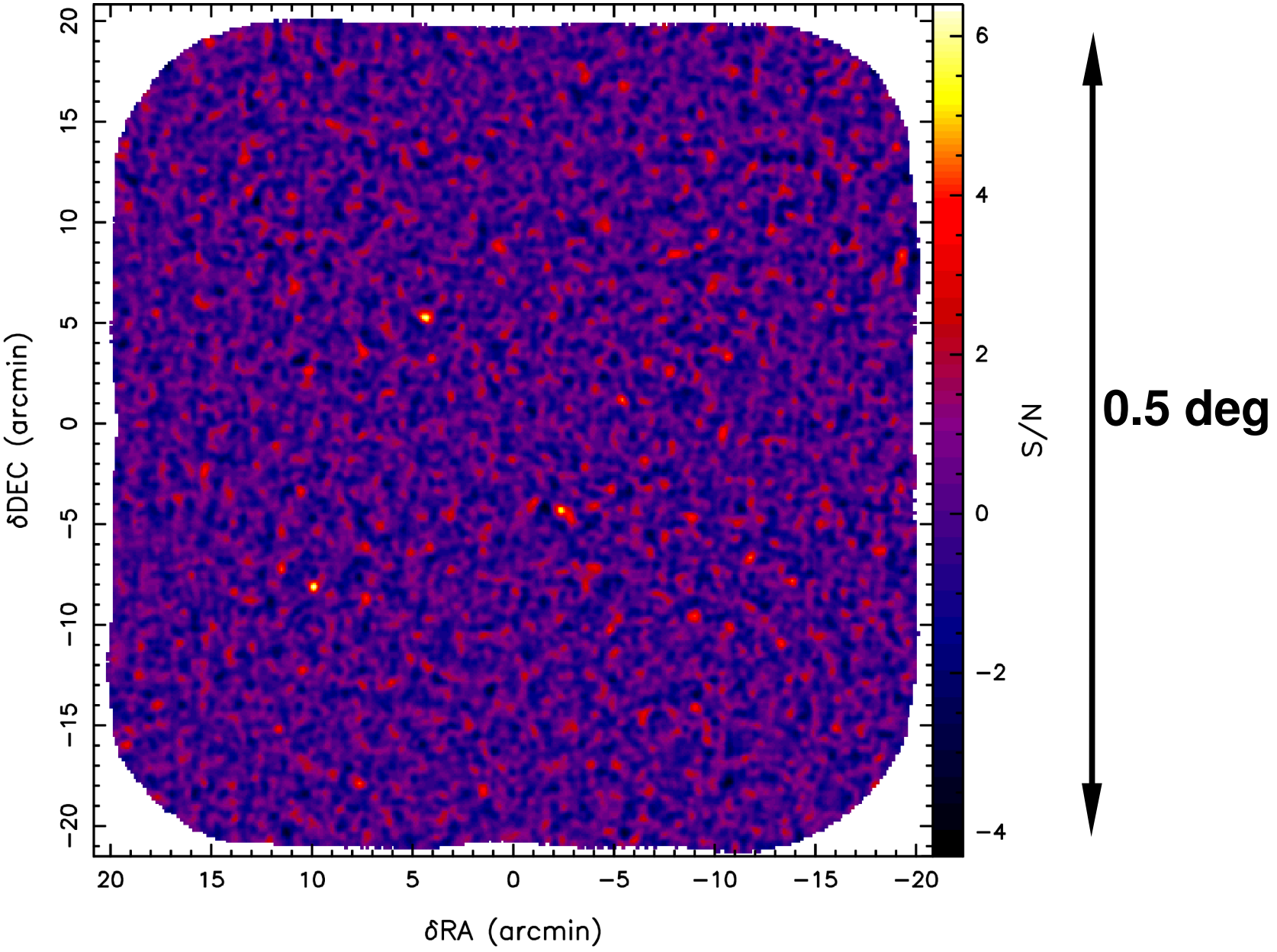
200 h scheduled

100 h complete

1.6 mJy RMS

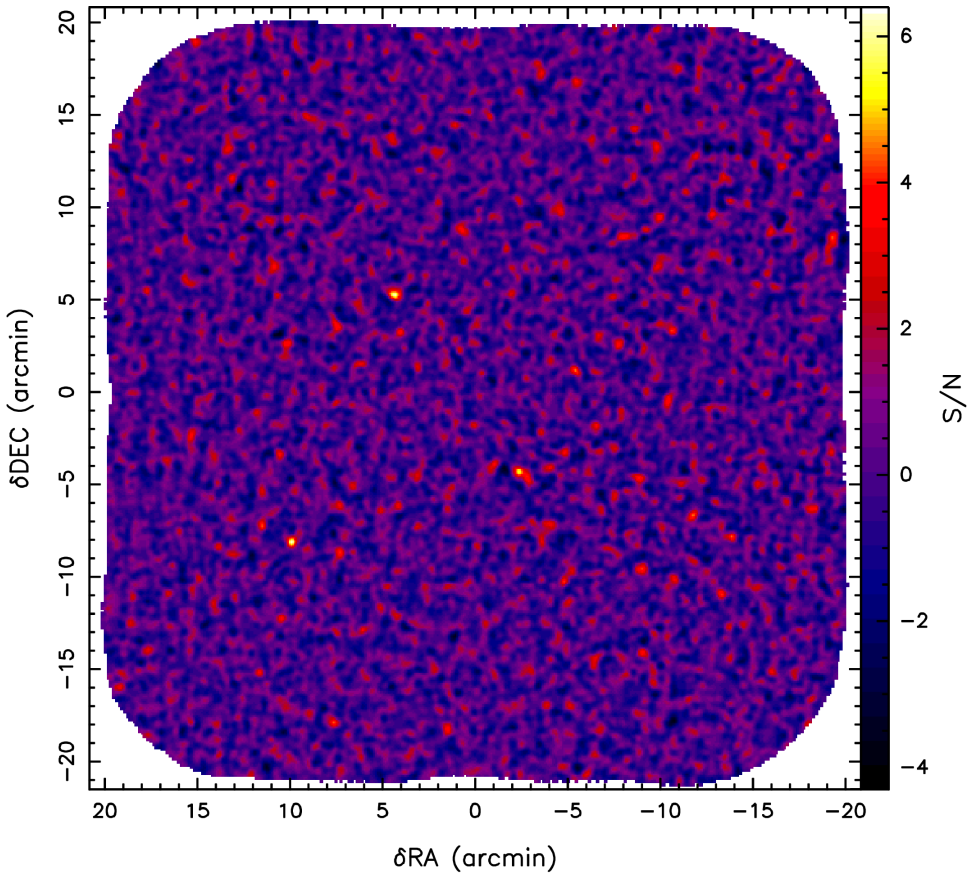
Goal:

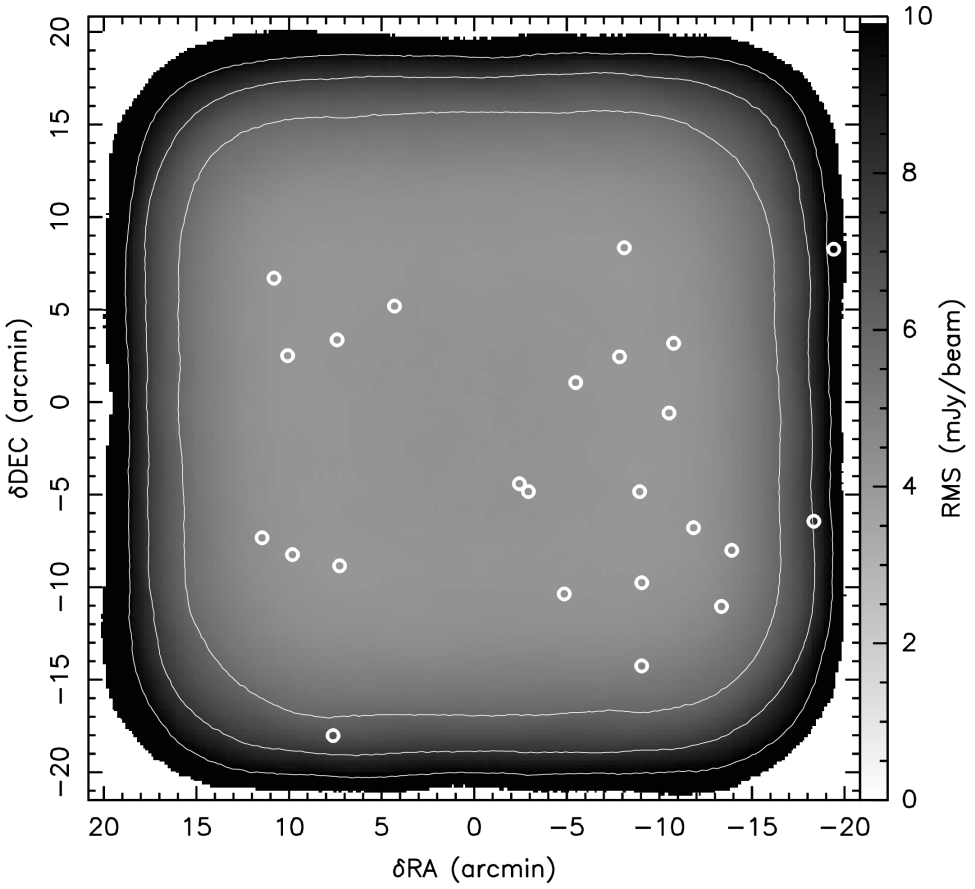
~1 mJy RMS



LABOCA CDFS at 850um...

(BoA Reduction)

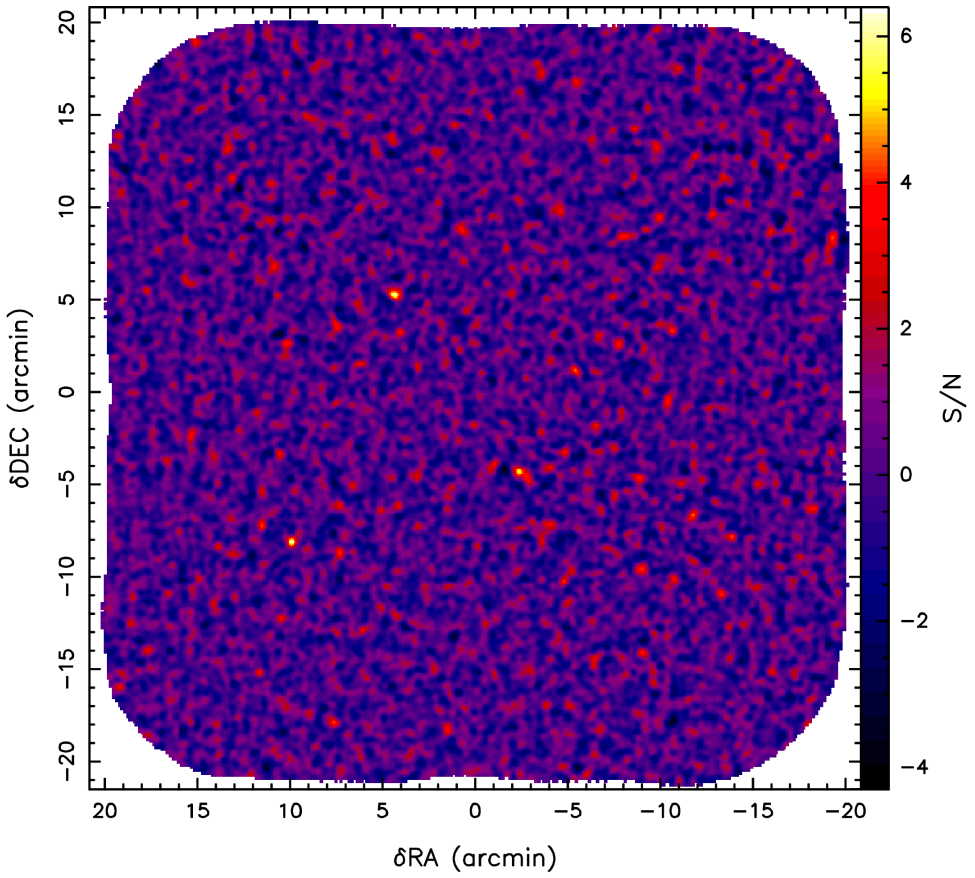


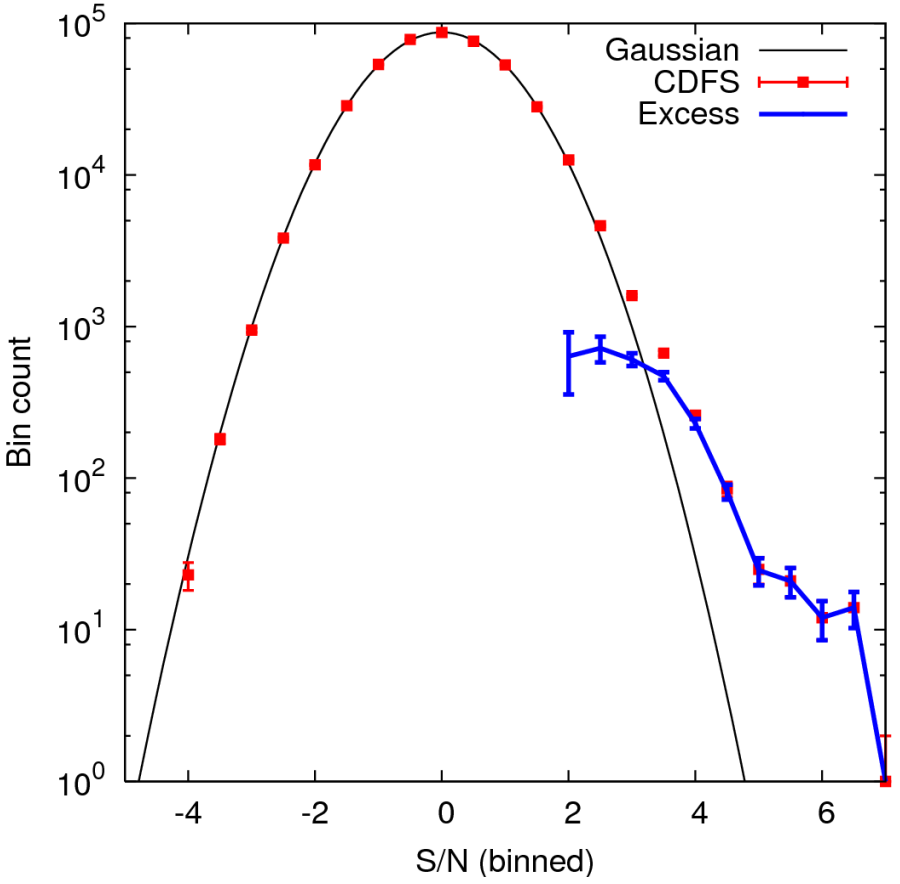


After 100 hours 0.5 deg x 0.5 deg area with uniform coverage

1.6 – 2.0 mJy/beam rms

LABOCA CDFS: Map Noise Distribution



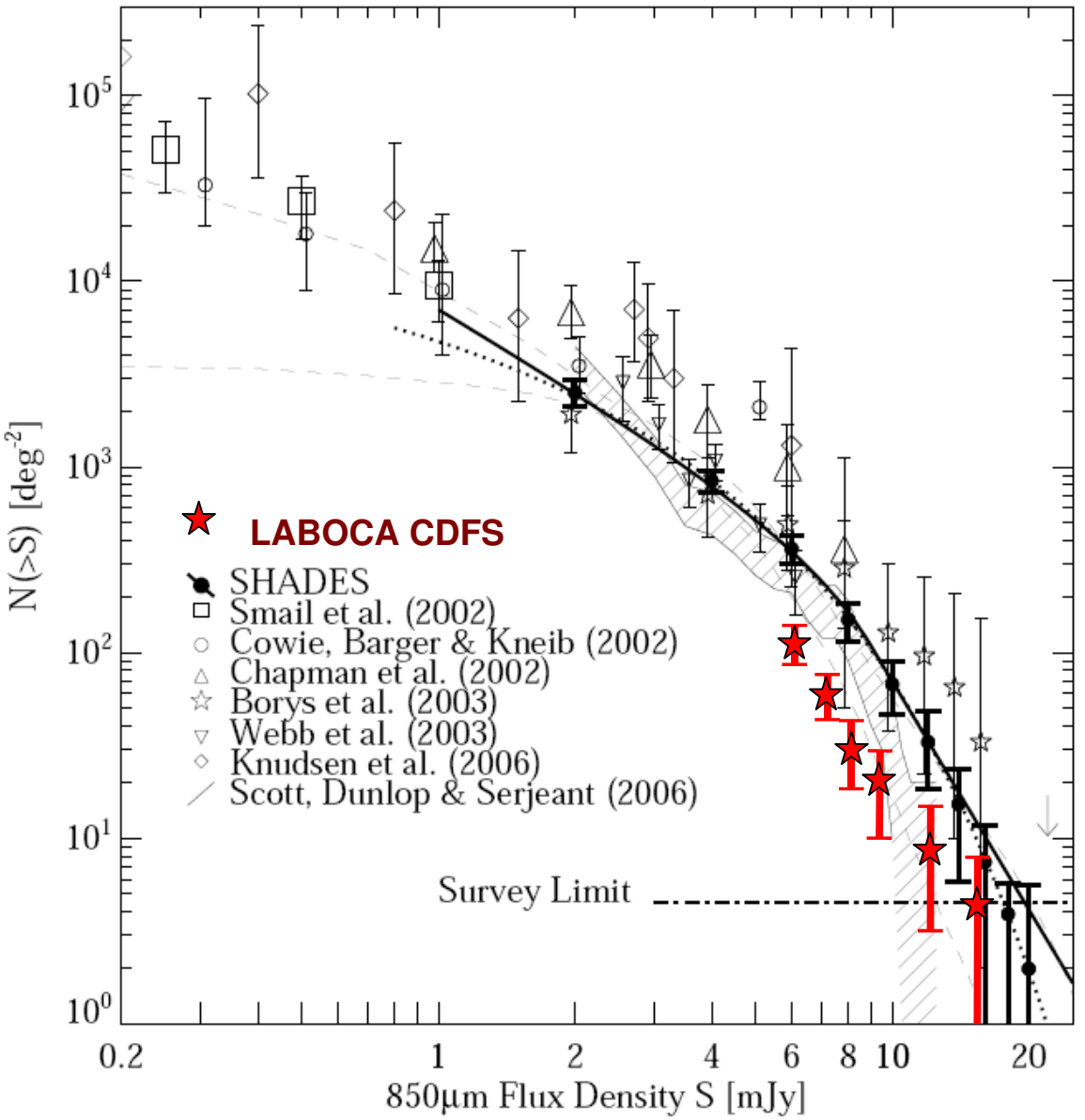


Noise is extremely consistent with Gaussian

with an expected tail at positive fluxes

due to resolved and unresolved sources...

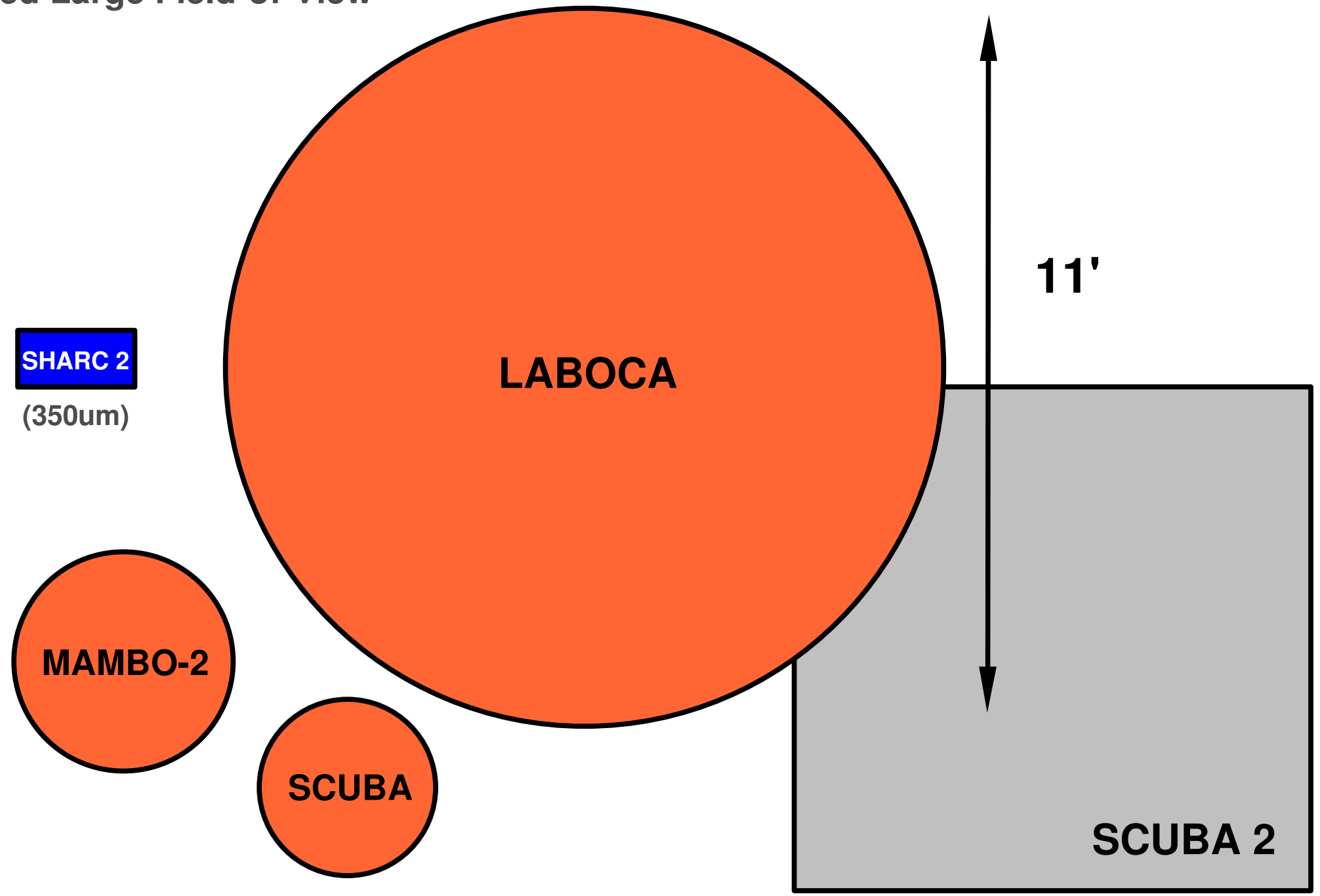
CDFS: First Results



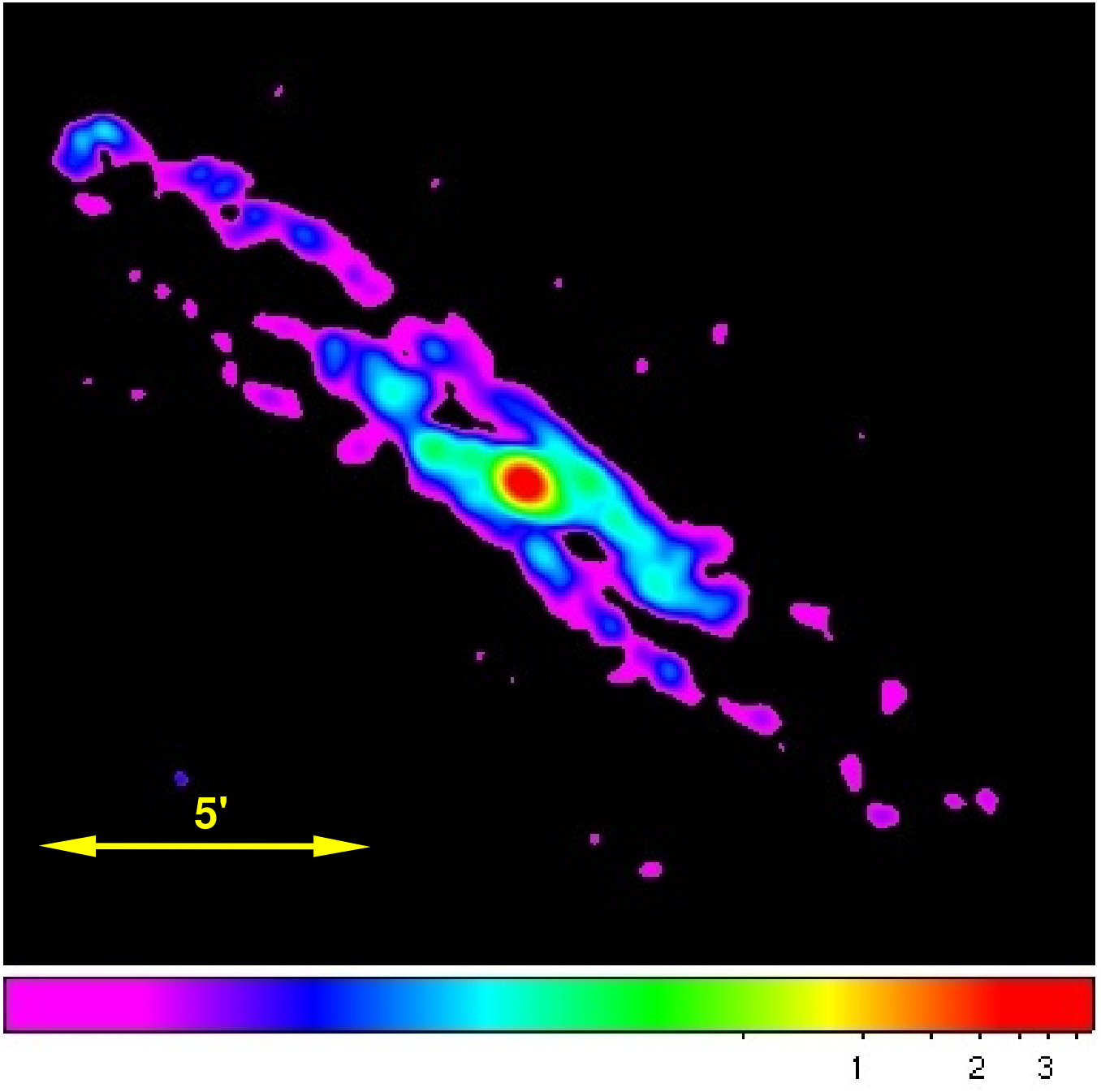
Coppin et al. 2006, MNRAS, 372, 1621

LABOCA Science Case: Large Scale Mapping

Need Large Field-of-View

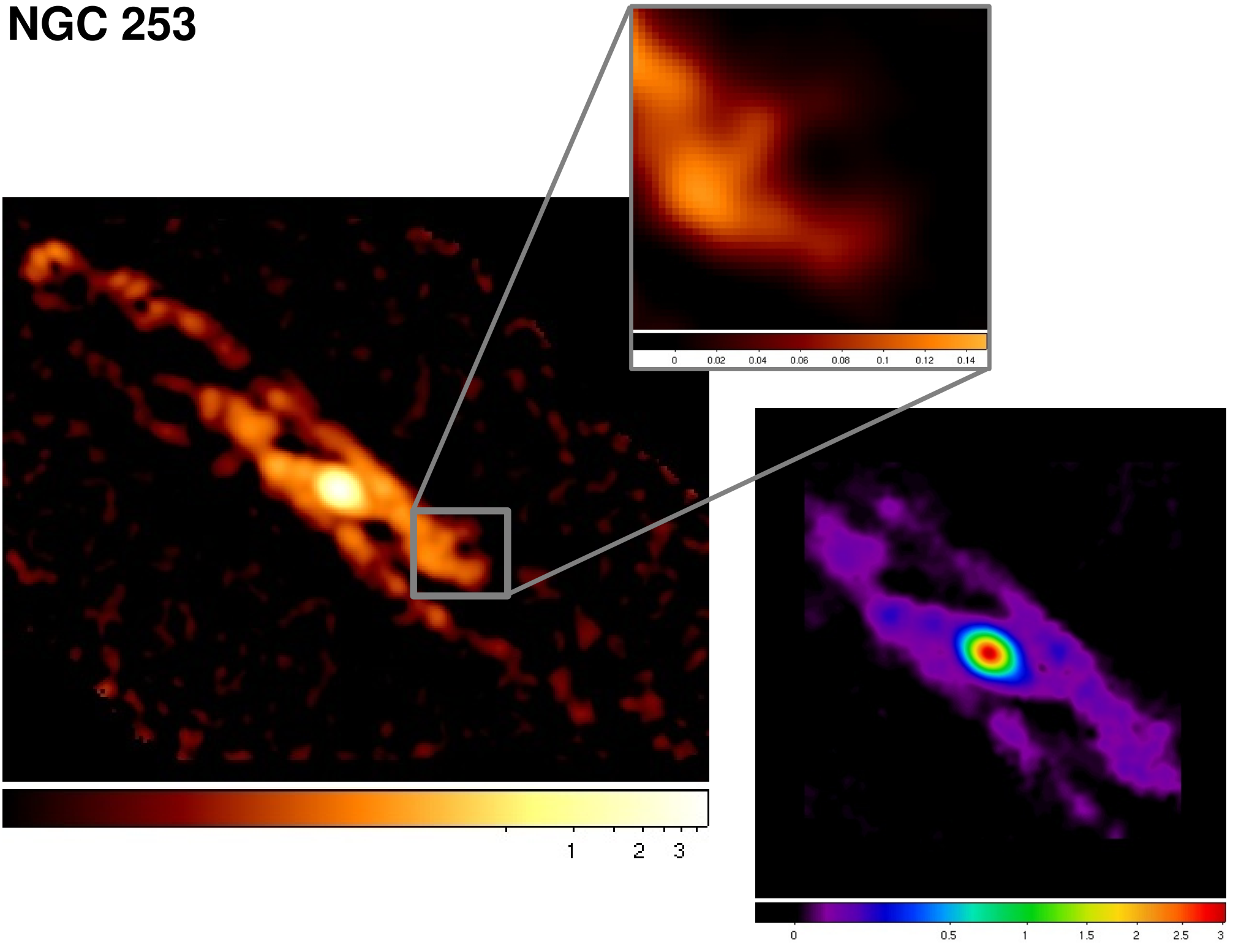


NGC 253

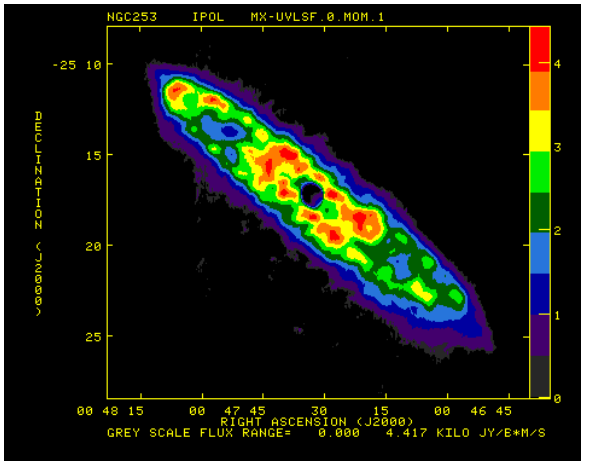


2 mJy/beam
RMS

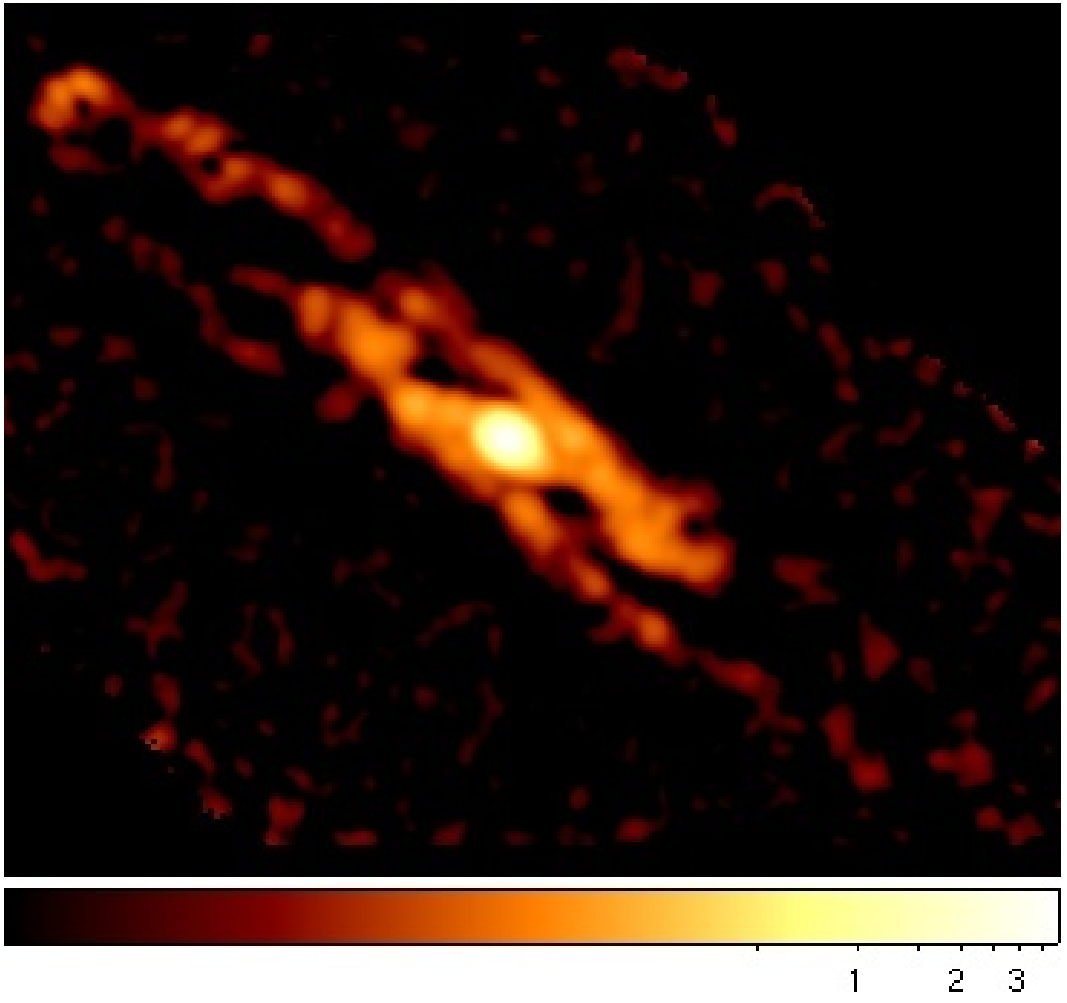
NGC 253



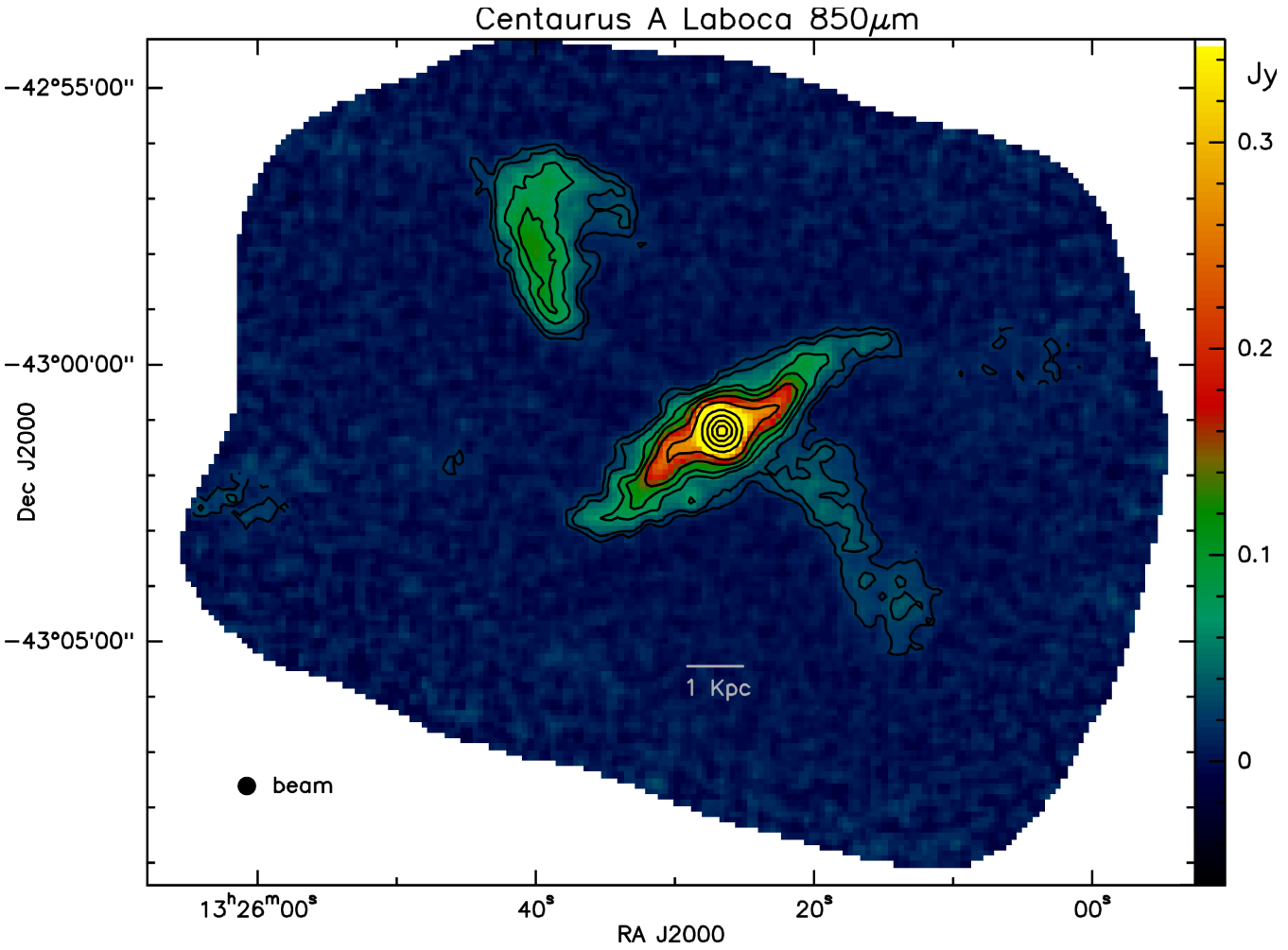
NGC 253

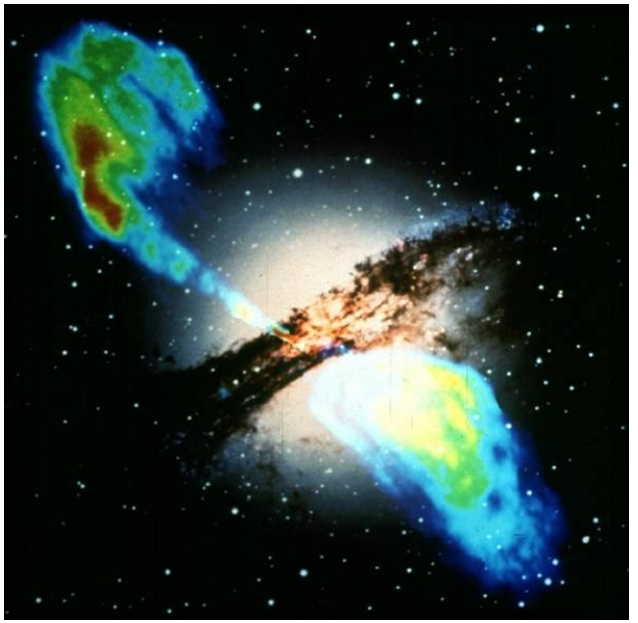

NGC253 IPOL MX-UVLSF.0.MOM.1
-25 10
15
20
25
DECLINATION (J2000)
00 48 15
00 47 45
30
15
00 46 45
RIGHT ASCENSION (J2000)
GREY SCALE FLUX RANGE= 0.000 4.417 KILO JY/B*M/S
0
1
2
3
4


The barred spiral starburst galaxy NGC 253
2MASS
Two Micron All Sky Survey
– Southern Facility –
2MASS Atlas Image Mosaic
Infrared Processing and Analysis Center & University of Massachusetts


1
2
3

Cen A


Centaurus A Laboca 850μm
−42°55'00"
−43°00'00"
−43°05'00"
Dec J2000
1 Kpc
beam
$13^h26^m00^s$
40^s
20^s
00^s
RA J2000
Jy
0.3
0.2
0.1
0



A. Weiss

Data Reduction for Imaging Arrays

Separation of Source and Noise Signals

Iterated sequence of statistical estimators

Computing cost linear with data size (unlike SVD and matrix methods)

Targeted filtering (not blind like PCA)

Easily adaptable to optimize for different science cases

Massively parallelizable (large data-sets)

Data Reduction for Imaging Arrays

Implementations

BoA

F. Schuller, A. Beelen, R. Schaaf, F. Bertoldi, C. Vlahakis, M. Nord

CRUSH

www.submm.caltech.edu/~sharc/crush

A. Kovács

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