Title: New CMB results

Date: Oct 23, 2008 05:15 PM

URL: http://pirsa.org/08100065

Abstract:

CBI pol to Apr'05 @Chile

Acbar to Jan'06, 07f @SP

Bicep1..2 @SP

CBI2 to early'08

QUaD @SP

Quiet1

Quiet2

1K HEMTs@Ch

ABS

keck@S

SCUBA2

(12000 bolometers)

JCMT @Hawaii

Spide

2312

bolomete

@LDB

SZA

(Interferometer)

@Cal

APEX

(~400 bolometers)

@Chile

ACT

(3000 bolometers)

3 frequencies @Chile

Clover

@Chile

Boom03@LDB

EBEX@LDB

004 — 2005 — 2006 — 2007 — 2008 — 2009 — 20

LMT@Mexico

WMAP @L2 to 2009-2013?

SPT

(1000 bolometers)

@South Pole

LHC

Bp

@L

SPTpol

ALMA

(Interferomet

@Chile

ASI @SP

Polarbear

(300 bolometers)@Cal/Chile

CAPMAP

AMI

GBT

52 bolometers

+ HEMTs @L2

9 frequencies

Planck09.3

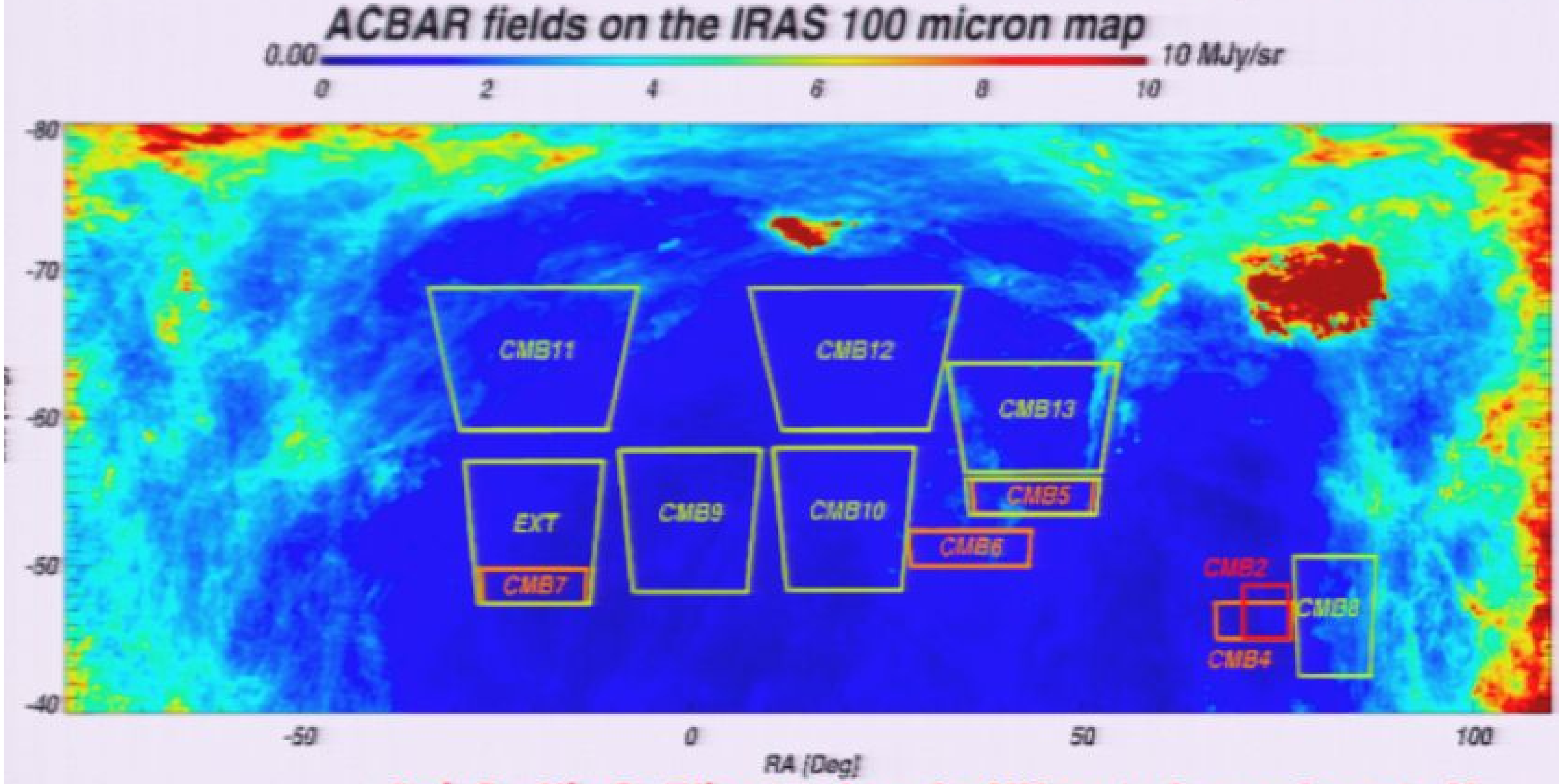
ACBAR08

1.7% of sky

Reichardt et.al. astro-ph Jan08, *revised Oct08 for wmap5*

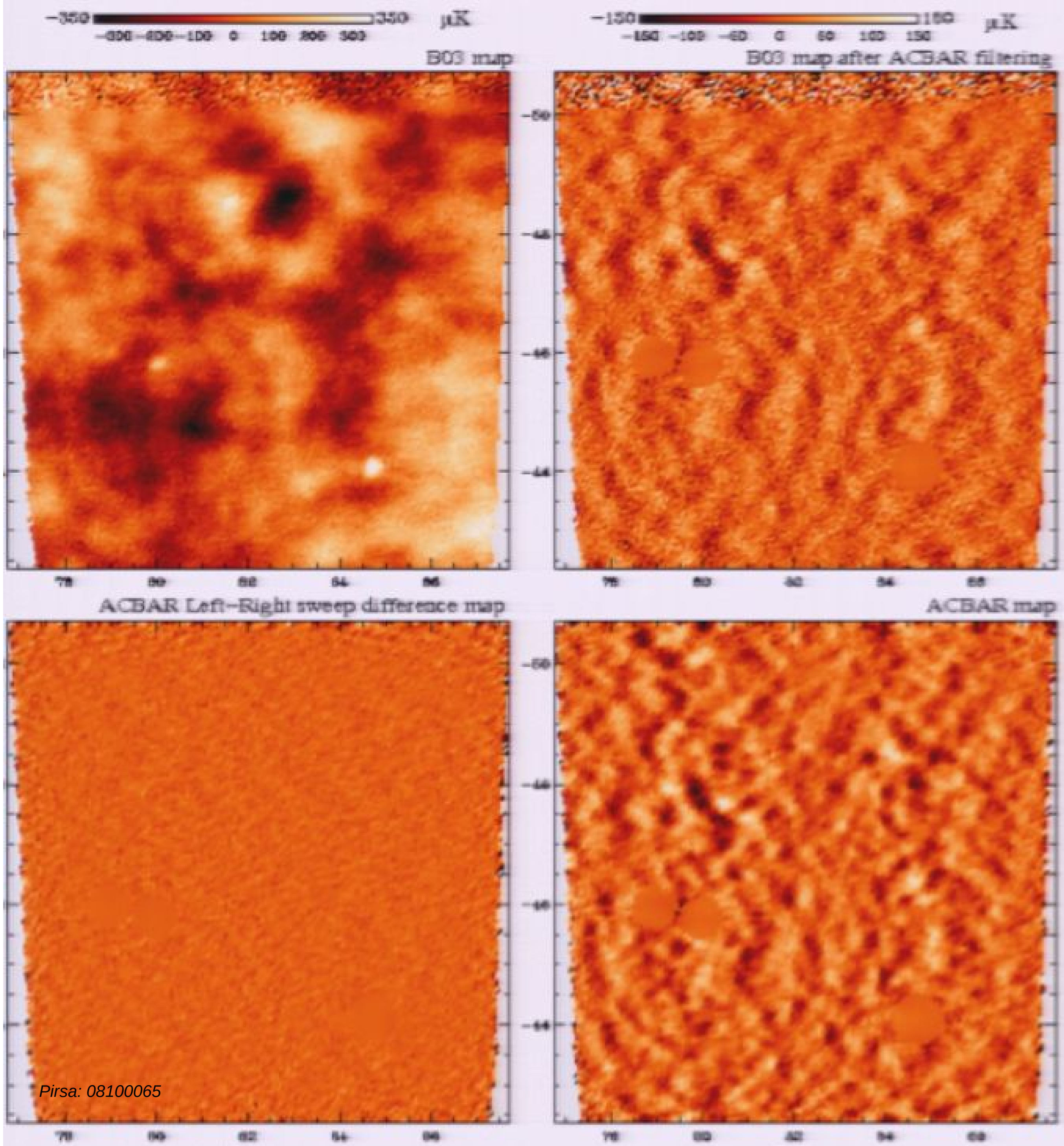
2.1 x detector-hours & 4.9 x sky coverage of ACBAR07 (new wide & shallow fields)

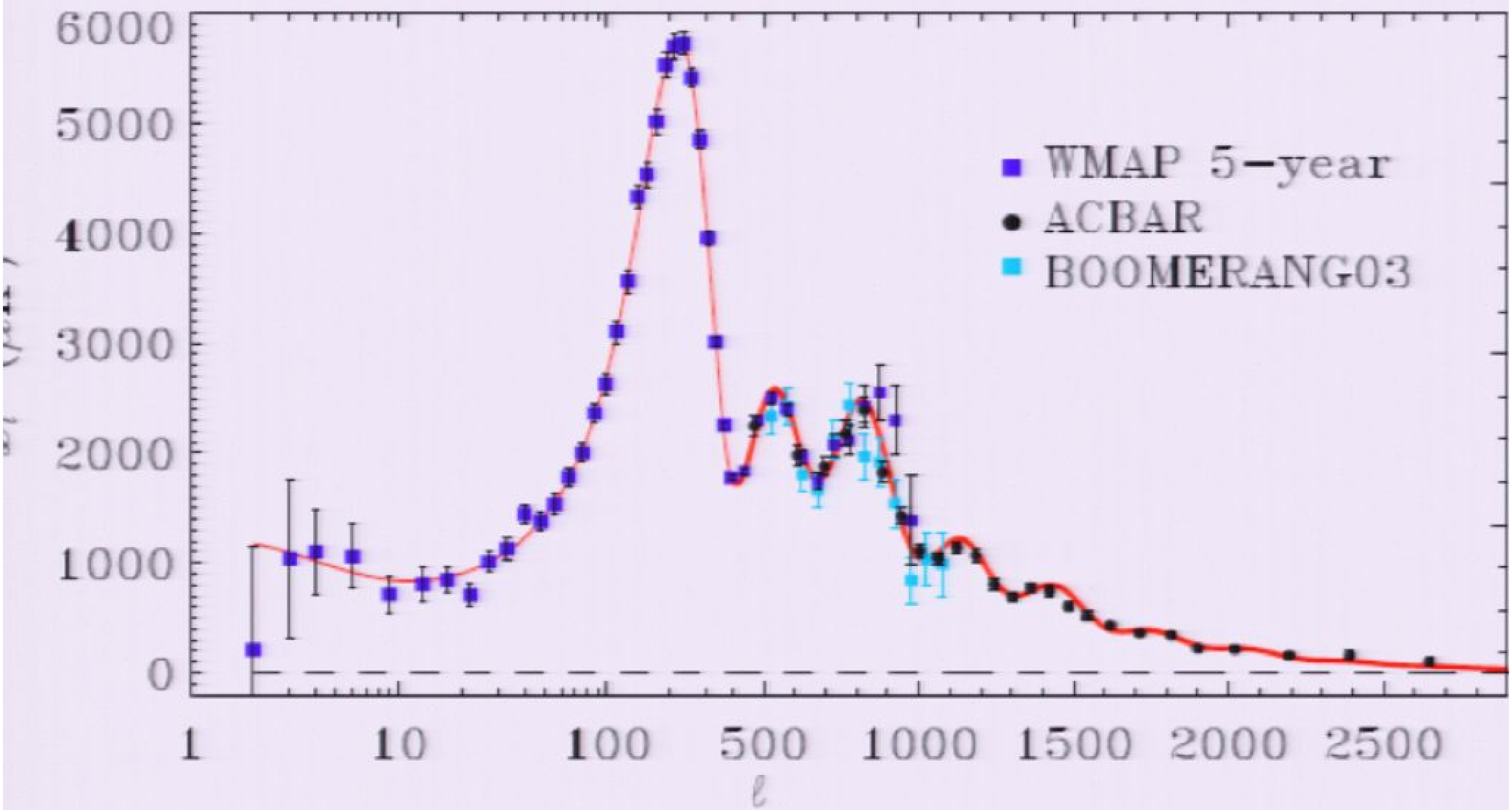
Calibration uncertainty: *2.1% from 6% via WMAP5 - improved from WMAP3*



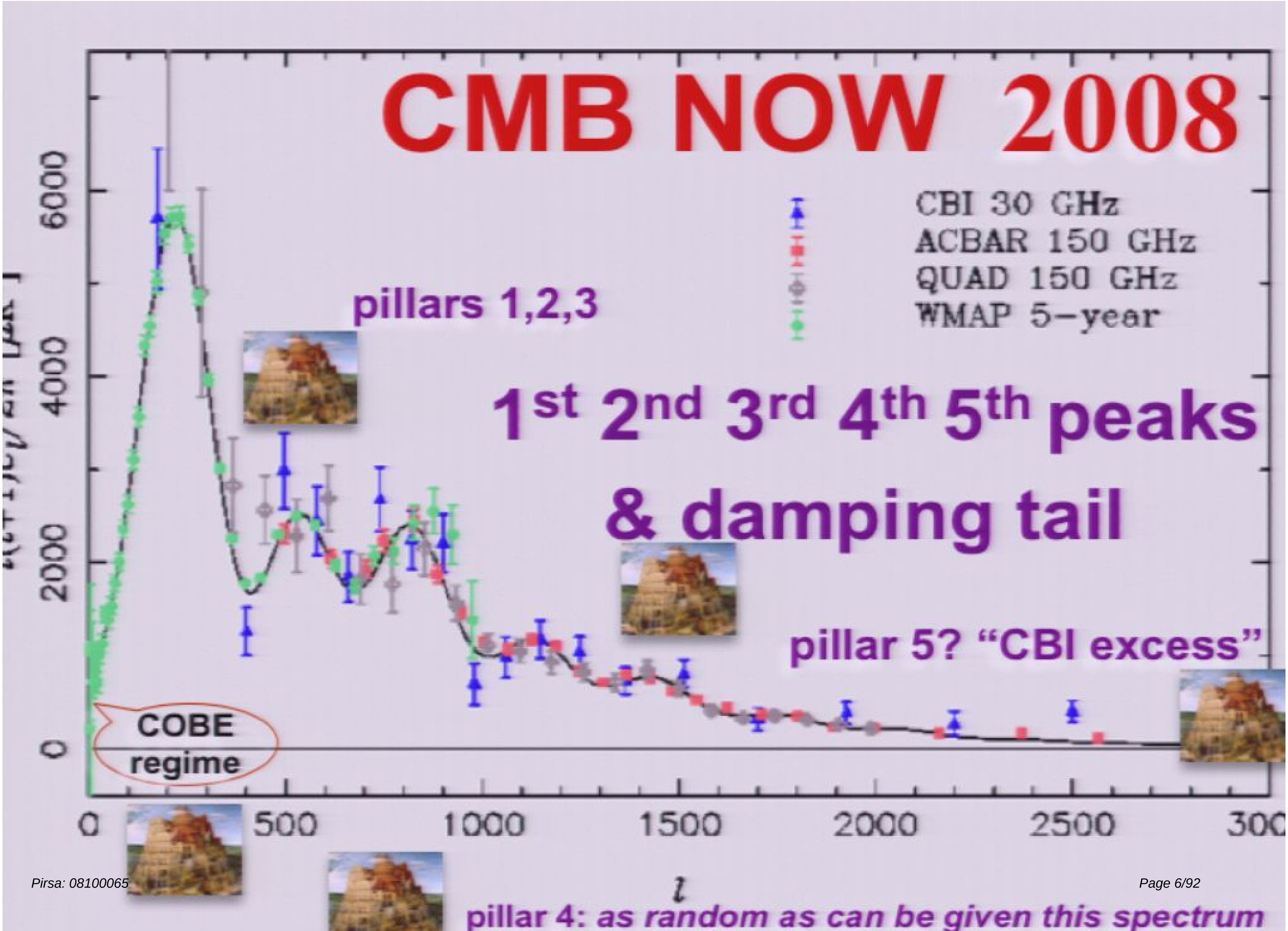
3rd & 4th & 5th peaks, brilliant damping tail

ACBAR excess > 2000, *1.1sigma consistent with CBI excess (tSZ)*, but could be sub-mm sources @ 150 GHz qsrc=29+12-28 cf. <~17-29


−350
350
μK
B03 map
−150
150
μK
B03 map after ACBAR filtering
ACBAR Left−Right sweep difference map
ACBAR map



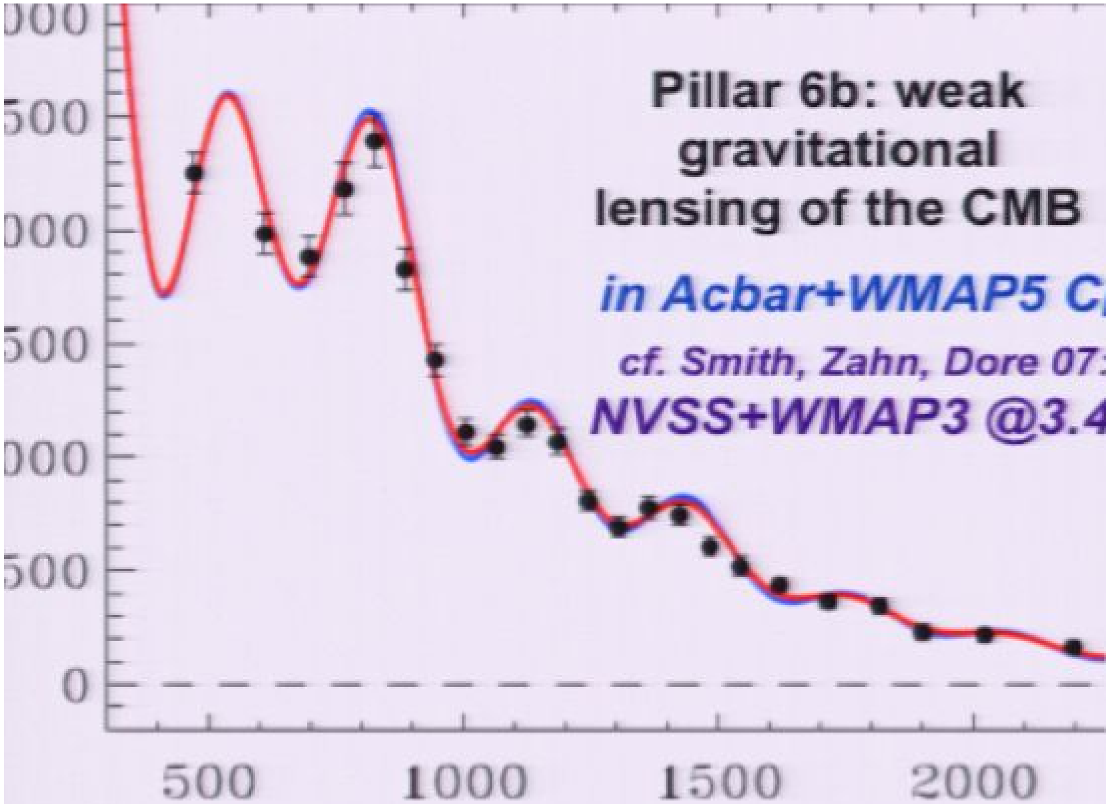
6000
5000
4000
3000
2000
1000
0
1
10
100
500
1000
1500
2000
2500
ℓ
WMAP 5-year
ACBAR
BOOMERANG03

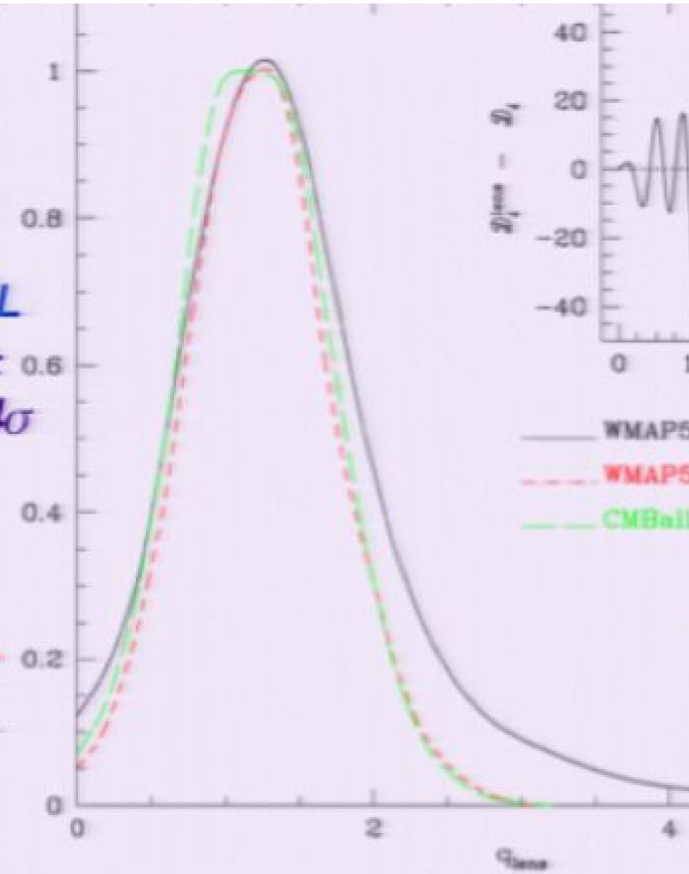

CMB NOW 2008
CBI 30 GHz
ACBAR 150 GHz
QUAD 150 GHz
WMAP 5-year
pillars 1,2,3
1st 2nd 3rd 4th 5th peaks
& damping tail
pillar 5? “CBI excess”
COBE regime
pillar 4: as random as can be given this spectrum
0
2000
4000
6000
0
500
1000
1500
2000
2500
l

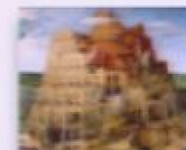
Pillar 6b: weak gravitational lensing of the CMB

in Acbar+WMAP5 C_L

cf. Smith, Zahn, Dore 07:
NVSS+WMAP3 @3.4σ



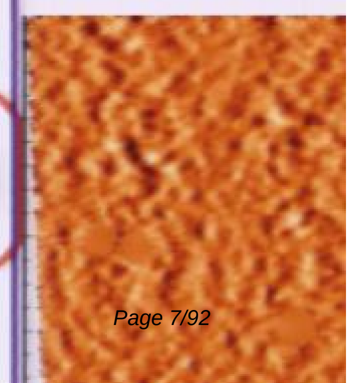




$$C_\ell^{\rm lens} = C_\ell^{\rm no-lens} + q_{\rm lens}\Delta C_\ell^{\rm lens}$$

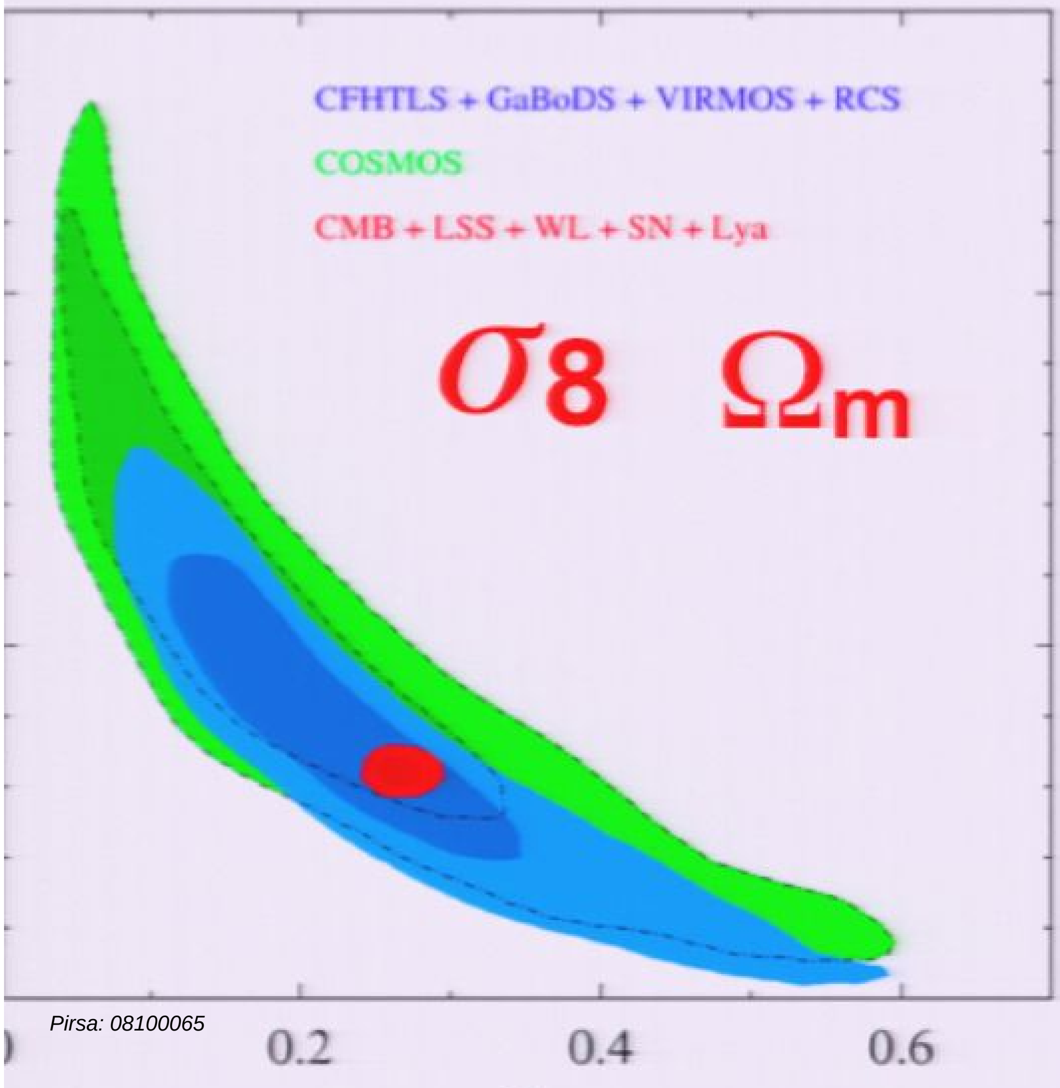
$$\Delta \ln \mathcal{E} = \ln[P({\rm lens}|data, theory)/P({\rm no-lens}|data, theory)]$$

		Bayesian evidence
wmap5	$q_{\rm lens} = 1.34^{+0.27(+1.51)}_{-0.26(-0.85)}$	$\Delta \ln \mathcal{E} = 2.04$
wmap5+ acbar	$q_{\rm lens} = 1.23^{+0.21(+0.83)}_{-0.23(-0.76)}$	$\Delta \ln \mathcal{E} = 2.89$
CMBall	$q_{\rm lens} = 1.21^{+0.24(+0.82)}_{-0.24(-0.76)}$	$\Delta \ln \mathcal{E} = 2.63$



Weak Lens now: CFHTLS-wide(22sq deg)+GaBoDS (13) +Virmos-Descart(8)+RCS1(53) Apr07+ & COSMOS07

cbar+wmap5 lens? σ_8 .89+.07-.09 (+.26-.34)



case	Ω_m	σ_8
LCDM	0.265+-.011	0.828+-.01
w0	0.265+-.013	0.829+-.02
w0-wa	0.265+-.014	0.831+-.02
ε_s	0.265+-.013	0.829+-.02
ε_s-a_s-ζ_s	0.265+-.013	0.832+-.02

recent weak lensing "alone"

CFHTLS	0.26+	0.83+.04-.05
	cf.	0.80+.05-.0
COSMOS	0.26+	0.88+-.07-.0
cf.		0.87+-.074

recent SZ CBIexcess **"cmb-alone"**

CBI+Acbar+Bima σ_8**SZ** ~.93 +.04-.05

planck1+jdem+dune .260+-.004 .850+-.00

ε_s-a_s-ζ_s case ε_s =.02+.07-.06

WMAP-BOOM-ACBAR-ACT:
the high resolution frontier

Toby
Marriage
01.08 for th
ACT
collaboratio

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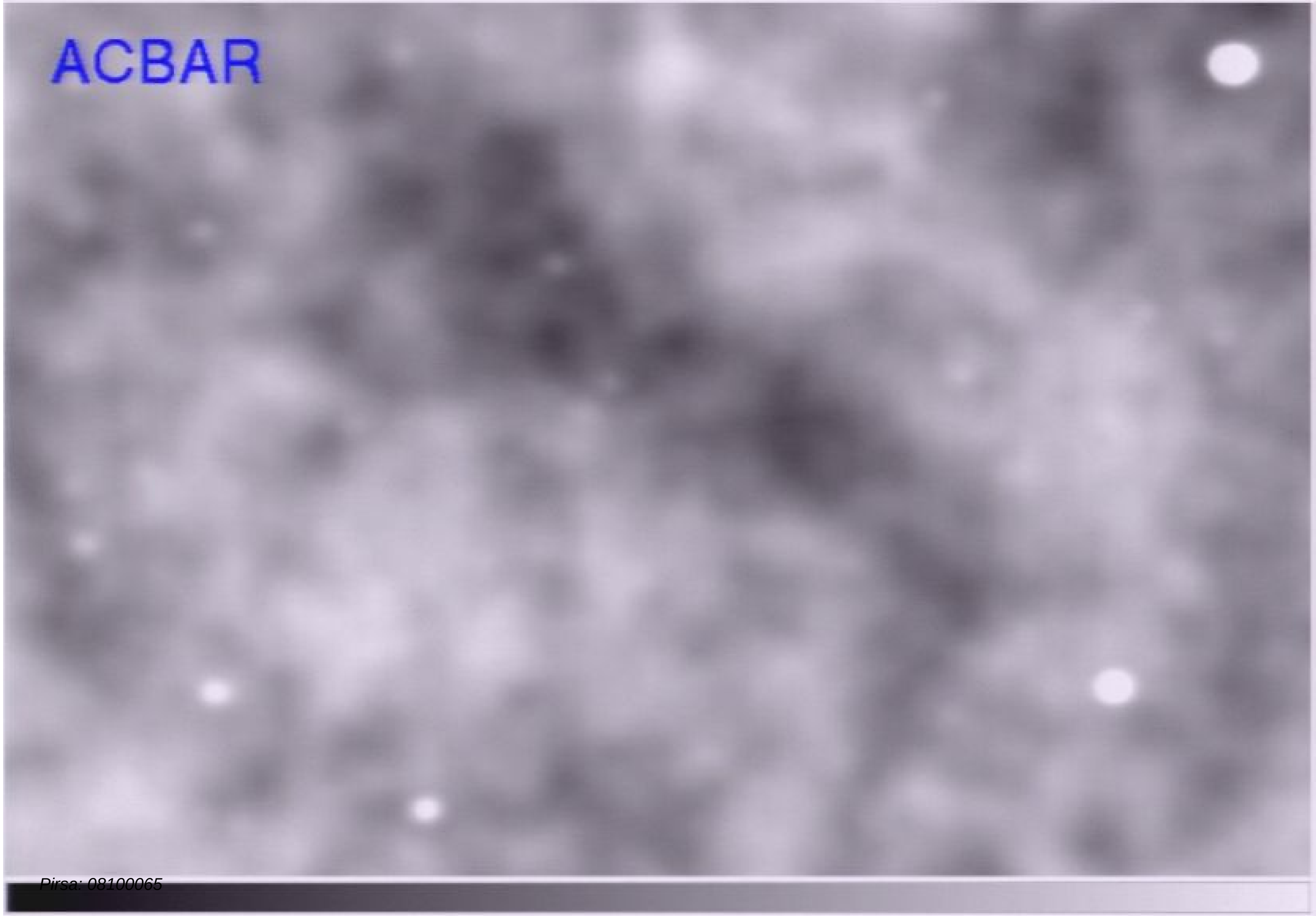

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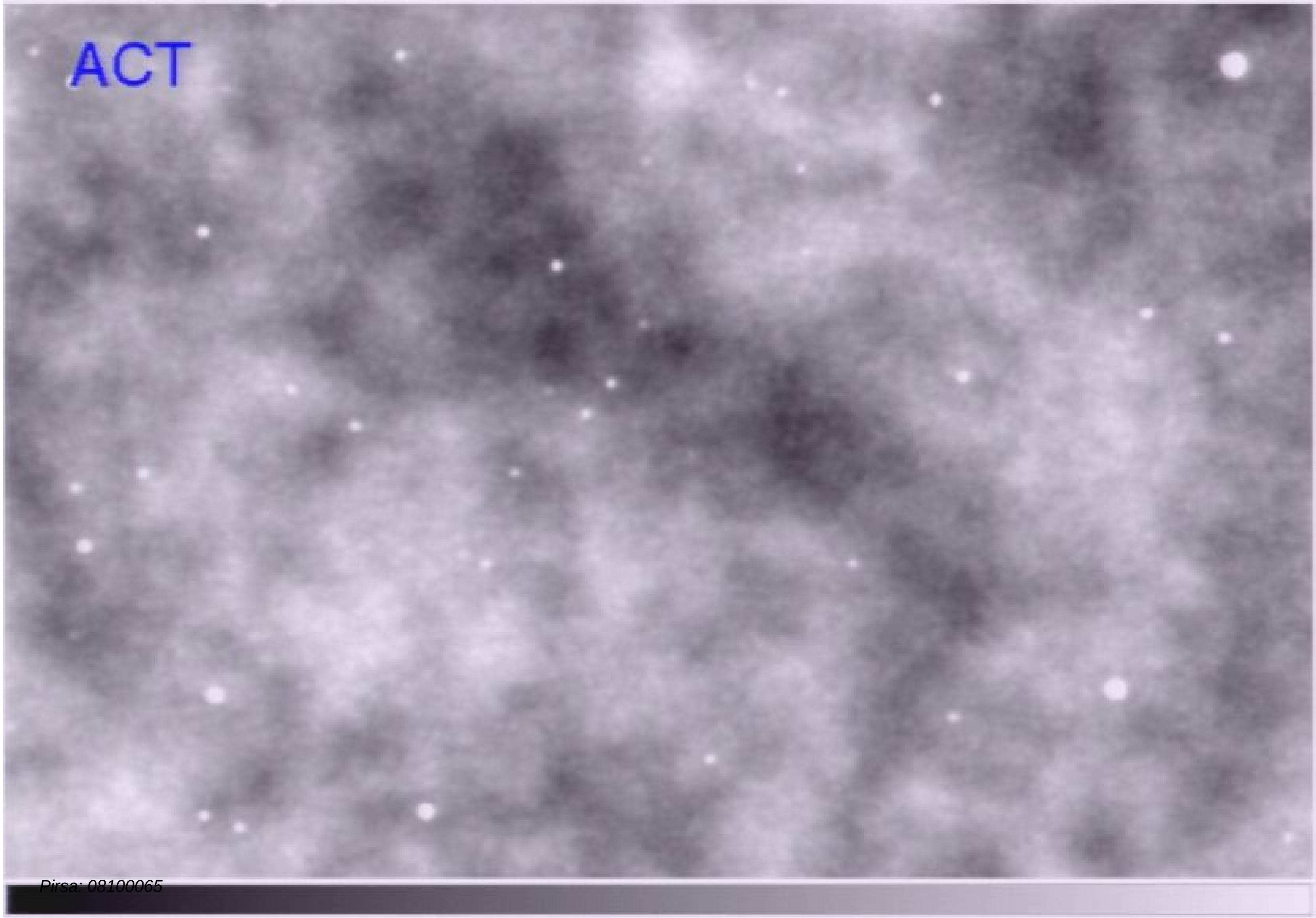

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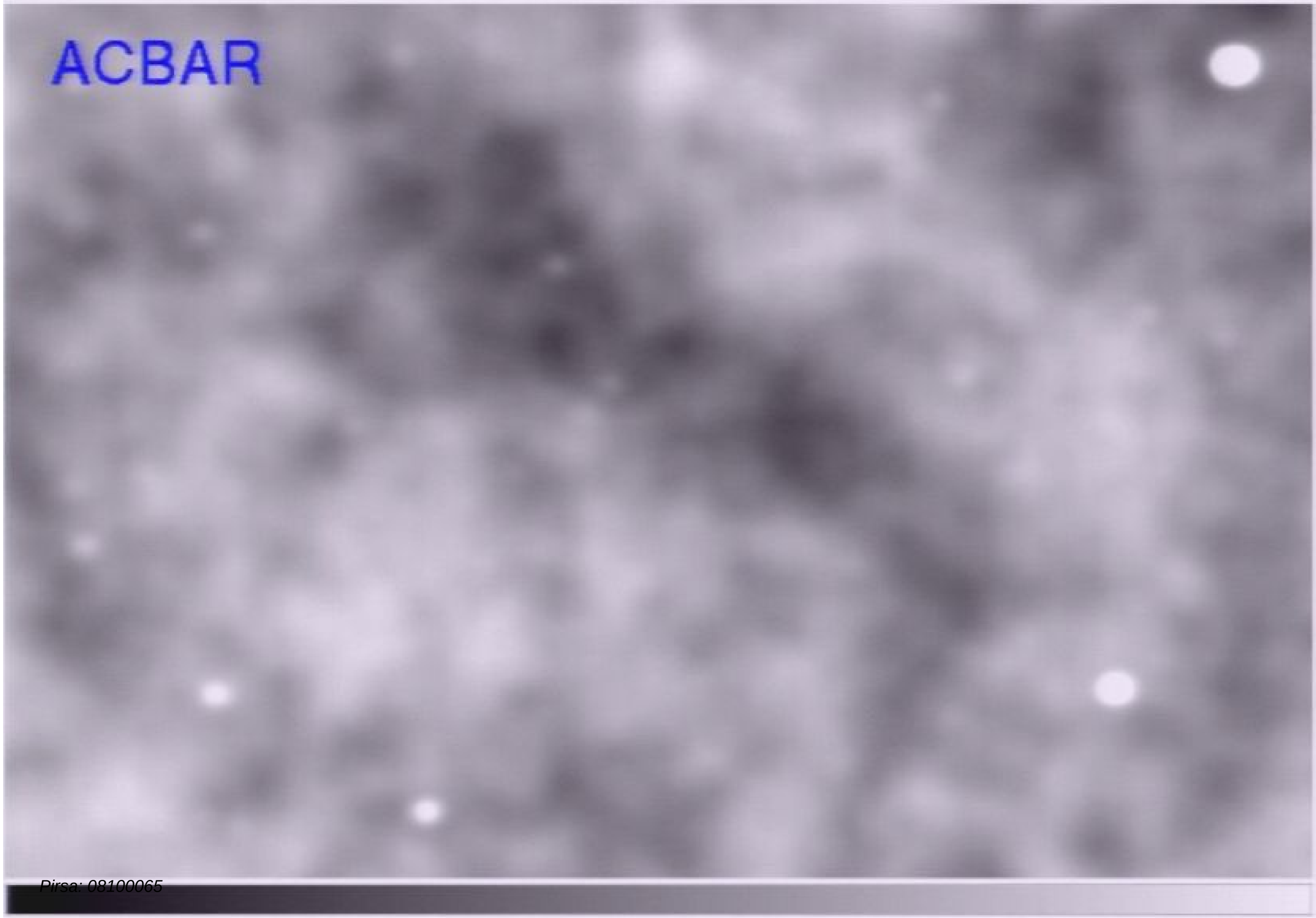

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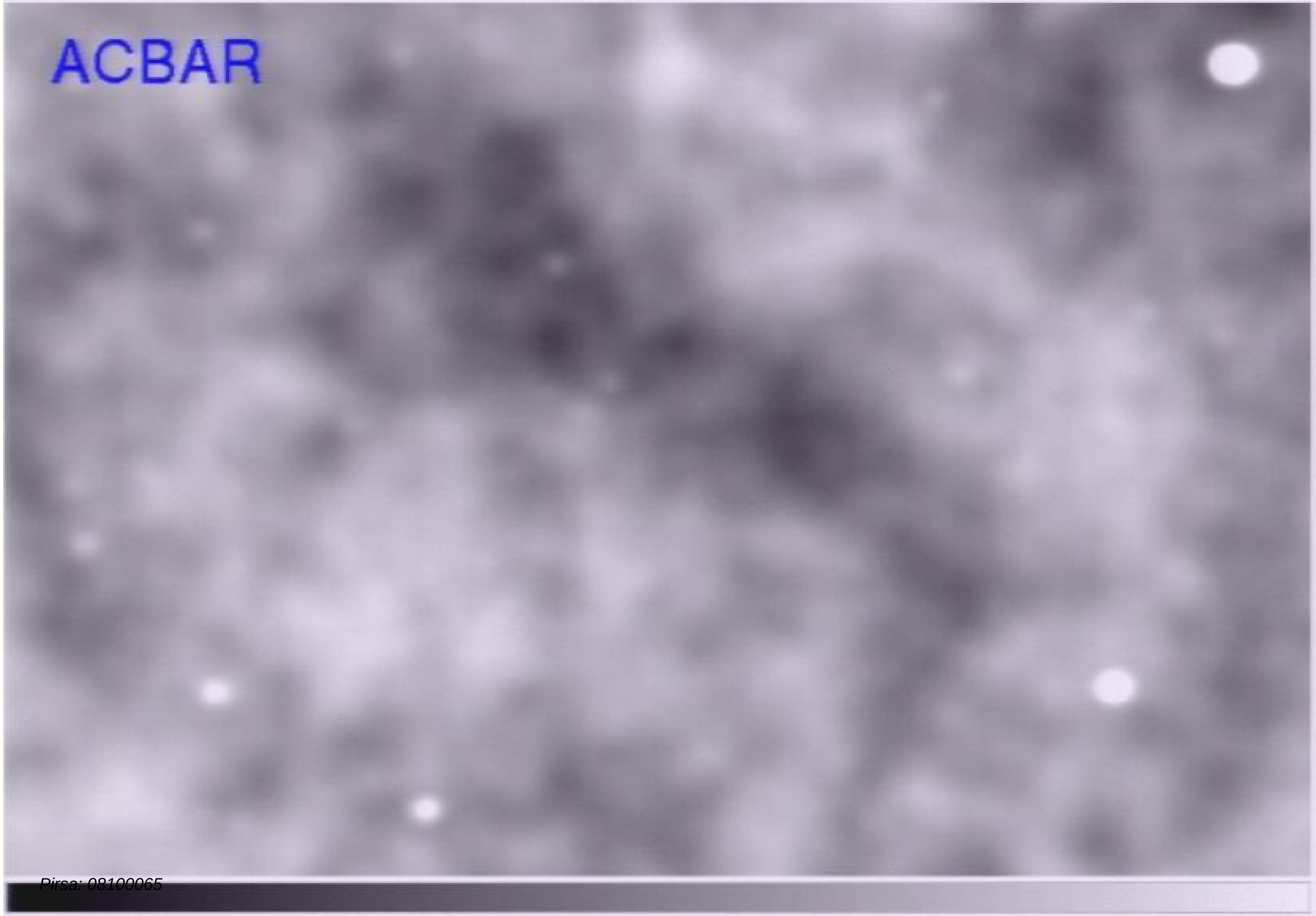

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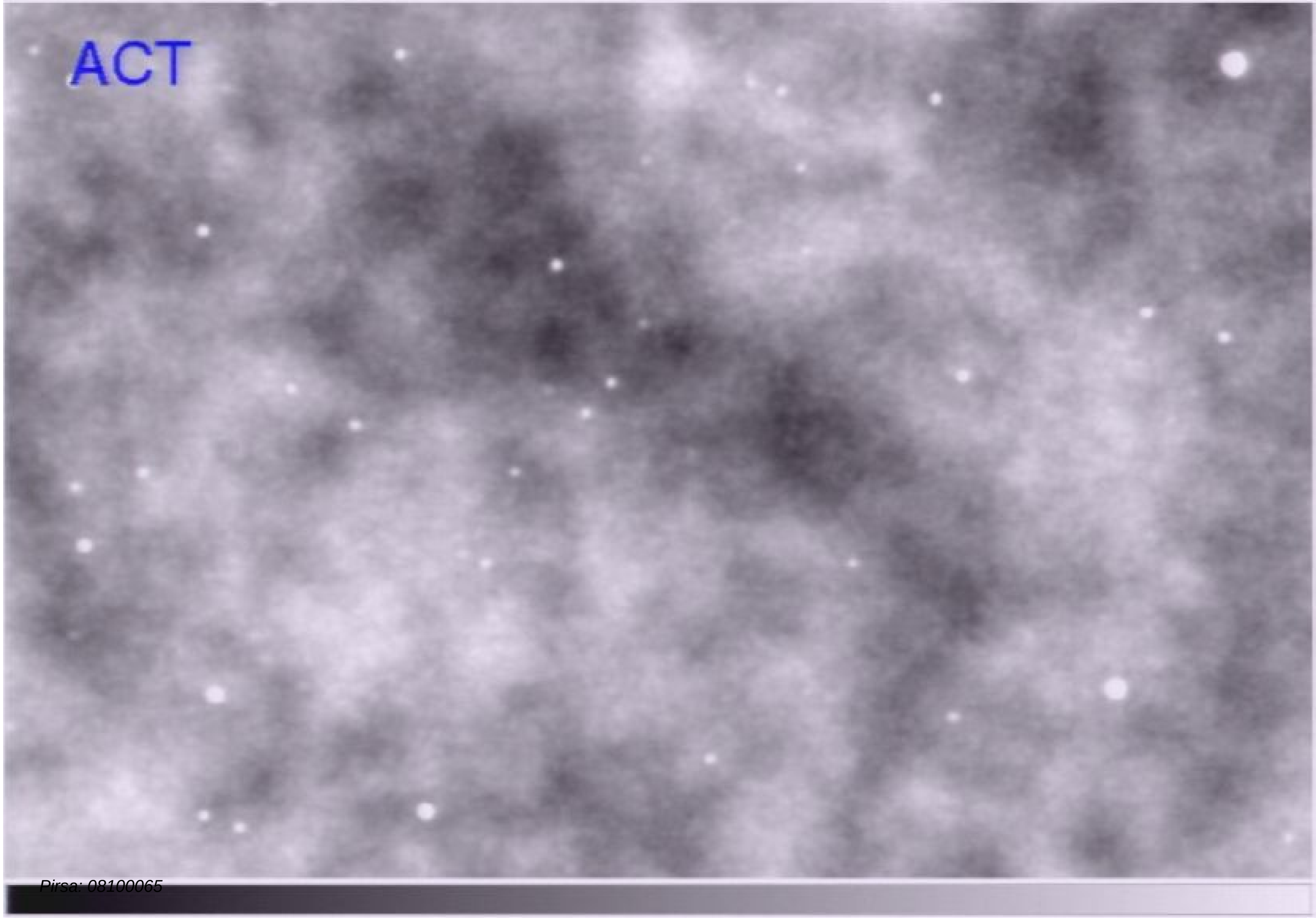

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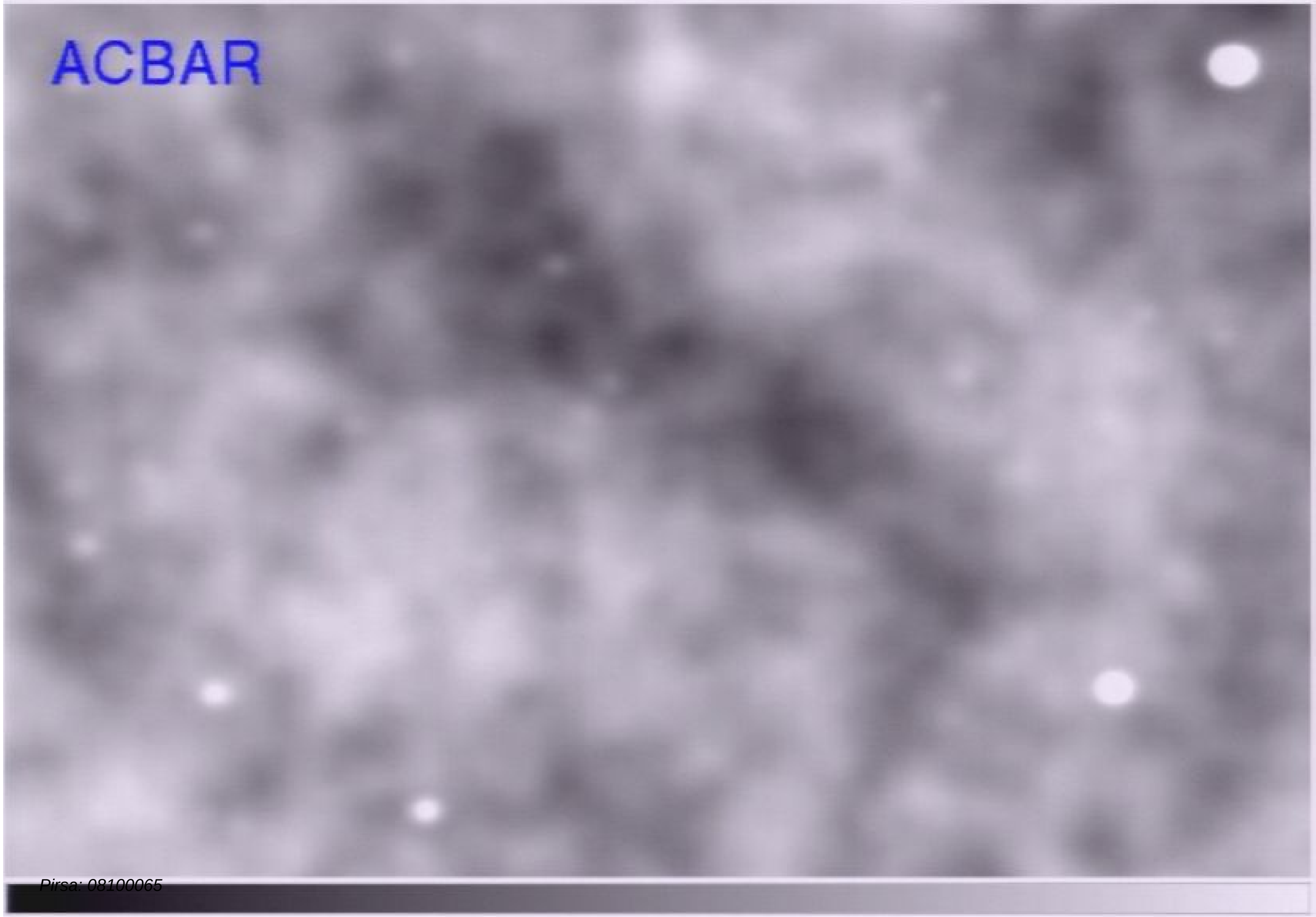

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ACT@5170m

why Atacama? driest desert in th
world. thus: cbi, toco, apex, asti
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CBI2@5040r

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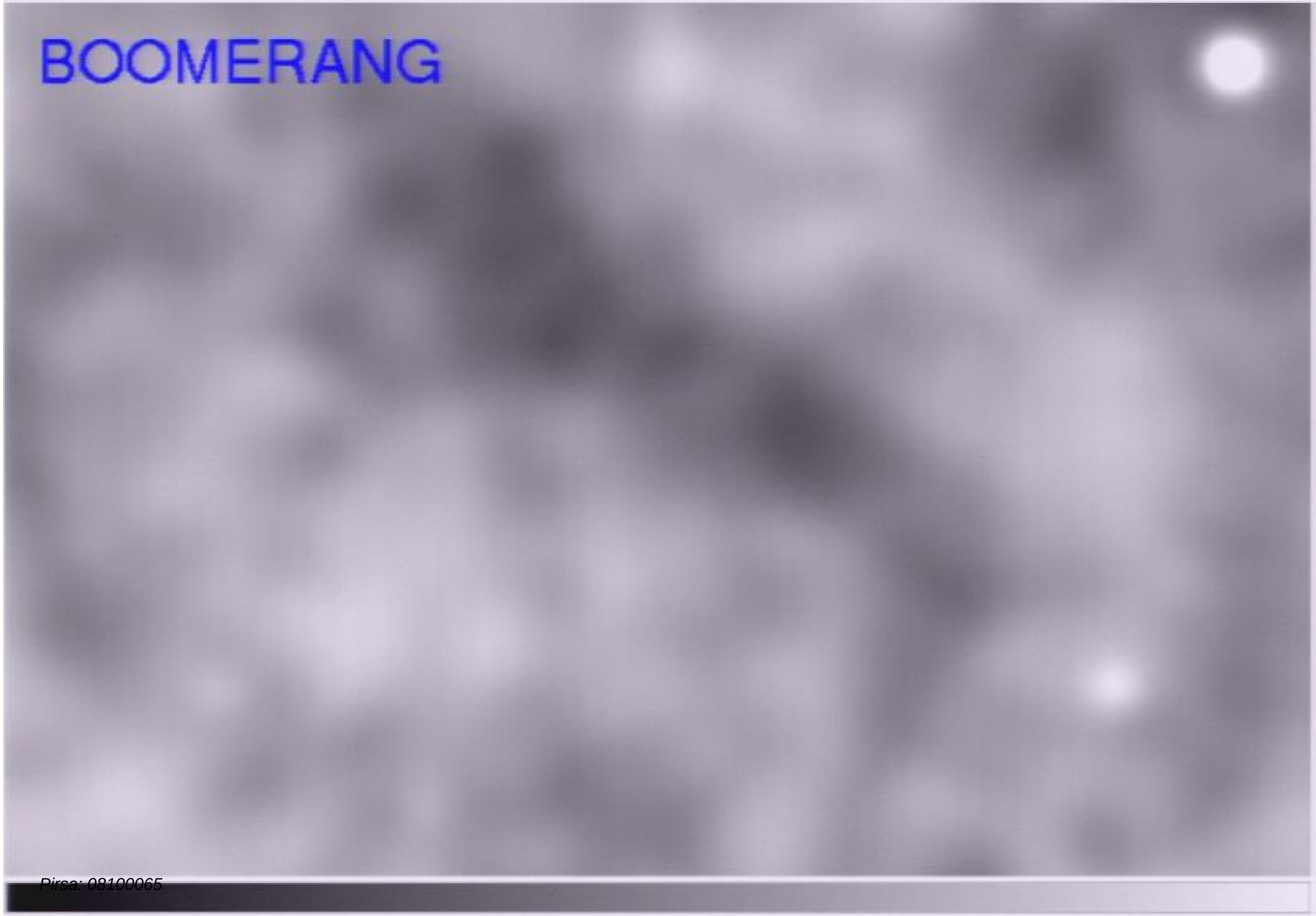

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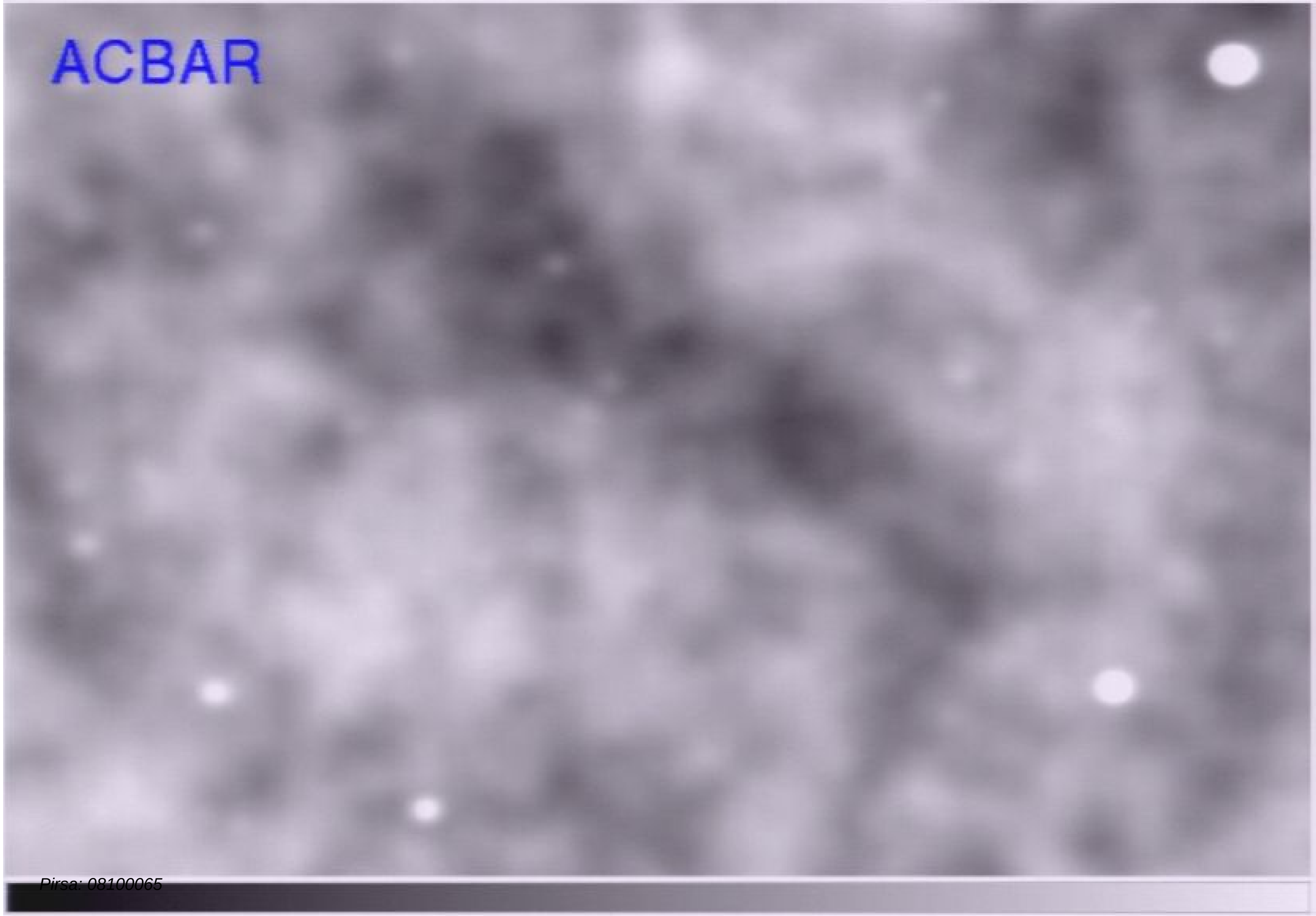

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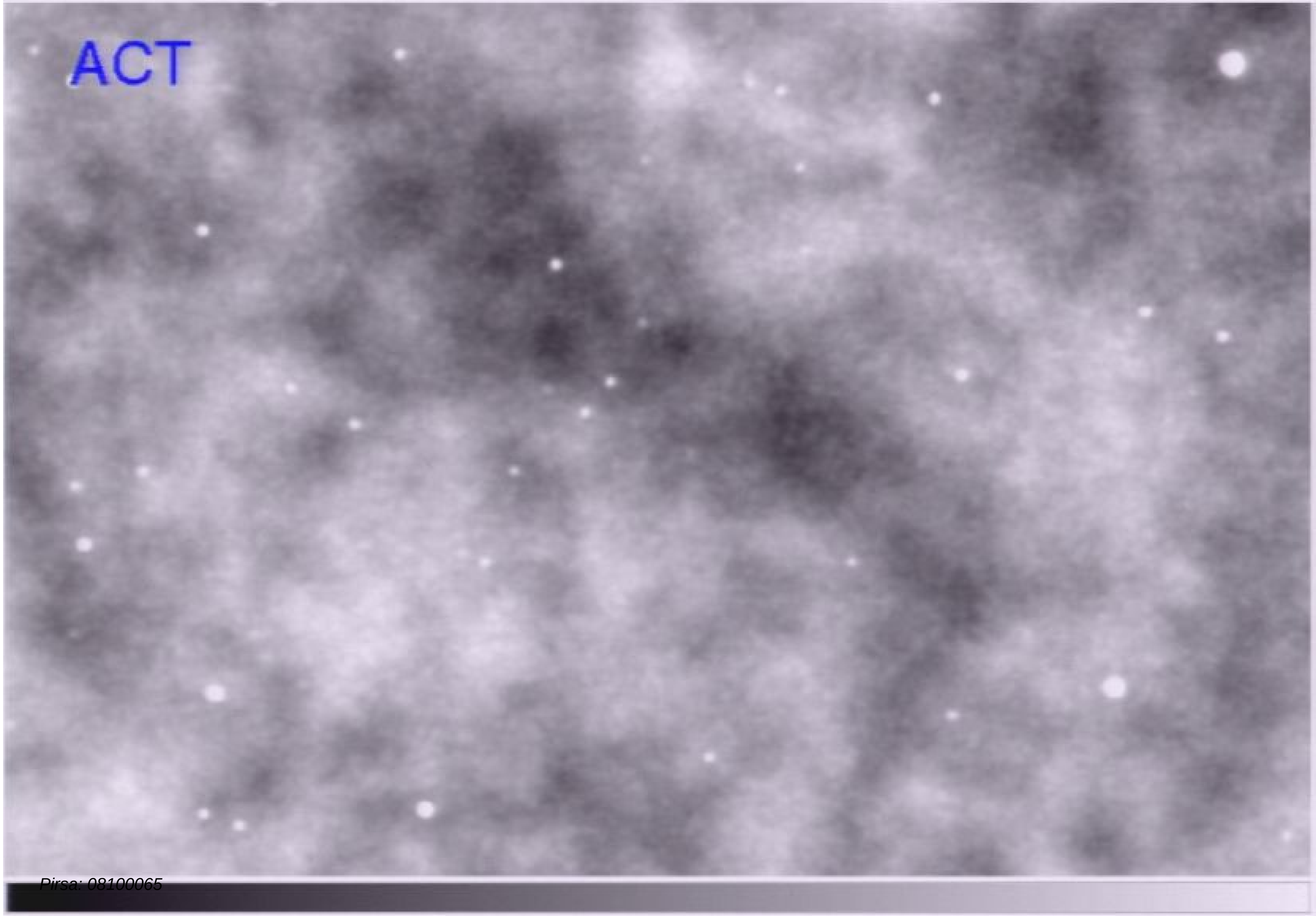

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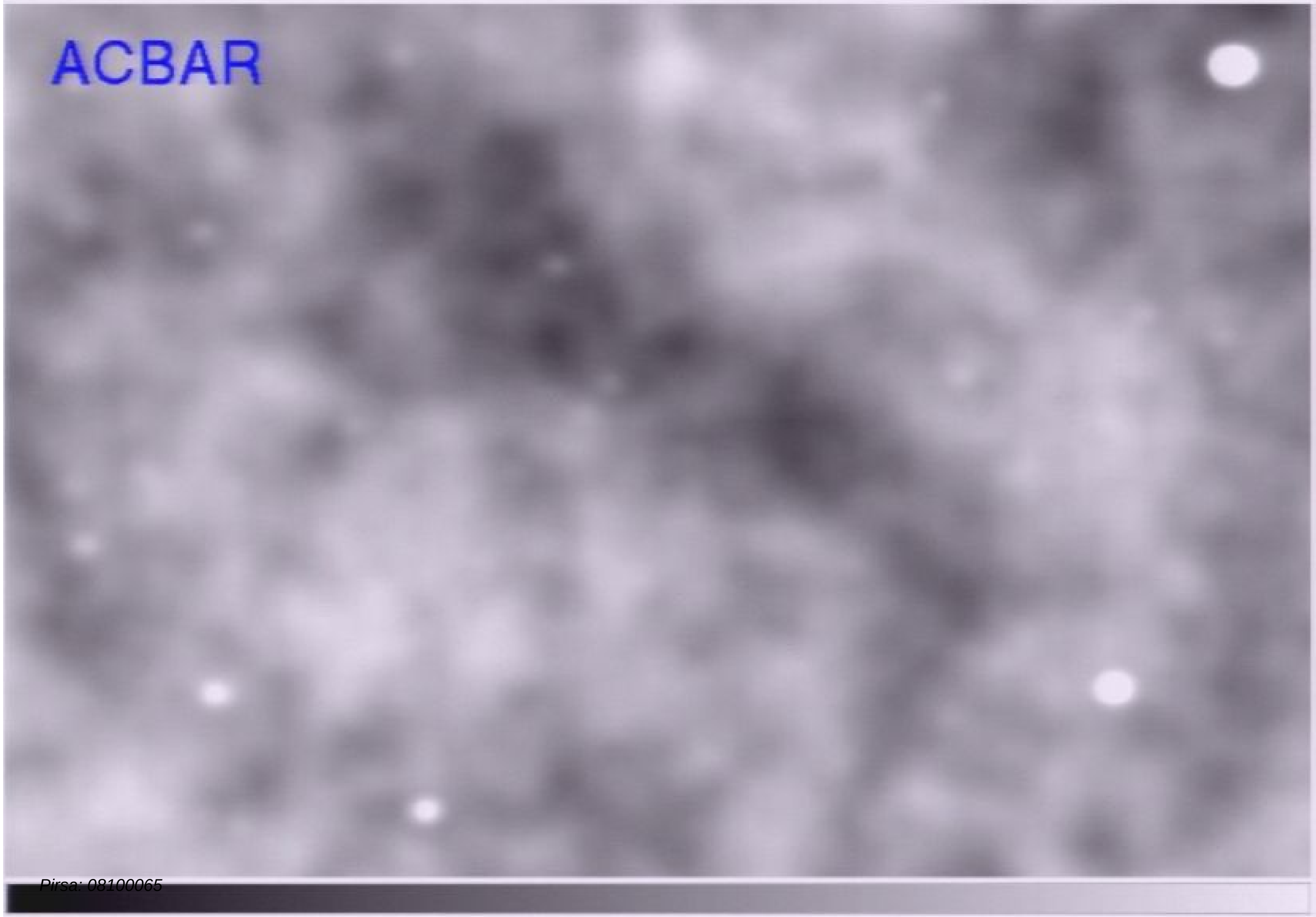

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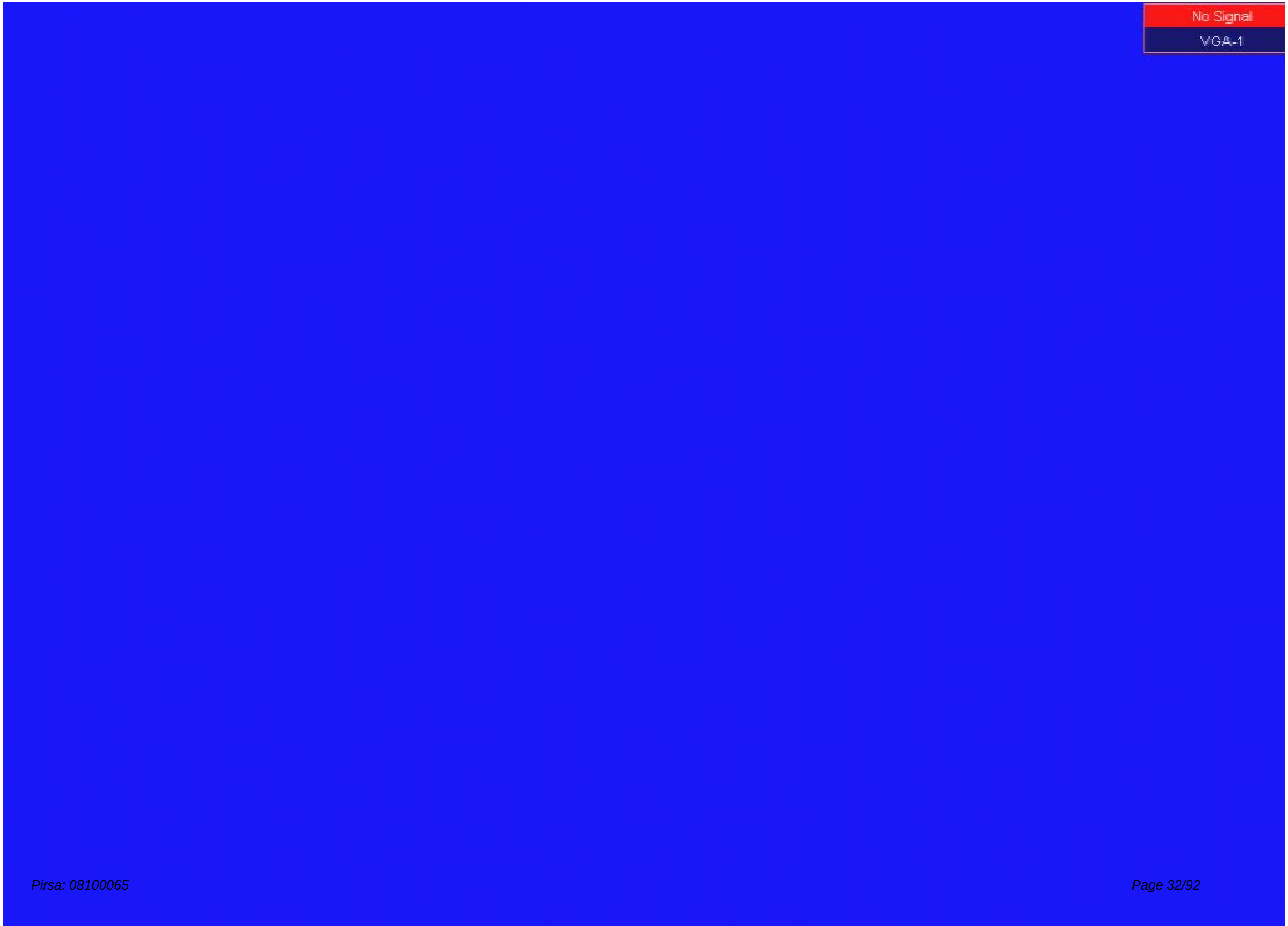

No Signal
VGA-1

No Signal

VGA-1

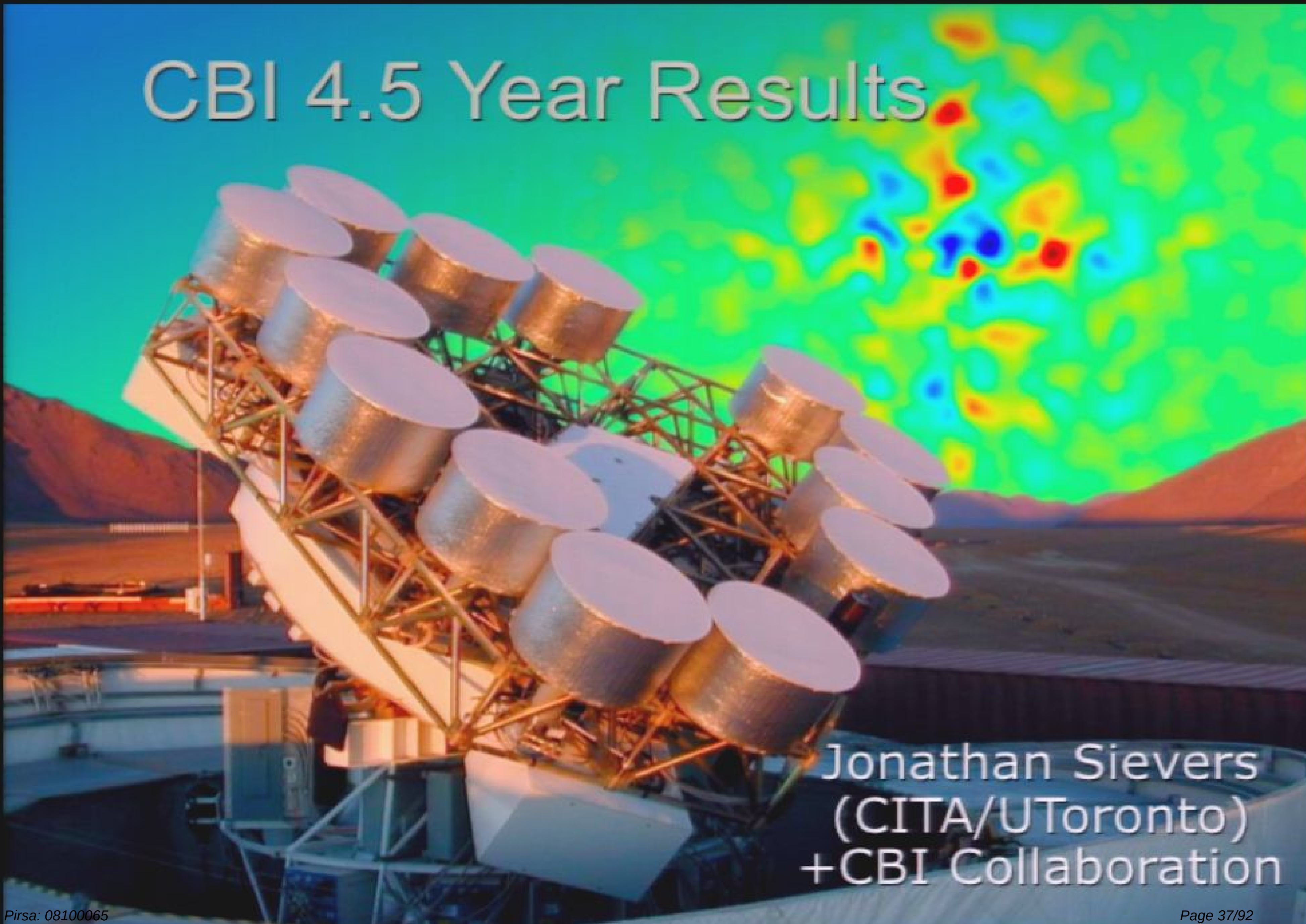
No Signal

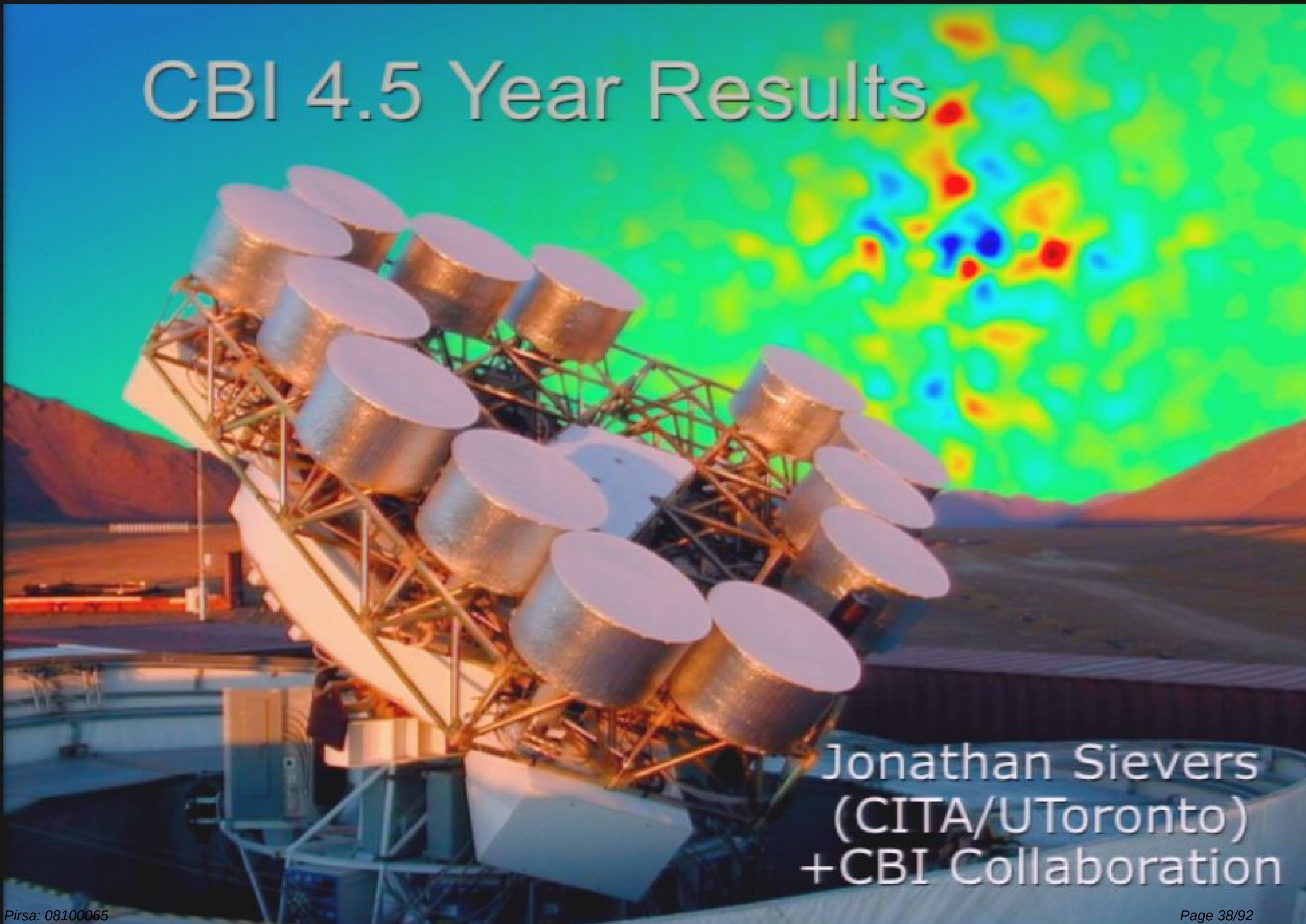
VGA-1

No Signal

VGA-1

No Signal
VGA-1


CBI 4.5 Year Results
Jonathan Sievers
(CITA/UToronto)
+CBI Collaboration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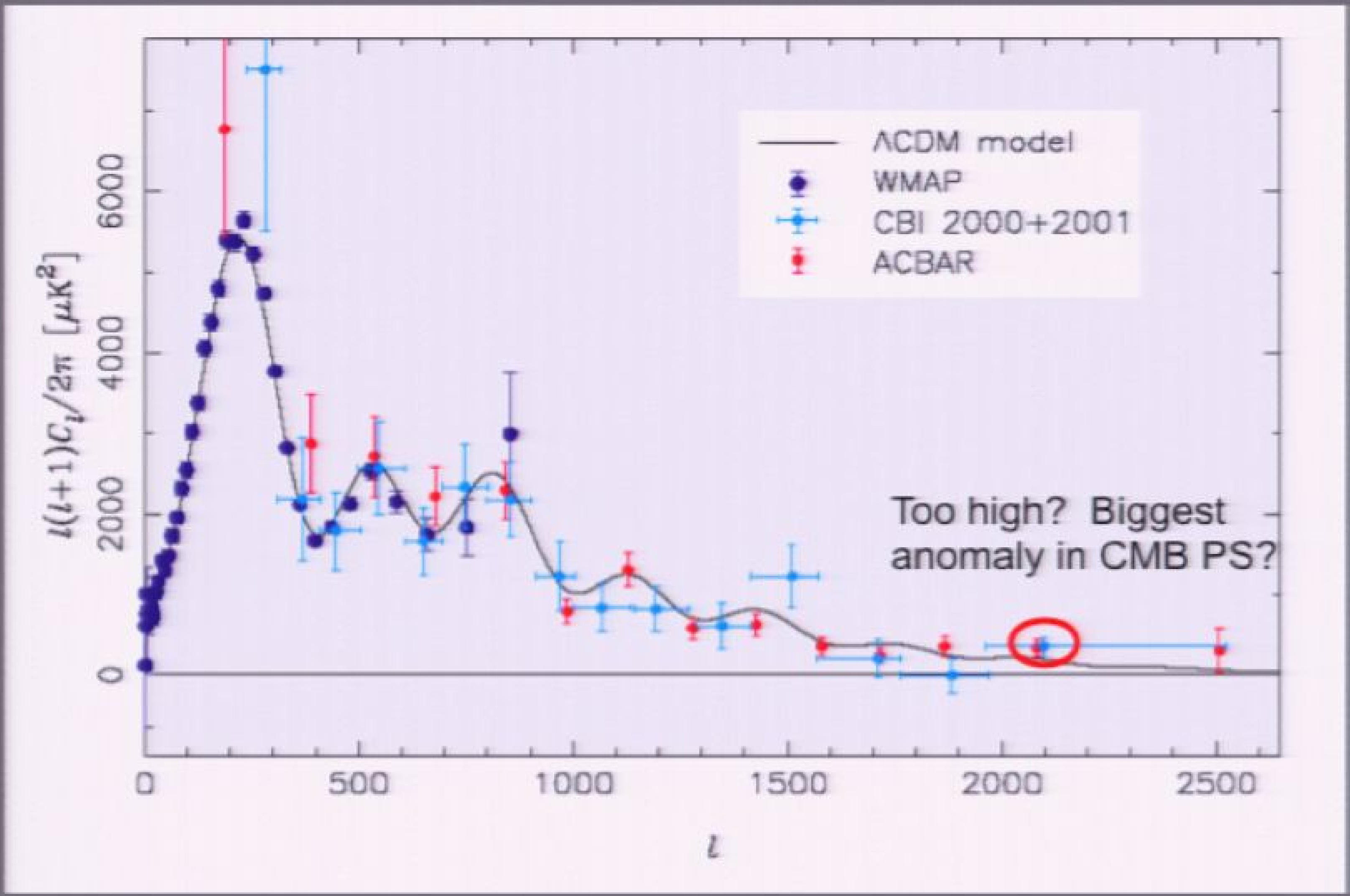
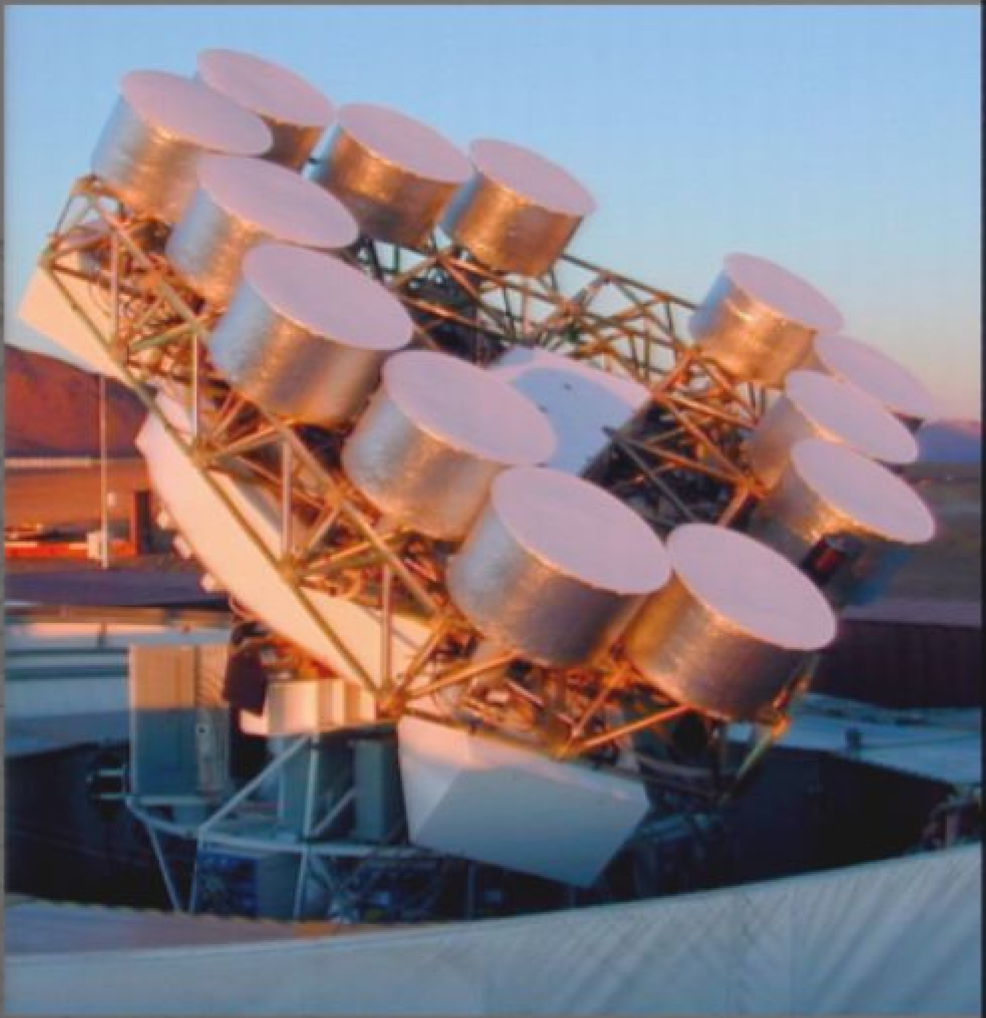
CMB in 2004, Readhead, et al.



The Cosmic Background Imager

- 13 90-cm Cassegrain antennas
  - 78 baselines
- 6-meter platform
  - Baselines 1m – 5.51m
- 10 1 GHz channels 26-36 GHz
  - HEMT amplifiers (NRAO)
  - Cryogenic 6K, Tsys ~25 K
- Single polarization (R or L)
  - Polarizers from U. Chicago
- Analog correlators
  - 780 complex correlators
- Field-of-view 44 arcmin
  - Image noise 4 mJy/bm 900s
- Resolution 4.5 – 10 arcmin



The CBI Adventure…

CBI located at 5080 meters in Atacama desert, Chile.

Area is used by NASA as a proxy for Mars for testing/developing equipment.

Land mines along border w/ Bolivia
(Hiking? Um, no.)

Atmosphere 55% of sea level.

Steve Padin wearing the cannular oxygen system

The CBI Adventure…

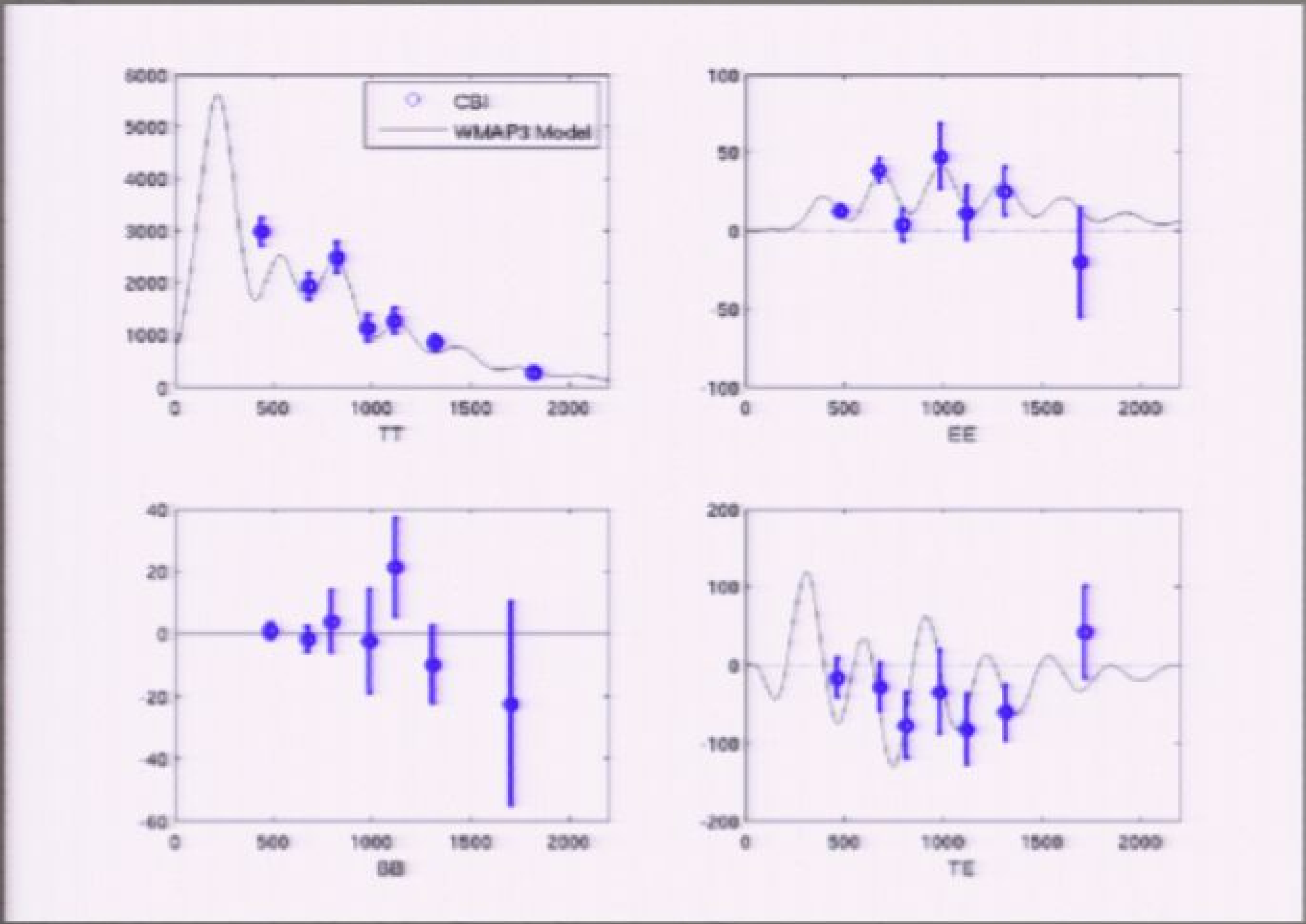
The CBI Adventure…

- Volcan Lascar (~30 km away) erupts in 2001

Very Clean Exp't

CBI polarization. Required virtually no filtering/ cleaning. Note axes on EE/BB 50-100x smaller than TT. Black curves *prediction* from WMAP TT.

Amplitude vs. (all) TT prediction:
TT=1.12+/-0.05
EE=1.02+/-0.14
TE=1.02+/-0.24
BB=0.22+/-1.55
(BB=μK)



JLS et al.

Combining CBI Datasets

Have 2 datasets. Partly overlap, observing strategy very different.

Make matrix that maps CMB sky (Fourier plane version thereof) to data for each dataset. (code written by Steve Myers)

Glue matrices together, then outer product gives correlated expected signal.

Feed signal into maximum likelihood pipeline, get optimal spectrum.

Run on CITA Sunnyvale beowulf cluster. Takes 2 hrs to do signals, 20 min to then get spectrum. (1600 Core-2 cores, 800 GB RAM, cost 400K)

(pipeline also being used for 21cm reionization)

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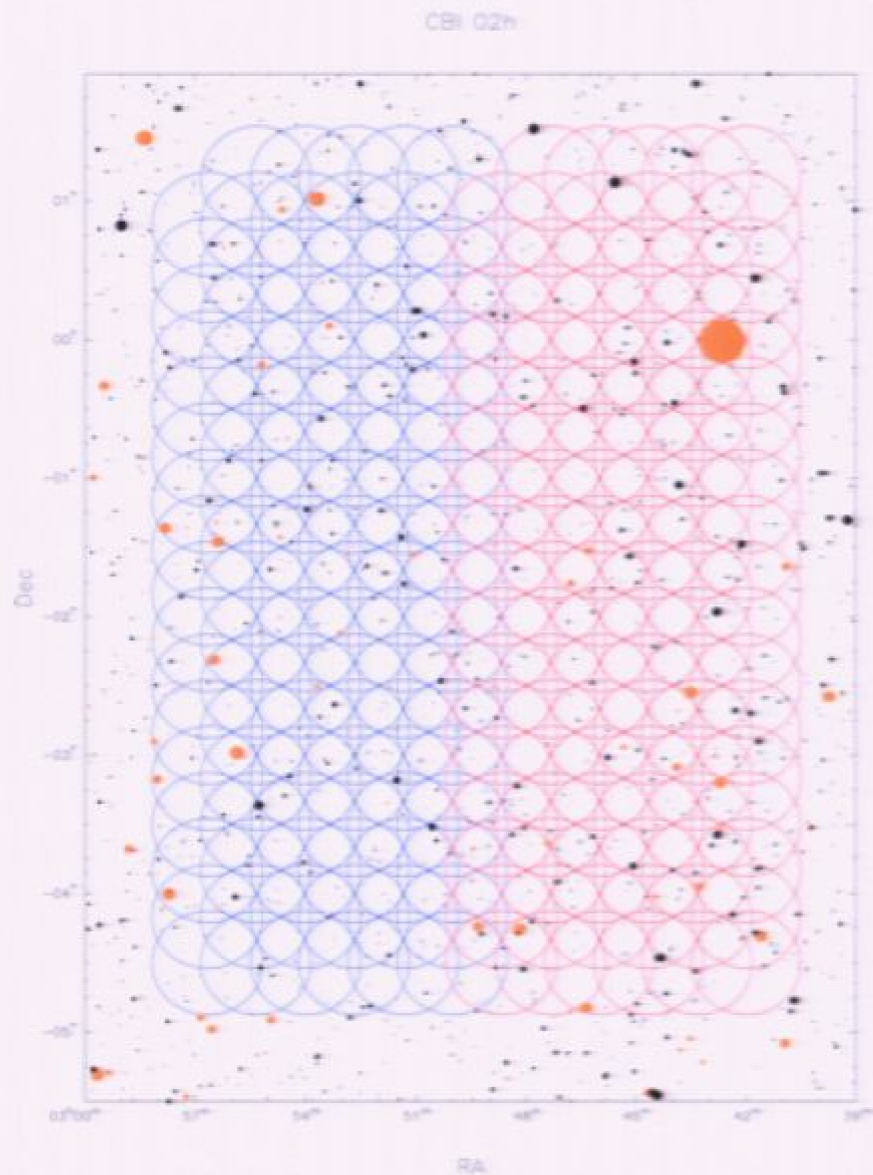
Main Challenge at 30 GHz: Discrete Source Foreground

- NVSS sources
- Detected at 30 GHz (OVRO 40m/ CBI)

STRATEGY:

- Project out all reliably detected low-frequency sources (NVSS: S_1.4 GHz > 3.4 mJy)
  LOSS OF SENSITIVITY

- Calculate the power contributed by sources below our cut for projection
  SIGNIFICANTLY UNCERTAIN



Caltech:
Larry Weintraub
Tim Pearson
Martin Shepherd
Tony Readhead

CITA:
Jon Sievers
Dick Bond

Green Bank:
Randy McCullough
Melinda Mello
Galen Watts

Key Players and warm optics (100-meter Robert C. Byrd Telescope in Green Bank, WV)

~2000 NVSS sources w/GBT @0.5 mJy

GBT Survey

GOALS

- Reduce loss of sensitivity due to "nulled" pixels
- Reduce uncertainty in the statistical contribution due to faint, unknown sources

Data collected in 2005/2006

170 Hours GBT Time

4574 NVSS sources in the CBI Fields Observed

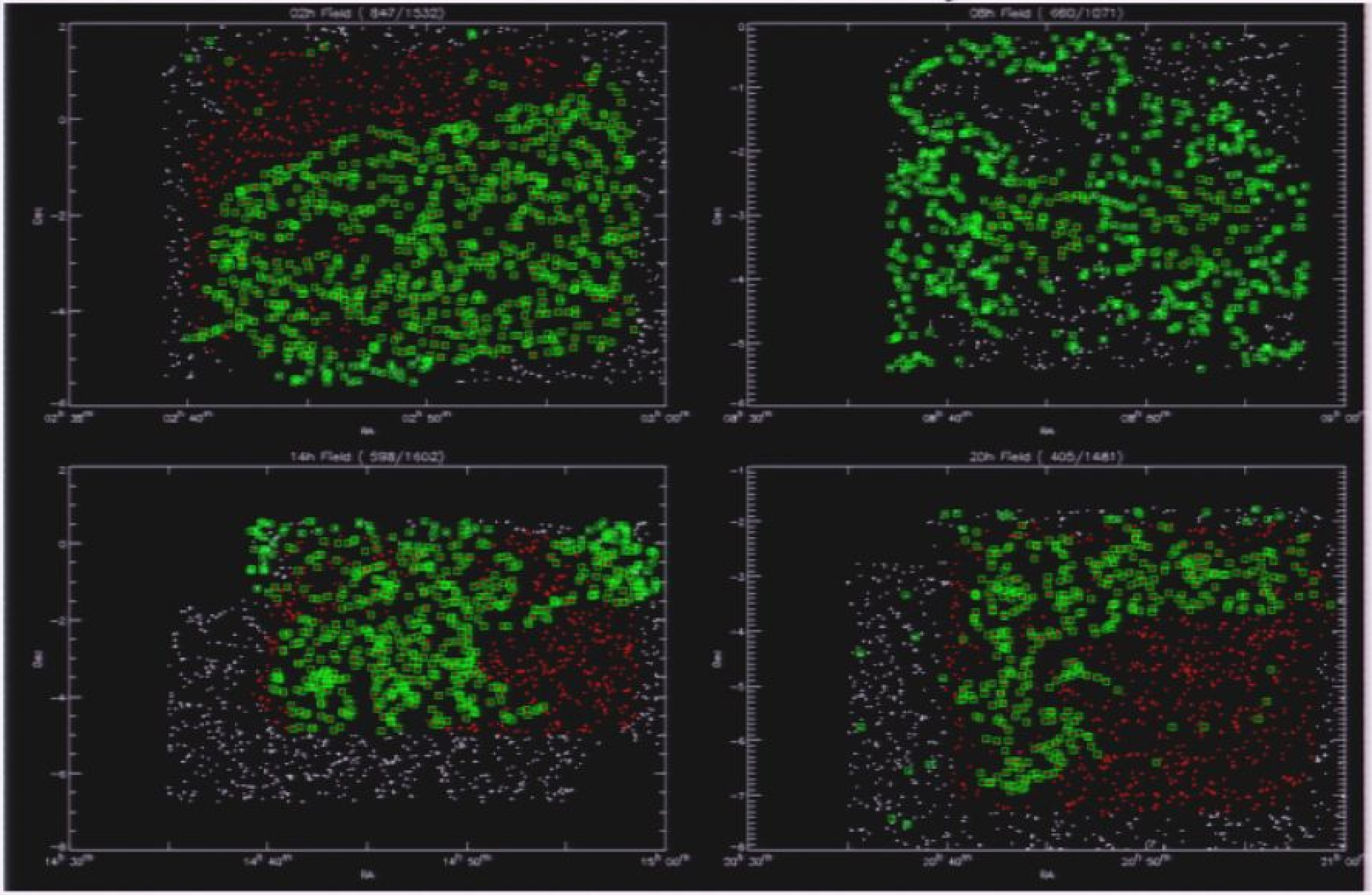
Individual, 70 second observations of each.

Data Filters

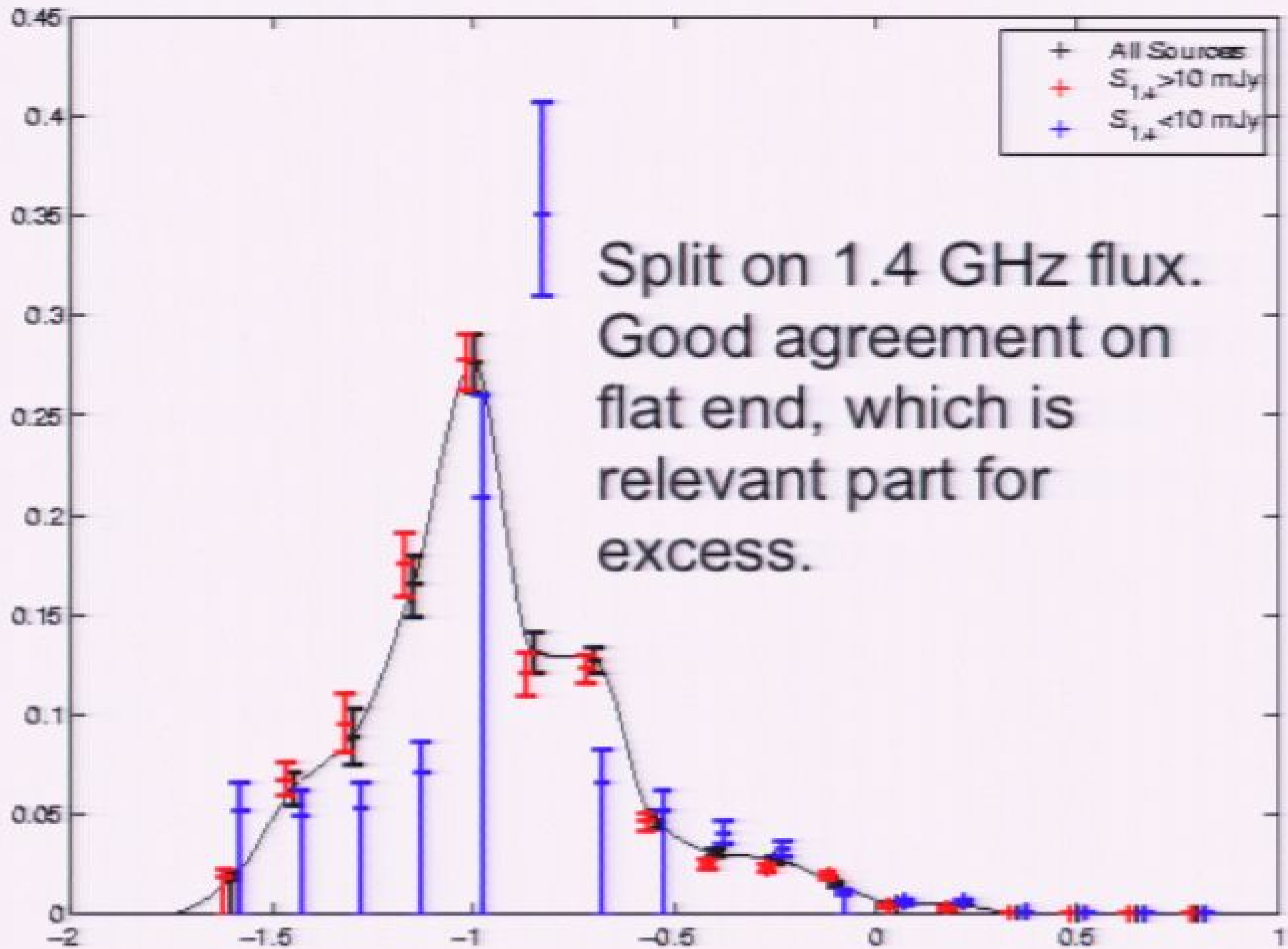
- Wind < 5 m/s
- Median Absolute Deviation Measurement noise (+/-20 min) < 1.0 mJy
- Preceding Peak/Focus succeeded (30-45 min)

2125 NVSS Sources In Final Dataset -- Typical Noise level 0.4 mJy

GBT Survey



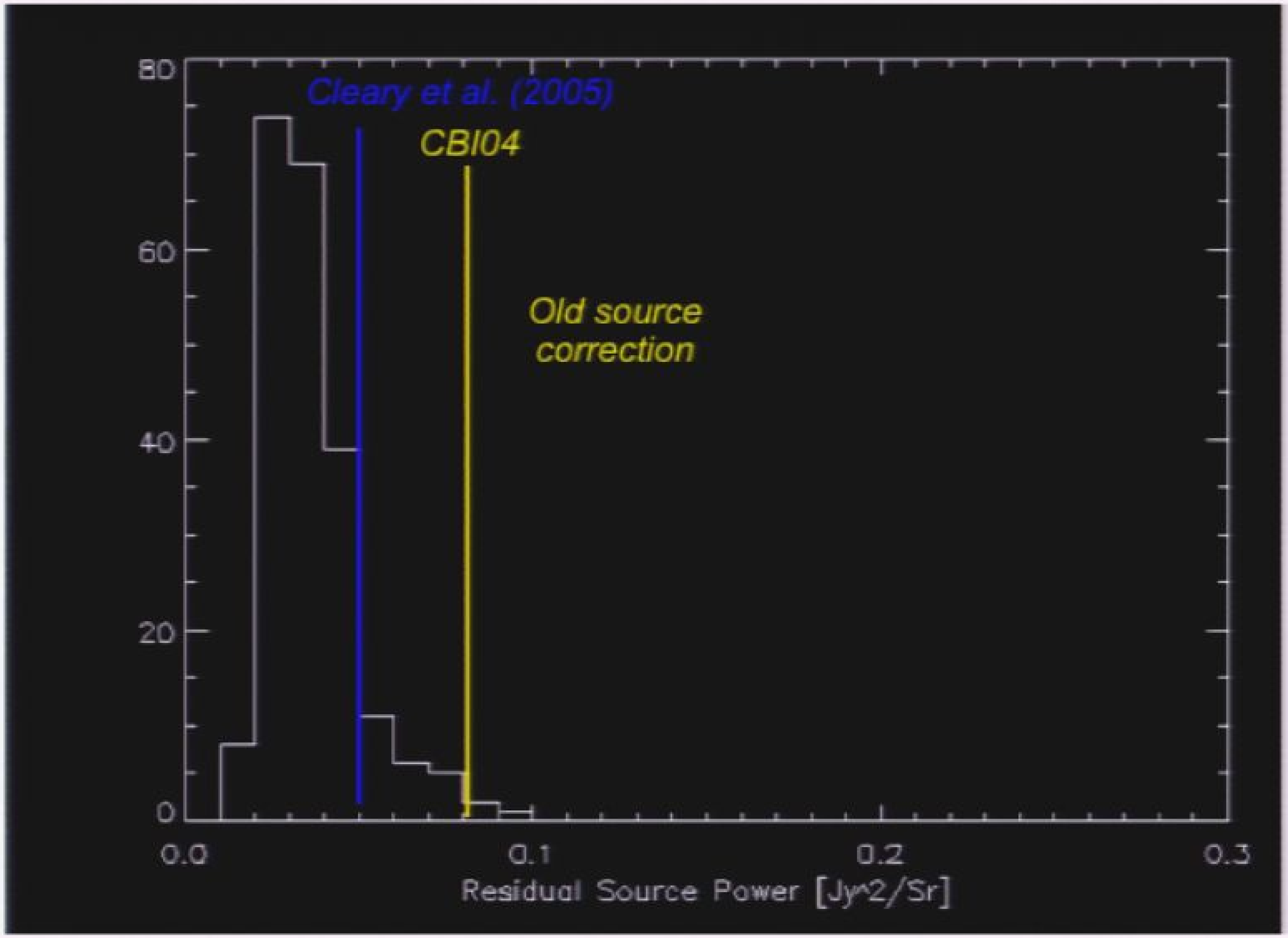
Spectral Indices



Sources cont'd:

- GBT/OVRO survey gives us very good handle on AGN-type sources (dominate above ~1.5 mJy @1.4).
- Second population of star-forming galaxies dominate counts @1.4 below ~1.5 mJy.
- Have *just* gotten data on these faint sources @30 GHz, they appear to be similar (on average) to brighter one.
- Spectrum finished, parameters still running.

GBT + OVRO 30 GHz: Residual Source Contamination



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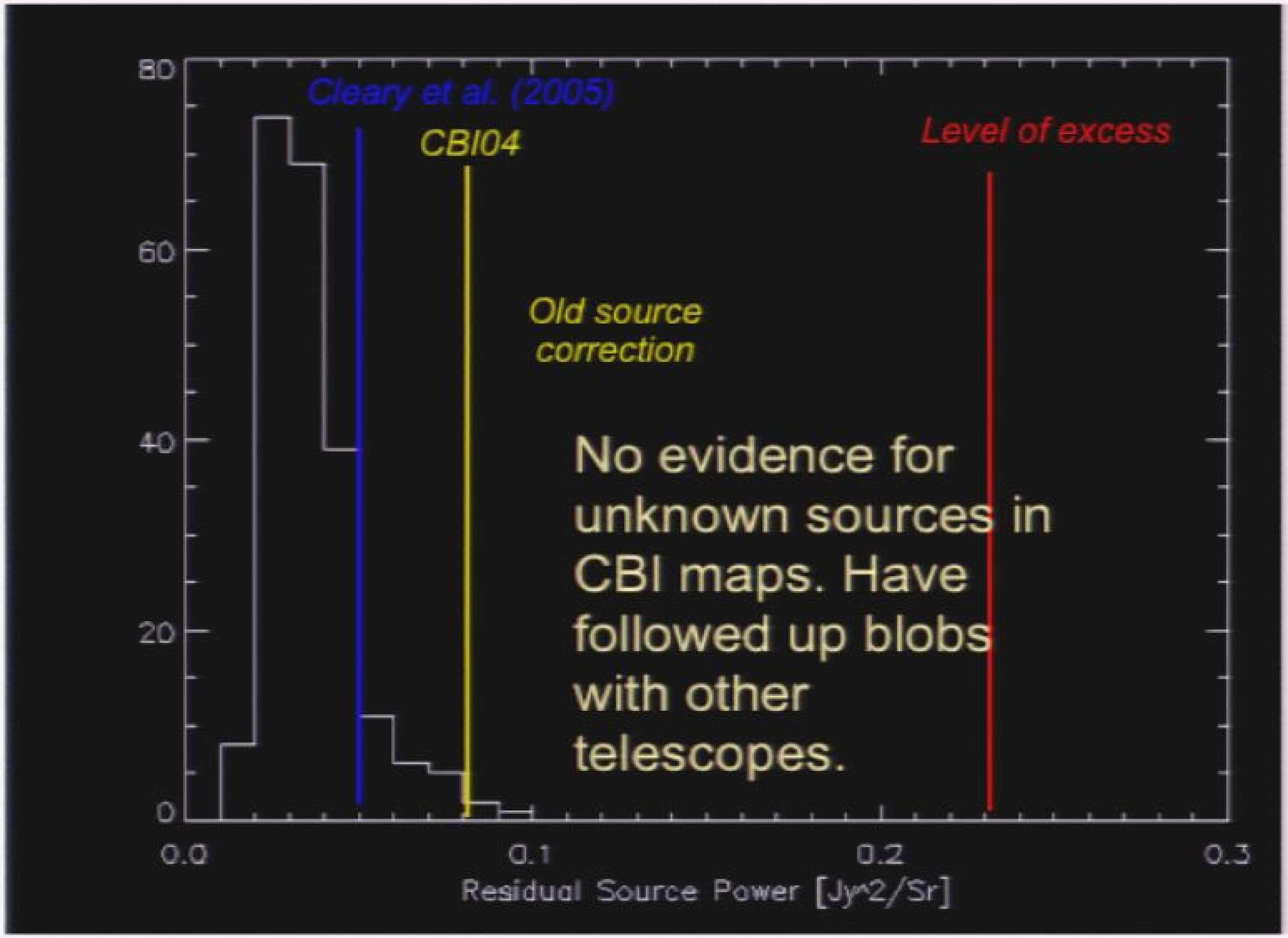
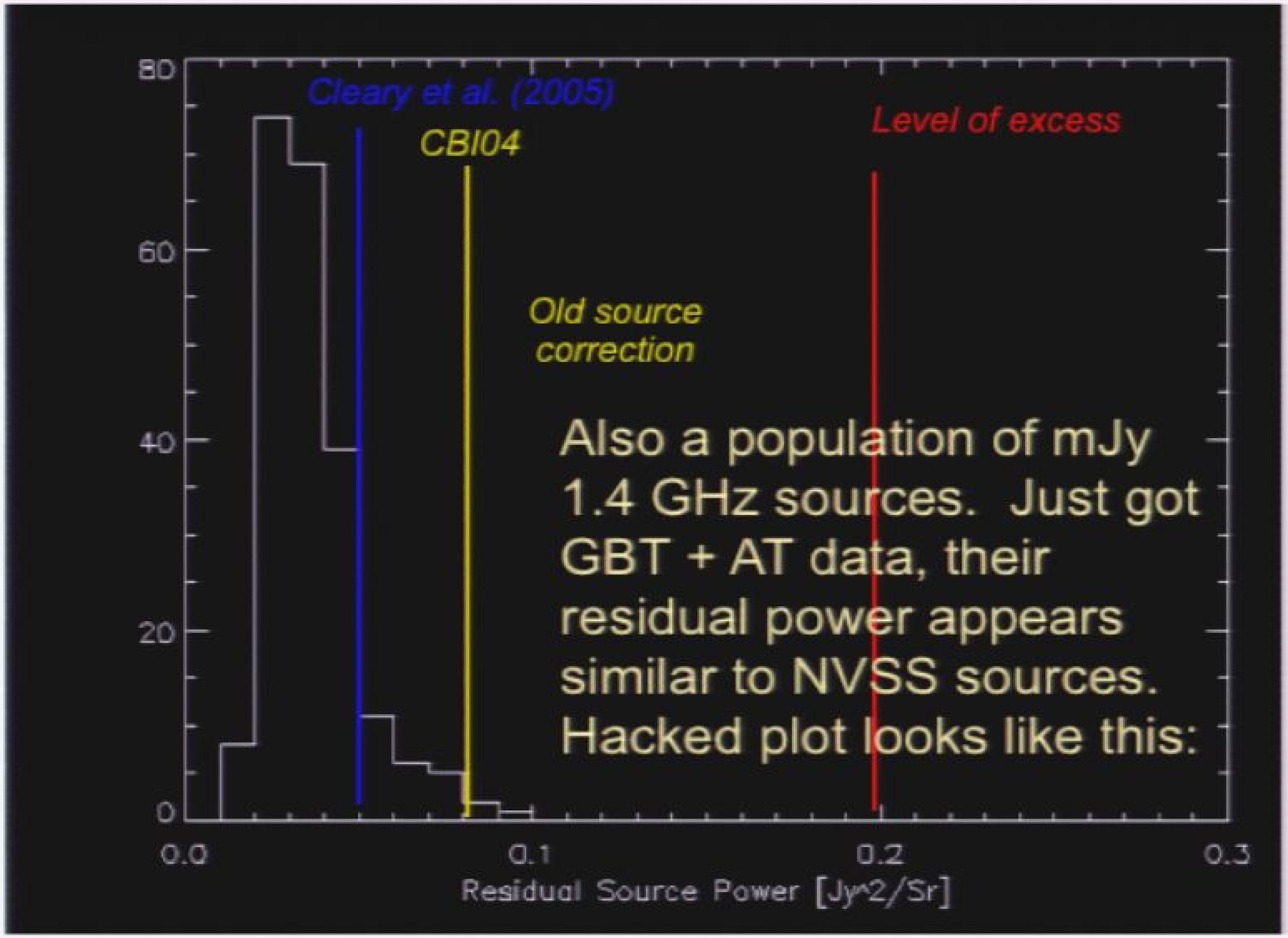
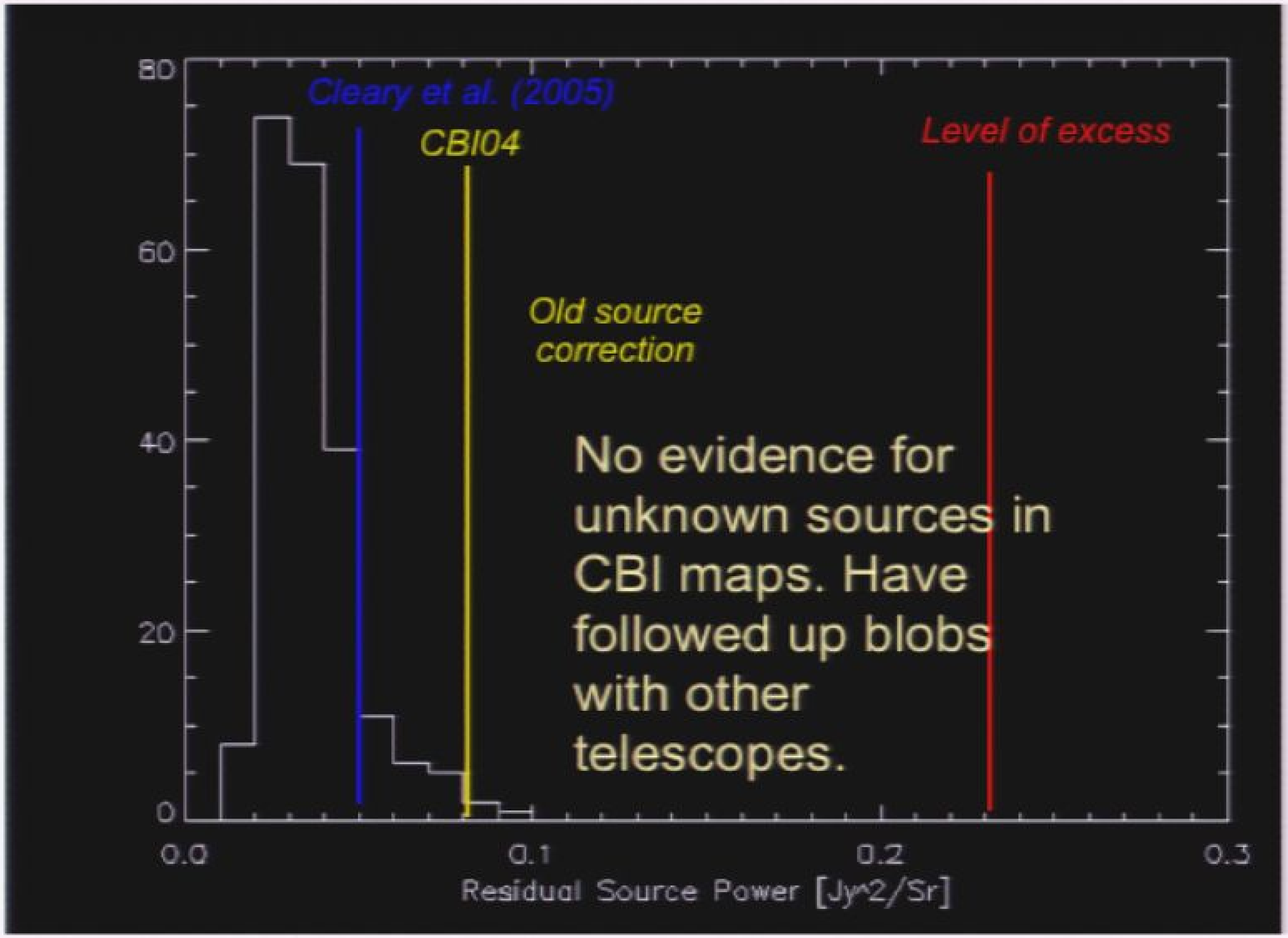


GBT + OVRO +AT 30 GHz: Faint 1.4 GHz sources



Also a population of mJy 1.4 GHz sources. Just got GBT + AT data, their residual power appears similar to NVSS sources. Hacked plot looks like this:

GBT + OVRO 30 GHz: Residual Source Contamination



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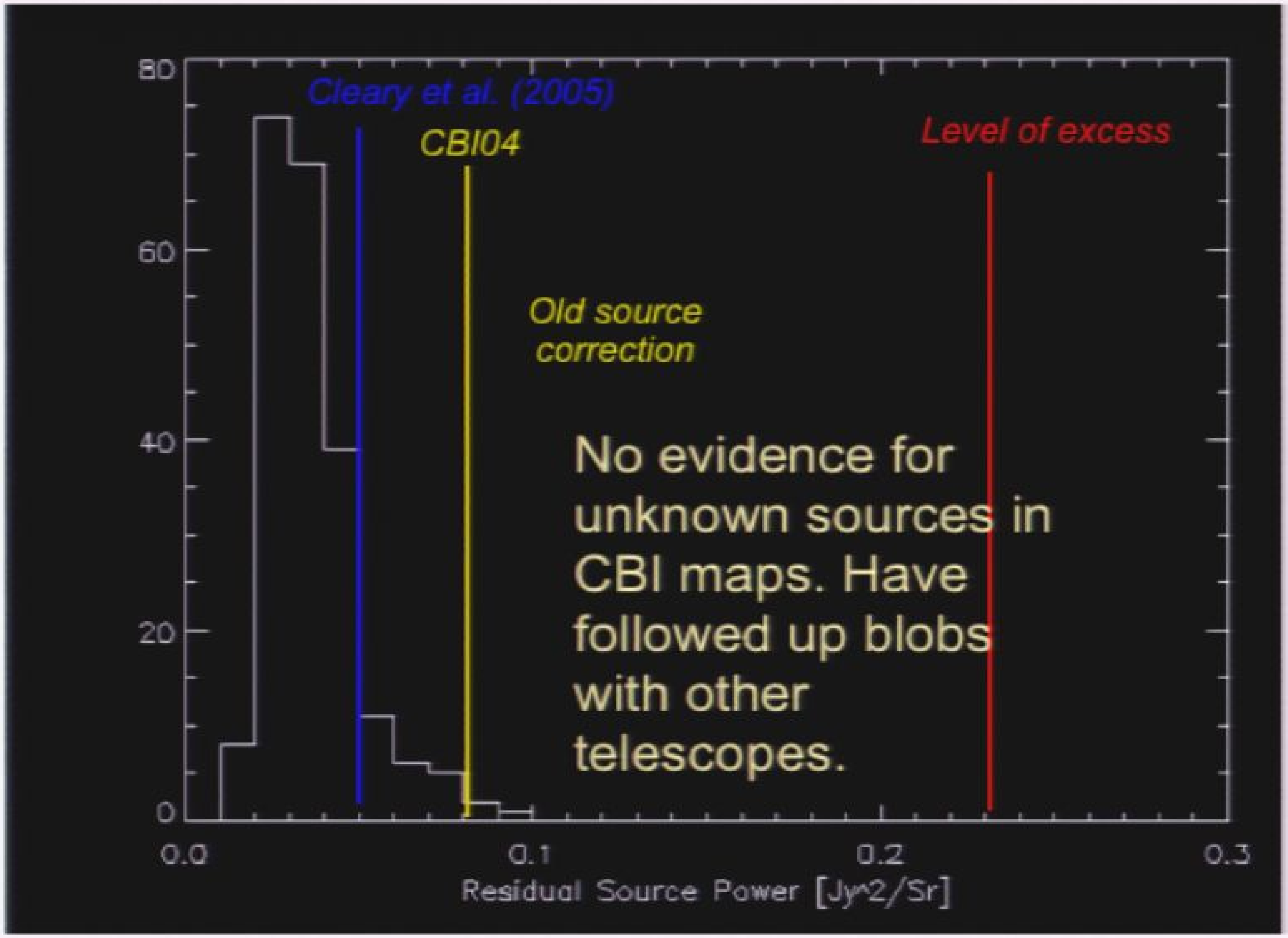
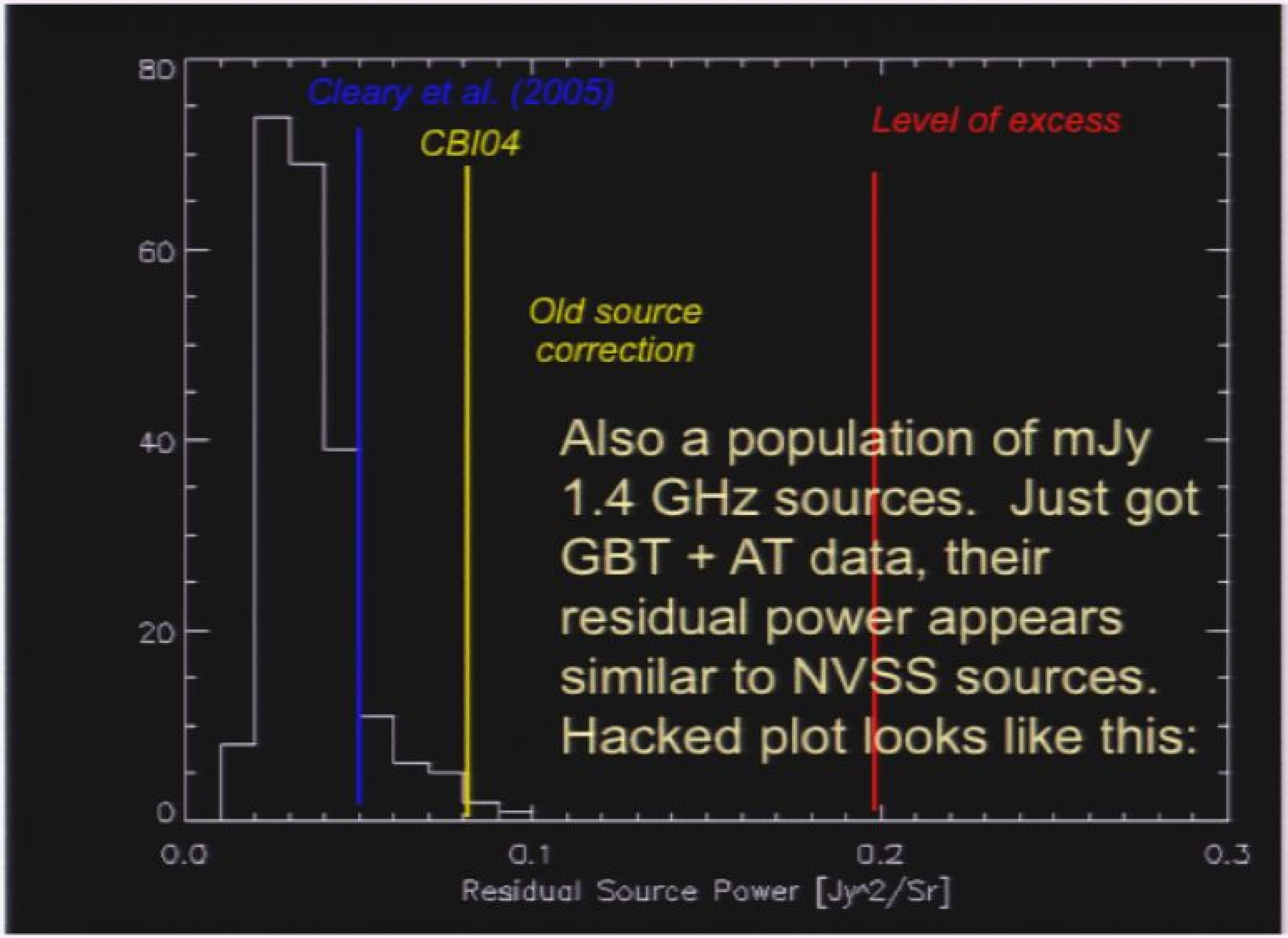


Other Possible Systematics

- Noise wrong? No. Can split data in two, measure noise + spectrum simultaneously.
- Pointing errors on bright sources? No. Simulate pointing errors - small. Also measure spectrum removing fields near bright sources - unchanged.
- Individual dish misalignment errors? No. Few uK^2
- Beam errors coupled to bright sources? No. Few uK^2 using Gaussian vs. measured beam for projection.
- Spectral index errors in projection? No. Tiny.
- Pipeline funnies? Works on all sims. Rewrote to not invert ill-conditioned matrices. (Raises damping tail by ~1/2 sigma, though highest ell unchanged).

GBT + OVRO +AT 30 GHz: Faint 1.4 GHz sources



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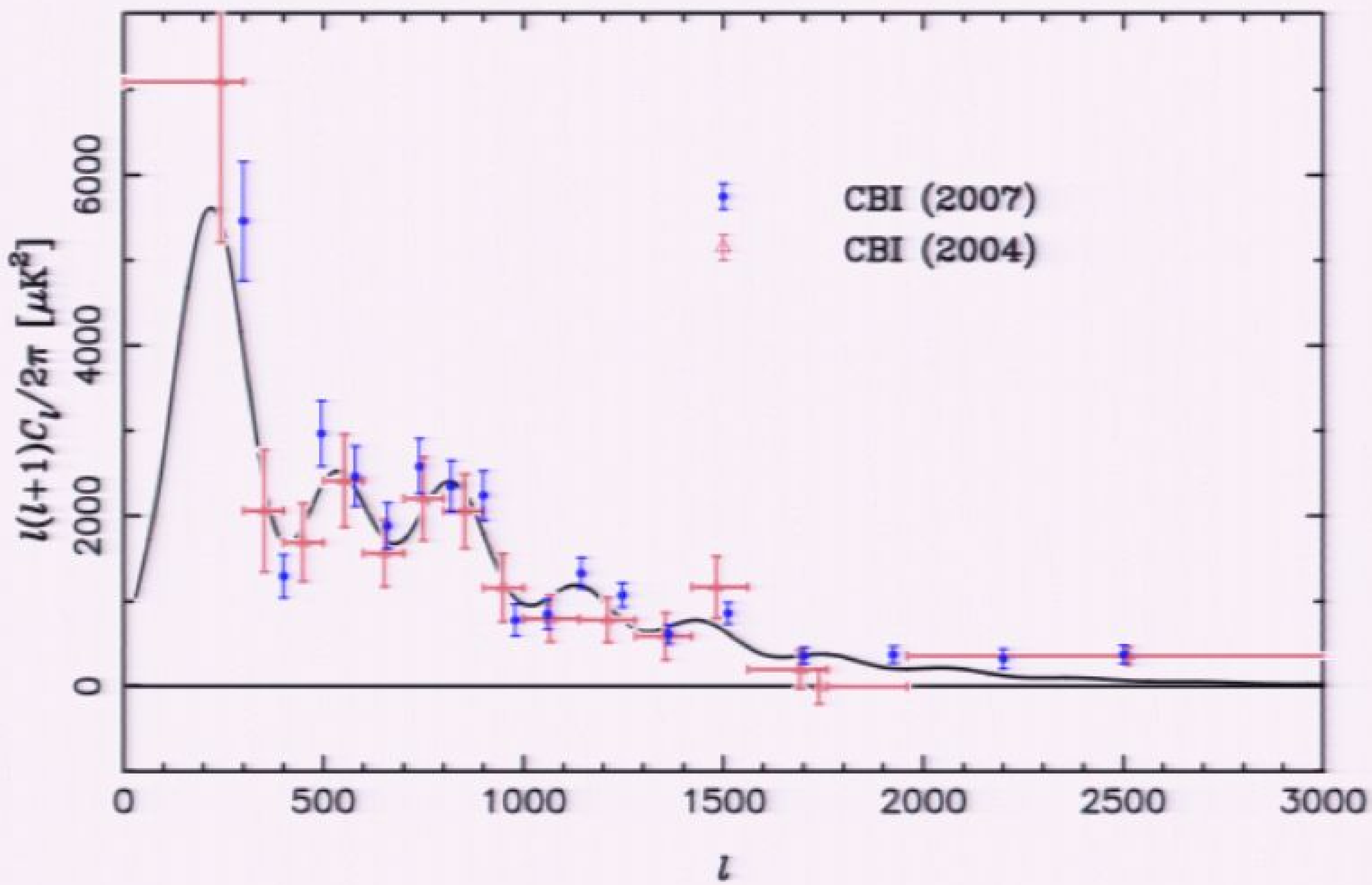
New CBI Spectrum



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CBI Excess

- Fit 3 component model directly to CBI data (not to power spectrum).
- 2 CMB components (ell<400, ell>400) and an SZ template (Bond et al. or KS)
- For Komatsu-Seljak template at σ_8=0.8, find 3.0±1.3 (thermal error) times expected.   Detect power above CMB only @2.5-2.9 sigma
- Each field sees at least KS expected level, all consistent with mean.

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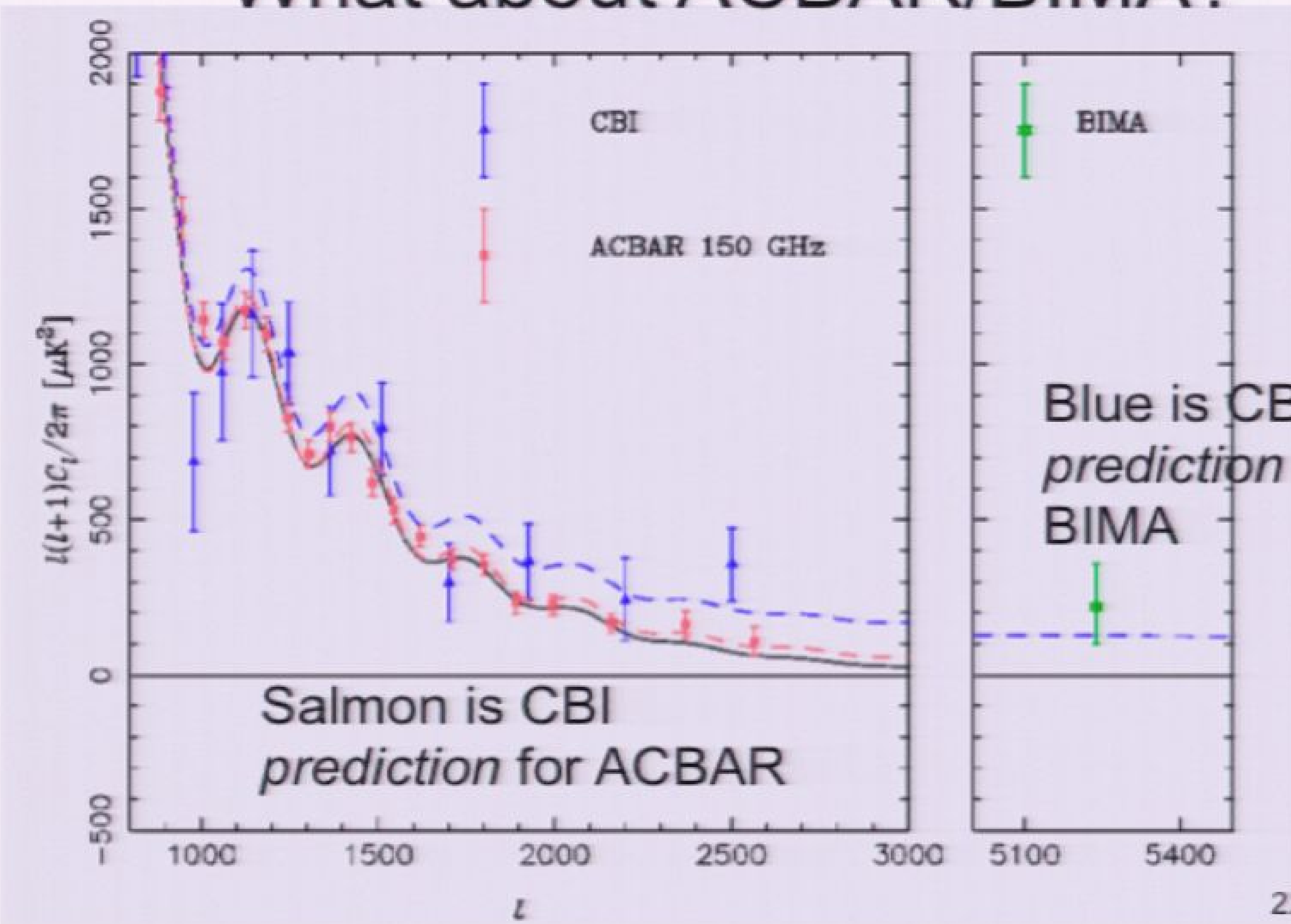
High-ell Zoom
What about ACBAR/BIMA?



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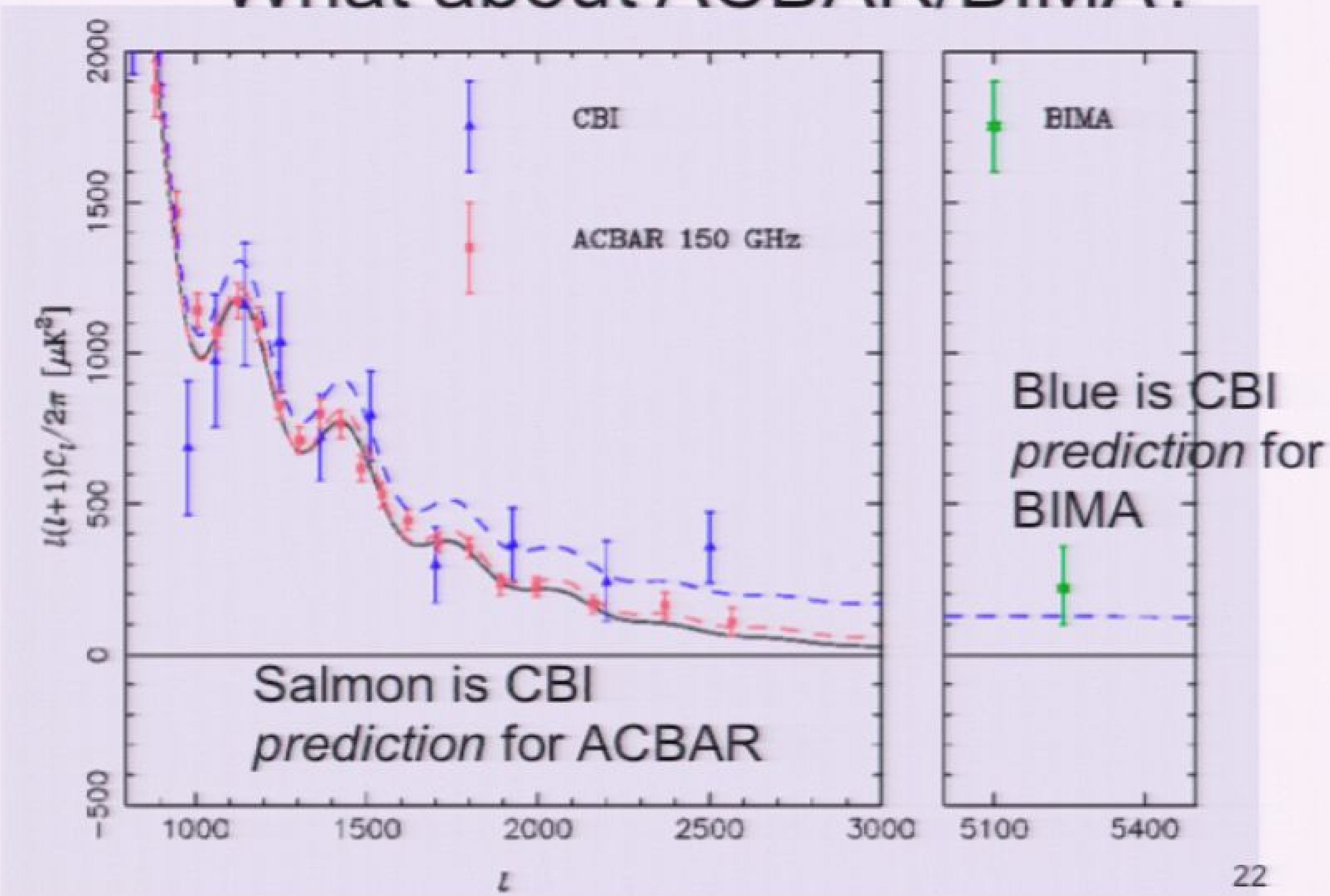

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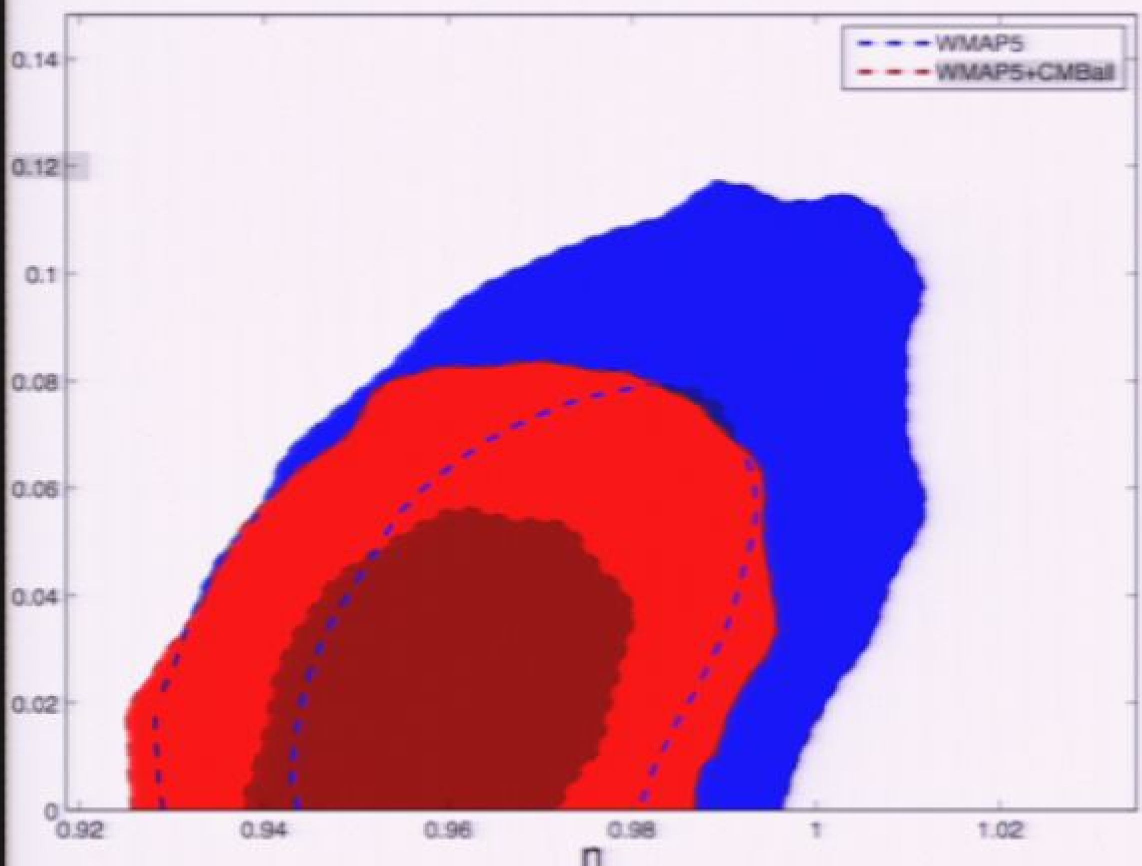
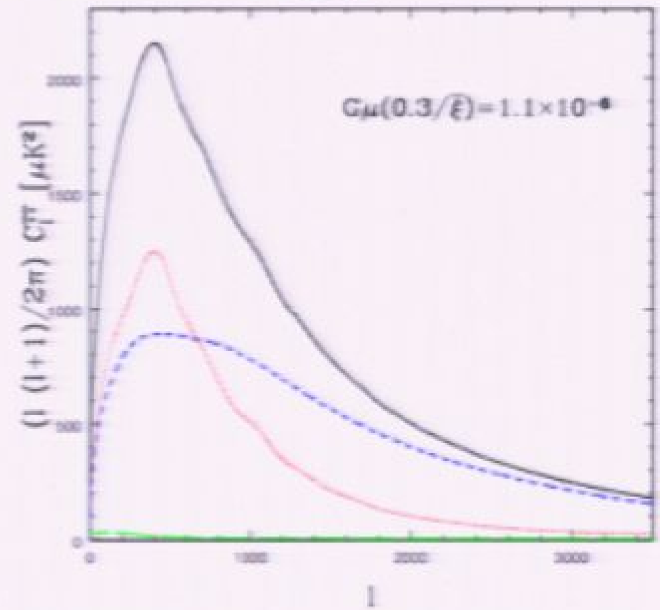
Why Should a Theorist Care

(If you think the origin of the high-ell signal is boring)

- Can learn qualitatively new things from CMB if can push out to higher ell.
- Must clean SZ, etc. from spectrum to get to fundamentals.
- If so, can constrain cosmic strings, spectral index running, etc.
- Some examples...

Fun With Cosmic Strings



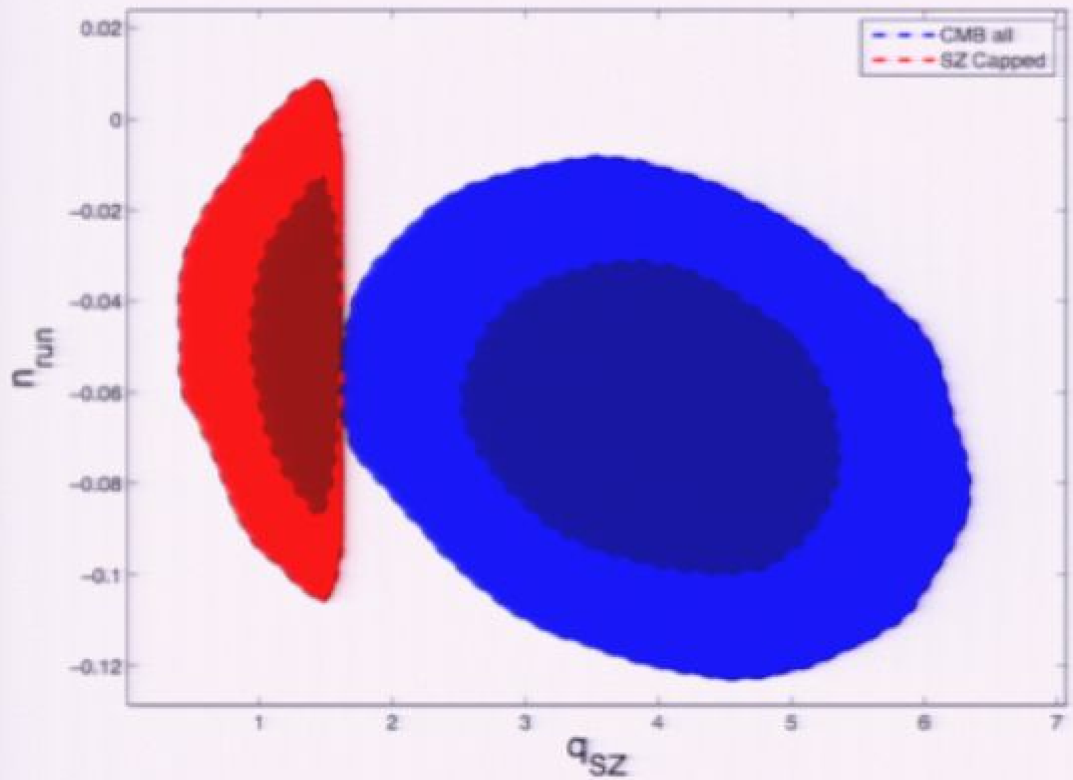


String template from Pogosian et al. for $G\mu$=1.1e-6 (0804.0810)

Addition of high-ell CMB constrains string amplitude, helps break string-n_s degeneracy.

NB - final parameters still running, but results will look similar.

n_{run}



Running of the spectral index is rather correlated with high-ell signal. Getting high-ell. Red contours have SZ contribution capped, blue allow it to float freely.

Same caveat - chains still running, so final answer will be a bit different.

Summary

- CBI sees power higher than expected at ell>2000 in CMB
- High-ell signal consistent with other experiments if from SZ.
- High-ell primary well constrained by standard ΛCDM, but very valuable for extended parameters.
- High-ell will be nailed soon - SZA, QUAD, SPT, Planck, ACT. And now for the next talk...

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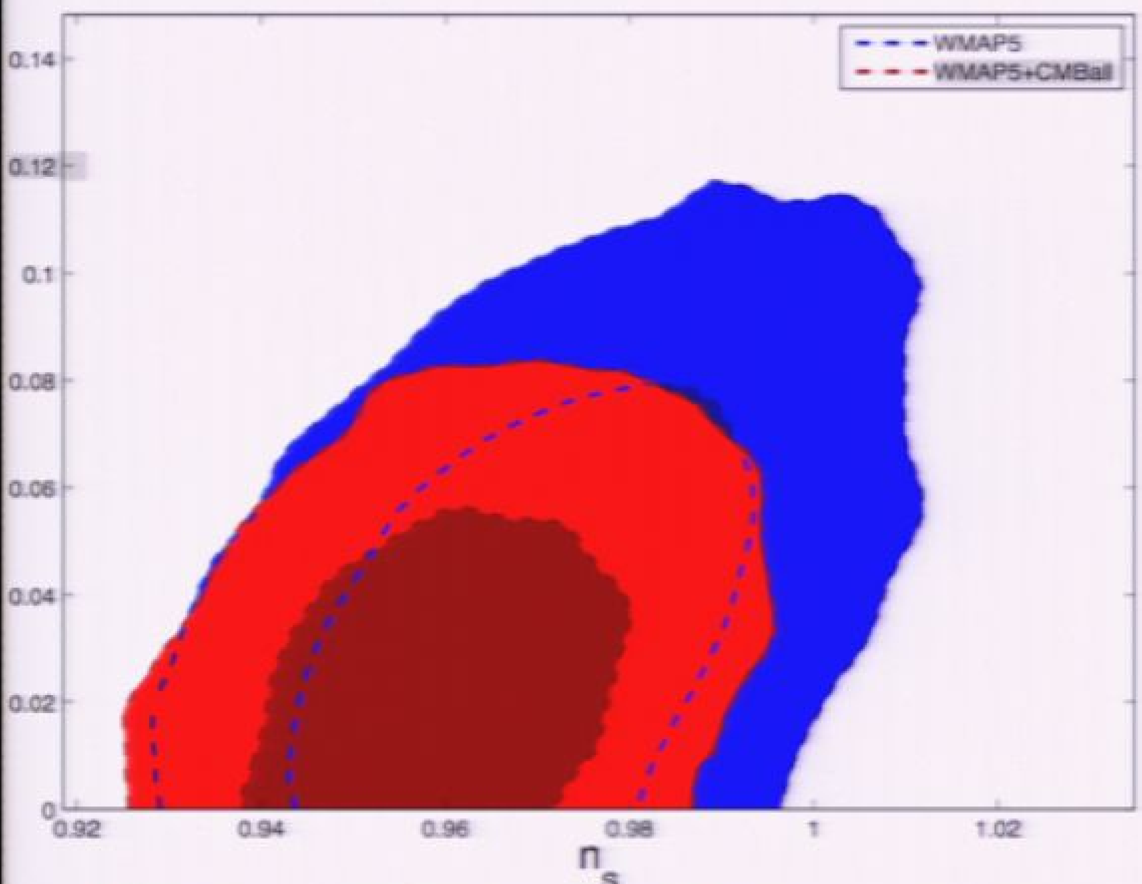

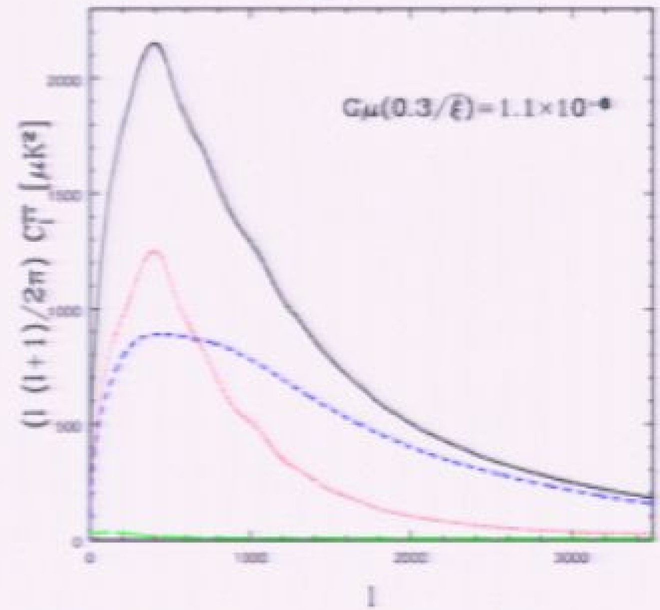

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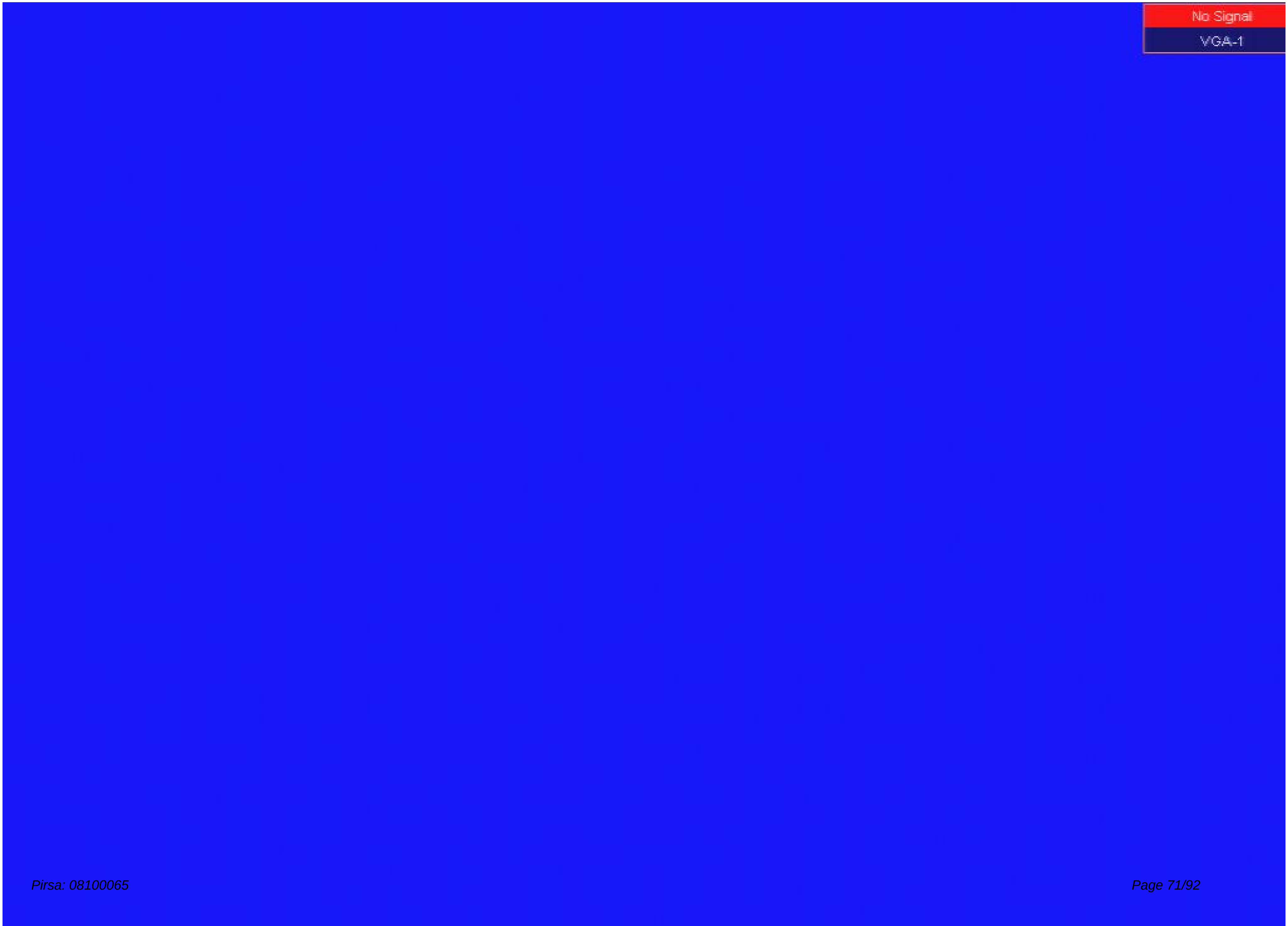

No Signal
VGA-1

ACT status update

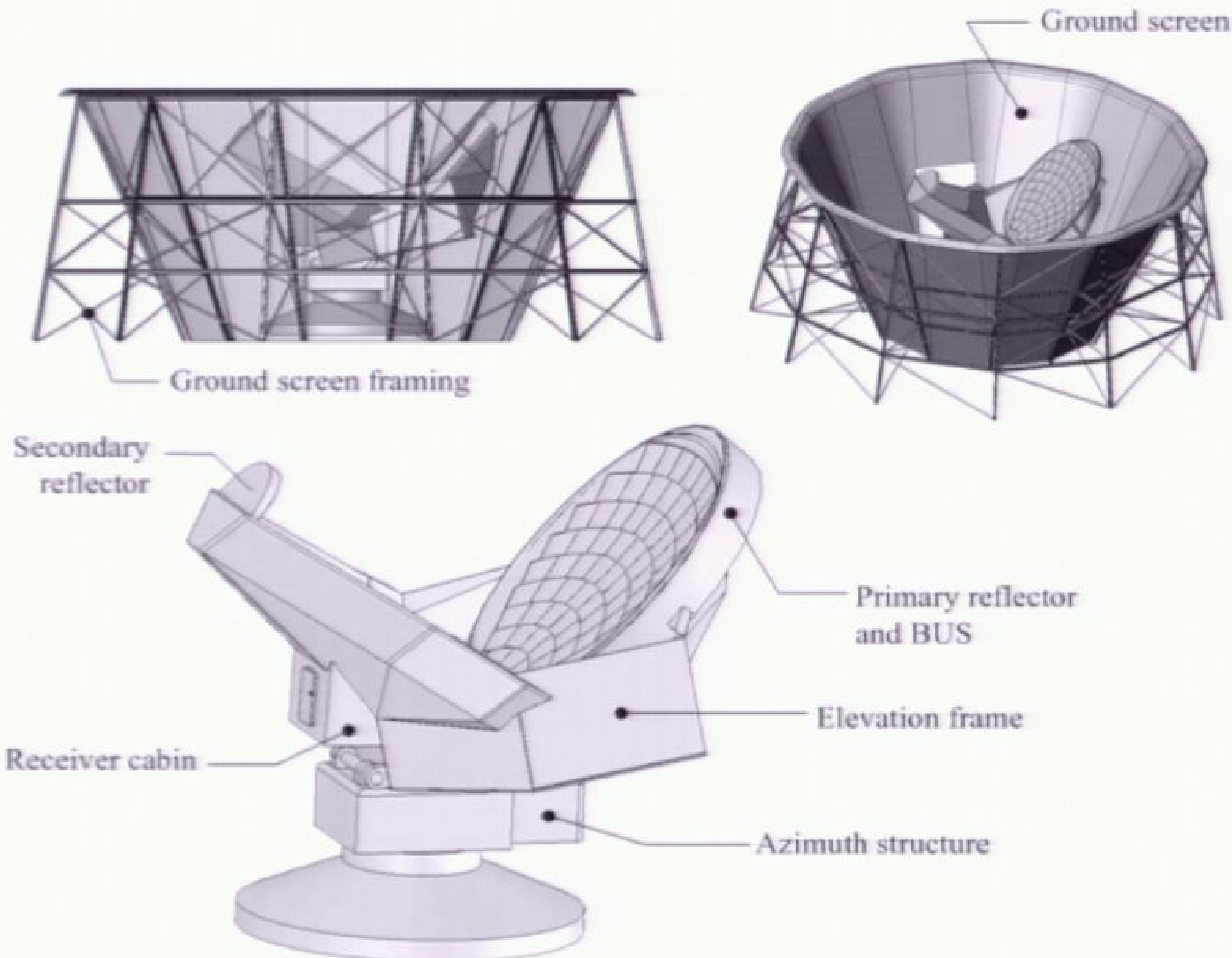
Mike Nolta

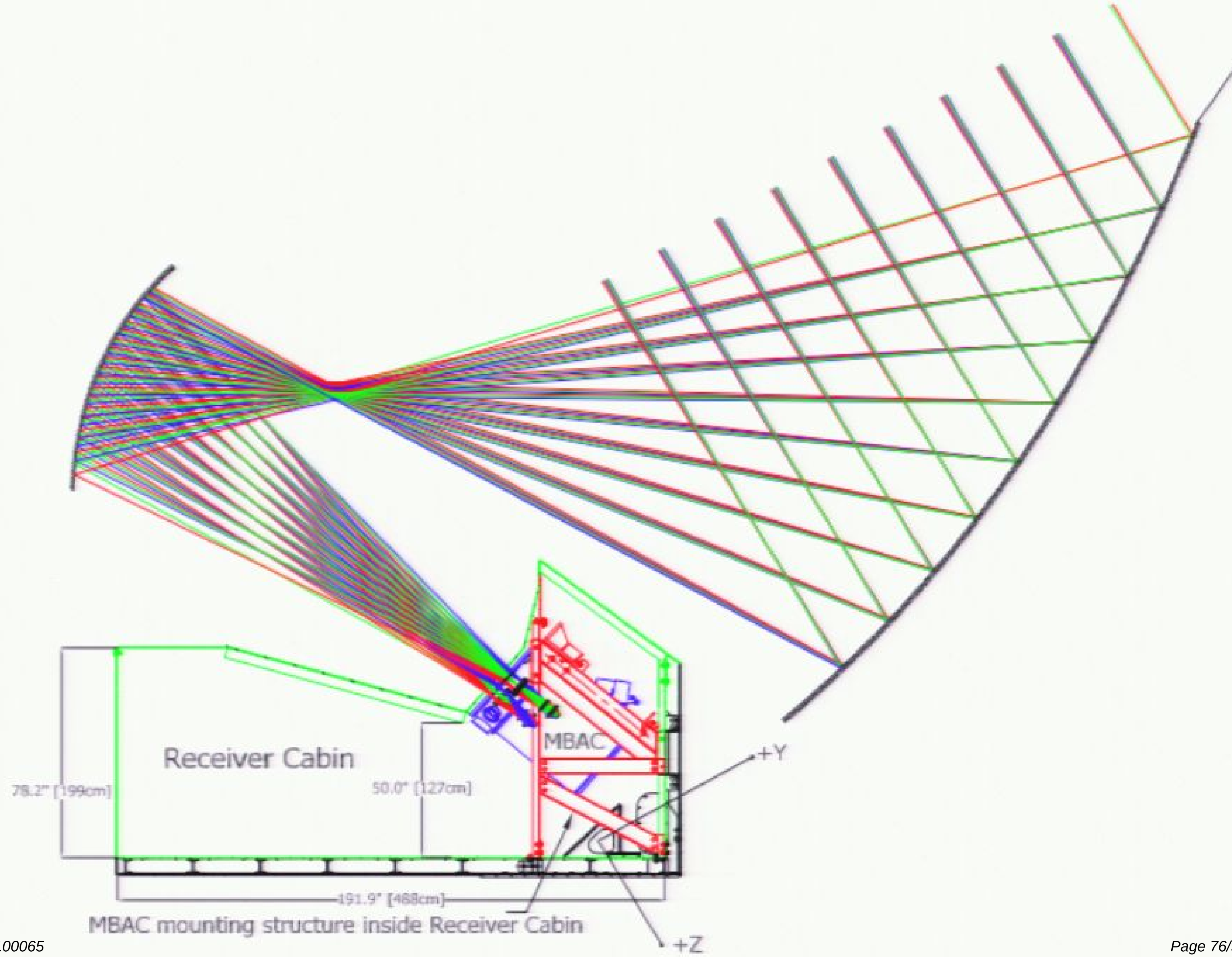
ACT status update

Mike Nolta

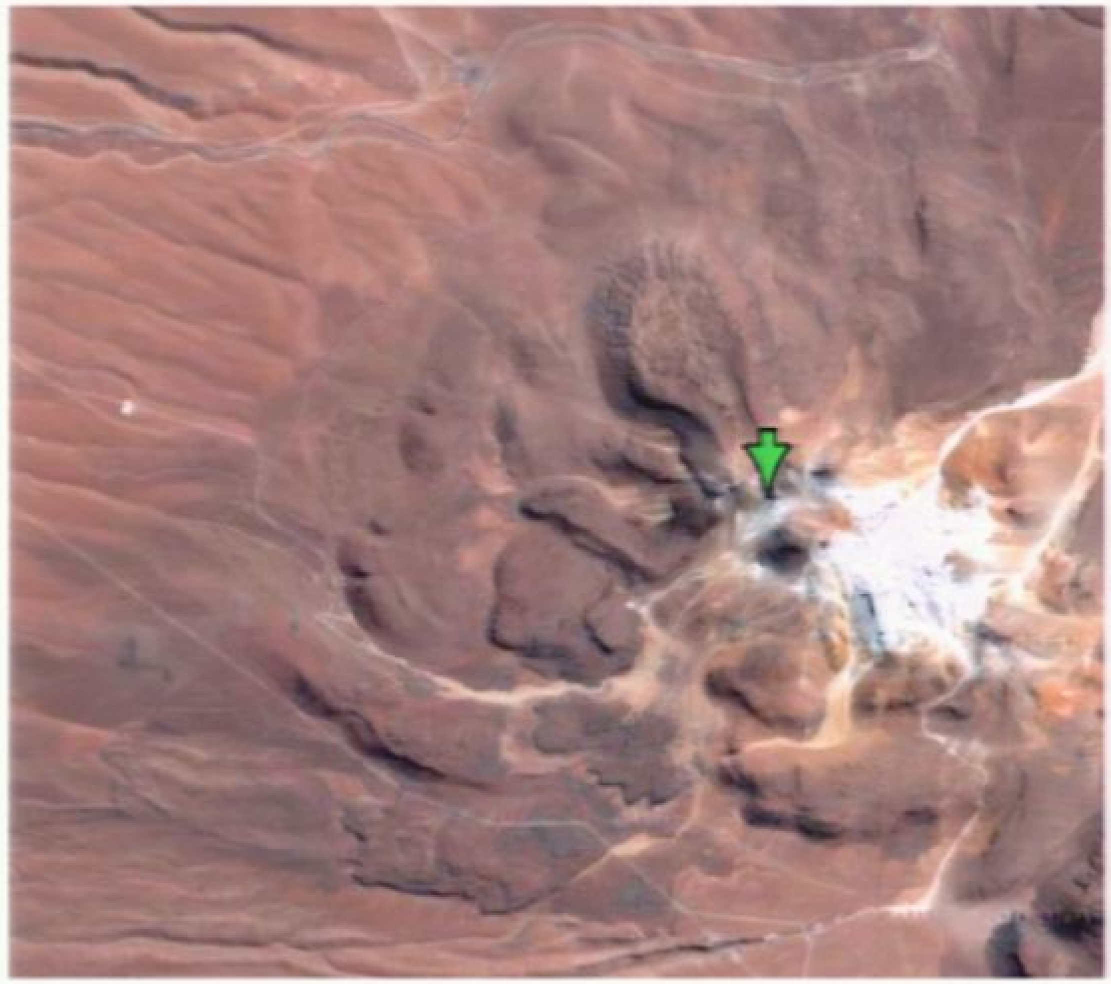
ACT status update

Mike Nolta


Ground screen
Ground screen framing
Secondary reflector
Primary reflector and BUS
Elevation frame
Receiver cabin
Azimuth structure

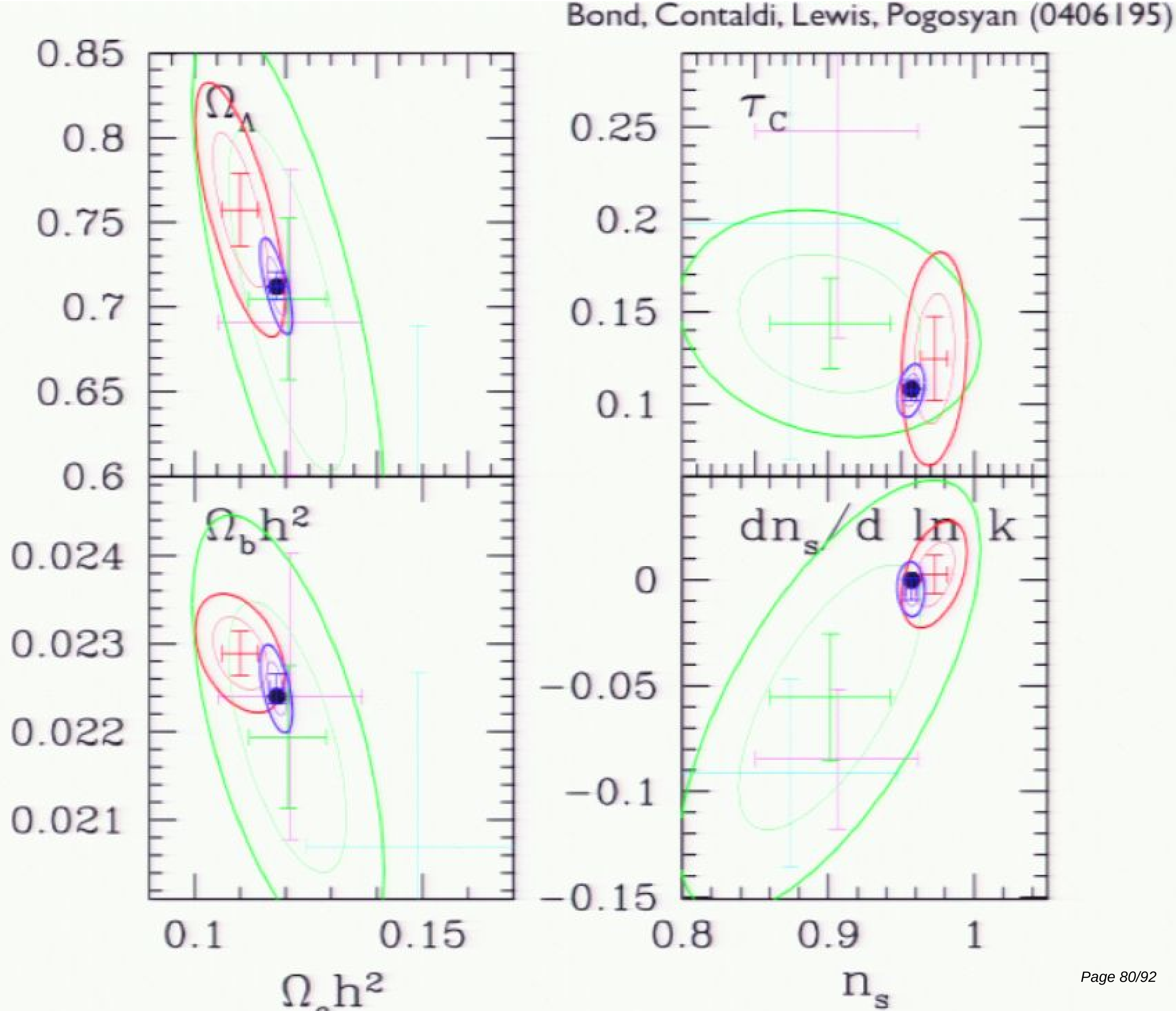

Receiver Cabin
MBAC
78.2" [199cm]
50.0" [127cm]
191.9" [488cm]
MBAC mounting structure inside Receiver Cabin
+Y
+Z

Site



Science Goals

- CMB power spectrum to l=10,000 (1')
  - WMAP measured l<1000 (15'), Planck will measure l<3000 (5')
- Blind SZ-selected cluster catalog
  - O(1000) clusters w/ M > 3×10^{14}
- Secondary anisotropies
  - kSZ, weak lensing, reionization

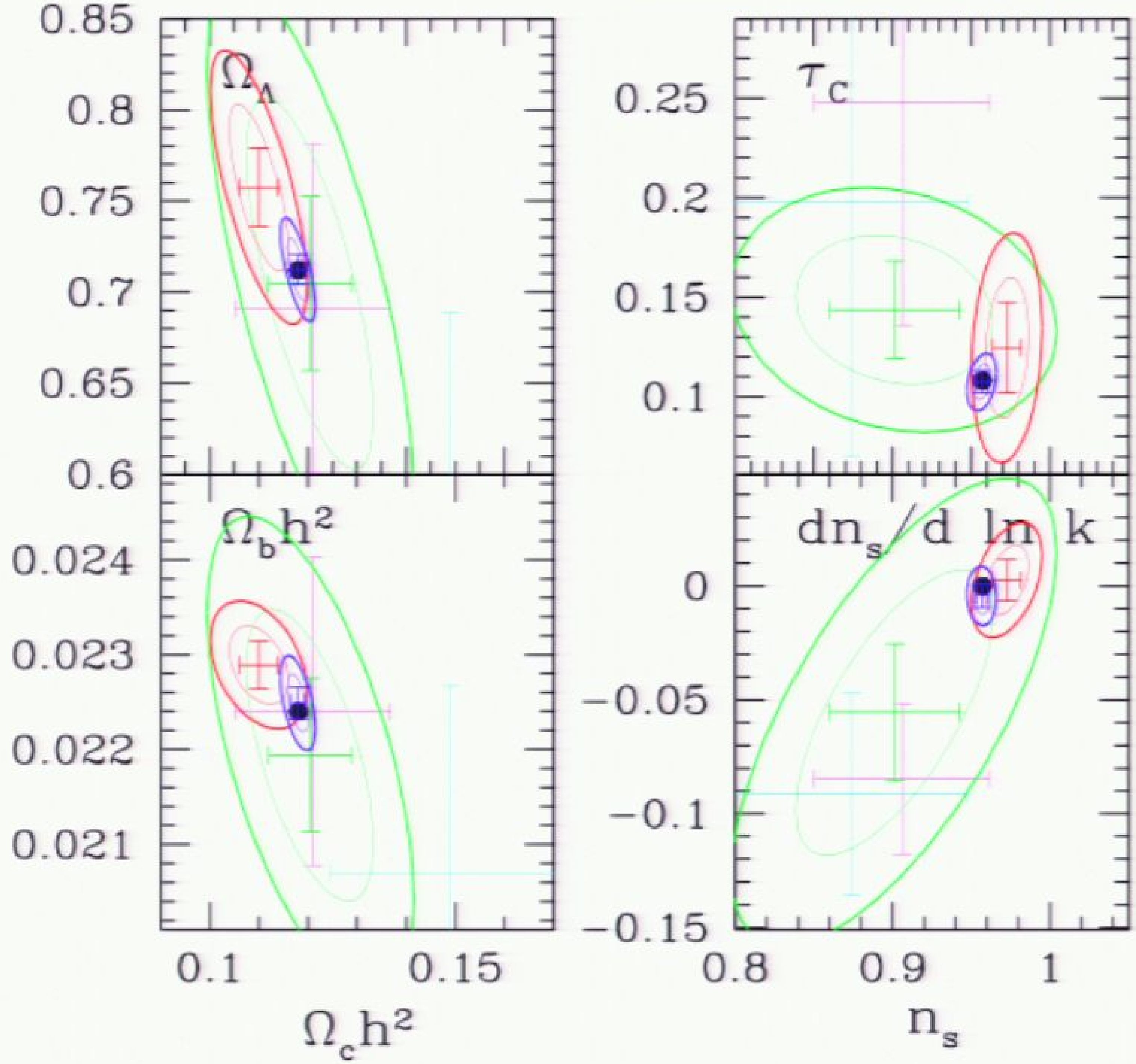


Bond, Contaldi, Lewis, Pogosyan (0406195)
Ω_Λ
τ_C
$\Omega_b h^2$
$dn_s/d \ln k$
$\Omega_c h^2$
n_s
0.85
0.8
0.75
0.7
0.65
0.6
0.25
0.2
0.15
0.1
0.024
0.023
0.022
0.021
0
−0.05
−0.1
−0.15
0.1
0.15
0.8
0.9
1

Observations

- First light: 22 Oct 2007
- 2007 season: 14 Nov to 17 Dec
  - single 145 GHz band
- 2008 season: 24 Aug to (Dec 31)
  - 3 bands: 145, 220, 280 GHz

Bond, Contaldi, Lewis, Pogosyan (0406195)



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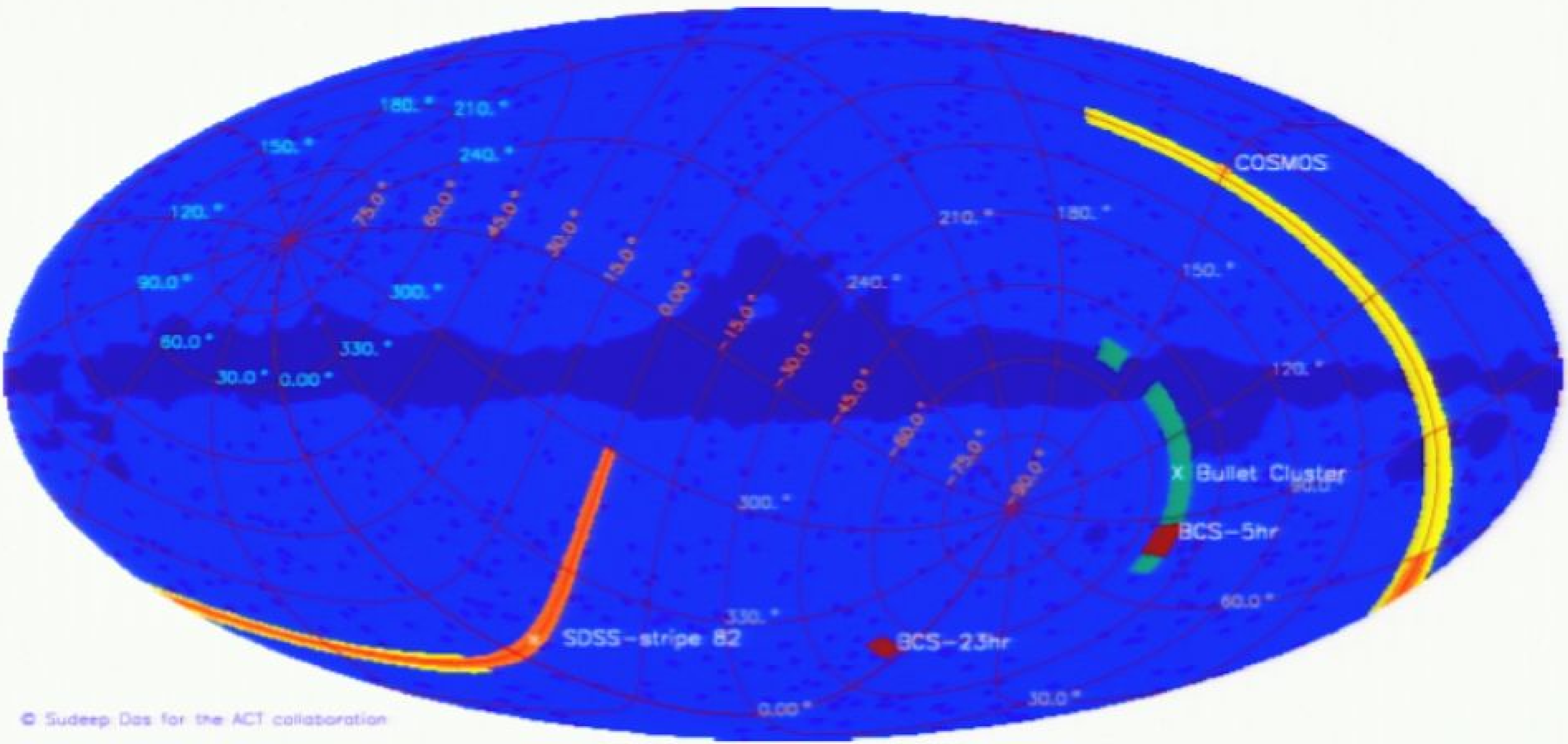
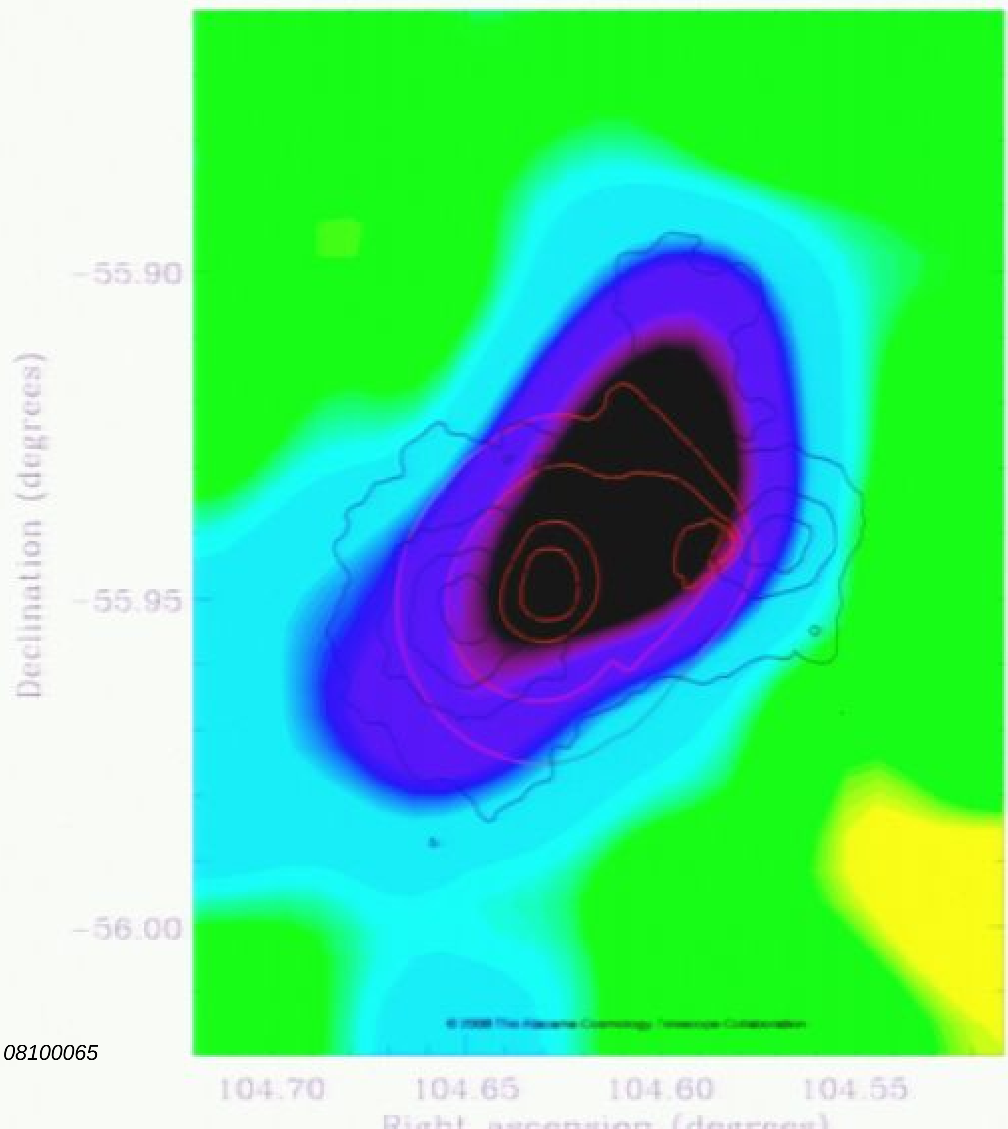

COSMOS
Bullet Cluster
BCS–5hr
SDSS–stripe 82
BCS–23hr
© Sudeep Das for the ACT collaboration

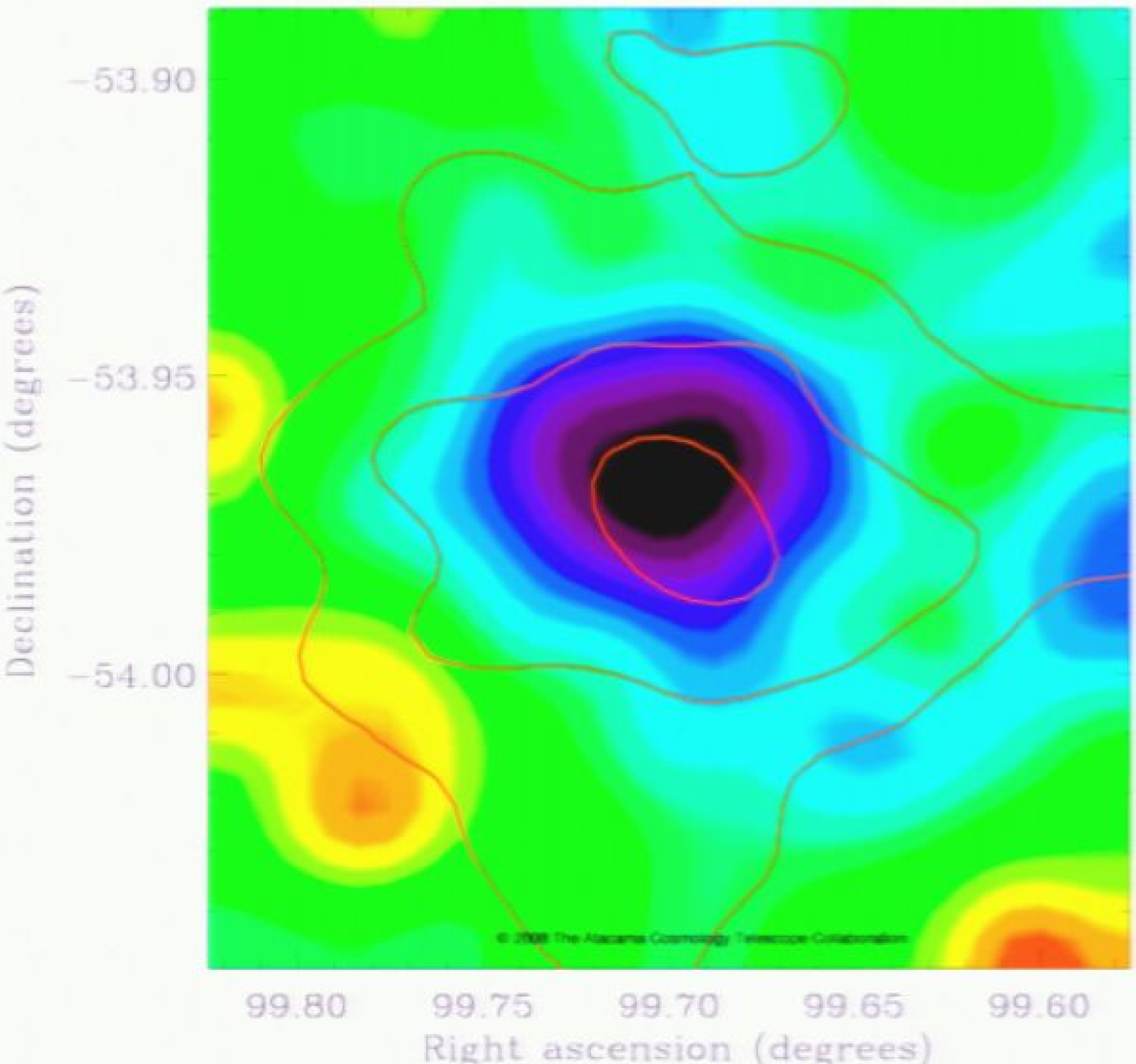
Computing challenges

- ACT produces as much data as WMAP-8yr every single night.
- Have to solve map = (big matrix) x TOD
- SciNet: new 33k core cluster at UofT

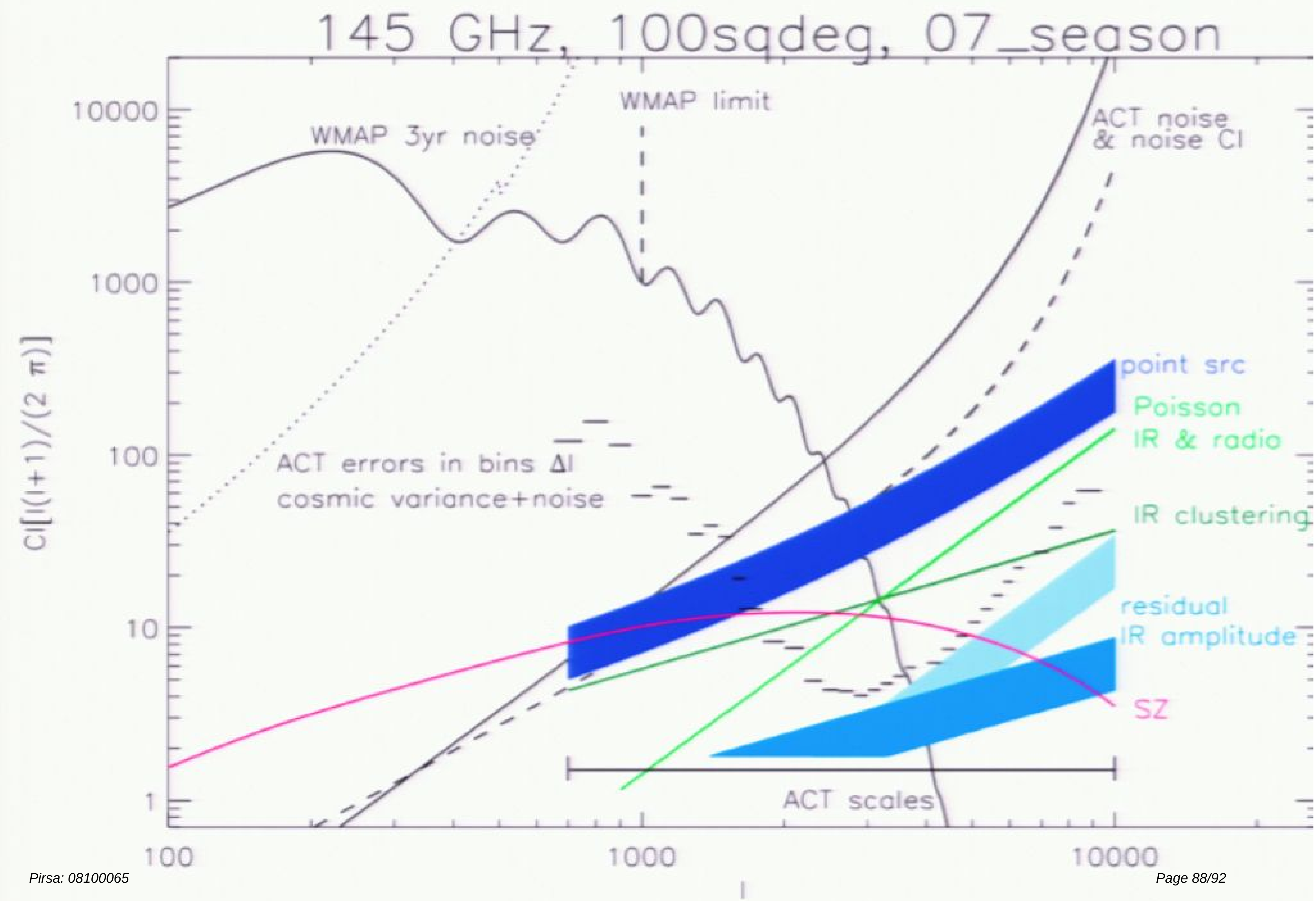
Just a little taste...



- Bullet cluster
- Contours are weak lensing (black) & X-ray (orange)
- A few minutes of 145 GHz data
- smoothed to 1.6'


-53.90
-53.95
-54.00
Declination (degrees)
99.80
99.75
99.70
99.65
99.60
Right ascension (degrees)

AS0592

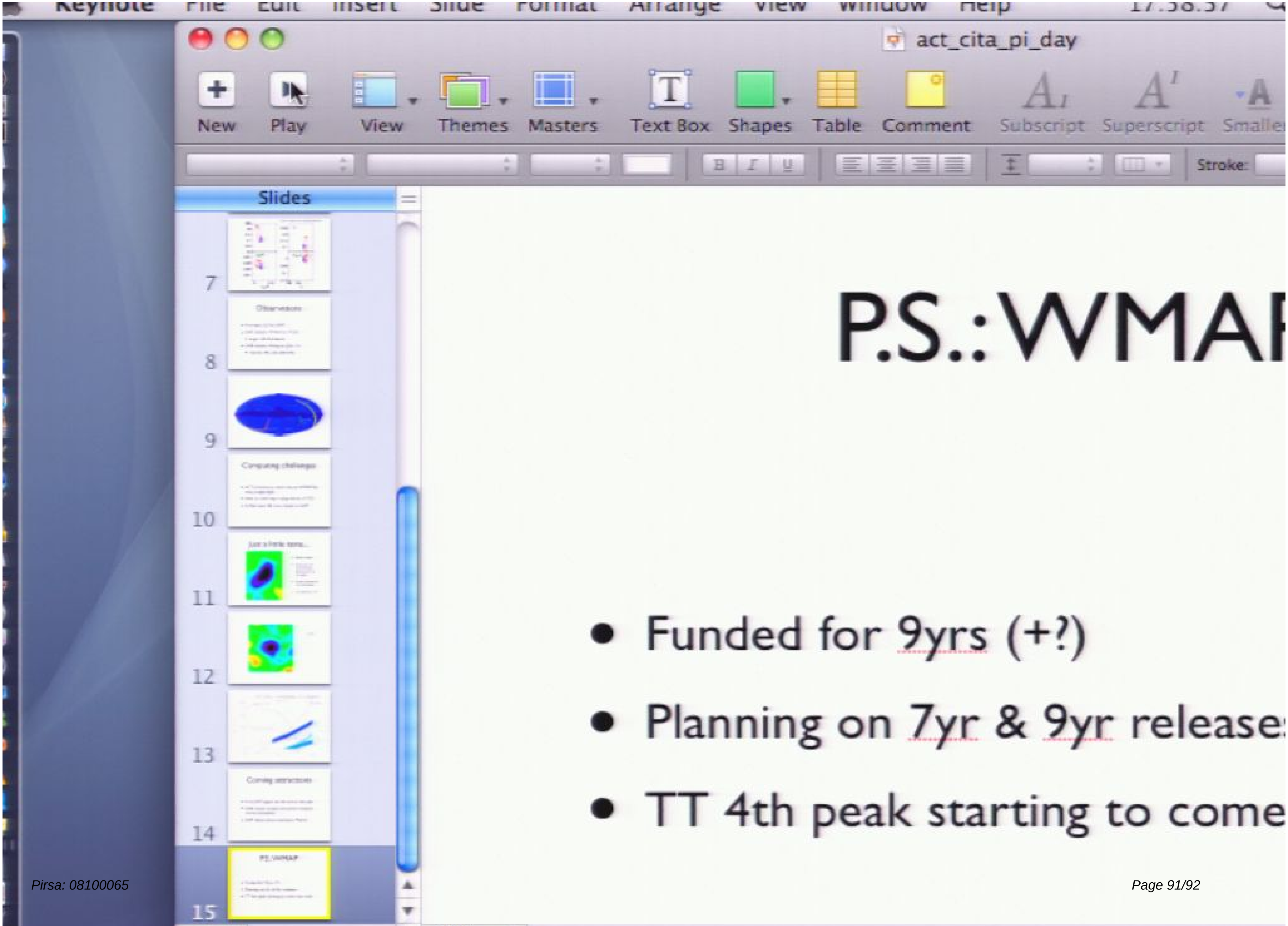

145 GHz, 100sqdeg, 07_season
WMAP limit
WMAP 3yr noise
ACT noise
& noise Cl
point src
Poisson
IR & radio
IR clustering
ACT errors in bins Δl
cosmic variance+noise
residual
IR amplitude
SZ
ACT scales
Cl[l(l+1)/(2 π)]
10000
1000
100
10
1
100
1000
10000
l

Coming attractions

- First 2007 papers by the end of the year.
- 2008 season analysis should be released shortly thereafter.
- 2009 observations starting in March.

P.S.: WMAP

- Funded for 9yrs (+?)
- Planning on 7yr & 9yr releases
- TT 4th peak starting to come into view


act_cita_pi_day
New
Play
View
Themes
Masters
Text Box
Shapes
Table
Comment
Subscript
Superscript
Stroke:
Slides
7
8
9
10
11
12
13
14
15
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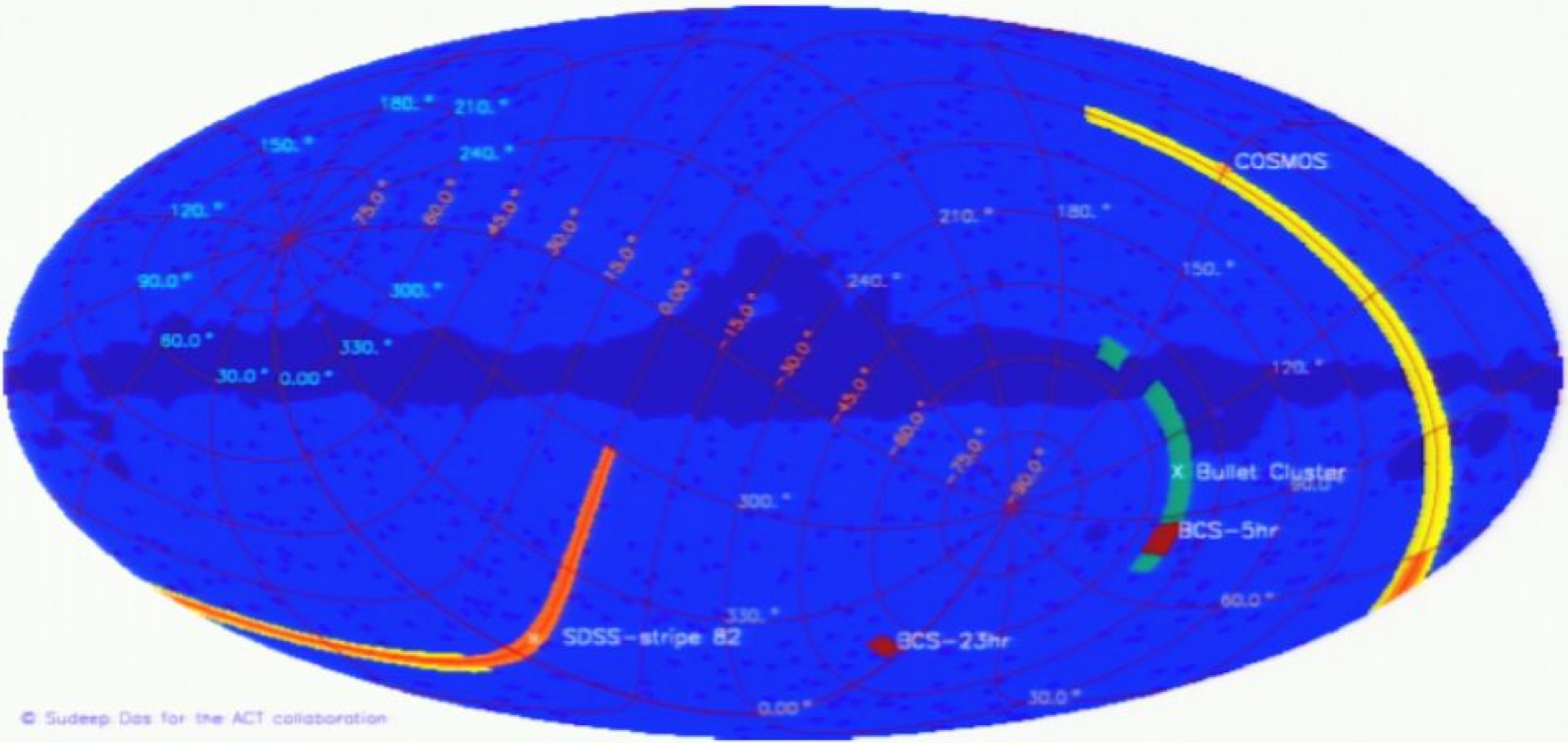

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