Using the SMA

Mark Gurwell

SMA Community Day

11 July 2011

Outline

- Submillimeter Array Background
- SMA Specifications
- Proposing for SMA Time
  - Statistics
  - Tools
  - Process
  - Help

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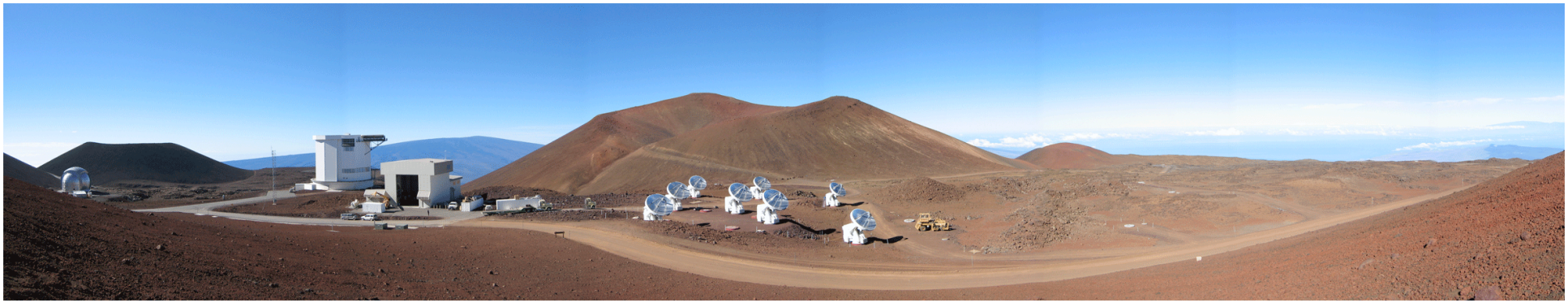
What is the SMA?

The SMA is a pathfinding instrument comprised of eight 6 meter antennas on Mauna Kea, HI, designed for high spatial and spectral resolution imaging in submillimeter atmospheric windows.

The SMA is now being used to study Solar System bodies, protoplanetary disks, star forming regions, evolved star envelopes, the Galactic Center, nearby galaxies, and ultraluminous galaxies at cosmological distances.

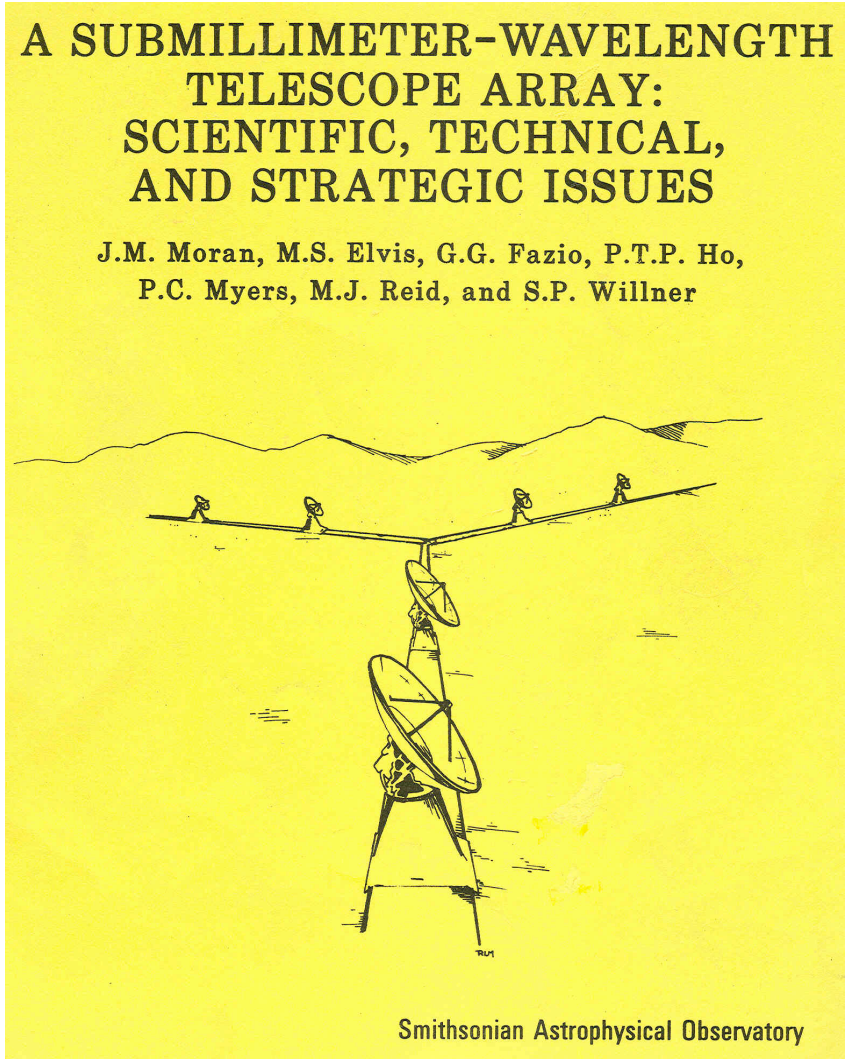


The SMA is a collaborative project of the Smithsonian Astrophysical Observatory, part of the Harvard-Smithsonian Center for Astrophysics, and the Academia Sinica Institute of Astronomy and Astrophysics (Taiwan)

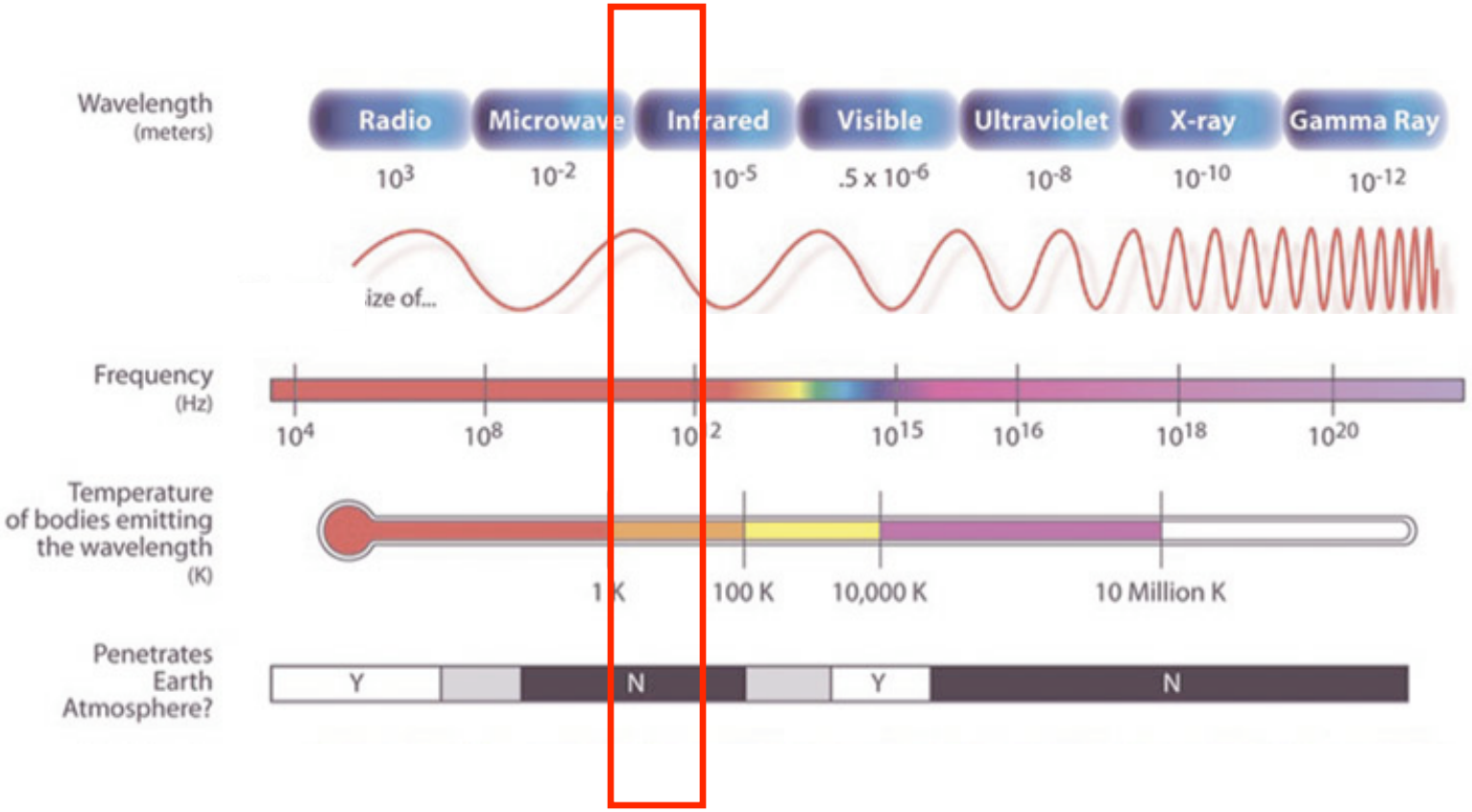
Historical Perspective

- 1984: SAO Study
- (1992-1998: CSO-JCMT)
- 1994: OSDA U. Hawaii
- 1996: ASIAA expansion

  +2 antennas (to 28 baselines)
- 1999-2003: antennas deployed to Mauna Kea
- 2004: first SMA science
- 2011: >336 refereed papers (rate > 1/week for 5 yrs)

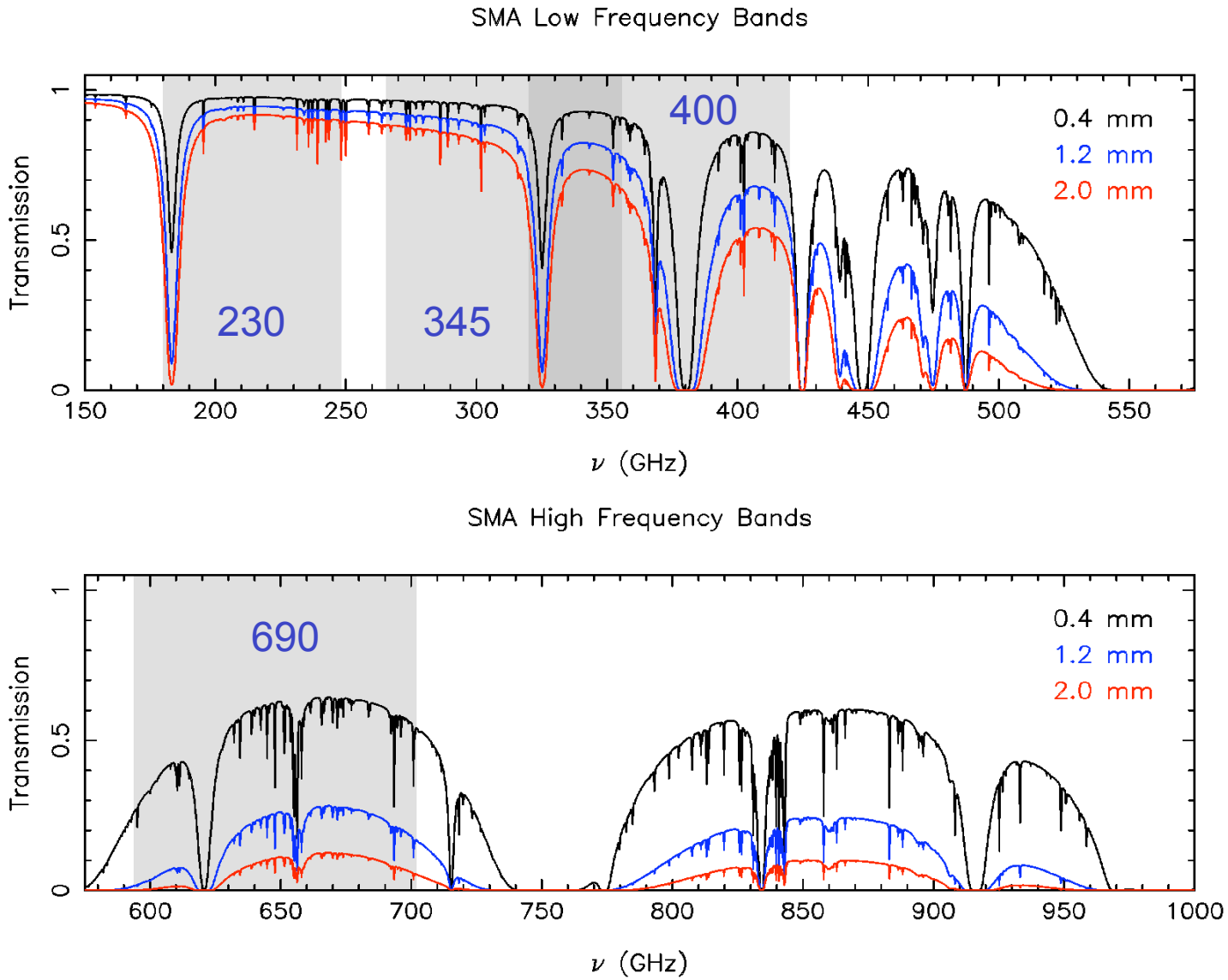


Submillimeter Windows

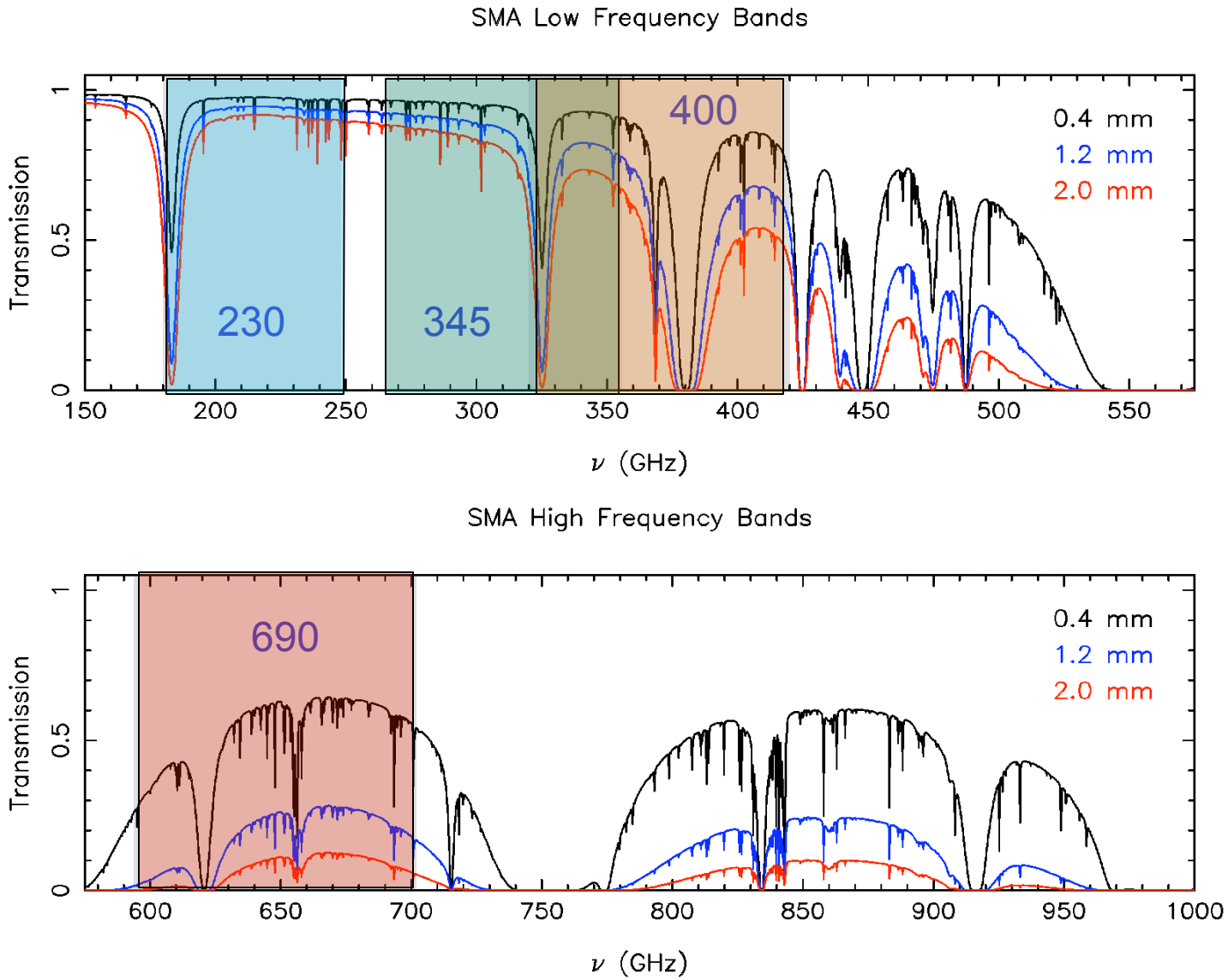


Cold material is best seen in submillimeter “light”

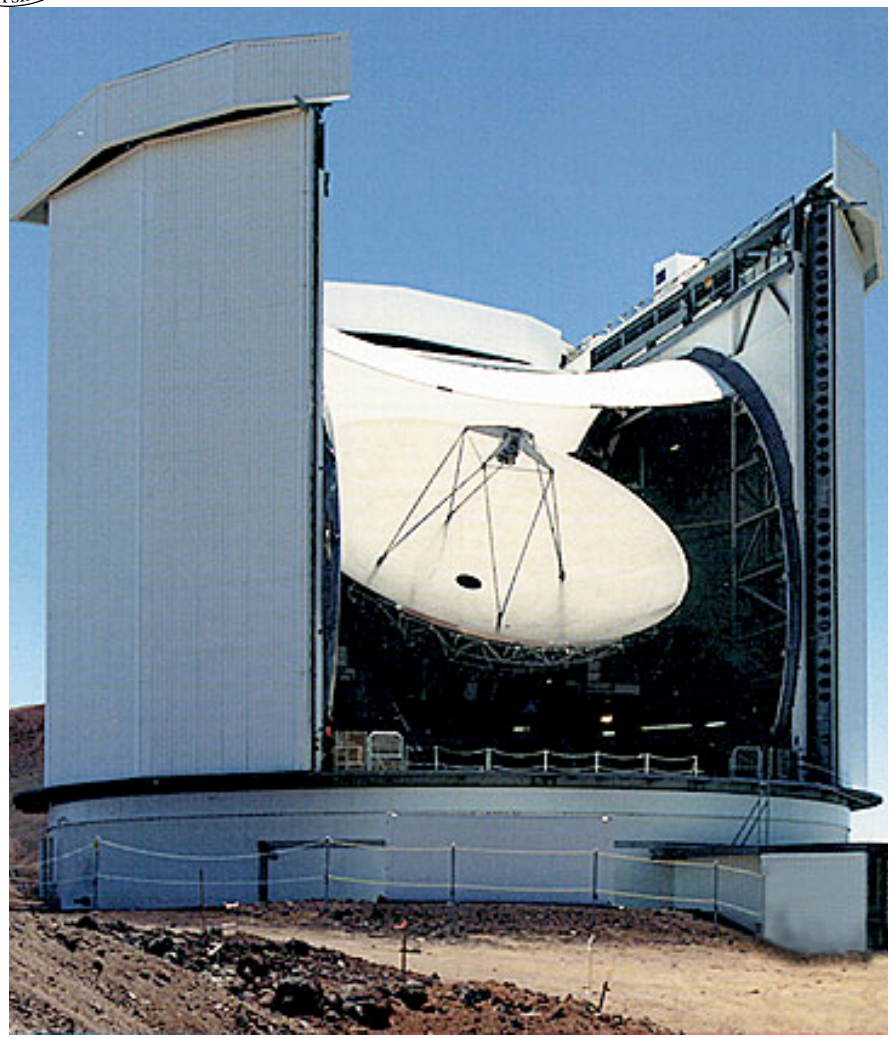
Submillimeter Windows



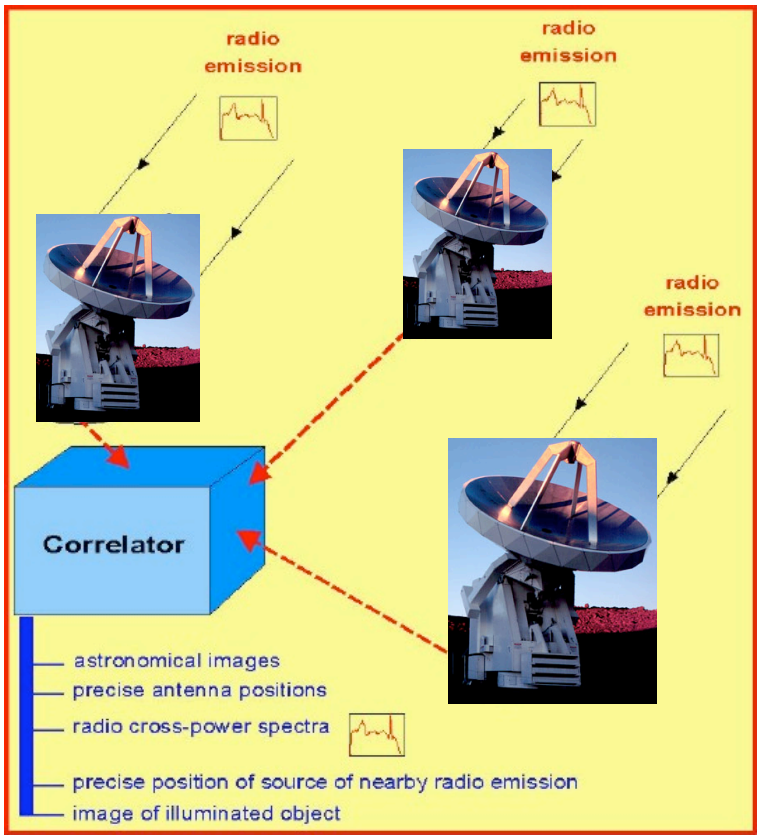
Submillimeter Windows



Single Aperture vs Interferometry



JCMT, 15-m (17” at 1mm)



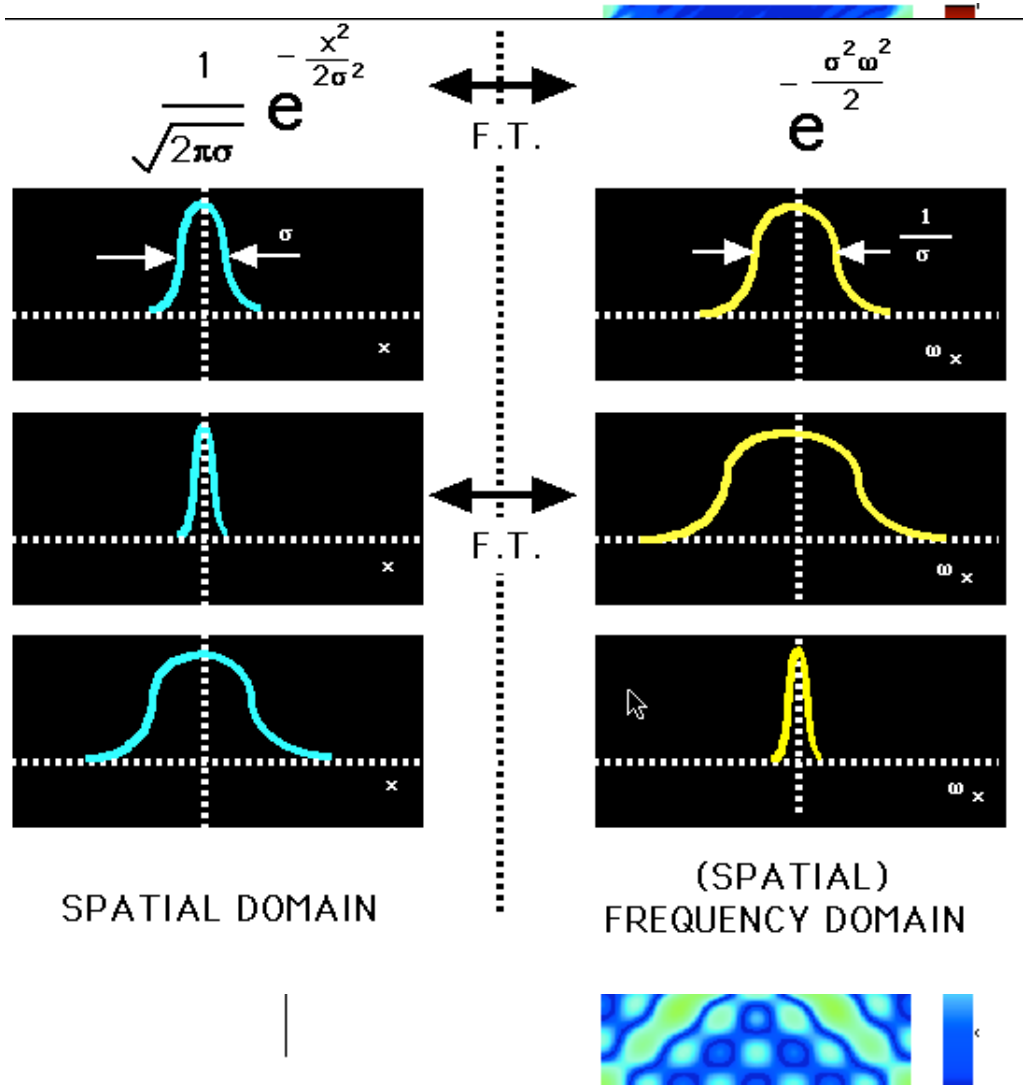
Resolution ~ wavelength/size

SMA, 8 x 6-m, (4” at 1mm)

R=6.508m (34” to 0.4”)

200 meters for 1” at λ=1mm

Spatial Frequencies



Short baselines – large spatial scales

Long baselines – small spatial scales

For high spatial dynamic range but small number of sampling points (antennas) need multiple configurations

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SMA Specifications

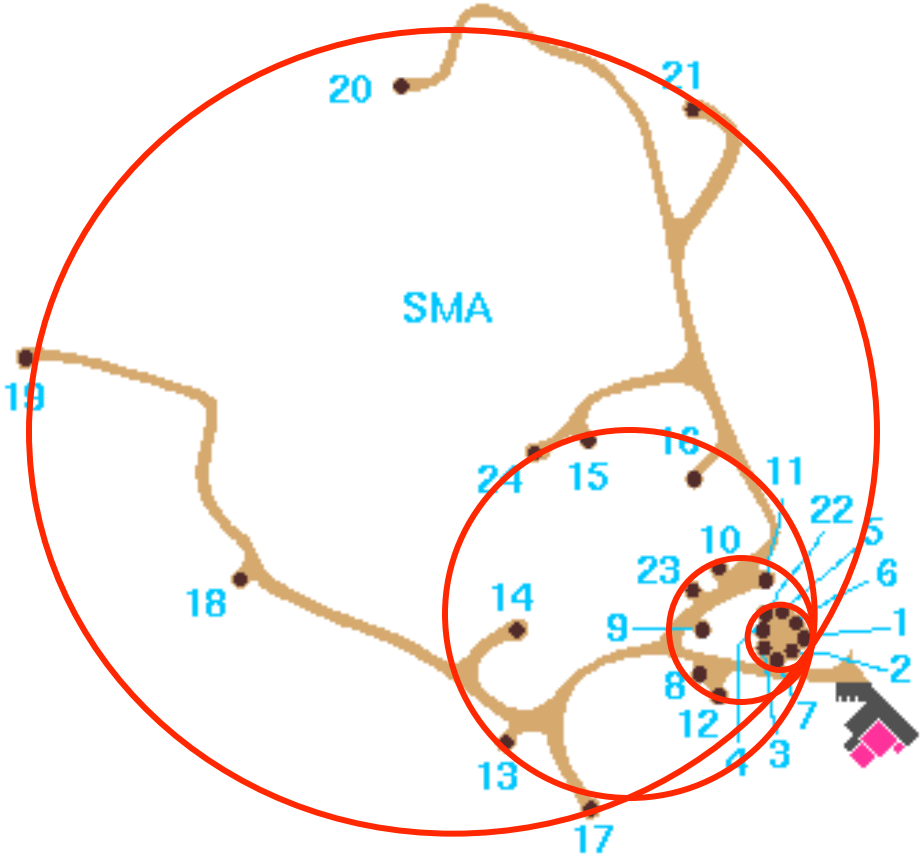
Antennas: 8 antennas of 6 m diameter, 12 μm rms surface
cost + imaging speed + collecting area (~JCMT)

Configurations: 24 pads in four rings
baseline lengths 8 - 508 m,
subarcsecond resolution, best ~0.1''

Receivers: max 8 per antenna; 1 or 2 simultaneously, each single pol.
full frequency coverage of atmospheric windows
dual polarization, "high" & "low" combinations allowed
'230' 177-256 GHz (L)
'345' 256-360 GHz (L)
'400' 320-420 GHz (H)
'600' 600-720 GHz (H)

Correlator: Bandwidth: 2 SB x 4 GHz (1 receiver) / 2 GHz (2 receivers)
up to 25 kHz resolution!
Sensitivity and bandwidth to span/resolve
extragalactic/galactic lines

Antenna Stations



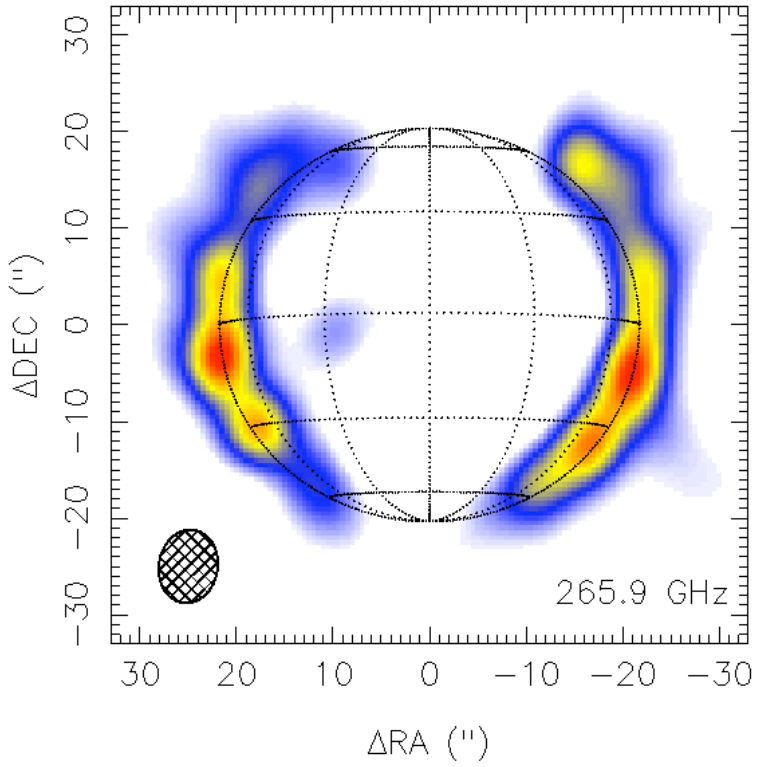
4 Nested Rings (Keto 1997)

4 Configurations

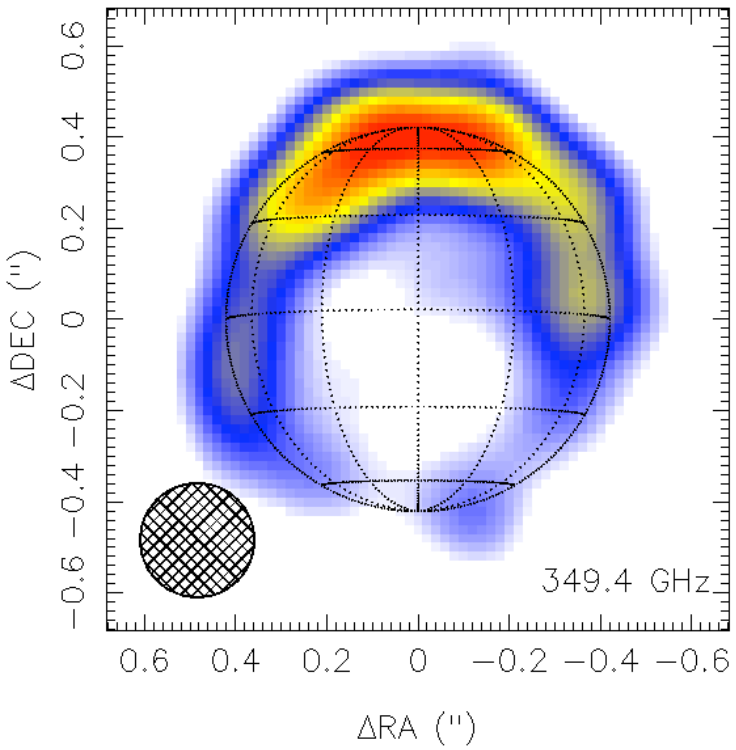
	230	345
Subcompact	9”	6”
Compact	3.5”	2.5”
Extended	1.3”	0.8”
Very Extended	0.5”	0.3”

Field of View/Resolution

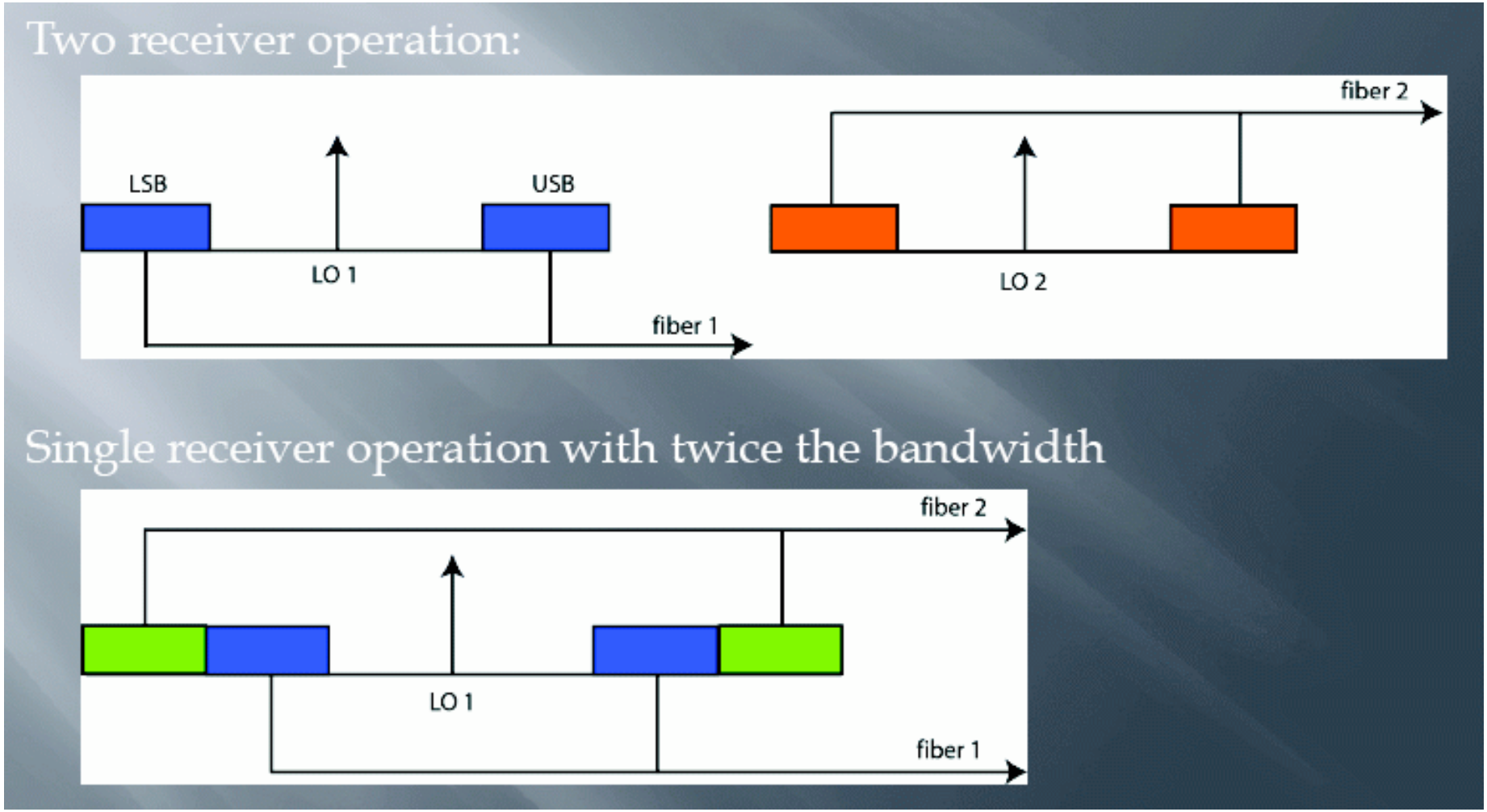
Jupiter HCN(3−2) Integrated Emission [SMA: 28 April, 2007]



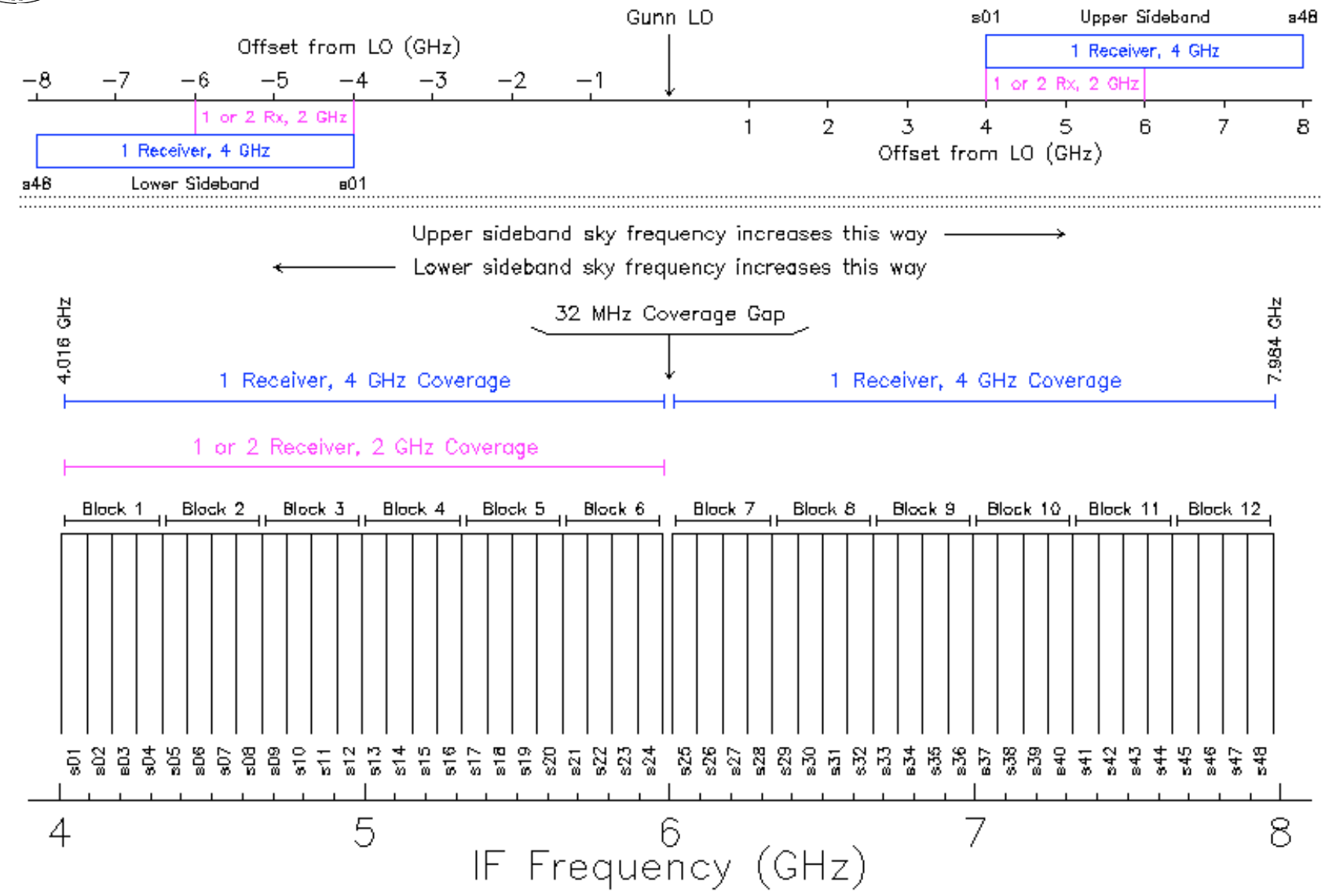
Titan CH_3CN Integrated Emission [eSMA: 23 March, 2009]



Single or Dual Rx Operation



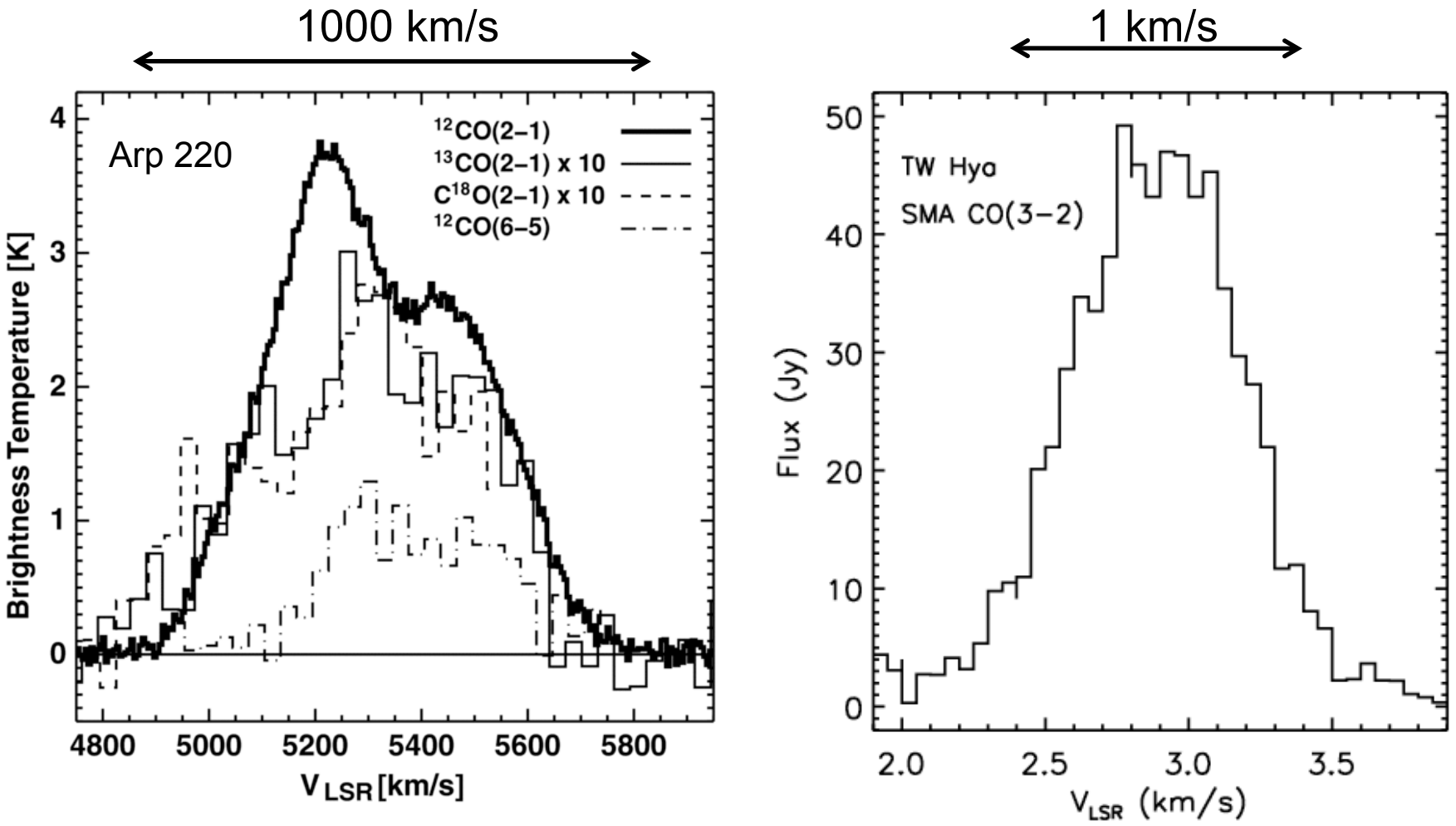
SMA IF System



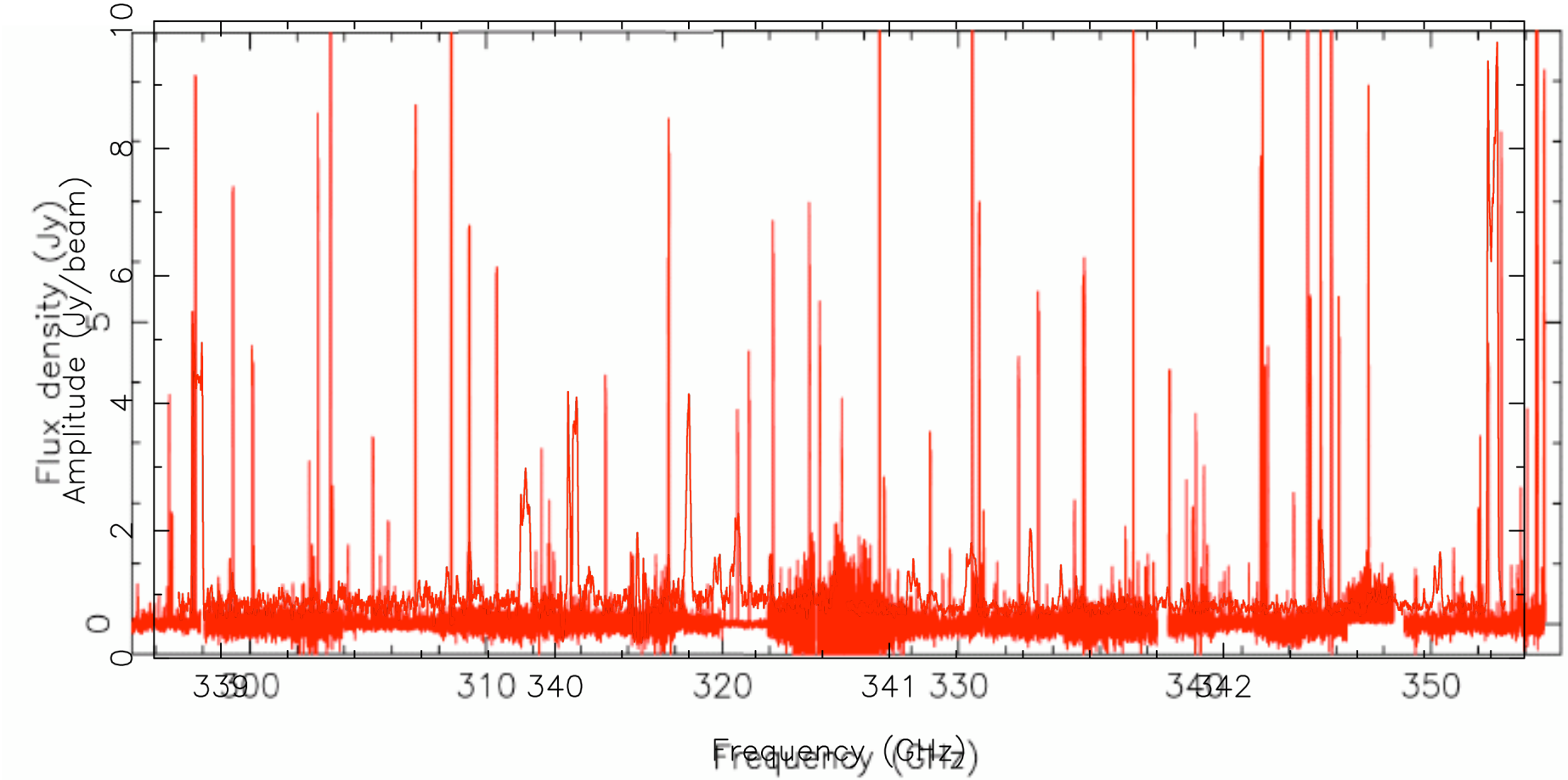
SMA Correlator

Bandwidth		Velocity Resolution (km/s)		
		230 GHz	345 GHz	690 GHz
Full Continuum	4 GHz / sideband	5200	3500	1740
Best Uniform Spectral Res.	812.5 kHz	1	0.7	0.35
Maximum* Spectral Res.	25 kHz	0.03	0.022	0.01

SMA Correlator

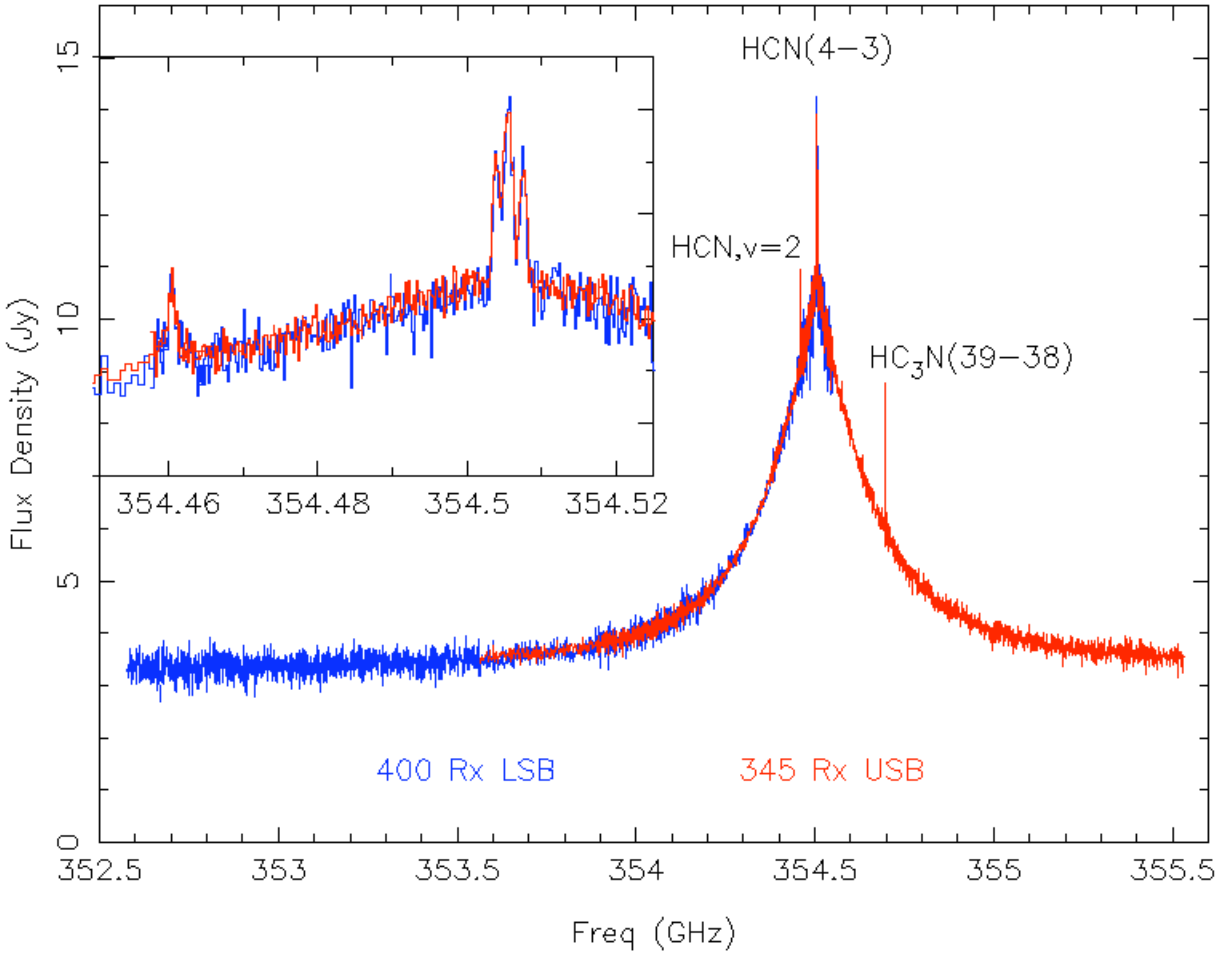


SMA Correlator – 4 GHz IF Example

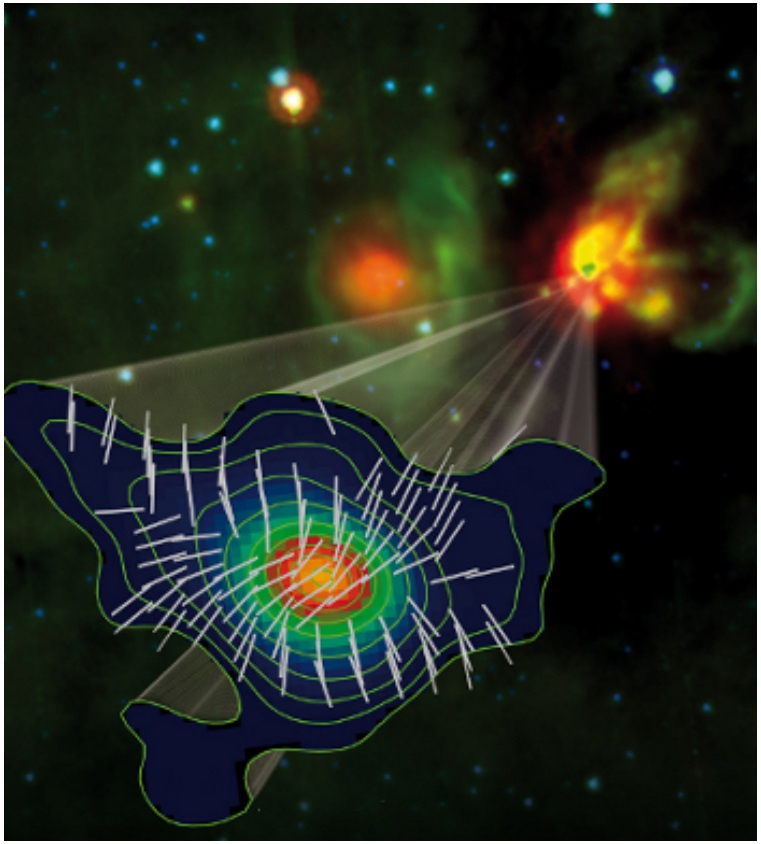


Courtesy Nimesh Patel

SMA Correlator – Dual Rx Example



Polarization



G31.41+0.31 (Girart et al)

- Single receiver, cycling quarter-wave plates (time-sharing to obtain full Stokes coverage)

- Dual receiver, direct full Stokes (no time-sharing, more efficient)

Sensitivity (6 hr)

230 Band 3.0 mm pwv		**8 GHz (Full Continuum)**		**1 km/s**	
Config	Beam	Point-Source Sensitivity (mJy)	Temp	Point-Source Sensitivity (mJy)	Temp
SUB	7.4”x7.1”	0.7	0.35 mK	70	31 mK
COM	3.3”x2.9”	0.5	1.2 mK	49	117 mK
EXT	1.3”x1.0”	0.5	9.1 mK	49	855 mK
VEX	0.5”x0.4”	0.5	54 mK	49	5.2 K

Sensitivity (6 hr)

345 Band 2.0 mm pwv		**8 GHz (Full Continuum)**		**1 km/s**	
Config	Beam	Point-Source Sensitivity (mJy)	Temp	Point-Source Sensitivity (mJy)	Temp
SUB	4.9”x4.7”	1.9	0.85 mK	150	67 mK
COM	2.2”x1.9”	1.35	3.3 mK	107	261 mK
EXT	0.8”x0.7”	1.35	24 mK	107	1.9 K
VEX	0.35”x0.3”	1.35	150 mK	107	12 K

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Observing and Proposal Information

- CfA allocates 72% of SMA Time (UH/ASIAA split rest)
- ‘open skies’ policy…accept proposals from anywhere
- proposal deadlines on 6 month cycle (March/September)
  - next deadline: **Wednesday, September 14, 2011**
- dynamic queue scheduling according to weather
- RTDC archive, data in public domain after 15 months
- Calibration and Imaging:
  - MIR (OVRO)/Miriad or AIPS (soon CASA)

Proposals

- Proposals reviewed by TAC (9-13 members) consisting of scientists from SMA, CfA, and outside community (IAA + CfA hold joint TAC science review)

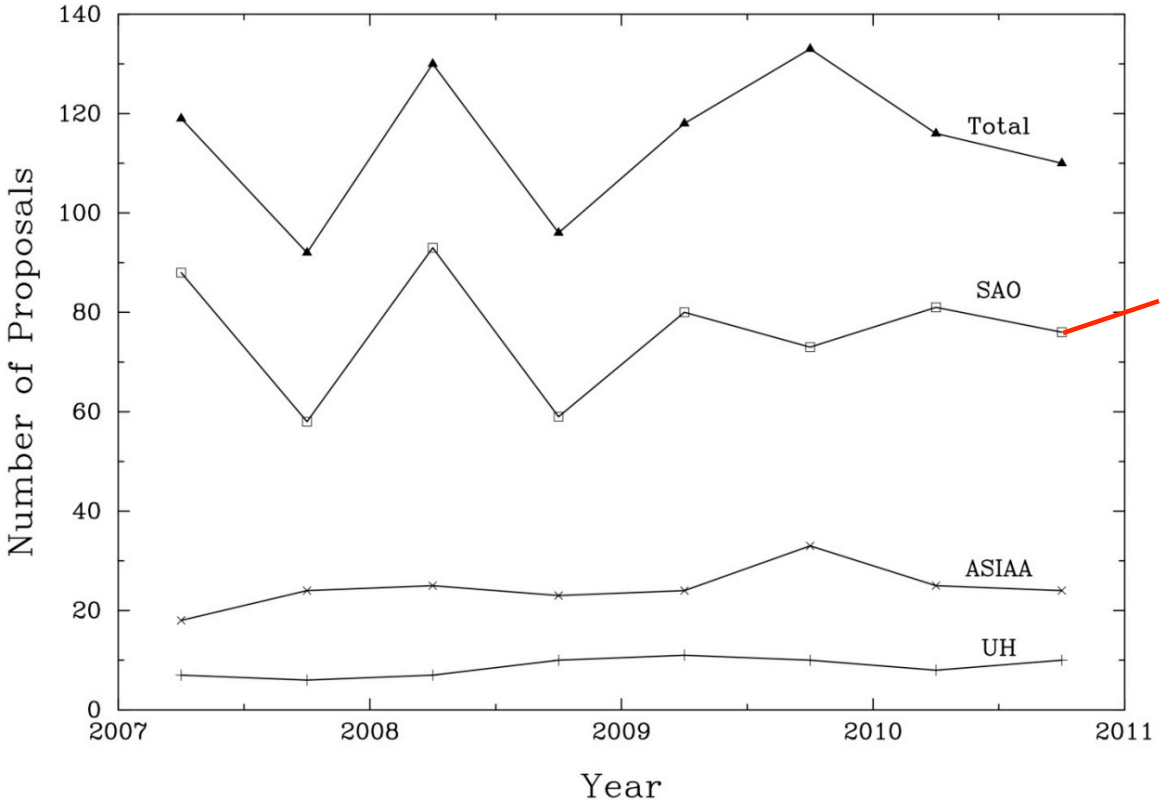
- Each proposal reviewed by minimum of 4-6 TAC members

- Proposals ranked, discussed and reevaluated at face-to-face

- configuration schedule to best accommodate highest ranked proposals

- Proposals are rated as
  - A: highest rating, executed on a best effort basis
  - B: middle rating, to be executed as time permits
  - C: lowest rating, will not be executed

Proposal Statistics



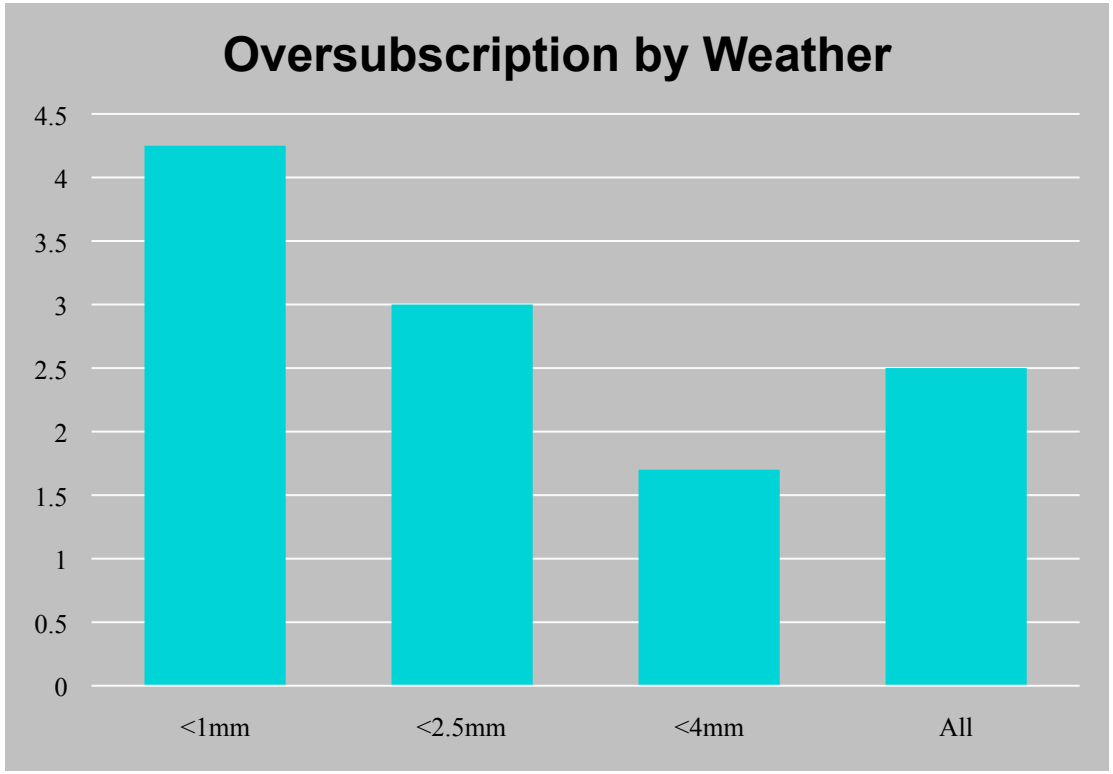
Number unique PIs: 172

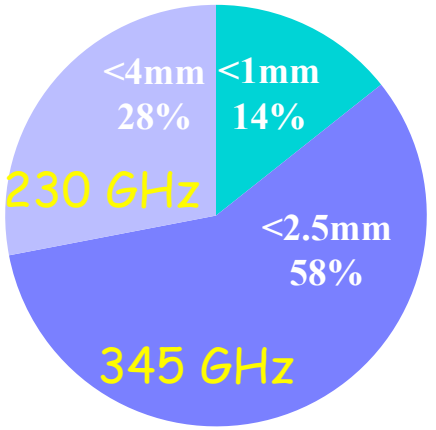
Allocated 1+ A tracks: 108

1+ successful obs: 169

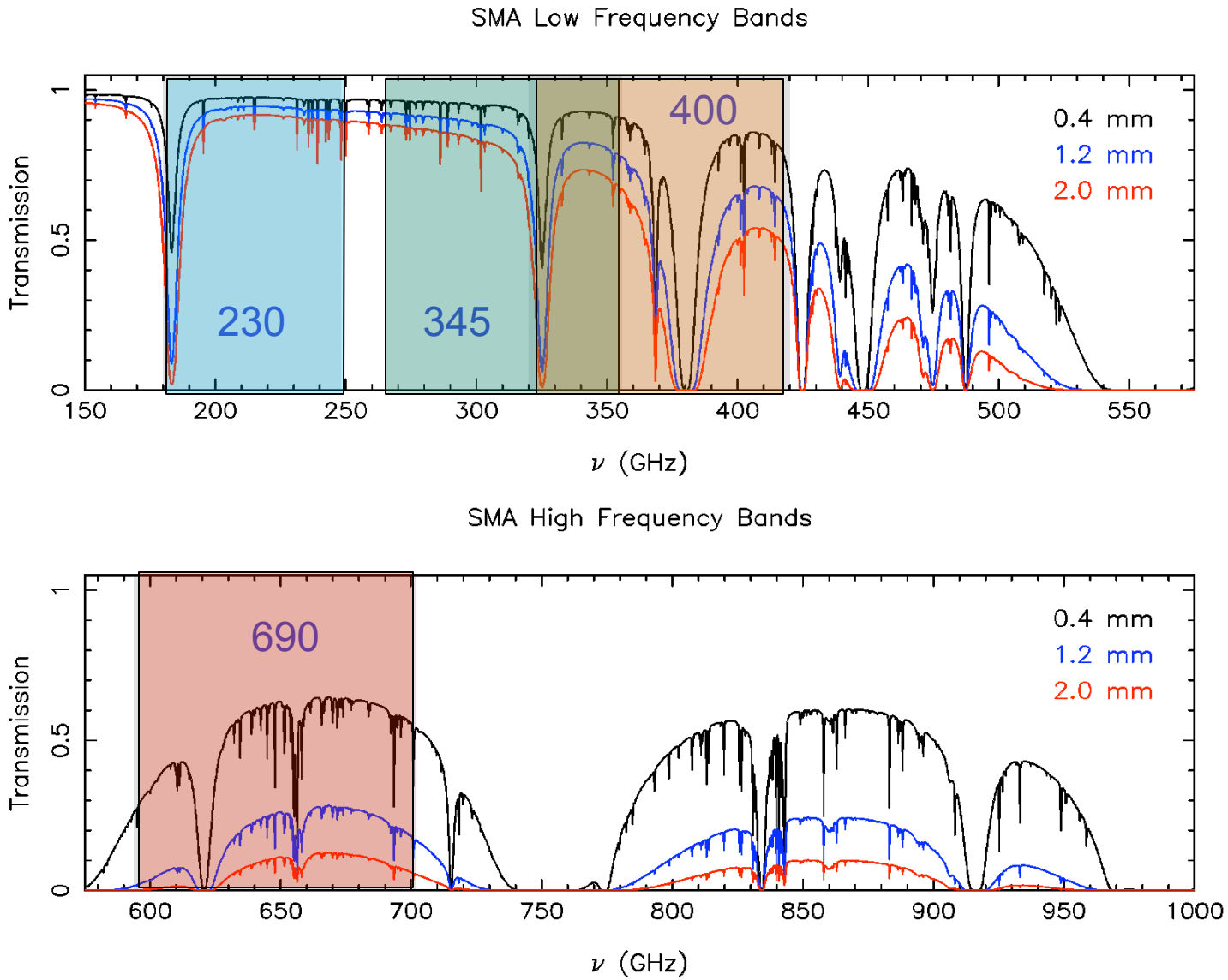
Time Oversubscription

Majority of time requests come at 345 GHz

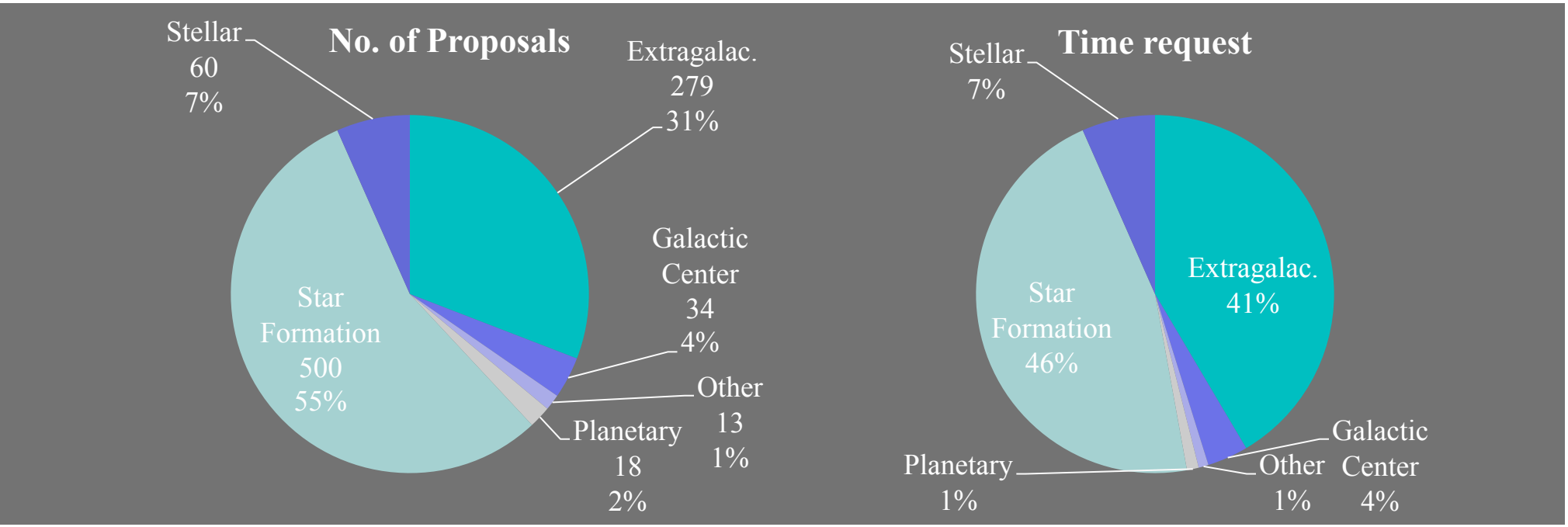




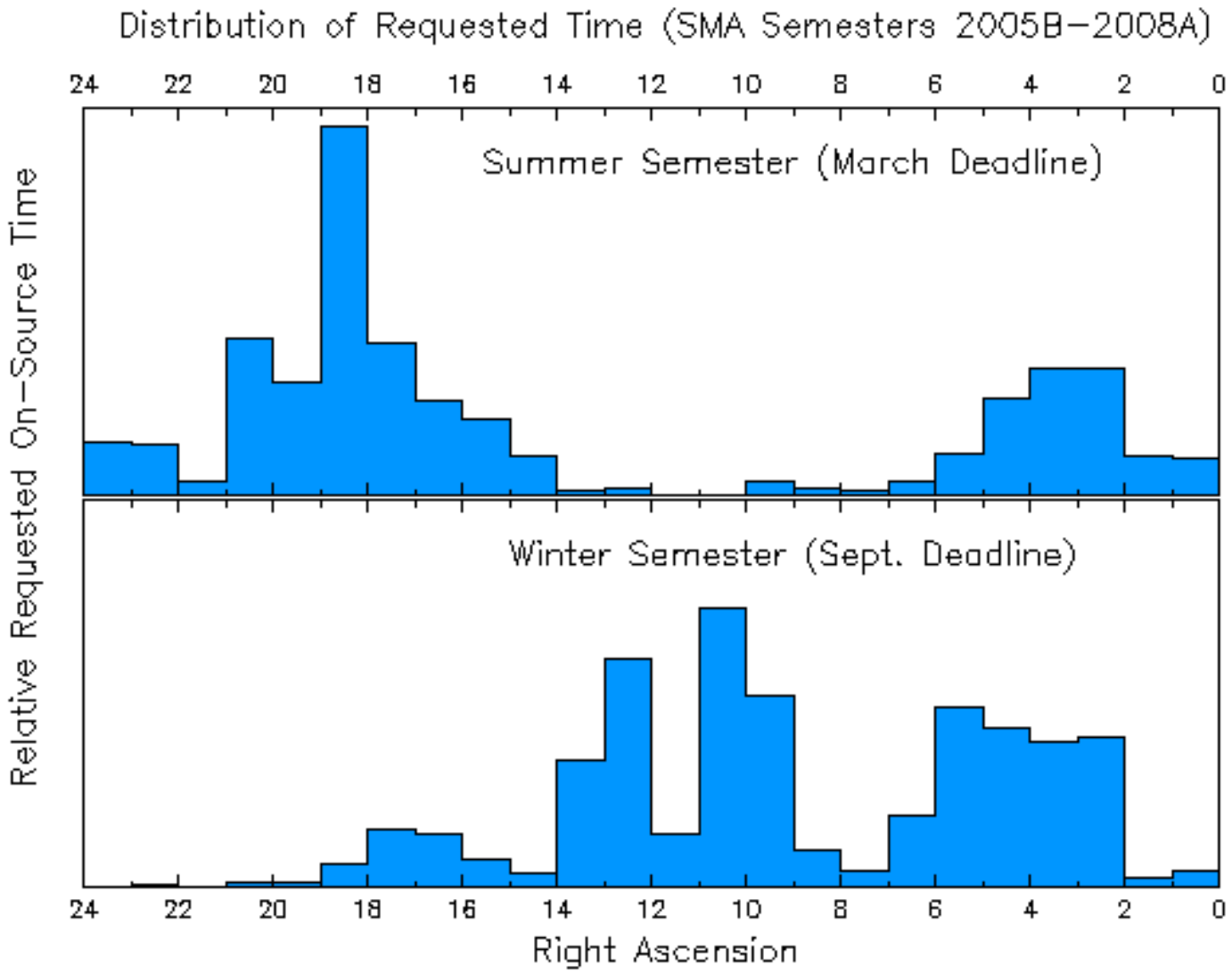
Submillimeter Windows



Proposal Statistics (through 2010B)



RA Coverage vs Semester



http://sma1.sma.hawaii.edu

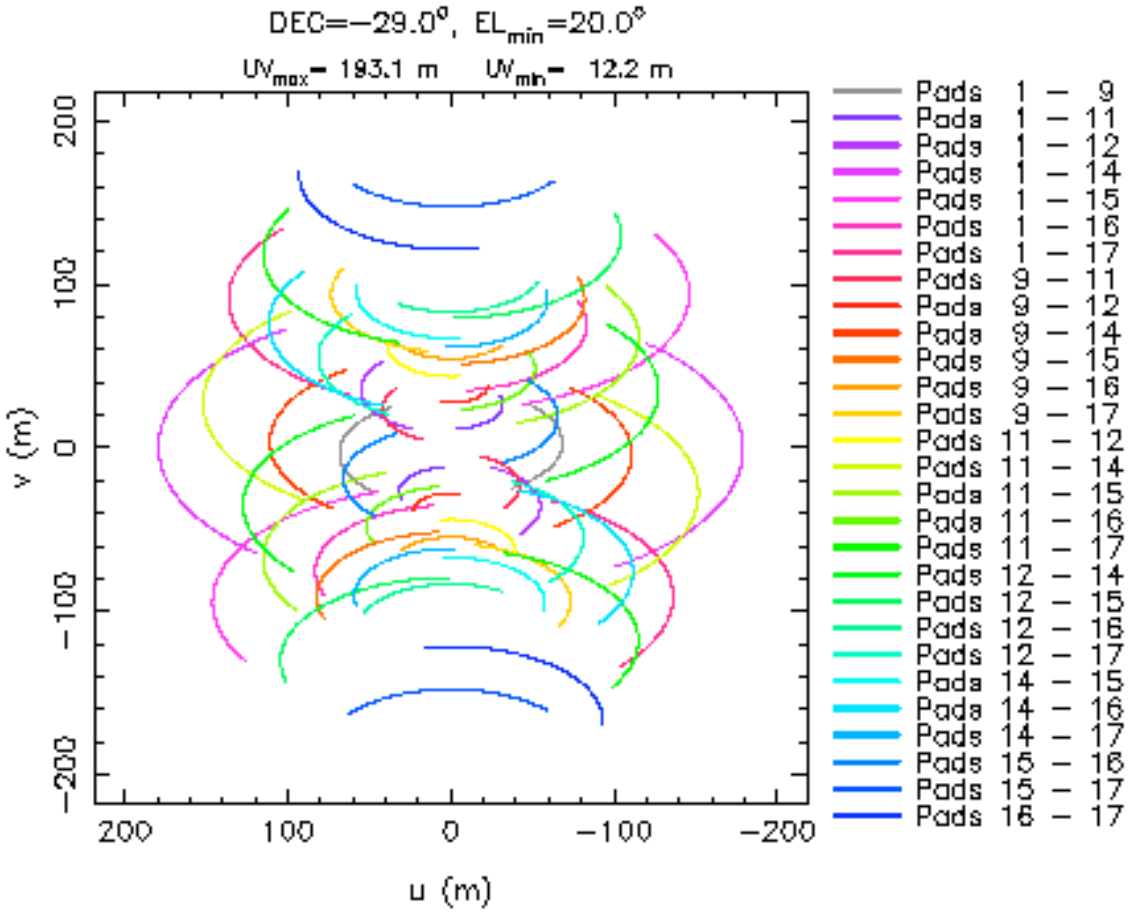
Call for Proposals
Technical Info.

Tools

User Account
Proposal Creation
Project Tracking


SMA Observer Center: Tools - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://sma1.sma.hawaii.edu/tools.html
SMA Observer Center: Tools
SMA Observer Center
Home
Proposing
Preparing to Observe
After Observing
Tools
Specs
Contact Us
Log In
Tools
Beam Calculator / Sensitivity Estimator
Planetary Visibility Function Calculator
Submillimeter Calibrator List
Passband Visualizer / Correlator Configuration Tool
System Temperature Calculator
SMA data archive search (at the CfA Radio Telescope Data Center)
Done

Beam Calculator/Sensitivity Estimator I



NOISE ESTIMATE (Natural Weights)

ν=345.8 GHz USB

η_{AP}=0.740 (dish σ_{RMS}=20 μm)

η_{MISC}=0.880

T_{RX}(DSB)=116.2 K

Precip. Water Vapor: 2.00 mm

$\tau_{225\ GHz}$=0.110 (model: am v3.6)

$\tau_{main\ sb}$= 0.372 $\tau_{image\ sb}$= 0.385

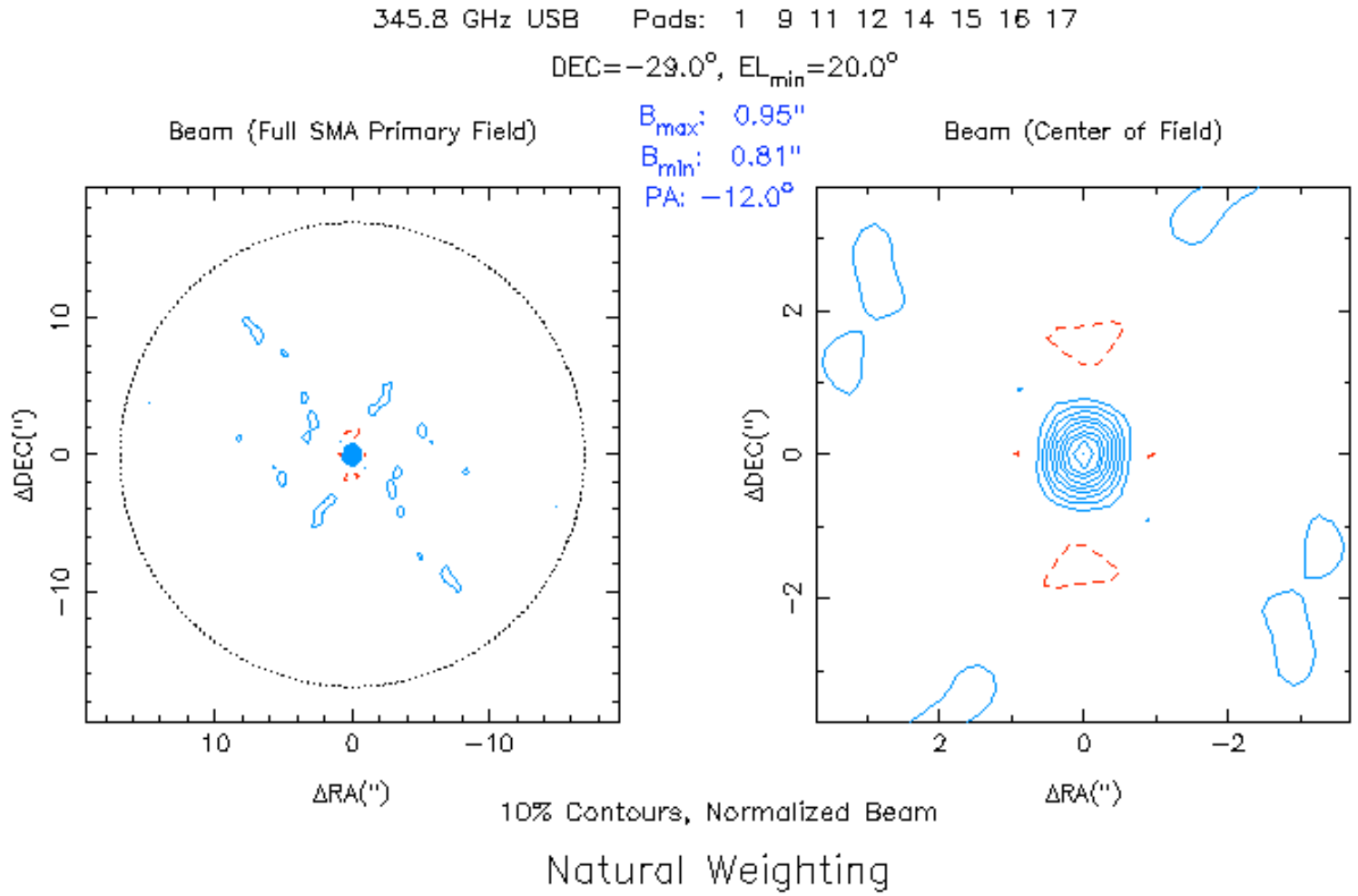
Transit T_{SYS}^{*}(SSB)= 828.6 K

On source int. time= 4.62 h

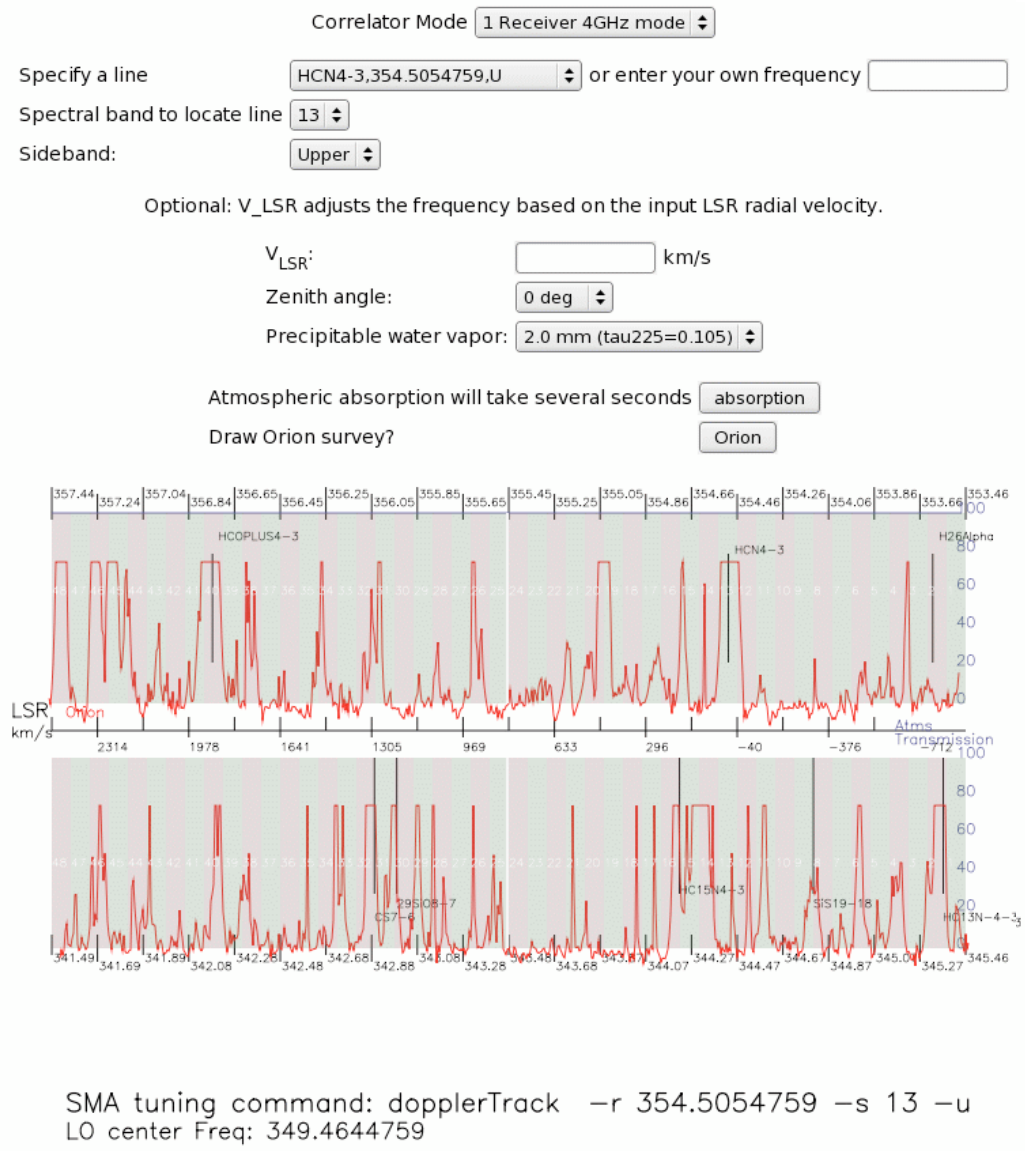
Beam size = 0.95" × 0.81"

BANDWIDTH	RMS NOISE/BEAM FLUX	T(RJ)
4 GHz	2.9 mJy	38.3 mK
2 GHz	3.9 mJy	51.1 mK
100 km/s	16.2 mJy	212.6 mK
1 km/s	161.5 mJy	2.13 K

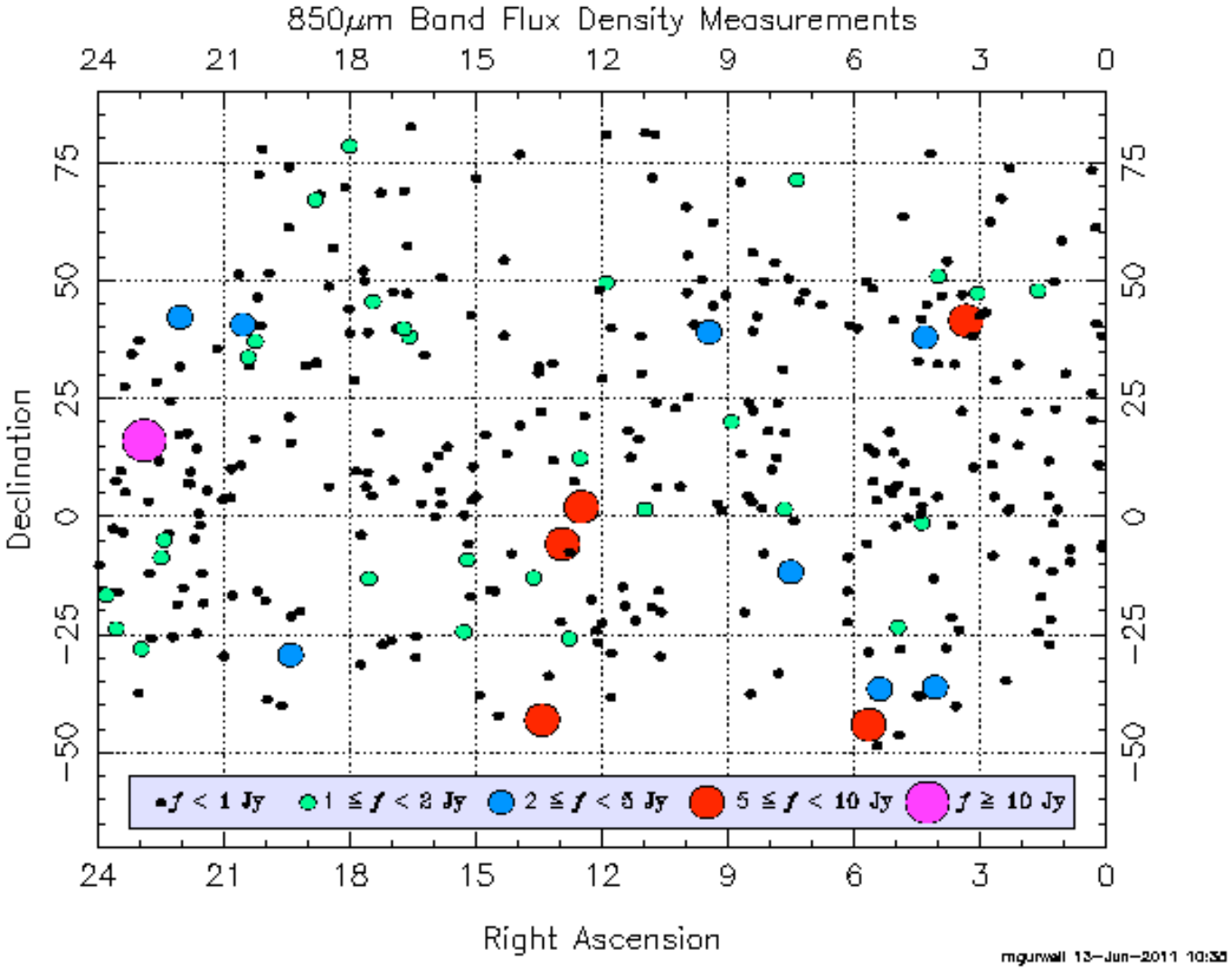
Beam Calculator/Sensitivity Estimator II

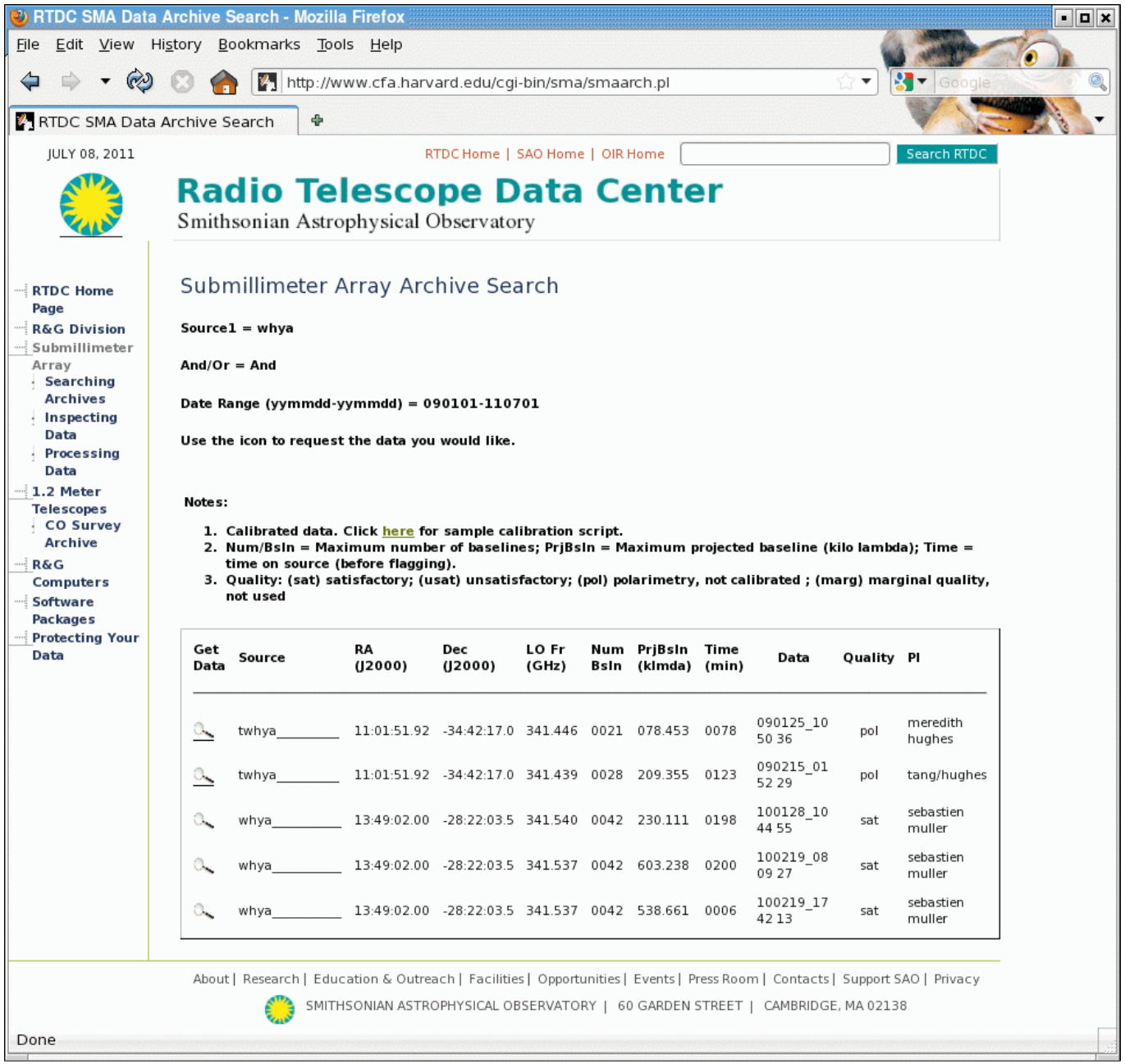


Passband Visualization



Calibrator Database




RTDC SMA Data Archive Search - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://www.cfa.harvard.edu/cgi-bin/sma/smaarch.pl
RTDC SMA Data Archive Search
JULY 08, 2011
RTDC Home | SAO Home | OIR Home
Search RTDC
Radio Telescope Data Center
Smithsonian Astrophysical Observatory
RTDC Home Page
R&G Division
Submillimeter Array
Searching Archives
Inspecting Data
Processing Data
1.2 Meter Telescopes
CO Survey Archive
R&G Computers
Software Packages
Protecting Your Data
Submillimeter Array Archive Search
Source1 = whya
And/Or = And
Date Range (yymmdd-yymmdd) = 090101-110701
Use the icon to request the data you would like.
Notes:
1. Calibrated data. Click here for sample calibration script.
2. Num/Bsln = Maximum number of baselines; PrjBsln = Maximum projected baseline (kilo lambda); Time = time on source (before flagging).
3. Quality: (sat) satisfactory; (usat) unsatisfactory; (pol) polarimetry, not calibrated ; (marg) marginal quality, not used
Get Data | Source | RA (J2000) | Dec (J2000) | LO Fr (GHz) | Num Bsln | PrjBsln (klmda) | Time (min) | Data | Quality | PI
twhya | 11:01:51.92 | -34:42:17.0 | 341.446 | 0021 | 078.453 | 0078 | 090125_10 50 36 | pol | meredith hughes
twhya | 11:01:51.92 | -34:42:17.0 | 341.439 | 0028 | 209.355 | 0123 | 090215_01 52 29 | pol | tang/hughes
whya | 13:49:02.00 | -28:22:03.5 | 341.540 | 0042 | 230.111 | 0198 | 100128_10 44 55 | sat | sebastien muller
whya | 13:49:02.00 | -28:22:03.5 | 341.537 | 0042 | 603.238 | 0200 | 100219_08 09 27 | sat | sebastien muller
whya | 13:49:02.00 | -28:22:03.5 | 341.537 | 0042 | 538.661 | 0006 | 100219_17 42 13 | sat | sebastien muller
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SMITHSONIAN ASTROPHYSICAL OBSERVATORY | 60 GARDEN STREET | CAMBRIDGE, MA 02138
Done

How to Propose

•Propose via the web forms at the SMA Observer Center; requires an initial one-time registration and account creation which takes just a few minutes

•Proposal submission includes filling in detailed project time requests and a cover sheet, and uploading a science and technical justification (PDF; 2 pages text + 2 pages figures, tables, references)

• If you have any questions, or are interested in assistance and/or collaboration with an experienced SMA user please contact us at propose@sma.hawaii.edu

Proposing Starts Here

If You Need Help…
or just have a Question

Questions regarding proposal feasibility and preparation, potential collaboration or technical help? Questions regarding the SMA Observer Center, problems with tools or proposal submission?

Contact us at propose@sma.hawaii.edu

We are available to provide advice and help

http://sma1.sma.hawaii.edu

Proposal Deadline: 14 Sep 2011


SMITHSONIAN ASTROPHYSICAL OBSERVATORY
SMA
ACADEMIA SINICA IAA

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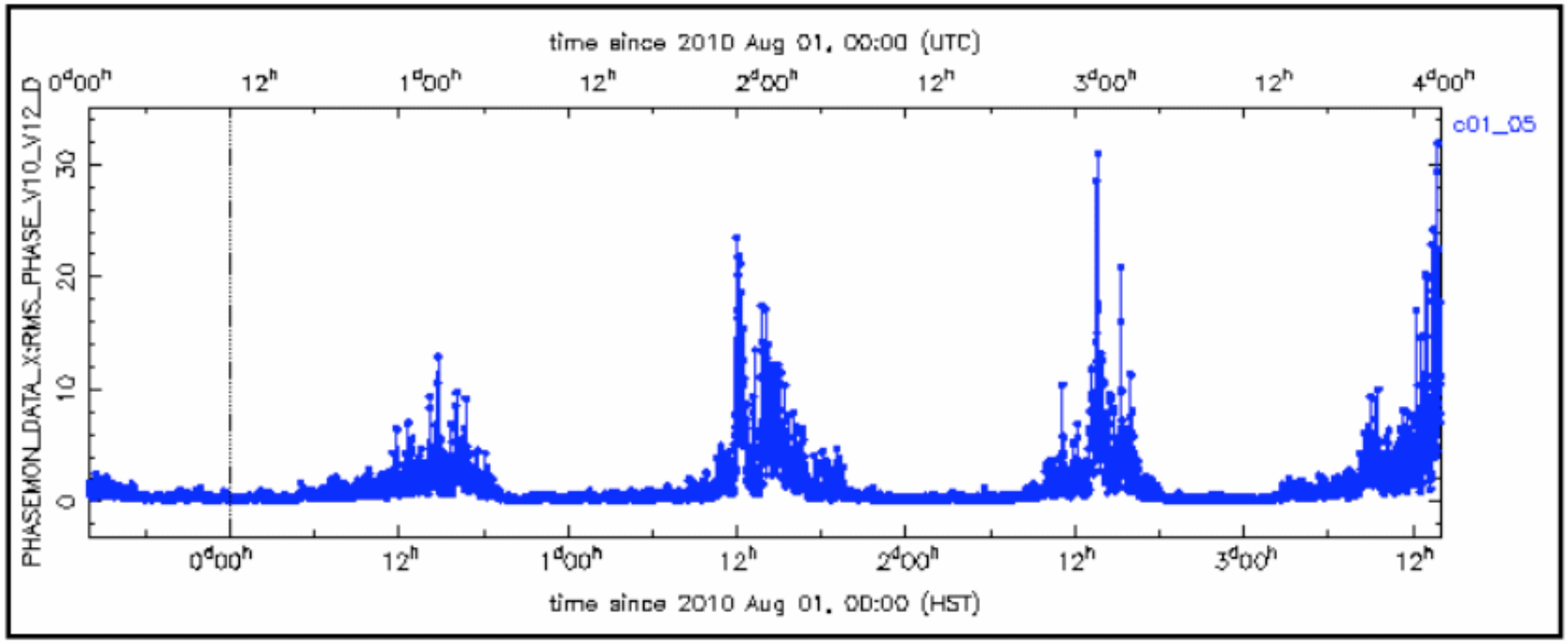
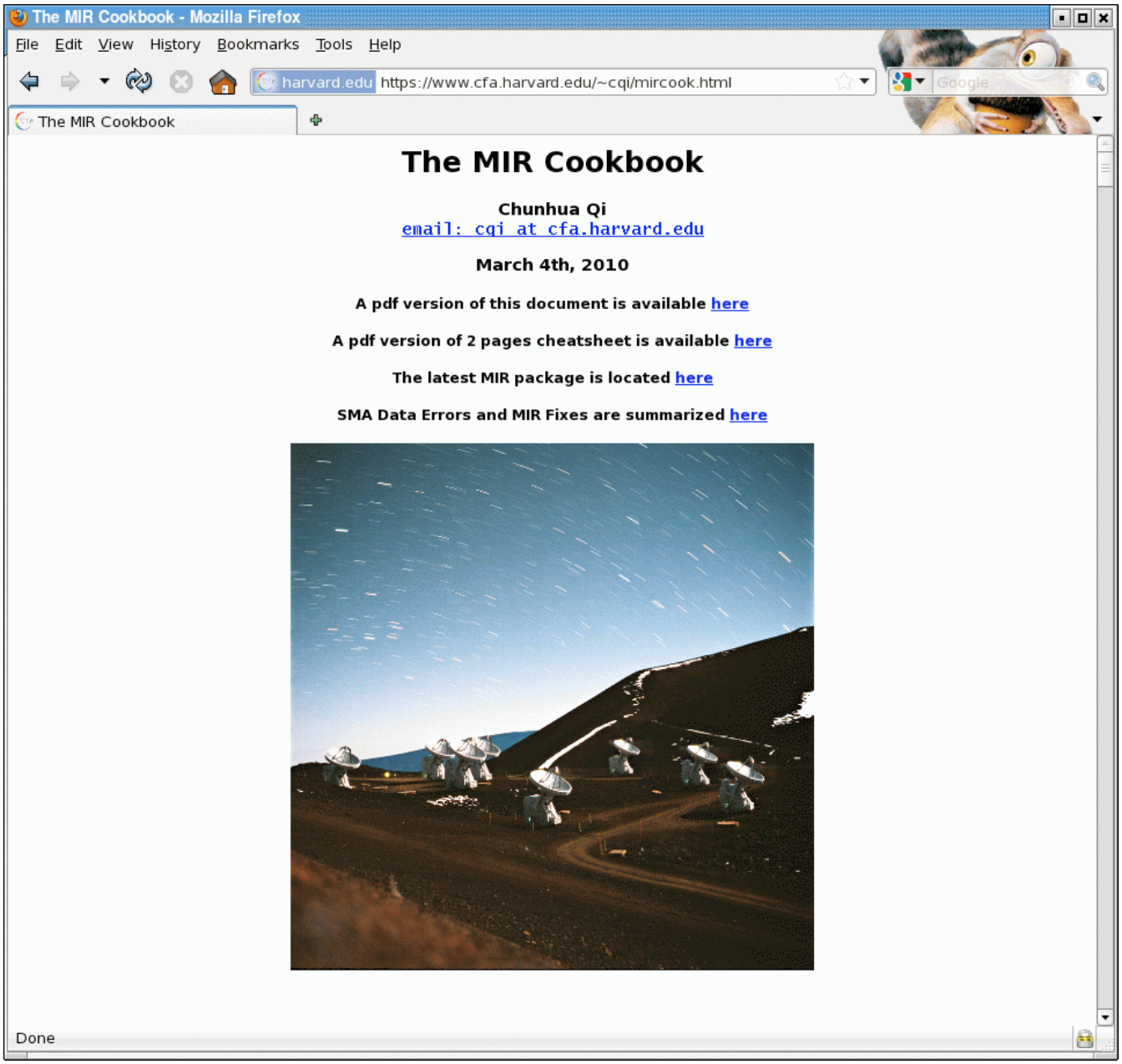
why night is better



Typical diurnal atmospheric phase noise variation over 4 days



The MIR Cookbook

Chunhua Qi
email: cqi at cfa.harvard.edu

March 4th, 2010

A pdf version of this document is available here

A pdf version of 2 pages cheatsheet is available here

The latest MIR package is located here

SMA Data Errors and MIR Fixes are summarized here