ALMA cycle 7 proposal

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Based on Alma-cycle-7-technical handbook

Call cycle 7

- The Cycle 7 proposal submission deadline is:

  15:00 UT on April 17, 2019
- **https://almascience.eso.org/proposing/call-for-proposals**

- About 4300 hours of 12-m Array time and 3750 hours of ACA From Oct. 2019 to Sept. 2020. This includes uncompleted grade A
- Grade A (33%) and B (67%). Grade C (50% to ensure adequate number of project)
- 22.5% for East Asia (EA);
- 33.75% for Europe (EU);
- 33.75% for North America (NA);
- 10% for Chile. (special policy)

Call cycle 7

- Any user has access to:
- User registration;
- The Call for Proposals and related documents and tools;
- Download of the Observing Tool (OT);
- Helpdesk “knowledgebase” articles listing solutions to common questions and problems;
- Archive access to non-proprietary data;
- All official ALMA user documentation and some software tools, including the ALMA Sensitivity Calculator, observing simulators, the ALMA spectral line database Splatalogue, etc.
- Helpdesk Ticket

- Access SnooPI, the tool for PIs to monitor their projects :
- **https://almascience.eso.org/observing/snoopi**

Five Science Categories

- 1. Cosmology and the high redshift universe
- 2. Galaxies and galactic nuclei
- 3. ISM, star formation and astrochemistry
- 4. Circumstellar disks, exoplanets and the solar system
- 5. Stellar evolution and the Sun

Cycle 7 Capabilities (I)

- At least 43x12m + 10*7m + 3xTP(line only, B3-8)
- Receiver bands 3, 4, 5, 6, 7, 8, 9, & 10 (wavelengths of about 3.1, 2.1, 1.6, 1.3, 0.87, 0.74, 0.44, 0.35 mm, respectively).
- Baselines up to 16.2 km for Bands 3, 4, 5, 6 and 7
- Baselines up to 3.6 km for Bands 8, 9 and 10.
- Baseline > 3.6 (C43-7 to C43-10) : long baseline configuration Include more frequent calibrations.
- Spectral line (< 5 tuning/band), Continuum and mosaic : B3-9 for 12m and 7m array
- Single-Dish spectral line : B3-B8
- Linear Polarization: B3-B7 on the 12m array
- Large Program

Cycle 7 Capabilities (II)

- Linear Polarization : 0.1% (3σ) - Ds/HPBW<0.33, continuum/line in B3,4,5,6,7 on 12m.
- Mixed correlator modes (both high and low frequency resolution in the same observation).
- Multi-source : < 10° (1° for long baseline) – < 150 pointing
- The maximum observing time per proposal, as estimated by the OT, is 50 hours (150h for ACA) – typical proposal ~7h (2-12h)
- Allowed Array Combinations and Time Multipliers (see table A-2)
- VLBI : 3mm and 1 mm

Non-Standard observing modes

Table 3: List of non-standard modes

Bands 9 and 10 observations
Band 7 observations with maximum baselines > 5 km if a suitable phase calibrator is not available within 5 degrees of the science target[1]
All polarization observations
Bandwidth switching projects (having less than 937.5 MHz aggregate bandwidths over all spectral windows)
Solar observations (Bands 3, 6 and 7)
VLBI observations
User-specified calibrations
Astrometric observations

Regular proposal

- **Regular proposal** : may request up to 50 hours of 12m array or 150 hours ACA in stand-alone.

- **Time constraints (TC)** :
- no restriction of time constraints
- Obs. of two 12m array config. within SG, are not allowed to have TC
- Obs. Of one 12m array config and ACA are allowed to have TC if requested (simultaneity in the 12m and 7m array)

- Program > 2h of obs. continuity cannot be guaranteed due to weather conditions and system interruptions. It can be asked, but if it fails, it will not be repeated.

Cycle 6 submitted Proposal and acceptance rate

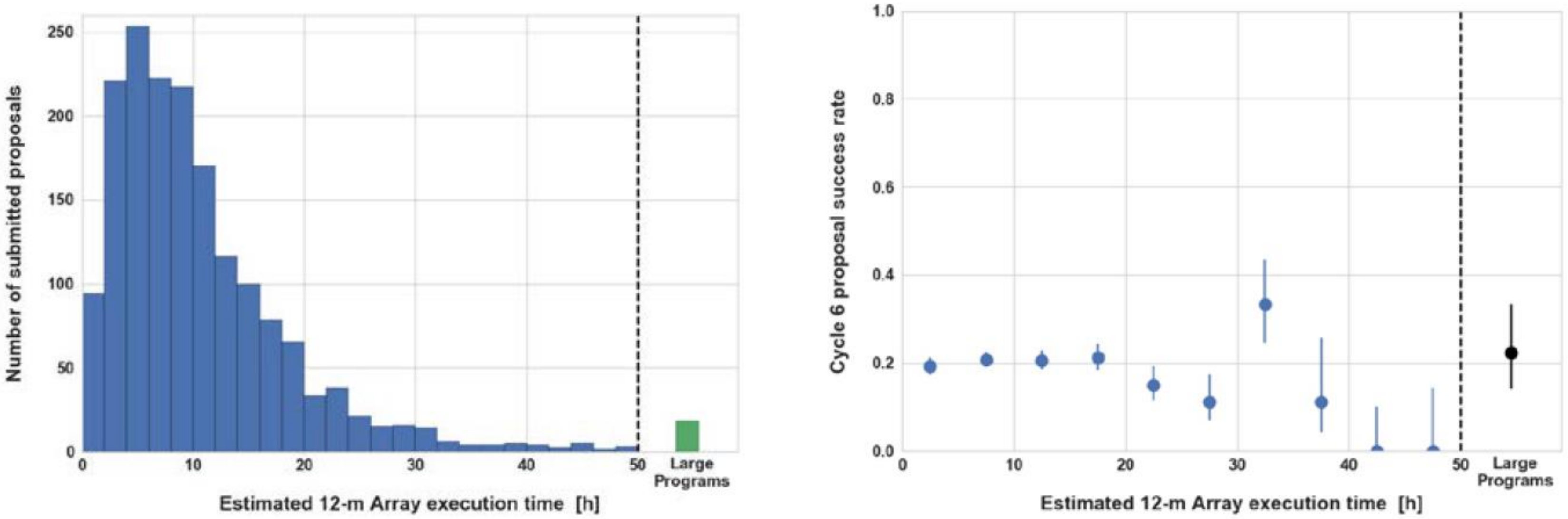


Figure 1: (Left) Number of proposals submitted as a function of the 12-m Array execution time in Cycle 6. (Right) The fraction of proposals (with 1σ confidence intervals) that are assigned priority Grade A or B as a function of the estimated 12-m Array time.

Large program evaluation

- The primary criteria to rank all proposals is the **overall scientific merit** of the proposed investigation and its potential contribution to the advancement of scientific knowledge.

- A Large Proposal in particular should address **strategic scientific issues** leading to **a breakthrough in the field**. Given the significant investment of ALMA resources, the rank of Large Proposals will also be based on the following criteria:

- **Technical feasibility** : fully justify the sensitivity, correlator setup, imaging requirements. Consistent with observatory best practices unless justified in the proposal.
- **Scheduling feasibility** : LP to be completed within Cycle 4 given the the configuration schedule.

- **Data products** : should describe the data products that will be produced to achieve their science goals. Expected to deliver these data products to the ARCs ➔ available to the community at large.

- **Management plan**: describes a schedule of work, roles of the proposal team, and a plan to disseminate the results.

Large program

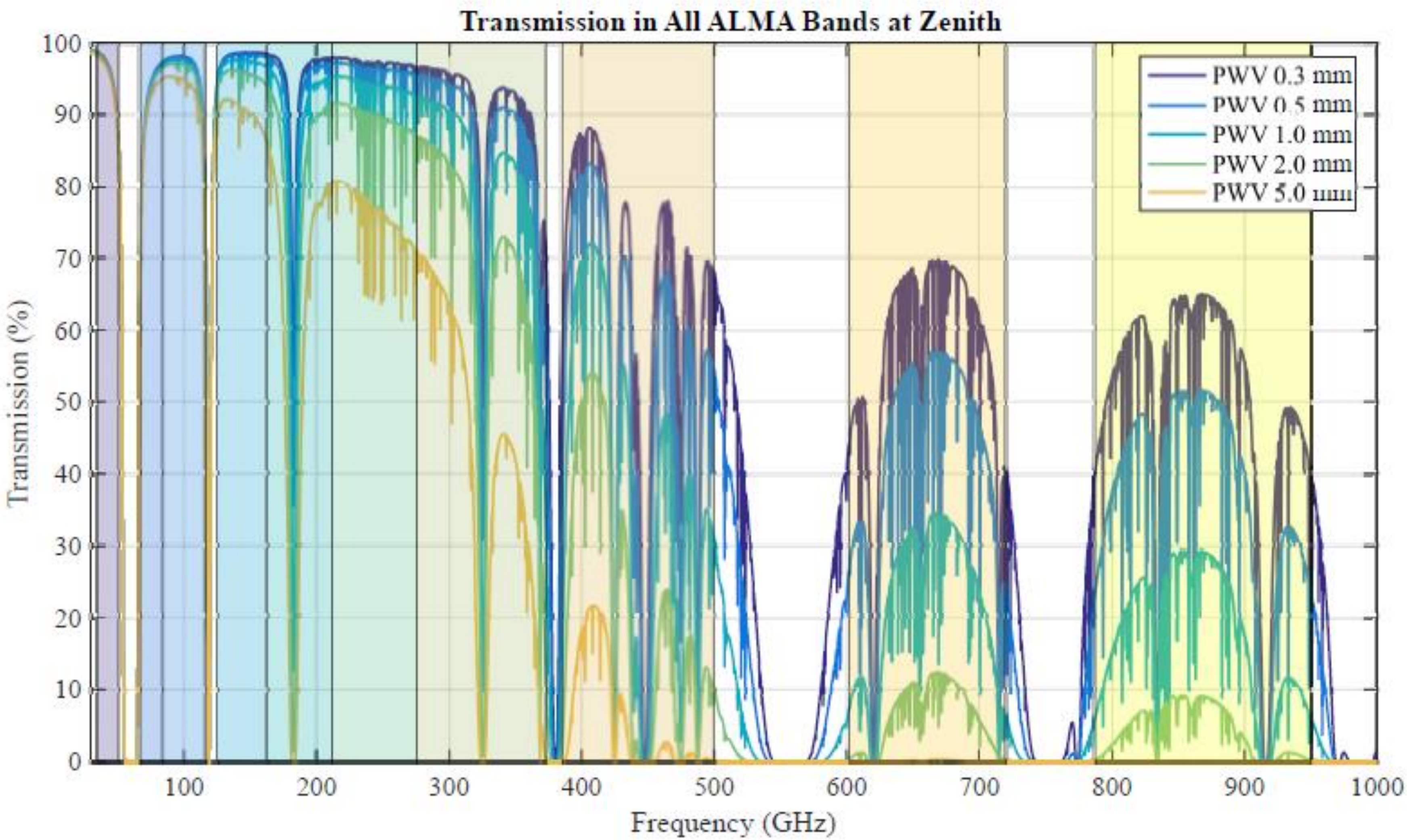
- **Large Programs** (LP) : to address breakthrough in the field and or strategic scientific issues that cannot be addressed with a series of smaller proposals. > 50 hours of 12m array or > 150 hours ACA in stand-alone.

- Up to 15% of the available time will be allocated to Large Proposals (i.e. 600h of 12m and 450h of ACA). Proprietary time 1year ; may have co-PIs

- Request time < 33% /LST range / baseline cfg > 12km
- Request time < 50% /LST range/ baseline cfg < 12km

→**LP mainly seems more suited for multi-sources**

Atmospheric windows



Weather statistics

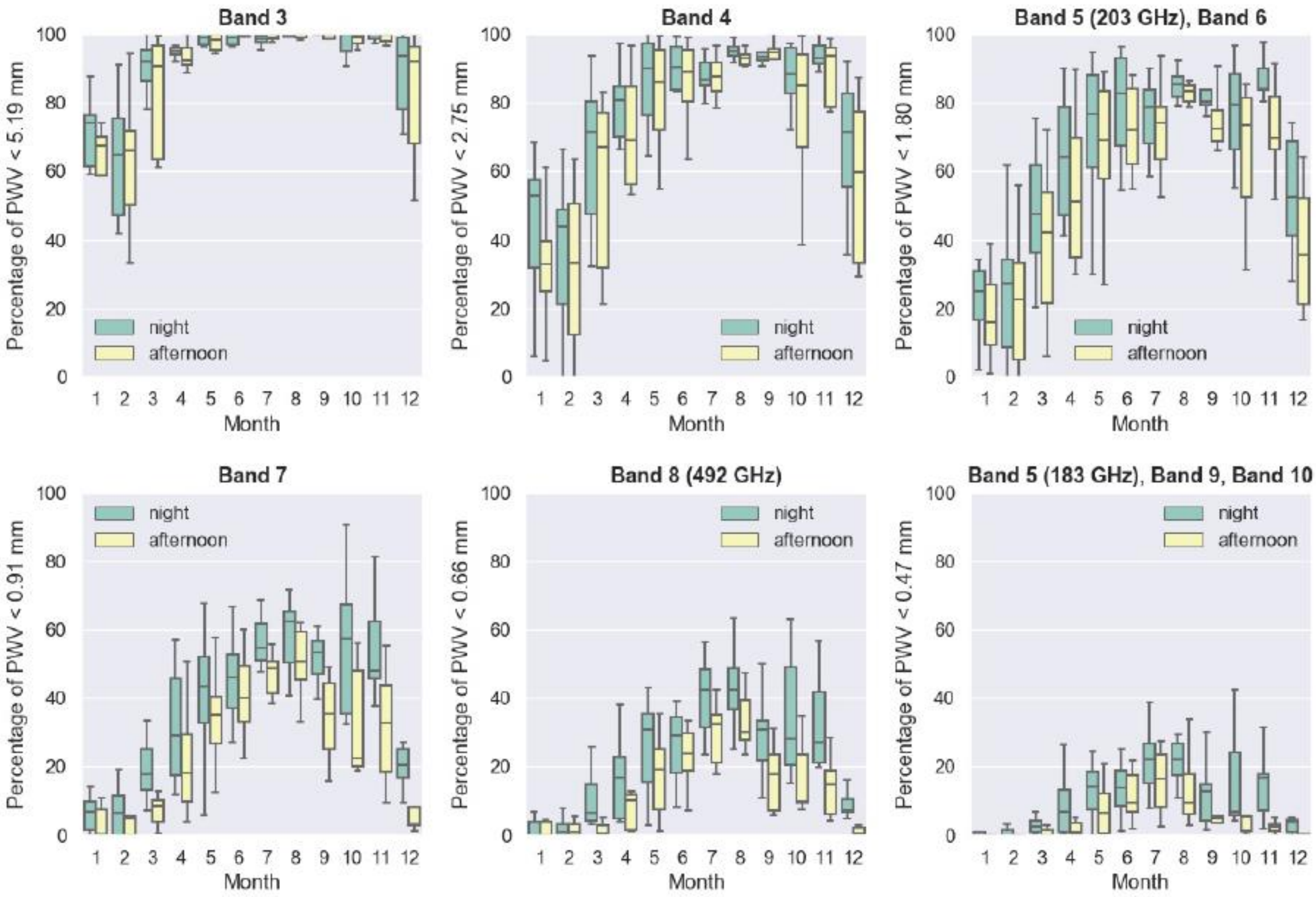


Figure 3: The percentage of time when the PWV is below the observing thresholds adopted for the various ALMA bands for night-time (green) and afternoon (yellow) and for an elevation of 60 degrees. The horizontal line within the box indicates the median. Boundaries of the box indicate the 25th- and 75th-percentile, and the whiskers indicate the highest and lowest values of the results. The data were obtained with the APEX weather station, ALMA measurements, and weather forecast data between September 2010 and February 2019.

Weather statistics

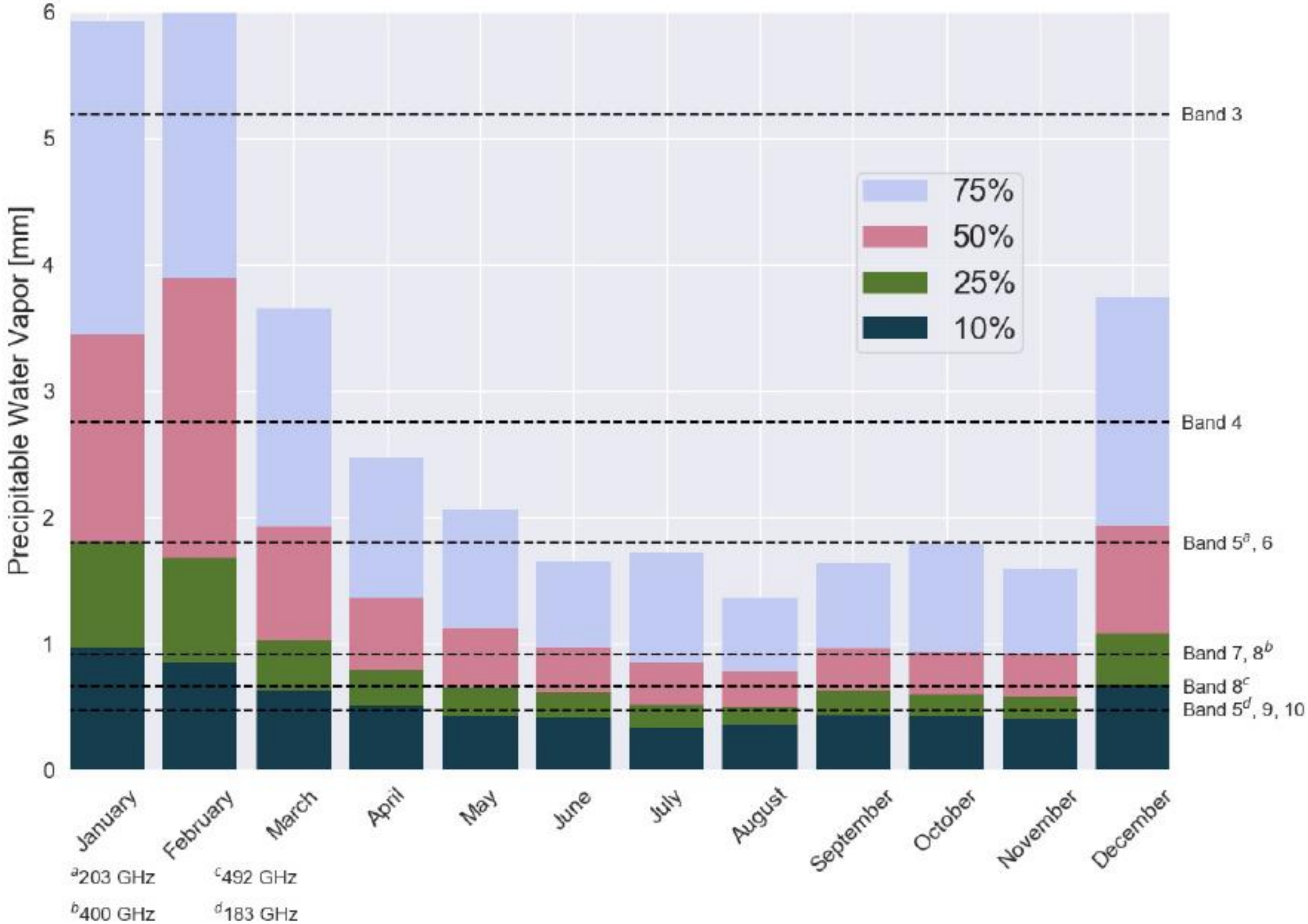


Figure 2: Fraction of time that the PWV falls below a given value along the year. The percentages shown indicate the fraction of time that the PWV is under the PWV value indicated on the y-axis. For example, in March 75% of the PWV measurements are under 3.6 mm, and in June 75% of the PWV measurements fall below 1.6 mm. The data were obtained with the APEX weather station, ALMA measurements, and weather forecast data between September 2010 and February 2019. The horizontal dashed lines show the PWV observing limits adopted for the ALMA bands for an elevation of 60 degrees.

Observing Pressure

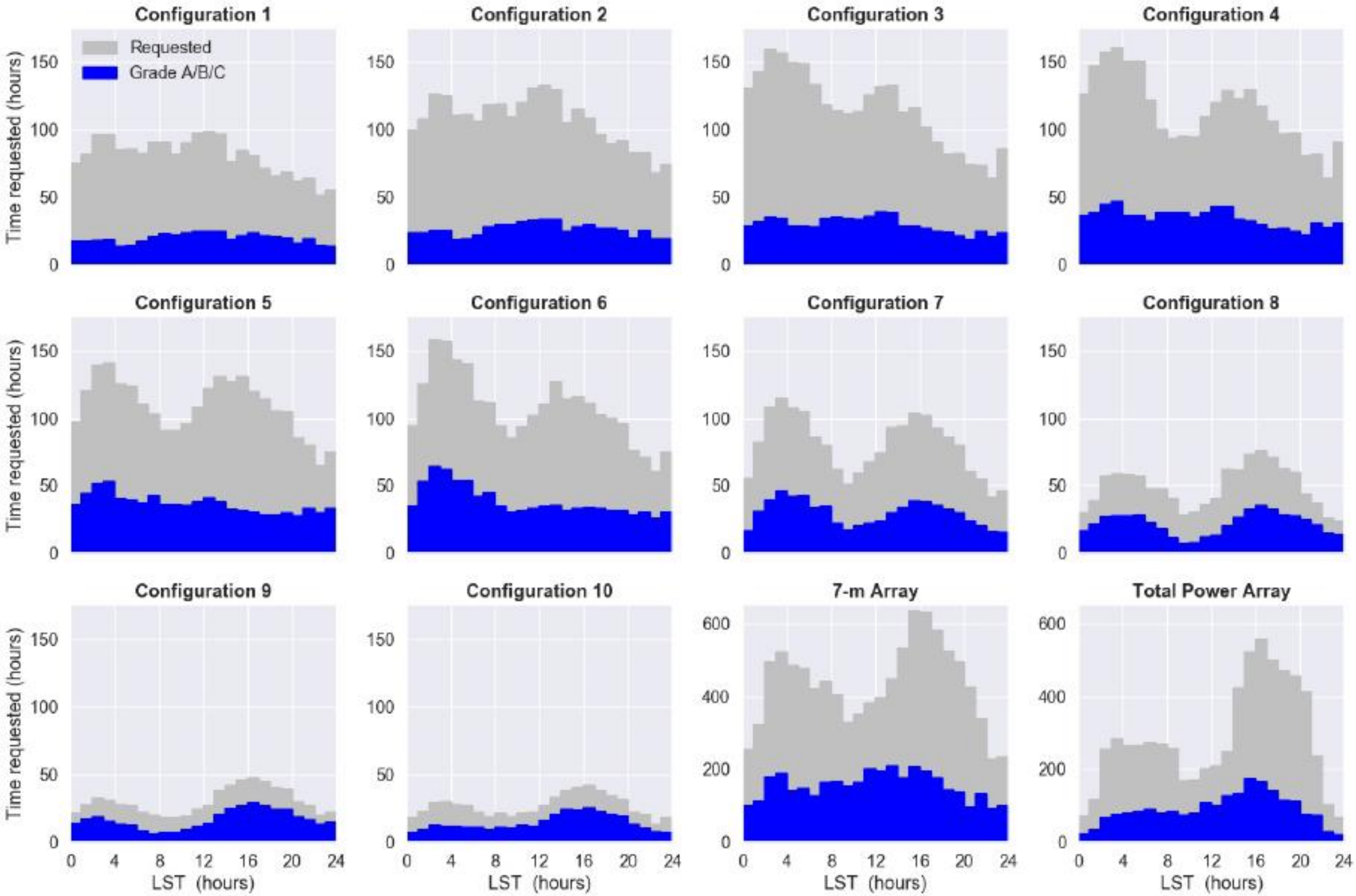
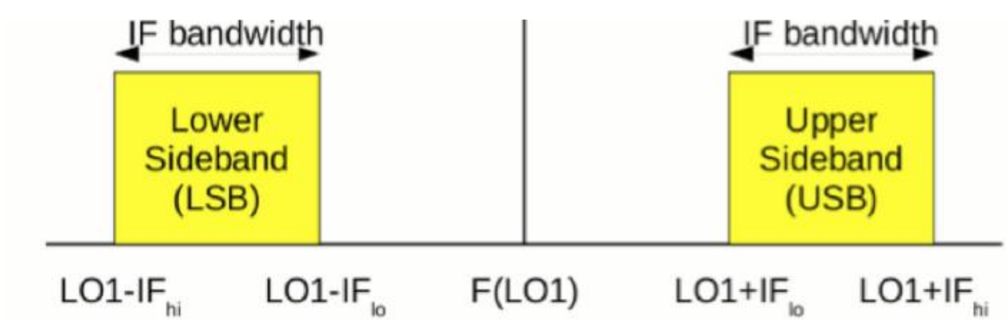


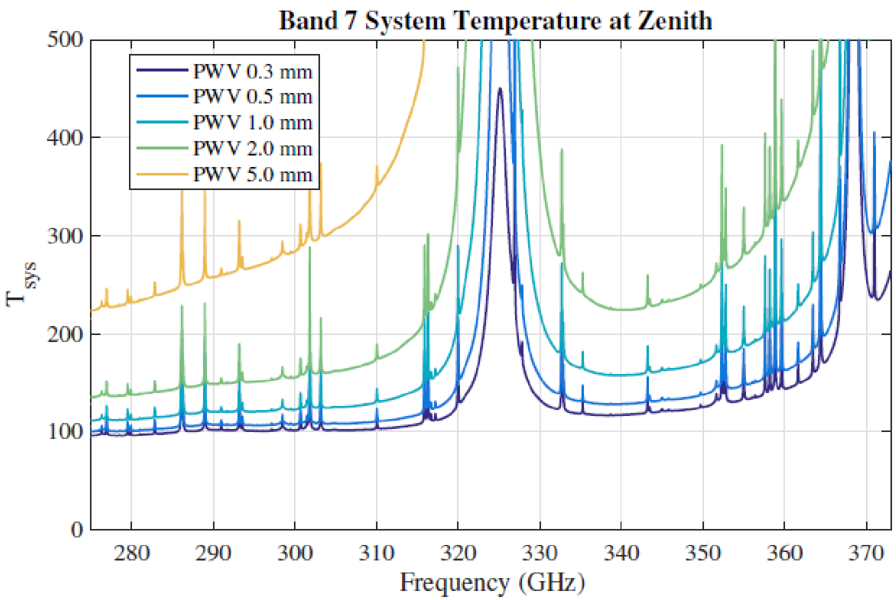
Figure 5: Distribution of estimated execution time in Cycle 6 proposals for all submitted proposals (gray) and proposals assigned Grade A, B, or C (blue). The figure does not include the unfinished Cycle 5 Grade A proposals carried over to Cycle 6.

Receivers

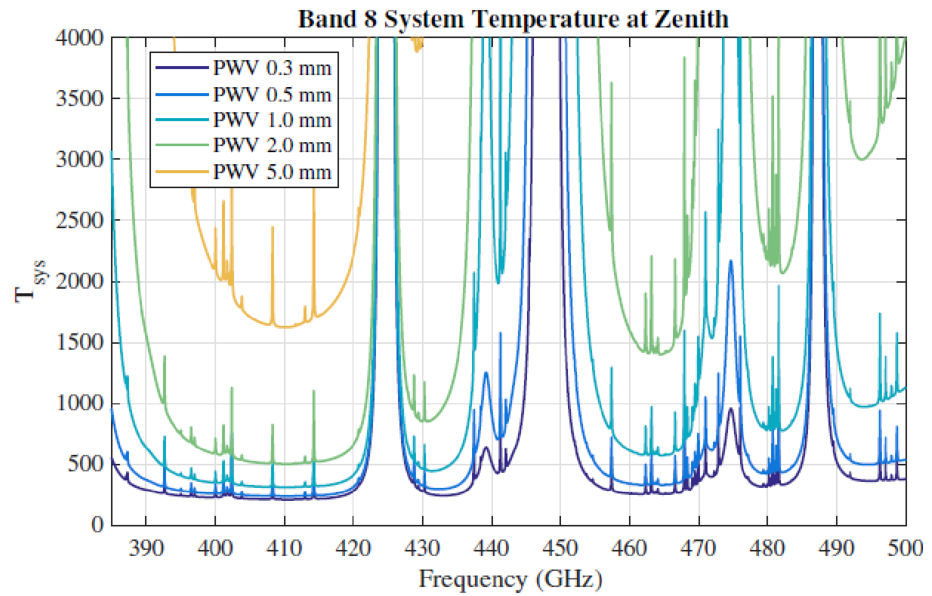
Band	Frequency/ Wavelength range (GHz)[1]/(mm)	LO range (GHz)	Sideband mode[2]	IF range (GHz)	Inst. IF bandw. (GHz)[4]	T_{rx} over 80% of band (K)[6]	T_{rx} at any frq. (K)[6]	TSYS(K)
3	84.0 - 116.0/ 2.59 - 3.57	92 - 108	2SB	4–8	7.5	<39[7]	<43[7]	70-120
4	125.0 - 163.0/ 1.84 - 2.40	133 - 155	2SB	4–8	7.5	<51	<82	80-140
5	158.0 - 211.0/ 1.42 - 1.90	166 - 203	2SB	4–8	7.5	<55	<75	50-200
6	211.0 - 275.0/ 1.09 - 1.42	221 - 265	2SB	4.5–10[3]	7.5	<83	<136	100-120
7	275.0 - 373.0/ 0.80 - 1.09	283 - 365	2SB	4–8	7.5	<147	<219	130-160
8	385.0 - 500.0/ 0.60 - 0.78	393 - 492	2SB	4–8	7.5	<196	<292	500
9	602.0 - 720.0/ 0.42 - 0.50	610 - 712	DSB	4–12	7.5(15)[5]	<175 (DSB)	<261 (DSB)	800
10	787.0 - 950.0/ 0.32 - 0.38	795 - 942	DSB	4–12	7.5(15)[5]	<230[8] (DSB)	<344 (DSB)	1-2000



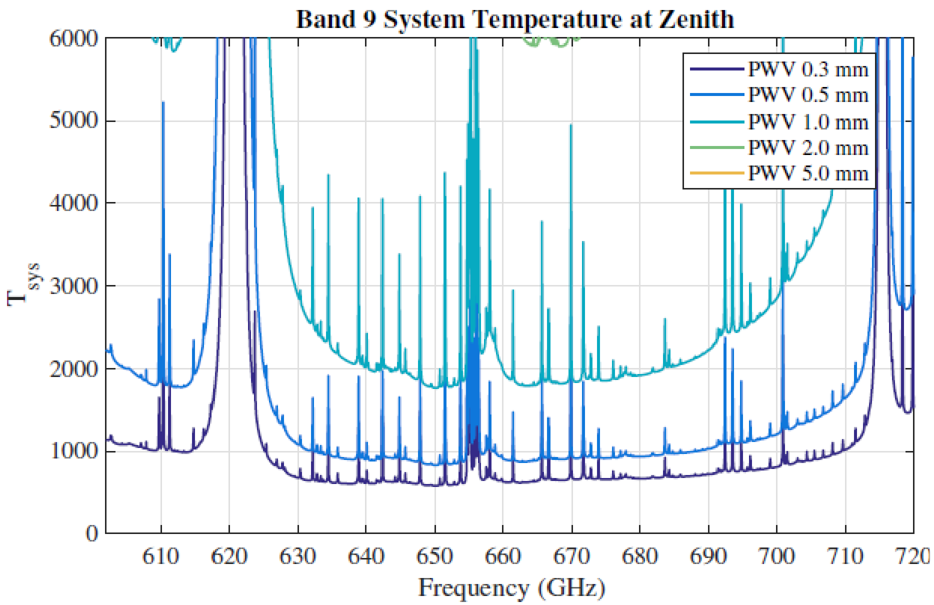
Tsys (B7-B10)



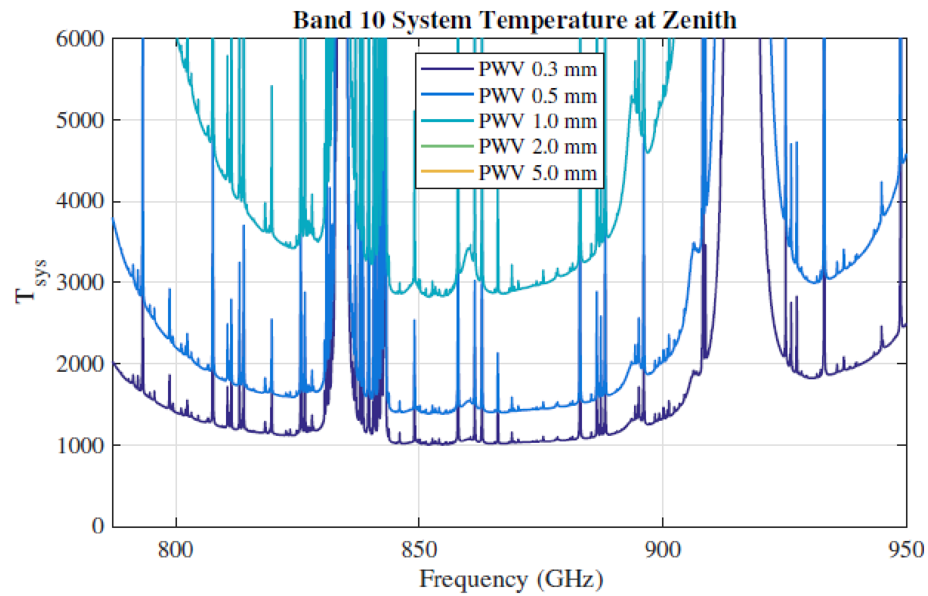
Band 7 System Temperature at Zenith
PWV 0.3 mm
PWV 0.5 mm
PWV 1.0 mm
PWV 2.0 mm
PWV 5.0 mm
T sys
Frequency (GHz)



Band 8 System Temperature at Zenith
PWV 0.3 mm
PWV 0.5 mm
PWV 1.0 mm
PWV 2.0 mm
PWV 5.0 mm
T sys
Frequency (GHz)



Band 9 System Temperature at Zenith
PWV 0.3 mm
PWV 0.5 mm
PWV 1.0 mm
PWV 2.0 mm
PWV 5.0 mm
T sys
Frequency (GHz)



Band 10 System Temperature at Zenith
PWV 0.3 mm
PWV 0.5 mm
PWV 1.0 mm
PWV 2.0 mm
PWV 5.0 mm
T sys
Frequency (GHz)

Tuning example (I)

Band/setup	Species/transition	Freq. (GHz)	Sideb.	bandwidth	BB	spws	Notes
3 a	**Standard cont.**	97.5[1]	dual	TDM			LO1=97.5
3 b *	HCO^+ (1-0)	89.188	LSB	58 MHz	1	1	HCO^+/HCN/H_2CO
-	HCN (1-0)	88.632	LSB	58 MHz	2	1	
-	CH_3OH (7(-2,6)-7(1,6))	101.293	USB	125 MHz	3	1	
	H_2CO (6(1,5)-6(1,6))	101.333	USB	125 MHz	3	1	
-	continuum spws	101.3	USB	TDM	4	1	
3 c *	CO (1-0)	115.271	USB	58 MHz	1	1	CO/CN/$C^{17}O$
-	CN (N=1-0)	113.499	USB	58 MHz	1	2	
-	$C^{17}O$ (1-0)	112.359	USB	117 MHz	2	1	
-	continuum spws	102.5	LSB	TDM	3	1	
-	continuum spws	100.5	LSB	TDM	4	1	
4 a	**Standard cont.**	145.0[1]	dual	TDM			LO1=145.0
4 b	CS (3-2)	146.969	LSB	117 MHz	1	1	CS/DCO^+
-	DCO^+ (2-1)	144.077	LSB	117 MHz	2	1	
-	SO2 (4(2,2)-4(1,3))	146.605	LSB	117 MHz	3	1	
-	H_2CO (2(0,2)-1(0,1))	145.603	LSB	117 MHz	4	1	
5 a	**Standard cont.**	203.0	dual	TDM			LO1=203.0
5 b	H_2O (3(1,3)-2(2,0))	183.31	USB	250 MHz	1	1	
-	continuum spws	181.4	USB	TDM	2	1	
-	H_2S (1(1,0)-1(0,1))	168.763	LSB	250 MHz	3	1	
-	continuum spws	170.8	LSB	TDM	4	1	
6 a	**Standard cont.**	233.0[1]	dual	TDM			LO1=233.0
6 b *	^{12}CO (2-1)	230.538	USB	937 MHz	1	1	J=2-1 CO isotopes
-	continuum spws	234.0	USB	TDM	2	1	
-	$C^{18}O$ (2-1)	219.560	LSB	937 MHz	3	1	
-	^{13}CO (2-1)	220.399	LSB	937 MHz	3	2	
-	continuum spws	216.5	LSB	TDM	4	1	

Tuning example (II)

7 a	**Standard cont.**	343.5[1]	dual	TDM			LO1=343.5
7 b *	continuum spws	343.0	LSB	TDM	1	1	$CO/HCO^+/HCN$
-	^{12}CO (3-2)	345.796	LSB	469 MHz	2	1	1/2-corr
-	$HC^{15}N$ (4-3)	344.200	LSB	234 MHz	2	2	1/4-corr
-	$H^{13}CN$ (4-3)	345.340	LSB	234 MHz	2	3	1/4-corr
-	HCN (4-3)	354.505	USB	469 MHz	3	1	
-	HCO^+ (4-3)	356.734	USB	117 MHz	4	1	1/4-corr
-	NHD_2 (2(2,0)-2(1,2))	356.230	USB	234 MHz	4	2	1/2-corr
7 c	^{12}CO (3-2)	345.796	USB	58 MHz	1	1	J=3-2 $CO/^{13}CO$
-	continuum spws	344.8	USB	TDM	2	1	
-	^{13}CO (3-2)	330.588	LSB	58 MHz	3	1	
-	continuum spws	331.6	LSB	TDM	4	1	
8 a	**Standard cont.**	405.0[1]	dual	TDM			LO1=405.0
8 b	CI ($^3P_1$ - $^3P_0$)	492.160	USB	117 MHz	1	1	$CI/^{13}CI$
-	CS (10-9)	489.751	USB	117 MHz	2	1	
-	continuum spws	477.5	LSB	TDM	3	1	
-	continuum spws	479.5	LSB	TDM	4	1	
9 a	**Standard cont.**	679.0	USB	TDM			LO1=671.0
9 b	^{12}CO (6-5)	691.472	USB	469 MHz	1	1	CO/CS
-	CS (14-13)	685.436	USB	117 MHz	2	1	
-	H_2S (2(0,2)-1(1,1))	687.303	USB	234 MHz	3	1	
-	$C^{17}O$ (6-5)	674.009	LSB	469 MHz	4	1	
10 a	**Standard cont.**	875.0	USB	TDM			LO1=867.0
10 b *	CO (7-6)	806.652	LSB	469 MHz	1	1	CO/HCO^+
-	HCO^+ (9-8)	802.458	LSB	117 MHz	2	1	
-	continuum spws	805.5	USB	TDM	3	1	
-	continuum spws	803.65	USB	TDM	4	1	

Standard Continuum frequency

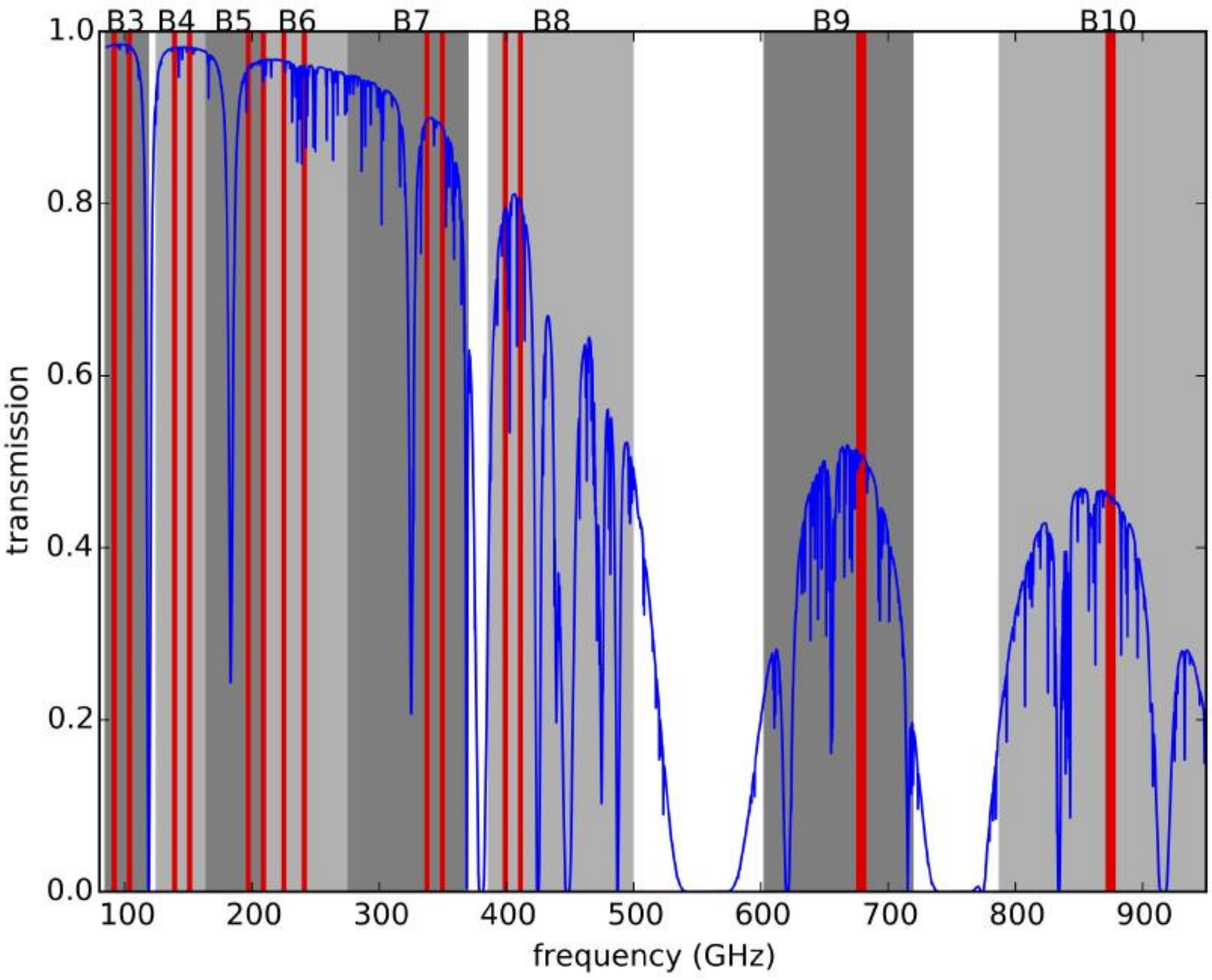


Figure 6.2: ALMA bands available in Cycle 7 (Bands 3 - 10), showing the frequency of the standard continuum settings as red shading. This gives the coverage of both USB and LSB, except for Bands 9 and 10, which have 8 GHz of bandwidth using the USB only. The available frequency coverage of each band is shown by the grey shading, and atmospheric transmission for 0.6 mm of PWV is given by the blue line.

Beams and short spacing (I)

- Single dish beam : HPBW = 1.13λ/D
- i.e. 8.5-17-25-39-58'' @ B9-B7-B6-B4-B3
- Synthesized beam : θs ~ λ/Bmax or better θs ~ 0.574λ/L80

L_{80} is the 80$^{\text{th}}$ percentile of the *uv*-distance in meters.

- Spatial filtering : Maximum recoverable scale (mrs) :
- θmrs = 0.6λ/Bmin or bette θmrs =0.983 λ/L05

L_5 is the 5$^{\text{th}}$ percentile of the *uv*-distance in meters.

Configuration	7-m	C43-1	C43-2	C43-3	C43-4	C43-5
Minimum baseline (m)	8.7	14.6	14.6	14.6	14.6	14.6
5th percentile or L05 (m)	9.1	21.4	27.0	37.6	54.1	90.9
80th percentile or L80 (m)	30.7	107.1	143.8	235.4	369.2	623.8
Maximum baseline (m)	45.0	160.7	313.7	500.2	783.5	1397.9
Configuration	C43-6	C43-7	C43-8	C43-9	C43-10	
Minimum baseline (m)	14.6	64.0	110.4	367.6	244.0	
5th percentile or L05 (m)	148.6	235.2	427.3	746.9	1228.1	
80th percentile or L80 (m)	1172.5	1673.1	3527.3	6482.6	8685.9	
Maximum baseline (m)	2516.9	3637.8	8547.7	13894.2	16194.0	

Beams and short spacing (II)

Table A-1: Angular Resolutions (AR) and Maximum Recoverable Scales (MRS) for the Cycle 7 Array configurations

Config	Lmax		Band 3	Band 4	Band 5	Band 6	Band 7	Band 8	Band 9	Band 10
	Lmin		100 GHz	150 GHz	183 GHz	230 GHz	345 GHz	460 GHz	650 GHz	870 GHz
7-m Array	45 m	AR	12.5″	8.4″	6.8″	5.4″	3.6″	2.7″	**1.9″**	**1.4″**
	9 m	MRS	66.7″	44.5″	36.1″	29.0″	19.3″	14.5″	**10.3″**	**7.7″**
C43-1	161 m	AR	3.4″	2.3″	1.8″	1.5″	1.0″	0.74″	**0.52″**	**0.39″**
	15 m	MRS	28.5″	19.0″	15.4″	12.4″	8.3″	6.2″	**4.4″**	**3.3″**
C43-2	314 m	AR	2.3″	1.5″	1.2″	1.0″	0.67″	0.50″	**0.35″**	**0.26″**
	15 m	MRS	22.6″	15.0″	12.2″	9.8″	6.5″	4.9″	**3.5″**	**2.6″**
C43-3	500 m	AR	1.4″	0.94″	0.77″	0.62″	0.41″	0.31″	**0.22″**	**0.16″**
	15 m	MRS	16.2″	10.8″	8.7″	7.0″	4.7″	3.5″	**2.5″**	**1.9″**
C43-4	784 m	AR	0.92″	0.61″	0.50″	0.40″	0.27″	0.20″	**0.14″**	**0.11″**
	15 m	MRS	11.2″	7.5″	6.1″	4.9″	3.3″	2.4″	**1.7″**	**1.3″**
C43-5	1.4 km	AR	0.54″	0.36″	0.30″	0.24″	0.16″	0.12″	**0.084″**	**0.063″**
	15 m	MRS	6.7″	4.5″	3.6″	2.9″	1.9″	1.5″	**1.0″**	**0.77″**
C43-6	2.5 km	AR	0.31″	0.20″	0.16″	0.13″	0.089″	0.067″	**0.047″**	**0.035″**
	15 m	MRS	4.1″	2.7″	2.2″	1.8″	1.2″	0.89″	**0.63″**	**0.47″**
C43-7	3.6 km	AR	0.21″	0.14″	0.11″	0.092″	0.061″	0.046″	**0.033″**	**0.024″**
	64 m	MRS	2.6″	1.7″	1.4″	1.1″	0.75″	0.56″	**0.40″**	**0.30″**
C43-8	8.5 km	AR	0.096″	0.064″	0.052″	0.042″	0.028″	N/A	N/A	N/A
	110 m	MRS	1.4″	0.95″	0.77″	0.62″	0.41″			
C43-9	13.9 km	AR	0.057″	0.038″	0.031″	0.025″	0.017″	N/A	N/A	N/A
	368 m	MRS	0.81″	0.54″	0.44″	0.35″	0.24″			
C43-10	16.2 km	AR	0.042″	0.028″	0.023″	0.018″	0.012″	N/A	N/A	N/A
	244 m	MRS	0.50″	0.33″	0.27″	0.22″	0.14″			

Non-standard modes

Table 4: Planned 12-m Array Configuration Schedule for Cycle 7

Start date	Configuration	Longest baseline	LST for best observing conditions
2019 October 1	C43-4	0.78 km	~ 22—10 h
2019 October 20	C43-3	0.50 km	~ 23—11 h
2019 November 10	C43-2	0.31 km	~ 1—13 h
2019 November 30	C43-1	0.16 km	~ 2—14 h
2019 December 20	C43-2	0.31 km	~ 4—15 h
2020 January 10	C43-3	0.50 km	~ 5—17 h
2020 February 1	*No observations due to maintenance*		
2020 March 1	C43-4	0.78 km	~ 8—21 h
2020 March 20	C43-5	1.4 km	~ 9—23 h
2020 April 20	C43-6	2.5 km	~ 11—1 h
2020 May 20	C43-7	3.6 km	~ 13—3 h
2020 June 20	C43-8	8.5 km	~ 15—5 h
2020 July 11	C43-9	13.9 km	~16—6 h
2020 July 30	C43-10	16.2 km	~17—7 h
2020 August 20	C43-9	13.9 km	~19—8 h
2020 September 10	C43-8	8.5 km	~20—9 h

Source observability constraints

Weather statistics

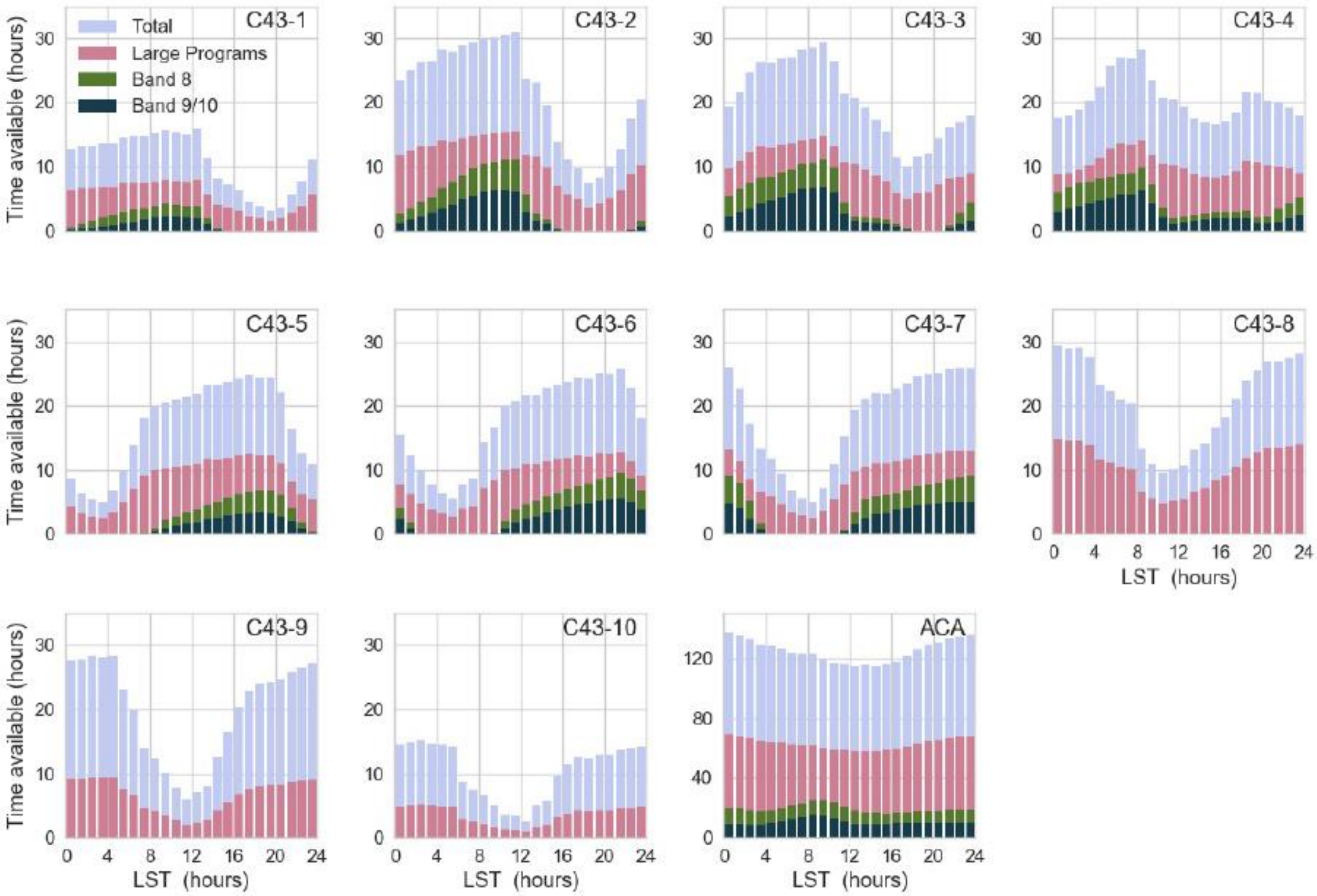


Figure 4: Effective observing time available per configuration for executing PI projects. As an example, up to 15 hours may be allocated to Large Programmes in configuration C43-2 at LST = 10 h. The total number of hours excludes time spent on observatory calibration, maintenance, reconfigurations, and other activities. The fraction of that time available for Large Programmes (pink) and high-frequency observations (green and dark blue) is also indicated. The configuration schedule and, consequently, the total number of hours available per configuration may change as a result of proposal pressure (Section 4.3.3). The data files containing these histograms are available here.

Table A-2: Allowed Array Combinations and Time Multipliers

Most Extended configuration	Allowed Compact configuration pairings	Extended 12-m Array Multiplier	Multiplier if compact 12-m Array needed	Multiplier if 7-m Array needed	Multiplier if TP Array needed and allowed
7-m Array	TP			1	1.7
C43-1	7-m Array & TP	1		7.0	11.9
C43-2	7-m Array & TP	1		4.7	7.9
C43-3	7-m Array & TP	1		2.4	4.1
C43-4	C43-1 & 7-m Array & TP	1	0.34	2.4	4.0
C43-5	C43-2 & 7-m Array & TP	1	0.26	1.2	2.1
C43-6	C43-3 & 7-m Array & TP	1	0.25	0.6	1.0
C43-7	C43-4	1	0.23		
C43-8	C43-5	1	0.22		
C43-9	C43-6	1	0.21		
C43-10	-	1			

C43-(N) combined with C43-(N+3)

ACA only combined with C43-1 to C43-3

Sidelobes

Configuration	7-m	C43-1	C43-2	C43-3	C43-4	C43-5
natural	44.0%	5.5%	5.0%	6.2%	10.4%	6.3%
briggs ($R = 0.5$)	42.2%	7.8%	6.6%	6.7%	7.3%	8.0%
uniform	39.0%	7.7%	16.7%	12.4%	11.0%	13.1%
Configuration	C43-6	C43-7	C43-8	C43-9	C43-10	
natural	4.6%	9.6%	7.8%	11.1%	13.0%	
briggs ($R = 0.5$)	6.2%	5.6%	9.7%	9.6%	11.3%	
uniform	11.3%	11.2%	10.1%	8.5%	12.0%	

Table 7.3: Sidelobe levels for a 1-hour observation of an unresolved source at a declination of $-23°$ with the different array configurations. The levels are indicated with three different weighting schemes used for the imaging.

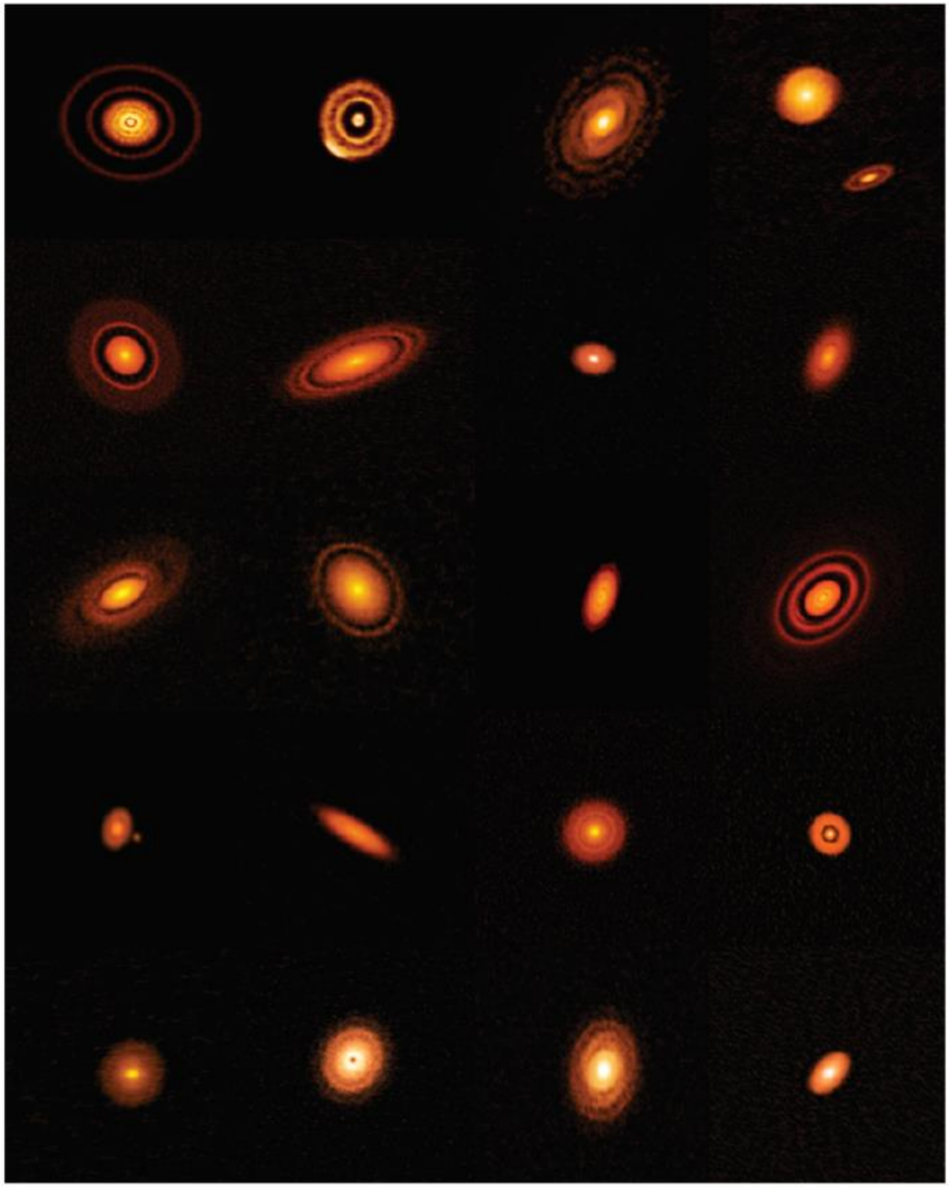


Figure 7.1: ALMA's high resolution images of nearby protoplanetary disks, which are results of the Disk Substructures at High Angular Resolution Project (DSHARP). The data provided by the observing team are available at https://almascience.org/almadata/lp/DSHARP/ Credit: ALMA (ESO/NAOJ/NRAO), S. Andrews et al.; NRAO/AUI/NSF, S. Dagnello

High angular resolution

Correlator (I)

- 4 basebands (i.e. SPW) with possible different setups
- Maximum usable BW : 1875 MHz

Correlator / Mode	Bandwidth (MHz)	Num. of ch. per pol. (in dual-pol.)	Ch. spacing (MHz)
BLC/TDM	2000*	128	15.625
BLC/FDM	1875	3840	0.488
BLC/FDM	938	3840	0.244
BLC/FDM	469	3840	0.122
BLC/FDM	234	3840	0.061
BLC/FDM	117	3840	0.0305
BLC/FDM	58.6	3840	0.0153
ACA	2000*	4096	0.488
ACA	1000	4096	0.244
ACA	500	4096	0.122
ACA	250	4096	0.061
ACA	125	4096	0.0305
ACA	62.5	4096	0.0153

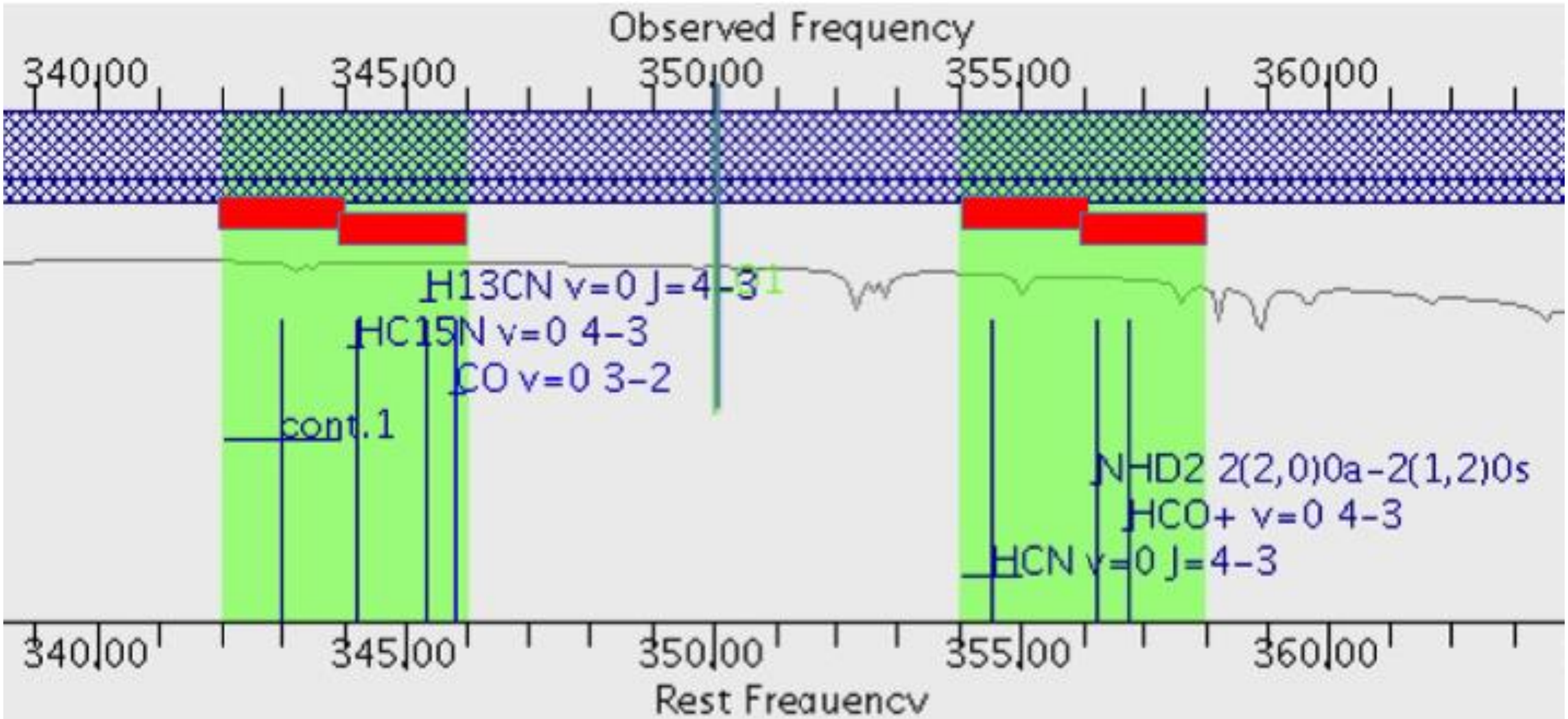
Correlator (II)

Usable bandwidth (MHz)	N = / Channels =	Spectral resolution (channel spacing) [kHz]				
	N =	1	2*	4	8	16
	Channels =	3840	1920	960	480	240
1875		977 (488)	1129 (977)	1938 (1953)	3904 (3096)	7813 (7812)
937.5		488 (244)	564 (488)	969 (977)	1952 (1953)	3906 (3906)
468.8		244 (122)	282 (244)	485 (488)	976 (977)	1953 (1953)
234.4		122 (61)	141 (122)	242 (244)	488 (488)	977 (977)
117.2		61 (31)	71 (61)	121 (122)	244 (244)	488 (488)
58.6		31 (15)	35 (31)	61 (61)	122 (122)	244 (244)

Default is FDM with N=2,
N=1 is recommended if linewidth/(Spec. Res.) < ~3-5

The 12m-array data rate : No limits (in previus cycle ~ 40 mb/s)

Correlator (III)



Bandpass (TDM/FDM)

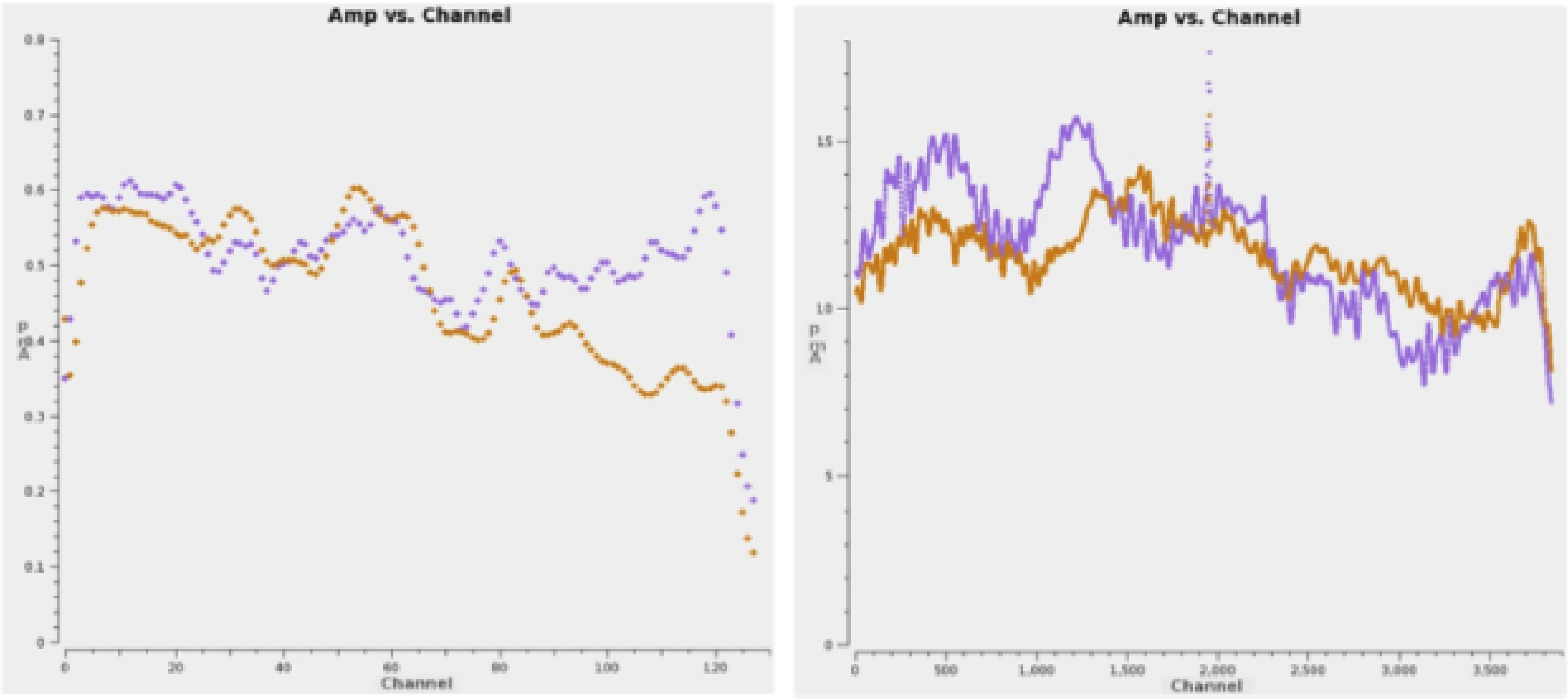


Figure 6.4: Comparison of TDM (left) and FDM (right) autocorrelation bandpass showing the dropoff in total power at the edges in the two modes. Colors represent the two polarizations from the example antenna. In TDM, 128 channels covering 2.0 GHz bandwidth are displayed, which illustrates the drop in power in the upper and lower 4 channels due to the anti-aliasing filter. The FDM spectrum has 3840 channels covering only the central 1.875 GHz, and the drop in power at the edges of this bandwidth is negligible (and comparable with the variations in the bandpass). (The narrow spike in the center of the FDM data is a test signal).

Bandpass (RF)

- The Bandpass is the calibration of the frequency response across SPW
- There is a residual amplitude and phase variation with a characteritic length of tens of MHz of 10% and 5°.
- The nominal bandpass accuracy is < 0.2% and < 0.5° over the spectral resolution requested.

Grid Sources Used for Bandpass

J0006−0623	J0237+2848	J0238+1636	J0319+4130	J0334−4008
J0423−0120	J0510+1800	J0519−4546	J0522−3627L	J0538−4405
J0635−7516L	J0750+1231	J0854+2006	J1037−2934	J1058+0133
J1107−4449	J1146+3958	J1229+0203L	J1256−0547	J1337−1257
J1427−4206	J1517−2422	J1550+0527	J1617−5848	J1642+3948
J1733−1304	J1751+0939	J1924−2914	J2025+3343	J2056−4714
J2148+0657	J2232+1143	J2253+1608	J2258−2758	J2357−5311

L = large scale emission

Table 10.1: The 35 Grid Sources Used by ALMA

Mosaic

- Observing a mosaic with ALMA is needed if a map size larger than approximately the HPBW of the primary beam is required.

- The default mosaic pointing pattern used by ALMA is a “fully sampled” hexagonal grid with equilateral triangles whose vertices are separated θhex= 0.511xHPBW which will sample the emission at the Nyquist spatial frequency.

- Note that a hexagonal mosaic has spacing θhex along a row (e.g., in right ascension) and 0.866xθhex between rows (e.g., in declination).

Hexagonal pattern with nyqvist sampling (white cross)

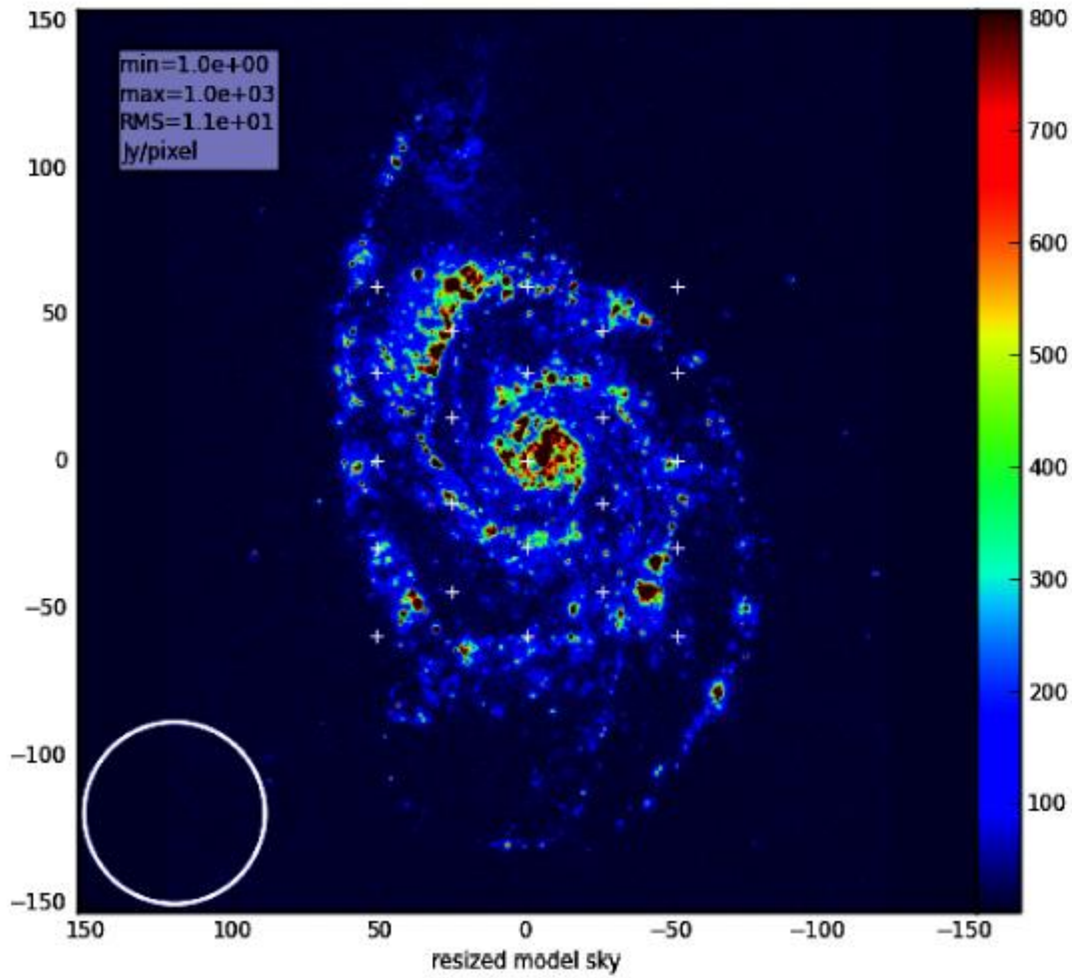


Figure 7.16: An example of mosaicing with a field of 2 arcmin extent at 100 GHz using a hexagonal pattern with Nyquist sampling (white crosses).

Spatial Filtering

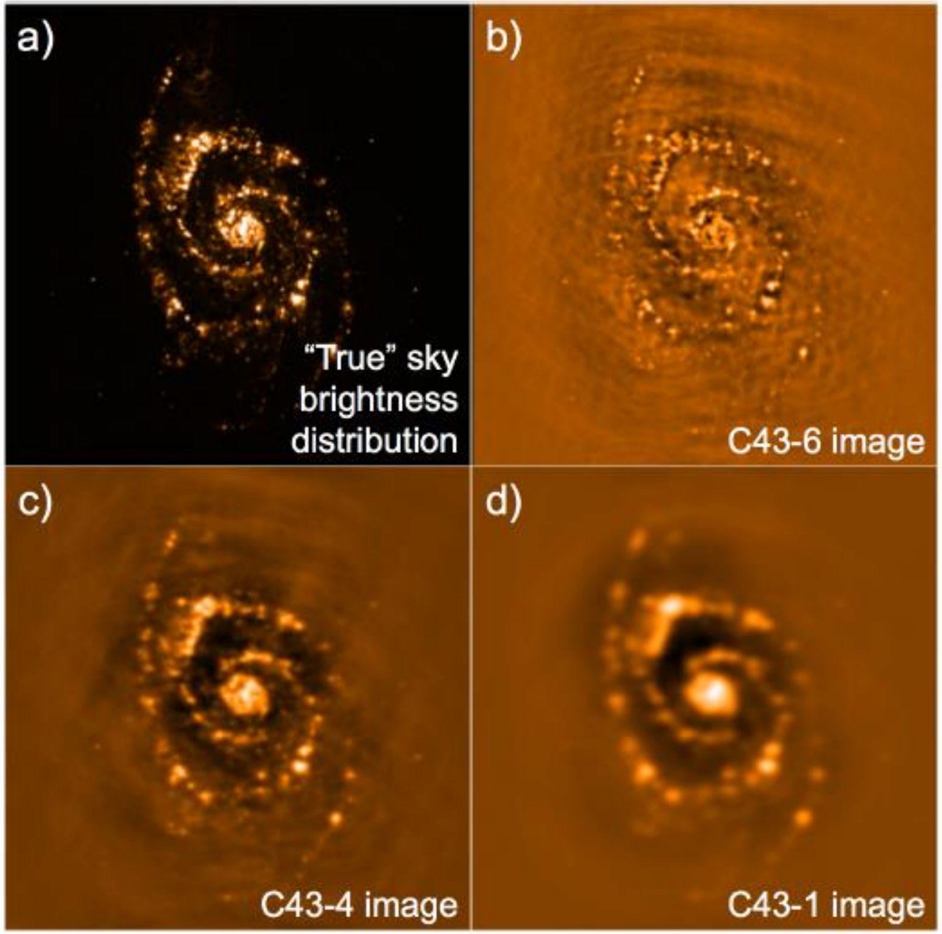


Figure 3.6: Examples of spatial filtering using the CASA task *simobserve* and actual ALMA configurations from Cycle 1. *Panel a (upper left)*: An optical image of the galaxy M51 used as a template for a true sky brightness distribution for the simulations. The frequency of the emission has been changed to 100 GHz, the image size has been scaled to $\sim 3' \times 3'$, and its declination has been changed to -40° to allow ALMA observations to be simulated. For the simulations, the galaxy was "observed" over a mosaic of 39 pointings, for ~10 hours in total. The resulting dirty images were CLEANed. *Panel b (upper right)*: The high-resolution image of the galaxy obtained when observed in an ALMA (Cycle 1) configuration with minimum and maximum baselines of 40.6 m and 1091.0 m, respectively (C32-6). The resulting synthesized beam is ~0.55″ and the maximum recoverable scale is 6.6″. *Panel c (lower left)*: Medium-resolution image of the galaxy when observed in an ALMA configuration with minimum and maximum baselines of 20.6 m and 558.2 m, respectively (C32-4). The resulting synthesized beam is ~1.1″ and the maximum recoverable scale is 14.4″. *Panel d (lower right)*: Low-resolution image of the galaxy when observed in an ALMA configuration with minimum and maximum baselines of 14.2 m and 81.4 m, respectively (C32-1). The resulting synthesized beam is ~3.8″ and the maximum recoverable scale is 36.4″.

Multi-array imaging

C43-3

C43-3 + C43-6

C43-3 + C43-6 + 7m

Model

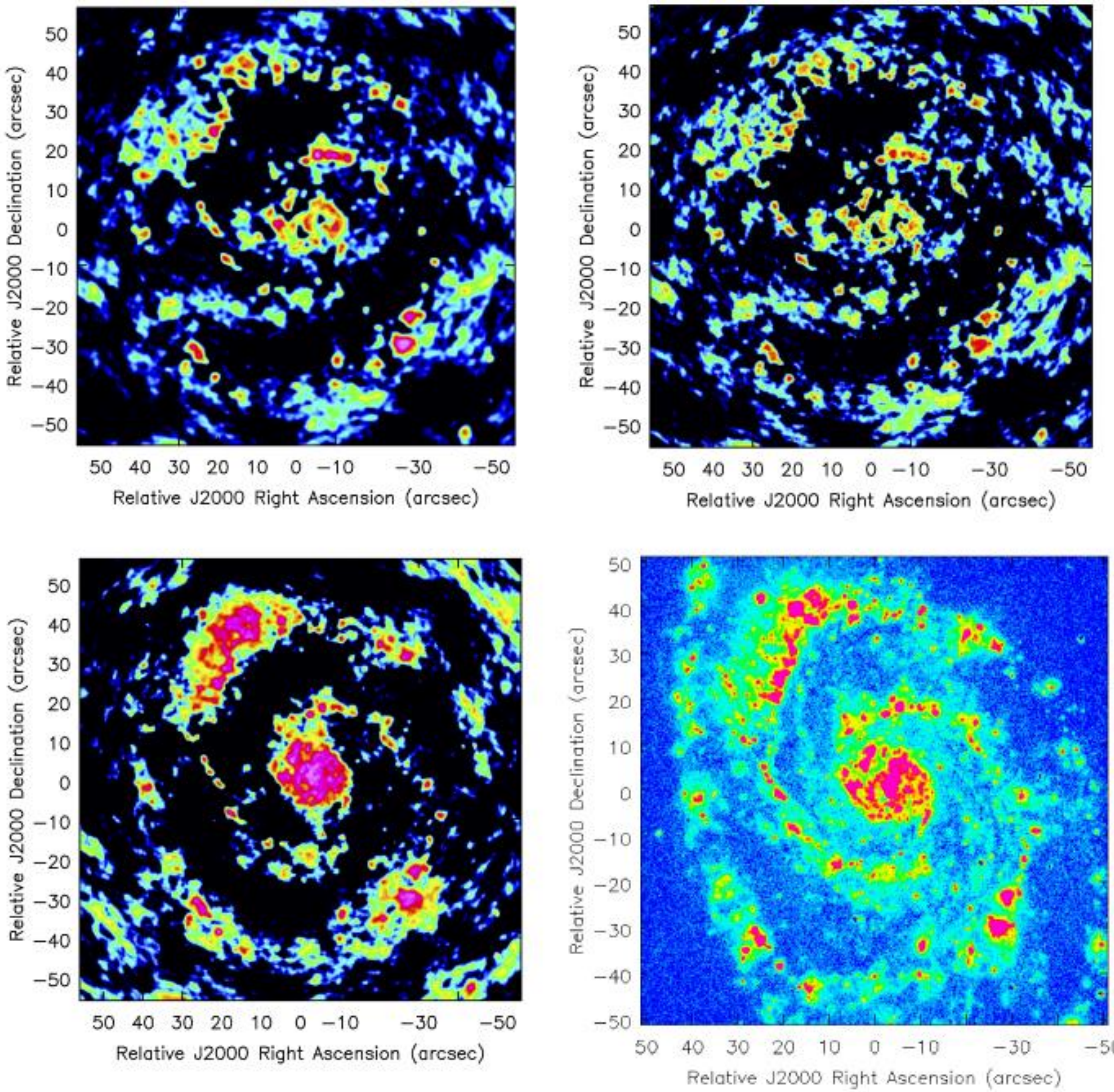


Figure 7.19: Images obtained using C43-3 (*top left*; 1 hour), C43-3 + C43-6 (*top right*; 1 + 3.3 hours) and C43-3 + C43-6 + 7-m (*bottom left*; 1 + 3.3 + 1.3 hours) Array combinations, and the image model itself (*bottom right*).

Polarization

- Stokes parameters

$$I = \frac{V_{xx} + V_{yy}}{2}$$
$$Q = \frac{V_{xx} - V_{yy}}{2}$$
$$U = \frac{V_{xy} + V_{yx}}{2}$$
$$V = \frac{V_{xy} - V_{yx}}{2}$$

$$V_{xx} = I + Q$$
$$V_{xy} = U + iV$$
$$V_{yx} = U - iV$$
$$V_{yy} = I - Q$$

require about 3 hours of parallactic angle coverage for proper calibration

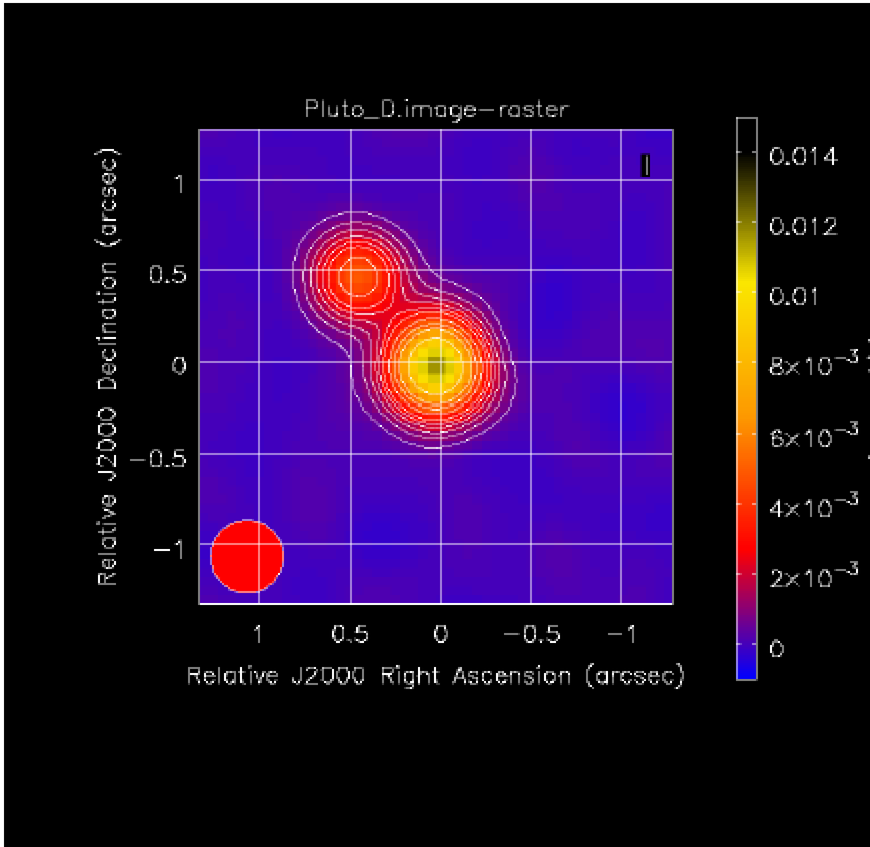
Table A-5: Default frequencies for Continuum Polarization Observations[1]

Band	spw1 (GHz)	spw2 (GHz)	LO1 (GHz)	spw3 (GHz)	spw4 (GHz)
3	90.5	92.5	97.5	102.5	104.5
4	138.0	140.0	145.0	150.0	152.0
5	196.0	198.0	203.0	208.0	210.0
6	224.0	226.0	233.0	240.0	242.0
7	336.5	338.5	343.5	348.5	350.5

Ephemeris objects (JPL/Horizon)

```
*******************************************************************************
 Date__(UT)__HR:MN     R.A.___(ICRF/J2000.0)___DEC           delta      deldot
*******************************************************************************
$$SOE
 2014-Dec-01 00:00 Am  18 51 01.8305 -20 41 18.087 33.5888476523329  17.7176571
 2014-Dec-01 00:20 Am  18 51 01.9382 -20 41 18.057 33.5889897735456  17.7169995
 2014-Dec-01 00:40  m  18 51 02.0461 -20 41 18.027 33.5891318772715  17.7132925
 2014-Dec-01 01:00  m  18 51 02.1542 -20 41 17.997 33.5892739389694  17.7065199
 2014-Dec-01 01:20  m  18 51 02.2624 -20 41 17.967 33.5894159340629  17.6966891
```

Example of high precision ephemeris test :
Pluto and Charon



Solar Observations

Band	LO Freq.	BB1 (LSB)	BB2 (LSB)	BB3 (USB)	BB4 (USB)
3	100	92-94	94-96	104-106	106-108
6	239	229-231	231-233	245-247	247-249
7	346.6	338.6-340.6	340.6-342.6	350.6-352.6	352.6-354.6

Config	Band 3	Band 6	Band 7
C43-1	X	X	X
C43-2	X	X	X
C43-3	X	X	
C43-4	X		

General guidelines for writing a proposal

- ALMA Cycle 3 proposals must be written in English and include the following sections:

- 1. Science case
- 2. Figures, tables and references (optional)
- 3. A brief statement on the likely potential for publicity (e.g. images, press releases etc.) arising from the proposed scientific observations.
- These sections **shall be submitted as a single PDF** document., **with a font size no smaller than 12 points. The total length of this document is limited to 4 pages** (A4 or US Letter format) **for regular proposals, and 6 pages for**
- **LP** (additional 2 pages to describe the management plan and data products)
- **Figure captions, tables and references may use 12-point font.**
- A file size limit of 20 MB will be enforced at submission.

- Users are encouraged to use the LaTeX template developed by ALMA for preparation of their proposals.
- **https://almascience.eso.org/proposing/proposal-template**

Science case

- **Describe the astronomical importance of the proposed project and include a clear statement of its immediate observing goals.**

- **Expected intensity of the target source(s), justify the Signal-to-Noise (S/N) ratio required to achieve the Goals , Size of the target**

- **Proposers can simulate ALMA observations using different array components and configurations . Simulations are not required.**

- **ALMA Review Panels span a wide range of scientific areas. Therefore, proposals should be written for an expert, but broad-based, astronomy audience.**

Technical Justification in the OT

- The Technical Justification is a form within the OT where you must justify the observational setup (sensitivity, imaging and correlator configuration), as well as non-standard requests.

- Each section includes at least one free-format text box that must be filled (50 characters minimum)

Note that any figures associated with the Technical Justification must still be included in the Science Justification PDF file, and clearly referenced in the TJ.

Technical Assessors will normally not read the Science Case, therefore all the necessary information must be included in the TJ itself.

An incomplete or incomprehensible Technical Justification will lead to the rejection of the proposal on technical grounds.

Proposal validation and submission

- Once the proposal is validated within the OT, it can be submitted to the ALMA Archive.

- Note that the proposal can be resubmitted by the Principal Investigator as many times as needed before the proposal deadline.

Quality Assurance

QA0: The monitoring of calibrations and overall performance during and just after an observation.

QA0+: A simplified and fast scripted imaging QA. Typically completed 30-90 minutes after each observation is taken, this is mainly used when the results from QA0 are unclear or marginal and will also be available in the QA0 report in Cycle 7.

QA1: This involves the measurement of performance parameters and telescope properties by the observatory.

QA2: Full calibration and generation of imaging products.

QA3: Issues found with the data by the PI or ALMA staff after data delivery.

Data Flow (I)

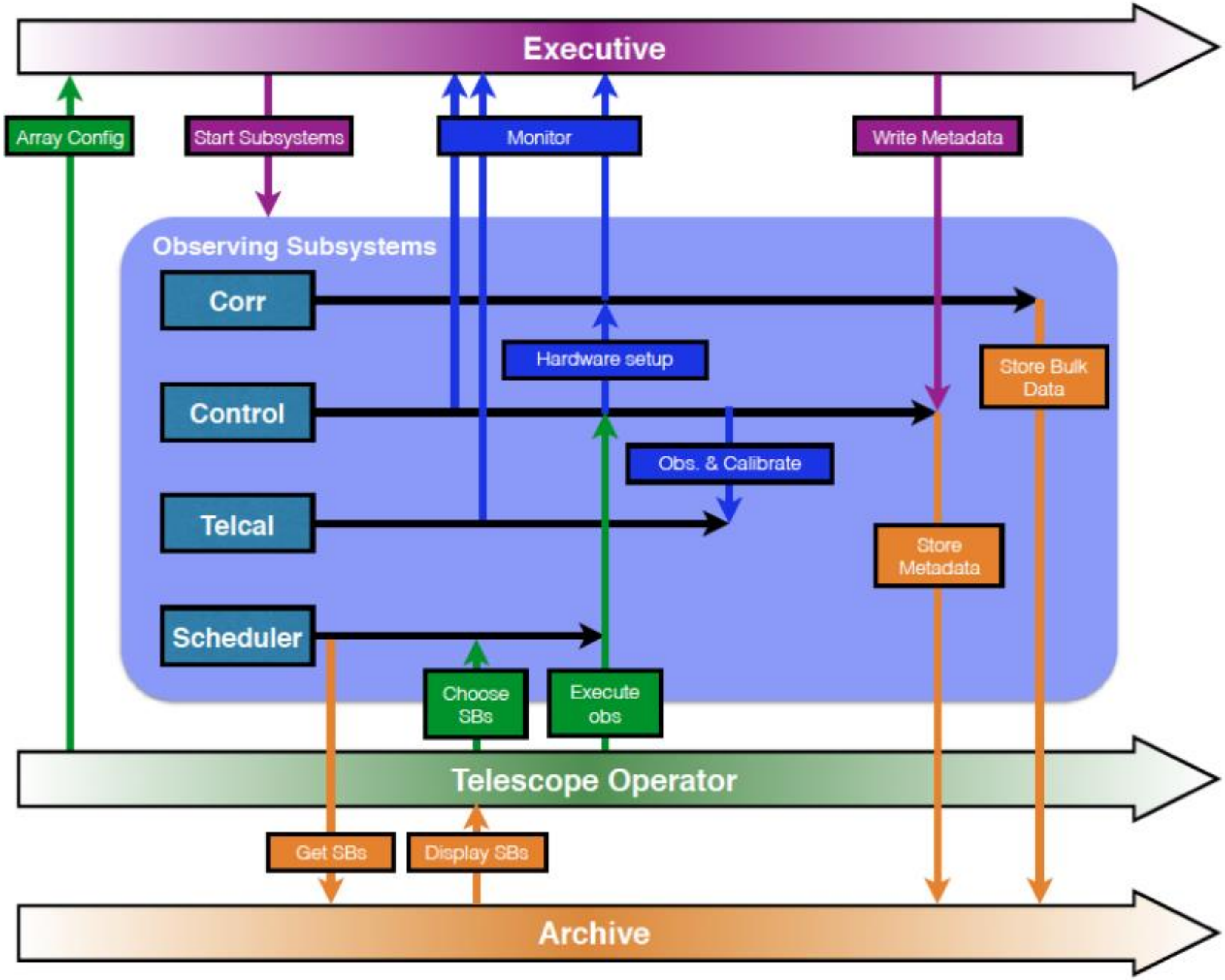


Figure 12.1: Main actors and roles during observations with ALMA. The horizontal direction represents time evolution.

Data Flow (II)

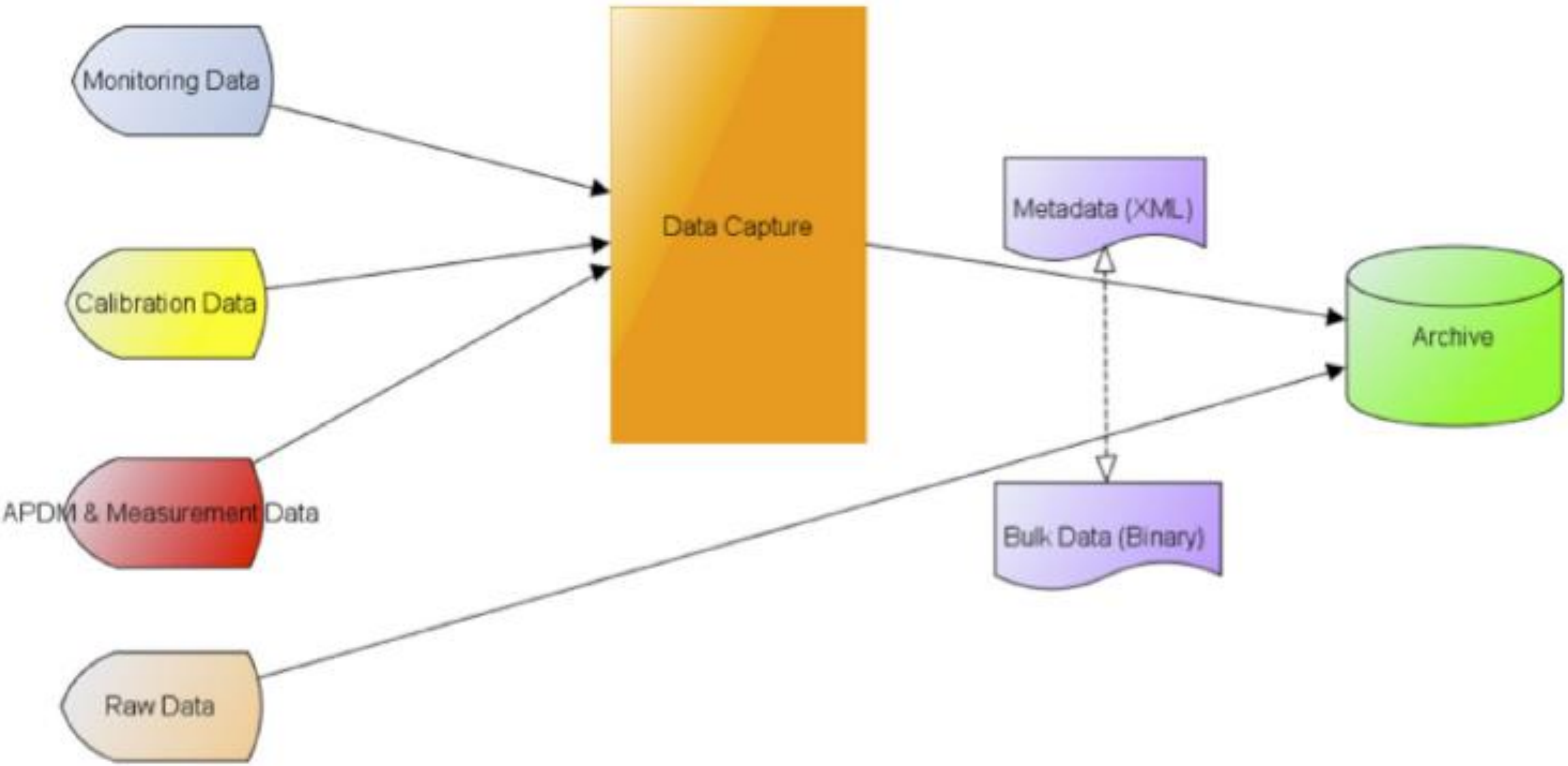


Figure 12.2: Data flow components.

Antenna

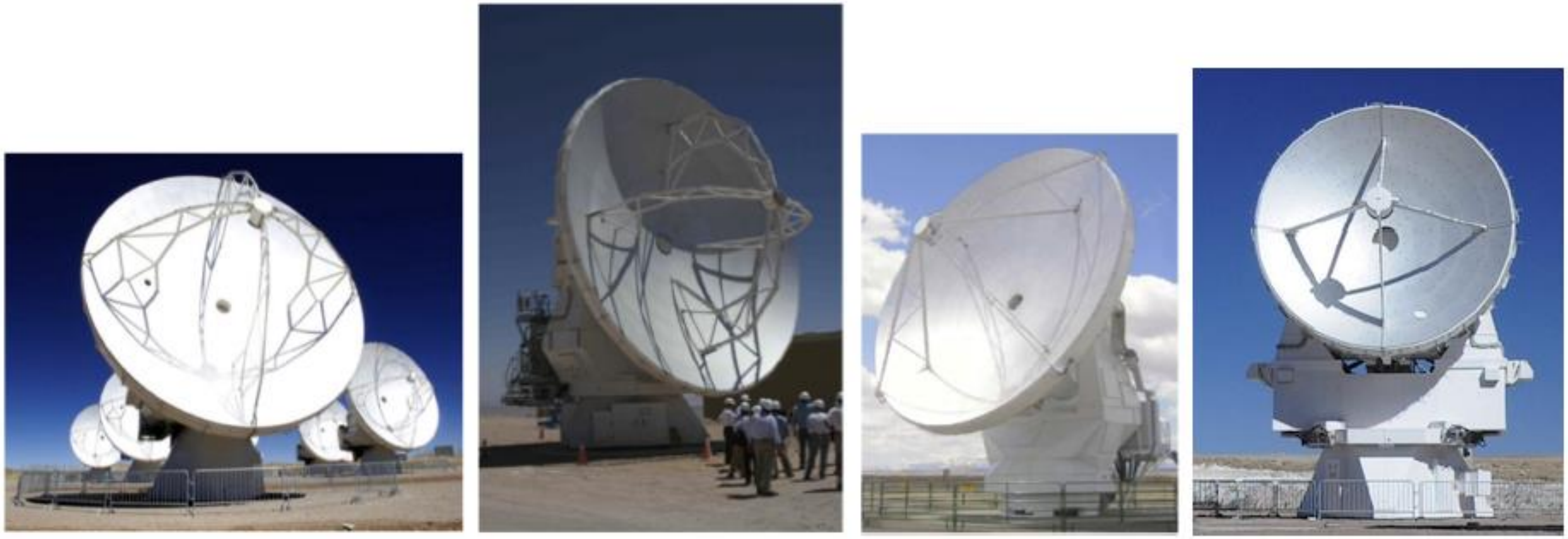


Figure A.1: The four different ALMA Antenna designs: Vertex 12-m, MELCO 12-m, AEM 12-m, and MELCO 7-m (from left to right).