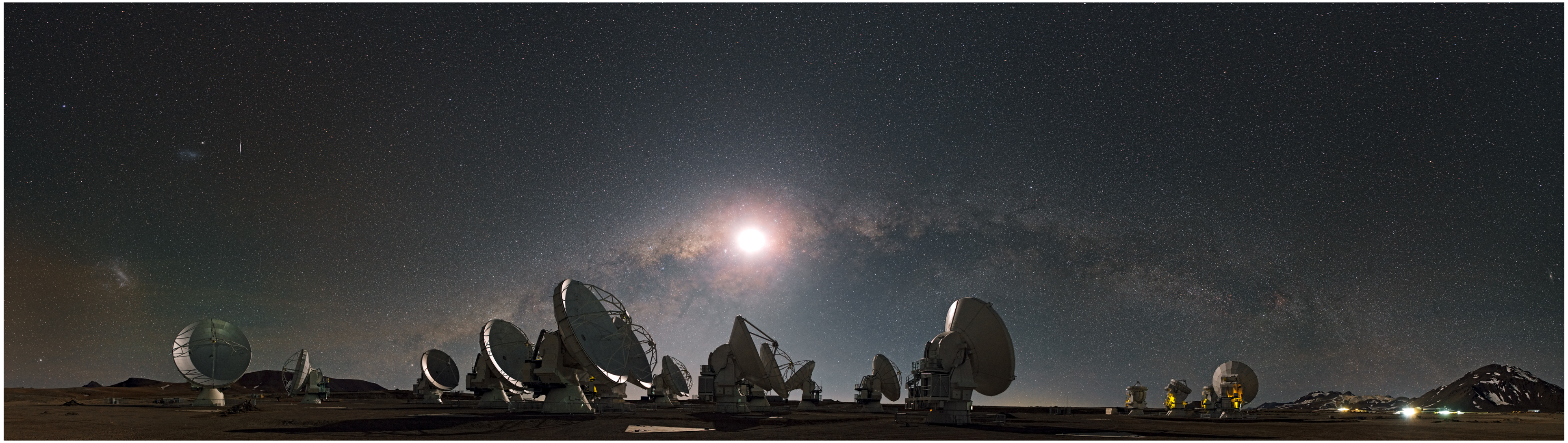
EUROPEAN ARC
ALMA Regional Centre || Italian

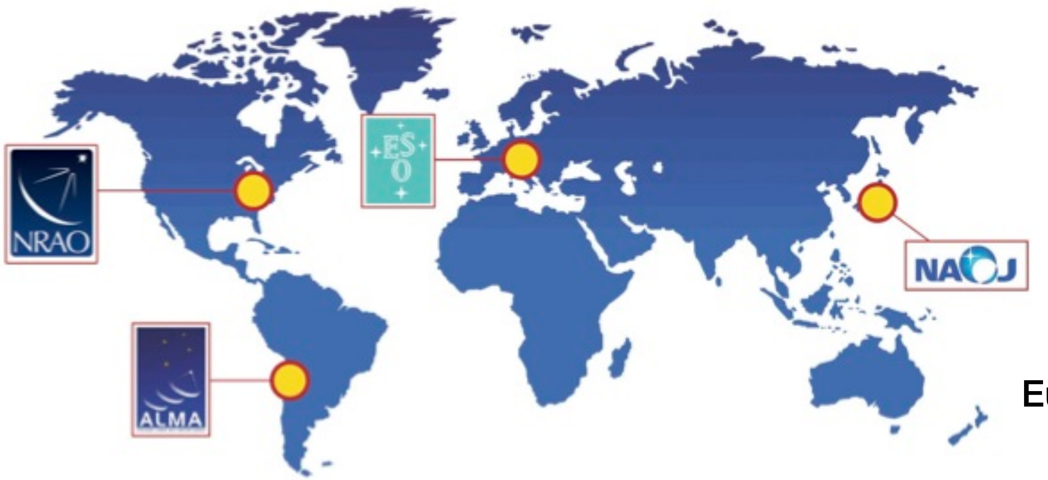
ALMA REGIONAL CENTRE ITALY
is Bologna

ALMA Early Science Cycle 5 Capabilities

Jan Brand – ALMA Regional Centre, Italian node



ORGANIZATIONAL STRUCTURE



Joint ALMA Observatory:

Europe (ESO): 33.75%
North America (NRAO): 33.75%
East Asia (NAOJ): 22.5%
Chile: 10%

European ARC nodes

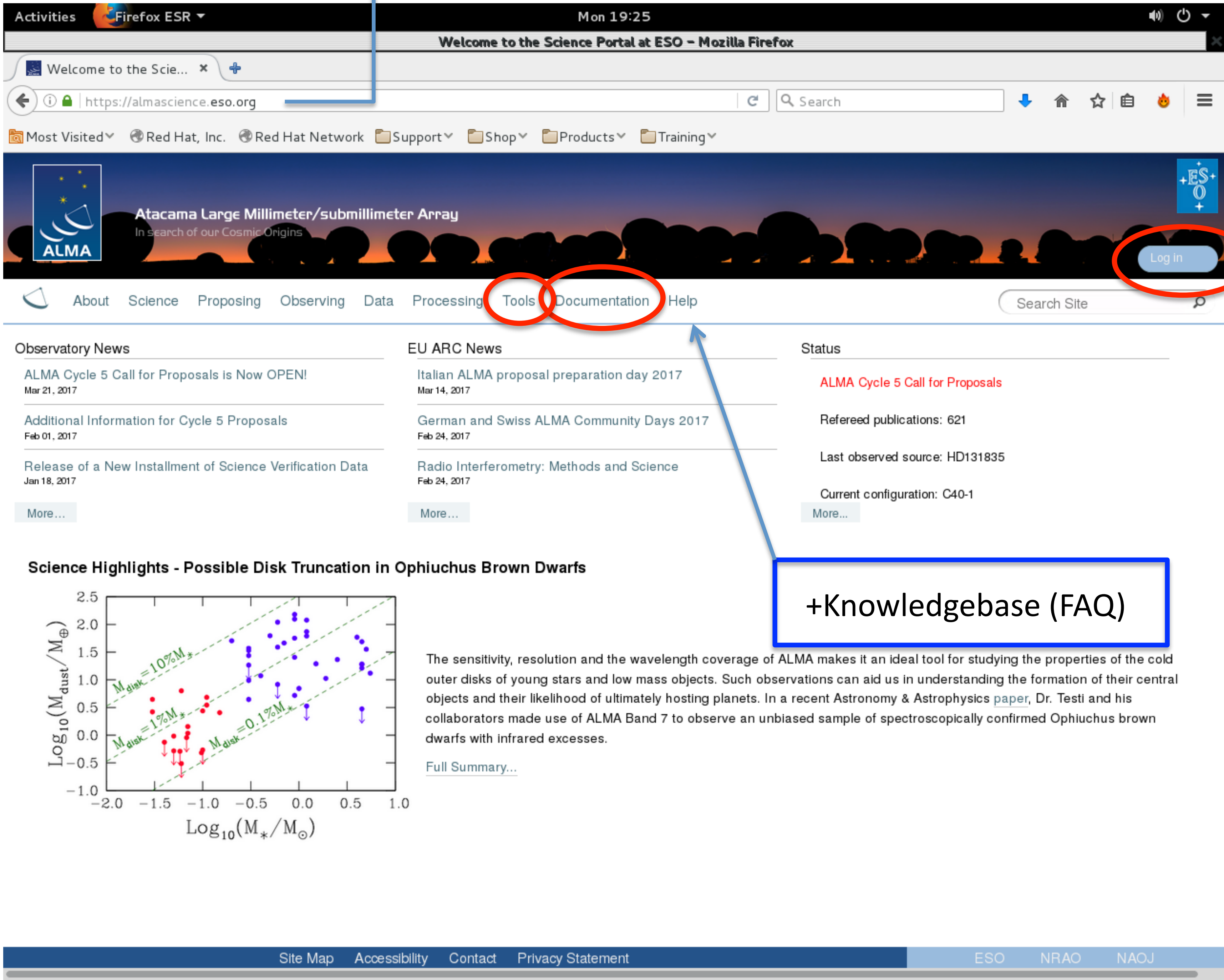
In Europe:

A network of 7 ARC-nodes and
1 Centre of Expertise, coordinated
by the central node at ESO.

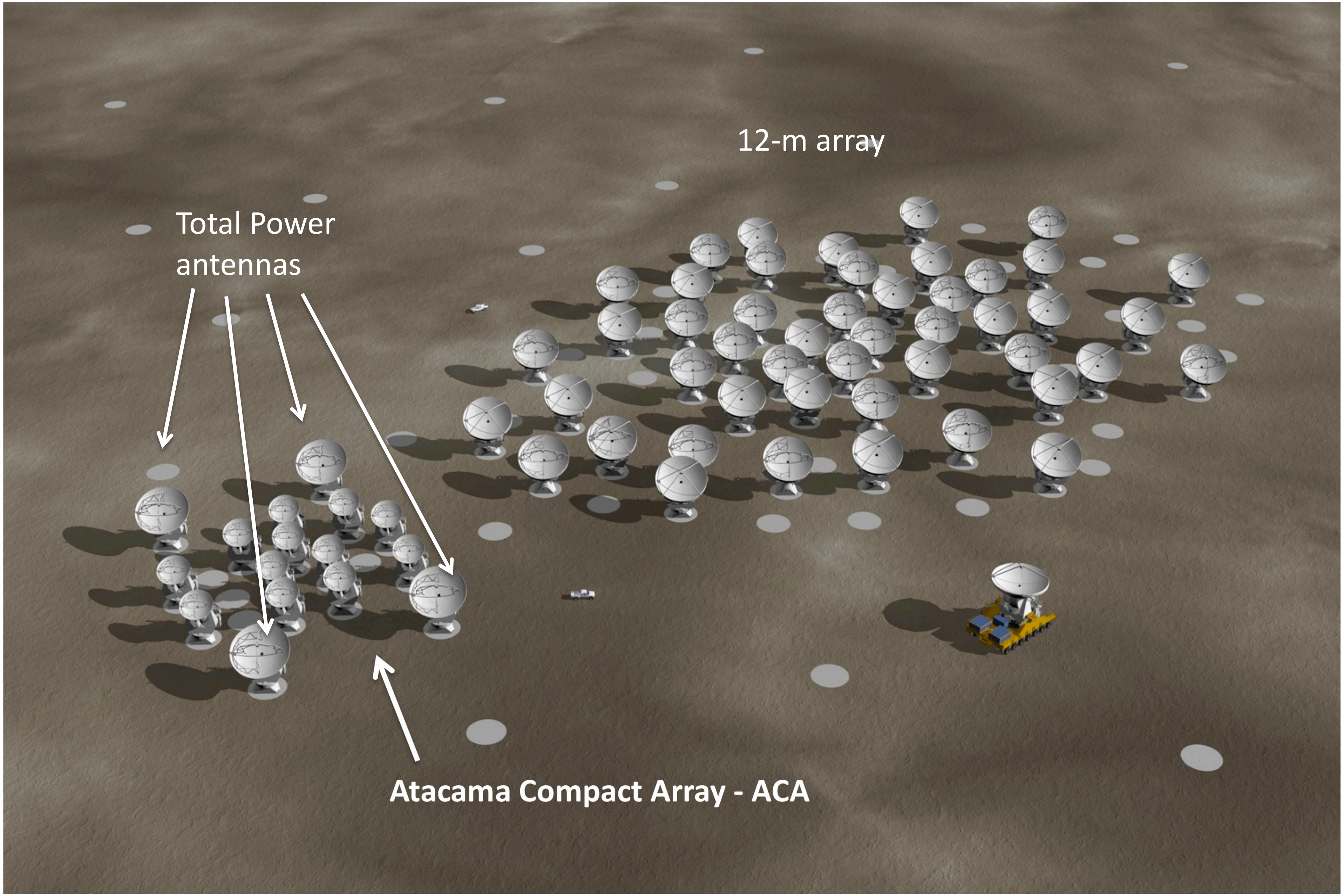
TIMELINE CYCLE 5

Date	Event
21 March 2017	Release Call for Proposals Cycle 5 + Documentation & Tools
20 April 2017 15:00 UT	**Proposal submission deadline**
End of July 2017	Announcement outcome review process
7 September 2017	**Submission Phase2 material by PIs**
October 2017	Start observations Cycle 5
September 2018	End of Cycle 5

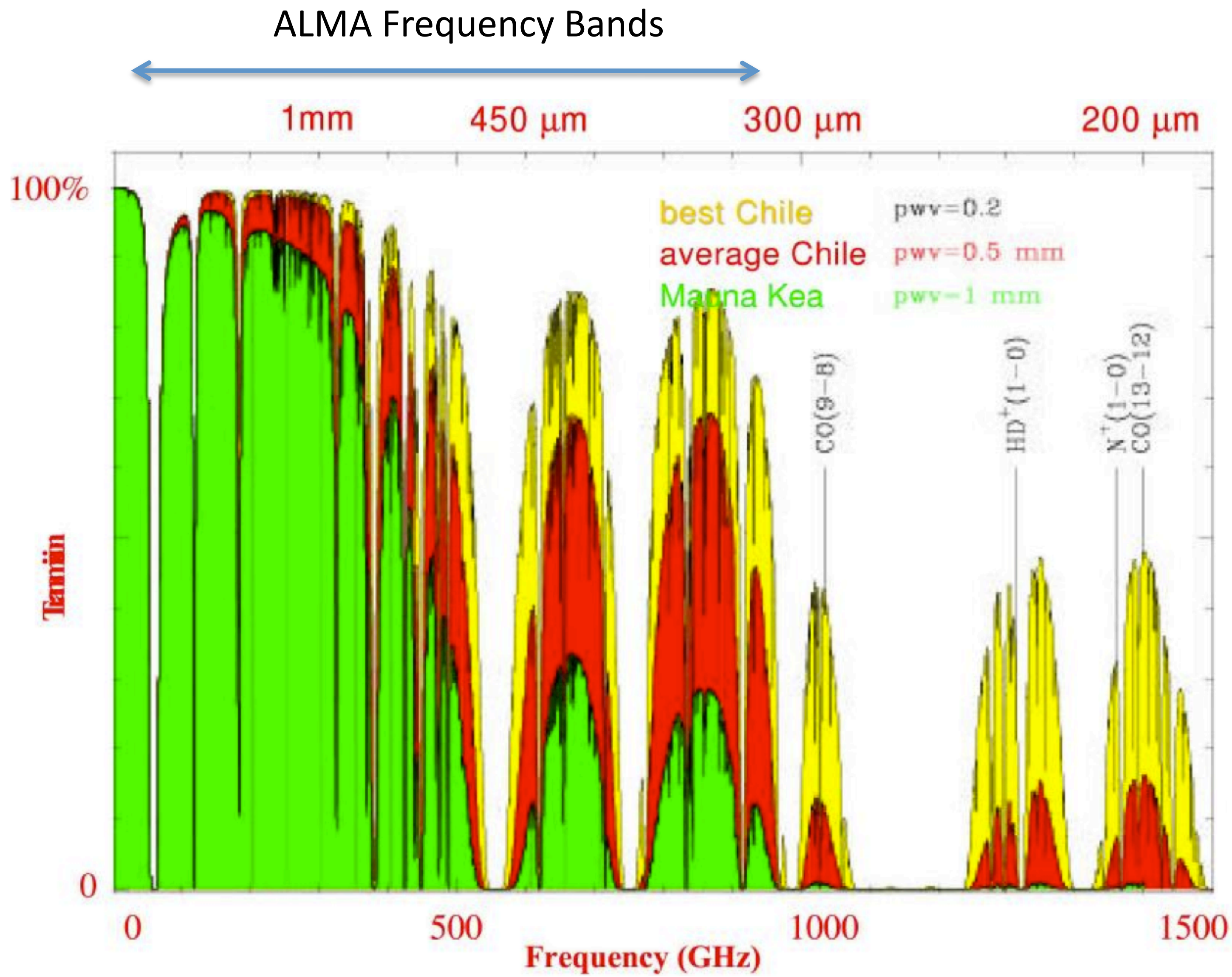
https://almascience.eso.org/



+Knowledgebase (FAQ)


12-m array
Total Power
antennas
Atacama Compact Array - ACA

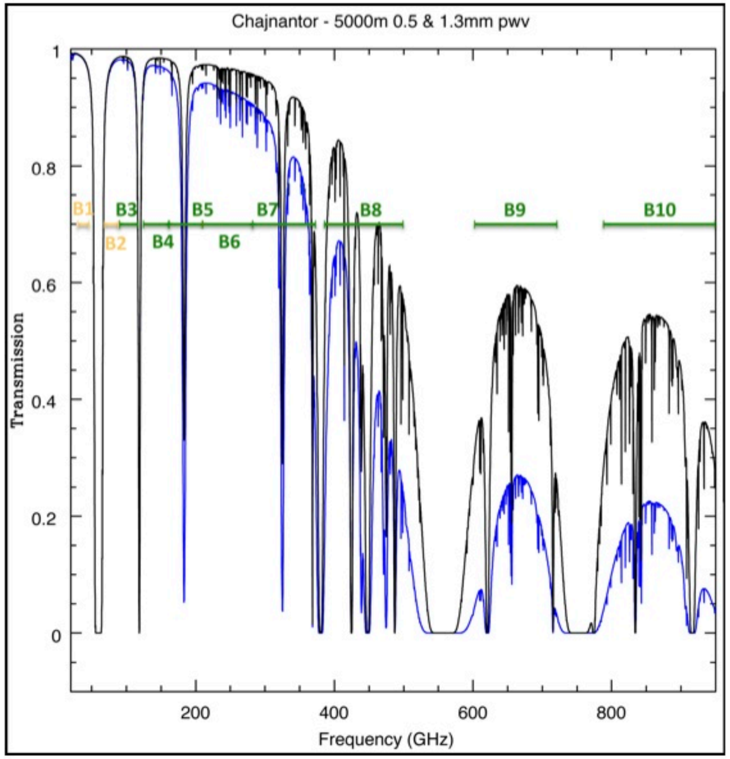
ATMOSPHERIC TRANSMISSION



ALMA *Full Operations Specifications*

	Specification
Number of Antennas	*50×12 m (12-m Array), plus 12×7 m & 4×12 m (ACA)*
Maximum Baseline Lengths	*0.15 - 16 km*
Angular Resolution (")	*~0.2" × (300/ν GHz) × (1 km / max. baseline)*
12 m Primary beam (")	*~20.6" × (300/ν GHz)*
7 m Primary beam (")	*~35" × (300/ν GHz)*
Number of Baselines	*Up to 1225 (ALMA correlators can handle up to 64 antennas)*
Frequency Coverage	*All atmospheric windows from 84 GHz - 950 GHz (with possible extension to ~30 GHz)*
Correlator: Total Bandwidth	*16 GHz (2 polarizations × 4 basebands × 2 GHz/baseband)*
Correlator: Spectral Resolution	*As narrow as 0.008 × (300/ν GHz) km/s*
Polarimetry	*Full Stokes parameters*

Been ramping up to this since Cycle 0.
… expected by Cycle 5 (=now! Still not there yet though…)
but before Cycle 7.



CYCLE 5 AVAILABLE RECEIVERS

Green: bands available in Cycle 5

Table A-3: Properties of ALMA Cycle 5 Receiver Bands

Band	Frequency range[1] (GHz)	Wavelength range (mm)	IF range (GHz)	Type
3	84 – 116	3.6 – 2.6	4 – 8	2SB
4	125 – 163	2.4 – 1.8	4 – 8	2SB
5	163 – 211	1.8 – 1.4	4 – 8	2SB
6	211 – 275	1.4 – 1.1	5 – 10	2SB
7	275 – 373	1.1 – 0.8	4 – 8	2SB
8	385 – 500	0.78 – 0.60	4 – 8	2SB
9	602 – 720	0.50 – 0.42	4 – 12	DSB
10	787 – 950	0.38 – 0.32	4 – 12	DSB

ALMA evolution and proposal statistics Early Science Cycles 0 - 4

	Cycle 0	Cycle 1	Cycle 2	Cycle 3	Cycle 4
	Sep. 2011 - Jan. 2013	Jan. 2013 - May 2014	Jun. 2014 - Oct. 2015	Oct. 2015 - Sep. 2016	Oct. 2016 – Sep. 2017
Telescope					
Hours x Science	**800**	**800**	**2000**	**2100**	**3100+**
Antennas	**> 12x12-m**	**>32x12-m +9x7-m+2TP**	**>34x12-m +9x7m+2TP**	**>36x12-m +10x7-m+2TP**	**>40x12-m +10x7-m+3TP**
Bands	**3, 6, 7, 9**	**3, 6, 7, 9**	**+4, 8**	**+10**	**+VLBI, Solar, LPs, ACA standalone (1800 hrs)**
Wavelengths [mm]	3, 1.3, 0.8, 0.45	as in Cycle0	+2, 0.7	+0.35	3 to 0.35
Baselines	≤ 400m	≤ 1000m	≤1500m	**≤10km**	**≤12.6km**
Polarisation	single dual	single dual	**full**	**full**	**full**

Proposal outcome					
Submitted	950	1108	1383	1589	1573
Highest priority	112	196	353	401	475
Filler	51	92	159	235	232
Success rate [%]	12 (17)	18 (26)	26 (37)	25 (40)	30 (45)
Pressure* global	8.5	5.7	3.9	4.0	3.3
Pressure Europe	11.9	9.1	4.9	4.9	4.1

*: submitted/accepted(A+B)

Cycle 5 capabilities – short version

MORE hours for science
MORE antennas
LONGER baselines
AN EXTRA receiver band
OK to ask for more time
MORE FLEXIBILITY in choice of useful configurations
EASIER phase 2

Cycle 5 capabilities – the details

Science time 4000 hrs (12-m array) + 3000 hrs (ACA)
< 5% for DDT-proposals; < 15% Large Programs;
< 20% for non-standard programs [incl. <5% VLBI] [all % wrt total time]

Antennas: 43 in 12-m array + 10 x 7-m + 3 x 12-m TP in ACA

Receiver bands:	3, 4, 5, 6	7	8, 9, 10
Wavelengths [mm]:	3.1, 2.1, 1.6, 1.3	0.87	0.74, 0.44, 0.35
Max baselines [km]:	< 16.2 (<1.1 B5)	< 8.5	< 3.6

Polarization: Full Stokes in Bands 3, 4, 5, 6, 7; 12-m array. Single pointings, on axis.
Continuum and full spectral resolution observations. (Linear pol.)

Spectral line + continuum 12-m array + 7-m array in all bands
Single field interferometry: all bands, 12-m and 7-m arrays.
Mosaics: bands 3 - 9
Single-dish spectral line observations: Bands 3 – 8

Max. data rate 66 Mb/s; warning at 40 Mb/s (PI will be contacted in Phase2)

Standard vs. non-standard observing modes

Standard modes: well-characterized and observations can be calibrated with the ALMA data reduction pipeline

Non-standard modes: require manual calibration by ALMA staff
(and remember: non-standard only get up to 20% of total available time)

Cycle 5 non-standard observing modes include:

- Observations in bands 8, 9 ,10
- Observations in band 7 with baselines > 5km
- All full polarization observations
- Spectral scans
- Solar observations
- VLBI observations
- Non-standard (= user-defined) calibrations
- Bandwidth-switching projects
- Astrometric observations

CYCLE 5: PROPOSAL TYPES AND OBSERVING MODES

✔ Large programs. Cannot be done as series of normal proposals;
>50 hrs; <15% total time + scheduling constraints based on LST and configs.
Only standard obs modes and no time-critical or ToO obs's

✔ mm-VLBI; Bands 3, 6; also submit to VLBI network (3mm to GMVA by 1/2/17;
1mm to ALMA by 20/4/17). Up to 37 antennas in phased array.
<5% total time; fixed period (March/April 2018, compact config: $b_{max} < 700$m)

✔ ACA stand-alone observing mode (short baselines and single dish).
No stand-alone TP-array (and no TP at all for B9, 10)

✔ Solar observing mode; Bands 3, 6. Only scheduled in certain periods (cf VLBI)

✔ Spectral line polarization; restricted to compact sources in Bands 3, 4, 5, 6, 7.
Minimum 3 hrs (for calibration purposes) . Linear polarisation.

Regular proposals. <50 hrs (12-m) or <150 hrs (ACA standalone).
Can be standard & non-standard, time-critical, multi-epoch, monitoring.
Target of Opportunity (ToO)
Director's Discretionary Time (DDT) Can be submitted any time; special policies

More proposal types

✔ Regular: Time < 50 hrs (12-m), < 150 hrs (ACA stand-alone). For observations that can be fully specified by the regular deadline.
May include standard & non-standard modes, but also time-critical, multiple-epoch observations, and monitoring of a target over a fixed time interval.
Users are encouraged to submit proposals asking > 10 hrs.

✔ Target of Opportunity (ToO): observations that can be anticipated but whose targets and time of observation is not known in advance. Needs trigger(s).
Submit at regular deadline.

✔ Director Discretionary Time (DDT) proposals may be submitted at any time during Cycle 5.

- Proposals requiring the immediate (within 3 weeks of approval) observation of an unexpected astronomical event;
- Proposals requesting observations on a highly competitive scientific topic, motivated by developments after deadline;
- Follow-up observations of a program recently conducted with ALMA or any other observing facility, where a quick implementation is expected to provide breakthrough results

Duplication & resubmission

Observation is considered duplication if *all* of the following conditions apply:

Target field location

Single field: if within the HPBW of the other observation

Mosaic: if >50% of pointings are within HPBW area covered by the other observations.

Angular resolution

If differs by factor ≤ 2 from that of the other observation.

Spectral windows

Continuum(*): requested rms for aggregate bw is better by factor of ≤ 2 from that of the other observation and the requested frequency is within a factor of 1.3

OR

Spectral line: if the central frequency in any requested correlator window observed in FDM is encompassed by the other observation observed in FDM mode and the sensitivity per channel, after smoothing to the same spectral resolution, is better by a factor of ≤ 2

* Continuum: proposed correlator setup must contain 2 or more windows with bw > 1.8 GHz

PI's MUST CHECK ARCHIVE + LIST OF ACCEPTED PROPOSALS CYCLE4:

https://almascience.eso.org/proposing/call-for-proposals/duplications

Duplication & resubmission

Short version:

New proposal to observe SGs from active program.
Is considered *resubmission* if SGs are duplications (=not different enough; details on previous slide) AND PI of either proposal appears as investigator on the other one.

Detailed version:

When submitting a proposal to observe some or all SGs of a currently active but unfinished proposal, ALMA will identify the relevant SGs as *resubmissions* if it constitutes a duplication of an active SG following the rules outlined in the previous slide AND the PI of the relevant Cycle 4 project is listed as PI, co-PI or co-I of the corresponding Cycle 5 proposal or the Cycle 5 PI is listed as an investigator on the Cycle 4 proposal.

(if observations successfully completed in Cycle 4, relevant portions Cycle 5 proposal will be cancelled. Obs's started in prev. cycle and accepted in Cycle 5 will be *observed with same setup* as in prev cycle, even though it has "slightly changed" in current cycle.)

Angular resolution *range* – new option Cycle 5

Essencials:

In Cycle 5, PIs will be allowed to enter a range of angular resolutions for a given SG in the OT. The range should be justified in the proposal and be scientifically meaningful.

Implication: SGs can be observed in more configurations hence more chance of being done.

Details:

In practice, if the PIs enter their sensitivity request in flux density units (e.g. Jy), the OT will assign to a given SG any number of configurations that fulfill the angular resolution range requested by the PI taking into account the observing efficiency. If the execution of a SG is time wise significantly more efficient in a subset of the allowed configurations, only that subset will be considered. This choice is reflected in the OT, which will only display the configurations that the Observatory will consider for scheduling the SG.

PIs aiming to obtain high quality images of complicated structures may enter their sensitivity request in temperature units. The time estimate in these cases will correspond to the time needed to achieve the surface brightness requested in the finest angular resolution specified. This should not prevent PIs from entering a range of angular resolutions, as it is expected that a relatively small range of angular resolutions will be scientifically meaningful for these programmes.

% of time PWV is below given value, per month

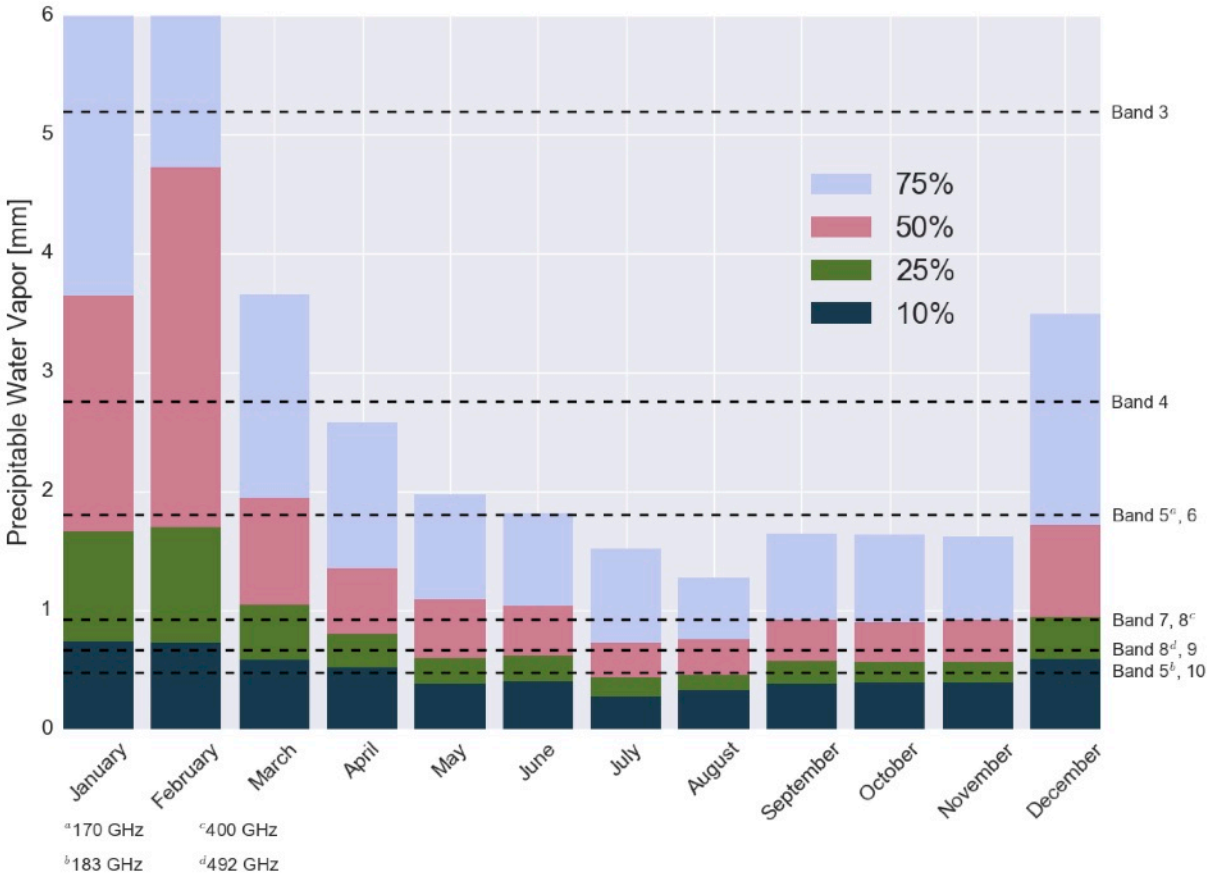
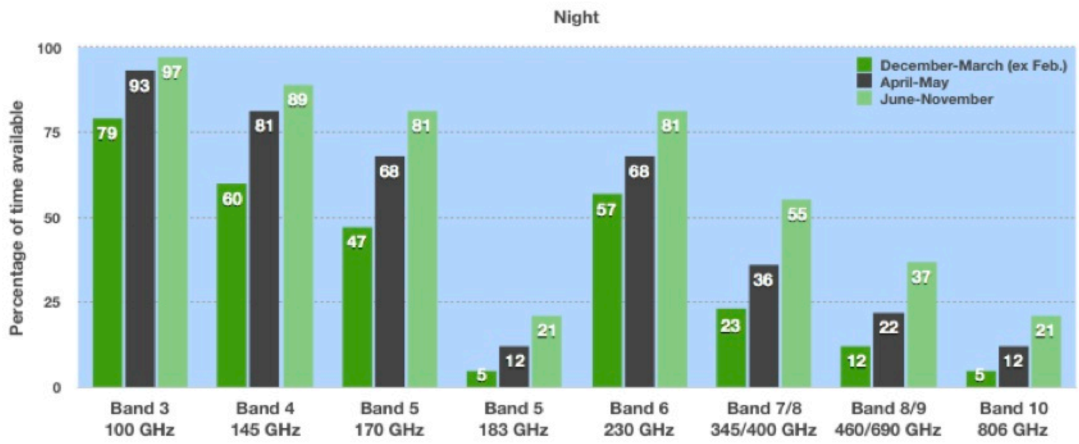
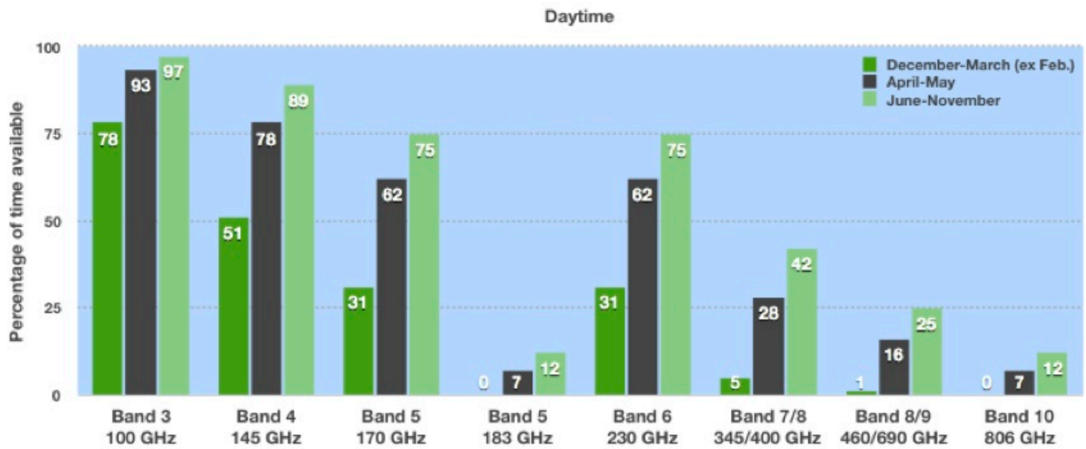


Figure 3. Fraction of time that the PWV falls below a given value along the year. The percentages shown indicate the fraction of time that the PWV is under the PWV value indicated on the y-axis. For example, in January, 75% of the PWV measurements are under 6 mm, while in June 75% of the PWV measurements fall below 1.8 mm. The data were obtained with the APEX weather station between 2007 and 2016. The horizontal dashed lines show the observing thresholds adopted for the various ALMA bands for an elevation of 60 degrees.

% of time PWV is below obs. threshold, per Band



Night



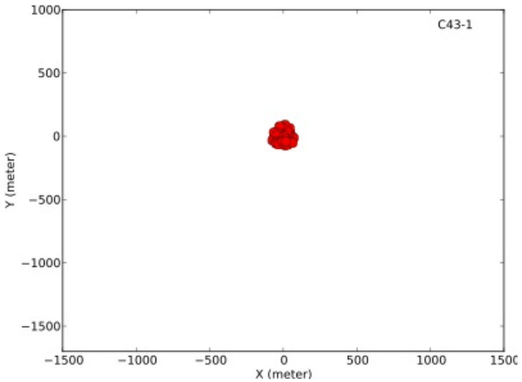
Day

Figure 2. The percentage of time when the PWV is below the observing thresholds adopted for the various ALMA bands for an elevation of 60 degrees. The data were obtained with the APEX weather station between 2007 and 2016. Results are shown for nighttime (top) and daytime (bottom) observations.

ARRAY CONFIGURATIONS

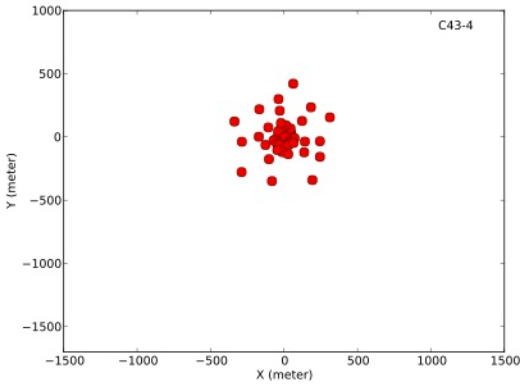
There will be ca. 13 reconfigurations during Cycle4 at the end of which the array is expected to have imaging properties similar to one of the nine representative configurations used to characterize the advertised imaging capabilities and to estimate the observing times.

C43-1

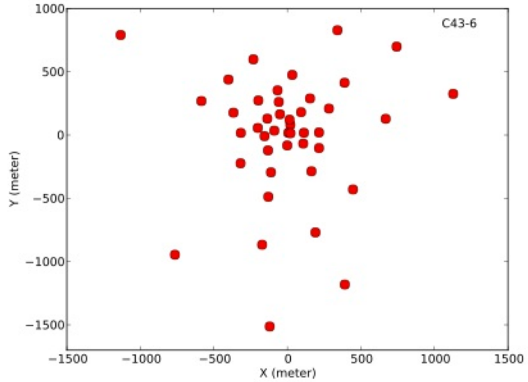


3 km

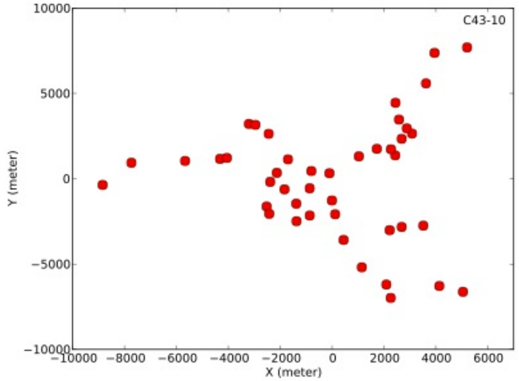
C43-4



C43-6



New configuration every 2-4 weeks.



C43-10

16 km

ARRAY CONFIGURATIONS CALENDAR

Table 2: Planned 12-m Array Configuration Schedule for Cycle 5

Start date	Configuration	Longest baseline[1]	LST for best observing conditions
2017 October 1	C43-7	3.6 km	~ 21h – 10h
2017 October 5	C43-8	8.5 km	~ 22h – 11h
2017 October 25	C43-9	13.9 km	~ 23h – 12h
2017 November 10	C43-10	16.2 km	~ 1h – 13h
2017 December 1-18	*No observations due to large antenna reconfiguration*		
2017 December 19	C43-6	2.5 km	~ 4h – 15h
2018 January 10	C43-5	1.4 km	~5h – 17h
2018 February 1-28	*No observations due to February shutdown*		
2018 March 1	C43-4	0.78 km	~ 8h – 21h
2018 March 30	C43-3	0.50 km	~ 10h – 0h
2018 May 15	C43-2	0.31 km	~ 12h – 3h
2018 June 15	C43-1	0.16 km	~ 14h – 5h
2018 July 15	C43-2	0.31 km	~ 17h – 7h
2018 August 15	C43-3	0.50 km	~ 18h – 8h
2018 August 30	C43-4	0.78 km	~ 19h – 9h
2018 September 15	C43-5	1.4 km	~ 20h – 10h

Restrictions:

1. Band 9, 10 obs's not scheduled outside LST-ranges in column 4.
   Band 7, 8 may be, but not recommended;

2. Hi-freq Bands 7, 8, 9, 10 + Band 5 not recommended around Altiplanic winter (esp. Dec-Feb) at any LST;

3. Projects that have imaging (config) requirements and time constraints that do not coincide cannot be scheduled.

PROPOSAL GRADING

Accepted projects are grades based on science rank, executive balance, scheduling feasibility:

Grade A (up to 33%) B (up to 67%) to fill up the nominal amount of available science time
Grade C: up to an additional 50% of the total available time to ensure availability of adequate number of projects for all configs and LST in case actual obs efficiency or weather cond's differ from expectations.

Only grade A are eligible to be rolled over to Cycle 6, if necessary

Restrictions:

1. VLBI props must be accepted by ALMA and VLBI network review; cannot get grade A or C;
2. LPs must get A to be accepted
3. Proposals needing band 7 daytime obs's unlikely to get grade C (still valid x Cycle5?)
4. Non-standard proposals not eligible to receive grade C (still valid x Cycle 5?)
   i.e. projects for bands 8, 9, 10 cannot be fillers.

OBSERVING PRESSURE

Strong LST (histogram) and frequency (not shown) dependence of observing pressure => proposals with broad range of acceptable angular resolutions have better chance of being scheduled and executed.

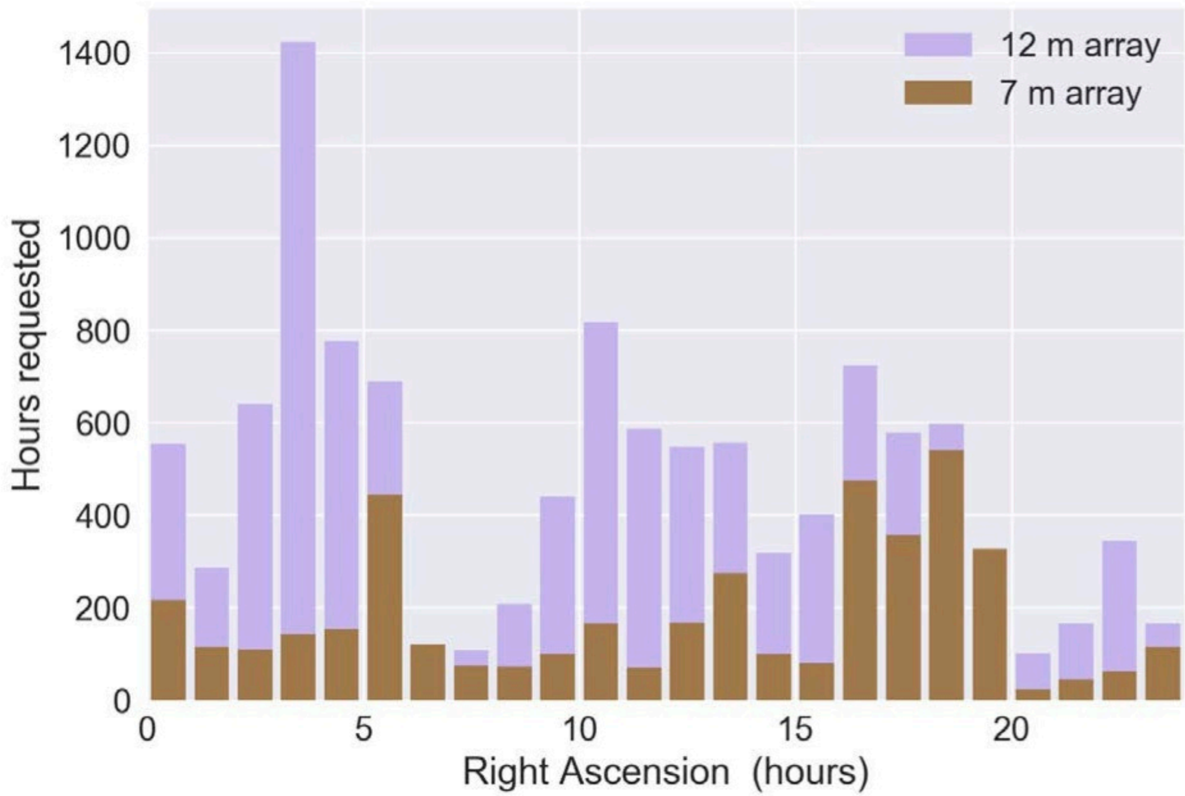


Figure 5: Distribution of requested 12-m Array time for the Cycle 4 proposals as a function of Right Ascension and colour-coded by array.

Table A-1: Angular Resolutions (AR) and Maximum Recoverable Scales (MRS) for the Cycle 5 Array configurations

Config	Lmax	Band	Band 3	Band 4	Band 5	Band 6	Band 7	Band 8	Band 9	Band 10
	Lmin	Freq	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	29.0"	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"	N/A	0.13"	0.089"	**0.067"**	**0.047"**	**0.035"**
	15 m	MRS	4.1"	2.7"		1.8"	1.2"	**0.89"**	**0.63"**	**0.47"**
C43-7	3.6 km	AR	0.21"	0.14"	N/A	0.092"	0.061"	**0.046"**	**0.033"**	**0.024"**
	64 m	MRS	2.6"	1.7"		1.1"	0.75"	**0.56"**	**0.40"**	**0.30"**
C43-8	8.5 km	AR	0.096"	0.064"	N/A	0.042"	**0.028"**	N/A	N/A	N/A
	110 m	MRS	1.4"	0.95"		0.62"	**0.41"**			
C43-9	13.9	AR	0.057"	0.038"	N/A	0.025"	N/A	N/A	N/A	N/A
	368 m	MRS	0.81"	0.54"		0.35"				
C43-10	16.2	AR	0.042"	0.028"	N/A	0.018"	N/A	N/A	N/A	N/A
	244 m	MRS	0.50"	0.33"		0.22"				

Notes for Table A-1:

1. See Chapter 7 of the Technical Handbook for relevant equations and detailed considerations.
2. Values evaluated for source at zenith. For sources transiting at lower elevations, the North-South angular measures will increase proportional to 1/sin(ELEVATION).
3. Lmax and Lmin are the maximum and minimum baseline lengths in the array.
4. All angular measures scale inversely with observed sky frequency.
5. Bold blue text indicates non-standard modes (Sect. 5.2).
6. Band 5 observations will start in March 2018, restricting the number of available configurations for this band in Cycle 5 (see Table 2: Planned 12-m Array Configuration Schedule for Cycle 5).

Resolution (arcsec):
$0.2 \times (300\text{GHz}/f)\ (1\text{km}/b_{max})$

MRS (arcsec):
$124 \times (1\text{m}/b_{min})\ (300\text{GHz}/f)$

FOV (arcsec):
$20.6 \times (300\text{GHz}/f)$

Blue: non-standard

MRS and Angular resolution

MRS = Maximum Recoverable Scale

Resolution (arcsec): 0.2 x (300GHz/f) (1km/b_{max})

MRS (arcsec): 124 x (1m/b_{min}) (300GHz/f)

FOV (arcsec): 20.6 x (300GHz/f)

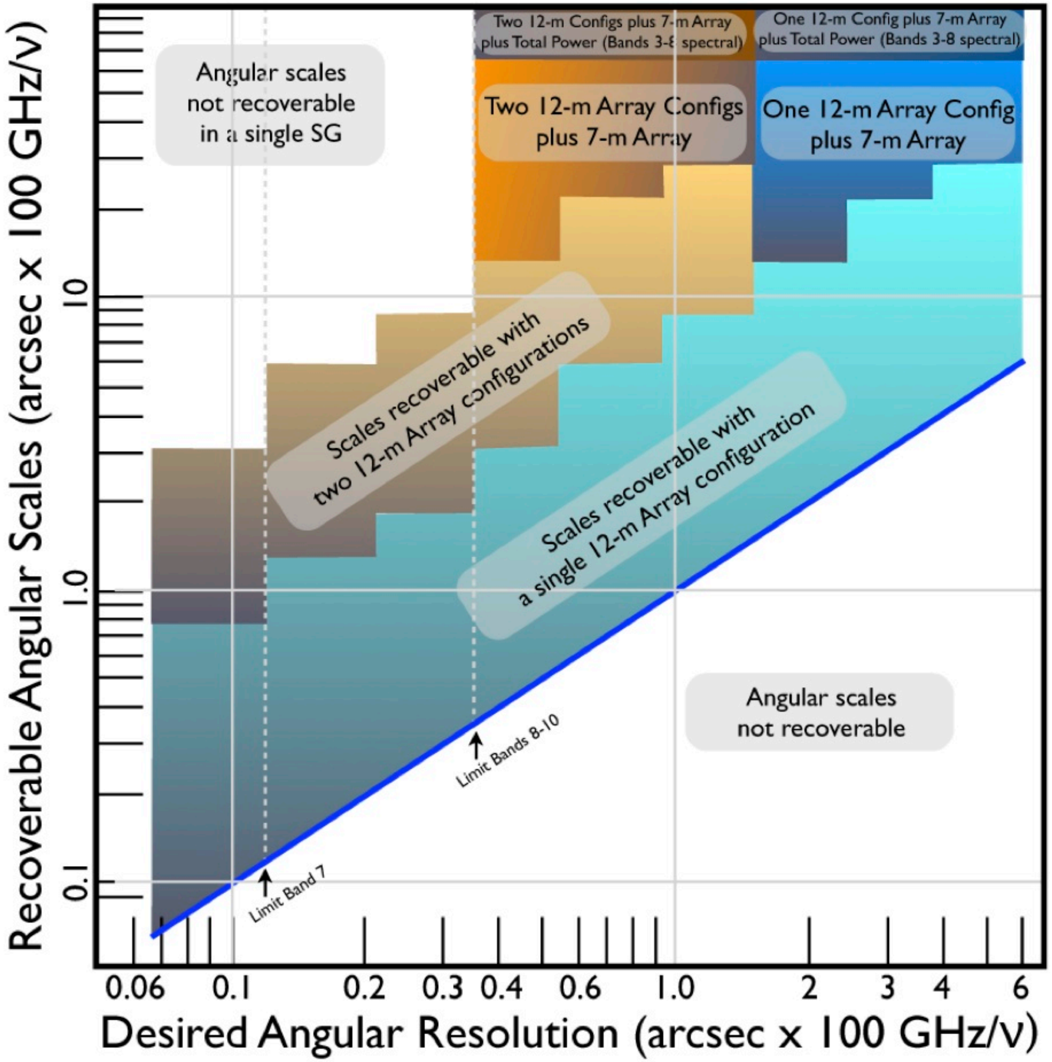
MRS is a "guideline for the largest angular structure on which some of the flux of a smooth structure can be reasonably recovered by the interferometer." (Cycle5 primer)

i.e. anything much larger will (start to) be 'resolved out': the **missing flux** problem, intrinsic to interferometers.

To recover this emission, additional observations needed, including observations with More compact configurations (with the 12-m array, the 7-m array, or single-dish [TP])

Only certain combinations of arrays are allowed – see next slides

MRS and Angular resolution



Useful figure to help you find whether more than one 12-m array configuration or a combination of arrays is needed to accommodate the MRS and angular resolution required by your project.

Allowed array combinations and time multipliers

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
7-m Array	TP			1	1.7
C43-1	7-m Array & TP	1		5	8.5
C43-2	7-m Array & TP	1		5	8.5
C43-3	7-m Array & TP	1		5	8.5
C43-4	C43-1 & 7-m Array & TP	1	0.4	5	8.5
C43-5	C43-2 & 7-m Array & TP	1	0.5	4.6	7.8
C43-6	C43-3 & 7-m Array & TP	1	0.4	2.3	3.9
C43-7	C43-4	1	0.4		
C43-8	C43-5	1	0.5		
C43-9	C43-6	1	0.5		
C43-10	-				

Notes for Table A-2:

1. See Chapter 7 of the Technical Handbook for relevant equations and detailed considerations.
2. Whether a more compact array configuration is needed is based on the user specified LAS compared to the MRS values corresponding to the more extended configuration, as listed in Table A-1. If the LAS is greater than the

Combining arrays can be very time consuming so choose wisely.

Spectral setup: sidebands, basebands & spectral windows

Observed sky frequencies need to be down-converted before being sent to the correlator.

For this to occur, the signal from the source is mixed with that of a (set of) Local Oscillator(s) which results in the creation of 2 sidebands, 'upper' and 'lower':

For the lower sideband (LSB): (F_{LO1} - IF_{lo}) to (F_{LO1} - IF_{hi})
For the upper sideband (USB): (F_{LO1} + IF_{lo}) to (F_{LO1} + If_{hi})

NB: for both polarizations!

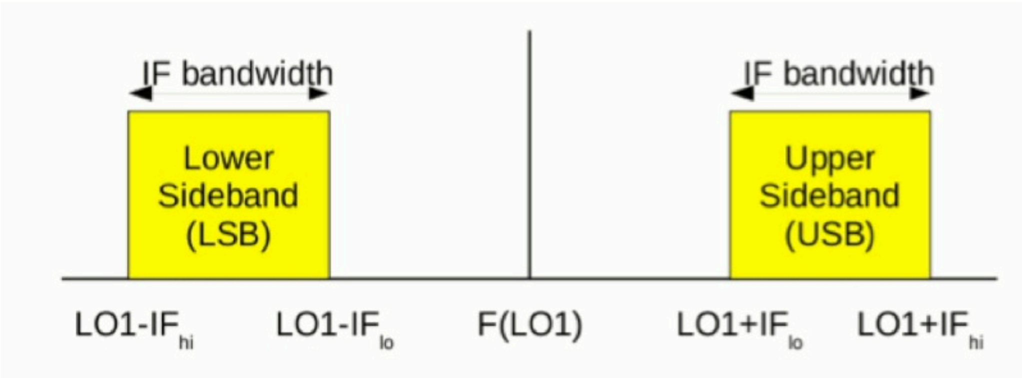


Figure 4.2: IF ranges for the two sidebands in a heterodyne receiver.

Spectral setup: sidebands, basebands & spectral windows

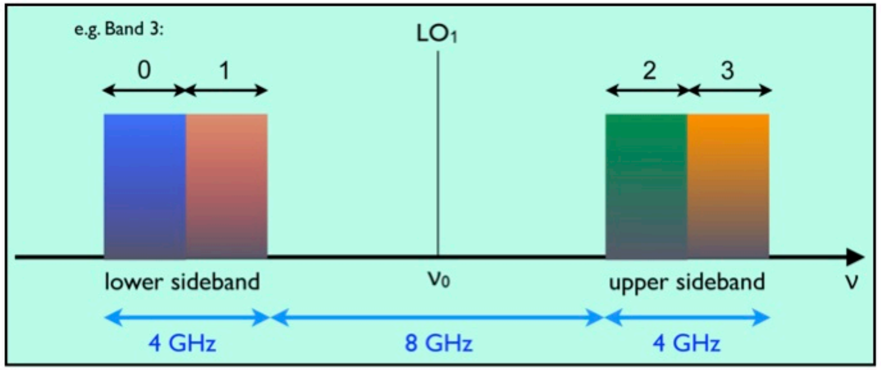


Figure 31: *A graphical view of basebands and sidebands. Basebands may be tuned to overlap if the user wishes, or may be located so as to maximize the total bandwidth (as shown). Each baseband may be further subdivided into as many as 8 spectral windows. Up to four spectral windows per baseband will be available during Cycle 5.*

Within these sidebands, ALMA produces 4 x 2 GHz basebands that can be placed inside each sideband.

NB: basebands are not independent: overlapping BBs do not reduce noise

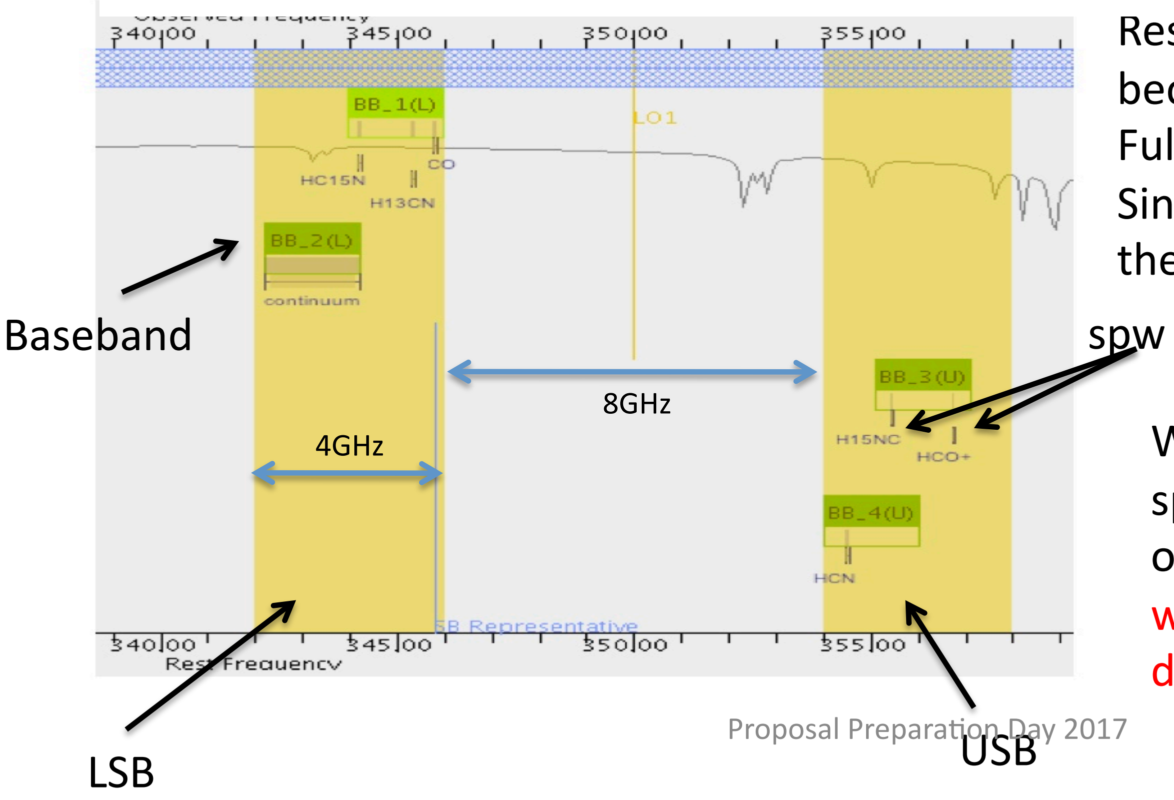
Spectral setup: sidebands, basebands & spectral windows

Table A-4: Properties of ALMA Cycle 5 Correlator Modes, dual-polarization operation [1,2]

Bandwidth (MHz)	Channel spacing[3] (MHz)	Spectral resolution (MHz)	Number of channels	Correlator mode[4]
1875	15.6	31.2	120	TDM
1875	0.488	0.976	3840	FDM
938	0.244	0.488	3840	FDM
469	0.122	0.244	3840	FDM
234	0.061	0.122	3840	FDM
117	0.0305	0.061	3840	FDM
58.6	0.0153	0.0305	3840	FDM

Continuum (BW_{tot} = 7.5GHz)

Spectral lines



Resolution = 2x channel spacing because of default Hanning smoothing.
Full Stokes => half the channels.
Single pol (instead of Dual): double the channels.

Within each baseband up to 4 spectral windows can be placed to observe lines. Spectral windows within a baseband can have different resolutions.

…AND FOR THOSE WHO SUCCEED, ANOTHER NOVELTY AWAITS:

In Cycle 4
the PI had to prepare the scheduling blocks

BUT

In Cycle 5
the PI only has to approve the Phase2 SGs

JAO will create the SBs for all accepted proposals centrally and simultaneously

PI can make corrections (small) or submit change requests (larger)
and can always ask for help from Contact Scientist (= us at the ARC)

BUT

Outcome of proposal reviews made known late July, and approval has to be given by **7 September**. PIs are away and ARCs are understaffed during vacation- and conference season so **DO NOT WAIT UNTIL THE LAST MOMENT WITH CHECKING AND APPROVING SGs** just in case problems arise and help is needed. **There will be Phase2 delegation, however (i.e. non-PI submission Phase2).**

USEFUL LINKS

Italian ALMA Regional Centre @ INAF-IRA Bologna: http://www.alma.inaf.it

Science Portal: https://almascience.eso.org/

Proposer's Guide
https://almascience.eso.org/documents-and-tools/cycle5/alma-proposers-guide

ALMA Primer
https://almascience.eso.org/documents-and-tools/cycle5/alma-early-science-primer

Observing Tool
https://almascience.eso.org/documents-and-tools/proposing/observing-tool/
https://almascience.eso.org/documents-and-tools/cycle5/alma-ot-usermanual

Technical Handbook
https://almascience.eso.org/documents-and-tools/cycle5/alma-technical-handbook

Knowledgebase/FAQ
https://help.almascience.org/index.php?/default/Knowledgebase/List
Helpdesk: https://help.almascience.org/

CHECK THE ARCHIVE BEFORE WRITING THE PROPOSAL