ALMA Telescope and its Cycle 3 Capability

ALMA EA Korea node

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of the European Organisation for Astronomical Research in the Southern Hemisphere (ESO), the U.S. National Science Foundation (NSF) and the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Republic of Chile. ALMA is funded by ESO on behalf of its Member States, by NSF in cooperation with the National Research Council of Canada (NRC) and the National Science Council of Taiwan (NSC) and by NINS in cooperation with the Academia Sinica (AS) in Taiwan and the Korea Astronomy and Space Science Institute (KASI).

Korean Flag at OSF at 2900m

Locations of ALMA and GMT

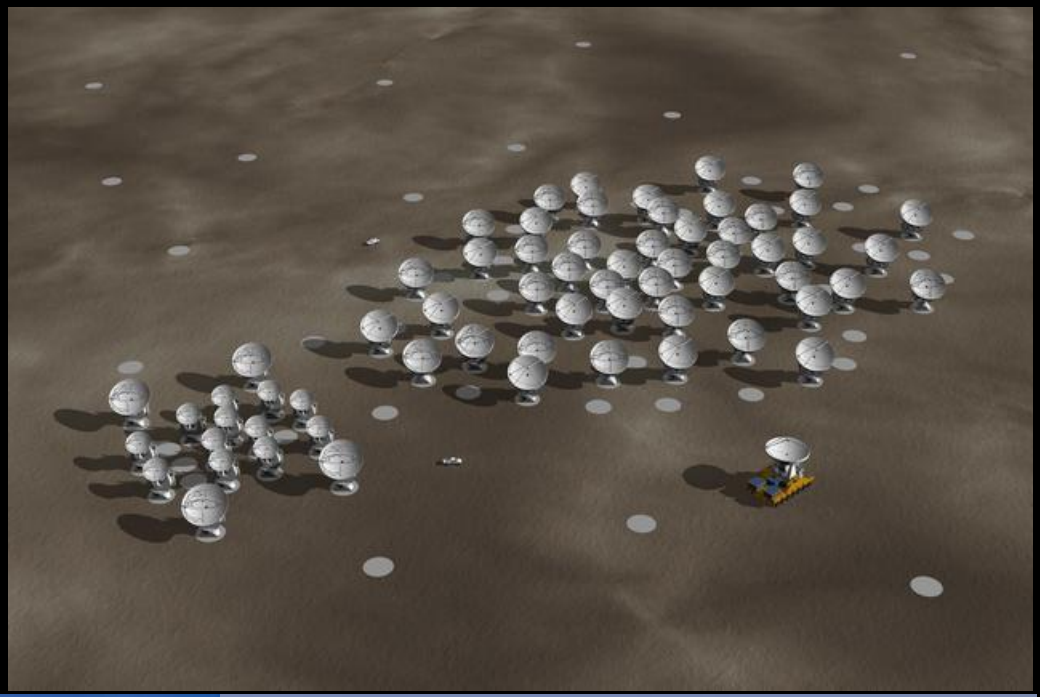
Antennas

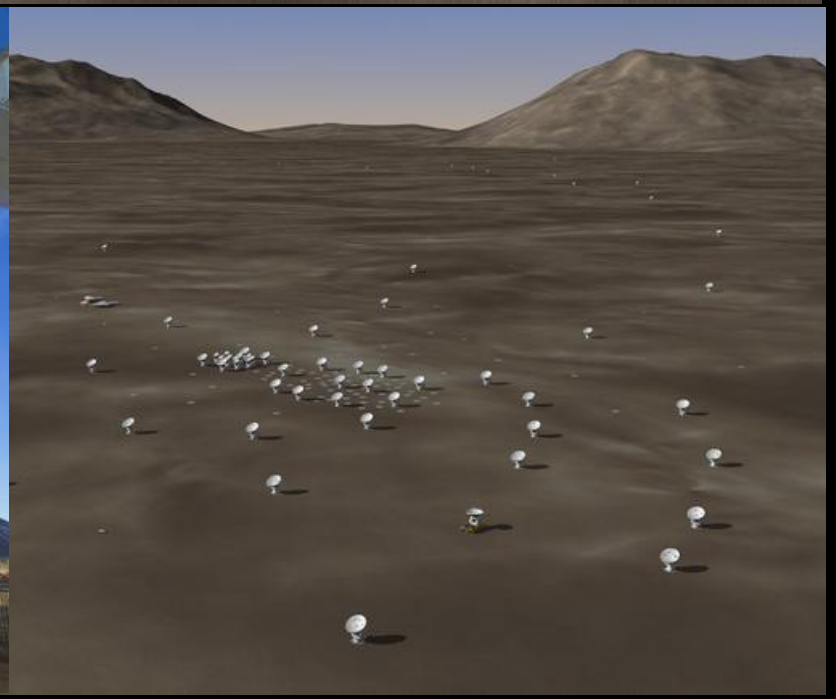
50x12m-Array

ACA: 12x7m-Array

4 12m-TP Array

Longest baseline: 16 km

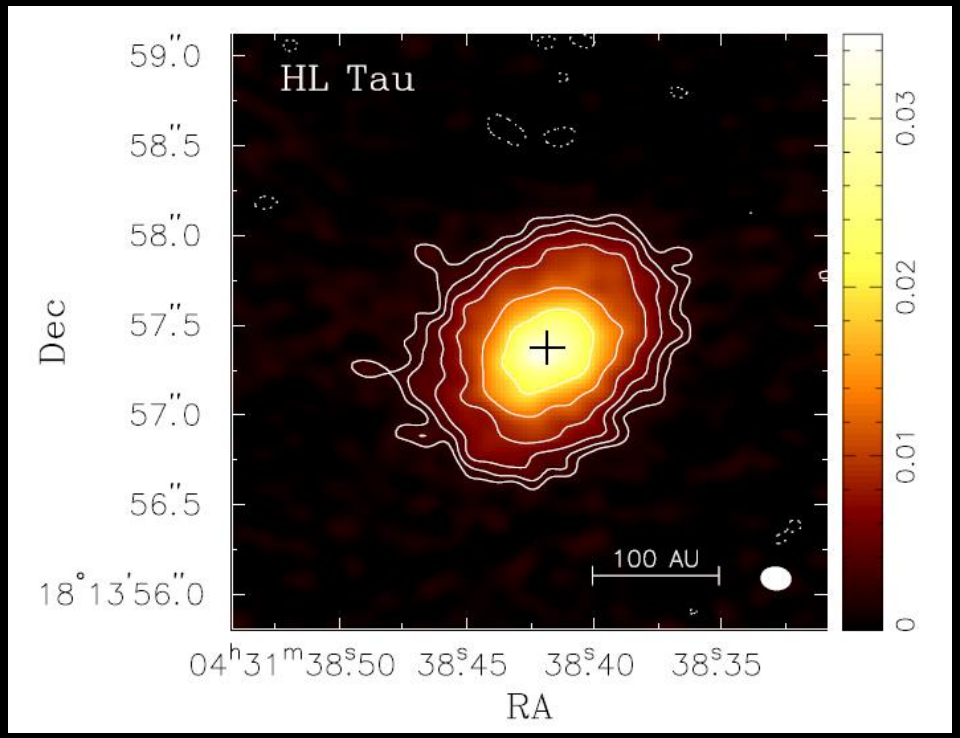


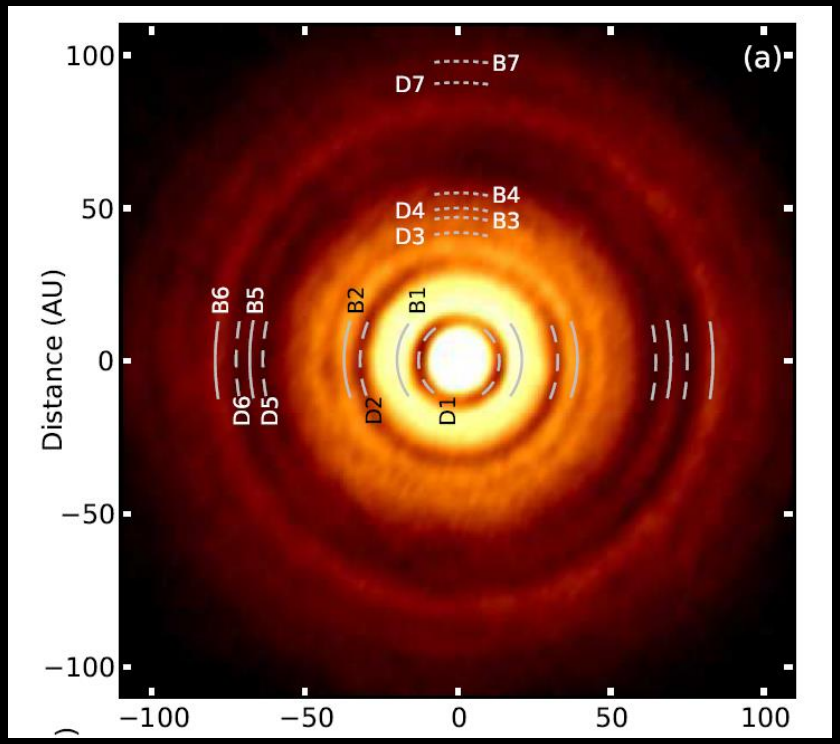


ALMA

Atacama Large Millimeter/Submillimeter Array

CARMA vs. ALMA





0.13 arcsec@1.3mm
Kwon+ 2011

0.035 arcsec@1.3mm
4.5 hour on-source time
SV for long-baselines
ALMA partnership+2015

Key dates for Cycle 3

- 24 March 2015: release of OT, start of proposal submission
- 23 April (15:00UT) 2015: Proposal deadline
- August 2015: Result of proposal review
- 1 October 2015: start of observations
- 30 September 2016: end of observations

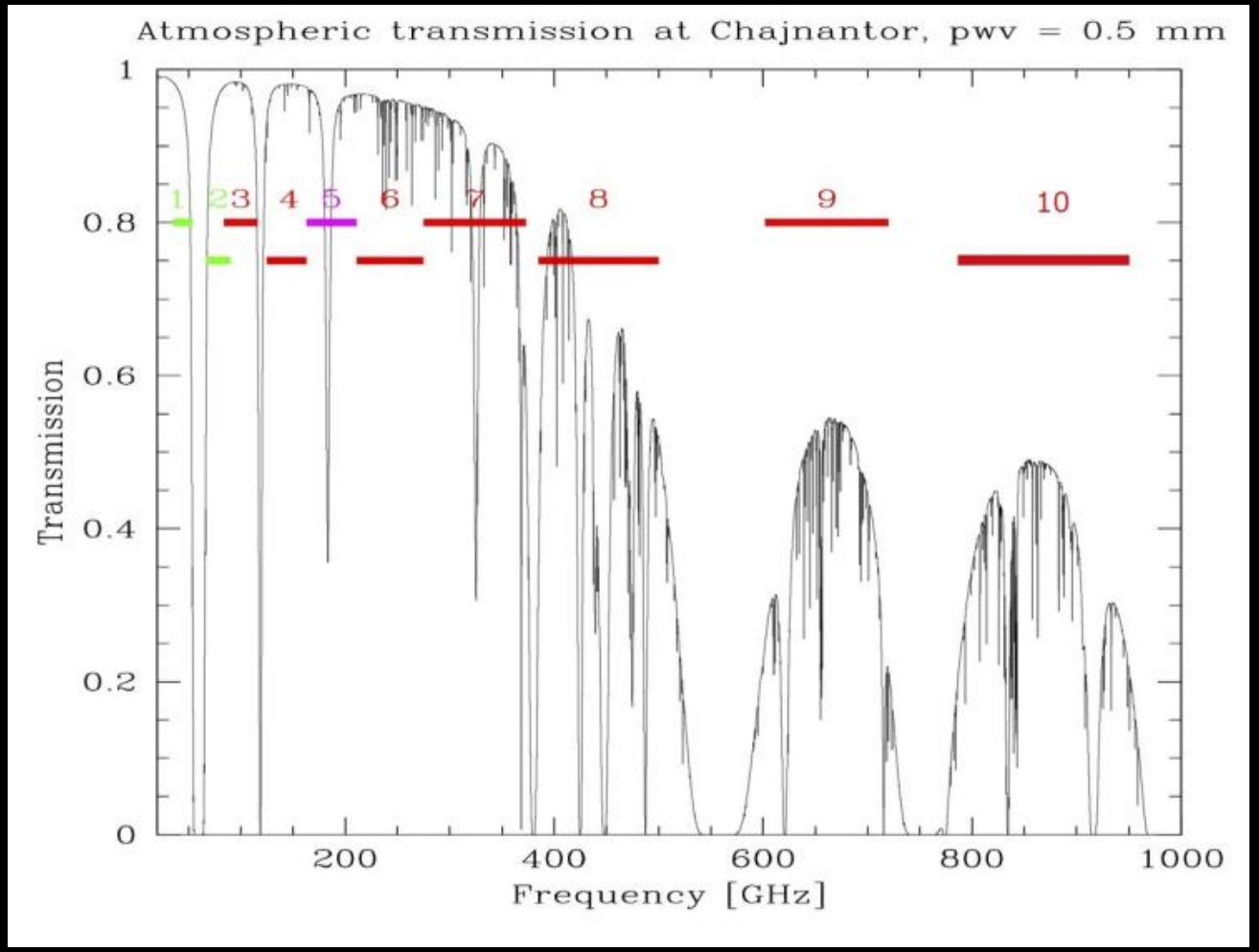
Total time and regional share

- Total observation time
  - 2100 hours (including A-graded C2 proposals) for each of 12-m Array and ACA
- Regional Share
  - 22.5% for EA
  - 33.75% for EU
  - 33.75% for NA
  - 10% for Chile

Antennas

- 12m-Array: 36
- ACA Array: complementary to 12m Array
  - 10 for 7m array
  - 2 for single-dish observation

Atmospheric Transparency



Receivers

- B3,4,6: up to 10 km
- B7: up to 5 km
- B8,9,10: up to 2 km

Band	Frequency range[1] (GHz)	Wavelength range (mm)	IF range	Type
3	84 – 116	3.6 – 2.6	4 – 8	2SB
4	125 – 163	2.4 – 1.8	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

Scheduling of Observing Band

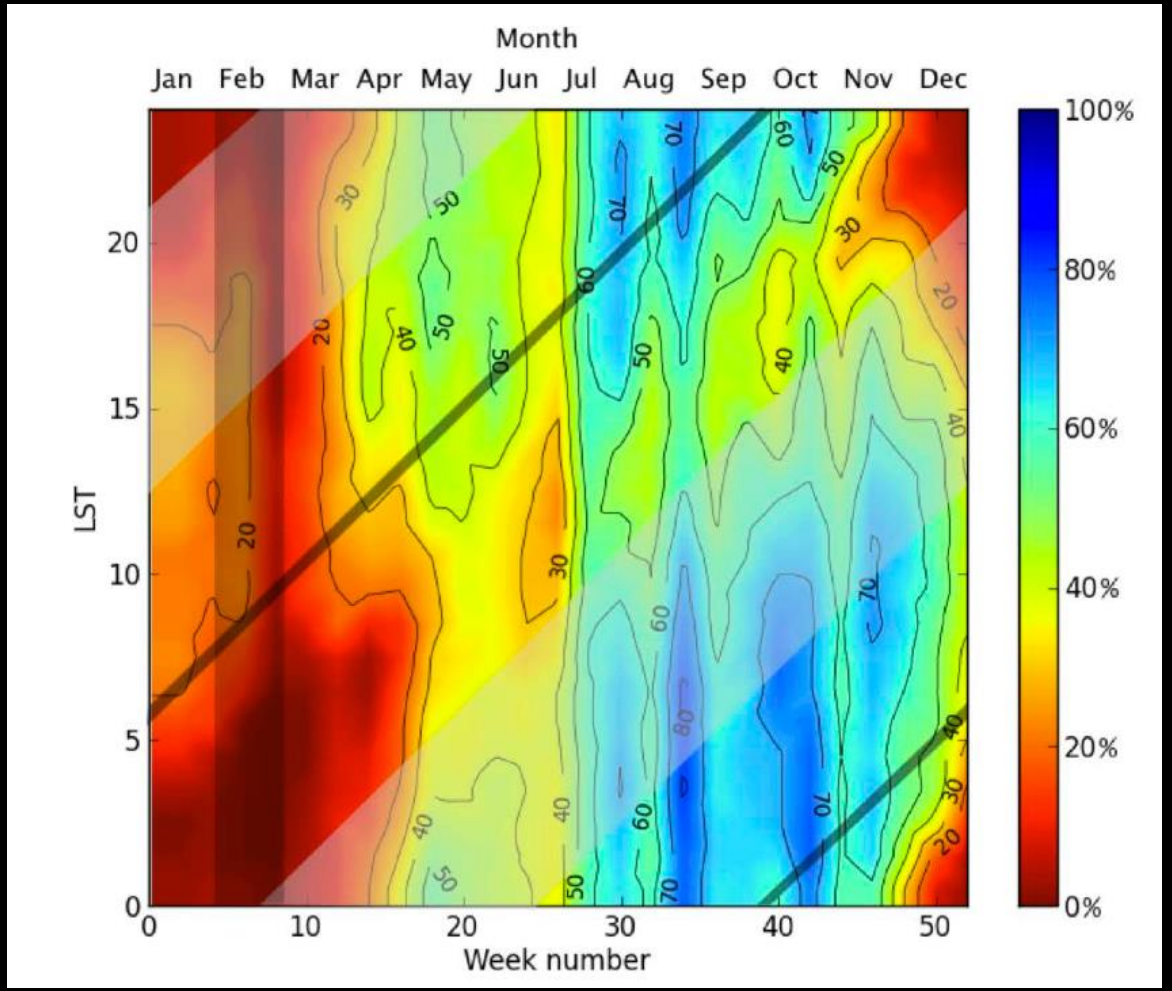


Table 2: Estimated maximum fraction of observing time suitable for observations in each band in Cycle 3

ALMA Band	Band 3	Band 4	Band 6	Band 7	Band 8	Band 9	Band 10
Fraction of time	100%	90%	70%	40%	20%	10%	10%

12-m, 7-m Array Configurations

- 8 configurations with 36 12m array
  - Six configurations with max baseline from 160m to 2 km
  - One configuration with max baseline 5 km
  - One configuration with max baseline 10 km
- One configuration with 10 7m array

12m configuration Schedule

Start Dates	Configuration	Night LST	Not recommended
2015 October 1	C36-8	~17h - 9h	High frequency projects especially during day time (LST ~10h-16h)
2015 November 10	C36-7	~19h - 11h	High frequency projects especially during day time (LST ~12h-18h)
2015 December 29 (Maintenance in February)	C36-1	~00h - 16h	High frequency projects any time , specially during day time (LST ~17h-23h)
2016 March 22	C36-2	~04h - 20h	High frequency projects day time (LST ~21h-03h)
2016 April 19	C36-3	~07h - 23h	High frequency projects day time (LST ~00h-06h)
2016 May 10	C36-4	~08h - 00h	High frequency projects day time (LST ~01h-07h)
2016 May 31	C36-5	~10h - 02h	High frequency projects day time (LST ~03h-09h)
2016 July 5	C36-6	~13h - 05h	High frequency projects especially during day time (LST ~06h-12h)
2016 August 30	C36-7	~16h - 08h	High frequency projects especially during day time (LST ~09h-15h)

12-m Array configurations

Frequency	Maximum Recoverable Scale without ACA[2,3]	Coarsest allowed angular resolution[2,3,4]	Finest achievable angular resolution[2,3,5]
(GHz)	(arcsec)	(arcsec)	(arcsec)
100	25.3	6.8	0.075
150	16.9	4.6	0.050
230	11.0	3.0	0.030
345	7.3	2.0	0.034
460	5.5	1.4	0.060
650	3.9	1.0	0.040
870	2.9	0.8	0.030

$$\theta_{MRS} \approx \frac{1.2\lambda}{2L_{\min}}$$

$$\theta_{CAR} \approx \frac{2\lambda}{166m}$$

$$\theta_{FAR} \approx \frac{\lambda}{10/5/2\,\mathrm{km}}$$

7-m Array Configuration, TP

Frequency (GHz)	Maximum Recoverable Scale[1,2,3] (arcsec)	
	7m	TP
100	42.8	62
150	28.5	41
230	18.6	27
345	12.4	18
460	9.3	13
650	6.6	
870	4.9	

$$\theta_{HFBW} \approx \frac{\lambda}{12m}$$

Time Estimates for mult-conf.

- Rule of thumb
  - estimate dt_ex, for 12-m extended configuration
  - 4*dt_ex for TP
  - 2*dt_ex for 7-m Array
  - 0.5*dt_ex for 12-m compact configuration
- Use OT
- Total time (12-m+ACA) < 100 hours

Spectral Capability

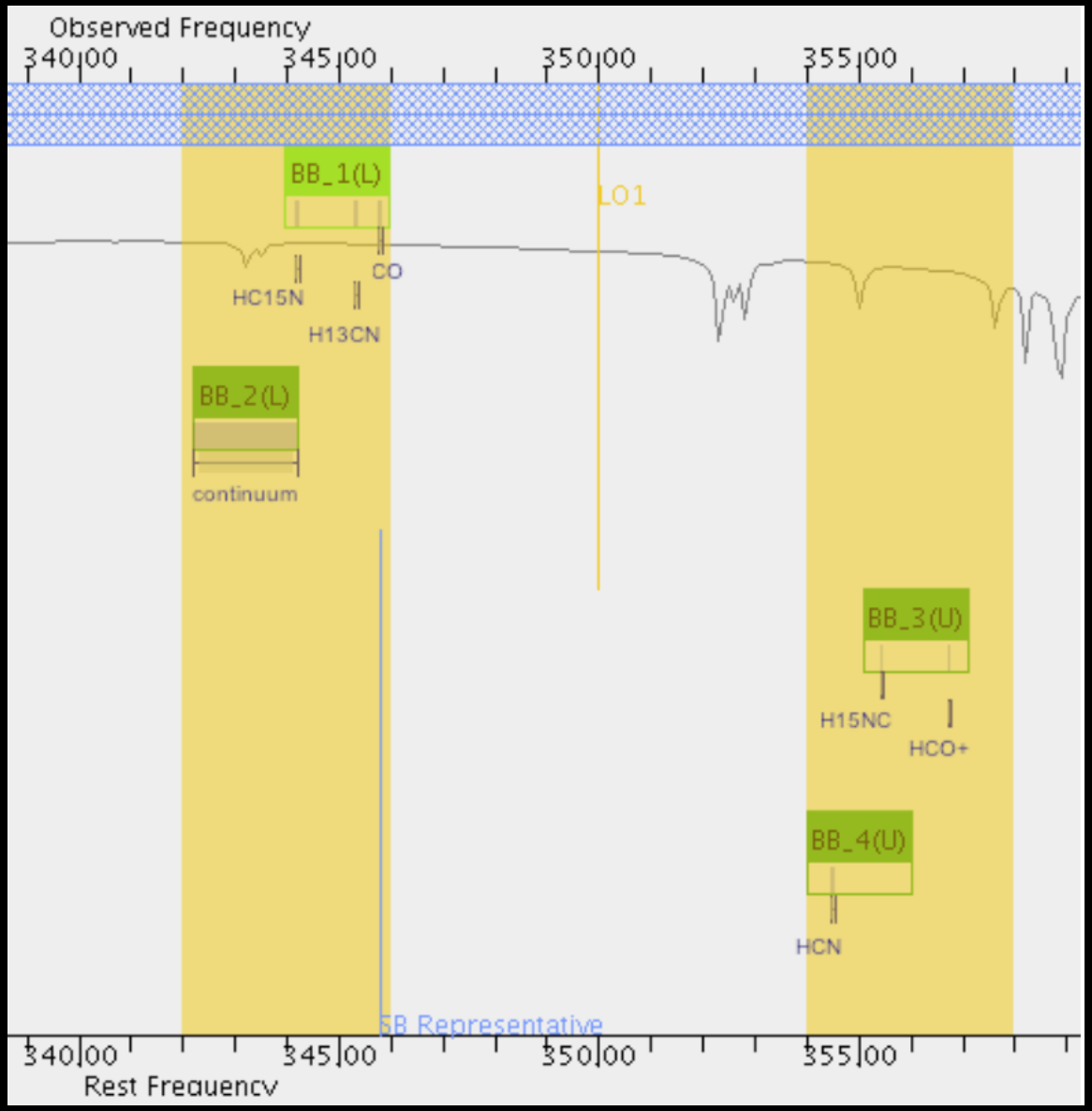
Number of BBs in 2SB in each sideband: 0, 1, 2, 4

Number of BBs in DSB (B9): no restriction

Spw in each BB: up to 4, share correlator resource among them

Should have same correlator mode with a BB

Binning of data of power 2 mainly due to limitation of data rate, maximum 60MB/s, average 6MB/s. Justify if you use more than 2x6MB/s



Correlator mode for dual pol

Bandwidth[3] (MHz)	Channel spacing[4] (MHz)	Spectral resolution (MHz)	Number of channels	Correlator mode
2000[3]	15.6	31.2	128[3]	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

Polarization

- Single Polarization, XX: more bandwidth or more spectral resolution
- Dual Polarization XX, YY: improve sensitivity of sqrt(2) compared with single pol case
- Full polarization XX, XY, YX, YY:
  - continuum obs in Band 3,6,7
  - LAS < 1/3 12-m primary beam, one field per source
  - Fixed frequencies
  - More than 3 hours for parallactic angle coverage

Band	SPW1	SPW2	LO1	SPW3	SPW4
	(GHz)	(GHz)	(GHz)	(GHz)	(GHz)
3	90.5	92.5	97.5	102.5	104.5
6	224.0	226.0	233.0	240.0	242.0
7	336.5	338.5	343.5	348.5	350.5

Standard vs. Non-standard

- Standard observing mode (75%) : data can be reduced by pipeline
- Non-standard observing mode (25%)
  - Bands 8,9,10 observations
  - Long baseline > 2 km
  - Polarization
  - Spectral Scans
  - Bands 7,8,9,10 with narrow spectral windows < 934 MHz
  - Non-standard calibrations

Source restrictions

- “SG(Science Goal): single angular resolution, sensitivity, Largest Angular Scale(LAS), receiver band
- No restriction on number of SG per proposal
- Total # of positions with 10 deg < 150 per SG per array
- One mosaic observing mode < 150 positions per SG

Astrometry

- Select user defined calibration
- Add the desired astrometric reference sources
- Position accuracy for baselines > 1 km is less than 0.01 arcsec

Calibration

- ALMA has good calibration strategies
- Dynamic range (ratio of peak to rms in the final image)
  - ACA and compact configuration of 12m array: 100
  - DR = 50 for extended configuration or Bands 9,10.
- Absolute Amplitude calibration
  - Better than 5% in B 3,4, 10% in B 6,7, 20% in B 8,9,10
- Bandpass accuracy
  - SN ratio per spectral resolution: 1000 in Bands 3,4,6 and 500 in Bands 7,8,9,10

ToO

- Only 12-m array
- < 2 weeks monitoring projects are unlikely fully observed
- within 2 weeks contact with the ALMA observatory can not be guaranteed
- Proposals requesting more than 2 hour good weather condition will be rejected.
- continuously monitoring observations, 3 hours for Band 3-7, 2 hours for Band 8-10

Limitations

- Maximum obs. Time, 100h (12m+ACA) per proposal
- The TP Array is only available for spectral line (no continuum) observations in Bands 3,4,6,7,8 (no 9,10)
- Polarization: on-axis, continuum in Bands 3,6,7 for 12m array. No ACA, no mosaic, no spectral line, no circular polarization

Priority flags of Proposals

- A: HP, 20% of 12m time, carry-over to Cycle 4
- B: HP, not carry-over to C4
- C: filler
- U: unsuccessful
- I: rejected because of technically infeasible with the C3 capability
- O: not observed because of duplication with a high-ranked project

Duplication

- Duplication check against C3 proposals, C2 grade A, C1 and C2 proposals with archived data (no check against C0)
- A SG will be considered a duplication of another SG only if the observations are judged scientifically equivalent.

Documents for Cycle 3 proposals

- Proposers Guide
  - Appendix A (Capability)
  - Appendix B (duplication)
  - Appendix C (Technical Justification)
- Early Science Primer
- Technical Handbook
- …

ALMA Project Group

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