ALMA Overview and Status

ALMA Community Days 2015

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ALMA Overview

- Aperture synthesis array for (sub)mm wavelengths of 10 mm – 0.3 mm (35 – 950 GHz)
- High, dry site, Chajnantor Plateau, Chile (5000m)
- 66 antennas (54 x 12m + 12 x 7m)
- Baselines from ~15 m to 16 km
- Resolution/arcsec ≈ 0.2(λ/mm)/(max baseline/km)
  - 5 mas for highest frequency/longest baseline
- Field of view / arcsec ≈ 17 (λ/mm) [12m dish]
- Sensitive, wide-band (8 GHz) receivers; full pol.
- Flexible digital correlator giving wide range of spectral resolutions.
ALMA Configurations

Most compact configuration (d ~ 150m): 0.5" … 5"

Demonstrated in 2014: most extended configuration (max 16km): 0.005" … 0.05"
OSF – Operations Support Facility

- Altitude 2900 m
- ALMA control room
- Technical labs
- Dormitories & canteen

ALMA Residence (under construction)
## Receiver Bands

<table>
<thead>
<tr>
<th>ALMA Band</th>
<th>Frequency Range (GHz)</th>
<th>Receiver Noise (K) over 80% of the RF band</th>
<th>Temperature (K) at any RF Frequency</th>
<th>produced by</th>
<th>Receiver Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31 - 45</td>
<td>17</td>
<td>26</td>
<td>tbd</td>
<td>HEMT</td>
</tr>
<tr>
<td>2</td>
<td>67 - 90</td>
<td>30</td>
<td>47</td>
<td>tbd</td>
<td>HEMT</td>
</tr>
<tr>
<td>3</td>
<td>84 - 116</td>
<td>37</td>
<td>60</td>
<td>HIA</td>
<td>SIS</td>
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<tr>
<td>4</td>
<td>125 - 163</td>
<td>51</td>
<td>82</td>
<td>NAOJ</td>
<td>SIS</td>
</tr>
<tr>
<td>5*</td>
<td>162 - 211</td>
<td>65</td>
<td>105</td>
<td>NOVA/OSO</td>
<td>SIS</td>
</tr>
<tr>
<td>6</td>
<td>211 - 275</td>
<td>83</td>
<td>136</td>
<td>NRAO</td>
<td>SIS</td>
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<tr>
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<td>275 - 373</td>
<td>147</td>
<td>219</td>
<td>IRAM</td>
<td>SIS</td>
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<td>385 - 500</td>
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<td>SIS</td>
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<td>602 - 720</td>
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<td>261</td>
<td>NOVA</td>
<td>SIS</td>
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<td>787 - 950</td>
<td>230</td>
<td>344</td>
<td>NAOJ</td>
<td>SIS</td>
</tr>
</tbody>
</table>

* Full Band 5 production from 2013 – 2017, Bands 1 and 2 TBD
ALMA Bands & Atmosphere

Chajnantor Atmospheric Transmission

- pwv = 0.5mm
- Cycle 0 and Cycle 1
- new in Cycle 2
- under Construction
- new in Cycle 3

Frequency (GHz)

(Adapted from P. Schilke)
Band 7 Performance

- Sensitivity ~2 times better than specification
Band 9 Performance

- Sensitivity up to 2 times better than specification

![Graph showing Band 9 Performance](image)
Construction Status

- Construction formally finished end of 2014
  - All 66 antenna elements equipped with 7 rx bands
  - Construction accounts mostly closed
  - Manufacturer warranty mostly expired

- Some items are ongoing
  - CSV/EOC (Extension of Capabilities)
  - Construction of ALMA Residence (ESO)
  - Vertex antenna astigmatism (NRAO)
  - Front End Handling Vehicle (NRAO)
  - ACA correlator topics (NAOJ)
Finalization of Modes needed for Full Operations

(From: S. Corder et al., 2015, final draft, “ALMA Transition To Steady State and Full Operations”)

- Long baseline capability [COMPLETE]
- All construction bands [COMPLETE]
- Solar observing
- Final polarization modes
- Improvements needed at high frequency
- Final implementation of single dish capabilities
- Long integration capability (at least 24 hours)
- Repeatable precision observations
ALMA Residence

- Last deliverable of ESO
- Modular concept with 6 dormitory buildings
ALMA Community Days | 13 - 15 Apr 2015
Residence Construction started

- In February 2015, the construction of the ALMA Residence has started, ongoing heavy earth works.
- Construction duration ~18 months.
0 – 90° astigmatism, amplitude $\propto$ temperature
- Cabin deformation + yoke
- Known at acceptance, but coefficient underestimated
- Correct value $d(\text{rms})/dT \approx 0.7\mu m/K$ (tower and astro-holography) due to astigmatism alone
  - Antenna surfaces are optimized at $\approx 7$C, rather than mean ops temp
  - Surface is typically out of specification ($>25\mu m$ rms) at low temperatures (= best night-time conditions)
  - Efficiency typically $\sim 20\%$ lower than AEM/Melco antennas at 690GHz

Corrective action
- Optimize surface correctly for -5C
  - Antennas in specification under almost all night-time conditions
  - Straightforward at OSF
  - More efficient at AOS, but riskier
- Use local heating to fix the problem
  - needed for daytime operation
  - under investigation
ACA Correlator

- Three technical issues (info from EA PM)
  - 3-bit linearity correction
  - Robustness improvement
  - Subarray mode

- Work is in progress
  - Verification at AOS (except subarray mode) ongoing, firmware problems found
  - No big impact for Cycle 2 obs. and science capabilities
  - Resolution before start of Cycle 3 (except Subarrays)

- Subarray mode
  - No issue for Cycle 3, plan to resolve it for Cycle 4
Development Projects

■ Band 5 (167-211GHz) full production (EU-led)
  ➢ Integration of first cartridge at OSF this month

■ Fibre connection OSF – Santiago (JAO-led)
  ➢ Technically complete, permits pending

■ ALMA phasing project/VLBI (NA-led)
  ➢ Technical implementation ongoing, aim to offer it in Cycle 4, operations model under discussion

■ Band 1 (EA-led)
  ➢ Building & testing prototype receiver

■ Band 2 prototype (NA), Band 2&3 study (EU)