ALMA Operations

- One call for Proposals per year (TBC)
- One single Time Allocation Committee for NA+EU+EA+Chile
- Service observing
  - PI not involved in the observations
- Dynamic scheduling
  - Best project in the queue determined every SB (hour scale)
  - Depends on weather + configuration + priority + balance between partners
ALMA Operations

- **Calibration and imaging pipeline**
  - Final product = data cube

- **Archive**
  - Raw data + pipeline products
  - Public after 12 months

- **ALMA Regional Centers (ARC)**
  - Scientific operations & user support outside Chile
  - Contact point between users and ALMA
  - Three ARCs
European ARC

Core tasks → ESO Garching
- Call for proposals, Phase I, Phase II
- Basic user support (helpdesk)
- Data product support = delivering data and software
- ALMA archive operations

http://www.eso.org/sci/facilities/alma/arc/

Same services are provided at
Charlottesville (NAASC) and Tokyo
European ARC

Additional tasks → ARC nodes
- User formation & community development
- **Face-to-face support** (core task)
- Special projects (extended archive & data reduction support)
- New developments

**Seven ARC nodes in Europe**
- INAF Bologna (I)
- Univ. Bonn (D)
- IRAM (F,D,E)
- Leiden Obs. (NL)
- Manchester Obs. (UK)
- Onsala Obs. (S,DK,SF)
- Prague (CZ)

- All nodes open to all European scientists but target own community
- **IRAM → French, German, and Spanish communities**
IRAM ARC node

www.iram-institute.org
arc@iram.fr

- New service provided by IRAM to French/German/Spanish community
- Based on PdBI user support + involvement in ALMA construction

User support  f2f support  Expertise center

ALMA Early Science  Proposal Preparation

Software dev.
Commissioning
D.Broguiere, A.Castro –Carrizo
M.Krips, V.Pietu
Welcome to the IRAM ARC Node

IRAM has established an ALMA user support center, which forms a node of the European ALMA Regional Center (ARC). The ARC nodes are providing support to the community in the preparation of ALMA observing proposals and in the data processing and analysis.

The ARC node is a new service provided by IRAM, open to all interested scientists with special emphasis on the German, French, and Spanish communities. More about the IRAM ARC node.

ALMA Early Science: Cycle 0

The first Call for Proposals for ALMA Early Science has been issued on March 30th 2011. Deadline is June 30th.
ALMA Early Science: Cycle 0

The first Call for Proposals for ALMA Early Science has been issued on March 30th 2011. Deadline is June 30th 2011 15h UT. The Call can be found on the ALMA Science Portal (click on the Call for Proposals tab).

The Early Science ALMA will consist of 16 antennas, equipped with bands 3, 6, 7 and 9. Two configurations, with baselines up to 400 m will be available. The observations will be performed on a best-effort basis only.

- Project timeline: check the How to use ALMA pages (checked & updated May 17th 2011)
- Correlator modes during Cycle 0.

Observing with ALMA: Early Science
Time Allocation Committee

- One single TAC for NA + EU + EA + Chile
  - Chair: N. Evans (Texas)

- Panels (ARP = ALMA Review Panels):
  - Cosmology and high redshift universe
  - Galaxies and galactic nuclei
  - ISM, star formation/protoplanetary disks and their astrochemistry, exoplanets
  - Stellar evolution, (the Sun) and the solar system

- ≥ 1 panel per science category
- 8 members per panel; list (probably) not public
Time Allocation Committee

- **Step 1**: ARPs meetings
- **Step 2**: APRC (ALMA Proporal Review Committee)
  - Chair: Neal Evans (not an ARP member)
  - Members: ARP chairs and deputy chairs
  - Merge outputs of individual ARPs into a single ranked list
    - With the aim to ensure that each region gets its share of ALMA time
      - **Time charged on PI affiliation**
- **Step 3**: Directors Council – final decision
Each proposal will be assigned a grade

- **A: highest priority proposals** < 20% of the available time
- **B: high priority proposals**
  - to be scheduled at lower priority than grade A proposals
  - A+B proposals account for 100% of the available time
- **C: scientifically fruitful proposals to be observed only as fillers**
  - to be observed only if no higher grade proposal for current conditions
  - ~50% oversubscription of available time
- **D: proposals rejected**
ALMA observing time

- No guaranteed time
- One single TAC for NA+EU+EA+Chile
- A world-wide collaboration
  - EU 33.75%, NA 33.75%, EA 22.5%, Chile 10%
  - In ESO: D~21%, F~16%, E~9%
  - In ALMA: D~7%, F~5.5%, E~3%

- IRAM community ~ 15%
- Cycle 0: plan to accept ~100 projects
- ALMA received 601 notice of intend in April...

- Expect huge competition
Cycle 0
ALMA Cycle 0

Cycle 0 call for proposals - timeline

- Issued March 30\textsuperscript{th} 2011
- Archive open June 1\textsuperscript{st}
- Deadline June 30\textsuperscript{th} 2011 15h UT
- ARP, APROC meetings August 2011
- September 2011: outcome of the proposal review process
- 30 September 2011: start of Cycle 0 science observations

- March/April 2012: expected deadline for Cycle 1 proposal submission
- 30 June 2012: end of Cycle 0
Cycle 0 call for proposals - policies

- Will allocate max. 500-700 hours observing time, in blocks of 8-12 hours
- OK: normal projects (<100h), Target of Opportunities
- NO: large projects (>100h)
- **Typical project duration = 5-7 hours**
- **Expect ~100 projects to be accepted**

- Open sky policy
- Basic quality checks done by JAO/ARC
- **12 months proprietary period** after dataset ready for delivery
ALMA Cycle 0

Cycle 0 call for proposals – best effort

- **Top priority is construction & commissioning of ALMA**
- Do not guarantee observations of all accepted projects
- Projects are not carried over to Cycle 1 if not observed
- Basic data quality check only
- PIs should invest own time and expertise in data reduction
Notice of intents

- ALMA asked for Notice of Intent April 29th
- Not mandatory, no commitments
- ALMA received **601 NoI**
  - Somewhat flat distribution as a function of configurations, receiver bands, scientific categories
- Expect a huge competition!
Cycle 0 array

**ALMA Cycle 0**
- 16 antennas
- 4 bands: B3, B6, B7, B9
- Baselines up to 400 m
- Mosaics up to 50 fields
- Calibration accuracy “as good as current arrays”

<table>
<thead>
<tr>
<th>ALMA</th>
<th>IRAM</th>
<th>GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>B3</td>
<td>B1</td>
<td>84-116</td>
</tr>
<tr>
<td>B6</td>
<td>B3</td>
<td>211-275</td>
</tr>
<tr>
<td>B7</td>
<td>B4</td>
<td>275-373</td>
</tr>
<tr>
<td>B9</td>
<td>--</td>
<td>602-720</td>
</tr>
</tbody>
</table>

**Limitations**
- Only ~30% observing time $\rightarrow$ **limited number of projects**
- No ACA, no short-spacings
- No pipeline, no polarimetry
- Restrictions in terms of observing modes (correlator modes)

**Best-effort basis only**
COMPACT CONFIGURATION

Dec=-60

Dec=-30

Dec=+0

Dec=+30
Angular resolution

<table>
<thead>
<tr>
<th></th>
<th>Band 3</th>
<th></th>
<th>Band 6</th>
<th></th>
<th>Band 7</th>
<th></th>
<th>Band 9</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact</td>
<td>5.5</td>
<td>4.8</td>
<td>2.4</td>
<td>2.1</td>
<td>1.6</td>
<td>1.4</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Extended</td>
<td>1.5</td>
<td>1.4</td>
<td>0.6</td>
<td>0.6</td>
<td>0.4</td>
<td>0.4</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

PdBI (800m) 0.8 0.3 0.2

Schedule

- **EXTENDED** October-November  RA ~ 21h to 09h
- **COMPACT** December-January  RA ~ 01h to 13h
- Shutdown   February           
- **COMPACT** March-April       RA ~ 07h to 19h
- **EXTENDED** May-June         RA ~ 11h to 23h
EXTENDED CONFIGURATION

shortest baseline = 36 m
lack of short spacings

Table 6. Maximum Scale (arcsec) for a source at Dec = -30 degrees

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Compact</th>
<th>Extended</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_{min}$ (m)</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Band 3 (&quot;)</td>
<td>21.0</td>
<td>10.5</td>
</tr>
<tr>
<td>Band 6 (&quot;)</td>
<td>9.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Band 7 (&quot;)</td>
<td>6.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Band 9 (&quot;)</td>
<td>3.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Sensitivities

- **16 antennas**: 2304 m² = 1.7 (PdBI 1350 m²)

<table>
<thead>
<tr>
<th>ALMA Band</th>
<th>Central Frequency</th>
<th>IRAM Band</th>
<th>Sensitivity gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>B3</td>
<td>100 GHz</td>
<td>B1</td>
<td>~1.8</td>
</tr>
<tr>
<td>B6</td>
<td>230 GHz</td>
<td>B3</td>
<td>~2.5</td>
</tr>
<tr>
<td>B7</td>
<td>345 GHz</td>
<td>B4</td>
<td>~3.5</td>
</tr>
<tr>
<td>B9</td>
<td>675 GHz</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

NB: ALMA sensitivity estimator somewhat optimistic

- All receivers with 8 GHz bandwidth x two polarizations (PdBI: 4 GHZ x two polarizations; 30m: up to 16 GHz x two pol.)

- **Time Estimator available on the User Portal or within the Observing Tool**
**Heterodyne** receivers are sensitive to Lower Side Band and Upper Side Band.

Receivers can be:
- **DSB** outputs the sum LSB + DSB → separated in the correlator
- **SSB** outputs LSB or DSB
- **2SB** outputs LSB and DSB separately
IRAM receivers

**PdBI**  SSB receivers 4-8 GHz (4 GHz bandwidth LSB or USB)

**EMIR090**  2SB receivers 4-12 GHz (16 GHz bandwidth)

**EMIR150** and **EMIR230**  SSB receiver 4-8 GHz

**EMIR330**  2SB receivers 4-8 GHz (8 GHz bandwidth)

**receivers have 4 to 16 GHz bandwidth**  

x 2 polarizations
ALMA receivers

ALMA B3/B4/B5/B7/B8 2SB receivers 4-8 GHz

ALMA B6 2SB receivers 6-10 GHz

ALMA B9 + B10 DSB receivers 4-12 GHz

All ALMA receivers bands have 8 GHz bandwidth

x 2 polarizations
ALMA correlator

- ALMA correlator = 4 basebands
- Each baseband processes
  - 64 antennas (2016 baselines)
  - 2 polarizations
  - 2 GHz input

- Each baseband can be centered anywhere* in the incoming 8 GHz
- All four basebands can be setup independently: gain on resolution / loss on bandwidth
  (* Minor limitations because of LOs finite step)
ALMA correlator

- Physically: correlator = 4 quadrants
- Full ALMA: 1 quadrant = 1 baseband
- <16 antennas: 1 quadrant = 4 basebands

Second quadrant now in place here.
ALMA : basebands

ALMA BAND 3

FREQ test 100.00000 LSB 6000.00 [V = 0.0 km/s]

Rest frequency (GHz)

BBAND 1

BBAND 2

BBAND 3

BBAND 4

Intermediate frequency IF1 (MHz)

Rest frequency (GHz)
ALMA : basebands

ALMA BAND 3

FREQ test 100.000000 LSB 6000.000000 [V= 0.0 km/s]

Rest frequency (GHz)

98 99 100 101 102

LSB

BBAND 1  BBAND 2

Intermediate frequency IF1 (MHz)

4000 5000 6000 7000 8000

BBAND 3  BBAND 4

Rest frequency (GHz)

110 111 112 113 114

USB
2 GHz input but 2 GHz – 31 MHz spectral windows

**Similar to Bure:** 1 GHz
Quarters → 320 MHz to 20 MHz spectral windows
Basebands modes

1 polarization output (H or V)

- 2 GHz  8192 channels x 1 Pol = 244 kHz resol.
- 1 GHz  8192 channels x 1 Pol = 122 kHz resol.
- 500 MHz 8192 channels x 1 Pol = 61 kHz resol.
- 250 MHz 8192 channels x 1 Pol = 30 kHz resol.
- 125 MHz 8192 channels x 1 Pol = 15 kHz resol.
- 64 MHz  8192 channels x 1 Pol = 7.6 kHz resol.
- 31.25 MHz 8192 channels x 1 Pol = 3.8 kHz resol.
- Continuum mode  256 ch. x 1 Pol = 7.8 MHz resol.
Basebands modes

1 polarization output (H or V)

- 2 GHz  8192 channels x 1 Pol = 244 kHz resol.
- 1 GHz  8192 channels x 1 Pol = 122 kHz resol.
- 500 MHz 8192 channels x 1 Pol = 61 kHz resol.
- 250 MHz 8192 channels x 1 Pol = 30 kHz resol.
- 125 MHz 8192 channels x 1 Pol = 15 kHz resol.
- 64 MHz  8192 channels x 1 Pol = 7.5 kHz resol.
- 31.25 MHz 8192 channels x 1 Pol = 3.8 kHz resol.
- Continuum mode  256 ch. x 1 Pol = 7.5 MHz resol.

Frequency/Time division modes
<table>
<thead>
<tr>
<th>Mode</th>
<th>Channels</th>
<th>Polarization</th>
<th>Frequency</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 GHz</td>
<td>4096</td>
<td>2 Pol</td>
<td>488 kHz</td>
<td>Resol.</td>
</tr>
<tr>
<td>1 GHz</td>
<td>4096</td>
<td>2 Pol</td>
<td>244 kHz</td>
<td>Resol.</td>
</tr>
<tr>
<td>500 MHz</td>
<td>4096</td>
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<td>122 kHz</td>
<td>Resol.</td>
</tr>
<tr>
<td>250 MHz</td>
<td>4096</td>
<td>2 Pol</td>
<td>61 kHz</td>
<td>Resol.</td>
</tr>
<tr>
<td>125 MHz</td>
<td>4096</td>
<td>2 Pol</td>
<td>30 kHz</td>
<td>Resol.</td>
</tr>
<tr>
<td>64 MHz</td>
<td>4096</td>
<td>2 Pol</td>
<td>15 kHz</td>
<td>Resol.</td>
</tr>
<tr>
<td>Continuum</td>
<td>128 ch.</td>
<td>2 Pol</td>
<td>7.6 MHz</td>
<td>Resol.</td>
</tr>
<tr>
<td></td>
<td>64 MHz</td>
<td></td>
<td>15.6 MHz</td>
<td>Resol.</td>
</tr>
</tbody>
</table>
4 polarization outputs (HH, VV, HV, VH)

- 2 GHz  2048 channels x 4 Pol = 976 kHz resol.
- 1 GHz  2048 channels x 4 Pol = 488 kHz resol.
- 500 MHz 2048 channels x 4 Pol = 244 kHz resol.
- 250 MHz 2048 channels x 4 Pol = 122 kHz resol.
- 125 MHz 2048 channels x 4 Pol = 61 kHz resol.
- 64 MHz  2048 channels x 4 Pol = 30 kHz resol.
- 31.25 MHz 2048 channels x 4 Pol = 15 kHz resol.
- Continuum mode 64 ch. x 4 Pol = 31 MHz resol.

Baseband = 8192 channels
Examples

ALMA B3/B4/B5/B7/B8 2SB receivers 4-8 GHz

ALMA B6 2SB receivers 6-10 GHz

ALMA B9 + B10 DSB receivers 4-12 GHz

Four basebands covering 8 GHz
Examples

ALMA B3/B4/B5/B7/B8  2SB receivers 4-8 GHz

ALMA B6  2SB receivers 6-10 GHz

ALMA B9 + B10  DSB receivers 4-12 GHz

Four basebands with different width/resolution

B9 + B10: choice of LSB vs USB done for each baseband
Examples

Two obvious limitations:
- 2 GHz-wide basebands must lie within the receiver IF
- spectral window must lie within baseband

Basebands in LSB and/or USB?
- 2SB receivers – B3/B6/B7 \(\rightarrow\) only 4+0 or 2+2
- DSB receivers – B9 \(\rightarrow\) 3+1 also possible

Four basebands with different width/resolution

B9 + B10: choice of LSB vs USB done for each baseband
Summary

- 4 independent spectral windows
- 2 GHz to 31.25 MHz bandwidth
  - 1, 2, or 4 polar. products
  - 8192 channels
- *OR* 2 GHz continuum

real bandwidths are smaller
- 1875 instead of 2000 MHz
- 938 instead of 1000 MHz
- 469 instead of 512 MHz
- 234 instead of 256 MHz
- 117 instead of 128 MHz
- 58.6 instead of 64 MHz

real resolutions are higher
- 1.2 to 2 times the channel spacing

real number of channels
- 7680 instead of 8192
Summary

- 4 independent spectral windows
- 2 GHz to 31.25 MHz bandwidth
  - 1, 2, or 4 polar. products
  - 8192 channels
- *OR* 2 GHz continuum

- Full-ALMA correlator is much more complex – can split the basebands in several/many windows
- Cycle 0 correlator is more simple – several limitations
Correlator Cycle 0

1 polarization output (H or V)

- 2 GHz  8192 channels x 1 Pol = 244 kHz resol.
- 1 GHz  8192 channels x 1 Pol = 122 kHz resol.
- 500 MHz 8192 channels x 1 Pol = 61 kHz resol.
- 250 MHz 8192 channels x 1 Pol = 30 kHz resol.
- 125 MHz 8192 channels x 1 Pol = 15 kHz resol.
- 64 MHz  8192 channels x 1 Pol = 7.6 kHz resol.
- Continuum mode  256 ch. x 1 Pol = 7.8 MHz resol.

FDM

TDM
1 polarization output (H or V) – actual channels numbers

- **1875 MHz** 7680 channels x 1 Pol = 244 kHz resol.
- **938 MHz** 7680 channels x 1 Pol = 122 kHz resol.
- **469 MHz** 7680 channels x 1 Pol = 61 kHz resol.
- **234 MHz** 7680 channels x 1 Pol = 30 kHz resol.
- **117 MHz** 7680 channels x 1 Pol = 15 kHz resol.
- **58.6 MHz** 7680 channels x 1 Pol = 7.6 kHz resol.
- Continuum mode 256 ch. x 1 Pol = 7.8 MHz resol.

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**FDM**

---

**TDM**
Correlator Cycle 0

2 polarization outputs (H and V) – actual channels numbers

- **1875 MHz**: 7680 channels x 2 Pol = 488 kHz resol.
- **938 MHz**: 7680 channels x 2 Pol = 244 kHz resol.
- **469 MHz**: 7680 channels x 2 Pol = 122 kHz resol.
- **234 MHz**: 7680 channels x 2 Pol = 61 kHz resol.
- **117 MHz**: 7680 channels x 2 Pol = 30 kHz resol.
- **58.6 MHz**: 7680 channels x 2 Pol = 15 kHz resol.
- **Continuum mode**: 256 ch. x 2 Pol = 15.6 MHz resol.

4 polarization outputs – not offered in Cycle 0
Correlator Cycle 0

All four spectral windows must share the same mode

- Same resolution/bandwidth for the four spectral windows
  - Continuum & line? Must compromise!
- Same number of polar. products
- Same position within the baseband
  - Making multi-line setups may be tricky, better prepare it asap
ALMA BAND 3

FREQ test 100.000000 LSB 6000.00 [v = 0.0 km/s]

BASEBAND 1 is centered at IF1 = 6268.77 MHz (LSB) RF = 99.73123 GHz

The four spectral windows will be 250 MHz/1 Polar
Limitation Cycle 0

The four spectral window share the same position within the baseband – is that a serious limitation?

Simple solution: spectral window all centered in baseband, move the basebands on the right position.

Problem if line to be observed is near the edge of the RF bandpass of the receiver.

One famous example: CO(1-0) at 115.3 GHz.

The OT does not force this restriction – caution with complex spectral setups!
ALMA BAND 3

FREQ total 114.000000 USB 6000.00 [V = 0.0 km/s]

Baseband 1 centered at 115 GHz
ALMA BAND 3

FREQ: toto 114.000000 USB 6000.000 [V= 0.0 km/s]

BASEBAND 1 is centered at IF1 = 7000.00 MHz (USB) RF = 115.000000 GHz

Spectral window not centered in baseband
Want to test spectral setups?

1. Use the **OT**/Spectral Editor
2. Use **GILDAS**/**ASTRO** to produce Bure-like plots

**FREQUENCY** – define obs. freq
**BASEBAND** – define basebands positions
**SPWINDOW** – define spectral windows
Spectral setup in the OT

Yellow areas = LSB/USB (here Band 7)
BB0 to BB3 = 4 basebands, each 2 GHz wide
SPW0 to SPW3 = 4 spectral windows, each within a baseband
Note similar position of SPWs in each baseband
Cycle 0 proposals

- ALMA capabilities ramping up FAST
  - No interest in long integration/complex projects in Cycle 0
  - ALMA ES capabilities and constraints are best suited for limited scope projects (as opposed to large scale surveys)

- **Typical project for ES should be few hours (4-10) and deliver result!**
- ALMA will accept only ~100 proposals
- Cycle 0 done on a **best-effort basis**
Must read

- ALMA Cycle 0 Proposer’s Guide
  Doc. 0.2, V1.1, May 2011

- ALMA Cycle 0 Technical Handbook
  Doc. 0.3, V1.0, May 2011

- New versions of these documents have been published on-line today