# ALMA Cycle 3 Capabilities & proposal preparation



### Marcella Massardi Italian Node of the ALMA Regional Center (INAF-IRA, Bologna)



EUROPEAN ARC ALMA Regional Centre || Italian

# **ALMA full array**

The Atacama Large Millimeter Array is a **mm-submm reconfigurable interferometer** 

- Inaugurated in March 2013 on the Chajinantor plain (5000m, Chile)
- Frequency range: **10 bands between 30-900 GHz** (0.3-10 mm)
- Antennas: 50x12m main array + 12x7m ACA + 4x12m Total Power
  - Baselines length: **15m ->150m-16km** + **9m->50m**
  - Bandwidth: **2 GHz x 4 basebands**
- Polarimetry: Full Stokes capability
- Angular Resolution:
- Velocity resolution:

40 mas @ 100 GHz, 5 mas @ 950 GHz As narrow as 0.008 × (Freg/300GHz) km/s

0.2" x (300/freg GHz)x(1km/max baseline)

~0.003 km/s @ 100 GHz, ~0.03 km/s @ 950 GHz

• High instantaneous imaging capabilities & setup flexibility





## **ALMA sites in Chile**



# **ALMA organization**

### World wide collaboration

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

#### Contributors share the observing time

#### Pl affiliation defines the time share on which the project is executed (Chilean have additional rules from Cycle 3 on)

Joint ALMA Observatory

- Execution of observations
- Array operations
- Scheduling of projects
- Data quality assurance and trend analysis
- Calibration plan maintenance
- Delivery of data to the archives
- Archive operations
- Pipeline operations





### ALMA Regional Centres

- User interface
- User support (via helpdesk and f2f)
- Data delivery to the PIs
- Mirror archive operations
- Software tools
- Astronomers on duty
- Data quality assurance

# **The ARCs**

- Interface between JAO and users
- 1 ARC per Partner:
  - NRAO for North America
  - NAOJ for East Asia
  - ESO for Europe (split in 7 nodes)
- Operation support
  - Archive replication
  - Astronomer on duty
  - Software tools
- User support
  - Community formation and outreach (schools, workshops, tutorials, ...)
  - Phase 1 (proposal preparation)
  - Phase 2 (scheduling block preparation)
  - Data analysis, Archive mining
  - F2F user support, Helpdesk





## **ALMA data flow**



Data is collected, reduced and archived. All the "almost" raw data is archived.

#### Each ARC hosts an archive mirror.



### **Enter the ALMA world through the ALMA Science Portal**

#### http://almascience.eso.org/



# A project lifetime: phase 1

PI has a good idea!

**PI estimates feasibility** 

PI splits project in Science Goals

PI writes the science case in pdf and register to the Science Portal

**PHASE I – Proposal submission** 

**TAC evaluation** 

Simulations are not compulsory (Sensitivity Calculator, OST, CASA) Minimum proposed observational unit including targets in the same sky region that roughly share the same calibration and spectral setup Max 4 page, font no smaller than 12, all included (<20MB) www.almascience.org

With the ALMA Observing Tool (OT) A copy of the project with the project ID must be saved and should be used for any resubmission within the deadline A=high ranked pass to Cycle 4 if not finished B=high ranked but not passed over C=maybe filler (depends on time shares and ranking)

# A project lifetime: phase 2

	Fach CO is converted into a Cabadalian Disale
PHASE II – Observing process	Each SG Is converted into a Scheduling Block
SB generation	checks the SR and finally approves them
Observations	Projects are dynamically scheduled according to telescope configuration, weather, ranking, project status
Quality assessment	QA0 and 1 = telescope conditions QA2 = Check for PI sensitivity requests Performed by ARC staff

# **Early Science Cycles**

Early Science observations are conducted on a best effort basis to allows community to observe with incomplete, but already superior array, with priority given to the completion of the full ALMA capabilities

#### **Past & current ALMA Early Science cycles:**

	<b>Cycle 0</b> Sep. 2011 – Jan. 2013	<b>Cycle 1</b> Jan. 2013 – May. 2014	<b>Cycle 2</b> Jun. 2014 – Oct. 2015
Telescope			
Hours dedicated to Science Antennas Receiver bands Wavelengths [mm] Baselines Polarisation <b>limitations</b> )	800 > 12x12-m no ACA 3, 6, 7, 9 3, 1.3, 0.8, 0.45 up to 400 m single-dual	800 > 32x12-m+9x7m+2TP 3, 6, 7, 9 3, 1.3, 0.8 0.45 up to 1000 m single dual	2000 (incl. some Cycle 1) > 34x12-m+9x7m+2TP +4, 8 +2, 0.7 up to 1500 +full (with
Proposal outcome			
Submitted	917	1133	1381
Highest priority	112	198	354 (35A, 319B)
Filler	51	93	159
Success rate	12% (18%)	17% (25%)	26% (37%)

#### **Pressure factors (highest priority projects)**

- Cycle 1: Europe: 9.1 (global ALMA: 5.8)
- Cycle 2: Europe: 4.9 (global ALMA: 3.9)

# **Early Science Cycle 2 projects**



Unlikely executed in day-time and winter

# **Early Science Cycle 3**

Hours dedicated to Science Antennas	2100 hours > 36x12m main array	y + 10x7m+2TP /	٩CA	
Receiver bands	3, 4, 6,	7,	8, 9,	+ 10
Wavelengths [mm]	3.1, 2.1, 1.3,	0.87,	0.74, 0.44	+0.35
Baselines	up to 10 km	up to 5 km	up to 2 km	
Polarisation	Single + Dual in all Band Full Stokes (with limitat	ls ions)		
Single dish Correlator modes	only spectral line in mixed (simultaneous	bands<8 s high and low re	solution)	

Date	Milestone
24 March 2015	Release of Cycle 3 Call for Proposals, Observing Tool & supporting documents
24 March 2015	Opening of the Archive for proposal submission
23 April 2015 (15:00 UT)	Proposal submission deadline
August 2015	Announcement of the outcome of the Proposal Review Process
1 October 2015	Start of ALMA Cycle 3 Science Observations
30 September 2016	End of ALMA Cycle 3

15:00 UT = 17:00 CEST

### Cycle 3 capabilities: receivers and spectral setup

Band	Frequency range <sup>1</sup> (GHz)	Wavelength range (mm)	IF range	Туре
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

Table A-4: Properties of ALMA Cycle 3 Receiver Bands

#### Main array and ACA use separate correlators that offer the same setups.

Time Division Mode (high sensitivity low spectral resolution) and Frequency Division Mode (Low sensitivity high spectral resolution) are available.

For each receiver 2 sidebands separated by 8-10 GHz and up to 4 basebands per sideband are allowed. Different correlator modes can be specified for each baseband

Up to 4 independent spectral windows (with up to 3840 channels) per baseband are allowed.

All spws within a given baseband must use the same correlator mode

Many channels observed at the same time imply high data rate. Maximum data rate allowed is 60MB/s, but data rate above 6 MB/s must be technically justified. Data can be binned to reduce data rate at correlator stage.



(see Kazi's talk)

### Cycle 3 capabilities: receivers and spectral setup

Table A-5: Properties of ALMA Cycle 3 Correlator Modes, dual-polarization operation <sup>1,2</sup>

	Correlator mode <sup>(5)</sup>	Number of channels	Spectral resolution (MHz)	Channel spacing <sup>(4)</sup> (MHz)	Bandwidth <sup>(3)</sup> (MHz)
] Continuum	TDM	128 <sup>3</sup>	31.2	15.6	2000 <sup>3</sup>
	FDM	3840	0.976	0.488	1875
	FDM	3840	0.488	0.244	938
	FDM	3840	0.244	0.122	469
	FDM	3840	0.122	0.061	234
	FDM	3840	0.061	0.0305	117
	FDM	3840	0.0305	0.0153	58.6

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(see Kazi's talk)

### Cycle 3 capabilities: angular scales

Maximum Recoverable Scale <sup>1</sup>	and Coarsest and Finest Angular Resolutions	<sup>1</sup> for the Cycle 3 12-m Array
	configurations	

Maximum Recoverable Scales for ACA 7-m

Frequency	Maximum Recoverable Scale without ACA <sup>2,3</sup>	Coarsest allowed angular resolution <sup>2,3,4</sup>	Finest achievable angular resolution <sup>2,3,5</sup>
(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

Frequency (GHz)	Maximum Recoverable Scale <sup>1,2</sup> (arcsec)
100	42.8
150	28.5
230	18.6
345	12.4
460	9.3
650	6.6
870	4.9

### Cycle 3 standard vs non-standard modes

Standard modes are pipeline-calibrated and imaged and quality is guaranteed Non-standard mode observations are conducted on a best effort basis. Up to 25% of time will be assigned to non-standard mode projects:

Bands 8,9 and 10 - only day-time in summer

- discarded if requires more than 2h of good weather continuously

Baselines >2km

**Polarization** 

•

- only main Array, continuum, B3, B6, B7,
- no ACA, no mosaics, no spectral line, no circular polarization
- Sources must have angular scale < 1/3 primary beam main array
- min 3hr/SG observations for calibration issues

#### Spectral Scans automatic setting of spectral windows to cover a frequency range

- <5 spectral windows per band,
- only 1 pointing/target (no mosaic or offset)
- targets \* tunings <150
- no ACA, no polarization

#### Spectral setups with only narrow band spectral window

- aggregate bandwidth <934MHz

#### User-defined calibration

Proposals with SG in non-standard modes outside the 25% of time will be graded C

### Cycle 2: Limitations & time available

Pointing: ≤ 150 pointings in the same Science Goal (single pointings or mosaic pointings). Individual pointings separated <10° and with the same spectral setup

**Observing Time:** < 100 hrs per proposal as estimated by Observing Tool (sum of all the array used)

# Declination: Shadowing Problem: Main Array: NO Dec < -75 deg, Dec > +25 deg (in compact config.) ACA: NO Dec < -70 deg, Dec > +20 deg

Moving Targets allowed No solar observations



Array:

ACA and TP antennas are available only to complement 12m array observations of extended emissions according to the OT suggestions (the OT estimates also the time needed as sum of the time on each array)

### Submit with the ALMA Observing Tool

01 My new idea - Observing Tool for ALMA (Early Science), version R	3.0.1	
<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>T</u> ool <u>S</u> earch <u>H</u> elp		Perspective
Project Structure	Editors	Tab manu far viewar
Proposal Program	Spectral Spatial Proposal Catalog	
My new idea	Proposal Information	
My new Idea     Proposal Proposal panel     Proposal Pianned Observing     Science Goal ()     Description	Proposal Ti Proposal C	I Title My new idea
	Editors Pane Abstract (max. 300 v	el 10 words)
Proposal <b>Complate Barry</b> . Turn the keys on the JTree below & read the Proposal <b>Complate Danel</b> Proposal <b>Complate Danel</b> Proposal <b>Complate Danel</b> Science Goal (Band 3 100 GHz (rest frame) de Outro Complate Danel	Feedback	
<ul> <li>Science Goal (Band 3 Nyquist-sampled mosa</li> <li>Science Goal (Band 6 Mixed 219 GHz SSB Co</li> <li>Science Goal (Band 6 13CO J=2-1 mapping c</li> <li>Science Goal (Band 6 Mixed simultaneous 12</li> <li>Science Goal (Band 9 700 GHz search for pat</li> </ul>	Description Feed	n Suggestion
Overview		
Project Overview	Contextual Help	Phase I: Science Proposal
<ul> <li>Panel</li> <li>Please ensure you and <u>user portal</u></li> <li>Create a new proposa</li> <li>Selecting <i>File</i> &gt; N</li> <li>Clicking on the</li> <li>Or clicking on this</li> <li>Click on the proposation of the proposa</li></ul>	I your co-Is are registered with the <u>ALMA</u> I by either: <i>lew Proposal</i> icon in the toolbar s <u>link</u> <u>osal</u> tree node and complete the relevant	New       Create       Validate       Submit         Science       Science       Proposal       Science         Proposal       Create       Science       Proposal         Click on the overview steps to view the contextual help       Importing       Template       Need         And       Library       Need       Phase 2       Steps

(see Kazi & Rosita's talks)

### Cycle 3 Proposal Types

- Standard (including also time-critical, multiple-epoch observations, and continuous monitoring of a target over a fixed time interval within Cycle 3).
- Target of Opportunity (ToO): to observe targets that can be anticipated but not specified in detail.

ToO and time-constrained projects requiring a time window smaller than 14 days will not be guaranteed but attempted on a best effort basis

- Director's Discretionary Time (DDT) proposals may be submitted at any time during Cycle 3
  - Proposals requiring the immediate (within 2 weeks) observation of an unexpected astronomical event
  - Proposals requesting observations on a highly competitive scientific topic
  - 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

# The science case & the duplications

Science categories used to distribute the proposals for review to the most qualified assessors:

- Cosmology and high z universe
- Galaxies and galactic nuclei
- ISM, star formation and astrochemistry
- Circumstellar disks, exoplanets and Solar system
- Stellar evolution and the Sun

#### Science case is limited to 4 pdf pages (A4, font size no smaller than 12 points) including:

- science case (recommended 2 pages)
  - describe the astronomical importance
  - include a clear statement of its immediate observing goals
  - explain how the expected intensity of the target source(s) was estimated
  - justify requested snr and angular scales
- figures and tables
- potential for publicity

Proposals must be self-contained. Use the latex template available on the SP!

**Cycle 3 proposals will be checked for duplication** against Cycle 1 and 2 projects that have archived data at the time of the Cycle 3 proposal deadline. Duplication is checked on SG basis. Check the Duplication page on the Science Portal (link in "Proposing") to check for your targets and the duplication conditions on the User policies ("Documents & Tools").

Observations are considered duplicates if **all** the following conditions are met:

- Target field location (or less than 50% overlap of a mosaic region)
- The highest angular resolution differ by a factor <2.
- Spectral windows overlaps by more than 50% (in TDM) or >50% of the lines overlaps (in FDM)
- Spectral resolution in overlapping spectral windows differ by a factor <2.
- The requested rms differ by a factor <2.

#### Repetition of SG proposed by the same group, if deemed necessary, must be scientifically justified.

# The technical justification

The Technical Justification for each SG is entered in text box in a dedicated OT panel divided in:

- sensitivity
- imaging
- correlator setup

The OT automatically identifies user choices that should be justified in dedicated text boxes to be filled:

- data rate
- Override of OT time estimate
- scheduling/time constraints
- user-defined calibration
- low elevation
- single polarisation
- non-Nyquist mosaic sampling

### Make your ALMA simulations (Observation Support Tool)

http	://almaost.ji	b.man.ac.uk/	A Observation Supp Queue Status • F	Si Ca R R	ubmit a request for a full simulation of ALMA apabilities for your target eceive the results via e-mail
Sky Setup	Source model	OST Library: Central point source	Choose a library source model or		Overview
	Upload a FITS file	Browse	You may upload your own model	Array configuration	Click thumbhais to view full-size images. Lett: inear colour scale, right: with histogram equalization. Early Science ALMA (Compact Cycle 0, 125 m baseline)
	Declination	-35d00m00.0s	Ensure correct formatting of this	Source model	All we ever see of stars are their old photographs
	Image peak / point flux in	0.0	Set to 0.0 for no rescaling of sour		
Observation Setup	Central frequency in GHz	90	The value entered must be within		
	Bandwidth in MHz 🗘	32	Use broad for continuum, narrow	Maximum elevation	77.88 degrees
	Required resolution in arcseconds	1.0	OST will choose config if instrume	Central frequency	90 GHz = Band 3
				Bandwidth	0.032 GHz
	Pointing strategy	Single 🗘	Selecting single will apply primary	Track length	3 hours x 1.0 visits
	Start hour angle	0.0	Deviation of start of observation t	System temperature	Tsys = Trec + Tsky = 37.0 + 4.42 = 44.15 K
	Start nour angle		Deviation of start of observation (	PWV Therefical BMS mire	0.000103223502008. b/in coherelluureichted conn
	On-source time in hours	3	Maximum duration is 24 hours	Restoring beam (resolution)	Major zois = 6.229 ancsec, minor zois = 5.176 ancsec, PA = 55.607 deg
	Number of visits	1	How many times the observation		Data products
	Number of polarizations		This affects the noise in the final		
Corruption	Atmospheric conditions	Good (PWV = 0.5 mm)   ≎	Determines level of noise due to	Your simulated image Download FITS file	
Imaging	Imaging weights	Natural   \$	This allows a resolution / sensitivi		the second of th
	Perform deconvolution?	No (Return dirty image)	Apply the CLEAN algorithm to dec		
( )				Disty Beam (Point Spread Function)	

(see Rosita's talk)

### Make your ALMA simulations (CASA simalma, simobserve, and simanalyze)



The task **simobserve** generates a data set with simulated visibilities based on an input model image.

The task **simanalyze** produces a cleaned image based on the simulated visibilities, and it generates some diagnostic images.

CASA also provides the task **simalma** that simplifies the steps needed to simulate ALMA observations that combine data from multiple arrays or multiple configurations.

Who needs CASA for simulations today and wants to access to our cluster can ask for an account

(see Rosita's talk)

### **The Science Goal: Sensitivity Calculator**

### http://almascience.eso.org/call-for-proposals/sensitivity-calculator

	Dec		00:00:00.0	00						
	Polarization		Dual					-		
	Observing Frequ	uency	345.00000		GHz			-		
	Bandwidth per l	Polarization	0.00000		GHz			-		
	Water Vapour		Automa	tic	Choice 🔾 M	lanual	Cho	oice		
	Column Densit	Column Density		3rd (	Octile)					
	tau/Tsky		tau0=0.158	3, Ts	ky=39.538					
	Tsys		157.027 K							
Individual Param	eters									
	12m Array				7m Array			Total Powe	er Arra	iy 🛛
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### **The Project Tracker**

### https://almascience.eso.org/observing/project-tracker

The Project Tracker (PT) is a software tool that allows Principal Investigators to track the observational and processing status of their ALMA science projects.

Back to Po	rtal 📗 Logout							
Project UID	Project Code	PI Name	Execut	Name	State	Version	Time of Creation	Timed Out
uid://A002 /X57814d/X6e	TEST.1.00002.	testuser	NA		Ready	13	2012-12-26	
uid://A002 /X5c0871/X1	TEST.1.00003.	testuser	EA		InProgress	0.7	2013-01-31	
uid://A002 /X57814d/X2	2011.0.00983.S	testuser	EA		Phase2Submitted	2.7	2012-12-26	
uid://A002 /X57814d/X38	TEST.1.00001.	testuser	EA		Ready	2.7	2012-12-26	
				Results 10 per page	•			





### The ALMA Archive https://almascience.eso.org/alma-data/archive



Atacama Large Millimeter/Submillimeter Array In search of our Cosmic Origins

#### You are here: Home > ALMA Data > Archive Query

#### ALMA Science Archive Query



#### **Archive query:**

allows users to identify observations that match given search constraints and to select observations of interest from the results table

#### **Delivery List:**

Full data related to a project. Available only for Cycle 0 projects!

Atac	<b>ama Lar<u>c</u></b> rch of our C	<b>ge Millimeter/s</b> i iosmic Origins	ubmillimeter Array				+ES •					
						Search Site	Q					
ESO	NRA	O NAOJ				Log in   Register   Reset Password	Forgot Account					
About	You are I Deliv	here: Home > Data > A <b>rerv List</b>	rchive > Delivery List									
Science	Note: Please see the knowledgebase article "Will re-reduction improve the Cycle 0 data products provided by the archive?" for a discussion of the changes to											
Proposing	CASA s	ince Cycle 0 data pr	ocessing was performed, and their	r possible impact	on the data produc	ts.						
Observing	The link on the project codes lead to the abstracts and author lists, the links on the content link to an index of the tarfiles. This index shows the main directories contained in each tar file as well as the location of the README and fits files.											
Data												
Archive	Release datasets	ates starting with 2 are still under invest	uyy indicate datasets that were de igation.	livered but afterw	ards problems were	e discovered that render the data unuseable	(QA3). Inose					
Calibrator Catalogue	Dogu	act Marked Deliv	vrian Depart									
Science Verification	Reque	est Marked Delive	Reset									
Data Processing		Project	Delivery	Release	PI Name	Project Title	Contents					
Documents & Tools				Date								
Knowledgebase/FAQ		2011.0.00101.S	2011.0.00101.S_2011-12-06	2012-12-06 04:27:58	Wang, Wei-Hao	Shedding Light on Distant Starburst Galaxies Hosting Gamma-ray Bursts v9	content					
User Services at ARCs		2011.0.00131.S	2011.0.00131.S_2011-12-06	2012-12-06	Maercker, Matthias	Piecing the shell together: ALMA and the detached shell around R Scl.	content					
<ul> <li>Helpdesk</li> </ul>												
ALMA Calendars		2011.0.00191.S	2011.0.00191.S_2011-12-06	2012-12-06 20:39:39	Boley, Aaron	Constraining the Formation Mechanisms of Wide-Orbit Planets:	content					
EU ARC						The Case of Fomalhaut b v0.6						
NA ARC												

### **The ALMA Archive**

### https://almascience.eso.org/alma-data/archive



# The ALMA Archive https://almascience.eso.org/alma-data/archive



### Get support for Cycle 3 from the Italian node!

In any stage of your ALMA projects,

for any data reduction with CASA,

for ALMA related stuff

contact us and/or organize your visit to the Italian ARC node!

Enjoy your ALMA Cycle 3 proposal!

Deadline: 15:00 UT on April 23, 2015