Ten years of ALMA
The Italian ALMA Regional Centre

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Summary

ALMA was officially inaugurated ten years ago, in March 2013. Our previous report, "Five years of Early Science and the Activities of the Italian ARC", in October 2015, presented the activities of the Italian node of the European ALMA Regional Centre during first 5 years of observations of ALMA. It seems appropriate now to give a status report on the Italian node's progress made since then.

ALMA has gone through a rapid evolution in the past 10 years in terms of number of antennas, configurations, frequency bands, and amount of hours available for scientific research, number of proposers and proposals submitted. Likewise the Italian node has evolved considerably, as has the community it serves. In this document we describe our activities over the past decade, undertaken towards supporting, expanding and educating the astronomical community, as well as towards the ALMA project, and the results obtained.

ALMA is continuously being upgraded and improved. Recently, a new development path has been defined in the 'ALMA2030 Development Roadmap', to identify the new science drivers for the coming years. In this framework, exciting new possibilities are opened up. In the last call, issued in April 2023, for the first time the possibility was offered to submit joint proposals with JWST, VLA and/or the VLT. Also in the next observing Cycle (number 10), Band 1 (35–50 GHz) becomes available, while in the near future we shall see the arrival of the new Band 2+3 combination (67–116 GHz). By 2030, the so-called wideband sensitivity upgrade (WSU) will revolutionise ALMA in many ways by upgrading many technical components (including receivers and correlator), modifying the data handling procedures, the pipelines and tools to improve the offered capabilities. All these developments will lead to exciting new possibilities for ALMA users. The Italian ARC will be prepared to continue its support and educational tasks with enthusiasm!

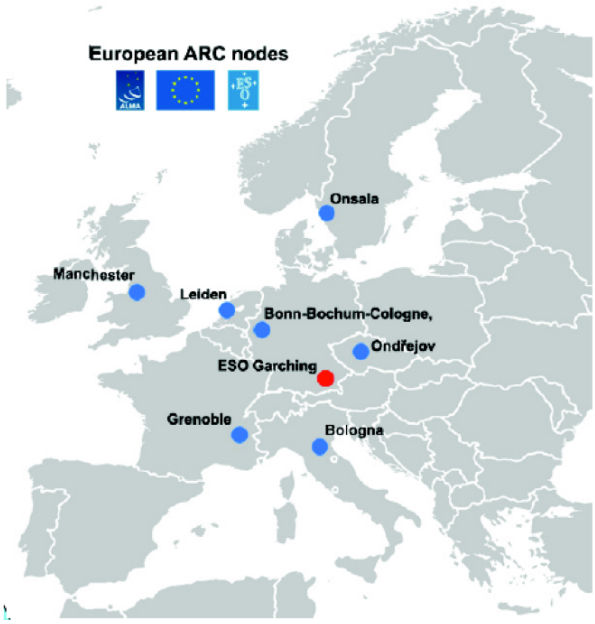


Figure 1: The European ARC network, coordinated by the central node at ESO, Garching. There are seven additional nodes, indicated in blue.

1 ALMA - current status

The Atacama Large Millimeter/submillimeter Array (ALMA) is a partnership of Europe, North America and East Asia, in cooperation with the Republic of Chile. ALMA is operated by the Joint ALMA Observatory (ESO, AUI/NRAO and NAOJ).

Observing proposals can be submitted once per year, in so-called Cycles. Currently we are in Cycle 9 (1/10/22 - 30/9/23) and the proposal deadline for Cycle 10 was on 10 May 2023. ALMA started operations in 2011 with so-called *Early Science* observations, with 16 12-m antennas available in the main array. The official inauguration took place in March 2013, when 32 main-array antennas were available. Full operational/science status was reached in 2016 (Cycle 4) and more than 40 antennas in the main array, 10 7-m antennas in the Atacama Compact Array (ACA) and three 12-m dishes in the Total Power (TP) Array, have been offered to observers ever since. Over the years the number of hours offered for observations has increased from 500-700 in Cycle 0 to 4300 hrs (on each of the arrays) in Cycle 10. Maximum baselines went from 400 m to 16 km; in Cycle 0 the frequency bands on offer were B3, 6, 7 and 9, in Cycle 10 one can apply for time in Band 1 and Bands 3-10.

The three partners are responsible for the publication of the Call for Proposals for their community. The interface between ALMA and the astronomical community is provided by the three partners through the ALMA Regional Centers (ARCs). In Europe the ARC is located at ESO in Garching, Germany. In Europe much expertise, both instrumental and scientific, in the ALMA-relevant frequency range was already present, and in order to take advantage of this situation it was decided from the very start to distribute certain tasks and responsibilities to a network of local ARCs ("nodes"; Hatziminaoglou et al. 2015). Currently this network consists of 7 nodes, coordinated by the central node at ESO (see Fig. 1). The Italian node is located in Bologna, hosted by the INAF-Istituto di Radioastronomia.

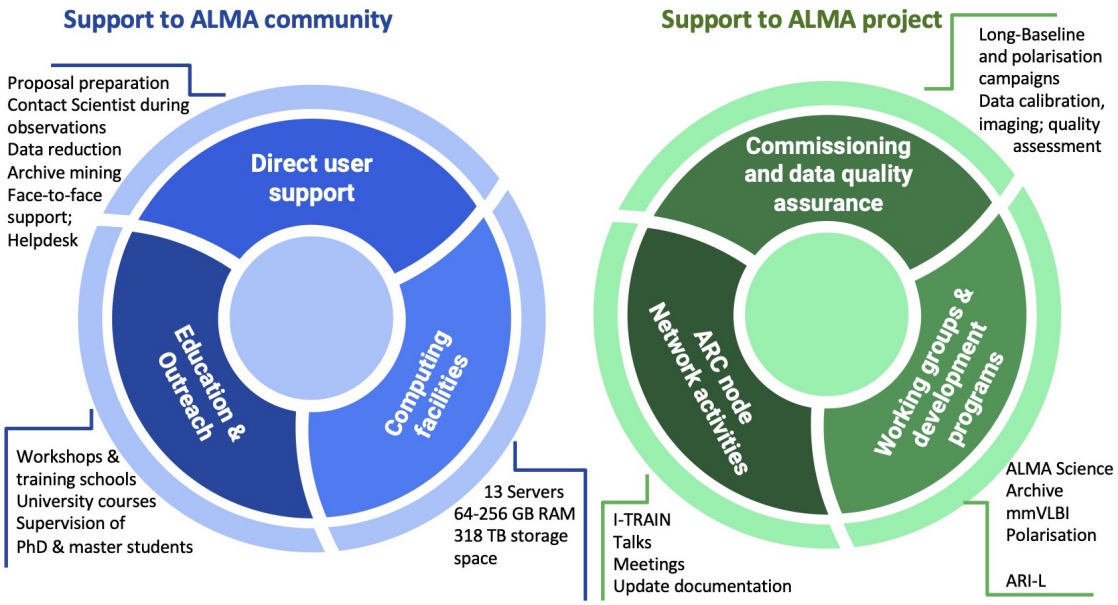


Figure 2: The main activities of the Italian ARC-node in a nutshell.

2 Italian ARC

2.1 Mission

The Italian ARC-node provides support to the Italian community of potential users of ALMA, and to the ALMA project itself. An important aspect of this is to make the community aware not only of the instrument itself, but of the existence of the support structure that is the European ARC-node network, and in particular the Italian ALMA Regional Centre (IT-ARC for short). Therefore, especially in the early days of the IT-ARC, we have presented seminars at various Italian institutes on ALMA and the Italian ALMA Regional Centre, to familiarise the community with this new instrument and its support system. Likewise we regularly gave, and still give, (invited) talks on these subjects at numerous conferences (e.g. the SAIt).

2.2 Support activities

We distinguish between support to the community and support to the ALMA project itself. A condensed overview of our activities on various fronts is presented in Fig. 2.

2.2.1 Support to the Community

The philosophy of the user support network for ALMA is that every astronomer, regardless of field or spectral range of research, should be able to successfully apply for observing time with ALMA and exploit the telescope data for scientific purposes. Around the time of the call for proposals for each new Cycle, we organise a "Proposal Preparation Day". On that occasion we present the instrumental capabilities for the upcoming observing cycle, explain eventual new features in the Observing Tool (OT, the tool for the proposal preparation and submission), new observing modes, restrictions and possibilities. In the course of time we have used various formats for these Proposal Preparation Days: from one-day meetings in person or on-line, to a 3-day event with science presentations by users

and discussion sessions on technical and scientific issues related to ALMA. We have also, on several occasions, brought the event to the community, by visiting observatories, research institutes and university departments, presenting a seminar on ALMA, the new Cycle and scientific results. On those occasions we also gave proposal support to the users after the seminar.
We also see it as part of our duty to bring together the existing community of astronomers working in (or making use of observations in) the (sub)mm field. Through the organisation of various events such as workshops and conferences, we provide a platform to facilitate the exchange of ideas and the initiation of collaborations. For example, we organise conferences on "mm-astronomy in Italy" since 2013. The occurrence was intended to be more or less bi-yearly, but we delayed the 2019 event of the series, because the Italian community met at the "ALMA conference" in Cagliari; it was delayed further because of the pandemic. The series could finally be restarted in 2023, when we organise the "Fifth workshop for millimeter astronomy in Italy", to be held in Bologna in June.

To each successful proposal a contact scientist (CS) is assigned from among the ARC-staff, who is the point of contact between the PI and the ESO-ARC; through the CS we extend our support to the entire lifetime of a project. Such practical, technical and scientific support is provided face-to-face (f2f), via our Helpdesk (help-desk@alma.inaf.it), email, phone or videocon (Zoom or Google-meet).

To help with data analysis we organise tutorials on various topics, such as the software package CASA, self-calibration and advanced imaging, calibration of polarimetric observations and the scientific exploitation of the archive. For a list of events organised by us see Table **??** and our web pages at https://arc.ira.inaf.it/past-events/. In addition, we contribute to events organised by others, such as the ERIS[1]-schools and the EAS[2]-conferences .
To be able to comply with the often demanding computing and storage requirements of ALMA projects (the size of a typical dataset has increased from $\sim$ 100 MB in Cycle 0 to $\sim$ 1 TB in Cycle 9), we maintain a dedicated computer cluster (see Fig. 3; 13 servers with 64–256 GB RAM and ca. 160 TB local work disk storage [typically 10-15 TB per server], and 318 TB of external storage space). Users can request access to the ARC-cluster, for their projects. Visitor accounts with 10 TB of disk space can be assigned for 6-months; this period can be extended if necessary.

2.2.2 Support to the ALMA project

To stay at the forefront of scientific research, ALMA must continuously evolve, be improved and developed. As part of the European ARC, we contribute to this effort in various ways, always aiming towards an improved operability of the array, assurance of fast delivery of reliable data to the PIs, and creating new opportunities for users to make scientific use of ALMA.
We have thus participated in science verification observations and data reduction campaigns; in the long baseline campaign, aimed at verifying the ability to calibrate and obtain high-quality images with array configurations using the longest baselines (ALMA partnership: Fomalont et al. 2015); we participate in improving the calibration of polarisation data, and in reviewing and testing new polarisation capabilities offered; ALMA science archive (ASA) exploitation (such as ARI-L, an independently financed ALMA Development Plan to reimage a large number of projects from Cycles 2-4: Massardi et al. 2021; see Sect. 2.3); writing the Archive Primer document (Rygl & Bendo 2022). We participate in software tests (the Observing Tool [OT], and the proposal review procedure, for

[1]European Radio Interferometry School
[2]European Astronomical Society

Computing Nodes

Name	RAM	CPU	Cores	Clock	Data Net	Work Disk	Scratch Disk	scheduler	groups	notes
arcbl17	64G	AMD Ryzen 7 1800X	8/16	3600	1GbE	3,5TB		N	arc-staff, arc-vlbi	
arcbl18	64G	Intel Xeon E3-1275 v6	4/8	3800	10GbE	22T	57G	N	arc-staff, arc-vlbi	
arcbl19	64G	Intel Xeon E3-1275 v6	4/8	3800	10GbE	11T	57G	N	arc-staff, arc-vlbi, arc-f2f	nfs server
arcbl20	256G	Intel Xeon E5-1650 v4	6/12	3600	10GbE	11T	65G	N	arc-staff, arc-vlbi, arc-f2f	
arcbl21	64G	Intel Xeon E3-1275 v6	4/8	3800	10GbE	11T	57G	N	arc-staff, arc-vlbi, arc-f2f	
arcbl22	256G	Intel Xeon E5-1650 v4	6/12	3600	10GbE	11T	65G	N	arc-staff, arc-vlbi	
arcbl23	256G	Intel Xeon E5-1650 v4	6/12	3600	10GbE	11T	65G	N	arc-staff, arc-vlbi	VM
arcbl24	256G	Intel Xeon E5-1650 v4	6/12	3600	10GbE	11T	65G	N	arc-staff, arc-vlbi	
arcbl25	256G	Intel Xeon E5-1650 v4	6/12	3600	10GbE	11T	65G	N	arc-staff, arc-vlbi	
arcbl26	256G	Intel Xeon E5-1650 v4	6/12	3600	10GbE	11T	65G	N	arc-staff, arc-vlbi	
arcbl27	64G	Intel Xeon E3-1275 v6	4/8	3800	10GbE	15T	57G	N	arc-staff, arc-vlbi	
arcbl28	256G	Intel Xeon E5-1650 v4	4/8	3600	10GbE	15T	57G	N	arc-staff, arc-vlbi	
arcbl29	256G	Intel Xeon E5-1650 v4	4/8	3600	10GbE	15T	57G	N	arc-staff, arc-vlbi	

Storage Nodes

Name	RAM	CPU	Cores	Clock	Data Net	RAID	Space	Storage	export
arcnas2	32G	Intel Xeon Silver 4108	8/16	1800	10GbE	ARC-1883IX-24	91	12x10TB RAID6	/lustre/arcfs0/ost3
arcnas3	32G	Intel Xeon Silver 4108	8/16	1800	10GbE	ARC-188x	72,8		/lustre/arcfs0/ost0
arcnas4	16G	Intel XeonE5-2603v3	6/6	1600	10GbE	ARC-1284ML-24	36,4T	12x4TB RAID6	/lustre/arcfs0/ost1
							91T	12x10TB RAID6	/lustre/arcfs0/ost2

Figure 3: Computing power and data storage facility at the Italian ARC

example), and contribute to the updating of ALMA documentation (such as chapters in the Technical Handbook, User manuals and the Guide to the European ARC). At the IT-ARC we develop tools to efficiently exploit the ASA, also in relation to other public data repositories (e.g. Burkutean et al. 2018). We furthermore contribute to the functioning of ALMA, by taking shifts as Astronomer on Duty in Chile, and performing quality assurance of the data before they can be made available to the PIs (the so-called QA2, and weblog review). Finally, we contribute to network-wide specialised working groups with our expertise (mm-VLBI, polarisation and archive mining).

2.3 Our expertises

The ARC-node network is set up such that basic user support can be had at all nodes. However, some tasks are more node-specific, because they are connected to the particular expertises of a given node.The Italian ARC-node has developed expertise in mm-VLBI, polarisation and archive mining. We shall give a brief description of each of these.

mm-VLBI: The use of ALMA as part of a global mm-VLBI array is considered a key scientific goal. Given the long-standing experience with VLBI at radio wavelengths of our host institute INAF-IRA, it was fitting that we strove to develop an expertise in mm-VLBI involving ALMA. This was boosted by our participation in the premiale project i-ALMA, that made it possible to enrich the ARC with an expert on mm-VLBI and to be involved in the development from the start and to raise our competence in this field. This has led to the invitation to become partners in the Black Hole Cam/Event Horizon Telescope (BHC/EHT) project and to making significant contributions to that project. See Sect. 2.7 for further details.

Polarisation: We contribute to the ALMA extension of polarisation capabilities since 2015, participating in the observational and data reduction campaign leading to the capabilities offered now. We contributed to the data reduction scripts, the quality assurance of polarisation data, and to the training of analysts. We have become one of the few nodes in the network with polarisation expertise and continue with the efforts to make ALMA meet the designed expectations in this observing mode.

Archive mining: With each observing cycle the ALMA science archive grows with observational data, and the scientific exploitation of the archive becomes an increasingly important factor in scientific research. In fact, the fraction of publications making use of ALMA archival data continues to increase, currently reaching fractions as high as 30% (Stoehr et al. 2022), following the trend shown in other observing facilities. From early on we contribute to making the ASA more accessible and containing more complete and higher quality products, and to explore it in connection with other catalogues. In 2017 we became leader of a 1-year international development study dedicated to the evaluation of the early Cycle data products, in order to identify strategies to complement the images that were only partially stored in the archive. The study led to the definition of the Additional Representative Images for Legacy (ARI-L) development project that was accepted by JAO in 2019 and funded by ESO until its successful conclusion in December 2022. The project went beyond the original goal of delivering images for 70% of the Cycle 2-4 dataset that were missing images in the ASA by reaching a fraction of 92%, counting more than 160000 delivered images, currently publicly available in the ASA. The calibrated measurement sets for those data are stored on tapes and delivered on request by the INAF-Italian Astronomical Archives (IA2). Currently the possibility to exploit the IA2 and IT-ARC resources for the storage of old ALMA calibrated datasets to cope with obsolecence of the data reduction software is being investigated.

2.4 Education

An important aspect of increasing the size of the community is to ignite interest in new generations of astronomers. We address this in two ways: direct education through involvement in University courses, lectures and seminars, and the supervision of students for their Master and PhD theses; we have also participated in, or co-organised, Scuole Nazionali di Astrofisica, lecture series on subjects requested by doctoral students and Training Network Schools. Detailed information on all of the above items can be found on the IT-ARC's website at http://arc.ira.inaf.it.

2.4.1 University courses and lectures

Introducing students early on to the scientific horizons made accessible by ALMA is very important. Every academic year since 2013-14, the Italian ARC has organised and presented the high-frequency part of the Laboratory of Astrophysics-course at the University of Bologna. In this course (part of the Laurea Magistrale), led by Rosita Paladino, students are working with real ALMA data, calibrating, cleaning and imaging them, and extract some scientifically relevant information from the results. The students have to submit a written report and pass an oral exam. Several students later came to do their *tesi di laurea* at the IT-ARC, or were using ALMA data for projects supervised elsewhere.

At the SISSA in Trieste, Marcella Massardi presents a series of lectures on basics of interferometry and science with ALMA and mm-astronomy for PhD students in the SISSA "Astrophysics and

Cosmology" group and, recently, including students from the national PhD program in "Space Science and Technology".

The above mentioned courses are being presented for the tenth time in the current academic year (2022-23).

We have occasionally organised and presented lectures of interest to PhD students, on topics such as molecular clouds, star formation and astrochemistry. Most recently this happened in December 2020, when three experts presented a series of lectures on the galactic- and extra-galactic interstellar medium (see our webpage for a link to the registrations on youtube).

2.4.2 Supervising students

As a result of our activities in promoting ALMA and its scientific potential, and offering support in all phases of a project, students have become interested in using ALMA data in their research - 'stand alone' or as part of a multi-frequency approach. While ALMA is heavily oversubscribed (a factor of 7 for European applicants), the ALMA Science Archive is becoming increasingly important: the data from the first 8 or 9 Cycles are now publicly accessible, and much is still unexplored. So far the staff at the IT-ARC have (co-)supervised 10 Master- and 6 PhD projects at UniBo and SISSA, while 5 PhD projects are currently on-going. The first PhD project that was financed by the Italian ARC was in "Ciclo XXXIII" (2017-2020; UniBo; PI Brand). Currently we are financing a PhD project at UniBo that started in Ciclo XXXVIII (2022; PI Paladino) and will do so for a project starting in 2023 (Ciclo XXXIX; PI Bonato).

2.4.3 Training Schools, Tutorials, Workshops, videos

The European ARC-node network puts much effort into the development of the user community in a variety of ways, such as Training Schools, tutorials and workshops:

I-Train: The European ARC Network organises I-TRAIN, a regular series of Interactive Training in Reduction and Analysis of INterferometric data. The sessions cover a wide range of topics of interest to the ALMA user community with the aim to help users gain expertise in working with interferometric data. We contributed to/presented sessions on the upgrade of the ALMA Science Archive (in connection with our Development Project), the Science Archive primer and polarisation observations.

ALMA explained: The European ARC network presents a series of 3-min videos with the purpose of introducing and explaining ALMA and basic interferometry principles to non- experts. We contributed three videos: on polarimetry, sensitivity and VLBI.

MAYA: Meeting of ALMA young astronomers: "aimed at gathering together early-career scientists, primarily graduate students and junior postdocs, and giving them the chance to present their work based on ALMA data to their peers, to interact with each other, and to build new collaborations and projects." (Muller et al. 2022). The IT-ARC has been actively involved in the MAYA SOC since its first edition in 2022.

Locally we have organised a number of training schools, tutorials or workshops, such as "Astrochemistry with ALMA" (in collaboration with INAF-OA Catania and funded by the EU through ITN LASSIE Network and COST Action CM0805); "Science with the ALMA Archive" (in collaboration with the EU ARC-node network); tutorials on the OT and CASA; workshops on topics such

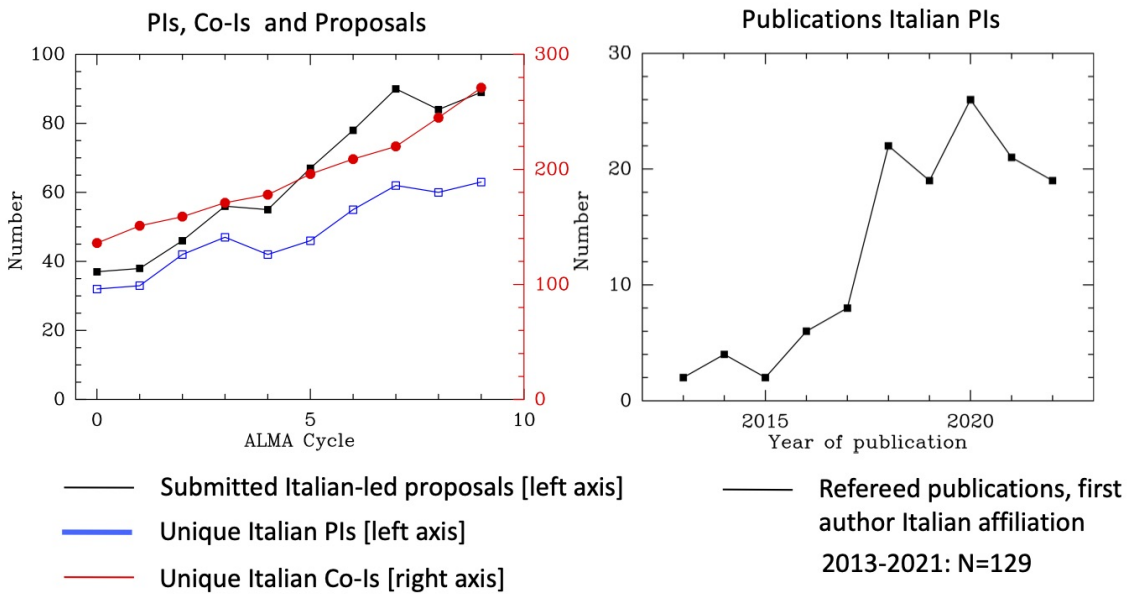


Figure 4: Statistics on PIs, Co-Is, and papers published

as ALMA data handling; polarisation; advanced imaging techniques; self-calibration, and on the imaging pipeline. We furthermore participated as lecturers in ERIS schools and gave presentations at EAS conferences.

2.5 Results

We see the consequences of our efforts on the community reflected most clearly in their interest in ALMA which has increased considerably, also in institutes with no historical radioastronomical background: from the first cycle (Cycle 0) to the most recent one (Cycle 9) the number of proposals and unique Italian PIs increased from 37 submissions by 32 PIs to 89 submissions by 63 PIs. The number of astronomers from Italian institutes that were Co-I on ALMA proposals duplicates from 136 to 271 in that period (see Fig. 4). The PIs and Co-Is came from about 15 institutes in 10 cities, from Catania to Trieste to Torino to Cagliari. Students asking for a project using ALMA data (see Sect. 2.4.2) are another sign of increased awareness among also the young generation not just of the existence of ALMA, but of the important science that waits to be uncovered by observations in the (sub)millimeter wavelength region.

Figure 4 also shows that the number of publications by PIs/first authors with an Italian affilliation shows a steady increase with time - another sign of the community successfully using ALMA. So far the counter stands at 129 refereed papers; the number of publications involving Italian researchers as co-authors will of course be much higher.

2.6 People

Table **??** lists all people who have been, or presently are, employed at the IT-ARC. The current staff consists of 8 people; their names are printed in boldface in Table **??**. Since 2006, when the first postdoc was hired on a 'Borsa di Studio', 18 young scientists have worked at the IT-ARC as postdocs, learning and often also teaching and sharing expertise in mm-interferometry, ALMA

observational techniques and data reduction. They were essential in the delivery of high-level support to the community. Ten of these postdocs have become permanent staff members (nine at four different INAF institutes; four are still at the IT-ARC), thus assuring that their valuable skills are not lost to the Italian astronomical community. Others have moved on and brought the expertise acquired at the Italian ARC to their new institutes, sparking interest in the use of ALMA.

2.7 Using our expertises

The skills we have matured naturally drive us towards involvement in other projects. For example, because of our expertise as ALMA support centre, we were involved in AENEAS, a Horizon2020 project to investigate the various requirements for an SKA Science Data Centre. In particular we led the WP that focused on the design of a user interaction model that could be implemented for the European SKA Data Centre (ESDC). Following this, since 2021, we head one of the task packages (TP3, dedicated to user engagement and data challenges) for the SKA Regional Centre Steering Committee, and operate as stakeholders in the SKA prototyping groups. In this framework we organised or contributed to the SOC of meetings at national ("SKA data challenges workshop" in 2019) and international level ("Hands-on containerization" in 2022 and "SKA Open Science school" in 2023).

Because of our expertise in interferometry and data reduction we were part of Black Hole Cam [Oct. 2017 - May 2021] and contributed to the EHT project, the international collaboration that succeeded in imaging the event horizon of the SMBHs in M87 and SgrA*, the results of which were publicly announced in 2019 and 2022, respectively. We contributed to the development of the calibration pipeline that was used to generate the images, and participated in the mediatic spread of these important achievements through press conferences, televised talk shows and interviews, newspaper interviews and various outreach activities. We continue contributing to EHT to the present day.

2.8 Towards 2030

ALMA is continually being upgraded and improved, with new capabilities becoming available at every Cycle. We contributed to some recent and ongoing upgrades such as the availability of new polarisation observing modes and the associated data reduction scripts, and to the upgrade and tests of user tools such as the archive interface, the OT and the proposal review tool. The use of ALMA as a phased array in mm-VLBI experiments (such as the EHT observations) requires special quality assurance procedures to allow ALMA data to be correlated with other antennas of the VLBI network, to which we contribute.

The 'ALMA Development Program: Roadmap to 2030' (Carpenter et al. 2018, 2020) describes the main areas to drive the development over the next decade. A first big novelty has been introduced in the latest call for proposals, with the opportunity to apply for joint proposals that match observations of ALMA with JWST, JVLA and/or VLT. In the near future the upgraded Band 2+3 receiver will provide a test bed for the next generation receivers. We will participate in the commissioning of these new receivers, as well as that of the new correlator planned for the wideband sensitivity upgrade (WSU; Carpenter et al. 2022). With the WSU the telescope's surveying and spectral capabilities will increase by huge factors by 2030, because of larger bandwidths and number of spectral channels.

How this will reflect on data and users is still under evaluation. What is already clear is that the data packages will increase significantly in size, and new tools, pipelines and data handling procedures will be put in place. The IT-ARC is already investigating upgrades of our computing and storage resources to anticipate the telescope upgrade and offer the right resources to the community in due time.

New skills will become relevant, including big data management techniques, machine learning and statistical approaches. Our staff is already involved in BRAIN, an ESO-lead development project (PI: Fabrizia Guglielmetti) that is exploiting Bayesian approach and machine learning techniques to improve the cleaning of images in shorter times with respect to what is currently typically used.

The IT-ARC guarantees support with all new features and capabilities and is therefore itself also adjusting and acquiring new expertises. We are thus evaluating if the current IT-ARC staff skills should be enforced by hiring new personnel with expertises in data management, advanced interferometric techniques and multi-wavelength research.

By the end of the WSU in 2030 ALMA will be a brand new telescope that will serve the scientific community for the following 10-15 years guaranteeing new transformational discoveries. The ARC network, and the IT-ARC within it, will retain its role of supporting the community, and preparing the new generations of researchers to face the technical and instrumental challenges and stimulate the scientific exploitation of this powerful instrument.

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Table 1: Events organised by the Italian ARC-node since 2005

Date	Event[†]	Comments
2023		
Oct. 16 - 19	EU ARC Network All-hands meeting	Modena
Jun. 12 - 14	5^{th} workshop on mm-astronomy in Italy	
Apr. 17	Italian ARC Proposal Preparation event	hybrid mode
Feb - April	ALMA towards Cycle 10 and beyond	seminar tour[a]
2022		
Oct. 5 - 7	ALMA Science Archive School[b]	
Apr. 4	Italian ARC Proposal Preparation day	online
Mar. 2 - 4	Meeting of ALMA Young Astronomers	online
2021		
Mar. 22	Italian ARC Proposal Preparation day	online
2020		
Nov. 30 - Dec. 2	The Interstellar Medium[c]	online
2019		
Sep. 30 - Oct. 2	SKA data challenges workshop	
Feb. 25 - 27	ALMA Science and Proposals Workshop	
2018		
Mar - Apr	ALMA Seminar + f2f: In preparation of Cycle 6	Bologna, Firenze, Torino
Mar. 12-13	Meeting of the EU ARC node representatives	Bologna
2017		
Dec. 11 - 13	Self-calibration and advanced imaging workshop	
Nov. 7 - 10	4^{th} workshop on mm-astronomy in Italy	
Apr. 4 - 5	ALMA proposal preparation days	day 2 for f2f help
Jan. 24 - 25	ALMA Archive and Imaging Pipeline workshop	
2016		
Apr. 11 - 12	Italian ARC Proposal Preparation day	
Mar - Apr	ALMA Science seminar	seminar tour[d]
Feb. 9 - 12	ALMA Data Handling Workshop	
2015		
Sep. 22-23	4 Cycles of Early Science: where do we stand?	Coffee talk Bologna/Medicina
Apr. 9	Italian ARC Proposal Preparation day	
Jan. 22 - 23	Workshop on mm-VLBI with ALMA	
Jan. 20 - 21	3^{rd} workshop on mm-astronomy in Italy	

[†] Events 2020 to mid-2022 necessarily held to absolute minimum because of COVID-pandemic

[a] Held at Padova, Bologna, Trieste, Firenze, Milano

[a] Bologna; organised in collaboration with the European ARC-node network

[c] Series of 9 lectures on the ISM and star formation for PhD students

[d] Held at Bologna, Padova, Trieste, Catania, Roma, Innsbruck

Table 1: Events organised by the Italian ARC-node since 2005, *continued*

Date	Event	Comments
2013		
Nov. 21	Italian ARC Proposal Preparation day	
Oct - Nov	ALMA Science seminar	seminar tour[e]
Jun. 25 - 28	European ARC polarisation internal workshop	EU ARC members only
2012		
Jun. 6	Observing Tool tutorial	
Apr. 2 - 3	2^{nd} workshop on mm-astronomy in Italy	
Mar. 26	News from the ALMA universe: ALMA observations and your ALMA Regional Centre	Coffee talk IRA
Feb. 15 - 17	EU ARC Network All-hands meeting	Desenzano di Garda
2011		
Jun. 13 - 17	Astrochemistry with ALMA School	Training School[f]
Apr - May	ALMA Observing Tool seminar	held at 11 institutes
2010		
Apr. 29 - 30	ALMA Community Days	
Apr. 27 - 29	CASA tutorial	
2009		
May 9	ALMA Community Day	
2007		
Mar. 2	ALMA Day 2007	ALMA/ARC/PRIN2007[g]

[e] Held at Bologna, Padova, Trieste, Catania, Roma, Brera, Torino, Napoli

[f] Bologna; Organised in collaboration with INAF-OA Catania. and funded by the EU through ITN LASSIE Network and COST Action CM0805

[g] Bologna; national meeting of participants to PRIN 2005 “In Preparazione di ALMA” (PI Walmsley), to discuss science with ALMA and possible application for a PRIN2007

Table 2: People employed at the Italian ARC-node since 2005

Name	Period			Comments[†]
Baronchelli Ivano	Apr. 2022	–	present	AdR
Boissier Jeremy	Oct. 2010	–	Sep. 2013	ESO/ALMA Cofund Fellow
Bonato Matteo	Jun. 2017	–	Sep. 2018	BdS
	Oct. 2018	–	Sep. 2021	AdR, partially co-financed by 'FORECaST' and 'Radio Sky 2020'
	Oct. 2021	–	present	ric. TD x ARI-L, partially co-financed by ARC
Brand Jan	Feb. 2005	–	present	coordinator; primo ric. TI
Burkutean Sandra	Apr. 2016	–	Mar. 2021	AdR; 2nd triennial co-hosted at Cambridge (UK)
Casasola Viviana	Mar. 2010	–	Feb. 2015	AdR
Fontani Francesco	Nov. 2005	–	Nov. 2007	INAF Fellowship
	Nov. 2007	–	May 2008	BdS
Giannetti Andrea	Mar. 2014	–	Dec. 2014	BdS
	Jan. 2017	–	Dec. 2019	AdR
Liuzzo Elisabetta[a]	Jul. 2013	–	May 2018	AdR
	Jun. 2018	–	Nov. 2018	ric. TD x AENEAS
Mancuso Claudia	Apr. 2017	–	Mar. 2018	BdS i-ALMA
Marcelino Nuria	Apr. 2014	–	Mar. 2016	AdR
Marchili Nicola[b]	Dec. 2017	–	Nov. 2018	AdR IAPS-Roma
	Dec. 2018	–	Nov. 2019	AdR
	Dec. 2019	–	Jul. 2021	ric. TD x BHC
	Aug. 2021	–	Dec. 2021	ric. TD x ARI-L
Massardi Marcella	Apr. 2011	–	present	manager; ric. TI
Mignano Arturo	Mar. 2009	–	Aug. 2016	AdR
Paladino Rosita[c]	Feb. 2011	–	Feb. 2016	AdR, Co-financed with DIFA (UniBo)
	Mar. 2016	–	Dec. 2016	AdR
Rossetti Alessandra	Dec. 2006	–	Jun. 2012	BdS
Rygl Kazi[d]	Feb. 2015	–	Oct. 2018	i-ALMA Fellow
	Oct. 2018	–	Jun. 2020	ric. TD x AENEAS
Sabatini Giovanni	Jan. 2021	–	Feb. 2023	AdR 'professionalizzazione'
Sanna Alberto	Sep. 2019	–	Jun. 2020	AdR
Schisano Eugenio	Jul. 2018	–	Nov. 2018	AdR

[†] Unless specified otherwise, all BdS and AdR contracts are on the IT-ARC budget

In **boldface**: current ARC-member

[a] Staff (TI) at INAF-IRA/ARC since Dec. 2018

[b] Staff (TI) at INAF-IRA/ARC since 20 Dec. 2021

[c] Staff (TI) at INAF-IRA/ARC since 30 Dec. 2016

[d] Staff (TI) at INAF-IRA/ARC since Jul. 2020

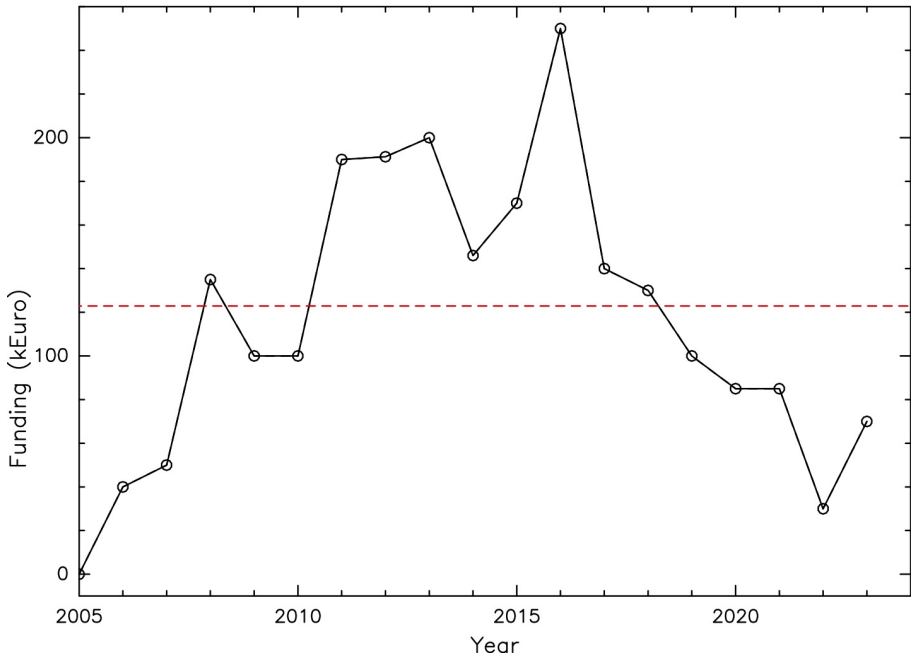


Figure 5: Funding for the Italian ARC-node, received directly from INAF 2005-2023. The dashed red line indicates the average amount of financing received per year over the entire period.

2.9 Financing

The ARC receives funding from INAF. A budget request is made every year, presenting a plan of operation covering a period of at least two years to ensure continuity in the execution of our tasks for the community. The budget covers the salaries of the postdocs (see column 3 in Table **??**), maintenance and upgrades for the computer cluster, organisation of Schools, tutorials, workshops and conferences, and travel. In more recent years we have included requests to finance a PhD position. Figure 5 shows the funding received by the IT-ARC from INAF, from its start up to and including 2023 (total $\sim$ 2.2 M€). The drop in funding requested since 2017 is mostly a consequence of the decreasing ratio of postdocs-to-staff after the recent concorsi, and of the availability of external funds to pay postdocs for specific projects; the increase in 2023 is due to the fact that this year it is our turn to organise the EU-ARC node network All-hands meeting, and our organisation of the "5th workshop on mm-astronomy in Italy".

Because of our activities and expertise, we have become involved in projects such as the Horizon2020 project AENEAS and Black Hole Cam (BHC), that both came with a modest amount of separate funding; these funds were used to pay postdocs to work on those projects (while also performing 'duties' for the IT-ARC) and to acquire a dedicated computer server (for BHC). Likewise, the ARC-led ALMA Development Plan, ARI-L, was independently funded by ESO; postdocs hired worked primarily on ARI-L. On the other hand, funding received in the context of the premiale project "i-ALMA" (2015-17; PI: Testi) has been used for ARC development. We have also benefitted from the presence of an ESO Cofund-Fellow (2010-13), who worked for the ARC and was paid by ESO. Sources of major additional funding are listed in Table **??**. For the organisation of some workshops and training events we have received some support (for catering, travel and/or support for participants with limited financial resources) from RadioNet and/or ORP.

Table 3: Sources of major additional/external financing

Project	Period	Comments
ESO-ALMA Cofund Fellowship[a]	Oct. 2010 - Sep. 2013	
i-ALMA	2015 - 2017	Premiale project[b]
AENEAS	2017 - 2020	
BlackHoleCam	Oct. 2017 - May 2021	
ALMA Development Project	2019 - 2022	ARI-L

[a] In the ALMA Early Science phase ESO Fellows could choose an ARC-node where to fullfill their fellowship; they were paid by ESO. Jeremy Boissier (now staff at IRAM, Grenoble) came to the IT-ARC

[b] PI Leonardo Testi (then at ESO/Arcetri); INAF-IRA/ARC was one of the participating institutes