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ALMA REGIONAL CENTRE ITALY
is Bologna

The Italian ALMA Regional Centre

Our experience with user support

Jan Brand, INAF-Istituto di Radioastronomia & Italian ARC - Bologna

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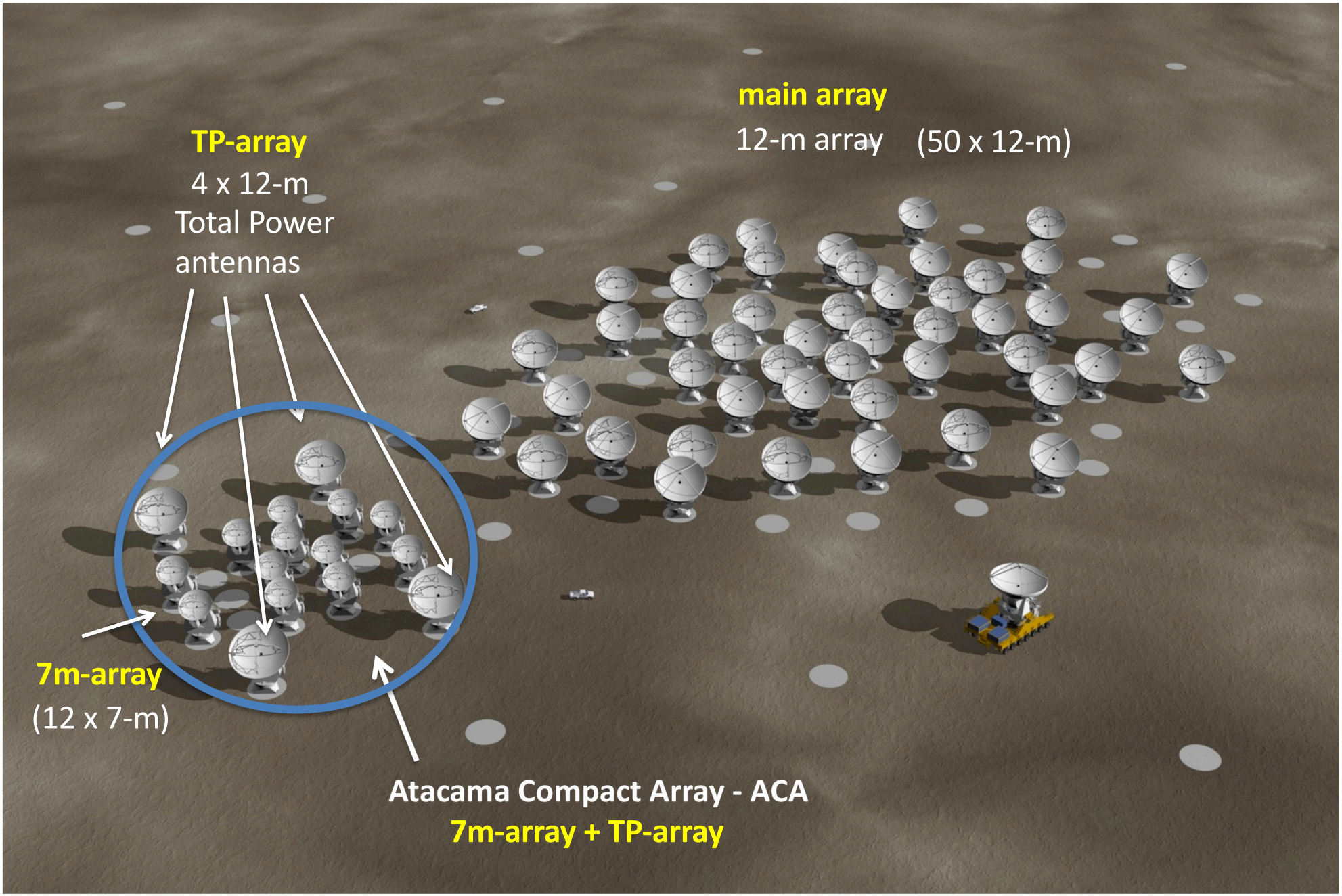
OUTLINE

1. ALMA; organisational structure;
   EU node network
2. How do we provide assistance
   a. direct user support
   b. community development (education, outreach)
   c. supporting the ALMA project
   Network activities
3. (Some) available tools
4. Using our expertise: projects and developments
5. Evolution and Outlook

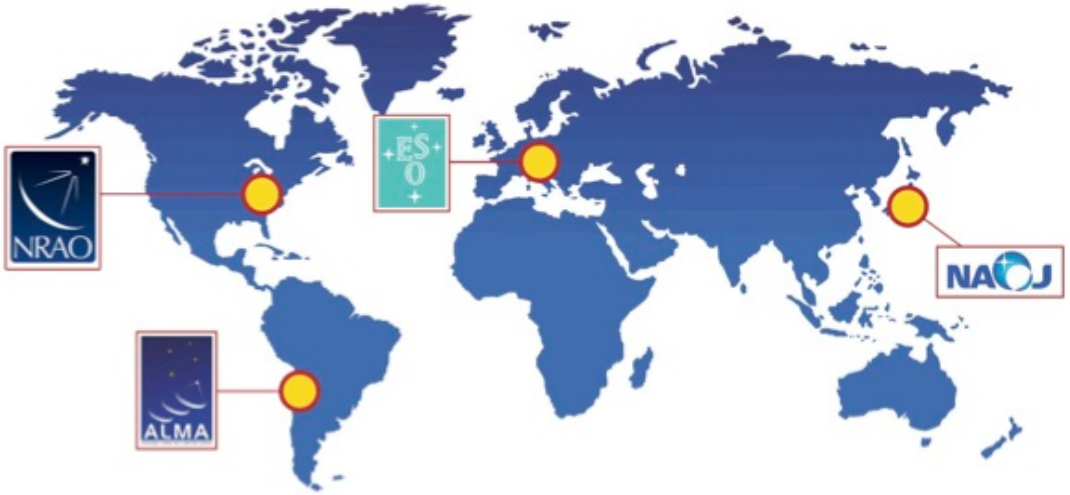
ALMA: Atacama Large Millimeter/submillimeter Array @ 5km alt. Chajnantor plateau, Chile



Interferometer, 66 antennas; main array: baselines 0.15 – 16 km

ORGANIZATIONAL STRUCTURE

#1.



Joint ALMA Observatory:

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

A user-support network for ALMA was set up, based on the philosophy that:

Every astronomer, regardless of field or spectral range of research, should be able to succesfully apply for observing time with ALMA.

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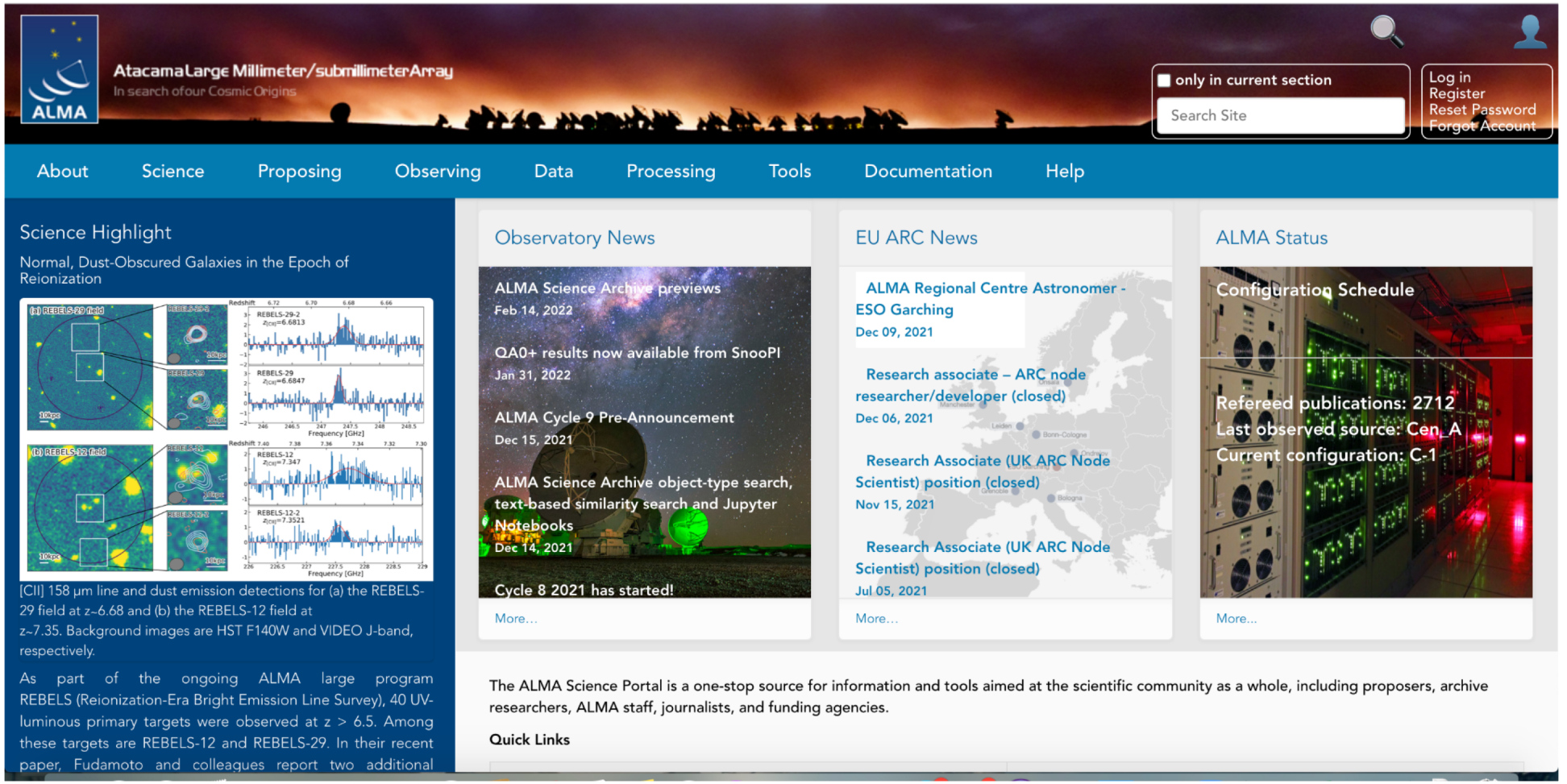
The source of all information and the departure point for all help requests:

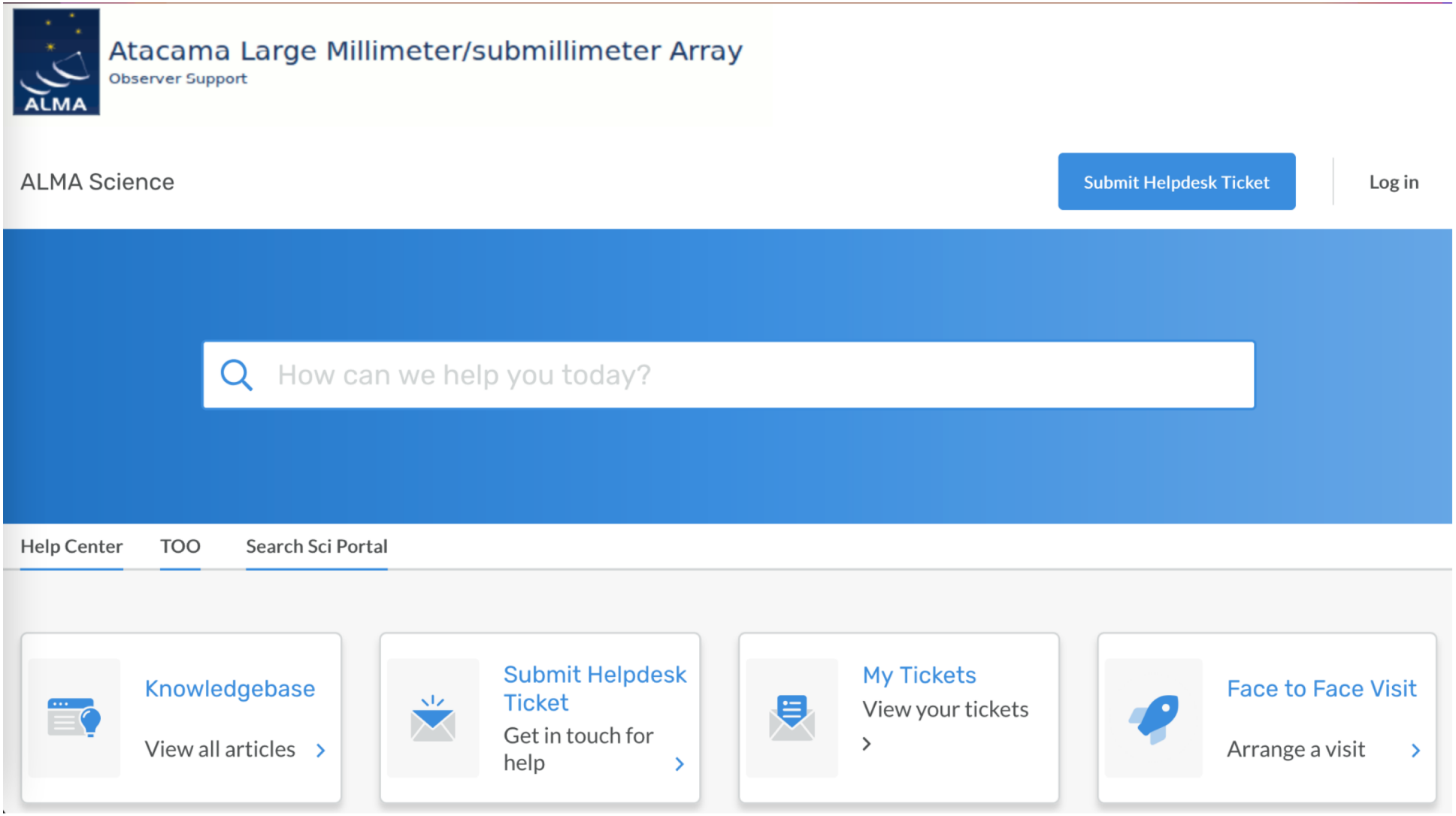
Science Portal

almascience.eso.org



The ALMA Helpdesk website

http://help.almascience.org



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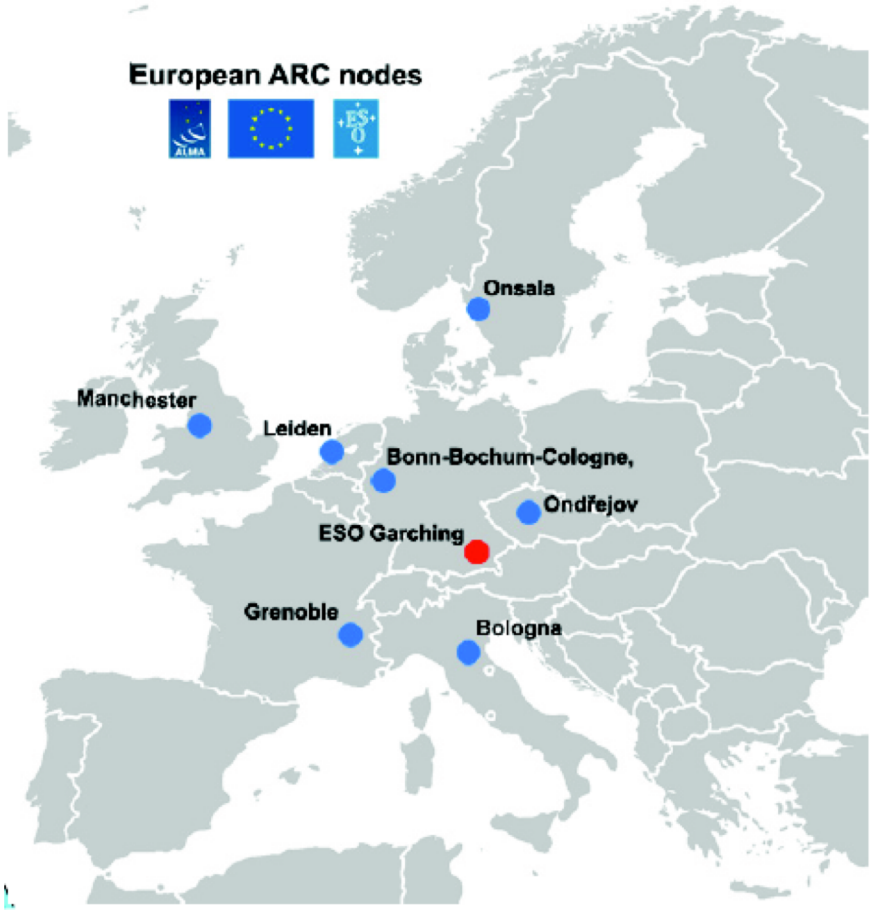
In Europe

A network of 7 ARC-nodes, coordinated by the central node at ESO.

Bound by an MoU, signed by all

Italian node EU-ARC Network hosted by INAF-Istituto di Radioastronomia (>2005)



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Support tasks in a nutshell:

Support to and development of user community

a Direct support to our users.
Help potential users with what is needed to successfully access the facility, to reduce and analyse the data.

b Education and outreach.
Create platform for meeting, exchanging ideas and finding collaborations.
Expand the community by attracting and training new generation
Introduce users to advanced tools for data reduction and analysis

Support to the ALMA Project

c Contribute to the functioning and development of ALMA user tools and facilities, particularly using our expertises.

#2a. Support to the community

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- **Helpdesk Available always! Face-to-face support**
  proposal preparation, data reduction (calibration, imaging) and analysis
- **Organise Community Event around Call for Proposals**
  various formats and durations. Practical & educational information and science presentations
- **Introduce users to software tools**
  for proposing and analysing data, e.g. AOT, CASA, ALMA simulators
- **Contact Scientist for Italian PI projects**
  follow and support accepted projects throughout their lifetime
- **Provide computing facilities**
  13 servers, 64-256 GB RAM, 318TB storage; high-speed connection 10Gbit/s

ARC computer cluster

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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

13 Servers, 64-256 GB RAM; 318 TB storage; high-speed connection 10Gbit/s

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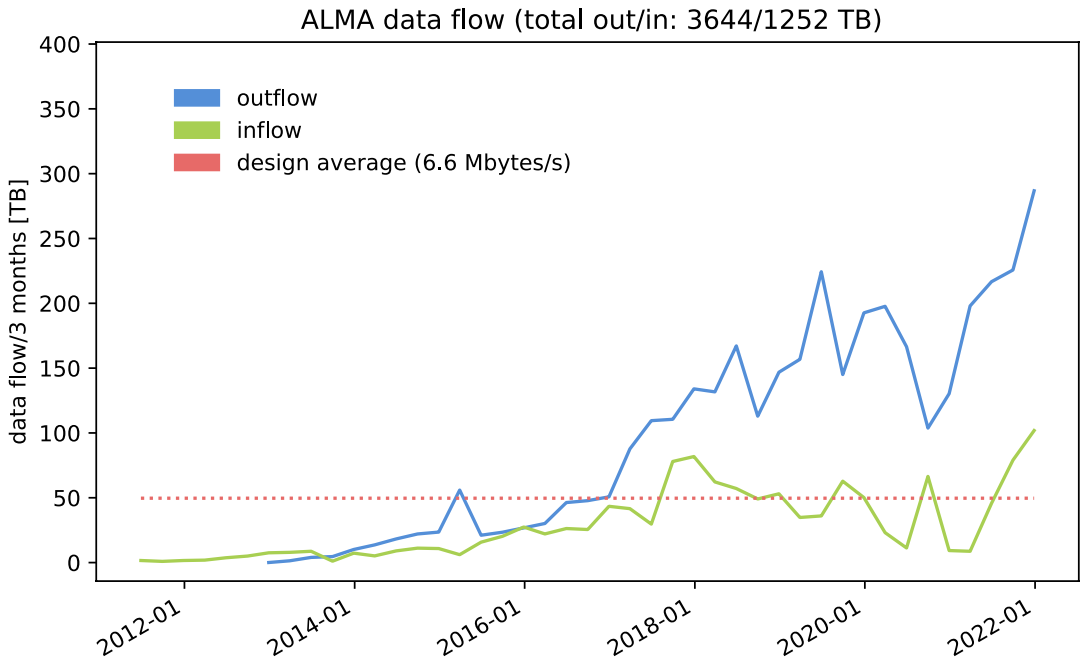
Data flow to and from ALMA Science Archive (ASA)



Typical size project Cycle 0 to 8:
~100 MB to ~1 TB

Total amount of data in ASA:
~1.3 PB

Credit: Felix Stoehr, ESO

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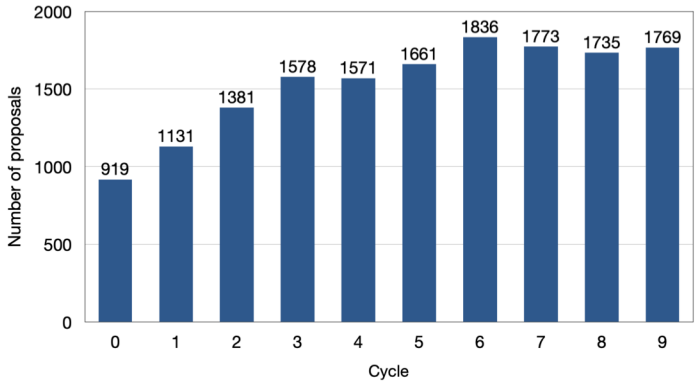
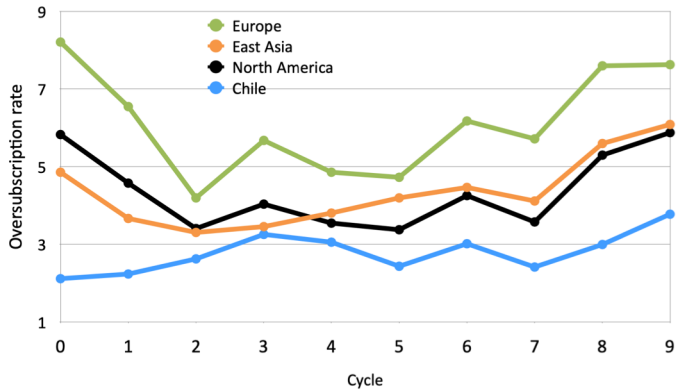
The importance of archival data

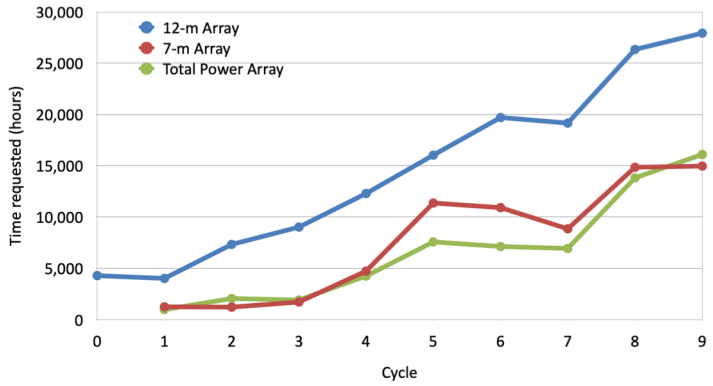
Number of submitted proposals by Cycle

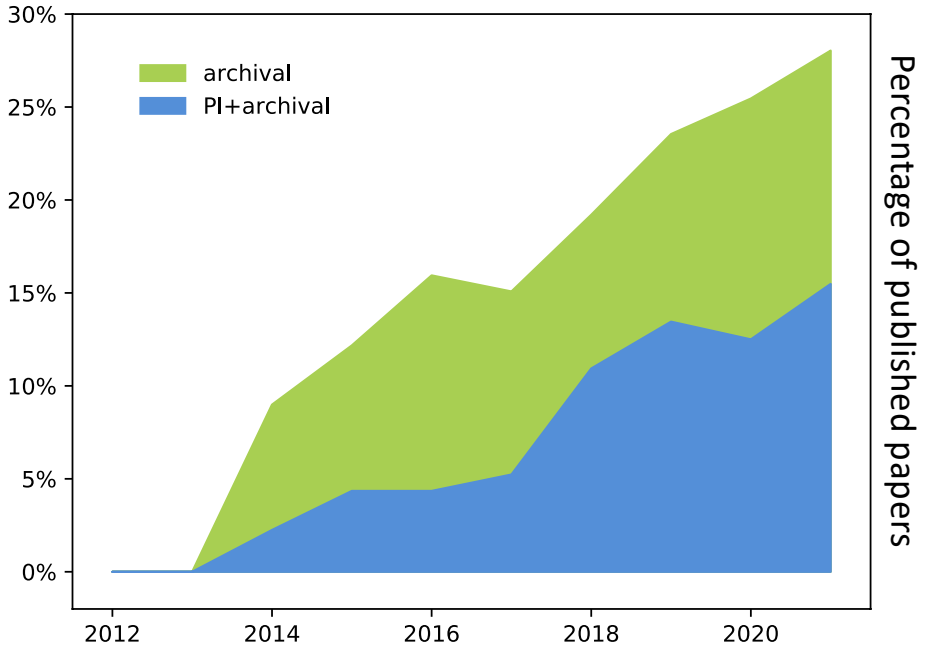


Oversubscription rate by Cycle



Time requested by Cycle





Credit (paper % plot): Felix Stoehr, ESO

#2b. Community development

Education & outreach

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- **Provide opportunities to meet, discuss ideas, network, create collaborations**

We:

- organise bi-annual Workshops on mm-astronomy in Italy
- contribute to conferences
- present and co-organise seminars

#2b. Community development

Education & outreach

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- **Generate interest: Attract and train a new generation (multi-wavelength astronomy is the future!)**

We do this through:

- Organising/participating in Schools, Training Networks
- Supervising students with Masters and PhD theses
- Teaching University Courses and hands-on Laboratories
- Organising/presenting lecture series for PhD students

#2b. Community development

Education & outreach

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- **Introduce users to advanced tools for data reduction and analysis**

- We organise specialised tutorials and workshops (e.g. on self-calibration, advanced imaging techniques and pipeline, polarisation, data handling, archive mining and mm-VLBI)

- We contribute to iTRAIN (series of interactive training sessions to help users gain expertise with handling interferometric data)

- Data visualisation tools: ADMIT, CARTA

Education, outreach

recent examples Italian ARC

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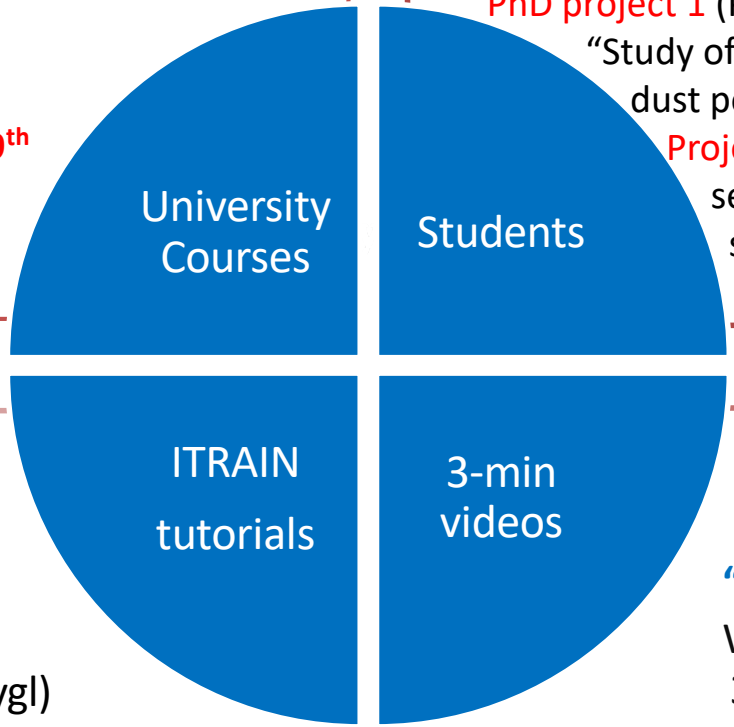
Radio Laboratory (@UniBO): Paladino, Brand, Sabatini. **In 2021-22 held for 8th time**: Oct. '21 [lectures, 2wks lab: ALMA data reduction].

mm astronomy (@SISSA): Massardi. **In 2022 held for 9th time** (ALMA + SKA)



Supervising students (UniBo and SISSA)
So far: 8 Masters, 9 PhD

PhD project 1 (Paladino) 2022-2025: "Study of magnetic field in galaxies from dust polarized emission"
Project 2 (Bonato): "A systematic search for ultra-bright high-z strongly lensed galaxies in Planck catalogues"

2021: on polarization (Paladino)
2022: on archive mining (Rygl)

"ALMA Explained"
We prepared instructional 3min videos on: sensitivity (Bonato), ALMA-VLBI (Liuzzo) and polarization (Paladino+)

Education, Outreach (cont'd)
recent examples Italian ARC

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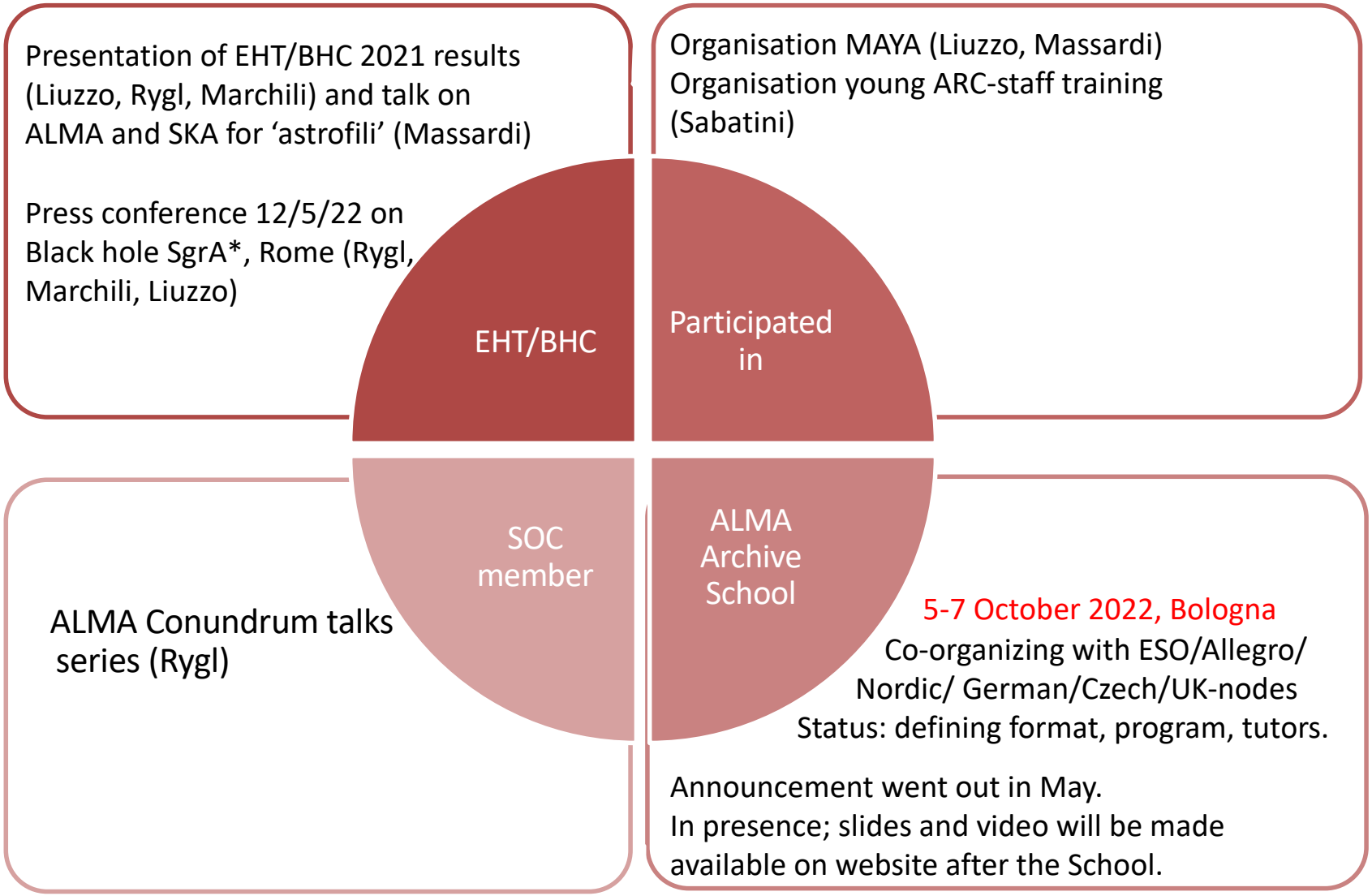

MOST TANGIBLE RESULTS USER SUPPORT

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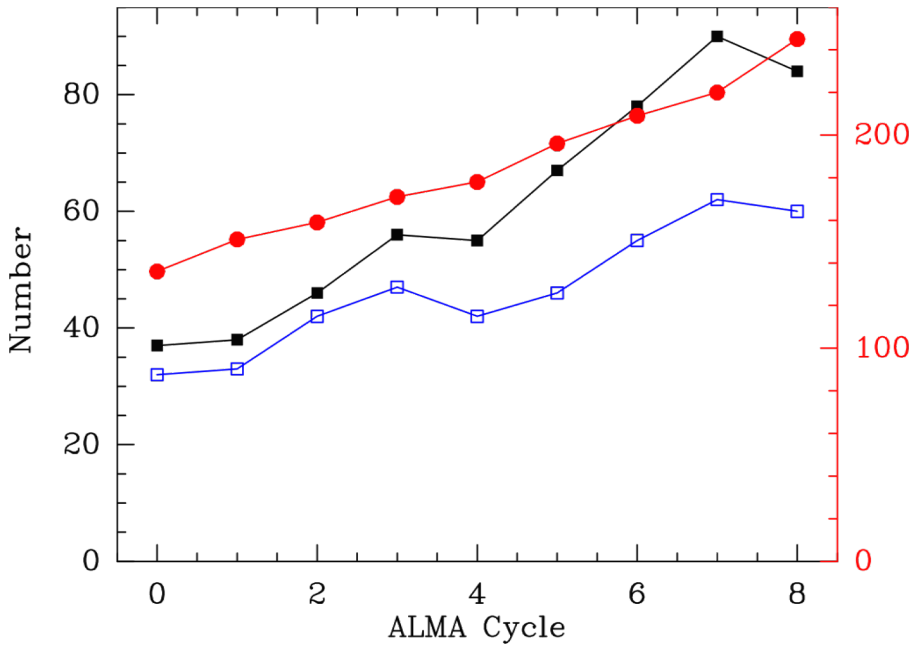
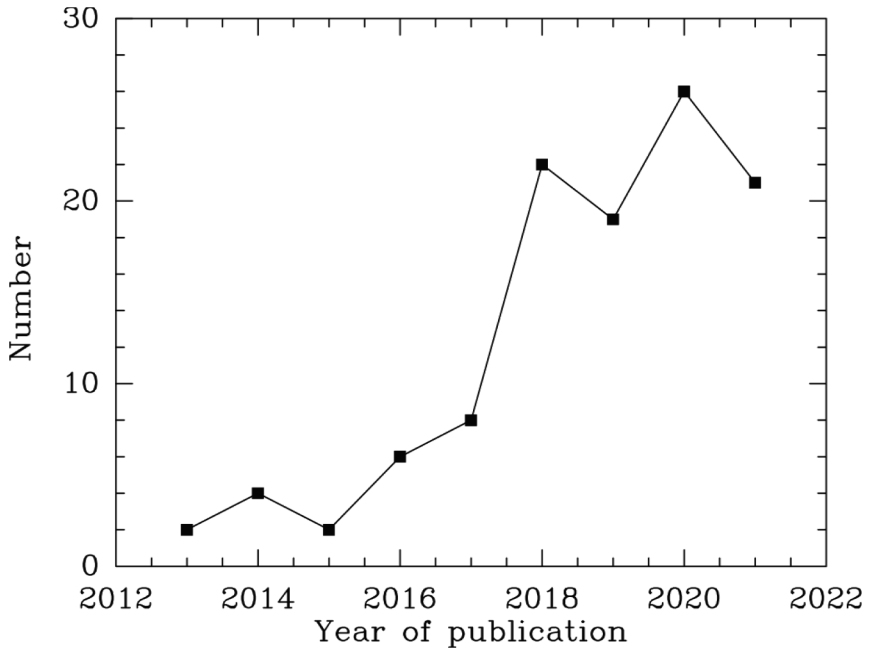
Considerably increased interest in ALMA, also in institutes with historically not a radioastronomical background.

Cycle 0 to 9: from 37 proposals by 32 PI's to 89 proposals by 63 PI's [Cy8: 245 Co-I]

PI's, Co-I's and Proposals



Publications Italian PI's



Submitted Italian-led proposals [left axis]

Unique Italian PI's [left axis]

Unique Italian Co-I's [right axis]

Refereed publications, first author Italian affiliation

2013-2021: N=110

[data provided by Felix Stoehr, ESO]

#2c. Supporting ALMA

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- **Contribute to functioning and development of ALMA user tools and facilities**

Variegated activities, always aimed towards an improved operability of the array, assurance of fast delivery of reliable data to the PI's and creating new opportunities for users to make scientific use of ALMA.

Examples:

- Participation in science verification observations and data reduction campaigns
- Long baseline campaign: calibration & high-quality images at longest baselines
- Quality assurance (QA2); weblog review
- Software tests (Observing Tool)
- Updating ALMA documentation (Technical Handbook, User Manuals, guide to EU ARC)
- Astronomer on Duty
- **Contributions to expert working groups: on polarisation, on mm-VLBI**
- **Archive mining (various projects)**

Network activities for the community

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Education, outreach
by the EU nodes network

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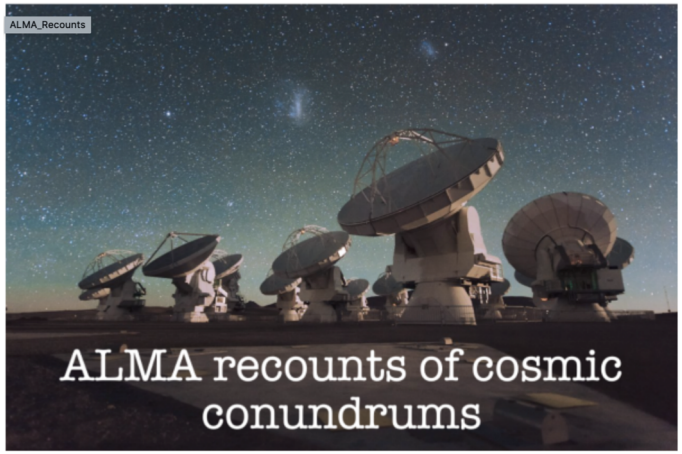
MAYA



[Meeting of ALMA Young Astronomers 2022]

https://www.youtube.com/playlist?list=PLSPuDgCIX-pYJkZ3VEd_SewcPkPh5BpyE

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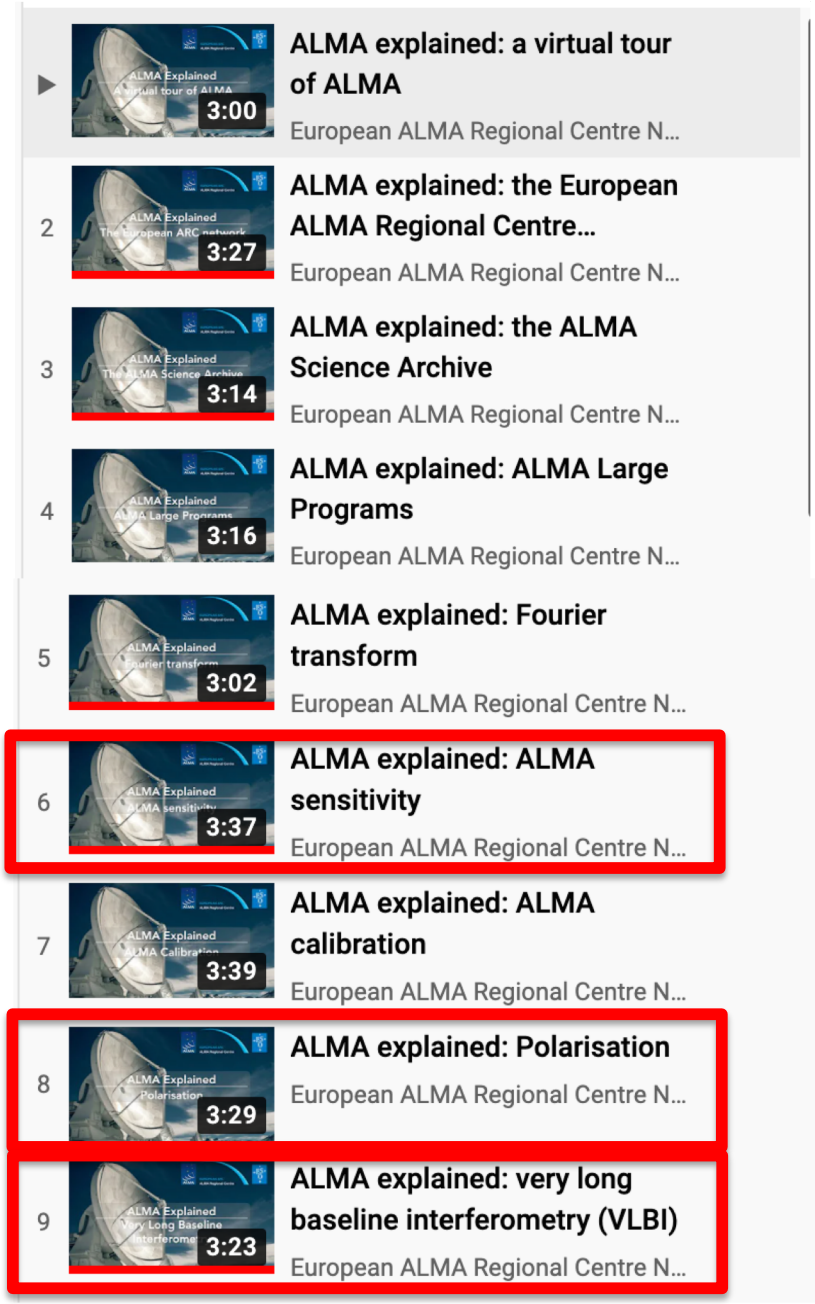
ALMA Explained

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. The videos have been prepared by experts from the ESO ARC and the ARC nodes in Europe. The first release includes 9 videos and more videos will come with time.

https://www.youtube.com/watch?v=730PrNwyuEs



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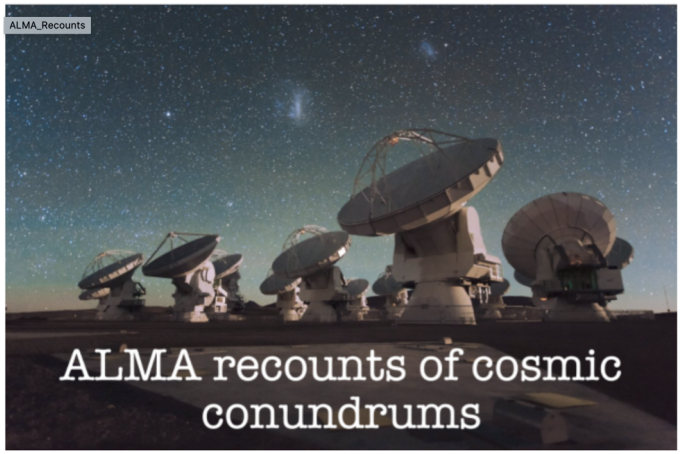
https://www.eso.org/sci/facilities/alma/arc/alma_recounts.html

Cosmic Conundrums

In each talk of this series a major astronomical question is discussed. The speaker describes the context of the question and then focuses on the ALMA contribution to the field. The aim is to highlight the unparalleled contribution of ALMA to the broader astronomical landscape and to provide an outlook towards the future.



Date	Question	Speaker
December 1, 2021 14:00 CET	How does dust enrichment around evolved stars work?	Leen Decin (KU Leuven)
January 12, 2022 14:00 CET	What is the coupling between molecular clouds, star formation and stellar feedback?	Eva Schinnerer (MPIA Heidelberg)
February 2, 2022 14:00 CET	How does the dynamics of galaxies evolve over cosmic time?	Francesca Rizzo (DAWN Kopenhagen)
March 2, 2022 14:00 CET	How are the building blocks of life formed?	Izaskun Jiménez-Serra (Centro de Astrobiología)
April 6, 2022 14:00 CEST	What is the role of filaments in star formation and how are they shaped?	Alvaro Hacar (University of Vienna)
May 4, 2022 14:00 CEST	How and when does planet-formation happen in disks?	Davide Fedele (INAF Osservatorio Astrofisico di Arcetri)
June 1, 2022 14:00 CEST	What do comets tell us about the origin of Earth?	Nicolas Biver (Observatoire Paris-Site de Meudon)

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https://almascience.eso.org/tools/eu-arc-network/i-train
Review all tutorials on the itrain youtube channel

I-TRAIN

The European ARC Network organizes 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. The duration of each training session is about one hour, including a live demo and interactive Q&A.

I-TRAIN #1: imaging with the ALMA Pipeline
4 December 2020, 11:00 CET

I-TRAIN #2: ALMA Science Archive update and ARI-L
15 December 2020, 11:00 CET

I-TRAIN #3: UVMultiFit
15 January 2021, 11:00 CET

I-TRAIN #4: ALMA WebLog inspection
19 February 2021, 11:00 CET

I-TRAIN #5: Simulating ALMA Observations with the OST
11 March 2021, 11:00 CET

I-TRAIN #6: Improving image fidelity through self-calibration
25 May 2021, 11:00 CEST

I-TRAIN #7: Polarization observations with ALMA
24 June 2021, 11:00 CEST

I-TRAIN #8: Exploring the ALMA Science Archive with ALminer
30 September 2021, 11:00 CEST

I-TRAIN #9: Stacking spectra in the image domain with LineStacker
15 October 2021, 11:00 CEST

I-TRAIN #10: Solar observations with ALMA
19 November 2021, 11:00 CET

I-TRAIN #11: Statistical continuum determination with STATCONT
10 December 2021, 11:00 CET

I-TRAIN #12: CARTA tutorial
18 February 2022, 11:00 CET

I-TRAIN #13: Writing & Reviewing ALMA Proposals
18 March 2022, 11:00 CET

I-TRAIN #14: Using ALMA archival data - A Primer
20 May 2022, 11:00 CET

Tools
to inspect, reduce and analyse the data

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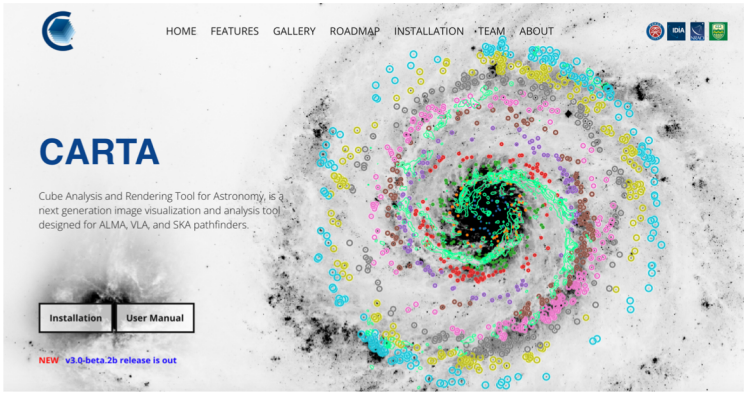
CASA
Common Astronomy Software Applications

Tools developed by the nodes of the European ARC network

https://almascience.eso.org/tools/eu-arc-network/tools



CARTA: the Cube Analysis and Rendering Tool for Astronomy

Alminer
ALMA archive mining and visualization toolkit

https://www.alma-allegro.nl/alminer/

https://admit.astro.umd.edu/index.html

The ALMA Data Mining Toolkit

#4.

OUR SPECIFIC EXPERTISES

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By design of the network, any of our activities are also done at other nodes.
Some are more node-specific. These are our areas of expertise:

1. mm-VLBI. Phased ALMA array as part of global mm-VLBI array. Long-standing experience IRA with radio VLBI, *noblesse oblige*. Involved in development from start and developed competence. This led to invitation to become partners in BHC/EHT project and to making significant contribution to that.

2. polarisation. Contribute to the ALMA extension of polarisation capabilities since 2015, participating in the observational and data reduction campaign leading to the capabilities currently offered. We contribute to the data reduction scripts, the quality assurance and to the training of analysts. Work on more efficient calibration and extension FoV of polarisation observations.

3. archive mining. Science archive continuously expanding and its scientific exploitation becomes increasingly important in research. Fraction of publications making use of ALMA archival data increases. From early on we contribute to make ASA more accessible and containing more complete and higher quality products, and to explore ASA in connection with other archives and catalogues.

Using our expertises

Projects, developments ALMA-related

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Sci Portal: https://almascience.eso.org/alma-data/aril
Project page: https://sites.google.com/inaf.it/ari-l

ARI-L: Additional Representative Images for Legacy

Massardi PI. ALMA Development Plan. Apply 'ARI' to archived data of Cycles 2-4 and ingest products into archive. Started officially: 7 June 2019.
Has reached goal 5 months before deadline. Got 6-mo. extension.

Paper with project description has been published:
Massardi et al. 2021 PASP 133, 085001 (arXiv:2107.11071)

Publications of the Astronomical Society of the Pacific, 133:085001 (15pp), 2021 August https://doi.org/10.1088/1538-3873/ac159c

CrossMark

The Additional Representative Images for Legacy (ARI-L) Project for the ALMA Science Archive

M. Massardi[1,2], F. Stoehr[3], G. J. Bendo[4], M. Bonato[1], J. Brand[1], V. Galluzzi[5], F. Guglielmetti[3], E. Liuzzo[1], N. Marchili[1], A. M. S. Richards[4], K. L. J. Rygl[1], F. Bedosti[1], A. Giannetti[1], M. Stagni[1], C. Knapic[5], M. Sponza[5], G. A. Fuller[4], and T. W. B. Muxlow[4]

[1] INAF—Istituto di Radioastronomia—Italian ALMA Regional Centre, via Gobetti 101, I-40129 Bologna, Italy; massardi@ira.inaf.it
[2] SISSA, Via Bonomea 265, I-34136 Trieste, Italy
[3] European Southern Observatory (ESO), Karl-Schwarzschild-Str. 2, D-85748 Garching bei München, Germany
[4] UK ALMA Regional Centre Node, Jodrell Bank Centre for Astrophysics, Department of Physics and Astronomy, The University of Manchester, Oxford Road, Manchester M13 9PL, UK
[5] INAF-Osservatorio Astronomico di Trieste—Italian Astronomical Archives, via Tiepolo 11, I-34131 Trieste, Italy
Received 2021 June 1; accepted 2021 July 19; published 2021 August 10

ARI-L

Collaboration with IA2 Trieste [storage calibrated data]

The ARI-L development project

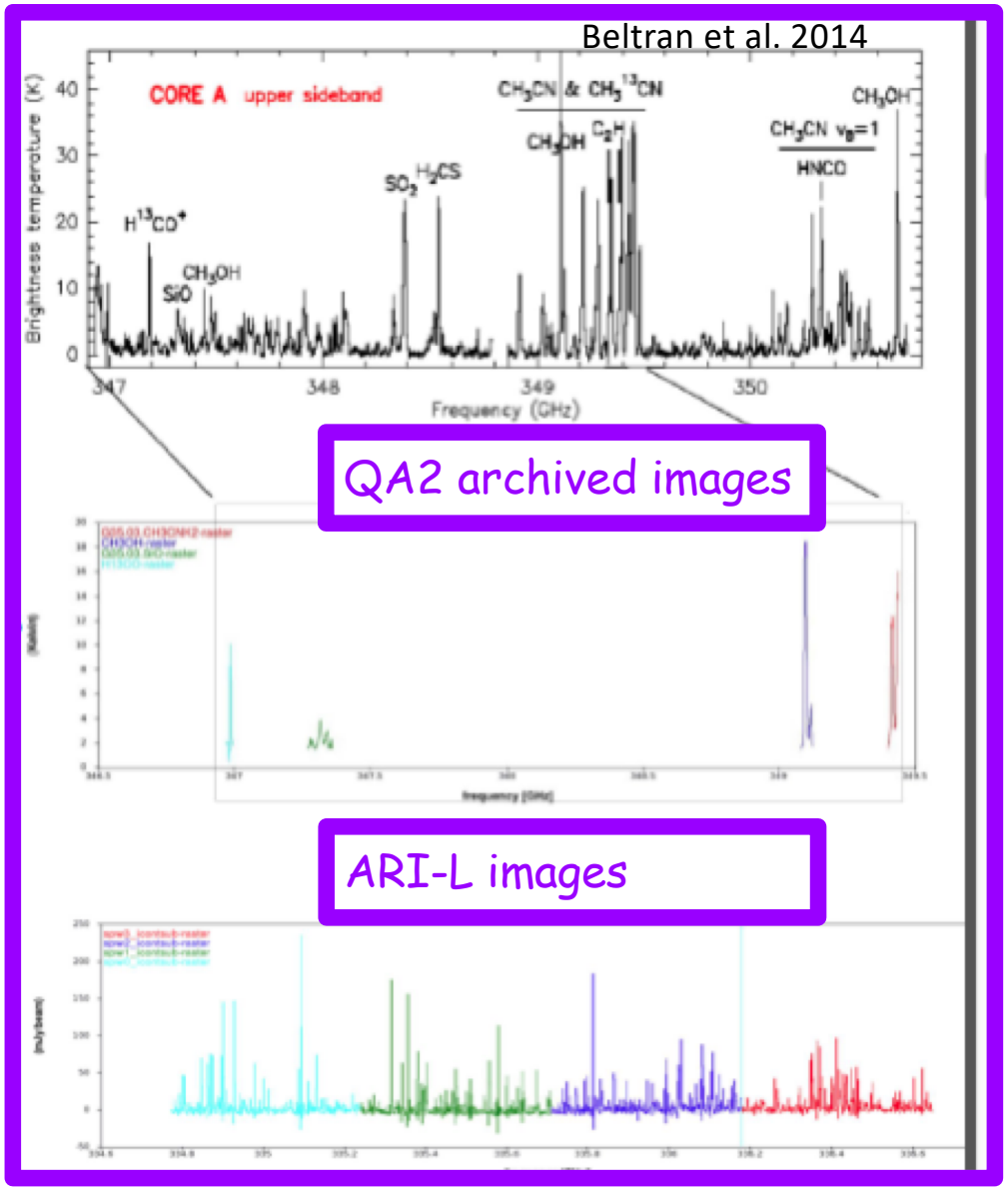
(via Science Portal:) https://almascience.eso.org/alma-data/aril

As of Cycle5 (>Sept. 2017) data pass through Imaging Pipeline. Full data cubes in archive. For earlier Cycles only QA2 products in ASA.

ARI-L produces full products for >70% of projects in Cycles 2-4 that are processable with the Imaging Pipeline and adds them to the ASA.

calibrated MS of the processed dataset will be released and stored at IA2, Trieste.

For support help-desk@alma.inaf.it



Massardi et al. 2019, ALMA Memo 614

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Using our expertises

Projects, developments "spin-off"; finished projects

AENEAS: Advanced European Network of E-infrastructures for Astronomy with the SKA (a H2020 project)

INAF-IRA (Massardi) was leader of WP5, which focused on design of user interaction model that could be implemented for the European SKA Data Centre (ESDC). Involved people from It-ARC and from other nodes (UK, Nordic). Funding for 2 FTE. Ended 9/2020.

BHC: BlackHoleCam (a H2020 project)

INAF-IRA/ARC official partners. Funding for 2 FTE + hardware.
Liuzzo and Rygl worked on CASA pipeline for mm-VLBI data. Ended 5/2021.

Liuzzo and Rygl with M87 in 2019

First SKA Data challenge

Burkutean PI, leader of IRA/ARC effort. Finding, extracting and characterizing radio sources. Competitive project.

Using our expertises

Projects, developments "spin-off"; active

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SKA Data Science & Support Centre

We are involved in this (inter)national follow-up of the H2020 AENEAS project; coordinating activities for SRC Steering Committee (set-up of proto-SKA Regional Centre). Massardi, Brand, Rygl, Liuzzo

EventHorizonTelescope / BlackHoleCam

Rygl, Liuzzo, Marchili. BlackHoleCam EU-funded project finished, but continue work on EHT data. Follow-up projects.
EHT-related activities in the Working Groups on "Calibration and Error", "Time Domain" and "Parameter Definition"

ORP: Opticon-RadioNet Pilot

Rygl, Liuzzo, Paladino are involved in this H2020 project that aims to "offer access to an unrivalled set of major and specialized observatories across Europe (and around the world) covering the optical, infra-red, sub-mm and radio wavebands"

#4.

How ALMA moves forward: the development program

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The ALMA partners contribute funds for new ALMA developments, promoting hardware, software and infrastructure improvements.

Examples:

East Asia
Band 1 receiver, 35-50 GHz
ACA spectrometer for the TP-array

Europe
Band 2 receiver development (coordinated by ESO)
The Additional Representative Images for Legacy project (ARI-L)

North America
ALMA Phasing System Phase 2 (APP2)
Upgrade Band 6 receivers

#5.

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Focus of user requests, type and level of support evolve with time

First years: users less expert and tools less advanced; requests mostly for basic info for proposals, and help with data reduction (calibration, imaging).

With time: many users become more experienced but new users still start at novice level. Also ALMA evolves and advanced tools for data handling are developed.

Now: we support an expanding and diverse community: **novices** to be trained, and **experienced users** require different type of assistence. **We participate in a variety of activities** ensuring we stay up-to-date with the evolution of the telescope and hard- /software and are able to provide the requested support.

OUTLOOK: ARC EVOLUTION

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Premise:
ALMA is continuously being upgraded and improved; both new and experienced PI's continue to need support with new observing modes and capabilities. New generation continues to need training and students need supervising.
We guarantee continued support, including all new features.

Experienced users may request we focus activities and skills on specific scientific and technological areas (advanced data analysis). Multi-wavelength research, especially through the use of archives, is becoming more and more requested. To match ALMA data, high-angular resolution data are desirable. One may thus expect increasing demand for support with data reduction/analysis of observations taken with other interferometers (incl. in near future SKA).

Many ARC nodes already expand their role to become the central point for synergy among many imaging facilities (collaboration across disciplines, cross-matching of datasets and linking communities) and we too
evolve towards a national center of expertise for radio and mm-interferometry.

We are undertaking steps to organize this on a transnational level and create a
N-ICE: Network of Interferometry Centres of Expertise
Of course while recognising and sharing expertise with groups outside the ARC-node network.

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https://www.alma.inaf.it
help-desk@alma.inaf.it

Current team


Jan Brand


Marcella Massardi

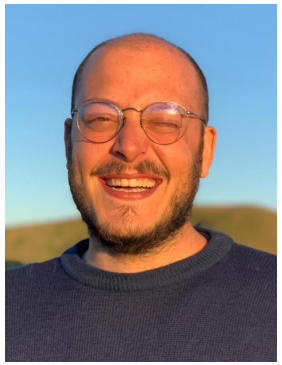

Rosita Paladino


Elisabetta Liuzzo


Kazi Rygl


Nicola Marchili


Matteo Bonato


Giovanni Sabatini


Ivano Baronchelli