Science and Technology in Italy for the upgraded ALMA Observatory - iALMA

Linea di intervento:

N.3: Programmi e/o progetti legati al potenziamento delle infrastrutture di ricerca esistenti che abbiano una valenza europea ed internazionale, anche in termini di impatto e che permettano di consentire la migliore partecipazione italiana ai programmi europei congiunti. Sono pertanto favorite quelle infrastrutture che: si autofinanziano almeno in parte attraverso servizi o altri progetti di ricerca; fanno parte di una rete europea; fanno parte di un ERIC (European Research Infrastructure Consortium) o sono in procinto di divenirlo; coinvolgono altre organizzazioni pubbliche o private distribuite sul territorio nazionale; non hanno già altre fonti di finanziamento in corso del MIUR per la stessa annualità e tipologia di spesa o siano ad esse complementari.

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1 Coordinator

Dr. Leonardo Testi – INAF-Osservatorio Astrofisico di Arcetri

2 Areas of the proposed activities

SAFE, GREEN AND EFFICIENT ENERGY	A small, but important part of this project is a feasibility study for the possible production of green energy at the ALMA site to partially substitute the current production, based on fossil fuel consumption. We plan to contract an Italian consulting firm to execute this study.
INDUSTRY FOR THE FUTURE AND MADE IN ITALY	iALMA is closely connected with Italian industries and the development of the capabilities of producing new and advanced technology. We especially forcus on the development and production of high technology components for microwave devices. iALMA will also engage the Italian green energy industry.
ICT AND SENSING DEVICES	A key part of the iALMA project is to develop and produce prototype of microwave receiver technologies.
PHYSICAL SCIENCE AND ENGINEERING	The project is mainly focused to develop the scientific, technological and industrial competences and capabilities to make the best possible use in Italy of the scientific opportunities of our participation in ESO and the Atacama Large Millimetre/submillimetre Array (ALMA).

3 Personnel

3.1 INAF Participants

Leonardo Testi **INAF-Osservatorio Astrofisico di Arcetri**	Coordinator of the project. LT has been working on the ALMA project since the early 2000s, first as an expert for the Science Software Requirements group, then, since 2003 as member and then chairman of both the European ALMA Science Advisory Committee (ESAC) and the global ALMA Science Advisory Committee (ASAC). Since 2007 he has been assigned by INAF in Munich at ESO to serve as European ALMA Programme Scientist. In this capacity he is responsible in Europe for the overall ALMA Science Requirements and the development of the long term scientific strategy for the observatory.
LEONARDO TESTI graduated in Physics at the University of Florence in 1993, then he obtained the PhD in Astronomy from the same University in 1997. In his years as Laurea and then Dottorato student he spent several	

long stints in important european institutes: ASTRON (Dwingeloo, NL), Max Planck Institut fuer Radioastronomie (Bonn, D), and Institut d'Astrophysique de Paris (Paris, F). From 1997 through 1999 he has been Postoctoral Scholar at the California Institute of Technology (California, USA), where he was working with the Owens Valley Millimeter Array group. In 1999 he moved back to Italy as Ricercatore Astronomo at the Osservatorio Astrofisico di Arcetri, where he now holds the position of Astronomo Associato since 2003. Since 2007 he has been assigned by INAF to work at the European Organization for Astronomical Research in the Southern Hemisphere (ESO) as Full Astronomer and European ALMA Programme Scientist. The research activities of LT are primarily based on observations at wavelengths from the optical through the radio of star forming regions. His interests include the formation of massive stars and stellar clusters in our own Galaxy and in the Local Universe, the formation of Brown Dwarfs, the formation and evolution of protoplanetary disks and the process of planets formation. LT is coauthor of over 200 refereed publications, his h-index is 47. He regularly serve as referee for some of the most important journals for astrophysics (A&A, ApJ, AJ, MNRAS, Nature). He has been Coordinatore Nazionale of a PRIN-INAF on Planet Formation, responsible for the Arcetri participation to the PACS and SPIRE Herschel guaranteed programmes on star formation and the connected funding from ASI, he is currently responsible for the participation of ESO in the EC-FP7 Radionet3 project, for which he serves as Board Member for ESO. He has been member or external expert of several international science policy committees, for the distribution of competitive research and infrastructure grants (NASA Origins in USA, ERC grants for EC, NWO grants for the Netherlands, ASI grants in Italy, DFG grants in Germany, and FONDECYT grants in Chile), and for the allocation of observing time at major facilities (eg. NRAO, HST, Spitzer, ESO, Subaru). He served as Italian representative in the ESO Scientific and Technical Committee and member and chairman of the ALMA Science Advisory Committee. He participated in developing the Astronet Science Vision for European Astronomy and is currently working on its update as member of the Astronet Science Vision Working Group and Chair of Panel C. LT has served as member of the INAF Scientific Council for two terms (2005-2007; 2008-2011).

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

Fabrizio Villa **INAF-IASF-Bologna**	Deputy coordinator of the project and responsible of the receiver development and of WP5. FV is involved in the most important national and international projects devoted to the development of radioastronomy receivers for space and ground experiments. At the moment is responsible of the Italian partitipation to the international consortium for the study of ALMA band 2. Moreover is responsible of the MI-ALMA project.

FABRIZIO VILLA was graduated in Physics on 1994 at the Università degli Studi di Milano. From 1994 to 1997 he obtained a fellowship with CIFS (Consorzio Interuniversitario di Fisica Spaziale) and he worked as responsible of the laboratory in a Italian company for the development of microwave telecommunication systems. In 1997 he obtained a research contract at the TESRE institute (now IASF) of the National Research

Council (CNR). In 2001 FV became staff of the same institute as researcher and in 2006 as senior researcher at the IASF (Institute of Space Astrophysics and Cosmic Physics) of the national wide Institute of Astrophysics (INAF). From 1997 has worked as microwave engineer in several experiments devoted to the measurements of the Cosmic Microwave Background anisotropies such as BEAST, COSMOSOMAS, and the Planck Satellite. For Planck FV worked at the development of the Low Frequency Instrument (LFI) being member of the Project System Team. Moreover within the Planck collaboration FV has been member of the Telescope Working Group, responsible of the Optical Interfaces of LFI, scientific responsible of the Planck/LFI Radiometer Chain Assembly calibration on ground. During the in-flight calibration of Planck, launched on May 2009, FV was responsible of the phase switches calibration of the LFI radiometers. Now, as member of the Planck core team, is responsible of the LFI detector pointing. In the framework of the INAF innovation programme, FV was Principal Investigator of a technology transfer funded proposal dedicated to the development of mm-wave passive imaging for civil applications. From 2004 to 2006 was member of the technical and scientific committee of the Consortium for Innovation and Technology Transfer in Emilia-Romagna. Now is responsible of the Italian partecipation to the international consortium for the development of the ALMA band 2+3 radiometer ad PI of the MI-ALMA study focussed to the development of multi-feed systems for ALMA. In addition to Planck activity, FV is involved in the development of an Italian balloon experiment (Large Scale Polarization Experiment) for the measurement of the polarization of the CMB. In particular FV is manager of the development of the telescope and antennas of the STRIP experiment (Stratospheric Italian Polarimeter). From 2001 FV is teaching at the University of Milano, Dept. of Physics in the framework of the "Space Insrumentation Laboratory" course. The H-index of FV, based on Citation Report is 28. In addition FV is involved in several outreach projects, public conferences, events and exhibitions.

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

Maria Elisabetta Palumbo **INAF-Osservatorio Astrofisico di Catania**	Deputy-Coordinator and Responsible for the Laboratory Astrophysics (WP6). MEP is an international expert in the laboratory studies of the effects of irradiation on the chemistry of ices and the related production of complex organic molecules.

MARIA ELISABETTA PALUMBO obtained her Master Degree in Physics in 1992 at the University of Catania. She obtained her PhD award in 1998. Since July 1995 she is research astronomer at Osservatorio Astrofisico di Catania. She has been working in the Laboratory for Experimental Astrophysics, at Osservatorio Astrofisico di Catania, since April 1991. In her research activity, she has studied experimentally, mainly by infrared absorption spectroscopy and by Raman spectroscopy, the effects of fast ions (3-400 keV) impinging on frozen gases (ices) at low temperature (10-100 K). This is an interdisciplinary study relevant to the understanding of the physical and chemical properties of ices in the interstellar medium and outer Solar System objects including comets. In particular she has studied the role of ion irradiation in the evolution of icy grain mantles and in the formation of molecules observed in dense interstellar molecular clouds. The main results she obtained focus on solid carbon monoxide and carbonyl sulfide, on the origin of carbon dioxide in interstellar icy grain mantles and on the

structure (amorphous vs crystalline and porous vs compact) of solid water. She is co-author of more of 75 articles published on refereed international journals with more than 1640 citations, without self-citations, and h-index 23 (Source: ISI Web of Science). MEP is PI of several experimental and observational projects accepted at international facilities; she is member of the Management Committee and coordinator of Working Group 2 (Heterogeneous Chemistry) in COST Action CM0805 "The Chemical Cosmos: Understanding Chemistry in Astronomical Environments (April 2009 - April 2013); she is PI of INAF as partner of ITN Marie Curie Network LASSIE (Laboratory Analysis for Surface Science in Europe). She has been member of the Scientific Organizing Committee of international meetings and summer schools. Furthermore she has given lectures to undergraduate and PhD students at the University of Catania on "Laboratory Astrophysics" and "Infrared spectroscopy" and has given lectures on "Infrared spectroscopy of solid state molecules" and "Energetic processing of solid state molecules" at the international Summer School held in Cuijk, The Netherlands (4-8 June 2012). She has been co-tutor of the thesis of 10 undergraduate students at the University of Catania, required for their master degree, and co-tutor of a PhD thesis. Presently she is co-tutor of a PhD student at University of Catania and supervisor of a FP7-Marie Curie ITN experienced researcher at INAF. She is referee for the following international journals: Astronomy and Astrophysics (since 1999); The Astrophysical Journal (since 2001); Icarus (since 2002); Meteoritics and Planetary Science (since 2005); Astrophysics and Space Science (since 2007); Surface Science (since 2008); The Journal of Physical Chemistry (since 2009).

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

Maria Teresa Beltran INAF-Osservatorio Astrofisico di Arcetri	Responsible for WP1. MB is an expert at international level of observational studies of complex molecules in high-mass star-forming regions carried out with millimeter facilities. She is a member of the Time Allocation Committee of ALMA.

MARIA TERESA BELTRÁN got her Physics Degree from the Universitat de Barcelona in 1996. In 1998 she got her Master Dissertation. From 1998 to 2002, has been a Smithsonian Astrophysical Observatory predoctoral fellow working at the Harvard-Smithsonian Center for Astrophysics in Cambridge (US). In 2002 she got her PhD in Astrophysics from the Universitat de Barcelona and in 2003 she was awarded with the Extraordinary Prize for Doctorate by the Universitat de Barcelona. From 2002 to 2008 she has been a postodoctoral fellow at the Osservatorio Astrofisico di Arcetri (Florence, Italy), researcher "Juan de la Cierva" at the Departament d'Astronomia i Meteorologia of the Universitat de Barcelona (Barcelona, Spain), and researcher "JAE" at the Consejo Superior de Investigaciones Científicas (Barcelona, Spain). From 2005 to 2008 she has also been teaching at the Physics Faculty of the Universitat de Barcelona (Spain). Since 2003 she is an INAF Ricercatore III livello working at the Osservatorio Astrofisico di Arcetri. In 2006 she got the Research Accreditation in the Science Field of the Quality Assurance Agency for the University System in Catalunya (AQU). Her research is focused on the study of the first stages of the formation of intermediate- and high-mass stars, at centimeter, millimeter, submillimeter, and infrared wavelengths. She is involved in several international projects and collaborations, most of them linked to high-mass star-formation. In these years she has published a total of 48

papers in refereed international journals of high impact. Her so-called H index is 17 according to the Astrophysical Data System. She has also published studies in other indexed journals such as the Revista Mexicana de Astronomía y Astrofísica, or IAU Proceedings. The results of her research have been presented in important international conferences of star formation, many of them as invited or contributed oral presentations. She is referee for important scientific and astrophysical journals (A&A, ApJ, Science). She has been/is a member of the Time Allocation Committee of the most important space and ground observatories (including ESO, Herschel and ALMA), and she has been referee for grant applications (Agència de Gestió d'Ajuts Universitaris i de Recerca, AGAUR, de la Generalitat de Catalunya).

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

Marcella Massardi **INAF-Istituto di Radioastronomia**	Responsible for WP3. She became a member of the Italian node for the ALMA Regional Center in 2010. Since then, in addition to her research activities in the millimetric extragalactic astronomy that is documented by several pubblication and participations in international collaborations (AT20G survey, Planck, Herschel), she is involved in coordinating the activities of support for the ALMA users. She collaborates to the development of new CASA tasks for data reduction. She contributes to the organization of outreach activities and seminars useful to join the Italian scientific community that observes in the millimetric and submillimetric bands. She investigated the properties of extragalactic radiosources in millimetric and submillimetric wavelength also in polarization.

MARCELLA MASSARDI got her PhD in Astrophysics from SISSA-ISAS (Trieste) in 2008 with a thesis on "The extragalactic sources at mm wavelengths and their role as CMB foregrounds". Since then she is a member of the international collaboration for the Australia Telescope 20 GHz (AT20G) Survey, that surveyed the whole Southern sky down to few mJy to investigate in total intensity and polarization properties of sources at mm wavelength. She is an expert observer at the ATCA. Since 2004 she is member of the ESA's Planck satellite consortium, since 2008 she participates to the Planck Core Team and since 2011 she is a Planck Scientist. She contributed to the development of numerous tools of use for the investigation of the CMB compact foregrounds. She contributed to the validation of the Early Release Compact Source Catalogue (ERCSC) and she is collaborating to the develpement of the Planck Legacy Catalogue. She was the PI of an ATCA observing program to collect observations of radio sources simultaneously with the Planck satellite over more than one year of its observations, to study their properties in the frequency range 4-857 GHz. She studied the observability of the early stages of galactic formation with telescopes as EVLA, ALMA and SKA. In particular, she investigated the observability of the Sunyaev-Zel'dovich (SZ) effect in cluster of galaxies and in the early stages of galactic formation. She investigated the contamination to the SZ effect signal due to the radio sources in the galaxy clusters. She was also PI for a project for observations of the Sunyaev-Zel'dovich effect in a high redshift massive galaxy cluster with the ATCA at 20 GHz. Since 2008 she is a member of the Herschel satellite

consortium to which she contributes working on lensed galaxies and high-redshift galaxy formation and on techniques for the identification of source population in submillimetric surveys. Since 2009 she is a member of the collaboration for the Evolutionary Map of the Universe survey that will be carried out with ASKAP at 1.4 GHz. In 2010 she won a permanent position at the INAF-IRA to work for the Italian node of the European ALMA Regional Center. Since then, in addition to her research activities, she is involved in coordinating the activities of support for the ALMA users. She collaborates to the develpement of new CASA tasks for data reduction. She contributes to the organization of outreach activities and seminars useful to join the Italian scientific community that observes in the millimetric and submillimetric bands. She is coauthor or first author of more than 50 papers on international journals and of review papers. She contributed as first author to publish some fundamental (and frequently cited) results for the collaborations she were involved with. She operates as referee for international journals (MNRAS, A&A, ApJ). She is currently involved in several observing programs that got time at Medicina radiotelescope, ATCA and ALMA.

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

Renzo Nesti **INAF-Osservatorio Astrofisico di Arcetri**	Responsible of WP4. Since 1999 at the Arcetri Observatory, he has been a designer of microwave passive devices mainly for radio astronomy applications, particularly front-end receiver devices for both ground and satellite instrumentation.

RENZO NESTI got the Laurea Degree in Electronic Engineering in 1996 and the PhD in Telecommunications and Information Technology in 2000 at the University of Florence.

At the University of Florence he was a grant holder to develop numerical models in the design of microwave devices and held seminars about devices and methods for applied electromagnetics in some courses at the Faculty of Engineering. He was supervisor of several (>30) Laurea Degree Thesis in Electronic and Telecommunication Engineering.

R. Nesti research area is mainly the development of analysis and optimization numerical techniques in the field of electromagnetic engineering aimed at the study and the design of passive microwave devices of radio receivers, like horns, orthomode transducers, polarizers and directional couplers. Such an activity, together with both industry and research institutions, deals mainly with ground and satellite systems in the field of radio astronomy and telecommunications.

He developed researches funded by: agreements with industry and research institutions (mainly Alenia Aerospazio Roma, Space Enginering Roma, ASI, Laben Milano, Oerlikon Contraves Roma); contributions and finalized projects of CNR and INAF; funds by MURST-MIUR.

At the Arcetri Observatory he has been participating or still is in radio astronomy projects (Planck/LFI, ALMA, FP5/Faraday, SRT, BarSPOrt, FP6/PHAROS, FP7/APRICOT) of international interest, taking care at the development of passive components for radio receivers. He has been named responsible of several work packages in the field of radio astronomy instrumentation and technological innovation projects.

Already involved in the ALMA project, R. Nesti collaborated with an international group developing the first

feasibility studies of the ALMA receiver, and giving a relevant contribution in the electromagnetic design of parts of the front-end optics of some cartridges, namely in band 1, 2, 3 and 4 (ref. M.Carter et al., "ALMA Front-end Optics" Proc. SPIE Int. Soc. Opt,, Volume 5489, pp. 1074-1084, Bellingham (WA), 2004), and has therefore been able to extend his knowledge of the ALMA instrument, assimilating its technological problems. The list of the main scientific publications in the period 2010-2013 is reported in section 11.	
Francesco Rea **INAF-Sede Centrale**	Responsible for WP8. Journalist since 1988, he collaborated with several important Italian national newspapers. Since 2009 he is at the head of the INAF Office for Communication with Public and Press.
FRANCESCO REA has a degree in contemporary literature and history with a thesis on "Per una storia istituzionale del Consiglio Nazionale delle Ricerche". FR is a professional journalist since 1994. Since November 2009 is Head for Media, Public and Institutional relations at INAF. From September 2005 to May 2008, is Lecturer in Communication Sociology at the Università della Calabria (Unical), Cosenza. From July 2007 to November 2009, is Head of Media Relations at the Italian Space Agency. From January 2007 to July 2007 is Spokesperson and Chief Press Officer of the Italian Minister Vannino Chiti, Relation with the Parliament and for the Institutional Reforms. From June 2006 to December 2006 is Chief Press Officer of the Minister Linda Lanzillotta, Regional Affairs. From September 1998 to May 2006 is Head of Media Relations at Italian Space Agency. From March 1997 to June 2001 is responsible of the editorial team of the RAI programme (Public Broadcast Tv) e "*Dalle Venti alle Venti*, after *Mille & Una Italia"*. From 1988 to 1997 works for several media: Italia Radio, l'Unità, La Repubblica, ASCA, Diario della Settimana, RAI, il manifesto, Paese Sera, Rinascita, Capitale Sud, Rassegna Sindacale. In the same period collaborates with different structure as Legambiente, Unipol. In his presently activity he collaborates with other media as Specchio Economico and the Radio Agency AREA. PUBBLICATIONS. Gli anni della Repubblica, author Giorgio Rocca with Roberto Roscani and the collaboration of Francesco Rea, l'Unità Publishing House. Viaggio nel cuore del PCI: Rinascita Publishing House. One of the various authors. Storia dello Spazio Italiano: Storia in Rete Publishing House. The list of the main scientific publications in the period 2010-2013 is reported in section 11.	

3.2 External participants

Universita' degli Studi di Bologna	Alma Mater Studiorum University of Bologna (UNIBO) participates to the project with fundamental contribution to the WP1 Science Working Group and WP2 Advanced Training. The coordinator of WP2 is Prof. L. Gregorini.
Alma Mater Studiorum University of Bologna (UNIBO), funded in 1088, is the most ancient university in Europe and it has been a site of astronomical studies since the end of the XIII century, although significant	

observations of the sky begun in the XVII century by Luigi Ferdinando Marsili. UNIBO invests expertise and financial resources in international and multi-cultural education and formation; among other things, it hosts the Confucius Institute headquarters, and it has been chosen by the Brazilian Government as national coordination of the project "Science without Border". The quality of research at UNIBO (in which Astrophysics is top rated) is world-wide recognized, counting more than 1200 partnership with institutions from every continent. UNIBO today ranks first among Italian Universities in the capacity for obtaining funds for research from the European Community, and ranks 27th if all the European Institutions are considered. In 1997 UNIBO created the Research Observatory with the task to annually asses the quality of research. UNIBO has more than 87,000 students enrolled in undergraduate and postgraduate courses; more than 42% are from areas out of the local region and more than 5900 are foreign students. Among students attending postgraduate courses, about 1700 are enrolled in different 53 PhD courses. In the whole University there are about 3000 faculty members and 2880 between technical and administrative people. Recently, UNIBO has been reorganized into 11 new Schools and 33 new Departments, including the Department of Physics and Astronomy (DIFA). The DIFA offers three levels of training in astronomy with the Bachelor of Science in astronomy, degree in Astrophysics and Cosmology, and a PhD in Astronomy. Both the master's degree and the PhD take advantage of the close collaboration with the three institutes of the INAF (Istituto Nazionale di AstroFisica), located in Bologna: the Institute for radio astronomy (IRA), the Institute for Space Astrophysics (IASF) and the Astronomical Observatory (OABO). A number of researchers of INAF have contracts for teaching specific courses in the master's degree, and are often co-supervisors of master's and PhD thesis projects. On the other hand, most of the teaching staff in the astrophysics field at UNIBO is associated/affiliated to one of the three INAF institutes in Bologna.

LORETTA GREGORINI, graduated in Physics at the University of Bologna, is now Full Professor of Astronomy and Astrophysics. She was chair-person of the "Corsi di Laurea Astronomici" and head of the Department of Astronomy. Now she is deputy of the Department of Physics and Astronomy and member of Senato Accademico. Teaching courses: Fisica Generale 2 for Laurea Triennale and Radio Astronomy for Laurea Magistrale in Astrofisica e Cosmologia; supervisor of more than 45 Laurea theses and of about 15 PhD theses. She was member of European networks and of evaluation Panel during FP6 and FP7. The research activity of LG is mainly in the field of astrophysics and observational cosmology, with particular interest in radio astronomy. The main subjects of her work are: multi frequency studies of active galactic nuclei; star-formation in nearby spiral galaxies; Cosmological evolution of galaxies using large radio and optical surveys and composition and properties of the faint radio population; properties of radio population selected at high frequencies; relations between molecular gas properties and star formation in galactic and extragalactic starbursts. She is co-author of more than 100 papers in referred journals and of more than 90 contributions in international and national conferences.

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

Universita' degli Studi di Firenze	The University of Florence (UNIFI) contributes in a fundamental way to WP1 Science Working Group and WP2 Advanced Training.

The University of Florence (UNIFI) is one of the largest universities and research organization in Italy: it has roughly 2000 tenure professors and researchers, roughly 1600 technic and administrative assistants and over 1900 between PhD students and PostDocs. UNIFI has a very extensive educational offer covering all disciplines with twelve Faculties, 139 Schools (bachelors and masters), and over 54,000 students, a quarter of which is coming from outside Tuscany. UNIFI has been recently reorganized in 24 departments, among which the Department of Physics and Astronomy offering all three levels of formation: the bachelor in Physics and Astronomy, the master in Physical and Astrophysical Sciences (with the Astrophysics Curriculum) and the PhD in Physics and Astronomy (with the Astronomy Curriculum). On average between 5 and 10 master degrees in Astrophysics are awarded every year, and 2-3 PhD students are enrolled. Both the master and the PhD in Astronomy take advantage of a close connection with the Astronomers of the Arcetri Astrophysical Observatory, part of INAF: they are officially responsible for several semester-long courses, and they are members of the PhD board of professors. The Department of Physics and Astronomy is also very tightly connected with LENS, the European Laboratory for Non-Linear Spectroscopy, which is an excellence center of UNIFI and with which there are many undergoing collaborations.

Prof. Marconi teaches the course "An Introduction to Astrophysics" during the third year of the bachelor (compulsory for all students), the course "Cosmology" (during the first year of the master and compulsory for all students of the Astrophysics curriculum) and the course of "Physics of Galaxies" (during the second year of the master). He is member of the PhD board of professors and responsible for the Astronomy curriculum of the PhD.

ALESSANDRO MARCONI (AM) got his master degree in Physics on 1993 at the University of Florence. From 1996 to 1997, he has been graduate student research assistant at the Space Telescope Science Institute. He got the PhD in Astronomy at the University of Florence on may 1998 and his thesis has been awarded the Livio Gratton prize for the best Italian PhD thesis in astronomy on 1999. From october 1997 to october 2006 he has been research astronomer (tenure position) at the Arcetri Astrophysical Observatory (INAF). Since november 2006 he is associate professor at the Department of Physics and Astronomy of the University of Florence. AM research activity is based on spectroscopy and photometry at optical and infrared wavelengths, mainly with the Hubble Space Telescope and the telescopes of the European Southern Observatory (ESO). In recent years he has also performed studies of optical interferometry with the VLT Interferometer. The topics of his research activities are: supermassive black holes (BH; mass measurements, relations with host galaxy and AGN activity); Active Galactic Nuclei (AGN; physical conditions of the Broad and Narrow Line Regions); metal abundances in starburst galaxies and the cosmological evolution of the mass-metallicity relation. AM is or has been coordinator of research units (UdR) in projects funded by the Ministry of School, University and Research (PRIN-MIUR) or

by INAF (PRIN-NAF); he is an UdR coordinator in a funded PRIN-MIUR 2010-2011 project. At the end of 2012, AM has published 116 articles on international refereed journals, 26 of which during the last three years. According to the ISI Web of Knowledge, his refereed publications have received 5100 citations in 3480 articles (excluding self-citations). On average, each publication has therefore received about 44 citations with an overall H-index of 37. In the last few years he has received over 20 invitations for colloquia or talk in international congresses. He is or has been member of several international committees: in particular in 2009 he has been named as the Italian representative in the Scientific and Technical Committee (STC) of European Southern Observatory (ESO) and since 2012 he has also been named chair of the same committee.

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

Universita' degli Studi di Catania	The University of Catania contributes to the project with a fundamental support to WP2 Advanced Training and WP6 Laboratory Astrophysics

The University of Catania, founded in 1434, is the oldest University in Sicily. It is among the largest universities in Italy with more than 50000 students. There is a rich educational offer with 136 Schools (bachelors and masters), courses for graduate students and 102 PhD courses. The University is organized in 22 departments among which the Department of Chemistry offering different levels of formation: the bachelor in Chemistry and Industrial Chemistry, the master in Organic Chemistry and Material Chemistry and the PhD in Material Science in collaboration with the Department of Physics and Astronomy and the Department of Engineering.

At the Department of Chemistry, Prof. Giuseppe Compagnini is in charge for the following courses: *Physical Chemistry* (undergraduate students); *The Physics and Chemistry of Materials* (Master students); *Molecular spectroscopy* (Master students); *Nanostructured materials* (PhD students). He also teaches "*Carbon based nanostructures*" at the Scuola Superiore di Catania and acts as a tutor for several degree thesis. Furthermore he is in the Steering Committee for the PhD course in Material Science (University of Catania) and he acted as a supervisor in 4 PhD thesis during the last five years.

GIUSEPPE COMPAGNINI obtained his master degree in Physics in 1989 at the University of Catania. He got the PhD in 1992. In 1993 he got a post-doc position at CNR (Consiglio Nazionale delle Ricerche). From 1997 to 2003 he was Assistant Professor in Physical Chemistry and since 2003 he is Associate Professor in Physical Chemistry at the University of Catania. He has co-authored more than 120 peer reviewed papers in international ISI journals with about 1800 citations and h-index 23 (Source: ISI Web of Science). He has presented over 30 invited talks at international conferences, and departmental seminars all over the world. He actually has a research group of 3 PhD students, 5 postgraduates working on laser and plasma materials processing for micro and nano applications. He is director of the National Group for Raman Spectroscopy and member of the Management Committee of COST Action "Composites of Inorganic Nanotubes and Polymers" (2010-2014).
Furthermore GC is referee for the following international journals: *Philosophical Magazine, Applied Physics Letters,*

Journal of Physical Chemistry C, Chemical Physics Letters, ACS Nano, Journal of Raman Spectroscopy, Journal of Surface Science, Carbon, Applied Surface Science, Applied Physics A. His scientific activity focuses on surface and interface analysis (photoelectron spectroscopy, surface enhanced spectroscopy, mass spectrometry); thin film physics and chemistry: deposition and modification by physical approaches (laser ablation, ion irradiation, plasma processes) and characterization by vibrational and electronic spectroscopy (Raman spectroscopy, infrared absorption, HR photoelectron spectroscopy). He has been collaborating with the experimental group working at Osservatorio Astrofisico di Catania for more than 20 years.

The list of the main scientific publications in the period 2010-2013 is reported in section 11.

3.2.1 Letters of commitments of external participants

1. Letter of commitment of Prof. Loretta Gregorini (Alma Mater Studiorum Universita' di Bologna)
2. Letter of commitment of Prof. Alessandro Marconi (Universita' degli Studi di Firenze)
3. Letter of commitment of Prof. Giuseppe Compagnini (Universita' degli Studi di Catania)

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

DIPARTIMENTO DI FISICA E ASTRONOMIA
Department of Physics and Astronomy - DIFA

A: Leonardo Testi
P.I. del progetto iALMA
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Karl Schwarzschild str. 2
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Germany

Caro Leonardo,

desidero confermarti il mio interesse a partecipare al progetto iALMA ed accetto con entusiasmo l'incarico di coordinare il WP Advanced Training con l'intento di contribuire alla formazione di giovani, con riferimento sia alle Lauree Magistrali sia ai corsi di Dottorato, nel campo dell'astronomia millimetrica e sub-millimetrica.

Credo di potere assicurare 4 mesi del mio tempo allo sviluppo del progetto, al di là dell'impegno connesso alla didattica, che costituisce per me un'attività istituzionale anche per gli aspetti di interesse del progetto iALMA.

Ti saluto cordialmente.

Bologna, 08.02.2013

Loretta Gregorini
P.O. di Astronomia e Astrofisica

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UNIVERSITÀ DEGLI STUDI FIRENZE
DIPARTIMENTO DI FISICA E ASTRONOMIA

Firenze, 8 Febbraio, 2013

Dr. Leonardo Testi,
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Karl Schwarzschild str. 2
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Germany

Caro Leonardo,

ti ringrazio per avermi chiamato a partecipare al WP Advanced Training, al quale fornirò il mio contributo in qualità di docente dell'Università di Firenze, titolare di corsi nelle lauree triennali e magistrali, e membro del collegio dei docenti del dottorato. Inoltre, come professore universitario presso il Dipartimento di Fisica e Astronomia dell'università di Firenze contribuirò a rinsaldare la collaborazione esistente tra INAF e l'astronomia universitaria, specialmente per quanto riguarda il suddetto progetto premiale.

Tuttavia, lo scopo più importante della mia partecipazione al premiale iALMA, al quale dedicherò tempo e risorse, riguarda la formazione delle nuove generazioni di astronomi che contribuiranno all'utilizzo scientifico ed allo sviluppo futuro di ALMA: è previsto che il premiale iALMA, se finanziato, fornirà diverse borse di dottorato alcune delle quali si appoggeranno presso il mio Dipartimento. Ma sarà anche mia cura cominciare a preparare gli studenti all'astronomia sub-millimetrica e all'utilizzo di ALMA nei corsi che tengo presso la laurea triennale in Fisica ed Astrofisica e la Laurea Magistrale in Scienze Fisiche e Astrofisiche, in modo da avere un congruo numero di candidati per le borse di dottorato.

Cordiali saluti,

Prof. Alessandro Marconi

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Prof. Giuseppe Compagnini

Dr.Leonardo Testi
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Caro Leonardo,

desidero confermarti che è mio interesse partecipare al progetto iALMA con l'intento di contribuire alla formazione di giovani attraverso i corsi di dottorato che si appoggiano presso il mio Dipartimento.

In particolare ritengo che la formazione della nuova generazione di astronomi debba essere intimamente legata a conoscenze di natura chimica e fisica di sistemi e processi che si svolgono a livello interstellare.

D'altra parte lo sviluppo di tecnologie avanzate sia per le osservazioni astronomiche che per l'analisi e la simulazione dei materiali fanno ormai parte delle competenze necessarie per un ricercatore che si occupa di problematiche astrofisiche.

Per questi motivi, credo fermamente che il corso di dottorato in Scienza e Tecnologia dei Materiali possa costituire un valore aggiunto in questa direzione.

Cordiali saluti

Prof. Giuseppe Compagnini

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3.3 Training

The goal of iALMA is to strengthen the scientific, technological and industrial Italian contribution to the largest ground based international infrastructure for the study of the Universe in the microwave: the Atacama Large Millimetre/submillimetre Array (ALMA). The contribution of Italy to ALMA is through its participation as a Member State to the intergovernmental European Organization for Astronomical Research in the Southern Hemisphere (ESO). Among the fields of astrophysical research, radio and microwave astronomy is one with the highest need of interdisciplinary research between astrophysics, laboratory experiments, and development of hardware and software technologies with high spin-off in applied and strategic sectors. Just as examples, the technology of microwave ovens and the data transmission via WiFi networks, which we all use everyday, are both based on technologies and projects developed for radioastronomy. With iALMA we plan to continue to develop the collaborations between astronomical, chemical and microwave technological research in Italy, with the main goal to develop and use ALMA. We will develop a set of interdisciplinary skills in a group of young students and postdocs, who will then be able to join the research or industrial infrastructure in Italy. As part of iALMA we plan, over four years, to train 6 PhDs (in Physics, Astrophysics or Chemistry) and at least 5 postdoctoral fellows in the scientific and technological areas covered by the project. This synergy between scientific-technical research and advanced training is made possible by the strong, long-term collaboration between INAF and the Universities of Bologna, Catania and Firenze.

3.4 Governance

The iALMA work plan is structured in 8 workpackages plus a management workpackage. The coordinator (Dr. L. Testi) will work with the support of two deputy-coordinators, one with direct responsibility for the Italian contribution to the development of the next generation ALMA receivers in Bologna and Arcetri (Dr. F. Villa), and a second with direct responsibility for laboratory astrophysics in Catania (Dr. M.E. Palumbo). The coordinator and the two deputy-coordinators form the management team of iALMA, each of them follows closely the progress of the workpackages in their assigned area and meet at least once a month, preferentially via video-conference. At least bimonthly, the meeting is extended to all the workpackage managers, normally via telecon. Project-wide meetings will be organized every year (starting with the kickoff meeting), in one of the project locations in Bologna, Catania or Florence or at the INAF Headquarters in Rome. Every year the project will produce a detailed report on the status of the activities and on the financial position for each workpackage and for the whole project. These reports are the responsibility of WP0 and will be presented to INAF and the competent bodies for the evaluation of the project.

Women participation in iALMA is not only strong among the project participants but especially in the governance structure: one of the deputy coordinators and four out of eight workpackage leaders are women.

An External Advisory Board (EAB) will evaluate the project progress and plans at yearly intervals. The members of the EAB are internationally renowned and qualified researchers in the scientific-technical fields of iALMA: Dr. C. Ceccarelli (IPAG, Grenoble, F), Prof. G. Fuller (Manchester University, UK), Dr. R. Laing (ESO), and Dr. A. Navarrini (IRAM, Grenoble, F). The EAB members are invited to all the annual project meetings (including the kickoff) where they assist to the presentations on the project status and progress, the EAB also receives at least two weeks before the meeting all the relevant documents, including the detailed annual reports. The EAB produces a report on the status and plans for INAF and the iALMA management team.

Dr. Cecilia Ceccarelli is a researcher at the Institut de Planetologie et d'Astrophysique de Grenoble (IPAG-CNRS, France); she is an expert of astrochemistry and star formation, mainly using millimetre and infrared observatories, both ground based and space borne.

Prof. Gary Fuller is Professor of Astrophysics at the University of Manchester (UK), his main research interest is in the chemical and physical conditions of high mass star forming regions in our Galaxy; he is currently leading the international consortium that is performing the preliminary designs of components for the ALMA Band 2 under contract with ESO.

Dr. Robert Laing is the European ALMA Instrument Scientist at ESO (Garching, Germany), he follows the scientific and technical developments and construction of the ALMA upgrades in Europe.

Dr. Alessandro Navarrini is the head of the receiver lab at the Institut de Radioastronomie Millimetrique (IRAM, France), under his leadership IRAM has completed the production of the 73 ALMA Band 7 cartridges; he is currently responsble for the IRAM involvement in the ALMA Band 2 international consortium.

4 Proposed keywords

Astrophysics, Microwave technology, Laboratory Astrophysics, green Energy for large facilities for Astrophysics

5 Objectives

The Atacama Large MIllimetre/submillimetre Array (ALMA) is the most important observatory worldwide for the study of the formation and evolution of galaxies, the study of star and planet formation and the study of the chemistry of complex organic molecules in space. The observatory is an intercontinental collaboration that includes countries in East Asia (Japan and Taiwan), Europe (the ESO member states), North America (USA and Canada), and South America (the host country Chile). Italy is part of this project from the beginning as a member state of the intergovernmental organization ESO. ALMA is currently in the final phases of construction and has started to produce transformational scientific results even in the so-called Early Science phase. INAF and the Research, University and Industry infrastructure in Italy are deeply involved in the various aspects of the ALMA project: with important contributions to the initial design, the industrial involvement in the construction, and the scientific exploitation of the observatory. ALMA is in the transition phase towards the Full Science and the scientific-technical priorities for the future scientific capabilities are now being planned. It is important to realize that the development plan of ALMA can directly support (in Europe through ESO) financially the

construction of upgrade parts and new infrastructure work designed to improve the operations efficiency, but does not provide all the necessary funding for the required R&D activities and the production of prototypes for parts and systems. In Europe these activities are mostly carried out using funding from the individual countries. The future scientific priorities for the ALMA upgrades suggested by the ASAC include the development and construction of next generation receivers for the frequency bands not yet available (including the so-called Band 2, 67-90Gz, with possible extension to 115GHz), the development of the capability of using ALMA as a station for the global mmVLBI network, and the production of green energy for the observatory.

iALMA focuses on promoting in Italy the synergy between: the expertise and strategies to optimize the scientific return for Italy of the investment in ALMA; the development of new technologies and instrumentation for ALMA; the chemical-physical laboratory experiments needed to understand the production in the Universe of the complex organic molecules observed with ALMA. The groups involved in iALMA include: the most active Italian groups in the use of millimeter observatories (including ALMA); the Italian node of the European ALMA Regional Centre (ARC), which supports the Italian users; the INAF laboratories for microwave receivers involved in the preliminary studies on the next generation ALMA receivers; the Italian laboratory of experimental astrophysics specialized in the study of the production of complex organic molecules on ices. An important added value of this project is the participation of professors from the universities of Bologna, Catania and Firenze, who make an essential contribution to the formation of the next generation of students in the scientific-technical areas of iALMA. The main objective of this project is to capitalize on the participation of Italy to the foremost operational infrastructure for the observation of the Universe worldwide. Instruments, technologies and expertise developed as part of iALMA will allow a leap forward to the science that will be done with ALMA in Italy and internationally, and Italy will play a leading role in developing key components for the observatory and its scientific use. Given the high level of interest around ALMA technologies and science worldwide, an active participation to the future evolution and science of the telescope will also be an efficient method to promote Italy internationally.

Developing strategies for efficient renewable energy production for ALMA is particularly important in this context. Currently ALMA produces energy using LPG and/or diesel turbines. This has a very high environmental impact and is very expensive for operations, especially in the long term. ALMA is interested in substituting, at least partially, fossil fuel consumption with renewable energy production, if a cost effective solution can be found. As part of this project, we propose to carry out a feasibility study to produce renewable energy (solar, wind or geothermic) at the ALMA site, in collaboration with an Italian consulting firm specialized in this type of analysis. If the feasibility study will demonstrate the viability of green energy production for ALMA, then new important possibilities may be opened for the Italian industry in this sector.

INAF is already very strongly involved in ALMA: in the scientific-technical original design, and in supporting the Italian industry involved in the construction activities; in the scientific exploitation and in supporting the operations of the facility by constituting an ARC node in Bologna to support users and by assigning some of its

personnel in key roles at ESO (e.g. L. Testi – European ALMA Programme Scientist; P. Andreani – European ARC manager); and is now involved in the participation to the preliminary design studies for the next generation microwave receivers for the Band 2. This last preliminary study is carried out by an international consortium of which INAF is a member together with the University of Manchester, STFC and Oxford University in UK, and IRAM in France. iALMA proposes to evolve these preliminary studies to the next critical level: the production and testing of prototypes.

iALMA has the following main goals:

1. Develop the support for the Italian community for the scientific use of the observatory. This will be mainly carried out by developing the expertise and competences of the ARC node in Bologna, especially to support polarimetric observing modes and the VLBI mode. Another essential goal is to develop a program of multidisciplinary advanced training in collaboration with the Universities of Bologna, Catania and Firenze.
2. Develop a prototype Band 2 cartridge for ALMA. The Band 2 cartridge prototype will be the result of the collaboration between the Science Working Group (SWG), responsible for the science case and science requirements, and the groups in the Arcetri and Bologna laboratories as part of the international ALMA Band 2 consortium. iALMA will develop the prototypes of the main components and of the full system for a receiver cartridge to cover the 67-90GHz (goal 67-115GHz) frequency range.
3. Study of the chemistry of complex organic molecules in the interstellar medium. The study of complex organic molecules will be carried out as a synergy between observations and laboratory experiments. It will be necessary to develop a completely renewed experimental setup in Catania, in order to be able to study the rare molecules that can now be observed with ALMA.
4. Feasibility study for the production of renewable energy at the ALMA site. A contract will be awarded to an Italian firm to produce the feasibility study. The main goal is to verify if the Italian renewable energy industry will be able to play a leading role in the design and construction of such a facility for the ALMA observatory in Chile.

iALMA is a four-year project. In the first phase the laboratories will have to be refurbished to prepare the experimental setups and to be able to carry out the tests on the receivers, at the same time, the manufacture of the prototypes of the main parts of the cartridge will be contracted. In the first phases of the project we will also hire three PhD students and the postdocs that will work on the project. The feasibility study for green energy production will also be completed during the first year of the project. During the second and third year of the project we will assemble and test the components and full system for the Band 2 cartridge in the laboratories of Arcetri and Bologna. In the Catania laboratory, during the second and third year the full set of instruments will be assembled in the experimental setup and the system will be tested, the first experiments of complex molecules productions in astrophysically relevant ices will be carried out. In this phase we also plan to organize a school for PhD students as part of the Scuola Nazionale di Astrofisica "F. Lucchin". During the forth year we expect to carry out more complex experiments in Catania and to start to compare the observational and laboratory results,

in this phase and with the input of the comparison between laboratory data and observations, we also plan to develop the most important observational programmes with ALMA Band 2 (which will form a key component of the full series construction proposal). During the last year we will also finalize the technical specification for the proposed ALMA Band 2 receiver, based on the results of the experience and testing with the prototype. All the documentation that will be the basis for the full series production proposal will be assembled to be presented to ESO/ALMA. During the third and fourth year of the project we will also evaluate the possibility of using one of the Italian radiotelescopes with the best optical quality (Noto or SRT) for testing the receiver on-sky. The SWG (WP1) will be in charge of developing an astronomical testing programme, while the laboratory groups in Arcetri and Bologna will provide the necessary technical support for the installation and operation of the receiver. The Italian ARC node will be responsible for the data analysis procedure, also developing specific CASA procedures, in collaboration with the groups that are responsible for the data analysis of Italian radiotelescopes.

Training is one of the key aspects of iALMA, for this purpose three of the most important universities in Italy are participating in the project. In modern astrophysics multidisciplinary training has become an important added value, it allows the young generations not only to perform research at the top level internationally, but also allows them to develop skills that will allow them to find alternative career opportunities in the industry. Within iALMA we will offer six PhD positions, three during the first year and three during the third year. The tight links with ESO and other international institutes will also allow the possibility of training periods abroad. The university professors involved in iALMA will also propose Laurea Magistrale (Master level) theses to the undergraduate students at the university in the topics of the project.

The dissemination of the results of the project will follow a variety of methods: the scientific and technical results of observations, experiments and receiver development will be disseminated in the international community following the standard practice of publishing research papers in refereed journals and through presentations at conferences, in addition we plan to organize an international conference on the topics of iALMA during the fourth year of the project; the results of the receiver development program, prototype construction and testing will be presented to the appropriate ESO and ALMA bodies, to support the advancement of the project to the full construction stage; similarly the renewable energy production feasibility study will be presented to ESO/ALMA for consideration and possibly we will explore financing schemes to proceed with the construction; finally we also plan to produce outreach documentation for various targets: the general public, funding agencies and the scientific community, this will be done in close collaboration with the INAF Office for Communication and the Education and Public Outreach Department at ESO.

Added value for Italy of iALMA

The goal of iALMA is to optimize the synergy in Italy between scientific, technological and laboratory mm-wave research within INAF and to strengthen the connections with the training at the universities of Bologna, Catania and Firenze. The final goal is to mantain and optimize in the long run the scientific and industrial return in Italy

from the investment in ESO and ALMA. In the specific case of the development of the Band 2 receiver, the goal of iALMA is to develop in collaboration with Italian industries the components of the cartridge including the final testing of the prototypes in the laboratory. This activity will eventually allow to develop in Italy the expertise to competitively produce these components and to be able to bid for the full production runs once the full Band 2 set of 73 cartridges will be approved for construction. The feasibility study for green energy production at the ALMA site will be used to promote renewable energy production for ALMA, possibly involving the Italian energy industry.

iALMA will also have important spin-off in Italy in areas not directly connected with astrophysical research, microwave technology is important also for space science, atmospheric studies and for the production of large use base goods. The development of microwave high technology in Italian industries will allow them to be more competitive in a strategic sector. For example, microwave technologies are used in the components of radars, for airport security instrumentation and for the development of radio communication at short and medium-short range. The techniques and technologies used in the astrophysics laboratories can also be used in the fields of semiconductors and complex electronics, as well as in medical research and the food industry.

6 Preparatory Activities

A large part of the scientific and technical ground work has been done as part of the past research activities of the groups involved in iALMA. On the observational side our team include most of the national experts of (sub)millimetre astrophysics, the Catania group has a strong and internationally recognized expertise in laboratory astrophysics, and the Arcetri and Bologna receiver groups have been involved since many years in top level receiver development for ground based and space borne microwave observatories (including early design work on ALMA receivers and the design and construction of the PLANCK-LFI instrument), more recently they are participating, as part of an international collaboration with STFC and IRAM, in a preliminary study of components for an ALMA Band 2, under contract with ESO.

The present project builds on the expertise and preliminary work and aims at maximizing the benefits of these. The proposed work on the Band 2 receiver will be based on the preliminary design and analysis work done under the ESO contract and in close collaboration with the international consortium. The development of the passive components, the mechanical, electrical and cryogenic interfaces of the Band 2 system that we propose to develop in detail in this project are part of the responsabilities of the INAF groups within the international ALMA Band 2 consortium. This project will allow INAF to build on the current collaboration and strengthen the Italian role in the Band 2 consortium. A key goal is to complete the development of components that can be produced by the national small enterprise network.

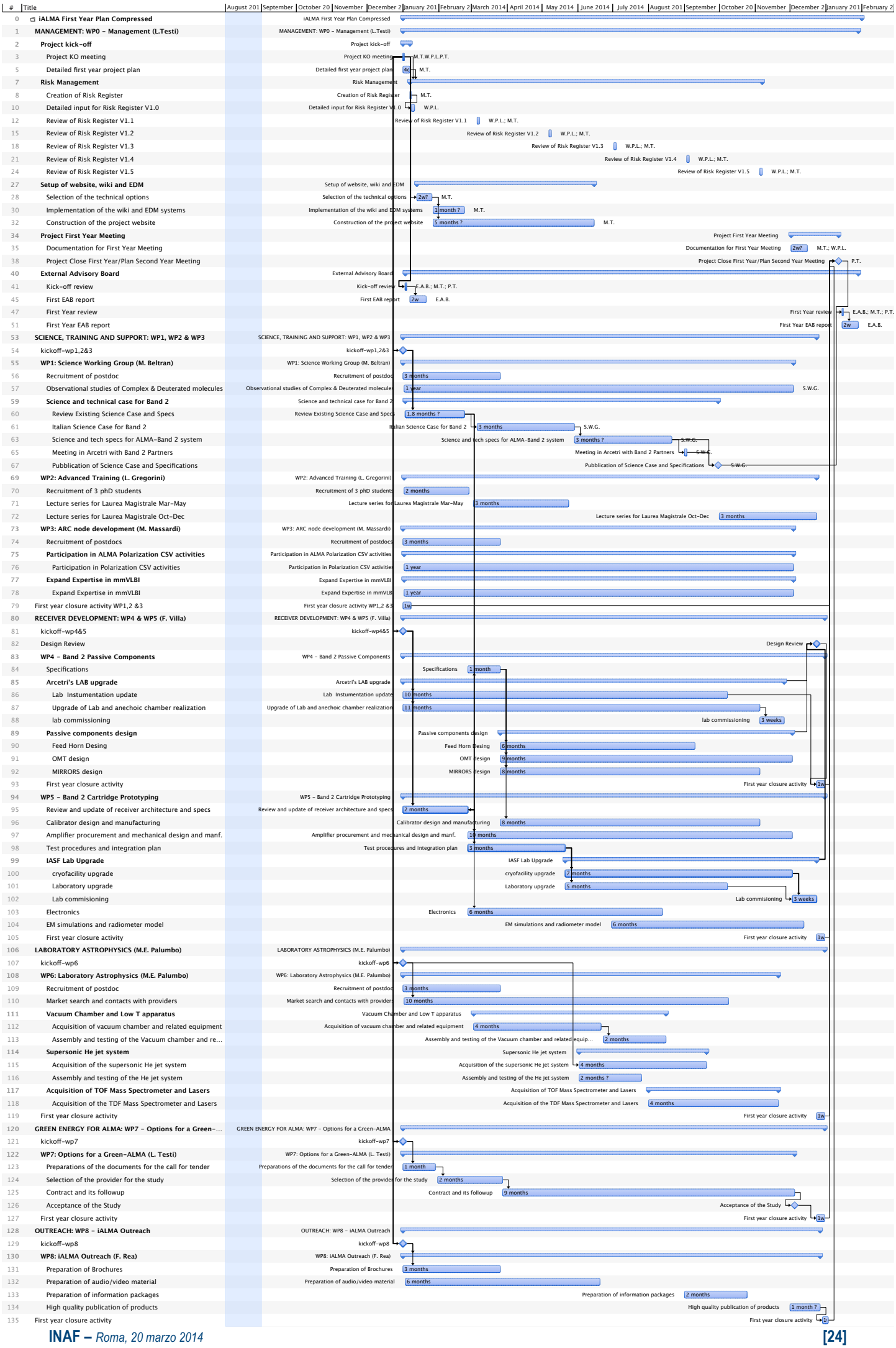
7 Project detailed description

iALMA aims to combine very diverse expertise that are present within INAF and together can allow the Italian system Research-Training-Industry to obtain the maximum return from the ALMA scientific capabilities and to reach a strategic position for the long term scientific and technological development of the observatory, and hence maximize also the possibilities of an industrial return for Italy in the short, medium and long term. Given the complexity of the project, iALMA is divided in 8 workpackages, plus a management workpackage. The workpackages are grouped in 5 big areas:

1. Science, Training and Support. This area includes the workpackages WP1 (Sceicne Working Group), WP2 (Advanced Training) and WP3 (ARC Node Development). The goal of these workpackages is to define the strategy and execution plans for the scientific observations; to ensure the training of students and postdocs, which is essential not only for the project, but more generally for the future of INAF and Italy in the scientific and technical areas covered by iALMA; and to develop the support functions of the Italian ARC node.
2. Receiver Development. Includes the workpackages WP4 (Band 2 Passive Components) and WP5 (Band 2 Cartridge Prototyping). The goal is to develop and test a prototype Band 2 cartridge for ALMA.
3. Laboratory Astrophysics. The WP6 (Laboratory Astrophysics) has the goal of designing, assembling, testing and using an experimental setup that will allow to measure the production of rare complex organic molecules in astrophysical ices.
4. Green Energy for ALMA. The WP7 (Options for a Green ALMA) has the goal of producing, in partnership with a specialized consulting firm, a feasibility study for renewable energy production for the ALMA observatory.
5. Outreach. WP8 (Outreach) will design and produce information material on iALMA scopes and results, the target audience will be the general public, funding agencies and the international research community.

Given the specialized nature and importance, both in terms of the technical complexity and of the financial needs, le big areas 2 and 3 will be under the direct responsibility of two deputy-coordinators, who form the iALMA management team together with the coordinator.

Project detail Work Packages description, schedule – Gantt Chart for the 1st year of the project



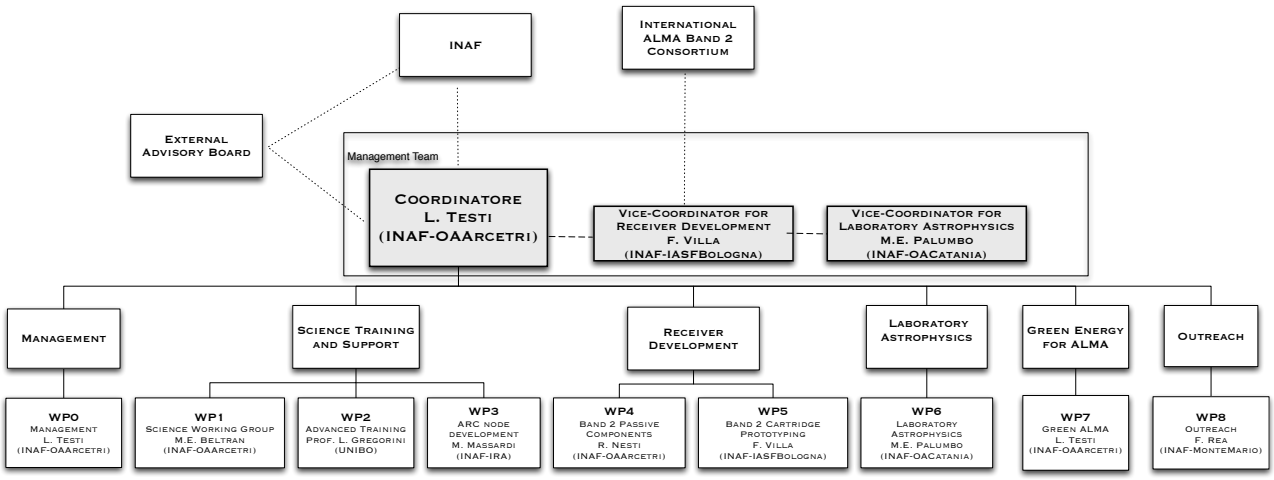
#	Title
0	**iALMA First Year Plan Compressed**
1	**MANAGEMENT: WP0 - Management (L.Testi)**
2	**Project kick-off**
3	Project KO meeting
5	Detailed first year project plan
7	**Risk Management**
8	Creation of Risk Register
10	Detailed input for Risk Register V1.0
12	Review of Risk Register V1.1
15	Review of Risk Register V1.2
18	Review of Risk Register V1.3
21	Review of Risk Register V1.4
24	Review of Risk Register V1.5
27	**Setup of website, wiki and EDM**
28	Selection of the technical options
30	Implementation of the wiki and EDM systems
32	Construction of the project website
34	**Project First Year Meeting**
35	Documentation for First Year Meeting
38	Project Close First Year/Plan Second Year Meeting
40	**External Advisory Board**
41	Kick-off review
45	First EAB report
47	First Year review
51	First Year EAB report
53	**SCIENCE, TRAINING AND SUPPORT: WP1, WP2 & WP3**
54	kickoff-wp1,2&3
55	**WP1: Science Working Group (M. Beltran)**
56	Recruitment of postdoc
57	Observational studies of Complex & Deuterated molecules
59	**Science and technical case for Band 2**
60	Review Existing Science Case and Specs
61	Italian Science Case for Band 2
63	Science and tech specs for ALMA-Band 2 system
65	Meeting in Arcetri with Band 2 Partners
67	Pubblication of Science Case and Specifications
69	**WP2: Advanced Training (L. Gregorini)**
70	Recruitment of 3 phD students
71	Lecture series for Laurea Magistrale Mar-May
72	Lecture series for Laurea Magistrale Oct-Dec
73	**WP3: ARC node development (M. Massardi)**
74	Recruitment of postdocs
75	**Participation in ALMA Polarization CSV activities**
76	Participation in Polarization CSV activities
77	**Expand Expertise in mmVLBI**
78	Expand Expertise in mmVLBI
79	First year closure activity WP1,2 &3
80	**RECEIVER DEVELOPMENT: WP4 & WP5 (F. Villa)**
81	kickoff-wp4&5
82	Design Review
83	**WP4 - Band 2 Passive Components**
84	Specifications
85	**Arcetri's LAB upgrade**
86	Lab Instumentation update
87	Upgrade of Lab and anechoic chamber realization
88	lab commissioning
89	**Passive components design**
90	Feed Horn Desing
91	OMT design
92	MIRRORS design
93	First year closure activity
94	**WP5 - Band 2 Cartridge Prototyping**
95	Review and update of receiver architecture and specs
96	Calibrator design and manufacturing
97	Amplifier procurement and mechanical design and manf.
98	Test procedures and integration plan
99	**IASF Lab Upgrade**
100	cryofacility upgrade
101	Laboratory upgrade
102	Lab commisioning
103	Electronics
104	EM simulations and radiometer model
105	First year closure activity
106	**LABORATORY ASTROPHYSICS (M.E. Palumbo)**
107	kickoff-wp6
108	**WP6: Laboratory Astrophysics (M.E. Palumbo)**
109	Recruitment of postdoc
110	Market search and contacts with providers
111	**Vacuum Chamber and Low T apparatus**
112	Acquisition of vacuum chamber and related equipment
113	Assembly and testing of the Vacuum chamber and re...
114	**Supersonic He jet system**
115	Acquisition of the supersonic He jet system
116	Assembly and testing of the He jet system
117	**Acquisition of TOF Mass Spectrometer and Lasers**
118	Acquisition of the TDF Mass Spectrometer and Lasers
119	First year closure activity
120	**GREEN ENERGY FOR ALMA: WP7 - Options for a Green-...**
121	kickoff-wp7
122	**WP7: Options for a Green-ALMA (L. Testi)**
123	Preparations of the documents for the call for tender
124	Selection of the provider for the study
125	Contract and its followup
126	Acceptance of the Study
127	First year closure activity
128	**OUTREACH: WP8 - iALMA Outreach**
129	kickoff-wp8
130	**WP8: iALMA Outreach (F. Rea)**
131	Preparation of Brochures
132	Preparation of audio/video material
133	Preparation of information packages
134	High quality publication of products
135	First year closure activity

7.1 WP0. Project Management.

Responsible: L. Testi (INAF-OAArcetri)

Members: F. Villa (INAF-IASF-BO), M.E. Palumbo (INAF-OACatania)

The iALMA organizational structure is shownin the block diagram in the figure. The management team is composed by the coordinator and the two deputy coordinators. They are responsible for the temporal and financial evolution of the project, they organize jointly the annual project meetings, keep the contacts with ESO/ALMA, the EAB and the partners of the international consortiumfor ALMA Band 2. The management team meets via video or telecon at least once per month and discusses the progress in each area of the project, with the goal of identifying and correcting any emerging problem in the evolution of the project. Every two months the meetings are extended to all the workpackage leaders. Project wide meetings are organized once per year. The management team is responsible for collecting the inputs and assembling the annual reports of the project and for the organization of the meetings with the EAB, which normally coincide with the annual project meetings. The EAB evaluates both the scientific and technical as well as the financial and schedule progress of the project.



The most critical risk areas for iALMA are: 1) ability to recruit the personnel in a timely fashion and with adequate qualifications, 2) time of delivery for the laboratory equipment and for the componetns produced externally, 3) the costs of equipment, components and services, 4) the difficulties in setting up properly and calibrating the laboratory experimental setup, 5) the performances of the components and of the whole system for the Band 2 cartridge, 6) the ability to obtain the required observational data. The first two risk areas have mainly an impact on the schedule of the project, the mitigation strategy is to start the recruitment procedure sas fast as possible after the approval of the project, with the goal of having all the personnel in place at the time of the kickoff or soon afterwards, note that a large fraction of the manpower is internal to INAF, so the risk is there and has to be mitigated, but the potential impact on the overall project is not too high. Similarly, the procurement of instrumentation and components, especially for the long lead items, will be activated as soon as

possible. The risk area 3) is critical for the total cost of the project, the strategy that we have applied in the setup of this proposal is to evaluate the cost of each product based on different suppliers and with direct inquiries to the service providers; in addition, we have in the WP0-Management budget the provision for a "contingency" of about 5% of the cost of instruments, components and services. The risk area 4) refers to the activities in the Catania laboratory, this is mitigated by the very large experience present in the group in seting up complex experimental setups for laboratory astrophysics. Risk area 5) is currently mitigated by the preliminary design study of some components that is being carried out by the ALMA Band 2 consortium, under contract with ESO; and additional mitigation strategy in a few cases of particularly critical components could be to produce the same piece in two different industries with different technologies and test the results against each other in the lab. Special attention will be given to the active components, i.e. low-noise amplifiers. There are no commercial amplifiers with the specs required for the ALMA receivers. Nevertheless, within other radioastronomy studies INAF is already looking into possible solutions for this procurement and we plan to develop strategies to make the best use of these developments within the institute. The risk area 6) is considered to be low, given the proven ability of the participants to obtain time at the most competitive observatories

The management team is responsible for compiling and maintaining a Risk Register for the whole project. The Risk Register will contain all the risks with a proper level of granularity for each workpackage. The Risk Register will be prepared at the beginning of the project collecting the inputs from all the workpackage leaders; i twill be periodically reviewed and revised. Each risk will have a score to compute the impact on costs and schedule of the project. For the most important risks the managemetn team will define the strategies, in consultation with the responsible of the workpackage, to retire the risk or mitigate its impact on the project.

The WP0 is also responsible for the set up of a public web site to publicize iALMA and its results, and for the set up of a wiki site for the internal use of the project. The WP0 also sets up the Electronic Documentation Managemetn system to store the project documents. The expected cost of WP0 is summarized in the table and includes the costs for the time, tool and trips of the management team for the WP0 activities, it includes the full costs for the annual project meetings and the full costs for the EAB members trips, it also includes a "contingency", computed as 5% of the total cost of instrumetns, equipments, components and services from third parties. The "contingency" budget will be used, if necessary, to mitigate or remove the most important risks, any use of the "contingency" will be properly documented and motivated.

iALMA will use the administration, human resource management and IT technical support provided by the INAF Headquarters, Arcetri, Bologna and Catania.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	70000		70000 (1)	25.6%
Personale Postdoc				
Consulenze scientifiche				
Altre prestazioni di terzi				
Attrezzature, strumentazioni e prodotti software	10000(2)	10000		3.6%
Materiali				
Infrastrutture				
Spese generali	12000(3)	12000		4.4%
Stages e missioni in Italia e all'estero	32000(4)	32000		11.7%
Spese di pubblicizzazione				
Altri costi funzionali al progetto	150000	150000 (5)		54.7%
TOTALE	**274000**	**204000**	**70000**	**100%**

Table – Detailed costs of WP0 – year 1

1) Cost of INAF and University personnel, computed assuming 70kE/year (12 man months total)

2) Cost for management tools and hardware: one laptop computer, project management software, cost to set up the website and the internal wiki system, Electronic Documentation Management system.

3) Overheads: computed assuming ~20% of total costs (excluding "contingency" and hardware cost).

4) Cost for the organization of the travels and meetings of the External Advisory Board (two meetings the first year, 5kE each), cost for traveling of the management team within Italy (Arcetri, Bologna, Catania and Roma, for a total estimate of 2kE), cost for the organization of two project wide meetings (kick-off and first year review, 10kE each

5) Cost for "contingency" for the first year of the project.

7.2 WP1. Science Working Group – Science Cases and Simulations

Responsible: Dr. M.T. Beltran

Institute: INAF-Osservatorio Astrofisico di Arcetri

Staff of INAF-Osservatorio Astrofisico di Arcetri: M.T. Beltran, R. Cesaroni, C. Codella, F. Fontani, L. Hunt, L. Testi

Staff of INAF-Istituto di Radioastronomia: J. Brand, I. Prandoni, V. Casasola

External staff: L. Gregorini (Universita' di Bologna), A. Marconi (Universita' di Firenze)

Deliverables of WP1

1. Italian Science Case for Band 2, supported by ancillary data and/or simulations (Year 1)
2. Requirements on the upgraded ALMA system to achieve the Science Case (Year 1)

3. Organization of a meeting in Arcetri of the SWG with the partners of the ALMA Band 2 consortium in Europe to discuss theScience Case and the Requirements (Year 1)
4. Observations of complex molecules in star forming regions with ALMA, Herschel and other telescopes, comparison with laboratory experiments and pubblication of results (Years 1-4)
5. A science observations plan for the Band 2 prototype at Noto or SRT (Year 3)
6. Coherent set of Projects for the upgraded ALMA (Year 4)
7. Organization of an international conference during the last year to publicise the results of the iALMA project (Year 4)

Goals of WP1:

1) Developing the Science Drivers and Strategies for ALMA Band 2

WP1 is responsible for developing the (Italian contribution to the) Science Case for Band 2. The current scientific research carried out by the members of this group has already highlighted the main scientific questions that cannot be addressed with the current ALMA but require a development of the instrument. Band 2 covers a frequency range that is relatively poorly observationally explored but that contains over 1000 interstellar molecular lines important for both galactic and extragalactic studies.

The work will start with the completion of the Italian Science Case for Band 2, which will be mostly based on work partially done as part of the initial feasibility study under contract with ESO and in collaboration with STFC and IRAM. The science requirements on the receiver will flow down from the science case and will be collected in a proper document to support the work of WP 4 and WP5. In the subsequent years WP1 will work on developing specific science programmes for the ALMA Band 2 based on the results from ALMA observations in the currently available Bands and on the comparison with the laboratory experiments developed as part of WP6.

The results of this work will be discussed within the international Band 2 consortium and will be publicized at international conferences and meetings, including the specific ALMA science workshops that are periodically organized by ESO and the ALMA partners. A workshop on the ALMA Band 2 Science Case and Requirements will be organized in Arcetri towards the end of the first year of the project and an international science conference on topics related to the iALMA project will be organized in the fourth year of the project.

2) Observations of complex organic molecules with ALMA

The members of the SWG are already involved in a strong international observational effort to study complex and rare molecular species in the interstellar space. These efforts are carried out since many years with the IRAM ground based observatories (e.g. the ASAI spectral survey Large Programme), with the Herschel Space Observatory (e.g. the CHESS spectral survey programme) and, since the very beginning of Science Verification and Early Science, with ALMA itself (with the observations of deuterated species and complex organic molecules

in star forming regions). Band 2 will be essential for ground-state transitions (J=1-0) of deuterated species, such as DCO^+, DCN, DNC, and N_2D^+, and for studies of complex organic molecules (COMs), which have started to be detected in star-forming regions (e.g. glycolaldehyde and formamide) and are crucial species for the formation of metabolic molecules. Initial comparison with the predictions of the laboratory experiments can already be done with the observational programmes that the SWG is currently carrying out. During the third and fourth year of the project, when the laboratory experiments in Catania will begin to produce the new results on the abundances of rare complex molecular species, these will be directly compared with the observational results to constrain the formation processes of these complex molecules and their chemical network in the interstellar medium.

3) Developing an astronomical test programme for the Band 2 receiver at the SRT

During the second and third year of the project, the SWG will develop an astronomical observational programme to test the Band 2 receiver prototype on-sky with either the Noto or SRT INAF radiotelescopes. The programme will include some basic testing by performing observations of well known sources in well known transitions to check the performances of the system against known sources and previous observations. If possible within the other constraints, the science programme will also include observations in deuterated species and complex organic molecules of targets that will be important for a future follow-up with ALMA in Band 2.

The team of WP1: The Science Working Group

The manpower for WP1 is provided by the members of the Science Working Group (SWG), they represent the best possible team at a national level for their solid expertise in (sub)millimeter astronomy and experience with interferometric observations and studies of molecular line and continuum emission both from Galactic and extra-galactic star forming regions. We also stress the group's know how in molecular spectroscopy and chemistry finalized to the investigation of the embedded phase of the star formation process, also through the study of complex molecular species (e.g. glycolaldehyde), which are tightly related to the formation of complex organic molecules, including the RNA, and hence to the birth of life. As a whole, the SWG has over 680 refereed publications, most of which related to observational studies at (sub)millimeter wavelengths. The group members are all involved in international collaborations and play a leading role in a number of these. In particular, we stress that among the SWG members are the most active users of ALMA based in Italian institutes: within the SWG we have all the PIs of the 6 Italian ALMA highest priority projects for Cycle 0 and 1. These facts demonstrate that the SWG is not only deeply involved in cutting-edge science, but is also highly qualified to lead projects in the field of (sub)millimeter interferometry. Note that two of the members (MTB and LH) are already participating in the science workpackage for the ESO feasibility study of the band 2 receivers for ALMA, led by Gary Fuller of the Manchester University, and are members of the ALMA Time Allocation Committee (Cycle 0 – Cycle 2: 2011- 2013). LT has been and IP is member of the most important ALMA science advisory committees. LT is currently European Programme Scientist for ALMA.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	58400 (1)		46700 (2) 11700 (3)	42.2%
Personale Postdoc	40500(4)	35000	5500	28.9%
Consulenze scientifiche				
Altre prestazioni di terzi				
Attrezzature, strumentazioni e prodotti software	10000 (5)	10000		7.2%
Materiali				
Infrastrutture				
Spese generali	20000(6)	20000		14.5%
Stages e missioni in Italia e all'estero	4000 (7)	3000	1000(8)	2.9%
Spese di pubblicizzazione	1000 (9)	1000		0.7%
Altri costi funzionali al progetto	5000 (10)	3000	2000(11)	3.6%
TOTALE	**138900**	**72000**	**66900**	**100%**

Table – Detailed cost for WP1 – First year

1) Cost of INAF and University personnel, computed assuming 70kE/year (10 man months total)
2) Cost for INAF personnel: 8 man months.
3) Cost for University personnel: 1 man month (UniBo) plus 1 man month (UniFi).
4) Cost for a full time postdoc on the project plus the cost for 2 man month for INAF funded posdoc
5) Cost for computers and software (MS Office, IDL, iWorks): 7kE for 1 top end workstation for ALMA data analysis and simulations with CASA (eg MacPro 12cores, 64Gb RAM and 4Tb fast i/o disk), 2kE for 1 laptop for the new postdoc, 1kE for the software licenses.
6) Overheads: computed assuming ~20% of all costs (except hardware).
7) Cost for short trips in Italy and abroad: 1kE for trips within Italy (to Arcetri, Bologna, Catania or the INAF headquarters in Rome), average cost for 4 abroad trips with a single night stay each; 3kE for international trips for meetings with the ALMA Band 2 consortium partners (IRAM-France, Manchester-UK, ESO-Germany), the estimated cost is for 3 trips with two nights stay each.
8) Other sources of financing for the activities of the SWG (primarily coming from Herschel-ASI data analysis funding, Radionet3 or ESO).
9) 1.0kE for publication costs for scientific papers on non-european journals (e.g. collaborations with overseas colleagues).
10) 4kE of other costs: organization of a meeting in Florence with the international ALMA Band 2 partners to discuss the science case.
11) Other sources of funding for external participants to attend the meeting in Florence (partner institutes funding or ESO funding).

7.3 WP2. Advanced Training

Responsible: L. Gregorini

Institute: Universita' degli Studi di Bologna e INAF-Istituto di Radioastronomia

External staff Universita' di Bologna: L. Gregorini, D. Dallacasa (Dipartimento di Fisica e Astronomia)
External staff Universita' di Firenze: A. Marconi (Dipartimento di Fisica e Astrofisica)
External staff Universita' di Catania: G. Compagnini (Dipartimento di Chimica)
INAF-Osservatorio Astrofisico di Arcetri staff: F. Fontani, L. Hunt, L. Testi
INAF-Istituto di Radioastronomia staff: J. Brand, V. Casasola, M. Massardi, I. Prandoni
INAF-Osservatorio Astrofisico di Catania staff: M.E. Palumbo

Deliverables of WP2

1. 6 PhD grants: 3 in the first year, the remaining 3 in the third year of this package (Year 1 and 3)
2. Lectures for second level courses (Laurea Magistrale) on subjects relevant to iALMA science (Year 1-4)
3. Organization of the "Open Laboratory Day" (Year 2)
4. Series of Lectures at the "F. Lucchin" National School of Astrophysics on subjects relevant to iALMA science (Year 3)

Goals of WP2

iALMA plans to carry out research, technology transfer and training aiming at strengthening the national and international community in millimetre and sub-millimetre astrophysics. This initiative is based on high level scientific and technological expertise, which is essential for the formation of highly specialized scientists and technicians. ALMA, which is now starting its valuable contribution to millimetre astrophysics, will be one of the top level instruments in the coming decades and the Italian astrophysical community needs to have to possibility to fully exploit the enormous scientific and technological capabilities offered by ALMA.
The goal to have a wider community and deeper knowledge in the millimetre astrophysics can be achieved by means of the education and formation of young generations. Master degree and PhD holders must be involved and trained in this project. PhD projects, which represent the highest level of
education, are a key element for the development and the final success of iALMA.

Universities in Bologna, Catania and Florence, possess a longstanding experience in the collaboration and integration with local INAF Institutes. Students have the opportunity both to attend lab courses and carry out Master degree thesis work in INAF institutes, allowing them a wide choice of the subject of their research.

Many PhD theses have been carried out in collaboration between Universities and INAF institutes, resulting in young researchers, who have provided key contribution to research at both Universities and INAF, but also with interdisciplinary skills very valuable in the production system in Italy and in international research centres.

In the framework of the iALMA project, considering a four year time span, we plan the following actions: funding PhD grants at each university specific to science and technology related to mm observations, construction of instrumentation operating in the microwaves and lab astrophysics;

organization of a school for PhD students on ALMA science and technology ; lectures for master degree students on subjects related to iALMA; Master theses on subjects related to iALMA will be given by university staff members at each university; organization of "Open Laboratory Days" offered to high school students of Emilia Romagna, Sicily and Tuscany.

Schedule of WP2 activities

In the first year of the present project 3 PhD grants will be assigned (1 at UniBO, 1 at UniCT, 1 at UniFI).

Cycles of specific lectures will be organized within each degree course. A coordination with the "F. Lucchin" national school in Astrophysics (responsible of the high level courses for PhD students since 1991) will be arranged. A suitable slot for the iALMA course for PhD students will be found either in the second or in the third year of the project. In the same period, when our laboratories will be operating full time, "open days" will be organized to allow young students to get in touch with front line research. An additional set of three PhD grants will be activated the third year of this project.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	93400		46700([1]) 46700([1])	31.2%
Formazione	180000([2])	180000		60.1%
Consulenze scientifiche				
Altre prestazioni di terzi				
Attrezzature, strumentazioni e prodotti software	6000([3])	6000		2.0%
Materiali				
Infrastrutture				
Spese generali	17000([4])	17000		5.7%
Stages e missioni in Italia e all'estero	3000([5])	3000		1.0%
Spese di pubblicizzazione				
Altri costi funzionali al progetto				
TOTALE	**299400**	**206000**	**93400**	**100%**

Table – Detailed cost for WP2 – First year

[1]) Cost for INAF and University personnel, computed assuming an average cost of 70kE/year and counting the man-months (8 man months for INAF and 8 man months for University

[2]) Cost for three PhD studentships, including the extra funding for long periods in foreign institutes.

[3]) Cost for three laptop computers, one for each of the students.

[4]) Cost of short trips for students to attend national schools and conferences.

7.4 WP3. The evolution and development of the Italian ARC node

Responsible: D. M. Massardi

Institute: INAF-Istituto di Radioastronomia

Staff of INAF-Istituto di Radioastronomia: J. Brand, M. Massardi, A. Mignano, R. Paladino, E. Liuzzo

Deliverables of WP3

1) Expand the scientific and technical expertise in mm-VLBI observations (Year 1-4)
2) Develop the capabilities to provide expert support to the users of polarimetry with ALMA (Year 1-4)
3) Contribution to the development of the polarimetric capacities of ALMA through participation in CSV activities (Year 1-2)
4) Support to the ALMA CSV acitivities towards the goal of having ALMA as part of the global mm-VLBI network (Year 3-4)

Objectives

One of the principal tasks of the Italian ALMA Regional Centre (ARC) is to provide support to potential ALMA users (see also Sect. 9). Now that ALMA has been available (on a very limited basis) for observations in two cycles of "Early Science", the user community has matured, and the role of the ARC nodes will change. In addition to mere user support we will be requested by a more demanding astronomical community to focus our activities and skills on specific scientific and technological areas so that within the European ARC network each node has its own expertises and contributes to the network not on a geographical but on a scientific basis. The Italian ARC intends to develop two areas of expertise in which it already has considerable competence, and which coincide with areas in which the ALMA project itself is becoming deeply involved: polarimetry and millimeter-VLBI.

Objective 1: polarimetry

The Italian ARC intends to become the European expert for polarimetric observations with ALMA. Measuring the polarization properties of astronomical sources is an important aspect of ALMA scientific programme. A large fraction of astronomical millimetre-wave sources produce partially polarized emission. Polarization is generally caused by scattering processes in the sources and/or the effects of magnetic fields. Measurements of the orientation and amount of polarization provide information on the emission mechanisms, the source geometry and the alignment and strength of the magnetic fields, which are thought to play a critical role in processes like star formation and AGN activity. Typically the fractional polarization is quite low , perhaps only 1 or 2% , but we need to be able to measure this rather accurately in order to get the astronomical information out. For this reason one of the most challenging ALMA technical requirements is to maintain the instrumental polarization below 0.1%.

The ALMA polarimetry capacity is currently being developed. The commissioning for this observing mode is on-going and full-Stokes parameter observations are expected to be offered starting with the next observing Cycle. Some members of the ARC have expertise in polarimetry, and the whole Italian ARC is in the process of addressing the role that polarimetric observation in each of the fields of our scientific expertise. In fact we aim at improving our knowledge and skills in polarimetry to be able to offer to the ALMA community the necessary support once the telescope will be operative also for full-Stokes polarization data. To prepare ourselves and gain experience we are applying for polarimetry data at other telescopes, we are reducing pre-existing polarimetry datasets from other interferometers, and we will participate to the analysis of polarimetric commissioning data from ALMA. At the same time our team is testing the CASA data reduction package for the handling of polarimetric data, developing new tasks that facilitate the process. The next step of this development plan for the Italian ARC calls for the employement of a polarimetry expert fully dedicated to the ARC-activities related to polarimetry, which will enhance our level of know-how in this field. This expert will also work in close collaboration with other ARC nodes and with the ALMA organisation, helping to bring the ALMA polarimetric capacities into operation.

Objective 2: mm-VLBI

The ALMA Development Plan, that sets the scientific context for transformational science with ALMA in 2020, considers as a key-point the use of the ALMA array as part of a global mm-VLBI array. VLBI observations at short millimeter wavelengths are required to resolve the compact radio components associated with active galactic nuclei. These components are optically thick at longer wavelengths, or obscured by scattering. Millimeter VLBI arrays on baseline of several km can observe at angular resolutions of 20 microarcsec. This is sufficient to resolve structures on the scale of an accretion disk around a massive black hole in the nearest quasars.

The INAF-Istituto di Radioastronomia has long-standing experience and collaborations in the VLBI network at radio wavelengths, and it is fitting that the Italian ARC strives to become experts on mm-VLBI involving ALMA. The scientific gain of millimeter-VLBI is tremendous, but it is both technologically and observationally a complex technique, because of the atmospheric influence on the relatively short wavelengths involved (which puts very high demands on the calibration of the observations, for example). Considering the experience with radio frequency VLBI of the ARC's host institute, we are in an excellent position to make significant contributions to the inclusion of ALMA in the global mm-VLBI network. To do this it is important to get involved from the start. We therefore need to enrich the ARC with an expert on mm-VLBI, who will work with the ALMA staff on this part of the Development Plan, and who will help raise the competence of the ARC in this field by working with the staff in defining scientific projects for existing and future mm-VLBI arrays.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	23333		23333(1)	14.7%
Personale post-doc	92250	70000(2)	22250(3)	58.2%

Consulenze scientifiche	5000(4)	5000		3.1%
Altre prestazioni di terzi				
Attrezzature, strumentazioni e prodotti software	4000(5)	4000		2.5%
Materiali				
Infrastrutture				
Spese generali	25000(6)	25000		15.8%
Stages e missioni in Italia e all'estero	9000(7)	7000	2000(8)	5.7%
Spese di pubblicizzazione				
Altri costi funzionali al progetto				
TOTALE	**158583**	**111000**	**47583**	**100%**

Tabella – Voci di costo per WP3 – Primo anno

1) Cost for INAF personnel, computed assuming 70kE/year (4 man month total)

2) Cost for two postdocs full time on the project

3) Cost for INAF-funded postdocs (3 postdocs for 3 man months each)

4) Cost for an ALMA polarimetry workshop in Bologna

5) Cost for one laptop each for the two new postdocs (2kE each)

6) Overheads: computed assuming ~20% of total costs (excluding the cost for hardware)

7) Estimated cost of travel for meetings with collaborators and experts at ESO and other European ARCS (5 trips, 1kE each including overnight stay), in the USA (1 trip, 2kE including overnight stay). Travel to Chile for participation in commissioning observations (1 trip, 2kE).

8) Travel costs will be partially paid by other sources (ESO, RadioNet)

7.5 WP4. ALMA Band 2 passive components prototypes and testing

Responsible: R. Nesti

Institute: INAF-Osservatorio Astrofisico di Arcetri

Staff of INAF-Osservatorio Astrofisico di Arcetri: R. Nesti, D. Panella

The purpose of WP4 is the development of passive devices for the ALMA band 2 front-end cartridge, comprising the exterior re-focusing optics. Such an activity involves the study phase, the desing, the fabrication and the experimental electromagnetic test on each of the three cascaded devices, ordered: re-focusing mirror system (MIRRORS), circular corrugated feed horn (FEED) and orthomode transducer (OMT). This activity can be regarded, in the framework of this project, preparatory and complementary to the WP5 activity working on the design of the cartridge and on the whole assembly characterization, comprising the front-end elements, with electromagnetic, mechanical, thermal and cryogenic tests.

The whole project is divided in four years, expecting as deliverables, concerning the WP4+WP5 workpackages, the full design of the whole ALMA band 2 cartridge, from the electromagnetic design of the

individual devices, their characterization, their assembly, the system study, until the full characterization in the operative cryogenic environment.

Shortly, as regards WP4, the activity can be articulated this way: the first year will be devoted to the design of the passive devices (FEED, OMT, MIRRORS), to the purchase of required and missing equipment and facilities, to the preparation of the logistics, including setting up the laboratory and the anechoic chamber. All aimed at the electromagnetic characterization of the individual passive devices. The second year will concentrate on engineering and fabrication of passive devices and on setting up logistics and instrumentation for the tests and finally on the tests themselves. The third year will focus on a critical design review, taking into account the possibility to revise unsatisfactory parts, on documentation production and on the starting of the effective collaboration in the work of WP5. The fourth and last year will be basically a continuation of this last point.

In more detail, WP4 activities are given in the following:

(1) 1st year activitiy
   a. Definition of electrical and mechanical requirements for FEED, OMT and MIRRORS. This activity continues the results of a study, currently in progress and already funded by other institutions.
   b. Instrumentation for circuital and radiative characterization of passive devices. Acquisition and development of a transmitter and receiver system for W-band antenna measurements. Acquisition of a vector network analyzer operating up to W-band for circuit measurements at microwave frequencies.
   c. Structural adjustment of the existing laboratory and anechoic chamber.
   d. Design of FEED, OMT and MIRRORS.

(2) 2nd year activity
   a. Engineering of FEED OMT e MIRRORS
   b. Fabrication of FEED, OMT e MIRRORS.
   c. Set up facilities and environments to make measurements.
   d. Development of software suitable for data acquisition and processing.
   e. Electromagnetic test on FEED OMT and MIRRORS.

(3) 3rd year activity
   a. Analysis of test results and critical design review.
   b. Revision and fabrication of unsatisfactory devices.
   c. Test report on passive component design: electromagnetic design, fabrication and test.
   d. Logistic operational and functional support to the activities of WP5 for the characterization of the cartridge system plus refocusing mirrors.

(4) 4rd year activity
   a. Continuation of point d. - 3rd year activity.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	58333		58333 (1)	9.5%
Formazione				
Consulenze scientifiche				
Altre prestazioni di terzi				
Attrezzature, strumentazioni e prodotti software	475500	450000	25500(2)	77.1%
Materiali				
Infrastrutture	50000(3)	50000		8.1%
Spese generali	23000(4)	23000		3.7%
Stages e missioni in Italia e all'estero	10000	10000		1.6%
Spese di pubblicizzazione				
Altri costi funzionali al progetto				
TOTALE	**616833**	**533000**	**83833**	**100%**

Table – Detailed costs for WP4 – First year

(1) Cost for INAF personnel, computed assuming 70kE/year.
(2) Software licences, instrumentation and material provided by INAF-OAArcetri
(3) Running costs for the laboratory
(4) Overheads: computed assuming ~20% of the total costs (excluding the costs for material and instruments)

7.6 WP5. Band 2 cartridge prototyping and testing

Responsible: Fabrizio Villa

Institute: INAF/IASF-Bologna

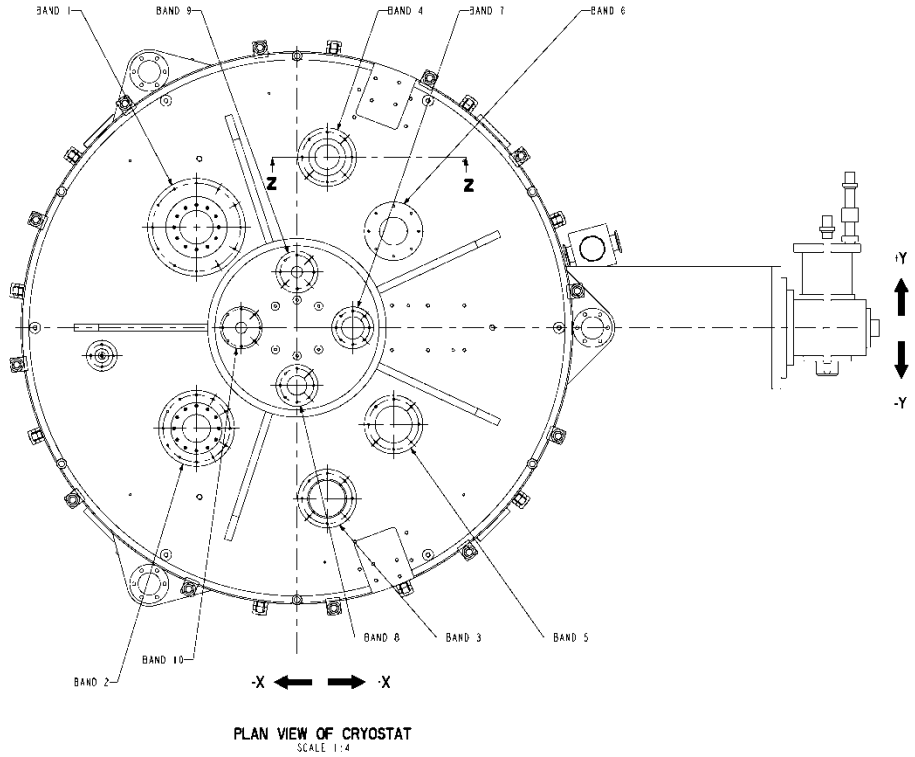
Other staff: M.Sandri, A. De Rosa

The work of WP5 will be conducted in synergy mainly with the WP1 and WP4.

The goal of the WP5 is to develop and calibrate a prototype ALMA band 2 cartridge front end in four year of activity. It is foreseen to design, build and to perform functional tests and calibration on a engineering model (EM). The engineering model will be representative concerning the performances and architecture whose scheme is reported in figure WP5-a. This model will permit to identify criticalities and to consolidate the test procedures and instrumentation. The receiver will be composed by an antenna and OMT (developed by WP4)

providing two signals proportional to the two orthogonal polarizations. The signals will be then amplified by two LNAs (Low Noise Amplifiers). These active components mainly will determine the noise performances of the radiometers. After a filtering section, the signals will be mixed with a stable RF signal to obtain a the output two IF signals in the 4-12 GHz frequency range to make them compatible with the ALMA back-end specifications.

Then after the EM, a cartridge will be developed (see Figure WP5-b) to be representative also for thermal and mechanical interfaces with the ALMA focal plane as figure below.



The main technological challenge to build low noise HEMT-based amplifiers at mm-wavelengths is the development of wafer foundry and packaging processes and techniques. The technology in Europe is still under development with respect the US industry but in these last 5 years several reasearches were dedicated to this. An activity is foreseen to select the appropriate provider of low noise amplifiers taking advantages of the collaborations already established in on-going ALMA feasibility study (band 2+3) and possibly within other Italian R&D project at mm-wavelength.

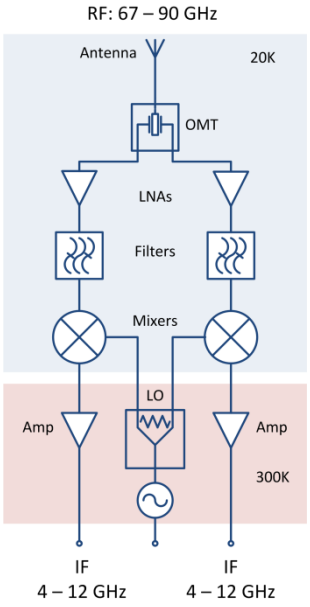


Figure WP5-a: conceptual scheme of the band 2 receiver

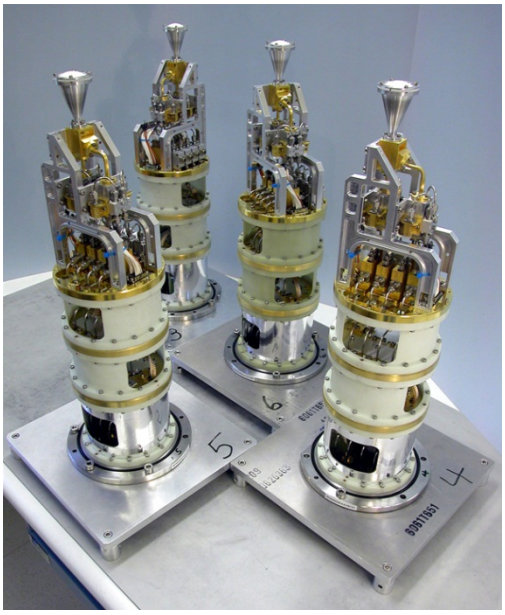


Figure WP5-b: Example of ALMA cartridges. Here the ALMA band 3 cartridges are shown.

The activities are outlined here after:

(1) 1st year activities (Development of the Engineering Model)

a. Update of electromagnetic and thermo-mechanical simulations of the receiver on the basis of the previous funded studies. Update and confirmation of the sub-system specifications. Update of the receiver architecture and mechanical design of the unit and thermal, electrical, and mechanical interfaces.
b. Design and manufacturing of calibrator
c. Amplifier procurement. Mechanical and electrical design and manufacturing of the amplifier box.
d. Definition of radiometer integration plan and test procedures
e. Upgrade of the cryofacility and laboratory instrumentation
f. Development of the electronics and software to bias the engineering model of the radiometer. Development of the read-out electronics and software.
g. Electromagnetic simulations with the ALMA antenna and development of the software model of the radiometer.

(2) 2nd Year activities (Integrazione e calibrazione del modello ingegneristico e progetto iniziale della cartuccia)

a. Amplifier box integration
b. Integration of the passive components sub-units (MIRROS, FEED, OMT) already developed by WP4 with the amplifiers.
c. Functional tests campaing

d. Calibration campaign
e. Identification of the criticalities
f. Final reports and guidelines for the cartridge development
g. Preliminary design of the Band 2 cartridge

(3) 3rd Year of activity (Manufacturing of the cartridge)
a. Finalization of the cartridge prototype design including thermo-mechanical analyses
b. Realization of the ALMA band 2 cartridge prototype
c. Preparation of the test plan
d. Development and update of the test instrumentation (back-end)
e. Integration and test activity.

(4) 4th Year of activities
a. Finalization of test activities
b. Finalization of final reports and guidelines for the pre-production phase.
c. Plan for the Band 2 cartridge "first light" using INAF telescope resources (NOTO or Sardinia Radio Telescope)

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	245000	140000(1)	105000(2)	22.1%
Formazione	35000	35000	0	3.1%
Consulenze scientifiche				
Altre prestazioni di terzi	125000	125000	0	11.3%
Attrezzature, strumentazioni e prodotti software	565000	423000	142000 (3)	50.9%
Materiali	20000	15000	5000 (4)	1.8%
Infrastrutture	10000	0	10000(5)	0.9%
Spese generali	100000(6)	100000	0	9.0%
Stages e missioni in Italia e all'estero	10000	10000	0	0.9%
Spese di pubblicizzazione				
Altri costi funzionali al progetto				
TOTALE	**1110000**	**848000**	**262000**	**100**

Table – Detailed costs for WP5 – First year

(1) Cost for 1 contract for 12 months (Thermal engeneer) and 1 contract for 12 months (AIV manager)
(2) Cost of INAF personnel assuming 70kE/year and counting a total of 18 man months

(3) Cost of software and hardware material provided by INAF (instruments, Calibrator, software license for EM calculations of antennas GRASP)
(4) raw material for mechanical workshop and tools from INAF
(5) Laboratory maintenance expenses provided by INAF running costs
(6) Overheads: computed as ~20% of total costs (excluding the cost of instruments and materials)

7.7 WP6. Laboratory Astrophysics

Responsible: M.E. Palumbo

Institute: INAF-Osservatorio Astrofisico di Catania

Staff of INAF-Osservatorio Astrofisico di Catania: G. Baratta, R. Di Benedetto, V. Greco, M.E. Palumbo, G. Strazzulla

Staff of INAF-Osservatorio Astrofisico di Arcetri: J.R. Brucato

staff of Universita' di Catania: G. Compagnini (Department of Chemistry)

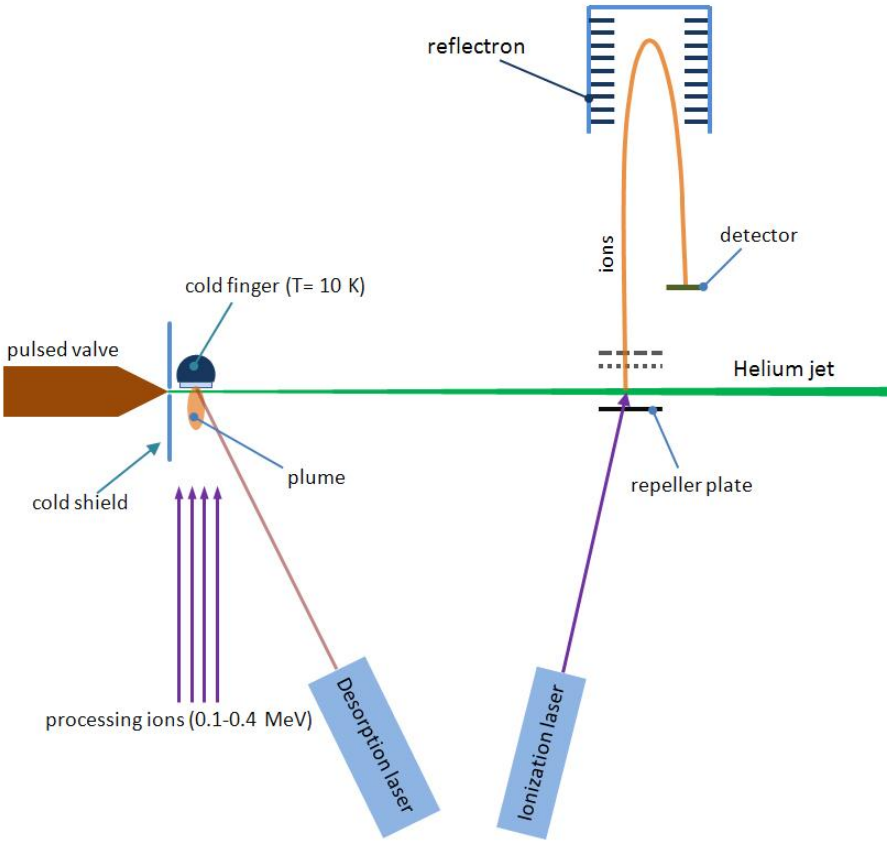
Deliverables of WP6

1. Procurement of the vacuum chamber, mass spectrometer, laser and other equipment (Year 1)
2. Assembly of the complete experimental setup in the laboratory (Year 2)
3. Calibrations and initial experiments to check functionality and sensitivity of the system (Year 3)
4. Experiments with simple ices, with irradiated ices, and with compounds of astrophysical interest (Year 4)

Goals of WP6

The aim of WP6 is to build up a new and original experimental set-up for advanced nonconventional interdisciplinary analysis of ices after radiolysis at low temperature in order to detect minor species formed which cannot be detected with conventional techniques. The proposed instrumentation will give us the unique opportunity to study "in situ" the complex chemistry induced in ion irradiated ice mixtures. In particular the proposed experimental set-up is, to our knowledge, the first capable to detect molecules "in situ" by a combination of laser desorption, jet cooling and VUV-UV photo-ionization followed by high resolution mass-spectrometric analysis of ion irradiated ices. During the first year we will proceed with the acquisition of the new instruments for the laboratory. Since the design of the instrumental setup is innovative and original, i twill be necessary to manufacture some components ad hoc, assemble and test all the subsystems individually before acquiring new parts. This will require a very intense activity in the laboratory and in the contacts with the providers.

A schematic depiction of the proposed experimental set-up is given in the figure below.



This experimental setup will give us the opportunity to study the formation of new molecules after ion irradiation of ice mixtures as follows:

- Deposition of a single ice component or of a mixture on the cold substrate (T=10 K).
- Irradiation of the sample with 0.1- 0.4 MeV ions.
- Desorption of the irradiated ice sample with the first laser pulse.
- Transportation of the desorbed material by a He stream supersonically expanded.
- Ionization by a second laser pulse.
- Analysis by a time of flight mass spectrometer (TOF-MS).

Available instrumentation at INAF – Osservatorio Astrofisico di Catania (http://web.ct.astro.it/weblab/)

- 200 kV ion implanter by Danfysik plus a system for "in situ" analysis (by infrared, Raman and UV-Vis-NIR spectroscopy) of the effects induced by fast ions and UV photons in targets (frozen gases or refractory solids) at low temperature. The "in situ" analysis is carried out within an Ultra High Vacuum (UHV) chamber (P = 10^{-9} mbar) equipped with a closed-cycle He cryostat (10-300 K)
- UV-VIS-NIR Perkin-Elmer Lambda 19 spectrometer + integrating sphere (range 190-2500 nm)
- UV-VIS-NIR Ocean Optics optical fibres mini-spectrometer (range 260-900 nm)

- FTIR spectrometer Bruker Equinox 55 (range 400-12000 cm^{-1}) plus FTIR microscope (range 600-10000 cm^{-1})
- FTIR spectrometer Bruker Vertex 70 (range 400-25000 cm^{-1})
- Microwave powered Lyman-alpha resonance lamp + system for "in situ" real-time measurement of UV photon flux
- laser Nd-YAG 266 nm UV (20 kHz, 30 mW)
- Raman Spectrometer Triplemate 1877E SPEX equipped with a CCD detector + confocal illuminator by DILOR (macro + microscope) (400-950 nm) (150-8900 cm^{-1} Raman shift by using the 514.5 nm Ar^+ laser line) plus a 300 mW multiline Ar ion laser.
- HE-785 mini Raman spectrometer by HORIBA (200-3300 cm^{-1}) equipped with CCD detector + optical fibers probe head and 300 mW 785 nm diode laser.

Required instrumentation. We plan to upgrade the available experimental set up in order to study the formation of complex molecules after ion irradiation of interstellar ice analogues using a nonconventional and interdisciplinary approach. However our aim is to maintain all the available analysis techniques. The new instrumentation will be located in the available space at INAF- Osservatorio Astrofisico di Catania. The requested equipment is described below and an estimation of its cost is given in brackets.

- Time of Flight Mass Spectrometer with Reflectron (350000 EUR)
- Desorption laser (200000 EUR)
- Ionization tunable laser (350000 EUR)
- Vacuum components (chambers, flanges, gates, lines, etc.) (200000 EUR)
- Vacuum pumps (Ions pumps, turbo-molecular pumps, controller, pressure gauge, etc.) (300000 EUR)
- Closed cycle Helium cryostat (T = 10-300 K) + xyz micro-positioning system (100000 EUR)
- Jet cooling source with pulsed valve (100000 EUR)

Expected results

Year 1:

Acquisition of the new instrumentation with the following priorities:

1. Vacuum chamber with low temperature facilities
2. Integration of the TOF spectrometer together with laser desorption and ionization tools

Year 2:

Set-up of the new instrumentation

Year 3:

Test of the overall system and dissemination of most relevant technical results. Particular attention will be devoted to test the detection limit of the integrated mass spectrometer through the desorption of simple ices and ice-mixtures loaded with known amount of molecular impurities and to test the consistency of the temperature. Matrix effects will also be evaluated and considered.

Year 4 and beyond

- Experiments in the new set-up with single ice components (e.g. H_2O, CO, CH_4, NH_3, CH_3OH, etc.) and "in situ" analysis of the irradiated ice.
- Experiments in the new set-up with astrophysical relevant ice mixtures and "in situ" analysis of the irradiated mixture.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	204000[1)]		186500[2)] 17500[3)]	10.8%
Formazione	35000[4)]	35000		1.8%
Consulenze scientifiche				
Altre prestazioni di terzi				
Attrezzature, strumentazioni e prodotti software	1600000	1600000		84.3%
Materiali	10000	10000		0.5%
Infrastrutture				
Spese generali	48000[5)]	48000		2.5%
Stages e missioni in Italia e all'estero	2500	2500		0.1%
Spese di pubblicizzazione				
Altri costi funzionali al progetto				
TOTALE	**1899500**	**1695500**	**204000**	

Table of costs of WP6 – First year

1. The cost of INAF and University personnel has been estimated assuming an average cost of 70kE/year and counting the man-month needed for the first year of the project (35 man months)
2. Cost of the INAF personnel (32 man months)
3. Cost of the University Personnel (3 man months)
4. Cost for 1-year postdoc for the project
5. Overheads: computed assuming ~20% of the costs, excludes instruments and materials

7.8 WP7. Options for a Green-ALMA

Responsible: L. Testi

Institute: INAF-Osservatorio Astrofisico di Arcetri

Deliverables of WP7

1. Award of a contract for the feasibility study of green energy production for the ALMA observatory (Year 1)
2. Review and acceptance of the complete feasibility study (Year 1)
3. Delivery of the feasibility study to ESO/ALMA (Year 2)

Goals of WP7

The goal of this workpackage is to award a contract to an Italian consulting company with experience in renewable energy to analyse the options for green energy production at the ALMA site.

The documentation for a call for tender for the feasibility study will be prepared and the call will be issued adhering to the Italian laws. A consulting contract will be set uop with the goal of obtaining a report on the technical and financial feasibility of producing and storing green energy for the ALMA observatory. The study will consider the geographical constraints of the observatory in northern Chile, including the requirement of supplying two sites at 2900m and 5000m altitude. A financial plan and a conceptual project plan which will include the main phases, timeline and costing for construction will be produced. The final study documents will be delivered to the appropriate bodies within ESO/ALMA and, if feasible, during the second and third year of iALMA we will try to identify the funding options to build the facility.

The timeline of the activity of this workpackage is: select the company and sign the contract within the first quarter of Year 1, complete the study in the following 9 months and deliver the reports to ESO/ALMA during Year 2 of iALMA.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	5800		5800(1)	6.1%
Formazione				
Consulenze scientifiche				
Altre prestazioni di terzi	70000(2)	70000		73.9%
Attrezzature, strumentazioni e prodotti software				
Materiali				
Infrastrutture				
Spese generali	4000(3)	4000		4.2%
Stages e missioni in Italia e all'estero	15000(4)	15000		15.8%
Spese di pubblicizzazione				
Altri costi funzionali al progetto				

TOTALE	**94800**	**89000**	**5800**	

Tabella – Detailed Costs of WP7 – year 1

1) INAF staff cost assuming an average cost of 70 kE/year. Manpower: 1 month to support the feasibility study
2) Cost foreseen for the feasibility study. The evaluation has been based on informal quotation by specialized companies considering the ALMA site and the 9 months of activity.
3) General expenses: calculated ~20% of total cost, excluding the contract for the feasibility study
4) travel expenses in Italy, Europe, and Chile for INAF personnel and external consultants.

7.9 WP8. iALMA Outreach

Responsible: F. Rea

Institute: INAF-Sede Centrale

The goal of this workpackare is to produce marterial for public outreach on the iALMA project, in synergy with the activities of the INAF Office for Public Outreach and the Education and Public Outreach of ESO.

We plan to prepare material on the on the scientific and technical objectives of iALMA, for instance broshures and "flyers" in Italian and English to be distributed to promote the project in the public at large, the national and international scientific community and funding agencies. We will also produce audio-video support material for conferences and public talks. WP8 will also be responsible for publishing the results of the project (science and technical reports, Band 2 cartridge test reports and the feasibility study for renewable energy production) in a quality that is adequate for using them to lobby funding agencies and "policy-making" bodies (at Italian, eruropean or ALMA levels).

We think that the iALMA project has a great potential both for outreach and marketing activities. Because of that we have prepared a dedicate package to be included in regular ESO and INAF outreach and communication activities. INAF has a communication central structure that coordinates a web magazine (Media INAF, the most followed in the astronomical field in Italy) and a webtv (INAFTV). Of course this structure also cover the regular activities of a central communication office: media relations, public and institutional relations, events, workshops etc… Furthermore INAF has 17 territorial structures (observatories and research centers) on the entire Italian territory. Each observatory and each research center has an educational office with a strong relation with the school department of his territory.

In this framework we would like to realize a video documentary (about 30') that will describe all the development of iALMA project. For that we plan to shoot footage in Chile, Europe and Italy. The same video could be used both for educational activities and for marketing and/or media communication. We will realize a short version of the video (3 minutes) as an advertising video.
Moreover we will realize a brochure regarding iALMA project (4 or 8 pages) that will describe the project and the possible spin offs we can obtain from it. Furthermore we will realize a dvd with a flash version of the

brochure, the videos and an interactive version of the brochure and/or a usb key with same products. Finally, we would like to realize a bag with the iALMA brand to present all these products,

We believe these multimedia products will effectively communicate the strenghts of iALMA to a wide and diversified audience.

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	70000		70000(1)	43.0%
Formazione				
Consulenze scientifiche				
Altre prestazioni di terzi	42000	42000		25.8%
Attrezzature, strumentazioni e prodotti software				
Materiali				
Infrastrutture				
Spese generali	16000	16000		9.8%
Stages e missioni in Italia e all'estero	10000	10000		6.1%
Spese di pubblicizzazione				
Altri costi funzionali al progetto	25000	25000		15.3%
TOTALE	**163000**	**93000**	**70000**	**100%**

Table – Detailed cost of WP7 – First year

1) INAF staff cost assuming an average cost of 70 kE/year (12 months)

8 Project expences

The iAMLA project is planned to be completed within four years. In terms of funding the major request is certainly during the first year when it is expected to invest money to setting up the project and experimental activities. The costs for Year 2 and Year 4 are mainly due to personnel and functional costs. During Year 3 in addition there are costs related to the fabrication of the Band 2 cartridge prototype and the cost for three additional PhD studentships. A significant fraction of the budget for the years 2, 3 and 4 will need to be secured in the coming years. The options we are pursuing at this time are to apply for a followup of the initial ESO Band 2 Study as part of the international collaboration for part of the finantial needs of the prototype development,

and to apply for followups of this project in future MIUR calls as well as other financing options withinthe framework of national and European grants.

	2014	2015	2016	2017
INAF	817	652	631	576
MIUR	3852	--	--	--
Other financial resources	86	80(1)+722(2)	80(1)+1509(2)	80(1)+571(2)
TOTAL	4755	1374	2140	1147

Table – overall cost for the four years of the project (KEuros)

NOTE.

(1) 80 kE/years for Universita' di Bologna, Cagliari and Firenze participation to iALMA

(2) 722kE, 1509kE, and 571kE for Year 2,3, and 4, are not available and needs to be found from other funding resources.

Details of the expenses during the first year (summary of all the expenses in each workpackage).

	Ammontare previsto	Fonte FOE 7%	COFIN Altre fonti di copertura	Incidenza %
Personale strutturato	828266	140000	688266	17.4%
Formazione	382750	355000	27750	8.0%
Consulenze scientifiche	5000	5000		0.1%
Altre prestazioni di terzi	237000	237000		5.0%
Attrezzature, strumentazioni e prodotti software	2670500	2503000	167500	56.2%
Materiali	30000	25000	5000	0.6%
Infrastrutture	60000	50000	10000	1.3%
Spese generali	265000	265000		5.6%
Stages e missioni in Italia e all'estero	95500	92500	3000	2.0%
Spese di pubblicizzazione	1000	1000		<1%
Altri costi funzionali al progetto	180000	178000	2000	3.8%
TOTALE	**4755016**	**3851500**	**903516**	**100%**

Table – first year total costs

Note that the publication cost is small because it only include costs for publiching on non-european journals for work in collaboration with non-european groups (from WP1). The cost of publishing in european journals are subsidized at national level and the publication costs for brochures, books etc. are handled through "Altre prestazioni di terzi" (see WP8 cost table).

8.1 Financial return

iALMA project is strictly linked to the Italian industrial production system. State-of-the-art laboratory instrumentation and software will be developed in conjunction with the Italian and/or Multinational corporations with Italian participation. The manufacturing of the Band 2 prototype will be mainly performed by Italian industries. The primary goal of the collaboration with Italian companies is the development of the technological expertise to produce the ALMA band 2 receiver looking forwards to the production of all the 73 receiver (including spares) for ALMA. In this framework, the Italian companies will be surely ready to participate at the international competition for the mass-production of the band 2 receivers. The envelope cost of an entire set of ALMA receivers is between 30 – 40 MEuros depending on the technology and frequency. Apart form scientific and technological advances, the monetary investment in the iALMA project will be soon recovered even with a fraction of the 33% of the overall cost in terms of industrial return.

Specifically for the WP4 we plan:

- To develop the passive compoments prototypes (FEED, OMT, MIRRORS) in collaboration with Italian Industries.
- To consolidate the collaboration with the Italian partners of the multinational corporations, mainly for the VNA (Vectorial Network Analyser). This is extremely important in view of the financial and technical resources optimization of the Italian Research Instituties.
- To arise the necessary expertise in design and build anechoic chamber at microwave and mm-wavelenght including absorbing material procurement.

For the WP5 the following advantages are foreseen:

- Italian companies will be involved in the upgrade of the cryofacility for receiver testing at IASFBO
- manufacturing of the amplifier box will be done by industry. This will require high precision mechanical manufacturing.
- Apart from the cryofacility upgrade, the cryofaciliy itself will be available as a multipourpose hi-tech facility to the other research institutes and companies. In this framework the upgrade will be as much as possible in a modular way to be adopted for future studies and needs.
- The update of the calibrator will be committed to Italian Companies. The expertise of the IASF-BO researchers will be then shared to industry
- The development of the ALMA band 2 cartridge prototype is certainly an important step both for the experimental and technological reasearch in Italy, and for the Industry. It will permit to trace a national roadmap to reduce the gap with the European and Extraeuropean partners in the field of microwave and mm-waves technologies.

The expertise gained during the development of iALMA band 2 receiver, can be easily used to develop other radioastronomical instrumentation. It is important to note that the microwave technologies are used in other fields such as remote sensing, observation of the atmosphere, and applications such as radars and passive imaging, security apparatus for aeroportual applications like TADAR (for example see http://www.esa.int/ita/ESA_in_your_country/Italy/Lo_spazio_per_la_sicurezza_negli_aeroporti/(print)). and for telecommunication systems.

9 State of the art and expected results

9.1 State of the art

The ALMA observatory and the Italian contribution

Presently ALMA is the most important International collaboration for an Earth-based observatory for the study of the Universe. Since the second half of the 1980's the construction of a large observatory operating at millimetre wavelengths has been a priority of Europe, North America and Japan. Achieving the scientific objectives of ALMA is a a priority in the long term plans of all these countries, in particular, for Europe, the Science Vision of Astronet and the long-term plans of all major countries (including the Long Term Plan of INAF). The main goal of ALMA is the study of our cosmic origins through the observation of the formation and evolution of stars and galaxies, and above all of the chemistry of complex organic molecules in regions of planet formation. Some of the specific scientific objectives include: the study of the formation of stars and planetary systems in our Galaxy and near our Solar system, the study of the chemistry of complex organic and pre-biotic molecules in interstellar space and in regions where planetary systems form.

Europe participates with a share of 37,5% in the construction and running of ALMA through the intergovernmental organization ESO, of which Italy is a member since 1982. The other International partners in ALMA are North America (United States and Canada; 37,5%), East-Asia (Japan and Taiwan; 37,5%) and Chile, the country that hosts the observatory. The observatory is completing the first construction phase at an altitude of 5000m in the Atacama desert in the north of Chile. This first phase foresees the completion of 66 telescopes that form ALMA and part of the instrumentation for the analysis of the radiation. Italy has made important contributions to the construction of the observatory through the participation in ESO: various research institutes of INAF were involved in the development of digital electronic correlator parts and devices for microwave receivers (Arcetri), the development of control software (Trieste) and of course in the definition of scientific objectives and specifications through participation in various work groups. With the scientific and technological participation in the project also comes a considerable return in industrial contracts for Italian high-technology companies: groups of Italian firms have obtained significant contracts (in terms of percentage of the total value of the European contribution to the project), for example for the development and construction of an antenna prototype, for the design and production of antennas built in Europe, and the design of a large fraction of the antenna stations at 5000m elevation.

One of the more important items in the annual budget of operating ALMA is the cost of fossil fuel for the generation of energy. Presently ALMA has an installation of three multi-fuel turbines to produce up to 14MW by means of burning LPG, plus several secondary diesel generators. The average mean continuous energy needs of ALMA in the operation phase is estimated to be about 5MW, with significantly higher peaks during the so-called "fast-switching" observing mode (during which the antennas are exposed to rapid accelerations to point to different sources on the sky every few seconds). The ALMA site offers considerable potential for the production of clean energy from renewable sources (solar, wind, and geothermal). The observatory intends to explore the possibility to substitute part of the production that has a high environmental impact with one of these sources in the future. Such an operation has the possibility to significantly reduce the cost of energy production in the long run and thus allows the investment of a larger part of the operational budget towards the development of the scientific capabilities. Therefore for several years the ALMA Science Advisory Committee has recommended feasibility studies to be carried out for the use of renawable energy.

Initial Science Results and the ALMA Development phase

Even though the ALMA construction phase is not yet completed, the observatory has started an initial phase of part time science operations using approximately 30% of the full capabilities, starting at the end of September 2011. The response from the international community has been overwhelming, a demonstration of the excellence level of the observatory: ALMA received proposal for observational projects for more than 10 times the available time. The very hard selection phase for the highest priority projects has been done by a committee of 50 international experts, italian researchers are principal investigators of several high profile projects(approx 10% of the European projects). The first ALMA results include the discovery of key molecules in the chemistry of life in a young proto-planetary system (ESO PR eso1234, http://www.eso.org/public/news/eso1234/), new insights on the formation mechanisms of planetary systems (ESO PR eso1216/eso1248/eso1301, http://www.eso.org/public/news/eso1216/ , http://www.eso.org/public/news/eso1248/, http://www.eso.org/public/news/eso1301/ , see also PR INAF dated 30/11/2012: http://www.media.inaf.it/2012/11/30/un-disco-inedito-per-alma/) and the enrichment with complex organic molecules and dust of the ISM during the last stages of stellar evolution (ESO PR eso1239, http://www.eso.org/public/news/eso1239/). Italian researchers have already started to obtain and publish top level scientific results in the scientific areas of the iALMA project: the study of complex organic molecules and of dust in star and planet formation regions, some of the results are shown in the figure. Additional programmes on the chemistry of deuterated molecules, complex organic molecules and protoplanetary disks are scheduled for high priority execution at the ALMA observatory during 2013.

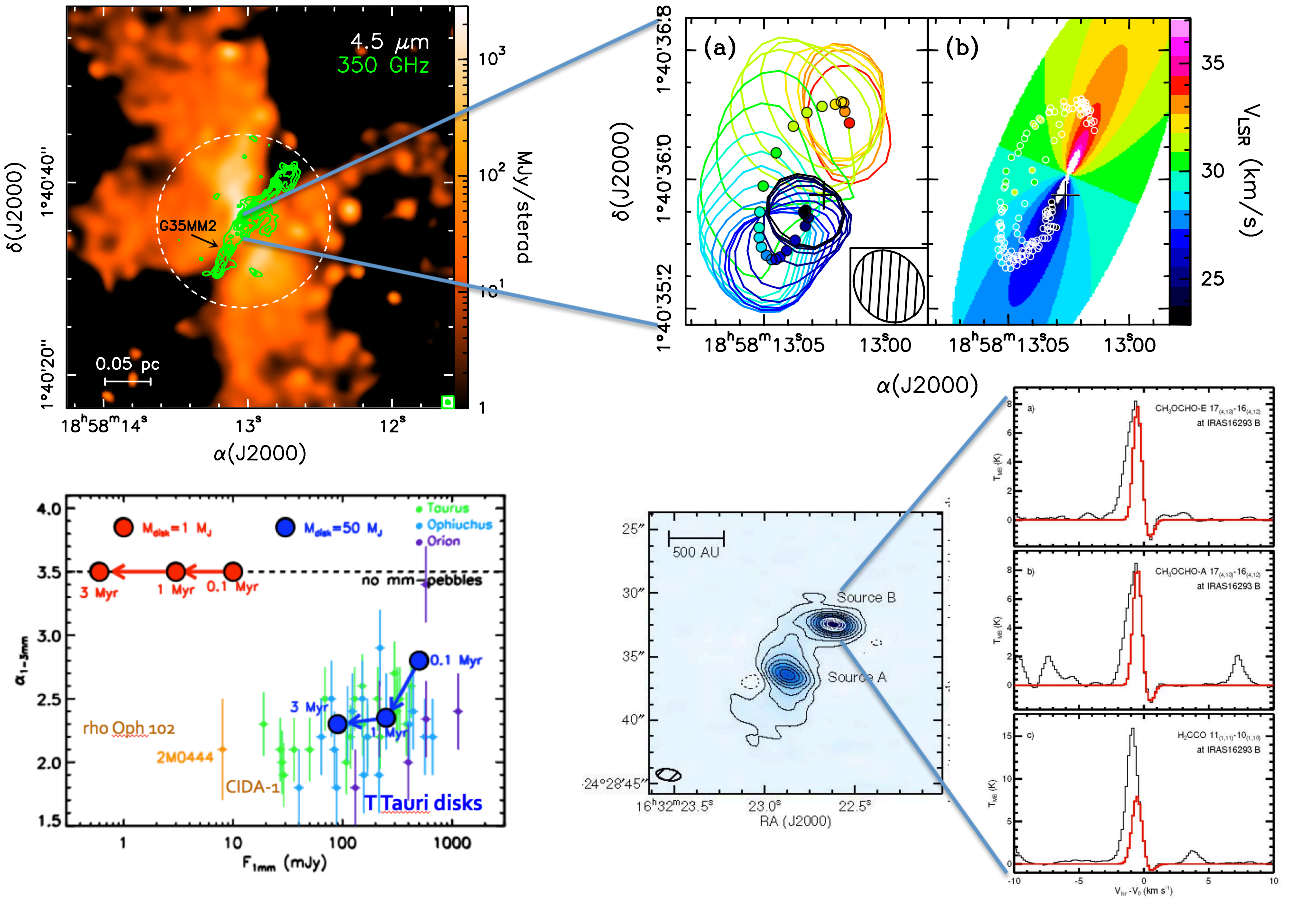


Figure 1. Examples of some of the scientific results from ALMA published by Italian groups and more closely connected with the iALMA science topics. Top: methanol (CH_3OH), metyl cianide (CH_3CN), and cianoacetylene (HC_3N) observed in the disk around a massive (prot-)star; bottom right: methyl formate (CH_3OCHO) and ketene (H_2CCO) observed in a young protoplanetary system similar thought to be a Solar analog; bottom left: evidence for the grain growth in disks around young brown dwarfs.

These initial results are already showing the huge potential of ALMA for the study of the formation and evolution of complex organic molecules in molecular clouds and planet forming regions, paving the road to the study of the chemistry of pre-biotic molecules. The impressive sensitivity of ALMA is finally allowing us to observe complex molecular species with very low abundance and yet critical for the chemistry of life. The chemical chains and processes for the formation of these molecules are yet to be understood and the laboratory experiments play a key role in this respect. The analysis of these low-abundance molecules in the laboratory requires an upgrade of the current facilities from the Raman and infrared spectroscopy techniques to time of flight mass spectrometry to measure directly the molecules produced in the samples, instead of detecting indirectly their electromagnetic emission.

The efficient and productive use of ALMA by the broad scientific community in Europe is facilitated by the essential role played by the European ALMA Regional Centre (ARC) and its seven nodes across Europe under the coordination of the central ARC node in ESO-Garching. To guarantee the full support to the Italian

community, INAF has created in 2005 an ARC-node located within the Istituto di Radioastronomia in Bologna. The nodes operate in close collaboration with each other and with the central node at ESO. Each node contributes its own specific expertise, in order to ensure that maximum advantage is taken of the European competences in the field of mm-astronomy and interferometry. The Italian ARC node has its own offices at the Istituto di Radioastronomia, with powerful computing facilities and data storage capacity; it currently employs 2 staff members and 5 post docs (including an ESO EC-FP7-Cofund fellow), experts in mm-astronomy and/or interferometry, plus one system manager. One of the principal tasks of the ARC is to support potential ALMA users with the preparation and submission of observing proposals, with the tracking of accepted ALMA projects (as Contact Scientist) up to the final data quality assessment, to provide assistance with data reduction with the Common Analysis Software Applications (CASA), with ALMA archive mining, and with handling of large datasets. The Italian ARC also develops new CASA tasks, investigates new techniques of data reduction and handling (also testing the use of GRID technology), and trains the Italian community that operates in the sub-mm and mm bands, and stimulates scientific discussion and collaborations through the organization of workshops and training schools.

As ALMA is approaching the end of construction, it is now starting the process to define the scientific priorities and the instrumental developments for the new ALMA capabilities (5-10 years period). Some of the scientific priorities have been already defined are:

- full development of polarimetric capabilities of ALMA in the very near future. The goal is to offer the full polarimetric scientific observing modes within 1-2 years.
- the capability for ALMA to work as station of the worldwide VLBI network. In collaboration with European (mainly through the MPIfR) and worldwide Institutes, INAF is involved to the ALMA Phasing Project. The goal of this project is to setup the first global VLBI commissioning observations by the end of 2014 and deliver the full system in 2015.
- the development of new receivers for ALMA in frequency bands not covered by the current hardware is encouraged. To specifically study complex organic molecules, deuterated molecules and cosmic dust, the development of new receivers in the band 67-90 GHz (band 2) is encouraged. INAF is already involved in a preliminary study carried out by an international consortium led by the Manchester University (UK) and composed by STFC, Oxford University, IRAM, and INAF.

European Industries and Research institutes may be funded directly by ESO for the manufacturing of the new ALMA receivers. Nevertheless, the fundamental R&D phase, all the activities needed to develop and test prototypes, the experimental activities in labs, the scientific case, as well as the needed expertise at the ARC nodes are expected to be funded predominantly within the individual countries (Italy in this case). All these areas are fundamental and strategic aspects for INAF and for the Italian scientific and technological community. The aim is to actively participate with principal role and responsibilities to the future ALMA hardware upgrades exploiting at the same time the ALMA scientific capabilities in an optimal way.

9.2 Expected results

Goals of this project

The main scientific goal of iALMA is to develop an integrated sceintific, technical and instrumental development strategy to allow the Italian researchers to fully use ALMA to study the chemistry of complex molecules in the initial phases of star and planet formation and to study the evolution of galaxies in the Universe. To achieve this over arching goal it is necessary to proceed on three distinct and yet very connected paths: the development of the science support for ALMA in Italy, the development of the ALMA instrumental capabilities with next generation receivers, the development in Italy of the capability to carry out the required laboratory experiments to reproduce and study the chemical processes for the production of complex molecules in interstellar ices.

- Develop the scupport for the scientific use of ALMA by the Italian community. The new scientific capabilities offered by ALMA imply the need to develop new competences also within the Italian ARC node, to support the effective and optimal use by the Italian community. With iALMA we especially target to develop the capabilities of the ARC to support polarimetric and VLBI capabilities. Measuring the polarization properties of astronomical sources is an important aspect of ALMA scientific programme, for example as a tool to measure magnetic fields and their role in the formation of stars and planets, and AGN activity. Typically the fractional polarization is quite low, perhaps only 1 or 2%, but we need to be able to measure this rather accurately. For this reason one of the most challenging ALMA technical requirements is that, after calibration, observations of an un-polarized source should show residual (instrumental) polarization of not more than 0.1%. The commissioning for this observing mode is on-going and full-Stokes parameter observations are expected to be offered starting with the next observing Cycle. Some members of the ARC have expertise in polarimetry, but to fully prepare the ARC to gain experience with the ALMA system and to support polarimetry users, it will be necessary to partecipate in the analysis of commissioning data from ALMA. For this purpose the ARC will need to support a scientist fully dedicated to the activities related to polarimetry, to work in close collaboration with other ARC nodes and the ALMA project in bringing the ALMA polarimetric capabilities into operation. Another area of expertise that we plan to develop in the ARC node is the support of mm-VLBI observations. The INAF-Istituto di Radioastronomia has long-standing experience and collaborations in the VLBI network at radio frequencies, and some members of the Italian ARC staff are themselves involved in such VLBI observations. The ARC node is thus in an excellent position to contribute to mm-VLBI with ALMA. One expert needs to be added to the ARC staff, who will be dedicated to the activities related to the ALMA VLBI.
- Development of an ALMA Band 2 prototype cartridge. The development of ALMA Band 2 receiversis essential for the study of complex and deuterated molecules in star and planet forming environments and for the study of low excitation molecular gas at intermediate redshifts ($z<2$). The detailed development of the science cases and scientific specification for the complete system are the main goals

of the SWG (WP1). An initial phase of R&D for the development of components for an new generation Band 2 ALMA receiver cartridge is being carried out under contract with ESO by an international consortium including STFC (and UK Universities), INAF (I) and IRAM (F). With iALMA we are proposing to advance this project to the next stage and start producing prototypes of the components and of the full cartridge system and to test them in the INAF laboratories in Arcetri and Bologna. The development and tests of the components and cartridges (WP4 and WP5) will be carried out in close connection with the work done as part of the WP1 for the scientific specifications, the goal is to support and increase the Italian role within the international consortium for the construction of ALMA Band 2. During the fist year of iALMA we will proceed with the purchasing and setup of the laboratory equipment and to procure the components from industries. During the second and third year the prototype will be assembled and we will test separately components as well as the full integrated system in the Arcetri and Bologna laboratories. During the third and fourth year of iALMA we will evaluate the possibility of testing on sky the receiver using the Italian radiotelescopes with the best surface accuracy: Noto or SRT. The rsults of the construction and testing of the prototype will be an important step for the definition of the final design and construction plan for the cartridge, these will form an essential part of the ALMA Band 2 production proposal that will be presented to the international consortium to ESO/ALMA for the approval as part of the ALMA Development Program (from 2018 and beyond).

- The chemistry of the complex organic molecules in the interstellar medium. More than 160 molecular species have been detected in space (an updated list is available at http://www.astrochymist.org/astrochymist_ism.html). Molecules are observed in the atmosphere of planets and satellites, on the surface of icy bodies, in comets, in the atmosphere of exo-planets and of evolved stars and in the interstellar medium. Molecular clouds are the site of star formation and complex organic molecules formed in these regions are expected to be incorporated in planets, satellites and comets frequently formed with a new star. It is generally accepted that most complex molecules form in icy grain mantles after surface reactions and as a consequence of the interaction with UV photons and low energy cosmic rays. Our knowledge on the formation and evolution of molecules in space is mainly based on experimental work. Experiments have shown that complex molecules are formed after ion and UV irradiation of icy mantles analogues. Most of these results are based on infrared (IR) spectroscopy and Raman spectroscopy. These are consolidated techniques which however have a limited sensitivity. ALMA provides astronomers with unprecedented sensitivity and resolution. This has already started to unravel the chemical composition of the molecular gas in dense clouds, to establish the role of the formation of icy grain mantles, and the re-release of these species and their 'daughter' molecules formed by surface reactions and by energetic processes as described above. As part of this project we will built up a new and original experimental set-up for advanced nonconventional interdisciplinary analysis of ices after radiolysis at low temperature in order to detect minor species formed which cannot be detected with conventional techniques. The proposed instrumentation will give us the unique opportunity to study "in situ" the complex chemistry induced in ion irradiated ice mixtures. In particular

the proposed experimental set-up is, to our knowledge, the first capable to detect molecules "in situ" by a combination of laser desorption, jet cooling and VUV-UV photo-ionization followed by high resolution mass-spectrometric analysis of ion irradiated ices. This will contribute to understand the origin of complex molecules, which were incorporated in planets, satellites and comets at the time of the formation of the Solar System and are believed to be the seeds from which life has developed on Earth. Mid-IR and Raman spectroscopy are powerful techniques but have a relatively low sensitivity to trace compounds. Indeed IR transmittance spectroscopy allows relative sensitivity not too far below 10^{-3} with respect to the abundance of the original species. For comparison, the detection sensitivity of laser desorption jet cooling molecular beam spectrometers is such that femto grams of material are sufficient for a mass-spectrometric analysis. Even by allowing a three orders of magnitude worse detection limit (1 picogram) for the proposed 'in situ' instrument, this will produce a relative sensitivity to trace compounds present in the irradiated ice down to 10^{-7} (mass abundance) with respect the abundance of the original species. These sensitivities will allow quantitative comparisons with the abundance ratios of the various species as measured in the interstellar space with ALMA. The detailed description of the proposed instrument setup is described as part of WP6.

- Feasibility study for green energy production for ALMA. One of the objectives of iALMA is to involve the national industries working in the green energy market to perform a feasibility study for the production of renewable energy for ALMA. The first year we will contract a consultancy enterprise with competence in this market to carry out a detailed feasibility study that will include an analysis of the possible technical solutions, the cost and timeline and the main phases for the implementation of a production and accumulation facility at the ALMA site, considering the peculiarity (altitude, geographical location, energy consumption profile etc.) of the observatory. Based on the outcome of the feasibility study we may investigate the possibility to present the project to ESO/ALMA for approval of a detail design and implementation phase. One possible activity in this area would be to seek external sources for funding, applying for specific infrastructure development funding.

Closely connected to the sceintific and technological objectives of iALMA are: advanced training, dissemination of the results in the scientific community and in the public at large, and the close relationship with Italian industries. Advanced training is ensured by the very strong connection between the INAF institutes and the Universities of Bologna, Catania and Firenze, professors from all these universitites are partners of iALMA. The publication of the scientific and technical results of iALMA in the scientific and technical community will be achieved following the normal practices of publication of research articles on international refereed journals and presentations at international conferences. iALMA participants have a long standing and widely recognized track record in publishing and presenting their results, as shown by the large number of publications in journals with high impact factor and also by the large number of invited contributions to conferences and invitations for talks and colloquia in international institutes. The advanced training activities are discussed in detail as part of the description of WP2 and are mainly focused to the training of PhD students and Master level students. We will

finance six PhD students as part of iALMA, three starting the first year of the project and three starting the third year, while lecture series will be prepared and delivered for the master students. During the third year of the project we will organize a series of lectures for PhD students on iALMA topics as part of the Scuola Nazionale di Astrofisica "F. Lucchin". We are also planning a series of activities targeted to high school students to promote their interest in the technological and scientific areas of iALMA for their future studies. The strong synergy between iALMA and the public outreach office of INAF (WP8) is designed to prepare and disseminate high quality outreach material on iALMA in the public as well as the funding agencies and the "policy-making" bodies (e.g. Ministers, European Community, ESO/ALMA).

10 Products and evaluation criteria of project achievements

iALMA foresees the release of detailed annual reports that track the project status. These reports will be reviewed by the External Advisory Board (EAB) as a part of the data pack for the evaluation of the project achievements and status. EAB will report on the annual reviews creating one of the important independent method of evaluation for both the intermediate and final results of the project. These EAB reports are indeed useful tools for INAF and MIUR to track the project.
Moreover iALMA will produce documentation, tools, instrumentation, and laboratory analyses to be evaluated directly. For each project areas and for each year, a list of the expected product and criteria is reported hereafter.

The table reports the products of the Science, Training, and Support activities (WP1, WP2, WP3) over the four years of the project.

	Products and evaluation criteria		
	WP1	WP2	WP3
Year 1	1. Documentation: Italian scientific case for ALMA band 2 (including simulations of observations) 2. Documentation: list of scientific specifications of ALMA band 2 in agreement with the scientific case 3. Pubblication of observations of deuterate species and complex molecules with Herschel and ALMA (and other mm-wave telescopes), and publications on the evolution of the interstellar medium. 4. meeting organization with SWG and other International partners	1. PhD fellowship at the Universities involved in iALMA. 2. Series of Lectures on iALMA for undergraduate Master students	1. Acquiring scientific and technical expertise in mm-VLBI through the hiring of a qualified postdoctoral fellow and the development of observing programs 2. Expanding competences in polarimetry by participation in ALMA CSV activities; the organization of a workshop with experts; reduction of polarimetric data; hiring of qualified postdoctoral fellow.
Year 2	1. Publication of scientific data alalyses using ALMA and comparison with laboratory experiments.	1. Open day organization dedicated to Laboratories 3. Series of Lectures on iALMA for undergraduate Master students	1. Consolidation of expertise with calibration and support to mm-VLBI through development of observing programs.

			2. Consolidation of expertise in polarimetry through participation in ALMA CSV and the development of observing programs. 3. Development and testing of CASA procedures for reduction of ALMA polarimetric data.
Year 3	1. Scientific plan for the "on-sky" verification of cartridge band 2 prototype using NOTO or SRT INAF radiotelescopes. 2. Pubblication of first results and comparison of data with laboratory experiments.	1. Organization of a iALMA related course at the Scuola Nazionale di Astrofisica (National School in Astrophysics) 2. PhD fellowship on iALMA 3. Series of Lectures on iALMA for undergraduate Master students	1. Development of competences in mm-VLBI with ALMA through participation in ALMA CSV activities. 2. Consolidation of competences in calibration, and support to mm-VLBI and polarimetry with ALMA by development of observing programs. 3. Support activity to Italian and European ALMA users in the field of polarimetry.
Year 4	1. Documentation: detailed plan for the scientific use of the ALMA band 2 (ALMA Band 2 Use Cases and Design Reference Science Plan projects) 2. Organization of the international conference with the aim to divulgate the scientific results of iALMA	1. Series of Lectures on iALMA for undergraduate Master students	1. Support activity to Italian and European ALMA users in the field of polarimetry and mm-VLBI.

For the WP4 and WP5 the status of the project are controlled on the basis of the planned reviews related to milestones. For such experimental activity the product to be verified are related to the prototypes. The criteria are mainly driven by the operation of the prototypes. Moreover we should add the hardware–related activities such as design phases and upgrades of laboratories.

	Products and evaluation criteria	
	WP4	WP5
Year 1	1. Evaluation of passive components designs and agreement with specifications 2. Development status and completion of upgrade of the anechoic chamber and related laboratory instrumentation	1. Design and manufacturing report of the calibrator 2. Integration plan and verification procedures for the engineering model (EM) 3. Status of the radiometer bias and signal acquisition electronics for the EM 4. Status of the cryofacility upgrade and related laboratory
Year 2	1. Passive components manufacturing and verification test report	1. Engineering model integration and test report
Year 3	1. Passive compoment development and manufacturing activity final report	1. Satus report of the ALMA band 2 cartridge prototype
Year 4	ALMA band 2 prototype development Final Report and first linght implementation study	

The products and evaluation criteria for the WP6 are listed in the following table:

	Product and evaluation criteria
	WP6
Year 1	1. Procurement of the thermal-vacuum chamber 2. TOF spectrometer integration with ionization instrumentation and laser desorption
Year 2	1. Finalization of the experimental setup
Year 3	1. Commissioning and test of the integrated laboratory 2. TOF spectrometer calibration using simple ice and ice-mixture with known amount of impurities. 3. Publication of innovative technical results
Year 4	1. Experiments with single ice compoments (e.g. H_2O, CO, CH_4, NH_3, CH_3OH, etc.) 2. Analyses "in situ" of astrophysical relevant ice mixtures

For the WP7-Green ALMA, an important evaluation criterion is the issue of a feasibility report for the green energy production and storage at the ALMA Observatory. This report is foreseen at the end of the first year of iALMA. Then the activity of WP7 will continue or will be ended, depending on the results of this feasibility study

The main products of the entire iALMA project are listed hereafter:

	Product and evaluation criteria
	iALMA
Year 1	1. Acquisition of all the foreseen personnel and 3 PhD selection 2. Procurement of the labs instrumentations and receiver components 3. Finalization of the documentation related to the ALMA band 2 scientific objectives and specification 4. Finalization of the feasibilty study of the ALMA green-energy 5. Organization of workshop on ALMA polarimetry 6. Participation to the CSV and collaboration to the mm-VLBI activities
Year 2	1. Finalization of Catania's lab experimental setup 2. Manufacturing and test of the sub-units of the band 2 radiometer engineering model 3. Open day devoted to laboratries
Year 3	1. Calibration and early experiments at the Catania Laboratory 2. Assembling and test of the sub-units of the ALMA band 2 cartridge 3. Organization of the National School in Astrophysics on iALMA 4. 3 PhD selection on iALMA
Year 4	1. Experiments and analyses 'in situ' of Astrophysical relevant ice mixture at the Catania Laboratory 2. Test 'on-sky' of the receiver using Italian radiotelescopes 3. Organization of an International Conference on iALMA

11 List of scientific publications of the participants

Here we list the main scientific publications in the period 2010-2013 for the participants in iALMA (Coordinator and workpackage leaders)

TESTI Leonardo – Refereed Journals publication list 2010-2013

1. Longmore, S. N., Bally, J., Testi, L., Purcell, C. R., Walsh, A. J., Bressert, E., Pestalozzi, M., Molinari, S., Ott, J., Cortese, L., Battersby, C., Murray, N., Lee, E., Kruijssen, J. M. D., Schisano, E., & Elia, D. 2013, Variations in the Galactic star formation rate and density thresholds for star formation, MNRAS 429, 987

2. Ricci, L., Isella, A., Carpenter, J. M., & Testi, L. 2013, CARMA Interferometric Observations of 2MASS J044427+2512: The First Spatially Resolved Observations of Thermal Emission of a Brown Dwarf Disk, ApJL 764, L27

3. Sánchez-Monge, Á., Beltrán, M. T., Cesaroni, R., Fontani, F., Brand, J., Molinari, S., Testi, L., & Burton, M. 2013, Different evolutionary stages in massive star formation. Centimeter continuum and H₂O maser emission with ATCA, A&A 550, A21

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5. Rygl, K. L. J., Benedettini, M., Schisano, E., Elia, D., Molinari, S., Pezzuto, S., André, Ph., Bernard, J. P., White, G. J., Polychroni, D., Bontemps, S., Cox, N. L. J., Di Francesco, J., Facchini, A., Fallscheer, C., di Giorgio, A. M., Hennemann, M., Hill, T., Könyves, V., Minier, V., Motte, F., Nguyen-Luong, Q., Peretto, N., Pestalozzi, M., Sadavoy, S., Schneider, N., Spinoglio, L., Testi, L., & Ward-Thompson, D. 2013, Recent star formation in the Lupus clouds as seen by Herschel, A&A 549, L1

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9. Pezzuto, S., Elia, D., Schisano, E., Strafella, F., Di Francesco, J., Sadavoy, S., André, P., Benedettini, M., Bernard, J. P., di Giorgio, A. M., Facchini, A., Hennemann, M., Hill, T., Könyves, V., Molinari, S., Motte, F., Nguyen-Luong, Q., Peretto, N., Pestalozzi, M., Polychroni, D., Rygl, K. L. J., Saraceno, P., Schneider, N., Spinoglio, L., Testi, L., Ward-Thompson, D., & White, G. J. 2012, Herschel observations of B1-bS and B1-bN: two first hydrostatic core candidates in the Perseus star-forming cloud, A&A 547, A54

10. Bressert, E., Ginsburg, A., Bally, J., Battersby, C., Longmore, S., & Testi, L. 2012, How to Find Young Massive Cluster Progenitors, ApJL 758, L28

11. de Juan Ovelar, M., Kruijssen, J. M. D., Bressert, E., Testi, L., Bastian, N., & Cánovas, H. 2012, Can habitable planets form in clustered environments?, A&A 546, L1

12. Robberto, M., Spina, L., Da Rio, N., Apai, D., Pascucci, I., Ricci, L., Goddi, C., Testi, L., Palla, F., & Bacciotti, F. 2012, An HST Imaging Survey of Low-mass Stars in the Chamaeleon I Star-forming Region, AJ 144, 83

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17. Tackenberg, J., Beuther, H., Henning, T., Schuller, F., Wienen, M., Motte, F., Wyrowski, F., Bontemps, S., Bronfman, L., Menten, K., Testi, L., & Lefloch, B. 2012, Search for starless clumps in the ATLASGAL survey, A&A 540, A113

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