The AMICA (Antarctic Multiband Infrared Camera) Project

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ABSTRACT

The Antarctic Plateau offers unique opportunities for ground-based Infrared Astronomy. AMICA (Antarctic Multiband Infrared CAmera) is an instrument designed to perform astronomical imaging from Dome-C in the near- (1 – 5 μm) and mid- (5 – 27 μm) infrared wavelength regions. The camera consists of two channels, equipped with a Raytheon InSb 256 array detector and a DRS MF-128 Si:As IBC array detector, cryocooled at 35 and 7 K respectively. Cryogenic devices will move a filter wheel and a flipping mirror, used to feed alternatively the two detectors. Fast control and readout, synchronized with the chopping secondary mirror of the telescope, will be required because of the large background expected at these wavelengths, especially beyond 10 μm. An environmental control system is needed to ensure the correct start-up, shut-down and housekeeping of the camera. The main technical challenge is represented by the extreme environmental conditions of Dome C (T~ -70 °C, p~640 mbar) and the need for a complete automatization of the overall system. AMICA will be mounted at the Nasmyth focus of the 80 cm IRAIT telescope and will perform survey-mode automatic observations of selected regions of the Southern sky. The first goal will be a direct estimate of the observational quality of this new highly promising site for Infrared Astronomy. In addition, IRAIT, equipped with AMICA, is expected to provide a significant improvement in the knowledge of fundamental astrophysical processes, such as the late stages of stellar evolution (especially AGB and post-AGB stars) and the star formation.

Keywords: Antarctica, Dome C, infrared camera, near-infrared, mid-infrared

1. INTRODUCTION

The potential of Antarctic Plateau sites for infrared astronomy has been recognized by several authors since many years (see for example Harper 1989; Bailey 1996; Burton et al. 2000; Storey et al. 2003). Because of the high elevation and the very low temperatures, indeed, the atmospheric water vapour content is very reduced and the light absorption and thermal emission of the atmosphere are significantly lower than in temperate sites. The first measurements of the near- and mid-infrared sky brightness, performed at the South Pole (Chamberlain et al. 2000), showed that the infrared sky is at least one order of magnitude darker than in temperate ground-based sites and the atmospheric transmission windows are wider and clearer. Basing upon these data, Lawrence (2004) modelled the atmospheric properties at Dome C (75°06' S, 123° 23' E, 3250 m) and found that even better observing conditions should have been expected. They can be summarized as follows:

- extremely reduced sky emissivity with respect to temperate sites: down to 40 times lower in the 3 – 5 μm region, and at least 20 times lower beyond 5 μm;

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- availability of new atmospheric windows, especially beyond 15 μm, inaccessible from any other ground-based temperate site;
- high stability of the atmospheric windows.

Recent measurements of the sky brightness between 2 and 14 μm at Dome C confirmed these predictions. In particular, the high stability of the atmospheric windows was measured: during five days of clear sky on 2004, the sky flux showed a variation of only 10% in the 11 μm N-band (Walden et al. 2005).

Not only the atmospheric background, but also the instrumental one is dramatically reduced by the efficient passive cooling at the temperatures of Dome C. With respect to a temperate high-altitude site (T~0 °C), the thermal emission of an instrument at Dome C is reduced to less than 60% at -35 °C (summer) and to about 20% at -90 °C (winter).

In conclusion, the sensitivity of an infrared telescope at Dome C is expected uncomparably higher than that of the same telescope in a temperate site. Such a comparison has been made by the NSWU Group (Burton et al. 2005), who showed that a 2-m class telescope at Dome C has the same sensitivity of a temperate 8-m class telescope at Mauna Kea in the 2 – 25 μm wavelength range.

Installing an infrared telescope at Dome C is not without costs and risks, however. The extreme environmental conditions responsible for the excellent observing circumstances require a special care in the choice of the instrumental components and in the maintenance of the operating conditions. Moreover, since observing people cannot stay at Dome C for long time, especially during winter, automatic operations are needed. Therefore a robotic instrumental setup, optimized for these extreme environments, has to be thought for Dome-C.

IRAIT (International Robotic Antarctic Infrared Telescope) is a 0.8-m aperture, f / 21.65 Cassegrain telescope especially designed to operate on the Antarctic Plateau (Tosti et al., this conference). It is provided with a wobbling secondary mirror to perform focussing, dithering (for near-infrared observations) and fast chopping (for mid-infrared observations), and a plane tertiary mirror to alternatively feed two Nasmyth foci. IRAIT has an alt-azimuth mount. It will be installed at Dome C on November 2007 and will operate in robotic mode. According to Burton et al. (2005), IRAIT is expected to have the same sensitivity of a 3-m class telescope in a temperate site.

AMICA (Antarctic Multiband Infrared CAmera) is a fully italian project aimed to build a camera for near- and mid-infrared astronomy (2 – 28 μm wavelength range) at Dome C. The camera will be finally operating on the IRAIT telescope since November 2007, and will be the main focal plane instrument for this telescope.

The various subsystems of AMICA are described in some detail in the rest of this paper. Like for the telescope, the main technical challenge for AMICA is represented by the extreme environmental conditions of Dome C, especially if the complexity of the instrument is taken into account. AMICA will host two detectors kept at 7 and 35 K by a two-stage closed-cycle cryocooler, plus cryogenic moving optics, and will be provided with fast control electronics to perform, in a completely automatic mode, readout at the typical frame rates of mid-infrared astronomy (up to 3 Msamples). Moreover, a widely sparse system of sensors and switches must perform a continuous monitoring of the working conditions in order to ensure the correct execution of automatic (unmanned) operations. Most of these subsystems are being developed to account for the extreme conditions like the very low temperature (as in the case of the coldhead, the proximity electronics and the environmental control system) or the reduced pressure that prevents an efficient thermal dissipation by warmed devices (as in the case of almost all the electronics).

AMICA will be the first european instrument to perform near- and mid-infrared photometric observations from the Antarctic Plateau. It is primarily expected to demonstrate the unique possibilities offered to ground-based astronomy from Antarctic high-elevation sites, for future extremely large telescopes. However, also astronomical data of unprecedented quality at near- and mid-infrared wavelengths are expected to be provided by this pioneering instrument.

2. AMICA DETECTORS

AMICA is provided with two devices for light detection in the near- and the mid-infrared spectral region, respectively.

The so-called Short-Wavelength Array (SWA) is a Raytheon CRC-463 InSb 256 × 256 array detector, sensitive to radiation in the 2 – 5.5 μm band. In this range of wavelengths, the quantum efficiency is larger than 0.8. This detector exhibits a charge capacity of about $2 \cdot 10^5$ e^-, depending on the applied bias voltage. The readout is performed via 4 output channels, with a typical readout noise of about 50 e^-. The dark current rate, measured at 35 K operating temperature, is not exceeding 3 e^-/s. The pixel pitch is 30 μm.

The Long-Wavelength Array (LWA) is a DRS Technologies MF-128 Si:As 128 × 128 array detector, sensitive to radiation in the 7 – 25 μm band. The quantum efficiency is typically in the 0.4 – 0.6 range, dropping below 0.4 at wavelengths longer than 27 μm. The charge capacity, around 10^7 e^-, is typical of a moderate-flux detector: it was preferred to a high-flux detector for the reduced readout noise levels (not exceeding 500 e^-). The choice was made possible by the low background expected at Dome C, that will allow to use such a detector even for low-resolution imaging (see Sect. 3). The readout is performed via 4 output channels at a high frame rate (up to 500 s^{-1} nominal, 1000 s^{-1} overclocked). The array can be operated in either a single- or multiple-sample mode: in addition, "destructive" or "non-destructive" readout schemes can be implemented in the multiple-sample mode. Typical values of the dark current rate at 10 K operating temperature (and 1.5 V applied bias voltage) are about $7 \cdot 10^5$ e^-/s. The pixel pitch is 75 μm.

Each detector will be mounted in such a way to be easily replaced with a bare multiplexer for test and optical alignment purposes. The mounting pcb is shown in Figure 1. The socket, manufactured by Wells-CTI, is being modified to reduce the volume and to allow for safe mounting at cryogenic temperatures.

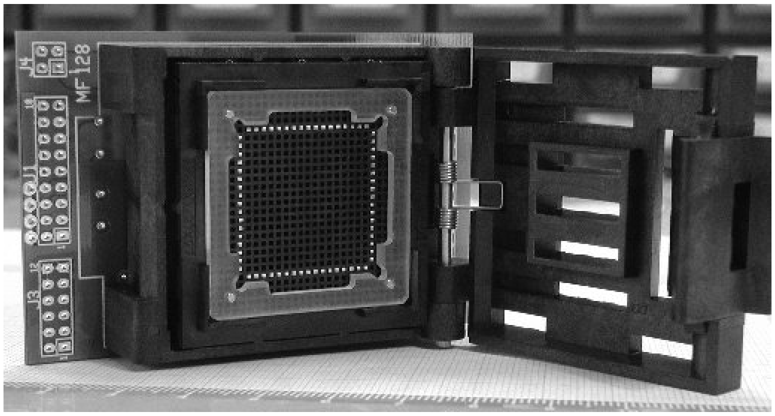

Fig. 1. A picture of the array detector mounting pcb with the socket manufactured by Wells-CTI, before its modifications.

3. AMICA OPTICS

A single optical system has been adopted to alternatively feed the two arrays. Given the broad wavelength range of operation, a fully reflective scheme has been designed. The ony refractive elements are the entrance window and the filters. The optical bench, the mirrors and their mounts, the cold stop and the filter wheel will made of the same material, namely the aluminum alloy Al 6061 T1: this will ensure a homologous contraction between mounting room temperature and the operating temperature (35 K), thus preserving the internal optical alignment of the camera. This principle has already been successfully used in other instrument (see for example Pel et al. 2000).

3.1 Optical layout

The optical layout is shown in Figure 2. It is composed by two off-axis parabolic mirrors, which act as collimator and camera, plus two plane mirrors: the first one is a fixed 45° mirror placed after the entrance window, aimed to fold the optical path thus reducing the occupied space; the second one is 45° sliding mirror, that will feed the SWA when inserted. Given the small aperture of the IRAIT telescope and the long wavelength range of operation, indeed, the performances are diffraction-limited. The effective focal length is 11500 mm, which corresponds to a demagnification of the telescope natural scale of 1:1.47. This choice has been made to get the largest possible Field-Of-View (FOV) while performing and adequate sampling of the Airy PSF. With the pixel pitch reported in Sect. 2, a plate scale of 0.538 arcsec/pix and 1.345 arcsec/pix is achieved on the SWA and LWA, respectively: this implies an optimal sampling (4 pixels) of the Airy disc at 3.42 and 8.54 μm and a total FOV of 2.29 × 2.29 arcmin^2 for the SWA and 2.86 × 2.86 arcmin^2 for the LWA.

All the mirrors are gold-coated in order to ensure the best reflectivity (larger than 98 %) over the whole wavelength range of operation. The entrance window, made of CdTe, provides a transmission higher than 70% in the 1 – 25 μm range. A cold stop is located on the exit pupil.

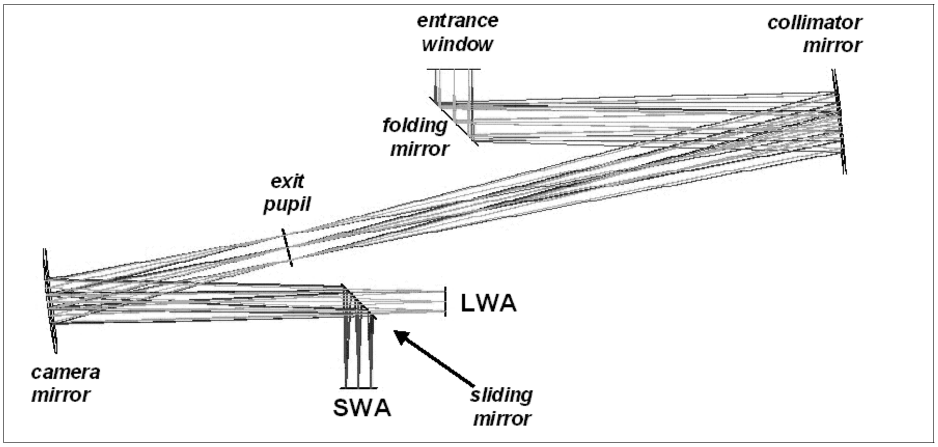

Fig. 2. AMICA optical layout

3.2 Filters

A filter wheel has been designed to host up to 11 filters (plus one empty position) having 1” diameter and 0.875” clear aperture. Given the unique properties of the site described in Sect. 1, a new set of broad-band filters has been defined (Valentini et al., this conference). The set consists of seven filters covering the whole wavelength range 2 – 28 μm: their properties are shown in Table 1. The filters where defined in such a way to produce the maximum signal-to-noise ratio with the minimum detected flux, taking into account the atmospheric windows at Dome C, their stability and the sky and instrumental thermal emission. An additional constraint during the computation of the filter set was represented by the need to keep the corresponding photometric system as close as possible to the standard KLMNQ system (i.e. to obtain small color terms in the transformation between these two photometric systems), in such a way to reduce as much as possible absolute calibration errors.

Toggling mirror

Up to 4 narrow-band filters (10% width) are still to be defined. They will be selected after a careful analysis of the spectral features of major interest in the wavelength range of operation, according to the final AMICA scientific program.

The filters will most likely be manufactured by Barr Associates, Inc. The materials used vary according to the wavelength interval covered by each filter. Short-wavelength filters (*KLM*) will likely be made of Barium or Calcium Fluoride; intermediate filters (N_1, N_2) could be made of Germanium or Zinc Selenide; finally, long-wavelength filters (Q_1, Q_2) will probably be made of CdTe. The expected average transmission for each filter is around 0.7 .

Band	**# 1** *(K)*	**# 2** *(L)*	**# 3** *(M)*	**# 4** *(N1)*	**# 5** *(N2)*	**# 6** *(Q1)*	**# 7** *(Q2)*
λ_C (μm)	2.33	3.67	5.04	8.77	11.60	18.86	22.41
Δλ (μm)	0.35	0.40	0.40	1.0	3.3	3.6	1.95

Table 1. AMICA broad-band filters basic data

4. AMICA CRYOSTAT

The dewar, of rectangular shape (25×46×30 cm^3) with an additional cylindrical section (14 cm diameter, 29 cm height) for the cryocooler coldhead, is being manufactured by IRLabs Inc. Preliminary drawings are shown in Figure 3. All the optics and mounts, the array mounts, and the cold worksurface will be made of the same material (Al 6061 T1). Because of the compactness of the optical design, however, a custom design was required for several components, such as the filter wheel assembly and the mechanism for the sliding mirror. Cryogenic stepper motors will be used to rotate the filter wheel and to insert and remove the sliding mirror. The head of the cryogenic refrigerator is mounted perpendicularly to the cold worksurface. Due to orientation contraints of the coldhead, the whole system will work in reverse position.

The whole optical system, including the motors, will be kept at the same temperature of the SWA detector, namely 35 K. The LWA detector will have to be cooled down to 7 K: for this reason the LWA mount, fixed to the cold worksurface, will be thermally insulated via a G-10 layer. Ten diode sensors provided by Lakeshore Inc. will continuously monitor the temperature inside the cryostat. Microheaters placed near the two detectors will keep the operating temperatures within 0.05 K.

Thanks to the very low temperatures, the thermal inputs on the cryostat are very reduced with respect to a temperate site: about one half during summer and one fifth in winter. This is an important advantage in the choice of the cooling system. Severe constraints are put by the environmental conditions and the site location, however. The cryostat will have to be vacuum-sealed with indium wire, whose performances are known down to cryogenic temperatures. Standard O-ring seals freeze out at ~ -30 °C and should fail under the conditions of Dome C.

As to the cryogenic cooling, an open cycle system cannot be an option. Closed-cycle systems have to be used at Dome C, which can efficiently work at its extreme conditions. Moreover, due to logistic requirements, the power consumption has to be reduced as much as possible. The cooling system finally proposed for the AMICA cryostat is a two-stage cryocooler manufactured by Advanced Research Systems, Inc. It is a Gifford-McMahon displex cooler that can provide up to 0.6 W refrigerating power at 7 K with a power consumption not exceeding 3.5 kW and very small vibration amplitudes on the coldhead. Pulse-tube coolers were another possible choice, mainly for the absence of moving parts: however, their power consumption is significantly larger (at least 7 kW).

A study of the cryocooler major components is in progress to check their functionality at the conditions of Dome C. The sealings on the coldhead will be made of indium, as for the cryostat. Heaters will be integrated into the coldhead areas where the Antarctic temperatures are a concern, like the cold tip and the valve motor. Winterization of the compressor is a more complex issue, and it has been proposed simply to keep it warm during operation. The limited power consumption has a crucial importance for the removal of the excess heat from the compressor. Due to mechanical design constraints on the IRAIT telescope structure, a derotating system for the helium flexlines cannot be implemented. The compressor must therefore be installed on the telescope and its refrigerating fluid pipeline has to be derotated. The refrigerating fluid currently chosen is glycole, but a study is in progress to use the cold air of Dome C. In both cases, thanks to the low power consumption, the refrigerating flow will be largely acceptable. Mounting the compressor on the telescope has the additional disadvantage to transmit large vibrations to its whole structure. In oder to minimize this effect, a highly-customized dampening system is currently under study.

Vacuum levels inside the cryostat are expected to be around 10^{-7} torr. The maintenance of the vacuum level and its emergency restoring in case of failure will be ensured by a vacuum pumping system permanently connected to the cryostat, that will be turned on when necessary. While the vacuum pump will be placed in a thermally controlled rack (see Sect. 7) and connected through a pipe to the cryostat, the final electromagnetic valve (necessary to remotely open or close the system) will be exposed to the same environmental conditions of the cryostat. A local warming of this valve is necessary, which however could inject thermal radiation inside the cryostat, seen by the detectors as straylight. In order to avoid this problem, a light trapping maze is being designed. The vacuum level will be indirectly monitored via the temperatures measured inside the cryostat.

Proximity electronics, attached to the cryostat in correspondence of the six electrical feedthroughs, will be exposed to the Dome C temperature too. In order to ensure its functionality, mostly passive components will be used, which can work at very low temperatures, while local microheaters are foreseen for the few active elements.

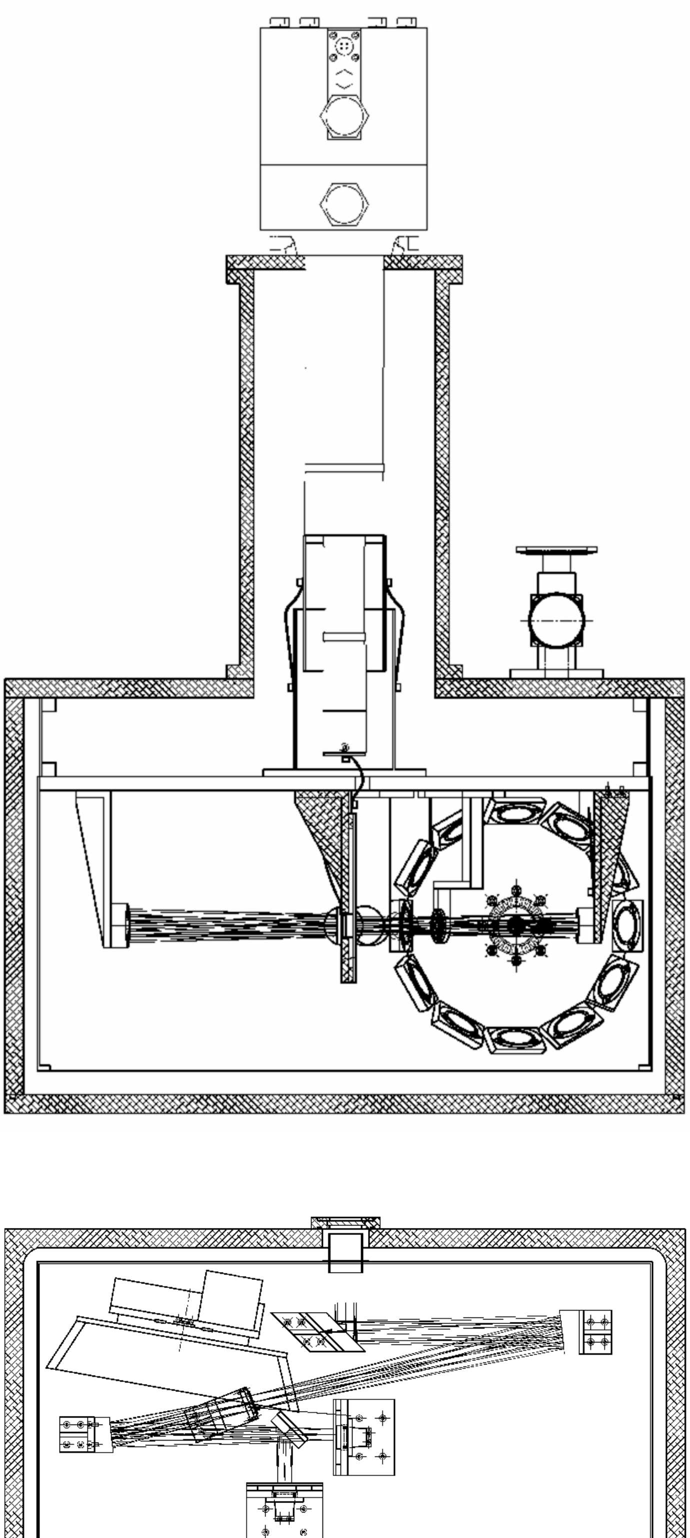

Fig. 3. Preliminary design of the AMICA cryostat

5. AMICA ELECTRONICS

The AMICA hardware electronics is composed by two basic packages: the Detectors Controller and the Environment Monitor.

5.1 Detectors Controller

The controller of the two detectors is described in detail by Bortoletto et al. (this conference). Generally speaking, it is composed by the following subsystems:

- a host-computer interface;
- a communication link between host and detector subsystem;
- a digital programmable sequencer;
- a clock programmable generator;
- two preamplifiers (one per detector);
- a unit for analog signal processing and analog-to-digital conversion.

These subsystems are distributed over two units of the instrument package: a “local unit”, near the host computer, and a “remote unit”, attached to the cryostat and directly connected to the detectors. The two units are interconnected by a high throughput (1.2 Gbaud) digital link on optical fiber cable having the following capabilities:

- transmission of clock sequences and commands (local to remote);
- transmission of data and telemetry (remote to local).

The sequence of operations is as follows. The host computer, an industrial Pentium 4 mobile CPCI-based, generates the digital clock sequences and sends them to the digital programmable sequencer and the clock programmable generator in the local unit. Analog clocks and biases are then generated and sent to the remote unit via the fast link.

The remote unit includes two pairs (one per detector) of clock and bias+preamp boards (see Figure 4), plus controllers for the temperature sensors, the heaters and the cryogenic motors inside the dewar. Once the detector (SWA or LWA, according to the position of the sliding mirror) is read out, the analog sequence is processed by the preamplifier in the remote unit and the output signals are sent back to the local unit.

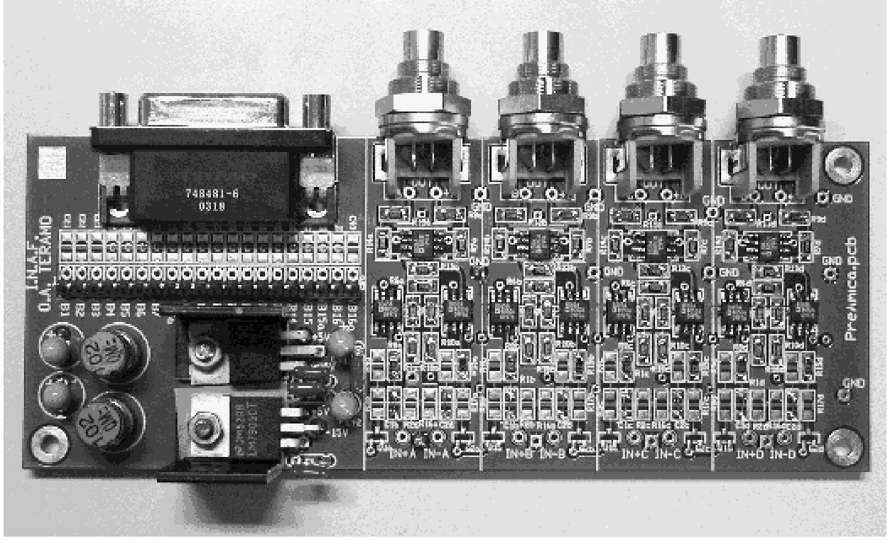

Fig. 4. The bias + preamp winterized board. It is expected to work at the temperatures of Dome C (down to -90 °C).

A fast analog-to-digital conversion is made in the local unit (at a rate up to 3 MHz) and the final data are stored memory. The local unit includes also a fast programmable gate array (FPGA) for real-time algebraic preprocessing of data (coadding of chop images, object/sky subtraction, etc.). The stored and preprocessed data are finally sent to the CPCI for further data processing (such as, for example, recentering and/or derotation before coaddition of sequences) and storing as fits images.

During the whole process, the remote unit controller sends also TTL triggers to the telescope secondary mirror for focussing, dithering or fast chopping.

The clock and bias+preamp boards are designed with ony passive elements, in order to work attached to the cryostat, at the very low temperature of Dome C. However, due to the very high frame rate, clocks are sent in differential mode by the local unit to the remote one, and received and reconstructed free of noise and distortion by a opto-electronic device. This elements is a not passive one, and will be locally warmed by a microheater in order to properly work at low temperature.

5.2 Environment Monitor

This package is described in detail by Di Rico et al. (this conference). It is based on a sparse set of thirty-three PT100 temperature sensors, one relative humidity gauge, heaters and fans, controlled by the host computer and a programmable logic controller (PLC). A general scheme of the power connections is shown in Figure 5. The aim of the Environment Monitor is to continuously control the operating conditions of the whole instrument, namely: the relative humidity inside the AMICA rack (see Sect. 7), the temperature of each component inside the rack, the vacuum level and the temperatures measured inside the cryostat. In case of failure of the operating conditions (i.e. if they are measured outside the range of operability for at least one component), corresponding correcting actions are started. If, for example, a generalized temperature increase is measured inside the cryostat while the cryocooler is running, thus indicating a vacuum failure, then the cryocooler is stopped, the vacuum pumping system is started and, once the pressure in the vacuum pipeline is low enough, the electromagnetic vacuum valve is finally opened. As another example, if the temperature of a componentn inside the rack is too low or too high, then a heater or a fan is switched on, respectively, until the temperature is within the acceptable range.

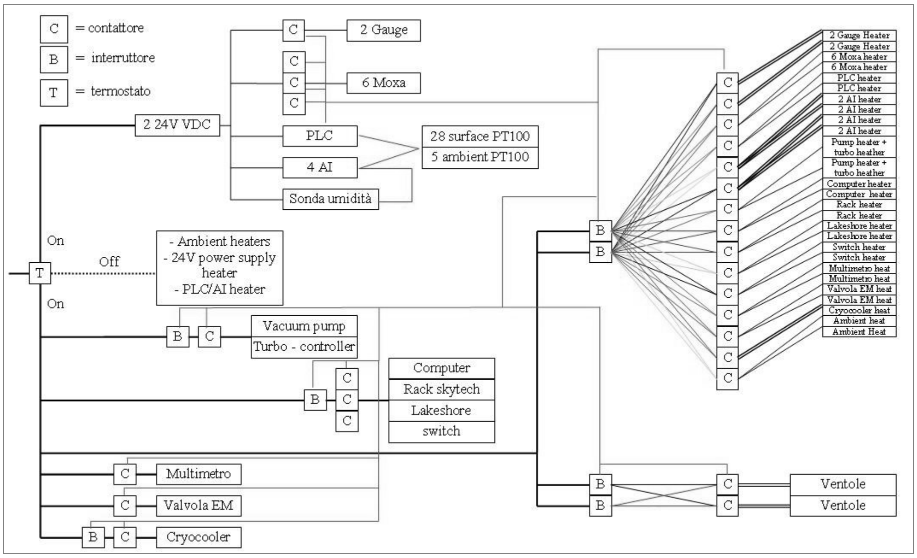

Fig. 5. General power connection scheme for the AMICA Environment Monitor

The PLC has 32 and 16 analog inputs and outputs respectively, and 24 and 16 digital inputs and outputs respectively. It will be responsible for the following general actions:

1) maintenance of the storage temperature for each component when the system is turned off;
2) warming of each component up to the minimum working temperature before starting the whole system;
3) start-up of the whole system in the correct order;
4) maintenance of the operating temperature for each component while the system is running;

5) shut-down of the whole system in the correct order;

6) return to point (1).

The PLC will also be interfaced with the IRAIT telescope's PLC. The complete telemetry of the system will be periodically written on a log file by the host computer.

AMICA is connected to a 3-phases power supply. Each segment of the power network is protected by circuit breakers to avoid a too high current absorption. In case of break events, the PLC forces a motor to turn on the breakers again.

6. AMICA CONTROL SOFTWARE (ACS)

A detailed description of the AMICA software architecture is given in Di Rico et al. (this conference). Here only the general philosophy is summarized.

A modular architecture has been conceived, that allows to implement the ACS in the more general Observatory Control Software (OCS, see Tosti et al., this conference). The OCS includes two indipendent modules: the ACS and the Telescope Control System (TCS). Like the TCS for the telescope, the ACS acts as a (camera) server application for the OCS.

The ACS is composed, in turn, by independent modules (threads) for the management of the basic AMICA subsystems, as follows:

- the Detector Control Software, which controls the camera acquisitions;
- the Chopper Control Software, which manages the exchange of information between the AMICA system and the IRAIT secondary mirror system;
- the Environment Control Software, which manages the CPCI and the PLC for the monitoring of the operating conditions and the restoring actions in case of failure (see Sect. 5).

This multithreading architecture, shown in Figure 6, has important advantages: it makes the developers' work easier, minimizes the realization time and simplifies the ACS operation.

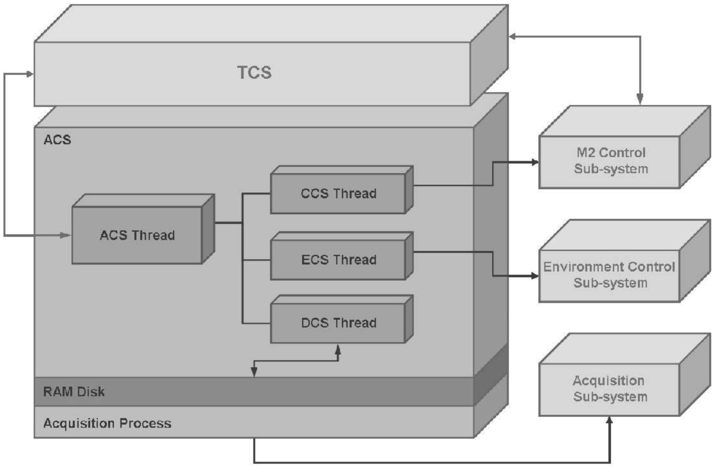

Fig. 6. The multithreading architecture of the AMICA control software (ACS)

The ACS is being designed using an Object Oriented approach. The starting point has been the definition of the scientific use cases. These allowed to define the different packages. The related libraries are under development.

7. AMICA RACK AND TELESCOPE INTERFACE

As already mentioned in the previous sections, many subsystems of AMICA will be hosted inside a thermally controlled rack. It will be composed by two cabinets.

The lower cabinet will host the cryocompressor and its vibration dampening device. All the remaining components (main electrical board, vacuum pumping system, control electronics local unit) will be hosted inside the upper cabinet. This cabinet, in particular, will have a central hole shaped in such a way the cryostat can be inserted there before mounting the rack to the telescope.

Indeed, due to the extreme conditions, even "normal" operations at the telescope are very difficult and their number should be minimized. For this reason, the whole rack will be assembled inside a "warm" tent (T~0 °C) before being mounted to the telescope: in particular, the cryostat will be inserted into the central hole where it will be allowed to slide along two rails.

The rack will then be moved to the telescope and mounted there. Finally, the cryostat will be attached to the telescope by simply sliding along the rails until a predefined position will be reached. No fine adjustments will be needed. The AMICA optical tolerance is indeed large enough that the mechanical coupling alone, within the mechanical tolerances, can provide the desired optical alignment.

The upper and lower cabinets walls will be thermally insulated with an insulating layer about 7 cm thick. Moreover, the upper cabinet will be provided with fans to be activated in case of overheating of the devices hosted therein. Such a device will not be needed for the lower cabinet, where the cryocompressor will be provided with its own refrigerating glycole- or air-based system.

All the cables will begin and end inside the rack, thus rotating with the telescope. Only two final connections will come out: the power supply (a 3-phase 380 V) and the data connection. These two cables will connect the AMICA rack to the IRAIT rack placed on the telescope floor (see Tosti et al., this conference). They will corotate with the azimuth rotation of the telescope, while a derotating chain will ensure their integrity during telescope elevation.

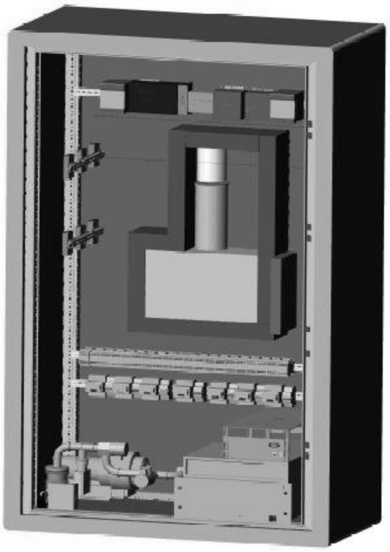

Fig. 7. Preliminary design of the AMICA rack (upper cabinet). The cryostat, with the cylindrical coldhead, is visible at the center.

A preliminary design of the AMICA rack, based on commercially available components, is shown in Figure 7. The rack is conceived in such a way that in case of severe failures it can be dismounted from the telescope and moved back to the tent for repair and maintenance. However, such a schedule cannot be applied during winter, because of the forced stop of all cranes and related devices (Malagoli, private communication). A modular design is therefore under development, with the aim to produce a rack composed by several small, indipendent, sub-racks that are light enough to be moved by a slide.

8. AMICA SCIENCE

AMICA is an instrument primarily intended to show the unique astronomical properties of the Dome C site up to 28 μm. Site testing at Dome C has already been undertaken up to 20 μm (Walden et al. 2005) and a significant amount of new data are expected from AMICA. But AMICA is expected also to provide astronomical data of fundamental importance.

Starting from the data available in literature (Chamberlain et al. 2000, Lawrence 2004) simulations of the AMICA expected performances were started. Preliminary results are shown in Figure 8 for some major photometric bands (L,M,N_1 and Q_2). The curves are referred to different values of the expected signal-to-noise ratio (30,10,5,3,1). The sky background magnitude is also shown for comparison.

For comparison, the simulations were performed also for the same instrument at a temperate site. A significant improvement of the performances is resulting at Dome C, as expected. The limiting performances are at least 4 magnitudes deeper in the near-infrared, and 2 magnitudes deeper in the mid-infrared.

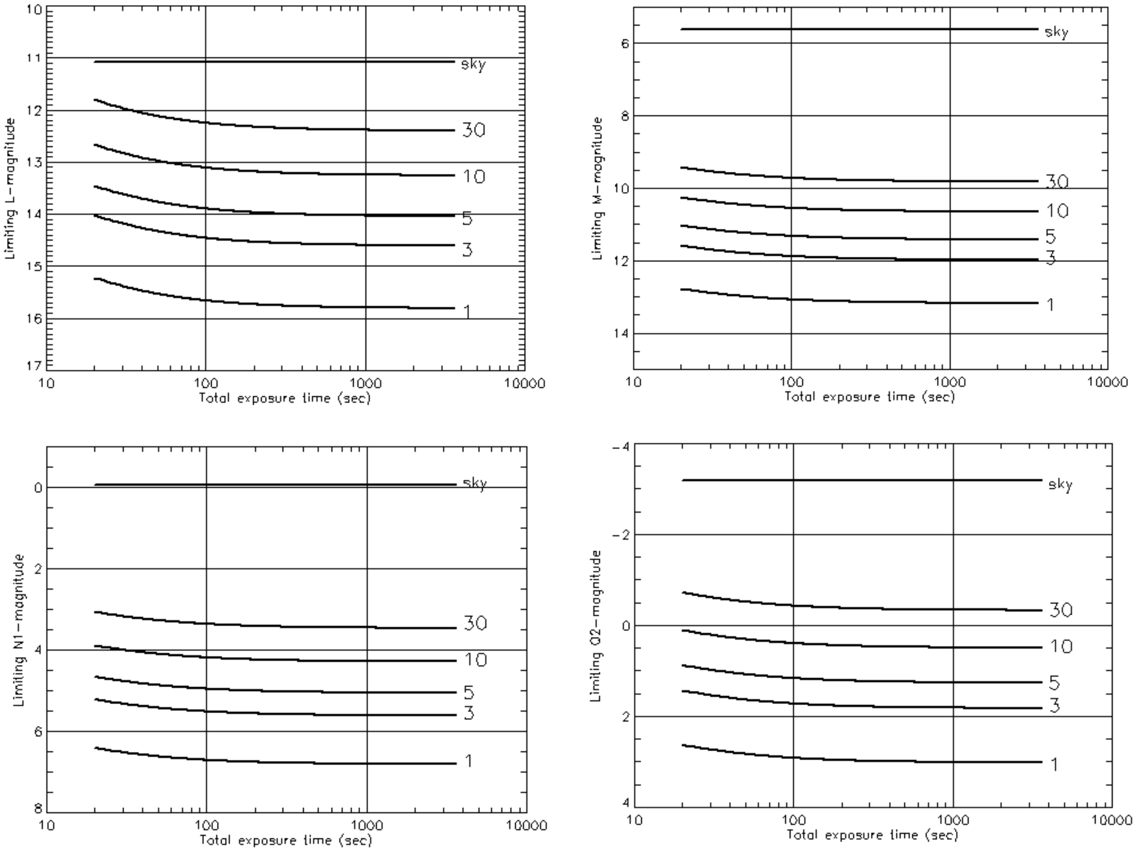

Fig. 8. Expected IRAIT+AMICA performances in four major photometric bands (L,M,N_1,Q_2). Curves are referred to values of signal-to-noise ratio equal to 30,10,5,3 and 1 (NEP).

Several nearby infrared astronomical targets have apparent magnitudes in the range covered by IRAIT+AMICA, such as for example late-type stars or star formation regions in the Milky Way (MW), the Magellanic Clouds (MC) or nearby Dwarf Spheroidal Galaxies (DSG). All these targets are also close enough to be well observed even with the low spatial resolution of AMICA. On the contrary, the relatively large field-of-view offered by this instrument allows to schedule infrared surveys of selected regions of the southern sky.

A possible list of scientific programs is as follows:

- study of the late stages of stellar evolution characterized by a significant mass-loss, such as AGB and post-AGB stars, in MW, in MC and nearby DSG;

- 2 – 28 μm multiband tomography of star formation regions in MW and MC;
- characterization of solar system bodies (mainly minor bodies, but also Jupiter and Saturn);
- detection of Hot Jupiters orbiting around cool stars (e.g. M-type stars);
- costruction of near-infrared (especially L bands) lightcurves for pulsating variables, especially RR-Lyrae stars;
- near-infrared (K,L,M) study of the extinction in MW and nearby galaxies.

A final important remark is concerning the observations length. The Dome C site position is such that a large portion of the sky is always visible. Moreover, a very high duty-cycle has been measured during the past campaigns. Finally, at wavelengths longer typically than 4 μm there is no difference between daytime and nighttime. In conclusion, AMICA is expected to continuously perform observations in automatic mode and therefore to produce a large amount of data. The reduction pipeline for the AMICA data is also under development.

REFERENCES

Bailey, J. 1996: PASA 13, 7B

Bortoletto et al., this conference

Burton, M. G., Storey, J. W., Ashley, M. C. 2000: SPIE Proceedings 4005, 326B

Burton, M. G., Lawrence, J. S., Ashley, M. C. B., Bailey, J. A., Blake, C., Bedding, T. R., Bland-Hawtorn, J., Bond, I. A., Glazebrook, K., Hidas, M. G., Lewis, G., Longmore, S. N., Maddison, S. T., Mattila, S., Minier, V., Ryder, S. D., Sharp, R., Smith, C. H., Storey, J. W. V., Tinney, C. G., Tuthill, P., Walsh, A. J., Walsh, W., Whiting, M., Wong, T., Woods, D., Yock, P. C. M. 2005: PASA 22, 199

Chamberlain, M. A., Ashley, M. C. B., Burton, M. G., Phillips, A., Storey, J. W. V., Harper, D. A. 2000: ApJ 535, 501

Di Rico et al., this conference

Harper, D. A. 1989: in “Astrophysics in Antarctica” (A92-22401 07-89). New York, American Institute of Physics, 1989, p. 123.

Lawrence, J. S. 2004: PASA 116, 482L

Pel, J.-W., Glazenborg-Kluttig, A. W., de Haas, J. C., Hanenburg, H., Lenzen, R., 2000: SPIE Proceedings 4006, 164

Storey, J. W. V., Ashley, M. C. B., Lawrence, J. S., Burton, M. G. 2003: Mem. SAIt Supplement 2, 13S

Tosti et al., this conference

Valentini et al., this conference

Walden, V. P., Town, M. S., Halter, B., Storey, J. W. V. 2005: PASP 117, 300