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IRAIT project: future mid-IR operations at Dome C during summer

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Abstract. The project IRAIT consists of a robotic mid-infrared telescope that will be hosted at Dome C in the Italian-French Concordia station on the Antarctic Plateau. The telescope was built in collaboration with the PNRA (sectors *Technology* and *Earth-Sun Interaction and Astrophysics*). Its focal plane instrumentation is a mid-infrared Camera (5-25 μm), based on the TIRCAM II prototype, which is the result of a join effort between Institutes of CNR and INAF. International collaborations with French and Spanish Institutes for the construction of a near infrared spectrographic camera have also been started. We present the status of the project and the ongoing developments that will make possible to start infrared observations at Dome C during the summer Antarctic campaign 2005-2006.

Key words. Antarctica — infrared:general — telescopes — site testing — surveys — infrared: stars

1. Introduction

The Dome C site (Zucchelli 2003; Candidi & Lori 2003), at 3200m above sea level, on the Antarctic Plateau, jointly exploited by Italian and French teams in the framework of the Concordia project, presents exceptional cold and dry sky conditions. Site testing campaigns have been performed during the last years in summer time, and compared to other Antarctic sites (Chamberlain et al. 2000; Hidas et al. 2000; Valenziano & Dall'Oglio 1999; Storey 1998). New data extended to winter time in the period 2002-2003 are now coming from a reduced version of the Australian AASTO system (AASTINO[1] Storey 2003; Calisse et al. 2003). Data collected so far points towards Dome C being the best place known on Earth for high quality low-sky-background observations in the mid-infrared. The Plateau is characterized by an high sky transparency, low levels of equivalent precipitated water and aerosols, low sky emissivity and low temperature. Optimistic expectations on the sky con-

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[1] www.phys.unsw.edu.au/~mcba/aastino containing also real-time sky condition at Dome-C

Fig. 1. IRAIT at the Coloti Observatory operated by University of Perugia. This 0.8m telescope was built in collaboration with the Italian Programma Nazionale di Ricerche in Antartide (PNRA), sectors *Technology* and *Earth-Sun Interaction and Astrophysics.*

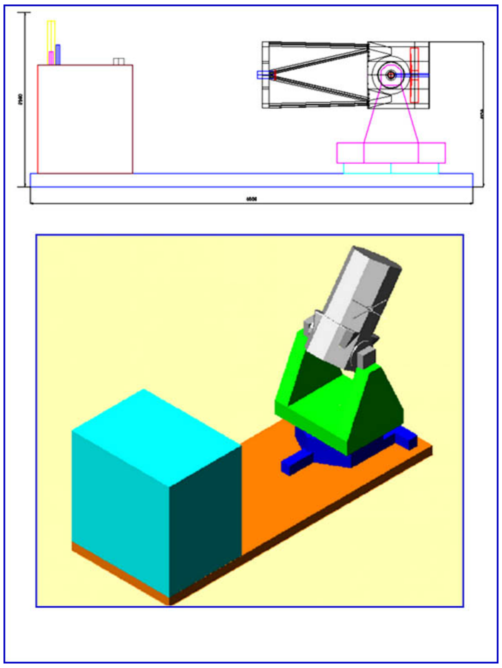

Fig. 2. Concept drawing of the IRAIT telescope in the standard ISO 20 container (credits: G. Nucciarelli.

ditions foresee that new windows may be opened in the spectral region between 20 and 40 μm, and that the 5-25 μm windows may be broader, more stable and less affected by absorption and emission than in any other place on Earth. Subarcsec seeing conditions, allow diffraction limited imaging (at least at near and mid-IR wavelengths) without complex optics. A moderate size telescope on the Antarctic Plateau can be as powerful as an instrument of much bigger size operating elsewhere in temperate sites. For an estimation of the mid-infrared performances of IRAIT at Dome C see Fiorucci et al. (2003).

The project consists of a fully robotic 0.8m telescope (built in collaboration with the Italian PNRA[2]), a mid-IR Camera (5-25 μm), and possible nearIR Camera (1.2-5 μm) for imaging and spectroscopy (Epchtein 2003; Abia 2003). The planned operating mode at Dome C will be double: a whole year observations (long-term plan) and summer campaigns (short-term plan). In this view the IRAIT first light is expected in December 2005.

Many open problems in star formation, late stages of stellar evolution, planetary physics and extragalactic astronomy would obtain large benefits from a mid-IR observatory in Dome C, with access to those exotic windows.

2. The Telescope

The telescope built for this research is a f/20 reflector, with a 0.8m parabolic primary mirror and a rigid alt-az mount (Fig. 1).

The original optical configuration was Cassegrain-like with a wobbling secondary mirror suitable for the specific techniques of IR observations (Fig. 3). The telescope is presently installed at Coloti[3], an observational facility of the University of Perugia

[2] `www.pnra.it`

[3] `wwwospg.pg.infn.it`

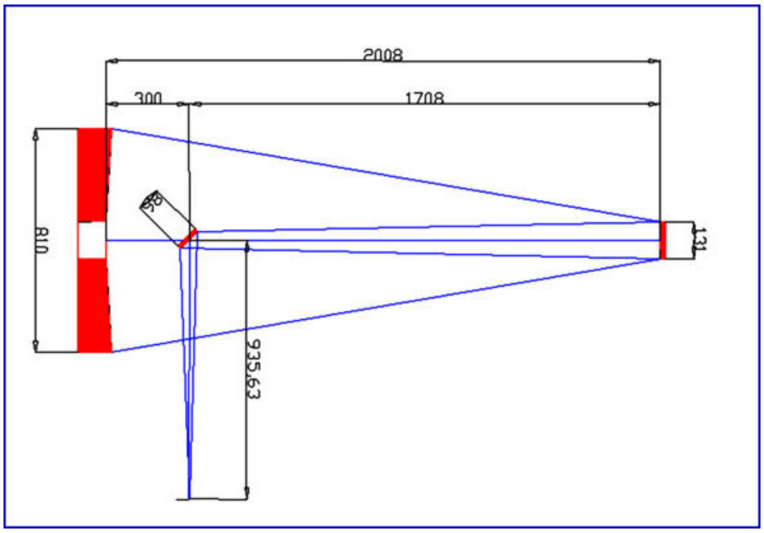

Fig. 3. The new optical scheme: a classical Cassegrain plus Nasmyth focus. The primary mirror diameter is 800 mm, the focal ratio of the primary 3, the total focal ratio 20, the telescope scale 12.89 ("/mm) (credits: C. Pernechele & G. Nucciarelli).

(Italy), where we are performing tests for manual and remote controlled operations. A full description of the telescope and its control system (hardware and software) can be found in (Tosti et al. 2003; Busso et al. 2002).

In order to be in operation at Dome C in 2005 and taking into account of the limited available budget, we are now updating the original project introducing some modifications in the optical configuration of the telescope in some mechanical components and in the control system. These changes will give us the possibility of pre-assembling the telescope and all the auxiliary devices (weather stations, communication system electronics etc.) in a single standard ISO 20 container (Fig. 2). This ensures an easy transportation, storage and installation of the telescope at Dome C, and reduces the total cost with the respect to the original plan (for the long-term plan and whole year operations structure, see e.g. Gasparoni et al. 2003).

3. The mid-infrared camera

The mid-IR Camera is designed to operate with the Boeing (ex-Rockwell) high-flux Si:As 128x128-pixel Focal Plane Array (FPA) for ground based, high background observations. The pixel size is 75μm. These detectors can operate with high quantum efficiency in the range 5 - 27 μm. So far we acquired experience in operating with such device using the He-cooled dewar and the acquisition electronics of the TIRCAM (TIRgo InfraRed CAMera) camera (Persi et al. 1994) in its latest upgrade (TIRCAM II, see Persi et al. 2001).

The camera will be equipped with a demagnification optical system, designed to obtain the best compromise between spatial resolution and optimal sampling of the source images. Antarctic environment requires robotic and remotely controlled operations for the telescope and its instrumentation, and imposes accurate insulation for all the equipment not working in warm rooms. A full description of the ongoing work on the front-end electronics and on

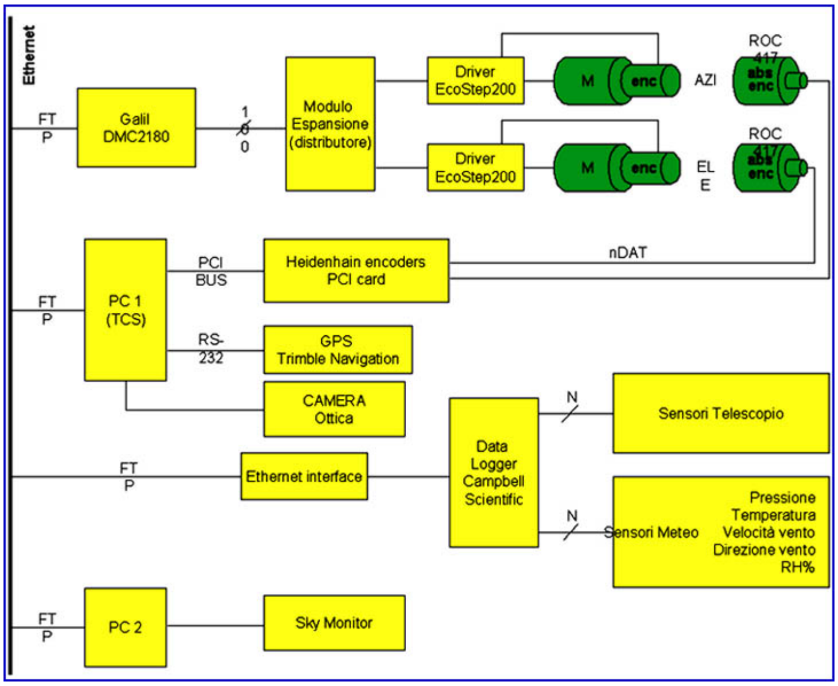

Fig. 4. IRAIT telescope control system.

the control software of the camera can be found in (Corcione et al. 2003).

4. Objectives for the summer operations

Interesting scientific targets are possible with an infrared observatory in Antarctica. Obviously only a limited part of them can be achieved with an 80cm telescope but, after a comparative analysis of the past and other future infrared projects, we are confident that even a moderate-size telescope will provide significant results in many fields (see for a report of the scientific aims of IRAIT Tosti et al. 2003; Busso et al. 2002).

Our short-term plan should permit to have a first light for IRAIT at Dome-C in the Antarctic summer of 2005-2006. So this should be the first mid-IR telescope to be operative at this wavelengths in the Antarctica Plateau, giving important information about what it's really possible to observe at this frequencies at Dome C, even in the worse sky conditions of the summer. This first phase could be seen as a sort of pilot site-testing at mid-infrared regimes. But even in this phase it is possible to perform science. For the mid-IR performances of the telescope plus camera system see Fiorucci et al. (2003). Relatively bright stars obvious are the best targets. For example the red Galactic objects related to star formation and late stages of stellar evolution. Mid-IR observations are useful to investigate the relation between stellar fluxes and the interstellar matter (ISM). Examples are surveys of mass losing evolved stars (AGB) (Abia 2003; Ciprini & Busso 2003a), surveys of dense ISM regions and star formation regions (Persi 2003), surveys to look

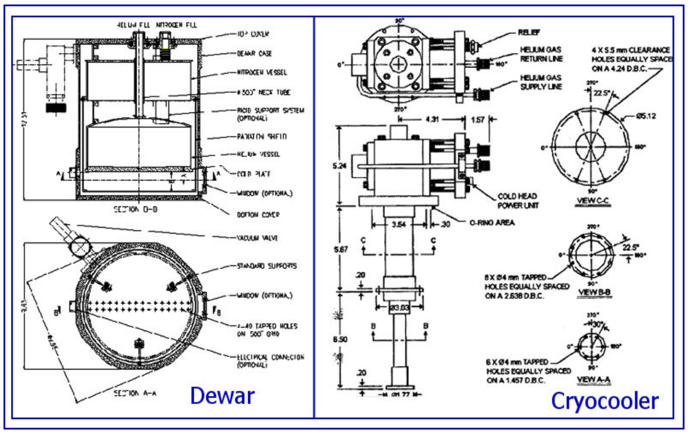

Fig. 5. Two possibility for the mid-IR Camera: a Dewar or a cryocooler.

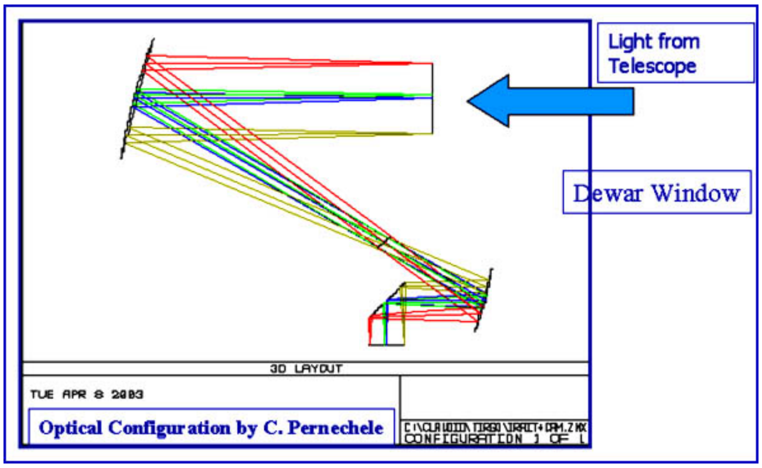

Fig. 6. The cold optical system of the mid-IR camera. This will be equipped with a demagnification system, designed to obtain the best compromise between spatial resolution and optimal sampling of the source images (credits: C. Pernechele).

for intrinsically cool objects, brown dwarfs, dwarf novae (Spogli & Fiorucci 2003) and giant planets (Dolci et al. 2003). In the full operational (winter) phase IRAIT will be able also to perform variability studies with repeated observations and monitoring of selected targets and regions of the sky. It should achieve extragalactic objects (sample of galaxies at low redshift accessible for color studies, star formations bursts, IR bright galaxies, as well and moreover, about 30-40 known souther blazars reachable (Tosti et al. 2003; Ciprini et al. 2003b).

5. Conclusions

In order to make the telescope fully compatible with the Dome C climatic condition, we shall now implement a series of upgrades to the existing telescope (optimizing thermal characteristics, insulating exposed parts etc.). We shall also finish and interface the IR camera. In the mean time we have pursued the creation of an international network for exploiting IRAIT also as a test bench for future, larger projects for astronomy at Dome C. There is a plan for transforming IRAIT into an Italian-French-Spanish telescope, according to which a second camera, for shorter wavelengths(1.2 - 5 μm) might be provided by a French-Spanish project. We thus hope that our relatively small instrument can become one of the starting points for building a modern infrared international observatory at Dome C.

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