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The IR facility of Campo Imperatore

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Abstract. The AZT-24 telescope is currently the most advanced telescope working at the Campo Imperatore Observatory and the only one with infrared instrumentation available on the italian soil. It is a 1.1m Ritchey-Cretien telescope equipped with a near infrared camera ($1 \div 2.5\ \mu m$) with the standard broad band filters (J,H,K,K'), some narrow band filters and grisms for low resolution spectroscopy. AZT-24 is controlled by an automatic software that allows remote operations and makes easier the survey programs by performing unattended observations on sequences of targets. At Campo Imperatore, AZT-24 is joined by an optical instrument, the Schmidt telescope, that widens the wavelength coverage accessible from one single site from 0.35 to 2.5 μm. The most relevant scientific results obtained during the two years of operation will be shortly illustrated.

Key words. automatic telescope – NIR camera

1. The Campo Imperatore Site

The Campo Imperatore Observatory (see Fig.1) is located at 2150 m a.s.l. on the Gran Sasso D'Italia mountain in the middle of Italy. It is reachable during all the year and has a 2Mbit/s permanent Internet connection and a guest house with 8 beds available for the visiting astronomers.
The weather statistics claim a 70% of clear sky nights during summer and about 30% during winter. The mean seeing is $1.5 \div 2.0$ $arcsec$, but values as good as 0.8 $arcsec$ have been measured. The typical sky brightness is reported in Table 1.

Johnson band	brightness
V	21.4 $mag/arcsec^2$
J	15.5 $mag/arcsec^2$
K	11.5 $mag/arcsec^2$

Table 1. Typical sky brightness at the Campo Imperatore Observatory

2. The AZT-24 Telescope

The AZT-24 (see Fig. 2) is a 1.1 m Ritchey-Cretien telescope having a focal ratio of $f/7.2$ and a corrected field of view of 20×20 $arcmin$. Its tracking strategy is based on an encoder closed loop system without any star tracker: this system guarantees more than 10 minutes of tracking without any visible image stretching.
The focal plane of the AZT-24 is occupied by the SWIRCAM NIR camera (D'Alessio et al. 2000). This is a 256×256 PicNic array $40\mu m\, pixels$ produced by Rockwell and cooled using liquid nitrogen. SWIRCAM mounts the standard broad band Johnson filters (J, H, K and K'), some narrow

Fig. 1. The Campo Imperatore Observatory

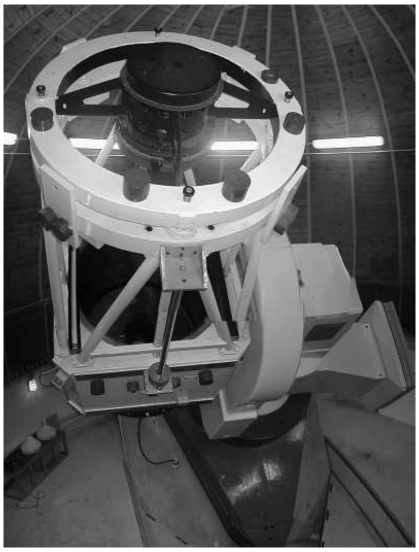

Fig. 2. The AZT-24 telescope

band filters ($FeII$, HeI, $H2$ and $Br\gamma$) and low resolution ($\sim$ 300) grisms for spectroscopy. The quality of the array is quite good with very few bad pixels (less than 100) and sensitivity flatness better than 40%. Other relevant parameters are the readout noise of 30 e^-, the gain of 5.9 e^-/DN and the dark current lower than 1 e^-/sec.
The image sampling is adequate to the mean seeing conditions of the site and is 1.04 $arcsec/pixel$ with a field of view of $4.4 \times 4.4\, arcmin$. The performances of the whole system at the sky are summarized in Table 2.

Johnson band	limiting magnitude
J	17.7 mag
H	16.9 mag
K	16.2 mag

Table 2. SWIRCAM performances at the AZT-24 telescope on point-like sources with 1 $minute$ of exposure at $S/N = 3$ and with a seeing of 2 $arcsec$

2.1. The AZT-24 Control System

MASTER (Di Paola et al. 2000a) is the client-server software that allows the AZT-24 system control both for scientific and technological activities.
The relevant features of MASTER are:

- Server side
  - complete management of the whole system from one single PC
  - modular architecture to control all the hardware devices

  - intensive use of multithreading and multitasking to optimize performances
  - images and data archive management (through a mySQL server accessible on the WEB)
- Client side:
  - handling of list of targets, each one with its own observational recipe, to allow automatic operations
  - online interactive control of the system
  - online and off-line schedule management
  - automation of frequent operations (dithering, sky images acquisition, ...)
  - automatic prereduction of the acquired images

The typical hardware configuration required to run MASTER is constituted by three PCs on a network. Of the three, the most important is the one physically connected to the hardware since it controls all the devices, it is the one running MASTER Server. The second PC is the one running MASTER Client, it may be substituted by the MASTER Server PC, but because the latter is usually located into the dome, its use may be not comfortable for the astronomer. The last PC is the one maintaining the general images archive and supplying services such as the images database engine, the WEB site, the meteo service etc. Also these tasks may be performed by the MASTER Server PC. Definitely the system can be run even on one single PC, this feature makes the architecture more fault tolerant and very inexpensive.

2.2. The Campo Imperatore Reduction Pipeline

PREPROCESS (Di Paola 2000b), the pipeline used at Campo Imperatore is available under the GPL license on many platforms among which: Linux, AIX, Windows and OS/2 (http://www.mporzio.astro.it /cimperatore/software.html).

Fig. 3. The Schmidt telescope

By editing an ASCII configuration file the user selects the image files to be processed and the operations to be performed. Allowed operations include:

- bias, dark, sky and bad pixels removal
- flat-fielding
- recentering of the images obtained from dithering using sources visible on the images themselves
- combination of recentered images through median, average with or without wings clipping, sum or difference
- convolution and smoothing
- distortion correction using the drizzling technique

All the configuration operations required by PREPROCESS can be automatically performed by the telescope control software (MASTER Client), which is able to launch the automatic reduction of the images as soon as their acquisition is completed.
PREPROCESS is able to process 5 images obtained by SWIRCAM with the related skies and flat field in less than 4 seconds on a 1.33GHz Athlon PC.

3. The Schmidt Telescope

The Schmidt telescope (see Fig. 3) has 60/90/180 cm $f/3$ optics and recently re-

newed control and pointing systems. It features an encoder closed loop tracking system without any star tracker: this system guarantees more than 5 minutes of tracking without any visible image stretching.
ROSI, the Schmidt CCD camera (Pedichini et al. 2000), is equipped with a 2048×2048 $13.5 \mu m$ *pixels* array produced by Marconi Applied Technologies (ex EEV). It is cooled using liquid nitrogen to $-90\,°C$ to lower dark current to less than $3\,e^{-}/min$. The camera is equipped with the standard optical Johnson filters and shows a $4.7 e^{-}$ read-out noise when read in 40 seconds.
The system sampling is 1.5 *arcsec/pixel* and the field of view of about 51×51 *arcmin* has an absolute distortion lower than 1 *pixel* at the border. The limiting magnitude with 1*minute* exposure and seeing of 2 *arcsec* in the V band is about 21.0 *mag*.

4. The Activities

The observing time on the AZT-24 telescope is shared between many projects: the SWIRT project for Supernovae detection and follow-up (Brocato & Dolci 2001), the Gamma-Ray Bursts follow-up (Speziali et al. 2000)(Antonelli et al. 2001) and many minor programs devoted to the study of IR variability and micro-variability, star formation and solar system minor bodies.
The AZT-24 activities have began at the end of 1999 and since then have produced more than 55000 images (500 hours of exposure). The 70% of this time has been used by the SWIRT project and the remaining 30% by the rest of the activities, producing 5 refereed papers, 10 posters, 1 IAU Circular and 11 GCN Circulars. At least 4 other papers are in preparation.
The Schmidt telescope is currently ending its commissioning phase and is mainly working on the CINEOS project for asteroid search at small solar elongations.

5. Conclusions

The IR instrumentation of Campo Imperatore is fully operative concerning the imaging mode, where it can exploit its optimization for survey and follow-up programs, including the automatic data reduction pipeline. The spectroscopic mode is going to be definitely activated.
The simultaneous availability of a working wide field optical instrument, the Schmidt telescope, widens the wavelength coverage accessible from one single site from 0.35 to $2.5\,\mu m$.
For further information see: *http://www.mporzio.astro.it/cimperatore/WWW/*.

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