PANIC Status

Description of the camera

PANIC will be a wide-field infrared imager for the 2.2m and 3.5m telescopes at the Calar Alto Observatory (CAHA). The camera optical design is a folded single optical train that images the sky onto the focal plane with a plate scale of 0.45" per 18 micron pixel at the 2.2m telescope and of 0.23" at the 3.5m telescope. A mosaic of four Hawaii 2RG of 2k x 2k made by Teledyne is used as detector and will give a field of view of 31.9'x31.9' and 16.4'x16.4' at the 2.2m and 3.5m telescopes, respectively.

This cryogenic instrument has been optimized for the Y, J, H and K bands. Special care has been taken in the selection of the standard infrared materials used for the optics in order to maximize the instrument throughput and to include the Z band.

The main challenges of the design have been: to produce a well defined internal pupil which allows reducing the thermal background by a cryogenic pupil stop; the correction of off-axis aberrations due to the large field available; the correction of chromatic aberration because of the wide spectral coverage; and the capability of introduction of narrow band filters ($\sim$1%) in the system minimizing the degradation in the filter passband without a collimated stage in the camera.

Milestones

The project "kick-off" took place in October 18th, 2006.

- Preliminary Design Review: November 21st, 2007
- Final Desing Review of the Optics: September 24th, 2008
- Final Desing Review of the Mechanics: December 2009
- Software Review: February 2010

Team

The people involved in the project belong to the MPIA and the IAA:

Josef Fried (MPIA) PI
Matilde Fernández (IAA) co-PI
Julio Rodríguez (IAA) Project Manager
Matthias Alter (MPIA) Electronics
Harald Baumeister (MPIA) Mechanics
Peter Bizenberger (MPIA) Optics
Concepción Cárdenas (IAA) Optics
Antonio García Segura (IAA) Software
Jens Helmling (CAHA)
Armin Huber (MPIA) Mechanics
José Miguel Ibañez (IAA) Software
Werner Laun (MPIA) Cryostat
Ulrich Mall (MPIA) Read Out Electronics
Vianak Naranjo (MPIA) Detectors

Jose Ricardo Ramos (MPIA) Electronics
Ralf-Rainer Rohloff (MPIA) Mechanics
Clemens Storz (MPIA) Software
Victor Terrón (IAA) Software
Ulrich Thiele (CAHA)
Marcos Ubierna (IAA) Mechanics [Until February 2008]
Karl Wagner (MPIA) Electronics

The status of the different packages is the following:

Optics

After the successful review of the optical Final Design (Sept. 2008), the definitive lens drawings were computed and all the optical elements were ordered in May 2009. The mirrors were purchased from Horst W. Kaufmann (Germany) and the nine lenses and entrance window from SESO (France).

Optical quality tests were performed on the mirrors before coating. After their aceptance they were coated and we received them in March 2010.

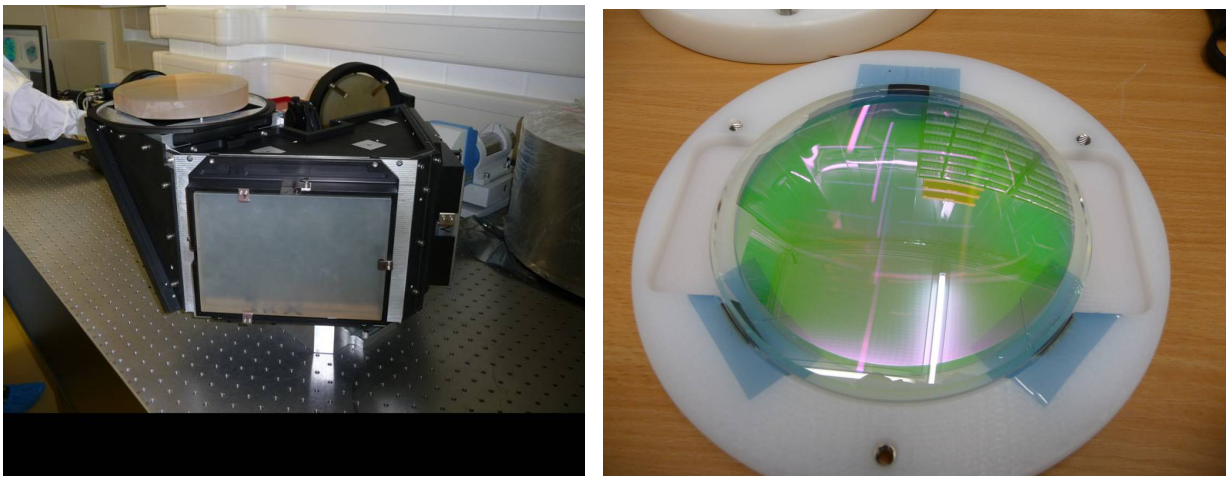

Figure 1: *Left:* Mirrors alignment. *Right:* the L8 lens in its storage box.

The chamfers are very delicate parts of the lenses that allow them to move axially while cooling or warming the camera; they keep the lenses in the right position. They have been a key point during the purchase and manufacture of the lenses. In May 2010 the PANIC team accepted the chamfer procedure proposed by SESO to manufacture the chamfers in our lenses. The procedure was checked using a dummy part made in Bk7 and a dummy of the L2 lens. We received the first lenses in May 2010 and the last ones in December 2010, except for two lenses (of BaF_2) that were received May 2011. Those two lenses suffered small deteriorations during the chamfer polishing (a very delicate process). The consecuences of this non-conformities have been evaluated within the whole optical design and the lenses have been accepted. We have obtained from SESO an extension of the guarantee period in order to test a cryogenic cycle in the PANIC mounts, for which we need the lens holders.

For the other lenses all the cryogenic tests have been done succesfully.

An engineering lens has been ordered for integration purposes (the pupil alignment at the telescope) and it is expected to be delivered in November 2011.

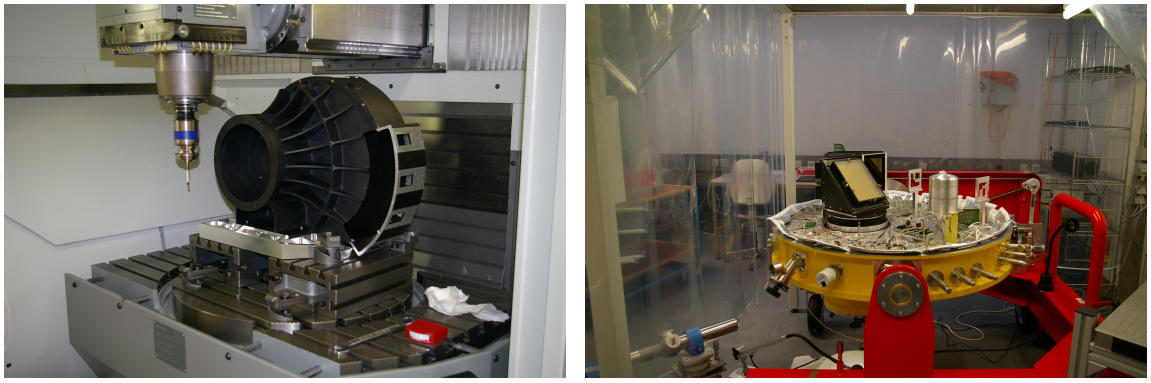

Figure 2: *Left:* Machining the filter wheels unit. *Right:* PANIC looking downwards: the optical bench with some elements on it.

Filters

The ZYJHKs broad band filters and the H_2 narrow band filter have been ordered and we expect to receive them in December 2011.

Mechanics

The order of purchase of the cryostat was placed on May 2009 to Reuter and it was received in January 2010. That month we also received the laboratory caddy[1]. The caddy which will be used on Calar Alto has been delivered.

On December 2009, after the successful review of the mechanical Final Design, we received the optical bench.

At the MPIA workshop the folding mirror structure was manufactured in April 2010 and the filter wheels and pupil wheel in October 2010. All wheels are already mounted on the optical bench.

The cryostat went succesfully through the vacuum tests. On February 2011 vacuum and cryo-tests were performed, including in the cryostat the mirror structure, the entrance baffle, and the entrance and exit windows[2]. We realized that we could not reach 80K as working temperature, as it was originally planned. After the optimization (including new special parts designed for that purpose) we confirmed that the optical system will work at 95K. The optical and mechanical models were recalculated and the drawings of the lens holders were redone.

The cryostat is working perfectly. All cabling for the motors, sensors, and detectors has

[1]A caddy is a customized trolley for transporting and supporting the camera.

[2]The exit window has been built for engineering purposes during the integration and verification phases. It will be covered during the normal operation of the camera.

Figure 3: PANIC (yellow) on the MPIA Caddy (red). Colours were chosen by the German team :)

been manufactured and tested.

The lens holders have been ordered to two German companies: the L1 (a large lens) to one company and the others to a second (cheaper) company, which has a few months delay in the delivery.

The wheels have been succesfully tested in cold.

The telescope adapter (of carbon fiber) is ready.

Detectors

The four Hawaii-2RG detectors have been tested and the level of coplanarity has been measured.

Electronics

The electronics which controls the motors and sensors for temperature and pressure is tested and working.

The read-out electronics has been successfully used with a Hawaii-2 detector. However the read-out with the PANIC detectors does not yield the values for gain and noise which have been measured by the manufacturer. The cause for this mismatch is currently under investigation.

Software

GEIRS - the general MPIA software package for IR detectors - has been modified for PANIC. These modifications include the ability to read-out 4 detectors and a different set of commands for the control of the motors.

The first prototypes of the Observing Tool (OT), the Quicklook and the Pipeline (PAPI) were presented at Calar Alto (May 20, 2009), IAA (October 9, 2009), and MPIA (February

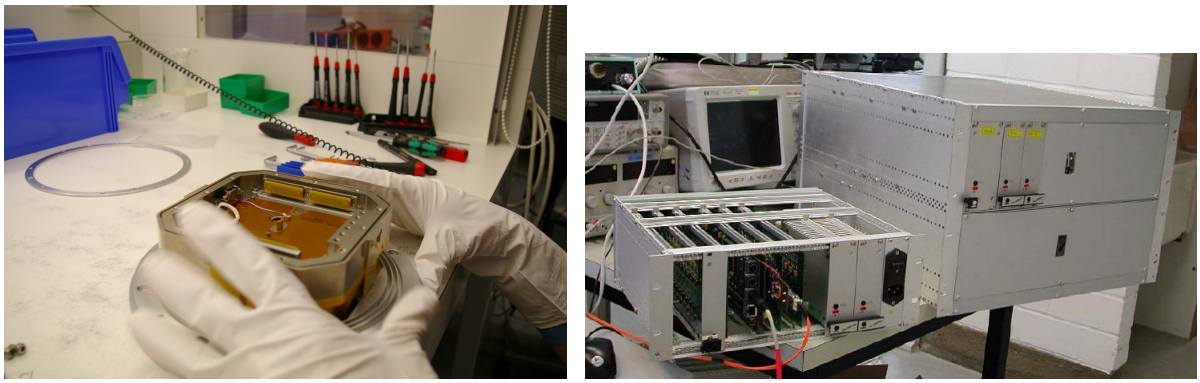

Figure 4: *Left:* Detectors. *Right:* Comparison between the new electronics developed for PANIC (left) and the old one (right).

16, 2010).

The packages for the time series reduction and analysis are also under development. The basics tasks have already been coded, as well as the database manager and one of the algorithms for the search for periods.

We plan to carry out the first software+hardware integration before the end of 2011, using all the available hardware of the camera. We will also check the interfaces between the different software tools.

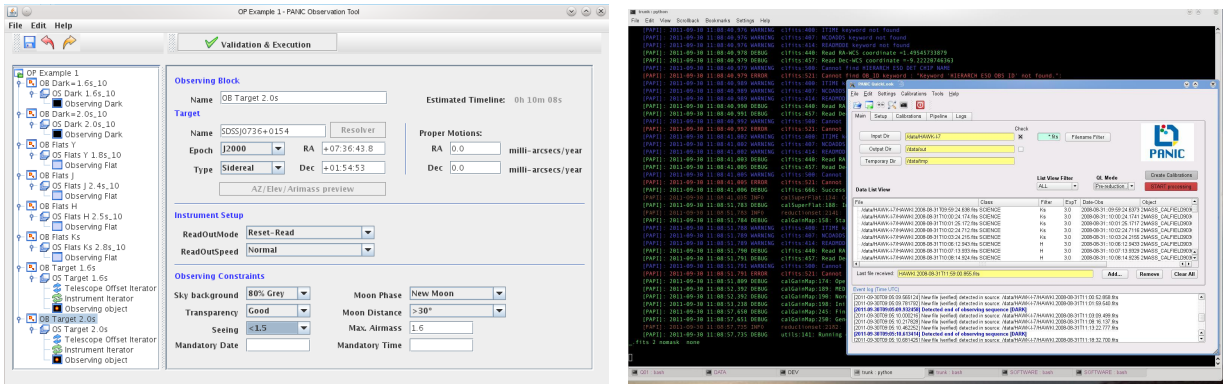

Figure 5: *Left:* Snap shot of one of the displays of the Observation Tool. *Right:* The PANIC Pipeline running.

AIV (Assembly, Integration and Verification)

The complete AIV plan is established.

The folding mirror structure was assembled, integrated and verified in October 2010. Cryogenic cycles have been performed for almost all lenses. The entrance and the exit windows have been tested in cool and in vacuum. The integration of the mirror structure in

the PANIC bench and the opto-mechanical axis alignment was done in July 2011.

A star simulator has been designed for the optical alignment and tests. All the components of the simulator are in-house and they will be assembled in October 2011 for the beginning of the lens integration. We expect the PANIC integration at the MPIA to last until April-May 2012. For this reason, we have already applied for commissioning time at the 2.2m telescope for June 2012.

Figure 6: Checking the alignment of the camera at the PANIC's lab of the MPIA in October 2010.

Commissioning at Calar Alto, both at the 2.2m and 3.5m telescopes, is expected to require less than 40 nights (in several observing runs) and we desire to be ready by the end of 2012.