Cell: 520 979 0101

ACE Observatory Control System

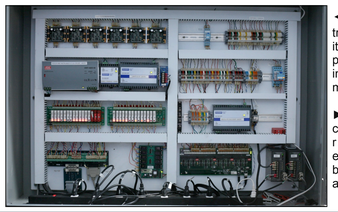
16 years of remote intercontinental observing

Peter Mack *Astronomical Consultants & Equipment, Inc.* www.astronomical.com

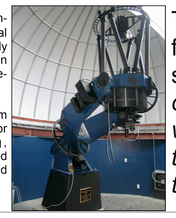
▲A fully renovated 0.6-m Boller & Chivens Telescope. The saddle boxes now contain Ethernet, USB, video and instrument connections. A dual filter wheel and X-Stage guider is installed. Note the automatic mirror covers.

The ACE Observatory Control System has been used for remote control since 1995. The system was designed for use at isolated observatories with no-one present on the mountain-top. The software provides complete diagnostic feedback to the astronomer and is supplemented by live audio-visual. Accessories include environmental sensors (weather station, all-sky camera, constellation cameras), automated mirror covers and remote power control. This gives the astronomer the same experience as being present at the observatory.

To make the system as robust as possible absolute encoding is used on most axes and all critical axes have closed-loop feedback. The electronics are optically isolated and power is distributed through UPS units to try to protect against lightning strikes. In an attempt to obtain long term support most intelligent items are now network addressable rather than ISA / PCI based.

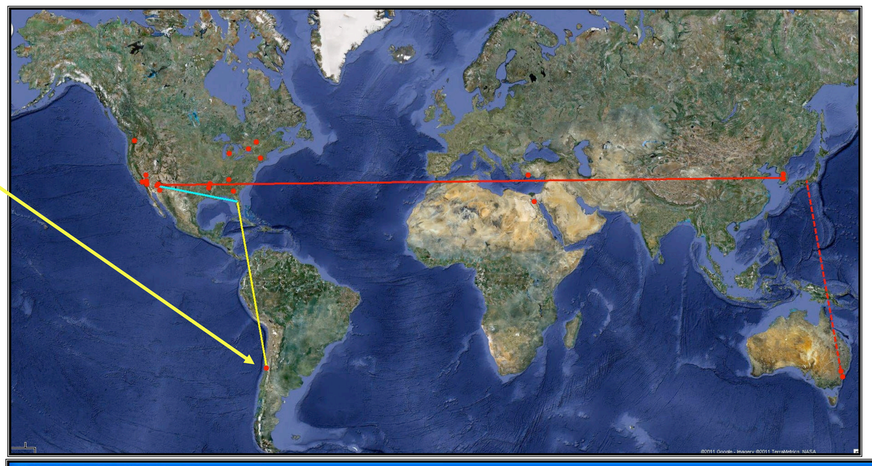


◄Optically isolated control cabinet. Individual items can be remotely power-cycled using an internet addressable remote power rack



► One of the ACE 0.6m class telescopes used for remote observing, equipped with a thinned back-illuminated CCD and an XY guider stage.

Three of the existing systems are now being equipped with fiber-fed échelle spectrographs so that remote / robotic instrument changes can be performed at will. *Near-term future developments include a scheduler and fully robotic observing with automated guiding. The software is also being updated to be deployable on both Linux and Microsoft Windows. Long term plans include scheduling across multiple telescopes.*

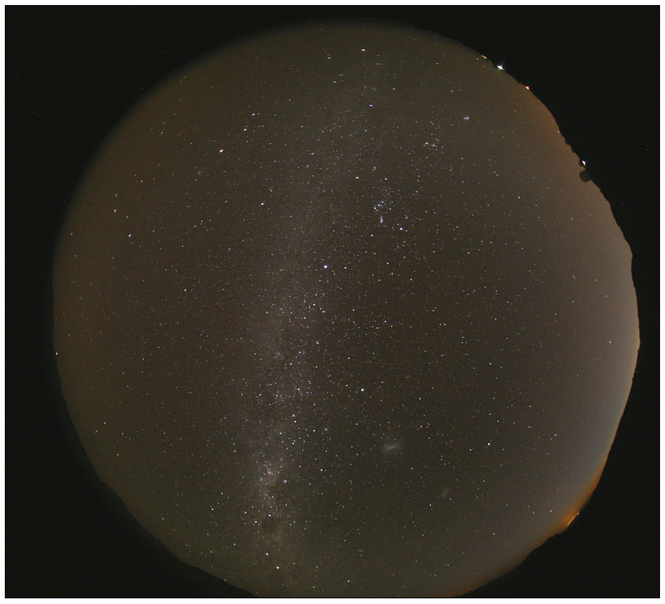


◄The system has been installed on 30 telescopes (red dots). The Korean Astronomy Space-sciences Institute (KASI) has operated an ACE 1.0-m telescope located on Mt. Lemmon (Arizona) from Taejeon, South Korea) since 2000. The telescope operator works during the daytime in Korea.

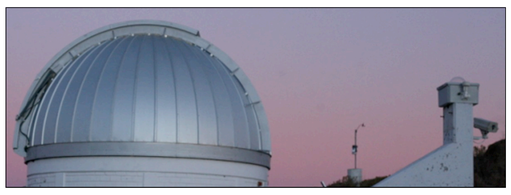
The SARA group operates two telescopes (at KPNO and CTIO) remotely from the SE continental USA.

A similar network between Japan and Australia is under construction.

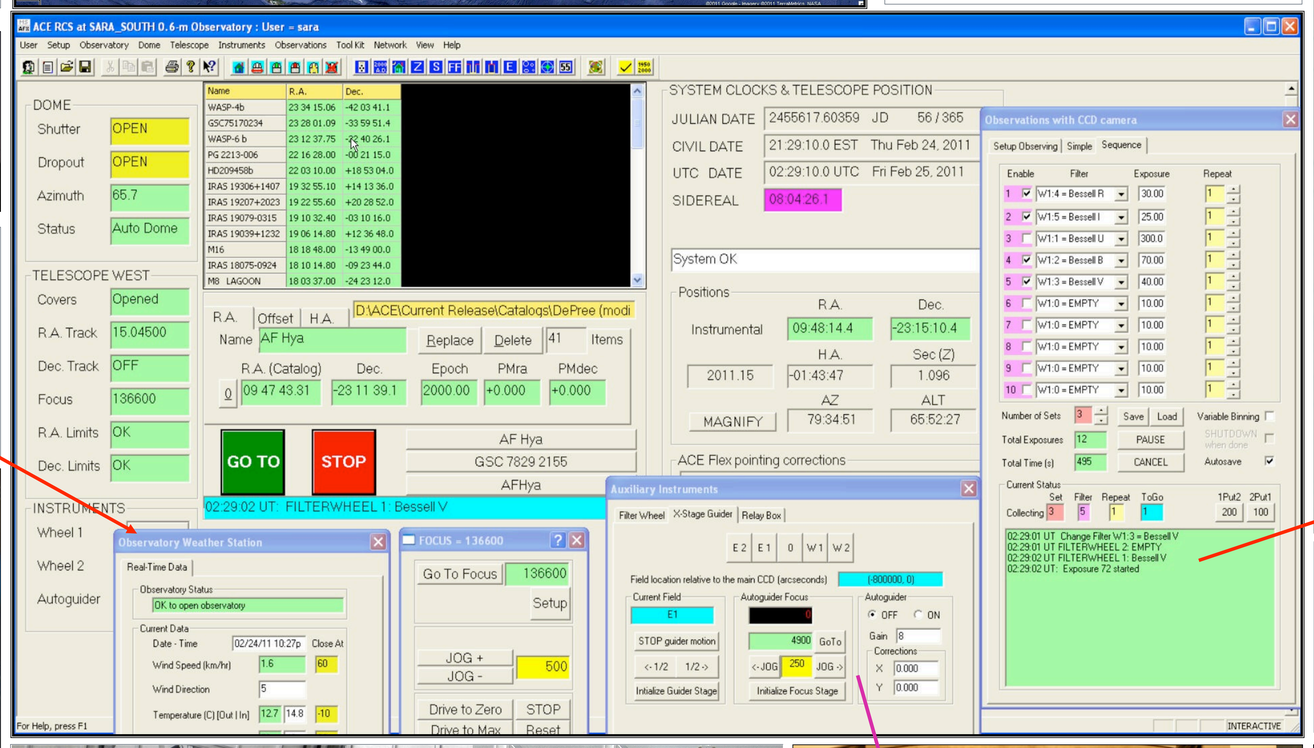
All the observatories are unattended.



▲A 360° 12 megapixel all-sky camera is used to remotely monitor sky conditions. Each color image is a 30s exposure at an effective 1600 ISO, obtained using an 8mm fisheye lens. The Magellanic Clouds and dust lanes in the Milky Way are clearly visible. Data is collected continuously throughout the night and archived.

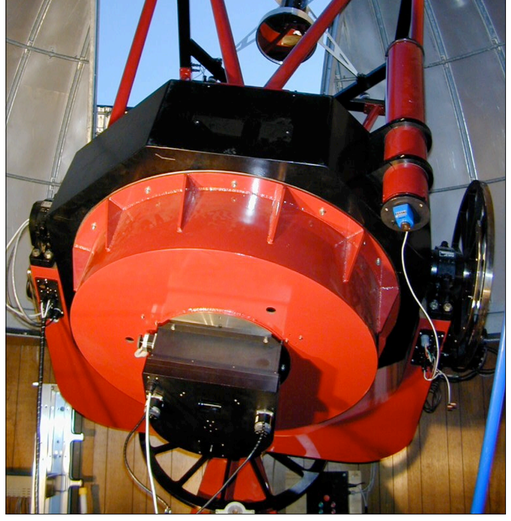


▲We have tried a variety of weather stations from inexpensive COTS models to premium models. We now use a wireless solar Davis Instruments station which is easily replaceable. (This one was mounted using an old oil drum filled with concrete). The housing for the all-sky camera and a weatherproof low-light level video camera are in the foreground.



▲The software allows for photometric sequences selecting from two stacked filter wheels. This tri-color image is the globular cluster NGC5272. (Photo credit: B. Murphy, Butler University).

A scheduler and observatory script is under development which includes the ability to perform a complete night of unattended observations with automated guiding.

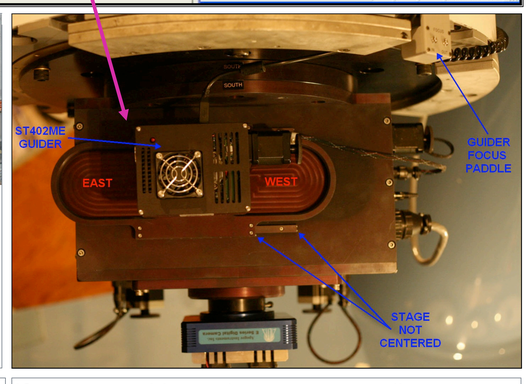


▲The first ACE 1.0-m Telescope, built in 1999. The telescope is now equipped with a cryotiger cooled ARC (*Leach*) camera fully integrated into the ACE control system. The equipment is operated remotely between Korea and the USA.

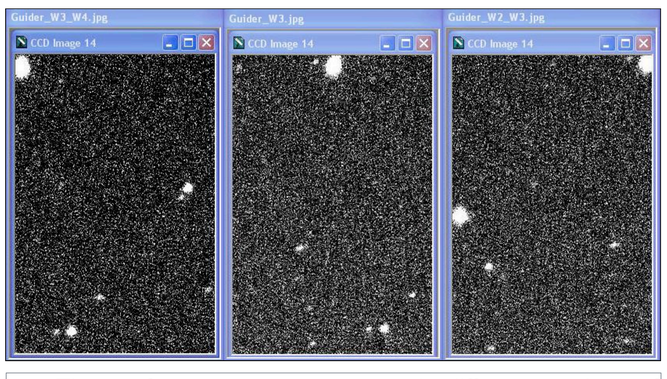
▲Azimuth encoding and variable speed azimuth control for an Ash dome.

◄Rain-Snow Sensor

▲The observatory enclosure is managed with an ACE SmartDome™ which is a fault-tolerant system to handle two shutter doors and up to 6 other devices, such as windscreens, platforms and observing cages. It integrates with rain-snow and cloud sensors to provide autonomous shutdown. It will also close a dome if communication is lost. The azimuth is equipped with either absolute or incremental encoding and has ramp-up/down speed control. The system has been deployed on roll-off roofs and classical domes up to 25m diameter.



If you would a demo, or to discuss our production line of telescopes and instruments please call me!



◄▲The software supports several different styles of autoguider acquisition modules. The one shown here is a simple X-Stage guider which has the ability to search multiple fields in the E-W direction. The result of moving the stage between pre-canned positions is shown above. A dual stacked filter wheel (providing 20 positions) is integrated into the module. ACE has deployed customized X-Y Stages and mirror curtains at numerous observatories.