The MMT Observatory

A joint facility of

The Smithsonian Institution &
The University of Arizona

# The MMT All-Sky Camera

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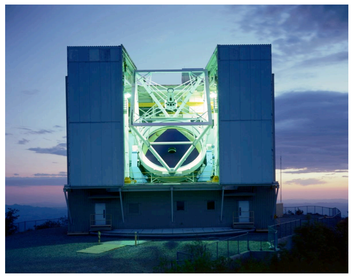


## Abstract

The MMT all-sky camera is a low-cost, wide-angle imaging system that takes images of the sky every 10 seconds, day and night. It is based on an Adirondack Video Astronomy StellaCam II video camera and utilizes an auto-iris fisheye lens to allow safe operation under all lighting conditions, even direct sunlight. This combined with the anti-blooming characteristics of the StellaCam's detector allows useful images to be obtained during sunny days as well as brightly moonlit nights. Under dark skies the system can detect stars as faint as 6th magnitude as well as very thin cirrus and low surface brightness zodiacal features such as gegenschein. The total capital cost of the system was less than $3500 including computer and high-quality framegrabber card, a fraction of the cost of comparable systems utilizing traditional CCD cameras.

## Introduction

Wide-angle optical imaging is a popular way of monitoring the sky that can provide a real-time view of current conditions. The CONCAM[1] network is a well-known example of this and has deployed CCD-based all-sky imaging cameras at many observatories around the world. Other observatories have deployed similar systems of their own such as CASCA at Las Campanas (http://ascam2.lco.cl), TASCA[2] at Cerro Tololo, SNOOP at Mt. Palomar (http://snoop.palomar.caltech.edu), and ESO's MASCOT[3] at Cerro Paranal. The Apache Point Observatory uses a different system that images the sky in the mid-IR[4]. Such systems can be more effective at detecting clouds equally well under all conditions (e.g. dark time vs. bright), but are much more complex and expensive. We merely wanted a simple, relatively inexpensive system that could go as deep visually as the human eye under dark skies and still provide useful images under a full moon.

## Hardware & Software

Our system is constructed from the following components:

*Camera:* We use a StellaCam II system from Adirondack Video Astronomy. It can integrate up to 256 frames (8.53 seconds) internally, has a variable gain setting, provides auto-iris control, and can be remotely controlled via RS232.

*Enclosure:* Pelco EH2515 outdoor CCTV enclosure.

*Lens:* Fujinon 1.4-3.1mm f/1.4 lens with 185 degree field and auto-iris capability.

*Framegrabber:* Integral Technologies FlashBus MV PCI.

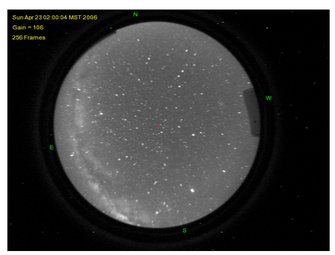
*Video Fiber Link:* Luxcom Technologies OM-7

The system is controlled by a small form-factor linux PC. The RS232 and video links between camera and computer are both fiber-isolated. The auto-iris lens allows safe operation under all lighting conditions, even direct sunlight. The anti-blooming characteristics of the StellaCam's Sony SuperHAD detector mitigate the effects of saturation when the sun or moon is in the frame.

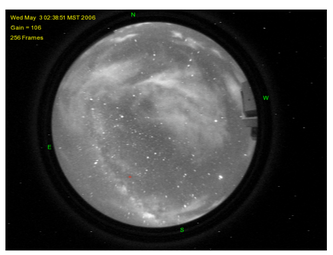
## Results

Here are some representative images taken under a variety of conditions:

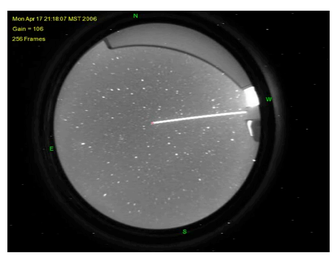
***Left:*** *Typical image taken under clear, dark conditions*



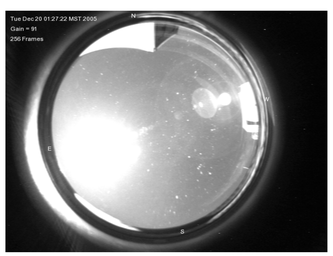

***Right:*** *Dark, moonless night with light cirrus*



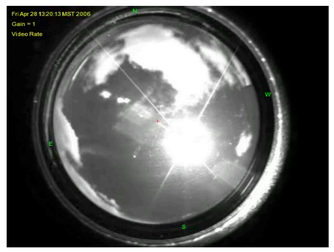

***Left:*** *Image taken with rayleigh laser system in operation*



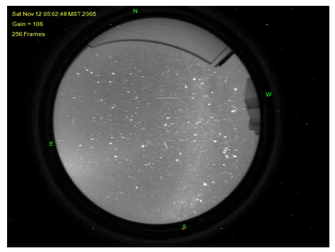

***Right:*** *Full moon rising in the east on a clear night*




***Left:*** *Typical image taken on a partly cloudy day*




***Right:*** *Image showing two meteors and zodiacal light*




The red crosses in the images denote the position the MMT is pointing at.

Data are currently archived in the form of DivX-format AVI movies. This format allows us to compress an entire day or night of images (>4000 on average) into a single 12 to 20 MB file that retains good image fidelity. Future work includes archiving and databasing of raw and differential images, automatically detecting transient phenomena and clouds, and monitoring sky brightness.

Current and archived data can be accessed at:

http://skycam.mmto.arizona.edu

## Conclusion

The MMT all-sky camera has been in routine operation for over a year. It has been a valuable resource both for observers and for MMT operations. It routinely achieves sensitivity of at least that of a dark-adapted human eye and does so at a rate of a frame every ten seconds. Light cirrus are easily detected, especially in the 15 minute animations that are generated with every new image. The upward-facing window of the camera has also been effective at detecting light precipitation that might otherwise have gone unnoticed.

### References

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2. R. Smith, D. Walker, and H. E. Schwarz, "The Tololo All Sky Camera", in *Scientific Detectors for Astronomy, The Beginning of a New Era*, P. Amico, J. W. Beletic, and J. E. Beletic, eds., pp.379-384, 2004.

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