Module CAMS — Installation and Procedures

Goals	Install and run the single-camera CAMS system
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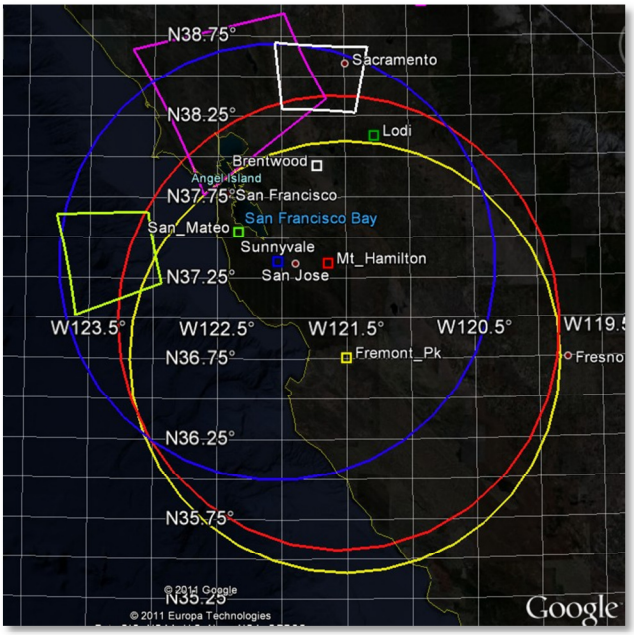
Background

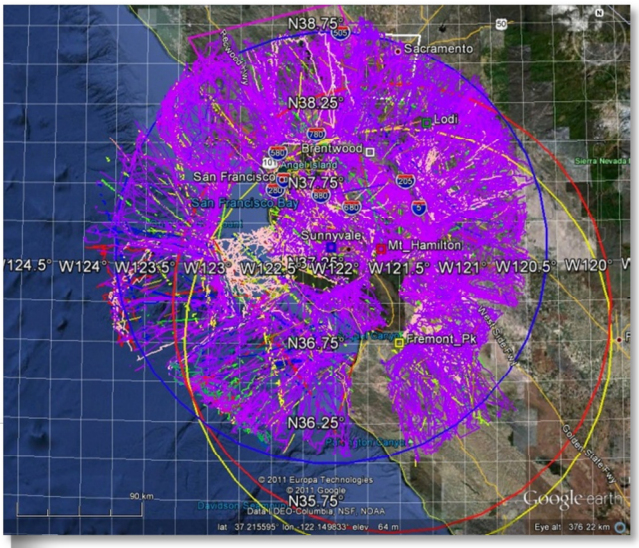
Single-CAMS
CAMS

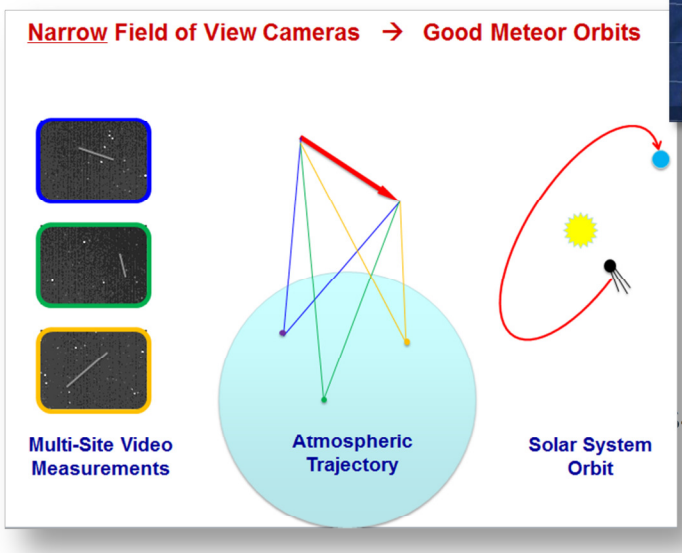
This document describes the single-camera CAMS system that you can install at your home, school, or other location. CAMS is an acronym for "**Cameras for All-sky Meteor Surveillance**". There are three main all-sky CAMS array sites set up in the Northern California network at **Fremont Peak**, **Lick Observatory**, and **Lodi (or Mountain View)**.

NASA/SETI is allowing amateurs to contribute to this science by setting up single-camera CAMS systems at their homes, schools, etc. and this will provide a level of redundancy against fog and other breakdowns as well as providing better accuracy in the data. You may be credited for discoveries and measurements made by your CAMS site. For additional information, see "**http://cams.seti.org/easyCAMS.html**".



The picture on the left shows the current areas of coverage of the CAMS arrays and the single CAMS sites. The next picture shows the meteor tracks from the Sunnyvale, CA CAMS array on a single night in Dec 9, 2011, with some cameras not functioning. You can see that Earth is under constant bombardment.



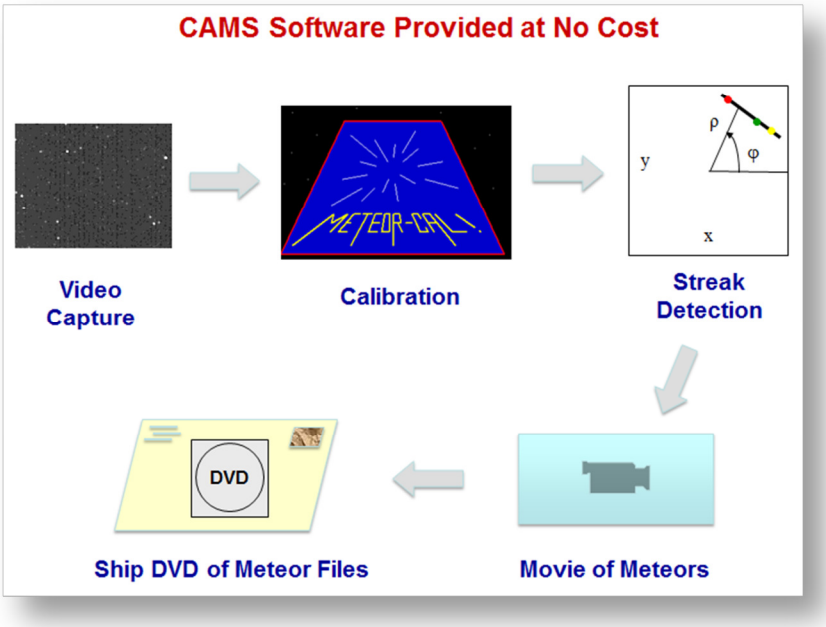


There are over almost 400 or more known meteor showers. 300 of those are

not confirmed. The purpose of the NASA/SETI CAMS project is to confirm the known meteor showers and discover new ones. You can visit "**http://www.ta3.sk/IAUC22DB/MDC2007/**" or just Google search "**Meteor Data Center**"

A meteor shower is caused when the Earth passes through the dust trail of a comet that has previously passed through Earth's orbital path without colliding with the comet. A meteor shower implies the presence of a potentially hazardous comet. If the dust trail can hit the Earth, so could its parent comet. The dust trail shares the same orbital path as its comet. In principle, it will be possible to guard against such impacts by looking along the meteoroid particle's orbit to those spots where the comet would be in such a dangerous position - possibly providing a few years of warning. There is no real need to find all the comets associated with the meteor showers, only those comets that would be in the position to impact Earth need to be located.

Using the CAMS array, since November, 2010, dozens of meteor showers have already been confirmed and two new ones have been discovered using this (as of August, 2011. See http://cams.seti.org for updates).



A CAMS system takes movies from a highly sensitive video camera and searches for signs of meteors in the video frames. This is done locally using software that is provided at no cost, in order to reduce the volume of files sent back to NASA/SETI. Data, in the form of small text files, is sent back to a central coordinator at NASA/SETI where triangulation (coincidence) from other sites is performed to ascertain additional information, such as speed, angle of attack, altitude, and finally the orbital elements of the particles. Only two cameras need to capture the same meteor and to determine the orbital elements of the particle stream. The more cameras that can detect the same meteor, the more accurate the orbital data becomes in addition to the higher the meteor count for all overlapping stations.

Before you begin:

- You will need the following items:
  1. **Watec WAT-902H2 Ultimate** (about $400)
     - http://www.spytown.com/watec-wat-902h2-ultimate-eia.html ($308)
     - http://www.avsupply.com/Watec/wat-902h2-ultimate.php

2. **Watec WAT-AD901 1210** (about $29) - Sometimes, the 12 VDC power supply does not ship with the camera. You may need to purchase one. You may be able to scrounge one up from an old adapter laying around like I did. Just be sure that the connect is the correct polarity before plugging it into the camera. If you are not in the US, you may need a different power supply.
   - http://www.spytown.com/watec-wat-ad901-1210.html ($29)
   - http://www.amazon.com/Watec-WAT-AD901-220VDC-300DH-525EX/dp/B006WXR6X8/ref=sr_1_1?ie=UTF8&qid=1339544094&sr=8-1 ($29 no tax, no shipping)

12-mm f1.2 Pentax lens (about $110)
   - http://www.spytown.com/pentax-c61215kp.html
   - http://www.nextag.com/Pentax-C61215KP-12MM-F1-616003011/prices-html
   - (also at AV supply)

3. **C-CS mount adapter** (about $16. You only need this if your lens doesn't reach focus with the camera)
   - http://www.bhphotovideo.com/c/product/569849-REG/Pentax_C80035_C80035_C_CS_Mount_Adapter.html

4. **Video cable for outdoor use** (I like to use RG6 cable with F-type to RCA on one end and F-type to BNC on the camera end. You can get the skinny cable to make it easier and I don't see any difference in interference. You can buy both skinny and regular RG6 cable at Home Depot.
   - Or 50ft from home depot (http://www.homedepot.com/h_d1/N-5yc1v/R-202698875/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053) $14

5. **BNC Male to F Female adapter** $2.90
   - (http://www.showmecables.com/viewItem.asp?idProduct=1062).

6. **F Female to RCA Male adapter** $1.22
   - http://www.showmecables.com/viewItem.asp?idProduct=2103

7. **EasyCap DC60 Plus - USB2.0 Version 3.2A or higher** ($31) We suggest purchasing two of these so you have one as a backup - it is a critical path and it can fail.

Note: The older version of EasyCap DC60 is about $8 and has proven to drop video frames and data. While it will work in some cases, it is better to get the "plus" verion.
   - http://www.amazon.com/Easycap-Version-Capturer-Camcorder-Compatible/dp/B0044XIQIW/ref=sr_1_1?s=electronics&ie=UTF8&qid=1338269556&sr=1-1

8. **Camera housing** $25
   - http://www.surveillance-video.com/sa-605.html
   - If you are going to mount the camera to a building or structure,
   - http://www.spytown.com/everfocus-fhb-300hb.html $35 with Heater/Blower
   - Spytown shipping is too high.

Additional equipment:
   - Extension cords ($10)
   - Wall timer ($15-$20) (I found that the electronic model is more reliable and doesn't lose time during power outages)
     http://www.lowes.com/pd_149289-95325-LW68465_0__?productId=3136285&Ntt=utilitech+timer&pl=1&currentURL=%2Fpl__0__s%3FNtt%3Dutilitech%2Btimer&facetInfo=

or you can go the traditional route with the inexpensive mechanical christmas tree timers that need to be constantly checked for accurate time:
http://www.christmaslightsetc.com/p/Outdoor-Timer/Photo-Control-Controllers-/-Timers-/-Light-Testers-/-Faders--20704--107.htm

- ShockBuster Ground Fault Circuit Interrupter (GCI) portable safety outlet. $13 from Lowes. Part number #30339011.
  http://www.lowes.com/ProductDisplay?partNumber=145275-33536-30339011&langId=-1&storeId=10151&productId=1135923&catalogId=10051&cmRelshp=rel&rel=nofollow&cId=PDIO1

- Tripod or other mounting system ($10 - $100)
  http://www.walmart.com/ip/Sony-39-Lightweight-Camera-and-Camcorder-Tripod-VCT-R100/4948189
- RG6 (cable tv) cable is best for long distances. Would require F-type screw-on adapters for the bayonet and RCA male ends
- 2 External hard drives
  - If your computer has an eSATA port, you should try to use an eSATA external drive. Sometimes, these are more expensive than the USB drives, but they're getting cheaper. Another option is the Thermaltake Dual Bay Docking Station ($70). This compatible with 2.5" and 3.5" internal SATA hard drives. The dual bay station allows you to backup from drive to drive. Each drive requires its own eSATA port for maximum performance (3,000mbps). Otherwise, you can use eSATA to USB 2.0 (480mbps). They also have a single bay unit for $20 less. With this, you can use cheaper 3.5" drives without having to purchase an enclosure for each.
    http://www.bestbuy.com/site/Thermaltake+-+Dual+Bay+Docking+Station+for+Most+Internal+SATA+Hard+Drives/9419596.p?id=1218102199901&skuId=9419596&st=thermaltake&cp=1&lp=14

- You can get External USB 2.0 or even USB 3.0 external hard drives for under $100 ea. I personally recommend units that are powered by the USB buss. http://www.amazon.com/Western-Digital-Passport-Essential-Portable/dp/B0041OSQ9S

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Task 1 - Set up the Camera

1.1. Set the camera settings as follows:

1.1.1. **BLC** = 1 and 2 ON, 3 OFF. This setting sets the backlight to the full chip and not just a portion of it.

1.1.2. **SHUTTER** speed. Setting switch 3 to off causes the camera to be in 1/60 second shutter speed, which is the same as switch 3 ON and the shutter speed setting to 8.

It is useful to set the shutter speed to 7 and then set the switch 3 to OFF. Essentially, what this does is it sets the shutter speed to 1/60 second for normal CAMS nighttime operation. However, it sets the shutter speed to 1/100,000 sec when it is ON. That way, if you need to do some daytime testing, the 1/100,000 shutter speed is easily accessible and you won't have to fumble around for the manual to figure out what the daytime setting is. Just remember to set switch 3 back to OFF when you're done.

Warning: Don't use a metal screwdriver to change these settings. The best thing to use is a plastic screwdriver. Using a metal screwdriver for these settings can easily damage the main board inside the camera.

1.1.3. **AGC** (automatic gain control) - set to LO or MGC. Some suggest setting to LO. The camera used for these instructions had to be set to MGC (manual gain control) in order to capture enough stars to be able to calibrate. Any AGC setting will skew the photometry, so the best setting is a MGC setting where the

gain is at the threshold of producing images as noise free as possible but with as many or more stars than LO produces.

Probably the best advice is to set the AGC to MGC and adjust the L-H gain setting until the image appears to show the same number of stars as the AGC LO setting does. However, I have found that a slight increase in gain over the AGC LO setting produces easier to see meteors during confirmation but the drawback is a slight increase in noise (which increases the number of false positives). The goal is to reach a balance of signal to noise. Too much gain and a clear night with 30 meteors will produce 800+ false-positives. When the gain is set correctly, a clear night with 30 meteors will produce only about 200-270 false-positives.

Warning: If you're going to use the MGC settings, don't use a metal screwdriver to change these settings. The best thing to use is a plastic screwdriver. Using a metal screwdriver for these settings can easily damage the main board inside the camera.

1.1.4. **GAMMA** - Set to off. The higher the gamma setting, the higher the noise. In addition, the higher the gamma setting, the lower the number of brightness levels, which is not good for getting accurate photometry measurements.

1.1.5. **LEVEL** - Experimenting with the settings of the LEVEL control hasn't exhibited any difference.

Warning: If you're going to use the LEVEL settings, don't use a metal screwdriver to change these settings. The best thing to use is a plastic screwdriver. Using a metal screwdriver for these settings can easily damage the main board inside the camera.

1.2. Attach the Pentax 12mm f/1.2 lens

1.2.1. Use the C-CS mount adapter (5mm silver knurled ring shown in the picture). The camera in this picture has a CS adapter already included as part of the camera (the

black 3.5mm knurled ring on the right).

A few comments:
The Watec camera comes with a 3.5mm black knurled ring adapter that provides an interface between the camera opening and the lens. This 3.5mm adapter is considered part of the camera. With that adapter, the camera is considered a CS style camera, which expects a 12.50mm backfocus lens. This 3.5mm adapter is designed to be adjustable to suit a variety of lens designs. However, for our use, this adapter is between 0.7 and 0.9mm too thin for the C-mount lens we're using. This Pentax lens is a C-mount lens, meaning that it has a 17.56mm backfocus. Therefore, with the knurled silver 5mm C-CS-mount adapter ring depicted below, it should reach focus on stars with the lens set to near infinity. However, because the 3.5mm adapter is too thin, the lens will reach focus on stars (infinity distance), but only with the focus set to about 10 inches, instead of the infinity setting. You have two choices:

(1) screw the 3.5mm adapter all the way in and set the lens to about 10 inches; You can mark the lens with a silver Sharpie pen where the infinity focus setting is if you like.

(2) Set the lens focus setting to near infinity (not all the way to infinity because you have to be able to tell that you've gone too far to know you are in focus) then loosen the allen set screws for the 3.5mm adapter and unscrew the adapter (probably about 0.8mm) while imaging until it is in focus. Then tighten the setscrews.

Since the second method doesn't really improve anything, I feel that the first method is the easiest and is what I would recommend.

The next 4 pictures show the spacing required to get the lens to focus on stars at near infinity.

The **total lens backfocus** is about 17.56mm. This is measured when the lens is at focus on something at infinity distance. Note how in this image, the **black 3.5mm adapter is unscrewed 0.88mm** instead of unscrewing the **5mm silver adapter**. This image shows the **correct** approach to unscrewing the adapter to correct the spacing if you elect to do it this way.

Note where the 0 marking on the ruler is. This is the **back plane of the lens** where the measurements are taken from. Also note that there is a 0.8mm gap between the 5mm adapter and the 3.5mm adapter. This is not the correct place to adjust the spacing.

Note that the **focus mark is set to near-infinity** and there is a 0.8mm gap between the 5mm adapter and the 3.5mm adapter.

1.2.2. Set the aperture setting all the way open (f/1.2).

Note: If you are experimenting with this in the daylight, you will notice that a higher focal ratio/aperture setting will allow you to see things in the room or outside. However, this will cut out a lot of light during the evening and reduce the effectiveness of the data. Be sure that when you finally configure for evening meteor recording that the aperture is set to 1.2.

1.2.3. Focus the lens so that it is either about where you see it in the picture or so that the infinity symbol is under the 1.2 notch, depending on which adapters you have. You will fine-tune the focus once the system is inside the weatherproof enclosure, the software is installed, and it is dark enough to capture stars in the camera.

1.3. Set up the weather-proof enclosure and wiring.

1.3.1. Mount the camera to the plastic mounting plate to the forward-most position on the plastic plate. If the plastic mounting plate is already attached to the rails, you have two choices for mounting the camera to the sliding plastic mounting plate:

1.3.1.1. You can remove the back of the enclosure using the small screws and slide the plate out the back. Attach the camera with the provided 1/4 - 20 screw; slide the plate back on to the rails; and replace the back of the enclosure.

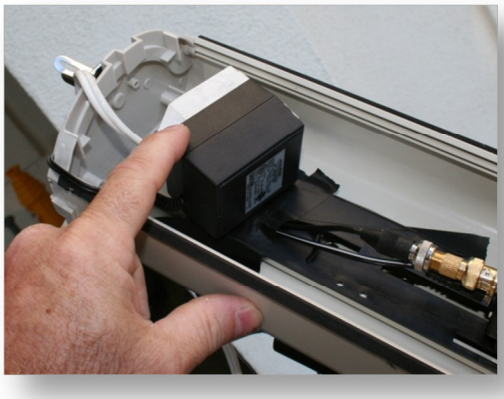
1.3.1.2. Another option is to just unsnap the plate from the rails. It might be a little difficult, but you can try to jiggle and force the plastic mounting plate out of the rails. Attach the camera with the provided 1/4 - 20 screw; then snap the plastic mounting plate into the rails.

1.3.2. If you have screws that can attach the plastic mounting plate to the rails, attach the mounting plate far enough back such that the end of the lens is about 3/8" from the inside window of the enclosure. You need to ensure there is a cushion of air between the window and the lens so as not to capture humidity between the two. Also, it is a good idea to leave enough room to be able to unscrew the lens for whatever reason without having to remove the camera from the rails.

Update: The tape didn't work for more than 2 months. I eventually put a drywall screw through the plastic platform into the rail to prevent the plastic platform from slipping. It was evident when I started to see some vignetting near the bottom of the FOV.

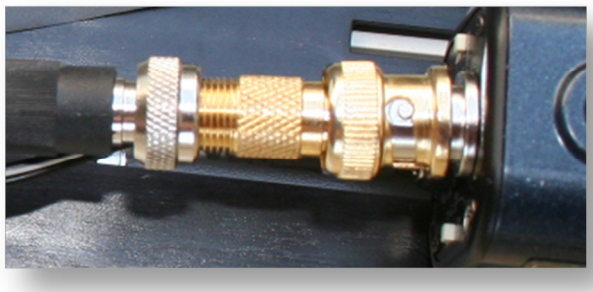
1.3.3. Thread the video cable **separate** from the power adapter cable so that you can later change the configuration by placing the power supply inside the enclosure during the winter to warm the enclosure. You will thread the video cable through the cable punch-out at the bottom-rear of the enclosure. My enclosure came with some plastic cable grommets to protect the cables from chafing. However, I had

to remove them in order to get the F-connector through.



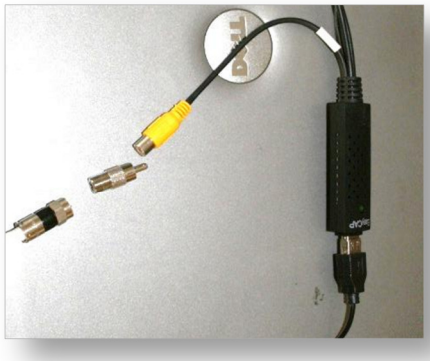
1.3.4. Attach the enclosure to the tripod.
Here, the enclosure is pointing downward.

1.3.5. Attach the video cable to the BNC Male to F Female adapter and then attach that to the camera's BNC connector. Then tape the video cable to the plate as shown in the pictures. Also attach the 12vdc power connector to the camera and secure the power cable to the adapter plate with tape.



1.3.6. On the other end of the video cable, connect the F Female to RCA Male adapter. You can also connect the RCA Male adapter to the yellow female plug on the

EasyCAP at this time, but don't plug the USB cable into the computer yet.



1.3.7. Connect an extension cord to the 12VDC power supply. Connect the other end of the extension cord to the wall timer. Configure the timer for sunset and sunrise and then plug the timer into an outlet. Cover the timer and all connections with saran wrap or something to protect against the rain and dew.

1.3.8. There is also a portable GFCI available for about $13 from Lowes that provides a level of safety against water intrusion on your electronics. Plug this into the wall, then plug the timer into the ShockBuster, then plug the extension cord to the timer.

1.3.9. Tape the punch-out hole to prevent bugs and water from entering the enclosure.

1.4. Install the EasyCAP driver from the EasyCAP DVD.

1.5. Install the Ulead Video Studio LE DVD

The reason to install the Video Studio application is so that you can use it to test the video connection in case something goes wrong. It is always best to test the hardware with the software that comes with the hardware.

1.6. Configure and test the Ulead Video Studio software...

1.7. Reboot

Task 2 - Introduction to the AutoCams Menu System and Cams Programs

The CAMS programs are an assortment of stand-alone console programs developed by programmer/scientist Pete Gural. Typically, console programs are executed from a command prompt. Most of the CAMS programs can be run either from a command prompt or by double-clicking on them from Windows Explorer. When these programs require input, a File Open dialog appears that allows you to navigate to and select a file or directory for the program to work on. In other places, you are prompted within the console window for input in the same manner as the old 1980s style DOS programs input.

When the programs run, they produce results typically by placing files into subdirectories at a location specified by the user. At the same time, they often display information and/or results in the same console window or adjacent console windows. The resulting files sometimes need to be manipulated before running the next program in the process.

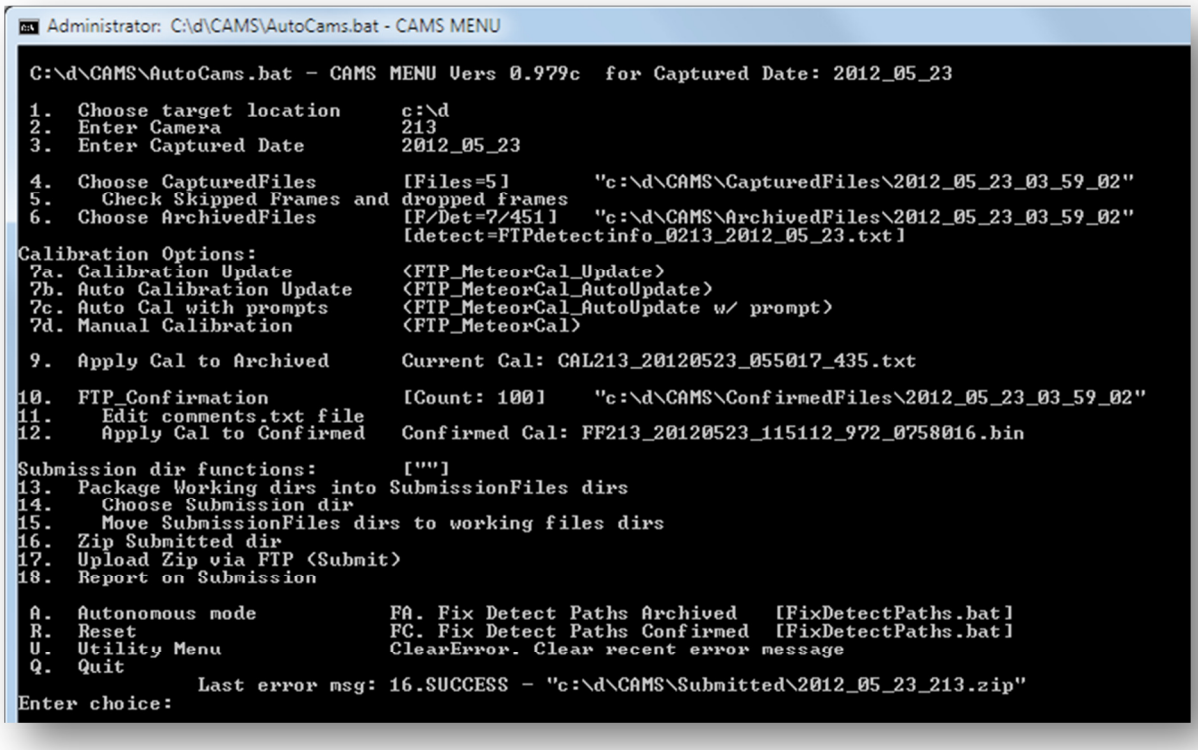
The order in which the programs are to be run and manipulation of the results in preparation for the next step in the process is called the "workflow". Knowing which program to run in the correct order and how to locate and manipulate the results in preparation for the next step in the workflow can be difficult to teach to the average user. A menu system, **AutoCams**, was created that works kind of like a checklist. It helps the average user repeatedly produce consistent and accurate results. In addition, AutoCams was designed to run the single-camera CAMS systems autonomously, night

after night, until the hard drive is full. Using AutoCams in autonomous mode, there are only a few situations where the user has to interact with the system:

- Performing a manual calibration for those nights when automatic calibration was not achieved
- To resolve errors when they occur
- To perform the optional Confirmation task (which can't be automated)
- When the disk full warnings appear.
- Making archive backups and burning DVDs

The AutoCams menu system takes some getting used to. It was designed to run in either **interactive** mode or **autonomous** mode.

Interactive AutoCams - In interactive mode, the premise is to start with the step numbered 1 and continue, step after step, until all the steps are complete. There are some steps that are optional. Some steps, like the manual calibration step, are only required if another step fails or if some of the steps are processed out of order (This can sometimes happen when resolving problems).



The interactive AutoCams menu has a utility menu that you can reach by entering U. The utility menu items start their numbering at 31. As a shortcut, you can enter utility menu items from the main menu and vice versa.

Autonomous AutoCams - In autonomous mode, all automatic steps are performed as configured. The AutoCams.Params.ini file has a configuration setting, "autonomouslevel" that can be configured so you can choose the level of autonomous operation. The default is "apply". This will stop the autonomous operation after the automatic calibration step. If you change this setting to "ftp" (without the quotes), it will perform all operations and upload each morning to the coordinator's server except for those batches that failed to successfully auto-calibrate. When the Windows Task scheduler is properly configured and a good wall timer is installed to control the power to the camera, all necessary functions are performed and completed a few minutes after capture completes. Logs are created and copied into the SubmissionFiles\date\camera\ArchivedFiles directory.

Failed Sessions

One last item of business that needs to be discussed is what to do on completely clouded out nights. The scientists have asked for you to create a "comments_<camera>.txt" file and submit the session as normal. You don't need to perform the optional confirmation step for these dates. The comment should indicate something terse, like "overcast", "completely overcast", "completely rained out", "failed to capture", etc.

Update: The current version (0.979e) of AutoCams autonomous mode processing default has been modified to stop autonomous processing after step "9. Apply calibration to detect file". The reason for this was to give the end-user a chance to examine the files, perform confirmation, resolve issues for cloudy nights, etc. To restore the operation to full autonomous mode is a simple task of changing the AutoCams.Params.ini file. Change the "autonomouslevel=apply" to the last step that you want it to autonomously execute. Valid step names are:

cal, apply, applyconfirmed, submit, zip, or ftp.

Note: The AutoCams system is an assortment of batch scripts. The source code for the scripts can be modified by a knowledgeable person. For example, if the scripts don't function properly, you do not need to wait for someone to fix them. However, it is best to communicate any required changes to Dave Samuels (dave@davesamuels.com) so that a new version of the scripts can be properly maintained, versioned, and distributed with the changes. Making extensive changes to the scripts on your own may prohibit us from being able to provide assistance.

Task 3 - Directory Structures.

Note: In the next month or so, I will be attempting to resolve a naming conflict that arrises out of the directory naming scheme that is currently employed. A more unique naming scheme is required when we go public to avoid loss of data by overwriting multiple capture sessions from the same camera on the same night. Some have suggested that this is an infrequent situation, but experience is showing that it is more frequent that we imagined. The .EXE programs will not be changed. Therefore, the scripts will need to perform these directory and filename changes outside of the programs and change the names back to names that are compatible with the .EXE programs when it is necessary. This will add some confusion in the beginning, but I'm sure it will be clear. Doing this

will allow the computer to make appropriate decisions without user intervention These changes will involve the following name changes:

- FTPdetectinfo_0ccc_yyyy_mm_dd.txt will change to:
  FTPdetectinfo_0ccc_yyyy_mm_dd**_hh_mm_ss**.txt

- The directory names will be change from:
  ..\CapturedFiles\yyyy_mm_dd_hh_mm_ss to:
  ..\CapturedFiles**ccc**_yyyy_mm_dd_hh_mm_ss

- The zip files will change the name from:
  yyyy_mm_dd_ccc.zip to:
  ccc_yyyy_mm_dd**_hh_mm_ss**.zip

- The stripped detect files will change their names from:
  FTPdetectinfo_scanned-ccc-#.txt to:
  FTPdetectinfo_scanned-ccc**_yyyy_mm_dd_hh_mm_ss**-#.txt

and
  FTPdetectinfo_confirmed-ccc-#.txt to:
  FTPdetectinfo_confirmed-ccc**_yyyy_mm_dd_hh_mm_ss**-#.txt

Directory Structure - The CAMS directory structure is quite specific. You can install the CAMS software on any directory of any drive. However, the directory structure inside that starting location is specific. The default installation location is C:\CAMS. For this documentation, we will assume that the executable directory is "C:\CAMS". If you installed the software under "F:\astronomy", you would need to place all the executables and scripts into "F:\astronomy\CAMS". The software requires that the directory from which the program is run is called CAMS. If you refer to software to "F:\astronomy\CAMS", the software will assume that the software is on "F:\astronomy\CAMS\CAMS".

Several subdirectories of CAMS are used for various file management reasons. Some have names that are dictated by the .exe programs and others are dictated by the AutoCams scripts. The required directory structure for the .exe programs is as follows (assuming C:\CAMS as the home directory):

ArchivedFiles

Cal

CapturedFiles

ConfirmedFiles

Important Note: These directories are referred to as the "**working directories**".

CapturedFiles - Contains the image frames captured by the camera. A new subdirectory is created each time the capture is started. Each subdirectory is named according to the date and time the capture was started. For example, 2011_12_13_01_56_38. The date and time represent the UTC time (Zulu or GMT if you prefer). If you stop capture and start it again on the same date, you will have two subdirectories. For example, if you stopped capture and restarted on 2011_12_13 at 02:10:14 UTC, you'd have both directories (2011_12_13_01_56_38 and 2011_12_13_02_10_14) under the CapturedFiles directory. Each subdirectory under CapturedFiles contains primarily files

following the naming pattern of FF*.bin. We often refer to these in conversation as the FF files. Each of these files represents about 8.5 seconds of video (specifically, 256 frames at your frame rate 29.97 NTSC or 25 PAL) (8.5 seconds for NTSC and 10.24 seconds for PAL). The file names are encoded with the camera number, UTC date, UTC time, milliseconds, and frame counter. Each FF file for an NTSC video camera is 1,228,820 bytes. This directory can be quite large on a winter nights of over 12 hours of capture (5400 FF files!)

Cal - Contains the calibration files. All the calibration files follow the naming pattern of CAL*.txt. These file names are also encoded with the camera number, UTC date, UTC time, and milliseconds. The UTC time is often 4.27 seconds (5.12 seconds for PAL) different from the matching UTC time in the matching FF file that was used for calibration. This is because the calibration file names use the middle of their 8.5 seconds (10.24 seconds for PAL) and the FF files use the beginning of their capture time.

Cal\BinFiles - This directory is a directory used by the AutoCams scripts. It was created so that a copy of the FF file used for calibration could be stored in case a subsequent night's processing requires it. We refer to one of these files as the "FF file used for calibration".

ArchivedFiles - This directory contains a list of subdirectories that are date/time encoded similar to how the CapturedFiles subdirectories are encoded. Each date/time encoded subdirectory contains a subdirectory that contains a detection file as well a copy of each FF file that has one or more detections in it. The detection file is named according to the following pattern: FTPdetectinfo*.txt. There are a few different variations of the name of this file. So most of us just call it the "detect file" for short. As of about December/January timeframe, the software was updated to use a different naming scheme for the FTPdetectinfo.txt file. The new naming scheme follows this pattern: "FTPdetectinfo_0ccc_yyyy_mm_dd.txt". For example: "FTPdetectinfo_0299_2012_03_07.txt". The ArchivedFiles subdirectory contains a subset of the files from CapturedFiles, typically between 1/7 to 1/20 of the number of files in the CapturedFiles subdirectory.

ConfirmedFiles - This directory contains a detection file that refers to only those detections that are confirmed as meteors or those where it is too difficult to tell whether it is a meteor or a bird or something else. (When in doubt, confirm it). The ConfirmedFiles directory has subdirectories similar to the subdirectories of the CapturedFiles and ArchivedFiles. The number of files under the ConfirmedFiles subdirectory is often 1/10 to 1/20 of the number of files in the ArchivedFiles directory.

The remaining directories are used by the AutoCams scripts:

SubmissionFiles

Submitted

Temp

Transmitted

SubmissionFiles - This directory has its own substructure that mimics the "working directories" structure. Under SubmissionFiles, each date has its own directory, named after the date ("SubmissionFiles\2012_03_07"). Under each date, another subdirectory for each camera exists. ("SubmissionFiles\2012_03_07\299"). If you are running two cameras, you might see both cameras under the date ("298" and "299"). Each camera directory contains a complete copy of the "working directories" for that date/camera combination. This makes it easier to move the files in and out of the working directories for additional processing. Lastly, an additional subdirectory under each camera directory is a directory called **EmailFiles**. This is a special directory that is created during submission processing that contains files that are used to assist in consolidation, reporting and submission. Remember, the FF files are not submitted daily like the detection files are. The EmailFiles directory contains a copy of the comments_???.txt file.

Submitted - This is a directory that is used during creation of the ZIP file that will be uploaded to the local coordinator's server. It is created from the files under the SubmissionFiles directory, so the subdirectory structure is similar. However, it does not include the FF files or log files. In the Submitted directory, you will often find .ZIP files that are named the same as matching subdirectories under the Submitted directory. These are .zip files that have been created but have not yet been uploaded (transmitted) to the local coordinator. Sometimes you will find more than one zip file with the same date (the file will have a numbered suffix such as "2012_03_07_2.zip"). These are zip files that were created after another zip file was already created. The reason for this is because, since anonymous FTP servers don't allow you to overwrite a file that you have already uploaded, we need to keep track of their file names and only upload the latest zip file.

Transmitted - When the upload script is run, and the upload is verified, all the uploaded zip files are "moved" to the Transmitted directory. You should probably keep these around for a while and archive them. There have been many times when the scientists have asked for additional copies. You can use this directory to help you keep track of the dates that have been transmitted to the local coordinator. Dates that are missing should be an indicator that you have some back processing to do.

Temp - This is a directory primarily used for verifying the FTP upload. The way the verification works is this. First, the .zip file is uploaded to the FTP server using the DOS FTP command line utility. Then, the script attempts to download that same file to the Temp directory and check for the presence of the zip file with the same name. If it is there, the upload is deemed to have succeeded and the copy in the Temp directory is deleted. If it is not there, the upload is deemed to have failed.

Task 4 - Download and configure the CAMS software

4.1. Download the zip file(s) from **www.davesamuels.com/cams** and unzip to **C:\CAMS**.

4.2. Determine the latitude and longitude of your camera. You can use this site:
http://www.getlatlon.com/

4.3. Edit "**C:\CAMS\Cal\CameraSites.txt**" using notepad and add the site information to the bottom of the file. Be sure to only use spaces (do not use tabs) to align the text columns. Ideally, you can copy a line of text and paste it to the end of the file. Then change the values

of the camera number, latitude, longitude, etc. You need to be sure to use only a camera number that was assigned to your site. For example:

C:\CAMS\Cal\CameraSites.txt

```
CAM#  Latitude  North Long  Alt(km)     Camera Descr file      Abbr Site Name
123456789a123456789b123456789c123456789d123456789e123456789f123456789g123456789
212   +36.66499 +121.66305  0.016      W902H2U_12mm.txt       SA   Salinas
```

4.4. **Save** and **Exit** Notepad.

4.5. Edit "**C:\CAMS\LASTSETTINGS.txt**" using notepad.

4.6. Change the Longitude and Latitude to match your site's coordinates.

4.7. **Save** and **Exit** Notepad.

4.8. Run "**C:\CAMS\CameraLiveViewer.exe**" to test the software.

4.9. If CameraLiveViewer fails to run with an error something like "the application software isn't configured properly..." do the following:

4.9.1. Double-click **vcredist_x86.exe**. This will provide the runtime libraries that are required. For Windows 7 systems, this library is included and this step would not normally need to be performed.

4.9.2. Test again.

4.10. With CameraLiveViewer running, point the camera in the general direction of a star field that has bright enough stars to locate and use the focus ring on the camera lens inside the weatherproof enclosure to focus the camera. Be sure to tape the lens and the aperture rings so that they won't move after you have reached focus.

Tip: Spend the necessary time to attain accurate focus now. Doing so now will prevent you from having to recalibrate the camera due to refocusing later. You will likely need to recalibrate manually every time you touch the camera.

4.11. Point the enclosure/camera in the general direction of the ALT/AZ that you were assigned for your camera. Check with a planetarium program to locate the stars that match your field of view (FOV).

Tip: If you have a green laser available, you can hold it on the enclosure (or temporarily tape it to it) so that they are both pointing in the same direction. You will be able to see the laser in the CameraLiveViewer window. You can use this to help you position your camera more precisely. If you don't have a green laser, you might have luck taping a straw to the enclosure and use it as a kind of siting scope.

Task 5 - Calibrate the FOV (Manual Calibration).

The field of view (FOV) needs to be calibrated so that there is an accurate record of the RA/DEC and flux for each meteor track. The way this works is that the program compares an image created from averaging actually 256 frames of video with a simulation of the same region of sky that is created from a database of up to 8.5 magnitude stars (C:\CAMS\STARS8TH_VBVRI.txt).

There are four methods for calibration. First is FTP_MeteorCal.exe. The second is FTP_MeteorCal_Update.exe. The third is FTP_MeteorCal_AutoUpdate.exe, and FTP_MeteorCal_AutoUpdate with prompts.

Use FTP_MeteorCal.exe under the following circumstances:

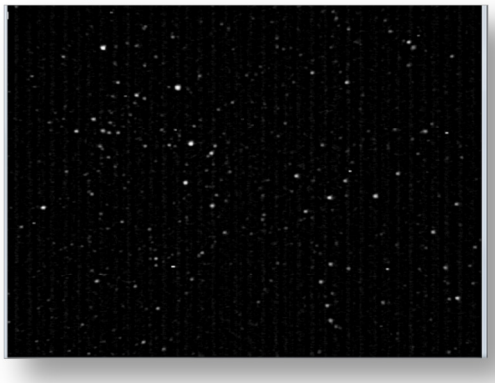
- when you first set up the system
- whenever the camera is moved
- when you can't obtain a "Mean O-C" under 1.0 with sufficient number of stars (at least 50 stars) with FTP_MeteorCal_Update.exe or FTP_MeteorCal_AutoUpdate.exe, and re-running FTP_MeteorCal_Update.exe several times doesn't improve the numbers.
- When AutoCal fails

5.1. Capture a few frames for you to use for calibration by performing the following step:

5.1.1. From a command prompt enter the following commands:

```
cd \cams
ftp_capture <your camera number> 0.02 c:
```

The program will respond with a text window and a graphic window. After about 12 seconds, it will terminate on its own.



5.2. Run "**C:\CAMS\FTP_MeteorCal.exe**".

5.3. Enter the **camera number**...

5.4. Navigate to and select an **FF...bin** file that has a star field that you recognize. The FF files will be located in a subdirectory of the C:\CAMS\CapturedFiles directory. The subdirectory is named with the most recent date/time.

5.5. Use a planetarium program to locate the center of the FOV.

Tip: Use a planetarium program, such as StarryNight, TheSky, Cartes du Ciel, etc. to determine the RA/DEC and Alt/Az at the time of day the .bin file was captured.

Cartes du Ciel means "Sky Chart". You can download it for free from:
http://www.ap-i.net/skychart/start

The planetarium program can be adjusted to the same UTC time as the time shown in the video frame. Move the planetarium program to point to the same constellation that you recognize.

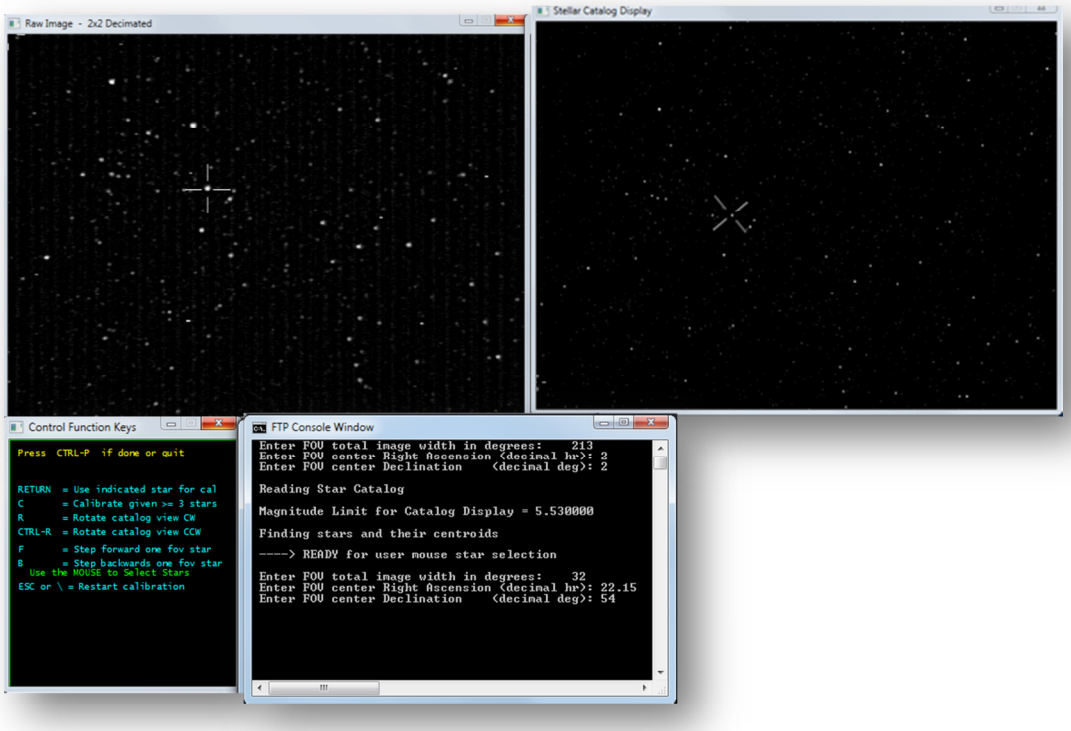
If you have previous calibrations the are close enough, you can use the RA/DEC values from that. Another improved method is to use the AutoCams "7d. Manual Calibration". It will prompt you for the time of the FF file you will be using for calibration and calculate your new RA, DEC, and FOV values for you.

5.6. Navigate to and select the "**...\CAMS\Cal**" directory to save the calibration to.

5.7. Enter the **FOV** width in degrees: **32**

5.8. Enter FOV center **Right Ascension** (degrees):
(obtain this from the planetarium program and multiply the hour by 15)
Example: 22hr 09m is **9**/60 + **22** = 22.15. Then multiply that by 15.
22.15 X 15 = **332.25**. So, you'd enter 332.25.

5.9. Enter FOV center **Declination** (decimal deg):
Example 54.21 for 54 deg 13' 9" (obtain this from the planetarium program)
Example: 13.15/60 + 54 = 54.219
The four calibration windows appear.



The image on the top-left is from a captured frame (FF file). The image on the top- right is produced from a database of stars over 8.5 magnitude. The window on the bottom-left is a window containing some instructions on how to skip forward or backward, to rotate the FOV, etc. The console window on the bottom-right is where you enter values and where it displays feedback during calibration.

The application will usually select a star on the left and right. Very often, it is difficult to match the stars that the application chooses for you. Just ignore that and select the star on the left that you recognize and do that same on the right.

5.10. **Select a star** on the left (from a captured frame) that matches a star on the right (from the database).

5.11. **Select the matching star on the right** (from the database) and press the **RETURN** key to accept. Be very careful to select the proper star. Avoid stars that have closely positioned stars adjacent to them. In that case, press **F** to skip forward to the next star.

5.12. Repeat until at least 6 stars have been matched/calibrated (try to calibrate the center and the corners first).

5.13. Once 6 stars are calibrated, the application will facilitate the selection of stars by choosing the star on the right and automatically matching it with the closest star on the left.

5.14. You should be able to just press **RETURN** for those that match. However, if you don't see a star on the left in the crosshair, press the **F** or **B** keys to move forward/backward to the next choice. You don't want to calibrate on noise, hot pixels, satellites, doubles, or other artifacts. Also, for the first 60-80 or so stars, press **F** if a star appears very close to another star.

5.15. Continue this accurate calibration **until about 40 -80 stars** have been calibrated.

5.16. At this point, press "C" to Calculate.

5.17. It will display:

```
Number of calstars used = 114 0.949523 0.417211

Mean O-C =   0.950 +-   0.417 arcmin

Do another calibration outlier purge (1=Yes,0=No)
```

5.18. The key value you are looking for is a "**Mean O-C**" value of 0.999999 or less. If it is greater than or equal to 2.50, press **1** to exclude some of the outlier's (Stars with a less than accurate alignment) and then it will re-calculate and show a new Mean O-C and the number of calstars used. If you can't achieve a Mean O-C of under 2.50 with sufficient number of stars (50-100, but not less than 40), you will need to re-do the FTP_MeteorCal.exe procedure again and be extra careful to skip doubles, hot pixels, etc. or use a different frame that has better video fidelity or less noise.

5.19. Once you achieve a Mean O-C value of under 1.000 with a significant number of calstars used, press "**0**", then **Ctrl+P** to process and save.

You should not need to, but if you want to rotate the database display during calibration you may do so by pressing R or Ctrl+R.

5.20. It is a good practice to then run an option "7b. Auto Calibration Update" after a manual FTP_MeteorCal.exe in order to refine the calibration further. Don't use an FF file that is earlier in the night than the one chosen for the manual calibration.

Task 6 - Manual Re-Calibration Example Run:

6.1. Here is an example of performing a Manual re-calibration using option "7d. Manual Calibration"...

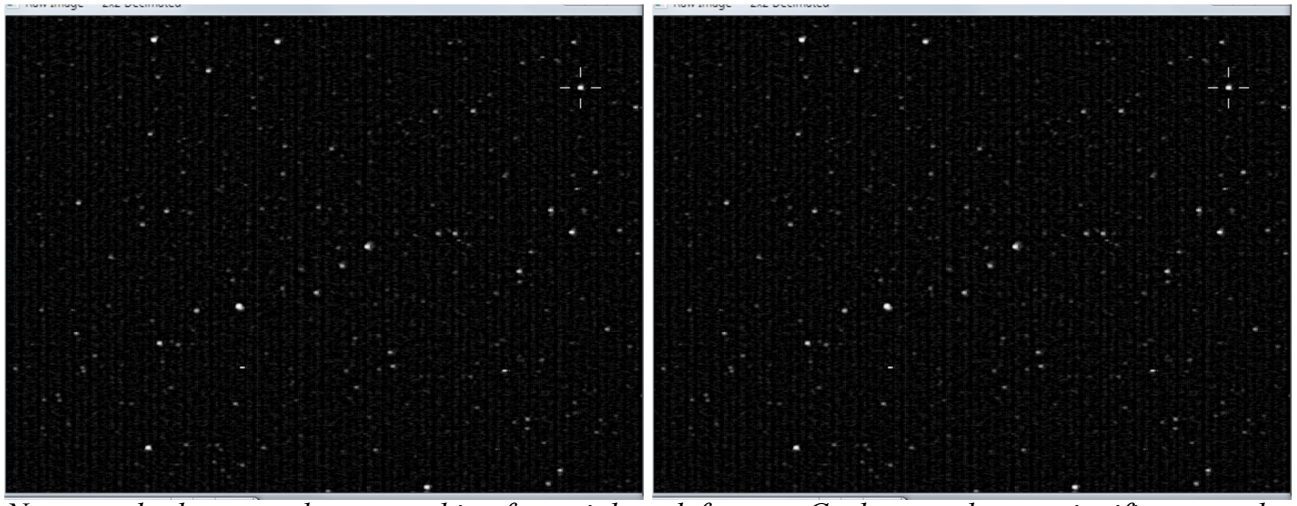
This might be helpful in running a manual cal when autocal fails. Here is a sample output…

- Yellow means what you enter;
- Gray means something you should read or pay attention to;
- Green means a result that you should be aware of

Single-CAMS
CAMS

```
 C:\CAMS\AutoCams.bat - CAMS MENU Vers 0.979e  for Captured Date: 2012_06_05

 1.  Choose target location     c:
 2.  Enter Camera               213
 3.  Enter Captured Date        2012_06_05

 4.  Choose CapturedFiles       [Files=1]       "c:\CAMS\CapturedFiles\2012_06_05_04_09_32"
 5.    Check Skipped Frames and dropped frames
 6.  Choose ArchivedFiles       [F/Det=0/425]   "c:\CAMS\ArchivedFiles\2012_06_05_04_09_32"
                                [detect=FTPdetectinfo_0213_2012_06_05.txt]
Calibration Options:
 7a. Calibration Update         (FTP_MeteorCal_Update)                  "c:\CAMS\ArchivedFiles\2012_06_05_04_09_32"
 7b. Auto Calibration Update    (FTP_MeteorCal_AutoUpdate)              "c:\CAMS\CapturedFiles\2012_06_05_04_09_32"
 7c. Auto Cal with prompts      (FTP_MeteorCal_AutoUpdate w/ prompt)    "c:\CAMS\CapturedFiles\2012_06_05_04_09_32"
 7d. Manual Calibration         (FTP_MeteorCal)

 9.  Apply Cal to Archived      Current Cal: CAL213_20120530_105148_548.txt

10.  FTP Confirmation           [Count: 0]      "c:\CAMS\ConfirmedFiles\2012_06_05_04_09_32"
11.    Edit comments.txt file
12.    Apply Cal to Confirmed   Confirmed Cal:

Submission dir functions:       [""]
13.  Package Working dirs into SubmissionFiles dirs
14.    Choose Submission dir
15.    Move SubmissionFiles dirs to working files dirs
16.  Zip Submitted dir
17.  Upload Zip via FTP (Submit)
18.  Report on Submission

 A.  Autonomous mode           FA. Fix Detect Paths Archived   [FixDetectPaths.bat]
 R.  Reset                     FC. Fix Detect Paths Confirmed  [FixDetectPaths.bat]
 U.  Utility Menu              ClearError. Clear recent error message
 Q.  Quit
              Last error msg:
Enter choice: 7d


'  The current captured date is:        20120605
'  The most recent  Cal file is: CAL213_20120530_044253_090.txt
'  The detect file is using Cal: CAL213_20120530_105148_548.txt
'     ("C:\CAMS\ArchivedFiles\2012_06_05_04_09_32\FTPdetectinfo_0213_2012_06_05.txt")

Press Enter to continue or [Q]uit:
  call "C:\CAMS\ValidateCal.bat" /cal "C:\CAMS\Cal\CAL213_20120530_105148_548.txt"
=======================================================
C:\CAMS\ValidateCal.bat /cal "C:\CAMS\Cal\CAL213_20120530_105148_548.txt"

  CAL213_20120530_105148_548.txt, [Cal stars=51] O-C=0.371+-0.161 Scale=2.509 [ALT=53.751 AZ=330.717] [RA=247.3660 DEC=64.505]

  RA=247.3660, DEC=64.505, time=10:51:48
  FOV=29.5

    call :CALC_CAL_VALUES 247.3660 64.505 105431 10:51:48 "C:\CAMS\Cal\CAL213_20120530_105148_548.txt"
set /a "bat_hour=((3100 / 60) + 5400) / 60) + 1000"

    Data from current calibration file: C:\CAMS\Cal\CAL213_20120530_105148_548.txt
       time=10:51:48, 10.8600
       RA  =247.3660, 2473660
       DEC =64.505
```

```
    Data from the FF file based on the entered time segment: 105431
       time=10.90
       RA  =255.2660
       DEC =64.505


    When the File chooser dialog appears, navigate to and select an FF file
    named something like this:
       FF213_20120605_105431...

    After that, you will be asked for the FOV, RA, and DEC of the
    new FF file.

    In the MeteorCal program:
      - Press ESC to re-enter FOV, RA, and DEC
      - Do the manual star matching from right to left
      - Press Enter after each match
      - Press F and B to skip forward or backward
      - When you have matched about 80 or more stars, press "C"
      - Then press "1" to discard outliers until the star count gets
        between 50 and 60.
      - Finally, press Ctrl+P to complete the calibration and return to the menu.


    Then, considering the new FF file with a time segment value
    of 105431, you will want to enter the following values:
       FOV = 29.5
       RA  = 255.2660
       DEC = 64.505
Press Enter to continue or [Q]uit:
    call "C:\CAMS\FTP_MeteorCal.exe" 213 "C:\CAMS\Cal"

------------------------------------------------------------
    METEORCAL 1.00 - Copyright 2010  Peter S. Gural
------------------------------------------------------------

 Opening dialog box to search for FF213*.bin files

 ----> READY for user mouse star selection
 Enter FOV total image width in degrees:    29.5
 Enter FOV center Right Ascension (decimal deg): 255.2660
 Enter FOV center Declination    (decimal deg): 64.505

 Finding stars and their centroids

 Reading Star Catalog

 Magnitude Limit for Catalog Display = 9.000000

 ----> READY for user mouse star selection
```



Now you do the manual star matching from right to left, press C when you have a significant number of cal stars matched, and press "1" to discard outliers until the star count gets between 50 and 60. Finally, Press Ctrl+P to complete the calibration and return to the menu.

```
********** Star #1 **********
********** Star #2 **********
********** Star #3 **********
********** Star #4 **********
********** Star #5 **********
********** Star #6 **********
********** Star #7 **********
********** Star #8 **********
********** Star #9 **********
********** Star #10 **********
********** Star #11 **********
Etc…

Calibration completed ----------------------------

 Field of View Size        =   20.8 X 27.2 deg
 FOV center Azimuth        =  330.3 deg East of North
            Elevation      =   53.7 deg Above Horizon
 Plate scale               =   2.8 arcmin/pixel
 Plate Roll wrt Std coords = -117.4 deg
 Camera Tilt wrt Horizon   =   0.8 deg
 FOV center RA             =  254.14 deg =   16.94 hr
 FOV center Dec            =   64.32 deg

 Cubic calibration completed ----------------------

 Field of View Size        =   22.1 X   29.6 deg
 FOV center Azimuth        =  330.3 deg East of North
            Elevation      =   53.7 deg Above Horizon
 Plate scale               =   2.8 arcmin/pixel
```

```
 Plate Roll wrt Std coords = -117.3 deg
 Camera Tilt wrt Horizon   =   0.8 deg
 FOV center RA             =   16.94 hr
 FOV center Dec            =   64.31 deg

 1   Xcoef =   8.885037e-017    Ycoef =  -4.336809e-017
 x   Xcoef =  -3.677461e-004    Ycoef =   7.123382e-004
 y   Xcoef =  -7.085541e-004    Ycoef =  -3.720296e-004
 xx  Xcoef =  -1.158927e-008    Ycoef =   4.430910e-009
 xy  Xcoef =  -9.863902e-009    Ycoef =   1.205106e-009
 yy  Xcoef =  -1.008194e-009    Ycoef =   4.514046e-011
 xxx Xcoef =  -1.342416e-010    Ycoef =   2.158130e-010
 xxy Xcoef =  -2.789358e-010    Ycoef =  -5.431456e-011
 xyy Xcoef =  -1.189345e-010    Ycoef =   2.197064e-010
 yyy Xcoef =  -2.774268e-010    Ycoef =  -4.729159e-011
 -----
 Mean O-C =   2.736 +-   5.244 arcmin
Number of calstars used = 192 1.258318 0.872481
Mean O-C =   1.258 +-   0.872 arcmin

 Cam 213 - Do another calibration outlier purge (1=Yes,0=No)
Number of calstars used = 58 0.447932 0.183810
Mean O-C =   0.448 +-   0.184 arcmin

 Cam 213 - Do another calibration outlier purge (1=Yes,0=No)

 Check Calibration:  CTRL-P to ACCEPT
                     Escape or \ to Start Over

 Hit ENTER key to return to main menu

SUCCESS
  Be sure to write down the date/time of the FF file used for calibration.

'    call "C:\CAMS\ValidateCal.bat" /cal "C:\CAMS\Cal\CAL213_20120605_105631_326.txt"
=====================================================
C:\CAMS\ValidateCal.bat /cal "C:\CAMS\Cal\CAL213_20120605_105631_326.txt"

  CAL213_20120605_105631_326.txt, [Cal stars=58] O-C=0.448+-0.184 Scale=2.762 [ALT=53.724 AZ=330.345] [RA=254.1820 DEC=64.319]


'    Next steps are:
'      1) Run AutoCams option "7b. Auto Calibration Update" to fine tune this manual calibration
'      2) Run AutoCams option "9. Apply Cal to Archived" once you have a good calibration


Press any key to continue . . .
```

6.2.

Task 7 - Understanding and Setting up the Twilight table.

The twilight table is a text file generated from a Microsoft Excel spreadsheet that calculates the sunset/sunrise/dawn/dark, and other parameters for every day of the year for 5 years. It requires that you enter some data about your site. If you don't have Microsoft Excel, have someone else edit the table with your Lat/Long and time zone and then they can send you the generated "twilight.csv.txt" file. The "twilight.csv.txt" file is read by LaunchCapture.bat and CheckTwilight.bat. In this task, you will modify the Excel spreadsheet, save the calculated values to a comma-separated values (CSV) text file, and run CheckTwilight.bat to report the launch characteristics for the LaunchCapture.bat file via the Windows Task Scheduler at the same time each day (you will create this scheduler task in the next task).

Note: The Daylight Savings calculation is embedded in this spreadsheet. Whether daylight savings is used for each date is determined based on the C10 and D10 fields that you can enter. However, if there is a chance that some part of this calculation makes it fail, and if that happens, there are a few things you can do to troubleshoot.

First, scan the table of dates under column H. Watch for when the 0 changes to 1 and then back again to 0. The dates these changes occur in the table should match the DST rules of your locale. If C10 and D10 are correctly entered and if column H has errors, there are a few solutions.

One is that your computer could be set to UTC time and then no DST offsets would be used. The DST calculation is set in the fields of column H. If you have issues with this, contact your central administrator and they will either give you a spreadsheet file that is compatible with your area or a text file that is compatible with your area. The Excel spreadsheet isn't required, only the text file.

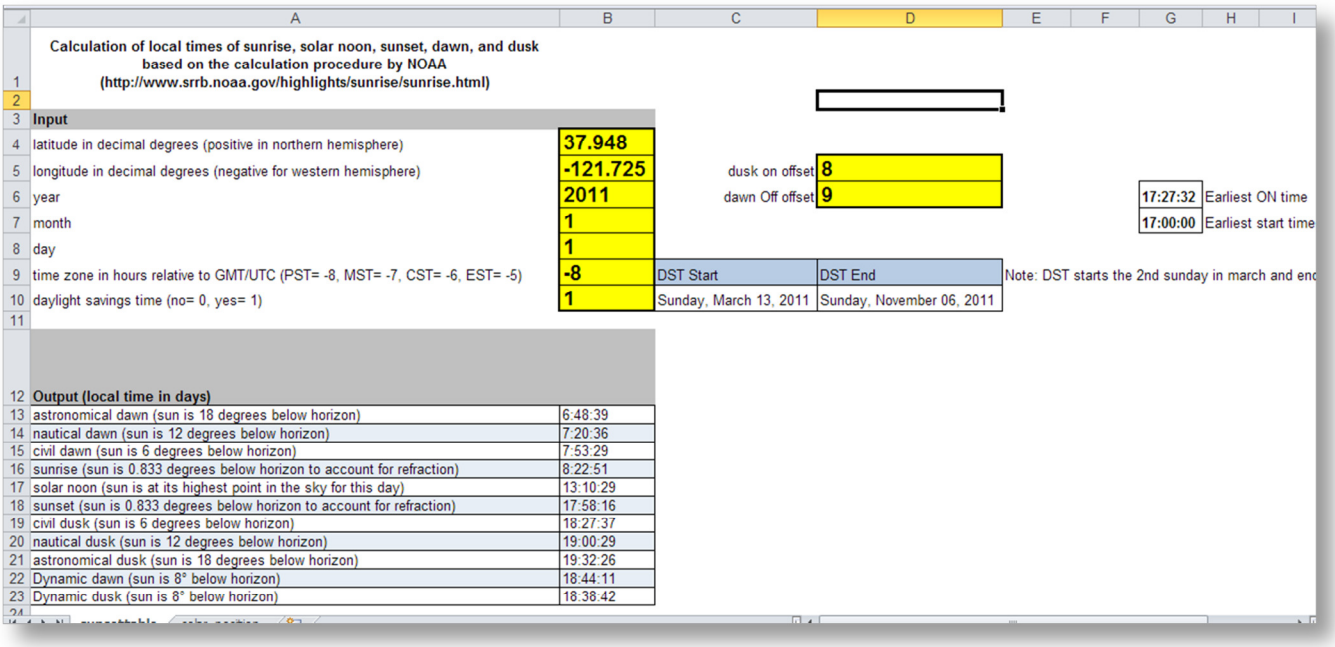
See the following web sites for DST tables containing DST dates and rules for different regions of the world (because web sites come and go, I will list several links):

http://wwp.greenwichmeantime.com/daylight-saving-time/usa/dst-2007.htm

http://www.webexhibits.org/daylightsaving/g.html

http://worldtimezone.net/daylight.html

7.1. Using **Microsoft Excel**, open the "**C:\CAMS\twilight.xlsm**" file. The spreadsheet appears:



	A	B	C	D	E	F	G	H	I
1	**Calculation of local times of sunrise, solar noon, sunset, dawn, and dusk based on the calculation procedure by NOAA (http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html)**								
2									
3	**Input**								
4	latitude in decimal degrees (positive in northern hemisphere)	37.948							
5	longitude in decimal degrees (negative for western hemisphere)	-121.725	dusk on offset	8					
6	year	2011	dawn Off offset	9			17:27:32	Earliest ON time	
7	month	1					17:00:00	Earliest start time	
8	day	1							
9	time zone in hours relative to GMT/UTC (PST= -8, MST= -7, CST= -6, EST= -5)	-8	DST Start	DST End	Note: DST starts the 2nd sunday in march and end				
10	daylight savings time (no= 0, yes= 1)	1	Sunday, March 13, 2011	Sunday, November 06, 2011					
11									
12	**Output (local time in days)**								
13	astronomical dawn (sun is 18 degrees below horizon)	6:48:39							
14	nautical dawn (sun is 12 degrees below horizon)	7:20:36							
15	civil dawn (sun is 6 degrees below horizon)	7:53:29							
16	sunrise (sun is 0.833 degrees below horizon to account for refraction)	8:22:51							
17	solar noon (sun is at its highest point in the sky for this day)	13:10:29							
18	sunset (sun is 0.833 degrees below horizon to account for refraction)	17:58:16							
19	civil dusk (sun is 6 degrees below horizon)	18:27:37							
20	nautical dusk (sun is 12 degrees below horizon)	19:00:29							
21	astronomical dusk (sun is 18 degrees below horizon)	19:32:26							
22	Dynamic dawn (sun is 8° below horizon)	18:44:11							
23	Dynamic dusk (sun is 8° below horizon)	18:38:42							

7.2. Complete the form by entering the appropriate values in the yellow fields:

- B4 - Latitude: **37.31488**
- B5 - Longitude: **-121.60542** (Negative values for Western hemisphere)
- B6 - Year: **2011** (enter the year of Jan 1 of the current year)
- B7 - Month: **1** (enter 1, for January)
- B8 - Day: **1** (enter 1, for January 1)
- B9 - Time zone: **-8** (enter the number of hours offset for your time zone. Use negative numbers for the western hemisphere. Do not include daylight savings offsets in this value)
- B10 - Daylight Savings: **1** (Enter 1, if DST is used in your timezone, otherwise, enter 0. The proper local time will be calculated for each date, based on B9, C10, and D10.
- C10 - DST Start: **03/13/2011** (enter the date when daylight savings starts. If B10 is set to 0, this field is ignored. Since 2007, the DST calculation in the USA was changed)
- D10 - DST End: **11/06/2011** (enter the date when daylight savings ends. If B10 is set to 0, this field is ignored)

- D5 - Dusk ON offset: **8** (enter the sun angle in degrees when it is dark enough to turn on the camera. Error on the side of capturing 5 minutes or so of white frames)
- D6 - Dawn OFF offset: **9** (enter the sun angle in degrees when it will be no longer dark enough to capture meteors. Error on the side of 5 minutes or so of white frames)

7.3. Take note of the value of "**G7 - Earliest start time hour**". This is a value, truncated to the hour. This field needs some explanation:

The "**Earliest start time hour**" field is calculated by scanning column E (Dusk ON) and looking for the earliest value throughout the year that appears in the column. You would typically think of Dec 21 as the longest night of the year. However, when you consider the dusk sun angle, the earliest ON time is not Dec 21. Finally, the value is adjusted to the lowest even hour. For example, in northern California, 17:27:32 is the earliest start time using 8 degrees for the dusk sun angle. The "Earliest start time hour" is then set to 17:00:00, which is the time that you should set your Task Scheduler to. At that time of each day, the LaunchCapture.bat script will run.

The LaunchCapture.bat script looks up the current date in the twilight.csv.txt file and fetches the Camera ON time for that date, along with the OFF time and other values. Then it calculates the length of time, in seconds, between the current time and the Camera ON time. Then it sleeps for that many seconds. Essentially, this puts the launch code to sleep until the Camera ON time. All these machinations are done to solve a few issues:

- The system can be run as unattended as feasible.
- The Dusk/Dawn is changing every day, so you won't need to constantly adjust the Camera ON/OFF times and the Task Scheduler start trigger.
- You don't want to captured multiple gigabytes of extra white-out until it is dark enough to capture stars and meteors.

The *Duration* value is calculated from the Camera ON time or the Current Time. When LaunchCapture.bat is executed before the scheduled Camera ON time, the delay is used and the caption bar indicates a progress bar "XXX-------" showing how much time is left to wait until the scheduled Camera ON time (which is also displayed in the title bar of the console window)

If, for some reason, the LaunchCapture.bat script is executed after the scheduled Camera ON time, there is no delay and the *Duration* value is adjusted to run from the current time until the Camera OFF time. The image below shows an example of the LaunchCapture.bat script output when it was launched at 17:05:59 where the Camera ON time is 18:44:44. In this case, the dusk sun angle is set to 8 degrees below the horizon and the dawn sun angle is set to 9 degrees below the horizon.

7.4. To save your changes to the editable spreadsheet, from the Excel menu, select **File > Save**.

7.5. To generate the "**twilight.csv.txt**" text file. This can be done either by using Save As or Copy/Paste:

7.5.1. Using Save As:

7.5.1.1. From the Excel menu, select **File > Save As**.

7.5.1.2. For "Save as type", select "**CSV (Comma delimited) (*.csv)**".

7.5.1.3. For "File name", enter "**c:\cams\twilight.csv**".

7.5.1.4. Then locate the file name in the "**C:\CAMS**" directory and rename it to "**twilight.csv.txt**".

7.5.2. Using Copy / Paste:

7.5.2.1. Using Notepad, open "**C:\CAMS\twilight.csv.txt**".

7.5.2.2. **Select All**.

7.5.2.3. Press the delete key (not Cut). **Delete**.

7.5.2.4. In Excel, click inside the spreadsheet.

7.5.2.5. Press Ctrl+A, to select all.

7.5.2.6. Press Ctrl+C, to copy into the clipboard.

7.5.2.7. In Notepad, **Paste**.

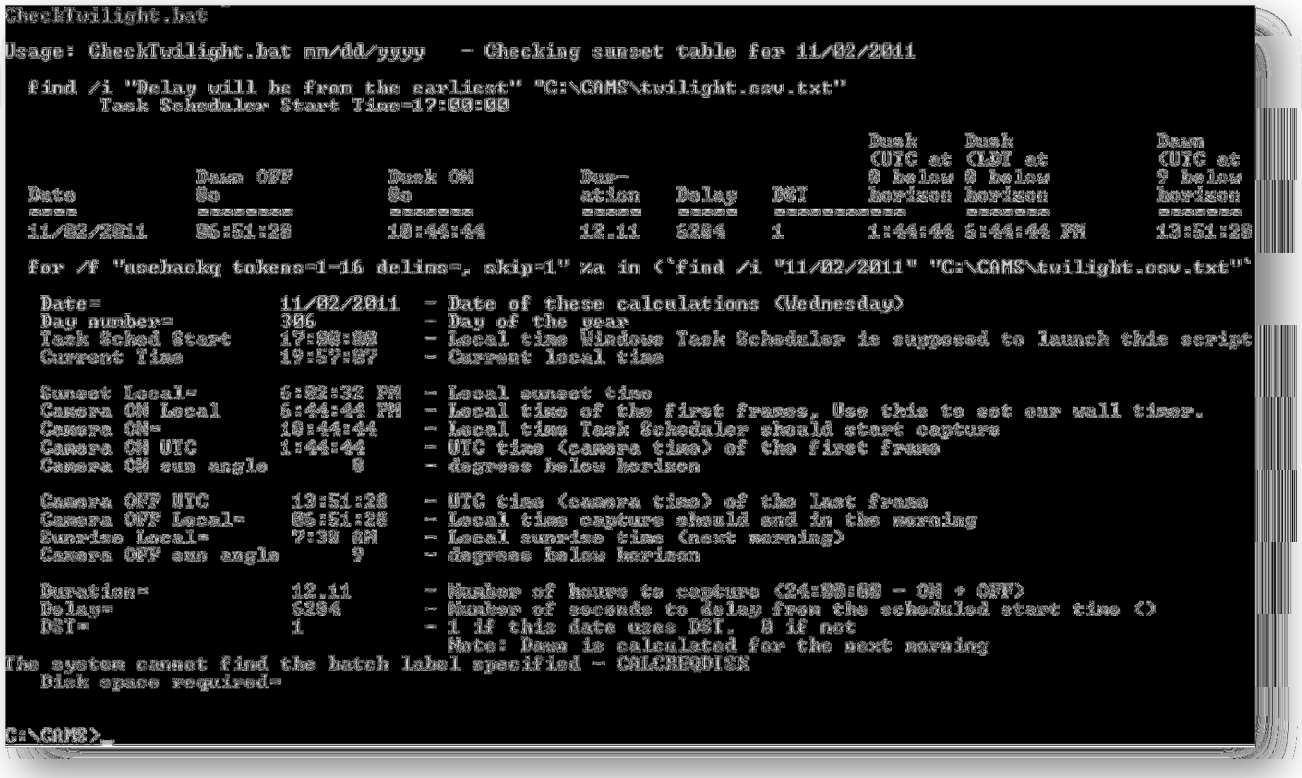
7.5.2.8. **Save**.

7.6. Validate the changes using CheckTwilight.bat...

7.6.1. From a command-shell, in the C:\CAMS directory, enter the following command:

```
C:\CAMS>CheckTwilight
```

7.6.2. CheckTwilight should show the sunset/sunrise to match the proper values for your location. See below...



Task 8 - Setting up the Task Scheduler

Note: The Windows Task scheduler behaves differently on practically every version of Microsoft Windows. The location of the program is even at a different location of almost every different version of Windows.

8.1. Start the **Windows Task Scheduler** according to the method on the version of Windows you are using. For example, on Windows 7, you can run the following command from **Start > Run**:

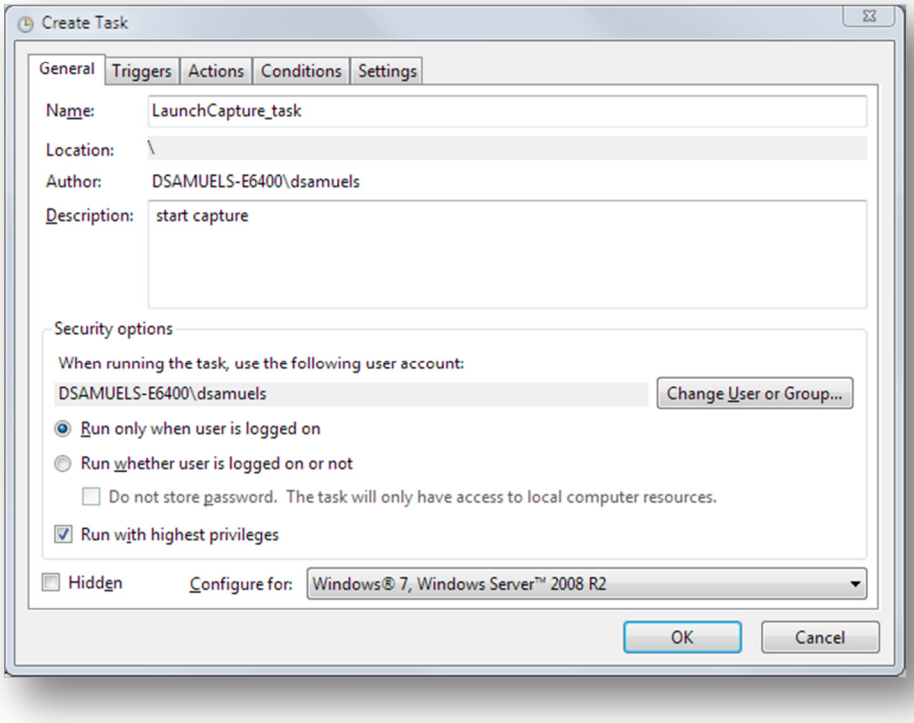
taskschd.msc /s

In Windows XP, the Task Scheduler is found in **Start > Programs > Accessories > System Tools > Scheduled Tasks**.

8.2. In the Actions pane on the right, select "**Import Task...**".

8.3. Navigate to and select "**C:\CAMS\LaunchCapture_task.xml**".

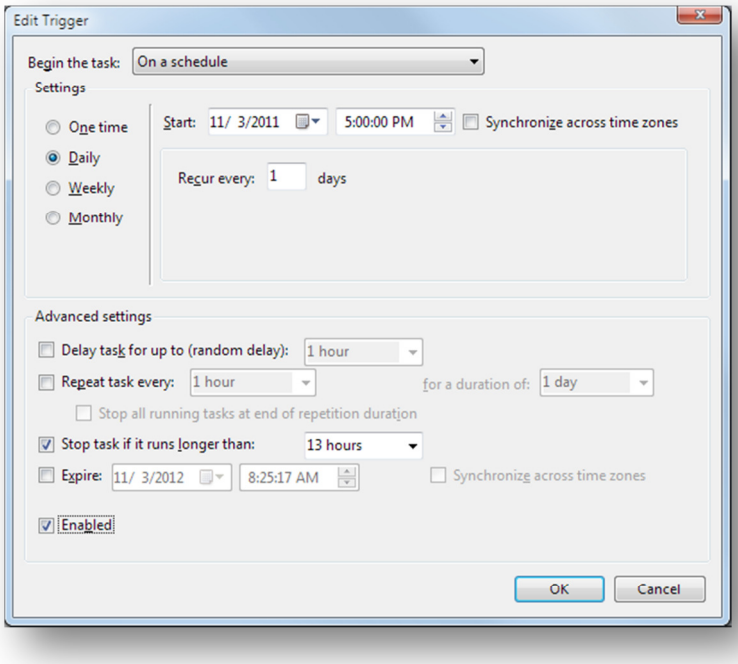
8.4. Click **Open**. The Create Task dialog appears.



8.5. The form should contain the following configuration:

- For Name, enter: **LaunchCapture_task**
- For Description, enter: **start capture.**
- **Run only when user is logged on**
- **Run with the highest privileges**

8.6. Select the **Triggers** tab. The Triggers tab appears.



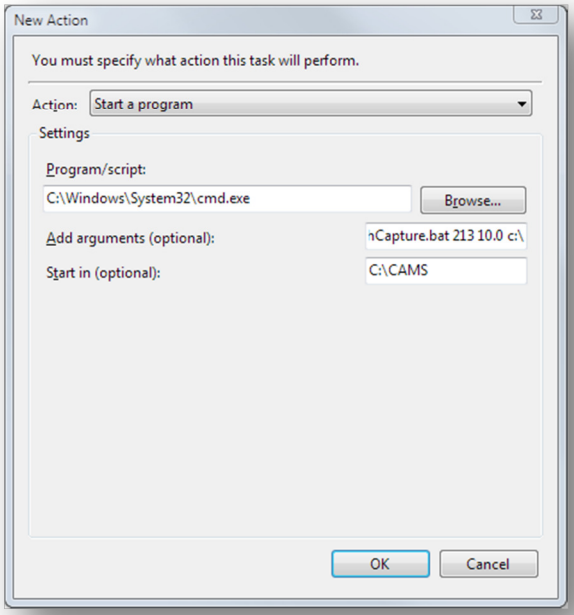
8.7. The form should be configured as follows:

- Begin the task: **On a schedule**
- Settings: **Daily**
- Start: (enter the value reported by CheckTwilight.bat as the "**Task Sched Start**". For example, 17:00:00 for northern California means to enter **5:00:00 PM**)
- Recur every:____**1**____days
- Advanced settings are all unchecked except:
    - **Stop task if it runs longer than**: __**13 hours**___
      (Note: You'll have to manually enter the text "13 hours". The closer to the pole you
    - Enabled

8.8. Click **OK**. The Triggers dialog is dismissed.

8.9. Select the **Actions** tab.

8.10. Click **Edit...**. The New Action dialog appears.



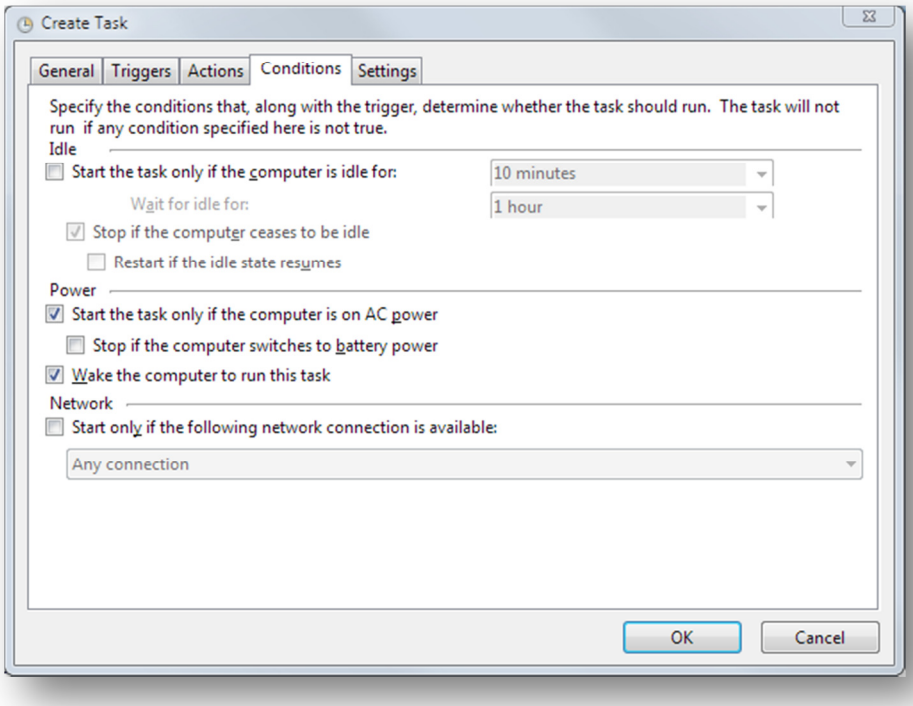
8.11. The form should be completed as follows:

- Action: **Start a program**
- Program/script: **c:\windows\system32\cmd.exe**
- Add arguments: **/k c:\CAMS\LaunchCapture.bat 213 0.02 c:\ autonomous**
- Start in: **C:\CAMS**

Note: If your system can't handle simultaneous capture and detect, then do the following: Rename the "**FTP_Capture.bat.ini.disabled**" file to "**FTP_Capture.bat.ini**".

8.12. Click **OK**.

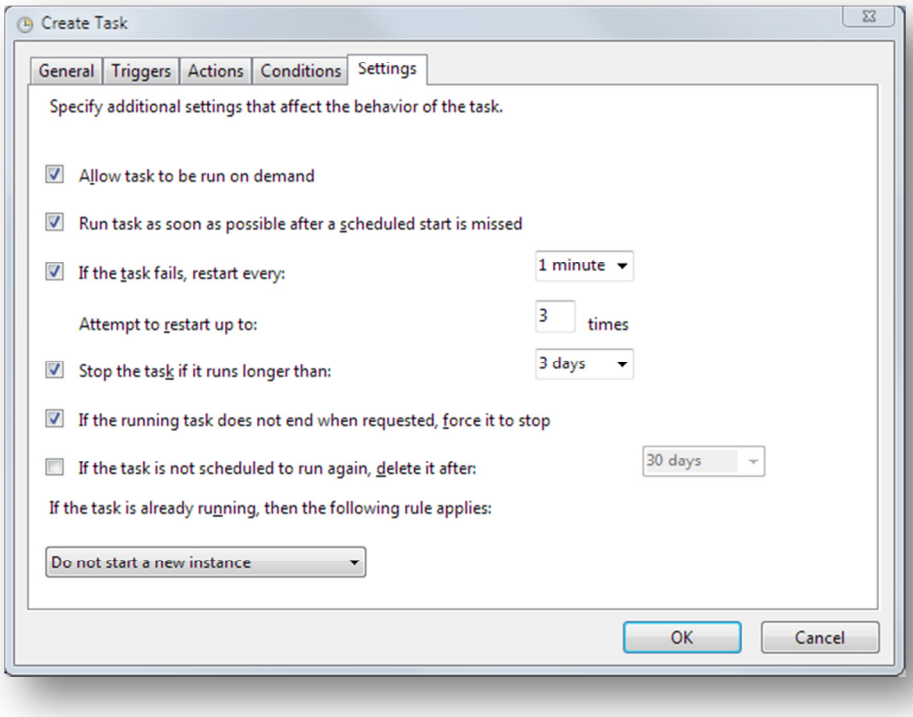
8.13. Select the **Conditions** tab.



8.14. The form should be completed as follows (all uncheck except):

- **Start the task only if the computer is on AC power.**
- **Wake the computer to run this task.**

8.15. Select the **Settings** tab.



8.16. The form should be configured as follows (All checked except):

- **If the task is not scheduled to run again, delete it after...**
- If the task is already running, then the following rule applies:
  Do not start a new instance

8.17. Click **OK**.

8.18. Test it by selecting the " **Run**" action in the Actions pane on the right.

8.19. Make any corrections as necessary.

8.20. **Close** the **Task Scheduler** window.

Task 9 - Summary of the daily procedures

This section outlines the procedures that will be performed daily. The Collect, Transmit, and Archive steps are still being worked out. The procedures for those steps are likely to evolve over time. What is most important is that data is not lost and that it gets transmitted to NASA.

These daily steps take less than 5 minutes per night of capture. More if you have issues to resolve. If you have enough storage, you can let the system run unattended for a week or so and perform the manual steps after the fact. The main thing is the keep capture going. The second most important thing is to keep the Reprocess step going (if you're not using the new CaptureAndDetect program).

If you don't capture, the project will be missing that data. If you don't reprocess, you will get behind and it is difficult to catch up.

9.1. **Capture video (Capture And Detect)**

This step should be configured to happen automatically according to the twilight.csv.txt file each day at the optimal time for the optimal duration. See Task 10 - Capturing Video.

If your computer has multiple CPUs and it can perform the real-time detection without dropping frames, you can use **FTP_CaptureAndDetect.exe**. Otherwise, **FTP_Capture.exe** is used.

9.2. **Identify the Source directories** (sometimes referred to as Target Location)

This step should automatically be handled in autonomous mode.

9.2.1. In the AutoCams menu, enter the values for "1. Target Location", "2. Camera", and "3. Captured Date". AutoCams will remember the target location and camera number.

9.2.2. The new CaptureAndDetect.bat script automatically updates the AutoCams.bat.ini configuration file so that the directories are already selected and it's ready to use. If it doesn't, or if you're processing another date, [R]eset and start over with "3. Enter Captured Date".

9.3. **Reprocess**

This step should automatically be handled in autonomous mode if your computer can handle the real-time capture and detect without dropping frames. .

The **FTP_Reprocess.exe** program performs the MeteorScan routine. When it finds a possible meteor, it records the information into the "C:\CAMS\ArchivedFiles\<target directory>\ftpdetectinfo.txt" file. This procedure is now incorporated into the CaptureAndDetect program. In the AutoCams system, this has been moved to the Utility menu since the CaptureAndDetect program now performs this in real-time.

9.4. **Calibrate**

This step should automatically be handled in autonomous mode if **autonomouslevel=cal** or higher is configured.

There are four methods for calibration. First is **FTP_MeteorCal.exe**. The second is **FTP_MeteorCal_Update.exe**. The third is **FTP_MeteorCal_AutoUpdate.exe**. The forth method is using **FTP_MeteorCal_AutoUpdate.exe** but being prompted for the target minimum meteor count and minimum acceptable Mean O-C value. Use FTP_MeteorCal.exe whenever the camera is moved, or if you can't obtain a "Mean O-C" under 1.0 with sufficient number of stars (at least 50 stars) with FTP_MeteorCal_Update.exe or FTP_MeteorCal_AutoUpdate.exe. Preferably, the autoupdate will do the job for you.

The **ValidateCal.bat** script can be used to check that the Mean O-C is under 1.0 and that the minimum number of stars is used. The **ValidateCal.bat** script can be run for the currently selected date by entering "**36. ValidateCal.bat**".

Optionally, the calibration procedure can be delayed until after the Reprocess procedure. If the calibration is performed after the **FTP_Reprocess** procedure, use **FTP_ApplyCal2Detectinfo.exe** to apply the calibration to the **FTPdetectinfo.txt** file after the fact.

9.5. Apply calibration to detect file

This step should automatically be handled in autonomous mode if **autonomouslevel=apply** or higher is configured.

Use this script to apply the new calibration file that you generated in the previous step to the FTPdetectinfo.txt file that is in the ArchivedFiles directory.

9.6. Confirmation

This step cannot be automated and remains a manual task. However, **you only need to perform this step if you want to track the meteor count locally**.

The Confirmation step is optional. However, if you get a chance to run it, it will give you an idea of the level of activity each night. If you perform the confirmation process meticulously enough, you can submit the FTPdetectinfo.txt file from the ConfirmedFiles directory instead of from the ArchivedFiles directory. In that case, the ConfirmedFiles subdirectories are usually much smaller.

9.7. Edit "comments.txt"

This step cannot be automated and remains a manual task. **You should provide one or more comments if your system could not auto-calibrate or if you were clouded out or couldn't record for some reason**.

Creates a **comments_*ccc*.txt** file (where "ccc" means the three-digit camera number) during confirmation and record your comments and observations in that file. It will be reported in the MeteorCount.*.bat scripts and included with the submission files.

9.8. Collect

This step should automatically be handled if **autonomouslevel=submit** or higher is configured.

With the AutoCams menu system, this is option "13. Package Working dirs into SubmissionFiles dirs".

The step involves moving the files out of the "working directories" and into a location that makes them easier to manage. Use the AutoCams option 13 for this, which launches the **StageFromConfirmed.bat** script with some command line arguments. It will move the files out of the working directories (ArchivedFiles, CapturedFiles, and ConfirmedFiles) into a dated directory under the SubmissionFiles directory tree. It also scans the files and makes some new files that are useful for the coincidence process and organizes the files into a Submitted subdirectory tree.

We called this target directory name "SubmissionFiles" because this is where we stage the files for submission. First, all the original source files and directories (the working

directories) are moved under this directory. Then, it manipulates the files and generates the appropriate files that will be used in the actual transmission. To do that, it creates an EmailFiles directory, under which some special files are created by analyzing the original source files. Then it copies the actual submission files to a directory named "Submitted". (The name isn't exactly correct, because technically, nothing has been submitted. We originally thought that it would work that way, but things have changed over time and the names haven't been changed to match the actual function.) The new subdirectory under the Submitted directory will contain a replica of the directory structure that can be reproduced on the coordinator's system. This makes it easier for our system to create a zip file of that directory structure and to transfer it to a central coordinator's system for Coincidence processing.

Watch for "Total Validation Errors = 0" at the end of the procedure. If it indicates that there were any errors, you will need to Undo the submission, repair the issues, and run 13 again.

Anytime you use menu option "15. Move SubmissionFiles dires to working files dirs" to work on files, you should put them back into the SubmissionFiles directory using option 13 again. For example, let's say that you have already transmitted a batch to your coordinator that was not confirmed prior to transmission. You would use option 15 to move the files into the working directory tree, perform the confirmation (option 10), then run 13 again to put them back... only this time, it would include the confirmation files that you just created. (In that case, you should also run **16 to create a zip** file for your archives that includes the confirmation).

9.9. Transmit

This step should automatically be handled in autonomous mode if **autonomouslevel=ftp** is configured.

Makes a ***zip*** file of the dated directory and ***transmits*** it to your coordinator as your submission according to the schedule arranged between you and your coordinator.

When you run option "17. Upload ZIP via FTP (Submit)", it also moves the zip file to the Transmitted directory if it successfully transmits the zip file to the server. You can view that directory to see what's been transmitted (or what hasn't been transmitted). A utility script "52. List Untransmitted Zips" will list those directories that haven't been successfully transmitted.

9.10. Archive

Make archive copies of the files to DVD. We do this in case they need to be reprocessed using new algorithms. Each night, there are over 6GB of data captured and processed. However, only a part of that needs to be archived. When your coordinator tells you that it is safe, you will delete the CapturedFiles subdirectory for the dates your coordinator approves. Then you can make a DVD of the remaining files under the SubmissionFiles directory.

It is a good idea to backup the SubmissionFiles directory and the Zip files to an external hard drive once a week for safekeeping.

Note: See the Task below labeled "MakeArchiveDateZip.bat". The section describes how to properly archive the files for storage at NASA.

9.11. **Submit Archives**

This step involves two different steps. (1) Uploading detection files, configuration files, and calibration files to NASA/SETI. (2) Copying the BIN files to a DVD and mailing the DVD(s) to NASA/SETI.

Task 10 - Capturing Video

In autonomous mode, this step will be performed automatically.

Typically, you will rely on the Windows Task Scheduler to execute the **LaunchCapture.bat** script at the same time each day. LaunchCapture.bat performs a bunch of checks, analyzes the twilight.csv.txt table and then eventually makes the call to FTP_CaptureAndDetect.exe with command line arguments that govern the capture process.

In the following discussion, **Camera ON** time means "recording start time" and **Camera OFF** time means "stop recording time".

Here is a brief summary of the LaunchCapture.bat functions:

- Gets the current time and compares it with the scheduled Camera ON time based on the sunset/dusk calculations in the twilight.csv.txt file.
- If the scheduled Camera ON time has already passed, then the current time is used as the Camera ON time in determining the *Duration* for the capture. No matter when the LaunchCapture.bat script is started, the *Duration* value should not calculate to a value to exceed the scheduled Camera OFF time. In other words, the Camera OFF time will always be honored.
- If the current time is less than the Task Sched Start time, the delay before starting the camera is calculated and the script is put to sleep until the scheduled Camera ON time. A progress bar and the scheduled Camera ON time are displayed in the title bar until the delay period is over and the program awakens to launch CaptureAndDetect. You are free to use the computer in any fashion necessary (except rebooting) during this delay period and it will not interfere with any processing on the computer.
- The script also calculates the required disk space based on the *Duration* value and the estimated size of the FF*.bin files. Then it presents a warning if you don't have adequate disk space... however, it continues to capture until the actual executable fails.

The **LaunchCapture.bat** script takes the following command line arguments:

- **Camera number** - Example: 212
- **Duration** - Example: 1
  This is the number of hours to capture. The script ignores the value of this argument, but it must be present. You may use 0, 1 or any other number, like 0.2.

- **Target location** - Example: C:
  This is the base location. It is in the form of drive:\path. However, whatever you provide here will only serve as the base directory, under which the "..\CAMS" directory structure will be created. For example: On 08/03/2011, if you use "H:\cams\2011", the CapturedFiles directory will be placed in a directory named something like this: "**H:\cams\2011\CAMS\CapturedFiles\2011_08_03_06_57_56**".
- **autonomous** - This is optional. If you specify autonomous, it will trigger some of the processing to execute in automous mode.

The **FTP_CaptureAndDetect.exe** program captures video in 256 frame intervals and stores them in a proprietary format. It takes up to four command-line arguments for controlling the application in batch mode. If any command-line argument is missing, the application will prompt for it. With batch systems, you want to avoid situations where programs prompt for input in batch processes. This process should be handled by the **LaunchCapture.bat** script that is executed by the scheduled task. However, you may encounter problems and you can troubleshoot by running the executable directly, provided you supply the proper command line arguments. You can also run it manually from the AutoCams menu if you ever need to start the capture process manually. This will guarantee that the command line arguments are proper.

Extremely Important: It is important to dedicate the computer to only capturing during the capture timeframe. Performing even the simplest tasks will result in dropping some frames. Ideally, the capture is run on a computer that has at least two CPUs. Hyperthreading can help, however, if you have an I5, or I7 processor, it is often better to turn off the hyperthreading option in the BIOS and let it function with real cores instead of the virtual CPUs provided by Hyperthreading. When hyperthreading is enabled, the virtual CPUs run at less than half the speed of the core they are created from. The net effect of a single CPU able to run a certain number of operations per second will only be able to run approximately a sum total of half that many operations per second when it is running as if it is 2 virtual cores. (In other words, 4 hyperthreaded CPUs are slower than a 2 CPUS configured in a dual core system) This is a well-documented and repeatably tested fact of hyperthreading. You will find individuals who argue with this, however, their arguments are typically not substantiated with repeatable empirical test results... or the testing used is insufficient to measure. If you can measure that your system does not drop frames with hyperthreading enabled, you wouldn't necessarily NEED to change the BIOS, but why run at half speed?

- The command-line format is: FTP_CaptureAndDetect <mode> <camera number> <duration> <target location>
  - **Mode** - 2=MOVE (recommended), 1=COPY, 0=no move or copy.
  - **Camera number** - Example: 212
  - **Duration** - This is the number of hours to capture. Remember that this value will need to be lengthened as winter approaches and the nights get longer. Example: 10.5 for 10 hours 30 minutes. You can use the CheckTwilight.bat script to help you determine the duration.
  - **Target location** - This is the base location. It is in the form of drive:\path. However, whatever you provide here will only serve as the base directory, under which the ..\CAMS

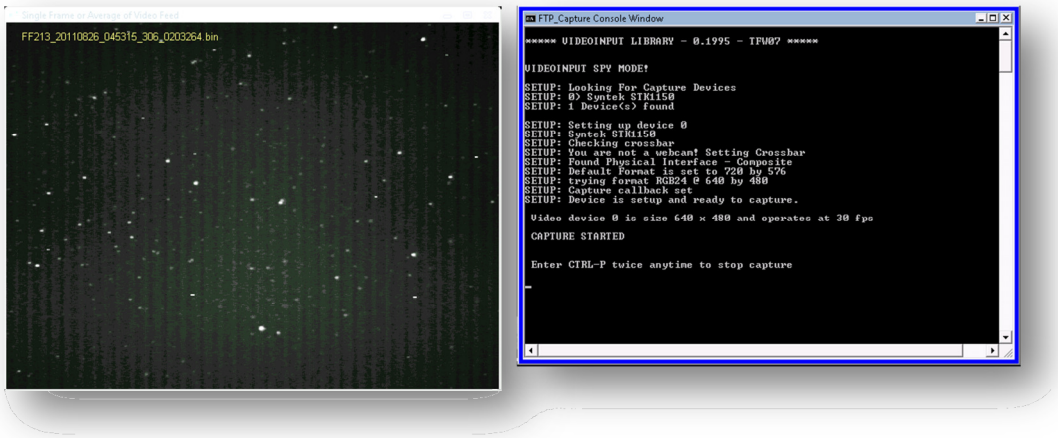
directory structure will be created. For example: On 08/03/2011, if you use "H:\cams\2011", the CapturedFiles directory will be placed in a directory named something like this: "**H:\cams\2011\CAMS\CapturedFiles\2011_08_03_06_57_56**".

If you specify this command-line on 08/03/2011 at 6:57:56 UTC:

ftp_capture 212 10 c:

It will capture video for camera 212 for 10.0 hours and store the video files in: "C:\CAMS\CapturedFiles\2011_08_03_06_57_56"

There is a naming convention for the resulting captured files. For example, a capture file named this:
"FF212_20110803_065810_358_0000256.bin" is a capture file for camera 212, started on 08/03/2011 at 06:58:06.358 UTC, for the first 8.5 seconds (the first 256 frames). The timestamp reflects the middle of the 8-second capture time, not the starting time. The remaining numbers (0000256) identify frame numbers or the frame count.



10.1. More information:

FTP_Capture or FTP_CaptureAndDetect can be run by double-clicking on the executable or from a command-line.

When you double-click these executables from Windows Explorer, the program will run in *interactive* mode, where it will prompt the user to enter the camera number, duration of the capture in hours, and the target location.

If the duration entered is zero, the user is prompted to manually start and stop the capture process. If the duration is greater than zero, the program automatically starts the capture and stops after the designated time has elapsed.

Alternatively, if the application is run from a command-line, optional command-line arguments can be provided to parameterize the execution of the program:

FTP_CaptureAndDetect [[[[mode] [camera number]] [duration hours]] [target location]]

Examples:

FTP_CaptureAndDetect

The user is prompted for the camera number, duration, and target location

FTP_CaptureAndDetect 2 212

The user is prompted for the duration, and target location

FTP_CaptureAndDetect 2 212 10.5

The user is prompted for the target location

FTP_CaptureAndDetect 2 212 10.5 "h:"

The program runs with the provided parameters.

FF files means "*Flatfield Temporal Pixel Video Capture and Compressed*". This is a proprietary video file format designed specifically for the purpose of this application. These video files cannot be viewed using standard viewers. You would need to convert them to another format to be able to review the video - various conversion utilities are provided for this purpose and they will be documented.

A folder is created for saving the FF files based on the date/UTime at the start of the capture. UTime means UTC time.

UTC is kind of the same thing as Greenwich Meantime, but there are significant differences. For the purpose of this discussion, it is the universally coordinated world clock time at longitude zero. UTC is used throughout these applications. Local time (civil time) is calculated as the UTC time added or subtracted from the timezone offset. Pacific Daylight Time is UTC -7 hours and Pacific Standard Time is UTC -8 hours.

The higher level directory is always user-specified and the "\CAMS\CapturedFiles\" is appended to the user-provided [target location]. For example: a capture that starts on Jan 5, 2011 3:11:05 UT and the target location specified was "D:\cams\2011" would have the FF*.bin files placed into the folder "**D:\cams\2011\CAMS**\CapturedFiles\2011_01_05_03_11_05\".

10.2. Manually terminating the Capture.

Don't just close the windows or terminate the process unless absolutely necessary. This will cause corrupt FF files. Instead, you have two options. One is to pause capture, and the other is to Cancel capture.

10.2.1. To Pause Capture, press **CTRL+P**.

10.2.2. To Cancel Capture, press **CTRL+P** twice. Then wait until all the windows close themselves.

WARNING: If you interrupt capture and then start it again, you will have multiple working directories with the same date. It is important to merge these directories into the earliest

directory before performing the other processing steps. The exception to this rule is if you had moved the camera to another position during the same night. In that case, you would ensure that you had exactly one directory for that date for each camera position.

Task 11 - Calibrating

In autonomous mode, calibration is automatically performed so there would be no need to perform this task unless the autocal during autonomous mode operation fails.

There are four methods for calibration. First is **FTP_MeteorCal.exe** (manual calibration). The second is **FTP_MeteorCal_Update.exe** (Cal Update). The third is **FTP_MeteorCal_AutoUpdate.exe** (autocal). The fourth is the same as the third, but it prompts you for the minimum number of calstars and the minimum O-C acceptable. Use FTP_MeteorCal.exe whenever the camera is moved, or if you can't obtain a "Mean O-C" under 1.0 with sufficient number of stars (at least 12 stars) with FTP_MeteorCal_Update.exe. In autonomous mode, you will only have to perform the calibration procedure when autocal fails (usually due to weather).

11.1. **AutoCal**

11.1.1. Auto calibration iterates through the FF files in the specified directory and performs these steps for each one:

- Checks the FOV for the star count.
- If the star count is less than the target number (usually 50 or higher), then it skips to the next file in the list.
- Otherwise, it checks the Mean O-C value. If the Mean O-C value is greater than the target amount (2.50 or lower), it will perform an outlier purge until either the star count falls under the target number or it succeeds in achieving the Mean O-C value. If it achieves the target Main O-C value with the target star count, then it creates a CAL file in the C:\CAMS\Cal directory from that FF file and ends.

Autocal produces a file, named **AutoCalUpdate.log** in the source directory. In the case where autocal fails, you can examine the log to determine possibly the best file to use for a manual calibration. The file listed in the log with the highest number of stars and a lower Mean O-C value would be a good choice.

11.2. **Cal Update**

11.2.1. From the AutoCams menu, select step "7. FTP_MeteorCal_Update". This step will automatically select a calibration file from the Cal directory to use as a basis for this calibration update.

11.3. **Manual Calibration**

Task 6 -Manual Re-Calibration Example Run: above describes the steps for performing the manual calibration. Use AutoCams menu option 8.

Task 12 - Apply Calibration to Detect File

In autonomous mode, this task is unnecessary unless there is an error and the calibration has to be performed manually.

The FTP_Reprocess.exe and FTP_CaptureAndDetect.exe programs perform the MeteorScan routine. When it finds a possible meteor, it records the event information into the "C:\CAMS\ArchivedFiles\<target directory>\FTPdetectinfo.txt" file. (In newer versions of the program, it the file is named FTPdetectinfo_0ccc_yyyy_mm_dd.txt) Sometimes, this file is simply referred to as the "*detect file*". For each event, the FF file and its CAL file is listed in the FTPdetectinfo.txt file. The X/Y and RA/DEC coordinates of the event are recorded in the section for that event. The problem is, the calibration step is almost always performed after the scan is complete. The meteorscan routine uses the most recent CAL file available, which is typically a date previous to the one it is processing. Therefore, it becomes necessary to patch the FTPdetectinfo.txt file with the new calibration file after calibration. At the same time, the X/Y and RA/DEC coordinate values of each event need to be skewed by the difference between the calibrations. The **FTP_ApplyCal2detectinfo.exe** program performs this job.

Note: This script will soon change its behavior in the following manner:
1) Before calling the FTP_ApplyCal2detectinfo.exe program, it will rename all the CAL files in the Cal directory to something that will not be visible to the .exe program. This is to avoid the confusing mess of what happens when there are Cal files that are newer than an AutoCal-generated cal file. This renaming function will apply to all Cal files except the latest file generated for the date in question.

2) Whether Apply succeeds or fails, the files will be renamed back.

12.1. From the AutoCams menu, select option "9. Apply Cal to Archived".

12.2. It will perform the operation and then return to the menu.

12.3. In interactive mode, navigate to and select the C:\CAMS\ArchivedFiles\<date/time>\FTPdetectinfo.txt.

12.4. Then follow the prompts.

It is imperative that the correct CAL file is applied to the detect file. One good test is to open the detect file with notepad and check if the CAL file listed for each event is the expected CAL file for the date in question. If it is not, you will need to correct the reason why it is not working and try again.

In interactive mode (when you're not using the AutoCams menu to launch it), the program produces an FTPdetectinfoC.txt file in the target directory. You will need to use that C file to validate that the program functioned as expected and then delete the original. Here is a command that will do that for you:

```
move     /y     ftpdetectinfoC.txt     FTPdetectinfo.txt
```

12.5. Calibration Troubleshooting:

Sometimes, there are troubles with calibration. A bad calibration one night will affect all subsequent nights. If you find that a night, or several nights in a row, are not processing properly, check the calibration files starting with the night before they seem to start going bad. You can rename all subsequent nights to something like "xCAL299_*.txt" and then run the AutoCams "7b. AutoCal" option. Or manually calibrate that oldest bad date. You should be able to autocal after that... at least for the clear nights. Overcast and partly overcast nights also produce problems. Option "7c. AutoCal w/ prompt" was designed to facilitate that.

Task 13 - Reprocessing (MeteorScan)

The FTP_Reprocess.exe program performs the MeteorScan routine. When it finds a possible meteor, it records the information into the "C:\CAMS\ArchivedFiles\<target directory>\ftpdetectinfo.txt" file. This can take several hours. The new autonomous mode performs this task in near-realtime and is no longer necessary unless the CapturedFiles need to be manually re-scanned for whatever reason. If that is the case, you'd be better off running the "**44. Multi-tasked Meteor Scan**" option from the Utility menu instead. This option will take advantage of the fact that your computer has multiple CPUs and divide the workload of reprocessing into as many chunks as the number of CPUs you have. The length of time for the multi-tasked reprocess is literally (1/Processors) the amount of time. The problem is that you are left with multiple output files that need to be merged. The utility menu has the "**44b. Merge Multi-tasked Meteor Scan Files**" script to combine the multiple output files into a single FTPdetectinfo.txt file.

Task 14 - Confirming (optional)

The Confirmation step is **optional**. However, if you get a chance to run it, it will give you an idea of the level of activity each night. If you perform the confirmation process meticulously enough, you can submit the detect file from the ConfirmedFiles directory instead of from the ArchivedFiles directory. In that case, the ConfirmedFiles subdirectories are usually much smaller.

If you have moved the files to another drive, the FTPdetectinfo.txt file will need to be patched so that the FF folder and the CAL folder entries reflect the new location. You can use the **FixDetectPaths.bat** script to make those changes for you. There is a batch script I wrote to fix it, but it hasn't been extensively tested yet.

14.1. It may be necessary to use the "15. Move SubmissionFiles dirs to working files dirs" option prior to performing the confirmation step. To undo the submission, follow these steps:

14.1.1. From the AutoCams menu, enter "3. Enter Captured Date" and follow the prompts.

14.1.2. If it tells you that it can't find the CapturedFiles directory, it is probably because it has already been run through submission. During Submission, it moves the files to another location. They need to be moved back to the working directories to continue.

14.1.3. Enter "14. Choose Submission dir" and follow the prompts.

14.1.4. Enter "15. Move SubmissionFiles dirs to working files dirs". It will move the files from the SubmissionFiles directories and restore them to the working directories. Also, the CapturedFiles, ArchivedFiles, and ConfirmedFiles directories will indicate the number of files, meteor count, etc.

14.2. From the AutoCams menu, select option "10. FTP_Confirmation". It will use the target location, camera, and captured date to create command line arguments when launching the program. If you run it in interactive mode, you will need to follow the prompts and navigate to and select the FTPdetectinfo.txt file.

14.3. It will display your image on the left and a console window on the right. The Console window needs to have the keyboard focus when entering in commands. If you see an event that appears to be a meteor, then press Enter to "accept". You need to error on the side of false-positives. False-positives are OK. When in doubt, accept.

14.4. Reject by pressing any other key.

14.5. You can go back as many as 15 events and re-enter your accept/reject decision.

14.6. You can press "f" to skip to the next FF file. Just remember that it will only be able go back no more than 15 events.

Task 15 - Collecting

The step involves moving the files to a location that makes it easier to manage. Use "StageFromConfirmed.bat" for this. It moves the files to a directory tree under "**.\SubmissionFiles\2011_08_05_04_40_44**".

Working directories (before)	SubmissionFiles directories (after)
..\ArchivedFiles 2011_08_05_04_40_44\ FTPdetectinfo.txt FTPdetectinfo_0213_2012_03_07.txt CameraTimeOffsets.txt LASTSETTINGS.txt FF*..bin	**..\ArchivedFiles** 2011_08_05_04_40_44\ FTPdetectinfo.txt FTPdetectinfo_0213_2012_03_07.txt CameraTimeOffsets.txt LASTSETTINGS.txt FF*..bin
..\Cal CameraSites.txt CAL213_20110805_050014_038.txt CameraSites-213.txt	**..\Cal** CameraSites.txt CAL213_20110805_050014_038.txt CameraSites-213.txt
..\CapturedFiles 2011_08_05_04_40_31\ *.bin	**..\CapturedFiles** 2011_08_05_04_40_31\ *.bin
..\ConfirmedFiles 2011_08_05_04_40_44\	**..\ConfirmedFiles** 2011_08_05_04_40_44\

FTPdetectinfo.txt FF*..bin	FTPdetectinfo.txt FF*..bin comments_213.txt
	..\EmailFiles **Cal-213** CAL213_20110805_050014_038.txt CameraSites-213.txt FF213_20110805_050009_751_0035072.bin 213_archived=533, confirmed=52.txt CameraSites.txt CameraTimeOffsets.txt comments_213.txt FTPdetectinfo_confirmed_213.txt FTPdetectinfo_confirmed-213-52.txt FTPdetectinfo_scanned_213.txt FTPdetectinfo_scanned-213-533.txt LASTSETTINGS.txt ReprocessParameters.txt submit_213.txt

After this step, you can run **MeteorCount.submission.bat** to report on the data collected under the .\SubmissionFiles directory tree.

Task 16 - Transmitting

This step involves two different steps.

16.1. Uploading a collection of detection files, configuration files, and calibration files to NASA/SETI. You will make a single zip file of the collected files and upload then to the FTP server. Use these steps for submission:

16.1.1. Use AutoCams option "**16. Zip Submitted dir**" to create the zip file. If it succeeds, the "Last error msg" at the bottom of the menu will indicate as such. If it fails, you will need to run option 16 again.

16.1.2. Use option "**17. Upload Zip via FTP (Submit)**". If it succeeds, it will indicate as such in the "Last error msg" at the bottom of the menu.

Sometimes the upload fails. This can happen for various reasons, such as network errors, timeouts, busy server, down server, etc. I have found that sometime retrying a few times it will eventually succeed.

You can troubleshoot the problem by using TotalCommander or FTP from a command line and trying to connect to the FTP server manually. If it succeeds, the problem may have gone away or cleared or the problem may be something wrong with corrupted scripts. Check the C:\CAMS\ftp.temp.txt file.

16.2. When you're ready, you will mail the collected DVDs to NASA.

(2) Copying the FF files to a DVD and mailing the DVD(s) to NASA/SETI.

Task 17 - DVD Archiving

Make archive copies of the files to DVD. We do this in case they ever need to be reprocessed using new algorithms.

17.1.1. Run the "61. MakeArchiveDateZip" script to remove all unnecessary files and to create a zip file for each date.

It leaves behind the SubmissionFiles\date\camera\EmailFiles directory. This directory is small and it is useful from keeping a running tab on the meteor counts.

17.1.2. Copy all the zip files to a DVD and mail to NASA/SETI

17.1.3. Delete the zip files from your hard drive to make room for more capture.

Congratulations! You have successfully configured the camera.

Task 18 - Autonomous Mode Instructions

These instructions are for running in autonomous mode. In autonomous mode, there is little to do. However, there are some daily or weekly tasks that you should probably follow.

18.1. Let the autonomous mode capture, detect, and calibrate the files on a daily basis. (That's the default for autonomouslevel=apply operation).

18.2. Periodically (it is up to you whether you do this daily, weekly, monthly, etc.), you need to check for failed autonomous mode runs and correct them.

Sessions that need further processing are still in the working directories.

It is best to start from the oldest and work forward. This is because of the way calibration files are determined during the preprocessing phase.

Here are some methods for checking on the status of things:

18.2.1. One method for determining which dates need manual processing is to use the AutoCams menu and do the following:

18.2.1.1. From the AutoCams menu, select "**3. Enter Captured Date**". It will list all the dates that haven't completed the submission/transmission process.

18.2.2. Another method is to work from the SubmissionFiles:

18.2.2.1. From the AutoCams menu, select "**3. Enter Captured Date**".

18.2.2.2. Enter **S** to list the SubmissionFiles directories.

18.2.2.3. Enter the number that is displayed to the left of the desired entry. The CapturedFiles and ArchivedFiles date will change to indicate that it is looking at the SubmissionFiles subdirectory.

18.2.2.4. Enter "**15. Undo from Submission**". It will move the SubmissionFiles for that date to the working files directories.

18.2.2.5. From this point, you can perform the "**10. FTP_Confirmation**" procedure. You can also re-do the calibration if needed.

18.2.2.6. Once you perform the confirmation, you can optionally enter **A** (for autonomous mode), and it will proceed in autonomous mode as if it was starting this immediately after capture. If you don't want to use the full autonomous mode to reprocess, use **13, 16, then 17**.

Task 19 - Calibration Tricks

This section provides some tips and tricks to facilitate manual calibration. A couple of things to note...

The Cal center Dec (deg), Cal center Azim (deg), and Cal center Elev (deg) values shouldn't change from night to night very much. If a calibration produces results where these values change more than a degree, it is an indication that it is either a bad calibration or the camera has moved. If the camera has moved, a manual calibration will be necessary. How can you tell which method to use? Examine a calibration file for another clear night after the night in question. If the values haven't changed, then it is a bad calibration. If the values have changed, the camera may have moved. If you delete the CAL file for the night in question, then run autocal for the subsequent night, if that produces a CAL file with these values the same, the night in question has a bad cal and you need to resolve that before transmitting it.

Important: After performing a manual calibration, **it is always a good idea to fine-tune that manual calibration with a calibration update**, either autocal or just cal update.

Tip: The RA drifts by approximately 1 degree per day when you consider there are 360 degrees in a circle and 365 days in a year.

19.1. First, check if you have a valid cal file for that camera in the current position. You can open that cal file and use the RA and DEC values as a starting point. If you want to use this method follow these steps:

19.1.1. From the AutoCams menu, enter [R]eset, to reset that date. Optionally, you can use option 3 and enter the date that you want to examine and copy from.

19.1.2. Enter option "36. Validate Calibration Files...". It will start listing the calibrations from the most recent to the older ones.

```
CAL213_20120530_105148_548.txt, [Cal stars=51] O-C=0.371+-0.161
Scale=2.782 [ALT=53.751 AZ=330.717] [RA=247.3660 DEC=64.505]
```

19.1.3. Make note of the date/time parts of the cal file name of the first one that comes appears in the list. You can stop the report any time by pressing Ctrl+C, then answer "N"o, don't terminate the batch job. In the example above, you'd want to write down the following information:

- File name: CAL213_20120530_105148_548.txt
- RA=247.3660
- DEC=64.505
- ALT=53.751
- AZ=330.717

Note: The date/time in the cal file name in the above example is:
05/30/2012 at 10:51:48.548 UTC.
Also, it is a good idea to monitor the ALT/AZ values from time to time to see if there is any migration in the mount over time. These are you best indicators if the camera has moved.

19.1.4. Enter AutoCams option 3 and enter or select the date for the day you need to calibrate. For this example, let's say it was 06/05/2012 (pretending that we had 5 days of rain or something).

19.1.5. See **Task 6 -Manual Re-Calibration Example Run:** above.

19.2. Determine which FF file (either from the ArchivedFiles or CapturedFiles directory) that you will be using for a manual calibration. This will be called the "FF file used for calibration".

19.2.1. One method of determining this is to perform the autocal function and watch for frames that have a sufficient number of visible stars. Write down the time section of the good file names.

19.3. Another trick is to examine the **AutoCalUpdate.log** file from the autocal pass. You should be able to locate this under the CapturedFiles directory. The log file will list all the files that it examined. You could start your manual Cal using the file name in the log that shows the highest number of stars with the lower value for Mean O-C.

19.4. Open the most recent calibration file in the **C:\Cal** directory whose date is the closest date to the date that you're calibrating.

19.4.1. Near the top of the file, you will find the following entries, along with their values, that will be useful for this task:

Calibration date
Calibration time (UT)
Cal center RA (deg)
Cal center Dec (deg)

Cal center Azim (deg)
Cal center Elev (deg)

19.4.2. Calculate the time difference (in hours) between the FF file used for calibration and the time of the calibration file. Note: AutoCams option 7d performs this calculation for you.

19.4.2.1. Example: The FF file used for calibration is FF299_20120209_**103741**_704_0871680.bin and the recent calibration file was CAL299_20120208_**022447**_641.txt.

19.4.2.2. Convert the times to decimal hours. This is done by dividing the minutes by 60, then adding the hours:
"103741" = (37/60)+10=10.617
"022447" = ((24/60)+2=2.4 (no need to be accurate to the second)

19.4.2.3. Then subtract 10.617 - 2.4 = 8.217 hours difference.

19.4.2.4. To convert the difference in hours to a difference in degrees, multiply the hours by 15:
8.217 * 15 = 123.255

19.4.2.5. Add this to the RA value in the previous calibration file.

19.4.2.6. Add to the RA value the number of days between the old date and the new date.

19.4.2.7. If the result is greater than or equal to 360, subtract 360 from the result:
194.717 + 123.255 + 1= **318.972**
or another example might be:
254.652 + 123.255 + 1= 378.907 - 360 = **18.907**

19.4.2.8. Use the result in the manual calibration as the RA (deg) value. Use the same Dec value in the previous calibration file's Dec (deg) value in the manual calibration.

19.5. If the camera may have moved and you can't attain a valid calibration update or autocal update using a good clear star field, you need to determine new values for both RA and Dec.

19.5.1. Use autocal to iterate through the FF files to view them until you recognize a star pattern that you can find in a planetarium program (such as Starry Night or Cartes du Ciel, etc). This will be referred to as the "FF file used for calibration".

19.5.2. Use the planetarium program and adjust the FOV to about 32 degrees.

19.5.2.1. Adjust the Lat/Long to your position.

19.5.2.2. Adjust the date/time to the date/time of your FF file to use for calibration. Be sure to adjust for Universal Time.

19.5.2.3. Set the orientation to terrestrial view (which puts the horizon down and the zenith up).

19.5.2.4. Move the view until the Alt/AZ approximately matches the Alt/AZ of the camera position.

19.5.2.5. Move the view a little more until you see stars the match the FOV of the FF file to use for calibration.

19.5.2.6. Obtain the RA/Dec and Alt/AZ from the Planetarium program.

19.5.3. Convert the RA value to degrees, if necessary by multiplying by 15. For example:
RA 14h 32m 48.2s
((32/60) + 14) * 15 = 218.25 degrees

19.5.4. The Dec value does not need to be converted.

19.5.5. Use those values when entering in the RA and DEC values into the manual calibration program.

Task 20 - Coincidence

This section will describe how the local coordinator can use the FTP_Coincidence.exe program. The Coincidence software is not broadly distributed because its sophisticated algorithms need to remain proprietary. There are competing projects that could direct funding away from the CAMS project funding if these algorithms get into the wrong hands.

The nature of the Coincidence software is to perform the triangulation and orbital calculations based on two or more triangulated fields.

In all the examples below, we will use Jan 21, 2012 to illustrate what exactly happens during processing.

Here is what we know so far...

20.1. Important: Make sure that your CameraSites.txt file in the "C:\CAMS\Cal" directory does not have any duplicate entries. It must also have an entry for each camera that Coincidence is going to encounter.

20.2. Download or copy the submission ZIP files to the C:\CAMS\Temp directory.

20.3. From AutoCams, select option "[R]eset.

20.4. From AutoCams, select option "3. Change Date". Manually enter a date in the format MM/DD/YYYY.

20.5. From AutoCams, select option "54. Coincidence". It will handle all the remaining processing and then launch the FTP_Coincidence.exe program.

The functions it will perform before launching the FTP_Coincidence.exe program are listed below for the date (Example 2012_01_21):

- AutoCams launches the Coincidence.bat script using the entered captured date (01/21/2012).
- Coincidence.bat launches and then performs the following steps...
- Unzips the files to a "C:\CAMS\Temp\Coicidence\2012_01_21" directory. Remember, the submission zip files place copies of the FTPdetectinfo_0camera_yyyy_mm_dd.txt files in the root of the zip file with the headers removed.
- It then creates an FTPdetectinfo_CaseHeader.txt file that can be worked on and manipulated much quicker than doing it directly in the large combined detect file. This will be prefixed to the combined detect file later.
- Strips all the headers from all the detect files.
- Combines all the detect files with their headers stripped so it can perform a detection count total.
- It performs a meteor count by counting all the ".bin" entries in the file.
- It obtains the current paths for "FF Folder" and CAL folder" in the detect file so they can be replaced with new paths for use during coincidence processing.
- The FTPdetectinfo_CaseHeader.txt file is patched to reflect the new detection count total, FF Folder path, and the CAL folder path values.
- The FTPdetectinfo_CaseHeader.txt is concatenated with the other FTPdetectinfo_scanneded*.txt files, thereby merging all the detection files for all the cameras for the specified date into a single FTPdetectinfoCoinc.txt file.
- The CoincidenceParameters.txt file is copied from the C:\CAMS directory to the C:\CAMS\versionHistory directory. The reason this is done is to avoid accidental distribution of the coincidence program.
- Finally, the C:\CAMS\FTP_Coincidence.exe program is launched using the following command line arguments:

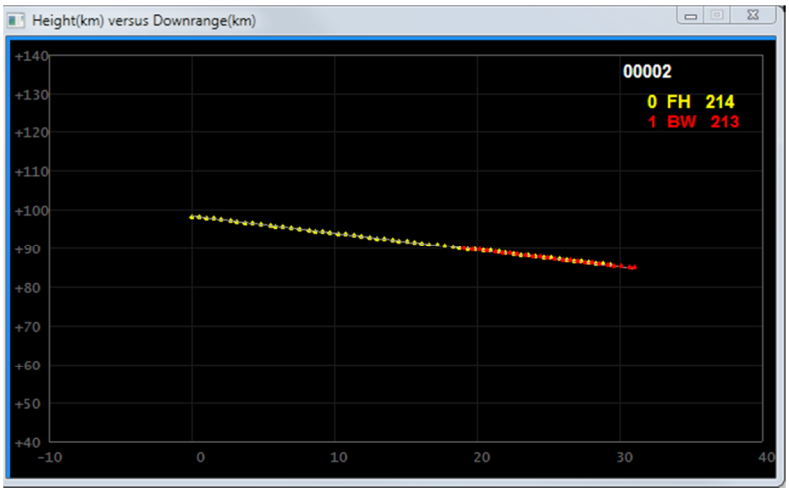
```
FTP_Coincidence "C:\CAMS\Temp\Coincidence\2012_01_21\FTPdetectinfo
Coinc.txt"
```

- Zips up the resulting displayJPGs and gefdat directories into "Coincident_2012_01_21.zip"

- Uploads the "Coincident_2012_01_21.zip" file to the upload server.

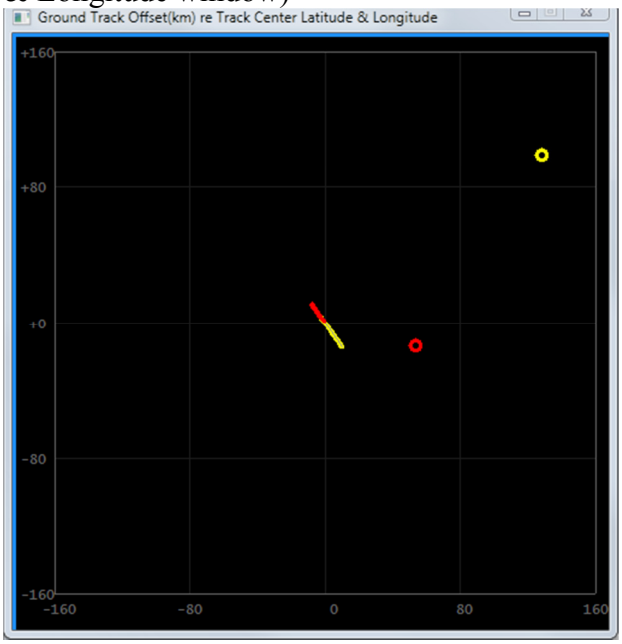
Some tips you might want to be aware of:

- Coincidence output will be in two directories: "displayJPEGs" and "gefdat".
- CoincidentMeteorLog.txt lists the date/time and camera numbers for each event.
- The "SummaryMeteorLog.txt" file contains additional information, such as the radiant info in RAinf, DECinf; the 3D ground track including begin and end for Lat, long, and height.
- The "SummaryOrbitLog.txt" file contains the orbital elements for the particle.
- The "NonCoincidentLog.txt" file contains information on detections that don't have a coincident event from another FF file, ether from the same camera or another camera. However, somehow it contains the RA/DEC and intensity of the singleton event. It would be useful to also add the length of the event, the duration, and the angle across the sky... somehow.
- The remaining files (that all begin with "CAMS_" are results that are compatible with the FIREBALL software program.
- The "displayJPEGs" directory contains three .jpg files for each coincident event.
    - CAMS_nnnnn_HeightVsRange.jpg
      (Bottom-left Height(km) versus Downrange(km) window)



The ideal result is two overlapping lines. In this example, you have camera 0 FH that tracked this meteor from 99km to about 85km height for 30km. Camera 1 BW tracked this meteor from 92km to 84km for about 14km downrange.

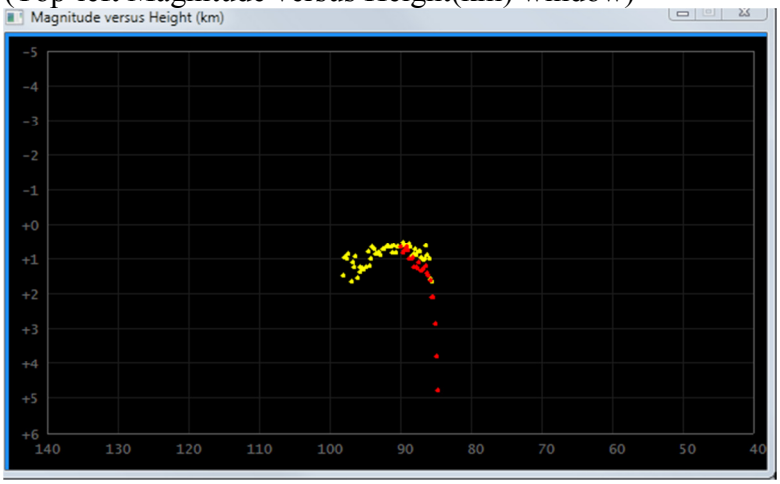
- CAMS_nnnnn_LatLong.jpg
  (Top-right Ground Track Offset(km) re Track Center Latitude & Longitude window)



The ideal result shows two overlapping lines that follow the same ground track. There is a possibility that one camera's track of the meteor doesn't actually overlap with another camera. However, the fact that they share the same linear path over the ground track "may" indicate that it was the same meteor. In those cases, you need to use a bit of care and

remember that (a) a meteor with a long ground track probably needs to have a higher intensity at some point than shorter lived meteors; (b) Because there is not overlap, you may have to discard this coincidence.

- CAMS_nnnnn_MagVsHeight.jpg
  (Top-left Magnitude versus Height(km) window)



The magnitude is corrected for distance. Ideally, you will see a rise in magnitude and then a drop in magnitude. The height in km allows you to see where the altitude of where it all occurred.

20.6.

20.7.

Task 21 - Manual Coincidence Preparation

To prepare it manually, you'd do something like the following steps:

21.1. Combine all the FTPdetectinfo.txt files for a single date for a specific area (for example, the San Francisco Bay Area CAMS files) into a single FTPdetectinfo.txt file. You can do this using the following command (notice the placement of the "+" symbols):

```
copy /y FTPdetectinfo_0201.txt+ftpdetectinfo_0202.txt...
FTPdetectinfo.txt
```

21.2. Then you need to patch the header in the file with three values; The Meteor Count, FF Folder, and CAL folder. You can determine the combined meteor count using the following DOS command:

```
find /i /c ".bin" "path\ftpdetectinfo.txt"

---------- FTPDETECTINFO.TXT: 1392
```

It will return the number of detections that we'll call "detection count".

21.3. Open the file with Notepad. The first 11 lines in the file are called the header. It looks something like this:

```
Meteor Count = 000009
-----------------------------------------------------
Processed with FTP 1.3 on Mon Dec 19 05:54:33 2011
-----------------------------------------------------
FF  folder = C:\CAMS\ArchivedFiles\2011_12_13_07_56_30\
CAL folder = C:\CAMS\Cal\
-----------------------------------------------------
FF  file processed
CAL file processed
Cam# Meteor# #Segments fps hnr mle bin Pix/fm Rho Phi
Per segment:  Frame# Col Row RA Dec Azim Elev Inten
```

21.4. Your job is to edit the file and replace the Meteor Count (shown in blue as 000009) with the "detection count" that you determined above.

21.5. You will then also need to change the directory values for "FF folder" and "CAL folder" to match the current drive and path to those directories.

21.6. Save the FTPdetectinfo.txt file and close Notepad.

21.7. Edit the ConincidenceParameters.txt file and make any changes that might be necessary. Here is one example of a CoincidenceParameters.txt file:

```
Maximum time for coincidence (sec)          = 60.0
Minimum site separation distance (km)       = 10.0
Minimum number of frames required           = 5
Minimum allowed convergence angle (deg)     = 5.0
Maximum allowed convergence angle (deg)     = 90.0
Maximum co-linearity convergence (deg)      = 5.0
Maximum distance from radiant (deg)         = 180.0
Minimum height of all meteors (km)          = 70.0
Maximum height of all meteors (km)          = 200.0
Measurement std dev (pixels)                = 0.4
Velocity model(0-const,1-lin,2-quad,3-exp)  = 3
Maximum radiant cone angle error (deg)      = 2.0
Maximum Vinf error re Vinf (percentage)     = 10.0
```

- Navigated to the C:\CAMS\Temp\Coincidence\2012_04_30 directory and selected "FTPdetectinfo.txt".
- Then it asked for the directory where the FF files are. Since those files are not provided, I'm stuck right there. But I selected C:\CAMS\Temp\Coincidence\2012_04_30 anyway and continued.
- Then it asked for the CAL file directory. I have the three cal files in the ..\Cal directory so I navigated to and selected:
- C:\CAMS\Temp\Coincidence\2012_04_30\Cal

It should produce two log files - with no line entries, just the header.

In the file CoincidenceParameters.txt, the first line is the time tolerance between cameras to look for coincidence (in time).

Maximum time for coincidence (sec) = 60.0

In example above the clocks could be off by as much as one minute.

Are the cameras well synchronized in time to GPS. The coincidence parameters have a time tolerance offset it will accept between cameras.

Are you 100% sure you are both pointing to the same volume of atmosphere - that is, has there ever been coincidence results between your two cameras in the past. You may not be correctly aligned to see the same meteor.

Hopefully the cameras are all well calibrated for their FOVs.

21.8. To use the Coincidence.bat script do the following steps.

- 21.8.1. Copy all the submission .zip files to C:\CAMS\Temp.
- 21.8.2. Start AutoCams.bat script and select a date using option 3.
- 21.8.3. From the utility menu, select option "24. Coincidence". It will do a bunch of processing, then launch FTP_Coincidence.exe. You will be prompted to navigate to and select the FTPdetectinfo.txt file.
- 21.8.4. Navigate to and select **C:\CAMS\Temp\Coincidence\<date>\FTPdetectinfo.txt**.
- 21.8.5. The program will run and show you how many detections it is processing. Then it will stop and ask you the "Press CR to end the program". That means press the Enter key.
- 21.8.6. That's it. The result files should be located in the "**C:\CAMS\Temp\Coincidence\<date>\ArchivedFiles**" directory.

21.9.

Task 22 - Archiving for DVD with MakeArchiveDateZip.bat

This section will describe the function of the script that was designed to perform a pre-DVD burn zip of the necessary files needed for shipping back for the scientific archives at NASA.

The CapturedFiles directory takes up the bulk of the space, which mostly consists of FF*.bin files with no detections in them. All the FF*.bin files with detections in them exist in the ArchivedFiles directory. By removing the FF*.bin files from the CapturedFiles directory, it will leave only the ArchivedFiles and/or the ConfirmedFiles directories (as well as the Cal and EmailFiles directories). Since the ConfirmedFiles directories are relatively small, we are going to archive the ConfirmedFiles as well as the ArchivedFiles, even though the ConfirmedFiles contains a small subset of duplicates. The reason for this is to avoid accidental destruction of necessary files during the file management procedures. Also, there are times when there be an ArchivedFiles directory but not a ConfirmedFiles directory. It will be too easy to mistakenly delete the ArchivedFiles directory before finding out that you don't have a ConfirmedFiles directory. Therefore, we will error on the side of safety. In this way, you will be saving to the archive ZIP files all the necessary files to reproduce the submission.

Note: There may be some merit in including the .zip file from the Transmitted directory, however, NASA will already have those and they can choose how they want to archive those on their own. If you want to include those, and maybe we should, I can update this script to include them... later.

You will end up with a zip file for each directory under the SubmissionFiles directory. You can move those .zip files to the DVD burner in 4GB groups (The size of the standard -R DVD format).

IMPORTANT: Always use DVD -R discs. Do not send discs in +R or +-R, or RW format.

The essence of this procedure is to perform the following tasks:

- Strip the source directory tree of any unnecessary CapturedFiles FF*.bin files.
- "Move" (not copy) the remaining files into a ZIP file named after the source directory. If you have multiple cameras, their Submission files will be archived within. This step will include deleting all the Zipped files except those found in the EmailFiles directory. (The EmailFiles directories will remain in order to be able to run the meteor count scripts to keep a running total).

Here is what we know so far...

22.1. It is important to follow these rules:

22.1.1. Never delete the source files until you have been told that the coincidence has been completed for the set.

22.1.2. Only perform these tasks on a month at a time. This follows efficient industry accepted archiving methods.

22.2. Manually go through the SubmissionFiles directory and delete the FF*.bin from the CapturedFiles directories for the month in question.

WARNING: Only delete the CapturedFiles after you have verified that the ArchivedFiles has the correct files in it. A script should probably be developed for this validation.

22.3. Run the MakeArchiveDateZip.bat script using any of several methods. The format of the program is to run the program with the following command line options:

```
MakeArchiveDatezip.bat camera "source directory" "target directory"
```

For example: To archive all the files for the month of January, 2012 for camera 299, you would run this command:

```
for /f "usebackq tokens=*" %a in (`dir "C:\CAMS\SubmissionFiles\2012_01*"
/b /ad /on`) do (call "MakeArchiveDateZip.bat" 299
"C:\CAMS\SubmissionFiles\%~a" "C:\CAMS\SubmissionFiles")
```

This will iterate through the 31 individual date directories of January and run the MakeArchiveDateZip.bat for each. You will end up with a .zip file for each date for the month of January as well as a directory with the same date name. That left over dated directory has the small EmailFiles directory for use in performing the running Meteor Count scripts.

22.4. When you are done, gather up the .zip files and put them onto a DVD per the instructions above.

Task 23 - "AutoCams.Params.ini" file settings

This section will describe the possible settings for the "AutoCams.Params.ini" file.

- **[COINCIDENCE]** section is for the coincidence program parameters.
  - **max.height**=249
    Number of kilometers for the maximum height display
  - **min.height**=40
    Number of kilometers for the minimum height display
- **[CALIBRATION]** section is for the calibration scripts.
  - **bat_calnstars**=80
    Minimum number of calstars for "7b. AutoCal" processing. Note: "7c. AutoCal w/ Prompts" still allows you to enter your own values, but it will default to these for the default.
  - **bat_caloc**=2.50
    Minimum number for acceptable "Mean O-C" results. If this value is not achieved, then the script reports a failure and aborts.
  - **bat_starcountthreshold=50**
    Used by ValidateCal.bat for reporting bad calibration files from the Cal directory. (See option "36. Validate Calibration".
  - **displaycalstars=false**
    Not Implemented
    If true, during calibration, it will plot the simulated image of the calibration stars as distributed across the FOV. Each will have the x, y residual displayed next to the star.
- **[AUTOCAMS]** section is for parameters that govern the AutoCams functions.
  - **autonomouslevel=apply**
    Possible options are (default is "apply")):

cal
apply
applyconfirmed
submit
zip
ftp

- **validatewait**=15
  How long to wait after StageFromConfirmed.bat performs the validation and displays the "Total Validation Errors"
- **completewait**=60
  How long to wait after autonomous mode processing. The delay allows a user to allow the unattended autonomous mode to system to delay for a longer period in order to catch and review the console before it kills the window.
-

```
[COINCIDENCE]
max.ceiling=249
min.height=40

[CALIBRATION]
bat_calnstars=80
bat_caloc=2.50
bat_starcountthreshold=50
displaycalstars=false


[AUTOCAMS]
autonomouslevel=apply
validatewait=15
completewait=60
```

-

23.1.

Task 24 - Multiple Cameras on one computer.

This section will describe how to configure multiple CAMS cameras on a single computer.

Warning: It is important that the computer has enough CPU and BUSS capacity to accommodate the additional requirements of the additional camera. The only proven method is to install it and test that it will be not dropping excessive frames on multiple cameras.

To configure a single computer to run AutoCAMS, you must have a separate AutoCams directory tree for each camera. You can set up multiple directories, like this:

- C:\CAMS (for your first camera that you've been using a while)
- C:\cam914\CAMS

- C:\cam915\CAMS
- etc.

Doing it this way allows you to create a distinctly named Windows Task Scheduler event for each camera as a separate event. Each scheduled task would be configured to run the LaunchCapture in the corresponding directory and camera on its command line.

> **Tip**: Alternatively, you could configure it to run on separate external hard drives. Each hard drive would be assigned a drive letter, C:\CAMS, D:\CAMS, E:\CAMS, etc. To avoid confusion, it might be a good idea to configure it like this instead:
>
> **C:\CAMS**,
> **D:\cam914\CAMS**,
> **E:\cam915\CAMS**.
>
> That way, you will never have confusion as to which camera is on what drive.

The following instructions will use cameras 901, 914, and 915 as an example.

It is important that you only use camera numbers assigned to you by your local CAMS network coordinator.

To avoid the need to modify all the paths and directory references in the first camera (901) , you will leave the existing camera directory where it has been "C:\CAMS". You will use this directory as the master directory for coping to the other CAMS directories.

24.1. Considering that you already have a single camera (camera 901) configured on the C:\CAMS directory, follow these steps:

24.1.1. Edit the "C:\CAMS\Cal\CameraSites.txt" file and add entries for the new cameras. Typically, these cameras will be at the same long/lat/alt so the only change from one camera to the next in the same site will be the camera number.

24.1.2. In the "C:\CAMS\Cal" directory, copy the "CameraSites-901.txt" file to "CameraSites-914.txt".

24.1.3. Edit the new "CameraSites-914.txt" file and change the camera number to match the filename.

24.1.4. Create the following three directory:

- C:\cam914\CAMS\Cal

24.1.5. Copy all the files (without the subdirectories) "C:\CAMS" to "C:\cam914\CAMS".

24.1.6. Copy all the files from "C:\CAMS\Cal" to "C:\cam914\Cal" .

24.1.7. In "C:\cam914\Cal", delete all the files that begin with "CAL901*.txt".

24.1.8. In "C:\CAMS914\CAMS" directory, edit the "AutoCams.bat.ini" file and modify as follows:

- bat_targetlocation=C:\cam914

- bat_camera=914
- bat_captureddate=*blank*
- bat_capturedfilesdir=*blank*
- bat_archivedfilesdir=*blank*
- bat_capturedcount=*blank*
- bat_archivedcount=*blank*
- bat_latestcal=*blank*
- bat_submissionfilesdir=*blank*
- bat_ftppassword=*unchanged*
- bat_ftpsite=ftp.seti.org
- bat_ftpuser=anonymous
- ftp_dir=incoming/cams
- bat_recent_errormsg=*blank*

24.1.9. Add a new Scheduled Task (with a unique name that includes the camera number) for the new camera as follows:

24.1.9.1. If you have Windows Vista or higher, you can export the existing LaunchCapture task, then import it as a new task and edit it to match the new location.

24.1.9.2. If you have Windows XP, you will need to create examine the existing LaunchCapture task and create a new one that matches it except for the camera number and location.

24.1.9.3. Change the Actions tab > Add arguments and change the arguments to:
/k c:\cams914\CAMS\LaunchCapture.bat 914 0.02 C:\cams914 autonomous

24.1.9.4. Change the Start in to:

24.1.9.5. C:\cams914\CAMS

24.1.9.6. Change the new AutoCams.bat.ini to empty out the drive, etc.

24.1.9.7. Make the following subdirs:

- ArchivedFiles
- Cal
- CapturedFiles

- ConfirmedFiles
- SubmissionFiles
- Submitted
- Temp
- Transmitted

24.1.9.8. Test it by selecting "Run" from the task window. The LaunchCapture windows will display and most likely go into "delay mode", waiting for the Camera ON time. You can defeat this by entering the following from a command prompt:

```
for /L %a in (1,1,10) do (process -k wait.exe)
```

24.1.9.9. After it runs for a few minutes...

- abort the capture by pressing Ctrl+P in the console window. It should attempt to perform the autonomous operations and fail.
- Then, locate the created working directories ("C:\cam914\ArchivedFiles*date_time*", ..\CapturedFiles*date_time*", "..\ConfirmedFiles*date_time*").
- Delete the directories that the test run just created.

Task 25 - Focusing Tips and Tricks.

There are a few tricks that can be employed to aid in focusing these cameras.

First, be sure that the distance from the back of the lens to the chip is 17.526mm (0.6900 in).

25.1. First, be sure that the distance from the back of the lens to the chip is 17.526mm (0.6900 in).

25.2. Set the focus to just under infinity and attempt to focus on a star or distant object on the far horizon. Make adjustments to the distance using C-CS mount adapters and spacer rings. Technically speaking, there should be a 5mm C-CS adapter ring and no 3.5mm adapter ring.

25.3. Turn up the gain to AGC HI during focusing. Don't forget to put it back to the normal setting after focusing.

25.4. Try to get the focus close using a visual approach.

25.5. Be careful with daytime focusing techniques if you have an autoiris lens because if the autoiris constricts, it will increase the depth of field and you will not be in focus at night time with a shallower depth of field when the iris is fully open.

25.6. Hartmann Mask or Batanov Mask focusing

25.6.1. Construct a Hartmann Mask or Batanov mask or some other focusing aide to obtain a more objective focus.

25.6.2. I don't like either of these because they block so much light and you still can't get a decent focus because they are not good for the last little bit of fine focus adjustments.

25.7. Diffraction Spike Focusing

25.7.1. This is a focusing aide that you can probably only use on very bright stars.

25.7.2. Tape some dental floss across the lens to make a cross.

25.7.3. Aim the camera at a bright star or planet. On high gain, it should produce 4 diffraction spikes that look like a crosshair for each bright star that is in focus.

25.7.4. If the star is out of focus, you will see 8 diffraction spikes (or double vision of the 4 diffraction spikes from a properly focused star).

25.7.5. When you get closer to being in focus, the objective determination for best focus is when:

- The diffraction spikes are the longest
- The diffraction spikes begin to show some striping
- The number of stars in the FOV is highest

25.8. Software assisted focusing:

25.8.1. One program that I'm aware of, K3CCDTools, has a focusing aide. It's $35 for the software. It has not been maintained for the last few years, but you may be able to get it to work on your computer. There is a 30 day trial period (it might be 60 days). The problem is, it might not work on Windows 7 (32 bit or 64 bit). You can go to (http://www.pk3.org/Astro/index.htm) and download it to see if it works. There may be some tricks that you have to use to get it to work with Windows 7. It works fine with Windows XP. It has a focusing dialog that should help with the focusing. ImagesPlus and other software that you have may also help to achieve an objective focus instead of relying on subjective methods.

- Use WDM interface in preview mode, which provides very fast preview. I recommend to use 10fps, which is fast enough while it retains good picture quality for focusing
- Use Zoom 200% in Video Capture mode for detailed focusing (requires faster computer)
- Use Brightness Level Meter with unsaturated star for measuring star's peek brightness. I recommend to use Low pass filter to reduce effect of scintillation (seeing variations).
- Read more in Help - Chapter 3.8 Video Capture – Brightness Level Meter.

- Use FFT Dialog for surface objects and watch quality graph in the middle part of dialog. The higher the number shown in the graph the better is focus. The focused object must be in the center of the screen.

25.9. Green Laser focusing:

25.9.1. I have not tried this, but someone suggested pointing a green laser at a distant wall and focusing using that. I imagine that this can be done during the daytime.

25.10.

25.11.

End