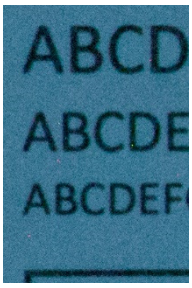
Benefit of Fan cooling your DSLR for Astrophotography

Something I started doing last year was to add a very simple attachment to my astrophotography system. I added a computer fan to my Nikon D5300 camera. I had read a lot about thermal noise and how some people have tried to add cooling to their DSLR cameras. There are devices called Peltier coolers which most of the dedicated astrophotography CCD cameras use to cool the imaging chip as much as 50 degrees Celcius below the ambient temperature. The big issue with this much cooling is to avoid condensation on any of the imaging glass or on the circuit boards. DSLRs are not designed to use these types of coolers and will most certainly have big issues with condensation. I thought about this problem and noticed that my DSLR warms up over time. It's well documented that it doesn't take much increase in temperature to significantly increase the amount of noise recorded on an imaging chip. I also noticed that there is nothing designed into the DSLR for addressing cooling except for maybe an internal heat sink or thermal insulation.

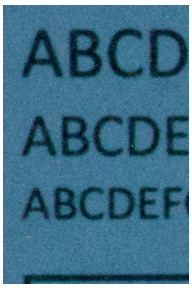
Condensation occurs when the temperature of a surface becomes colder than the ambient air temperature. The temperature at which this happens is called the Dew Point and it is always slightly below the ambient temperature and gets closer to the ambient temperature as the relative humidity rises. This means that when the relative humidity is high that most outside surfaces will very quickly become wet after sunset.

I realized that a fan can play an important role here. I can use the fan to blow air on the case of my DSLR which will help it to dissipate heat. This should help the electronics in the camera to run at a cooler temperature which should reduce the thermal noise in the resulting image. Because I am blowing ambient air on the camera, the surface of the camera will not be cooled below the ambient temperature. There should be no risk of internal condensation. I chose a 12 volt computer fan from an old computer that I was scraping. It has seven fins. I believe this is important because the larger the number of fins, the less vibration there seems to be coming from the fan. With the fan running, I can't feel any vibration when I place my hand on my DSLR. I decided to perform a test to prove that the noise recorded by my DSLR is less when using this fan.

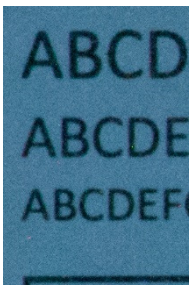
I set-up a test in a darkened room where I took 300 second exposures at ISO1600 for several hours. I took photos of a piece of paper with some printing on it. The room was illuminated by a single white LED. The camera was put into MANUAL mode so that every photo was taken using the exact same settings. After taking photos with the fan OFF for two hours I turned on the fan and continued shooting. Waiting two hours ensured that the camera was up to temperature just like it would during a hot summer evening of astrophotography. After a third hour of fan cooled 300 second exposures I was done. Here are the results:



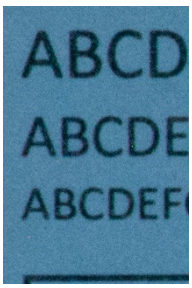
2 hours No fan



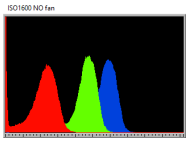
Fan on for 10 minutes

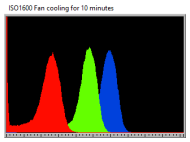


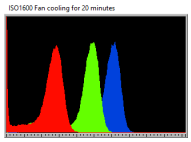
Fan on for 20 minutes

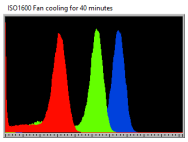


Fan on for 40 minutes

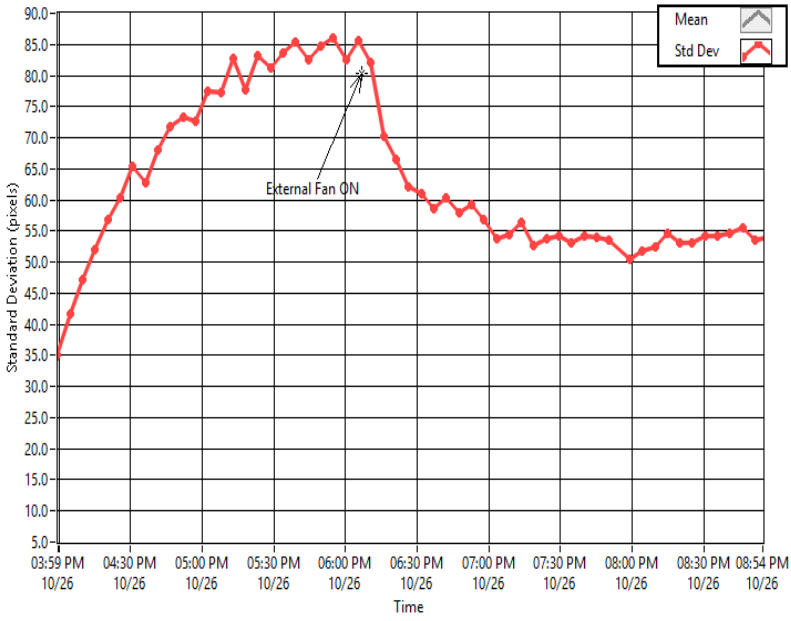








If you compare the first and last photo you can see that the noise is much finer and reduced. If you also compare the histograms you can see that the red, green and blue histograms get taller and thinner as the fan does its magic. I also wanted to generate some form of graph that would help visualize the benefits of fan cooling.



I invented a test where I took several 300 second DARKs at ISO800. A DARK image is created with the lens cap on the camera. In theory there is no light hitting the imaging chip so all of the noise in the image is due primarily to thermal noise. Again, I waited two hours with the fan OFF. Then I turned the fan ON. I wrote a program to calculate the standard deviation of the RAW data in the image files and graphed them here. Standard deviation can be used as a measurement of noise. *Note: The Y-axis is actually scaled in counts.*

From 4PM until roughly 5:45PM the camera was warming up. As it did the standard deviation, or noise, steadily increased. It started at 35 when the camera was cool and more than doubled to 85 in less than two hours. Once the fan was turned on the noise quickly reduced to roughly 54 in less than an hour.

I believe this proves that adding fan cooling to a DSLR will significantly reduce the thermal noise. This also shows that a DSLR takes a significant amount of time to reach it's equilibrium temperature.

Here are two photos showing how I have mounted the computer fan. I have the articulated LCD display rotated away from the camera and the viewfinder cap installed. The fan blows squarely onto the rear of the camera. I used a piece of clear Plexiglas and fastened it to the bottom of the camera. The RCA jack is plugged into a 12V source.