Pi3 for INDI/KStars How-To

by James Taylor

Purpose: Provide a relatively detailed, simple set of instructions for configuring a Pi3 for the purposes of controlling an astronomical telescope and imaging system with the use of INDI/KStars software.

What is needed (this is NOT a headless install):

- Pi3 computer
- Computer monitor with HDMI input and HDMI cable
- computer keyboard and mouse (USB)
- Ethernet cable (preferred, but WiFi will work) and internet access
- Micro SD card (16Gb minimum, 32Gb or larger preferred)
- Separate Windows PC or laptop capable of reading/writing to a micro SD card or SD card adapter for the micro SD
- A powered USB hub. The USB ports on the Pi3 will likely not provide enough power for the items you have that require USB power. In my case, the SSAG needs power for sure. I have a 4-port powered USB 3.0 hub plugged into the Pi3 and it works fine. There are a lot of posts about setting static port addresses for the USB ports but I have not found that necessary so far with this setup.

Author's Comments: The following are the steps I documented over the course of more than a month of trial and error as well as long hours spend on the INDI forums and elsewhere in the process of configuring my Pi3 to use with my Orion ATLAS (controlled via EQMod) , Canon 6D and Star Shoot Autoguider (SSAG) imaging setup. I want to thank INDI forum member “rlancaste” for providing me with the starting point via his personal notes. I also have to say that Jasem Mutlaq was invaluable in getting this together and goes out of his way to help. My primary reason for writing this guide is the hope that I might (in my small way) pay the community back. I hope you find it useful.

There is an assumption that you are reasonably proficient with a computer. I'm going to speculate that you wouldn't be messing with a Raspberry Pi3 if you weren't. If you are like me, you are: a very proficient user (both Mac and PC in my case), aren't afraid to tinker and take slight risks with your computer setup, already have an operating, computer-controlled (via my Windows laptop) astronomical imaging setup and are looking to switch to INDI and have never used Ubuntu before. My goal was to make these instructions as easy to follow as possible with a eye toward the things that I, personally, had to struggle to get done due to my unfamiliarity with both the Ubuntu operating system and the INDI/KStars software. If you know your way around Linux, you might find these instructions on the simple side.

Lastly, keep in mind that this is how I set the Pi3 up for MY use. I'll explain why I did what I did along the way but you will certainly want to tailor your installation to your needs and your equipment.

MAKE YOUR SYSTEM SD CARD

Download Ubuntu MATE for Raspberry. As I'm writing this, you need version 16.04. I downloaded via torrent, but take your pick. You will need a way to write to a micro SD card in order to use this on the Pi3.

- https://ubuntu-mate.org/download/ to download Ubuntu MATE
- https://help.ubuntu.com/community/Installation/FromImgFiles for help on making a bootable SD card from various operating systems.
    - I used Windows. Google/download Win32diskimager (links on the pages above) and it works fine. Unzip the xz file with the Ubuntu image on it, format it via instructions on the web pages above and install the image with Win32diskimager. Make ABSOLUTELY sure you have the correct drive letter for your SD card selected under the "device" pull downs (use your file browser window to verify). I found the online instructions easy to follow.

BOOT THE Pi3 AND GET STARTED

1. Install the micro SD with the MATE image on it into your Pi3 with everything connected to the Pi3 and power it up. Boot it up and let it install. It runs pretty much like most new computer startups I've ever been through. I have to admit, I have had a stall or two during my various tests with these instructions. Powering down and starting the Pi3 again always resulted in it continuing past the problem. Seems pretty robust.

2. After the install, you will see a MATE Welcome screen. On the bottom right corner of that screen is a red box that says "Raspberry Pi Information. Click on it.

- Now, resize the file system using the tool that you see in that section. It will free up all of the space on your SD card for Ubuntu to use.
- I would read the rest of the information on that screen.
- I have read some discussions about weather or not to update the Raspberry Pi or not, Kernel update issues, etc. I did do the Kernel update using the terminal window and the commands posted on that page. It worked at first, but I did another one later (after everything was installed) and it caused INDI to stop recognizing all of my equipment and I was only able to solve the problem myself by re-installing a backup I had. So, I would consider NOT doing the Kernel update at this time.

Note: If you are completely new to all this, the MATE Terminal is located under the "Applications/System Tools" menu located on the desktop. You'll need to use it a LOT. You can find it in the pull-downs and simply click and drag a shortcut for it onto the tools bar or the desktop so you have a quick link to it.

Now is a good time to play around with your new mini-computer. Find things and get familiar with what you can do. It will save you time and aggravation later. At the end of these

instructions I have some information about additional things you might consider doing to open up more space on your SD card, etc. by removing unwanted software.

3. Screen Resolution: Eventually, you may want to have nothing connected to your Pi3 but the Ethernet cable and the powered USB hub (or simply the USB hub) and remote to the Pi3. In that case, you might find it handy to make the screen resolution coming from the Pi3's video card static so it matches your remote computer resolution and fits better. I've seen some stuff online about “virtual” desktops as well but I haven't played with that. Do this step later if you want, or even skip it totally. I found that I was up and running fine here and really didn't need this step until I started remoting into the Pi3. Even then, it's not “required”, just convenient.

I want the resolution of the video the Pi3 is putting out to match the screen resolution on my laptop so when I remote in, everything fits nicely. The Pi3 will do fine on it's own, but if you don't do this, your Pi screen will show up funny on your remote computer if things don't match. However, once this is done – the Pi3s screen is now stretched with I have a monitor connected directly to it. So there's a slight trade-off.

i. Go to your intended remote computer and check the screen resolution. Mine is 1366x768 at 60hz refresh.
ii. Open Terminal on your Pi3 and type: sudo pluma /boot/config.txt (it will ask you for your admin password). Assuming you have the same Ubuntu software I have, it will open up the config.txt file for you to edit. Be careful here! A bad step can mess things up.
iii. Scroll down the file until you find the line with the following text
   - #hdmi_force_hotplug=0 (I found it at line number 89 on mine). Delete the “#” from in front of the text (the hash makes it a comment and not executed) and change the 0 to a 1. So make it: hdmi_force_hotplug=1

   Continue to find the following lines and delete the “#” from in front and change the value so the lines look like the following:
   - hdmi_group=2 (found this at line 195)
   - hdmi_mode=39 (found this at line 297). Now this one needs a bit more explaining. See that table of screen resolutions just before this line of code? The numbers are the right side are the group 2 numbers. Find your desired screen resolution and that's the number you put as the mode. Mine is 39, which give me 1360x768 at 60Hz.

You can always come back and change these back if you want. Do a reboot so it all takes effect.

GET ON INTERNET/UPDATES AND SOFTWARE

1. Now, you will need to be on the network at this point for sure if you aren’t already. I found Ubuntu MATE to make that pretty easy; about like any other computer I use. In fact, the Pi3, at this point, was already on the internet and ready to go. You should see a little Up/Down symbol on the tool bar on the upper right of the screen – that's the internet connections symbol. You can right click on it and open/edit the internet connections if you want to see what you have going. If you don’t have an icon you can navigate to “System/Preferences/Internet and Network/Network Connections” from the menu bar on the desktop and add what you need. I found it to be painless and no steps needed to be taken. Later will you want to use the network connections menu to edit your Ethernet port for a static

IP address to make connecting to a remote computer a consistent process. You may end up doing the same with the WiFi as well to use as a hotspot.

You are going to be downloading software off the Internet as we move forward. I read several posts regarding software downloading and installing and Synaptic Package Manager was recommended as a good program to use to, not only download programs for the Pi, but easily and completely remove programs you do not want (I'll talk about that at the end of the document). You can download it from the MATE Welcome screen's software tool or you can use command line: sudo apt-get install synaptic in Terminal and install it manually (what I did).

Along those same lines is something you may want to add to the Firefox browser (there should be an icon on your desktop menu bar for Firefox). Open Firefox and click on the top right tools menu and find the add-ons icon. In the “Extensions” section find an add-on called “DownThemAll” and install it. It’s a download manager recommended by several web sites I visited for use with Firefox. Frankly, I got frustrated trying to find that add-on the first time. If you find yourself running in circles - try to get to a basic, Firefox start page and navigate to the bottom of the page and see if you can't find a link to add-ons and try going from there.

Another download app that seems to be recommended is Gdebi Package Installer. The latest MATE install I did had this already included, so I don't think you'll need to get it. I found it in the Applications/System Tools/ menu and it also shows up on Firefox whenever I click to download a .deb file as a download method. So it's already there as near as I can tell. If not, you'll need to go find it and download it.

2. Now that you're connected, you’ll want to do some systems stuff and get the software you need/want.

- Open that MATE Terminal window
- To update the Kernel (SEE NOTE FIRST!): sudo rpi-update

NOTE: I did this command after I had been running my Pi3 for a couple weeks. AFTER I did this, INDI server stopped recognizing all my equipment. After starting a fresh install and NOT running this command, everything is fine. I suggest you DON'T do this one. It's your call.

- Update the software via Terminal (grab a drink, you'll be sitting there a while):
  sudo apt-get update
  sudo apt-get upgrade
- Download the INDI and Kstars programs http://www.indilib.org/download/ubuntu.html for info: sudo apt-add-repository ppa:mutlaqja/ppa
  sudo apt-get update
  sudo apt-get install indi-full
  sudo apt-get install indi-full kstars-bleeding
  sudo apt-get install kstars-bleeding-dbg indi-dbg

Note: The last one is optional but recommended for debugging.

Note2: Later you will want to do updates to both your Ubuntu software and the KStars and INDI software. To do that, you simply repeat the apt-get update and apt-get upgrade commands like you did earlier. However, Jasem from INDI, says there can sometimes be problems with the KStars updates and he recommends to do the following to update Kstars:

sudo apt-get update && sudo apt-get -y dist-upgrade

I don't see any reason you can't run that command at this point just to be sure (I did).

- Install General Star Catalog: sudo apt-get install gsc
- Install Astrometry. You can use Astrometry online but it's slow, so you'll probably want this. http://indilib.org/about/ekos/alignment-module.html is the place to start for information on this step. Also, the Astrometry web page is at http://astrometry.net if you want to do some research there.
  - Install Astrometry: sudo apt-get install astrometry.net
  - The index files have to be downloaded and installed. The INDI web site explains how to download the debian packages (Gdebi comes in handy here). The packages get installed into the Astrometry program once you have them on your computer. The web page explains how to pick which packages and where those files are located on your Pi3. One interesting thing I ran into was that after I downloaded a couple of the fits index files and tried to move/copy them from the downloads folder into the Astrometry folder – it wouldn't let me. I had to right click on the Astrometry folder and select to open it at a administrator before I could copy files into it.

- If you want to share files between computers on the network, you might want a specific app to help with that. Caja is already on your Pi3 at this point. (found in Applications/System Tools). I found at this point that I was able to find and connect to other computers on my LAN without installing anything else. Of course, you will need to make sure your other computers are allowing access, etc. This instruction isn't going to cover all that. Some folks use Samba for file sharing.

- If you are going to use PHD2 to guide, see the web site at http://launchpad.net/~pch/+archive/ubuntu/phd2 :
  - sudo apt-add-repository ppa:pch/phd2
  - sudo apt-get update
  - sudo apt-get install phd2

SWAP FILE (optional)

Now, I ran into problems almost immediately with my Canon 6D (full size sensor) on Ekos when trying to capture images. It crashed or locked up. I did some looking around, did some research, and installed a 2Gb swap file on my drive. A swap file is artificial, extra RAM. The Pi3 only has 1Gb. It's very easy to do and you can read where I got my info from at https://www.digitalocean.com/community/tutorials/how-to-add-swap-on-ubuntu-14-04

If you read the comments on that web page (at the end of the article) you'll find a guy that wrote a script to make it all super easy, https://github.com/CraftThatBlock/SwapUbuntu is the link. Read the page, use the terminal commands he provides and it's done in a flash. Reboot. It stopped the problems. I posted this solution on the INDI forums and a couple other users told me they tried it and it helped. Can't hurt! I can verify that Ekos is, in fact, causing the Pi to utilize the swap, although I've never seen anything close to the full 2Gb being used.

VNC SERVER

There are lots of options for setting up remote access if you want to run the Pi as a headless server. I am only interested in local control, not anything over the internet from far away. This is what I did to establish a connection to my laptop. I have three options: Ethernet cable connected directly between the Pi and Windows PC, or wireless across my LAN or wireless via a WiFi hotspot created on the Pi itself.

- I installed RealVNC viewer on my laptop to use to VNC into the Pi3. https://www.realvnc.com/docs/raspberry-pi.html#raspberry-pi-legacy Read through the page. Of note, I can use RealVNC Viewer on my iPad as well to control the Pi! Cool.

You have numerous software options for setting up a VNC server on your Pi. I've tried two of them, Vino and RealVNC. Vino works fine but I'm having trouble getting a WiFi hotspot working with Vino running the server. RealVNC also works fine and I've been able to get a hotspot to work while using RealVNC with absolutely no trouble. So, I'll cover what I've learned about both of them here and you can choose for yourself.

VINO

- For the VNC server on the Pi3, I installed Vino.
  sudo apt-get install vino
- Then run:
  vino-preferences (to set your preferences for login)
- Lastly, create a startup program in the startup applications (System/Preferences/Personal/Startup Applications) with the command: /usr/lib/vino/vino-server and it will start when the Pi is started. That way, Vino will start automatically (handy if you are headless – the Pi3, not you!).
- If you run into login problems from the remote computer due to encryption – run: gsettings set org.gnome.Vino require-encryption false It will cause Vino to be un-encrypted and you'll get nasty messages when you remote into it. For my application, with the Ethernet connected directly between the laptop and the Pi3 - who cares.

RealVNC

Go to this page (https://www.realvnc.com/docs/raspberry-pi.html#raspberry-pi-connect) to find all the information I'm about to provide for installing RealVNC. I'll explain the Hotspot option later.

- To install RealVNC manually (I think this is probably more direct), go to Terminal and run the command:
  `curl -L -oVNC.tar.gz https://www.realvnc.com/download/binary/latest/debian/arm/`
- Then run:
  tar xvf VNC.tar.gz
- After you run the previous command, you will see the file name of a debian package it created. Copy that full file name (it will have a .deb file extension) and insert it into this command in place of the “VNC-Server-package-name.deb” part and leave out the carrots:
  sudo dpkg -i <VNC-Server-package-name.deb>

That's it. It's installed. Now, you have a couple options here. You can manually start and stop RealVNC or you can just set it up to start automatically (which is what I've done).

- To start it run: sudo systemctl start vncserver-x11-serviced.service
- To stop it: sudo systemctl stop vncserver-x11-serviced.service (see a pattern?)
- To have it start automatically when you boot, just put the work “enable” in the previous example in place of start or stop and if you want to turn off automatic startup, use the word “disable”. For once, some programmer did something that was intuitive!

Static IP

This part can get a bit deep if you haven't messed with this before. I am going to talk about Port Forwarding and manual IP assignments. I'm going to simply tell you what I established as the steps that work for me. Your mileage may vary and the LAN address information you find may not match mine; particularly if you're on a MAC system.

If you plan to remote across your LAN or with a direct Ethernet cable running from the Pi3 into your computer – port forwarding won't be needed. If you are going to remote into your Pi3 using the WiFi local network in your house, you won't need to port forward. BUT, if you want to remote into your Pi3 from somewhere else or (in my case) have someone like Jasem remote into your Pi3 from across the world so he can show you what you're doing wrong or help you troubleshoot – you'll need to port forward. That will need to be done in your router. I used the web site https://portforward.com to assist me and managed it on my own. I'll leave it at that. Don't mess with port forwarding at this point unless you know you'll need it. Even then, I think you'll want to do the following steps first anyway.

For a static IP assignment on your Pi3, you'll need to start with a little research. You can Google a million pages that will assist you with setting up a static IP address and I suggest you look around; you'll get more info than I am about to provide. You will need the following information:

- Your current IP address for you Pi3
- Your router Gateway
- Your router Subnet Mask

The direct approach here is to open the Terminal on your Pi3 and type ifconfig and hit Enter. In that string of information, find the section for your Ethernet connection and have it handy. Wireless info is also here in case you want it for later.

1. Right-click on the internet connection symbol on the Pi (or go to System/Preferences/Internet and Network/Network Connections from the menu bar) so you can see your network connections. You should see (at a minimum) an Ethernet, Wired connection there. Highlight it and click Edit.
2. First off, it might be handy to write down the Device Mac address you see on the first screen you see. It's helpful for finding the Pi3 on your router if you go there to set up port forwarding later. On the other hand, if you are successful at setting up a static IP address, your Pi3 will be easy to find in your router settings since it's IP address will be already assigned.
3. Go to the IPv4 Settings tab.

4. In the Method drop down, select Manual
5. Click on the Add tab on the right to add a manual IP assignment to the connection.
6. Here's where you'll use the information from the ifconfig command you used earlier. Enter the IP address your Ethernet is currently using (shows as “inet addr” in ifconfig screen), the Netmask (shows up a “Mask”) and the Gateway (you can get this one by going to your windows PC and typing ipconfig in the command prompt window – it's listed as Default Gateway). Tab down to DNS Server and use the same address as the Default Gateway. SAVE and exit. Done.

You might want to pause and try to get onto the internet and make sure this all worked. Reboot and see if everything is still working OK.

BACKUP

Now would be a really good time to backup that SD card if everything seems to be working OK! Here's how.

Cloning the SD card is simple. Just follow these steps:

1. Get everything set up just the way you want it on your Raspberry Pi, whatever you're using it for. Then shut down the Pi and remove the SD card. Insert the SD card into your windows computer.
2. Start up Win32DiskImager, a program that you probably have from when you first set up your Pi.
3. In the "Image File" box, enter the path of your soon-to-be image file. For example, I put mine in C:\Users\James\Desktop\Pi3backup.img
4. Under the "Device" box, select your SD card.
5. Click the "Read" button to create the image file from your card
6. When it's done creating the image file, you can eject your SD card and put it back in your Raspberry Pi. Keep that IMG file in a safe place.
7. Backup often!!

Now, if anything ever goes wrong with your Pi (and if you fiddle around enough – it will!), you can restore your fully-set-up image using the reverse instructions:

1. Insert the SD card back into your computer. Follow the same, exact steps you used when you created the Pi SD card in the first place but install your backup image file instead of the Ubuntu MATE image file.

Now, if everything at this point has gone well, you should be at a point that you can start testing things. The steps I have provided to this point are, I think, just about the minimum steps you need to take to run INDI/KStars on your Pi3 and do it remotely (if you want). At the end of these instructions, I'll provide some additional how-to's I used that are equipment specific and some other tweaks you might want to try.

- If you have already installed a VNC viewer on your remote computer, you should be able to connect across your local network by entering the [now static] IP address of your Pi3 in the VNC viewer address. Depending on how you set Vino or RealVNC

preferences up, you may need a password, etc. and you may see warnings about un-encrypted connection, etc. But it should work.

- Start KStars. If you haven't found it already, its in the Applications/Education drop down from your Pi3 menu bar.

Note: Now, here's where, if you haven't done it already, you need to go to Indilib.org and start watching tutorial videos, etc. and learn how to use the software. I'm about to tell you, from my perspective, what you need to do to get up and running at a BASIC level. If you run into problems from this point forward with INDI or KStars, you need to get onto the INDI forums and start looking for help. I won't lie; this is the part where I started pulling my hair out. However, it turned out that many of my problems were caused by me trying to make things more complicated than they need to be. Others were driver or other errors that Jasem seems to be fixing at a rapid pace as users report them. Additionally, your equipment is probably not the same as mine. SO, cross your fingers here, grab a beverage of choice and lets move forward and hope things go well!

KStars Setup

I'll assume that you have done your homework with INDI and KStars before you move on. At least watch a few videos so you have the idea. I'm going to step you thought the most basic initial steps that I did so you can get started.

When you start KStars the first time, it's going want to run you through a setup wizard. Just follow the steps. Pick the nearest big town for your location (you can edit this later to be more precise) and download whatever extra data files you want (again, you can get this stuff later as well). I clicked on several data files at once and it looked like it choked, but give it some time and it will be fine.

Note: Before you proceed, I would have all of your telescope equipment connected to the Pi3 and powered. In my case, my USB (shoestring astronomy) serial adapter cable for my Atlas EQ-G, the USB to my Canon 6D and the USB to the SSAG are all plugged into the 4-port hub and turned on/powered.

CAMERA NOTE: See the Appendix information at the end for my Canon Camera info before you proceed here, if you're using a 6D. Also, regardless of what camera you're using, the Pi3 will automount the camera when you turn it on. You will need to “unmount” the camera before INDI can connect to it. You can do that manually (if I recall you just right click on the camera icon on the desktop and unmount it). The appendix info tells you how to configure the Pi so that it does not automount the camera (if that's what you want).

1. Find the Ekos icon on the tool bar, find Ekos in the tools drop-drop down, or simply type Cntrl+K and Ekos -KStars control panel will open.
2. Create your Profile and select the appropriate equipment. In my case its:
    1. Mode: Local
    2. Mount: EQMod Mount
    3. CCD: Canon DSLR

4. Guider: QHY CCD (Now this might seem funny since I'm using the SSAG. But the QHY CCD driver runs the SSAG since they are, apparently, the same hardware more or less).
5. Save
6. Hold your breath and press, Start INDI. In the INDI Control Panel that pops up, you should see a tab for each piece of equipment you have connected. You can connect each from here or you can go back to the Ekos control panel and press the Connect button and connect all at once (that's what I'm doing). Now, if you hit Connect and everything connects with no warnings....CONGRATS! You are where it took me over a month to get to (probably because I'm not smart).

GOOD LUCK!

Appendix

Now that you're all connected, here are some of the things you may want to do if you're using the same equipment as me. If not, maybe this information will carry over to what you're using.

Canon 6D setup in EKOS:

1. For imaging, put the camera in Bulb mode. If you're in manual, it will just snap images at whatever shutter speed you have set on the camera.
2. The Camera will automount to the desktop if you don't turn automount off. You can leave it on if you like but you will be required to unmount the camera before starting INDI each time. To do that:
    1. Go to Applications/SystemTools/dconfEditor
    2. drill down to org/gnome/desktop/media-handling
        1. uncheck: automount-open and automount buttons
3. Go to the Canon DSLR tab in the INDI Control Panel that opened when you started INDI. You will see a bunch of other settings tabs for the camera, starting with Main Control. I'll walk you through what I know.
    1. In Main Control, you should see a little green light next to connection if you have connected.
    2. Don't touch anything else on this page....except.....if you want to use Mirror Lockup when you are imaging, you will need to come to this tab and go to the Mirror Lockup setting at the bottom and set the delay time between lockup and shutter release on the right side there and press Set. This setting can get you a bit confused if you have it set when you don't need it. You also MUST be sure you have mirror lockup enabled in the camera menu to use this setting.
    3. Don't touch the Options tab for now.
    4. Image Settings. You can set up some default settings here. I have set the ISO I always like to use and the Capture Format to RAW; the rest I left alone. At the bottom of that list the transformation format setting - default is FITS. If you select Native, Ekos will leave the images as .cr2 files when it saves after taking a picture. You will find that if you let Ekos transform the photos to FITS, it will take a while (currently about 30s with my setup). Leaving them in Native takes less time (about 5s). Play with it and see. Ekos also tended to lock up during this process before I created the swap file; after that it tended to work better.
    5. As for the rest of the settings tabs across the top – I haven't played with any of them and left them alone. The Image Info tab will self-populate with information the first time you take a photo.
    6. Lastly, here's a suggestion from the forums to help speed the image issue along. In KStars, go to Settings/Configure KStars and then down to the Advanced tab. Uncheck the 3DCube and Auto-Debayer options. I'm told that will help.

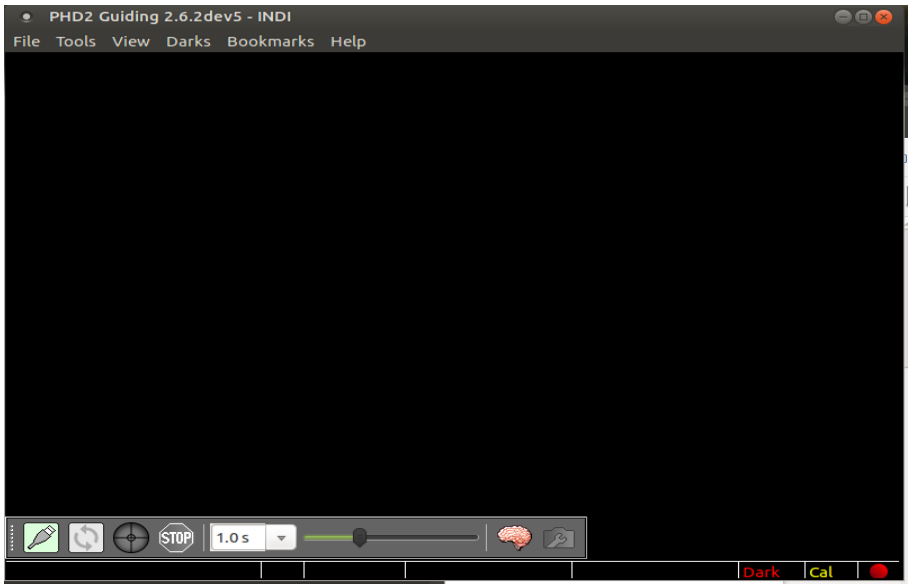
PHD2

The following is a set of instructions on how to install and use PHD2 on a Raspberry Pi3 using INDI/Ekos (KStars). In the example, the EQMod driver is used for Mount control and a Star Shoot Auto Guider (SSAG) is the example guide CCD. Obviously, you will need to substitute your own gear in the setups. I also assume in these instructions that you already have KStars installed and have already figured out how to start INDI server and connect your gear, as well as open and use Ekos, and you already have a working knowledge of PHD2. This is simply instructions for making PHD2 work within the Guider Module of Ekos.

First, you will need to install PHD2 onto your Pi3. In my case, my OS is Ubuntu MATE 16.04, which is recommended by the INDI web site and forums as the most stable for this application. The web site https://launchpad.net/~pch/+archive/ubuntu/phd2 is a good place to start reading. It contains the terminal commands to download/install PHD2 on your Pi. If you don't know how to use PHD2, you'll want to visit the PHD Open Guiding web site and get the instructions.

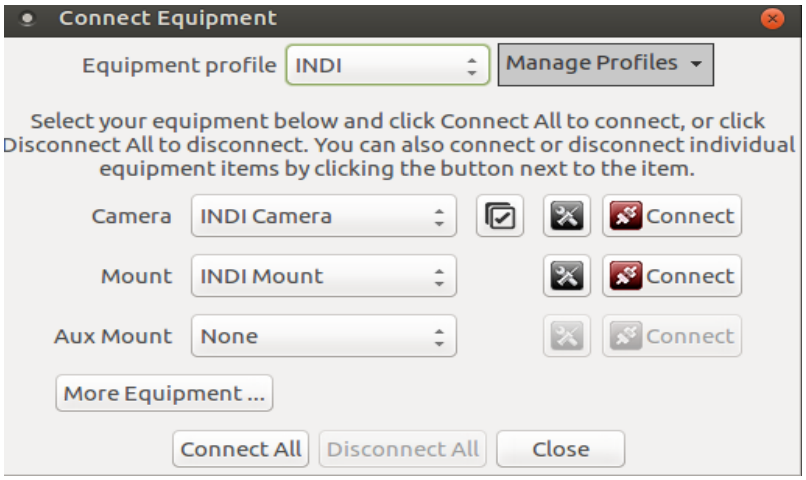
Once installed, you can use it with Ekos. Here's what to do to make it work. Please note – the default settings along the way are best left as-is. Messing with them is what got me in trouble when I first tried using it.

1. Start PHD2 in Terminal by simply typing PHD2 and pressing Enter. Do not connect anything at this point, simply get it open so you know it's working. You should see this window on my screen.

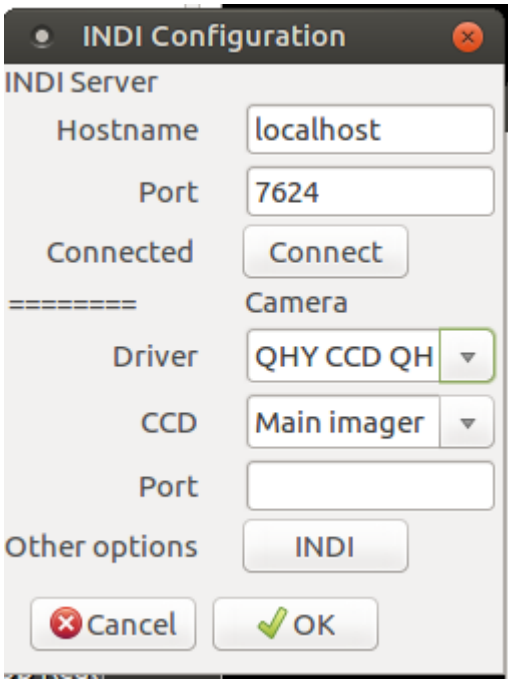


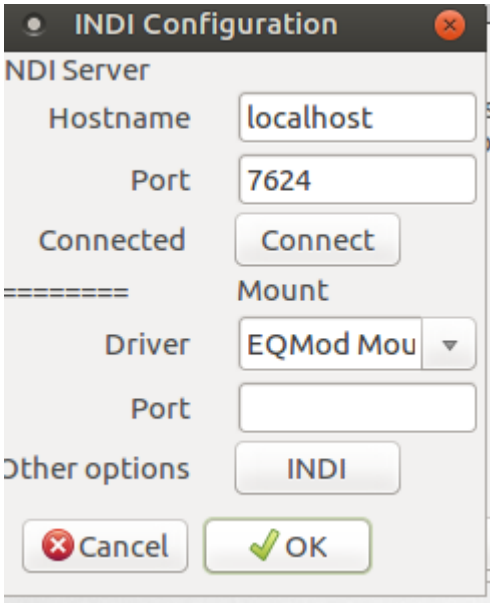
2. Start KStars, then INDI/Ekos and get the INDI server running and everything connected. At this point I would open the Guider Module in Ekos and check to make sure you have a working connection to your guide camera.

3. Now go back to PHD2 to connect/configure a camera and mount. Click on the USB icon on the bottom left of the PHD screen. Configure it like you see here. Name the profile what you want, I named it “INDI”.

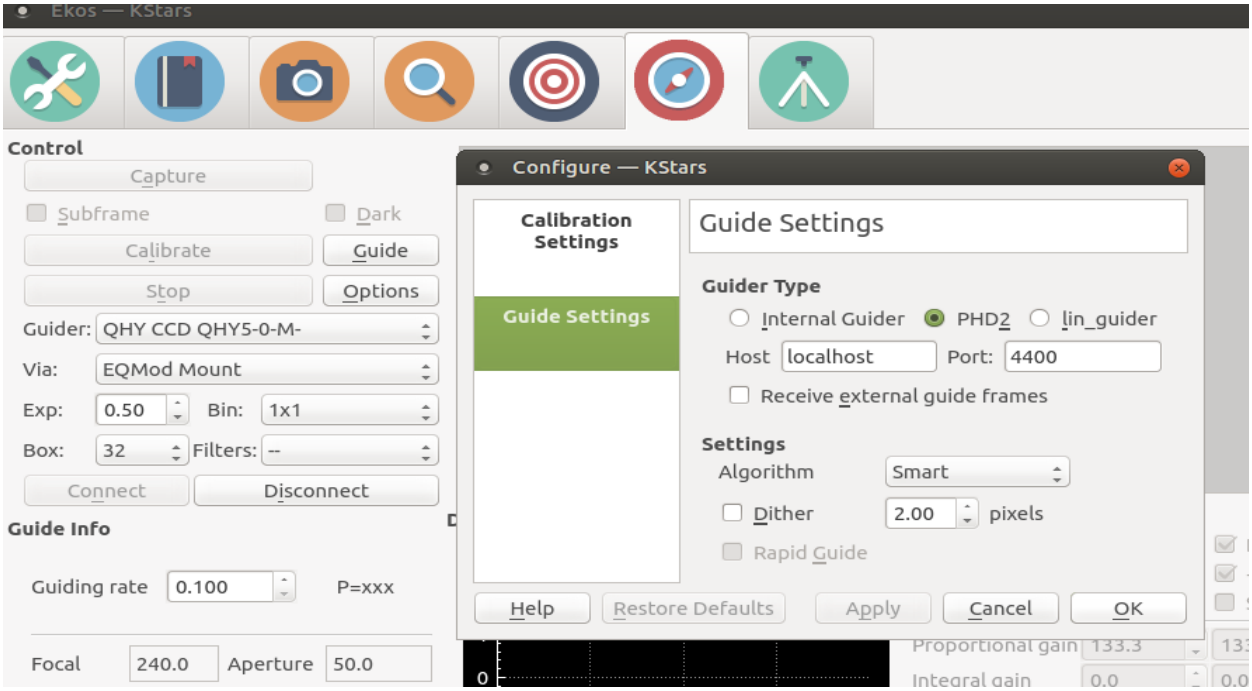


4. Now, confirm the camera and mount are set up properly within PHD2. Click on the setup icons next to the connect buttons. With INDI server already running and everything connected, this is what you should see in the two setup windows. Don’t touch anything here. Of course, you should see your equipment in place of mine in the screens. In my case, the SSAG CCD is using the QHY CCD drivers, so that’s why you see QHY instead of SSAG. Close these screens and hit “Connect All” on the PHD2 connect equipment screen.





Now go into the Ekos Guider Module and click on the Options button there near the middle. This is my setup with the Options window open and PHD2 selected. Notice that the port in the Options window is 4400 and the port in the screens above is 7642 – that's OK! They are the right numbers, do not be tempted to change them.



At this point hit "OK", close the options window you should be good.

Notice, if you've used PHD before, you might be tempted to go back to the PHD control panel and start looping the image like you normally do when it's stand-alone. Don't do that. Ekos will start PHD2 when you click "Guide" in the guider module. Of course, you DO need to go into PHD2 and configure the guiding options the way you want.

Notes:
1. Start Ekos first so PHD2 sees the drivers
2. Leave everything at the defaults.

Overclocking

Don't take my word for any of this. All I know is what I've found on Google. The Pi3 can be overclocked. The settings are right there in the same config.txt file you may have edited earlier to set your monitor/screen resolution. I can tell you this....I'm overclocking my Pi3 right now with moderate settings and it's stable and works fine. I “believe” I've seen a performance gain in Ekos during image capture. I think it chopped a good 15-20 seconds off the transformation time when capturing in FITS. I have no scientific data to back that up – just my observations. Rather than me throwing numbers at you, I suggest you Google the subject and make your own decision here. Here's what I'm using right now.

```
arm_freq=1300
gpu_freq=500
core_freq=500
sdram_freq=580
over_voltage=4
over_voltage_sdram=5
sdram_schmoo=0x02000020
dtparam=sd_overclock=100
disable_splash=1
disable_overscan=1
```

Making Disk Space

If you've explored your new MATE operating system, you probably saw a bunch of programs and some games, etc. on there that you don't want. Given that I set my Pi3 up exclusively for telescope operations, I needed nothing else on there – so I went at it with a big ax.

The Synaptic Package Manager that I suggested installing earlier comes in real handy here. If you open it, you can search for programs and it will delete the entire package for you. What I did was go through the menu of apps and look for stuff I know I won't use the Pi3 to do and deleted it. You'll get the idea if you use it. One trick I learned was to find the “-common” file associated with the program and select it for removal and it usually finds every other file in the system that is associated with it and marks it for removal as well. I opened up hundreds of Mb of space on the card doing this; making room for all of those Astrometry index files.

As a side note: I'm seeing about 16Mb of free space on my 32Gb SD card with a bunch of Astrometry index files installed. You can delete index files that Astrometry isn't using; there's instructions on the internet for doing that if you Google it. I can see running out of that space pretty quick with my Canon 6D taking a bunch of images. SO....I'm now running a 64Gb, 90Mb/s whopper on my Pi3. With the swap file and overclocking, it's a tad quicker than my previous card and I've got room to spare!

Connecting to your Pi3 Remotely

OK, so if you've set your static IP address and installed Vino Server (or a substitute) on your Pi3 and installed some kind of VNC viewer onto your intended remote computer, you're set to connect. I would first try connecting with your Pi3 connected to your local LAN.

Open your VNC viewer and type in the static IP address you set for your Ethernet connection on you Pi3. You should get connected.

If that works, take the Ethernet cable from the Pi3 and disconnect it from your LAN and plug it into the Ethernet port of the computer you want to use as your remote (you might have to disconnect the Ethernet cable from your computer to do this). You should be able to VNC connect to your Pi3 using the exact same IP address you just used to connect to your LAN since the Pi3 IP address is static. If this works, you now have the ability to start your Pi3 without a monitor, keyboard or mouse connected to it. You just start it and the VNC into it with your remote computer and do what you need to do from there. Of course, it's nice to have the option of starting your Pi3 with a monitor and stuff connected when you have some serious business to attend to on the Pi.

Hot Spot

It is possible to create a WiFi hotspot from your Pi3's wireless and connect to it via WiFi and do away with the Ethernet cable. Again, I have to thank rlancaste (from the INDI forums) for the information that got me to a successful conclusion here. The key for me was using RealVNC instead of Vino. I tried everything I'm about to tell you with Vino and it wouldn't work. I'm still not sure why RealVNC worked for me and Vino didn't but I suspect it's an encryption issue of some sort.

I found this to be pretty straight forward at the time I did it. First thing you need to do is actually create a WiFi Hotspot on your Pi. To do that:

- Navigate your way to the Network Connections window (System/Preferences/Internet and Network/Network Connections) to create a new WiFi Hospot.
- Click Add to create a new connection
- Select WiFi as the type of connection from the drop-down
- Now:
  - Give your connection a name at the top (mine is AstroPi)
  - Use that exact same name as the SSID
  - Change Mode to Hotspot
  - Go to the Wi-Fi Security tab and change it to WPA Personal (if you want a secure connection; recommended) and establish the password you want.
  - Hit Save, your done here.

Now, you need to be able to start that hotspot when you want it. On the desktop, right-click and select Create a Launcher. Name it something like “Start Hotspot” (your choice here) and insert the command “nmcli connection up <name of your hotspot>”. So for me, that command is: nmcli connection up AstroPi. Hit OK and that's done. Just double click on that launcher to make the WiFi hotspot happen. On my system, I can tell the hotspot started because the little up/down arrow for my netork connection in the tool bar goes away. I'll get that back later when I shut the hotspot down.

Now, when you start the hotspot, you can look for that WiFi connection from your remote computer and see the SSID you created (AstroPi in my case) and connect to it with the password you specified just like any other WiFi connection. Click properties on that connection and check out the IP address your remote computer was given. That will give you a clue to the IP address you need to use as the address in VNC viewer in order to connect to the Pi. In my case, the IP address assigned to my laptop by the Pi3 is 10.42.0.43. So that means the Pi3's address is 10.42.0.1 and that's what I put in the VNC viewer to connect. Works great.

Now, rlancaste also suggested a couple other launchers for the desktop that you can do here, if you want. Some systems are having problems with the nm-applet and it needs to be restarted. So a launcher with nm-applet as the command line can be created to do that. My up/down arrow on the desktop that indicates a network connect sometime just disappears. This launcher will bring it back. This isn't a critical thing. I generally don't care if the network arrows are there or not under normal circumstances.

The second launcher will turn off the hotspot and go back to normal network operations. That launcher needs the command line: gksu systemctl restart NetworkManager.service and I used the name that was suggested to me of “Restart Network Manager Service” as the name of the launcher.

So, if you do all that you will have a launcher to turn the hotspot on, another to turn it off and go back to normal and a third to restart the nm-applet when it decides to stop working. I suppose you could create a startup command in your startup programs to automatically start the hotspot when the Pi is turned on if you are going to run it headless and via a hotspot. I'm connecting with an Ethernet cable directly to start with and I can activate the hotspot if I like from there.