DeepSkyCamera Pro for Android

App for astrophotography

Manual and reference

Based on version 1.1.0

November 2025

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https://www.youtube.com/channel/UCHIUeFGXThOF0GJ5aijnr8w/

https://www.facebook.com/groups/745867855869000/

https://www.instagram.com/deepskycamera/

https://www.deepskycamera.de/

Table of contents

Preface

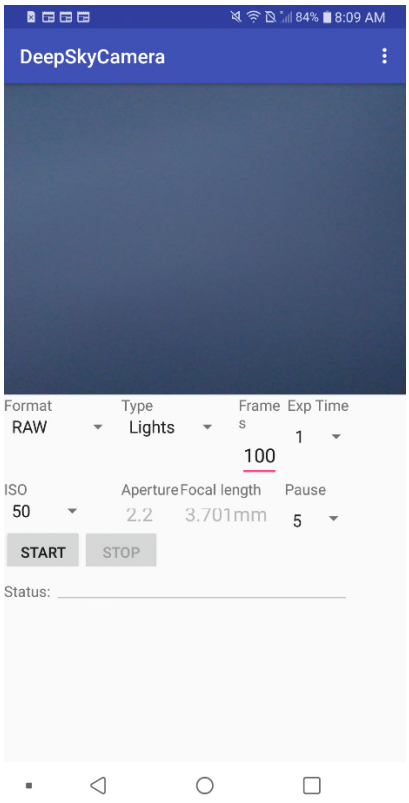
DeepSkyCamera for Android started in January 2018 as a programming project only for the LG G4 smartphone with Android 6. At first I did not intend to publish the app in any form. The app was only intended as a programming project for my own smartphone.

The aim of the project was that I could use the ultimate mobile solution for astrophotography - I didn't want to take a lot of technical luggage with me on vacation and when traveling by air. Baggage regulations for air travel have been tightened and made more expensive. Mobile astrophotography should be small and light, with a maximum of a small mobile mount in your luggage. That should be it then.

I finished the first version in February 2018 and during the first experiments with the app I was speechless: it worked! The continuous shooting function at maximum exposure time ran smoothly on the LG G4! One astro image after the other was taken and saved, followed by the dark frames, bias frames and flat frames. The focus was fine. So it works!

At that time, the app was in its first rudimentary version. Back then, a lot of the programming code was hardwired. But the basic things worked: you could set the number of pictures to be taken, choose exposure time and ISO, set type and format of the picture.

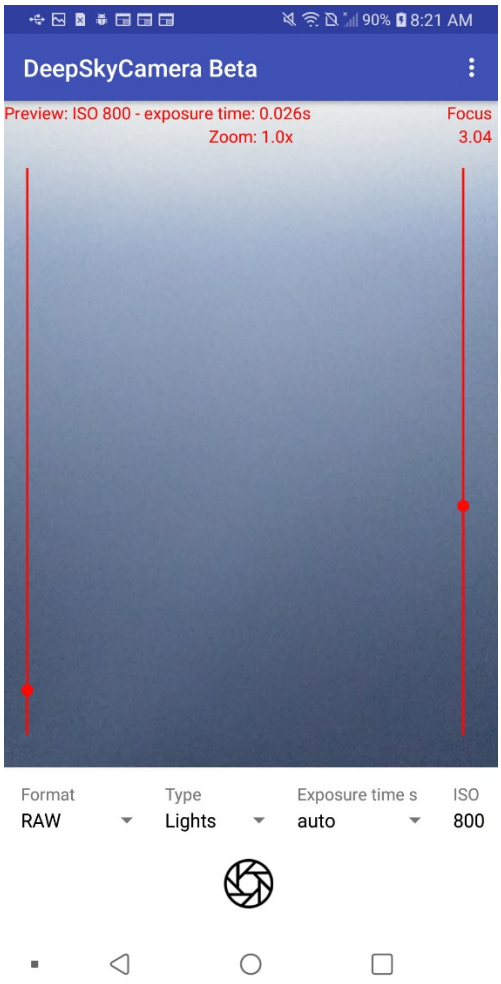
Some amateur astronomers heard about the app and asked if they could test it. Due to the inquiries, I‘ve uploaded app to Google Playstore in May 2018. The app was called DeepSkyCamera Beta. The UI was very basic.



Since everyone uses a different smartphone, I had to establish compatibility with the individual phones. Huawei and Honor devices offer up to 30 seconds, but Camera2API - and thus DeepSkyCamera - could only offer 1 second. What to do? I adapted the app to Huawei and Honor so that a maximum exposure time of 30 seconds is possible with these devices - almost no other app enables this. However, this adaptation to Huawei and Honor meant that there is a separate code area for these devices. The flagships of 2018 such as Huawei P20 Pro, Mate 20 Pro also had to be treated specially - again with their own code area.

For a long time I worked on the compatibility with Samsung S and Note devices, because many users asked about it. Similar to Huawei and Honor, Camera2API only offers 1/10 sec maximum exposure time. Far too little for astrophotography. In a first step, I was able to offer a maximum of 10 seconds exposure times for Samsung S6 to S8 and Note 5/8 in 2018 - which no other app can offer to this day (except for the original Samsung camera app). The programming code continued to grow - a separate code area had to be created for these Samsung models as well. The S9 was also released in 2018 and unfortunately my approach for S6 - S8 no longer worked. The solution for S9 / Note9 and higher should take over a year!

In 2019 the app appeared with a new user interface (version 1.3.0, August 2019). Slider as well as control bar were introduced. It was not so modern but functional.



I was able to further increase the compatibility with the smartphones, including full compatibility with Xiaomi and OnePlus devices - again with their own code section in app. With update 1.3.1 from

October 2019, I also wrote a manual for the app in German and English. At the same time, the Facebook group for the app, the YouTube channel and the Instagram account were created.

In the same year, I uploaded the app to the Huawei AppGallery for the first time. Since the app runs very well on Huawei and Honor, it no longer has an expiration date there.

In October 2019 I started the development of DSC Pro. Some functions were finshed by the end of the year (live star trails, star trails, animated star trails and timelapse). I've started coding of photo live stacking but in February 2020 Corona crisis evolved in Germany and due to my profession I was forced to work 12 to 14 hours per day during Corona crisis. In April I've decided to stop development of DSC Pro because the DSC Beta version was out on the markt and must be maintained. It was not possible for me to maintain DSC Beta and DSC Pro.

The year 2020 was all about full compatibility with Samsung devices. Finally I was able to offer 10 sec or 30 sec max exposure times for S9 / Note 9 and higher (Version 1.4.0 in March 2020). To this day, no other camera app can offer this. As a result, the program code grew more and more - because for these Samsung S and Note models I had to integrate my own code. At the same time, I was able to drastically increase the exposure time on some Samsung devices of the A models, e.g. Samsung A70 with 106 sec. I was also able to increase max shutter speed on other A-models accordingly, but only to about 70 seconds. Many new functions were integrated that year, including grid, burstshot mode, and the internal file browser was further enhanced. The maximum exposure time could be increased for some Xiaomi and realme devices (sometimes up to 60 seconds).

In the same year I made the app available in the Samsung Galaxy Store. Similar to the version in the Huawei AppGallery, the app in the Samsung Galaxy Store has no expiration date - because the app runs very well on Samsung S, Note and A models.

The year 2021 went on rapidly with new versions and new functions. External Bluetooth controllers can be used, exposure time extensions were added (including Google Pixel 4/5, OnePlus 8 Pro). Special code sections were added again, e.g. for OnePlus 8 and higher, OnePlus Nord and higher, realme 5. New functions have been added, e.g. histogram, sharpening and hot pixel removal. So far the app was in German and English - now Italian and Spanish have been added.

The response to DeepSkyCamera was and is enormous - in mid-2021 the app passed the 50,000 active installations mark for the first time. This number is very important because it tells you how many phones the app is used on continuously. The number of downloads is much higher at half a million, which is easy to explain. Users of the app switch phones and download the app again from the Playstore. As a result, the number of downloads increases faster than the number of active installations.

Around mid 2021 I've restarted development of DSC Pro and I've finished live stacking written in Java and Kotlin by the end of the year. But it was disappointing: Java and Kotlin are the primary languages on Android but they are too slow for the comprehensive calculations. Analyzing of a DNG file with star detection and finding homography took 4 minutes for one image – no user would accept that on a phone. On a PC with other stacking programs ist not an issue but on Android? No way.

I've decided in early 2022 to restart coding of DSC Pro. All the code for analyzing, aligning and stacking was written now in native C++ and that was really a performance boost! But code must be completely new written. That takes time.

In 2022 I was able top increase max shutter speed on lots of phones which for DSC Beta. On some Samsung phones I managed to increase maximum exposure time up to 10 min per frame (including A52, S20 Ultra, Note 20 Ultra). There might be more here, but I stopped at 600 sec per frame for now. 10 min for a single image is already a bit crazy. Compatibility has been increased further, including on Motorola phones and the new Honor devices (after being sold by Huawei). Here, the DeepSkyCamera app is still the only app in the Playstore that can offer long exposure.

With version 1.9.2 I integrated a calculator for point-like stars, i.e. up to which maximum exposure time the stars still remain point-like. Likewise a log file viewer was added, in order to have more analysis possibilities in particular with errors or problems.

The user interface of DSC Beta looks like an app from 2010 with an outdated design. In early 2023 I started to rewrite the UI of DSC. Mid 2023 I finished DSC Pro finally – but it was not ready for release. The UI of DSC Pro was based on the old design of the free version of DSC. So I wrote DSC Pro for the third time – now with the new UI. In 2023 I mainted the current version of DSC Beta 1.9x., the upcoming DS Free 2.0.0 and DSC Pro. That ws really stressful.

At the end of 2023 DSC Beta was also released in French with version 1.9.9 - so the app is now available in 5 languages.

In April 2024 I was able to release DSC version 2.0.0. The app left Beta status and is now called DSC Free – with a new, fresh and modern UI. I was able to integrate more compatability and more phones with 600 sec max shutter speed. In the meantime I've tested DSC Pro and all ist functions on nearly 300 phones that are in my test lab. In December 2024 I launched DSC Pro 1.0.0 with photo live stacking in RAW and JPEG as well as timelapse function, animated star trails, live star trails and star trails.

The project continues, of course - even if it is more than stressful on a few days and the manufacturers of the smartphones are thinking about new things or providing updates that lead to compatibility problems that I have to solve.

Finally, a warm and loving thank you to my wife Carla Margarida Lanca Seeboerger-Weichselbaum. I can't do it without you. And not without our son Neo Manuel either. I love you both.

Michael Seeboerger-Weichselbaum
Frankfurt am Main, Germany, December 2024

1. Introduction

DeepSkyCamera for Android is an app for astrophotography. You should be familiar with astrophotography in general. The most important thing:

Astrophotography is not a 1-click solution!

If you are not familiar with astrophotography please read a little bit about astrophotography before using this app (see chapter "Astrophotography" below which provides links on the Internet).

The image below shows Crab nebula M1 in constellation Taurus – taken with DeepSkyCamera app, Xiaomi Pocophone F1, telescope Takahashi TOA 130, 1000mm focal length, APM Lunt 13mm 100 degrees eyepiece, 112 light frames each 35 sec, ISO 800, 65 min total exposure time, additionally dark frames, bias frames and flat frames. Processed with DeepSkyStacker, Fitswork, Photoshop CC

Overview

The app uses the camera sensor on the back of your smartphone. You can set up an imaging plan to take pictures, including flat frames, darks frames and bias frames. The procedure is very similar to astrophotography with a DSLR or a dedicated astro camera with a CCD/CMOS sensor. The app takes the pictures – post processing (stacking, editing, processing) must be done with separate software (DeepSkyStacker, Sequator, Astronizer, Photoshop, Gimp, PixInsight, AstroPixelProcessor, etc.).

This manual describes Pro version of DeepSkyCamera for Android. Features:

- DeepSkyCamera for Android was the first app for astrophotography in Google Playstore. First version was released in May 2018.
- DeepSkyCamera Pro introduces photo live stacking in RAW and JPEG
- Additional functions: viewfinder live stacking, live star trails, star trails, animated star trails and timelapse
- A maximum of 1 million images can be taken in a series. The previous limit of 9999 images has been removed in version 1.0.4.
- Uses Camera2API to access the camera sensor. Max shutter speed, ISO, white balance etc. is determined via Camera2API only.
- Max shutter speed of 29 to 35 sec on lots of phones (f.i. Xiaomi Mi and Redmi, LG G, LG V).
- The only app in Google Playstore which provides 10 sec max shutter speed on Samsung (S6 - S9, Note 5 - Note 9) or 30 sec (Samsung S10/Note 10 and higher)
  Extended max shutter speed on:
  Samsung A06: 30 sec
  Samsung A13: 20 sec
  Samsung A14: 30 sec
  Samsung A15 (SM-A155): 25 Sek.
  Samsung A15 (SM-A156): 20 Sek.
  Samsung A16: 20 sec
  Samsung A23 4G: 49 sec
  Samsung A24 4G: 20 sec
  Samsung A33 5G: 30 sec
  Samsung A34: 20 sec
  Samsung A35: 600 sec
  Samsung A36: 50 sec
  Samsung A42 5G: 71 sec
  Samsung A51 5G: 22 sec
  Samsung A52 4G: 600 sec
  Samsung A52 5G: 75 sec
  Samsung A52s: 52 sec
  Samsung A53: 30 sec
  Samsung A54: 30 sec
  Samsung A55: 23 sec
  Samsung A70: 106 sec
  Samsung A71: 60 sec
  Samsung A72: 75 sec
  Samsung A73: 51 sec
  Samsung A80: 71 sec

Samsung M14 4G: 52 sec
Samsung M15:20 sec
Samsung M33: 30 sec
Samsung M34: 30 sec
Samsung M35: 54 sec
Samsung M44: 600 sec
Samsung M51: 71 sec
Samsung M52 5G: 52 sec
Samsung M54 (SM-M546): 30 sec
Samsung F62: 30 sec
Samsung Xcover 7: 20 sec

- Extended max shutter speed on these Samsung S and Note models with Qualcomm:
  Samsung Note 20 Ultra: 600 sec
  Samsung S20 Ultra: 600 sec
  Samsung S21 Ultra: 600 sec
  Samsung Note 20: 130 sec
  Samsung S20 5G: 130 sec
  Samsung S20 Ultra: 600 sec
  Samsung S20 Plus: 130 sec
  Samsung S20 FE 5G (SM-G781): 155 sec
  Samsung S21: 130 sec
  Samsung S21 Plus: 130 sec
  Samsung S21 Ultra: 600 sec
  Samsung S21 FE: 43 sec
  Samsung S22, S22 Plus, S22 Ultra: 55 sec
  Samsung S23, S23 Plus, S23 Ultra: 51 sec
  Samsung S24, S24 Plus, S24 Ultra, S24 FE: 51 sec
  Samsung S25 Ultra, S25 Plus, S25: 600 sec
  Samsung Flip 3: 70 sec
  Samsung Flip 4: 55 sec
  Samsung Flip 5: 51 sec
  Samsung Flip 6: 210 sec
  Samsung Flip 7, 7 FE: 45 sec
  Samsung Fold 2: 130 sec
  Samsung Fold 3: 130 sec
  Samsung Fold 4: 55 sec
  Samsung Fold 5: 51 sec
  Samsung Fold 6: 210 sec
  Samsung Fold 7: 600 sec
  Samsung Tab S7 FE: 120 sec
  Samsung Tab S8, Tab S8 Plus, Tab S8 Ultra: 50 sec
  Samsung Tab S9 Ultra, Tab S9 Plus, Tab S9: 51 sec
  Samsung Tab S10 Plus: 170 sec
- OnePlus 8 Pro: 55 sec max shutter speed, OnePlus 9 and 9 Pro: 52 sec max shutter speed; OnePlus 10T: 89 sec max exposure time; 11R and 13R: 75 sec, Nord 4: 30 sec
- Oppo A55: 37 sec, A57s: 37 sec, A15 and A16: 55 sec, A58: 70 sec, Oppo Reno 3: 90 sec
- Oppo Find X2 Pro: 55 sec
- Oppo Find X3 Lite: 183 sec max shutter speed
- Oppo Find X5: 84 sec max shutter speed

- Oppo Find X7 Ultra: 101 sec max shutter speed
- Oppo Find X8 Ultra: 104 sec max exposure time
- Provides 30 sec max shutter speed on Huawei and Honor devices.
- Extended shutter speed of 59 sec on Xiaomi Redmi 9, 43 sec on Xiaomi Redmi Note 9 and 34 sec max shutter speed on Xiaomi Mi 11 Lite 5G, Xiaomi Redmi Note 11: 44 sec; Xiaomi Black Shark 4 Pro: 51 sec, Xiaomi Redmi Note 13 Pro: 43 sec
- Xiaomi Mix Flip: 51 sec max exposure time.
- Extended shutter speed of 60 sec on realme Narzo 20, C21, realme 7 Pro: 60 sec and 43 sec on realme 8 Pro, realme GT Neo 2: 48 sec, C55: 60 sec
- Extended shutter speed of 40 sec on realme C2, C3, C3i, C15.
- Extended shutter speed of 32 sec on Google Pixel 4, 5. 17 sec on Google Pixel 6/6 Pro/7/7 Pro and 10 sec on Google Pixel 1, 3.
- Google Pixel 8 / 8 Pro / 8a / Fold: 24 sec max shutter speed
- Google Pixel 9 / 9 Pro / 9a / Fold: 24 seconds maximum exposure time
- Google Pixel 10 and 10 Pro Fold: 19 seconds maximum exposure time on all camera sensors
- Google Pixel 10 Pro and 10 Pro XL: 47 seconds maximum exposure time on camera sensors 0 and 2. 30 seconds on camera sensors 3 and 4
- Full support of Motorola One devices (32 or 36 sec max shutter speed), Edge devices and on Moto G9 and higher. Extended max shutter speed on Moto G30: 55 sec, G40 Fusion: 55 sec
- Motorola Edge 30, 30 Pro, 40 Pro: 51 sec max shutter speed
- Motorola Edge 40 Neo: 75 sek max exposure time
- Vivo X90 Pro and X90 Pro Plus: 43 sec max shutter speed , Vivo S1 Pro: 30 sec max shutter speed
- Vivo X100 Pro: 43 sec max shutter speed
- Vivo X100 Ultra: 33 sec max shutter speed
- Vivo V40, V29: 32 sec max exposure time
- Vivo Y15: 60 sec max shutter speed, Y51A: 32 sec max shutter speed
- Nokia XR20: 32 sec max shutter speed and on Nokia G10: 170 sec max shutter speed
- Asus Zenfone 8: 40 sec max shutter speed
- Sharp Aquos R7s: 30 sec max shutter speed
- Huawei Pura 70 models: 190 sek max shutter speed
- Preview area to point to the stars.
- Live histogram of viewfinder (not available on Samsung S6/7/8, Note5/8 and Legacy devices)
- Histogram of images (not available on Samsung S6/7/8, Note5/8 and Legacy devices)
- Noise reduction based on Camera2API and camera sensor
- Noise reduction without camera sensor (3X3 Median, 5X5 Median)
- Focus methods: manual, auto, infinity, hyperfocal.
- Customized infinity
- Focus lock/unlock.
- Exposure time and ISO of viewfinder can be set independently from the exposure time and ISO of the images.
- Synchronize exposure time of the images with exposure time of the live view.
- Set up a plan for your imaging session.
- Supported file formats: JPEG and RAW (DNG).
- Manual settings:
    - ISO
    - Exposure time

    - Interval time between two pics
    - Number of pics
    - Delay before the imaging session starts
    - White balance
- The path in which the images are stored can be selected individually.
- Save pictures also in SD card, if your phone supports SD cards.
- Night mode (black background and red text color) and daylight mode (white background, black text color).
- Night mode of the app works totally independent from Dark Mode of Android 10 (or higher). Night mode of the app works on Android 6.0 and higher.
- Whitebalance manually and automatically.
- Internal file browser which provides navigation, sorting and deleting of image files.
- Internal file browser can display the images and can zoom into the images.
- Zoom function (not available on Samsung S6/S7/S8 and Note 5/8).
- Grid.
- variable aperture (if supported, f.i. Samsung S9, S10, Note9, Note 10).
- variable focal length (if supported).
- Interval time 0 sec / Burst shot mode (not available on Samsung S6/S7/S8, Note 5/8, some A and J models).
- Sharpness (edge mode)
- Hot pixel removal
- Calculator for pinpoint stars
- Timestamp on JPEG files
- Support of external Bluetooth controller to start/stop the imaging session.
- Support of wired headset to start/stop the imaging session.
- Support of Samsung SPen to start/stop the imaging session.
- Huge compatability list with over 400 phones which contains the technical data of lots of phones.
- App available from Google Playstore, Samsung Galaxy Store and Huawei AppGallery.

Supported smartphones and increased exposure times

DSC Pro generally runs on any Android phone and offers long exposure times. This also applies to devices where the smartphone manufacturer has disabled long exposure times for third-party camera apps (Samsung, Motorola, Sony, Huawei, Honor, Oppo, realme, vivo). DSC Pro overcomes this restriction.

I maintain a complete list of supported smartphones:

https://www.deepskycamera.de/en/smartphones.php

On various smartphones, DSC Pro increases max exposure time (in some cases up to 600 seconds!). I also maintain a list of these extensions:

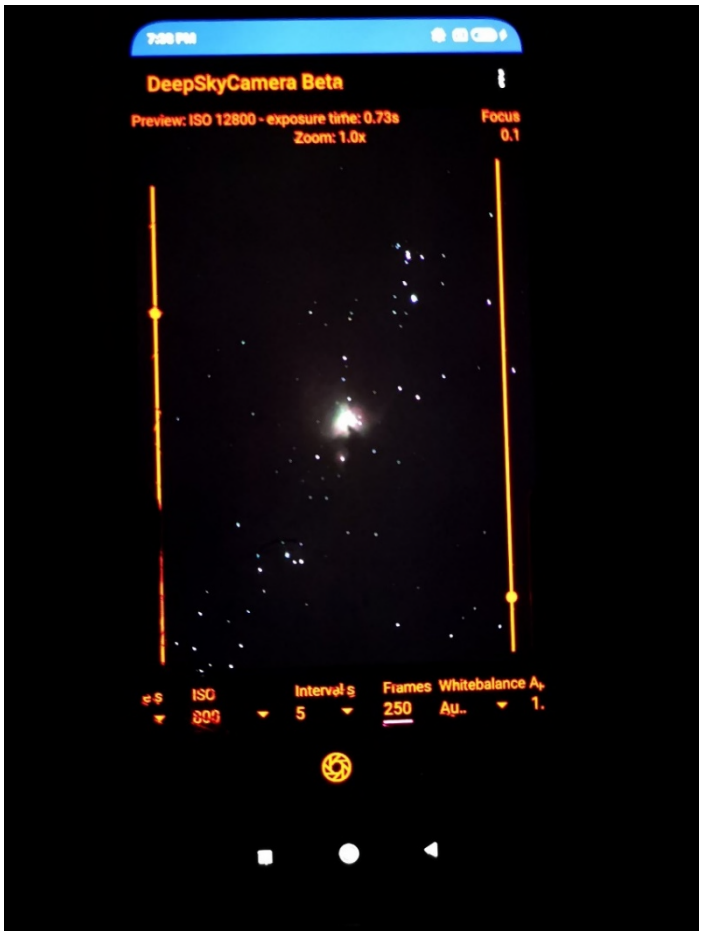
https://www.deepskycamera.de/en/extensions.php

How DeepSkyCamera Pro app works

The DeepSkyCamera app works differently from other camera apps. The settings of the viewfinder are totally independent from the settings of the images. This can be confusing but its essential. The advantage is that you can see the brightest stars in the viewfinder when you set ISO to 12800 (or

similar) and exposure time of the viewfinder to 1 sec. This is also an advantage when the phone is attached to a telescope. With some devices you can see the brightest objects in the viewfinder!

The image below shows Orion nebula M42 in the viewfinder of the app. The smartphone was attached to a Taskahashi FS 60 refractor. You take the pictures with other values (f.i. ISO 800 and 30 sec shutter speed).



After taking light frames, dark frames, bias frames and flat frames you have lots of files. The image files must be transferred to a computer. You must stack and process these files with separate software.

Astrophotography

This manual is NOT an introduction to astrophotography. This manual explains NOT what flat frames are or how to process the image files. When you are not familiar with astrophotography you'll find here some links which explains all the necessary things.

Astrophotography in general

https://astrobackyard.com/beginner-astrophotography/

http://astronomyonline.org/Astrophotography/Introduction.asp?Cate=Astrophotography&SubCate=AP01

https://loadedlandscapes.com/intro-to-astrophotography/

https://www.bhphotovideo.com/explora/photography/tips-and-solutions/how-to-do-basic-backyard-astrophotography-part-i-introduction

Smartphone astrophotography

NASA Book "A Guide to Smartphone Astrophotography" by Dr. Sten Odenwald

https://spacemath.gsfc.nasa.gov/SMBooks/AstrophotographyV1.pdf?fbclid=IwAR3j0Z_CE_MNGHpvE-jypdhkiwk0GzT2iszj2-F-oupQAVm1jimcJkgJFe8

Stacking software

Siril
https://siril.org/

DeepSkyStacker (DSS)

http://deepskystacker.free.fr/

Sequator

https://sites.google.com/site/sequatorglobal/

Fitswork
https://www.fitswork.de/software/

Nina

https://nighttime-imaging.eu/

PixInsight

https://pixinsight.com/

Astro Pixel Processor

https://www.astropixelprocessor.com/

Theli

https://www.astro.uni-bonn.de/theli/

StarTools

https://www.startools.org/

Postprocessing

Gimp

https://www.gimp.org/

Paint.net

https://www.getpaint.net/

Raw Therapee

https://rawtherapee.com/

Lightroom

https://www.adobe.com/products/photoshop-lightroom.html

Photoshop

https://www.adobe.com/products/photoshop.html

2. Requirements

These are the minimal requirements for DeepSkyCamera Pro:

- Android 6 or higher
- 3 GB RAM
- 64 GB flash

RAM is very important and DeepSkyCamera Pro runs on phones with 3GB RAM. Due to heavy memory operations (espcially during RAW photo live stacking) app can crash due to lack of memory. It depends on memory management of the phone. DeepSkyCamera Pro runs on Android 6 but there are a couple of minor issues on Android 6 and 7.

Best requirements for DeepSkyCamera Pro:

- Android 8 or higher
- 8 GB RAM
- 128 GB flash

More memory is always better for ever app or software. Its the same with DeepSkyCamera Pro.

3. Installation

The app is available at Google Playstore:

https://play.google.com/store/apps/details?id=de.seebi.deepskycamera.pro

If you have a Huawei or Honor smartphone you can install the app from Huawei AppGallery:

https://appgallery.huawei.com/app/C112904787

If you have a Samsung smartphone you can install the app from Samsung Galaxy store:

https://galaxystore.samsung.com/detail/de.seebi.deepskycamera.pro

You can install DeepSkyCamera Pro and DeepSkyCamera Free side by side.
Both apps are independent and you can use both apps. Updates of one app do not overwrite the other app.

Updates of the app are only available at Google Playstore, Huawei AppGallery and Samsung Galaxy Store. You will be notified by app stoe when a newer version is available.

4. First launch of the app

When starting the app for the first time, you must grant some specific rights to the app, such as for accessing the camera sensor. Whithout granting these rights, you cannot use the app.

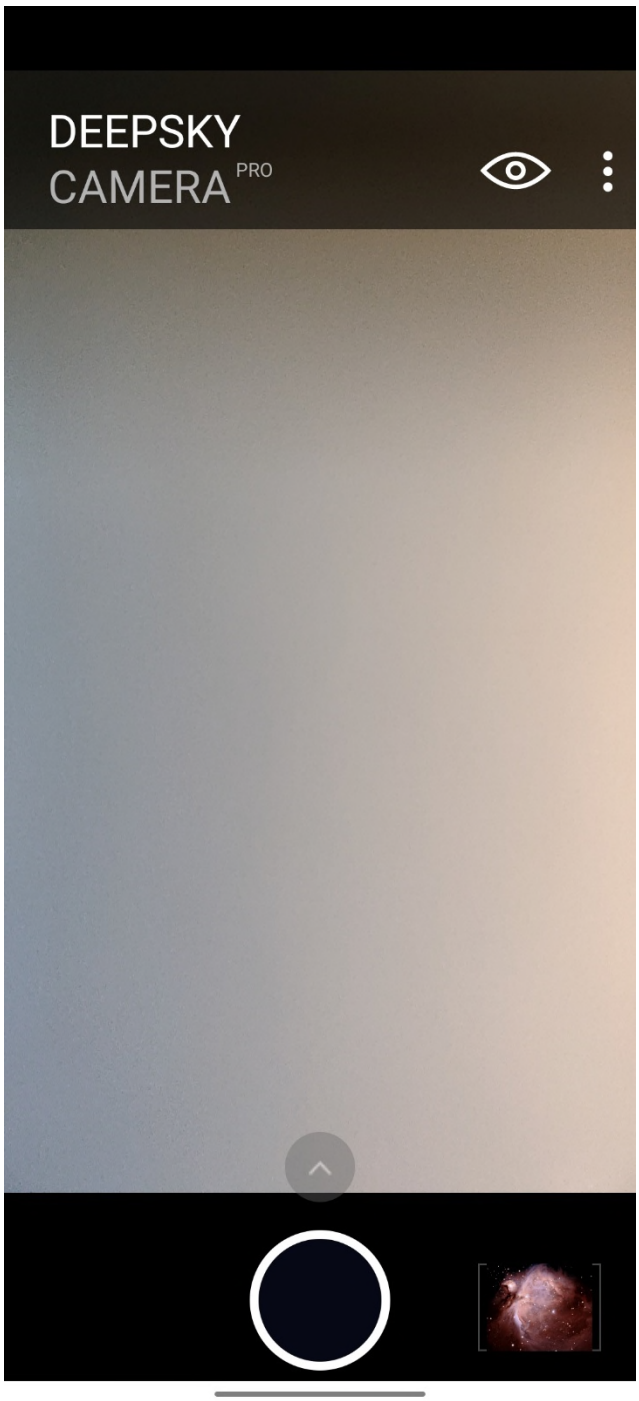
You'll see the welcome screen and a dialog which tells you what's new in this version. All the dialogs with blue background have an option at the end "Do not show again". If you don't tick the box, the dialog appears again after restart. On some devices with a small display, you must scroll down to see the option "Do not show again".

5. Main page of the app

On the main page, you'll find everything you need to take pictures, to do photo live stacking, assemble a timelapse video etc. Important configurations and settings are in the menu "Settings".

Overview

In the middle, you'll find the viewfinder and shows the live stream of the camera sensor. It's also called preview area or live view.



The start page consists of these elements:

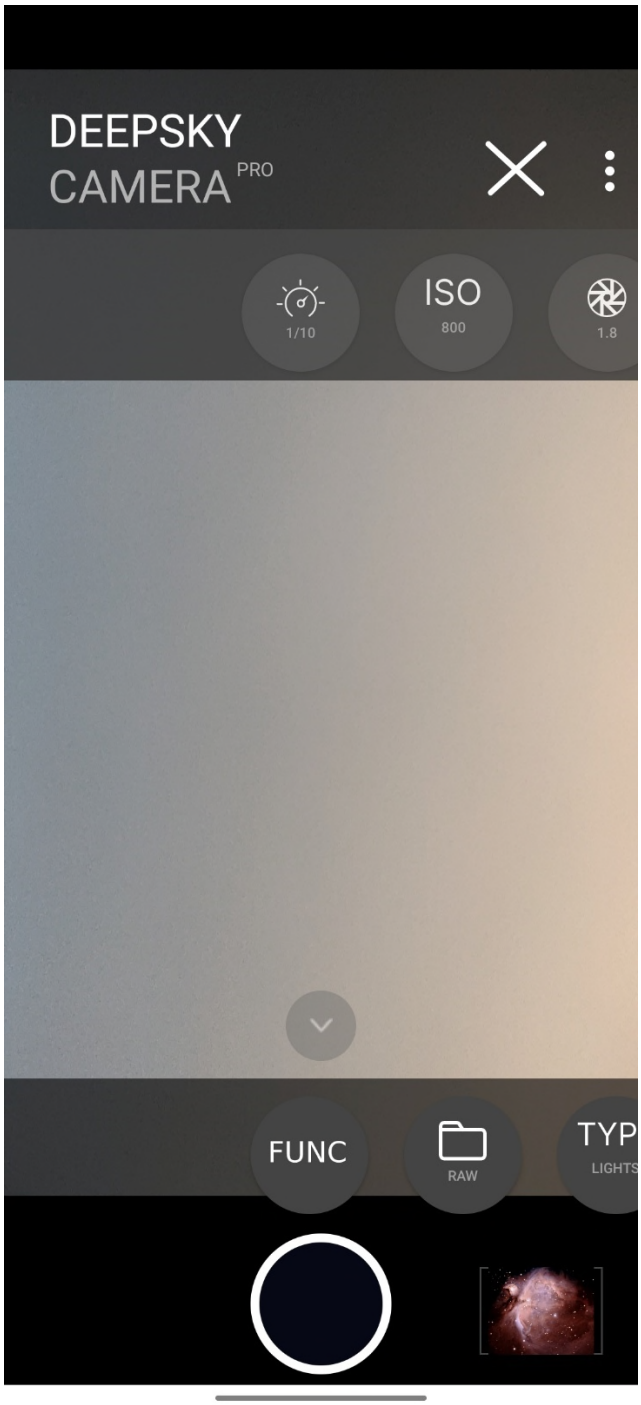
- In the center is the preview of the camera sensor. This ist he viewfinder.
- Three dots top right: the menu
- The eye symbol: Settings for the preview

- The triangle above shutter button: Opens control bar with functions and settings for the images
- The shutter button
- To the right of the shutter button is the icon for the internal file browser

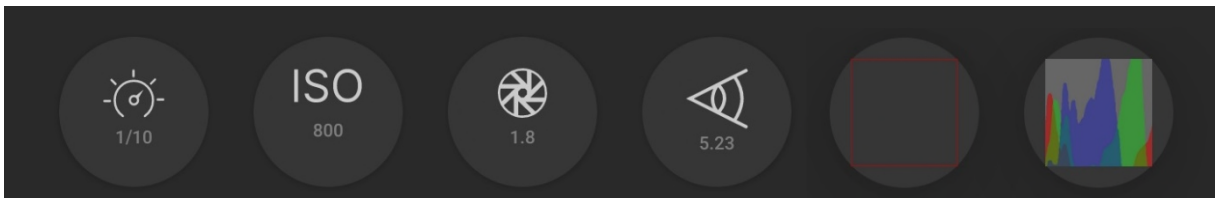
Note: The viewfinder may be black on some devices after startup. This is not a bug. The exposure time of the viewfinder is set to 1/10 second by default. This may be too low for some devices, which is why the viewfinder is dark on some devices. Increase the exposure time or the ISO value of the viewfinder (tap the eye icon).

Preview settings

When you tap the eye icon settings bar for viewfinder pops up.



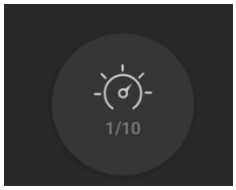
The control bar of viewfinder consists of several icons:



Here you can make the settings ONLY FOR THE preview. These are in the order of the icons:

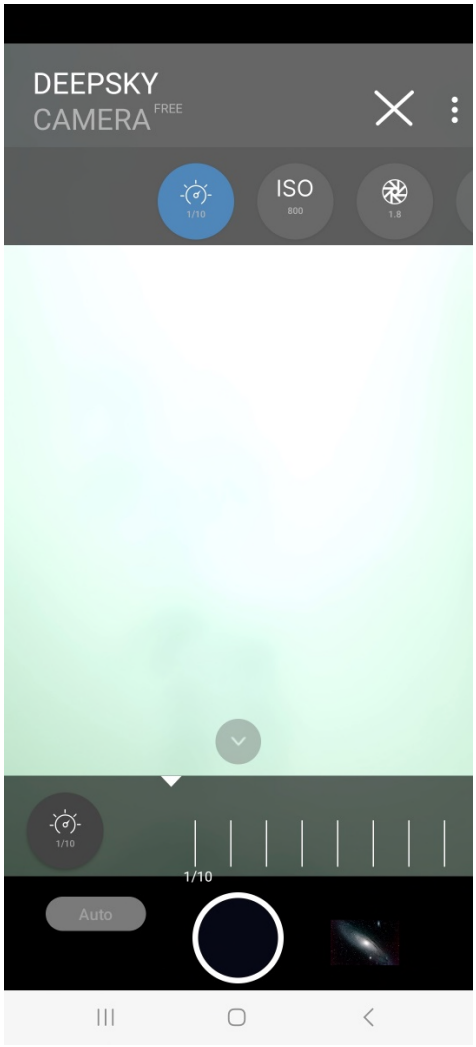
- Exposure time
- ISO
- Aperture
- Focal length
- Grid
- Histogram

Preview exposure time



The first icon is for the exposure time of the preview. If you tap the icon, a slider opens above the shutter button, which you can use to adjust the exposure of the preview. This is important, for example, if you want to take pictures of the moon. It is often very bright and here you have the option of adjusting the exposure time very low so that you can see all the details on the moon's surface. This is also useful with the sun (please only ever use a solar filter).

With the "Auto" option, the app automatically controls the exposure time of the preview and adjusts it continuously. In this case, the slider is hidden.



Note: The slider is not available on legacy devices.

At the same time, you can also adjust the ISO for the preview using the second icon. For moon it is recommended to use a low ISO number. For the sun (always only with a sun filter!) you also have to set the ISO value as low as possible (50, 100).

The slider for the exposure time of the preview initially has no influence on the later exposure time, which can be set in the slide bar above the shutter button. This exposure time for the specific recording is completely independent of the slider! DeepSkyCamera takes the approach that there are different settings: once for the preview and once for the recordings.

However, if you set the exposure time of the images to "Preview", then the exposure time set for the preview will be used for the exposure time of the images - this is referred to as synchronization of the exposure times.

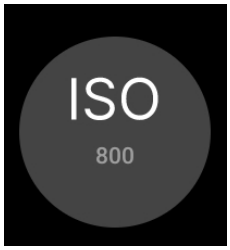
Under the starry sky, however, you should choose a higher ISO number and increase the exposure time of the preview until you see stars in the preview.

Note: The value for the exposure time of the preview is saved. If you close the app and restart it, the value you last used will be used.

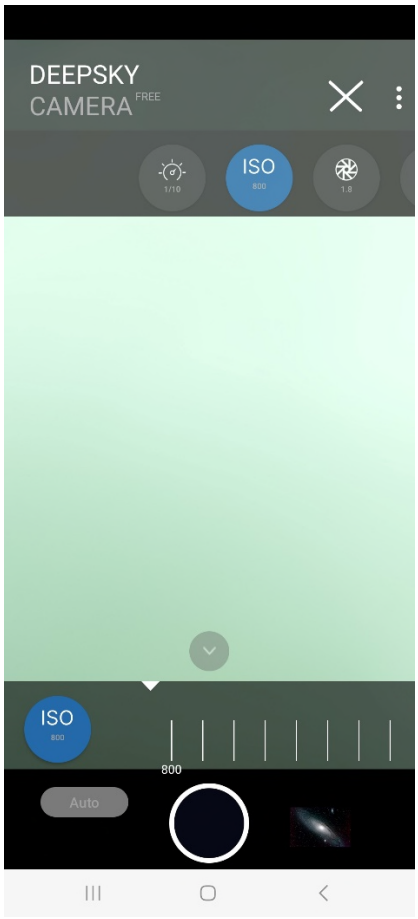
Max shutter speed of viewfinder is 1 sec if phone support 1 sec or higher. This is intended behaviour and has nothing to do with shutter speed of the images. Due to technical reasons its a problem on lots of phones when shutter speed of viewfinder is higher then 1 sec. On lots of phones the app hangs or crashes. It depends on phone, Android and camera sensor how this is handled. On some devices (f.i. Huawei, Honor) max shutter speed of 1 sec can be set but camera sensor reduces max shutter speed of viewfinder to something around 0.3 sec or 0.5 sec. The only thing you can do is to increase the ISO value of viewfinder to max ISO value (f.i. 3200, 6400, etc.).

When your device supports max shutter speed of 0.3 sec (or something faster then 1 sec) then camera sensor reduces max shutter speed of viewfinder automatically to supported max shutter speed. In this case 1 sec is not possible: max shutter speed of viewfinder is max shutter speed of the camera sensor.

Preview ISO



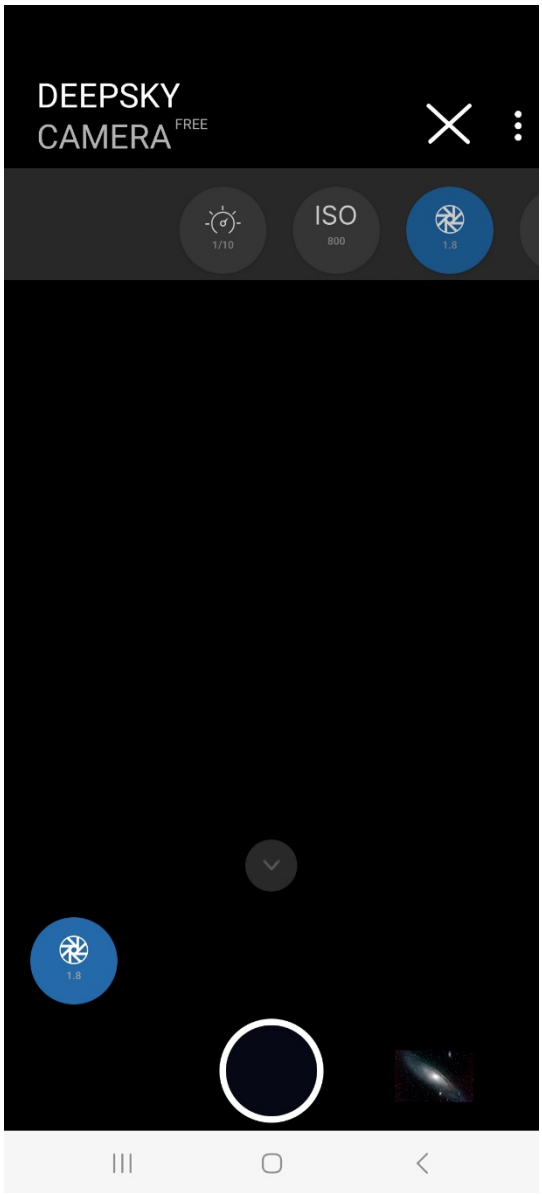
Tapping on the second icon opens the slider for the ISO range at the bottom. This setting can be used to specify the sensitivity of the sensor for the preview on the main page of the app. The possible ISO values depend on how the camera sensor was configured by the manufacturer and is different depending on the smartphone and camera sensor. The figure shows possible ISO values that can be set. The values can be different on your smartphone!



Note: On so-called legacy devices there is only the “Auto” setting. Legacy devices do not support manual settings and therefore do not support manual ISO.

Preview Aperture

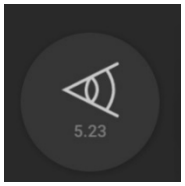
The third icon shows the available apertures. This depends on whether the manufacturer of the smartphone allows a variable aperture for the device. So far, only a few phones are able to offer a variable aperture. These are: Samsung S9, S10, Note 9 and Note 10 as well as Huawei P40 Pro (as of July 2020). On most smartphones, the aperture value is fixed and is for information purposes only.



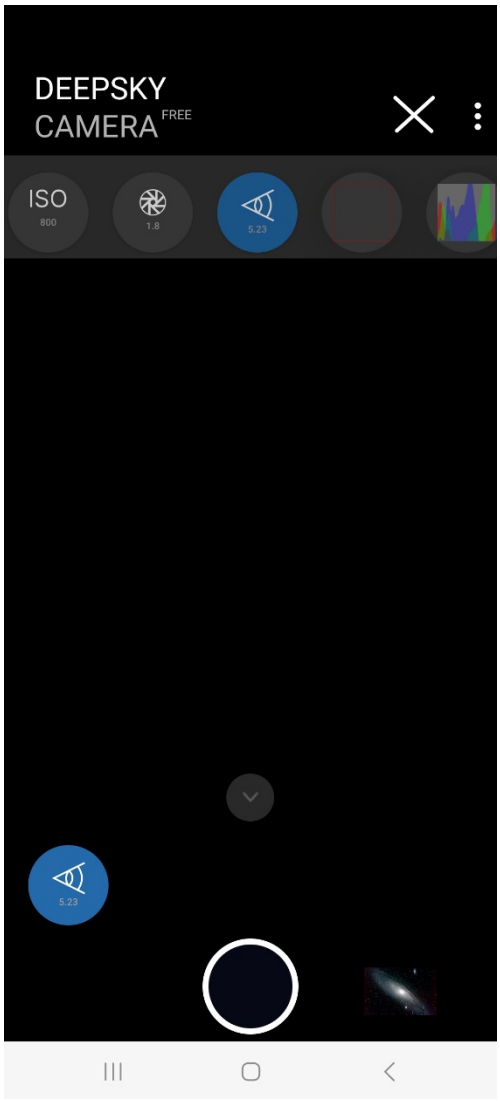
This setting only affects the preview. If you want to set the aperture for the images, you can do this in the bottom bar.

Note: There is no "Preview aperture" setting on so-called legacy devices.

Preview Focal length



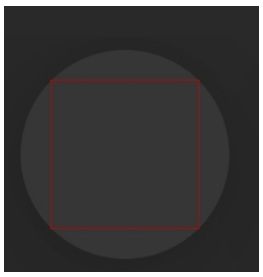
The fourth icon indicates the focal length. This depends on whether the manufacturer of the smartphone allows a variable focal length for the device. So far, only one phone is able to offer a variable focal length. This is: Huawei P40 Pro (as of July 2020). For most smartphones, the focal length is fixed and is for information purposes only.



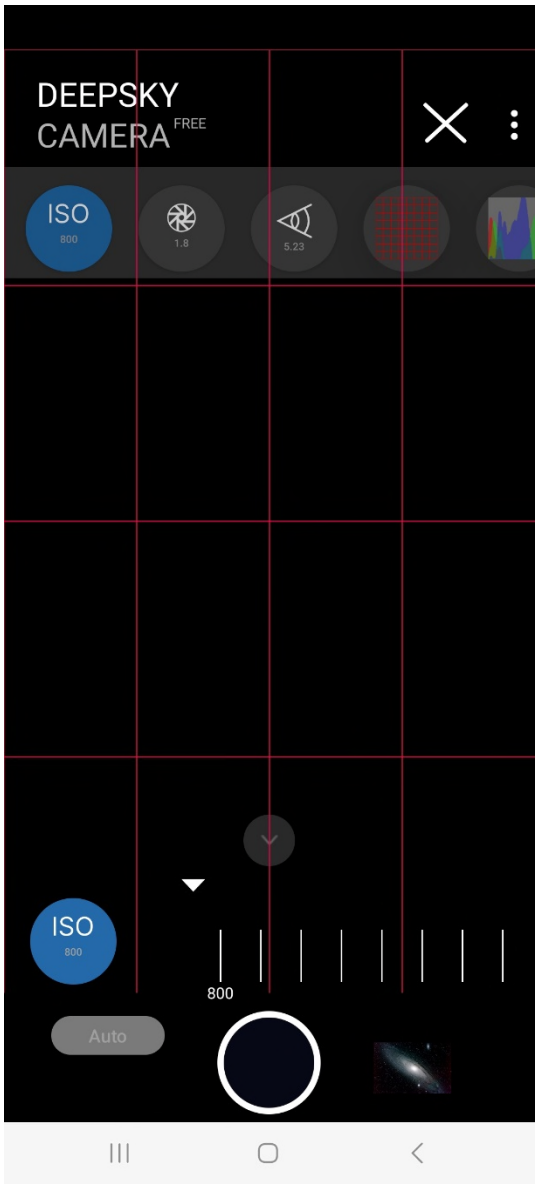
This setting only affects the preview. If you want to set the focal length for the images, you can do this in the bottom bar.

Note: There is no "Preview focal length" setting on so-called legacy devices.

Grid



You can place a grid on the preview. This grid is very practical if you want to align the phone to a line, e.g. horizon, roof, etc. The following image shows the fine grid.

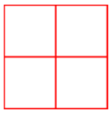


The grid is available in four forms:

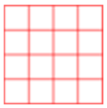
- No grid (default)
- Rough grid
- Fine grid
- Very fine grid

The viewfinder does not show a grid by default. The grid icon shows only the outer border.

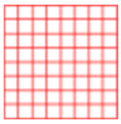
To get the rough grid you must tap the grid icon. You see the rough grid on the viewfinder. The icon changes.



To get the fine grid please tap again the icon.



To get the very fine grid please tap again the icon.

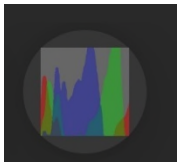


To turn grid off tap again the grid icon.

> **Note**: Grid is available on Android 8 and higher.

Histogram

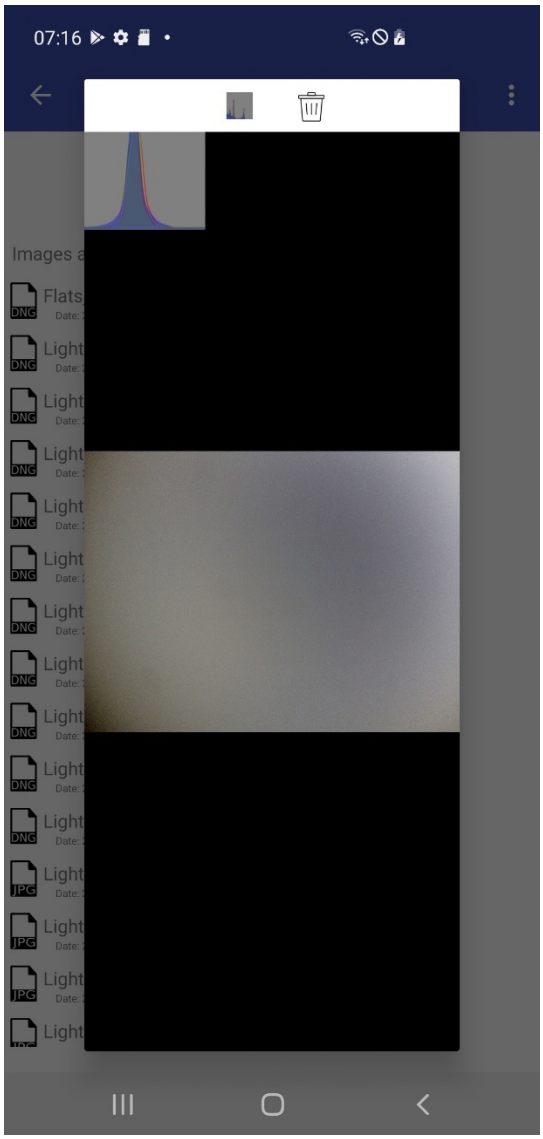
You can enable or disable histogram of viewfinder by tapping on histogram icon right to grid icon



When you enable histogram of viewfinder a small windows pops up and shows the current histogram of the stream which comes from camera sensor. Histogram is updated after 500 ms and can change when you move the phone or vary the settings.

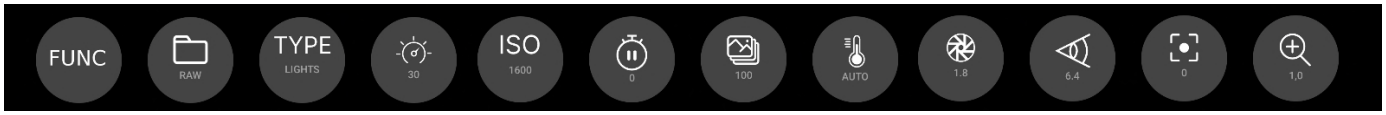
Note: Live histogram is available on Android 7 or higher. Live histogram is not available on Samsung S6/7/8, Note5/8 and Legacy devices.

Histogram is very helpful especially when you take flat frames. The peak of histogram of a flat frame should be in the middle. The image below shows a typical flat frame with histogram in internal file browser of DeepSkyCamera.



Control bar: Functions and settings for images

If you press the triangle above the shutter release button, the bar with the settings ONLY FOR THE IMAGES appears. The bar can be moved from right to left and back again. The bar contains several controls that are important for taking pictures and the functions (live stacking, star trails etc.).



> **Note**: All settings in the slider bar are saved. If you exit the app and restart it, the values you last used will be set again.

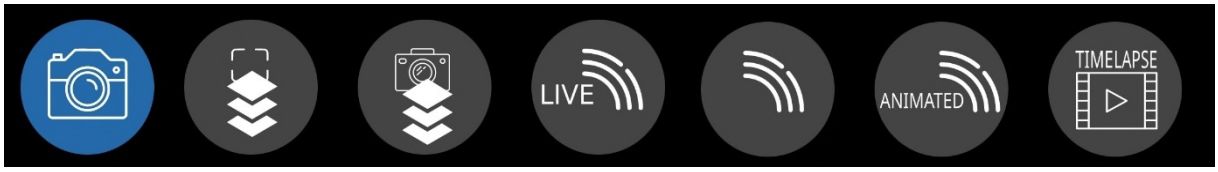
You can set this in the slider bar:

- Functions
- Format of the images
- Type of images

- Exposure time in seconds
- ISO
- Pause between two images in seconds
- Number of images
- White balance
- Aperture
- Focal length
- Focus
- Zoom

Functions

DSC Pro introduces several functions.

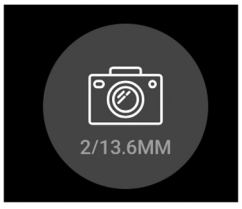


DSC Pro provides these functions:

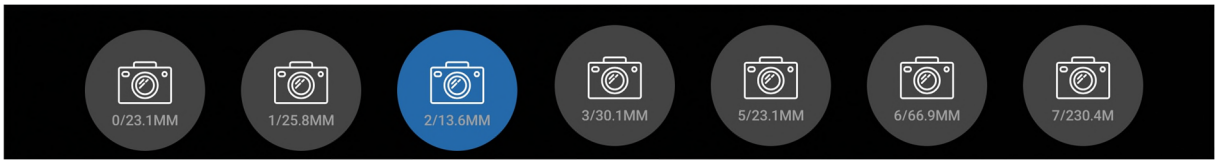
- Photo (default): takes one or more images. Same as in DSC Free.
- Preview Live stacking: this is live stacking of viewfinder without alignment of the images.
- Photo live stacking: DSC Pro takes images and stack these images (with analyzing and alignment).
- Live star trails: Builds a star trails image.
- Star Trails: Assemble a star trails images with images you have taken earlier.
- Animated star Trails: Star Trails as video. Assemble a video with images you have taken earlier.
- Timelapse: assemble a video with images you have taken earlier.

The functions are explained in chapter 8 "Functions".

Camera sensors



You can switch between camera sensors using this icon. A new bar will open, displaying all camera sensors accessible to the app:



Each icon shows the camera ID and focal length (in 36mm format). This makes it easy to see whether it is a telephoto, standard or wide-field lens. In the image above, you can see that the last camera sensor is a true telephoto lens – with a focal length of 230 mm!

> **Note**: By default, the camera sensor with Camera ID 0 is selected. This is the main camera sensor on the back.

The functions that you can select in the Func icon use the camera sensor you have selected, i.e. if you have selected Camera ID 2, for example, photo live stacking will be executed with Camera ID 2 (in this case wide-field). This also applies to all other functions such as live star trail, viewfinder live stacking, etc.

If you compare the camera sensors with your smartphone manufacturer's camera app, you may find that your smartphone manufacturer's camera app can access multiple camera sensors, while DSC Pro (and other third-party camera apps) can only access one sensor on the back of your phone. This is not a bug in the app. The reason is that the smartphone manufacturer's camera app runs as a so-called root user, which has more permissions and configurations than third-party camera apps. This is particularly the case with Oppo, Vivo, realme and OnePlus.

Furthermore, the smartphone manufacturer's camera app can access functions of the Android operating system (modified by the manufacturer) as a root user, which a third-party camera app (running as a so-called non-root user) does not have access to. This can lead to restrictions.

One of these restrictions may be that although another camera sensor (e.g. id 6) is visible, the viewfinder remains black after selecting the camera sensor and the app may become unstable. This can happen when searching for hidden camera sensors, but they cannot be accessed because the manufacturer does not allow it.

The following list serves as a rough guide to whether DSC Pro can access multiple camera sensors on your phone.

Google Pixel
DSC Pro can access multiple sensors on the back.

Huawei Pura and P models
DSC Pro can access multiple sensors on the back.

Motorola
Motorola hides additional camera sensors from third-party camera apps. However, DSC Pro can access these hidden sensors on the back, which other third-party camera apps cannot.

OnePlus
Mostly DSC Pro can access only one sensor on the back. But on some models DSC Pro can access more than one camera sensor on the back.

Oppo
DSC Pro can usually only access one sensor on the back.

realme
DSC Pro can usually only access one sensor on the back.

Samsung S, Fold and Flip models
DSC Pro can access multiple sensors on the back.

Special feature Camera Id 4 – this sensor with the number 4 does not exist; Samsung has skipped it and continues with Camera Id 5.

Samsung A, F , M and Tab models
Mostly DSC Pro can access more than one sensor on the back but there are models However, there are models where only one camera sensor is accessible.

Sony Xperia models
DSC Pro can access multiple sensors on the back.

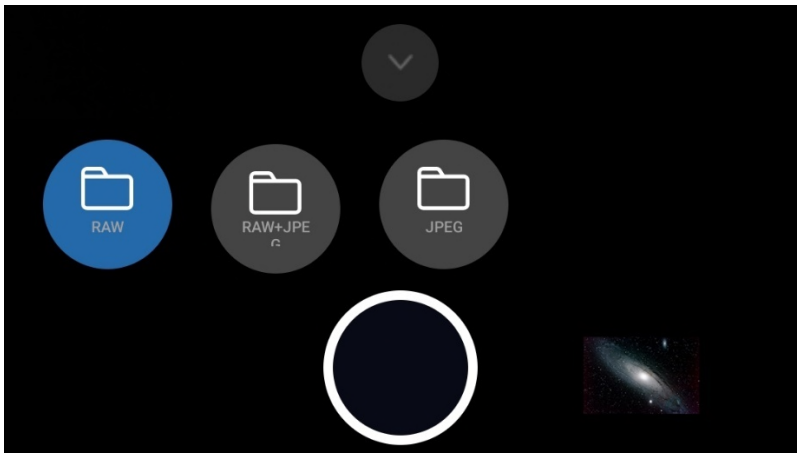
Vivo
DSC Pro can usually only access one sensor on the back.

Xiaomi
Xiaomi hides additional camera sensors for third-party camera apps. However, DSC Pro can access these hidden sensors on the rear, which other third-party camera apps cannot.

Format

You can choose between these formats:

- RAW: You take pictures in RAW with file extension .dng
- RAW+JPEG: You take pictures in RAW and in JPEG
- JPEG: You take pictures in JEPG with file extension .jpeg



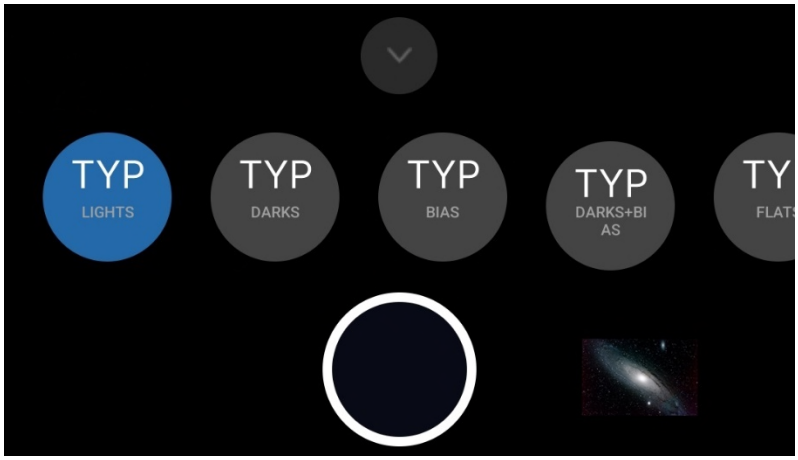
Note: There are smartphones on the market, which do not provide RAW (especially legacy devices). On those phones you can only take pictures in JPEG. The app detects automatically, what your device supports and changes the values in the control bar "Format".

Note: Due to technical reasons on Google Pixel 4a, 5, 7(und höher) only "RAW" and "JPEG" are available, not "RAW+JPEG".

Type

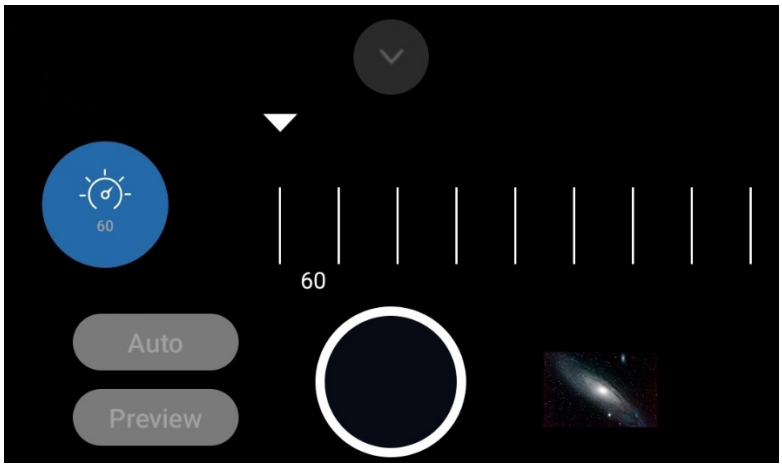
You can choose between these types:

- Lights: These are "normal" pictures of the stars, moon, etc.
- Darks: These are so called dark frames. The pictures must be taken with the same exposure time as the lights. You must cover the lens of your smartphone to take dark frames. The dark frames are useful, when you want to stack your images with separate software (DeepSkyStacker, Sequator, PixInsight, Astronizer, etc.). You can reduce the noise with dark frames.
- Bias: These are bias frames. When you select "Bias" the exposure time is automatically set to the fastest shutter speed available (e.g. 1/90000s or similar). You must cover the lens of your smartphone to take bias frames. The bias frames are useful, when you want to stack your images with separate software (DeepSkyStacker, Sequator, PixInsight, Astronizer, etc.). You can reduce the noise with bias frames.
- Darks+Bias: This is a combination of dark frames and bias frames. The app takes first the dark frames and then changes to bias frames with fastest shutter speed automatically. This saves time.
- Flats: They are great in combination with a stacking software to reduce the vignetting, dust on the sensor, etc. You need a flat field box or a T-Shirt for flat frames.



Exposure time

The control element "Exposure time" contains a list of available exposure times in seconds.



The values depend on the phone. Lots of smartphones provide max exposure time of 30 or 25 sec, other provide faster exposure times (8s or faster 1/4 sec). The list is dynamic. The app detects max exposure time of your phone and creates the list. For pictures of the night sky you should choose the highest possible value (20sec, 30 sec, etc.). For moon and the sun (with filter!) fast shutter speeds (1/10 sec and faster) are better, otherwise the moon or the sun will be overexposed. "Auto" exposure time is great only for sunsets, timelapse videos etc.

"Auto" is mostly not suitable in astrophotography. You can use is during daylight, sunsets etc. For deep sky and night sky images you should the longest shutter speed available (f.i. 30 seconds). Only for moon and sun images (sun always with appropriate solar filter!) you can set fast shutter speeds.

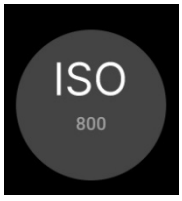
The entry "Preview" is useful when taking images of moon and sun (sun always with appropriate solar filter!). This function synchronizes the exposure time of the images with the exposure time of the viewfinder. The images will have the same shutter speed as the viewfinder.

Note: On legacy devices only "Auto" is available.

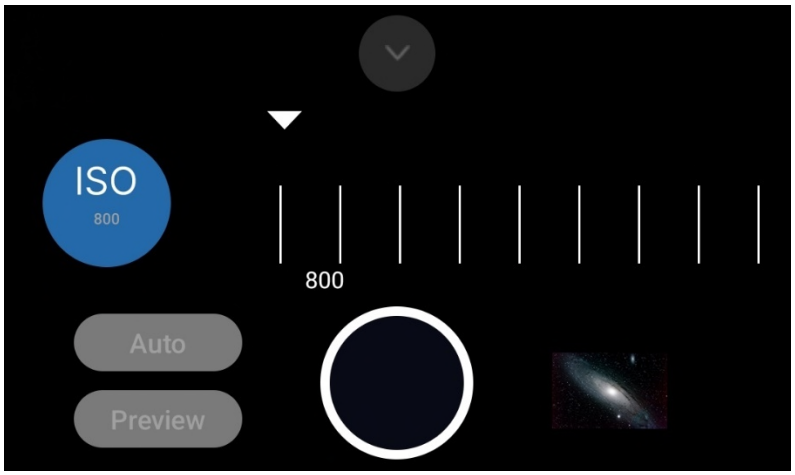
When you select "Auto" exposure time in spinner "Exposure time" ISO is set to "Auto". This is a behaviour of the camera sensor on Android. Google defined that "Auto" means "Auto" exposure time and "Auto" ISO. This can not be changed.

Note: Due to technical reasons "Auto" is not available on Samsung S6 – S8 and Samsung A51.

ISO



This is the sensitivity of the camera sensor. The normal term should be "Gain" but ISO is a term from the analogue world. The default is 800. Because of the wide aperature of the smartphones (mostly between f 1.5 and 2.5), you should not go higher than 800 or 1600. The values are device dependend. The app detects, which values the camera sensor supports and creates the list dynamically.

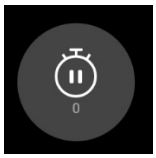


Note: On legacy devices only "Auto" is available.

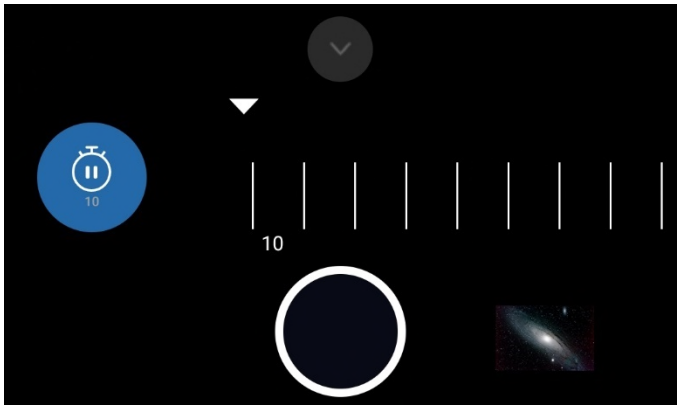
The entry "Preview" means that the ISO for the images is the same ISO value of the viewfinder.

When you select "Auto" exposure time ISO is set to "Auto". This is a behaviour of the camera sensor on Android. Google defined that "Auto" means "Auto" exposure time and "Auto" ISO. This can not be changed.

Interval time



Interval time is the time period between two images. Values are from 0 sec to 300 sec.



You have two options:

1. Interval time 0 sec ("Burst Shot Mode"). The interval time is not really 0 sec. The duration of interval time is set by camera sensor and its mostly 100 or 200 milliseconds. But the duration depends on lots of things which can not be controlled by the app:
    a. General administration and controlling by camera sensor
    b. Duration of writing an image file
    c. Speed of internal flash memory or SD card
    d. Speed of CPU
    e. Available RAM
    f. Activities of other apps or Android OS in the background

When you've selected interval time 0 sec the camera sensor triggers and controls the next image. It can not be changed by the app. The images are taken with minimal interval time. This changes some details of the app:

- When you set exposure time of the images faster then 1 sec and if you have date/time in file name then milliseconds are added to the filename. The reason is that taking the image, writing and taking next image can be so fast that the first image file can override the next image file.
- When you set fast or very fast shutter speeds (f.i. 1/100000 sec) it could be possible that a little bit more files are written then you've set in "Number of frames". The reason for this behaviour is that lots of data come in and the app tries to process the data sequentially. The app counts the number of frames but the camera sensor can be much more faster then counting. This happens NOT when you set slower shutter speeds (f.i. 2 sec, 10 sec or 30 sec).

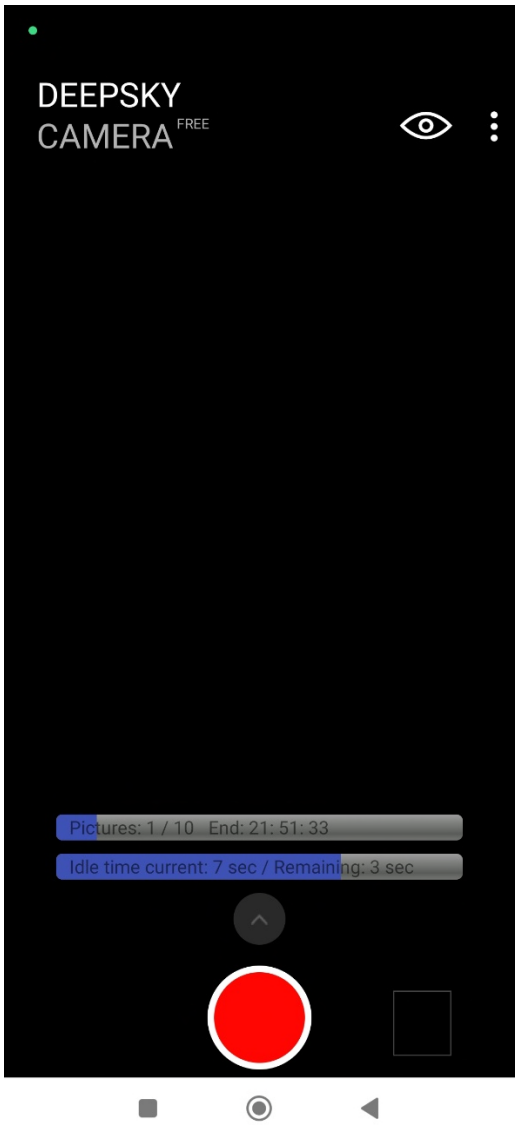
Note: Due to technical reasons interval time 0 sec is not available on Samsung S6-8, Note 5/8 and some Samsung-J models. Also not available on legacy devices.

2. Interval time greater then 0 sec. If you've selected a value greater then 0 the app pauses before taking the next image.

Please pay attention to the file size. Some smartphones have a camera sensor with an resolution of 8000 x 6000 pixel. A DNG file is about 90 to 100 MB, a JPEG file around 25 MB. The app must read the data from the sensor and must write the data to your storage location. The speed depends on the speed of flash memory or SD card. If you loose files please increase interval time or set it to 0 sec (in this case camera sensor controls the process). If your device is slow or do you have too much processes in the background (other apps running) it could be possible that this slows down the read/write process. Increase interval time to 6 sec or higher.

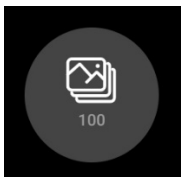
If you write on SD card please pay attention to the speed of your SD card. If you have a slow SD card (thats mostly nomal class 10 cards) it takes much more time to write the data. It could be possible that the app crashes after 100 images because writing is an asynchronus task. If you have too much asynchronous tasks in the queue then the device can run out of memory and app can crash or hang. When you want to save images on SD card use extreme fast SD cards. This is type UHS II or UHS III. Otherwise you will loose files or the app becomes unstable.

Note: A progress bar is shown when you have set the interval time (see chapter "The bars"). This is a simple bar which counts the seconds down until the end of interval time. This helps you to estimate how long the app is idle until the next image will be taken.

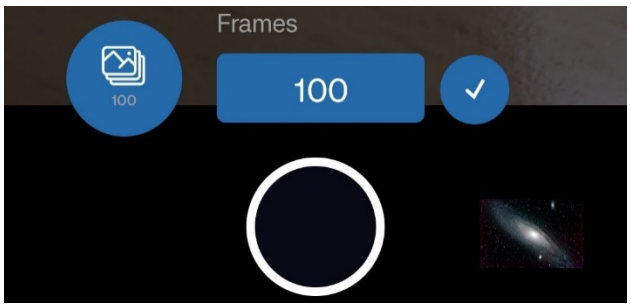


Note: Due to technical reasons the bar is not available on Samsung S6 – S8 and Note 5 – Note 8.

Number of frames



This is the number of pictures you want to take. The default is 100. The range of possible values is from 1 to 1 million. The previous limit of 9999 images has been removed since version 1.0.4.



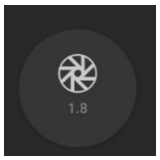
Note: When you change the number of frames in control bar and the keyboard does NOT show up you must configure the physical keyboard. Please check the steps in chapter 6 "Pairing the devices and activating the keyboard".

White balance

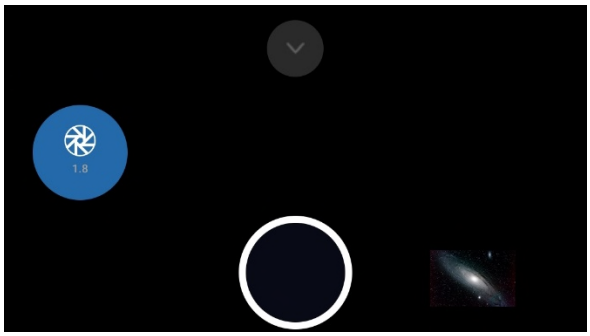
In the control element "Whitebalance" you can set the color temperature. The color temperature is listed in K (Kelvin). The list in the field "Whitebalance" is created dynamically. The values depend on the phone. The app detects on startup, which values the camera sensor supports and creates the list.

Note: On legacy devices only "Auto" is available.

Aperture



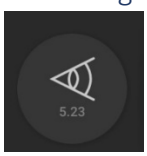
This listes the supported apertures of the camera sensor.



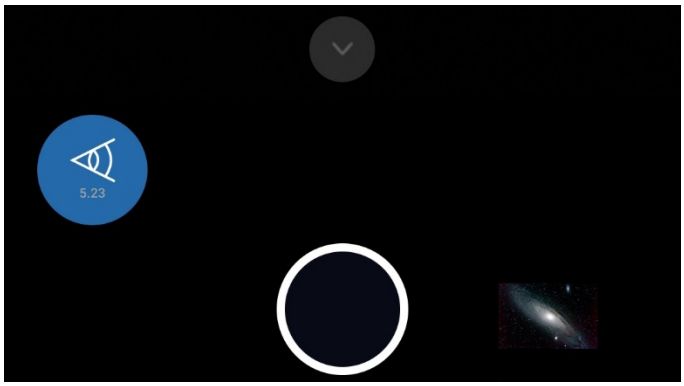
The values depend on the phone. Only a few phones provide a variable aperture. These are: Samsung S9, S10, Note 9, Note 10 and Huawei P40 Pro (Juli 2020). Most of the phones don’t support a variable aperture. The value can not be changed. Its for information only.

This setting affects the images. If you want to adjust the aperture of the preview, you can do this in the preview settings (eye icon).

Focal length



The spinner contains the supported focal lengths of the camera sensor.

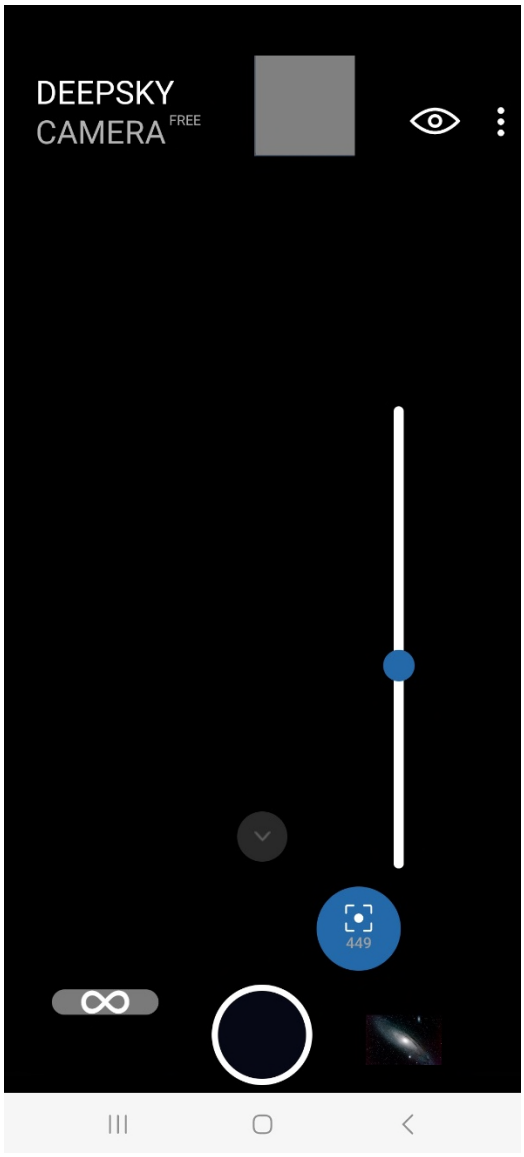


The values depend on the phone. Only one phone provides a variable focal length: Huawei P40 Pro (July 2020). Most of the phones don’t support a variable focal length. The value can not be changed. Its for information only.

This setting affects the images. If you want to adjust focal length of the preview, you can do this in the preview settings (eye icon).

Focus

You focus manually with slider for viewfinder as well as for images.



When you move the slider up and down, the focus changes.

> **Note**: The right slider is not available on legacy devices, or when you've set the focus method to "Auto", "Infinity" or "Hyperfocal" in menu "Settings". Slider is also not available on Samsung S6/S7/S8 and Note 5/8.

When you try to shoot the moon with a telescope, then it's easy to focus, because the moon is light enough. But to get the correct focus for stars, it is not that easy. You can do it by follwoing these steps:

1. Set ISO of the viewfinder to the highest value, e.g. 3200 or 6400. Increase exposure time of viewfinder up to 1 sec.
2. Point your phone to a bright star. You should see the star at the viewfinder.
3. Zoom in to the star via zoom slider in control bar of the images.
4. Now adjust the focus, by moving the focus slider up or down until you get a good image of the star. The star must be a pinpoint star. The focus value is shown in focus icon.
5. Take one or two test images. Check the images, if the stars are pinpoint stars or not. If not, adjust the right slider a little bit.
6. Take one or two test images again. Check the pictures again. If necessary adjust slider again.

7. Repeat step 4 – 6 until you get pinpoint stars. Please be patient. Getting the correct focus can take some minutes. The procedure is necessary.

> **Hint**: Use the volume +/- buttons on the left or on the right of your smartphone. It goes 0.01 steps up or down. You can set or adjust the value precisely. If you have a wired headset plugged in via the jack plug, you can also use the speaker buttons +/- on the headset to focus more finely.

The app provides a table with focus values for various devices. You'll find the table at: app menu -> Help -> Focus help. If your phone is listed, try the recommended value from table. If your device is not listed you must do experiments yourself. If you found the correct focus value for your device, please report the value to the developer of the app (go to menu -> Report your device). The developer adds your phone and the focus value to the focus table.

> **Note**: Focus value is stored on your device. When you restart the app, the focus value will be loaded and set.

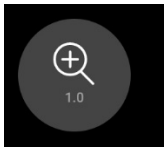
Left is the "infinity" icon.

You can use icon above focus slider to set the current value for the "Infinity" option. The value is saved. If you now select the "Custom infinity" option in the "Focus" section of the "Settings", the saved value for "Infinity" will be applied to both the preview and the images.

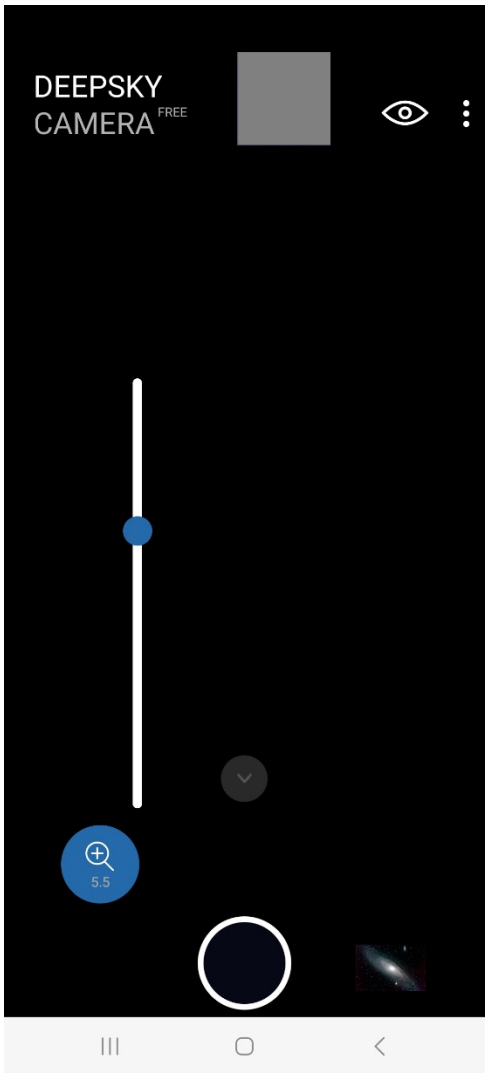
If you want to change the value, switch back "Manual" in the settings, set the value using the focus slider and then tap on the "Infinity" symbol. The previous value is overwritten by the new value.

> **Note**: This is not available on Legacy devices. Legacy devices do not provide manual focus. Function is also not available on Samsung S6/S7/S8 and Note 5/8.

Zoom



The last icon opens zoom slider.



You can zoom with the slider to bring an object closer. On the one hand, this is intended to make it easier to adjust the focus. The current zoom value is displayed in the zoom slider icon.

When you want to take images with the zoom you must first go to the "Settings" menu. Tap on the option "Digital zoom". You have three options:

- Zoom off
- Zoom at the viewfinder only (default)
- Zoom at viewfinder and images

When you want to take pics with zoom you must select the third option.

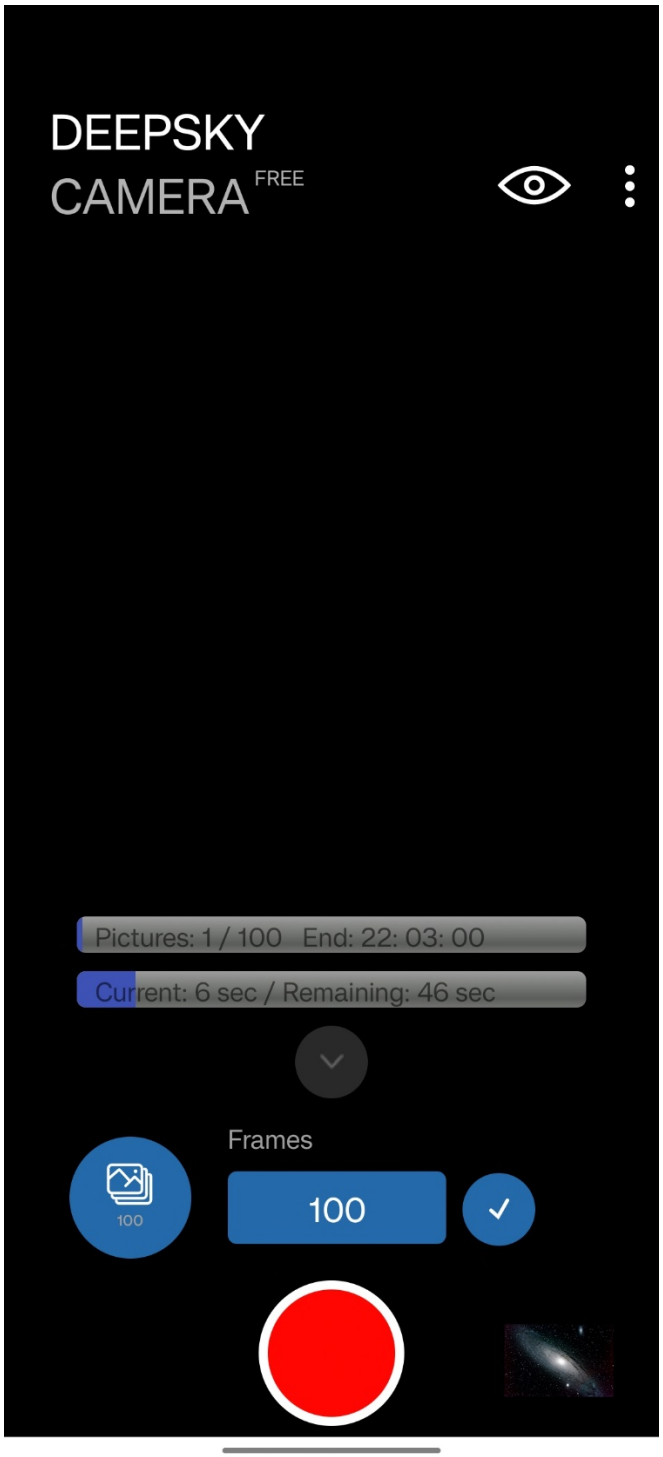
Pay attention that the zoom is a digital zoom. The quality of the pic can get worse because its not an optical zoom.

Note: Zoom function is only applicable to JPEG files, not to RAW/DNG files.

Note: Zoom function is not available on Samsung S6/S7/S8 and Note 5/8.

The bars: delay bar, progress bar, countdown bar, interval time bar, stacking bar

The app contains four bars which informs you about important things. The following image shows the two most important bars: progress bar and countdown bar.



- When you set a delay before the first image the **delay bar** appears. The delay bar counts the seconds down until the imaging session starts.
- When the imaging session starts a **progress bar** appears. It shows the current number of frames and the total number of frames.
- Below progress bar the **countdown bar** appears. It counts the seconds down until the end of the current image. The countdown bar is only visible when shutter speed is 2 sec or higher.
- When you've set an interval time between two images the **interval time bar** appears when interval time is 2 sec or higher. The bar counts the seconds down until the next image will be taken.

- When you use function photo live stacking the **stacking bar** is a combination of taking image, analyzing, stacking and displaying image. The time is added. Simple example: 30 sec exposure time and 5 sec for analyzing, stacking and displaying. Thats 35 sec in total. The processing time varies especially between first frame (reference frame) and the following frames beacuse analyzing of first frame takes longer than the following images.

6. Shutter button

The shutter button is the most important button. Alternatively you can use an external Bluetooth controller to start/stop the imaging session and without touching your phone. Please check chapter "External Bluetooth controller" below.

Start

Tap on shutter button and the imaging session starts. The app reads the settings from the control bar. During exposure time a progress bar comes up and shows the progress. You can stop the imaging session any time by pressing the shutter button again. Normally it‘s not necessary but when you’ve made a mistake (e.g. set wrong ISO or wrong exposure time) you can stop the session. Please be patient. On some devices, it takes a couple of seconds until the session will stopp.

During exposure time app seems to be frozen – but it isn’t. The app is busy and is taking pictures.

You should turn display always on. In menu "Settings" of the app is an option, where you can turn the display always on. Without this option the display turns off automatically after 15 – 30 sec (depends on your phone). The result is that the operating system sets the app into a hibernate mode. In hibernate mode the app does not operate and takes no pictures. That means, no image files will be written!

You can test that very easily. Take a couple of pics (e.g. 20 frames) with max shutter speed and wait until the display shuts off. Wait again 60 – 120 sec. Turn display on and check how many pics have been taken. When you miss frames turn "Display always on".

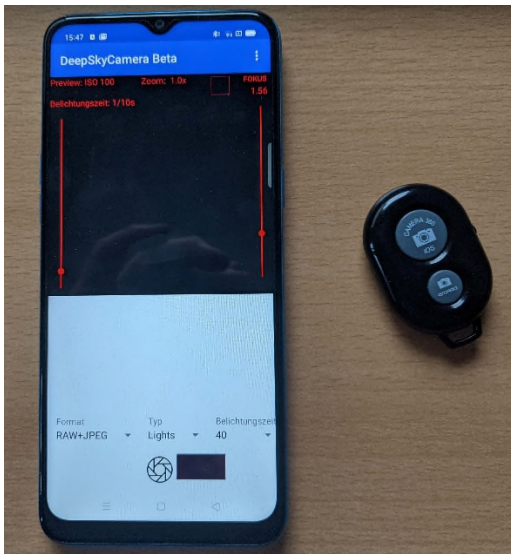
> **Note**: When you take pics of the stars, set the app into night mode (black background with red text color). You can set the night mode in menu "Settings" of the app (three dots upper right corner).
>
> **Note**: shutter button has no fucntion when you use function "Star trails", "Animated star trails" or "Timelapse" because these functions are started in a different way.

Stop

You can stop the imaging session at any time. Please tap shutter button once and stop request is send to the camera sensor. **But please be patient**. On some phones (Samsung, Xiaomi) it takes a couple of seconds until the imaging session is stopped. If you are impatient and you "hammer" on the button DeepSkyCamera app can stop or crash due to lots of requests to the camera sensor. On other phones (Huawei, Honor) the imaging sessions will be stopped immediately.
It is enough to tap button only once. Please wait until the imaging session has ended and the app is ready for the next session. **Please be patient!**

External Bluetooth controller

You can start and stop the imaging session with an external Bluetooth controller. Instead of touching the display of your phone you can do it remotely. External Bluetooth controllers are cheap and easy to use.



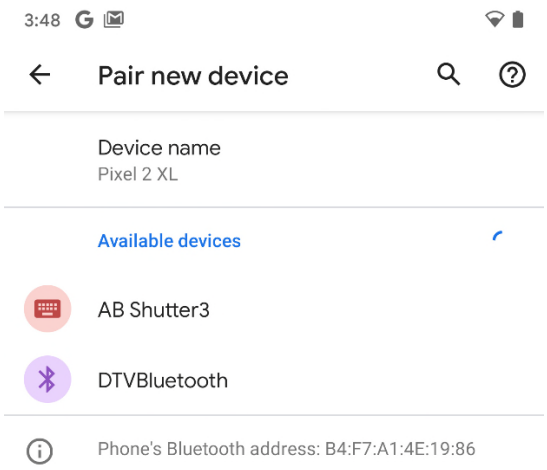
Before you can use the external Bluetooth controller you must do some preparations.

> **Note**: When starting the app for the first time, you must accept the “Find nearby devices” permission, otherwise the app will not respond to the external Bluetooth controller. If you have rejected this right, then the external Bluetooth controller will not work. To reset this you have to reset the app in the Android settings and clear the cache. You then have to restart the app and can accept the “Find nearby devices” right.

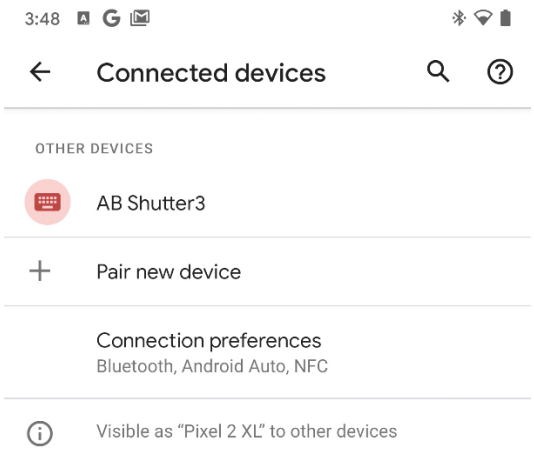
Pairing the devices and activating the keyboard

First you must pair the two devices and after a successful pairing you must activate the keyboard. You can do it in this way:

1. You pair the external bluetooth controller and your phone in the same way you connect a Bluetooth headset to your phone. You must activate Bluetooth on your phone and on your Bluetooth controller.
2. Go to Android Settings -> Bluetooth. The phone lists the available bluetooth devices.

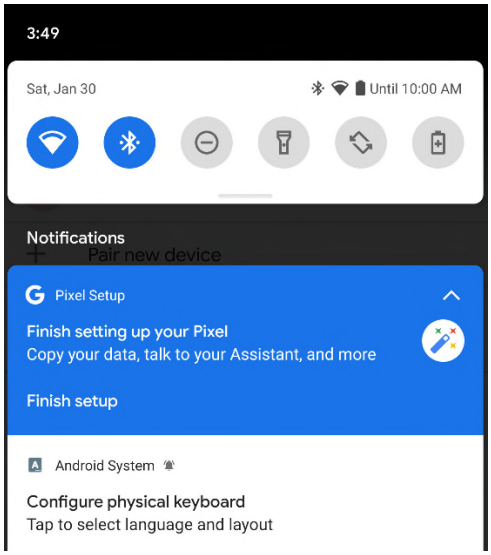


3. The external Bluetooth controller is named here "AB Shutter3" (the name of your controller can be different). You can pair your phone to this device by tapping on the name. On some devices you’ll get a confirmation dialog. After a successful conection the external Bluetooth controller is listed in "Connected devices".

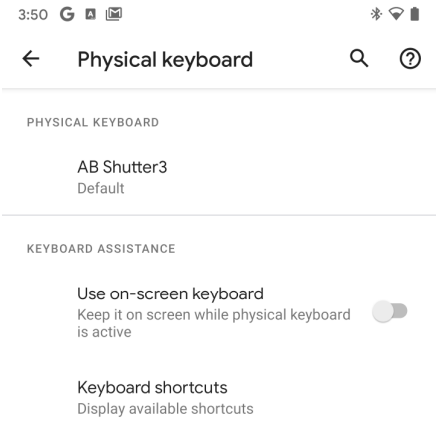


4. Now you must configure the physical keyboard on your phone. You must do it only once and your phone stores this information. When you connect your external Bluetooth controller next time the information is automatically restored.
   Why is it impoortant to configure the physical keyboard? If you don't do this the app waits for input from the Bluetooth controller only. In case you want to change the number of frames the app waits for input from your bluetooth controller. Because it does not have a keyboad nothing happens. Thats why you must tell the phone it should use the physical keyboard from your phone for other things than start/stop.
   Its easy to do: after succesfull pairing your phone asks you if you want to configure the physical keyboard. Tap now „Configure physical keyboard".

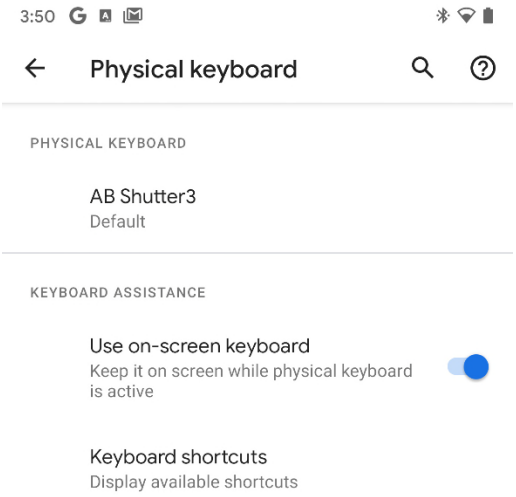
   Note: On some devices (f.i. OnePlus 8 Pro) you can not configure the physical keyboard. In this case the physical keyboard is automatically configured.



5. A dialog shows up. The option „Use on-screen keyboard" is turned off.



6. Turn the option „Use on-screen keyboard“ on.



Thats all – everything’s now configured and you can use your external Bluetooth controller.

How to use the external Bluetooth controller with DeepSkyCamera app

The usage is easy:

1. After successful pairing you start the app DeepSkyCamera.
2. Tap on the button on your external Bluetooth controller to start or stop the imaging session.
3. You can do a mix: You can start the session with your Bluetooth controller and you can stop by touching the shutter button (and vice versa).

Note: When you change the number of frames in control bar and the keyboard does NOT show up you must configure the physical keyboard. Please check the steps in last chapter "Pairing the devices and activating the keyboard".

> **Note**: The external Bluetooth controller must be close to the smartphone for the connection to remain intact. If the connection is lost, the app receives the stop signal and the session is aborted. This can easily happen if your external Bluetooth controller is too far away from your phone.

Wired headset

If you have a headset that is connected to your smartphone via a jack plug, you can start or stop the imaging session using the "Accept phone call / hang up" button. If the wired headset also has two volume buttons (+/-), you can use these buttons to focus very finely (0.01 steps up or down).

Samsung SPen

If you have a Samsung phone with SPen (Note series, from S22 Ultra onwards), you can use it to start and stop the imaging session. When you remove the SPen from its case, it is already connected to the phone and you don't need to do anything else. Press the black button on the side of the pen (not the silver button on top!) to start or stop imaging session.

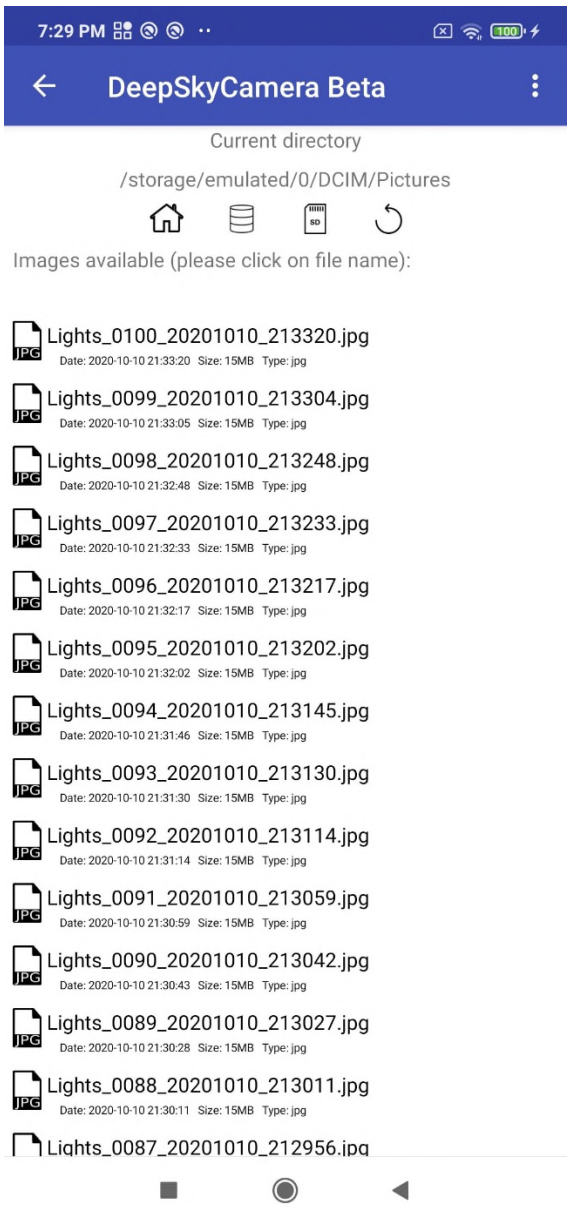
7. Internal file browser and displaying pictures

DeepSkyCamera contains an internal file browser where you can browse through the directories on your device. It contains an universal navigation, you can sort and delete files. Its also possible to display the images and to zoom into the image.

The pictures you‘ve taken can be displayed within the app. The app contains a file browser to browse and to view the images. Right next to the shutter button appears an icon, which is a thumbnail of the last taken image. Tap on the icon and you’ll get a list of images.

Internal file browser

The file browser lists all the files from a directory.



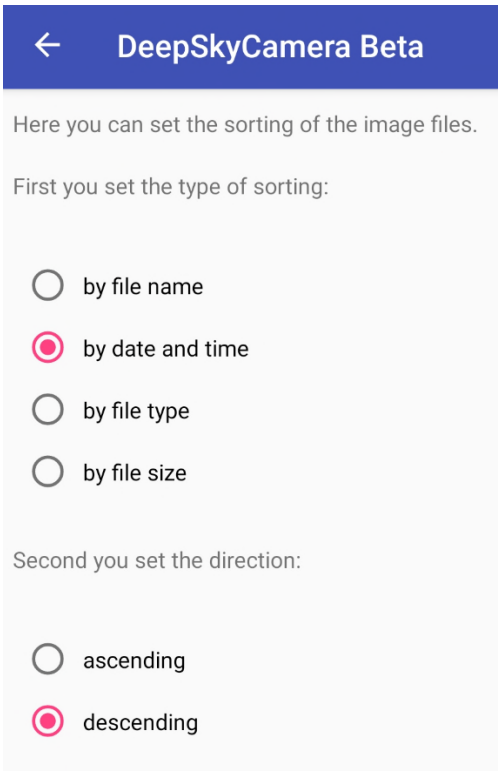
You can scroll the list. Below the filename you can see some additional data:

- Date and time of the image was saved
- File size in MB
- File type

Every entry in the list has an icon which shows if its a DNG, TIFF, MP4 or JPEG file.

Sorting

You can sort the list of files. Tap on the three dots upper right corner and tap "Sorting". A new page pops up.



In the upper field you can select the type of sorting:

- By file name
- By date and time
- By file type
- By file size

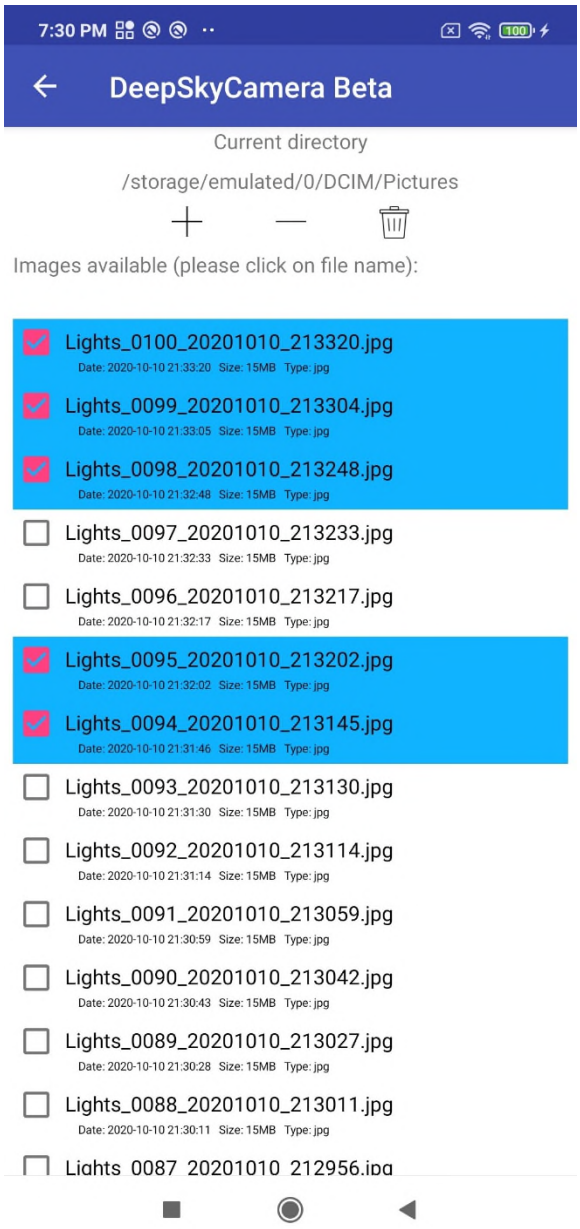
In the lower field you can select the direction of sorting: ascending or descending.

I use very often "by date and time" and "descending". This means that the latest picture is at the top of the list.

Note: To go back to the file list, tap the back arrow upper left corner.

Deleting

You can delete images if you want. Tap three dots upper right corner and select "Deleting". This opens a new page with a file list. You can select the files you want to delete

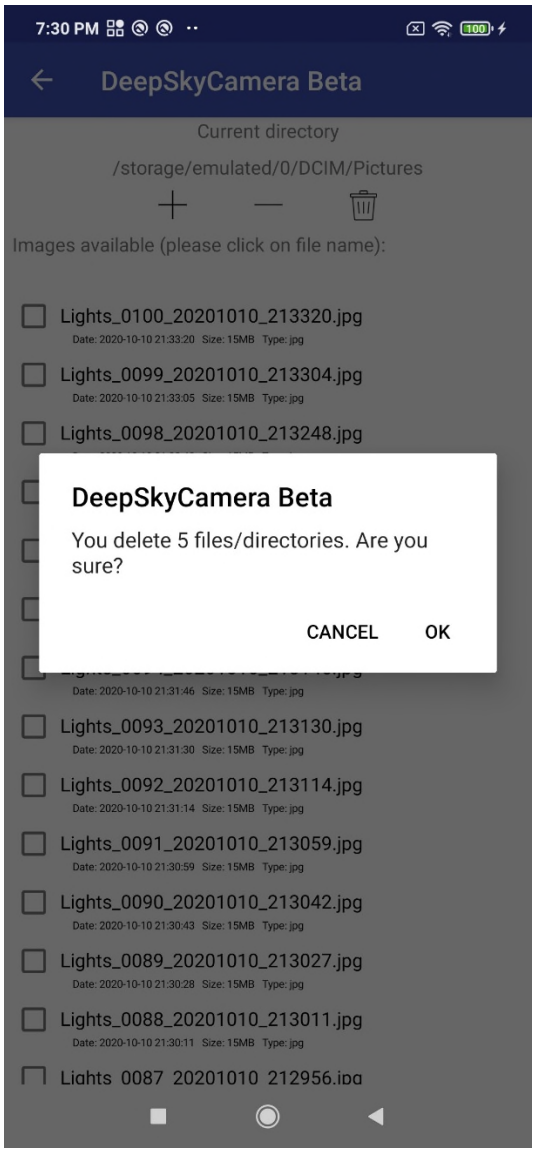


The list looks very similar to list from the internal file browser. Tap on a filename and the file is marked.

> **Note**: You can select multiple files at once by pressing and holding the file name. All files above it will be selected – either up to the first file in the list or up to a previously selected file.

Tap on Recycle bin and the marked files will be deleted.

Before the app the files deletes the app wants to get a confirmation.



You can cancel the process. If you want to delete the images please confirm.

If you want to delete every image in the directory tap on plus symbol. This selects every image.

The minus symbol deselects the images.

You can also delete directories or subdirectories. If the directory contains one or more subdirectories then the subdirectories will be also deleted.

Navigation

The internal file browser is also a universal navigation file browser. You can browse through the directories on your devices and you can display image files taken with other apps.
It shows only DNG, TIFF, MP4 and JPEG files.

Directories have a folder symbol. Tap on the folder symbol and the file browser opens the directory.

Use the top bar to navigate. Up to and including Android 13, you can use these icons to navigate the phone's file system. You can also navigate within the location if you have created subdirectories.

The icons in detail:

The home symbol jumps directely back to your storage location where you have stored your images taken with DeepSkyCamera.

Tap on this symbol and internal file browser jumps always to the root directory on your phone.

This symbol jumps to the root directory of your sd card. If you don't have an SD card installed or your phone does not have an slot for SD card then this symbol does nothing.

This symbol returns to the parent directory.

Displaying images and zoom

Tap on filename and the image will be displayed. Please be patient. When you tap on DNG files, it can take up to 30 seconds to load and display the images. The reason is, that the images in RAW/DNG are very large (on Huawei P20 Pro: 78 MB, P40 Pro: 98 MB!). After tapping, a circle appears, which indicates that the file is loading. JPEG files can be loaded and displayed faster than DNG files, because they are much smaller. TIFF files created by live stacking can also be displayed.

Note: To go back to the main page, tap the back arrow upper left corner.

You can zoom into the image with two fingers. With one finger you can move over the image and you can select a specific region.

At the top there are two icons to delete current image and to enable or disable histogram of current image.

Note: The icons are not available on Samsung S6/7/8, Note5/8.

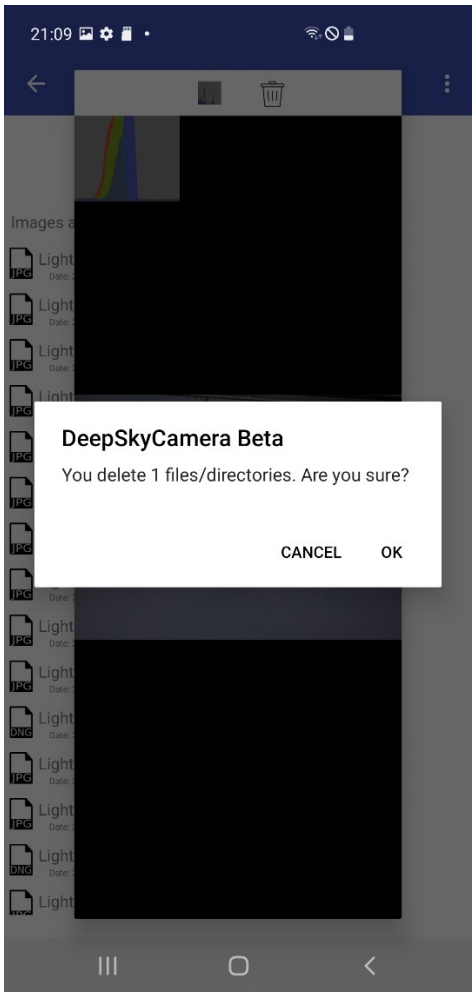
Histogram of current image

Tap on histogram icon and histogram is calculated of current image. To disable tap again on icon. If you want to have histogram permanent visible enable histogram only one time and thats it. DeepSkyCamera app stores this information. Every image you want to display later will show the histogram. The information is also stored when you exit the app and restart the app. The picture below shows an image with histogram.

Note: Histogram is available on Android 7 or higher. Live histogram is not available on Samsung S6/7/8, Note5/8 and Legacy devices.

Delete current image

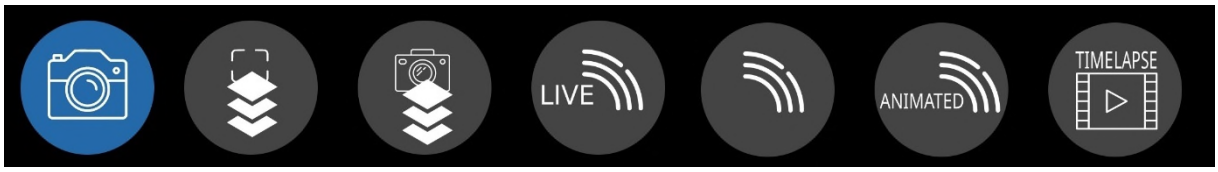
Tap on trash icon and current file will be deleted. Before file is deleted a dialog appears which you must confirm (or cancel in case of a mistake).



This function deletes only one image. If you want to delete more images at the same time this function is too slow. Use "Deleting" function to do a batch delete. Please go to chapter "Deleting".

8. Functions

Tap "Func" icon in control bar and function bar opens.



DSC Pro provides these functions:

- Photo (default): takes one or more images. Same as in DSC Free.
- Preview Live stacking: this is live stacking of viewfinder without alignment of the images.
- Photo live stacking: DSC Pro takes images and stack these images (with analyzing and alignment).
- Live star trails: Builds a star trails image.
- Star Trails: Assemble a star trails images with images you have taken earlier.
- Animated star Trails: Star Trails as video. Assemble a video with images you have taken earlier.
- Timelapse: assemble a video with images you have taken earlier.

The functions that you can select in the Func icon use the camera sensor you have selected. For example, if you have selected Camera ID 2, photo live stacking will be executed with Camera ID 2. This also applies to all other functions such as live star trails, viewfinder live stacking, etc.

Photo function

The photo function is the same as in DSC Free. Take images in RAW, RAW+JPEG or JPEG, set ISO, shutter speed, white balance etc. If you want to know how to do it please check chapter "Control bar: Functions and settings for images".

DSC Pro introduces a new option "Photo function" - "Show image" on "Settings" page. If its turned on (default is off) the image is shown on main screen after image is staken and saved to internal memory or SD card. This is great when you want to take a couple of test shots. You can immediately see on the screen if image is good or not good. And take care: don’t use this option when you take lots of images (100, 500, 1000). App can crash after a random number of images because of heavy processing of the image. So use this function only to evaluate test shots. Turn option off when you start your imaging session.

Viewfinder live stacking function

This is a quick stacking function which stacks images from viewfinder only. Lots of phones does not allow 1 sec or slower shutter speeds (f.i. 5 sec, 10 sec) for viewfinder. Camera sensors can become unstable and can crash when shutter speed is f.i. 5 sec. Lots of manufactuerers restrict max shutter for viewfinder at 1/3 sec or ½ sec. Thats not enough to see dark objects (f.i. M51, M57) in viewfinder when phone is attached to a telescope.

To get rid of this limitation preview live stacking function is your friend. A great purpose of this function is to center a dark objects in telescope. Now you can have up to 10 sec shutter speed for viewfinder. Its a quick stacking algorithm and the stacking result is displayed on main screen of DSC Pro. Difference to photo live stacking is that stacking result is not saved and the images are not aligned.

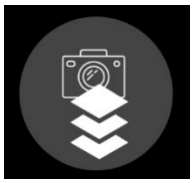
Tap icon "Preview live stacking" and you must set max shutter speed of viewfinder live stacking. Default is 1 but you can go up to 10 sec. That means: 10 images each 1 sec shutter speed are taken and stacked. After every image the stacked result is displayed in the app. When you select 5 sec app take 10 images each ½ sec shutter speed.

Note: ISO is taken from viewfinder settings. Shutter speed from viewfinder settings is ignored.

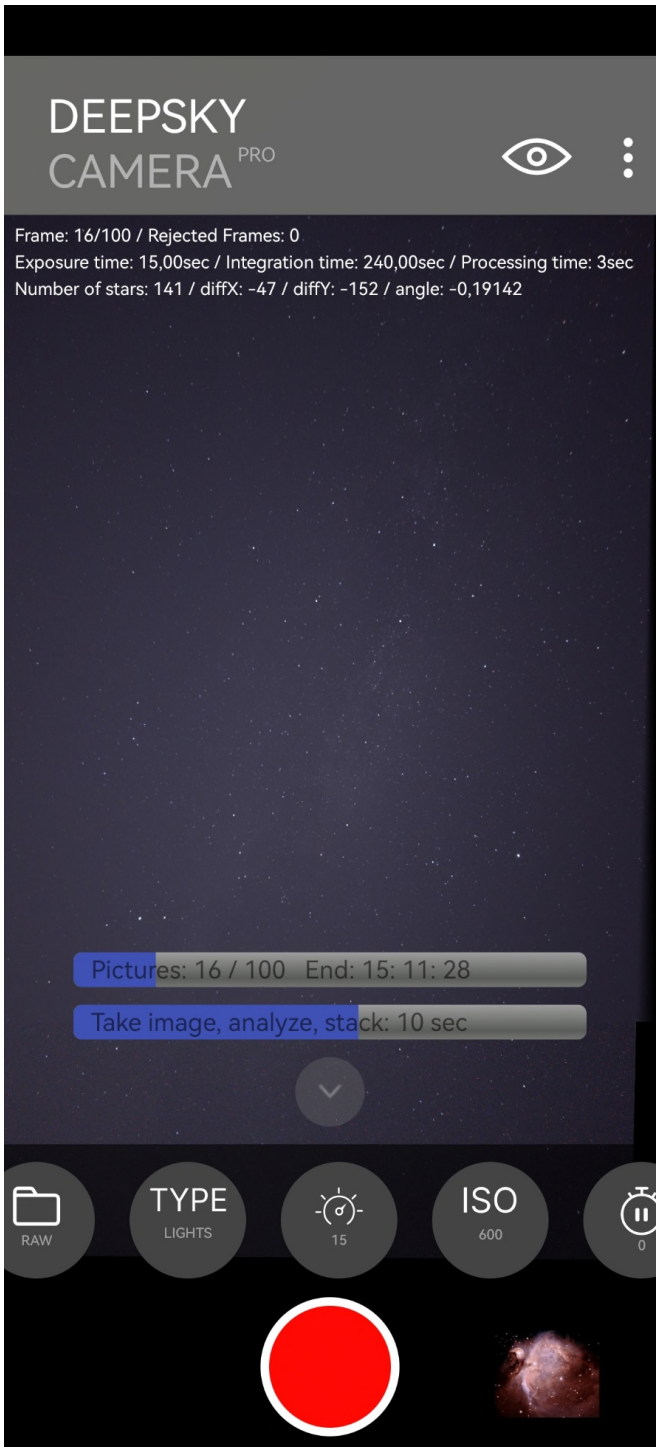
The stacking algorithm is set on "Settings" page. Default is "Add". This means every pixel of each image is added. The algorithm is very quick, only „Porter-Duff“ is quicker and does the same. The disadvantage is that the image gets quickly very light, it can be after 3 or 4 images. You can select "Average" and this means the the average value of each pixel is calculated.

Very important for this function is that the images are not analyzed and aligned. If you move the phone or telescope a little bit your target objects moves also and you can see it double, triple etc. The intention of this function is not real stacking. The intention of this function is to provide a better view because a couple of phones limit max shutter speed for viewfinder. Please keep this in mind.

Photo live stacking function



This function takes images and stacks the images in RAW or JPEG. The following image shows DSC Pro during photo live stacking – the stacked result is updated and displayed on the screen with some information about the image.



Note: By default photo live stacking works only with images of the night sky. The reason is that by default images are analyzed, e.g. app searches for stars in the image. When you try to stack daylight images whithout stars stacking will probably fail. It is possible to stack daylight images without stars but you must change settings. Please read chapter "Stacking of daylight images"

Photo live stacking consists of four steps which run automatically:

1. Take image
2. Analyze image, detect stars and build internal geometric figures for alignment
3. Align the image due to the geometric figures
4. Stack image and save stacked result image

Photo live stacking function takes images and stacks every image. Photo live stacking works also on images which are not tracked, e.g. images taken without telescope mount or without tracker. Images are analyzed, aligned and stacked. On "Settings" page you can disable analyzing and aligning but thats not rellay useful. Disable analyzing and aligning is useful for quick tests.

In photo live stacking first image is always the so called reference frame. All the other images are aligned to reference stars in reference frame. Analyzing of each image takes time and analyzing the first image takes a little bit longer than in second, third, fourth image. The reason is that reference stars are important for the alignment process. DSC Pro tries a couple of self written algorithms to detect stars and find the "best" stars and geometric figures.

The stars in the second frame are analyzed and DSC Pro tries to find the reference stars from reference frame in second image. This is faster than analyzing reference frame. It goes on with third frame and so on.

If second image is successfully aligned it can be stacked with reference frame. The stacked result is saved. In case you stop the process or app crashes or app hangs you have always the latest stacked result on your phone.

The same procedure with third frame, fourth frame and so.

Please pay attention to the second progress bar. Its called stacking bar. Its a combination of taking image, analyzing, stacking and displaying image. The time is added. Simple example: 30 sec exposure time and 5 sec for analyzing, stacking and displaying. Thats 35 sec in total. The processing time varies especially between first frame (reference frame) and the following frames beacuse analyzing of first frame takes longer than the following images.

Tracked and untracked images

DSC Pro can stack images from phones which are tracked by telescope mount or tracker. DSC pro can also stack untracked images.

Stacking of tracked images

The best is to use always a telescope mount or a tracker which tracks the stars. This makes it easier for DSC Pro to identifiy the stars in each image. You should activate the option "Analyze and align the frames" on "Settings" page. The reason ist that a mount or tracker can be misaligned to celestial north or south pole. Small misaligments of the mount or tracker results in movements of the stars and to field rotation.

DSC Pro can detect this and during alignment of the images it shifts the pixel of the images in x and y axis as well as with rotation angle.

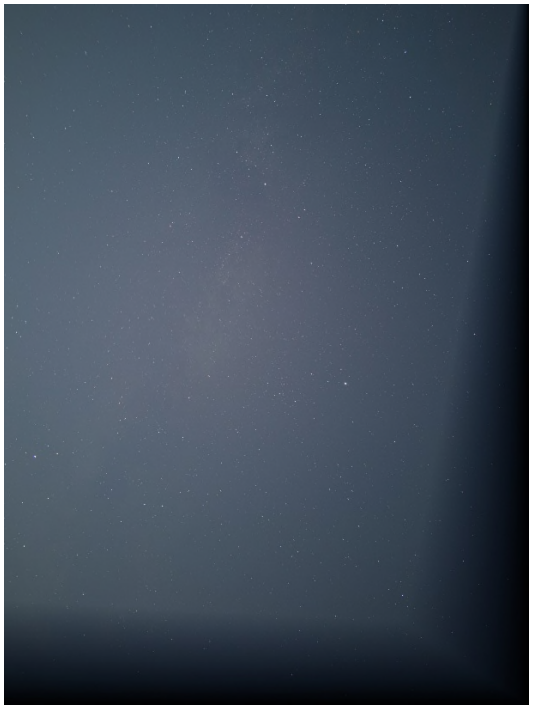
You will have some artefacts due to alignment at the edges but they are small. You must crop your image.

When you take image with your smartphone lens only and the phone is mounted on a telescope mount or tracker you can have very good results. The lens is wide field. The shift of the pixel in x and y axis is 0 or very close to 0 as well as the rotataioon angle. In my tests, I often got results in such situations where the values for x, y and rotation angle were all 0!

Stacking of untracked images

DSC Pro can stack untracked images. Put your phone on a tripod which is fixed. It does not follow the movement of the stars. Or you put smartphone on a table and point it to zenith. These situations are handled by DSC Pro. Every image is analyzed and aligned to reference frame.

Untracked images have a greater shift in x and y axis. After alignment artefcats are visible at the edges. The following image shows a stack of 100 DNG files each 15 sec exposure time. Thats 25 min integration time. You can see black artefacts at the right and at the bottom. These are due to the alignment process.



The next two images shows the reference frame and the 100th aligned frame. You see the difference between both images The shift between both images in x axis is -347 pixel and in Y axis -1076 pixel. Rotation angle is -3.469674942183059 degrees. The reference frame started during twilight and the 100th frame was taken when it was dark.

Due to the alignment of untracked images you will get these black artefacts at the edges. The artefacts are getting bigger the more images you take. There is a maximum of image you can stack. When the reference stars are moved completely out of the image analyzing will fail or will produce distorted images (check chapter "Distorted stacked image result").

In pratice you should not go higher than 20 or 30 min of integration time of untracked images. In fact it depends on focal length of the camera sensor how long does it take until the reference stars reached the edges.

Stacking of non-tracked images in the telescope

Non-tracked images taken with a telescope can also be stacked. However, there are several limitations:

- The field of view through the eyepiece is much smaller than the field of view with a smartphone lens. This causes the stars to move much faster.
- Due to the rapid movement of the stars in the eyepiece, very short exposure times should be selected so that the stars remain point-like.
  As soon as the stars become lines or streaks, the stacking will fail!
- Also due to the rapid movement of the stars in the eyepiece, the reference stars from the first image will quickly move out of the eyepiece. Then the reference stars can no longer be found and the stacking is aborted. You may only be able to capture a few images before the stacking fails. The number of images depends on the focal length of the telescope and the eyepiece. The greater the focal length of the eyepiece, the more images you will be able to capture. Eyepieces with a focal length of 30 to 50 mm are good. With a focal length of 10 mm, you may only be able to stack one or two images!

If you want to take pictures with a telescope, tracking is actually essential.

How to start photo live stacking

The settings for photo live stacking (ISO, shutter speed, white balance, focus etc.) are taken from control bar:

- Set format:
  - RAW or RAW+JPEG does RAW photo live stacking. Result is a TIFF file, in case of RAW+JPEG the stacked result is saved in TIFF as well as in JPEG.
  - JPEG does only JPEG photo live stacking
- Select exposure time, ISO, focus, white balance etc.
- Tap shutter button
- And wait ….

Important hints on photo live stacking

Photo live stacking is a universal stacking function but there are situation where stacking fails. Please check the following hints to get rid of problems during photo live stacking.

Eyepiece (telescope or binocular)

Please pay attention to the eyepiece when you take the images with a telescope or binocular. Tell DSC Pro which eyepiece you are using in the settings "Photo live stacking"). Activate option "Telescope, binocular" and select the eyepiece you are using:

- 40 – 82 degrees field of view (FOV) which shows a black area around FOV
- 100 – 120 degrees eyepiece field of view (FOV) which does not have a black area around FOV and camera sensor is fully illuminated.

The next image shows a typical image with a 68 degrees field of view eyepiece.

The dark area around FOV is smaller with a 82 degrees eyepiece:

Here is a picture taken with a 100-degree eyepiece. Since the smartphone lens vignettes, it is slightly darker at the edges. The 100-degree eyepiece can illuminate the entire camera sensor:

The reason for this setting: the dark area can contain hot pixel. DSC Pro detects hot pxiel but there can be circumstances where hot pixels are not detected in the black area around FOV. To avoid false star detection in black area (which can be a hot pixel) you should select eyepeice with 40 – 82 degrees FOV. If you have an eyepiece with 100 degrees FOV (or higher) you should select the second setting "100 – 120 degrees".

> **Note**: This setting is applicable to telescope or binocular. If you use smartphone only you should not select this setting.

Number of stars affects processing time

Please pay attention to the number of stars which are displayed during photo live stacking. The minimum number of stars is 9. The number of stars affects processing time. When number of stars in reference frame is high (f.i. 4000) then processing time slows down because 4000 stars must be checked in every image. This high number of stars can happen when ISO is too high. Try to decrease ISO (or shutter speed) that number of stars goes down.

A real example from my tests: On an old Huawei P9 with ISO 800 and 4000 detected stars processing time of a DNG file takes 31 sec. DSC detects 400 stars after decrease ISO to 500 and processing time goes down to 10 sec.

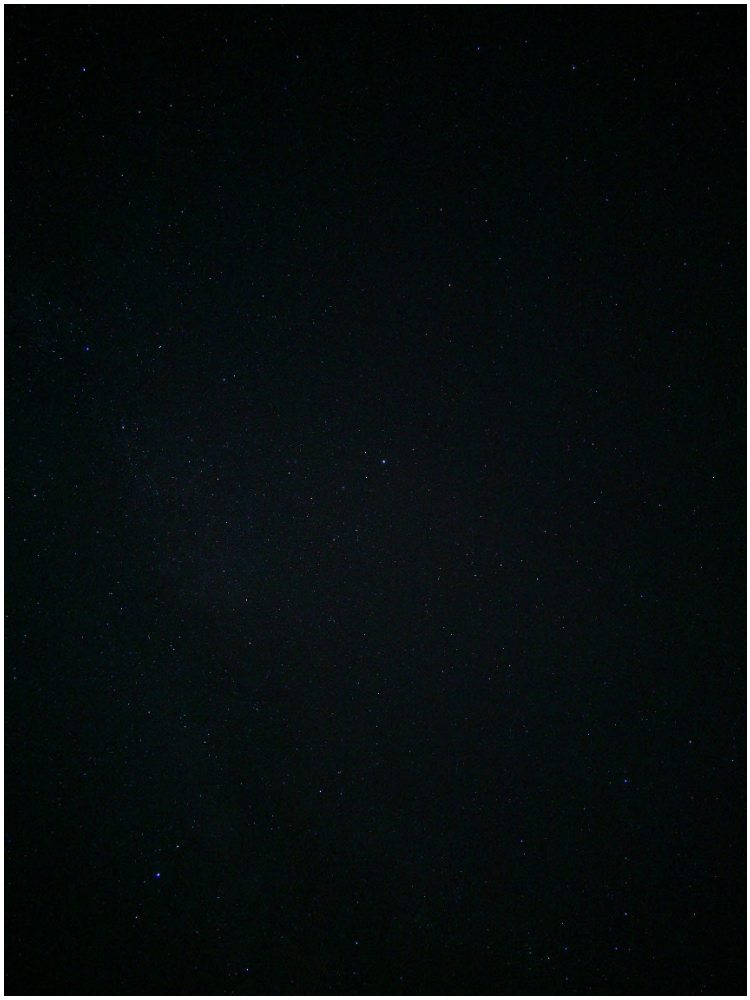
The best hint is that number of stars should be between 20 and 300. Its not a problem when number of stars is higher but processing time goes up. When number of stars is lower than the minimum number of stars then DSC displays a dialoge. In this case you should increase ISO and/or max shutter speed or check the sky conditions (clouds, too dark etc).

Result image of photo live stacking

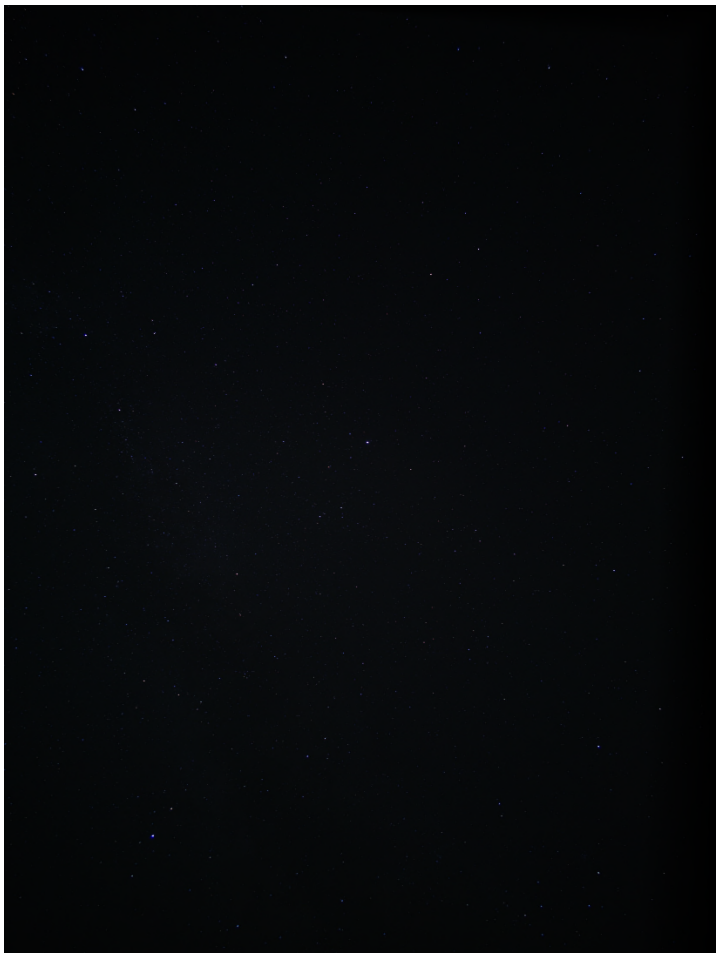
The result image is saved as a TIFF file (format: RAW or RAW+JPEG) or as a JPEG file (format: JPEG). The image is not ready yet – you must post process the image with apps or software like Photoshop, Lightroom, Gimp etc. Post processing means applying curves or other tricks to unveil more information in the image.

When you do photo live stacking in RAW teh result stacked image in TIFF looks very dark. Don't be disappointed. The data are in the image and you must post process the image.

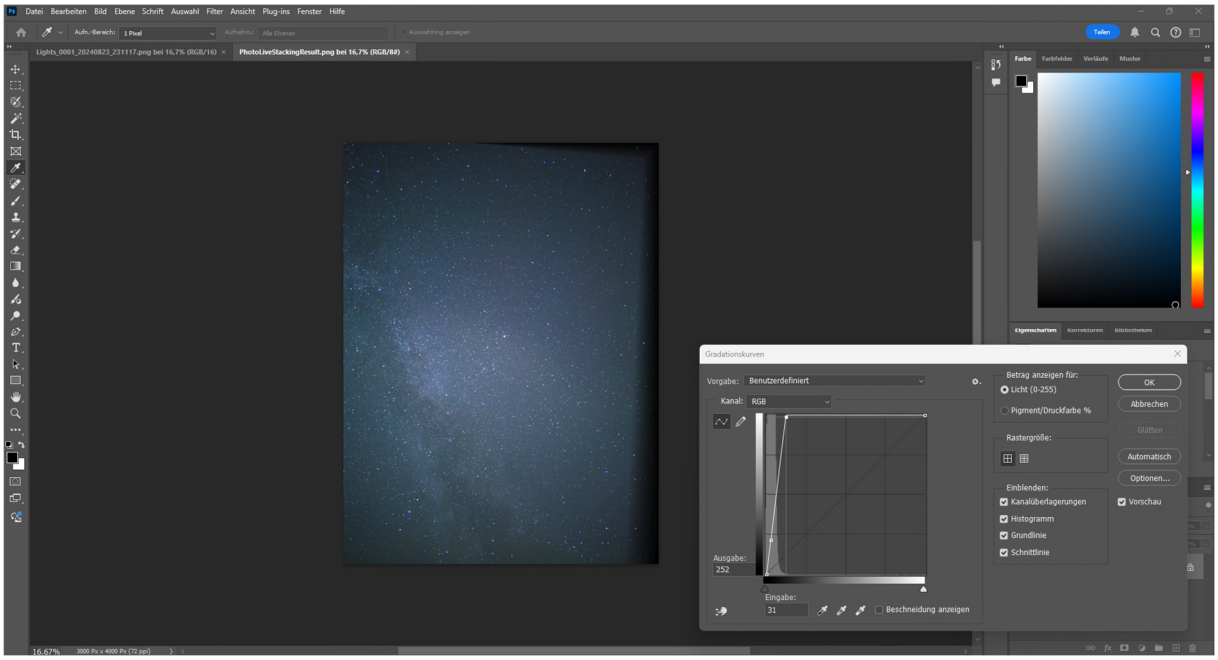
The following example compares one original DNG file, the stacked TIFF file and the post processed TIFF file. The first images shows the original DNG file, ist the first image in the row. Taken with Huawei P60 Pro, ISO 250, each image 15 sec, untracked.



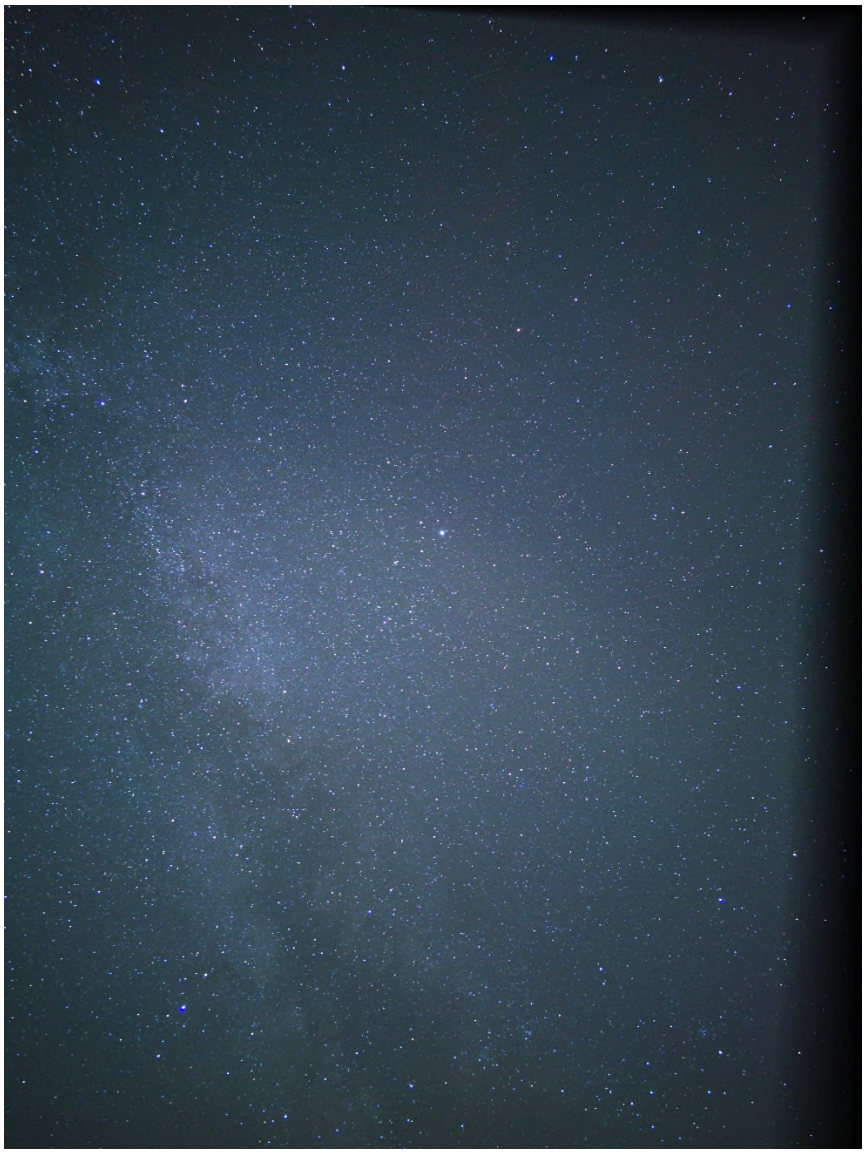
You can see only a couple of stars. The stacked result image file (30 images) looks like this:



It seems that there is no great difference between both images, its a little bit darker. But when you load the TIFF image into post processing software and you apply curves etc. you can unveil lots of data in the image. The following image shows the TIFF file in Photoshop with curves applied:

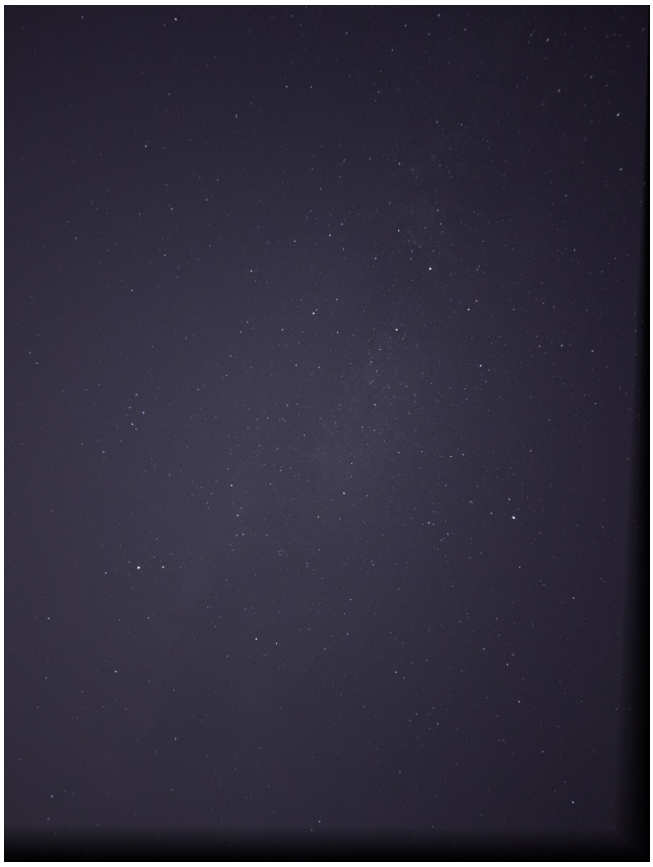


And here the result in full detail:



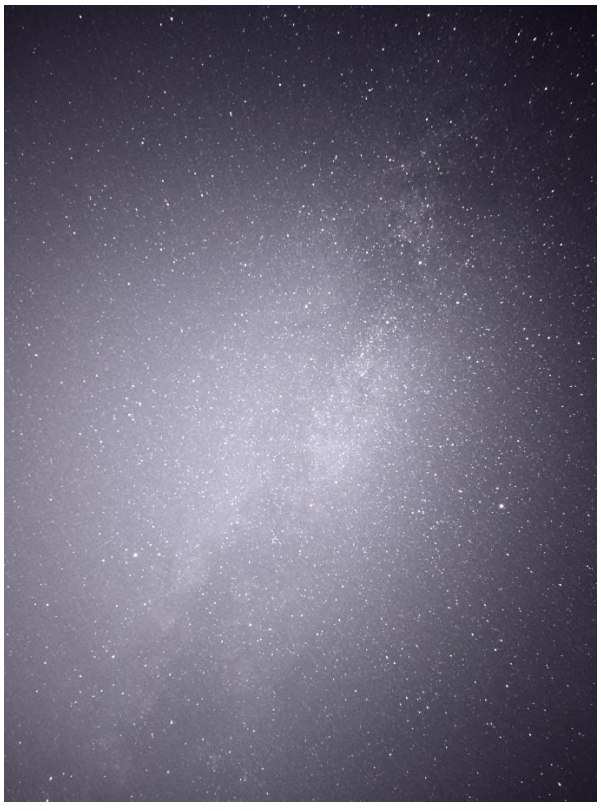
Please compare the images. It shows much more details.

I have a second example here. It shows the stacked result of RAW photo live stacking on a Google Pixel 7 device. The stacked result is a TIFF file and unprocessed. 24 DNG files were stacked. Each 15 sec exposure time.



You see stars, a little bit of milky way and the three constellations Cygnus, Lyra, Aquila. Artefacts are at the edges.

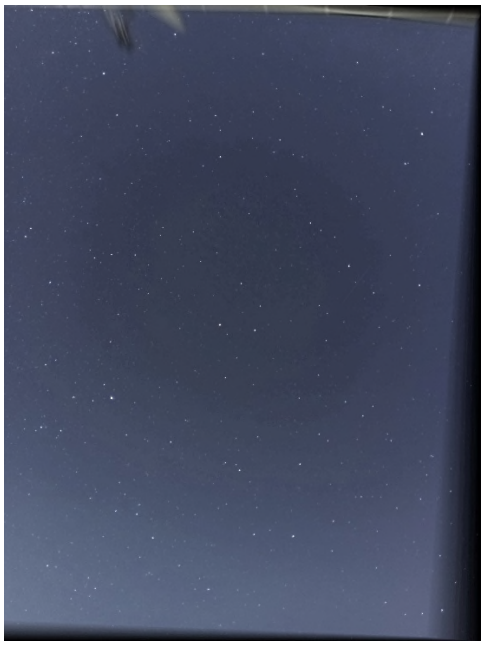
A quick process of the TIFF file gives better results. Only curves were applied and layer techniques were used. The image was cropped due to the artefacts at the left and at the bottom.



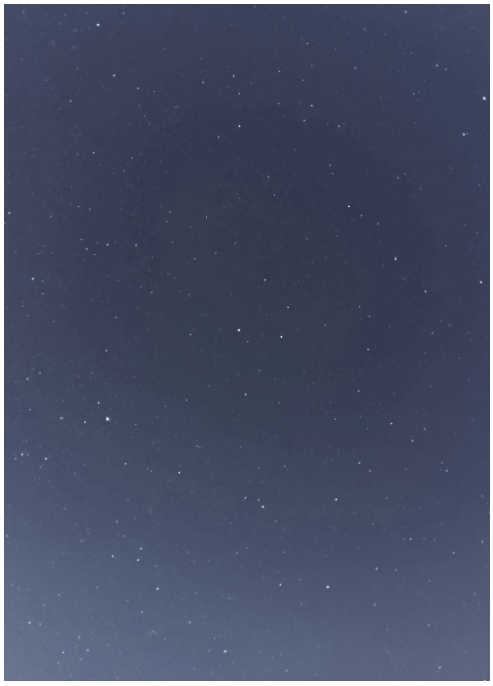
Post processing can go much further: remove vignetting, coloring, remove light pollution etc.

Artefacts at the edges of stacked images

When you align the images the stacked result will show some artefactes at the edges. The next images shows those artefacts due to the alignment of the frames.



This is normal and you must post process the image. You must crop the image to get a proper image like the next image.



Due to alignment these artefacts can be heavy when you stack untracked images. Artefacts at the edges are small for tracked images.

Good stacking

To get the best out of photo live stacking use this:

- use a mount or tracker which tracks the stars.

- it must be dark enough. Stacking in twilight will mostly fail because its too light.

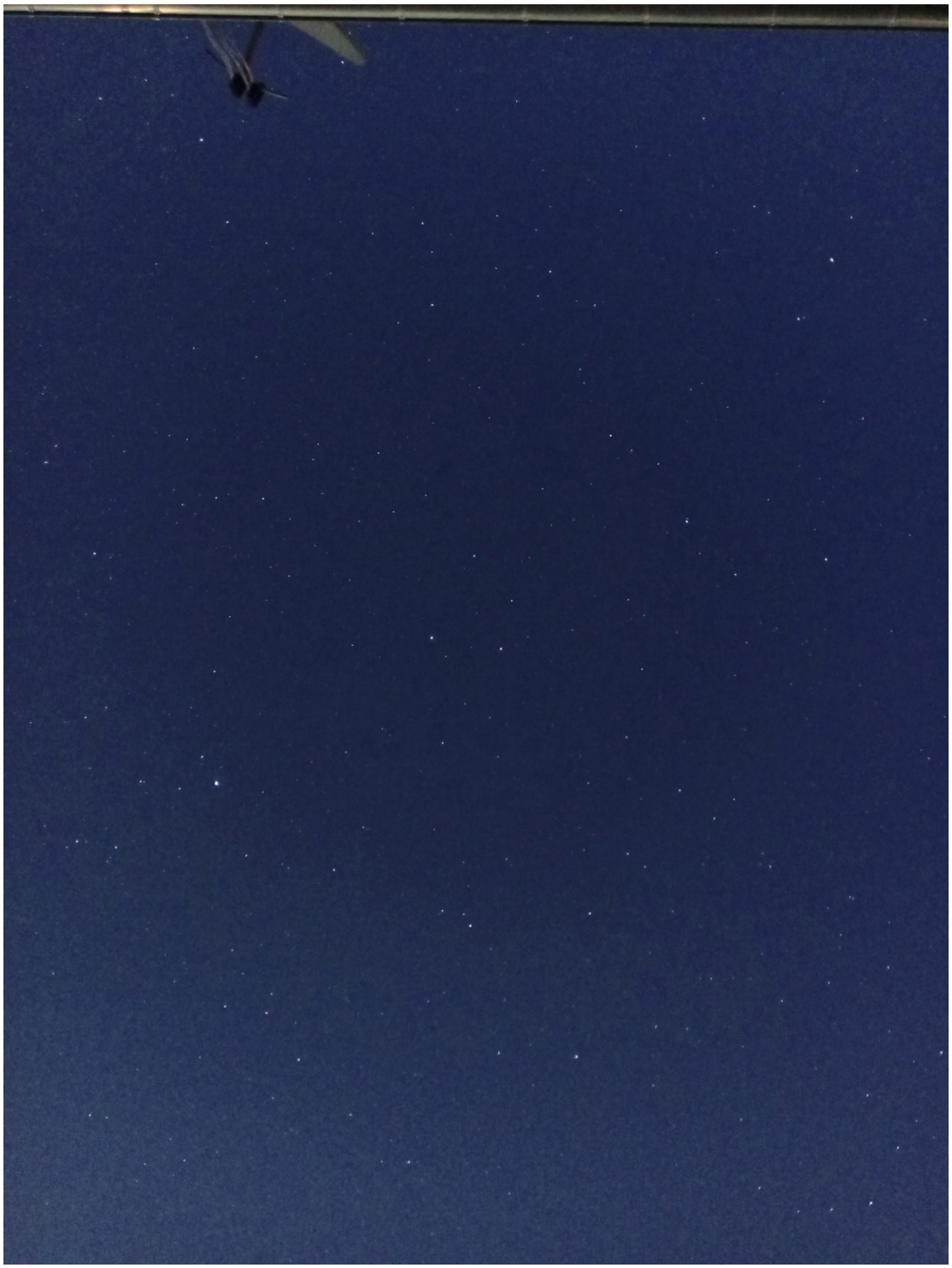
- no objects in foreground or only parts of objects at the bottom/top/left/right.

Here is a typical example of an image which is good for live stacking:

Next image is also a typical image which works with and without function "Do you have some objects in foreground of the image (house, tree, car etc.)". The house on the left, at the bottom and the roof on the right are removed during analyzing. This image will work.

The next image will work due to the function "Remove objects in foreground". The house on the left bottom will be removed during analyzing. If this function is turned off stacking fails. The reason is easy: the house is illuminated and the white wall contains lots of white pixels which can be identified as a "star". The clouds do not disturb the process. All reference stars are found.

Analyzing of the next image will also work. The roof and the satellit dish are very close to the edge. Thats not a problem for analyzing. Function "Remove objects in foreground" can be tuned off in this case.



Bad stacking

The following example is a typical example where photo live stacking fails due to too many objects in foreground and a sky background which is too light due to a bright light.

The reason why this image won't work is easy: the bright light illuminates the scenery. Function "Remove objects in foreground" can not remove all objetcs in foreground and the bright parts which can not be removed during analyzing are detected as white pixels and white "stars". Avoid those situations.

Focus value of infinity

Please pay attention to focus value of infinity. Stars in a single frame must be small and round. You must take the images with the correct focus value of infinity. If the stars are blurry due to a wrong focus value of infinity live stacking will fail. Live stacking fails because the stars are too big and star detection fails. App hangs at the first image and does not proceed. After a couple of attempts app gives up and stopps live stacking.

The following image is a typical images with blurry stars. The image was taken from a test shots with wrong focus values. Avoid these images!

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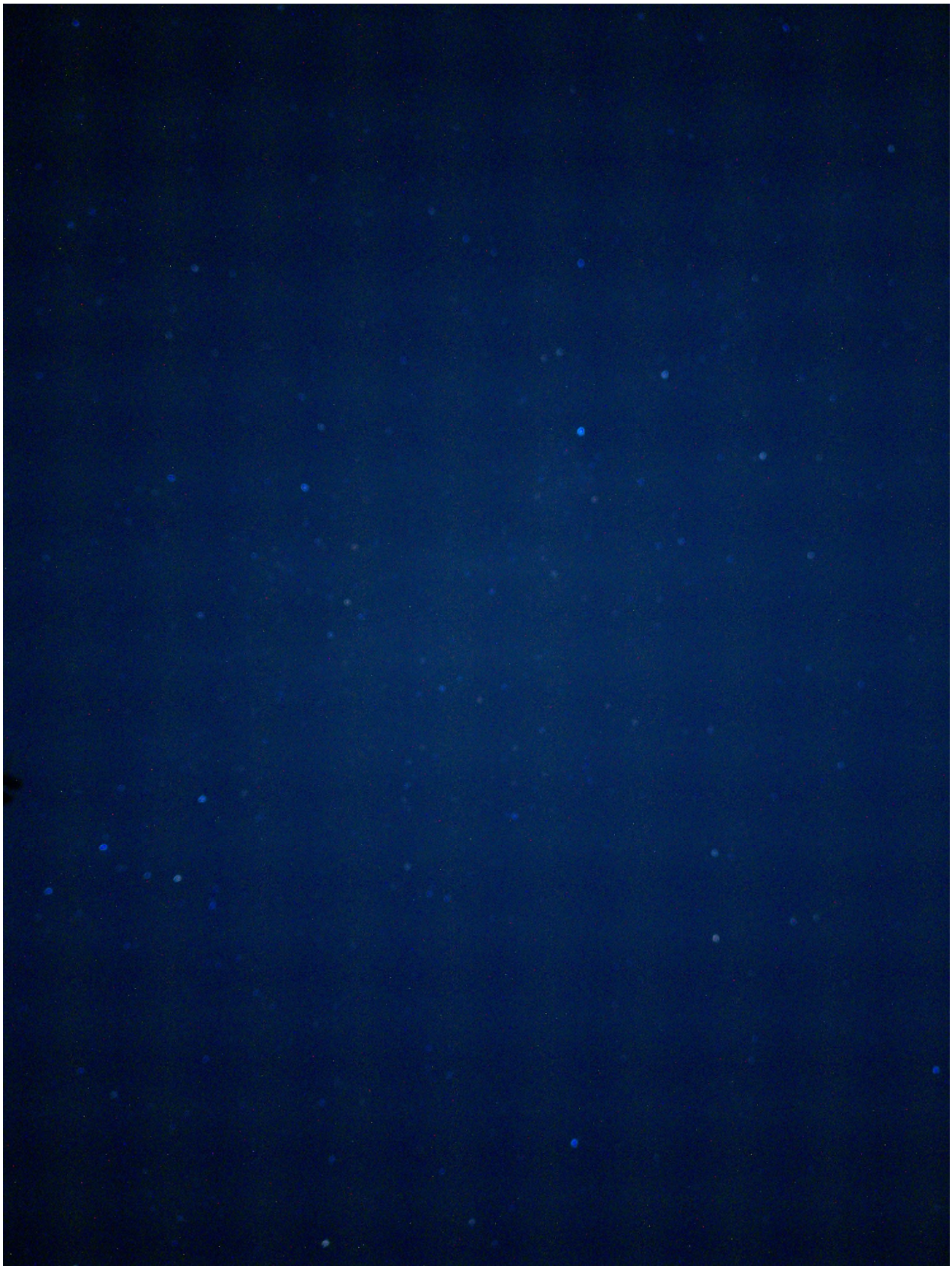
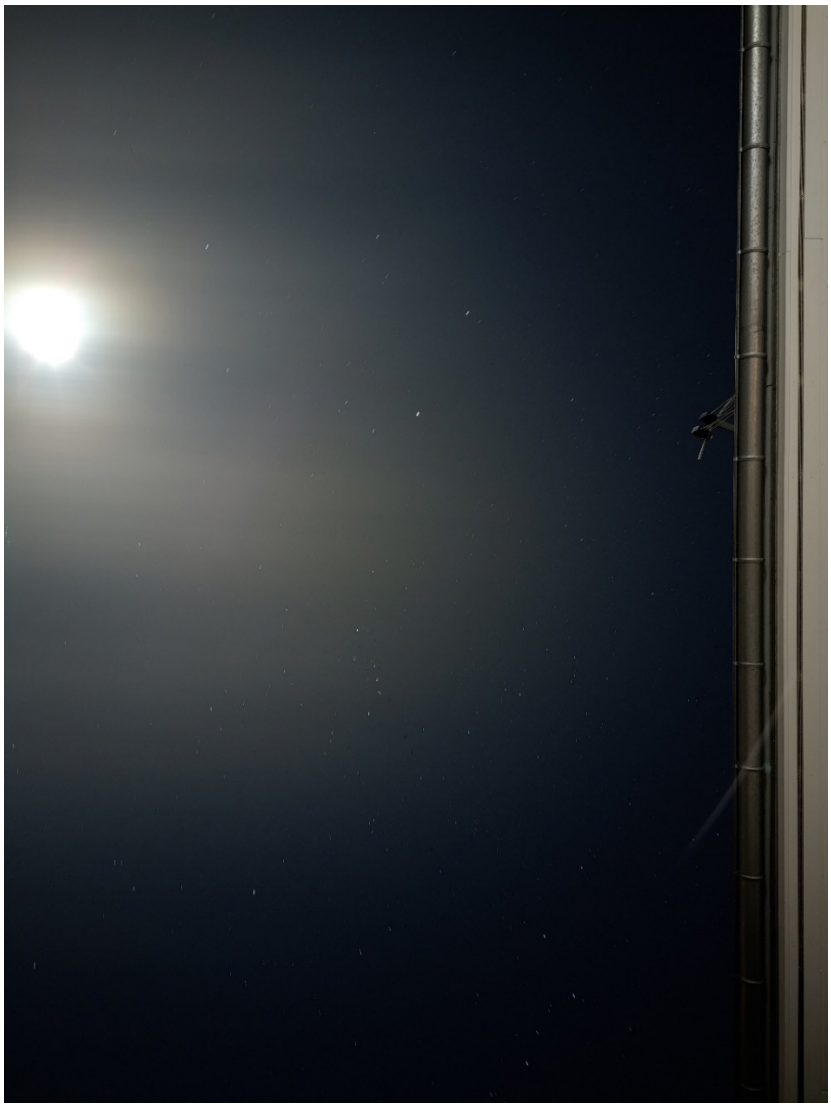


Clouds

Photo live stacking works with thin clouds but with larger clouds photo live stacking will fail and stars can not be detected. Stacking fails when some parts of the image are covered with clouds – the reference stars over the whole image are not detected. The following image shows lots of clouds at the bottom – stacking will fail because it can not find the stars at the bottom. Avoid this situation.

Moon in the image

Photo live stacking also fails when the moon is in the image. This results in areas of the image that are too bright and need to be analysed. The analysis gets stuck due to the excessive number of white pixels. DSC Pro cannot handle such situations – be sure to avoid having the moon in the image. The following image shows such a situation. The moon is severely overexposed due to the long exposure time (183 seconds in this case).



Rejected frames

You need at least 9 stars for photo live stacking (preview live stacking does not have analyzing and number of stars is not important). DSC Pro recognizes stars. If the number of stars is lower than 8 the image is rejected. You'll get an information at the screen. Or when the reference stars are not found.
Don't panic!!
You can save the rejected frame automatically (for later stacking or for analyzing). DSC Pro takes the next image and tries to analyze it. In case the number of stars is lower than 8 the image is rejected again and so on. Sometimes a frame is rejected but next frame works without issues. **Don't panic** and check the number of rejected frames which is shown on the screen. In case frames are constantly rejected stop the session. When you get constantly the reject message and there are no clouds or no objetcs in foreground do this:

- Increase or decrease ISO and/or shutter speed. Maybe ist too dark or too light.
- In case you take images during twilight it can be too light to identify stars. In this case wait until dark.
- During daylight stacking won't work. Ist definitely too light.

Processing time

Analyzing, alignment and stacking takes time. Processing time depends on Soc (Qualcomm, Mediatek, Unisoc, Kirin), on RAM (3 GB or 16 GB) and on type (RAW/DNG or JPEG). On phones like

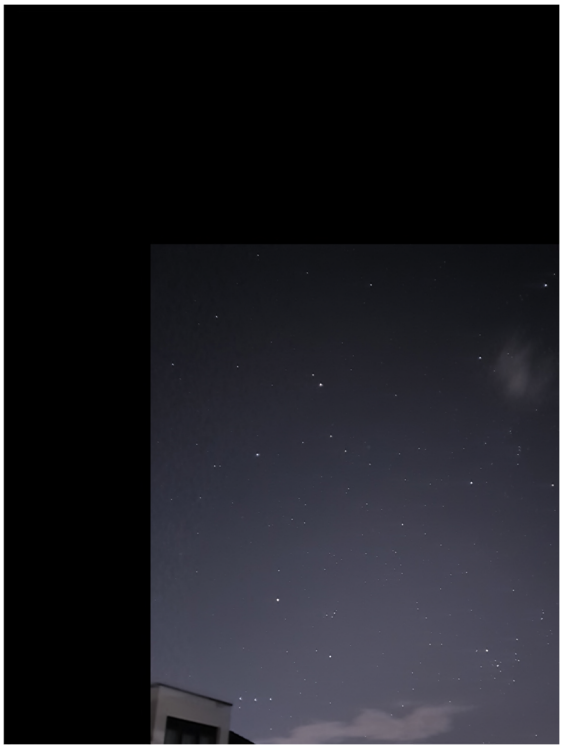
Google Pixel 7 RAW analyzing, alignment and stacking takes approximately 5 sec, JPEG photo live stacking on the same phone approximately 1,5 sec.

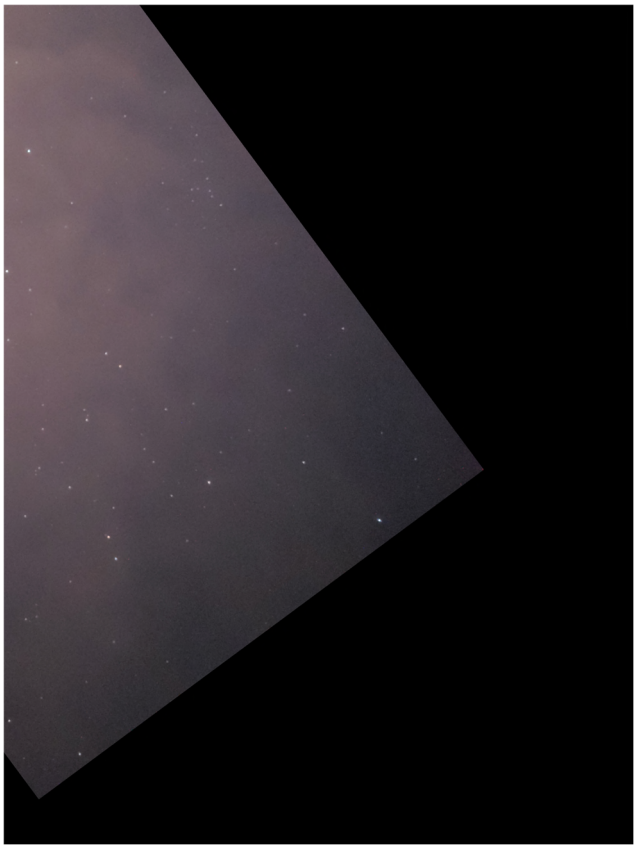
On some older Huawei models (P20 Pro, P30 Pro, Honor View 20) RAW photo live stacking takes up to 1 minute. The reason are huge DNG files on these phones and the slow Kirin processor. On these Huawei models a DNG file is around 100 MB per single frame while the file size of DNG image on Pixel 7 is around 23 MB which is typical for most of the current phones. If you don't see a progress on the screen please be patient and wait. **Don't panic**!

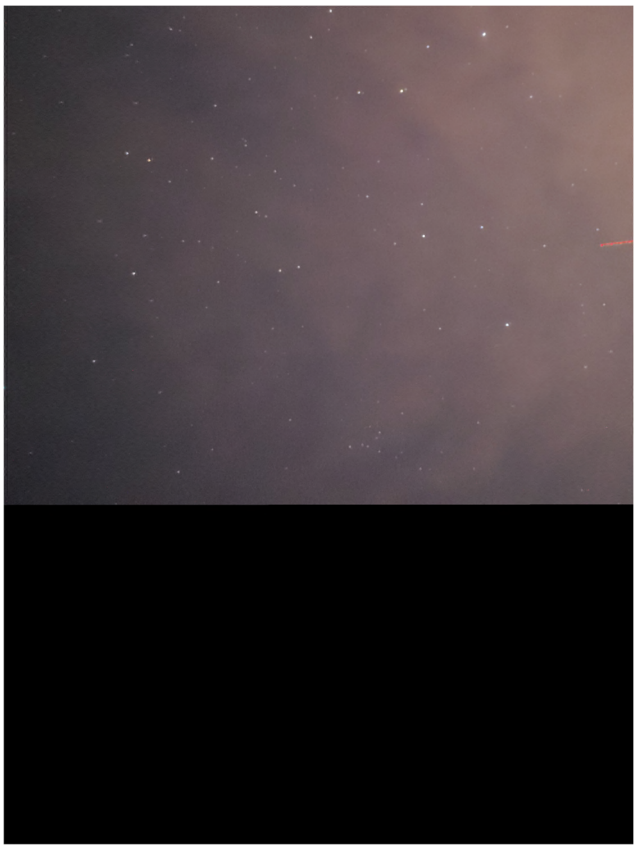
Distorted stacked image result

When photo live stacking shows a distorted image like the following images please stop the session and send me the stacked data via DSC Pro (tap three dots upper right corner – Report your phone – Include stacking zip file - Send). I'll receive the data and analyze the data.
You can check the data on your Android device (if Android allows access to the directory or use a computer and connect your phone via USB):

/storage/emulated/0/Android/data/de.seebi.deepskycamera.pro/files/Pictures/PhotoLiveStacking







When photo live stacking fails

A beautiful night sky and you try to do photo live stacking but nothing happens – no stacking result is displayed and app seems to be hanging. Progress bar hangs at the end.

This is typical when live stacking does not work and fails. There are a couple of reasons when live stacking fails. You must check a couple of things. The best advices are:

- Move your tripod and/or your phone a little bit and start live stacking again. This is very often necessary because there can be not enough reference stars in the image. DSC Pro tries to find more but because there are no reference stars live stacking fails.
- Check your sky conditions: Do you have clouds? DSC Pro can deal with minor clouds but large clouds causes live stacking to fail. Clouds can be too light and there are too much white pixel in the clouds.
- Check moon light. Is the moon too bright that the background of the night sky is highly illuminated? DSC Pro can not find reference stars in this situation.
- Check focus. Are stars round and small? A wrong focus value of infinity has a great impact on live stacking and it will fail. Focus again or find a new focus value of infinity.
- Check your ISO: Maybe ISO is too low that no reference stars are in the image. Or is it too high that the background is too light. No reference stars are found. Adjust your ISO value.
- Check your shutter speed: maybe its too fast (f.i. 1 sec) that no reference stars are in the image. Or ist too slow (f.i. 30sec) that the background is too light.
- Check again your shutter speed: When you take non tracked images (without mount or tracker) then there is a max shutter speed where the stars remain round. Everything slower means that the stars get trails. Because these are not round stars (thats what DSC Pro is searching for) photo live stacking can fail. Use "Calculator for pinpoint stars" to calculate the appropriate shutter speed.
- Check your situation: When you have houses, trees, cars etc. in your image try to use setting "Do you have objetcs in foreground?" on "Settings" in "Photo live stacking".
- Check your eyepiece: when you take images with your telescope with eyepiece you should tell DSC Pro which eyepiece you are using. Because lots of eyepieces have a small field of view (FOV) you see a large black area around FOV. There can be hot pixel in the black area around FOV which can be identified as stars. Activate "How to you take images with" and select your eyepice.
- Check your settings: Maybe you've changed settings in "Photo live stacking" (e.g. activated "Do you have objects in foreground?" because of foregorund objects) but your new imaging session is without objects in foreground. Because the option is activated DSC Pro tries to remove foreground objetcs. There can be too much areas removed from the images. This is not necessary of course and live stacking fails. In this case deactivate the option. Same with other settings: Please check if the settings from an earlier imaging session fit to your current imaging session.

Stacking of daylight images

By default photo live stacking works only with images of the night sky. The reason is that by default images are analyzed, e.g. app searches for stars in the images and app aligns the images. When you try to stack daylight images whithout stars stacking will probably fail. The reason is that DSC Pro searches for stars and your daylight image consists of too many white pixels which are not stars. Thats why stacking fails.

It is possible to stack daylight images without stars but you must change settings. Please go to "Settings" page and tap "Photo live stacking". Deactivate option "Analyze and align frames".

Sending stacking data to developer

In case photo live stacking fails or you want to report a great success you can send me stacking data via DSC Pro:

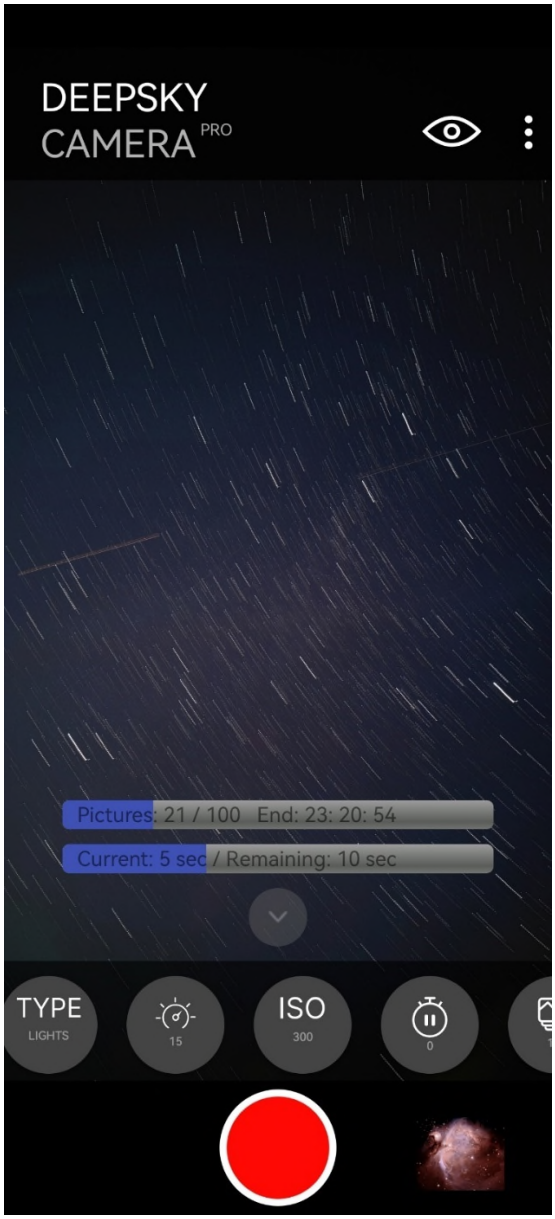
Tap three dots upper right corner – Report your phone – Include stacking zip file - Send. I'll receive the data and analyze the data. Please include your mail address for further questions/discussions.

Live star trails function

This function produces a star trail image. You set number of frames, ISO, shutter speed etc. and tap icon "Live star trails". Put phone on your tripod, table, chair etc. Don't forget to set a delay on "Settings" page. Press now shutter button and that's it. Every new image is added to the result image. After each new image the result is displayed on main screen of DSC Pro. The updated result image is copied to your storage location. In case app hangs or crashes you have always the latest result image.

> **Note**: Live star trails function takes image in JPEG and the result image is saved in JPEG only. You can set in "Format" RAW or RAW+JPEG but this won't have an effect. Images are always in JPEG.

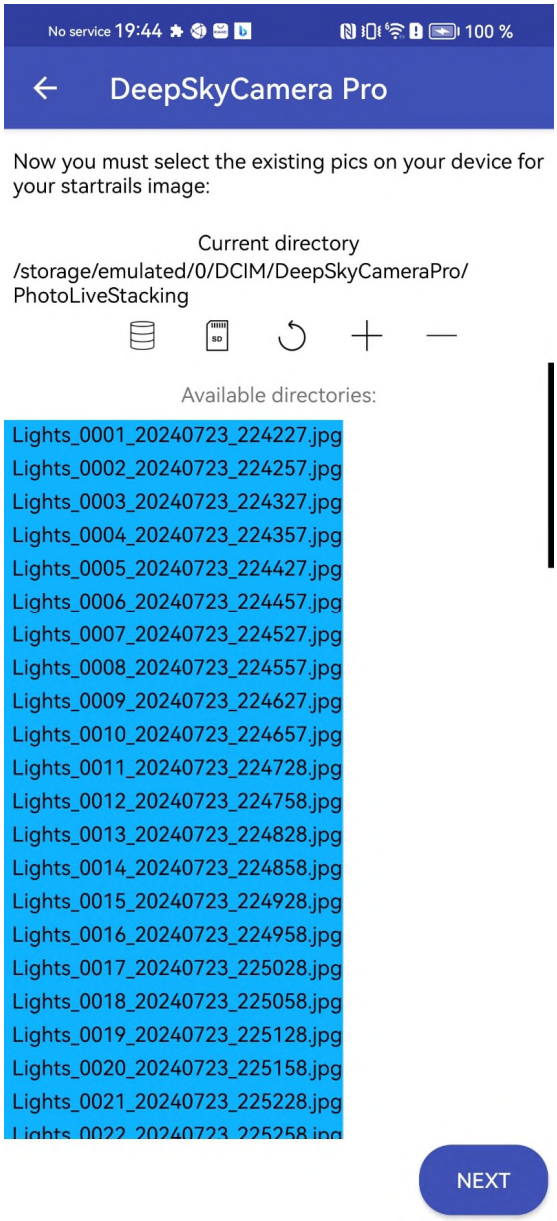
The star trails image is saved in DCIM/DeepSkyCameraPro/LiveStarTrails.



Star trails function

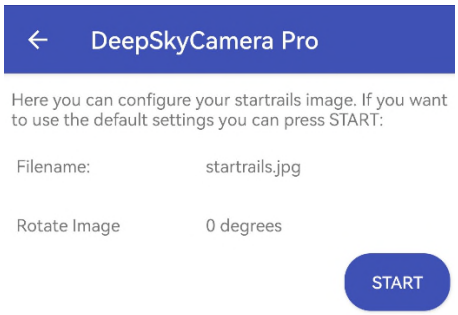
This function assembles a star trails image based on images you have on your phone. Maybe you have taken the images earlier or you got the images from elsewhere.

Tap icon "Star trails" and a page is shown. You can navigate through your file system and you can mark the images which are put together to an image file.

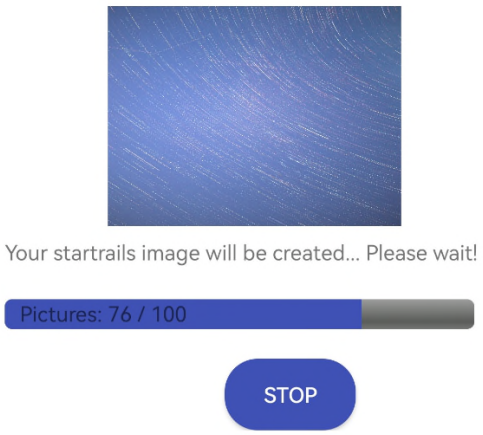


Note: You can select multiple files at once by pressing and holding the file name. All files above it will be selected – either up to the first file in the list or up to a previously selected file.

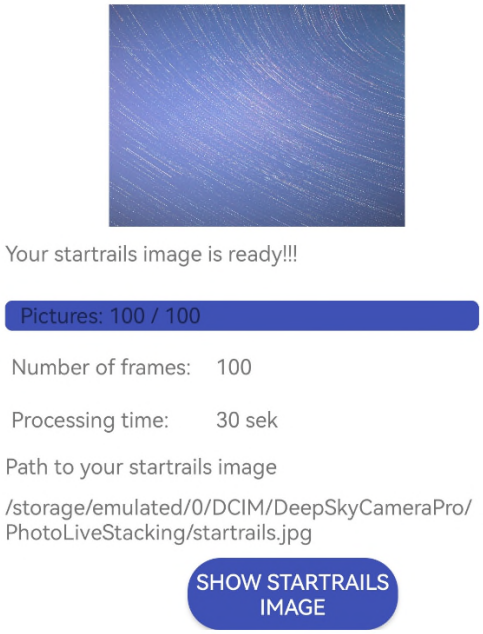
Tap "Next" and on the next page you must set two things: name of star trails image and rotation of each image in degrees (if you want to rotate it). If you don’t want to rotate the images leave rotation at 0 degrees.



Tap "Start" and the image is assembled. You see the progress and the status of the current image.

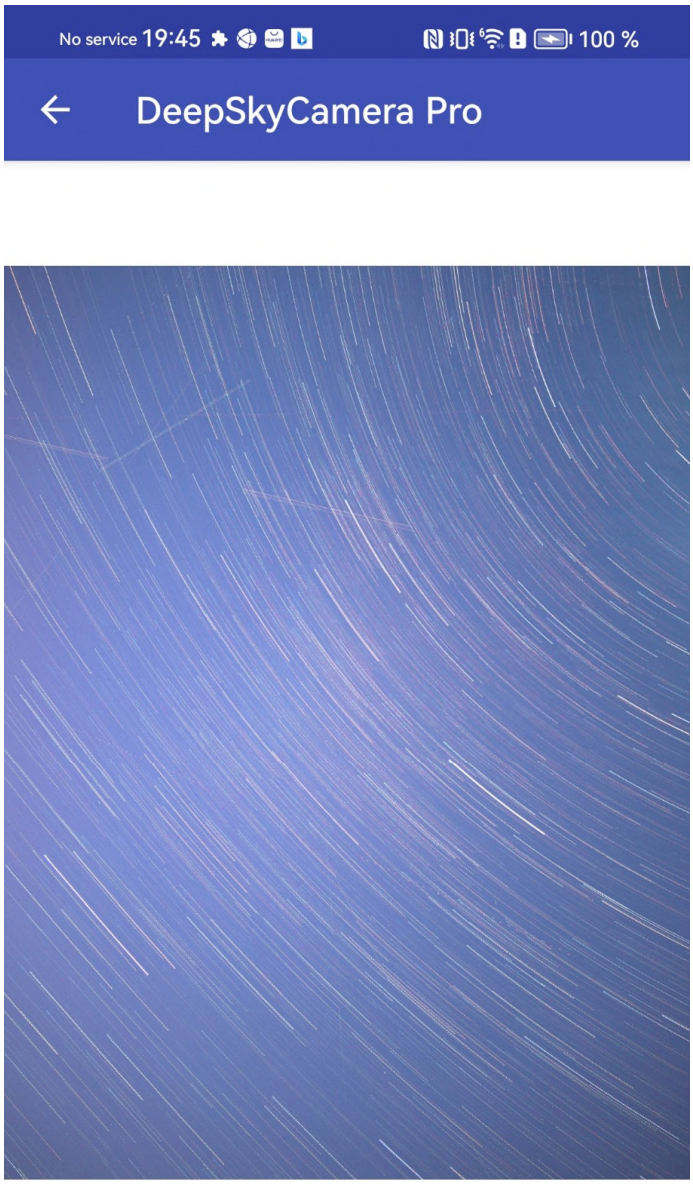


You get a confimation when the image is finished:



Tap "Show star trails image" and the assembled image is shown on the screen.

The image is saved in the same directory where you have the original image files.



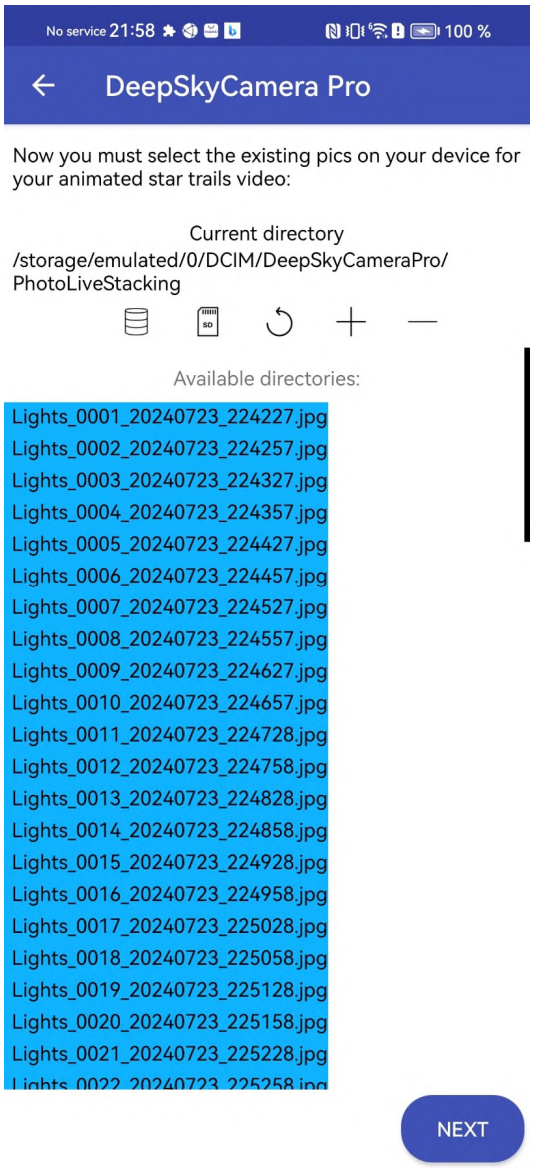
Note: The shutter button has no function when function "Star trails" is selected.

Note: You can zoom the result image with our two fingers.

Animated star trails function

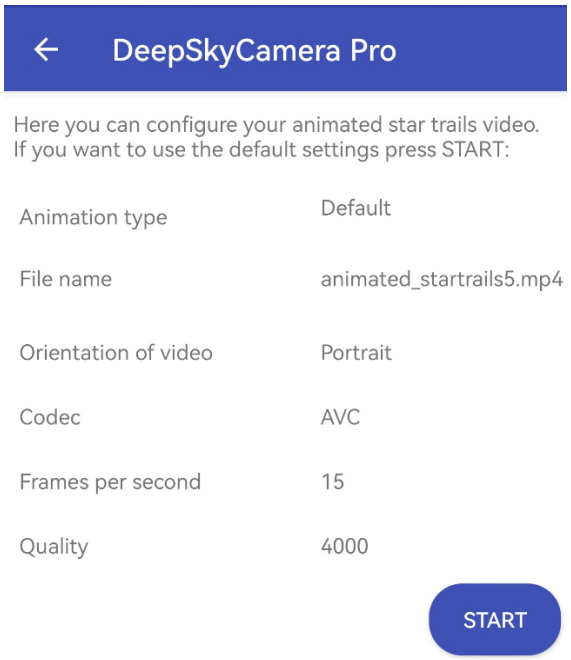
Animated star trails function assembles a star trails video. You see in the video how the trails get longer. DSC Pro supports different animation types: forwards, backwards, forwards and backwards. The video is saved as MP4 with AVC or HEVC codec.

Tap "Animated star trails" in function bar and a new page is shown. You can navigate through your file system and you can mark the images which are put together to a video file.



Note: You can select multiple files at once by pressing and holding the file name. All files above it will be selected – either up to the first file in the list or up to a previously selected file.

Tap "Next" and you get the basic settings for the video.

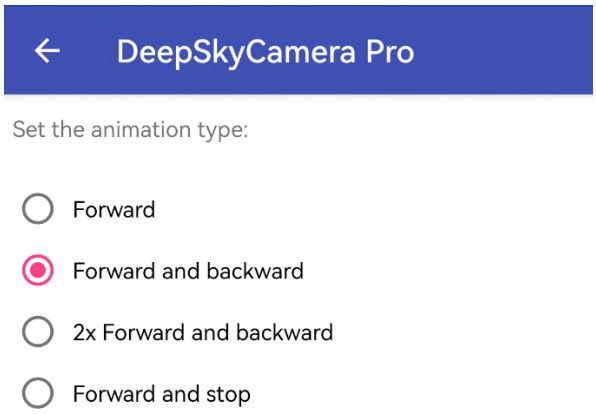


You can set:

- Animation type
- File name of video
- Orientation of video
- Codec of video
- Frames per second
- Quality

Tap "Animation type" to change the animation. These are the supported types:

- Forward: thats the default and trails get longer
- Forward and backward: trails get longer until the end and then they go back
- 2x Forward and backward: same as "Forward and backward", but two times.
- Forward and stop: takes very long!



Tap "File name" to change the file name. The file extension can not be changed.

Tap "Orientation of video" to switch between "Portrait" and "Landscape".

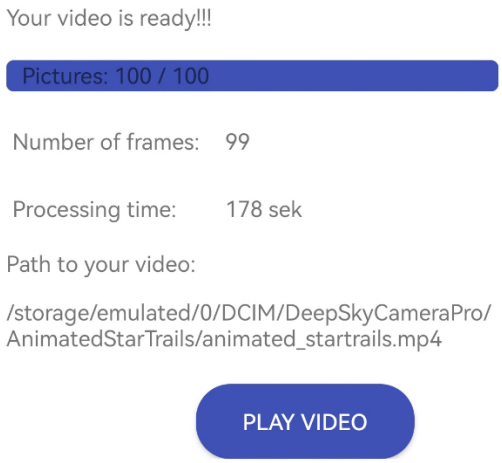
Tap "Codec" to switch between "AVC (H.264)" and "HEVC (H.265)",

Tap "frames per second" to change the frames per second.

Tap "Quality" to set kb per seconds.

Tap "Start" to start the creation of video file. The screen is updated with the progress:

When the process is finished you get a notification on the screen:



DSC Pro contains a small video player. Tap "Play video" and you can play the video in DSC Pro.

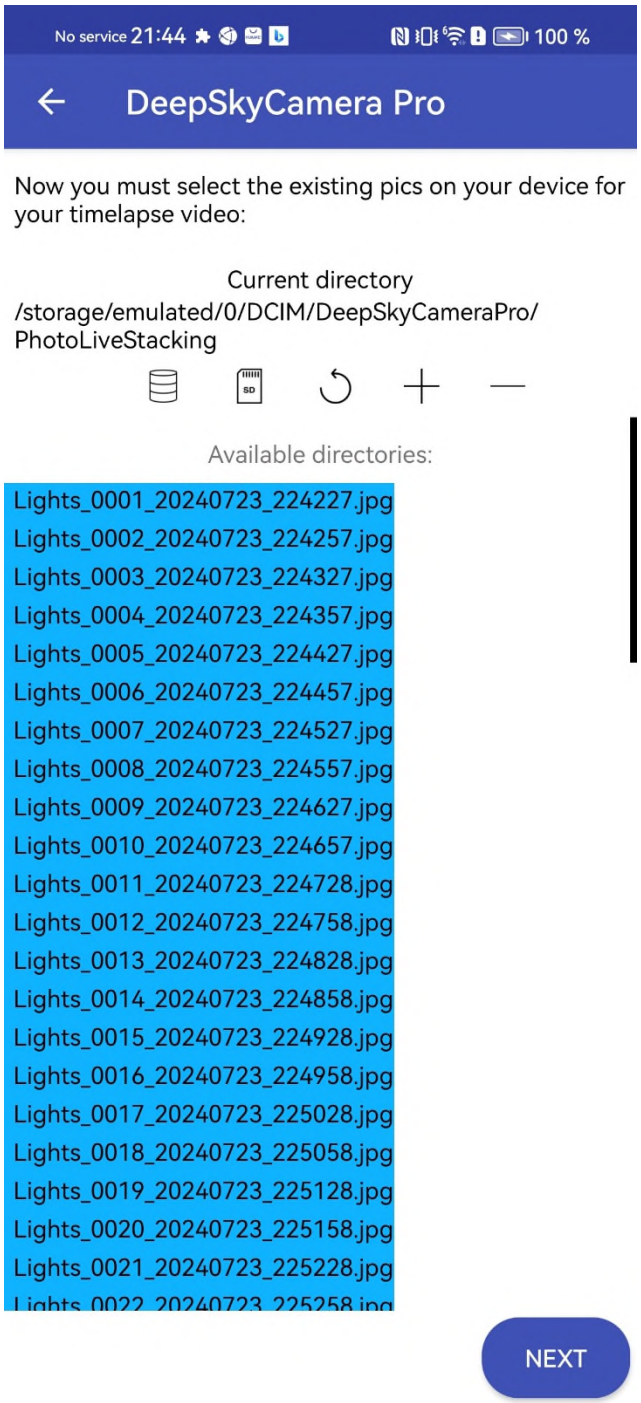
> **Note**: By default video player does not play automatically. Tap one time on the image and the controls are shown at the bottom.

The video file is stored in DCIM/DeepSkyCameraPro/AnimatedStarTrails.

Note: The shutter button has no function when function "Animated Star trails" is selected.

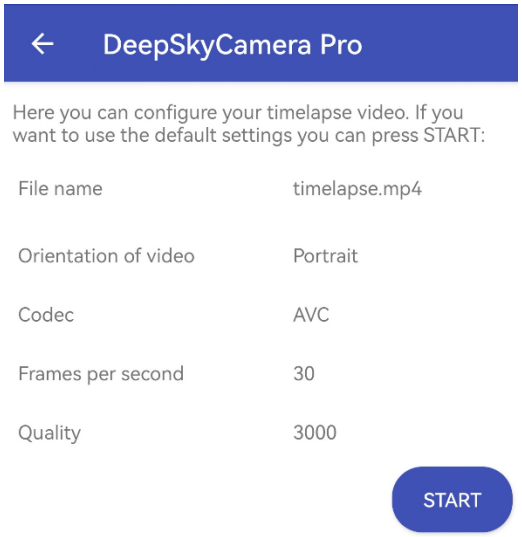
Timelapse function

Timelapse function assembles a timelapse video. Tap "Timelapse" in function bar and a new page is shown. You can navigate through your file system and you can mark the images which are put together to a video file.



Note: You can select multiple files at once by pressing and holding the file name. All files above it will be selected – either up to the first file in the list or up to a previously selected file.

Tap "Next" and you get the basic settings for the video.



You can set:

- File name of video
- Orientation of video
- Codec of video
- Frames per second
- Quality

Tap "File name" to change the file name. The file extension can not be changed.

Tap "Orientation of video" to switch between "Portrait" and "Landscape".

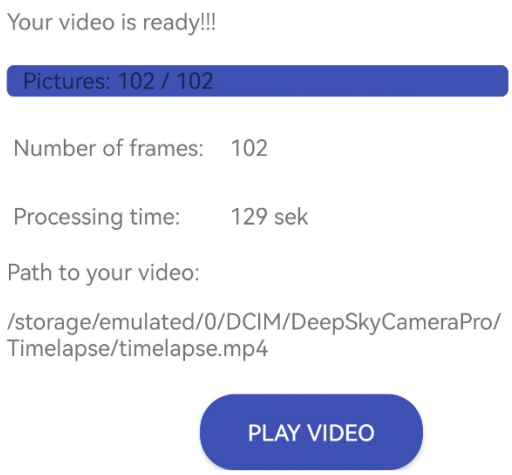
Tap "Codec" to switch between "AVC (H.264)" and "HEVC (H.265)",

Tap "frames per second" to change the frames per second.

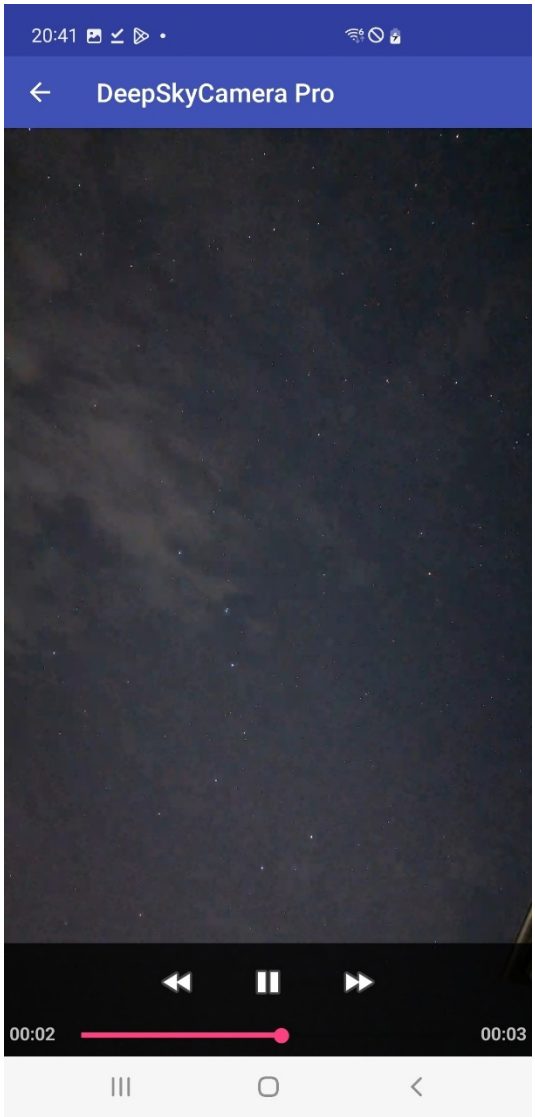
Tap "Quality" to set kb per seconds.

Tap "Start" to start the creation of video file. The screen is updated with the progress:

When the process is finished you get a notification on the screen:



DSC Pro contains a small video player. Tap "Play video" and you can play the video in DSC Pro.



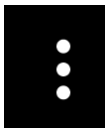
Note: By default video player does not play automatically. Tap one time on the image and the controls are shown at the bottom.

The video file is stored in DCIM/DeepSkyCameraPro/Timelapse.

Note: The shutter button has no function when function "Timelapse" is selected.

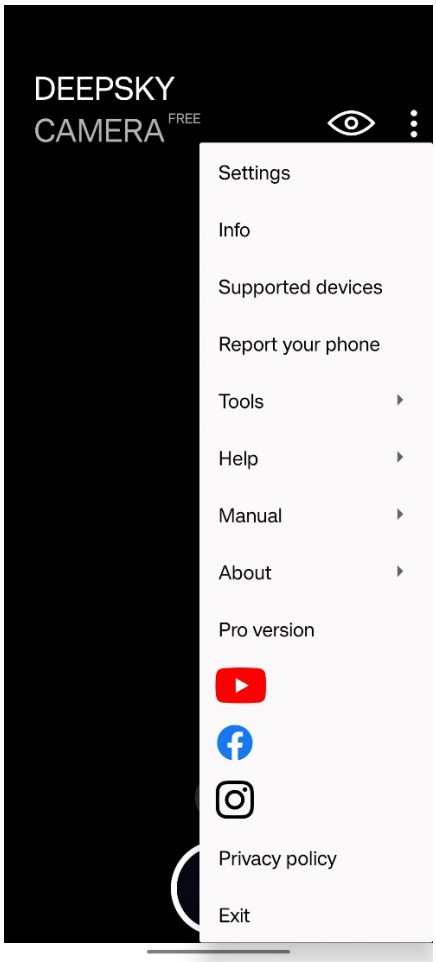
9. Menu

You'll get the menu by tapping on the three dots upper right corner.



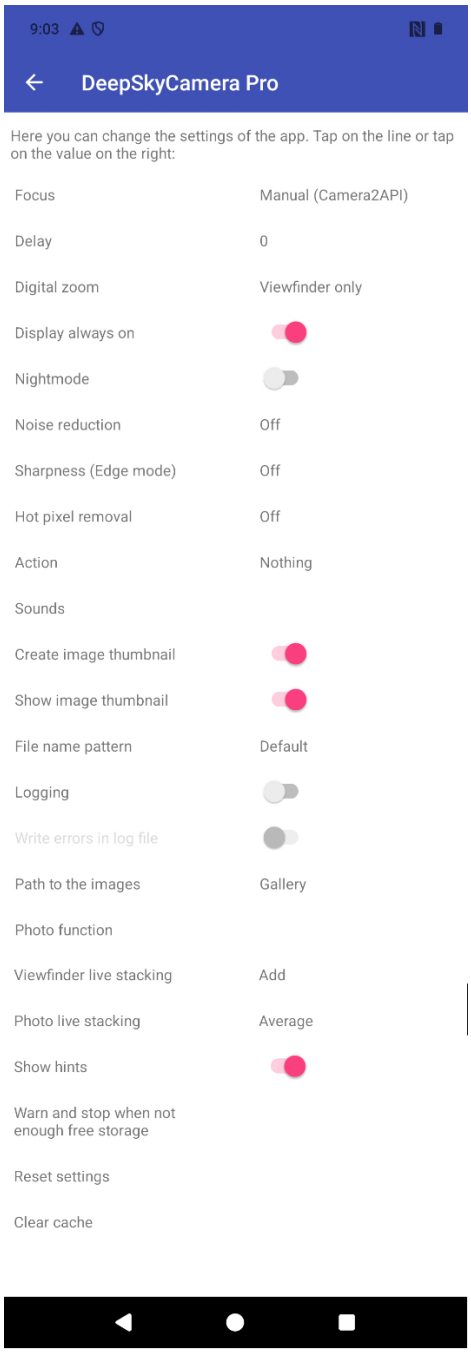
These entries are available:

- Settings: You can set or change the configuration of the app
- Info: Information about the camera sensor
- Supported devices: A list with compatible devices for DeepSkyCamera
- Report your device: You can report your phone to the developer.
- Tools: View log file
- Help: Help section
- Manual: The manual (what else)
- About: Information about the app
- YouTube: Link to YouTube channel "DeepSkyCamera"
- Facebook: Link to the Facebook group "DeepSkyCamera"
- Instagram: Link to #deepskycamera on Instagram
- Privacy policy: the privacy statement
- Exit: closes app



Settings

You can set and change the basic configuration on the "Settings" page.



To go back to the main page tap the back arrow upper left corner. It is also the same procedure on every sub page of the "Settings" page.

On devices with smaller displays you must scroll down to view more settings.

Focus

You can choose between these types of focussing:

- Infinity
- Customized infinity
- Hyperfocal
- Manual

- Autofocus

Note: Not each of the four options is available on all devices. The "Custom infinity" option is also only visible if you have set your own focus value for "Infinity" on the app's start page ("Infinity" icon).

Infinity

The mode "Infinity" tries to determine the correct focus value for infinity. It works on some devices pretty well (such as LG) but on other devices it doesn't work. The calculation is based on calibration data of the camera sensor. If "Infinity" does not work on your device and the stars are blurred you must focus manually or try "Hyperfocal".

Note: When you choose "Infinity" the slider for focus on the main page is not accessible and disabled.

Note: On legacy devices only "Autofocus" is available.

Customized infinity

This option uses a previously determined value of infinity. This option is initially not visible by default and will only be visible if you previously determine an "infinity" value with the focus slider and tapped the "infinity" icon on the main page of the app. The value for "Custom infinity" is then set for the preview and the images. This value is also set if you exit the app and start it again later. If you want to overwrite it, go back to "Manual", reset the value on the focus slider and tap on the "Infinity" icon. You can then switch back to the "Custom infinity" setting. The new infinity value is now used.

Hyperfocal

"Hyperfocal" sets the focus to a value, where the foreground is sharp as well as the background.

Note: When you choose "Hyperfocal" the slider for focus on the main page is not accessible and disabled.

Note: On some devices "Hyperfocal" is not available (Huawei, Honor, Samsung S6/S7/S8/Note 5/8, legacy devices).

Manual

"Manual" is the best focus mode for astrophotography. You have full control of the focus. Switching to "Manual" enables the focus slider. You can move the slider up or down to adjust the focus.

Note: On legacy devices "Manual" is not available.

Note: On Samsung S6/S7/S8, Note 5/8 only "Infinity" is available.

Manual on Samsung models with Android 12 (or higher)

Especially on Samsung models with Android 12 or higher there is the possibility to switch between two focus systems:

- Manual (Camera2API)
- Manual (Samsung)

Samsung introduced a second focus system with Android 12. One of the two focus systems will work, it just cannot be automatically determined which of the two focus systems is ready for use on your device. Therefore you can switch here manually if a focus system does not work. This is quickly noticeable because the focus does not change when the focus slider on the main page of the app changes. In this case you should change the focus system. Samsung models up to and including Android 11 are not affected!

Autofocus

Autofocus is not available on all devices. With autofocus, the camera sensor focuses. This setting is not recommended for taking pictures of the sun, moon and the night sky, and the focus of each image is often not the same.

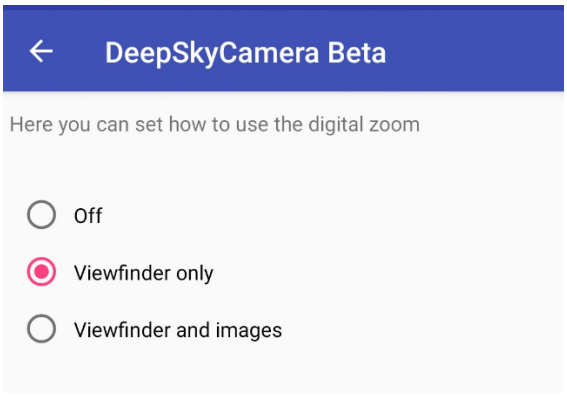
Delay

Here you can set a delay in seconds before the first image is taken.

Digital zoom

You have three options:

- Zoom off
- viewfinder only (default): the zoom is only available at the viewfinder
- Zoom at viewfinder and images: zoom is available for both viewfinder and the images



When you want to take pics with zoom you must select the third option. You can zoom in with your fingers at the view finder and the image is taken with the same zoom value.

Note: Zoom function is only applicable to JPEG files, not to RAW/DNG files.

Note: Zoom function is not available on Samsung S6/S7/S8 and Note 5/8.

Display always on

This function turns the display always on or off. On most of the phones it‘s necessary to turn the display always on, otherwise the display turns off after a small period and the app is set to hibernate mode by the operating system. In this case the app does not take images anymore. To prevent this behaviour, you should turn the display to mode "Display always on".

Nightmode

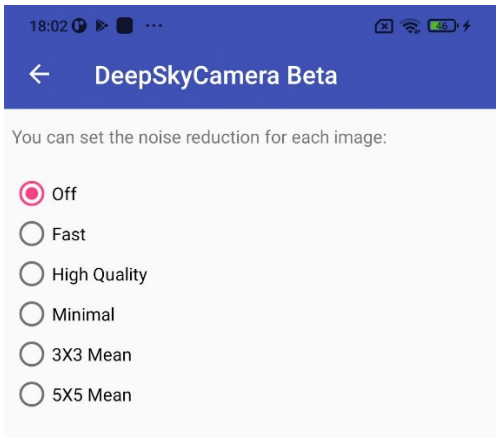
This option switches from daylight mode (default) to nightmode.
It is highly recommended to switch to nightmode (black background, red text color), when you want to shoot pictures from the night sky.

Noise reduction

This function reduces the noise in the image without taking dark frames and bias frames. The function is disabled by default. These are the available options:

- Off: No noise reduction (default)
- Fast: Fast noise reduction mode, recommended for interval times around 1 sec
- High Quality: best method to get the best quality of the pics with less noise. Highly recommended.
- Minimal: Simple method with minimal effect at the final image, but fast.
- 3x3 Median: Average value of 9 pixels (3x3) around each pixel
- 5x5 Median: Average value of 25 pixels (5x5) around each pixel

These functions reduce the noise in JPEG files. RAW/DNG remains untouched.

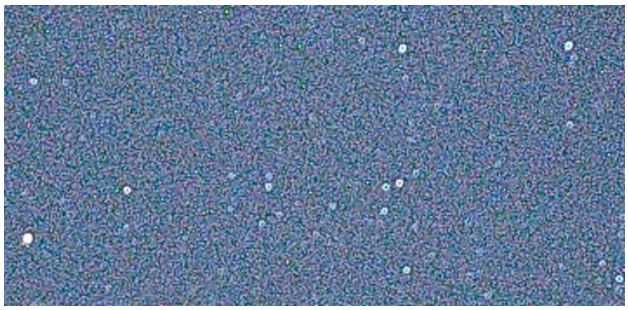


Note: Due to technical reasons only 3X3 Median and 5X5 Median are available on Huawei and Honor devices as well as on Samsung S6/S7/S8/Note5/Note8.

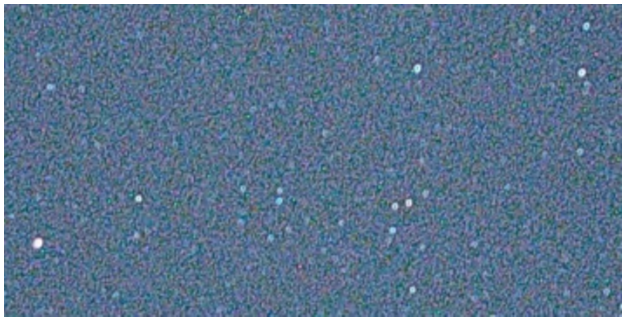
Note: The options depend on the camera sensor. The app detects automatically the possible options and creates the list dynamically.

The following examples show the differences between the settings Off, 3X3 Mean and 5X5 Mean. It is clear that the noise is very much reduced at 5X5 Mean - it will never go completely away with these algorithms. To do this, you have to use stacking. The examples show excerpts from images taken with Samsung A70, ISO 1882 and 15 sec exposure time.

Noise reduction off:



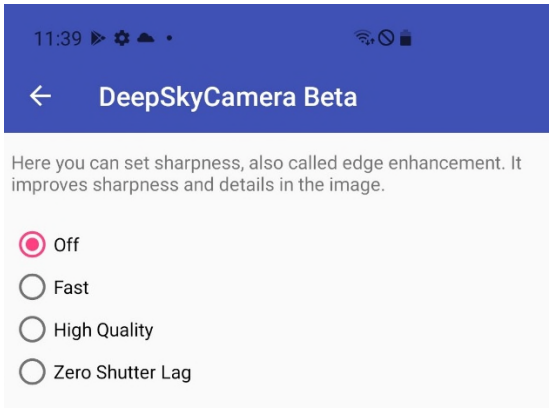
Noise reduction 3X3 Mean:



Noise reduction 5X5 Mean:

Sharpness (Edge mode)

This option improves sharpness and details in the captured image.



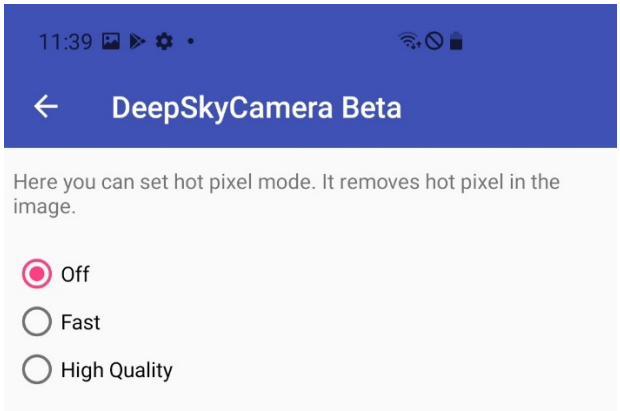
These are the available modes:

- Off: no enhancement.
- Fast: enhancement will be applied to image. The algorithm which is used will not slow down capture rate.
- High Quality: enhancement will be applied to image. It uses the highest-quality enhancement algorithm. This mode can slow down frame rate especially on fast shutter speeds (f.i. 1/1000 sec). On slow shutter speeds (f.i. 30 sec) this is not relevant and you can use "High Quality ".

Note: This function has no effect on these phones: all Huawei and Honor devices, Samsung S6/7/8, Note5/8.

Hot pixel removal

This option removes hot pixels in the captured image.



These are the available modes:

- Off: no hot pixel removal will be done.
- Fast: hot pixel removal will be applied to image. The algorithm which is used will not slow down capture rate.
- High Quality: enhancement will be applied to image. It uses the highest-quality enhancement algorithm. This mode can slow down frame rate especially on fast shutter speeds (f.i. 1/1000 sec). On slow shutter speeds (f.i. 30 sec) this is not relevant and you can use "High Quality ".

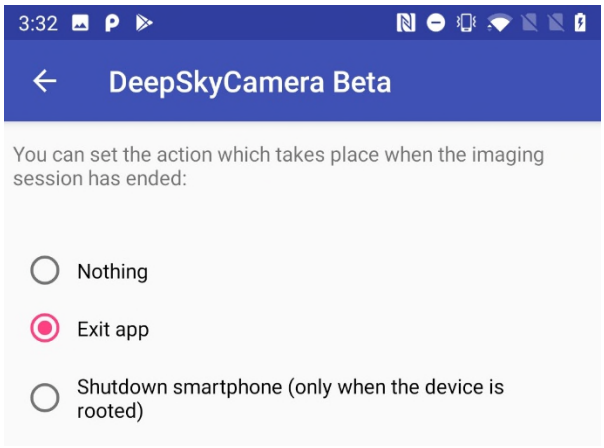
You can set the mode to "Off" when you use stacking software like DeepSkyStacker or Sequator. These programs remove hot pixel during stacking process with dark frames and bias frames.

> **Note**: This function has no effect on these phones: all Huawei and Honor devices, Samsung S6/7/8, Note5/8.

Action

This function tells the app what to do when the imaging session has ended. These are the available options:

- Nothing
- Exit app
- Shut down smartphone



The Option "Nothing" does nothing. The app is idle and waits for your input 😊

The option "Exit app" exits the app automatically, when the imaging session has ended. This is really useful, when you want to take pictures for a couple of hours. It saves energy.

The option "Shutdown Smartphone" shuts down the phone at the end of the imaging session. But take care: the option is on every phone available but to shut down, the device must be rooted. Without a rooted phone, the app will not be able to shut down the phone. A popup will appear, saying that you do not have enough rights.

Sounds

You can control shutter sound and end sound.

Play shutter sound

This option turns on or off the shutter sound. When this option is turned on you will hear a shutter sound at the beginning of each new image.

Play end sound

This option turns on or off the end sound. When this option is turned on you will hear an end sound. This tells you that your imaging session is finished.

Create image thumbnail

This option enables or disables the creation of the image thumbnail. The icon is displayed on the main page of the app right to shutter button. This option is very useful especially when you shoot with very fast shutter speeds (f.i. 1/1000 sec). You can get a little bit more performance when you turn this option off and no thumbnail icon is generated. The code to recode and recalculate the image size is not executed. Turning off this option is also recommended when you shoot at very fast shutter speeds and interval time is set to 0 sec ("Burst Shot Mode").

Keep in mind that this option controls only the creation of the image icon. Displaying image icon is controlled by the next option "Show image thumbnail".

> **Note**: This function is especially for devices with less RAM. Turning off this option, performance of the app will increase. On high end smartphones with enough RAM (3 GB or more), it‘s not necessary to turn off this option.

Show image thumbnail

If you turn this option on, a thumbnail will appear right next to shutter button. The size of the icon is 80x50 pixel.

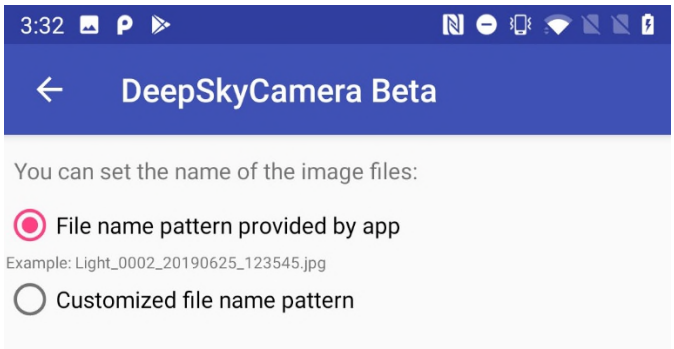
The previous option "Create image thumbnail" controls the creation of the thumbnail in general. Keep in my mind that only icons can be displayed when they are created.

> **Note**: This function is especially for devices with less RAM. Turning off this option, performance of the app will increase. On high end smartphones with enough RAM (3 GB or more), it‘s not necessary to turn off this option.

Turning off this option is also recommended when you shoot at very fast shutter speeds and interval time is set to 0 sec ("Burst Shot Mode").

File name pattern

This function controls the file names of the image files. You can choose between the default file names or customizable file names.



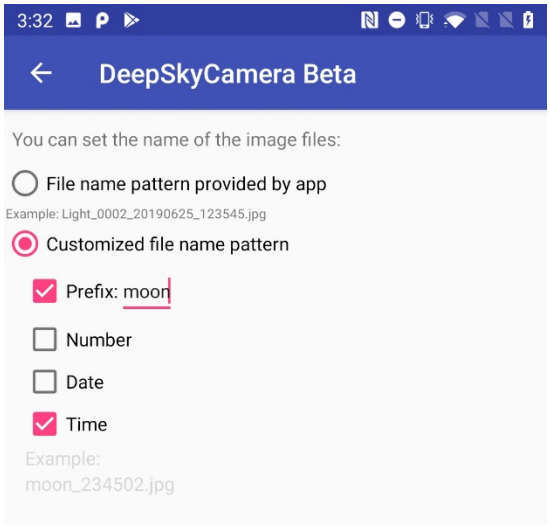
The option "File name pattern provided by app" creates the file names as follows:

- 1st step: Type of the image. The type can be selected on the main page of the app in the field "Type". It can be "Lights" for instance.
- 2nd step: A number with four digits, e.g. 0006.
- 3rd step: The current date year month day, e.g. 20190906
- 4th step: The current time hours minutes seconds when the file is generated, e.g. 010305

The default pattern generates following file name (this is an example):
Lights_0006_20190906_010305.dng.

The file extension depends on the format (which can be selected in control element "Format" on the main page). The extension is .jpg for JPEG files and .dng for RAW files.

The option "Customized file name pattern" gives you the possibility to define your own file name pattern. The prefix can be set on your own, e.g. "Moon" or "M31". You must set one character or more for the prefix. The number, date and time can be selected optionally.



Note: When you choose "Customized file name pattern" you should select two options or more. If you choose only one option ("Prefix" for instance) the file name is always the prefix name and the next picture overwrites the previous picture. That's why you should choose two or more options.

Logging

This option turns logging on or off. When logging is turned on, a log file on Android 6 – 10 is created in the directory where the images are stored. On Android 11 (or higher) the log file is always in the private directory (`Android/data/de.seebi.deepskycamera/files/Pictures`) and can be view via "Tools" menu entry.

The name of the file is "deepskycamera_log.txt". The log file logs every new pic, which is saved in your internal or external memory. Errors will also be logged in the file, when you turn on the option "Write errors to log file".

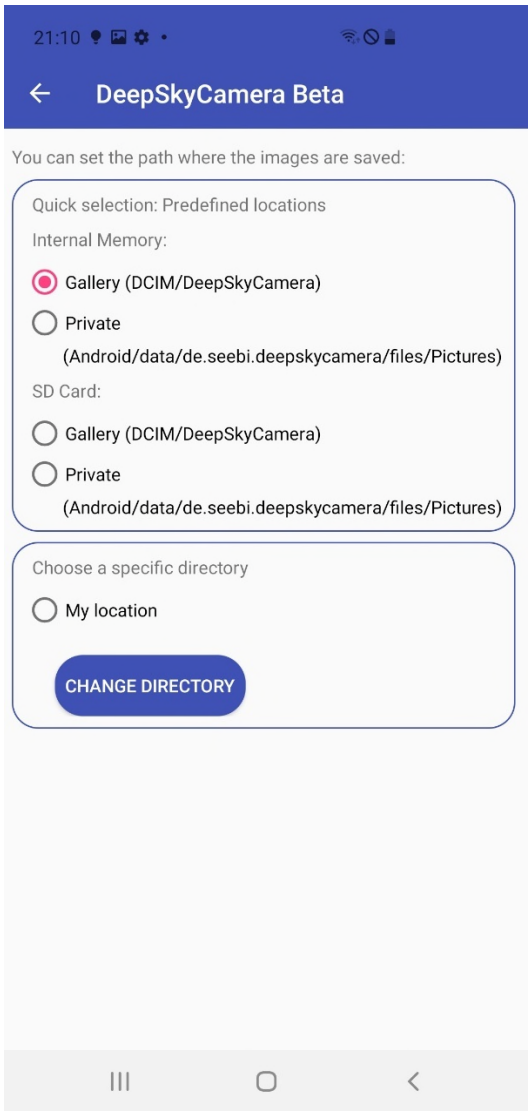
Write errors to log file

When this function is turned on, errors will be written into the log file. This is useful when you've detected a bug.

Note: Before you can activate this option you must turn "Logging" on.

Path to the images

This function sets the path to the images.



Since Android 11 default storage location is "Gallery":

`DCIM/DeepSkyCamera`

On Android 6 – 10 default storage location is so called private directory:

`Android/data/de.seebi.deepskycamera/files/Pictures`

This directory is sometimes hard to find. You can use an external file browser (f.i. FX File Explorer) or the internal file browser of DeepSkyCamera.

> **Note**: When you take images in JPEG format and storage location is "Gallery", the pictures will be added to the gallery. When you store the images in a different place then "Gallery", no images will be added to the gallery app. Don't worry they are saved on your device.

The page consist of two boxes. The first box contains predefined storage locations:

- Gallery (`DCIM/DeepSkyCamera`)
- Private (`Android/data/de.seebi.deepskycamera/files/Pictures`)

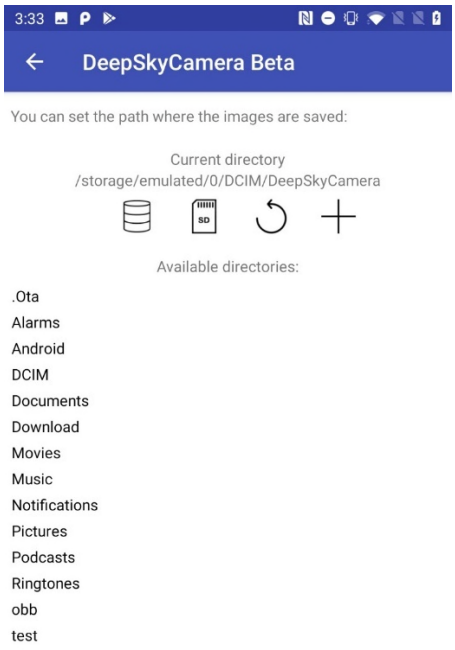
If you have a SD card installed you can set storage location to "Gallery" on SD card or to private directory on SD card.

Note: Section "SD card" is only visible when you have SD card installed. If you don’t have SD card in your phone the section "SD card" is NOT visible.

In the second box you can select or create any directory on your phone. Please note, however, that you may not have the appropriate read/write permissions in certain directories. This is not a bug in the app but is controlled by the rights management of the Android version on your smartphone. By tapping button "Change directory" a new page shows up, where you have the possibility to:

- Select an existing directory
- Create a new directory

Select “My location“ and you can use the “Change directory” button to select a different directory or create a new directory. To do this, tap the button and you will be taken to a new page.



The icons in detail:

By tapping first icon, app jumps always to the root directory of your device. If you want to set a directory to the current storage location of your images tap on the directory name (e.g. "Pictures"). The app opens the directory, and the choosen directory is automatically set as the new storage location. After that go back to "Settings" page via arrow button upper left corner!

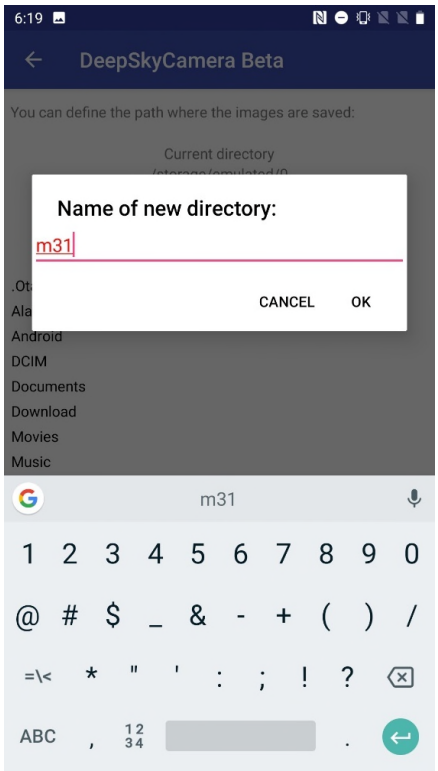
By tapping second icon the app opens the root directory of the SD card and shows a list with several directories. You can select another directory by tapping a directory name. But take care: it could be

possible that you do not have enough rights to write files on the SD card. The app tells you, when you have missing rights. In this case choose a different directory.

> **Note**: If you do not have a SD card installed, you will be redirected to the root directory of your internal memory.

By tapping this icon, you will always go one step back.

The fourth icon adds and creates a new directory on your internal memory or on your SD card. A new dialog appears, where you can enter a name for your new directory (e.g. "Moon", "Orion" etc.).



The created directory is automatically set as your storage location. Please go back via arrow button upper left corner.

> **Note**: The app tells you when you do not have the appropriate rights to create a directory. In this case choose a different parent directory.

Scoped Storage: Changes on Android 11 and higher

This chapter is only relevant to you when you are running Android 11 or higher. When you have Android 6 – 10 you can skrip this chapter. DeepSkyCamera Pro on Android 11 (or higher) implements so called "Scoped storage". This was a requirement set by Google and affects the visibility of directories on your device. This is part of privacy actions set by Google.

1. On Android 11 (or higher) lots of directories are forbidden/not visible to DeepSkyCamera, f.i. `Android`.

2. The default storage location (`Android/data/de.seebi.deepskycamera/files/Pictures`) is only visible to DeepSkyCamera. No other app can read/write the default storage location, maybe external file browsers can read it. DeepSkyCamera Pro's internal file browser can read/write this private directory but other apps can't.

3. The best storage location is one of the public directories like `DCIM` ("Gallery") or `Pictures`. Other apps like Gallery or file browsers can read/write these directories.

4. These are the public directories which are suitable for DeepSkyCamera:

`Documents, DCIM, Pictures, Download, Alarms, Audiobooks, Music, Podcasts, Ringtones, Movies, Notifications`

5. You can not create new directories at root level

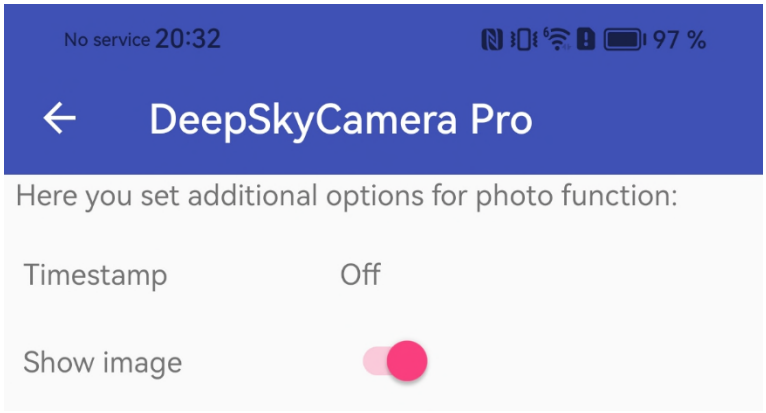
6. If you store on SD card you can do it also with Android 11 (or higher). But only these directories on SD card are allowed:

- private directory (`Android/data/de.seebi.deepskycamera/files/Pictures`)
- directory `DCIM`
- directory `Pictures`

Photo function

Here are the option for photo function:

- Timestamp
- Show image

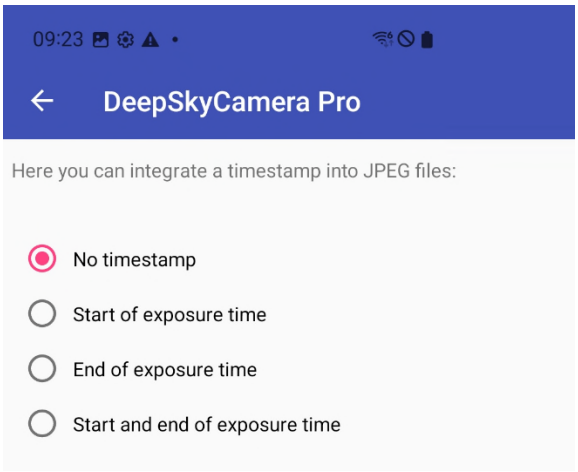


Timestamp

This feature allows you to add a timestamp to the bottom of the image. You can choose between the options:

- No timestamp (default)
- Start of exposure time
- End of exposure time
- Start and end of exposure time

The time stamp is in the millisecond range and is only integrated in JPEG files. RAW/DNG files remain untouched.

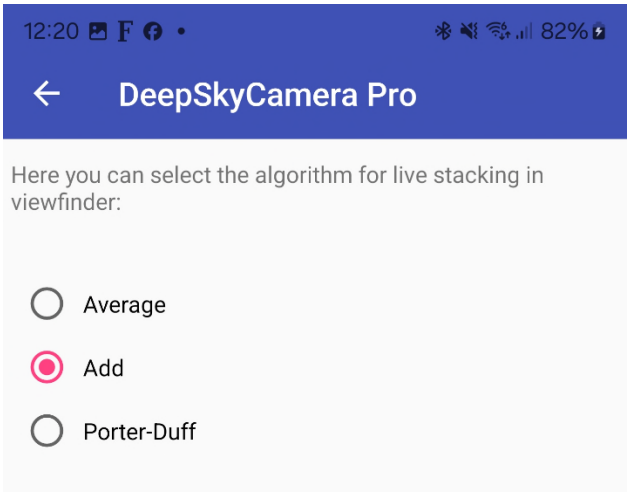


Show image

If its turned on (default is off) the image is shown on main screen after image is taken and saved to internal memory or SD card. This is great when you want to take a couple of test shots. You can immediately see on the screen if image is good or not good. And take care: don't use this option when you take lots of images (100, 500, 1000). App can crash after a random number of images because of heavy processing of the image. So use this function only to evaluate test shots. Turn option off when you start your imaging session.

Viewfinder live stacking

Here are the settings for viewfinder live stacking.



You can select three algorithms for preview live stacking:

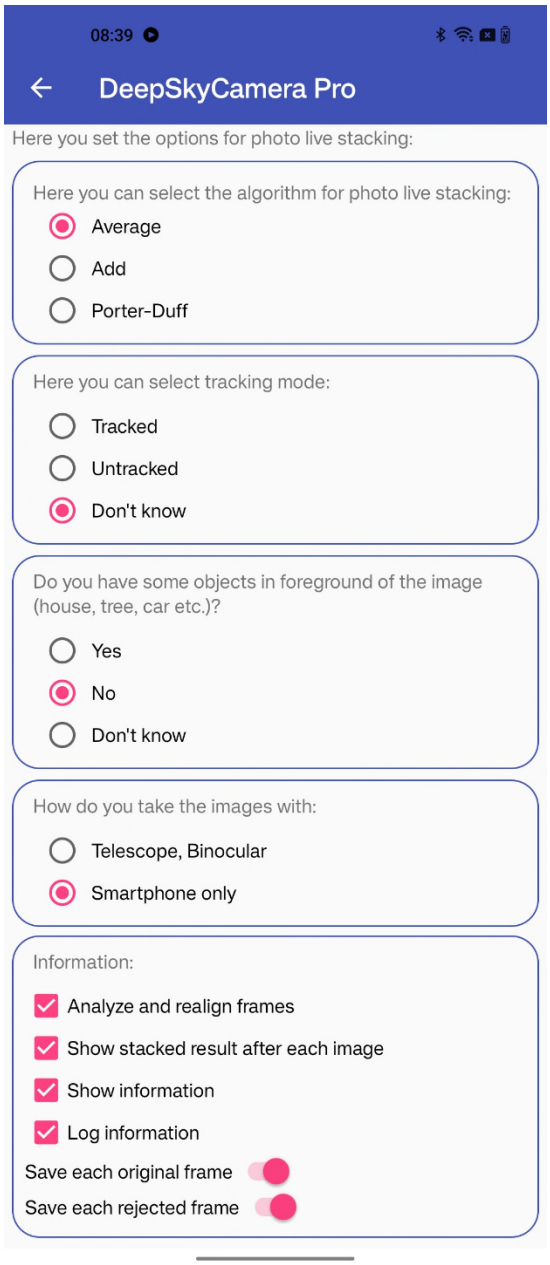
a. Average
b. Add (Default)
c. Porter-Duff

"Add" means that the same pixel from every frame is added. The result gets very quickly light. But thats very good for centering dark objects in telescope.

"Average" means the average of the same pixel in each frame.

"Porter-Duff" means the same as "Add" but its based on Porter-Duff algorithms and its faster than "Add". The result gets very quickly light.

Photo live stacking



There are a couple of settings available:

- Stacking algorithm
- Tracking mode
- Remove objects in foreground
- Take image with telescope or smartphone only
- Information about the stacked result

Algorithms

You can select three algorithms for photo live stacking:

a. Average (Default)
b. Add
c. Porter-Duff

Average means the average of the same pixel in each frame.
This is the best option and reduces noise but you need more images to work out the details.

Add means that the same pixel from every frame is added. But take care: the result gets very quickly light.

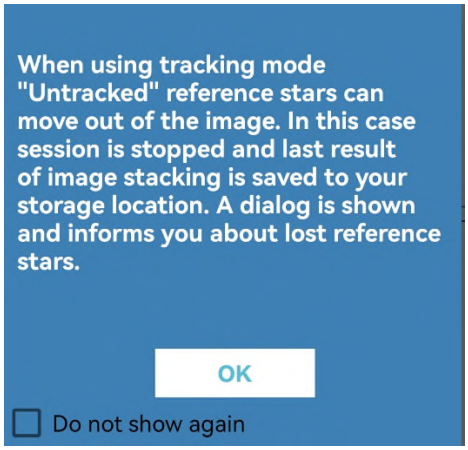
Porter-Duff means the same as "Add" but its based on Porter-Duff algorithms and its faster than "Add". But take care: the result gets very quickly light.

Tracking mode

DSC Pro can handle tracked and untracked images. In "Tracking mode" you can set explicitely the mode of tracking:

- tracked (with a motor or clock drive on a telescope mount, tracker etc.)
- untracked (phone without mount or tracker, no motor or clock drive. Phone only a atripod, table etc.)
- Don't know: If you are not sure select this option, this is default. This tracking mode handles both tracked and untracke dimages.

When you select "Untracked" you'll get a dialog which tells you that reference stars from first frame can move out of the image (because phone does not follow the movement of the stars).



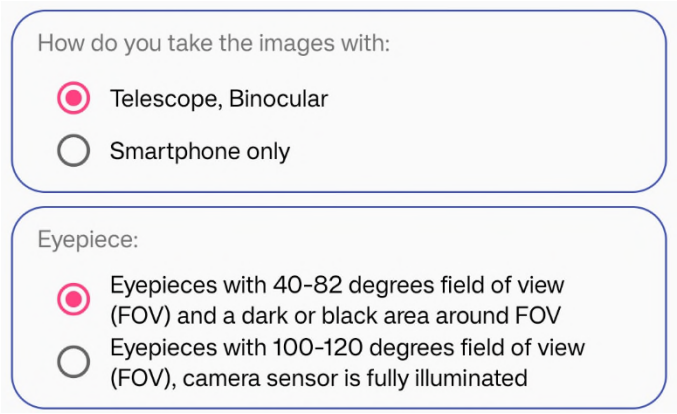
The same dialog appears when you start photo live stacking. When refrence stars moved out of the image photo live stacking is stopped and a dialog appears on screen which tells you that stars are moved out of the images. The last stacked result image is saved and you can get it in your storage location.

Foreground

This function helps you to remove object in foregrounds. They are not removed from stacked result. They are only removed during analyzing step. Turn this function on when stacking fails and try it again. Its not guaranteed that stacking will not fail but in lots of cases it will work.
The objects should be at the edges and not in the center of the image. Please check chapter "Hints on photo live stacking" to see which are good or bad examples for stacking purposes.

Take image with telescope, binocluar or smartphone only

This setting tells DSC Pro how you take the pictures: with a smartphone and a telescope or just with the smartphone without telescope. The default is "Smartphone only". That means that you take the images with smartphone only.



When you take the images with a telescope or binocular switch to "Telescope, Binocular". A new setting appears below. Here you specify the eyepiece you are using. If it is an eyepiece with 40 to 82 degrees, then you have a smaller field of view and a dark area appears around the field of view because the camera sensor is not completely illuminated. This setting prevents so-called hot pixels from being detected in the black area during live stacking in RAW or JPEG. If, on the other hand, you have an eyepiece with a 100 degree field of view (or higher), select the second option. Here the camera sensor is completely illuminated by the field of view and there is no black area around the field of view.

Information

The information settings are optional. You can disable analyzing and alignment of images. It should be turned on, also when you have a telescope mount or a tracker. You can disable/enable stacking information on the screen and log information are saved in DSC log file.

Option "Show stacked result after each image" is turned on by default and shows stacked image result after each image on the screen. You can disable it and the stacked result is not shown. When you deactivate this option information about the stacked image can not be shown on the screen and option "Show information" can not be activated/deactived.

In case you want to stack later or with other stacking software you can check the option "Save each original frame" which saves each images in your defined storage loaction. Also when a frame is rejected (due to minor clouds etc.) the frame can be rejected. This option saves the rejected frame for later use.

> **Note**: If you want to stack daylight images you must deactivate option "Analyze and align frames". Because daylight images do not contain stars photo live stacking will probabaly fail when the option is turned on. There could be too much white pixels in the image. Thats why you must turn off the option.

Warning and stop when memory is low

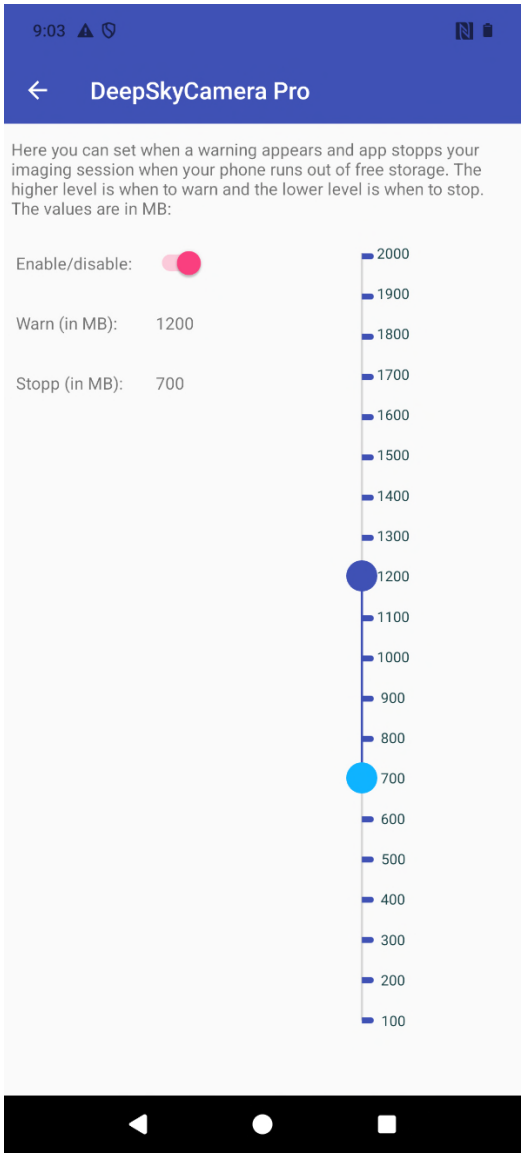
This function warns you when the free memory on your phone is running low. This function can also be used to stop the imaging session. You can set the values yourself for when the warning is given and when the recording is stopped.

On this page, you can generally switch the function on or off. When it is switched on, you can set the values yourself using two sliders on the scale. The upper slider indicates when the warning starts. The lower slider indicates the value at which the imaging session is stopped. The default values are: a warning is given at 500 MB and the recording session is stopped at 100 MB.

When moving the sliders, please note that the value for stopping can never be greater than the value for warning. The reverse is also true: the value for warning can never be less than the value for

stopping. The value for warning must always be greater than (or equal to) the value for stopping. You can set warning and stopping to the same value. However, this makes little sense.

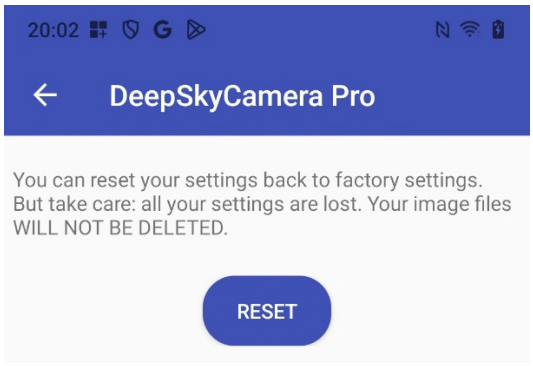
When the value for stopping is reached, the app ends the imaging session. The app displays a dialogue box for this. If you have activated the ‘Exit’ option in ‘Actions’, the app will then be closed.



Reset settings

This function resets app to factory settings. All settings are resetted, f.i. ISO, shutter speed, path to the images etc.

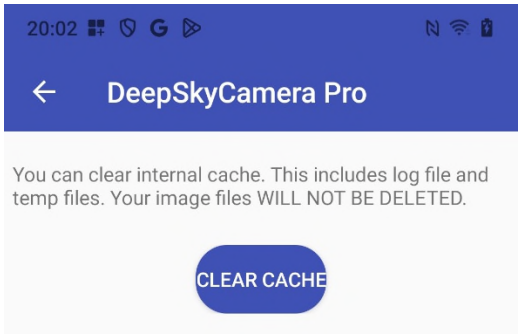
Note: Your images won’t be deleted.



Clear cache

This function clears internal cache of the app. When you use photo live stacking lots of temporarily data and files are saved to internal cache. This functions erases cache. After the operation you'll get more disk space. When you use RAW photo live stacking several GB disk space can be consumed by DSC Pro – it depends on file size of each DNG. file When you use JPEG photo live stacking the size of a file is much more smaller. But there can be lots of temporarily files in internal DSC cache. The advice is to clear cache after a couple of imaging sessions. The function deletes also log file.

Note: Your images won't be deleted.



Info

This lists some technical information about the first camera sensor on the back of your device.

Supported devices

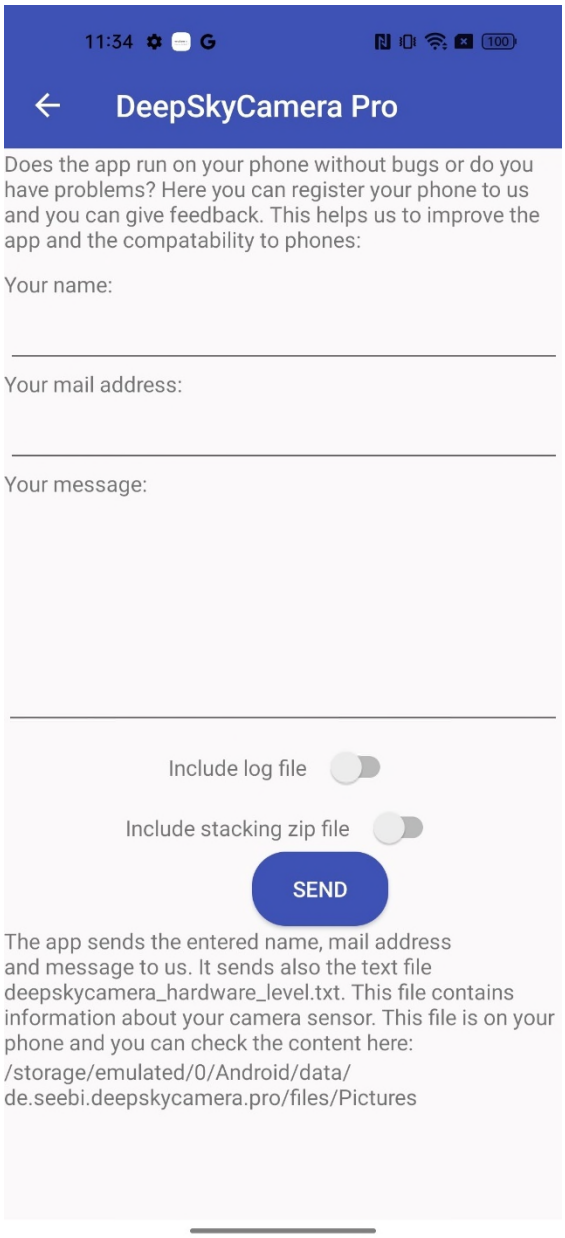
A listing of supported devices. The app runs fine on the listed devices. The list will be updated all the time. To have the actual information of listed devices, drag from top to bottom.

Select a phone name to see the technical details. Important for astrophotography is a device with a high value for exposure time (30 sec, 35 sec etc.).

> **Note**: If your phone is not in the list and the app runs fine anyway, please report your device to the developer, tapping "Report your phone" in the menu of the app.

Report your phone

You can send technical data of your device and comments, questions, problems etc. It's a communication channel to the developer. It helps to improve the app!!!



You can send anonymously. Name and mail address are optional.

The function "Report your device" sends the file *deepskycamera_hardware_level.txt* to the developer. The txt file contains technical data about the camera sensors of your phone. On Android 6 to 10 file is stored on your device in the same directory where your images are stored. On Android 11 or higher log file stored in private directory *Android/data/de.seebi.deepskycamera/files/Pictures*. The file is generated by the app during startup and contains definitely no personal data. The file is necessary for the developer, to get the data about the camera sensors. This helps a lot, when reporting and fixing a bug.

The option "Include log file" adds log file to the message. This is also very helpful when fixing bugs. If log file is disabled no log file is added to the message. You can enable or disable log file on "Settings" page of the app.

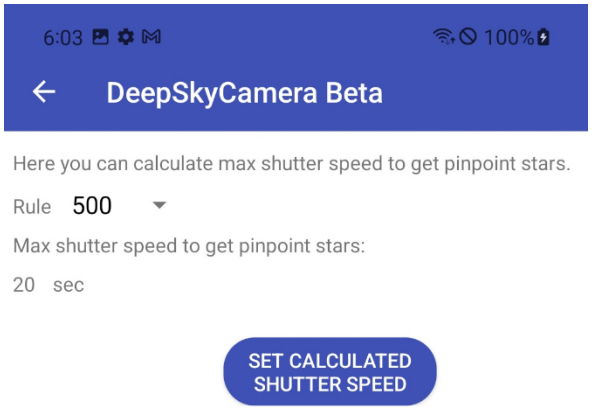
The option "Include stacking zip file" adds your stacking data to the message and sends it to developer. This is also very helpful when you have problems with photo live stacking and your stacking sessions fails. Developer receives the data and analyze the data.

Tools

Tools menu entry contains helpful tools.

Calculator pinpoint stars

If you don't have a telescope mount or tracking, you can calculate here what the maximum exposure time is for the camera sensor so that the stars remain pintpoint stars.



There are several formulas that can be used to calculate this. The app implements four formulas that you can choose from:

- 300 rule
- 400 rule
- 500 rule
- 600 rule

The 500 rule is a good average and works in many cases. The maximum exposure time is usually between 14 and 21 seconds.

By tapping “Set calculated shutter speed” button, the app sets the calculated time on the main page – you can start right away. However, you have to be careful - especially with phones that only offer a short exposure time (e.g. 1 sec). The calculator calculates the maximum possible exposure time of the camera sensor with the given focal length in order for the stars to remain point-like, but if your phone doesn't support this exposure time, you can't use this value - you then have to go to the maximum exposure time.

If you find that the stars do show slight star trails or an egg shape, use the 400 rule or 300 rule, which calculates a slightly lower maximum exposure time.

> **Note**: The calculated exposure time is not set on legacy devices, since only "Auto" exposure time exists there.

View log file

This function displays log file.

You can delete content of log file by tapping on trash icon

This deletes the content of log file not log file itself. If you don’t need log file please disable log file in "Settings" menu entry or delete the content from time to time. Otherwise log file gets bigger and bigger and can slow down the app.

Note: Page is empty when log file is disabled in "Settings" menu entry.

Help

This menu entry contains some help functions:

- Hints: hints about general use
- Focus help: a description how to focus manually. The page contains a table with focus values for infinity on various devices. If your device is not on the list, you must do experiments on your own to figure out what the best focus value for your device is. The stars must be pinpoint stars.
  If you have figured out the value of your device and your device is not listed, please report the value to the developer. He will add the value and the phone to the focus table.
- Tutorial: Link to the web site.
- New in this version: History of changes.

About

Information about the app.

Manual

The manual is available in PDF:

By tapping the PDF logo, the app downloads the latest manual from the server as a PDF file. **Here, you need an internet connection.**

YouTube

By tapping the YouTub logo, the app opens the YouTube app or the website and shows the YouTube channel "DeepSkyCamera". The channel is open to the public.

Facebook

By tapping the Facebook logo, the app opens the Facebook app or the website and opens the Facebook group "DeepSkyCamera". You need a Facebook account to view the content of the group. You can post your images, ask questions etc.

Instagram

By tapping Instagram logo, the app opens the Instagram app or the website and shows #deepskycamera. You need an Instagram account to view the content of the hashtag.

Privacy policy

The privacy statement.

Exit

This exits the app. If you don’t use the app, please exit the app, otherwise the app runs in the background and consumes energy from your battery.

10. Changelog manual

14.11.2025 Version 1.1.0

New chapter "Supported smartphones and increased max exposure times"

New chapter "Camera sensors"

New chapter "Stacking of non-tracked images in the telescope"

Revised chapter ‘Warning and stop when memory is low’ by expanding the functionality

26.09.2025 Version 1.0.5

New section "Moon in the image" in the chapter "Important information about Photo Live Stacking".

New image and note on 100-degree eyepiece in "Eyepiece (on telescope or binoculars)" in the chapter "Important information about Photo Live Stacking".

New section "Warning and stop when memory space is low" in Chapter 9, replacing the previous chapter "Warning and stop when 100 MB or less of free memory space is available".

31.07.2025 Version 1.0.4

New section "Samsung SPen" in chapter 6.

31.05.2025 Version 1.0.3

New chapters "Reset app" and "Clear cache" in chapter 9.
Notes in chapters "Internal file browser", "Star trails", "Animated star trails" and "Timelapse" regarding selection of multiple files at once by pressing and holding the file name.
Minor changes

21.03.2025 Version 1.0.2

New chapter "Warn and stop when 100MB or less of free storage" in chapter 9.
Minor changes

31.01.2025 Version 1.0.1

New chapter "When photo live stacking fails".
Chapter "Path to the images" rewritten.
Chapter 7 "Internal file browser" rewritten.
A couple of illustrations in the book are updated due to the new icon based function bar

11. Versions of DSC Pro

14.11.2025 Version 1.1.0

Switch between camera sensors (if permitted by the smartphone and third-party camera apps). All functions (Photo Live Stacking, etc.) are available.
App and manual in Polish
Google Pixel 10 and 10 Pro Fold: 19 seconds maximum exposure time on all camera sensors
Google Pixel 10 Pro and 10 Pro XL: 47 seconds maximum exposure time on camera sensors 0 and 2. 30 seconds on camera sensors 3 and 4
Samsung Galaxy XCover 7 (SM-G556B): 20 seconds maximum exposure time
OnePlus Nord 4 with 30 seconds maximum exposure time
Samsung A15 (SM-A156) with 20 seconds maximum exposure time
Bug fix Samsung A36 (SM-A366): DNGs were only black in the internal file browser, this has been fixed
Bug fix Oppo Find X3 Pro: images were blurred from the second image onwards, fixed
Bug fix Samsung S23 FE and S24 FE: green tint in images when WB is set to AUTO, fixed
Bug fix Motorola G85: long exposure times now work.
Bug fix Oppo A57s: Support for Android 13 to 15.
Bug fix Sony Xperia 1 VI: The app hung after the first image, fixed.
Bug fix Crosscall Action-X5: App hung at the end of the second image when shooting in RAW, fixed.
Bug fix Samsung S21 models with Exynos: files were double saved. When using type DARK+BIAS shutter speed of Bias frames in Exif data was wrong. This has been fixed.
Bug fix Samsung S6-8, Note5-8: App crashed when shutter speed or ISO of viewfinder was set to Auto. This has been fixed

30.09.2025 Version 1.0.5

The values for warning and stopping when storage space is running low is now customizable.
Oppo A58: 70 sec max exposure time instead of 16 sec.
OnePlus 11R: 75 sec max exposure time.
Samsung Tab S10 Plus (SM-X820): 170 sec max exposure time.
Vivo V40, V29: 32 sec max exposure time instead of 8 sec.
Full support for Fairphone 6.
Bug fix Samsung A55: Imaging session hung when the viewfinder exposure time was set to 1 sec. Fixed.
Bug fix Samsung A55: Images had a green tint under certain conditions. Fixed.
Bug fix Samsung Tab S10 Ultra, Plus and Tab S7 Plus: The sliders did not change the values for ISO, white balance, etc. Fixed.
Bug fix Samsung Flip 7: App hung during photo function, live star trails, viewfinder live stacking and photo live stacking when shooting in JPEG only. Fixed.
Bug fix Samsung Fold 7: App switched camera sensors. Fixed.
Bug fix Pixel 7 and higher: App did not exit at the end of the imaging session, even though the corresponding option was set. Fixed.
Bug fix Samsung Tab S10 FE + and S10 FE.
Bug fix Motorola Edge 50 Pro and Motorola G75: App froze during imaging session after the first image. Fixed.
Bug fix Motorola Edge 30 Ultra: Not all exposure times work, only the fixed predefined values in seconds: 32, 16, 12, 8, 6, 4, 3, 2, 1, 1/2, 1/3, etc.

Adaptation of the app to Android 16 (API level 36) and conversion of the app to 16 kB page size for all libraries used (libraw, libtiff, opencv, jpeglib, libz, etc.).

31.07.2025 Version 1.0.4

App and manual now also available in German
Support for Samsung SPen: this can be used to start and stop the imaging session, similar to an external Bluetooth controller
From now on, up to 1 million images can be captured in a series – the maximum limit of 9999 images no longer applies to the Pro version, only to DSC Free.
Samsung A36: 52 sec max exposure time
Samsung M35: App adapted to the device and 54 sec max exposure time
OnePlus 13R: 75 sec max exposure time
Bug fix: Sony Xperia 1/5/10: ISO bug fixed
Bug fix: Samsung A55, A25 5G, S24 (and higher) with model number U1 (US models)

31.05.2025 Version 1.0.3

New 'Reset app' function. This allows the app settings to be reset to factory settings.
New 'Clear cache' function. This deletes the app's internal cache and also resets the log file.By long-tapping a file name in functions timelapse, star trails, animated star trails and deleting files in the internal file browser will now select all files above it.
Additional interval times: 180 sec, 240 sec, 300 sec.
Full support for ZTE Nubia devices with Unisoc, realmeC67, realme 12 Lite
Honor Magic V3: 38 sec max exposure time
ZTE Nubia Focus 5G: 57 sec max exposure time
OnePlus 10T: 89 sec max exposure time
Higher ISO values for realme 9 Pro, Xiaomi Poco F5, Oppo A72
Bug fix: On realme C67 and Xiaomi Redmi Note 13 (only 23129RA5FL), some DNG files were displayed as black in the internal file browser. This has been fixed.
Bug fix: In the timelapse and animated star trails functions, the video files were sometimes not copied correctly at the end and were therefore corrupted. This has been fixed. Similarly, the alignment of the videos was sometimes incorrect.This has also been fixed.
Bug fix: Honor Magic V3, Samsung S6/S7/S8/Note 5, Moto G 5G - 2024, Xiaomi 11T, Motorola Razr Plus 2024
Bug fix: internal file browser, display of the default icon when no images are available.
App adapted to Android 15 (API Level 35)

21.03.2025 Version 1.0.2

New function: App warns when phone is running out of free disk space and stopps imaging session
Full support of Huawei Pura 70 models
Huawei Pura 70 models: 190 sec max shutter speed
Samsung S24 Ultra/S24 Plus/S24 with Qualcomm: DNG bug fixed (but NOT on Exynos!)
Samsung M14 (SM-M145F): 52 sec max exposure time
Full support of Motorola Edge 40 Pro
Motorola Edge 40 Pro: 51 sec max shutter speed
Bugfix: deleting files in internal file browser marked too much files, fixed
Bugfix Xioami Mi Pad 6, Xiaomi Poco X6 Pro, Oppo Reno 11 Pro, Samsung S25 Ultra: Slider didn\'t work, fixed
Bugfix: On some devices JPEG files were not rotated (f.i. Samsung A71 5G), fixed
New prefix "DSC" in customized file name pattern

31.01.2025 Version 1.0.1

Samsung S25 Ultra, S25 Plus, S25: 600 sec max shutter speed
Samsung S24 FE (SM-S721): 51 sec max exposure time
Samsung A06 (SM-A065): 30 sec max exposure time
Samsung A13 (SM-A137): 20 sec max exposure time
Samsung A15 (SM-A155): 25 sec max exposure time
Samsung A16 (SM-A165): 20 sec max exposure time
Samsung M15 (SM-M156): 20 sec max exposure time
Samsung M44 (Galaxy Jump 3): 600 sec max exposure time
Samsung M54 (SM-M546): 30 sec max exposure time
Black Shark 4 Pro: 51 sec max exposure time (instead of 1 sec)
realme C55: 60 sec max exposure time
Sharp Aquos R7s: 30 sec max exposure time (instead of 10 sec)
New icons for the functions
Bugfix: The case of the file extension is now taken into account for time lapse, star trails and animated star trails
Bugfix: Oppo Find X3 Neo, Find X2 pro: DNGs are now generated correctly and the app is adapted to the models
Bugfix: DSC Pro has been adapted to OnePlus 8 Pro, Nord 10.
Bugfix: Google Pixel 7 and higher: Preview Live Stacking crashed, has been fixed.
Bugfix: Xiaomi Redmi Note 13, only for the models: 23129RA5FL and 23129RAA4G.
Bugfix: Samsung S21 models: Exynos (NOT: Qualcomm): Green tint in stacked TIFF file has been fixed

02.12.2024 Version 1.0.0

Initial release with these functions:
Photo live stacking in RAW and JPEG up to max 9999 images from tracked and non-tracked images
Preview live stacking to enable longer exposure times of up to 10 seconds of viewfinder
Live star trails
Star trails of existing images
Animated star trail videos (mp4)
Timelapse videos (mp4)
Every function from DSC Free