Color index of digital meteors

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A few numbers to begin with.

20,000,000

number of single station meteors

10,000

number of acquired spectra

0

number of meteorites from meteor showers

How do we recognize meteor showers?

When studying meteor showers, we try to get as much information as possible. It started with photographic research in the 1960s and today we are witnessing an overflow of data from hundreds of stations around the world. With these data, we have a good informations about meteor showers, especially their dynamics and the movement of the particles that make them up.

Unfortunately, these data tell us little about the composition of these particles. Today, we obtain this information only from spectra, which, however, only cover the area of larger particles. Although photometric data on recorded meteors give us an idea of their size, they say nothing about the composition of these particles.

So, do we have any other option?

YES!

Let's try using information about

the color of meteors.

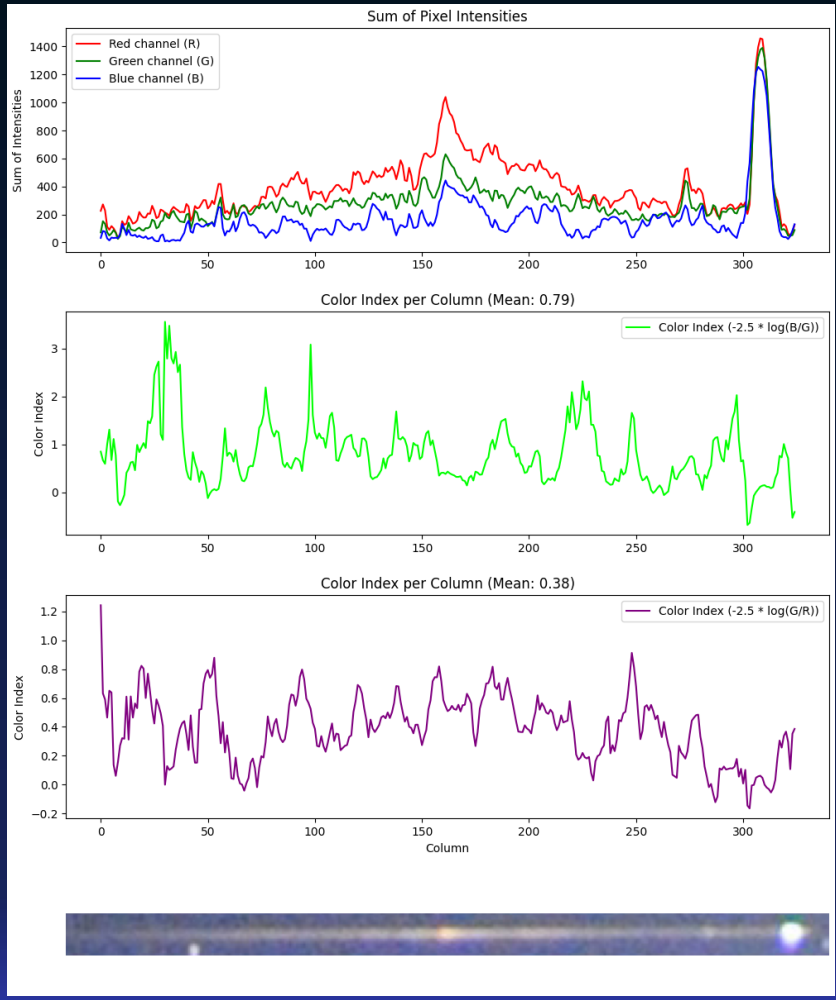
Determination of "color index"

This discipline dates back to the golden age of visual observations of meteor showers. However, the definition of that index varies in different older works, and new works on this topic are not increasing much. I therefore decided to try to process colored meteors photographed over the course of 15 years with one camera and one lens using the method I presented at IMC two years ago in Hungary.

Here are some samples...

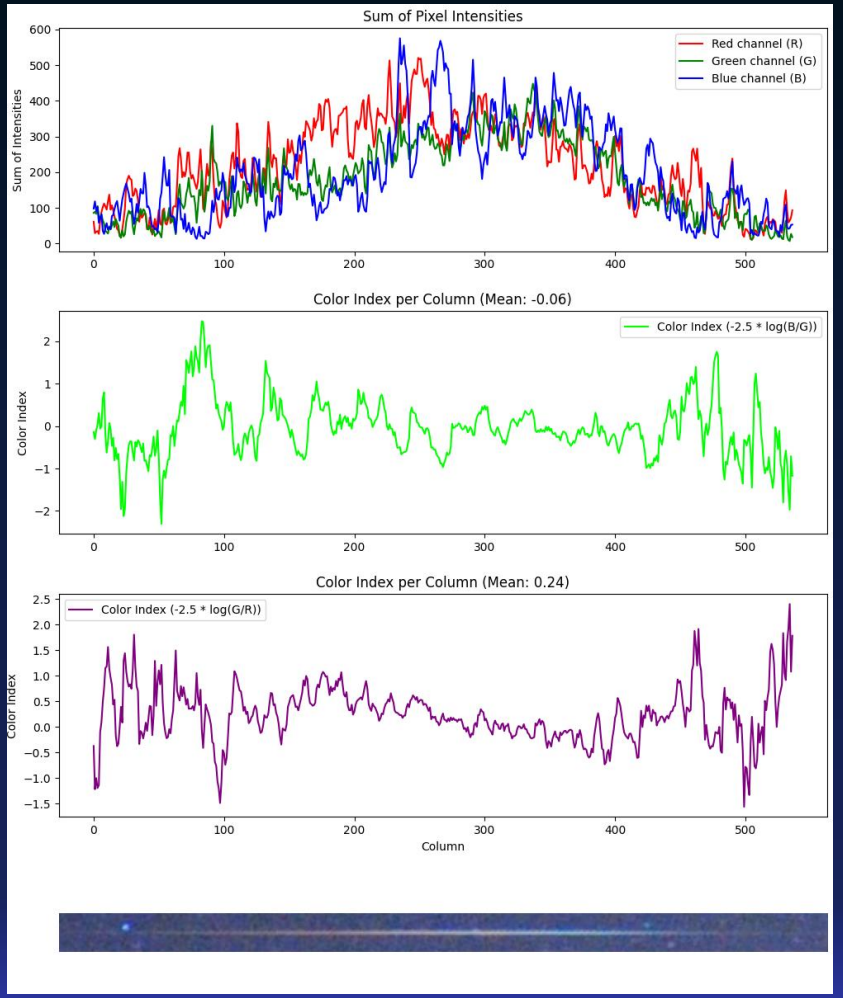
Dra_20111008_220136

Nikon D300 @ ISO 2500
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 8s
Bettola, Italy



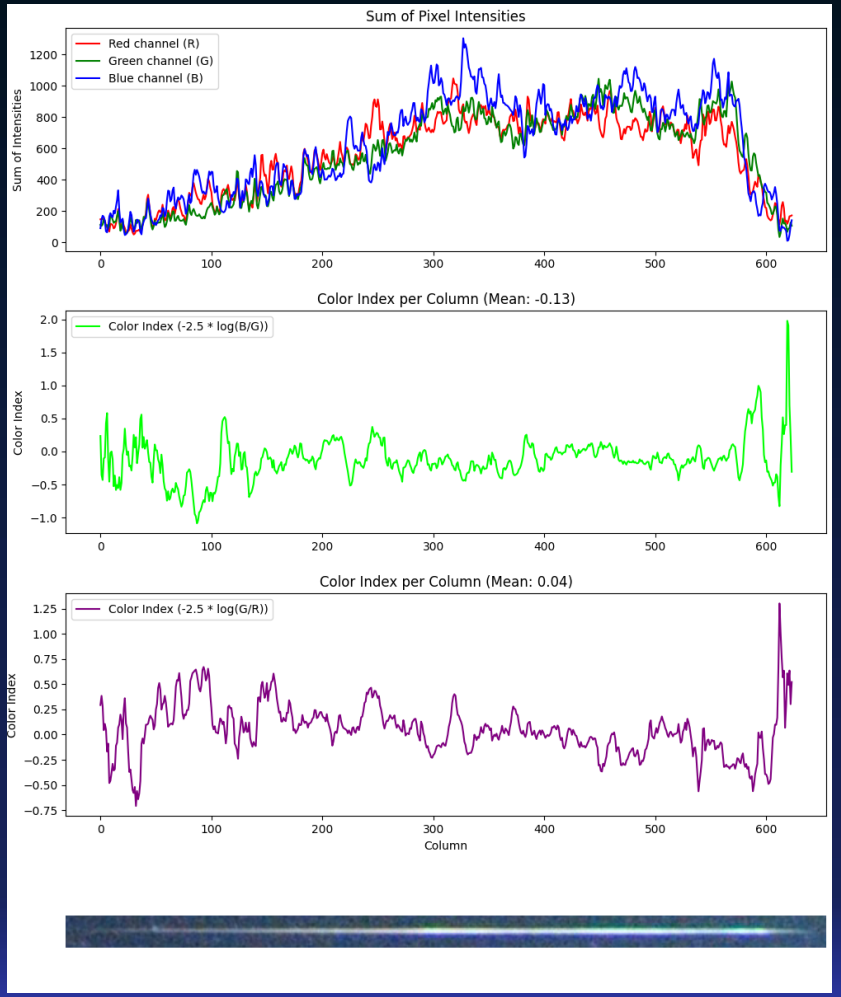
Dra_20111008_230032

Nikon D300 @ ISO 2500
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 8s
Bettola, Italy



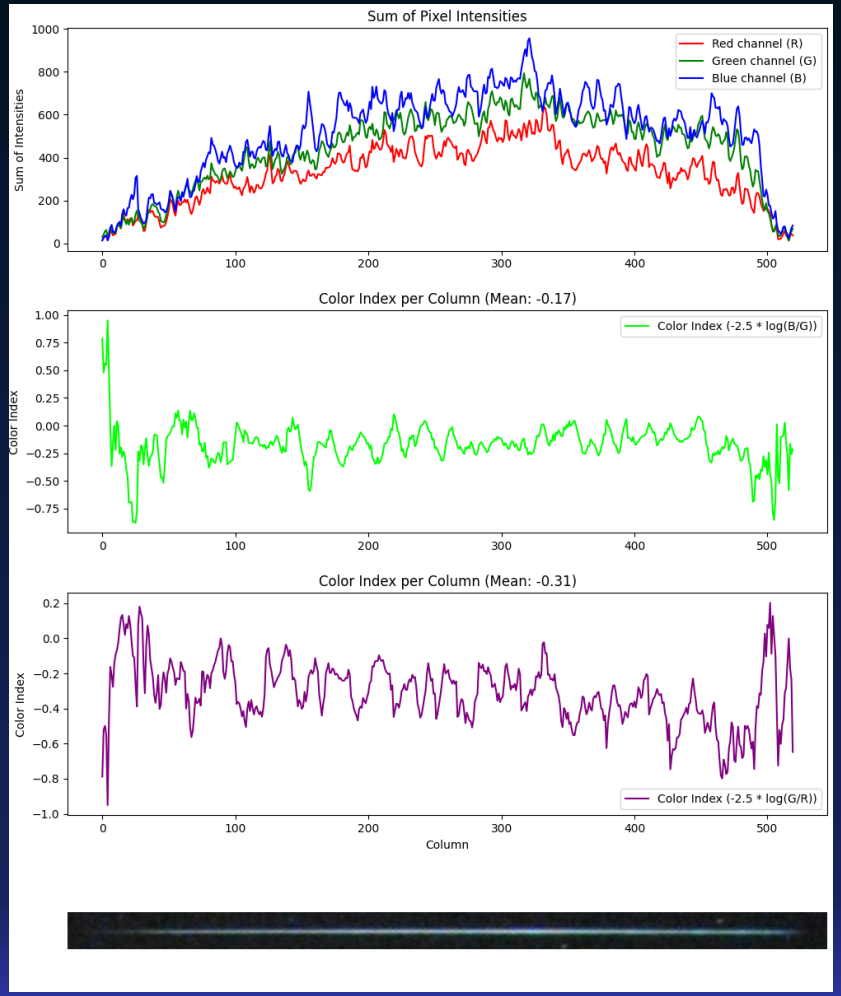
Gem_20121214_044511

Nikon D300 @ ISO 1600
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 8s
Donovaly, Slovakia



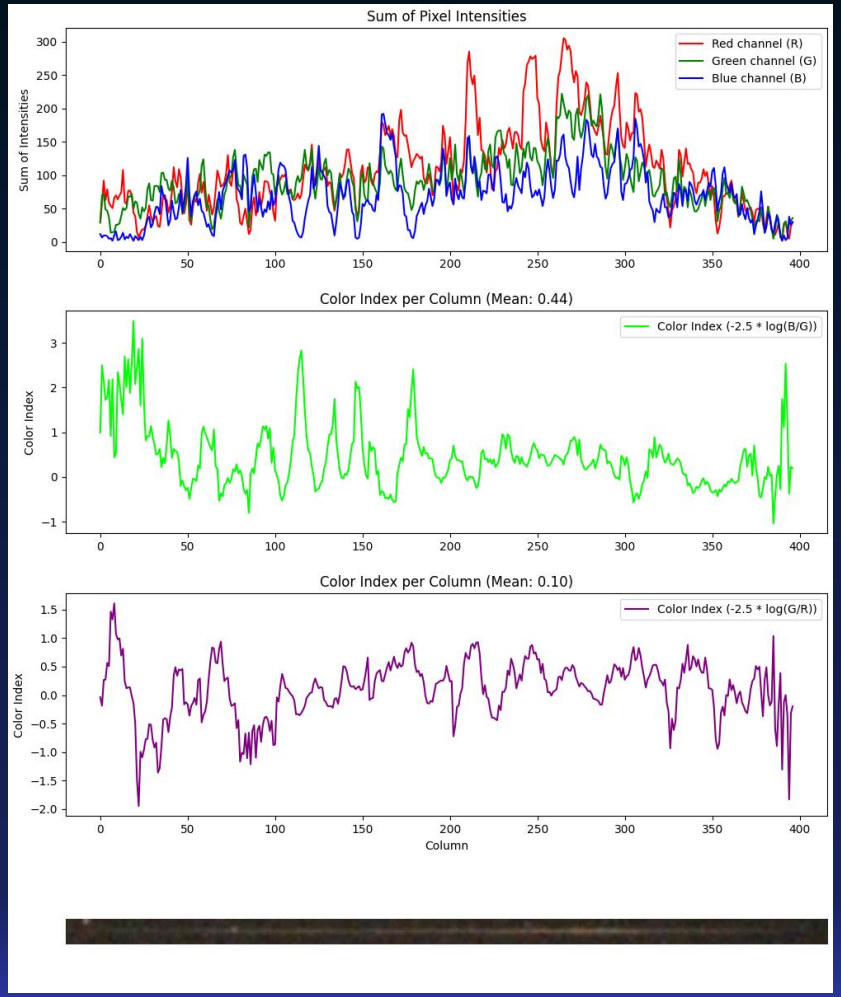
Gem_20151213_230114

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 11/2.8
exposure 8s
Boleráz, Slovakia



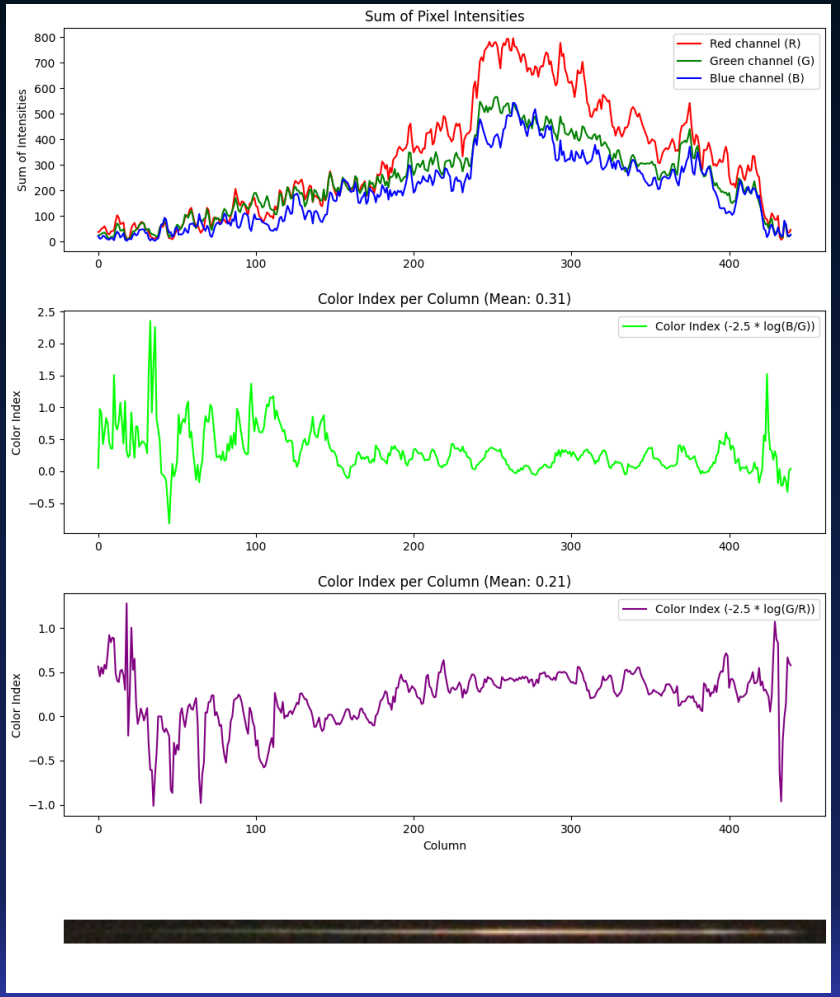
Lyr_20150422_233750

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 8s
Dunajská Lužná, Slovakia



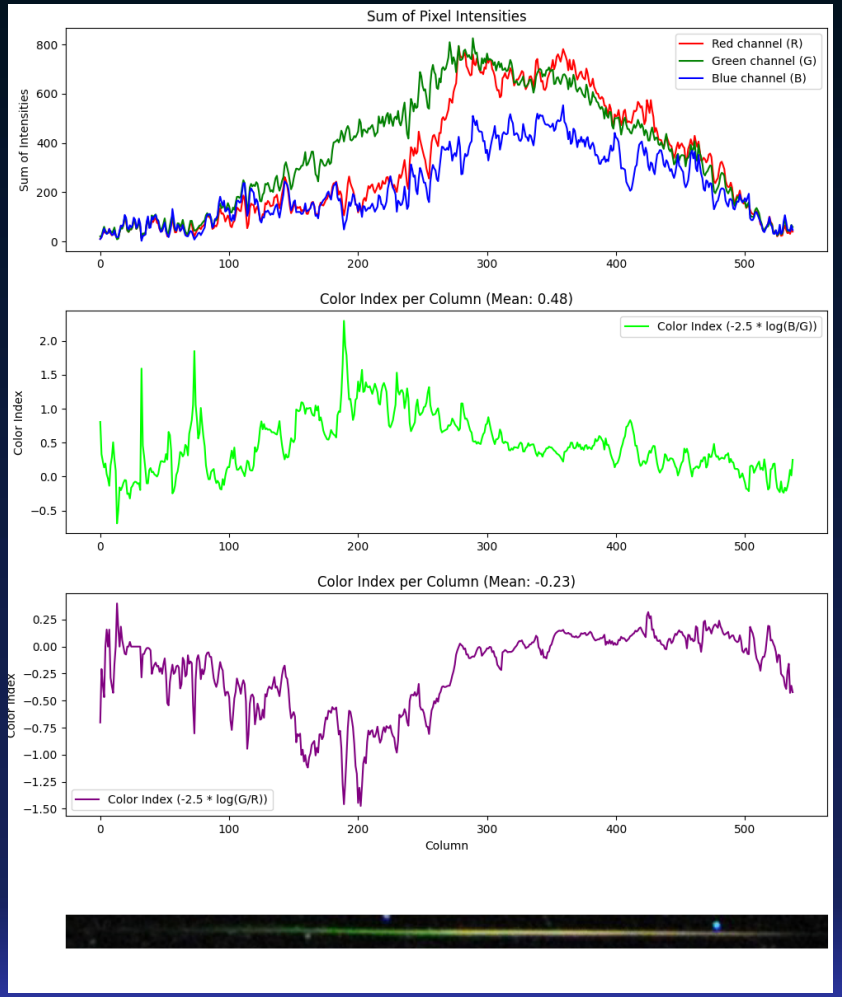
Lyr_20150423_014005

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 8s
Dunajská Lužná, Slovakia



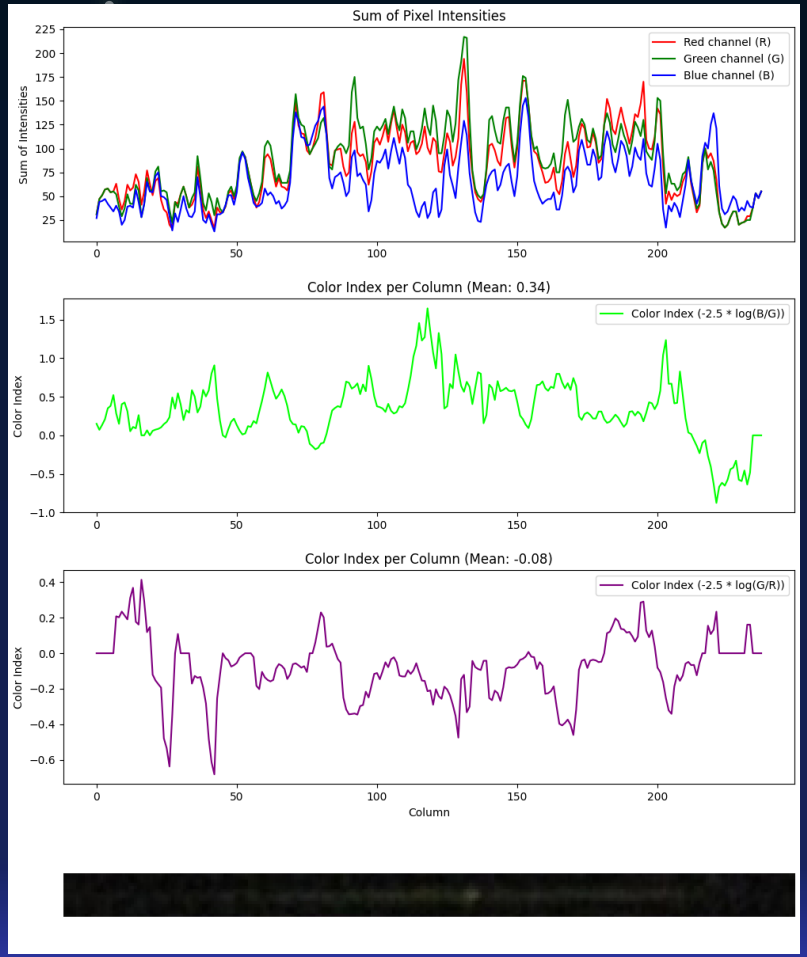
Ori_20221023_014528

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 14/2.8
exposure 9s
Látky, Slovakia



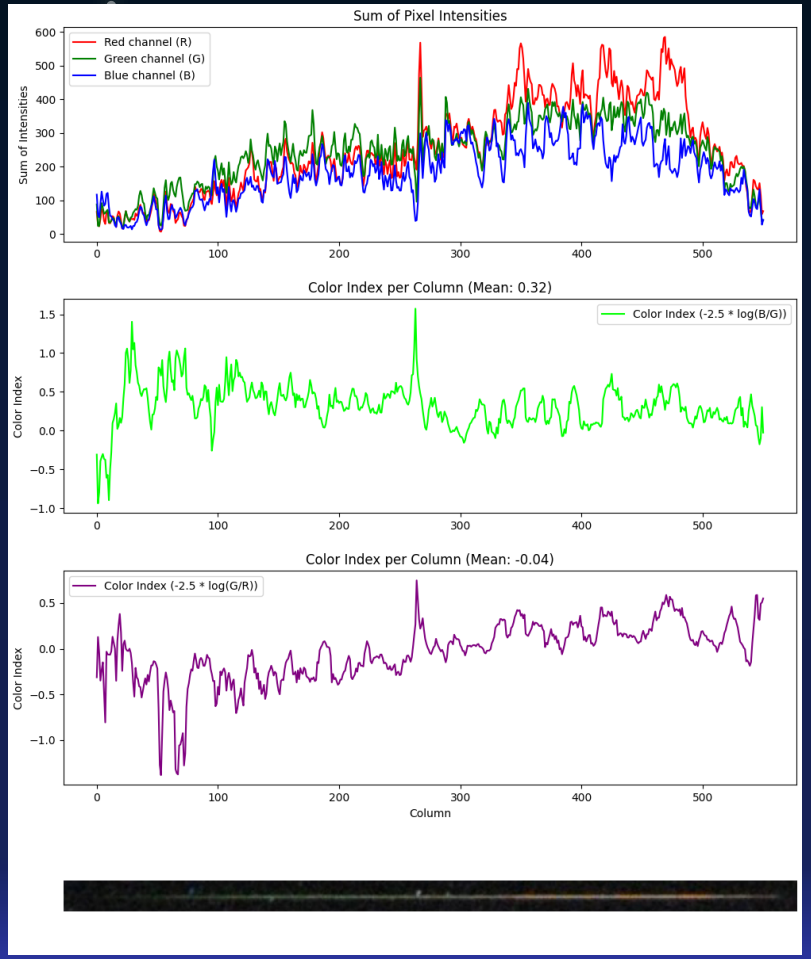
Ori_20221023_042018

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 14/2.8
exposure 9s
Látky, Slovakia



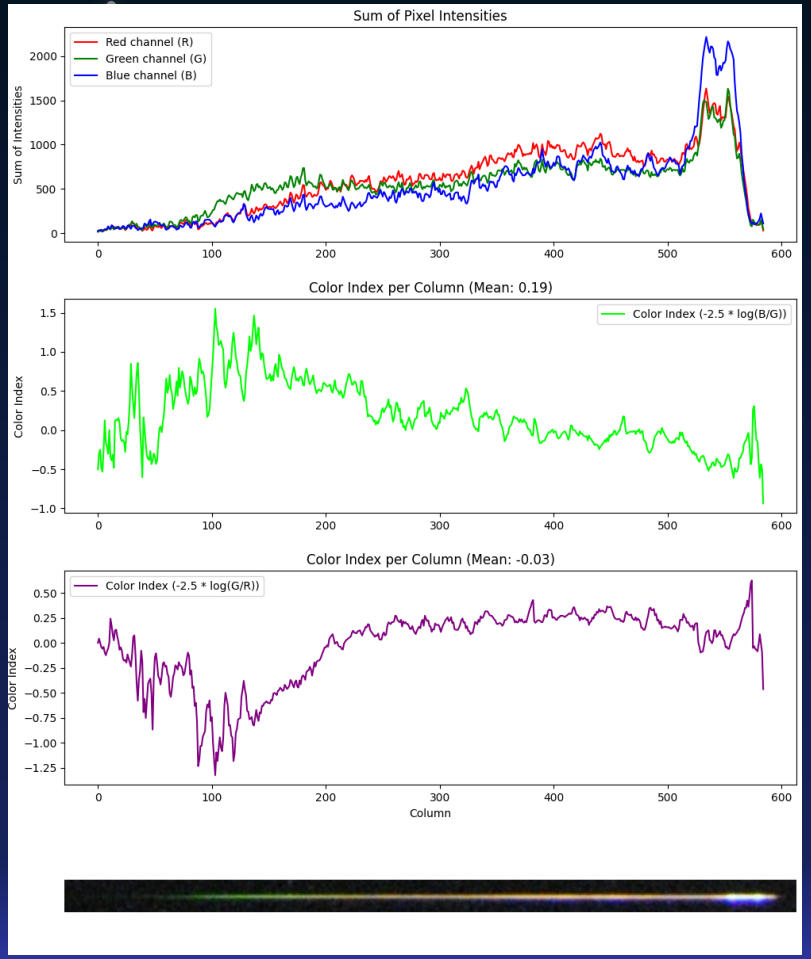
Per_20240810_234100

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



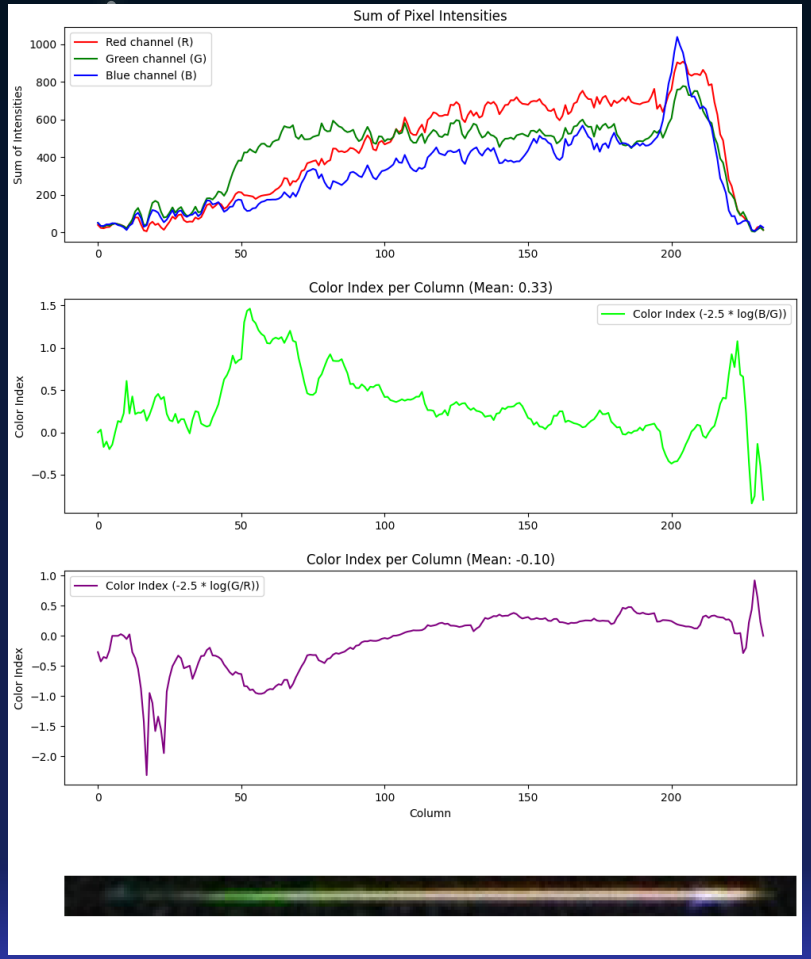
Per_20240810_234100

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



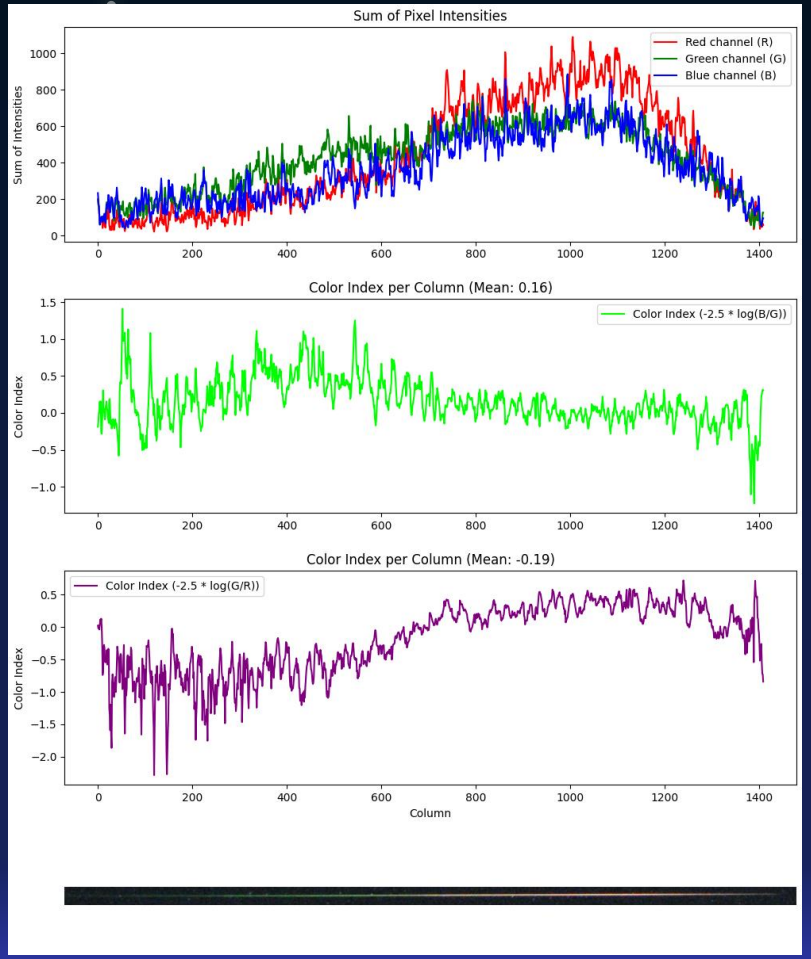
Per_20240811_030549

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



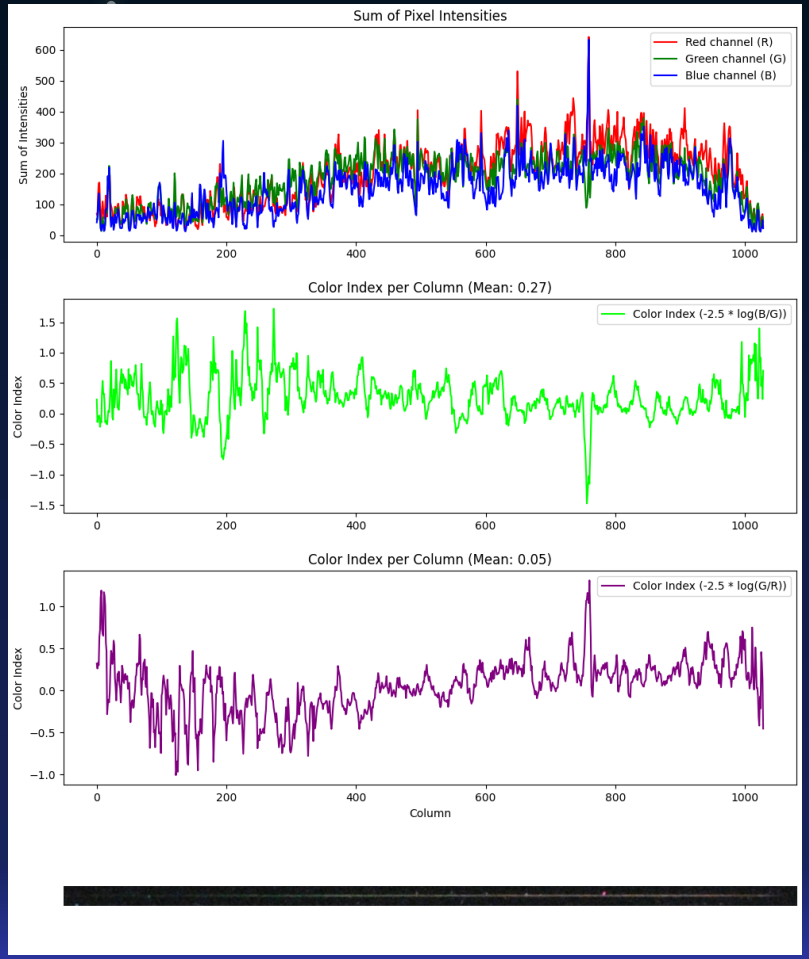
Per_20240811_215712

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



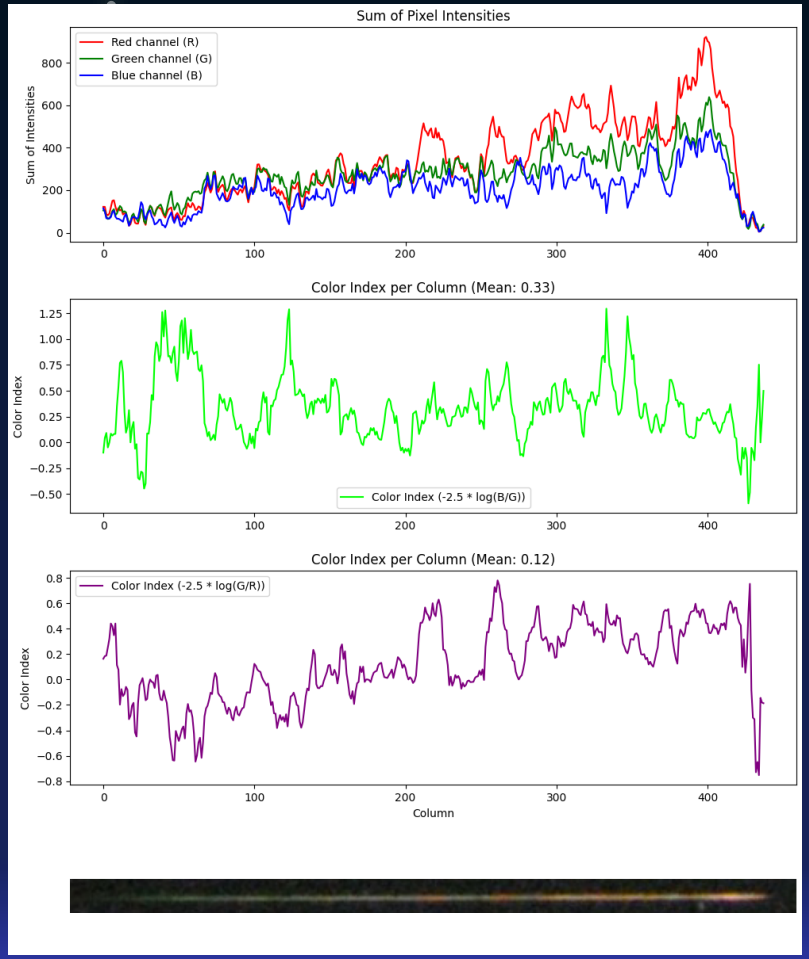
Per_20240811_220552

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



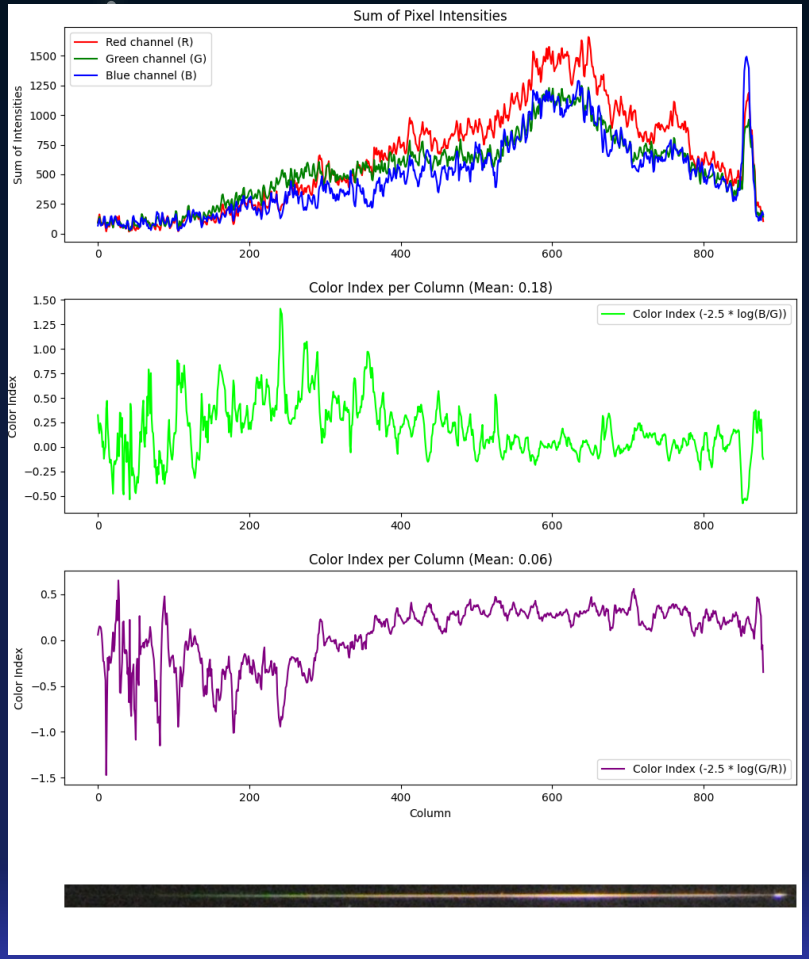
Per_20240812_00055

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



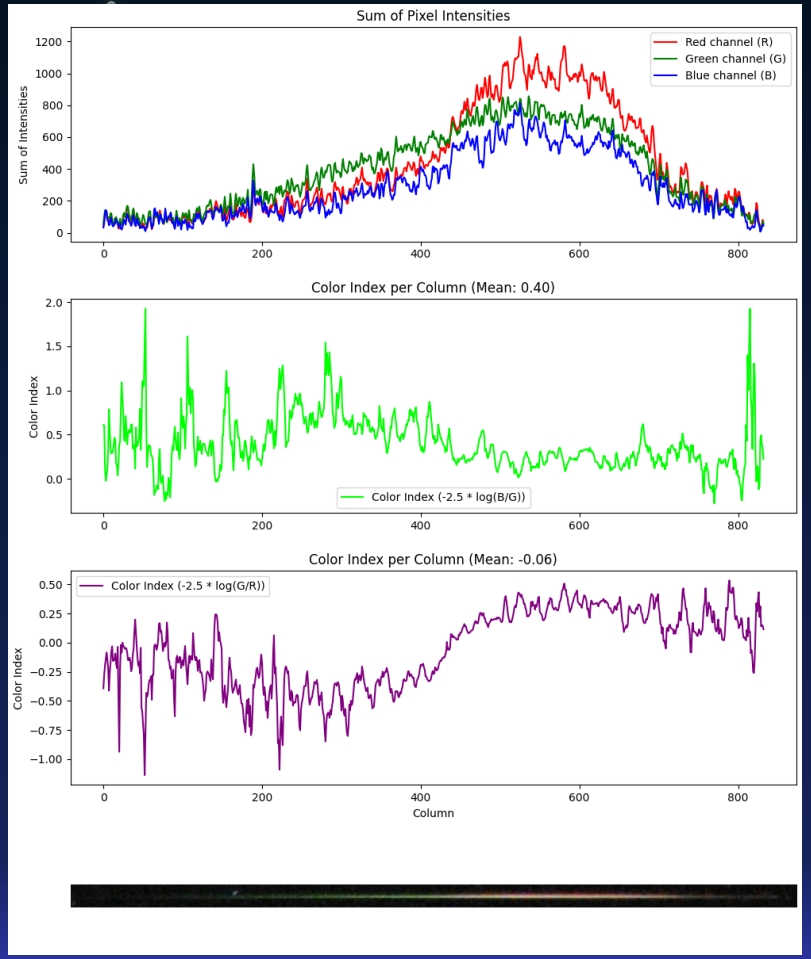
Per_20240812_225531

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



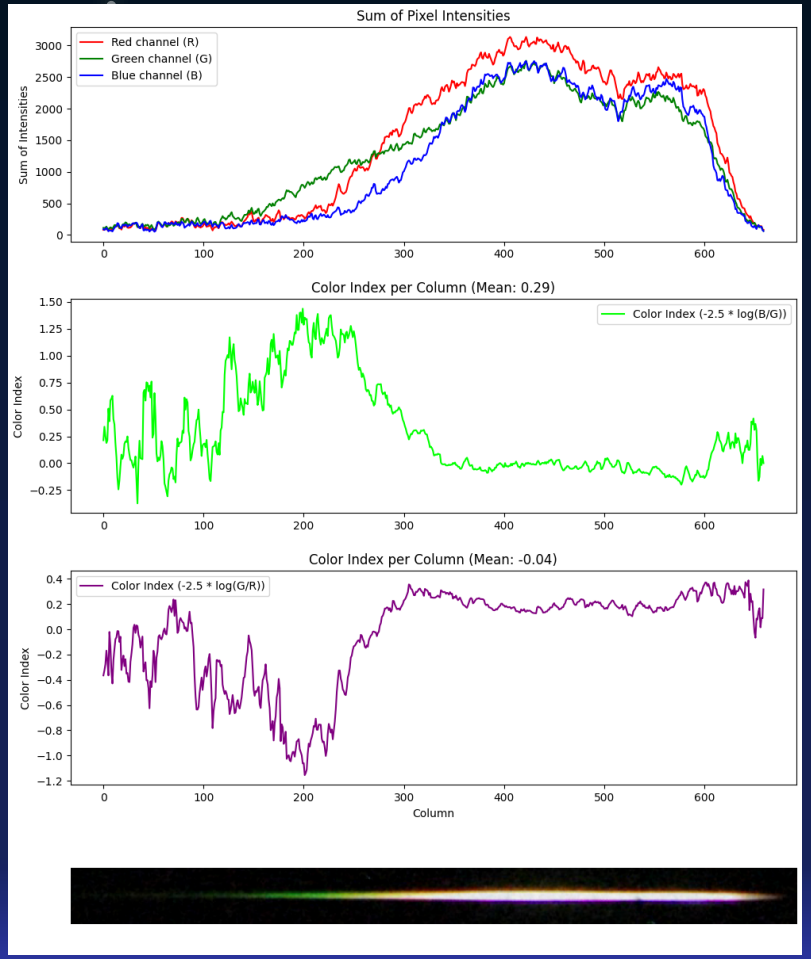
Per_20240813_013842

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 12/2.8
exposure 9s
U Sládečkov, Myjava, Slovakia



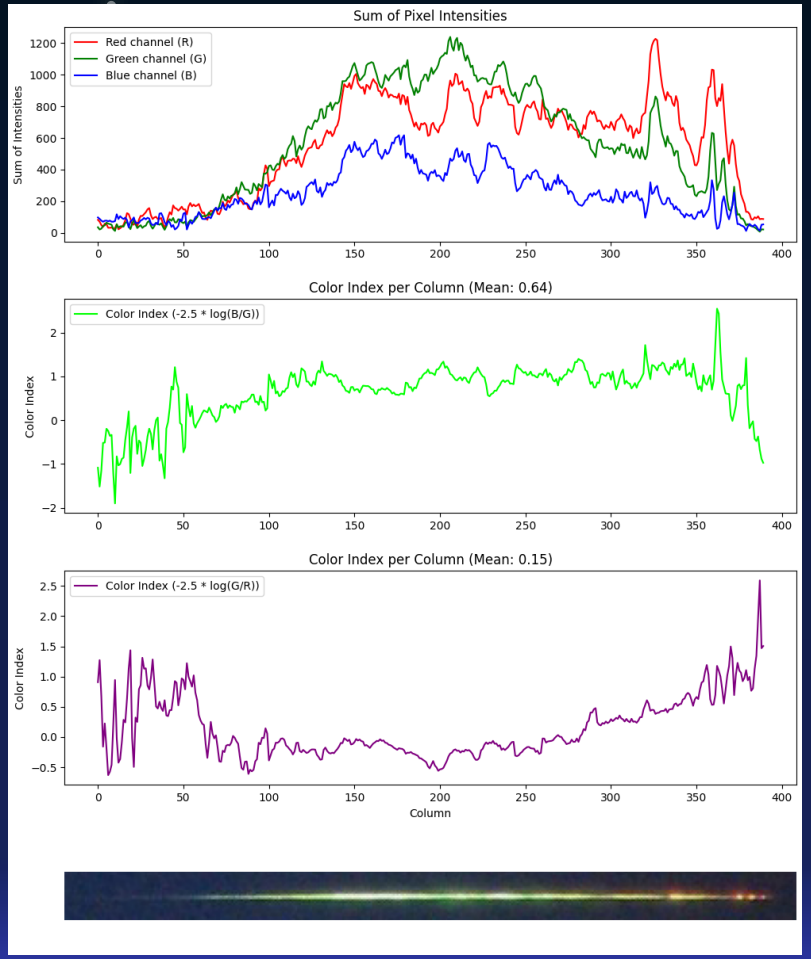
Spo_20090926_022824

Nikon D300 @ ISO 3200
Tokina 11-16mm F2.8 DX AT-X @ 16/2.8
exposure 8s
AGO Modra, Slovakia



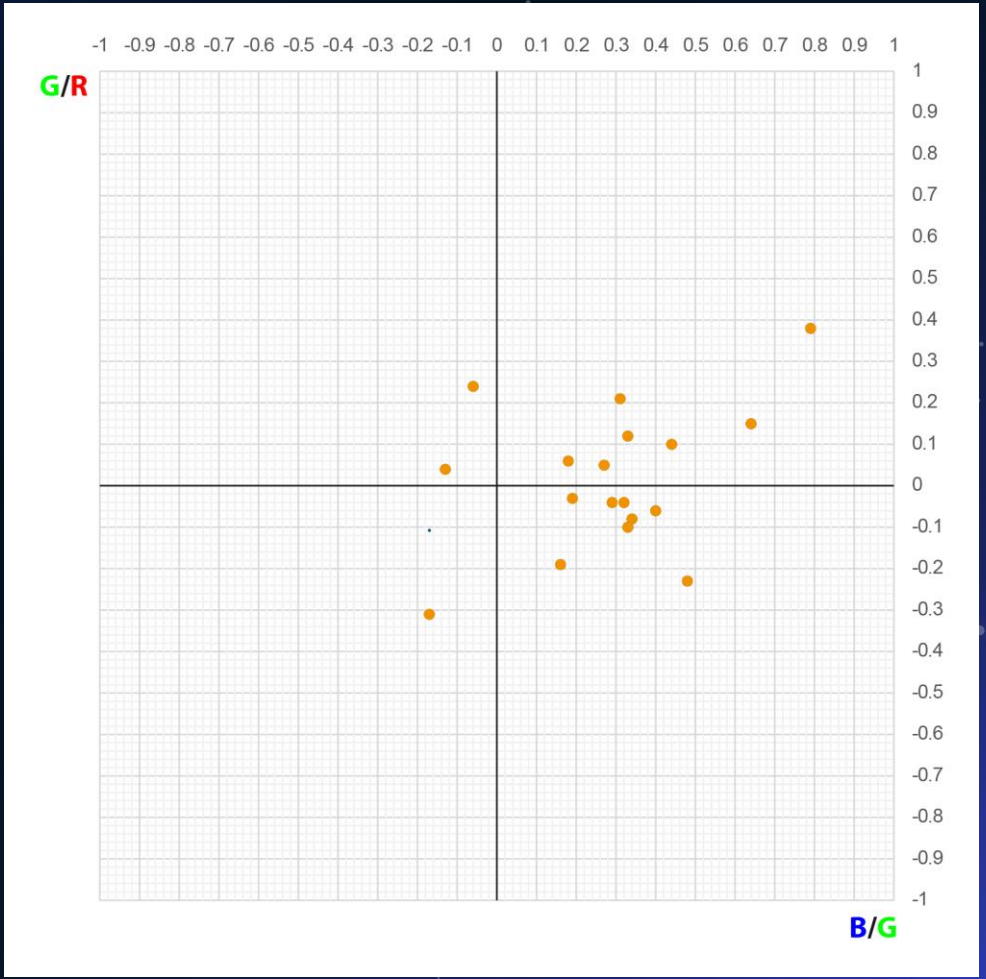
FB_20130824_210200

Downloaded from web camera
Černá Hora, Czech Republic



What did I actually find out?

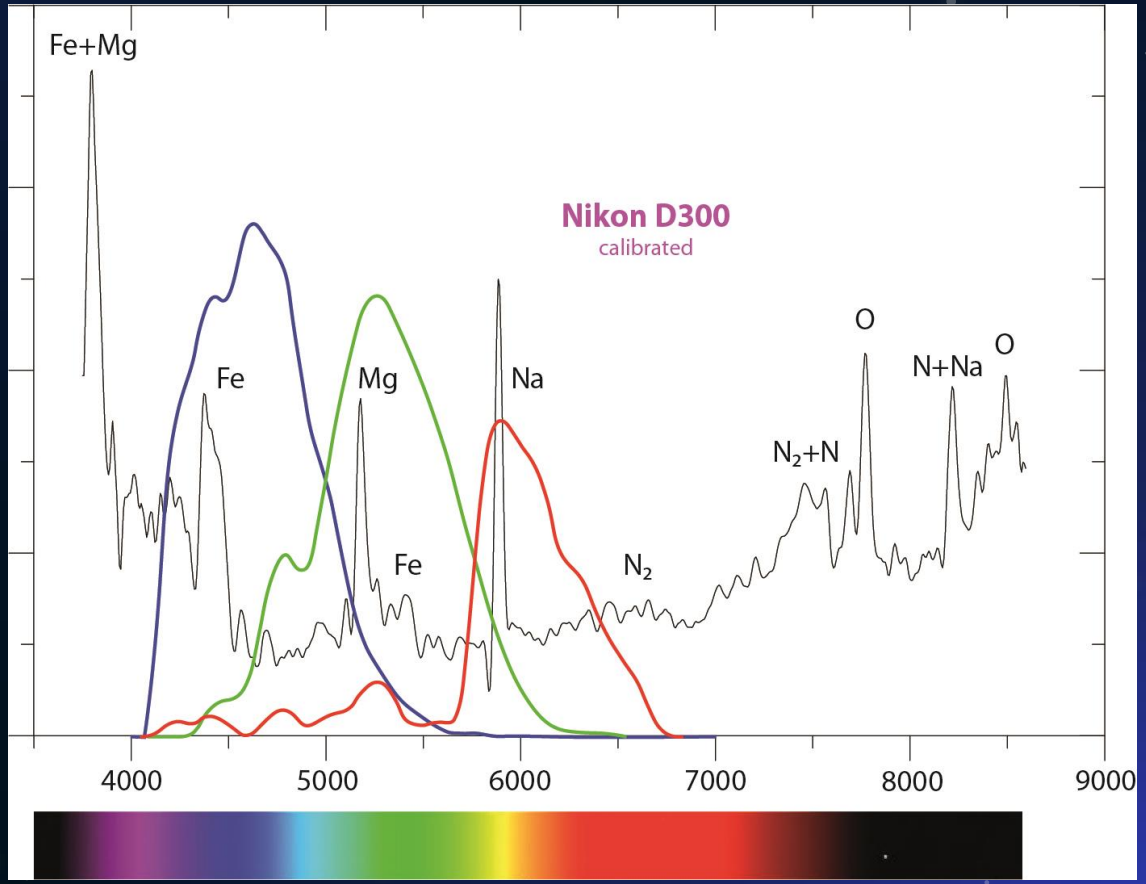
The graph shows the measured values of the "color index" for the B/G and G/R channels. At least one can see from them that the values for particles from long-period and short-period comets differ, which is the expected result.



Nikon D300

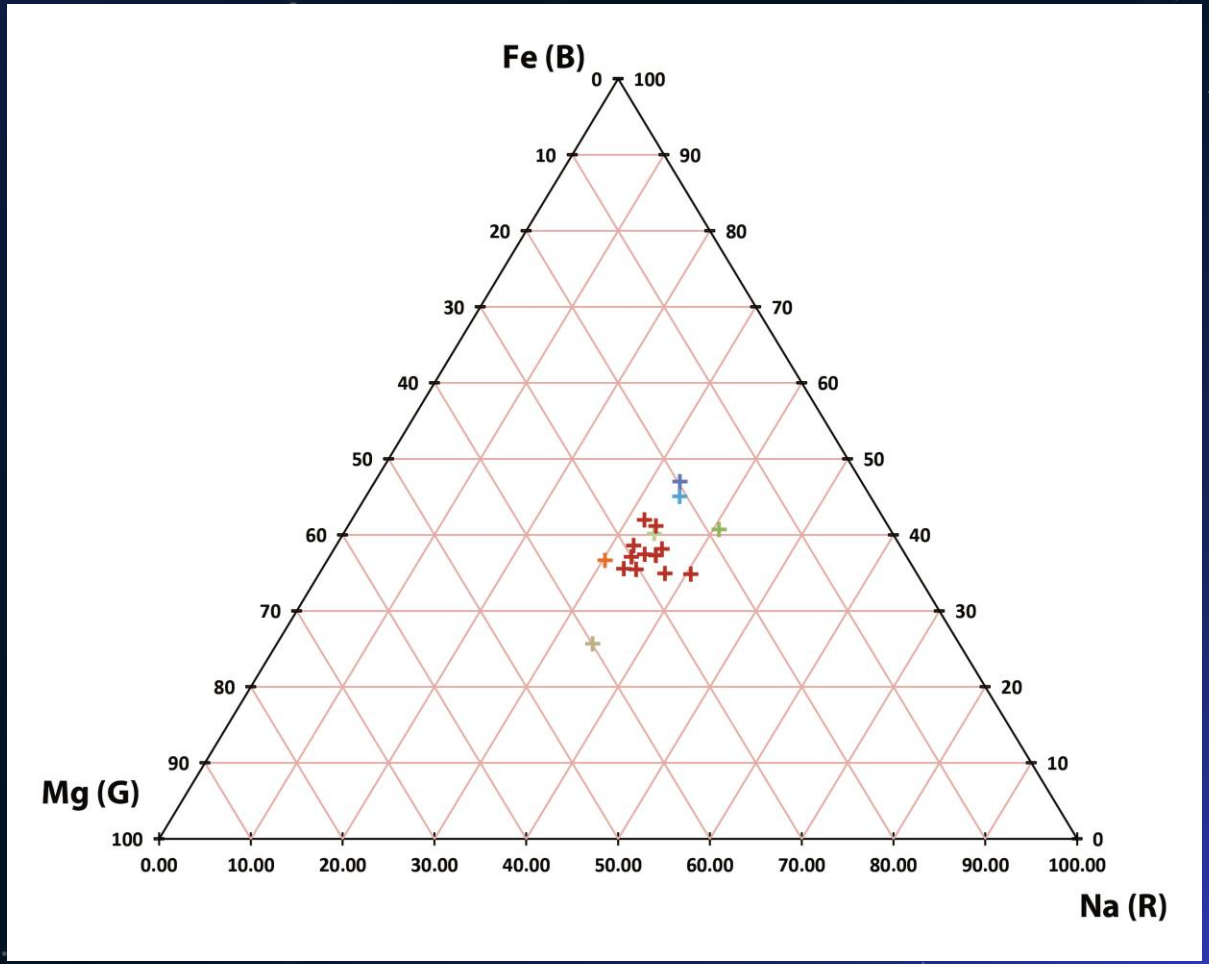
(2008)

But let's look at the system I use. An important parameter is the spectral sensitivity of the camera. If we project the main spectral lines of Na, Mg and Fe onto it, we see that the red channel mainly covers the sodium line, the green magnesium line and the blue iron line.



Ternary diagram

We use the ternary diagram shown here to compare the representation of these lines in the meteor. This diagram is already quite interesting and we can say that such use of colored meteors can bring at least a quantitatively good overview of the composition of the bodies that produced the photographed meteor.



But now a few limitations:

1. The spectral sensitivity of my camera is limited to the region from 400 to 700 nm. Above 700 nm, it doesn't matter so much, mostly atmospheric lines are found here. Below 400 nm, however, we have cut off the area where Fe and Ca shine, so we will not have the left part covered in the ternary diagram.
2. Color images are greatly affected by extinction – at low altitudes above the horizon, it absorbs the blue component, so the meteors are redder than they actually are. Therefore, a detailed reduction must be made before the measurement. This, of course, also applies to the color transmittance of the lens, which requires additional work.
3. It is also problematic to interpret or filter out the green train which is visible mainly in fast swarms of long-period comets – PER, LYR, ORI...
4. We do not have information about the speed and height of the meteor when taking photos with a static camera. These can only be obtained by parallel scanning the field with a video camera and matching the recording with another station. If we succeed, we can also extract temperature data from the color images, which would yield relatively complex data about the investigated particle.
5. Sequential shooting with a DSLR is demanding on the endurance of the mechanical parts, i.e. the shutter. So, it is better to use mirrorless cameras.

Conclusions

Photographing meteors with a color camera can bring a new kind of data about observed meteor showers.

In one night, we can get dozens of color images of meteors, which is 1 to 2 orders of magnitude more than with the spectroscopy method.

It is enough to process them correctly...


Finally, something for Peter C. Slansky ;)
Earth-grazer
11/08/2024 22:00:47
Neptune-C (IMX178C)
gain 450
4s exposure (2 frames added)
U Sládečkov, Myjava
Slovakia

Thanks!

Do you have any questions?

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