Fluorescence - Blue and not UV

Important prerequisites to explore the magic underwater world during night dives

Fig.1 This is a screenshot of one of my YouTube movies. I used a yellow barrier filter identical with TIFFEN #12 referred to as Amber in the Diagram.

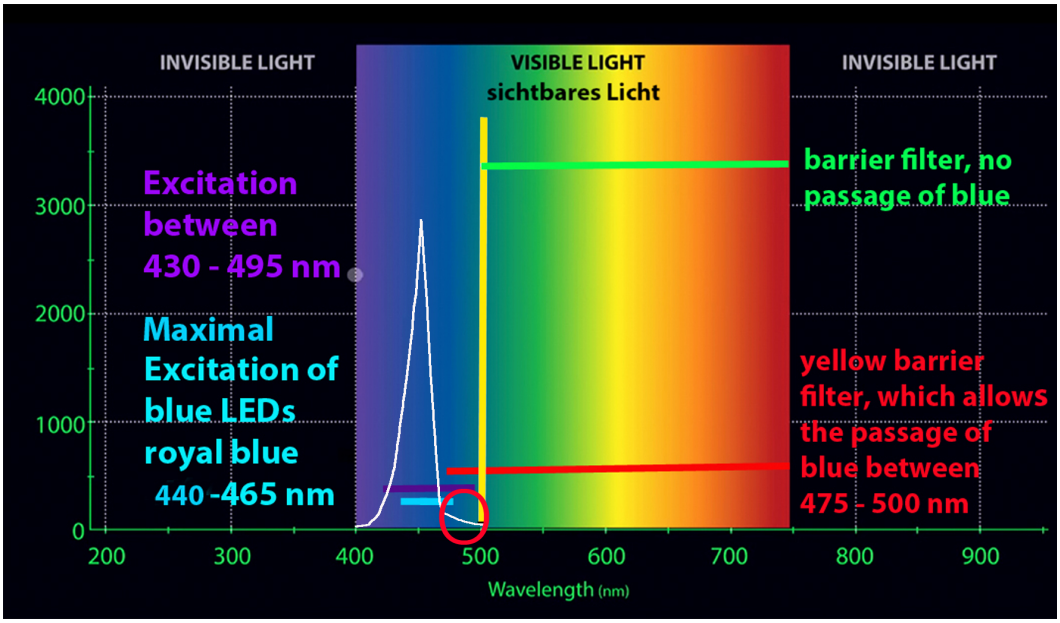
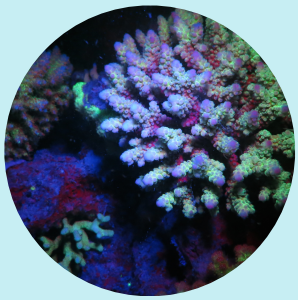


Fig.2 Excitation (torch) and barrier filters of camera and filter for the mask must carefully be geared to each other to get optimal impression and results of fluorescent targets. Optimal is a excitation between 450-465 nm. UV, wavelength below 430 nm give disappointing results. Multifunctional torches with red, white and UV-LEDs are a waste of money. I will explain this in detail in this article.

My camcorder equipment. SEALUX housing and 3 HighPower Fluorescence torches



Acropora spec. (see Fig. 12)

Vision HighPower torches on a scooter for long distance surveys

In the professional diver journal DIVEMASTER I have published in April 2016, issue 88 a German version with the title Blau und nicht UV (Blue and not UV)

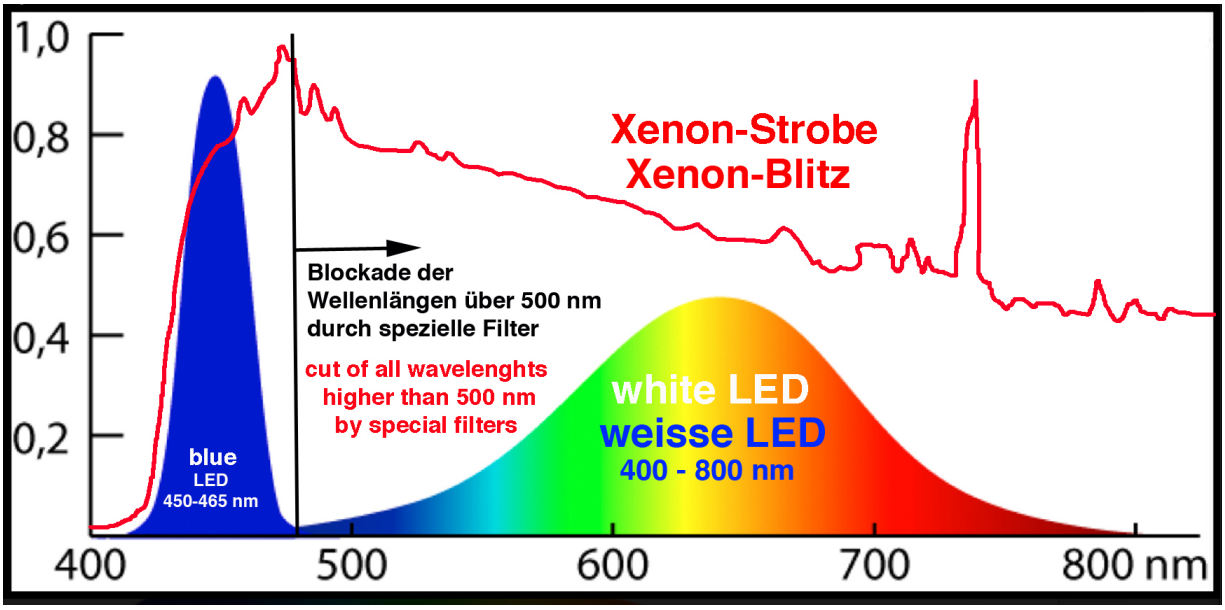


Fig. 3 This diagram shows the advantage of blue LEDs over the use of strobes for fluorescence in night dives. Royal-blue LEDs have a maximum at 450 nm. There is no strong emission higher than 500 nm. In contrast white LEDs emit light between the wavelengths of 400 - 800 nm. Strobes have a pattern comparable with daylight (5500-6500° Kelvin). In both cases (white LEDs and strobes) the wavelengths higher than 500 nm must be blocked by special blue filters. We use dichroic filters with an additional foil. I must not point out that a filter severely diminishes the strength of white LEDs or strobes. There remains a small part of the pattern between 430-490 nm only.

What you need for a good underwater-fluorescence:

There exist different opinions, which technique is considered as the best solution.

1.***Flash or LED-torches for underwater fluorescence is the question.***

Many photographers preferred underwater strobes (comparable to daylight) for still photos, since the light of LED torches were not sufficient for a good documentation of quick moving targets. Today the situation has changed significantly. It is possible today to use very strong HighTec LEDs, which can compete with strobes. This is indeed the case, when several torches are used simultaneously. The advantage of LED-torches is the possibility to prepare videos. You also do not need a pilot light. The tremendous disadvantage of strobes is that there are no blue flashes is available. In Fig. 3 is shown that a large part of the power of the flash must eliminated to get the wavelengths between 400-500 nm. This should be no problem if you use a HighEnd Strobe, which allows the cut of all wavelengths over 500 nm.

In our opinion the use of several HighEnd torches with blue LEDs (royal-blue; 450-465 nm) give the best results during night dives with fluorescence. Important is an integrated dichroic filter and reflectors for each LED. The angle of the beam should be higher than 50 degree.

2. ***Yellow Barrier filter for mask and camera***
Since most or even all blue light of the torch must be cut off to get the the correct rainbow colors of fluorescence, the selection of the right yellow filter plays an central role in underwater fluorescence.

My Recommendation

Detailed informations you will find on my WEB-page (English and German version). > https://www.uni-due.de/fluodives/HomeFinalE.html

In my hands we got the best results with HighPower Fluorescence torches. All my YouTube movies were taken with several self constructed torches since 2007. They contained the first commercially available blue HighEnd LEDs (OSRAM Semiconductors). From the very beginning (similar to my US colleague Charles Mazel, Nightsea) I equipped the torches with a dichroic filter and reflectors.

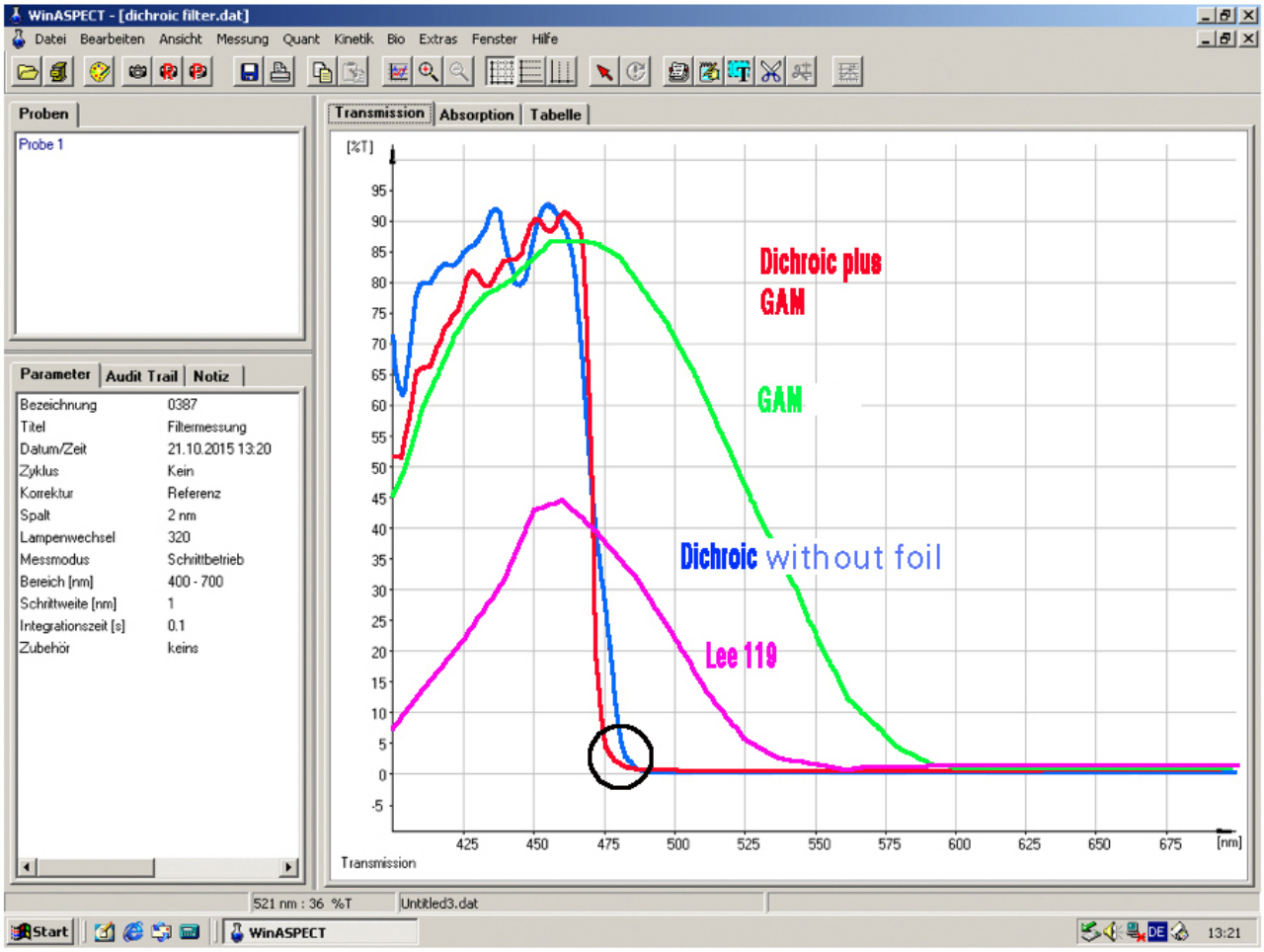


Fig. 4 The diagram shows the advantages of a dichroic excitation filter. At 450 nm about 48 % more light can pass the filter compared with a polyester foil (here LEE 119; 45 %). A strong flash could compensate the shortcoming. However, the LEE-filter allows also a transmission of blue light between 480-500 nm. The blue line represents a dichroic filter without additional foil, which is used with torches equipped with blue LEDs (royal-blue). The red line represents a dichroic filter plus additional foil, which must be used with flash or white LEDs.

Some providers offer blue filters (blue acrylic; PMMA). They are absolutely unacceptable,

What's a dichroic filter?

To start with we will explain the term “dichroic”.
The word comes from the greek and originally meant “two-colored”. This refers to the fact that optical objects can split up the light into two beams of different wavelengths (colors). The dichroic filter benefits from this effect: It selectively lets pass certain types of wavelengths (colors). Unmeant colors are reflected and cant't get through the filter.The filter consists of a glass substrate. Upon it, layers of an optical coating are built up which are deposited in a vacuum. Usually the layers are made of metal and vary in number and thickness depending on the intended wavelength. Dichroic filters use the principle of interference: Certain waves were deleted if two our more waves are one upon the other.

What are the advantages of dichroic filters?
First of all they have much better filtering characteristics whereby the original wavelength can pass unhindered. Therefore, the achieved color is more luscios and intensive. Conventional gel filters tone down the color what causes that the light becomes faint.Furthermore dichroic filters are more heat-resistent, because the glass substrate is more resistant than gel filters. Because light is reflected rather than absorbed, there is much less heating of the dichroic filter. They will not bleach out unlike the gel filters which often have to replaced.
The dichroic filters hardly heat up, so they'll not melt or deform. They have a much longer lifetime than conventional filters and are capable of achieving extremely high laser damage thresholds.
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Do dichroic filters have disadvantages?
As dichroic filters are made of glass they are more fragile and have to be treated carefully. Once they are broken repairing is impossible. Conventional filters are cheaper: You only have to pay one sixth of the price of a dichroic filter.

What's the conclusion?
Dispite the price difference the purchase of a dichroic filter is worthwhile. The colors are definitely brighter.You don't have to replace filters, so you don't have maintenance costs. The dichroic filters will pay off after a short time: A gel filter will cost xxx. The price of a corresponding dichroic filter is about xxx. At xxx watts the gel filters usually have an average lifetime of xxx hours.
After xxx replacements the costs for a dichroic filter rare even. At least by now the filter is worth it. By the way: After xxx hours the conventional filter would have been replaced again. The dichroic filter is like the Duracel bunny: Always drumming, never stopping.

This good explanation I have taken from http://eshop.steinigke.de/

Why so-called multifunctional torches yield bad fluorescence results
it contains

1) only few blue LEDs (no royal-blue; 450-456 nm)
2) UV-LEDs (around 390 nm) give lousy fluorescence. Several provider tell the fake that with UV-LEDs you do not need any additional blue excitation and yellow barrier filter. The divers (especially beginners) do not like additional mask filters. The confusion comes from the illumination with Black Light (Schwarzlicht) in the Disco.
3) the position of the LEDs is asymmetric
4) no reflectors
5) no blue dichroic filter (is not possible, because of the white and red LEDs)
6) Dimming is unnecessary, since the full power of a torch is the best what you could get for fluorescence (The dimming philosophy comes from the traditional Halogen torches, where the lead or NiMe Akku had only a capacity for 1 hour or less.

Fig.5 This is a Sola.Nightsea fluorescence torch (Light & Motion), which is one of the best fluorescence torches. I have removed the integrated dichroic filter, because the filter looks like a mirror and does not allow the view on the LEDs. The torch contains only one type of LEDs, here 9 blue LEDs (royal-blue, 450-465 nm), which are placed within small reflectors. The 3 central ones (spot) are operated separately from the 6 outer (flood) LEDs. The torch is easy to handle and can be recommended to people who want to get high end photos or video documentation. The price is relatively high (about 600 - 700 Euro). I have tested it in Marsa Shagra Village > http://youtu.be/EE8XiR8IFwk

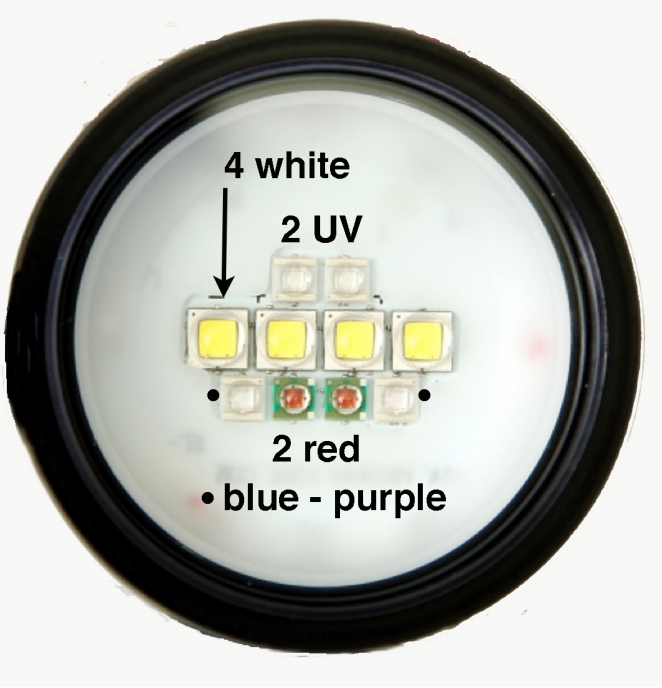


Fig.6 This is a typical representative of multifunctional torches. Especially newcomers will buy this sort of torches. To say it first: you will get lousy results. Such torches have several shortcomings. 1)The number of every sort of LEDs is too small to get an intensive illumination. 2) The 2 UV-LEDs (about 390 nm) are not suitable for a good fluorescence. 3) the same applies for purple blue LEDs (400-430 nm). 4) New comers are told that red light does not banish shy fishes. Anyhow you will not see to many fishes in the night. On the other hand lion fish like blue light (450-465 nm), which illuminates their small fish prey 4) the LEDs are not equipped with reflectors 5) the torch contains no built in blue dichroic filter This is of course not possible, since the white and red LEDs cannot be used together with a blue filter. 6). Such torches are quite expensive. I cannot recommend this type of torches.

Fig.7 These are my new TOPSELLERS on the basis of the Maxi Uni of TillyTec Direct > http://www.tillytec.de/

Topseller Maxi uni + LED Modul 5400-465-50 with blue LEDs (royal-blue)

Promotion

For Nightdives with Fluorescence

Technical specifications:

light power in mW according to manufacturer	4950
light power in lux	50000
beam angle in degree	recommended 50° and up
light color royal-blue	457-460 nm
burning time with 26650 battery	90-180 min
charging time	2-3 Stunden
housing length	140 mm
diameter tube	35 mm
diameter head	59 mm
weight out of water (without battery)	280 gr

all details are approximate data
Possible configurations and burning time with alkaline batteries / accumulators under the buttom "Information"

Description:

- including torch Maxi uni
- including LED Module 5400-465-50 blue (457-460 nm)
- including Dichroic-Filter (built in)
- including battery holder for AAA
- including protection ring for light head
- optional: phosphor filter (fits in the protection ring) quick reversible change of blue light into white light (2700° Kelvin) under water > 30 Euro

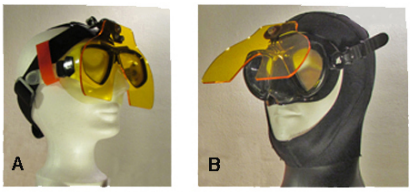
249,00 EUR

plus shipping

torch package
plus FlipUpVisor A
309,00 Euro
plus shipping

torch package
plus FlipUpVisor B
299,00 EUR
plus shipping

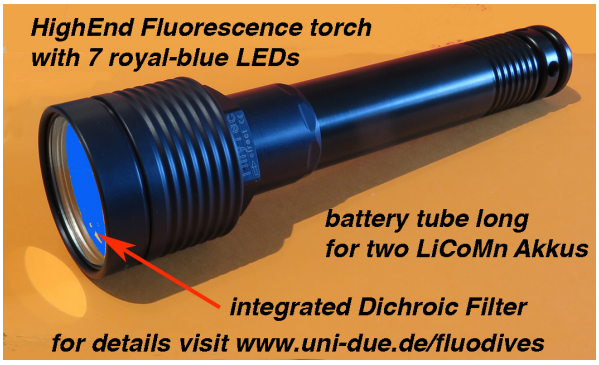
Yellow Barrier Filter for the Mask



Without yellow barrier filter you will see all targets in blue color only

A. FlipUpVisor with head strap for every mask

B. FlipUPVisor for mask with integrated adapter for action cameras



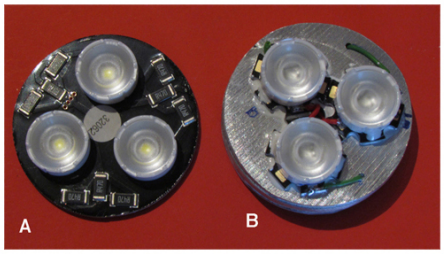
Yellow FlipUP Barrier Filter

Cutting of the Filter with Laser (YouTube Movie)

FilterBecause of my long experience with fluorescence during night dives I know that many commercially available filters were lost under water. Furthermore divers don't like them because of the additional handling. This is the reason that the use of UV- torches (wave lenght below 400 nm) frequently comes up for discussion, since excitation- and barrier - filter could be ommitted - the poor results show that this approach is wrong. The advantage of my filter - set is easy to understand: 1. sturdy position on the head 2. Quick change in seconds by turning up and down. 3. can be used on masks of every size. Point 2 is important especially for comparative judgement and documentation with white and fluorescence illumination.

Current Price list and Topseller

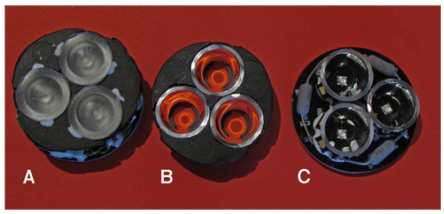
Blue-Module for Nightdives with Fluorescence
Choice of different reflectors
several you can modify yourself



A White light Module (available at TillyTecDirect)
B My standard Blue-Module (80 Grad, Flood; no Extra charge in addition to the Topseller-package)

Permanently fixed reflectors
choice between spot and flood
on demand: Extra charge 5 EUR

In the tradition of my first HighPower fluorescence torch worldwide in 2007



A and B choice of different reflectors
(20 up to 80 degree)
C permanently fixed reflectors
(80 degrees; flood), which have
no plastic cover at the front
result: higher intensity
Extra charge to the Topseller-Package
A and B 15 EUR C 10 EUR

HighEnd Blue-Module with 7 Power-LEDs

The fluorescence torch equipped with this module (32 Watt) is one of the strongest commercially available worldwide.
Even with an extra charge of 85 EUR in addition to the Topseller package the price of this torch is significantly less compared to other fluorescence torches.

Fig.8 Because of my long experience with HighPower Fluorescence torches since 2007 TillyTec has asked me to built the blue modules for their new Maxi Uni series. Orders of the whole fluorescence torch can be addressed directly to me > horst.grunz@uni.due.de Details you will find also on my WEB-page > https://www.uni-due.de/fluodives/HomeFinalE.html

All my LEDs (royal-blue) are equipped with reflectors, which are important for a concentration of light in an angle of 50-90 degrees. The LEDs have a beam of 120 degree. A lot of light is wasted without reflector. Many torch provider refer to the factory data of the LEDs. This is given in Lumen, which does not say anything about the intensity, which reaches the target. Therefore the strength of a torch should be given in LUX. > http://www.tillytec.de/info.php?nofiSiteName=info-ledmodule

During his talk in Colorado Dec. 2014 my US-colleague Charles Mazel (founder of Night Sea) has commented on screenshots of one of my YouTube movies >https://www.youtube.com/watch?v=3rC4G84OWIg at minute 19:14 **This talk was the motivation for me to start a systematic measurement of nearly all yellow filters in the spectrophotometer , which are available on the market.**

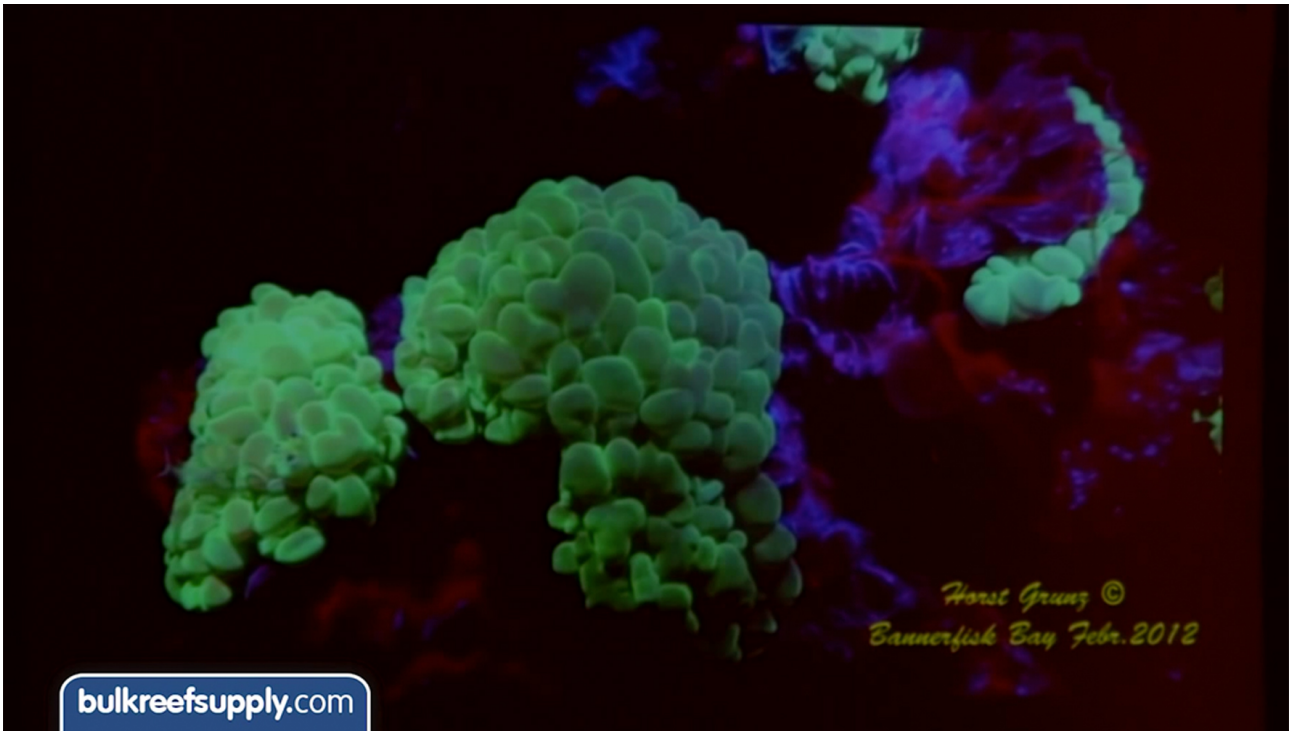


Fig.9 This is the original screenshot, which shows a lot of blue. I used a yellow barrier filter, which allows the transfer of some blue light below 500 nm. What Charles Mazel did not knew was the fact that I used a filter from Night.Sea in front of my camcorder.

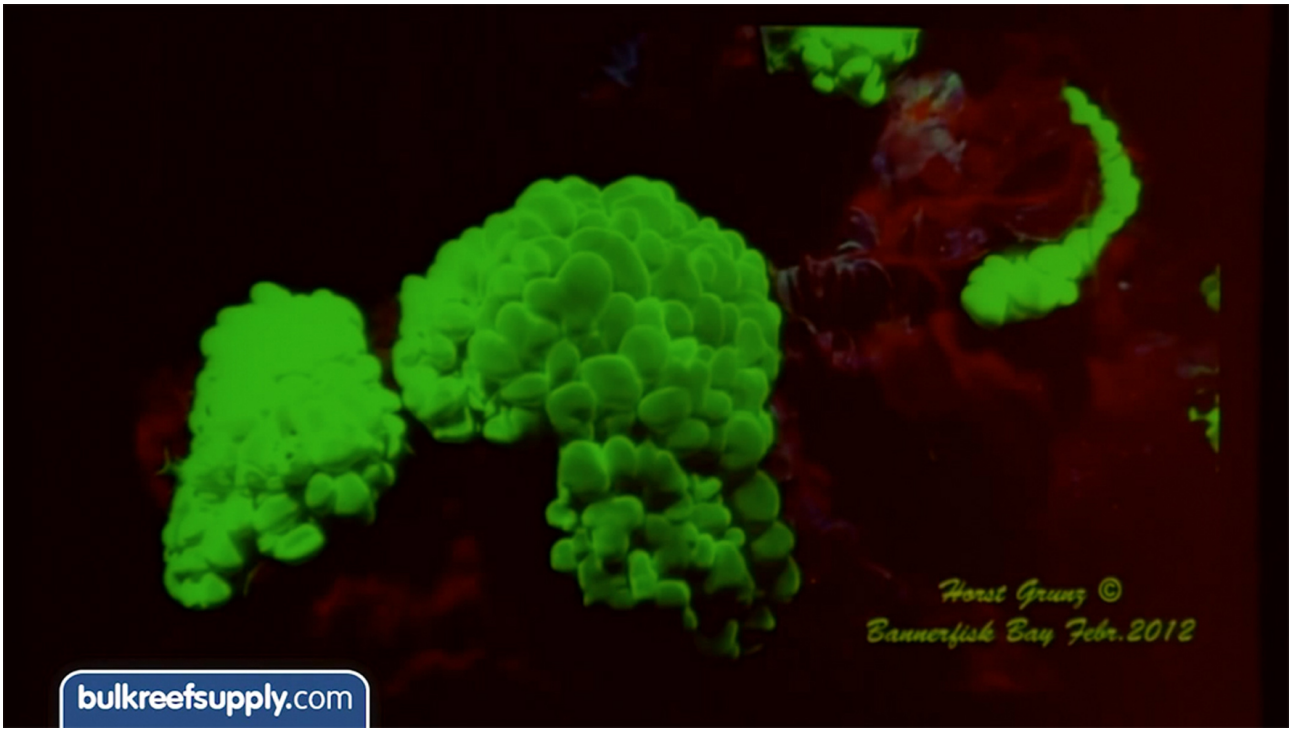


Fig.10 Here Charles Mazel removed the blue by inactivation of the blue channel in Photoshop. Also Charlie pointed out in his talk that the presence of some blue is a question of taste. Several divers prefer filters which allow a certain amount of blue, which is a certain contamination.

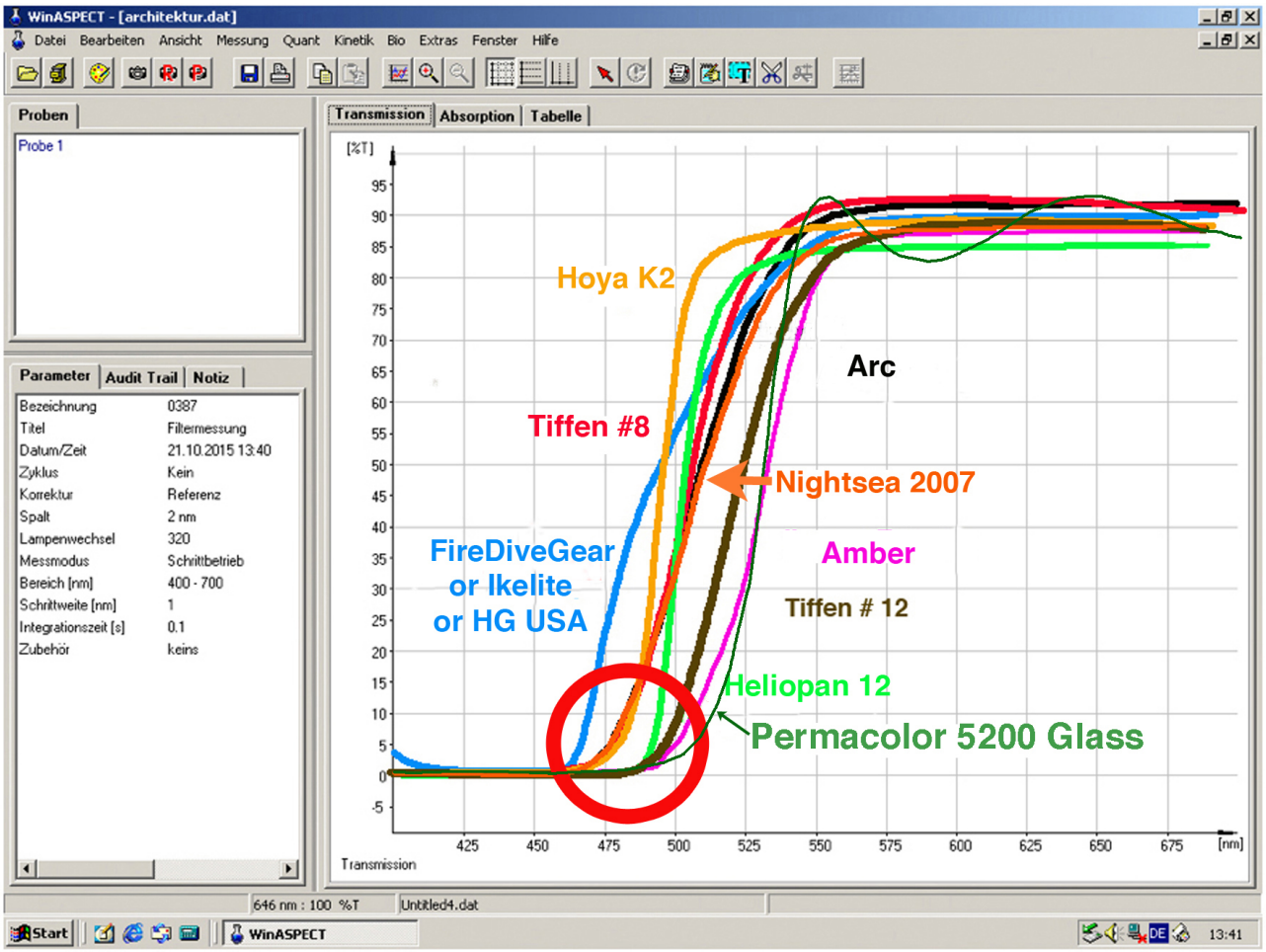


Fig.11 This diagram shows the transmission curves of a selection of yellow filters. Most of the filters allow a transmission of light above 500 nm. These wavelengths correspond to the rainbow colors green, green-yellow, yellow, orange, red and dark red (see fig.). For all my youTube movies I used the Nightsea 2007 (arrow). Nights sells now a barrier filter, which is identical with Tiffen # 12. This filter does not allow any blue contamination. This holds true also for Amber and Permacolor 5200 Glass. Many divers prefer presence of some blue in their photos or video. Below I will show some examples. In the correct application of fluorescence excitation and use of barrier filters the background of the photo should be homogeneously black instead of dark blue. From the subjective standpoint of view a blue background is often a nice contrast to yellow, green and especially red.

In the diagram I have marked the area with a circle, which represents wavelengths between 475-500 nm, i.e. blue contamination. The blue curve represents filters, which allow a lot of blue transmission (yellow filter from FireDiveGear or Ikelite). Tiffen #8 and Hoya K2 allow a moderate transfer of blue.

Below I will show several examples of corals with different yellow filters. In all cases fluorescent torches with royal-blue LEDs (450-465 nm) and an additional dichroic filter are used.

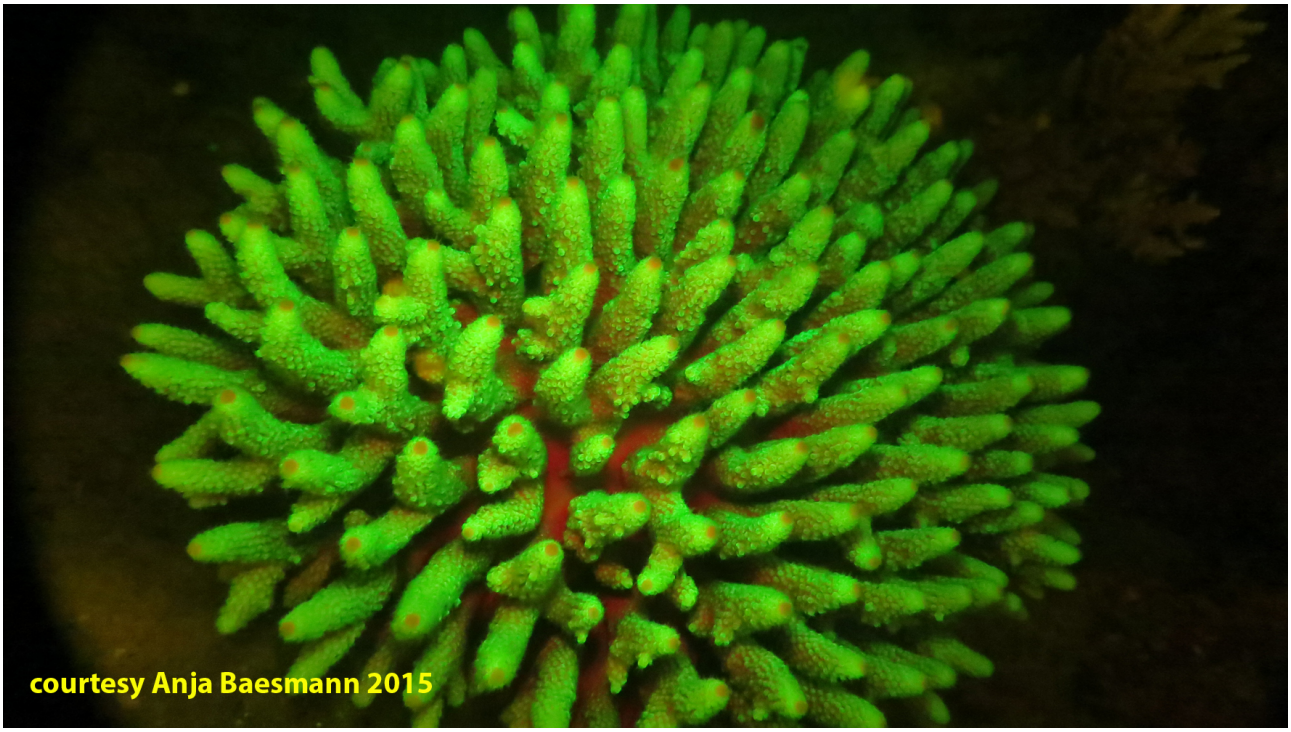


Fig. 12 Stone coral *Acropora spec*. During our fluorescence workshop in Maria Sahara Village in May 2015 Anja used a yellow barrier filter Tiffen#12. (Fig.11). This filter blocks all wavelenghts below 500 nm. There is no blue contamination. This is from the theoretical standpoint real true fluorescence. See the talk of Charles Mazel > https://www.youtube.com/watch?v=3rC4G84OWIg at minute 19:14 (Fig. 9 and 10)

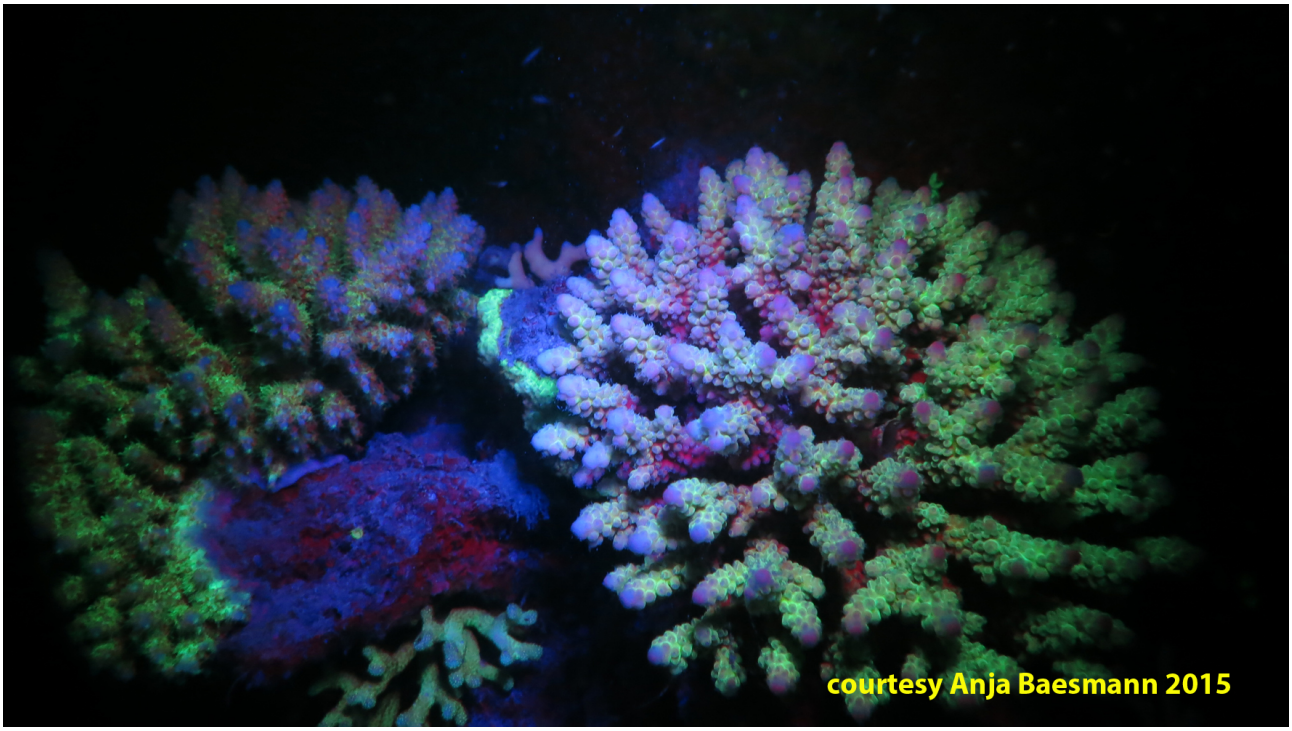


Fig.13 Stone coral *Acropora spec*. Here a yellow filter is used, which allows the passage of blue contamination (Fig.11; FireDiveGear). From the subjective standpoint the coral block looks better than Fig.12. So it is a question of taste. Anja Baseman used the Sola.Nightsea with royal-blue LEDs and integrated dichroic filter (Light&Motion) for all photos.

Fig.14 Fire coral (*Millepora spec.*) This a screenshot from my YouTube movie filmed in Hammata (March 2014) > http://youtu.be/xYuu5eqDEls I used a filter which blocks most of the blue up till 500 nm (Fig. 11). It is nearly comparable with Tiffen #12. Red color is significantly expressed. In the movie I used a torch with 3 royal-blue LEDs with or without dichroic filter.

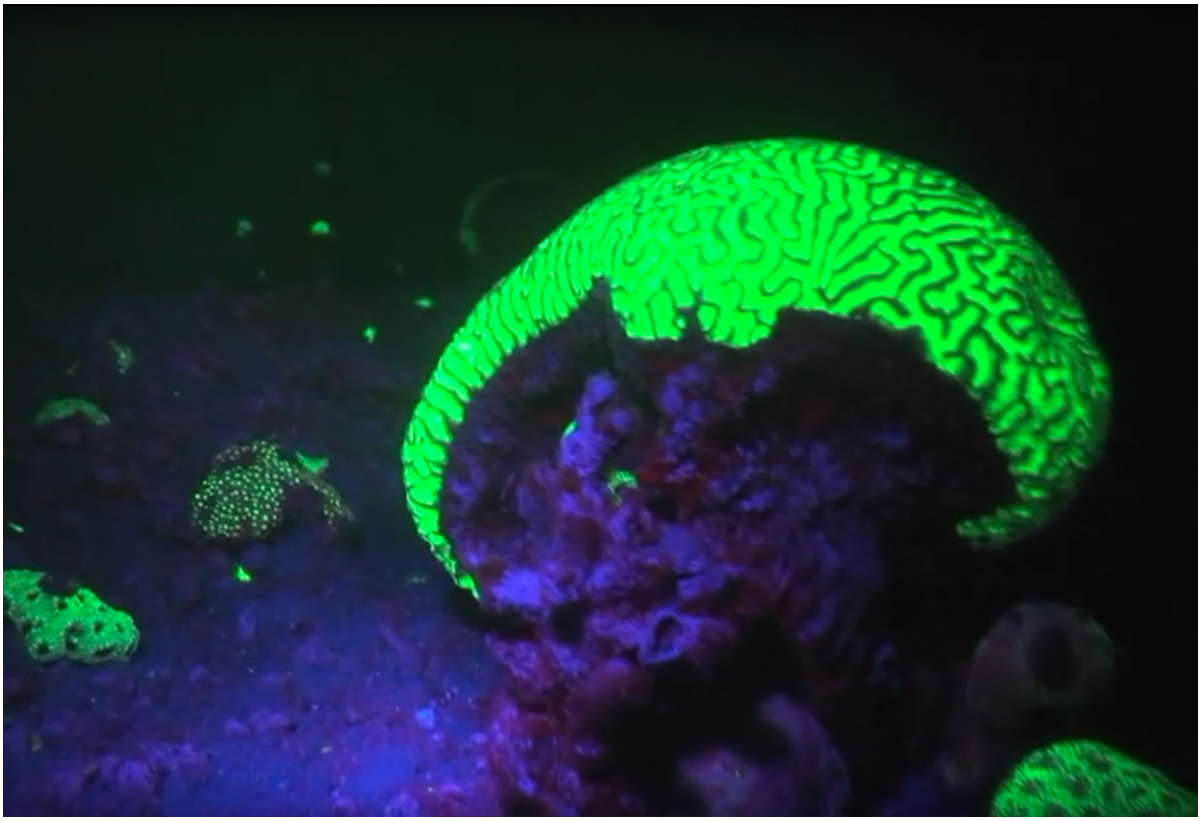


Fig.15 Brain coral (*Faviidae spec.*) This a screenshot from my YouTube movie taken in Dahab 2012 > http://youtu.be/_2rT_agiytk The blue area is a dead part of the coral block. For this session I used a filter, which allows the transmission of a moderate amount of blue (see Fig. 11; orange line Nightsea 2007). I used a torch with 3 royal-blue LEDs.

In Fig. 16 - Fig. 31 the transmission curves of different yellow barrier filters are shown. For reasons of clarity and comprehensibility I did not show all filter curves in a single diagram. Therefore similar filters are shown several times.

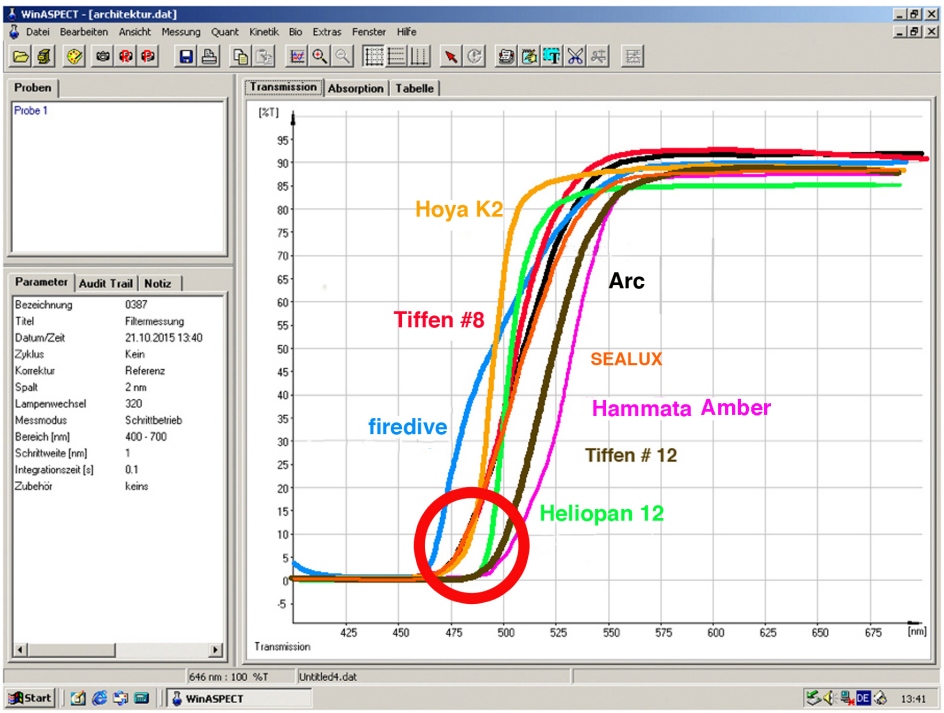


Fig.16 In the diagram I have marked the area with a circle, which represents wavelengths between 475-500 nm, i.e. blue contamination. Two extreme are shown. The blue curve represents a yellow filter, which allows the most blue transmission of all tested filters(see Fig.13). In contrast the filter (Hamata Amber) prevents every blue contamination (Fig. 14). SEALUX and Arc are yellow filters, which allow a transmission of moderate blue (Fig. 15).

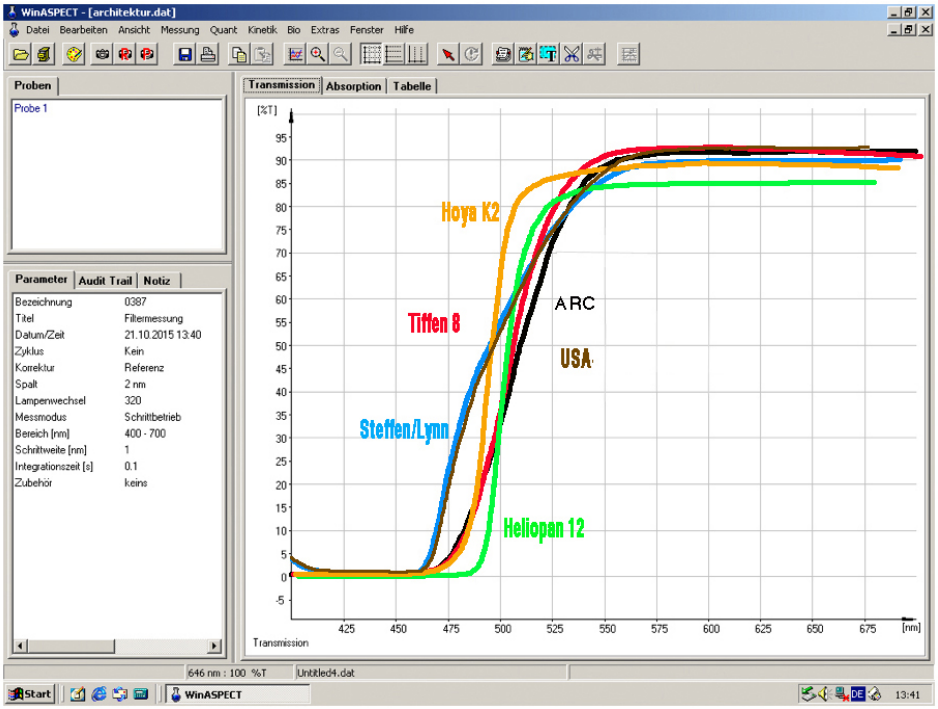


Fig.17 Tiffen #8 allows a moderate transmission of blue.Of interest is the fact that there are significant difference between the yellow filters Helipan and Hoya K2. Yellow PMMA of a factory in Sacramento is identical with the material of FireDiveGear (blue line).

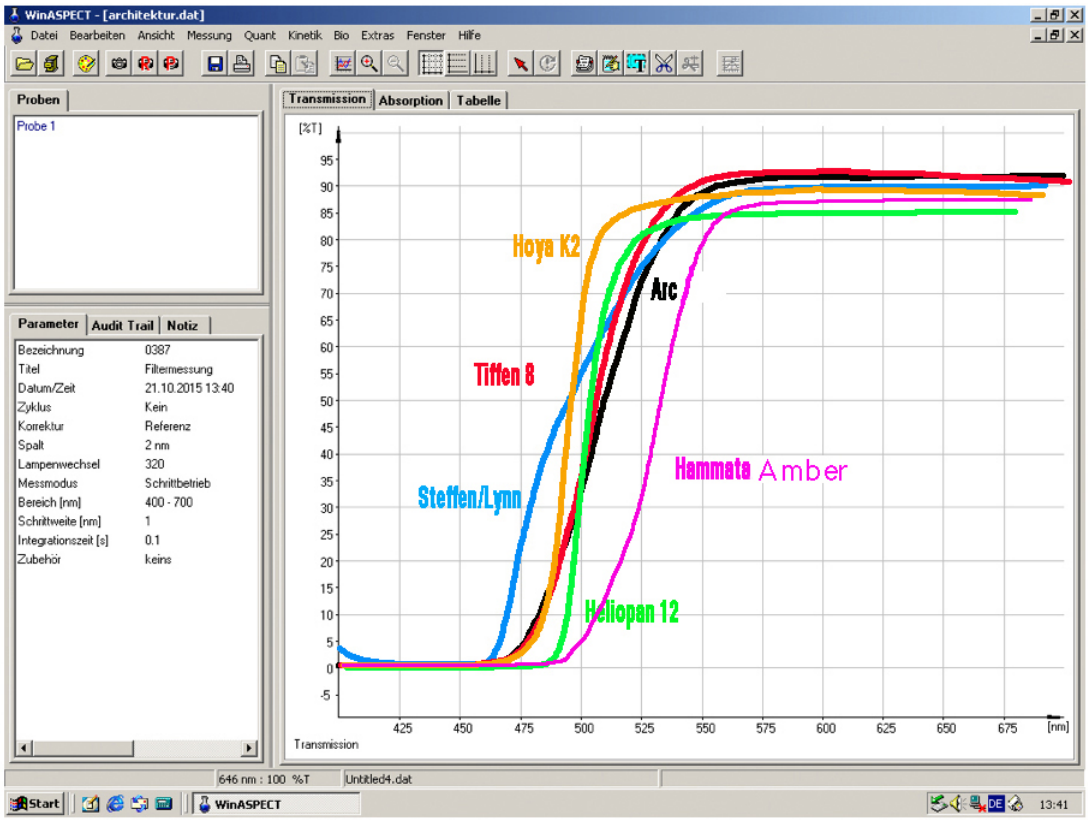


Fig.18 Heliopan 12 (green line) would be a good choice for fluorescence photos, which show some dark blue background instead of black.

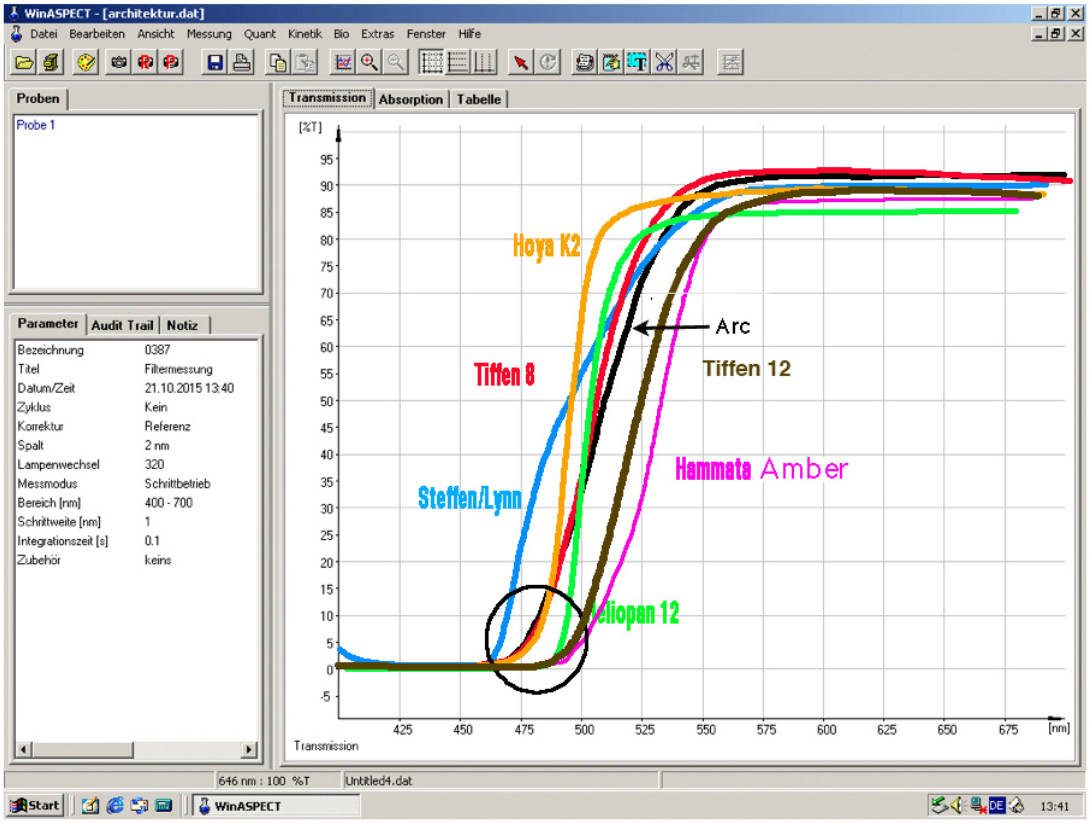


Fig.19 The yellow filter Tiffen #12 (brown line) similar to Amber (magenta line) prevents the transfer of most blue between 475-500 nm.

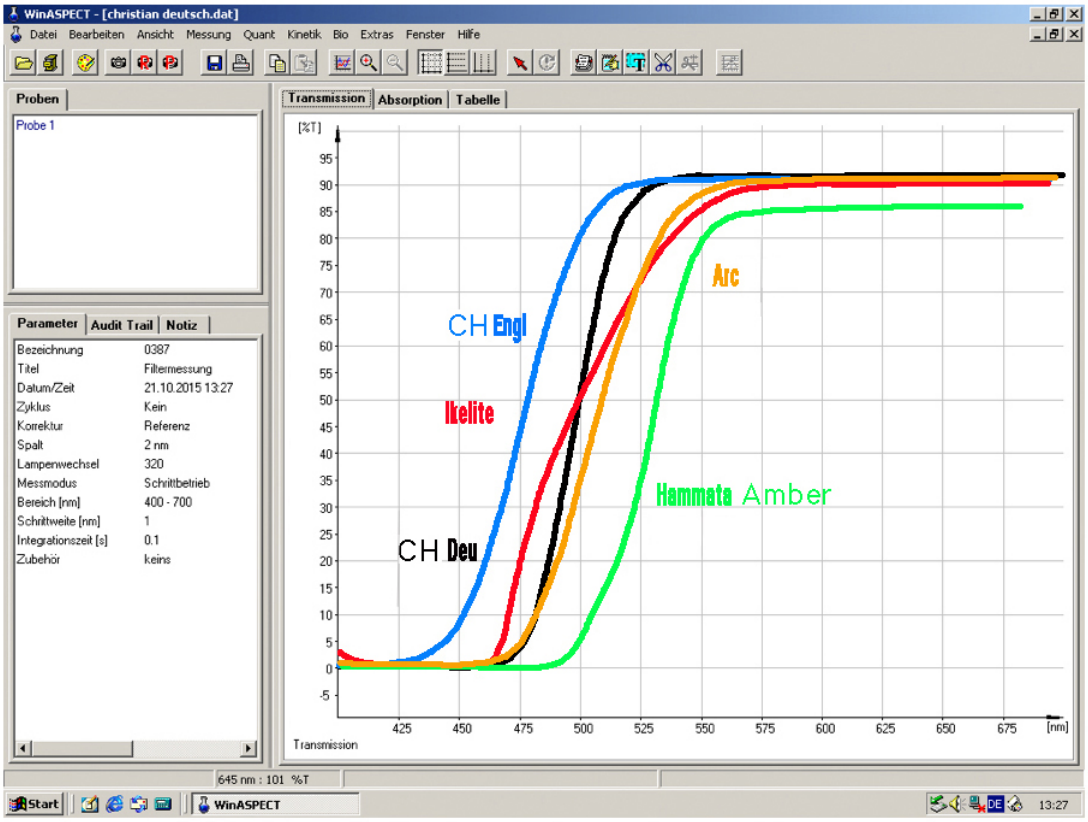


Fig. 20 The yellow filter CH Engl (blue line) can not be used for fluorescence, since it allows too large amounts of blue between 450-500 nm. The yellow filter Arc (orange) should give the best results.

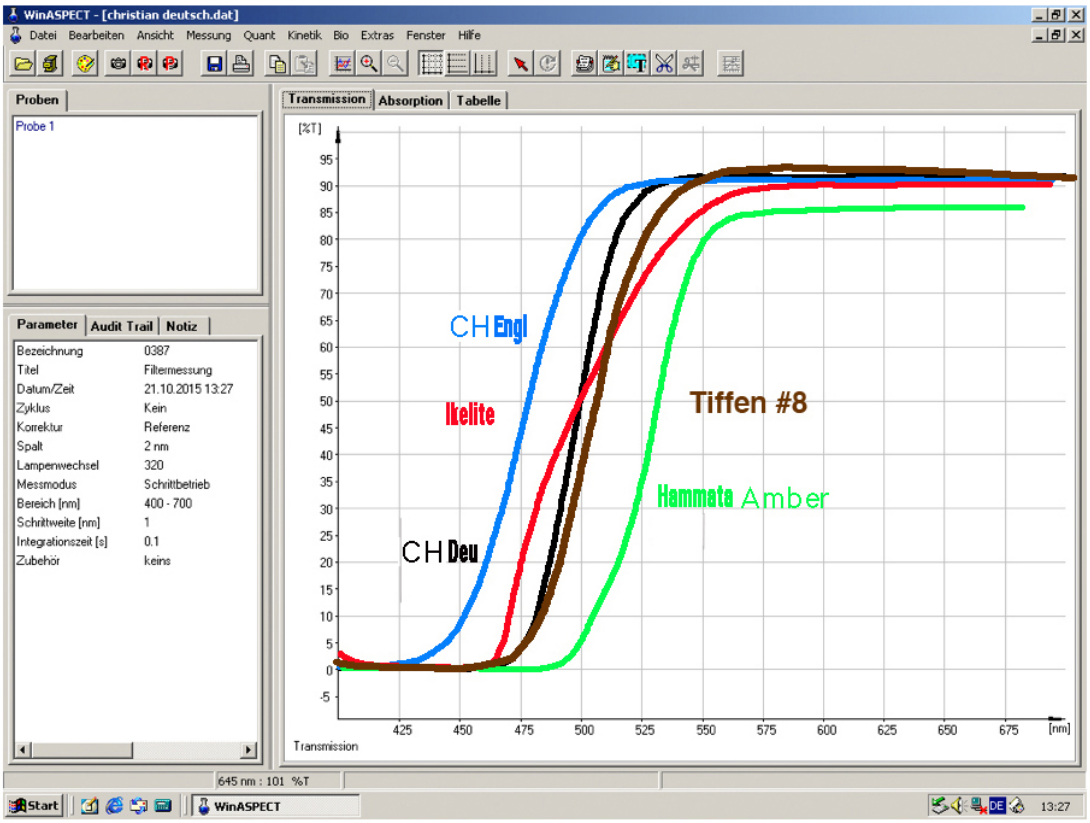


Fig.21 The yellow filter from IKELITE (red) is acceptable. However, I would prefer the Tiffen #8 (brown).

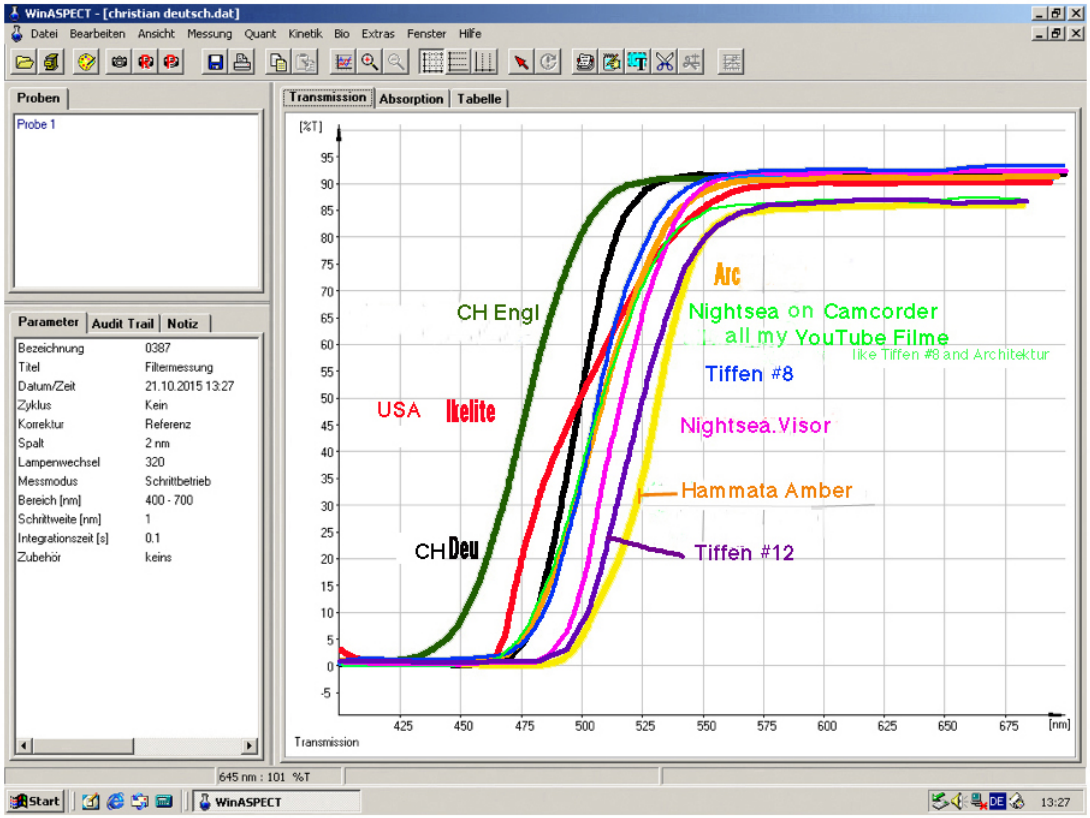


Fig.22 For nearly all my YouTube movies I used the Nightsea PMMA (green line (Fig. 15).

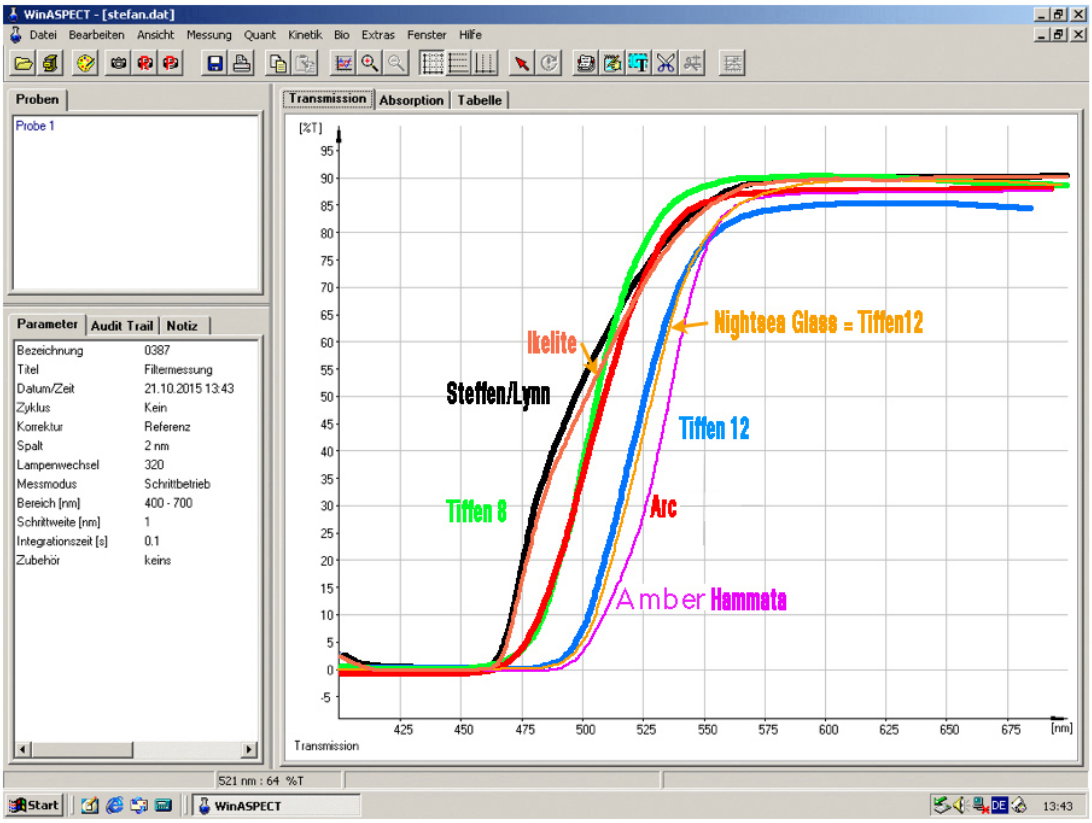


Fig.23 Nightsea sells now yellow filters (orange line), which are identical with Tiffen #12. There is nearly no blue contamination (Fig. 12).

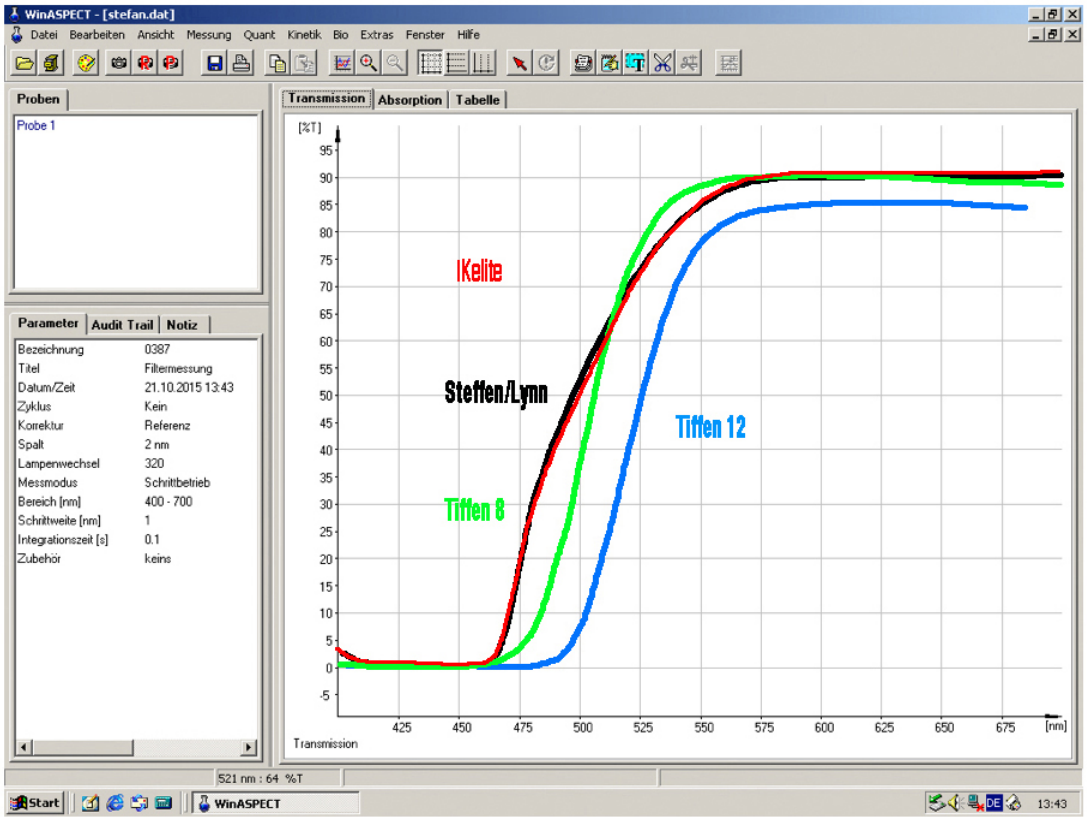


Fig. 24 The yellow filter of FireDiveGear (black line) is identical with the filter from IKELITE (red line).

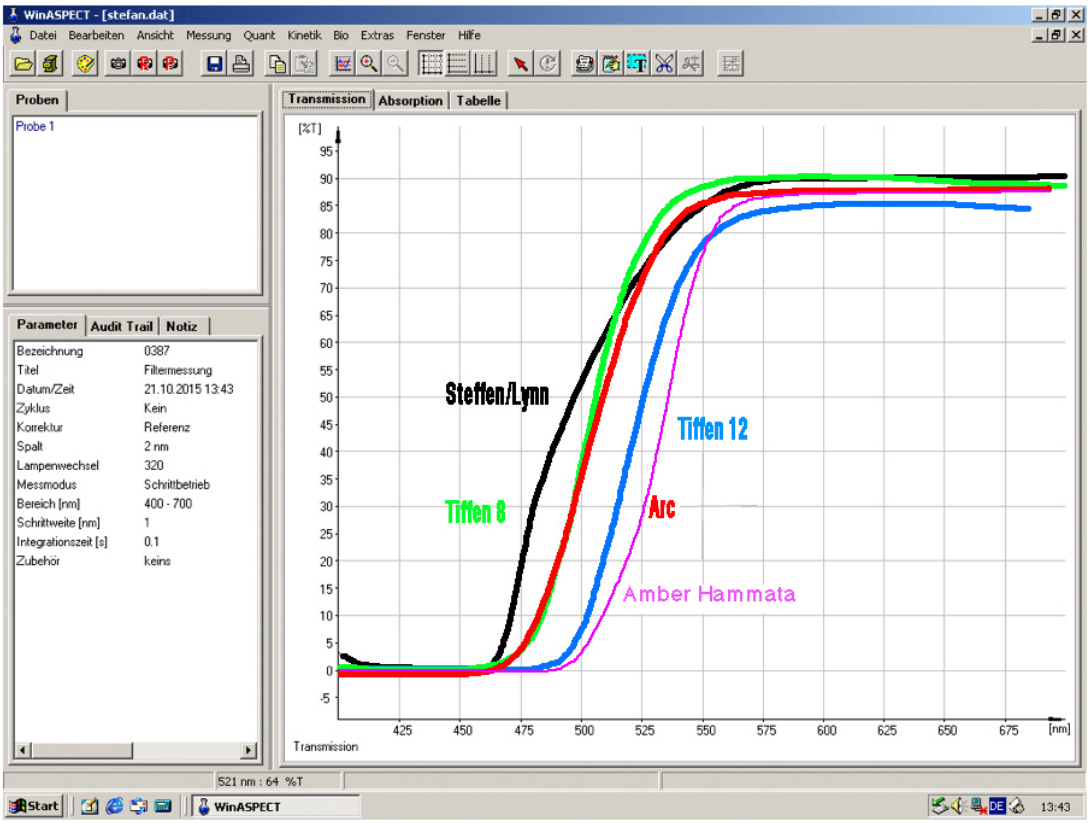


Fig. 25 Again a comparison between Tiffen #12, Tiffen #8 and FireDiveGear

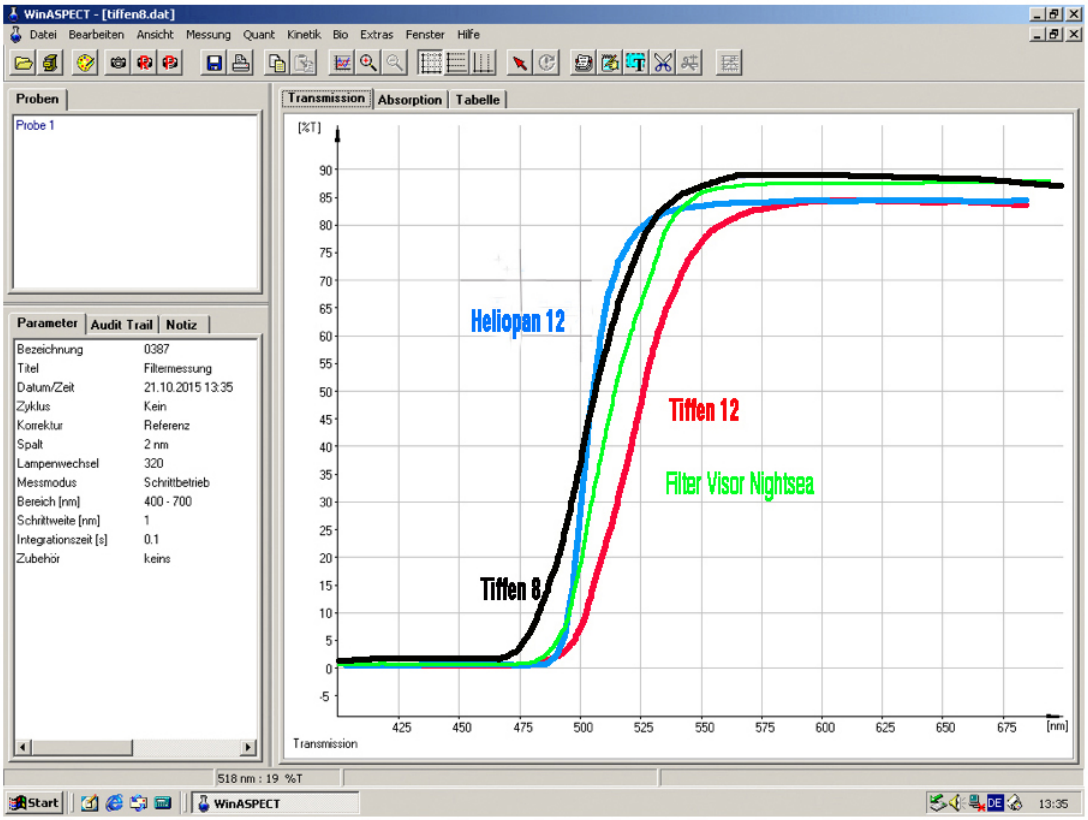


Fig. 30 The green line represents the transmission of the original Nightsea visor.

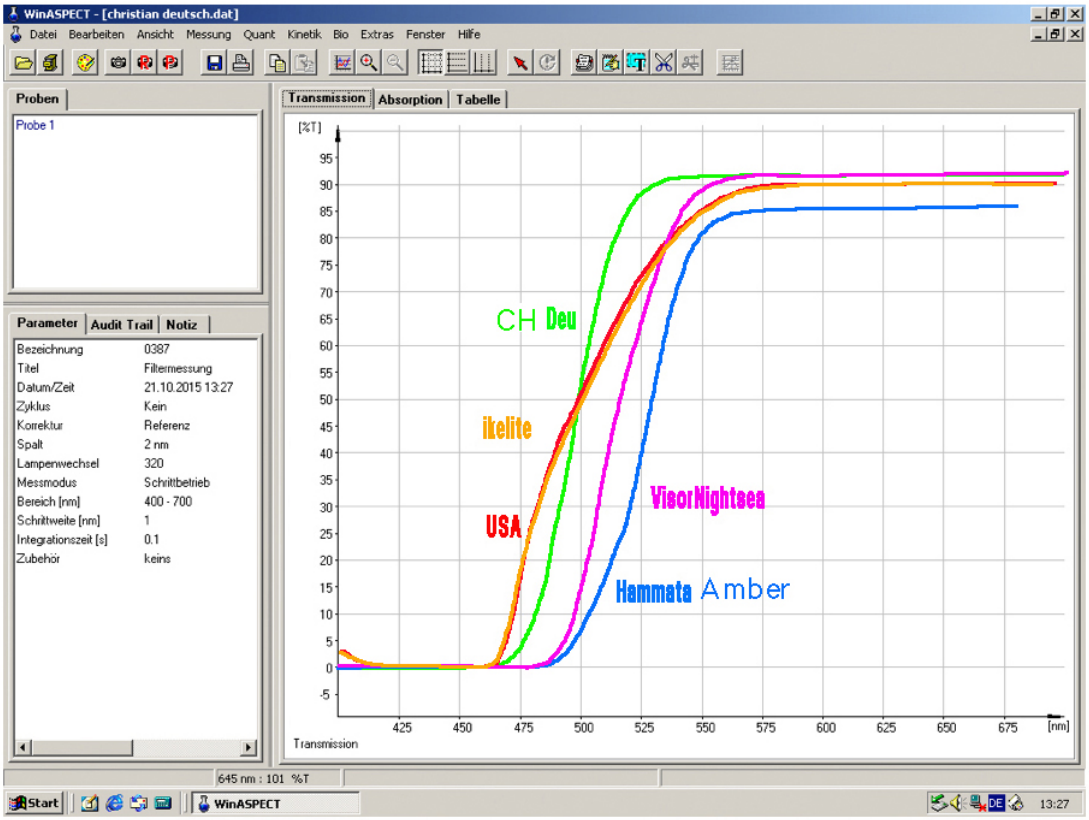


Fig. 31 Direct comparison between our FlipUpVisor (blue line) and the Nightsea Visor (magenta line)

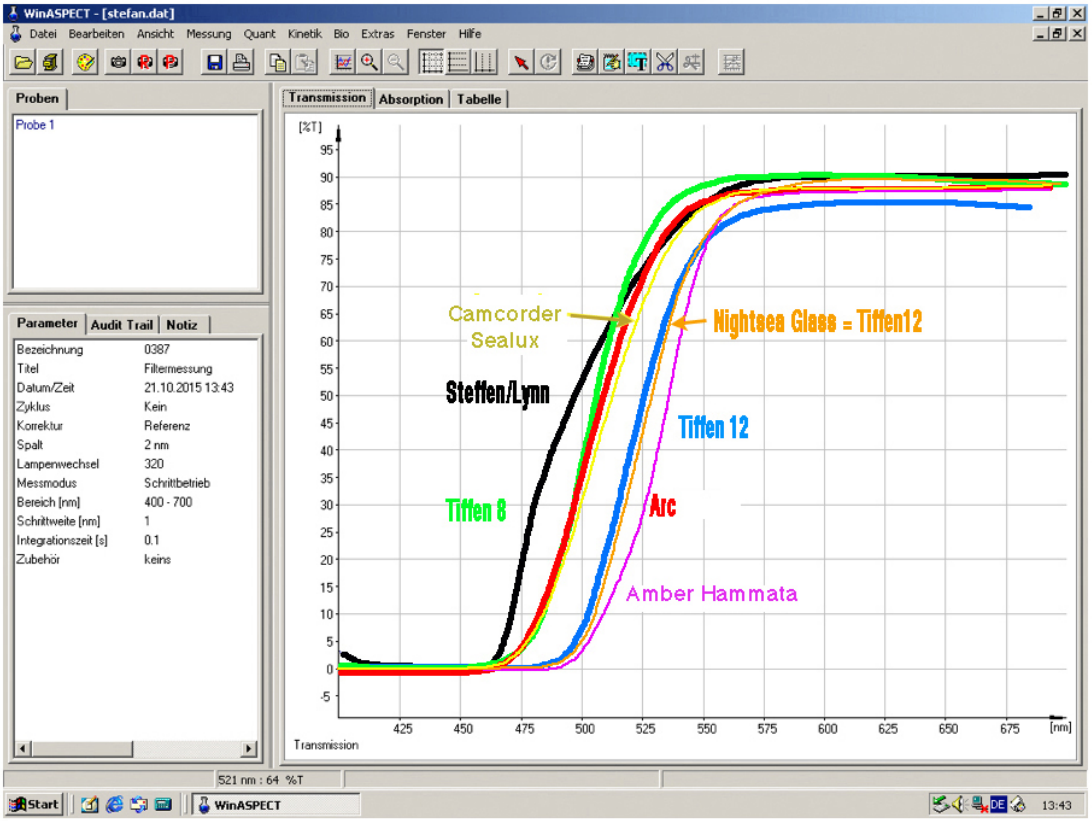


Fig. 26 The yellow filter Arc (red) is identical with Tiffen #8 and my filter at the camcorder housing SEALUX,

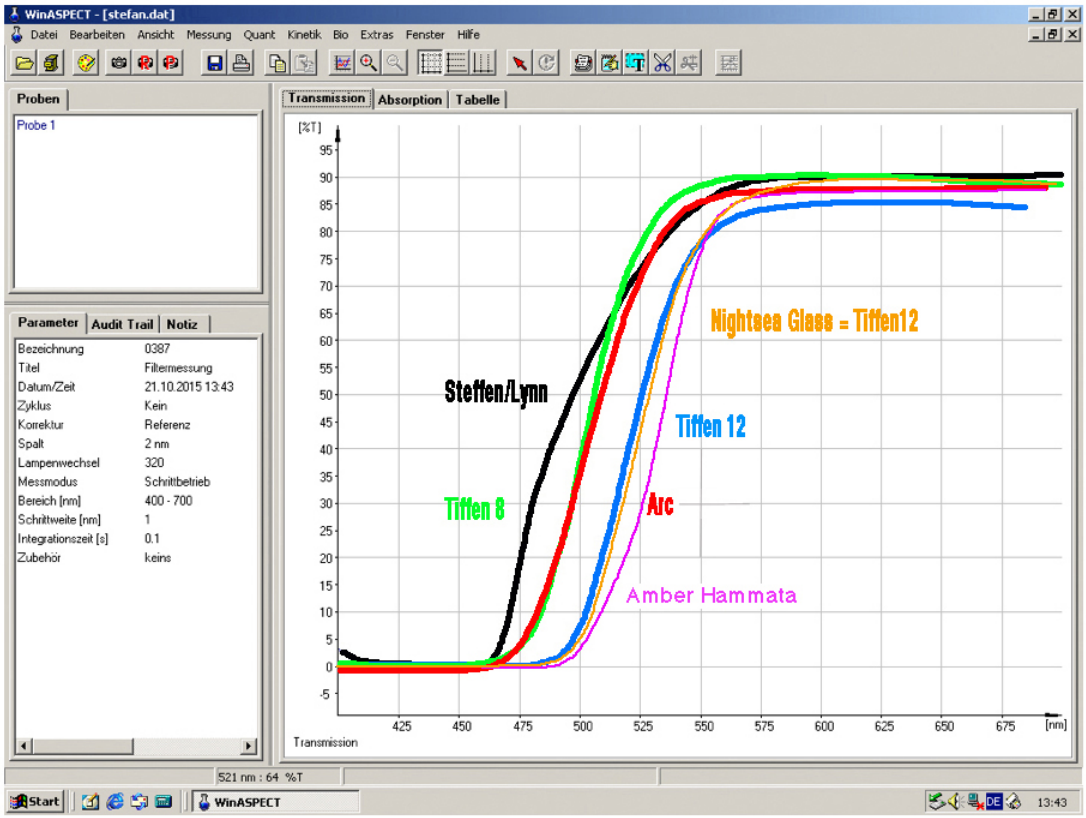


Fig. 27 Tiffen #8 (green line) and Arc (red line) would be a good choice.

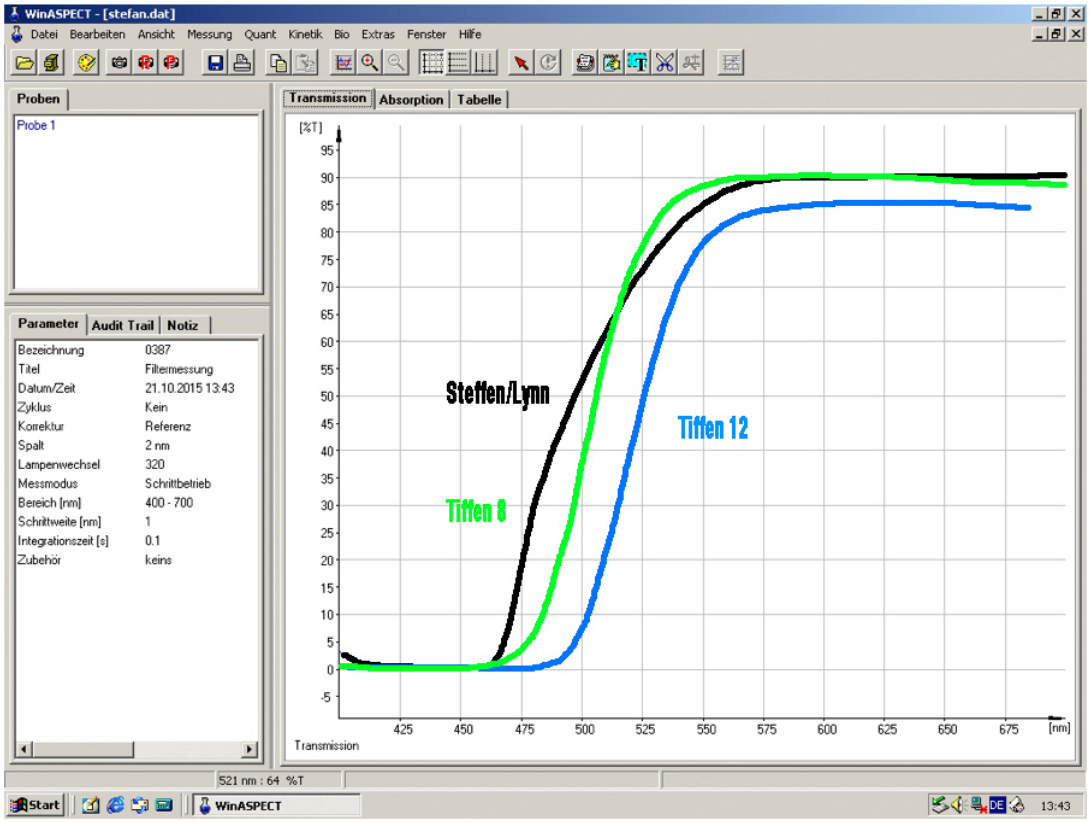


Fig. 28 Here a simple comparison between Tiffen #8, Tiffen #12 and FireDiveGear.

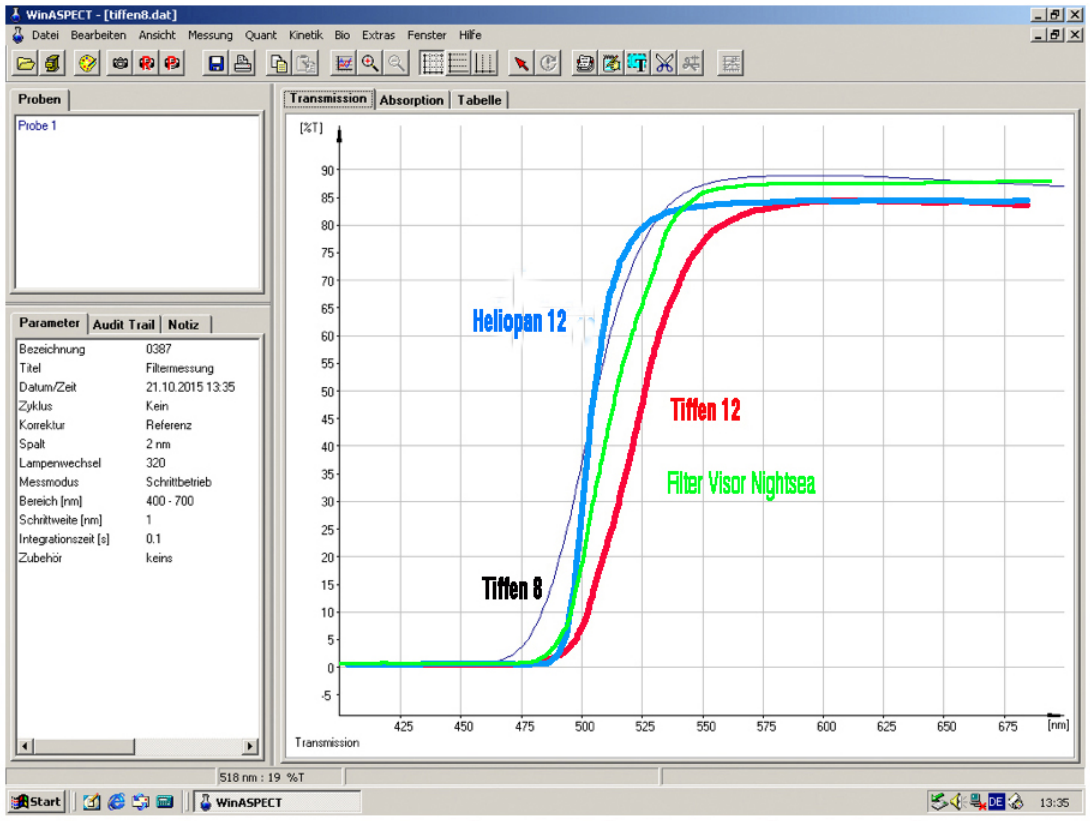


Fig. 29 Heliopan 12 allows the more blue transmission than Tiffen #8.

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http://youtu.be/d85ZNJz0gyY