Using a 660nm laser to expose legacy AgX Agfa, Ilford, HRT (BB) plates

Table of Contents

Using a 660nm laser to expose legacy AgX Agfa, Ilford, HRT (BB) plates
(Holographyforum.org post & discussion)

Post by jrburns47 » Mon Mar 14, 2022, 3:33 pm

Project Description: **Go to Table of Contents**

Twenty four 4x5 inch, red sensitive glass plates exposed to test new Cobolt Flamenco 660nm 500mw laser.

Plate types tested: Agfa 10E75 NAH, Agfa 8E75 (NAH), Agfa 8E75HD (NAH), Ilford SP696T (NAH), HRT BB640 (NAH).

All plates ranging in age from about 20 to 45 years old.

Hologram test setup: H2 transfer camera, H1 was 15 year old 12x16, 8E75HD NAH ruby pulsed portrait master exposed at 694nm transferred to 4x5" H2 image area, 1:1, both H1RC & H2RB collimated.

The purpose of these hologram tests was to ascertain whether or not the 660nm laser wavelength, and, more specifically, the Cobolt Flamenco laser, is suitable for exposing legacy Agfa, Ilford, and HRT red sensitive silver halide hologram plates and film. The plates and film tested were all originally designed for use with 632.8nm, 640nm, and/or 694nm laser light. In summary, the answer is yes, 660nm works well for successful exposures of these legacy materials.

The surprise finding (to me) is that these very old materials have lost two to three orders of magnitude of sensitivity as they've aged. Although not included in this series of test exposures, similar legacy green sensitive materials from the same manufacturers have not lost much sensitivity. Since it's possible to make good exposures on all the red sensitive materials tested, regardless of this loss of sensitivity, it seems possible that it's the red sensitizing dye(s) used that have lost sensitivity.

Some holographers making optical display holograms and using red sensitive legacy materials, particularly the Agfa 8E75HD and Ilford SP696T & SP673, use 632.8nm HeNe lasers with a maximum output power of about 50mw.

Newer SLM DPSS lasers at 640nm are now available at output powers up to 500mw as well as the 500mw 660nm laser used for these tests. Manufacturer's spec sheets for their legacy red sensitive materials show that their materials are very sensitive at 660nm as well as the more typically used 632.8nm and 640nm.

A major difference in these two new lasers is that the 660nm units are about 60% of the cost of the 640nm units and the 660nm units have double the warranty.

Anecdotally, holographers have found these legacy red sensitive materials to be significantly less sensitive than when new. The reasons have been variously ascribed to fogging and dark reaction, etc. while stored. It is this holographer's opinion that the poor results obtained by others, with these much lower power lasers, may have simply been the result of insufficient exposure due to a large loss of red light sensitivity in the legacy materials. The possible proof of this is demonstrated by the good results obtained when these same materials were exposed to two to three orders of magnitude more exposure than was required when new.

I welcome constructive comments and criticisms.

Below is a Dropbox link to an Excel spreadsheet with data on each of the 24 test exposures. I tried to upload it here directly but it's too large (all the photos) for the forum to accept. Please let me know if you have trouble accessing the link.
Please note that the numerous Excel spreadsheet explanatory cell notes and photos will not be visible unless you download the XLSX spreadsheet to a computer (not iPhone or iPad).

Link to Dropbox: https://www.dropbox.com/scl/fi/thlco6vy ... 75fwd0i3gq
Link to Academia.edu page: Joseph Burns

Forum Discussion: **Go to Table of Contents**
Post by Din » Tue Mar 15, 2022, 12:40 pm
jrburns47 wrote: ↑
Mon Mar 14, 2022 3:33 pm
The surprise finding (to me) is that these very old materials have lost two to three orders of magnitude of sensitivity as they’ve aged. Although not included in this series of test exposures, similar legacy green sensitive materials from the same manufacturers have not lost much sensitivity. Since it’s possible to make good exposures on all the red sensitive materials tested, regardless of this loss of sensitivity, it seems possible that it’s the red sensitizing dye(s) used that have lost sensitivity.
Have you any idea why the red sensitive film decayed faster than the green sensitive ones? At one time I thought it may have been differences in grain size, but they all are spec'd at the same grain size. So, I'm inclined to agree it may be the dye. but, why does the red dye decay faster than the green dye. Could it be they react differently to temperature? That is, at the same temperature, one decays faster than the other?

At any rate, the way to test whether it is the dye that makes the difference between red and green dye is to expose them both to blue. Since all silver halide films are blue sensitive, you remove the dye factor from the equation.

Post by dannybee » Thu Mar 17, 2022, 8:28 pm
thanks Din, so if the dye because age or heat becomes bleached, why not just dye it again there by restoring the dyes ability to transfer energy to the silver? mm nice info

Post by jrburns47 » Thu Mar 17, 2022, 11:01 pm
Dinesh,
The point of testing the 660nm laser was that it’s a red laser to expose red sensitive legacy materials. You could be correct about trying a blue laser, assuming one has an appropriate blue laser with which to test. That’s a whole other technical rabbit hole to go down that takes me away from the direction I’m trying to go in - use the red sensitive materials to make good finished display holograms. There’s a sub infinite number of ways to NOT make finished holograms now 😊. That’s certainly one of them 😊.

Dannybee,
As far as re sensitizing a several decades old gelatin emulsion with fresh red dyes - that sounds like another interesting experimental rabbit hole to go down. Have you tried this yourself? After an interesting email back and forth with Mike Medora (BB plates), it sounds like red dyes are a whole interesting sub genre by themselves. John Wiltshire, co-author of an interesting book about optical display holography with Martin Richardson, turns out to be an expert in silver halide emulsion development for holography. It would be interesting to hear his take on this.

Post by Din » Fri Mar 18, 2022 10:02 am
dannybee wrote: ↑
Thu Mar 17, 2022 8:28 pm
thanks Din, so if the dye because age or heat becomes bleached, why not just dye it again there by restoring the dye’s ability to transfer energy to the silver? mm nice info
I suppose you could. This was brought up recently. I think you'd have to choose your dye carefully; it must take in the laser wavelength and transfer some of the energy to the silver halide molecule, so the quantum efficiency of the dye at the laser wavelength determines the appropriate sensitivity.

Post by lobaz » Sun Mar 20, 2022 1:48 pm
Hi Jody,
a few years ago I had exactly the opposite problem: red Agfas (more than 20 years old) worked perfectly, while the green ones were completely dead.

jrburns47 wrote: ↑
Thu Mar 17, 2022 11:01 pm
You could be correct about trying a blue laser, assuming one has an appropriate blue laser with which to test.
You don't need a SLM one for testing plate sensitivity. A blue pointer for a few USD will be enough.
Petr

Post by Din » Sun Mar 20, 2022 6:45 pm
lobaz wrote: ↑
Sun Mar 20, 2022 1:48 pm
Hi Jody,
a few years ago I had exactly the opposite problem: red Agfas (more than 20 years old) worked perfectly, while the green ones were completely dead.

Petr
Petr's observation makes me think it could be caused by random events. If so, this could be due to double random walk ("drunkard's walk") events. This seems to indicate that dark reaction is (probably) the cause.

Post by jrburns47 » Sun Mar 20, 2022 9:25 pm
Petr & Dinesh,
Definitely odd that you had the opposite experience with Agfa materials vis a vis red vs green & thanks for the suggestion re a cheap blue pointer.

Re the blue pointer, I’m old school in the sense that whether or not a plate can be exposed (or not) and turn dark in developer, the only proof to me is if it can record a hologram. I was almost ready to throw out my red sensitive Ilford early in these tests since I was literally getting nothing. It was only after realizing that maybe a comparably MUCH larger exposure might be necessary for the Ilford, based on my prior successful tests in the sequence with the Agfa 10E75, that I finally got a result.

Re your opposite experience red vs green decrease/loss of sensitivity, in my tests with the red sensitive materials, large loss of sensitivity held true, to a greater or lesser degree, across manufacturers, i.e., Agfa, Ilford, HRT BB.

If/when you have time, download the spreadsheet with data about the 24 test plates and open it in Excel on a computer.

Other users of 8E75HD have also told me of a noticeable, if undefined, loss of sensitivity.

Regardless, I agree that storage conditions probably have a significant effect on people’s varying experiences with these legacy materials 😊.

Post by John W » Tue Mar 22, 2022 9:11 pm
Hi Jody,

Have you tried exposing the old red sensitive plates to green laser light?

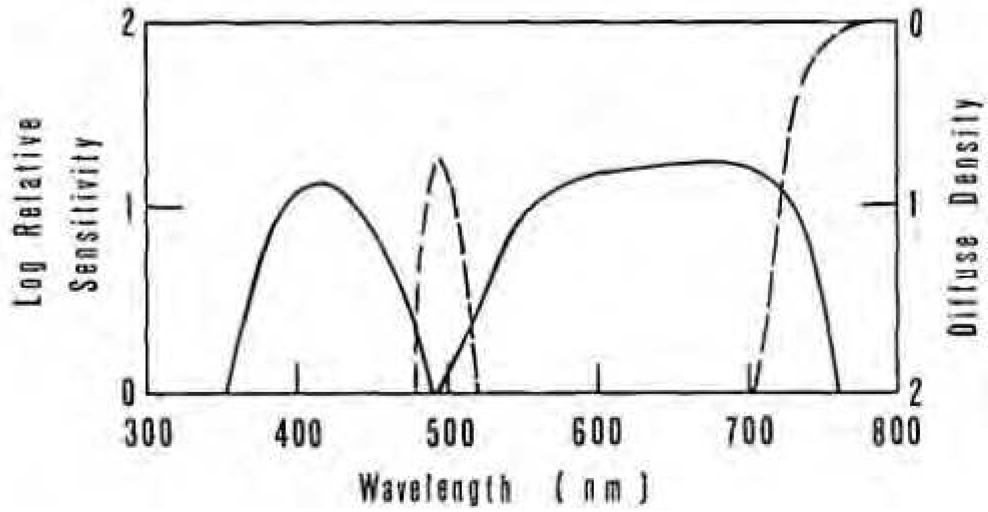
Obviously they don't have the correct dyes to be sensitive to green but given modern green lasers are fairly powerful I wonder if the emulsion would respond anyway?

And a similar thought.... Were you ever to experiment with adding dyes back in to the emulsion... it might be worth thinking about adding green dyes in to a plate that was originally sensitized to red, which would allow you to use the more powerful green lasers with those old red plates.

Post by Din » Wed Mar 23, 2022 9:54 am
John W wrote: ↑
Tue Mar 22, 2022 9:11 pm
Hi Jody

Have you tried exposing the old red sensitive plates to green laser light?

Obviously they don't have the correct dyes to be sensitive to green but given modern green lasers are fairly powerful I wonder if the emulsion would respond anyway?
John,
I think that the red emulsion would respond to green laser light because the sensitivity never actually goes to zero. But, the sensitivity falls quite a lot. Below, the sensitivity curve for 8e75, and you can see it does fall to zero at 500nm, but still has sensitivity at 514 (Argon) or 532 (Yag). I also had a quick look at the sensitivity of Slavich's pfg-01; in that film, there's fall of about 2 orders of magnitude for green. So, if Jody is finding a loss of sensitivity to almost 5 orders of magnitude in red film for red lasers, I'd suspect that there's be a further loss of 2 orders of magnitude, or more, when using a green laser. This is assuming that the dyes have not decayed, or there is no dark reaction, in which case the fall in sensitivity may be even more. Therefore a powerful enough green laser would record on a red sensitized film. But, with a fall of several orders of magnitude, you'd need a very powerful green laser, or, a long exposure, with the associated stability issues.

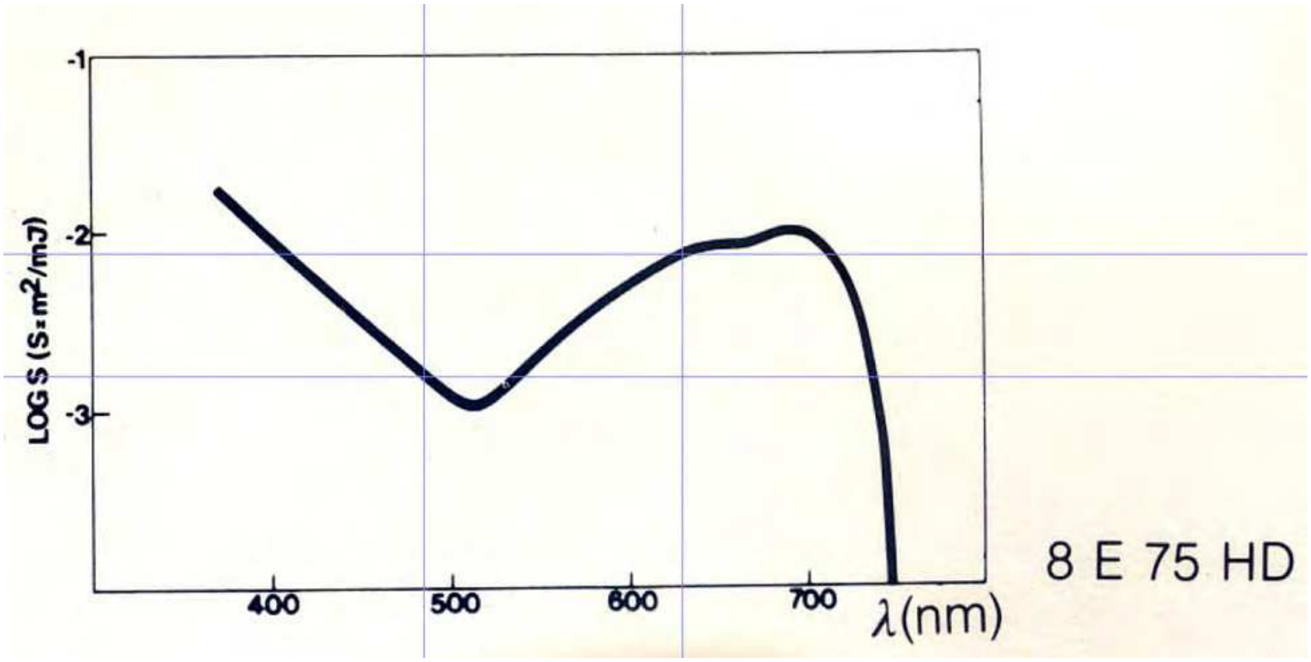


Post by Ed Wesly » Fri Apr 08, 2022 10:53 am
The curve in the post above is not exactly the true picture, as it is a graph of relative sensitivity, not absolute, unlike this curve, from Agfa Technical Information Bulletin 21.7271(688)LI, the rest of the bulletin available here: http://edweslystudio.com/Materials/AgX/ ... 271688.PDF

The absolute sensitivity never falls to zero, just varies over the spectrum, with that area that is the borderline between blue and green, cyan, where the 488 nm line of the Argon laser reigns supreme, is where it dips to its lowest value. The guidelines were put in place to show that the difference between the sensitivity at the He-Ne red of 633 nm is about an order of magnitude greater than that at 488 nm, almost 10X, or about 3 or 4 photographic stops, which are binary orders of magnitude, which is borne out in practical experience.

The -2 on the ordinate (vertical axis) could be translated as 100 microJoules/cm^2, and the -3 as 1000 microJoules/cm^2 or 1 full milliJoule/cm^2, since the axis is logarithmic. These figures are again borne out in practice, as 100- 200 microJoules/cm^2 is usually the bracketing point when I make test exposures at red wavelengths.

Comparing the 2 graphs, the shape of the curve is the same, but the numbering of the relative's ordinate, which is also logarithmic, starts at zero, and ascends as powers of 10, and once again it can be seen that the sensitivity difference between the 2 lambdas is an order of magnitude off. The drawback to the relative graph is that it gives an impression of absolutely no sensitivity, but the zero in a log axis is 10^0 = 1, so that dip is used as unity, the standard of comparison, not as an exposure suggestion.
ATTACHMENTS



8E75HDSensCurve.jpg (103.78 KiB) Viewed 670 times
"We're the flowers in the dustbin" Sex Pistols

Post by Din » Fri Apr 08, 2022 2:42 pm
Ed Wesly wrote: ↑
Fri Apr 08, 2022 10:53 am
The curve in the post above is not exactly the true picture, as it is a graph of relative sensitivity, not absolute, unlike this curve, from Agfa Technical Information Bulletin 21.7271(688)LI, the rest of the bulletin available here: http://edweslystudio.com/Materials/AgX/ ... 271688.PDF
Relative to what? Could you define 'relative sensitivity' , as opposed to 'absolute sensitivity'. Generally, plots such as these are normalised to unity, so that the maximum ordinate is, in effect, 1. Thus, if you're measuring intensity from some source, and I_0 is the maximum intensity, the ordinate is in units of I/I_0, making the maximum =1 (when $I = I_0$). In these cases, the ordinate is relative (normalised) to some constant. However, these curves don't specify any normalisation.

Ed Wesly wrote: ↑
Fri Apr 08, 2022 10:53 am

The absolute sensitivity never falls to zero,
Not entirely so. The sensitivity of silver halide is mostly in the uv/blue region. Silver halide film for photography/holography is infused with dye(s) to extend the sensitivity into the vis. The basic mechanism is a two-electron excitation process, whereby the dye molecule is excited by the radiation and the excited dye molecule passes an electron into the conduction band of the silver halide. However, because the actinic process whereby the dye gets excited occurs over a limited range, any individual dye has a limited range, so different dyes are used for different areas, such as X-Rays for dental photography. For holography, any given emulsion, with it's concommitant dye has a sensitivity over a limited wavelength range.

Ed Wesly wrote: ↑
Fri Apr 08, 2022 10:53 am

The -2 on the ordinate (vertical axis) could be translated as 100 microJoules/cm^2, and the -3 as 1000 microJoules/cm^2 or 1 full milliJoule/cm^2, since the axis is logarithmic. These figures are again borne out in practice, as 100- 200 microJoules/cm^2 is usually the bracketing point when I make test exposures at red wavelengths.
The scale actually states "Log S(S = m²/mJ). " Log(-2) = 1/100. So. S = 1/100 m²/mJ, or 100 mJ/m² (not cm²). Translated to µJ/cm², this comes to 10 µJ/cm², since 10^4 cm² = 1 m²

From "Topics in Applied Physics, vol 20: Holographic recording materials"

Post by Din » Fri Apr 08, 2022 2:42 pm
Ed Wesly wrote: ↑
Fri Apr 08, 2022 10:53 am
The curve in the post above is not exactly the true picture, as it is a graph of relative sensitivity, not absolute, unlike this curve, from Agfa Technical Information Bulletin 21.7271(688)LI, the rest of the bulletin available here: http://edweslystudio.com/Materials/AgX/ ... 271688.PDF
Relative to what? Could you define 'relative sensitivity' , as opposed to 'absolute sensitivity'. Generally, plots such as these are normalized to unity, so that the maximum ordinate is, in effect, 1. Thus, if you're measuring intensity from some source, and I_0 is the maximum intensity, the ordinate is in units of I/I_0, making the maximum =1 (when $I = I_0$). In these cases, the ordinate is relative (normalized) to some constant. However, these curves don't specify any normalization.

Ed Wesly wrote: ↑
Fri Apr 08, 2022 10:53 am

The absolute sensitivity never falls to zero,
Not entirely so. The sensitivity of silver halide is mostly in the uv/blue region. Silver halide film for photography/holography is infused with dye(s) to extend the sensitivity into the vis. The basic mechanism is a two-electron excitation process, whereby the dye molecule is excited by the radiation and the excited dye molecule passes an electron into the conduction band of the silver halide. However, because the actinic process whereby the dye gets excited occurs over a limited range, any individual dye has a limited range, so different dyes are used for different areas, such as X-Rays for dental photography. For holography, any given emulsion, with it's concomitant dye has a sensitivity over a limited wavelength range.

Ed Wesly wrote: ↑
Fri Apr 08, 2022 10:53 am

The -2 on the ordinate (vertical axis) could be translated as 100 microJoules/cm^2, and the -3 as 1000 microJoules/cm^2 or 1 full milliJoule/cm^2, since the axis is logarithmic. These figures are again borne out in practice, as 100- 200 microJoules/cm^2 is usually the bracketing point when I make test exposures at red wavelengths.
The scale actually states "Log S(S = m²/mJ). " Log(-2) = 1/100. So. S = 1/100 m²/mJ, or 100 mJ/m² (not cm²). Translated to µJ/cm², this comes to 10 µJ/cm², since 10^4 cm² = 1 m²

From "Topics in Applied Physics, vol 20: Holographic recording materials"

24 *K. Biedermann*

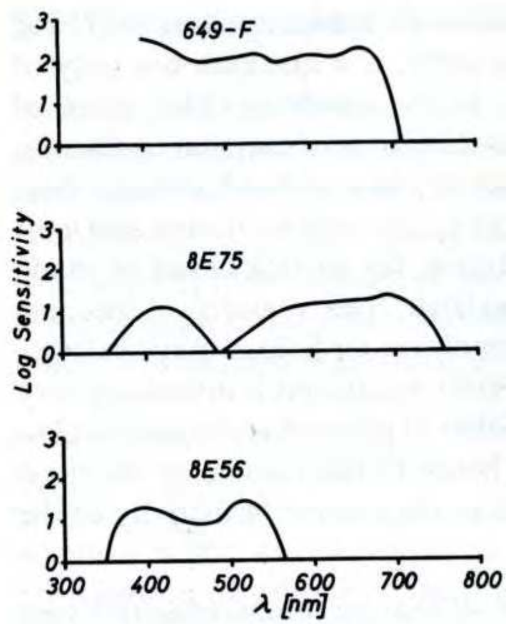


Fig. 2.1. Spectral sensitivity curves of three types of emulsions used in holography: Panchromatic spectroscopic plate Kodak 649-F; Agfa-Gevaert Scientia ("Holotest") 8E75, sensitized for the wavelengths 694 nm of the ruby laser and 633 nm of the He–Ne-laser; Scientia 8E56 sensitized for the wavelengths 454 to 514 nm of the Ar laser

biedermann.jpg (69.43 KiB) Viewed 666 times

END OF FORUM DISCUSSION

Go to Table of Contents

Data all 24 plates have in common:

Go to Table of Contents

Plate size: 4”x5”
Laser wavelength: 660nm
Laser power: 525mw
Laser optical axis: ~10.125”
Distilled water spray after darkroom processing stop step & bleach step
Filtered water wash after bleaching

Individual plate: 1 of 24

Go to Table of Contents

Exposure date: Dec. 21, 2021
Plate # & type: 355-01-2021, SP696T, 4x5", Emulsion batch 45C, NRC 6 wedge exposure mask.

Exposure data:

Exp. Length: 4"
Beam ratio: OB: 60-155 ergs + RB: 150-500 ergs = 840-2620 ergs/cm2/sec = 3-10:1 = Total ergs: 3360-10,480
(Using 840-C meter w/ 818-ST wand detector. Accidentally had attenuator in on position for the readings on this plate thus inaccurate)
Polarization: s-pol & p-pol, (OB HWP2 was accidentally rotated to p-pol!)

Darkroom data:

Temp: 73F
Developer: pyrogallol 2 part, very old BB pyro dev mixed Feb 2020
Dev. Time: 120”
Stop: distilled water in tray
Stop time: 30”
Bleach type: FeEDTA, mixed Feb 28, 2020
Bleach time: 4’30”, 1-3' to clear + 1'30"
Bleach wash time: 10’
PhotoFlo: N/A
Bleach wash temp: ~73F
Chem temp: ~73F

Comment:

NRC 6 wedge photomask. Photo 2 shows emulsion thickness variation only visible in reflected light. Similar to photoresist. Photo is enhanced to show this.

Photos (3): 1 of 24

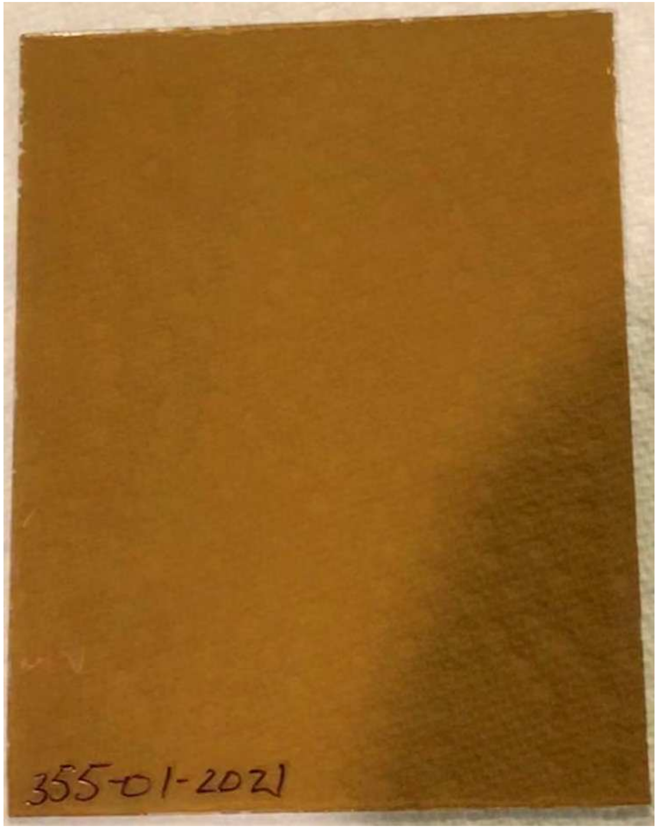


Fig. 1: 355-01-2021 photo 1 of 3

Fig. 2: 355-01-2021 photo 2 of 3

Fig. 3: 355-01-2021 photo 3 of 3

Individual plate: 2 of 24

Go to Table of Contents

Exposure date: Jan. 12, 2022
Plate # & type: 012-01-2022, 10E75NAH, Box labeled Mar 1985, 20 plates

Exposure data:

Exp. Length: 30ms
Beam ratio: OB: 60-155 ergs + RB: 150-500 ergs = 840-2620 ergs/cm2/sec = 3-10:1 = Total ergs: 3360-10,480
(Using 840-C meter w/ 818-ST wand detector. Accidentally had attenuator in on position for the readings on this plate thus inaccurate)
Polarization: s-pol & p-pol, (OB HWP2 was accidentally rotated to p-pol!)

Darkroom data:

Temp: ~70F
Developer: Pyrochrome 2 part, 125ml@ptA&B, mixed 12/29/2021
Dev. Time: 240"
Stop: filtered running water
Stop time: 120-180"
Bleach type: pyrochrome reversal, mixed 12/28/2021
Bleach time: ~120", held upside down in tray, clear + 15"
Bleach wash time: 5'
PhotoFlo: 1-2'
Bleach wash temp: 68-75F
Chem temp: ~70F

Comment:

After bleaching & washing for a couple of minutes, checked for image. Saw no image but saw internal edge scatter on RB side of plate. Took that as sort of a good sign. In both laser light & white light, able to see bottom PH knobs but no image from H1 at all. Can't see top knobs. Guessing it's an inline only from H2RB. TURNED OUT THAT H1RC HAD S-POL & H2RB HAD P-POL!

Photos (2): 2 of 24

Fig. 4: 012-01-2022 photo 1 of 2

Fig. 5: 012-01-2022 photo 2 of 2

Individual plate: 3 of 24

Go to Table of Contents

Exposure date: Jan. 12. 2022
Plate # & type: 012-02-2022, 10E75 NAH, Box labeled Mar 1985, 20 plates

Exposure data:

Exp. Length: 30ms
Beam ratio: OB: 60-155 ergs + RB: 150-500 ergs = 840-2620 ergs/cm2/sec = 3-10:1 = Total ergs: 3360-10,480
(Using 840-C meter w/ 818-ST wand detector. Accidentally had attenuator in on position for the readings on this plate thus inaccurate)
Polarization: s-pol

Darkroom data:

Temp: ~70F
Developer: Pyrochrome 2 part, 125ml@ptA&B, mixed 12/29/2021
Dev. Time: 180"
Stop: filtered running water
Stop time: 120"
Bleach type: pyrochrome reversal, mixed 12/28/2021
Bleach time: 80", 1' clear + 20"
Bleach wash time: 5'
PhotoFlo: 2'
Bleach wash temp: no data
Chem temp: no data

Comment: Eureka! A hologram. Wood grain apparent due NAH plate & s-pol. A little dimmer than I would like. Poss insufficient dev time, too high ratio, &/or too wide an H2RB angle to norm. looks typical of my old experiences w/ reversal bleaches w/ Ruben Nunez.

Photo (1): 3 of 24

Fig. 6: 012-02-2022 photo 1 of 1

Individual plate: 4 of 24

Go to Table of Contents

Exposure date: Jan. 14, 2022
Plate # & type: 014-01-2022, 10E75NAH, Box labeled Mar 1985, 20 plates, NRC 6 wedge exposure mask.

Exposure data:

Exp. Length: 300ms
Beam ratio: OB: 2.5-8mw + RB: 28-35mw = ~350,000 ergs/cm2/sec = 3-10:1 = Total ergs: ~105,000, from this point on, 818-ST wand attenuator was open.
Polarization: s-pol

Darkroom data:

Temp: ~68F
Developer: pyrochrome 2 part, 100ml@ptA&B, mixed 12/29/2021
Dev. Time: 240”
Stop: filtered running water
Stop time: 180”
Bleach type: pyrochrome reversal, mixed 12/28/2021
Bleach time: 120”
Bleach wash time: 5’30”
PhotoFlo: 2’
Bleach wash temp: 64-68F
Chem temp: !68F

Comment:

Best wedge was max exposure w/ very bright clean image. max wedge is free of bluish milkiness that I associated w/ reversal bleach. Maybe if emulsion surface has the bluish milkiness, it's underexposed. Best 10E75/56 I've ever exposed. No apparent burn in even in low ration areas with glasses frames.

<u>Photos (4):</u> <u>4 of 24</u>

Fig. 7: 014-01-2022 photo 1 of 4

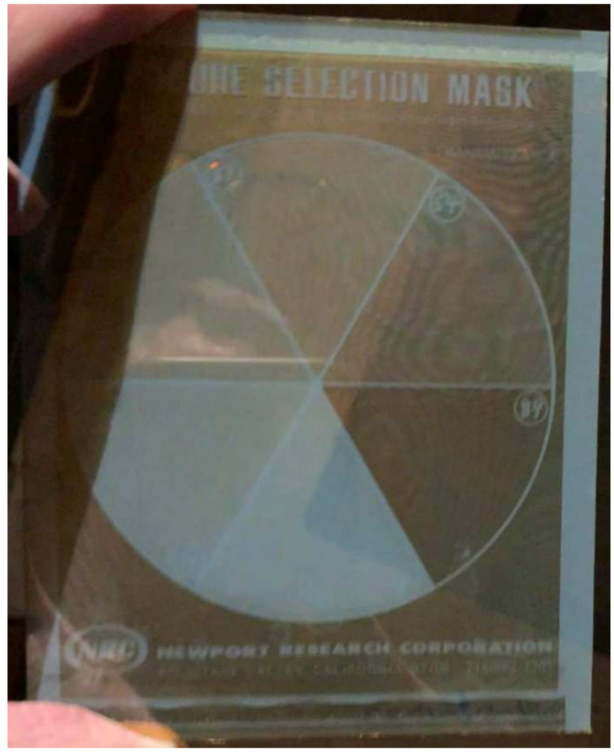


Fig. 8: 014-01-2022 photo 2 of 4

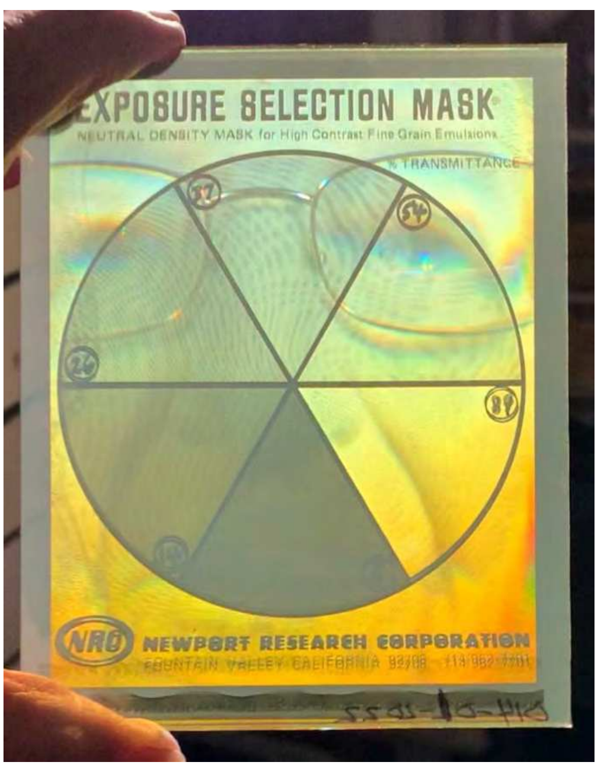


Fig. 9: 014-01-2022 photo 3 of 4

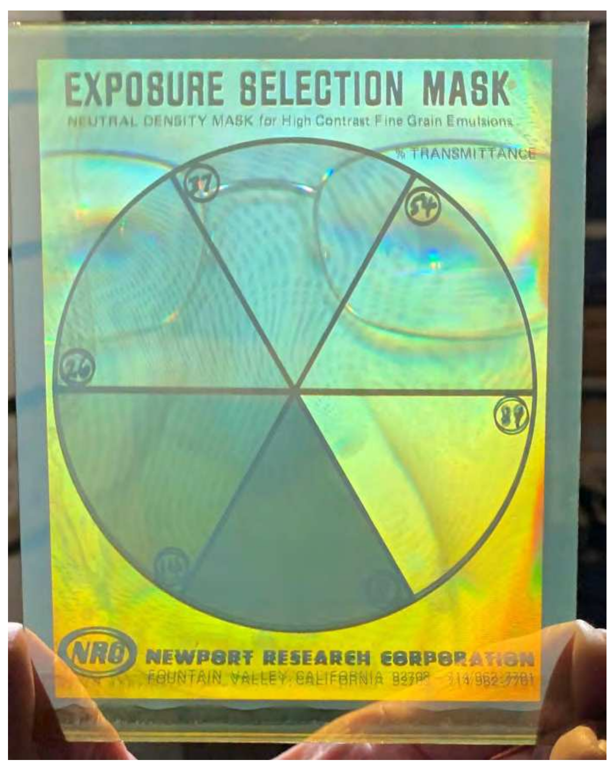


Fig. 10: 014-01-2022 photo 4 of 4

Individual plate: 5 of 24

Go to Table of Contents

Exposure date: Jan. 14, 2022
Plate # & type: 014-02-2022, 10E75NAH, Box labeled Mar 1985, 20 plates, 1st quadrant exposures: 7:47 (left upper), 7:58 (right upper), 8:09 (right lower), 8:21PM (left lower)

Exposure data:

Exp. Length: 200ms, 200ms, 300ms, 400ms, 500ms
Beam ratio: OB: 2.5-8mw + RB: 28-35mw = ~350,000 ergs/cm2/sec = 3-10:1 = Total ergs: 70,000-175,000
Polarization: s-pol

Darkroom data:

Temp: ~67.5F
Developer: pyrochrome 2 part, 90ml@ptA&B, mixed 12/29/2021
Dev. Time: 240”
Stop: filtered running water
Stop time: 180”
Bleach type: pyrochrome reversal, mixed 12/28/2021
Bleach time: 120”
Bleach wash time: 5’30”
PhotoFlo: 2’
Bleach wash temp: ~68F
Chem temp: ~68F

Comment:

Upper right quadrant, 300ms exp, seems best, ~108,000 ergs/cm2, 10,800uw/cm2.

Photos (3): 5 of 24

Fig. 11: 014-02-2022 photo 1 of 3

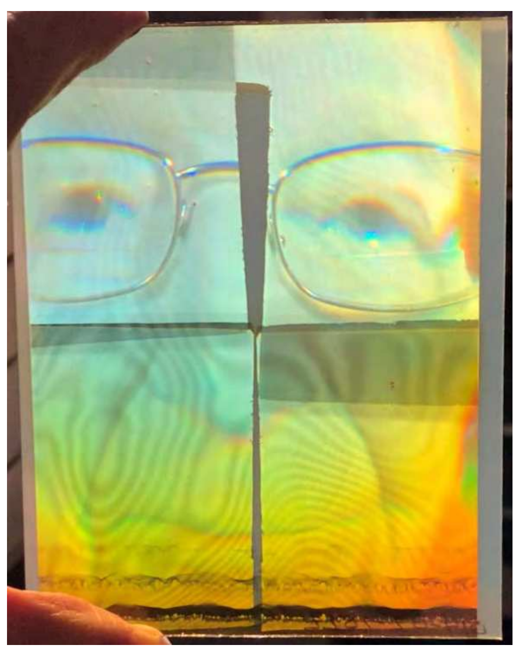


Fig. 12: 014-02-2022 photo 2 of 3

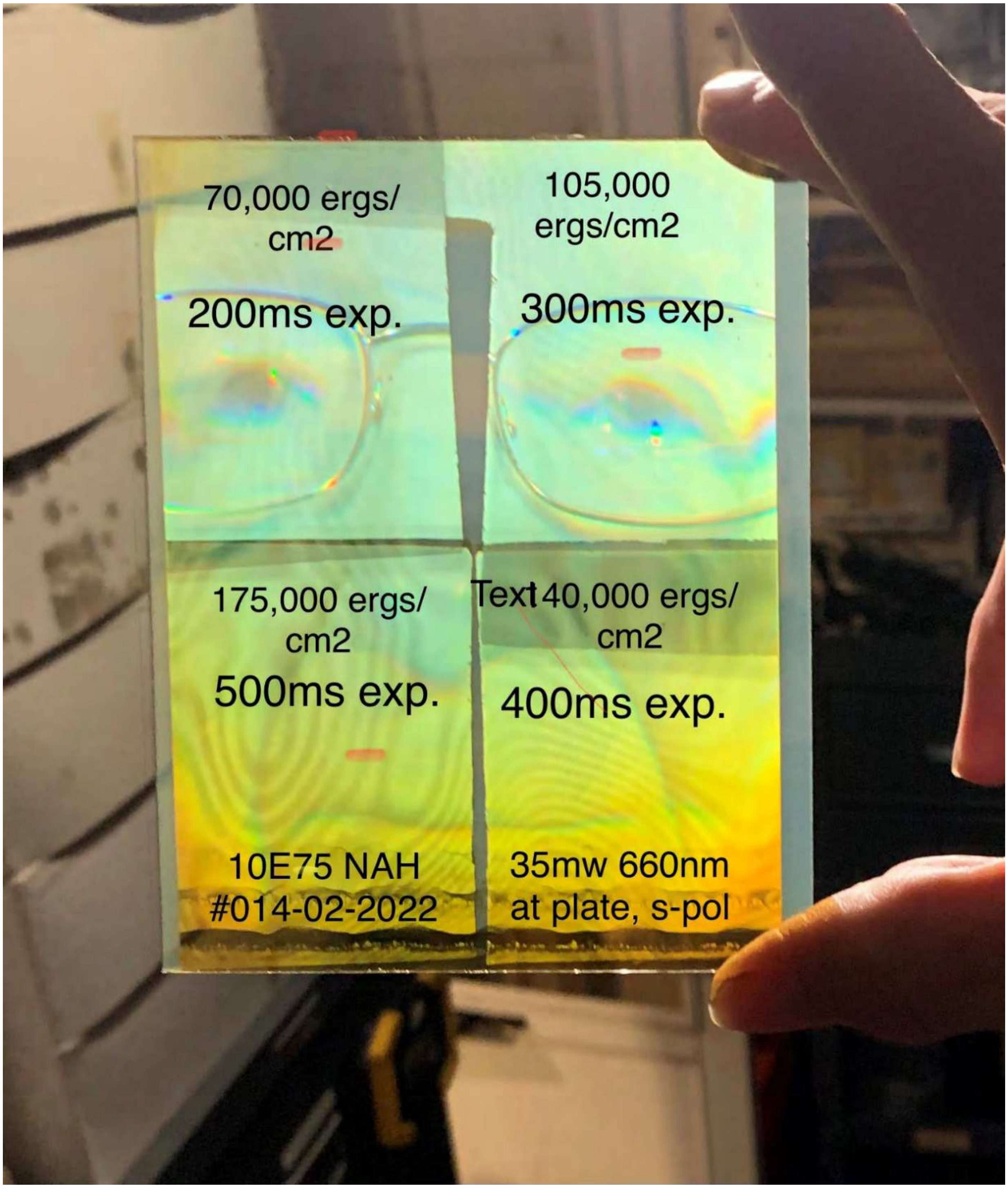


Fig. 13: 014-02-2022 photo 3 of 3

Individual plate: 6 of 24

Go to Table of Contents

Exposure date: Jan. 15, 2022
Plate # & type: 015-01-2022, SP696T, emulsion batch 45C, 2nd quadrant exposures:
6:12 (left upper), 6:31, (right upper) 6:46 (right lower), 7:00 (left lower),

Exposure data:

Exp. Length: 300ms, 300ms, 600ms, 900ms, 1800ms
Beam ratio: OB: 2.5-8mw + RB: 28-35mw = ~350,000 ergs/cm2/sec = 3-10:1 = Total ergs: ~105,000, ~210,000, ~315,000, ~630,000 ergs
Polarization: s-pol

Darkroom data:

Temp: no data
Developer: pyrochrome 2 part, mixed fresh ptA&B 1/15/2022
Dev. Time: 240”
Stop: filtered running water
Stop time: 180”
Bleach type: FeEDTA
Bleach time: 120”
Bleach wash time: 5’30”
PhotoFlo: 2’
Bleach wash temp: no data
Chem temp: no data

Comment:

No apparent exposure at all - no difference between image area & PH blocked area - nice even tanning over entire plate.

Photos (2): 6 of 24

Fig. 14: 015-01-2022 photo 1 of 2

Fig. 15: 015-01-2022 photo 2 of 2

Individual plate: 7 of 24

Go to Table of Contents

Exposure date: Jan. 16, 2022
Plate # & type: 016-01-2022, SP696T, emulsion batch 45C

Exposure data:

Exp. Length: 600ms
Beam ratio: OB: 2.5-8mw + RB: 28-35mw = ~350,000 ergs/cm2/sec = 3-10:1 = Total ergs: ~210,000 ergs
Polarization: s-pol

Darkroom data:

Temp: ~67F
Developer: D-19, mixed 1/16/2022
Dev. Time: 35-40"
Stop: Kodak very dilute stop bath
Stop time: 30"
Fix: F-24, mixed 12/23/2021
Fix time: 150"
Fix wash time: 10'
Fix wash temp: 68F
Chem temp: no data

Comment:

Processed w/ only Dev, Stop, Fix. Probably overdeveloped but nothing there.

Photos (2): 7 of 24

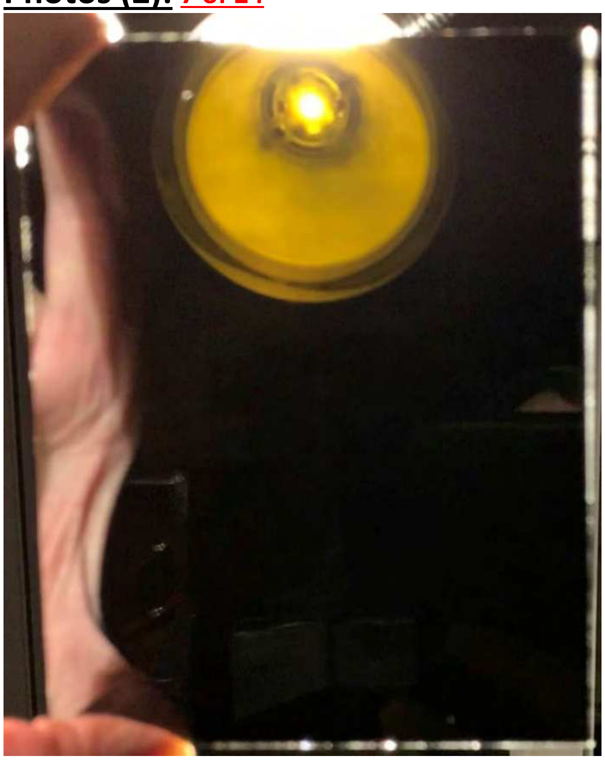


Fig. 16: 016-01-2022 photo 1 of 2

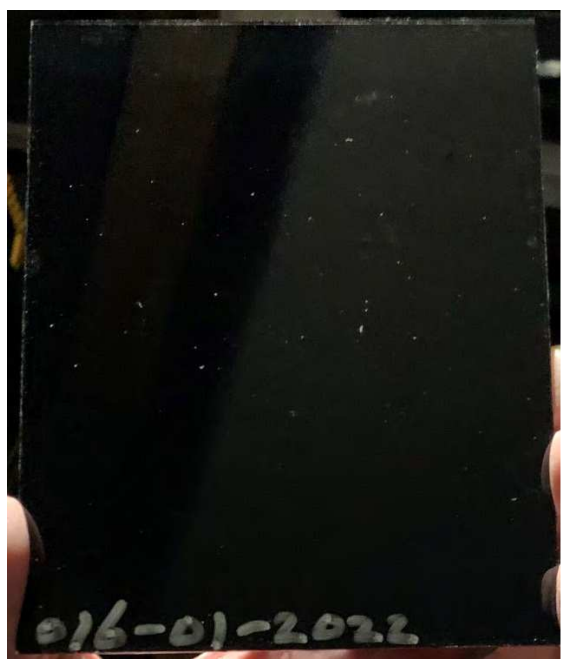


Fig. 17: 016-01-2022 photo 2 of 2

Individual plate: 8 of 24

Go to Table of Contents

Exposure date: Jan. 16, 2022
Plate # & type: 016-02-2022, 8E75, very old 8E75 not AH & not HD (only 2 plates of this)

Exposure data:

Exp. Length: 300ms
Beam ratio: OB: 2.5-8mw + RB: 28-35mw = ~350,000 ergs/cm2/sec = 3-10:1 = Total ergs: ~105,000
Polarization: s-pol

Darkroom data:

Temp: ~67F
Developer: pyrochrome 2 part
Dev. Time: 240"
Stop: filtered running water
Stop time: 150"
Bleach type: pyrochrome reversal
Bleach time: 150"
Bleach wash time: 5'30"
PhotoFlo: 2'
Bleach wash temp: ~68F
Chem temp: no data

Comment:

No apparent image - may have been overexposed.

Photos (2): 8 of 24

Fig. 18: 016-02-2022 photo 1 of 2

Fig. 19: 016-02-2022 photo 2 of 2

Individual plate: 9 of 24

Go to Table of Contents

Exposure date: Jan. 20, 2022
Plate # & type: 20-01-2022, 8E75, very old 8E75 nor AH & no HD (only 2 plates of this), 3rd quadrant exposures: 12:20 (left upper), 12:39 (right upper), 12:52 (right lower), 1:08 (left lower)

Exposure data:

Exp. Length: 10ms, 20ms, 40ms, 80ms
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 2,400-19,200
Polarization: s-pol

Darkroom data:

Temp: 67.7F
Developer: pyrogallol 2 part
Dev. Time: 210"
Stop: filtered running water
Stop time: 150"
Bleach type: pyrochrome reversal
Bleach time: 160"
Bleach wash time: 5'30"
PhotoFlo: 2'
Bleach wash temp: 68F
Chem temp: no data

Comment:

Changed beam ratio slightly. Processed ~ 17 hours after exposure. Type of dev unclear. Probably way too dark dev (no safelight visible through plate). After drying, a little scummy on emul side, wiped off w/ white cotton glove, maybe dried photoflo? Could be some exposure around edges.

Photos (2): 9 of 24

Fig. 20: 020-01-2022 photo 1 of 2

Fig. 21: 020-01-2022 photo 2 of 2

Individual plate: 10 of 24

Go to Table of Contents

Exposure date: Jan. 20, 2022
Plate # & type: 020-02-2022, SP696T, emulsion batch 57D, NRC 6 wedge mask

Exposure data:

Exp. Length: 300ms
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~72,000
Polarization: s-pol

Darkroom data:

Temp: 67-68F mixed 12/27/2021
Developer: BB Ascorbic acid
Dev. Time: 40”
Stop: filtered running water
Stop time: 60”
Bleach type: FeEDTA
Bleach time: 150”
Bleach wash time: 6’
Bleach wash temp: 65F
Ethyl#1: ~5’
Ethyl#2: ~3’
Ethyl#3: ~2’
Ethyl spray: sprayer failed
Chem temp: no data

Comment:

BB in dev name means a Colour Holographics version of the dev mixing formula. Switched from PhotoFlo to graded ethanol drying: 50/50, 70/30, 90/10 & 99% spray. Ethanol solutions not tested with hydrometer. No image - could be imagining but looks like something tried to be there.

Photo (1): 10 of 24

Fig. 22: 020-02-2022 photo 1 of 1

Individual plate: 11 of 24

Go to Table of Contents

Exposure date: Jan. 20, 2022
Plate # & type: 020-03-2022, 8E75HD NAH, NRC 6 wedge exposure mask

Exposure data:

Exp. Length: 300ms
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~72,000
Polarization: s-pol

Darkroom data:

Temp: 67-68F
Developer: BB Ascorbic acid
Dev. Time: 30-35”
Stop: filtered running water
Stop time: 360”
Bleach type: FeEDTA
Bleach time: 90”
Bleach wash time: 7’
~~Bleach~~ wash temp: 68F
Ethyl#1: 5’
Ethyl#2: 3’
Ethyl#3: 2’
Ethyl spray: yes
Chem temp: no data

Comment:

Came out, area of greatest exposure was best, needs more exposure and maybe ratio could be lower since no burn in. Best was 300ms, wood grain apparent. 1st perceptible exp was at NRC wedge 37%, about 26,640 ergs/cm2.

Photo (1): 11 of 24

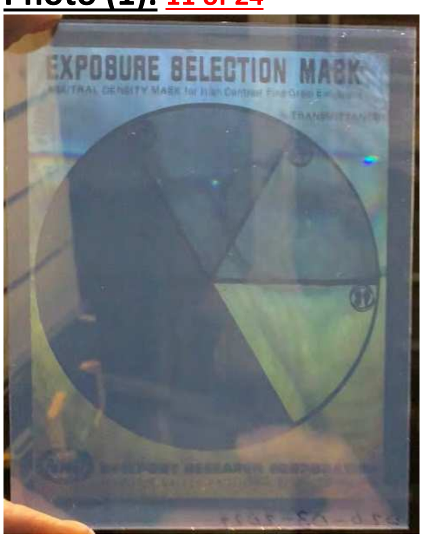


Fig. 23: 020-03-2022 photo 1 of 1

Individual plate: 12 of 24

Go to Table of Contents

Exposure date: Jan. 22, 2022
Plate # & type: 022-01-2022, SP696T, emulsion batch 45C, NRC 6 wedge exposure mask

Exposure data:

Exp. Length: 83”, set up remote shutter in darkroom.
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~19,920,000
Polarization: s-pol

Darkroom data:

Temp: ~69F
Developer: Nick's #5 catechol 2 part, Nick's#5 formulation for **Ilford**.
Mixed 12/28/2021
Dev. Time: 80”
Stop: filtered running water
Stop time: 240”
Bleach type: FeEDTA
Bleach time: 170”
Bleach wash time: 6’30”
~~Bleach~~ wash temp: 69+F
Ethyl#1: 6’
Ethyl#2: 3’
Ethyl#3: 2+’
Ethyl spray: yes
Chem temp: no data

Comment:

Deved ~ 7 hours after exposure. Dev started @~20". **Finally, a result from SP696T!** Area around NRC mask edges and max exp wedge are clearly the best.

Photo(1): 12 of 24

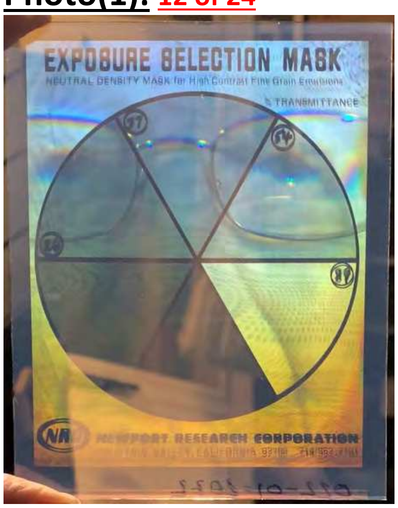


Fig. 24: 022-01-2022 photo 1 of 1

Individual plate: 13 of 24

Go to Table of Contents

Exposure date: Jan. 22, 2022
Plate # & type: 022-02-2022, 8E75HD, 4th quadrant exposure:
4:13 (left upper), 4:25 (right upper), 4:38PM (right lower), 4:51 (left lower)

Exposure data:

Exp. Length: 1”, 2”, 3”, 4”
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 240,000-960,000
Polarization: s-pol

Darkroom data:

Temp: ~69.5F
Developer: Nick’s #5 catechol 2 part, Nick's#5 for **Agfa**.
Mixed 12/28/2021
Dev. Time: 210”
Stop: filtered running water
Stop time: 180”
Bleach type: FeEDTA
Bleach time: 160”
Bleach wash time: 9’
~~Bleach~~ wash temp: ~69F
Ethyl#1: 6’
Ethyl#2: 3’
Ethyl#3: 2+’
Ethyl spray: yes
Chem temp: no data

Comment:

4" exp best. Interesting overlap between 3'&4" exposures. Try quadrant test bracketing 7' exp. **Starting to be a "pop" on this plate.**

Photo (1): 13 of 24

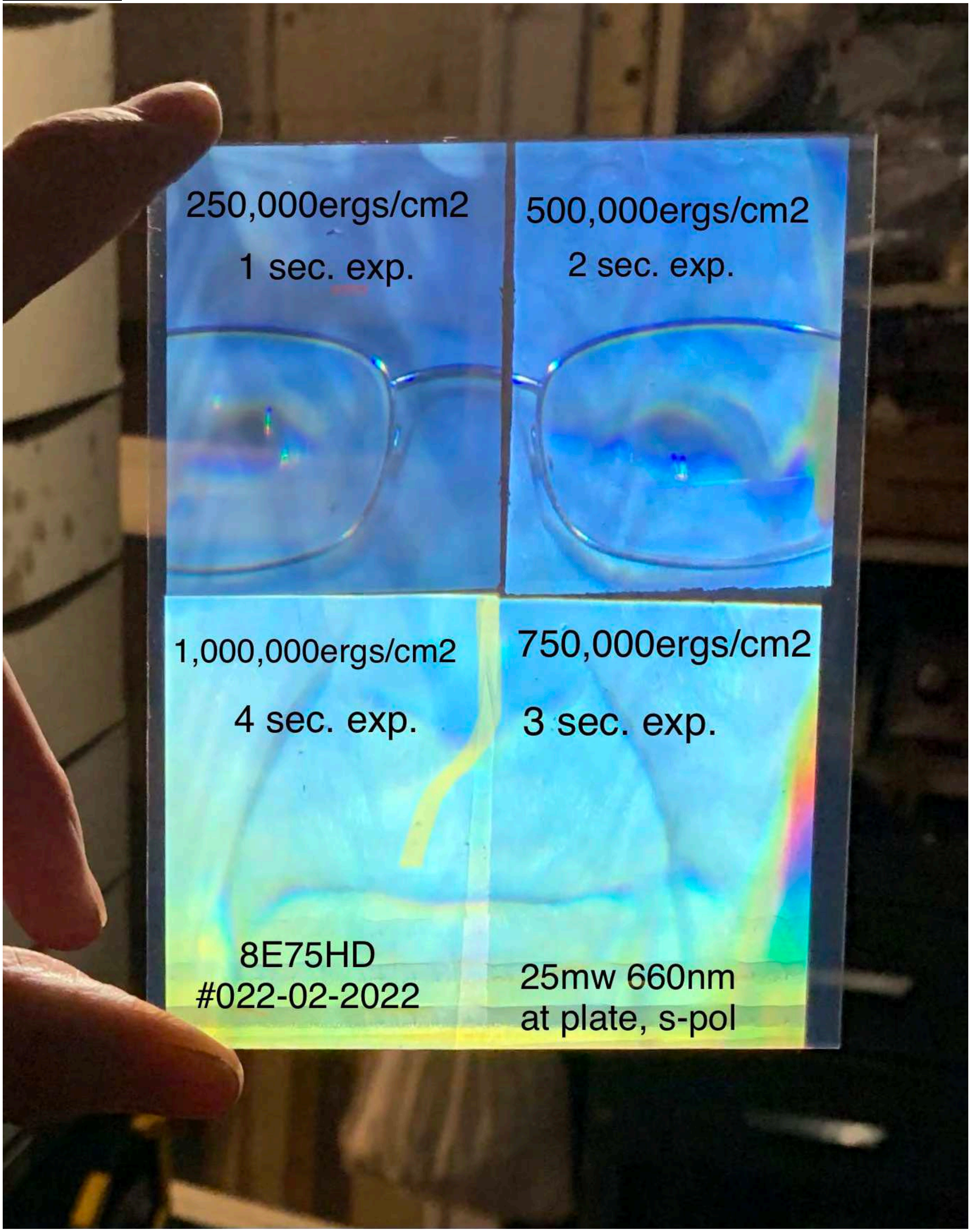


Fig. 25: 022-02-2022 photo 1 of 1

Individual plate: 14 of 24

Go to Table of Contents

Exposure date: Jan. 24, 2022
Plate # & type: 024-01-2022, 8E75HD, 5th quadrant exposure:
10:49 (left upper), 11:02 (right upper), 11:15 (right lower), 11:28 (left lower)

Exposure data:

Exp. Length: 5”, 6”, 7”, 8”
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 1,200,000-1,920,000
Polarization: s-pol

Darkroom data:

Temp: ~69.8F
Developer: Nick’s #5 catechol 2 part, Nick's#5 for **Agfa**.
Dev. Time: 240”, 18+ hours after exposing.
Stop: filtered running water
Stop time: 180”
Bleach type: FeEDTA
Bleach time: 240”, 3' total clr +1'
Bleach wash time: 9’
~~Bleach~~ wash temp: ~69F
Ethyl#1: 6’
Ethyl#2: 4’
Ethyl#3: 2’30”
Ethyl spray: yes
Chem temp: no data

Comment:

5" is best. Quadrant 1.

Photos (4): 14 of 24

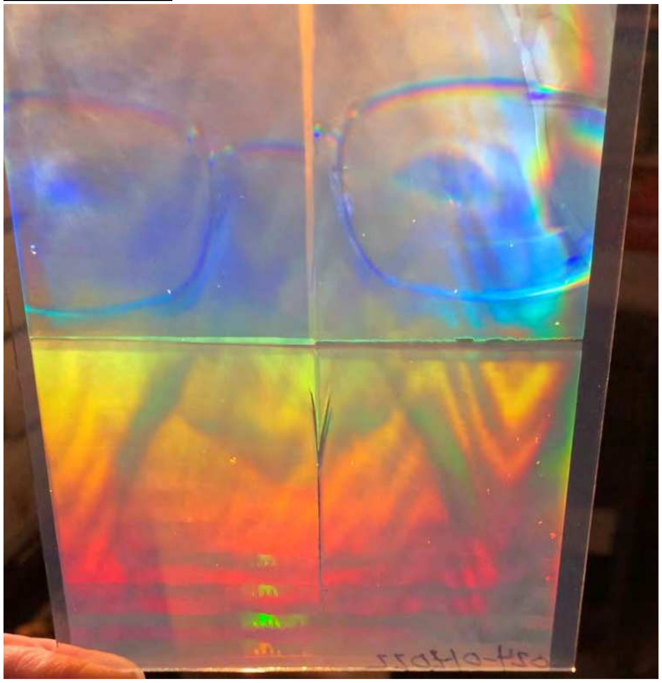


Fig. 26: 024-01-2022 photo 1 of 4

Fig. 27: 024-01-2022 photo 2 of 4

Fig. 28: 024-01-2022 photo 3 of 4

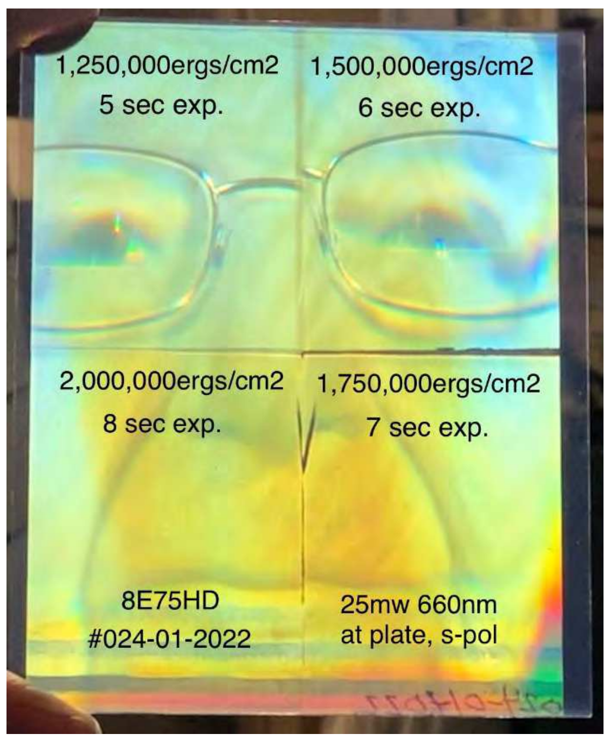


Fig. 29: 024-01-2022 photo 4 of 4

Individual plate: 15 of 24

Go to Table of Contents

Exposure date: Jan. 24, 2022
Plate # & type: 024-02-2022, SP696T, emulsion batch 45C, 6th quadrant exposure:
11:43 (left upper), 12:00AM (right upper), 12:20AM (right lower), 12:37AM (left lower)

Exposure data:

Exp. Length: 83", 130", 170", 210"
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 19,920,000-50,400,000
Polarization: s-pol

Darkroom data:

Temp: ~69.8F
Developer: Nick's #5 catechol 2 part, Nick's#5 formulation for **Ilford**.
Dev. Time: 240”, 18+ hours after exposing.
Stop: filtered running water
Stop time: 180”
Bleach type: FeEDTA
Bleach time: 300”, 3'30" total clr +1'30".
Bleach wash time: 9’
~~**Bleach**~~ **wash temp:** 68F
Ethyl#1: 6’
Ethyl#2: 4’
Ethyl#3: 2’30”
Ethyl spray: yes
Chem temp: no data

Comment:

Pleased that SP696T is finally giving good result. Just needed a lot more total exposure. 170" is best. (quadrant 3). Need to do AH coating or use p-pol since ALL previous exposures regardless of material have had wood grain. See plate 045-01 for stains as well.

Photo (1): 15 of 24

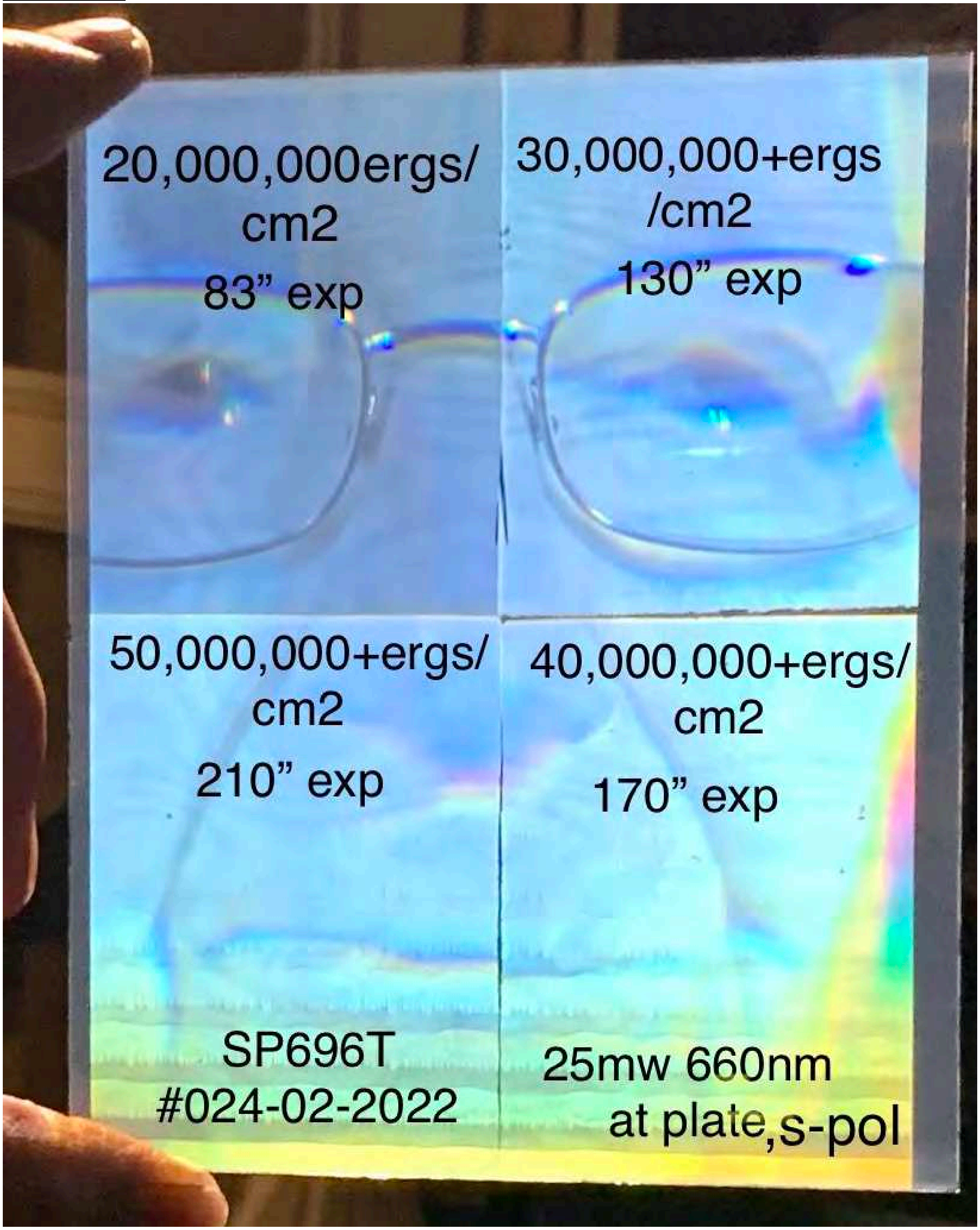


Fig. 30: 024-02-2022 photo 1 of 1

Individual plate: 16 of 24

Go to Table of Contents

Exposure date: Feb. 4, 2022
Plate # & type: 035-01-2022, SP696T, emulsion batch 45C, 1/4" 235 tape along H2RB plate edge to prevent edge scatter.

Exposure data:

Exp. Length: 170”
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~40,800,000
Polarization: **changed to p-pol**

Darkroom data:

Temp: 67.5F
Developer: Nick's #5 catechol 2 part, Nick's#5 formulation for **Ilford**.
Dev. Time: 90”, pretty dark.
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 240”, 2-2'30" clear, total 4'.
Bleach wash time: 10’
~~**Bleach**~~ **wash temp:** no data
Ethyl#1: 5’
Ethyl#2: 5’
Ethyl#3: 3’
Ethyl spray: yes
Chem temp: no data

Comment:

Looks decent. No woodgrain so p-pol worked & no edge scatter. Took out of drying cabinet after 17' and there was a drying line about 1/2" from bottom. Could also be improper water alcohol rqtio(s) in Ethanol baths & spray. Looking at 696T 024-02 & 035-01 side by side & looks like 4' dev time is better.

Photos (2): 16 of 24

Fig. 31: 035-01-2022 photo 1 of 2

Fig. 32: 035-01-2022 photo 2 of 2

Individual plate: 17 of 24

Go to Table of Contents

Exposure date: Feb. 5, 2022

Plate # & type: 036-01-2022, SP696T, emulsion batch 45C

Exposure data:

Exp. Length: 240"
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~40,800,000
Polarization: p-pol

Darkroom data:

Temp: 66.6F
Developer: Nick's #5 catechol 2 part, Nick's#5 formulation for **Ilford**. ~ 17 hours in tray before this use.
Dev. Time: 240", this Nicks#5ILF in tray ~17 hours.
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 345", 3-4' clear + 1'45", 5'45" total.
Bleach wash time: 11'30"
~~Bleach~~ wash temp: 68+F
Ethyl#1: 5'30"
Ethyl#2: 5'
Ethyl#3: 4'
Ethyl spray: yes
Chem temp: no data

Comment:

longer dev is definitely better. Image has more definition & the projected nose is more solid as are watery eyes.

Photo (1): 17 of 24

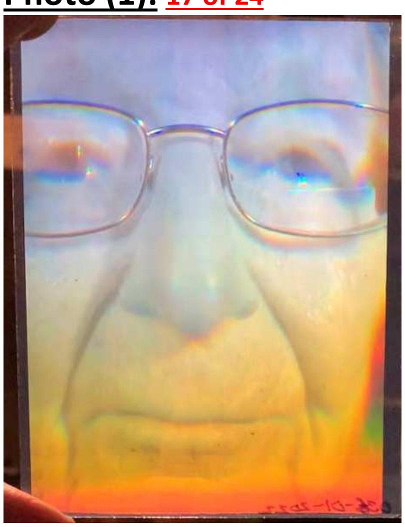


Fig. 33: 036-01-2022 photo 1 of 1

Individual plate: 18 of 24

Go to Table of Contents

Exposure date: Feb. 5, 2022
Plate # & type: 036-02-2022, 8E75HD

Exposure data:

Exp. Length: 5”
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~1,200,000
Polarization: p-pol

Darkroom data:

Temp: 66.7F
Developer: Nick’s #5 catechol 2 part, Nick's#5 for **Agfa**.
Dev. Time: 30-40”
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 95”, 50" clear + 45".
Bleach wash time: 10’
~~Bleach~~ wash temp: 68.5F
Ethyl#1: 5’30”
Ethyl#2: 5’
Ethyl#3: 4’
Ethyl spray: yes
Chem temp: no data

Comment:

036-02 definitely a little better than 036-01. Haven't yet found the sweet spot for SP696T. Both today's tests had drying lines. Need to check alcohol baths mixtures w/ hydrometer.

Photos (2): 18 of 24

Fig. 34: 036-02-2022 photo 1 of 2

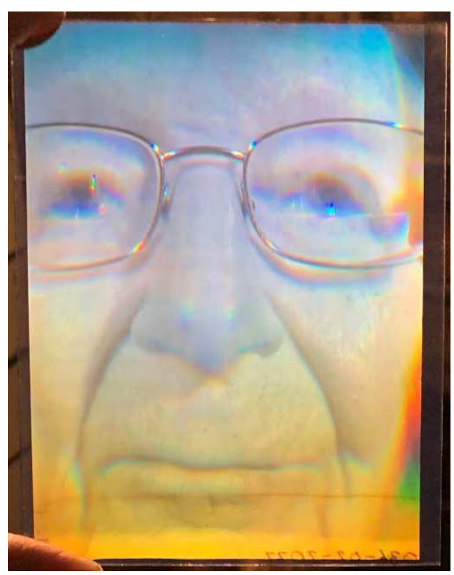


Fig. 35: 036-02-2022 photo 2 of 2

Individual plate: 19 of 24

Go to Table of Contents

Exposure date: Feb. 12, 2022

Plate # & type: 043-01-2022, SP696T, emulsion batch 45C, **TEA presensitized 1-1.5% 26C about 15 hours before.**

Exposure data:

TEA presensitization: mixed liter of 1-1.5% TEA w/ ~10 drops Photoflo. ~26C when presensitizing these 6 plates, 2' @. Then 10-30" tray of distilled H2O w/~10 drops photoflo. Then wiped blade edge of squeegee w/ photoflo fm tray & then squeegee 3 times emul side & 2-3 times glass side & wiped edges of @glass plate w/ blue shop towel. Air dried w/ hairdryer both sides ~2' @plate & into labeled transfer boxes. Bottom plate of two in transfer box had plastic edge guards to act as plate separators.

Exp. Length: 1st 20 data point exposures: 80" (1B), 60" (2B), 40" (3T), 20" (4T). Settle time for @~10'.
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 19,200,000-4,800,000
Polarization: p-pol

Darkroom data:

Temp: 69.8F
Developer: Nick’s #5 catechol 2 part, Nick's#5 formulation for **Ilford**.
Dev. Time: 300”, 2nd 5 step dev test, plastic container: 5', 4', 3', 2', 1'.
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 480”, 6' clr +2'.
Bleach wash time: 10’
~~Bleach~~ wash temp: no data
PhotoFlo:1’, squeegeed
Chem temp: no data

Comment:

max exposure 80" & 2'dev are best. Definite squeegee marks, & drying dimples & drip marks.

Photos (2): 19 of 24

Fig. 36: 043-01-2022 photo 1 of 2

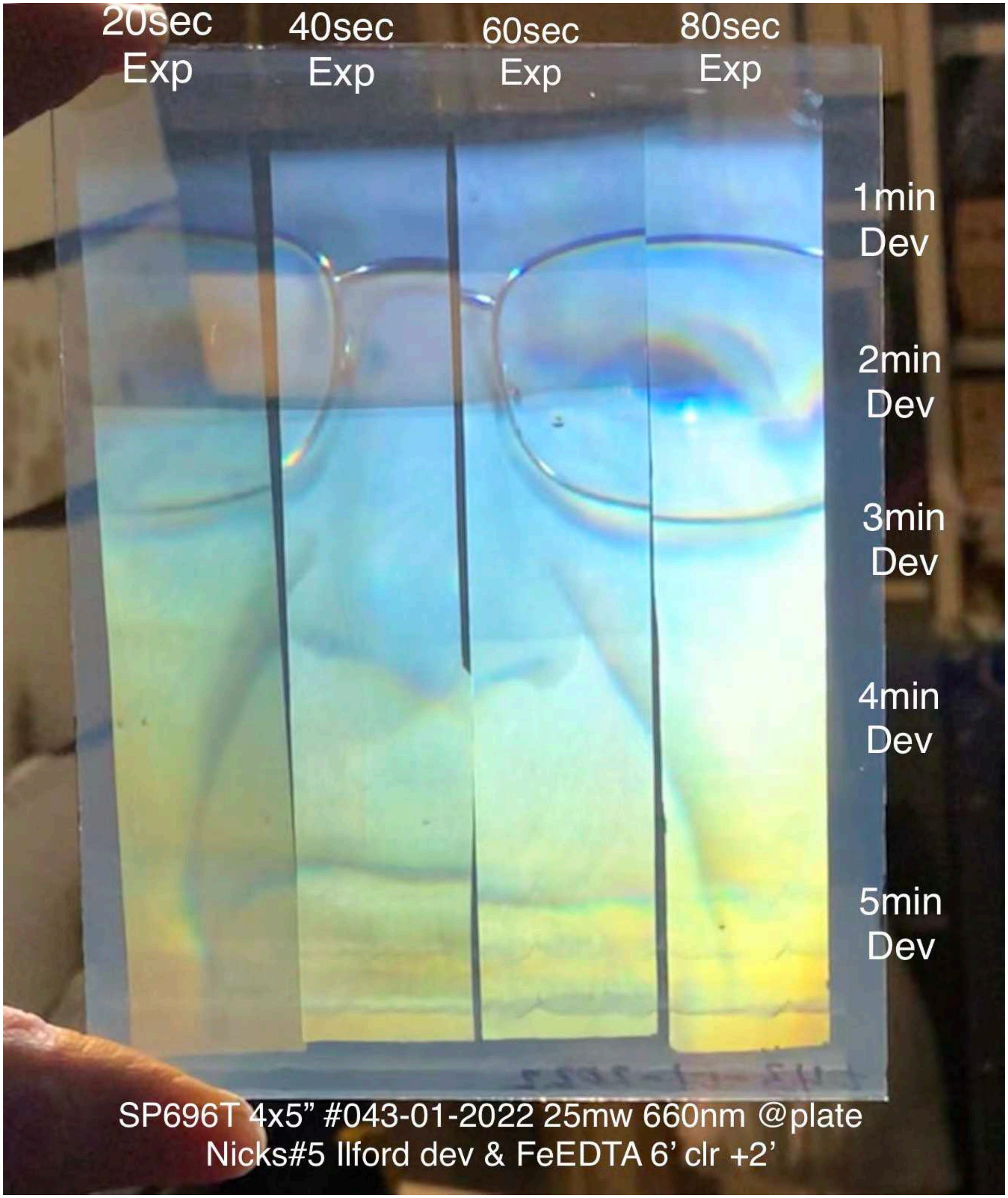


Fig. 37: 043-01-2022 photo 2 of 2

Individual plate: 20 of 24

Go to Table of Contents

Exposure date: Feb. 12, 2022

Plate # & type: 043-02-2022, HRT BB640, **TEA presensitized 1-1.5% 26C about 17 hours before.**

Exposure data:

TEA presensitization: mixed liter of 1-1.5% TEA w/ ~10 drops Photoflo. ~26C when presensitizing these 6 plates, 2' @. Then 10-30" tray of distilled H2O w/~10 drops photoflo. Then wiped blade edge of squeegee w/ photoflo fm tray & then squeegee 3 times emul side & 2-3 times glass side & wiped edges of @glass plate w/ blue shop towel. Air dried w/ hairdryer both sides ~2' @plate & into labeled transfer boxes. Bottom plate of two in transfer box had plastic edge guards to act as plate separators.

Exp. Length: 2nd 20 data point exposures: 150ms (1B), 70ms (2B), 50ms (3T), 20ms (4T). Settle time for @~9'.
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 36,000-4,800
Polarization: p-pol

Darkroom data:

Temp: 69.8F
Developer: BB ascorbic acid
Dev. Time: 360”, 3rd 5 step dev test, plastic dev container: 6', 5', 4', 3', 2'.
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 240”, 2'15" clear + 1'30".
Bleach wash time: 10’
~~Bleach~~ wash temp: no data
PhotoFlo: 1’, squeegeed
Chem temp: no data

Comment:

Nothing at all. Try a minimum of 5" exp.
Plate totally clear.

No photo

Individual plate: 21 of 24

Go to Table of Contents

Exposure date: Feb. 12, 2022
Plate # & type: 043-03-2022, 8E75HD, **TEA presensitized 1-1.5% 26C about 23 hours before**.

Exposure data:

TEA presensitization: mixed liter of 1-1.5% TEA w/ ~10 drops Photoflo. ~26C when presensitizing these 6 plates, 2' @. Then 10-30" tray of distilled H_2O w/~10 drops photoflo. Then wiped blade edge of squeegee w/ photoflo fm tray & then squeegee 3 times emul side & 2-3 times glass side & wiped edges of @glass plate w/ blue shop towel. Air dried w/ hairdryer both sides ~2' @plate & into labeled transfer boxes. Bottom plate of two in transfer box had plastic edge guards to act as plate separators.

Exp. Length: 3rd 20 data point exposures: 2500ms (1B), 1800ms (2B), 1200ms (3T), 600ms (4T).
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 600,000-144,000
Polarization: p-pol

Darkroom data:

Temp: 69.8F
Developer: Nick's #5 catechol 2 part, Nick's#5 for **Agfa**.
Dev. Time: 270", 1st 5 step dev test, plastic container: 4'30", 3'30". 2'30", 1'30". 30"
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 270", 1-3' clear + 1'30".
Bleach wash time: 10'
~~Bleach~~ wash temp: no data
PhotoFlo: 1', squeegeed
Chem temp: no data

Comment:

Max exp 2500ms & 2'30" dev best. Definite squeegee & drying marks on right side.

Photos (2): 21 of 24

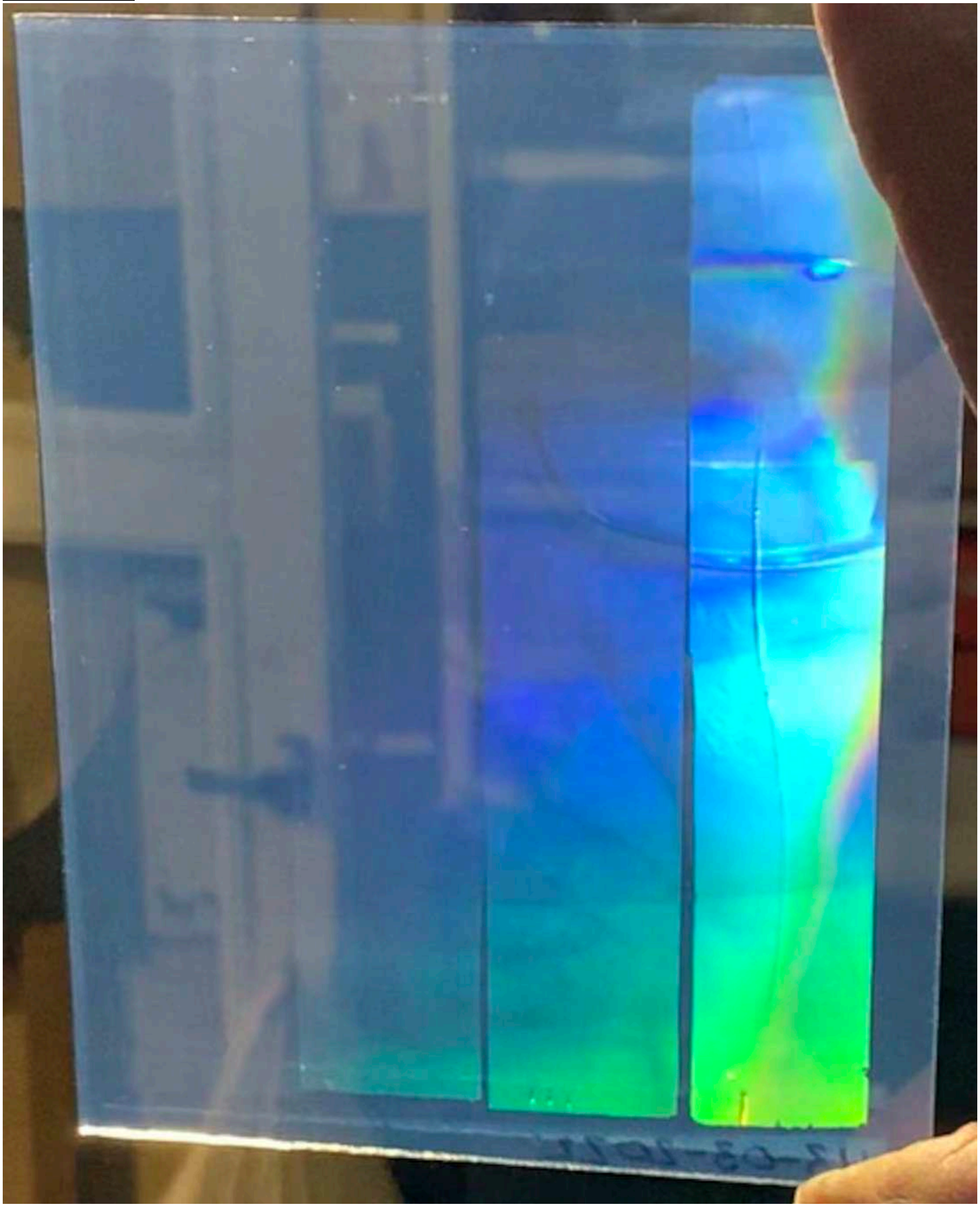


Fig. 38: 043-03-2022 photo 1 of 2

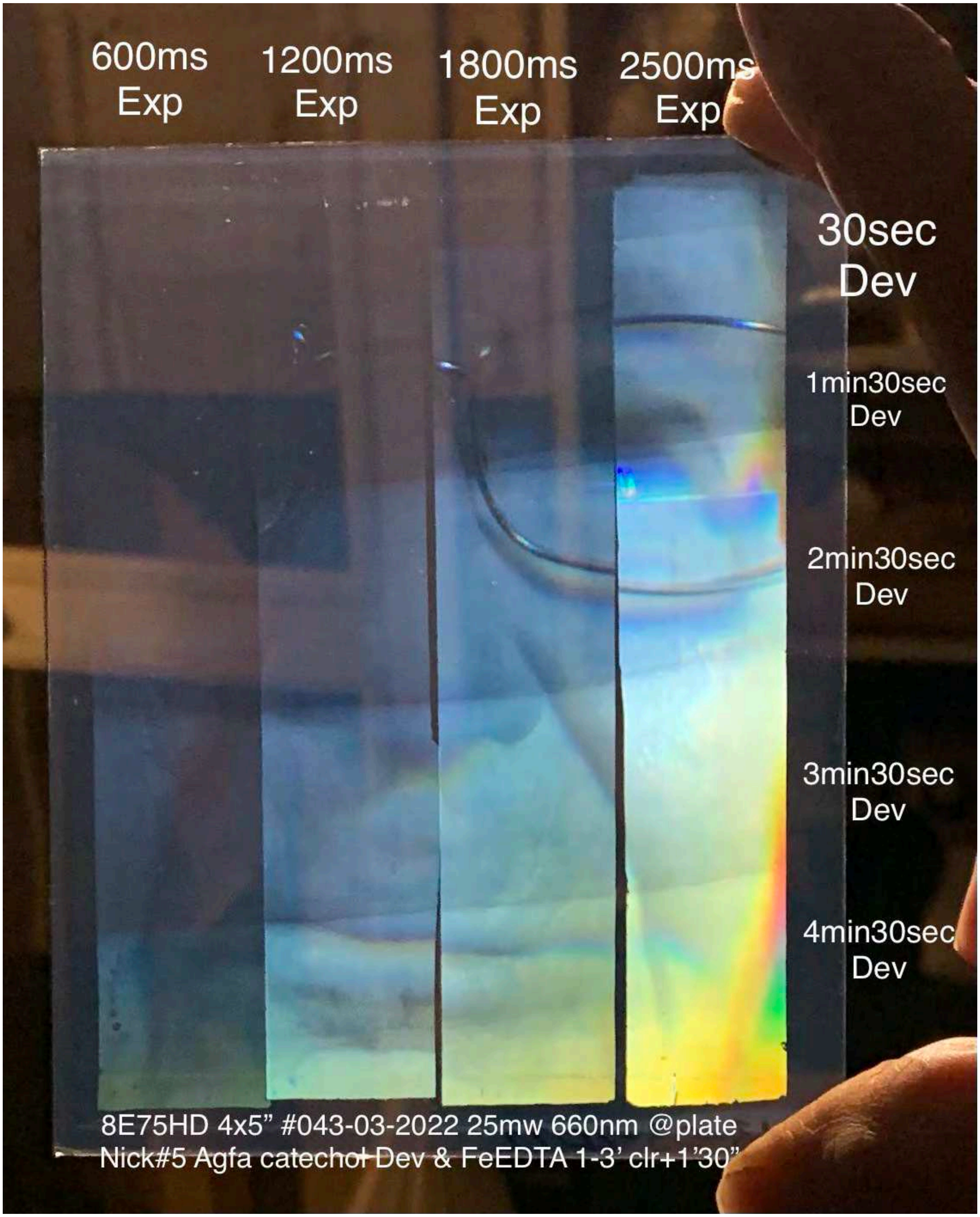


Fig. 39: 043-03-2022 photo 2 of 2

Individual plate: 22 of 24

Go to Table of Contents

Exposure date: Feb. 14, 2022
Plate # & type: 045-01-2022, SP696T, emulsion batch 45C, **TEA presensitized 1-1.5% 26C about 62 hours before. 1/4" 235 tape on H2RB edge to prevent edge scatter**.

Exposure data:

TEA presensitization: mixed liter of 1-1.5% TEA w/ ~10 drops Photoflo. ~26C when presensitizing these 6 plates, 2' @. Then 10-30" tray of distilled H2O w/~10 drops photoflo. Then wiped blade edge of squeegee w/ photoflo fm tray & then squeegee 3 times emul side & 2-3 times glass side & wiped edges of @glass plate w/ blue shop towel. Air dried w/ hairdryer both sides ~2' @plate & into labeled transfer boxes. Bottom plate of two in transfer box had plastic edge guards to act as plate separators.

Exp. Length: 80"
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~19,200,000
Polarization: p-pol

Darkroom data:

Temp: 67.1F
Developer: Nick's #5 catechol 2 part, Nick's#5 formulation for **Ilford**.
Dev. Time: 122"
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 400", 3-4'40" clear + 2'.
Bleach wash time: 10'
~~Bleach~~ wash temp: 70F
PhotoFlo: 1', squeegeed
Chem temp: no data

Comment:

Except for squeegee & drying marks, the best SP696T so far. There also appears to be some sort of strange gelatin marks or stains that might be from BIPS or old gelatin or excessive time in bleach or something else. Important to figure out what's going on with those stains and also be able to get rid of drying & squeegee marks or not worth doing TEA presensitization. See plate 024-02 for stains and weird marks as well.

Photos (4): 22 of 24

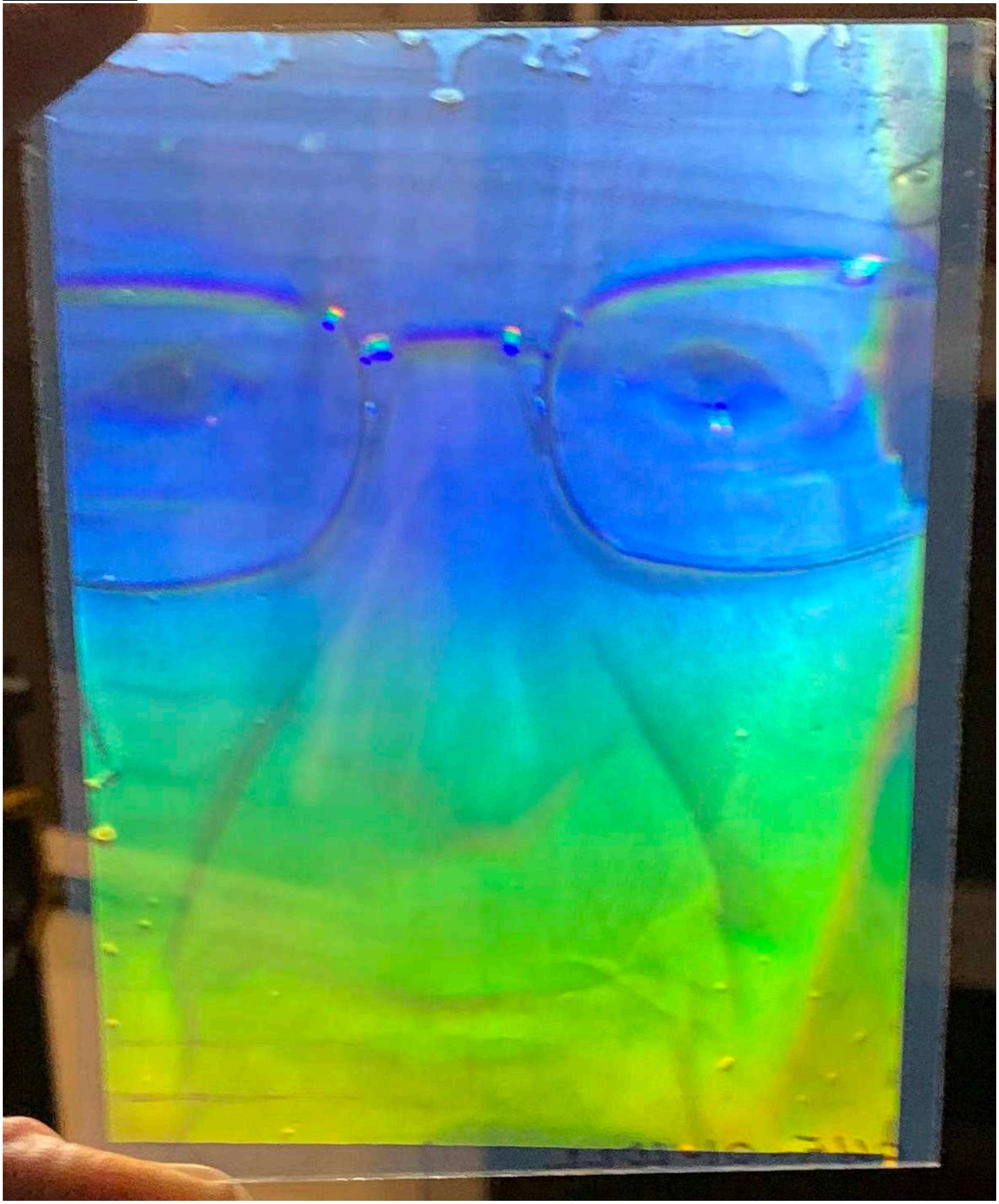


Fig. 40: 045-01-2022 photo 1 of 4

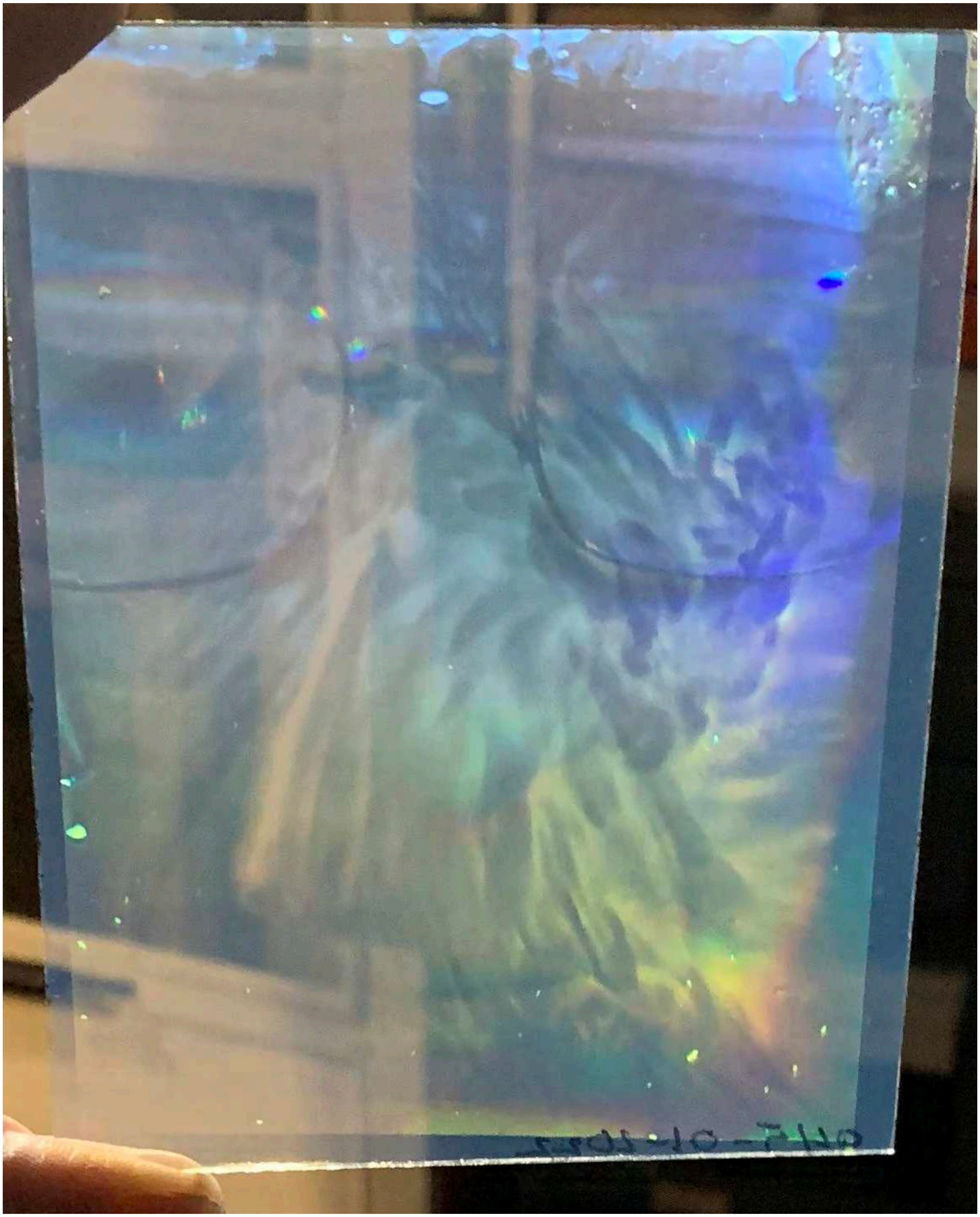


Fig. 41: 045-01-2022 photo 2 of 4

Fig. 42: 045-01-2022 photo 3 of 4

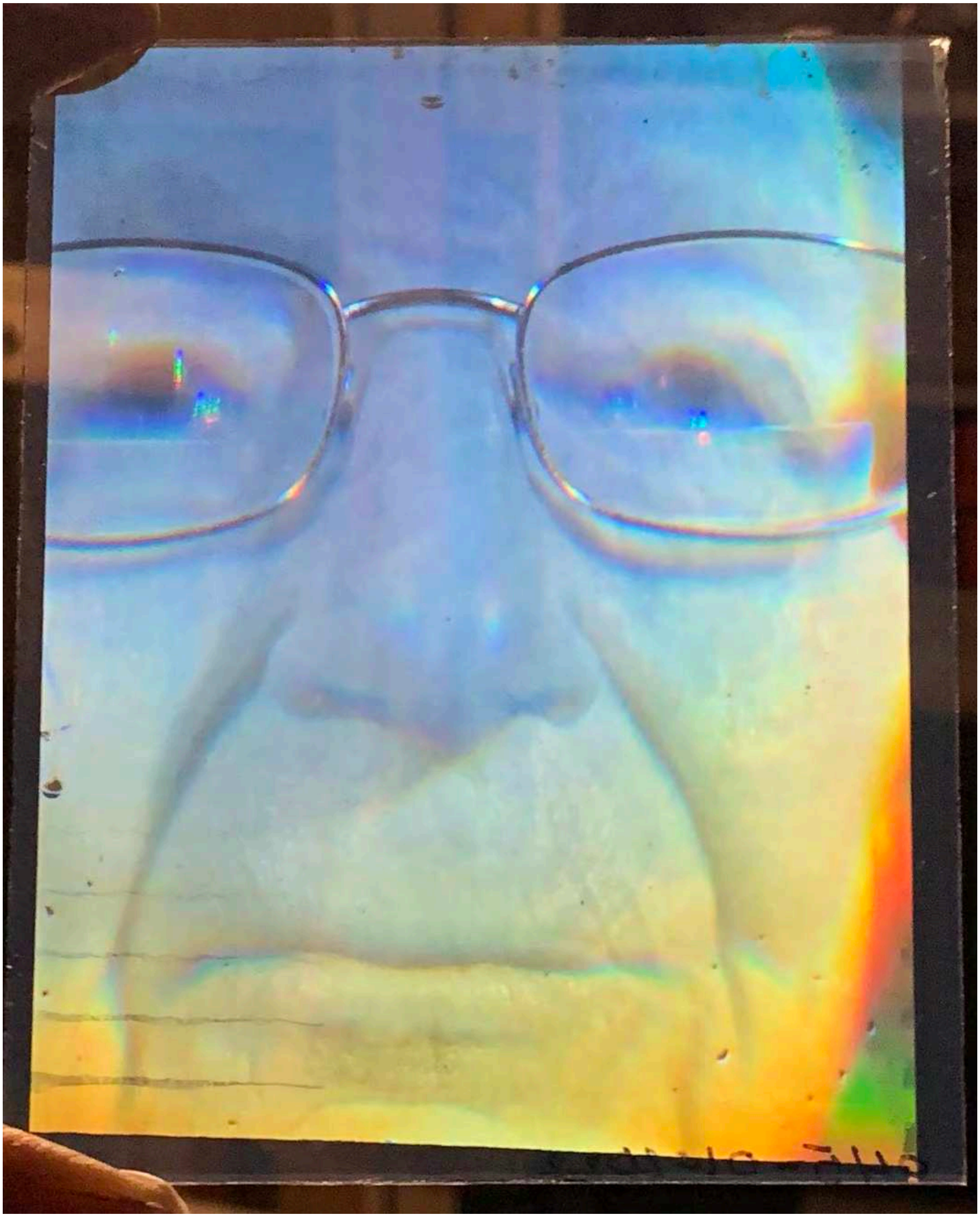


Fig. 43: 045-01-2022 photo 4 of 4

Individual plate: 23 of 24

Go to Table of Contents

Exposure date: Feb. 14, 2022
Plate # & type: 045-02-2022, 8E75HD, TEA presensitized 1-1.5% 26C about 62-63 hours before. 1/4" 235 tape on H2RB edge to prevent edge scatter.

Exposure data:

TEA presensitization: mixed liter of 1-1.5% TEA w/ ~10 drops Photoflo. ~26C when presensitizing these 6 plates, 2' @. Then 10-30" tray of distilled H2O w/~10 drops photoflo. Then wiped blade edge of squeegee w/ photoflo fm tray & then squeegee 3 times emul side & 2-3 times glass side & wiped edges of @glass plate w/ blue shop towel. Air dried w/ hairdryer both sides ~2' @plate & into labeled transfer boxes. Bottom plate of two in transfer box had plastic edge guards to act as plate separators.

Exp. Length: 2500ms
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: ~600000
Polarization: p-pol

Darkroom data:

Temp: 67.1F
Developer: Nick's #5 catechol 2 part, Nick's#5 for **Agfa**.
Dev. Time: 150"
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 150", 1'30"clear + 1'.
Bleach wash time: 10', in bl wash, plate started pink & went to grayish.
~~**Bleach**~~ **wash temp:** 70F
PhotoFlo: 1', squeegeed
Chem temp: no data

Comment:

Best 8E75HD so far except for squeegee and drying marks. Doesn't have the stain type marks visible on SP696T. If can't get rid of squeegee & drying marks, not worth doing TEA presensitization.

Photos (2): 23 of 24

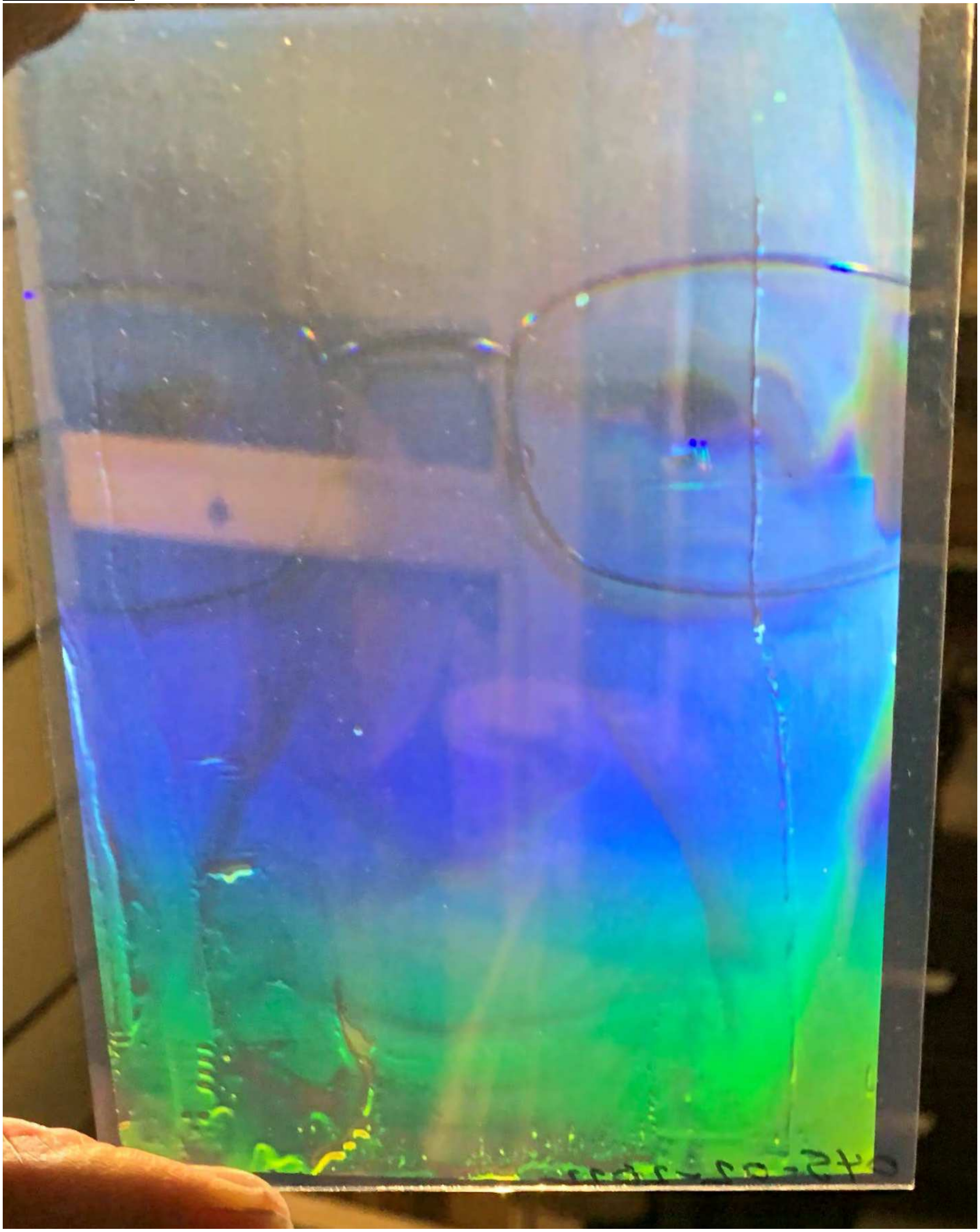


Fig. 44: 045-02-2022 photo 1 of 2

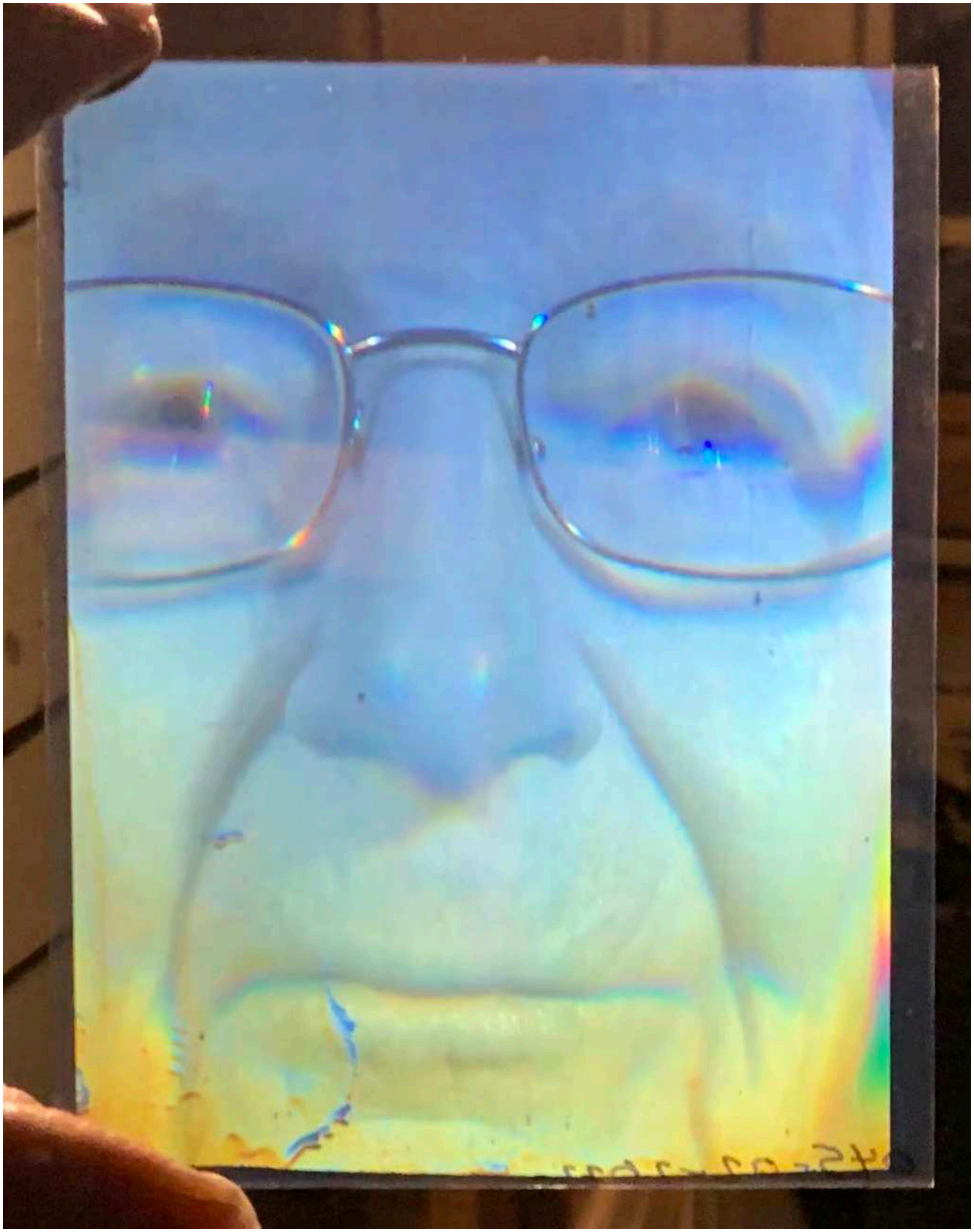


Fig. 45: 045-02-2022 photo 2 of 2

Individual plate: 24 of 24

Go to Table of Contents

Exposure date: Feb. 14, 2022

Plate # & type: 045-03-2022, HRT BB640, TEA presensitized 1-1.5% 26C about 63-64 hours before. 1/4" 235 tape on H2RB edge to prevent edge scatter.

Exposure data:

TEA presensitization: mixed liter of 1-1.5% TEA w/ ~10 drops Photoflo. ~26C when presensitizing these 6 plates, 2' @. Then 10-30" tray of distilled H2O w/~10 drops photoflo. Then wiped blade edge of squeegee w/ photoflo fm tray & then squeegee 3 times emul side & 2-3 times glass side & wiped edges of @glass plate w/ blue shop towel. Air dried w/ hairdryer both sides ~2' @plate & into labeled transfer boxes. Bottom plate of two in transfer box had plastic edge guards to act as plate separators.

Exp. Length: 4th 20 data point exposures: 40" (1B), 20" (2B), 10" (3T), 5" (4T).
Beam ratio: OB: 2.0-10.0mw + RB: 17-20mw = ~240,000 ergs/cm2/sec = 1.8-9:1 = Total ergs: 9,600,000-1,200,000
Polarization: p-pol

Darkroom data:

Temp: 67.1F
Developer: BB ascorbic acid
Dev. Time: 300” 4th 5 step dev test, 1st glass tank instead of plastic: 5', 4', 3', 2', 1'. BB ascorbic acid dev.
Stop: Kodak dilute stop bath, plus 3' filtered running water wash.
Stop time: dilute stop 30" + 3' water wash.
Bleach type: FeEDTA
Bleach time: 360”, 2-4' clear + 2'.
Bleach wash time: 10’
~~Bleach~~ wash temp: 70F
PhotoFlo: 1’, squeegeed
Chem temp: no data

Comment:

These HRT BB640 plates are exceptionally clear when processed. Fig. 46 photo shows relative clarities of 043-01 through 03.

Photos (2): 24 of 24

Fig. 46: 045-03, 01, 02-2022 photo 1 of 2

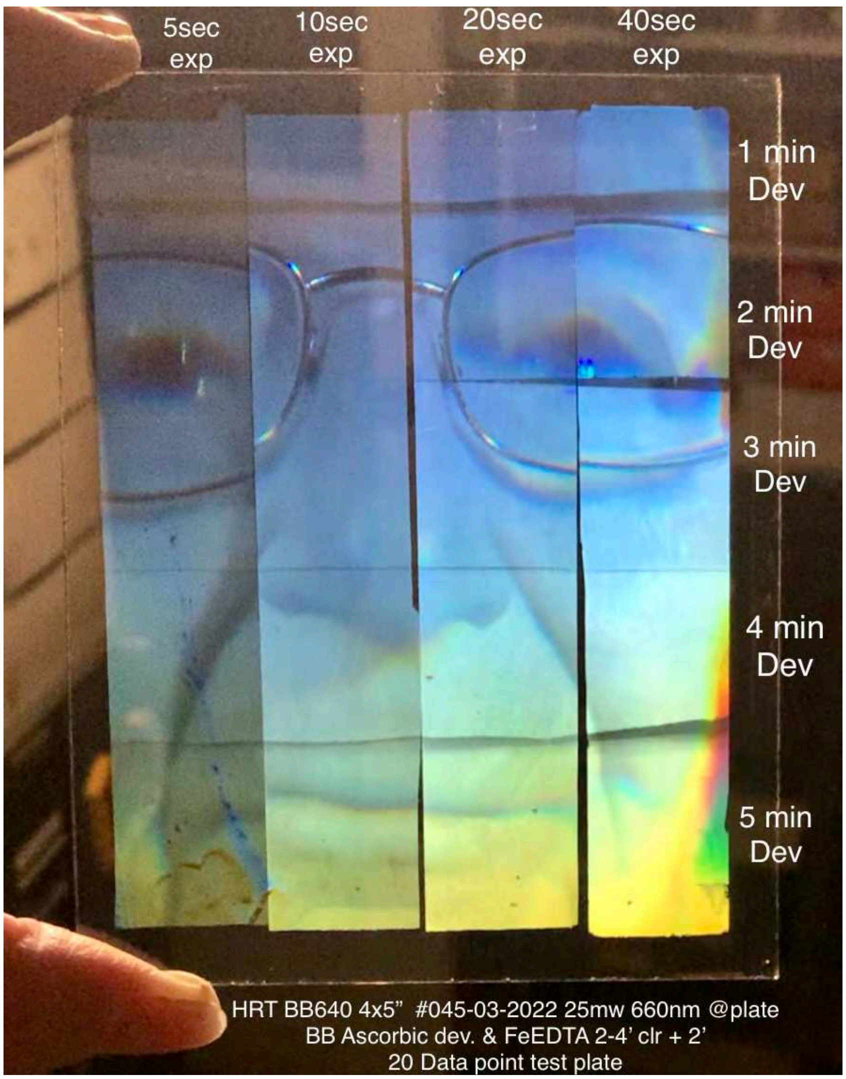


Fig. 47: 045-03-2022 photo 2 of 2

APPENDIX A:

Go to Table of Contents

Silver Halide Data Sheets: Agfa (10E75 & 8E75HD), 5 pages

NDT Technical Information

NDT / Holography

1. Introduction

Photographic materials for holography

Photographic materials for holography must meet specific requirements. Since the dimensions of the structure of the interference pattern to be recorded are usually of the order of magnitude of the wavelength of the light used for exposure, a very high resolving power is essential. A high speed is also desirable to allow short exposures.

However, high resolving power and high speed are somewhat incompatible properties, which makes it necessary to arrive at a compromise of the highest possible efficiency. The nature of the subject will determine whether the ideal solution of this problem will be slanted towards high speed or high resolving power.

According to the above principles, Agfa-Gevaert has developed 4 types of HOLOTEST photographic materials:

- 10 E 75 — High sensitivity - size of grain approx. 90 nm, resolving power approx. 3000 lines/mm, to be used with red light emitting lasers.
- 10 E 56 — Same properties as the 10 E 75 material, but to be used with green light emitting lasers.
- 8 E 75 HD — Size of grain approx. 35 nm, very high resolving power of approx. 5000 lines/mm, lower sensitivity than 10 E 75, to be used with red light emitting lasers.
- 8 E 56 HD — Same properties as the 8 E 75 HD material, but to be used with green light emitting lasers.

2. Amplitude holography

2.1. Density and amplitude transmission curves

The relation between density D and exposure E is usually represented by the characteristic curve. Fig. 1 shows these curves for HOLOTEST emulsions 8 E 75 HD and 10 E 75 for red laser light, 8 E 56 HD and 10 E 56 for blue and green laser light respectively.

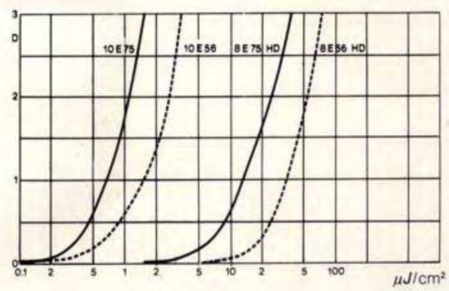


Fig. 1 — Characteristic curves at $\lambda = 514$ nm and $\lambda = 627$ nm
Developing: G282c (1 + 2) - 4 min - 20 °C
Intermediate rinsing: 1 min - 20 °C
Fixing: G328 (1 + 4) - 4 min - 20 °C
Density measurement: in parallel light

Characteristic curves contain useful information in the case of certain holographic exposures, but in general amplitude transmission curves are preferred, because a hologram acts as a diffraction screen to the incident wave front, where not the local density but the local amplitude transmission is the more important consideration. Amplitude transmission is defined as the ratio between the amplitudes of a monochromatic plane wave after and before passing through the photographic emulsion. This is usually a complex quantity; in other words, not only the amplitude but also the phase of the incident radiation is affected. However, in the case of processed emulsions, for measuring amplitude transmission $|T_a|$ the only easily measured quantity is intensity transmission $T_i = T_a T_a^*$, where T_a^* represents the complex conjugate of T_a.
This quantity is expressed as a function of the exposure of HOLOTEST 8 E 75 HD and 10 E 75 at a wavelength of 627 nm, and of HOLOTEST 8 E 56 HD and 10 E 56 at a wavelength of 514 nm respectively, in Fig. 2.
The energy per unit surface that corresponds to $|T_a| = 0.5$ can be regarded as an indication of the sensitivity.

AGFA

Approximate values of light intensities for $|T_a| = 0.5$ (corresponding to D = 0.6) are

- ~ 0.5 $\mu J/cm^2$ for 10 E 75
- ~ 10 $\mu J/cm^2$ for 8 E 75 HD
- ~ 1 $\mu J/cm^2$ for 10 E 56
- ~ 25 $\mu J/cm^2$ for 8 E 56 HD

These values will also be slightly affected by the processing conditions.

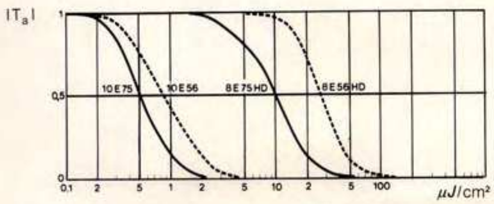
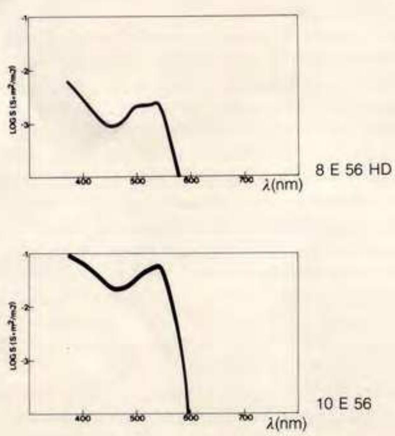


Fig. 2 — Amplitude transmission curves at λ = 514 nm - - - - -
λ = 627 nm ———

Developing: G282c (1 + 2) - 4 min - 20 °C
Intermediate rinsing: 1 min - 20 °C
Fixing: G328 (1 + 4) - 4 min - 20 °C

2.2. Colour sensitivity

HOLOTEST holographic emulsions 8 E 75 HD and 10 E 75 are specially sensitized for wavelengths between 600 and 750 nm, and are intended for use with the He-Ne laser (633 nm) and the ruby laser (694 nm). On the other hand, HOLOTEST holographic emulsions 8 E 56 HD and 10 E 56 are suitable for exposure to wavelengths up to 560 nm (krypton and argon lasers). The density and amplitude transmission curves given in Section 2.1. apply to the wavelength of the He-Ne laser of 633 nm and those of the krypton laser of 476 and 521 nm. To enable one to convert the exposure to other wavelengths, the absolute spectral sensitivities are shown in Fig. 3.



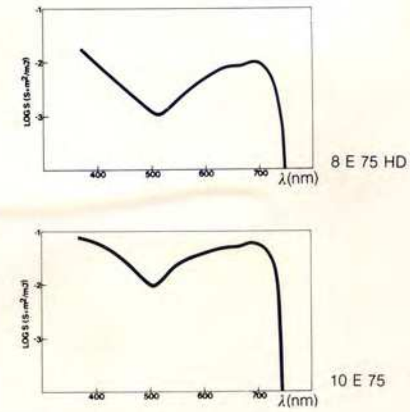


Fig. 3 — Absolute spectral sensitivity.
Curves to obtain a D = 0.60 above fog.

2.3. Image quality

An optical diffraction method was used to determine the image quality of the holographic emulsion. A double-beam interference exposure enabled us to examine the resultant diffraction screen. Fig. 4 shows in schematic form both the exposure and the reconstruction.

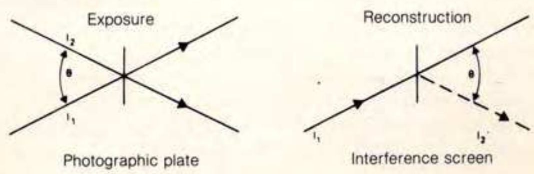


Fig. 4 — Schematic representation of exposure and reconstruction of double-beam interference.

During exposure, two plane waves having intensities I_1 and I_2 were incident on the photographic plate, each at the same angle to the normal. Representing the angle between the two rays by θ, spatial frequency f is given by

$$f = \frac{2}{\lambda} \sin \frac{\theta}{2}$$

where λ = wavelength in air (633 nm for the He-Ne laser). With θ = 90°, a spatial frequency of 2,235 lines/mm will then result. The separation between adjacent lines will then be the inverse of the spatial frequency equal to approx. 0.45 micron.

Modulation m depends on the polarization of the laser radiation and intensity ratio I_1/I_2. In the case described, lasers with linearly polarized radiation were used.
The electric vector was normal to the plane of incidence. The intensity ratio I_1/I_2 amounted to 0.5, corresponding to a modulation of 0.94. In general the modulation caused by the polarization considered here is

$$m = \frac{2\sqrt{I_1 I_2}}{I_1 + I_2}$$

Reconstruction took place as shown in Fig. 4. Ray I_1 was used for reconstructing ray I_2'. Intensity I_2' was a diffraction of the first order and hence ratio I_2'/I_1 is dependent on angle θ, modulation m, and the exposure. Fig. 5 shows ratio I_2'/I_1 against exposure.

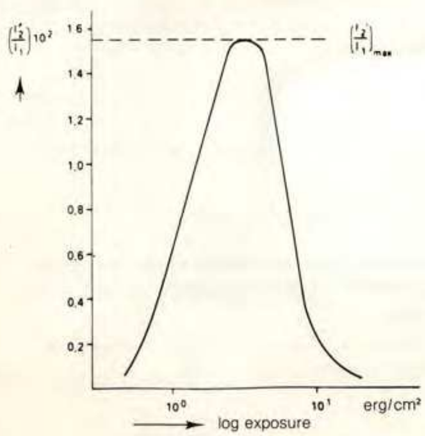


Fig. 5 — Dependence of diffraction efficiency on exposure

This function has a definite maximum. Ratio I_2'/I_1 can be considered as a measure of the quality of a screen and is therefore called diffraction efficiency. Fig. 6 and 7 show the optimum diffraction efficiency $(I_2'/I_1)_{max}$ as a function of the spatial frequency for HOLOTEST emulsions 10 E 75 and 10 E 56 respectively. Intensities I_1 and I_2' have not been corrected for Fresnel reflection, because the latter corresponds to the practical applications of holography. The actual diffraction efficiency of the photographic emulsion for the polarization used is higher still, especially at large values of angle θ. We should mention that the material was over-modulated by using the large modulation values of 0.94 or 1. In other words, this is not a case of linear transfer; intensities of higher orders of diffraction are also obtained. In order to compare the diffraction intensity to noise I_N at various spatial frequencies, exposures were carried out with a single laser beam of the same overall intensity, and the photographic plates were all processed and measured under identical conditions. The resultant ratio I_N/I_1 is also shown in Figs 6 and 7.

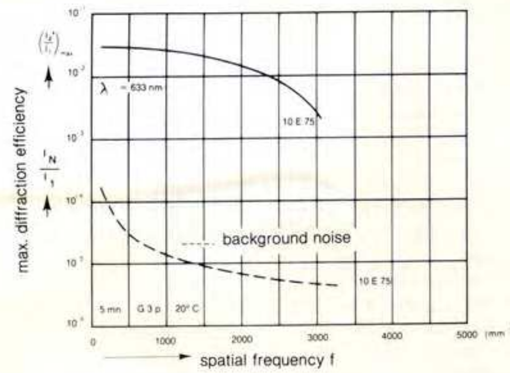


Fig. 6 — Maximum diffraction efficiency against spatial frequency, E-vector normal to plane of incidence; modulation 0.94.

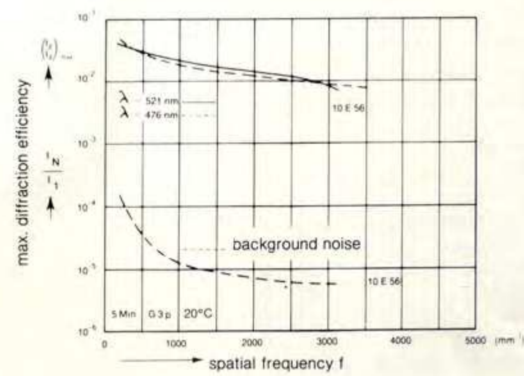


Fig. 7 — Maximum diffraction efficiency against spatial frequency, E-vector normal to plane of incidence; modulation m = 1.

2.4. Reciprocity behaviour
Q-switch lasers with pulsewidths of 10 to 50 ns are used for short exposures. In this case, the reciprocity behaviour of HOLOTEST emulsions is obviously important. To obtain densities $D \leqslant 2$, the exposure of HOLOTEST materials must be multiplied 2 to 4 times when Q-switch lasers are used.

2.5. Processing
Darkroom illumination
Recommended Agfa-Gevaert safelight filters:
- Complete darkness for HOLOTEST 10 E 75.
Maximum 10 min exposure with filter V505 for 8 E 75 HD.
- R 4 (dark red) for HOLOTEST 8 E 56 HD and 10 E 56.

Development
(for both transmission and reflection holograms)
2 min in GP 61 - 20 °C (see composition § 3.1.)

Fixing
4 minutes in G328 (dilution 1 + 4) or in any other rapid fixing bath.

3. Phase holography

3.1. Transmission holography

Where theoretically the maximum diffraction efficiency that may be achieved with an amplitude hologram will be 6.25% at the utmost, theoretically 100% may be achieved with phase holograms.
Technical literature describes a great number of processing systems that, with the highest possible diffraction efficiency enable the noise to be kept as low as possible.
The exposure doses that are required for making a good phase hologram amount to ~ 50 μ J/cm² for the emulsion 8 E 56 HD, and to ~ 25 μ J/cm² for the emulsion 8 E 75 HD, as a relatively high density (between D = 1.5 and D = 2.5) proves to be necessary.
For the Agfa-Gevaert HOLOTEST 8 E 56 HD and 8 E 75 HD emulsions (as the HOLOTEST 10 E emulsions after bleaching produce more noise than the 8 E types, they are not recommended for phase holography) the following processing is proposed:

3.1.1. Development:
2 min in GP 61 (20 °C) made up as follows:

GP 61

Water	700	ml
METOL	6	g
Hydroquinone	7	g
Phenidone	0.8	g
Na_2SO_3	30	g
Na_2CO_3	60	g
KBr	2	g
Na_4EDTA	1	g

water to make 1 litre

3.1.2. Intermediate rinsing in running water: 2 min (temperature 20 °C ± 2 °C).

3.1.3. Fixing in Agfa-Gevaert G 328 (1 + 4) rapid fixing bath, for 2 min (temperature = 20 °C ± 2 °C).

3.1.4. Intermediate rinsing in running water: 2 min (temperature 20 °C ± 2 °C).

3.1.5. Bleaching in a bleaching bath made up as follows:

GP 431

Water	600 ml
$Fe(NO_3)_3 . 9H_2O$	150 g
KBr	30 g

300 mg of phenosafranin dissolved in 200 ml of ethanol.
Water to make 1 litre.
To be used in a dilution of: 1 part GP 431 + 4 parts of water (temperature = 20 °C ± 2 °C).
The keeping quality of the ready-to-use bleaching bath in closed bottles is limited (approx. 1 week).

3.1.6. Rinsing in running water: 5 min.

3.1.7. Rinsing in demineralized water with 1 part of AGEPON for 200 parts of water, for 2 min at 20 °C.
After the treatment, the water should be evenly distributed over the surface of the glass plate or film.
If there are still drops being formed on the surface of the emulsion, the treatment in the AGEPON solution is to be extended.
When there is no demineralized water available, rinsing may also be carried out in a solution of 1 part of AGEPON for 200 parts of water, or in any other wetting agent.

3.1.8. The films and plates are to be dried in a vertical position and in a dustfree room, until the emulsion is completely dry. A forced drying system must not be used and the plates must not be turned around in the course of the drying process. Irregular drying or remaining water drops may cause stains being formed.

3.2. Reflection holography

Though theoretically emulsion layers of a thickness of 20 μm are necessary for reflection holography so as to achieve reflection holograms of top quality, it is still recommended to use the materials 8 E 56 HD and 8 E 75 HD with a thickness of the emulsion layer of 7 μm, as with these materials the distortion of the Bragg planes after processing will be smaller. This is why it is also possible to achieve high-quality reflection holograms on thinner emulsion layers.

The following processing is proposed:

3.2.1. Processing when the colour of the hologram has to approximate as closely as possible to that of the laser light.

3.2.1.1. Development: 2 min at 20 °C in a developer of the following composition:

GP 62

Part A		Part B	
water	700 ml	water	700 ml
METOL	15 g	Na_2CO_3	60 g
pyrogallol	7 g	demineralized	
Na_2SO_3	20 g	water up to	1000 ml
KBr	4 g		
Na_4EDTA	2 g		
water up to	1000 ml		

Use:
1 part A + 2 parts of water + 1 part B
Parts A and B keep well as separate solutions.
The ready to use solution can be used for a limited time only (1 to 2 hours).
Therefore parts A and B should be mixed immediately before use.
Remark: Pyrogallol is a hardening developing substance that may affect the skin. Therefore always wear rubber gloves when working with this developer. So as to achieve good reflection holograms, a density between D = 1.5 and D = 2.5 is to be reached.

3.2.1.2. Intermediate washing in running water: 2 min (temperature = 20 °C ± 2 °C).

3.2.1.3. Bleaching: till completely clear in a bleaching bath of the following composition:

GP 432

water	700	ml
KBr	50	g
boric acid	1.5	g
water up to	1000	ml

p-benzoquinone* 2 g/l to be added just before use.
The life of the ready to use bleaching bath in a well stopped bottle is limited to 1 week.
Temperature of the bleaching bath: 20 °C ± 2 °C.

3.2.1.4. Washing in running water: 5 min. (temperature = 20 °C ± 2 °C).

3.2.1.5. Washing in demineralized water with 1 part of AGEPON to 200 parts of water for 2 min at 20 °C.
After treatment the water must be evenly spread on the surface of the glassplate or film.
If there is still a formation of drops on the emulsion surface the treatment in the AGEPON solution must be prolonged.
When no demineralized water is available, washing can possibly be done in a solution of 1 part of AGEPON to 100 parts of water.

3.2.1.6. Drying should take place upright, in a dust-free room until the emulsion is completely dry. Do not use forced drying and never turn the plate during drying. Uneven drying or drops of water which remain on the emulsion will give rise to stains.

3.2.2. Colour shifting to a longer wavelength:

To obtain an image in which the colour has been shifted to a longer wavelength than that of the laser light, procedure 3.2.1. may be applied. The bleaching bath 3.2.1.3., however, should be replaced by the following one:

GP 433

water	700 ml
KI	30 g
boric acid	3 g
water up to	1000 ml

Add 2 g/l of p-benzoquinone* just before use.
The holographic picture obtained in this way is slightly less sharp than the one of procedure I. The colour, however, has been shifted to longer wavelengths.

3.2.3. Colour shifting to a shorter wavelength:

3.2.3.1. To obtain a holographic picture with a shorter wavelength than that of the laser light, procedure 3.2.1. may also be followed, provided that instead of 3.2.1.1. (developing bath GP 62) one of the following is used:
- G5c (2 min at 20 °C, dilution 1 + 5) or
- GP 61 (see 3.1.1.).

3.2.3.2. The colour of reflection holograms that are processed the same way as transmission holograms will also shift towards a shorter wavelength.

* Caution: The odour of p-benzoquinone in powder form is very irritating and inhaling it may be injurious to health. The following safety measures are to be observed: Always wear rubber gloves when working with this bleaching bath and a very fine dust mask; weigh and dissolve the powder in a fume chamber.

<u>Silver Halide Data Sheets:</u> (Colour Holographic (HRT) BB640), 2 pages

Go to Table of Contents

Colour Holographic

HOLOGRAPHIC BB PLATES

HOME PRODUCTS PROCESSING REVIEWS PAPERS

PROCESSING

hologram processing

lith processing

Recommended processing for holographic exposures made on BB plates.

PLEASE NOTE: The following formulas are given only as a guide, since different processing techniques work better for different types of holographic exposure.

The BB family of emulsions can be used for both transmission and reflection holography. Depending on the application, different processing schemes can be applied. The following processing is intended as a guideline that will result in bright and low scatter holograms:

Presensitisation	Water, TEA solution, 2 min. See procedures below
Exposure	150 – 300 µJ/cm 2
Development	AA developer (transmission, reflection), Pyrogallol (reflection)
Washing	Water, 5-10 min
Bleach	EDTA bleach
Final Wash	Water, 5-10 min
Final Rinse	Water with wetting agent, 1 minute

PRESENSITISATION
One of the characteristics of the BB plates is that the plates appear to become insensitive after a few weeks. This is due to a desiccation that can easily be addressed by a simple method, which renders the plate as sensitive as when it was first coasted.
The process is called presensitisation and there are two procedures.

A. Presensitisation methods for interferometry, security and colour holograms.

1. Prepare a solution of water with a few drops (3 or 4) of photographic wetting agent (Ilfotol or Kodak Fotoflo).
2. Stir enough to homogenize the solution.
3. Soak the plate for 2 to 3 minutes in the appropriate safelight conditions in a tray of the solution with the emulsion facing up.
4. There are various methods for drying the plate. Favourites are squeegeeing and then air drying with a warm fan heater on the glass side of the plate. Blotting with high quality absorbent blotting paper is another option, followed by warm air fan as before.
5. The presensitisation will last for about 2 days.

B. Presensitisation methods for display holograms.

The method is the same, except that the solution also contains a 3% solution of TEA (treiethanolamine).
Example solution would be 1 litre of water, a few drops (3 or 4) of wetting agent, 30ml TEA. Make sure mix is stirred adequately. The

solution can be reused many times.
The TEA confers more sensitivity than the plate would normally have, so if high sensitivity is required, use this method. TEA results also in some emulsion preswelling, and therefore there will be a colour shift in reflection holograms. To change the colour shift, different TEA concentrations can be used. To avoid colour shift, use method **A** or alternatively soak the plate after TEA treatment in a tray with water for 6 to 8 minutes and then dry.

PROCESSING THE PLATES FOR TRANSMISSION AND MASTER HOLOGRAMS.
The standard developer used for BB plates is a vitamin C based formula, which is very low in toxicity and is a fast developer. It is also re-useable until it slows down development time. Keep stoppered to avoid oxidation by air.

The recipe is, in the following order:

De-ionized Water	1/L
Ascorbic Acid	20g
Sodium Carbonate	20g
Sodium Hydroxide	6.5g
Phenidone	1g

A 30s development time @ 20°C is recommended.
After development, wash and put in bleach.

PROCESSING THE PLATES FOR REFLECTION HOLOGRAMS
A pyrogallol developer is recommended, and then the EDTA bleach as described above.
The general recipe for the pyrogallol reflection developers is:

Solution A	
De-ionized Water	0.5/L
Pyrogallol	5g
Solution B	
De-ionized Water	0.5/L
Sodium Carbonate	30g

Mix equal quantities of solutions A and B just before development.
A 1 minute development time at 20° C is recommended.
After development, wash and put in bleach.

BLEACH.
We recommend an Ferric EDTA based bleach, because it is re-useable and gives good results.

De-ionized Water	1/L
EDTA di-sodium salt	30g
Ferric Sulphate	30g
Potassium Bromide	30g
30% Sulphuric Acid	30ml
(or 90% Sulphuric Acid)	(10ml)

Bleach until emulsion clear of black silver.

Silver Halide Data Sheets: **(Ilford SP696T), 3 pages** Go to Table of Contents

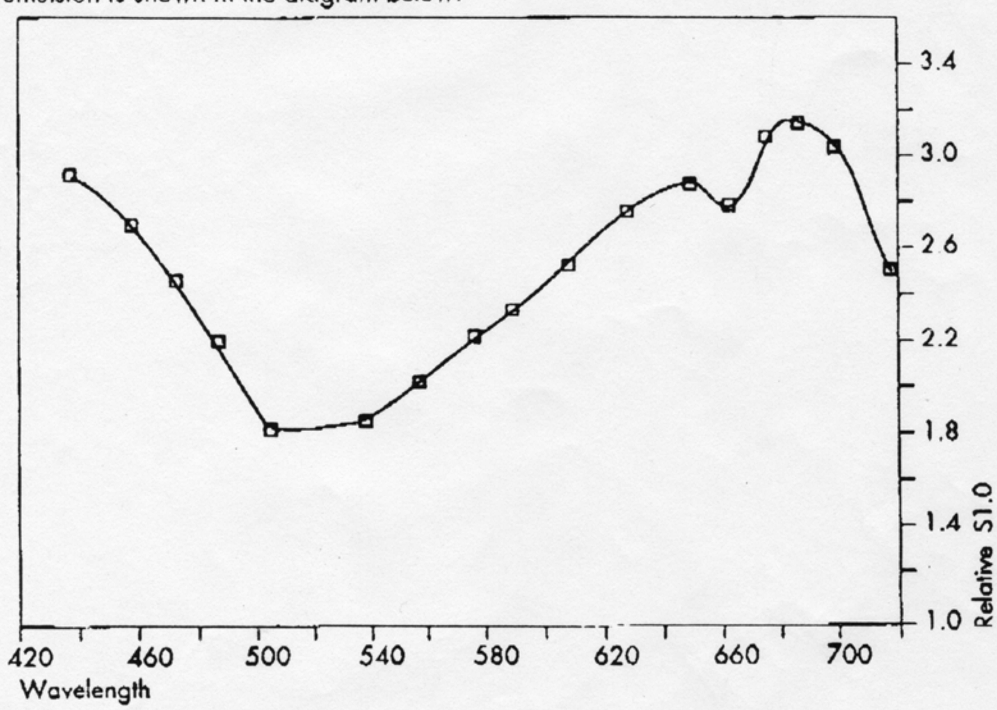
FACT SHEET

SCIENTIFIC PRODUCTS: HOLOGRAPHIC MATERIALS

SP696T RED SENSITIVE PLATES

ILFORD SP696T holographic plates are designed for general use where red lasers are used. They combine the features of the high sensitivity normally associated with silver halide emulsions with the low noise and low scatter usually only found in other media.

SP696T holographic plates are intended for use with all commonly used red lasers, including HeNe (633nm), krypton ion (647nm) and pulsed ruby (694nm). The spectral sensitivity of the emulsion is shown in the diagram below.



APPLICATIONS

SP696T plates have good speed, low noise and scatter characteristics and wide exposure latitude. These features make the plates highly suitable for all forms of holography including

- Denisyuk holography,
- production of phase transmission holograms for display applications,
- production of amplitude transmission holograms for interferometry,
- Production of reflection transfer holograms.

RED SENSITIVE HOLOGRAPHIC PLATES

ILFORD SP696T

ILFORD SP696T holographic plates are designed for general use where red lasers are used. They combine the features of the high sensitivity normally associated with silver halide emulsions with the low noise and low scatter usually only found in other media.

SP696T holographic plates are intended for use with all commonly used red lasers, including HeNe, krypton ion and pulsed ruby.

STORAGE

Store SP696T plates in a cool, dry place, preferably below 20°C at approximately 50%RH. Plates stored for 6 months or longer should be kept at a reasonably constant temperature, not exceeding 20°C. To avoid condensation, plates which have been stored in a refrigerator should be left in the original packaging for not less than two hours at room temperature before use.

SAFELIGHT RECOMMENDATION

Use an ILFORD 916 (dark green) safelight filter illuminated by a 15 watt bulb. The distance between the plate surface and the safelight should be at least 1.2 metres (4 feet).

COLOUR CONTROL

Colour control of the final image can be achieved by pre-swelling the emulsion with, for example, a triethanolamine solution before exposure. This pre-swelling step has the additional advantages of increasing the speed of the plates by 1-2 stops and will give brighter holograms.

EXPOSURE

Optimum exposure will depend on the laser being used and the type of hologram being made. Make a range of test exposures to find out the best exposure for the exposing and processing system in use. The exposure time is likely to be similar to that required for other red sensitive holographic materials.

PROCESSING

SP696T plates are compatible with all commonly found holographic processing solutions, including pyrogallol and catechol developers and ferric sodium EDTA bleach. Current development times and temperatures will provide a starting point for obtaining good results.

PROCESSING FOR AMPLITUDE TRANSMISSION HOLOGRAMS

The recommended developer is Ilford PQ Universal, diluted 1+4 for 5 minutes at 20°C. Rinse in an 2% acetic acid stop bath for 30 seconds. Fix in ILFORD HYPAM, diluted 1+4 for 1-2 minutes.

WASHING

After bleaching or fixing, wash SP696T plates for 5 minutes in cool, running water. For rapid and uniform drying, add 5ml/litre of ILFORD ILFOTOL wetting agent to the final rinse water.

DRYING

After washing, the plate may be carefully squeegeed to remove excess water, then dried in warm air at 30-50°C. SP696T plates are also compatible with graded solvent drying methods.

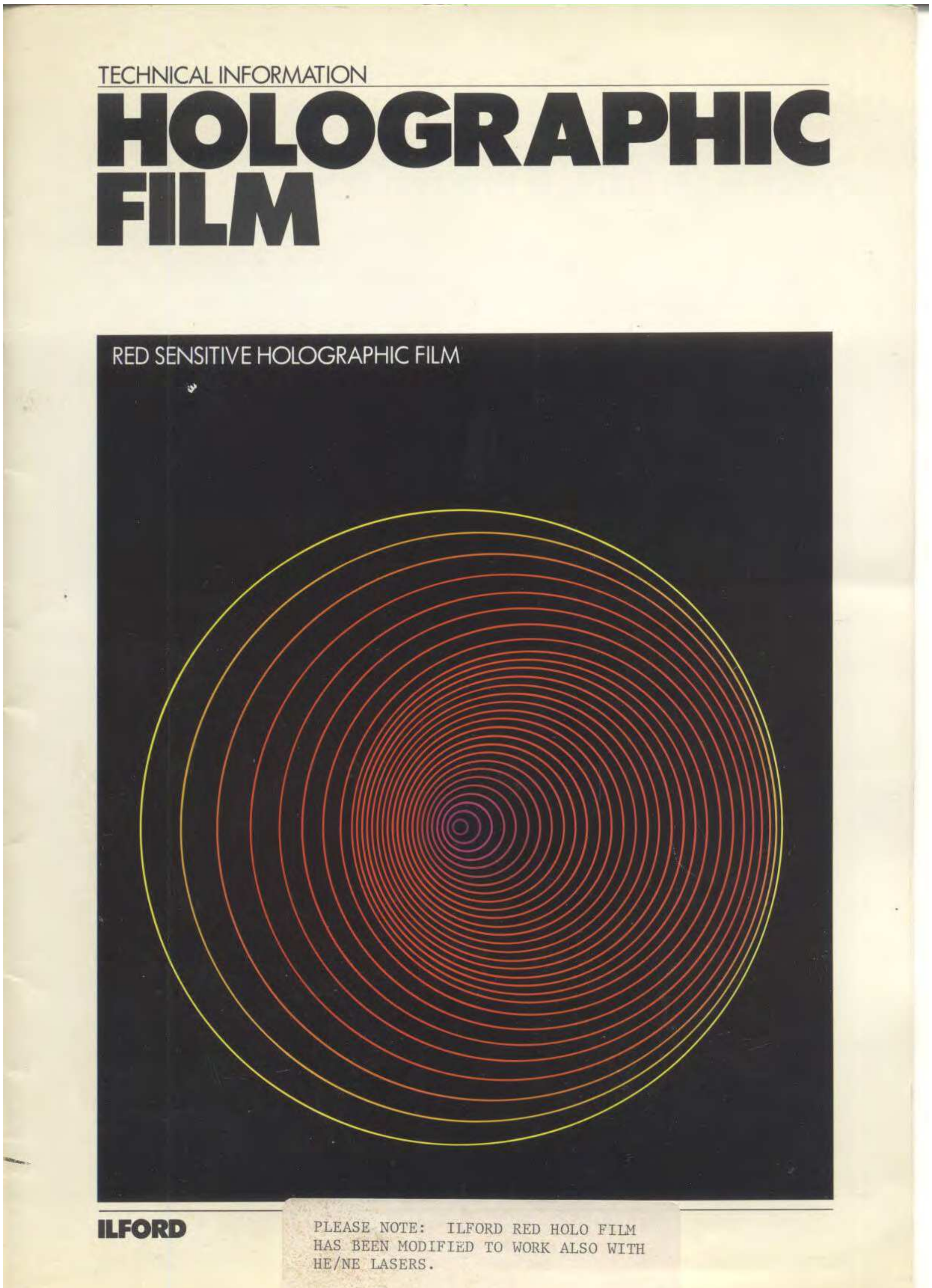
This is a new product made available to selected customers prior to possible inclusion in the range of branded products. The right is reserved to withdraw or modify the product at any time.

Ilford Limited Mobberley Cheshire England
14989027 F91

<u>Silver Halide Data Sheets:</u> (Ilford SP673 film version of SP696T), 11 pages

Go to Table of Contents

Five pages pertaining to reflection hologram processing deleted since these are transmissions.



2 FILM DESCRIPTION

SP673 film has been optimised specifically for use with Q-switched pulsed ruby lasers, and was developed for the manufacture of Lippmann-Bragg reflection holograms replaying in the yellow region of the spectrum. It is also ideal for the production of all low noise, non-wavelength shifted reflection and transmission holograms. The emulsion has maximum sensitivity to red light at 690-700nm, with reciprocity characteristics such that it responds optimally to short bursts of irradiation.

The film has an ultra fine grain emulsion with very high resolving power, greater than 7000 cycles/mm, and extremely low scatter characteristics. The optical clarity of the unexposed emulsion brings two benefits: higher definition in recorded holographic fringes and lower noise in the finished image.

Principal areas of application include:
Mastering for pulsed portraiture;
Contact copying by pulsed ruby laser;
Lamination into security documents;
Non-destructive testing.

2.1 Physical characteristics

SP673 has an emulsion layer 7 microns thick. To facilitate the incorporation of holograms into security documents and minimise problems of birefringence, the emulsion is coated on thin polyester substrate (63 microns). It is also available on thick triacetate substrate (200 microns) for optical clarity and ease of handling.

2.2 Storage

Unopened packages of SP673 film should be stored in a cool place, preferably 10°C (50°F) or below. If stored in a refrigerator, remove packages at least three hours before opening to enable the film pack to reach room temperature and thus avoid problems associated with condensation forming on the surface of the film, such as emulsion softening.

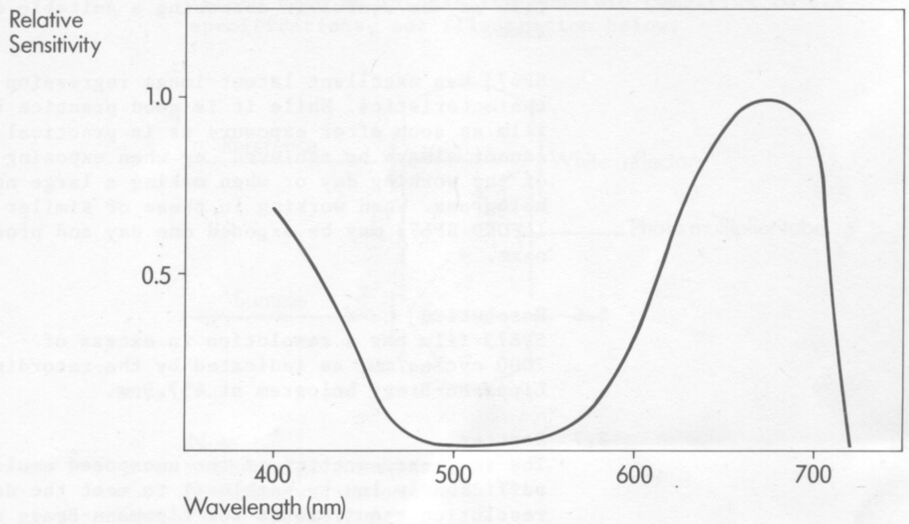
2.3 Safelight recommendations

SP673 film should be handled in blue/green safelight illumination provided by the ILFORD SP677 safelight used in an ILFORD DL10 darkroom lamp. This should be fitted with a 15W bulb. The minimum recommended distance of the safelight from the film is 1 metre.

Red sensitive films can be safely and conveniently handled in lighting from this safelight illumination; other safelights for red sensitive film are either not safe or are too dim to be of any practical use. If the SP677 safelight is not available, handle SP673 in total darkness.

2.4 Spectral sensitivity

SP673 emulsion is specially sensitised to light of 690-700nm. This makes it particularly useful when making holograms with Q-switched pulsed ruby lasers.



The above curve shows the relative spectral sensitivity of SP673 to white light flash exposure (10^{-4}s). This curve shows that SP673 has a maximum sensitivity at 694nm.

It can be seen from the above that the spectral sensitivity at 633nm is low compared to that at 694nm. It is not possible to compensate for this low speed to He/Ne lasers by increasing the exposure time. It is, however, possible to take advantage of the reciprocity characteristics of the emulsion and use a high intensity light source for a short time, such as achieved with scanning techniques.

2.5 Speed characteristics

It is not practical to recommend a single effective exposure for SP673 as this depends primarily upon laser wavelength and to a lesser extent on processing technique.

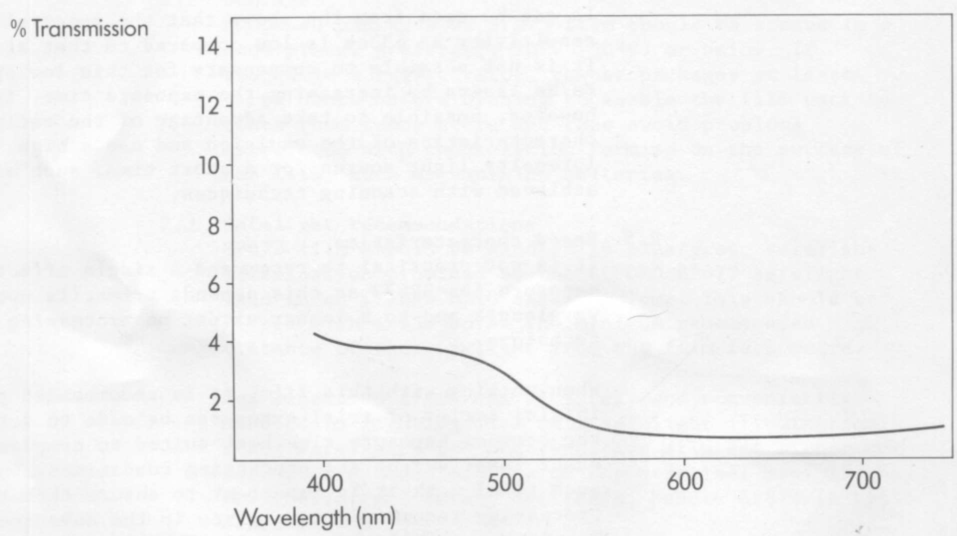
When working with this film, it is recommended that an initial series of trial exposures be made to determine the correct exposure time best suited to complement the exact laser set-up and processing conditions. During such trial work it is important to ensure that the processing recommendations given in the subsequent sections are followed carefully, so that a generally high level of image quality is obtained at the outset. Deviations in processing may then be made to suit individual requirements.

In certain cases, the spectral energy curve for this film may be useful in assessing a suitable exposure time.

SP673 has excellent latent image regression characteristics. While it is good practice to process film as soon after exposure as is practical, this cannot always be achieved, eg when exposing at the end of the working day or when making a large number of holograms. When working in these or similar conditions, ILFORD SP673 may be exposed one day and processed the next.

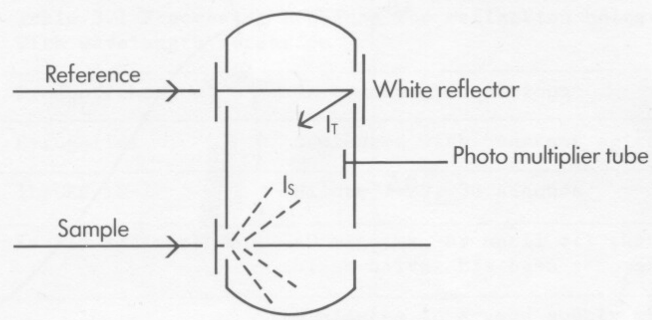
2.6 Resolution
SP673 film has a resolution in excess of 7000 cycles/mm, as indicated by the recording of a Lippmann-Bragg hologram at 457.9nm.

2.7 Scatter
The intrinsic scatter of the unexposed emulsion is sufficiently low to enable it to meet the demanding resolution requirements for Lippmann-Bragg recording, even in the blue spectral region. This same low scatter means that diffraction efficiencies comparable to dichromated gelatin can be achieved through higher fringe definition, and this, coupled with low post-processing scatter yields exceptionally high signal to noise ratios in the final hologram.



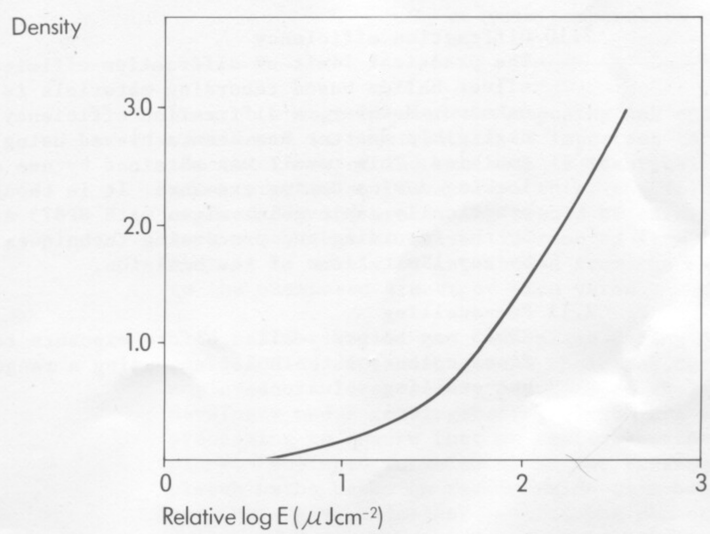
Note: % Transmission = $I_S/I_T \times 100$

The curve above shows the ratio of scattered light to specularly transmitted light for the unexposed emulsion throughout the visible spectrum. Scatter was measured by comparing the ratio of specularly transmitted light to forward scattered light in a spectrophotometer fitted with an integrating spheroid complying to CIE specifications, see illustration below.



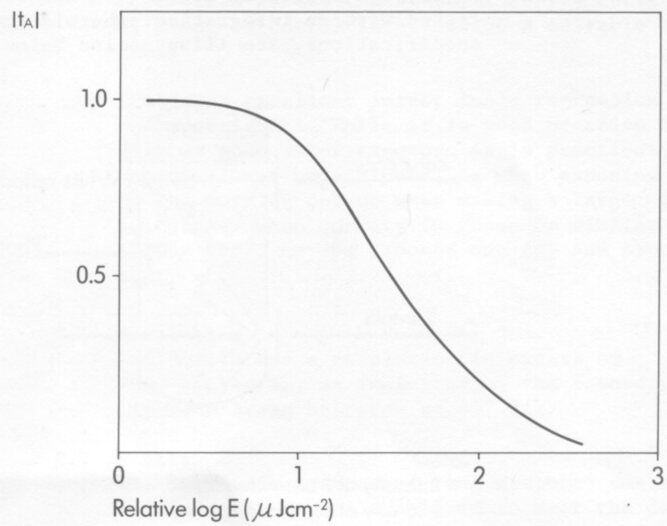
Note
I_T = Intensity of transmitted light
I_S = Intensity of scattered light

2.8 **Characteristic curve**



2.9 Amplitude transmission curve

Amplitude transmission is defined as the ratio between the amplitudes of a monochromatic plane wave after and before passing through the photographic emulsion.



Note

$|t_A| = \sqrt{10^{-D}}$ where D is density above fog

2.10 Diffraction efficiency

The practical limit of diffraction efficiency for these silver halide based recording materials is currently unknown. However, a diffraction efficiency of 97% with negligible scatter has been achieved using this emulsion. This result was obtained by use of a fringe locking device during exposure. It is thought that practically achievable values with SP673 are restricted by the recording and processing techniques rather than by any limitations of the emulsion.

2.11 Pre-swelling

SP673 may be pre-swollen before exposure to change the final colour of the hologram, using a range of pre-swelling solutions.

5 TRANSMISSION HOLOGRAMS

SP673 may be particularly recommended for making the following types of transmission holograms, when high diffraction efficiencies (up to 97%) with very low scatter may be expected:
Laser transmission masters
White light (rainbow) transmission masters
Diffraction gratings

Table 5.1 summarises the processing sequence for making transmission holograms with SP673. All times are given at 20°C (68°F) with constant agitation unless otherwise stated.

Table 5.1 Processing sequence for transmission holograms

Stage	Product/chemical	Recommended conditions
Development	ILFORD SP678C	Dilute 1+4, 4 minutes
Stop bath	ILFORD IN-1	Dilute 1+39, 30 seconds
Bleach	ILFORD SP679C	2 minutes
Wash		2 minutes in a good supply of fresh running water
Iodide bath	Optional	2 minutes
Final rinse	ILFOTOL	A few drops added to de-ionised or distilled water; squeegee film
Drying		In clean, warm air not above 40°C (104°F). Natural drying at room temperature may be done with care

When working with ILFORD SP678C developer, there is a choice of bleach: ILFORD SP679C or a special rehalogenating bleach formulation developed by ILFORD, a ferric sodium-EDTA bleach, which has also been found to give excellent results. See section 3 for formula.

Standard developers
When working with a standard developer such as Kodak D-19 or Tetenal Dokumol, it is important to bleach the film using a ferric nitrate bleach.

The formula for this is given below.

Ferric nitrate	100g
Potassium bromide	30g
Water to make	1 litre

Treatment with potassium iodide may be carried out when processing transmission holograms for exactly the same reasons and in exactly the same way as with reflection holograms. See section 3 for further details.

6 PROCESSING NOTES

Careful attention should be given to proper processing techniques, regardless of the material to be processed.

When preparing processing solutions, ensure that mixing vessels and processing dishes have been thoroughly cleaned before use. Discard processing solutions at the end of their working life. Do not attempt to economise by keeping solutions from one working period to the next if there is any risk that the solutions will not perform in the recommended way upon reuse. Mix fresh chemicals if there is doubt about the condition of any processing solution.

In general, it is satisfactory to mix chemicals with ordinary tap water. Care should be taken with bleach baths and the final rinse solution: de-ionised or distilled water is strongly recommended for making up these solutions.

For highest quality holograms, it is important to keep all processing solutions, including the wash water, at about the same temperature ($\pm 2^{o}$C or $\pm 5^{o}$F). In this way, image movement due to random shifts in the emulsion layer, as the gelatin alternately swells and shrinks during processing, will be minimised.

While exposure conditions can be varied to achieve good holographic performance over a wide range of development times and temperatures, it is generally advantageous to standardise on processing parameters such as time, temperature and agitation, and thereby minimise the effects of processing variability. In the same way, while it may be tempting to 'develop by inspection' to obtain the required result, for consistently good results, it is always best to process for the standard times. The hologram should then be examined after processing and the appropriate revised exposure or development time determined to produce a satisfactory hologram.

Finally, when solutions are kept from one day to the next, it is helpful to monitor the volume of film processed through them. As a guide, it is recommended that no more than 20 8x10inch sheets be processed in one litre of processing solution. In particular, this is true for ILFORD SP678C developer and ILFORD SP679C bleach.

6.1 Stop bath

ILFORD IN-1 stop bath is recommended between the the development and bleach stages, to prevent premature exhaustion of the bleach bath.

6.2 **Rinse**
As a final rinse after the final wash, immerse SP673 in distilled water to which ILFORD ILFOTOL wetting agent has been added. A few drops of ILFOTOL to each litre of water is sufficient. It is important to squeegee the film before drying.

6.3 **Drying**
The use of a film drying cabinet that blows warm air, preferably no higher than 40°C (104°F), over vertically hung holograms is recommended. Holograms can be air dried at room temperature with care, although drying marks may be observed when drying holograms in this way. Such marks may be minimised by the addition of ILFORD ILFOTOL wetting agent to the final rinse.

Adherence to the above simple guidelines will help to maintain a high standard of processing quality.

It should be noted that SP673 shrinks by 10% by the simple act of wetting and drying but the use of the developer/bleach combination described above will compensate for the shrinkage.

3.1 Pyrogallol developer

This is the most commonly used developer when processing holograms for wavelength retention. There are two generally accepted reasons for this. The first is that pyrogallol is a tanning developer, that is, it minimizes emulsion shrinkage during processing. Secondly, it leaves a brown stain which masks the scatter arising from the emulsion or bleach. If SP673 is correctly processed it will produce only negligible scatter so the pyrogallol stain is not helpful and may be removed to produce brighter holograms. This removal may be done at the end of the processing sequence by rinsing the film first in a 1% solution of potassium permanganate and then in a 1% solution of sodium metabisulphite.

Pyrogallol developer can be made as follows:

Part A	
Pyrogallol	6g
Ascorbic Acid	6g
Water to make up to	500ml
Part B	
Sodium Carbonate	30g
Water to make up to	500ml

Mix equal volumes of Part A and B immediately prior to development and process for 3 minutes at 20°C (68°F). Adjust exposure and development times for control of final image colour.

Important

Once Parts A and B have been mixed, the solution is unstable. It should be used immediately and discarded after use.

3.2 Ferric sodium-EDTA bleach

This is recommended for processing reflection holograms to achieve optimum results, and may be made up as follows:

Ferric sodium-EDTA	100g
Potassium bromide	10g
Water to make	1 litre

Ferric sodium-EDTA bleach forms a stable solution and is best kept in a half-full bottle. This bleach is unusual in that it can be regenerated by prolonged exposure to air (ie by leaving the solution in a dish or opened bottle overnight). This technique, however, will not prolong the life of the bleach indefinitely.

3.3 Treatment with potassium iodide

Phase holograms, consisting of silver halide, are inherently susceptible to photo reduction (printout). Amplitude holograms, where the fringes consist exclusively of metallic silver, are not. The light stability of phase holograms can be significantly improved by the use of a bath of potassium iodide. This should be employed after the hologram has been washed following the bleach bath.

Potassium iodide will cause a yellow stain on the hologram, together with some increase in scatter.

Method

Dissolve 2.5g of potassium iodide in 1 litre of tap water. After bleaching and washing (see table 3.1), immerse the film in the iodide bath at 20° (68°F); agitate the film continuously during this time. After two minutes, remove the film allowing the excess liquid to drain off.

<u>Silver Halide Data Sheets:</u> (relevant pages from Hans Bjelkhagen's book, "Silver-Halide Recording Materials for Holography and Their Processing), 4 pages

NB: When book was published, 1993, BB640 emulsion didn't yet exist.

Go to Table of Contents

Agfa:

Table 3.1. AGFA products

Material	Emulsion thickness [μm] plate/film	Spectral sensitivity [nm]	Sensitivity [μJ/cm²] at 514	633	694	Resolving power [ℓp/mm]	Grain size [nm]
8E75 HD	6/5	<750	-	10	20	<5000	35/44[a]
10E75	6/5	<750	-	1	2	<2800	90
8E56 HD	6/5	<560	25	-	-	<5000	35/44[a]

[a] The mean grain size before coating the emulsion is about 35 nm. Investigatins on the actual grain size in a coated emulsion indicate the mean grain size for the HD material of about 44 nm.

95

Ilford:

Go to Table of Contents

the blue-green version is named SP 695T (plates)/SP 672T (film). SP stands for Special Products. When first introduced in the early 80's, the red material (SP673) was produced mainly for recording with a Q-switched ruby laser, as Ilford was then part of a joint venture with Applied Holographics, PLC., developing a new mass-replication system for holograms. It was soon noticed that the new material was also in demand among the people working with CW lasers, e.g., HeNe lasers. The company has therefore modified the emulsion's sensitivity so that it could be useful for the HeNe laser recordings as well. The material has a high resolving power and the same sensitivity as Agfa's corresponding red-sensitive material but the Ilford green version is faster than the green Agfa 8E56 HD material. The reader may wish to refer to some of the papers on Ilford holographic materials [3.11-16].

The red-sensitive material has a built-in pre-swell treatment (BIPS factor), which means that the material will shrink about 8.8% after processing. This unique feature is of special interest to people working with reflection holograms. Holograms recorded at 633 nm will then replay at 577 nm, which gives an orange-yellow color, suitable for a variety of holographic images. A reflection master recorded with a ruby laser at 694 nm will reconstruct at 633 nm, which can be useful for film copying, using, e.g., a scanning HeNe-laser beam. The predetermined shrinkage will only occur if non-tanning processing chemicals are used such as products recommended by Ilford. Tanning processing solutions containing, e.g., pyrogallol or PBQ will partly over-ride the BIPS factor, producing holograms which will reconstruct at the wavelength close to the one used for the recording. If non-tanning processing is applied and no shrinkage wanted, Ilford recommends washing the unexposed material in water prior to exposure, which will remove the swelling agent in the emulsion. In addition to eliminating the BIPS factor, this treatment will also increase the sensitivity of the material by a factor of two.

3.3.1 Emulsion Characteristics

The characteristics of the two Ilford emulsions are presented in Table 3.2. Since the Ilford material is intended mainly for the use in reflection holography, it is not treated with anti-halation backing.

Figure 3.5 shows the characteristic curve and Fig.3.6 the spectral sensitivity.

3.3.2 Base Substrate and Formats

Ilford materials can be ordered on both glass and film. The glass plates are of the following formats:

4" × 5"	thickness	1.6 mm
8" × 10"	"	3.0 mm

Table 3.2. Ilford products.

Material	Emulsion thickness [μm]	Spectral sensitivity [nm]	Sensitivity [μJ/cm^2] at 442	514	633	694	Resolving power [ℓp/mm]	Grain size [nm]
FT340T/SP696T	6+0[a]	<700	-	-	200		<7000	30[b]
HOTEC R (film)	5+2[a]	<700	-	-	20	50	<7000	30[b]
SP695T (plate)	6+0[a]	<560	200	100	-	-	<7000	30[b]
SP672T (film)	6+1[a]	<560	200	100	-	-	<7000	30[b]

[a] The first figure indicates the thickness of the active emulsion and the second the gelatin supercoat.
[b] Mean grain size in a coated emulsion.

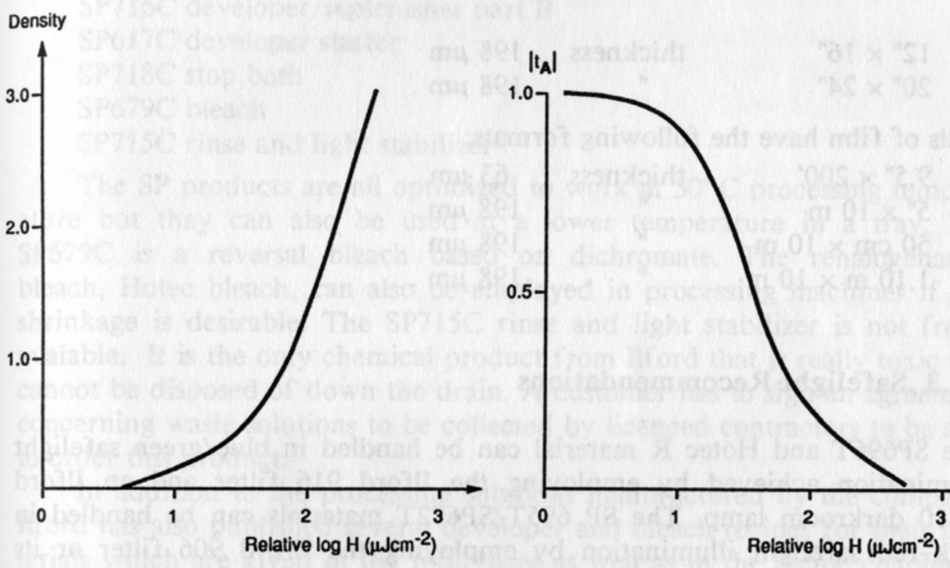


Fig.3.5. The characteristic curve and the amplitude transmission curve for Ilford's red-sensitive emulsion. (Reprinted courtesy Ilford Ltd.)

30 cm × 40 cm	thickness	3.0 mm
50 cm × 60 cm	"	5.0 mm

Ilford coated the holographic emulsion on either polyester or triacetate base. The polyester base is a 63 μm thick (2.5-mil) film and the triacetate base has a thickness of 198 μm (8-mil). The existing sheets of film have the following formats:

4" × 5"	thickness	198 μm
8" × 10"	"	198 μm

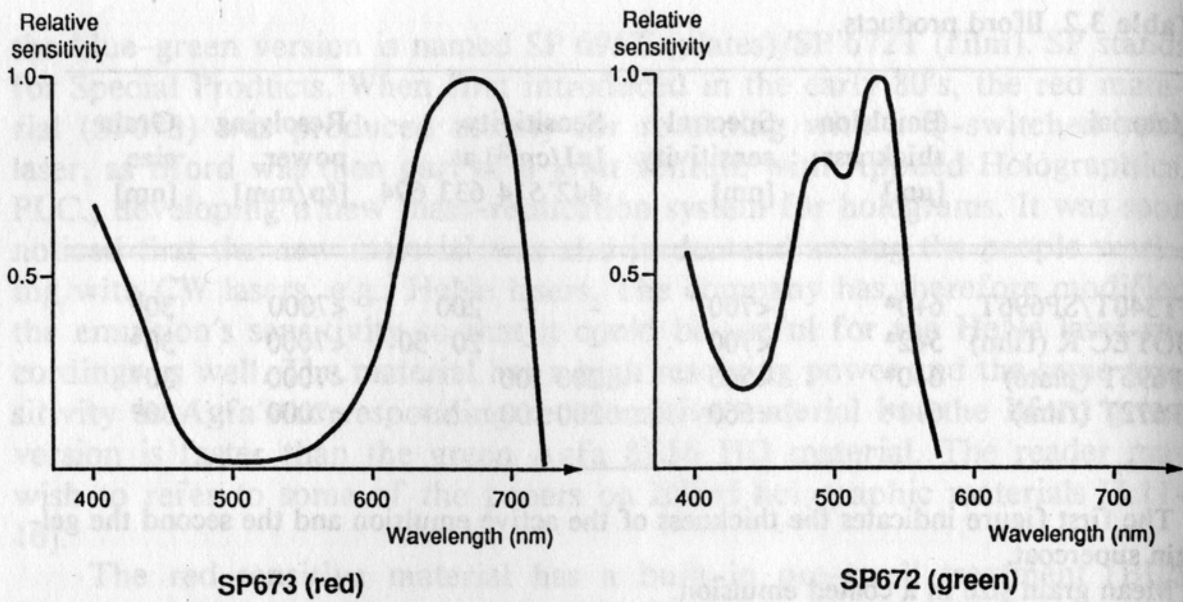


Fig.3.6. Spectral sensitivity curves for Ilford's red- and green-sensitive materials. (Reprinted courtesy Ilford Ltd.)

12" × 16"	thickness	198 μm
20" × 24"	"	198 μm .

Rolls of film have the following formats:

9.5" × 200′	thickness	63 μm
5" × 10 m	"	198 μm
50 cm × 10 m	"	198 μm
1.10 m × 10 m	"	198 μm .

APPENDIX B:

Go to Table of Contents

Chemical formulas used for processing 24 tests: 2 pages

Developers:

BB Pyrogallol also called Pyrochrome & JD-1 (Part A & Part B), (Tests 1-6, 8,9)

Part A:
1 liter distilled water
10 grams pyrogallol

Part B:
1 liter distilled water
60 grams sodium carbonate (anhydrous)

Mix equal parts sufficient to cover plate in tray just before processing. Good for about 15 minutes after mixing.
After development, wash in filtered water and put into bleach.

Kodak D-19 (Test 7)

2 grams Metol
90 grams sodium sulfite
8 grams hydroquinone
52.5 grams sodium carbonate (monohydrate)
5 grams potassium bromide
1 liter distilled water

BB Ascorbic Acid (Tests 10, 11, 20, 24)

20 grams ascorbic acid
20 grams sodium carbonate
6.5 grams sodium hydroxide
1 gram phenidone

Nick's #5 Catechol Ilford (Part A & Part B), (Tests 12, 15-17, 19, 22)

Part A:
60 grams sodium sulfite
20 grams catechol
10 grams hydroquinone
10 grams potassium bromide
1 liter distilled water

Part B:
20 grams sodium metaborate
120 grams sodium carbonate (anhydrous)
1 liter distilled water

Mix equal parts before processing. Good for about a day after mixing.

Nick’s #5 Catechol Agfa (Part A & Part B), (Tests 13, 14, 18, 21, 23)

Part A:
60 grams sodium sulfite (anhydrous)
20 grams catechol
10 grams hydroquinone
1 liter distilled water

Part B:
120 grams sodium carbonate (anhydrous)
1 liter distilled water

Mix equal parts before processing. Good for about a day after mixing.

Bleaches:

FeEDTA (Tests 1, 7, 11-24)

30 grams di-sodium EDTA
30 grams ferric sulfate
30 grams potassium bromide
65 grams sodium bisulfate
1 liter distilled water

Pyrochrome (Tests 2-5, 8,9)

4 grams potassium dichromate
12 grams sodium bisulfate
1 liter distilled water

Fix:

F-24 non-hardening fix (Test 7)

Start with ½ liter distilled water @125F/52C
152 grams sodium thiosulfate (anhydrous)
10 grams sodium sulfite (anhydrous)
25 grams sodium metabisulfite
Cold distilled water to make 1 liter

240 grams of the pentahydrate sodium thiosulfate can be substituted for the anhydrous
After sodium thiosulfate has completely gone into solution, add the sodium sulfite and so on.
It keeps up to 4 months in stoppered bottle. Capacity is 25 8x10” pieces.

Stop:

Tray of distilled water, and/or filtered running water and/or dilute Kodak stop bath.

Special thanks to Ed Wesly for his excellent website and emails and to Mike Medora for BB640 exposure and processing guidance.

APPENDIX C:

Go to Table of Contents

Cobalt Laser data sheet for Flamenco 500mw: 6 pages

The cooling for the laser is using the TEC plate for active baseplate temperature control instead of a coldplate with liquid chilling. So far, it’s worked very well and eliminates the need for a sometimes noisy liquid chiller and tubing.

Cobolt 05-01 Series

High Power | Single Frequency | CW Diode pumped lasers

Cobolt 05-01

Cobolt 05-iE

Applications

Raman Spectroscopy
Interferometry
Holography
Optical Tweezers
Super-resolution Microscopy

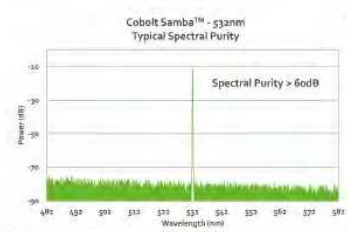
- CW output power up to 3 W in a perfect beam
- Extremely high level of spectral stability
- Stable single frequency operation over wide temperature range
- Ultra-low intensity noise, down to < 0.1 %
- 320 nm, 355 nm, 457 nm, 473 nm, 491 nm, 515 nm, 532 nm, 561 nm, 640 nm, 660 nm and 1064 nm
- Fully Integrated electronics option available
- Up to 24 months warranty, unlimited hours

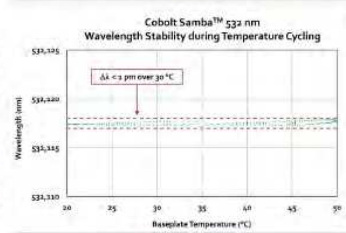
The Cobolt 05-01 Series lasers are continuous-wave diode pumped laser (DPL) devices operating at a fixed wavelength between 320 nm and 1064 nm. The lasers are built using proprietary HTCure™ manufacturing technology for ultra-robustness in a compact hermetically sealed package.

The Cobolt 05-iE is a fully integrated laser device, including all control electronics. The Cobolt 05-iE eliminates the need for an external controller, bringing the trusted laser performance of Cobolt 05-01 Series into a compact, self-contained device.

The lasers emit a very high-quality laser beam with stable characteristics over a wide range of operating conditions. Single frequency operation provides a narrow spectral bandwidth and long coherence length. The lasers are designed and manufactured to ensure a high level of reliability.

The Cobolt 05-01 Series lasers are intended for stand-alone use in laboratory environments or for integration as OEM components in instruments for applications including fluorescence microscopy, flow cytometry, DNA sequencing, HCA, Raman spectroscopy, interferometry, holography and particle analysis.





Typical Beam Profile

Cobolt 05-01 Zouk™
$M^2 < 1.1$

HÜBNER Photonics

Cobalt 05-01 Series

Performance Specifications

	Zydeco™*	Zouk™*	Twist™	Blues™	Calypso™*	Fandango™	Samba™
Wavelength in air (nm)	319.8 ± 0.3	354.8 ± 0.3	457.0 ± 0.3	473.0 ± 0.3	491.5 ± 0.3	514.8 ± 0.3	532.1 ± 0.3
Available Power Levels (mW)	20	10 20	100 200 300	100 200 300	200	300	500 1000 1500
Power stability (±2°C and 8hrs)	< 2%						
Noise, 20 Hz - 20 MHz (pk-pk)	< 5%	< 2%			< 5%	< 2%	< 1%
Noise, 20 Hz - 20 MHz (rms)	< 0.5%	< 0.2%			< 0.5%	< 0.2%	< 0.1%
Beam diameter at aperture (µm)	700 ± 50						
Beam symmetry at aperture	> 0.90:1						> 0.95:1
Beam divergence (full angle, mrad)	< 0.8		< 1.2				
Spatial mode (TEM_{00})	$M^2 < 1.2$	$M^2 < 1.1$					
Spectral linewidth (FWHM)	< 1 MHz						
Wavelength stability (±2°C and 8hrs)	< 1 pm						
Polarization ratio (linear, vertical)	> 100:1						
Warranty (unlimited hours)	12 mo. 3000 hrs	12 months			24 months	12 months	24 months

	Jive™	Bolero™	Flamenco™	Rumba™
Wavelength in air (nm)	561.2 ± 0.3	639.6 ± 0.6	659.6 ± 0.3	1064.2 ± 0.6
Available Power Levels (mW)	200 300 500	300 500	100 300 500	500 1000 2000 3000
Power stability (±2°C and 8hrs)	< 2%			
Noise, 20 Hz - 20 MHz (pk-pk)	< 1%	< 7%	< 1%	
Noise, 20 Hz - 20 MHz (rms)	< 0.1%	< 1%	< 0.1%	
Beam diameter at aperture (µm)	700 ± 50			1000 ± 50
Beam symmetry at aperture	> 0.95:1			
Beam divergence (full angle, mrad)	< 1.2	< 1.4	< 1.5	< 1.6
Spatial mode (TEM_{00})	$M^2 < 1.1$			$M^2 < 1.2$
Spectral linewidth (FWHM)	< 1 MHz			
Wavelength stability (±2°C and 8hrs)	< 1 pm			
Polarization ratio (linear, vertical)	> 100:1			
Warranty (unlimited hours)	24 months	12 months	24 months	

* Cobolt Zydeco™ 320 nm, Zouk™ 355 nm and Calypso™ 491 nm laser is not yet available in the 05-IE package.

Heat sink with fans for fiber coupling FIC-04

This device contains components that may be sensitive to Elecrostatic Discharge (ESD).

ESD protection can be achieved with proper electrical grounding.

WARNING VISIBLE AND INVISIBLE LASER RADIATION!

Avoid exposure to beam.
Class 3B Laser Product
Classified per IEC 60825-1:2014

Wvl (nm)	Max.Pwr (mW)
320	100
355	60
457	499
473	499
491	499
515	499
561	499
660	499

Avoid eye or skin exposure to direct or scattered radiation.
Class 4 Laser Product
Classified per IEC 60825-1:2014

Wvl (nm)	Max.Pwr (mW)
532	3000
561	1000
640	1500
660	1000
1064	4000

Model Number

WWWW-05-01-PPPP-CCCC

Wavelength — Power — Configuration:

- 500 = Gen 5b Controller, RS-232, CE / CDRH
- 600 = Gen 5b Controller, RS-232, OEM
- 700 = Gen 5b Controller, USB, CE / CDRH
- 800 = Gen 5b Controller, USB, OEM
- 1100 = Integrated electronics, CE / CDRH
- 1200 = Integrated electronics, OEM
- XXXX = OEM customization

Communication Interface

Communication	USB or RS-232
Standard Baudrate	115200

Cobolt 05-01 Series

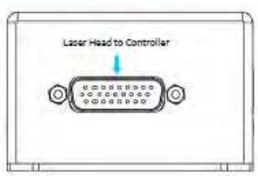
Operational Environment

The optical performance specifiations are not effected by the choice of electronics configuration. However when choosing between the Cobolt 05-01 and 05-iE the operation environment, power supply requirements and thermal management must be considered.

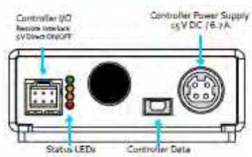
	05-01	Zydeco / Bolero	05-iE
Power supply requirements	15 VDC, 6 A		12 VDC, 6.7 A
System power consumption	< 65 W, typical 30W		
Maximum laser head baseplate temperature	50 °C	45 °C	45 °C
Ambient temperature, operation	10 - 40 °C	10 - 35 °C	10 - 35 °C
Laser head heat sink thermal impedance (at max ambient temperature)	< 0.2 K/W	< 0.18 K/W	< 0.15 K/W
Beam pointing stability (over operation temperature range)	< 10 µrad/°C, typical 5 µrad/°C		
Ambient temperature, storage	-10 -> +60 °C		
Humidity	0 - 60 % RH non-condensing		
Ambient air pressure	950 - 1050 mbar		

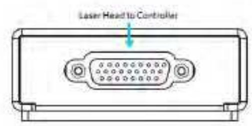
Electrical Interfaces

Cobolt 05-01 - Laser head



Cobolt 05-01 - Controller

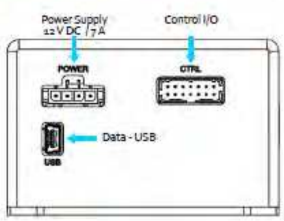




Molex 6 pin - Controller I/O

Pin	Function
1	Remote interlock
2	0 V – Ground
3	Direct Input
4	--
5	LED 1 (LASER ON)
6	LED 2 (ERROR)

Cobolt 05-iE - Laser head



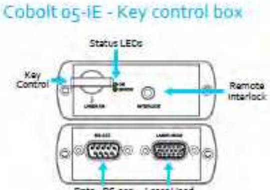
Molex 14 pin- Control I/O

Pin	Function
1	Remote interlock
2	0 V – Ground
3	0 V – Ground
4	RS-232 TX
5	RS-232 RX
6	LED 1A (LASER ON)
7	LED 1B (LASER ON)
8	LED 2 (ERROR)
9	--
10	--
11	Key Switch
12	Direct Input
13	0 V – Ground
14	--

Molex 4 pin - Power Supply

Pin	Function
1	0 V – Ground
2	0 V – Ground
3	+ 12 V - DC
4	+ 12 V - DC

Cobolt 05-iE - Key control box



Sub-D 15 pin- Control I/O

Pin	Function
1	LED 1A (LASER ON)
2	LED 2 (ERROR)
3	--
4	0 V – Ground
5	Key Switch
6	--
7	RS-232 TX
8	RS-232 RX
9	--
10	0 V – Ground
11	Remote interlock
12	--
13	--
14	--
15	0 V – Ground

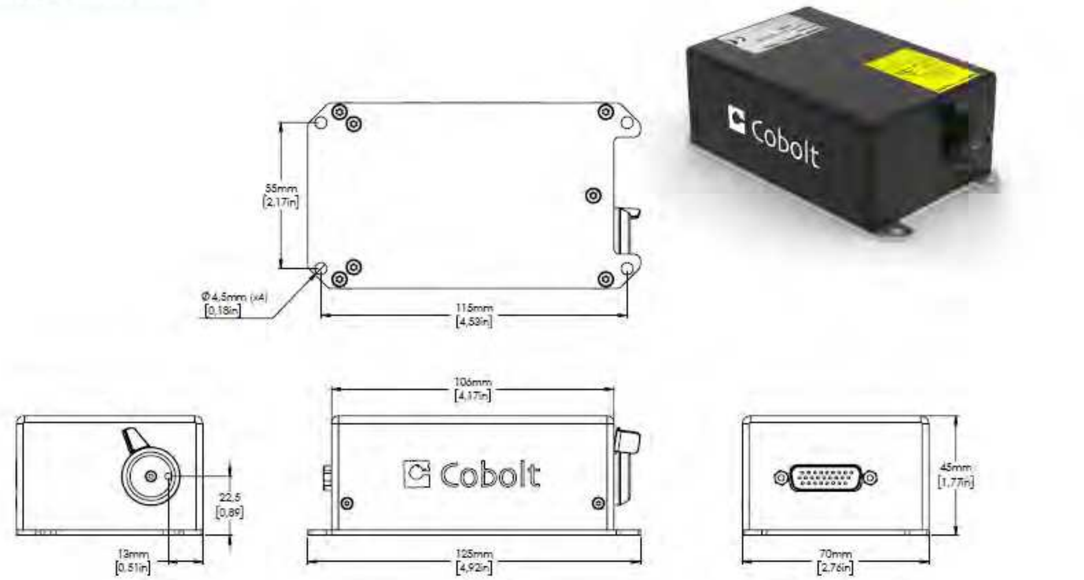
Sub-D pin- RS-232

Pin	Function
1	--
2	RS-232 TX
3	RS-232 RX
4	--
5	0 V – Ground
6	--
7	--
8	--
9	--

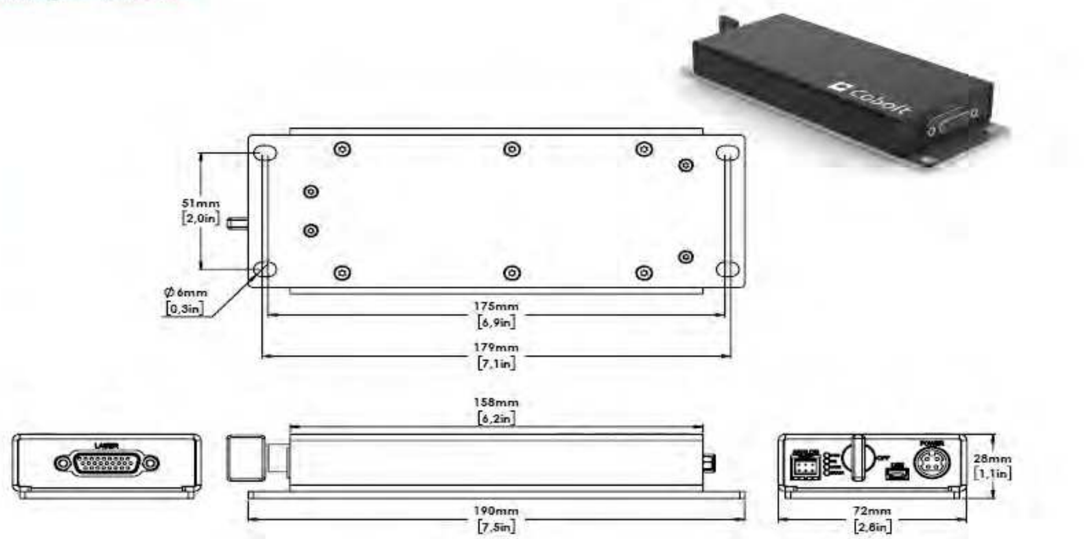
Cobolt 05-01 Series

Mechanical Specifications

Cobolt 05-01 Laser head



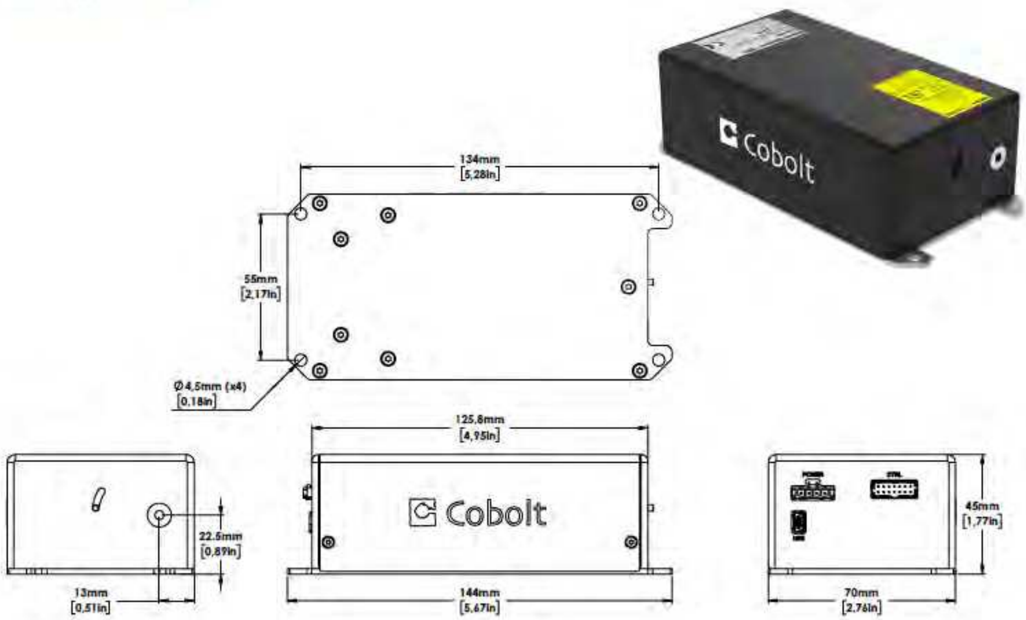
Cobolt 05-01 - Controller



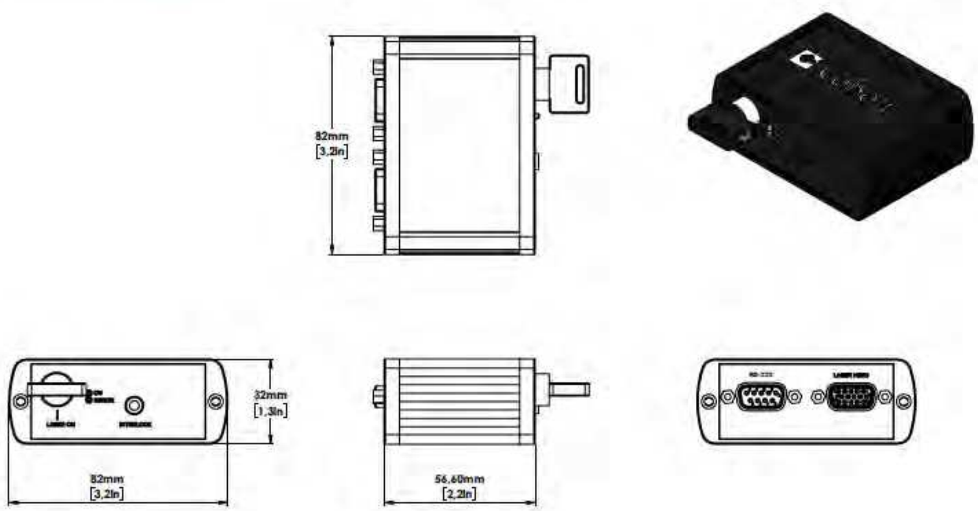
Cobolt 05-01 Series

Mechanical Specifications

Cobolt 05-iE Laser head



Cobolt 05-iE - Key control box



Cobalt 05-01 Series

Options and Accessories

- C-FLEX Laser combiner
- Laser head heatsink with fans for 05-01 lasers : HS-04
- Laser head heatsink with fans for 05-iE lasers : HS-05
- TEC Plate for active baseplate temperature control
- Heatsink with fiber coupling for 05-01 lasers : FIC-04

C-FLEX Laser combiner

Heatsink with fans

TEC-Plate for active baseplate temperature control

Heat sink with fans for fiber coupling FIC-04

D0882-A | SEPTEMBER 2022 | WWW.HUBNER-PHOTONICS.COM

Our Locations

Cobolt AB
(Sales in Norway, Sweden, Finland and Denmark)
Solna, Sweden
Phone: +46 8 545 912 30
Fax: +46 8 545 912 31
E-mail: info@coboltlasers.com

HÜBNER Photonics GmbH
(Sales in Germany, Switzerland and Austria)
Kassel, Germany
Phone: +49 561 994 060-0
Fax: +49 6561 994 060-13
E-mail: info.de@hubner-photonics.com

HÜBNER Photonics Inc.
(Sales in USA, Canada and Mexico)
San Jose, California, USA
Phone: +1 (408) 708 4351
Fax: +1 (408) 490 2774
E-mail: info.usa@hubner-photonics.com

HÜBNER Photonics UK
(Sales in UK and Ireland)

United Kingdom
Phone: +44 7359 440 871
E-mail: info.uk@hubner-photonics.com

www.hubner-photonics.com

Find local sales representatives:

Australlia, Benelux, Brazil, China, Estonia, Latvia, Lithuania, France, India, Israel, Italy, Japan, Poland, Russia, Belarus, Singapore, Malaysia, Thailand, South Korea, Spain and Portugal, Taiwan

Go to Table of Contents