

Film Test Data

Dec 14, 2004 by Don Westergren

The newest film test result is for Fuji SHQ 200 unhypered. It is a low cost film available through Walmart, Target, and many drug stores. My tests show it to be a poor film, about like Kodak RG100. Maybe hypering will bring out some red response, that remains to be seen.

Some of the new Film Test Data now incorporates a blue-green LED in addition to the RG&B LEDs. This blue-green LED is about 502 nm, very close to Oxygen III light. The data for each film is on a separate page, with annotation as well as the test photos and Bar Graph data. You can click on any film name in the summary below and go to that film page. Then click "Back" to come back to this page. Second, the bar graph data now evaluates the red, green, and blue response of each film compared to PhotoShop® saturated pure color.

I have added test results for Kodak Max Versatility 800 and Konica Centuria 400 color negative films. The films listed in red below are no longer in production. Most of them are also now out of date, but may be usable if kept in cold storage.

Many of these films were tested in actual night sky conditions by Pat Freeman with excellent examples of raw and processed images.

His web site is http://home.woh.rr.com/pfcf/astro_photos.htm

Summary Results Color Negative Film

The following data is a sample of the pictures taken with each film at the same total exposure. Each picture was scanned and color intensities measured with Photoshop, all using the same settings and procedures. The color intensity measurements were graphed in Excel to make the Bar Graphs. The graphs tell the real story for each film. The height of each bar shows a measure of light sensitivity compared to PhotoShop saturated pure RG&B colors (scale up to 255). The LED light image measured was selected to give unsaturated measurements for all films tested. The bars indicate sensitivity linearly, so 1/2 height is about 1 stop down. Each film has a designation like H0 or H12, which indicates the hypering time at 30°C, 3 psig in forming gas. Designations like H12-50 indicate hypering at 50°C.

The ratings are based on the levels of the bar graphs for each film and exposure. The best films have a reasonably even color level across the red-green and blue, and have the highest light sensitivity.

Old Royal Gold 200 H36	Good/Great	Needs Hyper Rebate Change, more B&G than PPF
New RG 200 H1450	Good+	Needs Hyper Rebate Change, more B&G than PPF
PJ 400 H12 4-22mth old	Good +	Slightly better than fresh hypered
PPF 400 H0-H12	Good +	Outstanding for unhypered film, hypering helps little
Old RG 400 H0-36	Good +	Outstanding unhypered, hypering loses short sens.
PJ 400 H12 Fresh	Good +	Very even colors, needs hypering
Supra 400 H0-H31	Good +	Outstanding for unhypered film, hypering helps little
LE 400 H0-H48	Good	Slightly less than Supra, hypering doesn't help
Supra 800 H36	Conditional +	Very blue/green - Comet, Gal. & Reflection Nebula?
Portra 800 H24	Conditional	Very blue/green - Comet, Gal. & Reflection Nebula?
Agfa Optima II 400 H36	Conditional -	Very green - Comet, Galaxy & Reflection Nebula?
Royal Gold 100 H36	Acceptable+	About 12 stop less than Supra400 for long exposures
KonicaCenturia400 H0	Acceptable	About 1/2 stop less than Supra400, very low blue-green (OIII)
Portra 800 H0	Acceptable	Low reds, green & blue are good
Old Royal Gold 200 H0	Acceptable	About like hypered Royal Gold 100
Fuji NPH 400 H0-H80	Acceptable	About 1/2 stop less than Supra400, no hypering effect
Agfa Optima II 400 H0	Acceptable -	About 1 stop less than Supra400
Fuji Superia 400 H0-H36	Poor	Good green, very low red & blue
PJ 400 H0	Poor	Very even colors, very low sensitivity

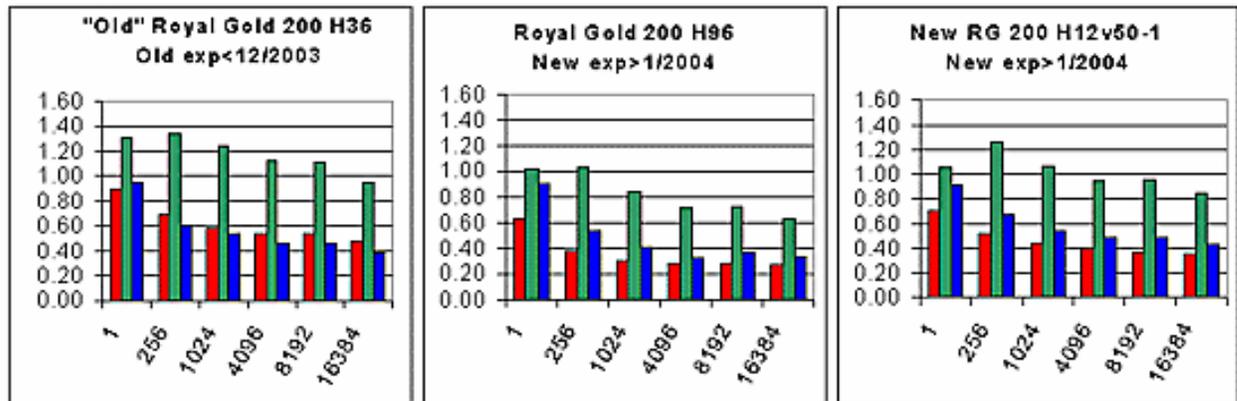
Fuji SHQ 200 H0	Poor	Some Green, Low blue & extremely low red
Royal Gold 100 H0	Poor	Very low red & Green, extremely low blue
Supra 800 H0	Poor	Good green, very low red & blue
Max Versatility 800 H0	Poor	Good green and blue, very low red & green-blue

Summary Results Color Slide Film

Two slide films were tested in the unhypered condition, but processed with either standard or push+2 E-6 chemicals. The slides were scanned on the same scanner as the negative film tests, however the comparison with color negative film is an eye-ball comparison. The relative comparisons of the two films with each other are sensitive and accurate. Both 35mm and 120 roll tested push+2 both films. Both sizes tested the same.

Fuji Provia400 push+2	Good/Great	Very even colors for > 17 min (short are more B&G)
Fuji Provia400 std develop	Good	Very even colors, ¼ stop less red than E200+2
Kodak E200 push+2	Good	Very low blue, good red and green
Kodak E200 std develop	Good (-)	Very low blue, good red and green, red like Provia std

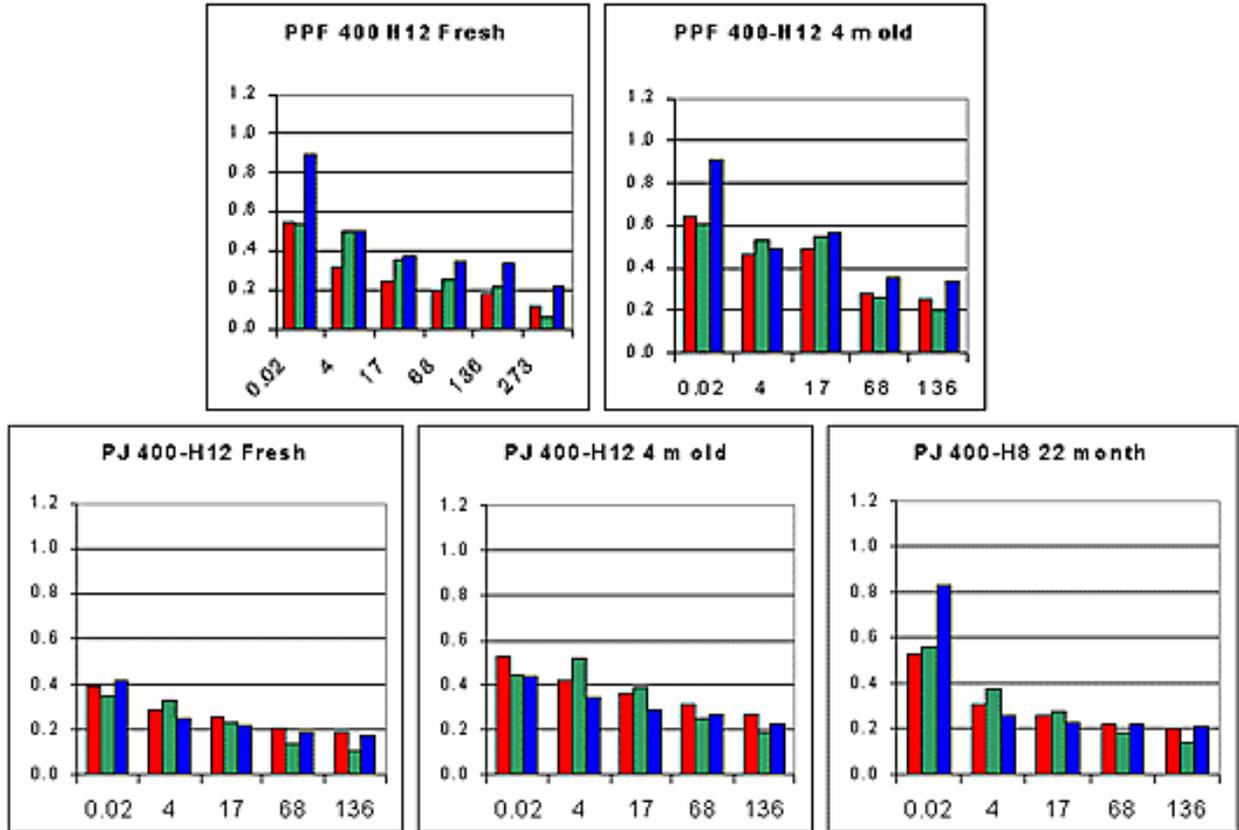
Kodak announced a change to their Royal Gold films in early 2002. The first of the new RG 200 was available around June 2002. The new film tests with reduced red light sensitivity and takes about 3x to 4x longer to hyper. The old RG 200 was terrible unless fully hypered to the point of rebate (the orange background on the negative) turned slightly brown. The new RG200 is a bit more tolerant of being under hypered, but is best when the rebate color is changed. Hypering @ 30°C required 36 hours for the old RG 200, it now takes over 96 hours (try 110 hrs) @ 30°C or (slightly better) 12 hours @50°C. Incidentally, RG 200 is the only currently available color negative film that really needs hypering for astrophotography. The new RG 400 isn't tested yet. Kodak has now announced changes to their Supra films for this fall. Click here for a [comparison](#) of Supra400 unhypered with new RG200 hypered 36 hours @30°C.



In evaluating films for your own use, consider the height of each color bar for the exposures you use, the subject matter and overall color balance desired. Having all the color bars at the same level will produce the most accurate colors. But if you are shooting a blue nebula, you don't need high red sensitivity so a film rated as poor overall may be the best choice if it has high blue sensitivity (try Supra800 H36). If you are shooting with a fast F ratio, using short exposures up to 16 minutes or so, Supra 400 (H0 and H31) and Old Royal Gold400 H0 are the most sensitive and have good color balance. Longer shots up to 4 hours show significant reciprocity losses in light sensitivity for all films. Old Royal Gold200 H36 is the most sensitive for long shots (1 to 4 hours+) but has increased green sensitivity. New RG 200 is slightly less sensitive to reds than the old RG 200, but is still better than any other color negative film. Supra400 both H0 and H31 are good, as is Royal Gold400 H0 and LE 400. RG400 and LE400 are less sensitive than the old PPF400 for 1-4 hours, but they are better than the other films tested.

A surprise result is the film response to hypering and storage in a freezer. I had a few old rolls of PJ400 H8 and H12 left over from planned astrophoto sessions that got clouded out. I have religiously used only fresh hypered films in the past. The 4-month-old PJ400 H12 tests better than fresh hypered, and the 22-month-old PJ400 H8 does too. I store all my hypered film in the freezer after placing the film back in its plastic container with a few grains of water softener salt (for absorbing moisture) and sealed with plastic electrical tape. I mark each container with the date of

hypering. Hypering helps some films a lot, like Royal Gold200 and Supra800 H36 (green & blue, not red). Other films like Supra400 benefit a slight amount from hypering, but are very good unhypered. One film is actually hurt by hypering; Royal Gold400 loses sensitivity up to about 1/2-hour exposures.



The Future: I plan to explore the storage of hypered films to include New Royal Gold 200. This investigation of storage affects will necessarily take some months. This testing is sensitive enough to evaluate any differences in film response to hypering at 50°C vs. 30°C. I also plan to evaluate Tech Pan, hypered both fresh and stored.

Acknowledgement: I want to extend my thanks to Bert Katzung and Joe Mize, both on the APML. Bert put my early film test results on his page to make them available on the web, long before I could setup this page. Joe helped review the data and gave me a lot of help understanding how to setup this web page.

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Comparison of Supra400 unhypered with New Royal Gold hypered 36 hrs @ 30°C

Both photos taken with an Astro Physics 7"/f9 refractor, 45 minutes. Both scanned with same scanner settings and adjusted with auto level in Photoshop 7.0. No other adjustments to color or image processing other than reducing pixel size for publishing on this web site.

These are two ~200K pictures, so give them a few moments to load.



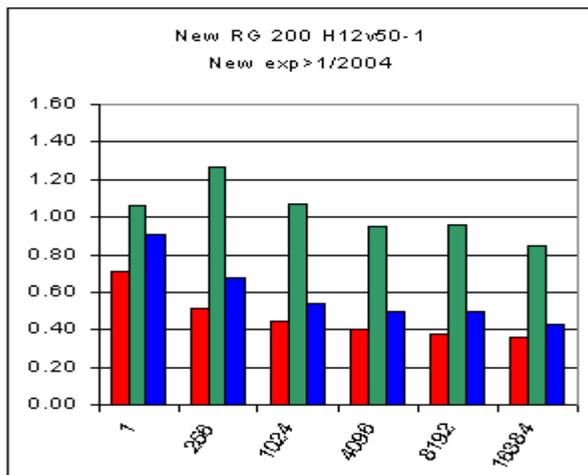
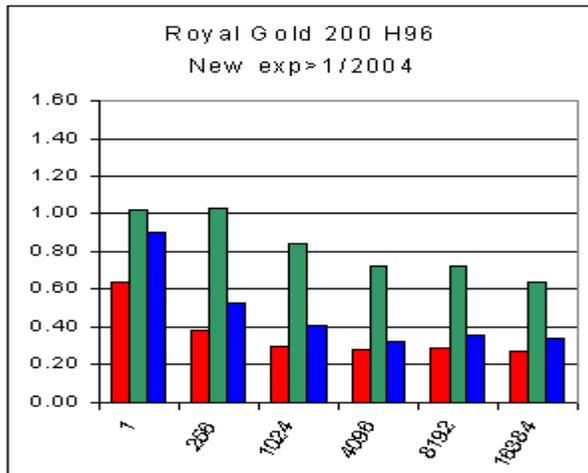
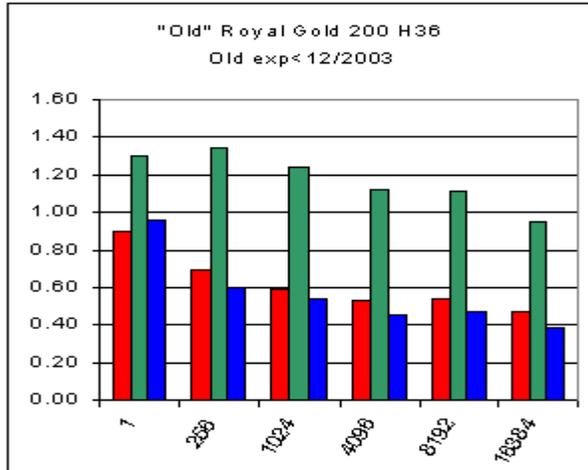
Supra400 Unhypered



New RG200 H36@30°C

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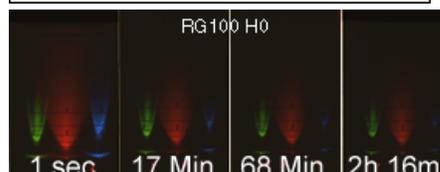
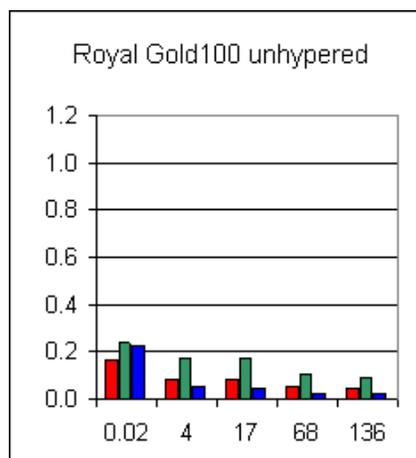
RG200 Comparison of "Old" film (expire date before 1/2004) with "New" RG200 hypered at 30°C, marked H96 for 96 hours, and 50°C, marked 12 50-1 for 12 hours. Bars show relative sensitivity compared to PPF400 1 second exposure. Red LED spectrum centered on Halpha.



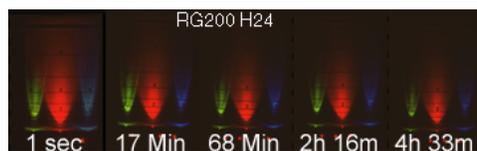
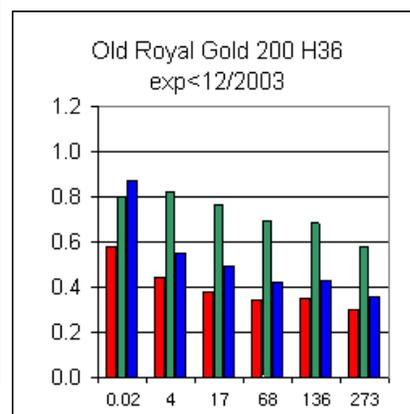
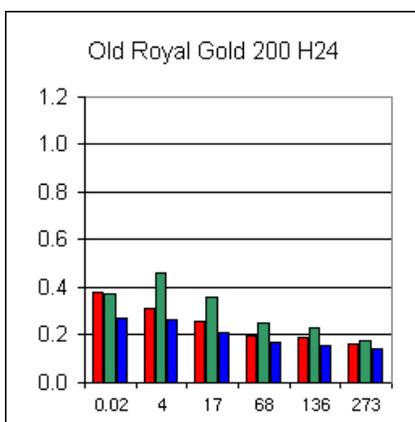
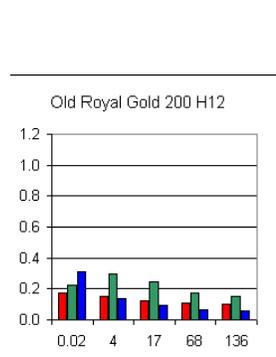
Old Royal Gold 200 Color Neg

Expiration Date to 12/2003, discontinued

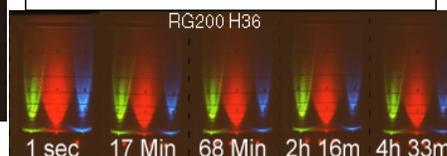
Unhypered
 Rated Acceptable
 About like RG100 Hypered



Hypered Fully
 Needs rebate color change
 (Hyper @ 30°C 36 hours)
 Rated Good/Great (Best of current color films)
 Better than PPF, with more green



No Rebate Change



Rebate Change, fully hypered

New Royal Gold 200 Color Neg
Expiration Date 1/2004 or later

Unhypered
Not tested yet

Fully hypered Rated Good+ (Best of current production color films as of Aug 2002)

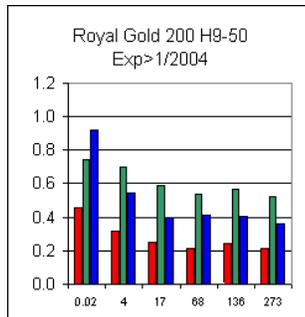
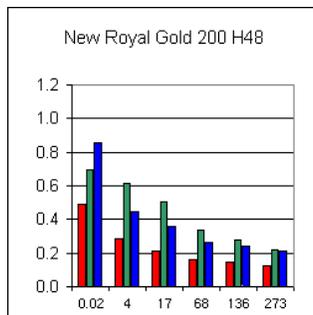
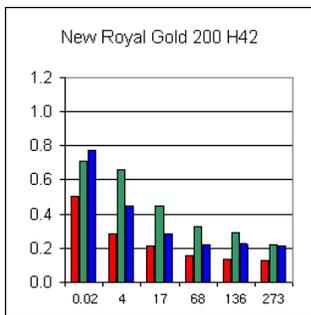
Better than PPF, with more green

50°C hypers better than 30°C

Hypering needs rebate change

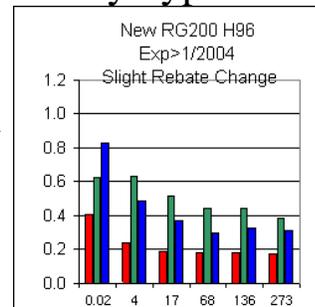
Recommend 110 hrs 30° or 14 hrs @ 50° for full hypering

No Rebate Change

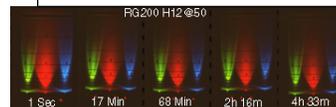
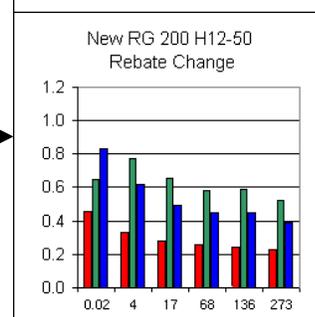


Rebate Change fully hypered

30°C

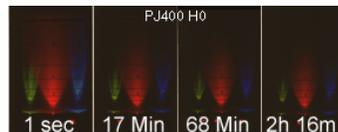
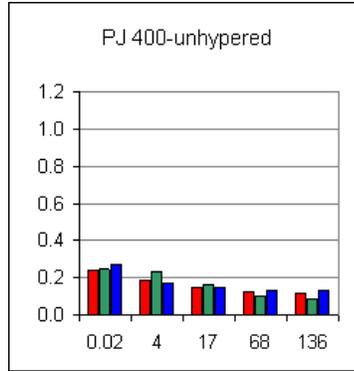


50°C

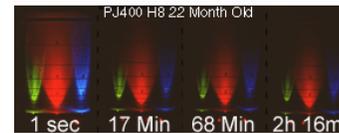
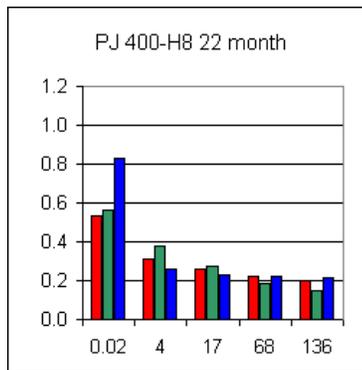
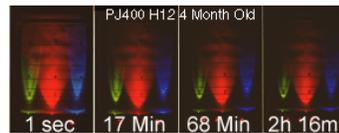
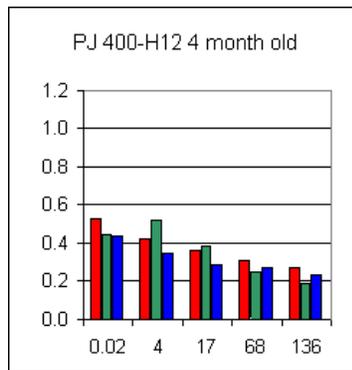
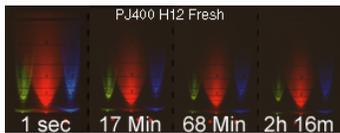
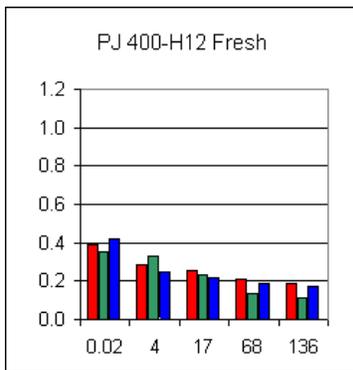


Kodak PJ 400 Color Neg

Unhypered
 Rated Poor
 Good color response
 Very low sensitivity

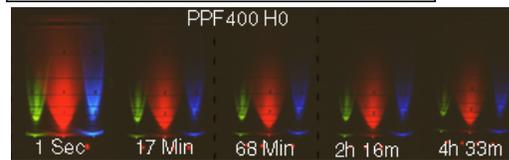
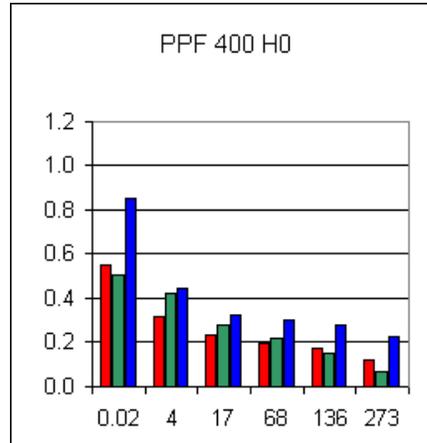


Hypered
 Rated Good (+)
 Very good sensitivity
 Good color response
 Hypering helps
 No rebate color change
 Aged 4 months (or more) in dry
 freezer increases hyper effect

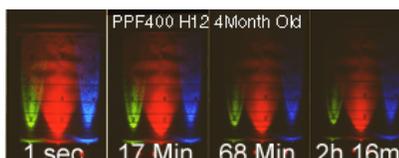
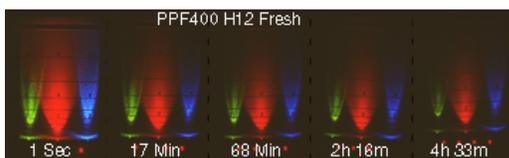
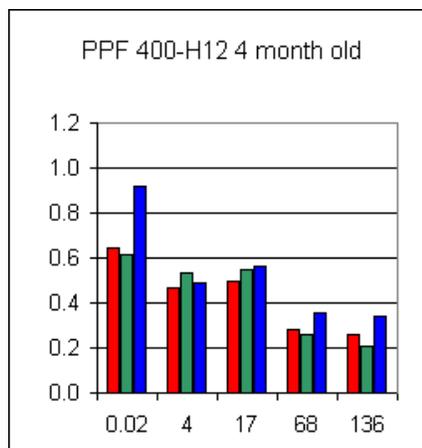
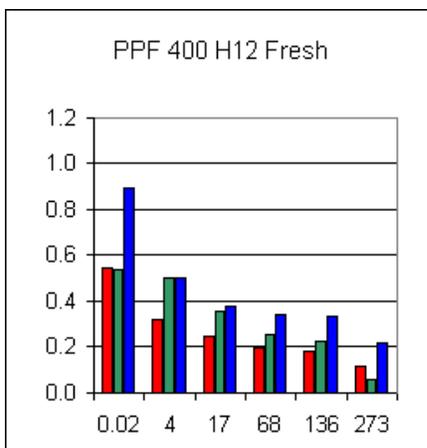


Kodak PPF 400 Color Neg

Unhypered
 Rated Good Unhypered
 Very good sensitivity
 Good color response



Hypered
 Rated Good (+)
 Very good sensitivity, Good color response
 Hypering doesn't do anything until aged
 4 months in dry freezer
 No longer available for 35mm
 No rebate color change



Old Royal Gold 400 Color Neg

Kodak announced a change to RG400,

It is not tested yet

Unhypered

Rated Good (+)

Outstanding for unhypered film

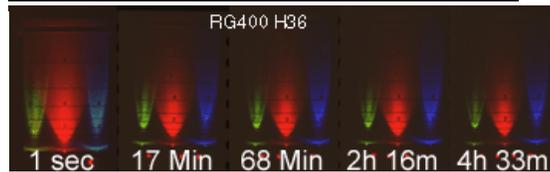
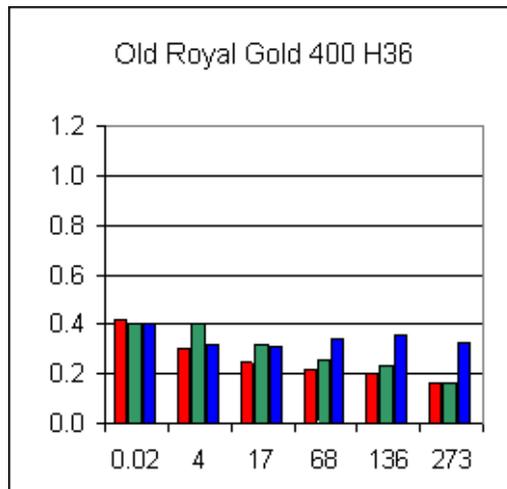
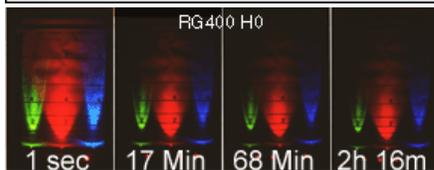
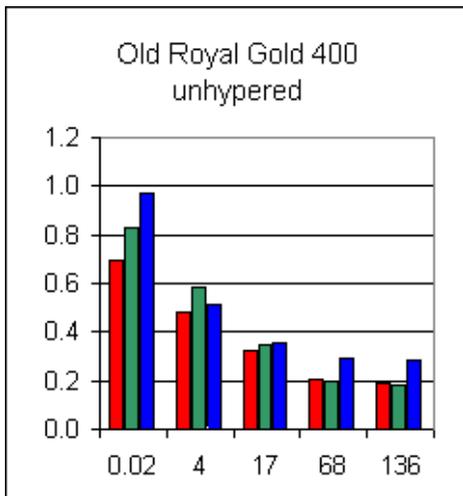
Hypered

Rated Good (+)

About like PJ400 hypered, with better blue

Loses short exposure sensitivity with increased hypering

Hypering doesn't add any red to long exposures



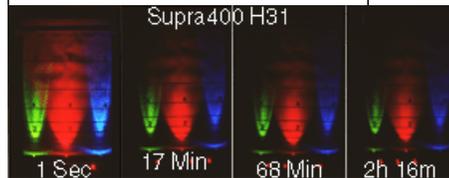
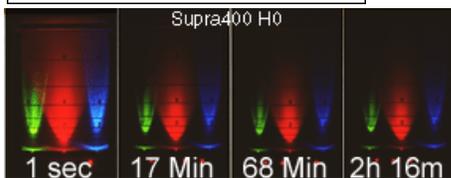
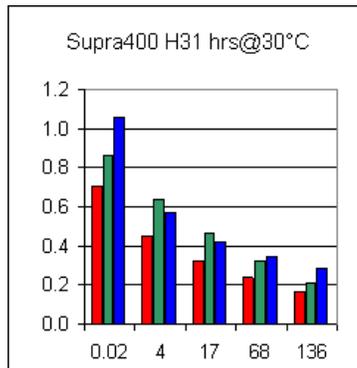
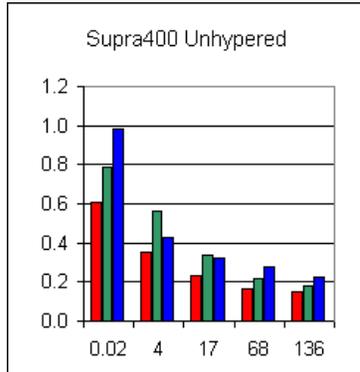
No Rebate Change

Kodak Supra 400 Color Neg

Unhypered

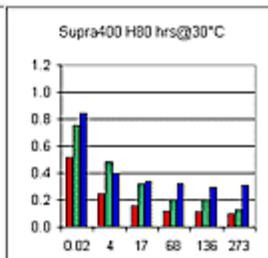
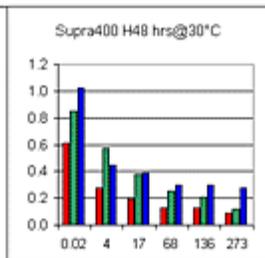
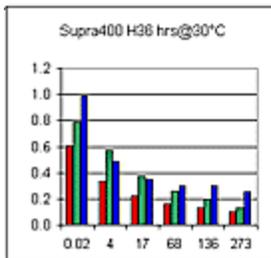
Rated Good (+)

Outstanding for unhypered film, Hypering doesn't help much
Kodak announced change to Supra after Sept 2002



No Rebate Change
Best Hyper

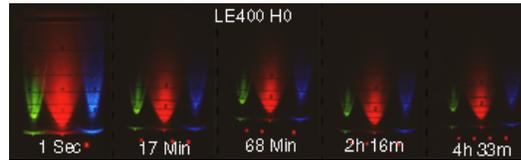
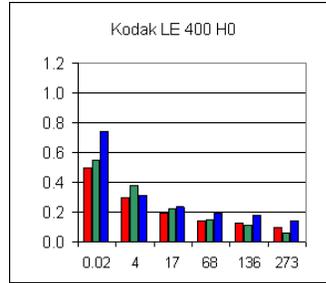
More hyper loses R&G response



No Rebate Chg

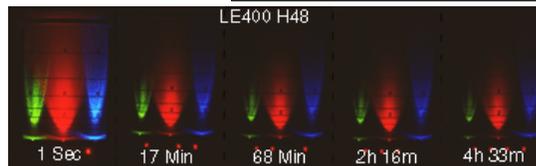
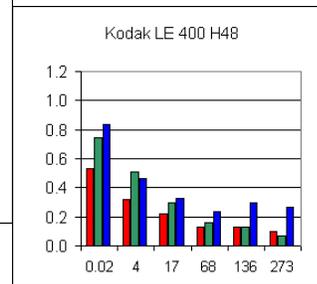
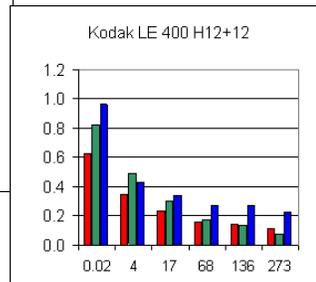
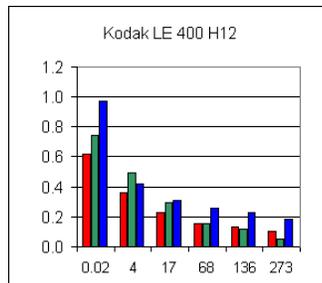
Kodak LE 400 Color Neg

Unhypered
Rated Good
Slightly less than Supra 400



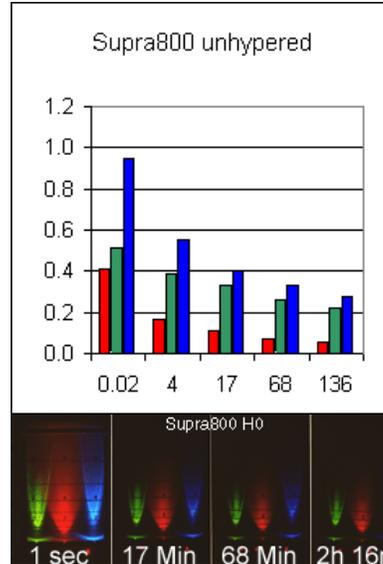
Hypered
Rated Good
Slightly less than Supra 400
Hypering doesn't help long exposures except blue
No rebate color change

Are PJ400 & LE400 the same?
Testing shows they are different.

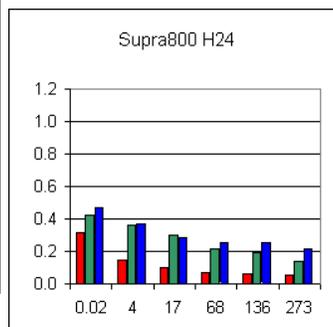
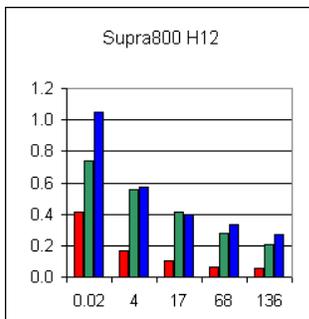


Kodak Supra 800 Color Neg

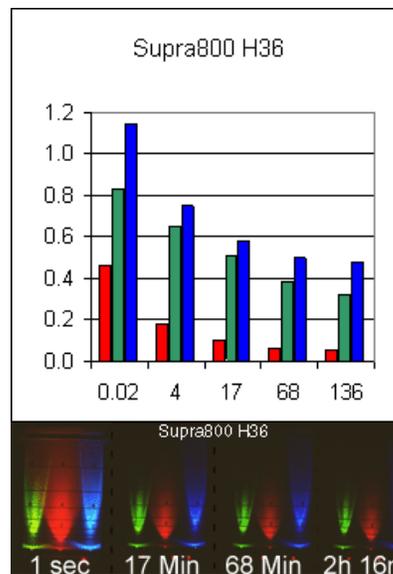
Unhypered
 Rated Poor
 Very low red



Hypered
 Rated Conditional
 Very green/blue/Low red
 Comet, Galaxy & Blue Reflection Nebula?



No Rebate Change



Kodak Portra 800 Color Neg

Unhypered

Rated Acceptable for very short exposures

Good blue & green

Very low red for long exposures

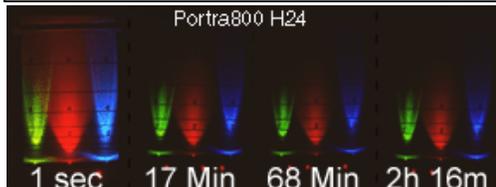
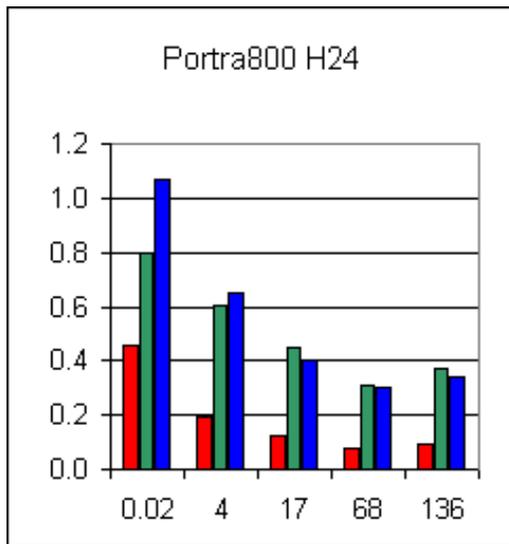
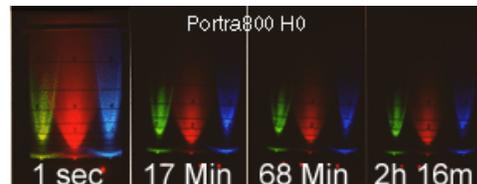
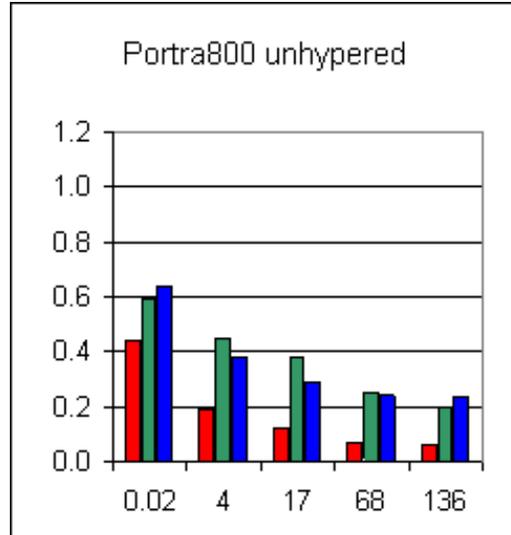
Hypered

Rated Conditional

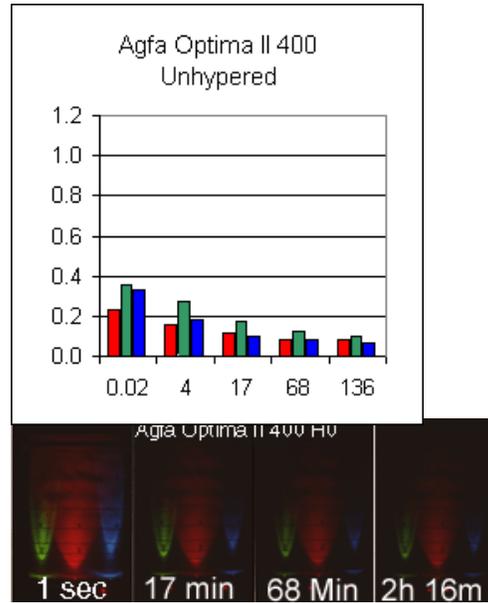
Very green/blue - Low red

Comet, Galaxy & Blue Reflection Nebula?

No rebate color change

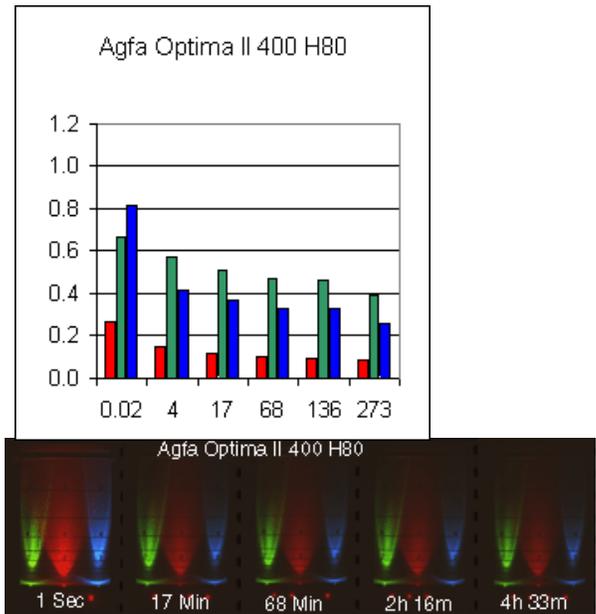
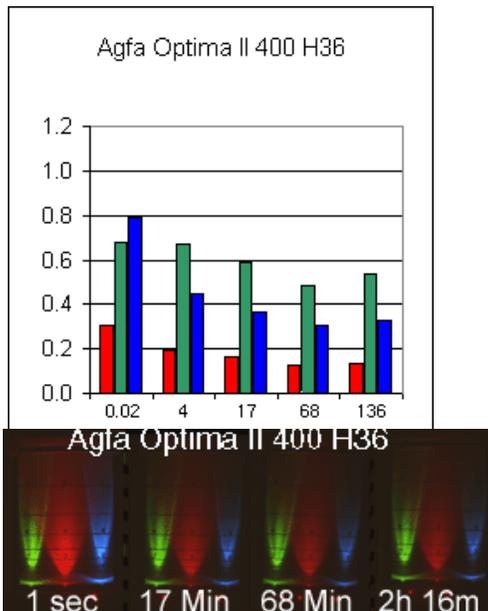


Agfa Optima II 400 unhypered
 Rated Acceptable (-)
 About 2 stops less sensitive than PPF



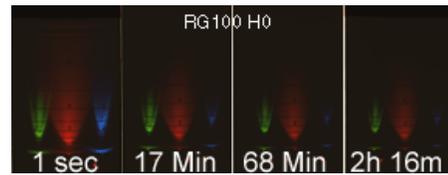
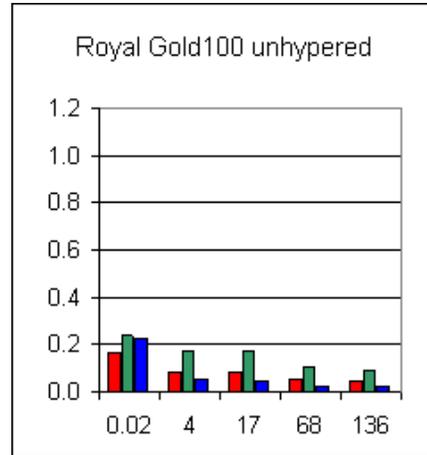
Agfa Optima II 400 H36 to H80
 Rated Conditional (-)
 Very green/Low red –Comet, Galaxy & Reflection Nebula?
 No rebate change

Hypered 36 hours @ 30°C gives best reds.
 Hypering more loses overall sensitivity

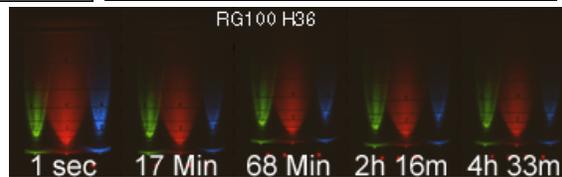
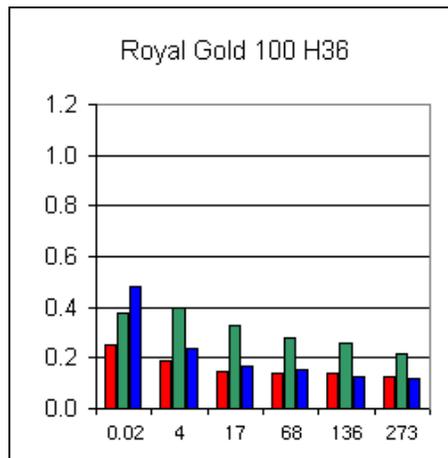
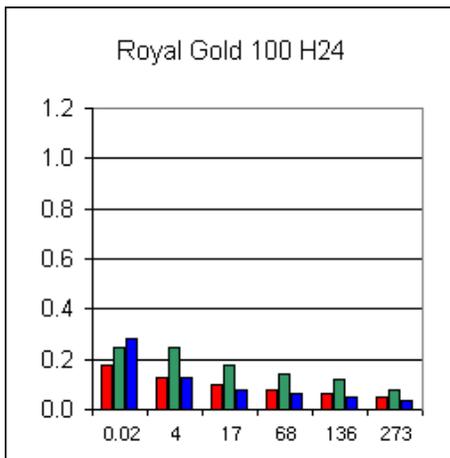


Kodak Royal Gold 100 Color Neg

Unhypered
 Rated Poor
 Very low red & Green, extremely low blue



Hypered
 Hypered 24 hours Rated Poor
 Hypered 36 hours Rated Acceptable
 About 1/2 stops less than Supra 400
 No rebate color change



Konica Centuria 400 Color Neg Film

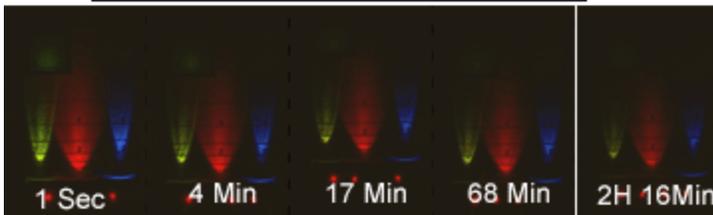
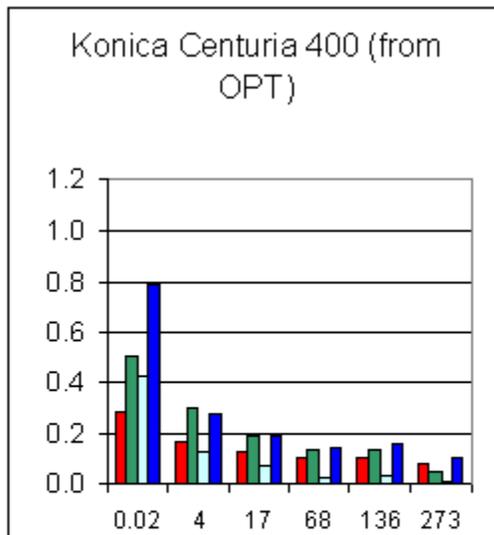
From OPT June 2004

Rated Acceptable

Reds about 1/2 to 1 stop less sensitive than Supra 400 out to 4-1/2 hours

Greens and Blues give nice color balance

Green-blue (502 nm tested) very poor 1 hour and longer (3rd bar each group)



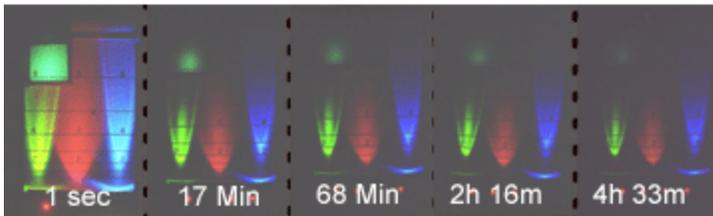
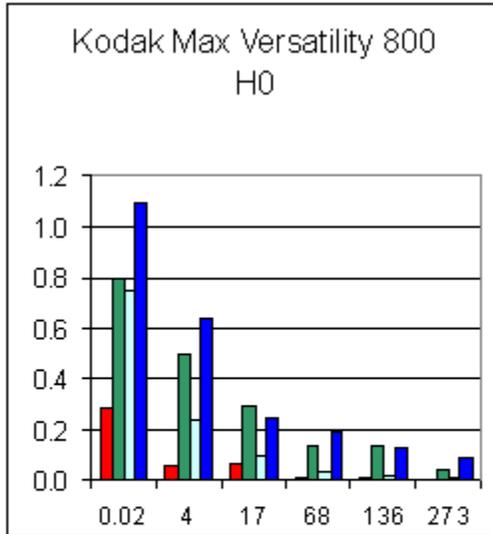
Kodak Max Versatility 800 Color Neg Film

Rated Poor

Very poor red response, almost blind to red at 1 hour and longer

Strong Green and Blue, but loses green-blue (Oxygen III) after 17 min

Tested unhypered

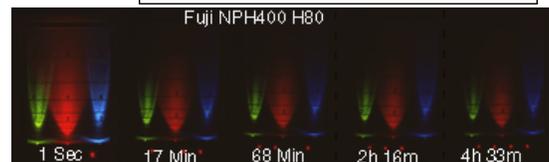
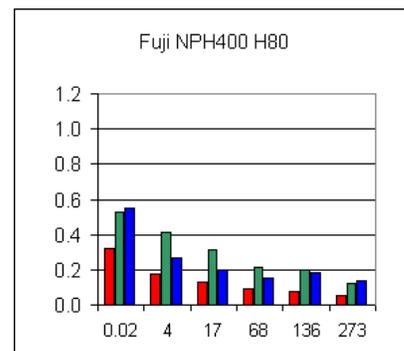
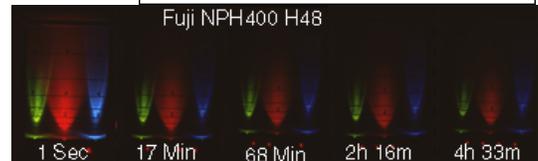
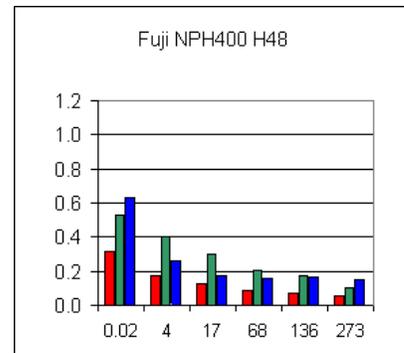
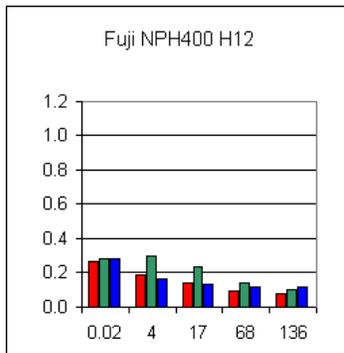
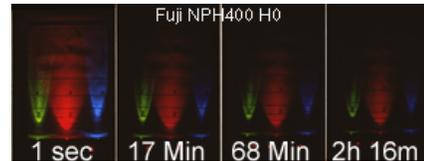
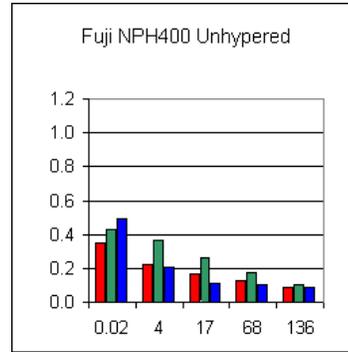


Fuji NPH 400 Color Neg

Rated Acceptable

About 1/2 stop less than Supra 400

Low hypering effect – better green
& blue,
reduced red

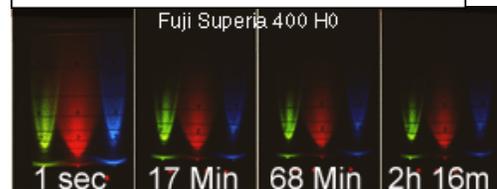
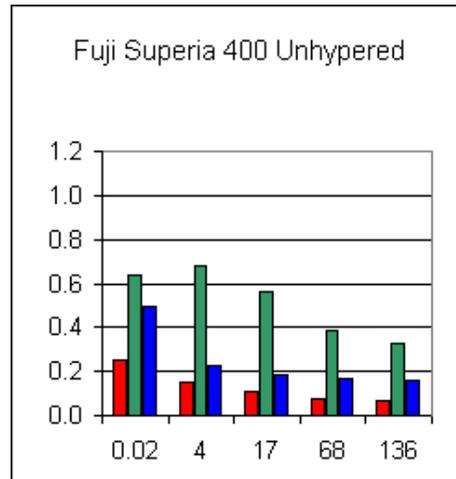


Fuji Superia 400 Color Neg

Unhypered

Rated Poor

Good green, very low red & blue

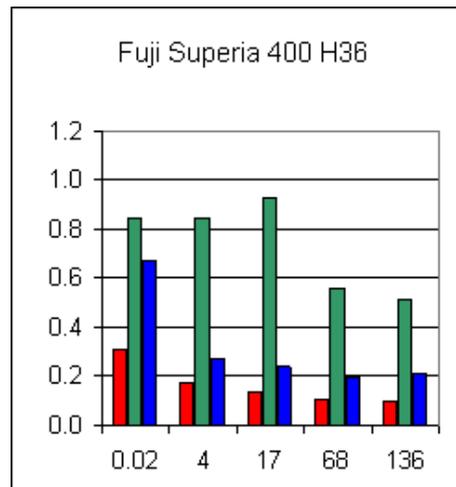


Hypered

Rated Poor

Hypering helps slightly

Great green, very low red & blue



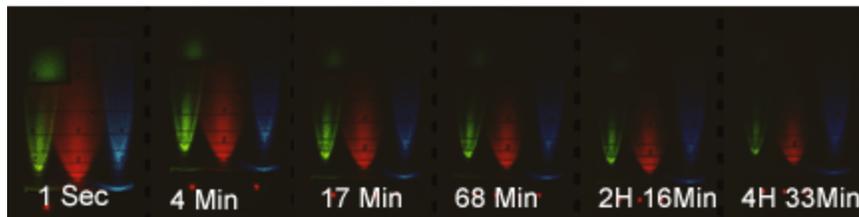
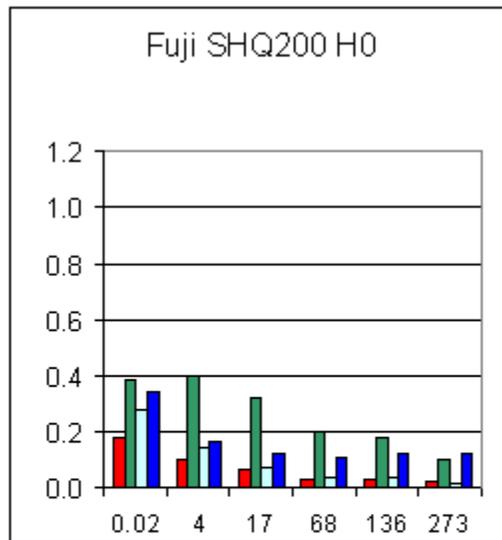
FUJI SHQ200

"Super High Quality" unhypered

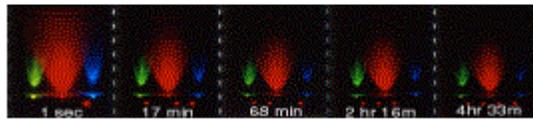
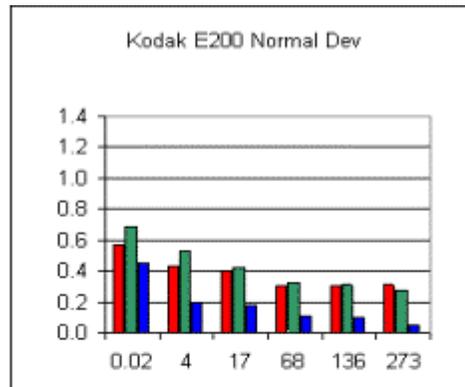
Rated Poor

Good Green, Low Blue, Very Low Red

Especially 17 minutes and longer



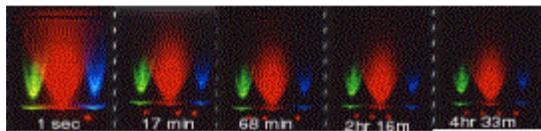
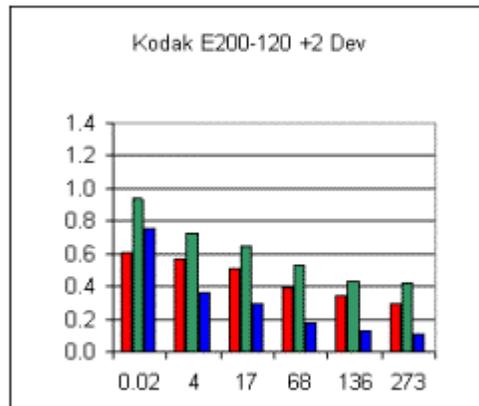
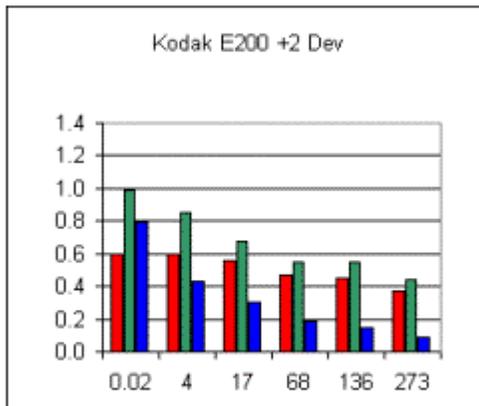
Kodak E 200 Color Slide



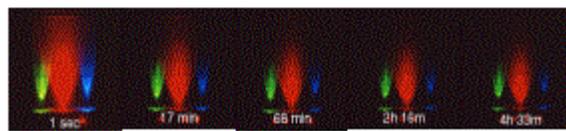
35 mm E200 std

Roughly equal to RG400 H0
except for very low blue

Push 2 processing gains about 1/2 stop
Blue is very low
35mm and 120 size act the same

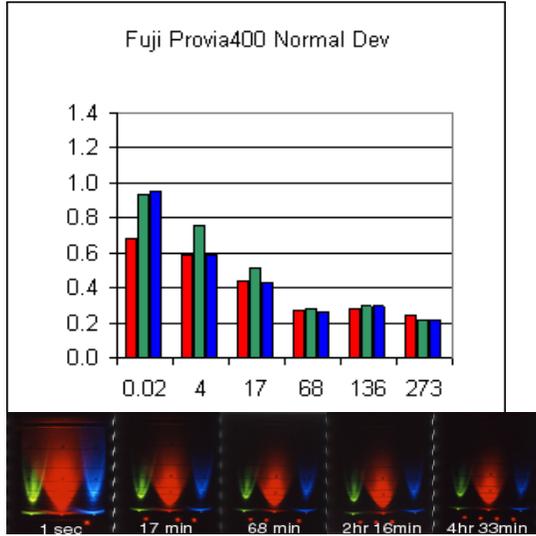


35 mm E200 +2



120 E200+2

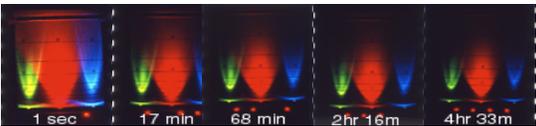
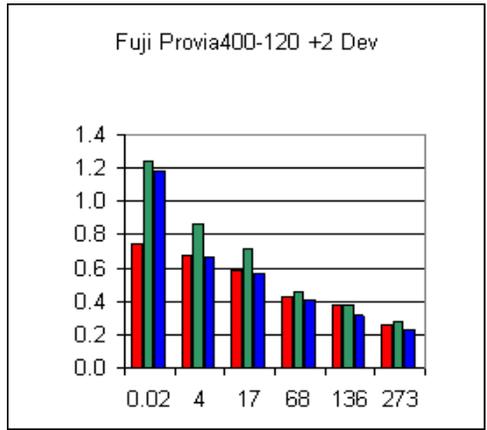
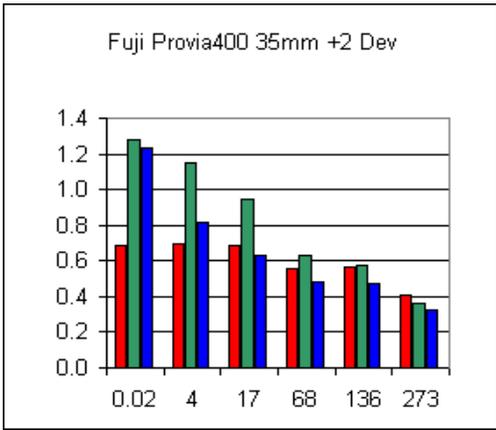
Fuji Provia 400 Color Slide



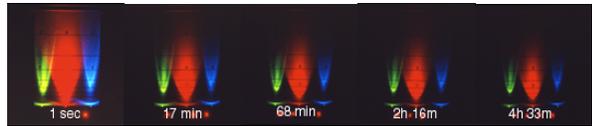
35mm Provia 400 std

Roughly equal to RG400 H0 Good colors

Push 2 processing gains about 3/4 stop for long exp.
 Blue lower than red, but much better than E200
 35mm and 120 size act nearly the same



35 mm Provia 400 +2



120 Provia 400+2

Film Test Summary

Updated December 14, 2004

Since I first published film test data in 2002, several films have become unavailable or changed by the manufacturers. This update reflects a few added films, and lists which ones are no longer available (highlighted in red below). The newest films are Konica Centuria400 (acceptable) and FujiSHQ200 (poor).

There is no perfect film for astrophotography. These test results show that the popular films used for Astro photos are the best available. Hypering helps, but doesn't come close to eliminating reciprocity failure. Interestingly, hypering affects some film layers at different rates; partial hypering may work on one layer and not on another. Long-term freezer storage of PJ400 hypered seems to increase the hypered effect. This is a big surprise, and needs more investigation with other films (a necessarily long process). All hypering was done at 30°C or at 50°C. These lab tests eliminate the sky conditions and telescope optics as factors in comparing films. When sky conditions come into play, the results could be quite different. Future tests will also look at Tech Pan.

These film tests were conducted to evaluate currently available (2002-2004) color negative 35mm films for long exposures for deep sky astrophotography. I used Red (660nm), Green (565nm) and Blue (468nm) LEDs illuminating a white paper target. All exposures were the same total illumination, using neutral density filters and lens f-stops for exposure times from 1 second to 4 hours-34minutes (16,384 sec = 2^{14} sec). The negatives were scanned with the same scanner settings. Intensity readings were made at the same locations on each negative using the Photoshop readout tool for Red, Green and Blue components. These tests include progressive hypering in 12 hour increments @ 30°C@3psig using Lumicon forming gas. Hypering is noted by H0=unhypered, H12=hypered for 12 hours, H1450=hypered 14 hours @ 50°C. Recently Kodak changed the Royal Gold 200 and 400 films. The new RG200 lost a bit of red sensitivity compared to the old film, and it requires a lot longer time to hyper (3x to 4x). It must be hypered until the rebate color just changes to get the most out of it. RG 400 was also changed but I haven't tested it yet. Kodak also announced that it is discontinuing Supra 400.

Summary Results Color Negative Film

This is a summary of this test series results for color negative film. It is a little difficult to describe

the characteristics of a film in only 5 or 6 words because these films have varying response at 1 second, 17 minutes, and 4-1/2 hours. I biased my opinions by depending more on the longer exposures. I tried to put them in order as I see them, with the best at the top of the list. I used three

ratings for most of the films (Good-Acceptable-Poor). I have one more category – Conditional –

because some films might be very useful for certain sky objects that have more blue or green light rather than red.

The ratings are based on the levels of the bar graphs for each film and exposure. The best films

have a reasonably even color level across the red-green and blue, and have the highest light sensitivity.

Old Royal Gold 200 H36	Good/Great	Needs Hyper Rebate Change, more B&G than PPF
New RG 200 H1450	Good+	Needs Hyper Rebate Change, more B&G than PPF
PJ 400 H12 4-22mth old	Good +	Slightly better than fresh hypered
PPF 400 H0-H12	Good +	Outstanding for unhypered film, hypering helps little
Old RG 400 H0-36	Good +	Outstanding unhypered, hypering loses short sens.
PJ 400 H12 Fresh	Good +	Very even colors, needs hypering
Supra 400 H0-H31	Good +	Outstanding for unhypered film, hypering helps little
LE 400 H0-H48	Good	Slightly less than Supra, hypering doesn't help
Supra 800 H36	Conditional +	Very blue/green –Comet, Gal. & Reflection Nebula?
Portra 800 H24	Conditional	Very blue/green –Comet, Gal. & Reflection Nebula?
Agfa Optima II 400 H36	Conditional -	Very green –Comet, Galaxy & Reflection Nebula?
Royal Gold 100 H36	Acceptable+	About 12 stop less than Supra400 for long exposures
KonicaCenturia400 H0	Acceptable	About 1/2 stop less than Supra400, very low blue-green (OIII)
Portra 800 H0	Acceptable	Low reds, green & blue are good
Old Royal Gold 200 H0	Acceptable	About like hypered Royal Gold 100
Fuji NPH 400 H0-H80	Acceptable	About 1/2 stop less than Supra400, no hypering effect
Agfa Optima II 400 H0	Acceptable -	About 1 stop less than Supra400
Fuji Superia 400 H0-H36	Poor	Good green, very low red & blue
PJ 400 H0	Poor	Very even colors, very low sensitivity
Fuji SHQ 200 H0	Poor	Some Green, Low blue & extremely low red
Royal Gold 100 H0	Poor	Very low red & Green, extremely low blue
Supra 800 H0	Poor	Good green, very low red & blue

Summary Results Color Slide Film

Two slide films were tested in the unhypered condition, but processed with either standard or push+2 E-6 chemicals. The slides were scanned on the same scanner as the negative film tests, however the comparison with color negative film is an eye-ball comparison. The relative comparisons of the two films with each other are sensitive and accurate. Both 35mm and 120 roll

tested push+2 both films. Both sizes tested the same.

Fuji Provia400 push+2	Good/Great	Very even colors for > 17 min (short are more B&G)
Fuji Provia400 std develop	Good	Very even colors, ¼ stop less red than E200+2
Kodak E200 push+2	Good	Very low blue, good red and green
Kodak E200 std develop	Good (-)	Very low blue, good red and green, red like Provia std

[Film Test Summary](#) [Film Test Data](#) [Film Test Procedure](#)
[E-Mail Don Westergren](#)

FILM TEST PROCEDURES

Updated 8/27/2002

By Don Westergren

The results of any test can be influenced by how the test is conducted. This description will help you understand how and why the test was conducted the way it was. After having completed some of these tests, there are things I would change, but change would have introduced inconsistencies in the results. No lab test selection of film is better than the real experience of taking pictures through your own telescope of objects in the sky. These tests compare films without the variability of scopes and sky conditions.

The reason for these tests is to show what these films will do with long exposures. I modeled my test setup based on the test setup by Robert Reeves (his tests really inspired my effort). But his tests didn't include long exposures nor hypering effects. Since I shoot with a 7"/f9 Astro Physics refractor, some of my shots go for over 3 hours.

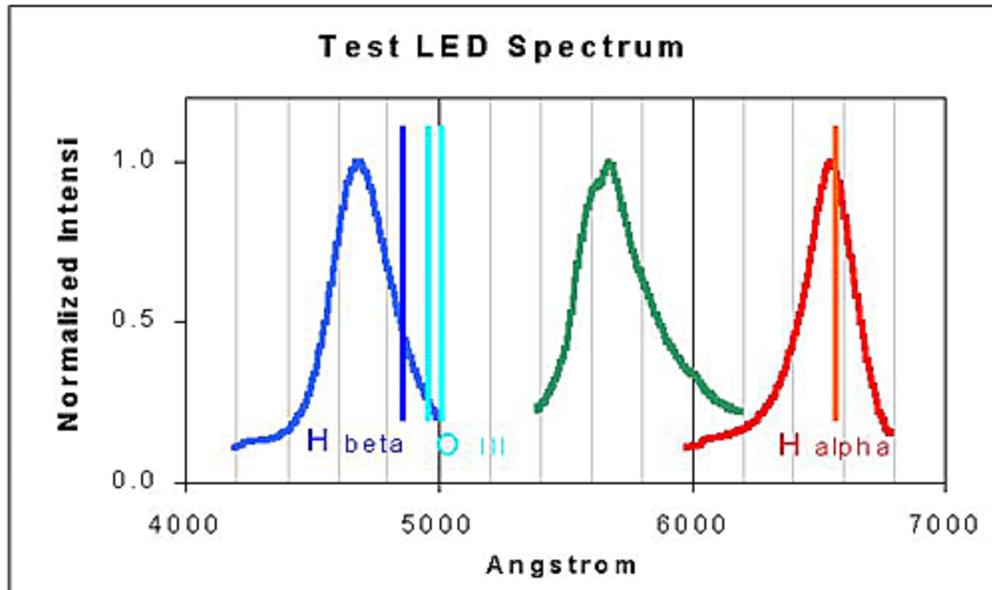
SELECTION OF FILMS:

Since I shoot color negative film and have experience with Kodak films (PPF400, PJ400, Supra400, and Royal Gold400) they were automatically on my list. PPF400 is no longer available, but I had a roll stashed away. I don't have any PPF400 left, so that was the best use I could choose for it. The other films were chosen based on discussions I've read on the Internet and reports from other astrophotographers of the films they have tried. I didn't try to do all the films available (cost and time have something to do with that decision). But I wanted to cover other film brands to see if any were good for astrophotography.

TARGET SET UP

I built a box about 2 ft tall with a hole in the top large enough for the camera lens and neutral density filters to fit through. The bottom of the box has a white paper target. The first few rolls of film used white ink-jet photo paper, but the paper was too thin and wrinkled, causing a few shadows of the LED light. I soon replaced that with a white card stock. I printed black lines at intervals of 2ⁿ inches (2, 4, and 8) to reference multiple stops of light intensity. I ended up using the reference lines for measuring the light intensity in Photoshop at the same relative locations for each film. The LEDs were from Radio Shack, each with a rated wavelength. Blue (276-316) is 468 nm. Green (276-304) is 565 nm. Red (276-309) is 660 nm. The LEDs were setup to illuminate a fan shaped area on the target paper. They were powered with a regulated power supply, with a variable resistor in series with each LED to control intensity. The blue and the red were much brighter than the green, so their power was reduced slightly. An additional set of 4 dim red LEDs were placed behind the main target LEDs with external switches to turn on and off. These 4 LEDs were used to indicate the binary code of the exposure time to keep from mixing negatives (hey, I exposed over 500 individual pictures to get this series done).

The light spectrum of the LEDs in my light box were measured using an SBIG spectrometer with an ST-7. The setup was calibrated with Neon light for the red and green LEDs. Neon doesn't have any measurable light bands at the shorter blue wavelength, so we had to extrapolate from the red & green LED settings. The results show that the red LED is almost right on the Halpha spectral line, which means the tests are very good for evaluating films for nebula photographs. The blue and green are not on the Hbeta and Oxygen III lines. I will have to work on ways to make the test more realistic.



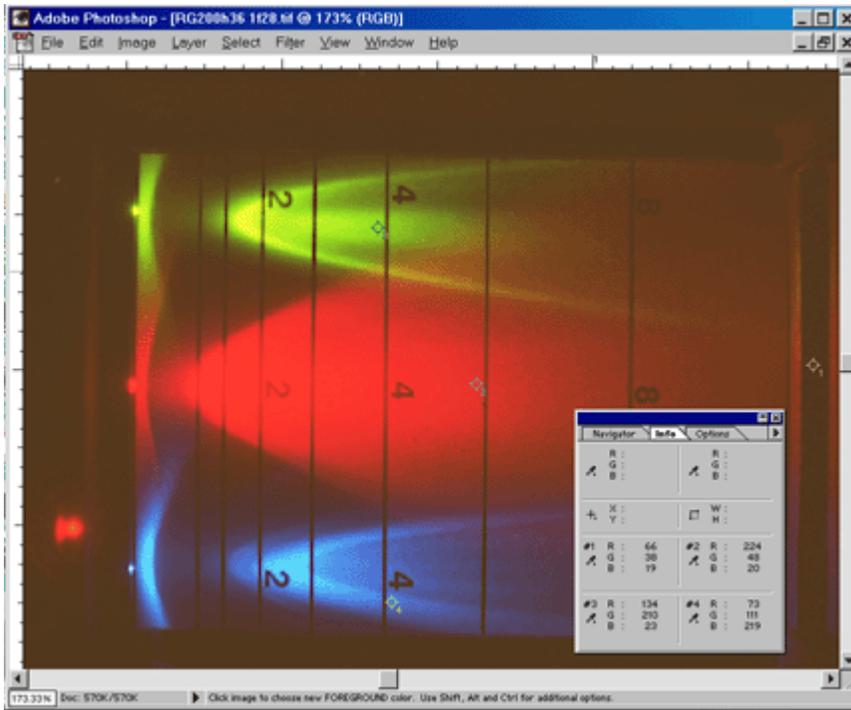
EXPOSURES

My Nikon FTN with Nikkor 50mm/f1.4 lens was used for the tests. I fitted a filter adapter to use 58mm filters and bought a set of neutral density filters to give either 2 or 3 stops per filter. By using the larger diameter filters, I avoided vignetting when I stacked 4 filters for the longest exposure. The short exposure was 1 sec at f2.8. I exposed for longer times by compensating with increased f-ratio and/or the neutral density filters. That way all the exposures were the same total light accumulation. The exposure times (seconds) increased in powers of 2 from 1 second to 16384 (2^{14}) seconds (4 hours-33 minutes).

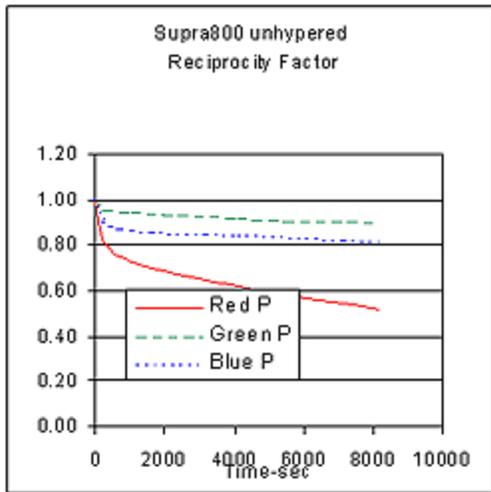
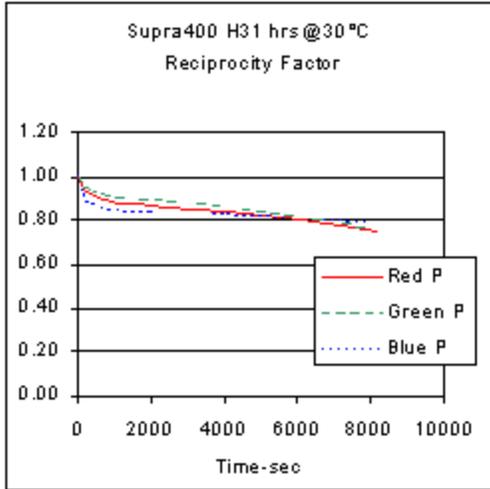
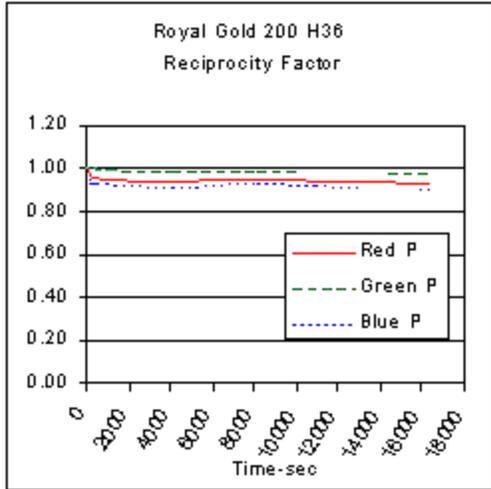
PROCESSING & EVALUATION

All the color films were processed at a local 1-hour facility with C-41 chemistry, standard processing (not pushed). All films were scanned with an Epson 1640SU with Negative Scanner Attachment using the same manual scanner settings for exposure, gamma, and color balance. I found that the scanner is very consistent after it has warmed up for at least 20 minutes before scanning. Color intensities were measured using the Photoshop Info command at the same location (max near the "4" line) on each exposure. The individual RGB numbers at a single location were summed to give the total intensity of that color location. The unlighted (black areas) were sampled as a tare value and

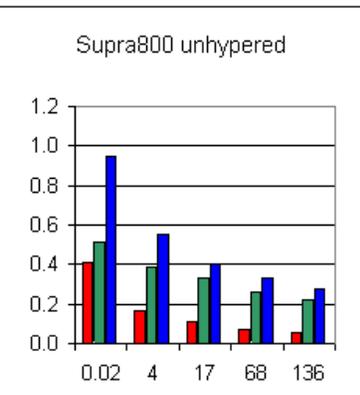
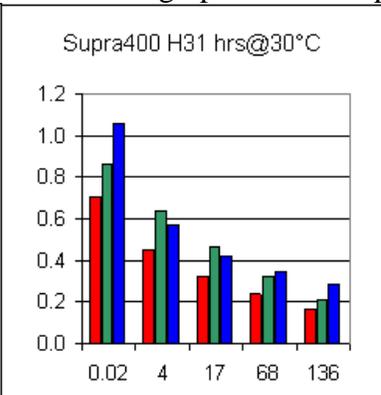
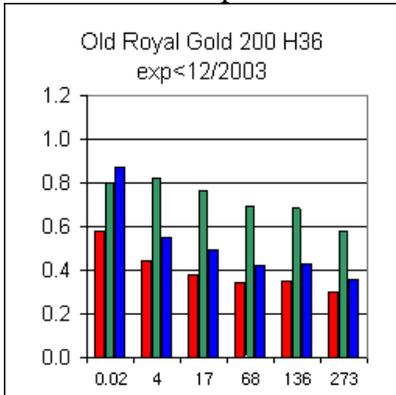
subtracted to give a measure of true intensity. These intensity values were used to assess the reciprocity losses. A sample of the measuring process is shown here (RG200H36 at 1 sec):



The measurements were placed in an Excel spreadsheet and processed to create graphs of the results. The Schwarzschild Exponent ($P=1+(n/m)$ where $\text{time}=2^m$) was calculated for each color. This exponent has usually been expressed as a constant, but I found that it varies with exposure time and color for each film. Here are some examples (good to poor):



The line graphs of the reciprocity exponent are interesting, but they don't convey how usable a film will be for long exposures. The color intensities were normalized PhotoShop saturated color (compared to 255 reading in PS) and plotted directly into bar graphs. These bar graphs are presented in the Film Test Data page, along with samples of the actual test pictures. Here are the bar graphs for the exponent films above:



HYPERING FILM

The films were hypered using a Lumicon Model 300 hyper kit. The films are placed in the chamber in their cassettes and the chamber evacuated to about 26 to 28 inches of Hg. The lower figure is achievable with the hand vacuum pump. I reach the higher vacuum using an electric vacuum pump (converted air-condition pump) hooked to the outlet of the hand pump with hand pump action. I hold the film in the vacuum for about ½ hour and heat it to 30°C. Then I purge with hyper gas to 10 inch Hg and re-evacuate. I purge 3 time for the lower vacuum and twice if I reach 28 inch Hg. Then I fill the tank to +3psig and seal it by closing the valve. Hypering time starts with the 3psig. I end the hypering time by evacuating the chamber with the hand pump to about 25 inch Hg. I store all my hypered film in the freezer after placing the film back in its plastic container with a few grains of water softener salt (for absorbing moisture) and sealed with plastic electrical tape. I mark each container with the date of hypering.

[Film Test Summary](#) [Film Test Data](#) [Film Test Procedure](#)