Film Test: Delta 100 4×5" DDX 1+4 20°C Tray

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Procedure

Ilford Delta 100 "best before May 2015" 4x5" sheet film, which has been continually refrigerated at 3°C, was removed 2 hours before the test to reach ambient temperature. 7 sheets of film were identically exposed using Eseco SL-2 sensitometer, using its green light source. One half of each sheet received two exposures (about 0.3 s each), the other got six exposures to simulate the effect of a longer exposure tablet. Exposed film was then stored for about 10 minutes at room's ambient 20.5°C. Development took place in steel "chafing table" food catering trays. They were filled, with 1 l of: water, freshly mixed Ilford Ilfotec DDX 1+4 developer, citric acid 1.5% stop bath, Ilford Rapid Fixer 1+4, water. Everything was held at 20°C ± 0.1°C, as measured by a calibrated lab thermometer.

Film was inserted one sheet a time into the first water bath and agitated for 2 minutes by hand, at which point 2 initial sheets (out of the 7 in total) started to be processed while the timer was set for a 22 minute countdown.

Agitation was manual (by hand) using Alan Ross's technique, which involves removing the bottom-most sheet, by hand, and placing it on top of the stack, while gently pushing the stack down. Emulsion faces down. This technique can be slow or rapid, I have applied the rate of about 7 sheet movements per 10 seconds, which is relatively rapid. See http://alanrossphotography.com. Subsequent sheets were introduced at 17, 11, 7½, 5½, and 4 minute countdown points. Prior to developing, those sheets continued to wait in the initial holding water bath.

Despite finger heat transmitting to the developer, its temperature remained at 20°C due to the tempering effect of the large water bath surrounding each steel dish. This was verified at the end of the fixation step with the thermometer.

After developing, film was stopped for 2 minutes, fixed for 5, rinsed briefly, and washed for 10 minutes in running water, followed by Ilfotol 1+200 wetting agent rinse and a quick heated air dry.

Densities were read on the following day using Heiland PM Densitometer TRD 2. There are two columns for each developing time, representing the shorter exposure, and the longer one, labelled "3e", equal to a triple duration of the first exposure. All densities are absolute, meaning that the first value, at the top of each shorter exposure column represents the actual film base+fog. This code loads the data and prints the table (may show on the next page in a PDF).

```
library(readr)
delta100_ddx1_4_tray_2017 <- read_csv("delta100.ddx1.4.tray.2017.csv")
```

```
library(kableExtra)
options(knitr.table.format = "html")
options(knitr.table.format = "latex") # Uncomment for PDF output using TeX
knitr::kable(delta100_ddx1_4_tray_2017, caption = "Raw density data", booktabs = T) %>%
  kable_styling(latex_options = c("scale_down"))
```

I have some concern about the quality of the column labelled "4 min 3e" which seems to show slightly higher (by 0.03) first few readings than expected. However, that column has only a minor effect on the results, which are primarily driven by the first column "4 min". The "3e" column has a smoothing effect and it provides data for the final 3 points of that curve, only. Once I recheck the data I will update the findings if there is any impact.

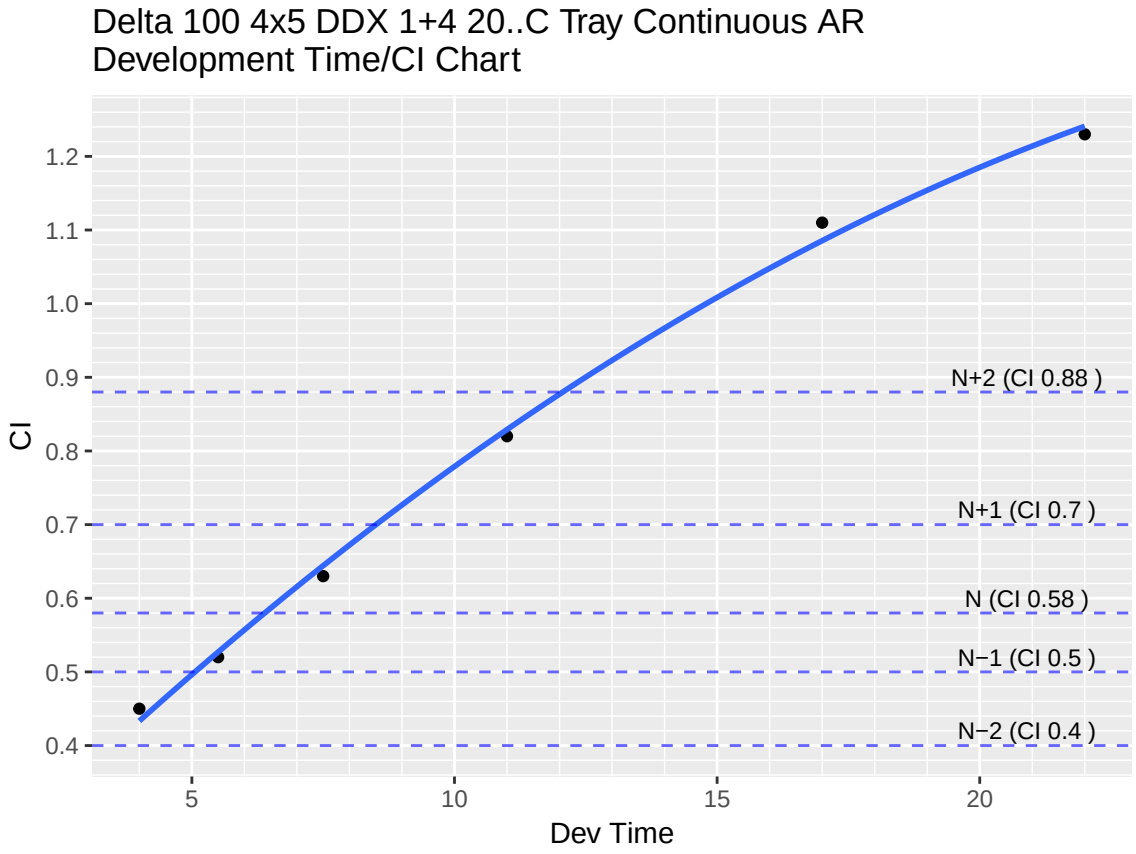
Table 1: Raw density data

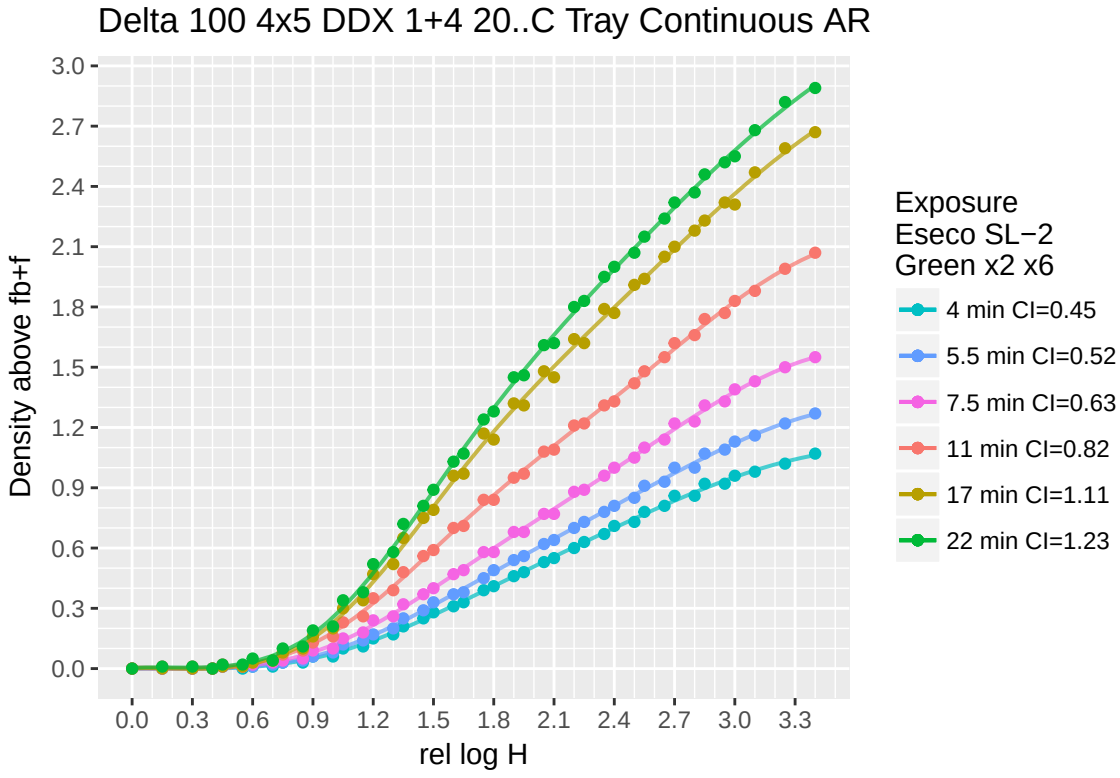
He	4 min	4 min 3e	5.5 min	5.5 min 3e	7.5 min	7.5 min 3e	11 min	11 min 3e	17 min	17 min 3e	22 min	22 min 3e
0.00	0.09	0.12	0.08	0.09	0.10	0.11	0.11	0.12	0.14	0.14	0.16	0.18
0.15	0.09	0.12	0.08	0.10	0.10	0.12	0.12	0.13	0.14	0.15	0.17	0.20
0.30	0.09	0.13	0.08	0.11	0.10	0.14	0.12	0.16	0.14	0.18	0.17	0.22
0.45	0.10	0.15	0.09	0.13	0.11	0.16	0.13	0.21	0.15	0.24	0.18	0.29
0.60	0.10	0.18	0.09	0.17	0.12	0.21	0.14	0.28	0.17	0.34	0.21	0.39
0.75	0.12	0.23	0.11	0.23	0.14	0.29	0.18	0.38	0.22	0.48	0.26	0.56
0.90	0.15	0.29	0.14	0.29	0.19	0.37	0.24	0.51	0.30	0.66	0.35	0.76
1.05	0.19	0.37	0.20	0.38	0.25	0.48	0.34	0.68	0.44	0.89	0.50	0.99
1.20	0.24	0.43	0.25	0.46	0.34	0.58	0.46	0.82	0.61	1.10	0.68	1.21
1.35	0.30	0.51	0.33	0.54	0.42	0.69	0.59	0.96	0.79	1.31	0.88	1.42
1.50	0.37	0.58	0.41	0.63	0.50	0.79	0.70	1.07	0.93	1.46	1.05	1.63
1.65	0.42	0.65	0.46	0.71	0.59	0.88	0.82	1.20	1.11	1.62	1.23	1.79
1.80	0.50	0.72	0.57	0.79	0.68	0.99	0.95	1.33	1.28	1.78	1.44	1.98
1.95	0.57	0.79	0.64	0.87	0.78	1.07	1.08	1.43	1.45	1.93	1.62	2.13
2.10	0.64	0.85	0.72	0.94	0.87	1.16	1.20	1.54	1.59	2.05	1.78	2.25
2.25	0.72	0.93	0.81	1.02	0.99	1.25	1.33	1.67	1.76	2.19	1.99	2.42
2.40	0.80	0.98	0.89	1.09	1.10	1.34	1.44	1.78	1.91	2.32	2.16	2.55
2.55	0.87	1.04	0.99	1.18	1.20	1.44	1.59	1.89	2.08	2.46	2.31	2.70
2.70	0.95	1.10	1.08	1.25	1.32	1.54	1.73	2.00	2.24	2.61	2.48	2.86
2.85	1.01	1.14	1.15	1.31	1.41	1.61	1.85	2.11	2.37	2.73	2.62	3.00
3.00	1.05	1.19	1.21	1.36	1.49	1.66	1.94	2.19	2.45	2.81	2.71	3.07

Curves

By trying the below code a few times, using slightly different values of `log.e.offset` I have estimated it at 0.4. The ideal value would be 0.45 as that would match the fact that the 2nd half of each sheet received triple of the original exposure, that is an additional 1½ f-stops, and each stop equals 0.3 $\log_H$. However, this match would align the centre of the curves perfectly, but not the toe or shoulder, because of a very slight reciprocity failure which affects that longer (6 x 0.3 sec) exposure. This can be seen as an underexposure of about 0.04—0.05 in the resulting densities at the toe of the curve, and an overexposure of about the same towards Zone IX part of the curve. Ideally, a sensitometer with a longer step tablet would be more appropriate, while maintaining shorter exposures.

```
source("plots.R")
plot.film.test(delta100_ddx1_4_tray_2017,
               title = "Delta 100 4x5 DDX 1+4 20°C Tray Continuous AR",
               sensitometry = "Exposure\nEseco SL-2\nGreen x2 x6",
               log.e.offset=0.4, df=6, combined.pairwise.plot = TRUE)
```

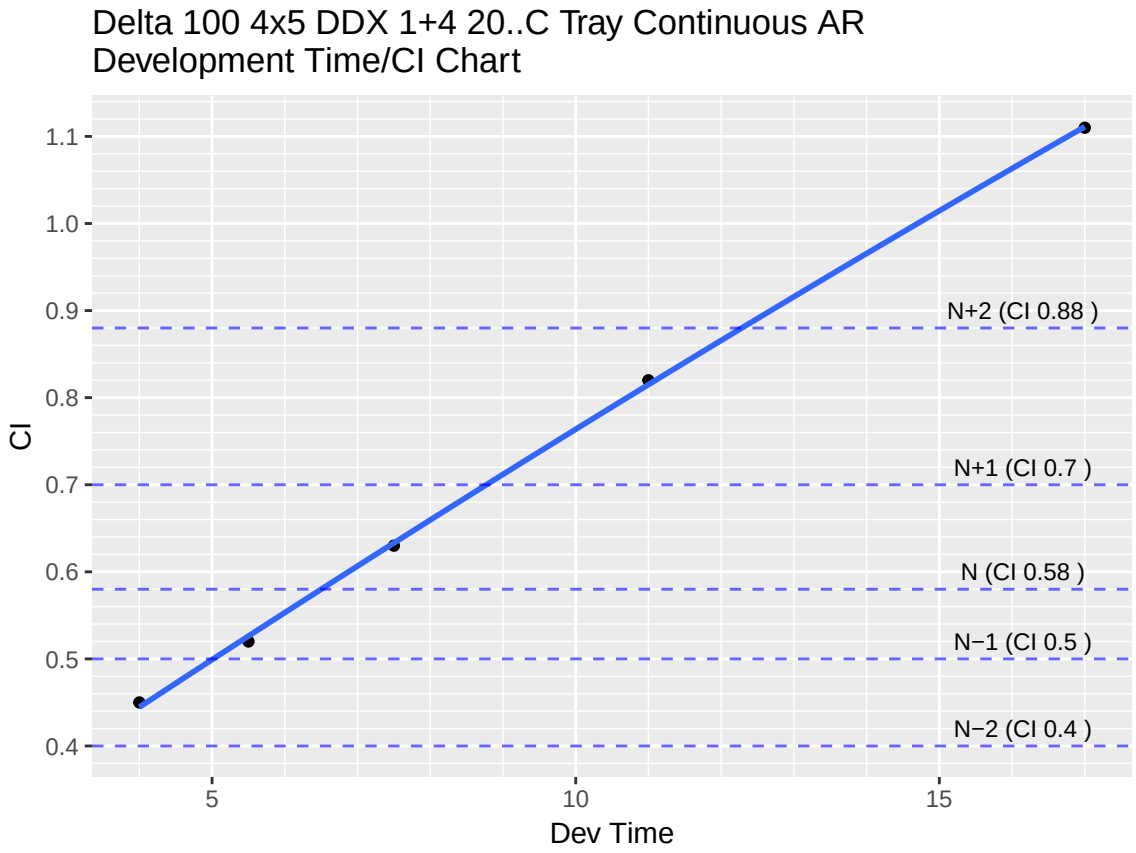

Delta 100 4x5 DDX 1+4 20..C Tray Continuous AR
Development Time/CI Chart
CI
Dev Time
N+2 (CI 0.88)
N+1 (CI 0.7)
N (CI 0.58)
N−1 (CI 0.5)
N−2 (CI 0.4)

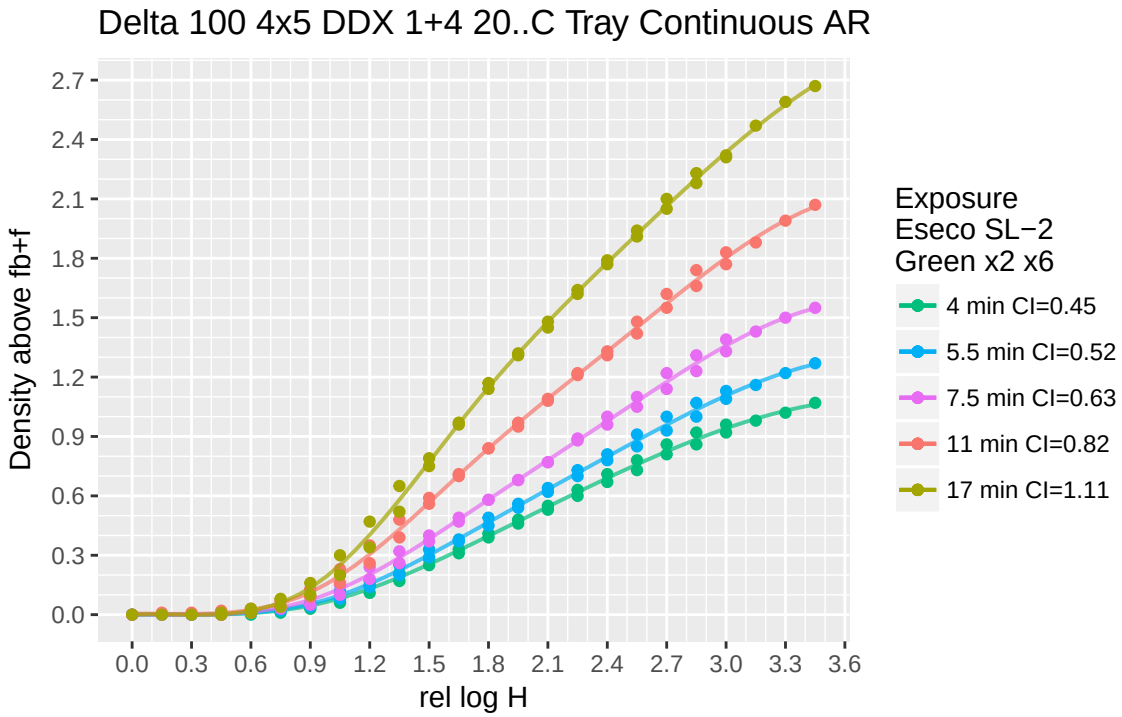

Delta 100 4x5 DDX 1+4 20..C Tray Continuous AR
Density above fb+f
rel log H
Exposure
Eseco SL−2
Green x2 x6
4 min CI=0.45
5.5 min CI=0.52
7.5 min CI=0.63
11 min CI=0.82
17 min CI=1.11
22 min CI=1.23

Model improvement: Removing the 22 min curve

It seems that the reciprocity failure affects the 22 min curve the most, which leads to a curvature of what should be a linear development time chart. Since 22 minutes is an excessive development time and an unlikely one to be of use with this film (unless N+3 development was needed), a cleaner set of curves results from a smaller data set, which excludes those last two columns (column 12 and 13) representing the 22 minute sheet. The `log.e.offset` parameter can now be increased to its theoretical value of 0.45 which makes the curve plot cleaner, without affecting the results at all.

```
plot.film.test(delta100_ddx1_4_tray_2017[-c(12:13)],   # Exclude the last 2 columns
               title = "Delta 100 4x5 DDX 1+4 20°C Tray Continuous AR",
               sensitometry = "Exposure\nEseco SL-2\nGreen x2 x6",
               log.e.offset=0.45, df=6, combined.pairwise.plot = TRUE)
```





Conclusion: Film Development Times

The appropriate development times for Ilford Delta 100 4x5" in Ilford Ilfotec DDX 1+4 at 20°C using trays with manual agitation (Alan Ross agitation technique) based on the above plots are:

N-2	N-1	N	N+1	N+2
Not recommended	5 min	**6 min 30 s**	9 min	12 min 30 s

More information

The code used to generate this report is in the script file `plot.R` which is available free of charge from Rafal Lukawiecki's GitHub page, see: https://github.com/RafalLukawiecki/film_tests where you will also find links to forum discussion and credits.

You can reach Rafal at raf@rafal.net and you can see photos that benefited from this code at http://rafal.net

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