

Assessment of X-rite and Gretag

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Color Measurement Instrument

Gretag Macbeth Spectro Eye

- One in IE GRIS 210; one in ME 256
- Colorimetry: Spectrum (380nm to 730 nm), CIE $L^*a^*b^*$, L^*C^*h (a^*b^*), ΔE^* , XYZ (**OPTIONAL**)
- XYZ calculated from spectrum readings is very close to XYZ readings given by Gretag
- Densitometry: Density



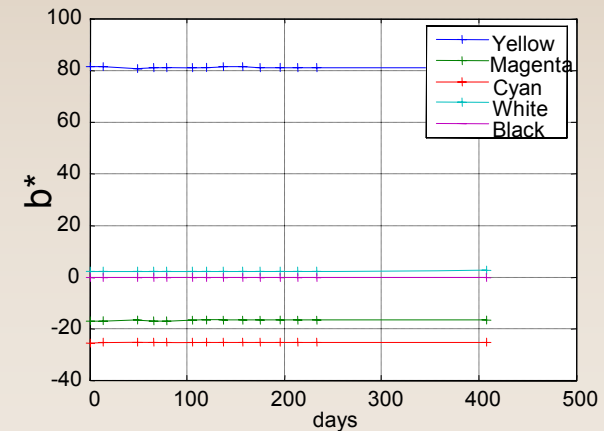
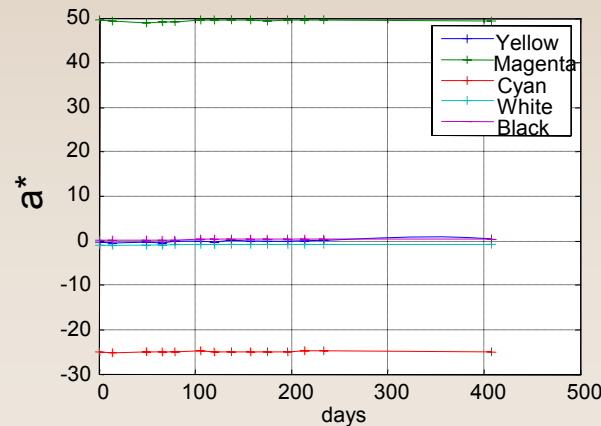
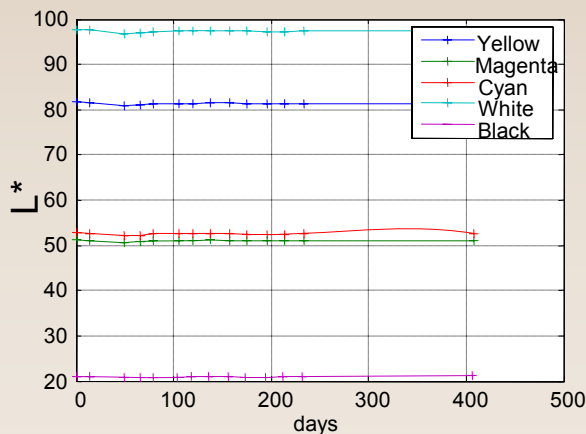
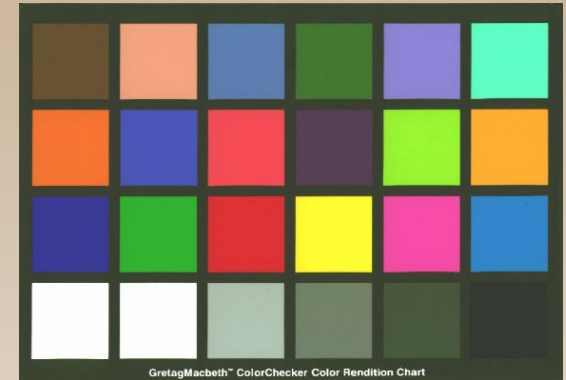
X-rite DTP70

- One in IE GRIS 210
- Colorimetry: Spectrum, CIE $L^*a^*b^*$, L^*C^*h (a^*b^*), ΔE^* , XYZ
- Automatic sheet-fed



Instrument Color Consistency Check

- Bi-weekly check on Gretag
- With Gretag ColorChecker
- Compare to history L^* , a^* , b^* , and ΔE for all color patches
- (XYy readings given by ColorChecker is NOT reliable)

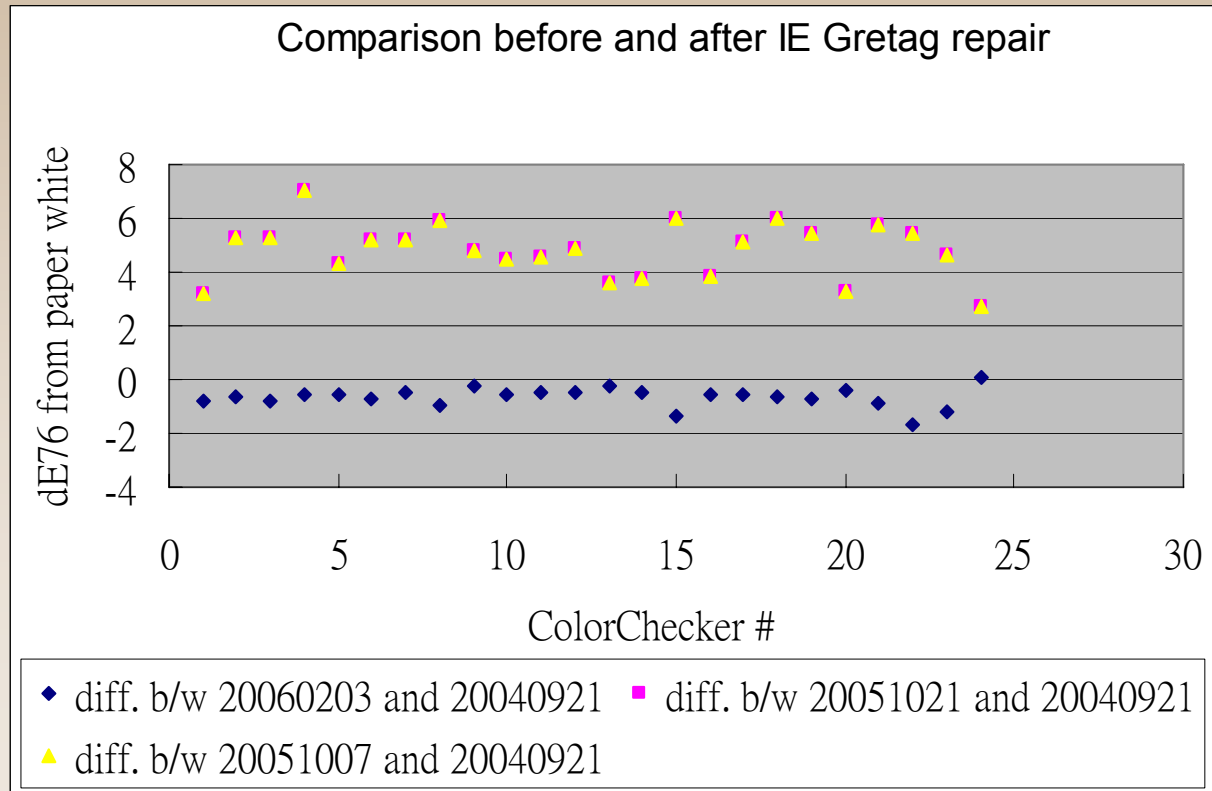


Color Measurement Procedure Document

- Title: color measurement acquisition process
- Color metrics: CIE ΔE_{76} ramp and ΔE_{94} MCDM
- Follows the measurement processes and metrics used by HP

IE Gretag Repair on 11/9/2005

- IE Gretag keep doing accuracy check by measuring ColorChecker biweekly since Sept. 2004
- Since Oct. 7 2005, we began to see the deviated measurement
- Sent back for repair on 11/9/2005, and received on 2/1/2006

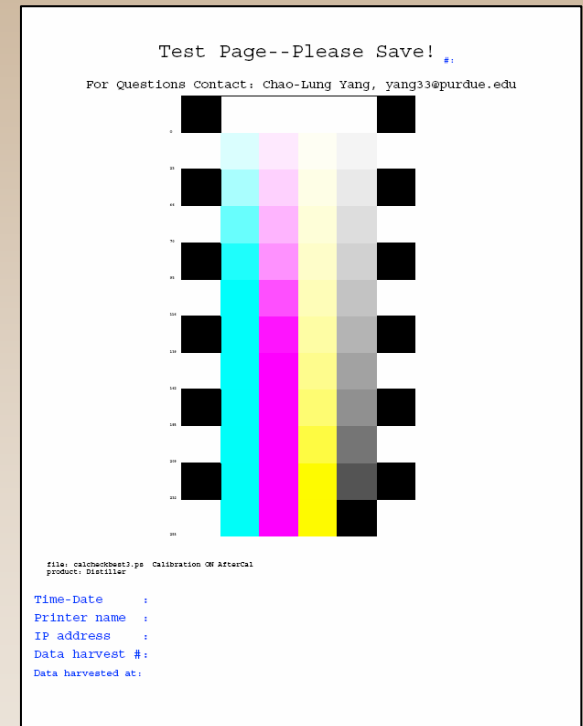


Assessment of Instruments

- Investigate the difference between X-rite and Gretag
- 4 experiments were conducted
 - ◆ Compare the mean of ΔE_{76} which is calculated from measured spectrum values
 - » UV filter option of X-rite had been investigated first
 - ◆ Compare the standard deviation of ΔE_{76}
 - » Consistency of X-rite and Gretag
 - ◆ Investigate the aperture size of X-rite
 - ◆ Comparison of measuring time
- Purchased new instrument “X-rite” in Dec. 2005

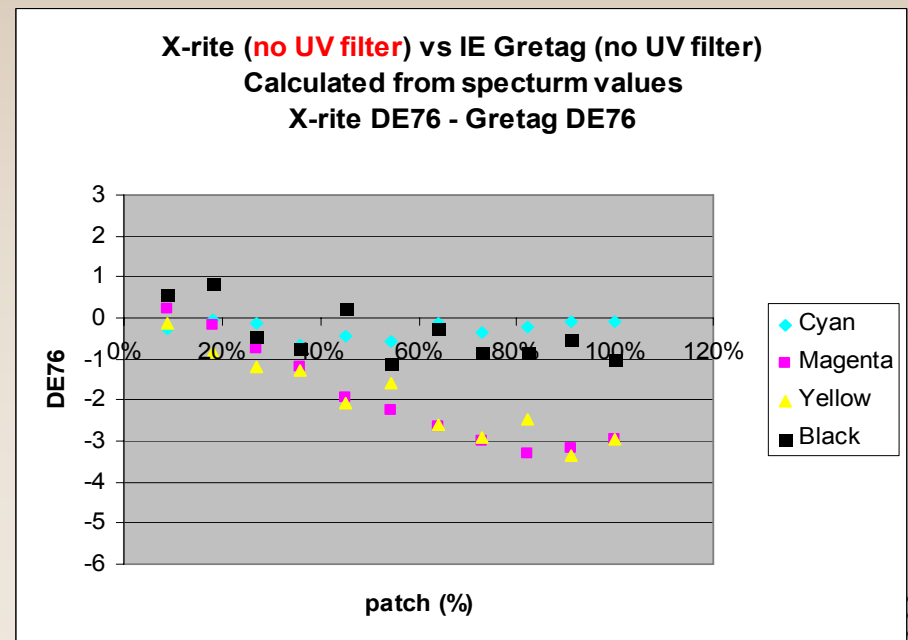
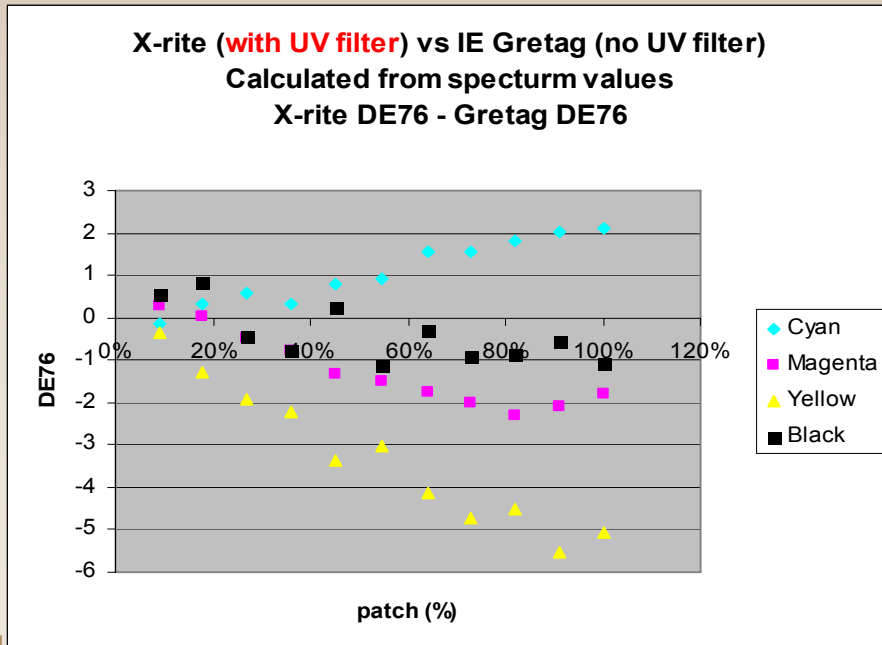
Comparison of Measured Mean $\Delta E76$ and Standard Deviation (one sample, 5 times)

- One test page was measured 5 times by X-rite and Gretag to obtain spectrum values (wavelength 400~700 μm)
 - ◆ Each time measure each patch **once**
- Use measured spectrum values to compute the $\Delta E76$ value (distance from paper white, normalized)
 - ◆ Based on the procedure suggested by Terry Nelson (see document “Color Measurement acquisition process”)
- Comparison
 - ◆ Investigate the UV filter option of X-rite
 - ◆ Compare mean of $\Delta E76$
 - ◆ Compare variance of $\Delta E76$ -> consistency issue
- Statistical analysis was provided on this comparison (95% confidence level)



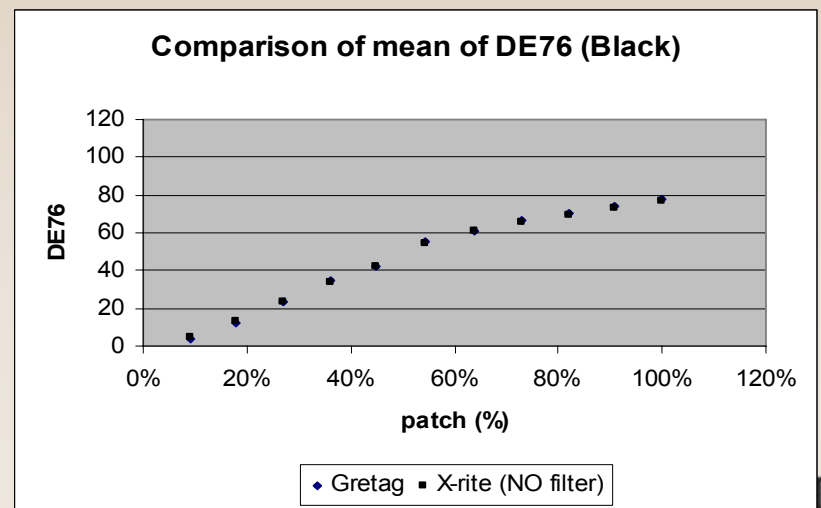
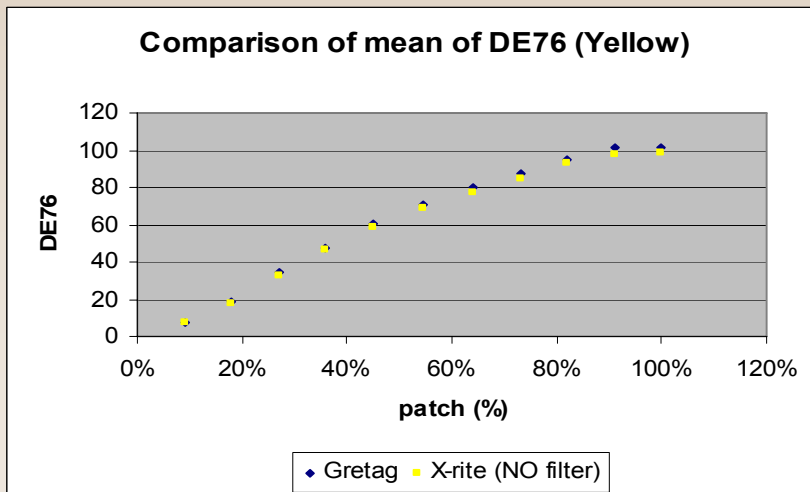
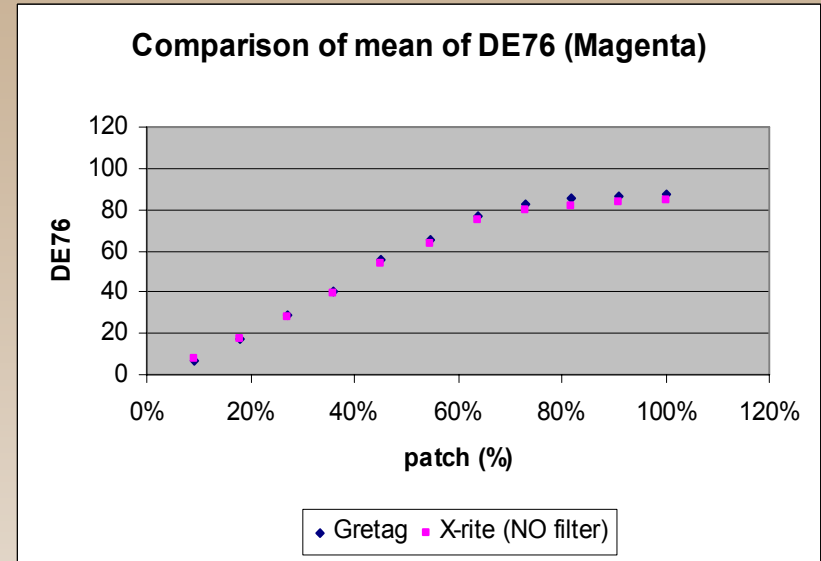
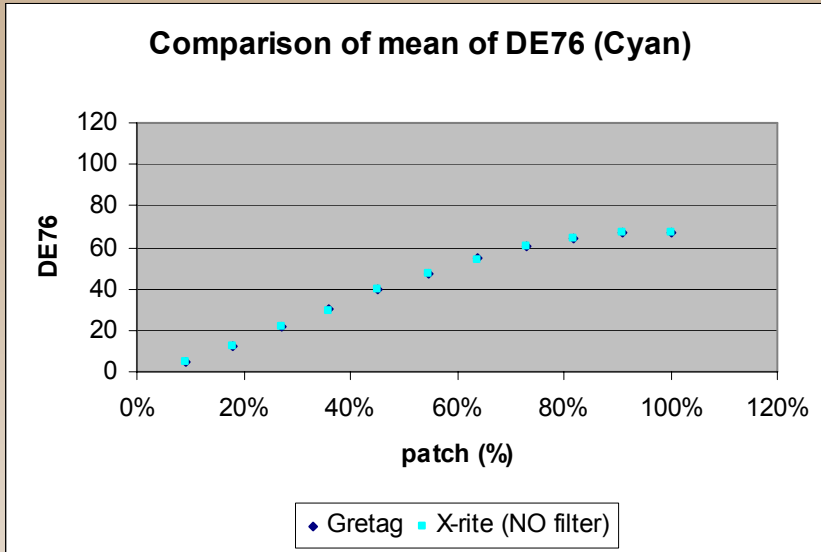
UV Filter Option

- UV filter option provided by X-rite can filter out the UV portion when profiling targets printed on substrates containing optical brighteners (Xrite.com)
- Compute the difference of X-rite ΔE_{76} and Gretag ΔE_{76} (X-rite - Gretag)
- The measurement by X-rite **without UV filter** is closest to Gretag
 - ◆ Suggest to use NO UV filter option in our grading procedure



Comparison of Mean of ΔE_{76} X-rite vs Gretag (5 samples)

- No filter



Comparison of Mean of $\Delta E76$ (cont')

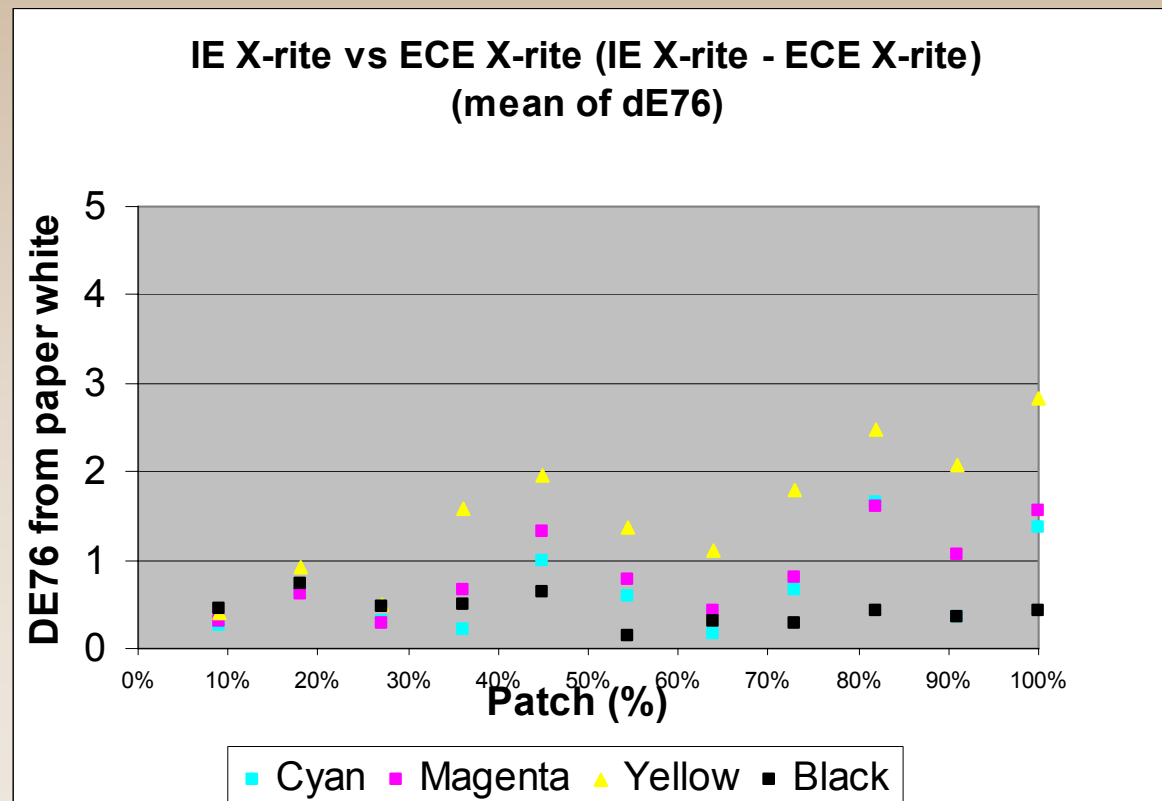
X-rite vs. Gretag (5 samples)

	X-rite		Gretag		diff. of mean	X-rite		Gretag		diff. of mean
	mean	stdev	mean	stdev		mean	stdev	mean	stdev	
9%	4.38	0.09	4.66	0.03	-0.28	7.35	0.10	7.13	0.22	0.22
18%	11.95	0.08	12.01	0.06	-0.06	17.34	0.09	17.53	0.20	-0.18
27%	21.98	0.07	22.11	0.23	-0.13	28.23	0.08	29.00	0.26	-0.77
36%	29.76	0.09	30.40	0.28	-0.65	39.57	0.08	40.78	0.11	-1.21
45%	39.58	0.07	40.02	0.43	-0.44	53.48	0.06	55.42	0.46	-1.94
54.50%	46.91	0.05	47.50	0.06	-0.59	63.25	0.05	65.48	0.35	-2.23
64%	54.22	0.03	54.36	0.17	-0.14	74.49	0.05	77.14	0.18	-2.65
73%	60.45	0.04	60.79	0.15	-0.33	79.37	0.05	82.37	0.18	-3.00
82%	64.21	0.04	64.43	0.11	-0.22	82.00	0.04	85.33	0.16	-3.33
91%	66.65	0.04	66.72	0.09	-0.07	83.56	0.05	86.74	0.15	-3.18
100%	67.10	0.06	67.18	0.05	-0.08	84.62	0.06	87.56	0.08	-2.94
9%	7.04	0.03	7.19	0.07	-0.15	4.50	0.18	3.92	0.15	0.58
18%	17.97	0.03	18.81	0.10	-0.85	13.02	0.12	12.20	0.14	0.82
27%	32.88	0.05	34.06	0.25	-1.18	23.15	0.10	23.61	0.48	-0.45
36%	46.43	0.14	47.72	0.13	-1.28	33.63	0.23	34.38	0.32	-0.75
45%	58.80	0.09	60.86	0.32	-2.06	42.07	0.04	41.86	1.08	0.21
54.50%	69.28	0.05	70.88	0.08	-1.61	54.43	0.03	55.52	0.75	-1.10
64%	77.56	0.13	80.16	0.21	-2.60	60.81	0.08	61.06	0.34	-0.25
73%	84.52	0.07	87.41	0.14	-2.89	66.02	0.01	66.84	0.51	-0.82
82%	92.66	0.11	95.14	0.40	-2.48	69.52	0.06	70.36	0.35	-0.84
91%	97.95	0.10	101.31	0.12	-3.36	73.31	0.08	73.86	0.10	-0.55
100%	98.28	0.09	101.22	0.28	-2.94	76.59	0.05	77.62	0.18	-1.03

- Cyan and Black has smaller difference between X-rite and Gretag
- Magenta and Yellow has larger difference in higher density levels (red number marks diff. of $\Delta E76 > 1$)

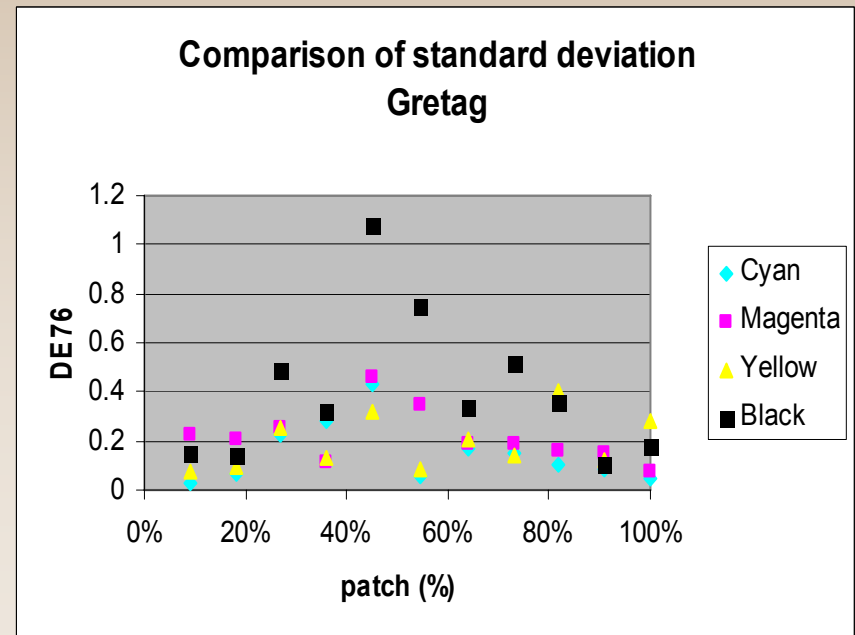
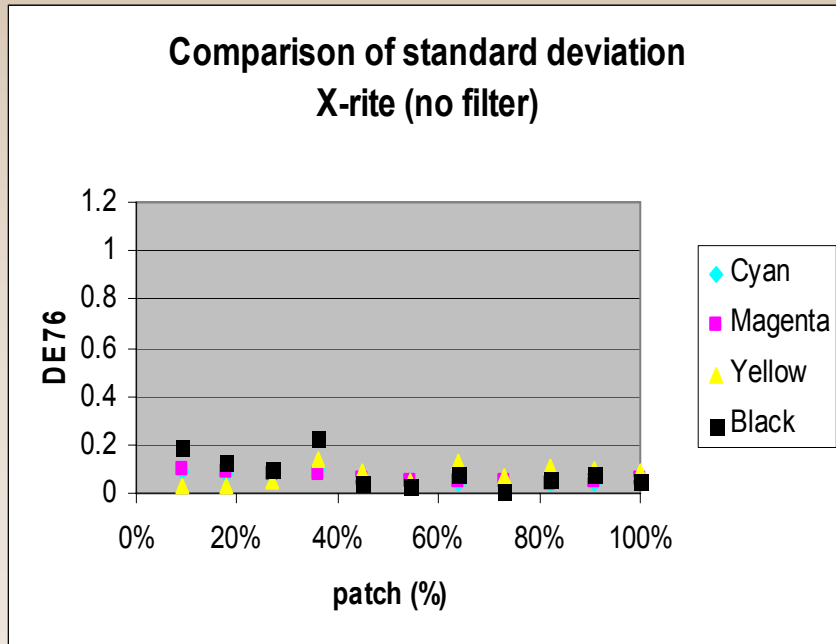
Comparison of Mean of ΔE_{76} IE X-rite vs ECE X-rite

- No filter
- Sample number: 5



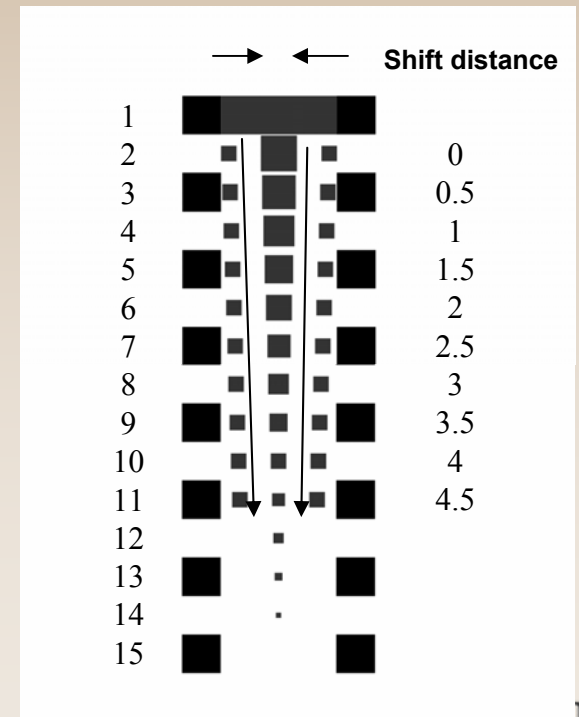
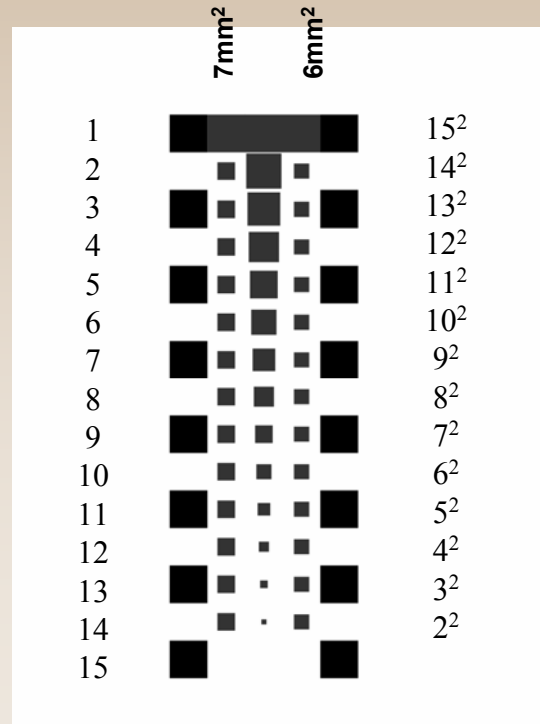
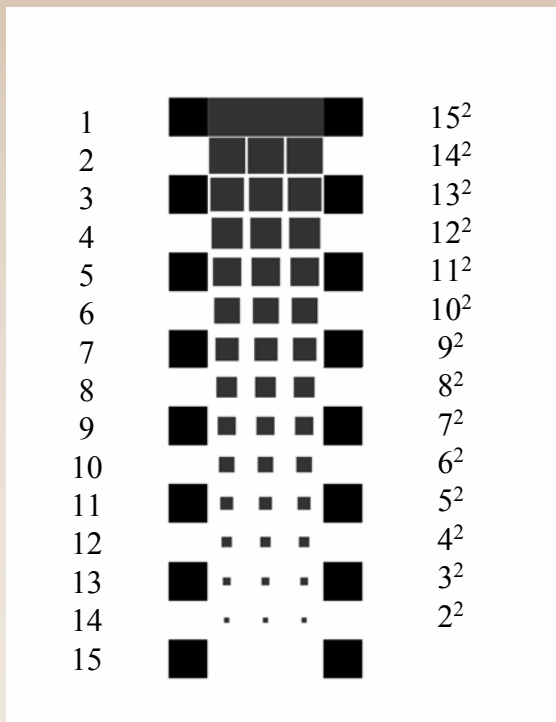
Comparison of Consistency

- Standard deviations were computed based on 5 samples
- X-rite has better consistency against Gretag (X-rite measures the same spot of each patch in a test-page)



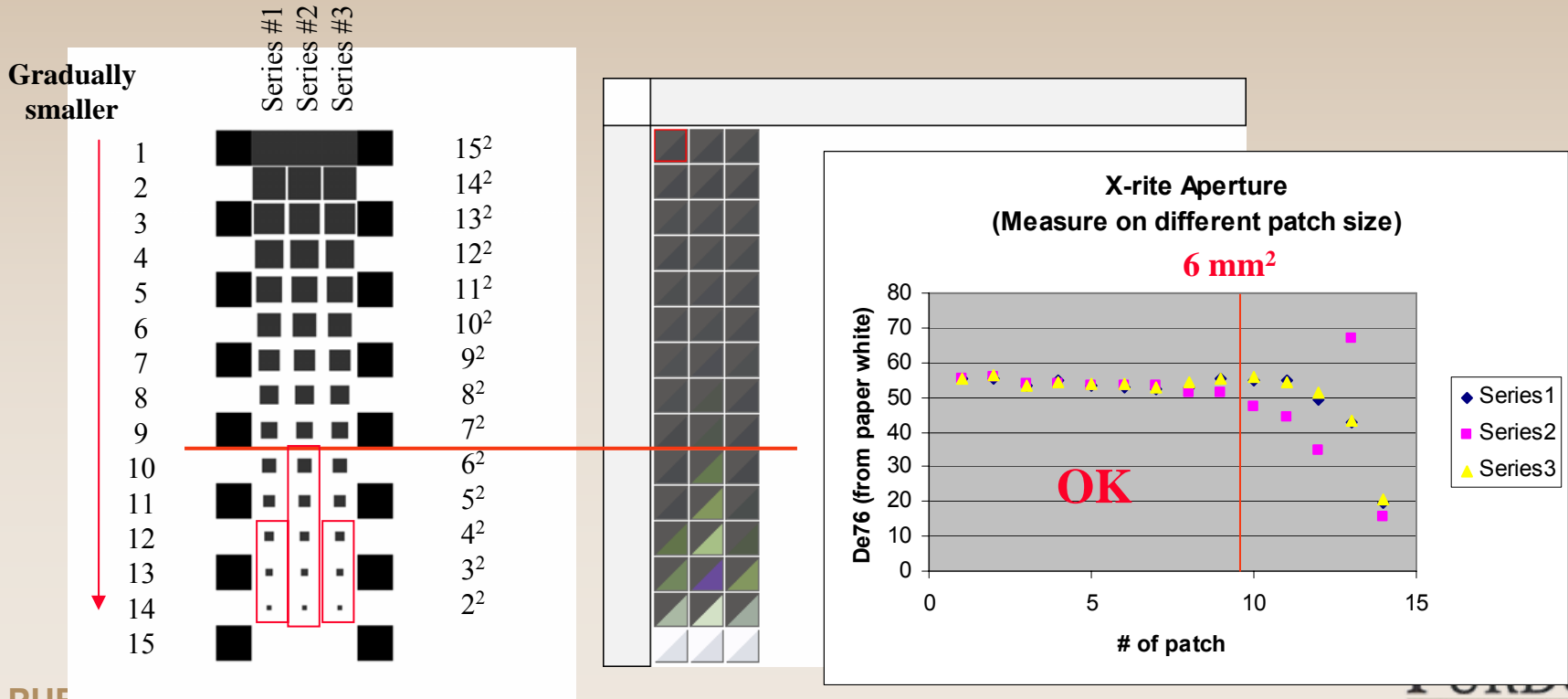
X-rite's Aperture

- Design several samples and measured by X-rite to investigate
 - ◆ The size of X-rite's aperture (mm^2)
 - ◆ Measuring behavior of X-rite
- Central series of patches is the reference



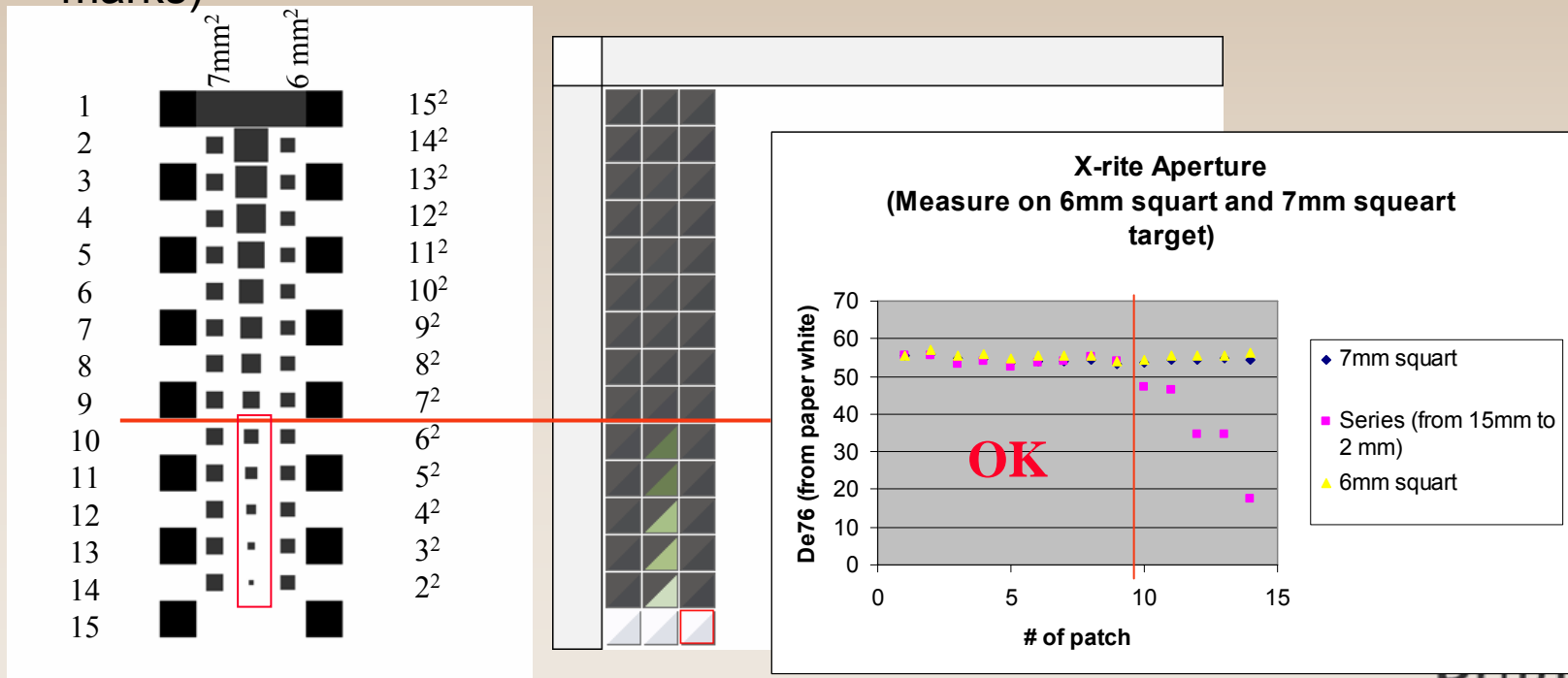
Aperture Size

- Different patch sizes are measured by X-rite in a single sample
- The measurements of patches bigger than 6mm^2 are consistency
- The suggested patch size should not be smaller than 6mm^2 (no information about aperture on X-rite manual)
- The measures on the central series appears to be different from other series



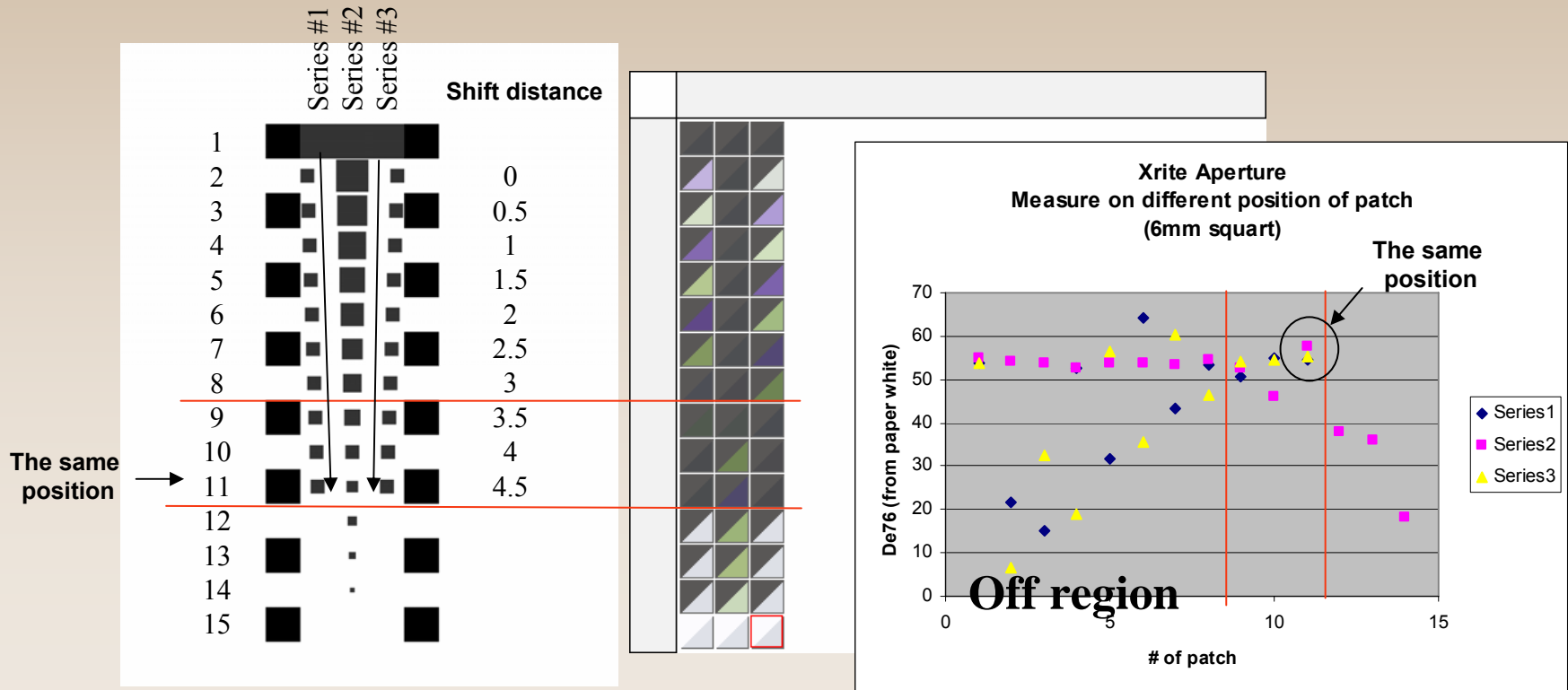
Aperture Size (cont')

- Series 1 and 3 are 7mm^2 and 6mm^2 , respectively (for double-check)
- 7mm^2 and 6mm^2 series are measured correctly
- In this case, results show X-rite can measure “side-line” patches better than central line (possible reason might be the correlation with size of alignment marks)



X-rite's Measuring Position

- Check the position of measuring aperture
- Series 1 are 6 mm² patches moving from left to right (0.5 mm each)
- Series 3 are 6 mm² patches moving from right to left (0.5 mm each)
- Measuring position is on the center of the patch based on the 15mm² alignment marks (we also use 15mm² alignment marks on our data harvesting test-page)



Comparison of Measuring Time

- Measuring time of X-rite and Gretag
 - ◆ Measure density values and spectrum values at the same time
 - ◆ Gretag
 - » Moving Gretag on the test-page
 - » Data is stored in Excel (immediately stored when pushing bottom)
 - » Total measuring time is around 120 second for 48 patches
 - ◆ X-rite
 - » Feeding test-page to X-rite
 - » Data is saved by manually operation (5 seconds)
 - » Measuring time is around 25 seconds for 48 patches
 - » Total time is 30 seconds
- X-rite is much faster than Gretag

Conclusion

- X-rite has better measuring performance than Gretag
 - ◆ Shorter measuring time (30 second vs. 120 second)
 - ◆ Good consistency
- Other advantages
 - ◆ Better visualization function and data management on embedded software (Colorport software)
 - ◆ Automatic calibration
 - ◆ Alleviate labor fatigue
- Drawbacks
 - ◆ Higher difference on Magenta and Yellow (in high density levels)
- Should use patch size larger than 6 mm²