ED Spectrum

This note presents a series of four 100 millimeter f/12 telescopes using "extra-low dispersion" (ED) glasses to correct color errors. This series was developed as an aid to understanding the nature of this color correction and its impact on performance. As shown in Figure 1a, the objective elements of each telescope consist of a triplet (containing an equiconvex lens from the ED glass) and a planoconvex crown singlet. A single lens field corrector was added near, but not at, the focal surface; this is shown in Figure 1b. The details, with dimensions in millimeters, of each telescope are provided in Table 1.

The four ED glasses selected range in Abbe number from 82 to 95: Schott's FK51 and Ohara's FPL51, FPL52 and FPL53. The refractive indices for d light (5846 A) are plotted against the Abbe number in figure 2. For reference, the other glasses used in the telescopes are plotted, as well as Schott's FK5 Fluorcrown.

Actually, it is not the level of dispersion that aids in color correction, but the level of anomalous dispersion. Optical glass catalogs often list values called partial dispersions that are used as indicators of this anomalous dispersion. On the red side, partial dispersion Pc,s for each of these glasses is plotted against Abbe number in Figure 3. Partial dispersion Pc,s is the relative dispersion between red C light (6563 A) and infrared s light (8521 A). The line on the graph represents the "Normal" line; most standard crown and flint glasses will fall fairly close to this line. On the blue side, partial dispersion Pg,f for these glasses is plotted against Abbe number in Figure 4. Partial dispersion Pg,f is the relative dispersion between blue F light (4861 A) and deep blue g light (4358 A).

Each of these telescopes was optimized for RMS wavefront error against a broad visual band and a two inch field. The resultant longitudinal color error, in millimeters, across the visual spectrum is given in Figure 5. The monochromatic RMS wavefront error, in waves, is given in Figure 6.

From the partial dispersions, it is obvious that FK5 could not be included as an ED glass in the series. But why not CaF2? Frankly, I could not get the system to converge to a viable solution in this band using CaF2. Possibly, this was due to the geometrical constraints required of the solutions.

Figure 1a -- Optics,Objective

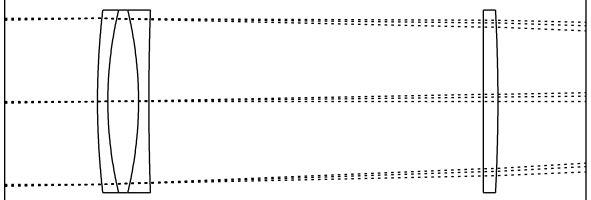

Figure 1b -- Optics,Corrector

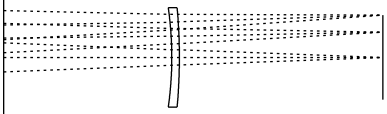

Table 1 -- Prescriptions

	FPL51		FK51		FPL52		FPL53	
	radius	thknss	radius	thknss	radius	thknss	radius	thknss
BaK2	529.8	5.57	527.85	5.74	494.15	5.92	502.67	5.66
ED	259.71	16.55	279.65	15.32	298.35	14.54	313.49	14.17
BK7	-259.71	5.56	-279.65	5.53	-298.35	5.5	-313.49	5.53
	1844.2	180.08	1934	178.24	1714.7	148.37	2442.7	162.11
K5	Flat	7.93	Flat	8.09	Flat	8.54	Flat	8.63
	-1140.8	874.87	-1025.8	872	-789.88	896.48	-747.81	874.04
K5	-236.46	4.08	-247.6	4.12	-261.18	4.13	-270.43	4.16
	-373.12	109.641	-426.62	113.617	-518.07	117.133	-646.53	122.834
image	-8244		-10826		-16233		-80477	

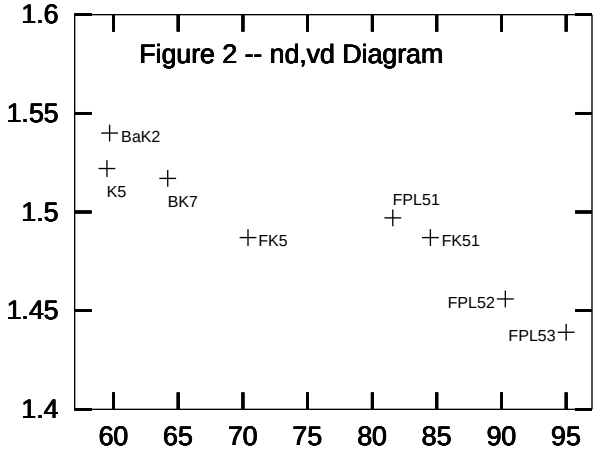
Figure 2 -- nd,vd Diagram
BaK2
K5
BK7
FK5
FPL51
FK51
FPL52
FPL53
1.6
1.55
1.5
1.45
1.4
60
65
70
75
80
85
90
95

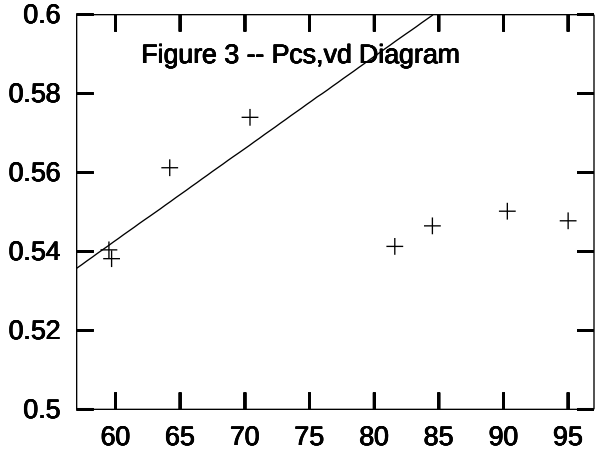
Figure 3 -- Pcs,vd Diagram
0.6
0.58
0.56
0.54
0.52
0.5
60
65
70
75
80
85
90
95

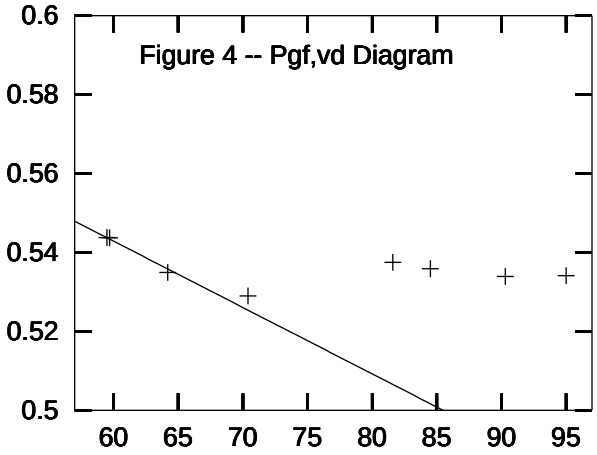
Figure 4 -- Pgf,vd Diagram
0.6
0.58
0.56
0.54
0.52
0.5
60
65
70
75
80
85
90
95

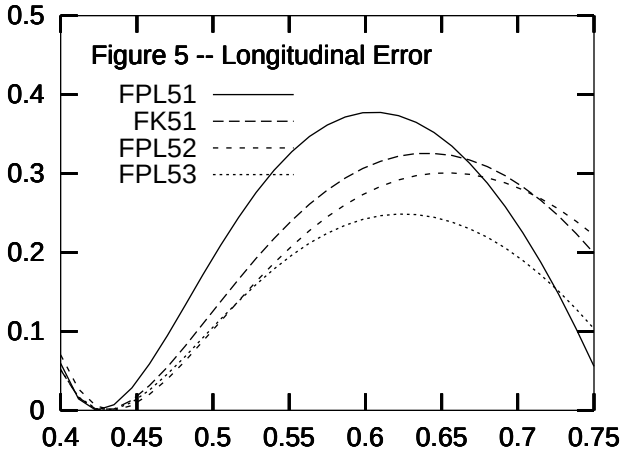
Figure 5 -- Longitudinal Error
FPL51
FK51
FPL52
FPL53
0.5
0.4
0.3
0.2
0.1
0
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75

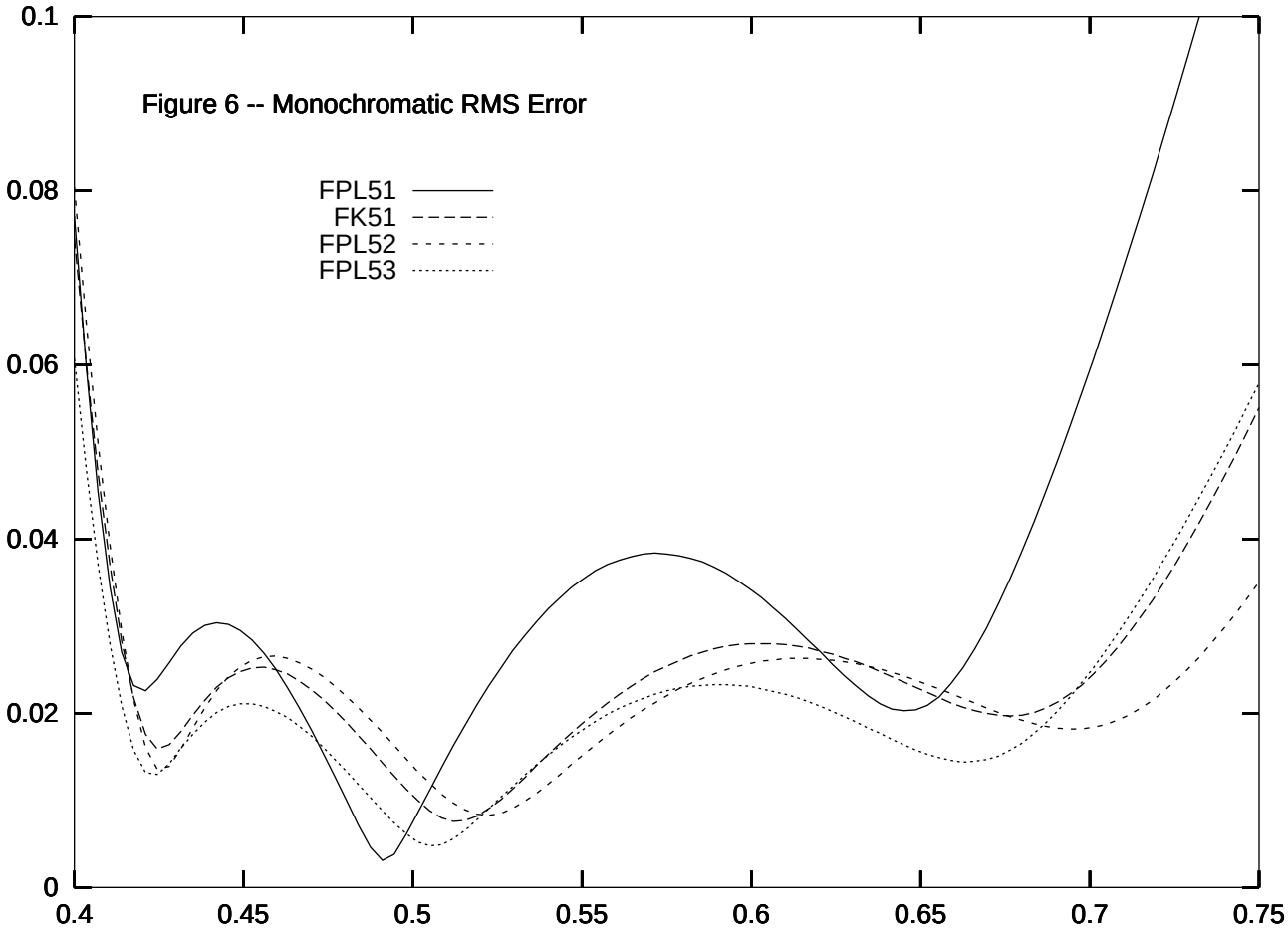
Figure 6 -- Monochromatic RMS Error
FPL51
FK51
FPL52
FPL53
0.1
0.08
0.06
0.04
0.02
0
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75