Appendix A. Converting fourth-order Zernike spherical aberration coefficients to D/mm^2

Expressed in Zernike terms, the fourth-order spherical wavefront aberration is given by

$$W(\rho) = C_4^0 Z_4^0 = C_4^0\sqrt{5}(6\rho^4 - 6\rho^2 + 1) \qquad [A1]$$

where ρ is the normalized radial distance (i.e. $\rho = y/y_{max}$) and C_4^0 is the coefficient for a pupil radius y_{max}.

In equation (A1), the Zernike wavefront error is composed of three components. The fourth-power term represents Seidel primary spherical aberration, the second-order term defocus and the third a piston term. The polynomial ensures that the average wavefront error across the pupil is zero. Thus considering only the Seidel spherical aberration term, $W(\rho)_{SSA}$, we have

$$W(\rho)_{SSA} = 6\sqrt{5}C_4^0\rho^4 = 6\sqrt{5}C_4^0 y^4/y_{max}^4 \qquad [A2]$$

However, the power at radial distance y is given by[13, 47]

$$P_y = (dW/dy)/y \qquad [A3]$$

Combining (A2) and (A3) we find

$$P_y = [24\sqrt{5}C_4 y^3/y_{max}^4]/y = 24\sqrt{5}C_4^0 y^2/y_{max}^4 = [24\sqrt{5}C_4^0/y_{max}^4]y^2$$

Thus, in terms of the coefficient *b* used earlier (equation 1 etc), we have

$$b = [24\sqrt{5}C_4^0/y_{max}^4] \qquad [A4]$$

b will be in D/mm^2 if C_4^0 is in microns and y_{max} is in mm.

APPENDIX B. Reproducibility of power profile data with Phase Focus instrument

Figure B1 shows the reproducibility of repeated measurements of the power profiles of an additional OASYS for presbyopia lens (low add, -3.00D). Figures B2 and B3 show the reproducibility of repeated measurements of the power profiles of two additional Purevision low add lenses and one additional high add lens, respectively.

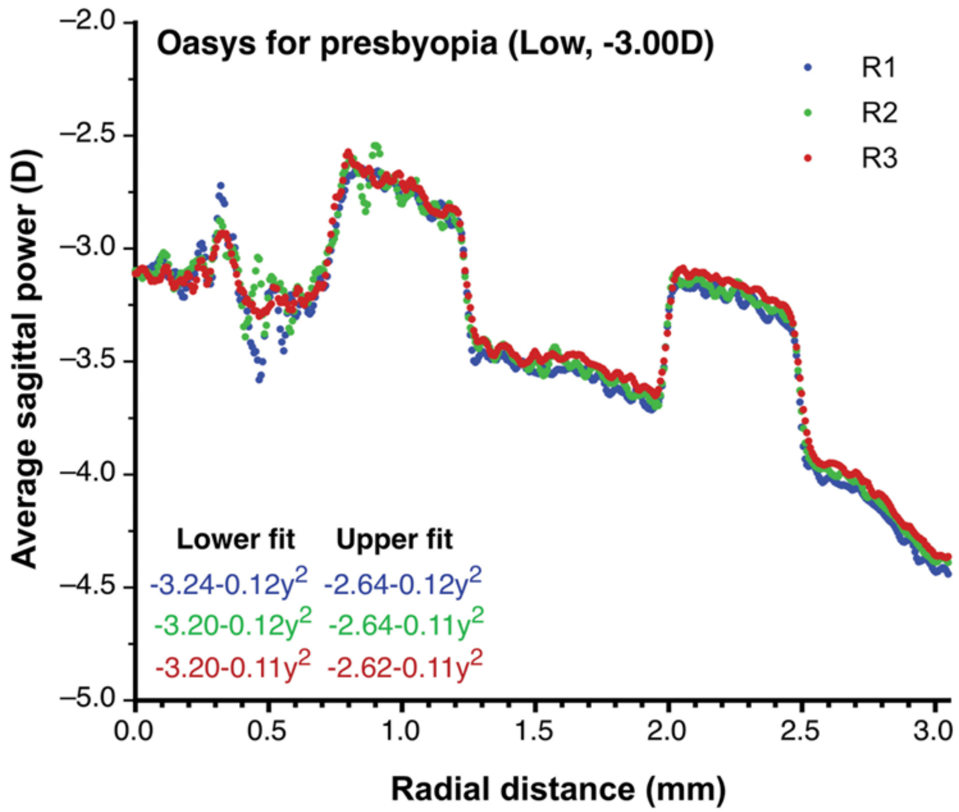

Figure B1. Three repeated measurements of the power profile of a single low-add OASYS for presbyopia lens with nominal –3.00D distance power. The equations of the lower and upper parabolic fits for the three measurements are given.

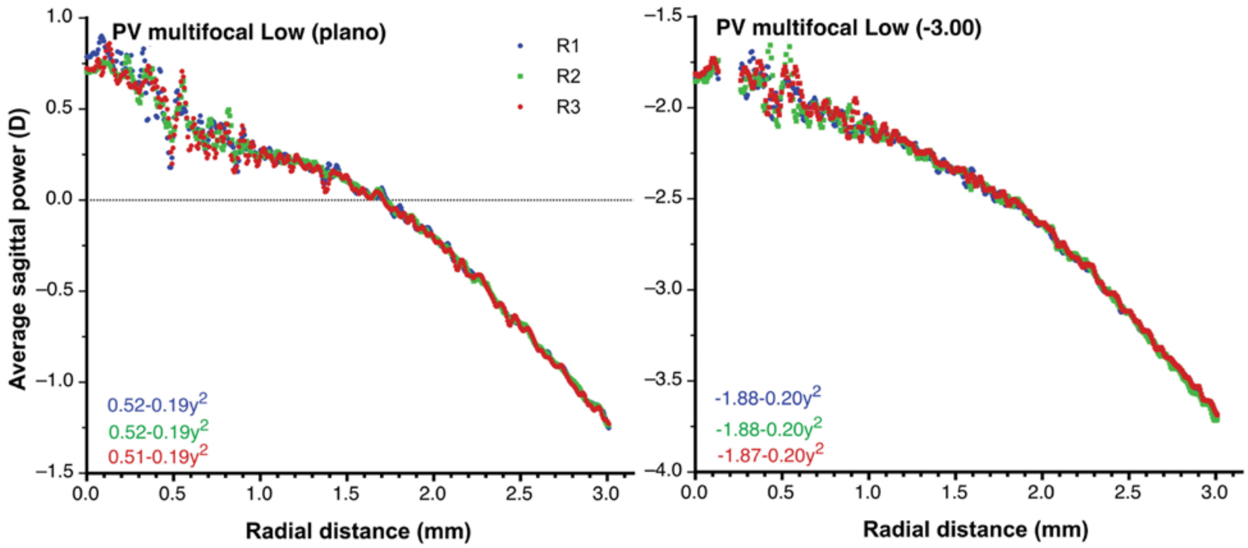

Figure B2. Three repeated measurements of the power profile of low-add Purevision lenses, with nominal plano (left) and -3.00D (right) distance powers. The equations of the smooth parabolic fits are given.

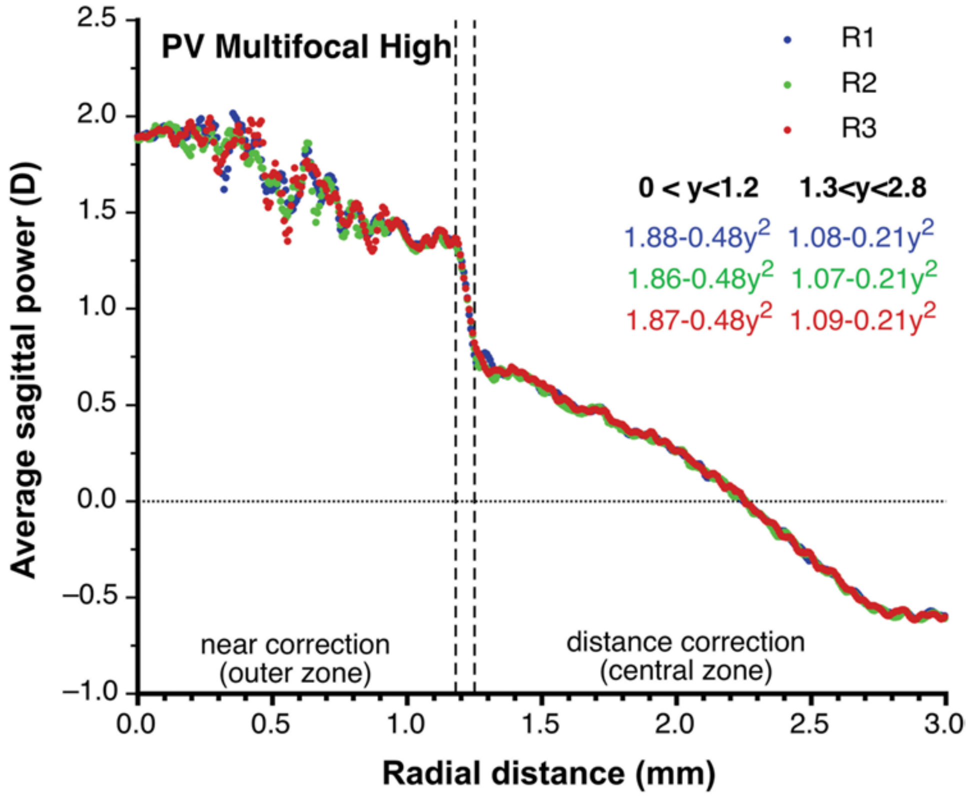

Figure B3. Three repeated measurements of the power profile of a single high-add Purevision lens with nominal plano distance power. The equations of the central and outer zonal parabolic fits for the three measurements are given.

APPENDIX C. Average refractive power for circular and annular areas of a lens with primary spherical aberration

We assume that the power profile is given by Equation [2] in the text, i.e.

$$P_y = P_0 + by^2$$

Circular area of radius y_c

The average power P_a is given by:

$$P_a = \frac{\int_0^{y_c}(P_0 + by^2)2\pi y \partial y}{\pi y_c^2}$$

$$\text{i.e. } P_a = \left(\frac{2}{y_c^2}\right)[P_0 y^2/2 + by^4/4]_0^{y_c}$$

$$\text{i.e } P_a = P_0 + by_c^{\ 2}/2 \qquad [C1]$$

Annular area of inner and outer radii y_1 and y_2

In this case the integral is between limits y_1 and y_2 and the normalizing area is $\pi(y_2^{\ 2} - y_1^{\ 2})$. The result is:

$$P_a = P_0 + b(y_2^{\ 2} + y_1^{\ 2})/2 \qquad (B2)$$