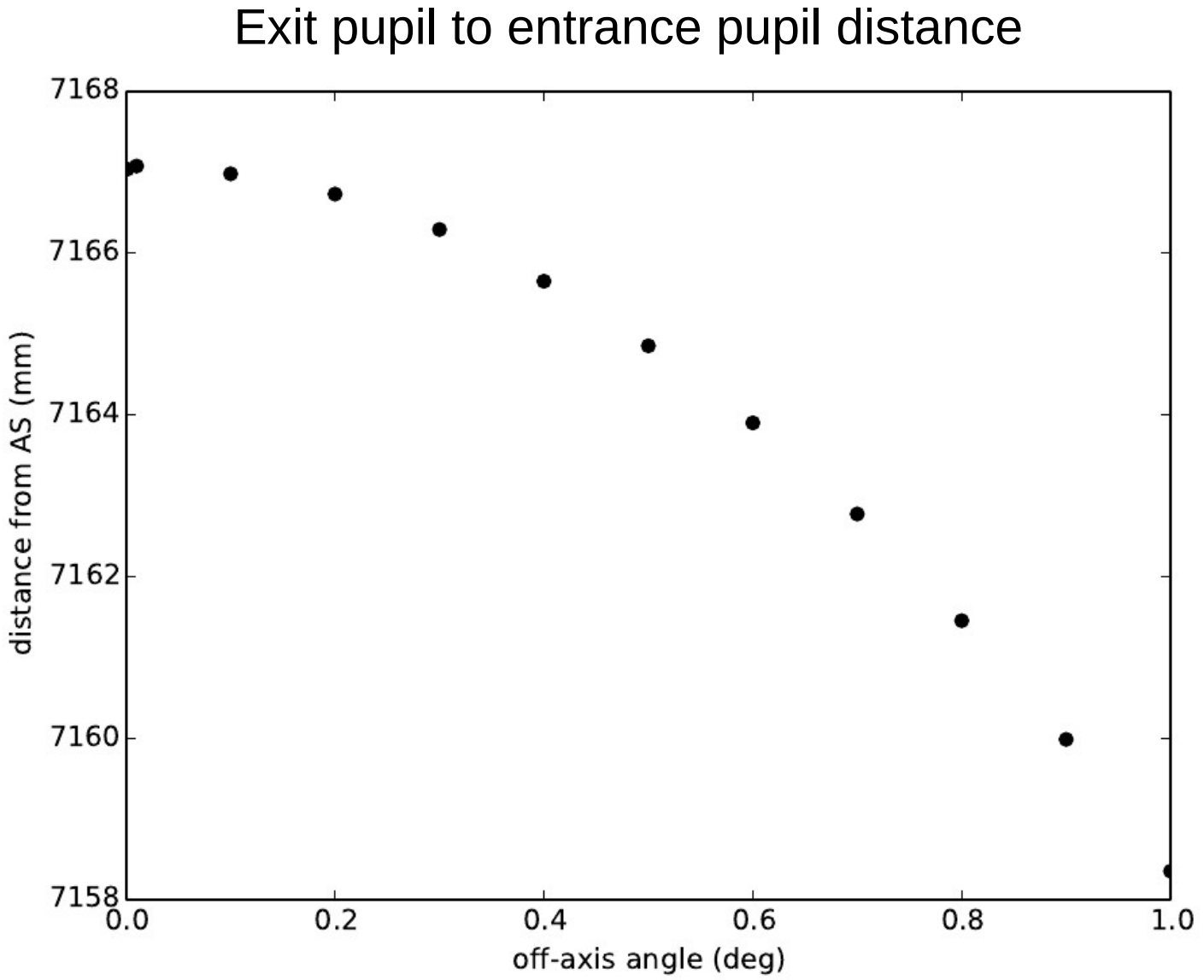
Changes since v3.4

- interpolation accuracy (surface/perturbation grid points)
- OPD calculation (chief ray, entrance/exit pupils, reference sphere)
- optical design files (data/lsst/optics_x.txt, more digits)
- n_silica (data/lsst/silica_dispersion.txt)
- monochromatic source (opdwavelength)
- radius of reference sphere (EPR) **[I]**
- Zernike polynomials in Cartesian coordinates **[II]**
- Zernike polynomials in Noll's nomenclature
- perturbation for fused surface **[III]**

I. EPR calculation

- EPR is wavelength and optical layout dependent. e.g., EPR changes from 2730.07 mm (-0.1mm camera piston) to 2730.19 mm (+0.1 mm camera piston).
- using small angle ray (tan θ = 1e-5)
- after the ray landing on the image plan, extend it and find z-intercept
- PhoSim's EPR is different by 870nm from Zemax's (tested on +- 0.1 mm camera piston cases), which causes ~7e-6 nm rms error on OPD.

I. EPR calculation



II. Cartesian derivatives of Zernike polynomials

- derivatives determine the normal of the surface
- polar coordinate problem: instability at small r, not defined at r=0
- using Cartesian expression of Zernike polynomials in R. J. Mathar 2009, which lists z1-z55 explicitly.
- may need to use recursive methods for higher terms

Image::interceptDerivatives

normal_x += -$\partial S/\partial \mathbf{r}$ * x/r + $\partial S/\partial \boldsymbol{\varphi}$ * y/(r*r);

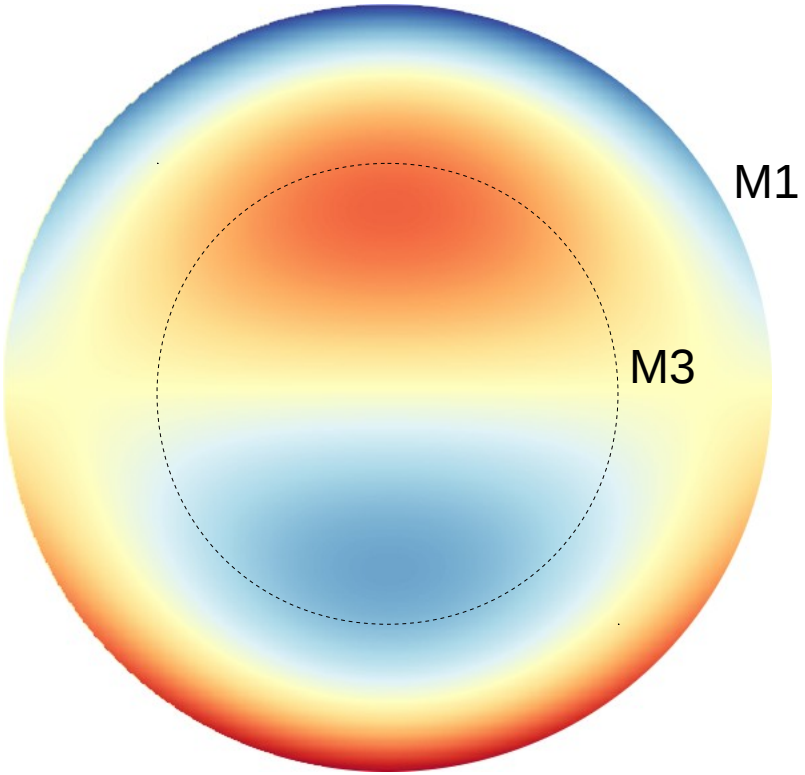
normal_y += -$\partial S/\partial \mathbf{r}$ * y/r – $\partial S/\partial \boldsymbol{\varphi}$ * x/(r*r);

S: surface perturbation

III. perturbation for fused surface (work in progress)

- extra parameter (rmax) for every perturbation model

z7 vertical coma



(from wiki)

previous PhoSim implementation