Validations and Predictions of Chromatic PSF effects in PhoSim

Differential Chromatic Refraction

Space

Atmosphere

Chromatic Seeing

atm

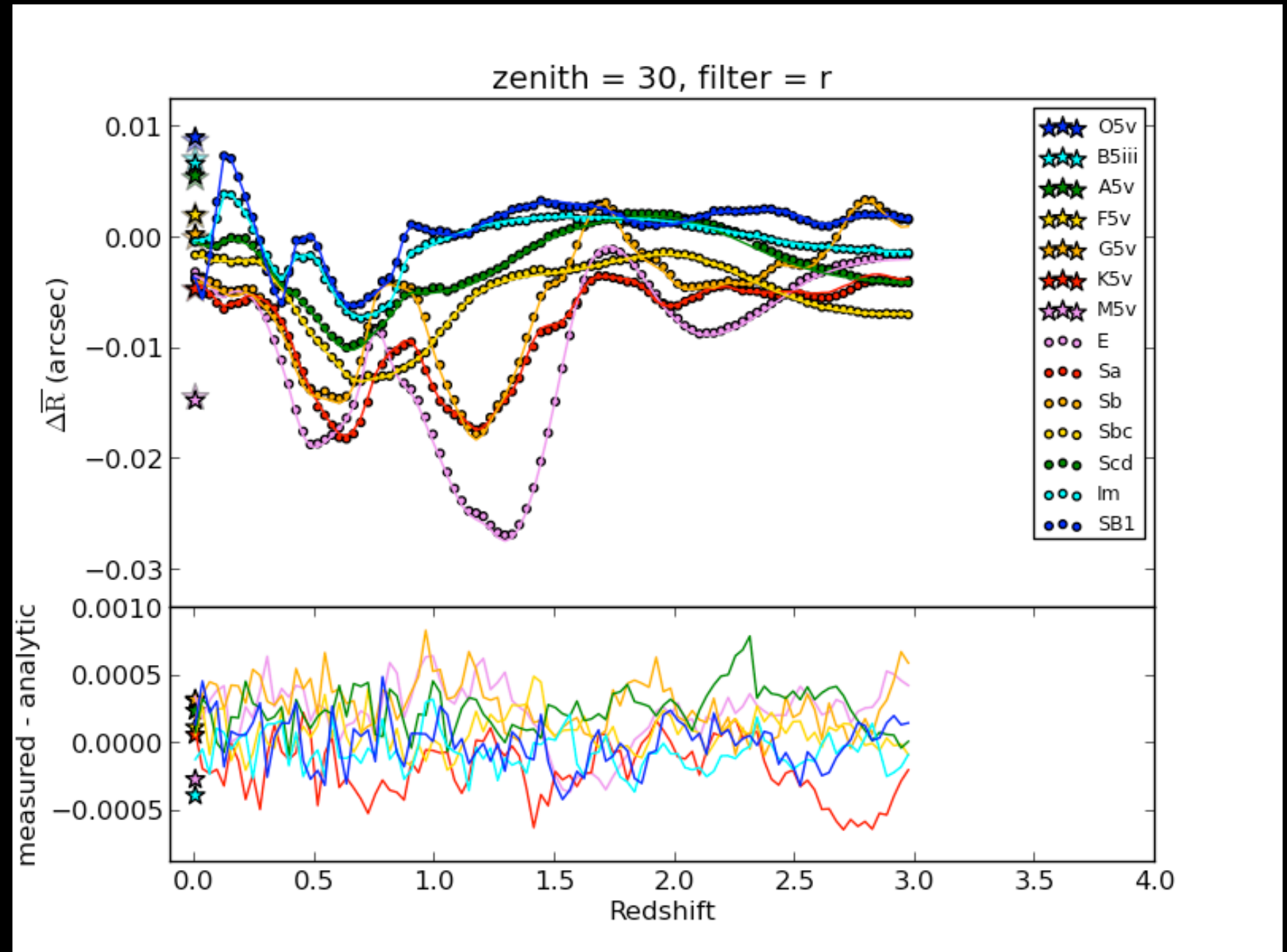Josh Meyers - Stanford University

Centroid shift validation in PhoSim

Cross-validate PhoSim and analytic expression for DCR centroid shifts.

Procedure
1. Simulate grid of G5v stars.
2. At same positions and with same atmosphere, simulate stars with other stellar and galactic SEDs.
3. Measure centroids in SExtractor and subtract!

Second moment shift validation in PhoSim

Cross-validate PhoSim and analytic expression for DCR second moment shifts.

Procedure
1. Simulate grid of G5v stars.
2. At same positions and with same atmosphere, simulate stars with other stellar and galactic SEDs.
3. Measure second moments with python script.

zenith = 30, filter = r

Legend: O5v, B5iii, A5v, F5v, G5v, K5v, M5v, E, Sa, Sb, Sbc, Scd, Im, SB1
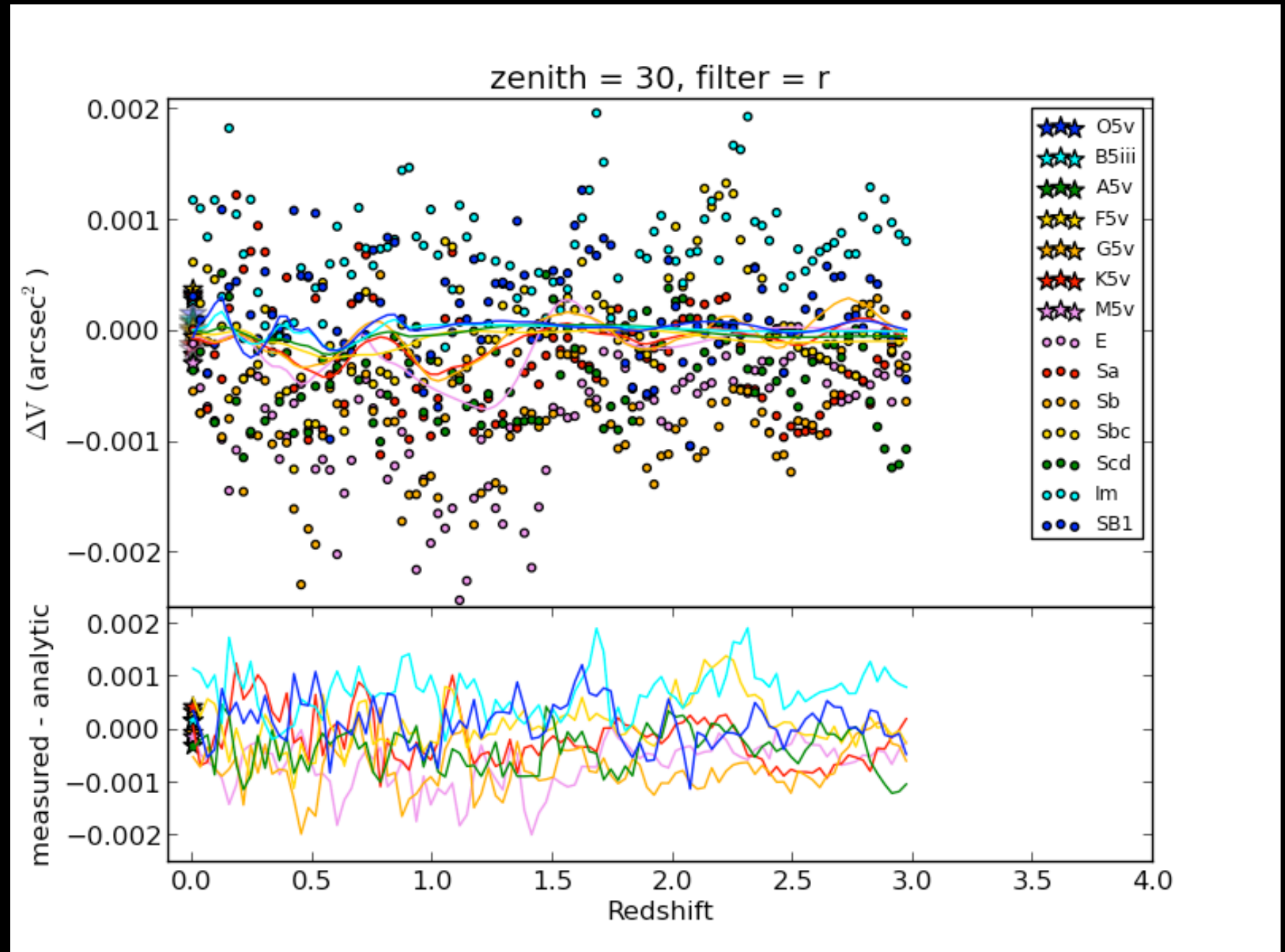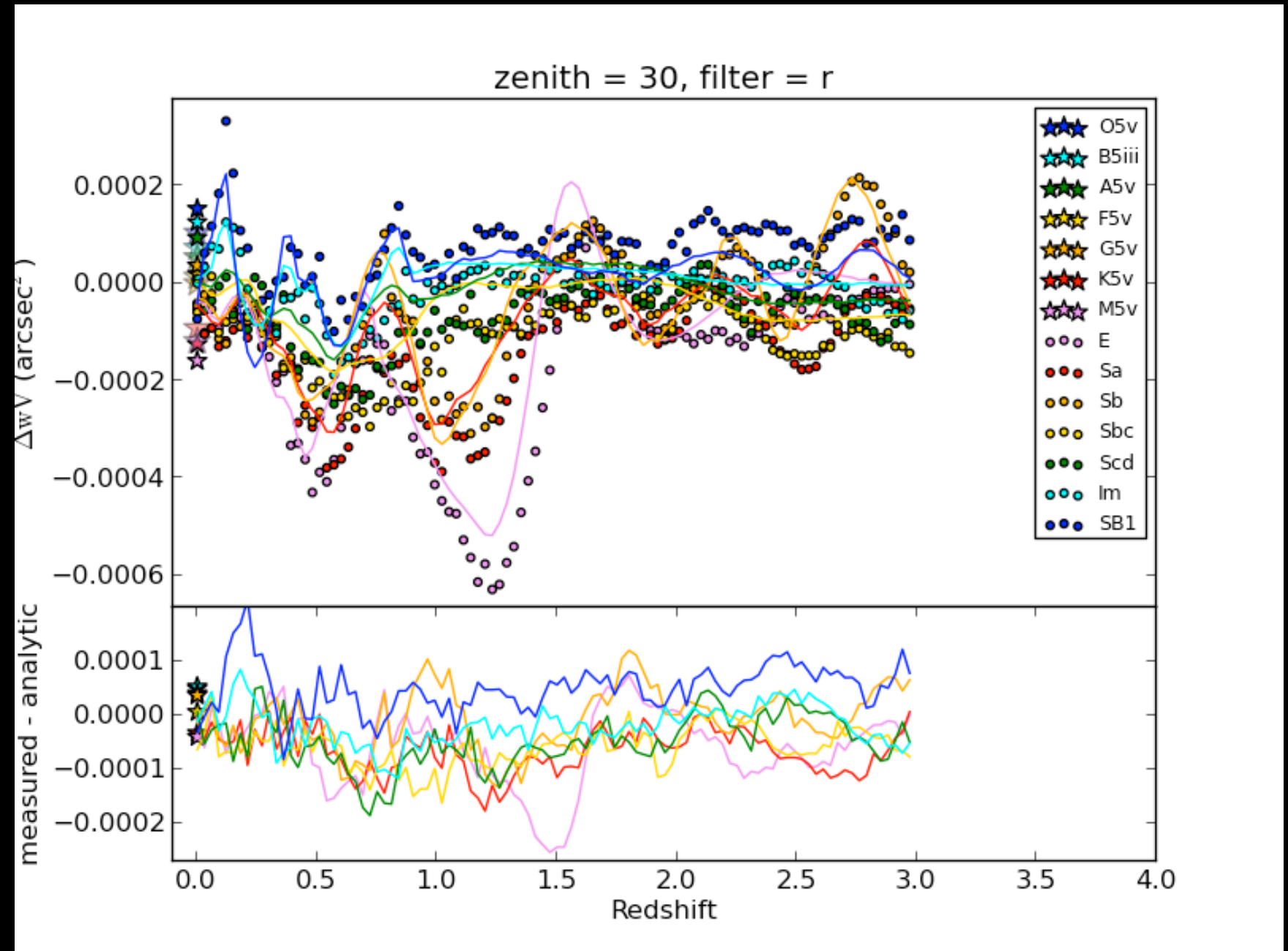
Second moment shift validation in PhoSim

Cross-validate PhoSim and analytic expression for DCR second moment shifts.

Procedure
1. Simulate grid of G5v stars.
2. At same positions and with same atmosphere, simulate stars with other stellar and galactic SEDs.
3. Measure second moments with python script.
4. Measure *weighted* second moments and compare to analytic formula for *weighted* second moments.
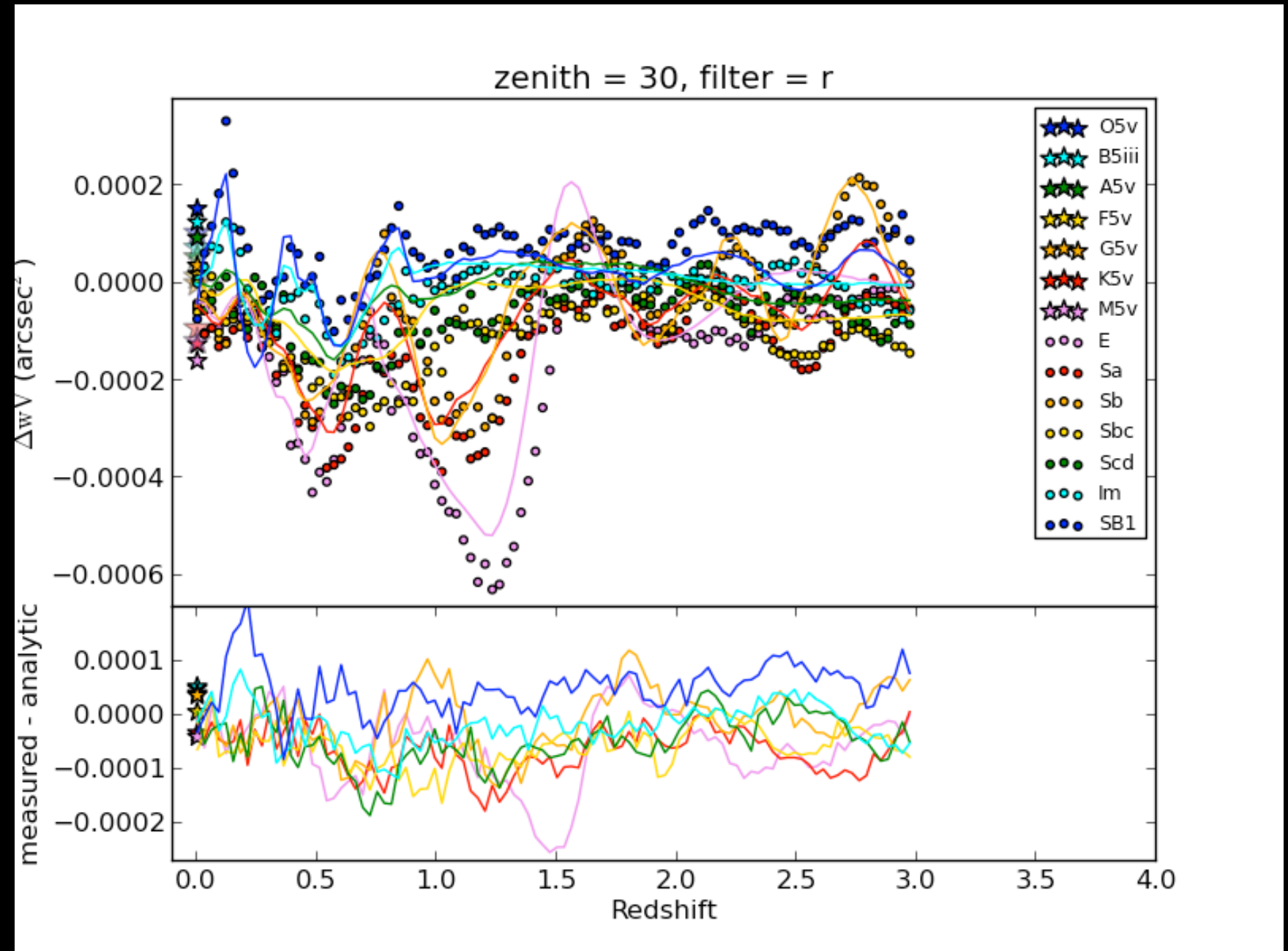
Second moment shift validation in PhoSim

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Procedure
1. Simulate grid of G5v stars.
2. At same positions and with same atmosphere, simulate stars with other stellar and galactic SEDs.
3. Measure second moments with python script.
4. Measure *weighted* second moments and compare to analytic formula for *weighted* second moments.

Feature requests:
1. "telescopemode 0" but retain throughput
2. secondmomentsfile analogous to centroidfile

Chromatic seeing validation in PhoSim

Cross-validate PhoSim and analytic expression for chromatic seeing.

<u>Procedure</u>
1. Simulate monochromatic stars.
2. Do this both with and without optics+detectors.
3. Fit Moffat profiles to stars.

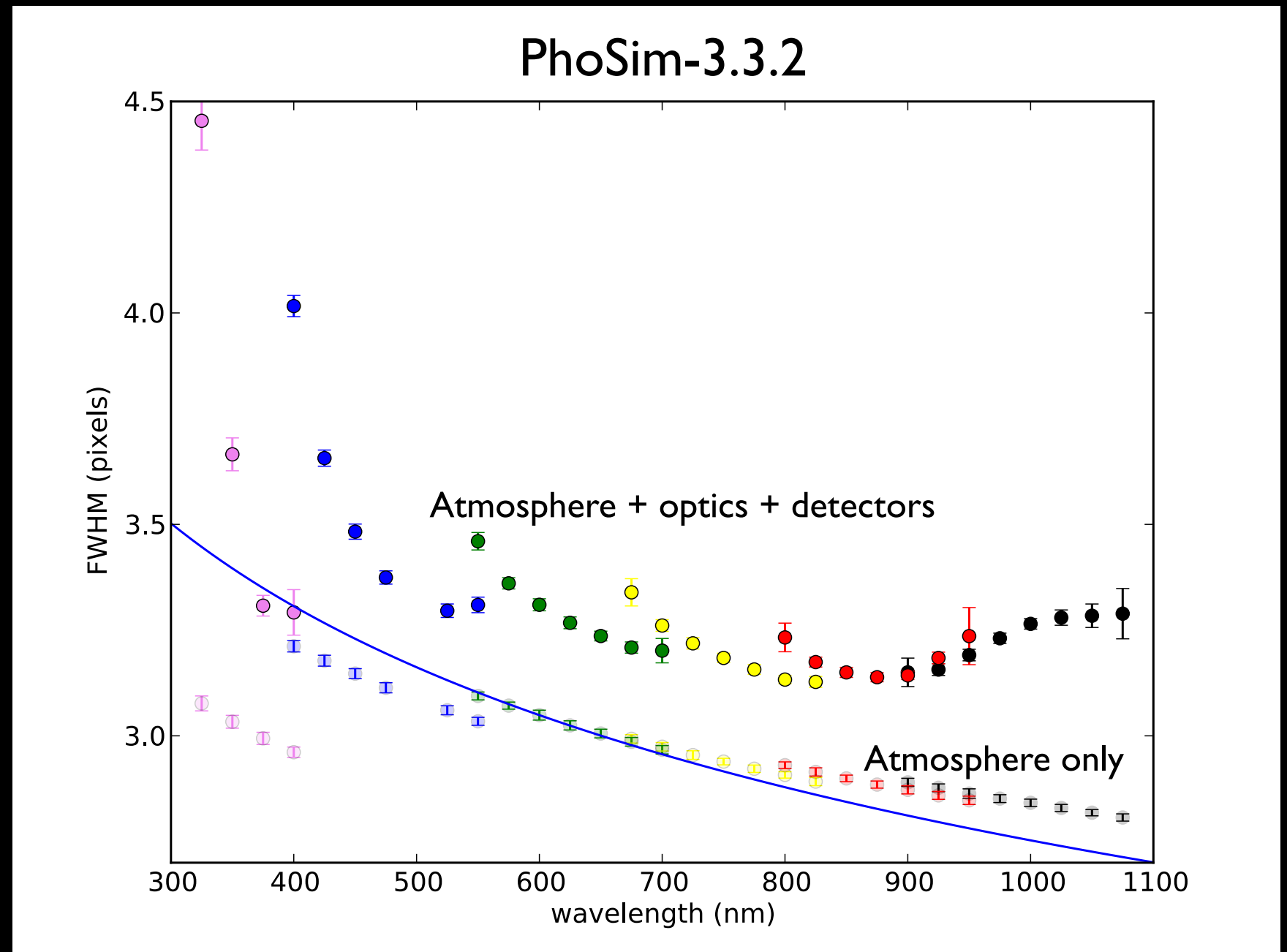Mysterious gaps between filters at fixed wavelength.

Chromatic seeing validation in PhoSim

Cross-validate PhoSim and analytic expression for chromatic seeing.

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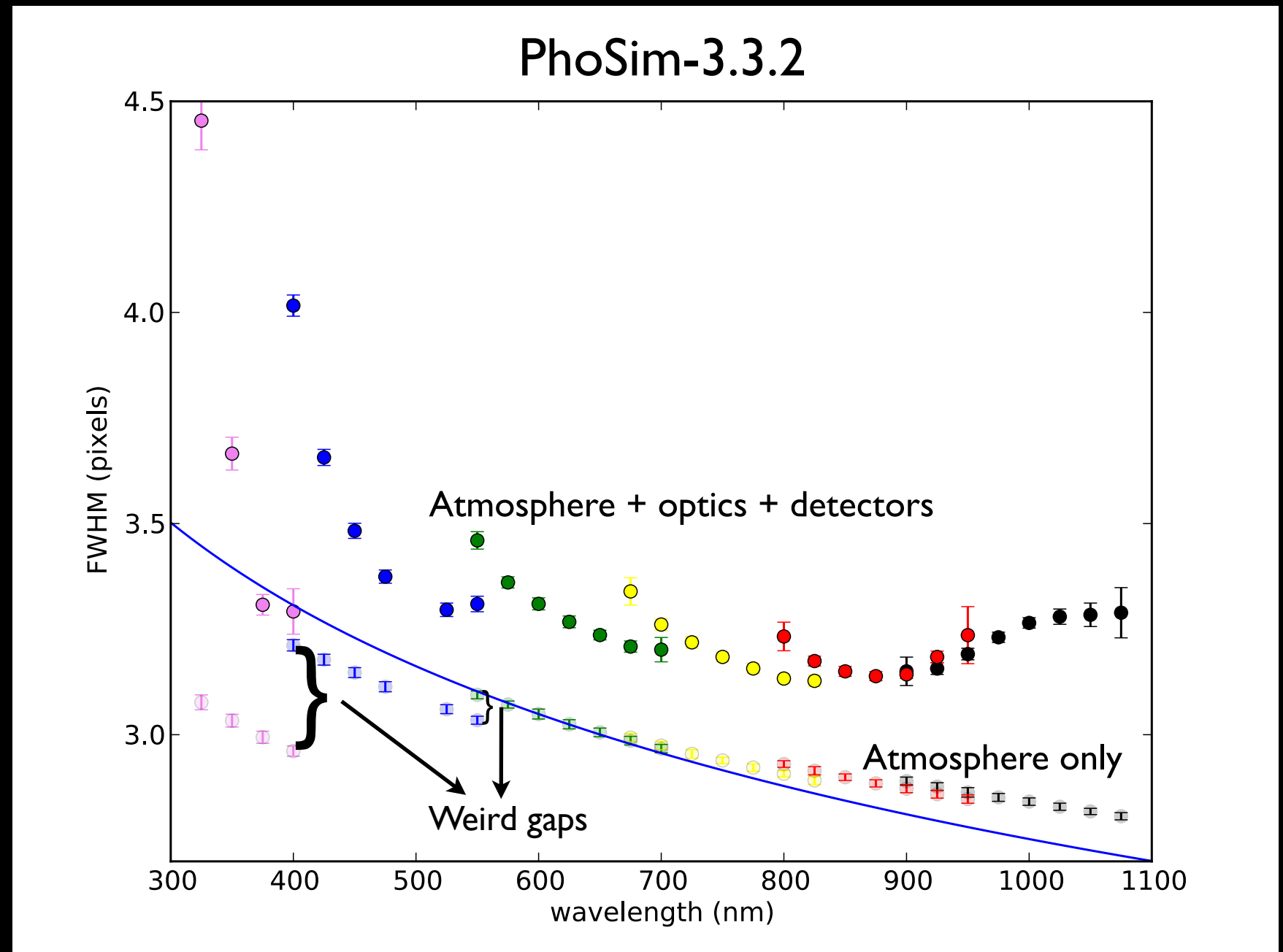Mysterious gaps between filters at fixed wavelength.

Chromatic seeing validation in PhoSim

Cross-validate PhoSim and analytic expression for chromatic seeing.
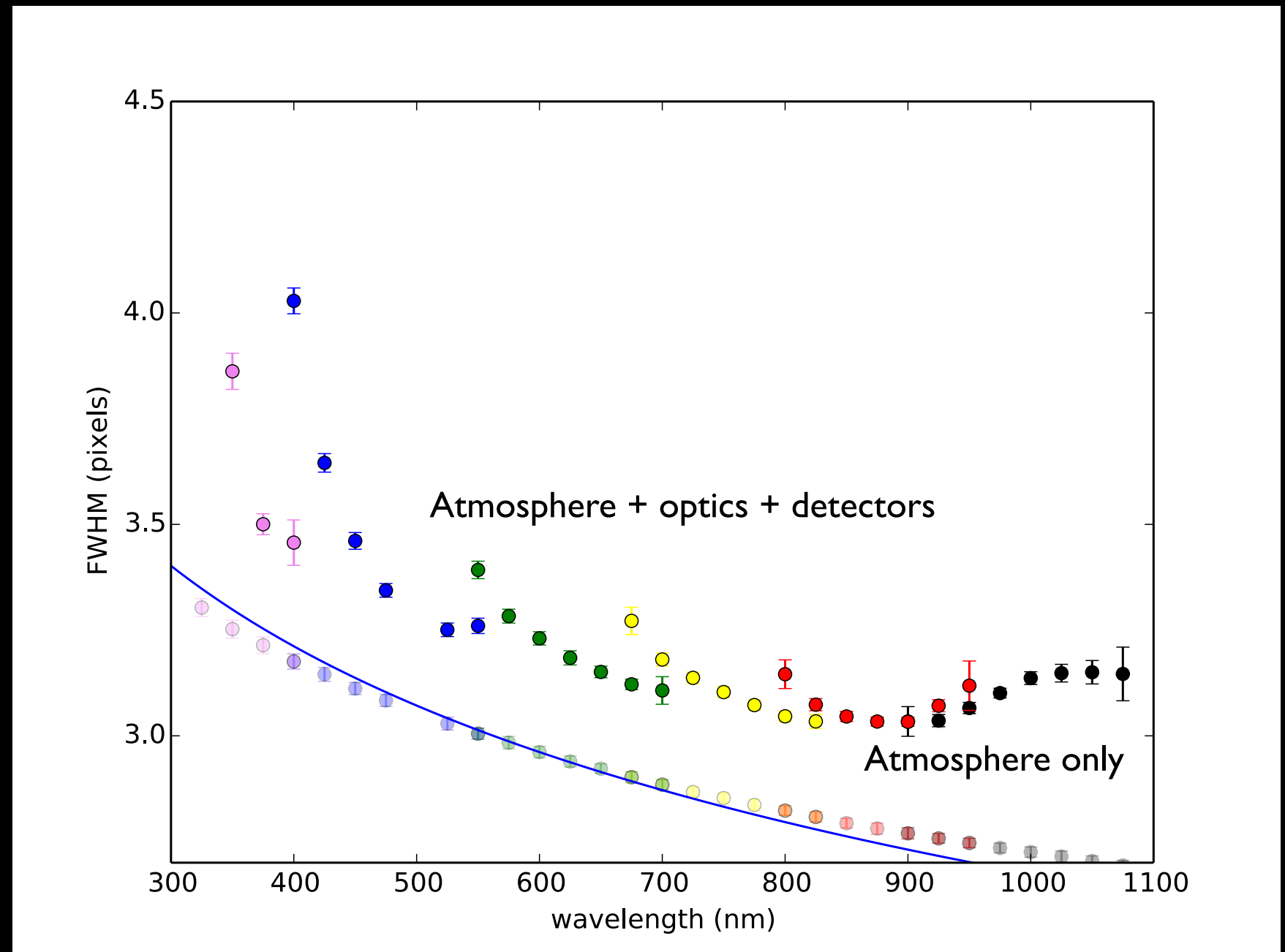
Procedure
1. Simulate monochromatic stars.
2. Do this both with and without optics+detectors.
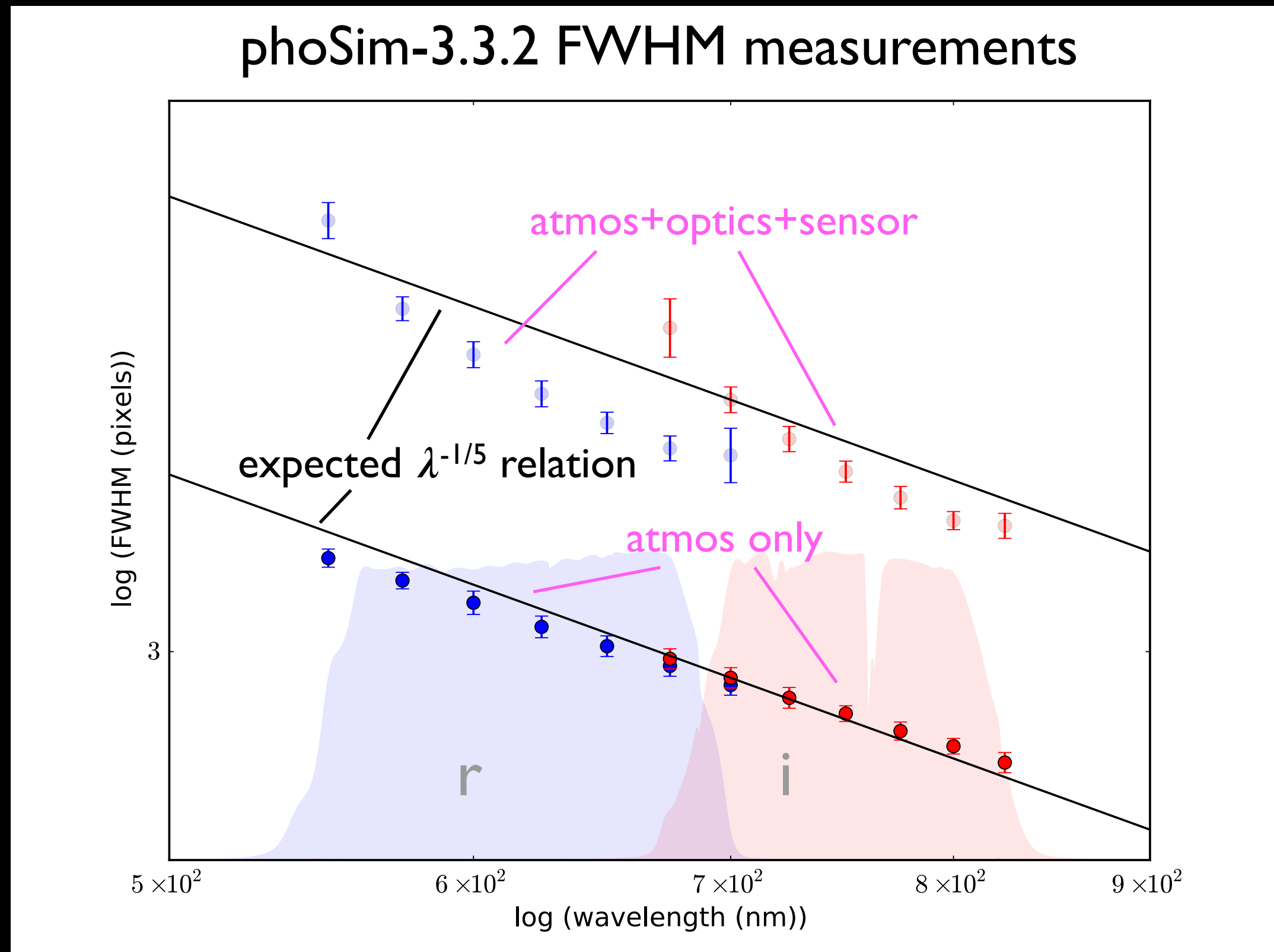3. Fit Moffat profiles to stars.

Mysterious gaps between filters at fixed wavelength.

Traced to bug in handling of central_wavelengths.txt data.

Will be fixed in PhoSim-3.4

Josh Meyers - Stanford University

Learned that optics and sensor increase slope of chromatic seeing

phoSim-3.3.2 FWHM measurements

atmos+optics+sensor

expected $\lambda^{-1/5}$ relation

atmos only

r

i

log (FWHM (pixels))

log (wavelength (nm))

3

5×10^2 6×10^2 7×10^2 8×10^2 9×10^2
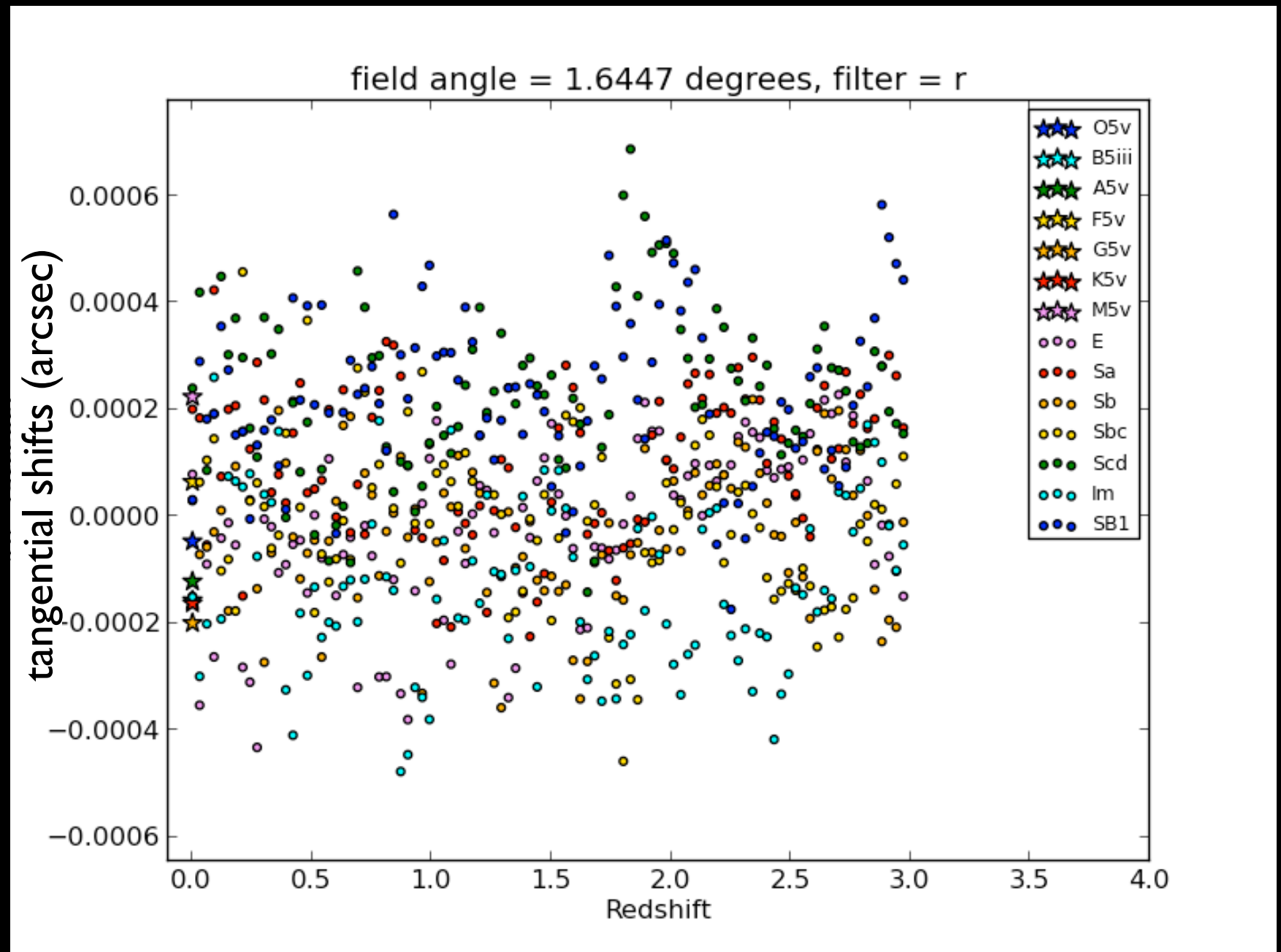
Optics: looking off-axis

What is effect of optics from looking off axis?

Procedure
1. Grid of G5v stars.
2. Grid of stars with other stellar and galactic SEDs.
3. Measure centroids in SExtractor and subtract.

No shifts in tangential direction.

Nonzero but negligible shifts in radial direction.
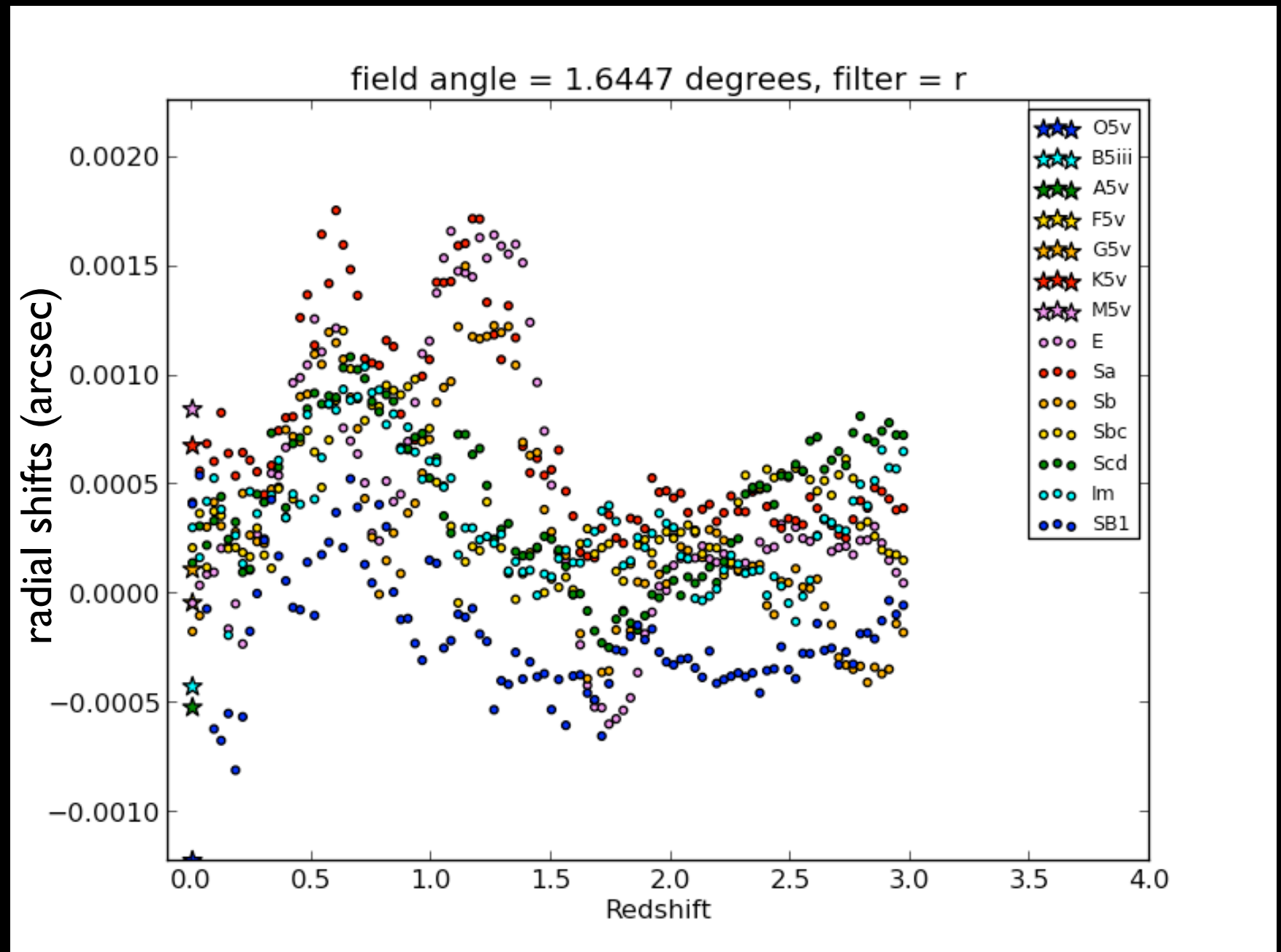
Optics: looking off-axis

What is effect of optics from looking off axis?

Procedure
1. Grid of G5v stars.
2. Grid of stars with other stellar and galactic SEDs.
3. Measure centroids in SExtractor and subtract.

No shifts in tangential direction.

Nonzero but negligible shifts in radial direction.

field angle = 1.6447 degrees, filter = r

Final thoughts

- It could be useful to...

  - be able to run in telescopemode 0 but retain throughput

  - output a secondmomentsfile like the centroidfile

  - be able to easily simulate images of different catalogs with the same atmosphere, but without regenerating said atmosphere each image