ASTR 597: 3D Optical Raytracing Topics

Following are suggested activities for investigating astronomical instrumentation topics using the 3D raytracing apparatus. Many of them relate to the APO 3.5 meter optical design, which has the prescription:

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2
1.0
-1.0 0.0 -12279.7 -1.01927
1.0 -4833.421 -3164.172 -2.18427
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1. What is the on-axis performance of the APO 3.5 m telescope. Put in context by relating the RMS and total extent of the spot pattern to arcseconds, pixels, typical seeing, etc.
2. Use an off-axis bundle (comes in at an angle) of modest proportions (typical field angle for this telescope) to deduce the plate scale in microns per arcsecond. For a reasonable maximum field angle, what is the fractional blur in arcseconds, and compared to the offset (fractional blur vs. displacement)?
3. Investigate the field curvature of the 3.5 m focal plane. What radius do you deduce for the focal plane?
4. Investigate distortion of the focal plane. Is it pincushion or barrel distortion? How large is the effect (in % of the field) for SPICAM, which has a 2000-pixel CCD sitting at the focal plane of the telescope?
5. Using the skew measure to indicate asymmetry arising from coma, at what point (what field angle) does astigmatism take over from coma as the primary aberration (when does the skew peak and start to roll over?).
6. If we want to maintain 0.5 arcsec imaging capability (say 0.25 arcsec RMS), how large can our field be if we require that it is physically flat? You can pick a compromise focus (screen) position that allows the largest possible field.
7. If we want to maintain 0.5 arcsec imaging capability (say 0.25 arcsec RMS), how large can our field be if we allow it to curve with the focal plane (hard to do, in practice)?
8. If I put a 1 cm-thick flat glass plate 5 cm in front of the image plane so I can put the detector in vacuum, I will create some negative spherical aberration. We want to know how serious this is. Evaluate the impact (in arcseconds, pixels, etc.) for a field point on-axis and off at 3 arcminutes (in the sky).
9. Compare the above design of the 3.5 m to the ideal RC telescope as developed on page 2-15 of the class handouts (following the Wikipedia prescription). Evaluate at field center, and at an angle where coma asymmetry is apparent.
10. Other investigations may involve other telescopes, field-flatteners, etc. Go nuts!

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