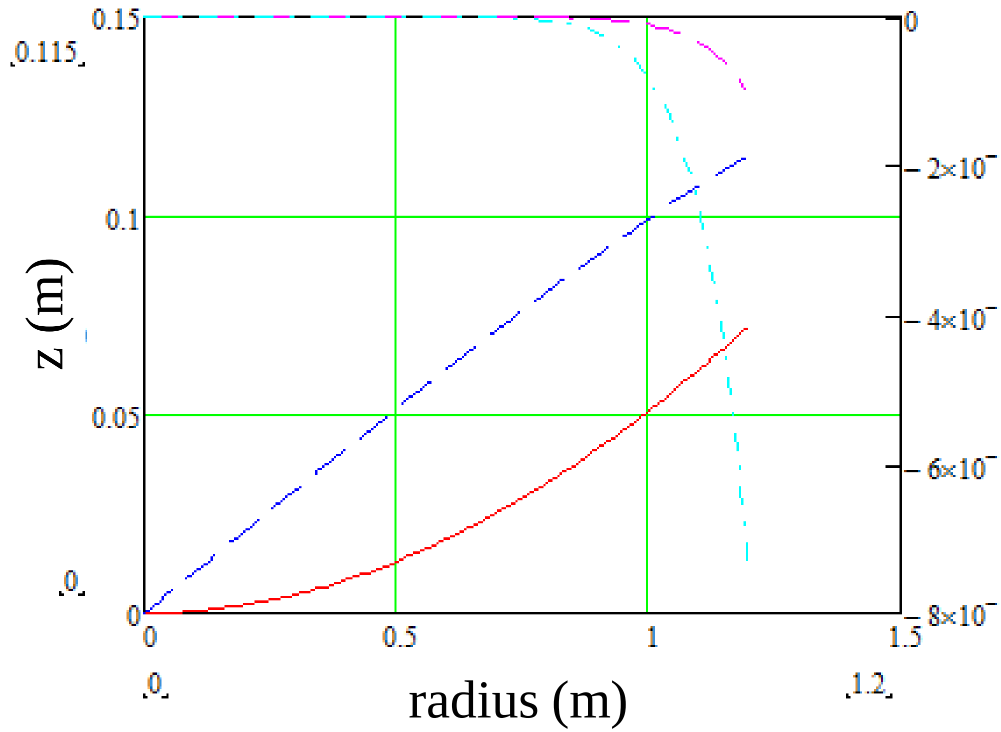
Ray tracing for Schwarzschild-Couder telescope

- Program set up to do ray tracing for S-C telescope, using mirrors as specified by Vassiliev et al. Astroparticle Physics 28 (2007) 10...27.
- Mirrors defined via sum of series in parameters related to mirror and telescope dimensions, e.g.

$$V_4 := \frac{1}{6144}\cdot\frac{(\eta+1)^4}{\eta^7}\cdot\left[-120\cdot\frac{\eta}{\eta+1} - \frac{2\cdot\left(14\cdot\eta+\eta^2-77\right)}{\alpha} + \frac{3\cdot(5\cdot\eta-3)}{\alpha^2} + \frac{2}{\alpha^3}\right]$$

- Ray tracing requires these shapes ("sag functions") and their derivatives...known only with limited precision as series truncated.

- Primary mirror sag function, derivative thereof and differences when last term in series omitted:



- Series shows good convergence.

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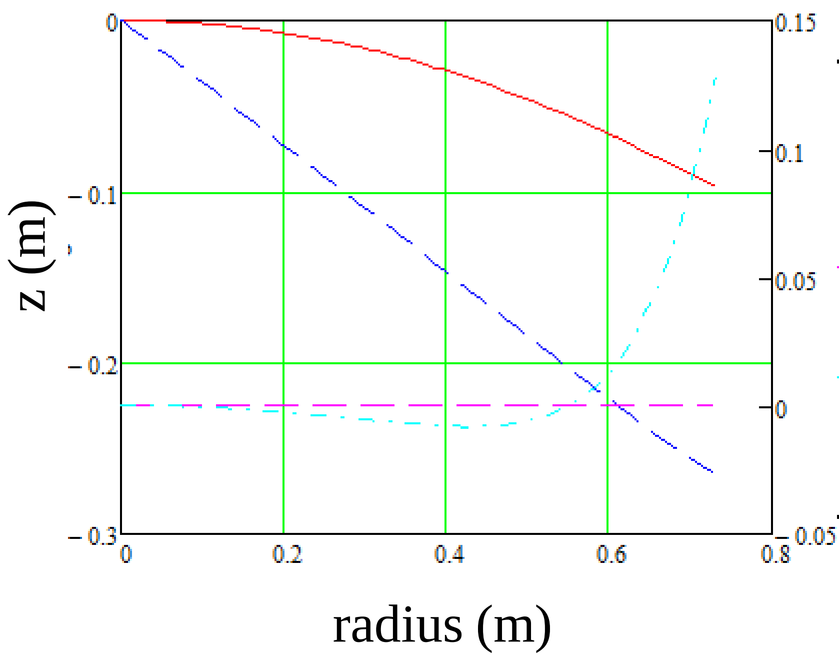
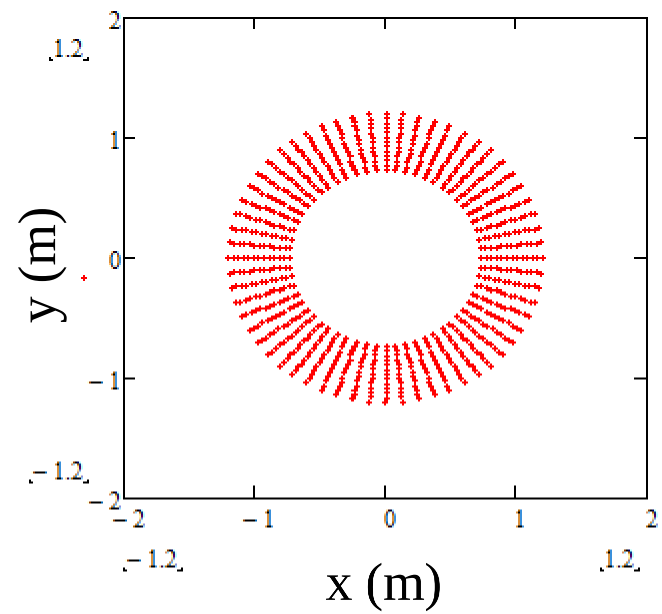
- Secondary mirror sag function, derivative thereof and differences when last term in series omitted:



- Convergence of series looks rather poor!

- Rays from sources at 10 km height directed at primary ("shadow" is due to secondary):



- Sources at up to 5° off-axis looked at (cursorily!) so far.

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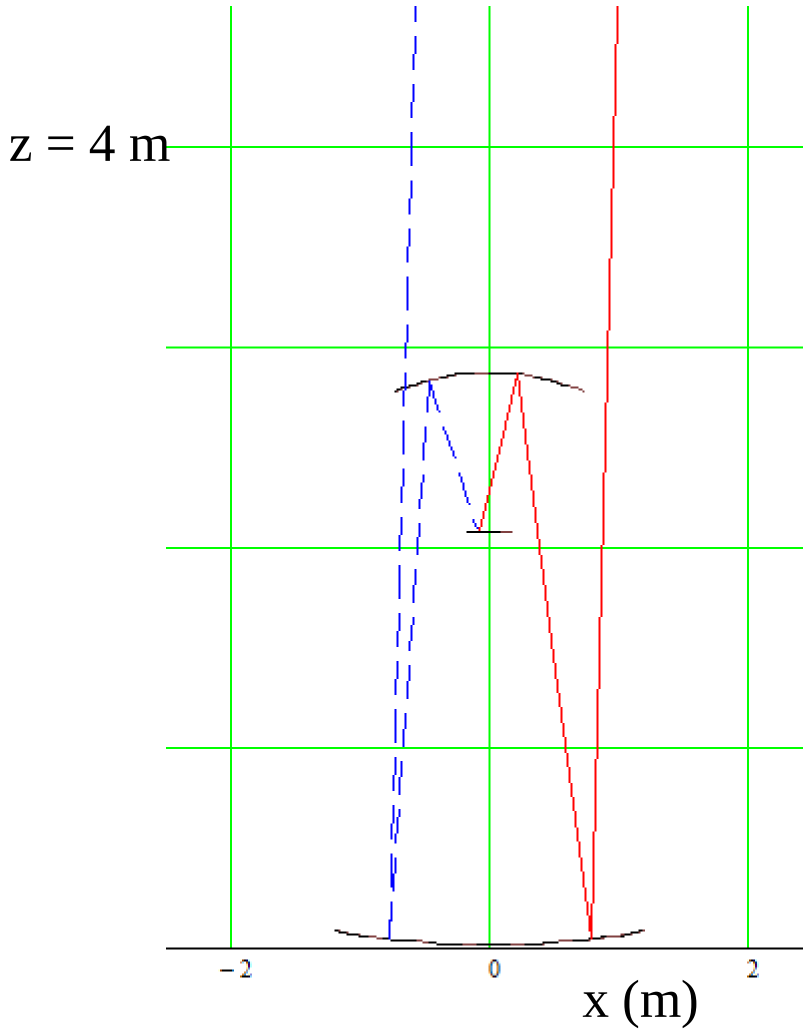
- An example:
  - Primary focal length 4.8 m.
  - Secondary focal length 1.4 m.
  - Primary diameter 2.4 m.
  - Secondary diameter 1.5 m.
- Track rays through telescope to focal plane.
- Picture opposite is for source at 2.5°.



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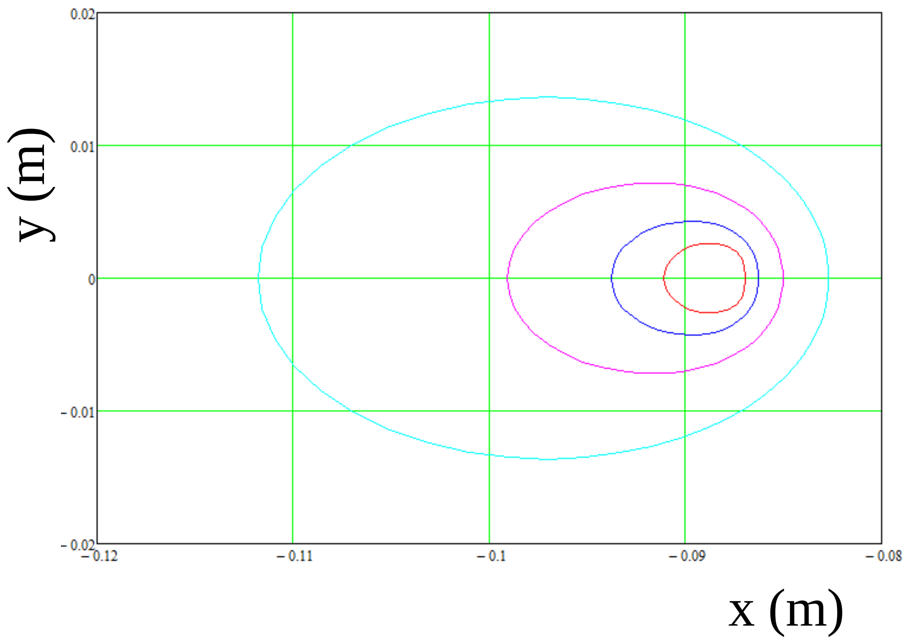
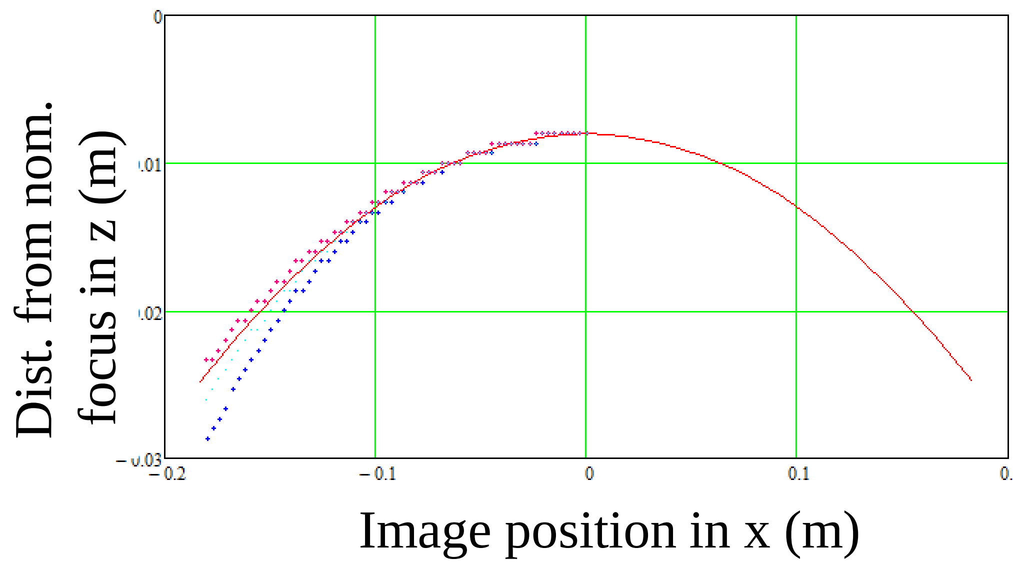
- Resulting image on focal plane:



- Focus poor as nominal position of focal plane is for object at infinity and “plane” should be curved!

- Shift position of focal plane, for range of object angles, to deduce optimal shape (assumed spherical for now) and position of camera:



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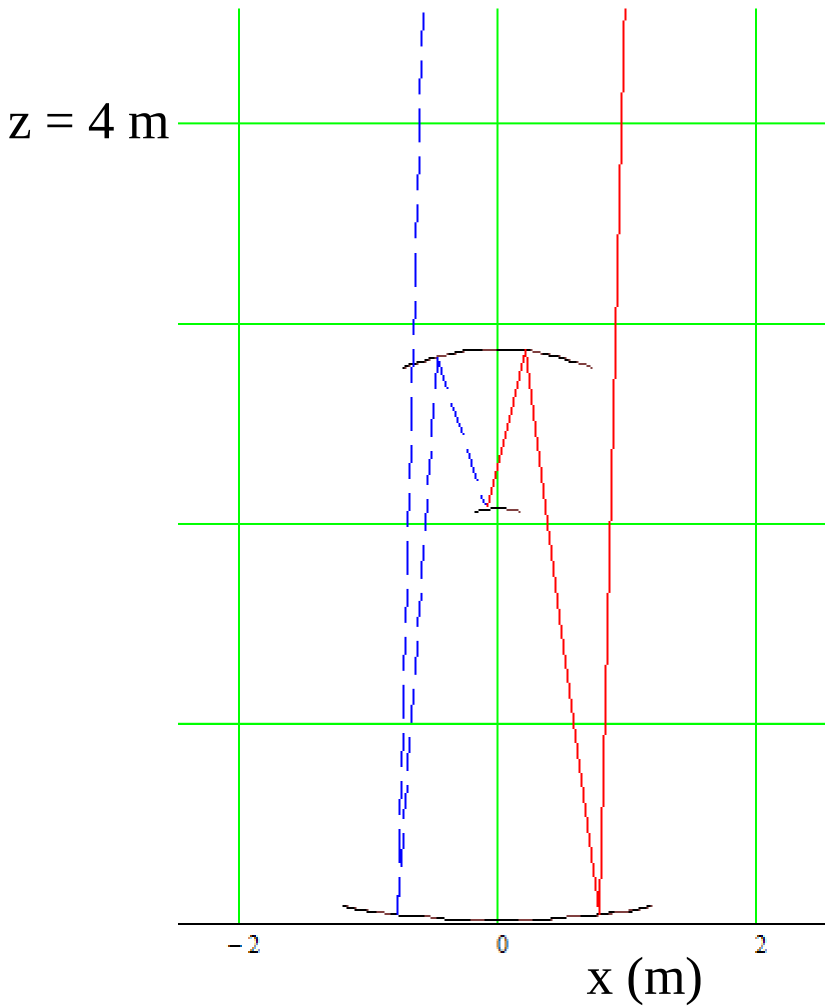
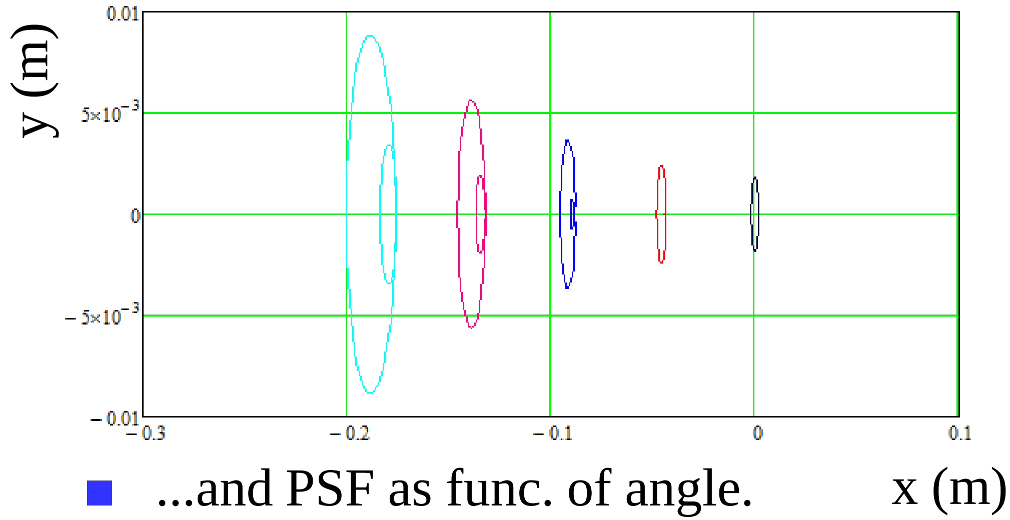
- Use this camera in telescope:



- Resulting images for range of angles...



- ...and PSF as func. of angle.