Ray tracing Laboratory

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SHADOWVUI is a visual interface to the SHADOW x-ray tracing program:
http://www.esrf.eu/computing/scientific/xop2.1/shadowvui/index.html

Exercises

Demagnification with a single mirror

Example 1
Let us consider a square source, 50micron X 50micron, with uniform angular divergence 0.5mrad X 0.5mrad.
We want to create a 10micron vertical spot, so we try to demagnify the source by a factor of 5.
We start with a single spherical mirror, with:
r=500cm (distance source-mirror)
r'=100cm (distance mirror-tangential focus)
i=88° (incidence angle from the normal)
Radius of the mirror?
Footprint size on the mirror?
Vertical spot size?

Example 2
As example 1, but we double the source-mirror and mirror-focus distances:
r=1000cm (distance source-mirror)
r'=200cm (distance mirror-tangential focus)
Radius of the mirror?
Footprint size on the mirror?
Vertical spot size?

Example 3
Now, let us change the demagnification: D=3 instead of 5.
r=600cm (distance source-mirror)
r'=200cm (distance mirror-tangential focus)
Radius of the mirror?
Footprint size on the mirror?
Vertical spot size?

Example 4
Now, let us repeat example 3 changing the mirror: let us put an elliptical cylinder.
r=600cm (distance source-mirror)
r'=200cm (distance mirror-tangential focus)
Semi-axis a and b of the mirror?
Footprint size on the mirror?
Vertical spot size?

Example 5
Now, let us repeat example 1 changing the mirror: let us put a cylinder working sagittaly.
r=500cm (distance source-mirror)
r'=100cm (distance mirror-tangential focus)
Sagittal radius of the mirror? (ro=5.8165cm)
How is the spot?

Resolving power of a spherical grating

Example 6
Let us consider a source, 250micron X 10micron, with uniform angular divergence 0.1mrad X 0.1mrad, and a spherical grating:
r=400cm (distance source-grating)
r'=150cm (distance grating-tangential focus)
Radius=2000 cm
N=6000 l/cm (groove density)
First external order: k=1 (Shadow convention)
Alpha=80.94452° (incidence angle from the normal)
Beta=84.254° (diffraction angle from the normal)

Vertical spot size?
We want to know the resolving power R. Let us check that R>10000
One possibility is to generate a source with 2 energies: 99.995eV and 100.005eV, and ray-trace. If the two images at the focal plane are resolved, then R>10000 (R=100eV/10meV=10000)

Example 7
The second method consists in generating a source with uniform energy and check the energy distribution of the radiation that is passed through an exit slit. Let us do the case : exit slit width=10micron
R=?