Stray light control in off-axis Three Mirrors Anastigmats for Earth observation

CSL

OIP Sensor Systems

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Front baffle
M1
Aperture stop
M2
Aperture Π
FPA (T)
FPA baffle
M3
FPA (R)   Fold mirror
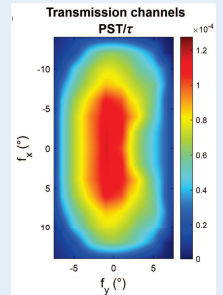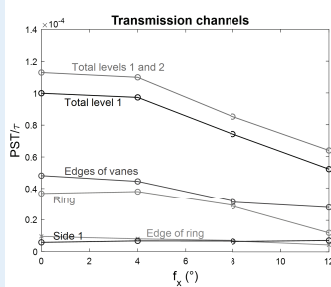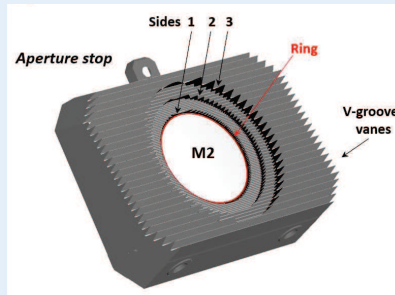Housing
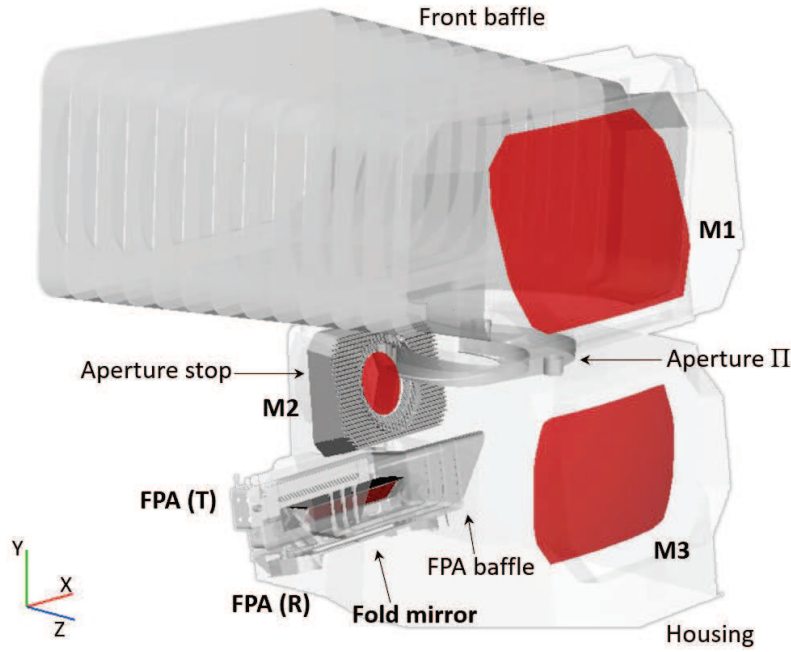
Stray light from non-optical elements

We focus on controlling 1st order scattering and straight shots

- The front baffle and aperture Π restrict the quantity of light that is able to enter inside the system, blocking most of the out-of-field illumination
- Aperture stop is covered with V-groove vanes
- The FPA baffle
  - Restricts view from detector toward M3, which is slightly oversized, therefore suppressing any out-of-field 1st order scatter path from the housing (*)
  - Blocks straight shot from light reflected on M1 toward FPA (**)
  - Should not be too long or it would become visible from the detector by reflection on M3, which would cause SL


(*)

(**)
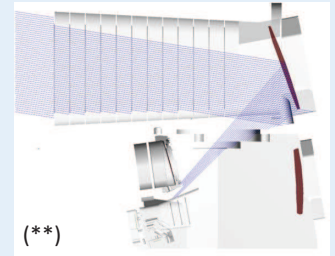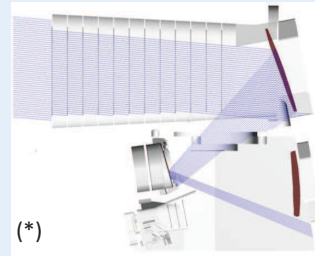
Scattering on the aperture stop

The aperture stop is a critical element. It is visible from the detector and illuminated by a large quantity of light, both in-field and out-of-field. Even with excellent black treatment it would contribute to significant 1st order stray light. V-groove vanes are applied on the aperture stop, acting as light traps and blocking most 1st order scattering. The residual SL comes mostly from the edges of the vanes and 2nd order scattering is minimal

Sides 1 2 3
Ring
Aperture stop
V-grooves vanes
M2

Transmission channels
Total levels 1 and 2
Total level 1
Edges of vanes
Ring
Side 1   Edge of ring

Transmission channels
PST/τ

Scattering on the mirrors

The mirrors contribute to stray light due to roughness scattering and contamination. A roughness below 1nm is achieved and the resulting BSDF is measured. A double Harvey model fit is performed to simulate the scattering effect by ray tracing at any wavelength. Scattering on the different mirrors contribute differently to the PSF (width and amplitude) as scattered light is focused/defocused by successive mirrors. For example, M2 has the smallest FWHM as its scattering is concentrated after reflection on the concave mirror M3.

$\theta_0 = 8°\ 20°\ 35°\ 45°$

$(y=y_0)$
M1+M2+M3
M2
M3
M1
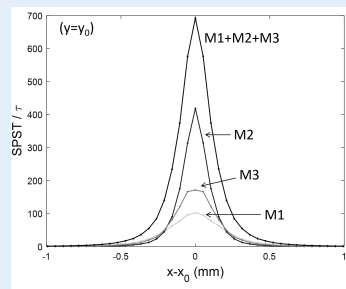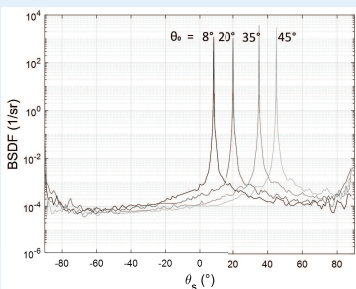
Ghosts in the butcher block

Ghosts occur at the butcher block, close to the focal plane. The only way to control them is to use anti-reflection coatings, or to have the butcher block with sufficient length and distance from the FPA to produce widespread ghosts

Butcher block
Filter stacks
1.2mm
FPA (R)

SPST/τ

Input surface (AR coated)
vacuum
Spectral filter
Output surface (AR coated)
NZK7 glass
Mask
vacuum
Sensor