Double pass system

Tarun Kumar

Double pass

This example explain how to perform tolerance analysis in a double pass systems

In a double pass system light retro-reflected back through the optical system

Therefore, tolerance events are not independent

If the surface is irregular, it must have the same irregularity in return pass

If the elements are decentered/tilted they would at the same position for return beam

So, we need to use carefully placed coordinate breaks, pickups, and user defined tolerances to model this!

Double Pass

- We used a catalog double lens monochromat
- Can be generalized for optical system made of any number of lenses
- We assume that the two lenses are mounted in a barrel
- Incoming and reflected beam are collimated

Double Pass

- Import the catalog lens 033484000 from Linos Photonics
- Remove any solve and bring it to a focus using quick focus with RMS spot size and centroiding
- Set the aperture type to float by aperture size
- Set wavelength is 0.583 um
- Field type to angle/radial and with only one field (x=0, y= 0)
- Insert a dummy surface 30 mm before the first lens
  - Make it an aperture stop
  - A reference to global coordinate
  - Semi-diameter of 7 mm

Double Pass

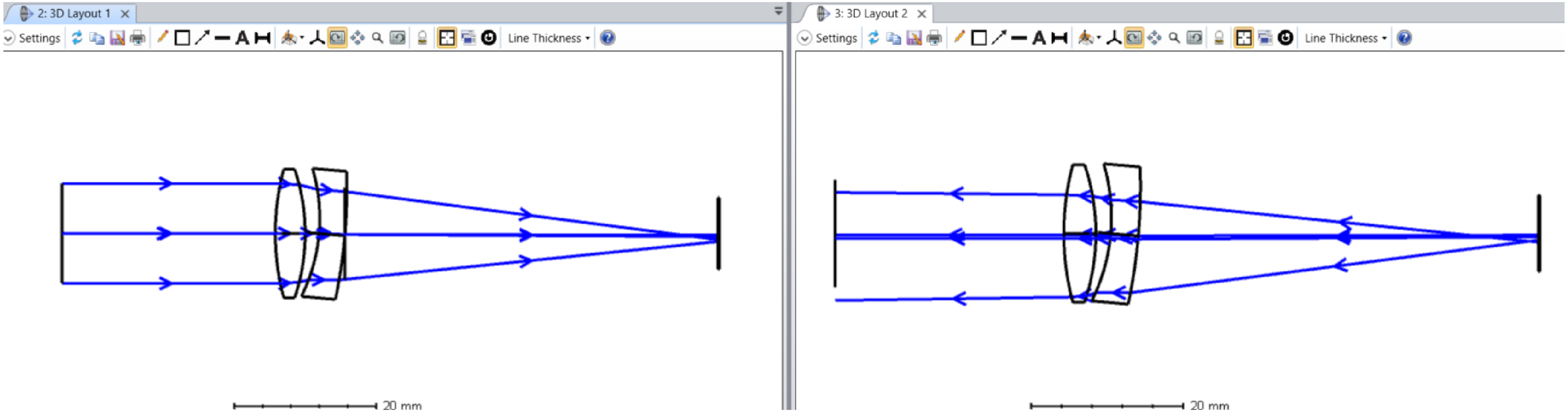
- Make the lens double pass using the tools within OpticStudio
  - This will do the hard-job of converting IMA to mirror and inserting lens data in reverse order
- Switch to Afocal image mode i.e output beam is collimated
- Give the mirror surface a 5 mm semi-diameter and aperture
- Convert the thickness from pickup solves to position solves on the second pass
  - Position solves will lock the second pass thicknesses to absolute positions
- Remove the solve from the last surface and fix it to the -30 mm

Double Pass

- Note, the two lenses are mounted on their front faces
    - Their rear faces can then be wedged with respect to their front faces
- Use the Tilt/Decenter tool three times to build elements and decenter manually
- Always start with the outer element first and then nest the inner ones
- Use tilt/decenter tools across the first pass assembly, this covers how the whole barrel can be misaligned
- Next, go to each lens and use tilt decenter tools to cover how each element can be misaligned independently
- Lock each of the second pass lens surface to corresponding first pass surface
    - This is achieved by inserting a coordinate break and using the return solve

Verify

Open two 3 D plot windows, one starting with first surface to mirror surface (left plot) and other starting from mirror-surface to the last surface (right plot). Add a tilt to either of the lens in the first Pass, it should follow in the second pass.



Double Pass

- To model surface tilts and irregularities
  - Make second-pass surfaces irregular, with pickups to original surfaces
  - When tolerancer makes original surfaces irregular and populates the parameter
  - Pickups will transfer values to the second pass surfaces!

Double Pass- Tolerancing

- Sources of error?
    - Lens radii, thickness
    - Irregularity of lens surface
    - Wedge of lens
    - Tilt/decenter of lens
    - Material of lens
    - Mirror radius, tilt, decenter, irregularity

Double Pass- Tolerancing

- The barrel can be misaligned with respect to the beam
- The lenses can be misaligned with respect to the barrel
- The rear surface of each lens can be misaligned with respect to the front
- The mirror can be misaligned with respect to the beam
- All surfaces have errors on radius and irregularity
- We need to lock everything on the second pass to be the same as the first
- It must be exactly the same error on the second pass
- And one compensator, the rear lens-mirror spacing, to adjust for them!

Double Pass- Tolerancing

- We need to translating all of these into tolerance data editor
- See the comments section of TDE (or directly “double_pass_tolerance.tol”) for explanation
- An important note on thicknesses:
  - We only have three thicknesses tolerance: first and second lens
  - Rest of the thicknesses are picked by the solves
  - Tolerance in thickness of lens 1 compensated with airgap while for lens two is the next airgap is the main compensator

Double Pass- Tolerancing

- We started with standard tolerance values and run about 1000 Monte-Carlo simulation
- See the comments section of TDE (or directly “double_pass_tolerance.tol”) for explanation
- An important note on thicknesses:
  - We only have three thicknesses tolerance: first and second lens
  - Rest of the thicknesses are picked by the solves
  - Tolerance in thickness of lens 1 compensated with airgap while for lens two is the next airgap is the main compensator
- Insure you have opened the file “double_pass_tolerancing.zpl” before proceeding

Double Pass- Tolerancing

- Tolerances values are of moderate commercial order and can be adopted as per manufacturer
- Setup the tolerance analysis as described below.
    - Use RMS wavefront and 5 rings with 3 cycles as the lens is highly corrected
    - Monte-Carlo simulation ~ (# of operands in TDE)^2
    - Fewer MC simulation can be performed initially to insure everything is working as expected