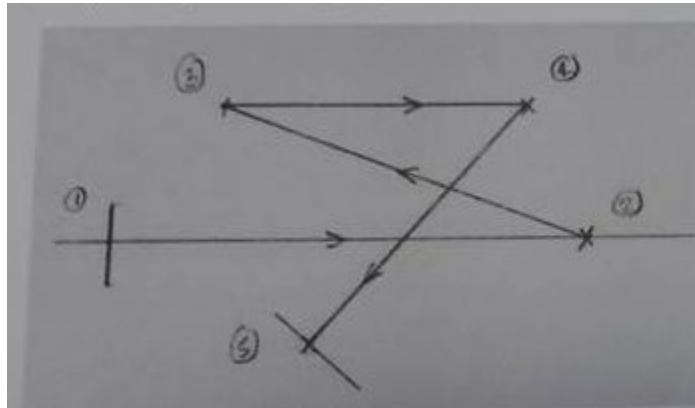


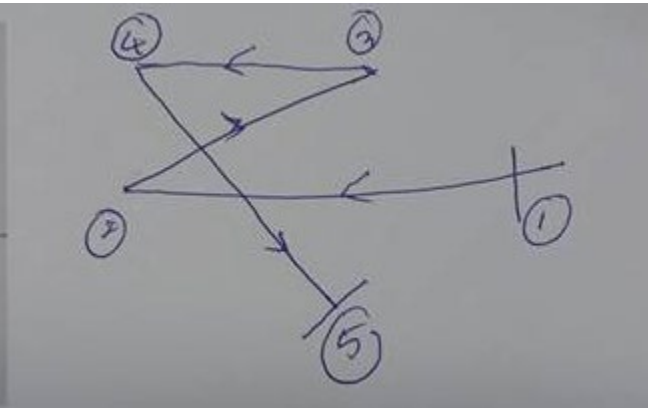
FFBUILD

- First, lay out the rough geometry you are after.

Original system



Flipped system



Original macro: FFBUILD.MAC

- Light comes in from the left through surface 1 (default stop), hit mirrors (surfaces 2, 3, and 4), and then go to the image plane (surface 5). The mirrors are assigned as Zernike surface type.
- Run the original FFBUILD macro to lay out the surfaces with flat mirrors. Then run the automatically generated FFBUILD_OPT.MAC to optimize the system and replace the flat surfaces with curved surfaces.

System with flat surfaces

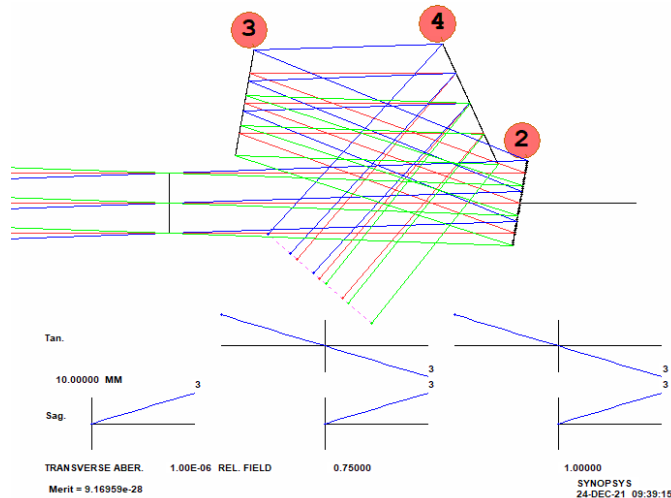
```

FFBUILD
SYSTEM
ID EXAMPLE FFBUILD

OBB 0 2 12
WAVL CDF
UNI MM
CFOV
END

GEOM
2 MIRROR 0 0 140
3 MIRROR 0 40 30
4 MIRROR 0 40 120
5 IMAGE 0 -30 60 -7 7
END

SHAPES
2 ZERN
3 ZERN
4 ZERN
END
    
```



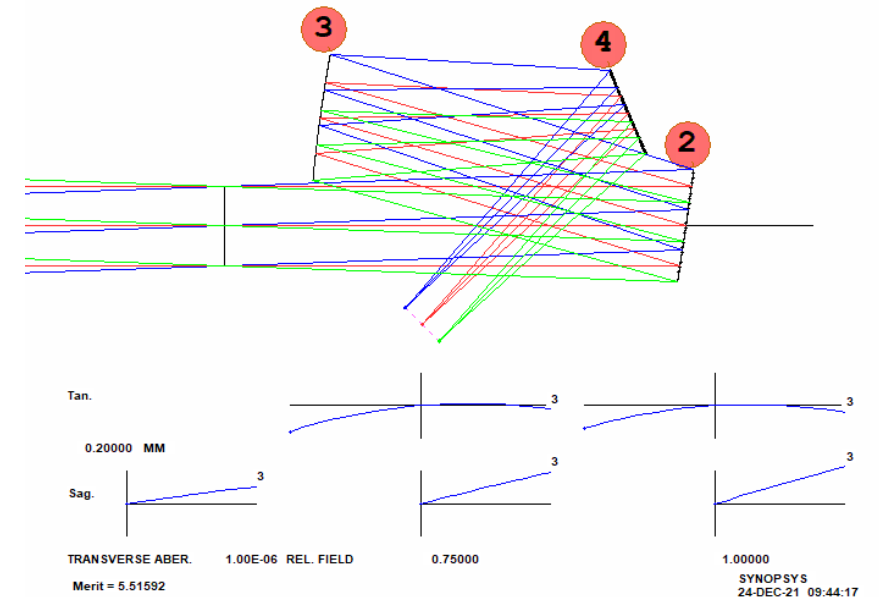
System with curved surfaces

```

FFBUILD_OPT.MAC

PANT
SKIP
VY 2 YG
VY 2 ZG
VY 3 YG
VY 3 ZG
VY 4 YG
VY 4 ZG
VY 5 YG
VY 5 ZG

EOS
VY 2 AG
VY 3 AG
VY 4 AG
VY 5 AG
VY 2 RAD
! VY 2 CC 10 -10
! VY 2 G 3
! VY 2 G 4
! VY 2 G 7
! VY 2 G 8
! VY 2 G 10
! VY 2 G 11
! VY 2 G 14
! VY 2 G 15
! VY 2 G 16
! VY 2 G 19
! VY 2 G 20
! VY 2 G 23
! VY 2 G 24
    
```



Flipped system macro: FFB_flipped.MAC

- Add the command LRAYS (Left RAYS) to the original macro as shown below so that the object rays will come in from the right and propagate to the left.
- Change Z coordinates for surfaces 2-5 in the GEOM section as shown below to flip the system.
- As seen in the system shown below, object rays come from right side and finally reach image plane (surface 5) after being reflected by the flat mirrors 2, 3, and 4.

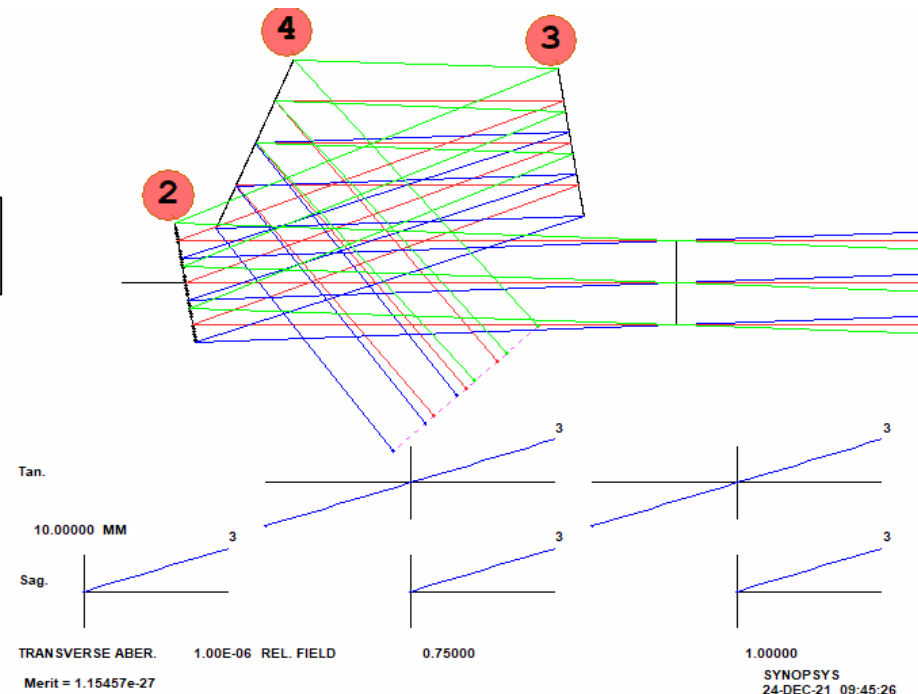
```
FFBUILD
SYSTEM
ID EXAMPLE FFBUILD
LRAYS
OBB 0 2 12
WAVL CDF
UNI MM
CFOV
END

GEOM
2 MIRROR 0 0 -140
3 MIRROR 0 40 -30
4 MIRROR 0 40 -120
5 IMAGE 0 -30 -60 -7 7
END

SHAPES
2 ZERN
3 ZERN
4 ZERN
END
```

Mirror coordinates before flipping

```
GEOM
2 MIRROR 0 0 140
3 MIRROR 0 40 30
4 MIRROR 0 40 120
5 IMAGE 0 -30 60 -7 7
END
```



Run FFBUILD_OPT.MAC

- Then run the automatically generated FFBUILD_OPT.MAC to optimize the system.

```
FFBUILD_OPT.MAC
PANT
SKIP
VY 2 YG
VY 2 ZG
VY 3 YG
VY 3 ZG
VY 4 YG
VY 4 ZG
VY 5 YG
VY 5 ZG
EOS
VY 2 AG
VY 3 AG
VY 4 AG
VY 5 AG
VY 2 RAD
! VY 2 CC 10 -10
! VY 2 G 3
! VY 2 G 4
! VY 2 G 7
! VY 2 G 8
! VY 2 G 10
! VY 2 G 11
! VY 2 G 14
! VY 2 G 15
! VY 2 G 16
! VY 2 G 19
```

