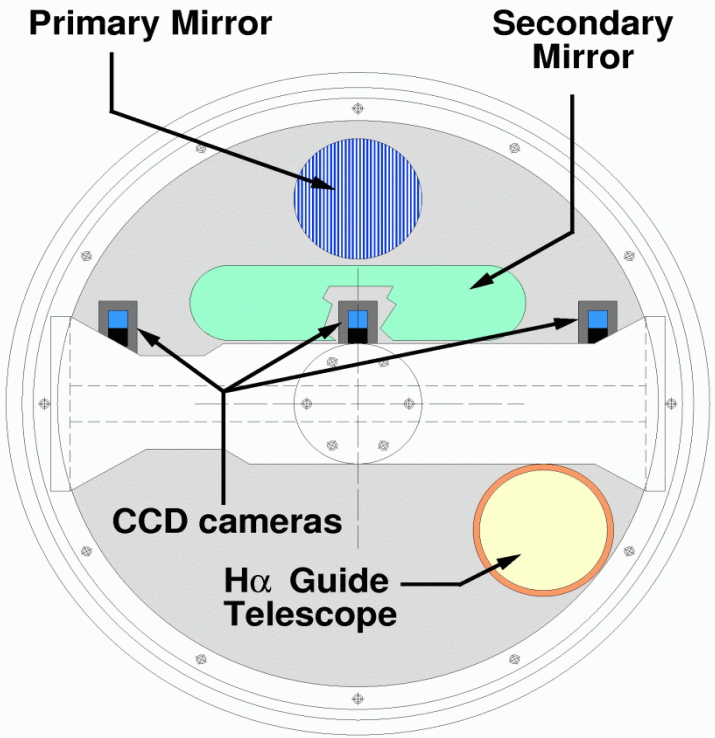
MOSES Optical Design

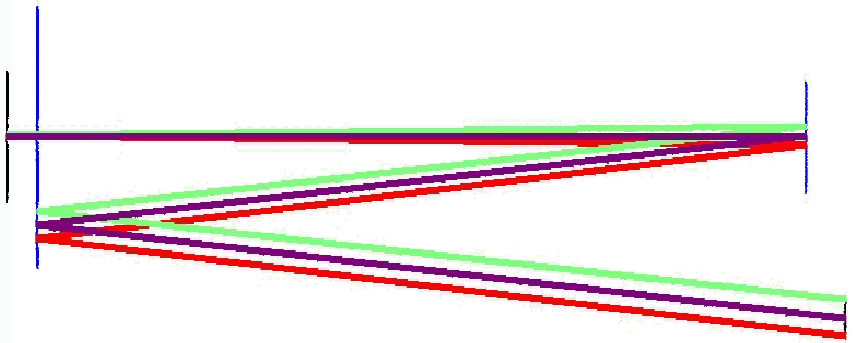
Or

“How less is more”

Henry (Trae) Winter III

Optical Path



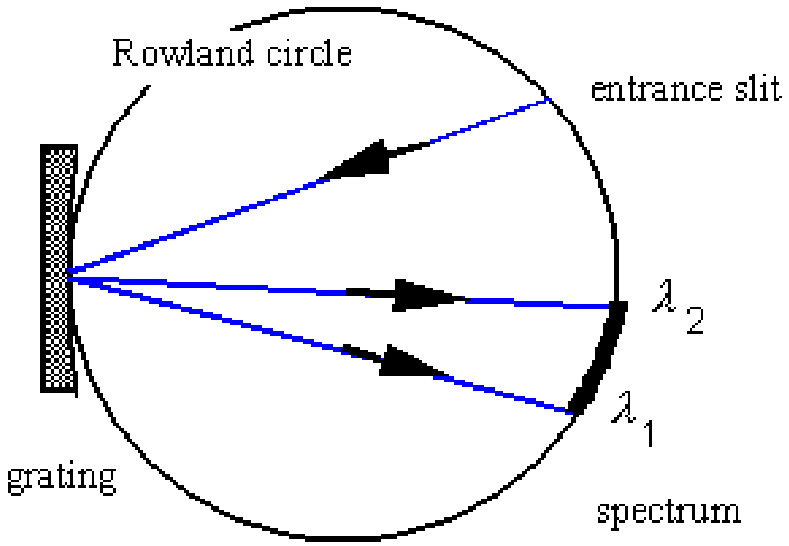


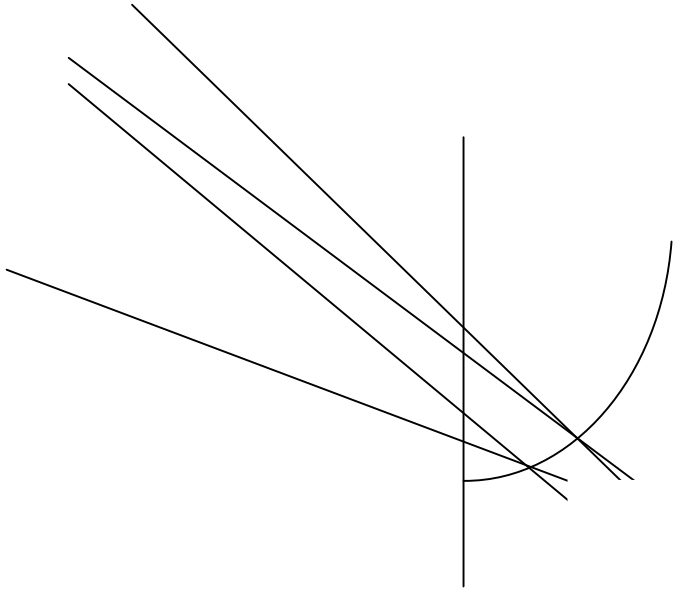
- Rectangular Entrance Aperture: 94.0 mm x 87.0 mm

MOSES Concave Spherical Mirror

- Zerodur™ Low expansion substrate
- Ruling Density: 950.0 mm-1 +/- 1.0 mm-1
  - 10,800 mm-1 is possible
  - Reduces likelihood of “Rowland Ghosts”
- Multi-Layer coated to optimize reflectance at 304 Å (~ 40 %)
- Radius of Curvature: 9480 mm +/- 5.0 mm
- Effective Focal Length: 4740 mm
- Working f/#: 37.032
  - Slow Beam

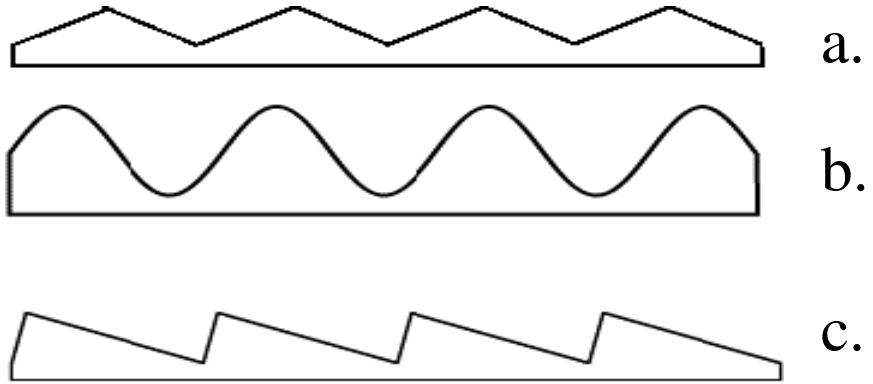
Why Have A Slower Beam?





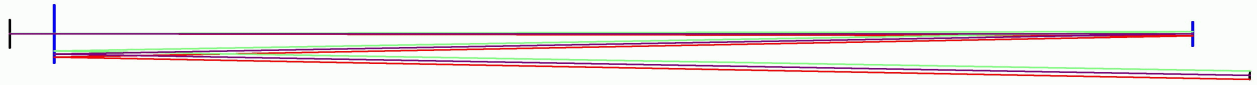
- Spectral aberrations decrease as f/# increases
- Helps spot sizes on flat CCD's

Grove Shape



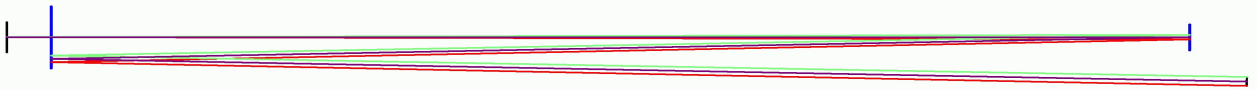
- The rulings on gratings normally have shape (a).
- Holographic gratings have a sinusoidal pattern (b).
- In order to increase efficiency in one order, grooves can be “blazed” (c).
- Novel blazing techniques may be able to adjust efficiency in multiple orders ???

Folding Flats



- Material: Low thermal expansion substrate
- Multi-Layer coated to optimize reflectance at 304 Å (~ 40 %)
- Optical Surface: Flat
- Minimum Area: 192.5 x 50.3 mm
- Micro-roughness: Goal of 0.5 nm
- Use of folding flat reduces the total track of the instrument to 2518.308 mm (which will actually fit into the 2794 mm payload)

Thin Aluminum Filters

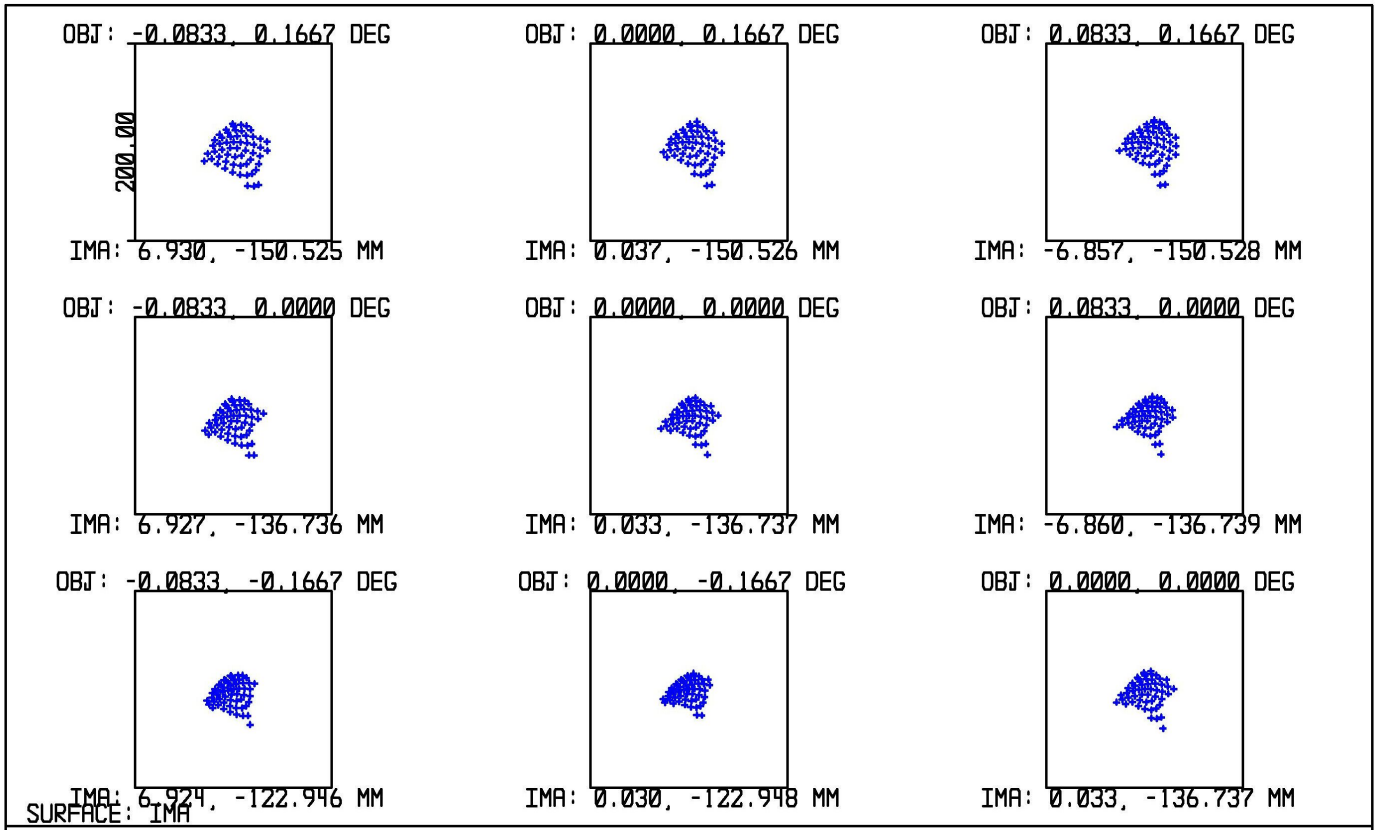


- Few thousand Å's thick
  - Very fragile
  - Cannot be very large
- Placed in the focal plane in front of CCD's
  - Precise location TBD
- Needed to reject optical light to keep CCD's from being overwhelmed
- Possibly coated with Tellurium to reduce the amount of 284.2 Å contamination

At the CCD's

- CCD's tilted +/- 1.6581° to minimize aberrations due to curved focal plane
- Pixel size: ~ 13.4 μm
- Spot Sizes obtained by entering the above values into the ZEMAX™ ray-tracing software
- N= +1 Avg. RMS Spot Radius : 20.309 μm
- N= 0 Avg. RMS Spot Radius : 5.828 μm
- N= +1 Avg. RMS Spot Radius : 19.541 μm

N= +1 Spot Diagram

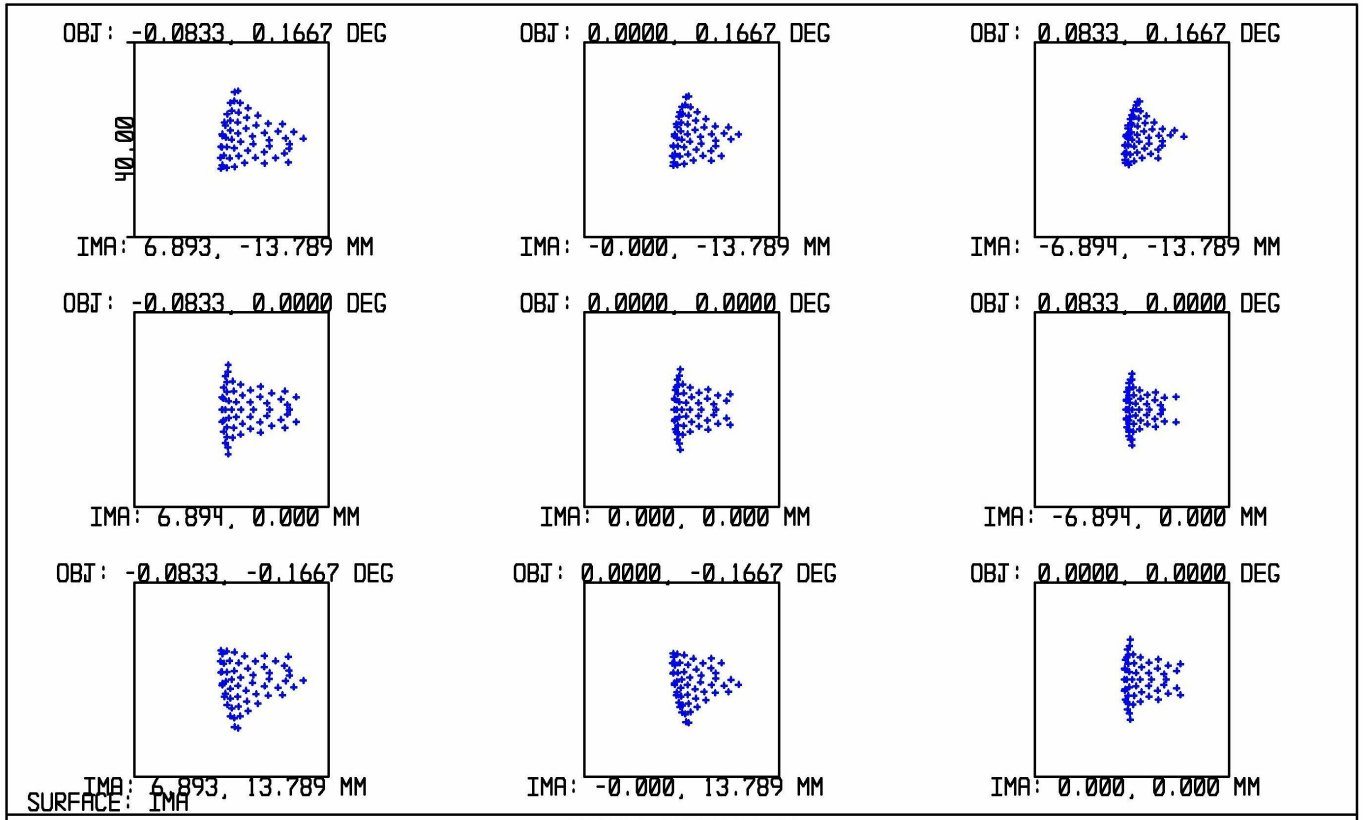


SPOT DIAGRAM

MOSES SLITLESS SPECTROGRAPH
FRI JUL 19 2002 UNITS ARE MICRONS.

FIELD	:	1	2	3	4	5	6	7	8	9
RMS RADIUS	:	24.713	23.005	22.611	21.068	19.246	18.880	17.947	16.069	19.246
GEO RADIUS	:	50.460	49.274	48.144	45.523	44.138	42.810	39.894	29.646	44.138
BOX WIDTH	:	200		REFERENCE	: CHIEF RAY					

N= 0 Spot Diagram



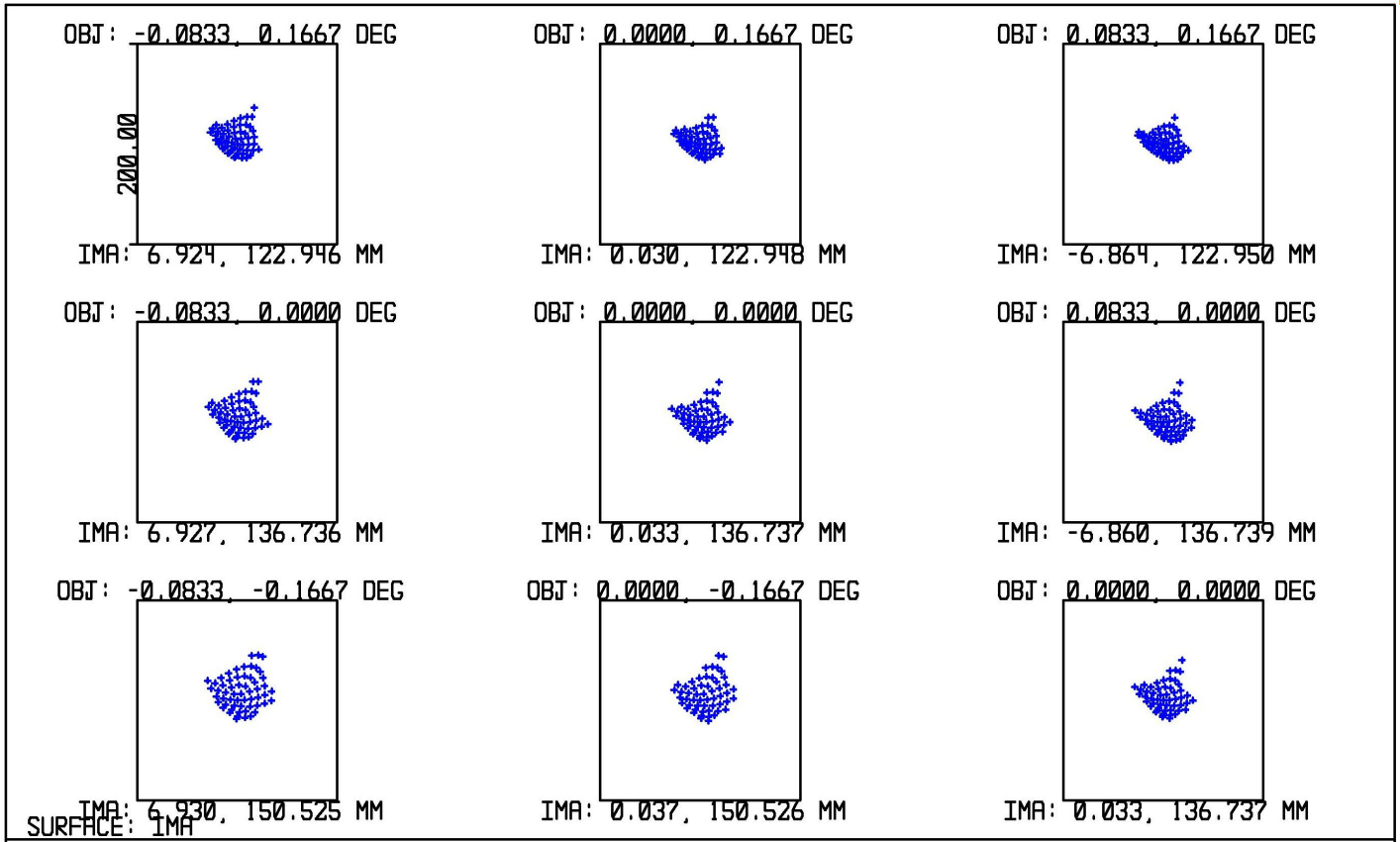
SPOT DIAGRAM

MOSES SLITLESS SPECTROGRAPH
FRI JUL 19 2002 UNITS ARE MICRONS.

FIELD :	1	2	3	4	5	6	7	8	9
RMS RADIUS :	7.043	5.594	4.764	6.911	5.443	4.613	7.043	5.594	5.443
GEO RADIUS :	14.765	11.748	10.689	13.544	10.474	9.418	14.765	11.748	10.474

BOX WIDTH : 40 REFERENCE : CHIEF RAY

N= -1 Spot Diagram



SPOT DIAGRAM

MOSES SLITLESS SPECTROGRAPH
FRI JUL 19 2002 UNITS ARE MICRONS.

FIELD	:	1	2	3	4	5	6	7	8	9
RMS RADIUS	:	17.947	16.069	15.701	21.068	19.246	18.880	24.713	23.005	19.246
GEO RADIUS	:	39.894	29.646	28.640	45.523	44.138	42.810	50.459	49.273	44.138

BOX WIDTH : 200 REFERENCE : CHIEF RAY

Summary

- Optically speaking MOSES is a very simple design
- Very robust with proven components
- Relatively inexpensive optical components