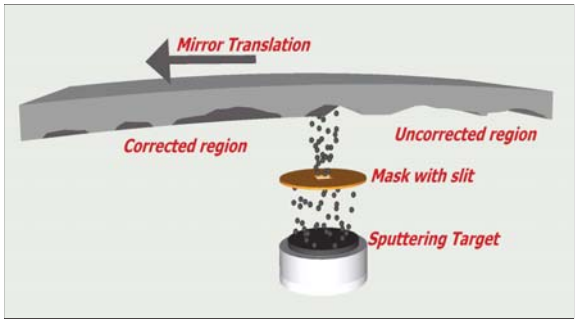
# Differential Deposition For Surface Figure Corrections In Grazing




## ABSTRACT

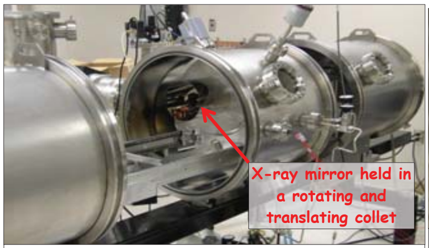
- Differential deposition corrects the low- and mid- spatial-frequency deviations in the axial figure of Wolter-type grazing incidence X-ray optics.
- Figure deviations is one of the major contributors to the achievable angular resolution. Minimizing figure errors can significantly improve the imaging quality of X-ray optics.
- Material of varying thickness is selectively deposited, using DC magnetron sputtering, along the length of optic to minimize figure deviations.
- Custom vacuum chambers are built that can incorporate full-shell and segmented X-ray optics.
- Metrology data of preliminary corrections on a single meridian of full-shell x-ray optics show an improvement of mid-spatial frequencies from 6.7 to 1.8 arc secs HPD.
- Efforts are in progress to correct a full-shell and segmented optics and to verify angular-resolution improvement with X-ray testing.


## CONCEPT

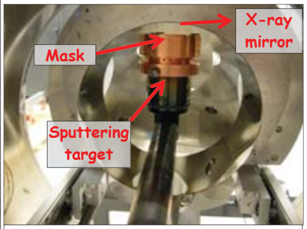



- Mask with a slit between sputtering target and mirror under correction limits the spatial extent of deposition
- Slit width is determined based on the spatial wavelength under correction
- Mirror is translated with varying speed to achieve varying thickness deposition

## INFRASTRUCTURE

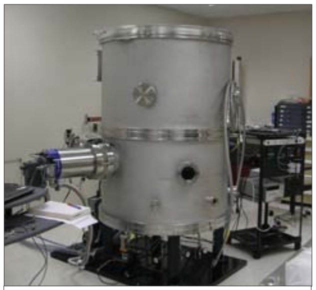



Custom vacuum chamber for full-shell mirrors

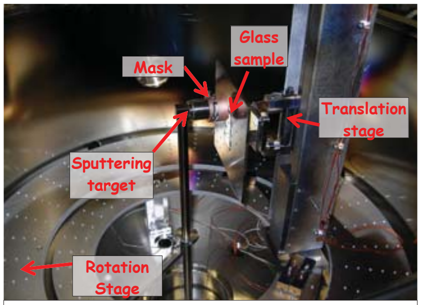



Sputtering head with copper mask positioned inside shell

- Rotation and translation stages allow motion of mirror over target
- Motion stages are computer controlled and are programmed for each correction



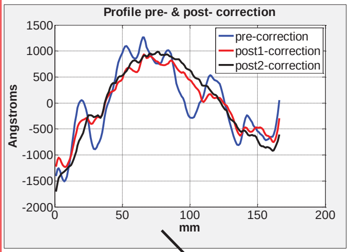
Custom vacuum chamber segmented mirrors

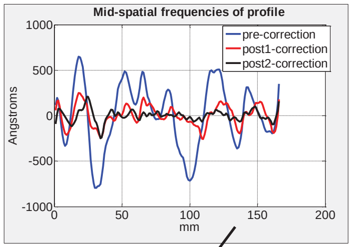



Sputtering head with copper mask positioned inside the chamber

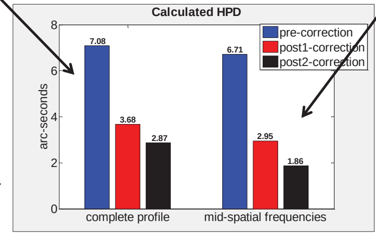
- Custom designed chamber can accommodate segmented optics and half-meter diameter full-shell optics
- Mirror can be rotated for azimuthal correction and translated for axial correction using computer controlled stages

## RESULTS TO DATE




- 2 stages of correction targeting mid-spatial frequency features of a single meridian of full-shell x-ray mirror
- Long trace profiler is used for surface – figure metrology of the mirrors




- Mid-spatial frequency correction improves the HPD (2-bounce system) calculated from the metrology data from 6.7 arc sec to 1.9 arc sec

## ONGOING WORK

- All-azimuth correction on full-shell optics is currently underway
- Efforts are in progress to quantify the improvement achieved with x-ray testing
- Segmented optics have higher effect of stress associated with the coatings
- A detailed study of optimizing the coating parameters to minimize coating stress is currently underway
- In-situ metrology will be installed in future that enables efficient correction
- Actively variable slits are under consideration to correct various spatial-frequencies in a single iteration

## APPLICATIONS

- Finer angular resolution for light-weight mirrors is highly in demand for x-ray astronomical applications
- Collaborative effort between NASA and NIST is developing optics for neutron imaging. High spatial resolution is desirable for this optics that could potentially have several applications such as high resolution water mapping on Lunar or Martian surface, Neutron microscopy and radiography, Medical therapies, Small-Angle Neutron Scattering Analysis (SANS)