International X-ray Observatory (IXO)

Mirror design for the International X-ray Observatory

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I. Introduction

- International x-ray Observatory (IXO) represents the merger of the XEUS and Constellation-X programs
- Extremely large grazing incidence x-ray telescope for imaging and spectroscopy applications
  - Build upon knowledge gained from Chandra, XMM-Newton, Suzaku
- Consists of a large area, main x-ray mirror, feeding a set of detectors which can be placed in and out of the focused x-ray beam: imaging calorimeter, wide-field imager, polarimeter, high timing resolution spectrometer, and low energy dispersive spectrometer. Telescope bandwidth > 0.1 to 10 keV
- Includes Hard X-ray Telescope and hard x-ray imager, with bandwidth > 10 – 40 keV *(see Poster 457.17, Gorenstein)*

II. Main X-ray Mirror

- Two types of main mirrors under consideration
  - Thermally formed (slumped) glass
  - Silicon pore optics
- We describe the design issues and performance of the slumped glass mirror design. (*See Poster 457.03, Zhang, for a description of glass slumping for IXO*)

III. Requirements

- 5 arc-sec HPD on-axis
- Effective area
  - 3 square meters at 1 keV
  - > 1 square meter at 6 keV

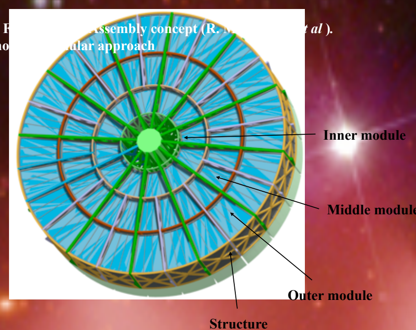
IV. Design Constraints

- Mass – mirror segment mass ≤ 830 kg
- Modular design - less expensive, faster, fabrication and assembly (see [1], [2])
- Outer diameter (driven by payload fairing diameter and mass constraints)
  - Realistically constrained at 3.2 m for largest shell, without structure
  - Un-slumped substrate and slumped mirror segment size
  - Limits azimuthal extent of modules which limits number of modules [1]
- Field-of-view/vignetting (see [5])
- Focal length – change EA(E); longer focal length = greater mass (see [6])
- Resulting effective area performance (on-axis) exceeds 1 keV requirement and falls slightly below 6 keV requirement [4]

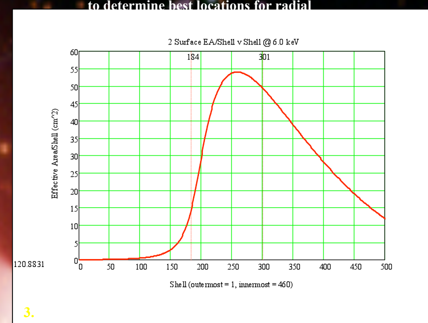
V. Remaining Issues

- **Increase effective area at 5-7 keV for realistic structural designs**
  - Requires decreasing structural obscuration and/or increasing module size
- Investigate impact of Carbon overcoating on low energy effective area

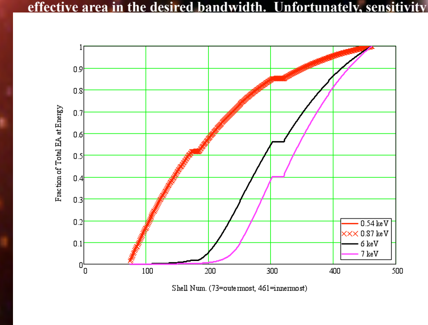
1. F… Assembly concept (R. M… *al*). sho… ular approach



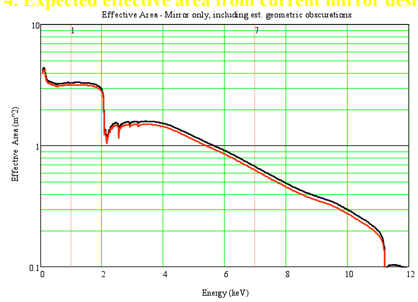
2. Examine effective area per shell as a function of shell number (i.e., radius) to determine best locations for radial



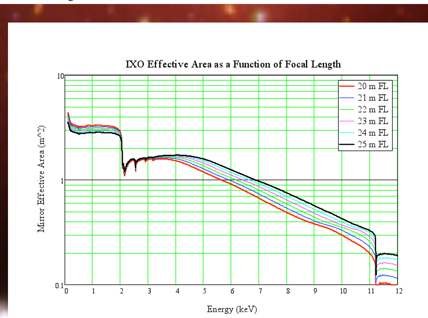
3.
(above), and integrated effective area starting from the outermost Shells in (below).. The radial break point between inner, middle, and outer modules is seen as vertical dashed lines (above), and flat regions (below). Break points are chosen so as to maximize effective area in the desired bandwidth. Unfortunately, sensitivity



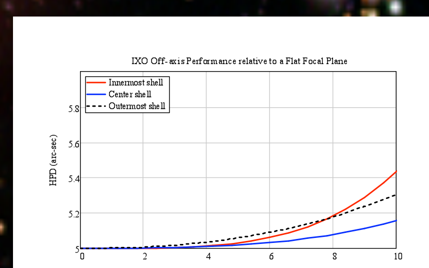
4. Expected effective area from current mirror design



Mirror Effective Area– The top, white curve depicts the expected total area, including the obscuration of an assumed structure. The lower, yellow curve, depicts the effective area including allocated losses due to particulate contamination, misalignments, and scatter.



6. Choice of focal length is a trade between high and low energy effective area, and mass. (Longer focal length increases mass of optical bench). Currently 20 m focal length envisioned, but potential of future mass savings, and carbon overcoat (giving more low energy area) may make a longer focal length possible.



7.
accounts for approximately 70 per cent of total performance. Other contributors (thermal stability, aspect solution, gravity release, etc.) are field-independent. So off-axis imaging degradations are small.

5. Expected maximum detector field-of-view is ~ 10 arc-min radius. Mirror design includes a designed-for field-of-view, over which shells are not shadowed by their adjacent neighbor. Using a larger unshadowed FOV increases off-axis effective area, but with less densely packed shells. This results in a few percent decrease in on-axis effective area.

Background image of Bullet Cluster courtesy of - X-ray: NASA/CXC/CfA/M.Markevitch et al.; Optical: NASA/STScI, Magellan/U.Arizona/D.Clowe et a