Improvements to the HRMA Effective Area

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Outline

Introduction

New values for the HRMA A_{eff} have been calculated, based upon new optical constants and the addition of a very thin contamination layer to the HRMA.

Optical Constants

The iridium optical constants used in the calculation of the HRMA effective area were determined as part of the *Chandra* Synchrotron Calibration Program.

Optical constants were defined by measuring the reflectivity of witness flats coated simultaneously with the *Chandra* optics.

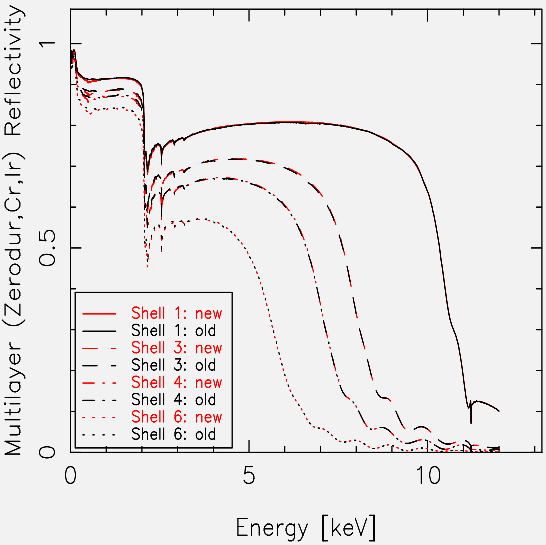
Reflectivity measurements were undertaken both at the National Synchrotron Light Source, at Brookhaven National Labs, and at the Advanced Light Source at Lawrence Berkeley National Labs.

Improvements to the Optical Constants

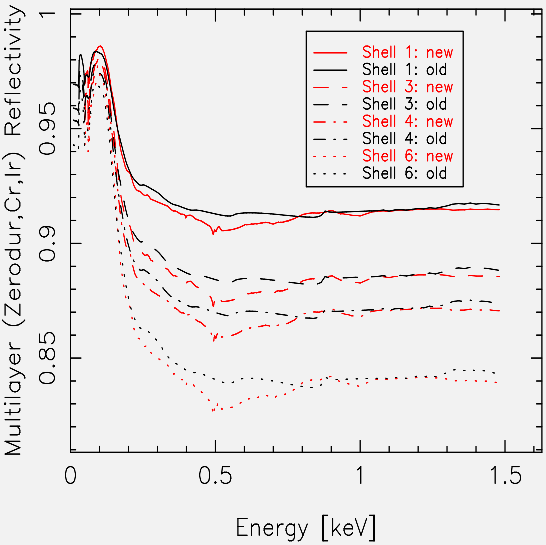
Improvements over the previous results from the optical constant program include:

- Constants below 940 eV from measurements with the Advanced Light Source Beamline, rather than from Henke
- Constants above 940 eV derived from fits to multiple witness samples, rather than just a single mirror.

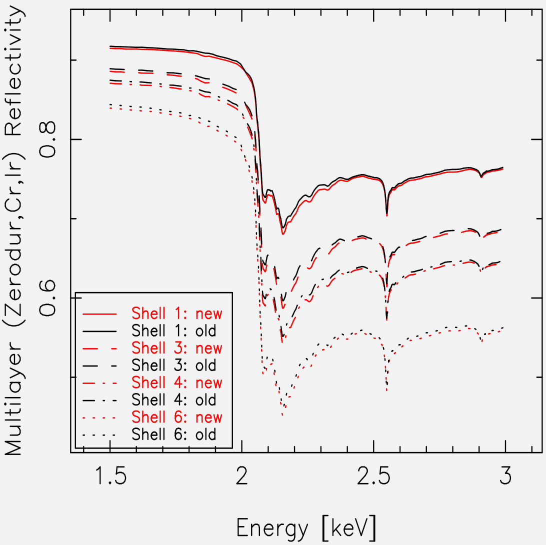
Comparison of New and Old Optical Constants



Comparison of New and Old Optical Constants



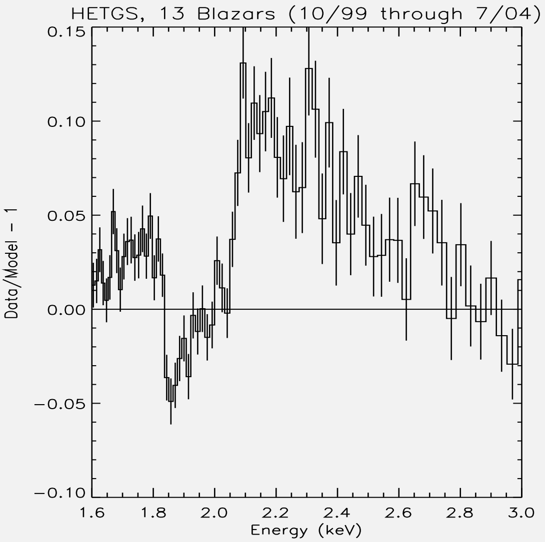
Comparison of New and Old Optical Constants



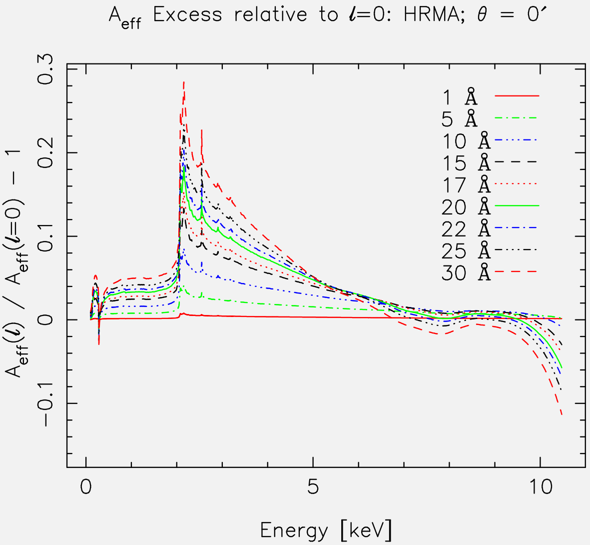
HRMA Contamination Layer

- Observations of stacked power-law sources with HETG/ACIS indicated a problem near the Ir M edge
- A thin hydrocarbon layer would improve the response near the edge. Because there is no experimental evidence for a contamination layer at the XRCF, we apply it to on-orbit simulations only.

Observational Evidence



The Effect of a Contamination layer on A_{eff}



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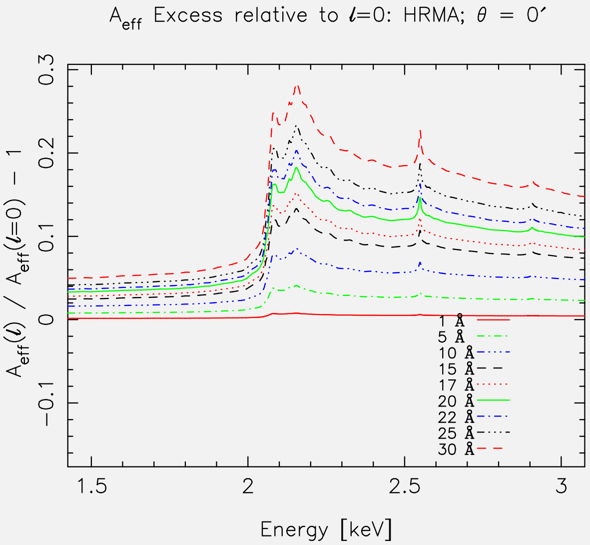
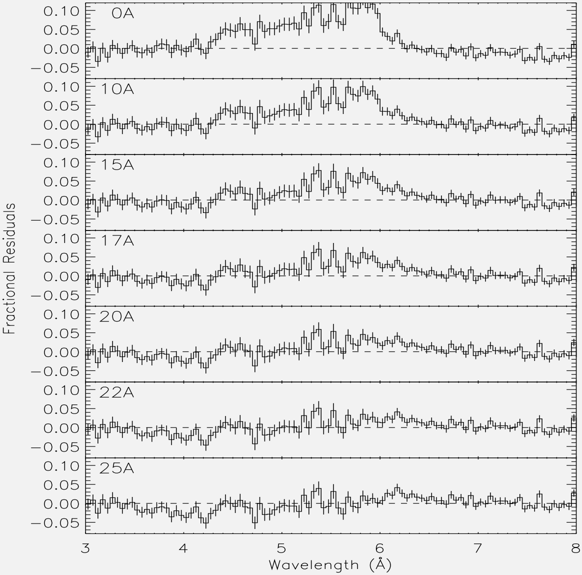


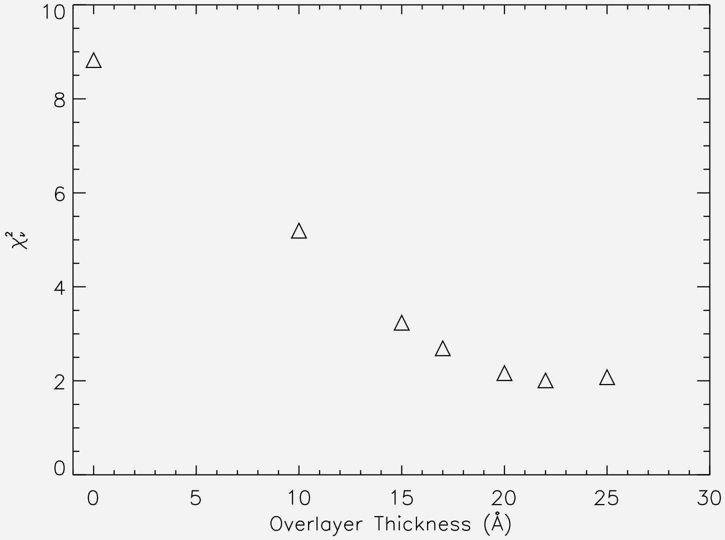
Fitting the Contamination Layer

- The stacked sources were fit using various contamination layer thicknesses.
- The best fit was for a 22Å thick layer of CH_2.

Fits


0A
10A
15A
17A
20A
22A
25A
0.10
0.05
0.00
−0.05
Fractional Residuals
3
4
5
6
7
8
Wavelength (Å)

Goodness of Fit



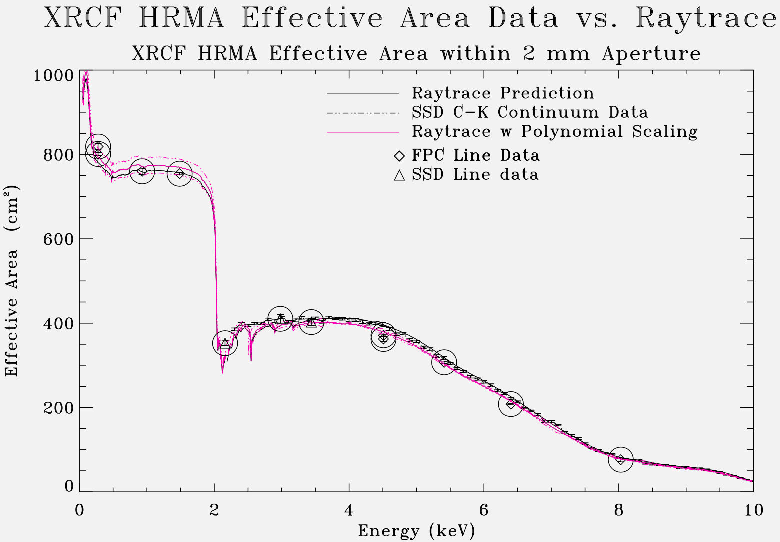
Calculation of A_{eff}

The prediction of the on-orbit A_{eff} is based upon

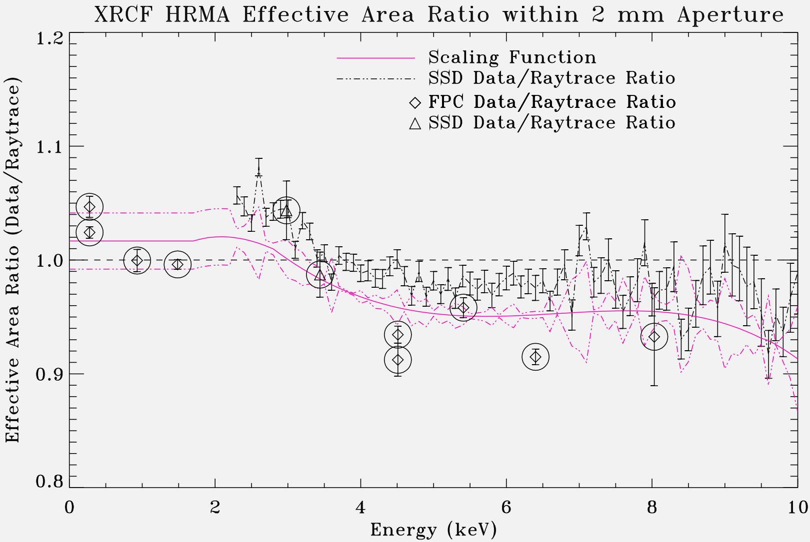
- Absolute measurements of the on-axis A_{eff} during ground based testing at the XRCF
- Predictions of the XRCF on-axis A_{eff} from raytraces in the XRCF configuration
- Derivation of correction factors to account for differences between the measured and predicted A_{eff}.
- Raytraces of the on-orbit configuration using these correction factors.

While the correction factors are derived for the on-axis A_{eff}, they are applied uniformly for all source positions.

XRCF Corrections



XRCF Corrections



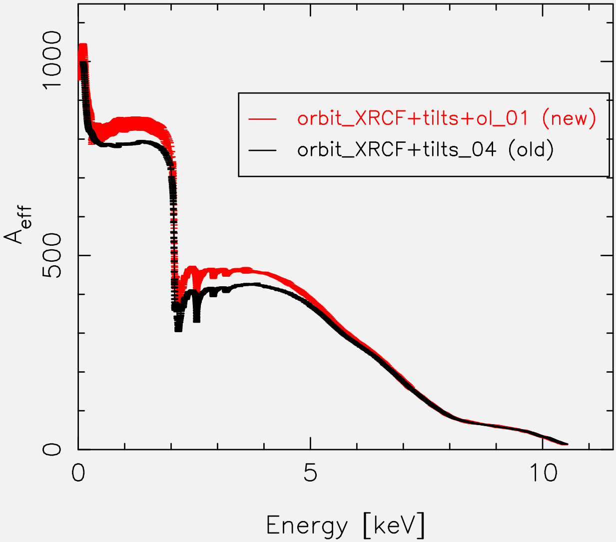
Uncertainties in the A_{eff}

The new release of the HRMA A_{eff} tabulates thecurrent *quantifiable* uncertainties in the A_{eff}, which derive from the following sources:

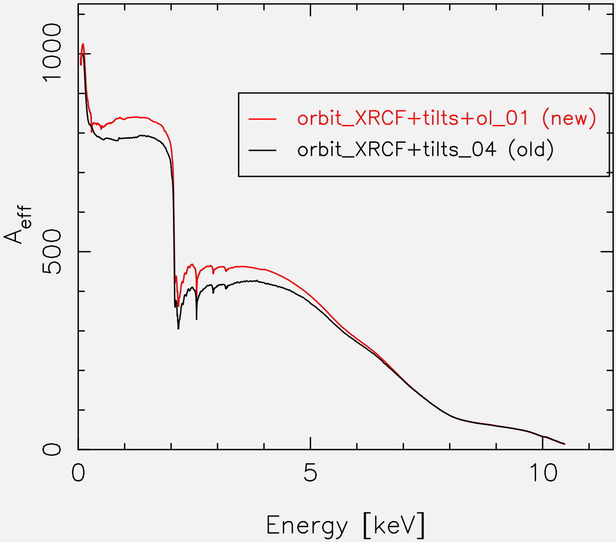
1. Uncertainties in the optical constants. These are negligible.
2. Uncertainties in the A_{eff} measurements at the XRCF. These are essentially quantified as the errors in the spread of the SSD and FPC measurements.
3. Uncertainties in the raytraces due to insufficient sampling of the model phase space. This can be made negligible.

In practice, the only significant quantifiable errors are the XRCF measurement errors.

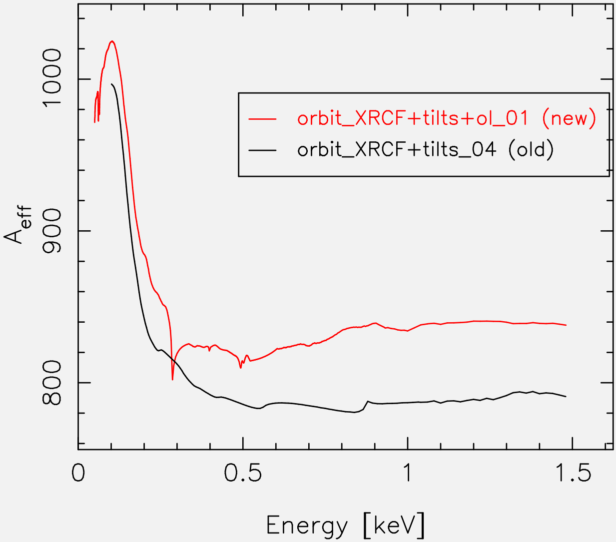
New and Old A_{eff}



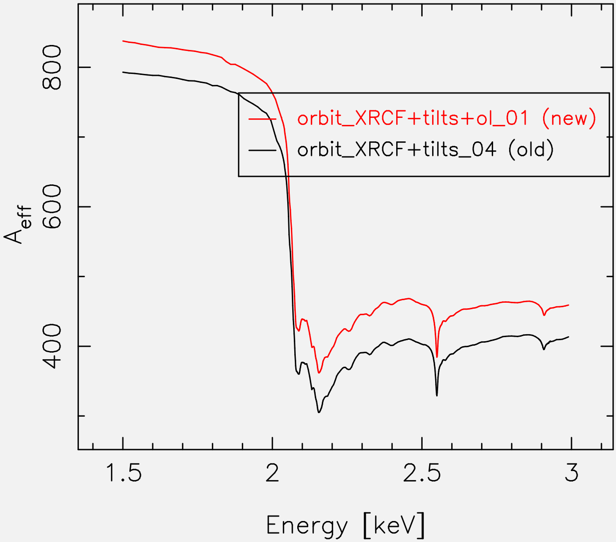
New and Old A_{eff}



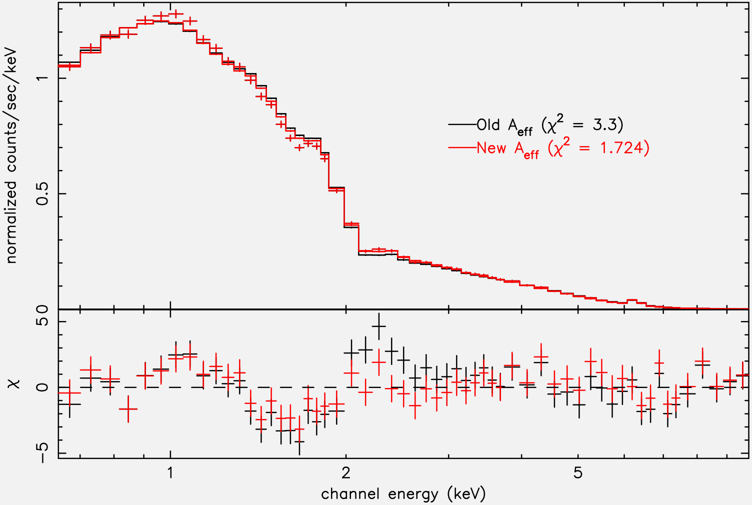
New and Old A_{eff}



New and Old A_{eff}



Galaxy Cluster Fits



[Thanks to A. Vikhlinin]

Summary

- The HRMA A_{eff} has been regenerated, incorporating new optical constants and a thin contamination layer on the HRMA
- The new A_{eff} improves fits near the Ir M edge, as well as at lower energies
- The new A_{eff} is significantly larger than the previous version