Revisiting Iridium Optical Constants for the Chandra HRMA Effective Area

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Participants in the Chandra Synchrotron Calibration Program

… include, but not necessarily limited to the following:

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- The authors are grateful for discussions and encouragement provided by the late L.P. Van Speybroeck, whom we remember fondly.

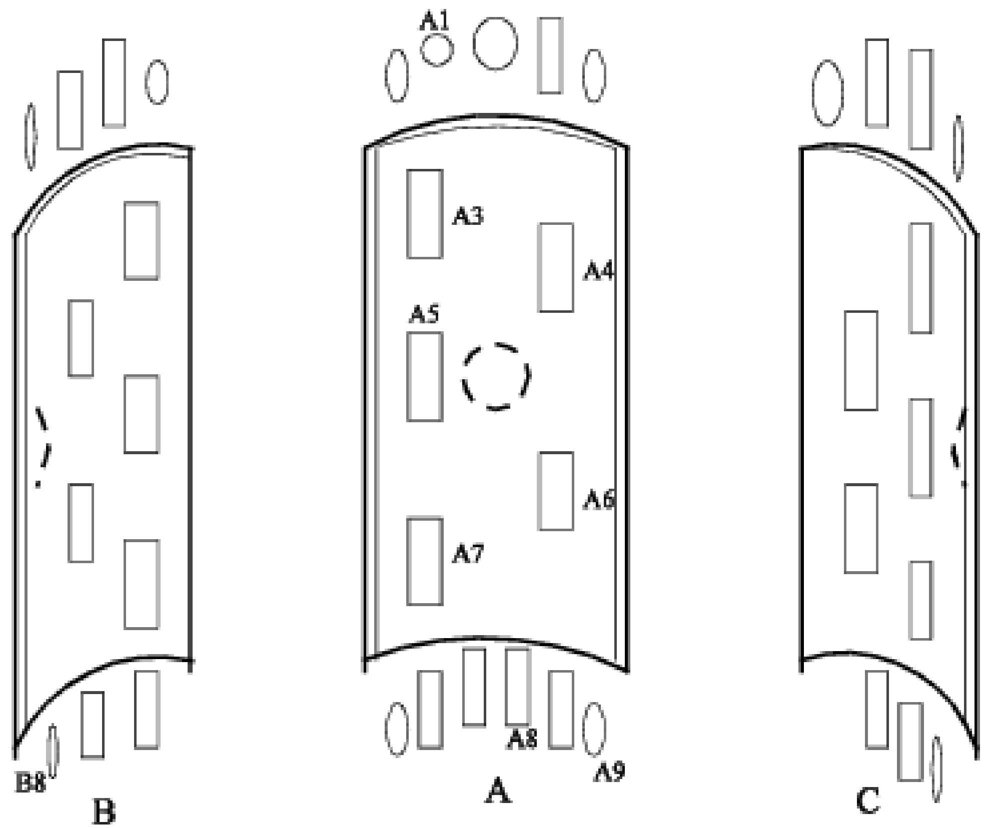
Outline

- Introduction
- Modeling and parameters
- Review: Optical Constants 5-12 keV
- Overlayer modeling at M-edges
- 1000-2000 eV optical constants
- Low-energy results
- XPS measurements of the overlayer

Review and update of the Ir optical constants is timely.

- Currently we use 940-12000eV results from a single mirror.
- Mirror-to-mirror M-edge discrepancies were not resolved as of launch date.
  - Assumed n X CH_2 overlayer, unverified.
- 50-1000 eV low-energy data never reduced for use in Chandra calibration.
- Indications of Ir M-edge artifacts in Chandra source analyses.

Reviewing the coating configuration:



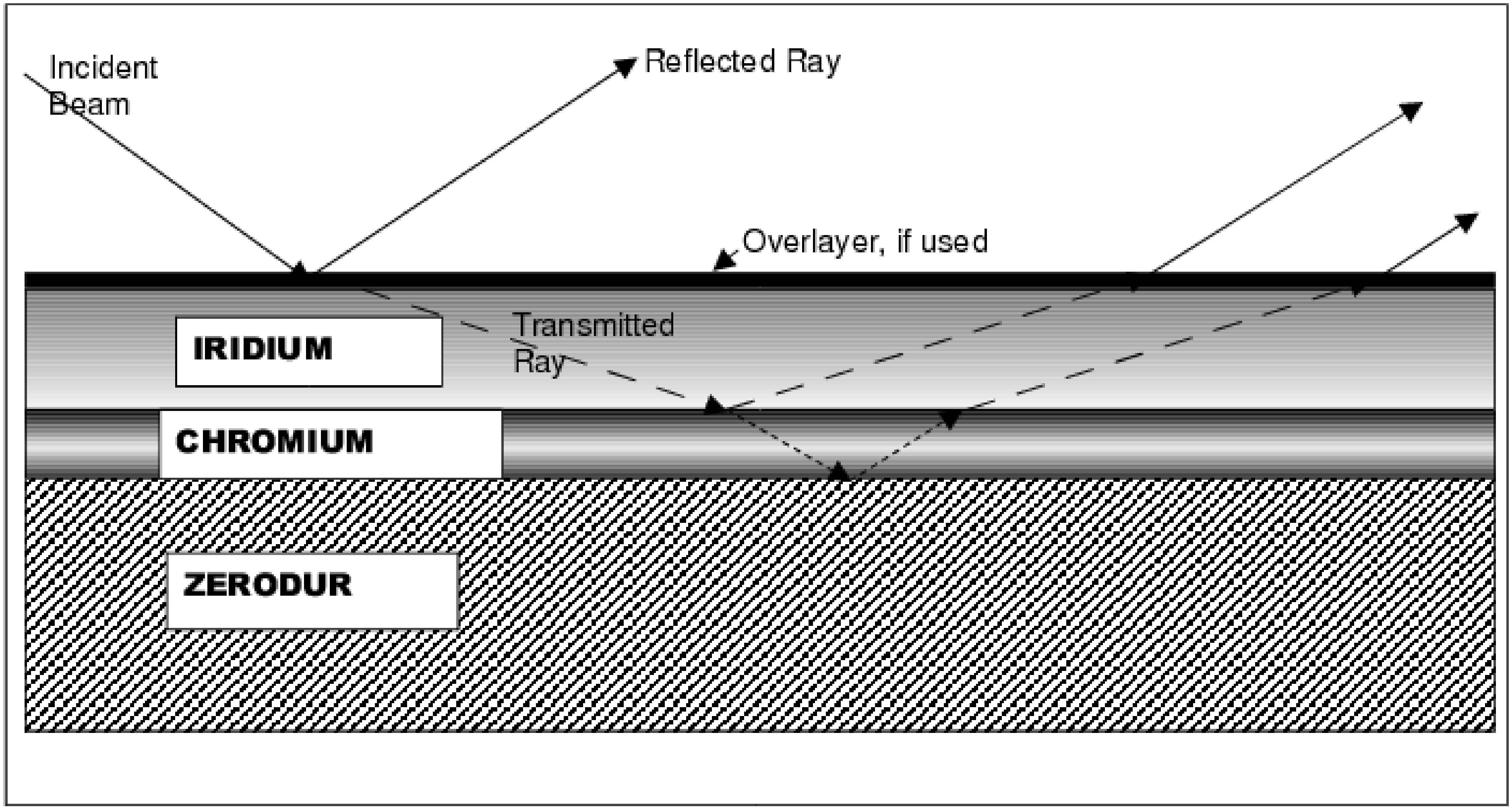
NOTE THREE LONGITUDINAL SECTIONS:A, B and C

OUTBOARD SAMPLES BECAME PRODUCTION WITNESS FLATS

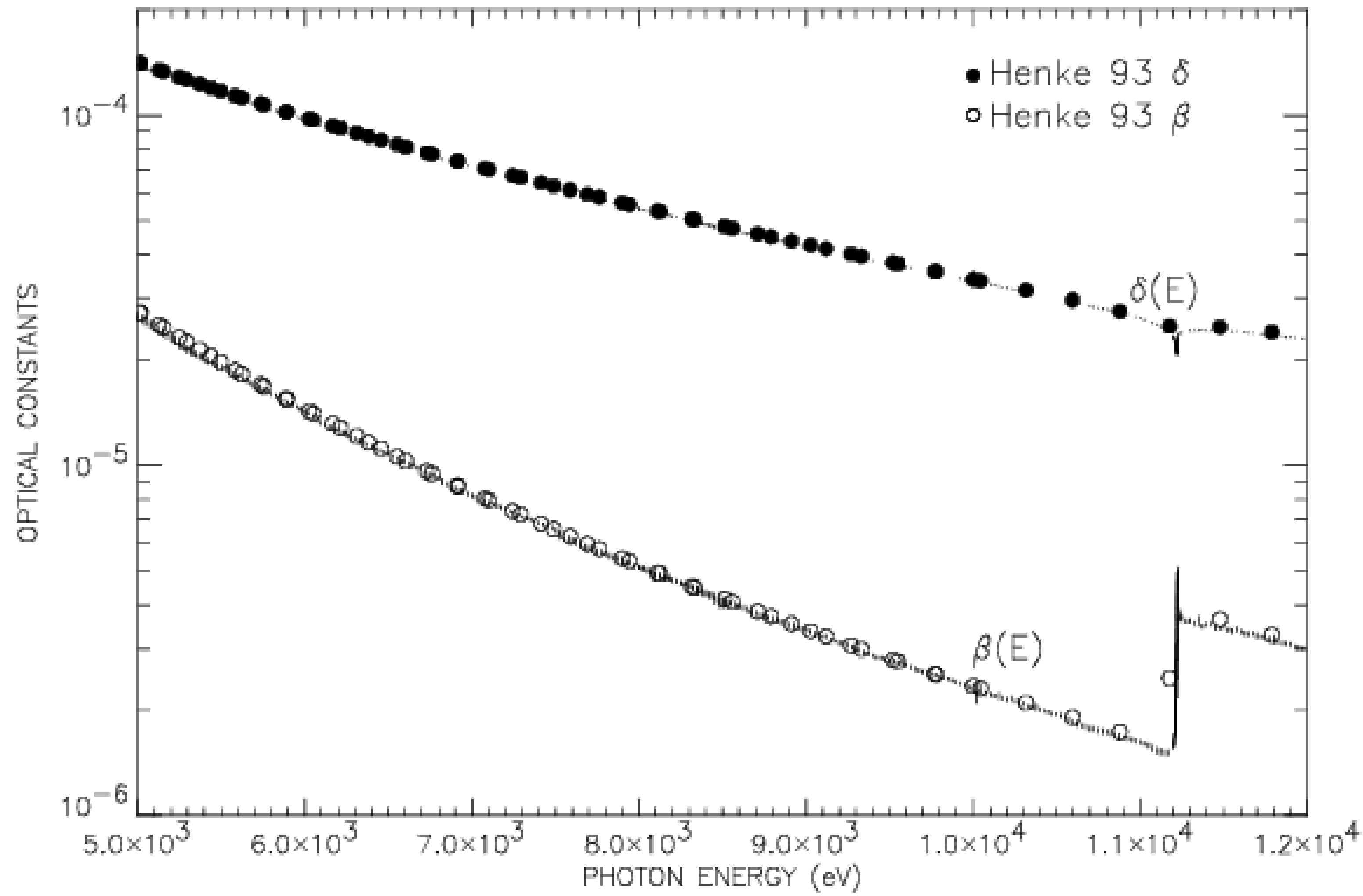
Optical constants were determined from synchrotron reflectance measurements versus angle and versus energy.

- R vs θ to determine Ir, Cr layer depths, surface roughness/interdiffusion depths, and overlayer.
- R vs E to determine Ir $\delta(E)$, $\beta(E)$, with layer and roughness parameters frozen.
- Four beamlines used, with energy ranges broken down for optimized monochromaticity and intensity.
- At least one angle scan per energy range for alignment/parameters, except below 1000 eV.

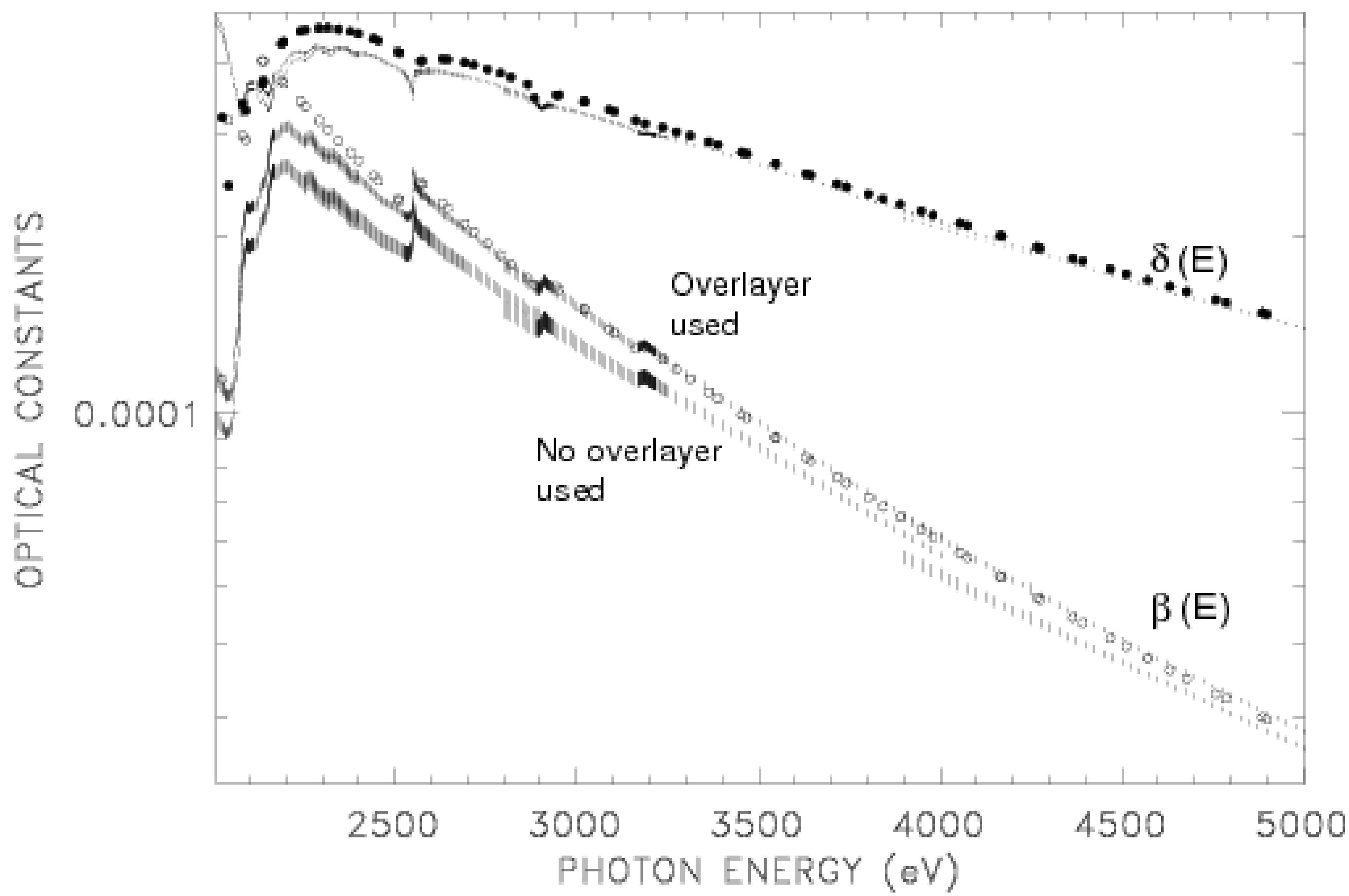
We employ a four-layer model with an optional overlayer to derive δ, β.



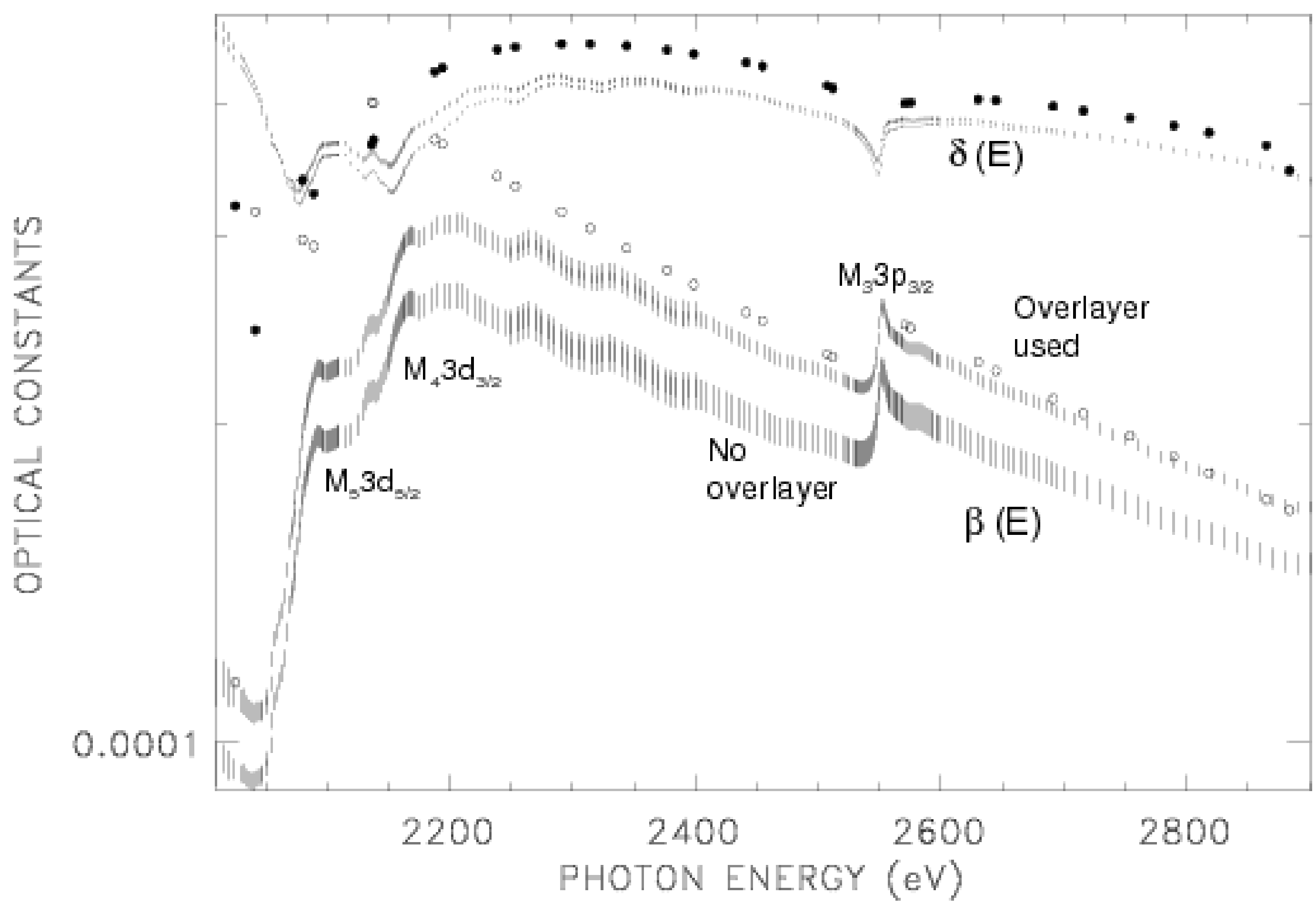
5-12 keV optical constants: A1 mirrors are indistiguishable.



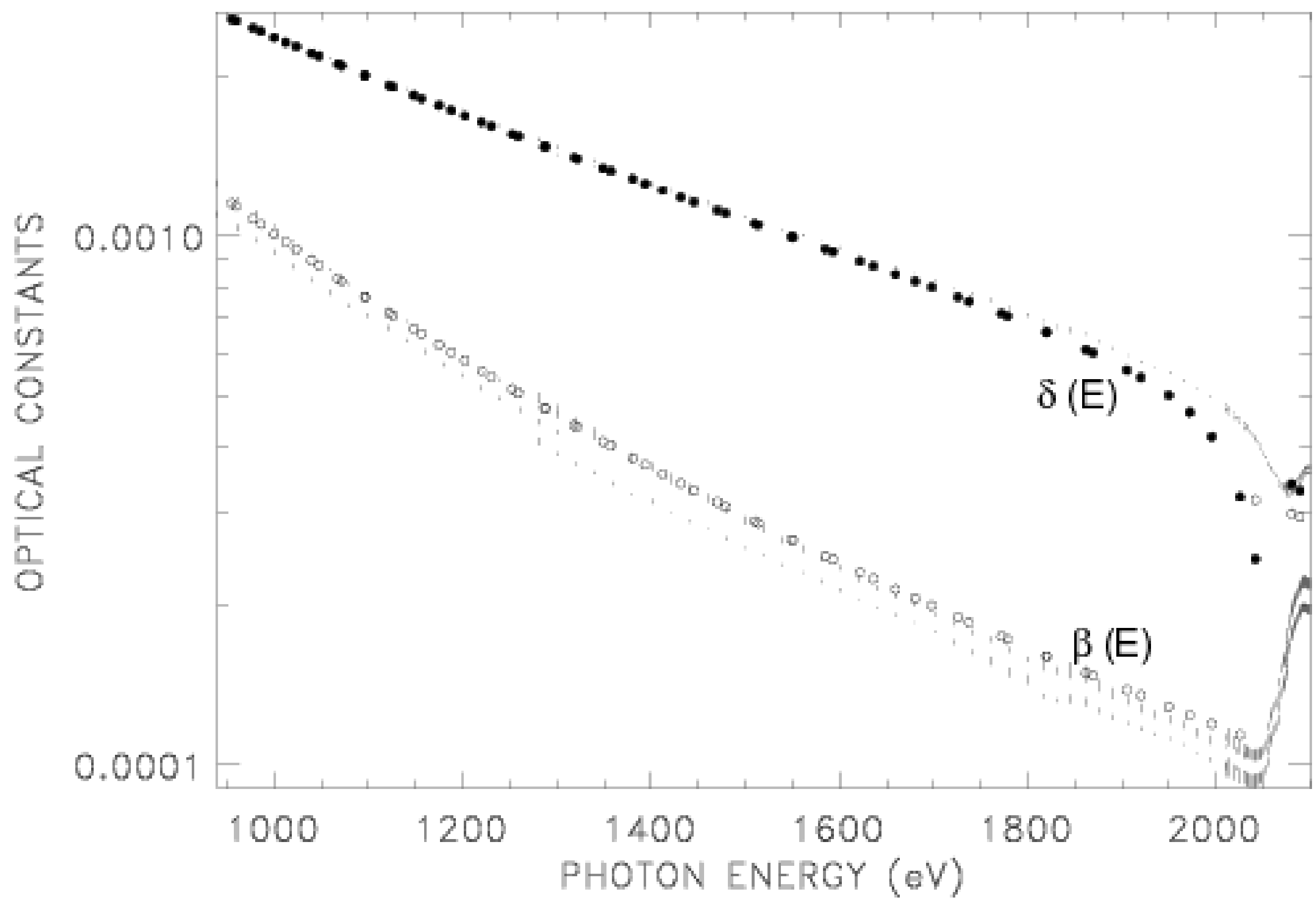
In the Ir M-edge region, an overlayer is necessary for fits, consistency.



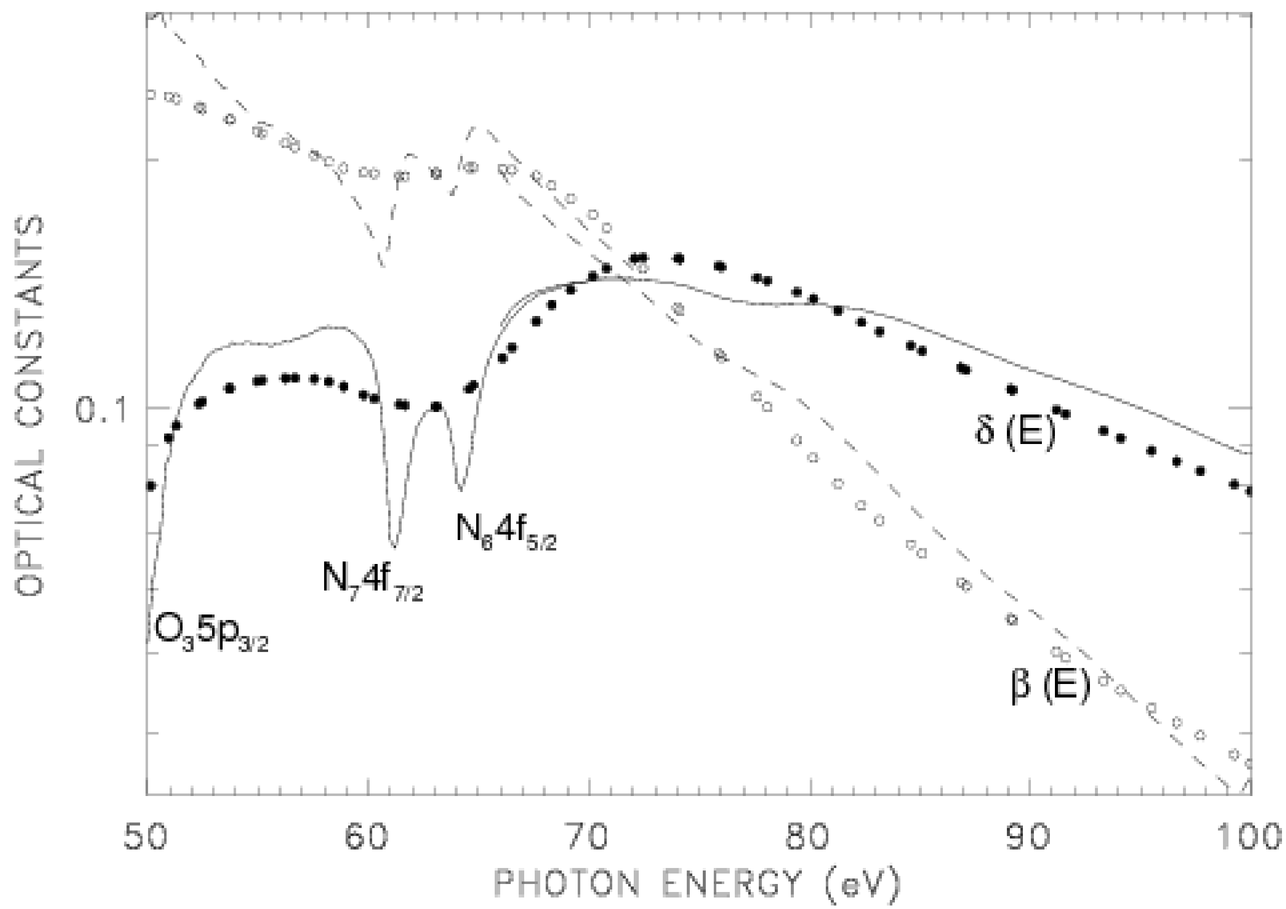
M-edges require an overlayer in model due to masking of Ir absorption.



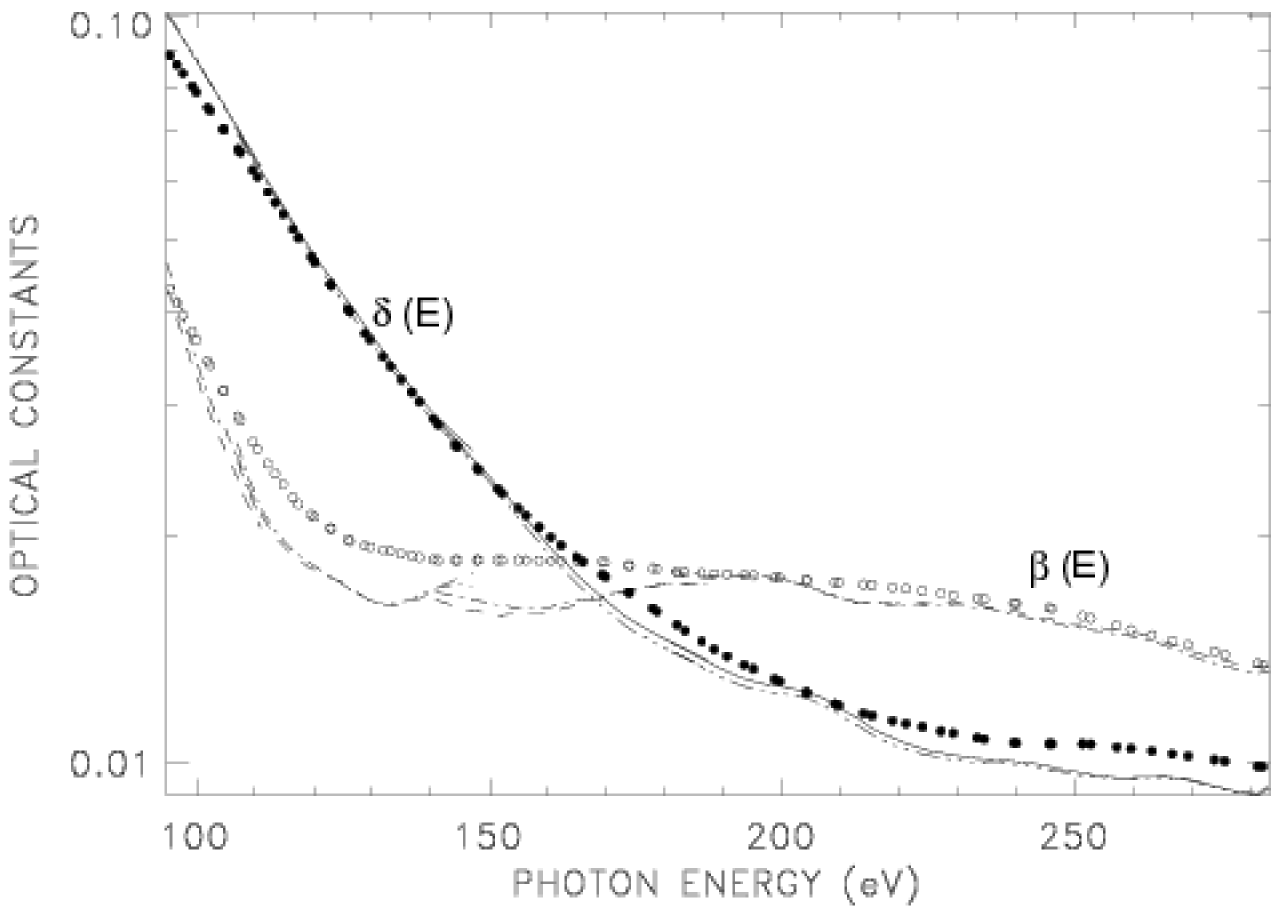
1000-2000 eV $\beta(E)$ is also more consistent with overlayer.



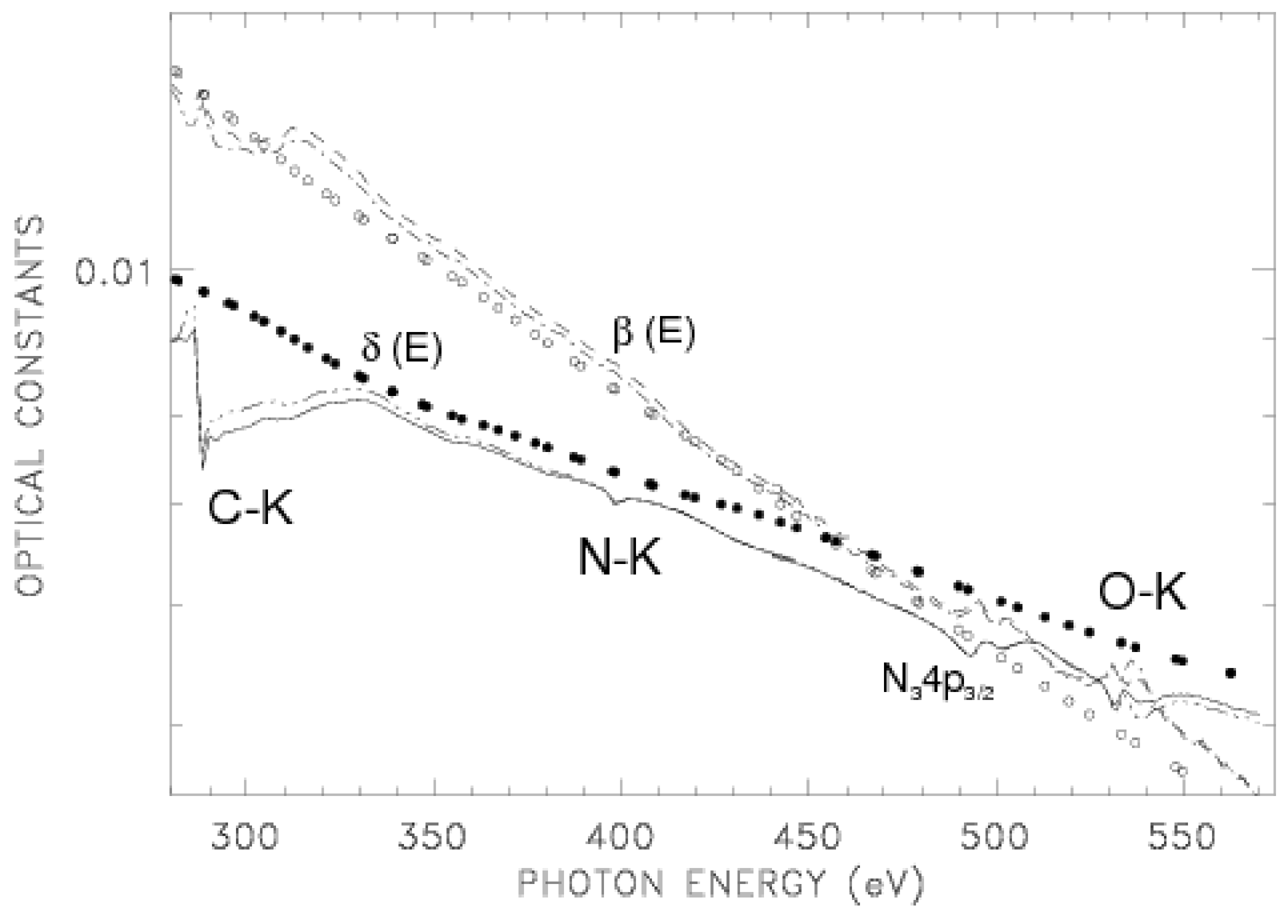
Low-energy data: As with M-edges, the detail obtained is significant.



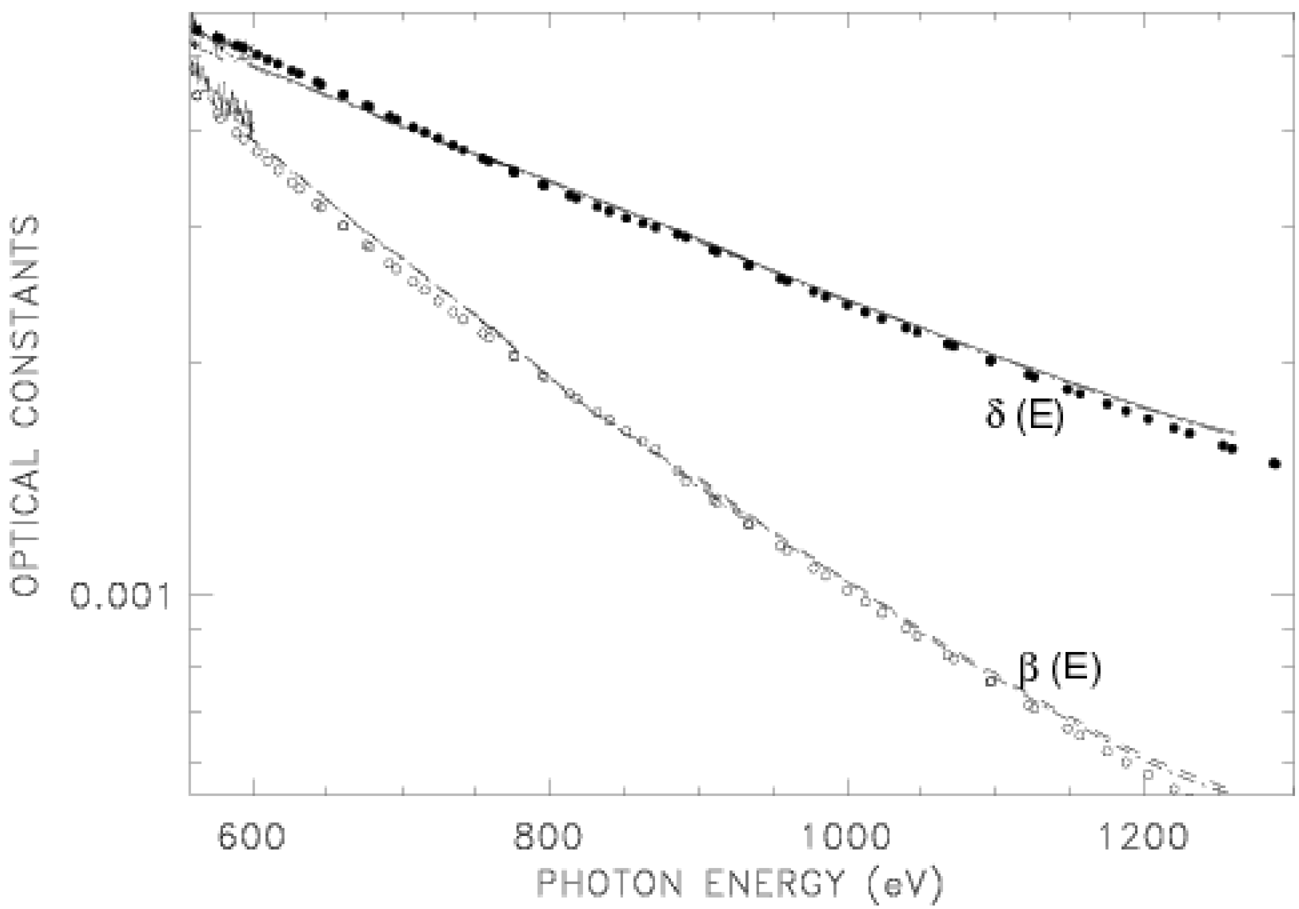
Some significant differences appear from tabulated between N-edges.



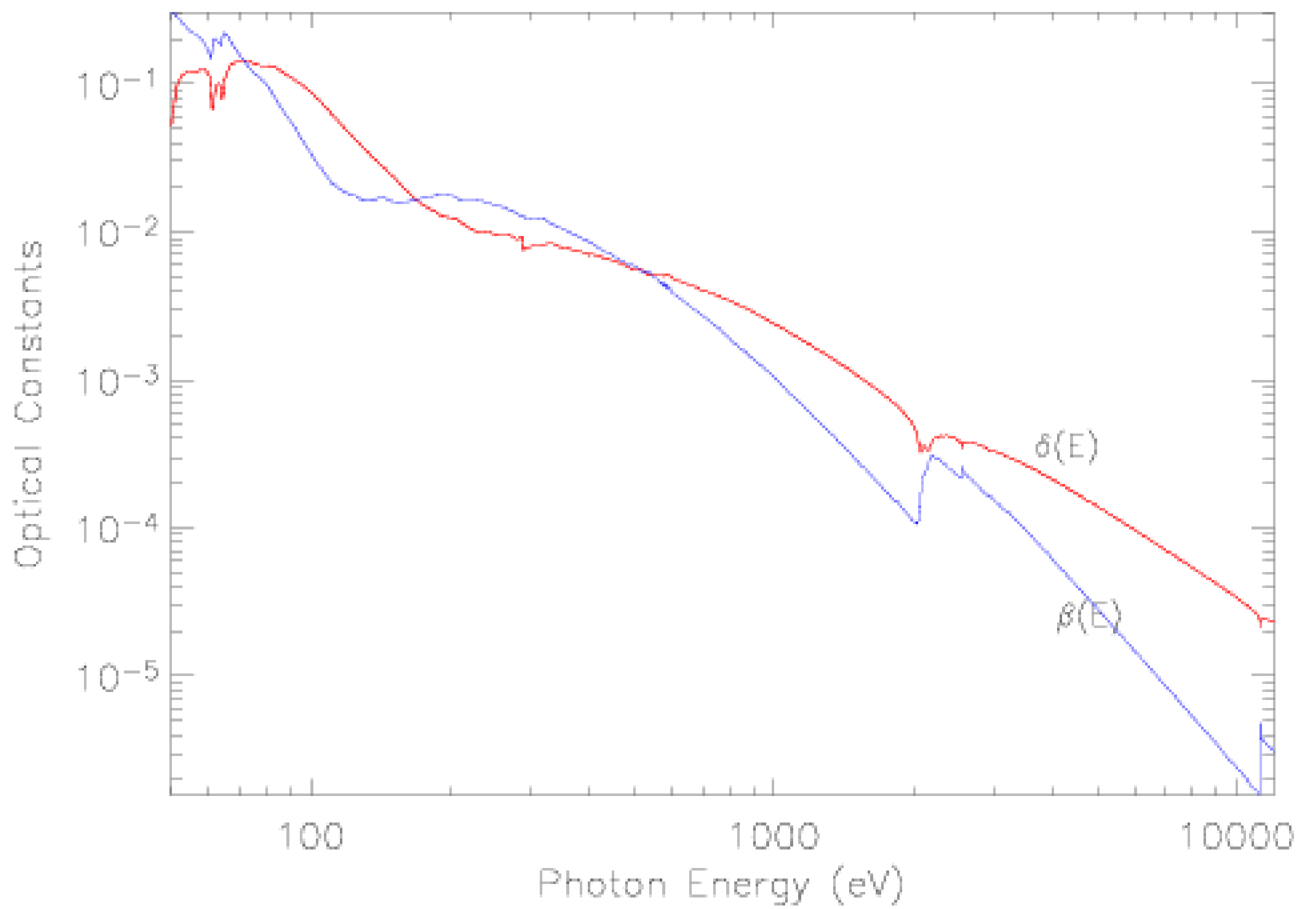
C- and O-K leave signatures with our naïve overlayer composition.



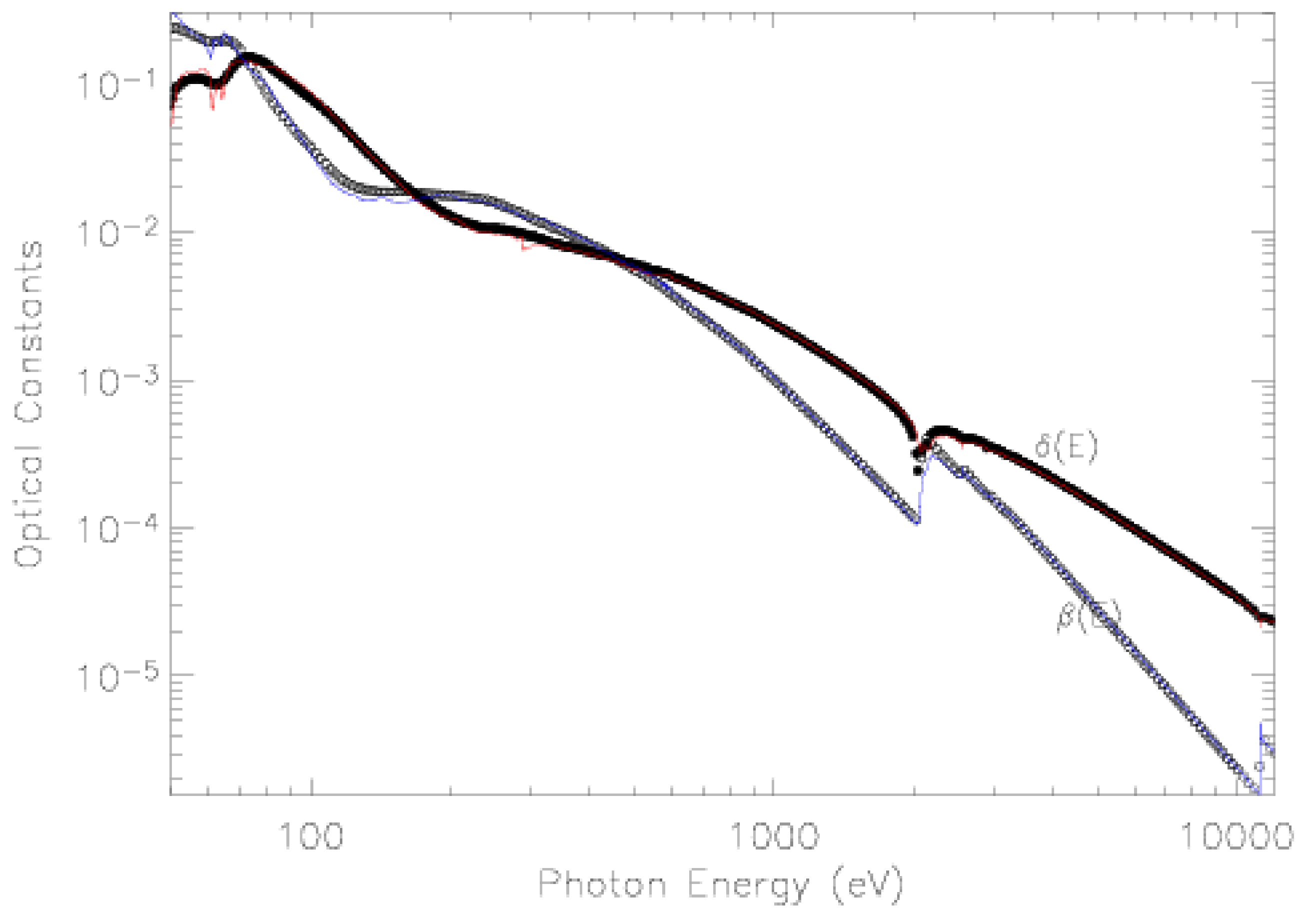
In the featureless 600-1200 eV range, we obtain only slight variations from tabulated.



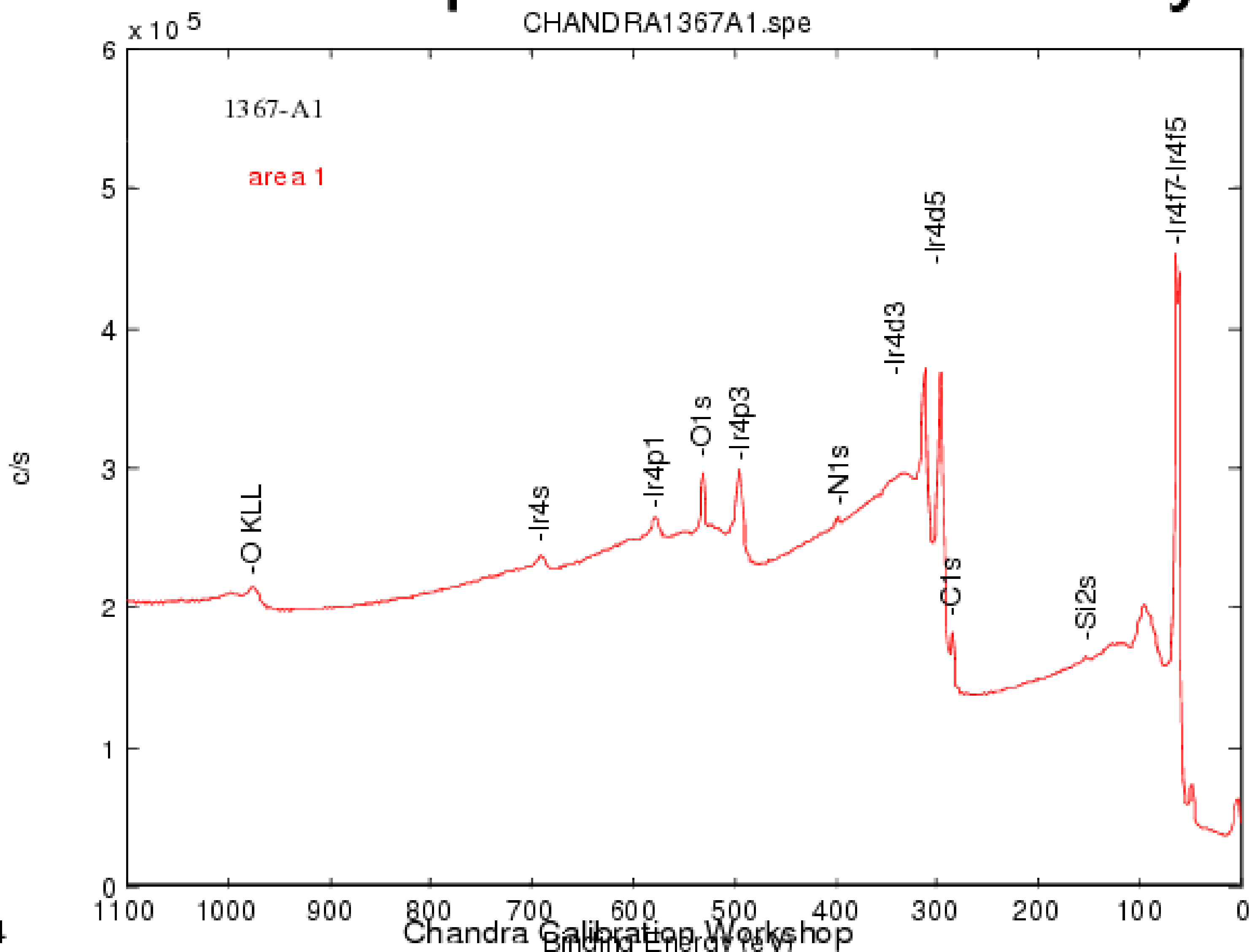
Here are our current best results (not yet implemented in the CalDB)



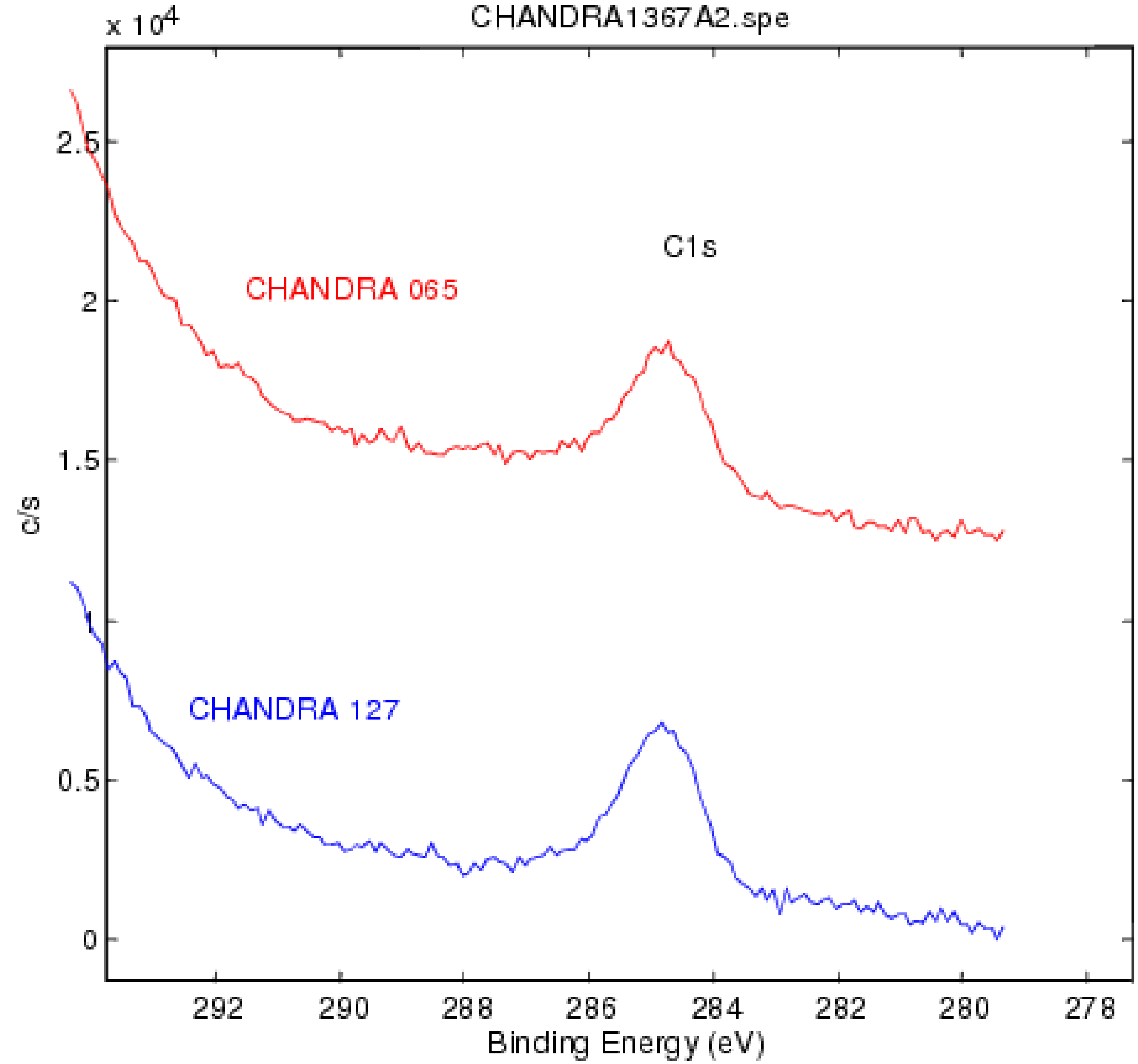
Our current results, with 1995 Henke/Gullikson for comparison.



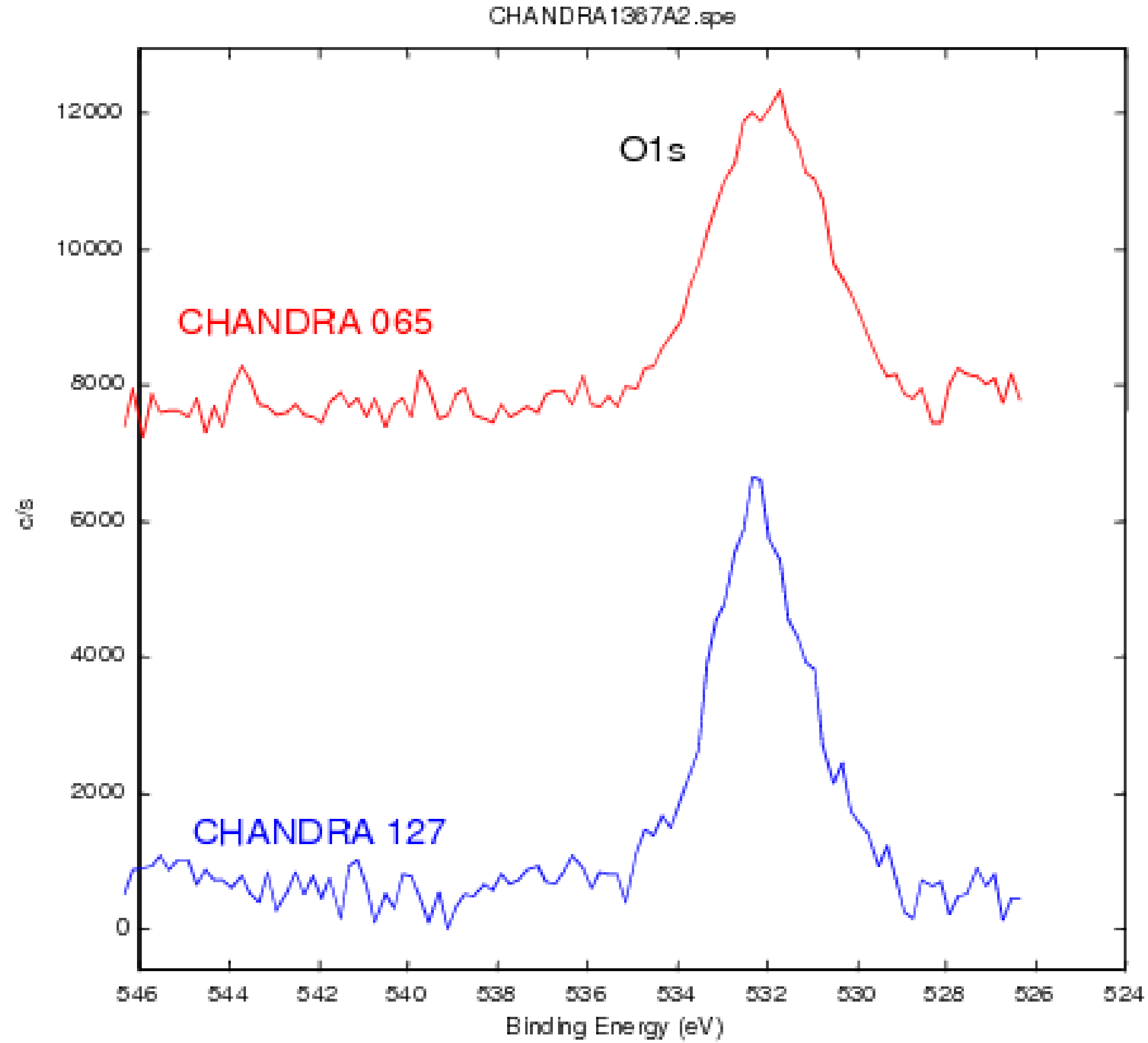
XPS survey scan of 065 reveals several components in overlayer.



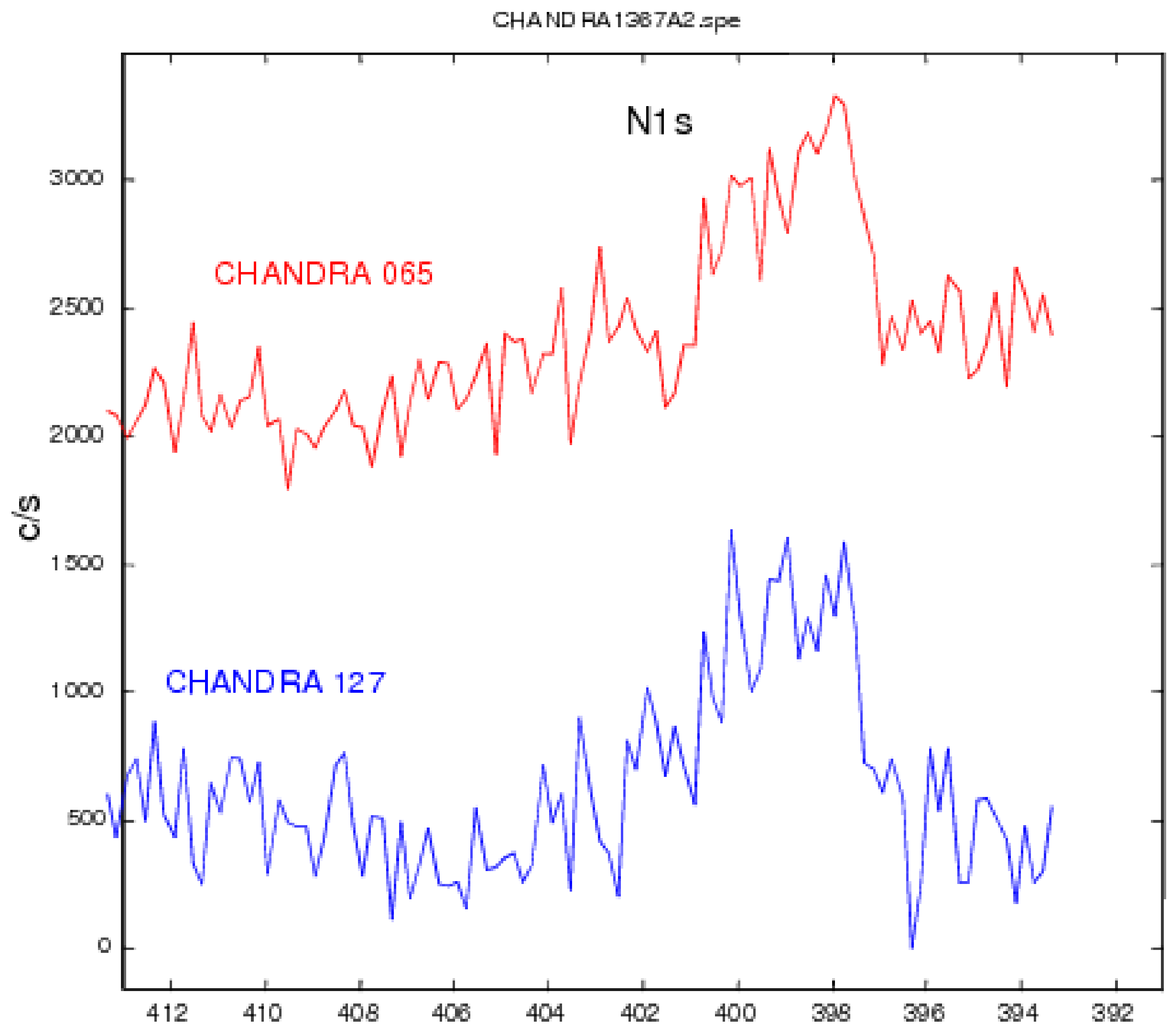
High-resolution C1s Spectra



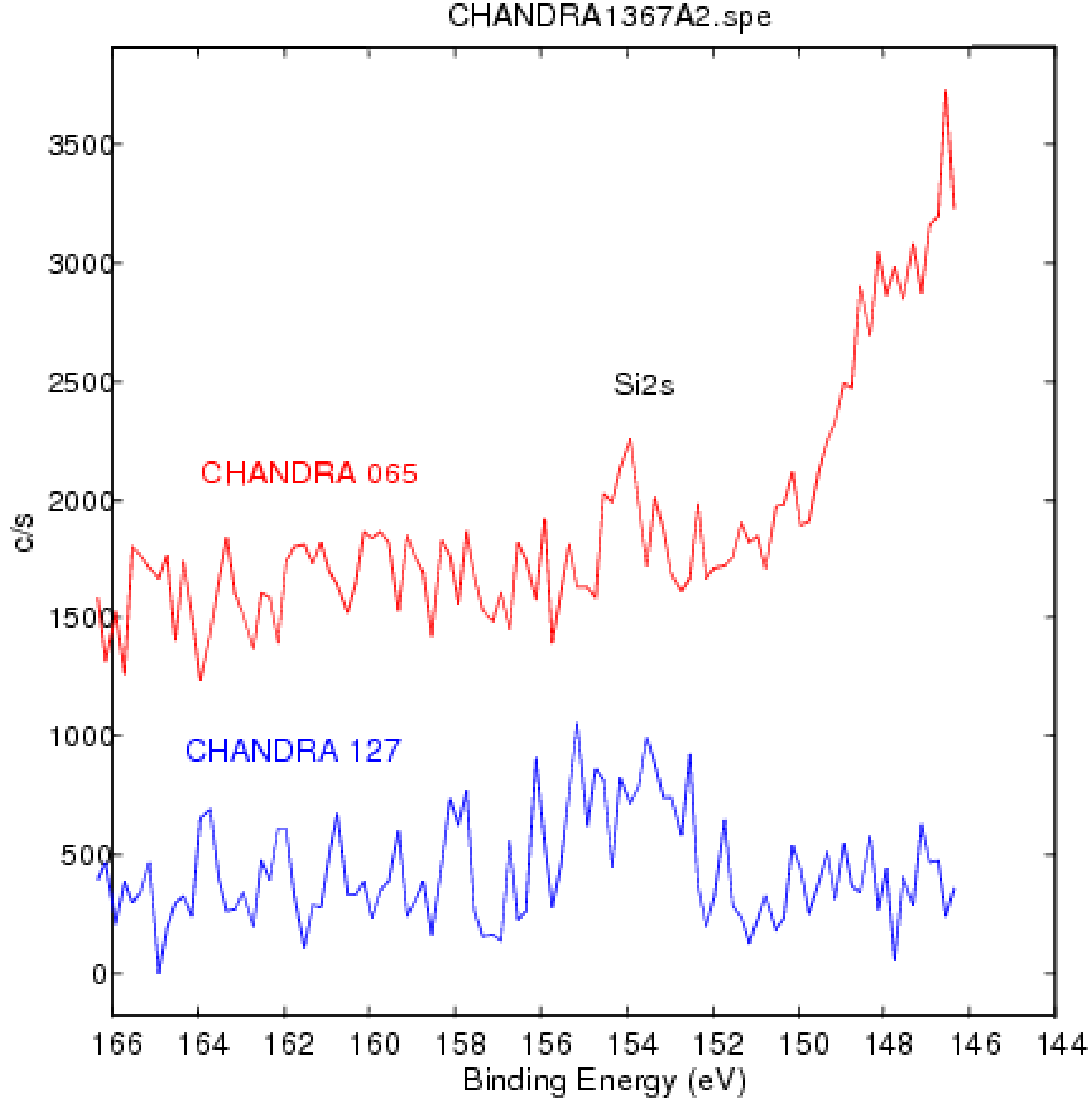
High-resolution O1s Spectra



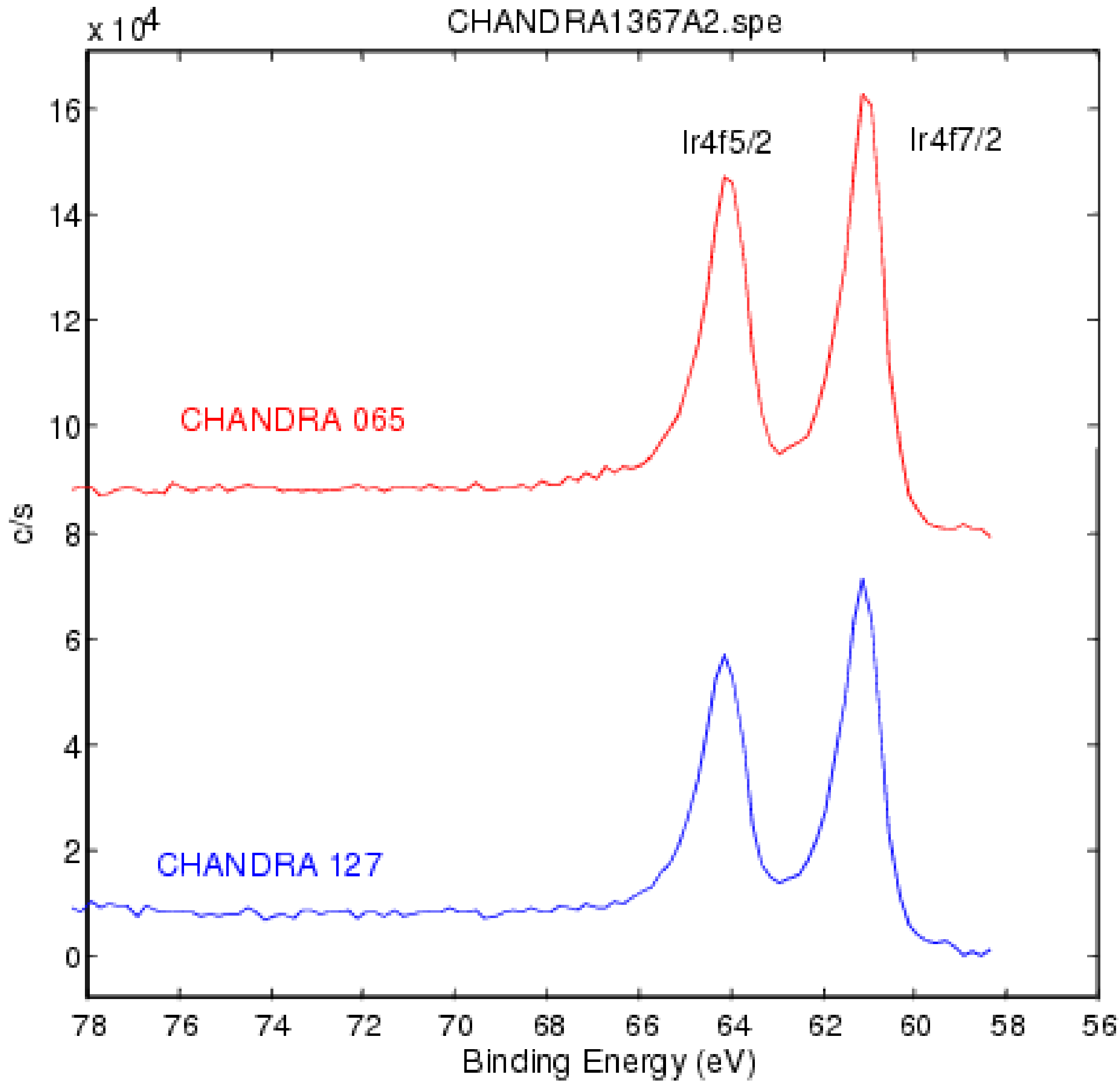
High-resolution N1s Spectra



High-resolution Si2s Spectra



High-resolution Ir4f Spectra



Summary

- We have a nearly final set of Ir optical constants, which will soon be finalized and published. => Appl. Optics; Gullikson tables.
- Refinements must be folded into HRMA model to evaluate Ir M-edge artifacts in Chandra analyses. (See D Jerius, this workshop.)
- XPS confirms the overlayer, and may be evalutated further to help mitigate C, O, and N signatures in low-energy results.