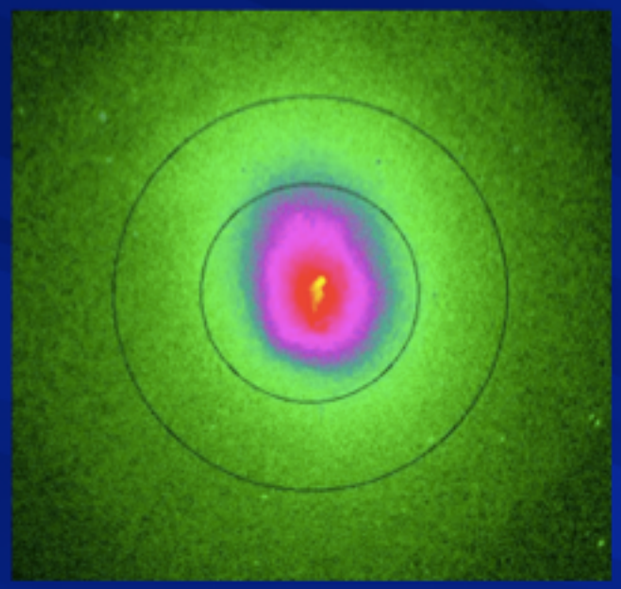
Chandra Calibration Status

CUC Meeting Sep. 27, 2016

ACIS Effective Area - Monitoring the Contamination

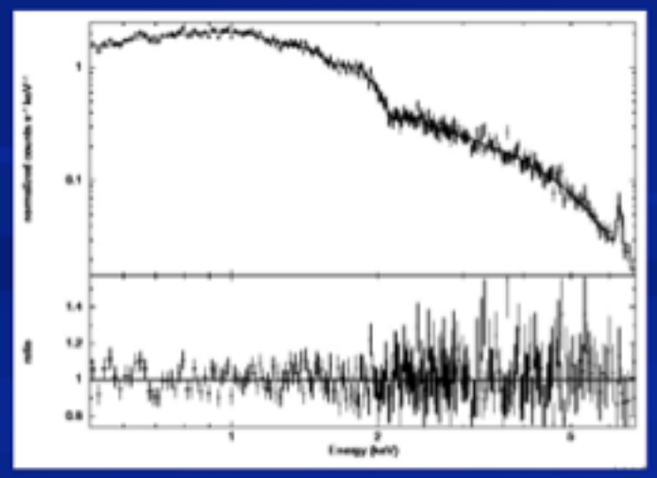
Abell 1795

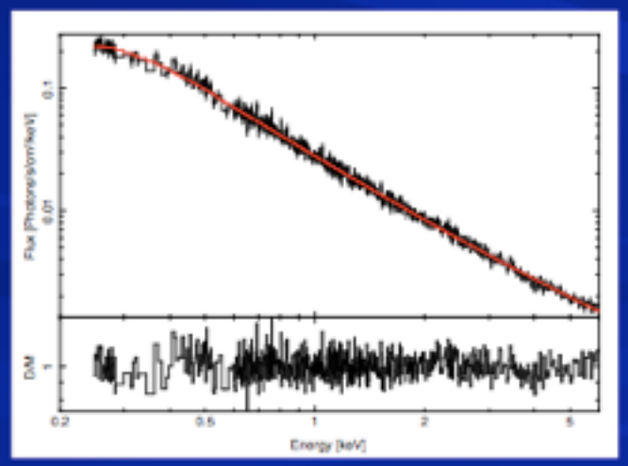


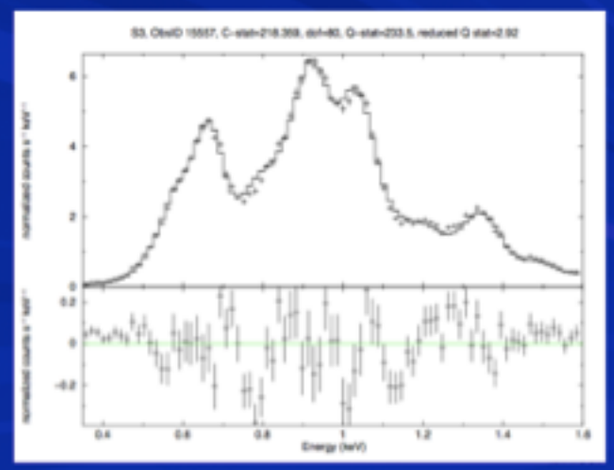
Blazars

Mkn 421
PKS 2111-304

E0102-72

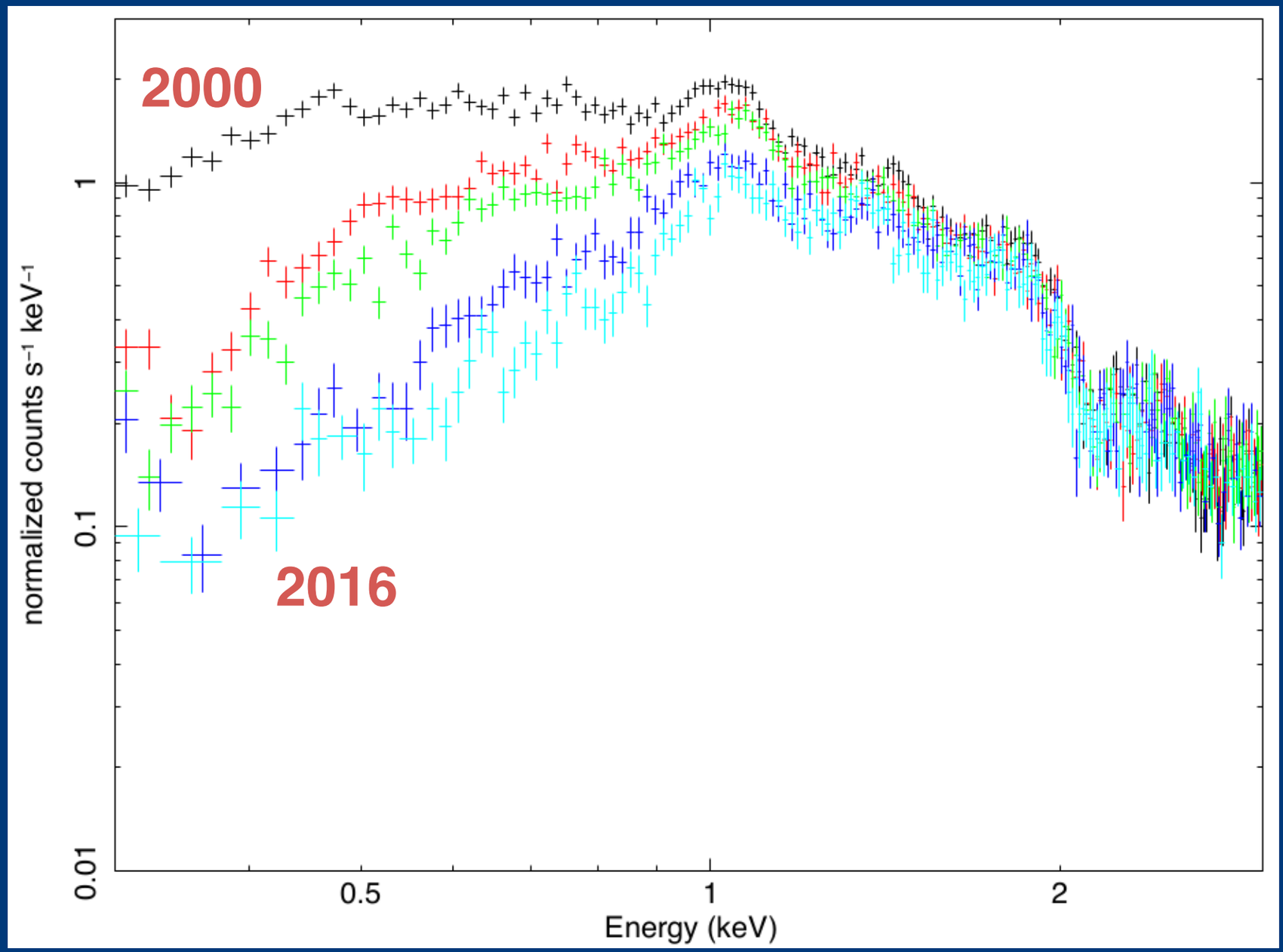






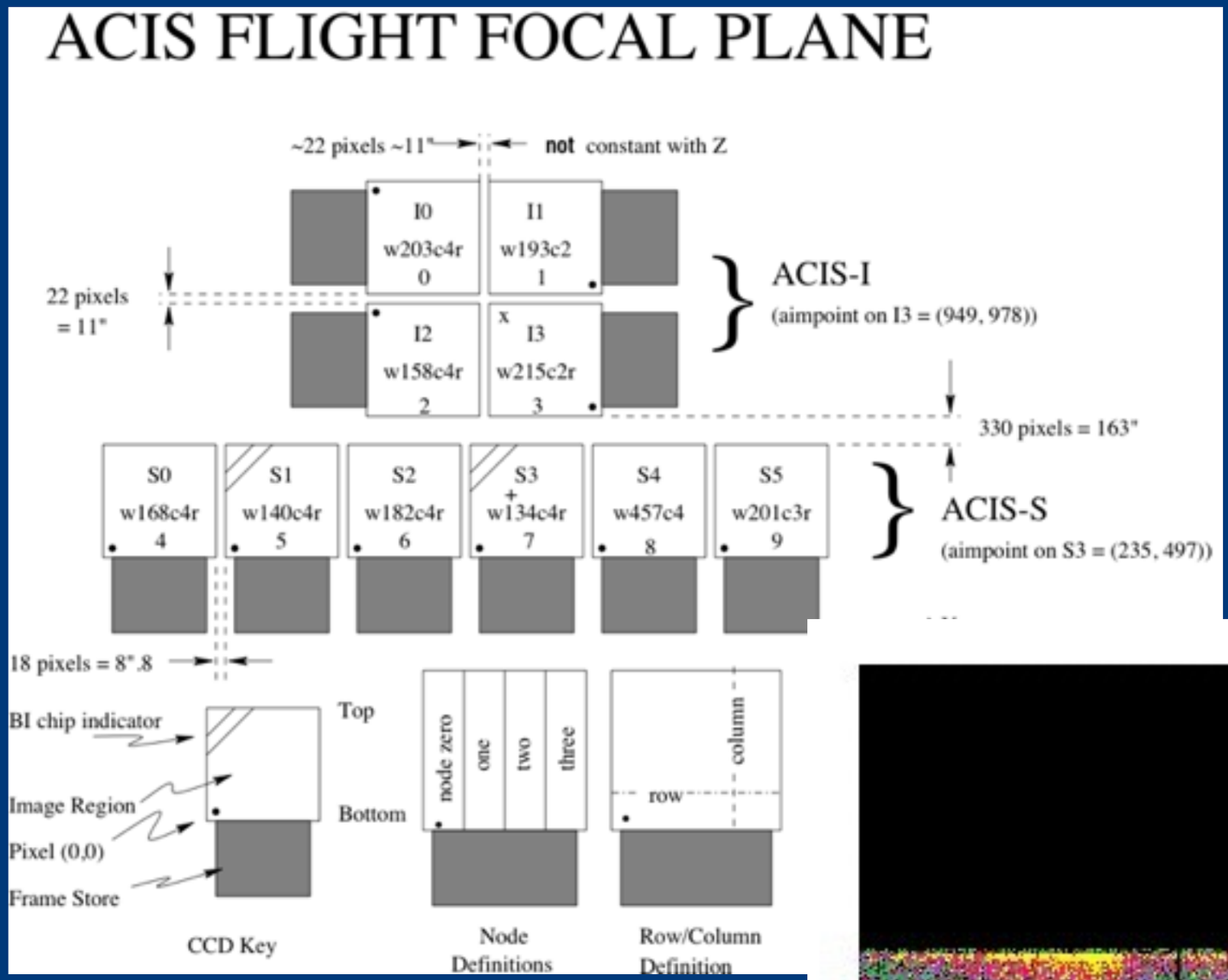
ACIS Effective Area - Monitoring the Contamination

Abell 1795 spectra through the years



ACIS Effective Area - Monitoring the Contamination

Big Dither LETG/ACIS-S Observations of Mkn 421



Recent Observations

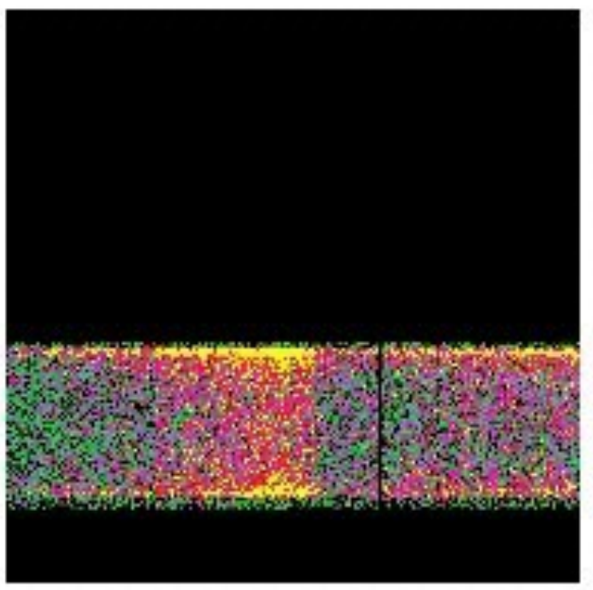
Mar. 2015

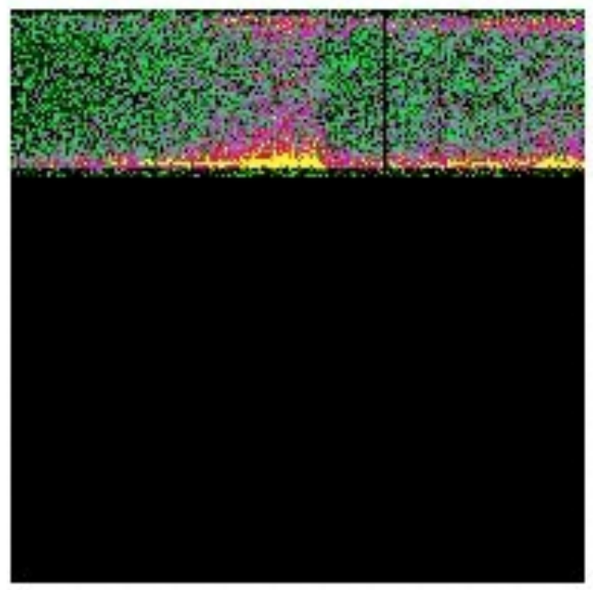
Jul. 2015

Dec. 2015

Jul. 2016

ACIS-S1



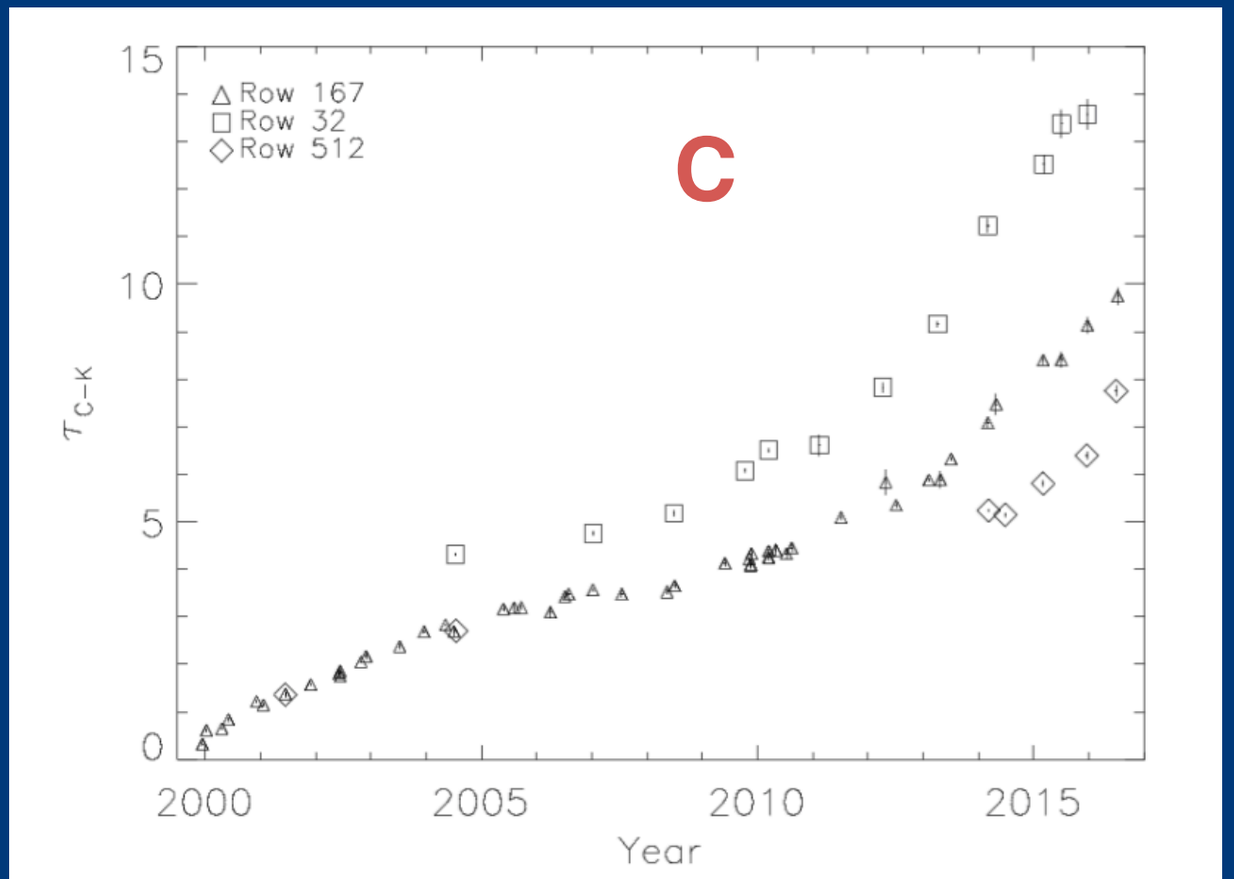


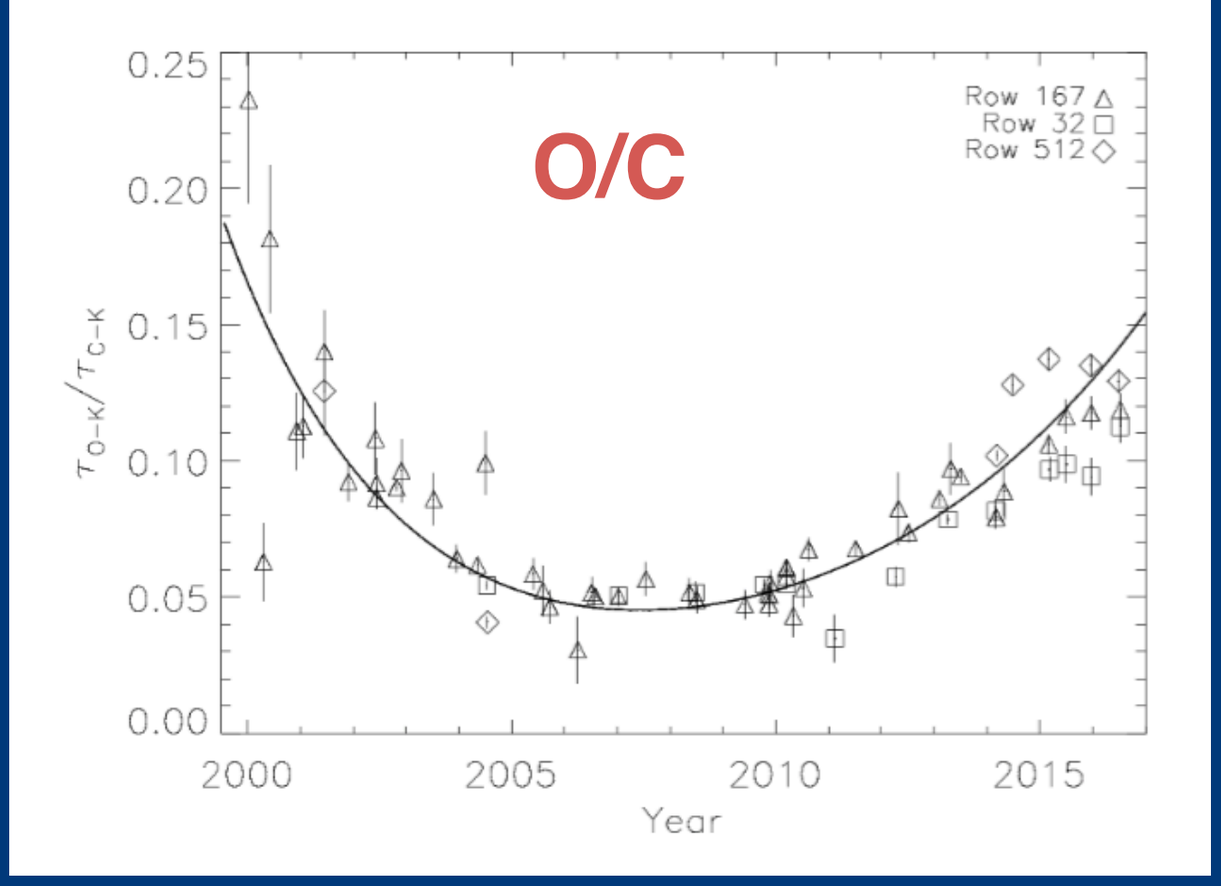
ACIS Effective Area - Monitoring the Contamination

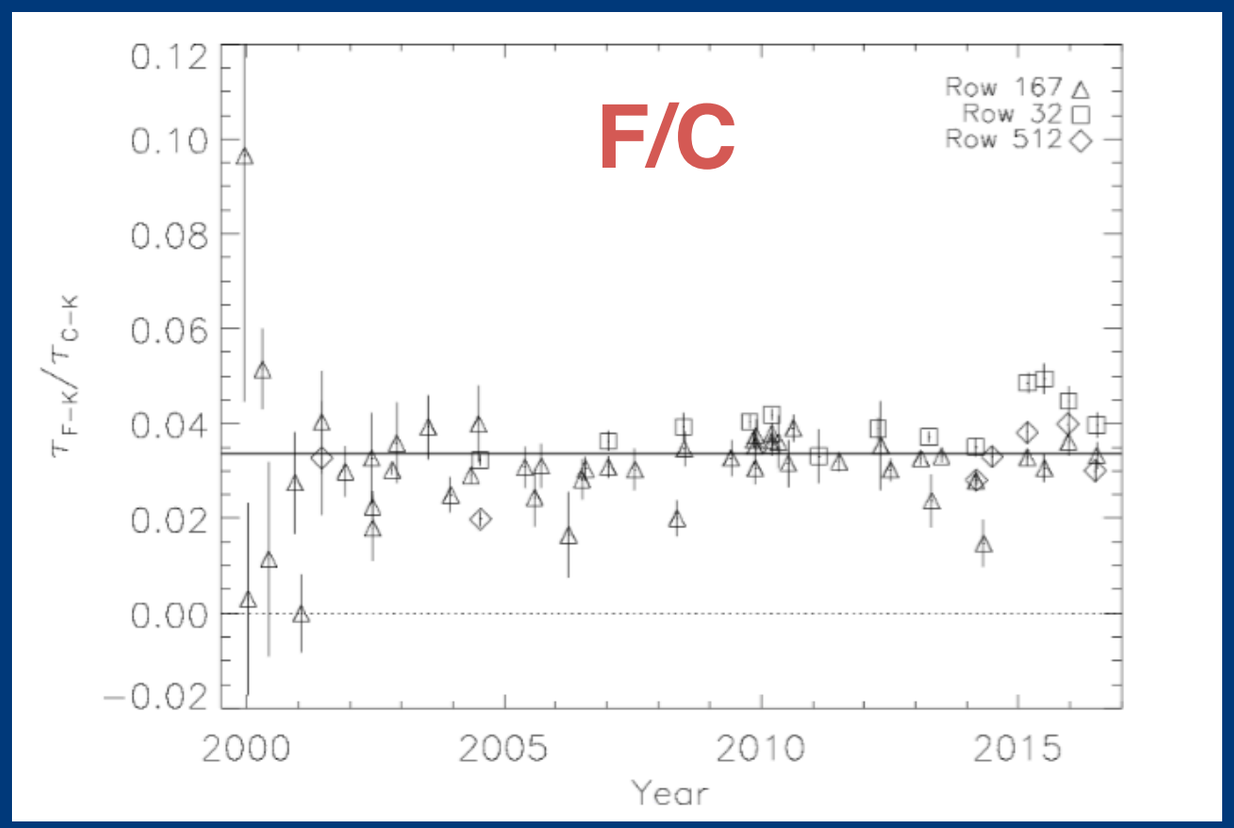
Three components to ACIS Contamination Model:

- **Composition**
- **Time-dependence**
- **Spatial-dependence**

Composition and Time-dependence

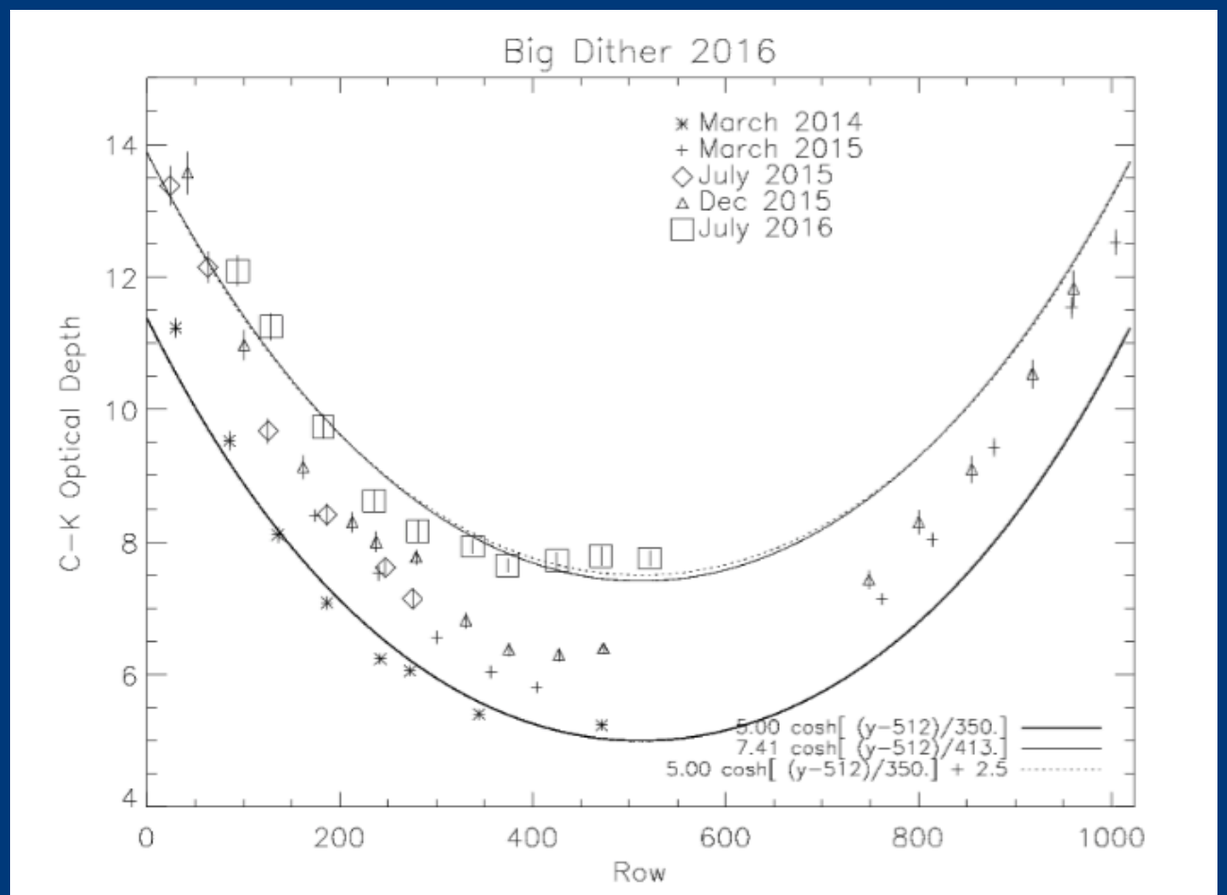


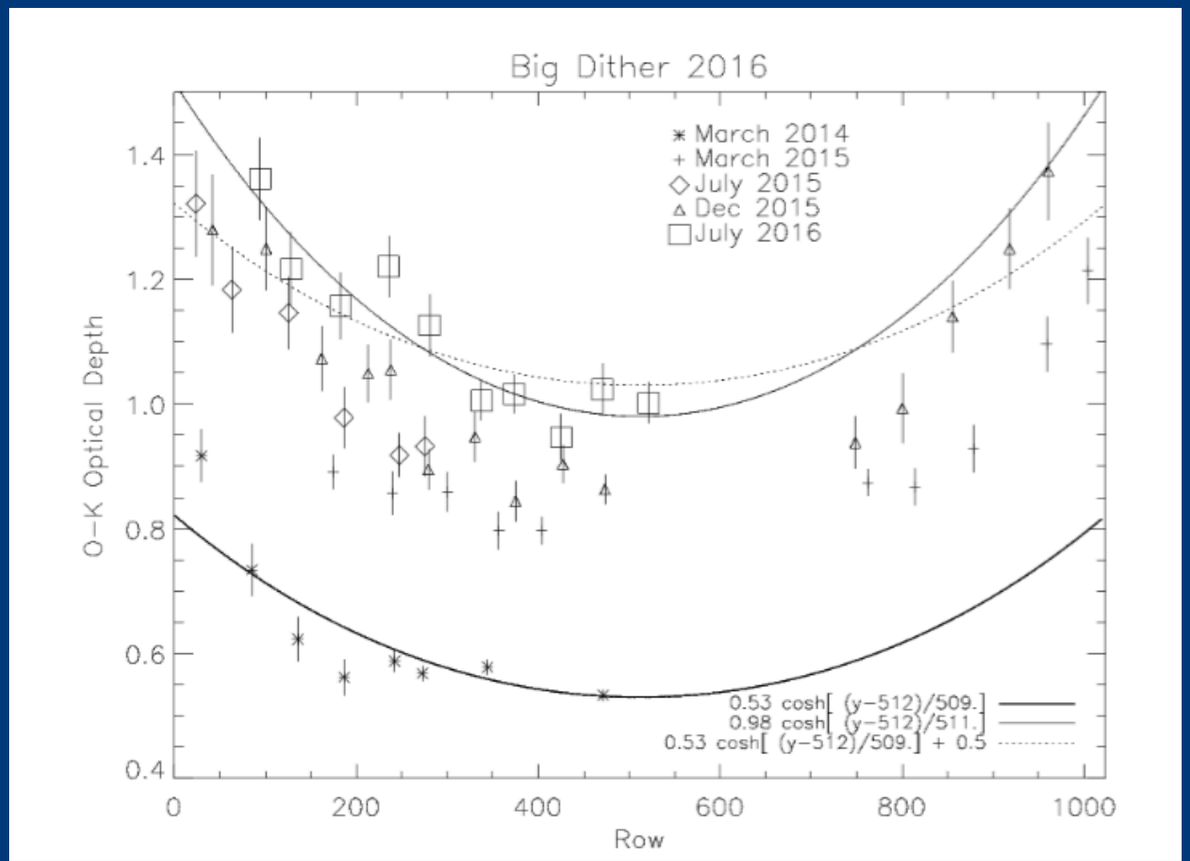


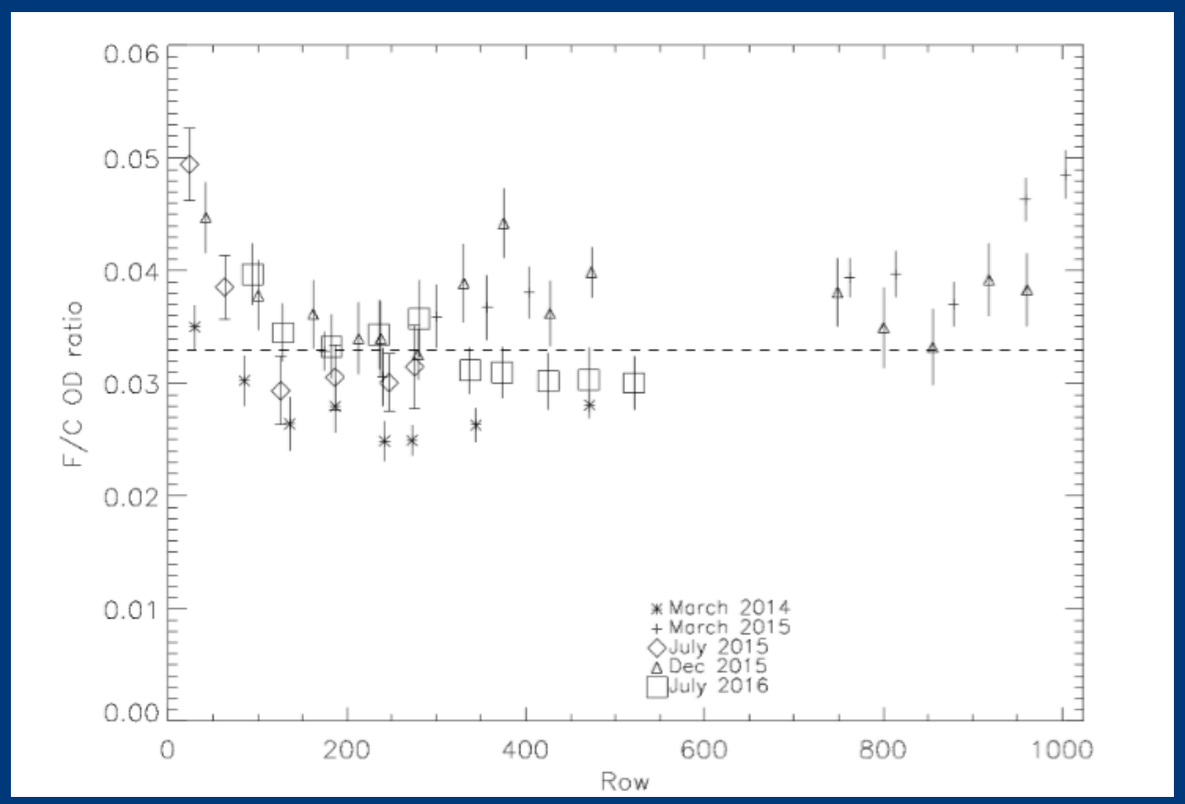


ACIS Effective Area - Monitoring the Contamination

Spatial-dependence

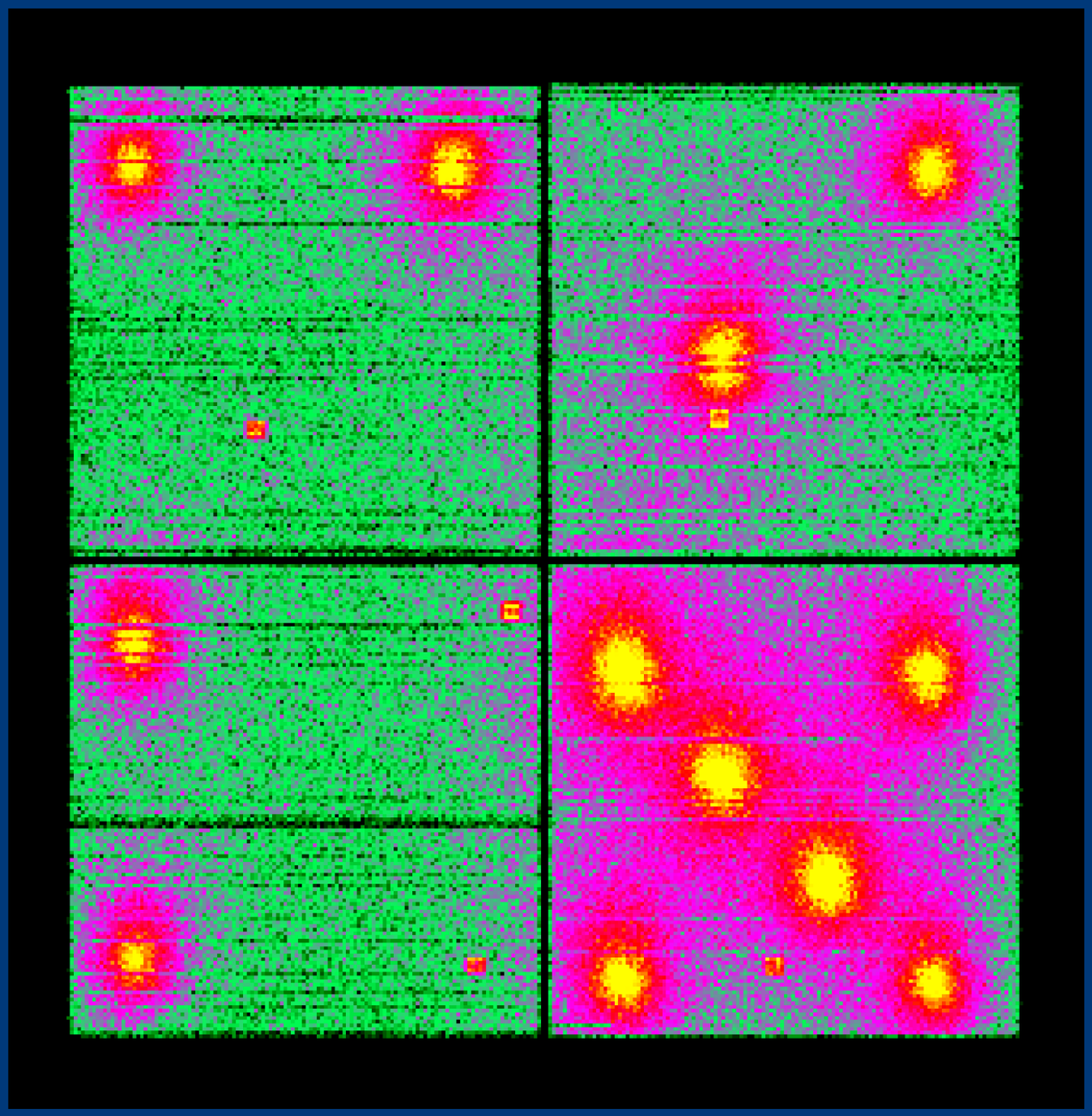






ACIS Effective Area - Monitoring the Contamination

Raster Scan of Abell 1795 on ACIS-I



Apr., 2016 data

ACIS Effective Area - Monitoring the Contamination

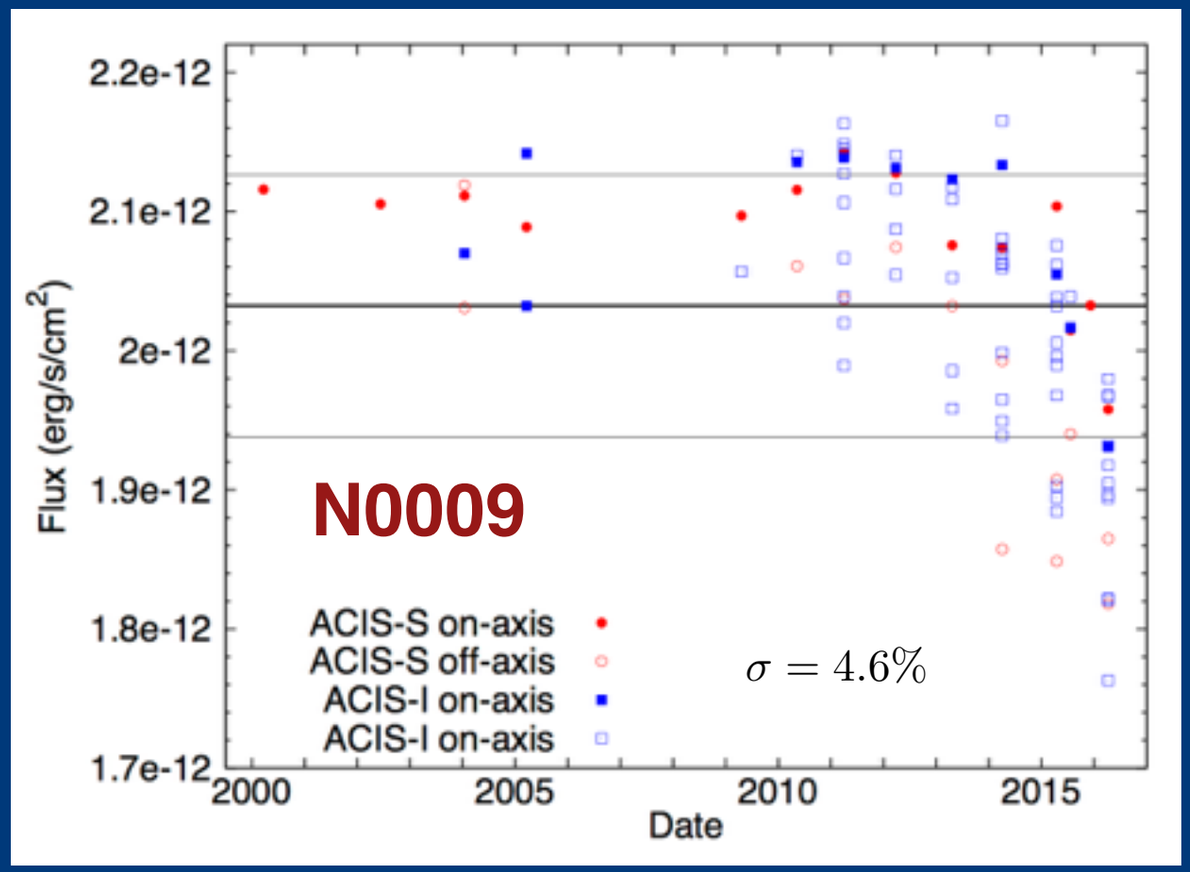
Updated ACIS contamination model scheduled for release in Oct., 2016 (v9968 or CALDB N0010).

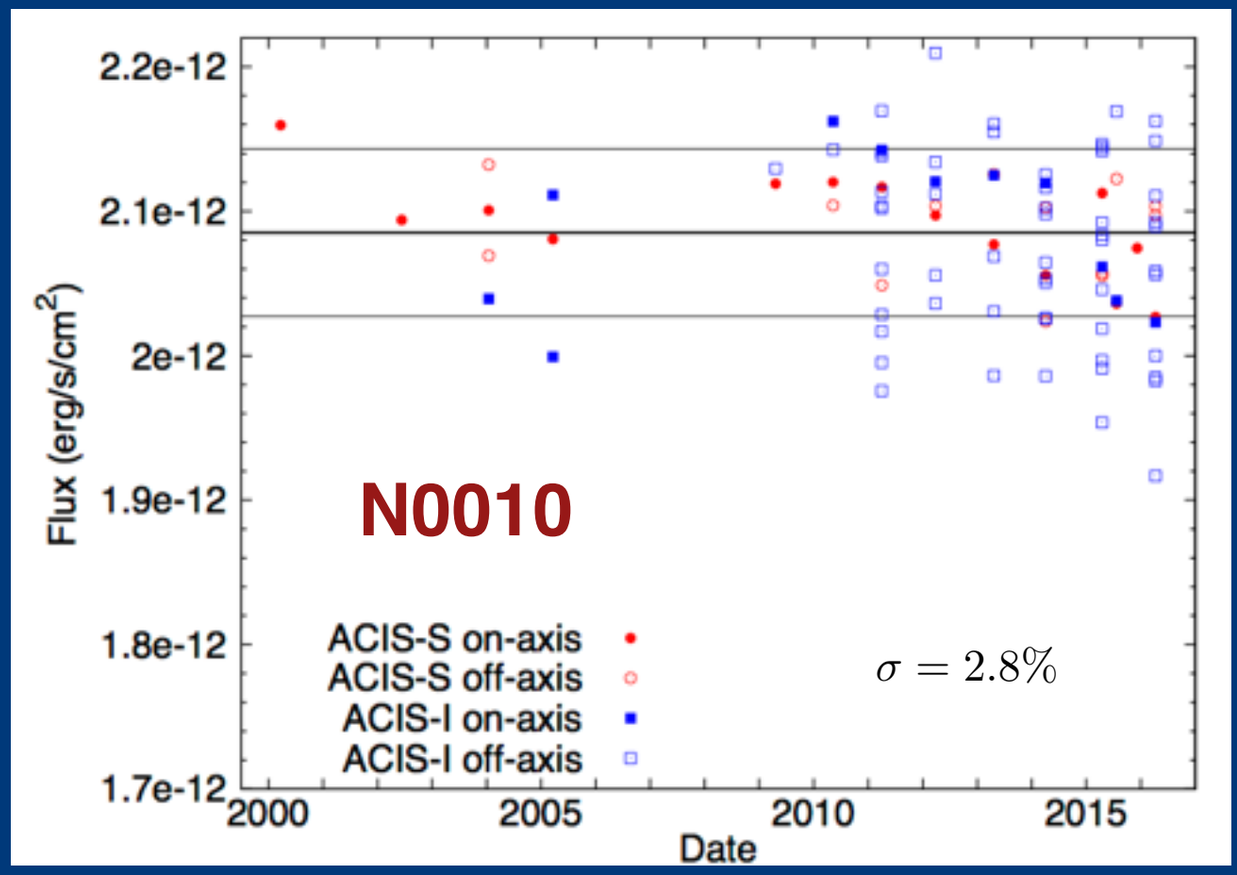
- This model has much greater flexibility regarding the treatment of the three detected elements in the contaminant(s) (C, O and F) , which should make future adjustments easier.
- For ACIS-S: C, O and F have separate time and spatial dependencies.
- For ACIS-I: C and O have separate time and spatial dependencies while the opacity at the F K-edge is proportional to the opacity at the C K-edge.

ACIS Effective Area - Monitoring the Contamination

Comparison of present ACIS contamination mode (CALDB N0009) with the new and improved model (v9968 or soon to be CALDB 0010)

Abell 1795 (0.5-1.0 keV)

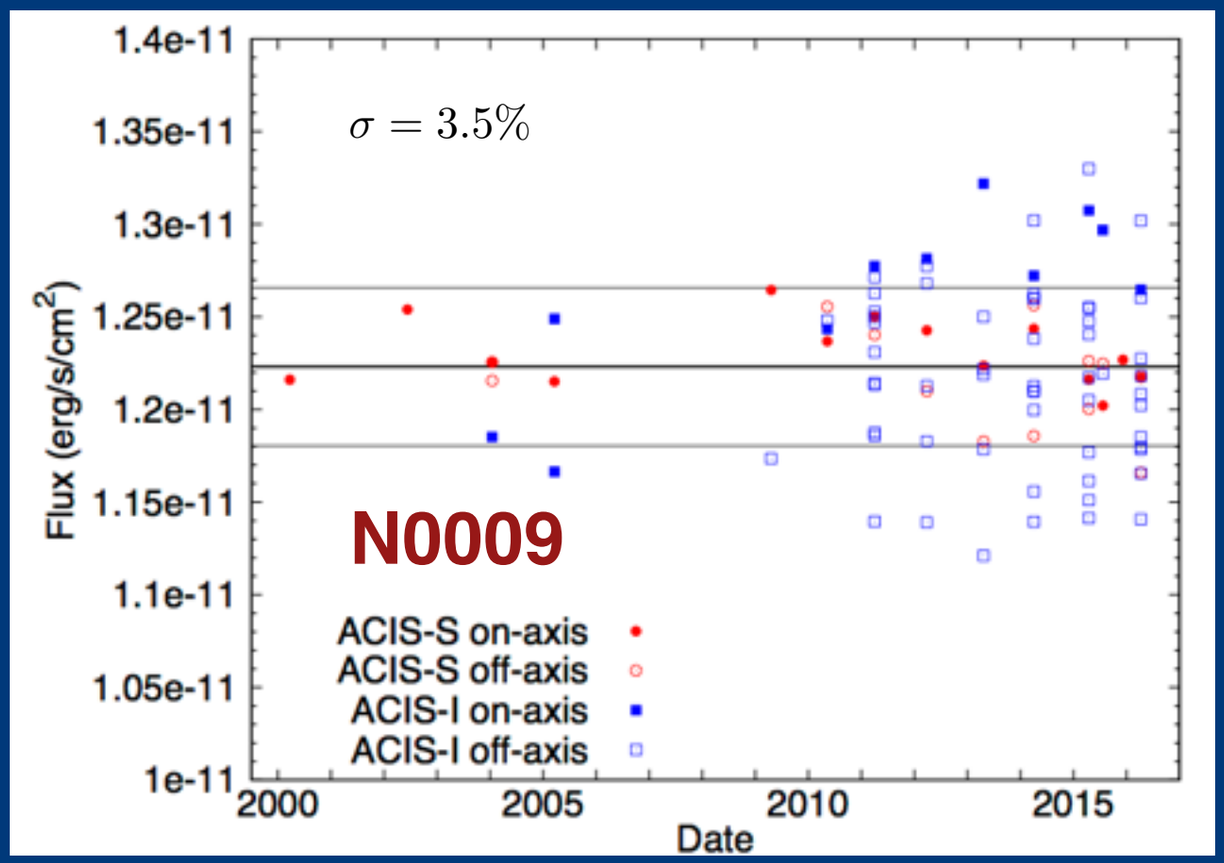


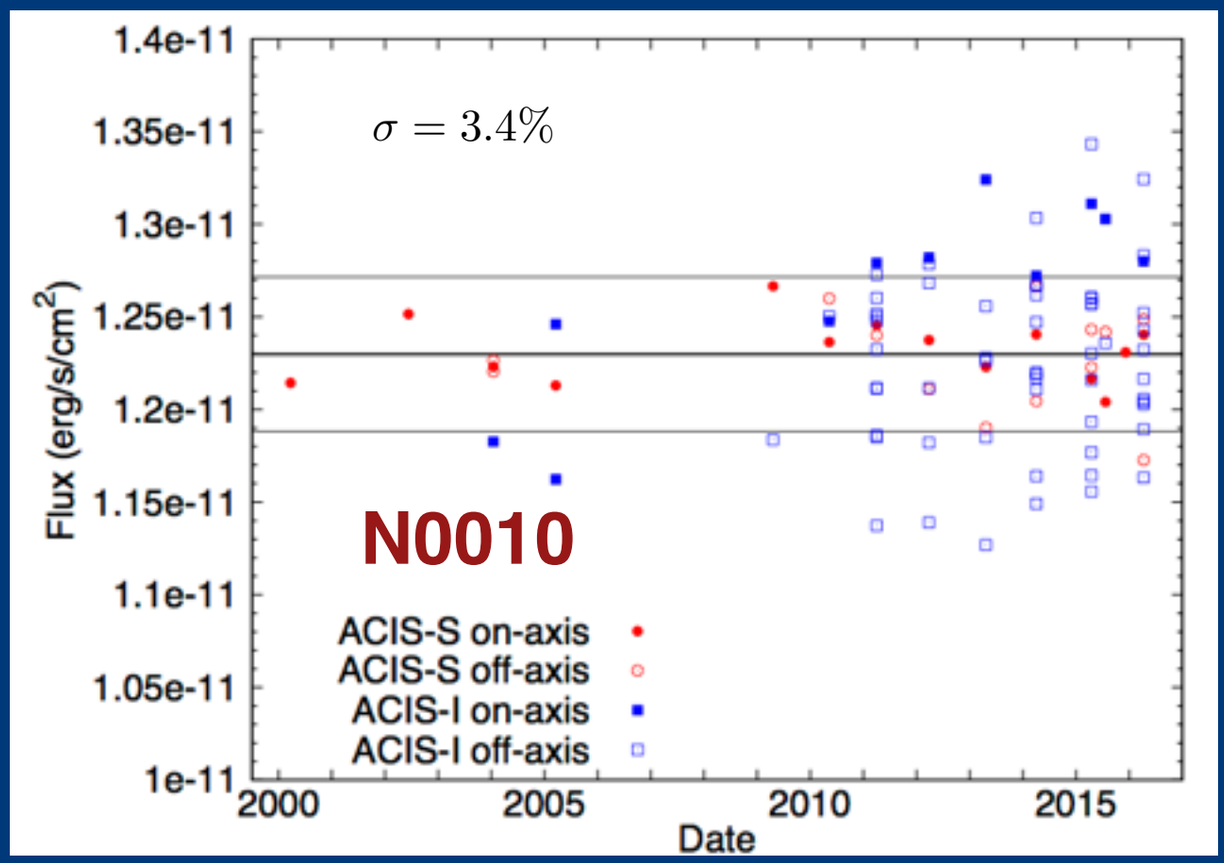


ACIS Effective Area - Monitoring the Contamination

Comparison of present ACIS contamination mode (CALDB N0009) with the new and improved model (v9968 or soon to be CALDB 0010)

Abell 1795 (0.5-7.0 keV)

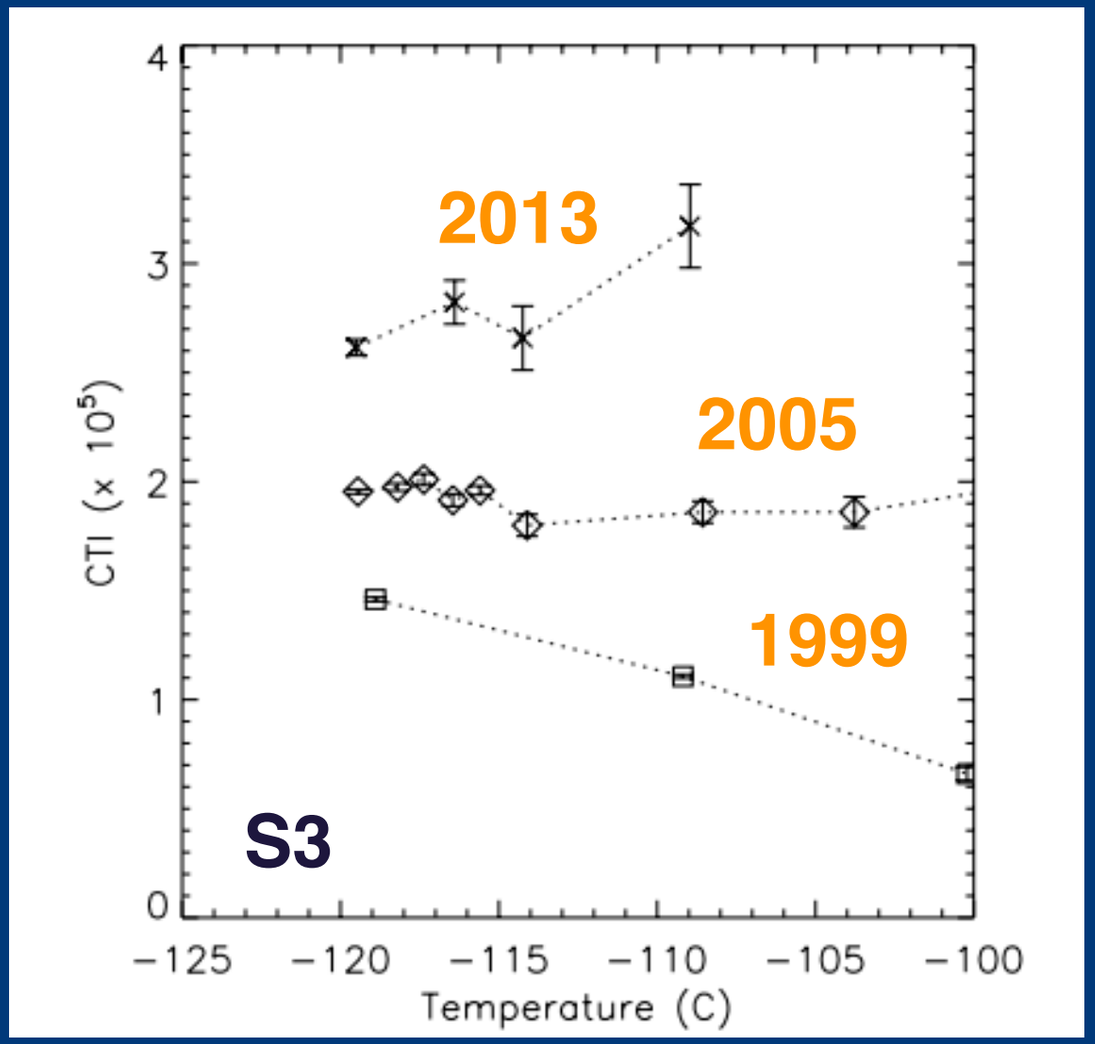


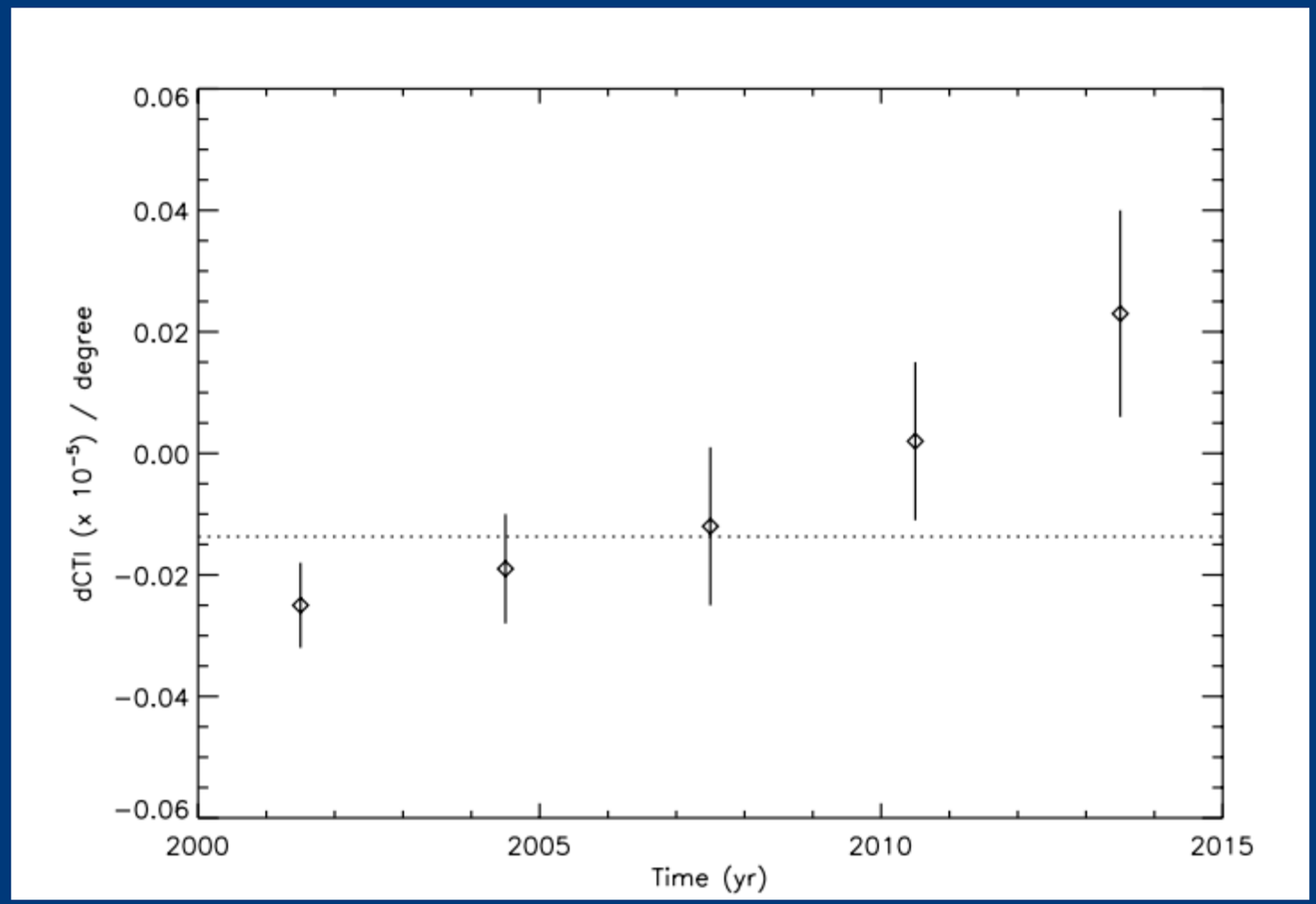


ACIS Gain - Temperature-Dependent CTI Correction

Two gain corrections are applied to ACIS data:

- **Temperature-dependent CTI correction**
- **Time-dependent gain correction.**

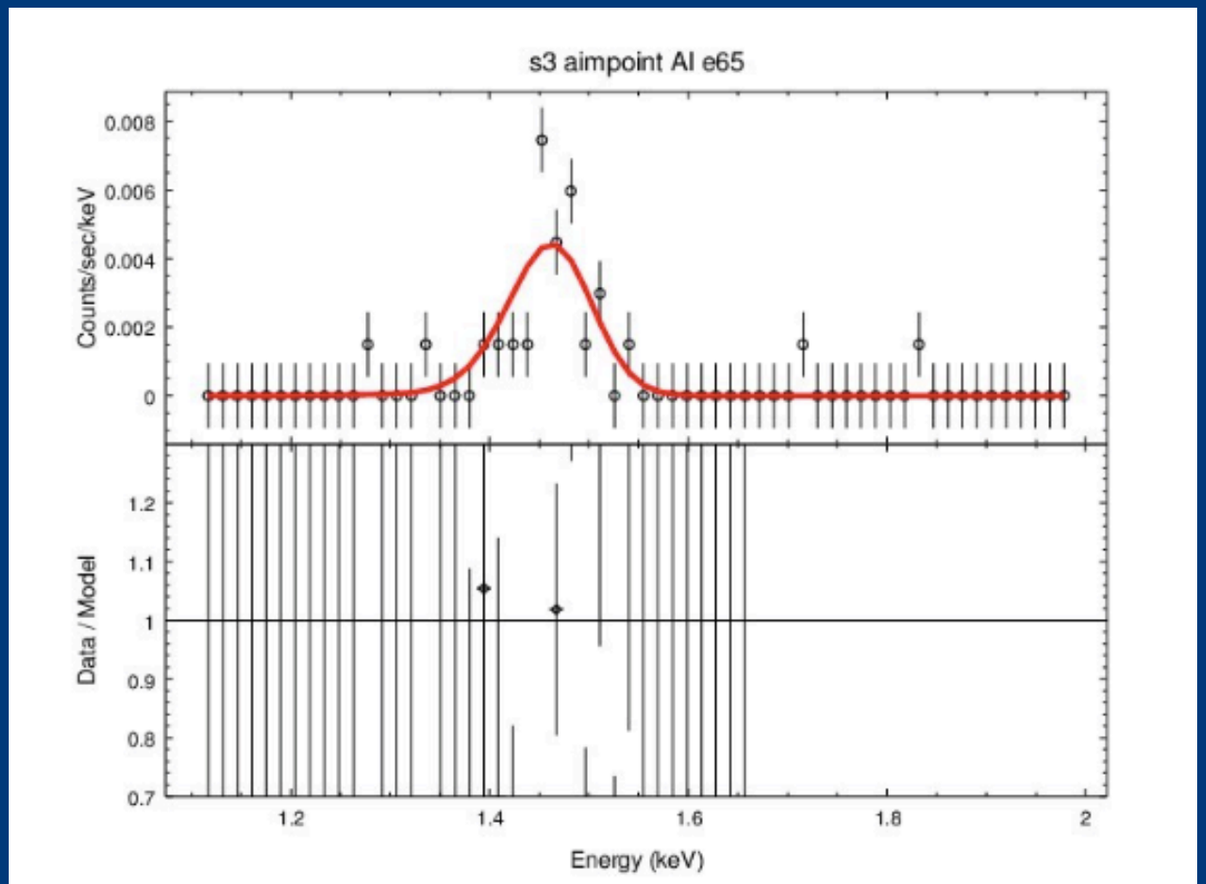


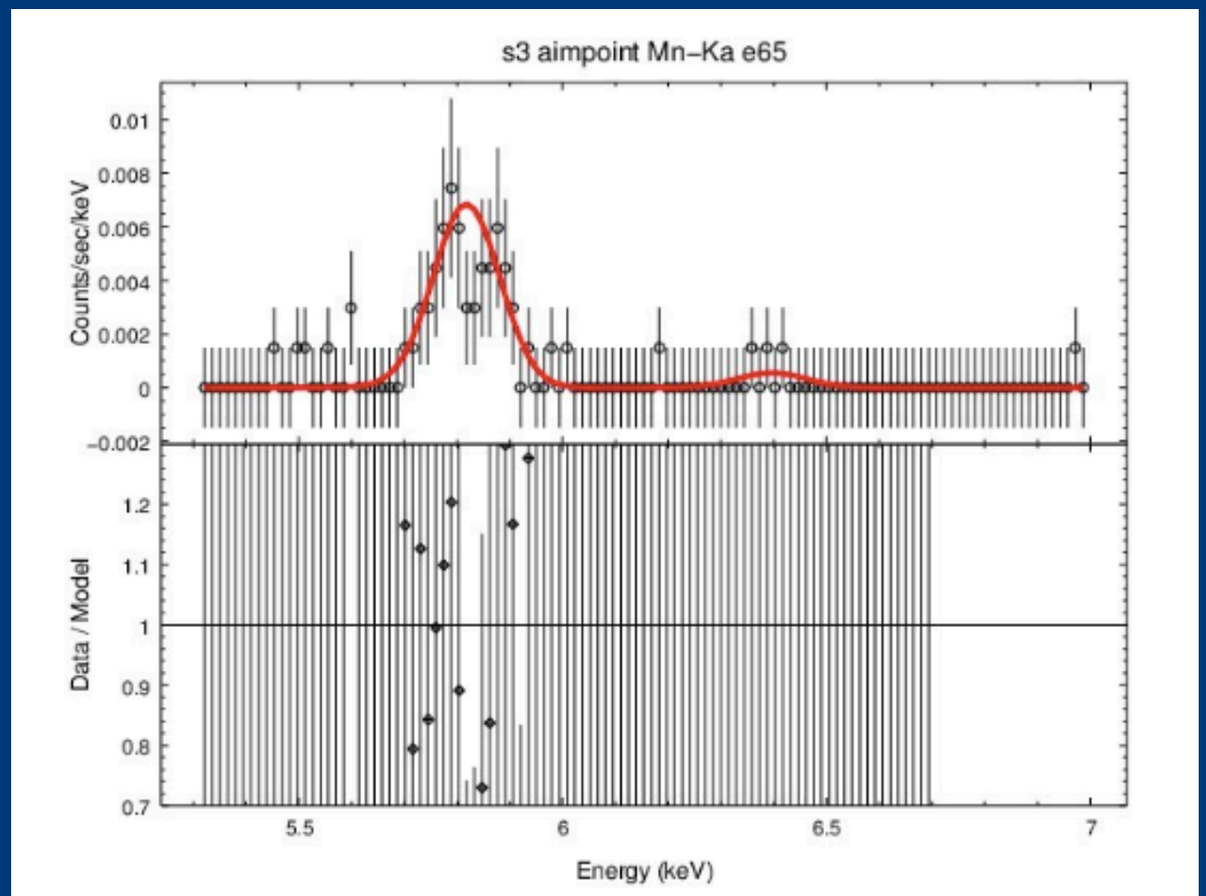


Up till now, a constant d(CTI)/dT has been applied to ACIS data (the horizontal line). We are in the process of adjusting the CALDB so that the appropriate d(CTI)/dT value, given the date of the observation, will be applied.

ACIS Gain - Time-Dependent Corrections

2016 ECS data - ACIS-S3 aim-point





Old tgain files:

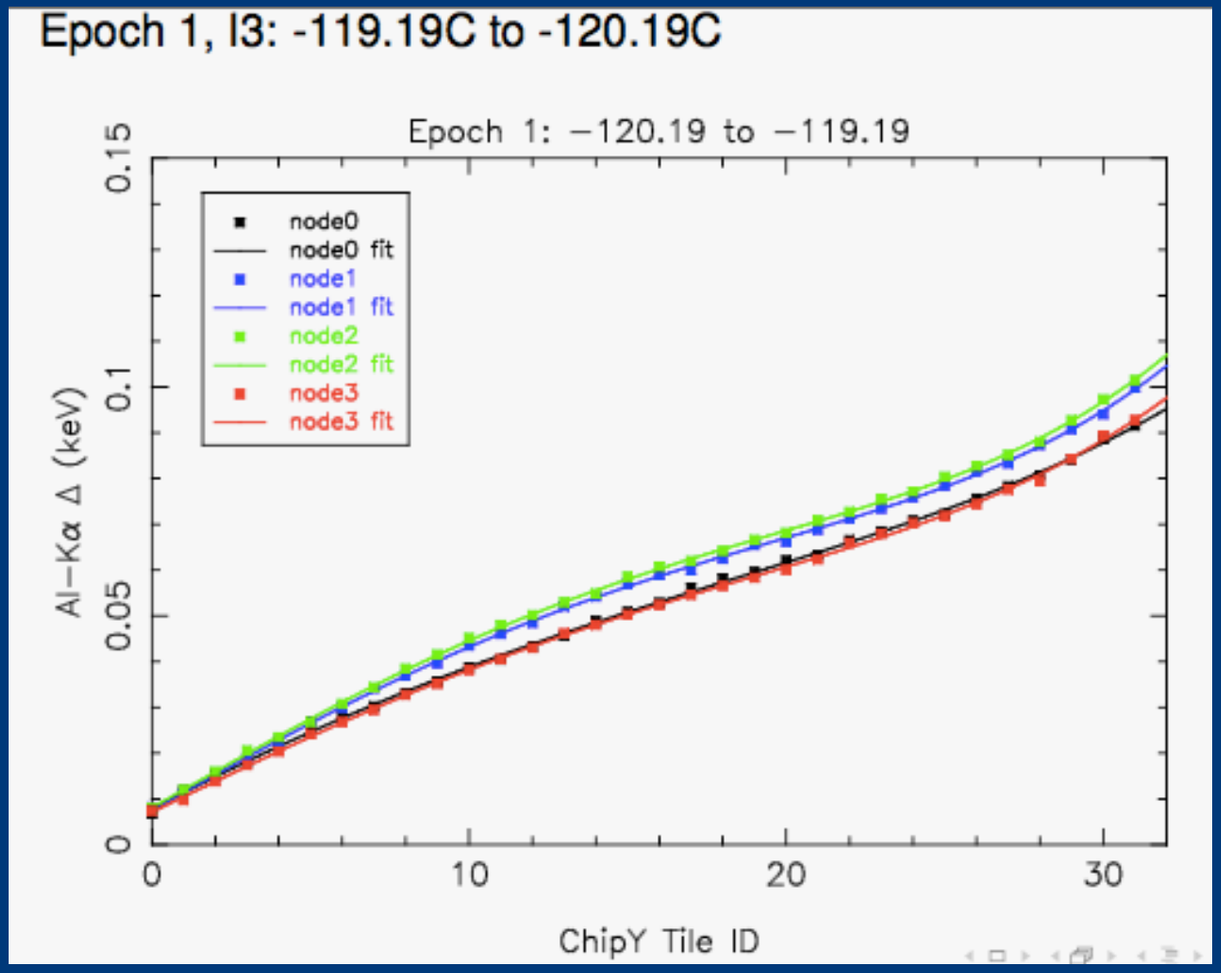
- 32 by 32 pixel regions
- every 3 months
- T < -119.2 C

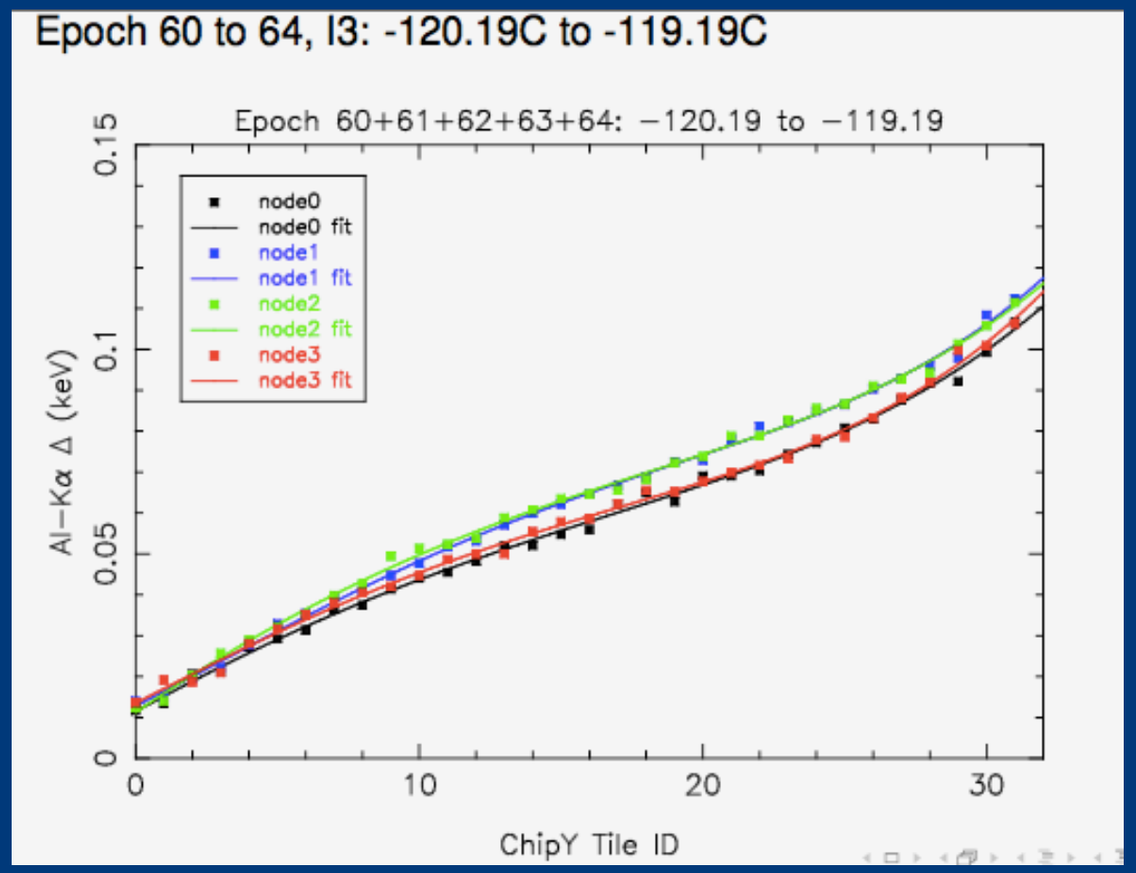
New tgain files (effective Sep., 2016):

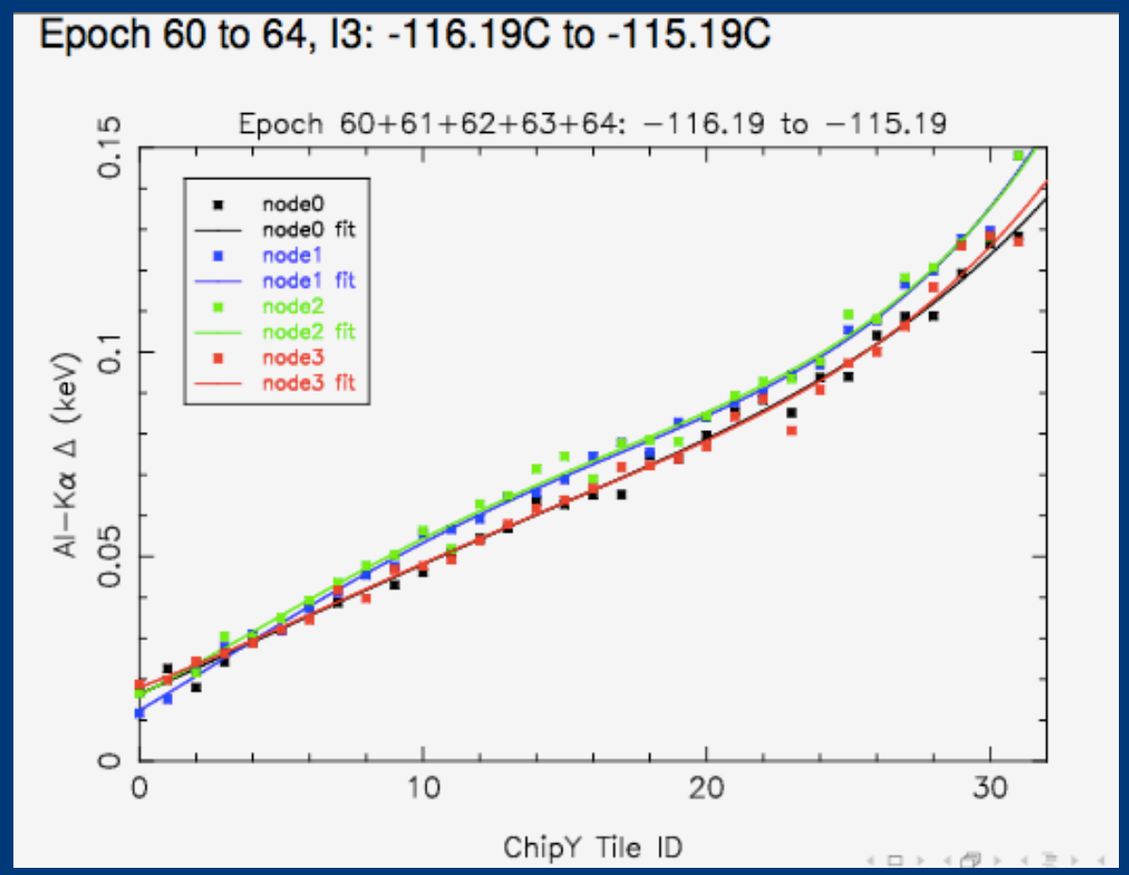
- 32 by 32 pixel regions
- Every 6 months
- T < -117.2 C

ACIS Spectral Resolution

ACIS-I3

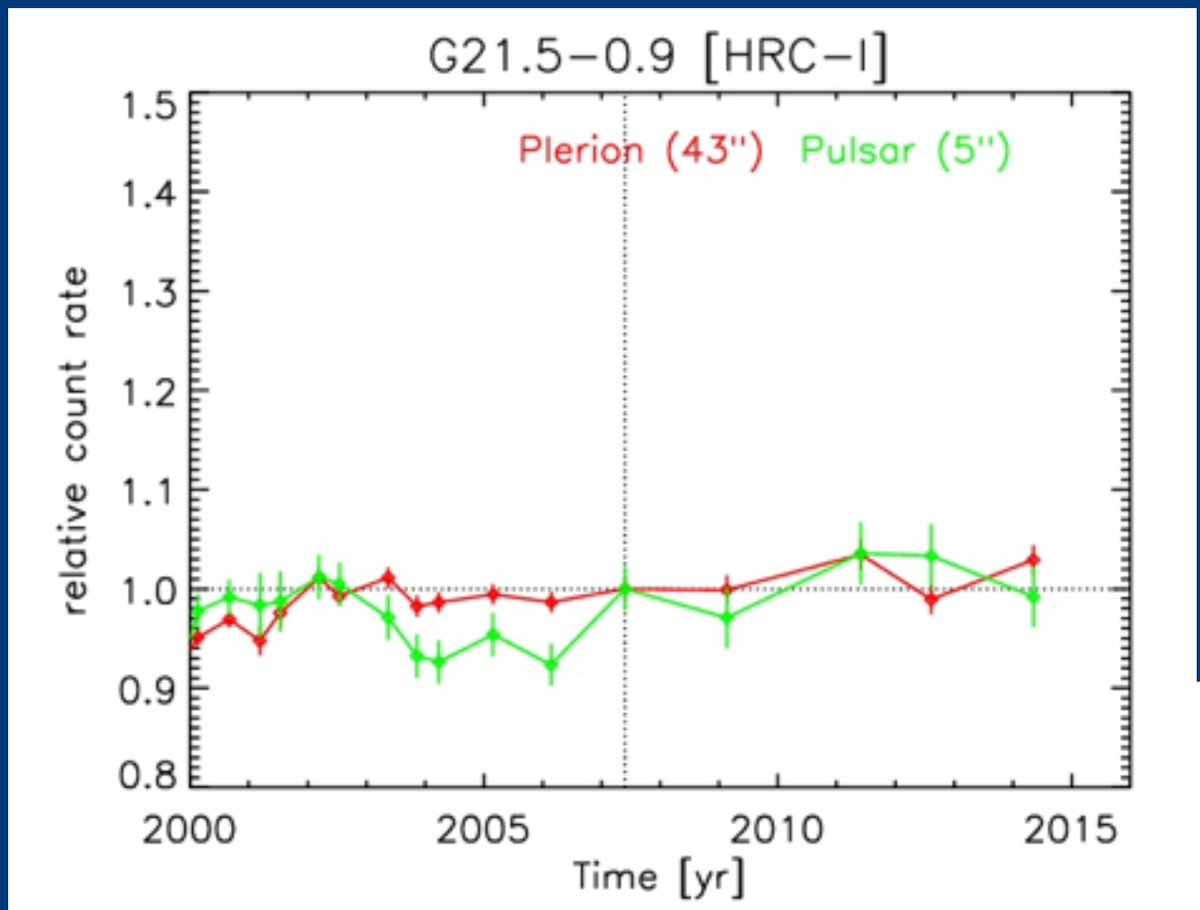






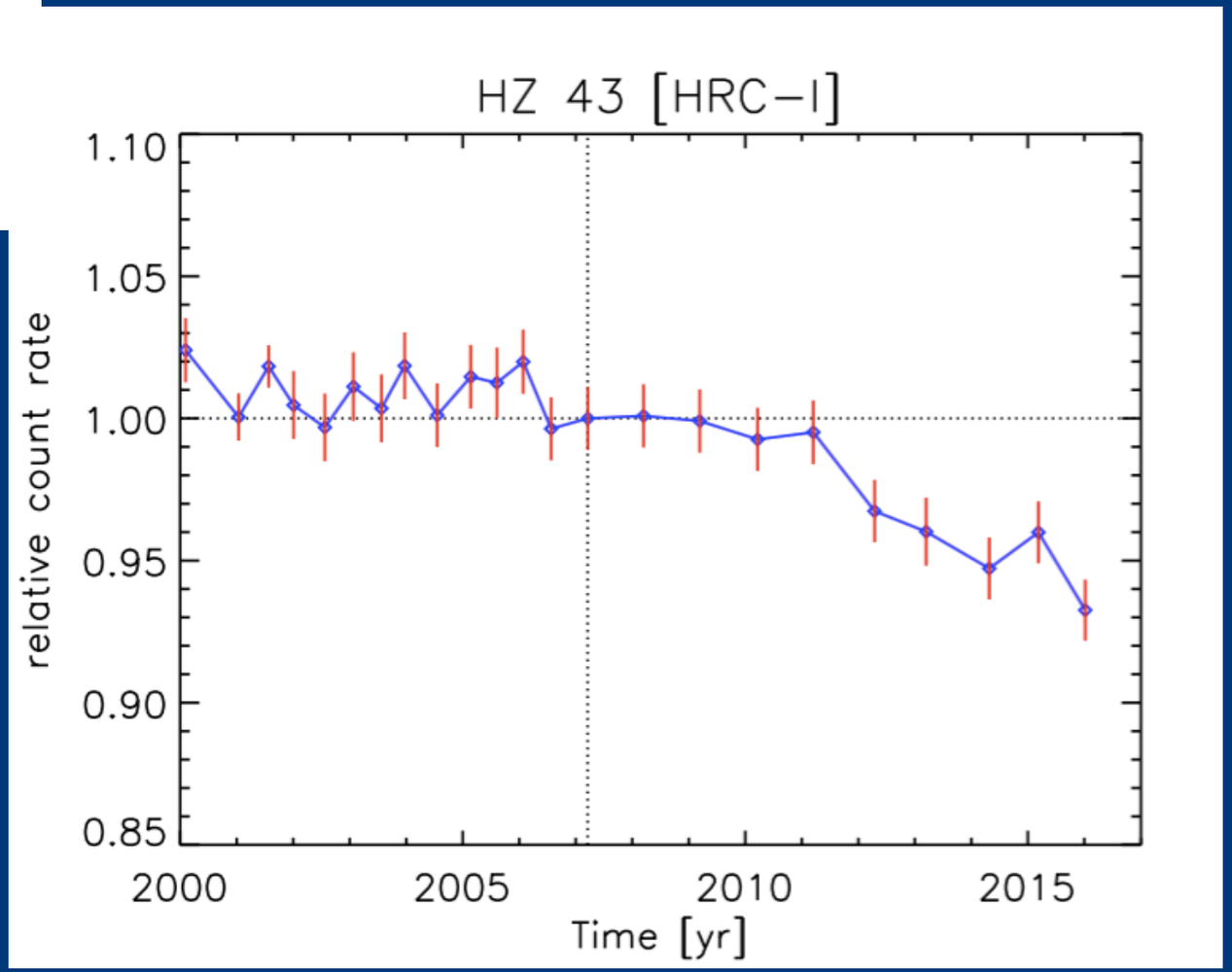
In the process of fitting ECS data taken over the course of mission with the goal of generating a set of time- and temperature-dependent scatter matrices.

HRC-I Calibration Status



Hard Soft

Soft Source



Empirical PSF Library

The Chandra data archive will continue to host the highest spatial resolution X-ray data available to the astronomical community for quite some time. On scales less than one arc second, the detector responses become very important.

Last Updated: 2016-Sep-25

Chandra Empirical PSF

V.L. Kashyap & D. Jerius

Summary

We have constructed empirical Chandra PSFs using on-axis HRC-I observations of AR Lac, using events filtered to remove most of the effects that cause the observed PSF to broaden.

Introduction

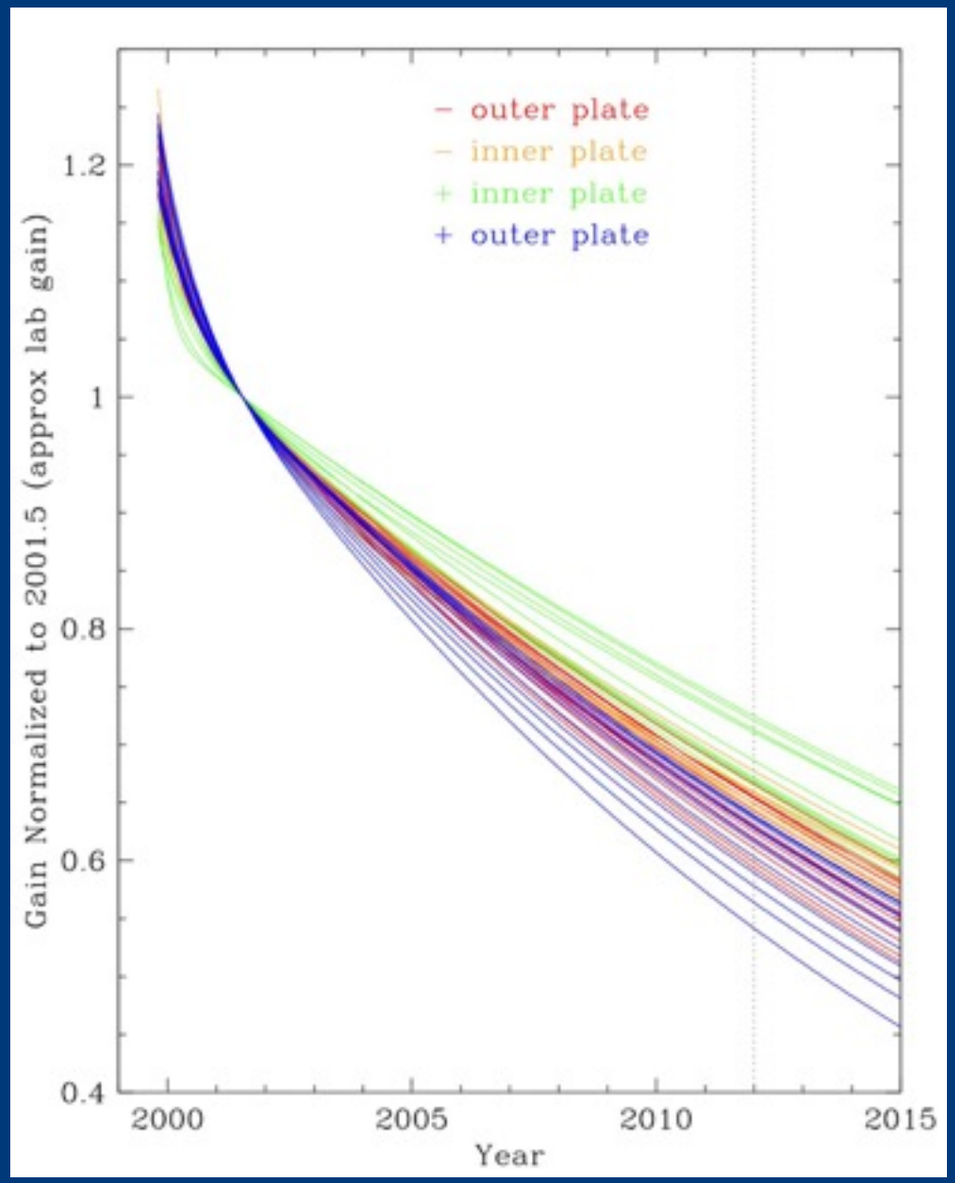
There are some known discrepancies between the raytrace model and the observed PSFs for Chandra. For example, the observed HRC profile is sharper than suggested by the model, despite the model not taking into account sources of systematic uncertainties like tailgating and degap; and in contrast, the observed ACIS profile is broader than suggested by the model, which is attributable to an incomplete model of the ACIS pixellation and to the difficulties of obtaining a "clean" unpiled point source.

We have therefore undertaken to put together an empirical model of the on-axis PSF using HRC-I observations of AR Lac. AR Lac is an unresolved spectroscopic eclipsing RS Cvn type binary (K0IV+G5IV, m_V=6.11, d=43 pc), which emits optically thin radiative emission primarily in the 1-10 MK temperature range. It has been observed regularly over the Chandra mission as part of a calibration program to monitor the HRC gain. It has been known to flare often, though the base emission is steady (Drake et al. 2014)

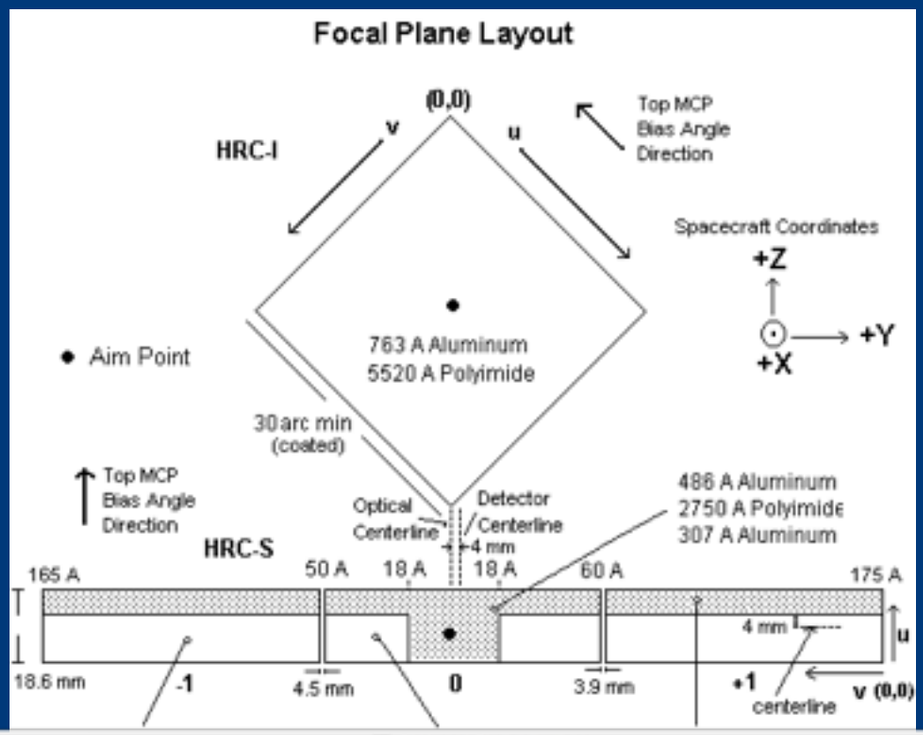
We expect the images provided below to be useful for carrying out comparisons with observed datasets, as well as for further calibration efforts to improve the SAOtrace raytrace model. Care must be used before these images are used to compare to ACIS sources, since the effects of the HRC detector PSF has not been removed from them. That is, these images must be first deconvolved using the HRC detector PSF, and then blurred with a model of the ACIS detector PSF before comparing with on-axis ACIS sources. Efforts to construct a direct ACIS counterpart of the empirical PSF using a variety of on-axis sources are ongoing.

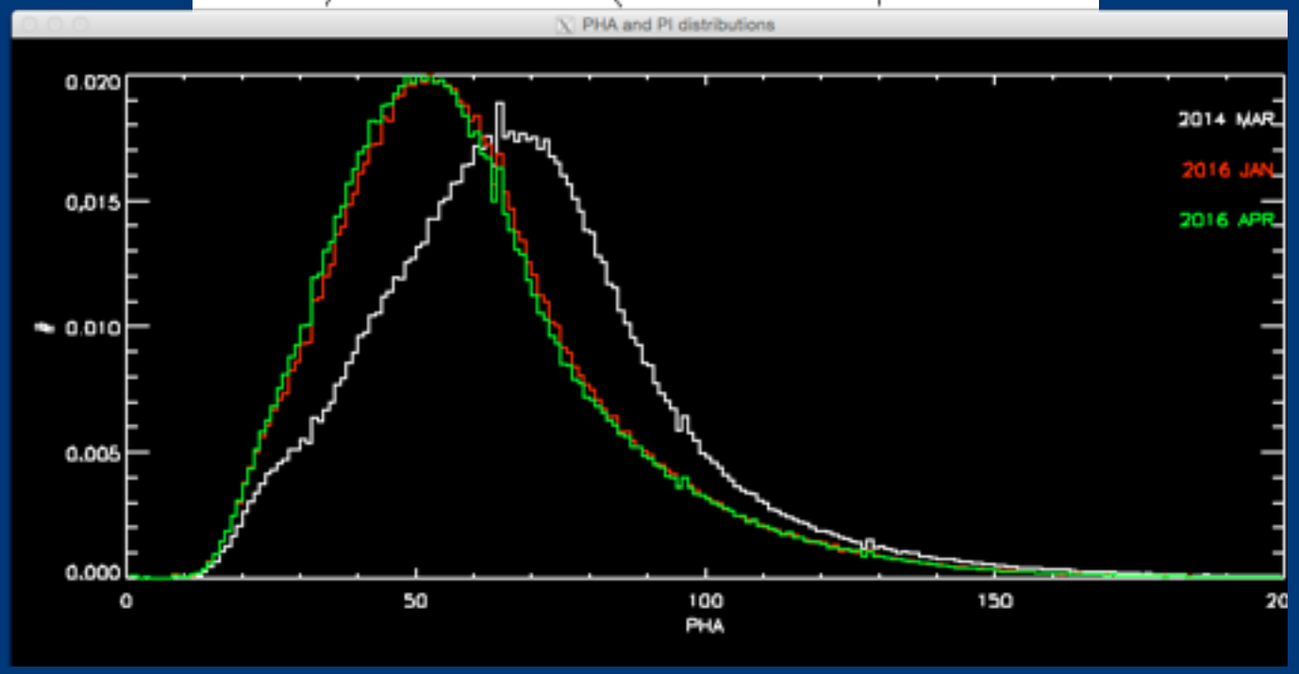
LETG/HRC-S Calibration Status

The Chandra Calibration plan includes annual HRC-I and LETG/ HRC-S observations of the white dwarf HZ43



~10% gain loss per year

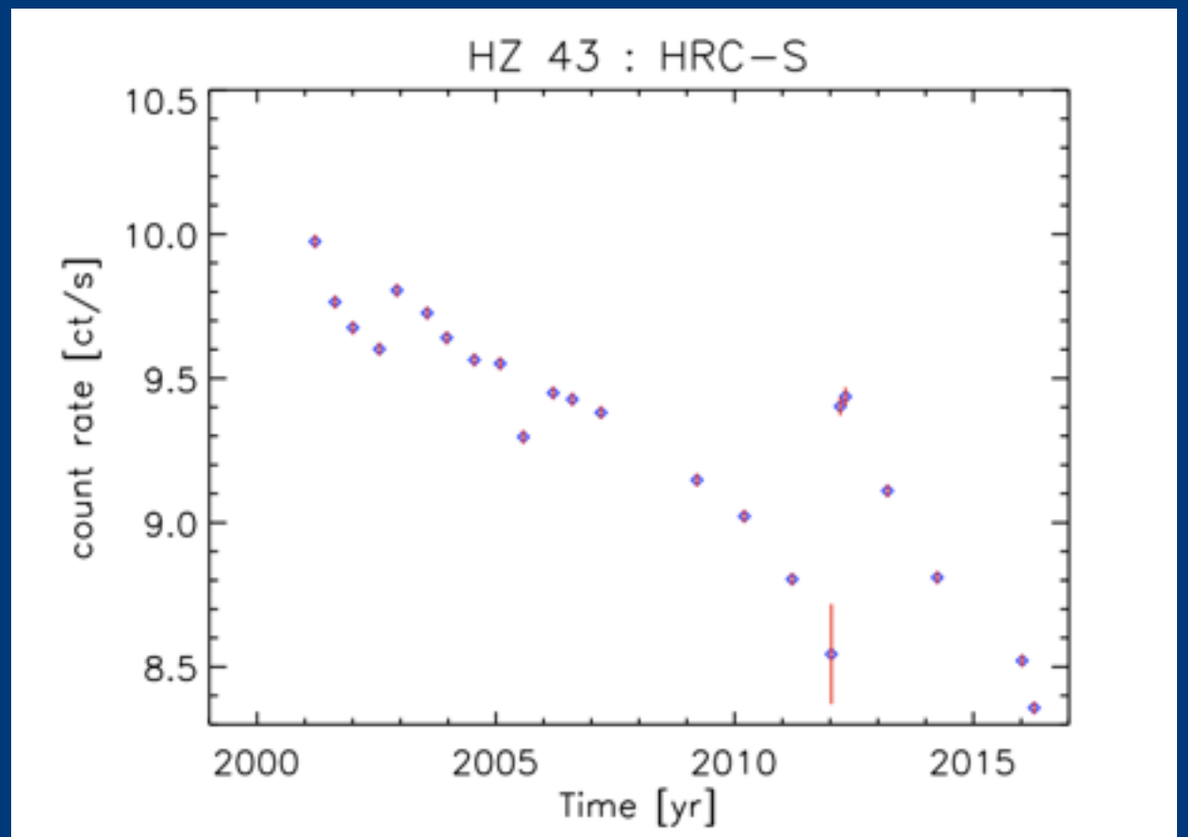




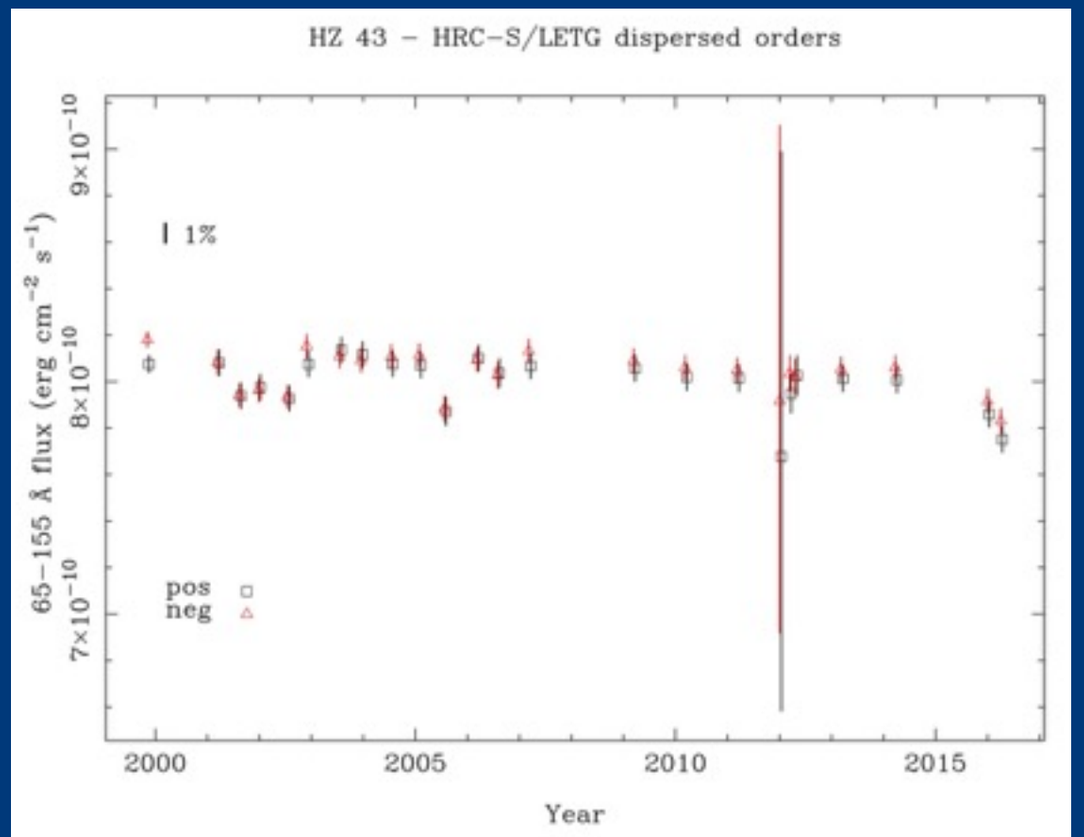
LETG/HRC-S Calibration Status

The degradation in the HRC gain and QE is corrected with annually calibrated gain maps (derived from AR Lac raster scans) and QE maps. Prior to 2009, the QE maps applied a wavelength-dependent correction. Since 2009, a wavelength-dependent correction is also applied.

Uncorrected LETG/HRC-S data



Corrected LETG/HRC-S data



2-3% QE loss per year

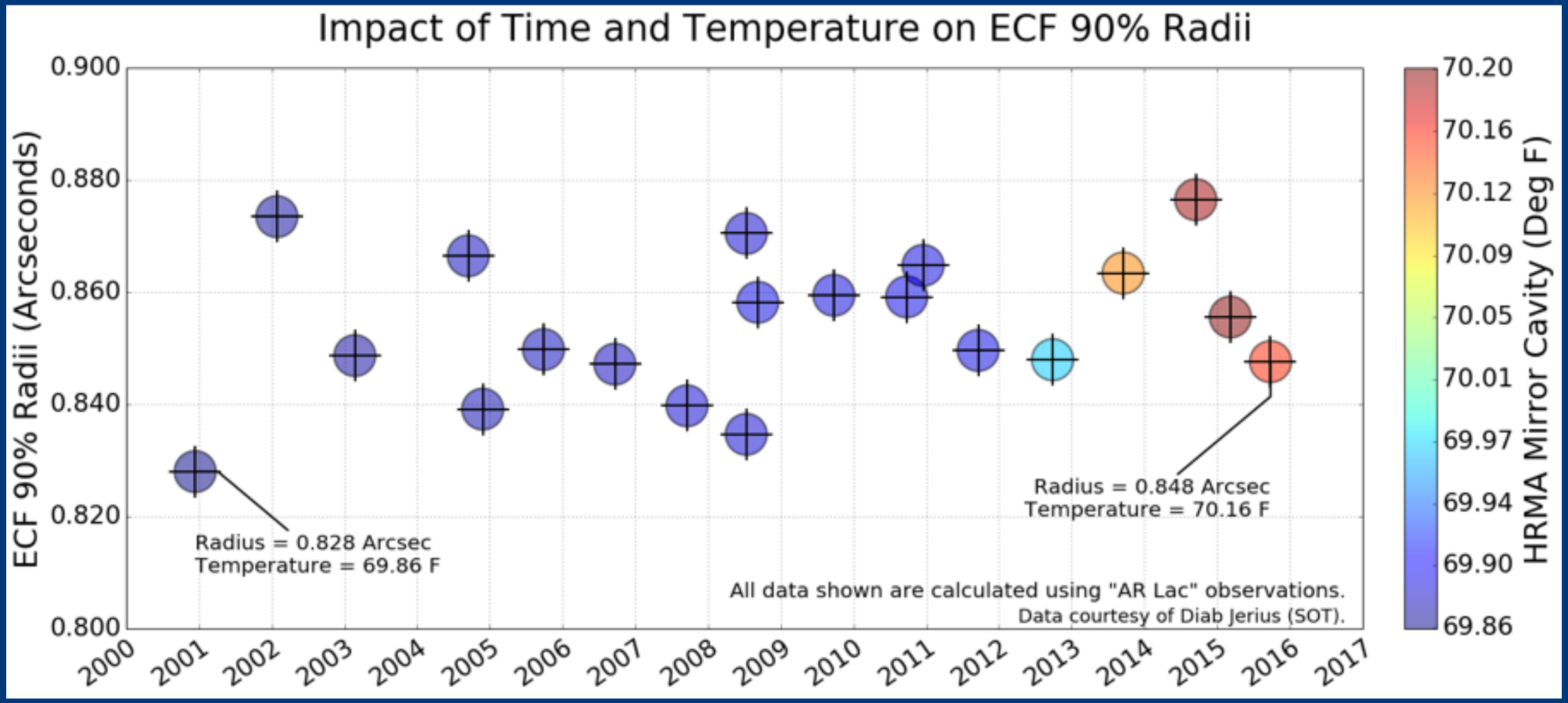
LETG/HRC-S Calibration Status

Future Plans

- There are no plans at the present time to further increase the HV. Any adjustment to the operating HV of the HRC-S posses some risk.
- As in the past, any further QE or gain loss will be corrected through the release of annual QE maps and PIMMS tables.
- Even an increase of 20% in the exposure time of LETG/HRC-S observations will not have a significant impact on the overall Chandra observing budget.

HRMA Calibration

Stability of Chandra Imaging



Matt Dahmer / Northrup Grumman

AO-18 Calibration Plan

Total exposure time for AO-18 is 999 ksec which is an increase of 167 ksec over last year's plan. The increase in exposure time is mainly due to the continued decline in ACIS effective area below 2 keV due to the build-up of contamination.

Break down:

ACIS (NONE+LETG) - 76%

- Two sets of Big Dither observations (Dec. and Jun.) - 360 ksec
- One full A1795 raster scan (Apr.) - 295 ksec
- ACIS-S and ACIS-I aim-point observations of A1795 six months after the full raster scan (Oct.)
- .A set of three E0102 observations on ACIS-S and one at the ACIS-I aim-point (Feb.)

AO-18 Calibration Plan

HRC (NONE+LETG) - 12%

- Three LETG/HRC-S observations of HZ43 (Nov., Mar. and Jul.) to monitor the QE decline
- HRC-I and HRC-S AR Lac raster scans used to derive gain maps.
- Two HRC-I on-axis observations of AR Lac to monitor the PSF (Sep. and Feb.)

Remaining gratings observations - 12%

- Interleaved detector/gratings observations of Mkn 421
- Coordinated (XMM-Newton, NuStar and SWIFT) observations of 3C 273

Calibration Schedule

ACIS

- Release a new ACIS QE map for the period 2012-2016.
- Release a set of ACIS blank sky background images.
- Release a set of time and temperature dependent scatter matrices
- Revise the software used to generate the time-dependent gain maps.
- Monitor the ACIS contamination.
- Screen for background flares.
- Investigate the possibility of using astronomical sources for the generation of the gain maps.

HRC

- Continue studies on optimizing the HRC-I PSF.
- Release an updated HRC-I QE map.
- Develop a time-dependent HRC-I QE.
- Monitor the gain and QE of the HRC detectors.

Calibration Schedule

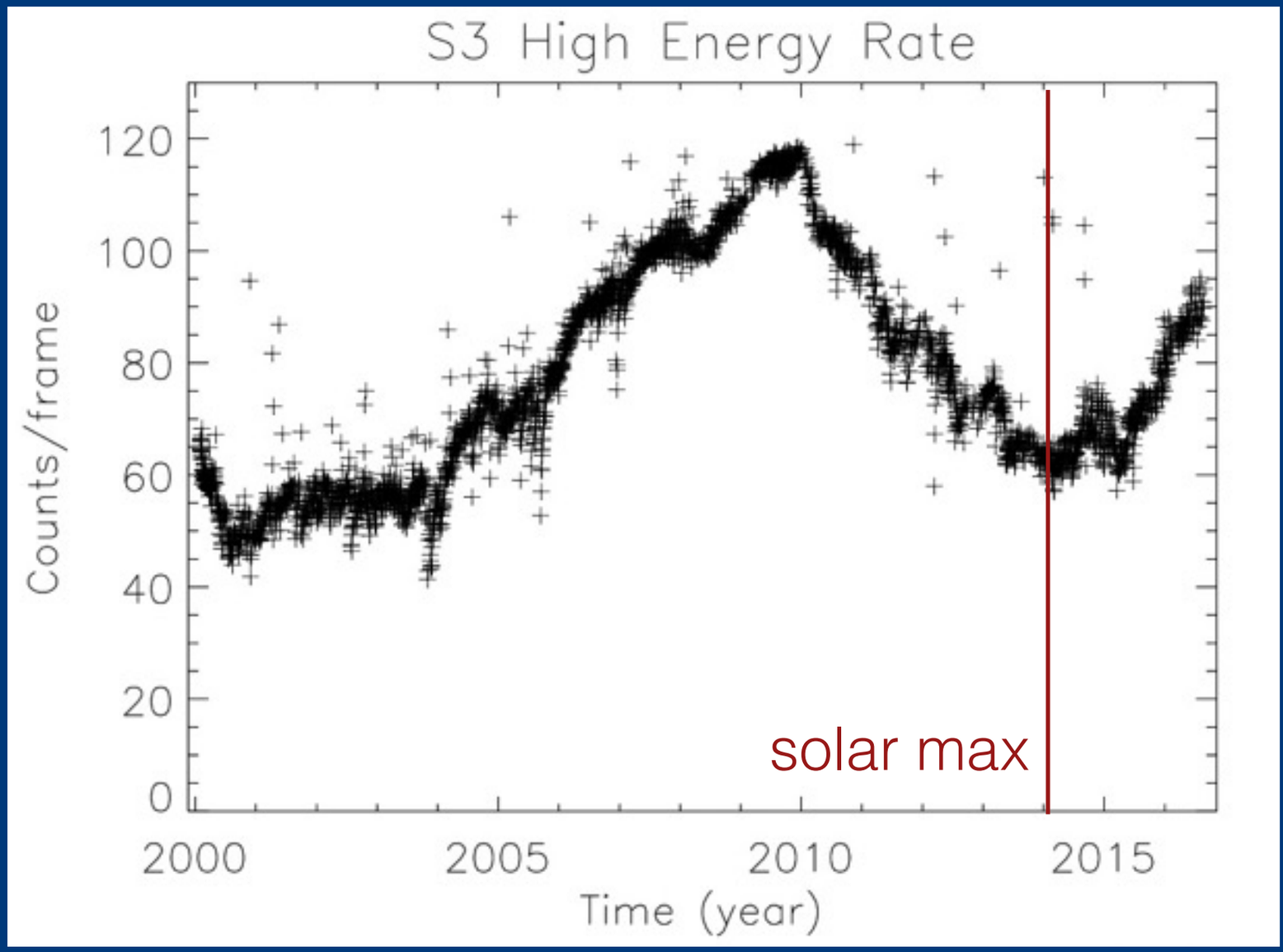
Gratings

- Determine if update are required to the transmission efficiencies of the 0th and higher orders of the HETG
- Release an updated HRC-S de-gap map to correct an off-set in the 0th order location and some residuals in the wavelength scale.
- Improve the LETG/HRC-S effective area calibration near the O and C K-edges
- Release the annual wavelength-dependent HRC-S QE map
- The extraction efficiency for LETG/HRC-S data was re-calibrated in 2015. The same now needs to be done for LETG/ACIS-S data

HRMA/SAOTrace

- Port SAOTrace to latest versions of CentOS, Mac OS X, Linux Mint.
- Add ability to read HEASARC SIMPUT (i.e., simulated input files)
- Incorporate improved method for simulating PSF/Wings into SAOTrace
- Post a web-based HRMA users guide.

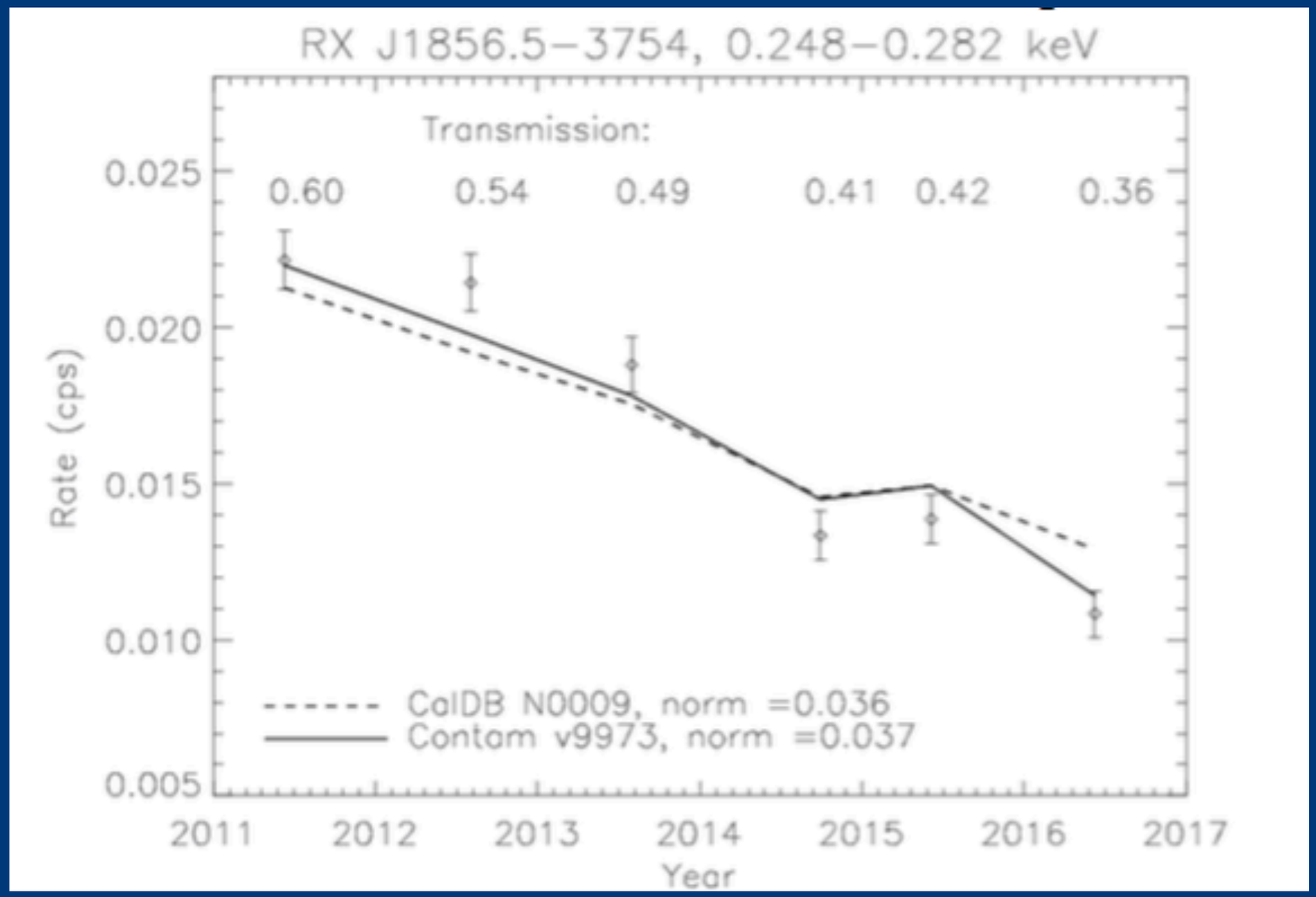
ACIS Background



A new set of ACIS blank sky background files are being compiled. Now that data has been accumulated for more than a full solar cycle, studies can be carried-out to determine if there are any significant changes in the charge particle-induced detector background between cycles.

ACIS Effective Area - Monitoring the Contamination

LETG/ACIS-S observations of Isolated Neutron Star RXJ1856-3754



- Absorption below the C-K edge is dominated by L shell absorption of C, O and F.
- No evidence for absorption from H, but the would require H/C>1000.
- Opacity increase of a factor of two over the past five years.