Characterizing the contaminant on Chandra ACIS using Abell 1795 observations

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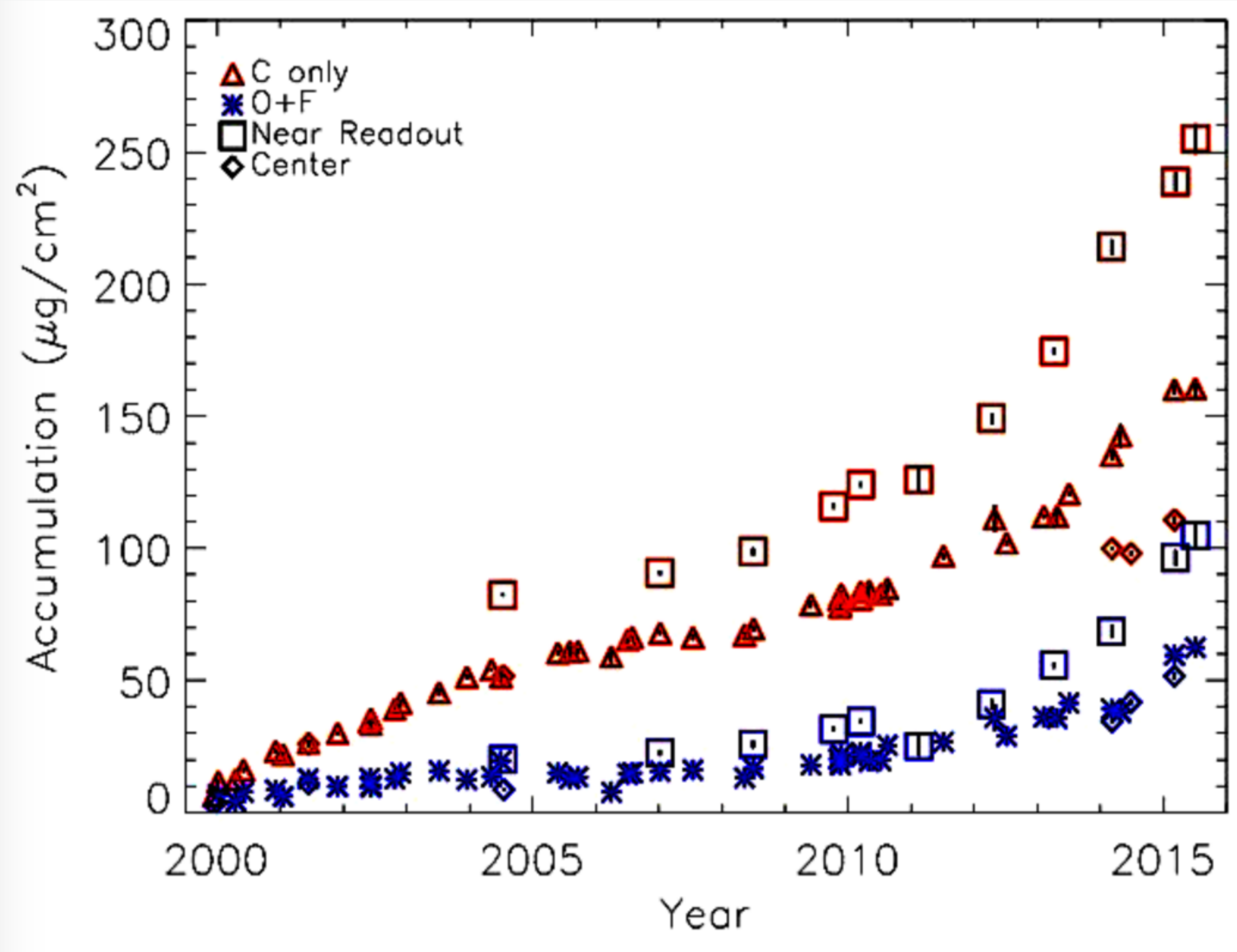
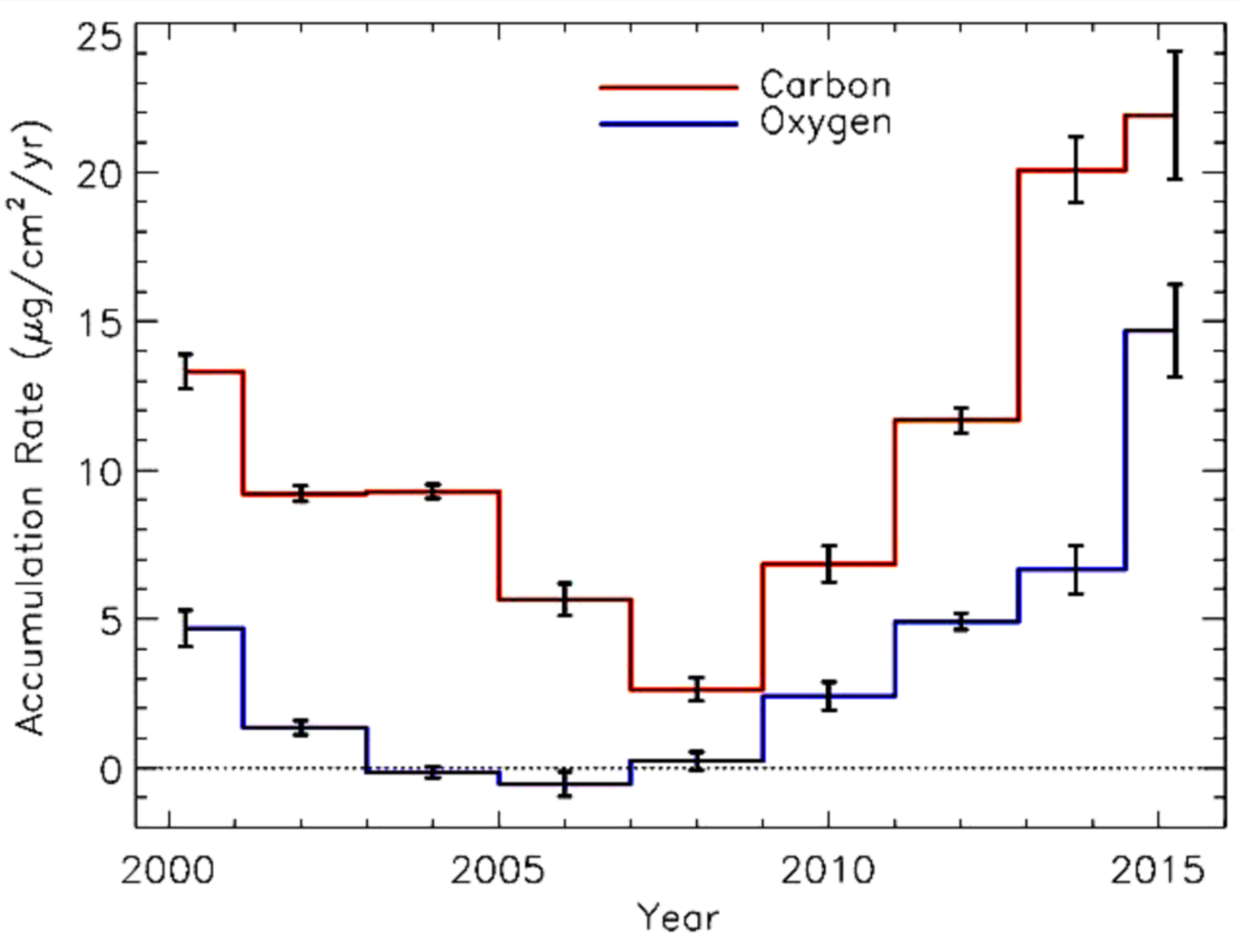
International Astronomical Consortium for High Energy Calibration

Contaminant on the OBF

- Molecular contaminant on the ACIS optical blocking filter
- Absorption from C, O, F
- Time dependence
- Spatial dependence
- Time dependent chemical composition





O'Dell et al. 2015

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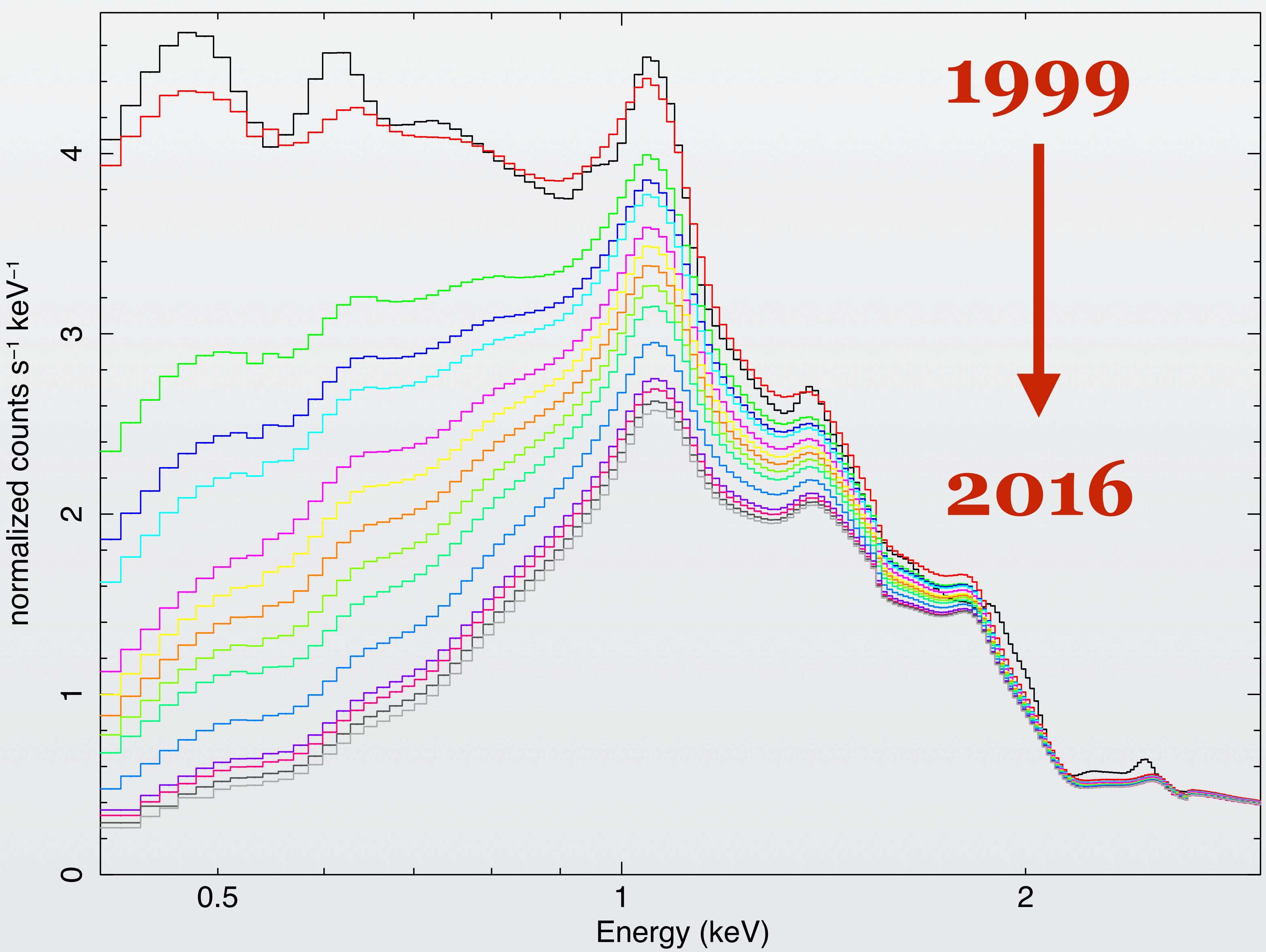

Monitoring the contaminant

Multi-prong approach to monitor the buildup of the contaminant

- Abell 1795
  - time dependence
  - spatial structure
  - covers ACIS-S and ACIS-I
- Blazars (e.g. Mkn 421)
  - time dependence
  - spatial structure
  - chemical composition
  - covers ACIS-S
- E0102
  - independent verification of contamination models
- ECS data
  - time dependence
  - spatial structure
  - covers ACIS-S and ACIS-I
  - fading due to its 2.7 years half-life

Monitoring the contaminant

Multi-prong attack to monitor the buildup of the contaminant

- **Abell 1795**
  - **time dependence**
  - **spatial structure**
  - **covers ACIS-S and ACIS-I**
- Blazars (e.g. Mkn 421)
  - time dependence
  - spatial structure
  - chemical composition
  - covers ACIS-I
- E0102
  - independent verification of contamination models
- ECS data
  - time dependence
  - spatial structure
  - covers ACIS-S and ACIS-I
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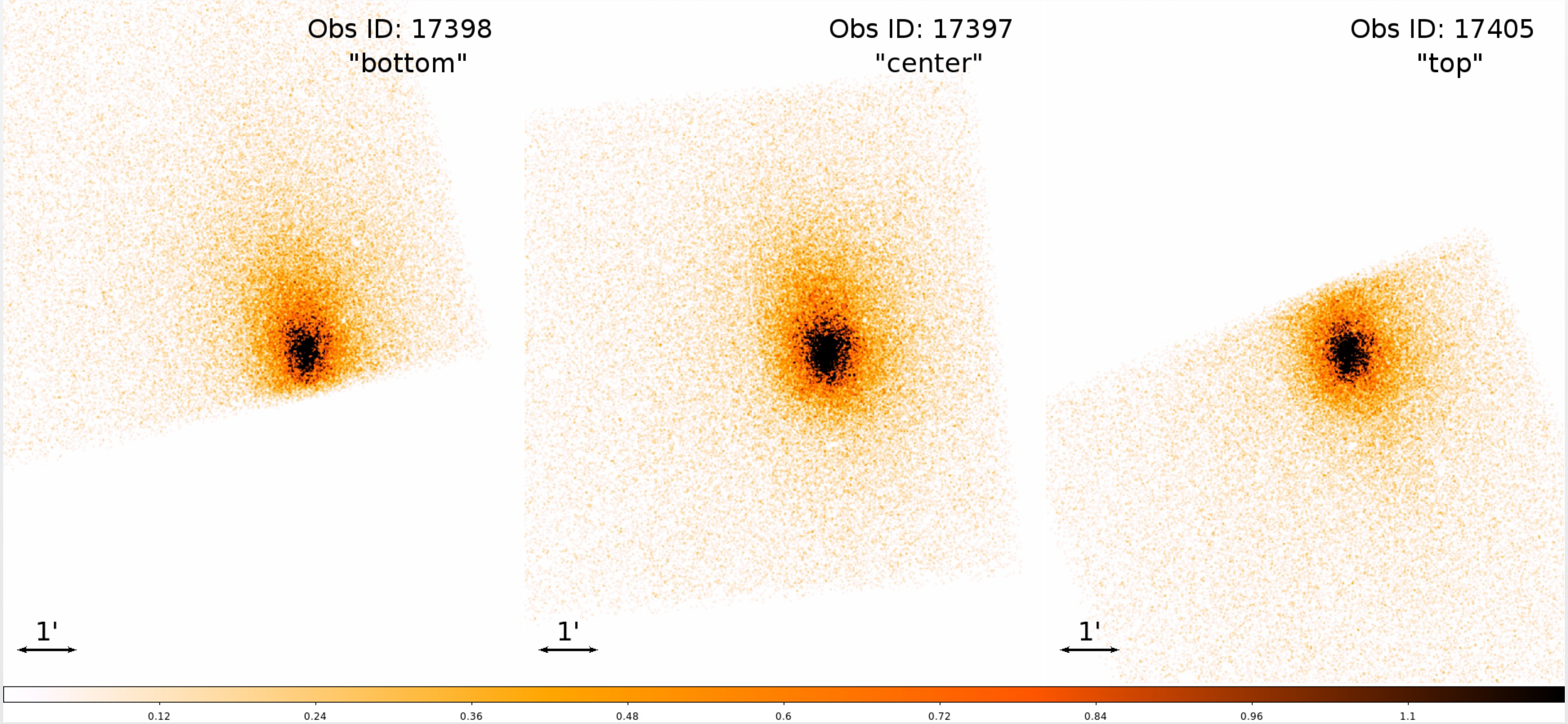
ACIS observations of A1795

- Raster scan with ACIS-S and ACIS-I once every year
- 3 pointings with ACIS-S
- 12 pointings with ACIS-I
- Monitor the aimpoint every 6 months



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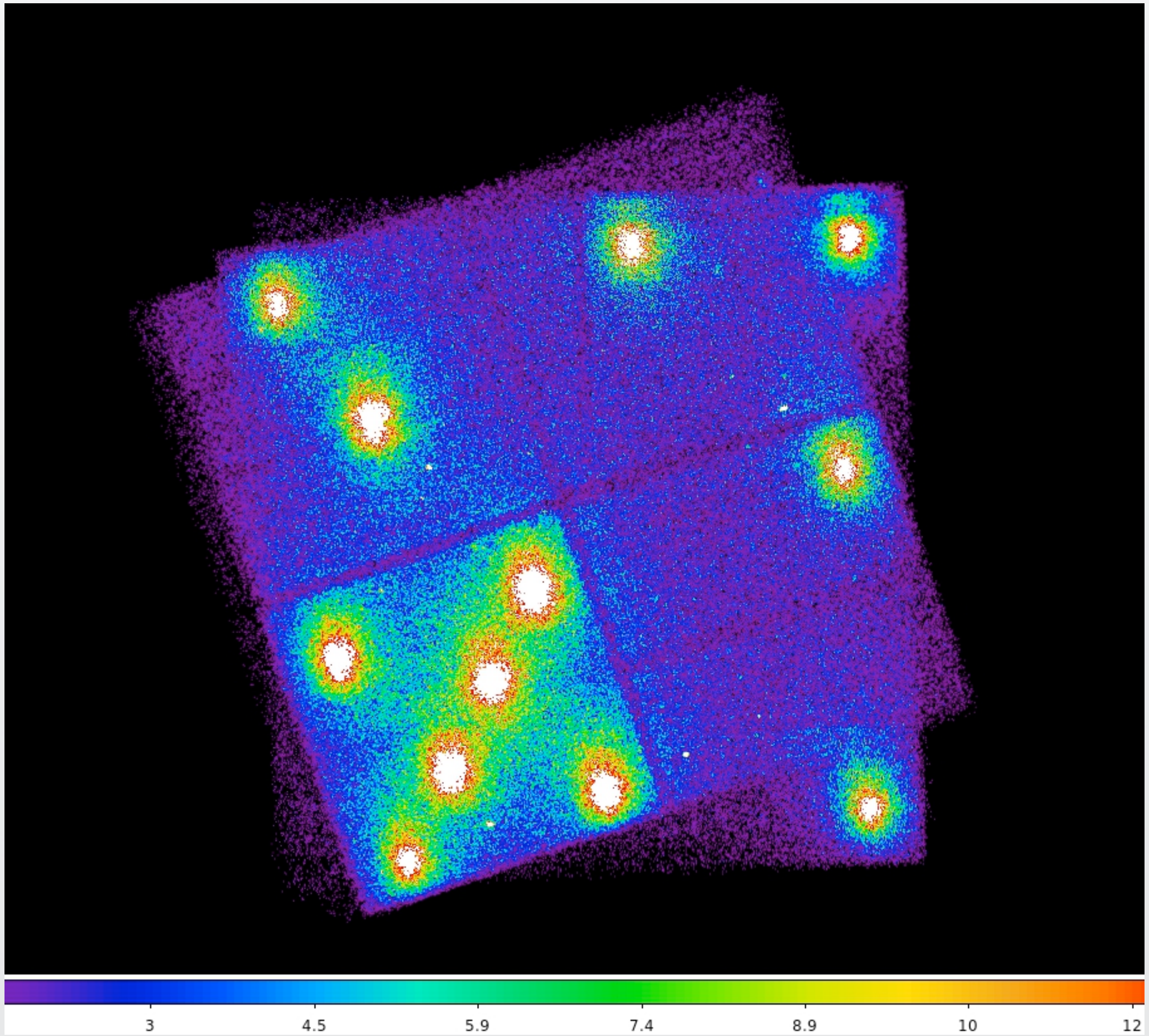
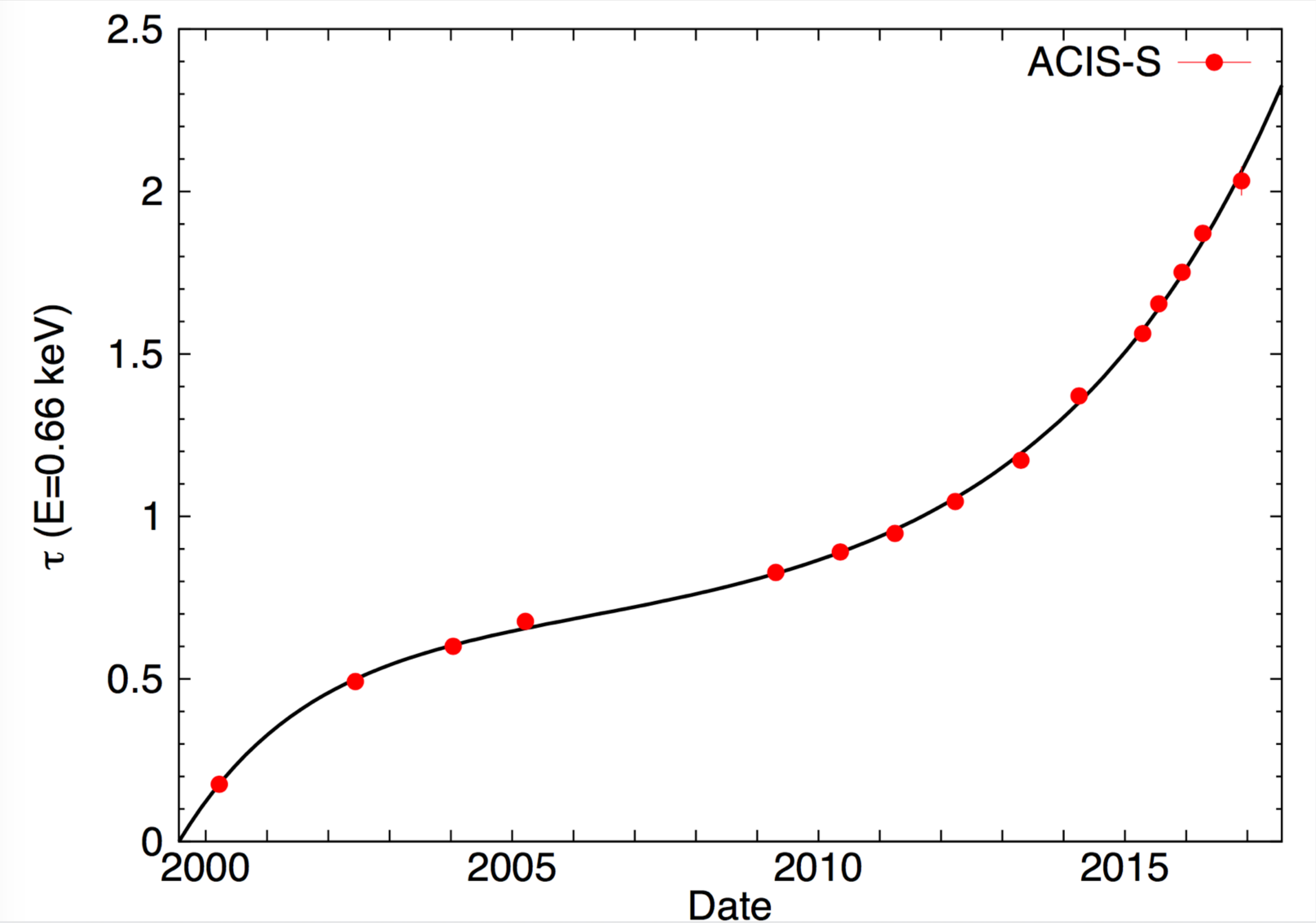


Time dependence of the contaminant

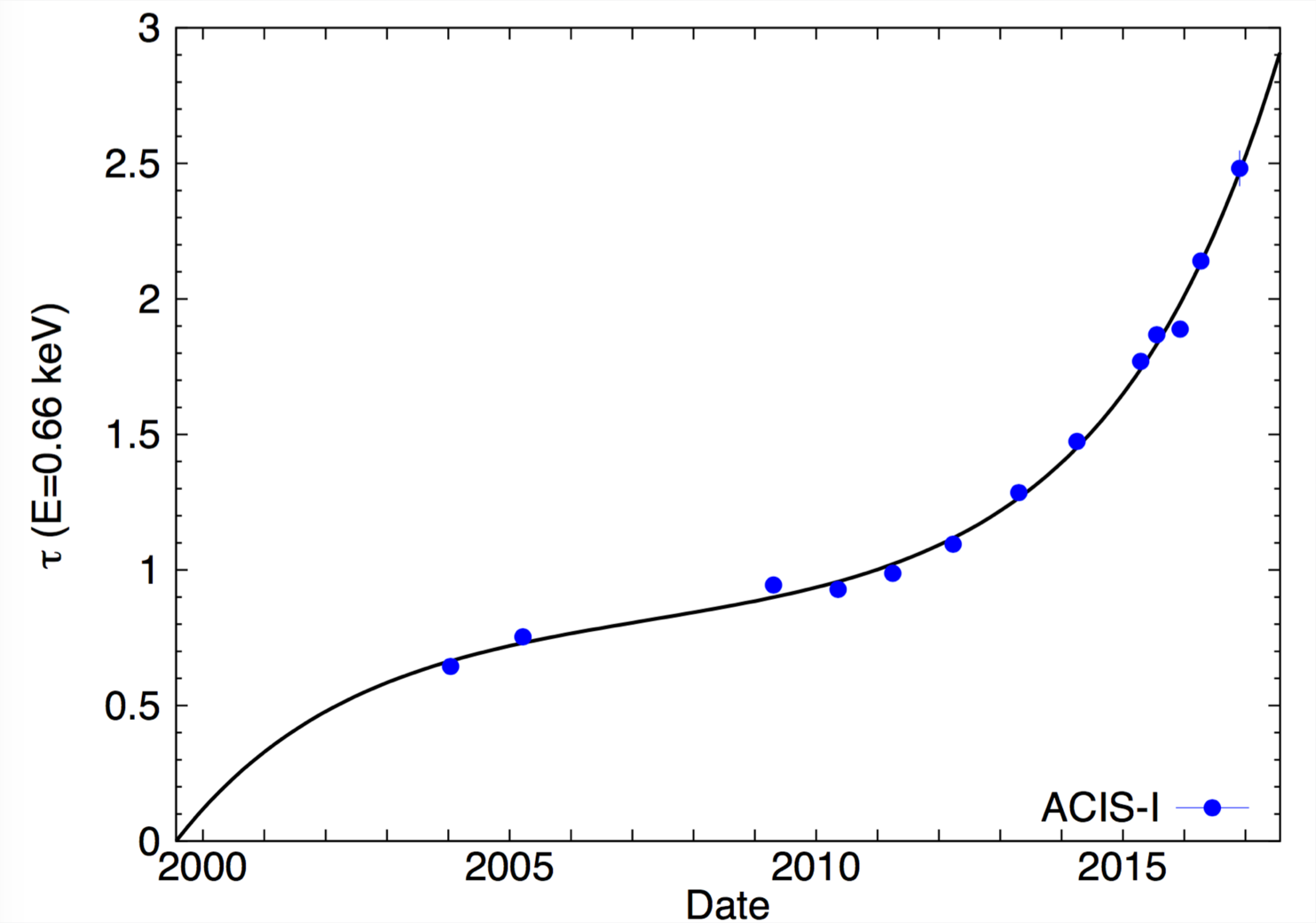
- Each observation is 10-20 ks
- Uniform data analysis procedure

- Computing the time dependence:
  - point sources excluded
  - spectral characteristics of Obs ID 494 (December 1999) used as reference by extracting circular region with 65” radius centered on A1795
  - spectrum described with Galactic column density, APEC models, and ACIS contamination with fixed O/C and F/C ratios
  - For subsequent observations the spectra of the same 65” circular region is extracted with the contamination correction turned off
  - The follow-up spectra are fit with best fit spectrum obtained from Obs ID 494 and additional ACIS contamination

Time dependence of contaminant in the center of ACIS-S



Time dependence of contaminant in the center of ACIS-I



Conclusions on the time dependence of the contaminant in the center

- Exponential buildup of the molecular contamination on the OBF continues

- The time evolution of the contaminant can be described with two exponential models

- Although ACIS-S and ACIS-I had similar optical depths until about 2012, more recently ACIS-I appears to have higher contaminant level

Spatial structure of the contaminant

- Each observation is about 10 ks
- Uniform data analysis procedure

- Computing the shape of the spatial structure:
  - point sources excluded
  - for each epoch a grid is defined centered on the center of A1795 extending along y direction of the detector
  - Spectra for each regions is extracted and ARFs are generated with the contamination correction turned off
  - For regions in the top/bottom chipy regions the extra contamination relative to the center is determined by extracting the spectrum in the same region and adding an extra contamination component
  - spectra are described with Galactic column density, single temperature APEC model, and ACIS contamination models with fixed O/C and F/C ratios

Spatial structure of the contaminant

- Raster scan with ACIS-S and ACIS-I once every year
- 3 pointings with ACIS-S
- 12 pointings with ACIS-I
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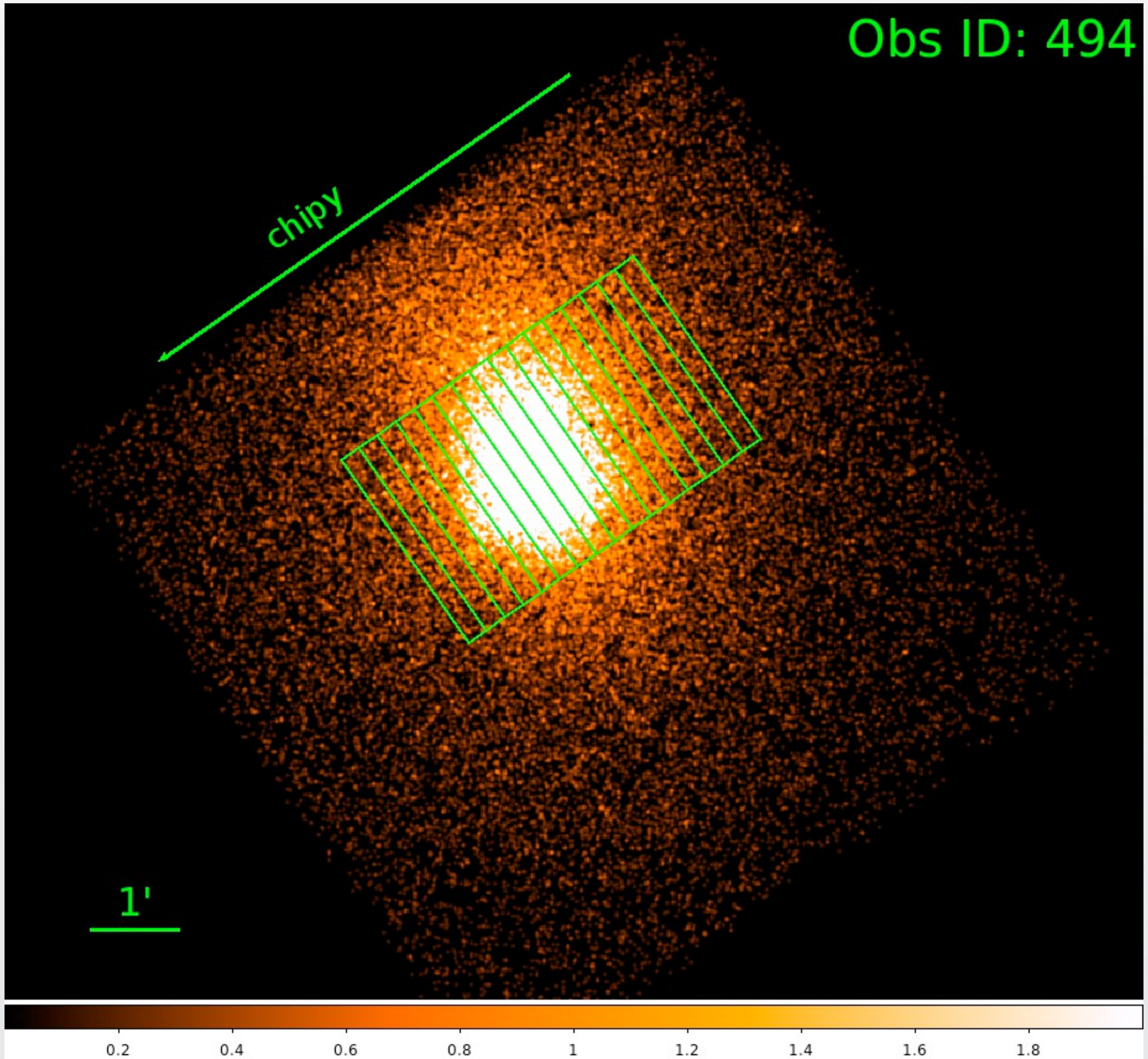
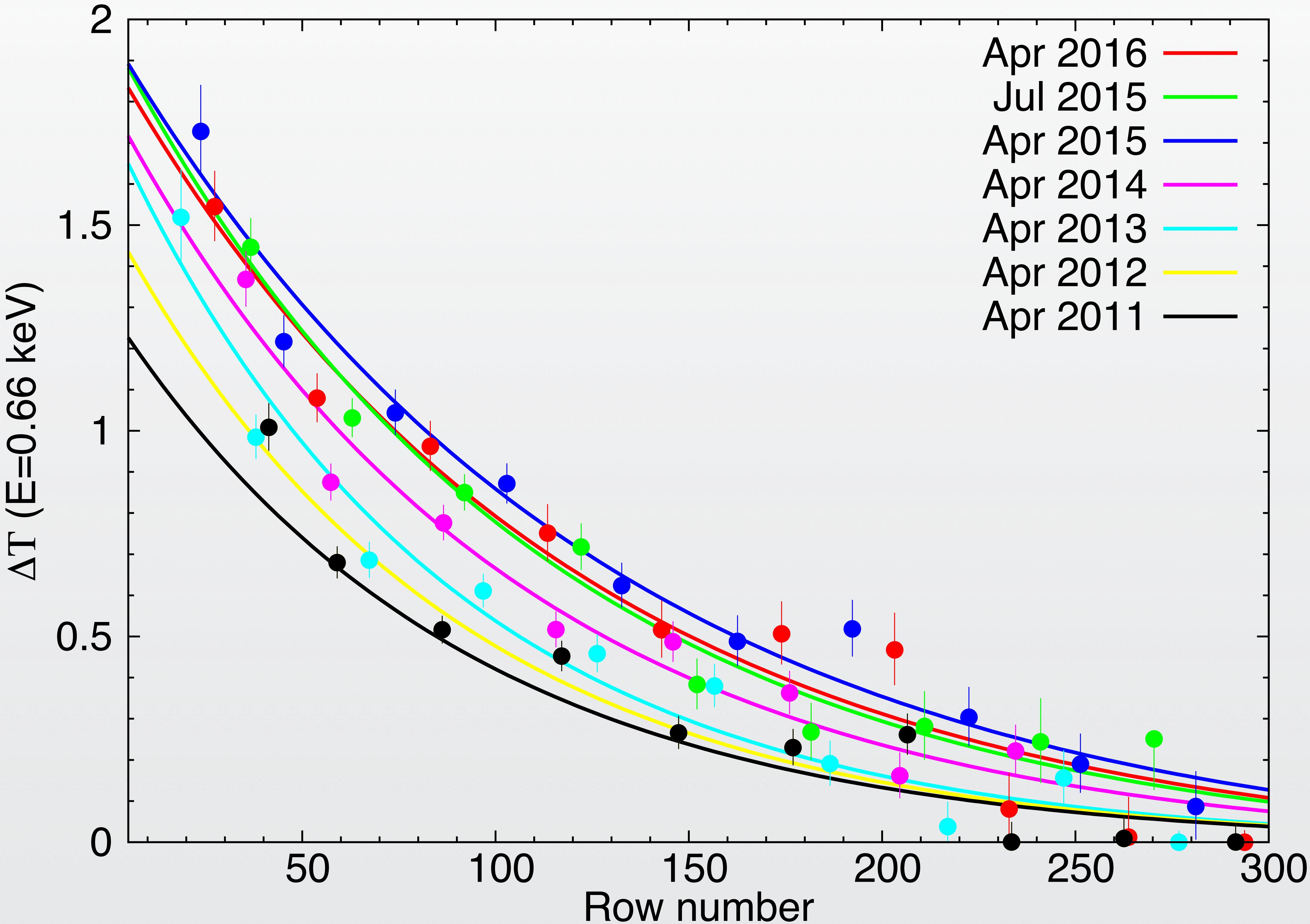
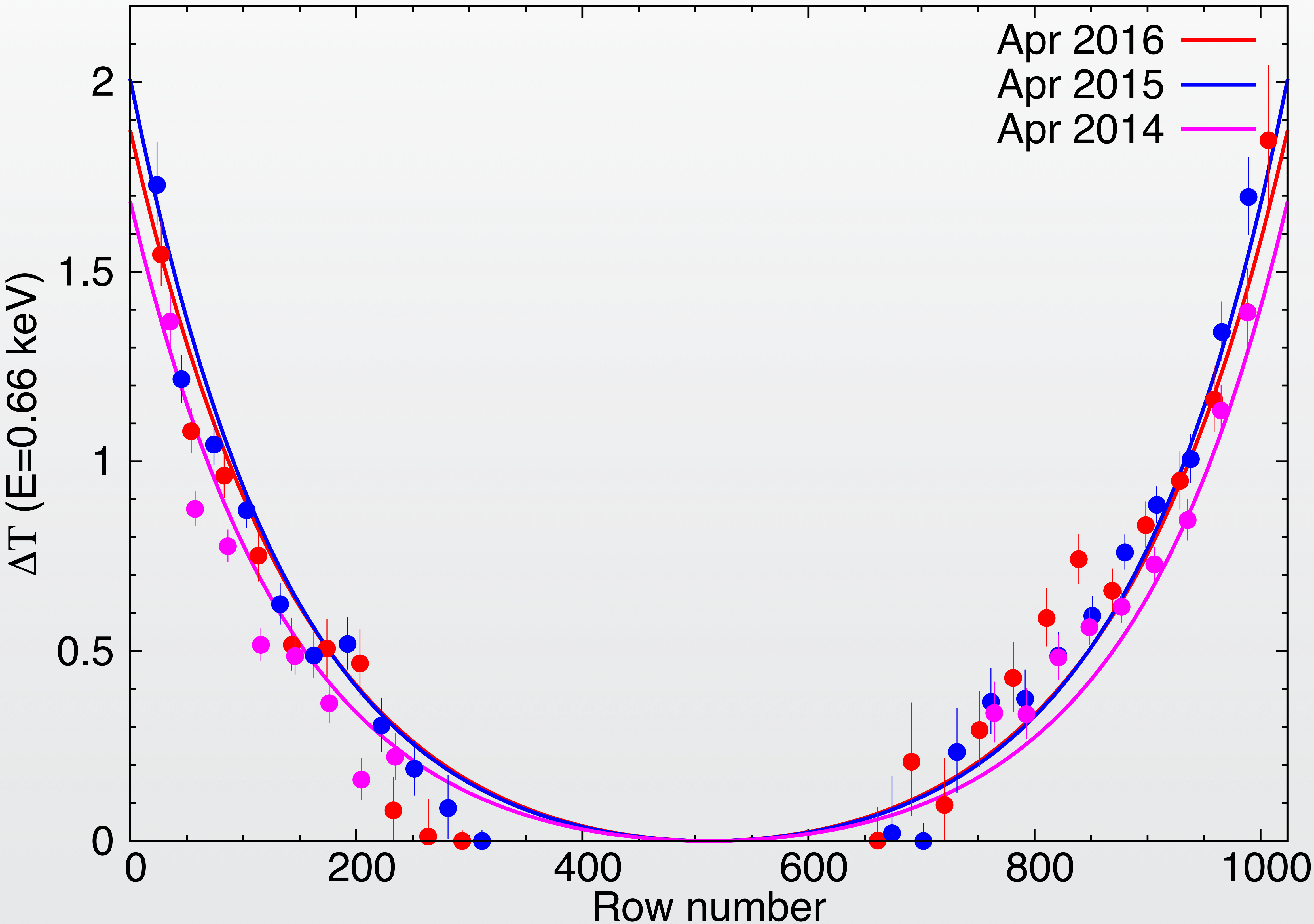


Shape of the spatial structure of the contaminant on ACIS-S

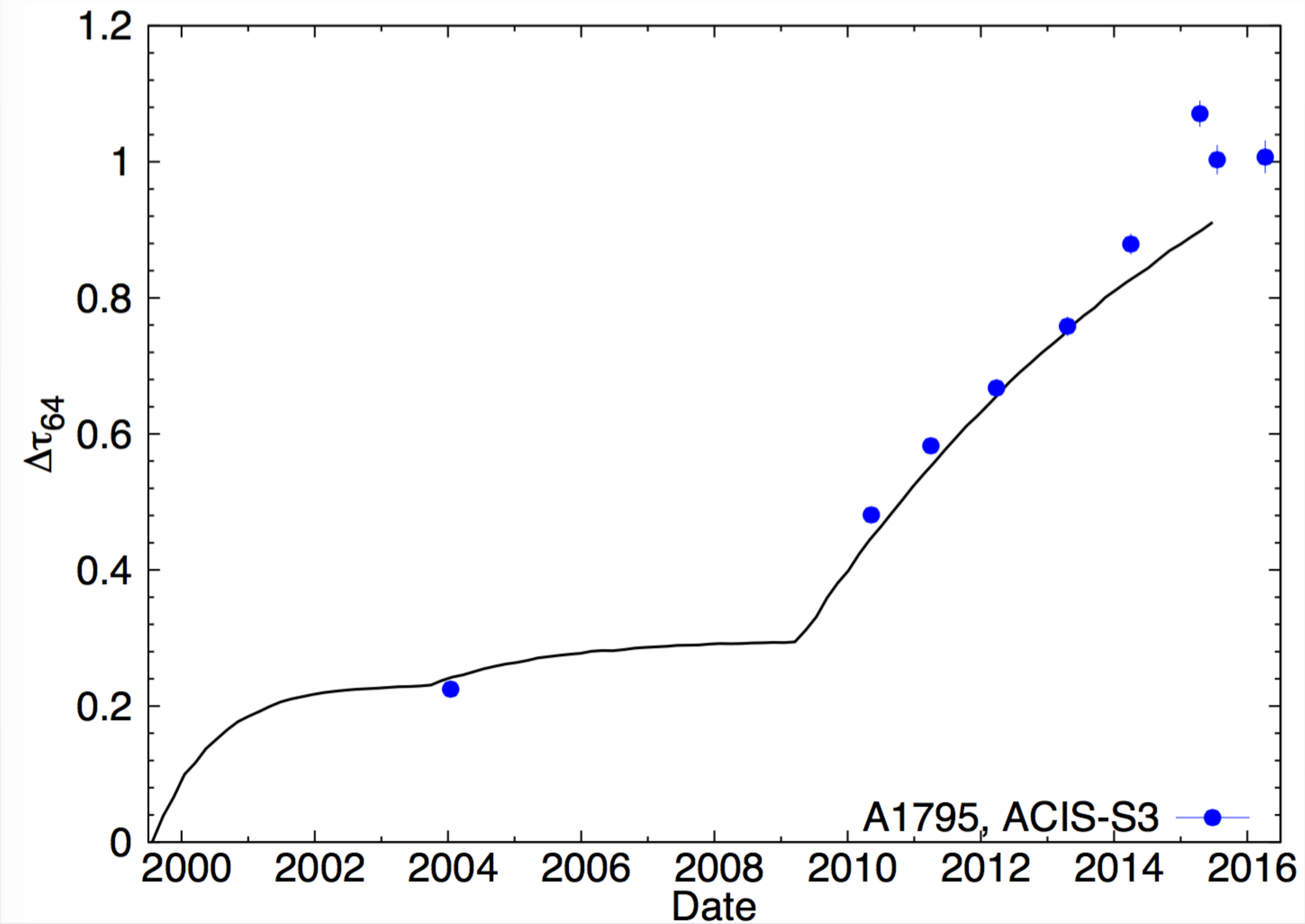


Shape of the spatial structure of the contaminant on ACIS-S



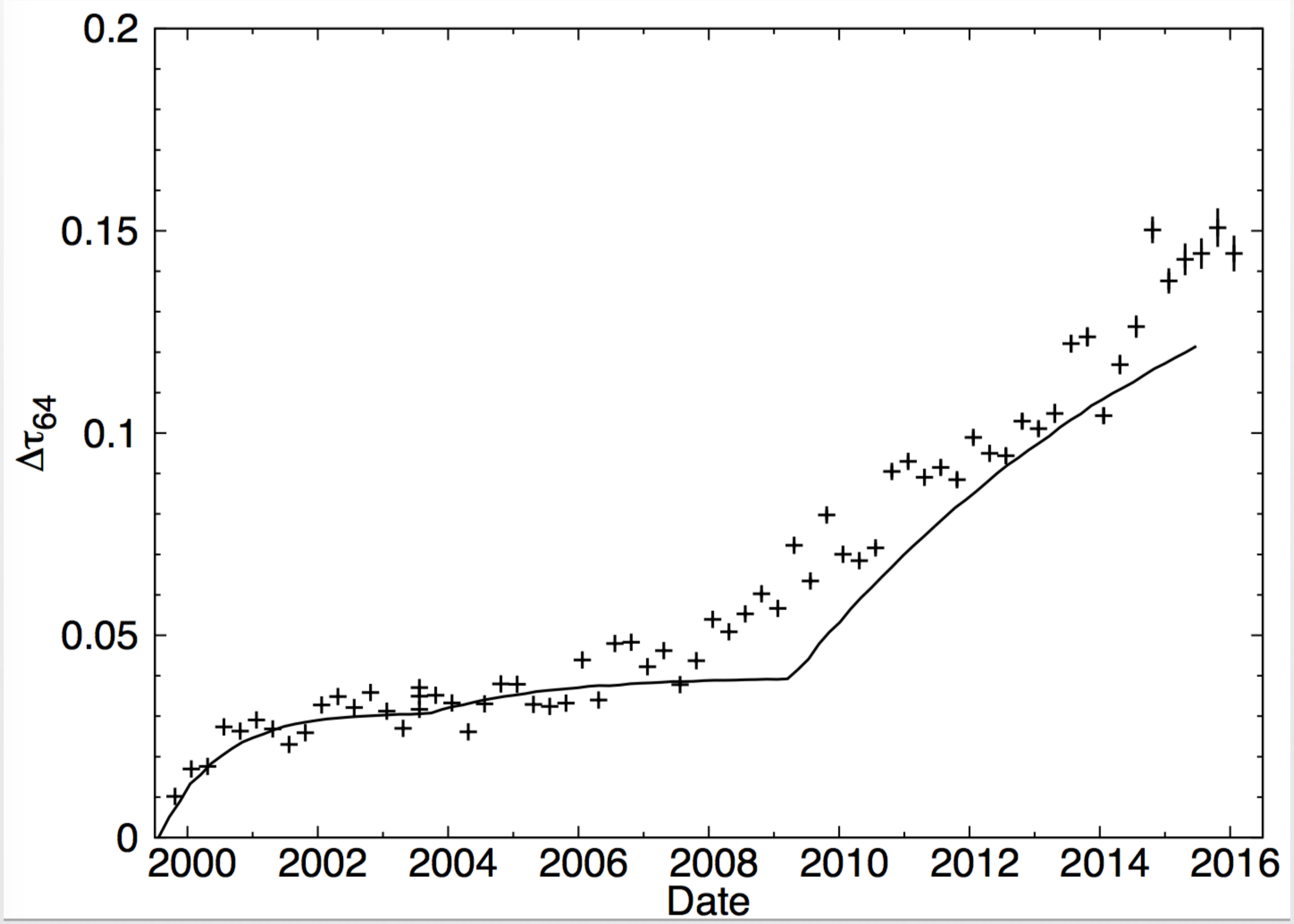
Edge-to-center difference using A1795 data

- Optical depth relative to the center at E=0.66 keV
- Only ACIS-S3 data is shown
- Solid line is from Vikhlinin's results (ECS and A1795 data)



Edge-to-center difference using ECS data

- Similar analysis performed for individual ECS epochs
- From epoch 45 “warm” data is included
- Plot shows optical depths relative to the center at E=1.49 keV
- Solid line is normalized from Alexey’s results (ECS and A1795 data)



Conclusions on the spatial structure of the contaminant

1. The spatial structure of the contaminant can be described with an exponential model that is similar albeit slightly broader than before 2014
2. After the rapid increase in the center-to-edge difference between ~2009-2014, $\Delta\tau$ appears to level off
3. Given that this process started before the detector-housing heater was turned on, it seems unlikely that the slow-down of the contaminant at the edges was triggered by the heater
4. Possibly, another contaminant layer is accumulating that is less sensitive to temperature differences between the center and edge of the detector