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CORRAREA Calibration Status

IACHEC Workshop 2019

21.05.19, Christian Pommranz

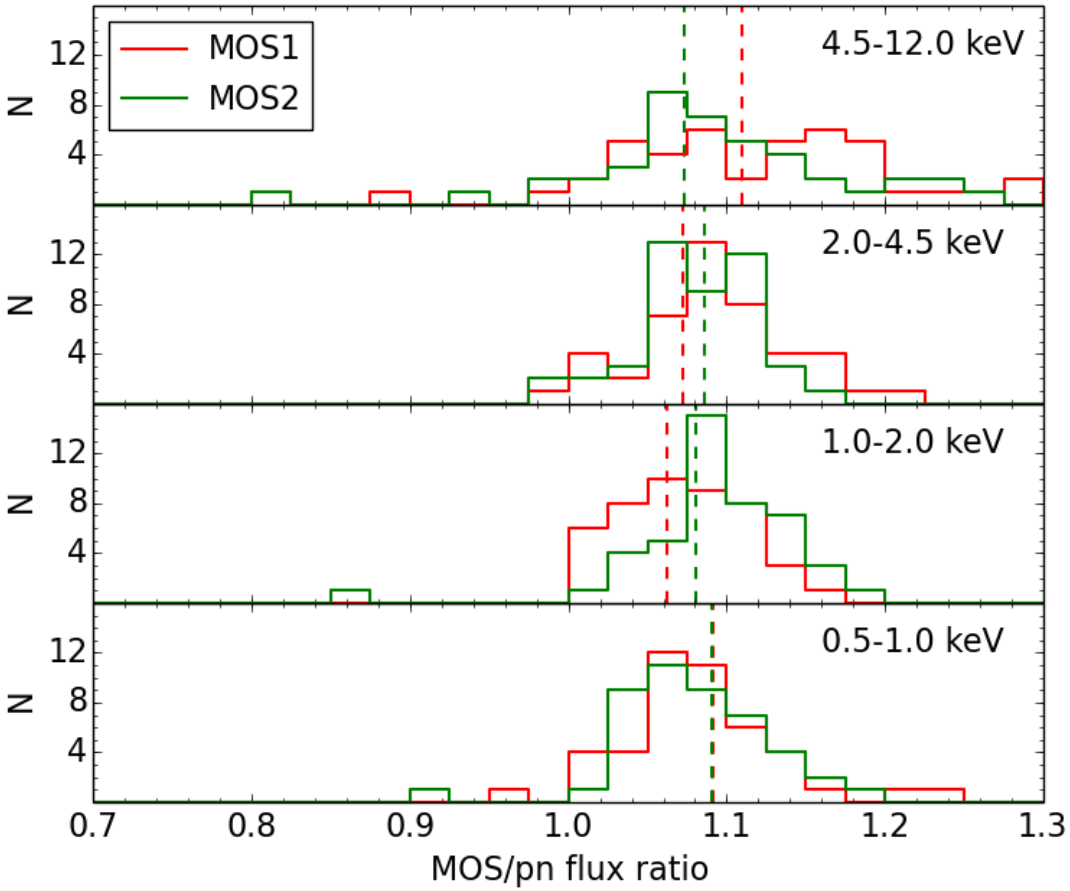
CORRAREA

Introduction

Flux Ratios MOS/pn

Sample of 46 sources
(Read et al. 2014)

Fluxes from 3XMM-DR7



CORRAREA

- Determine empirical correction of the EPIC on-axis effective areas
  - Energy-dependent multiplicative factor
- Cross-calibration of the effectice area of XMM-Newton EPIC cameras
  - Reference instrument: pn
- Stacked residual method for determining the residual ratios

CORRAREA

- Based on previous work by Andy Read et al., 2014
- SAS v14.0: CORRAREA introduced as non-default option in arfgen (Matteo Guainazzi et al., 2014)
- I recently „inherited“ the project in Tübingen from Cornelia Heinitz and continue the work in collaboration with Michael Smith et al.
- **Goal:** Make it a default correction in one of the next SAS versions

From Source Catalog to Fitted Ratios

Select Source Sample from 3XMM-DR7 (347 sources)

- Original source selection, screening and stacking: Read et al., 2014

Selection criteria:

1.) point-like

2.) modes: Full Frame, Large Window, Small Window

3.) filters: Thin, Medium, Thick

4.) # of counts (0.2-12 keV): - MOS: > 5000 cts
- pn: > 13 500 cts

5.) count rates: - MOS: < 0.7 (FF), < 1.5 (LW), < 4.5 (SW)
- pn: < 6 (FF), < 0.3 (FFext), < 3 (LW), < 25 (SW)

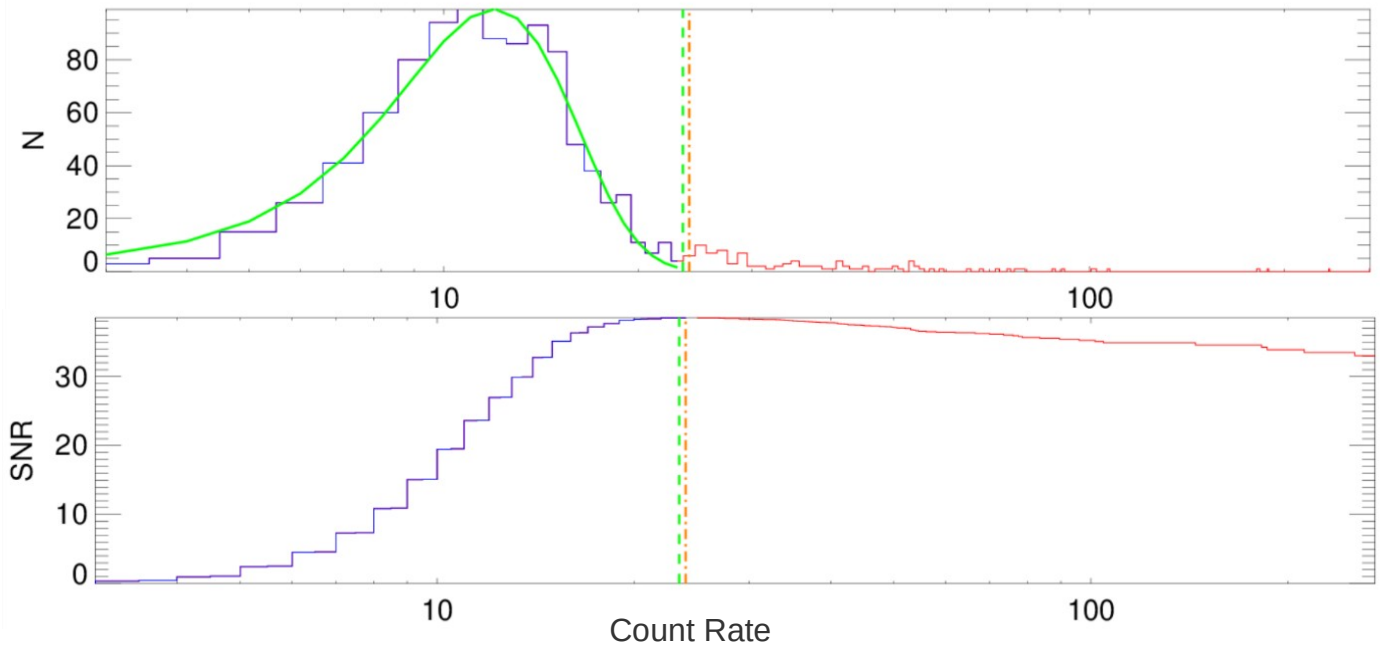
6.) near on-axis (boresight-to-source distance < 2')

7.) out of the plane of the Galaxy (|galactic latitude| > 15 deg

Final: Discard observations with multiple results (crowded fields)

Deflare

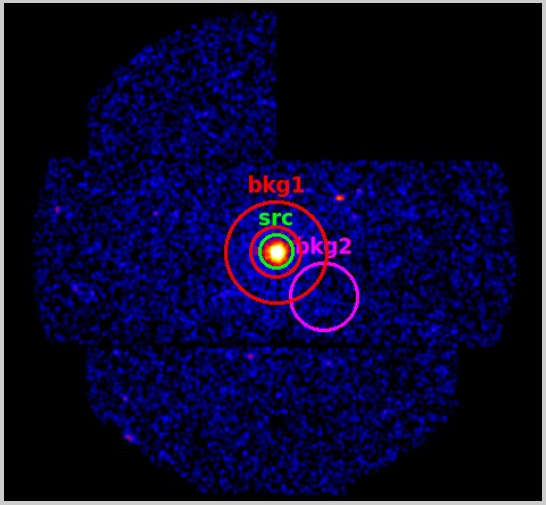
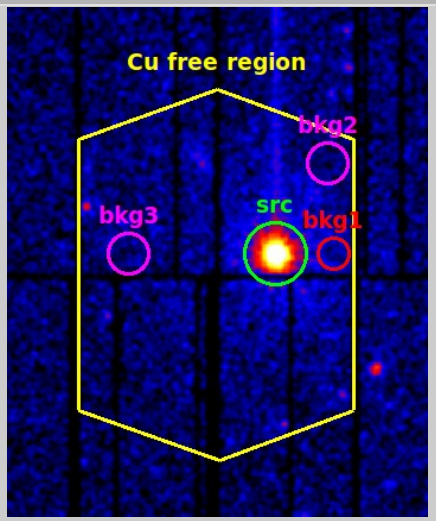
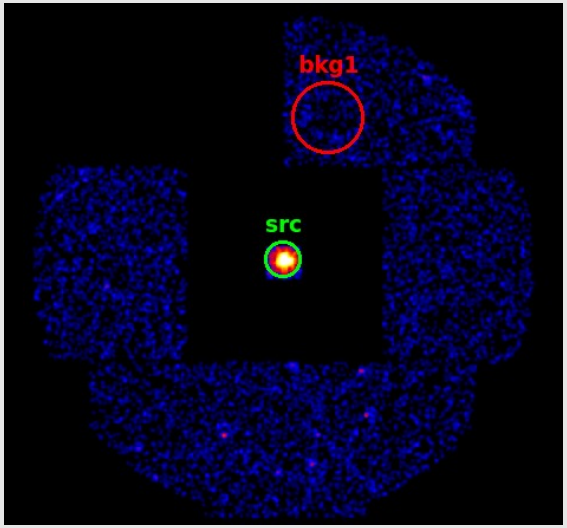
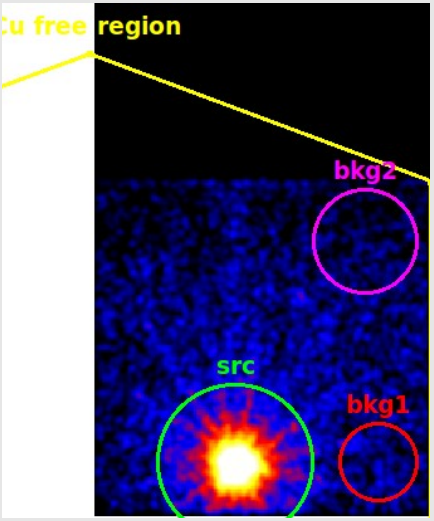
- Common GTI defined specifically / dynamically per observation
  - Threshold on count rate by Gaussian fit or maximium SNR
- Investigate lightcurves >10 keV for MOS and 10-12 keV (pn)



Visual Screening

- Define maximum source extension radius and background selection
- Discard or treat:
  - Crowded fields
  - Chip gaps and bad CCD columns close to the source
  - Extended targets, extended emission
  - Chip loss (quadrant or entire detector)

FROM SOURCE CATALOG TO FITTED RATIOS

	MOS	pn
FF		
SW		

Pile-up

- Remove piled-up sources from sample
- Pile-up analysis using:
  - Source count rate
  - Pattern distribution plots for circular and annular regions with increasing inner radii
  - Direct evaluation via diagonal patterns (MOS-only)
- „Vague“ cases exist

Stacking, Fitting and Convolving Reference Model

- Produce source and background spectra, RMF and ARF files
- Stacking spectra for each detector
  - Exposure-weighted RMF and ARF files
- Fit reference model (phenomenological) to pn data

$$wabs \times [\, power + power + Gauss + Gauss + Gauss \,] \times edge$$

- Convolve reference model with MOS1 and MOS2 responses

Calculation and Fitting of Residual Ratios

- Residuals realigned to a new uniform energy grid
- Calculation of residual ratio:

$$\alpha = \frac{data_i}{model_{pn} \otimes response_i} \cdot \frac{model_{pn} \otimes response_{pn}}{data_{pn}}$$

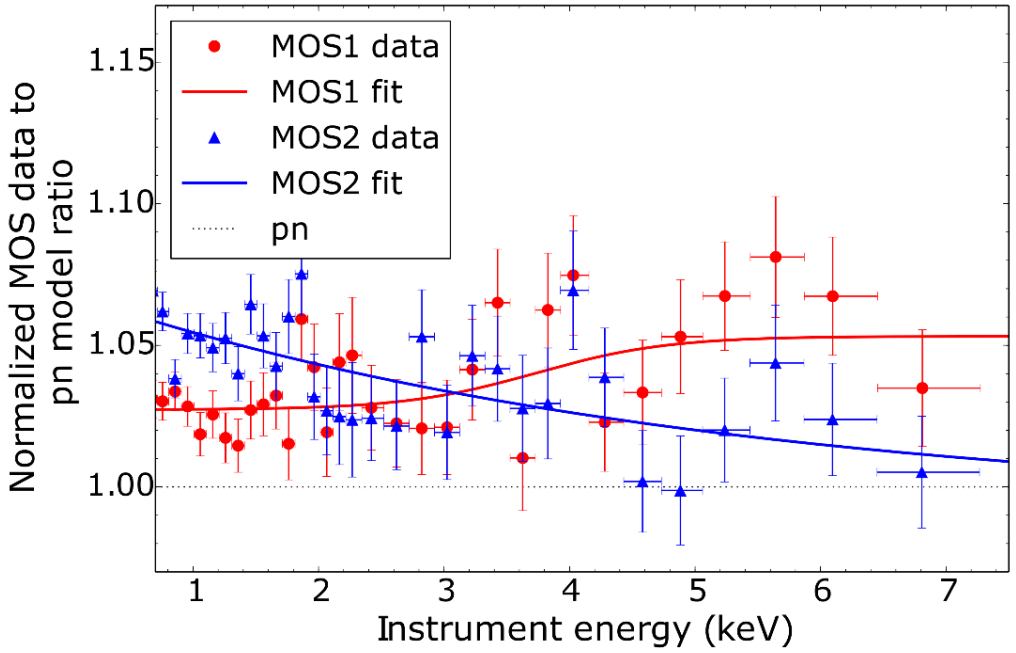
- Fitting of residual ratios (currently two possible functions):

Calculation and Fitting of Residual Ratios

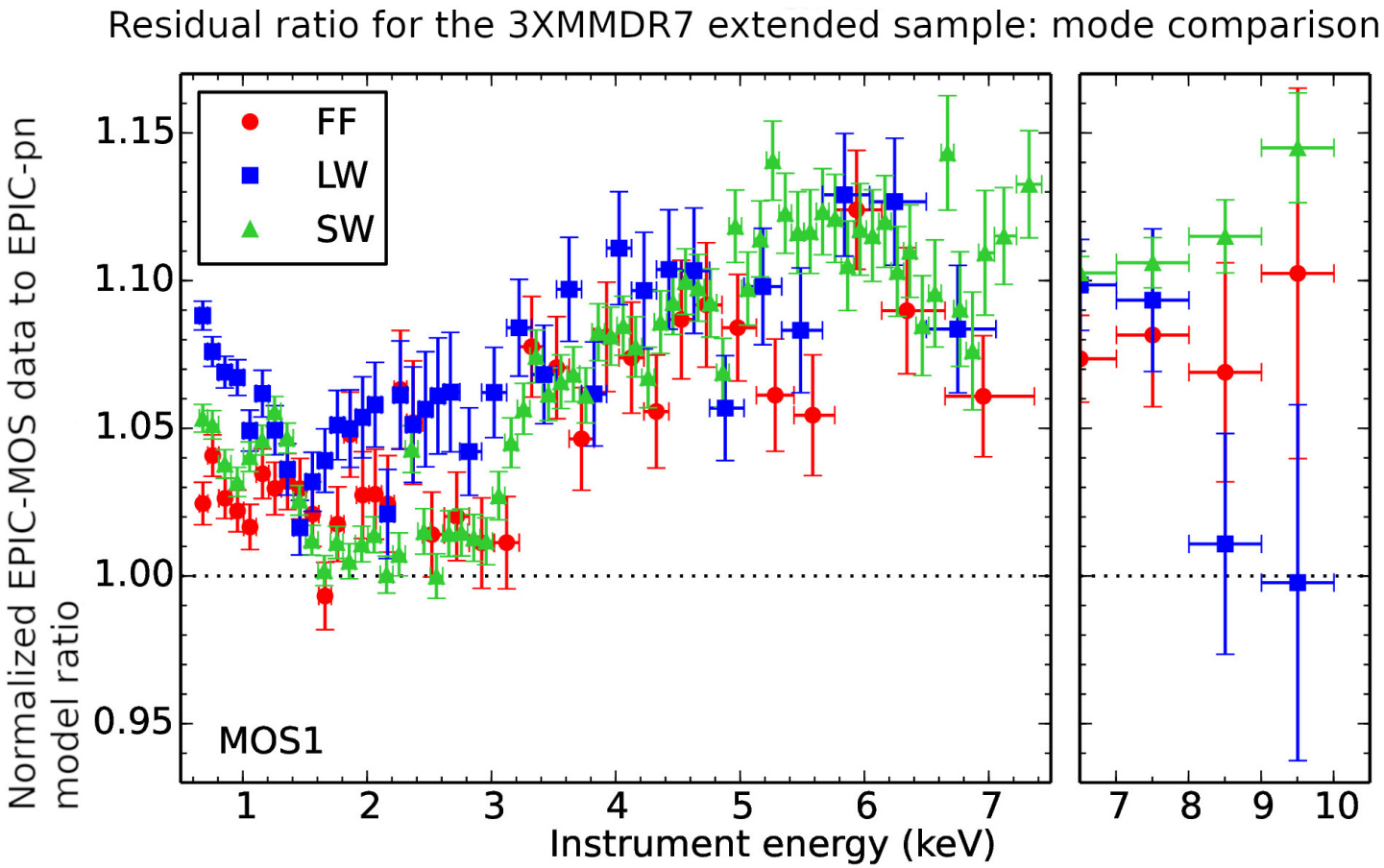
$$R_i(E) = a_i + a_{pn} + b_i \cdot e^{-c_i \cdot e^{-d_i \cdot E}}$$

$$R_i(E) = a_i + a_{pn} + b_i \cdot \frac{1}{1 + \exp\left(\frac{-E + c_i}{d_i}\right)}$$

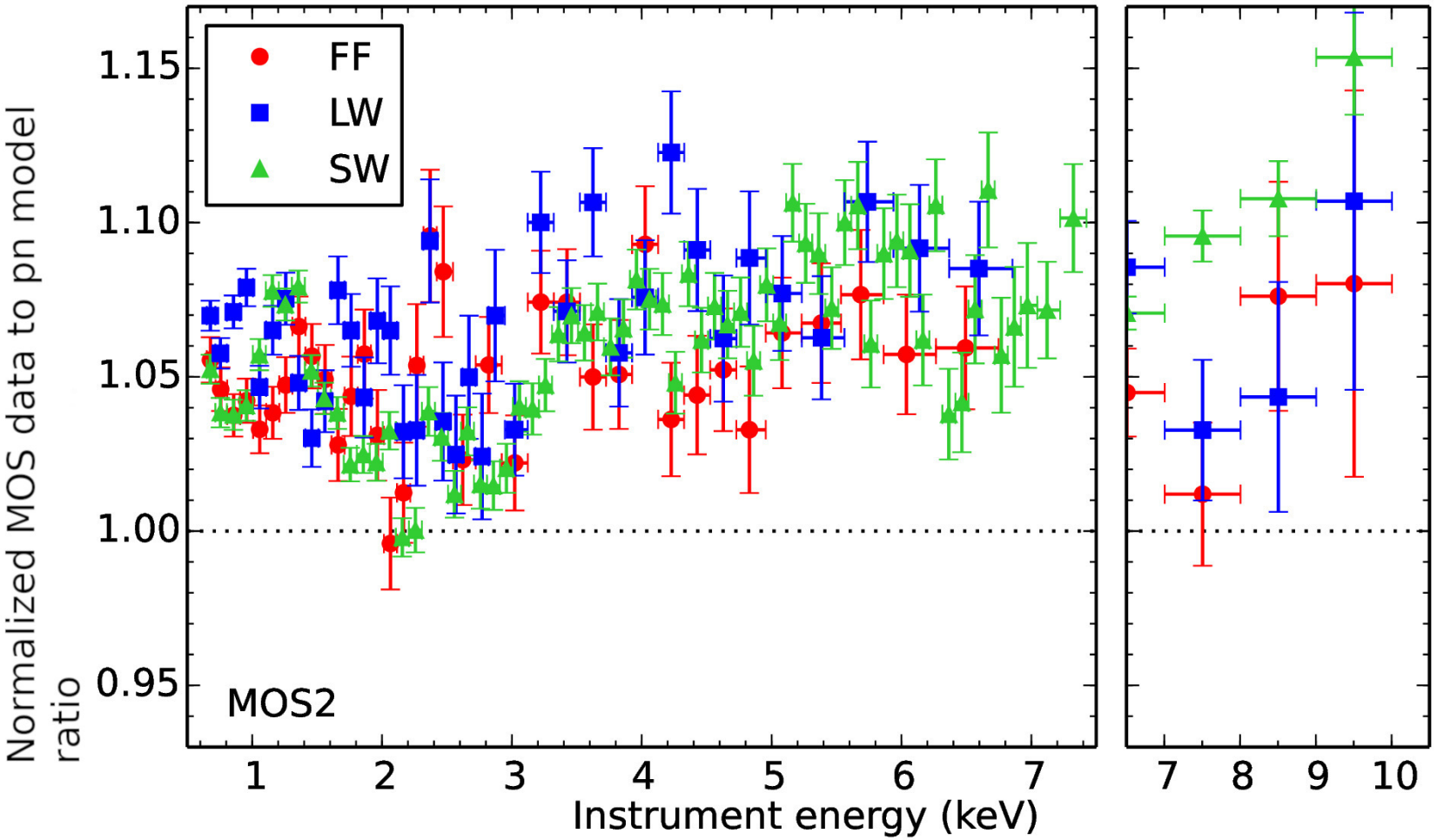
i: MOS index (1, 2)
R: MOS to pn empirical correction factor
a, …, d: Best fit parameters



Residual ratios (most recent sample)



FROM SOURCE CATALOG TO FITTED RATIOS



Outlook

OUTLOOK

- MOS/pn comparison at higher energies (> 8 keV)
- Automation
- Make CORRAREA a default empirical correction in one of the next SAS releases
- Update with 3XMM-DR8 catalog, SAS v17.0 and current calibration files

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Thank you.

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