Crab calibration update

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CALTECH

Crab campaign

Purpose

1) Scientific: Provide a monitoring campaign of the Crab complementary to GBM and BAT, which are snapshots with 2% flux measurements and accurate slope measurement, coordination with other observatories
2) Calibration: Collecting more Crab spectrum at various off-axis angles, measure the detector absorption parameters, absolute normalization

Current status of the Crab campaign

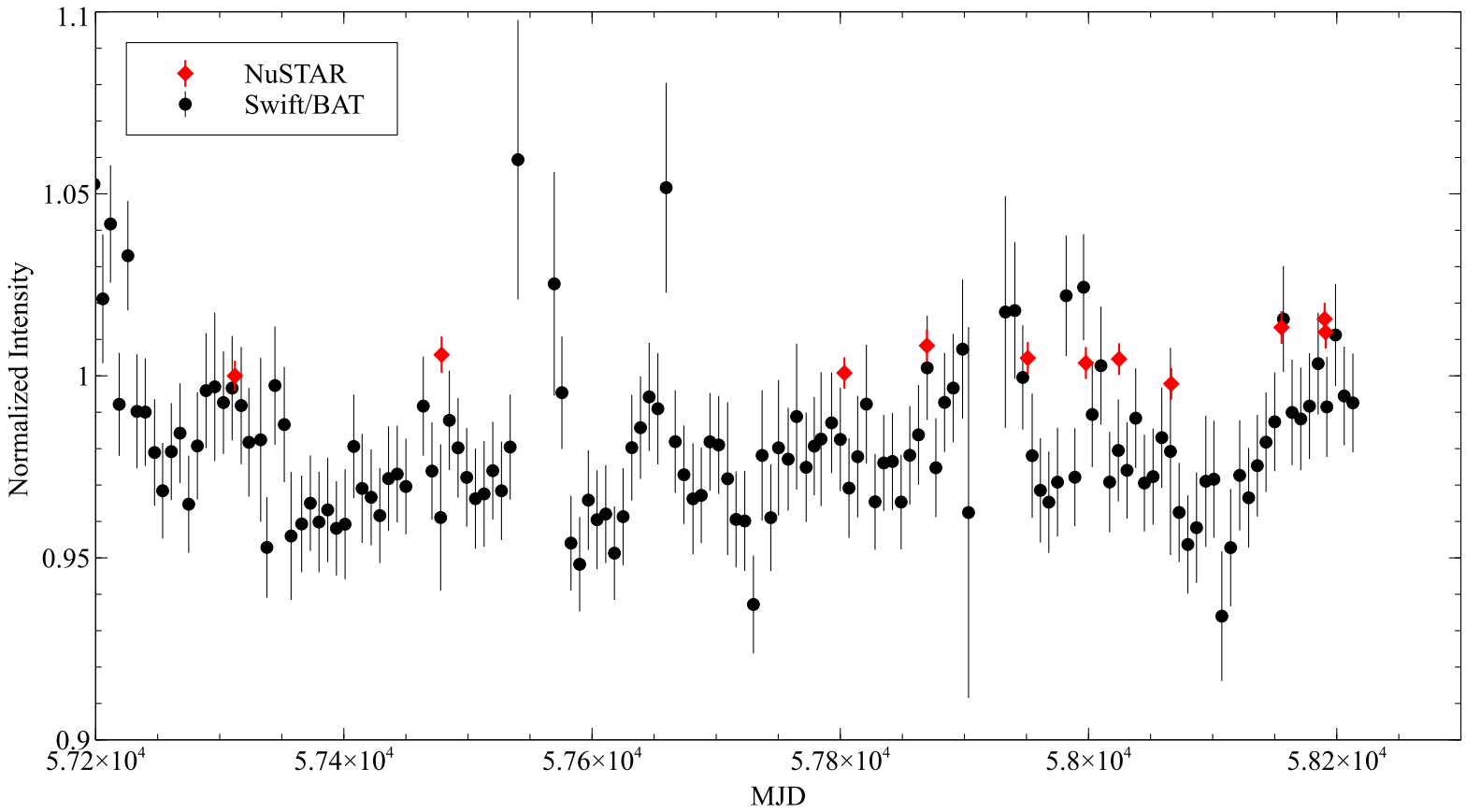
Stray Light (SL):

Work Title	ObsID	Bkg ObsID	Date
Mar2018b	10402002006	10402006002	2018:073:00:20:01
Mar2018a	10402002004	10402006002	2018:072:05:00:01
Feb2018	10402002002	10402003002	2018:037:12:00:05
Nov2017	10311001008	10311002008	2017:313:15:25:00
Oct2017	10311001006	10311002006	2017:271:15:00:00
Sep2017	10311001004	10311002004	2017:244:20:10:00
Jul2017	10311001002	10311002002	2017:198:01:25:01
Apr2017	10210001003	10210002003	2017:116:18:20:47
Feb2017	10210001002	10210002002	2017:050:07:20:26
Apr2016b	10110005001	10110004002	2016:092:13:27:56
Apr2016a	10110004002	10110005001	2016:091:18:15:01
Oct2015b	10110003002	10110002002	2015:291:03:30:29
Oct2015	10110002002		2015:290:16:15:13
Oct2015a	10110001002	10110002002	2015:290:05:05:05

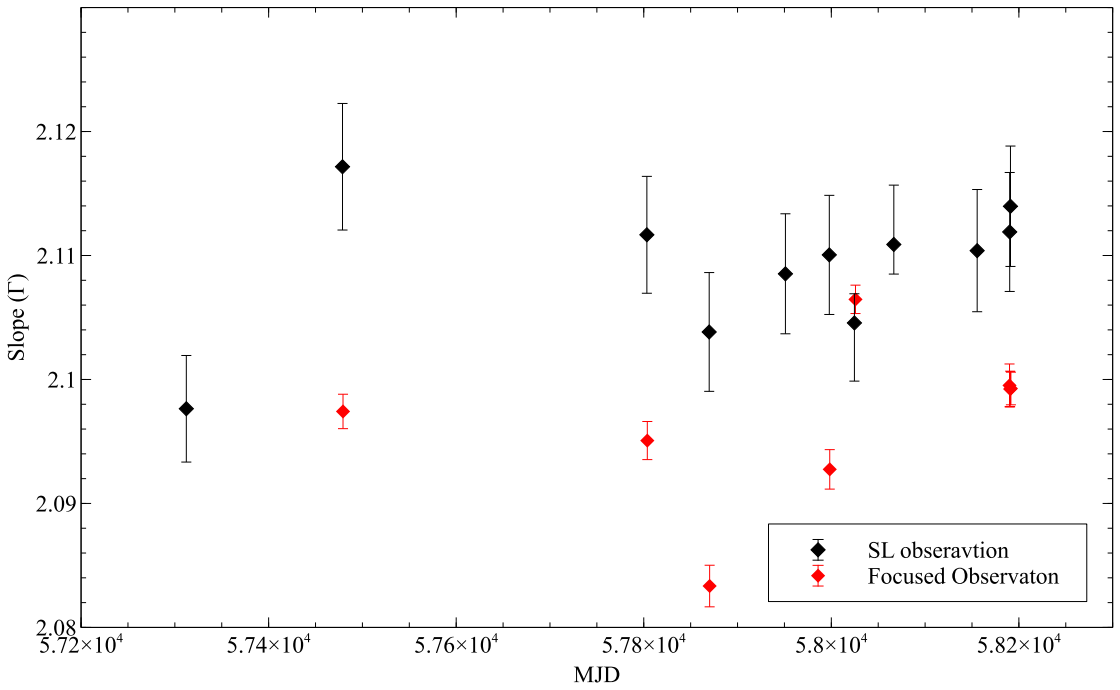
Focus:

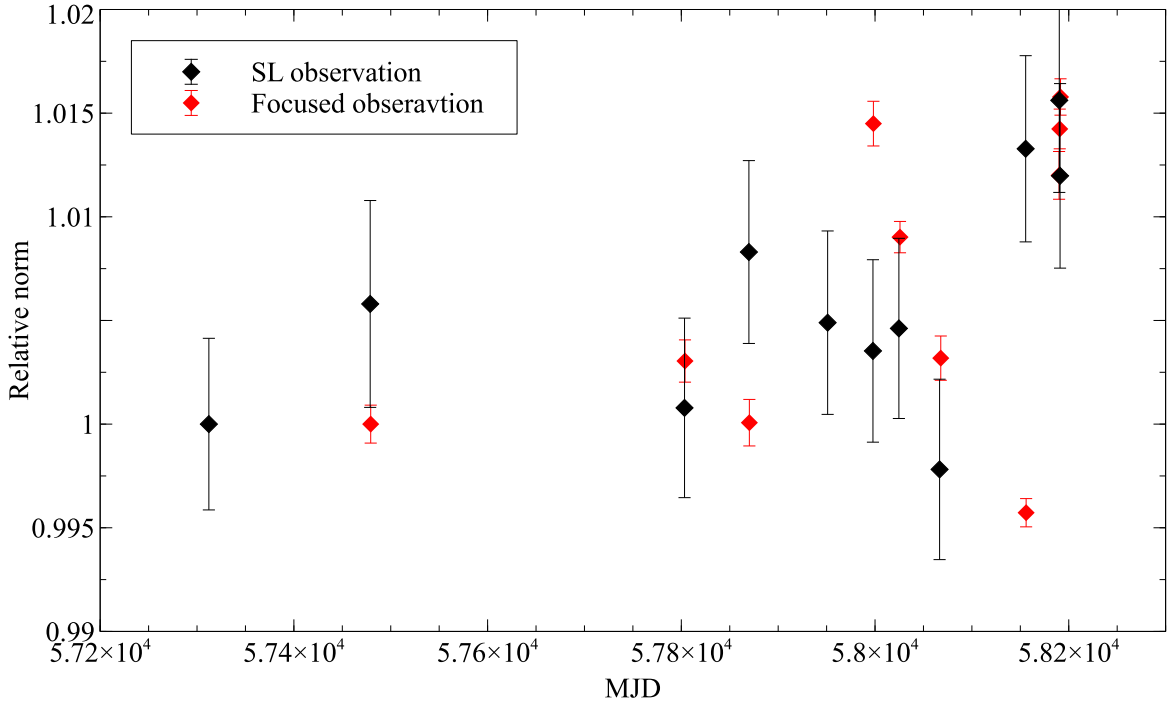
Work Title	ObsID	Bkg ObsID	Date
Mar2018Fc	10402001008	10402006002	2018:073:11:30:01
Mar2018Fb	10402001006	10402006002	2018:072:16:15:00
Mar2018Fa	10402001004	10402006002	2018:072:00:10:00
Feb2018	10402001002	10402003002	2018:037:23:25:05
Nov2017	10302001006	10311002008	2017:314:20:40:04
Oct2017	10302001004	10311002006	2017:272:18:15:01
Sep2017	10302001002	10311002004	2017:245:07:30:00
Apr2017	10202001007	10210002003	2017:117:05:27:58
Feb2017	10202001006	10210002002	2017:050:18:30:09
Apr2016	10002001009	10110004002 (B) /10110005001 (A)	2016:092:07:02:35

SL observations



SL v. Focused

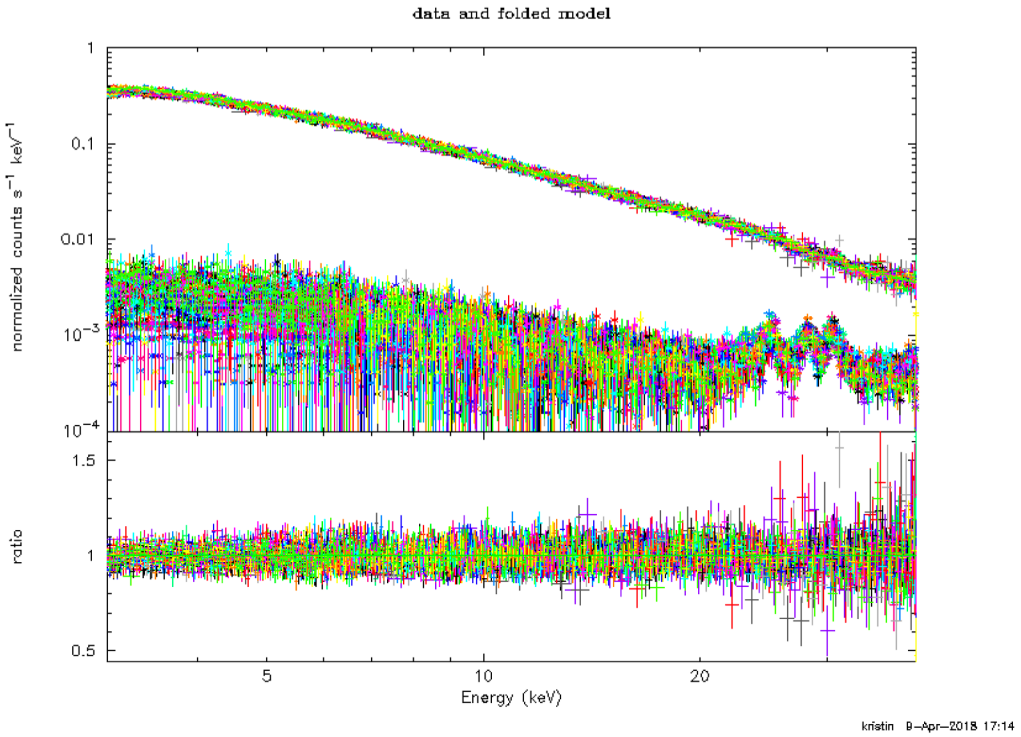


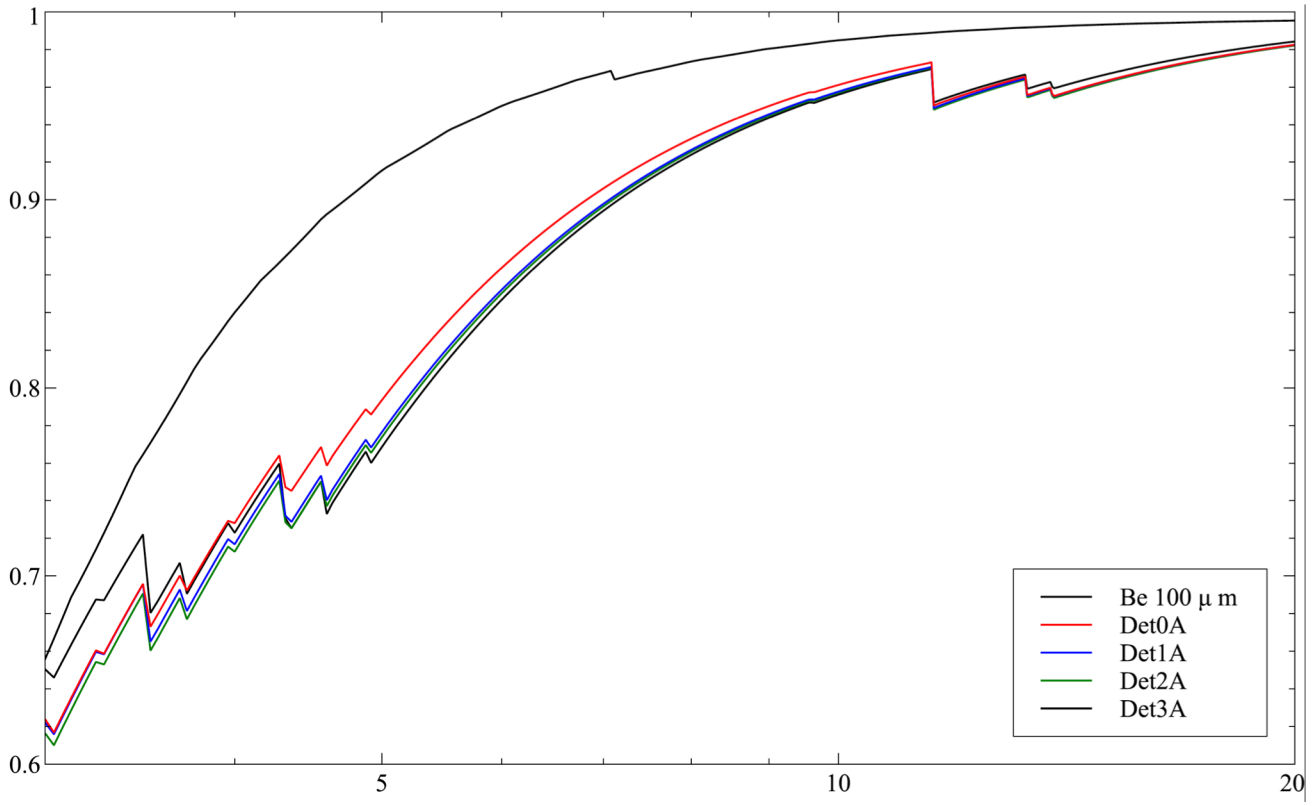


Important: Differences are expected, primarily we calibrated the ARF against a Crab Γ=2.1, and this is why we are redoing the focused calibration.

Detector absorption parameters

The detector absorption parameters (Pt and CZT thickness) are assumed constant for all epochs.





Re-calibration of NuSTAR vignetting functions

Old approach:

- 30+ focused observations were because of insufficient statistics lumped into 7 one arcminute wide bins.
- They observations were assigned according to the weighted average value of their off-axis angles.
- The interpolated vignetting data point was set at the weighted average of all included observations in a bin.

Problem with this is that the off-axis angles spanned by a single observations are sometimes larger than 1 arcmin.

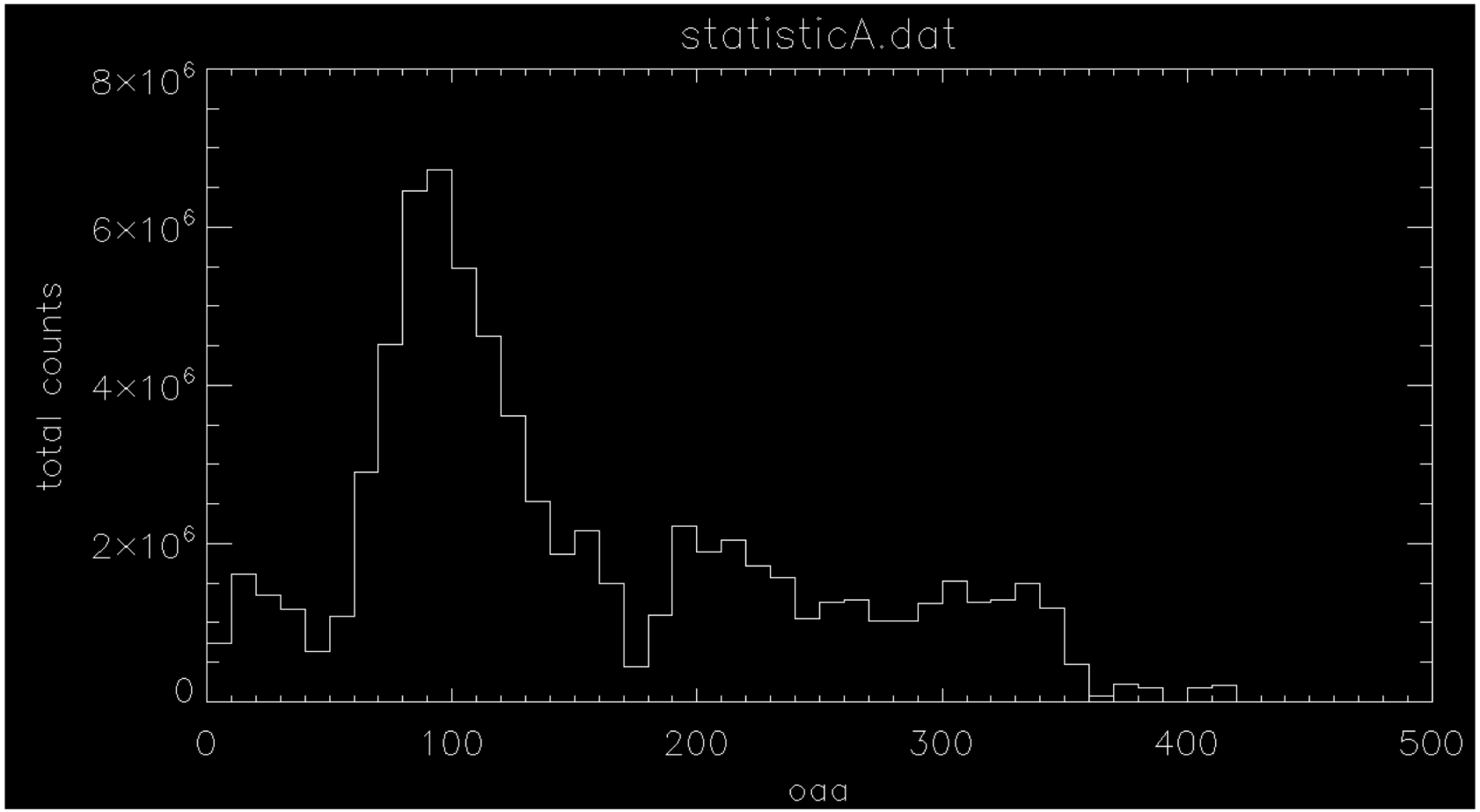
New approach

- The base data set now numbers 50+ observations
- Strict vetting of data to avoid problems with gaps
- All observations are split up and each photon is reassigned into new spectra based on its off-axis value
- Stray-light observations are used to calibrate the detector absorption parameters

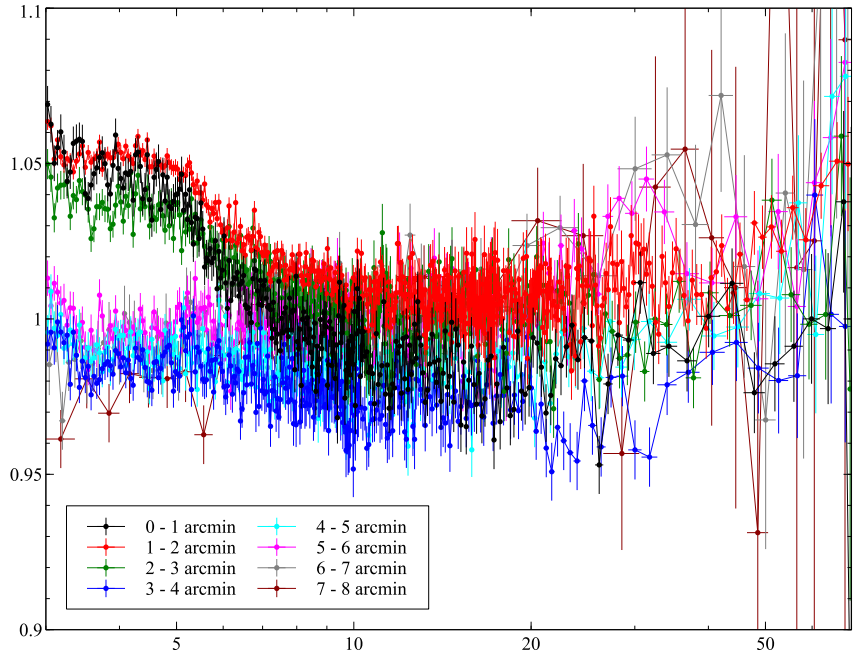
Concerns:

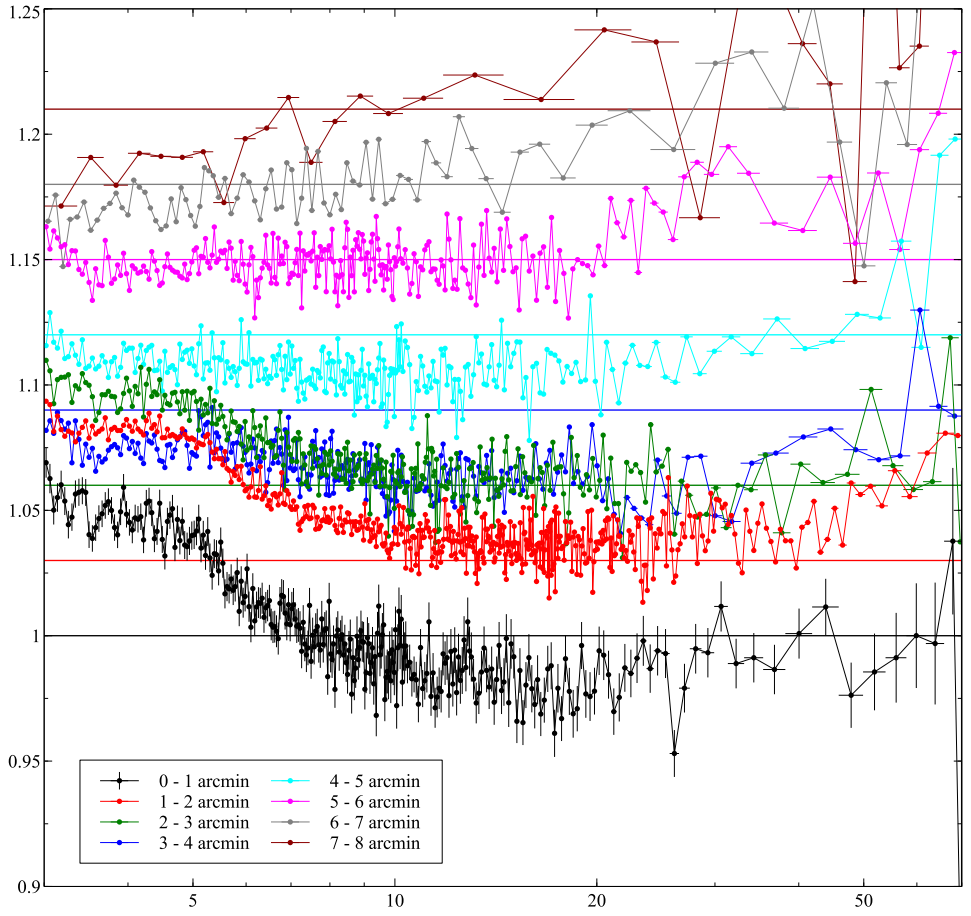
- Spectra from different epochs are combined and washes out the Crab flux and slope variations: we accept these drawbacks in favor of obtaining featureless spectra across all off-axis angles.

Counts v. Off-axis angles

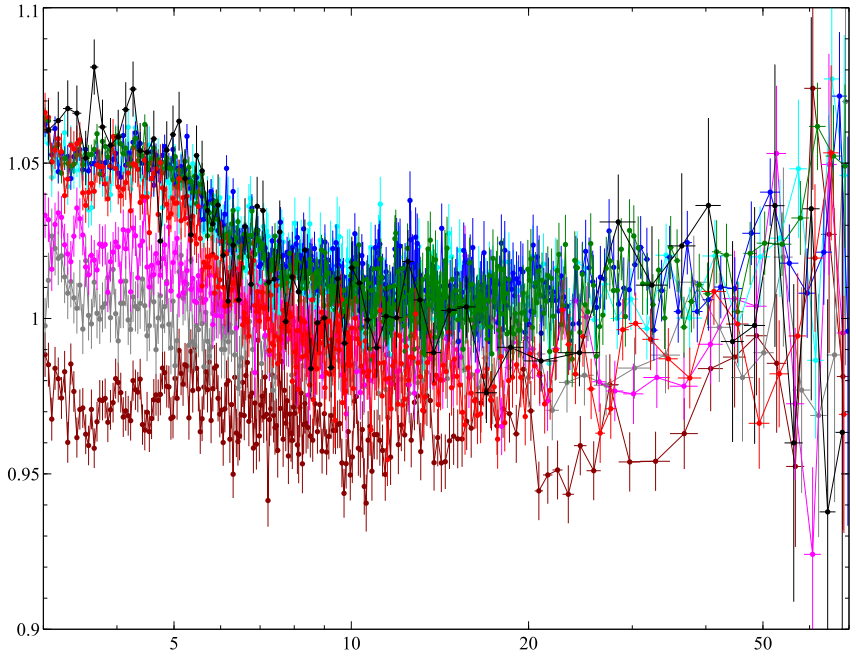


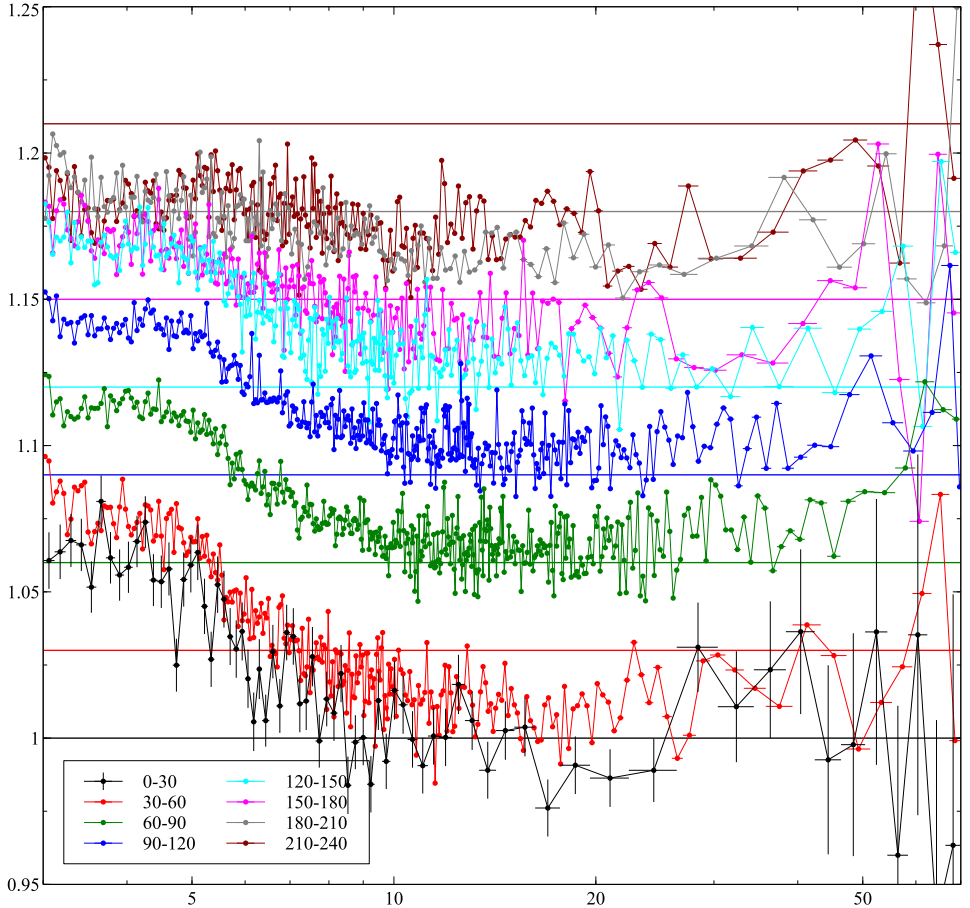
1 arcminute binning



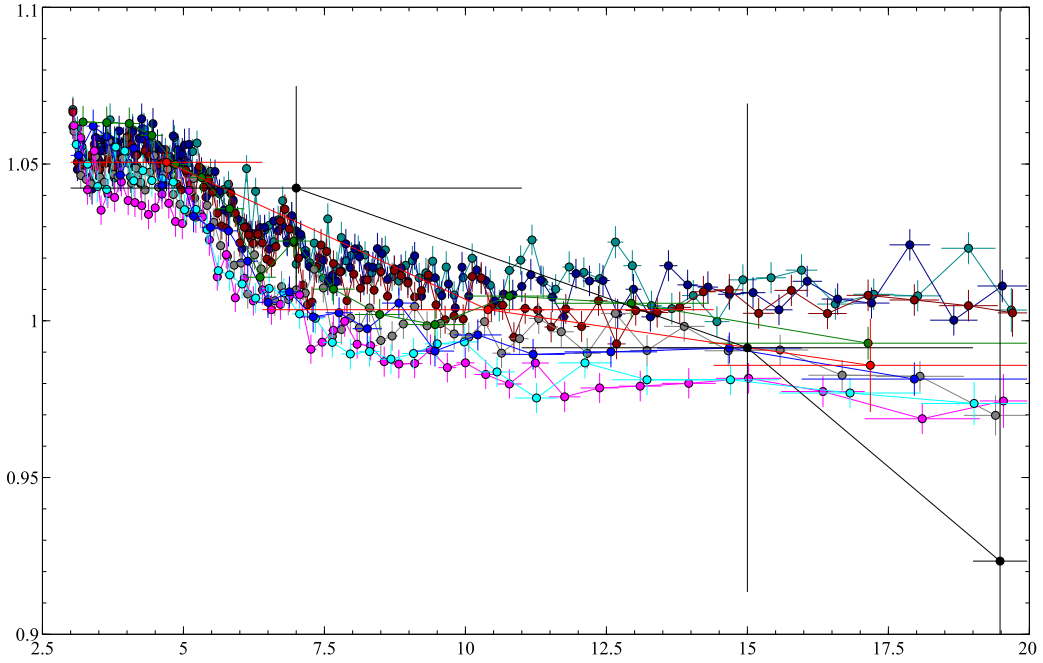


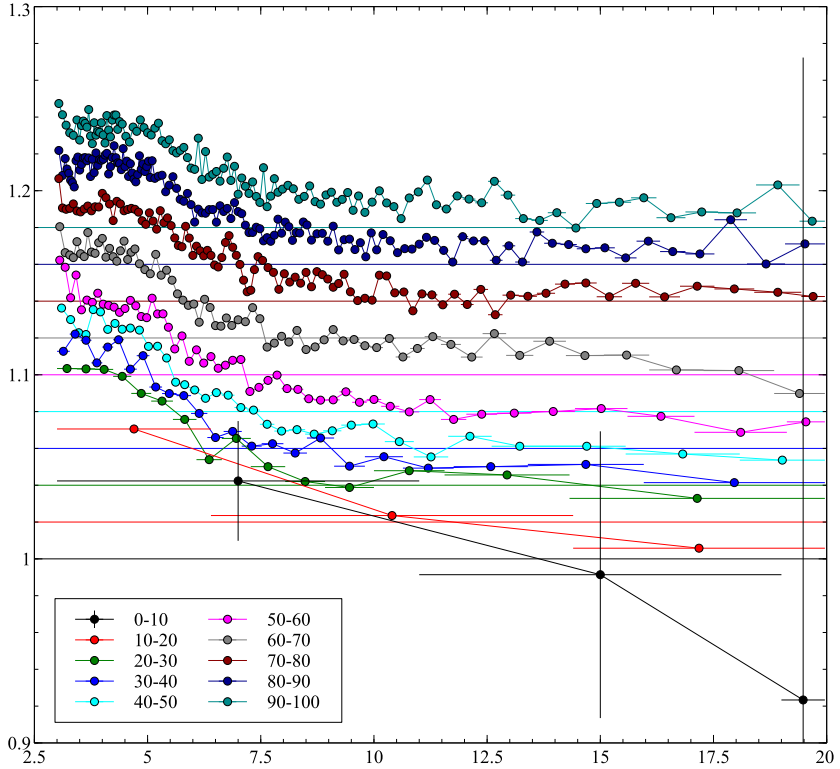
30 arcsecond binning



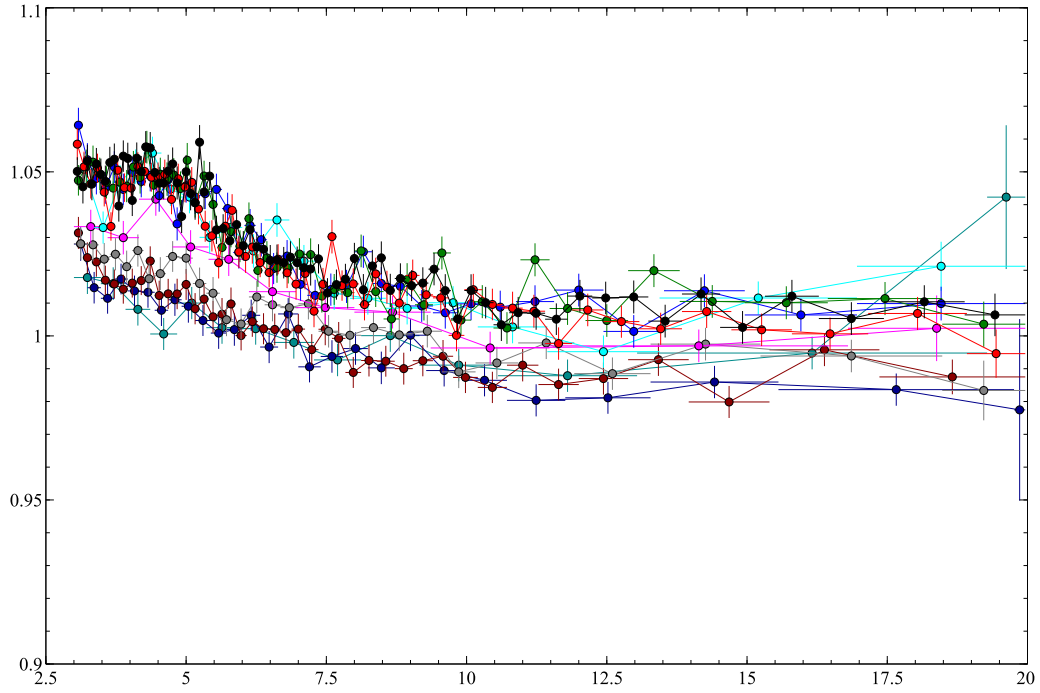


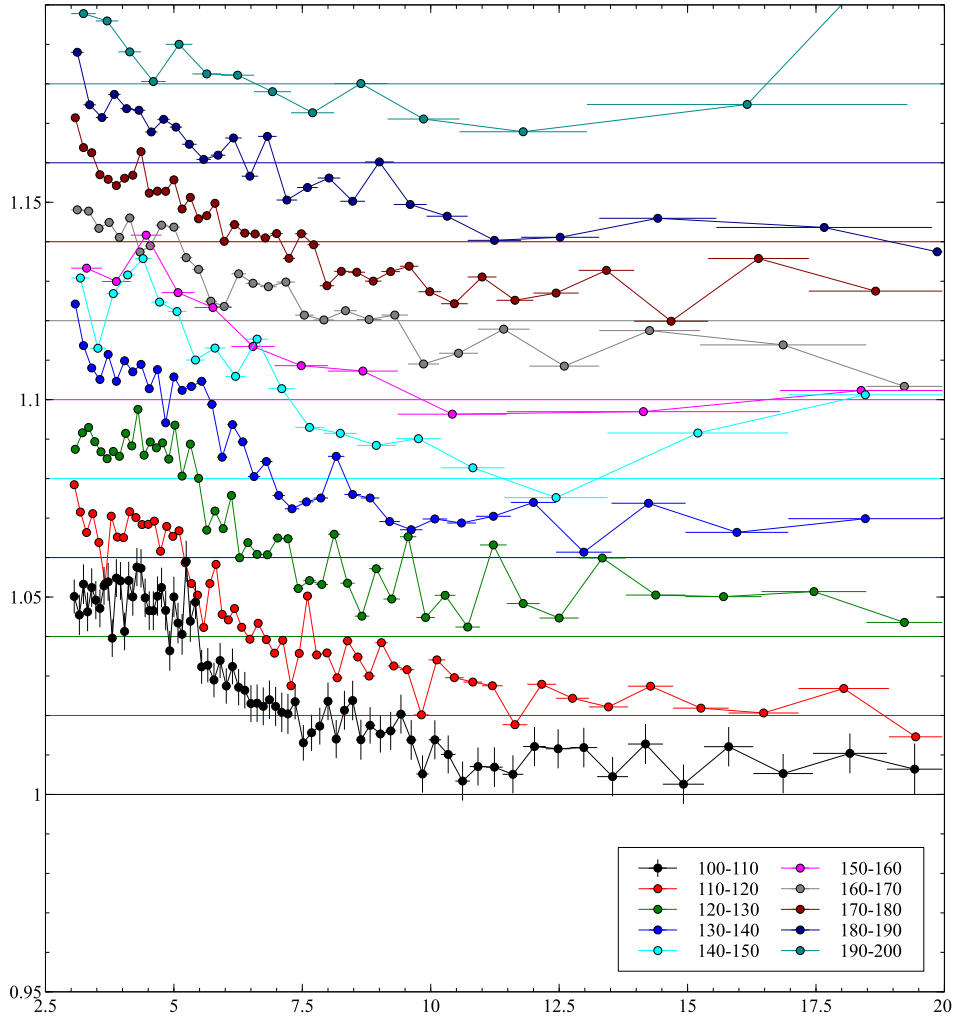
10 arcsecond binning



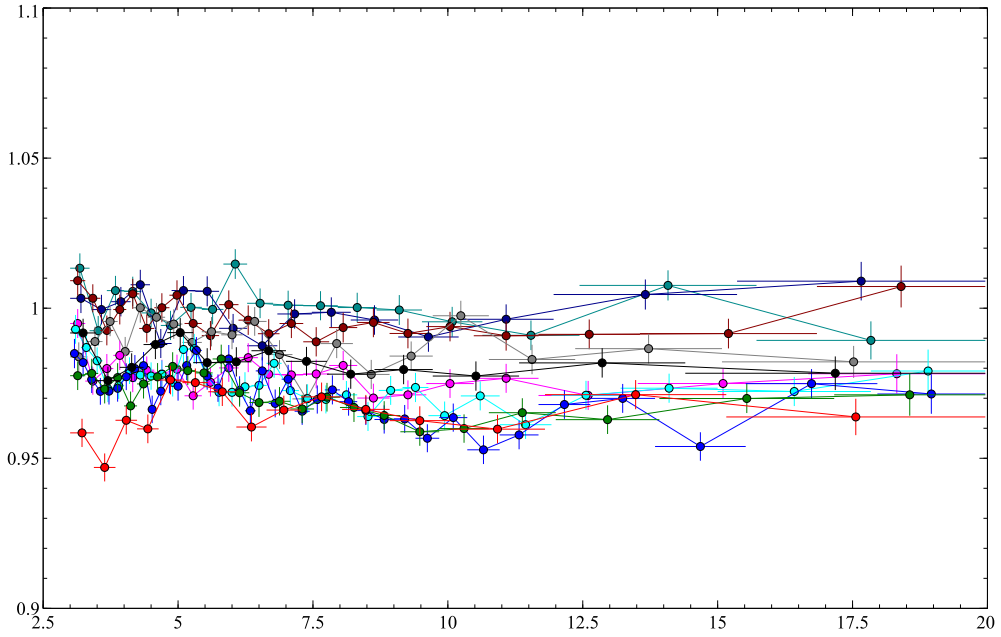


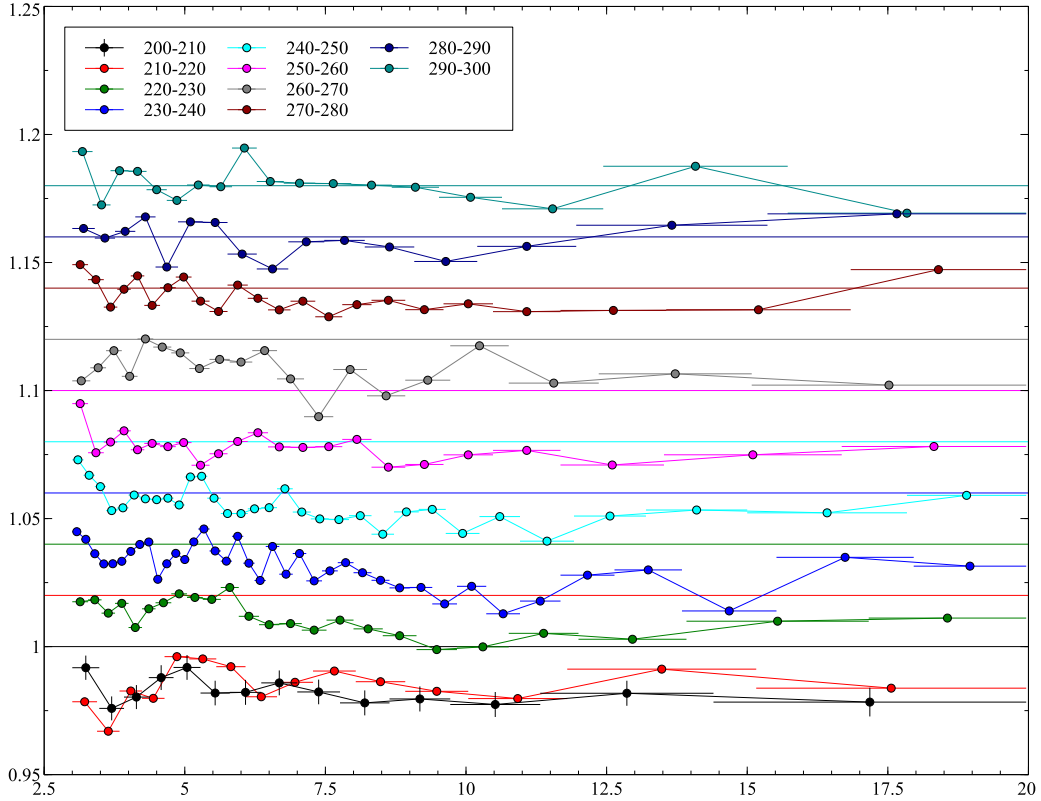
10 arcsecond binning



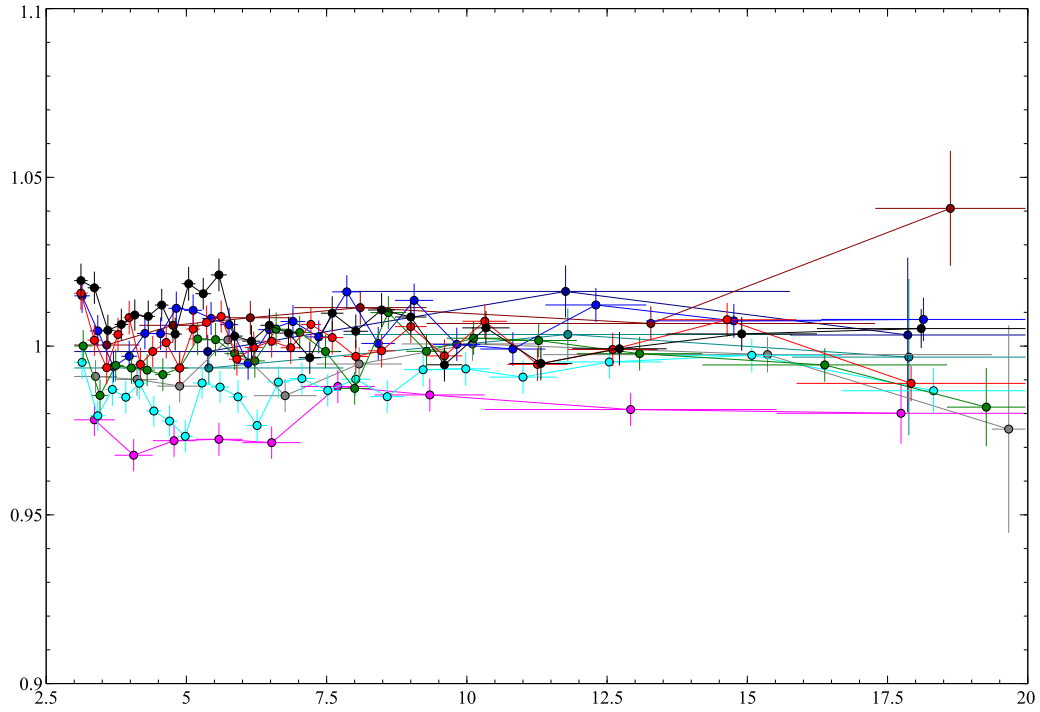


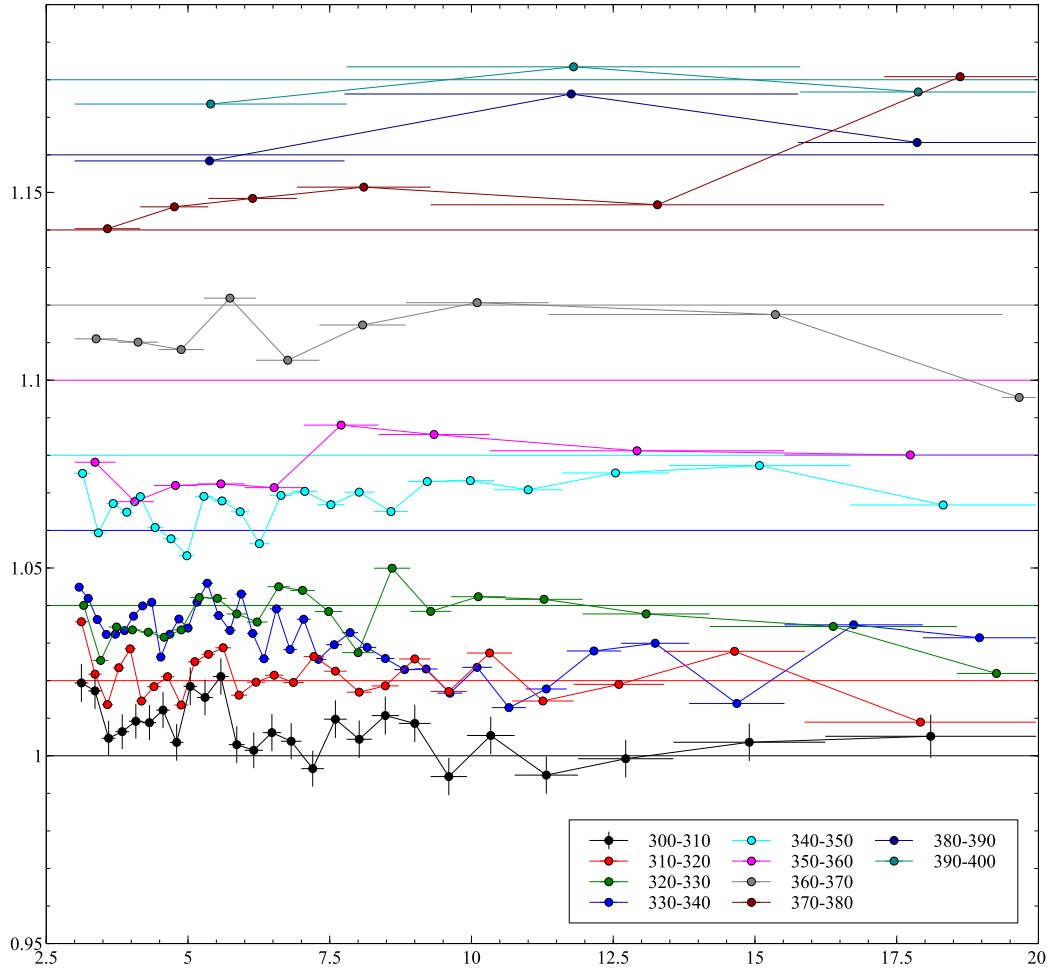
10 arcsecond binning





10 arcsecond binning





Procedure

- New detector parameters obtained with SL observations
- Target model derived from SL observations
- Low energy (3-20 keV) large scale features are done with the 10" meta data set.
- Bumps and wiggles will be investigated on 30" scales.
- High energy (20-80 keV) large scale features will be evaluated with 1' groups.