

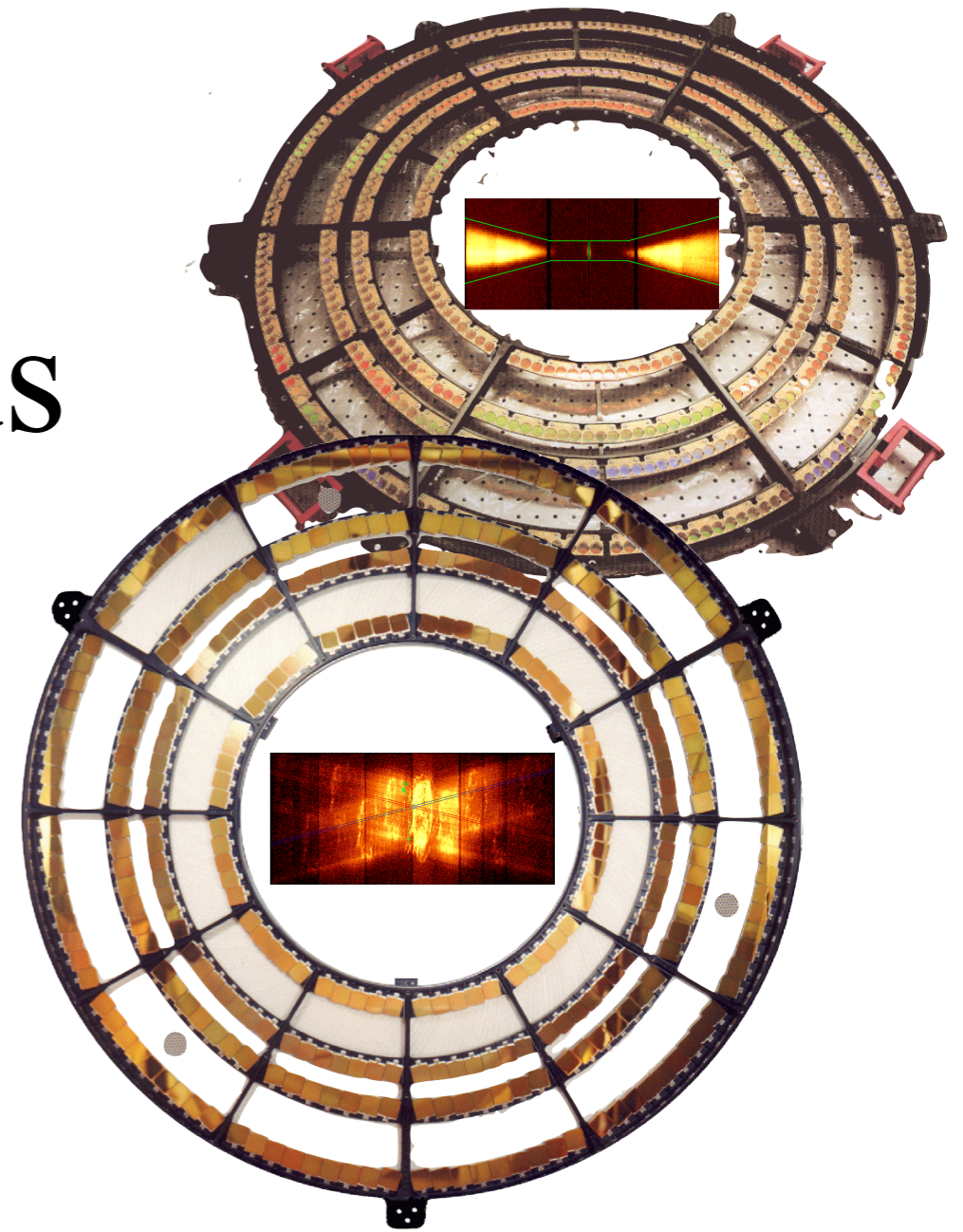


MIT KAVLI INSTITUTE

# HETG/LETG — Status

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HETG IPI: Prof. C.R. Canizares  
MIT Kavli Institute

Performance April 2019 — October 2019

**HETG/ACIS-S** 2210 ks

- 69 observations on 19 targets (28 GO, 15 GTO, 3 Cal, 11 TOO, 12 DDT)

**HETG/HRC-I** 41 ks

- 1 observation (GTO; “redo”);

**LETG** 659 ks, 5 targets

- 16 LETG/HRC-S observations (2 GO, 5 GTO, 4 Cal, 5 TOO)
- 1 LETG/HRC-I observations (Cal)
- 7 LETG/ACIS-S observations (Cal)

*Grating performance is nominal.*

<http://tgcat.mit.edu>

*TGCat* has 2044 extractions for 494 objects (+75/+4 since last report)

Total volume: 456 GB

Downloads: 229 packages, 74 GB

Maintenance: port to modern infrastructure (PHP, MySQL), new server continuing.

# HETG GTO Science Program



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## Cycle 18:

- ★ ULX/BH: NGC 1313 X-1 481 ks Ultra-luminous source outflow: absorption, emission lines
- ★ NS/BH: GRS 1915+105 97 ks Black hole accretion, line variability
- ★ XRB: 4U 1626-67 45 ks Neutron star accretion; Fe K absorption variability

## Cycle 19:

- ★ **AGN:** Fairall 51 234 ks Seyfert 1, warm absorber variability (w/ NuSTAR 120 ks)
- ★ **HMXB:** 4U 1907+09 142 ks Accreting neutron star; wind emission, absorption lines
- ★ Stars: V773 Tau 140 ks Evolution of pre-MS stars; flares (w/ NuSTAR 150 ks)
- ★ Stars: TW Hya 73 ks Accretion/winds in pre-main-sequence stars (*HETG/HRC-I*)
- ★ ISM: 4U 1636-53 128 ks Si, Fe absorption edges; part of survey vs  $N_H$

## Cycle 20:

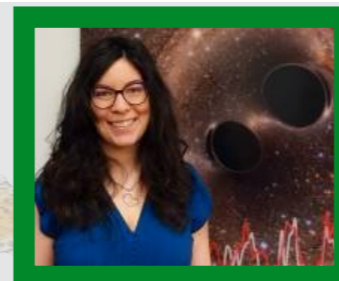
- ★ NS: Terzan 5 X-2 0/200 ks TOO (10%); Neutron Star Equation of State
- ★ NS: IGR J17480-2446 0/200 ks TOO (10%); Neutron star (slowly rotating)
- ★ LIGO: GW2019nnnn 0/300 ks TOO (10%); Gravitational wave transient
- ★ Stars: SZ 96 246 ks Young, low mass stellar accretion
- ★ **XRB:** 4U 1626-67 48 ks Neutron star accretion (monitoring)
- ★ SNR: Cas A 0/100 ks Decadal visit — 20 yrs on, dynamics
- ★ **AGN:** Mrk 335 0/280 ks TOO Narrow Lined Seyfert, w/ NuSTAR, NICER; warm absorbers

## HETG Postdoc status/activities:

Dr. Rozenn Boissay-Malaquin now at UMBC/GSFC (XRISM)

Dr. Paul Hemphill — supported through end of year.

*Currently advertising for 2 positions.*





# LETG GTO Science Program

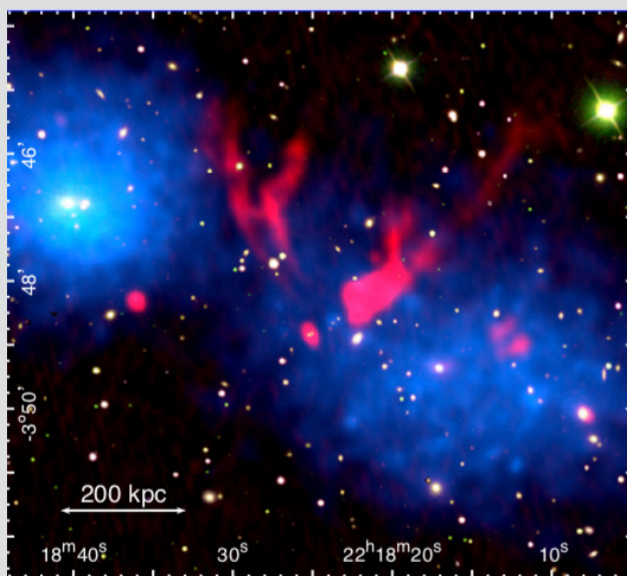


## Cycle 18:

- ★ AGN: (Kaastra/SRON) IC 4329a 174 ks Neutral, warm absorbers (HETG/ACIS-S);  
Mehdipour & Costantini, (2018, A&A, 619, A20) *Probing the nature and origin of dust in the reddened quasar IC 4329A with global modeling from X-ray to infrared.*
- ★ Stars: (Predehl/MPE) Proxima Cen 166 ks Reference spectrum of an old M-dwarf (LETG/HRC-S)

## Cycle 19:

- ★ NS: (Predehl/MPE) RX J2143.0+0654 173 ks Cyclotron Absorption Line in an Isolated Neutron Star (LETG/HRC-S)
- ★ ISM: (Kaastra/SRON) 4U 1608-522 25 ks ISM dust, Mg and Si K-edge absorption (HETG/ACIS-S)
- ★ Gal: (Kaastra/SRON) 1E 2216/1E 2215 147 ks Shocks in Galaxy Cluster Collisions (ACIS-I)  
Gu et al (2019, Nature Astronomy, 3, 838) *Observations of a pre-merger shock in colliding clusters of galaxies*

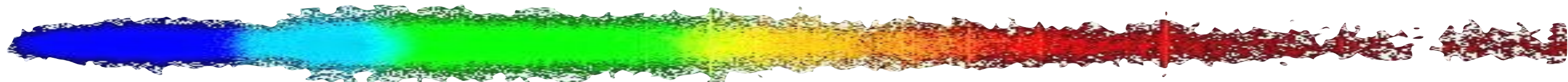


“... Here we report on the discovery of a unique shock in a cluster pair 1E 2216 and 1E 2215. The two clusters are observed at an early phase of major merger. Contrary to all the known merger shocks observed ubiquitously on merger axes, the new shock propagates outward along the equatorial plane of the merger. This discovery uncovers an important epoch in the formation of massive clusters, when the rapid approach of the cluster pair leads to strong compression of gas along the merger axis. ...”

Composite image of the pre-merging cluster 1E 2216.0-0401 and 1E 2215.7-0404. The SDSS gri image is overlaid with the radio emission at 325 MHz from GMRT (red), and 0.5 – 8.0 keV X-ray emission from Chandra (blue). The linear scale is provided in the bottom left corner.

## Cycle 20:

- ★ NS: (Predehl/MPE) RX J1856.6-3754 166 ks Isolated neutron star, calibration (with eRosita) (LETG/HRC-S)
- ★ Gal: (Kaastra/SRON) NGC 5548 168 ks AGN outflows, absorption, ionization, obscuration (HETG/ACIS-S)

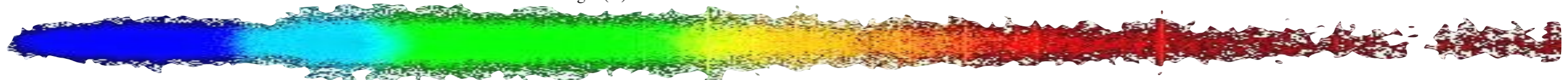
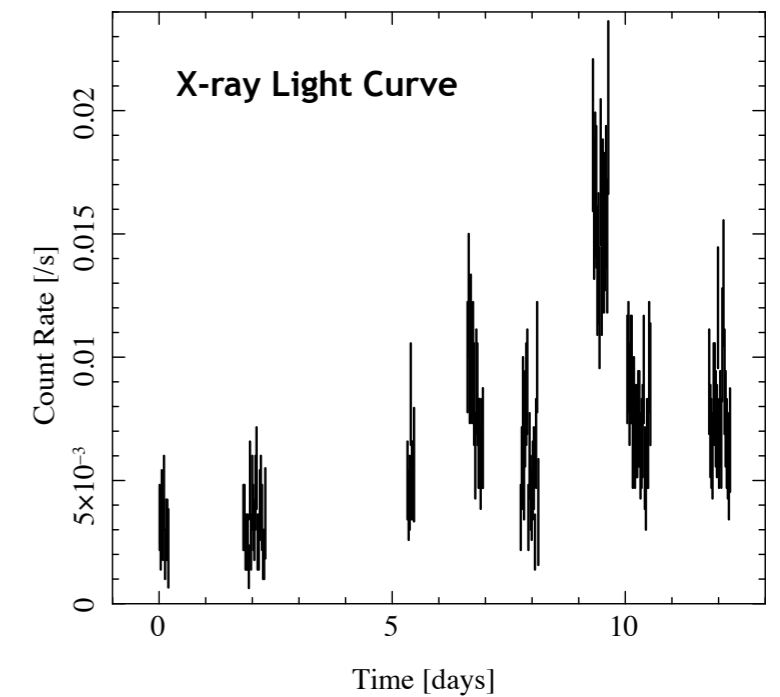
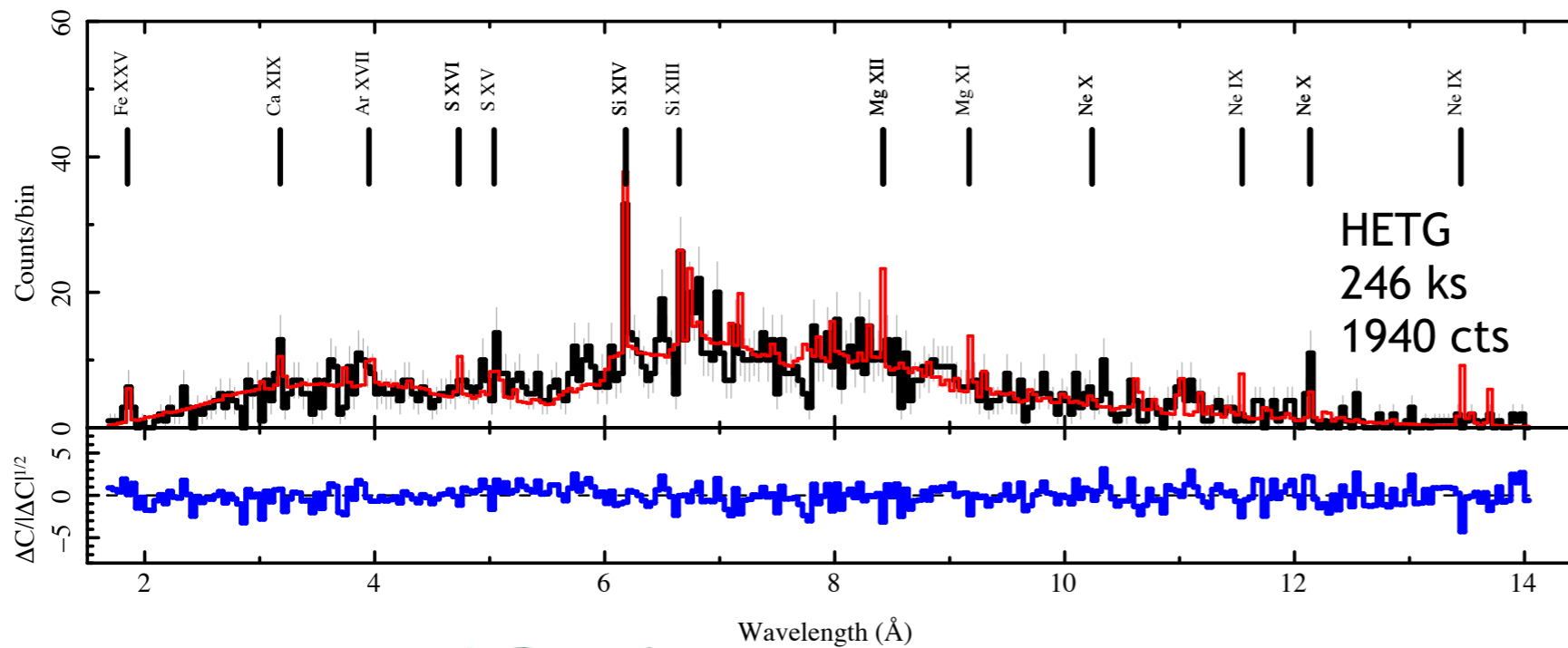
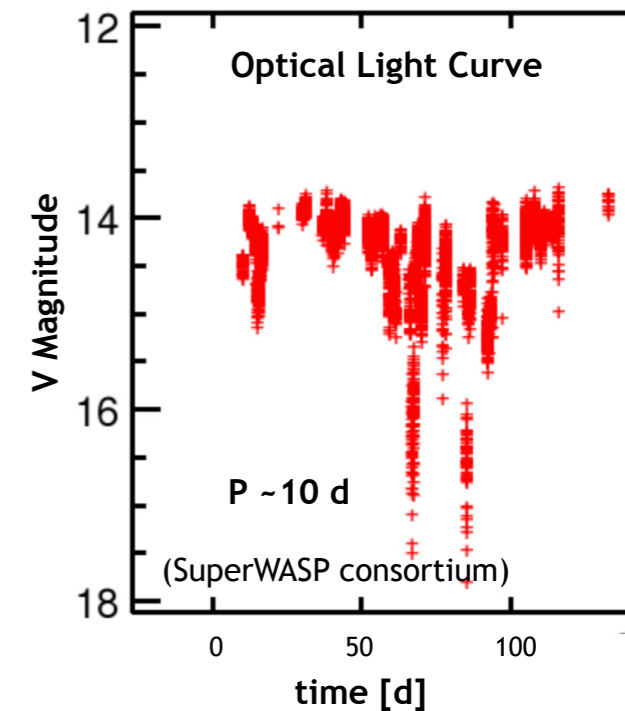
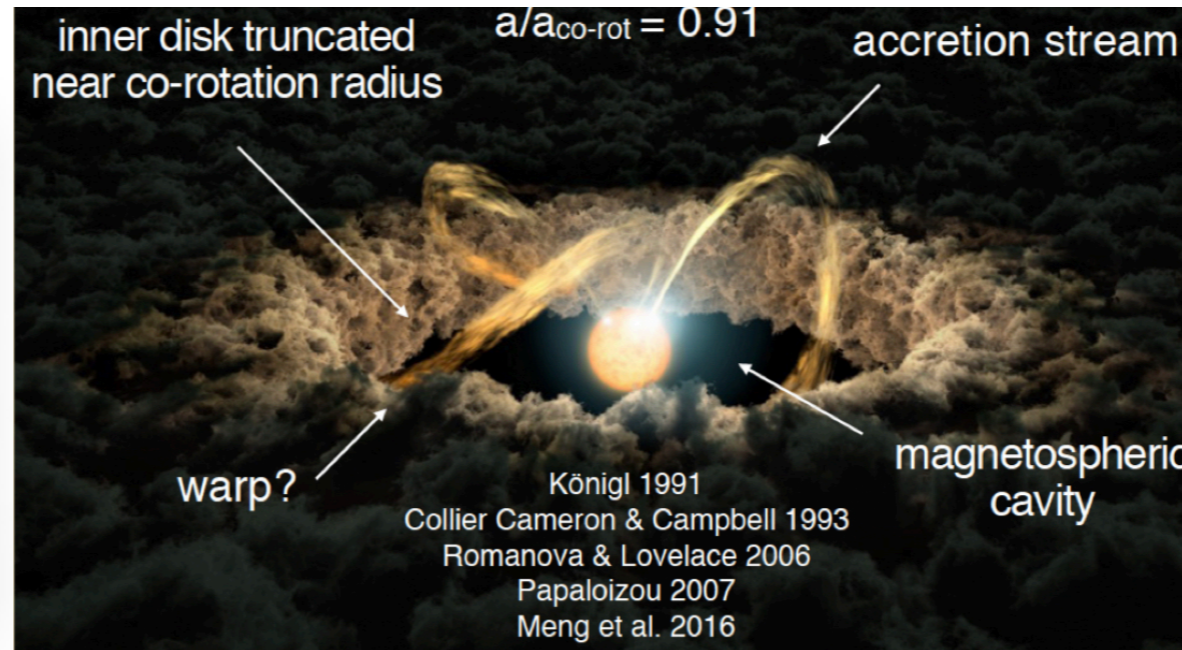


# HETG GTO Science: Pre-main-sequence stars: SZ 96

(Lead scientist: David Principe)



**Sz 96 – A rare, X-ray bright pre-MS star at the cusp of disk dispersal:** Located in the nearby Lupus star-forming region ( $d \sim 200$  pc; Comeron 2008, HFR, Vol 2), Sz 96 is a  $\sim 3$  Myr old M1.5 type pre-MS star with no evidence of any spectroscopic binary (Cieza et al. 2013, ApJ, 762, 100 and ref. therein). The mid-IR SED of Sz 96 indicates the presence of a dusty circumstellar disk which is strongly correlated to evidence of mass accretion during pre-MS stellar evolution (Hartigan et al. 1995, ApJ 452, 736). Indeed, Hughes et al. (1994, AJ, 108, 3) detect an  $H\alpha$  emission line EW of 11 Angstroms indicating weak.

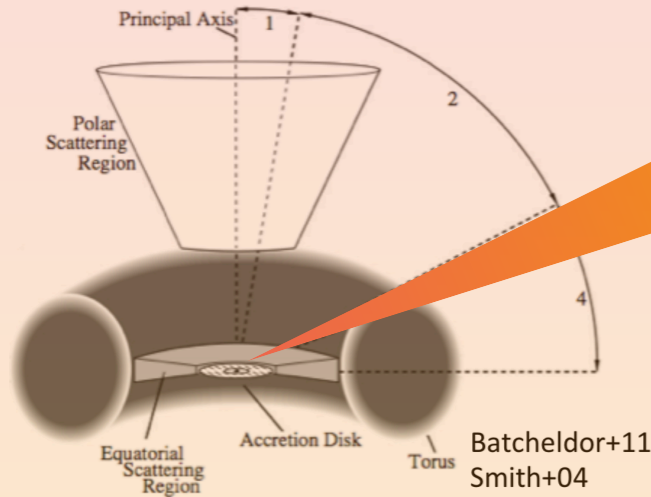




# HETG GTO Science: Active Galactic Nuclei: Fairall 51



Seyfert Galaxy - intermediate view between obscured and polar.



(Preliminary analysis by Rozenn Boissay)

- The source varied by about x2, as hoped -- useful for testing reflection models
- The reflection component is clear from NuSTAR and makes HETGS modeling more secure
- The Fe-K line is clearly detected -- useful for testing reflection models
- There may be a previously unobserved feature at 7 keV

More to do:

1. fitting warm absorber models (although source is fainter than expected)
2. testing for a relativistically broadened Fe-K line, useful for estimating BH spin
3. test models of the serendipitous 7 keV feature

