

BeppoSAX-WFC catalog of fast X-ray transients

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ABSTRACT

We performed a search for fast X-ray transients (FXTs), here defined to be transients with durations longer than one second and less than one day, through data of the Wide Field Camera (WFC) instrument onboard the BeppoSAX X-ray observatory collected between June 1996 and April 2002. The WFC sensitivity ranged from 10^{-9} erg s $^{-1}$ cm $^{-2}$ (2-10 keV), for a time scale of 10 s, to a few times 10^{-11} erg s $^{-1}$ cm $^{-2}$ for a time scale of 10^5 s. The WFC location accuracy was 0.7-4.9' at 68% confidence. We focused our search on gamma-ray bursts (GRBs), X-ray flashes (XRFs), X-ray flares from high-mass X-ray binaries and stellar flares. 149 FXTs were detected. 63 of these are new to the literature. 38 flares are identified with 22 nearby stars. Three stars have never been seen flaring before in X-rays or optical (NLTT 51688, GR Dra and UCAC4 255-003783). We find that the MeV transient GRO J1753+57 is most likely the same object as GR Dra rather than an AGN as previously thought. Eleven flares were detected from known high-mass X-ray binaries with irregular wind accretion. 100 GRBs were identified of which 24 have not been published before. We classify 37% of the X-ray detected GRBs as XRFs with a relatively large X-ray to gamma-ray flux ratio, gamma-rays being measured with the BeppoSAX Gamma Ray Burst Monitor. The duration/spectral hardness distribution of all FXTs is bimodal, separating the group roughly in transients shorter and longer than 1 ksec and with relatively hard and soft spectra, respectively. We identify the 'short' FXTs as GRBs and XRFs and the 'long' FXTs as flares from nearby late-type stars and X-ray binaries. The BeppoSAX-WFC FXT sample is found to be consistent with the one observed by Einstein Probe, when the sensitivity of the two instruments is taken into account, suggesting that the bulk of the population of faint events disclosed by Einstein Probe may represent the extension of a similar population to lower luminosities.

Key words. Catalogs – Gamma-ray bursts – Gamma-rays: stars – X-rays: bursts – X-rays: binaries – Stars: flare

1. Introduction

The X-ray sky is dynamic, more so than the visual sky. Variability is detected on all observable time scales and up to the largest amplitudes. Often the dynamical range is so large that sources change from undetectable to the brightest levels and back. If the duty cycle of activity is low (i.e., if the flux increases for $\leq 10\%$ of the time) we call it a transient event (e.g., Chen et al. 1997). This definition of a transient is somewhat arbitrary and it depends on detector sensitivity. For our purposes, the dynamic range of the flux variation between peak and undetectability is of order 10^3 . The duration of X-ray transient activity can vary between milliseconds (e.g., soft gamma-ray repeaters and type-II bursts) to years (e.g., low-mass X-ray binaries). One class of transients concerns those that last shorter than ~ 1 day and longer than ~ 1 s and are generally not associated with the X-ray bright accreting compact objects in X-ray binaries. Such transients are generally called fast X-ray transients (FXTs) and include a mixture of different sources.

The brightest FXTs are Gamma Ray Bursts (GRBs) and stellar flares. GRBs happen in external galaxies and are associated with two different classes of progenitors, where the collapse of a massive star or the merging two compact objects (neutron stars, black holes) yields a relativistic expanding jet that produces the GRB and its afterglow (e.g., MacFadyen & Woosley 1999; Woosley & Bloom 2006; Metzger et al. 2010). GRBs last shorter

than 1 hr, often shorter than 1 min, and are bright in > 30 keV γ -rays (e.g., Gehrels et al. 2009). They are also bright in 1-10 keV X-rays. In fact, it was realized that a substantial fraction of GRBs have a soft spectrum while having similar (statistical) properties otherwise (including the spectral model, e.g. Strohmayer et al. 1998; Heise et al. 2001; Sakamoto et al. 2005). A fair fraction of FXTs even have no detectable γ -ray emission. These are called X-ray flashes (XRFs). Since the detectability of γ -ray emission depends on the sensitivity of the employed γ -ray detector, an unbiased definition of XRFs is that the peak energy in the νF_ν spectrum is lower than 10 keV. However, the peak energy is often difficult to measure and it is more practical to employ a definition based on the ratio of measured photon flux between X-rays and γ -rays. The ratio is typically larger than 1 for XRFs and similar or slightly lower for the so-called X-ray rich GRB (XRR), (Barraud et al. 2003; D'Alessio et al. 2006). There is substantial evidence that XRFs are simply very soft GRBs. They have the same spectral model, timing properties and afterglows (Kippen et al. 2003; Soderberg et al. 2004, 2006).

Stellar flares are abundant in stars of late spectral type (i.e., that of the Sun or later) and young T Tau stars. This was convincingly shown by Kepler and TESS, the latter of which detected more than 120 thousand of them in the optical (e.g., Seli et al. 2025). TESS detected stellar flares in 7.5% of all monitored stars. The X-ray counterparts to stellar flares have peak luminosities of about 10^{27} - 10^{32} erg s $^{-1}$ (Pye et al. 2015), except for

'superflares' that can be up to 10^3 times more luminous. For typical sensitivities of about 10^{-10} erg s $^{-1}$ cm $^{-2}$, these flares can be detected up to a few hundred parsecs distance, which renders them an isotropic sky distribution (c.f., Gilmore & Reid 1983) just like the extragalactic GRBs.

FXTs have been detected ever since the advent of space-borne X-ray astronomy. Two early reports are Heise et al. (1975) and Rappaport et al. (1976). The first systematic studies on complete databases of some X-ray instruments were published in the 1980s. Connors et al. (1986) studies data taken by the HEAO 1 A-2 experiment in the 2 to 60 keV bandpass at a sensitivity of 10^{-10} erg s $^{-1}$ cm $^{-2}$ (on a time scale of a few seconds) and discovered five transients with durations of 60 to 2000 s and peak fluxes up to 10^{-9} erg s $^{-1}$ cm $^{-2}$. The rate corresponds to 10^4 - 2×10^5 such transients per year over the whole sky, or 10-200 above a threshold of 10^{-8} erg s $^{-1}$ cm $^{-2}$. Connors et al. suggested that most events are stellar flares from dMe-dKe stars, caused similarly as solar flares, namely by energetic magnetic field reconfigurations.

Ambruster & Wood (1986) reports ten transients with the HEAO 1 A-1 experiment, eight of which are stellar flares and two are speculated to be X-ray counterparts to faint GRBs. They infer an all-sky rate of 1500-3000 yr $^{-1}$ above 8×10^{-11} erg s $^{-1}$ cm $^{-2}$ (0.5-20 keV).

Pye & McHardy (1983) reports twenty-seven hours-long transients with Ariel-V SSI, eleven of which are identified with stellar flares and one is a GRB. The remaining transients are speculated to be a mix of these types of sources. The all-sky rate is inferred to be ~ 1500 yr $^{-1}$ above 4×10^{-10} erg s $^{-1}$ cm $^{-2}$ (2-18 keV).

Gotthelf et al. (1996) searches through all IPC (Imaging Proportional Counter) data in the 0.5-3.5 keV bandpass from the Einstein Observatory for transients lasting shorter than 10 s and finds 42 cases with peak fluxes between 2×10^{-10} and 1×10^{-9} erg s $^{-1}$ cm $^{-2}$. This implies an all-sky rate of 2×10^6 yr $^{-1}$ or 16 yr $^{-1}$ above 1×10^{-8} erg s $^{-1}$ cm $^{-2}$ which appears comparable with the Connors et al. result although there is a narrower selection for duration.

Arefiev et al. (2003) combines data sets, investigating a 'few hundred' FXTs from six instruments on five observatories that operated in the 1970s through 1990s with widely different sensitivities and fields of view. They conclude that FXTs comprise a variety of types of sources, predominantly GRBs and stellar flares and that the origin of many, particularly apparent GRBs without gamma-ray signals (which later were called XRFs), are of unknown origin. Arefiev et al. estimate an all-sky rate of tens of thousands per year above a fluence of 10^{-2} Crab-sec.

Searches of FXTs at much fainter fluxes than mentioned above were also carried out with X-ray narrow field telescopes aboard XMM, Chandra, ROSAT, XRISM (e.g., Sun et al. 1998; Quirola-Vázquez et al. 2022; Tsuboi et al. 2024; Eappachen et al. 2024; Khan et al. 2025). Several faint FXTs with duration from about 100 s to 1000 s were found down to flux of around 10^{-13} erg s $^{-1}$ cm $^{-2}$. In this regime, a wider variety of sources are making up FXTs. In addition to stellar flares and GRBs/XRFs dominating the brighter end, faint FXT include tidal disruption events (e.g., Jonker et al. 2013; Auchettl et al. 2017), supernova shock break out (e.g., Waxman et al. 2007; Alp & Larsson 2020; Novara et al. 2020), GRBs orphan afterglows (e.g., Bauer et al. 2017; Wichern et al. 2024) and quasi-periodic eruptions from massive black holes (e.g., Miniutti et al. 2019; Giustini et al. 2020; Quintin et al. 2023; Lu & Quataert 2023).

Currently, there are two work horses for detecting FXTs with wide field monitors: MAXI (Monitoring of All-sky X-

ray Image) on the International Space Station (Matsuoka et al. 2009) and WXT (Wide-field X-ray Telescope) on the Einstein Probe (EP, Yuan et al. 2022, 2025). ISS and EP both lack gamma-ray instruments. Therefore, MAXI and WXT lack synchronous gamma-ray coverage and depend on such coverage asynchronously from elsewhere. MAXI is particularly efficient in detecting stellar flares since these generally last longer than the sample time of any point on the sky of about 1 min per 1.5 hr. MAXI has for the past 15 years (up to October 10, 2025) reported through its alert messaging system 150 stellar flares from 29 sources (e.g., Tsuboi & Sasaki 2020). WXT is perfectly suited for detecting FXTs, thanks to its large instantaneous field of view of 3600 square degrees and its deep sensitivity of 2.6×10^{-11} erg s $^{-1}$ cm $^{-2}$ (0.8 mCrab) in a 1000 s observation in soft X-rays (0.5-4 keV). A preliminary analysis of the first year of EP observations (Wu et al. 2025) resulted in 128 transients, that included 28 stellar flares, 30 events with a gamma-ray counterpart and 52 events without, either because they are XRFs or because no gamma-ray instrument covered the event. Another study (Zhang et al. 2025b) searched the gamma-ray counterpart in 63 FXTs detected by EP (that excluded stellar flares and known sources), finding 14 such events. While the identification of the full EP sample is ongoing, extensive follow-up observations of a subset shows that several of them are associated to GRBs, including high redshift GRBs, XRFs (e.g., Liu et al. 2025; Gianfagna et al. 2025; Sun et al. 2025) but also some to TDEs (Li et al. 2025) and oddballs (Zhang et al. 2025a).

In the 1980s, FXTs were ill understood and in strong need of exploration. Thanks to the prospering development of wide-field coded aperture cameras with large-area multiwire proportional counters (e.g., Proctor et al. 1978; Fenimore & Cannon 1978; Willmore et al. 1984; Brinkman et al. 1985; Skinner et al. 1987; Mels et al. 1988), SRON started in the mid-1980s the successful design and construction of the Wide Field Camera (WFC) instrument for the Italian-Dutch BeppoSAX X-ray observatory with the specific goal to collect data on FXTs. The WFC was launched in April 1996. The mission lasted 6 years. The WFC was very successful in detecting thousands of transient events and, for instance, made an essential contribution to solving the GRB distance scale (Costa et al. 1997b; van Paradijs et al. 1997). Much of the work with the WFC has been published, but a specific paper reporting the complete results of the FXTs detected by the WFC and their proposed identification has been missing. The present paper aims to fill this void, providing a complete flux-limited sample of FXTs that can be used as a reference for current wide field monitor missions.

We have performed a systematic search of FXTs in the WFC data archive, which, thanks to enormously improved computational capabilities in the two decades since the operational end, has become much better feasible. In addition, we provide simultaneous data from the Gamma-Ray Burst Monitor (GRBM) on BeppoSAX, enabling for all these WFC FXTs a homogenous coverage of their gamma-ray emission. We further supplement their gamma-ray properties with data from the Burst And Transient Source Experiment (BATSE) on the Compton Gamma-Ray Observatory when available. We present some analyses of the catalog and compare them with studies from other satellites. In Sect. 2, we describe the employed instrumentation, in Sect. 3 the observations and in Sect. 4 the method of search for FXTs in WFC data. The result is a catalog that is described in Sect. 5. Section 6 discusses the analysis of the overall spectra and classification of the uncertain cases in the catalog. Section 7 presents a discussion of the results. An extensive analysis of the compar-

ative properties of GRB, XRR and XRF classes is forthcoming (Piro et al., in preparation).

2. Instrumental description

BeppoSAX (Boella et al. 1997) hosted two identical cameras comprising the WFC (Jager et al. 1997), pointed in opposite directions and perpendicular to the pointing of the three narrow field instruments (NFI) onboard (LECS, MECS and PDS). They were coded aperture cameras, consisting of a multi-wire position sensitive large-area ($25.6 \times 25.6 \text{ cm}^2$) proportional counter (Mels et al. 1988) paired with, at a distance of 70 cm, a similarly sized gold-plated stainless-steel mask etched with 20 thousand holes following a pattern based on a triadic difference set (in 't Zand et al. 1994). This resulted in the following characteristics: a bandpass of 2 to 30 keV, a photon energy resolution of 20% at 6 keV (full width at half maximum), a net effective area of 141 cm^2 at 6 keV, a highest possible photon detection rate of 2000 cts s^{-1} , a field of view 40×40 square degrees (3.7% sky coverage per camera), an angular resolution of 5 arcmin and a source location accuracy down to 0.7 arcmin (68% confidence). As a reference, the standard Crab X-ray source, when placed on axis, had a photon-count rate of 280 cts s^{-1} in the full bandpass, while the count rate due to the cosmic diffuse X-ray background was approximately 160 cts s^{-1} .

The coded aperture imaging yields coded detector images that need to be decoded on the ground to obtain sky images. This imaging has the advantage, compared to focusing techniques, that it enables a large field of view and relatively cheap optics, but the disadvantage is that photons of all celestial sources are detected on the same detector area resulting in cross talk between different positions in the field of view. The WFC sensitivity ranged between 15 mCrab (2-30 keV, integration time 1000 s) in the crowded Galactic center field with many bright sources, particularly Sco X-1, and 6 mCrab far away from the Galactic plane (5-sigma detection threshold). An in-depth description of the WFC can be found in Jager et al. (1997).

The WFC instrument was very well suited for detecting FXTs because it combined roughly 1-day exposures with a large field of view at sufficiently high angular resolution to enable identification with known X-ray sources or counterparts in the optical, radio or other wavelengths.

The second instrument on board BeppoSAX relevant for the present study is the GRBM (Amati et al. 1997; Feroci et al. 1997; Costa et al. 1998). It consisted of four independent CsI(Na) detectors also used as lateral anticoincidence shields of the Phoswich Detector System (Frontera et al. 1997), each with a size of 1136 cm^2 , had a bandpass of 40 to 700 keV and a sensitivity of $10^{-8} \text{ erg s}^{-1} \text{ cm}^{-2}$ for 1 s. Two of the four detectors were perpendicular to the viewing direction of a WFC unit. Therefore, an event observed with a WFC camera had an optimum GRBM collecting area.

Finally, we use publicly available data¹ from the BATSE instrument (Fishman et al. 1994; Paciesas et al. 1999) on the Compton Gamma-Ray Observatory (CGRO). This was an array of NaI detectors for the study of GRBs that flew from 1991 to 2000 and had full sky coverage in the nominal 20-325 keV bandpass.

3. Observations

The BeppoSAX satellite was launched on April 30, 1996, in a low-Earth low-inclination orbit with a height of about 600 km and an inclination angle of 4 deg. The near to equatorial orbit ensured the least disturbance by high-energy particle backgrounds from Cosmic Rays by taking full advantage of the screening effect of the Earth's magnetic field and avoiding most of the extreme particle flux in the polar regions and the South Atlantic Anomaly (SAA), as demonstrated by the Particle Monitor on board the satellite (Campana et al. 2014). That minimized the necessity to switch off the instruments during passages of such high flux portions of the orbit (Boella et al. 1997). Regular operations started in June and continued until April 30, 2002, for a total of 2156 d or 31 thousand satellite orbits. Apart from intermittent short periods due to operational incidents, the science instruments were turned off for longer periods during May-August 1997 to install the one-gyro mode, and during October 2001 to install the gyro-less mode. Furthermore, WFC unit 1 was turned off in May 1998 to let it recover from presumable frost bite. The total net time that the high voltage (HV) of the proportional counters was at a normal operational level was 1285 days for unit 1 and 1353 days for unit 2. These numbers are impacted by the fact that not always sufficiently accurate star tracker data is available to infer the pointing information of the WFC within a few arcminutes or ensure pointing stability. This reduces the useful observation time by 35%. Finally, the nearby Earth often obscures (parts of) the field of view. Only 44% of the time the Earth is completely outside the field of view of a WFC camera.

Both WFC cameras continuously observed the X-ray sky, except for times when the Earth blocked the field of view or when the satellite passed the SAA. In the latter case, the cameras were put in standby mode by lowering the high voltage. Including times when the Earth occulted (part of) the field of view, the sum of the exposure times of both cameras when the pointing was stable and known is 5.33 years or approximately 168 million seconds. In Fig. 1, a Galactic map of the coverage is given. The WFC did not provide a uniform coverage of the sky. In particular, the maximum coverage was obtained on the ecliptic poles (due to absence of Earth occultations there) and is approximately 13 million seconds. Also, fields around the Galactic center, the Galactic plane, the Crab nebula (opposite the Galactic center), Cygnus and LMC are more exposed. The Galactic center and Crab nebula fields were the sole primary targets for the WFC among the BeppoSAX instruments.

The WFC sensitivity ranged from $10^{-9} \text{ erg s}^{-1} \text{ cm}^{-2}$ (2-10 keV) for a time scale of 10 s, to a few times $10^{-11} \text{ erg s}^{-1} \text{ cm}^{-2}$ for a time scale of 10^5 s. This implies that it was not sensitive to detect flashes like those discovered by Gotthelf et al. (1996) in Einstein data or Sun et al. (1998) in ROSAT data. On the other hand, the WFC sensitivity is comparable to that of EP WXT for events shorter than about 50-100 s, while it does not reach the EP-WXT sensitivity for longer durations (see Sect. 7).

The GRBM was particularly used to detect GRBs. When a threshold was exceeded, the instruments triggered into high-resolution data collecting mode. The GRBM catalog of GRBs includes 1082 GRBs, one third of which was missed by the on-board trigger logic for various reasons and identified on ground using more sensitive algorithms (Frontera et al. 2009). Apart from GRB data, the instrument provided rate measurements at 1 s resolution and two bands: nominally 40-700 and >100 keV. For most of the FXTs reported here, these rate measurements are available. Of the 100 putative GRBs detected by the WFC, 79 were detected by the GRBM.

¹ BATSE data is available at URL gammaray.nsstc.nasa.gov/batse/grb/

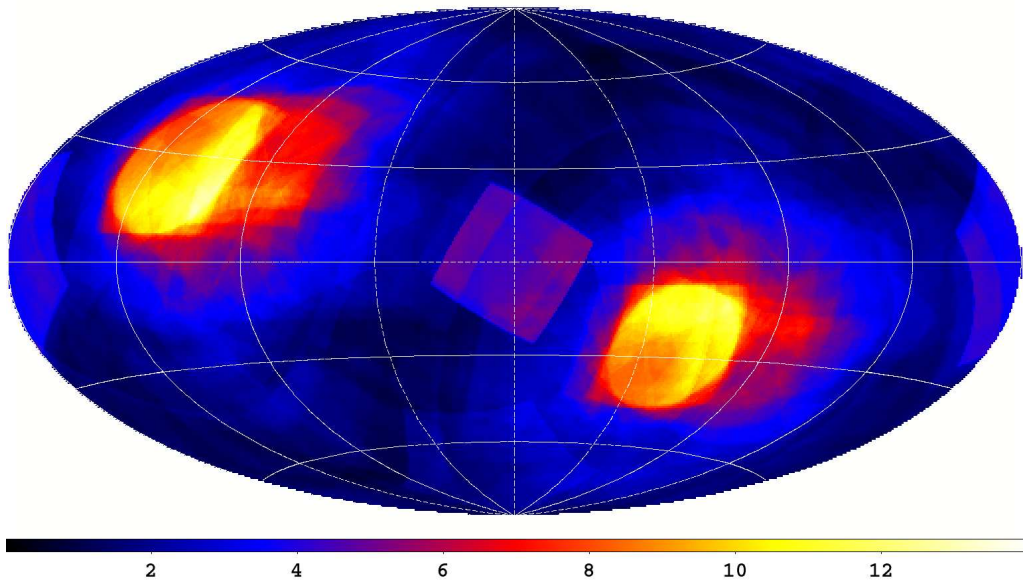


Fig. 1. Aitoff projection Galactic map of WFC exposure in units of Msec

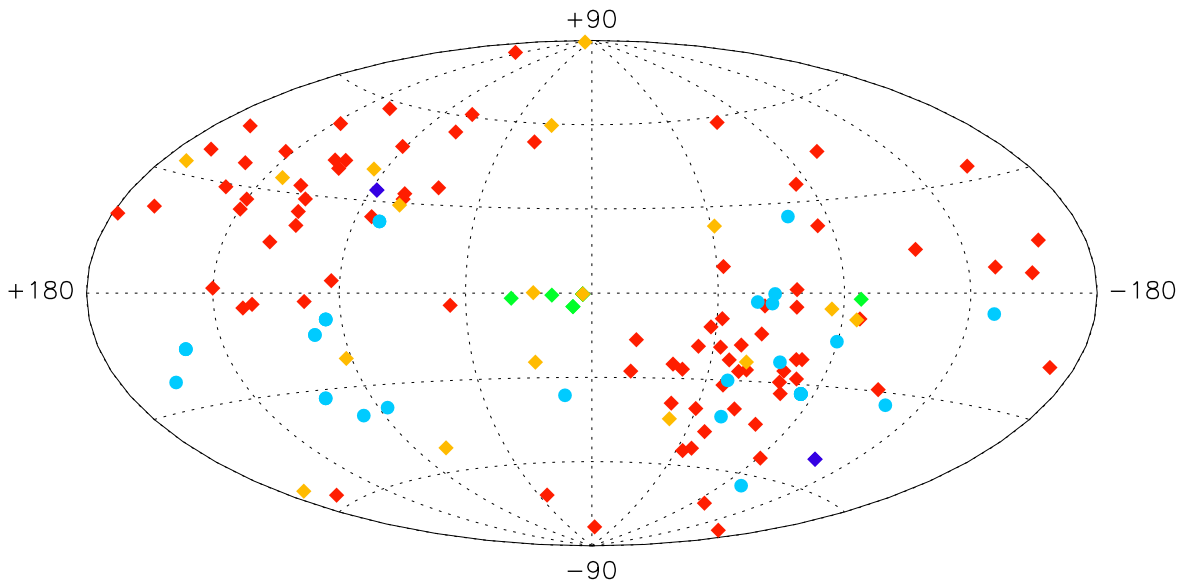


Fig. 2. Aitoff projection Galactic map of 149 FXTs. Red diamonds refer to GRBs, light blue to stellar flares, orange to unconfirmed GRBs ('GRB?' in Table 1), green-crossed o flares from X-ray binaries and dark blue to unconfirmed stellar flares

The Large Area Detectors (LADs) of the BATSE instrument were slightly more sensitive than the GRBM, particularly towards lower energies (the bandpass went down to 20 keV). They operated simultaneously with BeppoSAX for 3.8 yr, ending with the termination of the Compton Gamma Ray Observatory on 4 June 2000. Many of the events which were visible to BATSE did not activate its onboard trigger system which indicates that the 50-300 keV peak fluxes were below $0.2 \text{ cts s}^{-1} \text{ cm}^{-2}$ (1024 ms time scale). Like GRBM, BATSE was only sensitive to burst-like features with strong variability below 1 min time scales. Of the 65 GRBs detected by WFC before the end of CGRO, 27 GRBs were detected by BATSE through time-wise coincidence. The remaining were probably mostly occulted by Earth as seen from CGRO in its low-Earth orbit.

4. Search method and selection criteria

For our purposes, a transient is a point source in the sky which, for a limited time ($\sim 1 \text{ s} - \sim 1 \text{ d}$ in our case), brightens to a flux level significantly higher than the noise at that sky location as caused by all other sources (other astrophysical point sources in and outside the field of view, the cosmic diffuse background and the particle-induced background). From the complete WFC database, we extracted sky images in the complete bandpass for data stretches of 10 s, 60 s, 300 s and 1 BeppoSAX orbit (1.5 hr) duration, sampling the data at intervals half the stretch durations. The sky images were reconstructed from coded aperture images through normalized cross correlation of the detector images with the mask pattern, combined with Iterative Removal Of Sources

(IROS; Hammersley 1986; Jager et al. 1997). The detector spatial data were binned to match the coded mask resolution of $1 \times 1 \text{ mm}^2$. Since the mask consists of 255×257 bins, the cross correlation results in images of 510×512 pixels. The sky images were normalized to the standard deviation from the expected Poisson noise, so that they are in units of significance. These images were searched for FXTs

1. on catalog positions of, for instance, flare stars within 100 pc in the lists of Kowalski (2024) and of stars that have shown flares in MAXI observations (29 stars). The trigger criterion for a candidate transient then is a significance of 3 or higher;
2. through blind searches in the whole field of view. The trigger criterion for a candidate transient then is a significance of 5 or higher.

In all practical circumstances here, significance is equal to the signal-to-noise ratio because the source contribution to the Poisson noise is much lower than from all other sources. A significance of 5 or higher yields a probability of less than 7.5% that there is one pixel in a single image with such a significance from noise.

The validation of candidate transients to true transients involved the visual check of the sky image for errors in the reconstruction (e.g., high noise levels for parts of the image) and, subsequently, generating light curves for the detected positions at time resolutions of 1, 10, 60, 300 and 900 s. If the light curves showed a clear temporary enhancement of the flux 3σ above the zero level over multiple time bins within the original 5 or 3σ triggering time interval, the trigger was validated as a transient. For new sources, this reduces the false source probability to less than 2×10^{-5} (chance probability for statistical $>3\sigma$ positive fluctuations in two or more light curve bins for that particular position in the image, times roughly 10 trials in the light curve).

There are three caveats to this method. First, the calibration of the detector spatial response is not complete. On local scales, there are deviations from a flat response. This is typical for multi-wire proportional counters. It yields an overall systematic localization error of 0.7 arcmin (68% confidence). This imperfection makes it impossible to predict the image position of any point source any better than that, even if the celestial position of sources in the field of view is known at sub-arcsec accuracy like for most catalog sources. Thus, when searching for detections, the point-spread function is fitted to any high signal-to-noise pixel with X and Y left free within boundaries of ± 3 pixels in our case. Obviously, this will bias the fitted flux to positive and negative stochastic noise fluctuations. Therefore, it makes sense to increase the significance thresholds by a factor of $\sqrt{3}$, so to 5.2 for catalog sources.

A second caveat is that employing data stretches of 10 s, 60 s, 300 s and one BeppoSAX orbit (often with an exposure of about 1800 s) leaves less than optimum detection thresholds for transients with durations in between these values. We estimate that the maximum significance disadvantage of this sampling is about 30%.

A third caveat is that the point-spread function (PSF) full-width at half maximum (FWHM) is between 1.0 sky pixel at best and a few pixels for far off-axis angles and large spectral hardness. Thus, for soft spectra and small off-axis angles, the PSF may be somewhat undersampled which deteriorates the sensitivity.

Apart from the searches for FXTs in images, searches were also performed in the time profiles of detector event rates at 1 s resolution, for whole detectors as well as for quarters of detectors. This was done automatically as well as by eye. This

search method is sensitive for burst-like (sub-minute) events; for longer time scales the event rates are subject to changes in particle background and Earth obscuration. When a candidate event was found, its reality was checked by generating a sky image for the duration of the event and searching for an accompanying point source like above. False events are usually due to solar activity (in extremely bright X-rays or particle winds) outside the field of view or to X-ray bursts from active low-mass X-ray binaries (i.e., Galloway et al. 2020).

The procedure for FXT identification evolved over years of working with WFC data. It has a strong human component to it (i.e., the many visual checks). Roughly 90% of all candidates were rejected during the validation. It may be that some faint transients are not caught but we note that the detection threshold obtained is close to the one predicted by Jager et al. (1997), see Fig. 7.

5. Catalog

Our search resulted in 149 FXT detections. Table 1 presents their basic parameters. The column description is as follows.

1. 'ID' - Identification, following the GRB convention of date at which the transient event occurred supplemented, for multiple events on a single day, with a rank letter from the alphabet;
2. 'Ref' - 'u' for unpublished event, 'a' for published by D'Alessio et al. (2006). Numbers refer to the papers cited in the footnote;
3. 'r' - an x denotes a case in which the community was alerted in near real time (i.e., within hours) with the position of the event (55 cases). A + sign denotes a case where additionally the NFI observed the event within hours (38 cases²);
4. 'OP' - BeppoSAX observation identification ('Observation Period');
5. WFC unit that detected the event (1 or 2);
6. MJD(UTC) of the start of the event;
7. T90 duration. This type of duration was introduced in Fishman et al. (1994). We determined it by fitting a cubic spline through the light curve and determining for the cubic spline, as a function of time from the start time of the event onward, the fraction of the total cts cm^{-2} fluence accumulated. T90 was taken as the duration between the times when 5% and 95% of the fluence is accumulated;
8. 1σ error in T90. This was determined by creating 1000 Monte Carlo realizations of the light curve, sampling from a normal distribution for each data point a flux from the measured value and its 1σ uncertainty, and calculating the standard deviation of the 1000 T90 values;
9. R.A. (eq. 2000.0) of the event, as determined from the centroid of the fitted point spread function and the attitude data of BeppoSAX. The position has been determined from the full-bandpass image with the optimum signal-to-noise ratio;
10. Dec. (eq. 2000.0), determined as for R.A.;
11. The positional uncertainty of the event, expressed as the radius of the 68%-confidence circular error region, in units of arcmin. This is according to the calibration as discussed in Heise et al. (1998b);
12. The angular separation between the event position (columns 9 & 10) and the identified optical counterpart (last column) in arcmin. If there is no identified counterpart, as is the case in a number of GRBs without optical follow-up, this column is kept empty;

² See URL www.mpe.mpg.de/~jcgr/grbgen.html and references therein

13. CGRO-BATSE counterpart id. (for definition, see Fishman et al. 1994; Paciesas et al. 1999), or offline identification ('untrig.'). Note that BATSE ceased operations on June 4, 2000;
14. WFC (2-30 keV) peak fluxes in $\text{cts s}^{-1}\text{cm}^{-2}$ and dead time corrected. Note that the WFC flux for the Crab source is $2.1 \text{ cts s}^{-1}\text{cm}^{-2}$, which for a Crab-like spectrum translates to 2.0 and $3.3 \times 10^{-8} \text{ erg s}^{-1}\text{cm}^{-2}$ for 2-10 and 2-30 keV, respectively;
15. GRBM (40-700 keV) peak fluxes in cts s^{-1} per detector corrected by division with the cosine of the off-axis angle. Note that 1) in case the GRBM peak flux is left blank, it was not possible to reliably infer a value because the transient lasts $\geq 1 \text{ h}$ which makes it impossible to distinguish it from changes in the background that have a similar time scale; 2) in case the GRBM peak flux is marked by 'n.a.', GRBM data is not available; 3) this is a WFC-based table, implying that in a number of cases the GRBM did not detect the event. The GRBM peak rate is not corrected for dead time, which introduces an error of 0.3% at maximum;
16. The spectral softness ratio between the WFC (2-30 keV) and GRBM (40-700 keV) peak fluxes, multiplied by a factor of 1000. Note that the peak fluxes in the two instruments are measured at the same time resolution as employed in Fig. 4 but not necessarily at the same time;
17. Type of event, based on the optical/radio counterpart (next column) or when there is a clear simultaneous gamma-ray signal. When there is no clear counterpart and no clear gamma-ray signal in either GRBM or BATSE, the type is labeled with a question mark.
18. Identification of the event with the most likely counterpart. This column may also have facts of interest. One of these facts is whether D'Alessio et al. (2006) finds whether a GRB is X-ray rich ('XRR') or XRF. Note that we have a different criterion for XRF (see Sect. 7).

A synopsis of Table 1 is the following. 149 transient events are listed of which 64 have not been published before. 100 events are associated with GRBs (of which 23 unpublished; c.f. Vetere et al. 2007). 70 are without GRBM counterpart (49 stellar flares and 21 others). 11 stellar flares are associated with supergiant fast X-ray transients (SFXTs) or other high-mass X-ray binaries (HMXBs) and 38 from flaring stars. Nine sources (2 SFXTs, 7 stars) are repeating between 1 and 6 times. The total number of unique sources in the table is 127, out of which 22 are stars (including 5 RS CVns, 3 BY Dra variables, 3 T Tau stars and 2 G-type stars), 4 SFXTs, 1 HMXB and 100 GRBs/XRFs. 18 events have tentatively been identified as GRBs, but without the detection of a gamma-ray signal by the GRBM, BATSE or any other instrument, thus falling under the XRF class. Two of these (020410 and 020427) have detected afterglows which makes their association to GRBs more probable than the remaining 16 cases. Those 16 cases have been labeled 'FXT' in the last column of Tables 1 and 2, and in Fig. 4.

Figure 2 shows a Galactic map of all 149 transients. The distribution reflects the non-isotropic coverage of WFC observations, see Figure 1.

Figure 3 shows the light curves of 49 transient events that can be attributed to stars and X-ray binaries. All data are shown of subsequent observations that continuously pointed at the source. Usually this concerns one OP, but occasionally this concerns up to 5 OPs. For all data we applied the standard allowed star tracker configurations. Furthermore, we included in this data set those data where the source radiation traverses at least 150 km above

Table 3. Five most significant iron line detections in stellar flares.

Event	Source	E(line) (keV)	EW (keV)	Signi- cance
970123	BY Dra	6.52 ± 0.13	1.63	5.2
970321	NLT 51688	6.53 ± 0.07	1.89	4.7
990909	SAX J1819.3-2525	6.45 ± 0.05	1.80	12.7
001207	CC Eri	6.53 ± 0.05	2.17	15.0
010119	Algol	6.68 ± 0.10	2.10	5.9

the Earth horizon. During some of these data, the Earth may obscure other parts of the field of view. For the light curve of event 010315 (GT Mus), a further constraint was applied where the Earth was required to be completely out of the field of view, as in this particular case the standard star tracker configuration was unacceptable when the Earth was in the field view (the flux of GT Mus would drop to zero during these times).

Figure 4 shows the light curves of the 100 GRBs, focusing on times closer to the (shorter) events. Also shown are the 5-30/2-5 keV spectral hardness ratio and the GRBM photon count rates. The latter data are raw data without background subtraction, in contrast to the WFC light curves. For further info on GRBM detected events (e.g., fluence and peak flux in cgs units), see Frontera et al. (2009) and Guidorzi et al. (2011). The same selection of good time intervals was applied as for Fig. 3 (allowed star tracker configurations and a source that is at least 150 km above the Earth horizon).

We note that very bright events (i.e., 10 Crabs or brighter) were excluded on 971010 (MJD 50731.505104, OP2622, WFC unit 2), 000305 (51608.175961, 8616, 1) and 000411 (51645.119576, 8902, 2) because they exhibit a suspect top-hat light curve with a duration of 10-16 s. These are suspected to be false because of improper processing of raw satellite data.

6. Analysis

We extracted overall WFC spectra of all 149 events, integrating over the duration of each event. These spectra were fitted with 3 models: a power law, a black body spectrum and thermal bremsstrahlung. All spectra were absorbed with XSPEC model 'phabs', with cross sections according to Verner et al. (1996), abundances according to Wilms et al. (2000) and equivalent Galactic hydrogen column densities N_{H} following HI4PI Collaboration et al. (2016) through `ftool 'nh'` (version 6.36). A narrow emission line was included at the energy of the Fe K line. For most spectra, the fits with the power law are best. 11% of the black body fits show lower χ^2_{r} and 39% of the bremsstrahlung fits. However, in all these cases the quality of the fits is similar for the power law fits. Therefore, for the remainder we only consider the power law fits. Interstellar absorption and a narrow line were set to Galactic values and zero, respectively, except for a few cases where they were necessarily left free to obtain a good fit. Table 2 presents the results of the spectral analysis with a power law, including a presentation of the 2-30 keV fluence and 2-30 keV isotropic energy output for all cases for which a distance is known. Three groups are discernable in distance and, therefore, energy output: nearby stellar flares (10^{34} - 10^{38} erg), flares from X-ray binaries at a few kpc ($\sim 10^{40} \text{ erg}$) and GRBs ($\sim 10^{51} \text{ erg}$). See Tables 3 and 4 for cases where an emission line was included at the Fe K location and N_{H} was left free, respectively.

For 5 stellar flares the inclusion of the emission line at $\approx 6.5 \text{ keV}$ was necessary for a good fit. The 5 cases are in decreasing

order of significance: 001207 (flare from CC Eri), 990909 (first flare from SAX J1819.3-2525), 010119 (third flare from Algol), 970321 (flare from 1RXS J214641.1-854303) and 970123 (first flare from BY Dra), see Table 3. The two most significant Fe-K lines are shown in Fig. 5. Note that none of the GRB average spectra showed a significant Fe-K emission line. However, some bursts have transient narrow spectral features in WFC data: GRB990705 (Amati et al. 2000), GRB990712 (Frontera et al. 2001) and GRB011211 (Frontera et al. 2004a).

For 5 FXTs, it was necessary to leave N_H free during the spectral fitting, see Table 4. These all happen to be cases where the event is from a HMXB. Four of these are from SFXTs. This is well understood. In these systems, variable winds can temporarily obscure the line of sight, giving rise to changes in N_H . There is one GRB (GRB000528) that shows evidence of a changing high hydrogen equivalent column density (Frontera et al. 2004b).

Figure 6 shows the diagram of T90 duration (column 7 of Table 1) versus power-law photon index (column 7 of Table 2). The 5 different types of sources are indicated with different colors.

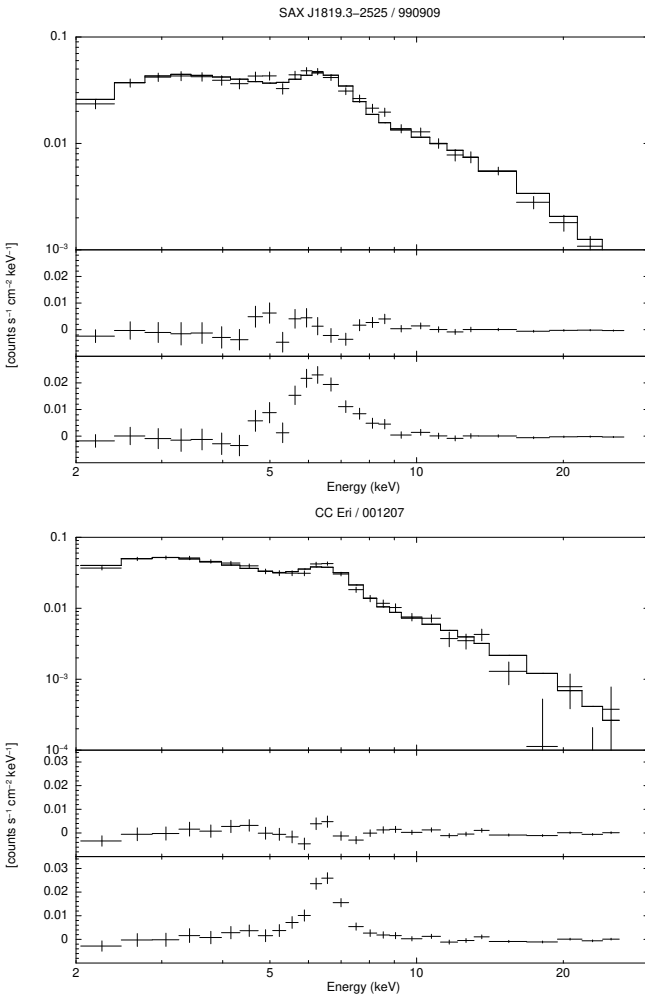


Fig. 5. Spectra showing strong Fe-K emission lines for CC Eri and SAX J1819.3-2525 on top of power-law continuum models. The top panels show the data and model spectrum, the middle panels the residuals between data and model and the bottom panels the same residuals after setting the line fluxes to zero. The equivalent widths of these two cases are 2.17 and 1.80 keV, respectively. The line widths have been fixed at 0 keV. The line of SAX J1819.3-2525 has been discussed in in't Zand et al. (2001).

Table 4. Excess values for N_H if left free.

Event	Source	Excess N_H (10^{22} cm^{-2})	Galactic N_H
960825	IGR J17544-2619 1	22.0 ± 1.2	1.32
980311	SAX J1818.6-1703	161 ± 85	1.17
990220a	SAXJ 1819.3-2525 3	23 ± 15	0.03
000920	IGR J17544-2619 4	3.2 ± 2.7	1.17
010324b	AX J1845.0-0433	26 ± 11	1.40

GRBs and stellar flares are clearly distinct in this diagram. GRBs are short and hard (low photon index), while stellar flares are the opposite. The uncertain classes are mostly associated with GRBs without gamma-ray signals ('GRB?' in Table 1, orange symbols in Fig. 6).

Since the uncertain GRB cases are all without a GRBM signal or data, they did not trigger real-time alerts to the community and follow-up observations with, among instruments elsewhere, the NFI. Thus, the WFC data are the only data on these events. There is one exception, GRB991217, which triggered a prompt reaction because of the strong WFC signal and a noise peak in the GRBM data. No NFI observation took place but optical follow up was engaged with 1 m class telescopes. No afterglow was detected brighter than $R \approx 22$ within 0.5-2.5 d (Mohan et al. 1999).

Considering that the brightest X-ray stellar flares have a luminosity of $10^{32} \text{ erg s}^{-1}$, this implies that stellar flares can be detected by the WFC (taking a sensitivity of $2 \times 10^{-10} \text{ erg s}^{-1} \text{ cm}^{-2}$ for duration of about 1000 s) to a maximum distance of 64 parsecs, which ensures the completeness of star catalogue (Gaia Collaboration et al. 2023). The association of the uncertain GRBs to X-ray-dominated GRBs, i.e. XRFs, is supported by the fact that these events share the same duration-spectral index region populated by GRBs (Fig. 6).

There are a few unidentified longer cases that are on the border between GRBs and stellar flares. They are the two events from GR Dra and the two events from SAX J0346.6-3906 (dark blue symbols in Fig. 6). These are further discussed in Sect. 6.1.

6.1. Interesting individual cases

6.1.1. GR Dra

Williams et al. (1995, 1997) reported the detection in November 1992 with CGRO-Comptel of the MeV transient GRO J1753+57. The source was detected in two consecutive 14-d 'viewing periods' (VPs) with a 1-3 MeV peak flux in one VP of $10^{-6} \text{ cts s}^{-1} \text{ cm}^{-2}$. This flux equals half the flux of the Crab source in the same bandpass. The spectrum is consistent with that of an AGN. Within the 4 deg error radius of the source (4-sigma confidence), 14 candidate counterparts were identified which are not galaxy clusters. 3 of them are stars, 7 are AGN and 4 are of unknown type. By virtue of the similarity in gamma-ray behavior to 2 other transients, the source was suspected to be of AGN origin. Carramiñana et al. (1997) searched for optical counterparts among 9 radio sources and 10 AGN in the error region but was unsuccessful in finding an unambiguous variable counterpart.

We find two transient events in our catalog whose positions are consistent with that of one of the candidates identified by Williams as counterpart: 1ES 1727+590 = GR Dra. This object is, at 3.6 deg from the centroid position of GRO 1753+57, the third closest of nine. Therefore, we conclude that we have de-

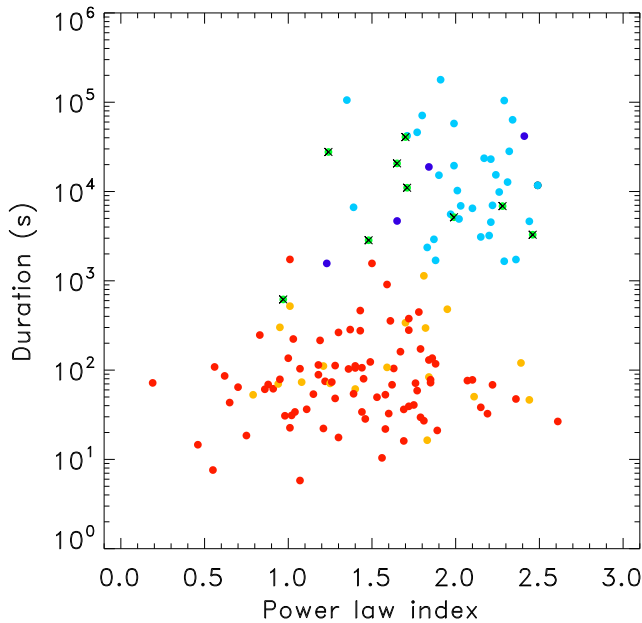


Fig. 6. Diagram of T90 duration versus power law photon index for all WFC events. Red dots refer to GRBs, light blue to stellar flares, orange to unconfirmed GRBs ('GRB?' in Table 1), green-crossed to flares from X-ray binaries and dark blue to unconfirmed stellar flares.

tected the second and third outburst of the MeV transient GRO 1753+57 but now at 2-30 keV instead of 1-10 MeV and that it is a Galactic star rather than of extragalactic origin. The WFC-detected flares are much shorter than 4 weeks as observed by CGRO-Comptel. This suggests that the transient event seen by CGRO may comprise multiple events in 2 VPs.

The peak flux that we observe, about $0.08 \text{ cts s}^{-1} \text{ cm}^{-2}$, is about 40 mCrab. Thus, the 0.5 Crab flux measured by CGRO suggests a hard MeV tail. The X-ray spectrum is rather soft, with a photon index of 2 or a bremsstrahlung temperature of 4.6 keV.

What type of star is GR Dra? It is a bright ($V=8.26$) G0 star at a distance of 139 pc. Schachter et al. (1996) detects optical variability from this star. GR Dra exhibits persistent X-ray emission at a level of 1.4 mCrab (0.1-2.4 keV; Voges et al. 1999). The astrometric excess noise measured with GAIA is 0.134 mas (Gaia Collaboration et al. 2023) which is too low to detect binarity (c.f., Gandhi et al. 2022).

If GR Dra is the same as GRO 1753+57, how can a G0 star give rise to MeV transient emission? We suggest that GR Dra may house a compact object. Sensitive follow-up observations should be interesting.

6.1.2. SAX J0346.6-3906 = UCAC4 255-003783

We see two transient events lasting less than 1 hr and peaking at about 100 mCrab and with a moderately hard spectrum (photon index 1.8). There are no known X-ray sources at its location. There is one optical counterpart: UCAC4 255-003783, a cool star in the Epsilon Cha star association. Since SAX J0346.6-3906 is a repeating source, it cannot be a (long) GRB. The event may be a faint X-ray burst due to a distant X-ray binary. For a maximum expected luminosity, the Eddington limit of a H-rich accreting neutron star, the distance would be $\sim 30 \text{ kpc}$ which

would place it at a somewhat unlikely location outside the Galactic Bulge.

6.1.3. 1RXS J214641.1-854303 = NLTT 51688

This object has been identified with a $V=13.4$ M3.5 dwarf star NLTT 51688 (Riaz et al. 2006) at a distance of 16 pc (Gaia Collaboration et al. 2023), which has never been seen to flare before but whose spectral type is fully consistent with flaring activity. We detect a significant Fe-K line from this source, which suggests that substantial obscuration of the flare source occurs (c.f., Mushotzky et al. 1993).

6.1.4. 2RE J051724-352221 = CD-35 2213

This object has been identified with a $V=11.7$ M4Ve dwarf star (Scholz et al. 2005) at a distance of 12 pc (Gaia Collaboration et al. 2023), which has never been seen to flare before but whose spectral type is fully consistent with flaring activity.

6.1.5. Others

971019. This is the brightest and the softest GRB event. A combined WFC/BATSE spectral fit over the whole event shows a peak energy in the νF_ν spectrum of $19 \pm 1 \text{ keV}$ compared to an average peak energy of about 200 keV for classical GRBs (Kippen et al. 2003). This is the prototypical X-ray flash (XRF) case of our sample.

980306 is classified as XRF on the basis of BATSE data instead of GRBM data (Kippen et al. 2003). It was followed up with the BeppoSAX NFI on August 1-2, 1999, 17 months after the event. This observation is not yet discussed in the literature. No source was detected with MECS within the WFC error box above $1.7 \times 10^{-3} \text{ cts s}^{-1}$ (3.5-sigma upper limit) corresponding to a flux of $\sim 10^{13} \text{ erg s}^{-1} \text{ cm}^{-2}$.

980429. This is the first XRF that was followed up with a sensitive device within a matter of days (Heise et al. 1998a). The NFI observed the position between 32.45 and 53.4 hrs after the flash and detected one source at a position of $R.A._{2000.0}=130.1507 \text{ deg}$, $Decl._{2000.0}=+22.8584 \text{ deg}$ with an uncertainty of 1'. This is 1:1 from the WFC centroid, so fully consistent. The source is weak, with a MECS photon count rate of $(2.11 \pm 0.39) \times 10^{-3} \text{ cts s}^{-1}$ over 37364 s net exposure time, and no variability nor spectrum could be detected. The photon rate implies a 2-10 keV flux of a few times $10^{-13} \text{ erg s}^{-1} \text{ cm}^{-2}$. Since there is no clear decay during the NFI observation, the source cannot unambiguously be identified as the afterglow. Optical follow up after 2.8 d failed to find a counterpart, with limiting magnitudes of $B \sim 22$ and $R \sim 21$ (Djorgovski et al. 1998). This source was also followed up in 2007 and not detected above an upper limit of $4.5 \times 10^{-14} \text{ erg s}^{-1} \text{ cm}^{-2}$ (presumably in 0.5-10 keV; Romano et al. 2008).

991106. This event cannot be completely ruled out as a type-I X-ray burst (Cornelisse et al. 2002). The Galactic latitude of this event is -2.6 deg . The event was followed up with the NFI between 7.9 and 27.0 hr after the event. The MECS exposure time is 31.7 ksec, and the LECS exposure 11.8 ksec. The MECS data show a detection of a point source in the WFC error box. The flux is $1.8 \times 10^{-3} \text{ cts s}^{-1}$ in the MECS, which for a Crab spectrum

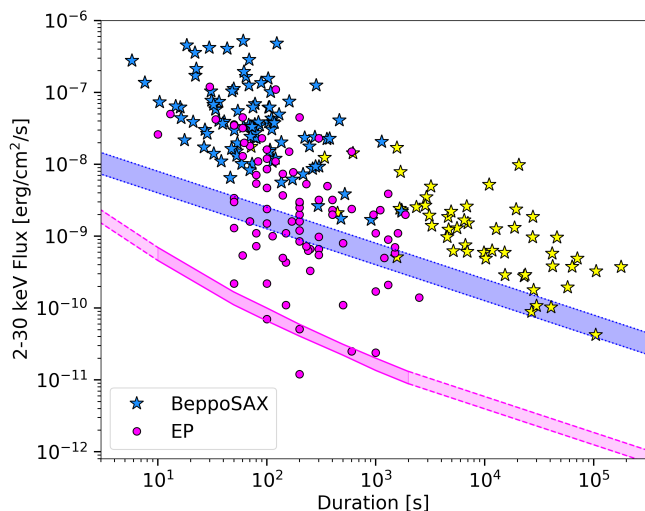


Fig. 7. Comparison of average 2-30 keV fluxes for Einstein Probe and BeppoSAX events. 149 BeppoSAX-WFC GRBs and stars from the present catalog are represented in blue and yellow asterisk symbols, respectively. 84 EP-WXT transients (without stars and Galactic sources, from Wu et al. (2025) and Aryan et al. (2025)) are in magenta-filled circles. The BeppoSAX-WFC sensitivity is drawn as a blue band since it depends on the particular X-ray source configuration in any observed sky image (for example, it depends on the inclination angle and on the pointing). The EP-WXT sensitivity is represented as a magenta band and corresponds to the 90% confidence interval (as reported at <https://ep.bao.ac.cn/leia/cms/article/view?id=38>) in the time range 10-1000 s. Below and above this time range, we extend the sensitivity lines assuming a photon limited regime (t^{-1}), and a background limited regime ($t^{-1/2}$), respectively (dashed lines). We note that the EP-WXT sensitivity was extrapolated to the 2-30 keV band assuming the same spectrum as here, so it is not to be considered as exact since the type of spectrum can change substantially the flux level.

is roughly $10^{-13} \text{ erg s}^{-1} \text{ cm}^{-2}$ which is very low for an X-ray burster with such a short burst.

7. Discussion

The faintest FXT that we find has a peak WFC flux of $0.02 \text{ cts s}^{-1} \text{ cm}^{-2}$ (and a duration of 20 h) which, for a Crab-like spectrum, translates to $2 \times 10^{-10} \text{ erg s}^{-1} \text{ cm}^{-2}$ (2-30 keV). For a 10^3 s exposure, the formal 5-sigma sensitivity is the same value (2-30 keV) for fields away from the Galactic center and for the on-axis position. For other positions in the field of view, the sensitivity reduces approximately pyramidically towards the edge and the average over the field of view is about $4 \times 10^{-10} \text{ erg s}^{-1} \text{ cm}^{-2}$.

Our coverage is 5.33 yr exposure for 2 WFC cameras times the 0.47 sr field of view of one WFC camera. This equals 2.50 yr sr and implies a yearly all-sky rate of $755 \pm 62 \text{ yr}^{-1}$. This is of the same order of magnitude as what was found with the detections by Ariel V and HEAO in the 1970s based on fewer events (Ambruster & Wood 1986; Pye & McHardy 1983).

An interesting comparison to make is with the recent results from the WXT on EP. From General Coordinate Network (GCN) circulars of the first year of EP operations, Wu et al. (2025) collected 128 FXTs, including stellar flares and known sources, while Aryan et al. (2025) collected 72 FXTs, excluding stellar flares. For a field of view of 1.1 sr and assuming an observation efficiency of 90%, this yields a total all-sky rate of GRBs

and stellar flares of roughly $1600 \pm 140 \text{ yr}^{-1}$ (note that the fraction of GRBs and stellar flares in this sample is unknown at the writing of this paper). This is a factor of 2 higher than for the WFC. This can roughly be explained by a difference in sensitivity. The WXT sensitivity is $0.26 \times 10^{-10} \text{ erg s}^{-1} \text{ cm}^{-2}$ (0.5-4 keV) for an exposure time of 10^3 s . EP-WXT has a substantially better sensitivity than BeppoSAX-WFC for events lasting longer than about a few tens of seconds, because the WXT is photon limited, it being a direct focusing camera, while the WFC is background limited. In Fig. 7, we plot the average flux in the 2-30 keV range versus duration for events detected by either WFC or WXT. Here, the EP-WXT flux has been extrapolated from 0.5-4 keV to 2-30 keV using the published WXT spectra and, therefore, does not take into account any possible spectral breaks between 4 and 30 keV. For the duration, we applied the T90 values for the WFC sample and the durations mentioned in the appropriate GCN circulars for the EP sample. When we consider only the 50 EP events above the BeppoSAX-WFC sensitivity (taking the center line of blue-filled region as dividing line), the fraction of EP events that would be detectable by the WFC is 0.61. If we correct the value of 1600 above for this fraction, the all-sky rates of transients are comparable: the EP rate reduces to 960 ± 221 , a factor of 1.27 ± 0.24 higher than the WFC rate. Systematic effects, for instance due to the different bandpasses of the WFC and WXT, will add uncertainty to this number.

The comparison of BeppoSAX versus EP events in Fig. 7 (blue stars for BeppoSAX and magenta circles for EP), excluding sources like stellar flares, leads to the following conclusions:

1. the rate of the events in the two instruments is comparable when one considers the region above the BeppoSAX-WFC sensitivity;
2. in both instruments, particularly EP, there appears to be a lack of events of duration shorter than about 40-50 seconds compared to longer durations. This is consistent with the extensive evidence that the X-ray emission in GRBs is longer than in gamma-rays (Piro et al. 1998);
3. at duration larger than about 50 seconds, where the bulk of events lies, the better EP sensitivity discloses a population of faint events;
4. the distribution of the faint EP events seems to connect without gaps with brighter events (both by BeppoSAX and EP).

The latter point suggests that the bulk of the population of faint EP event could represent the extension of the brighter one and thus could share the same origin, i.e. be associated to GRB-like progenitors. In fact, in a few cases, these faint events have been indeed explained in this context (Rastinejad et al. 2025; Jiang et al. 2025; Srinivasaragavan et al. 2025; O'Connor et al. 2025). In this regard it should be pointed out that the association of this faint population to GRBs is much more difficult because any gamma-ray signal associated to such faint events would be undetectable by GRB monitors currently flying. It could only be achieved by follow-up campaigns disclosing the associated afterglows and counterparts.

Another interesting comparison to make is with MAXI. According to the MAXI alert messages disseminated through email, MAXI has detected 150 stellar flares in 15 years from 29 unique stars which translates to a yearly all-sky rate of approximately 15 yr^{-1} above a sensitivity threshold of about $6 \times 10^{-10} \text{ erg s}^{-1} \text{ cm}^{-2}$ (2-30 keV; Matsuoka et al. 2009). This is substantially lower than WFC, WXT and other missions. Parts of this can be explained by the worse sensitivity and an incomplete count on our part from the literature. MAXI has a large sky coverage for

events that last longer than one MAXI orbit and should be quite efficient in detecting these.

The census of late-type main sequence stars is complete for distances of up to about 200 pc from GAIA measurements, for a limiting G magnitude of 21 (Gaia Collaboration et al. 2023). Pye et al. (2015) determines an X-ray peak flux range for stellar flares of 10^{27} - 10^{32} erg s⁻¹. The WFC sensitivity limit of 2×10^{-10} erg s⁻¹cm⁻² implies that even for the smallest distance of 1 pc, not the whole range of peak fluxes of stellar flares can be detected. Thus, the reach of WFC detections is smaller than that of optical detections of late-type stars. Therefore, any WFC detection of a stellar flare should be identifiable through an optical counterpart and this is indeed the case.

We identified 33 stellar flares by cross checking positions with catalogs of stars (e.g., Kowalski 2024). The location of an additional event is coincident with ROSAT source 1RXS J214641.1-854303 and M3.5 star NLTT 51688, a probable flare star. Four further flares were detected from sky regions that are not known to host a known flare star. These have been tentatively identified with other counterparts, one which exhibited gamma-ray flares in the 1990s (GR Dra) and one with a cool star (UCAC4 255-003783). Therefore, 87% of the long-duration/soft events could be unambiguously identified through obvious counterparts.

42% of the FXTs reported here have not been reported previously. This applies to 37 out of 38 stellar flares, 3 SFXTs and 23 out of 100 GRBs. This is unfortunate for this revolutionizing phase of GRB research when the distance scale of GRBs was first established. The reason is that the missed-out GRBs are mostly gamma-ray poor. This prevented quick-look recognition of GRBs in the GRBM and quick follow-up in WFC data for localization, specially in the early phase of the mission lifetime. However, some were recognized in real time and triggered broad band follow-up observations. It was then realized that they were at similar distances as GRBs and exhibited broad-band afterglows not unlike GRB, motivating the association of XRF to a class of GRBs (e.g., Piro et al. 2005; Galli & Piro 2006; Amati et al. 2004). This association has been further consolidated following the launch of HETE II (Lamb et al. 2004) and Swift (Gehrels et al. 2009), with XRF sample studies of the joint BeppoSAX-HETE-2 sample (D'Alessio et al. 2006; Sakamoto et al. 2005) and Swift (Sakamoto et al. 2008).

If we apply a peak flux softness ratio (see column 17 in Table 1) threshold of 16 or larger, above which we fail to detect a GRBM signal for most GRBs, for XRFs we find 37 such cases or 37% of all GRBs. This is roughly consistent with earlier findings, although those make a distinction between 3 classes rather than 2 and apply thresholds to different definitions of spectral hardness ratios: X-ray flashes ($H_s > 1$ with $H_s = \text{fluence}(2-30 \text{ keV})/\text{fluence}(40-400 \text{ keV})$), X-ray rich GRBs ($0.32 < H_s < 1$) and classical GRBs ($H_s < 0.32$) (D'Alessio et al. (2006), see also Sakamoto et al. (2005)). Note that the hardest GRBs in our sample have a softness ratio of 0.8 (GRB990123 and GRB000210). These rates are slightly different compared to the sample detected by EP-WXT. For example, Zhang et al. (2025b) finds that 22% of FXTs detected by EP-WXT have a gamma-ray counterpart, searching in GECAM and Fermi/GBM data. This difference likely arises from the better sensitivity of EP-WXT, which can detect transients as faint as a few times 10^{-11} erg s⁻¹cm⁻², an equivalent sensitivity that cannot be achieved by any GRB detector currently in operation in gamma rays. The difference in the rates could also be due, in part, to the different band-passes of the GRBM, with respect to Fermi-GBM (8 keV – 40 MeV) and GECAM (10 keV – 6 MeV). The GRBM sensitiv-

ity, though, is comparable to Fermi-GBM and GECAM (order of 10^{-8} erg s⁻¹cm⁻²). Finally, it is obvious that the EP sample is biased because of its lack of direct γ -ray coverage since it does not host a γ -ray instrument.

The science goal of the WFC, when the instrument was proposed in the 1980s, was the acceleration of data collection on FXTs to better determine their origin. The WFC has detected about 149 FXTs in the categories of GRBs/XRFs (100), stellar flares (38) and SFXT flares (11). The first-time fast (within hours) and accurate (within arcmin) localization of GRBs solved the decades-long enigmatic mystery of their origin. The topping off with stellar flares has made the identification possible of 99% of all FXTs and explained their origin. The conclusion is that the WFC instrument has met its science goal.

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Author contributions. Data extraction: JZ and CG. Data analysis: JZ, LP and GG. Manuscript preparation: JZ. Manuscript review and improvement: all authors. It is noted that no AI tool has been employed in the data reduction analysis nor manuscript preparation.

Online data concern the time series data of Figs. 3 and 4. These are available at <https://doi.org/10.5281/zenodo.18849381>

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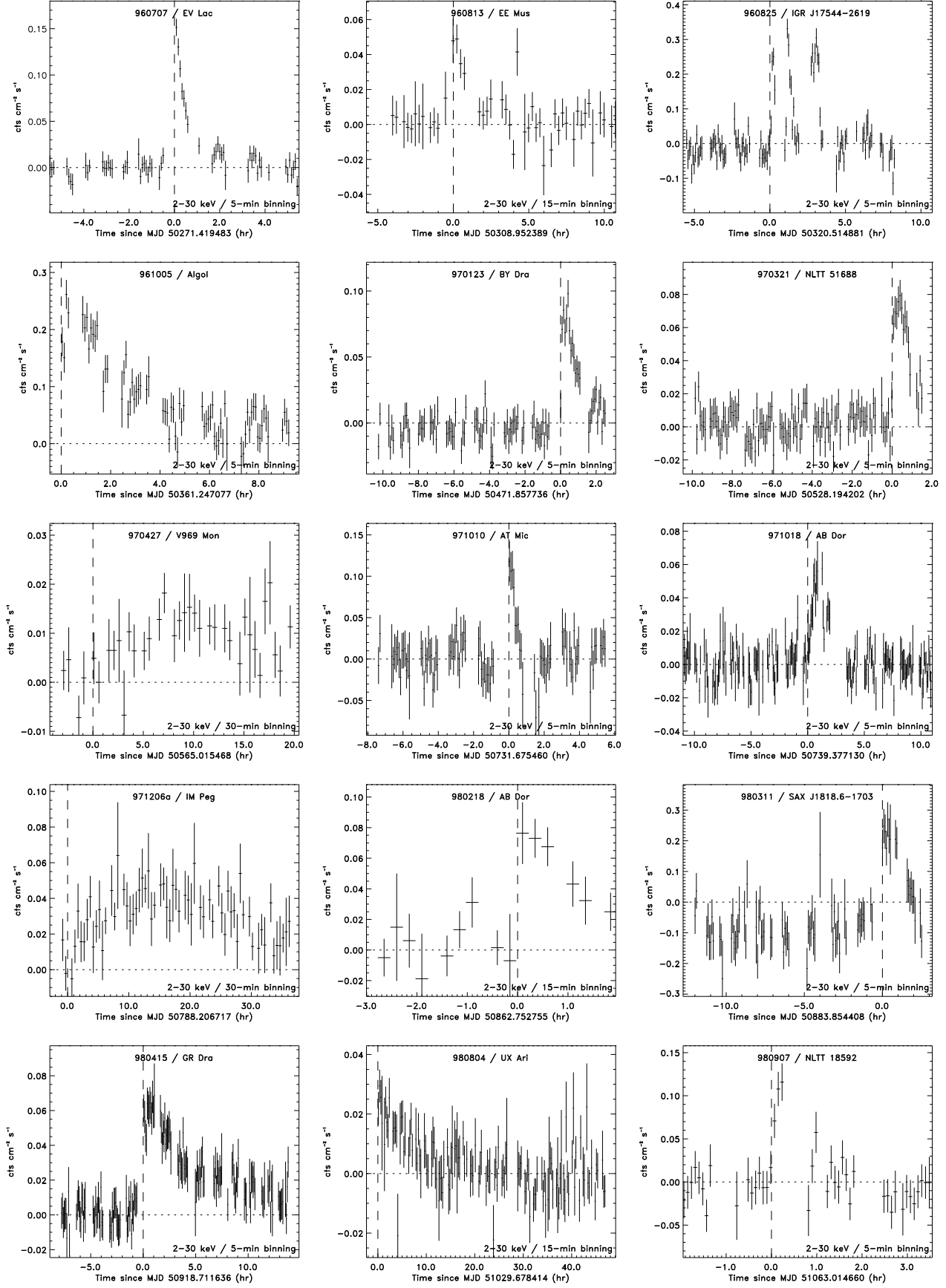


Fig. 3. Light curves of 49 magnetic flares.

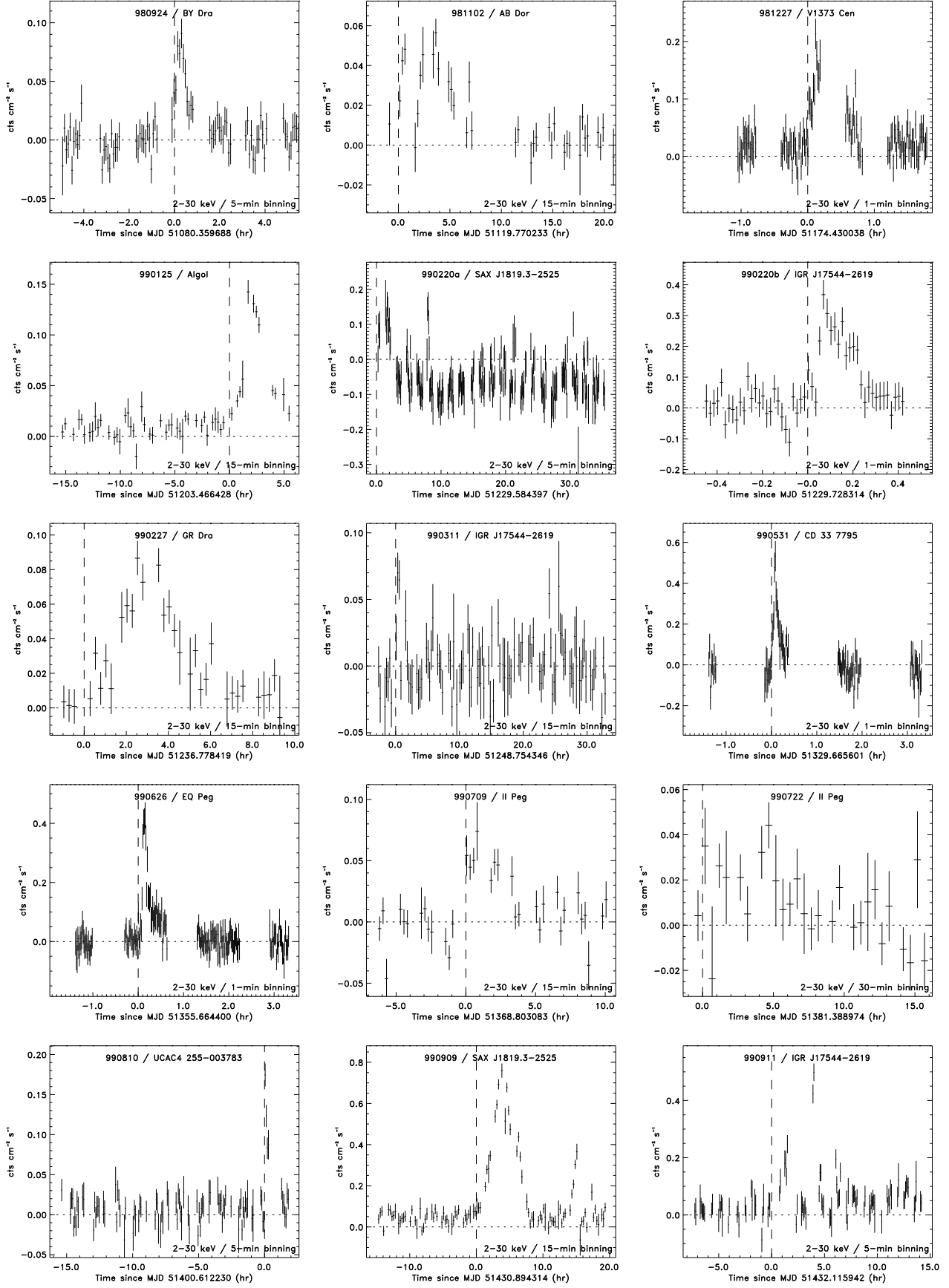


Fig. 3. cont'd (2/4)

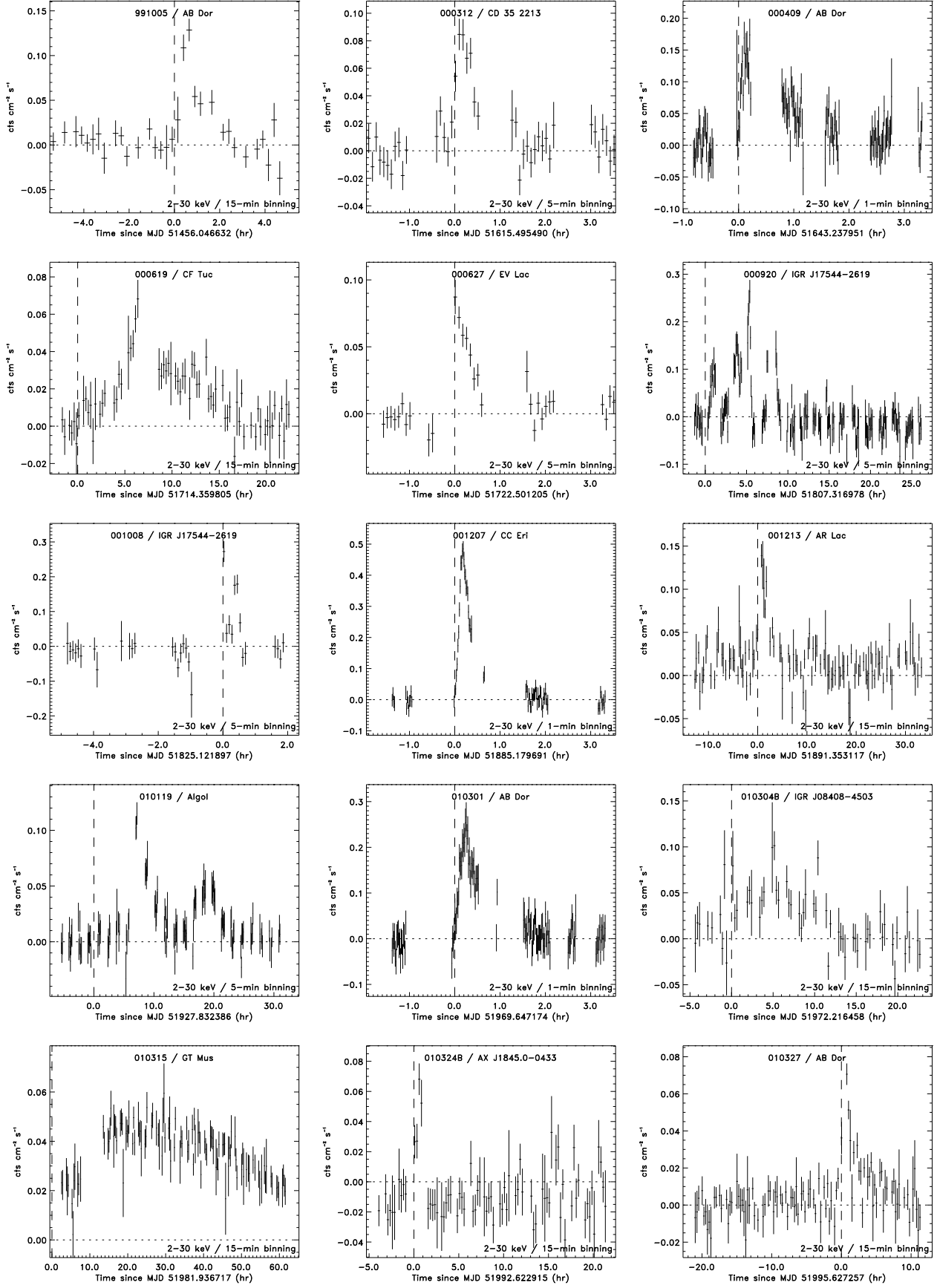


Fig. 3. cont'd (3/4)

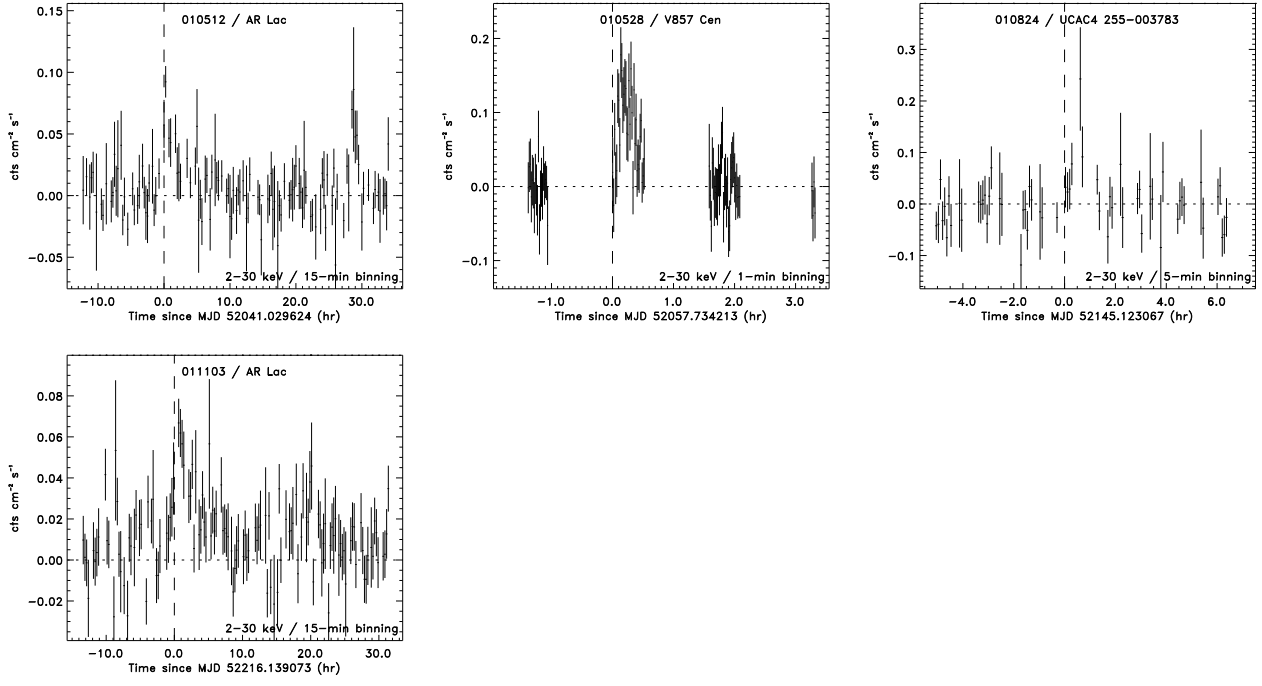


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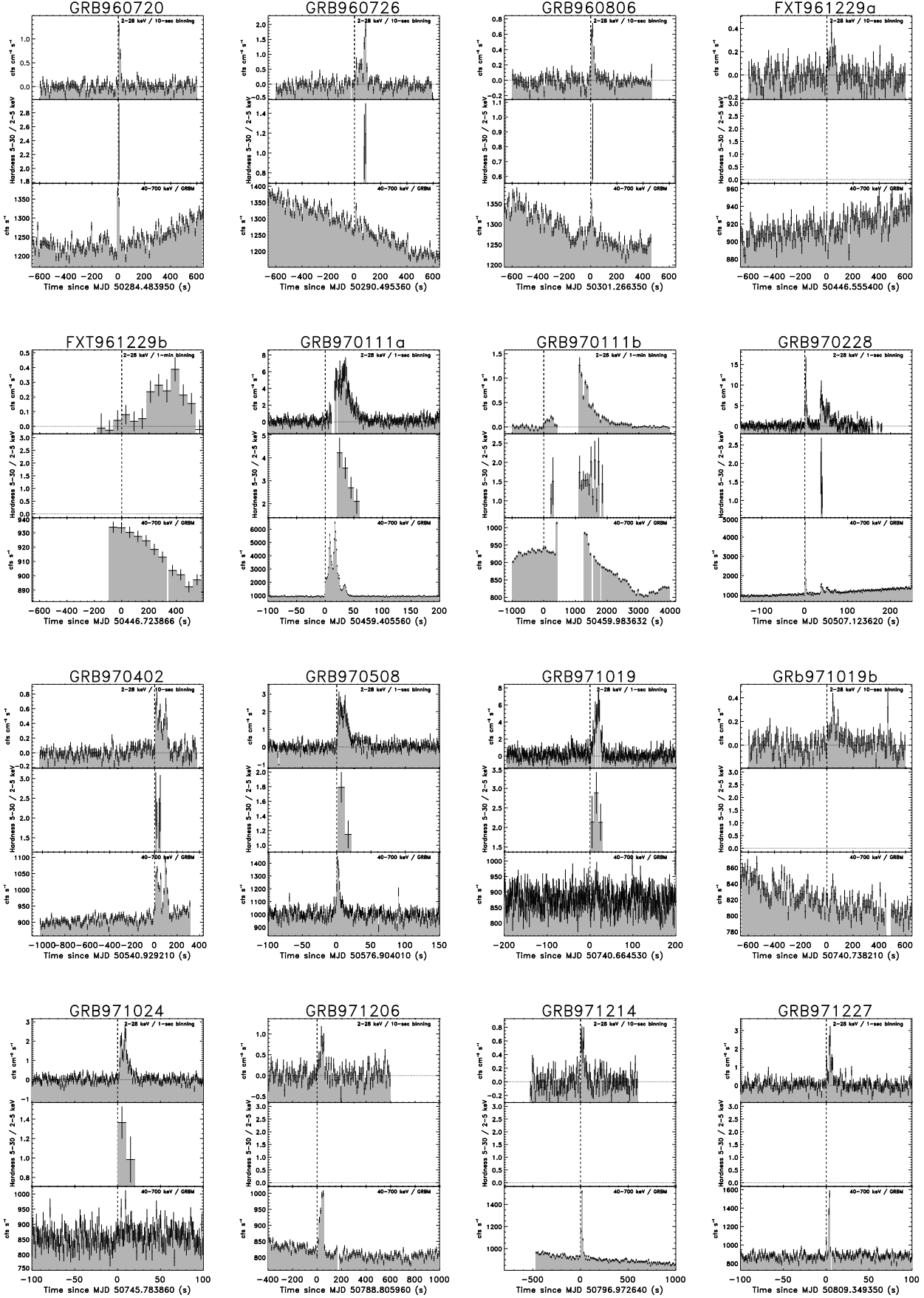


Fig. 4. Light curves of all 100 GRBs. Top panels: in WFC full bandpass (2-30 keV). Middle panels: 5-30/2-5 keV spectral hardness ratio from WFC data. Bottom panels: 40-700 keV GRBM light curves. (1/7)

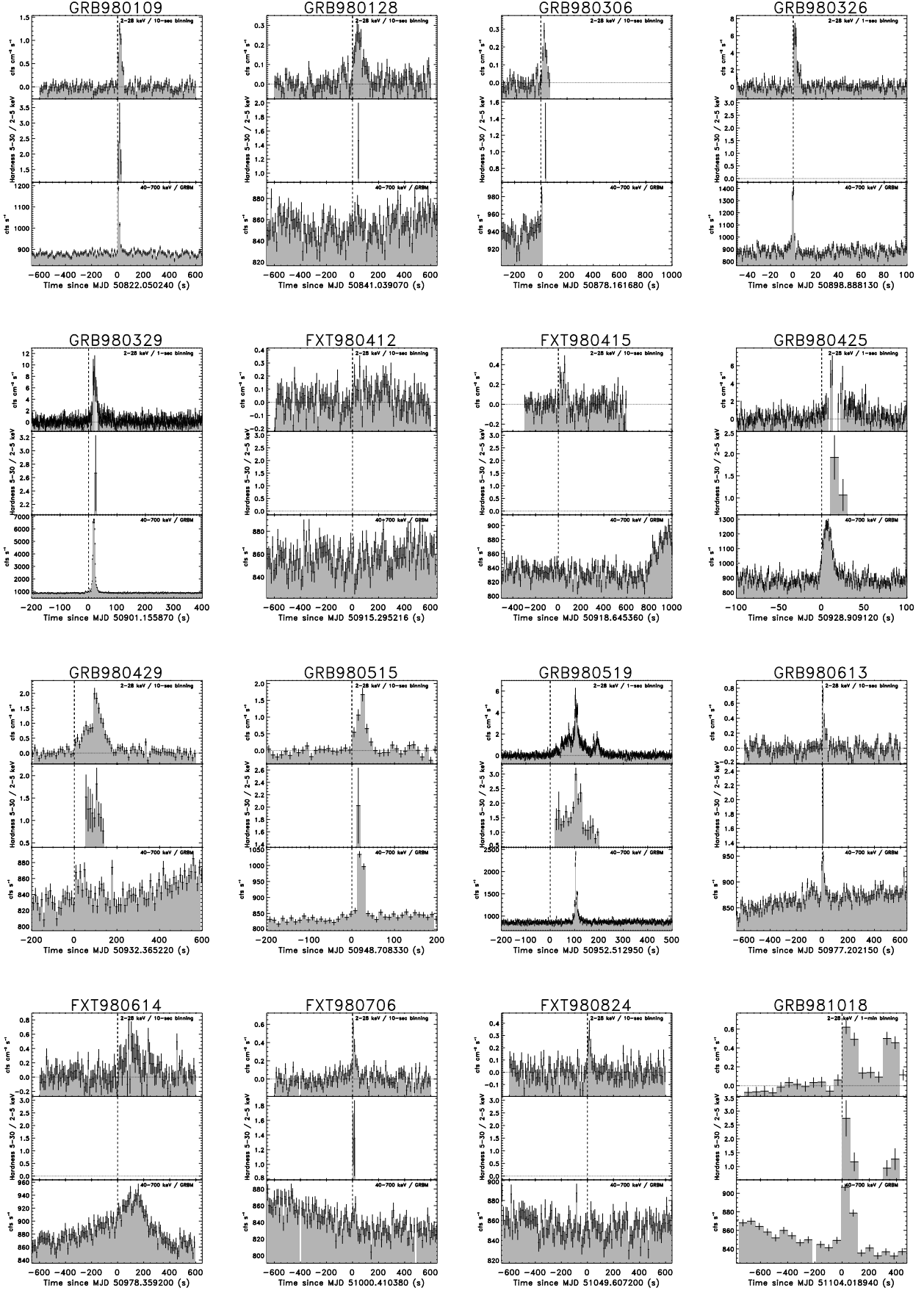


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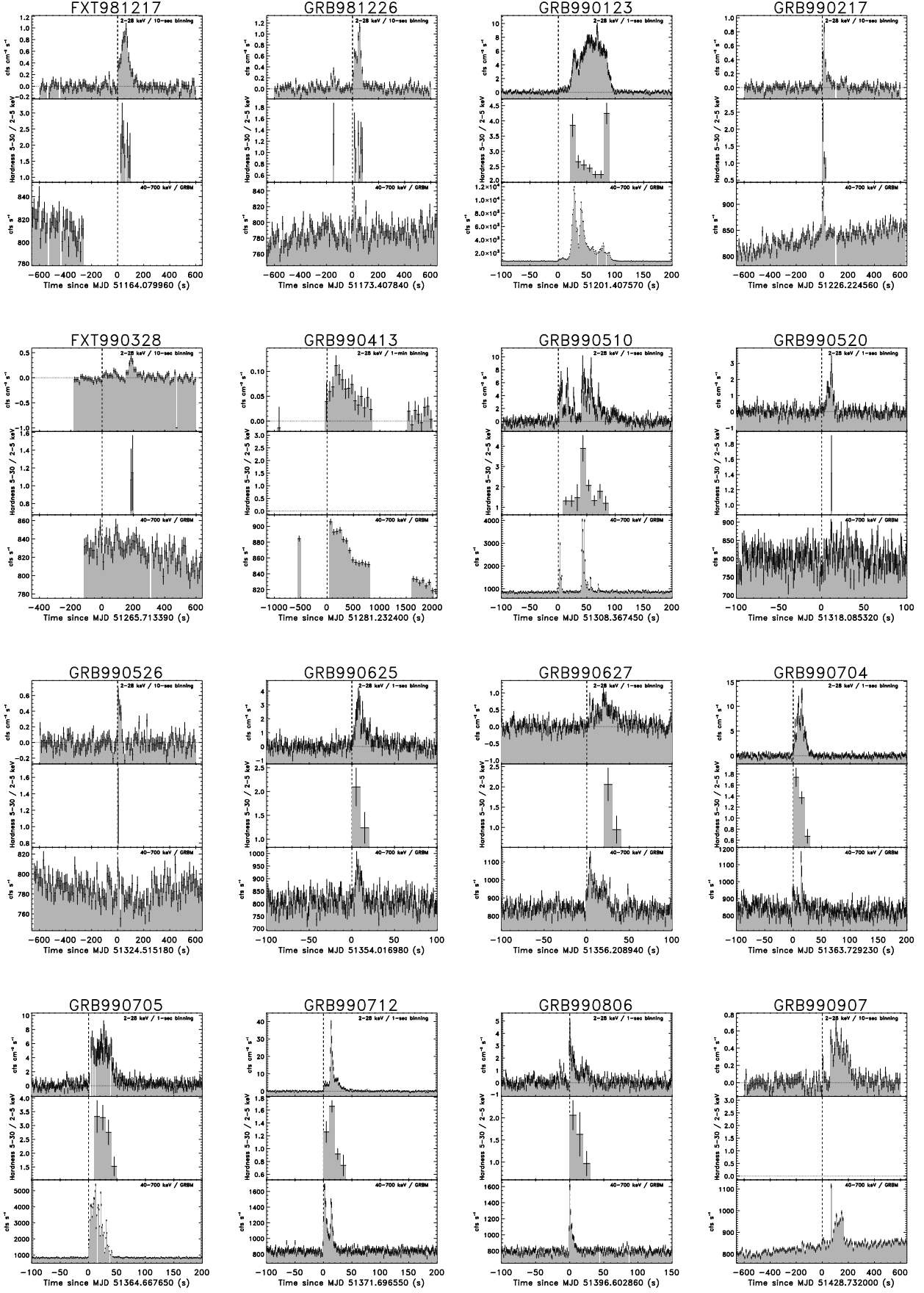


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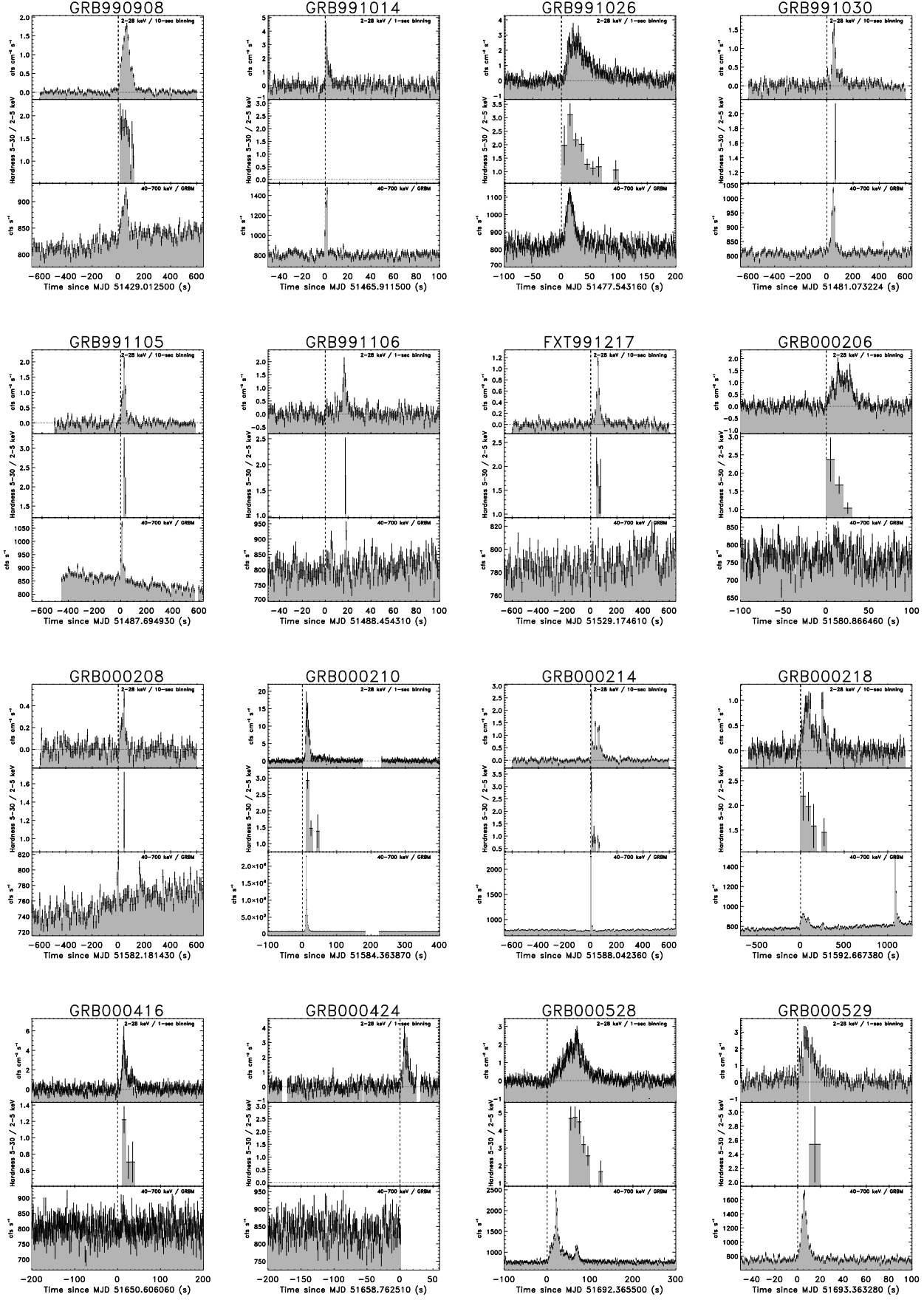


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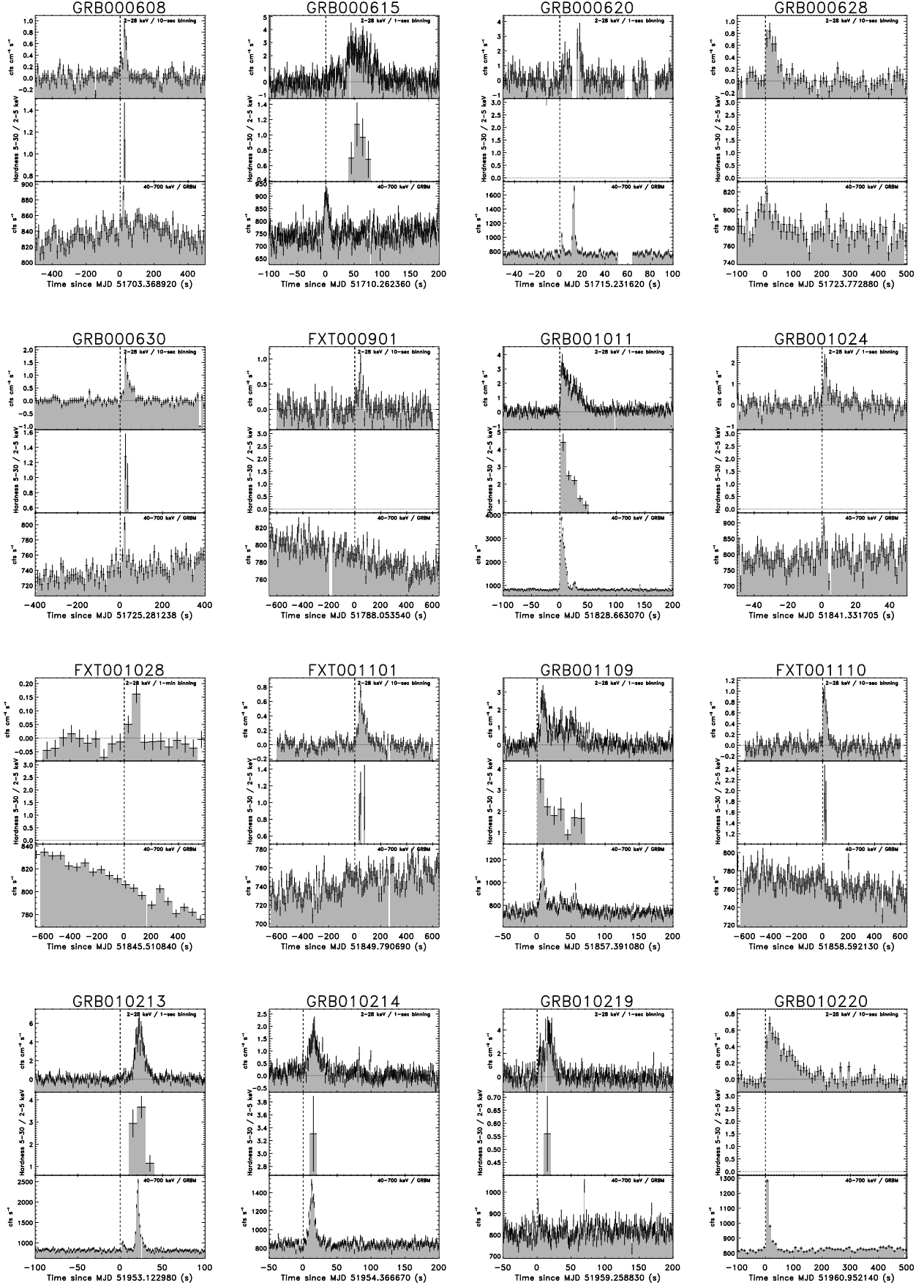


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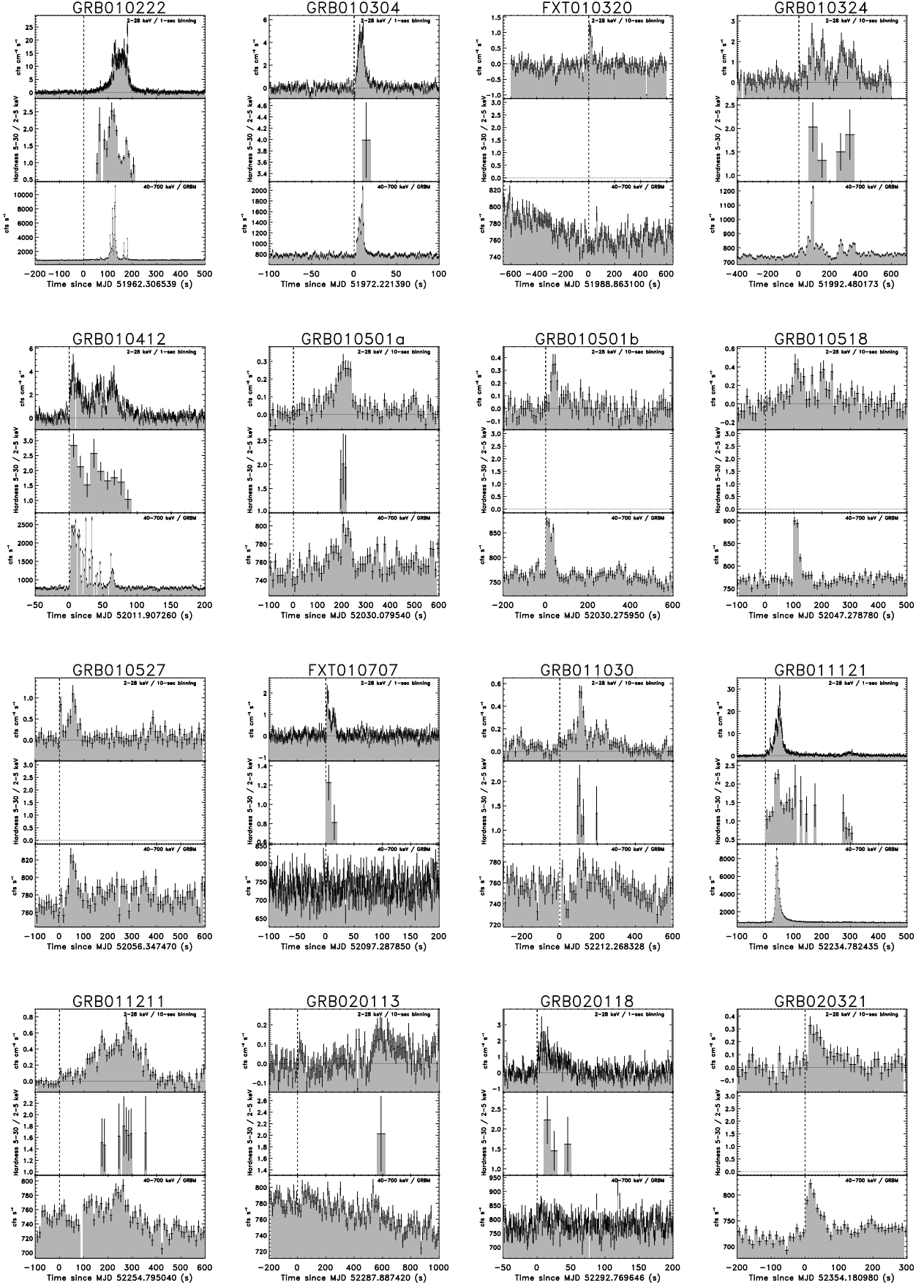


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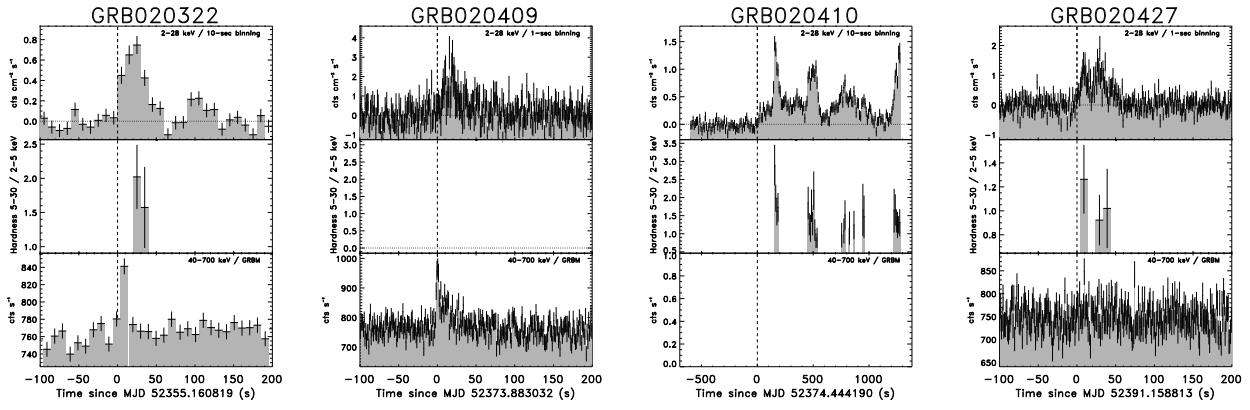


Fig. 4. cont'd (7/7)

Table 1. Catalog of 149 FXTs detected with BeppoSAX-WFC. For an explanation of this table, see Sect. 5 of main text.

ID	Ref ^r	r	OP	WFC	MJD(UTC) start	T90 (s)	T90 err (s)	R.A.	Dec.	Err. (^o)	Dev. (^o)	BAT- SE ID	Peak flux		Soft ness ratio	Type	Identification / remarks
													WFC (cts s ⁻¹ cm ⁻²)	GRBM (cts s ⁻¹)			
960707	u		616	1	50271.419483	11728.6	1787.2	341.7196	+44.3296	1.68	0.64		0.152			Flare star	EV Lac flare 1 / M-dwarf flare star with superflares (ref43)
960720	1	x	675	1	50284.483950	21.1	8.2	262.6197	+49.0970	2.64		5545	1.21	1220	1.0	GRB	GRB970720 / First WFC GRB published, too large error reg for follow up
960726	u		689	2	50290.495360	77.7	2.2	208.8450	-52.4484	2.74			1.81	190	9.8	GRB	GRB960726
960806	u		735	1	50301.266350	27.1	4.8	32.6648	-0.6359	2.91			0.65	155	4.3	GRB	GRB960806
960813	u		757	2	50308.952389	15368.9	520.6	187.8133	-65.8235	3.15	2.49		0.049			Flare star	EE Mus=1RXS J123052.5-655020
960825	2		820	2	50320.514881	11021.7	442.4	268.6070	-26.3305	1.70	0.27		0.332			SFXT	IGR J17544-2619 flare 1 / SFXT
961005	u		1075	2	50361.247077	19486.5	816.1	47.0574	+40.9467	1.67	0.88		0.262			Flare star	Algol flare 1 / Flare star in a binary with an early-type star
961229a	u		1448	2	50446.555400	52.9	7.9	224.7979	+18.5786	6.02			0.36	<20	>18	GRB?	FXT961229a / XRF coincident with BD +19 2895 (K0 star)?
961229b	3		1448	1	50446.723866	339.3	41.0	38.7055	-0.8724	3.31			0.39	<20	>20	GRB?	FXT961229b / XRF coincident with PKS J0234-0049 (RADIO GALAXY)
970111a	4	+	1485	2	50459.405560	43.3	2.3	232.0354	+19.5933	1.74			6.60	5800	1.1	GRB	GRB970111 / First GRB with follow up
970111b	3		1487	1	50459.983632	1567.0	148.9	86.1699	-40.7063	1.56			1.27	90	14	GRB	GRB970111b / Long GRB
970123	u		1565	2	50471.857736	6999.3	370.9	278.4714	+51.7236	1.91	0.26		0.098			Flare star	BY Dra flare 1 / M-dwarf flare star
970228	5	+	1671	1	50507.123620	68.5	1.2	75.4315	+11.7859	1.78	0.81		15.01	3900	3.8	GRB	GRB970228 / First GRB with successful follow up and distance
970321	u		1780	1	50528.194202	4634.3	189.3	326.4788	-85.7153	1.73	0.87		0.079			Flare star?	NLTT 51688=1RXS J214641.1-854303 / M3.5 star with no known flare activity
970402	6	+	1830	1	50540.928920	103.6	4.4	222.6150	-69.3224	4.66			0.75	160	4.7	GRB	GRB970402
970427	u		1930	2	50565.015468	57767.6	3532.6	99.2513	-5.3676	2.82	1.33		0.018			RS CVn	V969 Mon=1RXS J063656.7-052104 / Faintest detected flare
970508	7	+	1984	2	50576.904030	40.7	2.2	103.4250	+79.2696	1.94		6225	2.71	410	6.6	GRB	GRB970508 / First GRB with radio scintillation and evidence for beaming
971010	u		2622	2	50731.675460	1731.6	464.3	310.4521	-32.4547	3.75	1.51		0.117			Flare star	AT Mic / dwarf M flare star
971018	u		2699	2	50739.377130	9869.6	1541.3	82.1835	-65.4403	2.22	0.62		0.057			T Tau star	AB Dor flare 1
971019a	8		2705	2	50740.664410	22.2	1.9	217.6194	+74.3645	2.56		untr	6.09	55	111	GRB	GRB971019a / XRF
971019b	u		2706	1	50740.738210	446.8	33.6	88.9121	-74.9495	3.61			0.36	35	10	GRB	GRB971019b
971024	a		2732	1	50745.783860	16.1	1.5	140.6739	+51.3087	2.04		untr	2.46	60	41	GRB	GRB971024 / XRR
971206a	u		3066	2	50788.206717	105662.9	2871.4	343.2672	+16.8327	1.89	0.46		0.042			RS CVn	IM Peg
971206b	9		3066	1	50788.805960	76.3	9.6	161.0457	-5.7792	4.44		6521	0.94	180	5.2	GRB	GRB971206
971214	10	+	3123	1	50796.972640	86.1	22.8	179.1035	+65.1916	4.06	0.54	6533	0.64	585	1.1	GRB	GRB971214
971227	11	+	3205	2	50809.349350	14.6	1.2	194.4174	+59.2444	3.70		6546	2.69	650	4.1	GRB	GRB971227
980109	12	x	3289	2	50822.050240	36.4	18.6	6.5210	-63.0221	2.29		6564	1.25	285	4.4	GRB	GRB980109 / No afterglow found (no NFI)
980128	8		3465	2	50841.039070	112.4	24.5	15.9980	+58.5142	2.78		untr	0.26	<20	>13	GRB	GRB980128 / XRR
980218	u		3714	1	50862.752755	5561.7	453.1	82.1791	-65.4693	3.09	1.13		0.076			T Tau star	AB Dor flare 2
980306	a		3875	2	50878.161680	38.3	2.7	240.8666	-77.8760	2.91		untr	0.30	35	8.4	GRB	GRB980306 / XRR
980311	13		3905	2	50883.855408	6861.6	630.7	274.7542	-16.9006	5.00	10.57		0.269			SFXT	SAX J1818.6-1703
980326	14	x	4057	1	50898.888130	5.8	2.4	129.1306	-18.8800	3.19	1.56	6660	6.22	480	13	GRB	GRB980326
980329	15	+	4073	2	50901.155870	64.4	3.7	105.6408	+38.8432	3.22	0.84	6665	9.29	6345	1.5	GRB	GRB980329
980412	u		4169	2	50915.295216	480.4	24.6	123.0199	-49.5219	4.74			0.27	<20	>14	GRB?	FXT980412 / XRF, coincides with HD 6881 (K3(III) star)
980415	u		4202	2	50918.645360	73.3	8.4	246.6110	+63.5242	5.00			0.29	<20	>14	GRB?	FXT980415 / XRF
980415b	u		4202	2	50918.711636	41707.5	1623.7	262.1440	+59.0247	1.64	0.89		0.061			High-E transient?	GR Dra flare 1 / See also 990227

Table 1. continued.

ID	Ref [†]	r	OP	WFC	MJD(UTC) start	T90 (s)	T90 err (s)	R.A.	Dec.	Err. ([∘])	Dev. ([∘])	BAT- SE ID	Peak flux		Soft ness ratio	Type	Identification / remarks
													WFC (cts s ⁻¹ cm ⁻²)	GRBM (cts s ⁻¹)			
980425	16	+	4281	2	50928.909030	49.7	3.6	293.7303	-52.8553	2.63	1.31	6707	6.34	400	16	GRB	GRB980425=SN1998bw / first supernova Ic association
980429	17		4320	2	50932.365870	129.8	5.8	130.1491	+22.8360	1.92			1.99	35	57	GRB	GRB980429 / XRF
980515	18	+	4462	2	50948.708330	30.8	3.7	319.3480	-67.2500	2.63			1.67	185	9.0	GRB	GRB980515 / no counterpart found in other wavelengths than X-rays
980519	19	+	4480	2	50952.512600	160.8	3.4	350.5923	+77.2505	1.53	0.69	6764	6.15	1515	4.1	GRB	GRB980519 / very soft prompt black body X-ray spectrum
980613	9	+	4677	2	50977.202150	53.0	9.5	154.4848	+71.4853	3.42	1.68		0.71	85	8.3	GRB	GRB980613
980614	u		4683	1	50978.359433	301.2	16.2	337.7366	+33.3625	5.00			0.57	20	>29	GRB?	FXT980614
980706	u		4894	2	51000.410380	83.7	12.7	193.1647	+28.0604	3.19			0.57	<20	>38	GRB?	FXT980706
980804	u		5072	2	51029.678414	71073.1	4338.6	51.6457	+28.6986	2.39	1.07		0.029			RS CVn	UX Ari / Very long stellar flare
980824	u		5166	2	51049.607200	46.4	16.1	268.3526	+48.5036	4.24			0.34	<20	>17	GRB?	FXT980824 / XRF
980907	u		5275	1	51063.014660	6656.2	554.0	117.2305	-76.6945	2.45	1.13		0.116			Flare star	NLTT18592=2RE J074922-764149 / dMe star; 555 TESS flares (ref45)
980924	u		5385	1	51080.359688	6910.1	606.1	278.5036	+51.7251	2.35	0.94		0.091			Flare star	BY Dra flare 2 / M-dwarf flare star
981018	3		5618	2	51104.017550	356.1	7.6	110.2276	+1.0364	2.11		untr	0.62	35	18	GRB	GRB981018
981102	u		5745	1	51119.770233	23037.3	2736.7	82.1867	-65.4456	2.20	0.30		0.057			T Tau star	AB Dor flare 3
981217	9		6002	2	51164.079960	111.0	10.7	294.6259	+80.5517	1.95			0.98	n.a.		GRB?	FXT981217
981226	20	+	6055	1	51173.407840	136.1	18.3	352.4125	-23.9166	1.81			1.12	60	19	GRB	GRB981226 / XRF
981227	u		6069	2	51174.430038	2365.3	202.2	175.1515	-62.0102	2.18	1.37		0.213	50	4.3	Flare star	V1373 Cen=1RXS J114028.6-620142 / BY Dra type star
990123	21	+	6221	1	51201.407570	61.0	0.4	231.3719	+44.7483	1.44	1.11	7343	9.39	11200	0.8	GRB	GRB990123 / 2nd brightest in GRBM
990125	u		6231	2	51203.466428	12755.2	1190.7	47.0381	+40.9607	1.64	0.36		0.148			Flare star	Algol 2 / flaring K star in a binary with an early-type star (ref44)
990217	9	+	6383	2	51226.224560	172.5	24.5	45.7130	-53.0933	2.31			0.86	85	10	GRB	GRB990217
990220a	22		6419	1	51229.584397	27016.4	736.8	274.8431	-25.4646	4.23	3.84		0.161			HMXB	SAX J1819.3-2525 flare 3
990220b	23		6419	1	51229.728314	618.5	65.4	268.6071	-26.3230	2.13	0.19		0.368			SFXT	IGR J17544-2619 flare 2
990227	u		6473	2	51236.778419	18847.8	1888.9	262.1621	+59.0221	1.93	0.79		0.083			High-E transient?	GR Dra flare 2 / G0 star unknown as flare star, possibly GRO J1753+57 (gamma-ray flarer). See also 980415b
990311	23		6570	1	51248.754346	5152.2	950.8	268.5934	-26.3139	3.80	1.04		0.070			SFXT	IGR J17544-2619 flare 6
990328	u		6742	1	51265.715390	296.1	26.0	136.5108	-54.9291	2.84			0.39	<20	>19	GRB?	FXT990328 / XRF
990413	3		6829	2	51281.232860	1735.4	138.2	160.1040	+81.8236	2.54			0.11	60	1.8	GRB	GRB990413 / long GRB
990510	24	+	6902	2	51308.367430	103.0	3.9	204.5196	-80.4961	1.60	0.11	7560	8.62	3105	2.8	GRB	GRB990510 / bright in WFC
990520	8	+	6952	1	51318.085320	10.4	1.4	128.9784	+51.3096	2.99		untr	2.95	<80	>37	GRB	GRB990520 / XRF
990526	a		6975	1	51324.515180	26.6	21.0	155.6031	-62.7798	3.09		untr	0.59	25	24	GRB	GRB990526 / XRF
990531	u		6990	1	51329.665601	2914.6	717.5	172.9817	-34.6066	2.16	0.10		0.533			T Tau star	CD-33 7795=1RXS J113155.7-343632 / 32 flares seen with TESS (Ref46)
990625	25	x	7072	2	51354.016980	36.3	2.8	6.6877	-31.2028	2.68			3.50	175	20	GRB	GRB990625 / too large initial error box for follow up
990626	u		7088	2	51355.664400	1694.3	397.2	352.9638	+19.9369	1.90	0.27		0.427			Flare star	EQ Peg / M-dwarf flare star with superflares
990627	26	+	7096	2	51356.208940	53.8	2.3	27.1347	-77.0958	2.32			0.96	300	3.2	GRB	GRB990627
990704	27	+	7141	1	51363.729230	21.9	1.1	184.8717	-3.8021	1.90			12.48	310	40	GRB	GRB990704 / XRF
990705	28	+	7147	2	51364.667650	69.0	3.8	77.4676	-72.1307	1.78	0.28		6.65	4720	1.4	GRB	GRB990705
990709	u		7167	1	51368.803083	15224.4	1735.9	358.7690	+28.6291	2.74	0.64		0.074			RS CVn	II Peg flare 1
990712	29	x	7188	2	51371.696550	29.6	1.0	337.9701	-73.4058	1.50	0.12		38.22	820	47	GRB	GRB990712 / Brightest WFC GRB
990722	u		7263	2	51381.388974	29925.5	3012.1	358.7840	+28.6111	4.82	1.91		0.044			RS CVn	II Peg flare 2

Table 1. continued.

ID	Ref [†]	r	OP	WFC	MJD(UTC) start	T90 (s)	T90 err (s)	R.A.	Dec.	Err. ([∘])	Dev. ([∘])	BAT- SE ID	Peak flux WFC (cts s ⁻¹ cm ⁻²) GRBM (cts s ⁻¹)		Soft ness ratio	Type	Identification / remarks
990806	30	+	7348	1	51396.602510	34.0	3.4	47.6466	-68.1245	2.13		7701	4.28	785	5.5	GRB	GRB990806
990810	u		7362	2	51400.612230	4678.7	580.9	56.6564	-39.1073	2.17	0.37		0.174			T Tauri?	SAX J0346.6-3906=UCAC4 255-003783? / This is a 16 mag 3700K star (see also 010824)
990907	9	+	7523	2	51428.732000	223.0	24.9	112.6887	-69.4057	1.99		7755	0.63	275	2.3	GRB	GRB990907
990908	9	x	7523	2	51429.012500	104.3	5.8	103.4133	-75.0104	1.50			1.76	90	20	GRB	GRB990908
990909	22		7546	2	51430.894314	20651.4	759.2	274.8459	-25.3962				0.760			HXMB	SAX J1819.3-2525 flare 2
990911	u		7553	1	51432.115942	27726.3	1690.4	268.6409	-26.3300	1.97	1.83		0.499			SFXT	IGR J17544-2619 flare 3
991005	u		7692	2	51456.046632	6486.0	573.7	82.1773	-65.4560	2.25	0.38		0.129			T Tau star	AB Dor flare 4
991014	31	+	7749	2	51465.911500	7.6	1.2	102.7685	+11.5979	3.75		7803	3.88	620	6.3	GRB	GRB991014
991026	9		7820	2	51477.543160	106.3	4.0	248.7926	-89.5048	1.65			3.28	315	10	GRB	GRB991026
991030	9		7840	2	51481.073455	114.2	13.7	122.5798	-48.4265	2.40			1.49	230	6.5	GRB	GRB991030
991105	9	x	7859	2	51487.694720	111.4	27.2	180.8616	-66.7735	2.12		7841	1.98	215	9.2	GRB	GRB991105
991106	9	+	7860	1	51488.454310	32.6	2.5	336.2170	+54.3647	3.21			3.67	110	33	GRB	GRB991106 / XRR
991217	32	x	8073	2	51529.174610	107.3	16.0	345.8144	+0.2494	4.5			1.13	<20	>57	GRB?	FXT991217
000206	33		8374	1	51580.866460	39.3	3.1	226.4360	+72.1146	1.86		untr	1.75	50	35	GRB	GRB000206 / XRR
000208	a		8386	1	51582.181370	58.9	19.7	28.9025	-22.8470	3.62		untr	0.44	50	8.9	GRB	GRB000208 / XRR
000210	34	+	8406	1	51584.363870	61.8	3.1	29.8032	-40.6742	1.77	1.05		17.17	20710	0.8	GRB	GRB990210 / Brightest GRBM GRB
000214	35	+	8425	1	51588.042360	117.6	15.8	283.5719	-66.4414	1.62			2.59	1825	1.4	GRB	GRB000214
000218	u		8468	2	51592.667380	377.1	35.1	114.4409	-71.3064	1.93			0.98	185	5.3	GRB	GRB000218
000312	u		8683	2	51615.49454	4538.2	881.3	79.3413	-35.3630	2.20	0.27		0.085			Flare star	CD-35 2213=2RE J051724-352221 / dMe star). 110 flares with TESS (Ref34)
000409	u		8881	1	51643.237951	10243.4	691.1	82.1924	-65.4477	2.05	0.24		0.174			T Tau star	AB Dor flare 5
000416	9	x	8942	2	51650.606060	68.4	4.5	258.8558	-71.6100	2.27		untr	5.69	85	67	GRB	GRB000416 / XRF
000424	9	x	9004	2	51658.762510	34.0	2.5	104.7273	+49.8753	2.44		8086	3.39	n.a.		GRB	GRB000424
000528	9	+	9145	2	51692.365500	108.5	5.9	161.2791	-33.9859	1.60			2.65	1615	1.6	GRB	GRB000528
000529	9	+	9153	2	51693.363180	28.4	2.3	2.3505	-61.5298	2.46			3.15	860	3.7	GRB	GRB000529
000608	9	x	9232	2	51703.368920	47.5	13.8	6.2623	-69.0416	3.28			0.84	50	17	GRB	GRB000608
000615	9	+	9251	1	51710.262360	78.0	4.9	233.1700	+73.8184	2.01			3.49	160	22	GRB	GRB000615 / XRF
000619	u		9275	1	51714.359805	46040.4	2876.4	13.2643	-74.6457	1.86	0.38		0.068			RS CVn	CF Tuc
000620	9	x	9275	2	51715.231620	31.1	2.7	113.8024	+69.1922				3.53	895	3.9	GRB	GRB000620
000627	u		9331	1	51722.501215	1656.5	657.9	341.7074	+44.3234	2.33	1.17		0.087			Flare star	EV Lac 2 / M-dwarf flare stars with superflares (Ref32)
000628	u		9341	2	51723.772880	80.0	9.7	236.1639	-69.7477	2.82			0.84	50	17	GRB	GRB000628
000630	u		9352	1	51725.281238	72.3	16.3	233.8921	+57.8930	2.82			1.65	75	22	GRB	GRB000630
000901	u		9696	2	51788.053540	520.3	20.7	268.6004	-26.3313	4.4			0.91	<20	>46	GRB?	FXT000901 / XRF, coincides with EQ J084834.9-785352 / M5 star (unknown as flare star). (Ref35)
000920	23		9832	2	51807.316978	27644.8	347.7	268.6704	-26.3206	1.87	3.42		0.263			SFXT	IGR J17544-2619 flare 4
001008	23		9934	2	51825.121897	2845.9	720.2	268.6704	-26.3206	2.72	0.48		0.272			SFXT	IGR J17544-2619 flare 5
001011	9	x	9957	2	51828.663080	48.2	2.2	275.7687	-50.8999	1.56	0.53		3.60	3005	1.2	GRB	GRB001011
001024	u		10050	1	51841.331705	17.6	0.8	125.5960	-87.7158	3.80			1.96	105	19	GRB	GRB001024 / XRF
001028	u		10055	2	51845.510840	70.0	162.7	173.2039	-86.1883	5.40			0.16	<50	>3.3	GRB?	FXT001028 / XRF
001101	u		10091	1	51849.790690	120.3	17.6	123.1415	+48.2890	2.27			0.74	<10	>74	GRB?	FXT001101
001109	9	+	10146	1	51857.391080	74.9	2.9	277.5242	+55.3079	1.84			2.86	460	6.2	GRB	GRB001109
001110	u		10159	2	51858.592130	61.4	12.0	300.6197	-20.5037	2.56			0.97	<20	>48	GRB?	FXT001110 / XRF
001207	u		10302	1	51885.179691	3213.1	1055.0	38.5894	-43.7960	1.46	0.27		0.485			Flare star	CC Eri, brightest stellar flare

Table 1. continued.

ID	Ref [†]	r	OP	WFC	MJD(UTC) start	T90 (s)	T90 err (s)	R.A.	Dec.	Err. ([°])	Dev. ([°])	BAT- SE ID	Peak flux		Soft ness ratio	Type	Identification / remarks
													WFC (cts s ⁻¹ cm ⁻²)	GRBM (cts s ⁻¹)			
001213	u		10320	2	51891.353117	42078.5	2763.9	332.1754	+45.7434	2.20	0.21		0.139			RS CVn	AR Lac flare 1
010119	u		10570	1	51927.832386	63553.8	6590.2	47.0529	+40.9608	1.83	0.58		0.115			Flare star	Algol flare 3 / K-type flaring star in a binary
010213	a		10725	2	51953.122980	22.6	2.4	257.3390	+39.2681	1.93			5.80	1550	3.7	GRB	GRB010213 / XRF
010214	36	+	10727	2	51954.366670	78.8	4.3	265.2453	+48.5508	2.25			1.98	655	3.0	GRB	GRB010214
010219	u		10747	1	51959.258830	32.5	2.2	94.1820	-69.7800	2.26			4.10	160	26	GRB	GRB010219
010220	9	+	10753	2	51960.952140	247.0	21.4	39.2459	+61.7612	1.97			0.66	455	1.5	GRB	GRB010220
010222	37	+	10767	1	51962.306539	123.5	3.5	223.0499	+43.0130	1.46	0.34		24.53	9840	2.5	GRB	GRB010222
010301	u		10800	1	51969.647174	4924.1	383.8	82.1948	-65.4533	1.68	0.28		0.267			T Tau star	AB Dor flare 6
010304	9		10822	2	51972.221380	18.5	1.3	316.5876	+53.2077				4.99	1225	4.1	GRB	GRB010304
010304b	u		10822	1	51972.42479	40679.7	2875.1	130.2049	-45.0477	2.76	0.69		0.101			SFXT	IGR J08408-4503
010315	u		10883	1	51981.336717	178681.4	3009.2	175.0108	-65.3811	1.55	3.55		0.064			RS CVn	GT Mus
010320	u		10923	1	51988.863100	71.0	13.7	277.1368	-10.6302	2.84			1.12	<30	>37	GRB?	FXT010320
010324a	38		10954	1	51992.480173	464.4	29.4	107.8541	+19.9954	2.43			2.38	510	4.7	GRB	GRB010324 / coincident with LEDA 1613994
010324b	u		10954	2	51992.622915	3281.9	838.8	282.5536	-4.5534	9.70	2.04		0.068			SFXT	AX J1845.0-0433
010327	u		10972	1	51995.627257	28185.2	2319.9	82.1861	-65.4506	2.32	0.01		0.071			T Tau star	AB Dor flare 7
010412	9	x	11085	1	52011.907160	88.8	3.1	294.9057	+13.6124	1.65			4.74	1860	2.5	GRB	GRB010412
010501a	u		11203	2	52030.079540	215.2	19.2	88.2420	+78.7952	2.31			0.30	60	4.9	GRB	GRB010501a
010501b	9		11203	1	52030.275950	71.9	6.8	286.7133	-70.1803	4.18			0.34	120	2.9	GRB	GRB010501b
010512	u		11268	1	52041.02962	104431.7	1966.7	332.1789	+45.7261	3.42	0.98		0.092			RS CVn	AR Lac flare 2
010518	9	x	11292	2	52047.278780	264.2	23.6	161.6546	-57.7643	3.21			0.43	130	3.3	GRB	GRB010518
010527	u		11324	2	52056.347470	71.4	10.2	189.2384	+36.1791	3.01			1.10	65	17	GRB	GRB010527
010528	39		11330	1	52057.734213	3100.8	690.1	116.9450	-57.6173	2.41	0.51		0.178			Flare star	V857 Cen = Gl 431 / M dwarf flare star
010707	9		11486	1	52097.287850	16.4	2.7	205.5666	-38.5365	2.16			2.04	<70	>29	GRB?	FXT010707 / XRF
010824	u		11828	2	52145.123067	1566.4	530.7	56.6818	-39.1525	14.19			0.243			T Tauri?	SAX J0346-3906 / see also 990810
011030	9	x	12150	1	52212.268328	280.3	14.2	310.9180	+77.2925	1.95	0.50		0.52	30	18	GRB	GRB011030 / XRR, first real time follow up X-ray flash
011103	u		12167	2	52216.139073	23581.1	3016.2	332.1717	+45.6598	2.86	4.90		0.067			RS CVn	AR Lac flare 3
011121	9	+	12252	1	52234.782435	284.3	2.4	173.6086	-76.0259	1.45	0.26		29.64	7695	3.9	GRB	GRB011121 / 2nd brightest IN WFC / peak flux of first peak
011211	9	+	12361	1	52254.795040	276.2	18.2	168.8179	-21.9368	1.70	0.83		0.72	50	14	GRB	GRB011211 / XRR
020113	u		12497	2	52287.887420	909.4	62.3	226.6594	+83.4713	4.12			0.18	35	5.2	GRB	GRB020113
020118	9		12513	2	52292.769646	54.3	4.4	9.4460	+59.5364	2.27			2.85	60	47	GRB	GRB020118
020321	31	+	12705	1	52354.180980	135.9	13.4	243.1410	-83.7157	3.31			0.31	100	3.1	GRB	GRB020321
020322	3	+	12712	2	52355.160819	105.7	6.0	270.2379	+81.0880	2.47	1.21		0.75	80	9.4	GRB	GRB020322
020409	3	x	12830	1	52373.882928	73.5	4.9	131.2984	+66.6810	3.75			3.24	210	15	GRB	GRB020409
020410	40	+	12830	2	52374.444190	1137.8	10.8	331.6779	-83.8217	1.52	0.34		1.46	n.a.		GRB?	GRB020410 / XRR
020427	41,42	+	12933	2	52391.158859	50.4	4.6	332.3803	-65.3276	2.22	0.34		1.90	<100	>19	GRB?	GRB020427 / XRF, first coincidence of GRB with ionospheric event

[†] 1 - Piro et al. (1998); 2 - in't Zand et al. (2004a); 3 - in't Zand et al. (2004b); 4 - Costa et al. (1997a); 5 - Costa et al. (1997b); 6 - Nicastro et al. (1998); 7 - Piro et al. (1998); 8 - Kippen et al. (2003); 9 - Vetere et al. (2007); 10 - Dal Fiume et al. (2000); 11 - Antonelli et al. (1999a); 12 - in 't Zand et al. (1998b); 13 - in 't Zand et al. (1998a) 14 - Celidonio et al. (1998); 15 - in 't Zand et al. (1998b); 16 - Pian et al. (1999); 17 - Romano et al. (2008); 18 - Ricci et al. (1998); 19 - in 't Zand et al. (1998b); 20 - Frontera et al. (2000); 21 - Corsi et al. (2005); 22 - in't Zand et al. (2000); 23 - in't Zand et al. (2004a); 24 - Kuulkers et al. (2000); 25 - Piro (1999); 26 - Antonelli et al. (1999b); 27 - Feroci et al. (2001); 28 - Amati et al. (2000); 29 - Frontera et al. (2001); 30 - Montanari et al. (2001); 31 - in 't Zand et al. (2000); 32 - Muller et al. (1999); 33 - Heise et al. (2001); 34 - Piro et al. (2002); 35 - Antonelli et al. (2000); 36 - Guidorzi et al. (2003); 37 - in't Zand et al. (2001); 38 - Guidorzi et al. (2001); 39 - in't Zand et al. (2001); 40 - Nicastro et al. (2004); 41 - Amati et al. (2004); 42 - Fishman et al. (2002); 43 - Osten et al. (2010); 44 - van den Oord & Mewe (1989); 45 - Seli et al. (2025); 46 - Lawson et al. (2002).

Table 2. Spectral fits with a power law. No line was included in fit, except for events listed in Table 3. N_H was fixed at the Galactic values, except for events listed in Table 4. Distances were extracted from Simbad and are in parsec via GAIA parallaxes or redshift (indicated with prefix $z =$).

ID	OP	WFC	MJD-start	Time span (s)	N_H (10^{20} cm $^{-2}$)	Photon index	2-30 keV fluence (10^{-6} erg cm $^{-2}$)	χ_r^2	Distance (pc/z)	2-30 keV energy (ergs)	Identification
960707	616	1	50271.419483	5400	1.50	2.49±0.09	2.96±0.14	1.38	5.05	1.5×10^{34}	EV Lac 1
960720	675	1	50284.483892	30	0.24	1.89±0.20	0.33±0.05	0.94			GRB960720
960726	689	2	50290.495360	100	2.06	2.10±0.18	1.16±0.14	0.74			GRB960726
960806	735	1	50301.266350	40	0.25	1.81±0.19	0.33±0.05	0.62			GRB960806
960813	757	2	50308.952389	3000	5.30	2.24±0.26	1.69±0.29	0.76			EE Mus
960825	820	2	50320.514881	14400	13.20	1.71±0.14	23.59±2.05	0.89	2523.34	2.7×10^{40}	IGR J17544-2619 1
961005	1075	2	50361.247077	18000	1.00	1.99±0.08	19.94±1.17	1.60	27.57	2.5×10^{36}	Algol 1
961229a	1448	2	50446.555400	80	0.29	0.79±0.37	0.36±0.16	1.00			FXT961229a
961229b	1448	1	50446.726181	380	0.25	1.70±0.25	1.74±0.36	0.60			FXT961229b
970111a	1485	2	50459.405560	70	0.45	0.65±0.07	7.17±0.44	0.71			GRB970111
970111b	1487	1	50459.983632	2800	0.36	1.50±0.06	10.92±0.50	1.09			GRB970111b
970123	1565	2	50471.857736	5400	0.50	2.22±0.11	4.27±0.26	1.40	16.56	1.7×10^{35}	BY Dra 1
970228	1671	1	50507.123620	75	1.36	1.62±0.08	3.52±0.24	0.85	$z=0.695$	2.3×10^{51}	GRB970228
970321	1780	1	50528.194202	5400	0.80	2.44±0.13	3.45±0.21	0.98	15.55	1.1×10^{35}	NLTT 51688
970402 [†]	1830	1	50540.929040	130	1.69	1.07±0.10	1.62±0.14	0.67			GRB970402
970427a	1930	2	50565.015468	72000	3.60	1.99±0.19	6.75±0.94	0.63	412.39	2.1×10^{38}	V969 Mon
970508	1984	2	50576.904010	20	0.40	1.75±0.09	0.66±0.05	0.56	$z=0.835$	9.9×10^{50}	GRB970508
971010	2622	2	50731.675460	3000	0.40	2.36±0.37	1.64±0.41	1.20	10.70	2.4×10^{34}	AT Mic
971018	2699	2	50739.377130	10800	0.70	2.26±0.13	2.98±0.23	1.04	14.85	1.3×10^{35}	AB Dor 1
971019a	2705	2	50740.664495	23	0.21	1.21±0.15	1.54±0.22	1.09			XRF971019a
971019b	2706	1	50740.738210	200	0.92	1.78±0.28	0.39±0.09	0.84			GRB971019b
971024	2732	1	50745.783860	35	0.14	1.69±0.12	0.41±0.04	0.88			GRB971024
971206a	3066	2	50788.206717	108000	0.80	2.07±0.14	13.62±1.28	1.16	98.37	3.4×10^{37}	IM Peg
971206b	3066	1	50788.805960	60	0.39	1.35±0.27	0.79±0.20	0.58			GRB971226
971214	3123	1	50796.972640	80	0.14	0.62±0.25	1.20±0.30	0.48	$z=3.418$	3.0×10^{52}	GRB971214
971227	3205	2	50809.349380	6	0.09	0.46±0.19	0.39±0.07	0.62			GRB971227
980109	3289	2	50822.050240	50	0.14	1.11±0.12	1.11±0.12	0.91			GRB980109
980128	3465	2	50841.039070	130	3.61	1.28±0.15	0.49±0.06	0.78			GRB980128
980218	3714	1	50862.752755	7200	0.70	1.97±0.19	4.17±0.56	0.45	14.85	1.5×10^{35}	AB Dor 2
980306	3875	2	50878.161680	70	0.70	2.15±0.21	0.18±0.03	0.48			GRB980306
980311	3905	2	50883.855408	10800	11.70	2.28±0.73	8.83±8.83	1.53	2469.14	1.1×10^{40}	SAX J1818.6-1703
980326	4057	1	50898.888130	8	0.63	1.07±0.20	0.69±0.13	1.23	$z=0.9$	1.2×10^{51}	GRB980326
980329	4073	2	50901.155986	30	0.88	0.70±0.13	4.34±0.54	1.12	$z=3.6$	1.2×10^{53}	GRB980329
980412	4169	2	50915.295220	300	2.28	1.95±0.42	0.34±0.12	0.56	408.11	6.8×10^{36}	FXT980412
980415	4202	2	50918.645360	100	0.23	1.08±0.37	0.30±0.13	1.20			FXT980415
980415b	4202	2	50918.711636	50400	0.30	2.41±0.09	9.63±0.49	1.73	138.89	3.2×10^{37}	GR Dra 1
980425	4281	2	50928.909146	50	0.38	1.53±0.17	2.30±0.32	0.82	$z=0.0085$	3.6×10^{47}	GRB980425
980429	4320	2	50932.365567	180	0.30	1.84±0.09	2.65±0.19	1.39			GRB980429
980515	4462	2	50948.708330	50	0.28	0.98±0.16	1.31±0.18	0.94			GRB980515
980519	4480	2	50952.512950	270	1.85	1.67±0.03	4.85±0.14	0.67	$z=1.58$	2.6×10^{52}	GRB980519
980613	4677	2	50977.202150	40	0.47	1.58±0.24	0.29±0.06	1.06	$z=1.0969$	7.4×10^{50}	GRB980613
980614	4683	1	50978.359200	350	0.72	0.95±0.40	1.15±0.58	0.71			FXT980614
980706	4894	2	51000.410380	50	0.10	1.84±0.23	0.24±0.04	0.82			FXT980706
980804	5072	2	51029.678414	50400	1.20	1.80±0.08	14.15±0.82	1.23	50.55	6.1×10^{36}	UX Ari
980824	5166	2	51049.607200	60	0.30	2.44±0.39	0.13±0.03	1.05			FXT980824
980907	5275	1	51063.014660	1200	1.40	1.39±0.22	2.03±0.37	0.58	10.89	3.3×10^{34}	NLTT18592
980924	5385	1	51080.359688	3000	0.50	2.03±0.19	2.03±0.28	1.07	16.56	6.7×10^{34}	BY Dra 2
981018	5618	2	51104.018940	420	1.50	1.61±0.14	3.29±0.37	0.80			GRB981018
981102	5745	1	51119.770233	28800	0.70	2.21±0.17	3.91±0.42	1.08	14.85	2.1×10^{35}	AB Dor 3
981217	6002	2	51164.079960	160	0.56	1.21±0.09	1.95±0.15	0.82			FXT981217
981226	6055	1	51173.407872	250	0.15	1.86±0.09	1.14±0.07	0.44	$z=1.11$	2.2×10^{51}	GRB981226
981227	6069	2	51174.430038	3000	12.10	1.83±0.12	2.44±0.20	1.19	109.27	5.0×10^{36}	V1373 Cen
990123	6221	1	51201.407801	80	0.18	0.86±0.02	12.92±0.24	1.38	$z=1.6$	7.1×10^{52}	GRB990123
990125	6231	2	51203.466428	21600	1.00	2.31±0.07	6.70±0.28	0.60	27.57	1.3×10^{36}	Algol 2
990217	6383	2	51226.224560	100	0.12	1.79±0.14	0.44±0.04	0.86			GRB990217
990220a	6419	1	51229.584397	10800	0.30	5.09±1.40	1.17±1.17	1.80	5910.17	9.6×10^{39}	SAX J1819.3-2525 3
990220b	6419	1	51229.728314	720	13.20	0.97±0.11	4.43±0.35	0.93	2523.34	3.4×10^{39}	IGR J17544-2619 2
990227	6473	2	51236.778419	18000	0.30	1.84±0.12	9.90±0.86	0.77	138.89	3.0×10^{37}	GR Dra 2
990311	6570	1	51248.754346	2400	13.20	1.99±0.24	2.74±0.51	0.41	2523.34	2.1×10^{39}	IGR J17544-2619 6
990328	6742	1	51265.715390	250	3.57	1.82±0.29	0.32±0.07	0.94			FXT990328
990413	6829	2	51281.232400	840	0.23	1.01±0.15	1.55±0.20	0.42			GRB990413
990510	6902	2	51308.367450	120	0.82	1.36±0.06	6.55±0.32	0.93	$z=1.6187$	3.7×10^{52}	GRB990510

Table 2. continued.

ID	OP	WFC	MJD-start	Time span (s)	N_H (10^{21} cm^{-2})	Photon index	2-30 keV fluence (10^{-6} erg cm^{-2})	χ_r^2	Distance (pc/z)	2-30 keV energy (ergs)	Identification
990520	6952	1	51318.085320	15	0.37	1.56±0.17	0.31±0.04	0.54			GRB990520
990526	6975	1	51324.515180	40	3.39	2.61±0.33	0.19±0.04	1.28			GRB990526
990531	6990	1	51329.665601	1800	0.60	1.87±0.16	4.10±0.51	0.88	49.67	1.4×10^{36}	CD-33 7795
990625	7072	2	51354.016980	20	0.13	1.69±0.17	0.59±0.08	0.97			GRB990625
990626	7088	2	51355.664400	2400	0.40	1.88±0.11	5.36±0.42	0.93	6.18	2.5×10^{34}	EQ Peg
990627	7096	2	51356.208940	40	0.60	1.15±0.12	0.44±0.04	0.78			GRB990627
990704	7141	1	51363.729230	30	0.28	1.58±0.06	3.17±0.15	1.29			GRB990704
990705	7147	2	51364.667650	50	1.04	0.88±0.07	7.97±0.60	1.46	$z=0.843$	1.2×10^{52}	GRB990705
990709	7167	1	51368.803083	11880	0.50	1.90±0.21	3.51±0.55	0.91	39.12	1.2×10^{36}	II Peg
990712	7188	2	51371.696550	40	0.26	1.79±0.04	5.10±0.17	1.46	$z=0.433$	2.0×10^{51}	GRB990712
990722	7263	2	51381.388974	50400	0.50	4.76±2.39	0.47±0.47	0.92	39.12	1.2×10^{35}	II Peg
990806	7348	1	51396.602860	35	0.49	1.44±0.12	0.85±0.08	0.66			GRB990806
990810	7362	2	51400.612230	1200	0.30	1.65±0.13	2.37±0.25	1.44	44.01	5.8×10^{35}	SAX J0346.6-3906
990907	7523	2	51428.732694	190	1.35	1.03±0.10	2.09±0.18	1.05			GRB990907
990908	7523	2	51429.012500	130	0.98	1.63±0.04	2.60±0.08	1.25			GRB990908
990909	7546	2	51430.894314	28800	0.20	1.65±0.03	85.46±1.98	1.24	5910.17	5.7×10^{41}	SAX J1819.3-2525 2
990911	7553	1	51432.115942	28800	13.20	1.24±0.09	24.20±1.52	0.67	2523.34	3.8×10^{40}	IGR J17544-2619 3
991005	7692	2	51456.046632	9000	0.70	2.10±0.14	4.91±0.45	0.98	14.85	2.0×10^{35}	AB Dor 4
991014	7749	2	51465.911500	7	2.12	0.55±0.23	0.42±0.10	0.63			GRB991014
991026	7820	2	51477.543218	95	0.94	1.44±0.06	2.72±0.14	1.29			GRB991026
991030	7840	2	51481.073224	120	2.52	1.18±0.13	1.80±0.21	0.65			GRB991030
991105	7859	2	51487.694930	100	3.88	1.40±0.13	1.39±0.16	0.90			GRB991105
991106	7860	1	51488.454310	25	4.43	1.60±0.21	0.19±0.03	0.85			GRB991106
991217	8073	2	51529.174610	100	0.39	1.59±0.10	0.70±0.06	1.21			FXT991217
000206	8374	1	51580.866460	40	0.21	1.72±0.09	0.59±0.04	0.54			GRB000206
000208	8386	1	51582.181430	60	0.12	1.77±0.22	0.25±0.04	0.56			GRB000208
000210	8406	1	51584.363870	30	0.18	0.91±0.07	4.91±0.31	0.79	$z=0.8456$	7.5×10^{51}	GRB000210
000214	8425	1	51588.042360	100	0.45	1.88±0.07	1.78±0.09	0.99	$z=0.46$	8.1×10^{50}	GRB000214
000218	8468	2	51592.667380	505	1.07	1.72±0.11	3.51±0.30	0.55			GRB000218
000312	8683	2	51615.495490	2400	0.40	2.21±0.17	1.73±0.19	0.87	11.70	3.1×10^{34}	CD-35 2213
000409	8881	1	51643.237951	3600	0.70	2.01±0.12	2.31±0.18	1.03	14.85	1.0×10^{35}	AB Dor 5
000416	8942	2	51650.606060	50	0.53	2.22±0.12	1.02±0.08	0.84			GRB000416
000424	9004	2	51658.762510	20	0.83	1.04±0.14	0.80±0.10	0.87			GRB000424
000528	9145	2	51692.365500	110	0.72	0.56±0.04	4.54±0.17	2.32			GRB000528
000529	9153	2	51693.363410	30	0.14	1.46±0.24	0.31±0.06	0.98			GRB000529
000608	9232	2	51703.368920	50	0.20	2.36±0.25	0.32±0.05	0.81			GRB000608
000615	9251	1	51710.262360	100	0.23	1.85±0.12	2.24±0.20	0.89			GRB000615
000619	9275	1	51714.359805	54000	0.90	1.77±0.08	15.14±1.17	1.43	87.53	2.1×10^{37}	CF Tuc
000620	9275	2	51715.231620	21	0.40	1.02±0.26	0.95±0.24	1.36			GRB000620
000627	9331	1	51722.501215	2400	1.50	2.29±0.15	1.58±0.14	1.48	5.05	5.1×10^{33}	EV Lac 2
000628	9341	2	51723.772880	60	0.82	1.45±0.19	0.75±0.12	0.56			GRB000628
000630	9352	1	51725.281240	70	0.22	1.85±0.17	0.82±0.11	0.93			GRB000630
000901 [‡]	9696	2	51788.053540	70	13.30	1.01±0.62	0.34±0.34	1.20	28.77	3.4×10^{34}	FXT000901
000920	9832	2	51807.316978	36000	13.20	4.15±0.71	10.80±10.8	1.69	2523.34	1.2×10^{40}	IGR J17544-2619 4
001008	9934	2	51825.121897	2000	13.20	1.48±0.15	4.39±0.52	1.38	2523.34	3.4×10^{39}	IGR J17544-2619 5
001011	9957	2	51828.663070	60	0.67	1.28±0.05	2.02±0.08	0.90			GRB001011
001024	10050	1	51841.331705	10	0.91	1.30±0.28	0.16±0.04	1.22			GRB001024
001028	10055	2	51845.510840	120	0.87	0.94±0.48	0.23±0.17	0.79			FXT001028
001101	10091	1	51849.790690	150	0.47	2.39±0.16	0.59±0.05	0.90			FXT001101
001109	10146	1	51857.391080	65	0.34	1.22±0.08	1.90±0.14	0.94			GRB001109
001110	10159	2	51858.592130	60	0.69	1.40±0.16	0.84±0.12	0.62			FXT001110
001207	10302	1	51885.179691	2400	0.20	2.20±0.04	6.42±0.15	1.88	11.55	1.4×10^{35}	CC Eri
001213	10320	2	51891.353117	12600	2.30	1.71±0.13	6.60±0.69	1.30	42.51	2.9×10^{36}	AR Lac 1
010119	10570	1	51927.832386	86400	1.00	2.34±0.11	9.43±0.55	0.94	27.57	2.1×10^{36}	Algol 3
010213	10725	2	51953.123154	25	0.35	1.01±0.09	2.00±0.18	0.90			GRB010213
010214	10727	2	51954.366670	40	0.20	0.95±0.11	0.88±0.08	0.67			GRB010214
010219	10747	1	51959.258830	30	0.70	2.19±0.17	0.90±0.10	0.80			GRB010219
010220	10753	2	51960.952140	200	7.08	0.83±0.10	1.78±0.15	1.41			GRB010220
010222	10767	1	51962.306539	200	0.18	1.49±0.03	24.30±0.52	2.11	$z=1.477$	1.1×10^{53}	GRB010222
010301	10800	1	51969.647174	2400	0.70	2.02±0.07	5.10±0.25	1.65	14.85	1.5×10^{35}	AB Dor 6
010304	10822	2	51972.221390	20	8.77	0.75±0.09	1.68±0.13	0.97			GRB010304
010304b	10822	1	51972.42479	50400	9.70	1.70±0.29	8.12±2.02	1.84			IGR J08408-4503
010315 [§]	10883	1	51981.336717	234000	7.50	1.91±0.03	47.95±1.02	2.42	119.09	2.1×10^{38}	GT Mus
010320	10923	1	51988.863100	31	18.40	1.25±0.21	0.69±0.13	1.39			FXT010320

Table 2. continued.

ID	OP	WFC	MJD-start	Time span (s)	N_H (10^{21} cm $^{-2}$)	Photon index	2-30 keV fluence (10^{-6} erg cm $^{-2}$)	χ_r^2	Distance (pc/z)	2-30 keV energy (ergs)	Identification
010324a	10954	1	51992.480173	400	0.98	1.43±0.15	7.78±0.99	1.36			GRB010324
010324b	10954	2	51992.622915	3300	14.00	2.46±0.41	1.97±1.37	1.47	6097.56	9.5×10 ³⁹	AX J1845.0-0433
010327	10972	1	51995.627257	10800	0.70	2.32±0.18	2.63±0.26	0.80	14.85	1.1×10 ³⁵	AB Dor 7
010412	11085	1	52011.907276	100	3.13	1.18±0.06	4.87±0.26	0.81			GRB010412
010501a	11203	2	52030.080697	200	0.62	1.19±0.14	0.64±0.07	1.36			GRB010501a
010501b	11203	1	52030.276181	40	0.42	0.19±0.25	0.51±0.14	0.63			GRB010501b
010512	11268	1	52041.029624	3600	2.30	2.29±0.30	1.74±0.35	1.40	42.51	5.1×10 ³⁵	AR Lac 2
010518	11292	2	52047.278780	300	7.29	1.30±0.24	0.92±0.19	1.20			GRB010518
010527	11324	2	52056.347470	90	0.13	1.76±0.21	0.96±0.16	1.26			GRB010527
010528	11330	1	52057.734213	2100	0.80	2.15±0.16	2.35±0.27	0.66	10.76	3.5×10 ³⁴	V857 Cen
010707	11486	1	52097.287850	20	0.41	1.83±0.12	0.30±0.03	2.07			FXT010707
010824	11828	2	52145.123067	1500	0.20	1.23±2.89	0.11±0.11	0.99	44.01	3.0×10 ³⁴	SAX J0346-3906
011030	12150	1	52212.268328	350	0.90	1.72±0.10	1.10±0.08	1.01			GRB011030
011103	12167	2	52216.139073	5400	2.30	2.17±0.24	2.69±0.44	0.92	42.51	7.9×10 ³⁵	AR Lac 3
011121	12252	1	52234.782435	100	0.78	1.37±0.03	14.62±0.37	0.94	$z=0.36$	4.1×10 ⁵¹	GRB011121
011211	12361	1	52254.795040	400	0.34	1.43±0.07	2.69±0.16	0.86	$z=2.1435$	2.6×10 ⁵²	GRB011211
020113	12497	2	52287.887420	800	0.45	1.59±0.20	0.63±0.10	1.67			GRB020113
020118	12513	2	52292.769646	60	3.91	1.39±0.15	1.18±0.14	0.60			GRB020118
020321	12705	1	52354.180980	60	0.73	1.00±0.24	0.31±0.07	0.91			GRB020321
020322	12712	2	52355.160819	60	0.40	1.40±0.14	0.65±0.08	0.80	$z=1.80$	4.5×10 ⁵¹	GRB020322
020409	12830	1	52373.882928	50	0.33	1.26±0.23	1.00±0.22	0.56			GRB020409
020410	12830	2	52374.444190	1300	0.70	1.81±0.05	9.59±0.34	1.00			GRB020410
020427	12933	2	52391.158813	70	0.24	2.11±0.14	0.62±0.06	0.43	$z<2.30$	<7.0×10 ⁵¹	GRB020427

[‡]For GRB000901, the distance and energy output were applied for an identification with EQ J084834.9-785352, see Table 1; [†] For GRB970402, the spectral modeling was limited to 2-10 keV, because the spectrum shows a sharp drop above 10 keV; [§] For event 010315 from GT Mus, the spectral modeling was limited to 2-13 keV, because the spectrum shows a sharp drop above 13 keV.