

Bursts observed with JEM-X - reconstructing light curves

exemplified by bright bursts from SGR 1806-20

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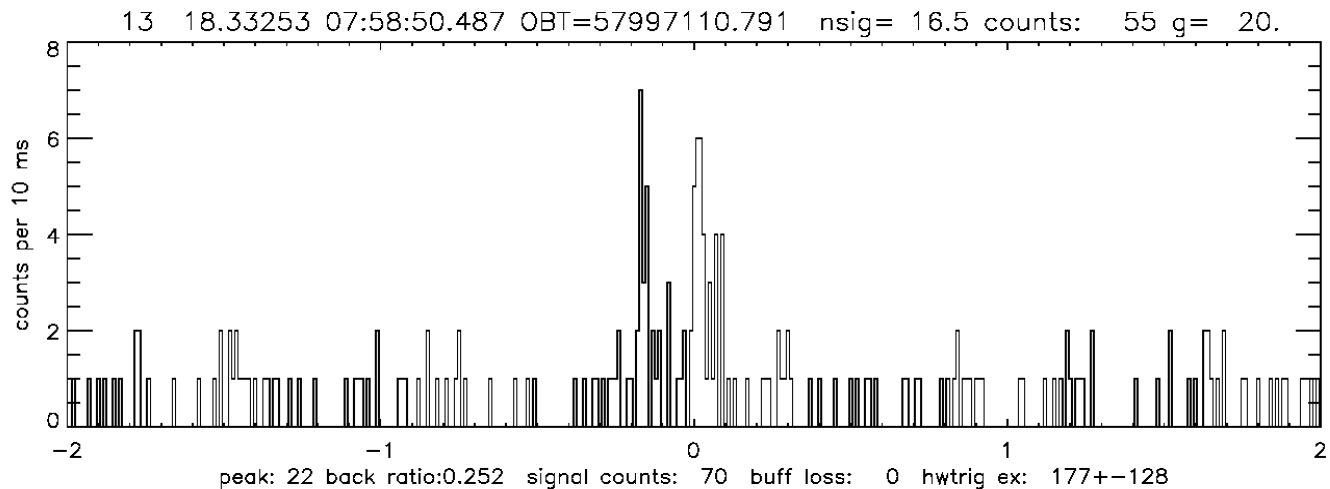
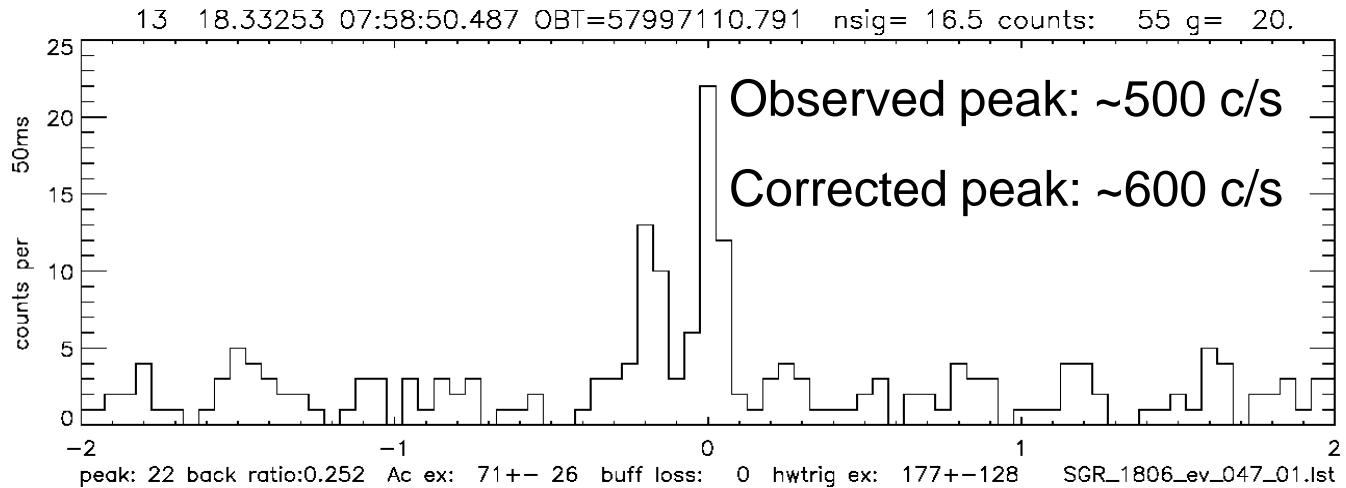
JEM-X count rate limitations

- JEM-X was designed to handle persistent source of a strength of a few Crab (140 c/s)
- TM constraints allow sustained transmission of <100 c/s, but TM buffer may contain 50 000 events.
- Intrinsic HW deadtime ~ 5.3 micro-sec \Rightarrow 200 000 c/s
- Read-in deadtime to buffer of 5 events: 180 micro-sec \Rightarrow ~ 5000 c/s
- SW event processing: > 600 micro-sec \Rightarrow <1000 c/s effective maximum rate
- SGR event typically has duration of ~ 100 ms with rates reaching 10 000 c/s \Rightarrow less than 100 accepted photons
- Bright SGR events have deadtime approaching 90%

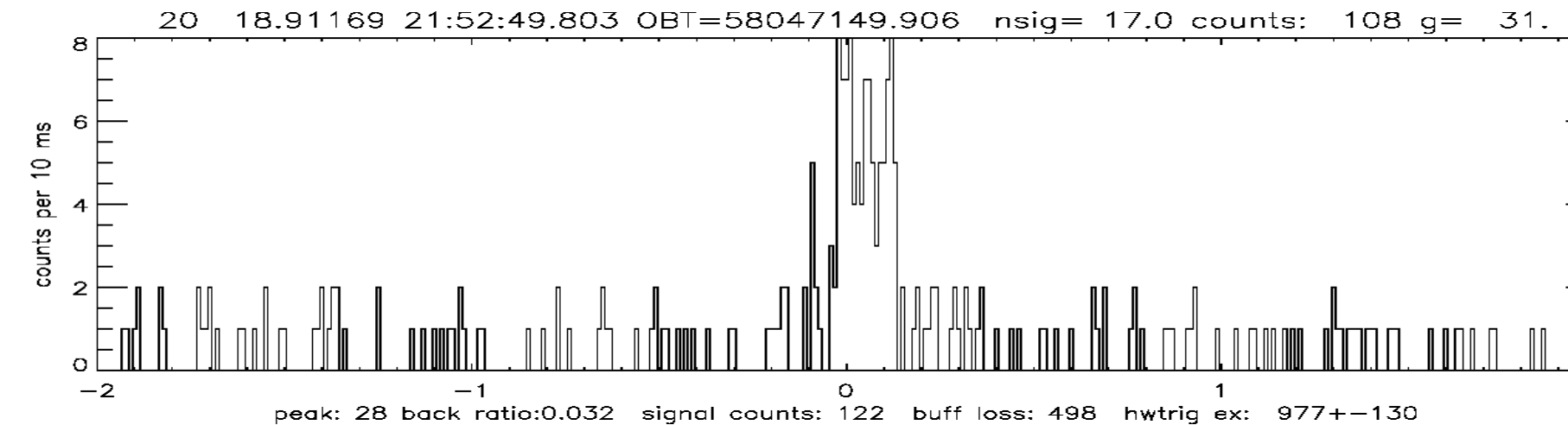
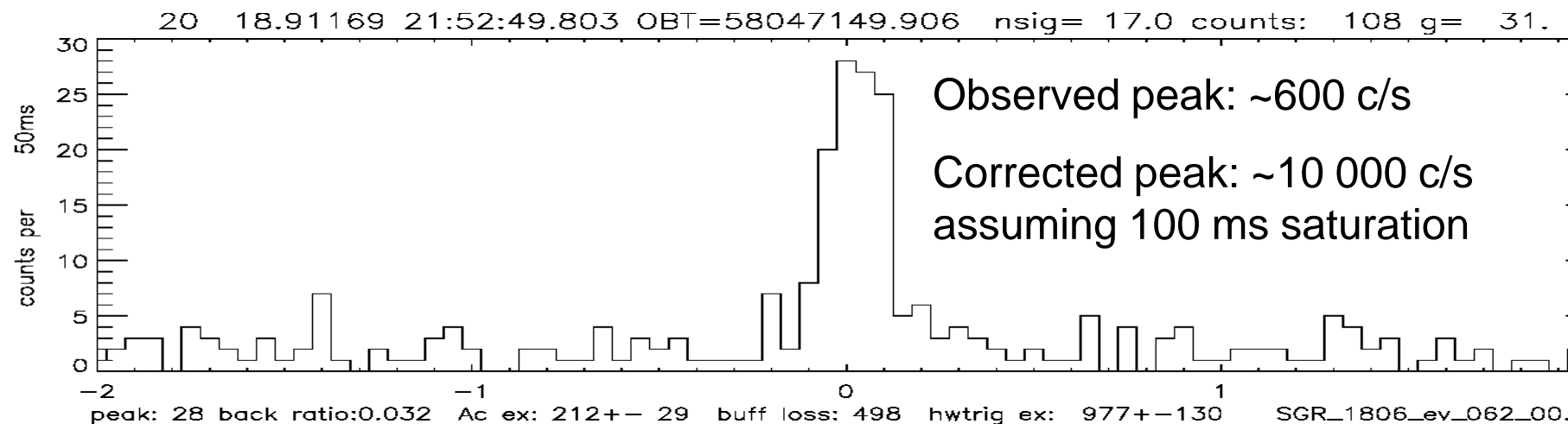
JEM-X dead time calculations

- Dead time calculations are based on HK data with 8 sec resolution returning 8 sec averages
- Calculation based on detailed timing of "branches" of event processing
- For events with time scales shorter than 8 sec, details are not covered
- Affected events: X-ray bursts, gamma ray bursts, soft gamma repeaters with peak rates $>$ about 5 Crab
- Very detailed folded light curves of bright X-ray pulsars also affected
- "Normal" bright SGR bursts has ~ 1000 excess HW-triggers seen in 8 sec HK, but only ~ 100 processed events
- Number of total HW-trigger is recorded with 8 sec resolution, so statistical uncertainty is ~ 125 counts
- Fluence may be reconstructed with $\sim 20\%$ accuracy
- Simple light curves (single spike) may be partly reconstructed, distributing excess events to saturated part of LC

Unsaturated SGR event, ~70 photons



Saturated SGR, 120 accepted events, ~1000 triggers



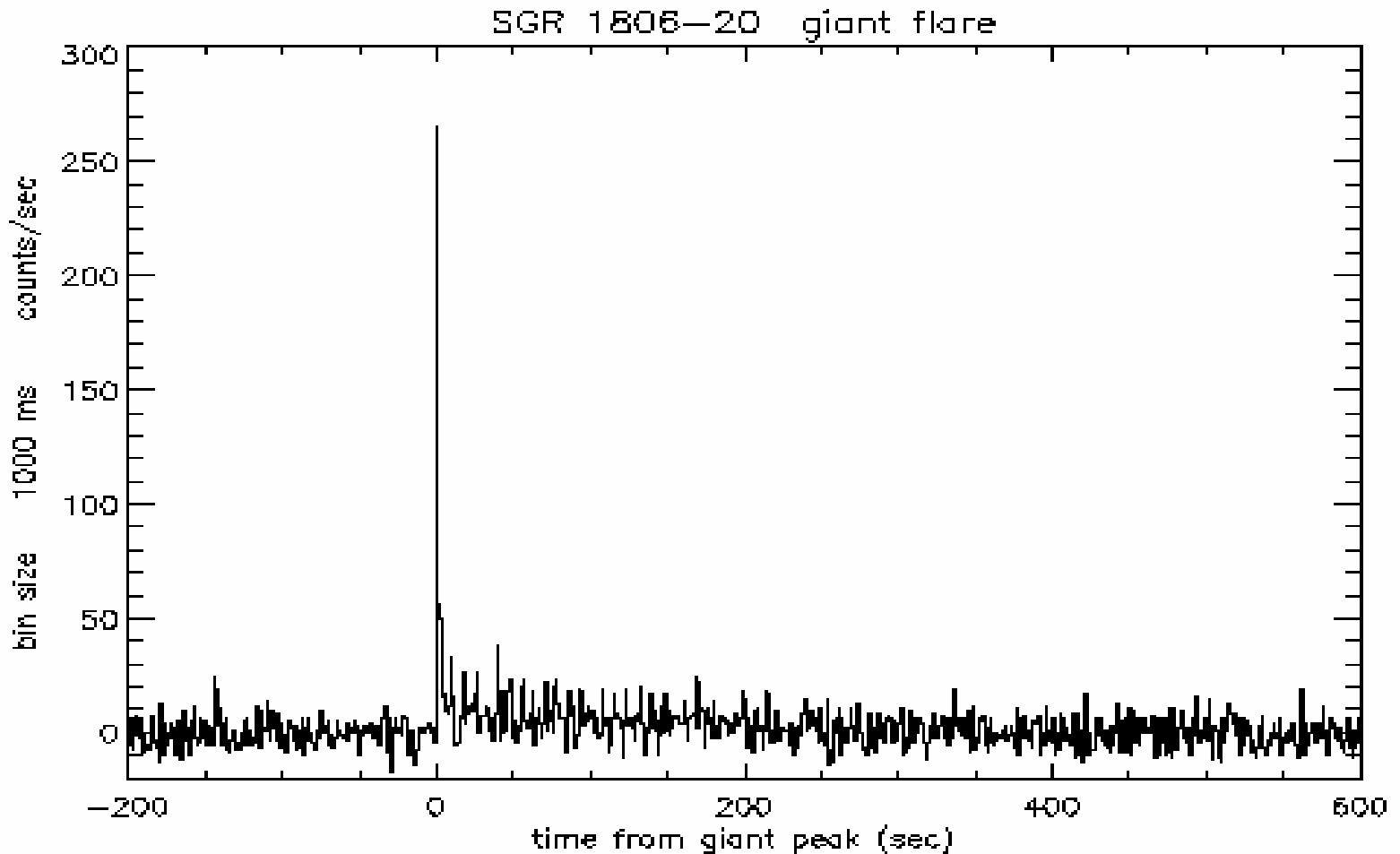
Giant flare from SGR 1806-20

- Giant flare observed from **SGR 1806-20** on December 27 at 21:30:26 UT (GCNs 2920, 2921, 2922, 2923, 2925, 2927, 2928, 2929, 2930, 2931, 2936 and more).
- 106 degrees off INTEGRAL axis.
- Fluence >0.3 erg/cm² estimated by RHESSI (Boggs et al. GCN 2936) corresponding to energy release $>8 \times 10^{45}$ erg at 15 kpc
- SPI ACS data for this event (GCN #2920) are public
- Other INTEGRAL data are awarded to Feroci et al. () and for polarization studies only to Kouveliotou et al.

Giant flare from SGR 1806-20 in JEM-X

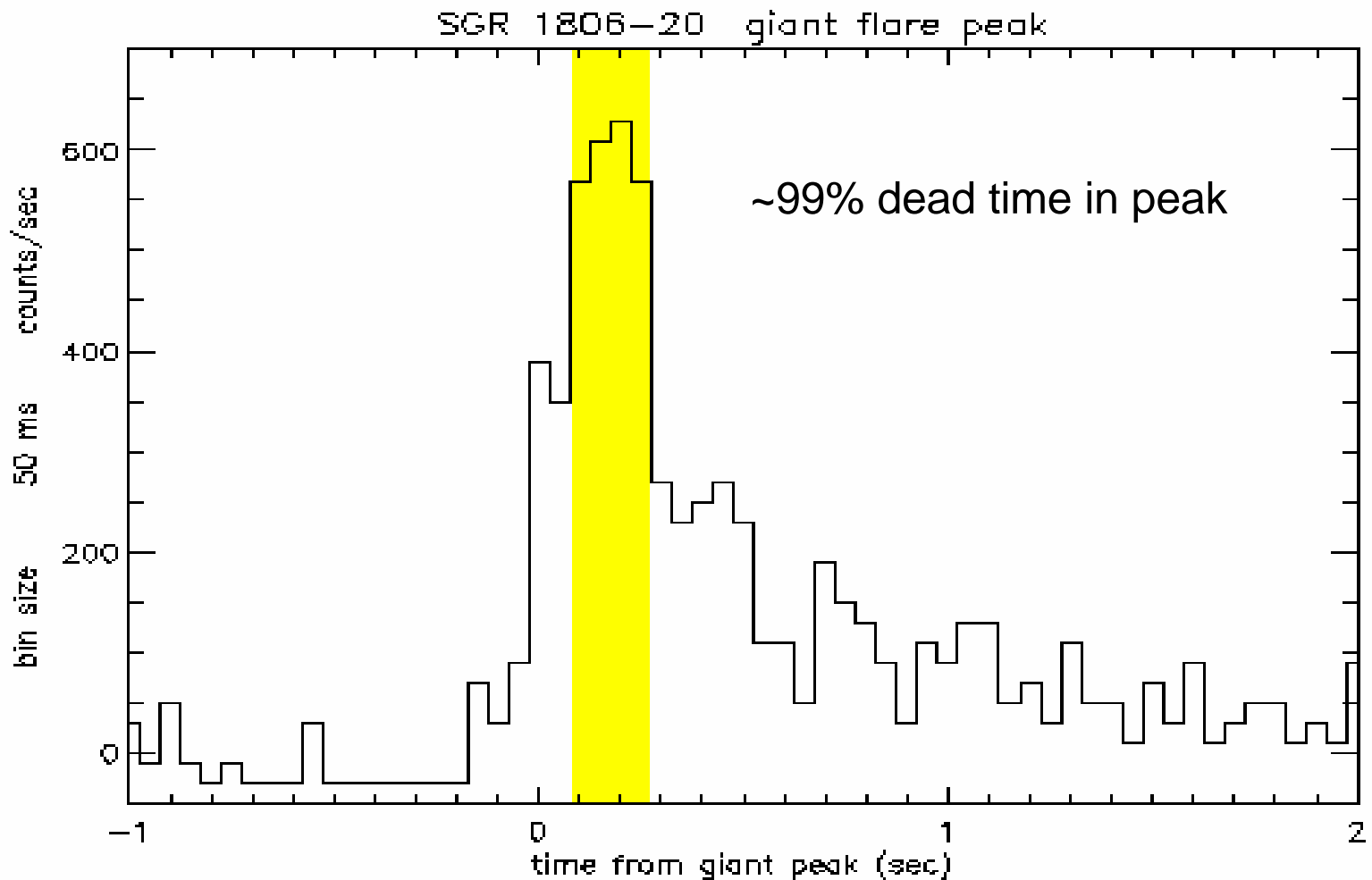
- Giant flare occurred on Dec 27, 2004 on the magnetar SGR 1806-20
- The JEM-X detector is "hit" about 15 degrees from below on the IBIS side, penetrating through sat structure and 2 mm steel detector vessel
- Giant peak is followed by pulsed tail for more than 200 sec
 - 7.57 +/- 0.03 sec pulse period derived
- ~200 ms sec giant peak is heavily saturated
 - Assuming 200 ms flat-top peak → peak trigger rate > 200 000 c/s
 - Dead time for accepted events is about 99%
- Upper cut-off employed at ~50 keV for accepted events
 - Half of excess HW triggers in the tail are above 50 keV, while 75% in the giant peak are above 50 keV (caution: pile-up!)
 - Accepted events are mainly in the 30-50 keV range

Accepted event rate in JEM-X (~ 50 keV cut-off)

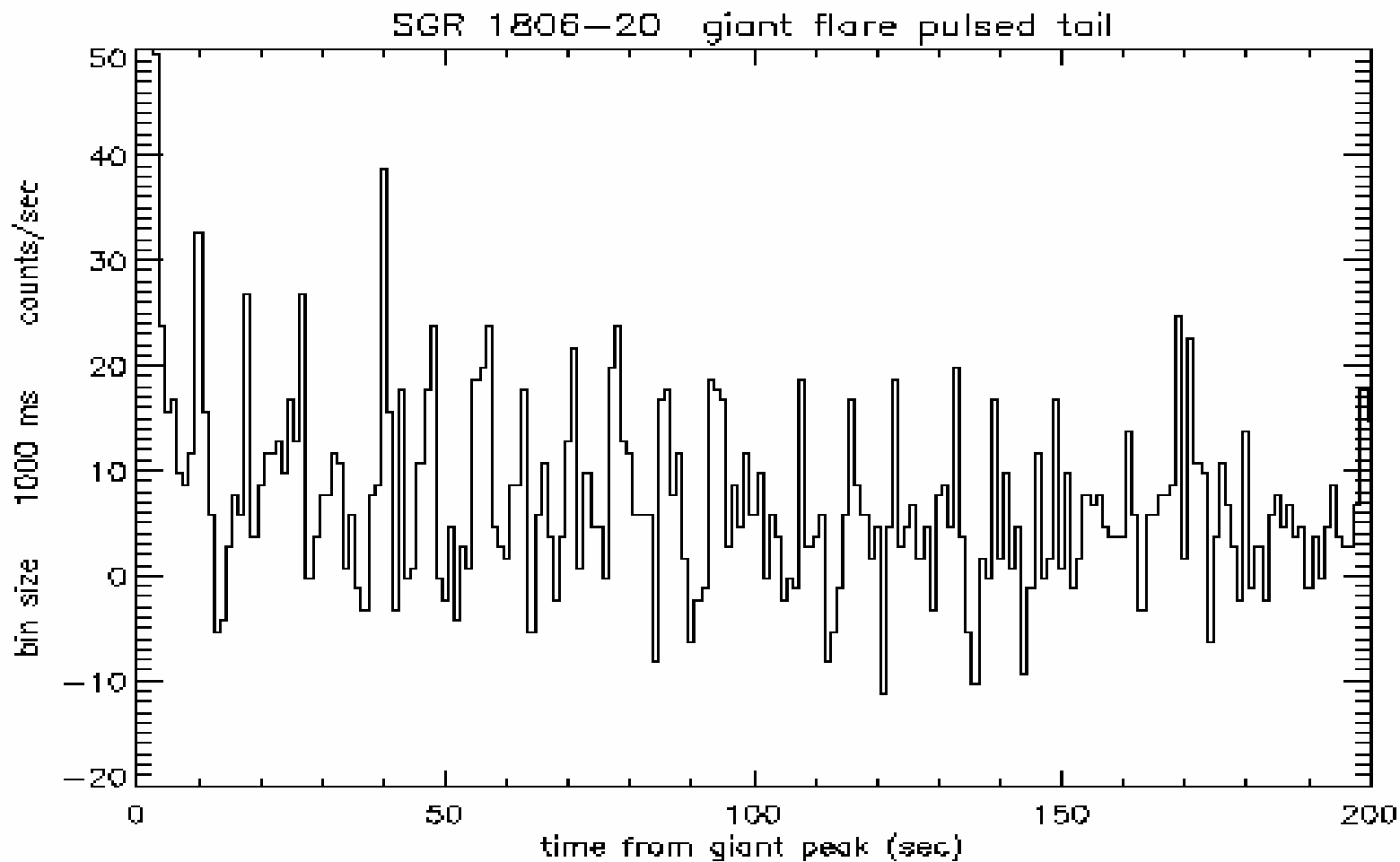


SGR 1806-20 giant flare peak

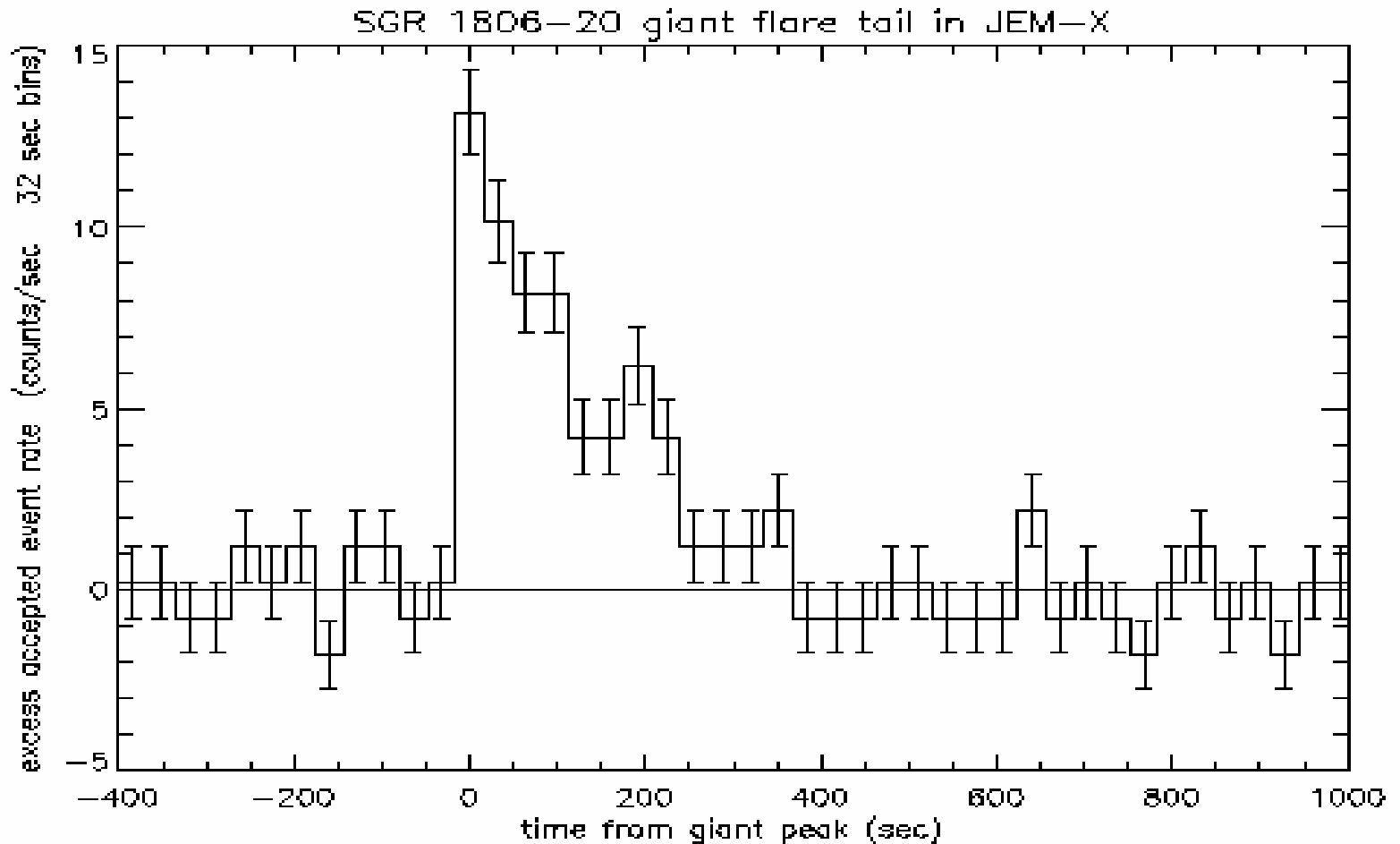
dead time corrections (~99%) imply >100 000 c/s in <200 ms peak (30-50 keV)



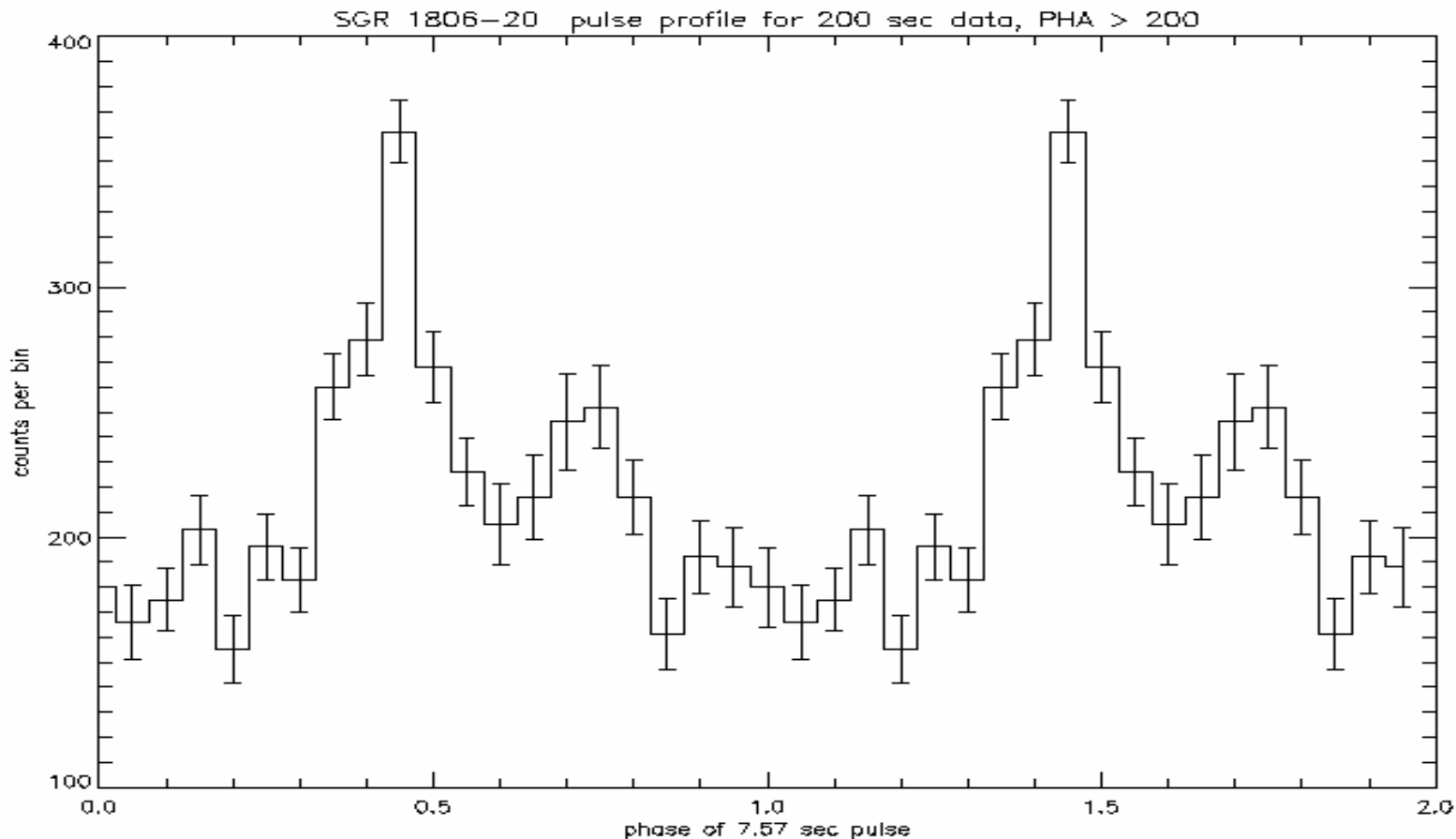
SGR 1806-20 pulsed tail



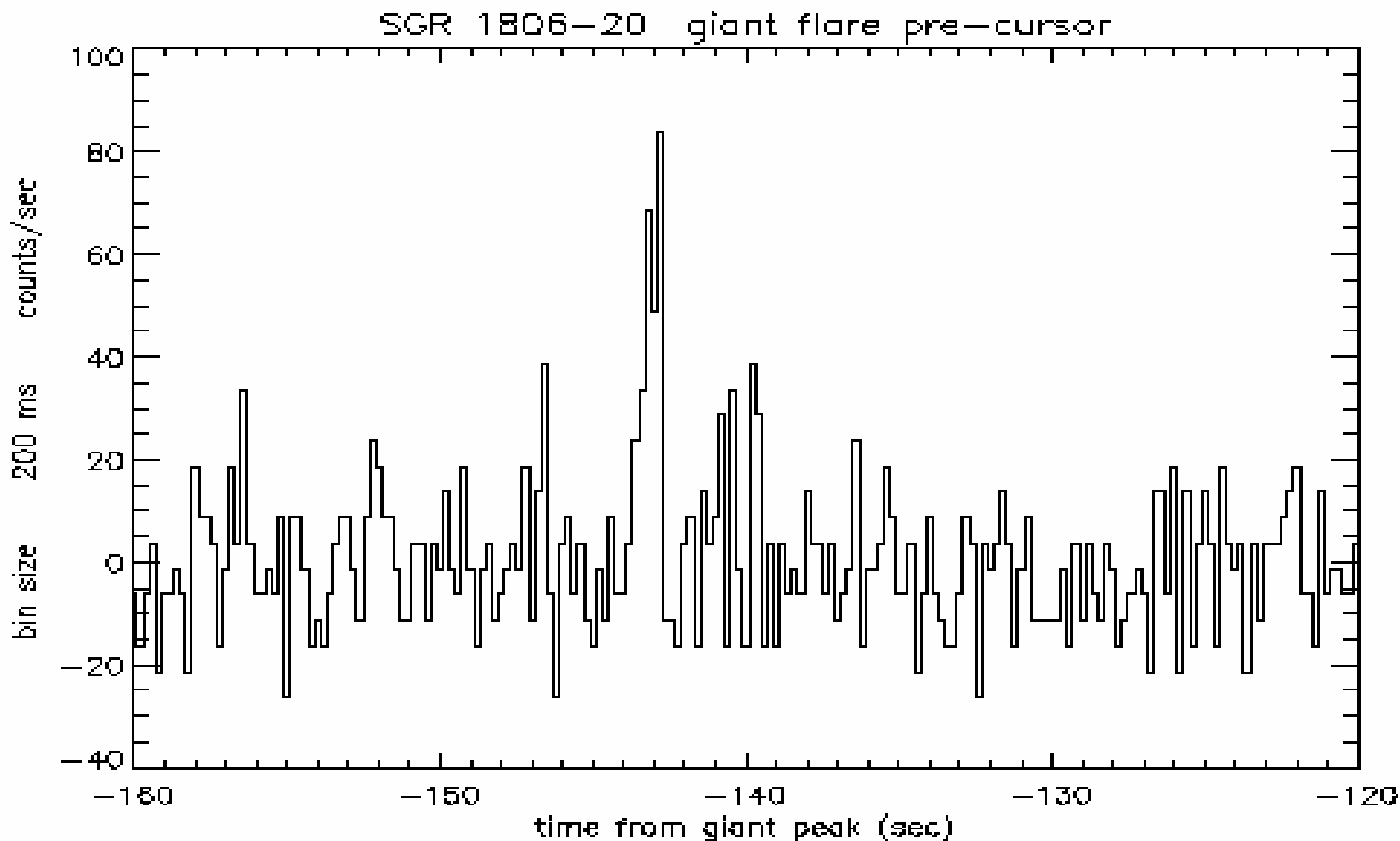
Excess count rate extends for more than 200 sec



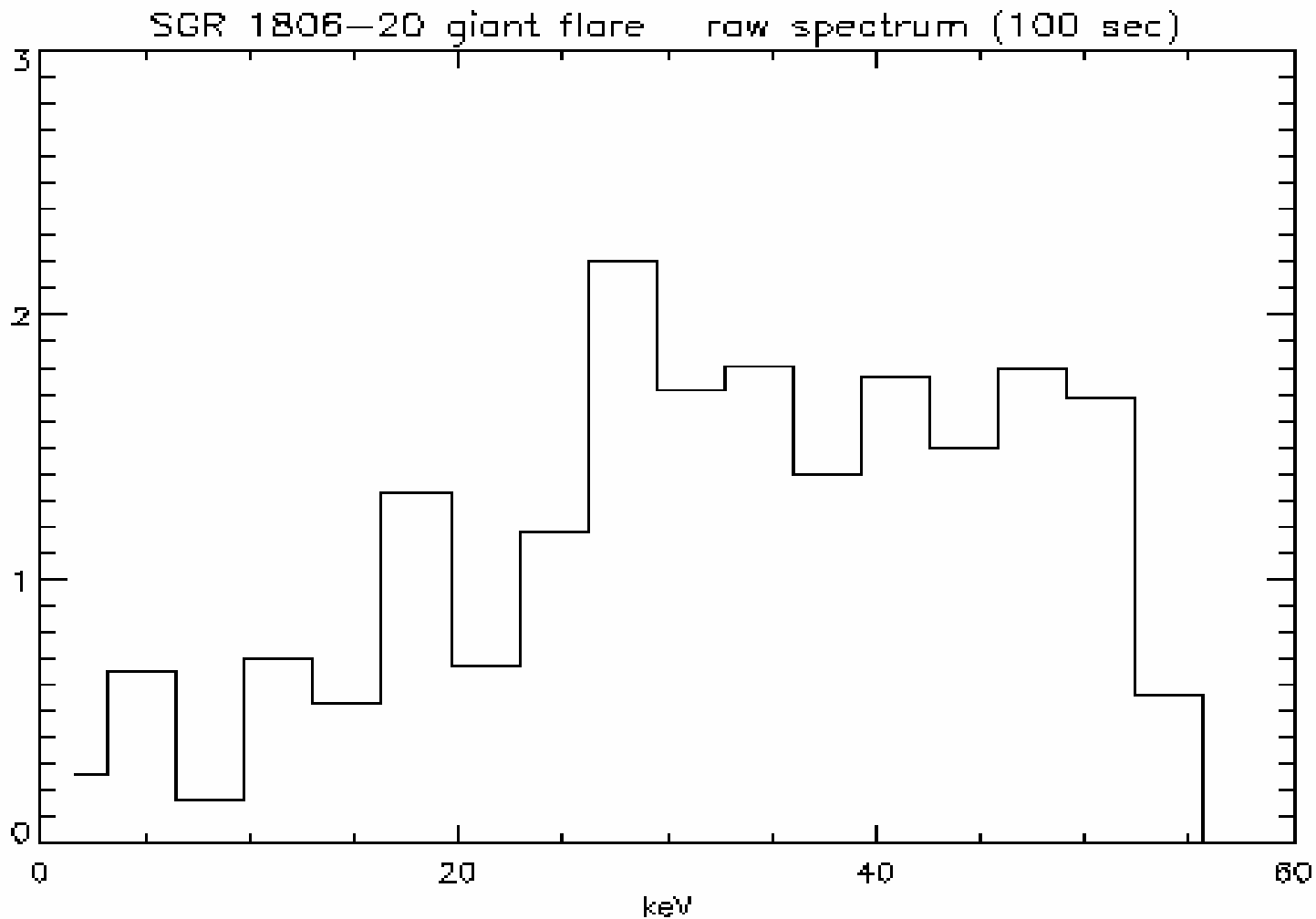
Pulse profile for 7.57 s period based on 200 sec of ta



Giant flare pre-cursor at T-143 sec (background subtracted)



SGR 1806-20 raw spectrum



Summary and Conclusions

- JEM-X dead time effects become significant for rates larger than a few Crab (~ 500 c/s) and severe for rates > 10 Crab (1000 c/s)
- Dead times for variability shorter than 8 sec are difficult to estimate
 - However, estimates can be improved by proper use of HK data
- Most affected are SGR bursts (and in particular the giant flare!)
- Estimates of peak rates for XRBs are also affected
- Severe dead time is indicated by events rejected by "5-buffer-full" condition in the HK.