Smithsonian Astrophysical Observatory

Memorandum

To: M. Cappi, Strong Gravity SDT/YB Team, XMS team mrg-2010-02v2
From: M. Garcia
Date: April 14, 2010
Re: XMS high/mid/low resolution event rates for bright AGN

This memo arises out of the concern that the bright AGN that will be used to observed strong gravity effects – in particular those for which time-resolved measurements of test particle orbits will be made – may generate counting rates in the XMS that are sufficient to overwhelm it. If this occurs events will not be lost, but the energy resolution of the events will be degraded. Our current science requirements flow-down specifies the XMS as the primary instrument for these observations and we desire the full resolution, so this possible outcome is undesirable. The option of using a 'diffuser' (see Willingale, 2008 BSDO_NFI memo) for these observations is also undesirable, as it lowers the overall effective area by 62% at low energies and up to 80% at 8 keV.

The conclusion is that there is some degradation in the energy resolution, but the effect is moderate. Even in the worst case ~70% of the events are either high- or mid-resolution. There should be very little impact on the science, and is certainly a smaller effect than the diffuser would entail. However, this effect should be evaluated again if the XMS decay time constant is increased beyond the current baseline of 300usec.

We used the event simulator 'simx' (http://ixo.cfa.harvard.edu/wiki/IXO/IXOSimulators) to estimate the rates, and the list of AGN from Table 4-3 (reproduced below) of the Con-X BEPAC response (dated Jan 22 2007). Fluxes over 2-10 keV were taken from this table, and spectral slopes and N_H were taken from McKernan, Yaqoob and Reynolds (2007 MNRAS 379, 1359) or Grupe etal (2010 ApJS 187, 64). Mean value of flux in this table is 4.1×10^{-11} cgs, median is 3.5×10^{-11}. A histogram of the fluxes is included in the plots below. The 2-10 keV fluxes in this table are from an ASCA survey of bright AGN that was completed several years ago. Counting rates were calculated for a representative set of these AGN, using both the slumped glass and silicon pore optics effective area files. For the SPO these areas came from the file ixo_matrices_20103103.zip which came from Nicola Rando on March 31, 2010. For the glass optics the areas are from ixo_ucal_5p0_081030.rsp. These are plotted below, labeled as the 2008 Glass (green) and 2010 SPO (red) curves (from Andy Ptak).

The definition for high/med/low resolution events is shown on the last figure below. We note that the use of 1.5 msec and 6.0 msec as the high and mid res time intervals appears to be based on a one pixel time constant of 150 usec, and high and mid intervals of 10 and 40 time constants. If the relevant time constant is instead 300 usec the intervals are likely 3.0 msec and 12 msec and the high counting rate effects are more prominent. Both cases are considered below. We also did a few cases with intervals of 1.6ms and 2.9ms,

re: Caroline Kilbourne's email of April 18, 2010. The energy resolution for the high events is 2.5eV, mid is expected to be 3.5eV, and low >10eV.

The below is from Randall's Feb 2010 draft (not yet finished nor released) memo on SIMX:

Event Grades in simx

The event simulator simx contains routines to calculate deadtime, along with special code to handle the more complex situations that arise with microcalorimeters. The process occurs in two steps. Step 1 considers the time-ordered event lists, stepping through each event, looking to see if the next event on that pixel is within τ_{rec}, (listed in the simx mission definition as DeadTimePerEvent), and if so, the event at best Mid-res. If it is also within the MidResDeadTime, the event is Low-res. Otherwise, it's counted as provisionally High-res.

Then the event list is stepped through again, looking at each event and when the *previous* event occurred. If this preivous event occurred within τ_{rtb} (MidResDeadTime) seconds, then simx counts the event as Low-res. Otherwise, it's left as was. There is no specific marking for secondary events.

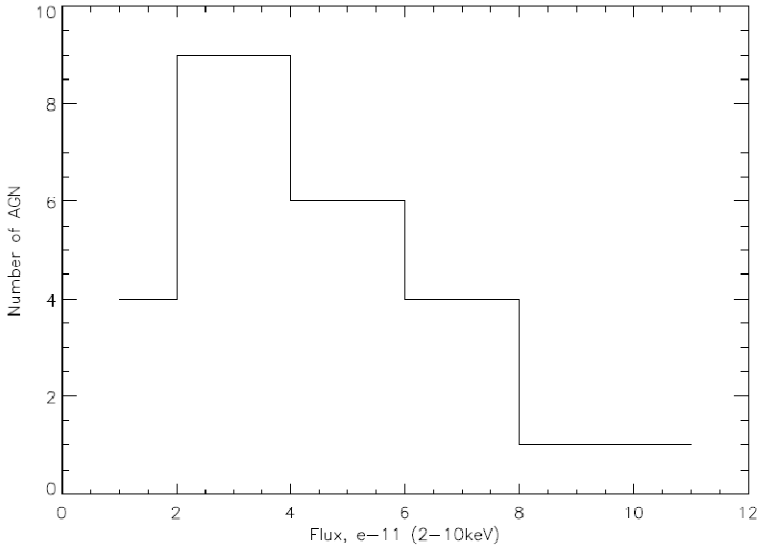
The values in the parameter file for IXO are (units are in seconds):

IXO:XMScore:DeadTimePerEvent 6e-3
IXO:XMScore:MidResDeadTime 1.5e-3

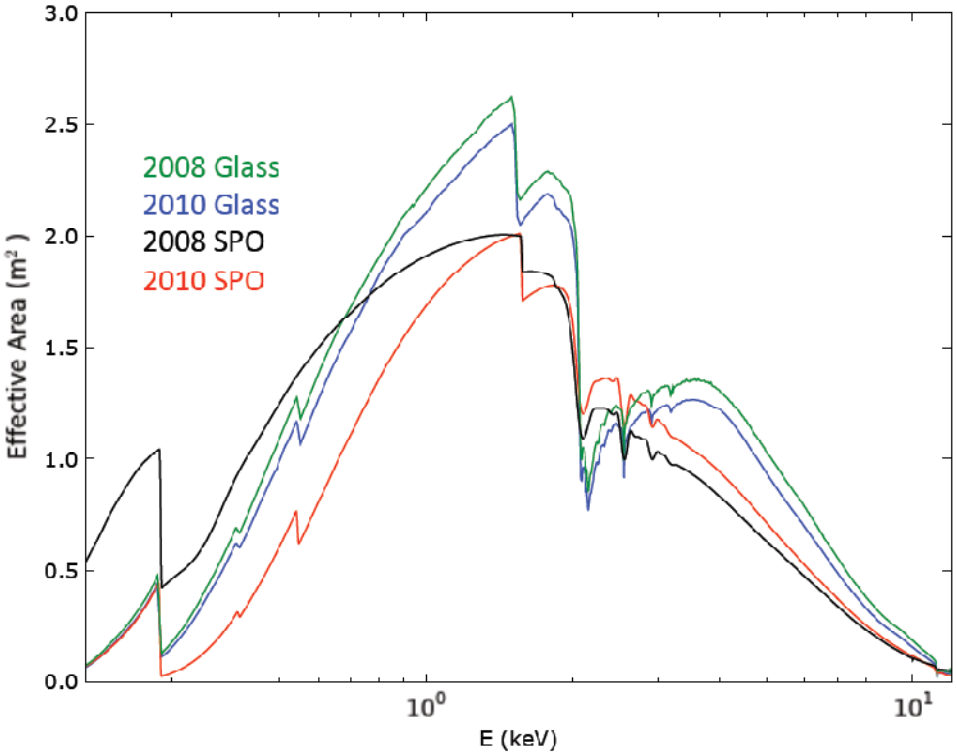
	Flux (2-10keV)	Γ	NH	SPO				Glass			
1.5ms, 6.0ms				High	Mid	Low	Total rate	High	Mid	Low	Total rate
IC4329A	7e-11	1.83	3e21	76%	13%	11%	340c/s	71%	16%	13%	430c/s
MCG6-30-15	4e-11	1.76	6e20	79	12	9	280	74	14	12	380
MKN 509	6.6e-11	1.63	1e20	70	16	14	460	61	20	19	640
MKN 355	1e-11	2.3	4e20	87	7	6	160	82	10	8	240
3ms, 12ms											
IC4329A	Same values as above			58	21	21		53	22	25	
MCG6-30-15				65	18	17		57	21	22	
MKN 509				52	23	25		43	24	33	
MKN 355				77	13	10		69	17	14	
1.6ms, 2.9ms											
MKN 509				81	5	14		75	6	19	
MKN 355				83	4	13		77	6	17	

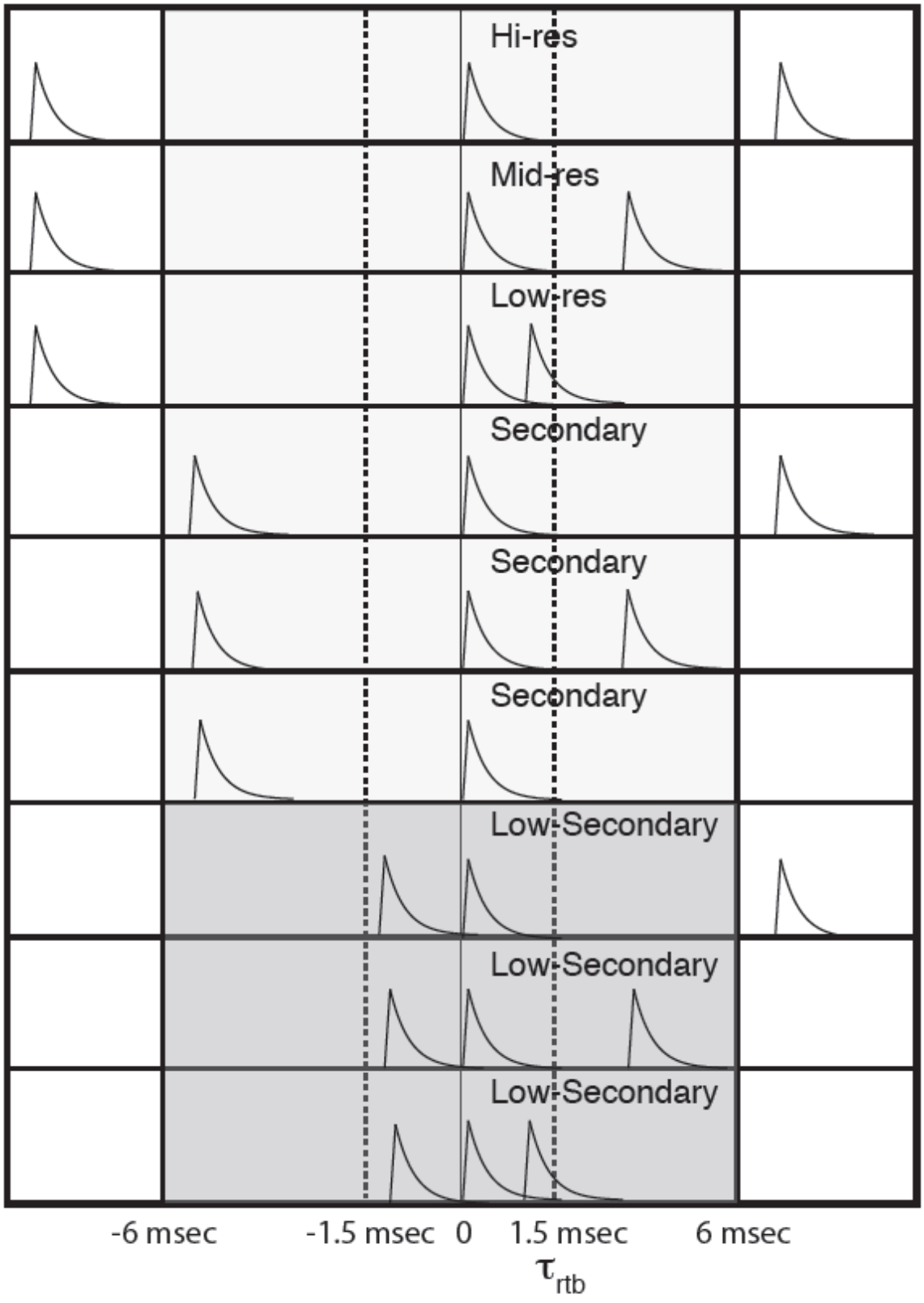
Table 4-3: Target AGN for GR Tests

Target	BH Mass (10^6 $M_\odot$)	2-10 keV flux (10^{-11} erg cm^{-2} s^{-1})	t_{orb} (ks)	FOM (flux*t_{orb})
IC4329A	1	7	1.0	7.0
MGC-6-30-15	2	4	2.0	8.0
NGC 4051	2	2	2.2	4.4
NGC 5506	2	7	2.2	15.5
MKN 766	4	2	4.0	8.0
MKN 335	5	1	5.1	5.1
NGC 7314	5	4	5.1	20.4
NGC 7469	7	3.2	7.7	24.6
NGC 4593	8	4.5	8.1	36.5
NGC 4151	13	10	13.2	132
MCG+8-11-11	15	2.3	15.2	35.0
NGC 3516	23	5	23.3	116
NGC 3783	29	7	29.3	205
NGC 3227	44	2.8	44.5	125
NGC 2922	52	0.4	52.6	21.0
MCG-5-23-16	70	9	70.8	637
MKN 509	72	6.6	72.9	481
F 9	81	2.5	82.0	205
MR 2251-178	98	5	99.2	496
NGC 7213	98	3	99.2	298
MKN 841	100	1	101.2	101
NGC 5548	110	5	111.3	557
ARP 102B	140	1.1	141.7	156
NGC 2110	200	3.5	202.4	708
MCG-2-58-22	350	3.3	354.2	1169



XMS


2008 Glass
2010 Glass
2008 SPO
2010 SPO
Effective Area (m²)
E (keV)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
10⁰
10¹


Hi-res
Mid-res
Low-res
Secondary
Secondary
Secondary
Low-Secondary
Low-Secondary
Low-Secondary
-6 msec
-1.5 msec
0
1.5 msec
6 msec
τ_{rtb}