JEM-X Background Counts caused by Photons not traversing the Mask.

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DSRI JEM-X Technical Note #8
981123

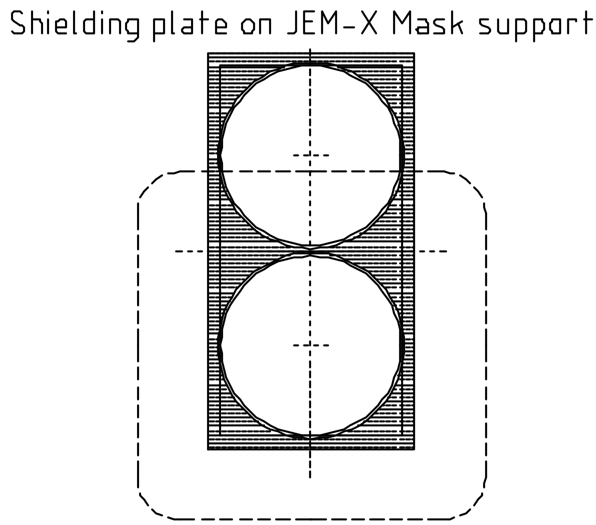
1) The Diffuse Flux Background in JEM-X

In the existing evaluations of the sensitivity of JEM-X the contribution to the background from the cosmic diffuse flux has been assumed to arrive only through the holes in the mask. In other words, the mask platform and the walls of the rectangular tube supporting the mask have been assumed to be completely opaque to the X-rays. This is an acceptable approximation only at the lower end of the JEM-X energy range. At 20 keV the transmission of the mask platform is 35 % and at 25 keV it reaches 60 %. For the walls of the support tube the corresponding numbers are 20 % @ 20 keV and 50 % @ 25 keV. An appreciable contribution to the diffuse flux may therefore be expected in the upper end of the primary JEM-X energy range. This may seriously reduce the sensitivity of the instrument in this range.

2) The Transmission Function for the JEM-X Collimator

The collimator is constructed with two sets of lamellae, crossing at 90E. The height of the collmator is 57 mm and the square tubes formed by the crossing lamellae have inside dimensions of 6.6×6.6 mm. The zero response curve is a square of 13.2E×13.2E full width. The opening angle of the collimator is chosen such that the transmission of the collimator is zero at the same angle where the overlap between the mask mask shadow and the detector window goes to zero.

If we project the transmission function of the central tube in the collimator on the mask plane we get a square 787×787 mm, i.e. significantly larger than the 535 mm diameter mask. And on top of that we must even add the transmission function from alle the other tubes in the collimator. In the mask plane, we must therefore draw circles with 125 mm radius around every point on the perimeter of the above square. The final extent of the area, from which we can receive flux therefore becomes a square with rounded corners, as illustrated in Figure 1. It is obvious that we must be concerned about the diffuse flux from this large area. Fortunately, the collimator transmission is low over most of this area.



Figur 1 JEM-X Mask Support Panel with indication of Collimator FOV.

3) Contributions from the peripheral areas.

The relative contributions from the different part of the collimator field of view have been calculated. The results, considering only the collimator transmission, not the transmission of the structural elements, are given in the table below:

Table I. Relative Contributions to total Background

Region	Relative area	Transmission	Contribution
Mask (normalization)	1.000	0.25	0.250
Mask frame	0.043	0	0.000
Mask of other unit	0.032	0.25	0.008
Mask frame of other unit	0.006	0	0.000
Top platform	0.235	energy dependent	#0.235
IBIS sidewall (shielded)	0.051	0	0.000
SPI sidewall	0.051	energy dependent	#0.051
Endwall	0.050	energy dependent	#0.050
Total outside mask	0.468	energy dependent	#0.344

We note (last column), that due to the low transmission of the masks the contributions of the diffuse flux arriving outside the mask may exceed the contribution through the mask.

The problems associated with the flux arriving through the mask of the other unit will be dealt with in a separate note.

4) The Transmission Characteristics of the Structural Elements.

The top platform is aluminium honeycomb with aluminium face sheets, each 0.635 mm. The height of the honeycomb is 38.75 mm, the thickness af the honeycomb walls: 25.4µ, the cells are 3.18 mm across. The total thickness of aluminium is approximately 1.5 mm. The transmission function through this thickness of aluminium is shown in figure 2.

The side walls are aluminium honeycomb with CFRP face sheets, each 0.6 mm. The honeycomb again is 38.75 mm high, the walls are 18µ Al and the cell is 4.8 mm across. The side walls are traversed at very low angles, #6.6E, corresponding to 1/cos-factors of 8 or more. We have used an average 1/cos-factor of 12 for the calculation of the X-ray transmission, the final result is very similar to that calculated for the transmission through the top panel.

5) Background Calculations and Sensitivity Estimates.

Figure 3 shows the background calculations for JEM-X, curve 1 is the diffuse flux through the mask and walls of the structure, and curve 2 is the internal detector background (induced by cosmic rays and high energy gammas). Curve 3 is the total diffuse flux, including the contribution through the top plate around the mask, taking into account the shielding of the top plate itself.

We see, that without additional shielding we will have an increase in the background of about 25 % in the energy band between 20 and 35 keV.

6) Conclusions

To maintain our stated sensitivities, it is essential to reduce the peripheral contributions, at least up to 35 keV. The top platform is the dominant contributor to the unwanted background, and, due to its limited area, it is also the easiest to cover with some additional absorbing material.

We therefore propose to cover the top platform with a plate capable of absorbing at least 90 % of the photons at 35 keV. It is desirable to use a material from which the K-fluorescense photons will be effectively absorbed in the aluminium top platform. This limits our choice to the elements with atomic number less than 34.

We have found that 1 mm of brass (67 % Cu, 33 % Zn) would be adequate The area to be covered is 0.24 m^2, thus the weight of the shielding will be about 2 kg.