Crosstalk between the JEM-X Units

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981123

1) Background

As discussed in a previous note[1] the field-of-view of the collimator in front of one JEM_X unit includes part of the other units mask. This is illustrated in figure 1. This “cross-talk” is unfortunate, as it will complicate the analysis of all image data substantially. The question has been raised, whether there are advantages to be gained from the crosstalk as well. This note will illustrate the issues.

2) Will there be a gain in sky coverage?

Initially we may recall from TN #8, that the increase in the diffuse flux coming from the crosstalk mask is only 3 % of the diffuse flux through the primary mask. This is because of the influence of the collimator transmission function, which is small over most of the crosstalk FOV. Obviously we cannot expect a dramatic gain in useful sky coverage from this small number of additional photons.

Looking at Figure 1 one get the intuitive impression that the crosstalk effect will add a lot of new sky to the FOV. This is not so. What the crosstalk does is to increase somewhat the sensitivity of (or at least the number of photons detected) within the crosstalk FOV. This is illustrated in figure 2, where the distribution of sky exposure is shown across the FOV excluding (full contour curves) and including (dotted curves) the crosstalk contribution. The sky exposure goes to zero at the edge of the primary mask FOV because there overlap between mask shadow and detector window goes to zero, but also because the collimator transmission is approaching zero here - this has been the basis for the collimator design.

Any practical definition of the instrument FOV must include some sensitivity threshold, defined for instance by requiring a sky exposure factor of at least 10% of that in the center of the FOV. Using this criterion we have derived an increase of 5 % in the useful FOV resulting from the inclusion of the crosstalk contribution. Even putting the sensitivity threshold down to 1% we get only a 7 % increase when including the crosstalk photons. Note, that within the central parts of the FOV - out to about 4E off-axis angles, there is no significant increase in sensitivity.

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[1] DSRI/JEM-X/TN #8, 981123

3) What complicates the image analysis?

The analysis of each image must cover the full field-ofview (FOV). If some part of the FOV is left out, a possible (transient) source in this area will be missed, and, if it is a strong source, its presence in the image will disturb the analysis of the sources within the accepted FOV.

The analysis of the JEM-X images must take into account all the factors which affect the observed shadowgrams. The primary factors are:

a) The hole pattern in the mask(s).
b) The obscuration of the hole pattern by the mask support structure(s)
c) The obscuration of the hole pattern by the collimator.

It is the second factor, the mask support structure, which requires complex calculations within the crosstalk FOV. The mask support structure consists of 60 mm high ribs in a pattern shown on figure 3. Identical rib-patterns are placed on both sides of the mask. The ribs will shadow sections of the mask, the exact shapes of the shadows will have to be calculated for each direction considered. Of course such shadowing is also present within the primary FOV. But because the typical off-axis angles are much smaller the shadows are not so significant here. Moreover, precisely because we want to diminish the complicated effects of the rib shadows we have chosen to close all holes which have their centers covered by the mask support structure.

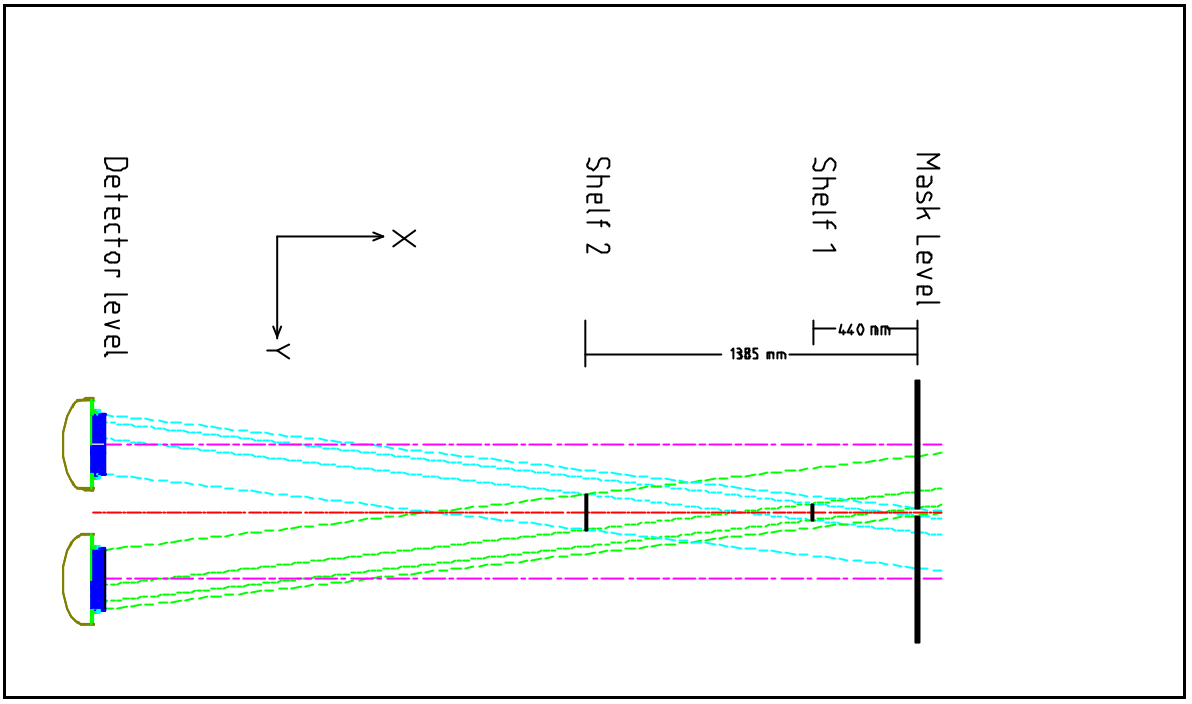
4) Conclusions

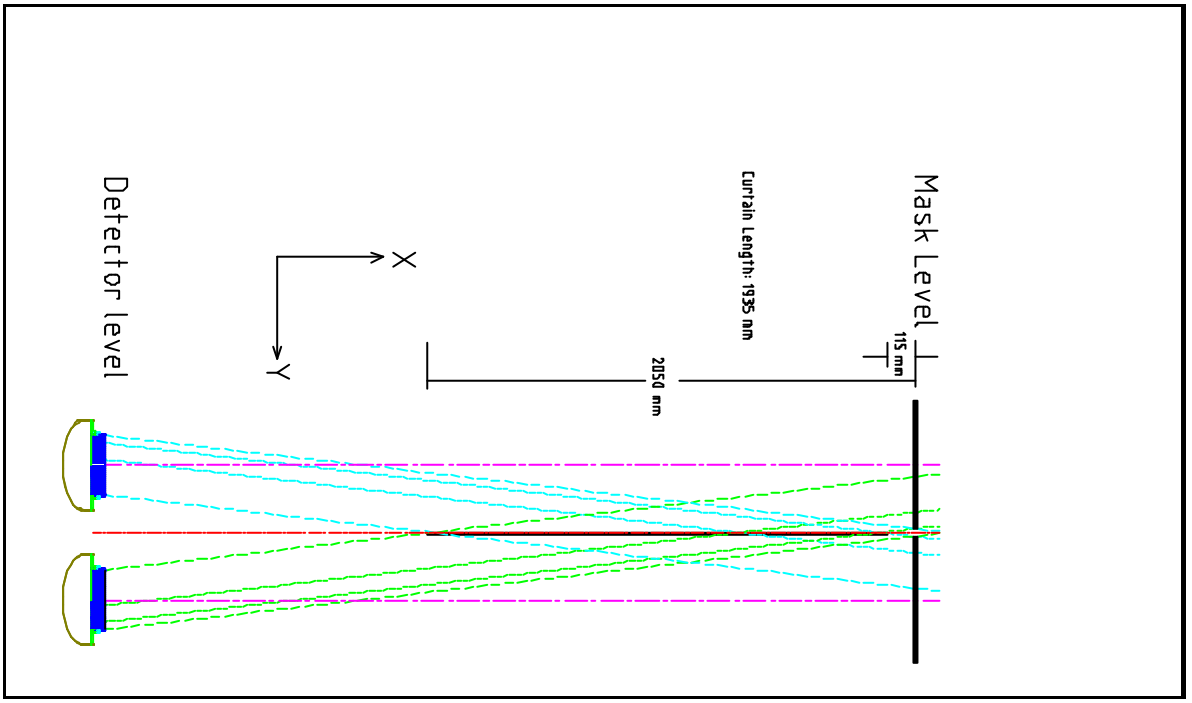
The crosstalk between the two JEM-X units will complicate the data analysis significantly and will allow only a marginal increase in sensitivity and sky coverage. Therefore we want to eliminate this effect by introducing suitable shielding between the two units.

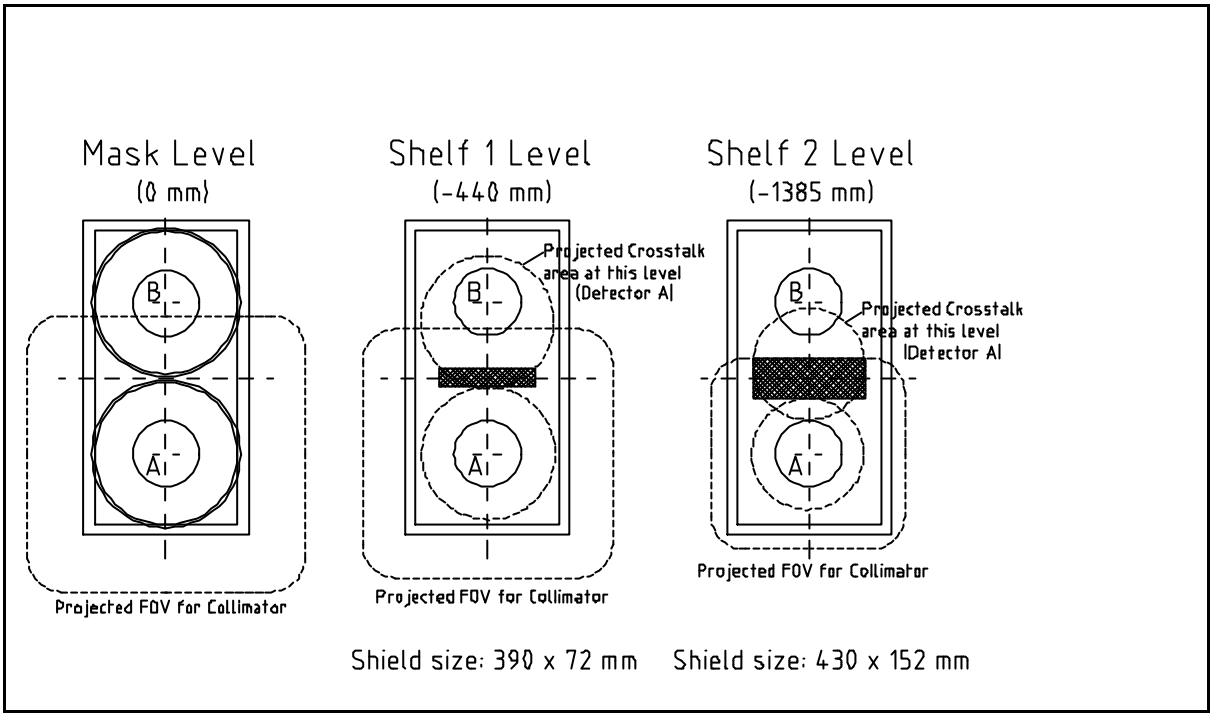
We have identified two acceptable shielding geometries, one based on a “curtain” dividing the interior of the mask support tube, the other based on two “shelves” located at well defined heights within the tube. The two configurations are illustrated in figure 4 and 5. Due to the advanced state of the fabrication of the flight model mask support tube we intend to solicit advice from ESTEC/Alenia on the implementation of the preferred option.

In the case of the “shelf”-solution we suggest to use brass plate 1 mm thick for the shielding, for the “curtain”-solution a weaved copper or steel mesh with a surface density of 1000 g/m^2 will be adequate. We prefer the shelf solution as it appears to us as less risky. If the curtain fails during launch it may easily block the apertures of both instruments almost completely.

The weight of the required shielding will be about 750 g for both solutions. To this must be added the support structure which estimate to be less than 500 g in either case.


Detector level
X
Y
Shelf 2
Shelf 1
Mask Level
1385 mm
440 mm


Detector level
X
Y
2050 mm
Curtain Length: 1935 mm
Mask Level
115 mm


Mask Level
(0 mm)
B
A
Projected FOV for Collimator
Shelf 1 Level
(-440 mm)
Projected Crosstalk
area at this level
(Detector A)
B
A
Projected FOV for Collimator
Shelf 2 Level
(-1385 mm)
Projected Crosstalk
area at this level
(Detector A)
B
A
Projected FOV for Collimator
Shield size: 390 x 72 mm
Shield size: 430 x 152 mm