Mandatory checks to be done for UVIT observations

Version 1.1 (07 April 2017)

The main thrust of checking for safety of UVIT is to ensure (i) there is no bright source in the field which could trigger "Bright Object Detect (BOD)" in the hardware that would put all the detectors OFF, (ii) there is no ultra-bright source near the field which would scatter excessive radiation in the field and (iii) there is enough photon flux in the VIS detector to make tracking of spacecraft feasible. The list of things to be checked before proposing for UVIT observations are outlined below:

(I)) Choice of VIS filters

Run BSWT (http://uvit.iiap.res.in/Software/bswt) for a field of 20' in radius and either get the PDF or ASCII output. This output gives the B-V colors of stars along with their V-band magnitudes within 20' radius of the target source. Select the five brightest stars from this list. From their colors get their closest spectral type from Table 1. This table gives the B-V colors corresponding to various spectral types. Once the spectral type is known from the table, proceed to ETC (http://uvit.iiap.res.in/Software/etc) and get the expected count rate in the VIS filters. Choose the VIS filters such that none of the stars give > 4800 c/sec and attach the count rates obtained. Further, for good tracking of the aspect, there should be at least 2 stars within 12' radius of the target with count rates greater than 30 c/sec (for good S/N) and lesser than 1000 c/sec (to avoid saturation) in the chosen filter. These count rates should be attached.

Table 1: Colors of stars and their spectral type (Source: http://www.stsci.edu/~inr/intrins.html)

Sp. Type	B-V	Sp. type	B-V	Sp. Type	B-V	Sp. Type	B-V	Sp. type	B-V
B0.0	-0.30	B5.0	-0.16	A2.0	0.05	F2.0	0.35	K2.0	0.92
B0.5	-0.28	B6.0	-0.14	A3.0	0.08	F5.0	0.45	K3.0	0.95
B1.0	-0.26	B7.0	-0.13	A4.0	0.12	F8.0	0.53	K4.0	1.00
B1.5	-0.25	B7.5	-0.12	A5.0	0.15	G0.0	0.60	K5.0	1.15
B2.0	-0.24	B8.0	-0.11	A6.0	0.17	G2.0	0.63	K7.0	1.33
B2.5	-0.22	B8.5	-0.09	A7.0	0.20	G3.0	0.65	M0.0	1.37
B3.0	-0.20	B9.0	-0.07	A8.0	0.27	G5.0	0.68	M1.0	1.47
B3.5	-0.19	B9.5	-0.04	A9.0	0.30	G8.0	0.74	M2.0	1.47
B4.0	-0.18	A0.0	-0.01	F0.0	0.32	K0.0	0.81	M3.0	1.50
B4.5	-0.17	A1.0	0.02	F1.0	0.34	K1.0	0.86	M4.0	1.52

(II) Choice of FUV/NUV filters (Case 1: Both FUV and NUV GALEX images are available)

Check if GALEX images are available covering 20 arcmin radius around the field from

. If yes, note the details (center of the field, availability of NUV or FUV, duration of the exposure, and type of exposure-imaging/spectroscopy) of the tiles of the images and provide them in "Technical Justification"

If both NUV and FUV images of GALEX are found (i) find the GALEX magnitude of the brightest object in the GALEX field in case of points sources (however find the highest rate in any 7 x 7 pixel window in the GALEX image, in the case of extended sources) (ii) get the magnitudes (in case of extended sources) using the following two relations

$m^{FUV} = -2.5 * \log (CPS) + 18.82$
$m^{NUV} = -2.5 * \log (CPS) + 20.08$

If the magnitudes (either for point sources or extended sources) obtained are brighter than 15 mag, correct for saturation using $M_{corr} = C_0 + (C_1 * M_{obs} + C_2)^{1/2}$ (Camarota & Holberg 2014, MNRAS, 438, 3111) .This equation is valid in the magnitude range of 1.5 to 17.5 in FUV and 9.5 to 17.5 in NUV. The coefficients C_0 and C_1 for FUV and NUV bands needed for correction are given in Table 2.

Table 2: Coefficients to correct for saturation in the GALEX magnitudes

Coefficient	NUV	FUV
C_0	2.634	5.371
C_1	26.316	20.000
C_2	-245.329	-210.200

Once the corrected magnitudes are known get the count-rates in UVIT filters using Table 3. Choose those filters for which the count rates are lesser than 1500 in both NUV and FUV

Table 3: Count-rates in FUV (for a magnitude of 18.22) and NUV (for a magnitude of 20.00). This can be used to get the count-rates in any UVIT filters

FUV: GALEX magnitude of 18.22 mag corresponds to the following rates in UVIT		NUV: GALEX magnitude of 20.00 mag corresponds to the following rates in UVIT	
Filter	Count rate	Filter	Count rate
CaF2	1	Silica	1
BaF2	0.85	NUV-B4	0.22
Sapphire	0.63	NUV-B13	0.27
Silica	0.22	NUV-B15	0.074
		NUV-N2	0.055

(III) Choice of FUV/NUV filters (Case 2: Only NUV GALEX images are available)

If only GALEX-NUV images are available for 20' radius (i) Find the magnitude of the brightest source in the GALEX field (in case of point sources) or get the highest rate in any 7 x 7 pixel window (in

case of extended sources), (ii) Get the NUV magnitude (in case of extended sources) using m^{NUV} = -2.5 * log (CPS) + 20.08 (iii) if the derived NUV magnitude (either for point sources or extended sources) is brighter than 15 mag, correct for saturation using the procedures outlines above. After correcting for saturation (if needed) get the FUV (GALEX) magnitude using Rayleigh – Jeans approximation as

$$m^{FUV} = m^{NUV} - 1.65$$

From m^{FUV} and m^{NUV} of GALEX, calculate the expected count-rates for FUV and NUV filters in UVIT using Table 3. Choose that filters that give count rates lesser than 1500 in both NUV and FUV.

(IV) Choice of FUV/NUV filters (Case 3. GALEX images are NOT available)

If the 20' radius is not covered by GALEX NUV images, there is a lot of uncertainty. In case the field lies in any of the bright areas (within ±30 deg. Galactic latitude or LMC or SMC) any exposures in NUV and FUV are not permissible. Alternatively, if the field lies outside the bright areas, the brightest source within 20' radius should be checked in TD1 (http://heasarc.gsfc.nasa.gov/db-perl/W3Browse/w3table.pl?tablehead=name%3Dtd1&Action=More+Options) and the counts calculated for the selected filters, so as to check that the limits are not exceeded. Please note that the absence of source should be taken as presence of a source with a flux of 2 x 10^{-13} erg/sec/cm^2/A, and the count-rate for this flux in various UVIT filters are given in Table 4.

Table 4: Count-rates in UVIT filters for a flux of 2 x 10^{-13} erg/sec/cm^2/A inTD-1

FUV-filters	FUV Count-rate	NUV-filters	NUV count-rates
CaF2-1	74.5	Silica	955
CaF2-2	67.3	NUV-B15	59.6
BaF2	60.0	NUV-B13	275.8
Sapphire	50.0	NUV-B4	218.5
Silica	17.3	NUV-N2	50.6

(IV) Check for scattered light

Check is also required for the scattered light from any ultra bright source outside the field up to a radius of 5 deg. We note that scattered radiation from any planet at a radius > 5 degree is within acceptable limits for all the VIS/NUV/FUV filters. In photon counting mode, the count-rate for any planet or very bright star if it were in the field and observed with the chosen filter should be lesser than that given in Table 5

(V) Choice of Gratings:

For observations with grating,   the following is recommended. NUV grating can be used when the count-rate in NUV Silica is less than 1133. Similarly, FUV gratings can be used when the count-rate in FUV CaF2 is less than 892. This is valid when the full window of 512 x 512 pixels is used.

Table 5: Allowable count-rates for bright stars/planets located at various distances from the field center

Angle	Counts
20'< Source < 30'	10^4 c/sec
0.5 deg < source < 1.0 deg	10^6 c/sec
Source at > 1 deg	$10^6 *\exp((\alpha - 1)/0.834)$ c/sec; alpha is the angle in degrees

In integration mode, the limits are about 20 times larger than this.

Notes:

1. **The above checks are valid only when UVIT is the prime instrument. However, if SXT or LAXPC is the main instrument, there is a need to widen the search radius used in BSWT and GalexView due to the offsets of SXT (0.0721 degree) and LAXPC (0.1156 degree) relative to UVIT. Therefore, if SXT is the prime instrument increase the search radius from 20 arcmin to 25 arcmin, and if LAXPC is the main instrument increase the search radius to 28 arcmin. This facility with varying search radius is now available with the current version of BSWT. Here, user has to choose the Primary Instrument (UVIT,SXT,CZTI,LAXPC). Therefore, users are requested to choose the Primary Instrument while running BSWT.**

2. **Proposers requiring observations in small window sizes are requested to refer to the "AstroSat Proposers Guide" for more details before configuring the instruments**