COS/GALEX Acceptance Testing

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Summary

A detailed acceptance test for use of the GALEX catalog with COS has been performed. There are 7 discrete steps in processing GALEX data, and each of these has successfully passed testing. There are 2 steps in the cross-match process, and 1 of these (matching with a 2" search radius) is not fully functional.

Attachments: GALEX_SP_TYPE.apt, MATCING.apt, gsc2_galex.xls

Introduction

For COS (and later ACS/SBC and the STIS MAMAs), the GALEX catalog will be used as part of bright object checking. The use of this data, which is obtained at wavelengths similar to that of the HST UV detectors, will eliminate some of the error due to extrapolating from the optical to the UV when using the GSC2 data. This document describes the procedure for using GALEX data for COS, and presents the results of acceptance testing for each step. As the GALEX catalog is not yet complete, providing sample test data is not always possible (e.g. if a region with no GALEX coverage is needed, a region that meets those required now may not in the future as the GALEX survey moves towards completion). However, for those cases were the test data is unlikely to change, test data is provided.

There are several different ways to run BOT at this time, depending on which aspect needs to be tested. The four modes available at this time are:

Mode	Command line flag
GSC2 checking only	-P bot.catalog="GSC2"
GALEX checking only	-P bot.catalog="GALEX"
GSC2 and GALEX checking, no cross-match	-P bot.catalog="GSC2,GALEX"
GSC2 and GALEX checking, cross-match	-P bot.catalog="GSC2,GALEX,XMATCH"

The present default for COS is GSC2 and GALEX checking with no cross-matching.
It is sometimes helpful to be able to create targets with defined fluxes to aid in test. This can be done by creating a target whose name begins with BOT-TARGET-GALEX*, where the * is any text. For these targets, the flux information (Fuv, Nuv, FuvErr, and NuvErr) in the Other Fluxes field will be used for processing (and no GALEX search will be performed).

GSC2 Checking Only

This aspect was covered in the COS Acceptance Testing document, and will not be covered here.

GALEX Checking Only

There are seven steps that need to be verified regarding GALEX analysis.

Fall Back to GSC2

For the case where there is no GALEX data, BOT should fall back and use GSC2 data for processing. The object KPD0005+5106 (00^h 08^m 18.4^s, $+51^o$ 23' 19.0") has, at present, no GALEX data. When processed by BOT (with cross-matching turned on), the GSC2 data is used.

3-sigma Cutoff

To eliminate data of questionable validity, only fluxes with $\geq$3-sigma detection are to be used; note that this check is per flux value, not per object (i.e. an object with a 3-sigma NUV flux and a <3-sigma FUV flux will have the NUV flux accepted). The following objects were used to test this capability:

GALEX	FUV	FUV (err)	3-sigma	NUV	NUV (err)	3-sigma	BOT Result
J000030.2-440036	17.5	4.6	Yes	22.5	4.0	Yes	FUV, NUV
J000036.8-435640	13.1	4.2	Yes	8.2	3.1	No	FUV
J000001.8-435846	9.8	3.4	No	14.2	3.9	Yes	NUV
J000042.4-435858	6.1	2.9	No	11.9	4.1	No	No fluxes
J000002.5-434159	No flux			9.6	3.0	Yes	NUV
J235928.1-435049	20.7	4.9	Yes	No flux			FUV

Spectral Type Conversion

A parameter --- fr_{mod} --- was defined to allow the GALEX fluxes to be used to determine a spectral type for the object. The parameter is defined as:

$$fr_{mod} - (FUV_flux + FUV_flux_err)/(NUV_flux - NUV_flux_err)$$

A lookup table is then used to convert the fr_{mod} parameter to a spectral type:

fr_{mod}	Spectral Type	fr_{mod}	Spectral Type

3.455	O5	0.008818	F0
2.360	B1	0.001257	F5
2.255	B5	0.0002975	G2
1.166	A1	0.00002776	G5
0.1131	A5	0.00007745	K0

As with the GSC2 spectral type determination, if fr_{mod} falls between two values, always round up to the bluest type.

The attached proposal GALEX_SP_TYPE can be used to verify that the correct spectral types are being determined; in the proposal, the name of the object gives the correct spectral type, and the alternate name gives the value of fr_{mod}.

Count Rate Determination

After the spectral type is determined, the base count rate (the count rate for the nominal flux (10^{-14}) in the look-up table) is derived. At this time, dummy values are used in the look-up table, which can be determined via the following algorithm:

Item	Value	Counts
Detector	FUV-A	1000
	FUV-B	2000
	NUV	3000
Limit	Global	0
	Local	100
Spectral Type	O	10
	B	20
	A	30
	F	40
	G	50
	K	60
	M	70
Sub-type	0	0
	1	1
	2	2
	4	4
	5	5
Central Wavelength	XXXX	0.XXXX

For example, if you are using the NUV detector and the G185M/2010 grating, the local count rate for an A1 star would be 3000+100+30+1+0.2010=3131.2010.

Several objects, with a variety of spectral types and both detectors, were run through APT, and in each case, the correct base count rate was determined.

Scaling based on True Flux

The base count rates need to be adjusted for the true flux of the object. The scaling is straightforward:

True count rate = Base count rate * (Object flux/Base flux)

Prior to using the GALEX flux values, they must be converted from uJY to standard flux units. This is done via:

$F_{nuv} = 5.69 \times 10^{-18}$ **x** NUV_flux
$F_{fuv} = 1.29 \times 10^{-17}$ **x** FUV_flux.

The objects used in the previous step were used to confirm that the scaling was being properly performed.

For the NUV MIRRORs, the background count rate needs to be added AFTER the scaling for the true flux of the object for the global check. The following dummy values are presently used for the background:

Elemet	Background
MIRROR	25
MIRRORB	50

One of the test objects used both mirrors, and the background was properly included.

Aperture Correction

The look-up table values all assume the standard PSA aperture. For those observations that use the BOA aperture, and aperture correction needs to be applied. The following dummy values are presently used:

Detector	Spectral Element	Factor
FUV	G130M	0.10
FUV	G140L	0.15
FUV	G160M	0.20
NUV	G185M	0.25
NUV	G225M	0.30
NUV	G230L	0.35
NUV	G285M	0.40
NUV	MIRROR	0.45
NUV	MIRRORB	0.50

The objects used in the previous step were used to confirm that the scaling was being properly performed.

Alert Trigger Checks

Once the count rates are determined, they are compared against the alert triggers. This capability was tested as part of the GSC2 acceptance test.

GSC2/GALEX Cross-matching

For each object, both the GSC2 and GALEX catalogs are searched for objects. A cross-matching is then performed to link objects between the two catalogs.

Match Limit (2") Check

When performing the cross-matching, a limit of 2 arc-seconds in positional difference is allowed. The proposal MATCHING.apt (which has a parallel COS exposure to get a large number of GALEX sources) was used. The proposal was first processed by BOT using the bot.catalog="GSC2,GALEX" option, to produce all the GSC2 and GALEX objects in the field. A hand matching was then performed to determine which objects should be matched --- a total of 30 objects were matched. The proposal was then processed with the XMATCH option selected to have BOT perform cross-matching, and a total of 19 objects were matched. Of the 11 objects that should have been matched but weren't, 5 were due to multiple GALEX objects were matched to the same GSC2 object (the tool only supports one GALEX match with any GSC2 object). The remaining 6 missed matches are currently unexplained (see OPR 57165). The total object list, as well as the matching results, can be seen in the spreadsheet gsc2_galex.xls.

GALEX Type Takes Precedence

For those cases where there is a match, the processing should proceed with the GALEX information. For all cases in the above test case, where a GALEX type was determined (in some cases the GALEX fluxes were <3 sigma and were rejected), BOT did use it for further processing instead of the GSC2 information.