GALEX IMAGING MODE QUALITY ASSURANCE
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1. INTRODUCTION

Quality assurance (QA) of GALEX imaging data products is performed independently of the data processing pipeline and evaluates both individual imaging observations ('visits' or 'subvisits') and coadded imaging products ('mains' or 'coadds').

For visits, the QA process determines whether or not the data 1) falls within the established QA limits (grade = PASS/FAIL) and, 2) should be included in any coadded products (coadd = YES/NO). A passing QA grade is necessary but not sufficient for inclusion in coadded products[1]. An separate QA grade is determined for coadded products.

General users of GALEX data will find the QA grade alone to be adequate for judging quality in most cases. However, while only data with a passing QA grade are allowed in official public data releases (e.g. GR2), all Guest Investigator (GI) observations – regardless of quality – are released to the principal investigators, which become available to the public after the proprietary period expires. In this case, details about the QA process, flags, and comments provided in this document are valuable for accessing data quality.

2. GENERAL DESCRIPTION OF IMAGING QA PROCESS

QA is performed in 4 stages. All observations are subject to the first two stages. The last two stages are relevant to coadded products.

- **Stage 1**: Automated checks are performed and one of three possible QA grades (PASS, FAIL, or UNKNOWN) and one of two possible coadd status levels (YES/NO) are recomended. The meaning of each grade/coadd combination is:

  PASS/YES or NO: Data has passed all automated QA checks. If the FOV center is within $3'$ of the planned position the coadd status is set to YES otherwise NO.

  FAIL/NO: Data has failed some critical component of the automated QA checks and is NOT recommended for inclusion in coadded products. QA flags provide the details needed to assess why the data has failed the QA process.

  UNKNOWN/NO: Automated QA checks are not able to determine the quality of the data to a level that warrants a PASS or FAIL grade and is therefore NOT recommended for inclusion in

[1]The most common reasons for this is that the field of view (FOV) is offset by more than 3 arcminutes or a bright transit occured during an observations that is otherwise acceptable.

coadded products. Flags provide detail about potential concerns. Further manual inspection is required.

- **Stage 2**: Manual inspections by a QA analyst are performed using the QATool application and are designed to accomplish four things: 1) resolve the status of data which receives an automated grade of UNKNOWN, 2) independently confirm or override the automated PASS/FAIL grade and coadd recommendation, 3) provide comments about strong artifacts, unusual features or noteworthy objects, and 4) on rare occasions, make suggestions for reprocessing the data in order to improve it.

- **Stage 3**: Coadded products are built for data sets that have a visit coadd status of YES. Automated QA checks are performed on the coadds to determine a PASS/FAIL/UNKNOWN grade recommendation.

- **Stage 4**: Manual inspections of the coadds to resolve automated UNKNOWN grades and confirm or override automated PASS/FAIL grades.

3. THE QA REPORT

3.1. QA Report Content

The QA report provides a concise summary of the status of each visit or coadded product (see Figure 1 for example reports). The last line of the header is a list of report columns. The columns are ‘ | ’ delimited and are described below.

1. **ECLIPSE** – Mission eclipse reference number for visit. Set to ‘MAIN’ for coadded products.

2. **FIELD** – Target name with visit number and sub-visit number appended as appropriate.

3. **FEXPTIME** – Recovered FUV exposure time (seconds). Set to −1 if the FUV intensity map does not exist.

4. **NHVNOMF** – Time FUV detector is at nominal high voltage (maximum possible FUV exposure time; seconds).

5. **NEXPTIME** – Recovered NUV exposure time (seconds). Set to −1 if the NUV intensity map does not exist.

6. **NHVNOMN** – Time NUV detector is at nominal high voltage (maximum possible NUV exposure time; seconds).

7. **RA** – Planned right ascention of FOV center (J2000 decimal degrees).

8. **DEC** – Panned declination of FOV center (J2000 decimal degrees).

9. **GRELEASE** – Pipeline version.

10. **GRADE** – QA grade (PASS/FAIL/UNKNOWN).

11. **COADD** – Coadd status of visit (YES/NO). Set to NA for coadded products.

12. **FLAGS** – String of auto generated QA flags (all capitals, space separated).

13. **#<ANALYST> MANUAL FLAGS #COMMENTS** – String containing analyst id in brackets, manual inspection flags (space separated), and freeform comments (begins with). If there is no analyst id, then no manual inspection has occurred.

3.2. Example QA report

Figure 1 is an example QA report for visits (top) and coadded products (bottom). Of most interest are those visits that have a FAIL grade or a coadd status of NO, so we review those in detail. (For reference, Appendix A provides a concise table of all possible QA flags, their meanings, and effect on the the QA grade and coaddd status. Detailed descriptions of the flags appear in § 5, 6, and 7.)

In the example visit QA report, two visits have FAIL grades – eclipse 11003 and 12666.

The automated flags for eclipse 11003 indicate that the observation has no FUV data (NUV_ONLY; § 5.6), the recovered time is less than 80% of the observation time (TIME_RECOVERY_LOW; § 5.6), and the NUV PSF[2] is suspect (NUV_PSF_BAD; § 5.4). None of the afore mentioned are sufficient to automatically FAIL the visit. However, the fact that the exposure time is less than 30 seconds (TIME_BELOW_MIN; § 5.6) is sufficient to automatically FAIL the visit because the quality of such short exposures are impossible to assess with any confidence. The coadd status is NO because of the FAIL grade.

Unlike eclipse 11003, eclipse 12666 has sufficient exposure time but suffers from other problems. The plate solution has revealed that the astrometry is off by more than $0.75''$ (ASTROMETRY_SHIFT; § 5.1), the NUV PSF is suspect (NUV_PSF_BAD; § 5.4), the aspect solution may be problematic (ASP_ERRSTDEV and ASP_ERRDIFF; § 5.5), and the FOV center is offset by more than $3'$ from the planned position (OFFSET_NOCOADD; § 5.2). In this case, the poor astrometric solution automatically causes the FAIL grade. The manual inspection confirms that the aspect solution is also bad (Asp_Bad_Image; § 6). Thus, had the astrometry been within limits the data would still receive a FAIL grade.

In the example visit QA report five visits have PASS grades but also a coadd status of NO – eclispes 8712, 10871, 10874, 12332, and 8630.

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[2]Due to improvements in the image reconstruction software, most PSF warning flags are now erroneous (§ 5.4).

```
# EXAMPLE VISIT QA REPORT
# Sat Jul 15 00:05:37 2006
# ECLIPSE | FIELD | FEXPTIME | NHVNOMF | NEXPTIME | NHVNOMN | RA | DEC | GRELEASE | GRADE | COADD | FLAGS | #<ANALYST> MANUAL FLAGS #COMMENTS
12677 | GI1_004001_A2734_0002 |    -1.00 |    -1.00 |  1414.00 |  1418.00 |   2.8436 | -28.8463 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<treyer>  #
12799 | GI1_004001_A2734_0003 |    -1.00 |    -1.00 |   990.80 |  1507.00 |   2.8390 | -28.8455 | ops-v5_1_0 | PASS | YES | ASP_ERRSTDEV ASP_ERRDIFF NUV_ONLY TIME_RECOVERY_LOW OVERRIDE_UNK_PASS OVERRIDE_COADD_N | #<wyder> ASP_Ok #
12802 | GI1_004001_A2734_0004 |    55.00 |   130.00 |  1130.20 |  1556.00 |   2.8345 | -28.8477 | ops-v5_1_1 | PASS | YES | ASP_ERRSTDEV ASP_ERRDIFF TIME_RECOVERY_LOW OVERRIDE_UNK_PASS OVERRIDE_COADD_N          | #<clare> ASP_Ok #
 8312 | GI1_004002_A0262_0001 |  1698.05 |  1707.00 |  1698.05 |  1702.00 |  28.2101 |  36.1444 | ops-v5_1_0 | PASS | YES |                                                                                       | #<tab>  #
 8590 | GI1_004003_A3104_0001 |  1588.00 |  1597.00 |  1588.00 |  1592.00 |  48.5829 | -45.4319 | ops-v5_1_0 | PASS | YES |                                                                                       | #<tim>  #
 8697 | GI1_004004_A3266_0001 |   530.00 |   541.00 |   530.00 |   536.00 |  67.8812 | -61.4318 | ops-v5_1_0 | PASS | YES |                                                                                       | #<tab>  #
 8698 | GI1_004004_A3266_0002 |   911.00 |   923.00 |   911.00 |   917.00 |  67.8109 | -61.4297 | ops-v5_1_0 | PASS | YES |                                                                                       | #<wyder>  #
 8712 | GI1_004005_A0548_0001 |   441.00 |   588.00 |   441.00 |   582.00 |  86.5349 | -25.7051 | ops-v5_1_0 | PASS | NO  | TIME_RECOVERY_LOW OFFSET_NOCOADD                                                      | #<rhee> Diff_Reflection #
 8714 | GI1_004005_A0548_0002 |  1103.00 |  1112.00 |  1103.00 |  1107.00 |  86.6686 | -25.6219 | ops-v5_1_0 | PASS | YES |                                                                                       | #<tab> Diff_Refl_Movie #
 8885 | GI1_004005_A0548_0003 |    -1.00 |    -1.00 |   564.00 |   568.00 |  86.6600 | -25.6353 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<tas> Diff_Refl_Movie #
 8886 | GI1_004005_A0548_0004 |    -1.00 |    -1.00 |   412.00 |   416.00 |  86.6620 | -25.6192 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<rhee> Diff_Refl_Movie #
 8892 | GI1_004005_A0548_0005 |    -1.00 |    -1.00 |    74.00 |    78.00 |  86.6558 | -25.6368 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<min> Diff_Refl_Movie #
 8893 | GI1_004005_A0548_0006 |    -1.00 |    -1.00 |  1090.00 |  1094.00 |  86.6624 | -25.6217 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<clare>  #
 8715 | GI1_004006_A3376_0001 |  1100.00 |  1109.00 |  1100.00 |  1104.00 |  90.4095 | -39.9973 | ops-v5_1_0 | PASS | YES |                                                                                       | #<wyder>  #
 8716 | GI1_004006_A3376_0002 |  1076.05 |  1106.00 |  1076.05 |  1100.00 |  90.4282 | -39.9887 | ops-v5_1_0 | PASS | YES | ASP_ERRSTDEV ASP_ERRDIFF OVERRIDE_UNK_PASS OVERRIDE_COADD_N                           | #<suvi> ASP_Ok #
10158 | GI1_004007_A3389_0002 |    -1.00 |    -1.00 |   976.00 |   982.00 |  95.4618 | -64.9291 | ops-v5_1_0 | PASS | YES | NUV_PSF_BAD NUV_ONLY OVERRIDE_UNK_PASS OVERRIDE_COADD_N                               | #<rhee> Diff_Refl_Movie NUV_PSF_Ok #
10871 | GI1_004008_A1644_0001 |    -1.00 |    -1.00 |   128.00 |   134.00 | 194.1954 | -17.3417 | ops-v5_1_0 | PASS | NO  | NUV_ONLY OFFSET_NOCOADD                                                               | #<min> Diff_Refl_Movie #
10874 | GI1_004008_A1644_0002 |    -1.00 |    -1.00 |  1163.00 |  1194.00 | 194.1852 | -17.3223 | ops-v5_1_0 | PASS | NO  | ASP_ERRSTDEV ASP_ERRDIFF NUV_ONLY OFFSET_NOCOADD OVERRIDE_UNK_PASS                    | #<clare> ASP_Ok #
10901 | GI1_004010_A3556_0001 |    -1.00 |    -1.00 |   325.00 |   332.00 | 201.3635 | -31.5939 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<rhee>  #
10904 | GI1_004010_A3556_0002 |    -1.00 |    -1.00 |  1480.00 |  1486.00 | 201.3405 | -31.5829 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<treyer>  #
10924 | GI1_004011_A3558_0001 |    -1.00 |    -1.00 |  1676.00 |  1680.00 | 201.9661 | -31.5139 | ops-v5_1_0 | PASS | YES | ASP_ERRSTDEV ASP_ERRDIFF NUV_ONLY OVERRIDE_UNK_PASS OVERRIDE_COADD_N                  | #<treyer> ASP_Ok #
10971 | GI1_004012_A3560_0001 |    -1.00 |    -1.00 |   142.00 |   146.00 | 203.0961 | -33.1318 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<treyer>  #
11380 | GI1_004016_A1991_0001 |    -1.00 |    -1.00 |   967.00 |   970.00 | 223.6105 |  18.6157 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<suvi>  #
11003 | GI1_004017_A2147_0001 |    -1.00 |    -1.00 |     9.00 |    20.00 | 240.5439 |  15.9577 | ops-v5_1_0 | FAIL | NO  | NUV_PSF_BAD NUV_ONLY TIME_BELOW_MIN TIME_RECOVERY_LOW                                 | #<friedman>  #The NUV_PSF_BAD may be a bad measurement due to low exposure time.
 7143 | GI1_004020_A3716_0001 |  1672.05 |  1701.00 |  1672.05 |  1696.00 | 313.0276 | -52.7806 | ops-v5_1_0 | PASS | YES | ASP_ERRSTDEV ASP_ERRDIFF OVERRIDE_UNK_PASS OVERRIDE_COADD_N                           | #<tas> ASP_Ok #
11722 | GI1_004020_A3716_0002 |    -1.00 |    -1.00 |  1507.00 |  1518.00 | 312.9793 | -52.7746 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<min>  #
12332 | GI1_004020_A3716_0003 |    -1.00 |    -1.00 |    43.00 |    79.00 | 312.9805 | -52.5957 | ops-v5_1_0 | PASS | NO  | NUV_ONLY TIME_RECOVERY_LOW OFFSET_NOCOADD                                             | #<rhee>  #
12633 | GI1_004021_A2399_0004 |    -1.00 |    -1.00 |  1322.05 |  1326.00 | 329.3360 |  -7.8127 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<tas>  #
 7797 | GI1_004022_A2589_0001 |   848.05 |   857.00 |   848.05 |   852.00 | 350.9652 |  16.7707 | ops-v5_1_0 | PASS | YES | FUV_PSF_WARNING                                                                       | #<rhee>  #
12298 | GI1_004022_A2589_0002 |   101.00 |   102.00 |  1700.05 |  1704.00 | 350.9882 |  16.7840 | ops-v5_1_0 | PASS | YES | FUV_PSF_WARNING                                                                       | #<suvi>  #
12299 | GI1_004022_A2589_0003 |   101.00 |   102.00 |  1704.00 |  1707.00 | 350.9897 |  16.7873 | ops-v5_1_0 | PASS | YES | FUV_PSF_WARNING                                                                       | #<min>  #
12666 | GI1_004023_A4059_0002 |    -1.00 |    -1.00 |   724.00 |   754.00 | 358.9044 | -34.7804 | ops-v5_1_0 | FAIL | NO  | ASTROMETRY_SHIFT NUV_PSF_BAD ASP_ERRSTDEV ASP_ERRDIFF NUV_ONLY OFFSET_NOCOADD         | #<tim> ASP_Bad_Image #Astrometry is off but PSFs appear to be OK.
12667 | GI1_004023_A4059_0003 |    -1.00 |    -1.00 |   635.00 |   639.00 | 359.2207 | -34.7889 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<tim>  #
10922 | GI1_004025_A3528_0001 |    -1.00 |    -1.00 |  1697.00 |  1701.00 | 193.5005 | -29.2323 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<tas> Diff_Reflection #
10980 | GI1_004026_A2063_0001 |    -1.00 |    -1.00 |  1512.00 |  1515.00 | 230.8561 |   8.5993 | ops-v5_1_0 | PASS | YES | NUV_ONLY                                                                              | #<min>  #
 8630 | GI1_004027_A3158_0001 |  1026.00 |  1456.00 |  1026.00 |  1452.00 |  55.6489 | -53.2440 | ops-v5_1_0 | PASS | NO  | ASP_ERRSTDEV ASP_ERRDIFF TIME_RECOVERY_LOW OFFSET_NOCOADD OVERRIDE_UNK_PASS           | #<clare> ASP_Ok #No blob
```

```
# EXAMPLE COADD QA REPORT
# Mon Jul 17 22:52:58 2006
# ECLIPSE | FIELD | FEXPTIME | NHVNOMF | NEXPTIME | NHVNOMN | RA | DEC | GRELEASE | GRADE | COADD | FLAGS | #<ANALYST> MANUAL FLAGS #COMMENTS
MAIN | GI1_004001_A2734       |    55.00 |   130.00 |  3535.00 |  4481.00 |   2.8354 | -28.8464 | ops-v5_1_1 | PASS | NA  | TIME_RECOVERY_LOW                                                                     | #<clare>  #
MAIN | GI1_004004_A3266       |  1441.00 |  1464.00 |  1441.00 |  1453.00 |  67.8367 | -61.4305 | ops-v5_1_1 | PASS | NA  |                                                                                       | #<clare>  #
MAIN | GI1_004005_A0548       |  1103.00 |  1112.00 |  3243.00 |  3263.00 |  86.6662 | -25.6231 | ops-v5_1_1 | PASS | NA  |                                                                                       | #<tim>  #
MAIN | GI1_004006_A3376       |  2176.05 |  2215.00 |  2176.05 |  2204.00 |  90.4187 | -39.9930 | ops-v5_1_1 | PASS | NA  |                                                                                       | #<tab>  #
MAIN | GI1_004010_A3556       |    -1.00 |    -1.00 |  1805.00 |  1818.00 | 201.3447 | -31.5849 | ops-v5_1_1 | PASS | NA  | NUV_ONLY                                                                              | #<tas>  #
MAIN | GI1_004020_A3716       |  1672.05 |  1701.00 |  3179.05 |  3214.00 | 313.0161 | -52.7792 | ops-v5_1_1 | PASS | NA  |                                                                                       | #<min>  #
MAIN | GI1_004022_A2589       |  1050.05 |  1061.00 |  4252.10 |  4263.00 | 350.9766 |  16.7786 | ops-v5_1_1 | PASS | NA  |                                                                                       | #<friedman>  #
```


Fig. 1.— Examples of a visit (top) and coadd (bottom) QA report.

For all of these visits, the reason the coadd status is set to NO is that the FOV center is offset by more than $3'$ from the planned position (OFFSET_NOCOADD; § 5.2). Eclispes 10874 and 8630 also have aspect solution warnings (ASP_ERRSTDEV and ASP_ERRDIFF; § 5.5) that required manual inspection to resolve. The manual inspections found the aspect solutions to be fine (Asp_Ok; § 6) and thereby overrode the automatic UNKNOWN grade to a PASS grade (OVERRIDE_UNK_PASS; § 6). It is not a coincidence that many of these visits also have the TIME_RECOVERY_LOW flag set. Exposure time is lost finding appropriate stars to trace the aspect solution because the pointing is offset from the planned position.

In the example coadd QA report there is an entry for each field that has more than one visit with a PASS grade and YES coadd status. Coadded products are unlikley to have any significant QA issues given the screening of the visit data for coadd inclusion.

4. USING DATA THAT FAILS QA

4.1. Correctable Data

Data with a failing QA grade may still be of use if the reasons are **limited** to astrometry related problems (ASTROMETRY_SHIFT or ASTROMETRY_ROTATION; § 5.1). The user of the imaging data can correct the astrometry and feel confident that the data are fine. If it is part of a multiply visited target, the corrected data can be included in a user built coadd. Even those without plate solutions (MISSING_PLATE_SOLUTION; § 5.9) could be fine if an astrometric solution is found by the user.

4.2. Uncorrectable Data

The only time that data can, unequivocally, not be used for scientific analysis is if the problems are uncorrectable outside of enhancements to the GALEX direct imaging pipeline. This situation is limited to confirmed image aspect solution errors or cases of sub-nominal detector high voltage operation. Confirmed aspect solution errors will have either the ASP_Bad_Plot or ASP_Bad_Image (§ 5.5, 6.2) flag set in the QA report comments. The HV_LOW (§ 5.3) flag will be set in the QA report in the event of sub-nominal detector high voltage.

5. AUTOMATED QA DESCRIPTION

The following describes the specific checks performed by the automated QA and the meaning of all flags. Not all files mentioned are available as part of public or guest investigator data releases. To shorten file name descriptions the field name (target/visit/sub-visit) portion is represented as 'X'.

For a single observations, the automated QA checks that the data are within acceptable limits of astrometry, FOV center, detector high voltage settings, point spread function, aspect solution, exposure time, pipeline version, FUV window charging (blob), and that requisite files are present.

For coadded products, the automated QA checks that the data are within acceptable limits for astrometry, point spread function, exposure time, pipeline version, and that the requisite files are present. Additionally, coadd-specific checks confirm that the product includes all visits and only visits that have been deemed acceptabled for coadding, each visit is built with the appropriate pipeline version, and the exposure time is consistent with the sum of the exposure time of the visits approved for coaddition.

5.1. Astrometry

Plate solutions are computed independently of the astrometric solution in order to test the quality of the astrometry. This is done by matching pipeline source catalog objects to stars selected from a subset of the ACT, SAO, and USNOA star catalogs. A minimum of 6 stars within a match radius of $4''$ are required to compute the plate solution. Therefore, if our astrometry is off by more than $4''$ no plate solution is generated and the data will receive a FAIL QA grade with the MISSING_PLATE_SOLUTION flag set. The data, however, may be fine other than the astrometric error.

If a plate solution has been successfully derived (X-nd-cat_mch_rtastar_stats.txt), the shift and rotation are evaluated. If the offset from the combined x/yshift is greater than $0.75''$ (0.5 pixel) the flag ASTROMETRY_SHIFT is set. If the absolute rotation angle is greater than $0.02°$ (corresponding to an offset of 0.5 pixel at $0.6°$ from center) the flag ASTROMETRY_ROTATION is set. Either condition is sufficient to generate a FAIL grade.

In the event that fewer than 15 stars are matched when deriving the plate solution, the PLATE_SOL_MATCHES_LOW flag is set. If no stars are matched the PLATE_SOL_NO_MATCHES flag is set. Both are purely informational and do not effect the QA grade.

5.2. Field of View Offset

Image products are constructed from photon lists around the **planned** FOV center. The actual FOV center may be offset from the planned center. Typically the offset is less than an arc-minute. If the observation is offset by more than $3'$, the OFFSET_NOCOADD flag is set and the data is excluded from any coadded products (by setting the coadd status to NO) to ensure that edge artifacts do not contaminate the interior region of properly centered observations. Should the FOV center be offset by $48'$ or more, the OFFSET_FAIL flag is set, the QA grade is changed to FAIL, and the coadd status defaults to NO. Figures 2 and 5 show examples of observations with offset problems.

5.3. Detector High Voltage

During an early phase of the mission several observations (eclipses 643 to 749) were performed with the high voltage of the detectors set below the nominal operating level. Proper use of this data would require a special and unique calibration which is unlikely to occur in the foreseeable future. Visits with eclipse numbers that fall in the range of 643 to 749 set the flag HV_LOW and is sufficient to generate a FAIL grade. This is not directly applicable to coadded data products.

5.4. Point Spread Function

Although the GALEX PSF is neither Gaussian nor uniform, an attempt is made to estimate the FWHM of point sources in a way that catches many PSF-related problems.

Note: Most PSF warning flags for data processed with pipeline version v5 and above are erroneous. The quality of the aspect solution has been greatly improved thereby making the PSF warning flags of little utility.

In theory, because the same aspect solution is applied to both the NUV and FUV (obtained simultaneously), if the PSF in one band is within acceptable limits the other should also be within limits. The PSF measurements are sensitive to background estimates and crowding.

Furthermore, because the SNR in the FUV detector is always lower than that of the NUV detector the FUV PSF measurements are less reliable than the NUV PSF measurements. The FUV PSF is only considered if the observation is FUV only (has no simultaneous NUV data).

The estimators are derived from the pipeline X-[f/n]d-psf_stats.txt output. Specifically, the average value for fitFWHM and the moments FWHM(A) and FWHM(B) for a limited sample of likely point sources within the central 1200 pixel radius at all detector position angles are inspected.

The ratio of FWHM(A)/FWHM(B) is a good indicator of how elongated the PSF is. While large values of fitFWHM are also indicative of problems with image construction. The following empirically derived conditions find the vast majority of problematic fields independent of aspect solution (the source of PSF quality) checks.

For NUV images: If FWHM(A)/FWHM(B) > 1.2 or fitFWHM $\geq 8''$ then the flag NUV_PSF_BAD is set. If FWHM(A)/FWHM(B) ≤ 1.2 and fitFWHM $> 5.7''$ then the flag NUV_PSF_WARNING is set.

For FUV images: If FWHM(A)/FWHM(B) > 1.13 or fitFWHM $\geq 8''$ then the flag FUV_PSF_BAD is set. If FWHM(A)/FWHM(B) ≤ 1.13 and fitFWHM $> 5.7''$ then the flag FUV_PSF_WARNING is set.

Because the central 1200 pixel radius is also the likely location of pointed observations of large galaxies, the afore mentioned issue of background levels and crowding can cause spuriously large PSF measurements especially in the FUV (i.e. M31). Therefore, if the NUV PSF is within acceptable limits but the FUV PSF fails, the FUV PSF flag is changed to a warning. PSF_BAD is not sufficient to generate a FAIL grade. If no other critical flag is set it will generate an UNKNOWN grade. A PSF_WARNING has no effect on the QA grade.

In the event that the pipeline fails to measure a PSF (most likely due to the inability to locate sufficient point sources) the F/NUV_PSF_UNKNOWN flag is set and the grade will remain UNKNOWN.

5.5. Aspect Solution

GALEX executes a spiral dither pattern of order 1 arcminute during observations. One of the more challenging tasks performed by the pipeline is to create images from the raw time and detector position tagged photons lists. The accuracy of the aspect solution derived from the spacecraft reported pointing information is often not accurate enough to generate images with the desired PSF quality and astrometric solution. The pipeline component *deltaphot* attempts to refine the pointing knowledge. The basic function is to locate known stellar sources in the field of view, track the true dither pattern, and generate accurate aspect and astrometric solutions.

Deltaphot is robust and performs optimally for the vast majority of observations, however, difficulty can arise when the spacecraft's pointing knowledge error exceeds expected tolerances of spacecraft motion, position or roll. If *deltaphot* is unable to accurately track the stellar sources (looses lock), that portion of time is rejected and the recovered exposure time is reduced. The limiting case occurs when *deltaphot* is unable to match any stars and no aspect solution is possible. The ability to compensate for these effects is the primary factor in producing instrument limited PSFs, recovering the full exposure time and accurate astrometry.

The automated QA aspect checks are designed to flag observations where *deltaphot* may have made an erroneous aspect solution. Problems can range from the subtle - tracking errors that increase the PSF or false stellar source matches that lead to incorrect astrometry; to the dramatic - oscillating lock between multiple stars (due to drifting) resulting in images with duplicate, offset sources. See Figure 2 for example images with aspect solution errors. **With the advent of pipeline v5, aspect solution errors occur very rarely**.

WARNING: Since guest investigators will obtain all program data regardless of quality assessment, they must take QA aspect flags seriously and examine images with great care before using the data. A QA analyst has provided their opinion in the comments section of the QA report about any field with aspect warning flags set. Nonetheless, GIs should examine all images, whether flagged with aspect warnings or not, before using the data. Despite best efforts, data with errors may escape detection.

Using the *deltaphot* pipeline statistics file (X-asp_stats.txt), the automated QA will flag aspect solutions where the difference between the *deltaphot* solution and spacecraft reported solution is large enough to potentially cause problems for *deltaphot*. Specifically, two conditions are considered. 1) If the difference between the minimum and maximum offset between the *deltaphot* and spacecraft reported RA (errx) or DEC (erry) exceeds $50''$ the flag ASP_ERRDIFF is set. 2) If the standard deviation of the offset between the *deltaphot* and spacecraft reported RA (errx) or DEC (erry) exceeds $15''$ the flag ASP_ERRSTDEV is set.

As this check will flag possible but not certain *deltaphot* related errors (most flagged observations are fine), either condition will prevent a PASS grade but not cause a FAIL. If no other critical flags are set the resulting grade will be UNKNOWN and manual inspection is required.

Due to the wide functionality of the *deltaphot* program, aspect, PSF and astrometry errors often occur simultaneously. Aspect solutions are applicable to visit level data only. The QA process excludes any visit with aspect solution problems from coadded products.

5.6. Exposure Time

The exposure times recorded in the headers of the end product intensity maps (X-[f/n]d-int.fit) are inspected. If the FUV **and** NUV exposure times are zero or can not be retrieved a NO_DATA flag is set. If the FUV **or** NUV exposure times are zero or can not be retrieved a NUV_ONLY or FUV_ONLY flag is set respectively. These flags are independent of the planned observation type and detector operating status. Automated QA does not verify if the observation was planned as F/NUV-only. A NO_DATA flag will generate a FAIL grade.

If the exposure time for either band is less than a release-dependent minimum (typically 30 seconds) the flag TIME_BELOW_MIN is set and a FAIL grade is generated. Such low exposure times suggest *deltaphot* or pointing related problems.

The warning flag TIME_RECOVERY_LOW is set when the recovered exposure time is less than 80% of the time the detector was operating at the nominal high voltage setting (the maximum possible exposure time). When the recovered exposure time falls below this level *deltaphot* has likely had some difficulty computing the aspect solution. It does not mean that there are any problems with the time it has recovered - just that more than 20% of the observation time was not recoverable.

5.7. Pipeline Version

The GALEX data processing pipeline has been prone to rapid improvements. Therefore, automated QA confirms that the pipeline version under which the data product was built is at the level designated (or higher) for the specific data release. The version is read from the header of the intensity maps. If the pipeline version is lower than expected, the GRELEASE_LOW flag is set and the QA grade is set to FAIL.

5.8. FUV Window Charging/Blob

For reasons that are still not fully understood, a small area on the edge of the FUV detector window can accumulate charge anomalously. As the charge builds up, field emission can trigger the FUV microchannel plate directly beneath it. When the charge is strong, the field emission can be detected above the background levels in FUV images. This is commonly referred to as the blob. The blob is rigorously tracked in every observation by comparing the detector high pulse height count rate to total count rate in the affected region. It behaves in a reasonably predictable manner. Space weather events, however, can cause rapid changes. When the count rate from the blob begins to exceed manageable background levels the FUV detector is turned off and the window is allowed to discharge.

FUV window charging always occurs at the same location on the FUV **detector**; however, because the imaging products are always oriented North-up East-left, the blob can appear anywhere along the FOV edge due to the spacecraft roll angle.

Automated QA queries the mission operations trending database for the blob tracking values. If the ratio of high pulse height count rate to total count rate (hiq_blob_cr/blob_cr) in the region is ≥ 0.2 the BLOB_RATIO_HI flag is set and the blob is likely to be easily visible in the FUV data. If the ratio is between 0.1 and 0.2 the BLOB_RATIO_MEDIUM flag is set and the blob may be detectable depending on the background levels in the FOV. If the ratio is between 0.013 and 0.1 the BLOB_RATIO_LOW flag is set, however it is unlikely to be easily distinguishable from the background.

If the trending database does not contain the appropriate count rate statistics a NO_BLOB_INFO flag is set and the grade remains UNKNOWN. This can occur for some early mission data observed before the first FUV window charging event and prior to blob region count rate tracking.

Any BLOB flag is sufficient to prevent a PASS grade (remain UNKNOWN). Manual inspection by a QA analyst will determine if the data is acceptable for PASS. Figure 3 is an example of LOW, MED, and HIGH BLOB_RATIO flagged data.

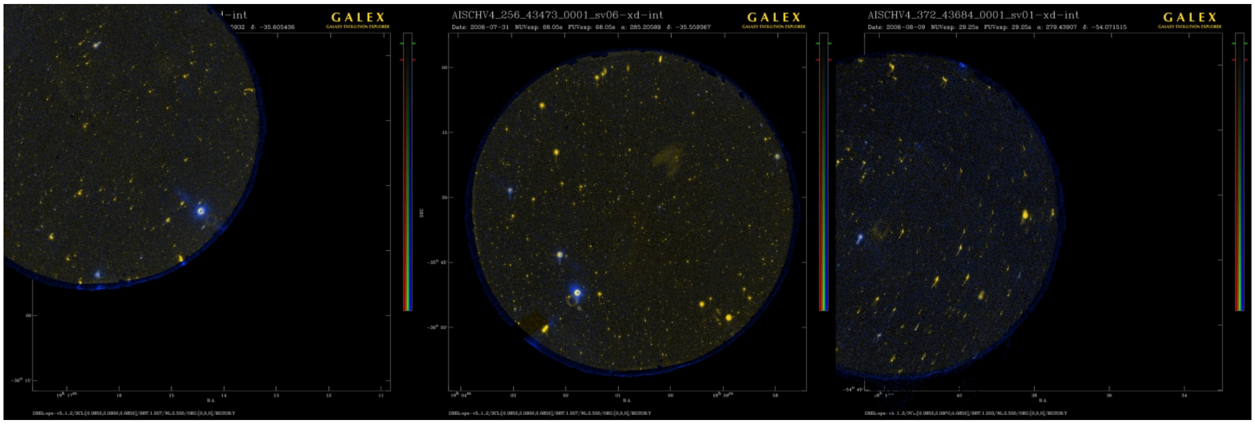

Fig. 2.— Examples of a poor quality aspect solutions. Note the ‘motion’ trails associated with the bright point sources. The examples on the left and right also exhibit large offsets from the planned FOV center.

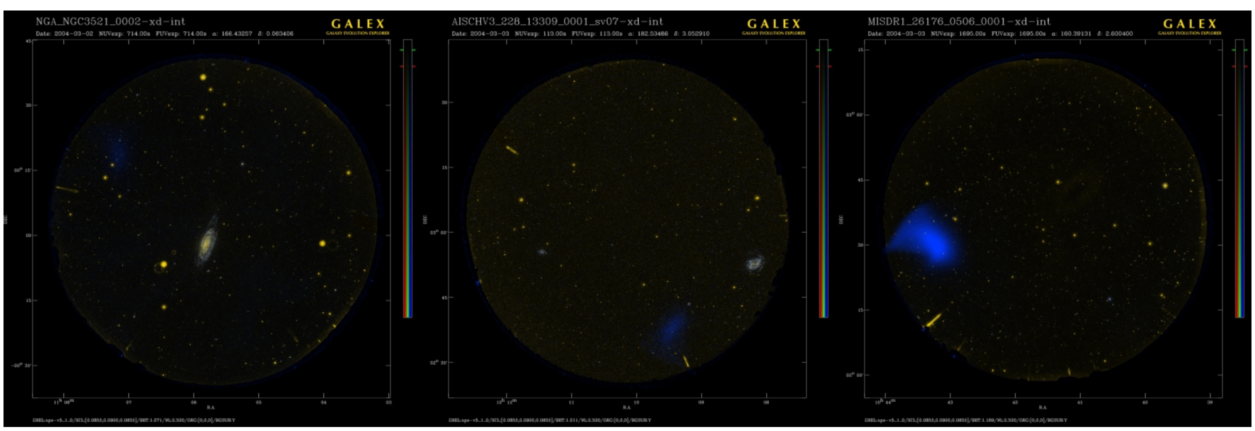

Fig. 3.— Examples of FUV window charging (the blob). In standard North-up East-left projected data, the blob can appear anywhere along the FOV edge depending on the spacecraft roll angle. In these examples the BLOB_RATIO_LOW (left), BLOB_RATIO_MED (middle), and BLOB_RATIO_HI (right) flag is set.

5.9. Requisite Files

Automated QA checks for the existence of four band-specific and five band-independent critical files in the pipeline directory. Other than a flag for a missing plate solution, most missing file issues are resolved by reprocessing and are unlikely to be seen for data made available to guest investigators or the public.

Flags for all missing files are suppressed if the NO_DATA flag is set. Flags for FUV or NUV band-specific files are suppressed if the NUV_ONLY or FUV_ONLY flags are set respectively.

The following band-specific files must exist: intensity maps (X-[f/n]d-int.fit*), high resolution response maps (X-[f/n]d-rrhr.fit*), background maps (X-[f/n]d-skybg.fit*), and PSF measurements (X-[f/n]d-psf_stats.txt). Non-existence will set the MISSING_[F/N]NUV_INT, MISSING_[F/N]UV_RRHR, MISSING_[F/N]UV_SKYBG, and MISSING_[F/N]UV_PSFSTATS flags respectively. Any of these flags is sufficient to generate a FAIL QA grade.

The intensity maps must also be compressed otherwise the [F/N]UV_INT_NOT_COMPRESSED flag is set and a QA grade of UNKNOWN will persist.

The following band-independent files must exist: aspect solution status file (X-asp_stats.txt), plate solution (X-*-cat_mch_rtastar_stats.txt), merged band source catalog (X-xd-mcat.fits), summary statistics file (X-sumstats.txt), and jpeg image of the data (X-xd-int_2color.jpg). Non-existence will set the MISSING_ASP_STATS, MISSING_PLATE_SOLUTION, MISSING_MCAT, MISSING_SUMSTATS, and MISSING_COLOR_JPEG flags respectively. Any of these flags is sufficient to generate a FAIL QA grade.

Note that aspect solutions are not applicable to coadded data.

5.10. Coadds/Mains

Once the visit level data has been through the automated and manual QA inspection process, coadds (mains) are built for those targets with multiple visits.

The same automated QA checks are performed on coadded data products as are done for single visits except the non-applicable checks for sub-nominal high voltage settings, blob presence, and aspect solution issues which are only possible to perform at the visit level.

In addition to the visit level checks, coadd specific checks confirm that the product includes all visits and only visits with an approved QA coadd status, each visit is built with the appropriate pipeline version, and the exposure time is consistent with the sum of the exposure time of the visits with an approved QA coadd status.

These checks are accomplished by comparing the expected visits eclipse numbers, exposure times and pipeline versions in the final visit QA report for a given target to the visit eclipse numbers, visit pipeline version and total exposure time in the header of the coadd intensity maps.

If an approved visit is missing from a coadd a MISSING_VISIT_[F/N]UV_# flag is set where # is the 4 digit visit number. If an unapproved visit is included in the coadd a BAD_VISIT_[F/N]UV_# flag is set. Similarly the BAD_VISIT_[F/N]UV_ECLIPSE_# is set when unapproved eclipse number are included. An UNEXPECTED_VISIT_[F/N]UV_# flag indicates that a visit whose grade and coadd status has not been established is included in the coadd. A MISSING or BAD or UNEXPECTED flag will generate a FAIL QA grade.

If the exposure time of the coadd is greater or less than the total expected from the approved visits then a TIME_GAIN_[F/N]UV or TIME_LOSS_[F/N]UV flag is set respectively. A TIME_GAIN or TIME_LOSS flag will generate a FAIL QA grade.

If the pipeline version number for an included visit is missing from the coadd header a VISIT_[F/N]UV_GRELEASE_MISSING_# flag is set for informational purposes and has no effect on the QA grade.

It is unlikely that any of these flags will appear in a released coadd QA report because they will have been resolved before the data is released.

It is possible to perform automated QA on coadded data without prior knowledge of the QA grade of the constituent visits. In this case a NO_VISIT_CHK flag is set.

5.11. Automated Grades

A FAIL grade will result from any of the following flags: ASTROMETRY_SHIFT, ASTROMETRY_ROTATION, OFFSET_FAIL, TIME_BELOW_MIN, MISSING_ASP_STATS, HV_LOW, MISSING_[file], GRELEASE_LOW or NO_DATA. For coadded data a FAIL will also occur if a MISSING_VISIT_#, BAD_VISIT_#, UNEXPECTED_VISIT, or TIME_[LOSS/GAIN]_[F/N]UV flag is set.

Provided none of the above strict FAIL flags are set, an UNKNOWN grade will persist if a [F/N]UV_PSF_BAD, [F/N]UV_PSF_UNKNOWN, ASP_ERR[*], or BLOB_RATIO_[*] flag is set.

If none of the strict FAIL or UNKNOWN persisting flags are set then the automated QA grade will be PASS.

6. MANUAL QA INSPECTION

Manual inspection by a QA analyst is needed to confirm the automated grade or resolve an UNKNOWN grade into a PASS or FAIL grade. In order to resolve an UNKNOWN grade that analyst must address the reason why the automated QA assigned the UNKNOWN grade.

An analyst may override **any** automated QA grade or coadd status. QATool is the application designed to facilitate this process. It allows analysts to quickly inspect the relevant data and auxiliary pipeline products.

6.1. Grade and Coadd Status Overrides

If an analyst changes the automated QA grade an OVERRIDE_[PASS/FAIL] flag is set depending on whether the automated QA grade was PASS or FAIL. When automated UNKNOWN grades are resolved the corresponding flag also indicates the final resolved grade (e.g. OVERRIDE_UNK_[PASS/FAIL]). Likewise the coadd status may be modified by a analyst and the OVERRIDE_COADD_[Y/N] flag will be set.

6.2. Manual Flags

When an analyst manually inspects data to resolve an UNKNOWN QA grade, the specific reason the automated QA assigned the UNKNOWN grade must be addressed. The most common reason for an UNKNOWN grade are concerns about the aspect solution (§ 5.5), the PSF (§ 5.4), or FUV window charging (Blob, § 5.8).

To resolve concerns about the aspect solution, the analyst will inspect the boresite tracking plot for discontinuities and/or irregular motion, inspect the fits and/or jpeg representations of the image data for signs of blurring, streaking, duplication etc., and inspect the low resolution time-series 'movie' of the data to watch the FOV movement/dither over the course of the observation.

If the aspect solution is deemed good the manual flag ASP_Ok is added and the grade is set to PASS. If the boresite plot shows irregular motion and the corresponding problematic behavior is is seen in the 'movie', the flag ASP_Bad_Plot is added and the grade is set to FAIL. If the aspect solution problems are severe enough to be detected with a visual inspection of the image, the ASP_Bad_Image flag is added and the grade is set to FAIL.

As mentioned in § 5.4, most automated PSF warnings are erroneous. To resolve concerns about the PSF, analysts are only required to perform a visual inspection of the image data intensity maps. At their discretion they may inspect the pipeline generated PSF fits image or measure the PSF independently. If the analyst determines that the PSF is acceptable, the manual flag [F/N]UV_PSF_Ok is set.

To resolve concerns about the presence of FUV window charging (Blob) the diagnostic plots for Blob activity (high pulse height count rate images in the region of the FUV detector where the blob occurs) as well as the fits and jpeg representations of the image data are inspected. If the analyst determines the Blob is present the Blob manual flag is set. If the analyst determines that the automated BLOB_RATIO_[*] flag is erroneous then the data will be passed (no comment is required).

Analysts have the ability to disregard the automated QA field of view offset check and manually flag data for a large offset and set the coadd status to NO using the Offset_FOV flag.

6.3. Manual Comments

Analysts may, depending on work load, provide comments about diffuse reflections that appear in the central regions of the field of view (Figure 4), transiting objects (Figure 5), variable objects, note unmasked detector hot spots and 'miscellaneous' comments. Table 1 summarizes the standardized analyst comments. Free form comments may also appear. Analysts do not provide comments about common edge artifacts or bright point source artifacts (detector window reflections, dichroic reflections, or FUV wire scatter).

Diffuse reflections from off-axis stars are one of the more common artifacts noted by analysts. See Figure 4 for some bright examples. These diffuse reflections are often time variable as the detector is dithered during the observation. Some diffuse reflections may only be obvious while inspecting the times series 'movie' representation of the data. In this case the Diff_Refl_Movie standardized comment is set in lieu of the Diff_Reflection comment. The same applies for transiting sources and the Transit_Movie comment. See Figure 5 for an example transiting object (satellite).

Figure 5 also provides an example an observation with scattered light contamination from an extremely bright nearby star. Scatter light contamination like this is very rare due to observing constraints and there is currently no standardized comment for this type of artifact. We provide an example for completeness. The analyst would note this as a free form or miscellaneous comment.

7. COMMENTS ON GUEST INVESTIGATOR REPROCESSING

Prior to pipeline v5, special processing was occasionally performed on some GI data to improve data quality by repairing aspect solution errors. This involved excising time intervals where *deltaphot* erred (flag = Reprocessed(T1...TN)) or by relying solely on the less accurate spacecraft reported position information for aspect and astrometry solutions (flag = Reprocessed_No_Dphot). This is no longer necessary with pipeline v5 or greater.

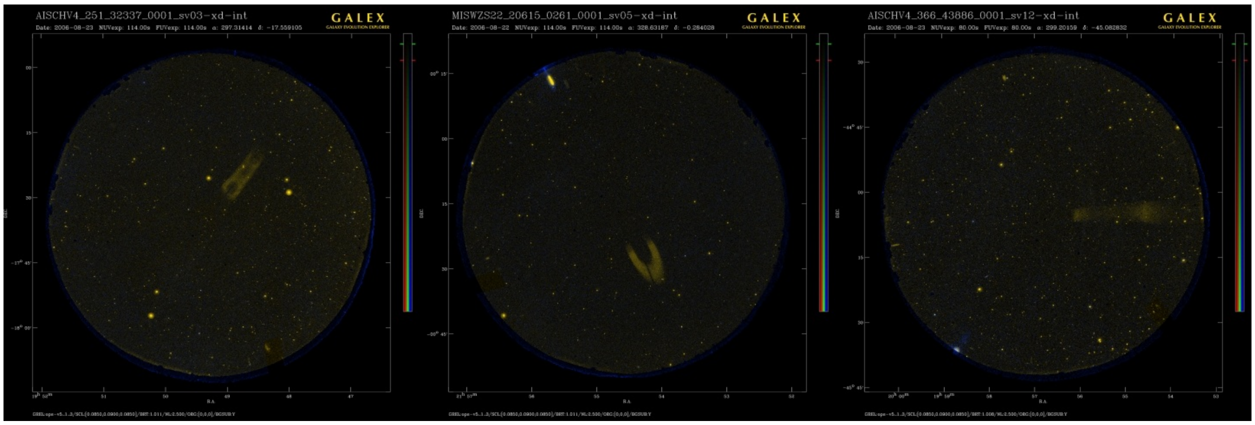

Fig. 4.— Examples of bright diffuse reflections generated during execution of the dither pattern.

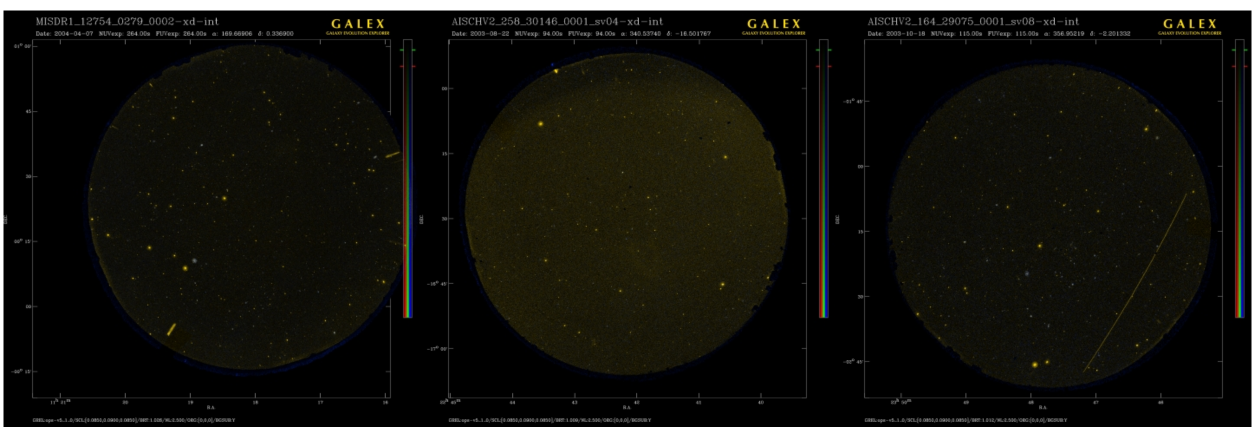

Fig. 5.— Miscellaneous QA issues. Left: FOV offset from planned position. Middle: A rare case of scattered light from an extremely bright nearby star. Note the crescent shape near the top. Right: Transiting object.

A. SUMMARY OF QA REPORT FLAGS AND COMMENTS

Table 1. Summary of QA Report Flags and Comments

§	FLAG	MEANING	CONDITION	GRADE [COADD] RESULT*
	Automated Flags			
5.1	ASTROMETRY_SHIFT	astrometry error	shift distance $> 0.75''$	FAIL
5.1	ASTROMETRY_ROTATION	astrometry error	absolute rotation $> 0.02^\circ$	FAIL
5.1	PLATE_SOL_MATCHES_LOW	15 or less stars matched for plate solution	$n \leq 15$	N/A
5.1	PLATE_SOL_NO_MATCHES	no stars matched to generate plate solution	$n = 0$	N/A
5.2	OFFSET_NOCOADD	FOV center is offset by at least $3'$	$3 \leq$ offset $< 48'$	[NO]
5.2	OFFSET_FAIL	FOV center is offset by at least $48'$	offset $\geq 48'$	FAIL
5.3	HV_LOW	detector high volatage below nominal	eclipse 643 to 749	FAIL
5.4	NUV_PSF_UNKNOWN	NUV PSF not measured	N/A	UNKNOWN
5.4	NUV_PSF_BAD	possible NUV PSF problem	FWHM(A)/FWHM(B) > 1.2 or fitFWHM $\geq 8''$	UNKNOWN
5.4	NUV_PSF_WARNING	unlikely NUV PSF problem	FWHM(A)/FWHM(B) ≤ 1.2 and fitFWHM $> 5.7''$	N/A
5.4	FUV_PSF_UNKNOWN	FUV PSF not measured	N/A	UNKNOWN
5.4	FUV_PSF_BAD	possible FUV PSF problem	FWHM(A)/FWHM(B) > 1.13 or fitFWHM $\geq 8''$	UNKNOWN
5.4	FUV_PSF_WARNING	unlikely FUV PSF problem	FWHM(A)/FWHM(B) ≤ 1.13 and fitFWHM$>5.7''$	N/A
5.5	ASP_ERRSTDEV	possible bad aspect solution	err[RA/DEC]_stdev > 15	UNKNOWN
5.5	ASP_ERRDIFF	possible bad aspect solution	err[RA/DEC]max-err[RA/DEC]min $> 50''$	UNKNOWN
5.6	NO_DATA	no intensity maps with exposure time	f/nexptime $\leq$ 0s	FAIL
5.6	NUV_ONLY	no FUV intensity maps with exposure time	fexptime $\leq$ 0s and nexptime $>$ 0s	N/A
5.6	FUV_ONLY	no NUV intensity maps with exposure time	nexptime $\leq$ 0s and fexptime $>$ 0s	N/A
5.6	TIME_BELOW_MIN	recovered exptime below minimium	0s $<$ f/nexptime $\leq$ 30s	FAIL
5.6	TIME_RECOVERY_LOW	recovered exptime less than 80%	f/nrecovertime $\leq$ 80%	N/A
5.6	TIME_RECOVERY_HIGH	recovered exptime greater than 105%	f/nrecovertime $\geq$ 105%	N/A
5.7	GRELEASE_LOW	pipeline version less than minimum	GRELEASE $<$ expected	FAIL
5.8	BLOB_RATIO_HI	FUV window charging likely strong	hiq_blob_cr/blob_cr > 0.2	UNKNOWN
5.8	BLOB_RATIO_MEDIUM	FUV window charging likely moderate	$0.1 <$ hiq_blob_cr/blob_cr < 0.2	UNKNOWN
5.8	BLOB_RATIO_LOW	FUV window charging likely weak	$0.013 <$ hiq_blob_cr/blob_cr < 0.1	UNKNOWN
5.8	NO_BLOB_INFO	no FUV window charging statistics available	N/A	UNKNOWN
5.9	MISSING_NUV_INT	missing NUV intensity map	no X-nd-int.fits file	FAIL
5.9	MISSING_FUV_INT	missing FUV intensity map	no X-fd-int.fits file	FAIL
5.9	MISSING_NUV_RRHR	missing NUV high-res response map	no X-nd-rrhr.fist file	FAIL
5.9	MISSING_FUV_RRHR	missing FUV high-res response map	no X-fd-rrhr.fits file	FAIL
5.9	MISSING_NUV_SKYBG	missing NUV background map	no X-nd-skybg.fits file	FAIL
5.9	MISSING_FUV_SKYBG	missing FUV background map	no X-fd-skybg.fits file	FAIL
5.9	MISSING_NUV_PSFSTATS	missing NUV PSF estimates	no X-nd-psf_stats.txt file	FAIL
5.9	MISSING_FUV_PSFSTATS	missing FUV PSF estimates	no X-fd-psf_stats.txt file	FAIL
5.9	MISSING_PLATE_SOLUTION	missing plate solution	no X-nd-cat_mch_rtastar_stats.txt file	FAIL
5.9	MISSING_MCAT	missing merged band source catalog	no X-xd-mcat.fits file	FAIL
5.9	MISSING_COLOR_JPEG	missing QA jpeg images	no X-xd-int_2color.jpg file	FAIL
5.9	MISSING_ASP_STATS	missing aspect solution error estimates	no X-asp_stats.txt file	FAIL
5.9	MISSING_SUMSTATS	missing pipeline summary	no X-sumstats.fits file	FAIL
5.9	NUV_INT_NOT_COMPRESSED	NUV intensity map not compressed	no X-nd-int.fits.gz file	UNKNOWN
5.9	FUV_INT_NOT_COMPRESSED	FUV intensity map not compressed	no X-fd-int.fits.gz file	UNKNOWN
5.10	UNEXPECTED_VISIT_NUV_#	unexpected NUV visit included in coadd	visit coadd status unknown	FAIL
5.10	UNEXPECTED_VISIT_FUV_#	unexpected FUV visit included in coadd	visit coadd status unknown	FAIL
5.10	MISSING_VISIT_NUV_#	approved NUV visit missing from coadd	visit coadd status YES and not included	FAIL
5.10	MISSING_VISIT_FUV_#	approved FUV visit missing from coadd	visit coadd status YES and not included	FAIL
5.10	BAD_VISIT_FUV_#	unapproved NUV visit included in coadd	visit coadd status NO and included	FAIL
5.10	BAD_VISIT_FUV_#	unapproved FUV visit included in coadd	visit coadd status NO and included	FAIL
5.10	BAD_VISIT_NUV_ECLIPSE_#	unexpectd NUV visit eclipse# in coadd	visit eclispe# $\neq$ coadd eclispe#	FAIL

Table 1—Continued

§	FLAG	MEANING	CONDITION	GRADE [COADD] RESULT*
5.10	BAD_VISIT_FUV_ECLIPSE_#	unexpectd FUV visit eclipse# in coadd	visit eclispe# ≠ coadd eclispe#	FAIL
5.10	BAD_VISIT_NUV_GRELEASE_#	NUV visit w/bad GRELEASE included in coadd	visit GRELEASE ≠ coadd GRELEASE	FAIL
5.10	BAD_VISIT_FUV_GRELEASE_#	FUV visit w/bad GRELEASE included in coadd	visit GRELEASE ≠ coadd GRELEASE	FAIL
5.10	VISIT_NUV_GRELEASE_MISSING_#	NUV visit GRELEASE info missing from coadd	not in coadd header	N/A
5.10	VISIT_FUV_GRELEASE_MISSING_#	FUV visit GRELEASE info missing from coadd	not in coadd header	N/A
5.10	TIME_LOSS_NUV	NUV exptime less than sum of approved visits	coadd NUV exptime < expected	FAIL
5.10	TIME_LOSS_FUV	FUV exptime less than sum of approved visits	coadd FUV exptime < expected	FAIL
5.10	TIME_GAIN_NUV	NUV exptime greater than sum of approved visits	coadd NUV exptime > expected	FAIL
5.10	TIME_GAIN_FUV	FUV exptime greater than sum of approved visits	coadd FUV exptime > expected	FAIL
5.10	NO_VISIT_CHK	visit quality not checked for coadd product	none	N/A
	Manual Flags			
6.1	OVERRIDE_FAIL	FAIL grade overridden by analyst	none	PASS
6.1	OVERRIDE_PASS	PASS grade overridden by analyst	none	FAIL
6.1	OVERRIDE_UNK_PASS	UNKNOWN grade resolved as PASS by analyst	none	PASS
6.1	OVERRIDE_UNK_FAIL	UNKNOWN grade resolved as FAIL by analyst	none	FAIL
6.1	OVERRIDE_COADD_Y	coadd YES status overridden by analyst	none	[NO]
6.1	OVERRIDE_COADD_N	coadd NO status overridden by analyst	none	[YES]
6.2	ASP_Ok	aspect solution appears good	none	PASS
6.2	ASP_Bad_Plot	aspect solution appears bad from boresite plot	none	FAIL
6.2	ASP_Bad_Image	aspect problems obvious in image	none	FAIL
6.2	FUV_PSF_Ok	FUV PSF okay upon close examination	none	PASS
6.2	NUV_PSF_Ok	NUV PSF okay upon close examination	none	PASS
6.2	Offset_FOV	large FOV offset from planned position	none	[NO]
6.2	Blob	FUV window charging visible in Blob QA plot or image	none	FAIL
	Manual Comments			
6.3	Diff_Reflection	interior diffuse reflection visible in JPEG image	none	N/A
6.3	Diff_Refl_Movie	interior diffuse reflection visible in NUV movie only	none	N/A
6.3	Transit_Satellite	bright satellite trail visible in JPEG image	none	N/A
6.3	Transit_Movie	transit is visible only in NUV movie	none	N/A
6.3	Transit_Asteroid	asteroid trail is visible	none	N/A
6.3	NUV_Hot_Pixel	unmasked NUV detector hotspot	none	N/A
6.3	FUV_Hot_Pixel	unmasked FUV detector hotspot	none	N/A
6.3	Variable_Source	variables source is detected	none	N/A
6.3	Miscel	miscellaneous (described in comments)	none	???
7	Reprocess()**	request reprocessing with limited time interval(s)	none	N/A
7	Reprocessed()**	reprocessed with limited time interval(s)	none	N/A
7	Reprocessed_No_Dphot**	reprocessed without deltaphot refinement	none	N/A

Note. — 'X' = field (i.e. target/visit/sub-visit), '#' = visit no., *Assuming no other issues. **Obsolete for pipeline versions ops-v5 and above.

B. GLOSSARY

AIS All-sky Imaging Survey [EXPTIME=100 s]

All-sky survey tile A tile composed of multiple, separate dithered pointings, called legs, occurring within a single eclipse.

CPS Counts per second.

DIS Deep Imaging Survey [EXPTIME=30,000 s]

Dither A controlled motion of the satellite to move the telescope boresight in a tight, slow spiral pattern that moves outward to 1.5 diameter across the sky.

Eclipse Time interval during which the Sun is occulted by the Earth during a particular orbit of the spacecraft, typically 1800-2000 sec in length. All GALEX observations occur while GALEX is in eclipse. One target is observed per eclipse. The data acquired during an eclipse is sometimes referred to as an eclipse.

EXPTIME Nominal exposure time in seconds at each location in a GALEX survey.

FUV Far Ultraviolet detector

GALEX Galaxy Evolution Explorer

Leg A single, dithered pointing within an all-sky survey tile.

MCP Microchannel Plate, the high-voltage electron-multiplier array that is the basis for the GALEX detectors.

MIS Medium-Imaging Survey [EXPTIME=1500 s]

NGS Nearby Galaxy Survey [EXPTIME=1500 s]

NUV Near Ultraviolet detector

Observation The acquisition of photon data from a region of the sky during a single orbital night (eclipse).

Pointing Generic term referring to the location on the sky of a single, dithered GALEX field of view. A single tile or a target may consist of one or more pointings.

Primary Tile A tile whose center coincides with a non-AIS target center or whose legs coincide with all-sky survey leg centers. Thus a target can be roughly described as a primary tile plus an optical wheel setting.

PSF Point Spread Function, the distribution of light in an image of an unresolved object

Region A pre-defined area on the sky where one or more targets (see list below) are clustered. A region is used for planning purposes.

SC Spacecraft

Secondary Tile A tile with no single target counterpart, i.e., a secondary tile's photon data will come from multiple targets. Note that no data from secondary tiles exist in the GR1 release.

Sub-visit A sequential count of legs detected and processed by the pipeline (see leg and all-sky survey tile). If all data for an AIS tile reach ground and are processed normally, the sub-visit number will correspond to the leg number, but if there are data gaps or the processing is aberrant in some way, legs may be missing (or possibly split in two), but sub-visit numbering will always be sequential. (Note the rough correspondence between visit vs. eclipse, and sub-visit vs. leg.)

Survey A type of observation designed to study the sky at given depth (exposure time), with a given sky coverage and location, and in Imaging, Grism, or Opaque GROW mode. (See Survey Summary in the GR1 documentation.)

Target An area of sky observed by GALEX together with the spacecraft-motion and instrument commands used for that observation. Note that because the commanded spacecraft motion can be complex, a target can have a complex shape. In particular, All-sky Imaging Survey (AIS) targets are composed of several separate pointings, which may or may not overlap. Also note that the same geometric part of the sky (see Primary Tile) may be observed in both direct and grism modes, making two targets. A target can be roughly described as a primary tile plus an optical wheel setting. Targets may overlap one another. Most targets will consist of a single, roughly-circular, 1.25 degree diameter GALEX field of view, or, for AIS targets, a series of overlapping fields of view.

Tile An area of sky for which the pipeline has generated (or will generate) an image using GALEX photon data. A tile may have an arbitrary shape (see Target), but in general will comprise one or more images with north in the +Y direction. (See Primary Tile, and Secondary_Tile.) Most tiles will consist of a single, roughly-circular, 1.25 degree diameter GALEX field of view, or, for AIS tiles, a series of overlapping fields of view.

Visit The planned sequential repeat count of an observation from a single eclipse of a single target. For example, if 10 widely-separated eclipses are allocated for observing a particular target, the visits will be numbered 1 through 10. Note that since not all planned observations are made successfully, and some data may not reach ground, some visits may be missing from a sequence. See also sub-visit.

VisitData Processed data from a single visit

WCS World Coordinate System (FITS CRVAL1,CDELT2,CROTA2,etc.)