# Modified and New Brewer GW-Basic Subroutines

**This file describes the Brewer GW-Basic Subroutines that have been modified or added for use with the NOAA-EPA Brewer Network (NEUBrew). These new routines were deployed to all NEUBrew Network instruments on May 3, 2007 ~2200 UTC.**

## Modified Brewer GW-Basic Subroutines

### UM (Umkehr)

The Umkehr (UM.rtn) subroutine was modified to allow more control over the repetition of UM measurements within Solar Zenith Angle sections of a Brewer Schedule. Historically, the UM routine was placed at the end a Brewer command string in a schedule file as shown the example below:

Excerpt from Brewer Schedule using the original UM routine.

```
-85.803
pfWZuxzsum
-80.803
pfWZuxzsum
-75.803
```

When schedule execution reached the "um" command at the end of command line, the um would execute continually until the next Solar Zenith Angle was reached.

The new Umkehr routine introduces a new variable *L9%* that is used to control the number of times the UM routine executes before it continues in the schedule or returns to the beginning of a command string. The variable *L9%* is set using the **new Brewer routines KA – KI (see New Brewer Subroutines below)**. K* routines are placed just before the UM routine a schedule command string as shown in the example below:

Excerpt from Brewer Schedule using the new UM routine and K* routines.

```
-92.40
pfpdo3b1hgb0kaum  <-(See Note 1)
-90.0
pfpdo3kaum  <-(see Note 1)
-85.0
pfpdo3uxkeum30  <-(See Note 2)
-80.0
pfpdo3kcumuxdskdumuxkcum30  <-(See Note 3)
```

Note 1:   The KA routine sets variable $L9\%$ = 500.   Thus, the UM routine will try to execute 500 times repeatedly, or until the next Solar Zenith Angle is reached in the schedule.   This mode of operation is for the most part, identical the operation the original UM routine.

Note 2:   This example shows the flexibility of the modified UM routine and new K* routines. The KE routine sets variable $L9\%$ = 6. In this mode, the UM routine will execute 6 times in a row.  The number 30 at the end of the command string instructs the Brewer to repeat the current command string 30 times, or until the next Solar Zenith Angle is reached.

Note 3:   Similar to Note 2, except the UM routine is executed 2 times before the command line is executed from the beginning of the line.


**DS (Direct Sun), ZS (Zenith Sky), PS (Optical Depth), and UV (Ultraviolet)**

NEUBrew schedules have a high duty cycle. Observations of DS, ZS, PS, UM, and UV data revealed elevated dark counts and periodic spikes in dark counts that didn't exist with previous (less strenuous) schedules. Examples of the elevated dark counts are show in Figures 1 and 2.
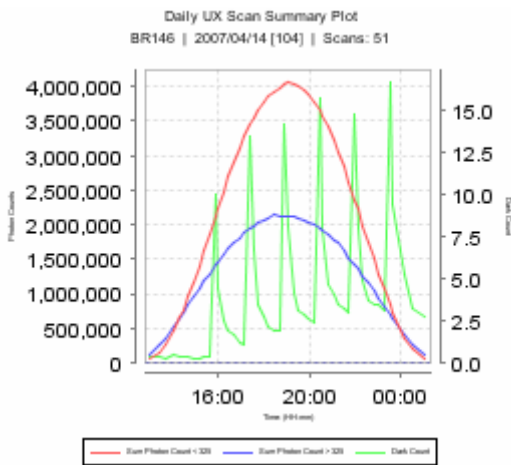


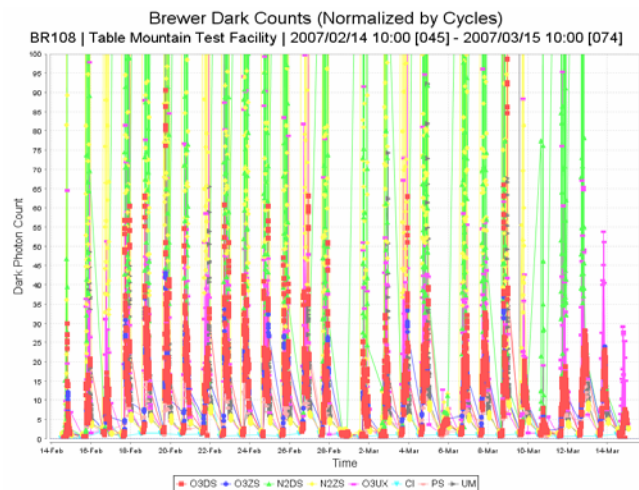Figure 1  Daily UV Summary showing Cyclic Spikes in UV Dark Counts



Figure 2  30 Day Time Series of Dark Counts from BR108 Prior to Modified DS,ZS,PS, and UV Routines

Further examination of the GW-Basic routines and observations of the Slit Mask operation before, during and after these routines revealed the Brewer's Slit Mask was often left in an open position. This allowed light to reach the Brewer's Photo Multiplier Tube (PMT) in between measurements, and most likely causing the PMT to saturate and produce high Dark Counts. The Slit Mask assembly is shown in Figure 3.

Slit Mask Shown in the Shutter Position, the proper quiescent position to shield the PMT from exposure to light.
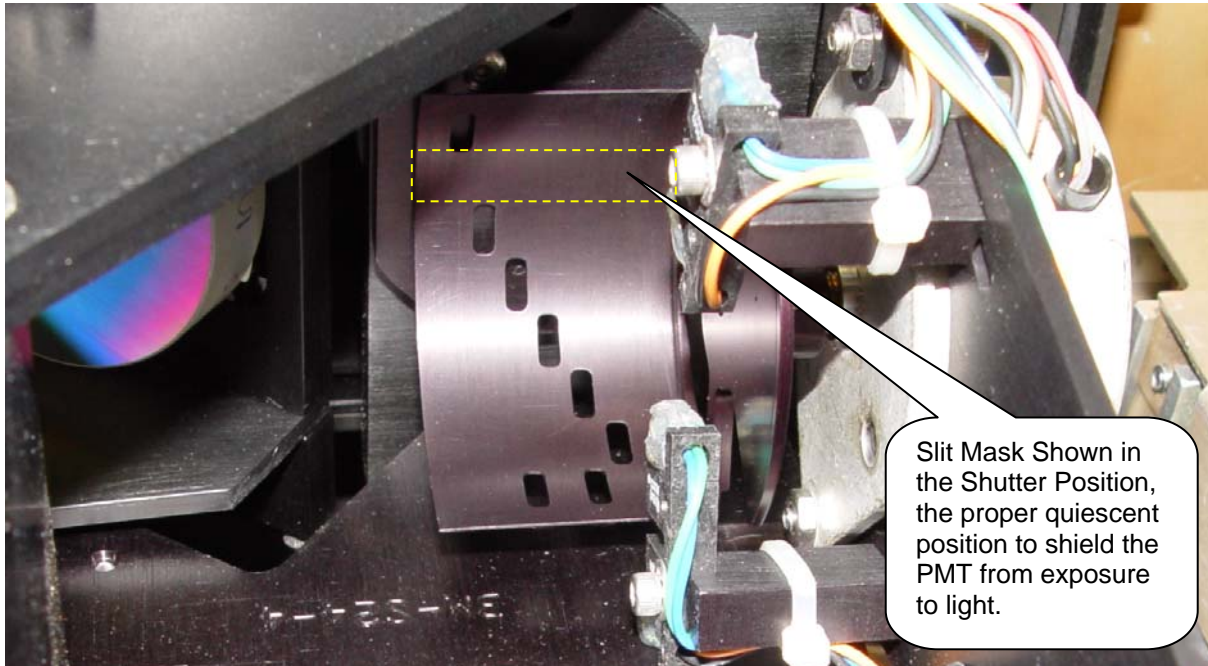
Figure 3  Brewer Slit Mask Shown the with Mask in the Shutter Position which blocks light from reaching the PMT.

The modification to the DS, ZS, PS, and UV routines ensures that the Slit Mask is returned the shutter (closed) position at the end of each routine. Figures 4 and 5 show examples of Dark Counts after the new routines were deployed the network instruments.
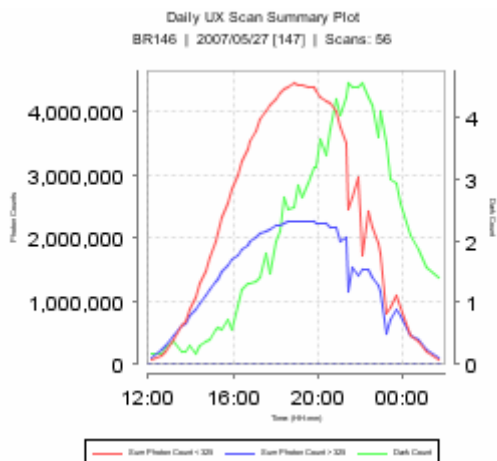




Figure 4  Daily UV Summary showing smaller Dark Counts and no spikes. The rise in Dark Counts through the day can be attributed to instrument temperature dependence.
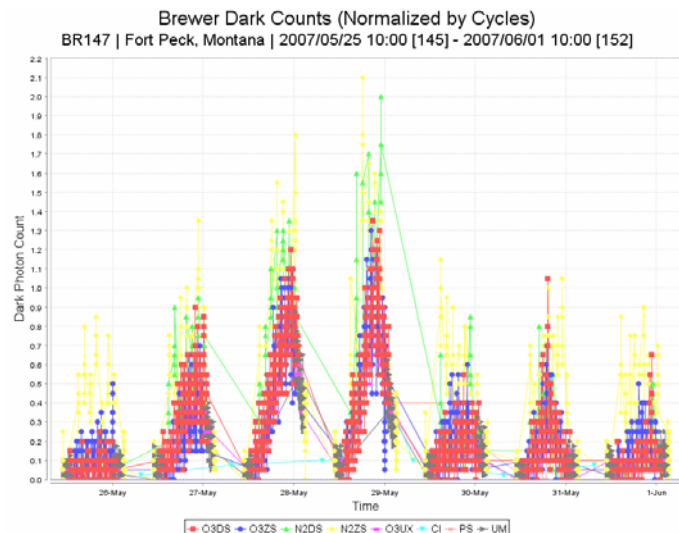
Figure 5  One week Dark Count plot showing reasonable Dark Counts for all routines. Rises in Dark Counts can be attributed to instrument temperature dependence.

One additional change was made to the PS routine. Originally the PS routine did not have a specified number cycles, it inherited its cycle count from the cycle count set in what ever routine preceded it the schedule.  For NEUBrew network operation the number of Slit Mask cycles in the PS routine has been hard-coded to five (5).

### ED (End-Of-Day)

Previous version of Brewer schedules used WS, WQ, and WE routines at the 105 Solar Zenith Angle command line.  These routines were performing variations of End-Of-Day processing. It was noted that these were causing the Brewer to reset itself several times per day, and would write duplicate entries into the many of the Brewer's daily average files. For this reason, these routines were removed from the NEUBrew schedules.  One side-effect of removing these routines was the Brewers stopped performing a daily FR routine to reset the Micrometer and Filter Wheel #3. We discovered the FR routine should be called from with the ED routine, but the command was commented-out in the ED routine.  The commented statement has been re-instated in the ED routine.

## New Brewer GW-Basic Subroutines

New Brewer routine were added to give the new UM (Umkehr) routine more control over the number of times the routine would execute.  The new routines **KA, KB, KC, KD, KE, KF, KG, KH, and KI** are used in conjunction with the new UM routine. Each of the K* routines sets a global variable (**$L9\%$**) in the Brewer Software to determine how many times the UM routine will execute in succession. A K* command is placed in a schedule command line just before the UM command. See the UM section at the top of this document for examples of how the K* routines are used in schedules.  Table 1 below identifies how many times the UM command executes when preceded by one of the K* commands.

Table 1   K Subroutine UM Execution Counts

| Subroutine Name | Number of times UM routine executes |
|---|---|
| KA | 500 |
| KB | 1 |
| KC | 2 |
| KD | 4 |
| KE | 6 |
| KF | 8 |
| KG | 10 |
| KH | 12 |
| KI | 14 |