FES Scattered Light Anomaly Update

Daryl Weinstein and Michael Carini

July 1992

On February 20th, 1991, the scattered light in the FES was first noticed. Since that time, we have been working to understand the unusual behavior of this anomaly. We have found that by obtaining the counts of the sky background with the target in the aperture (*i.e.* "counts in") as well as the average of counts at four predetermined points in the FES we get a fairly good indication of how the scattered light is behaving at a particular β angle. In the following, we will discuss the methods used and tests performed in order to obtain a better understanding of the FES scattered light anomaly.

1 Methods

We have been using two methods to monitor the behavior of the FES scattered light. The first is to calculate the average of the counts measured at each of four predetermined points in the FES. This has proven to be a very good indication of the level of the scattered light at a particular β angle. The second method is to use the record of "counts in", which is defined as the sky background counts near the reference point with a target in either of the large apertures. These counts are recorded on the observing scripts by the telescope operators. Only the "counts in" of stars 7.5 magnitudes or fainter are used since some of the flux from bright stars may spill out of the aperture. For a similar reason, small aperture counts are not used. Figure 1 shows the "counts in" along with the four points data from days 1992/048 through 1992/188. From this plot, we see a good agreement between the two methods being used to monitor the scattered light. This demonstrates the reliability of both the four points method and the "counts in" method to determine the scattered light during actual operations.

2 Tests

During the onset of shadow season #29, the FES scattered light was not observed to increase dramatically, in contrast to its behavior during the previous shadow season. We believe that we can, in part, explain the unusual behavior of the scattered light during this time. Assuming that whatever is causing the scattered light is associated with the end of the telescope tube, we postulate that an increase in scattered light is due to the thermal shock that the end of the tube experiences upon entering and exiting shadow. During the first five days of shadow season #29, the satellite continuously monitored an object at $\beta \sim 48°$. This cooled the end of the telescope tube, thus minimizing any thermal shock the tube would experience upon entering shadow. To test this theory, we tried passing through shadow at different β angles. As we predicted, after going through shadow at a $\beta \sim 65°$ or higher, we saw a noticeable increase in the level of scattered light. This increase would generally decay to its previous level in the following 12-24 hours unless we passed through shadow at a high β again the next day. These results lead us to believe that if the spacecraft passes through

every shadow at a low β ($\leq 65°$), we could prevent the scattered light from skyrocketing, and keep it at its "normal" levels. Furthermore, we believe that the FES scattered light is influenced by the pointing angles of the satellite during the previous 24 hours. For example, a huge increase in scattered light was noticed when we maneuvered to $\beta \sim 128°$ after being at $\beta \sim 38°$ for the previous 24 hours (as seen in Figure 1).

On June 29, 1992, we conducted another formal engineering test to measure the level of scattered light as a function of β. This test entailed performing a pitch slew from $\beta \sim 35°$ to $\beta \sim 130°$. During this slew, the satellite continuously collected data on the sky background. The results of the test are plotted in Figure 2. The ratio of the FESCAM counts to FESPRIM counts (s/o) is 1:3.76. We do not, however, recommend using these results exclusively to predict the scattered light levels at corresponding β values. Although this is a good representation of the scattered light vs. β angle for this particular day, it can not be relied upon for every day since our experience indicates that the level of the scattered light varies on a day to day basis for any given β angle.

3 Results

In Figure 3, we have plotted the data from before and after shadow season #29. The large daily variations observed in the scattered light since shadow season #29 make it difficult to accurately estimate the level of scattered light at a given β from this plot. Therefore, we have developed some rough guidelines to assist the operations staff and guest observers in estimating the amount of scattered light present at a particular β angle. Please note that these values may or may not change after shadow season #30.

- $30° \leq \beta \leq 60°$: Estimate scattered light level from the graph (Figure 1).
- $60° \leq \beta \leq 125°$: 232 ± 100 S/O Counts

Although the level of scattered light still varies from day to day, it has not had any major impact on operations. In addition, we feel that with continued monitoring of this anomaly we can predict the levels of scattered light reasonably well, and therefore make the best of this situation.

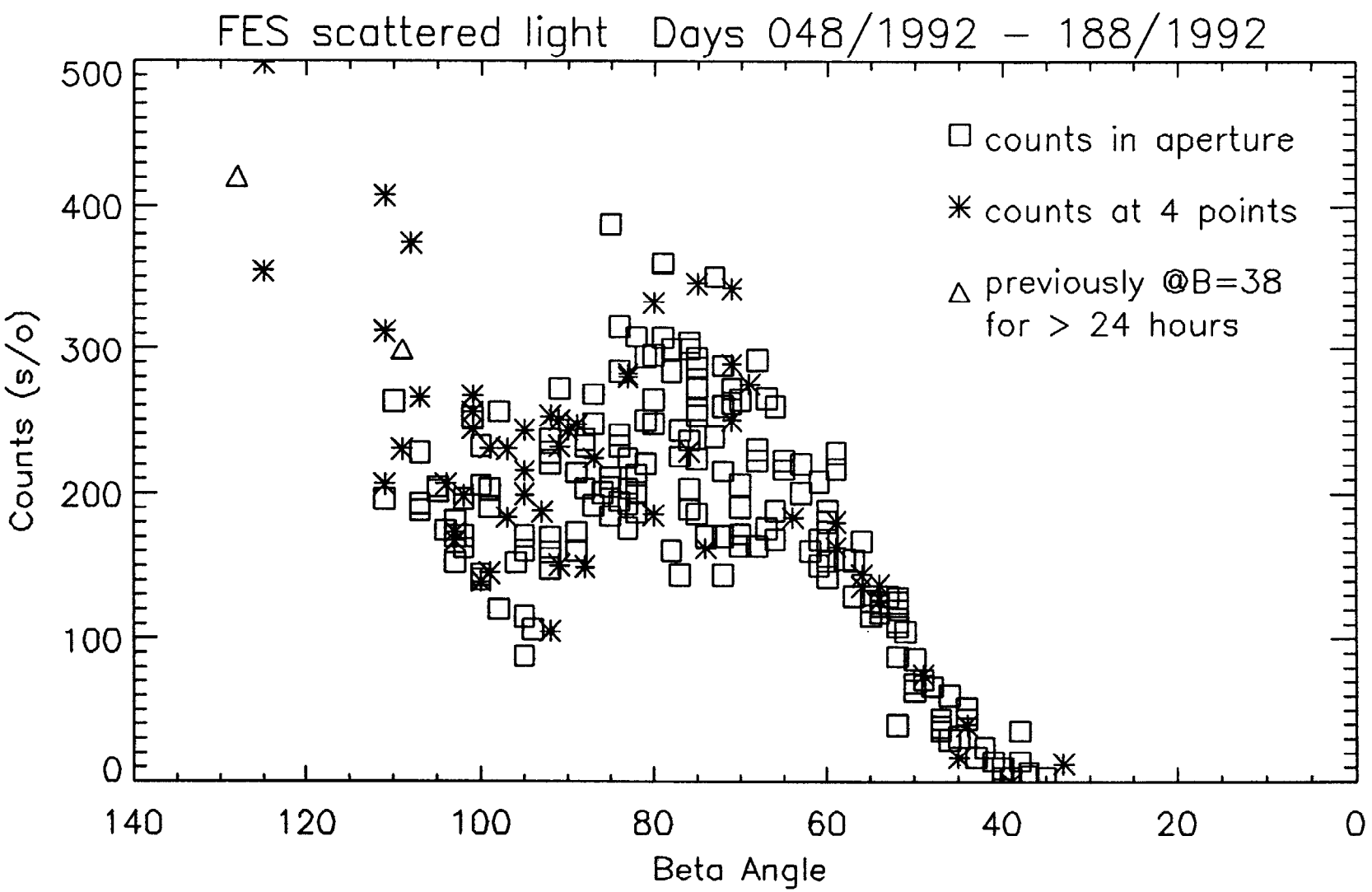
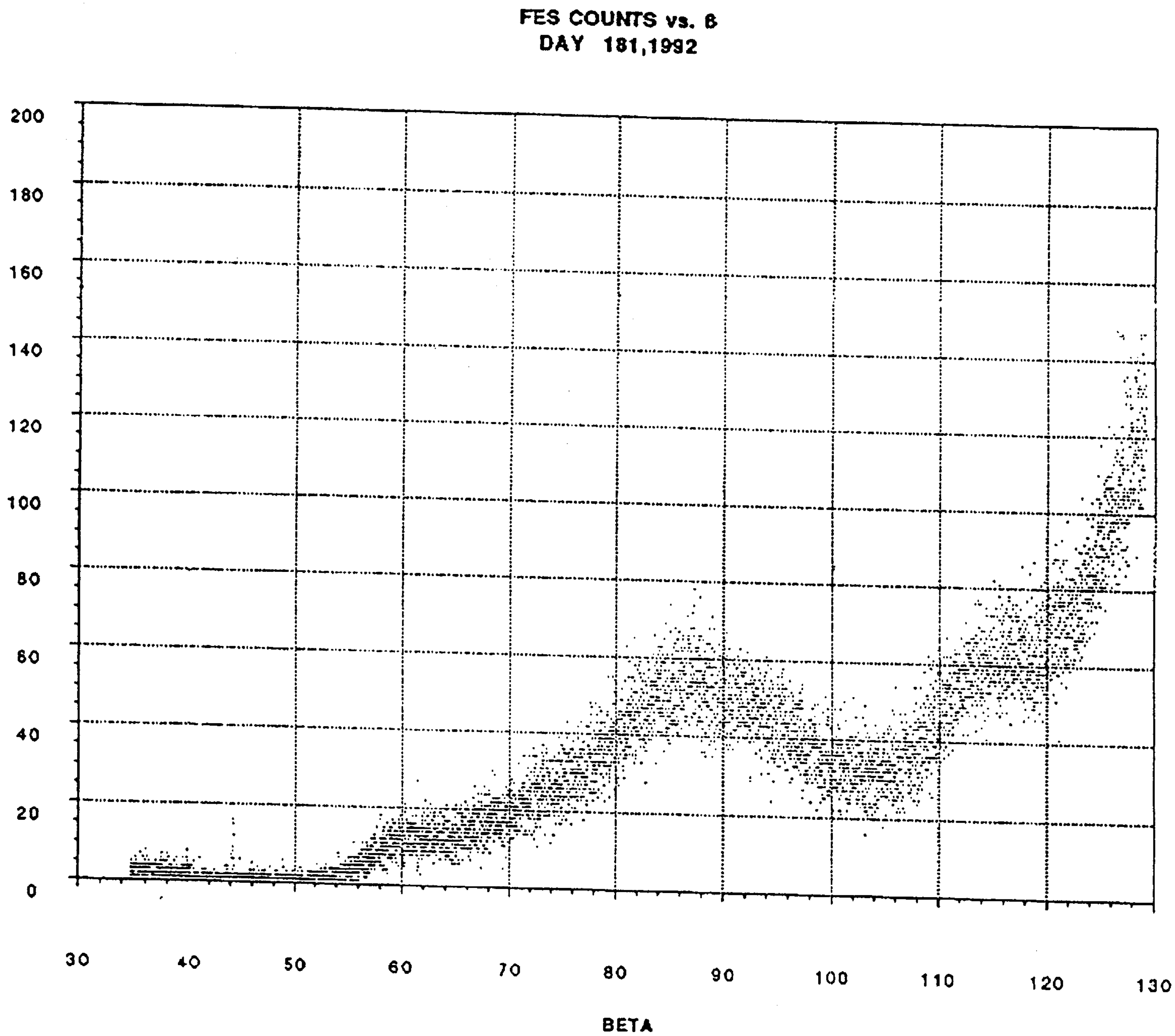

FES scattered light Days 048/1992 – 188/1992
Counts (s/o)
500
400
300
200
100
0
140
120
100
80
60
40
20
0
Beta Angle
counts in aperture
counts at 4 points
previously @B=38
for > 24 hours

Figure 1



FES MEASURED COUNTS-FIELDCAM, FES1ROM, 20 KBPS

Figure 2

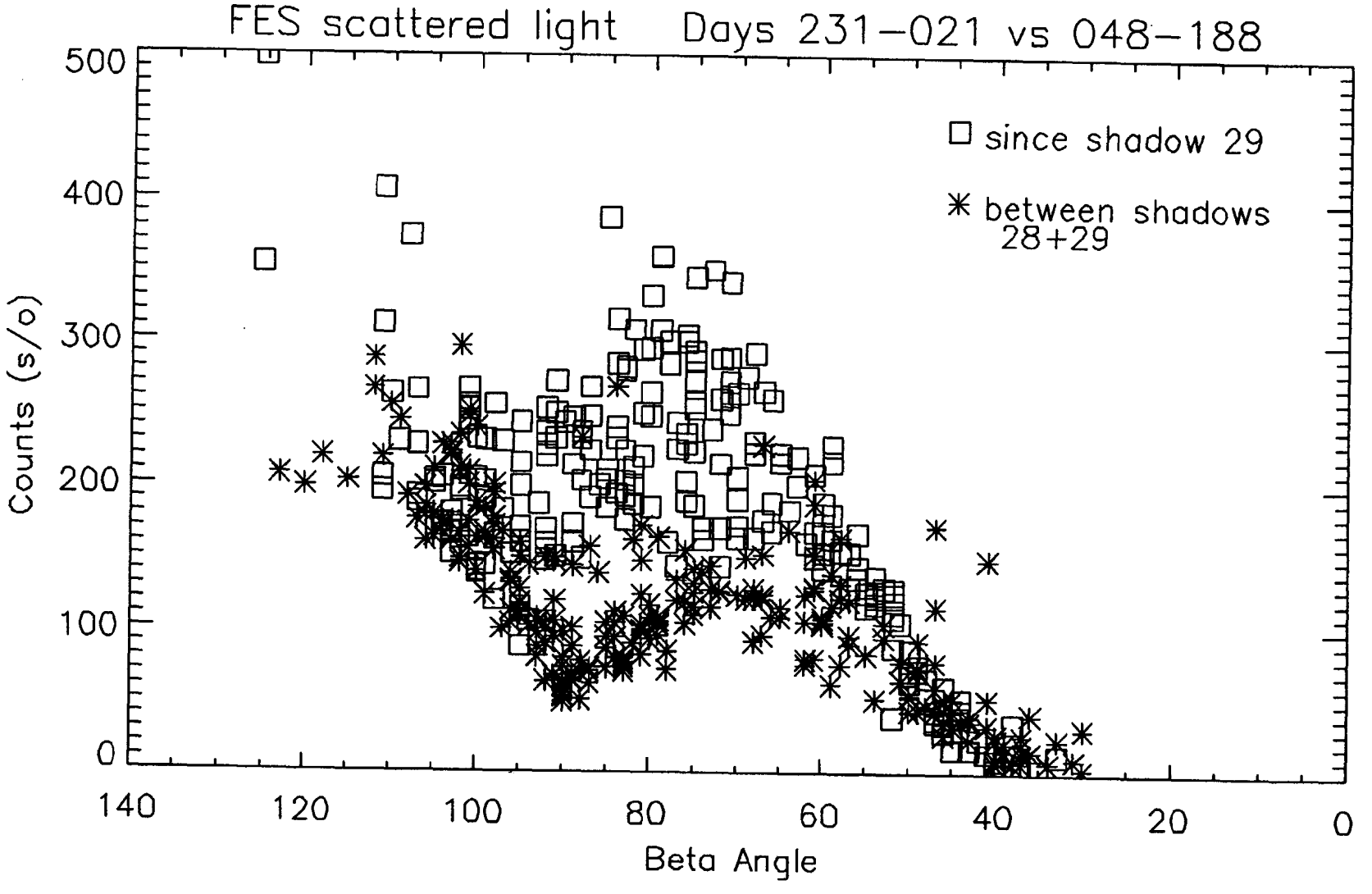

FES scattered light Days 231–021 vs 048–188
since shadow 29
between shadows 28+29
Counts (s/o)
500
400
300
200
100
0
140
120
100
80
60
40
20
0
Beta Angle

Figure 3