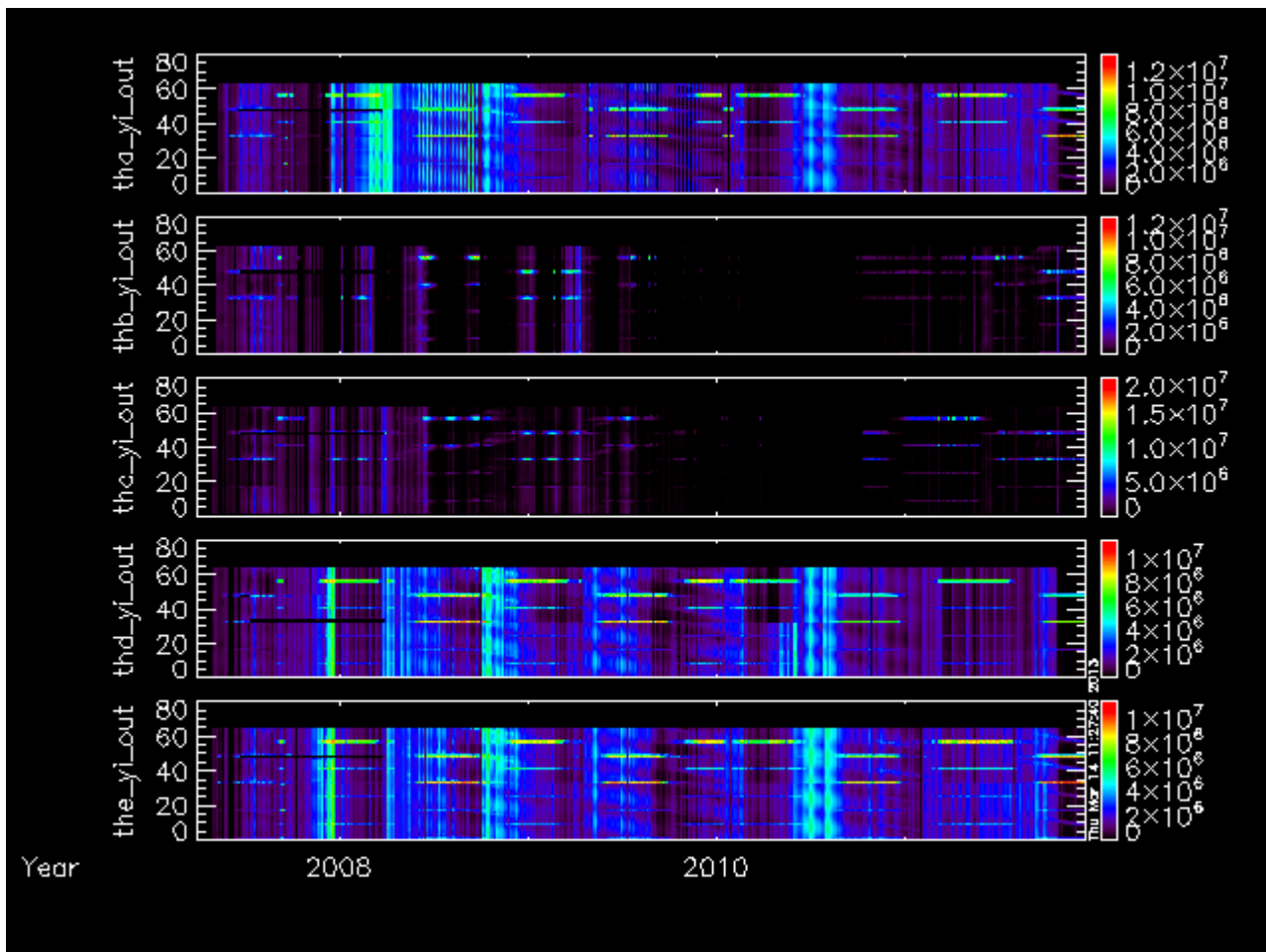# THEMIS
SST Contaminated Bins
draft 003

thm_soc_XXX_sst_contaminated bins
Mar 14 2013

1. Bin Contamination from Raw Data:

THEMIS SST data can be affected by extra counts from the sun or earth shine. The TDAS software package has the ability to deal with contaminated angular bins in full mode, but not in reduced mode. Figure 1 shows a plot of SST full-mode raw ion data, accumulated in 1 day intervals, plotted versus time and bin number.
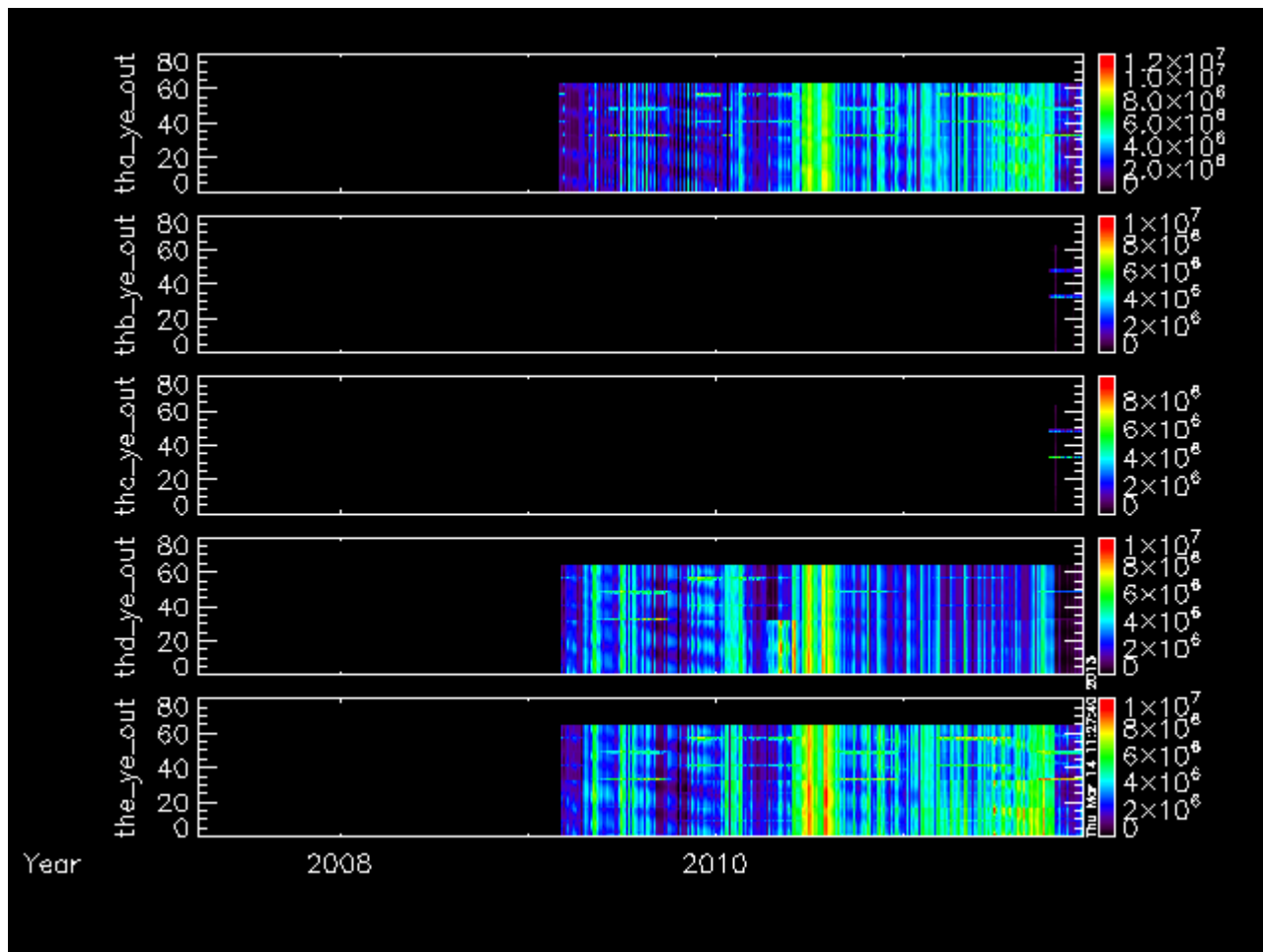
Figure 1: Daily average of SST full-mode raw ion data versus time and angular bin number.

Contamination can be seen in the horizontal lines on the plot.

Figure 2a shows this same plot for electrons.

Figure 2a: Daily average of full-mode raw electron data versus time and angular bin number.

Note that early in the mission the electron rates were lower, and do not show up well on the linearly scaled plot. Figure 2b shows the plot with log scaling.
.

Figure 2b: Log scaled plot of electron data.
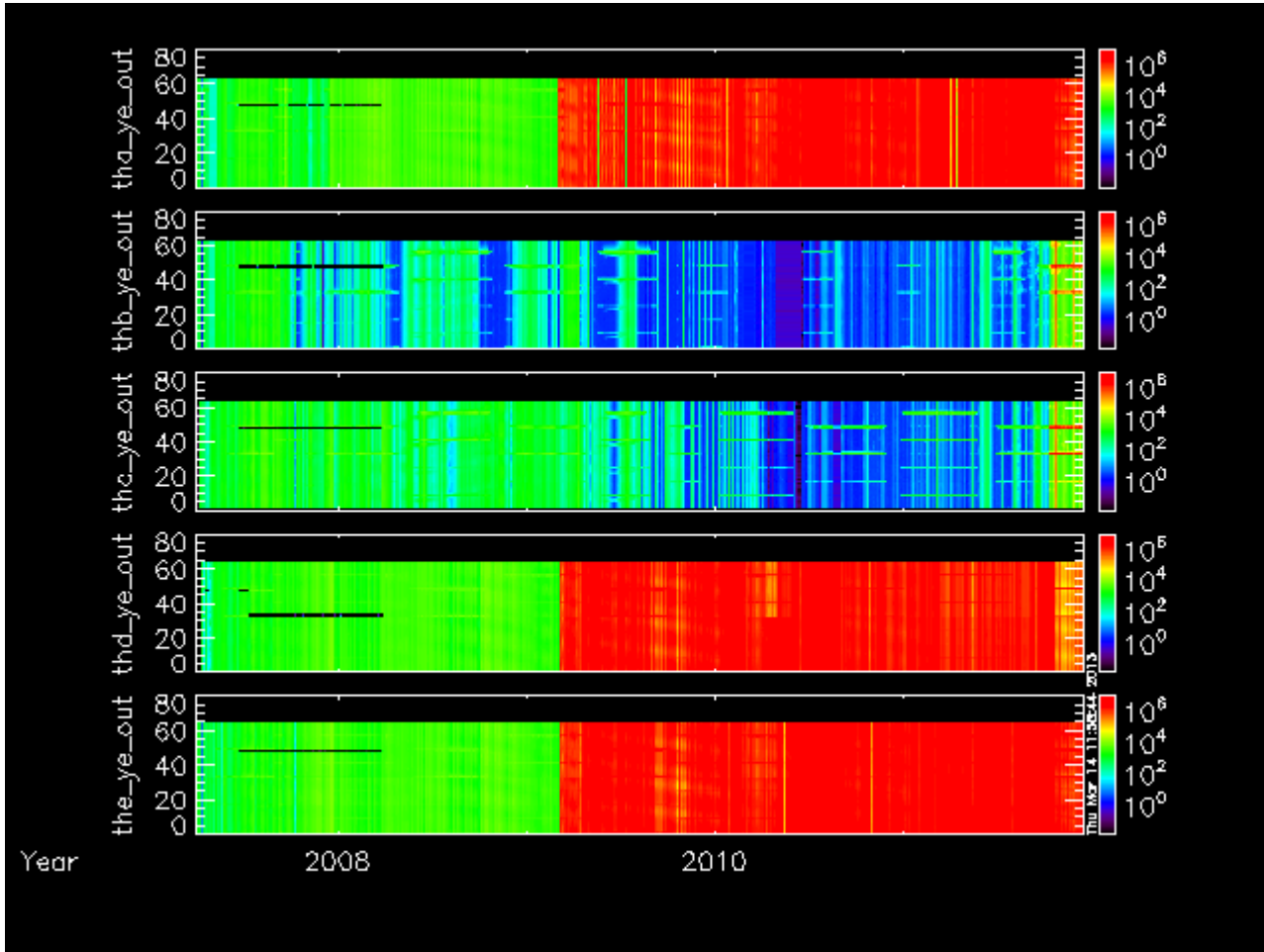
From Figures 1 and 2, we see that while the sun contaminated bins are not always the same for all probes at all times, there are two different "modes" of sun contamination, one where contamination is seen in bins near 8, 24, 40 and 56, while the other has contamination in bins near 0, 16, 32, and 48. The different probes are in different "modes" at different times, but the "modes" are the same for all probes.

To get a better idea of which bins are most contaminated, we can average the angular distribution over the full mission for each probe. Figure 3 shows the average of raw data versus angular bin for the full mission for each probe.

From the Figure, the contaminated bins are easily seen; bins [0, 8, 16, 24, 32, 40, 47, 48, 55, 56] are well above the other bins in the plot. Also bins 33 and 57 show some effect of contamination. These bins are marked by red plus signs on the plot. Figure 4 shows the same data for electrons. The contamination effect is less noticeable in the lower valued bins, but is clearly seen in the higher bins. We will adopt the same set of contaminated bins for electrons as for ions, though, to retain simplicity.

Figure 3: SST full-mode ion raw data per day, averaged for the full THEMIS mission through 2012-12-31.
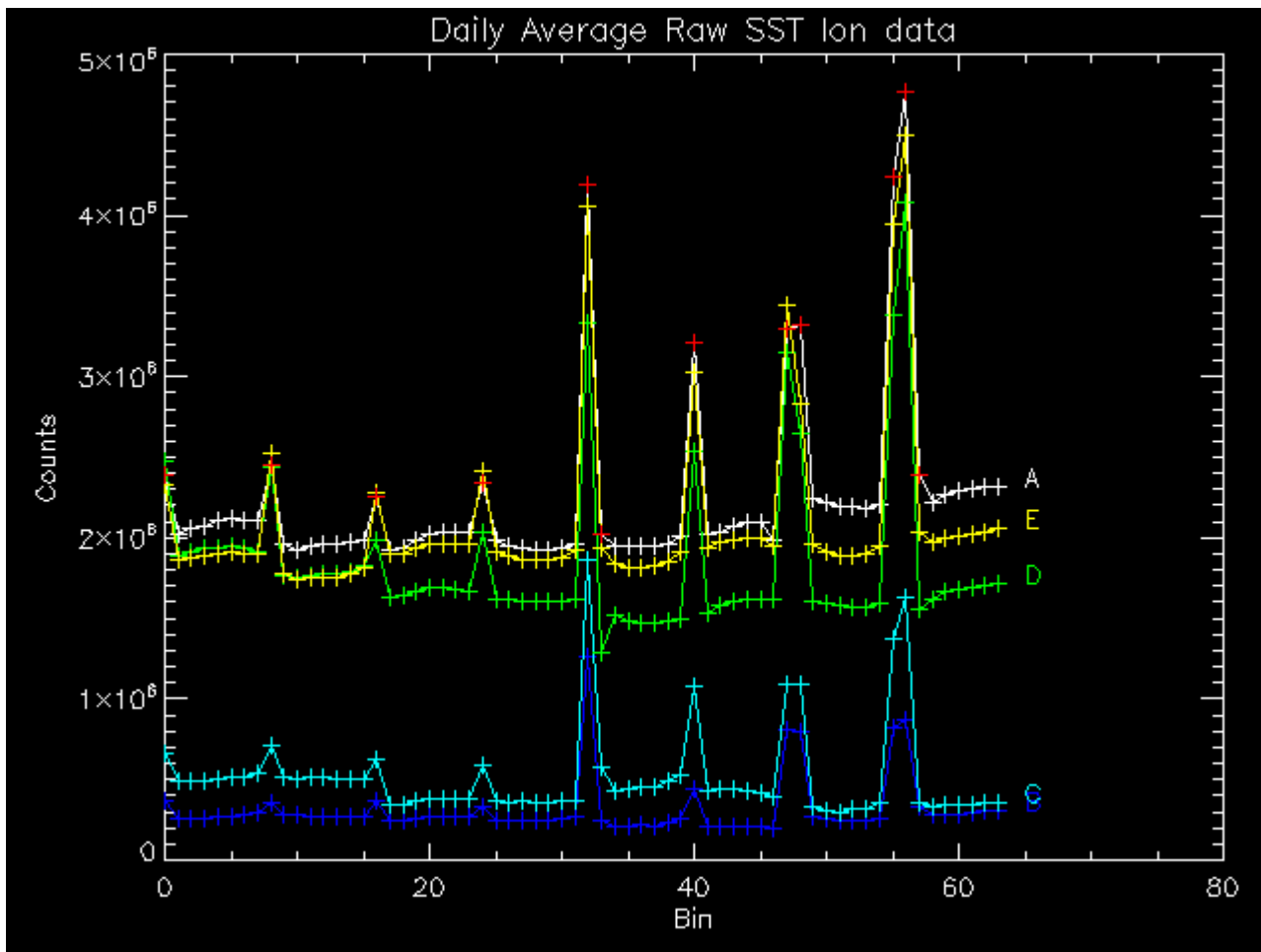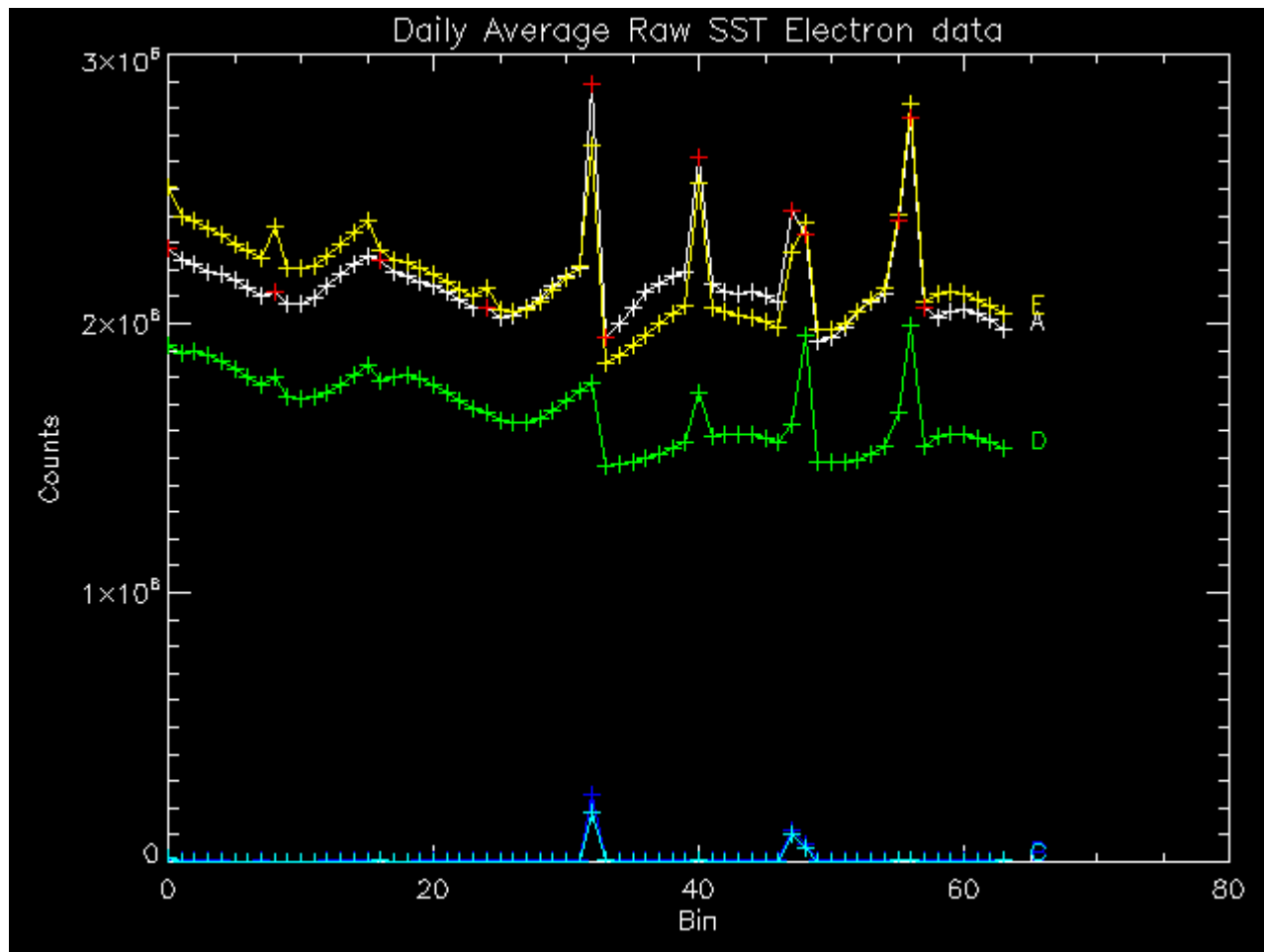
Figure 4: SST full-mode electron raw data per day, averaged for the full THEMIS mission through 2012-12-31.

2. SST angle Maps and contamination:

Angular binning for SST (and ESA) is controlled by maps which have been loaded onto THEMIS as ETC tables. Each SST angular map contains 128 values, stored as 2 byte integers; the full angular range is divided into 4 theta sectors, for polar angle and 32 phi sectors, for azimuthal angles. As the spacecraft rotates, counts from each of the four SST sensors are recorded in the bins for the appropriate angles. There are 10 different angle maps for SST, loaded onto a 2560 byte sector of the EEPROM starting at the IDPU address 0x3E800. We have verified the position and values for the angle tables via a flatsat dump. Here is an example of a 32X4 angle map from the flatsat dump, for SST full-mode ions:

```
 0   0   1   1   2   2   3   3   4   4   5   5   6   6   7   7   8   8   9   9  10  10  11  11  12  12  13  13  14  14  15  15
16  16  17  17  18  18  19  19  20  20  21  21  22  22  23  23  24  24  25  25  26  26  27  27  28  28  29  29  30  30  31  31
32  32  33  33  34  34  35  35  36  36  37  37  38  38  39  39  40  40  41  41  42  42  43  43  44  44  45  45  46  46  47  47
48  48  49  49  50  50  51  51  52  52  53  53  54  54  55  55  56  56  57  57  58  58  59  59  60  60  61  61  62  62  63  63
```

For the first sensor, the first two phi sectors correspond to bin 0, the next two to bin 1, the next two correspond to bin 2, and so on. The next sensor starts filling bins at bin 16, the next at bin 32, and the fourth at bin 48.

For reduced-mode ions, in 6 bin mode, this is the map from the flatsat dump:

```
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 97 97  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 97 97  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
2  2  2  2  2  2  2  2  3  3  3  3  3  3 97 97 97 97  4  4  4  4  4  4  5  5  5  5  5  5  5  5
4  4  4  4  4  4  4  5  5  5  5  5  5 97 97 97 97  2  2  2  2  2  2  3  3  3  3  3  3  3  3
```

This map shows how the SST contamination is currently handled for reduced mode ions. It is not done through commands, instead the bin values for the phi sectors that are expected to be contaminated are set to invalid values. In this case, for the theta-phi combinations that correspond to full-mode bins 8, 24, 39, 40, 55 and 56 the counts are directed into bin 97 (0x61). Since there is no bin 97, the counts are not recorded. For single bin reduced mode, the concept is the same, except in this case the invalid bin value is set to 17 (0x11):

```
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

 There are a number of other bins that show the effects of contamination, as we have seen in the previous section. Given the SST contaminated full-mode bins, we can make the appropriate changes, setting the bin values to 97 (or 17) for the phi sectors corresponding to full mode bins [0, 8, 16, 24, 32, 33,40, 47, 48, 55, 56,57]. The resulting 6 bin angle map is:

```
97 97  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 97 97  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
97 97  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 97 97  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
97 97 97 97  2  2  2  2  3  3  3  3  3  3  3  3  3 97 97  4  4  4  4  4  4  5  5  5  5  5  5 97 97
97 97  4  4  4  4  4  4  5  5  5  5  5  5 97 97 97 97 97 97  2  2  2  2  3  3  3  3  3  3  3  3
```

The resulting 1 bin map is:

```
17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
17 17 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17
17 17  0  0  0  0  0  0  0  0  0  0  0  0  0 17 17 17 17 17 17  0  0  0  0  0  0  0  0  0  0  0  0
```

These maps have been generated for both ions and electrons, and a full set of SST angle maps in unformatted bytes has been copied to **http://sprg.ssl.berkeley.edu/~jimm/themis/SST/SST_angle_maps.dat**

The next step is to load this set of maps back onto the flatsat, and verify that the load was correctly done. Once this is done then we can consider loading the maps onto the THEMIS probes.

3.   Loading SST Angle Maps to EEPROM

Each of the maps is loaded to a memory address on the EEPROM, in addition, the different SST modes have Table of Contents entries loaded onto the EEPROM that give the commands used to load each table onto the ETC. There are eight angle maps to be loaded, and 10 TOC entries, for a total of 18 RAW IDPU commands. These command are stored in file TBD.