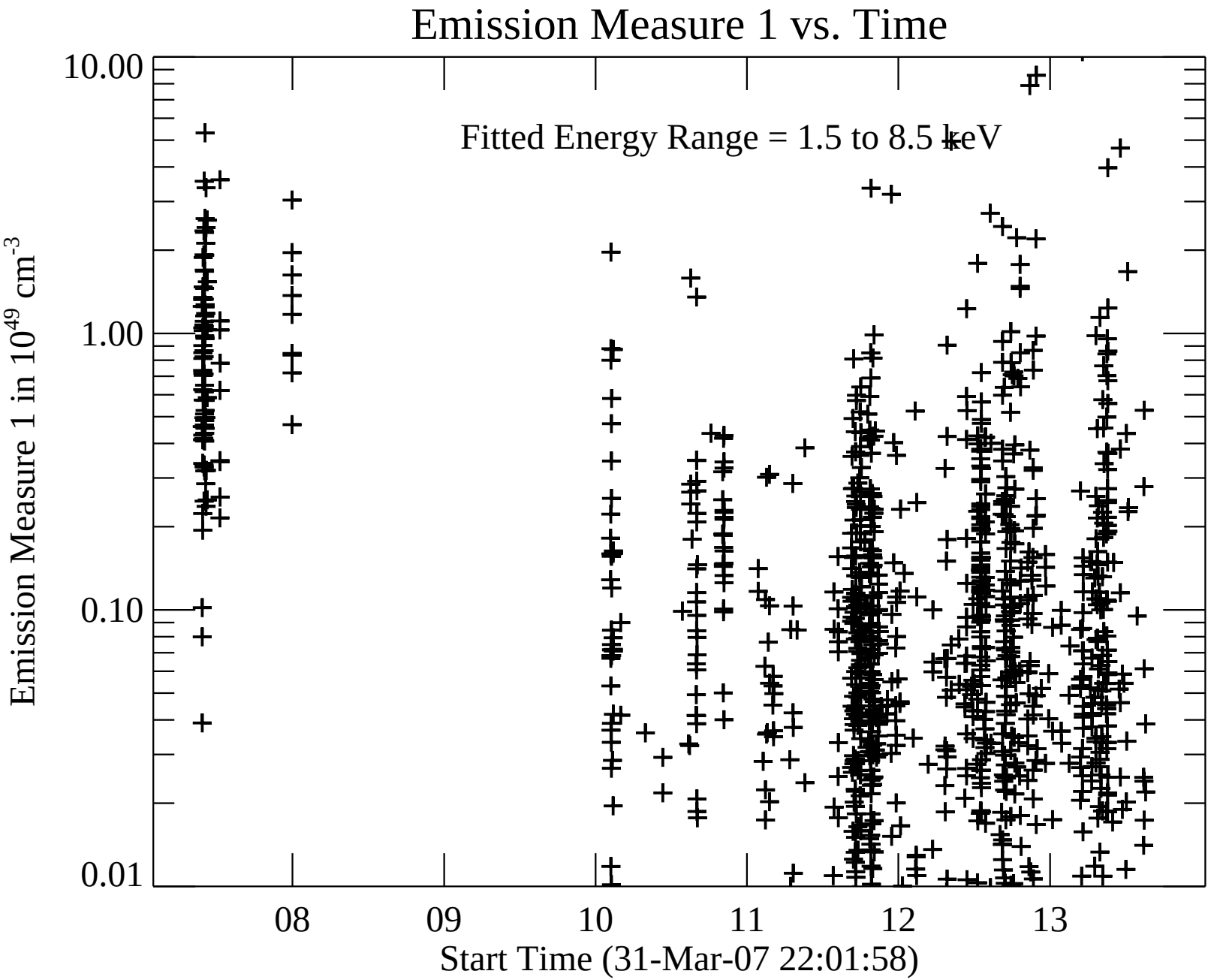
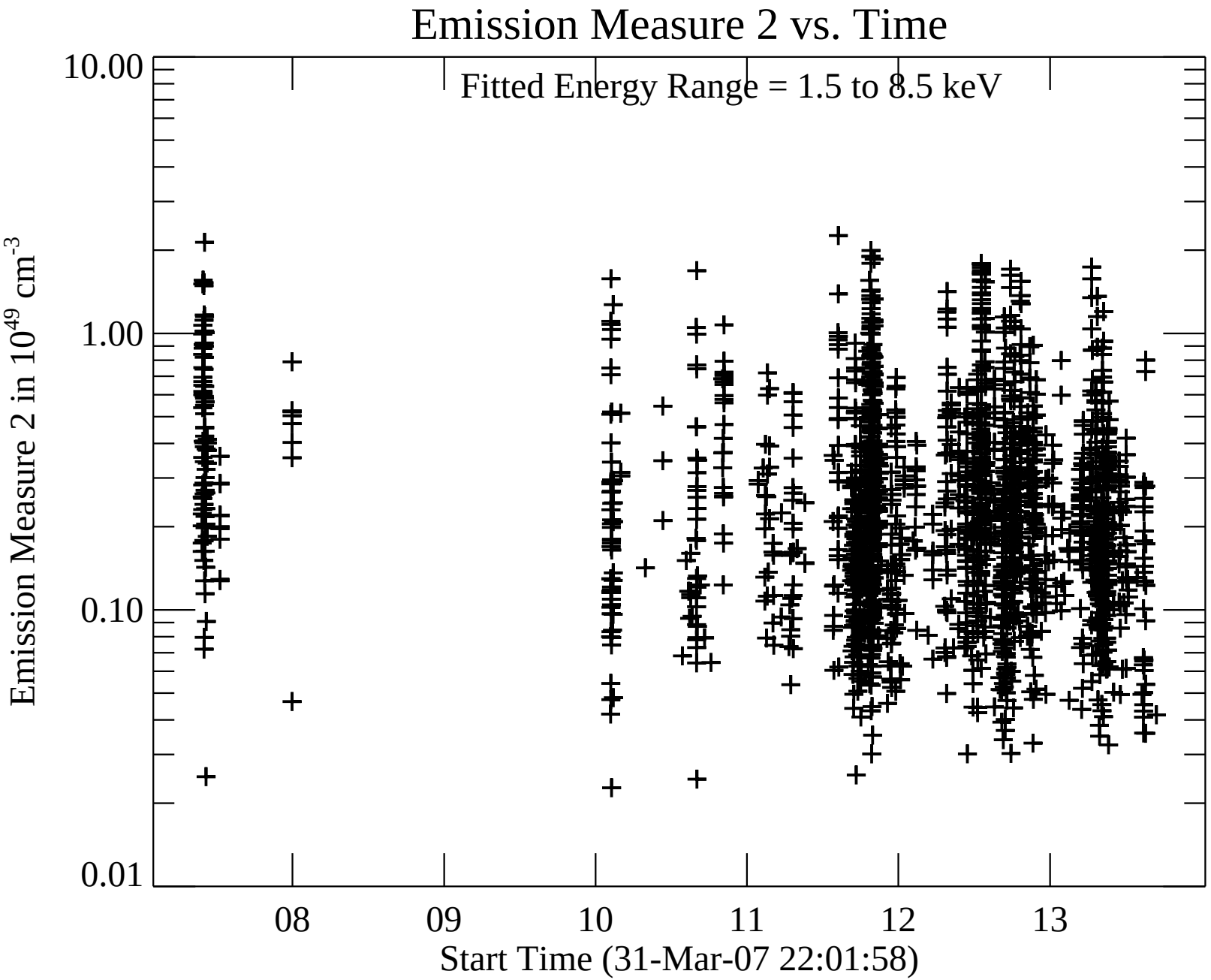
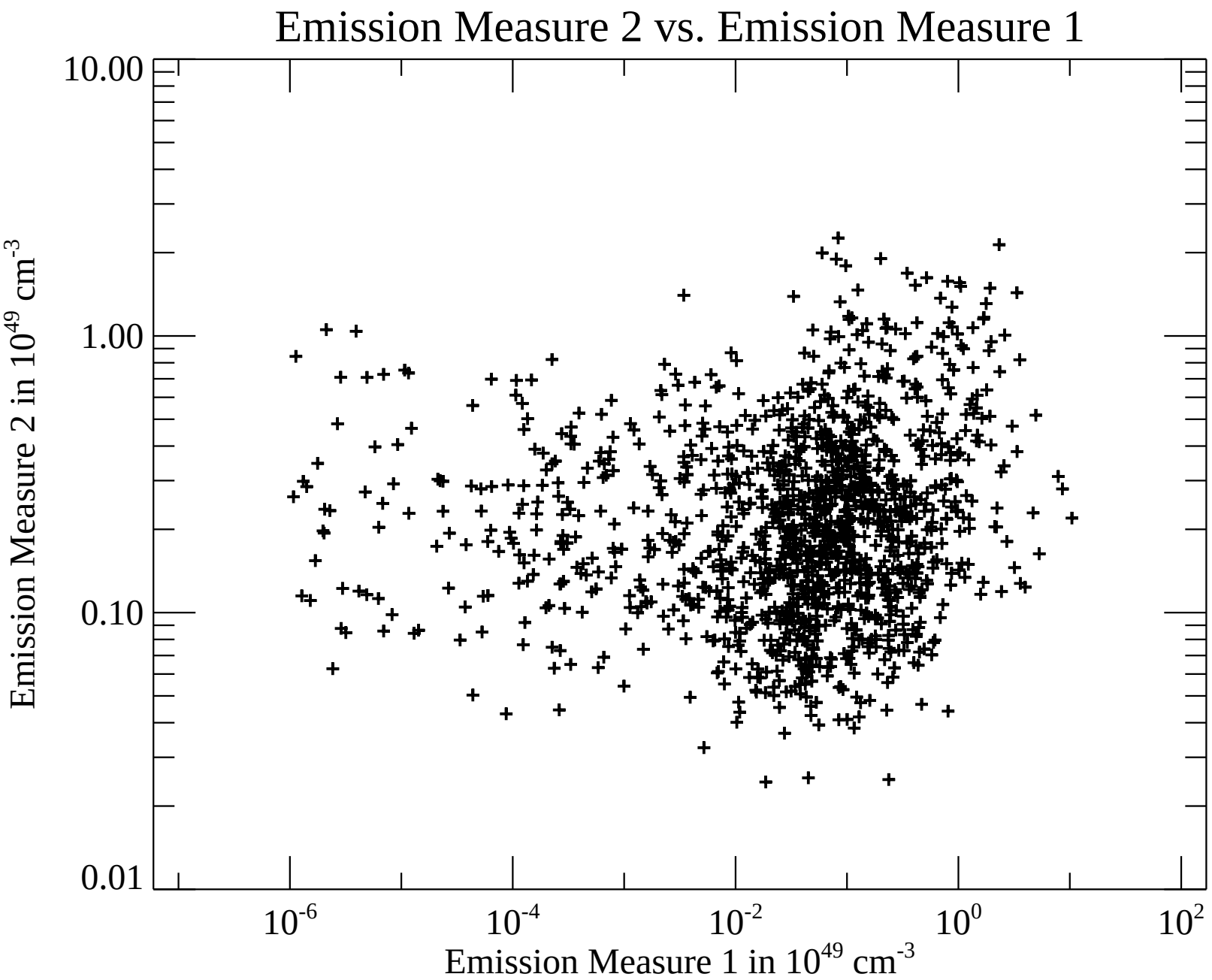
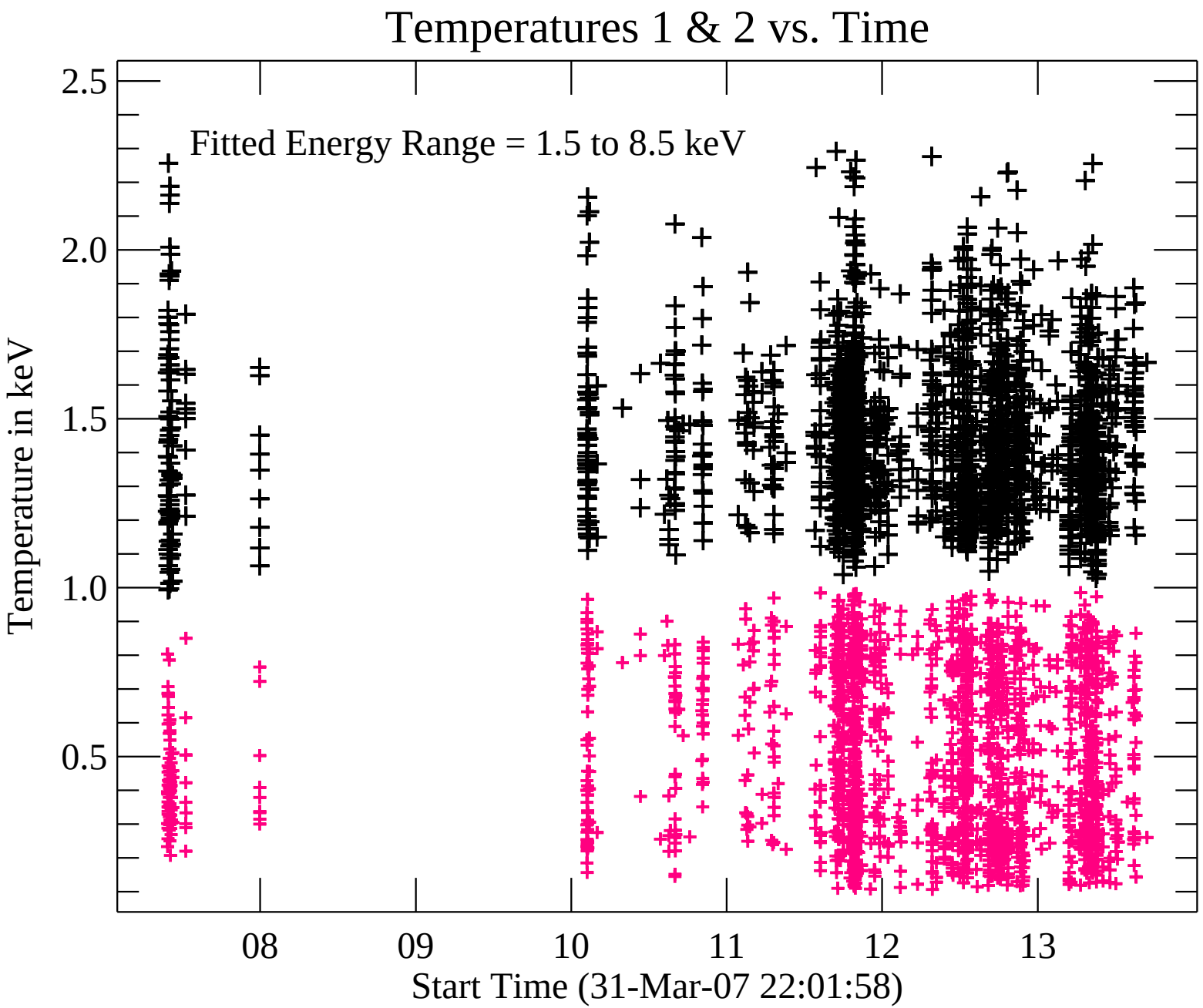
```
C:\Users\bdennis\OneDrive\NASA\Missions\Messenger\extended_2014\call_sax_long_21nov2014.pro
; Command to call SAX_long_ddMMMyyyy
; Time gaps in contiguous intervals lt 300 s.

dg = strarr(7) + '20140918' ; Date results fits files were generated for 1.5 to 8 keV fits with all abundances free
; dg = strarr(7) + '20140916' ; Date results fits files were generated for 5.5 to 8 keV fits with only Fe abundance free

 sax_long_21nov2014, s, $
  reread = 0, $              ; Read data from fits files if reread = 1
  ps_plot = 2, $ ; ps_plot = 0 for no plot, 1 for portrait, and 2 for lanscape mode
;  plot_no = '0_Fe_free', $ ; Text included in .ps, .txt, and .sav output file labels
  plot_no = '0_all_free', $ ; Text included in .ps, .txt, and .sav output file labels
  n_files_to_read = 10000, $  ; maximum number of files to read if available
  duration_min = 1.e20, $     ; Plot all events with durations >duration_min seconds
  path = 'C:\Users\bdennis\OneDrive\NASA\Missions\Messenger\', $
  current = 'extended_2014\', $
  results = 'results\', $
  data_folder = 'data\', $
  fit_function = '2vth_abun+drm_mod', $ ; Fit function used. Note: changed + to _ in sax_long_***.pro for use in file name.
;  year_of_data =   ['2012'], $
  year_of_data =   ['2007',   '2008',    '2009',   '2010',   '2011',   '2012',   '2013'], $ ; Year of data in file
;  date_generated = ['20140816'], $
;  date_generated = ['20140310', '20140310', '20140310','20140309', $
;                    '20140306', '20140307', '20140429'], $ ; Date when file generated
;  date_generated = ['20140504', '20140504', '20140504','20140504', $
;                    '20140504', '20140504', '20140504'], $ ; Date when file generated
;
;  date_generated = ['20140816', '20140816', '20140816','20140816', '20140816', $
;                    '20140816', '20140816'], $ ; Date when file generated
  date_generated = dg, $ ; Dates when files for each year were generated
;  year_of_data =   ['2012'], date_generated = ['20140307'], $
;  year_of_data =   ['2013'], date_generated = ['20140429'], $
;  year_of_data =   ['2007', '2010', '2011', '2012', '2013'], $
;  date_generated = ['20140310', '20140309', '20140306', '20140307', '20140310'], $
;  bad_dates = [['01-jan-2000', '02-jan-2000'], ['01-jan-2001', '02-jan-2001']], $ ; dummy bad dates
  bad_dates = [['08-mar-2011', '09-mar-2011'], ['07-jun-2011', '17-jun-2011'], ['02-aug-2011', '06-aug-2011'], $
               ['30-aug-2011', '10-sep-2011'], ['22-sep-2011', '25-sep-2011'], $
               ['04-oct-2011', '08-oct-2011'], ['14-oct-2011', '16-oct-2011'], $
               ['04-nov-2011', '06-nov-2011'], ['17-nov-2011', '19-nov-2011'], $
               ['02-jan-2012', '03-jan-2012'], ['23-jan-2012', '06-feb-2012'], $
               ['02-mar-2012', '07-mar-2012'], ['17-may-2012', '19-may-2012'], $
               ['27-may-2012', '30-may-2012'], ['02-jul-2012', '08-jul-2012'], $
               ['12-jul-2012', '15-jul-2012'], ['11-sep-2012', '12-sep-2012'], $
               ['19-sep-2012', '24-sep-2012'], ['08-oct-2012', '10-oct-2012'], $
               ['14-oct-2012', '15-oct-2012'], $
               ['16-mar-2013', '17-mar-2013'], ['21-jun-2013', '24-jun-2013'], ['20-aug-2013', '23-aug-2013']], $
  instrument = 'SAX', $
  n_spectra = 20, $          ; Not currently used
  e_bk = [1.5, 5.3], $       ; Energy range for background flux
  mm_temp1 = [0.1, 8.0], $   ; Minimum and maximum temperature (T1 in keV) allowed
  mm_em1 = [0.001, 100.0], $  ; Minimum and maximum emission measure (EM1 in 10^49 cm^-3) allowed
```

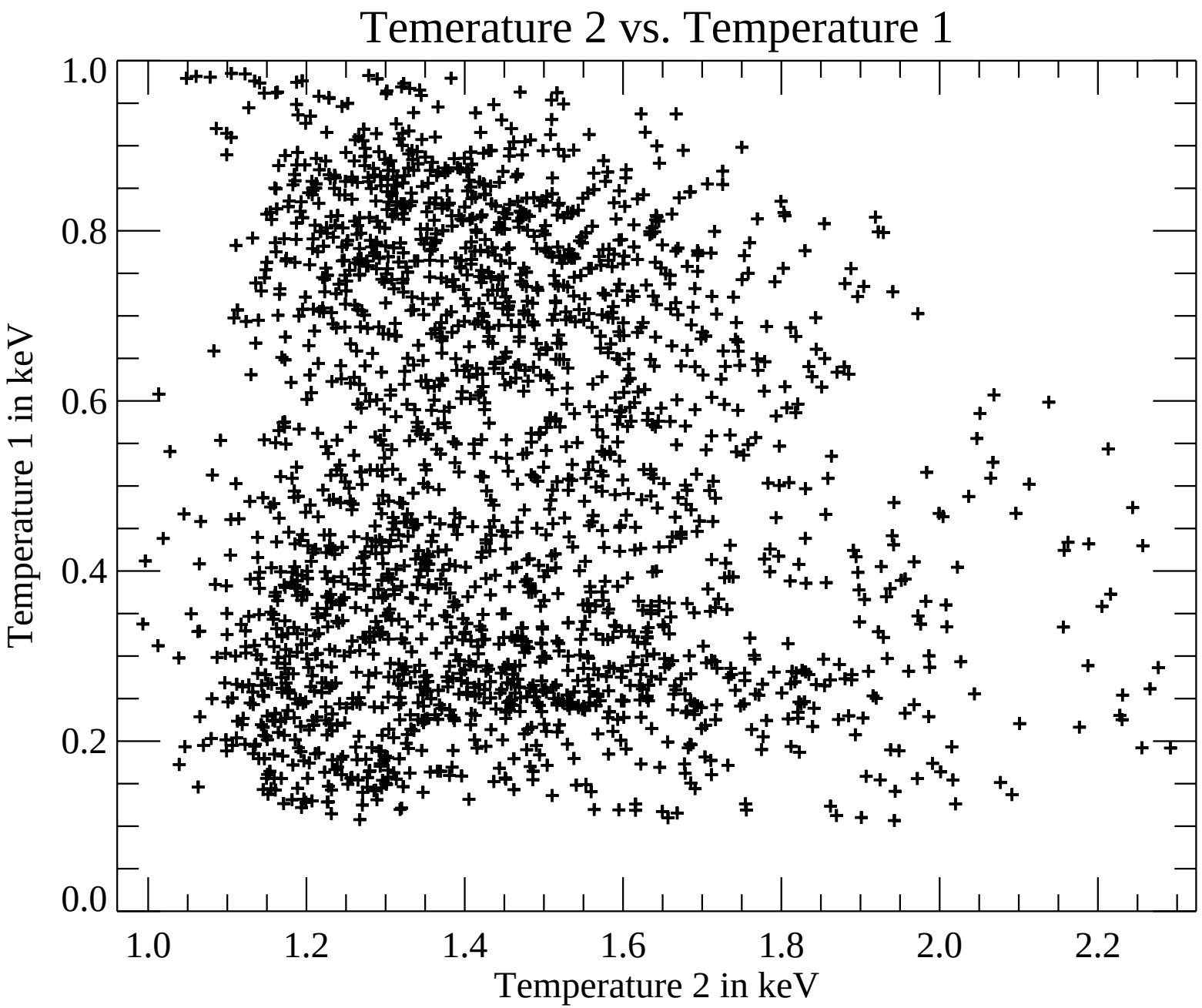
```
  mm_temp2 = [0.5, 2.5], $    ; Minimum and maximum temperature (T2 in keV) allowed
  mm_em2 = [0.01, 2.5], $   ; Minimum and maximum emission measure (EM2 in 10^49 cm^-3) allowed
  mm_67 = [0.1, 10.0], $     ; Minimum and maximum count flux at 6.7 keV (in counts s^-1 cm^-2 keV^-1) allowed
  mm_duration = [300.0, 10000.0], $ ; Minimum and maximum duration allowed
  mm_chi = [0.5, 1.8],  $     ; Minimum and maximum value of chi_squared allowed
;  mm_temp = [0.0, 2.0], $    ; Dummy minimum and maximum temperature (in keV) allowed
;  mm_em = [0.0001, 100.0], $ ; Minimum and maximum emission measure (in 10^49 cm^-3) allowed
;  mm_67 = [0.3, 10000.0], $  ; Minimum and maximum count flux at 6.7 keV (in counts s^-1 cm^-2 keV^-1) allowed
;  mm_chi = [0.005, 100.5], $ ; Minimum and maximum value of chi_squared allowed
  fe_pd_w = [[2.6, 0.6], [1.17, 0.22]], $  ; Fe abundance with +/-1-sigma uncertainty relative to the Asplund (2009) photospheric value
                          ; Phillips and Dennis (ApJ, 748:52, 2012), Warren (ApJL, 786:L2, May 2014)
  cor_to_photo = [3.98, 3.89, 1.41, 3.89, 1.51, 3.55] ; Ratio of CHIANTI coronal to Asplund et al. (2009) photospheric abundances
                                      ;  for Fe, Ca, S, Si, Ar, and Mg
  end

Fitted Energy Range = 1.5 to 8.5 keV
Fit function = 2vth_abun+drm_mod
Starting parameters = 0.0,0.5,2.0,1.5,0.5,1.0,1.0,0.4,1.0,1.0,1.0,0.0,1.0
Free mask =    1   1   1   1   1   1   1   1   1   0   1   1   1

Procedure started on Mon Dec 01 15:15:25 2014

Total number of spectra analyzed = 2067
Number of spectra analyzed with EM1 > 0.0 = 1345
Fraction of spectra analyzed with EM1 > 0.0 = 0.65

Total number of flares analyzed = 657
Number of long events included in abundance averages = 527
```

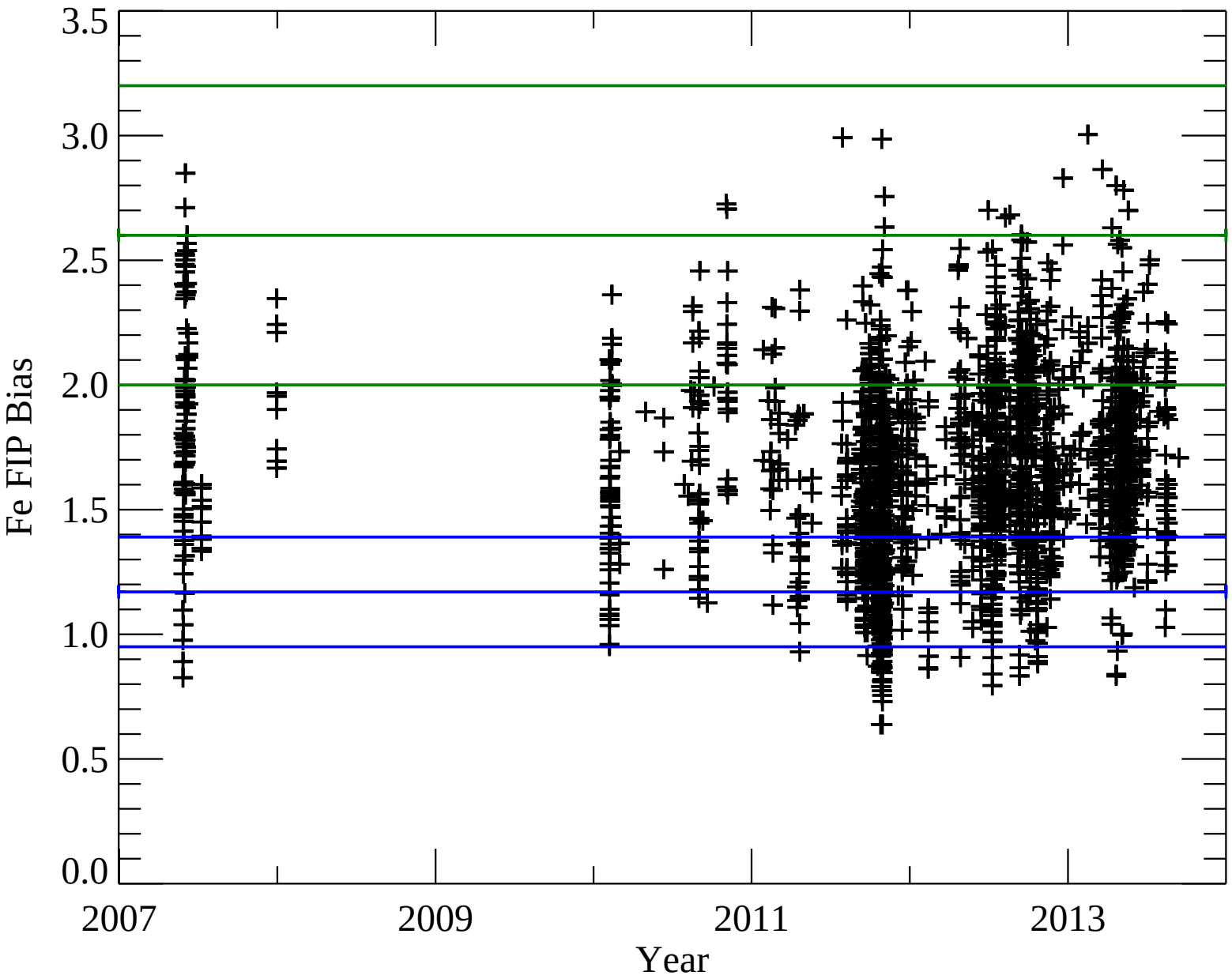

Emission Measure 1 vs. Time
Fitted Energy Range = 1.5 to 8.5 keV
Emission Measure 1 in 10^{49} cm^{-3}
10.00
1.00
0.10
0.01
08
09
10
11
12
13
Start Time (31-Mar-07 22:01:58)

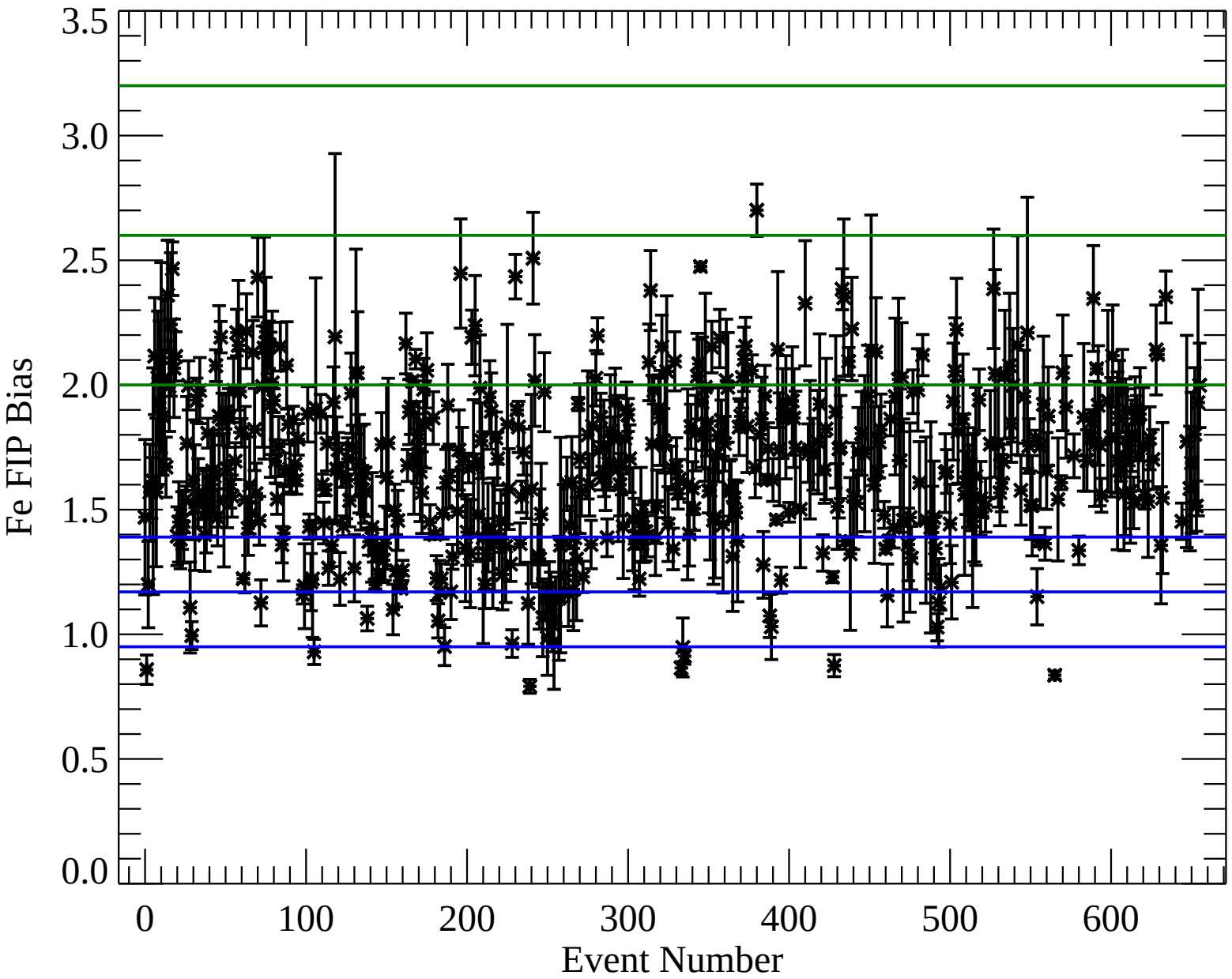

Emission Measure 2 vs. Time
Fitted Energy Range = 1.5 to 8.5 keV
10.00
1.00
0.10
0.01
Emission Measure 2 in 10^49 cm^-3
08
09
10
11
12
13
Start Time (31-Mar-07 22:01:58)

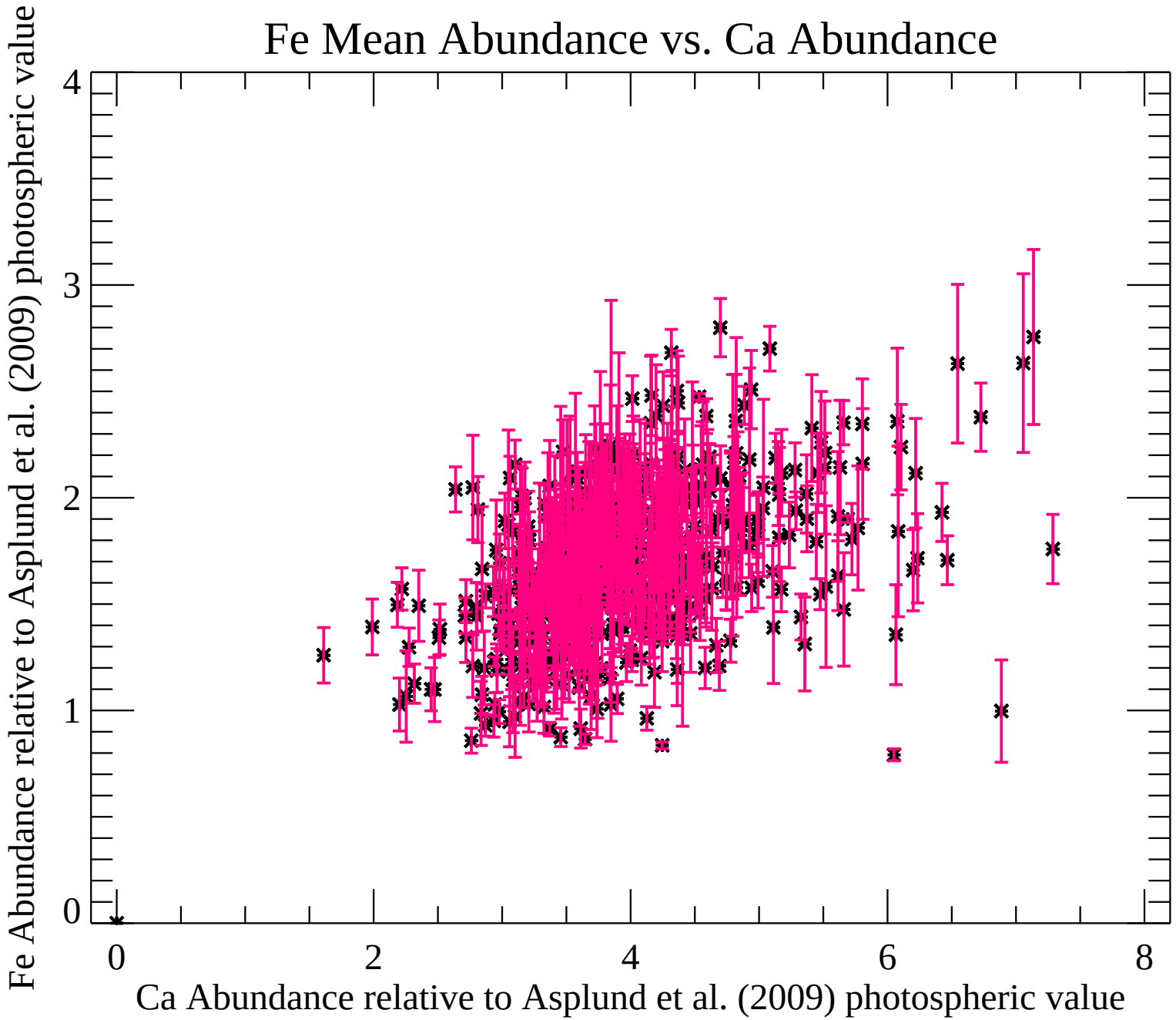

Emission Measure 2 vs. Emission Measure 1
10.00
1.00
0.10
0.01
Emission Measure 2 in 10^49 cm^-3
10^-6
10^-4
10^-2
10^0
10^2
Emission Measure 1 in 10^49 cm^-3

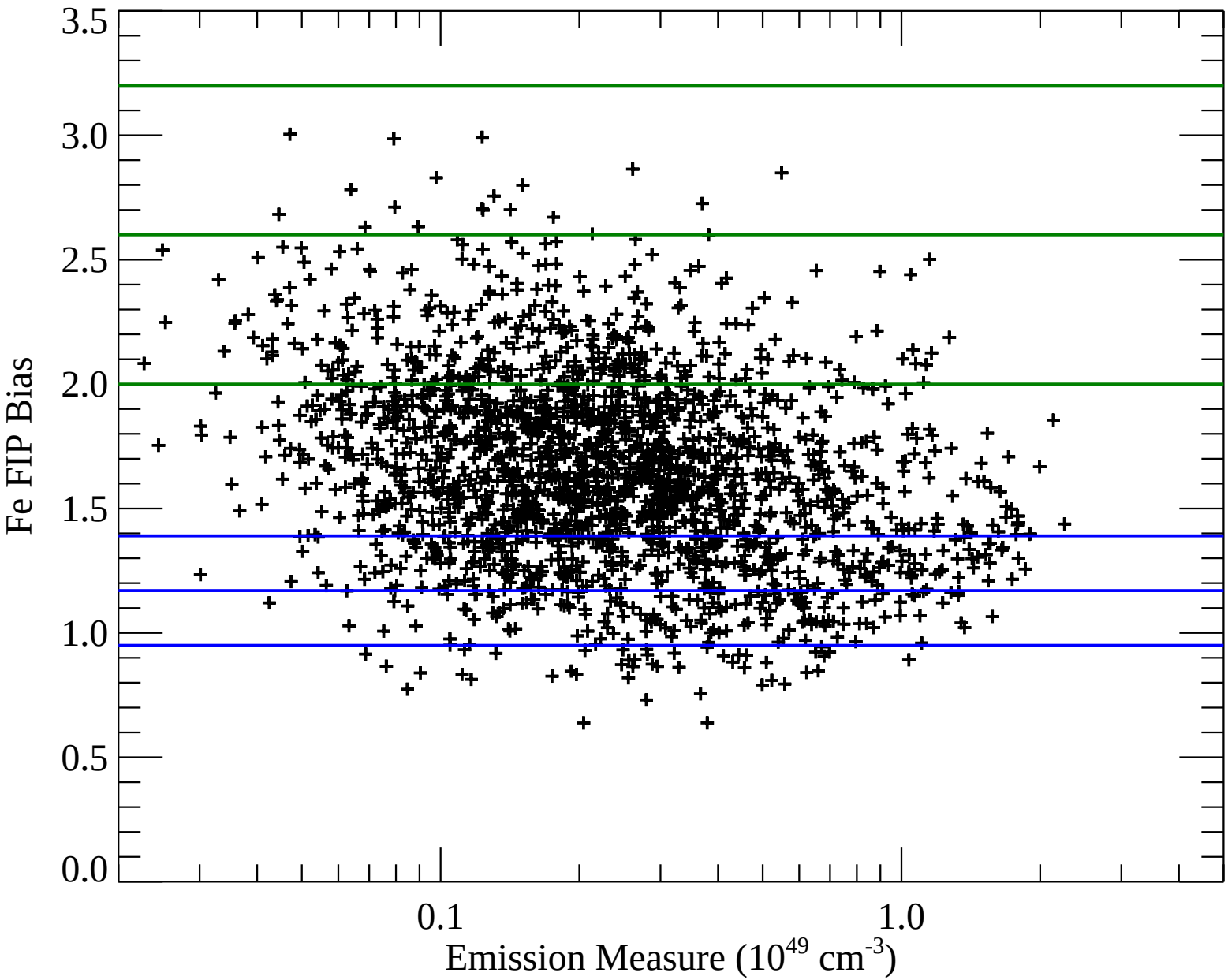

Temperatures 1 & 2 vs. Time
Fitted Energy Range = 1.5 to 8.5 keV
Temperature in keV
2.5
2.0
1.5
1.0
0.5
08
09
10
11
12
13
Start Time (31-Mar-07 22:01:58)

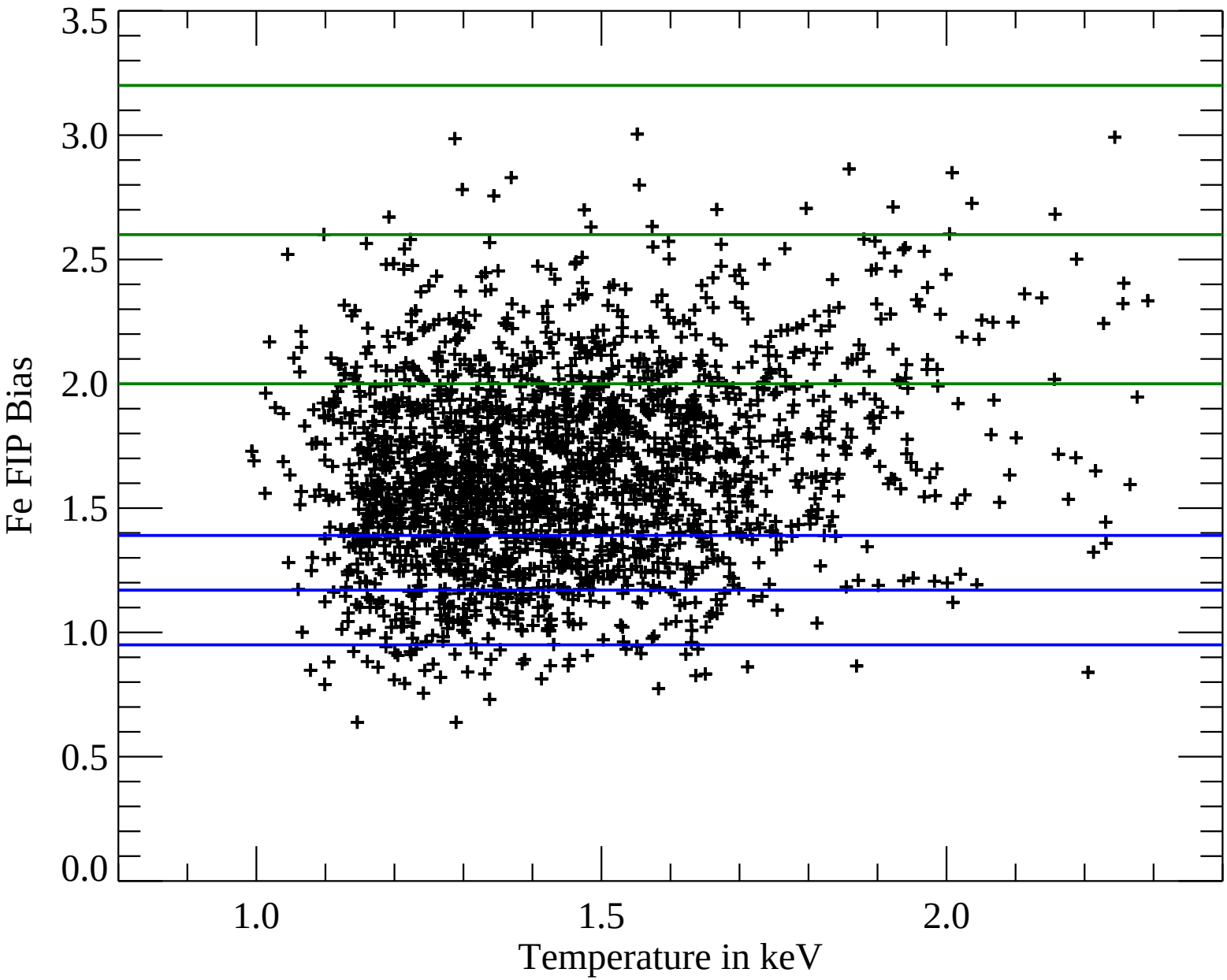

Temerature 2 vs. Temperature 1
Temperature 1 in keV
1.0
0.8
0.6
0.4
0.2
0.0
1.0
1.2
1.4
1.6
1.8
2.0
2.2
Temperature 2 in keV

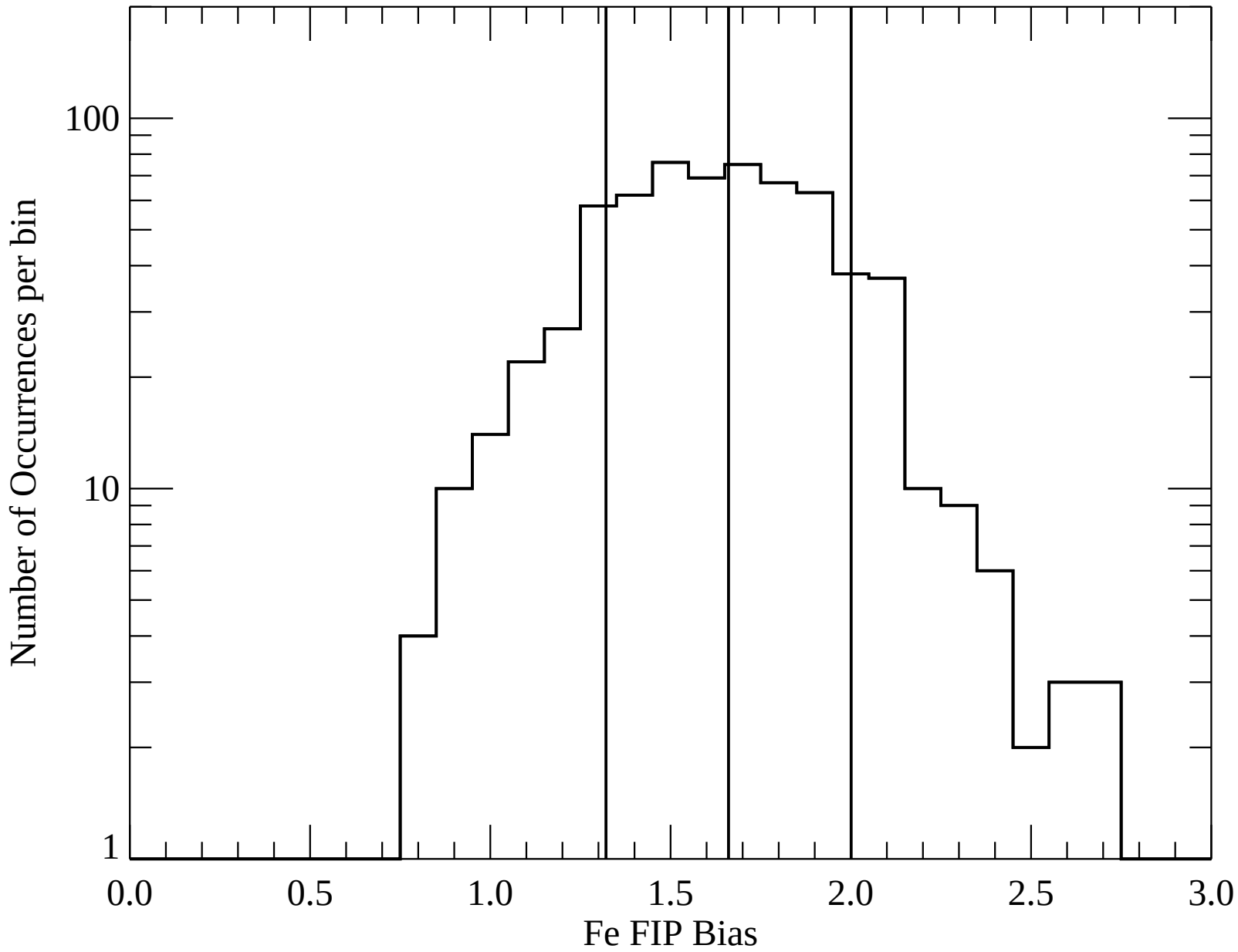

3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fe FIP Bias
2007
2009
2011
2013
Year

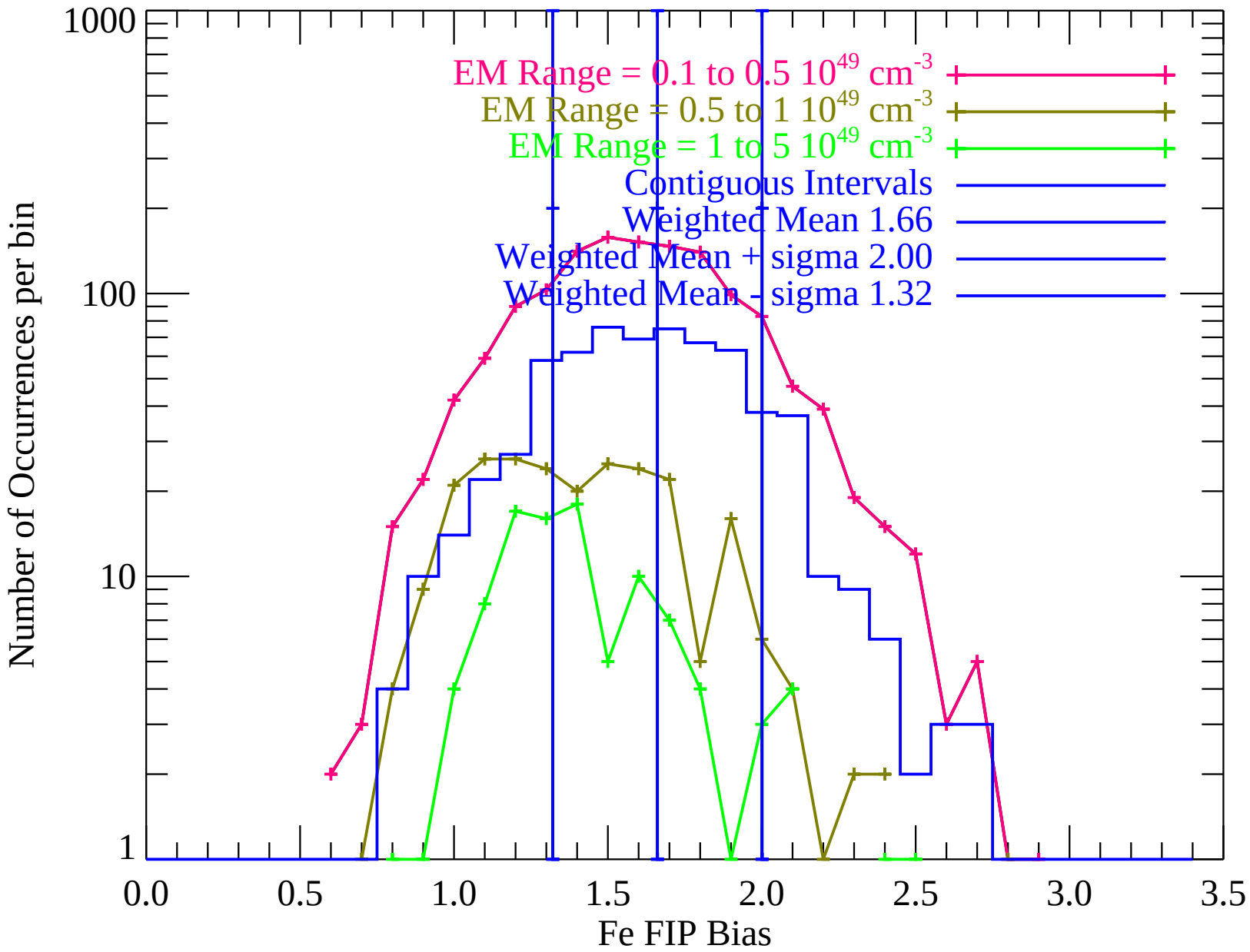

3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fe FIP Bias
0
100
200
300
400
500
600
Event Number

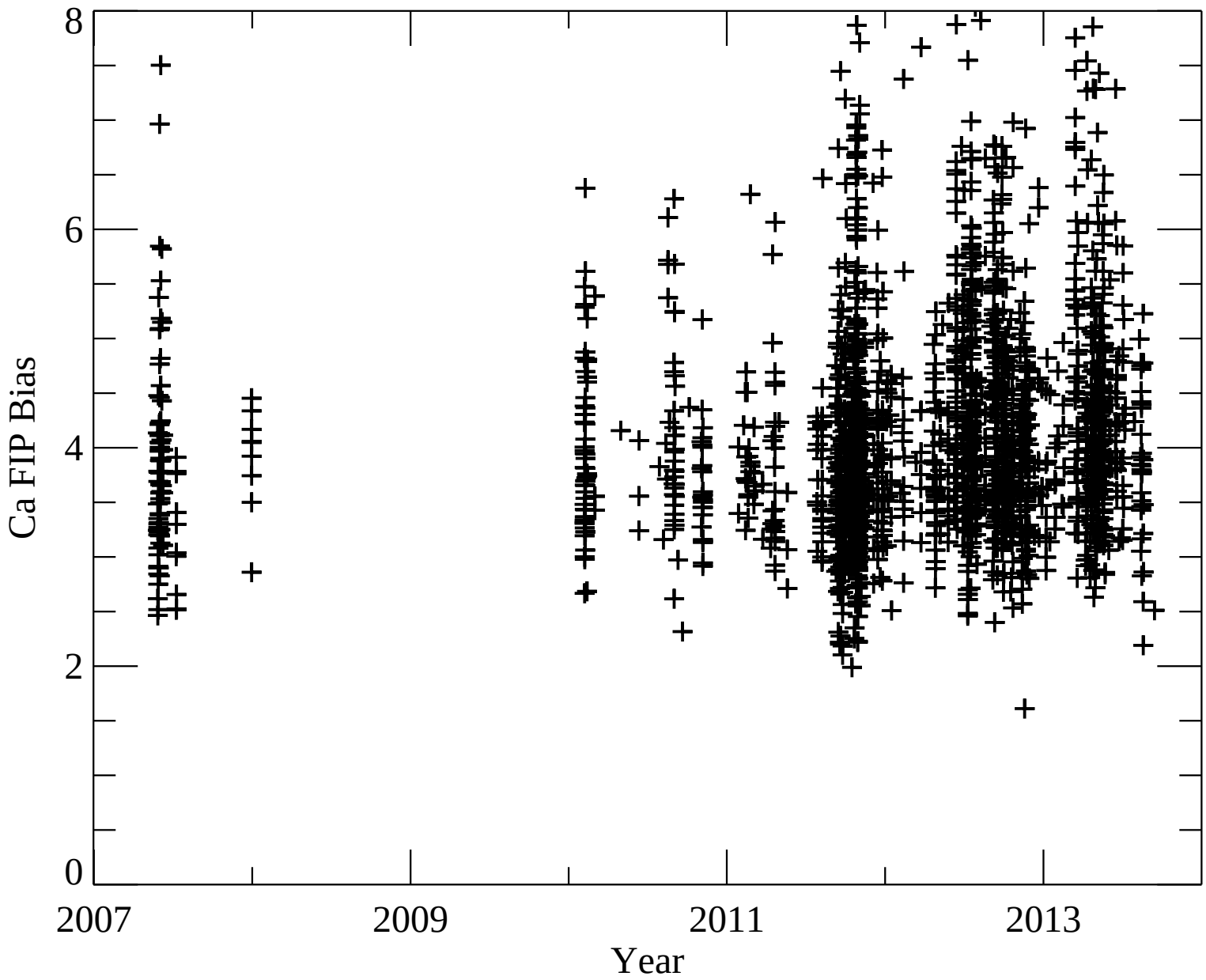

Fe Mean Abundance vs. Ca Abundance
Fe Abundance relative to Asplund et al. (2009) photospheric value
Ca Abundance relative to Asplund et al. (2009) photospheric value
0
1
2
3
4
0
2
4
6
8

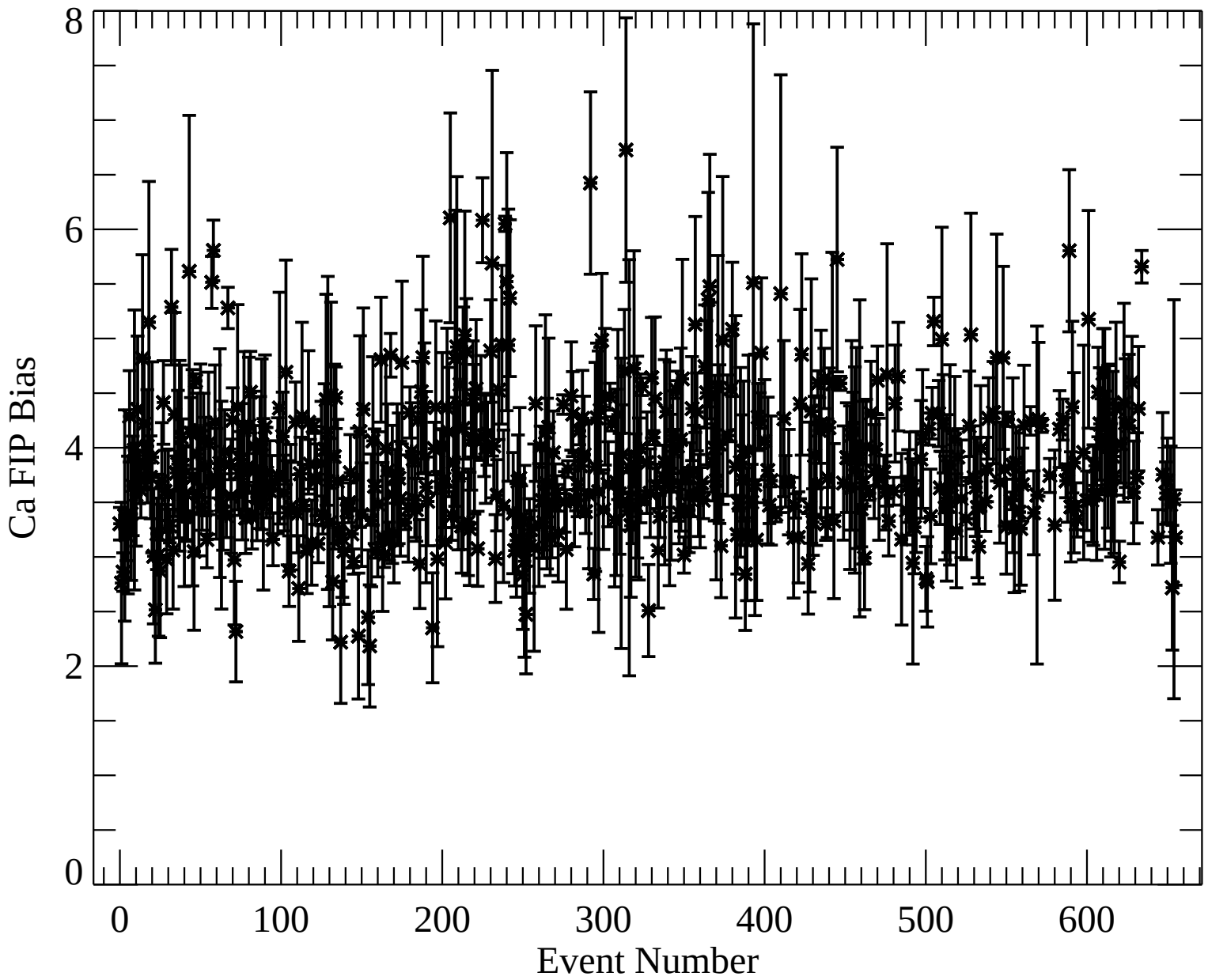

3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fe FIP Bias
0.1
1.0
Emission Measure (10^{49} cm^{-3})

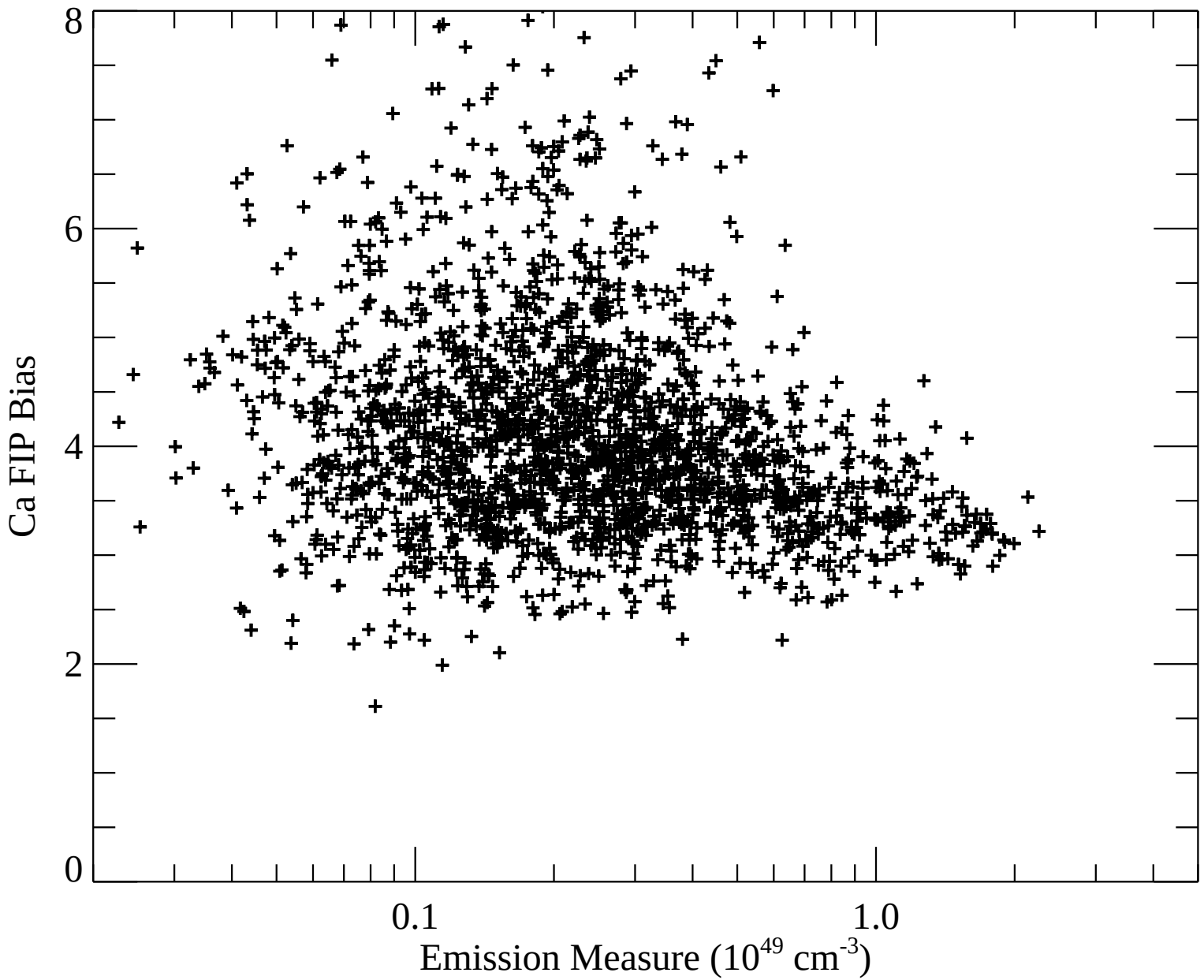

3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fe FIP Bias
1.0
1.5
2.0
Temperature in keV

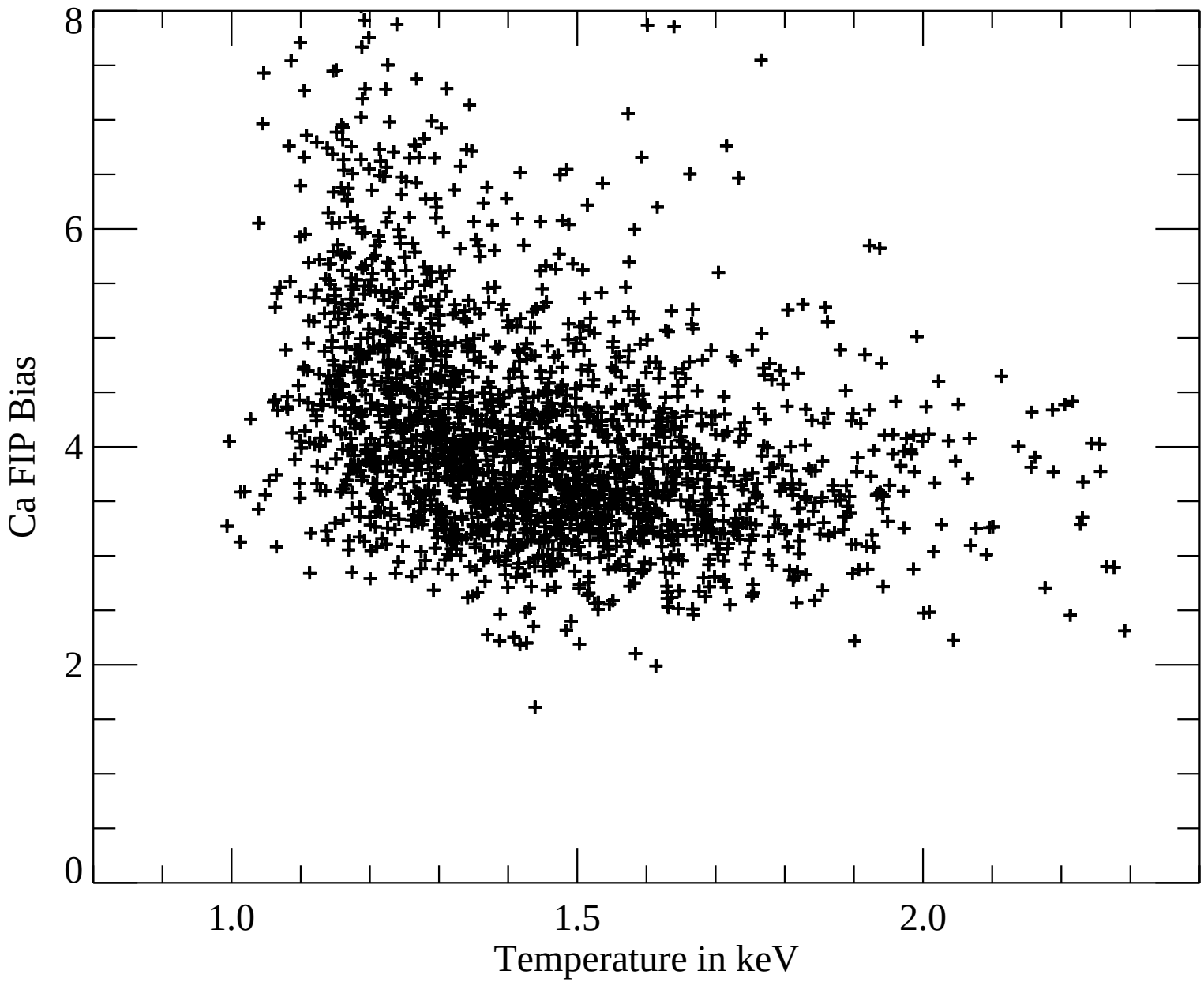

100
10
1
Number of Occurrences per bin
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Fe FIP Bias


1000
100
10
1
Number of Occurrences per bin
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Fe FIP Bias
EM Range = 0.1 to 0.5 10^49 cm^-3
EM Range = 0.5 to 1 10^49 cm^-3
EM Range = 1 to 5 10^49 cm^-3
Contiguous Intervals
Weighted Mean 1.66
Weighted Mean + sigma 2.00
Weighted Mean - sigma 1.32

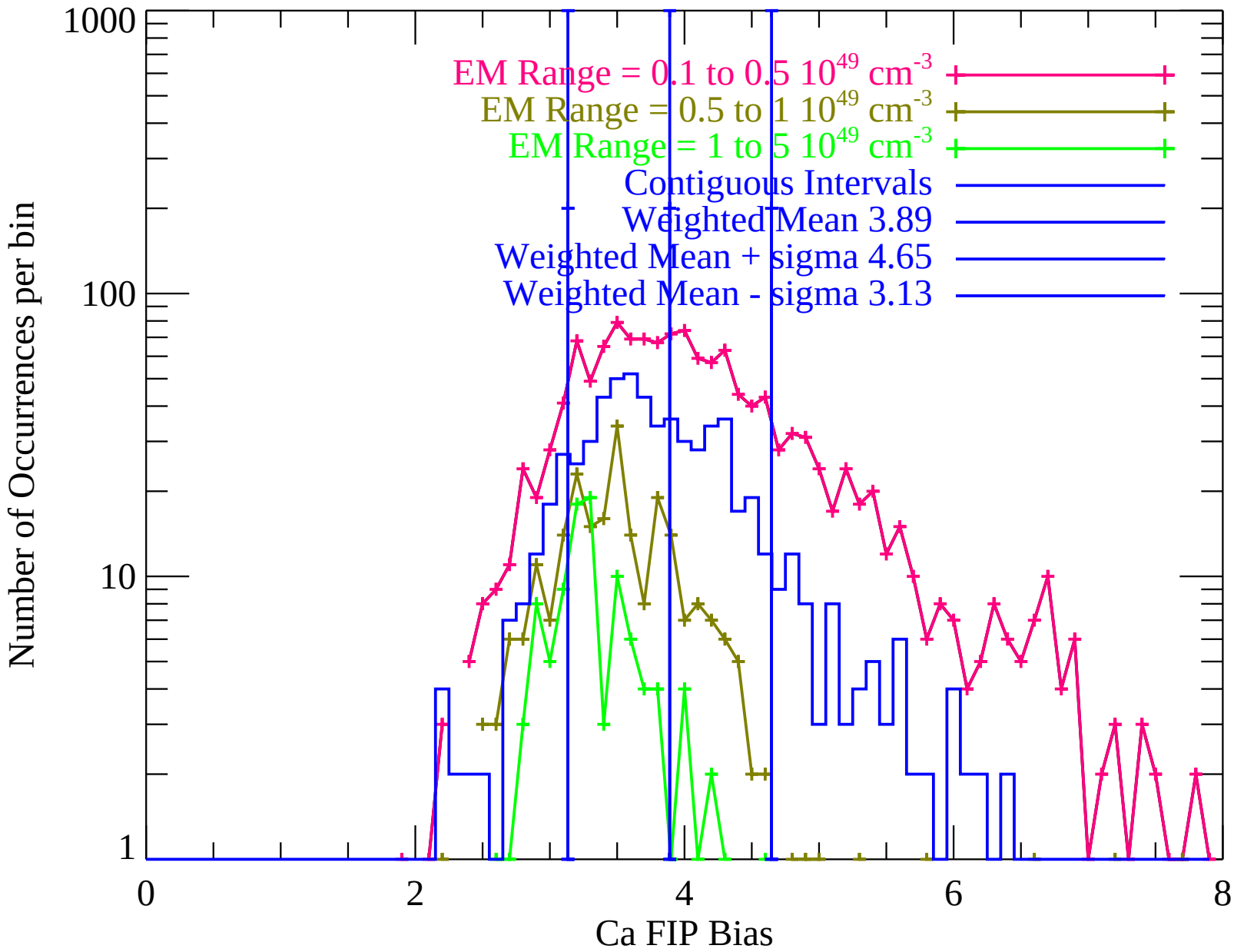

8
6
4
2
0
Ca FIP Bias
2007
2009
2011
2013
Year

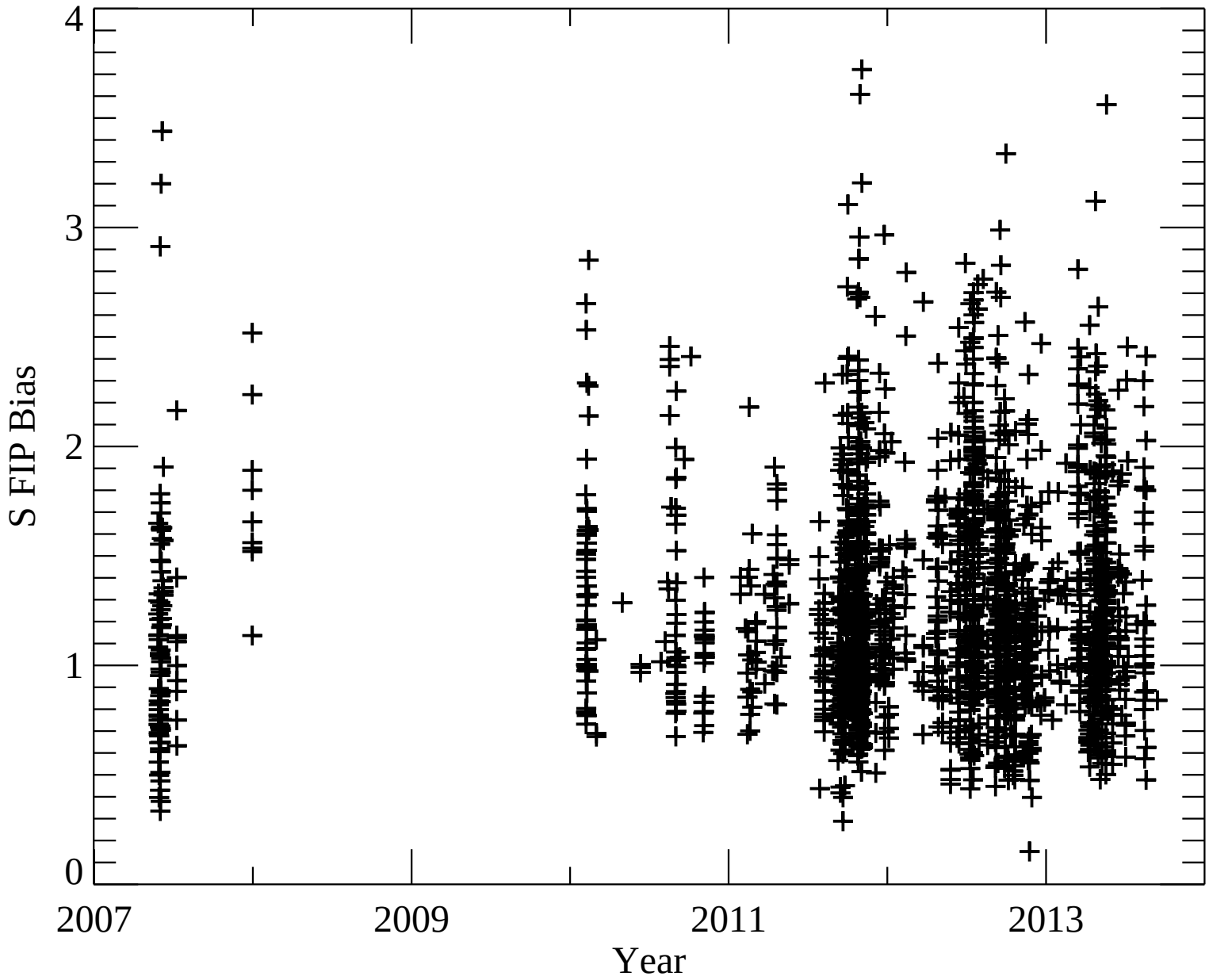

8
6
4
2
0
Ca FIP Bias
0
100
200
300
400
500
600
Event Number

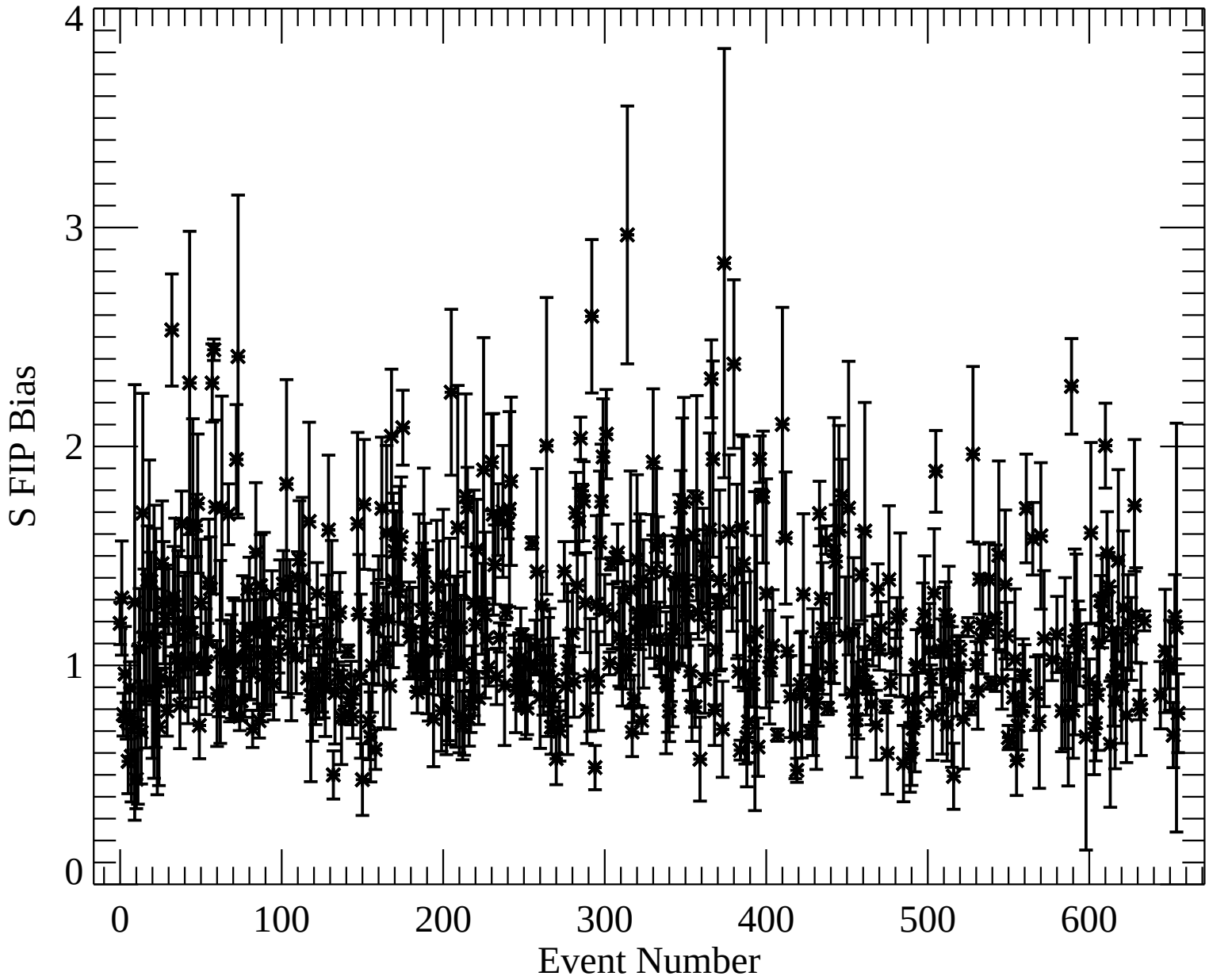

8
6
4
2
0
Ca FIP Bias
0.1
1.0
Emission Measure (10^{49} cm^{-3})

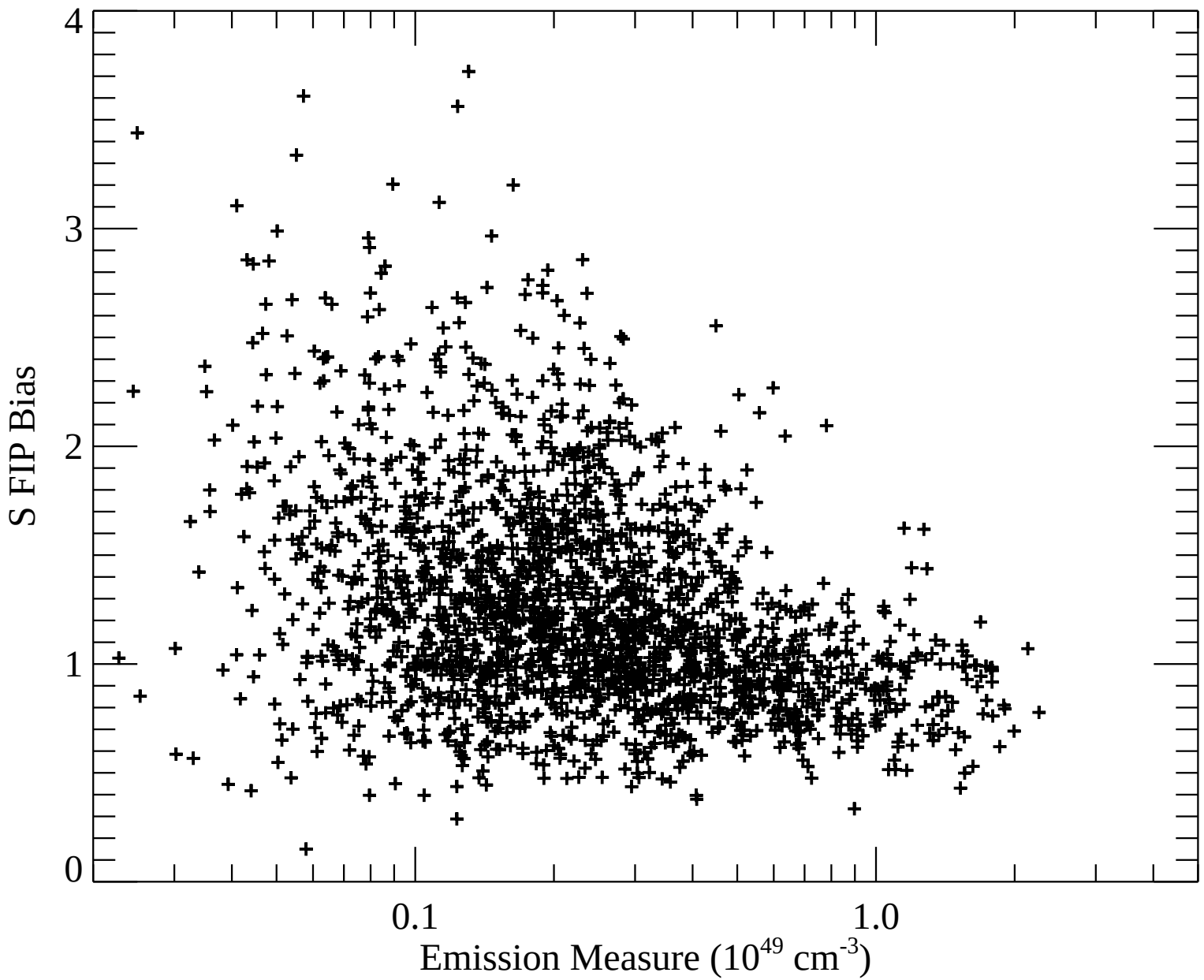

8
6
4
2
0
Ca FIP Bias
1.0
1.5
2.0
Temperature in keV

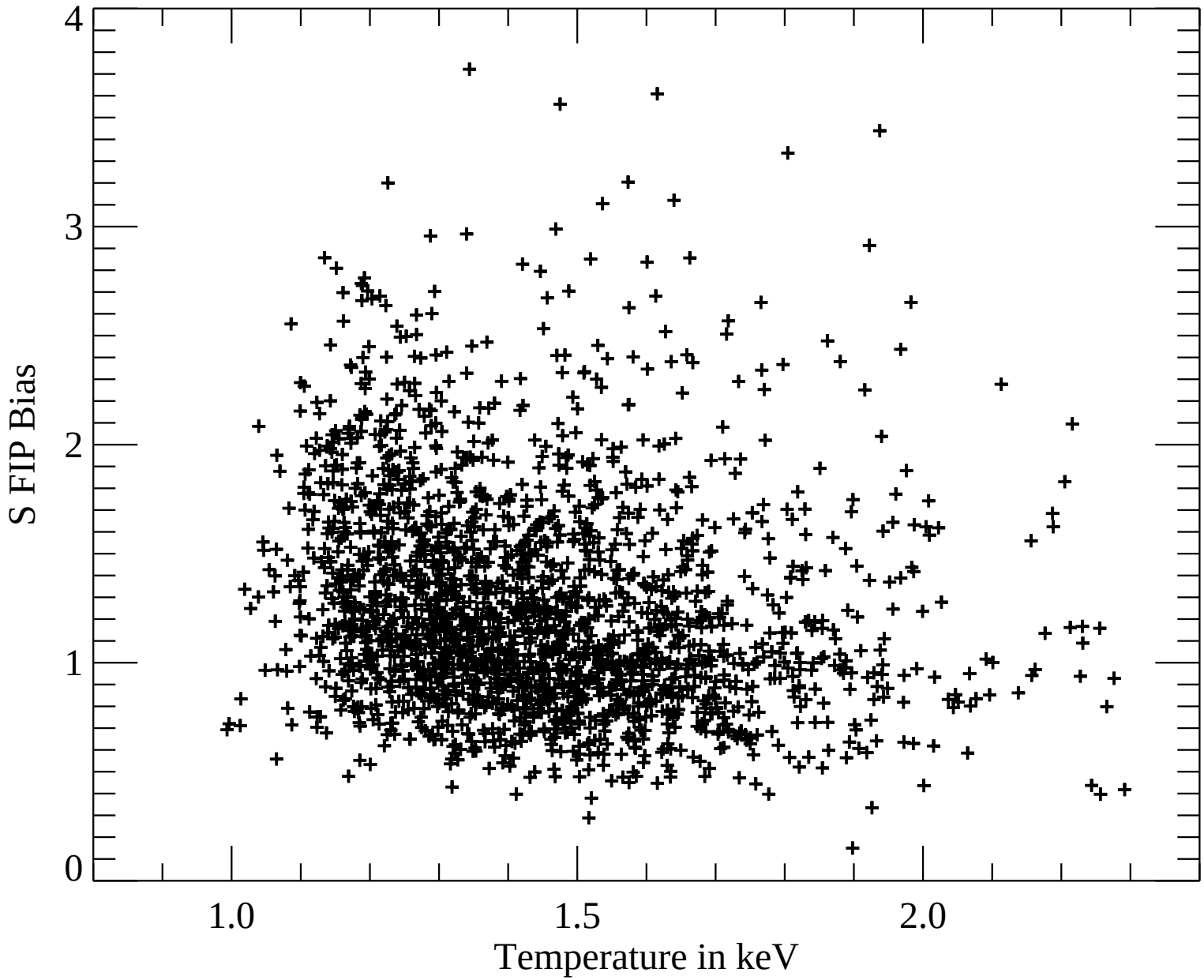
Ca FIP Bias
0
1
2
3
4
5
6
7
1
10
100
Number of Occurrences per bin


1000
100
10
1
0
2
4
6
8
Number of Occurrences per bin
Ca FIP Bias
EM Range = 0.1 to 0.5 10^49 cm^-3
EM Range = 0.5 to 1 10^49 cm^-3
EM Range = 1 to 5 10^49 cm^-3
Contiguous Intervals
Weighted Mean 3.89
Weighted Mean + sigma 4.65
Weighted Mean - sigma 3.13

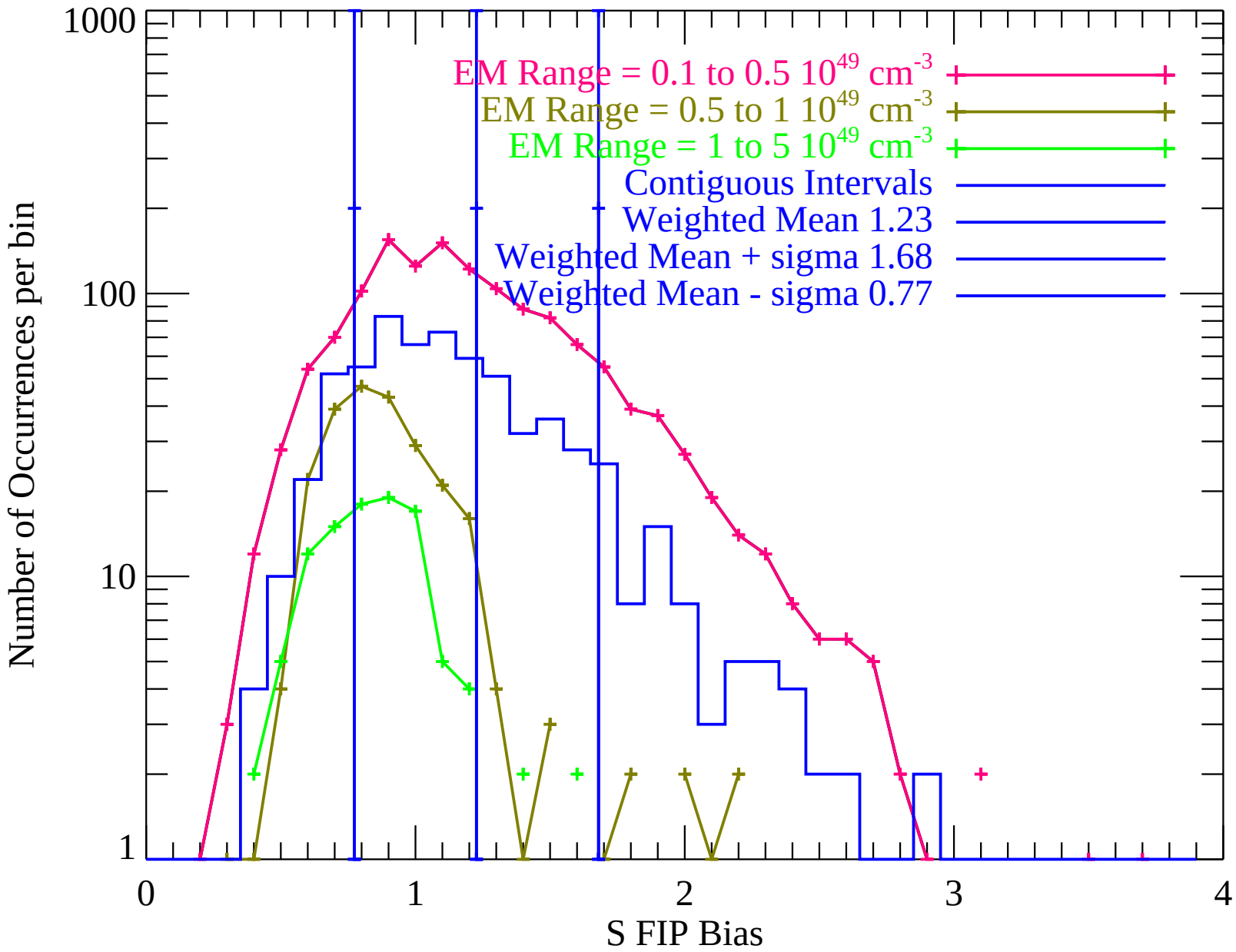

S FIP Bias
0
1
2
3
4
2007
2009
2011
2013
Year

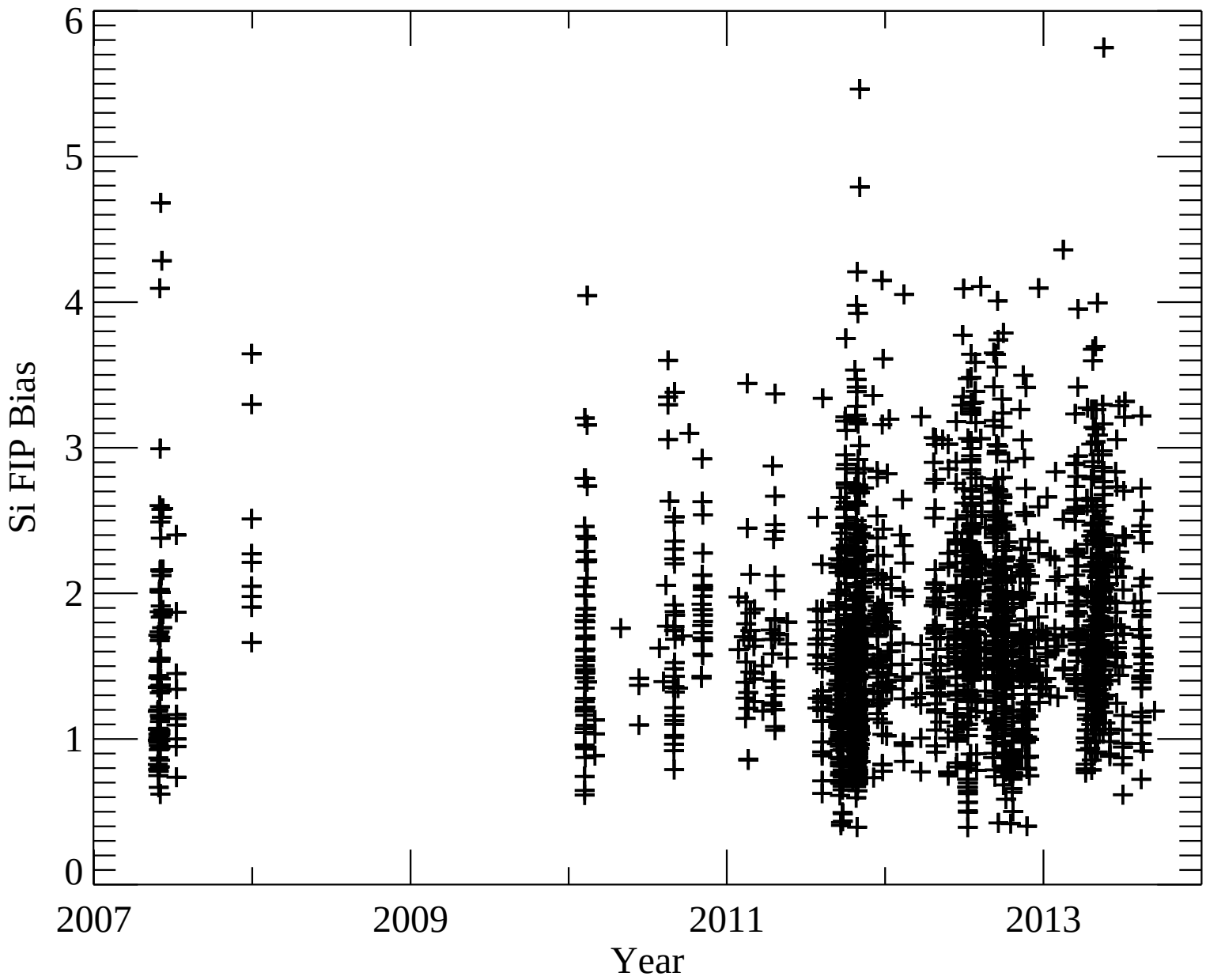

S FIP Bias
Event Number
0
1
2
3
4
0
100
200
300
400
500
600

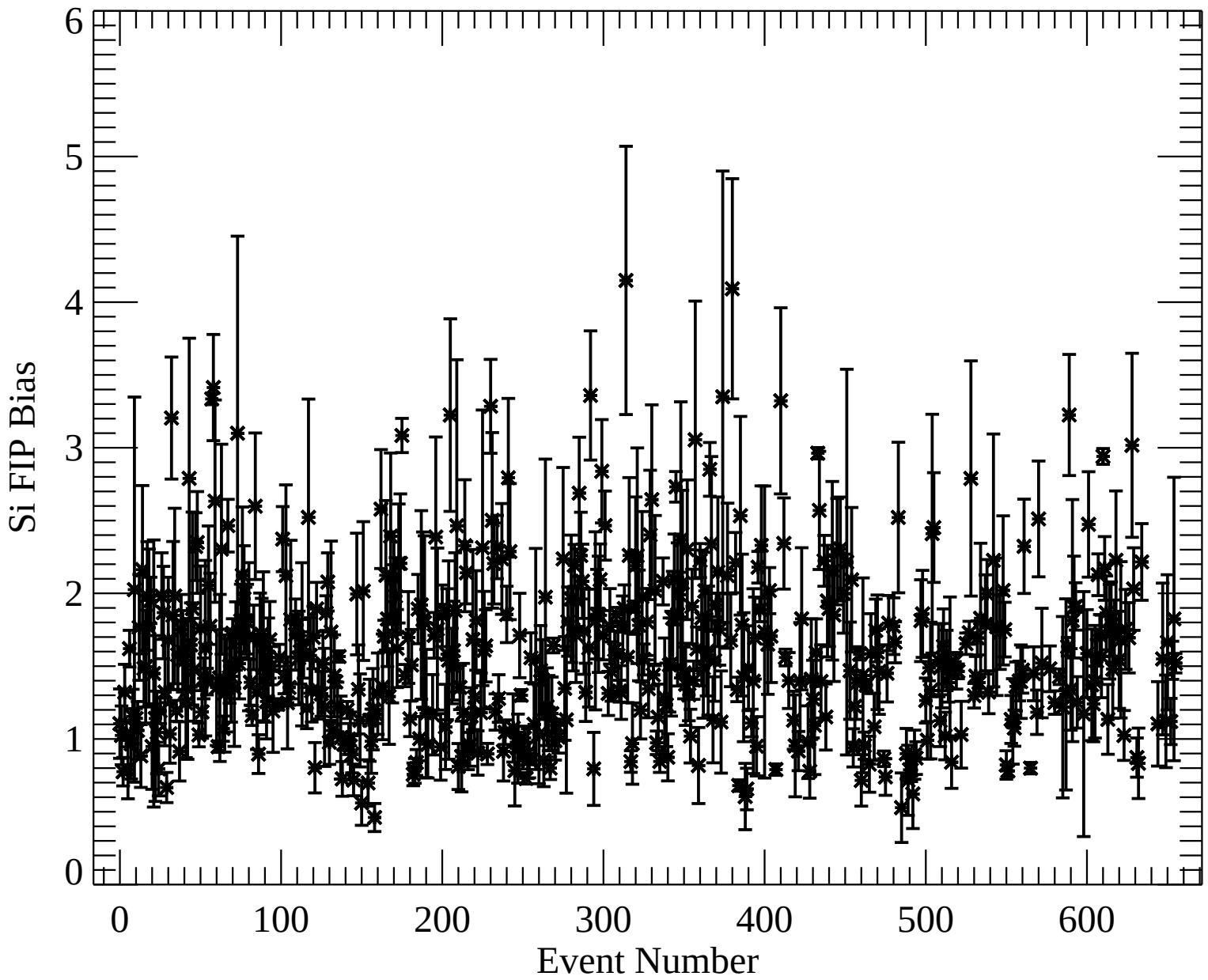

4
3
2
1
0
S FIP Bias
0.1
1.0
Emission Measure (10^{49} cm^{-3})

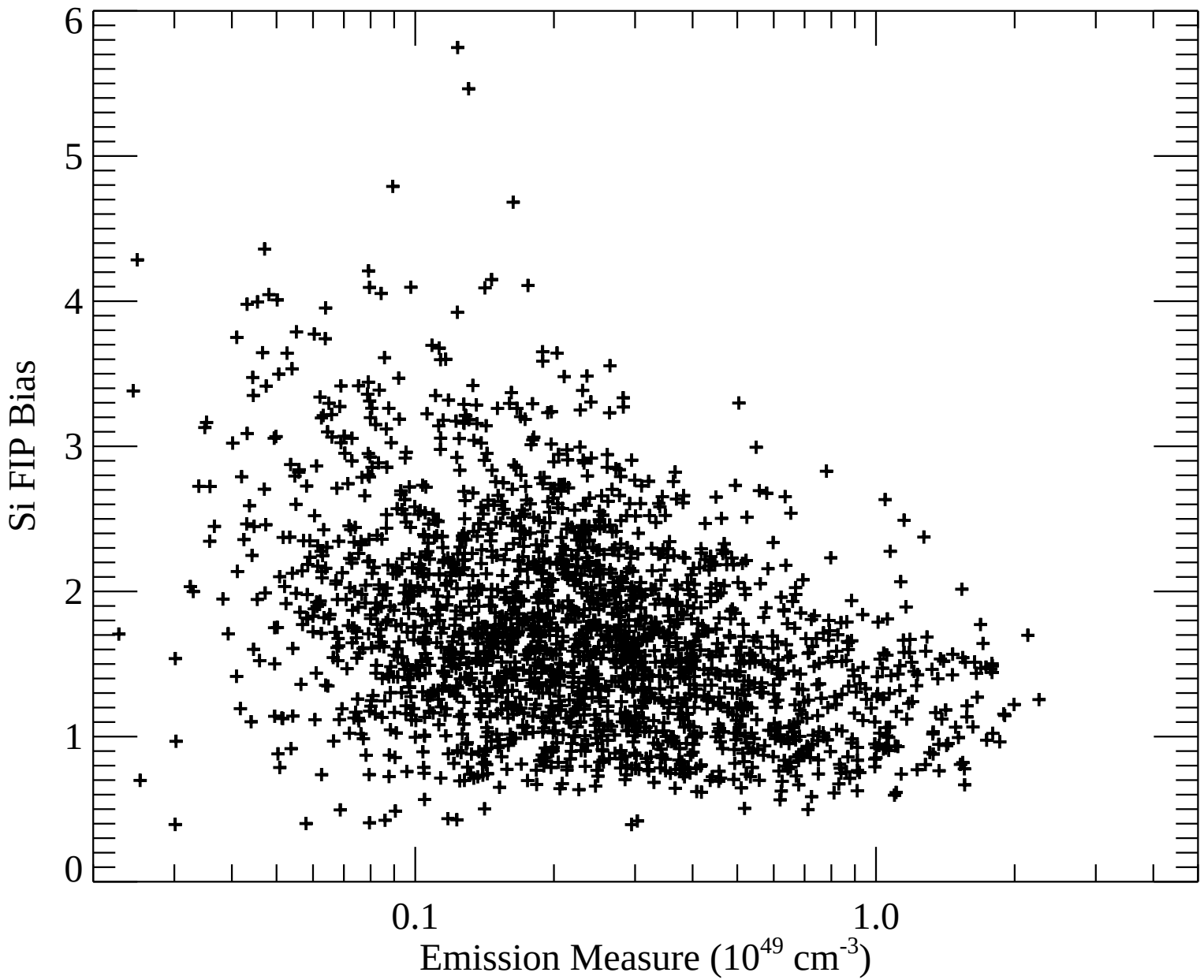

S FIP Bias
0
1
2
3
4
1.0
1.5
2.0
Temperature in keV

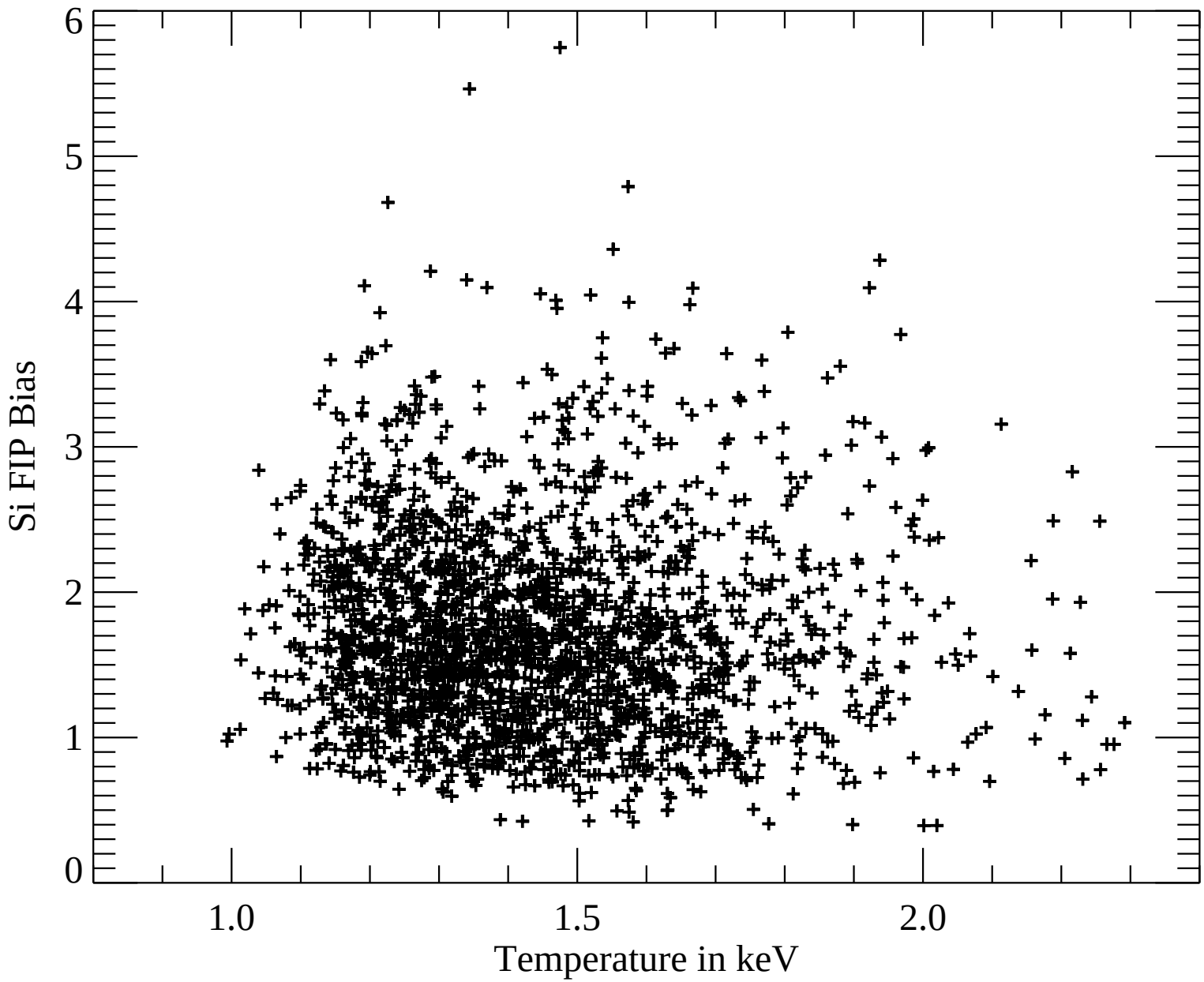
S FIP Bias
0
1
2
3
4
5
6
7
Number of Occurrences per bin
1
10
100


1000
100
10
1
0
1
2
3
4
Number of Occurrences per bin
S FIP Bias
EM Range = 0.1 to 0.5 10^49 cm^-3
EM Range = 0.5 to 1 10^49 cm^-3
EM Range = 1 to 5 10^49 cm^-3
Contiguous Intervals
Weighted Mean 1.23
Weighted Mean + sigma 1.68
Weighted Mean - sigma 0.77

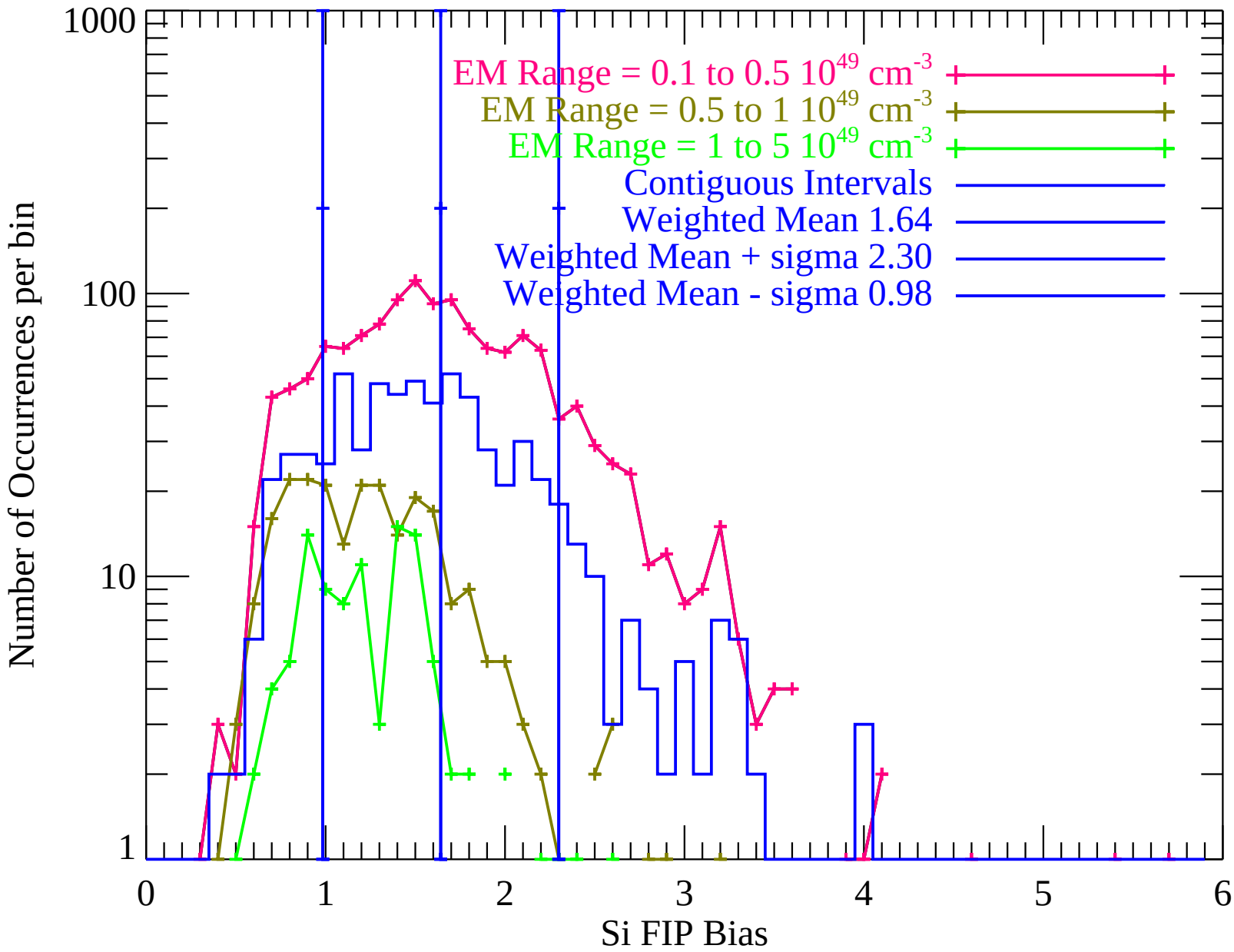

Si FIP Bias
Year
0
1
2
3
4
5
6
2007
2009
2011
2013

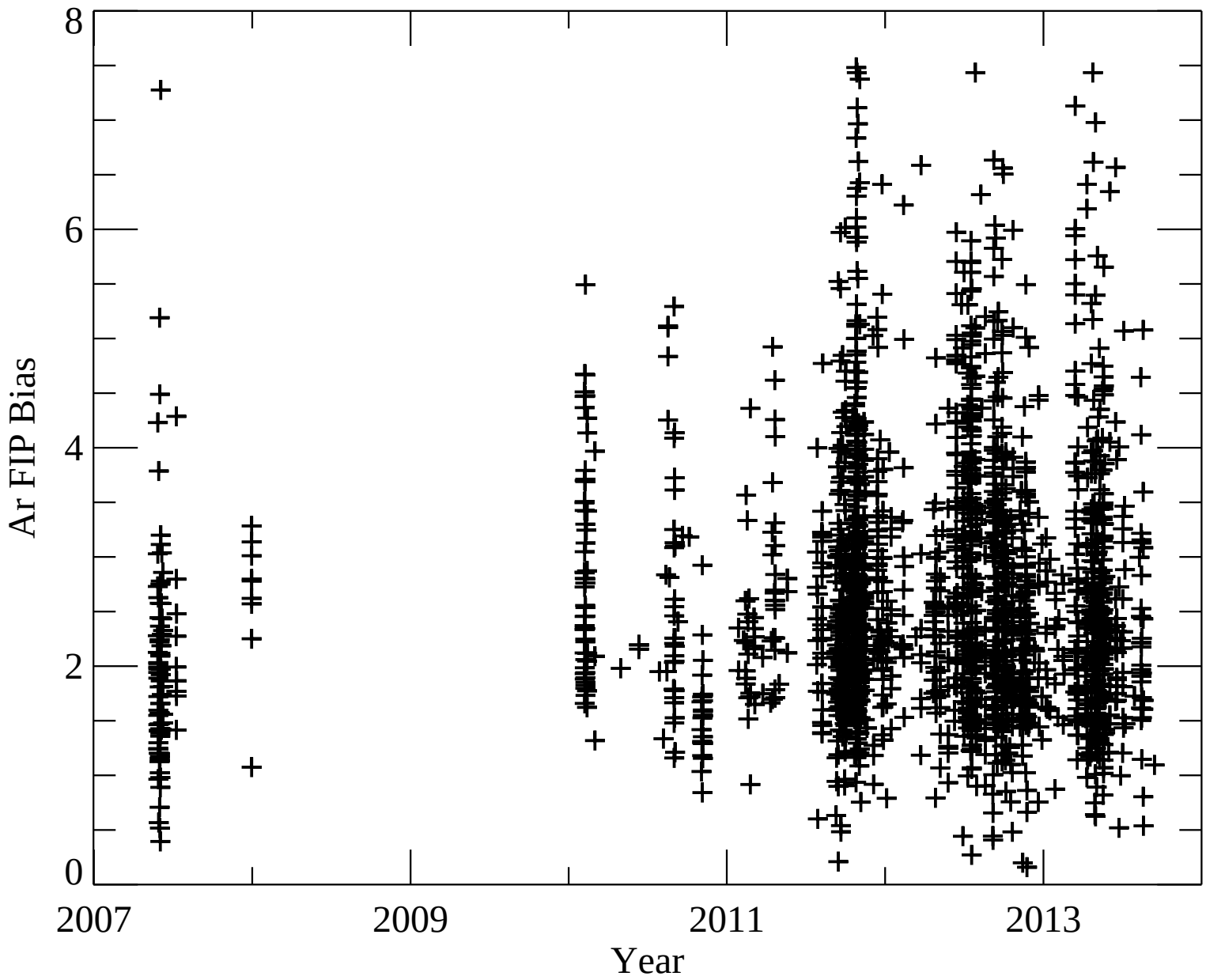

Si FIP Bias
Event Number
0
1
2
3
4
5
6
0
100
200
300
400
500
600

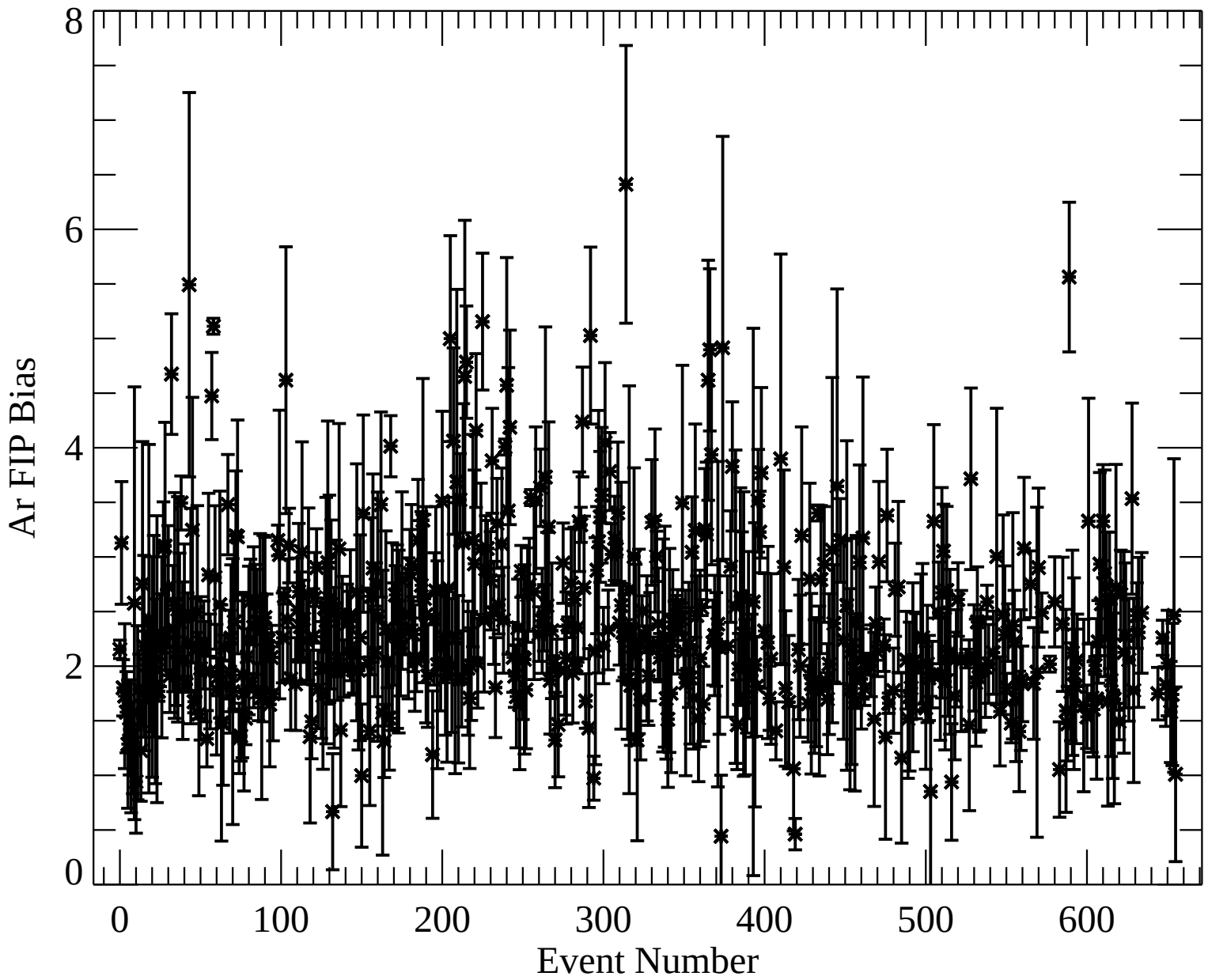

6
5
4
3
2
1
0
Si FIP Bias
0.1
1.0
Emission Measure (10^{49} cm^{-3})

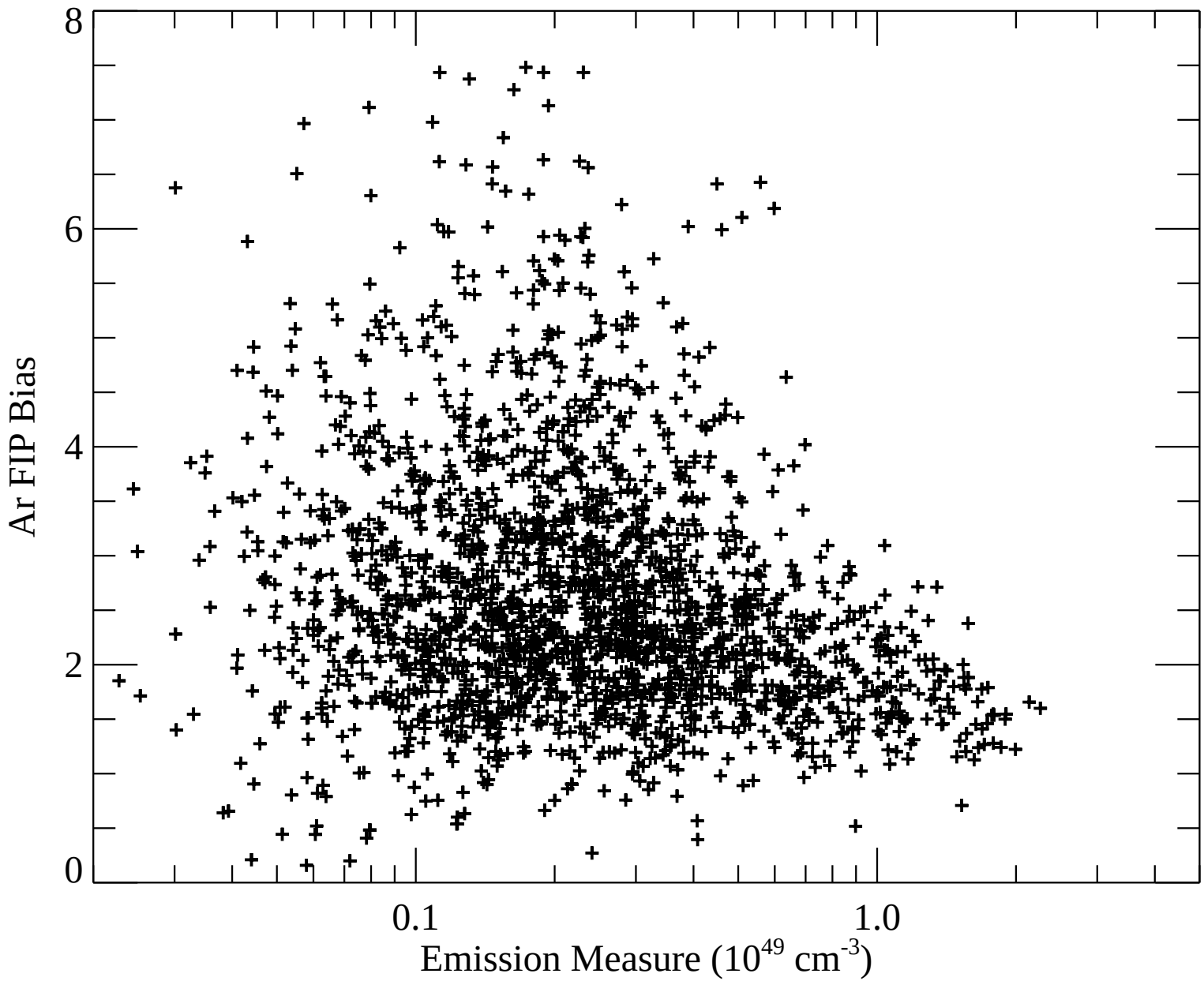

Si FIP Bias
0
1
2
3
4
5
6
1.0
1.5
2.0
Temperature in keV

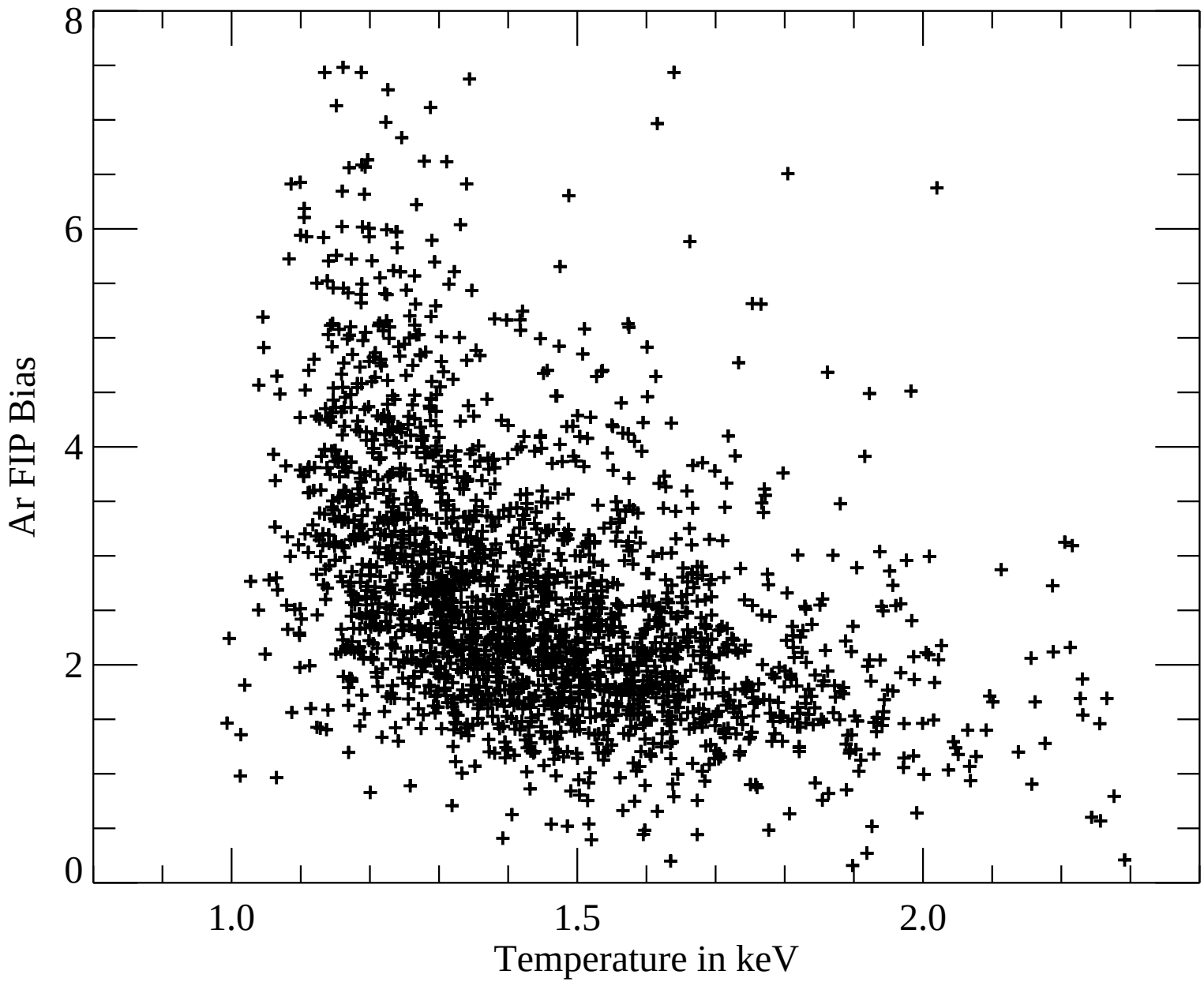
Si FIP Bias
0
1
2
3
4
5
6
7
1
10
100
Number of Occurrences per bin


1000
100
10
1
Number of Occurrences per bin
0
1
2
3
4
5
6
Si FIP Bias
EM Range = 0.1 to 0.5 10^49 cm^-3
EM Range = 0.5 to 1 10^49 cm^-3
EM Range = 1 to 5 10^49 cm^-3
Contiguous Intervals
Weighted Mean 1.64
Weighted Mean + sigma 2.30
Weighted Mean - sigma 0.98

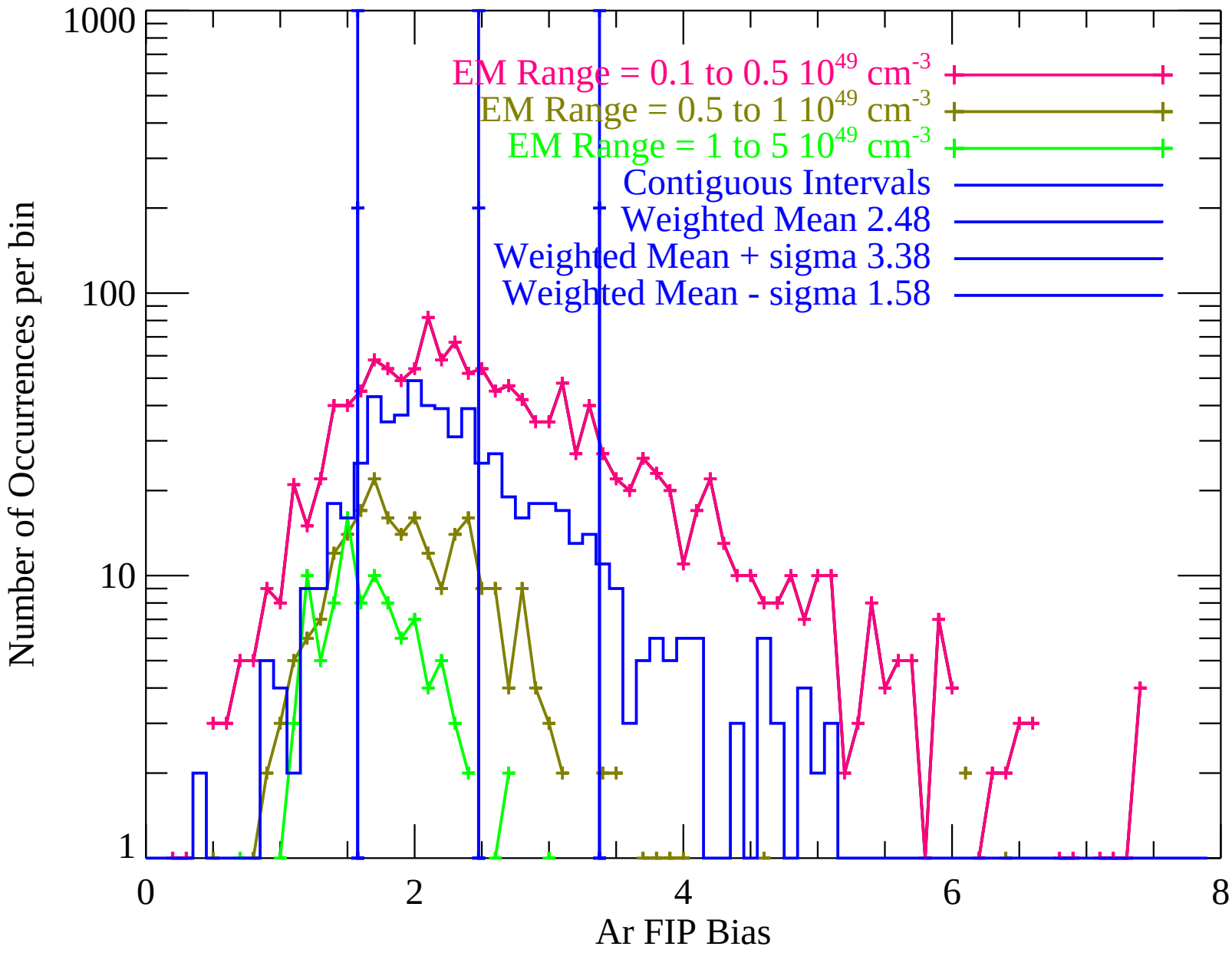

8
6
4
2
0
Ar FIP Bias
2007
2009
2011
2013
Year

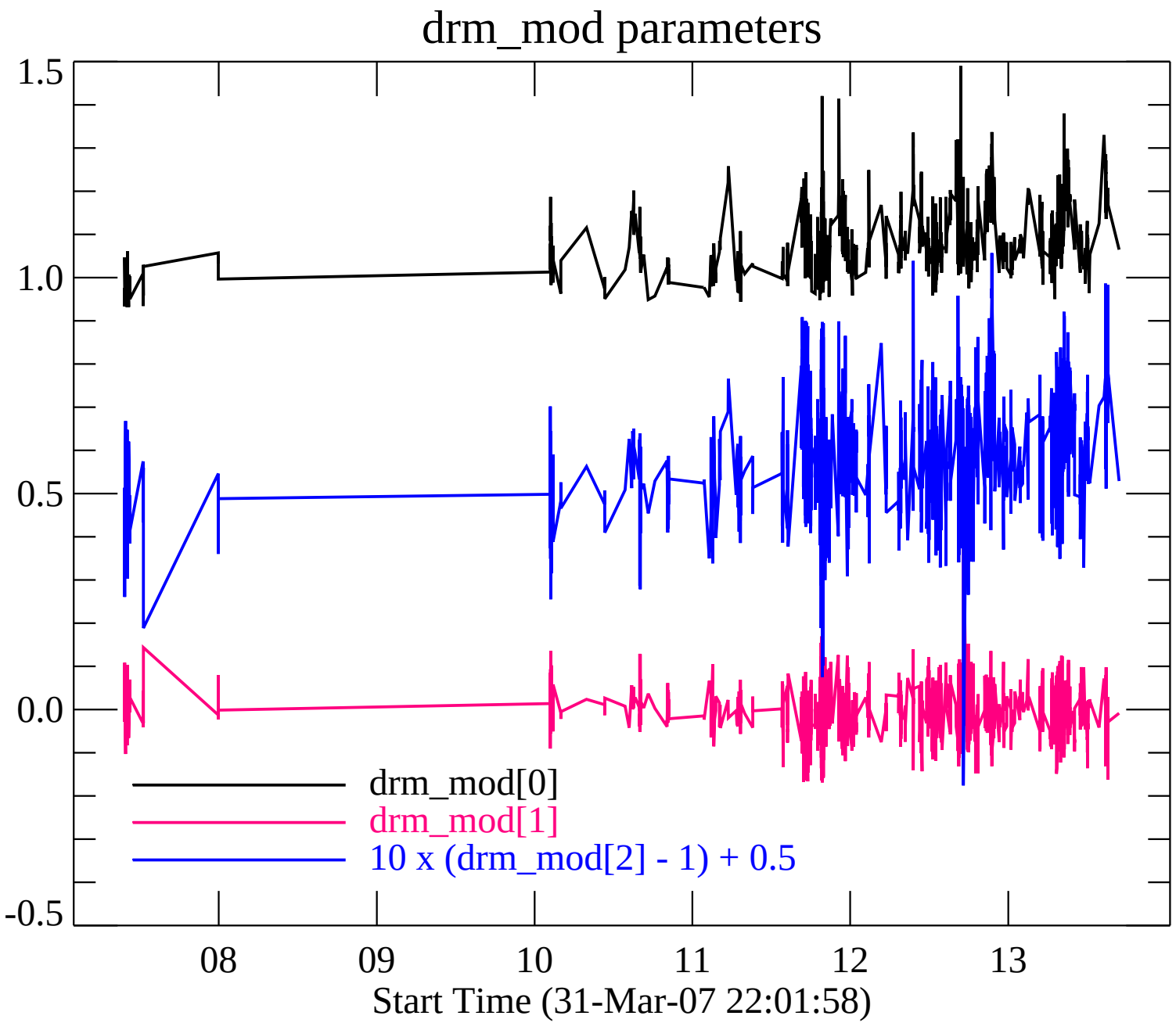

8
6
4
2
0
Ar FIP Bias
0
100
200
300
400
500
600
Event Number

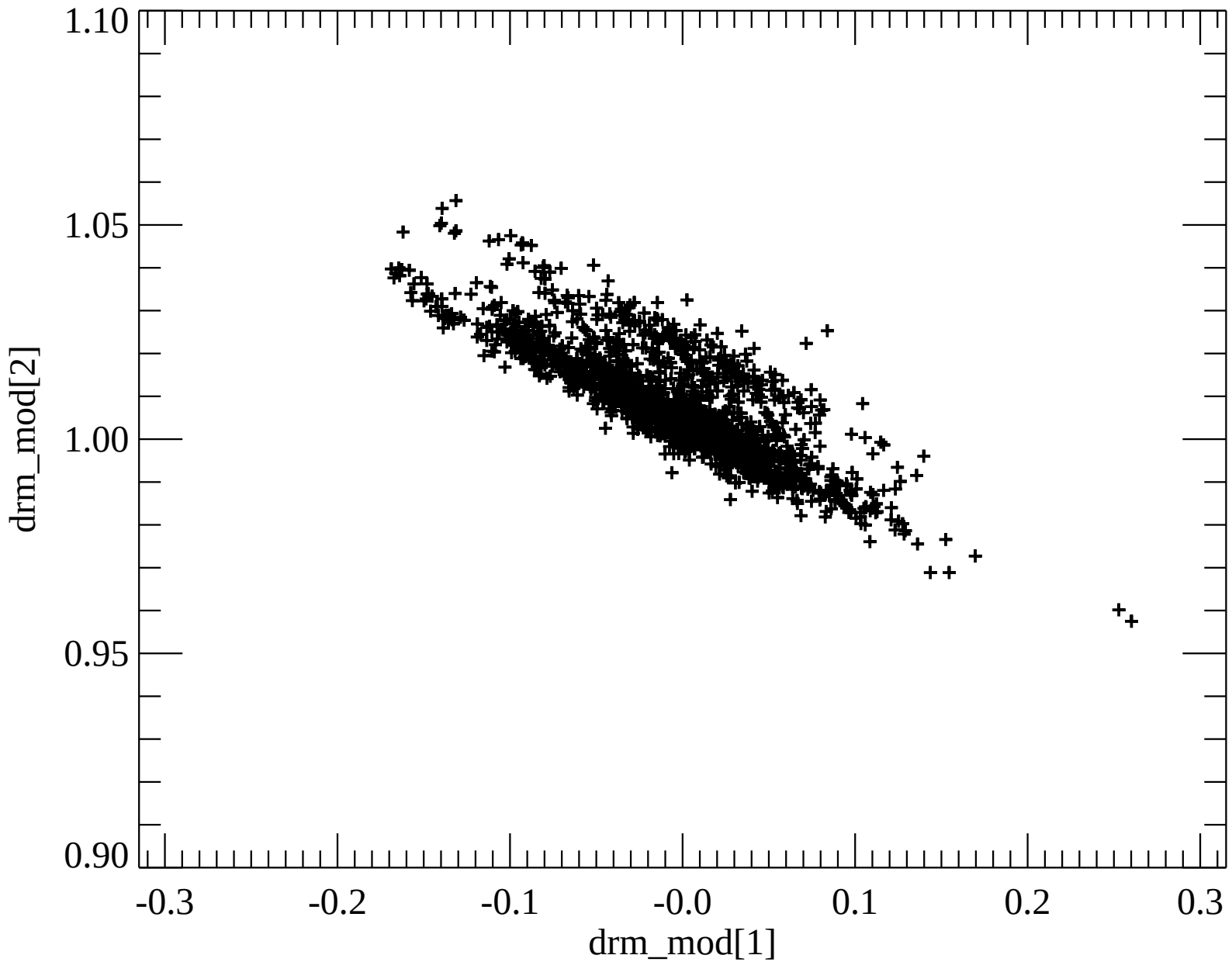

8
6
4
2
0
Ar FIP Bias
0.1
1.0
Emission Measure (10^{49} cm^{-3})

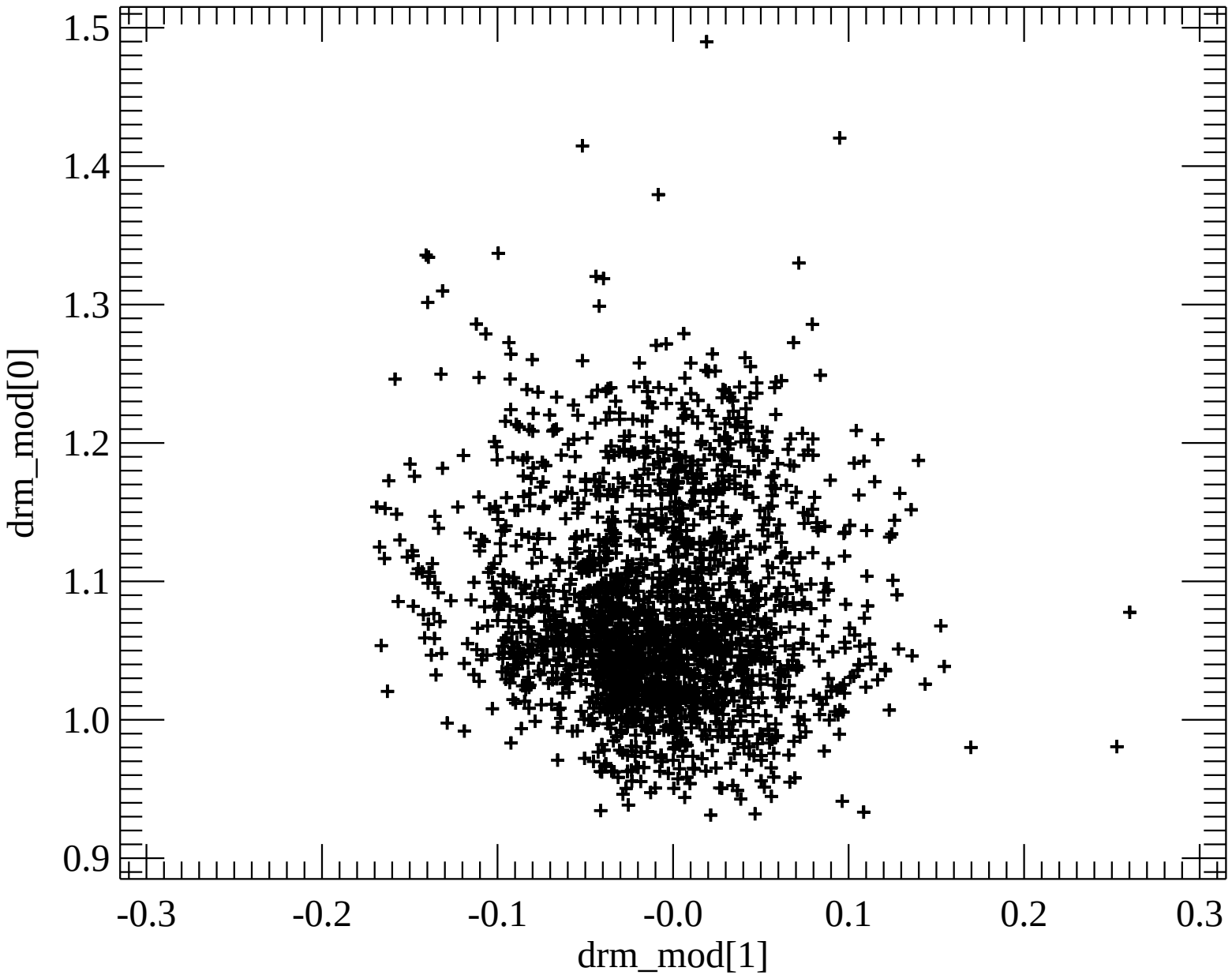

8
6
4
2
0
Ar FIP Bias
1.0
1.5
2.0
Temperature in keV

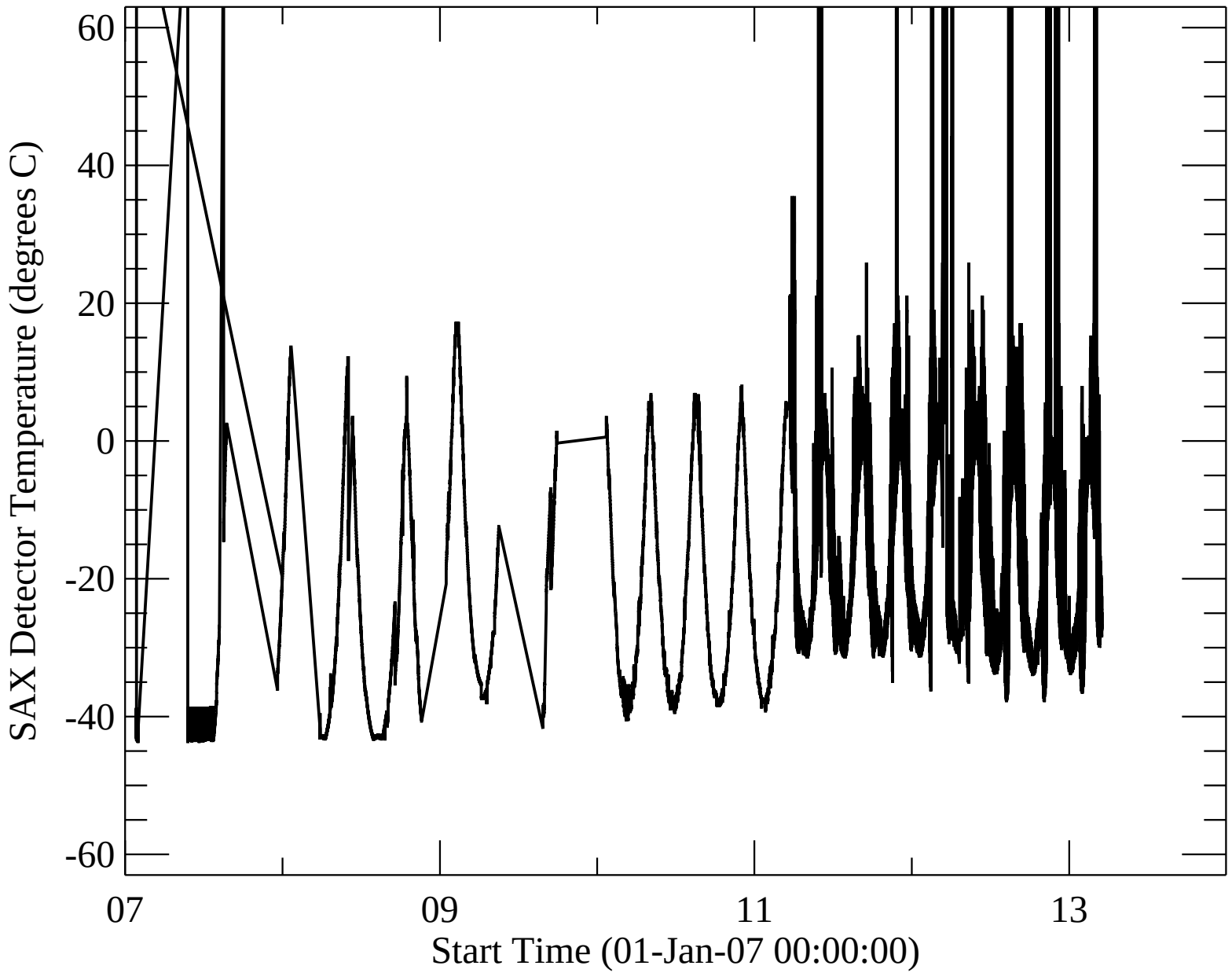
Ar FIP Bias
0
1
2
3
4
5
6
7
1
10
100
Number of Occurrences per bin

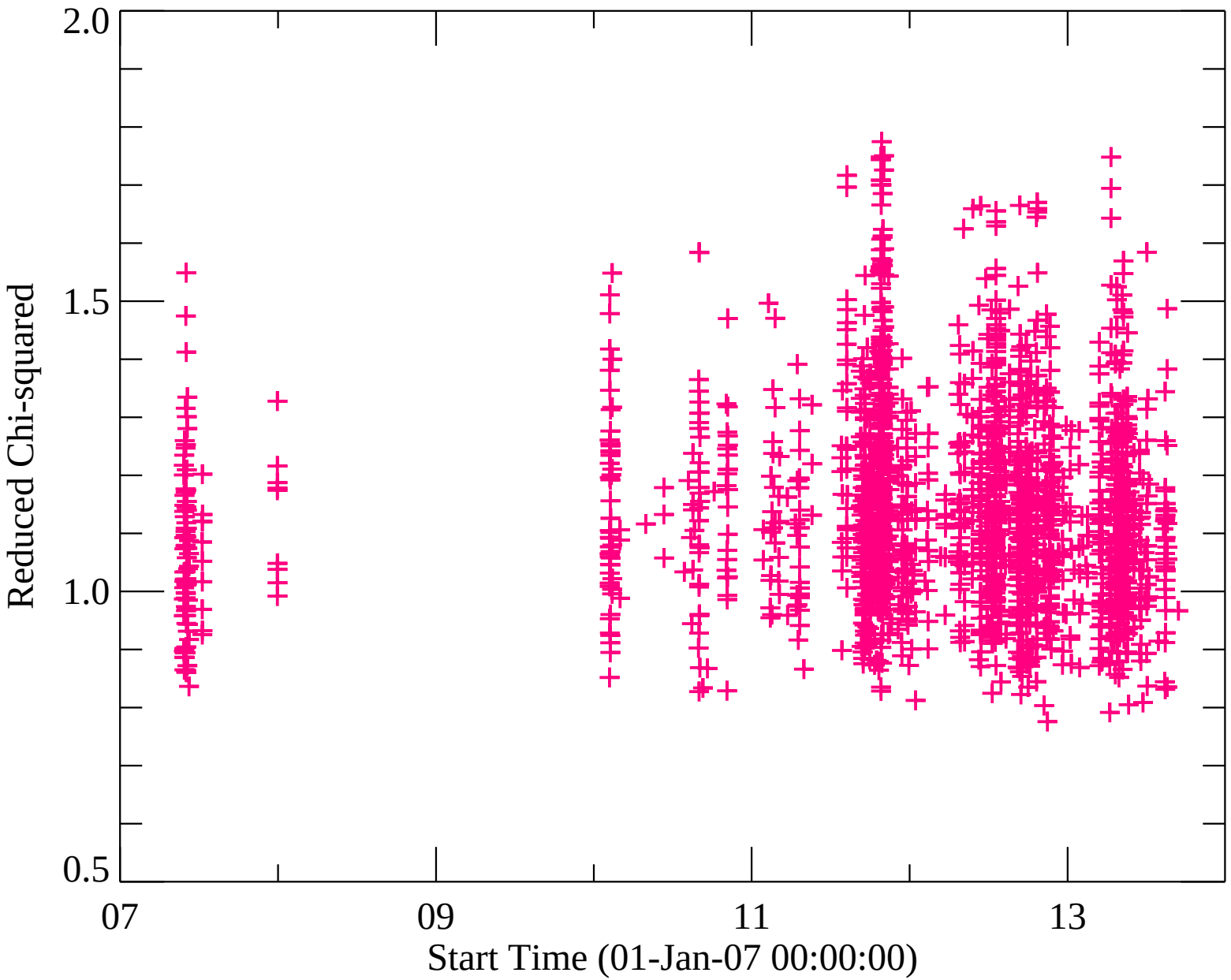

1000
100
10
1
0
2
4
6
8
Number of Occurrences per bin
Ar FIP Bias
EM Range = 0.1 to 0.5 10^49 cm^-3
EM Range = 0.5 to 1 10^49 cm^-3
EM Range = 1 to 5 10^49 cm^-3
Contiguous Intervals
Weighted Mean 2.48
Weighted Mean + sigma 3.38
Weighted Mean - sigma 1.58

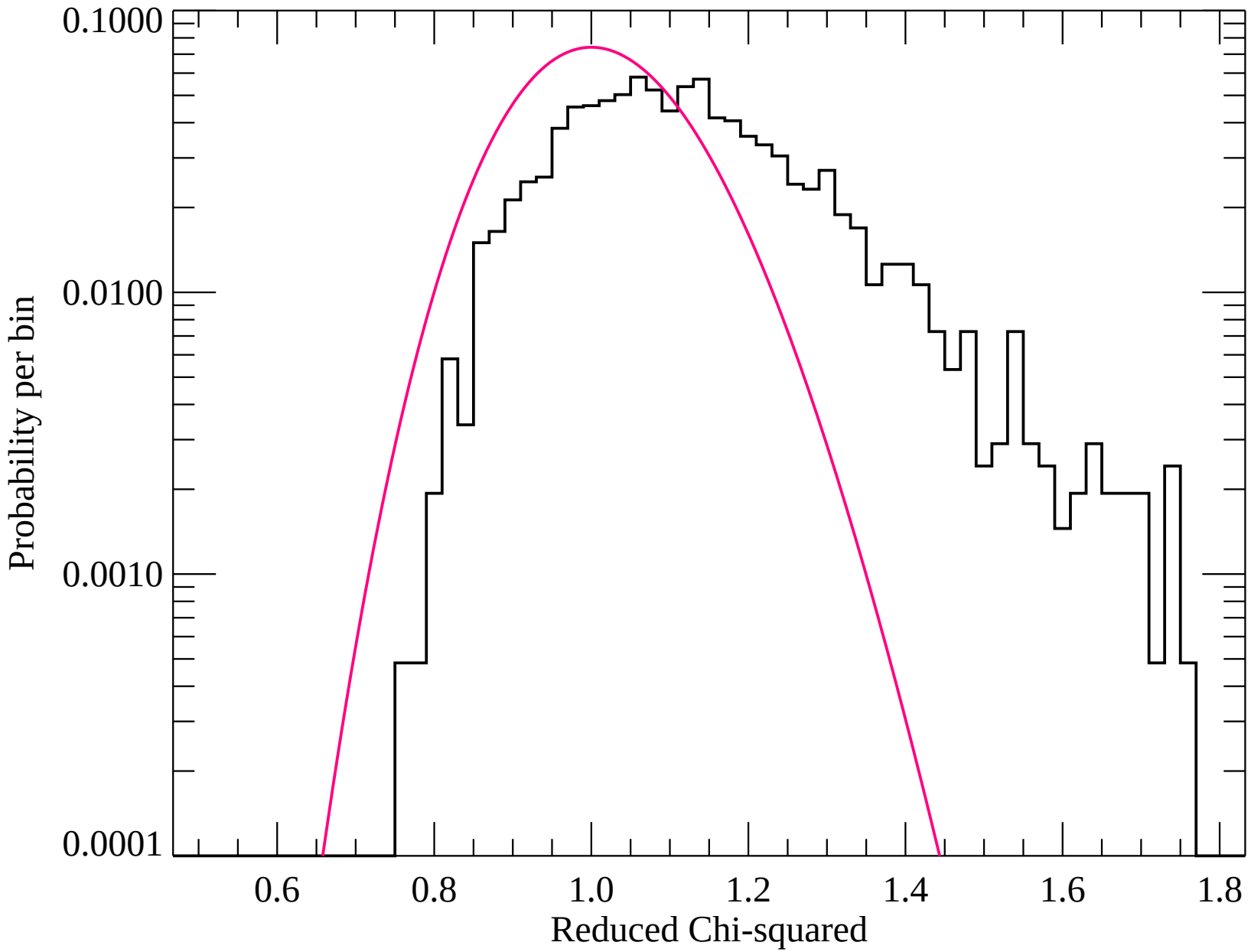

drm_mod parameters
1.5
1.0
0.5
0.0
-0.5
08
09
10
11
12
13
Start Time (31-Mar-07 22:01:58)
drm_mod[0]
drm_mod[1]
10 x (drm_mod[2] - 1) + 0.5

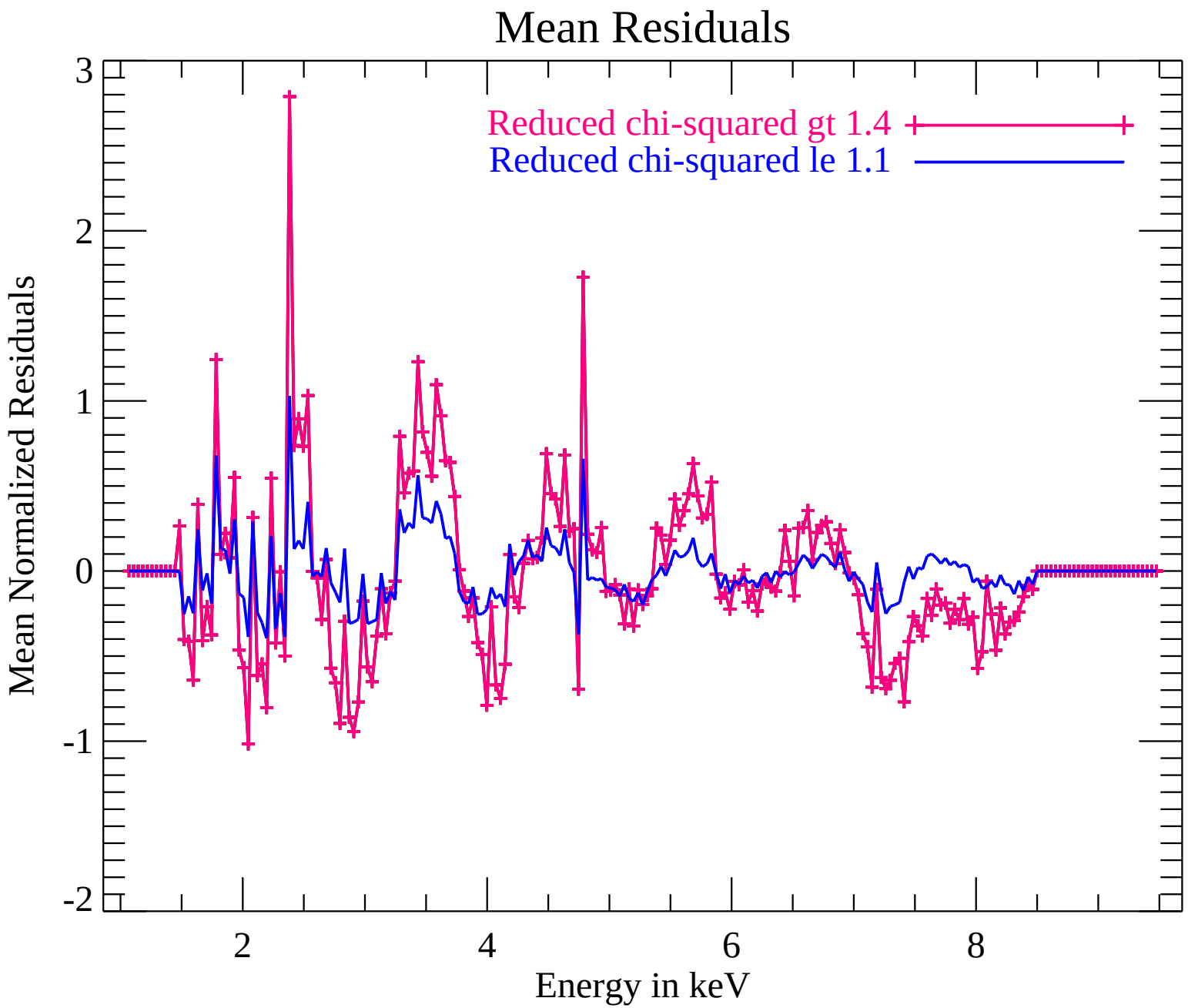

1.10
1.05
1.00
0.95
0.90
drm_mod[2]
-0.3
-0.2
-0.1
-0.0
0.1
0.2
0.3
drm_mod[1]


1.5
1.4
1.3
1.2
1.1
1.0
0.9
drm_mod[0]
-0.3
-0.2
-0.1
-0.0
0.1
0.2
0.3
drm_mod[1]


60
40
20
0
-20
-40
-60
SAX Detector Temperature (degrees C)
07
09
11
13
Start Time (01-Jan-07 00:00:00)


2.0
1.5
1.0
0.5
Reduced Chi-squared
07
09
11
13
Start Time (01-Jan-07 00:00:00)


0.1000
0.0100
0.0010
0.0001
Probability per bin
0.6
0.8
1.0
1.2
1.4
1.6
1.8
Reduced Chi-squared


Mean Residuals
Reduced chi-squared gt 1.4
Reduced chi-squared le 1.1
Mean Normalized Residuals
Energy in keV
3
2
1
0
-1
-2
2
4
6
8