Explorer-Nautilus 2001 and 2003 data

Pia–Draft to the ROG collaboration

Abstract

This report contains considerations on the Explorer and Nautilus 2001 and 2003 data. In particular, I will show preliminary results from a re-analysis of the data.

1 Introduction

The present work has the aim of performing a re-analysis on the 2001 and 2003 data of Explorer and Nautilus.

The reasons for this are:

- The 2001 data used in the paper [1] had a problem in the calibration of the matched filter. This is due to the fact that it was the first time the data from the new acquisition were filtered off-line and not all the debugging of the code was completed;

  This produced, on the average, a factor 0.5 for Nautilus and 0.6 for Explorer in the T_{eff} of the filtered data;
- The vetoes on auxiliary channels (for the 2001 data) were not applied as in the past, considering the total lenght of the event;
- The coincidence window was based on Eq.(5) of [1], but there was an error in the code, which used the windows of the "previous" event. I have some also comments on the way the Eq. has been used, which I will present in the next section;
- In the published data some choices were done to veto the data (10 mK on the hourly T_{eff}, 7 mK on the T_{eff} before the events). Once we have found the problem in the calibration new files have been created and distributed to the collaboration ≈ 1 year ago:

  explorer2001.eve and nautilus2001.eve,

  on axcalc /exp/rog/astone/read_eve/2001data/

  These are the files from which I extracted the events to be exchanged with the TAMA group.

  The vetoes in these files were obtained from the ones in the paper, rescaled for the 0.5 and 0.6 factors (Nautilus: 5.3 mK on the hourly T_{eff}, 3.8 mK on the T_{eff} before the events. Explorer : 6.4 mK on the hourly T_{eff}, 4.5 mK on the T_{eff} before the events.). These factors have been evaluated by G. Pizzella and he has done checks on the new files. As far as I can remember the conclusion was that the two data sets (the one used in the paper and this new one) gave similar results. At that time I hadn't yet implemented in my code the two functions to do the energy check and the moving window, thus -given the fact that the energy test played a crucial role in result- I didn't check by myself this result.
- Now we have the 2003 data. The main problem was to try to apply the same rules to repeat the analysis. The problem which arises is: which are the *same rules* ?

The ones which have been published **(a)**

or the ones obtained in the "correct" data set **(b)** ?

And, also, given the fact that the sensitivities 2001-2003 are not the same, *same rules* means same T_{eff} levels or levels rescaled according to the new sensitivities **(c)** ?

- In one of the collaboration meeting it was agreed to use the criterion **(a)**, to avoid to publish results obtained with different numbers and having in mind that the choice of a different criterion should not be so crucial for the final result.
- I have never been particularly happy with the veto on the events T_{eff}: it happened that some cosmic - ray events were eliminated with this veto and we insert various random holes in the data which are difficult to be considered when evaluating the coverage time of the analysis.
- In all the coincidence analysis which I am going to show I have applied the energy consistency check, exactly as it has been applied in the paper on CQG (with 68%).

2 Data characterization and some considerations on the coincidence window

All this points were still open in my mind and then I tried, first of all, to do the effort to find a general rule to create and analyze the two data sets.

In this report I will briefly show some results and preliminary conclusions.

I have used the 2001 events properly normalized (the ones which are correct) and the 2003 events (the only list which we have produced).

In the following, I have never used the data which produced the results in the CQG paper, for the reasons stated above.

To do the analysis, first of all I evaluated the sensitivities of the detectors in the two runs, in the absence of any veto. I have used the median, which is roughly comparable with the peak of the corresponding histogram, and which is robust enough to give a good measure of the sensitivities. Table 1 shows the median of the T_{eff} (hourly and before the events). Table 2 shows the median of the β_3, rad/s, which are important to state the coincidence window. These values are estimated injecting (in software) the response of the detector to delta-like signals, in the absence of noise. The estimation is obtained from the decay time $\tau_3 = 1/\beta_3$ of the filtered output. It is updated every ≈ 30 minute (to be checked with Sabrina). The relation beetween β_3 and the bandwidth Δf is $\beta_3 = \pi\ \Delta f$, but it is not clear to me exactly how this definition works in practice (two resonance modes which are well separated in frequency or two resonances which overlap).

Comparing the values which I get in Table 2 with those in Table 1 of [1] and also with the values in Table 1 of the version April, 30 of the report "Update..." it can be seen that all values are " roughly comparable" except the value of Nautilus 2001. **The value of Δf in the table is 0.4 Hz, while I get on the average a value of 3 Hz.** This produces a huge difference in the coincidence window (which is of the order of ± 0.5 s in the published paper, and± 0.05 s using the actual value) and hence on the final result. Moreover. let me stress that: the Eq. (5) of [1], which gives the coincidence window as a function of R_e (the energy SNR) and of the bandwidth Δf has been obtained with simulations in which Δf was estimated from β_3.

In particular, these values can be different as a function of the time (see the figures, which gives the histograms).

Table 1: Summary of the sensitivities during the 2001 and 2003 runs. The quantity considered is always the median.

Detector	Hourly T_{eff} 2001	Hourly T_{eff} 2003	T_{eff} before ev. 2001	T_{eff} before ev. 2003
Explorer	2.2 mK	2.4 mK	2.3 mK	2.6 mK
Nautilus	2.8 mK	1.6 mK	2.4 mK	1.7 mK

Table 2: Summary of the β_3 [rad/s] values during the 2001 and 2003 runs. The quantity considered is always the median.

Detector	2001	2003
Explorer	39 rad/s	25 rad/s
Nautilus	10 rad/s	32 rad/s

Fig. 3 and Fig. 4 are an example of events which were accepted with the procedure used in the paper, but would not be accepted with the rule I just defined. This is just an example, I am not concluding that it was wrong to accept these events.

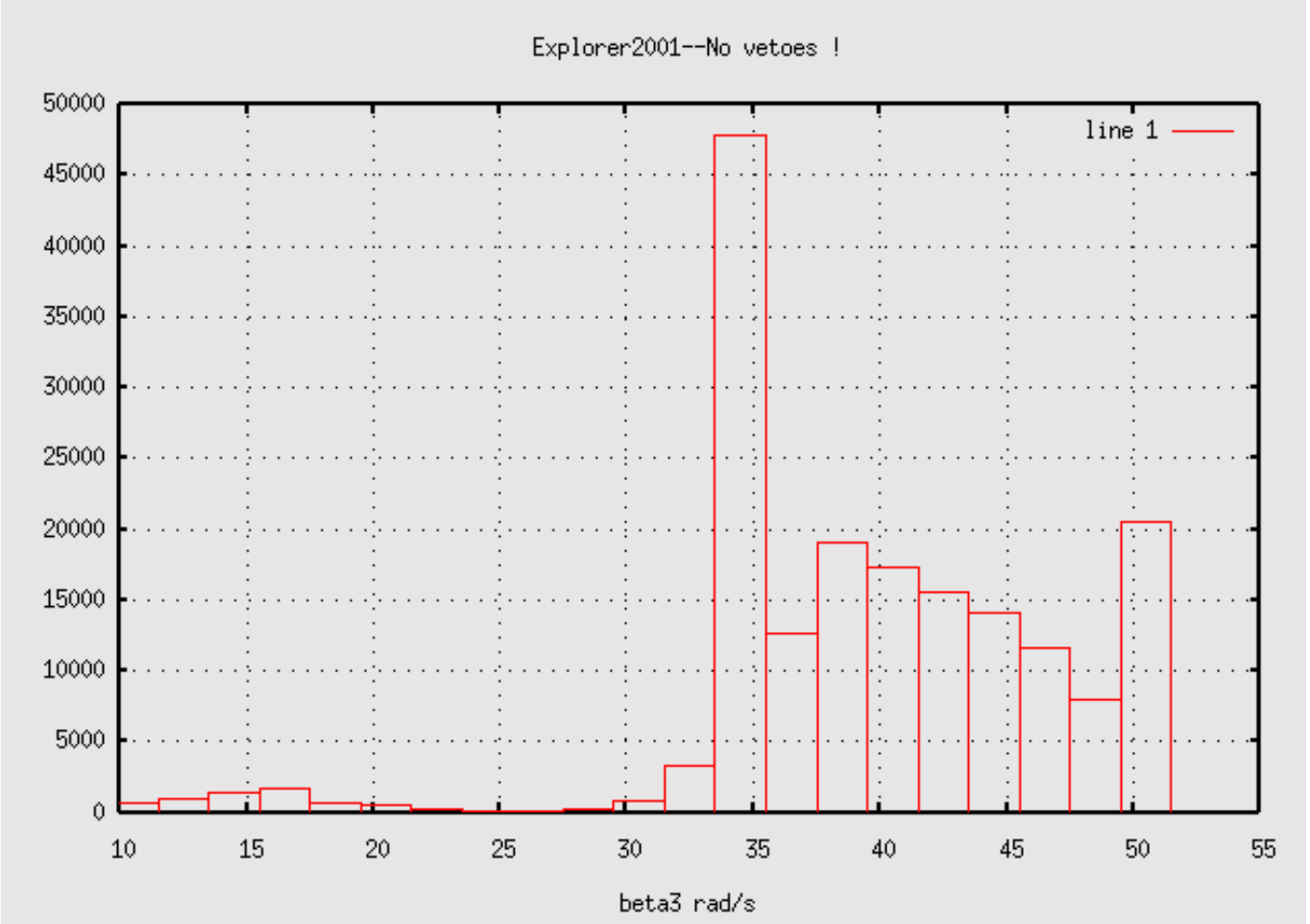

Figure 1: 2001 run: Explorer histogram of β_3. The value used in the CQG paper was $\pi \times 9 = 28$ rad/s

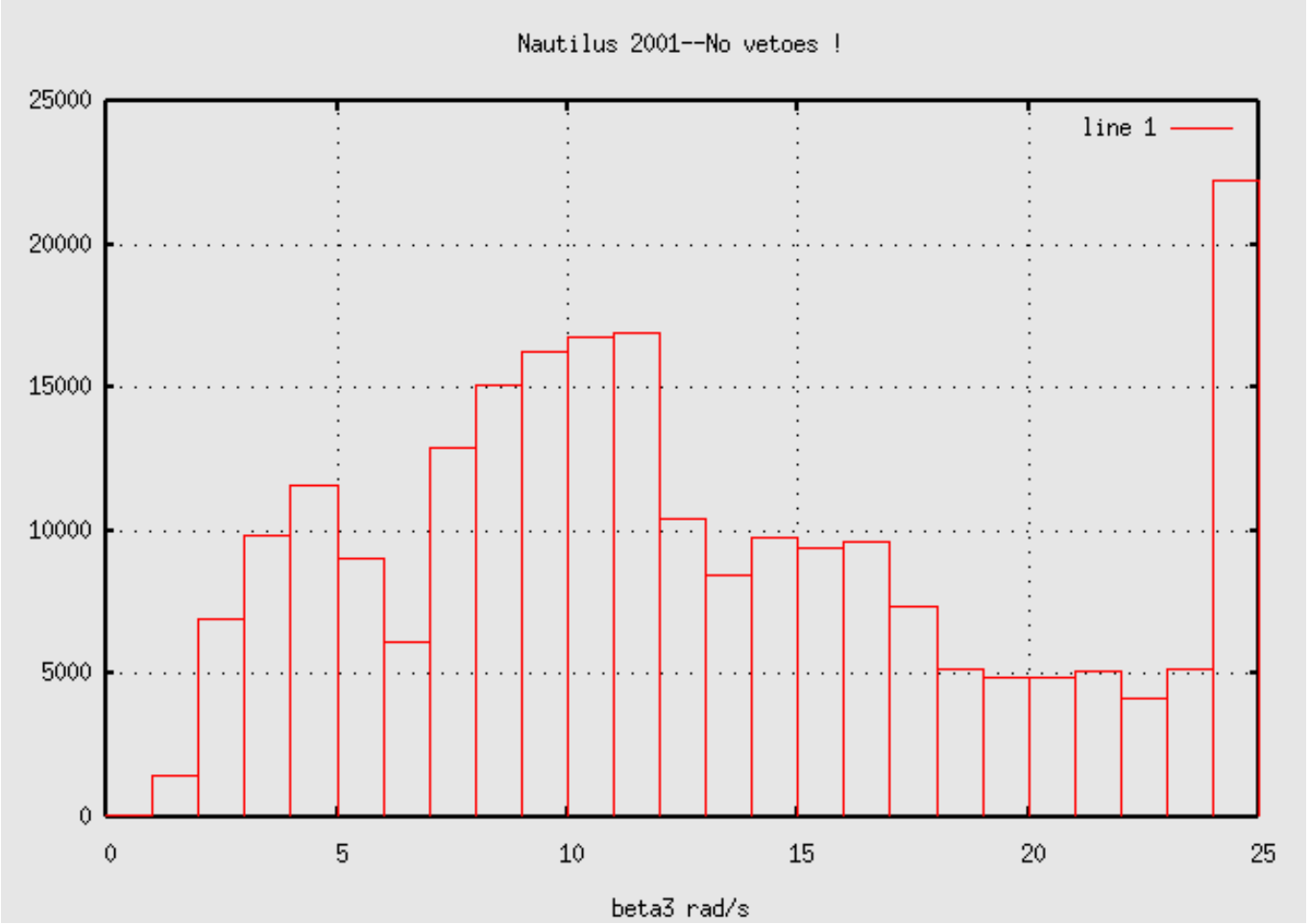

Figure 2: 2001 run: Nautilus histogram of β_3. The value used in the CQG paper was $\pi \times 0.4 = 1.3$ rad/s

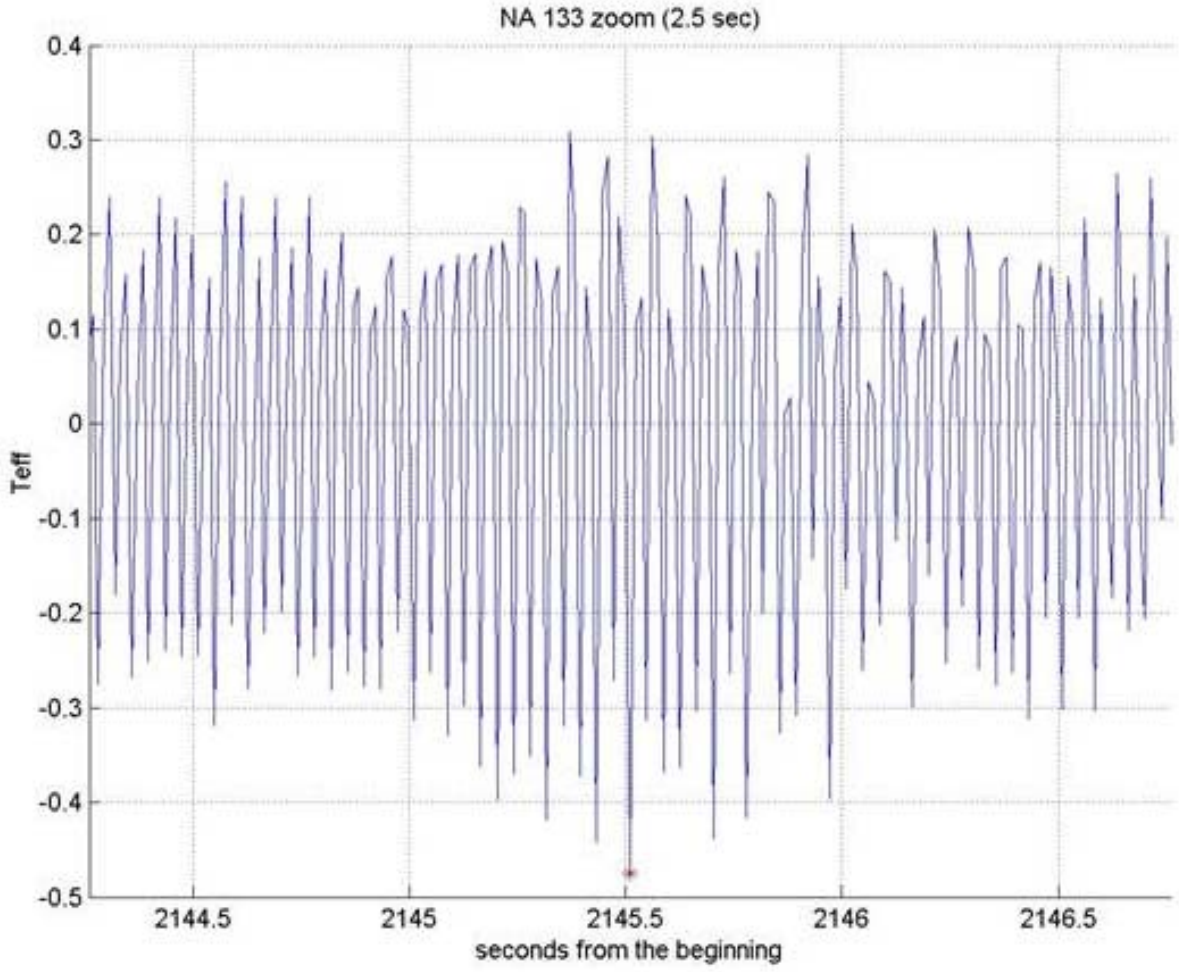

Figure 3: 2001 run: the Nautilus event on the day 133 (13/05 12:35, mjd=52042).This event is not accepted with the variable window applied with the actual β_3= 2 rad/s.The time delay Explorer-Nautilus is -0.12 s.It is in the events list in the CQG paper.

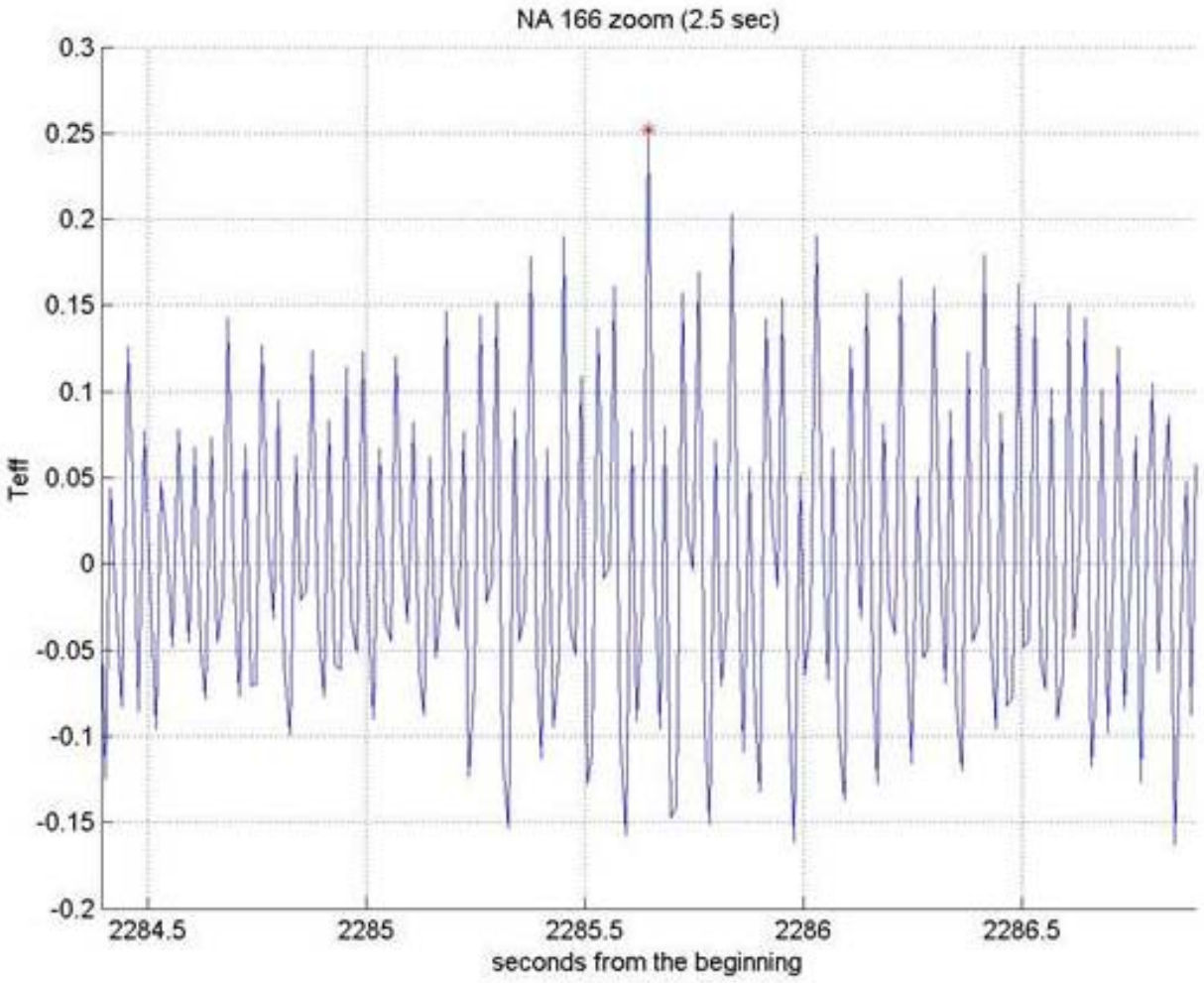

Figure 4: 2001 run: the Nautilus event on the day 166 (15/06 12:35, mjd=52075).This event is not accepted with the variable window applied with the actual $\beta_3 = 4$ rad/s.The time delay Explorer-Nautilus is 0.39 s. It is in the events list in the CQG paper.

Table 3: Days and number of events during the 2001 and 2003 runs

Detector	Days 2001	N events 2001	Days 2003	N events 2003
Explorer	215	138811	256	74661
Nautilus	193	61903	172	143528

3 The new 2001 and 2003 data sets: vetoes and coincidence window

I have decided to veto the data only for the hourly T_{eff} (a part from flags, calibration level, sismics in the year 2001, validation file for Nautilus, given by Viviana.)

- Criterion for the veto: I vetoed all the hours during which the hourly T_{eff} was greater than **3*median** (rounding the number to an integer).

  Thus I get: 7 mK, 7 mK for Explorer in the years, respectively, 2001 and 2003;

  8 mK, 5 mK for Nautilus in the years 2001 and 2003;

  File names:

  2001data/explorer2001_new.eve, nautilus2001_new.eve.

  2003data/explorer2003_new.eve, nautilus2003_new.eve.

- Criterion for the window: for each event I have used the actual β_3, value which is written in the event files. Then, given the fact that the resulting window in the year 2001 is so much different from the one used in the paper I have also runned a "test" with $\pm$ 0.5 s window. Regarding this point, I think that the experience of Francesco in the coincidence with cosmic rays is of extreme importance. I am aware of the fact that the formula used for the window applies only to delta signals at the input of the detector, in phase with the sampling, but the point is that this is the formula written and used in the paper. If we are not convinced that this is the proper way to do, then we should find and declare a new rule. In the draft of the 2003 analysis the same formula has been repeated and used (with an additional factor to take into account the sampling time and the distance of the detectors).

Table (3) shows the event numbers and the observation times, with the presented choices.

3.1 Results with the new criteria

I show here a summary of results with the new criteria. I will refer to these choices as "new cuts". The results are given as histograms, binned in 1 hour bins and always referred to Greenwich (a part an example, given for comparison...)

The background has been estimated with only 100 shifts, with 1 second delay each time. Thus this gives only a rough estimation.

- Fig. 5 and Fig. 6 (sidereal and solar, respectively): 2001 data with variable window: number of coincidences 43. Number of coincidences which pass the energy consistency test, as defined in the paper: 18. Background= 17.4 events (with the energy test). Mean in each bin=0.73.
- Fig. 7 and Fig. 8: 2001 data with a $\pm$ 0.5 s window: number of coincidences 250. Number of coincidences which pass the energy consistency test, as defined in the paper: 113. Background= 103.3 events (with the energy test). Mean in each bin=4.3.

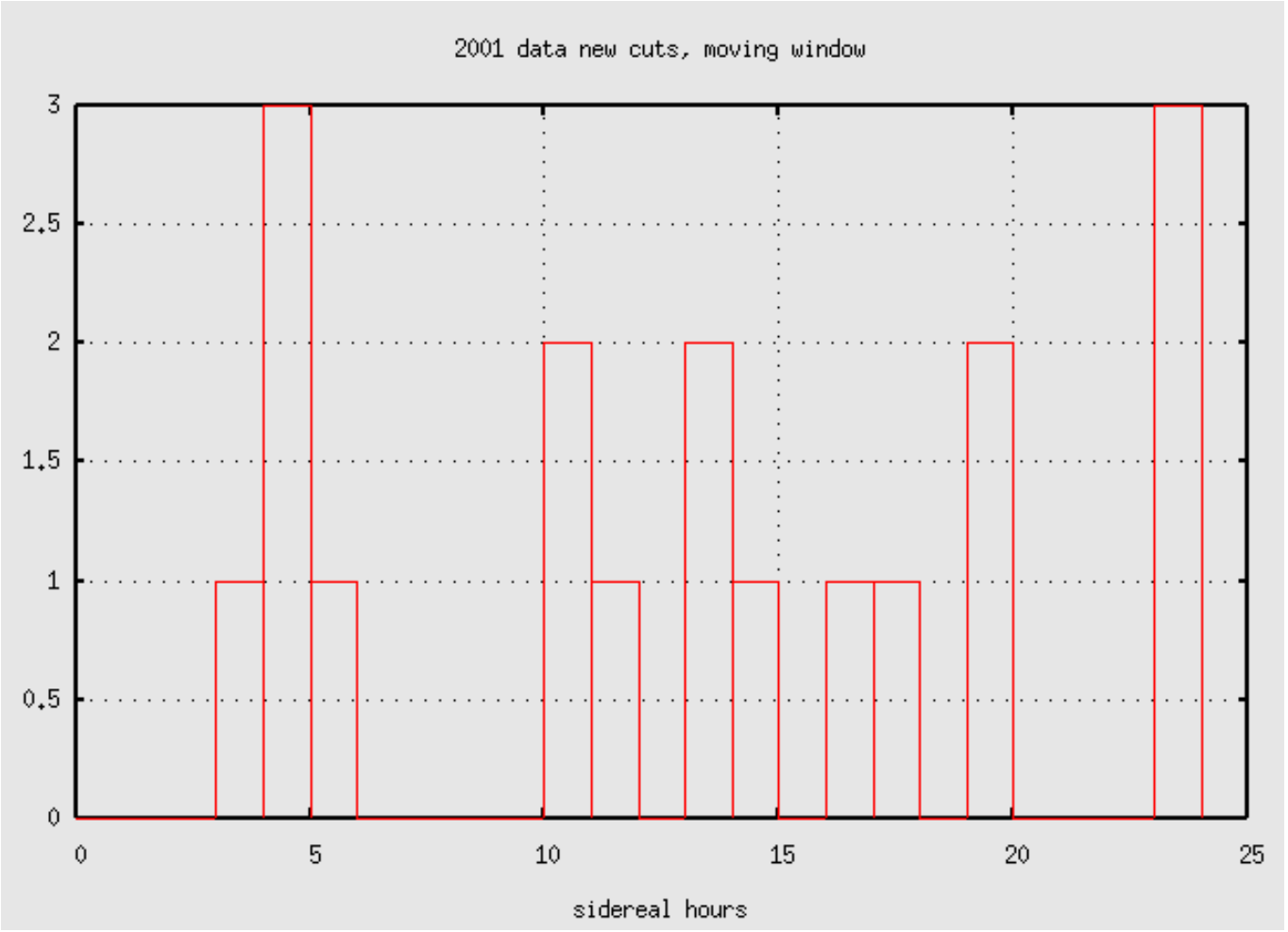

Figure 5: 2001 run, new cuts: Explorer-Nautilus coincidence events with variable window, as a function of the sidereal Greenw. time, in 1 hour bins. 18 events. From shiftfile01_new.info

- Fig. 9 and Fig. 11 : 2003 data with variable window: number of coincidences 26. Number of coincidences which pass the energy consistency test, as defined in the paper: 16. Background= 17 events (with the energy test). Mean in each bin=0.7

Fig. 10 is the same result shown in Fig. 9, but the sidereal time is referred to the Explorer longitude. This is an example which might be interesting to note something which is probably already "known": an histogram, if shown and analyzed only "by eye" can be misleading and, in particular, the use of one convention or of a different convention for the sidereal time does not produce in the histogram a simple tranlation of the x-axis. I know this is already well known..but I found the exercise quite nice..My conclusion is that no result can be given on the basis of counts in bins (e.g., the Poisson probability in each bin..., a figure which fortunatly is no more in the last version of the report, but was present in the paper on CQG.).

My conclusion from the analysis of the above data and figures is that no sidereal effect (in the sense of the paper on CQG) is present on these data. A model comparison,

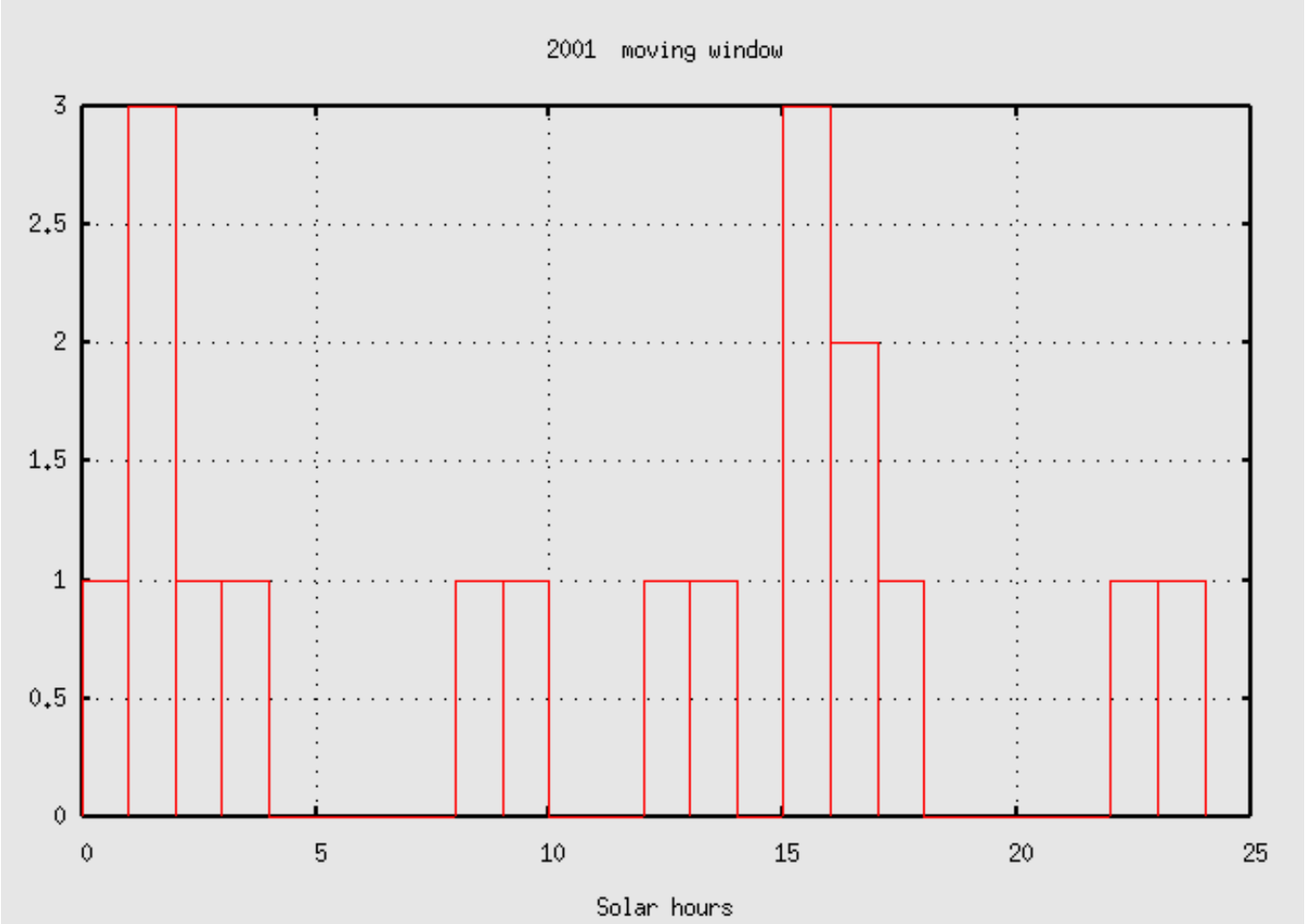

Figure 6: 2001 run, new cuts: Explorer-Nautilus coincidence events with variable window, as a function of the solar time, in 1 hour bins.

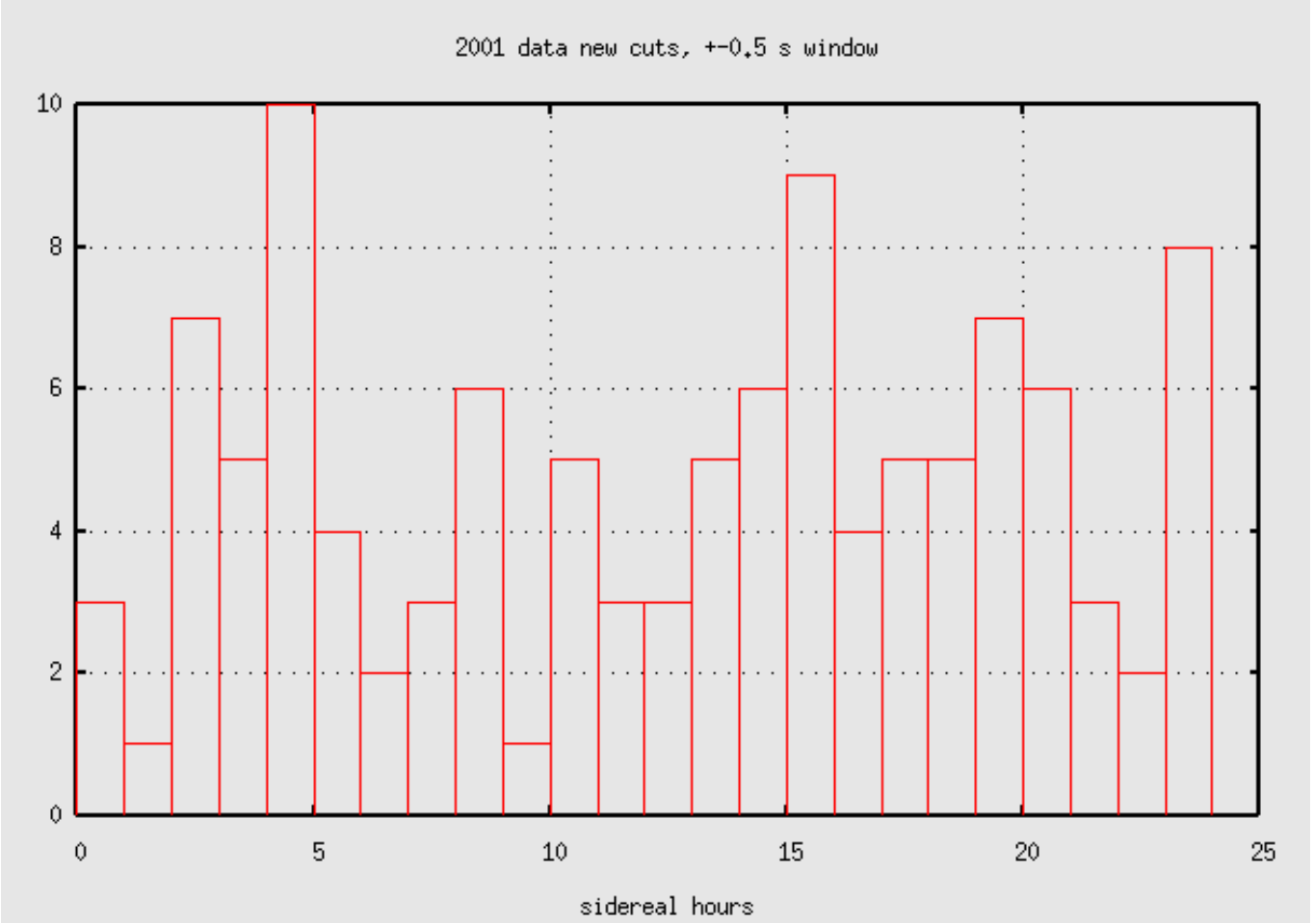

Figure 7: 2001 run, new cuts: Explorer-Nautilus coincidence events with a +-0.5 s window, as a function of the sidereal time, in 1 hour bins. 113 events. From shiftfile01_new05.info.

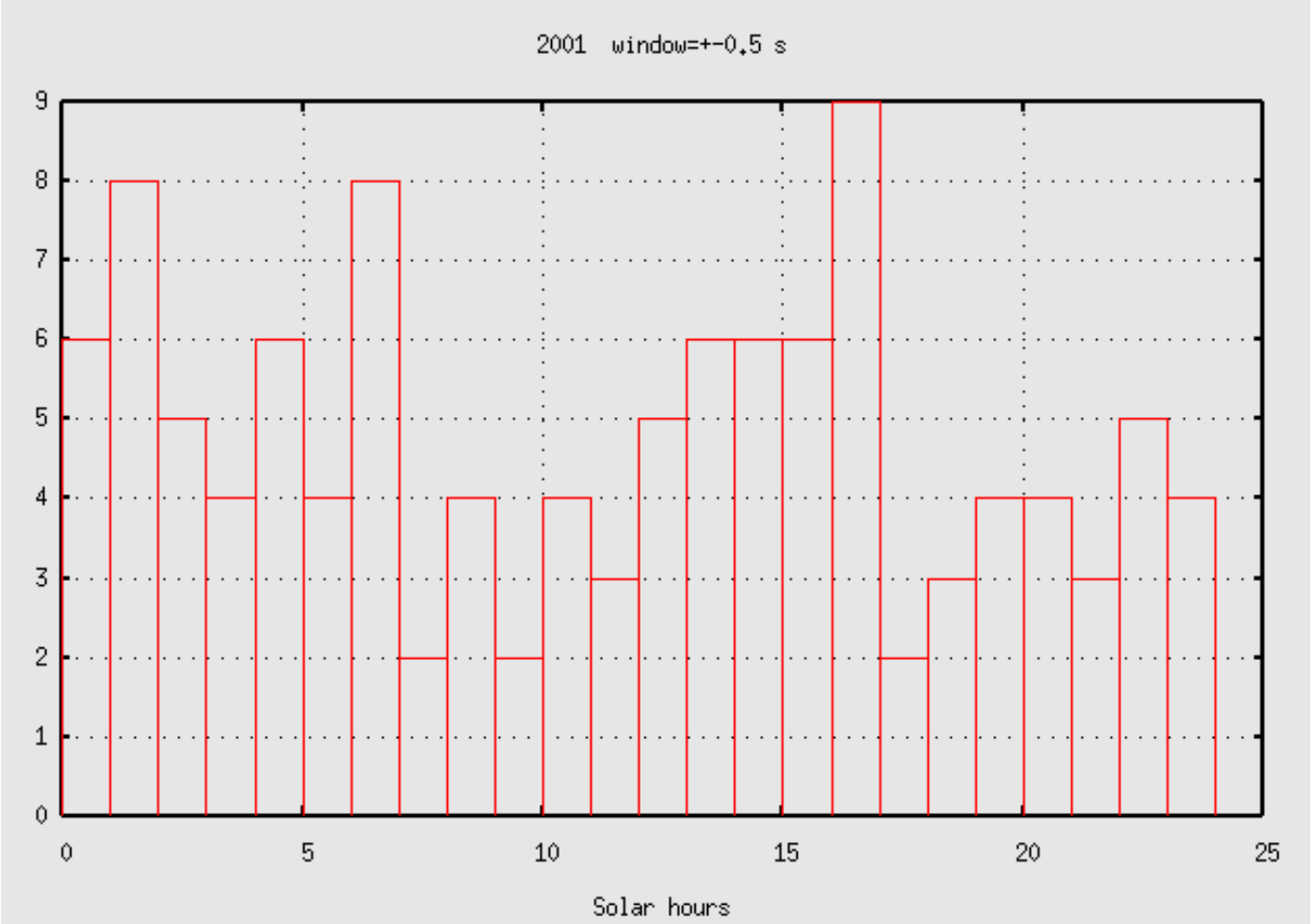

Figure 8: 2001 run, new cuts: Explorer-Nautilus coincidence events with ± 0.5 s window, as a function of the solar time, in 1 hour bins.

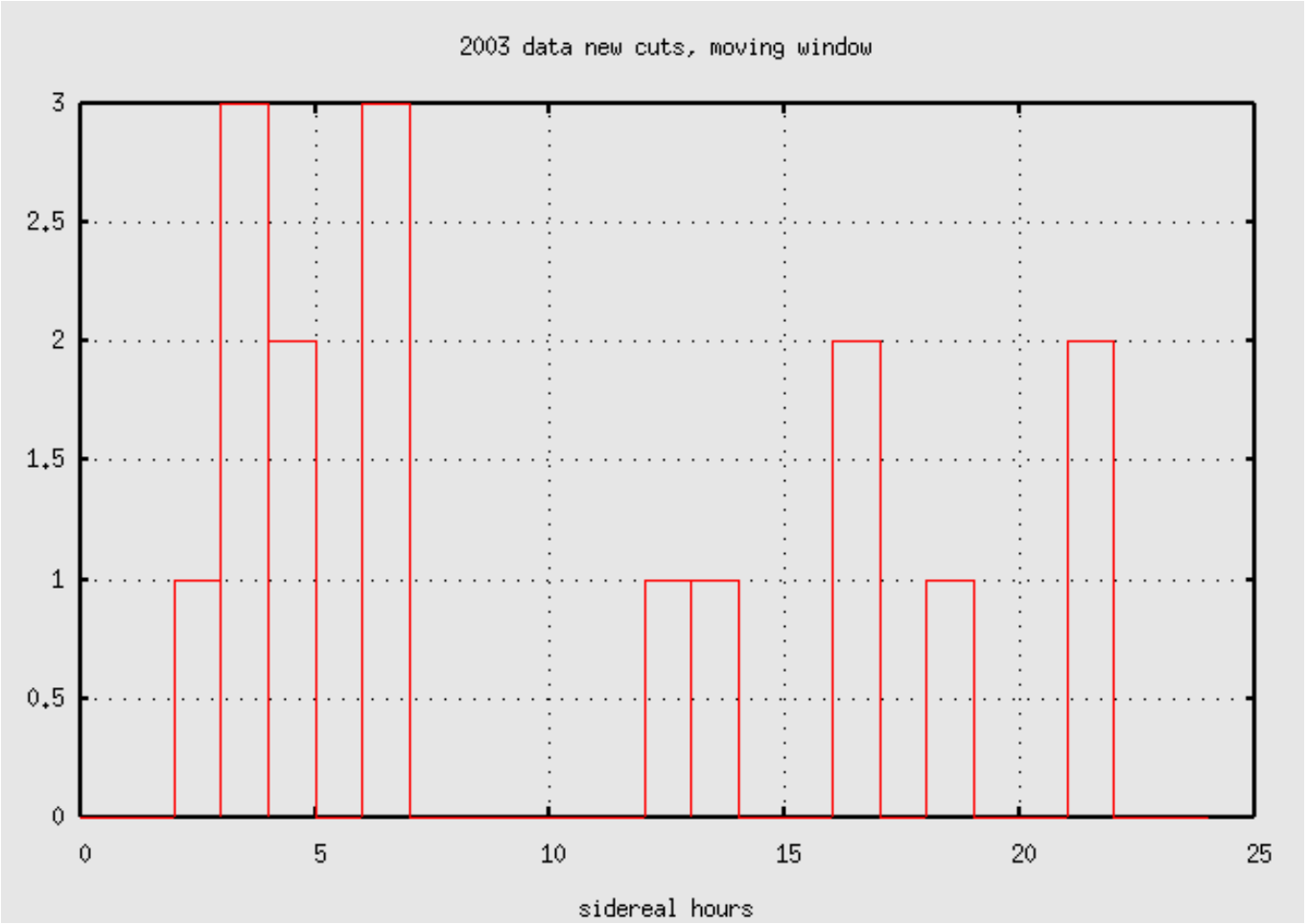

Figure 9: 2003 run, new cuts: Explorer-Nautilus coincidence events with variable window, as a function of the sidereal time, in 1 hour bins.16 events. From shiftfile03_new.info

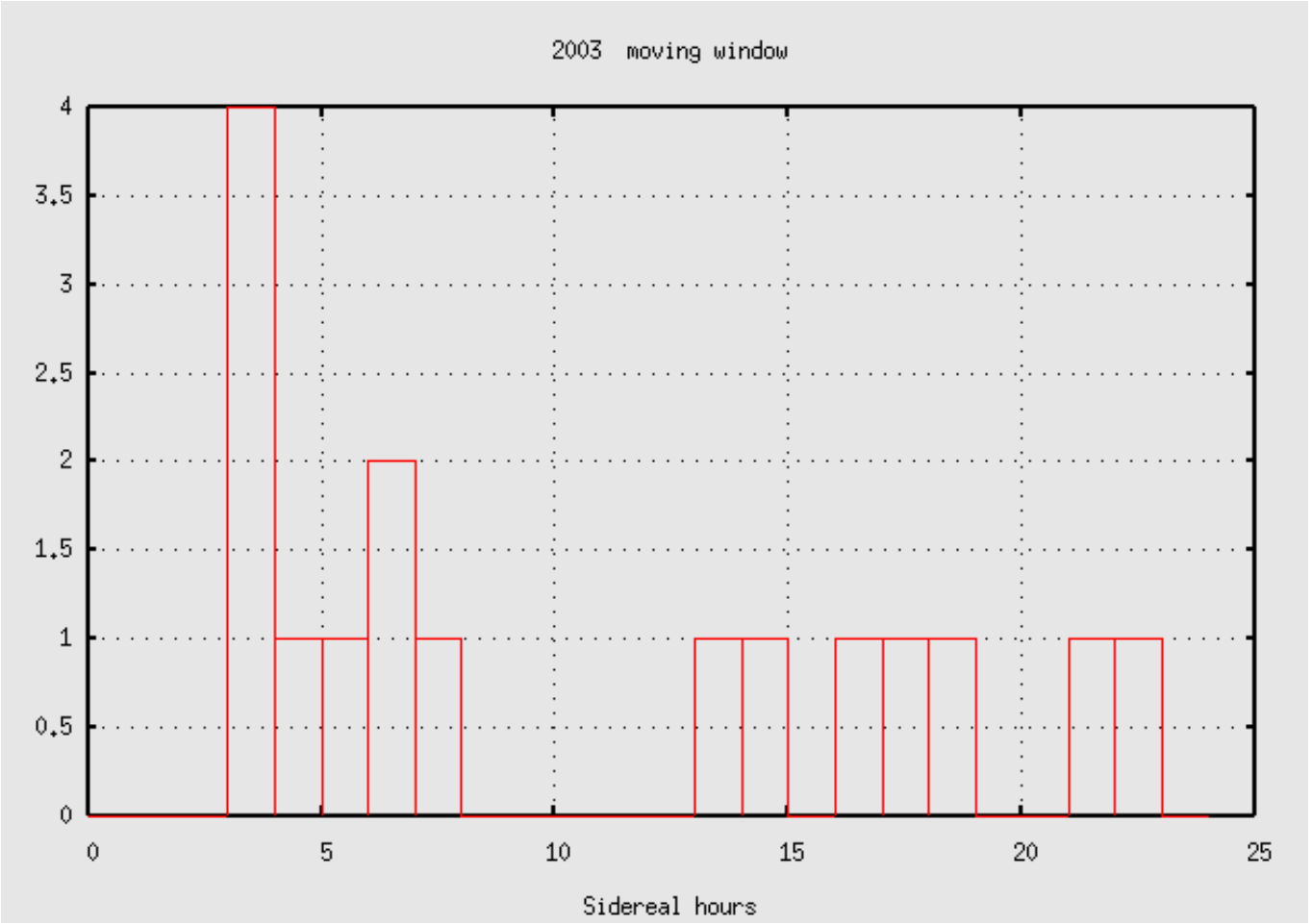

Figure 10: 2003 run, new cuts: Explorer-Nautilus coincidence events with variable window, as a function of the sidereal time, in 1 hour bins. The difference with the previous graph is that this is plotted as a function of the sidereal time at the Explorer location. See the text for comments

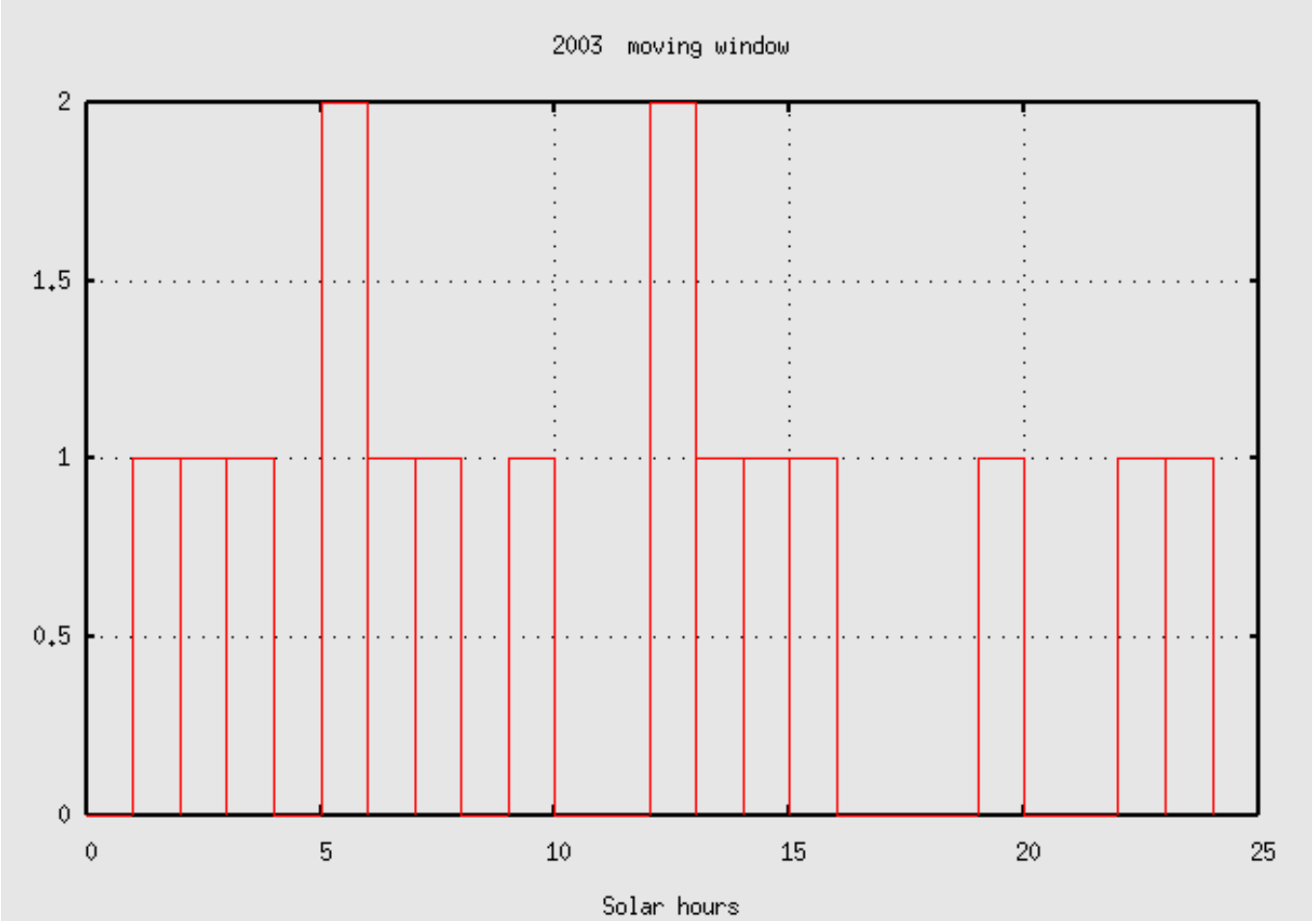

Figure 11: 2003 run, new cuts: Explorer-Nautilus coincidence events with variable window, as a function of the solar time, in 1 hour bins.

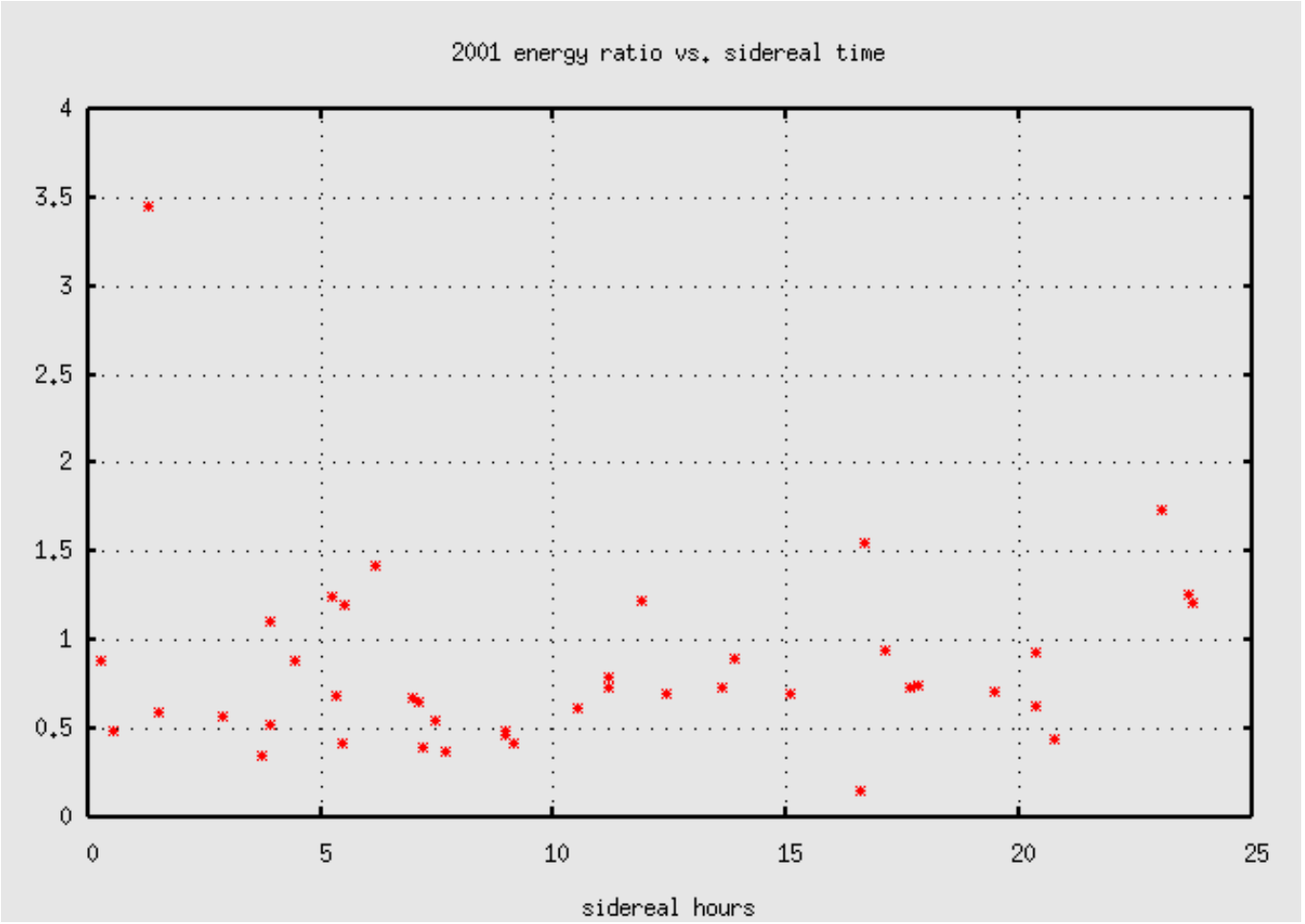

Figure 12: 2001 run, new cuts, moving window: Ratio h (Explorer) /h (Nautilus), as a function of the sidereal time

based on GC or GD patterns (no polarization), gives practically a null information.

In the following Figs. (12,13,14), I plotted the ratio of the amplitudes of the Explorer/Nautilus events which are in coincidence (no energy veto), as a function of the sidereal time. The idea was to try to see if some "particular" structure was present when the detector is well oriented toward the GD or GC. I didn't noticed any particular feature in the graphs.

4 2001 data: results with criteria similar to the ones in the events list in the CQG paper

This part of the report is something which I didn't had planned to do... As explained, I wanted simply to test the results using a new rule for vetoing the data, not so different from the ones used, but such to be -really- the same on the various files.

I expected only some "small" deviations from what was found and published...while what I get was totally unexpected. I knew that the statistical meaning of the published result was very small, but these new results seem to be really "meaningless".

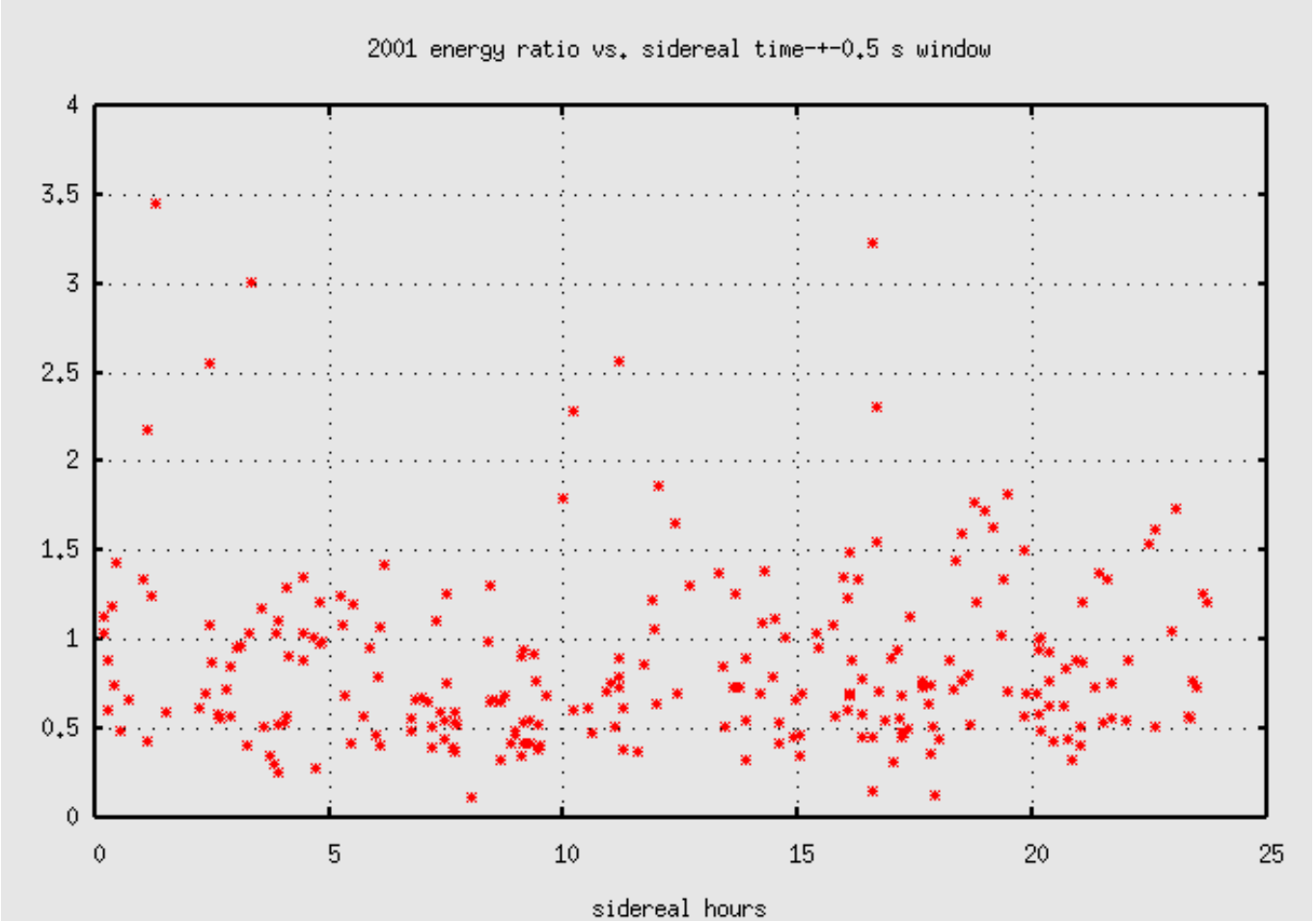

Figure 13: 2001 run, new cuts, window $\pm$ 0.5 s: Ratio h (Explorer) /h (Nautilus), as a function of the sidereal time

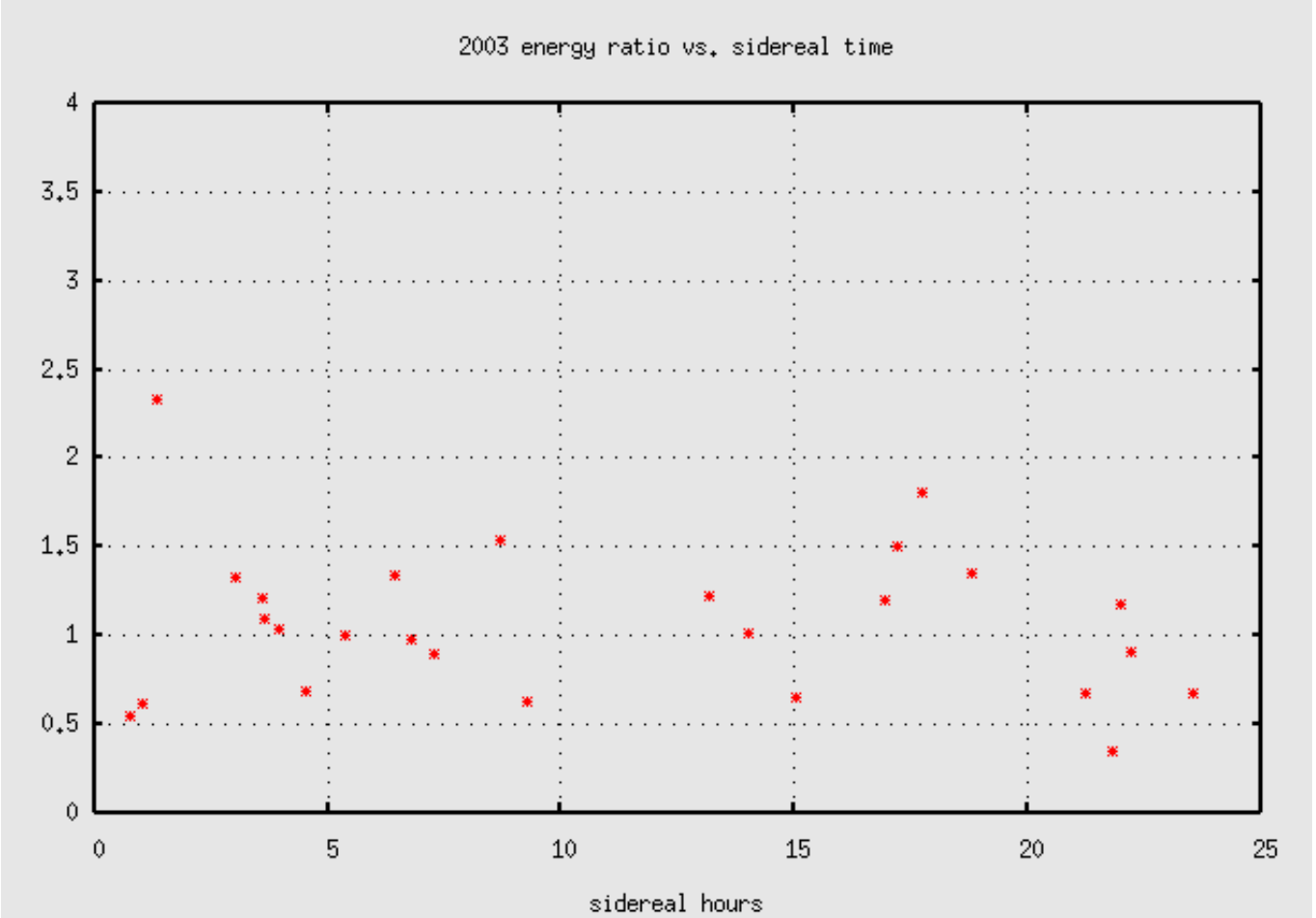

Figure 14: 2003 run, new cuts, moving window : Ratio h (Explorer) /h (Nautilus), as a function of the sidereal time

Then, I decided to go back and re-analyze the 2001 data (again, the data with the proper normalization, but with veto criteria very close to the published ones). More specifically:

- Vetoes on the hourly averages= 5.3 mK for Nautilus, 6.4 mK for Explorer,
- Vetoes on the event T_{eff}= 3.8 mK for Nautilus, 4.5 mK for Explorer,

Results are shown in Figs. (15, 16, 17, and 18):

- 2001 data with a $\pm$ 0.5 s window: number of coincidences 102. Number of coincidences which pass the energy consistency test, as defined in the paper: 67. Background=61.8 events (with the energy test). Mean in each bin= 2.6
- 2001 data with a variable window, but with $\Delta f = 0.4$ Hz for Nautilus (constant, as done in the CQG paper): number of coincidences 195. Number of coincidence s which pass the energy consistency test, as defined in the paper: 123. The aim of this exercise was to do something more similar to what published, to compare the two results.

Even these results are very different from the ones which have been published. I am in particular very much worried about the results in Fig. 17, which I expected to be very similar to the published one.. I know there is still some difference between my results and the published ones (e.g. for Explorer I have used the β_3 of each event and never the average value), but I don' t think some differences can hide a true effect, if it was really present.

I wish to discuss this point with the collaboration, I expect that somebody else has repeated the analysis with these files and maybe there is something wrong in what I have done.

5 Conclusion

I have shown here some re-analysis of the 2001 and 2003 Explorer and Nautilus data. My conclusion is that nothing interesting is present in the data. I am really worried about results from the re-analysis of the 2001 data.

Nothing interesting seems to be present in the 2003 data.

6 File names:

This is only a technical note for me.

- 2001 data: A) expl01_mjd.eve,naut01_mjd.eve e 2001data/explorer2001.eve, nautilus2001.eve

  2001 data, with the new cuts on effective temperature: B) expl01_mjd_new.eve, naut01_mjd_new.eve e 2001data/explorer2001_new.eve, nautilus2001_new.eve
- 2001 data: coincidences: shiftfile01.info coincidences of the files A) within $\pm$ 0.5 s (dato a Sergio)

  shiftfile01_wincqg.info coincidences of the files A) with variable window but with Df Nautilus fixed at 0.4 Hz
- 2001 data: coincidences: shiftfile01_new05.info coincidences of the files B) within $\pm$ 0.5 s

  shiftfile01_new.info coincidences of the files B) with variable window.
- 2003 data: C) expl03_mjd_10mk.eve,naut03_mjd_10mk.eve

  and 2001data/explorer2003_10mk.eve, nautilus2003_10mk.eve

  2003 data, with the new cuts on effective temperature: D) expl03_mjd_new.eve, naut03_mjd_new.eve and 2003data/explorer2003_new.eve, nautilus2003_new.eve

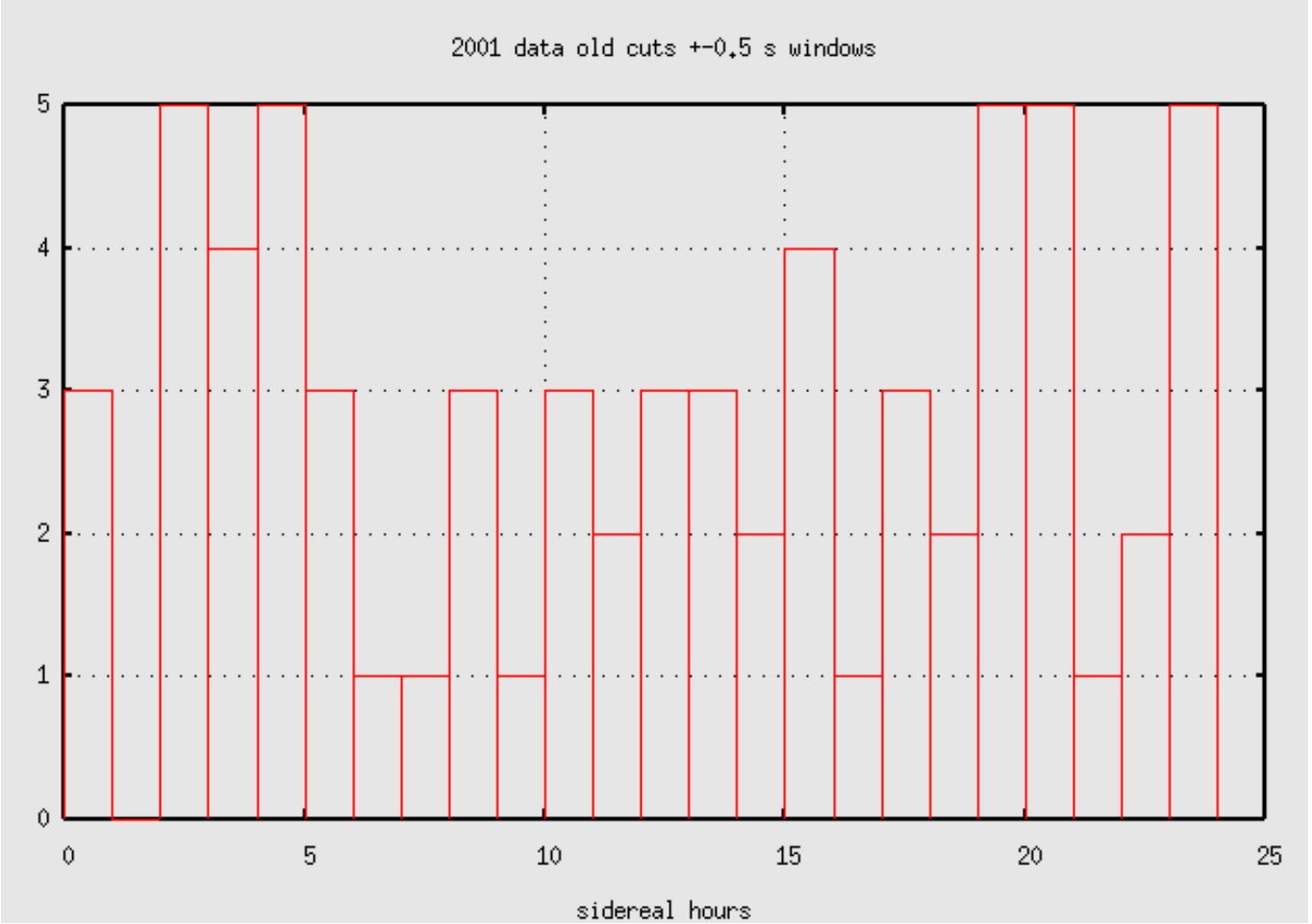

Figure 15: 2001 run: Explorer-Nautilus coincidence events with a $\pm$ 0.5 s window, as a function of the sidereal time, in 1 hour bins. The criteria for the vetoes are derived from the ones used in the CQG paper. 67 events.

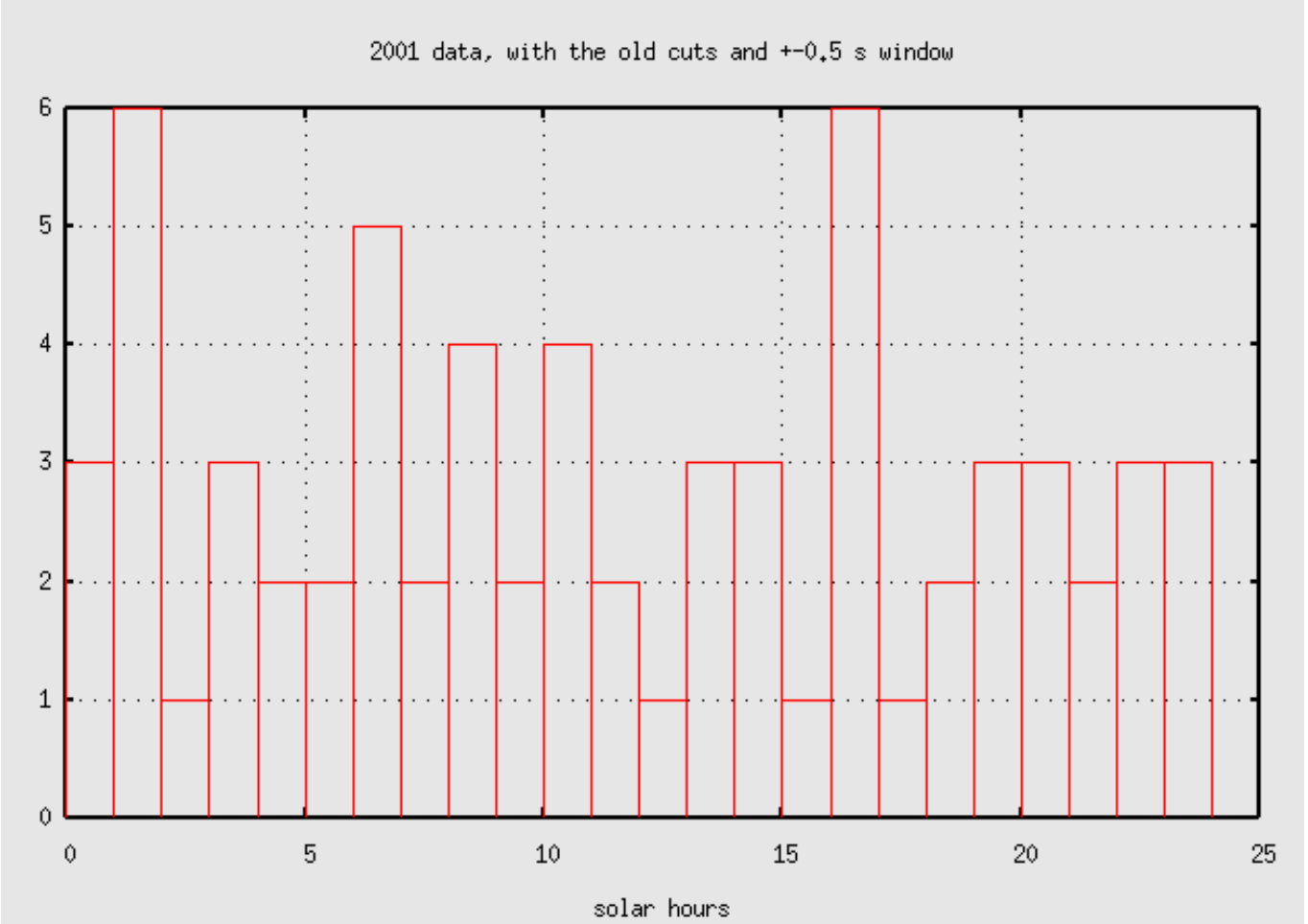

Figure 16: 2001 run: Explorer-Nautilus coincidence events with a $\pm$ 0.5 s window, as a function of the solar time, in 1 hour bins. The criteria for the vetoes are derived from the ones used in the CQG paper.

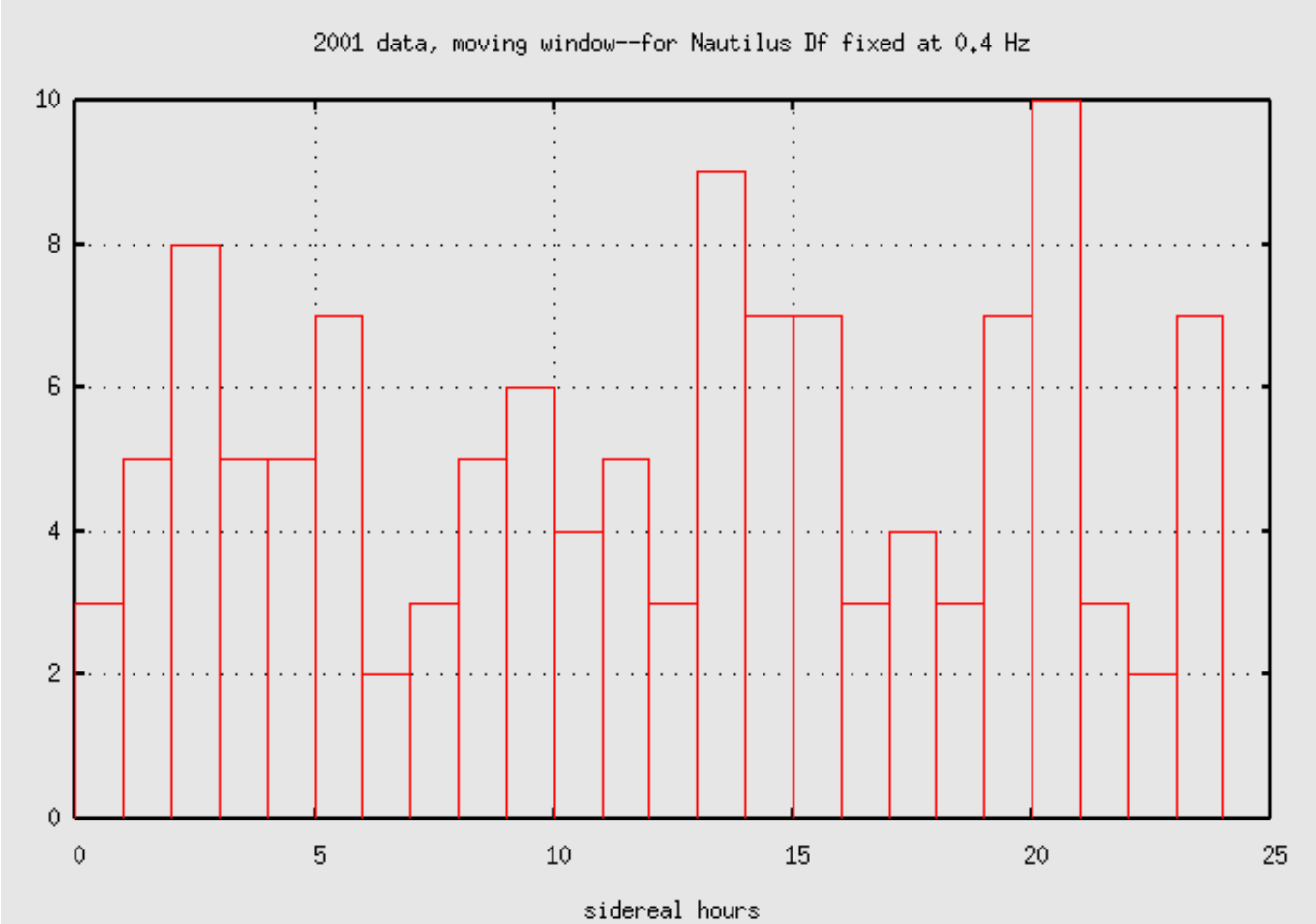

Figure 17: 2001 run: Explorer-Nautilus coincidence events with variable window, but with the Nautilus bandwidth fixed at 0.4 Hz, as a function of the sidereal time, in 1 hour bins. The criteria for the vetoes are derived from the ones used in the CQG paper. 123 events.

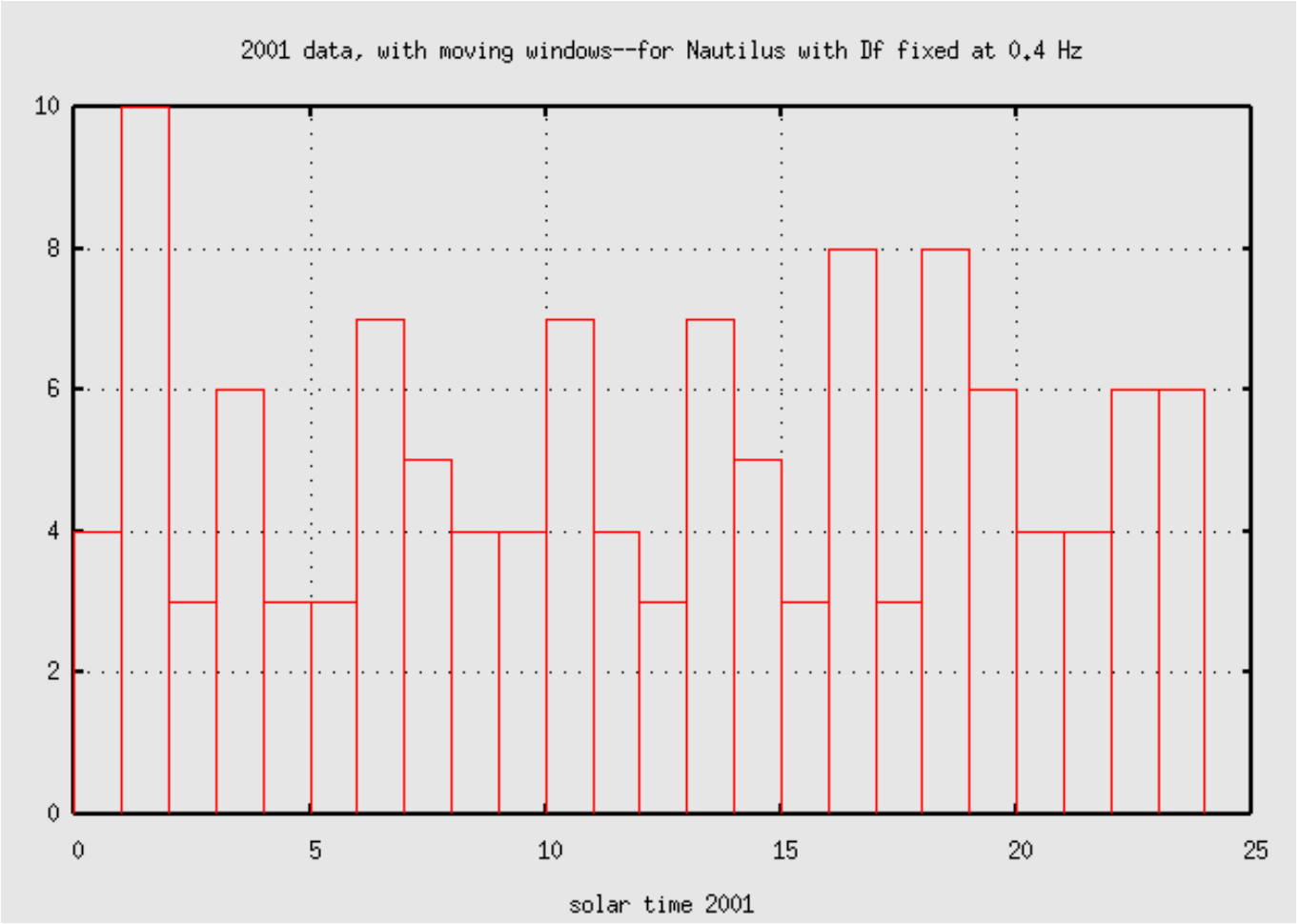

Figure 18: 2001 run: Explorer-Nautilus coincidence events with a variable window, but with the Nautilus bandwidth fixed at 0.4 Hz,as a function of the solar time, in 1 hour bins. The criteria for the vetoes are derived from the ones used in the CQG paper.

- 2003 data: coincidences: shiftfile03_new.info coincidences of the files D) with variable window. shiftfile03.info coincidences of the files C) with a $\pm$ 30ms window (dato a Sergio).

References

[1] P. Astone et al., Class. Quantum Grav. **19** (2002) 5449.