Statistical vetoes for GEO 600

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Overview

Various types of vetoes:

1. ***Nullstream-veto***
   (using a DER_DATA_HNULL)

2. ***Noiseprojection-veto***
   (using a record of the noise and a known TF to DER_DATA_H)

3. ***Statistical veto***
   - using NO knowledge about the detector.
   - using only a statistical correlation between DER_DATA_H and a GW-free auxiliaury channel

Definition: VETO EFFICIENCY

Starting point:

- **2 sets of triggers from chacr**
- **H_i = triggers from G1:DER_DATA_H**
- **C_i = triggers from auxiliary channel**
- **each H_i and C_i constist of a few parameters**
  (time, central_freq, duration, SNR, ...)

$$num\_H = \sum^{i} H_i \qquad \text{and} \qquad \mathrm{num\_C} = \sum^{\mathrm{i}} \mathrm{C_i}.$$

total number of triggers in the data stretch

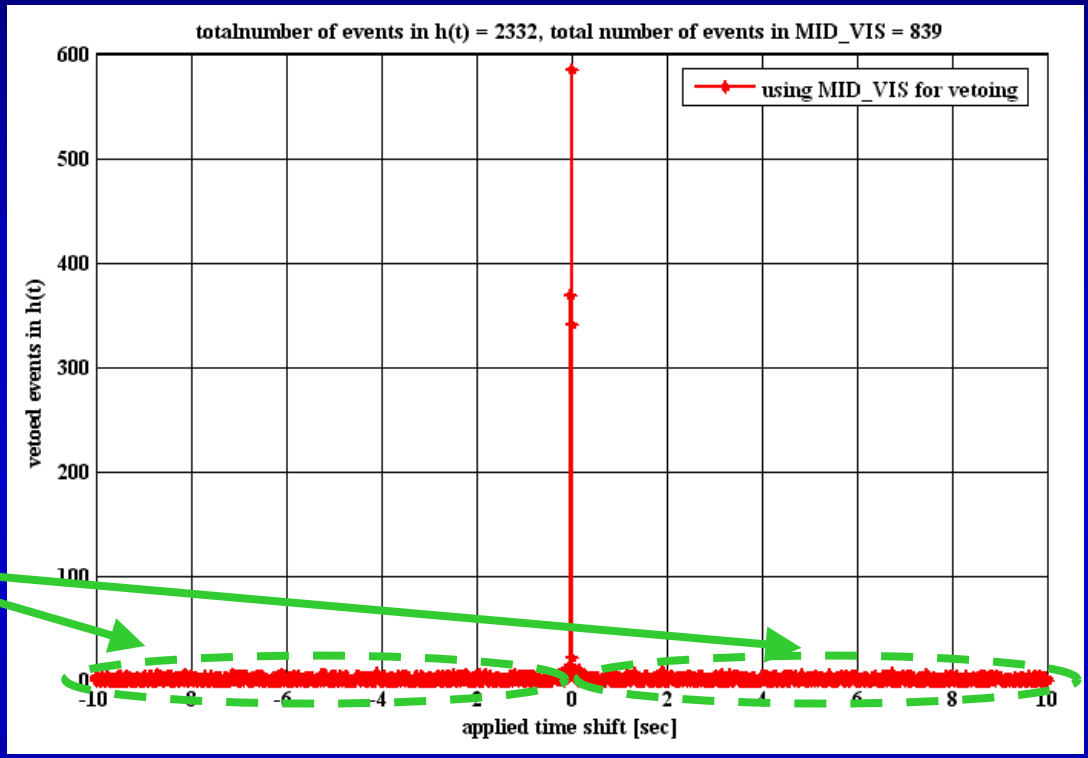
VETO EFFICIENCY:
(percentage of H triggers that get vetoed)

$$E_C = \frac{num\_H_{veto}}{num\_H} \cdot 100 \qquad [\%]$$

Definition: BACKGROUND

Determine the *significance of the statistical correlation* by timeshifting the data.

Background = average of vetoed events for timeshifted data.



B_C is measure of how many ***potential GW events get falsely vetoed*** per time stretch.

$$B_C = \frac{\sum_{i=1}^{j} num\_H_{veto}(\Delta t_i)}{j} \quad [\text{counts/time}] \quad \text{with} \quad \Delta t \neq 0$$

Definition: VETO-SNR and Use Percentage

VETO-SNR:
Performance of a veto can be judged by the ratio of efficiency and background.

$$SNR_C = \frac{E_C}{B_C} \qquad [\% \cdot \mathrm{time/counts}]$$

Use percentage
Ratio of vetoed H-events and used triggers from the auxiliary channel.

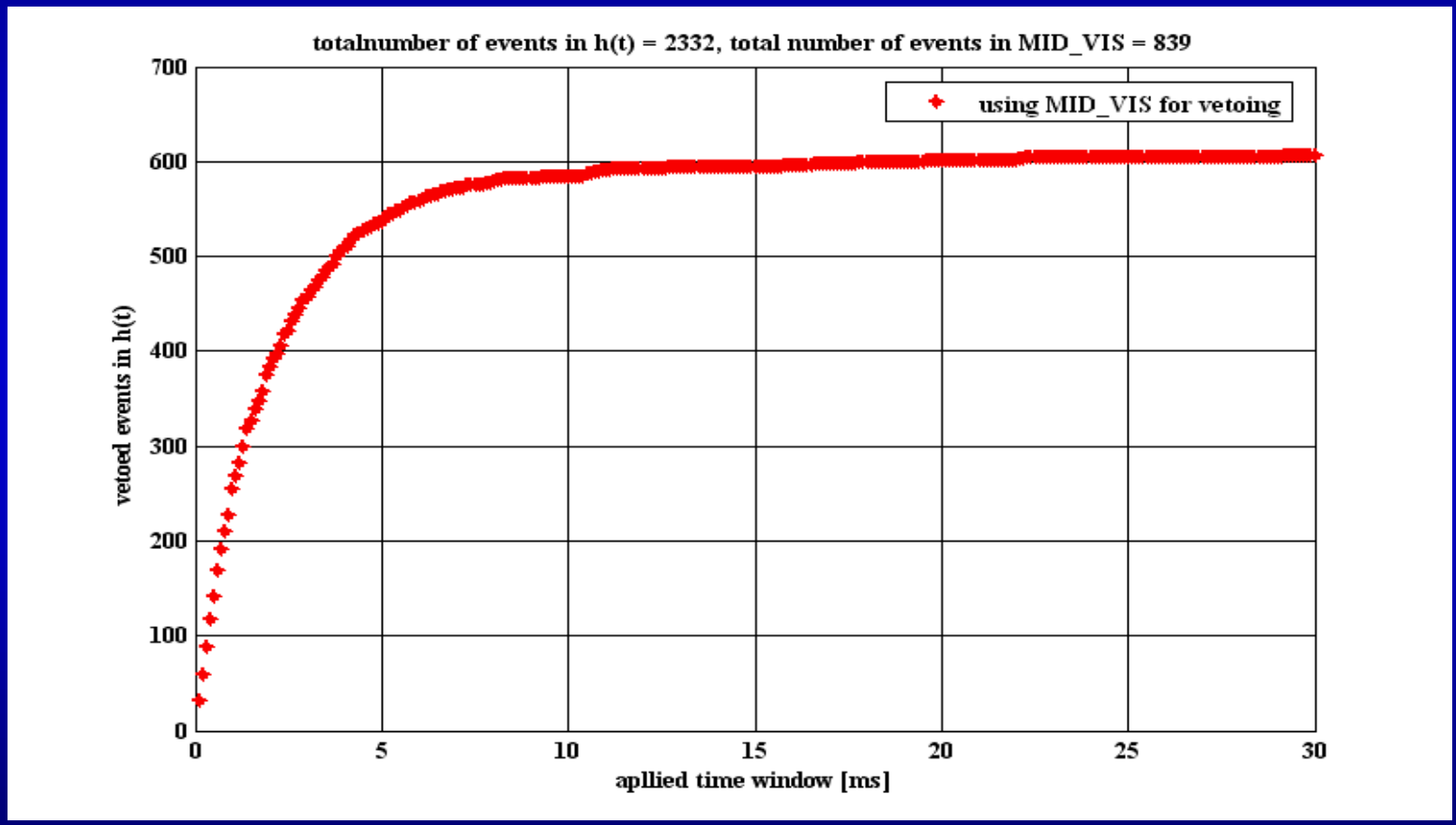
$$UsPer_C = \frac{num\_H_{veto}}{num\_C} \cdot 100 \qquad [\%]$$

DUST

G1:LSC_MID_VIS veto

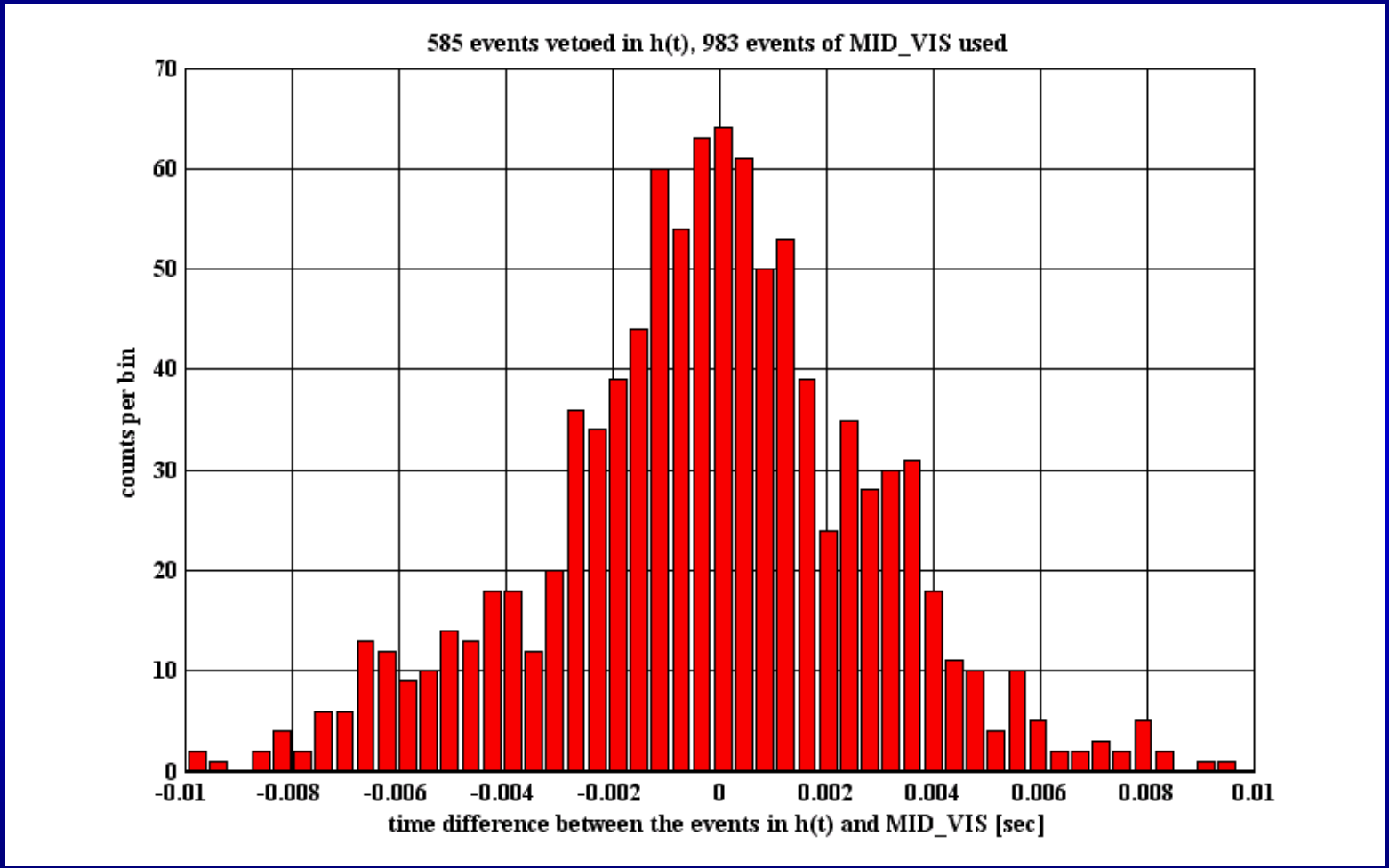
Applying a time window

Used 8 hours of data from summary page Sun_3 (2006-05-14 14:59:46)
= still high dust concentration in GEO clenaroom.



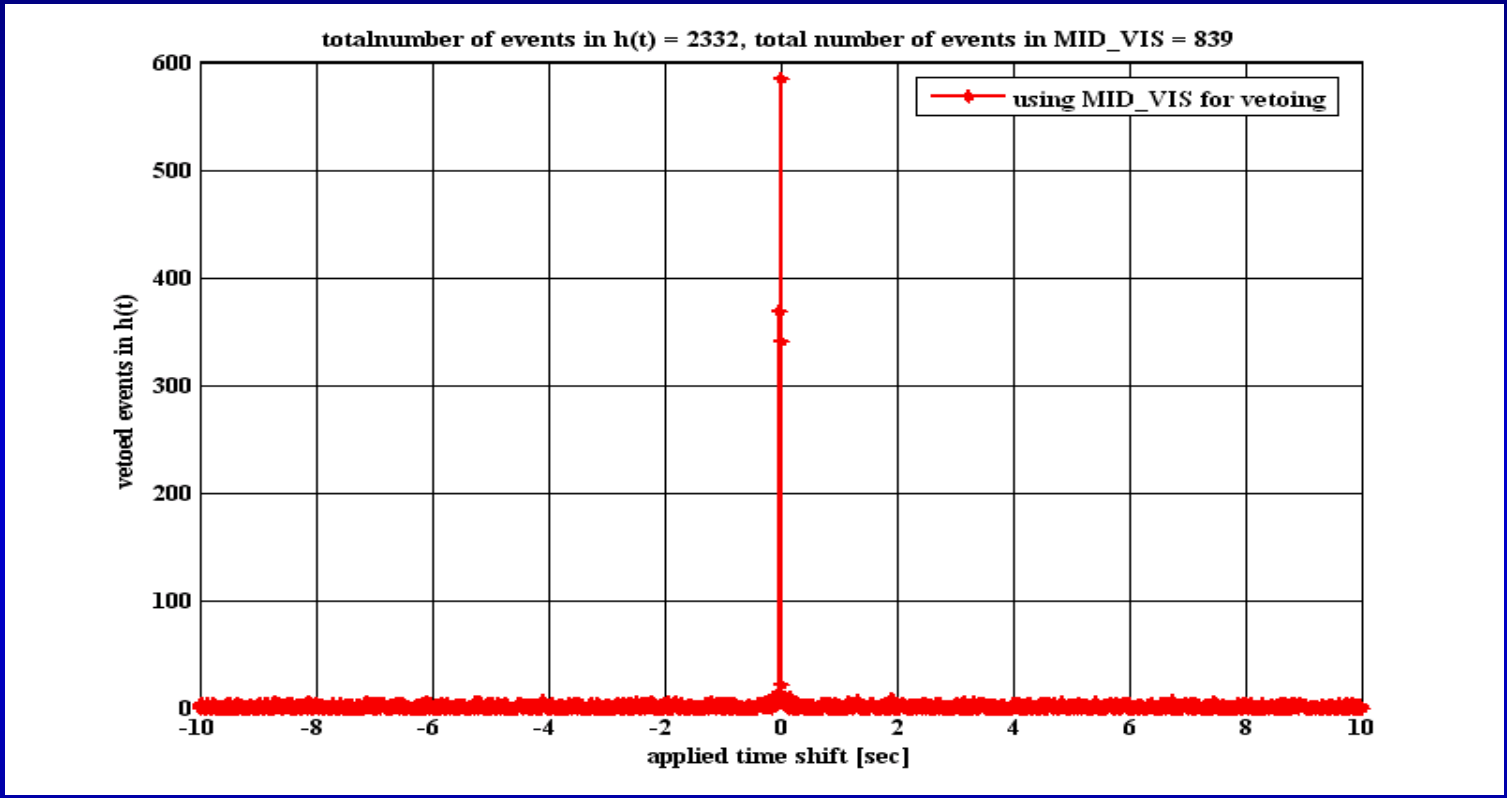
Going forward with T_win = 10 msec.

High resolution time shifted analysis



No significant time offset visisble !
Applying +/- T_win.

Efficiency / Background



Efficiency = 25%
Background = 1.13 events / 8 hours
Use percentage = 70%

Conclusion: good handle of the data with high dust concentration !

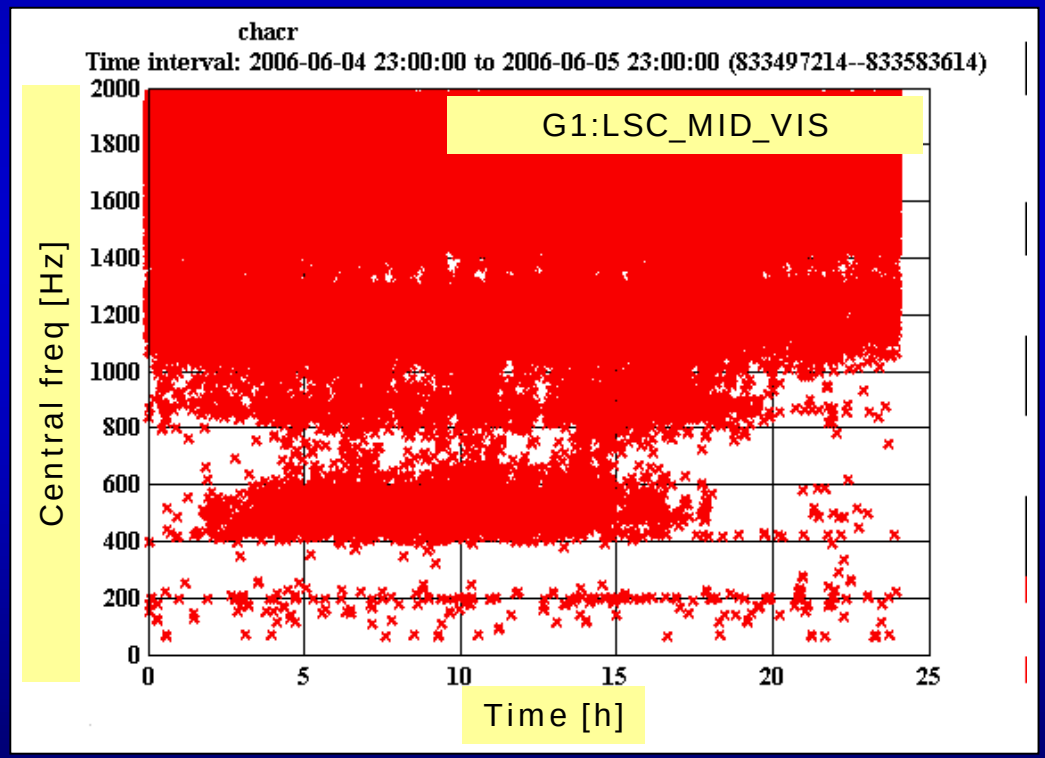
Application for all June 2006

- **Much less glitches from dust, because dust concentration was significantly decreased.**
- **Partly extremely high glitchrates in LSC_MID_VIS to to excess noise in MIC-loop.**

Epoch 1
(glitchy MIC_loop)
833155214 to 835023600
***7000* MID_VIS glitches / hour**

!!!

Epoch 2
(fixed MIC_loop)
835023600 to 835747213
***25* MID_VIS glitches / hour**



- **It turned out to be useful to also apply a freq_window.**

Epoch 2, June 2006

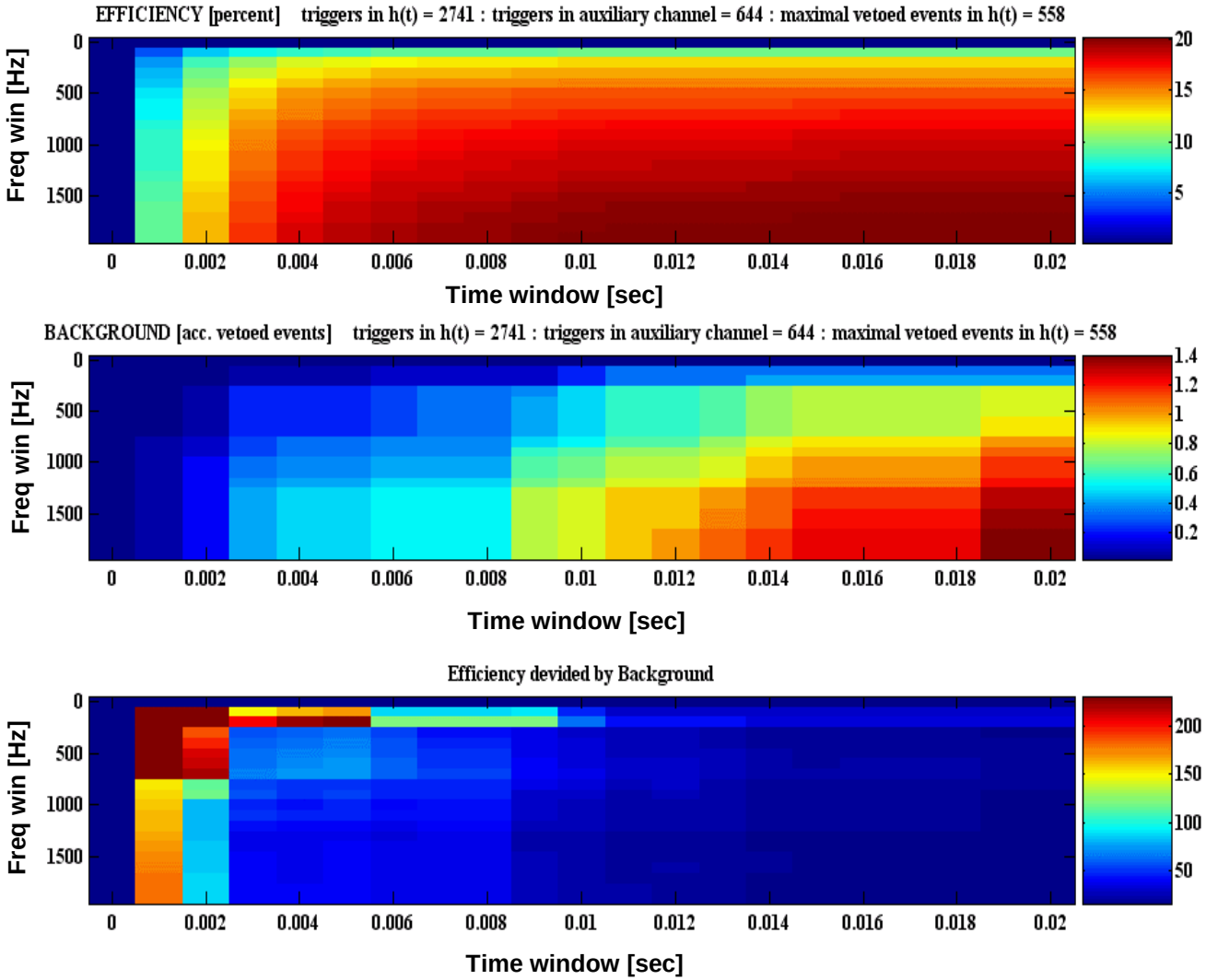
1 day of data

<u>Chosen windows:</u>

T_win = 4 msec

Freq_win = 1 kHz

Efficiency = 15%
Back. = 0.5/day
SNR = ca. 80



Epoch 1, June 2006 (MIC noise)

If we would choose the same windows as for Epoche 2 we would end up with a background of 25/day.

Too much !
=> tighter windows !

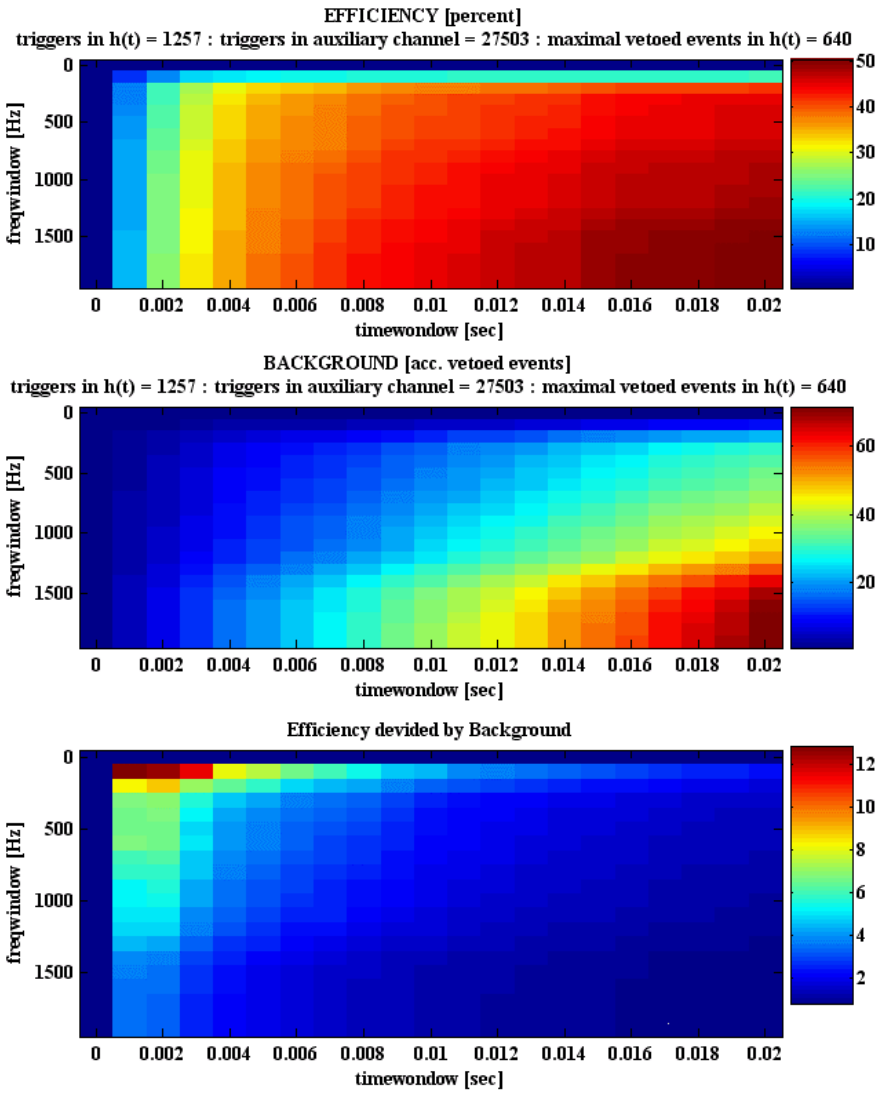
1 day of data

Chosen windows:

T_win = 1 msec

Freq_win = 100 Hz

Efficiency = 10%
Back. = 2/day
SNR = ca. 12

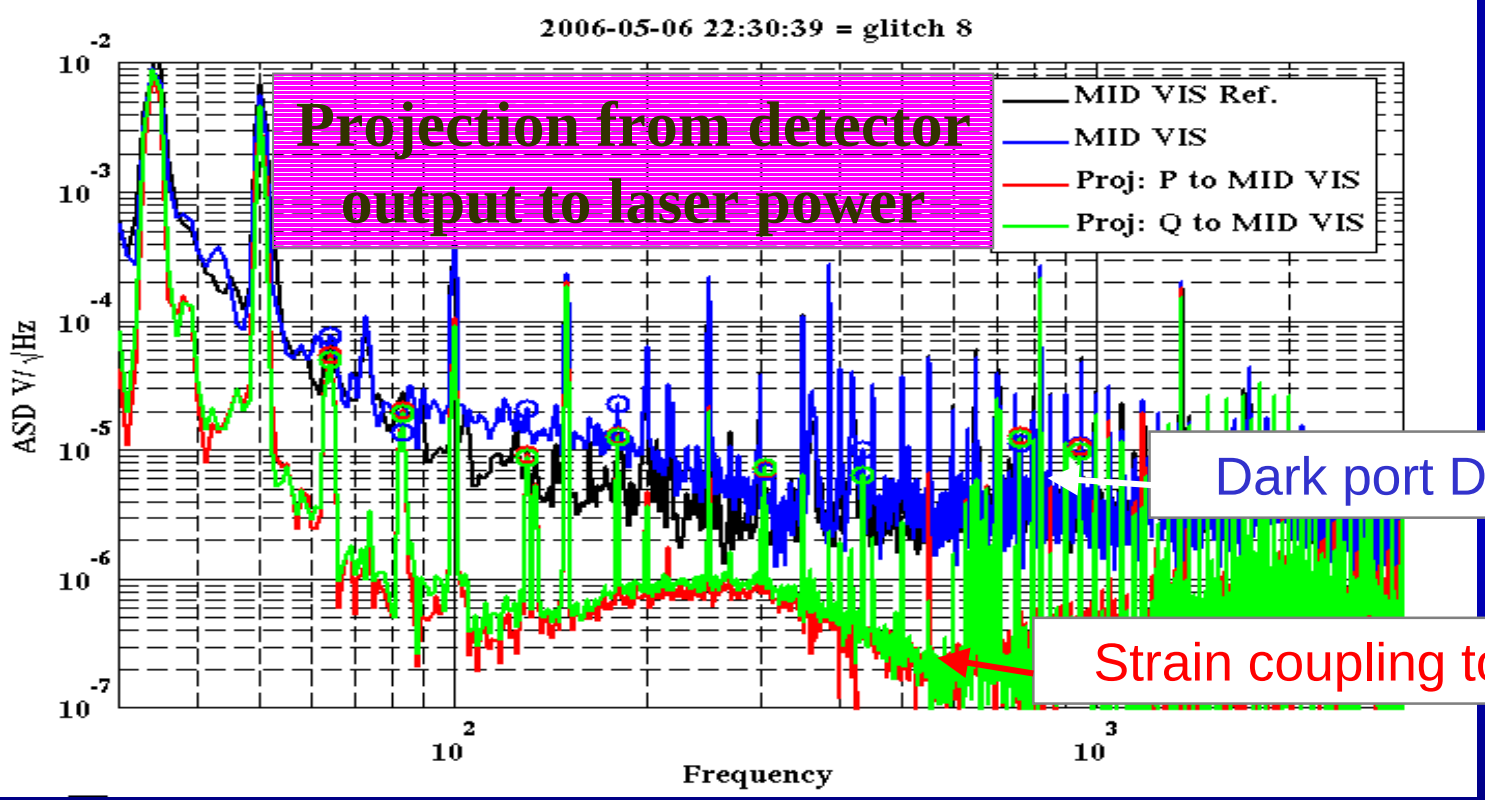


Summary for June 2004

	Epoche 1	Epoche 2
Glitchrate MID_VIS	7000 / h	35 / h
Starttime	833155214	835023600
Endtime	835023600	835747213
T_win [msec]	1	4
Freq_win [Hz]	100	1000
Efficiency [%]	**9**	**16**
Use percentage [%]	**0.4**	**78**
Background [1/day]	**2.3**	**0.15**

Back coupling ?

LSC_MID_VIS is generated from the same PD as DER_DATA_H.

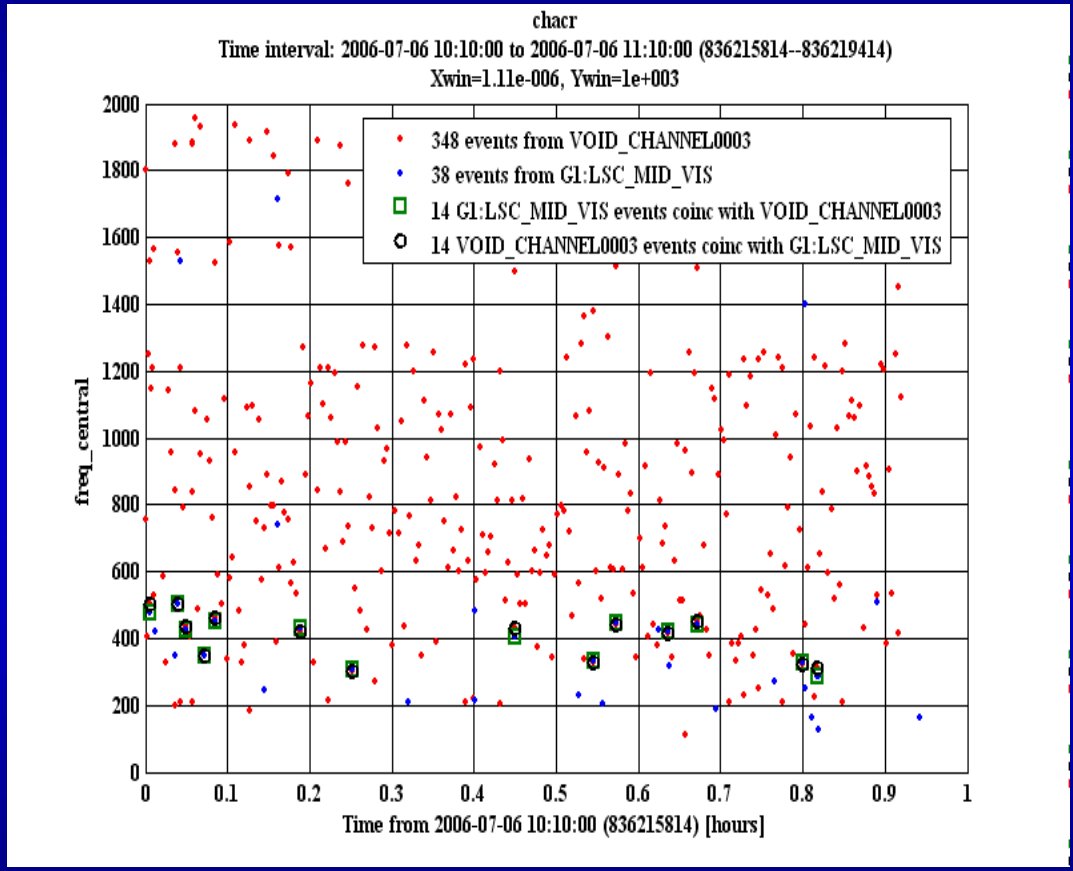


Strain back coupling doesn't explain instrumental channel coincidence,

But how for very large events ???

Hardware injections

- Hardware injections to determine the level of backcoupling
- Injecting h-like events
- A few percent of the injections show up in MID_VIS
- To make the veto save we need to apply an additional amplitude cut. (ongoing)



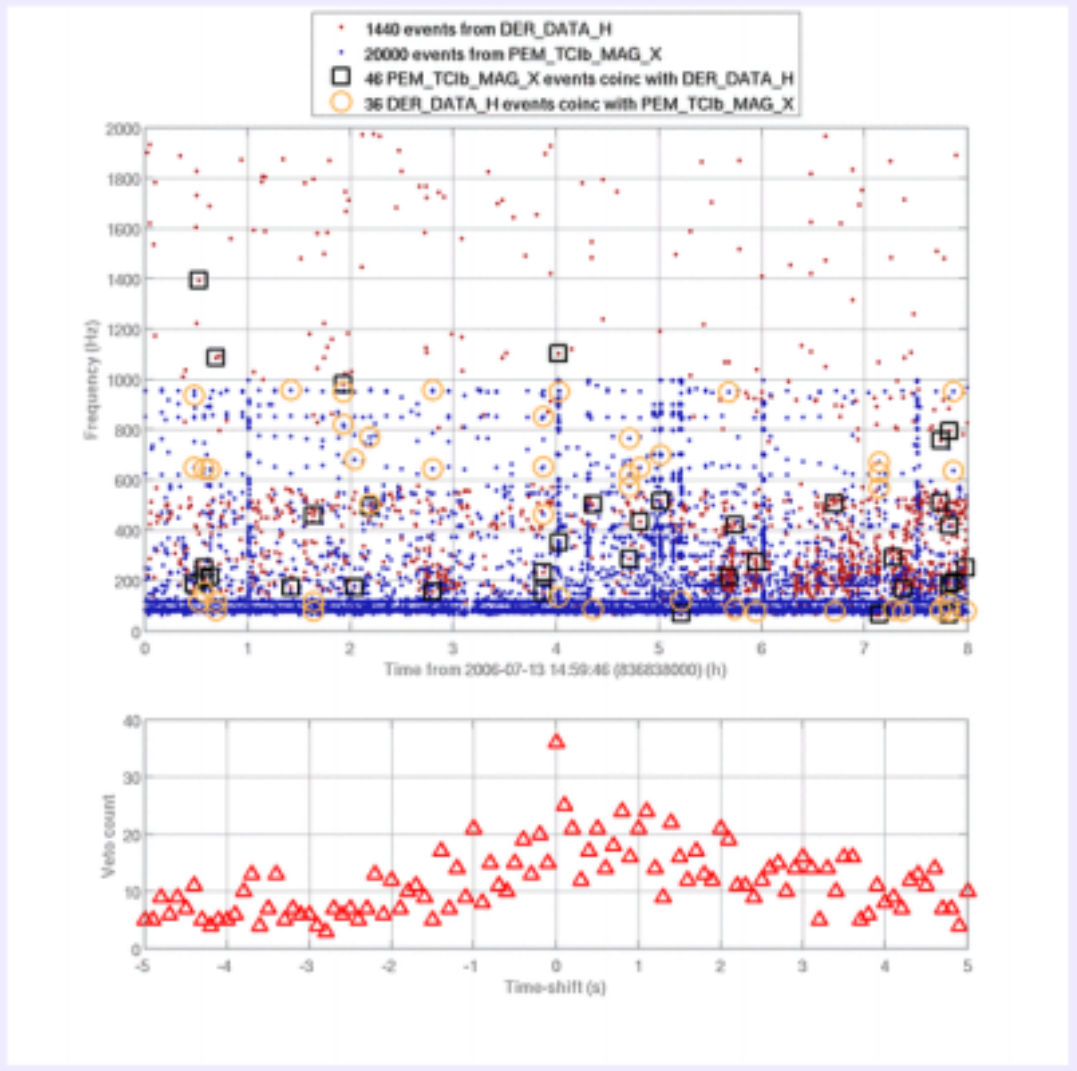
Magnetometer

G1:PEM_TCIb_MAG-X

Magnetometer coincidences

About 30 to 50 coinc. / 8h
T_win = 10 msec
No F_win

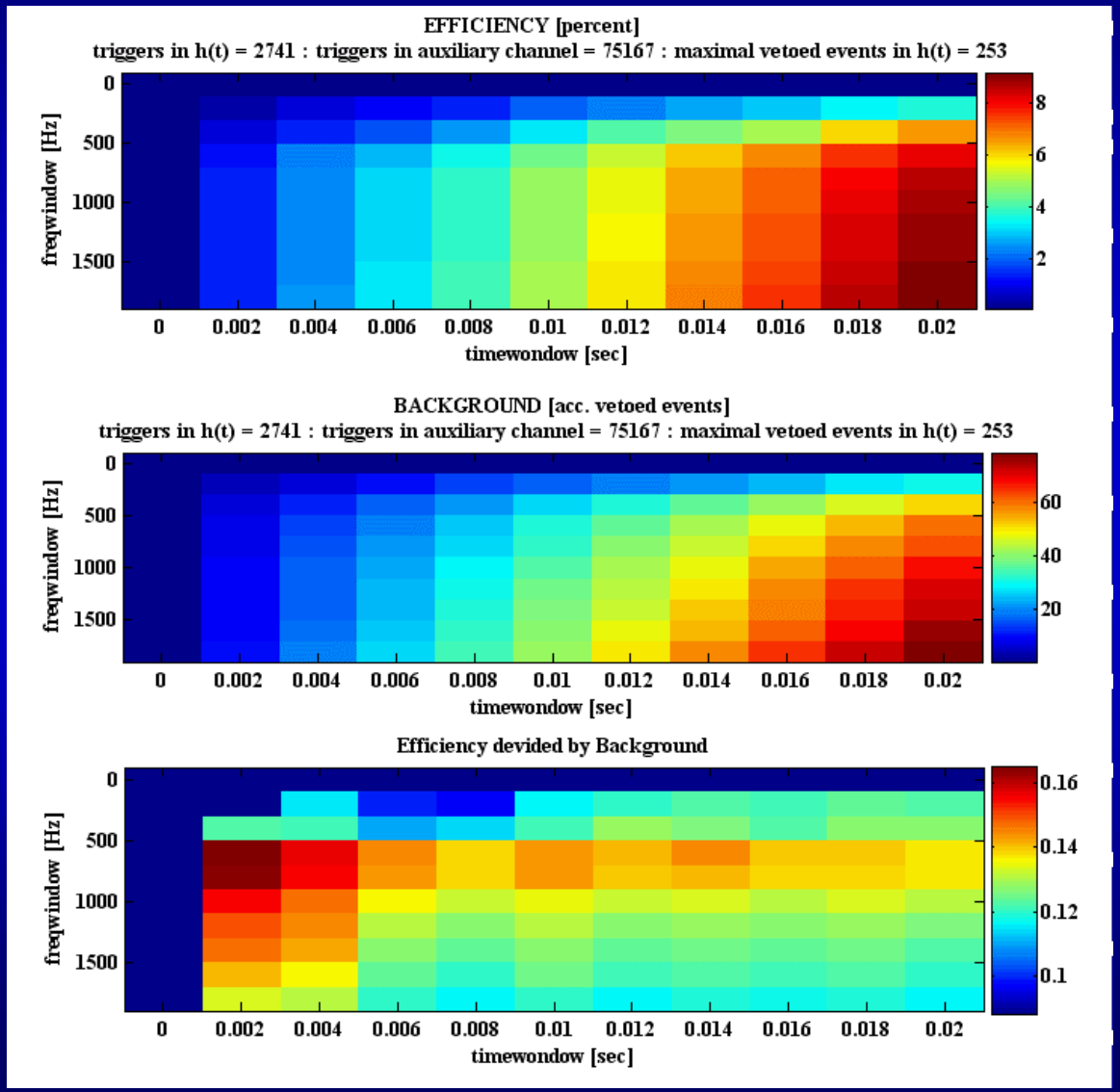
<u>Problem:</u>
Background
due to high Eventrate
(= 3000 / h)



Efficiency – Background – Veto_SNR

Best SNR for
T_win = 1 to 2 msec
F_win = 800 Hz

⇒ low efficiency
⇒ high background



Best result so far

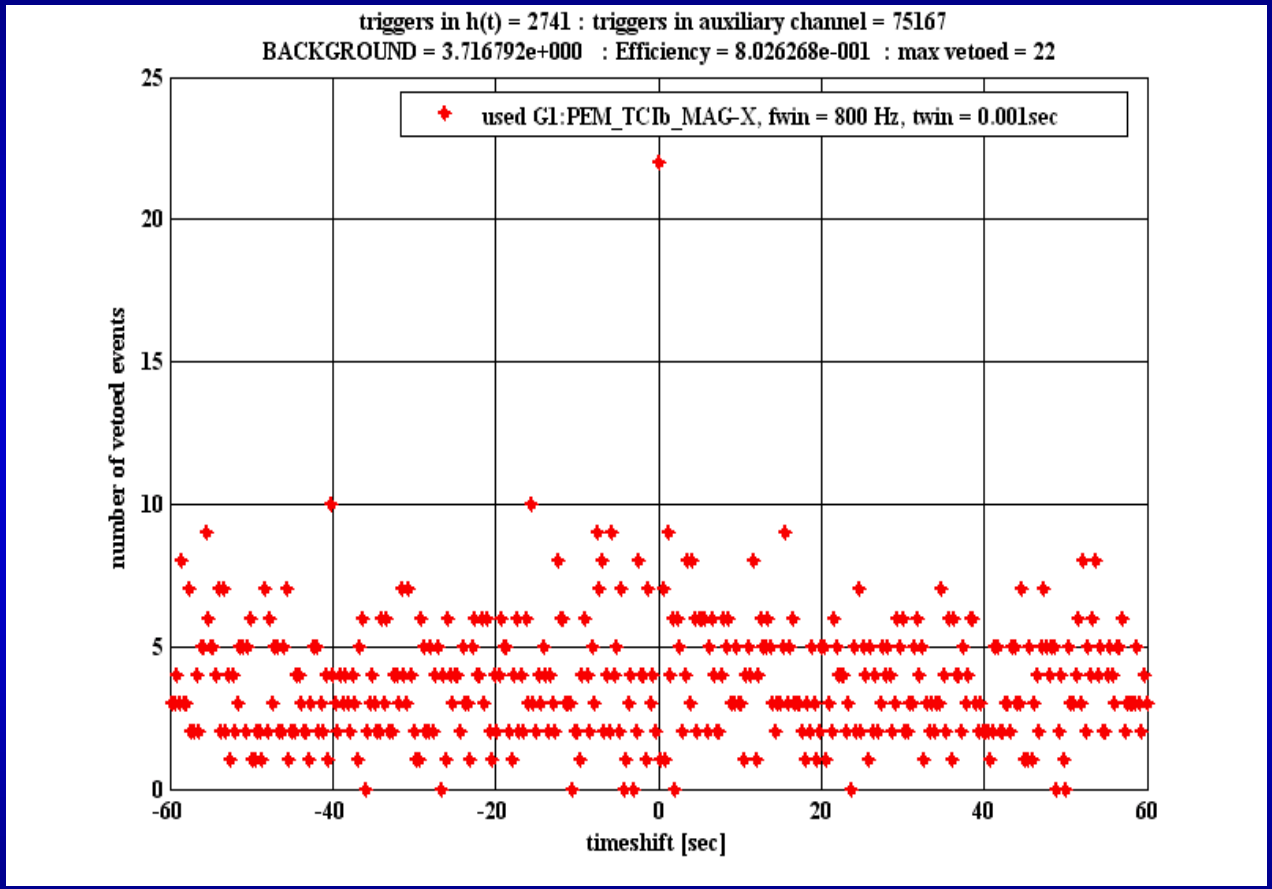
1 day of data

<u>Chosen windows:</u>

T_win = 1 msec

Freq_win = 800 Hz

Efficiency = 0.8%
Back. = 3.7/day
SNR = 0.16
Use perc = 0.03 %



Not very encouraging !!!

Maybe introducing an amplitude window can increase the performances

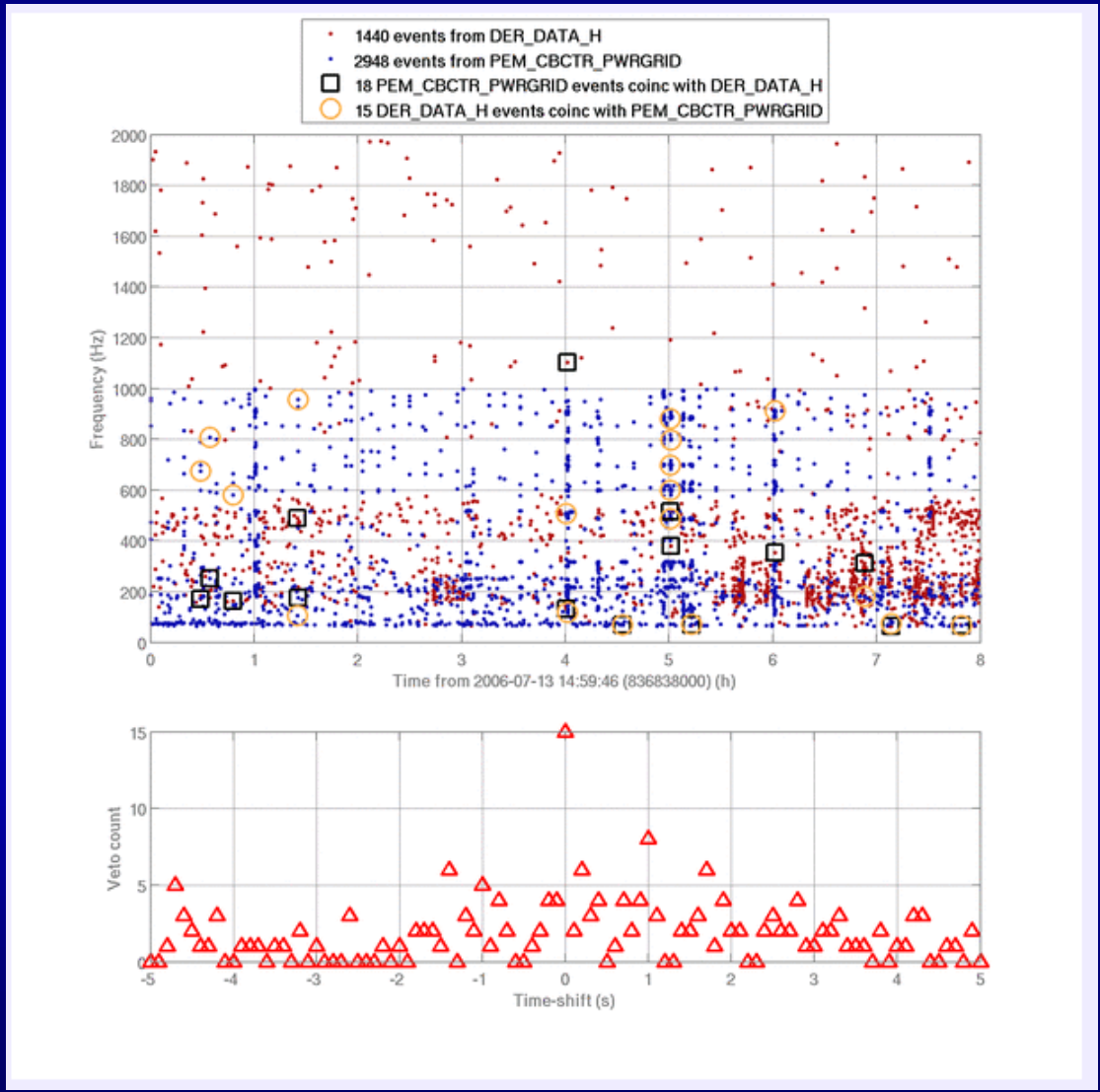
Mains

G1:PEM_CBCTR_PWRGRID

Mains coincidences

About 10 to 30 coinc. / 8h
T_win = 10 msec
No F_win

<u>Problem:</u>
Background

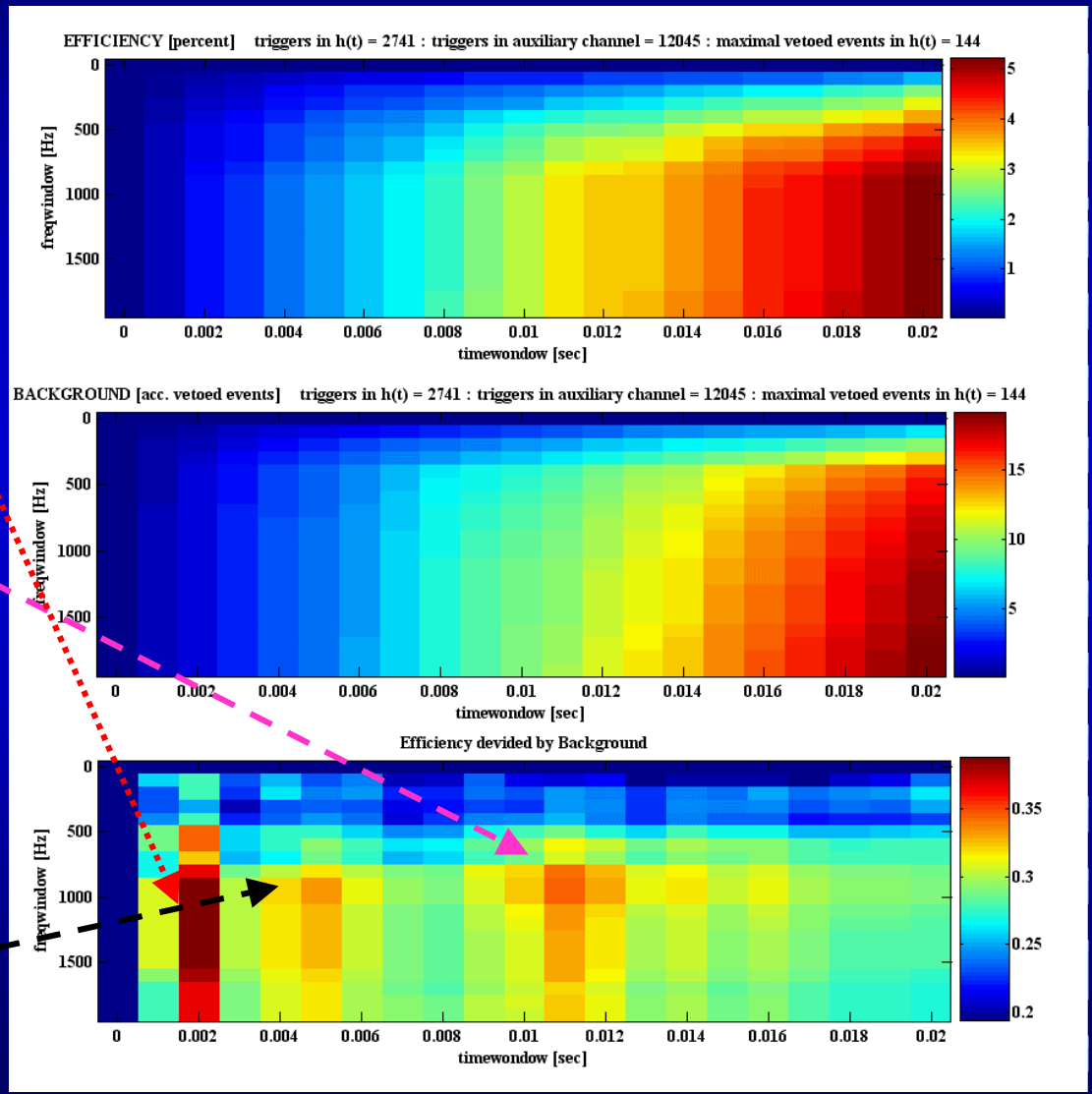


Efficiency – Background – Veto_SNR

Best SNR for
T_win = 2 msec
F_win = 1000 Hz
=> low efficiency

2nd Best SNR for
T_win = 11 msec
F_win = 800 Hz
=> Too high backg.

Best compromise
T_win = 5 msec
F_win = 1000 Hz



Best result so far

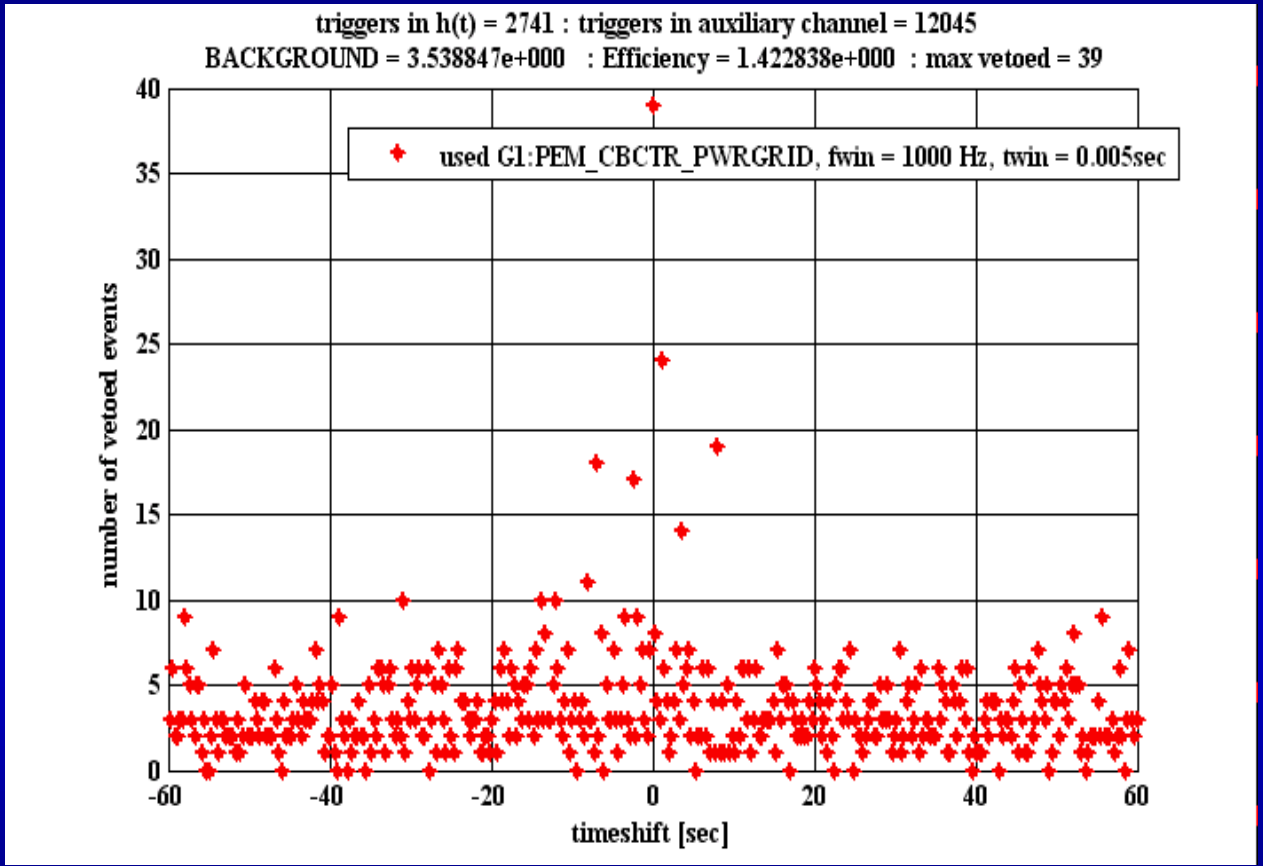
1 day of data

<u>Chosen windows:</u>

T_win = 5 msec

Freq_win = 1000 Hz

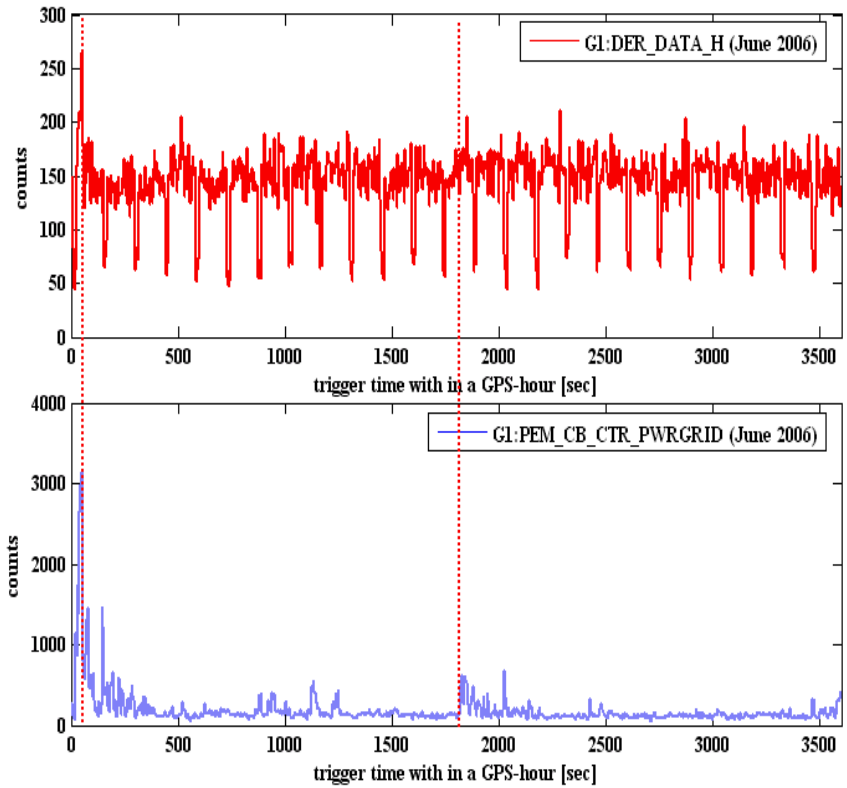
Efficiency = 1.4%
Back. = 3.5/day
SNR = 0.4
Use perc = 0.3 %

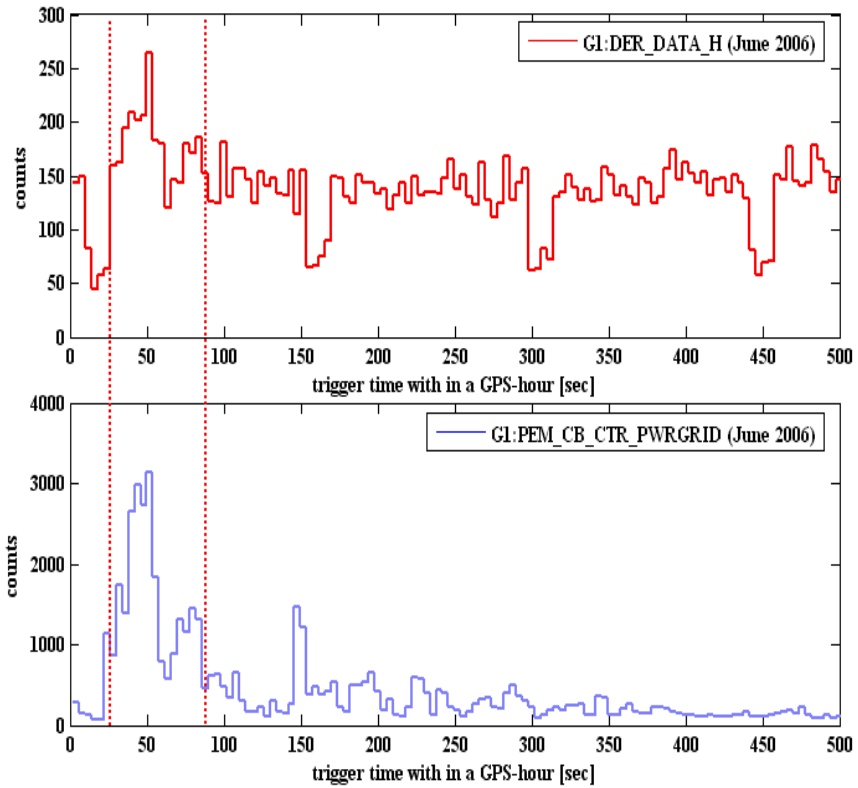


Not encouraging !!!

Maybe introducing an amplitude window can increase the performances

Hourly glitches from the mains





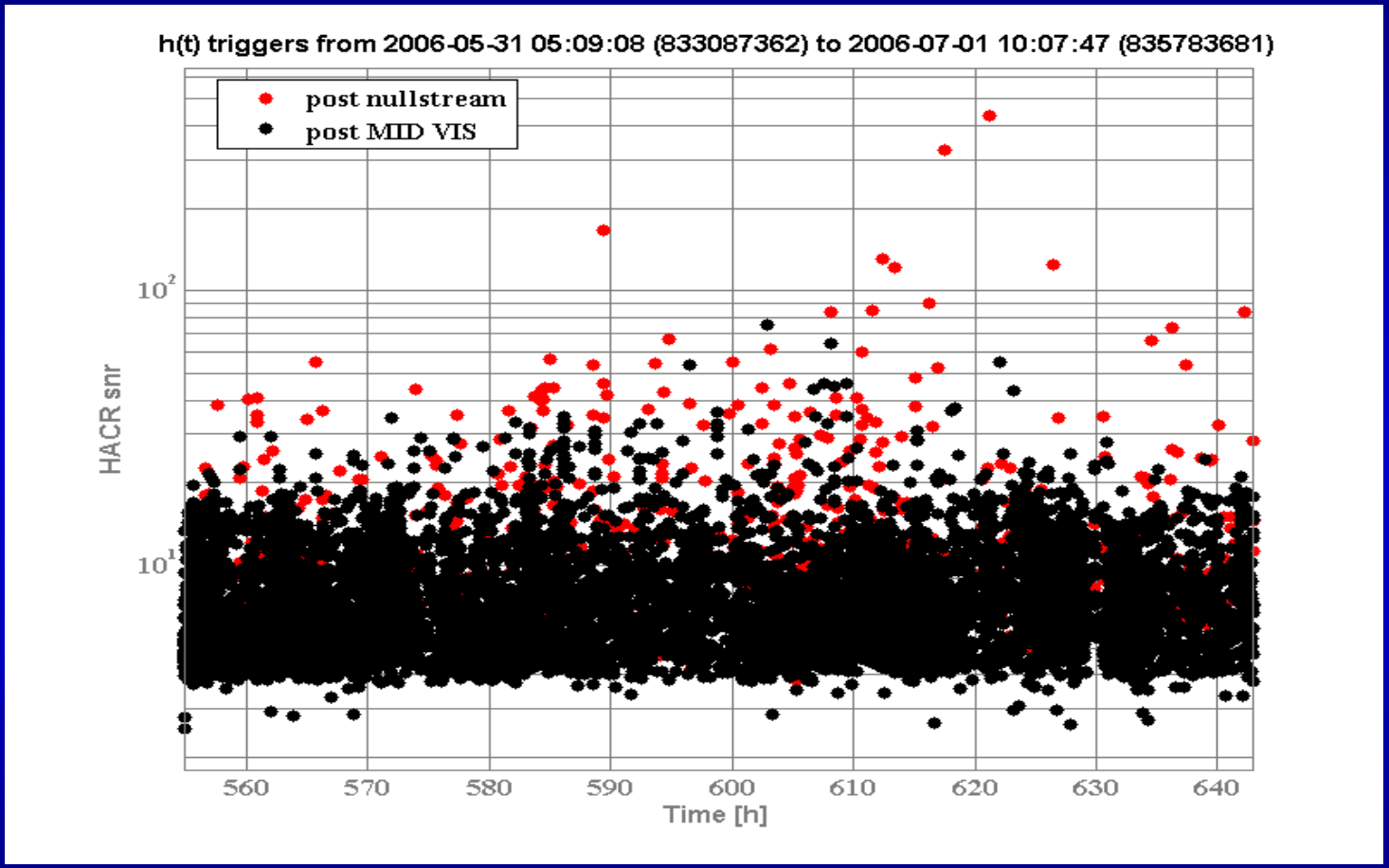
- **Could take out seconds 20 to 100 of every GPS hour.**
- **We would loose about 2% of duty cycle. (worthwhile?)**

Summary (1)

Veto channel	MID_VIS epoch 1	MID_VIS epoch 2	B-Field	Mains
Glitchrate in veto channel	7000 / h	35 / h	3000 / h	100 / h
T_win [msec]	1	4	1	5
Freq_win [Hz]	100	1000	800	1000
Efficiency [%]	9	16	0.8	1.4
Use percentage [%]	0.4	78	0.03	0.3
Veto-SNR [a.u.]	12	80	0.16	0.4
Background [1/day]	2.3	0.15	3.7	3.5

Propose: Only to use vetoes with a VETO-SNR >1

Application of MID_VIS for June 2006



- **Red dots without MID_VIS veto**
- **Black dots after application of MID_VIS veto**

Summary (2)

- **LSC_MID_VIS veto looks very promising:**

  - for high dust rate
  - for low dust rate
  - even on times of high MIC_loop noise
  - application for all June gave good results
  - TO DO: Amplitude cut to supress potential backcoupling.

- **PEM_TCIb_MAG-X + PEM_CBCTR_PWRGRID:**

  - poor performance
  - could be applied if we want to pay the price of an high background.
  - maybe an amplitude cut can help?

E N D

Issue to discuss: Deadtime

$$D_{H_m} = H(time)_m \pm N \cdot H(dur)_m$$

Do we need the N?

If, yes what number should be assign to N?