Application of a statistical veto to a full month data of S5 from GEO 600

Stefan Hild for the GEO600-team

Max-Planck-Institut für Gravitationsphysik
(Albert-Einstein-Institut)

Universität Hannover

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 little 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, ...)

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

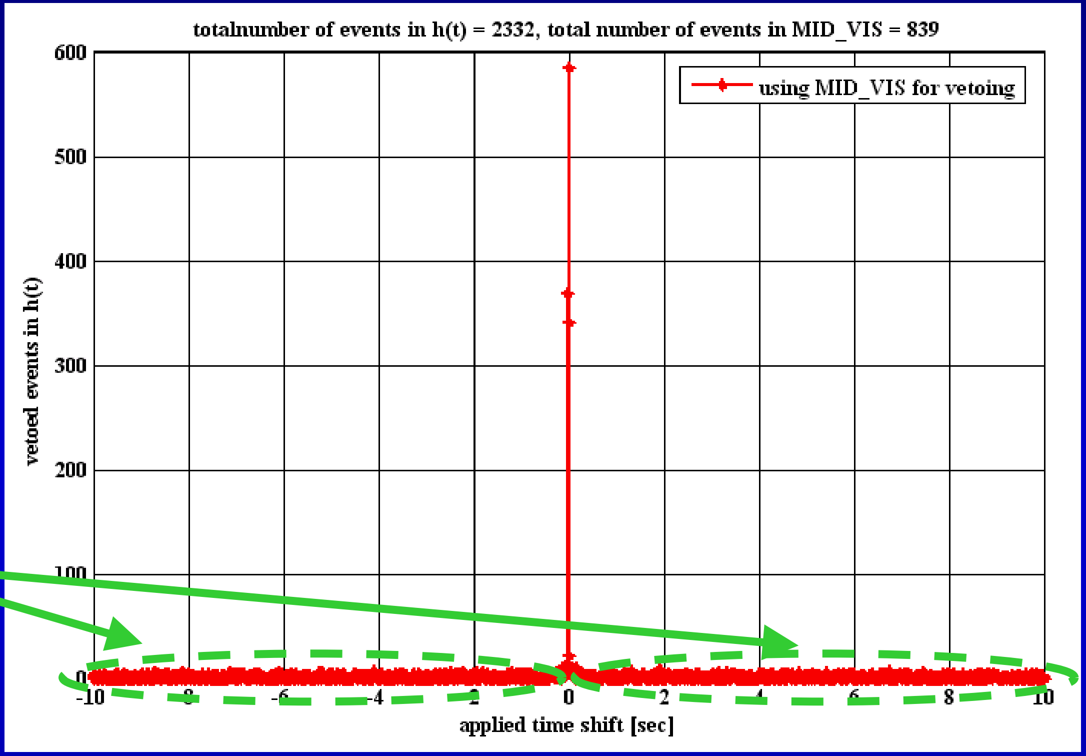
total number of triggers in the data stretch

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.

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

EXAMPLE 1:

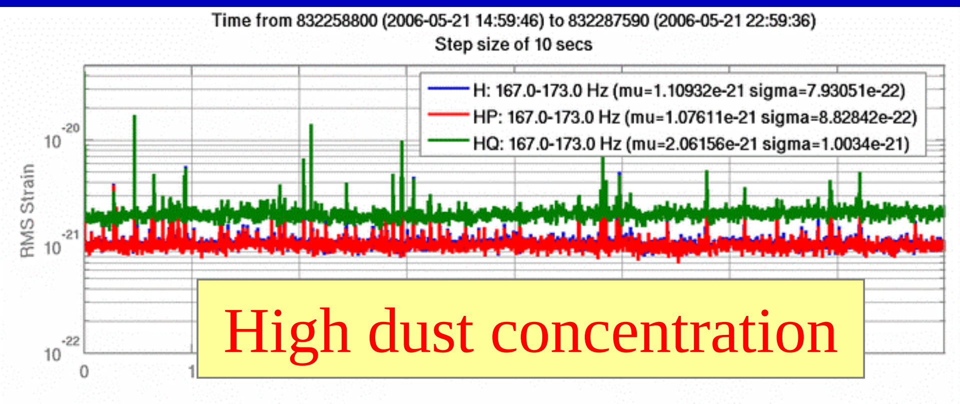
THE DUST_VETO

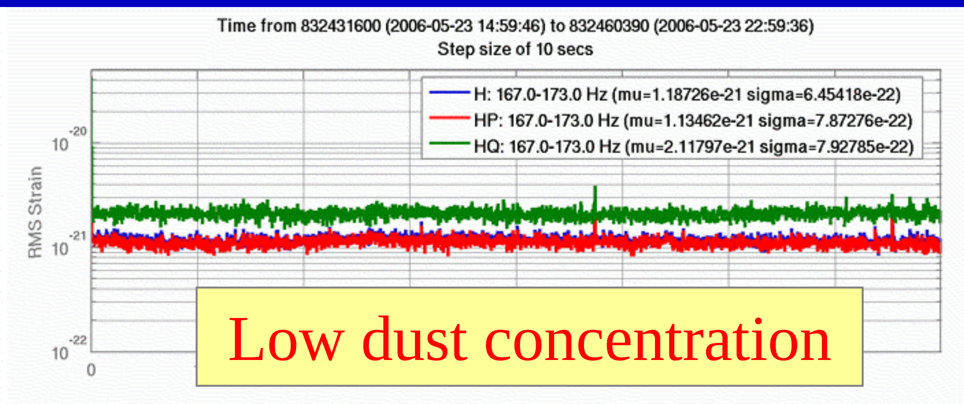
high dust concentration

(G1:LSC_MID_VIS veto)

Motivation: why a statistical veto ??

In May we found dust falling through the output beam to cause a significant number of glitches.



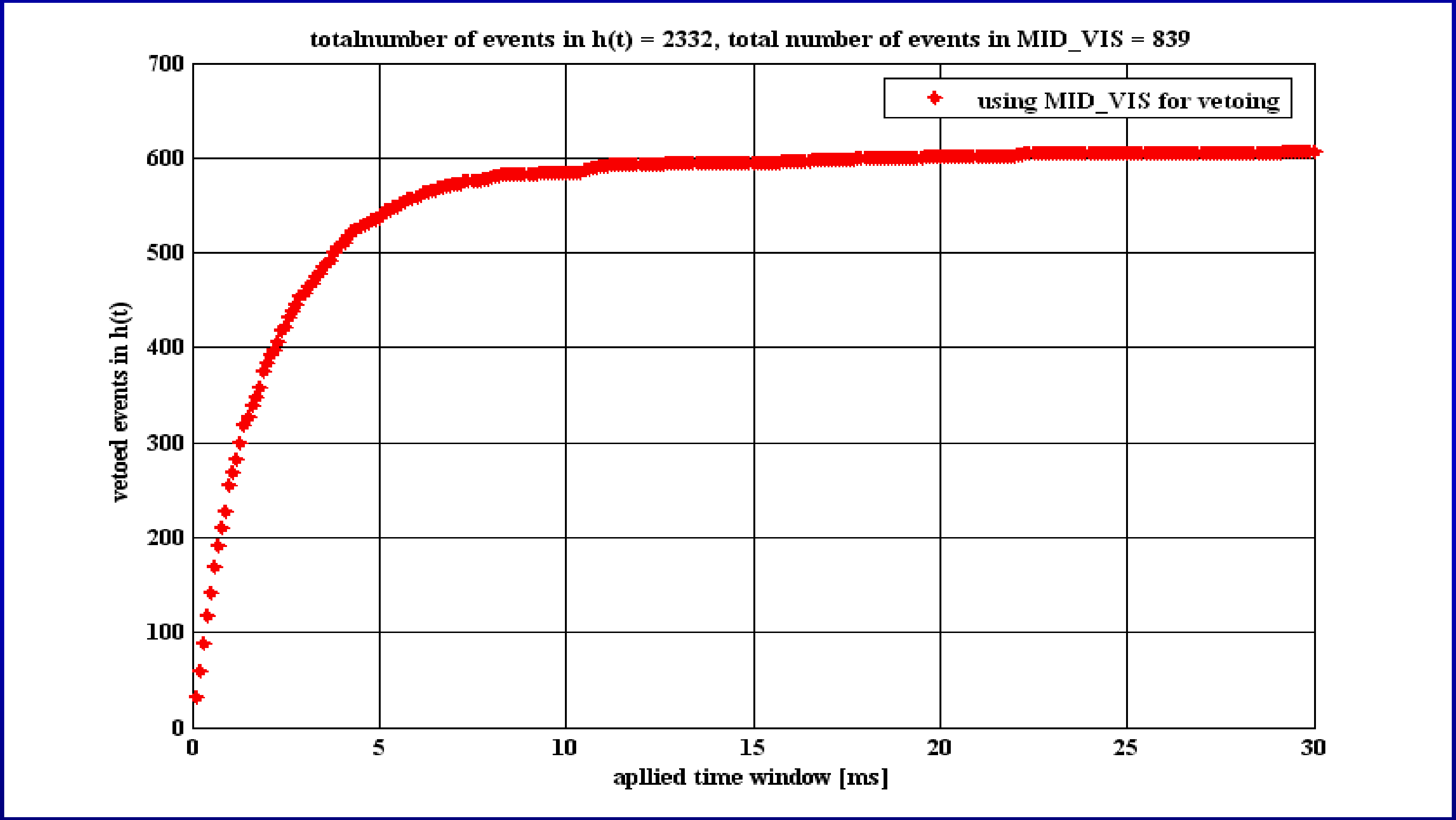


- **Not visible in noise projections.**
- **A clear statistical correlation to the DC darkport power.**

=> Only possibility is a statistical veto.

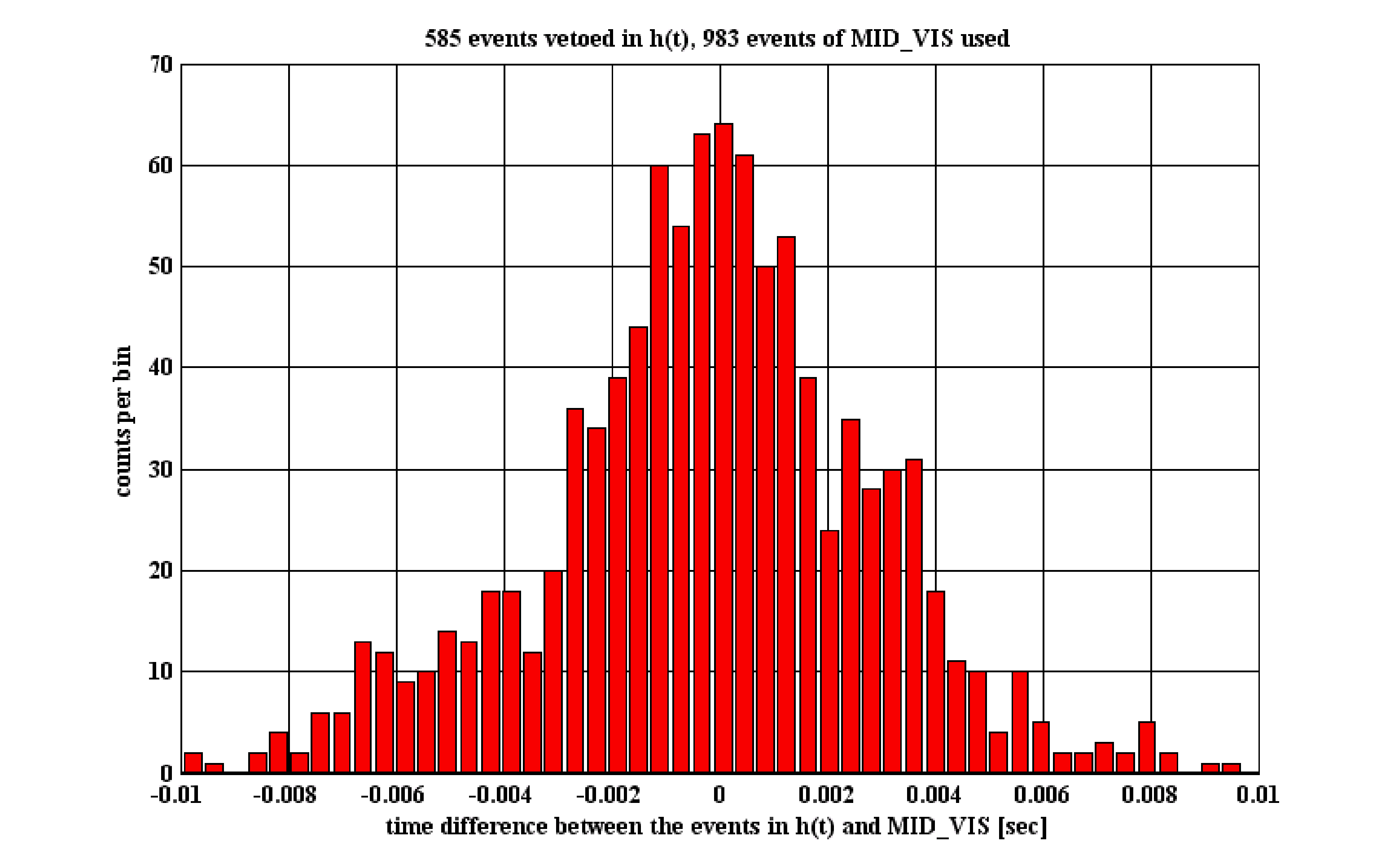
Applying a time window

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



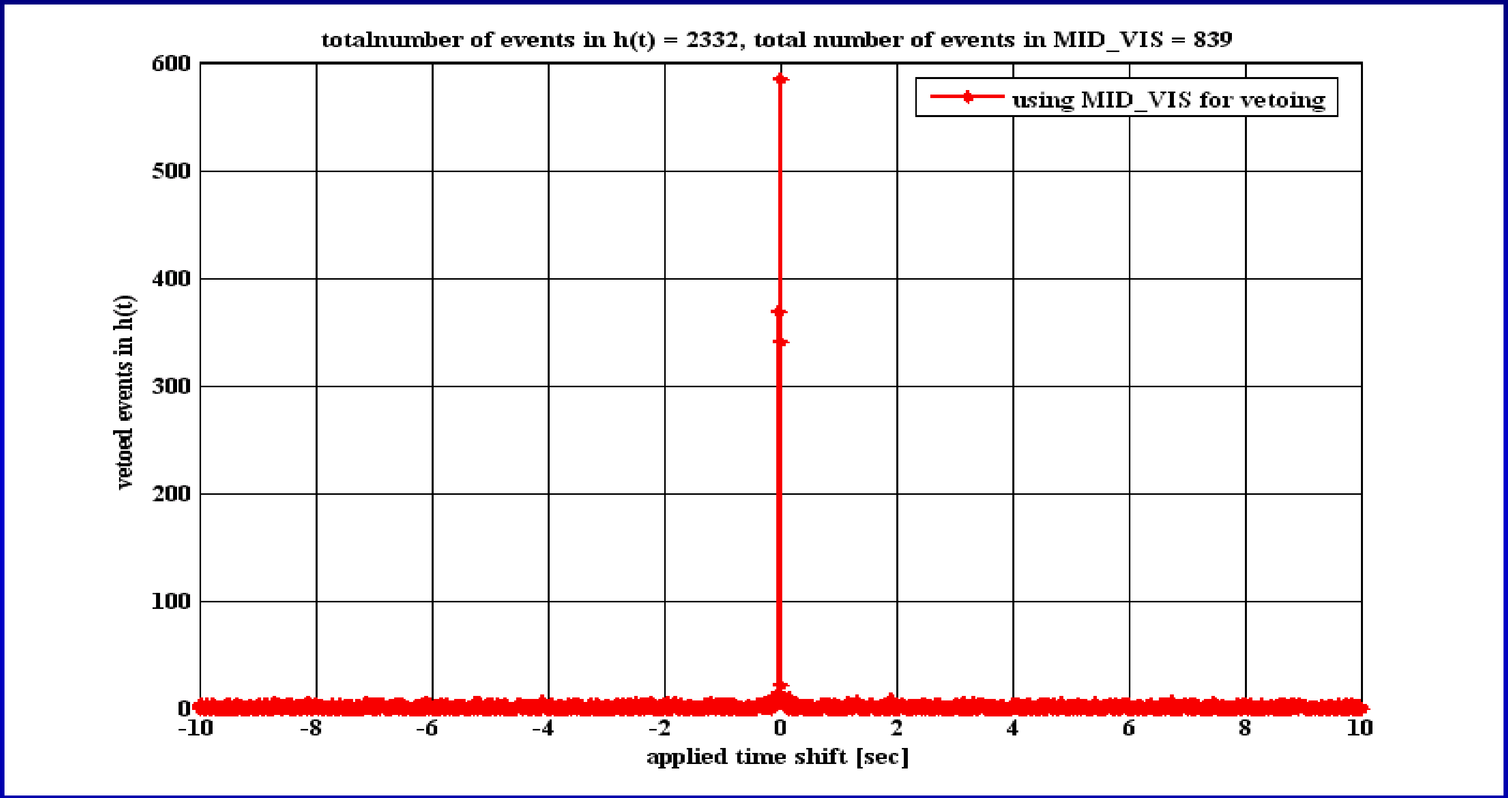
Going forward with T_win = 10 msec.

High resolution time shifted analysis



No significant time offset visisble !
Applying a symmetric time window (+/- 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 !

EXAMPLE 2:

THE DUST_VETO

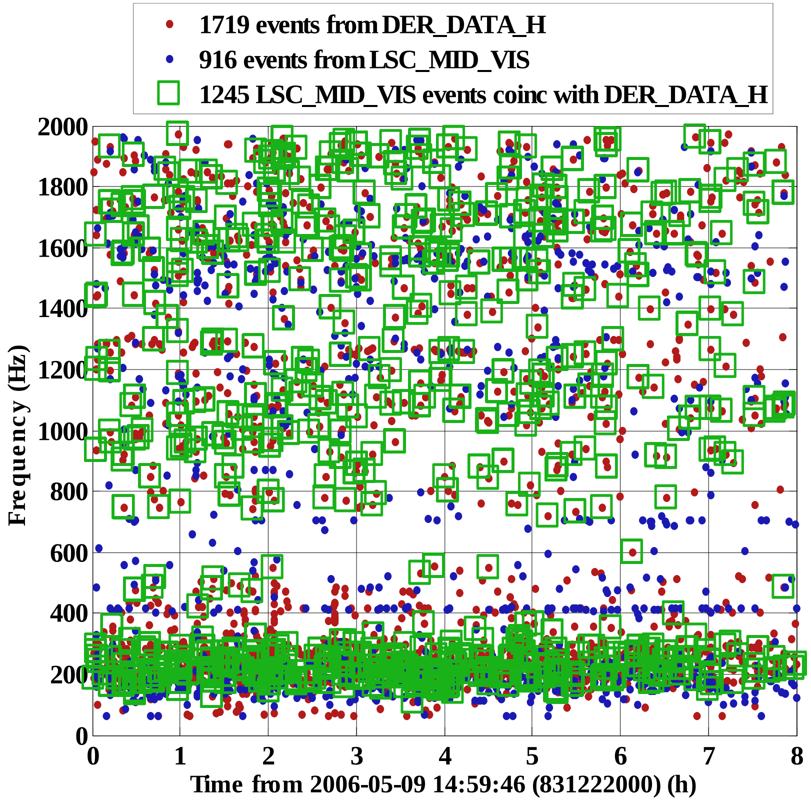
low dust concentration

(G1:LSC_MID_VIS veto)

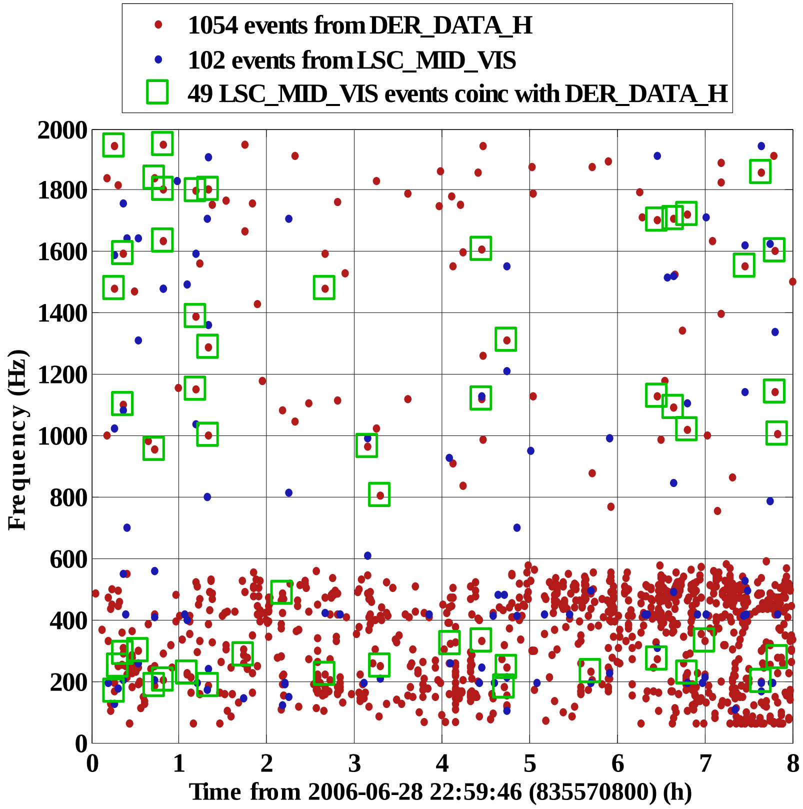
Application of the veto to full data set of September 2006

After reduction of dust concentration

high dust concentration

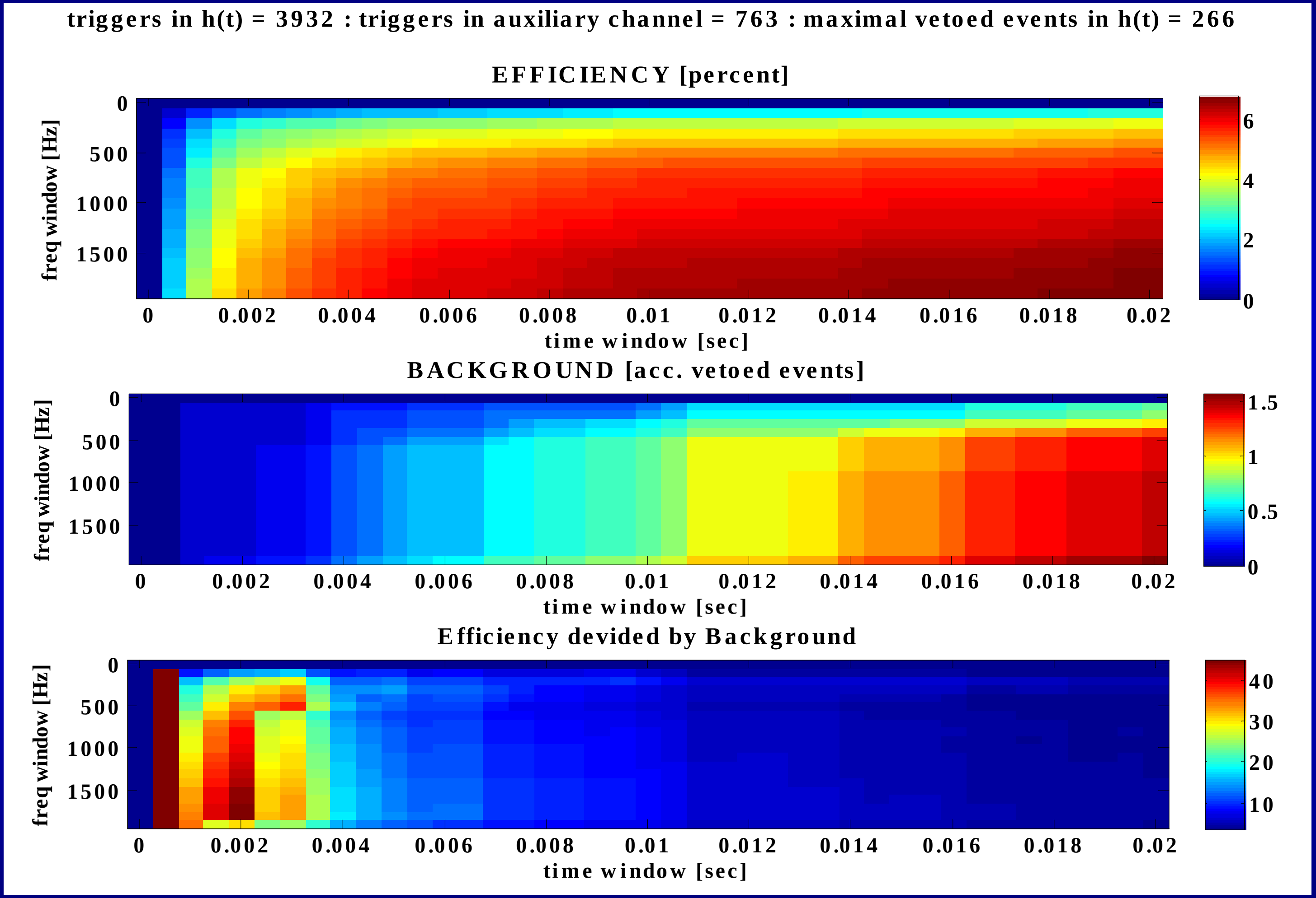


low dust concentration



Glitches from dust significantly reduced !
Still some glitches coincident with MID_VIS left (situation for most of S5)

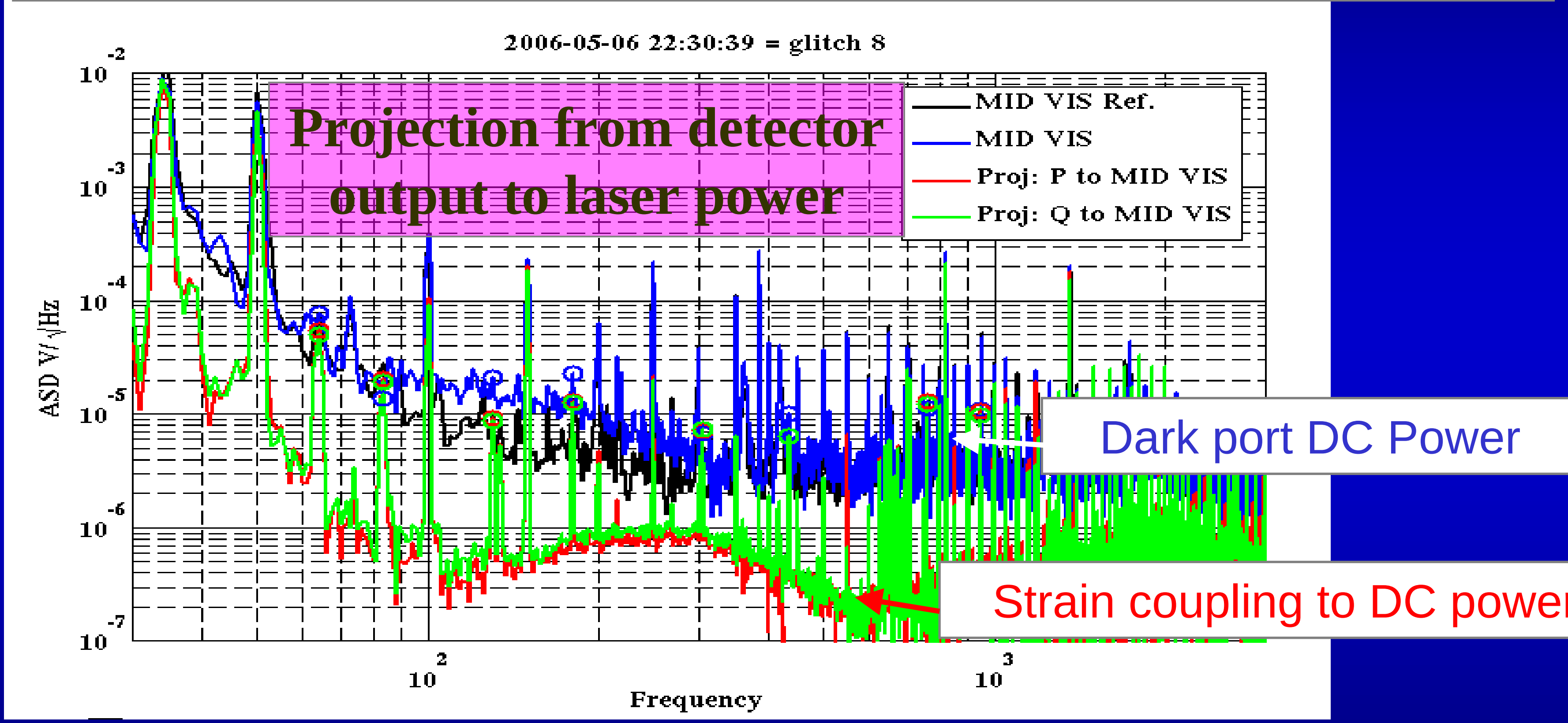
Time and Frequency window



T_win = 0.008 sec, F_win = 1 kHz

Back coupling ?

LSC_MID_VIS is generated from the same PD as DER_DATA_H.

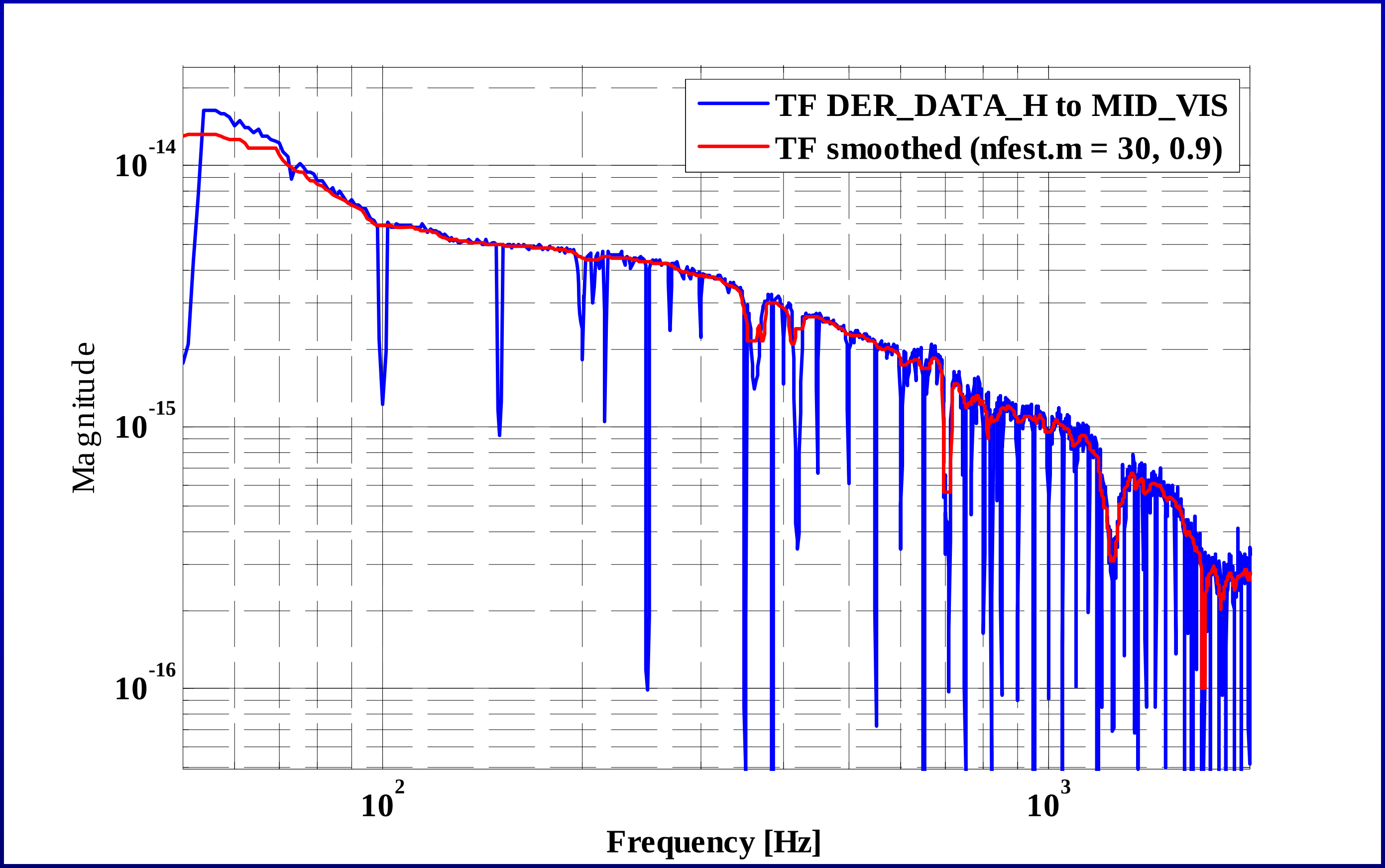


Strain back coupling doesn't explain instrumental channel coincidence,

But how for very large events ???

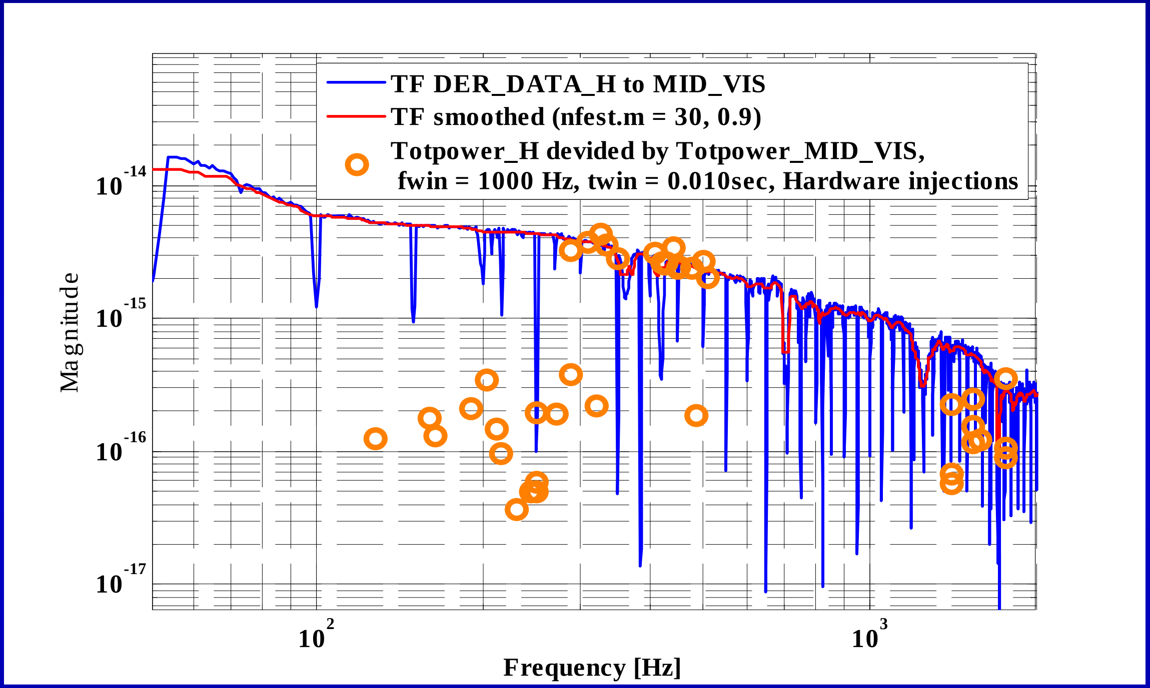
TF from diff displacement to MID_VIS

We can measure the TF for backcoupling by injecting differential displacement:



Hardware injections

GW-like hardware burst injections:



Orange circles: For coincident events compare ratio of Totpower of the two triggers to the magnitude of the backcoupling TF.

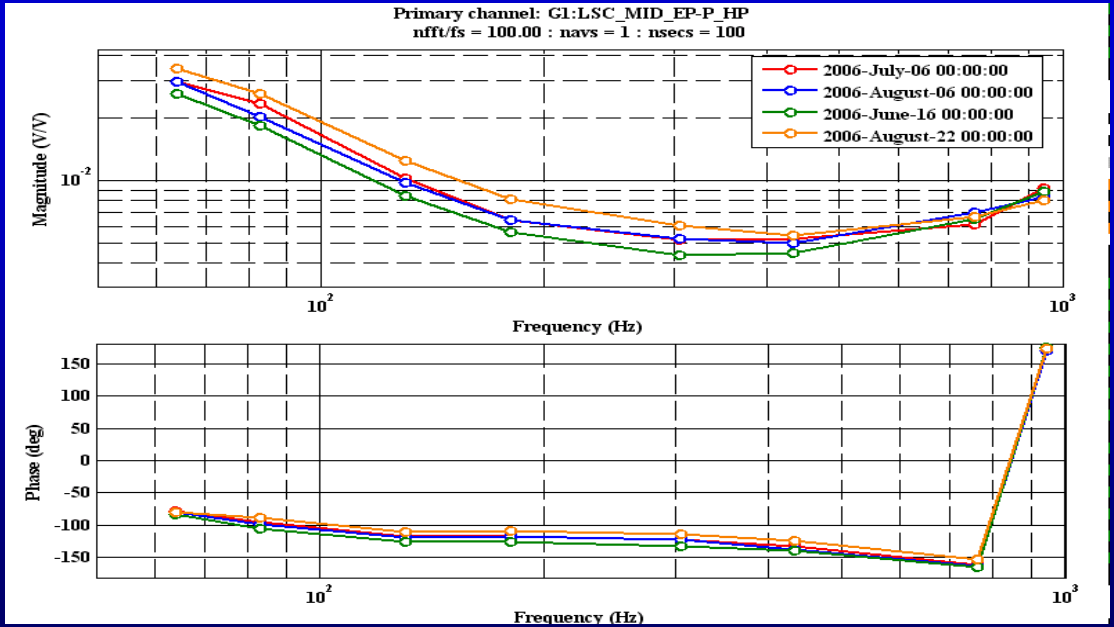
Two populations:

- matching the TF = GW-like injections
- ratio below the mag of TF = dust glitches (present during HW-inj, too)

Stability of the TF

Using the TF we can apply an frequency dependent amplitude cut.
⇒ Find the coincidence events that are GW-like.
⇒ Exclude this triggers from being vetoed.

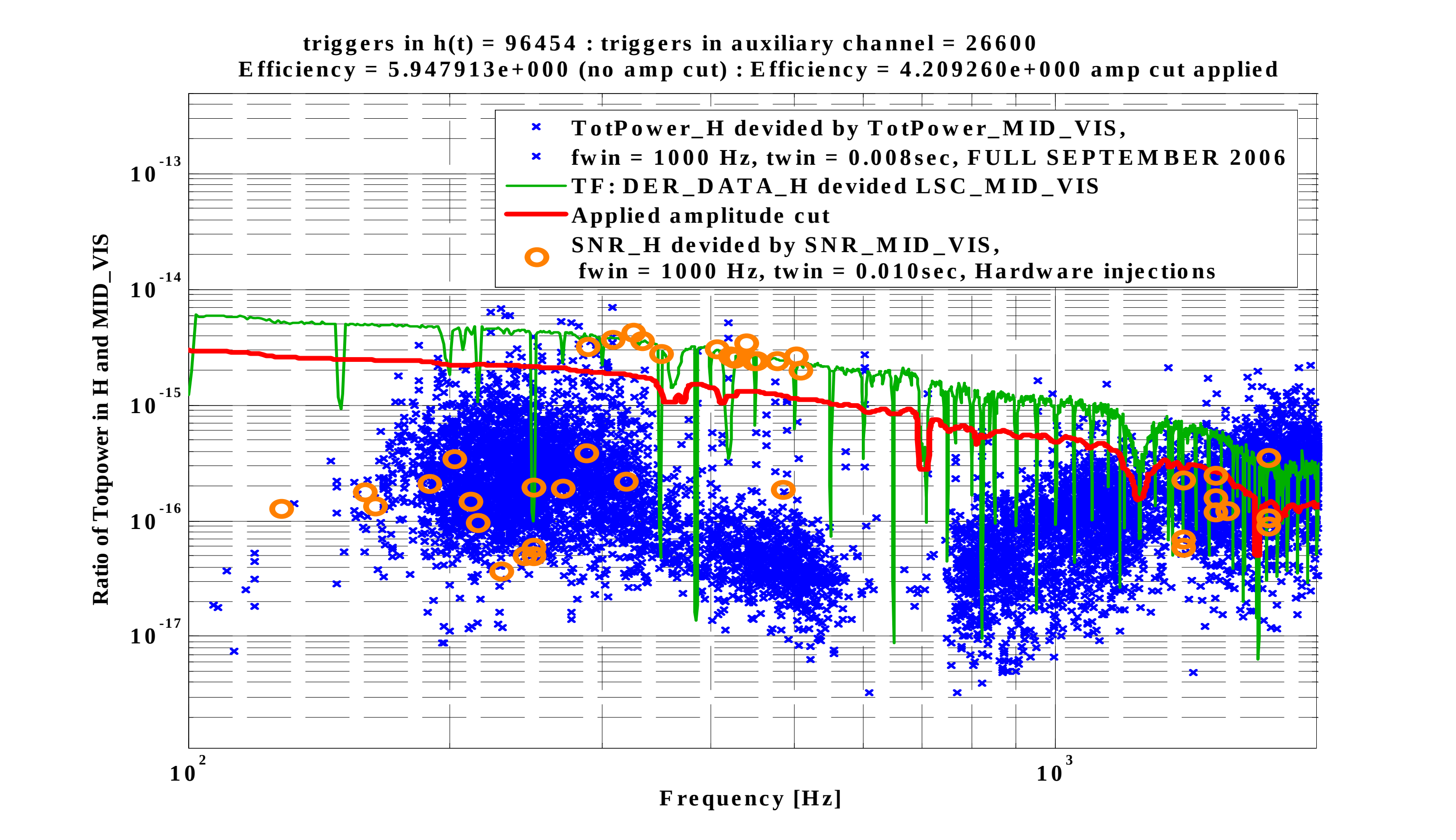
Two things to take into account:
- Uncertainties in the parameter estimation of HACR
- Stability of the backcoupling TF.



TF seems to stable within 50% on month scale.

The result for September 2006

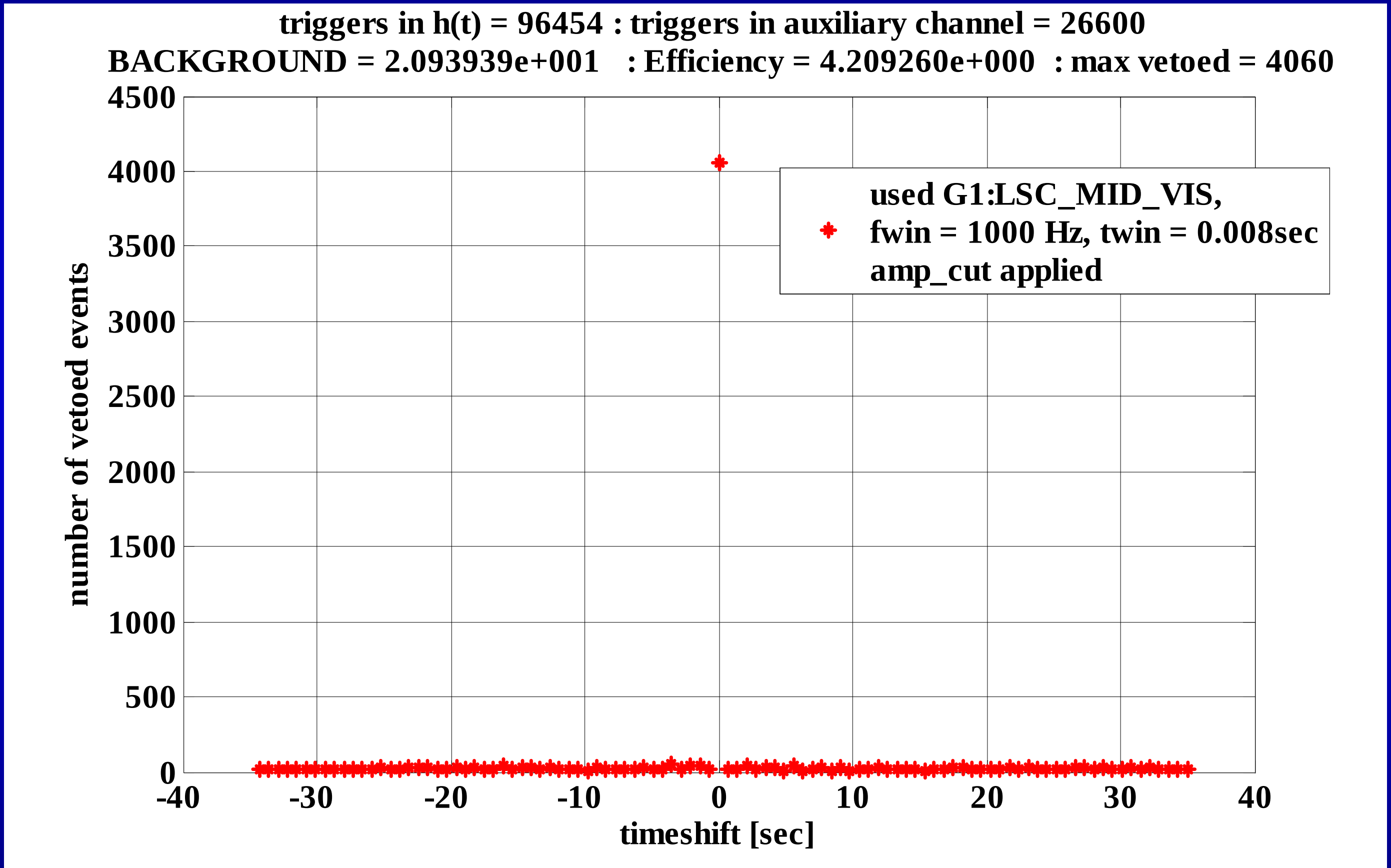
All triggers with a ratio of the totpower being above the red line are excluded from being vetoed (freq-dependent amplitude cut applied).



The red line is two times lower than the measured TF to be on the save side in terms of uncertainties (mentioned on last slide)

Performance for full September data set

Analysis done after applying: Science, chi^2 and nullstream veto.



Efficiency = 4.2 %, Usepercentage = 15%, Background = 0.7events/day

Summary

The MIDVIS statistical veto allows to veto the dust glitches.

The method consists of applying:
- time window for coincidence
- frequency window for coincidence
- frequency dependent amplitude cut to exclude GW-like signals from being vetoed.

The veto was applied to full month data set from GEO.

Performance for the periode of high dust rate is very good.

Performance for periods of low dust concentration is still reasonable.

The method is not restricted to the dust veto, but can be applied to any (GW-free) channel showing a statistical correlation to h(t).

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