BurstMon diagnostic of detector noise during S4 run

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- burstMon FOMs
- S4 run results
- summary & plans

burstMon run for S4

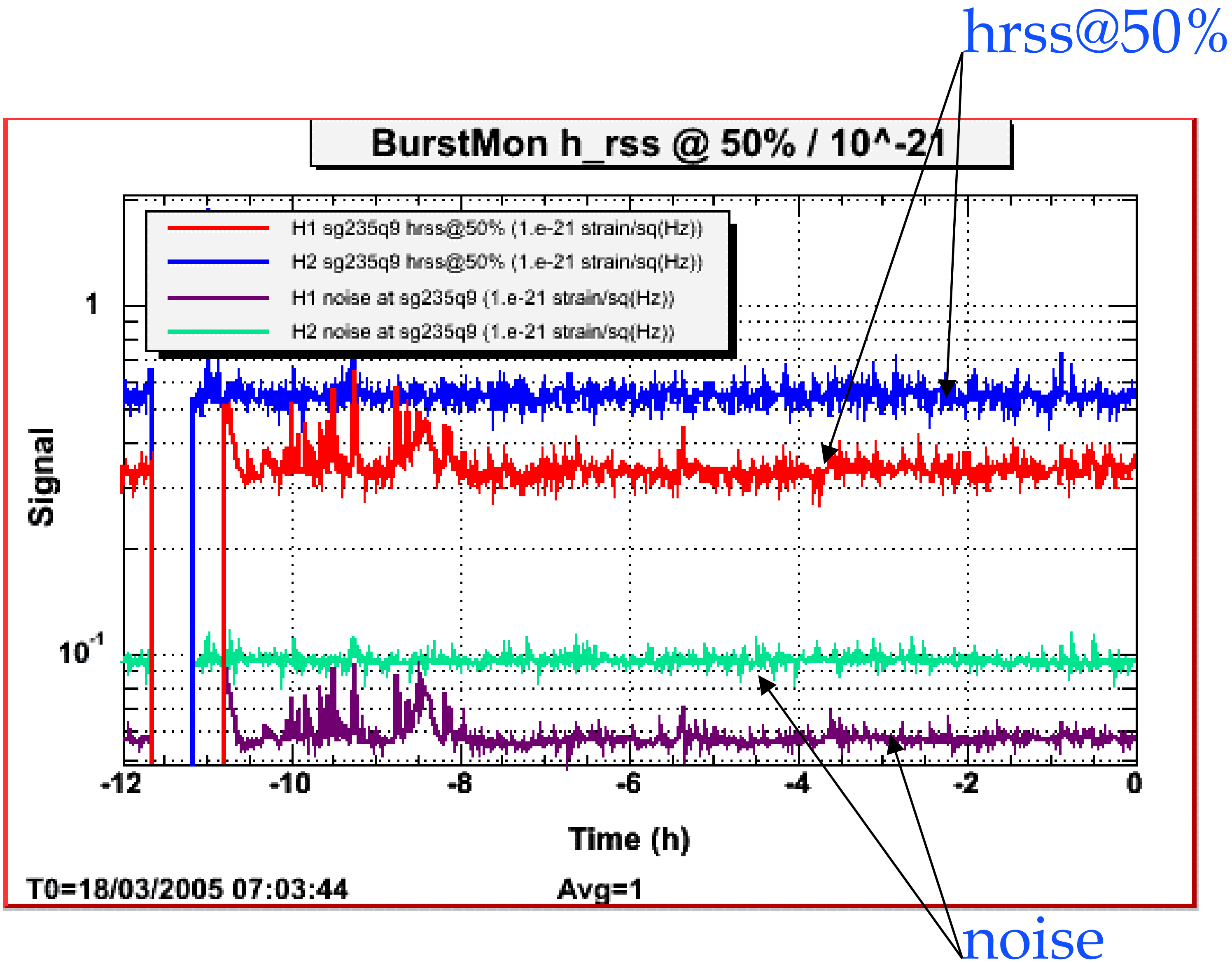
- Single detector burst monitor
- Run 6 burstMon jobs → 2 jobs per each detector

  2 bands (<1kHz & <2kHz), time stride 1 minute
- FOMs are available in real time in the control rooms
  - All information is recorded into trend frames
  - also daily summary web page: (thanks to L.Cadonati) http://lancelot.mit.edu/~cadonati/S4/online/S4report.html
- express detector performance in few burst FOMs
  - detector sensitivity: detected strain @50% efficiency
  - noise non-stationarity & non-Gaussianity
  - Loudest trigger statistics

hrss@50%

- **FOM:** detected hrss amplitude of injections at 50% of efficiency and 1 Hz false alarm rate.
- **Method:** real time injection of simulated bursts and their detection with WaveBurst-like algorithm
- **Injections during S4 run:**
  - **waveforms: SG100Q9, SG235Q9, SG555Q9**
  - **Uses Patrick's EZcalibrate to get hrss in strain/sqrt(Hz)**
  - **200 injections/stride/waveform → repeat analysis 600 times**
  - **do injections only for 1kHz burstMon jobs**

hrss@50%

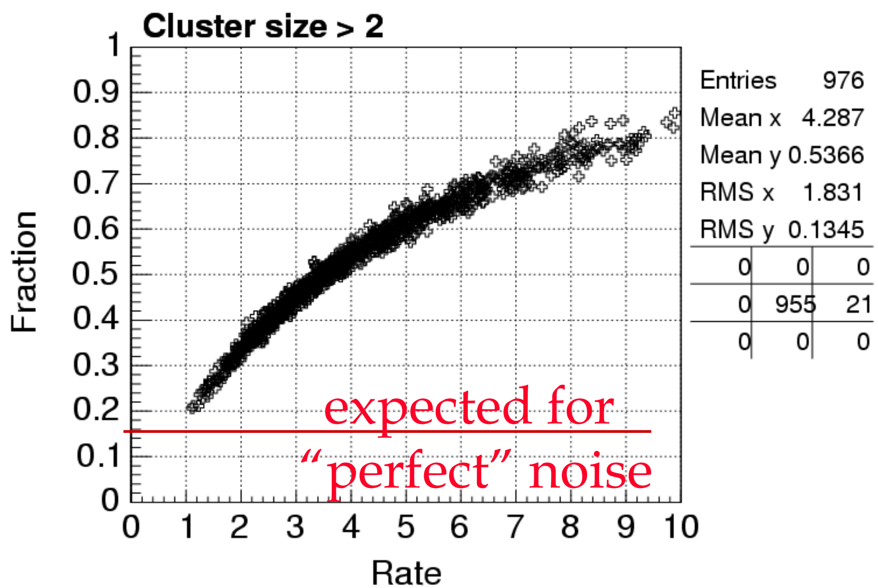

hrss@50%
BurstMon h_rss @ 50% / 10^-21
H1 sg235q9 hrss@50% (1.e-21 strain/sq(Hz))
H2 sg235q9 hrss@50% (1.e-21 strain/sq(Hz))
H1 noise at sg235q9 (1.e-21 strain/sq(Hz))
H2 noise at sg235q9 (1.e-21 strain/sq(Hz))
Signal
1
10^-1
-12
-10
-8
-6
-4
-2
0
Time (h)
T0=18/03/2005 07:03:44
Avg=1
noise

Pixel rate/fraction

- Select "black" pixels (1%), reconstruct clusters
  - Stationary G-noise → few pixels in a cluster →high cluster rate
  - Non-stationary noise → "fat" clusters →low cluster rate
  - Cluster rate is not a good noise characteristic at low threshold !
- Instead of clusters, look at rate of pixels (TF volume units).
  - select "fat" clusters (size>N)
  - rate of pixels in fat clusters
  - or pixel fraction:

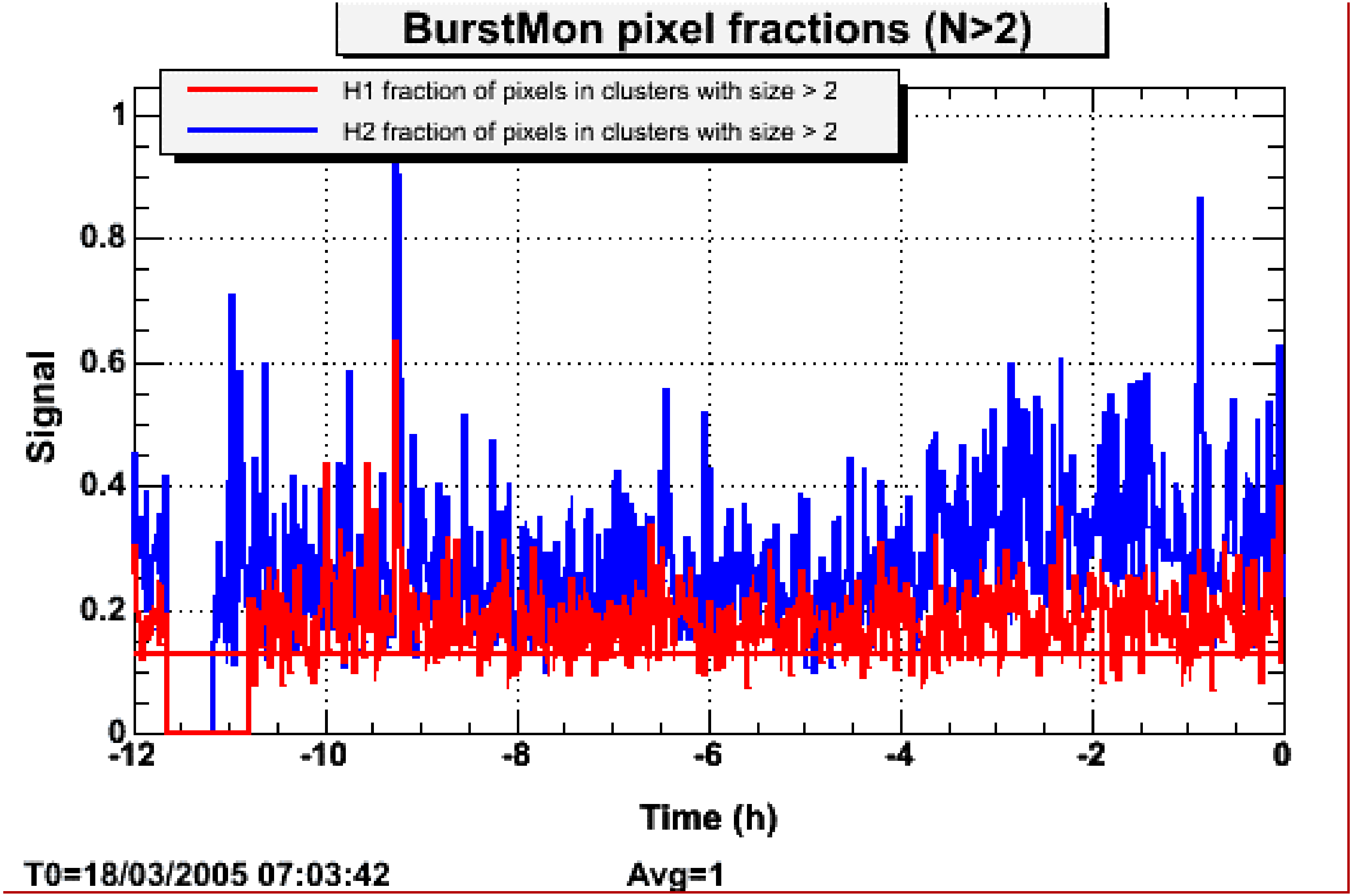
$$fraction = \frac{pixels_{C\_FAT}}{pixels_{C\_ALL}}$$

Fraction of glitchy TF volume

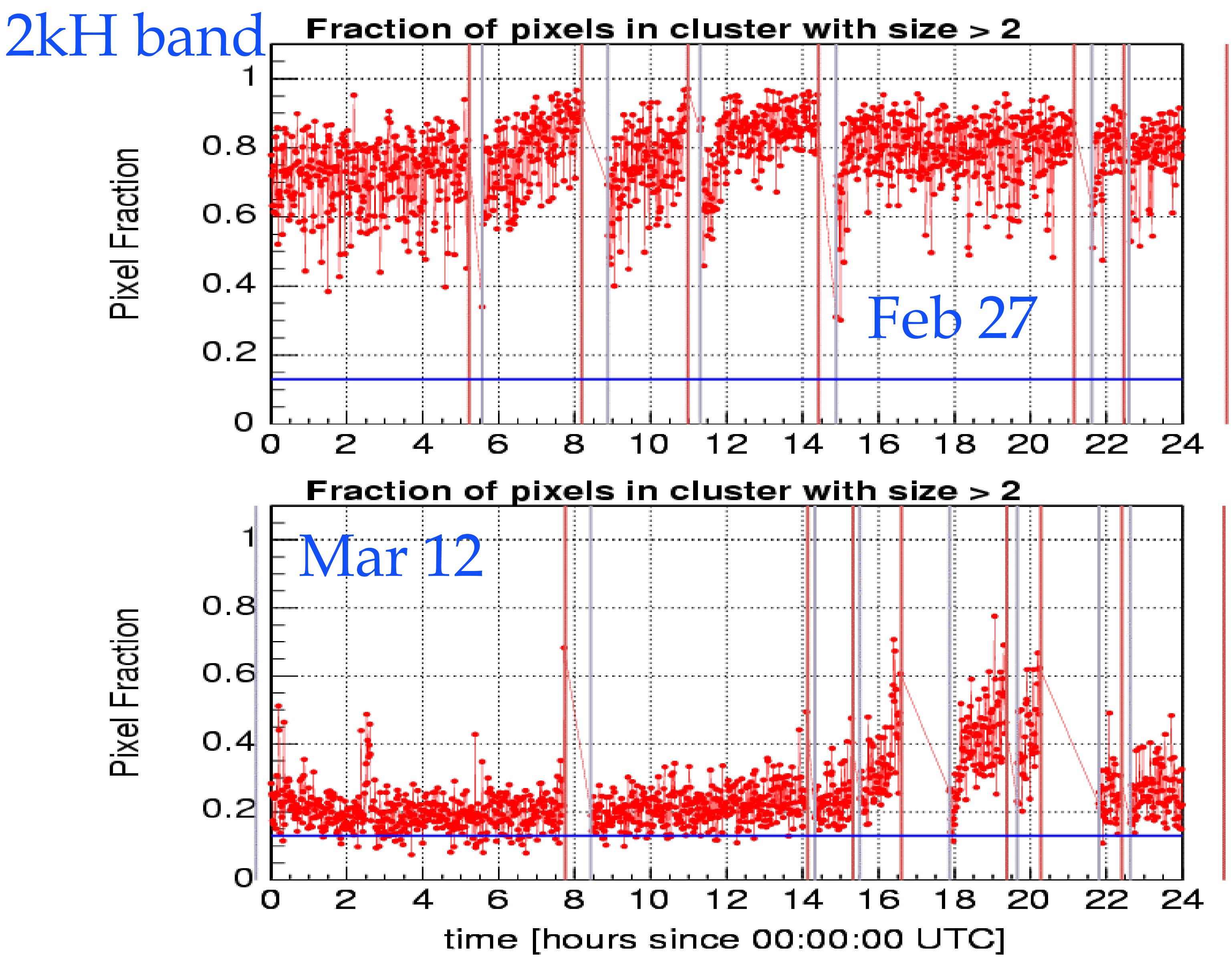


Large p-fraction – indication of "hot"/glitchy detector noise

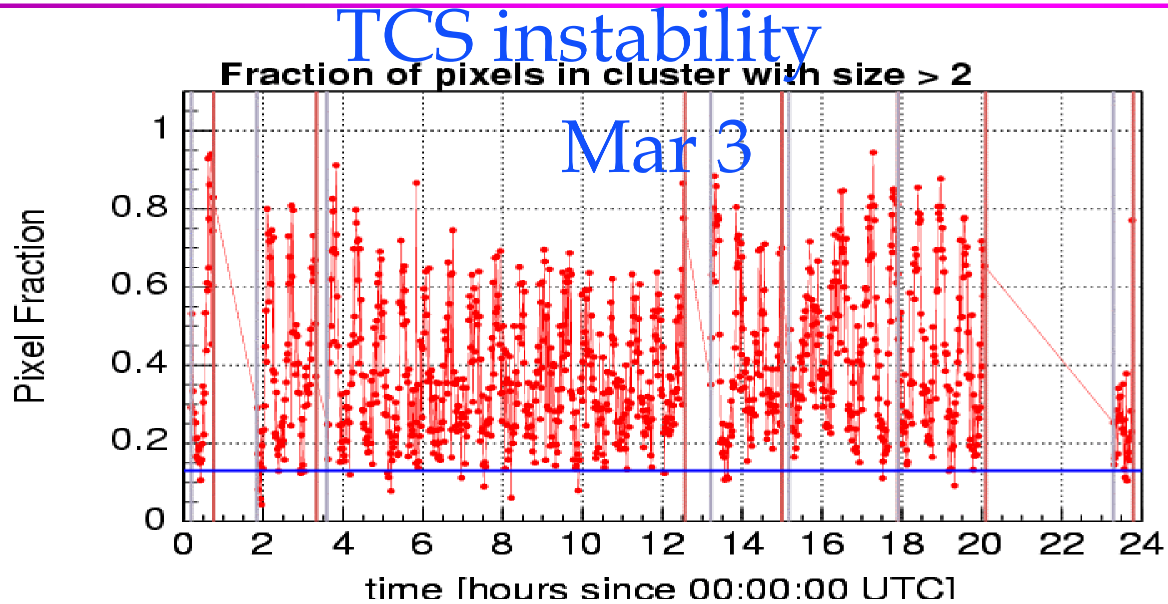
Pixel rate/fraction FOM



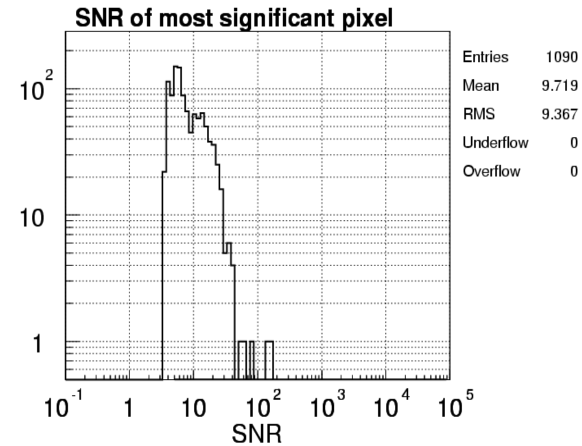
L1 pixel fraction before/after RFO fix

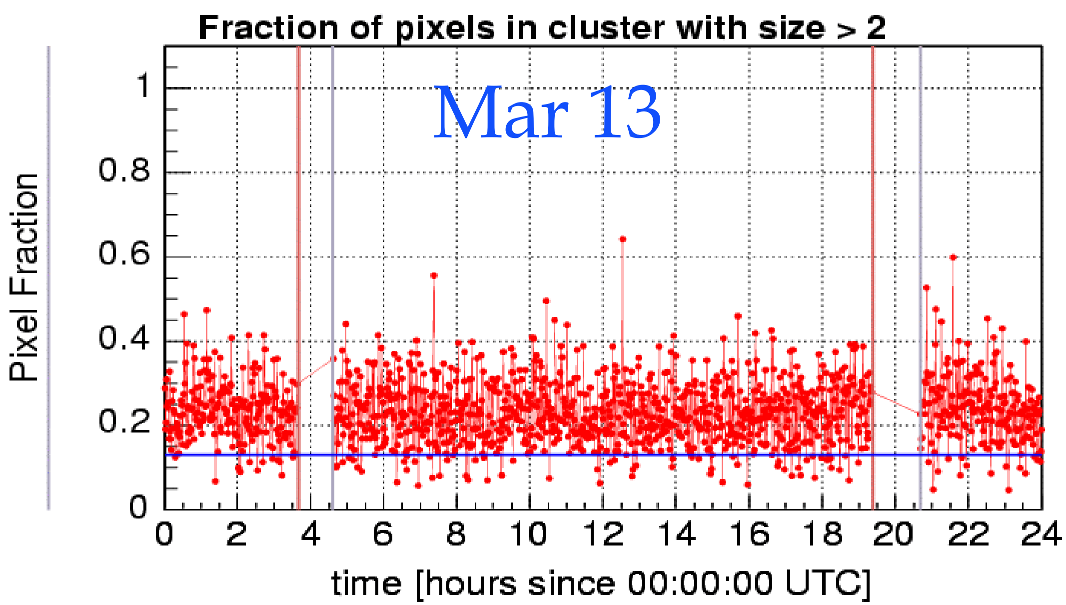


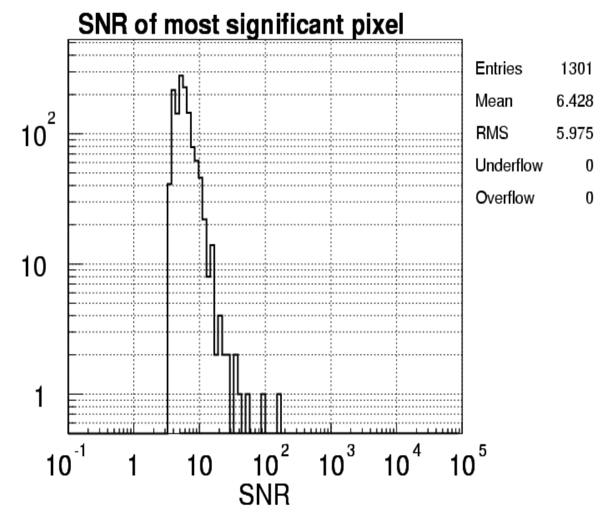
H1 pixel fraction (1kHz)



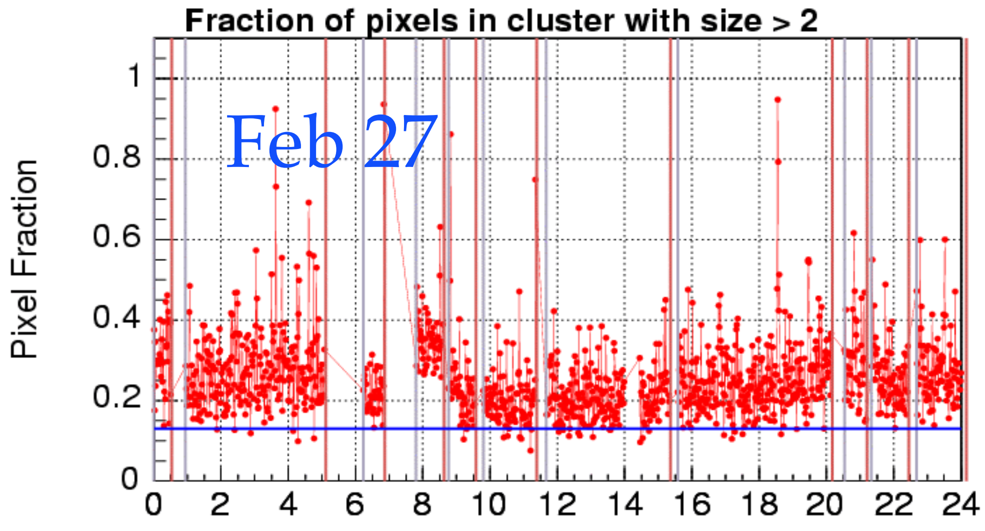
SNR

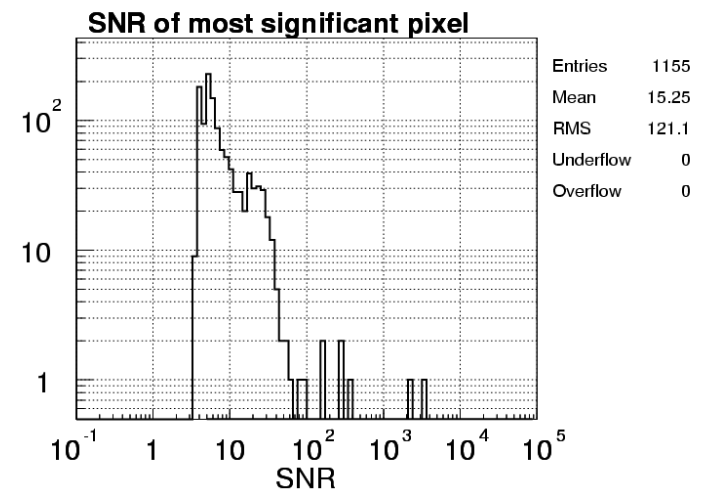


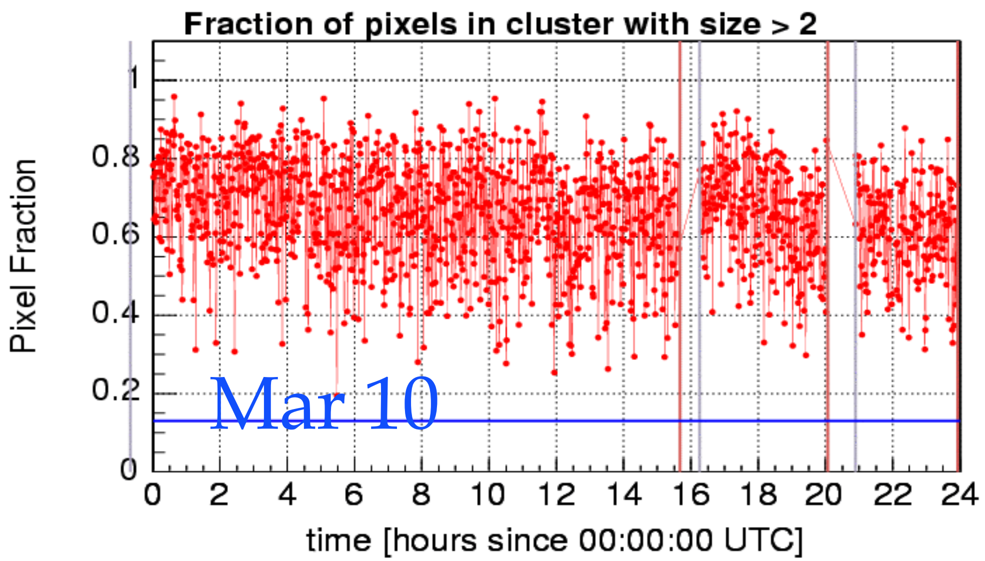


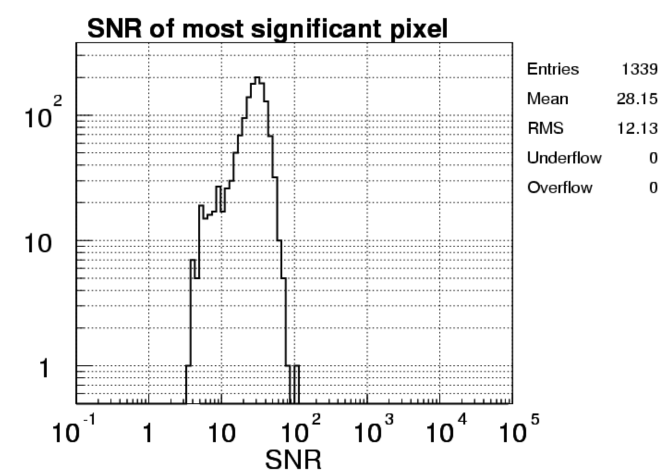


H2 pixel fraction (2kHz)







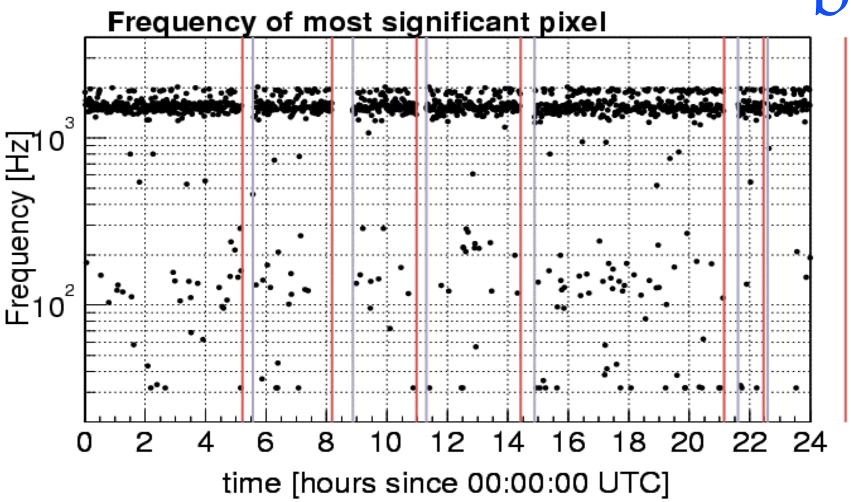


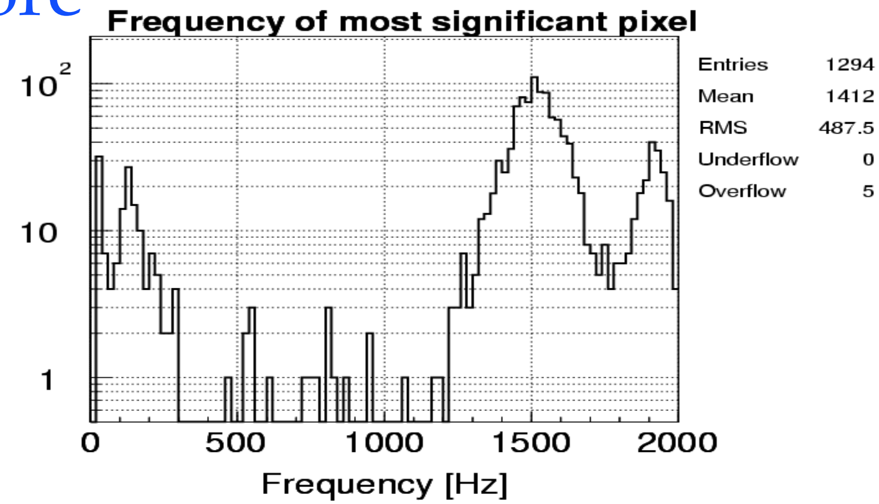
Most Significant Trigger (MST)

- Select most significant trigger for each stride (1 min)
- Shows dominant source of glitches
- Save in trend files
  - Central frequency
  - Central time
  - SNR
- Maybe need to look at the second significant trigger as well

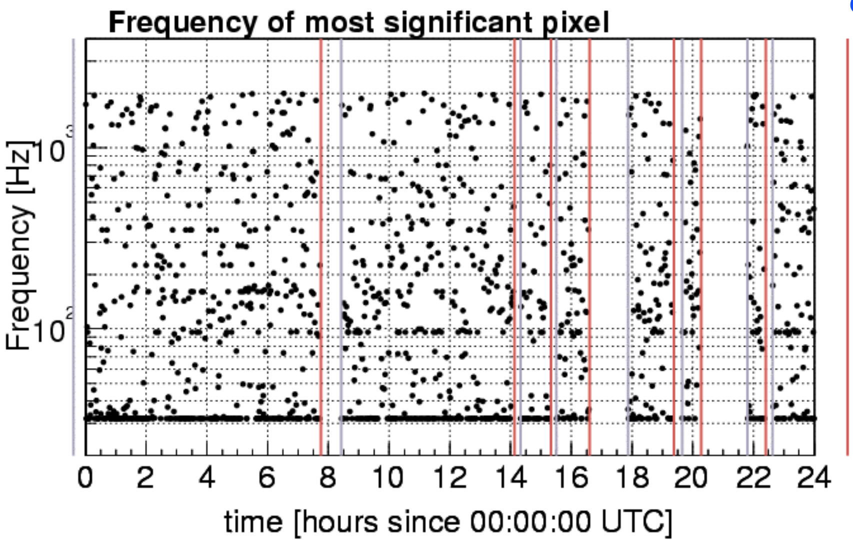
L1 Dominant noise source frequency

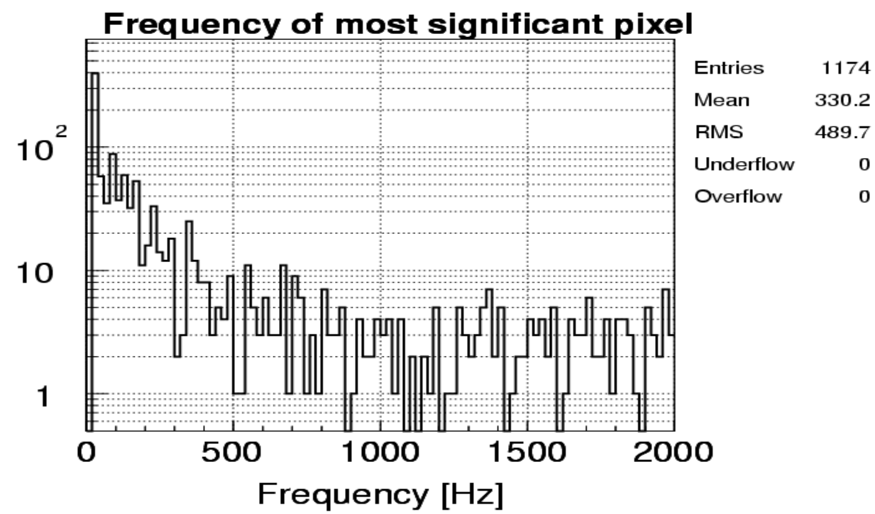
before



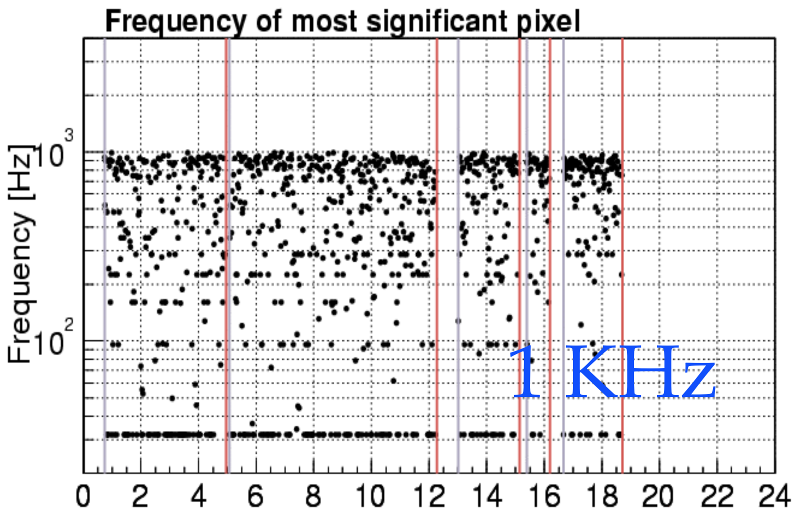


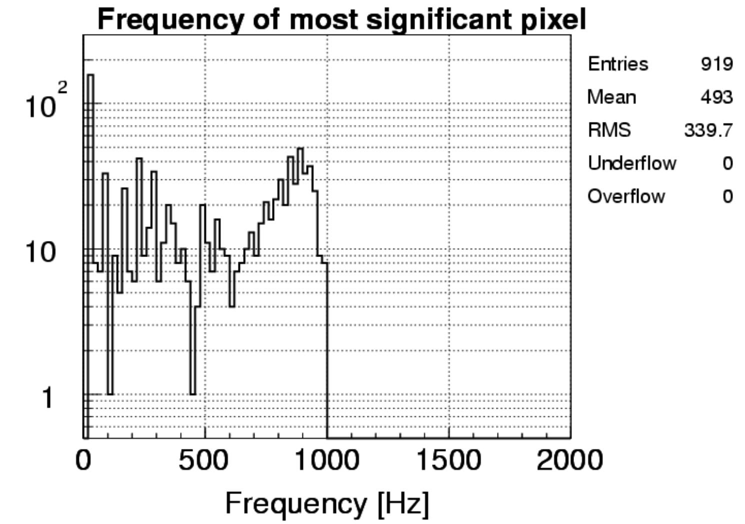
after

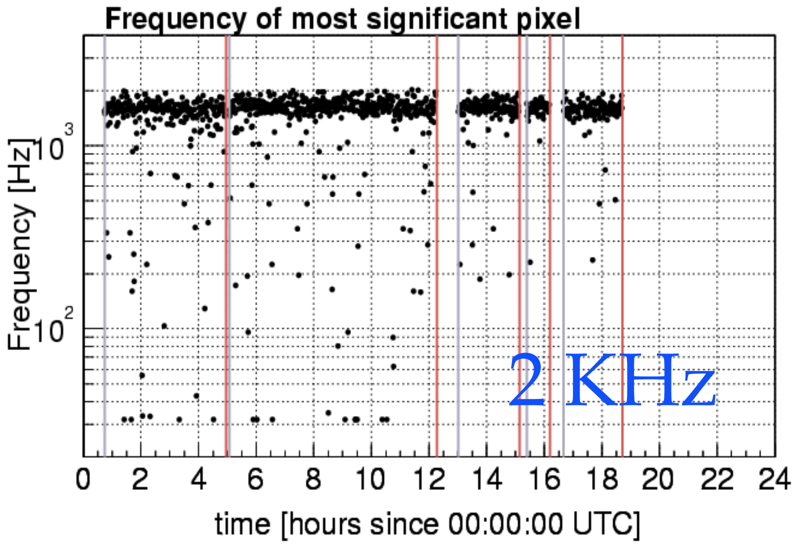


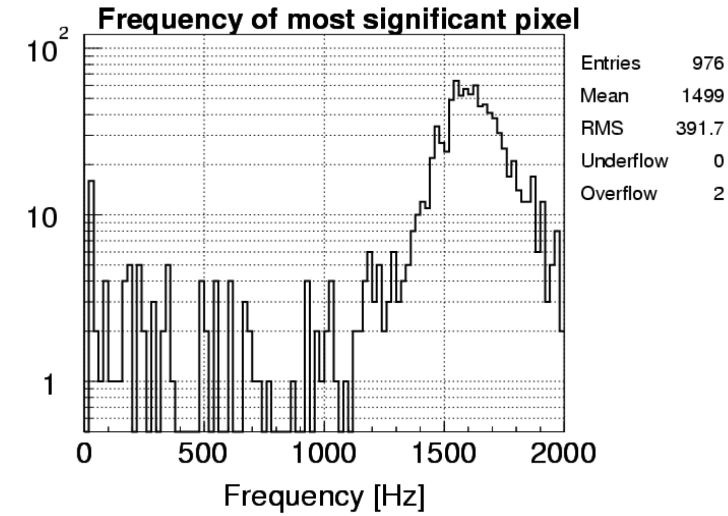


H2 Dominant Noise Source frequency

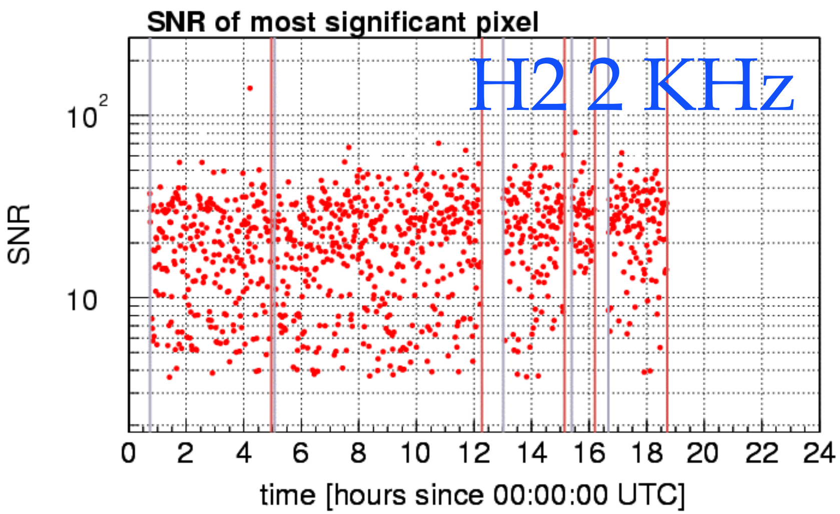




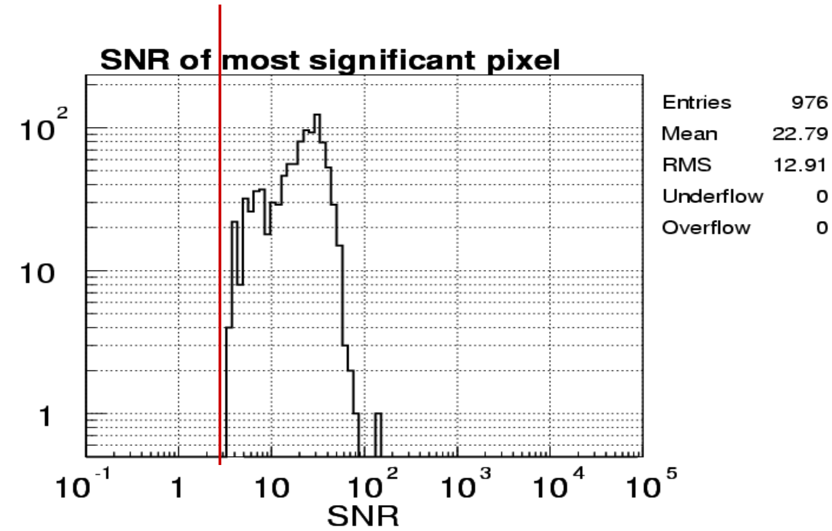




Dominant SNR (March 1)



BM threshold



for 3 detectors like that, at SNR threshold of 40-50

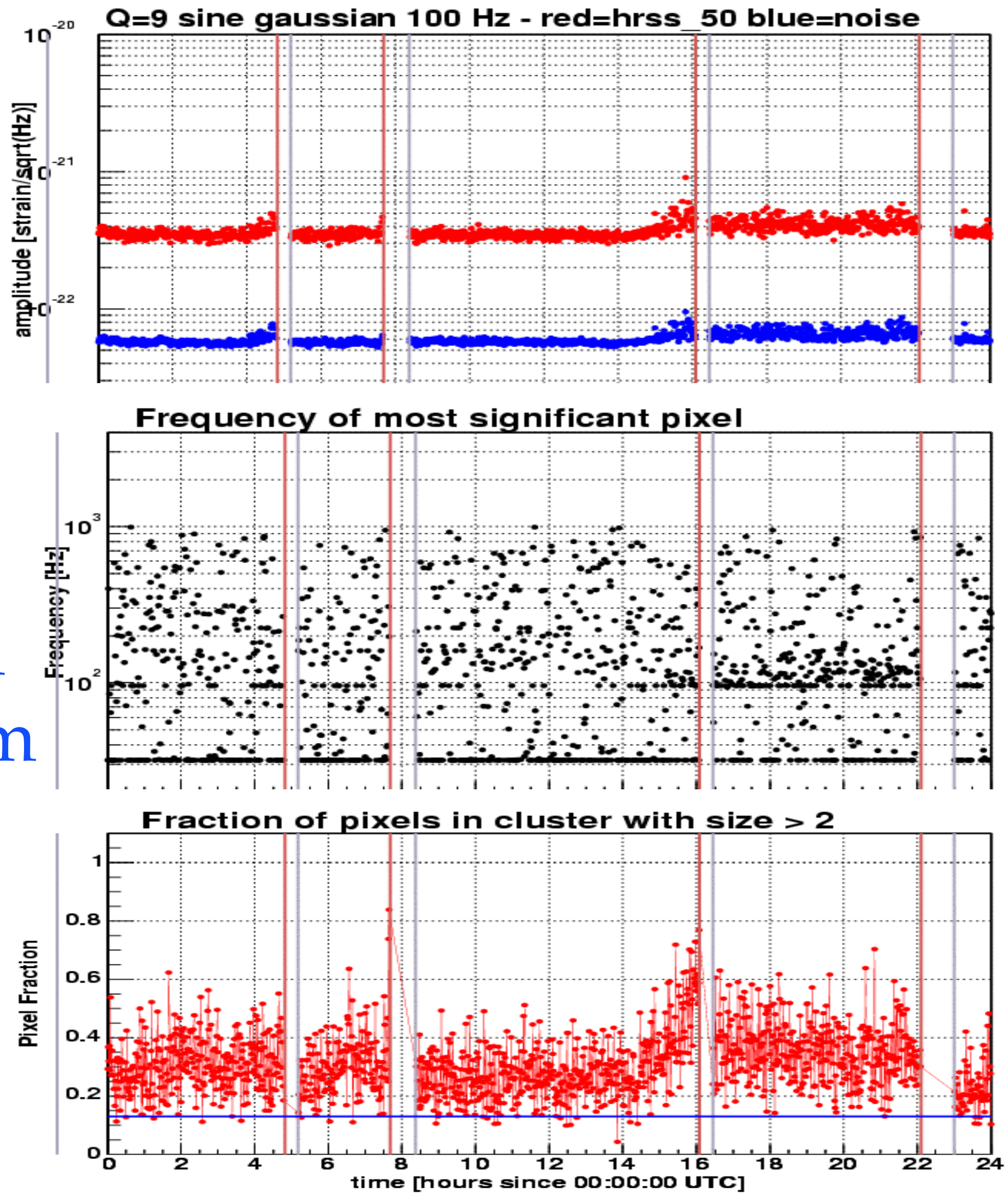
$$\left(\frac{1}{60\sec}\right)^3 \times (0.1\sec)^2 \approx 2\cdot 10^{-7}\,Hz$$

for G-noise expect this rate at SNR threshold of 6-7

WB: ~3*10-8Hz for H1/L1 SNR 25, H2 SNR 12
for G-noise expect: H1/L1 ~ 9, H2 ~ 4.

L1 trends for March 13

10^{-22} →



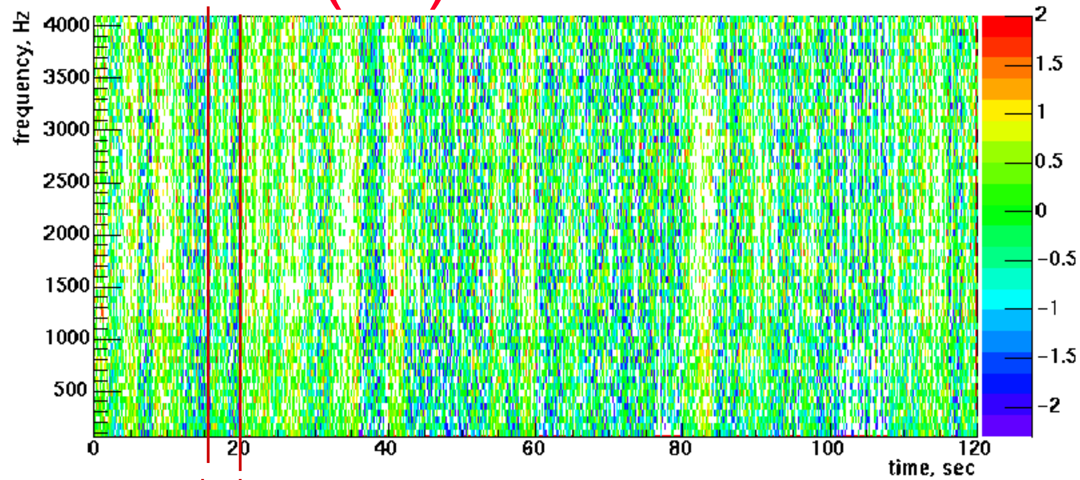
BM is pointing to a problem but does not tell what is a problem

noise variabilty

S2(L1): 732631083

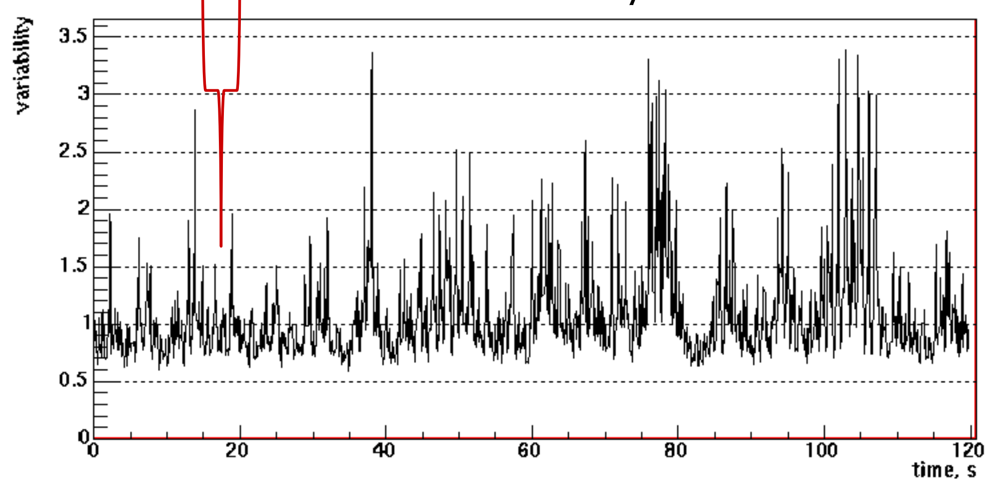
Amplitude

Noise RMS



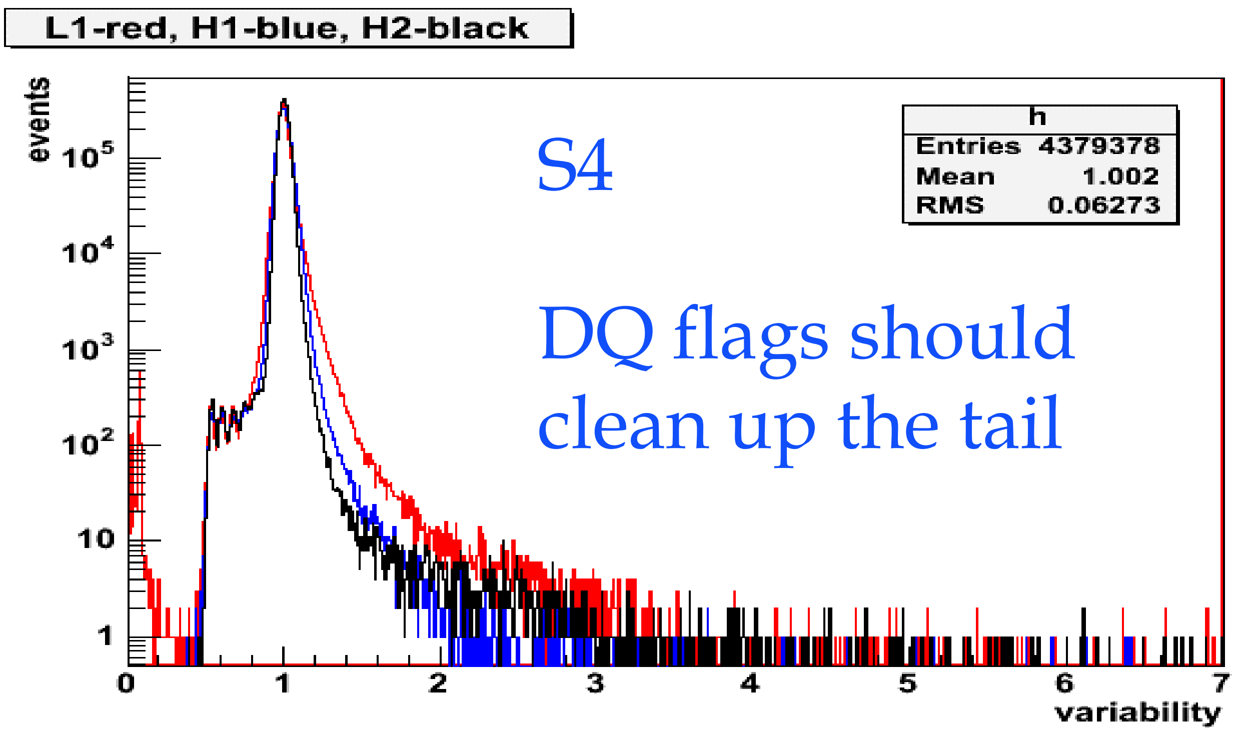
time interval 1/16 sec

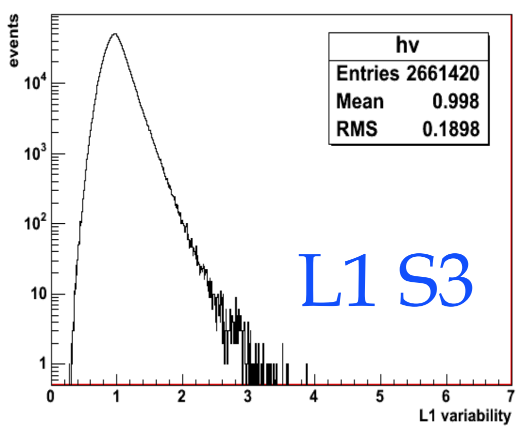
- **Variability - rms of normalized amplitudes calculated for shor time intervals**

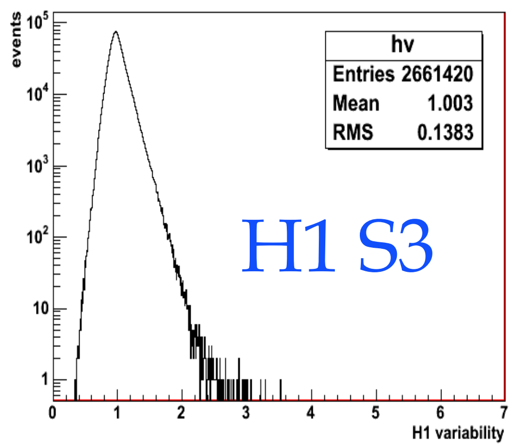


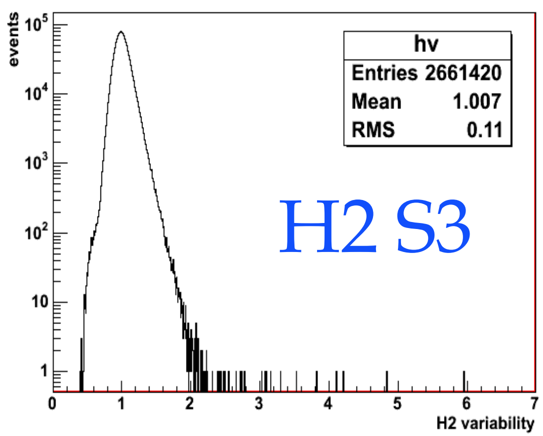
High noise variability main problem for burst S3 analysis

S3/S4 Variability

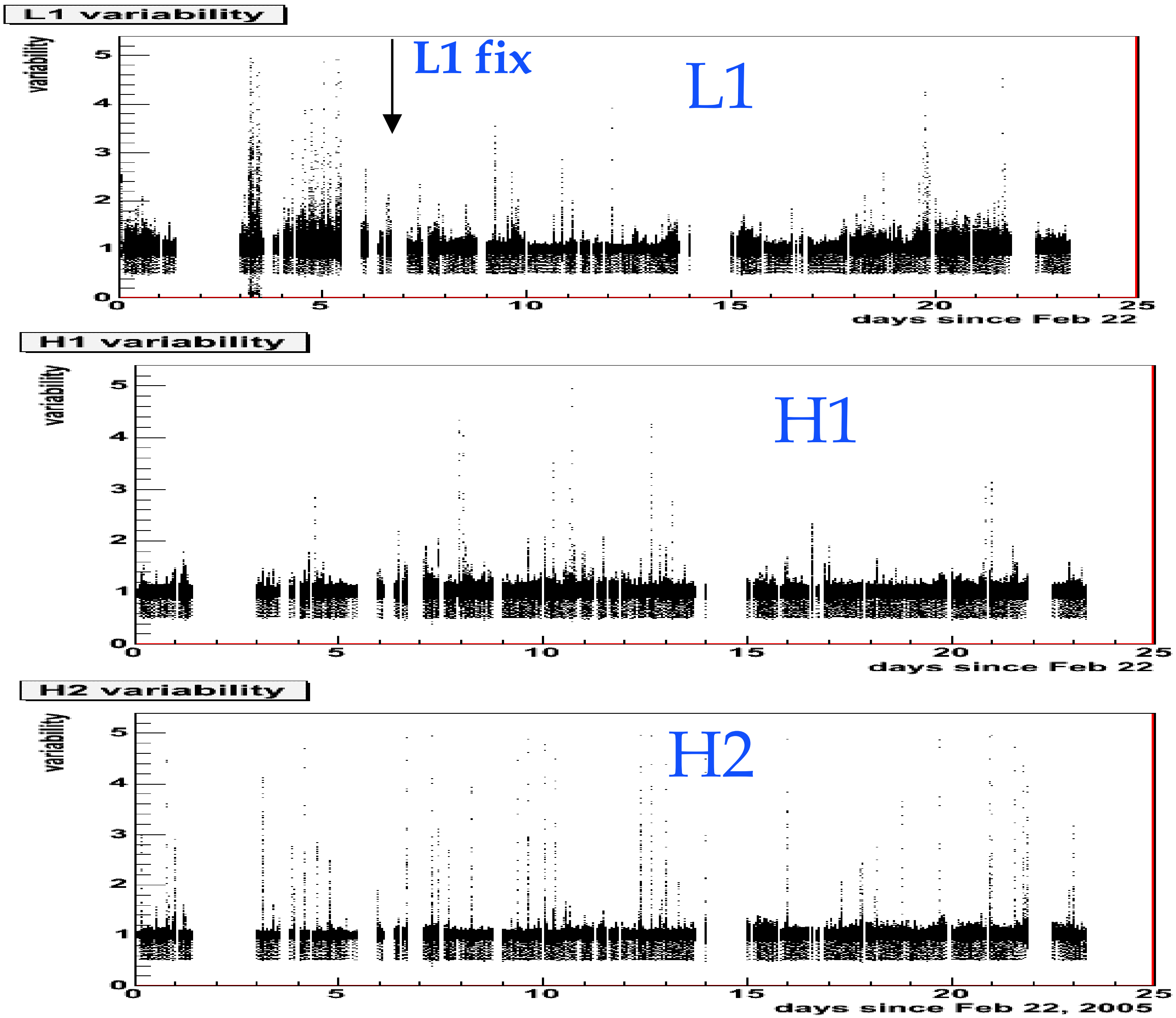








S4 variability vs time



Conclusion & Plans

- BM measures sensitivity to bursts and points to dominant burst noise sources.
- Trouble-free operation during S4 run

- Plans
  - Add MST hrss
  - Output MST reconstructed waveform (-0.5sec,0.5sec) to dmt-viewer
  - Update documentation
  - Run burstMon job for 0-256Hz band to look more closely at low frequency noise.
  - with few minor improvements intend to use for S5