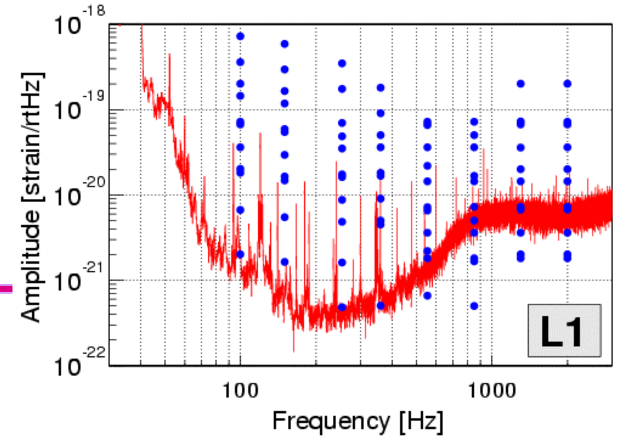
Update on the Analysis of S2 Burst Hardware Injections

L. Cadonati (MIT), A. Weinstein (CIT)
for the Burst group

Hannover LSC meeting, August 20, 2003

LIGO-G030428-00-Z

S2 Burst Hardware Injections



- Short, narrow-bandwidth signals (sine-Gaussians).
- Signal amplitudes should span the range from "barely detectable" to "large, but not so large as to break lock".
- Each sine-Gaussian has $Q \sim 9$; total duration $\sim Q/f_0$

Frequency f_0 (Hz) Duration (msec)	100 90	153 58	235 38	361 25	554 16	850 11	1304 7	2000 4.5
Time from segment start t_0 (sec)	20	40	60	80	100	120	140	160

For details on the injections and the analysis:

- AJW's presentation at the march LSC meeting LIGO-G030081-00-Z
- http://ligo.mit.edu/~cadonati/S2/Inject/S2injections.html

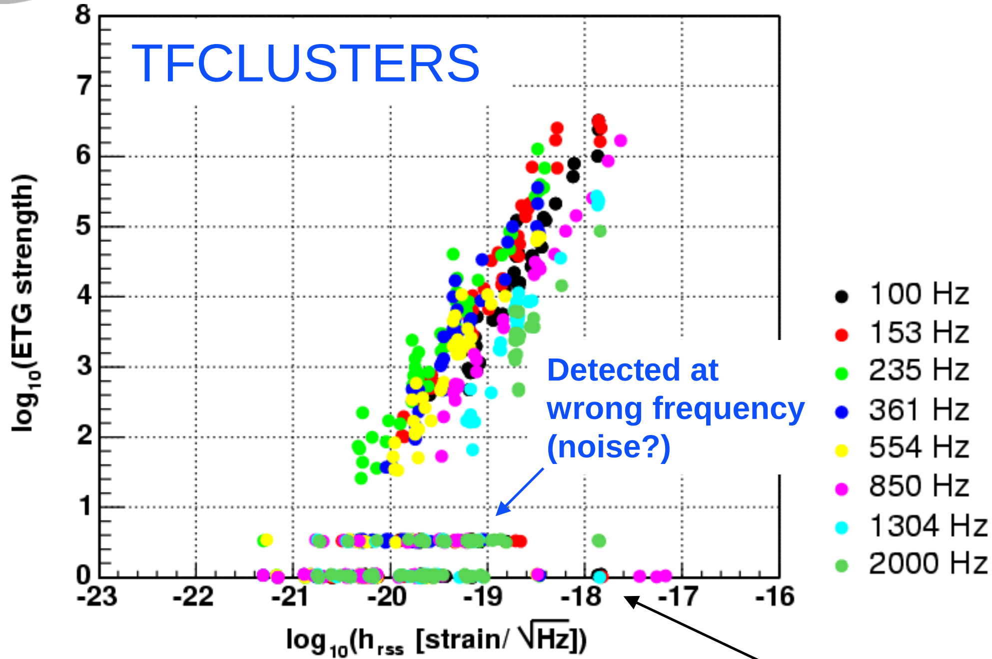
Use of Harwdare Injections in the Burst Analysis

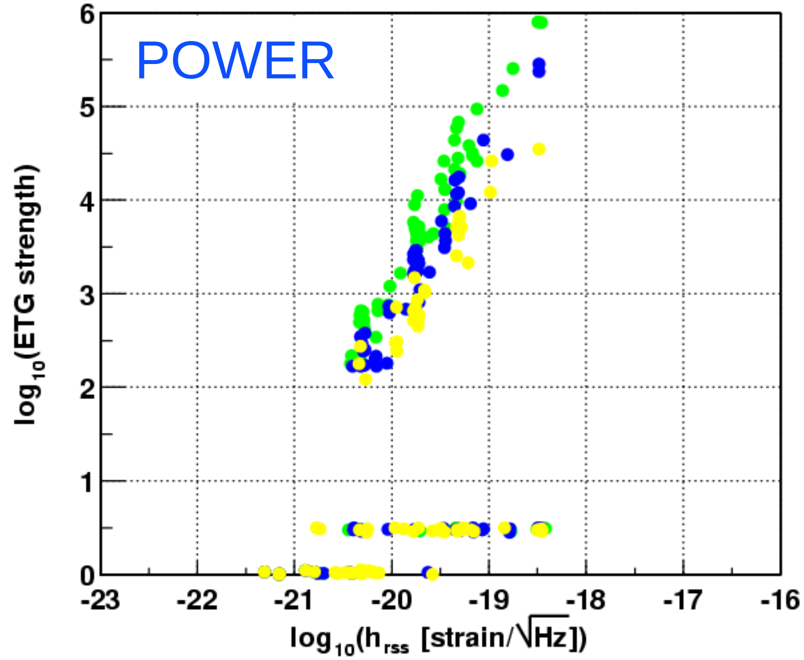
- Test of Event Trigger Generator sensitivity, time, frequency, amplitude resolution
- Validation of software injection code
- Test of correlation/coincidence techniques
- Veto safety studies

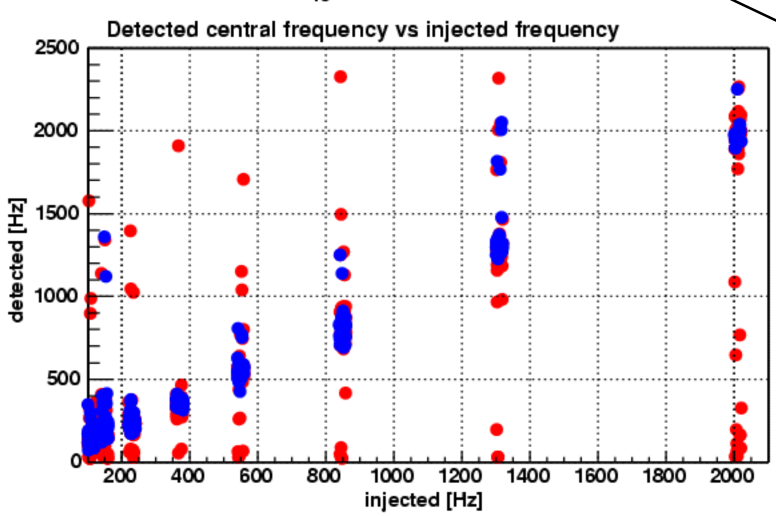
- The work presented here is preliminary: better resolution, burst parameter estimation will soon be available from the new burstDSO (J. Sylvestre)

- New calibration files recently became available – will be used in comparison with software simulation engine

L1 injections (pre and intra-run)



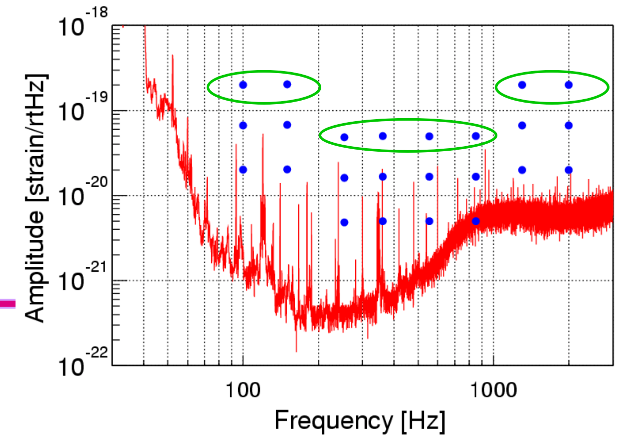


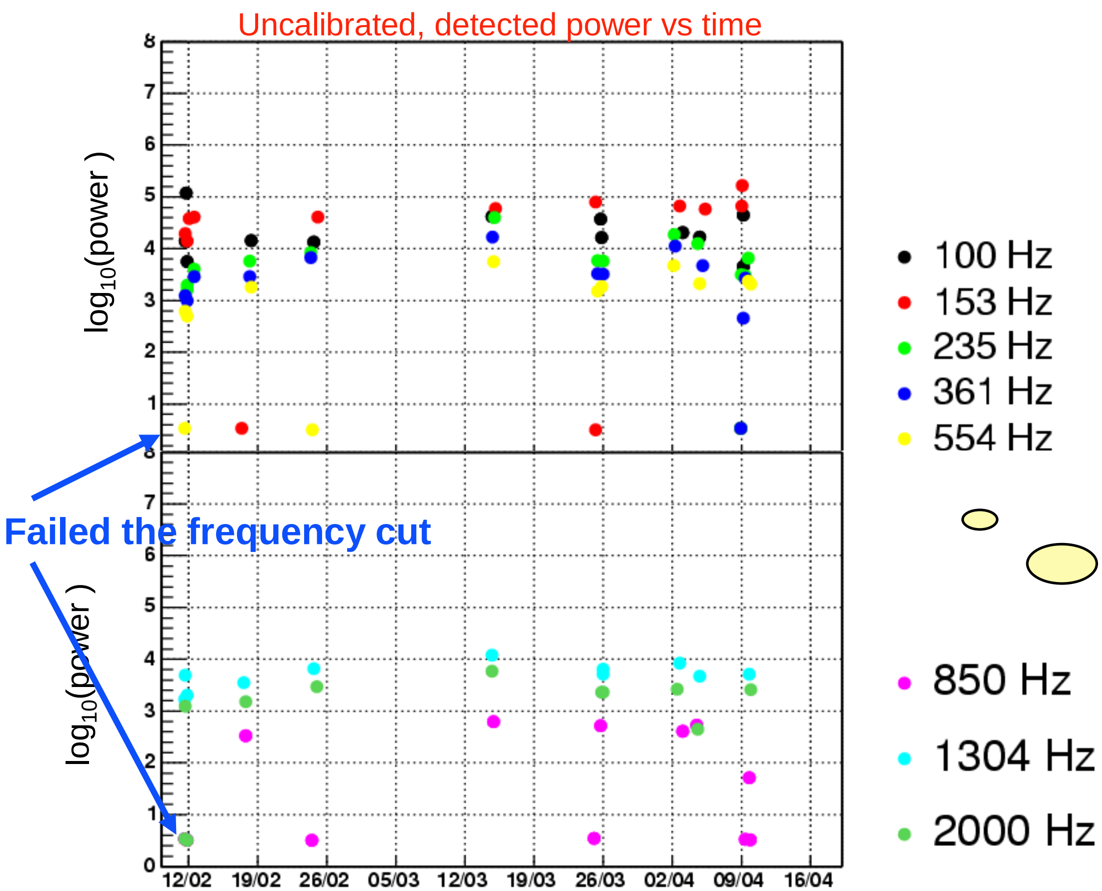


TFCLUSTERS (settings as in the online run) failed to detect some loud events.
This is being addressed in the new release of TFCLUSTERS and the burstDSO.

$$h_{rss} = \left[\int |h(t)|^2 dt\right]^{1/2} = \sqrt{\frac{Q}{4\sqrt{\pi}f_0}}\, h_{peak}$$ for sine gaussians

L1 stationarity





- Intra-run injections reconstructed with TFCLUSTERS (still old setup - some are missed)
- Sine gaussians, Q=9 and:

  235, 361, 554, 850 Hz

  2×10^{-16} m/sqrt(Hz)

  100, 150, 1304 and 2000 Hz

  8×10^{-16} m/sqrt(Hz)

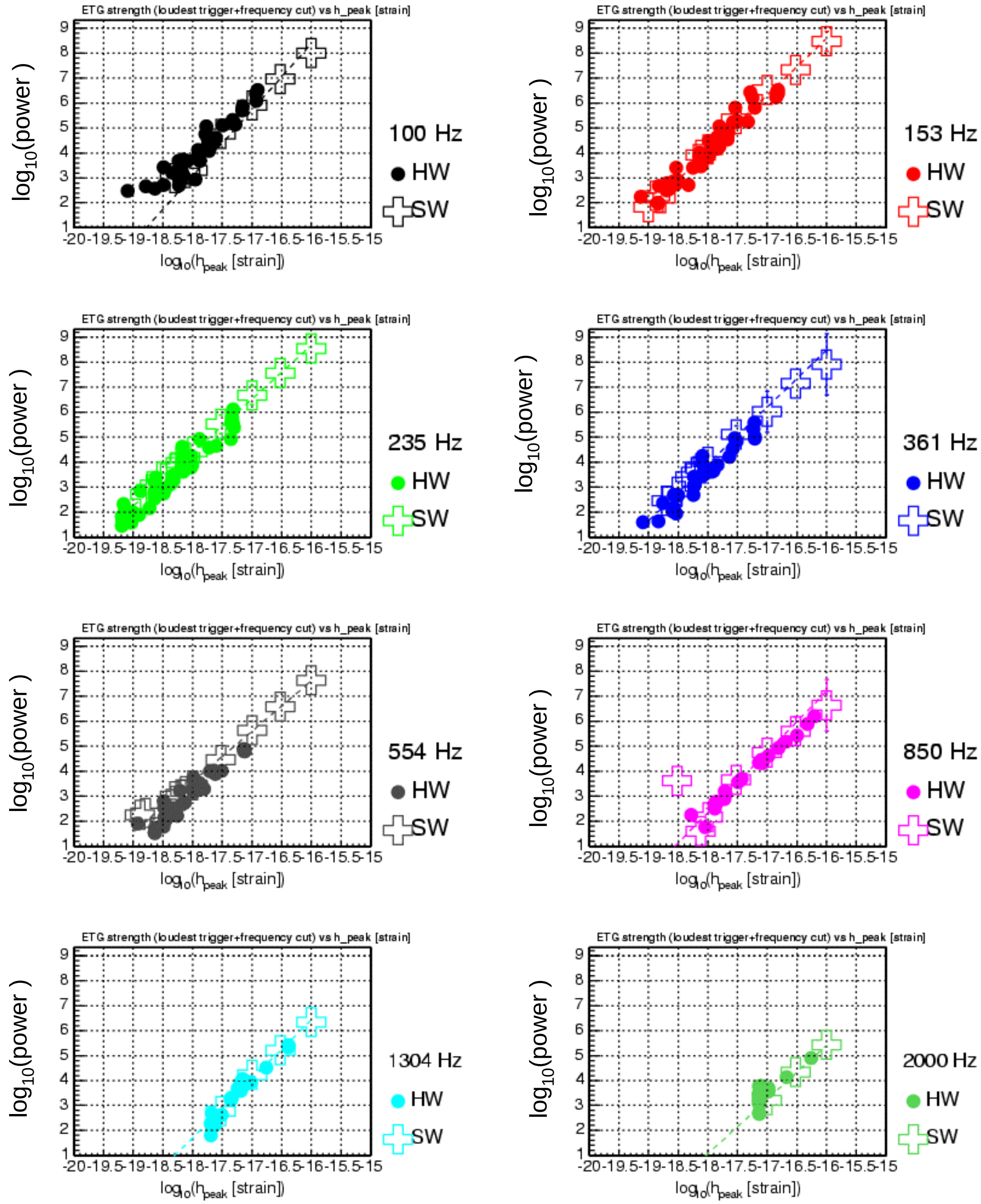
Up to 1 order of magnitude fluctuations in the detected power

Hardware vs software injections

- Dots: hardware
- Crosses: software

- Hardware injections:
  - » Q=9 sine gaussians
- Software injections:
  - » Q=9 sine gaussians, at 23 times uniformly distributed in the S2 playground
  - » Calibration taken care of in LDAS (respfilt function in DataCond)
- Agreement:
  - » fits of response versus h_{peak}
  - » 20-50% with power law 2 constrained
- USED ONLINE CALIBRATION
  - » will repeat with new calibration (V02) and with implementation of the parameter estimator (h_{rss} vs h_{rss})

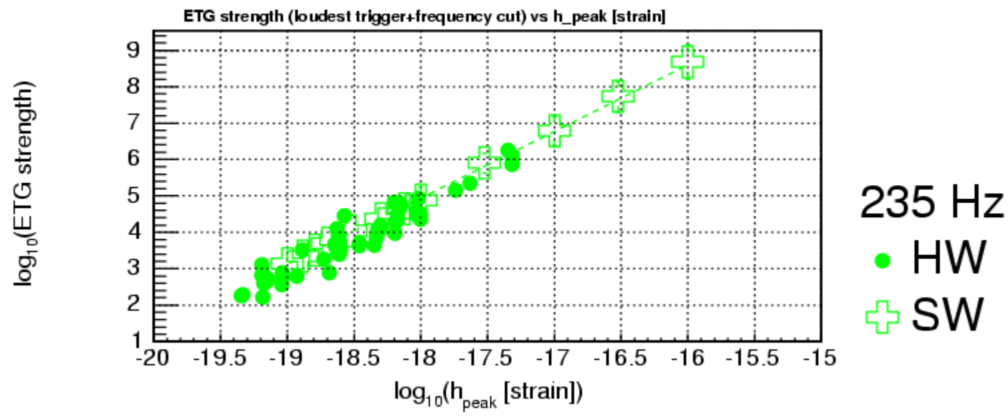
$\log_{10}$(power) detected vs h_{peak}

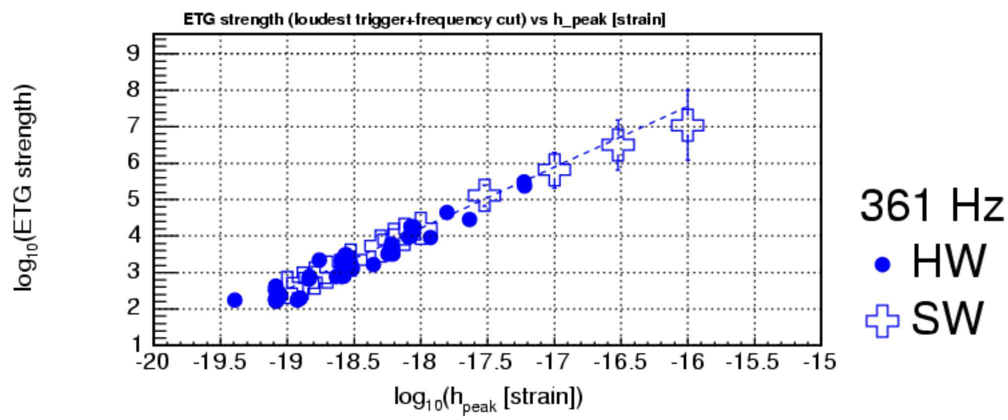


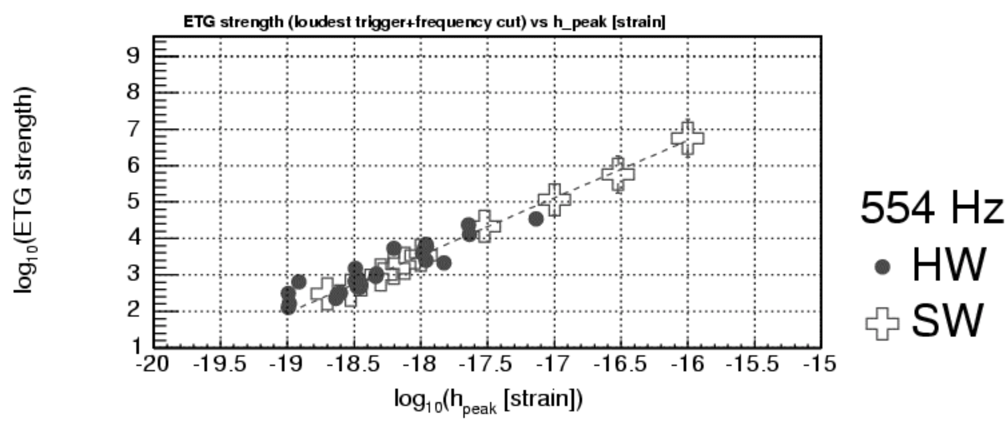
L1

With EXCESS POWER

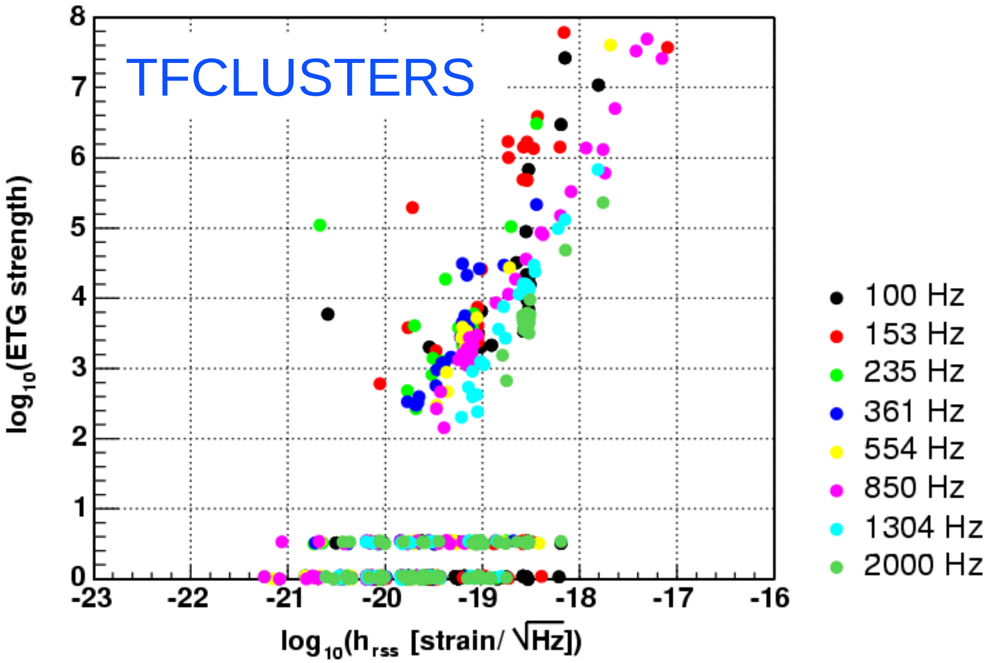
$\log_{10}$(SNR) detected vs h_{peak}

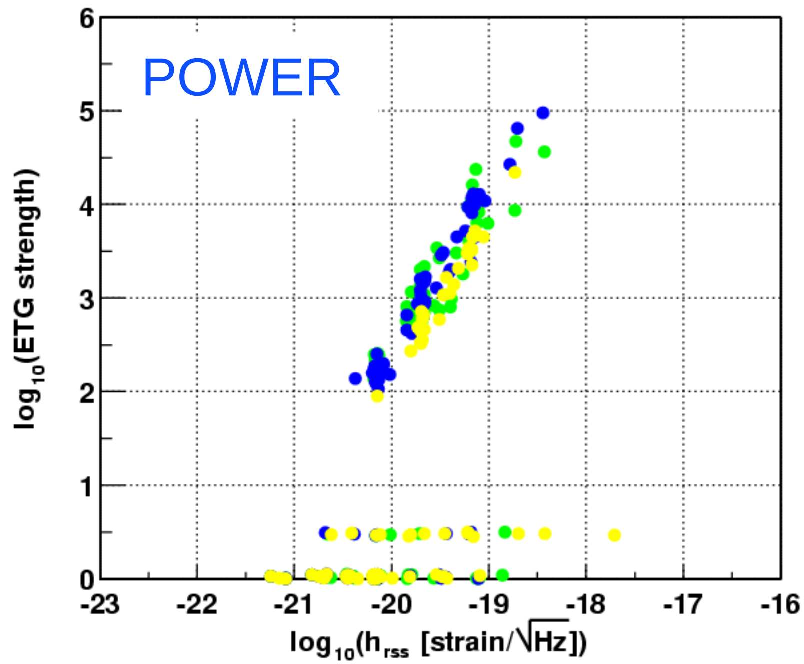






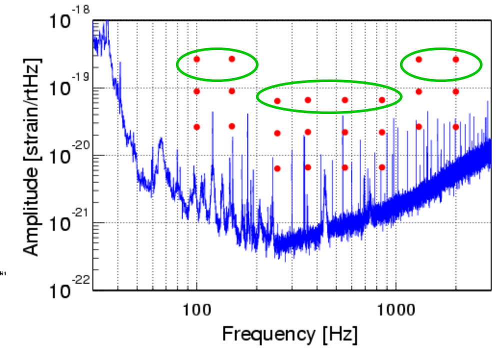
H1 injections (pre and intra-run)

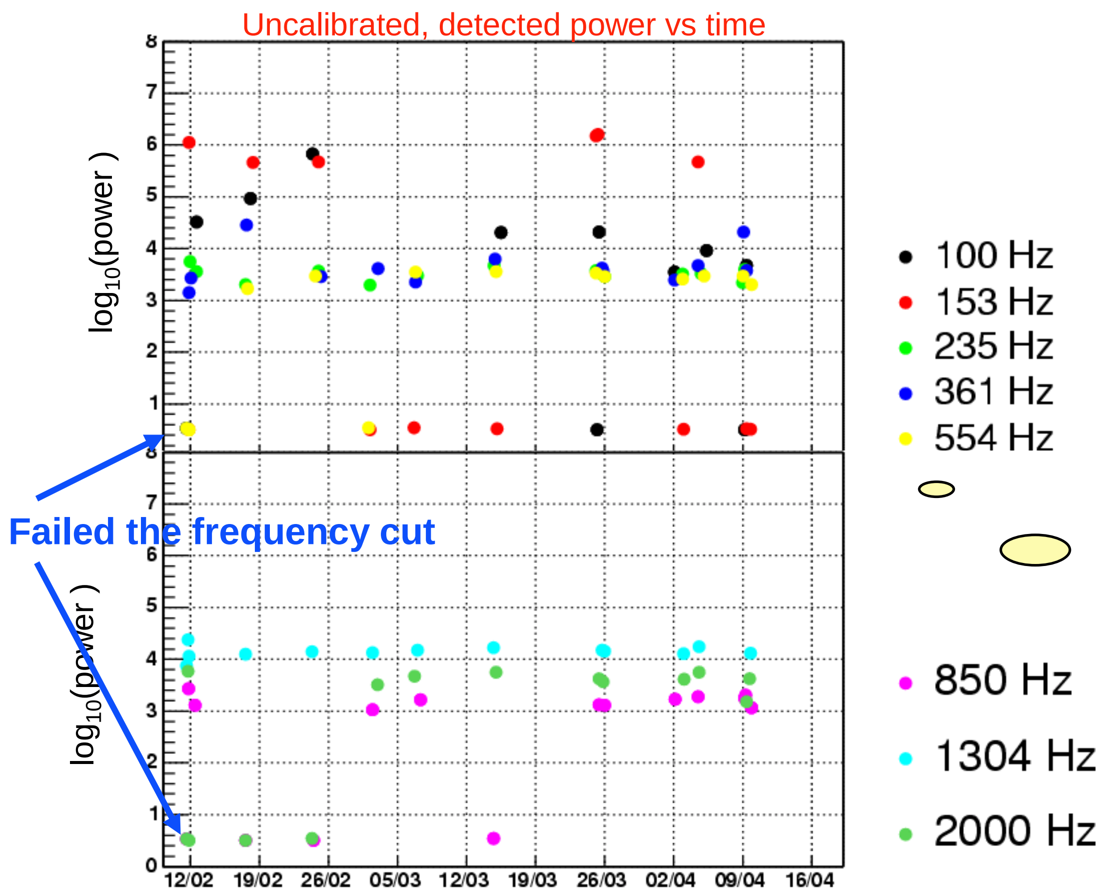




LIGO

H1 stationarity



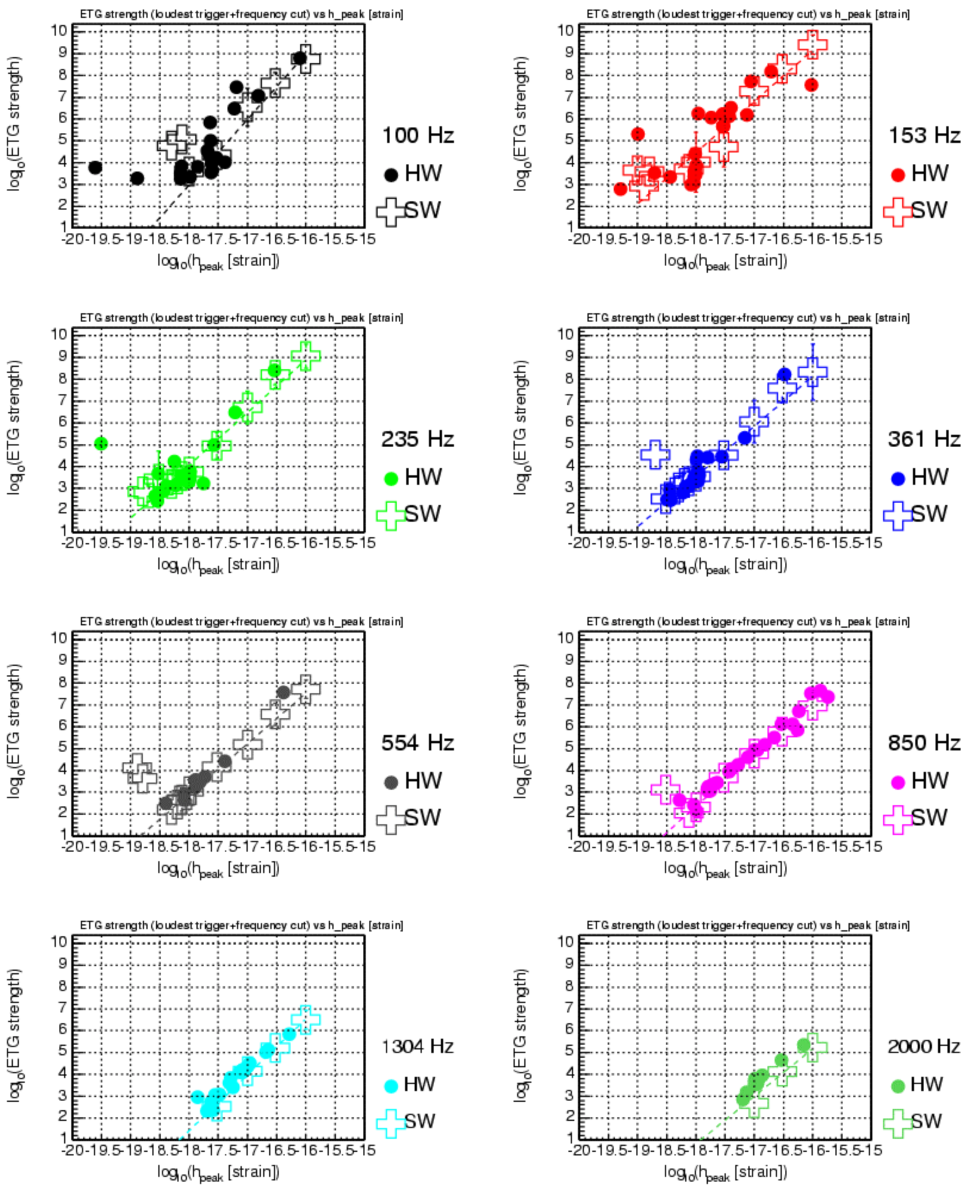


- Intra-run injections reconstructed with TFCLUSTERS (still old setup - some are missed)
- Sine gaussians, Q=9 and:
  - 235, 361, 554, 850 Hz
    - 2.6×10^{-16} m/sqrt(Hz)
  - 100, 150, 1304 and 2000 Hz
    - 1×10^{-15} m/sqrt(Hz)

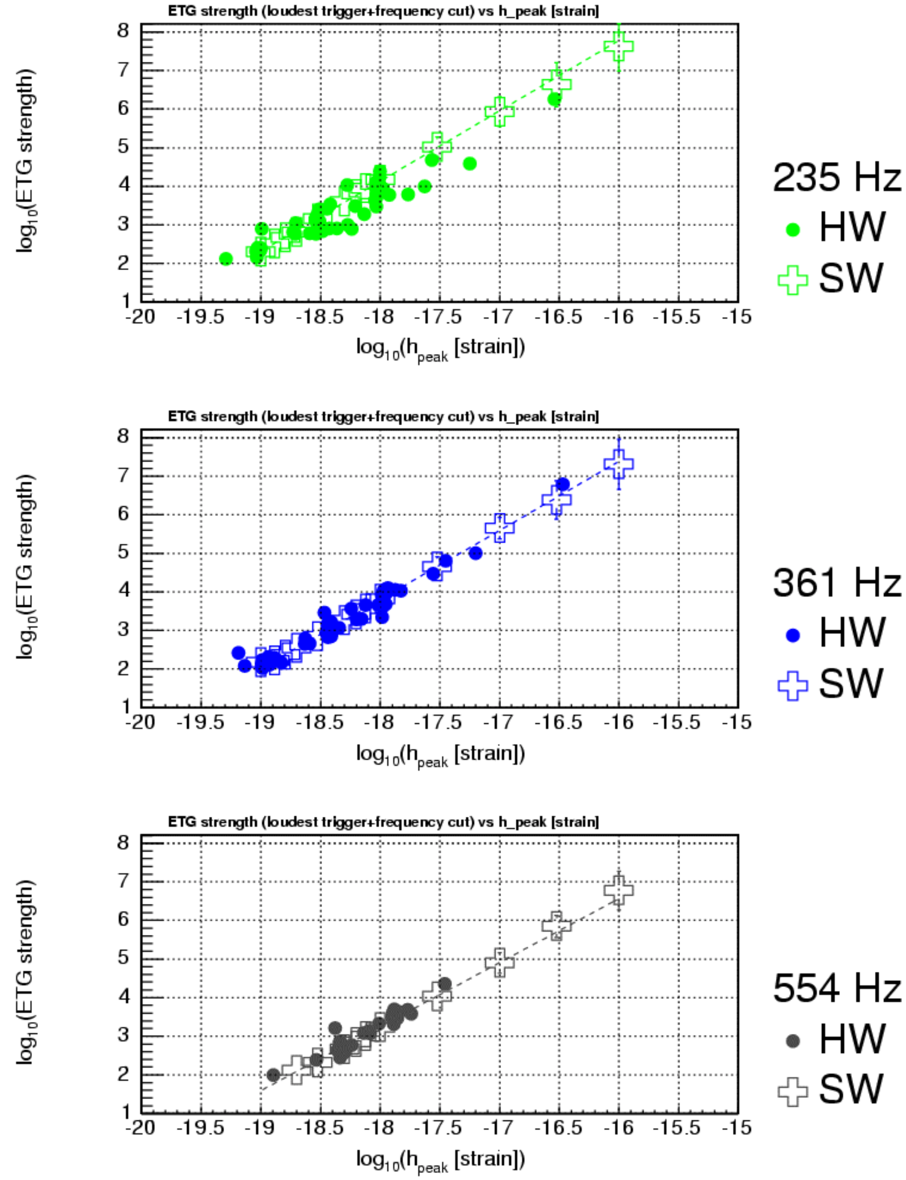
Largest fluctuation at low frequency (100-153Hz)

H1

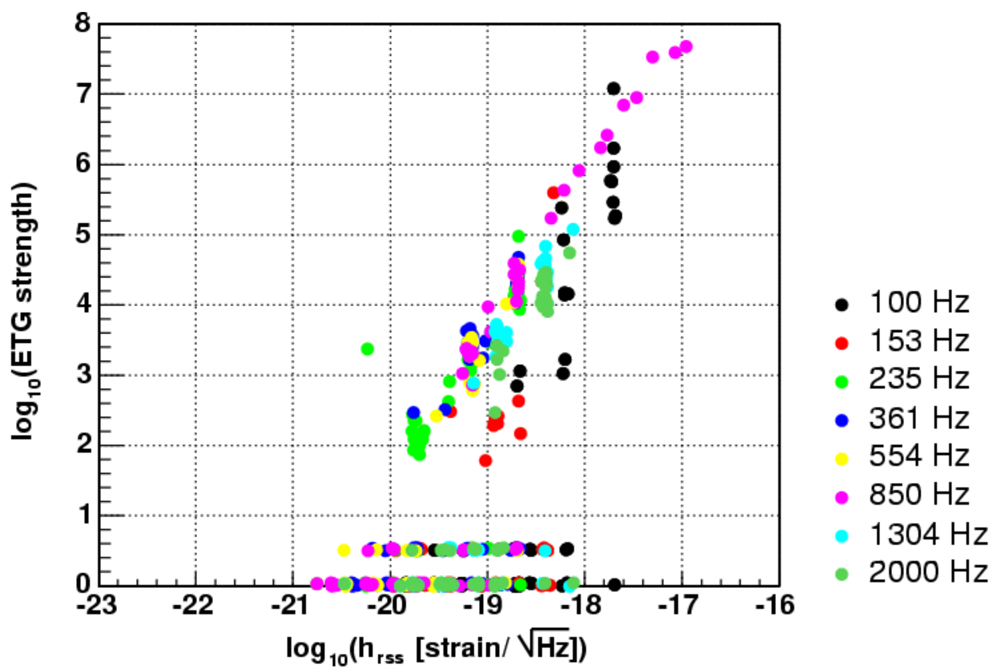
TFCLUSTERS

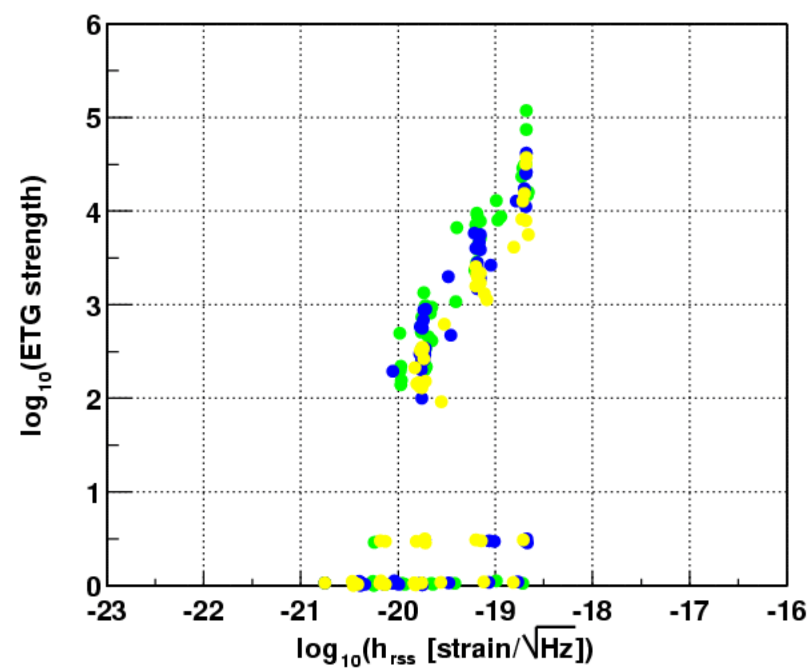


POWER

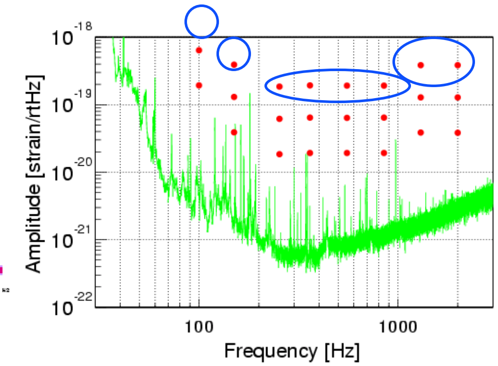


H2 - TFCLUSTERS

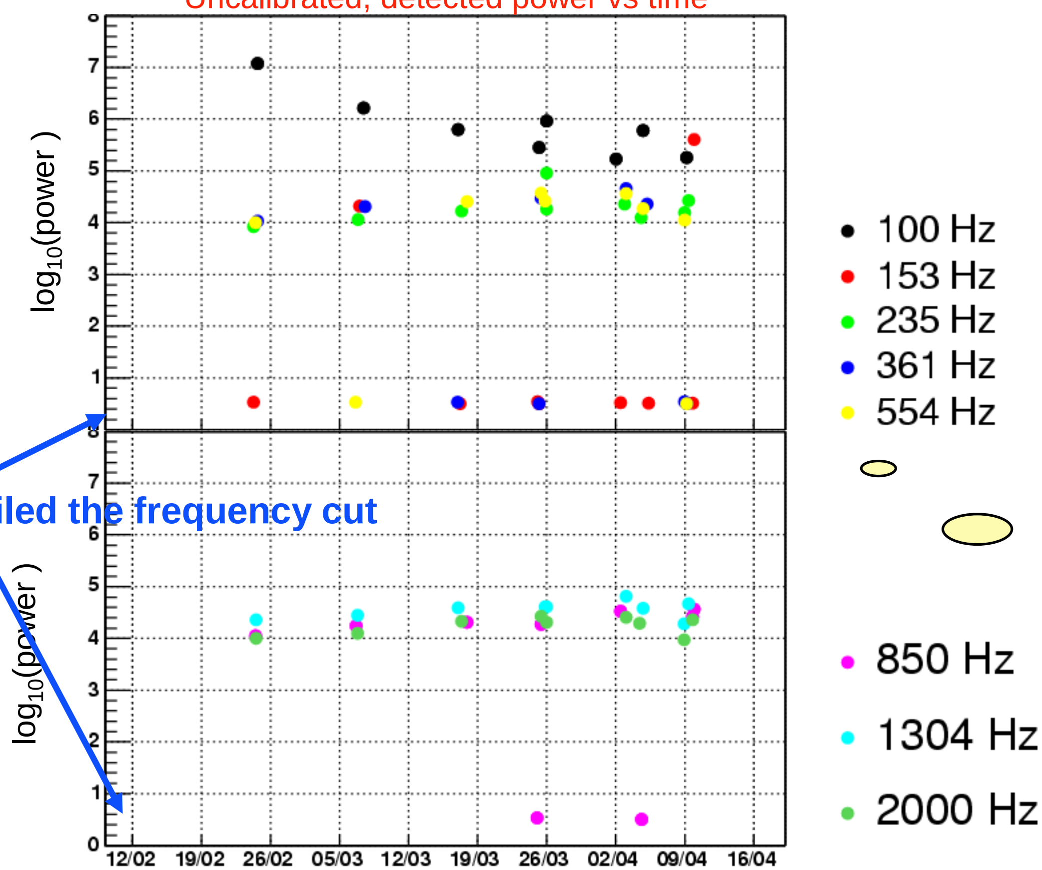




H2 stationarity



Uncalibrated, detected power vs time



- Intra-run injections reconstructed with TFCLUSTERS (still old setup - some are missed)
- Sine gaussians, Q=9 and:

  235, 361, 554, 850 Hz

  4×10^{-16} m/sqrt(Hz)

  100, 150, 1304 and 2000 Hz

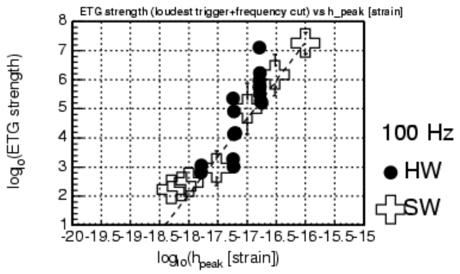
  8×10^{-16} m/sqrt(Hz)

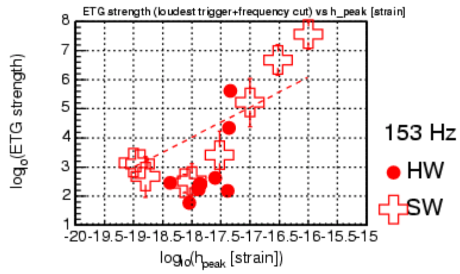
  100 Hz 4×10^{-15} m/sqrt(Hz)

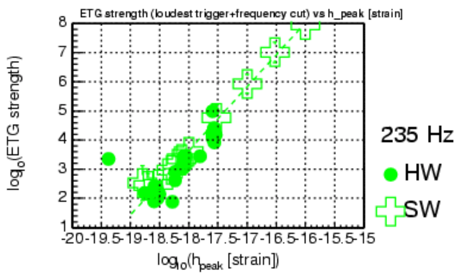
Large fluctuation at low frequency (100-153Hz)

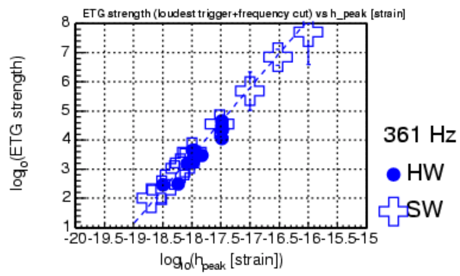
H2

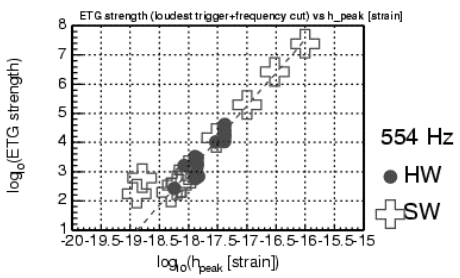
TFCLUSTERS

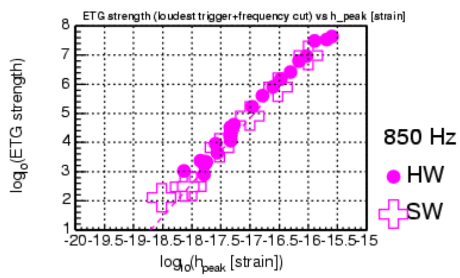


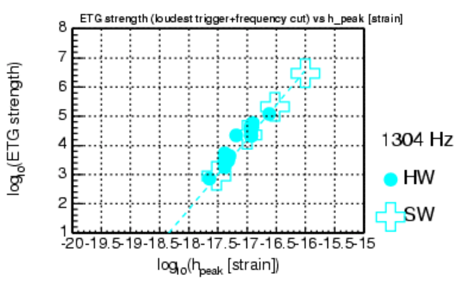


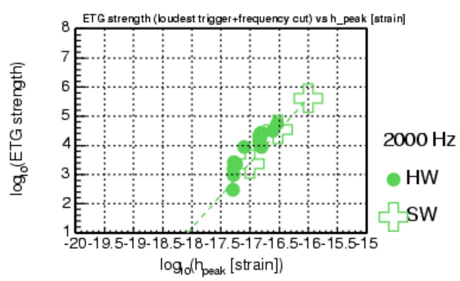




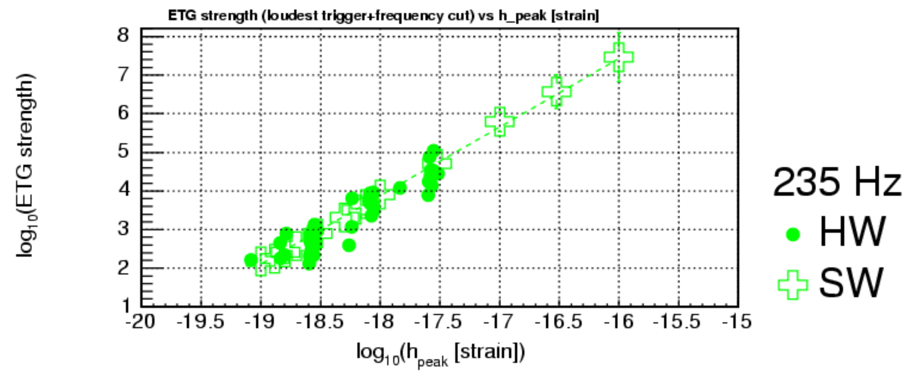


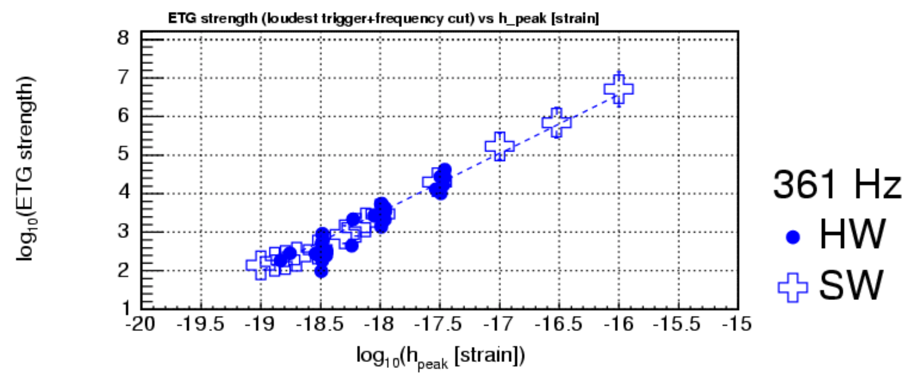


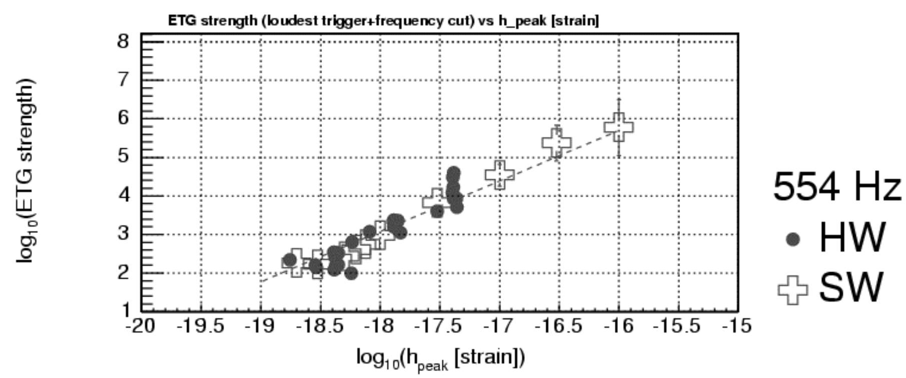




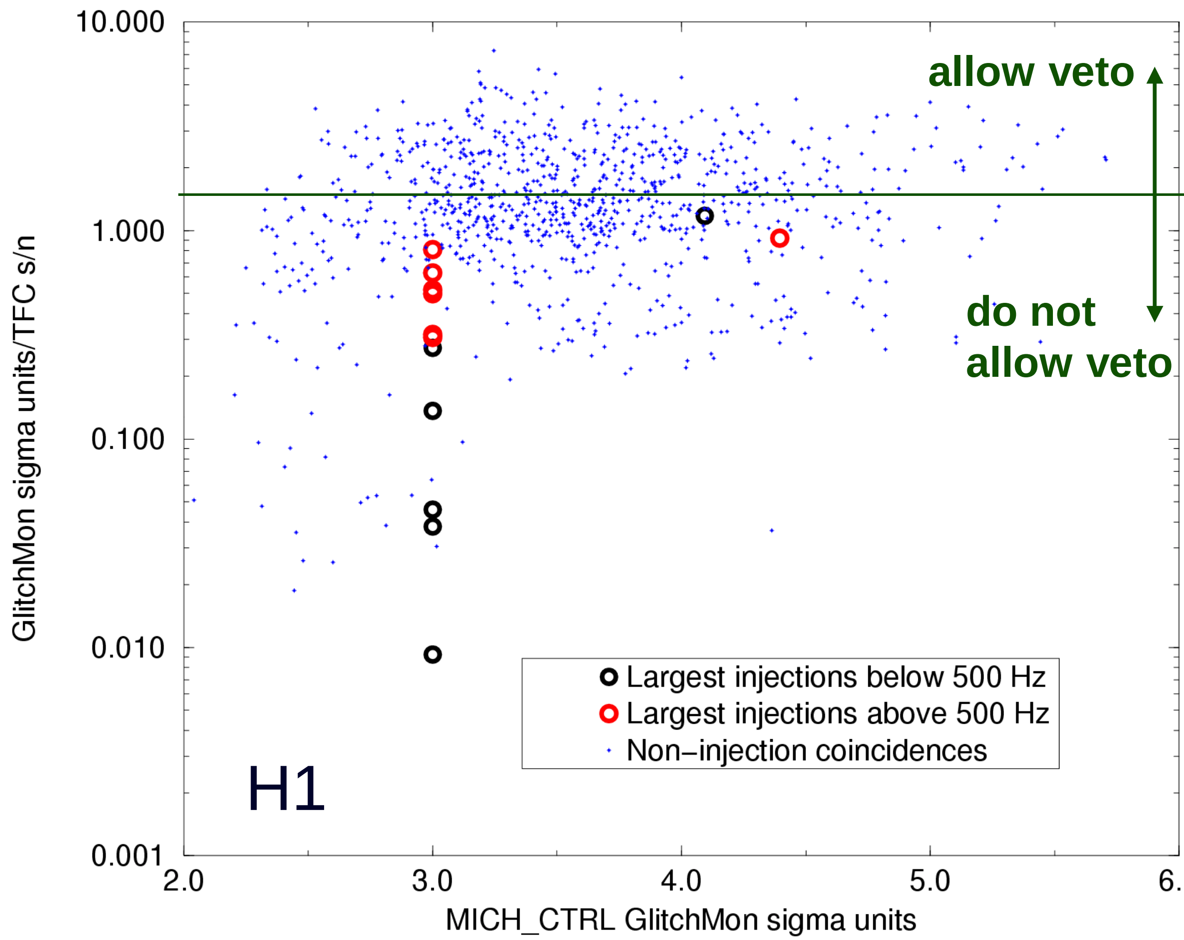
POWER







Veto safety studies (Ito, Schofield)



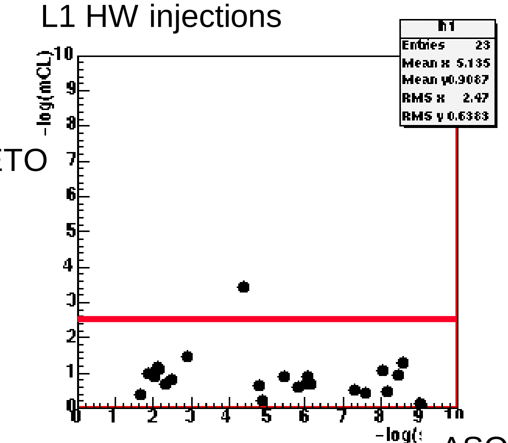
The position of this cut
Is not decided yet!

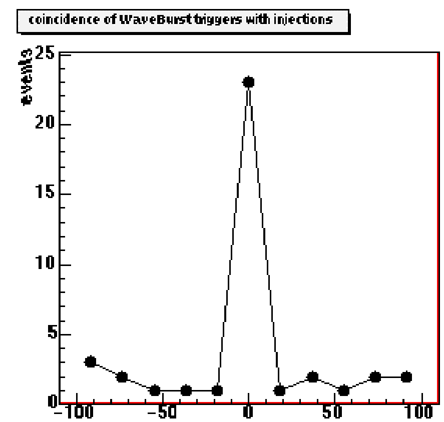
Study veto safety
with hardware injections

WaveMon veto safety studies (S. Klimenko)

- Used hardware injections to look for cross coupling between AS_Q and veto channels
- Select qualified triggers by setting a threshold on strength of veto clusters.
  - » Lost <4% waveMon AS_Q triggers with this cut

L1 HW injections





Time lag [s]

In Progress:

- ➢ Re-run WaveMon on-line on larger number of channels and wider frequency band.
- ➢ Study of veto efficiency