Introduction to kleineWelle

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Description

- Multiresolution Wavelet-based transient search algorithm
- Time and Scale (Frequency) information
- Implementations in Matlab and DMT
- Single-channel trigger generation
- Online event rate and profile monitor in progress

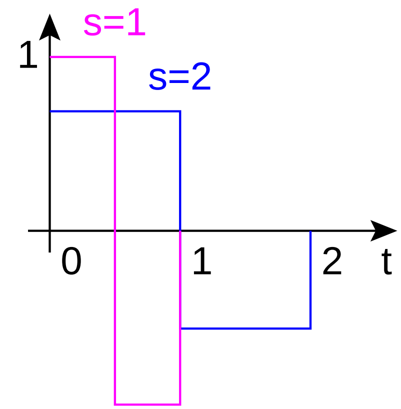
Discrete Dyadic Wavelet Transform

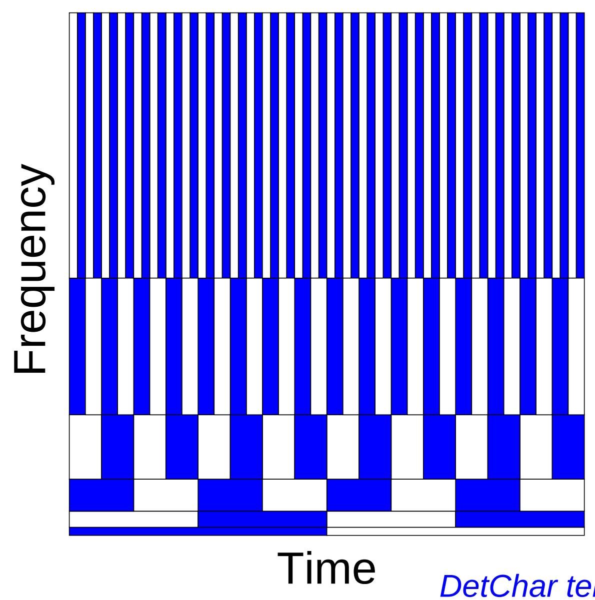
Project $h(t)$ onto time-shifted and scaled wavelets.

Continuous Wavelet Transform:

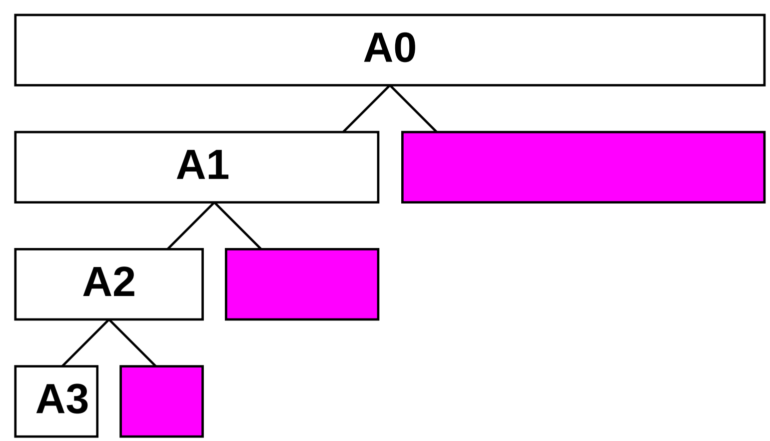
$$W_f(u,s) = \int_{-\infty}^{\infty} h(t) \frac{1}{\sqrt{2^s}} \psi\left(\frac{t-u}{2^s}\right) dt$$

Haar Wavelet

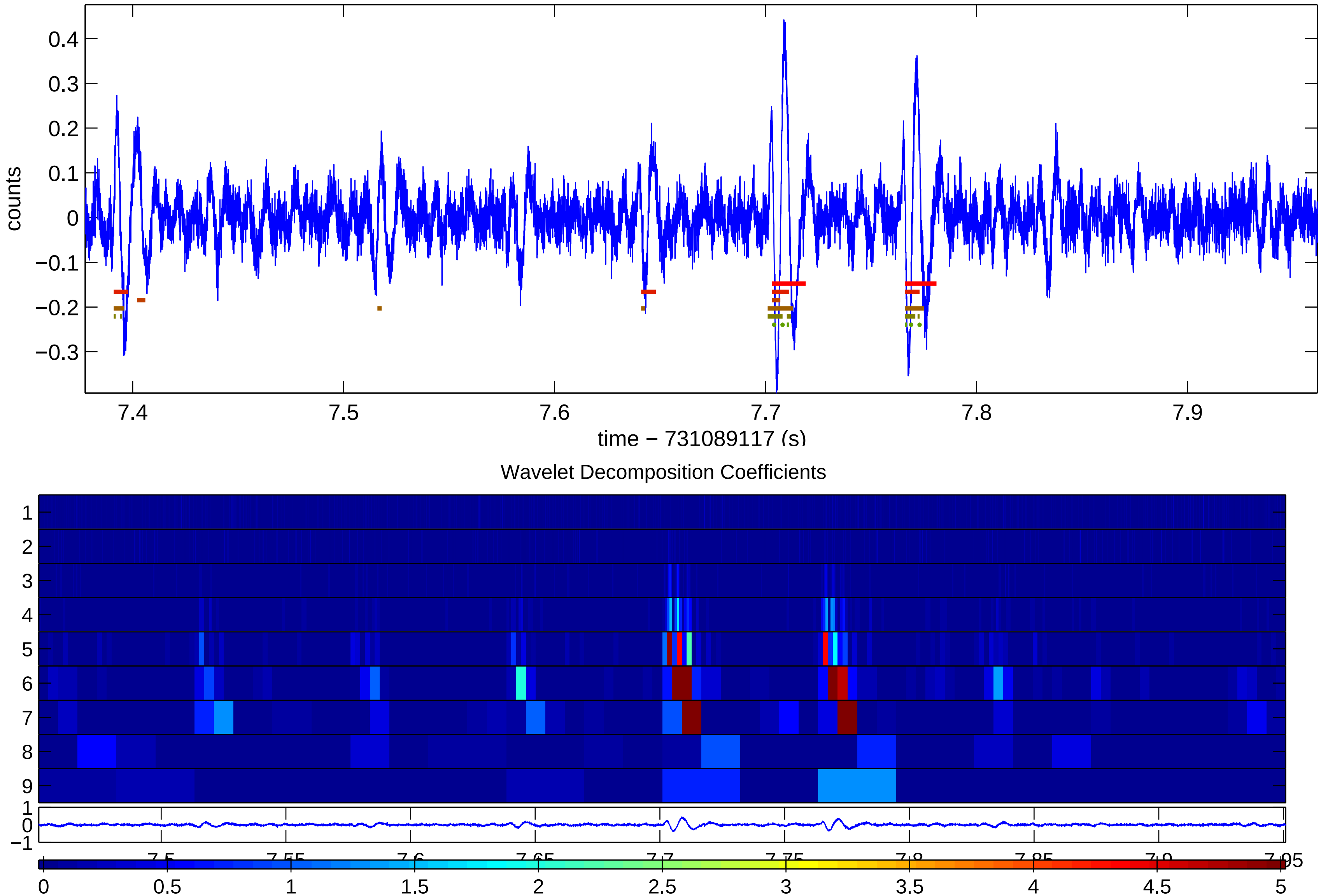




Dyadic Wavelet Decomposition Tree



Example Haar Wavelet Decomposition



KleineWelle pipeline

- Begin with a segment of raw timeseries (ASQ)
- High pass filter (70 Hz Butterworth)
- Train and Apply Linear Predictive Filtering (1024 Order)
- Discrete Wavelet Decomposition (Haar Wavelet)
- Threshold on absolute normalized pixel amplitude in each scale to generate black pixels
- Cluster black pixels in time and in scale within a certain pixel distance of each other
- Threshold on a joint cluster significance of the summed normalized energy
- Produce single channel, single-IFO triggers

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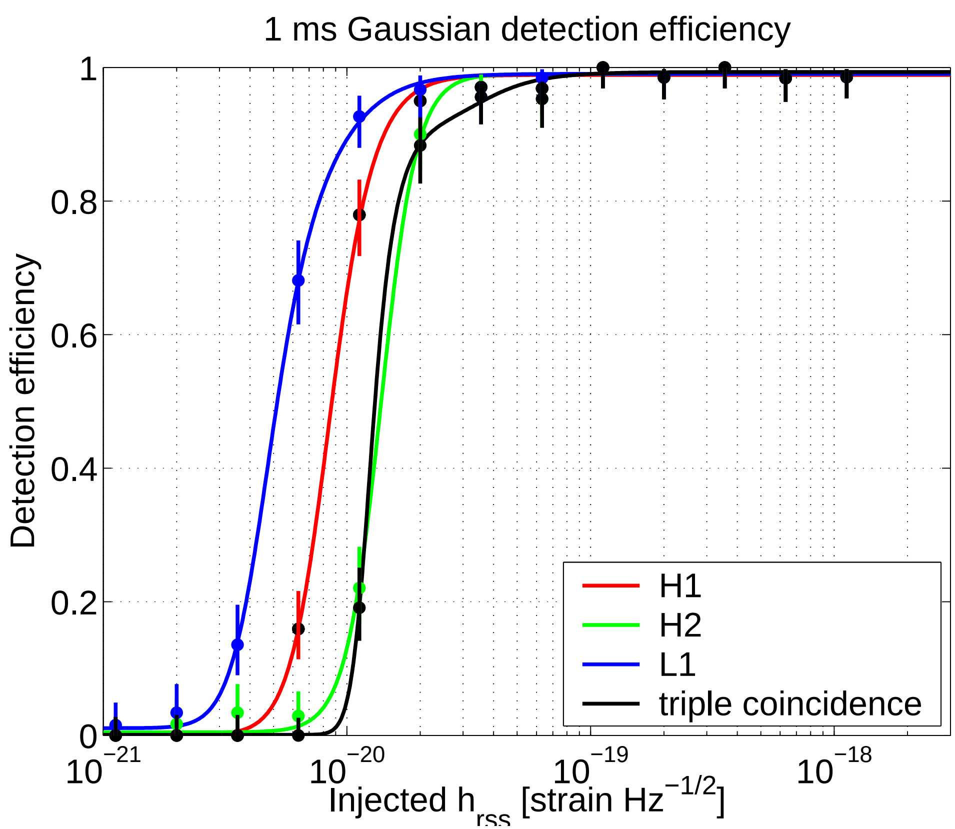
Trial run over GA1 MDC



- Stride 16s
- HighPass 70Hz
- LPEF Order 512
- over scales 5-8
- black pixel threshold 3.0
- max distance between clustered pixels 2
- minimum cluster significance 20.0

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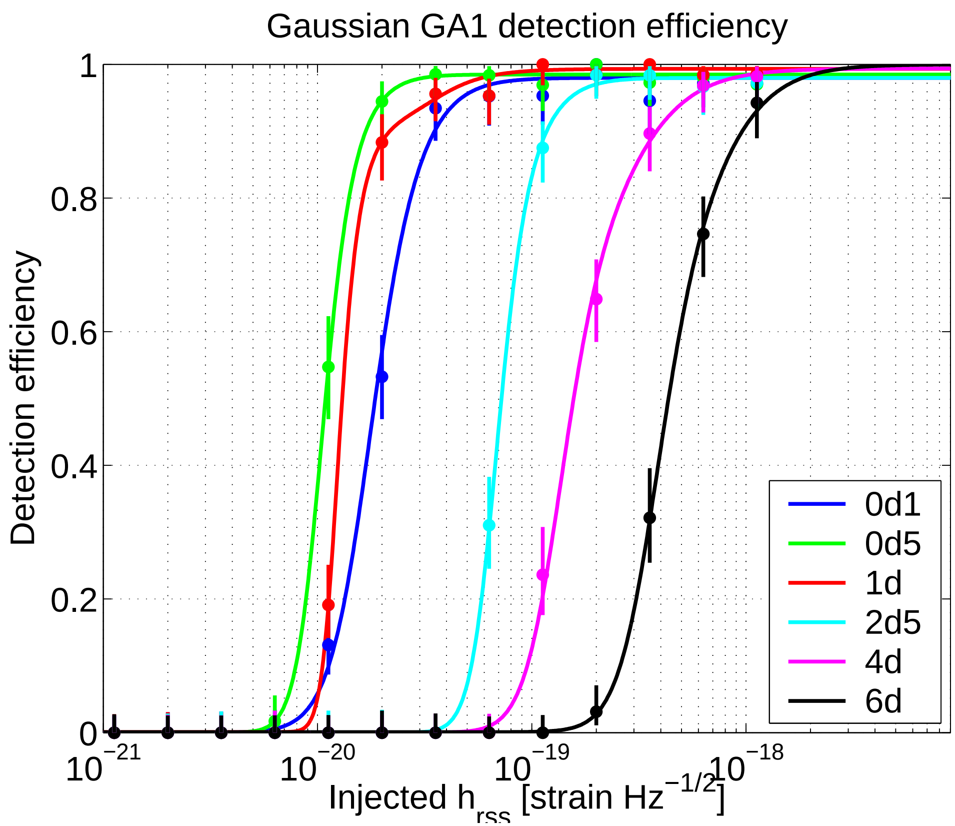
Triple coincident efficiencies for GA1



50% Efficiency:

- 0.1 – 1.85×10^{-20}
- 0.5 – 1.09×10^{-20}
- 1.0 – 1.31×10^{-20}
- 2.5 – 7.21×10^{-20}
- 4.0 – 1.58×10^{-19}
- 6.0 – 4.35×10^{-19}

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S3 Playground Triggers

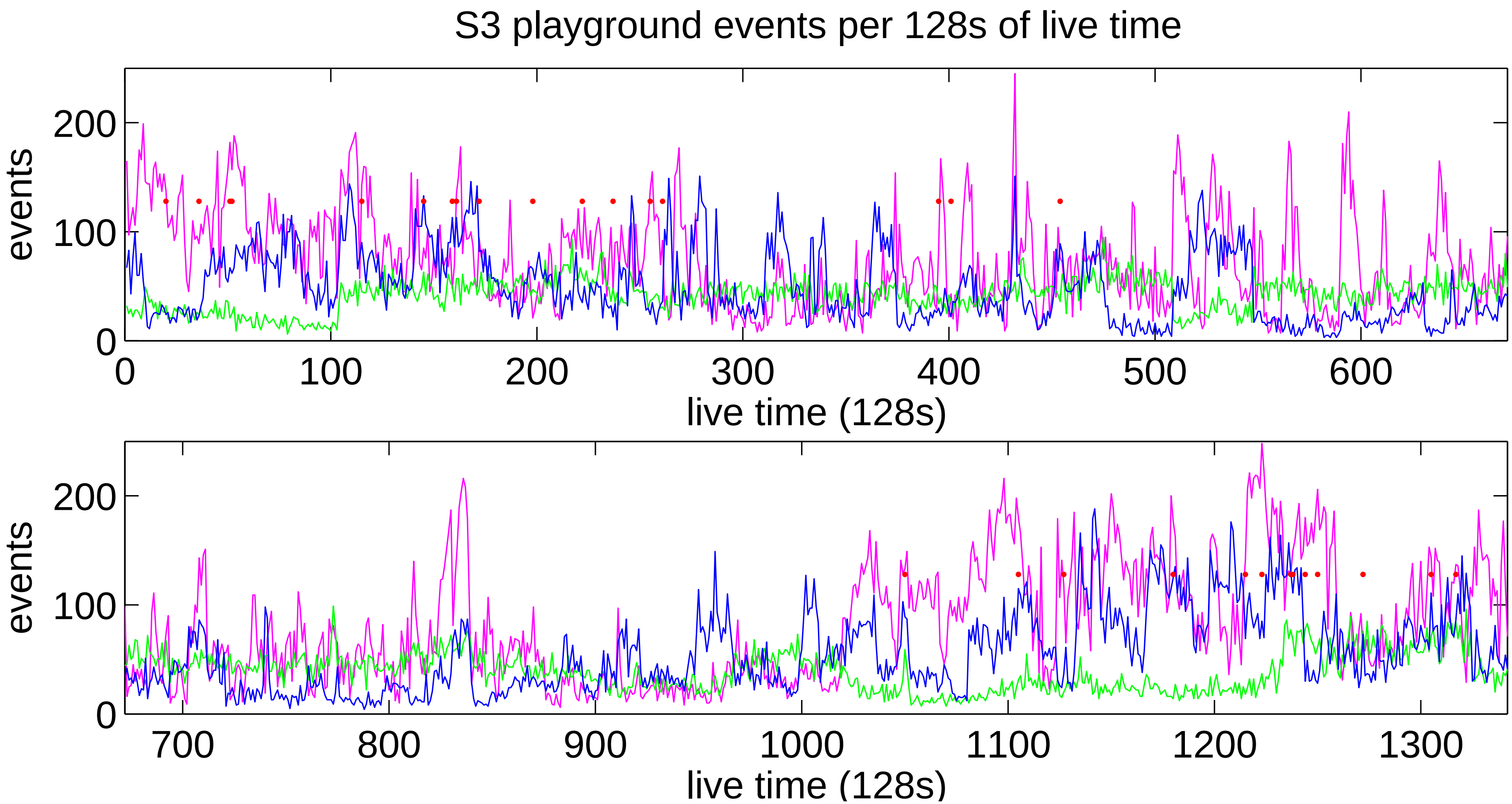
S3 Playground triggers have been generated with the following parameters

- Stride of 16 seconds
- 6th order Butterworth HPF at 70Hz
- 512 order Linear Predictive Filter
- analyzing wavelet scales 5-8
- black pixel amplitude threshold of 3.0
- pixel clustering distance of 2
- minimum cluster significance of 20.0

Time coincidence is applied requiring overlap in time between H1 and H2, and overlap within a 10 ms window between H1/H2 and L1 resulting in 30 triple-coincident events over a live time of 88,912 s (337 μHz)

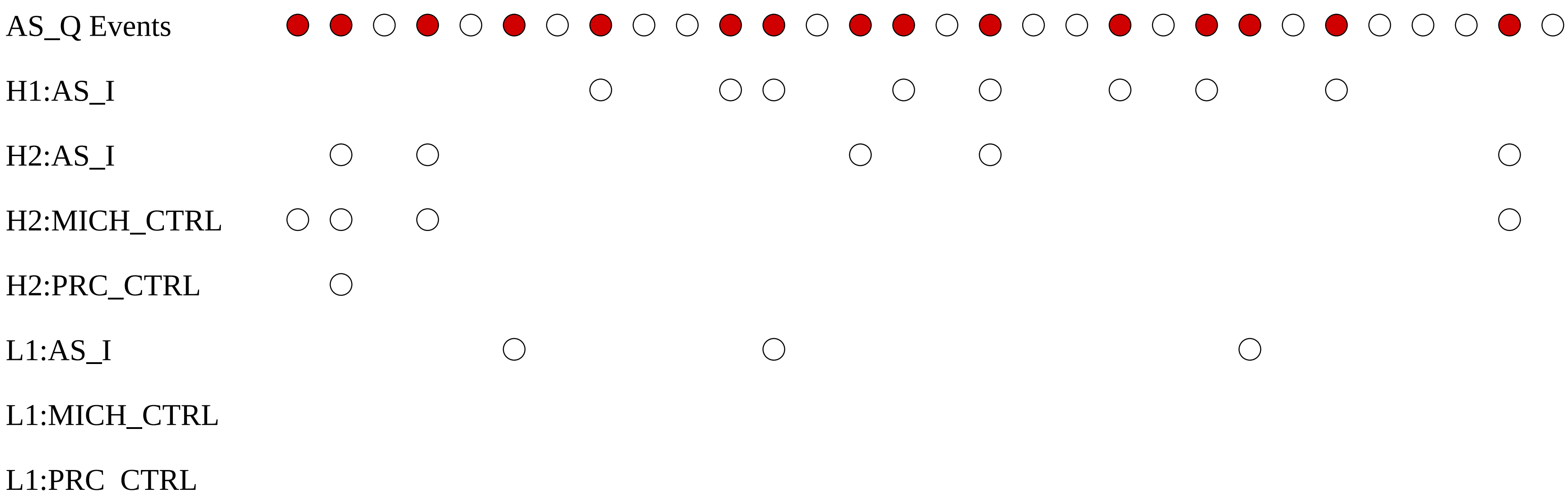
S3 Playground rates

Shown here are the single interferometer event rates per 128 seconds of playground live time for H1 (magenta), H2 (green), and L1 (blue). The red dots correspond to the location of the 30 triple coincident events.



Veto performance

Sevel auxillary channels are tested for possible veto candidates for the triple coincident events. The following table presents the successful vetoes for each channel. More details on the kleineWelle veto triggers can be found at http://ligo.mit.edu/∼richerme/S3.



15 of the 30 triple coincident events are succesfully vetoed.

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Future plans

- Include kleineWelle as part of the GDS distribution
- Continue development of online DMT rate and event distribution monitor
- Study S3 triggers over AUX and PEM channels
- Test kleineWelle over a large variety of waveforms

Relevant Links

- The main page containing source code and some documentation is at *http://ligo.mit.edu/∼lindy/kleineWelle/kleineWelle.html*
- An introduction to multiresolution methods for transient detection which outlines the basic kleineWelle algorithm as well as the Q Transform is in “Multiresolution techniques for the detection of gravitational-wave bursts" *http://ligo.mit.edu/∼shourov/q/documentation/multiresolution.p*
- Phil Richerme has run a study of S3 glitches using kleineWelle: *http://ligo.mit.edu/∼richerme/S3*
- There is a growing collection of kleineWelle (and other) triggers of various channels in the S3 Glitch Production Archive: *http://lancelot.mit.edu/ldas/dc/protected/S3GlitchRuns.html*