DetChar MTG

2014年6月10日(火)　　譲原浩貴

- 以下の論文について簡単に紹介する

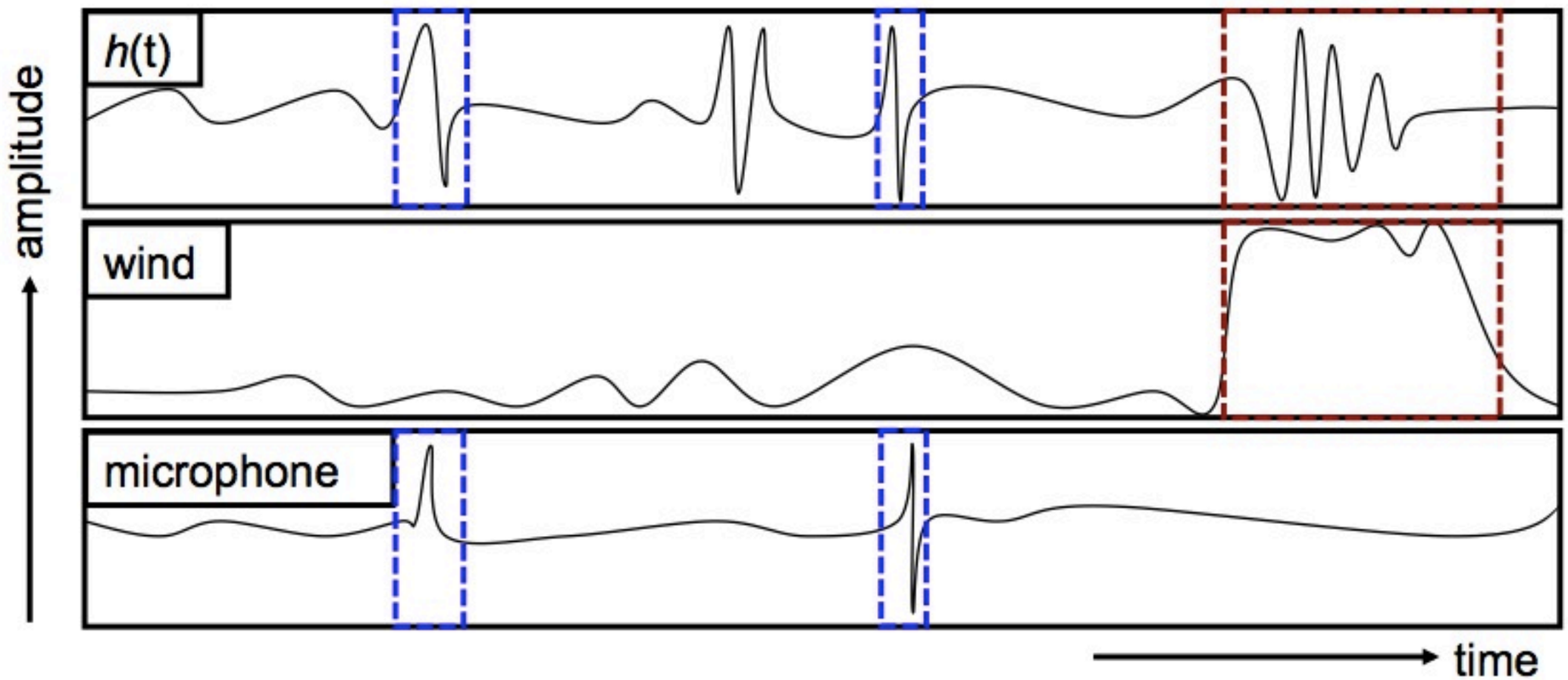
arXiv : 1107.2948 (hierarchical method)

http://arxiv.org/abs/1107.2948

arXiv : 1403.1431 (bilinear coupling veto)

http://arxiv.org/abs/1403.1431

ノイズイベント特定の必要性



h(t)に重力波候補イベントがたくさん現れる

補助チャンネルを用いて、ノイズイベントを同定していく(veto)

ノイズイベントが混入した時間は重力波探索には用いない

wind, microphone以外にもチャンネルはある (>100channels)

Hierarchical vetoにおける統計量の定義

重力波チャンネルh(t)と補助チャンネルのtrigger同士のcoincidenceの数を用いてsignificanceを定義する。triggerはKleineWelleにより生成される

$$S = -\log_{10}\left(\sum_{k=n}^{\infty} P(\mu, k)\right)$$

n : 時間Tの間にh(t)と補助チャンネルの間にあるcoincidenceの数

P(μ, k) : poisson分布のpdf

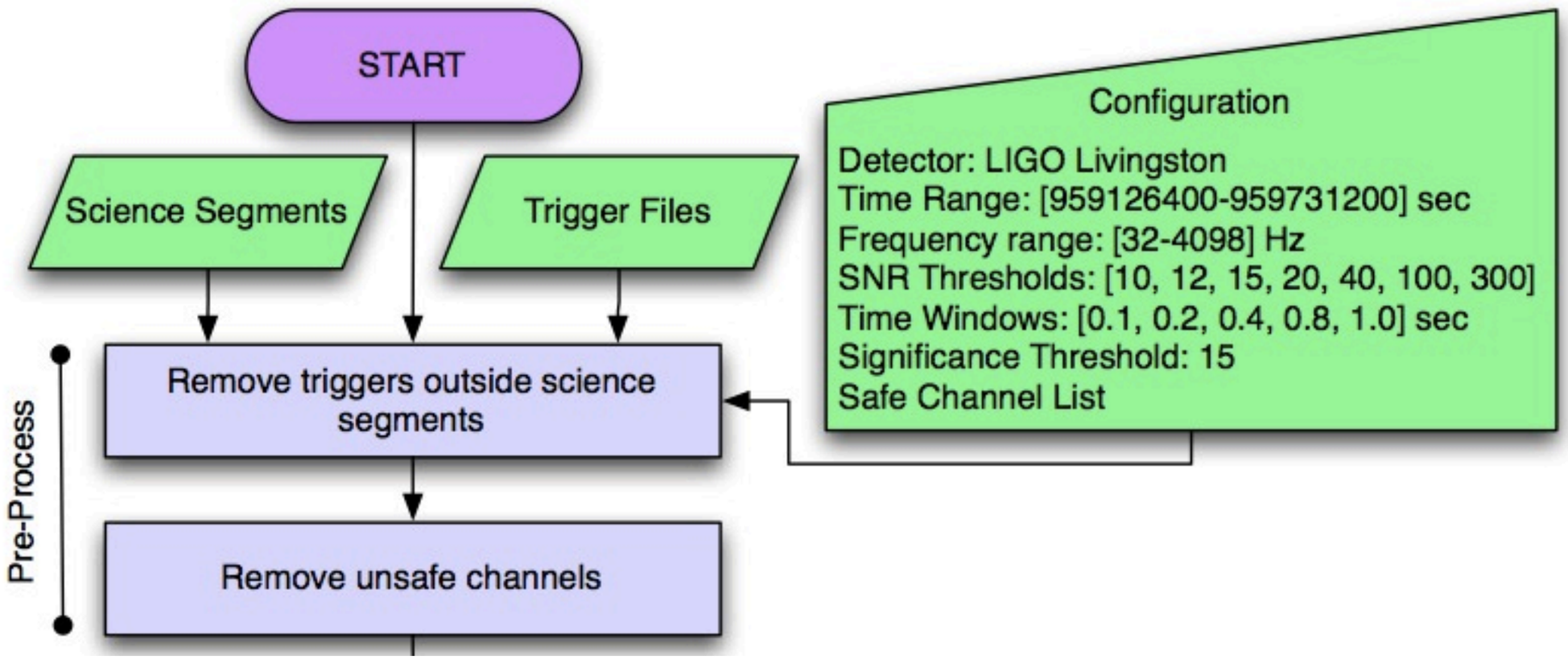
$$P(\mu, k) = \frac{\mu^k e^{-\mu}}{k!}. \qquad \mu = \frac{N_h N_{aux} T_{win}}{T_{tot}},$$

μはランダムに偶然起こるcoincidenceの期待値

階乗の計算があるため、実際の計算には次の式を用いる

$$\sum_k^{\infty} P_{poi}(\mu, k) \approx P(\mu, k)$$

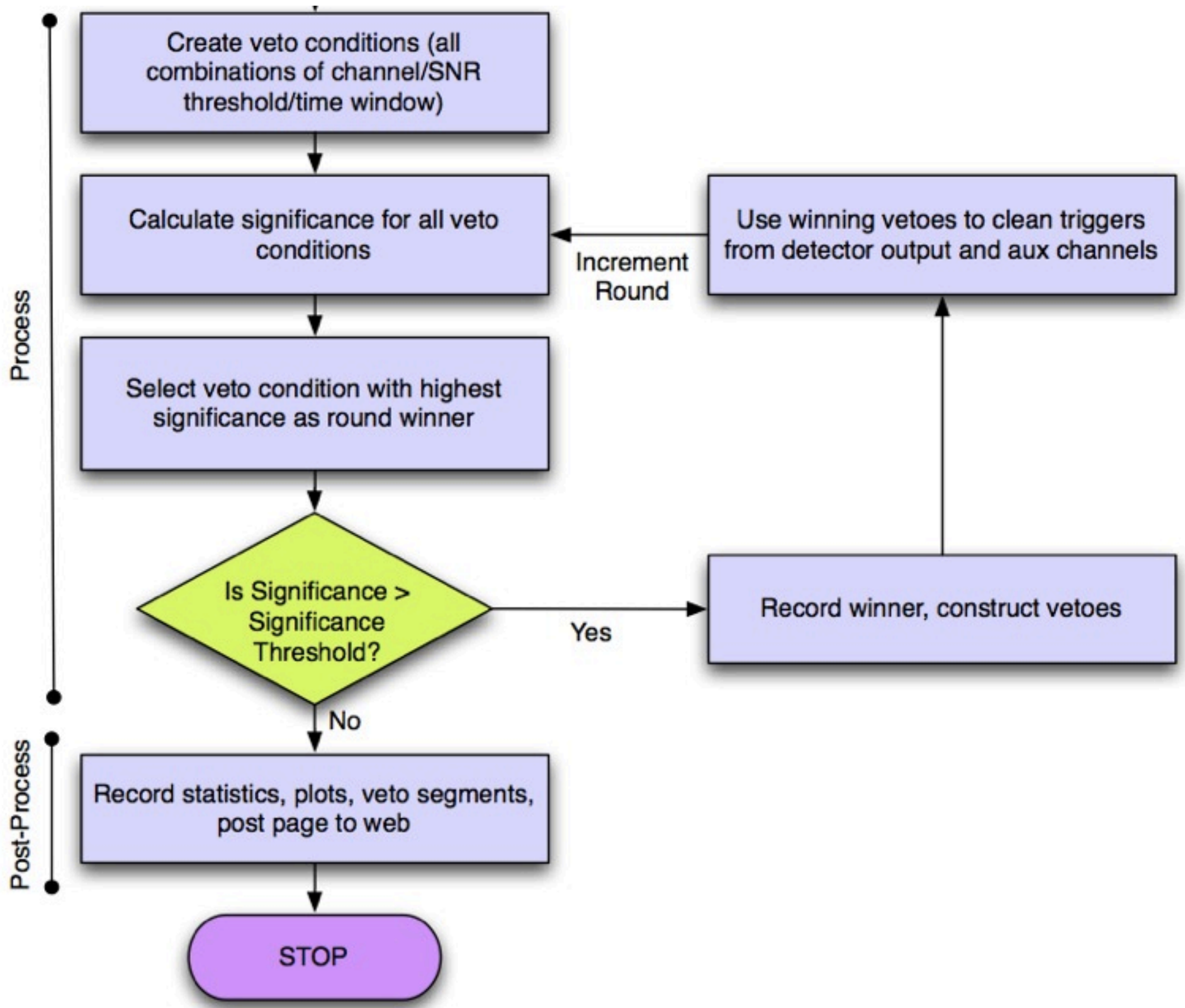
Hierarchical veto アルゴリズム(1)



・Trigger Filesは事前にKleineWelleを用いて生成しておく

・safe channelは、hard injectionを行ったときに影響しないchannnelのことを指す

Hierarchical veto アルゴリズム(2)



解析結果の一例

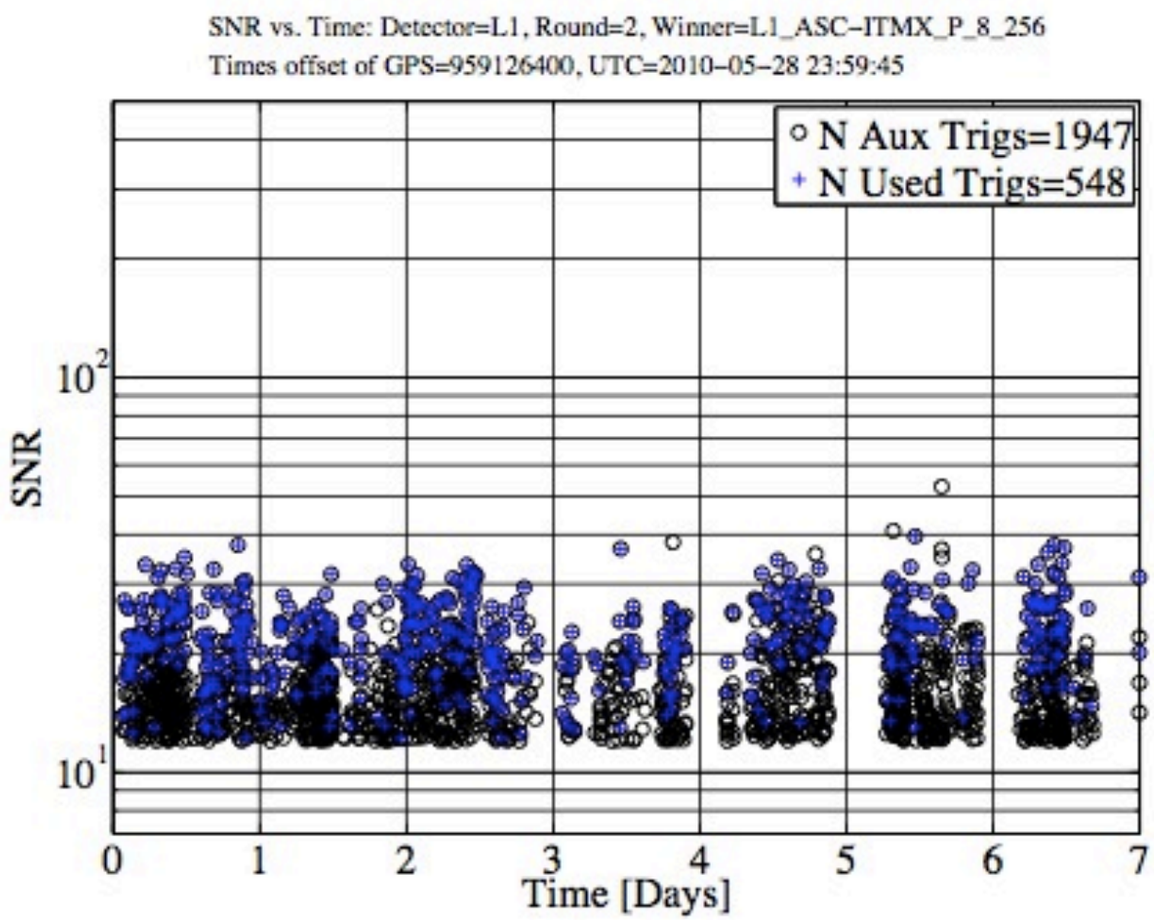


Figure 4. SNR versus time for noise transients in the ITMX pitch channel. The subset of these coincident with a transient in $h(t)$ are marked with blue plus signs.

補助チャンネルのTrigger

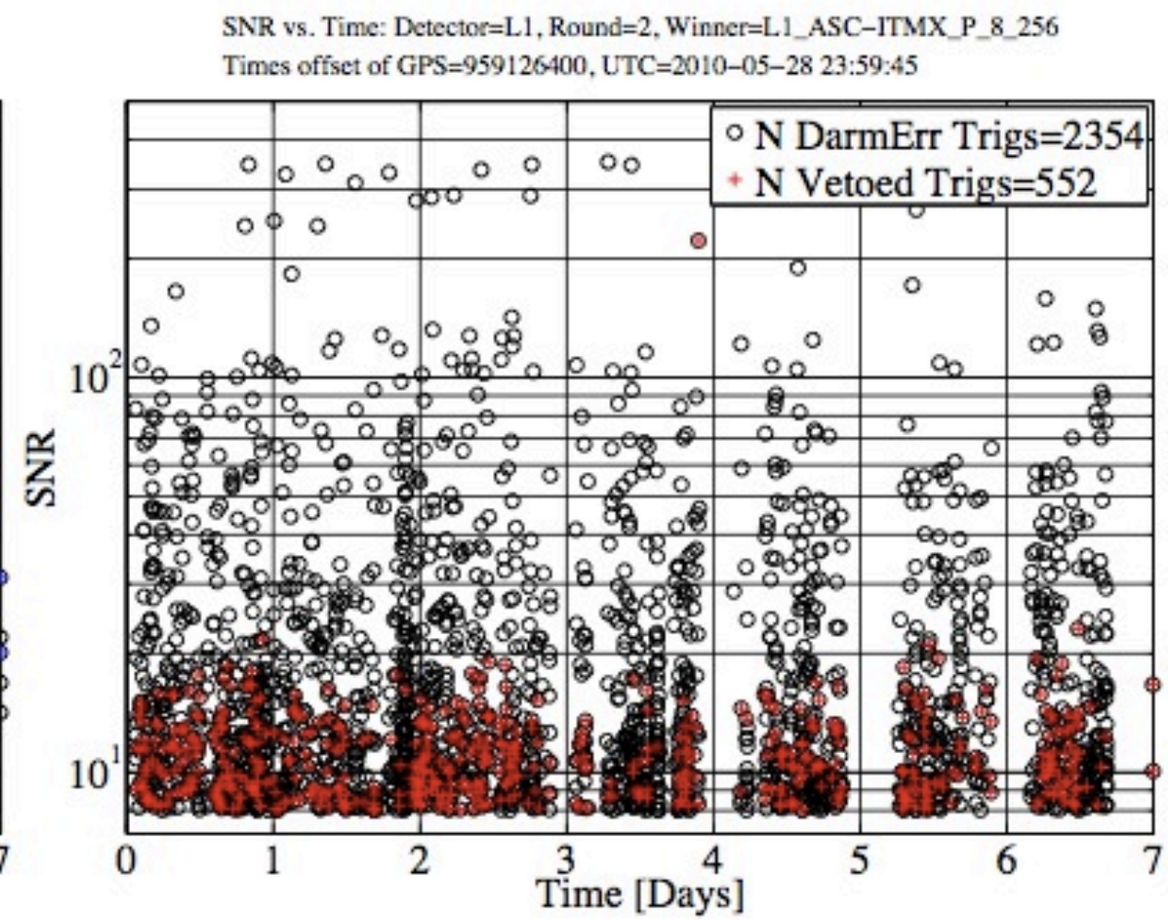


Figure 5. SNR versus time for noise transients in $h(t)$. The subset of these vetoed by the ITMX pitch channel are marked with red plus signs.

重力波チャンネルのTrigger

Hierarchical vetoの性能評価

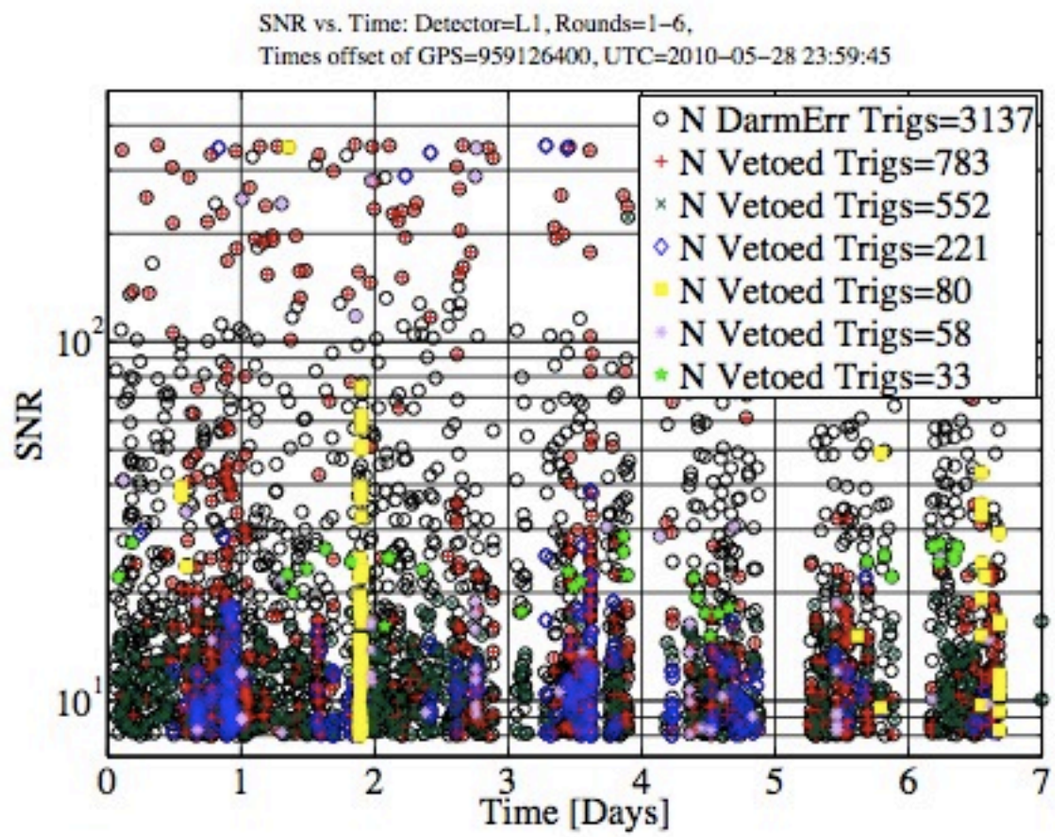


Figure 10. SNR versus time for noise transients in $h(t)$ (black), and the subset of these vetoed in each of the first six rounds (colored markers).

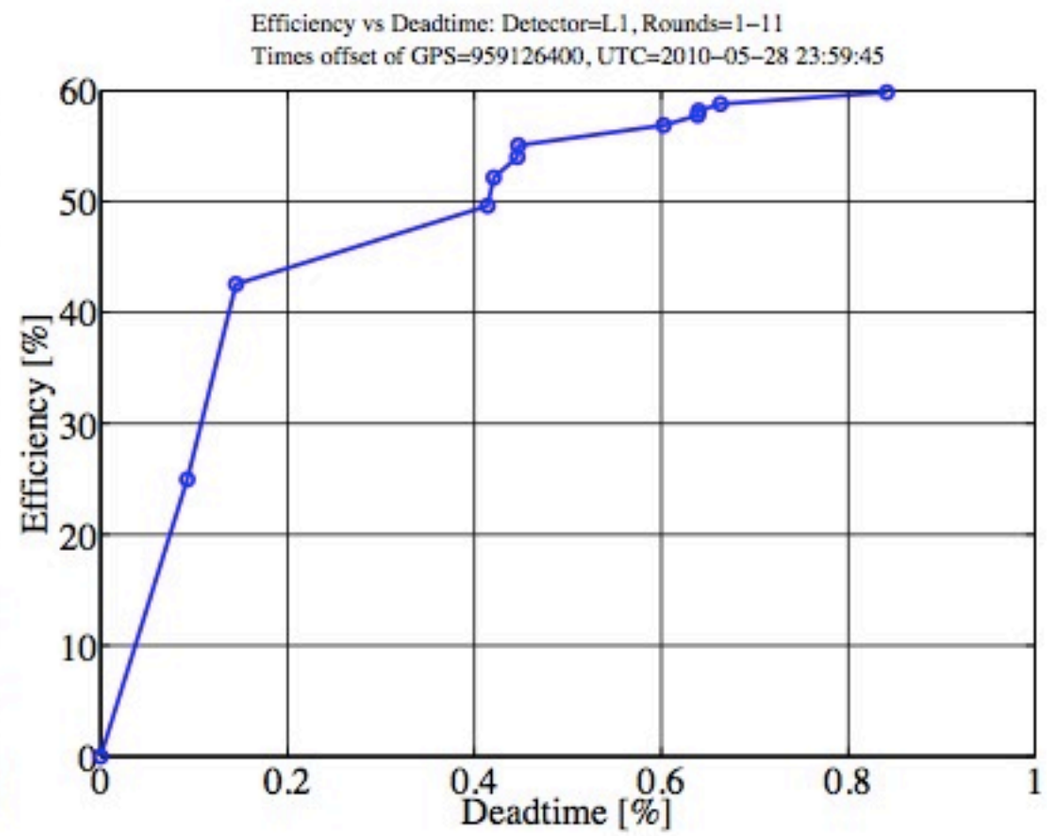
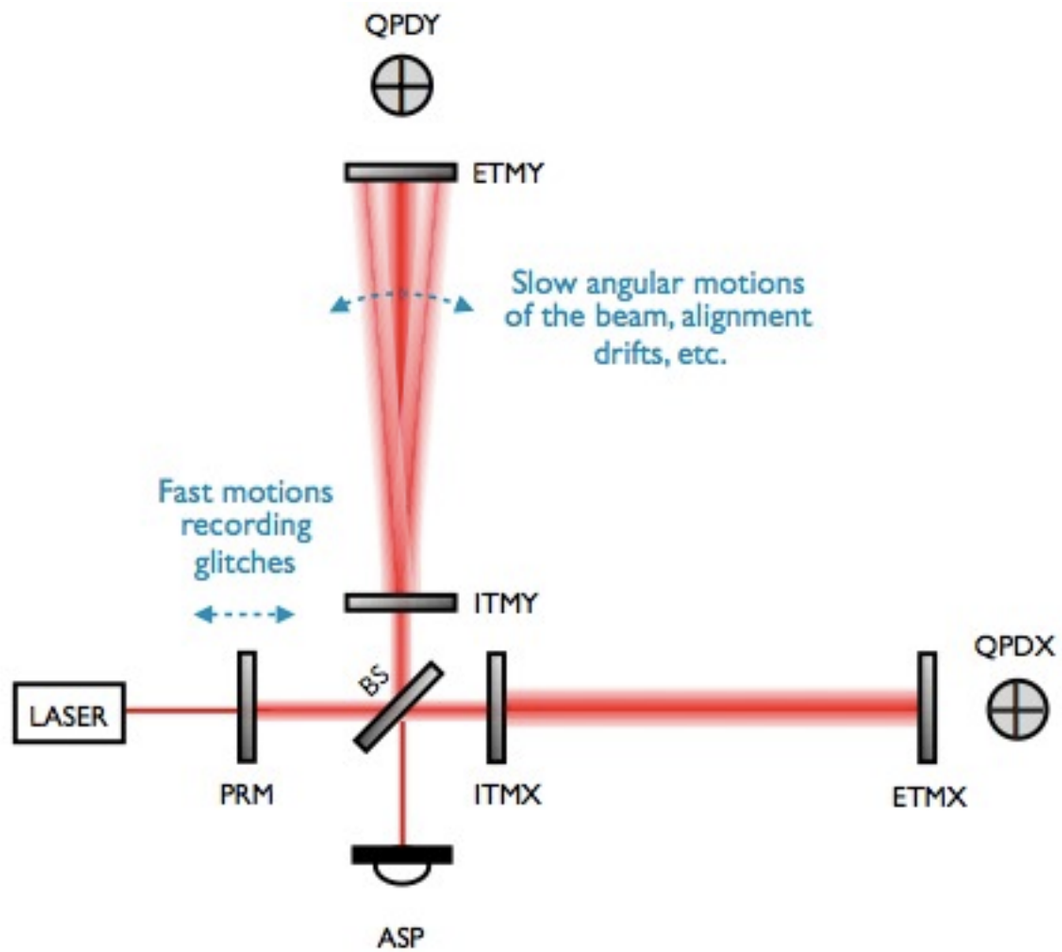


Figure 11. Efficiency versus deadtime for all rounds. Each round is marked with a circle (the initial condition of zero deadtime and efficiency is also marked). The slope of each line segment is the efficiency to deadtime ratio for that round.

・検出効率が高く、deadtimeが少ないことが望ましい

noise couplingの発生



・ミラーの揺れが最終的にbeamの光軸のずれなどを起こし、最適な状態ではなくなる

・混入したがほかのchannelにも現れる (noise coupling)

primary, secondary channelを用いた統計量の定義

We consider a simple model of the coupling between a combination of instrumental channels and the GW channel. In particular, our hypothesis is that many of the glitches in the GW channel H (with time series data $h(t)$) can be "best-witnessed" by a bilinear combination of a primary channel X_i and a secondary channel Y_j. i.e.,

$$h(t) \propto p_{ij}(t), \tag{2.1}$$

where

$$p_{ij}(t) \equiv x_i(t)\, y_j(t) \tag{2.2}$$

denote the data from a "pseudo channel" P_{ij} which is a bilinear combination of $x_i(t)$ and $y_j(t)$, the time-series data recorded in X_i and Y_j.

The consistency of the glitches in the GW channel H with the pseudo channel P_{ij} can be tested by computing the linear correlation coefficient between $p_{ij}(t)$ and $h(t)$, over an appropriate frequency band:

$$r_{ij} \equiv \frac{\langle h\,,\, p_{ij}\rangle}{\|h\|\,\|p_{ij}\|}, \tag{2.3}$$

primary, secondary channel

Primary channel (X_i)	Secondary channel (Y_i)
Length feedback control signals (e.g., LSC-MICH_CTRL, LSC-PRC_CTRL)	Beam position on the mirrors (e.g., ASC-QPD{X,Y}_{P,Y})
Angular torque feedback control signals (e.g., ASC-ETM{X,Y}_{P,Y})	Beam position on the mirrors (e.g., ASC-QPD{X,Y}_{P,Y})
Length feedback control signals (e.g., LSC-MICH_CTRL, LSC-PRC_CTRL)	Interferometer misalignment signals (e.g., ASC-WFS{1,2}_Q{P,Y})

・LIGOのケース

・これらのchannelはどうやって見つけたのか？

解析結果一例

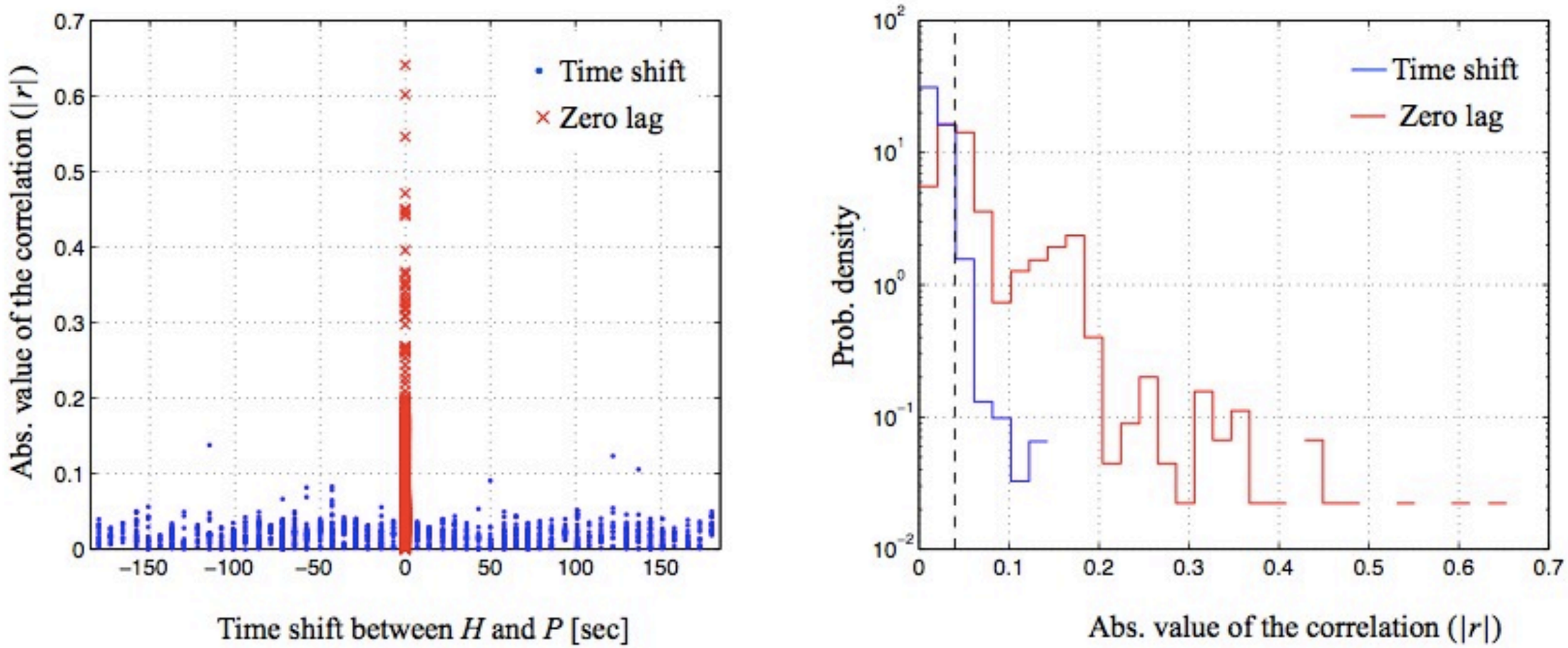
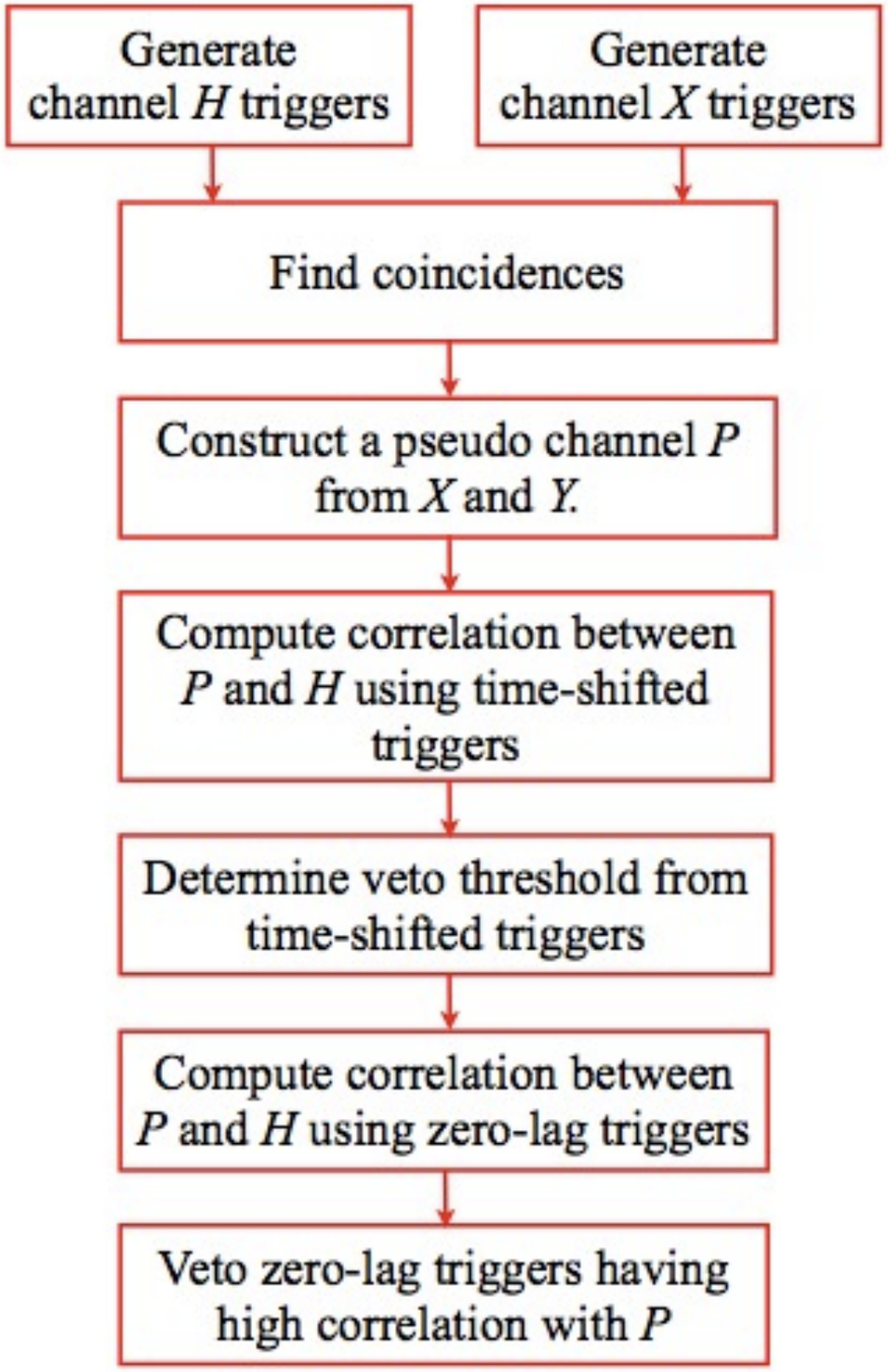


FIG. 2: An example of the correlation of a pseudo channel P_{ij} with the GW channel H. The left panel shows the absolute value of the linear correlation coefficient r between H and P_{ij} as a function of the time shift between the channels, while the right panel shows the distribution of $|r|$ from the time-shifted coincidences (blue) and zero lag (red). The pseudo channel is constructed from a bilinear combination of LSC-MICH_CTRL channel and ASC-QPDY_P from the L1 detector.

bilinear veto アルゴリズム

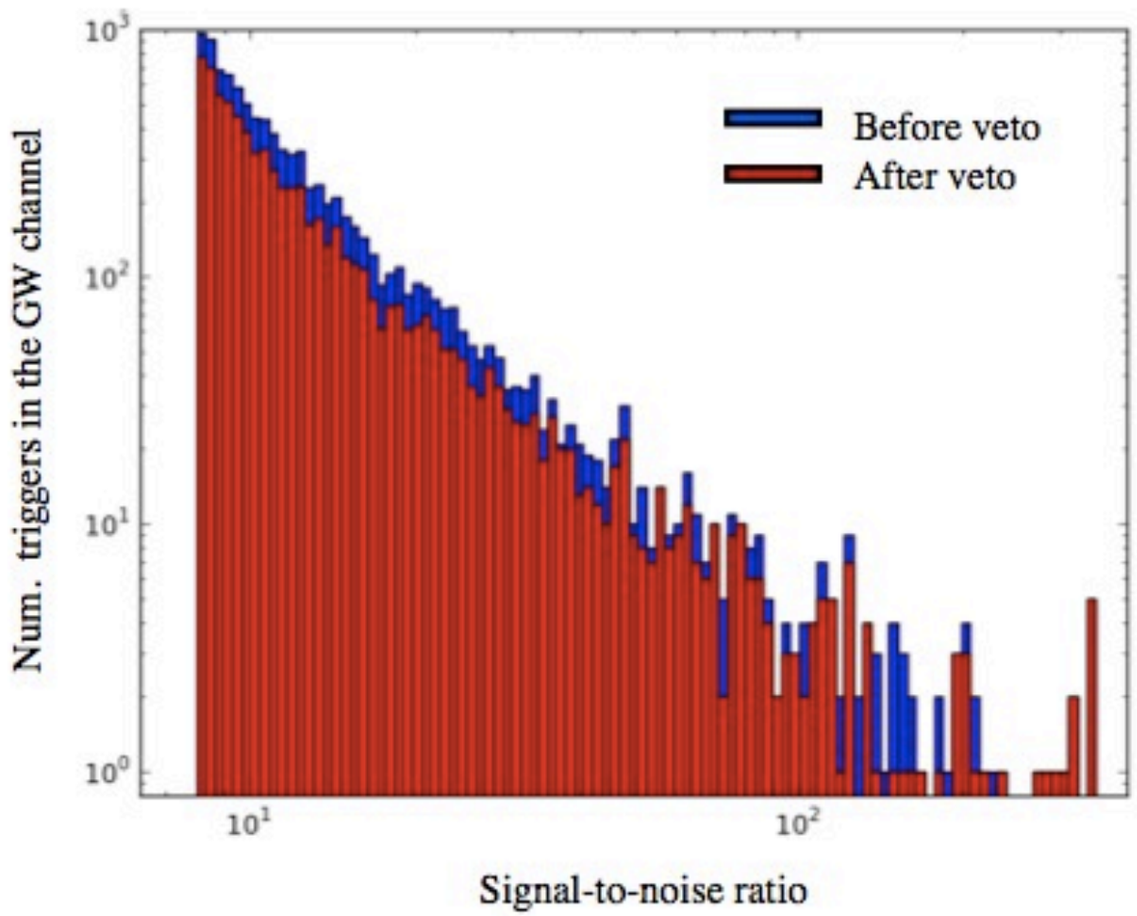


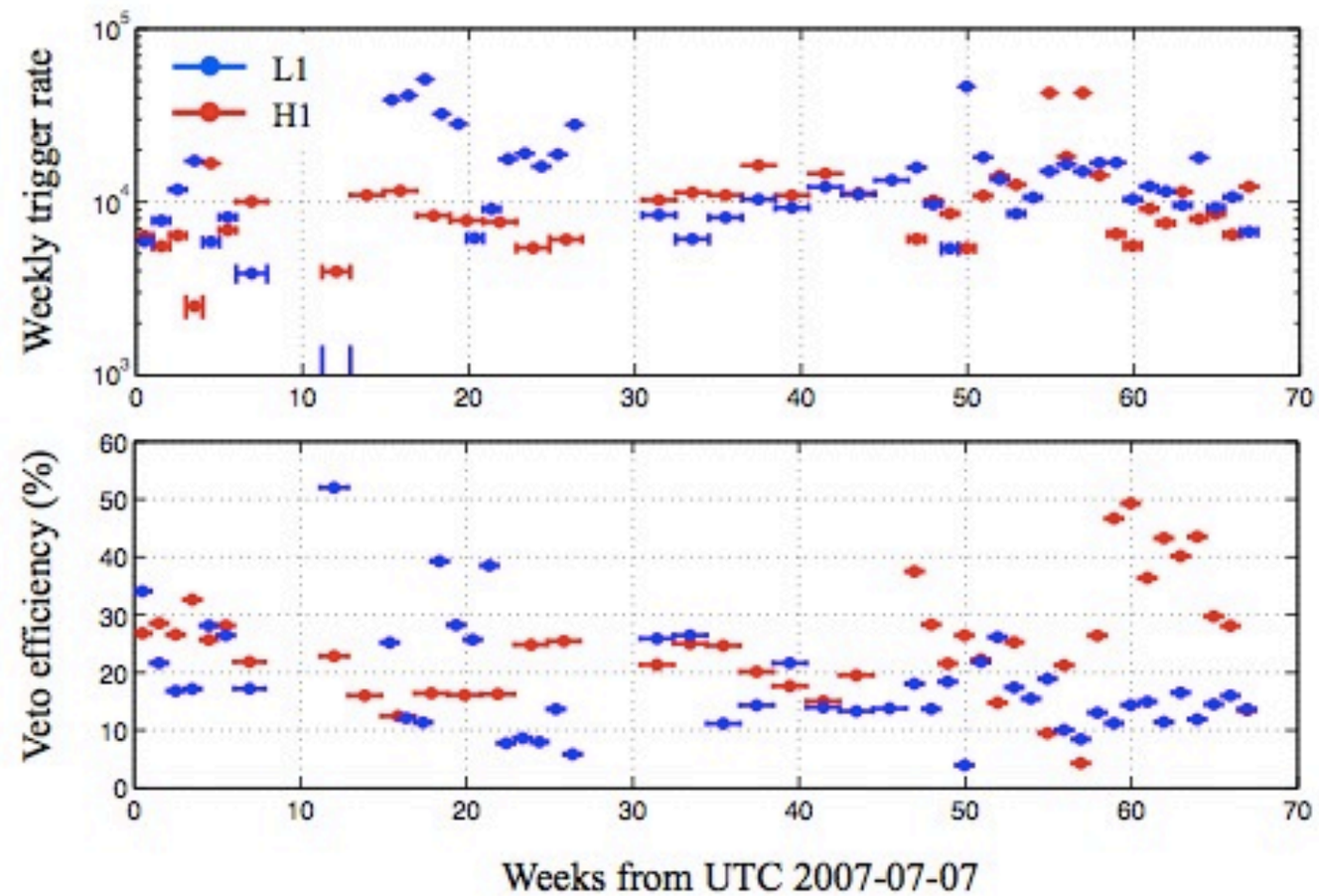
・trigger生成はKleineWelleによる

・時刻をずらすことで、データ同士の相関をなくしbackgroundを評価する

・significanceのしきい値を決定する

1 weekのデータ解析結果





(左) 9712個のtriggerの中, 2446個をノイズとveto

(右) trigger rateとveto efficiency

赤 : LIGO Hanford　青 : LIGO Livingston