

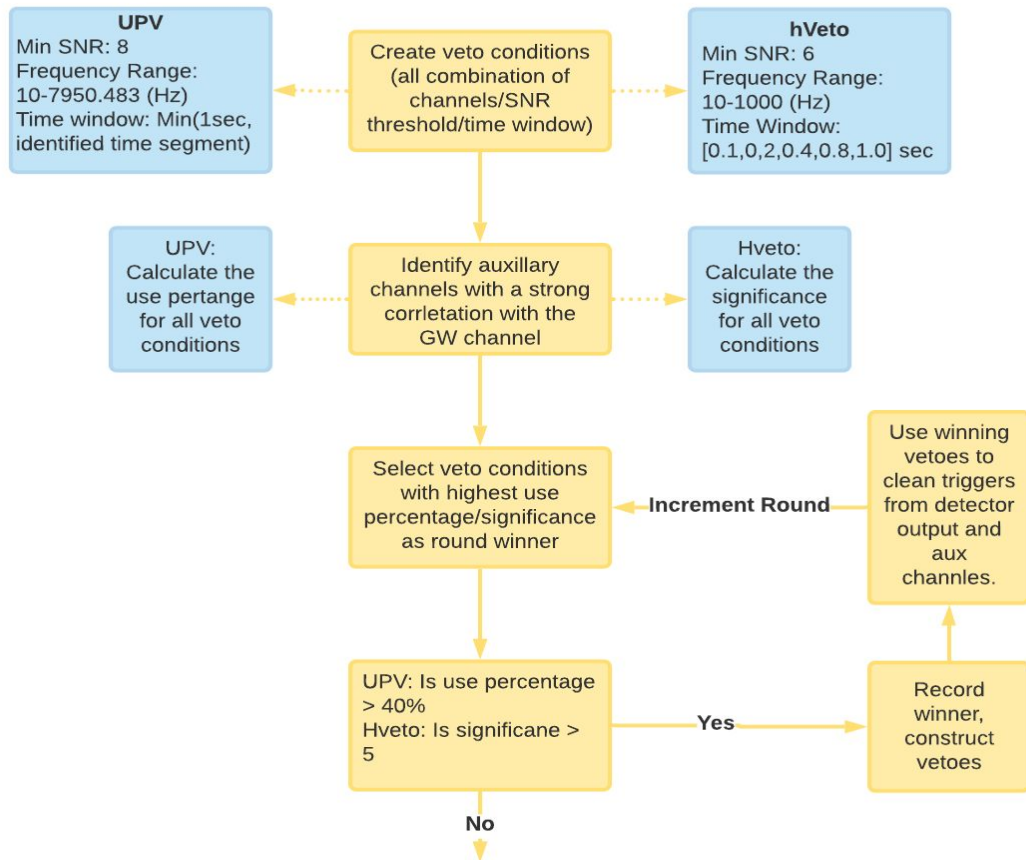
Comparison of Hveto and UPV

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Used Percentage Veto and Hierarchical Veto

- Both algorithms veto triggers in the gravitational wave strain channel by comparing strain channel triggers with triggers in auxiliary channels.
- Virgo collaboration: Used Percentage Veto algorithm (UPV)
- LIGO: Hierarchical Veto algorithm (Hveto)

How each algorithm functions?



Main Differences:

- Configuration values
- Correlation:
 - Used percentage
 - Significance

$$\text{Used Percentage}(\rho) \equiv \frac{100 \times N_{\text{coinc}}^{\text{aux}}(\rho)}{N_{\text{Total}}^{\text{aux}}(\rho)}$$

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

Comparison Runs -- Multiple channels (February 7 - February 14)

	Min SNR	Frequency Range (Hz)	Flag
Hveto	7	10-2000	DMT-ANALYSIS_R EADY:1
UPV	7	10-2000	DMT-ANALYSIS_R EADY:1

Step 1 : ran both algorithms with the same parameters over a full channel list on the length of a day

Step 2: for each algorithm, select all round winners on each day of the chosen week

Step 3: ran both algorithms with the same parameters over their own winner channels on the length of a week.

Channels: round winners for each day (February 7 - February 14)

UPV

H1:LSC-REFL_A_LF_OUT_DQ

H1:ASC-Y_TR_A_NSUM_OUT_DQ

H1:ASC-Y_TR_B_NSUM_OUT_DQ

H1:ASC-X_TR_B_NSUM_OUT_DQ

H1:LSC-POP_A_LF_OUT_DQ

Hveto

H1:LSC-POP_A_LF_OUT_DQ

H1:OMC-LSC_I_OUT_DQ

H1:PEM-EX_ADC_0_19_OUT_DQ

H1:LSC-MICH_IN1_DQ

H1:ASC-DHARD_P_OUT_DQ

H1:LSC-PRCL_OUT_DQ

H1:LSC-POP_A_RF45_Q_ERR_DQ

H1:LSC-PRCL_IN1_DQ

H1:ISI-HAM6_BLND_GS13Y_IN1_DQ

H1:LSC-REFL_A_LF_OUT_DQ

H1:SQZ-LO_SERVO_CTRL_OUT_DQ

H1:LSC-REFL_A_RF9_Q_ERR_DQ

H1:PEM-CS_ACC_BSC1_ITMY_X_DQ

H1:SQZ-OMC_TRANS_RF3_I_NORM_DQ

H1:LSC-REFL_A_RF45_I_ERR_DQ

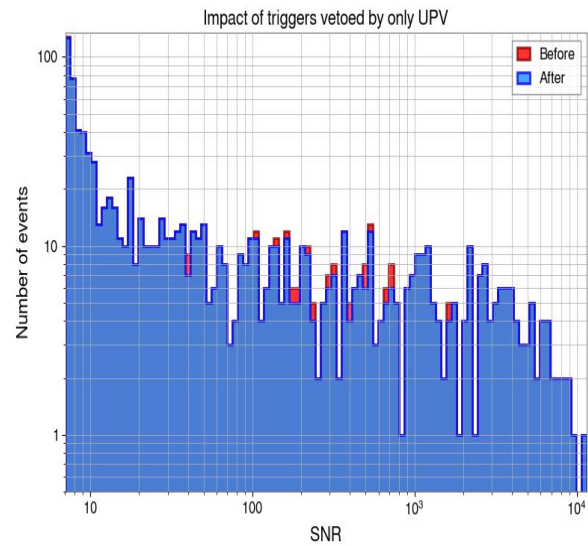
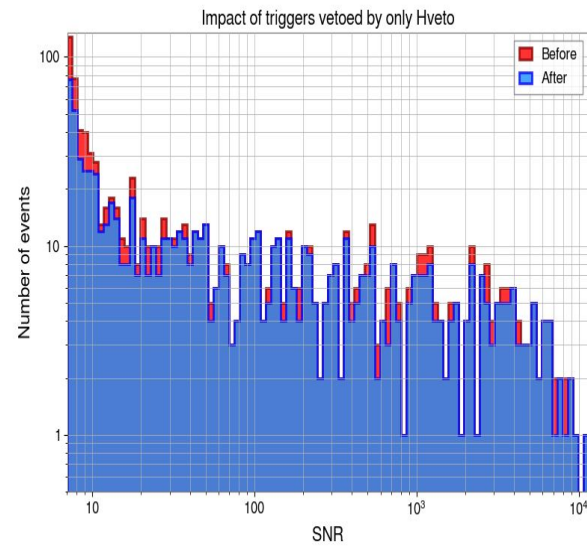
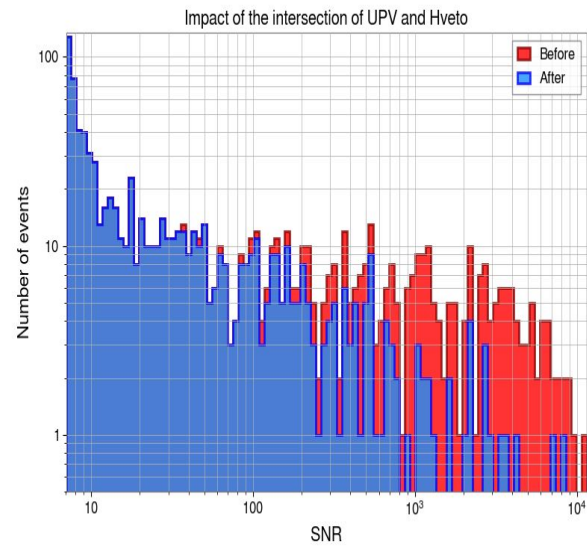
H1:PEM-EX_EFM_BSC9_ETMX_X_OUT_DQ

H1:SQZ-LO_SERVO_ERR_OUT_DQ

Questions we tried to answer

- Why did Hveto have more rounds and thus use more channels than UPV?
- In the case of multiple-channels runs, why were some triggers vetoed by UPV but not Hveto?
- In the case of multiple-channels runs, why were some triggers vetoed by Hveto but not UPV?

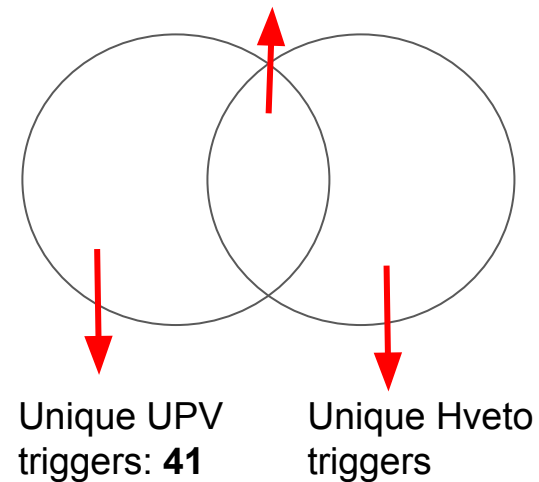
Results: Week-long runs (Multiple Channels)



Very roughly, Hveto behaves better in vetoing triggers than UPV does.

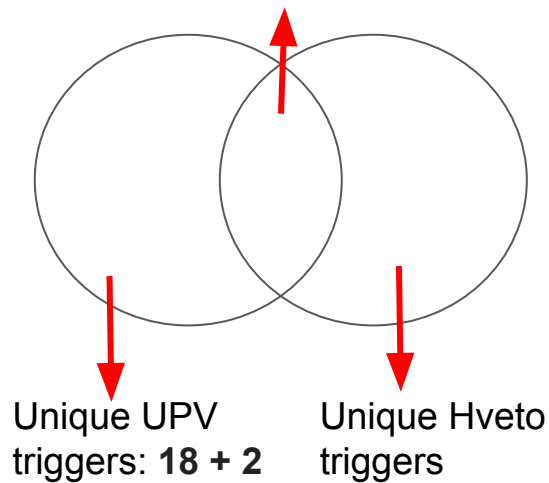
Analysis (1): Unique UPV Triggers

Shared triggers



First round

Shared triggers



First round + Other rounds

Hveto (multiple channels) did not catch these 23 triggers in its first round, but it successfully found them in its following rounds.

Vetoed triggers from the Strain channel (23 triggers)

Peak Time	Frequency	SNR	round
[[1265097766.71289, 93.0793228149414, 6393.85498046875], 2]			
[[1265102022.221191, 269.2848205566406, 3064.9091796875], 2]			
[[1265102145.615234, 75.26299285888672, 2801.871337890625], 2]			
[[1265247339.480468, 39.78929901123047, 1303.6982421875], 2]			
[[1265278420.293457, 217.740966796875, 3787.065185546875], 2]			
[[1265350357.919433, 217.740966796875, 1485.3023681640625], 2]			
[[1265357467.779785, 217.740966796875, 304.8404846191406], 2]			
[[1265389488.51416, 217.740966796875, 1088.881591796875], 2]			
[[1265415439.081543, 269.2848205566406, 9360.162109375], 2]			
[[1265551412.543945, 115.11315155029297, 5195.751953125], 2]			
[[1265552104.948242, 115.11315155029297, 1021.59521484375], 2]			
[[1265656323.43164, 93.0793228149414, 707.48583984375], 2]			
[[1265688644.333984, 49.20825958251953, 4169.978515625], 2]			
[[1265693178.643554, 115.11315155029297, 5409.70458984375], 2]			
[[1265735778.885742, 142.36285400390625, 7600.84326171875], 2]			
[[1265211592.65625, 10.608750343322754, 219.6233367919922], 4]			
[[1265208083.80664, 49.20825958251953, 1072.17822265625], 6]			
[[1265425951.513672, 75.26299285888672, 1361.9827880859375], 6]			
[[1265556090.802734, 75.26299285888672, 5376.09228515625], 6]			
[[1265638754.504394, 217.740966796875, 161.82504272460938], 7]			
[[1265742400.998047, 93.0793228149414, 905.9186401367188], 8]			
[[1265545893.108398, 115.11315155029297, 1166.84912109375], 10]			
[[1265582544.693359, 93.0793228149414, 3466.598388671875], 10]			



Second winner channel

2	H1:OMC-LSC_I_OUT_DQ	0.10	7.75	121.23	52.00	4.64	0.00	22.08	0.01
					[39/75]	[39/840]	[7.29/525168.10]	[227/1028]	[55.19/525216.00]

- Time window = 0.1s
- Specific look:
 - $[[1265097766.71289, 93.0793228149414, 6393.85498046875], 2]$

The veto segment used by the round 1 winner channel is

1265097766.996875 1265097767.096875 (0.1s)

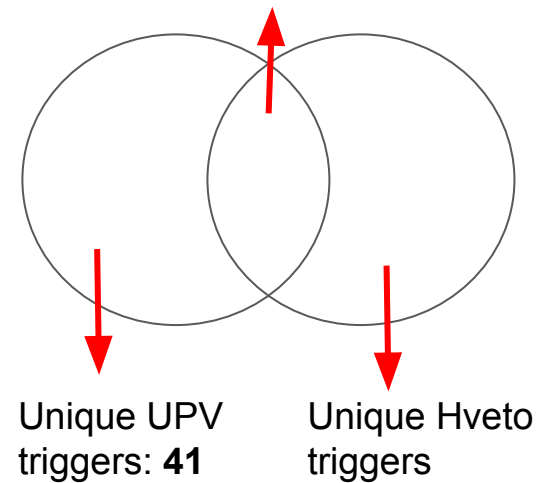
The veto segment used by the round 2 winner channel is

1265097766.656787 1265097766.756787 (0.1s)

Insight: help explain why Hveto has much more rounds in than UPV does

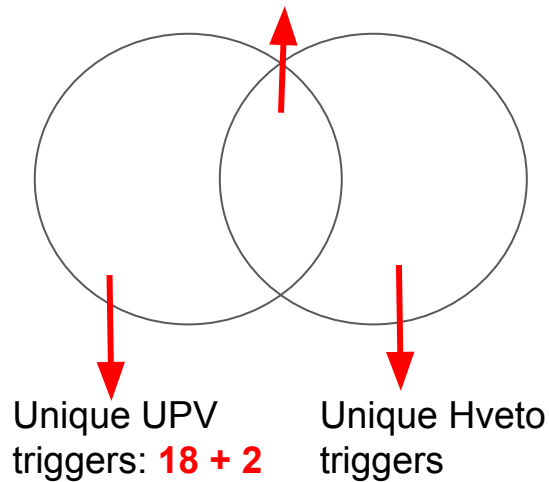
18 triggers uniquely found by UPV

Shared triggers



First round

Shared triggers



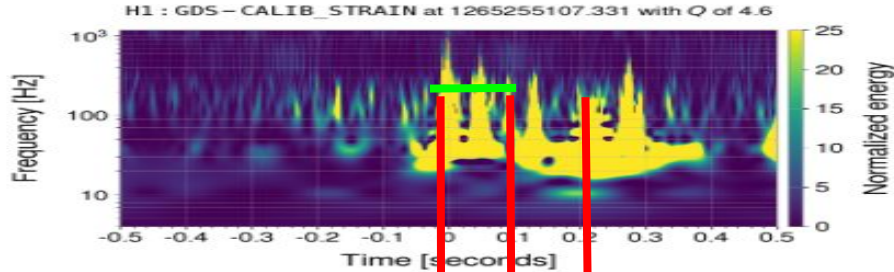
First round + Other rounds

- The choice of the time window

Time Window Comparison

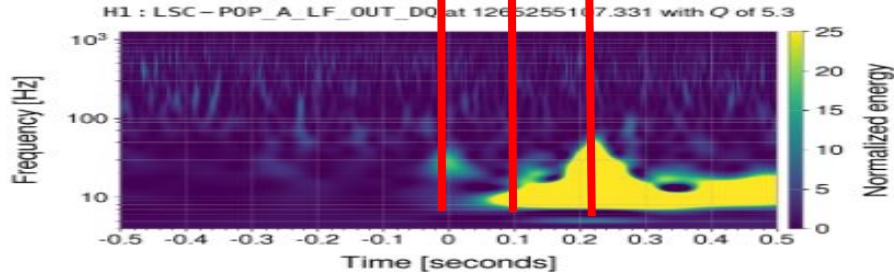
H1 : GDS-CALIB_STRAIN

GPS Time	Frequency	C
1265255107.33	160.0 Hz	4



H1 : LSC-POP_A_LF_OUT_D0

GPS Time	Frequency
1265255107.52	17.8 Hz



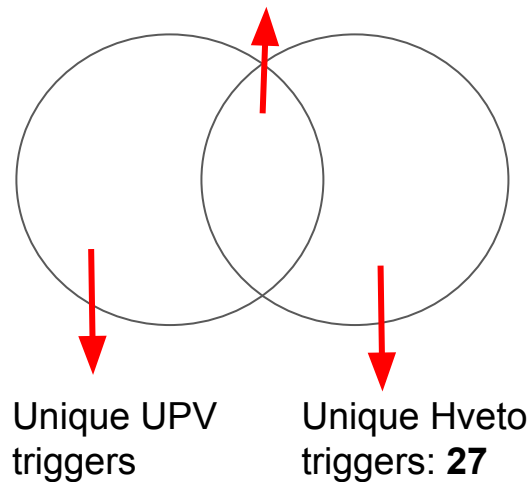
The strain channel scan is centered at a time 0.19s earlier than the time the auxiliary channel is centered at.

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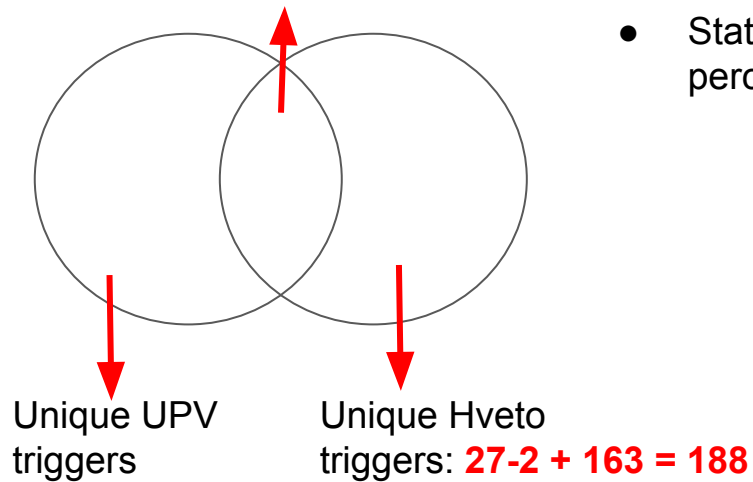
Analysis (2): Unique Hveto Triggers

Shared triggers



First round

Shared triggers

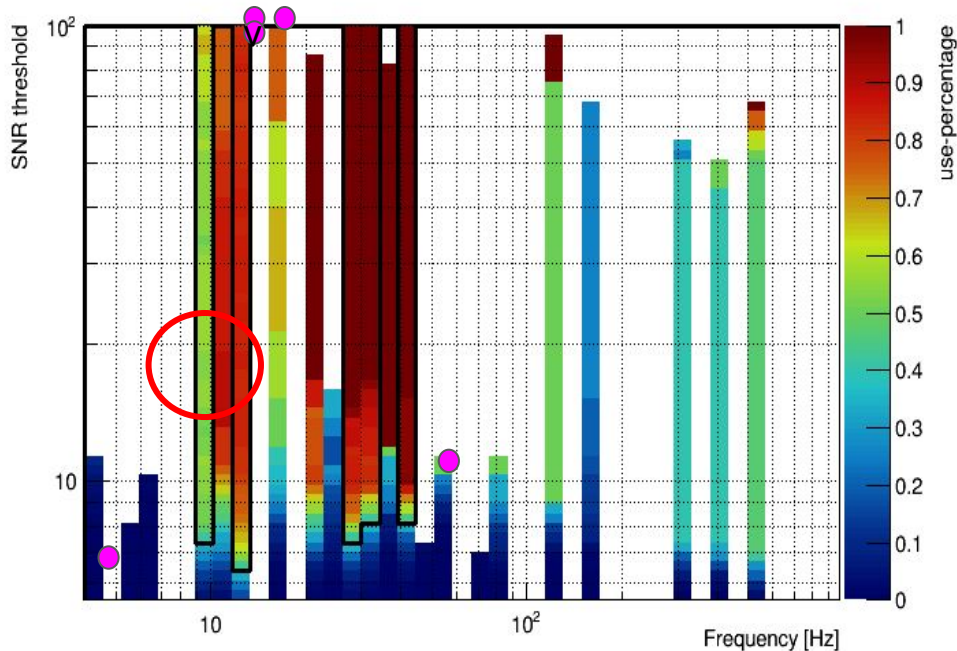


First round + Other rounds

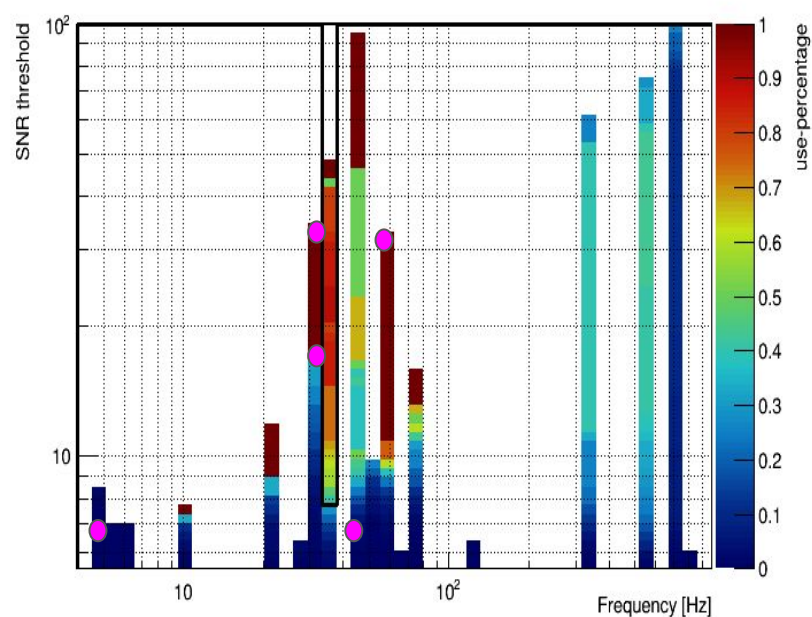
- Statistics related to used percentage

Why UPV missed some triggers which were found by Hveto

H1:LSC-POP_A_LF_OUT_DQ: use-percentage (cumulative)



H1:LSC-REFL_A_LF_OUT_DQ: use-percentage (cumulative)



Observations for running multiple channels

- In general, Hveto vetoes more triggers than UPV does, but Hveto has much a higher dead time than UPV does.
- Hveto has more round winners than UPV does because of its use of time windows.
- Hveto missed triggers vetoed by UPV because of time window issues.
- UPV missed triggers vetoed by Hveto because of statistical reasons (used percentage).

Future

- DQ shifts

Thank you for listening!
Questions?