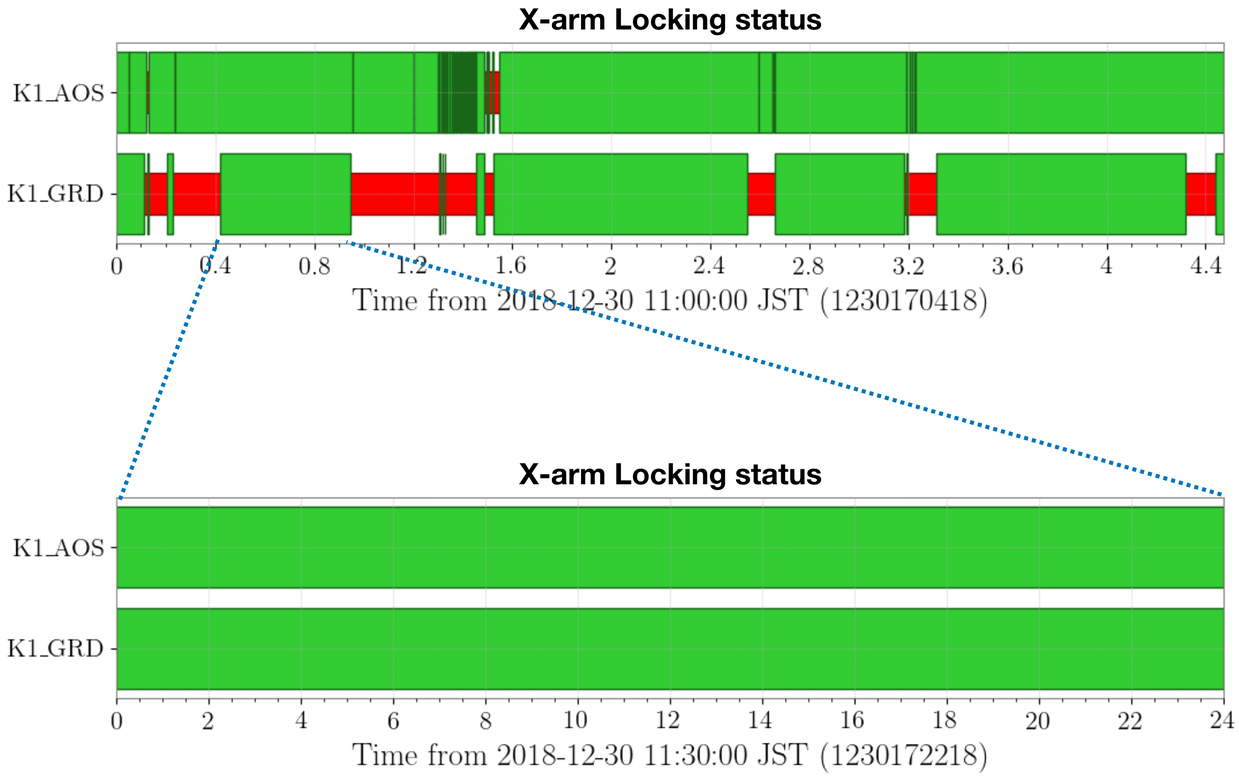
hveto Report
for PCal Injection Data with Locked status

PIL-JONG JUNG, MACHINE LEARNING MEETING, **8 FEBRUARY 2019**

Contents

Data status



Raw data in KISTI :

JST 11:00~16:00 30 Dec 2018 [~ 4.5h]

GPS 1230170418 1230186518

prepared Trigger data :

JST 11:00~12:00 30 Dec 2018 [~1h]

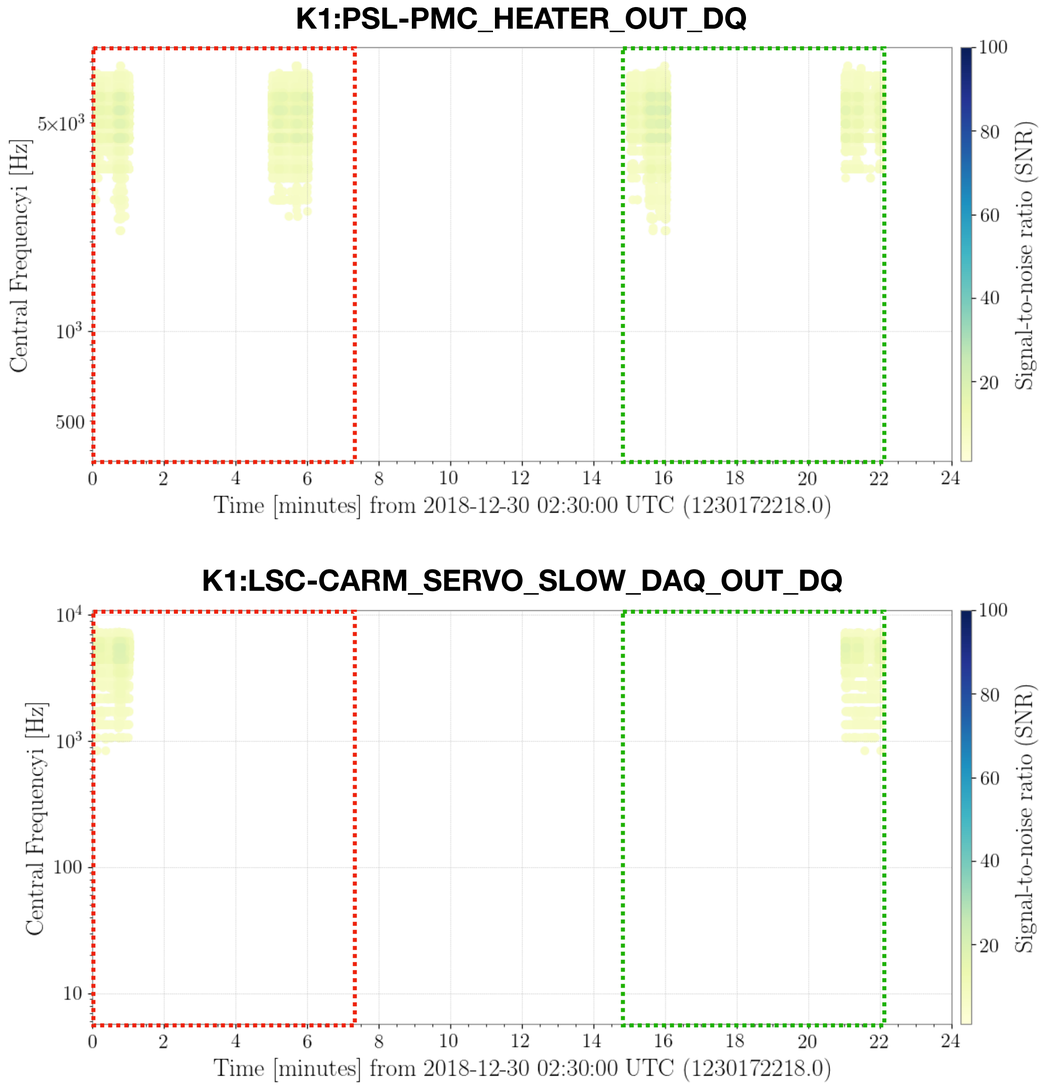
GPS 1230170418 1230174018

Available data :

JST 11:30~11:54 30 Dec 2018 [~ 24m]

GPS 1230172218 1230173658

Selected segments



Unlocked subsystems during X-arm locking :

PSL, LSC, ALS and IMC channels

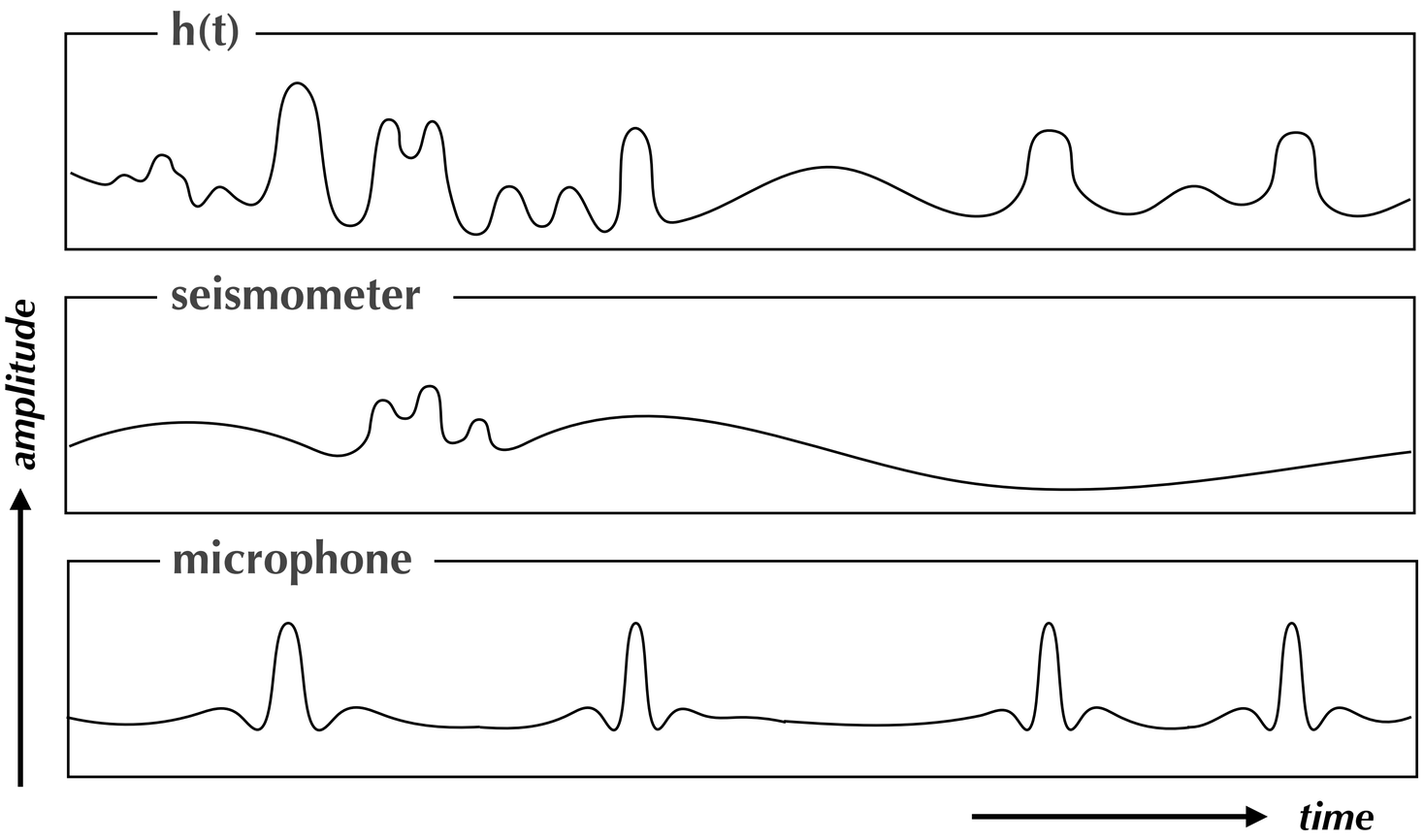
Available segment for hveto :

- segment 1
  GPS 1230172218 1230172608 [~6m 30s]
- segment 2
  GPS 1230173118 1230173508 [~6m 30s]

Available Trigger data :

316 channels except empty trigger data

About hveto



Trigger Find

∨

Calculate Significance

∨

Select veto condition

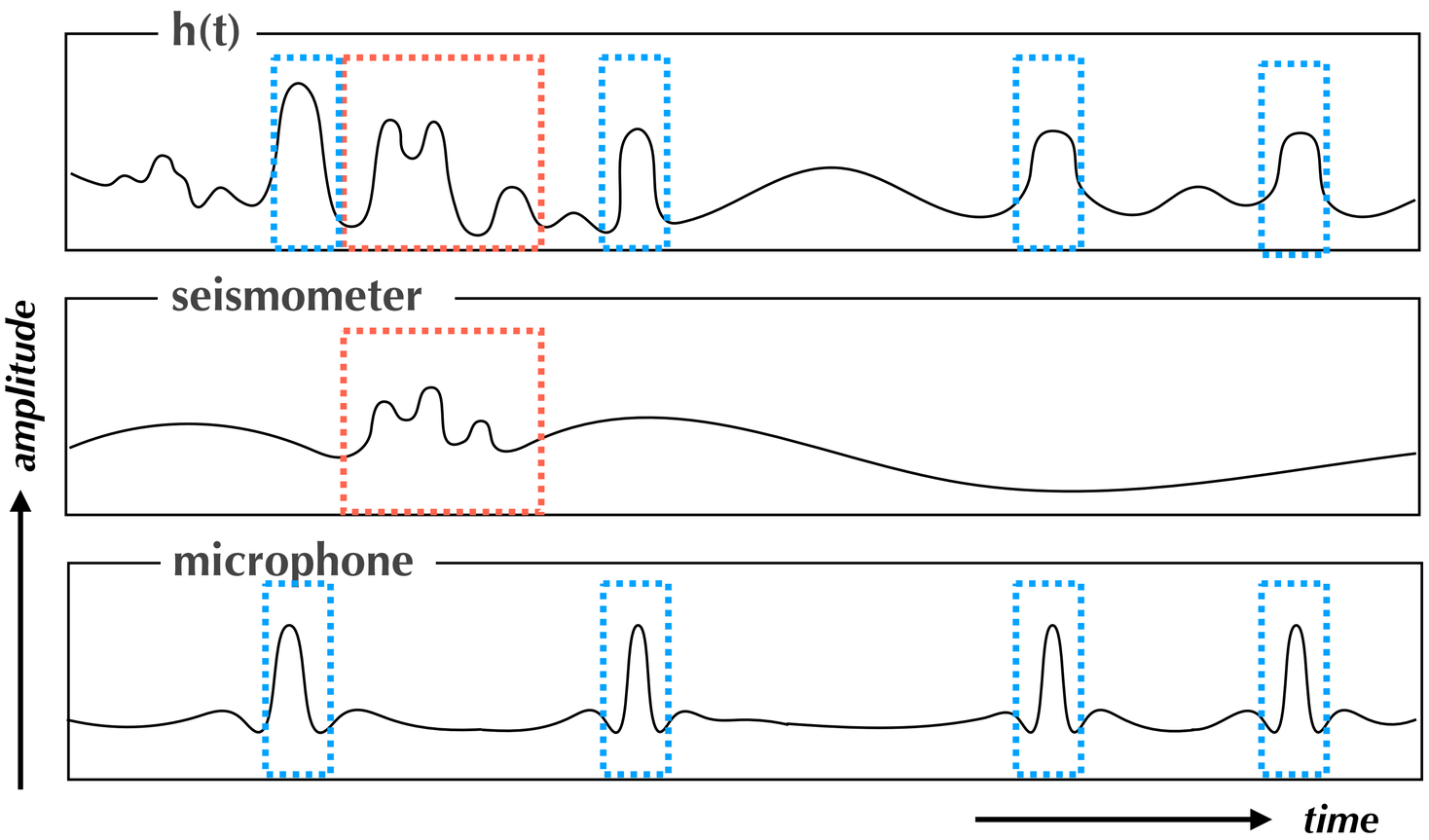
∨

hveto Process

∨

STOP

About hveto



Trigger Find

∨

Calculate Significance

∨

Select veto condition

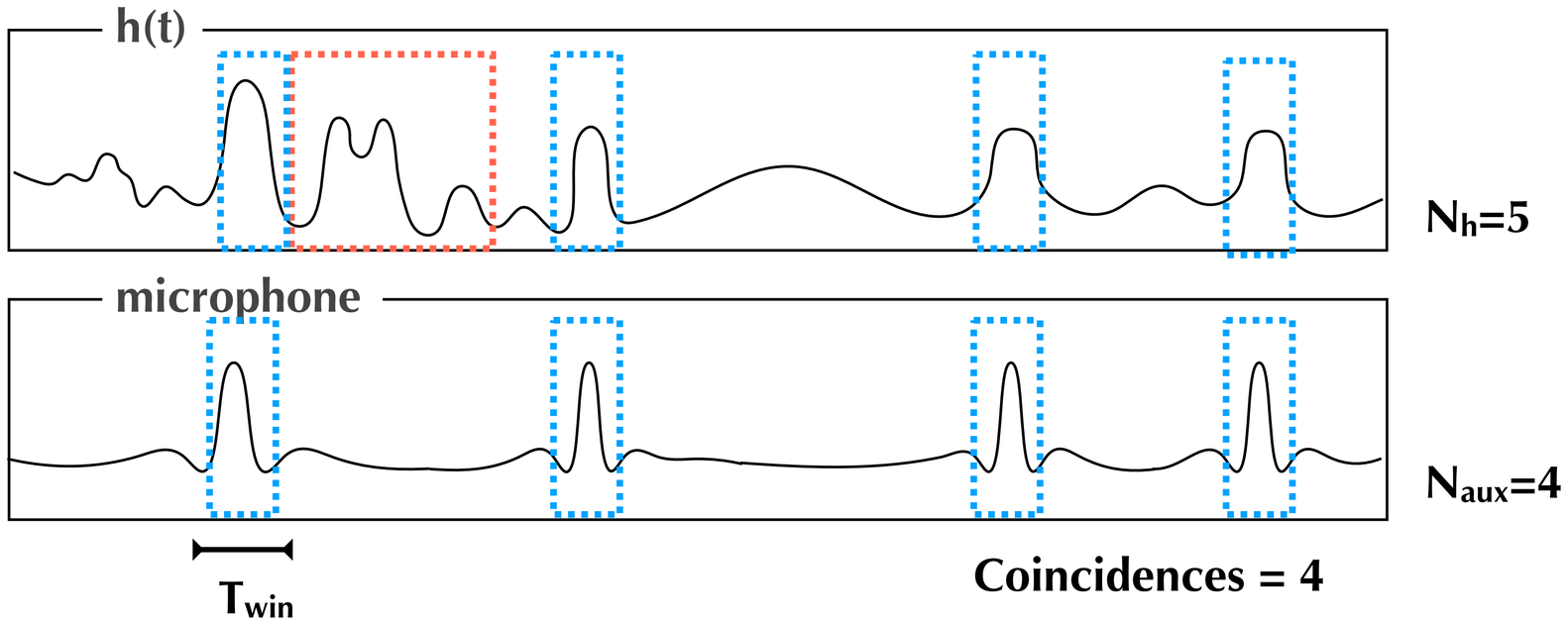
∨

hveto Process

∨

STOP

About hveto



Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

hveto Process

∨

STOP

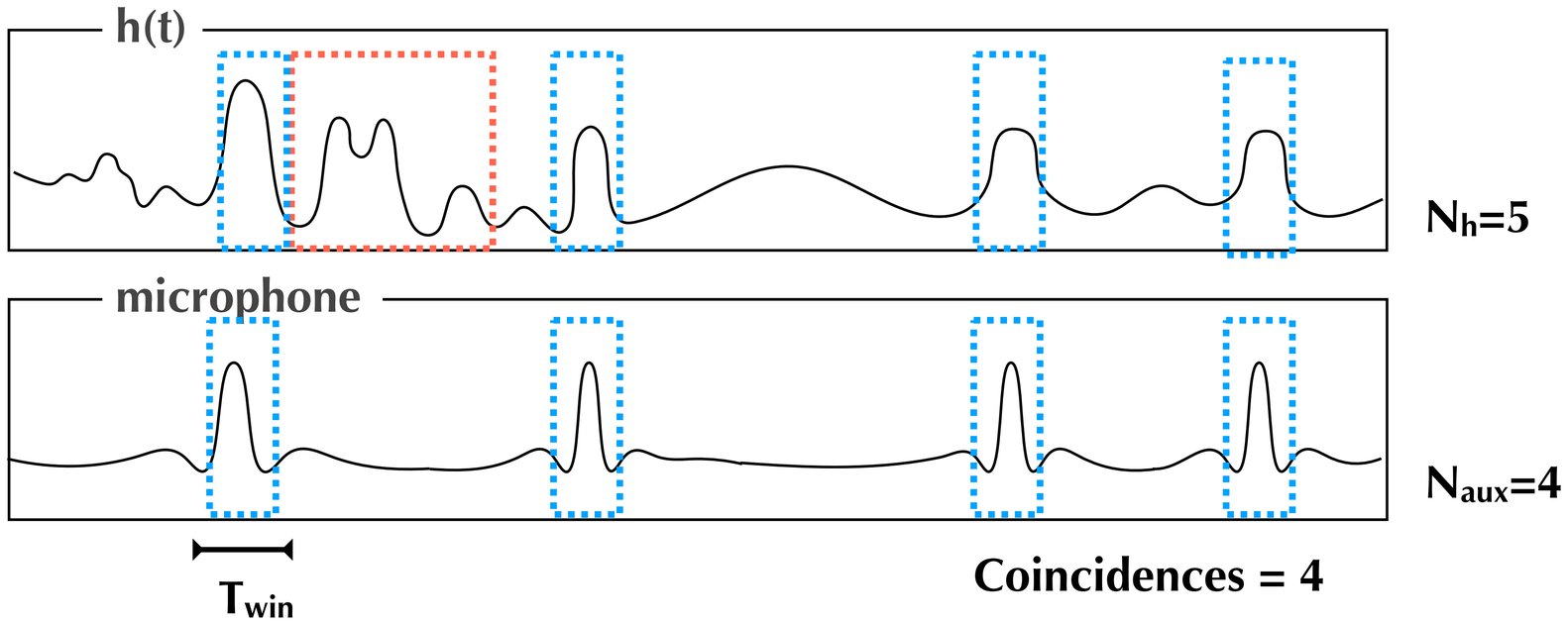
Significance : $S = -\log_{10}(\sum_{k=n}^{\infty} P(\mu,k))$

Poisson probability distribution function : $P(\mu,k) = \frac{\mu^k e^{-\mu}}{k!}$

μ : Expected Number of chance coincidences $\mu = \frac{N_h N_{aux} T_{win}}{T_{tot}}$

n : Number of Coincidences

About hveto



Select veto condition

- Time Range
- Frequency Range
- Time Windows
- SNR Thresholds
- Significance Threshold
- Safe Channel List

Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

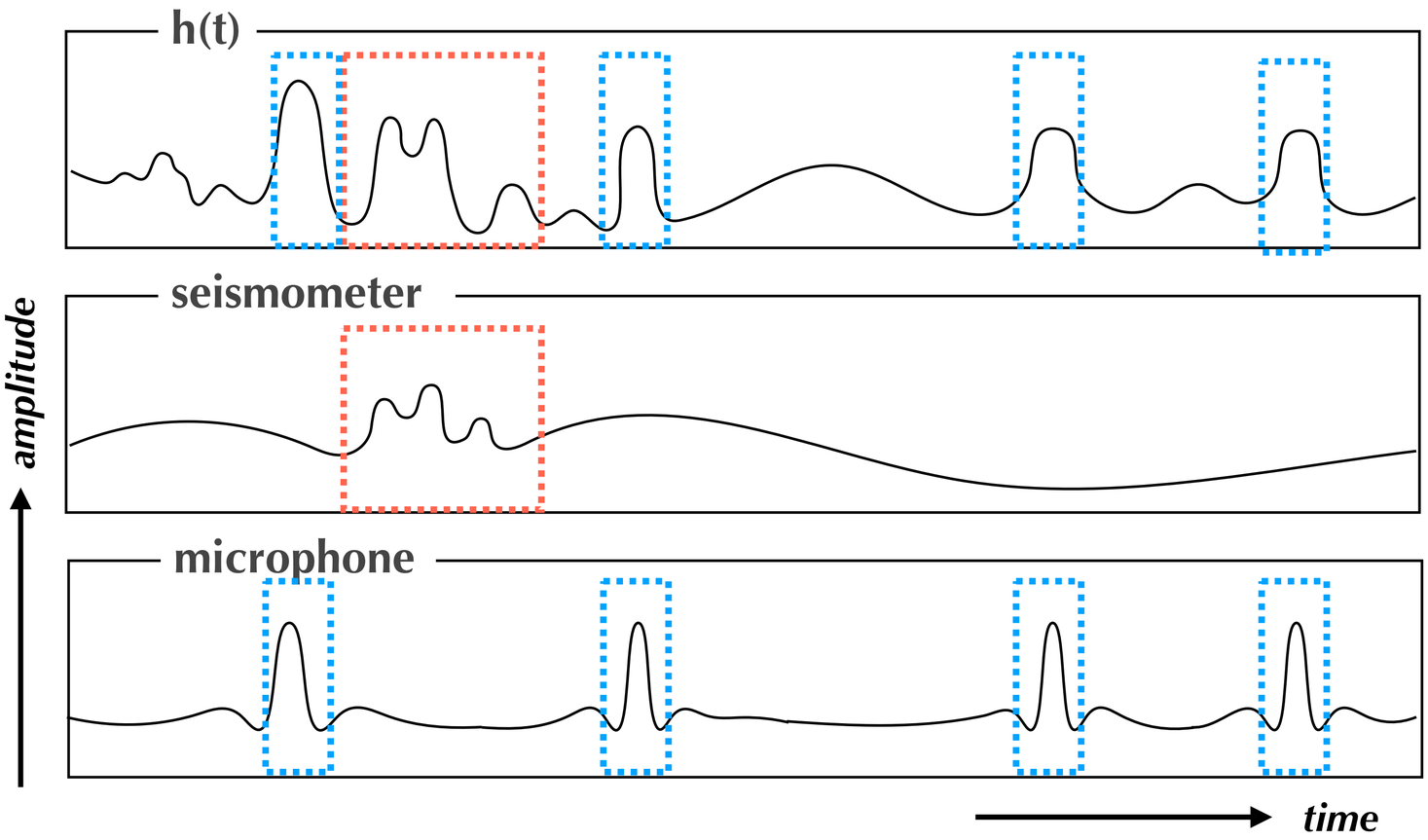
hveto Process

∨

STOP

#2 About h-veto method

About hveto Round 1



Significance of seismometer : $S_{SEIS} = 20$

Significance of microphone : $S_{MIC} = 100$

Trigger Find

∨

Calculate Significance

∨

Select veto condition

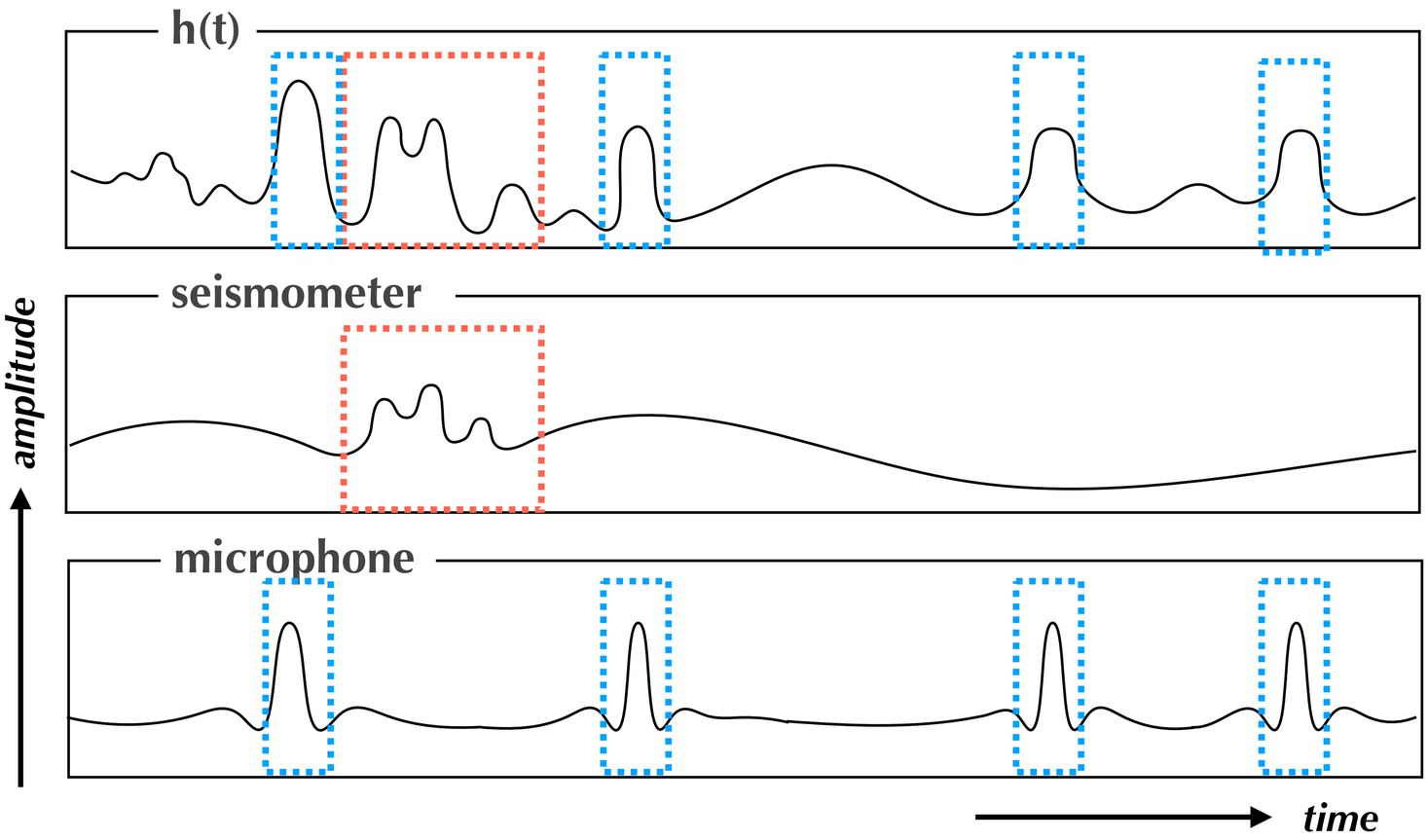
∨

hveto Process R1

∨

STOP

About hveto Round 1



Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

hveto Process R1

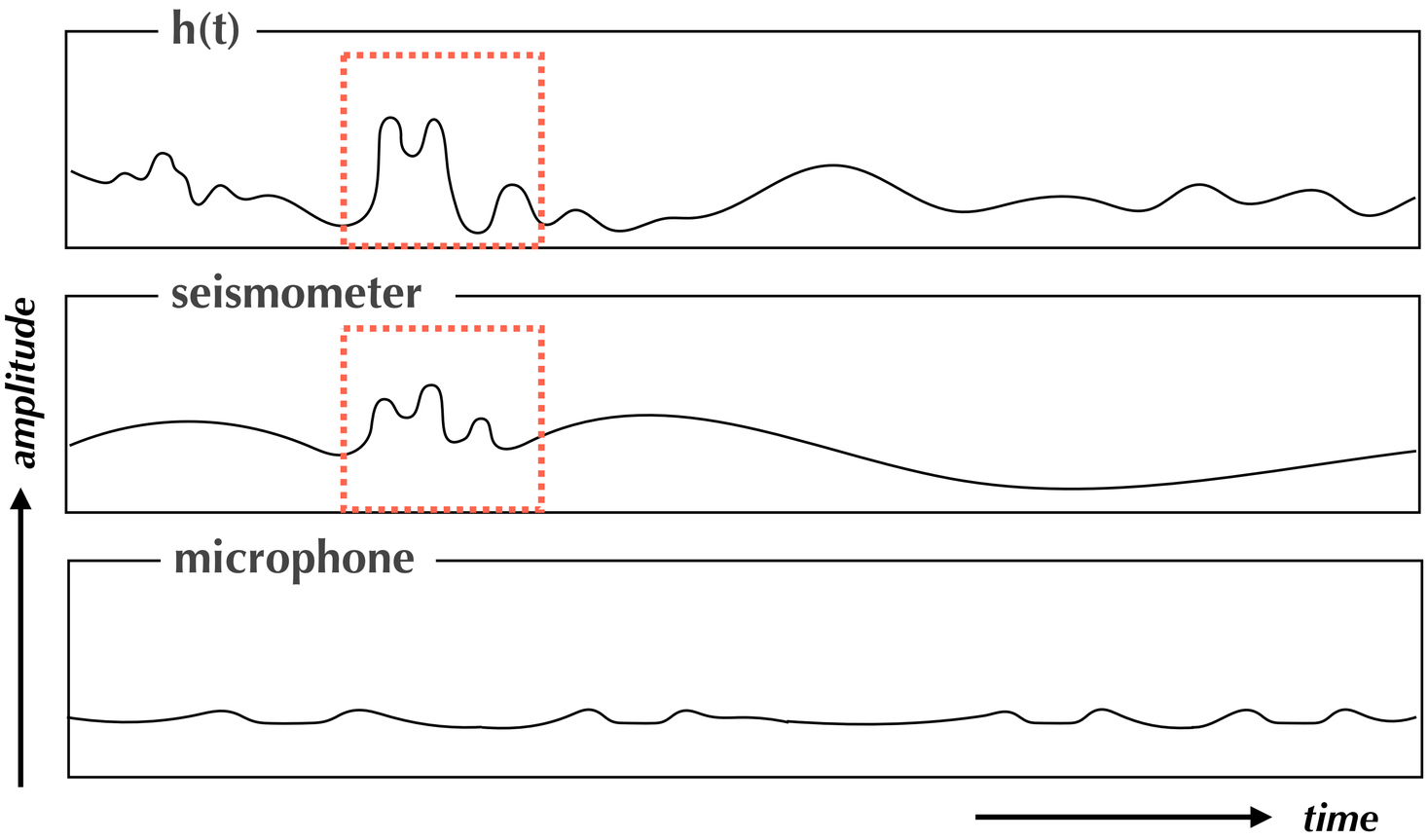
∨

STOP

Significance Threshold : 5

If Significance > Significance Threshold ? $S_{MIC} = 100 > S_{Threshold} = 5$

About hveto Round 2



Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

hveto Process R2

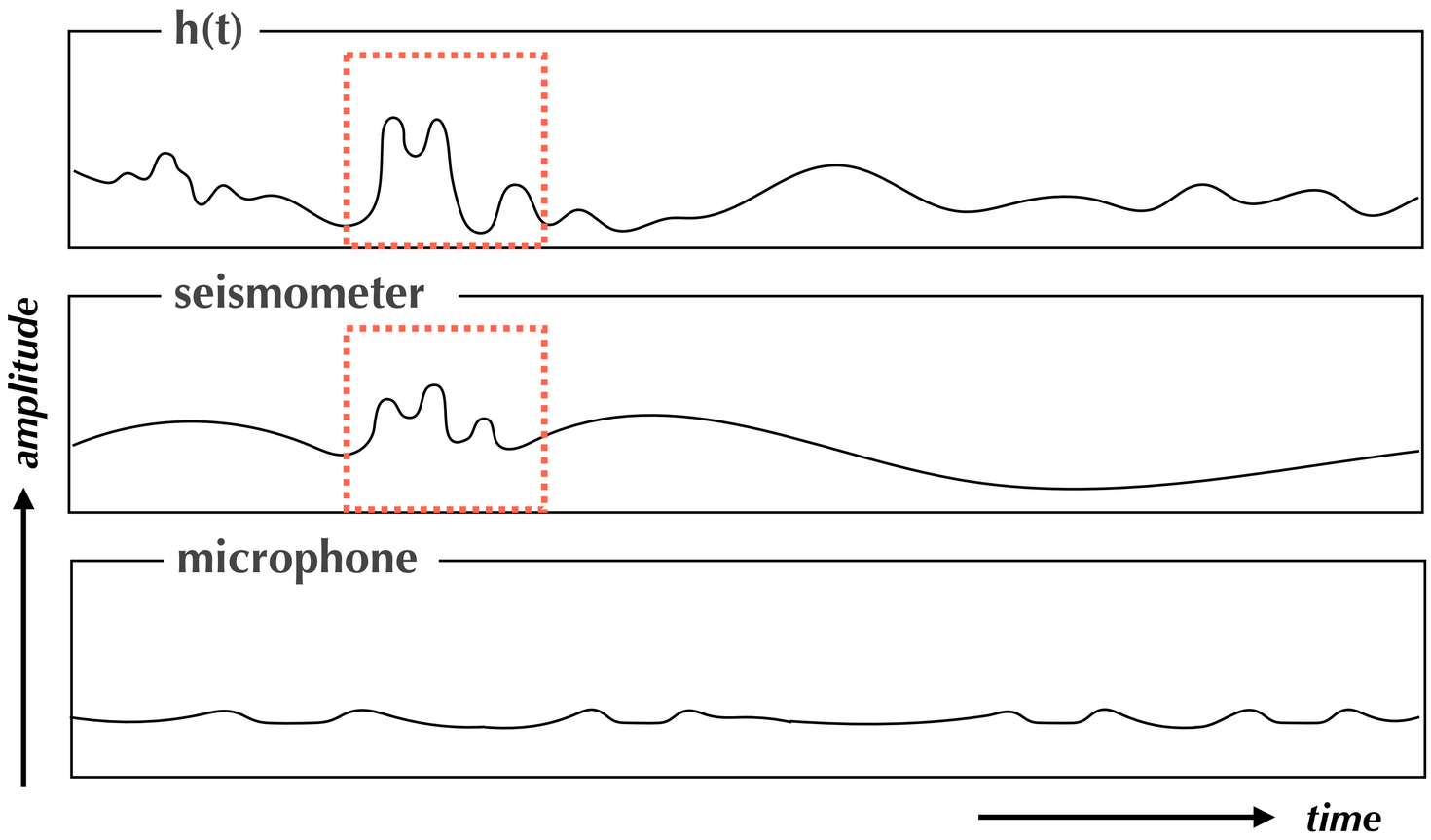
∨

STOP

Significance of seismometer : $S_{SEIS} = 20$

Significance of microphone : $S_{MIC} = 0$

About hveto Round 2



Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

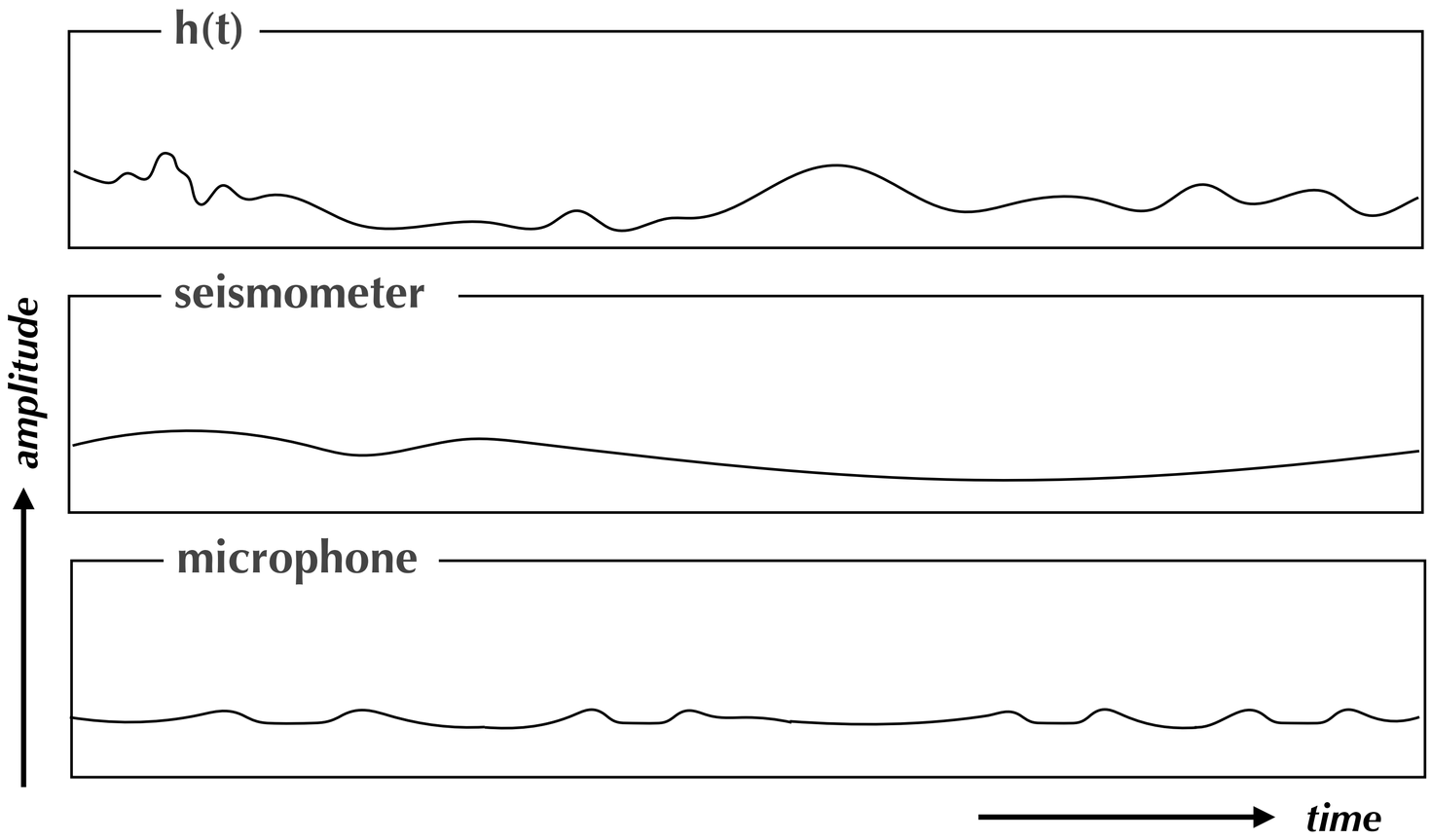
hveto Process R2

∨

STOP

If Significance > Significance Threshold ? $S_{SEIS} = 20 > S_{Threshold} = 5$

About hveto Round 3



Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

hveto Process R3

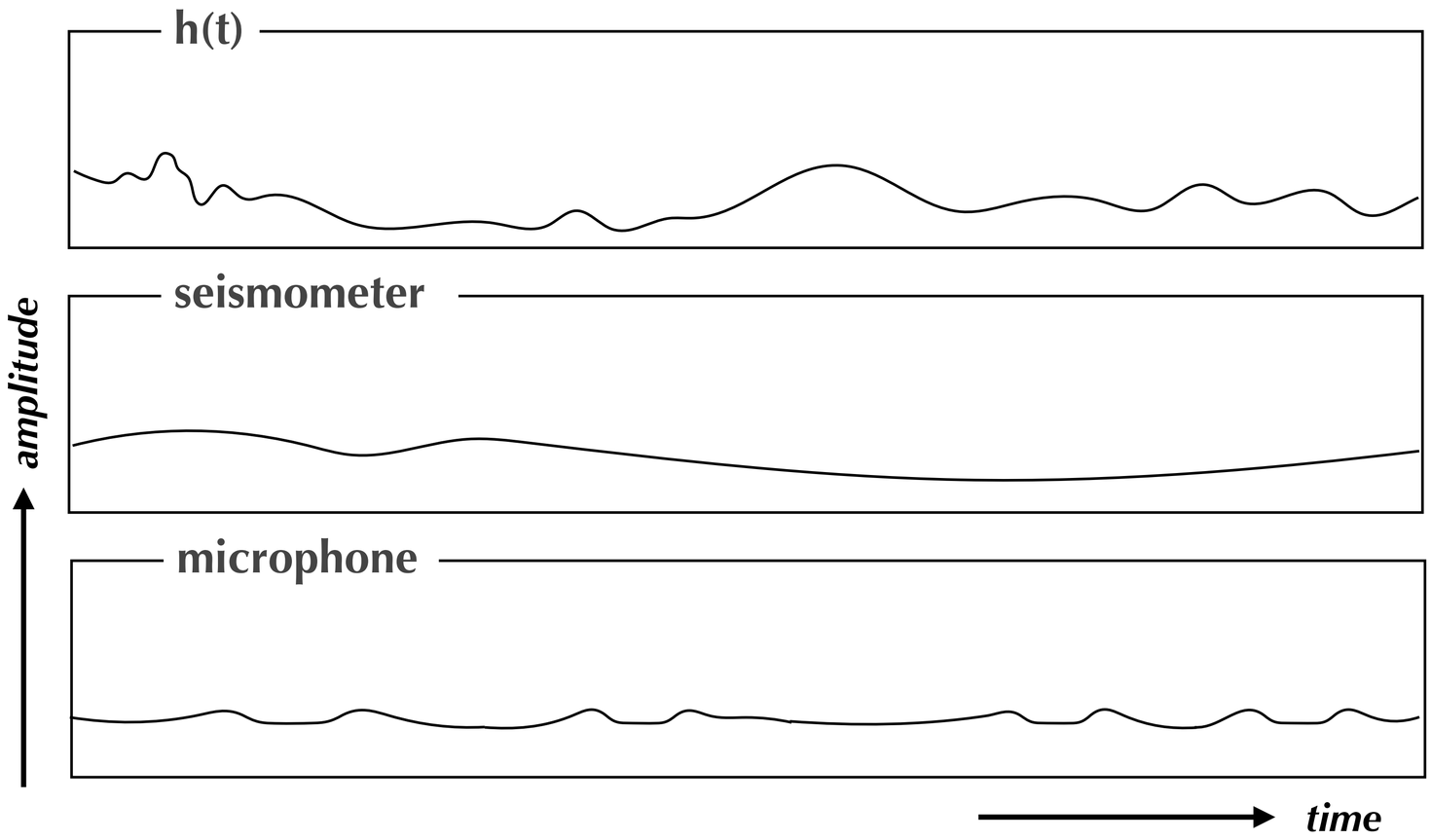
∨

STOP

Significance of seismometer : $S_{SEIS} = 0$

Significance of microphone : $S_{MIC} = 0$

About hveto Round 3



Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

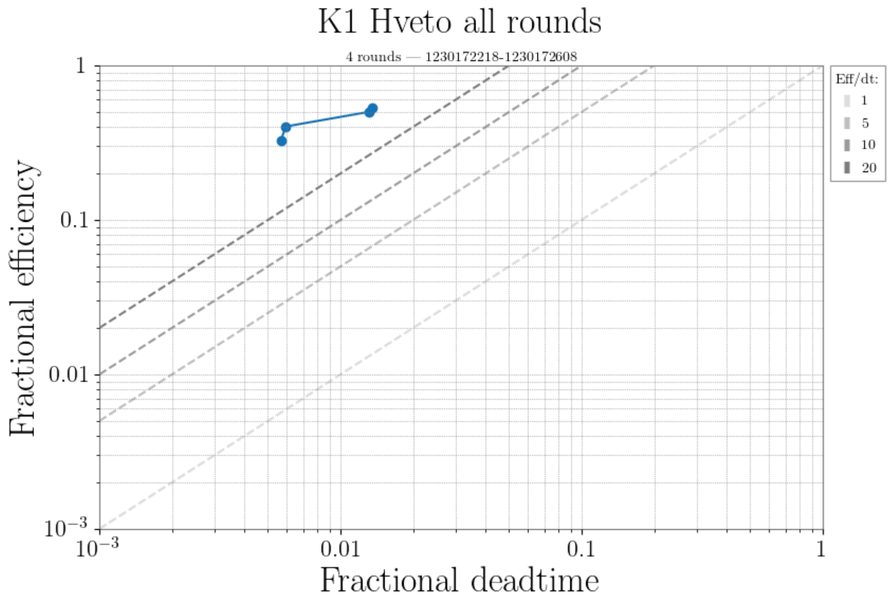
hveto Process R3

∨

STOP

If Significance > Significance Threshold ? $S_{SEIS} = 0 > S_{Threshold} = 5$

About hveto



$$\text{Efficiency} \equiv 100 \times \frac{N^{GW}{}_{vetoed}}{N^{GW}{}_{total}}$$

$$\text{Dead Time} \equiv 100 \times \frac{T_{vetoed}}{T_{total}}$$

If $\frac{Efficiency}{Deadtime} \gg 1$ Veto is useful

If $\frac{Efficiency}{Deadtime} \sim 1$ Same time removed at random

Trigger Find

∨

Calculate Significance

∨

Select veto condition

∨

hveto Process R3

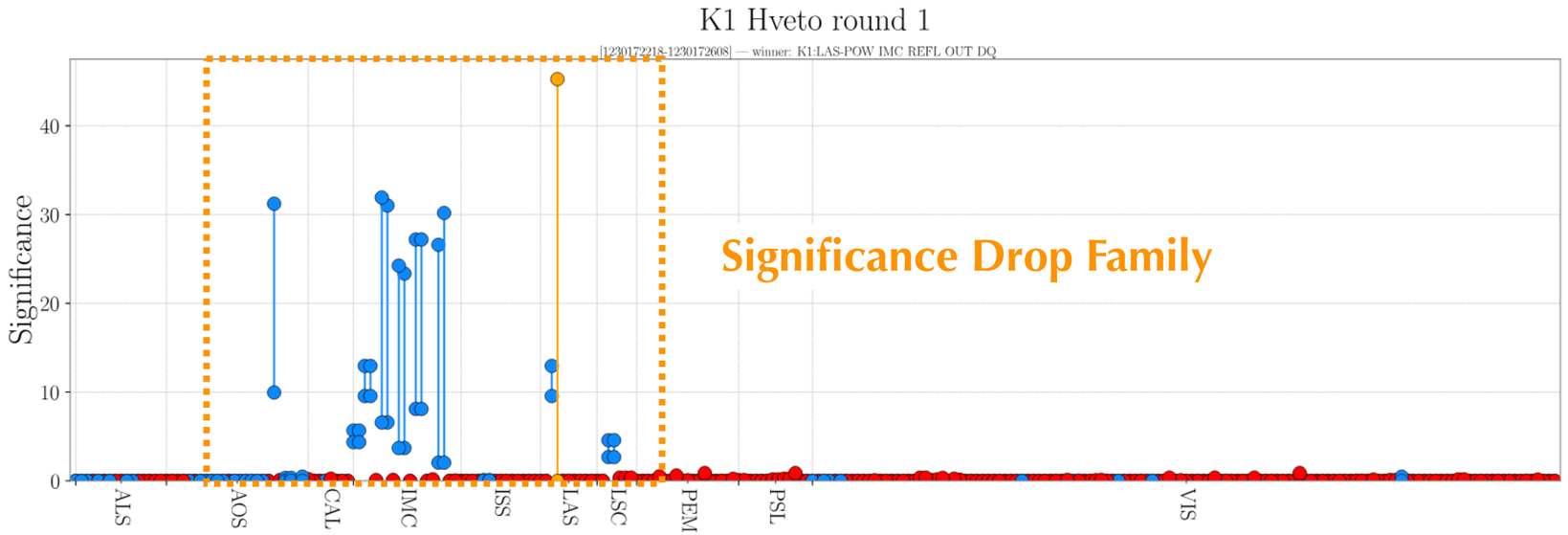
∨

STOP

#2 About h-veto method

About hveto

Significance Drop Plot



- ✓ **Yellow** is round winner Channel
- ✓ **Blue** is channel with the significance decline
- ✓ **Red** is channel with the significance Increase or non-change

Trigger Find

∨

Calculate Significance

∨

Select veto condition

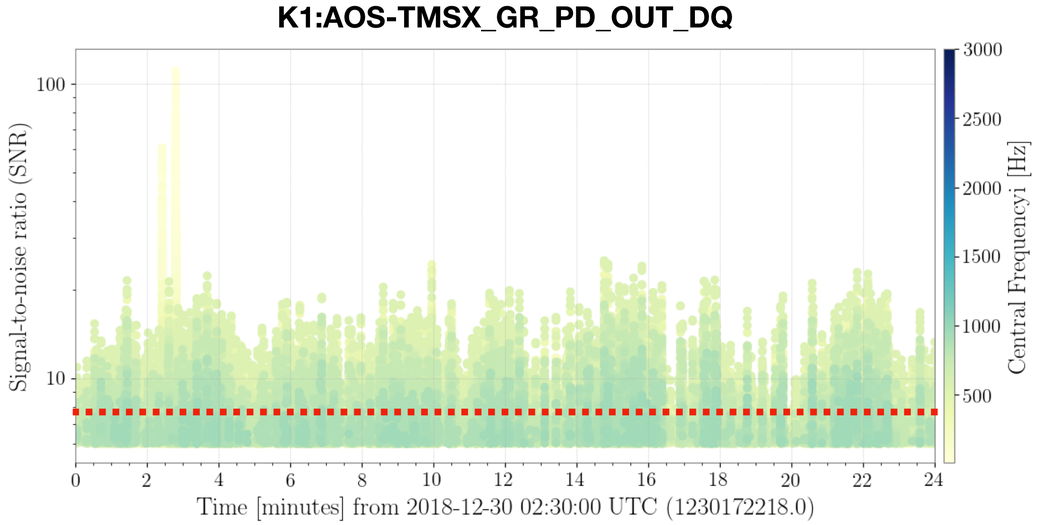
∨

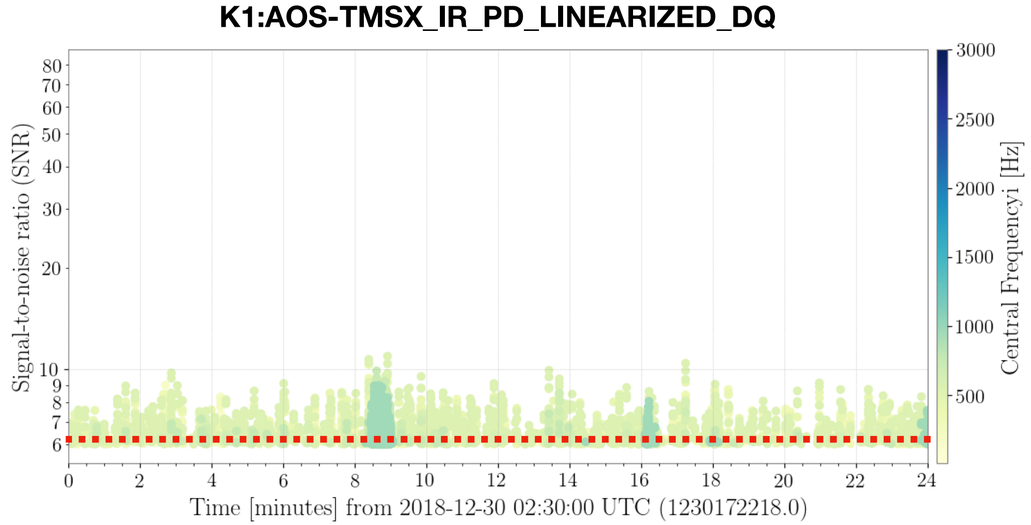
hveto Process R3

∨

STOP

hveto configuration in segment1





 # hveto

snr-thresholds = 7.50, 7.75, 8.00, 8.50, 9.00, 10.00, 11.00, 12.00, 15.00, 20.00, 40.00, 100.00, 300.00

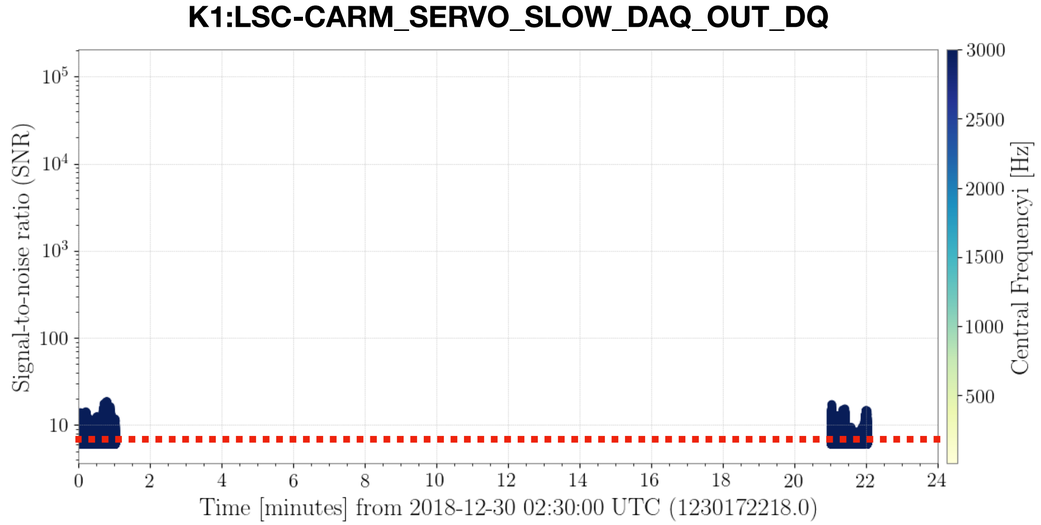
time-windows = 0.10, 0.20, 0.40, 0.80, 1.00, 4.00, 8.00, 10.0

minimum-significance = 5.0

 # primary

channel = K1:LSC-CARM_SERVO_SLOW_DAQ_OUT_DQ
K1:AOS-TMSX_GR_PD_OUT_DQ
K1:AOS-TMSX_IR_PD_OUT_DQ

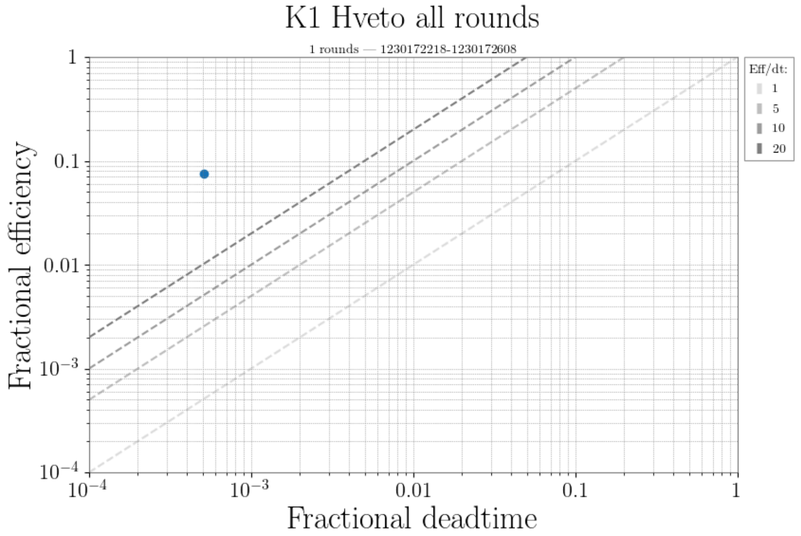
snr-threshold = 6

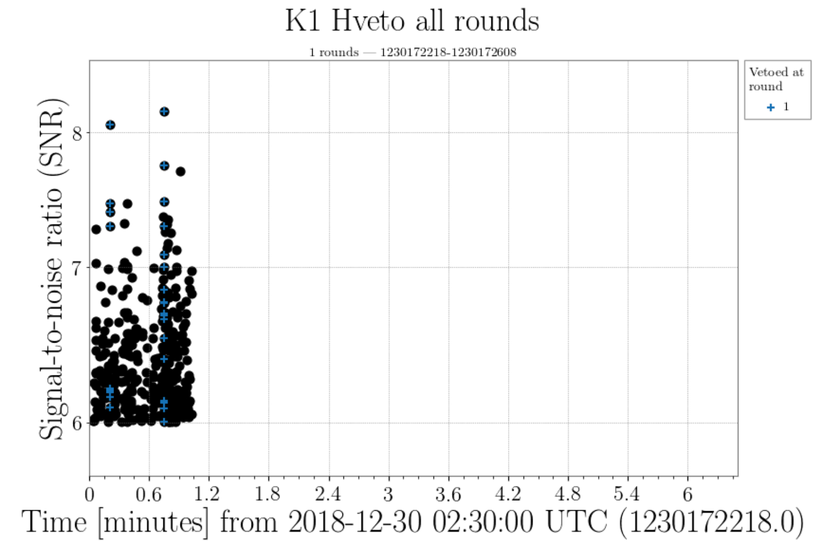


#3 hveto Result

hveto result about K1:LSC-CARM_SERVO_SLOW_DAQ_OUT_DQ in segment1

>> more detail





 # Segment 1 -s 1230172218 -e 1230172608 [~6m 30s]

 # hveto

snr-thresholds = 7.50, 7.75, 8.00, 8.50, 9.00, 10.00, 11.00, 12.00, 15.00, 20.00, 40.00, 100.00, 300.00

time-windows = 0.10, 0.20, 0.40, 0.80, 1.00, 4.00, 8.00, 10.0

minimum-significance = 5.0

 # primary

channel = K1:LSC-CARM_SERVO_SLOW_DAQ_OUT_DQ

snr-threshold = 6

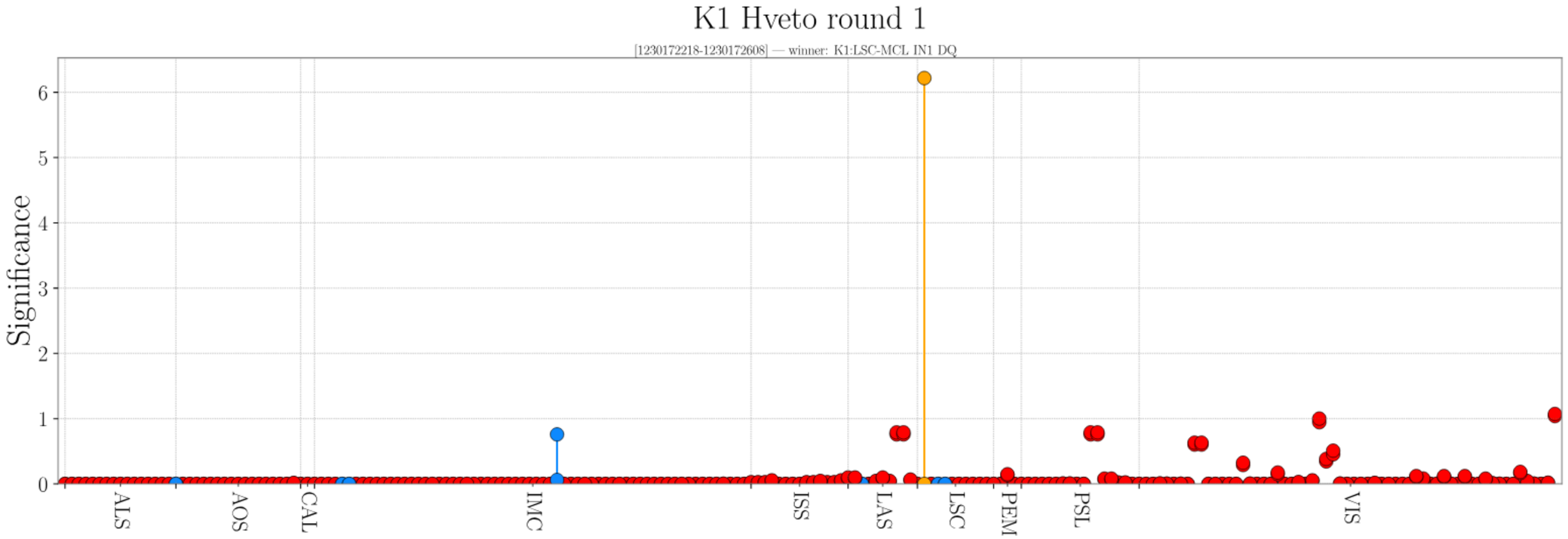
 # safety

unsafe-channels =

#3 hveto Result

hveto result about K1:LSC-CARM_SERVO_SLOW_DAQ_OUT_DQ in segment1

>> more detail

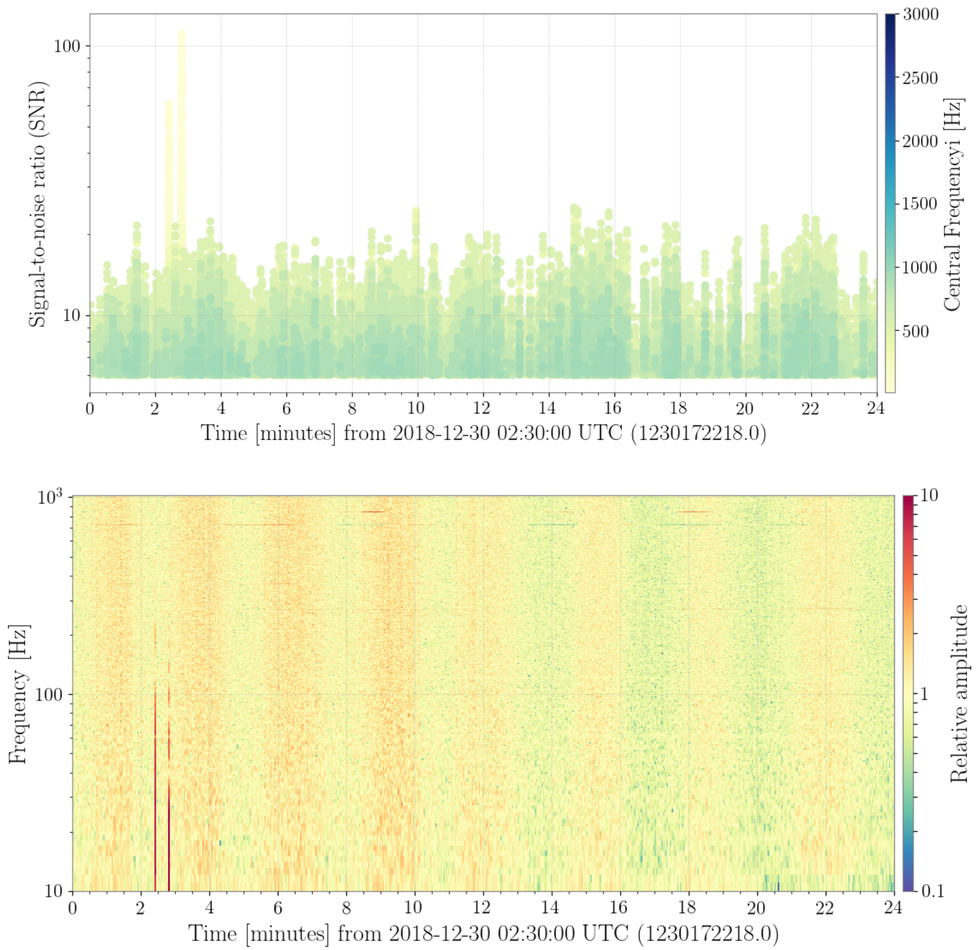


Round 1, Winner = K1:LSC-MCL_IN1_DQ, window = 0.1, SNR thresh = 7.75, significance = 6.22

#3 hveto Result

hveto result about K1:AOS-TMSX_GR_PD_OUT_DQ in segment1

>> more detail



 # Segment 1 -s 1230172218 -e 1230172608 [~6m 30s]

 # hveto

snr-thresholds = 7.50, 7.75, 8.00, 8.50, 9.00, 10.00, 11.00, 12.00, 15.00, 20.00, 40.00, 100.00, 300.00

time-windows = 0.10, 0.20, 0.40, 0.80, 1.00, 4.00, 8.00, 10.0

minimum-significance = 5.0

 # primary

channel = K1:AOS-TMSX_GR_PD_OUT_DQ

snr-threshold = 6

 # safety

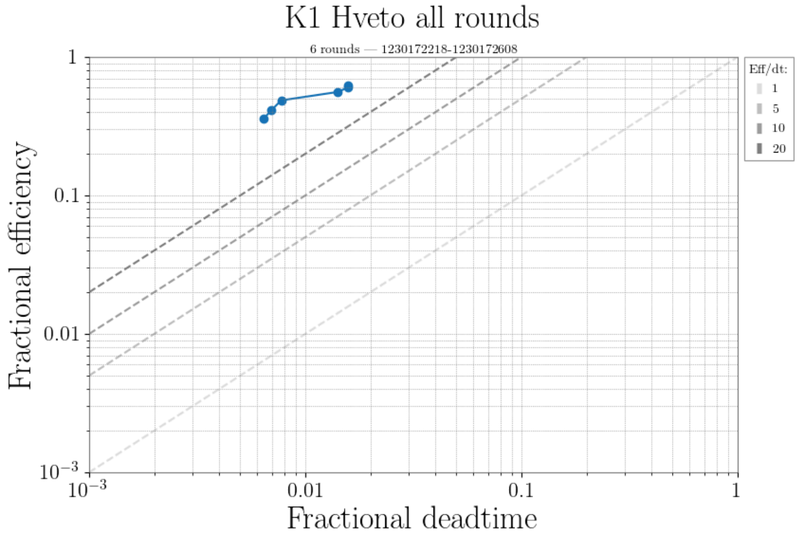
unsafe-channels =

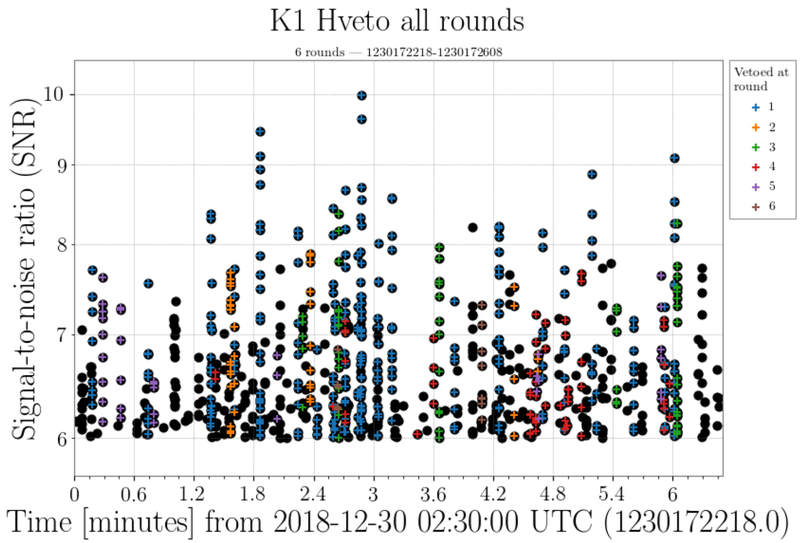
>> Round details

No rounds completed above threshold. Analysis stopped with K1:ALS-YARM_REFL_IN1_DQ achieving significance of 0.01 [Twin: 0.1s, SNR: 8.0]

hveto result about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1

>> more detail





 # Segment 1 -s 1230172218 -e 1230172608 [~6m 30s]

 # hveto

snr-thresholds = 7.50, 7.75, 8.00, 8.50, 9.00, 10.00, 11.00, 12.00, 15.00, 20.00, 40.00, 100.00, 300.00

time-windows = 0.10, 0.20, 0.40, 0.80, 1.00, 4.00, 8.00, 10.0

minimum-significance = 5.0

 # primary

channel = K1:AOS_TMSX_IR_PD_OUT_DQ

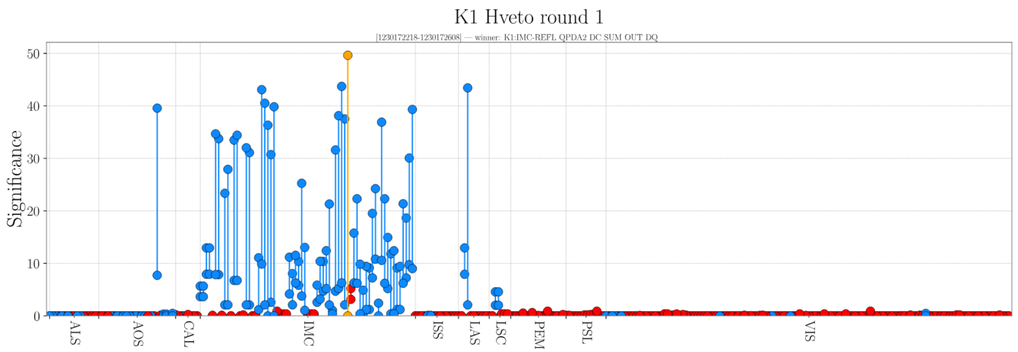
snr-threshold = 6

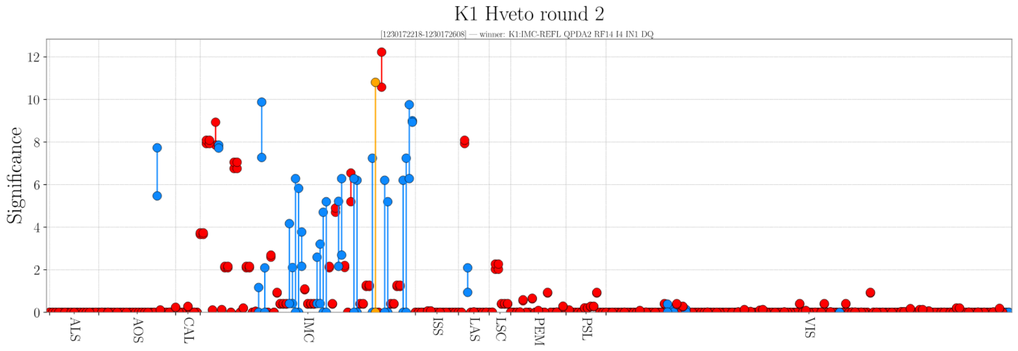
 # safety

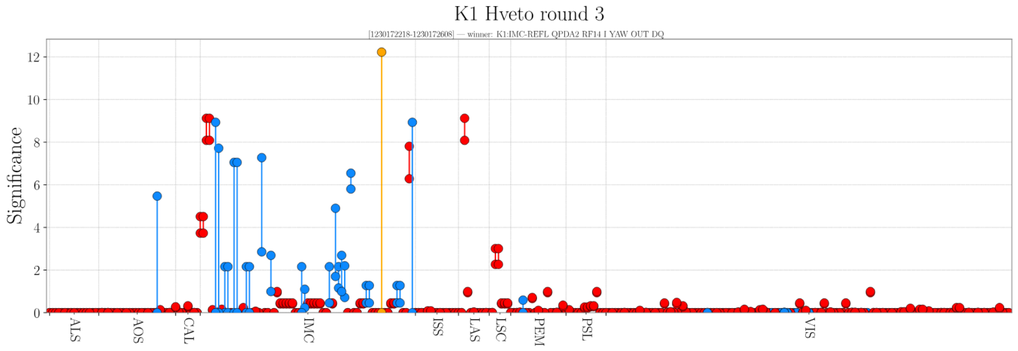
unsafe-channels =

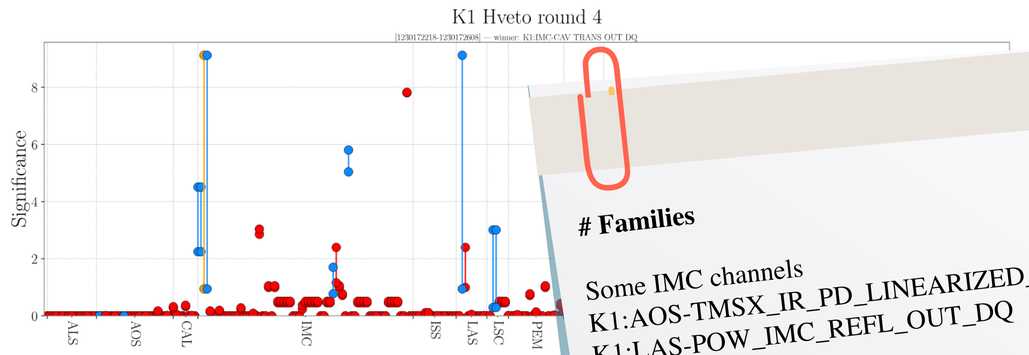
hveto result about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1

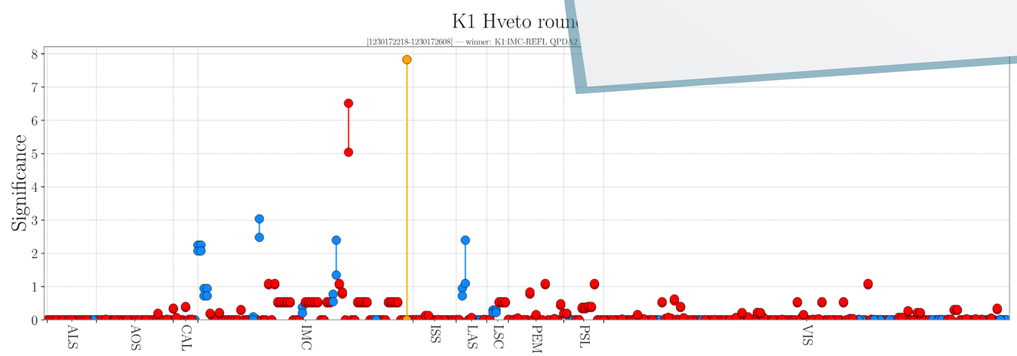
>> more detail











 # Families

Some IMC channels
K1:AOS-TMSX_IR_PD_LINEARIZED_DQ
K1:LAS-POW_IMC_REFL_OUT_DQ

Round 1, Winner = K1:IMC-REFL_QPDA2_DC_SUM_OUT_DQ, window = 0.1, SNR thresh = 7.75

Round 2, Winner = K1:IMC-REFL_QPDA2_RF14_I4_IN1_DQ, window = 0.1, SNR thresh = 7.75

Round 3, Winner = K1:IMC-REFL_QPDA2_RF14_I_YAW_OUT_DQ, window = 0.1, SNR thresh = 7.75

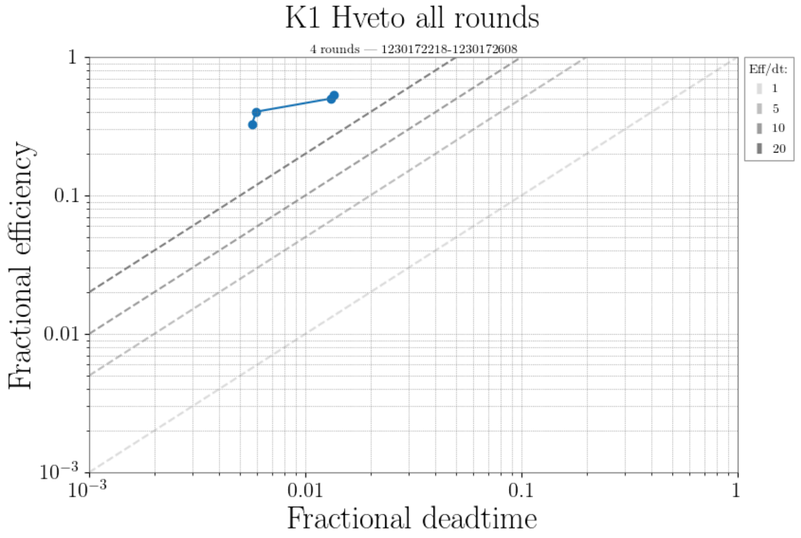
Round 4, Winner = K1:IMC-CAV_TRANS_OUT_DQ, window = 0.1, SNR thresh = 7.75

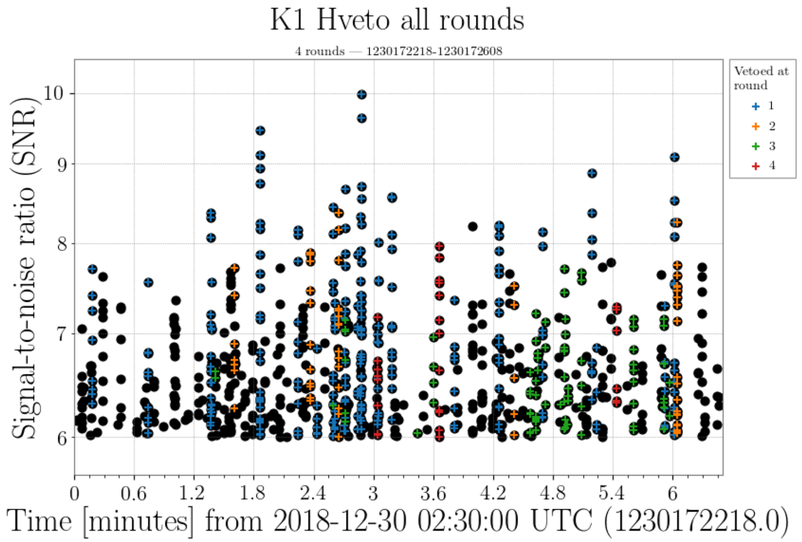
Round 5, Winner = K1:IMC-REFL_QPDA2_RF14_Q_PIT_OUT_DQ, window = 0.1, SNR thresh = 7.75

Round 6, Winner = K1:IMC-REFL_QPDA2_DC_YAW_OUT_DQ, window = 0.1, SNR thresh = 7.75

hveto result about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1

>> more detail





 # Segment 1 -s 1230172218 -e 1230172608 [~6m 30s]

 # hveto

snr-thresholds = 7.50, 7.75, 8.00, 8.50, 9.00, 10.00, 11.00, 12.00, 15.00, 20.00, 40.00, 100.00, 300.00

time-windows = 0.10, 0.20, 0.40, 0.80, 1.00, 4.00, 8.00, 10.0

minimum-significance = 5.0

 # primary

channel = K1:AOS_TMSX_IR_PD_OUT_DQ

snr-threshold = 6

 # safety

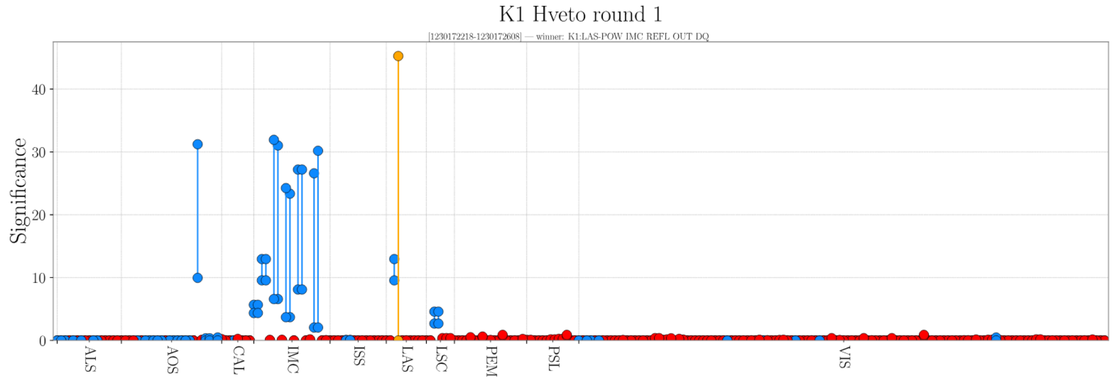
unsafe-channels =

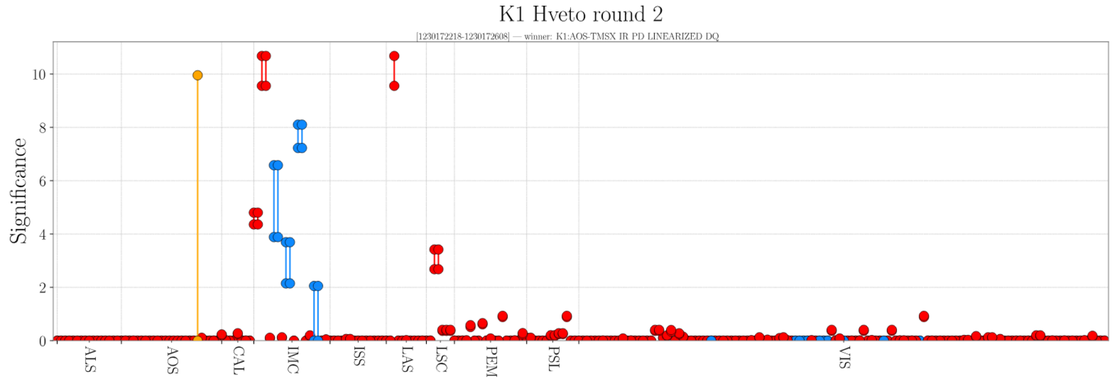
All K1:IMC-REFL channels

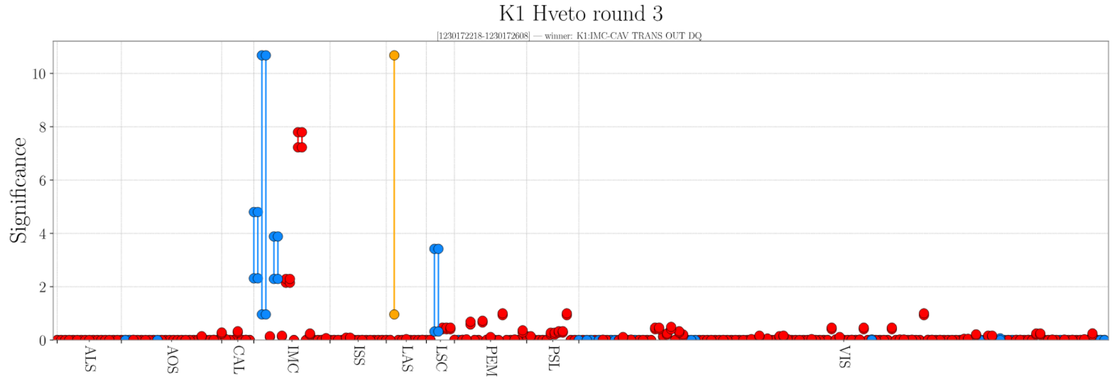
#3 hveto Result

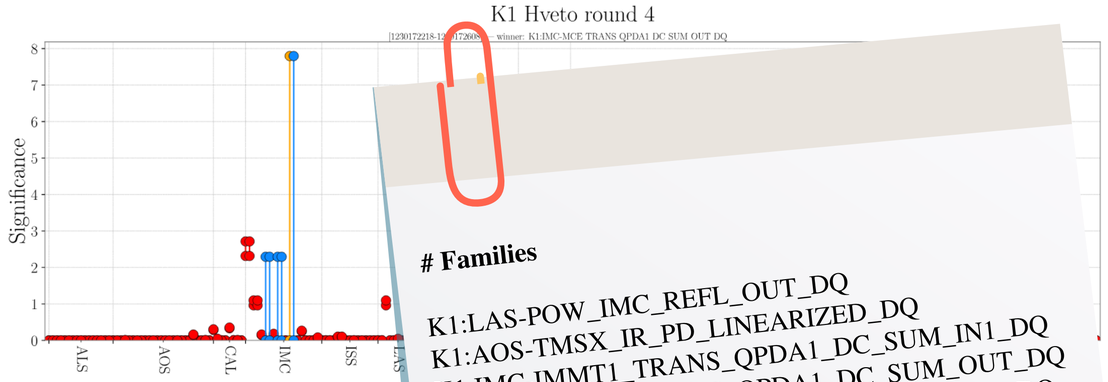
hveto result about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1

>> more detail









 # Families

K1:LAS-POW_IMC_REFL_OUT_DQ
K1:AOS-TMSX_IR_PD_LINEARIZED_DQ
K1:IMC-IMMT1_TRANS_QPDA1_DC_SUM_IN1_DQ
K1:IMC-IMMT1_TRANS_QPDA1_DC_SUM_OUT_DQ
K1:IMC-IMMT1_TRANS_QPDA2_DC_SUM_IN1_DQ
K1:IMC-IMMT1_TRANS_QPDA2_DC_SUM_OUT_DQ
K1:IMC-MCE_TRANS_QPDA1_DC_SUM_IN1_DQ
K1:IMC-MCE_TRANS_QPDA1_DC_SUM_OUT_DQ
K1:IMC-MCE_TRANS_QPDA2_DC_SUM_IN1_DQ
K1:IMC-MCE_TRANS_QPDA2_DC_SUM_OUT_DQ

Round 1, Winner = K1:LAS-POW_IMC_REFL_OUT_DQ, window = 0.1, SNR thresh = 7.75

Round 2, Winner = K1:AOS-TMSX_IR_PD_LINEARIZED_DQ, window = 0.1, SNR thresh = 7.75

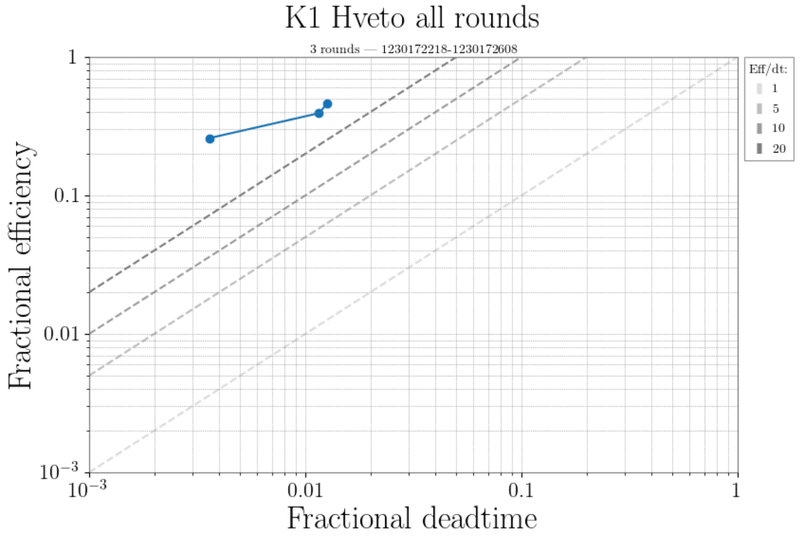
Round 3, Winner = K1:IMC-CAV_TRANS_OUT_DQ, window = 0.1, SNR thresh = 7.75

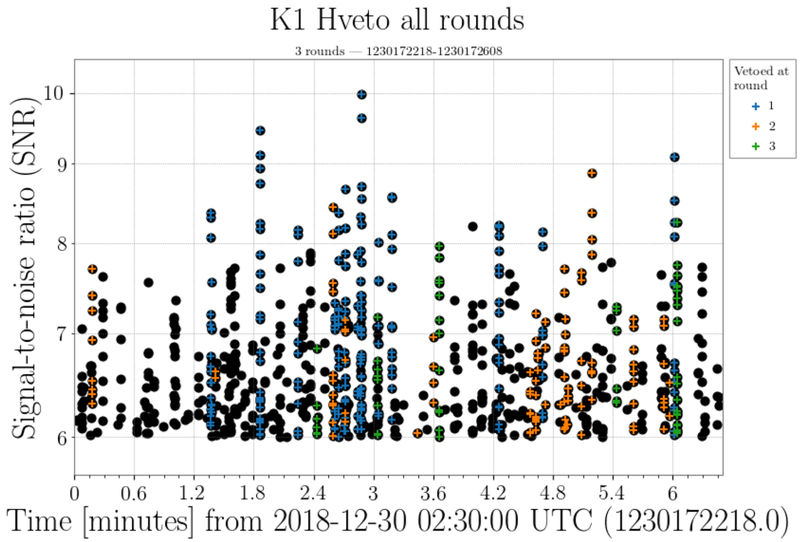
Round 4, Winner = K1:IMC-MCE_TRANS_QPDA1_DC_SUM_OUT_DQ, window = 0.1, SNR thresh = 7.75

#3 hveto Result

hveto result about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1

>> more detail





 # Segment 1 -s 1230172218 -e 1230172608 [~6m 30s]

 # hveto

snr-thresholds = 7.50, 7.75, 8.00, 8.50, 9.00, 10.00, 11.00, 12.00, 15.00, 20.00, 40.00, 100.00, 300.00

time-windows = 0.10, 0.20, 0.40, 0.80, 1.00, 4.00, 8.00, 10.0

minimum-significance = 5.0

 # primary

channel = K1:AOS_TMSX_IR_PD_OUT_DQ

snr-threshold = 6

 # safety

unsafe-channels =

All K1:IMC-REF channels

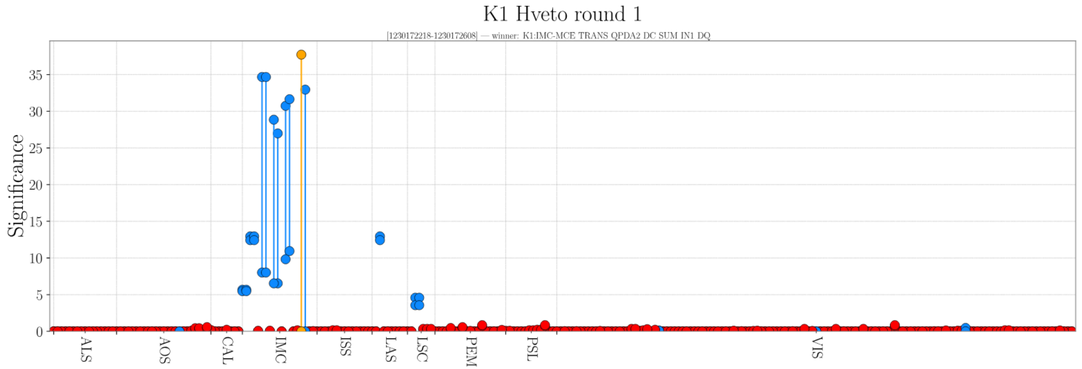
K1:LAS-POW_IMC_REFL_OUT_DQ

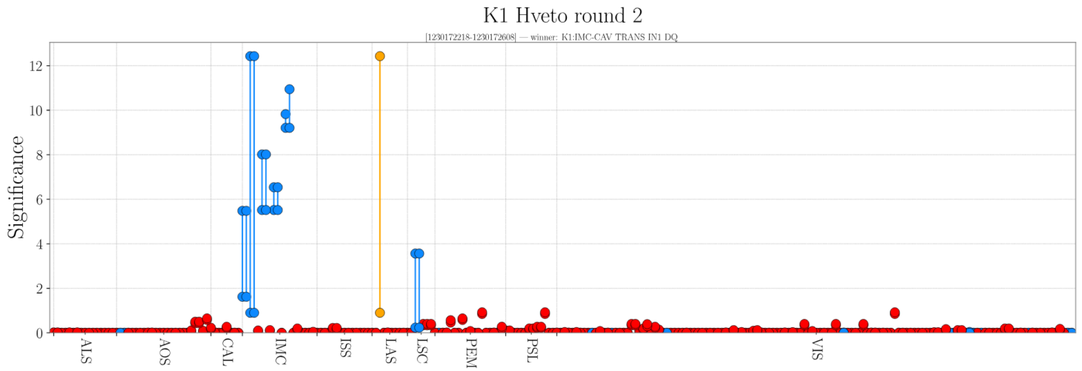
K1:AOS-TMSX_IR_PD_LINEARIZED_DQ

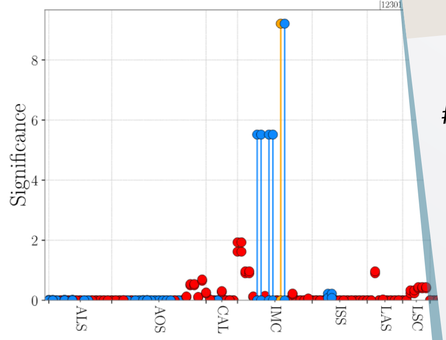
#3 hveto Result

hveto result about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1

>> more detail







 # Families

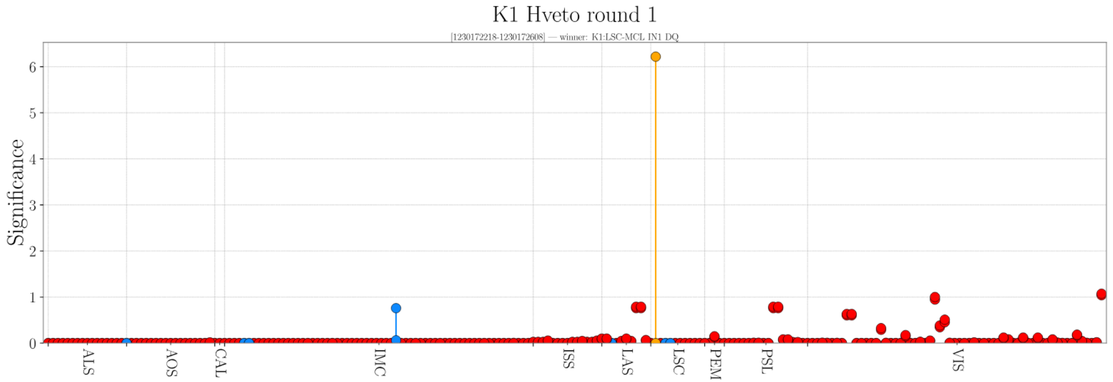
K1:IMC-IMMT1_TRANS_QPDA1_DC_SUM_IN1_DQ
K1:IMC-IMMT1_TRANS_QPDA1_DC_SUM_OUT_DQ
K1:IMC-IMMT1_TRANS_QPDA2_DC_SUM_IN1_DQ
K1:IMC-IMMT1_TRANS_QPDA2_DC_SUM_OUT_DQ
K1:IMC-MCE_TRANS_QPDA1_DC_SUM_IN1_DQ
K1:IMC-MCE_TRANS_QPDA1_DC_SUM_OUT_DQ
K1:IMC-MCE_TRANS_QPDA2_DC_SUM_IN1_DQ
K1:IMC-MCE_TRANS_QPDA2_DC_SUM_OUT_DQ

Round 1, Winner = K1:IMC-MCE_TRANS_QPDA2_DC_SUM_IN1_DQ, window = 0.1, SNR thresh = 7.75

Round 2, Winner = K1:IMC-CAV_TRANS_IN1_DQ, window = 0.1, SNR thresh = 7.75

Round 3, Winner = K1:IMC-MCE_TRANS_QPDA1_DC_SUM_OUT_DQ, window = 0.1, SNR thresh = 7.75

Result Analysis about K1:LSC-CARM_SERVO_SLOW_DAQ_OUT_DQ in segment1 >> coherence detail



Round winner channel :

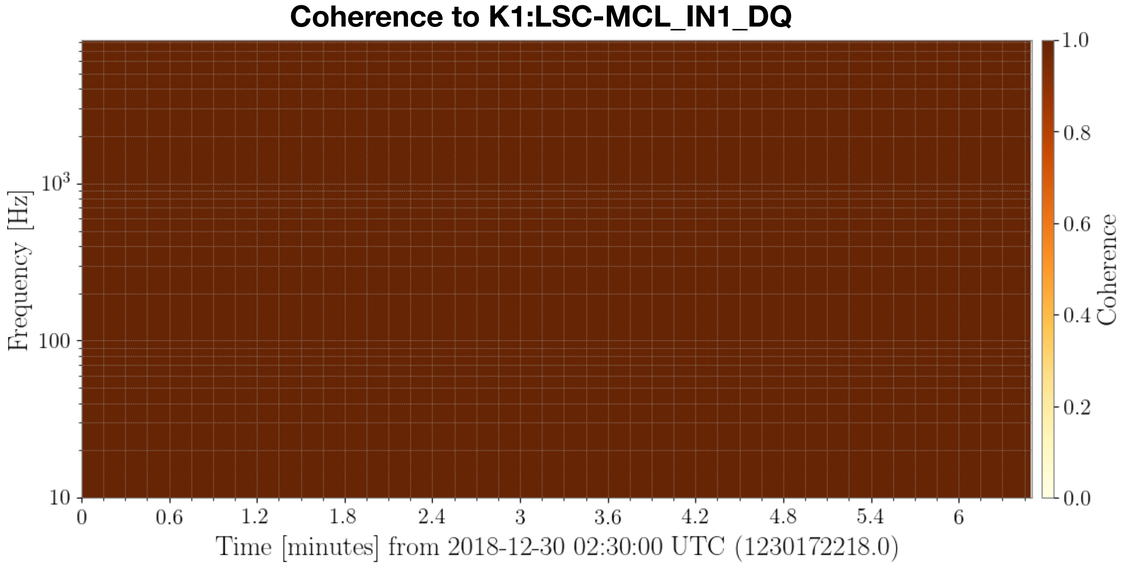
K1:LSC-MCL_IN1_DQ

Coherence check :

K1:LSC-MCL_IN1_DQ is always 1

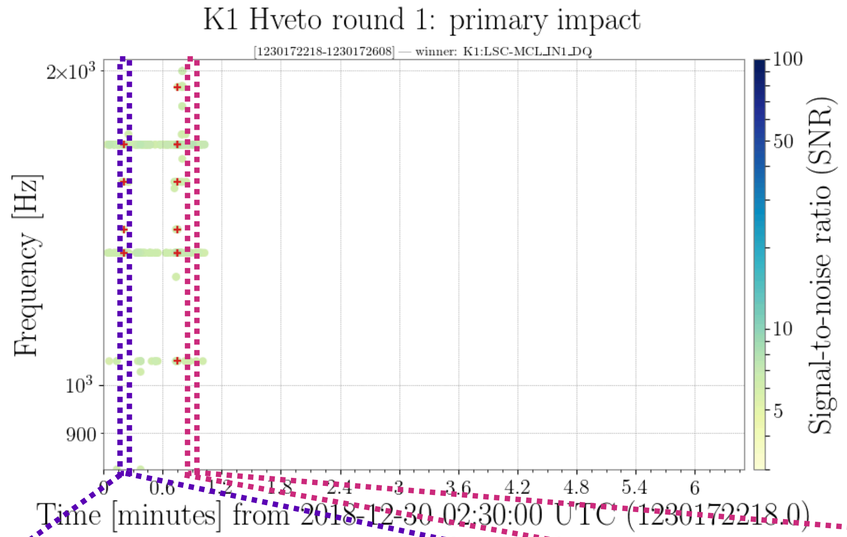
Coherence

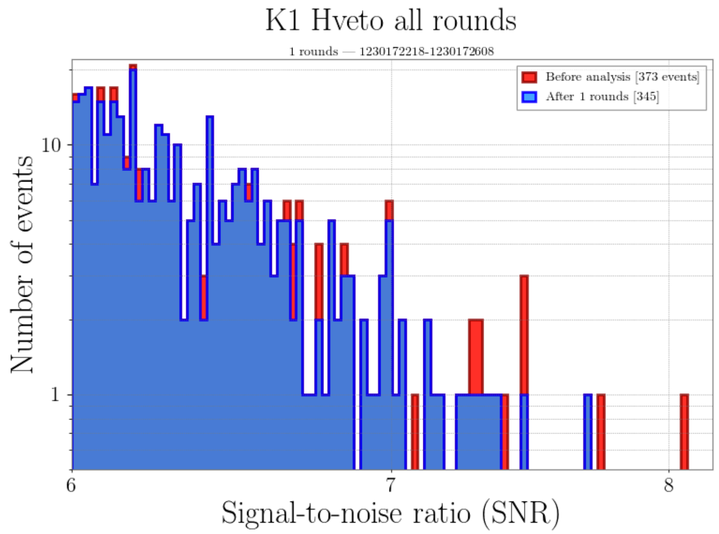
aux_channel	ch1	ch2	ch3
K1:ALS-DRIFTX_SERVO_IN2_DQ	0.0282	0.035	0.0398
K1:ALS-DRIFTX_SERVO_OUT_DQ	0.0282	0.035	0.0398
K1:ALS-GEN_MON_OUT_DQ	0.12	0.0382	0.0295
K1:ALS-PDHX_MIXER_DAQ_OUT_DQ	0.0802	0.034	0.0779
⋮			
K1:LAS-POW_PMC_RIN_OUT_DQ	0.0126	0.0325	0.0386
K1:LAS-POW_PSL_OUT_DQ	0.0129	0.0354	0.0424
K1:LSC-CARM_SERVO_FAST_DAQ_OUT_DQ	0.0185	0.0233	0.8231
K1:LSC-MCL_IN1_DQ	0.0191	0.0239	1
K1:LSC-REFLAIR_A_LF_IN1_DQ	0.1665	0.6544	0.0243
K1:LSC-REFLAIR_A_LF_OUT_DQ	0.1665	0.6544	0.0243

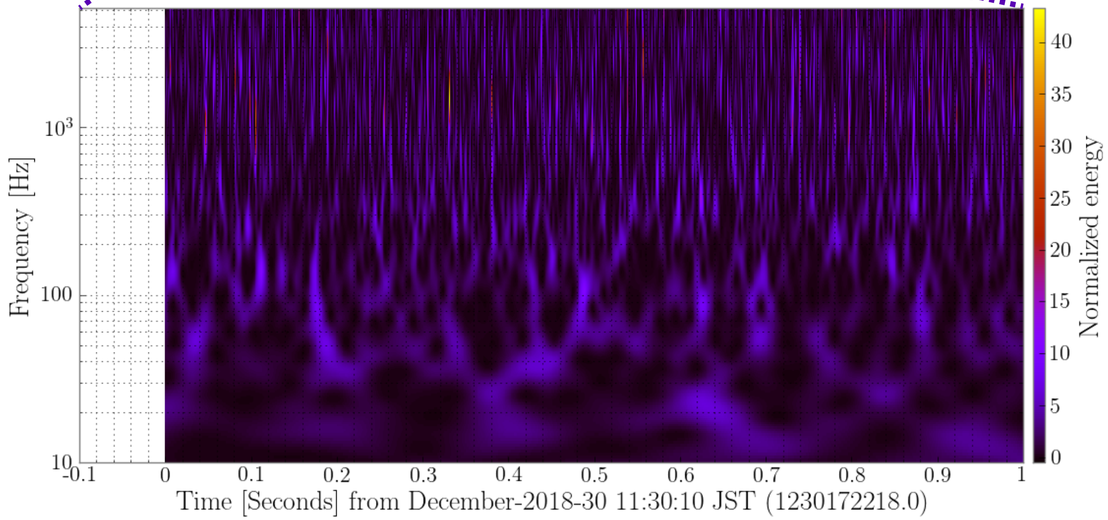


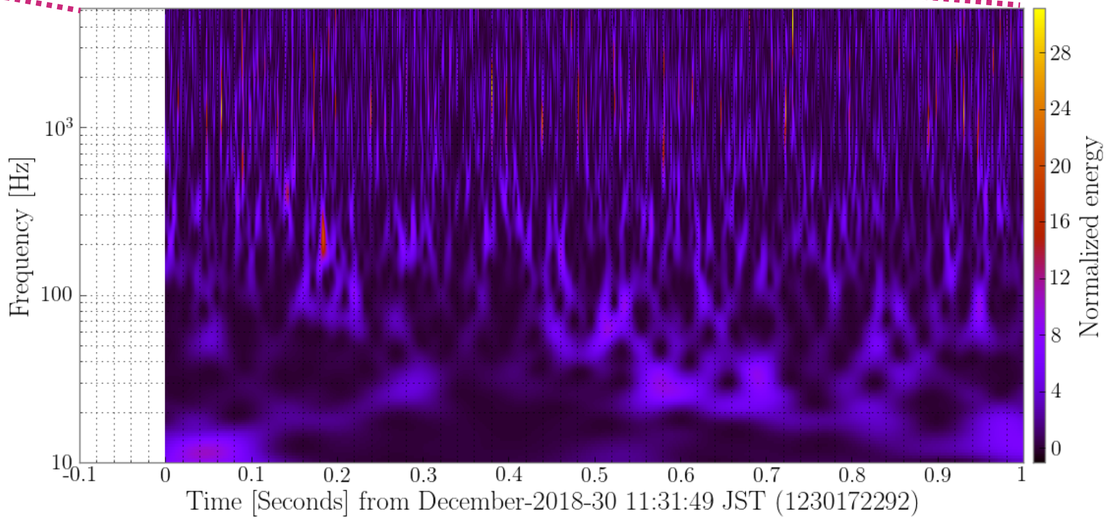
#4 Result Analysis

Result Analysis about K1:LSC-CARM_SERVO_SLOW_DAQ_OUT_DQ in segment1









#4 Result Analysis

Result Analysis about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1

>> coherence detail

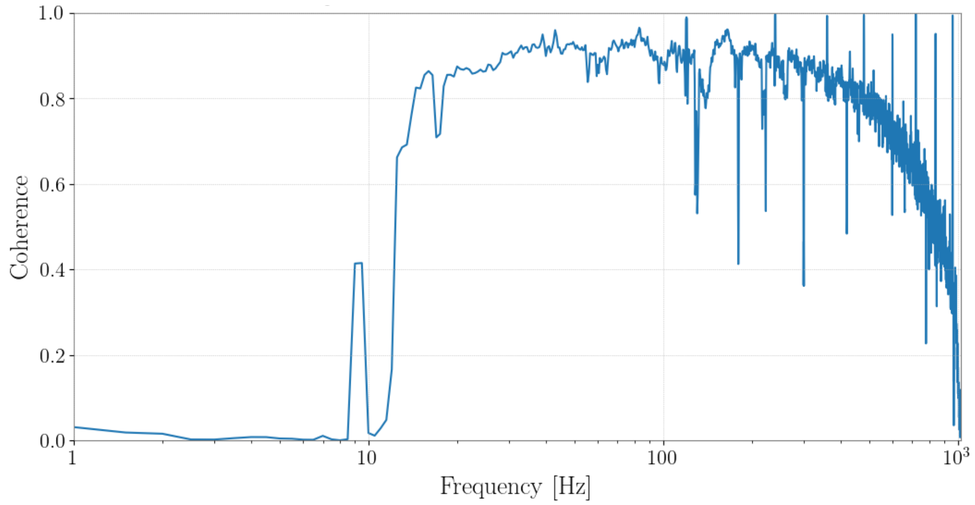
Coherence

aux_channel	ch1	ch2	ch3
K1:ALS-DRIFTX_SERVO_IN2_DQ	0.0282	0.035	0.0398
.			
.			
K1:AOS-TMSX_IR_PD_LINEARIZED_DQ	0.1919	0.9902	0.0239
.			
.			
K1:IMC-CAV_REFL_IN1_DQ	0.255	0.7121	0.0219
K1:IMC-CAV_REFL_OUT_DQ	0.255	0.7121	0.0219
K1:IMC-CAV_TRANS_IN1_DQ	0.2403	0.7533	0.0223
K1:IMC-CAV_TRANS_OUT_DQ	0.2403	0.7533	0.0223
K1:IMC-IMMT1_TRANS_QPDA1_DC_PIT_OUT_DQ	0.0216	0.0589	0.0143
K1:IMC-IMMT1_TRANS_QPDA1_DC_SUM_IN1_DQ	0.2368	0.741	0.0224
K1:IMC-IMMT1_TRANS_QPDA1_DC_SUM_OUT_DQ	0.2368	0.741	0.0224
.			
.			
K1:IMC-REFL_QPDA1_DC_PIT_OUT_DQ	0.1739	0.4101	0.2393
K1:IMC-REFL_QPDA1_DC_SEG1_IN1_DQ	0.2574	0.7198	0.0377
K1:IMC-REFL_QPDA1_DC_SEG2_IN1_DQ	0.2572	0.71	0.0296
K1:IMC-REFL_QPDA1_DC_SEG3_IN1_DQ	0.2512	0.6865	0.0376
K1:IMC-REFL_QPDA1_DC_SEG4_IN1_DQ	0.2384	0.669	0.0703
K1:IMC-REFL_QPDA1_DC_SUM_OUT_DQ	0.2589	0.7189	0.0216
.			
.			
K1:LAS-POW_IMC_OUT_DQ	0.2403	0.7533	0.0223
K1:LAS-POW_IMC_REFL_OUT_DQ	0.2568	0.7112	0.0225
.			
.			

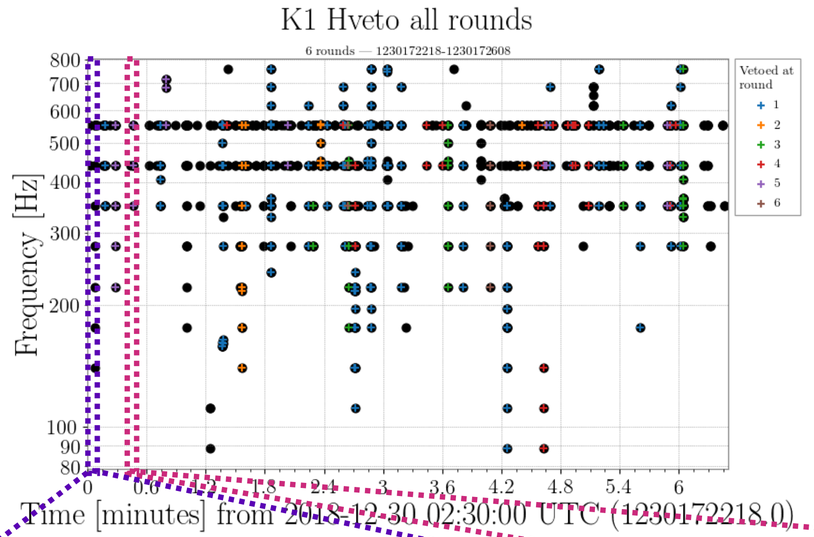
Round winner channels :

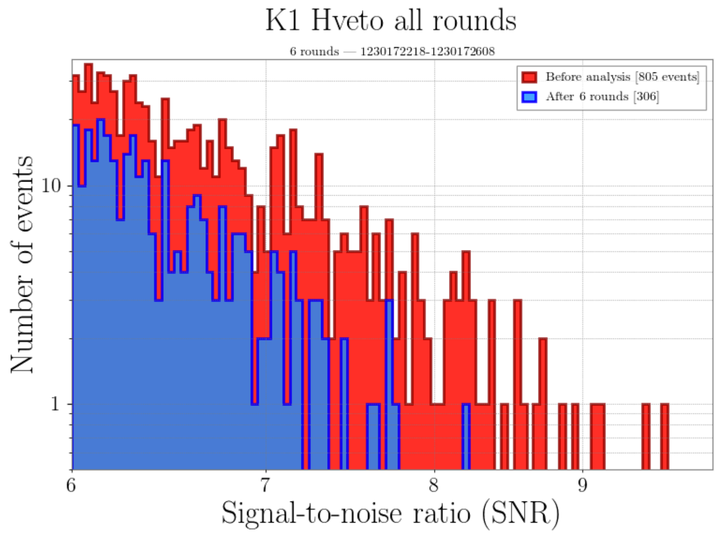
K1:IMC-REFL_QPDA2_DC_SUM_OUT_DQ
…
K1:IMC-CAV_TRANS_OUT_DQ
K1:IMC-CAV_TRANS_IN1_DQ
K1:LAS-POW_IMC_REFL_OUT_DQ
K1:AOS-TMSX_IR_PD_LINEARIZED_DQ
K1:IMC-MCE_TRANS_QPDA2_DC_SUM_IN1_DQ
…

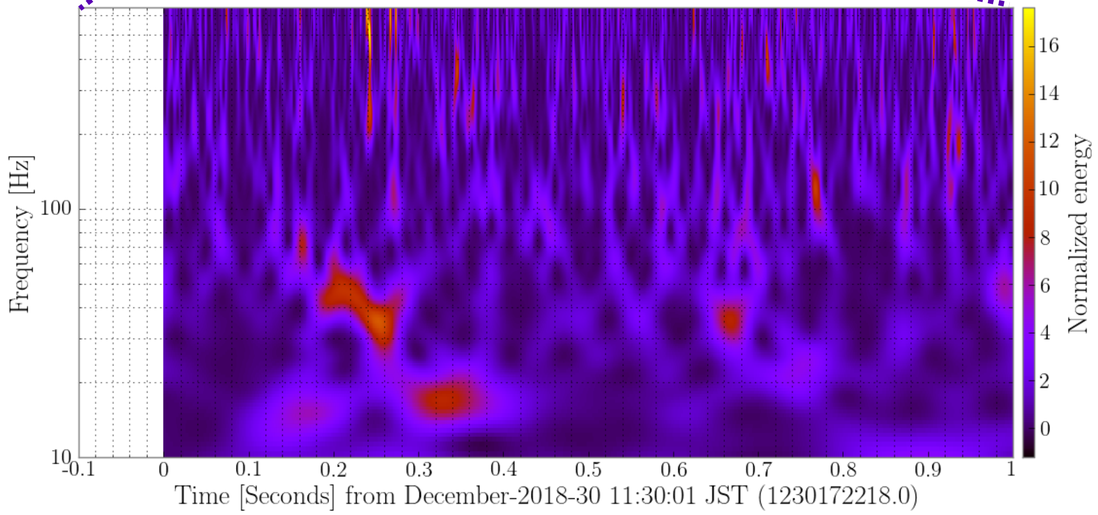
Coherence to K1:IMC-REFL_QPDA2_DC_SUM_OUT_DQ

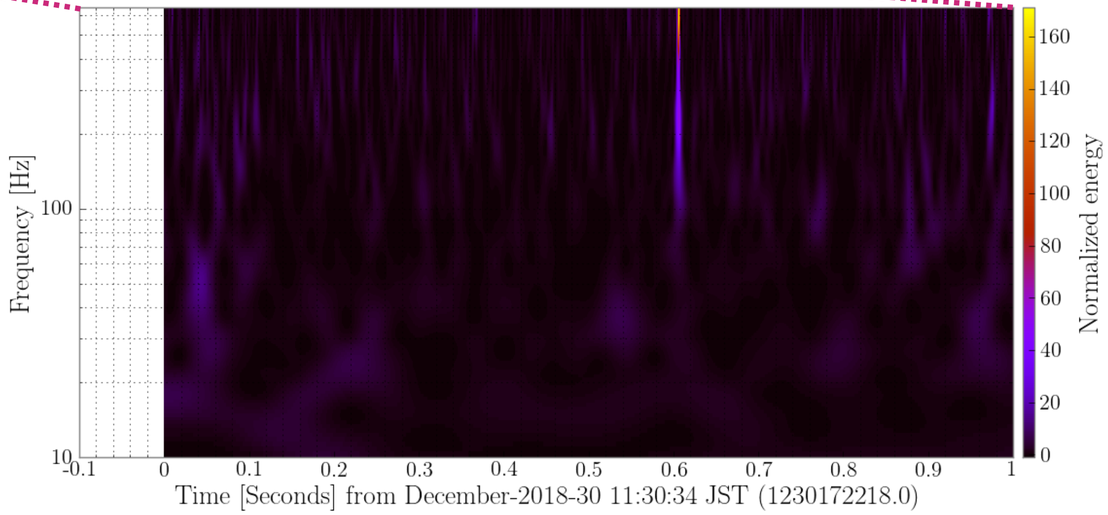


Result Analysis about K1:AOS_TMSX_IR_PD_OUT_DQ in segment1









#4 Result Analysis

Beyond

Future Assignment

Transfer remaining data to KISTI

Unfortunately, much time is required

Need more trigger data

Omicron environment and enough storage space over 1TB are required

More information

Locking condition for each sub-channel

Need to understand the auxiliary channels

Glitch Classification

Data accumulation

Capture glitches that utilize various tools such as coherence, spectrogram, hveto, and CAGMon.

and then,

Classify Glitch types through Omegascan

Glitch source Hunting

TBD