BLOCK-NORMAL BASED VETO ANALYSIS

Shantanu Desai
For
Penn State Relativity Group

LSC Meeting, August 17 2005

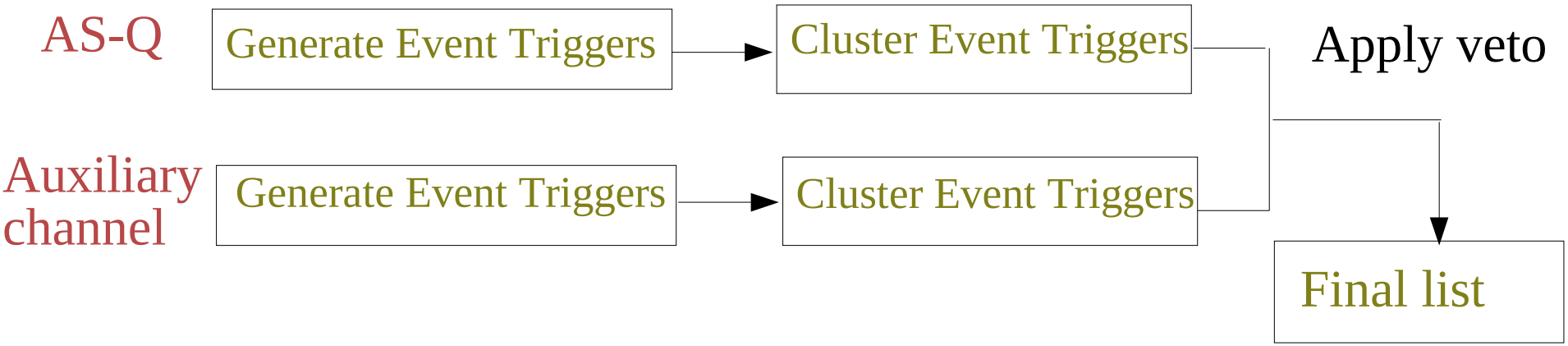
https://gravity.psu.edu/~s4/vetoes

Talk Outline

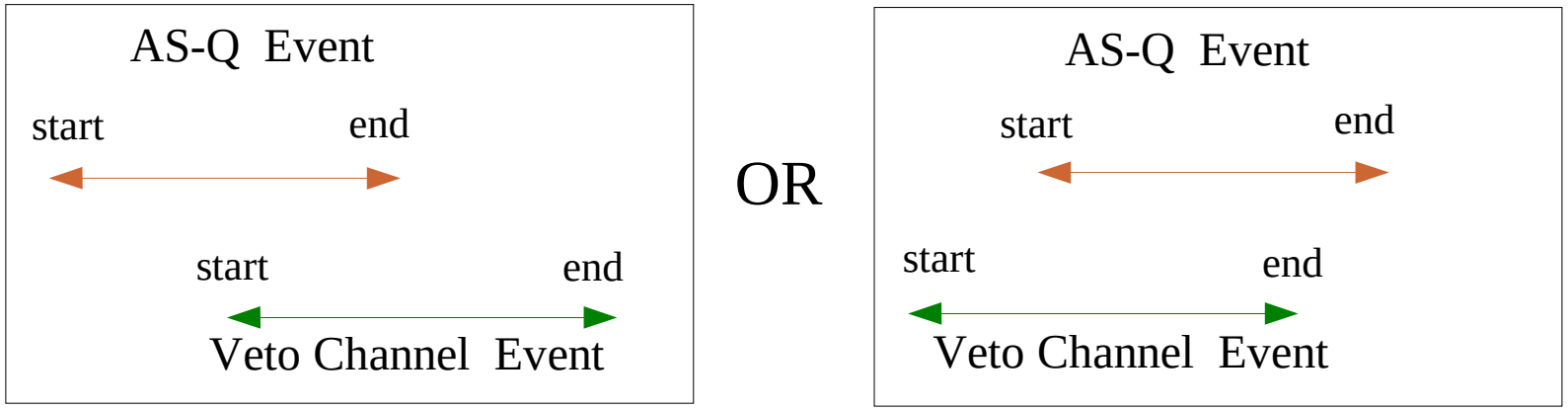
- Introduction to veto implementation with Block-Normal
- Variables used for veto tuning
- Figure of Merit used for optimizing veto effectiveness
- Results of S4 veto tuning
- Effect of veto (POB-I) used for S4 Block-Normal Result
- S4 veto safety studies (Preliminary)

Block-Normal based vetoes

- Use **SAME** ETG (Block-Normal) on AS-Q as well as auxiliary channel



- To veto an event , look for overlap in duration



Veto processing

- Block-Normal processing on GW channel (AS-Q) is done in discrete frequency bands :
  96-192 Hz (A4); 192-320 Hz (B4); 384-512 Hz(C4); 512-640 Hz (D4); 704-832 Hz (E4) ; 832-1024 Hz (F4) . Infrastructure set up to do processing of any veto channel in the above frequency bands

- Given the large # of possible auxiliary channels and frequency bands, a thorough investigation of all veto channels and frequency bands is a formidable task.

- Focus on channels found to be good vetoes during from BN studies on S3 as well as Kleine-Welle studies *(Alessandra , Erik etc)* during S4/E12.

- Look for vetoes within the same frequency band as AS-Q

Veto tuning method

- Post-S4 have been doing veto tuning with the segment list proposed by the burst group in May 2005 which covers entire S4.
- AS-Q threshold used was $\rho_2 = 3$; $P_E = 10$ (same threshold was used for S4 Block-Normal analysis.)
- For all veto channels $\rho_2 = 3$, lower limit on $P_E = 4$;
  where ρ_2 = Change point threshold.
  P_E = Relative Excess Power threshold
- P_E was varied until the effectiveness of a given veto channel is maximized based on an effective Figure of merit.

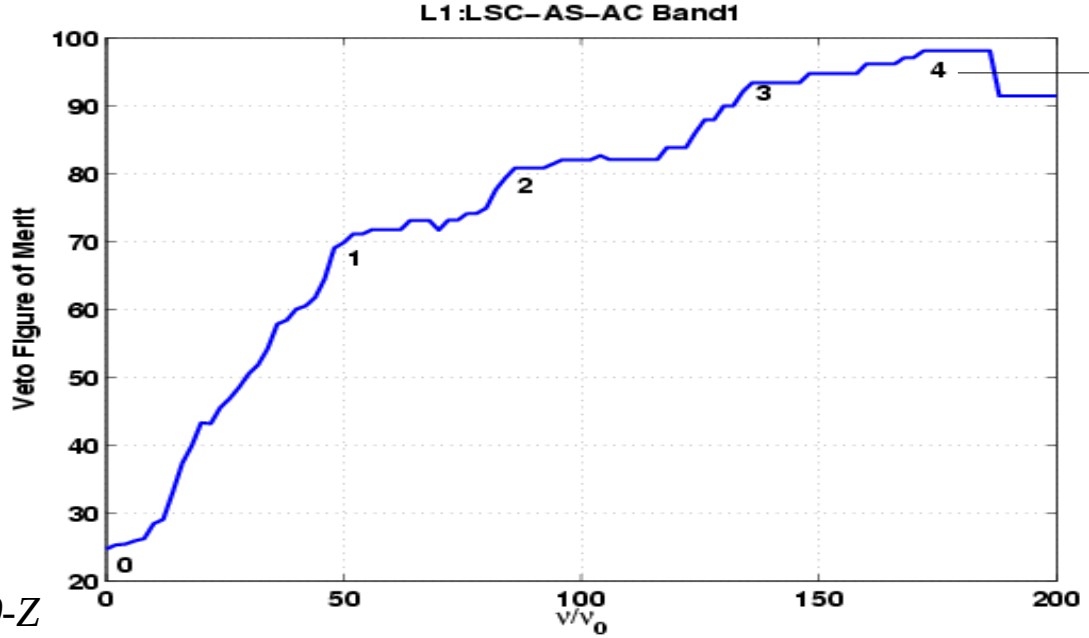
Initial Figure of merit

Figure of Merit (FOM) = (No of Events Vetoed) / (Veto Deadtime)

(No of Unvetoed Events)/ (Livetime - Veto Deadtime)

- Initial Strategy chosen was to maximise FOM . However,
- We found that FOM does not converge to a maximum value sufficient no of vetoes.

512-640 Hz



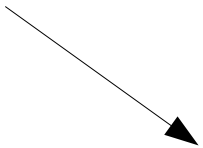
At point (4) only 1 event gets vetoed and deadtime = 0.01 %

From S3

New Figure of merit

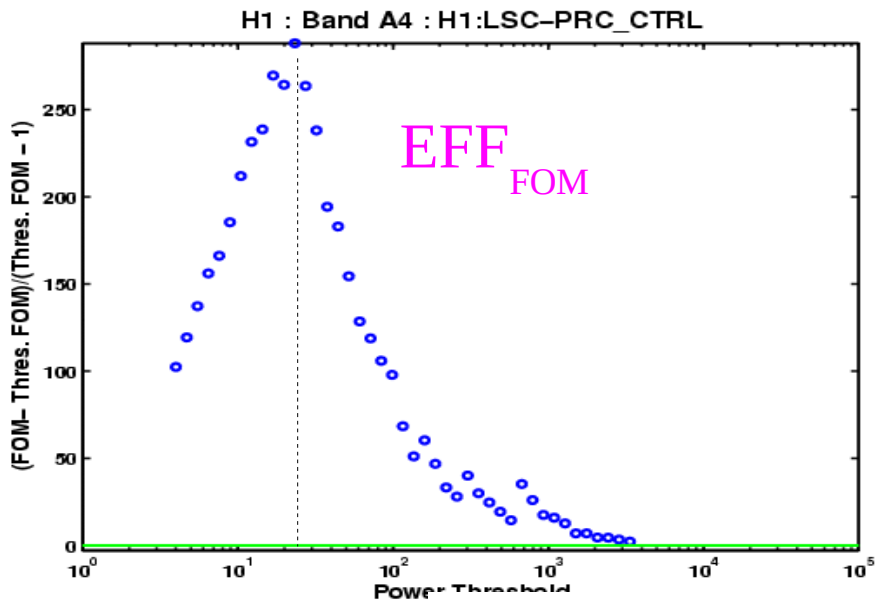
- Instead, calculate threshold value of FOM such that the probability that a random or ineffective veto has this large a value is only 5 %. This is called (Threshold FOM). (*See LIGO-T030181-00-Z)*
- For an ineffective veto, Threshold FOM ~ 1. However if number of vetoed events, are small and/or deadtime small then value of Thresold FOM also increases.
- For a good veto FOM > Threshold FOM. Use the following quantity used to judge veto effectiveness (*proposed by John McNabb)*

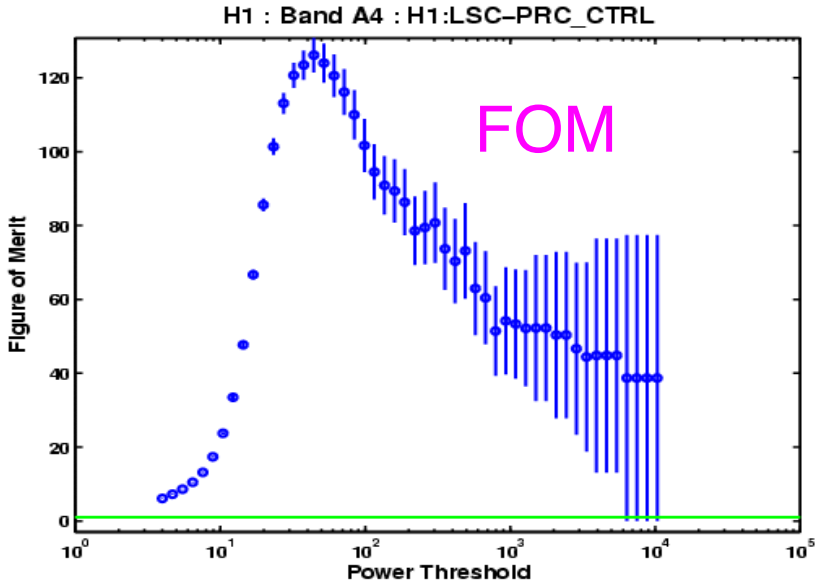
$$EFF_{FOM} = \frac{FOM - Threshold\ FOM}{Threshold\ FOM - 1}$$

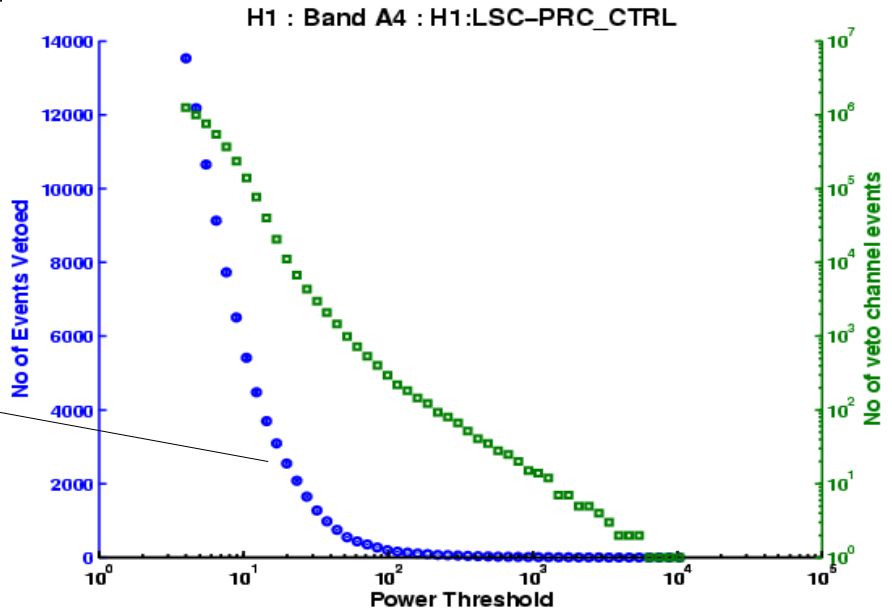


This indicates at how many sigmas a given veto channel is significant

Figure of merit variation







At max value of EFF_{FOM}
1.6 % AS-Q events get vetoed
Dead-time = 0.02 %

H1 : LSC-PRC_CTRL
192 - 320 Hz

Selection of S4 veto

- All results of veto tuning available at https://www.gravity.psu.edu/~s4/vetoes/

- As frequency increases EFF_{FOM} drops , implying that veto effectivness decreases with increasing frequency.

- Some examples of good vetoes which have $EFF_{FOM} > 10$
  POB-I, PRC-CTRL POB-Q, MICH-CTRL, AS-AC

- Looked at overlap in fraction of events vetoed by different channels.
  About 50 % of AS-Q events vetoed by PRC-CTRL also vetoed by POB-I

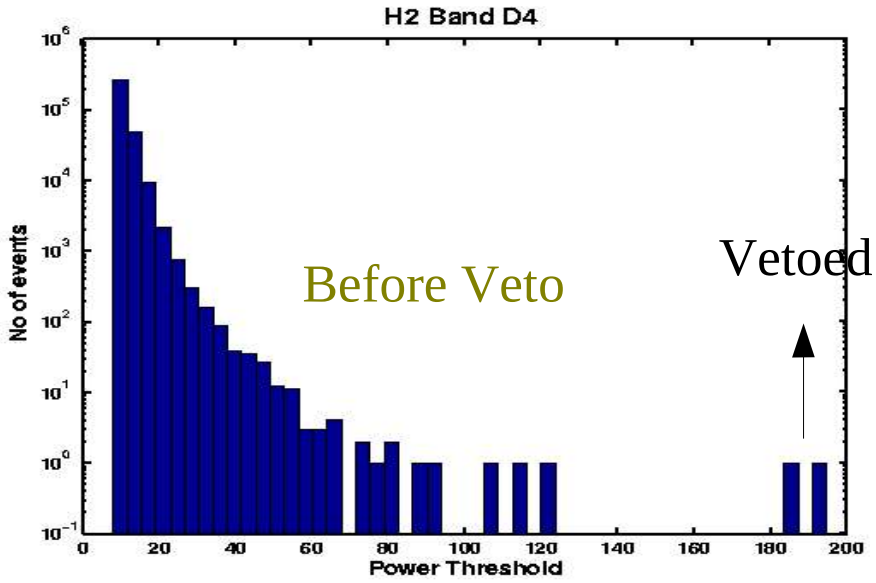
- For S4 BN result, used POB-I as a veto for H1 (96 – 640 Hz)
  H2 (96 - 1024 Hz), L1 (96 – 1024 Hz) at values of P_E at which EFF_{FOM} is maximized and maximum value of $EFF_{FOM} > 10$

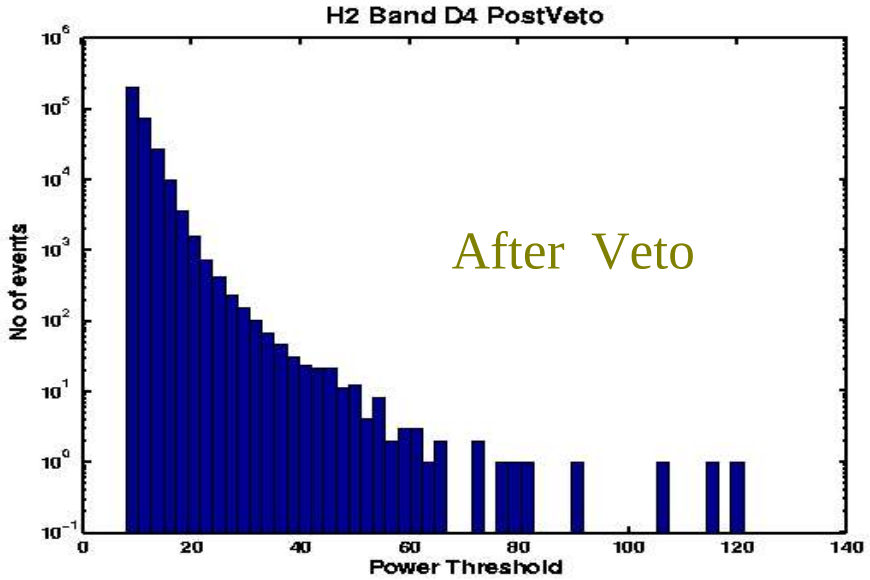
Effect of POB-I veto per ifo and band

H2 : Total live-time = 1,397,072 secs

Band	POB-I events	Total AS-Q events	No of events vetoed	Dead-time (secs)
A4	257	126932	54 (0.04%)	5.8 (0.0004%)
B4	1087875	157465	5054 (3.2%)	9926 (0.71%)
C4	700146	131837	2015 (1.5%)	6167 (0.44%)
D4	725927	132524	1827 (1.4%)	6440 (0.46%)
E4	696951	140084	1225 (0.87%)	6117 (0.44%)
F4	759243	197721	1213 (0.6%)	4437 (0.3%)

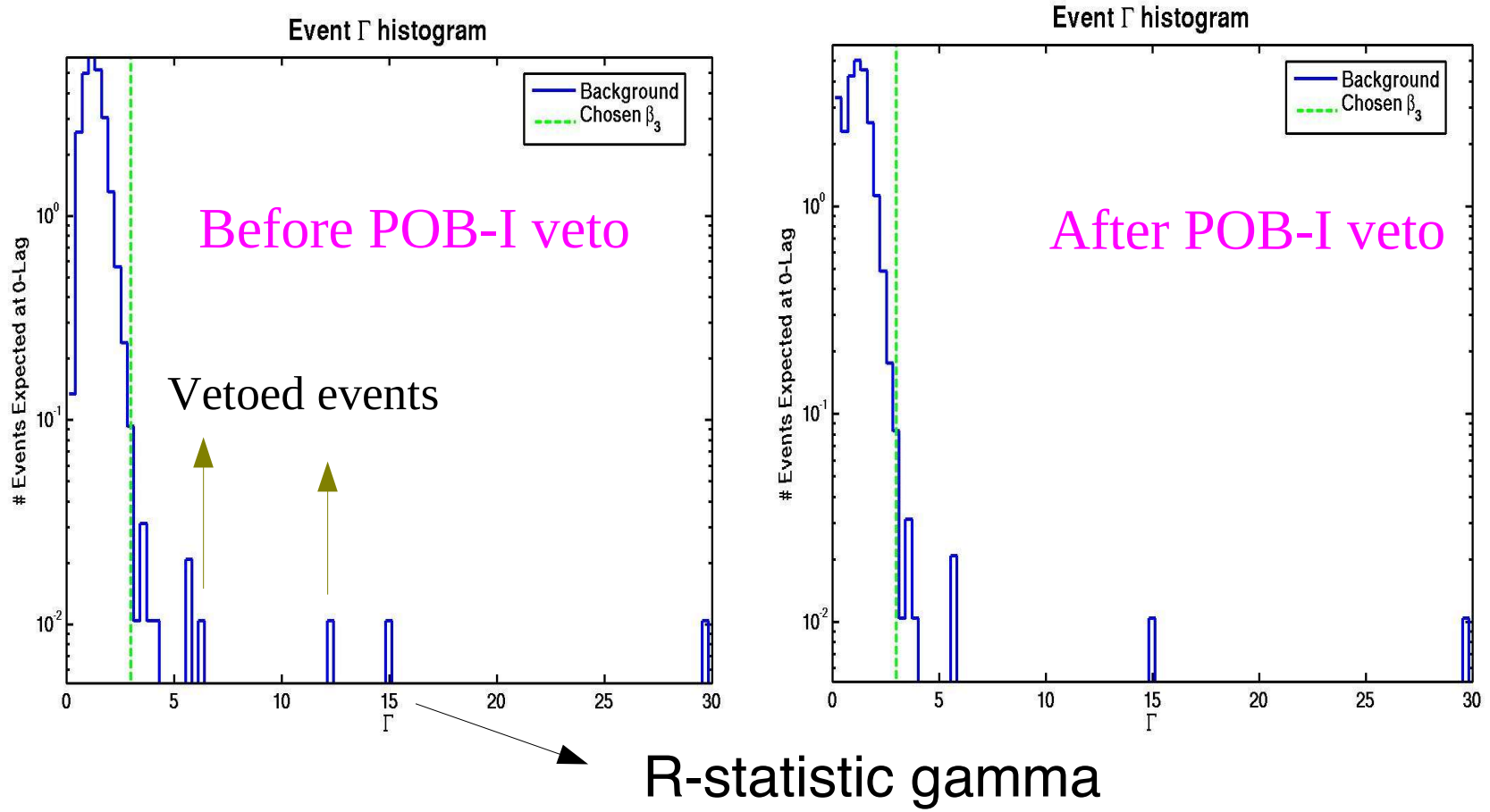
Comparison of AS-Q amplitude distribution before and after veto





Effect of veto on triple coincidence

of non-zero lag events after triple coincidence



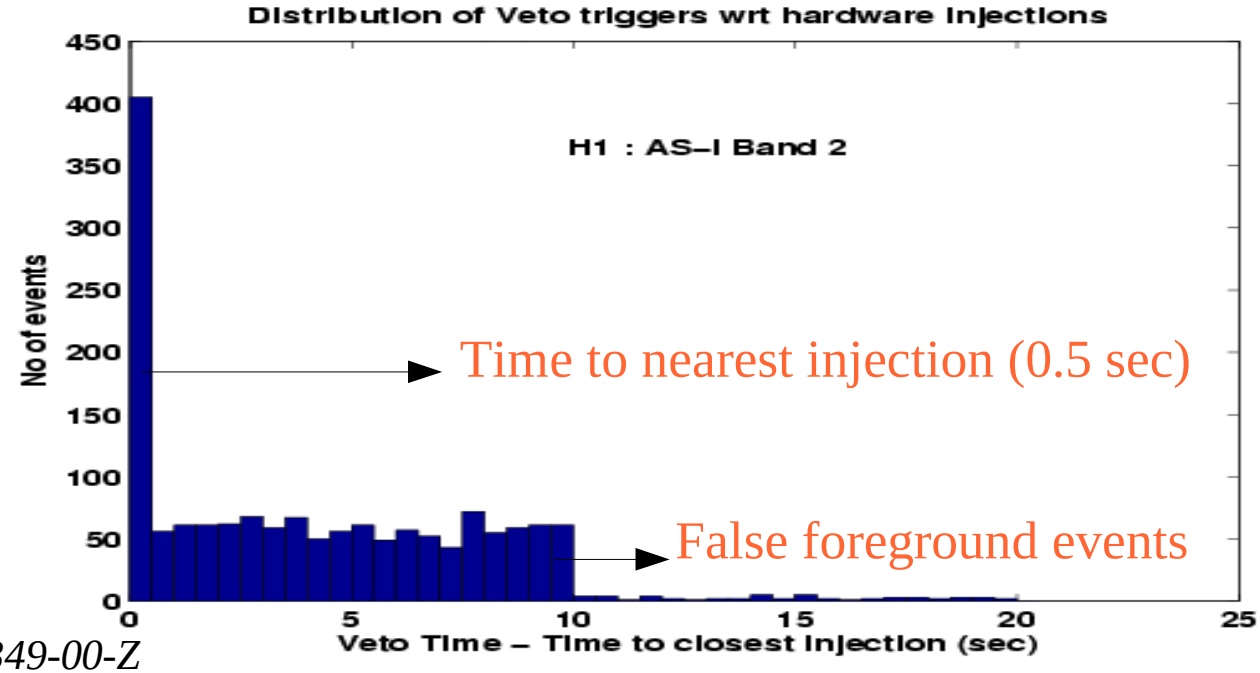
Before vetoes, 6 triggers with Gamma > 5
After vetoes, 4 triggers with Gamma > 5, Dead-time ~ 0.7 %

S4 veto safety studies

- Veto safety studies during S3 based on hardware injections indicate that AS-I is not a safe veto (all frequency bands). All other channels safe vetoes. *(see G050115-00-Z)*

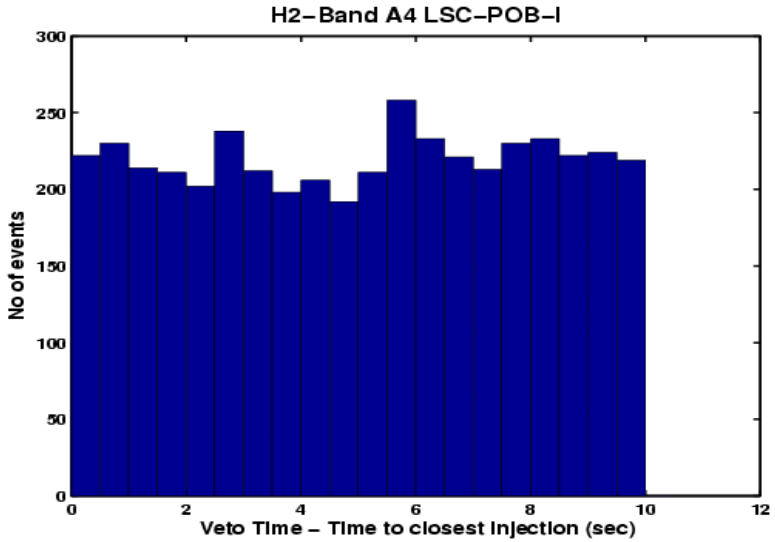
- Veto channels investigated (so far) for safety studies : POB-I, AS-I, AS_AC, PEM-RADIO-LVEA

- Method used was plot veto channel events vs time to nearest injection



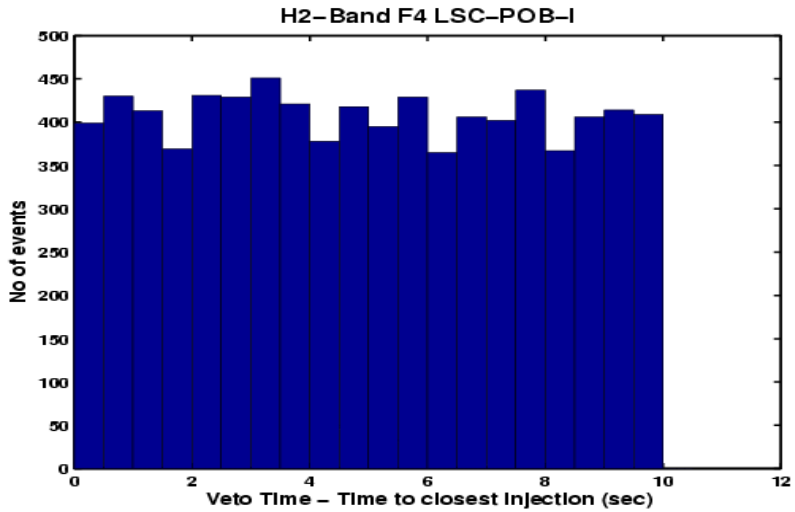
(From S3: 384-512 Hz)

POB-I Veto Safety Studies



H1 Band A4

P_E	Events within 0.5 sec	False foreground events
4	163	165
10	19	17
15	8	4

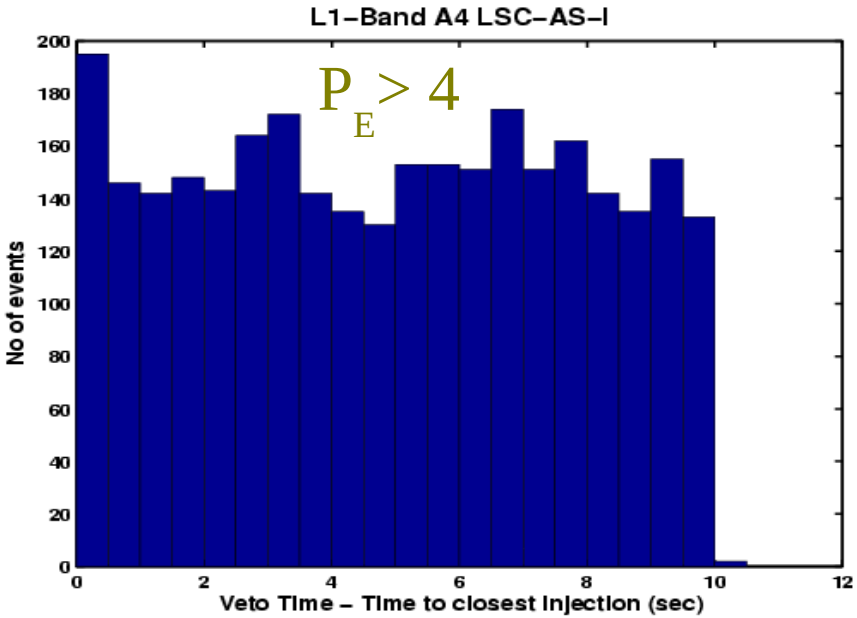


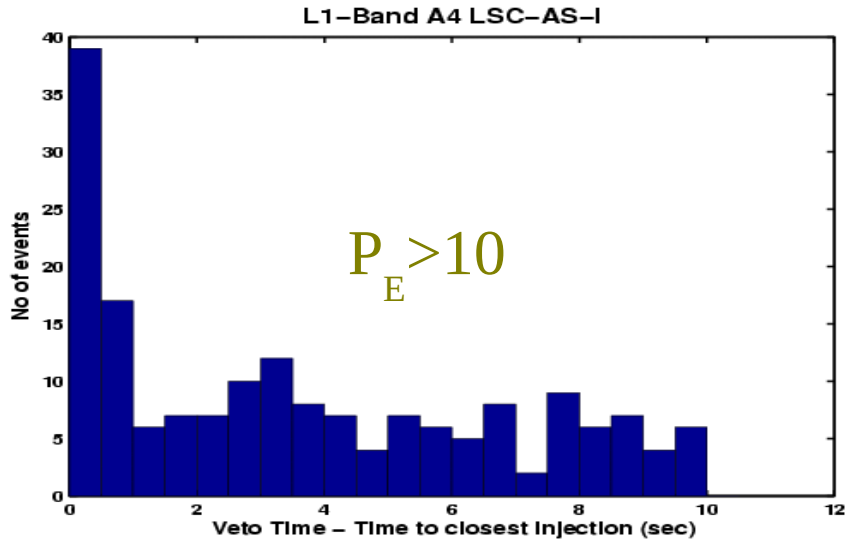
L1 Band E4

P_E	Events within 0.5 sec	False foreground events
4	234	221.8
10	14	16.2
15	1	1

POB-I is a safe veto for all 3 IFOs and all bands (based on these studies)

AS-I veto safety studies





L1 Band A4

P_E	Events within 0.5 sec	False foreground events
4	195	155.6
10	39	7.8
15	34	1.3

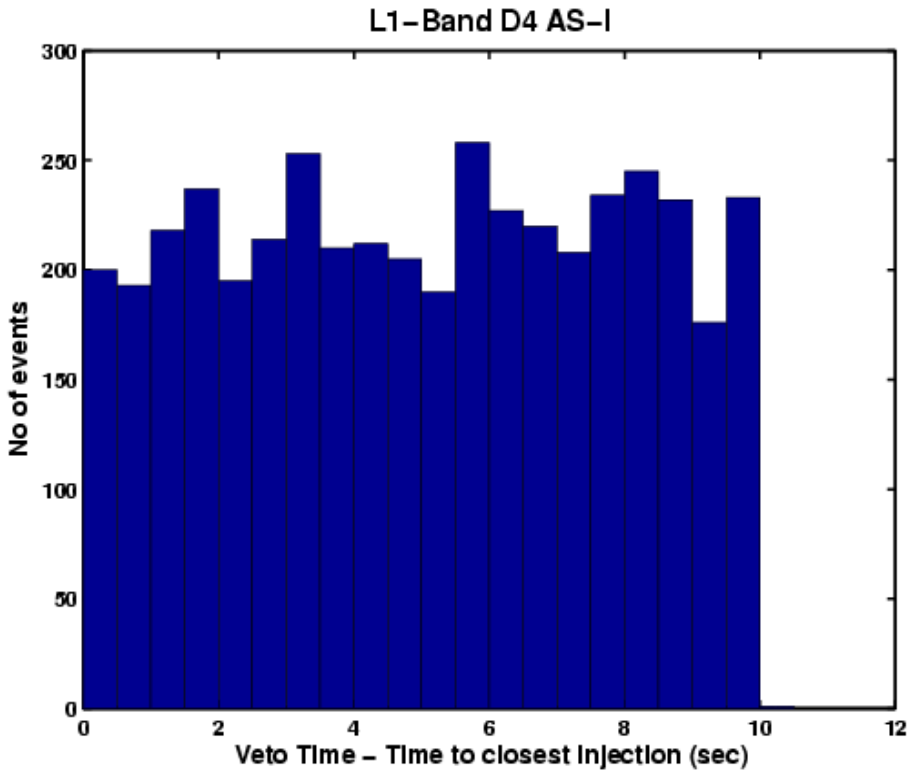
H1 Band A4

P_E	Events within 0.5 sec	False foreground events
4	259	201.6
10	29	15.7
15	12	2.1

H2 Band A4

P_E	Events within 0.5 sec	False foreground events
4	358	287
10	75	46
15	45	26

AS-I veto safety studies



L1 Band D4

P_E	events within 0.5 sec	false foreground events
4	185	226.1
10	21	15.5
15	1	1.1

H1 Band F4

P_E	events within 0.5 sec	false foreground events
4	227	257.4
10	17	16.6
15	3	1.3

- AS-I not a safe veto for low frequency bands (96-320 Hz) , but is safe at high frequencies 512-1024 Hz. For Band C4 (384-512 Hz) cannot decide. However very few burst injections at high frequencies

- Preliminary studies indicate that POB-I and AS-AC, PEM-LVEA safe in all frequency bands

Conclusions and future plans

- A quantitative procedure to identify and tune parameters of veto channels carried out on S4 data.
- LSC-POB-I identified as the best veto channel and was used in the analysis pipeline to veto per-IFO AS-Q triggers before triple coincidence.
- Veto safety studies indicate that AS-I not a safe veto in the low frequency bands (up to 320 Hz).
- Draft of a paper indicating details of veto selection and veto tuning procedure under preparation to be submitted to CQG.
- Run Block-Normal on various auxiliary channels on a daily basis during S5.