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Inspiral Glitch Veto Studies

Peter Shawhan
(LIGO Lab / Caltech)
For the Inspiral Analysis Group

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Looking Back: Vetoes in the S1 Inspiral Analysis

Vetoed H1 events if there was also a large glitch in REFL_I

- Within a time window of ±1 second
- Very clean veto: deadtime = 0.2%

Considered using AS_I as a veto for L1

- Abandoned this due to veto safety concerns

Overview of Inspiral Veto Studies

Has been a lengthy process!

Have pursued a few different approaches to explore vetoes:

(All using inspiral triggers from playground data)

- **Visual examination of loudest playground events with DTT**

  Look at AS_Q and many other channels, with various filters

- **Look at inspiral trigger rate on segment-by-segment basis**

- **Calculate veto efficiency vs. deadtime for possible vetoes**

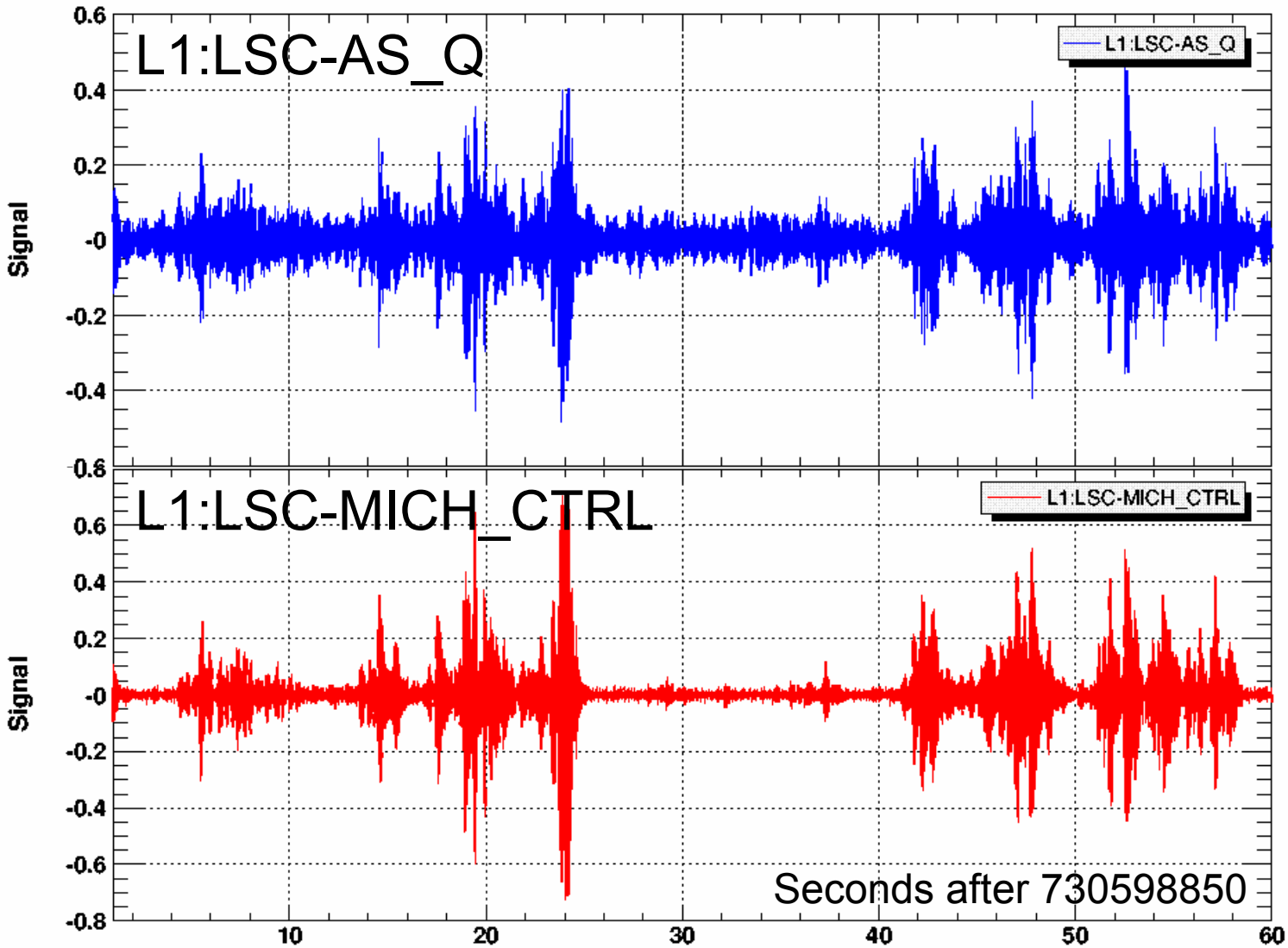
  Use veto triggers generated by glitchMon

  Various channels, filters, thresholds

Veto safety has been evaluated for some channels

AS_I is unsafe; POB_I, POB_Q; REFL_I, REFL_Q are safe

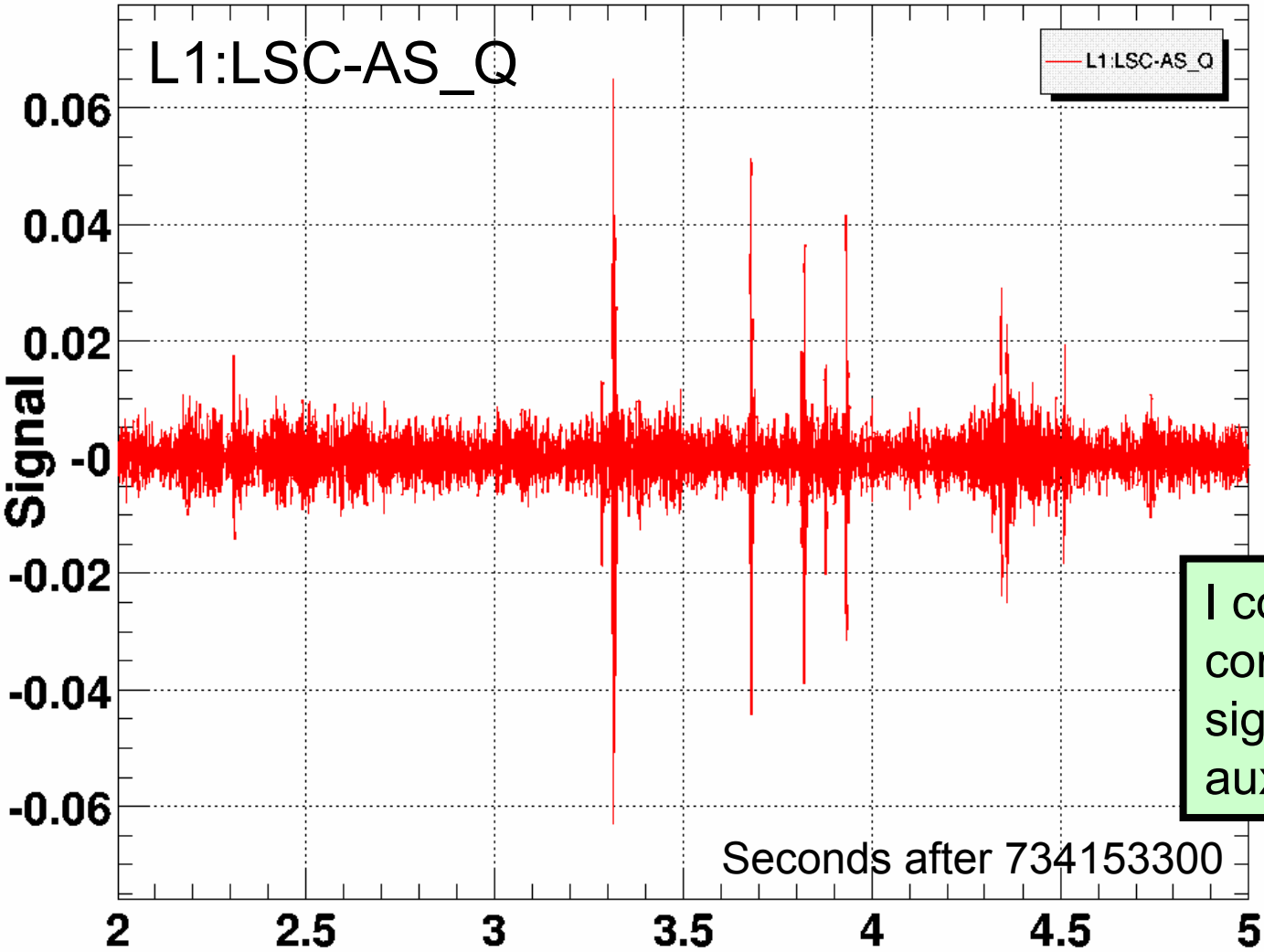
A Loud "Inspiral" Event in L1



Both with 80-500 Hz band-pass filter

Also see glitching in POB_I, POB_Q, REFL_Q & PRC_CTRL

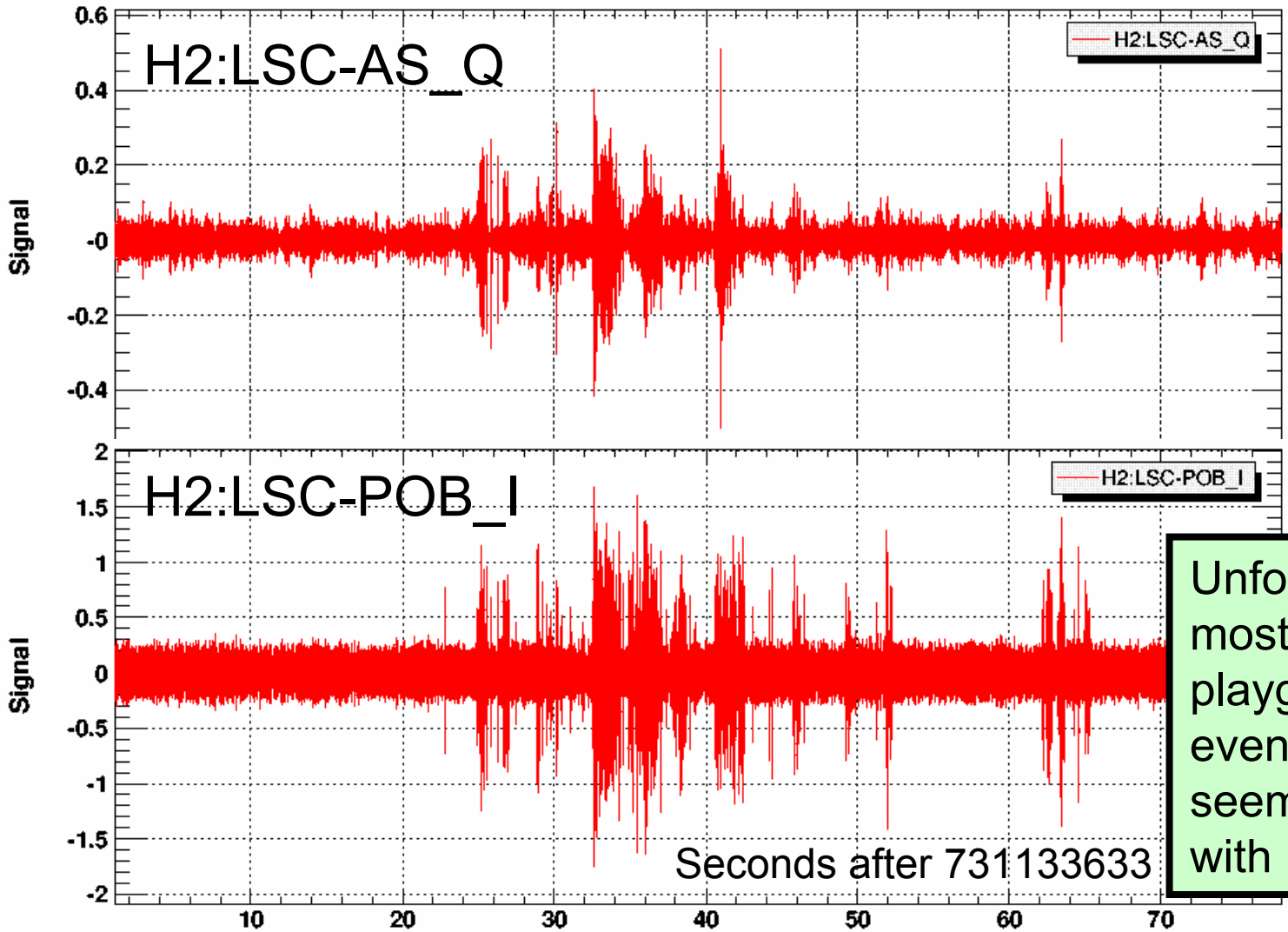
Another Loud Event in L1



With
200-500 Hz
band-pass
filter

I could not find a corresponding signature in any auxiliary channel

The Loudest Event in H2

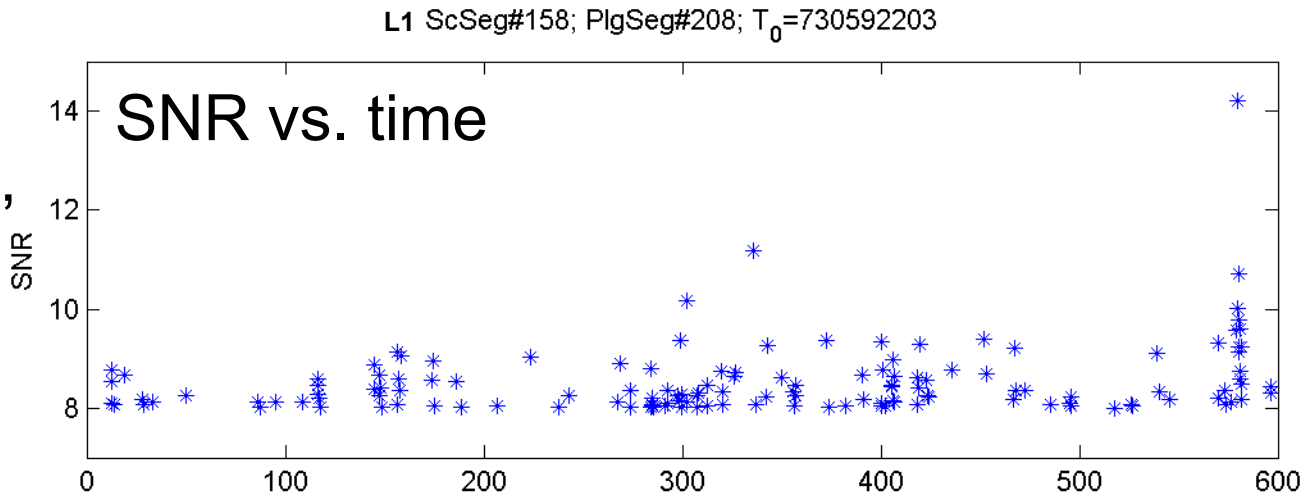


Both with 80-150 Hz band-pass filter

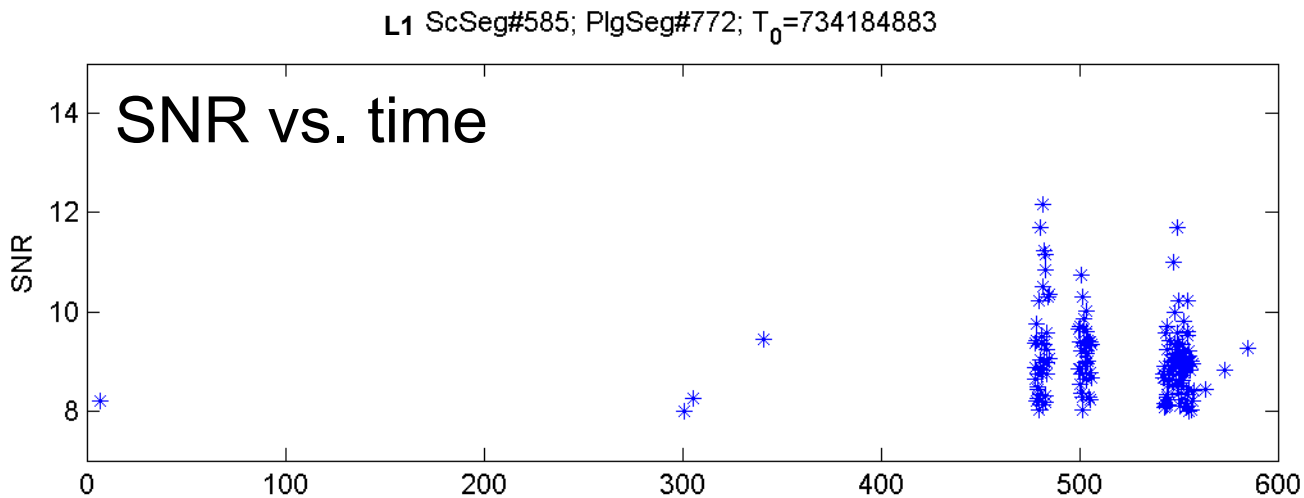
Unfortunately, most of the H2 playground events do *not* seem to correlate with POB_I

Inspiral Trigger Rates, Segment by Segment

In segments with high rates, sometimes triggers are spread out…



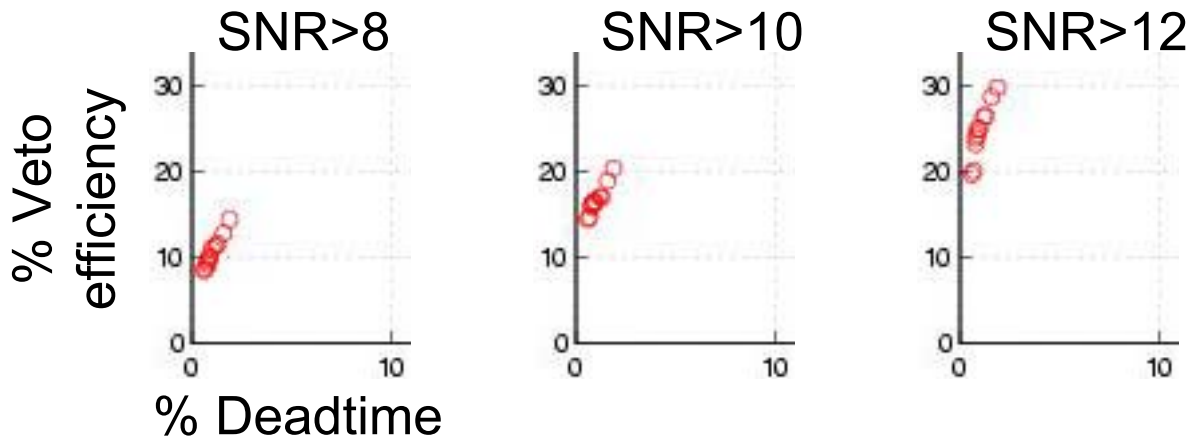
…and sometimes they form "stripes"



Veto Efficiency vs. Deadtime for Various Prospective Vetoes

For a given veto channel, filter, and veto trigger threshold, calculate veto efficiency and deadtime for various "windows", and for different sets of inspiral triggers

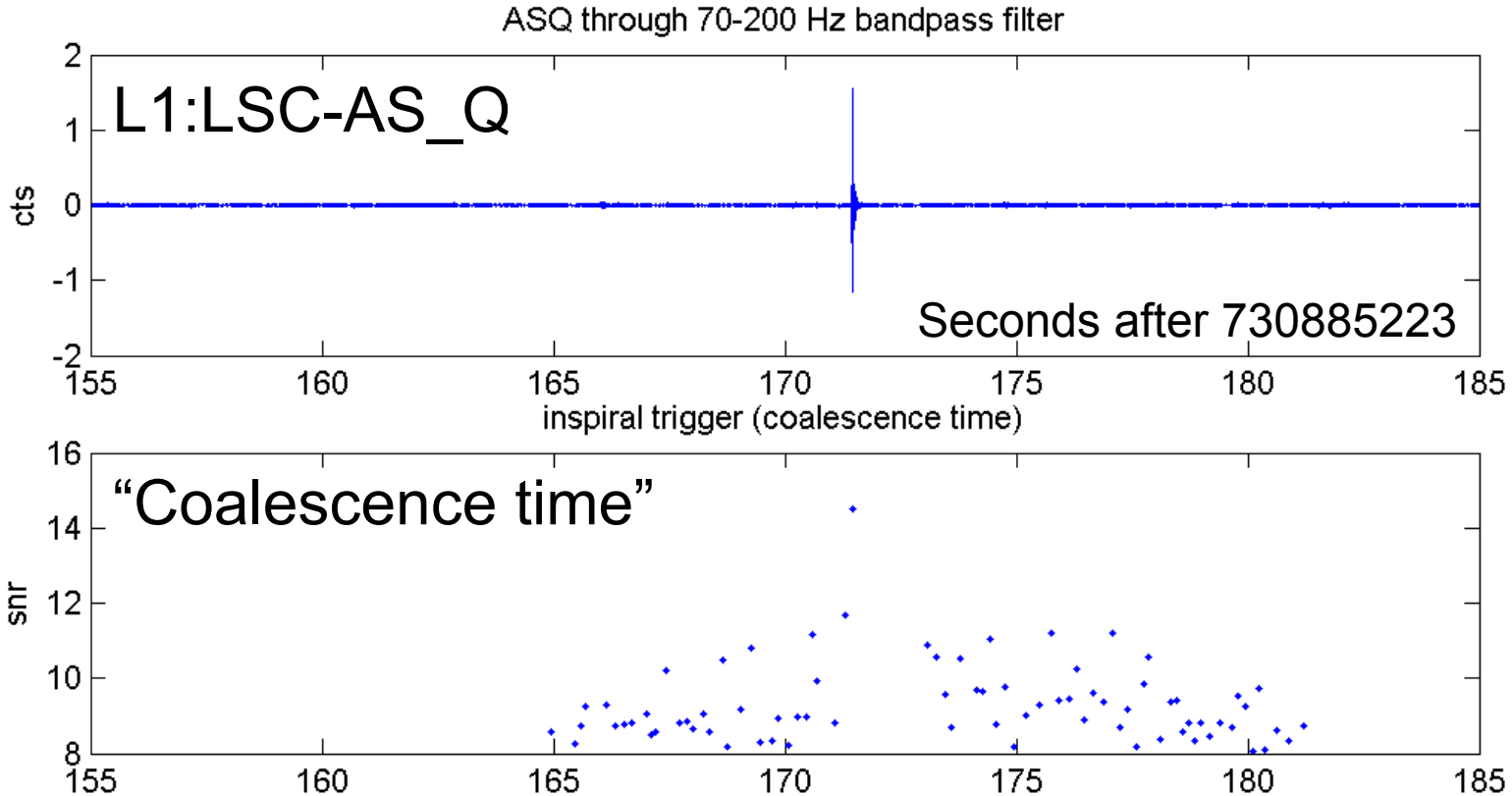
Example: L1:LSC-POB_I with Chebyshev 70-Hz high-pass filter, threshold = 6σ, windows from 0 to ±1 second
(also require live intervals to be at least 4 seconds long)



Note: AS_DC is not nearly as good a veto for inspiral as for burst

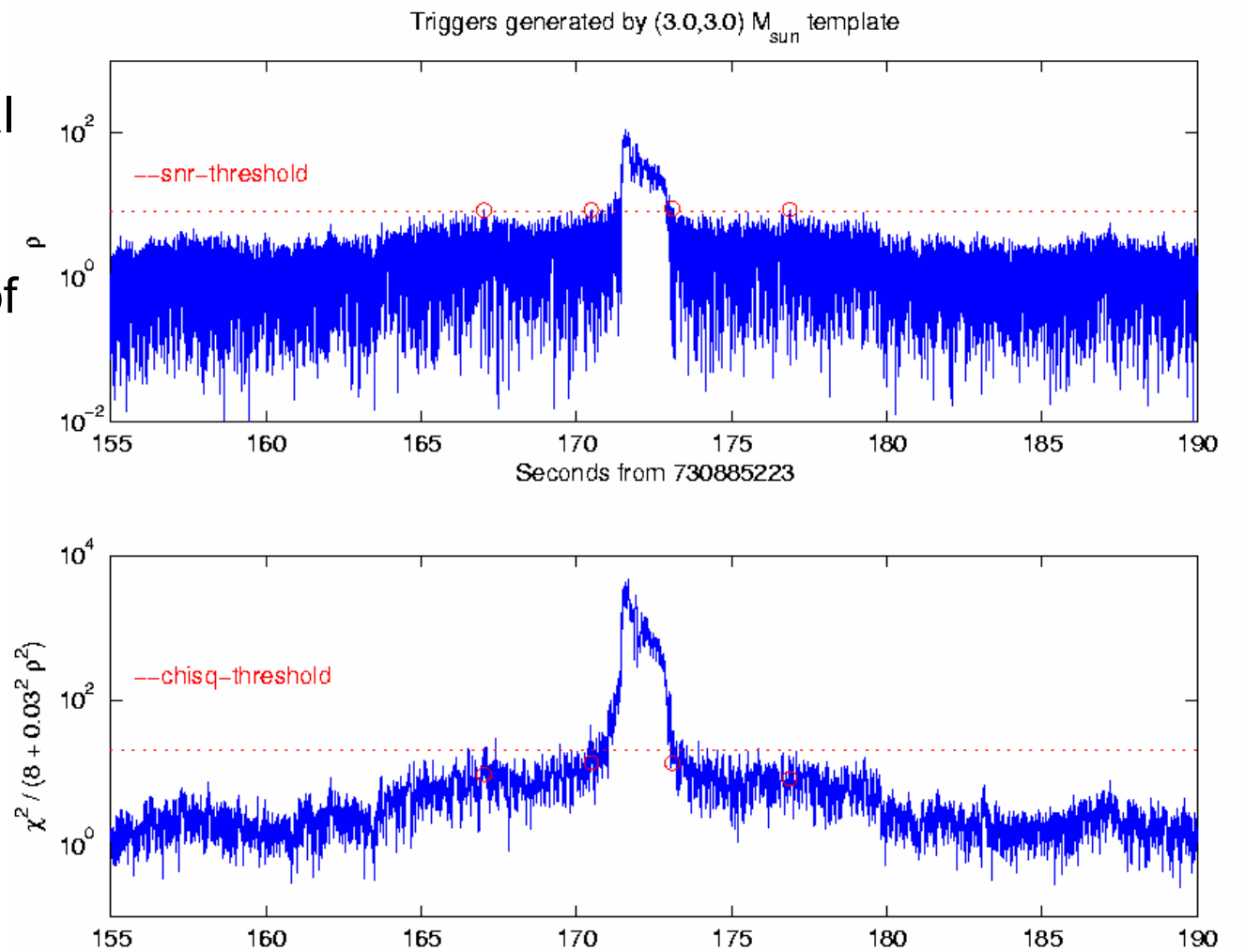
Timing Issues

A glitch can yield a calculated inspiral coalescence time far from the time of the glitch



Timing Issues

"Inaccurate" inspiral coalescence times are understood to arise from ringing of the template filter, combined with the χ^2 threshold



Exploring Wider Windows

Same case as before: L1:LSC-POB_I with Chebyshev 70-Hz high-pass filter, threshold = 6σ

		SNR>8		SNR>10		SNR>12	
Window	Dead%	effic	used	effic	used	effic	used
-1,+1	1.9	14.4	7.5	20.4	1.8	29.8	0.7
-2,+2	2.8	18.2	9.1	23.4	2.3	30.2	0.8
-2,+4	3.7	23.8	11.4	29.9	2.6	33.5	0.9
-4,+4	4.4	24.4	12.8	32.3	3.1	38.0	1.1
-4,+6	5.2	25.1	14.6	35.4	3.5	45.5	1.2
-4,+8	5.9	26.8	15.9	40.5	3.6	56.3	1.2
-8,+8	7.2	30.6	17.5	43.6	4.1	57.9	1.4
-8,+12	8.4	31.0	19.6	45.1	4.8	59.4	1.4

Can achieve rather high veto efficiencies, but deadtime is somewhat higher than we are comfortable with

Some segments have very high deadtime, but few/no inspiral triggers

Exploring Higher Veto Trigger Thresholds

For various target deadtimes:

					SNR>8		SNR>10		SNR>12	
Channel	Filt	Th	Window	Dead%	eff	used	eff	used	eff	used
MICH_CTRL	100	30	-8,+8	0.5	9.5	23.3	26.3	9.3	52.3	4.7
POB_I	70	10	-.5,.5	0.5	5.1	13.2	8.7	4.2	19.5	1.4
MICH_CTRL	100	25	-8,+12	1.0	11.6	23.9	27.7	6.8	53.6	2.3
POB_I	70	9	-2,+2	1.0	13.8	17.3	20.0	5.1	29.9	1.5
AS_DC	10	6	-.5,.5	1.9	7.0	2.3	6.7	0.2	2.7	0.1
AS_DC	no	6	-.5,.5	2.5	7.8	3.9	10.7	0.3	6.3	0.0
MICH_CTRL	100	11	-1,+1	1.9	14.1	6.2	31.4	1.3	38.3	0.5
POB_I	70	6	-1,+1	1.9	14.4	7.5	20.4	1.8	29.8	0.7
POB_I	70	9	-4,+8	1.7	17.0	23.5	30.7	8.1	51.9	1.5
AS_DC	10	6	-2,+2	5.3	11.4	4.8	10.9	0.3	3.7	0.1
AS_DC	no	6	-1,+1	4.3	8.4	5.1	11.1	0.4	6.3	0.0
MICH_CTRL	100	11	-4,+4	5.3	23.1	10.5	40.3	2.0	46.6	0.7
POB_I	70	6	-4,+6	5.2	25.1	14.6	35.4	3.5	45.5	1.2

Physical Mechanisms

Many of the L1 triggers, and much of the POB_I variability which leads to excess deadtime, seem to have significant frequency content near 70 Hz

Physical mechanisms for this:

PRC loop (for which POB_I is the error signal) has known instability at 70 Hz when gain is too high

When gain of DARM loop goes too low (due to low optical gain), get glitches at 70 Hz

The inspiral filter code used a low-frequency cutoff of 70 Hz

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Summary

Some promising veto conditions for L1

We have not yet decided on the “optimal” choice

No good candidates for H1 or H2

In H2, POB_I correlates sometimes, but unimpressive overall

Plan to re-filter data with a higher low-frequency cutoff

Hope to make inspiral event rate lower and more stable

Will then revisit vetoes